



Report for Ofcom

Digital Comms Value Chains



14 April 2022



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Granular view of the value chain

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Analysys Mason undertook wide-ranging research into the Digital Communications Value Chain for Ofcom

Purpose of the work

- Analysys Mason was commissioned to undertake research into the Digital Communications Value Chain
- The aim of the work is to inform Ofcom's thinking and activity in digital communications markets

Structure of this report

This report is structured according to the multi-stage process used to progress the research:

- A high level value chain map
- A granular view of all value chain activities
- One-pager assessments of selected markets
- Strategic commercial analysis



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We have defined a small number of key types of roles in the digital communications value chain

Summary of key types of roles in the digital communications value chain

Role	Who chooses to use the service	Nature of choice	Notes
Demand-side gateways	End user	Necessary (to consume a particular service)	We define gateways as <u>necessary</u> conduits to deliver a service that is chosen and controlled by the end user. Gateways can be two-sided (e.g., app stores), or one-sided (e.g., devices, browsers and ISPs). Gateways are <u>functional</u> bottlenecks from the perspective of a firm seeking to provide a service to the end user, and often stem from a lack of multi-homing by the user
Demand-driven enablers (DDE)	End user	Optional	DDEs are also chosen by the end-user and are ancillary / <u>not strictly necessary</u> to the service provision. This includes search, discovery and some forms of content aggregation and recommendations.
Suppliers	Competing service provider	Necessary	Inputs from suppliers are defined as those inputs that are chosen by the service provider and are <u>integral</u> to the provision of the service. Enablers and gateways also provide inputs, but these are either determined by the end user rather than the supplier or are ancillary rather than integral to the service being provided (see next).
Supply-driven enablers (SDE)	Competing service provider	Optional	Inputs from SDEs are <u>not strictly</u> part of the final product, but create benefits for the service provider (wider addressable market, better sales conversion, higher-quality product). This category includes, for example, integrated payment platforms (alternative to bank transfers), supply-side platforms for digital advertising (alternative to direct sales / sponsorships)

Notes:

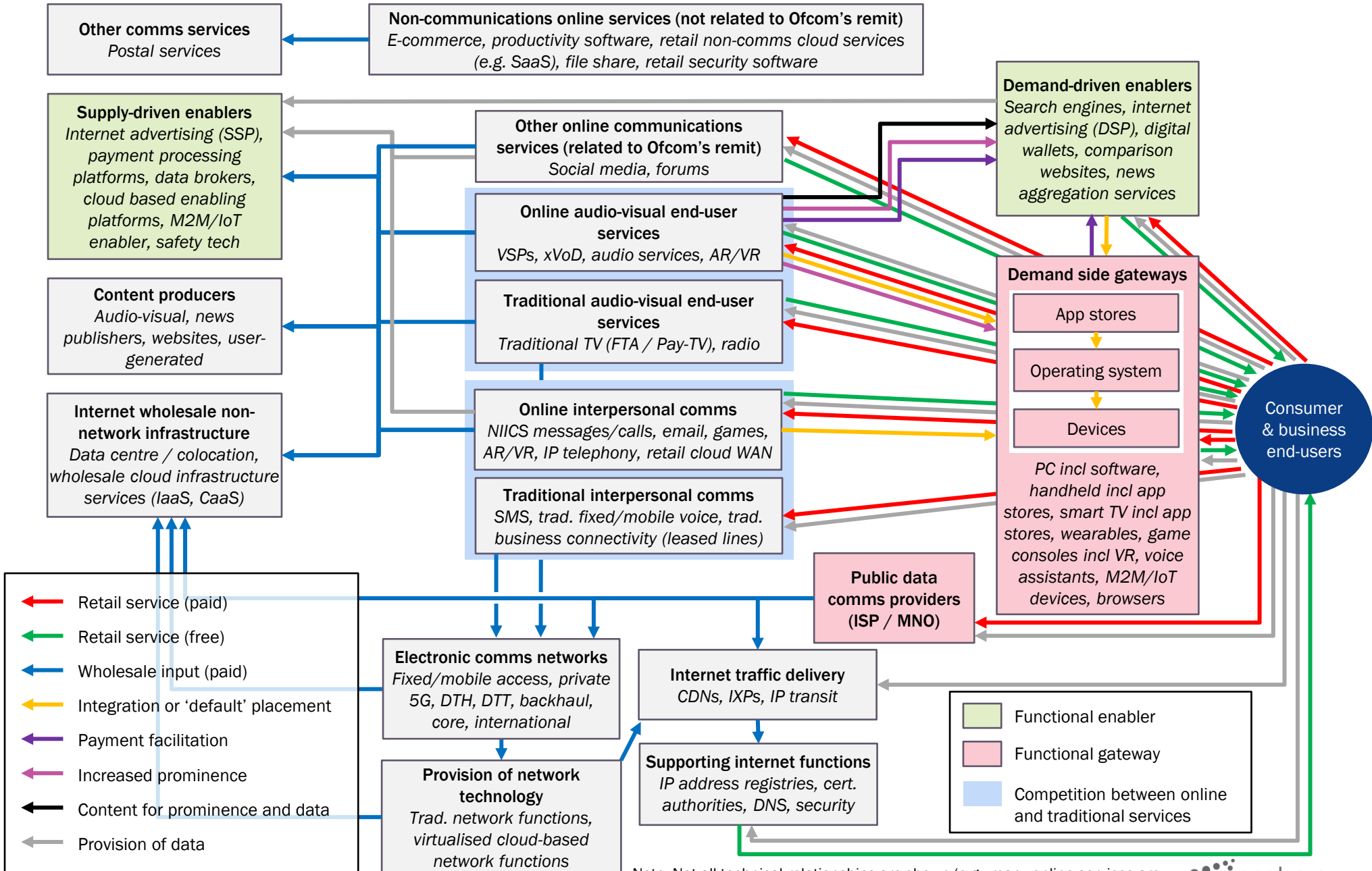
- End user = consumers or businesses that use services at the retail level
- Service provider = provider of one of the 'competing services' in a horizontal market
- The Furman Review uses the terms 'gateway' extensively, although there is not a single unified definition in the report. The term encapsulates the ability of a firm to mediate the relationship between services and users (not necessarily through a two-sided market)
 - the Furman Review associates the term gateway with various forms of control and market power – we have elected to use the term gateway here to reflect a functional bottleneck (from the perspective of a service provider in a given horizontal market), although gateways can lead to control and market power.

On the following slide we present a high level view of the communications value chain, which captures competition, commercial relationships and intermediaries

Notes on the high-level view:

- The picture presents a unified view of the communications value chain, that tells a commercial story, building on an understanding of how technical inputs feed into the commercial relationships
- We classify enablers and gateways from a functional point of view – the nature of inputs, enablers and gateways informs the more detailed analysis later in this report
- The high-level categories of value chain activities (the text in bold) are used across the high-level view and the detailed list of markets (see next section)

High-level value chain map



Note: Not all technical relationships are shown (e.g., many online services are delivered over internet and comms infrastructure without a commercial relationship)

While it is impossible to capture everything on a single page, the high level map provides a useful foundation for further analysis

The high-level value chain map shows:

- A sensible, manageable and comprehensive split of activities in the value chain (which is used to structure the granular view in the next section)
- The dependencies and bottlenecks of Ofcom's regulated services on other sectors, and in particular highlights gatekeepers and enablers (which supports an analysis of 1- and 2-sided markets)
- The competition between traditional and online services, and the complex and multiple types of commercial relationships introduced by online services (this is shown in particular for AV services)
- The complex and numerous relationships with the end user (which supports a discussion of how online players can capture a greater share of these relationships)
- Synergies and incentives for vertical integration, e.g.:
 - many of the wholesale paid inputs can be (and are) replaced by vertical integration within large companies
 - DDEs can and do strike agreements (through commercial relationships) with gateways, to make themselves less avoidable (e.g. Google as default search on iOS, or Netflix having a button on TV remotes, or pre-installed apps on mobile devices). This points to synergies from vertical integration between DDE and Gateways (e.g. Google providing search and Android OS, or the Chrome browser)

There are other dynamics that may not be possible to capture on a single page (but which are considered in the wider research):

- The map does not capture all the nuances around data flows, including the nature of data, the ability to process the data and the purpose of processing the data
- Gateways sometimes mediate flows of information and value and sometimes don't
- There may be bundling of communications services with services outside the main markets in the scope of work
- Wholesale input flows can be for a range of objectives (e.g. direct inputs, increased efficiency) and the map does not segment the types of wholesale inputs (including showing wholesale relationships which are not contractual)



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We provide a comprehensive mapping of the activities in the communications value chain

- In the following slides, we present our comprehensive mapping of the activities in the communications value chain
 - in total we present 62 activities potentially in scope for further analysis
- We have grouped the activities under a smaller number of categories, which are aligned to the high level map and are summarised in the table on the right
- The categories are informed by the following criteria:
 - a focus on traditional and online end-user comms services
 - including online end-user services that may not be communications but may be in Ofcom's remit
 - including activities which support these services (whether communications related or not)
 - for illustration, we mention some activities which are not in scope for further analysis
- For each activity, we provide:
 - name of activity
 - definition (including trends/dynamics where necessary)
 - examples of key players/offerings

Summary of communications value chain categories

Value chain activity categories	Activity count
Online audio-visual end-user services	6
Traditional audio-visual end-user services	2
Online interpersonal comms	7
Traditional interpersonal comms	4
Other online communications services (related to Ofcom's remit)	2
Internet service providers	1
Internet traffic delivery	3
Supporting internet functions	5
Electronic communication networks	9
Provision of network technology	2
Internet wholesale non-network infrastructure	2
Content producers	4
Supply driven enablers	6
Demand driven enablers	5
Demand side gateways	8
Sub-total of activities potentially in scope for analysis	66
Non-communications online services (not related to Ofcom's remit, non-exhaustive)	6
Other communications services	1

End-user audio-visual services can be split into two broad categories where online services are increasingly replacing traditional ones

Activity	Definition	Example Players
<i>Online audio-visual end-user services</i>		
Video-sharing (open) platforms	<ul style="list-style-type: none"> Video-sharing platforms where content can be created by end-users (generally free to access, though with premium options) 	YouTube, Vimeo, DailyMotion, Facebook
Subscription Video on Demand (VoD)	<ul style="list-style-type: none"> Subscription (usually monthly)-based VoD where content is curated by the service provider 	Netflix, Amazon Prime, NowTV, AppleTV+
Free VoD	<ul style="list-style-type: none"> VoD services that are free to the end user: often ad-funded, though BBC funding via license fee is a special case 	iPlayer, All4, Roku Channel, My5
Transactional VoD	<ul style="list-style-type: none"> One-off fees paid for purchasing or renting content 	Apple iTunes, Amazon Video, Sky Store, Google Play Movies
Audio services (podcasts, audio books)	<ul style="list-style-type: none"> Audio-only services including podcasts and audiobooks Includes both free (usually with ads and paid-for services) 	Audible, Spotify, Apple Podcasts, Google Podcasts
Holographics, AR, VR	<ul style="list-style-type: none"> Computer-generated simulations that reflects real-life (holographics), includes some aspects of real-life (AR) or is separate to real-life completely (VR) Only 'passive' services are considered here, when it's a substitute for audio-visual 	Apple Clips, Ikea Place, Google Street View, Roblox
<i>Traditional audio-visual end-user services</i>		
Traditional TV broadcast services (e.g., FTA, Pay-TV)	<ul style="list-style-type: none"> Providing broadcast TV content incl. both free-to-air and Pay-TV 	BBC, Sky, ITV, Channel Four
Traditional radio broadcast services	<ul style="list-style-type: none"> Providing broadcast Radio content incl. both free-to-air and Pay-TV 	BBC, Times Radio, Virgin Radio, Classic FM

Similarly, communications services can also be split into online and traditional

Activity	Definition	Example Players
<i>Online interpersonal communications</i>		
Number independent interpersonal communications serviced (NIICS) messages	<ul style="list-style-type: none"> Calls and text messages delivered over the Internet Calls can be voice or video Allows one-to-one and one-to-many communications 	WhatsApp, Skype, iMessage, Facebook Messenger, MS Teams, Slack
NIICS calling	<ul style="list-style-type: none"> Services are typically application or device-type specific, though with some interoperability functions 	WhatsApp, Skype, Facetime, Facebook Messenger
Email	<ul style="list-style-type: none"> Electronic mails send from a PC or mobile device client Largely interoperable (can send emails between email providers) 	Gmail, Hotmail, Microsoft Outlook, Yahoo! Mail
Online games	<ul style="list-style-type: none"> Some online games provide communications tools that mirror other communication methods (e.g. text and voice communications) 	Roblox, Fortnite, Minecraft, online sports games
Holographics, AR, VR	<ul style="list-style-type: none"> Computer-generated simulations that reflects real-life (holographics), includes some aspects of real-life (AR) or is separate to real-life completely (VR) Only 'interactive' services are considered here, when it's a substitute for person-to-person communications 	Mesh (Microsoft), The Wild, Meta (Horizon Workrooms, Breakroom), Roblox
Retail cloud-based wide areas networks	<ul style="list-style-type: none"> Wide area multi-site communications networking solutions delivered over the cloud, and often bundled with other functions (e.g. file management, one to many broadcast meetings) 	MS Teams/SharePoint, Oracle, Slack
IP business telephony	<ul style="list-style-type: none"> IP alternative to multi-line business phone services, initially provided 'on-prem' but migrated to 'off prem' which allowed cloud based provision and value added services (e.g. unified comms and omni-channel) 	Vonage, Nextiva, Matrix247, Emarsys
<i>Traditional interpersonal communications</i>		
SMS messaging	<ul style="list-style-type: none"> Messaging service that uses the SMS communication protocols and is usually embedded in mobile devices 	EE, Three, Vodafone, O2
Traditional fixed voice telephony	<ul style="list-style-type: none"> Traditional fixed voice services, using the Public Switched Telephone Network (PSTN) (analogue) or Voice over IP (VoIP) (digital) protocols 	BT, Sky, Virgin Media, TalkTalk
Traditional mobile voice telephony	<ul style="list-style-type: none"> Traditional mobile voice services, using either circuit switched or packet switched (e.g. VoLTE) technology 	EE, Three, Vodafone, O2
Traditional business connectivity (e.g. leased lines)	<ul style="list-style-type: none"> Private links to provide telecoms services between business sites 	BT, Colt, Virgin Media, TalkTalk

Some other internet-native activities are relevant to Ofcom's remit, including those with links to comms, media plurality and online harms

Activity	Definition	Example Players
<i>Other online communications services (related to Ofcom's remit)</i>		
Social media	<ul style="list-style-type: none"> Online interaction platforms where users can update status, share content, and engage in forum-style discussions 	Instagram, Facebook, Twitter, LinkedIn
Forums	<ul style="list-style-type: none"> Online platforms to exchange ideas with less emphasis on building online profiles than social media platforms Direct messaging functions make these services like OTT messaging 	Quora, Reddit, Tumblr, Stack Overflow
<i>Non-communications online services (not related to Ofcom's remit, non-exhaustive)</i>		
E-commerce (e.g. online shopping)	<ul style="list-style-type: none"> Activity of buying goods and services over the Internet, rather than from physical shops 	Amazon, Asos, Currys, Tesco
Productivity suites for verticals (e.g. Teams, Slack, e-government)	<ul style="list-style-type: none"> Platforms that serve specific groups/purposes/industries, such as workspace collaboration, virtual classroom 	Teams, Slack, Google Classroom
Productivity software (e.g. Google Sheets, Microsoft 365 etc.)	<ul style="list-style-type: none"> Software that is used to produce and engage in information, usually for a specific purpose 	Google Sheets, Excel, Word, Google Calendar
Other retail non-communications cloud services	<ul style="list-style-type: none"> On-demand computing services for end-users such as data storage and CRM 	iCloud, Google Cloud, Dropbox, Salesforce
P2P and file share	<ul style="list-style-type: none"> Software that is designed to distribute and share files, usually peer-to-peer 	BearShare, LimeWire, BitTorrent, Vuze
Retail security software	<ul style="list-style-type: none"> Software that protects end-users from online threats, such as viruses and ransomware 	McAfee, Norton, Avast, Kaspersky
<i>Other communications services</i>		
Postal services	<ul style="list-style-type: none"> Physical fulfilment of items between consumers and businesses 	Royal Mail, UKMail, DPD, Evri, DHL

End-users cannot access the internet without an ISP, and these are in turn supported by various types of infrastructure and services

Activity	Definition	Example Players
<i>Internet service providers</i>		
Public data comms providers (ISP / MNO)	Retail providers of access to internet connectivity (fixed and mobile) to end users	BT, Virgin, Three, O2, Sky
<i>Internet traffic delivery</i>		
Caching services and Internet content delivery network (CDN)	Web pages and Internet content is served locally through geographically distributed servers (caches), usually closer to the end-users to have quicker access to data and retain sufficient bandwidth on the main network	Akamai, Fastly, Microsoft Azure, AmazonCloud, Cloudflare
Internet exchange providers (IXPs)	Providers of physical space where different networks (ISPs, CDNs, service providers) exchange traffic	LINX (non-profit), NetIX-LON, Equinix, LIPEX
IP transit providers	Providers of paid connectivity to the global internet (as an alternative to a peering arrangement, which is usually free)	Level3, Cogent, Global Telecom and Technology (GTT), Telia Carrier
<i>Supporting internet functions</i>		
IP address registries	<ul style="list-style-type: none"> Includes Internet Corporation for Assigned Names and Numbers (ICANN) and Regional Internet Registries (RIRs) ICANN is responsible for managing and coordinating several databases of namespaces and numerical spaces of the Internet at a global scale (incl. central repository of IP addresses) There are five RIRs which manage such namespaces and numerical spaces for a region of the world 	Internet Corporation for Assigned Names and Numbers (ICANN), RIPE NCC, LACNIC, APNIC
Certificate authorities and registrars	<ul style="list-style-type: none"> Certificate authorities issue digital certificates, including those for HTTPS, the secure browsing protocol for the World Wide Web Registrars manage Internet domain names and need to be accredited by higher-level registries 	Comodo, Digicert, GlobalSign, GoDaddy
Domain Name System (DNS) host	DNS is a decentralised naming system (through servers) that translate between IP addresses and website names. DNS servers are run by DNS hosts	Microsoft Azure, Google Public DNS, Oracle, Cloudflare
DNS registrar	DNS registrars manage the initial purchase and registration of domains, and interact with the IP address registries	Domain.com, Bluehost, Hostgator, GoDaddy, Network Solutions
Wholesale security services	Security services provided to online services on a wholesale basis, including protection against distributed denial of service (DDoS) and threat intelligence platforms	Cloudflare, Fastly, Akamai, Ukfast, Palo Alto, Anomali

Traditional communications and AV services are delivered over electronic communications networks, and these are now being used to deliver online services

Activity	Definition	Example Players
<i>Electronic communication networks</i>		
Fixed access networks	<ul style="list-style-type: none"> Part of the fixed network that connects subscribers to the backhaul and core network of the service providers 	BT, Virgin Media, Cityfibre, Gigaclear
Mobile access networks	<ul style="list-style-type: none"> Part of the mobile network that connects subscribers to the backhaul and core network of the service providers 	CTIL, MBNL
Private 5G networks	<ul style="list-style-type: none"> Provision of 'out of the box' private wireless network, with access hardware and core functionality provided by cloud provider 	AWS Private 5G
DTH TV satellite networks	<ul style="list-style-type: none"> Satellite networks that directly transmit broadcast TV channels to end-users' home 	Freesat, Sky
DTH broadband satellite networks including GEO and LEO/MEO	<ul style="list-style-type: none"> Satellite networks that offer 2-way broadband connectivity to end-users' homes Includes well established Geostationary (GEO) satellites, and newer constellations of Low- and Medium-Earth Orbit (LEO and MEO) satellites 	Eutelsat, Avanti, Starlink, OneWeb
Terrestrial DTT broadcast	<ul style="list-style-type: none"> Network of terrestrial broadcast towers used to deliver freeview content 	Arqiva
Backhaul connectivity	<ul style="list-style-type: none"> Part of the network that connects access to the core 	Openreach, CityFibre, Colt, Gigaclear
Core networks	<ul style="list-style-type: none"> Centralised functions within a telecoms network that include high-capacity routing, traffic management and interconnection 	BT, Virgin Media, Sky
International data connections (e.g. undersea cables)	<ul style="list-style-type: none"> International networks designed to carry telecoms signals over a long distance, i.e. undersea cables 	Apollo, EXA, Amitie, AEConnect-1
<i>Provision of network technology</i>		
Traditional network functions	<ul style="list-style-type: none"> Providers of traditional network products and services to communication service providers, including core and access functions 	Ericsson, Nokia, Huawei, Cisco
Virtualised cloud-based network functions	<ul style="list-style-type: none"> Providers of new virtualised cloud-based network functions, including core and edge functionality 	Amazon, Cisco, Google, Nokia, Ericsson

Internet wholesale non-network infrastructure activities are also relevant for inclusion in the scope of work; we mention content providers for completeness

Activity	Definition	Example Players
<i>Internet wholesale non-network infrastructure</i>		
Data centres and colocation	<ul style="list-style-type: none"> Provision of space, power and server appliances for storing and running web-based content and applications 	Equinix, Amazon Web Services, DigitalOcean, UpCloud
Wholesale cloud infrastructure services (IaaS, CaaS)	<ul style="list-style-type: none"> Provision of server hardware to run cloud-based applications and services (Infrastructure as a Service, IaaS), and provision of engine to 'containerise' applications to run on IaaS (Containerisation as a Service, CaaS) 	Microsoft, Google, DigitalOcean, UpCloud, Dell, Amazon
<i>Content producers</i>		
Audio-visual content	<ul style="list-style-type: none"> Professional content produced for traditional broadcast services and video streaming 	BBC Studios, Netflix, Amazon Studios, All3Media
News publisher content	<ul style="list-style-type: none"> Published content reflecting news 	Daily Mail, Metro, The Times, Telegraph; Guardian
Website content	<ul style="list-style-type: none"> Professional content on any website on World Wide Web 	Amazon, Wikipedia, Tesco, BBC
User-generated content	<ul style="list-style-type: none"> Content generated by users incl. audio-visual, text, status etc. 	YouTube, Twitter, Instagram, Twitch

Enablers can be split between supply-driven and demand-driven (which are directly interfacing with end-users)

Activity	Definition	Example Players
<i>Supply-driven enablers</i>		
Internet advertising, supply-side platforms (SSP)	<ul style="list-style-type: none"> Marketing tools that help manage supply-side advertising inventory over the Internet 	SpotX, Google Ad Manager, Magnite, Amazon Publisher Services
Payment processing platforms	<ul style="list-style-type: none"> Platforms connecting merchants with multiple service payment providers through a single channel 	Stripe, Apple Pay, Amazon Pay, PayPal
Data-brokers	<ul style="list-style-type: none"> Platforms that aggregate end-user data from multiple sources 	Verisk, Acxiom, Oracle, Epsilon, Experian
Cloud based enabling platforms	<ul style="list-style-type: none"> Provision of cloud-based analytics and computer services (e.g. playout) 	Google Cloud, Microsoft Azure, Amazon Web Services
M2M/IoT enabler	<ul style="list-style-type: none"> Intermediary in the M2M/IoT value chain, providing enabling capabilities (such as application enablement or device management) 	Activity, Emnify, Ericsson, Mavoco, Nexign, Nokia, NTELS
Safety technology	<ul style="list-style-type: none"> Various services and applications covering harm detection, moderation, age verification and assurance 	Yoti, Jumio, TrustElevate, Crisp, SuperAwesome, DragonflyAI, Qumodo
<i>Demand-driven enablers</i>		
Search engines	<ul style="list-style-type: none"> Software / applications that search for words input by the end-user, and return websites that relates with such words 	Google, Microsoft Bing, Yahoo!, Yandex
Internet advertising, demand-side platforms (DSP)	<ul style="list-style-type: none"> Marketing tool that aids advertisers to manage and find advertising inventory over the Internet 	Google DV360, Amobee, Roku, Samsung Ads
Digital wallets	<ul style="list-style-type: none"> Online payment systems that connect with bank accounts and aggregate payment information 	Apple Pay, Google Pay, PayPal, Samsung Pay
Comparison websites	<ul style="list-style-type: none"> Comparison websites acts as search tools where potential shoppers can review and compare offerings based on price, features and performance reviews 	GoCompare, Compare the Market, Which, Confused
News aggregation services	<ul style="list-style-type: none"> Aggregators of news content from news websites 	Apple News and Apple News+, Google News, Flipboard, Pocket

Devices and their associated software act as demand-side gateways which are required by end-users to access services

Activity	Definition	Example Players
<i>Demand-side gateways</i>		
PC devices, including installed software	<ul style="list-style-type: none"> Personal computers which are either fixed (desktop) or portable (laptop) 	Lenovo, HP, Dell, Apple
Handheld devices and smart phones, including operating systems and app store ecosystems	<ul style="list-style-type: none"> Handheld devices such as smartphones, tablets; where some are installed with systems such as eSIM, app stores (incl. 3rd party) and operating systems 	Apple, Samsung, LG, ZTE, GetJar
Smart TV devices and streaming devices (sticks, boxes)	<ul style="list-style-type: none"> TV devices that that can be connected to the Internet and have installed app stores Devices such as boxes and sticks that can be attached to TVs to provide content and application aggregation 	Samsung, LG, Sky Glass, Amazon Fire TV stick, Apple TV 4K, Chromecast
Wearables	<ul style="list-style-type: none"> Electronic devices that can be worn as accessories such as smart watches 	Apple Watch, Samsung Gear products, Google (Fitbit)
Game consoles, including VR	<ul style="list-style-type: none"> Devices that output game interfaces, usually with additional controllers 	Microsoft Xbox, Sony PlayStation, Nintendo Wii, Meta Oculus
Smart home and voice assistant devices	<ul style="list-style-type: none"> Smart home devices and appliances can be controlled remotely over an Internet connection Voice assistant devices can receive audio inputs, compute replies and output these replies 	Google, Microsoft, Amazon, Apple
M2M/IoT devices	<ul style="list-style-type: none"> Hardware devices continuously connected to the Internet 	Bosch, IBM, Vodafone
Browsers	<ul style="list-style-type: none"> Services and applications that allow connection to World Wide Web (websites) 	Google Chrome, Mozilla Firefox, Apple Safari, Microsoft Edge



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Demand-side gateways

Strategic commercial analysis

Introduction

- In the following section we present a high-level assessment of selected activities in the digital communications value chain
- This part of the assessment includes a structured 'one-pager' for each activity

We have used a consistent format for each one-pager to capture a range of market dynamics

Summary of key market dynamics included on 'one-pager' summaries

Category	Market dynamic	Notes
Summary characteristics	Main business model	Summarise how that activity makes money (or its other purpose where relevant, e.g. create data, drive loyalty), confirm free vs paid services
	Approx. market size	Indication of market size, either in financial terms or volume terms, on a global basis, dependent on readily available data
	Market maturity	High/Medium/Low assessment of demand, technology, business model (may not be sensible to separate these)
	Key market players	Exhaustive list (as far as reasonably possible) of key players, and comment on concentration/dominance
Power balance between stakeholders	Ability to exert control in the value chain	Activity is a gateway, enabler and/or 2-sided market
	Nature of relationship with end-users	Paid vs free, access to data, bundling, scope to gain new relationships, risk of disintermediation, importance of wholesale relationships, ability to exert control
	Nature of wholesale relationships	Purpose of wholesale relationship, contractual vs. non-contractual, spectrum on the contractual means (arms length, partnership, co-channel, vert. integration)
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Data visible/obtainable by the activity, importance to competitive advantage, source (1 st or 3 rd party), internal use (e.g. by Netflix) vs external use (e.g. by Google for placing ads on 3 rd party websites), use within market or cross market (i.e. collect data in one market and use in another)
	Role of networks effects	Importance of network effects, and where these are offset by multi-homing and interoperability
	Role of scale and scope economies	Importance of scale, presence of Hyperscalers/players with presence across the value chain, vertical integration, advantage from dominance in other markets
	Role of other differentiators	Importance of other factors, such as proprietary algorithms (i.e. IP or expertise), exclusive access to content, brand
Other	Role in disruption/substitution	Either disrupting, or being disrupted by other activities
	Role of regulation	Commercial impact of regulation, either within an activity or between activities

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Video-sharing (open) platforms

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	VSPs allow any end-users (including consumers and businesses) to upload videos. VSPs primarily make money through internet advertising and are usually free to end-users (though paid/subscription-based ad-free services are available, e.g. YouTube premium)
	Approx. market size	Global YouTube ads revenues of USD19.772 billion in 2020 (we note that this will only be a portion of the total VSP market)
	Market maturity	Medium - demand, technology and business model is well established (e.g. for websites such as YouTube), but the market continues to develop (e.g. rise of TikTok)
	Key market players	YouTube, Vimeo, DailyMotion, Flickr, Facebook, Instagram, TikTok, Twitter, Twitch
Power balance between stakeholders	Ability to exert control in the value chain	VSPs are intermediary platforms, typically creating a two-sided market between advertisers and end-users; potential to exert control on the value chain (and become gateways) if sufficient market share is reached, though this is offset by high competitive intensity and market entry; some platforms (YouTube, FB/Insta) may be seen as 'must be on' by business users
	Nature of relationship with end-users	Direct, primarily free, relationship with end-users with the purpose of collecting data about end-user viewing behaviour and monetising the platforms through advertising
	Nature of wholesale relationships	Contractual relationships with end-user uploaded content (in terms of payment for certain views etc.), these are arms' length as most VSPs do not create content themselves
Competitive advantage, profit drivers and potential barriers to entry	Role of data	End-user choice and usage statistics are collected by VSPs, which helps them tailor video content suggestions. This improves recommendations to achieve specific business objectives (which could be distinct from end-user interest or quality – e.g. engagement, stickiness), as well as provide more targeted ads and improve monetisation; access to this end-user data provides a significant competitive advantage
	Role of network effects	Network effects are significant as increases in both viewers and creators of content reinforce each other and drive up the value of the platform; multi-homing can be applied, however end-users may stick with one service (e.g. YouTube)
	Role of scale and scope economies	Scale provides a significant advantage with the ability to reach more viewers and content creators (both consumers who will upload videos, and professional content producers); YouTube (Google) is the best known example with Google having various other products across the value chain, e.g. economies of scope between YouTube, Search and ad SSPs, as well as CDN (Google Global Cache)
	Role of other differentiators	Recommendation and tailoring algorithms are key pieces of Intellectual Property (IP) to keep viewers engaged and maintain attention
Other	Role in disruption/substitution	Disrupting traditional broadcast services and associated advertising revenues, and to some extent disrupting Video on Demand (VoD) streaming services as end-user content becomes more professional.
	Role of regulation	VSPs are subject to the AVMSD, transposed as the Audio Visual Media Services Regulation of 2020 in the UK. This requires platforms to police their content which creates additional compliance cost, from human moderators and/or advanced Artificial Intelligence (AI) algorithms to detect harmful content. Platforms play a role in policing advertising and sponsorship (e.g. hidden ads, age appropriateness of ads, brand safety). Management of IP infringement through notice and takedown, combined with monetisation tool (YouTube content ID) create a different set of incentives / dynamics than in traditional media

Video on demand (VoD) services

Summary of activity

Category.	Market dynamic	Notes
Summary characteristics	Main business model	Provision of on-demand video streaming services, whereby the content is professionally curated, rather than being user-generated. Subscription VoD (SVoD) and Transaction VoD (TVoD) are monetised via fixed payments (recurring and one-off respectively) from the end user; free VoD makes money usually through advertising, similar to VSPs; BBC iPlayer is funded via the license fee; there are hybrid models where end-user can pay to see less or no advertising. TVoD may include revenue sharing (based on actual viewing).
	Approx. market size	UK: GBP4.5bn for SVoD and TVoD (2021) ¹
	Market maturity	The business model is maturing, with some well established platforms, but market entry by large players (Apple TV+, Disney+, Peacock)
	Key market players	Netflix, Amazon Prime & Video, NowTV, iPlayer, All4, Roku, Sky Go & Store, Google Play Movies, Mubi, Disney+, Apple TV+, Paramount+
Power balance between stakeholders	Ability to exert control in the value chain	Competition between large number of players suggests limited control can be exerted, though sometimes competition is limited due to exclusive content (e.g. Marvel movies) and there are significant scale effects (see below). Some platforms offer nesting/aggregation on behalf of third party providers (e.g. Amazon Prime Channels)
	Nature of relationship with end-users	Direct relationship with end users, either paid-for or registered, allowing the services to collect a significant amount of data about end-users' choices, which can be used to tailor content product, acquisition and recommendation; this in turn can give a competitive edge when commissioning or producing content in competition with suppliers
	Nature of wholesale relationships	OTT platforms such as Netflix and Amazon are producing more content (vertically integrated) for their VoD services (by also using end-user preference data) rather than depending solely on content rights secured through arm's length contracts, while traditional integrated broadcasters are spinning off their production studios to partner more with OTT platform providers. Links to device platforms (e.g. default placement and/or inclusion in app stores) are important for achieving prominence and discoverability with end-users.
Competitive advantage, profit drivers and potential barriers to entry	Role of data	VoD providers collect data about customer viewing preferences use this to improve content suggestions tailored to users and also help decide on content acquisition or production (when the company has a vertically-integrated content production function)
	Role of network effects	Network effects are present since as the number of users increases, recommendation algorithms have more data to work with. Multi-homing is common especially with the increasing number of services and different content on each
	Role of scale and scope ²	Scale is important to be able to fund exclusive rights or content production, which can be monetised across the subscriber base; e.g. Amazon is present across SVoD, free VoD (IMDb TV) and TVoD and has recently moved into premium sports (UK premier league); some scope advantage in having vertically-integrated production capability (as this gives first refusal on exclusivity of that content, which can be a key differentiator).
	Role of other differentiators	Different content available on different platforms is a key differentiator, with a trend towards increasing exclusivity (e.g. inhouse 'original' content (see above) or exclusive deals, such as sports); some supporting IP in recommendation and tailoring algorithms
Other	Role in disruption/substitution	Having a large disruptive impact on traditional broadcast services and the associated viewing times (which in turn affects funding from advertising revenues); also competes with VSPs for share of AV viewing attention
	Role of regulation	VoD services also fall under AVMSD, though due to curated nature of content incur a much lower moderation burden; there are some rules to protect children from harmful content (around adult nature, product placement and sponsorship). DCMS closed a consultation on Audience protection standards on Video-on-Demand Services in August 2021.

Source of market size: ¹Based on 2021 Analysys Mason estimates informed by published actuals from VoD operators; excludes advertising and free VoD | Source of other information: Analysys Mason, press search | ²The points here are not economies of scale and scope as such, but are related to being large and/or doing multiple activities

Traditional broadcast TV distribution services

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	Provision of traditional TV broadcast distribution services, including Free To Air (FTA) and PayTV, over Digital Terrestrial Television (DTT), Cable and Satellite networks. Services make money in three main ways: advertising, subscription revenues (only for Pay-TV) and license fee funding (only for BBC)
	Approx. market size	UK: GBP12.5 billion (2020) ¹
	Market maturity	High - As demand, technology and the business model are all mature, and usage is declining with a shift towards online services and younger audience demographics
	Key market players	BBC, ITV, Channel Four, Channel 5, Sky, Virgin Media, BT
Power balance between stakeholders	Ability to exert control in the value chain	Limited ability to exert control: established competition between broadcasters, and influence over content production/acquisition is waning in face of new competition from (sometimes large) online service providers
	Nature of relationship with end-users	Pay-TV services have a direct relationship with end-users and in most cases a two-way link through a set-top box (offering a source of viewing data), but the relationship for FTA services is more indirect (end-user intelligence available from sampling only, e.g. from BARB)
	Nature of wholesale relationships	Wholesale relationships include the production and acquisition of content, and relationships with advertisers. Production of content is often 'in-house' (and vertically integrated with distribution), though other content is purchased from third parties (arm's length payment)
Competitive advantage, profit drivers and potential barriers to entry	Role of data	See comment on relationship with end-users
	Role of network effects	Network effects support Pay-TV services (more users mean more revenue to produce/develop content, and more data on viewing preferences) and ad-funded services (more viewers means more ad revenue);
	Role of scale and scope ²	Scale is important for content acquisition/production and attracting ad revenues; some scope benefits of having in-house production capability
	Role of other differentiators	Exclusive programmes/channels can act as differentiators
Other	Role in disruption/substitution	Viewing of traditional broadcast services is being strongly disrupted by a range of services competing for users' attention, including online audio-visual services, social media and other online activities such as games. Viewing trends among younger people feature a much greater proportion of non-TV viewing (e.g. VoD, YouTube, Gaming) than for older people. As viewers of traditional distribution services continues to migrate away, the funding of these services is put under pressure.
	Role of regulation	Prominence regulation means PSB channels must appear as the first channels on electronic programme guide (Sky/Virgin Media needs to have PSB channels first, in a certain order); such requirements do not apply to OTT services; PSB's need to fulfil statutory purposes such as balanced services and content for interests of different audiences; The Communications Act 2003 requires that PSBs offer channels to all major platforms ("must offer"), and that providers such as Sky "must carry" them

Source of market size: ¹ Based on 2020 revenues from "Media Nations 2021" for the total of commercial PSB channels, digital multi-channels, platform operators and publicly funded channels | Source: Analysys Mason, press search, Ofcom | ² The points here are not economies of scale and scope as such, but are related to being large and/or doing multiple activities

Holographics, AR and VR (AV and interpersonal communications)

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	Computer-generated simulations that reflects real-life (holographics), includes some aspects of real-life (AR) or is separate to real-life completely (VR). Business models are still at a very nascent stage, but likely to include mass-market applications which are free for end-users (e.g. networking and communications, search, maps), supported fully or partially by new advertising revenue opportunities, plus other paid applications (e.g. games, AV services)
	Approx. market size	Suitable data not available
	Market maturity	Low, technology is nascent (both hardware and software) and business models not established
	Key market players	Facebook/Meta (Oculus), Google (Glass), Magic Leap, Microsoft (HoloLens), Apple, Samsung, Huawei, Valve, DAQRI, HTC, Sony
Power balance between stakeholders	Ability to exert control in the value chain	Currently low control in the value chain however this could change as services provider a key interface (like browsers for example), which mixes hardware and software. This gives potential for more control / aggregation / bottlenecking of services that have to go through the interface, and the 'all-senses' nature of the services also makes 'multi-screening' on multiple devices very hard.
	Nature of relationship with end-users	Likely to support a range of relationships with end-users, including free, paid, ad-funded, bundled etc, which in turn will likely give service providers access to a wide range of end-user data
	Nature of wholesale relationships	Likely to support a wide range of wholesale relationships, including advertising (i.e. intermediary / 2-sided market), partnerships, arms-length contracts etc
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Data is likely to play a large role, including both technical data (for monitoring and improving end-user experience) and commercial data (e.g. content viewing data, location data, interaction and networking with other users data); players with existing large repositories of data (e.g. Meta, Google) have competitive advantage over others as new entrants
	Role of network effects	Network effects are likely to be important: a greater user base will provide more data and provide an environment that reflects real life better, which in turn makes the activities more popular; interoperability and multi-homing are dynamics yet to be observed
	Role of scale and scope economies	Existing presence across the value chain likely to bring significant competitive advantages, as users of existing networks and services can be offered migration to new services. Likely economies of scope in supporting services (Content Delivery Networks (CDNs), cloud processing and analytics functions)
	Role of other differentiators	The level of realism/usability of services, and integration/interoperability across different activities, are likely to be differentiators
Other	Role in disruption/substitution	Depending on the development of these technologies they could disrupt virtually all communications industries, ranging from gaming, messaging, calls to manufacturing
	Role of regulation	No specific regulation as such, though existing and emerging regulation for online services (e.g. video sharing, online harms) will have an impact similar to today's services; new regulatory questions will also emerge around ownership of social identities/ "avatars" of end-users

Audio services (music, podcasts, audio books)

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	Business models are varied and can range from subscription services and freemium models to free advertisement-centric strategies as well as a pay-per-item model which is primarily used for audiobooks
	Approx. market size	Global podcast market: USD14.25bn; Global audiobook market: USD4.13bn; Global music streaming market: USD15.5bn ¹ (all 2021)
	Market maturity	Medium: while technology and business model are established, the market is growing rapidly as many big players such as Amazon, Spotify and Apple invest heavily due to the “stickiness” of these products/services
	Key market players	Service providers and aggregators: Amazon incl Audible, Apple, Spotify, PocketCast, Stitcher
Power balance between stakeholders	Ability to exert control in the value chain	Services tend to form part of a portfolio of products offered by large enterprises which offer a wide range of services, and therefore may contribute to ecosystem effects (i.e. end-users being loyal to a particular Hyperscaler brand or collection of services) Few content creators have the scale required to be able to shun large platforms and negotiate themselves Content producers (e.g. music labels) play a major role and are key stakeholders (and sometimes shareholders) in services (Spotify, Tidal), exerting significant power over audio services
	Nature of relationship with end-users	Many audio products (including podcasts, audio books and streaming services) are sold on a subscription basis, including releases on a daily, weekly or monthly basis, thereby engaging the end-user in a sticky manner. Where a user buys a product on a one-off basis (e.g. a single purchase of an audio book), this effect is lessened.
	Nature of wholesale relationships	Typically, contractual relationships with the content producers (which include podcast creators, writers and music artists). Increasing vertical integration between content production and distribution (e.g. Spotify exclusive content, Stitcher app)
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Still at a nascent stage but understanding how users interact with these products (more so for podcasts and music than books) may inform firms about valuable behavioural patterns which may increase the success of future products and acquisitions. In addition, it may also help better target advertisements and therefore result in increased ad revenue and lower user churn.
	Role of network effects	From the audio services aggregator’s point of view, the larger the user base, the higher potential for these existing users to expand the recognition of podcasts and audiobooks to newer audiences.
	Role of scale and scope economies	The larger the user base of the audio services aggregator, the higher the ability to invest in either acquiring or producing (in-house / ‘original’) new content. There are further scope benefits in offering multiple forms of audio content (e.g., music, podcasts, audio books)
	Role of other differentiators	In some instances, particular niches for specific customer segments may help a podcast or audiobook firm lock in loyal customers looking for specific content.
Other	Role in disruption/substitution	The audiobook industry has the potential to disrupt the physical book market, as it offers the possibility for many users to enjoy the content they want while multitasking. Podcasts are not a new concept but have been gaining popularity as users start paying more attention to on-demand content which allows them to flexibly choose when and where they want to interact with media and entertainment products. Podcasts are having a large substitutive impact on broadcast radio.
	Role of regulation	Audiobooks and podcasts are largely unregulated and do not have to comply with the broadcasting rules applied to radio and TV.

Traditional radio broadcast services

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	The traditional radio broadcast business model is based on offering free content to users in order to reach significant scale and then attract firms to advertise on their stations and charge them for advertisement time.
	Approx. market size	UK: GBP1.25 billion (2020) ¹
	Market maturity	High: the market is very mature as it has been operating for around a century and is now being overtaken by newer technologies and business model, such as streaming services and podcasts
	Key market players	BBC (non commercial), iHeartMedia, CBS, Salem Media Group, Cox Radio, Global
Power balance between stakeholders	Ability to exert control in the value chain	Radio broadcasters remain important to advertisers and to music publishers, artists and collecting society; their market power is much diminished, however, due to the increase in popularity of streaming and podcasts, and the increased connectedness of car audio systems
	Nature of relationship with end-users	Radio broadcasters have traditionally had a strong brand, with many listeners spending several hours listening to radio programmes; different broadcasters may appeal to different audiences, and there has traditionally been a strong local / regional component to programming and listener engagement, which remains a differentiator compared to other audio services
	Nature of wholesale relationships	Wholesale relationships mainly limited to those with advertisers and royalty payments with music rights owners. Both are arms length contractual relationships
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Being able to harness the power of data and analytics is something that radio broadcasters did not exploit until recently, however, those that have, are able to better understand their users and offer more targeted content which consequently attracts more ad-revenue.
	Role of network effects	N/A – primarily scale related
	Role of scale and scope economies	More listeners will tend to increase ad revenues.
	Role of other differentiators	Other differentiators may include focusing on a specific customer segment and leverage the strong loyalty of its niche customer base to ask for higher prices for airtime to advertisers.
Other	Role in disruption/substitution	Radio broadcasting services are being strongly disrupted by streaming platforms offering on-demand content, including podcasts and streaming music. The role of voice assistants (which may auto-select a particular piece of content) is further disrupting radio.
	Role of regulation	Radio broadcasters are regulated by Ofcom, who require radio broadcasters to abide by the Broadcasting Code which has in place measures to avoid hate crime as well as other offences. Podcasts and audio streaming are not subject to this code.

Source for market size: ¹ UK figure is based on Ofcom's "Communications Market Report 2021"

Sources: Analysys Mason, press search, Statista, Ofcom



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Number independent interpersonal communications serviced (NIICS)

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	Services include provision of messaging and voice/video calling 'over the top' (OTT), i.e. via an internet connection, and independent of the ISP (i.e. 'QoS-managed VoIP services provided by the ISP are not included). Services tend not to generate revenue, but are used as a complement to other online services, to increase engagement and stickiness (e.g. Google Duo, chat functions of games, iMessage on Apple Devices), or as a source of data for adjacent platforms (end-user data for Facebook from Facebook Messenger and WhatsApp)
	Approx. market size	UK: 1239 billion messages sent and 49 billion minutes (2021) ¹
	Market maturity	Medium - the concepts are long established, but use of secondary benefits (data, loyalty, added value) is a more recent dynamic
	Key market players	WhatsApp, Skype, iMessage and Facetime, Facebook Messenger, MS Teams, Signal, Telegram, Google Messages, Zoom
Power balance between stakeholders	Ability to exert control in the value chain	NIICS applications are gaining popularity for application-to-person messaging, impacting business marketing and customer service; these applications also have interfaces with voice assistance software (e.g. automated restaurant booking).
	Nature of relationship with end-users	Direct, usually free, relationship with end-users; users typically unaware of what data is being collected: most platforms promise security/encryption but still collect some data (e.g. device information and names of contacts)
	Nature of wholesale relationships	Limited wholesale relationship (if any) with data brokers or internet advertising which can be more easily managed and not exposed if vertically integrated (such as Facebook Messenger and its advertising tools)
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Depending on the security/encryption promised, data about communications, contacts, content of messages can be received (which could act as a competitive advantage for monetisation); however, end-users are becoming increasingly aware of the privacy implications of NIICS calls and messages
	Role of network effects	Most platforms are not interoperable, creating very strong network effects which are starting to entrench some market shares (e.g. WhatsApp), though this is alleviated by some multi-homing. Note the RCS protocol is aimed at making SMS messages more feature rich and competitive with NIICS services, and Google/Samsung have a partnership to make RCS messages interoperable between the Android-Messages and Samsung-Messages apps.
	Role of scale and scope economies	Scale is very important to be able to achieve network effects and convince end-users to use the service (even given some multi-homing); Meta with WhatsApp and Facebook Messenger (linked to Facebook) is an important example
	Role of other differentiators	Privacy (encryption levels, treatment of data etc.) can play a role for end-users when choosing the provider
Other	Role in disruption/substitution	Disrupting traditional communications services (i.e.. traditional voice and SMS)
	Role of regulation	NIICS voice and messaging services are not subject to the same restrictions around data use from ePrivacy regulations as traditional voice and messaging services. The European Electronic Communications Code included number independent interpersonal communication services (NIICS), but the UK government did not transpose the full requirements.

Source of market size: ¹ Based on 2021 Analysys Mason forecast, based on published actual data up to Q3 2020; messages are total of OTT IP-based messages on all devices; minutes for OTT VOIP services on all devices

Sources: Analysys Mason, press search, DCMS

Traditional messaging and voice/video calling services

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	Services include provision of messaging and voice calling via a conventional dedicated telecoms network service (usually vertically integrated with the network). Business model involves paid services, with payments based on usage (i.e. fee per SMS, or minutes used) and/or flat fees (e.g. minutes and texts included in 'line rental' charges)
	Approx. market size	UK: 63.7 billion messages sent and 202 billion minutes (2021) ¹
	Market maturity	High - services are long established in terms of demand, technology and business model, and traffic has been declining with a shift towards online services
	Key market players	BT, EE, Vodafone, O2, Three, Sky, Virgin Media, TalkTalk, Gigaclear, KCOM, Lebara, Lycamobile, GiffGaff, Tesco Mobile
Power balance between stakeholders	Ability to exert control in the value chain	Low - these services are being used less frequently (due to competition with OTT services), are highly commoditised and interoperable; hence they have limited ability to exert control in the value chain
	Nature of relationship with end-users	Direct relationship with end-users: paid-for services, provided by Communications Providers (CPs) which can be bundled together (i.e. SMS and calling); provides some data on traffic and contact preferences
	Nature of wholesale relationships	Combination of vertical integration (e.g. BT) and wholesale relationships (e.g. with access and backhaul networks) which are governed by arm's length contractual terms
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Usage (of calls, texts and the Internet) and some basic personal information (name, address etc.) can be accessed by CPs. However there are specific restrictions on repurposing data for ECS providers
	Role of network effects	Classic definition of network effects, though complete interoperability negates any competitive advantage; as usage moves to 'free' OTT services, network benefits are mainly a fallback (e.g. an iPhone user may use the same interface for SMS and iMessage), most do not multi-home between different providers but there is an increasing shift towards OTT
	Role of scale and scope economies	Scale effects are limited to national coverage; Hyperscalers are not (currently) present
	Role of other differentiators	'Multi-play' bundling with other services (e.g. internet access, PayTV, across fixed/mobile) provides some differentiation
Other	Role in disruption/substitution	Being disrupted by online communications services being available for free, and from a wide range of sources (e.g. overt messaging/call apps, as well as communications functionality in productivity suites, online games, etc.)
	Role of regulation	There are a range of relevant regulations, including access to emergency services, e-privacy limiting the use of data for non-communications services. The European Electronic Communications Code includes requirements for interconnection and interoperability, though the phone-number-based nature of these traditional services makes them inherently interoperable.

Source of market size: ¹ Based on 2021 Analysys Mason forecast, based on published actual data up to Q3 2020; messages are total of SMS, MMS and operator IP-based (excl. A2P); total voice traffic on fixed and mobile networks

Sources: Analysys Mason, press search

Cloud-based enterprise communications and network services

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	<p>Services include contemporary internet-based communications services for businesses, supporting both office and home working, and including voice, video and messaging communications. The activity covers a broad range of services:</p> <ul style="list-style-type: none"> Communications features of online productivity suites (such as MS Teams, Slack, Google Meet Up and Zoom). These are delivered 'over the top' (i.e. purely over the public internet) with a 'best effort' quality of service. Pricing is per user. Virtual, cloud-based software defined wide area networks (SD-WANs) which are dedicated to a particular organisation and can be used to provide voice, video and file transfer services. These can be provided over public, private or hybrid cloud infrastructure, and include a degree of managed/assured QoS. 'On ramp' services are an add-on which gives a direct connection to the WAN provider's cloud network (the public internet is not used). Providers include AWS, Oracle, Microsoft, Palo Alto. Pricing typically per hour & per GB. Smaller business connectivity platform providers (such as 8x8, Broadsoft (Cisco), Virtual1, Polycom, exponential-e). These often offer 'unified communications' or 'omni-channel' services, targeted at call centres or professional services firms (such as accountants or solicitors). These platforms are often sold through resellers. Pricing is per user.
	Approx. market size	Global: USD16 billion for Unified Comms and hosted voice (2020) ¹ and USD1.6 billion for SD-WAN (2020) ²
	Market maturity	Medium - This field has been developing slowly for over a decade, as SME demand has gradually increased and larger companies finish amortising their infrastructure before moving to the cloud; however, migration it has accelerated significantly with Covid-19
	Key market players	See above examples
Power balance between stakeholders	Ability to exert control in the value chain	Bundling of OTT services with other products (e.g., MS teams with Office 365) may lead to high concentration with a few large companies, though there is still significant competition in provision of WAN and unified comms services.
	Relationship with end-users	Purchasing decisions made by IT departments, though usage by individual users is visible to the service provider
	Wholesale relationships	Extensive wholesale contractual relationships with resellers and network providers. Some vertical integration (e.g. large Hyperscalers)
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Enterprise-level data on calls and traffic may be obtained to improve services; visibility of company files as part of wider productivity suite offering (subject to strict confidentiality limitations) allows provider to develop and refine 'internal search' functionality
	Role of network effects	Some limited network effects: it is often more convenient if the other users (e.g., another business) has the same platform, but there are workarounds if not (e.g., browser-based clients)
	Role of scale and scope economies	Scope economies are important in order to be able to bundle different functions together; Microsoft Teams started aggregating several functions together such as access to the Office suite, Yammer, and other Microsoft applications on a single platform
	Role of other differentiators	Services have high stickiness / cost of switching: migration onto an IP communications platform is straightforward, but there are significant barriers to migrating off to another platform. Brand (including security, resilience and performance) and customer relationships with the enterprises are important differentiators
Other	Role in disruption/substitution	Disrupting traditional enterprise communications services, such as phone calls and emails, however they could also act as substitutes for personal communications to a degree
	Role of regulation	Regulators may need to consider a world where most communication services are delivered by a small number of large providers



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Social media and online discussion forums

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	These are usually free to users (to maximise take up and network size), financed through (typically targeted) advertising; some platforms may offer add-on services such as e-commerce (Facebook Marketplace) or premium functionalities (e.g. LinkedIn Premium), which bring subscription and commission revenues to the platform
	Approx. market size	UK Facebook revenue reported as GBP1.37 billion in 2020 (we note that this is only part of the UK social media/forum market)
	Market maturity	Medium - demand, technology and business model is well established for some platforms (e.g. for Facebook), but the market continues to be disrupted by new services (e.g. rise of TikTok); regulation and policy issues are evolving (see below)
	Key market players	Instagram, Facebook, Twitter, TikTok, SnapChat, LinkedIn, Quora, Reddit, Tumblr, Stack Overflow
Power balance between stakeholders	Ability to exert control in the value chain	Large social media platforms have a high ability to exert control, as they encompass different functions in a single platform, fight for end-user attention and embed advertising as a monetising tool, which then allows them to exert influence on other parts of the value chain (e.g. Meta's subsea cables, TIP). Forums and more targeted social media platforms (e.g. Reddit) have lower impact.
	Nature of relationship with end-users	Very close relationships with the end-users, with data collected through different functions (picture detection, status detection, content posted or consumed, relationship with connections)
	Nature of wholesale relationships	Advertising: For large players advertising platforms are usually vertically integrated; otherwise third party contractual agreements at arm's length
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Social media allows various data to be collected around end-user choice, behaviour and contacts which can be used to improve the offerings, as to increase engagement on the platform and target advertising, providing a competitive advantage
	Role of network effects	Network effects are very significant as users get value from connecting with other users, and there is limited interoperability across social networks, despite multi-homing being very common; network effects apply on both sides of the platform, as advertising products benefit greatly from having better data to target advertising
	Role of scale and scope economies	Scale is important to get a larger user base and monetise the platform better by increasing audiences but also improving the value proposition of advertising products through data (e.g. for products such as Facebook's LookAlike Audiences) Engagement is increased through scope, by offering users more reasons to use and engage with the platforms (e.g. games, videos), which in turn provides more incentives for advertisers and content providers to offer services through the platform
	Role of other differentiators	Social media platforms such as TikTok that are differentiated can gain traction very quickly, but established ones also can add competing features quickly
Other	Role in disruption/substitution	Social media competes strongly for attention, in part by adding new features, thereby disrupting other entertainment services, such as online audio-visual services, games etc.
	Role of regulation	Social media is closely linked with online harms; a draft Online Safety Bill is under way in the UK to prevent online harm in content sharing platforms which may lead to additional costs for these platforms in order to adequately monitor compliance with these rules



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Public data communications providers (including fixed ISPs and data services from MNOs)

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	Provision of data services to end users (including consumers and businesses) to access the global internet. Includes fixed internet service providers (ISPs) and the data services of MNOs. Business model is simple retail subscriptions for internet connectivity packages, which are typically structured by speed of connection and total data consumed.
	Approx. market size	UK: GBP28 billion (2021) ¹
	Market maturity	High – demand, technologies and business models are well established, though there ongoing technology development and investment (e.g. in 5G and fibre)
	Key market players	BT, Virgin Media, Sky, TalkTalk, Vodafone, Three, O2, EE, GiffGaff, Tesco Mobile
Power balance between stakeholders	Ability to exert control in the value chain	Service is a functional gateway (a necessity to access the internet), though scope for differentiation between ISPs is limited in practice (e.g. hybrid fixed-mobile services, speed, price, customer service); risk of becoming a commodity and disintermediation (e.g. internet connectivity bundled with devices and 'things'); net neutrality currently limits the bargaining power ISPs have over content providers (limited to agreements over placement of content caches within ISP network); some substitution between fixed and mobile access, at the margin
	Nature of relationship with end-users	A direct relationship with end-users, with some access to data – see below. MNOs relationship with end-users could be disintermediated if connectivity is bundled with devices and/or use of e-sim functionality becomes prevalent
	Nature of wholesale relationships	Some ISPs are vertically integrated with their network functions, though wholesale arms-length contractual relationships are extensive in the UK (e.g. fixed ISPs using Openreach and potentially others, MVNOs using their host network); various wholesale relationships with network vendors and other service providers; MNOs have wholesale relationships with device providers, e.g. incl. Apple, Google, Samsung
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Data about end-user consumption can be available which could give some competitive advantage such as browsing time or destination. There is also registration data collected by ISPs that would include name, address etc. The use of this data is regulated and it cannot be sold to other parties, but can be used to improve services. ISPs technically have visibility of user browsing/streaming habits (e.g. via DPI), though we understand most don't systematically collect this data.
	Role of network effects	None - provides access to networks, rather than being a network itself
	Role of scale and scope economies	Mobile services tend to have a large scale (within a national context) due to the initial investment needed for networks (or network access if an MNVO). On the fixed side, scale is less important due to wholesale regulations, with a large number of small ISPs (including those created by new fibre deployments), though it remains to be seen whether a reduced scope of service (i.e. not also having a PayTV offering) will impact competitiveness
	Role of other differentiators	Vertical integration of fixed and mobile services allows new hybrid fixed-mobile packages with increased resilience (e.g. BT, Vodafone)
Other	Role in disruption/substitution	Potential to be disrupted by large tech companies also providing connectivity as part of the device (e.g. Google Fi in the US, Canada and Mexico); products such as Apple Private Relay and encrypted DNS could take data away from ISPs, but the impact of such is unclear
	Role of regulation	Net neutrality regulation contributes to the current regime of many services being carried 'over the top', without ISPs/MNOs being able to charge the players offering those services. ePrivacy Directive puts obligations around confidentiality (limits data use without consent), and use of traffic and location data



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Content delivery networks (CDNs), including caching services

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	CDNs provide a service to websites and other content providers to bring their content closer to end-users, reducing load times and improving quality of experience. Business model is based on ongoing payments to host/serve content from websites/provider to CDN
	Approx. market size	Global: USD16.4 billion ¹
	Market maturity	Medium - CDN technology is well established, but as data traffic needs increase these networks are expected to evolve more to focus on user experience, ability to scale quickly and delivering more livestream content
	Key market players	Akamai, Fastly, Microsoft Azure, AmazonCloud, KeyCDN, Cloudflare, ImagineEngine, PageCDN, Google Global Cache
Power balance between stakeholders	Ability to exert control in the value chain	A key enabler to the internet: while websites can technically function without CDNs, a slow user experience on international sites/content would likely drive people towards local content only (could become a de facto gateway with sufficient power/scale); furthermore, without CDNs, international connectivity costs would be much higher, reinforcing their key role in the value chain
	Nature of relationship with end-users	Caches have a direct connection to end-users (as they serve the content based on end-user requests), providing a source of data on total traffic demand and popularity of different sites/content.
	Nature of wholesale relationships	Typically via arms length commercial agreements (i.e. between the website or content provider and the CDN), though vertical integration can take place for providers large enough which start self-supplying (e.g. YouTube can use Google Global Cache, and Amazon Prime Video can use AWS), meaning that 3 rd -party CDN providers may be left with the 'long tail' of content/services. Key commercial relationship with ISPs (in terms of placement of caches/POPs within ISPs networks), though such placement is typically mutually beneficial
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Data is used to inform where CDNs should locate their caches and upgrade their links, to compete with other CDN providers (creating some competitive advantage)
	Role of network effects	Successful CDNs have many routes to many end points connected to many networks: see comments on scale/scope next
	Role of scale and scope economies	Due to the global nature of the internet, scale is critical: a CDN that can serve a website quickly to a greater proportion of the earth's population will be more attractive to that website. Large tech players can usually be vertically integrated providing their own CDNs; some Hyperscalers provide CDN for third-parties as well. There are a number of scope economies related to multiple point of presence locations (see next)
	Role of other differentiators	The nature of CDN networks (which are effectively a series of interlinked caches) lend themselves to offering protection against certain types of malicious attacks (e.g. DDoD attacks from botnets), and more recently the provision of edge-computing services. Some CDN providers suggest a smaller number of higher capacity cache locations is better than having a large number of low capacity cache locations (though it is not clear which strategy is more advantageous)
Other	Role in disruption/substitution	Disruptive to international IP transit services, reinforced by Hyperscalers who build their own cables to connect to their own caches
	Role of regulation	As designated 'intermediaries', CDNs are not directly liable for the content hosted on their systems. If the associated regulations were to change, there is a risk they would incur additional costs to implement suitable moderation processes

Source of market size: ¹ Global figures are as of 2021 and based on MarketsAndMarkets' estimate of USD14.4 billion in 2020 and a CAGR of 14.1% (representing total global revenues for the CDN market)

Source: Analysys Mason, press search, Markets and Markets, GMI



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Certificate authorities

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	Certificate authorities are entities that provide digital certificates that help websites, people or devices establish their authentic online identity; certificates associated with websites are purchased from Certificate Authorities in exchange for fees
	Approx. market size	Global: USD102 million in 2021 ¹
	Market maturity	High - there is established and growing demand for certificates and encrypted websites are now the default (in part because of Google's policies in Chrome and Search)
	Key market players	Symantec, GoDaddy, Comodo, GlobalSign, Digicert, Verisign, Entrust, Microsoft, Amazon, Google
Power balance between stakeholders	Ability to exert control in the value chain	As an enabler for online security, CA's have high ability to exert control as most websites need a certificate for security and also to boost search engine rankings (although it is not always a necessity)
	Nature of relationship with end-users	Website-associated certificates are not directly linked with end-users, but for some end-users who may filter out websites without certificates, it can act as a security measure
	Nature of wholesale relationships	Vertically integrated for large providers (Amazon, Google etc.), or contractual agreements for the provision of a certificate with third-party providers
Competitive advantage, profit drivers and potential barriers to entry	Role of data	While certificate authorities have visibility of data associated with the entities requesting certificates, the "trusted 3 rd party" nature of the authority limits use of that data to improving their own service.
	Role of network effects	Larger certificate authorities (by market share) may be considered more trustworthy, and therefore attract more users
	Role of scale and scope economies	Scope is important as other internet-related services can be bundled; Microsoft, Google and Amazon all offer digital certificate authorities, as well as others such as GoDaddy which can bundle CA's with relevant services (e.g., domain registry and hosting)
	Role of other differentiators	There are limited differentiators as the service is standardized (apart from efficiencies from bundling), some expertise and an understanding of supporting functions / tools including Public Key Infrastructure (PKI) and encryption is required (though the technical requirements of this last point can represent a barrier to entry)
Other	Role in disruption/substitution	N/A
	Role of regulation	Various industry regulation and standards initiatives, including audits by WebTrust and ETSI.

Source of market size: ¹Based on figures published by psmarketresearch, with forecast extrapolated from 2019

Source, Analysys Mason, press search, netcraft, PKI consortium

Domain Name System (DNS) – including hosts, registrars and registries

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	DNS is a distributed network of servers that translates domain names to numerical IP addresses. There are two main types of service: <ul style="list-style-type: none"> ▪ DNS registrars: where an end-user can purchase a domain name to use for a particular website ▪ DNS hosts: which undertake the process of resolving a domain name request to the associated IP address DNS registrars tend to operate a subscription-based model, while the services from DNS hosts are often provider for free. Some registrars offer free hosting services. The market also includes DNS registries which are given the right to administer a particular domain.
	Approx. market size	Suitable data on DNS services-only not available (estimates include other value add services such as DDoS protection)
	Market maturity	High - As DNS is one of building blocks of the internet, acting as the 'phone books' of the internet; DNS is also fundamental to interworking between services across the internet: when a service calls onto another web service, it nearly always does so through a domain name rather than an IP address
	Key market players	Microsoft Azure, Google Public DNS, Oracle, Cloudflare, OpenDNS, Cisco, Comodo, DNSFilter, Akamai, Verisign, GoDaddy, Nominet, Domain.com, Bluehost, Ionos, Network Solutions
Power balance between stakeholders	Ability to exert control in the value chain	While DNS is a key enabler to the internet, the large number of root servers and mirrors means that any one company is unlikely to be exert a significant amount of control over the value chain. Registrars typically compete to sell domain names in the same domain. Some registries have market power with their domain names, but that is currently addressed through ICANN with wholesale price restrictions where deemed necessary, and by their program of allowing new top level domains to be created that can provide competition to existing domains.
	Nature of relationship with end-users	It acts as an invisible but integral part of the internet for the end-users: most end-users will have a relationship with a DNS host, but many may not realise which organisation is providing the service (usually chosen by the ISP)
	Nature of wholesale relationships	Websites have a wholesale relationship with their DNS registrars, while stakeholders within the DNS market have various further relationships (e.g. Verisign (registry) administers the .com domain and GoDaddy (registrar) has a wholesale relationship with Verisign)
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Data about fundamental Internet data requests are available at a very granular-level, and therefore is closely linked with encrypted protocols (HTTPS) and end-user protection from malware, harmful content and IP spoofing
	Role of network effects	DNS is an open protocol and collaborative efforts from the industry ensure that DNS implementation on various systems does not limit interoperability
	Role of scale and scope economies	Scale is important to be able to provide bundled services such as registrar and hosting services
	Role of other differentiators	Speed of DNS resolution by hosts is the main proposition for an end-user changing their provider
Other	Role in disruption/substitution	N/A – this is largely open and mature
	Role of regulation	ICANN regulates some high-level stakeholders such as registries which administer top level domains (e.g. .com). EU regulations include several provisions to ensure security, stability and resilience of DNS services.

Wholesale security services

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	Solutions to protect platforms and networks from cyber attacks including distributed denial of service, malware attack prevention, threat intelligence, and increasingly blocking of malicious contents
	Approx. market size	UK: GBP8.9 billion (FY2021) ¹
	Market maturity	Medium: the need to protect from attacks and malware is well established, however methods used by attackers are constantly evolving
	Key market players	Cloudflare, Amazon, Akamai, Fortinet, Google, Sectigo
Power balance between stakeholders	Ability to exert control in the value chain	Low – security services tend to be bundled with other services (e.g. CDN), and have limited scope to exert control on their own. Security services are important to overall resilience of online services.
	Nature of relationship with end-users	None
	Nature of wholesale relationships	Typically arms-length contractual relationships between the providers of online content (websites and content providers) and the security services provider.
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Service providers have access to data about the nature and frequency of attacks which will help to improve services (e.g. threat intelligence)
	Role of network effects	A larger user base increases the data available to improve services (see above)
	Role of scale and scope economies	Scale is important in defending against DDoS attacks: a CDN with many caches of high capacity is less likely to be overwhelmed. Scope economies are also relevant, with many wholesale security services offered alongside other (CDN) services.
	Role of other differentiators	Scalability and flexibility are important differentiators and can be better provided by cloud and CDN providers; other developing technologies such as blockchain, cloud and AI/ML are also used in security services (and could provide differentiation)
Other	Role in disruption/substitution	N/A
	Role of regulation	Net neutrality regulations are limiting the blocking of DDoS traffic at the ISP layer (as ISPs worry whether that would count as discriminating against certain traffic types), which is likely therefore supporting the industry for protection from wholesale security providers Online harms regime will put further emphasis on blocking access to nefarious and illegal content

Source of market size: ¹ 2021 financial year figures from “UK Cyber Security Sectoral Analysis 2021” for DCMS by Ipsos MORI

Source: Analysys Mason, press search, Department for Digital, Culture, Media & Sports



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Mobile access networks

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	Provision of public wireless network access, typically vertically integrated with a service provider (MNO) but sometimes selling through a separate service provider (MNVO). Revenues flow from end users to the service provider to the access provider, in the form of monthly subscription fees and/or usage fees. The network is primarily used to deliver services to handsets (i.e. voice, messaging and data), with new use cases being explored (e.g. across production and logistics, agriculture, transport, healthcare), driven by 5G
	Approx. market size	UK: GBP1.3-2.0 billion (2021); ¹
	Market maturity	High - public mobile access is well established in terms of technology, demand and business model
	Key market players	Vodafone, EE, O2 and Three; some private networks operate shared access licensed bands
Power balance between stakeholders	Ability to exert control in the value chain	The MNOs that own/operate the access networks have a relatively high amount of control downstream, as market entry is severely constrained; they also have very well-defined contracts with upstream infrastructure providers (for towers) as these are typically negotiated together with asset sales (but the balance of power changes as contracts expire); operators part of large international groups can exert some countervailing power vis-à-vis network vendors, but this is limited and has led operators to participate in initiatives to pursue broader supply (e.g. Open RAN / TIP)
	Nature of relationship with end-users	Provides the final connection to the end-user, through a combination of geographic coverage, capacity and quality of service. Any failures or service disruption can have a significant impact on the perceived reliability/resilience of the whole MNO service.
	Nature of wholesale relationships	Vertically integrated with most MNOs (Three, EE etc.), or contractual agreements with smaller providers (MVNOs). Mobile access providers have divested passive infrastructure assets (e.g. towers) to infrastructure investors. Most large MNOs retain a majority stake in these assets, but some MNOs (outside the UK) are starting to divest active assets as well (Polkomtel to Cellnex in Poland)
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Service providers have access to end user data on their customers, and on other mobile users who call or message their customers through traditional communication services; access networks as a separate entity see similar data, but may not have much details on end users besides the characteristics of their device; the data they handle is primarily related to managing network quality
	Role of network effects	Limited outside of traditional telephony / messaging; even for those, the network effects act across all providers as services are interoperable and interconnected
	Role of scale and scope economies	Achieving national scale is important for public mobile services, and creates a barrier to entry and tends to keep national markets to 3-4 MNOs in total. Scope economies are seen as key to monetising investments in 5G (with the public mobile networks planned to deliver a greater number of use cases)
	Role of other differentiators	High investment requirements, market access limited by the need to access scarce resources (spectrum, land/towers, MNC, numbers)
Other	Role in disruption/substitution	Developments around network virtualisation and cloud-based network functions are having a disruptive impact. Private 5G networks (including those provided by Hyperscalers) will compete for the provision of new use cases. Developments around virtualised- and open-RAN will bring new technical architectures and suppliers.
	Role of regulation	Regulated spectrum is essential for provision of services.

Source of market size: ¹ Estimated based on the assumption that mobile operators spend 10%-15% of total revenues (around GBP13.3 billion for the calendar year 2021) on recovering the cost of mobile access networks (i.e. both opex and depreciation)

Sources: Analysys Mason, press search

Private cloud-based 5G networks

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	With many 5G network functions designed to be software-driven natively, and the integration of managed 3GPP-based wireless solutions into industrial processes and enterprise connectivity, cloud players and system integrators are exploring synergies between private 5G enterprise networks and cloud computing. These synergies cut across marketing and sales channels, as well as technology, and coincide with large-scale adoption of cloud and automation by more enterprises.
	Approx. market size	Suitable data not available, likely to be very small at the moment.
	Market maturity	Low - This is a very new area, with technologies and products being developed recently such as AWS 5G Private Cloud (since Dec 2021)
	Key market players	AWS 5G Private offers an end-to-end solution, Microsoft Azure offers a 5G core network (Fusion Core)
Power balance between stakeholders	Ability to exert control in the value chain	Currently the ability to exert control in the value chain is low, but it could potentially be very high if the technology is adopted by large enterprises and the synergies materialise; MNOs are keen to contest this market, and there is wide scope for partnerships between MNOs, cloud players and systems integrators, as they all bring different assets and expertise to grow what is essentially a new enterprise market
	Nature of relationship with end-users	Enterprise users interesting in these products would have a direct relationship with one or more suppliers, often a party playing the role of systems integrator; this has the potential to be multi layered, depending on needs – for example, an enterprise could purchase the network and integrate it with its system itself, or could rely on an integrator (e.g. IBM, Accenture) to procure a private 5G solution as part of a broader IT / digital transformation exercise
	Nature of wholesale relationships	Providers of integrated solutions aggregate inputs from multiple parties (hardware, software, cloud computing resources); Hyperscalers have the opportunity to vertically integrate some of these activities
Competitive advantage, profit drivers and potential barriers to entry	Role of data	N/A
	Role of network effects	N/A
	Role of scale and scope economies	Scale is important to be able to provide a complete end-to-end solution; Amazon has recently started offering 5G private networks which can allow it to cross and up-sell other services; economies of scope through integration with other enterprise IT and automation are likely to be very meaningful
	Role of other differentiators	Reliability, resilience and end-user quality of experience are likely to be key differentiators
Other	Role in disruption/substitution	Primarily disruptive to established wired and Wi-Fi based solutions; this seems to be a new market, contestable by a broad range of market participants and not just MNOs
	Role of regulation	Access to spectrum for private networks is a major issue (enabler / barrier); regulatory status of providers will likely need clarifying, as this cloud based network function may not be strictly speaking 'private' and may raise issues related to reliability and resilience as the enterprise does not fully control all functions. Access to spectrum is a significant factor for the provision of services

International networks (e.g. undersea cables)

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	Provision of physical data connection between countries and continents. Often includes undersea cables, though land-based routes are also relevant. The business model is based on selling wholesale, international capacity to ISPs and large technology companies, through agreed contracts
	Approx. market size	Global: USD1.7bn invested and 67 000 km deployed per year ¹
	Market maturity	Medium - international connections such as submarine cables have been used for a long time, though recent investments by internet Hyperscalers may be changing the industry dynamic (see below)
	Key market players ²	Apollo (Vodafone), EXA, Amitie, AEConnect-1 (Aqua Comms), 2Africa, Atisa (DOCOMO), ARCOS, SEACOM
Power balance between stakeholders	Ability to exert control in the value chain	While undersea cables are critical to the functioning of the global internet, extensive competition (e.g. multiple routes between major population centres) has limited control over the value chain. Hyperscalers are investing in their own cables, though mainly for self supply purposes: they do not monetise their capacity (though they do swap it). These Hyperscaler investments are taking demand away from commercial players which is affecting the competitive balance in the market.
	Nature of relationship with end-users	None
	Nature of wholesale relationships	Arm's length contractual agreements with 3 rd -party users of the cable, including SLA's and capacity provided. Where Hyperscalers have invested, these companies used their (portion of their) cables purely for self-supply (vertical integration): they do not sell the capacity to 3 rd -parties, though they do undertake 'swaps' with other cable operators to secure capacity on other routes.
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Limited access to data and hence limited competitive advantage due to this
	Role of network effects	None
	Role of scale and scope economies	Scale is important to have funding for such an investment (hence movement of Hyperscalers into this market), though the order of magnitude is lower than some other investments (e.g. Google-backed 9,000-kilometer FASTER cable cost USD300 million, which is low compared to (e.g.) fibre access network investments in the UK.)
	Role of other differentiators	Route and total capacity are key differentiators
Other	Role in disruption/substitution	None
	Role of regulation	Likely to be affected by wholesale access regulations in each country that hosts a landing station.

Source for market size: ¹ <https://www.telecomreview.com/index.php/articles/wholesale-and-capacity/5059-billion-dollar-subsea-cable-investments-expected-by-2024>

² Undersea cables can be owned by different entities incl. operators, consortia or private firms; we provide the name of the cable and the entity holding commercial relationships in parentheses if different than the cable name; e.g., Amitie is owned by a consortium and serves under the same name, where consortium is comprised of Facebook, Microsoft, Aqua Comms and Vodafone

Source: Analysys Mason, press search, Global Industry Analysts



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Traditional network functions

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	Selling of network equipment to communications providers. Traditional network functions are delivered via standardised solutions implemented in a largely proprietary way by vendors. Hardware and software are largely integrated. Business model includes sale of initial and ongoing goods and services (including full design/build/operate solutions) for both hardware and software.
	Approx. market size	Global: GBP125 billion estimated ¹
	Market maturity	High - As network vendors have mature demand levels with established business models; arguably declining as software-defined networking and open / disaggregated network technology is becoming progressively more viable
	Key market players	Ericsson, Nokia, Huawei, Cisco, Juniper, ZTE, Samsung; also includes more specialist providers (e.g. of antennas) that can sell direct to operators, but more often supply through large vendors
Power balance between stakeholders	Ability to exert control in the value chain	Currently high, concerns over Chinese vendors have left Nokia and Ericsson as the two main options for purchasing conventional network functions. However, this dynamic is being alleviated by virtualisation and cloudification, allowing a range of new small and large players to offer new (i.e. non-traditional) network functions.
	Relationship with end-users	None (although at some point all large vendors had a handset business, and Huawei does retain this line of business)
	Nature of wholesale relationships	Vendors and CPs are usually separate companies with arm's length contractual agreements, though where managed services are provided, dependency on the vendor by the CP can be extensive
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Planning is very data intensive, but traditionally optimisation has been very manual and relatively 'blind' to user experience; several initiatives (past and present) involve major app / content providers feeding back quality of experience data to MNOs to improve optimisation, although automatic optimisation remains limited.
	Role of network effects	No network effects per se, although interoperability (or lack thereof) has an impact on flexibility (E.g. for repurposing last-gen equipment to lower-demand areas, or across international footprint for large groups)
	Role of scale and scope economies	Vendors are global in scale, and bundle HW, SW, design and turnkey deployment / operations, creating large barriers to entry to new vendors (evidenced by concentration). Power of suppliers appears high, with many specialised suppliers either acquired or selling through traditional vendors. Threat from open and disaggregated network technology (e.g. TIP, OpenRAN) which reduce barriers to entry and could shift market power across the value chain; virtualised and cloud-based network functions reduce the ability of vendors to bundle HW and SW
	Role of other differentiators	Competition is normally based on cost and/or reliability of equipment, but longer term strategic inputs e.g. in standardisation bodies and government support are very impactful (e.g. Huawei and 5G)
Other	Role in disruption/substitution	Currently being disrupted by move to virtualisation, cloud provision and entry by Hyperscalers (see related slides)
	Role of regulation	Limited direct role, mediated by network operators. Detailed oversight by GCHQ re cyber/national security risk.

Source for market size: ¹ Estimated based on the total revenues of the major network equipment vendors: Huawei, Ericsson, Nokia, ZTE, Cisco

Source of other information: Analysys Mason, press search

Virtualised / cloud-based network functions

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	The overall concept of 'virtualising' network functions refers to migrating these functions from dedicated (sometimes proprietary) hardware appliances running network functions (mostly in the form of software today), to these functions being able to run on a broader range of (typically) commercial off-the-shelf (COTS) hardware. A natural evolution of virtualisation is that the software elements of network functions can ultimately be run on cloud (i.e. shared IT) infrastructure and platforms ('cloud native functions'). Virtualisation could in principle apply to all network functions, including those in the core and at the edge (access), although some functions will need to be run in physical proximity to the hardware. The overall proposition is that with more 'disaggregated' functions, operators can reduce costs and increase modularity, flexibility and innovation in their networks.
	Approx. market size	Global: USD26.4 billion (2021) ¹
	Market maturity	Software-based network functions are mature, but virtualisation is a new phenomenon, with a relatively low degree of maturity. Cloud-based network functions are new and largely unproven for large established operators.
	Key market players	Traditional network vendors are offering virtualised/cloud-based functions (e.g. Cisco, Nokia, Ericsson, Juniper, Huawei). In addition, public cloud providers (e.g. Google, Amazon, Microsoft) are also starting to offer some cloud-based networks, primarily for enterprise users rather than operators. The Telecoms Infrastructure Project (TIP) is an industry initiative, initiated by Meta but supported across a broad range of stakeholders, that aims to improve productisation and availability of open and disaggregated telecoms solution, leveraging virtualisation.
Power balance between stakeholders	Ability to exert control in the value chain	The separation of the hardware and software opens up the equipment value chain to a range of other suppliers, and also potentially increases the role of systems integrators. These changes allow some potentially large companies to enter the value chain for providing network functions to telecoms operators, whereby they could potentially exert control (due their size and any future high market share). However, the telecoms operators have a key role as buyers of the network functions, and there is an open question about whether the cost saving and performance gains of having more suppliers for a particular function is offset by the increased integration costs overall.
	Relationship with end-users	None
	Nature of wholesale relationships	Expected to be conventional arms-length wholesale relationships between operators and suppliers, though with potentially many more suppliers than with the traditional vendor-operator model.
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Important for optimisation and automation (e.g. automated fault resolution); no use for personal data
	Role of network effects	Primarily at the standardisation / productisation stage (e.g. through industry organisations such as TIP)
	Role of scale and scope economies	Large economies of scale as in all software markets; telecoms is a large user of IT resources, which could provide larger scale to cloud platforms if network functions can be migrated to cloud (hybrid private/public); potential economies of scope (portfolio expansion) for systems integrators, who can address operators' needs in the network space in lieu of traditional vendors
	Role of other differentiators	Requires deep understanding of network functions and the evolving needs of telecoms operators.
Other	Role in disruption/substitution	Potential to disrupt traditional network vendors (though they are all offering their own virtualised cloud solutions). Some concerns among operators (e.g. MNOs) that capture of large parts of value chain by Hyperscalers could leave them less able to invest.
	Role of regulation	None

Source of market size: ¹ Based on 2021 Analysys Mason estimate of total network cloud infrastructure spend by telecoms operators worldwide | Source of other information: Analysys Mason, press search



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Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	Provision of space and power to install the servers/appliances required to run online and cloud-based applications. There are various types of data centre, including: Hyperscaler-owned (i.e. Hyperscalers own in-house data centres), 3 rd party data centre providers (offering power and space services to Hyperscalers, and large/small enterprises), enterprise (i.e. those owned in-house by an enterprise) and telecom (data-centres owned by telecoms operators). Business model is mainly based on on-going fees to power and host servers/appliances (with some one-off installation/commissioning revenue), with density of racks and energy-efficient cooling being key commercial drivers.
	Approx. market size	UK: GBP2.9 billion (2021) ¹
	Market maturity	High - the provision of datacentres services is long established
	Key market players	Equinix, UpCloud, Ark Data Centres, Dell, Interxion
Power balance between stakeholders	Ability to exert control in the value chain	While the activities underpin much of the value chain for cloud and online services, offerings are commoditised and there is significant competition. Expansion by data centre providers into other services (e.g. IaaS) could represent increased scope for control.
	Nature of relationship with end-users	Direct retail relationship with enterprises using datacentres to house their servers (though many companies are migrating to cloud services, whereby datacentre space is sold on a wholesale basis)
	Nature of wholesale relationships	Typically arms length wholesale relationships with other service providers, though there are significant examples of vertical integration (e.g. Hyperscalers such as Google, Amazon and Microsoft all operate their own data centres)
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Limited role for data in improving services
	Role of network effects	None
	Role of scale and scope economies	Significant scale economies (larger data centres have lower cost per unit) are creating a significant barrier to entry (building a new data centre is very expensive). Some economies of scope in the provision of complementary services (such as connectivity)
	Role of other differentiators	Differentiators include rack density (greater rack density means more customers per unit of floorspace) and cooling efficiency: both of which will reduce the unit cost charged to customers. IXP-style connectivity within data centres (i.e. between providers of online services) is another important differentiator). DCs are 'tiered' based on the diversity of power supplies and connectivity routes they offer, and increasingly the nature of the power supply (renewable based) is becoming important to users.
Other	Role in disruption/substitution	Economies of scale driving a reduction in owned data centres by enterprises and telecoms operators, in favour of these companies moving their equipment to larger data centres or to using cloud services further up the cloud services 'stack'. The second effect has caused data centre and colocation revenue to fall in recent years, though it is now expected to stabilise.
	Role of regulation	No significant regulation

Source of market size: ¹Based on 2021 Analysys Mason estimates for colocation and server-hosting revenues, informed by published actuals from all data centre operators

Sources: Analysys Mason, press search

Wholesale cloud infrastructure services, including infrastructure and ‘containerisation’ as services (IaaS / CaaS)

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	<p>Communications services (including both telecoms and AV services) are increasingly being delivered via software running over standardised IT infrastructure, over the Internet. There are cost and performance benefits to be realised if these services can be used shared (i.e. cloud based) computing resources. There are a number of key concepts underpinning this paradigm shift:</p> <ul style="list-style-type: none"> Infrastructure as a Service (IaaS): whereby a cloud provider gives flexible access to shared computing resources (typically through virtual machines). A variant of this service is ‘bare metal’, with access to dedicated computing resources (e.g. physical CPU) Microservices: the practice of dividing up network software functions into small, flexible standalone packages of software Containerisation: once a microservice has been created in software, it is ‘containerised’ into a form that can be run on the IaaS resources mentioned above through a container engine (e.g. Kubernetes (‘K8s’) and Docker) Container as a Service (CaaS): whereby a cloud provider offers the engine to perform the containerisation <p>These concepts will allow communications services to be more flexible and scalable. Initially non-critical functions (e.g. CRM) will be delivered in this way, though cloud-native 5G is not far behind (e.g. Dish Network in the USA). Large internet providers (Hyperscalers) are seeking to gain a share of this new market (see below).</p>
	Approx. market size	Global: USD 64.3 billion (2020) ¹
	Market maturity	Low for communications providers – operators are cautious about transitioning to cloud, contractual relationships are not mature
	Key market players	Microsoft, Amazon, Google, DigitalOcean, UpCloud, Dell
Power balance between stakeholders	Ability to exert control in the value chain	Large cloud players are gradually entering the value chain for communications services by: 1) hosting non-critical services on their infrastructure; 2) providing software for operators to host ‘cloud ready’ services on their own infrastructure; 3) providing consultancy. Over time, operators are expected to move more of their functions to the cloud, at which point a relatively small number of large cloud providers (e.g. Microsoft, Google, Amazon) may have a large ability to control the value chain.
	Relationship with end-users	None
	Nature of wholesale relationships	Typically arms-length contractual relationships (between operators and cloud providers) though related examples of partnerships (e.g. Microsoft acquisition of AT&T Cloud Network Technology, which is it using to deliver a cloud network solution back to AT&T)
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Some access to usage data that could improve or support services
	Role of network effects	None
	Role of scale and scope economies	Large scale of Hyperscalers will allow services to be offered at low cost (one of the key drivers); scope economies are another key driver as multiple types of network functions can be run on the same shared underlying computing infrastructure.
	Role of other differentiators	Performance, configurability and flexibility of computing resources are likely to be significant differentiators
Other	Role in disruption/substitution	Likely to disrupt the model for providing network functionality (e.g. internet Hyperscalers potentially winning share from the cloud offerings of traditional network vendors) and the balance of retail vs. wholesale demand for datacentres
	Role of regulation	Regulators may need to consider a world where most communication services are delivered by a small number of large providers

Source of market size: ¹Estimate of worldwide infrastructure as a service (IaaS) market published by Gartner | Source of other info: Analysys Mason, press search



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Data brokers

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	Platforms that aggregate end-user data from multiple sources and sell either data or aggregated insight to third parties
	Approx. market size	Data brokerage is likely to be limited in the UK; the overall market globally is estimated at USD257 billion (2021) ¹
	Market maturity	High - It is a mature market with established players; they offer a range of services besides data brokerage, which leverage their relationships with first party data providers (controllers) and their extensive existing databases – this includes for example credit checks and other KYC applications; GDPR and other privacy regulations are creating significant constraints and complexities on their activities, which both limits the scope of what they can offer in the UK, and increases barriers to entry
	Key market players	Verisk, Acxiom, Oracle, Epsilon, Experian, Equifax
Power balance between stakeholders	Ability to exert control in the value chain	Medium – in the communications value chain, they have a limited impact; they can provide useful data inputs for advertising and user targeting, and automated provisioning of end users services that requires risk assessment or KYC checks is likely to increase the market power of large, established brokers
	Nature of relationship with end-users	Data brokers collect end-user data which might be gathered through public sources or bought through private sources; end-users are largely unaware of the scope and role of data brokers, and very few have direct relationships with them; much of the data is processed on behalf of other companies, not necessarily with end user consent (see Role of regulation)
	Nature of wholesale relationships	Data brokers have wholesale relationships with other enterprises as their customers, but may also buy data from others (credit card companies)
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Data is the service provided and is a vital element; end-user information may include name, age, gender, interests, purchase history etc.
	Role of network effects	N/A
	Role of scale and scope economies	Scale is important for data brokers to offer an attractive bundle of data; Hyperscalers are not present in this market but they can sell data to data brokers
	Role of other differentiators	Primary differentiators are related to scope and scale, and to their ability to plug into established processes within other industries (e.g. KYC and credit checks)
Other	Role in disruption/substitution	Automation of service provisioning that requires KYC checks (e.g. getting a mobile line) and credit (including personal credit and handset subsidies) increasingly relies on automated checks, in which data brokers play a central role
	Role of regulation	Data brokers are subject to GDPR (and UK equivalent) rules, which severely limits their ability sell personal data, unlike in the USA; they can however process data they already hold, and are likely to do so through legitimate interests rather than consent in many cases (e.g. for KYC and credit checks); many brokers allow end-users to view (and correct) the information it has gathered, but this is in many cases a mechanism to enrich their data sets and obtain users' (not necessarily fully informed) consent to use their data in a broader way

Source of market size: ¹ Based on 2020 global data brokers market revenue of USD246.09 billion and a CAGR of 4.3% by Maximize Market Research

Sources: Analysys Mason, press search, Maximize Market Research

Cloud-based enabling platforms

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	<p>Cloud-based enabling platforms sell resources to their customers which they can offer under their own brand. Modern enabling services relevant to the communications sector are typically based in the cloud, and we present here two example functions:</p> <ul style="list-style-type: none"> ▪ Voice and messaging platforms, such as Twilio. Twilio is best known for providing companies like Airbnb and Uber with SMS and voice services. For example, it provides the platform from which passengers can anonymously call (or be called by) their Uber driver. Some alternatives to Twilio include MessageBird and Plivo ▪ Cloud playout services, such as Brightcove, which allows companies worldwide to publish and distribute video on the web (e.g. for smaller VoD players, or for marketing campaigns and corporate communications). Some alternatives to Brightcove include Dacast, IBM Cloud Video and Wistia. Both AWS and Microsoft have cloud playout services. <p>The first category is sometimes known as a Communications Platform as a Service (though there is some overlap of this term with enterprise communications platforms – see other slide). The second category is sometimes known as Online Video Platforms. While both terms feature “platform”, these are not technically ‘Platform as a Service’, which sits lower in the stack, and supports the development of online software. These services could be classified as a type of Software as a Service (albeit operating at a wholesale level in some cases).</p>
	Approx. market size	Company revenues as indicators of market size: Twilio = USD1.8 billion (2020); Brightcove = USD197 million (2020) ¹
	Market maturity	Medium – Some companies are well established, but market is highly fragmented with scope for further innovation
	Key market players	See above examples.
Power balance between stakeholders	Ability to exert control in the value chain	Limited ability to exert control at this stage. While some players may be quite large (e.g. Twilio) there are alternatives, and nature of services is potentially quite niche. If Hyperscalers start to grow or acquire their offerings in this area, further control may be exerted.
	Nature of relationship with end-users	Services can be retail (e.g. to business end-users) or wholesale (e.g. to other online service providers). Where services are retail, end-user data could be gathered to help refine services.
	Wholesale relationships	Expected to be arms length contractual relationships
Competitive advantage, profit drivers and potential barriers to entry	Role of data	See above comment on end-users
	Role of network effects	None
	Role of scale and scope economies	Scale may be important to offer lower prices and compete. There is potential for scope economies (e.g. bundling playout services with CDN services)
	Role of other differentiators	Brand image and scale can be differentiators for enterprises looking for such services
Other	Role in disruption/substitution	Potential for some disruption. Voice and messaging platforms may be disrupting part of the business of traditional telcos. Cloud playout services may be contributing to overall disruption of traditional broadcast services by VoD.
	Role of regulation	None

Source of market size: ¹ Company reporting

Sources of other information: Analysys Mason, press search

M2M/IoT application providers

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	The general M2M/IoT proposition is to connect new types of things (i.e. beyond PCs, mobile phones, etc.) to the internet on a large scale. Those 'things' can be relatively simple (e.g. moisture sensor in a field of crops) or much more complicated (e.g., enabling robots to communicate in real time with a control system). Value chain includes devices, connectivity and application services. Application providers include three main components: <ul style="list-style-type: none"> Backend systems, which include servers to collect and analyse data Software platforms including device management, automation, security and data analytics Other services such as billing and customer support
	Approx. market size	UK: GBP2.6 billion (2021) ¹
	Market maturity	Medium – while some use cases and demand levels are still developing (e.g. private 5G as a mechanism for automation) other use cases are more mature (e.g. fleet management)
	Key market players	The application provider landscape is highly fragmented, including generalists and specialists across: device management, application development and data analytics. Hyperscalers such as AWS, Google and Microsoft all offer IoT software stacks.
Power balance between stakeholders	Ability to exert control in the value chain	The activity is a potentially important supply side-enabler. Combining applications with connectivity and devices has potential to exert control, but value chain is still developing and fragmented, and dynamics are still playing out.
	Nature of relationship with end-users	Currently limited direct relationship with end-users, but where application players can build a full M2M/IoT service, relationships with end-user could be captured.
	Nature of wholesale relationships	To build a full end-to-end M2M/IoT service will likely require wholesale relationships with device providers and connectivity providers. Systems integrators may also play a key role in bringing the three components together (applications, connectivity, devices)
Competitive advantage, profit drivers and potential barriers to entry	Role of data	As the key value chain function dealing with data, application providers potentially have visibility of large amounts of data from each associated IoT/M2M use case, potentially giving competitive advantage and ability to capture more of the value chain
	Role of network effects	Network effects are potentially important (due to large number of connected devices), but value will depend on specific use case.
	Role of scale and scope economies	Scale economies are more relevant to devices (see other slide). Scope economies are potentially useful, to integrate various service components (e.g. backend and software components) and also with connectivity and devices).
	Role of other differentiators	As with any communications related service, reliability/resilience performance likely to be a key differentiator. Scalability and ease of integration with other services are also likely to be key to winning market share.
Other	Role in disruption/substitution	The role of application providers in dealing with IoT/M2M data creates a risk to traditional connectivity providers (e.g. MNOs) of becoming 'dumb pipes' in the M2M/IoT value chain.
	Role of regulation	N/A

Source of market size: ¹ Based on 2021 Analysys Mason estimates for IoT application revenues

Sources: Analysys Mason, press search

Safety technology

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	Comprises both large tech companies (Google, Microsoft, Amazon) and smaller third-party providers; involves ID and age verification, user protection and platform level governance
	Approx. market size	UK: GBP314 million (2020) ¹
	Market maturity	Low - As this is a growing market with new use cases and technologies being developed, and an increasing focus on data protection and awareness around online harms
	Key market players	SuperAwesome, Yoti, Samurai Labs, Digital Safety CIC, ActiveFence, Podium, plus internal platforms of major social media providers: TikTok, Meta (Facebook and Instagram), Google (YouTube)
Power balance between stakeholders	Ability to exert control in the value chain	Low - They interact mainly with the end-user and their inputs; hence it is used usually based on end-user choice
	Nature of relationship with end-users	These services mainly interact with the end-users, but in various ways: either free or with a subscription, standalone or integrated with another service
	Nature of wholesale relationships	Large players usually develop their own technologies (vertically integrated), while third-party providers typically have contractual relationships with the websites or content providers they support
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Access to data is a key issue: 3 rd party technology providers need extensive datasets on harmful content (to develop their technology, including training AI/ML) but this is a) typically personal data and b) typically held within social media services
	Role of network effects	Related to the data point above, platforms with large numbers of users provide the richest source of data to develop the technology to identify harms and improve products and services.
	Role of scale and scope economies	There are significant scale differences between large tech providers and smaller third-party providers. There are also material economies of scope between the algorithms that recommend content and the algorithms that moderate content.
	Role of other differentiators	Intellectual property in the techniques and technologies for identifying and/or preventing harm is a key differentiator. Third-party providers usually choose to focus on one area of safety tech (age verification, harmful video etc.) to develop this intellectual property.
Other	Role in disruption/substitution	N/A
	Role of regulation	The Online Safety Tech Industry Association (OSTIA) was founded in 2020, and part of the remit will be to inform regulation, legislation and policy in this area.

Source of market size: ¹ Based on the report “The UK Safety Tech Sector: 2021 Analysis” by the DCMS

Sources: Analysys Mason, press search, Department for Digital, Culture, Media & Sport



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Digital wallets

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	Digital wallets provide a convenient way for consumers to purchase goods and services, either via a single device (e.g. Apple Pay) or convenient app/web interface (e.g. PayPal). End-users 'link' a bank account or existing credit / debit card to their digital wallet(s), and the wallet provider charges transaction fees to the bank account provider for use of the service. Merchants can decide whether to accept payments from digital wallets. Main business model is in driving loyalty to a device or service ecosystem (see below).
	Approx. market size	Global mobile wallet market: USD11bn (2020) ¹ ; PayPal revenue: USD21bn (2020)
	Market maturity	Medium – while the technology and proposition is fairly new, it has seen a strong take-up by consumers: a 2021 survey by Samsung revealed that 62% of the UK would prefer to use their payment card through their mobile wallet.
	Key market players	Apple Pay, Google Pay, PayPal, Samsung Pay, Amazon Pay
Power balance between stakeholders	Ability to exert control in the value chain	While the activity is a demand-side enabler / 2-sided market, digital wallets are not necessary for a purchase and hence currently have low ability to exert control in the value chain (on their own). However, as part of a suite of ecosystem services, digital wallets can contribute to switching costs away from certain device- or service-providers (alternative wallets do not support 'tap to pay').
	Nature of relationship with end-users	Services have a direct relationship with end-users, though the associated data is strictly controlled by banking privacy rules.
	Nature of wholesale relationships	Merchants can decide whether to accept payments from digital wallets and might consider factors such as payment security and popularity of the service (they may need to accept popular wallets such as Apple Pay); digital wallet providers also have agreements with banks and card schemes for providing services in exchange for fees; if bundled with devices (usually vertically integrated) then some integration is required (e.g. FaceID)
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Digital wallet providers can retain anonymised transaction data (as Apple states). Providers have implemented various methods and standards around data protection (e.g. tokenisation, device fingerprinting, other frameworks such as Samsung KNOX) and Google states that they do not share transaction history with third-party advertisers or other Google targeting ads.
	Role of network effects	On the wholesale side, network effects play a role as merchants start to accept various wallets as secure payment methods as more users adopt them. On the user side, many people multi-home using other banking services and cards
	Role of scale and scope economies	Scale is a important requirement to get both end-users and merchants on the platform; many device providers / Hyperscalers are present (e.g. Google Pay, Apple Pay) who bundle the services for those owning the device; digital wallet providers can also be vertically integrated with payment processing providers (e.g. PayPal offering both digital wallet and payment processing)
	Role of other differentiators	Method (and ease) of user authentication, device authentication and data protection are key differentiating factors. User authentication can take place through the device, i.e. smartwatch, face recognition, fingerprint, PIN, password or a 'swiped' pattern
Other	Role in disruption/substitution	Disrupting traditional banking services (not in Ofcom's remit)
	Role of regulation	Relevant financial regulations apply

News aggregation services

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	These services aggregate news items and articles from multiple publishers in one place, offering both an outlet for news publishers to advertise their content, and a place where users can find, and in some cases consume, news from multiple providers. These services can either be free to end users (e.g. Google News, Apple News) or subscription-based (e.g. Apple News+); free services can be ad-supported and platforms often share related ad revenues with publishers
	Approx. market size	Suitable data not available
	Market maturity	Medium – online news consumption is mature, but the ways in which users are discovering, sharing, consuming news keep evolving
	Key market players	Apple News+, Apple News, Google News, Flipboard, Pocket, Facebook News
Power balance between stakeholders	Ability to exert control in the value chain	High: depending on the publisher, linking from aggregators can be a major source of traffic, particularly for ad-supported news; for the relatively small proportion of paying subscribers to individual publications, news aggregation can be a convenient way to get exposure to content and recommendations and increase the utility of their subscription (which also benefits publishers)
	Nature of relationship with end-users	These can be free or paid-for, and act as intermediaries between the end-users and content providers; paid services benefit directly from the scale of demand from end-users, while free services aim at providing relevant content and improve their understanding of users' interest for other purposes (e.g. advertising)
	Nature of wholesale relationships	Contractual relationships between publishers and news aggregators govern revenue sharing, data sharing, and the approach to linking vs. aggregating content; news publishers in some countries (albeit notably not in the UK) have sought to derive ancillary copyright-related payments for linking and aggregating news items, with limited success so far, as they themselves derive significant value from linking (effectively free advertising) from news aggregators
Competitive advantage, profit drivers and potential barriers to entry	Role of data	News aggregators collect end-user data specifically about the service accessed/content provided which can be used to improve the offerings, and to better monetise the platform; data on interests and what sources of news individual users consume is easier to obtain for aggregators than for publishers
	Role of network effects	Network effects are primarily indirect, as large aggregation platforms are more important and attractive to publishers, particularly for ad-based content; the type of users is disproportionately important for many news publishers, as a small minority of users subscribe to publishers' content and contribute a large proportion of their revenue
	Role of scale and scope economies	Limited besides the network effects highlighted above
	Role of other differentiators	Access to content is a significant factor; however exclusive content is not commonplace
Other	Role in disruption/substitution	Established structural impact to print newspapers, with further disruption to online news websites (e.g. The Guardian) which may have reduced traffic due to news aggregators
	Role of regulation	Several attempts to regulate payments from aggregators to publishers (e.g. ancillary copyright) (Spain, France, Australia)



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PC devices, including installed software

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	Business model is rather simple which includes sale of hardware (personal computer devices)
	Approx. market size	Global: USD162 billion (2021) ¹
	Market maturity	High
	Key market players	Lenovo, HP, Dell, Apple, Acer, Asus
Power balance between stakeholders	Ability to exert control in the value chain	Demand-side gateway: while PC hardware tends to have a limited scope to exert control on the value chain, the installed operating system (OS) tends to be from one of three large providers (Microsoft, Apple or Google), which lends itself to users using default or pre-installed services or app stores and ecosystem effects.
	Nature of relationship with end-users	Direct paid relationship with the end-user where the device is required to access services; PC devices usage data does tend to yield the same rich set of data as handheld devices and smart TVs
	Nature of wholesale relationships	Wholesale include pre-installs of OS (usually an arms length agreement for windows PCs or vertically integrated for Apple) and default functionality (e.g. Apple payments to Google to keep Google as the default search engine in the Safari browser).
Competitive advantage, profit drivers and potential barriers to entry	Role of data	PCs can collect personal data; however this is more limited than mobile devices/smart TV's and wearables
	Role of network effects	Some network effects from applications such as FaceTime on Apple Macbooks. Devices themselves are generally interoperable with some people multi-homing (especially for work and leisure use), though with some integration benefits with other hardware (e.g. streaming from iPhone to Mac)
	Role of scale and scope economies	Scale is important to reduce unit costs and exert control over component suppliers; some Hyperscalers offer PC devices with Apple as one of the largest ones; vertical integration with operating systems and default applications can influence take-up of other software
	Role of other differentiators	Brand important to perception of performance and reliability; components and software are largely commoditised; some scope for differentiation with new hardware features (e.g. 2-in-1 devices, trackbars)
Other	Role in disruption/substitution	N/A
	Role of regulation	N/A

Source for market size: ¹ Based on 2021 global PC market revenue from The Business Research Company's report "Personal computers global market report 2021"

Sources: Analysys Mason, press research, The Business Research Company

Handheld devices, smart phones, and app store ecosystems

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	Business model includes sale of hardware (hand-held devices), which can be a one-off purchase, or financed by an MNO through a subscription (bundled with connectivity); two main ecosystems exist, with strong tying with app stores (revenue through one-off or subscription fees for apps, in-app purchases, ads) where the app store provider takes a share of revenue (15-30%)
	Approx. market size	Global value of smartphone sales: USD409 billion; Western Europe: USD56 billion ¹
	Market maturity	Medium - Demand and players have been established for a while, but the proposition is constantly developing
	Key market players	Apple, Samsung, ZTE, Huawei, Google, Motorola, Amazon
Power balance between stakeholders	Ability to exert control in the value chain	Demand-side gateway: handheld devices have high ability to exert power in the value chain due to default applications, app stores and other bundled services (such as iMessage with Apple products, and Google search and browser on devices with the Android OS), which all contribute to switching costs away from the device. App stores are two sided markets (between end-users and developers).
	Nature of relationship with end-users	Direct paid relationship with the end-user where the device is required to access services; handheld devices can gather extensive data about usage, contacts, location, health, etc. The rich source of data means that handheld devices act as a platform where new applications can be developed and new ways to interact with customers can be created. eSIMs have potential to disrupt the relationships that MNOs hold, via the device, with end-users.
	Nature of wholesale relationships	App stores include wholesale relationship with software/app developers (usually via a revenue share model).
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Data collected: Handheld devices can collect a variety of data around device/app usage, and in some cases this data can be better associate to an individual profile than with PCs. In addition, these devices also collect personal data such as location, screen time, alarm times, steps taken in a day, other health-related measures Data usage: The collected data can then be used for advertising for third parties or to impact end-user choice on the app store and by ranking of the applications available to gain more end-user attention
	Role of network effects	Some network effects associated with closed services attached to specific devices (e.g. iMessage on iOS devices)
	Role of scale and scope economies	Significant scope effects arise from the 'ecosystem' around mobile devices, which includes services (e.g. Apple Music) and other devices (set top boxes, PCs, tablets, smart speakers) which share data, apps, settings and can even interoperate. This drives loyalty and stickiness to that ecosystem, self preferencing and increased switching costs (e.g. created by bundled applications and services: messaging services, AV services, map services, digital wallets, integration with other types of device).
	Role of other differentiators	Most device designs and the brand is protected through patents; further differentiation around device performance (processing speed, battery life, camera performance, screen quality)
Other	Role in disruption/substitution	Some disruption to the traditional AV/broadcast market, as it creates competition for the share of 'screentime' eSIM technology has the potential to significantly disrupt the MNOs relationship with the end-user.
	Role of regulation	Limited specific regulation, though there has been scrutiny under antitrust regulations

Source for market size: ¹ Based on 2021 global smartphone market revenue from Statista

Sources: Analysys Mason, press search, Statista

Smart TV devices and streaming devices (sticks, boxes)

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	Business model includes sale of hardware for consuming contemporary AV services, including those delivered online and with on-demand consumption. Includes the 'smart' functionality of modern TV sets (where the business model is to drive upgrade purchases) and plug-in 'sticks', where the business model is to provide a low cost upgrade for an existing TV set to allow the sale/consumption of new AV services. Both Smart TVs and sticks are typically bundled with app stores which manage the applications that can be installed on the device. Revenue streams also include on-device advertising and in-app purchases. In some cases, the Operating System (OS) may be a relevant component of business model (e.g. Android TVs)
	Approx. market size	Ofcom 2021 technology tracker showed that 68% of UK households have a Smart TV which is connected to the internet
	Market maturity	High - Ofcom's survey shows that most adults have connected TV devices in their homes (high penetration)
	Key market players	Samsung, LG, Sony, Sky Q and Glass, Panasonic, Amazon Fire Stick, Apple TV 4K, Chromecast, Freeview Play
Power balance between stakeholders	Ability to exert control in the value chain	Demand-side gateway: Smart TVs and streaming devices have high ability to exert control especially around prominence of different content platforms, as well as shortcut buttons on remote controls
	Nature of relationship with end-users	Direct paid relationship with the end-user where the device is required to access services; smart TVs can collect data on usage of channels and streaming apps; which can help deliver more targeted advertising; research has shown that smart TV's can and do report this data back which may not always be consented by the end-user
	Nature of wholesale relationships	Wholesale relationship with software/app developers: smart TVs include third-party apps but can have a more restricted selection than handheld devices, due to the more fragmented TV manufacturer landscape, and the need to make sure each app is compliant with different brands of TV. This last dynamic creates an opportunity for Hyperscaler-produced sticks to provide a low-cost upgrade and become the main interface (e.g. Google Chromecast, Amazon Firestick)
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Viewers' choice of platforms and how much time is spent on each can be obtained by smart TVs, allowing personalised data to be collected for advertising and other purposes. This can be a significant competitive advantage if used (see above)
	Role of network effects	The fragmented market for TV hardware (compared to handhelds) limits network effects, and provides an opportunity for Hyperscalers to exert influence (e.g. Sony, Panasonic and Philips all offer TVs with Google's Android OS).
	Role of scale and scope economies	Similar to handheld devices, some ecosystem network effects, e.g. Samsung TVs and handheld devices; TVs with an Android OS and Google devices and services; TVs compatible with Amazon's Alexa voice assistant. Hyperscaler are presence in OS and streaming devices (Google Chromecast and Android OS, Apple TV, Amazon Fire Stick) which also provide streaming/video services and can use smart TVs to promote own content over others (via app stores and OS)
	Role of other differentiators	Brand important to perception of performance and reliability; components are largely commoditised; some scope for differentiation with OS and support for apps and integration with other devices (e.g. voice assistants)
Other	Role in disruption/substitution	Disruption to traditional broadcasters and Pay-TV operators by making online video more accessible
	Role of regulation	PSB prominence rules on EPGs

Smart home and voice assistance devices

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	Voice assistance relies on software that can recognise voice, process and respond to voice commands; voice assistance software is used in smart speakers and other 'smart' devices (smartphones, smart TV's, smart watches, etc.)
	Approx. market size	Global: USD8.3 billion (2021) ¹ primarily linked to device sales, in particular smart speakers
	Market maturity	Medium - relatively new technologies, but the ecosystem has coalesced around Amazon Alexa and Google Assistant (integrated in third-party devices) and Apple Siri (in Apple devices only); demand is less mature, with discretionary and experimental usage for most users and applications; beyond devices, the revenue model is indirect, closely linked to other services (search, Amazon Prime, Apple Music)
	Key market players	Amazon Alexa, Google Assistant, Apple Siri, Microsoft Cortana; all except Microsoft offer a range of smart home devices integrating these assistants, and many third-party manufacturers integrate Google Assistant and/or Amazon Alexa in their devices
Power balance between stakeholders	Ability to exert control in the value chain	These devices act as gateways to services such as music platforms, radio, weather forecasts and smart home controllers; this gives them the potential to have a high degree of control over these services, and influence / restrict end-user choices (where they default to a particular family of services)
	Nature of relationship with end-users	Direct paid relationship with the end-user where the device is required to access services (e.g. Siri integration on iPhones); and indirect relationship when users purchase third-party devices or applications (e.g. Alexa installed on Sonos speakers).
	Nature of wholesale relationships	Relationships exist between assistant providers (Google, Amazon) and (1) third-party manufacturers of smart home devices and (2) software/app developers, including of smart home systems; smart speakers often have default apps (sometimes provided by the same company, e.g. Apple Music through Siri)
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Voice recognition itself is mature and readily available, but the ability to interpret commands remains nascent and highly complex, and can only be improved through the use of large amounts of data in many different contexts, which plays to the strength of players with access to a lot of data and powerful search-like capabilities (with their stores of data being added to by the voice assistants)
	Role of network effects	Network effects are driven by the improvement that assistants can achieve by serving a broad and diversified base of users and needs; indirect network effects arise when third-party manufacturers and developers adopt or support a specific assistant due to market size
	Role of scale and scope economies	Scale is important to reduce unit costs and exert control over the suppliers; economies of scope are related to the benefits users derive from being able to use the same assistant on multiple devices, which reduces adoption and usage frictions, and can improve the utility they derive from using the assistant
	Role of other differentiators	Brand perception linked to performance, reliability and trust; differentiation through deals with manufacturers and app developers
Other	Role in disruption/substitution	Traditional radio services and any commoditised services will be disrupted by the default choices of the assistant; lack of visual cues when using voice assistant may affect user agency and choice
	Role of regulation	The industry has argued for new rules to ensure that makers of smart speakers protect listener access to radio services

Source of market size: ¹Based on 2020 global smart speaker revenue of USD1.7 billion and a CAGR of 17.1% from MarketsAndMarkets

Sources: Analysys Mason, press search, Markets and Markets

M2M/IoT devices

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	The general M2M/IoT proposition is to connect new types of things (i.e. beyond PCs, mobile phones, etc.) to the internet on a large scale. Things range from very simple (e.g. moisture sensor in a field of crops) to more complicated (e.g. embedded data connection in an electric car). Value chain includes devices, connectivity and application/enabler services. Devices in the M2M/IoT value chain require additional hardware: <ul style="list-style-type: none"> • Sensor and actuators capture data from the device and respond to instructions / make changes to the device • Communications hardware allows the device to connect to a network to send/receive data and instructions Business models include sale of the devices on a standalone basis to end-users and/or solutions providers (for which connectivity and backend systems must be also added) or sold to end-user with connectivity/backend systems embedded with the sale of the device (e.g. Amazon Kindle and some connected cars)
	Approx. market size	UK: GBP1 billion (2021) ¹
	Market maturity	Medium – while some use cases and demand levels are still developing (e.g. private 5G as a mechanism for automation) other use cases are more mature (e.g. fleet management)
	Key market players	The IoT/M2M device domain includes chipset designers and sellers (e.g. Arm, Altair, Qualcomm), providers of SIMs and connectivity modules (e.g. G+D, Sierra Wireless and Telit), plus OEMs that build devices such as Smart Meters (e.g. Diehl Metering and Itron)
Power balance between stakeholders	Ability to exert control in the value chain	Devices represent a demand-side gateway. Combining devices with connectivity and application/enabler services has potential to exert control, but value chain is still developing and fragmented, and dynamics are still playing out.
	Nature of relationship with end-users	Potential for a full- or no-relationship with the end-user. Where the device is bundled with connectivity and application services, the device provider owns the relationship with the end-user (e.g. Amazon Kindle). Where the device is part of an end-to-end service provided by a service provider, the device itself may be incidental to the customer relationship.
	Nature of wholesale relationships	Wholesale relationships with connectivity and application/enabler providers are important, and would typically be arms-length contractual relationships. Installation/commissioning providers are important, and make up a material proportion of device value.
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Data collected is limited by the specific use case, and could confer competitive advantage, depending on the terms of use
	Role of network effects	Network effects are potentially important (due to large number of connected devices), but value will depend on specific use case.
	Role of scale and scope economies	Scale economies could be important to drive down the cost of individual devices (for those use cases that require very large numbers of devices)
	Role of other differentiators	The importance of other differentiators is to be proven in time, but could include reliability/longevity of devices, processing capability, compatibility with other types of device and services. Use of 5G chipsets is currently expensive, so devices that use other connectivity (e.g. Wi-Fi) could have a cost advantage in the short term (until the cost of 5G chipsets falls).
Other	Role in disruption/substitution	Where the connectivity is embedded with the device, this risks disrupting the conventional relationship with the end-user that connectivity providers such as MNOs may have expected to maintain.
	Role of regulation	Type approval / compliance with frequency management measures for wireless devices; conditions of portability to a new supplier for embedded devices

Source of market size: ¹ Based on 2021 Analysys Mason estimates for IoT hardware revenues

Sources: Analysys Mason, press search

Browsers

Summary of activity

Category	Market dynamic	Notes
Summary characteristics	Main business model	Essential software for browsing the World Wide Web. Usually provided for free, either as default or pre-installed software, but others can be downloaded. Commercial purpose ranges from being a source of data (e.g. Google Chrome), to encouraging use of productivity software (e.g. Microsoft Edge)
	Approx. market size	Negligible (browsers are typically free)
	Market maturity	High - It's a mature market with established players
	Key market players	Google Chrome, Mozilla Firefox, Apple Safari, Microsoft Edge, Opera, Vivaldi
Power balance between stakeholders	Ability to exert control in the value chain	While browsers are a functional demand-side gateway (many online services cannot be accessed without one), influence on the value chain is limited to default choice of search engine (which can easily be changed by the end-user) and minor improvements in functionality for some applications (e.g. Microsoft SharePoint is best suited to be accessed in Edge)
	Nature of relationship with end-users	Direct, free relationship with the end-user and is required to access the World Wide Web; essential part of value chain between devices and other online services, including search engines
	Nature of wholesale relationships	Wholesale relationships can include agreements for default search engines in browsers and default browsers on certain devices (although nature of agreements can be opaque or non-existent when vertically integrated)
Competitive advantage, profit drivers and potential barriers to entry	Role of data	Some data is collected by browsers such as hardware/software data (IP address, battery, CPU etc.), location, browsing history, logins, cookie settings and information, however, some providers have more aggressive data collection practices than others.
	Role of network effects	Network effects are negligible; multi-homing is common, especially depending on the device
	Role of scale and scope economies	Scale is not so important; various Hyperscalers such as Google and Microsoft are dominant players which can then connect the value chain between devices and the search engines; it helps to provide devices which can then use default browsers
	Role of other differentiators	Visual appearance, speed and security are significant differentiators, and lead to strong self-preferencing behaviours, effectively creating a barrier to switching
Other	Role in disruption/substitution	N/A
	Role of regulation	Microsoft was previously obligated to offer a choice of browsers on new installs of Windows, but the obligation expired in 2014



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Granular view of the value chain

One-pager assessments of selected markets

Strategic commercial analysis

NIICS

Smart speakers

Safety technology

Video on Demand

Cloud for telco networks

Connectivity services for enterprises

Content delivery networks (CDNs)

In the following sections, we provide a ‘deep dive’ strategic commercial analysis of seven selected markets

Overall structure of strategic commercial analysis

Each section follows a similar structure (though not all sections have all points):

- Business model
- Value chain
- Market players, trends, metrics and shares
- Technical and business model innovations
- Relationships across the value chain
- Conclusions

Markets selected for strategic commercial analysis

- NIICS
- Smart speakers
- Safety technology
- VoD
- Cloud for telco networks
- Connectivity services for enterprise
- Content Delivery Networks (CDNs)



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Content delivery networks (CDNs)

NIICS services' primary focus tends to be for non-revenue purposes such as increasing loyalty, complementing other services and collecting data

- Number-independent interpersonal communications service (NIICS) is defined by Ofcom as 'interpersonal communications service which does not connect to publicly assigned numbering resources' and include WhatsApp, Viber, iMessage
- Most NIICS services include provision of messaging and voice/video calling 'over the top' i.e., using an internet connection
- Most services include one-to-one or many-to-many (usually referred to as 'groups') communications¹ as opposed to one-to-one for SMS or traditional calling
 - group chats increase stickiness to some providers and create network effects²
- Services tend not to generate revenue from usage directly, but can be used for other purposes such as
 - complementing other online services (e.g. gaming)
 - increasing engagement and stickiness to an ecosystem (e.g. Google Duo, iMessage on Apple Devices)
 - as a source of data for adjacent platforms (end-user data for Facebook from Facebook Messenger and WhatsApp)
- Revenue generation can come from enterprises, e.g. application-to-person (A2P)³ messages through NIICS

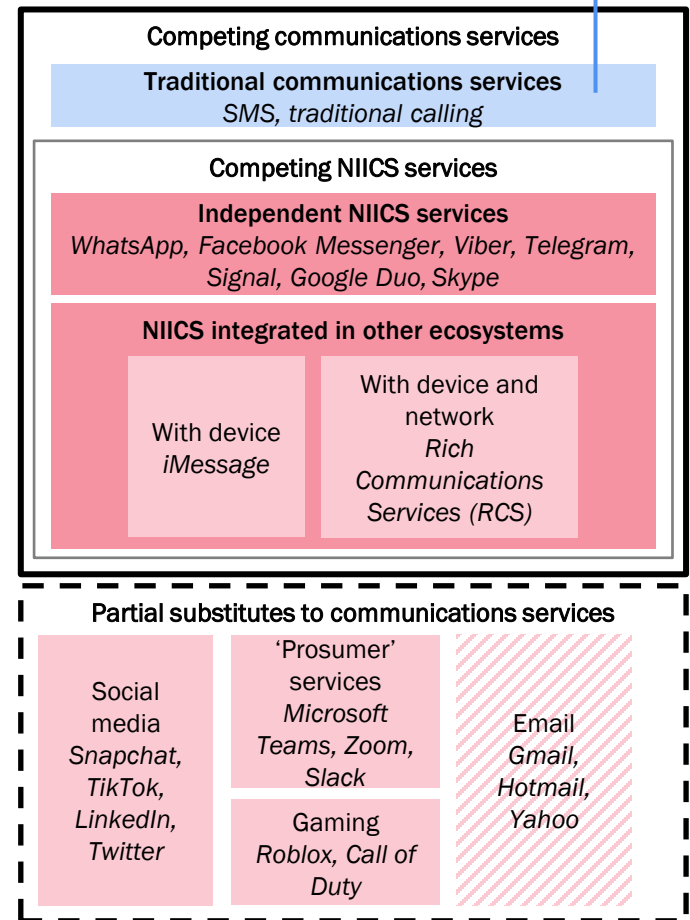
¹ There are also one-to-many 'event' communications which are more related with 'prosumer' services

² The typical definition of network effects is that the value to an individual user is increased with a greater number of users taking the service. Network effects in NIICS services create switching costs in the dynamics of group chat. Once in a group (which may be quite small), a user is likely to face substantial inconvenience to move to another service (since all members of the group would have to move). So, group chats encourage users to stay with a particular NIICS provider. However, conventional network effects are still relevant: the larger the user base, the more likely is it that potential group members will already have an account with a particular NIICS provider when the group is set up.

³ An A2P message is any type of message that is sent to a consumer mobile client for a commercial purpose from any source other than a private consumer account

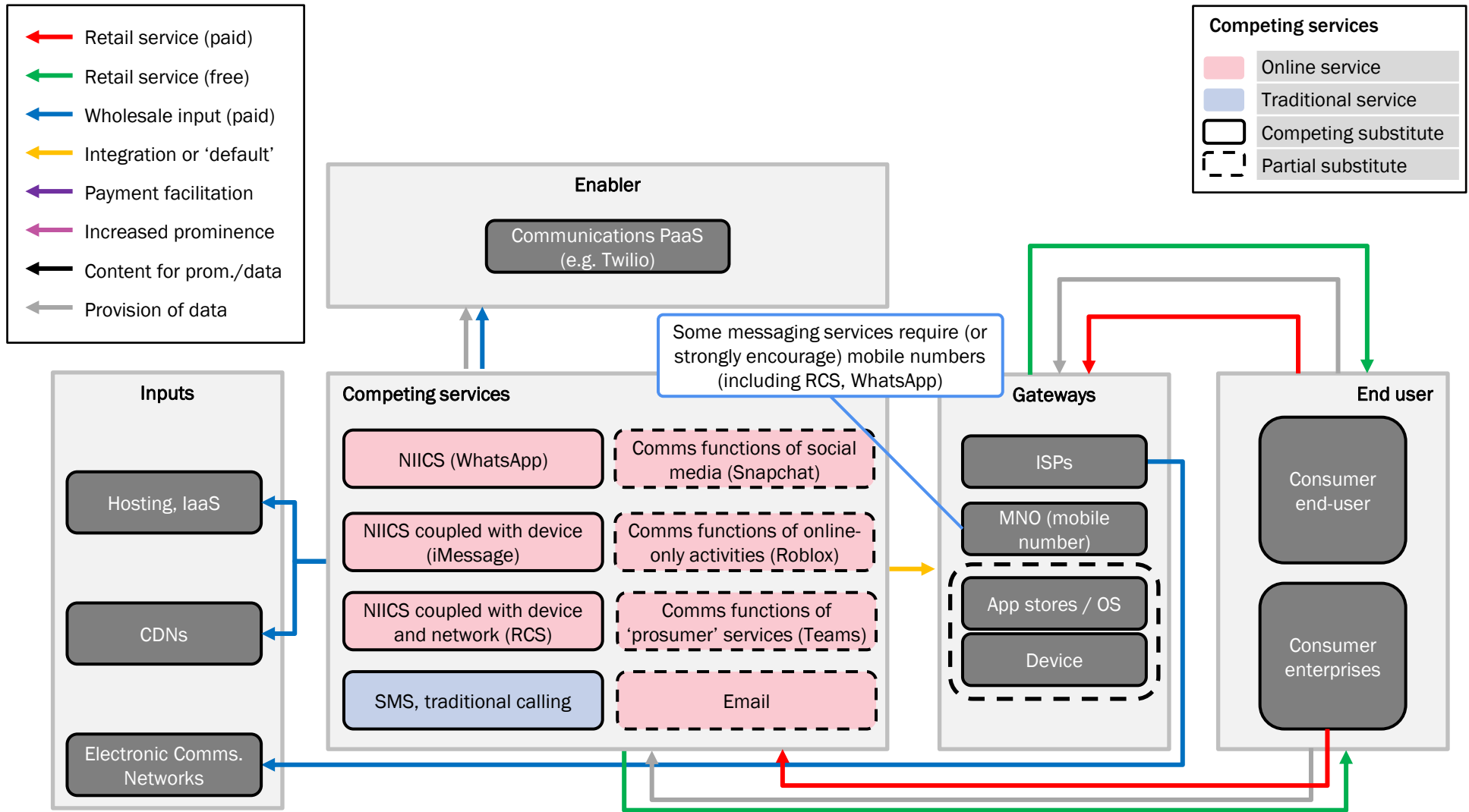
Unlike NIICS, traditional services can reach any device and are interoperable

Grouping of NIICS services



- NIICS services
- Traditional services
- Only-messaging services without call options

The value chain for NIICS includes competition with similar services and an important role for certain gateways that manage the relationship with end-users



Hyperscalers such as Meta, Apple and Google are the major players in NIICS services, but there are also smaller alternatives such as Telegram

Summary of key NIICS services in the UK

UK penetration appears low which might be due to integration of both of these services with SMS, likely to be other Hyperscalers' strategy to be able to compete with Meta

There are other NIICS services, but will have small take-up in the UK¹

Operator	WhatsApp	Facebook Messenger	iMessage / FaceTime	RCS	Google Duo	Telegram	Discord	Viber	Signal
Ownership	Meta (listed)	Meta (listed)	Apple (listed)	Open joint attempt by networks and device manufacturers (Google)	Google (listed)	Private	Private	Rakuten Group (listed)	Private
Founded in	2009	2008 (with Facebook); 2011 (standalone)	2011	2007 (Google's support in 2019)	2016	2013	2015	2010	2018
Services offered	Messaging Calling Video calling	Messaging Calling Video calling	Messaging Calling Video calling	Messaging Calling Video calling	Calling Video calling ²	Messaging Calling Video calling	Messaging Calling Video calling	Messaging Calling Video calling	Messaging Calling Video calling
No. of global monthly active users	2 billion (Feb 2020)	1.3 billion (2020)	N/A (est. over 1 billion iPhone users)	1.2 billion (2020)	N/A	500 million (Jan 2021)	150 million (Sept 2021)	260 million (2021)	40 million
UK users penetration and (estimated million users), 2021 ³	63% (38 million)	49% (29 million)	iMessage 19% (13 million); FaceTime 20% (13 million)	5% (3 million)	N/A	9% (5 million)	4% (3 million)	3% (2 million)	2% (1 million)
Features / differentiators	Largest network for NIICS	Mainly used to enhance the Facebook social media platform	Bundled with Apple devices and integrated with the SMS application	Focus on interoperability and integrated with SMS application	Focus on high-quality, encrypted video calls	Focus on privacy with usernames and self-deleting past conversations	Focus on group calls, and used especially by online gamers	Encrypted alternative to others	Uses open source software, which is used by WhatsApp; end-to-end encrypted

¹ WeChat, Line and Kakao Talk all have 3% or lower penetration in the UK

² Google Duo allows voice/video messages to be sent

³ Based on Analysys Mason Research's Connected Consumer Survey carried out in 2021 with 1013 participants in the UK answering the question 'Which of the following social or communications apps do you use on your mobile phone?'; UK users are total of children and adults, where smartphone penetration is applied for children by age range (as reported by Ofcom)

Source: Analysys Mason, company websites, press search, Ofcom

‘Prosumer’ services are mostly used in business: these do not represent complete substitutes for NIICS which are typically used as personal messaging tools

- ‘Prosumer’ services have similar features to NIICS services used for personal messaging, but their usage is generally more around business settings
- While statistics are difficult to find about usage of NIICS services such as WhatsApp and ‘prosumer’ services such as Teams, their usage characteristics are expected to be different:
 - ‘prosumer’ services can be interoperable, unlike NIICS which are more closed; ‘prosumer’ services have a need to enable collaborations across different enterprises
 - in April 2020, Microsoft Teams and Slack announced calling integration between services
 - ‘prosumer’ services usage is expected to include more use of calls (incl. video calls) due to professional meetings, where NIICS services may be more focussed on messaging (and voice messages)
 - ‘prosumer’ services are also more integrated with other productivity tools such as file sharing, cloud storage, surveys, calendars etc.
 - i.e. Microsoft Teams syncs with various other features such as calendar, file management and sharing, channels etc. and is sold as a bundle to enterprises

Summary of key ‘prosumer’ services in the UK

Operator	Teams	Slack	Zoom	Google Chat / Google Meet ²
Ownership	Microsoft (listed)	Salesforce ¹ (listed)	Listed	Google (listed)
Founded in	2017	2009	2011	2013 (from Google Hangouts)
Services offered	Messaging Calling Video calling File management Interface with other apps	Messaging Calling Video calling Interface with other apps	Messaging Calling Video calling	Messaging Calling Video calling File mgt Interface with other apps
No. of global monthly active users	250 million (June 2021)	N/A	12.9 million (Feb 2020)	N/A
Revenue, 2020 (USD million)	N/A	903	2,651	N/A
No. of global daily active users	75 million (March 2020) 115 million (Oct 2021)	12.5 million (March 2020)	4.8 million (March 2020)	250 000 (Google Meet)
Features / differentiators	Bundles various services offered by Microsoft, incl. Microsoft 365, Outlook, SharePoint	Main competitor to MS Teams; filed antitrust complaint against Microsoft to the EC in 2020	Focus on video calls and meetings, and used frequently for meetings across enterprises	Google Chat has similar features to Teams and Slack, whereas Google Meet has a focus on video calling

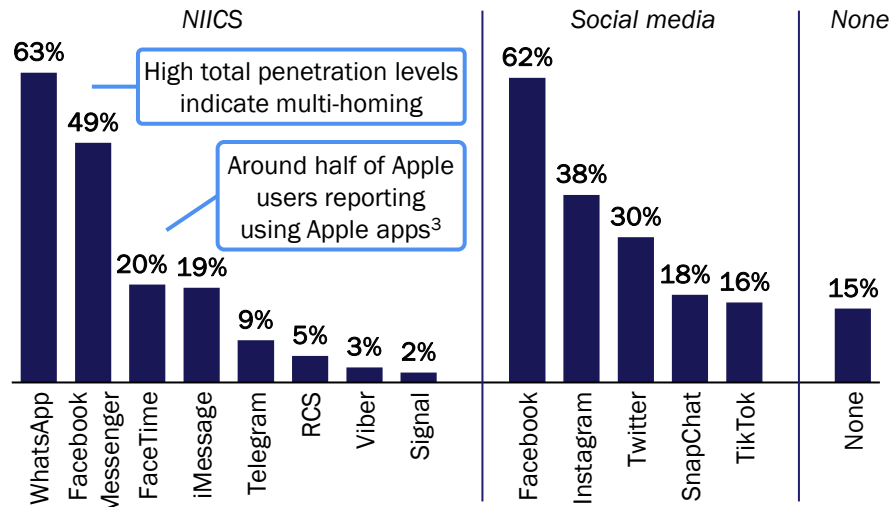
¹ Salesforce completed the acquisition of Slack in June 2021 for USD27.7 billion

² Google Chat and Google Meet are separate platforms, born out of Google Hangouts

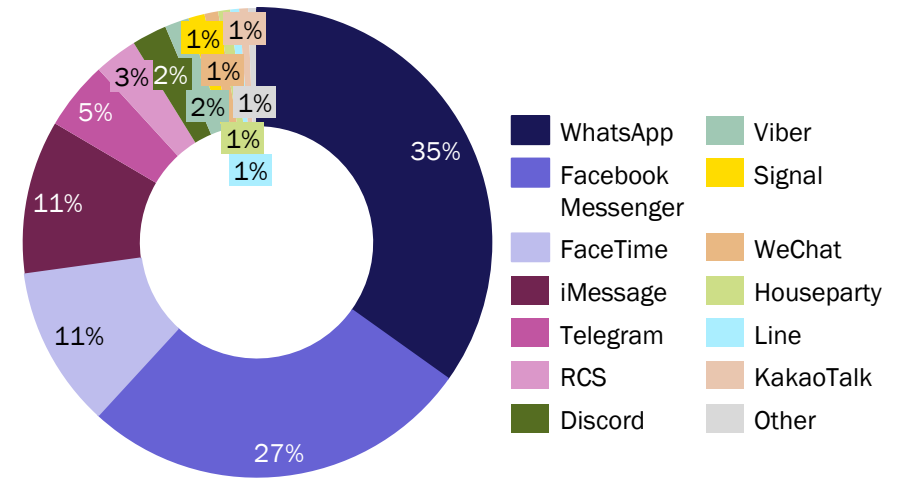
Source: Analysys Mason, company websites, press search

Data on the penetration of different NIICS services shows that Meta-owned services have the highest market share, followed by Apple

Penetration of NIICS and social media platforms in the UK, 2021 (%)¹



Estimated market shares of user accounts in the UK, 2021²



- Based on the CCS, Meta owns the most used NIICS platforms (WhatsApp, Facebook Messenger)
- Almost all social media platforms have messaging functions which closely compete with NIICS platforms, the most popular also owned by Meta
- Only 15% of respondents in the UK do not use either NIICS or social media platforms

- Based on the penetration levels from CCS, market shares of user accounts in the UK have been estimated
- Meta-owned WhatsApp and Facebook Messenger together appear to make up for 62% of NIICS user accounts
- This is followed by Apple’s services and with rest of the market being fragmented with rather small players
 - RCS, supported by Google, could experience further growth

¹ Based on Analysys Mason’s Connected Consumer Survey (CCS) carried out in 2021 with 1013 participants in the UK

² Based on penetration figures from CCS, excluding social media and cloud-based enterprise

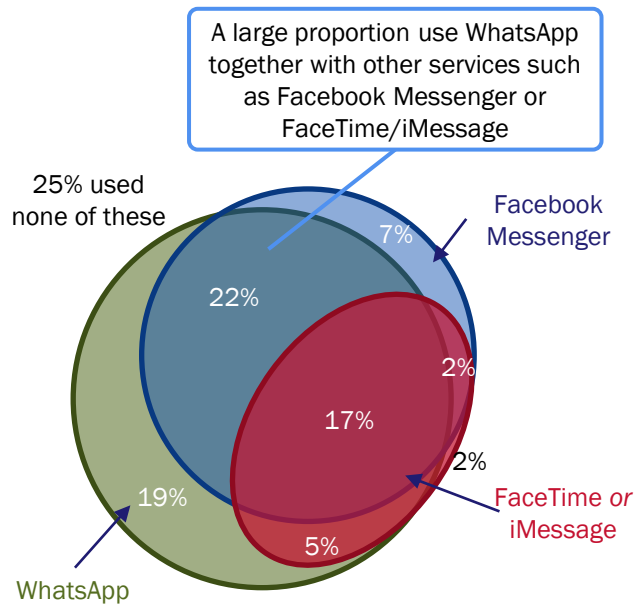
³ Around 40% of respondents to our CCS reported having an Apple device, suggesting around half of those report using Apple’s communications apps. This low ‘usage’ is from a combination of using other apps (e.g. WhatsApp) or being unaware of the functionality (because iMessage is integrated with the SMS app).

⁴ Our survey asked a simple question as to whether a particular application is used | Source: Analysys Mason

Our survey shows *whether* a service has been used⁴, but data on *how much* (e.g. number of messages sent) is not publicly available

High penetration levels show that multi-homing is common, with Meta services leading, and additional features show a much lower take-up than use of messaging

Overlap of usage between the largest providers in the UK, 2021 (%)¹



In a survey of UK NIICS and social media users, the usage rate of different features, 2021 (%)¹

Feature	Feature penetration
Messaging	81%
Picture sharing	49%
Free voice call	46%
Video calls	38%
Voice messages	30%
File sharing	17%
Games	16%
Online purchases	15%
Stories	13%
Following influencers	10%
Location sharing	9%
Paid for voice calls	8%
Stickers	7%
Customer support	7%
Sending money	6%
Other features	4%

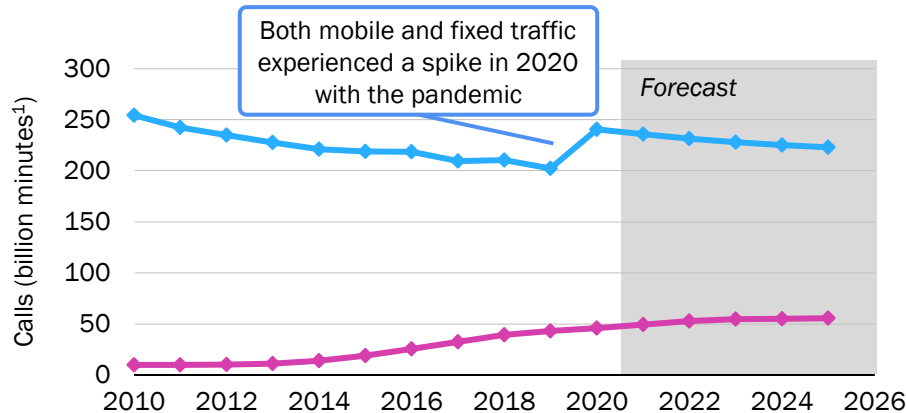
Out of the top five features, four are related to communications

- There is a large usage overlap between the largest NIICS providers and Meta-owned services are used widely
 - only 2% of the participants use FaceTime / iMessage without WhatsApp or Facebook Messenger (both owned by Meta)
- According to the Connected Consumer Survey, messaging, voice calls, video calls and voice messages were among the top five most used features among users of NIICS and social media platforms
 - users of both NIICS and social media platforms point out that communications-related features are most frequently used

¹ Based on Analysys Mason Research’s Connected Consumer Survey (CCS) carried out in 2021 with 1013 participants in the UK
 Source: Analysys Mason

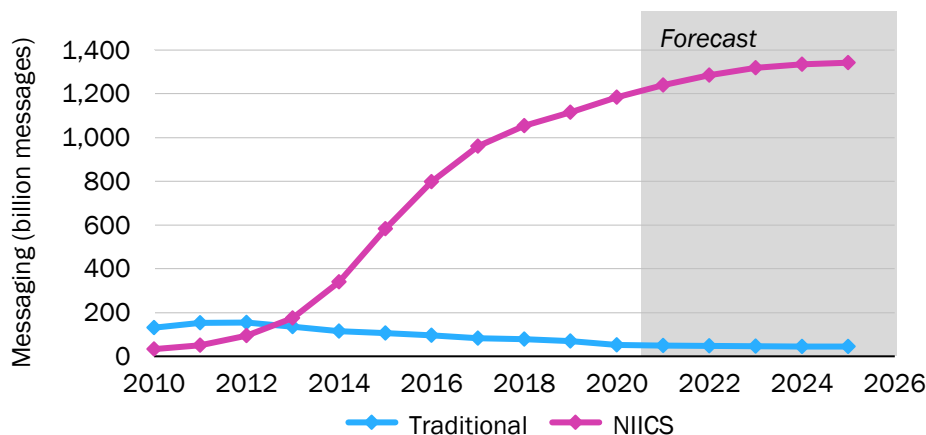
NIICS messaging traffic has long overtaken traditional messaging services, while traditional calls are expected to remain as the principal way for calling

Calls traffic in the UK by traditional and NIICS



- Traditional calls volume was decreasing until 2020 when the Covid-19 pandemic resulted in a surge for traditional calls volume
 - both mobile and fixed calls experienced an increase of around 20% in 2020
- Overall traditional calls traffic is expected to keep decreasing after 2020, mainly driven by fixed calls traffic reduction while mobile calls traffic is expected to remain stable
- NIICS calls traffic is expected to increase in the next five years, although still much lower than traditional calls traffic
- NIICS messaging has long overtaken traditional messaging which is expected to decline further by 2025, while NIICS messaging is expected to increase at a slower rate
- NIICS services traffic is driven by several factors:
 - conversations typically include a higher number of messages due to free nature of these services
 - group messages also contribute significantly to traffic levels
 - demographics plays a key role, with younger users having a preference for NIICS services over traditional services

Person-to-person messaging traffic in the UK by traditional and NIICS



The overall impact on telecoms operators of losing traditional call and message revenues can be mitigated to some extent via a rebalancing of pricing between these services and data

¹ Outgoing call minutes for both traditional and NIICS

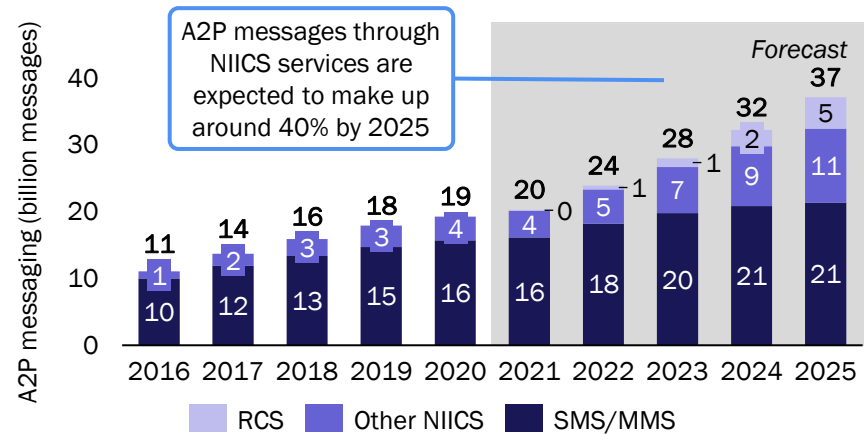
Source: Analysys Mason

Many NIICS services are developing propositions to monetise their platforms, and play a central role between brands and consumers (such as WhatsApp Business)

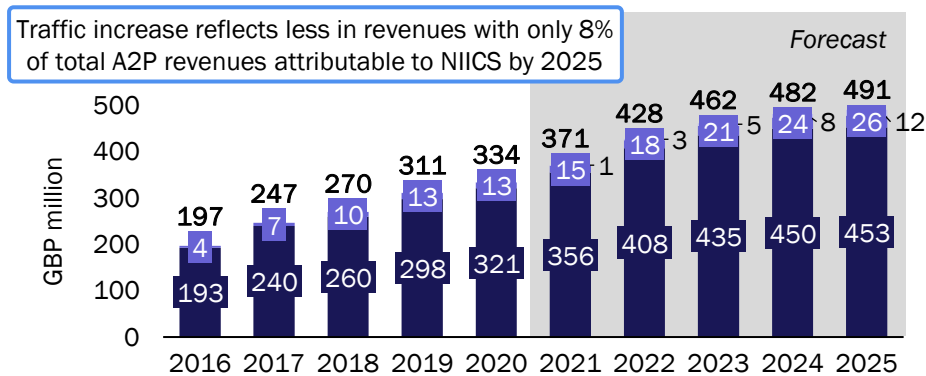
- An A2P message is any type of message that is sent to a consumer mobile client for a commercial purpose from any source other than a private consumer account
- A2P messages are increasingly sent through NIICS services, though SMS/MMS are expected to remain relevant due to their interoperable nature and ability to reach any mobile device
- Most NIICS services have launched A2P propositions to secure a central role between brands and consumers
 - 20 billion A2P messages were sent via Facebook Messenger in June 2018¹
 - WhatsApp Business grew from having 5 million users in Q1 2019 to 50 million in Q2 2020; >175 million people message on WhatsApp Business every day as of 4Q 2020²
- Rising SMS wholesale rates will drive business take-up of NIICS
 - the price per NIICS A2P message is lower than that for SMS
 - furthermore, pricing is different for NIICS which is per user / session as opposed to per message for SMS

- A2P messages are used for customer service as well as for other use cases such as notifications, security and surveys
- For customer services A2P, NIICS have taken over SMS/MMS where brands can rely on low-cost conversational chats
- RCS, specifically, is expected to play a significant role in A2P messages, especially in the long-term, through Google’s support
 - integration with other Google services such as Search and Maps can help strengthen RCS’s position for A2P messages

A2P messaging traffic in the UK by platform



A2P messaging revenue in the UK by platform



¹ Facebook (2018), 'Why messaging businesses is the new normal'

² Facebook (2021), 'Fourth Quarter 2020 Results Conference Call'

Source: Analysys Mason incl. (Research report 'Application-to-person messaging: worldwide trends and forecasts 2020-2025', Facebook, press search

Other technical and business model innovations for NIICS services include features which blur the lines with social media platforms

- Compared to other online services such as VoD and hardware (smartphones, smart speakers etc.), NIICS has limited scope for both differentiation and revenue generation
- Further technical and business model innovations could include:
 - advertising on the NIICS platform
 - WeChat allows brands to advertise on its platform
 - adverts were considered for WhatsApp, but were later withdrawn due to concerns about user reaction
 - new features and interfaces
 - for example “stories” / “moments” on WhatsApp (after Snapchat’s popularity)
 - WhatsApp is also considering “communities” (effectively groups of groups)
 - integration of mobile games or other applications (e.g. ride hailing in WeChat)
 - interfaces with other (new) platforms (e.g. access to Metaverse from WhatsApp or Facebook Messenger)

We think there are a number of factors which will mitigate the risk of a large NIICS provider gaining dominance and being able to exploit end-users

Factors mitigating the risk of a dominant NIICS provider being able to exploit end-users

Interoperability would help (though may be some way off)

- If interoperability between NIICS services were to be developed¹, then this would alleviate concerns over a single large operator
- However, the current major operators have limited incentive to create interoperability. On WhatsApp, the closed nature of the service supports the current (group) network effects. Apple's iMessage service is also closed, and designed to encourage loyalty to Apple's device ecosystem. RCS is being promoted by Google, and while this will be interoperable across multiple device manufacturers (and network operators), until iMessage and WhatsApp adopt the standard, RCS will effectively be an ecosystem play supporting Google's Android operating system
- The IETF messaging layer security (MLS) working group is now exploring standards for interoperability, but these would need to be adopted by major players to significantly influence the market

The A2P market should keep SMS alive for the time being

- Our forecasts for A2P message traffic (see earlier slide) show that traditional services (i.e. SMS) are expected to account for the majority of A2P messages, up to 2025 and beyond, due to their device- and app-agnostic nature
- There are some scenarios under which SMS could be dropped, though the likelihood of these is uncertain:
 - email and NIICS were used together for A2P messaging which would replace the needs for SMS's ubiquitous nature; or
 - NIICS services providing interoperability between each other, and hence replace SMS's ubiquitous nature; or
 - one provider having almost complete coverage of users, and hence becoming the sole go-to provider

There are mechanisms that would limit harm






- While there are material (group) network effects and behavioural inertia, end-users can switch to an alternative service, if they feel they are being exploited or abused by a NIICS service
 - while the 'threshold' for such a move is uncertain, and users may tolerate quite a bit before they move, the threat of such a move may be enough to 'keep service providers honest'
- Finally, it may be possible for smaller NIICS providers to develop interoperability in the future, to challenge a more dominant provider

Source: Analysys Mason, press search, <https://www.ietf.org/id/draft-mahy-dispatch-immi-content-00.html> |

¹ The EU's proposed Digital Market Act is expected to include some requirement for interoperability between NIICS services

Scale, lack of interoperability, network effects and multi-homing mean that it may be difficult for the position of market leaders to be challenged

Porter's Five Forces framework

Metric	Explanation
	<ul style="list-style-type: none"> Some barriers to entry are not high for NIICS: <ul style="list-style-type: none"> low capital requirements, ease of negotiation with distribution channels (i.e. app stores) and less regulation But reaching scale (of usage) may prove difficult and deter new entrants as first-movers already have large scale (e.g. Meta-owned services) and gaining new customers does not necessarily mean taking customers from large providers, due to a lack of interoperability and the free services (multi-homing is common and helps user resilience)
	<ul style="list-style-type: none"> Certain other services (such as messaging functions with games and prosumer services) could technically substitute, but are unlikely to have a significant impact as users are still showing a strong desire for dedicated, private and free interpersonal communication services
	<ul style="list-style-type: none"> In theory, users could have some bargaining power due to limited product differentiation and the free nature of services Also, scale of usage and user base determines the ability of these services to achieve results (enhancing other platforms, collecting data, generating revenue etc.) However in practice network effects, incumbency effects (conversation history) and group chats reduce this power
	<ul style="list-style-type: none"> There is a limited role for suppliers, as operations are usually software-driven, run in-house, and can even be based on open source software (e.g. Signal) Some platforms run on 3rd party cloud infrastructure (e.g. Zoom runs on AWS), and while a move would be difficult, large platforms have the option to move to their own or bare metal infrastructure (in certain locations), which limits supplier power Hence, low bargaining power of suppliers should enhance competition
	<ul style="list-style-type: none"> Lack of interoperability creates high network effects within each provider and renders complete transfer of users very difficult (due to multi-homing) Services with large existing user bases such as those owned by Meta remain very attractive <ul style="list-style-type: none"> even though some users may multi-home between different services, they are still likely to have accounts with the largest players due to ease of finding contacts, which results in same-side network effects iMessage and RCS are bound by devices and do not have as large a user base as WhatsApp or Facebook Messenger group chats reduce potential of migration and increase network effects of large providers Beyond scale, the main current differentiators are privacy and encryption <ul style="list-style-type: none"> encrypted services are available from multiple operators; changes to privacy policy could cause users to migrate, though previous effects have been limited

There are various value chain relationships for NIICS, where the most important is bundling with devices (as demand-side gateways)

Considerations for relationships across the value chain

Considerations	Explanation
Prospects for substitution to intensify	<ul style="list-style-type: none"> ▪ Messaging, calling and video calling are functions for other services such as social media, gaming, forums and email <ul style="list-style-type: none"> – hence all above are considered to be existing partial substitutes for NIICS – lines are blurring between NIICS and the above (social media especially) with the potential to integrate other services with NIICS ▪ Substitution could increase in the mid-to-long term future with further use cases defined for AR/VR and holographic applications <ul style="list-style-type: none"> – although, these are very nascent areas which are still not yet clearly defined ▪ Complementarity is likely to limit prospects for substitution where interfaces to social media and emerging use cases for AR/VR/holographic can be implemented within NIICS (similar to interfaces between Facebook and Facebook Messenger)
Balance of bargaining power	<ul style="list-style-type: none"> ▪ Bargaining power with end users: network effects diminish users' bargaining power, however importance of scale and increasing awareness around data usage and privacy, give some power to users (although co-ordination among end-users is limited) ▪ NIICS providers could increase their bargaining power within the value chain if; <ul style="list-style-type: none"> – clearer ways are defined for providing data to third parties (although likely to be very limited due to potential online safety regulation) – enterprises (and hence customer services) depend more on NIICS through application-to-person (A2P) channels
Bundling practices	<ul style="list-style-type: none"> ▪ Bundling helps create an ecosystem that boosts the popularity of both the NIICS services and other services that they are bundled with, however this approach can limit reach as the target market is bounded by other criteria such as device ownership ▪ There are two main bundling methods for NIICS services: <ul style="list-style-type: none"> – bundling with devices: This is the most common bundling method which can help create ecosystems (mostly closed ones, e.g., Apple devices with iMessage) that boost device sales and increase NIICS popularity – bundling with network/ISP and device: RCS, which is supported by Google, is designed to be similar to other NIICS services and was developed with the expectation to replace traditional communications (although not accomplished yet)
Scope for “horizontal” interconnection and interoperation relationships	<ul style="list-style-type: none"> ▪ Issues with interoperability could be improved by wholesale providers providing interoperability between services, however large players such as Meta would be less willing to participate (with high existing market power) ▪ NIICS can be used as a source of users for other ventures and provide complementarity between online platforms by the same company <ul style="list-style-type: none"> – existing ventures: Facebook Messenger helps drive stickiness to Facebook social media platform – new ventures: Meta announced its intention to build a metaverse, and it could leverage its existing user base on social media platforms as well as NIICS such as WhatsApp and Facebook Messenger ▪ NIICS could also include interfaces to other third-party online services such as e-commerce, ride-hailing services (i.e., WeChat) etc. <ul style="list-style-type: none"> – although there is a risk that this can be limited due to awareness around online safety and privacy (both by users and regulators)

In conclusion, we see profitability having a limited role in NIICS, WhatsApp and MS Teams continuing to hold share, and limited prospects of external challenges

Analysis of possible market outcomes

Aspect of market outcome	Comment
Profitability in the long term	<ul style="list-style-type: none"> ▪ For consumer NIICS services, profitability is not very relevant. Services tend not to generate revenue from usage directly, but can be used for other purposes such as: <ul style="list-style-type: none"> - complementing other online services (e.g. gaming) - increasing engagement and stickiness to an ecosystem (e.g. Google Duo, iMessage on Apple Devices) - as a source of data for adjacent platforms (end-user data for Facebook from Facebook Messenger and WhatsApp) ▪ For prosumer NIICS services, profitability is a relevant consideration, as these often include a paid option. However, this profitability is likely to be constrained by the presence of products such as MS Teams, which is offered as part of a bundle alongside a wider suite of business productivity offerings
Who is in the best position to succeed	<ul style="list-style-type: none"> ▪ WhatsApp reaches the majority of end-users, and this position is unlikely to change in the near future. All the services in this area are provided free (at the point of use) and therefore price competition is not a differentiator or source of disruption. The 'group network effects' are powerful, and there is significant behavioral inertia to shifting whole groups of people onto a different platform. While signing up to a new consumer NIICS service (multi-homing) is easy, it may not be effective at displacing traffic from the market leader. Indeed, controversies around privacy policy (not in the UK) and service outages have done little to dent the user base. To date, WhatsApp has been able to offer similar innovative features as rivals, suggesting that the platform is influenced by the offerings of others and users' ability to multi-home, but has been able to keep up ▪ While entry into the market has few barriers (established standards, open-source code / APIs, low distribution costs), the network effects of the established providers make it challenging for a new entrant to gain scale ▪ We note that the 'feature parity' aspect of prosumer NIICS is similar to consumer: for a time, Zoom had better features than MS Teams (more people visible on screen, ability to 'broadcast' live events), but MS Teams has now implemented similar features. Angles through which they differentiate tends to be related to other applications, such as productivity (e.g. access to Microsoft SharePoint through Teams). It is expected that much of the enterprise communication services market will use Microsoft Teams
Prospect of external challenges	<ul style="list-style-type: none"> ▪ Any future crack-down on big technology companies (e.g. forced divestment of WhatsApp by Meta) could have an impact) ▪ Regulated interoperability could also have an impact, though the detailed implementation is critical (whether simple forwarding would qualify as interoperability) ▪ If a government were to insist on encryption keys being shared, this could impact the perception of privacy (as once the key has been shared, there is a perceived risk that a hacker could obtain it)

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Granular view of the value chain

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Strategic commercial analysis

NIICS

Smart speakers

Safety technology

Video on Demand

Cloud for telco networks

Connectivity services for enterprises

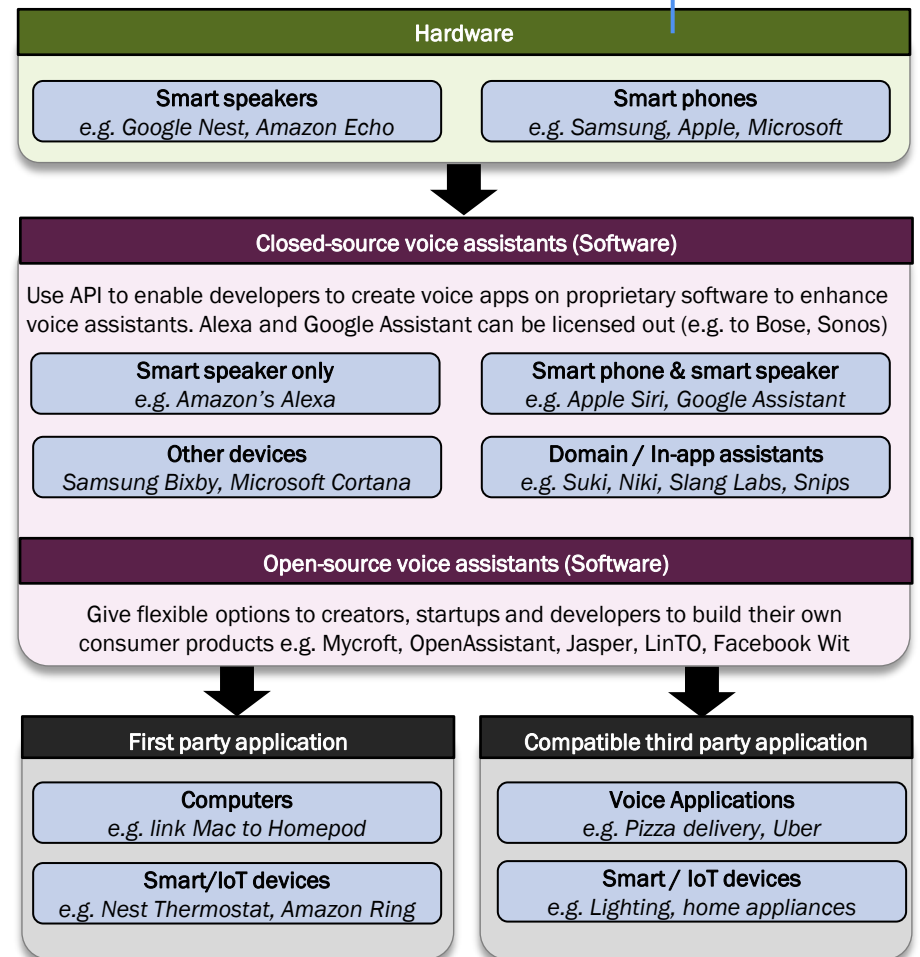
Content delivery networks (CDNs)

Smart speakers are one of the main applications of voice assistants, though there is an increasing focus on their integration with other smart devices

- A voice assistant is software that can recognise, process and respond to voice commands and is integrated into hardware, predominately smart speakers and smart phones
- There are two types of voice assistants on the market:
 - **general voice assistants** (e.g. Alexa) that can interact with a range of queries/applications
 - **specialised voice assistants** focus on a specific domain with limited vocabulary and specific responses (e.g. Snips specialises in commands for playing music)
- When integrated in smart speakers, voice assistants can **become a gateway to the internet**
 - as a **verbal interface** with search, content selection and audible services through voice applications
 - as a **controller of “smart” devices**, such as lighting, thermostats, security monitors and home appliances
 - app developers are exploring a **range of other uses**
- The voice assistant, smart speaker and smart devices can be first-party integrated by the voice assistant vendor (vertical integration), or third-party integrated if the vendor has set up services to allow for manufacturers to create enabled devices
- Big players use a **below cost pricing strategy**¹ for smart speakers to increase sales but monetise their platforms with complementary lines of business, such as e-commerce and search, and can charge voice-app developers to be the recommended app for a specific command

Smart Speaker hardware is a ‘dumb’ terminal, with voice assistant intelligence being hosted on cloud platforms

Voice assistant ecosystem



¹ It is reported, for example, that Amazon's Alexa speakers are sold above cost at full retail price, but are often available at discounted prices (i.e. 'on sale') | Source: Analysys Mason, VoxyDigital, press search

Amazon Echo was the first smart speaker introduced to the UK in 2016, and now there are currently five popular speakers ranging in price from GBP30 to GBP300

Comparison of the five main smart speakers in the UK

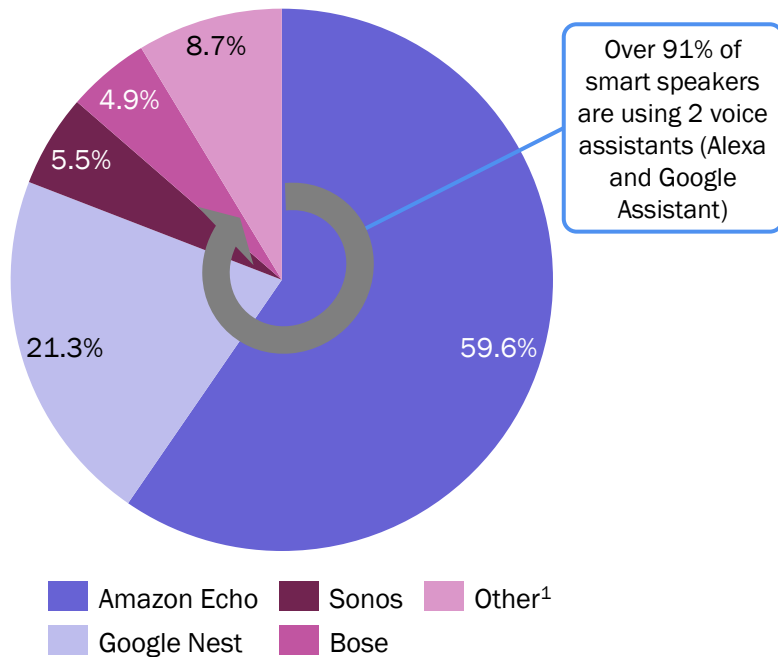
Brand	Amazon Echo	Google Nest	Sonos	Bose	Apple HomePod
Release date	Sep 2016 (US 2014)	Apr 2017	Oct 2017	Nov 2017	Feb 2018
Voice assistant	Alexa	Google Assistant	Alexa, Google Assistant	Alexa, Google Assistant	Siri
User rating ¹	9.4	9.2	8.7	9.8	8.9
Price range	GBP30 (Dot) GBP89 (4 th Gen Echo) GBP189 (Echo Studio)	GBP55 (Google Mini) GBP89 (Nest Hub)	GBP189 (Sonos One) GBP329 (Sonos Move)	GBP229 (Bose 200) GBP289 (Bose 500)	GBP89 (Mini) GBP259 (HomePod)
Features/ Differentiation	<ul style="list-style-type: none"> Lowest prices (Echo Dot) More than ~60 000 skills (voice apps) Drop-in function, allows you to call any Echo in a household Most popular cloud provider with AWS 	<ul style="list-style-type: none"> Superior language tech Accepts a more free-form conversation. Can control many smart home devices ~40 000 actions (voice apps) Google Assistant is supported by Android 	<ul style="list-style-type: none"> AirPlay2 (enables it to talk to Siri and form pairing with Apple HomePod) Superior quality sound and speaker versus other smart speakers Access to Google Assistant or Alexa 	<ul style="list-style-type: none"> Superior quality sound and bass versus other smart speakers Access to Google Assistant or Alexa 	<ul style="list-style-type: none"> Seamless integration with other Apple products ~10 000 shortcuts (voice apps)
Music services supported	Spotify, Amazon Music apps, Pandora, TuneIn	Spotify, Google Play Music, Pandora, YouTube Music	Spotify, Tidal	Spotify, Pandora, TuneIn	Apple Music
Languages ²	8 as well as 6 English dialects	12 as well as 6 English dialects	12 as well as 6 English dialects	12 as well as 6 English dialects	21 as well as 5 English dialects
Disadvantages	Requires app to use on mobile devices	Can't read or send emails or messages	Expensive compared to Hyperscaler products	Expensive compared to Hyperscaler products	Limited interaction with non-Apple products

¹As of Jan 2022 from Which.co.uk, and is a blended average across appearance, sound, application;²As of April 2021

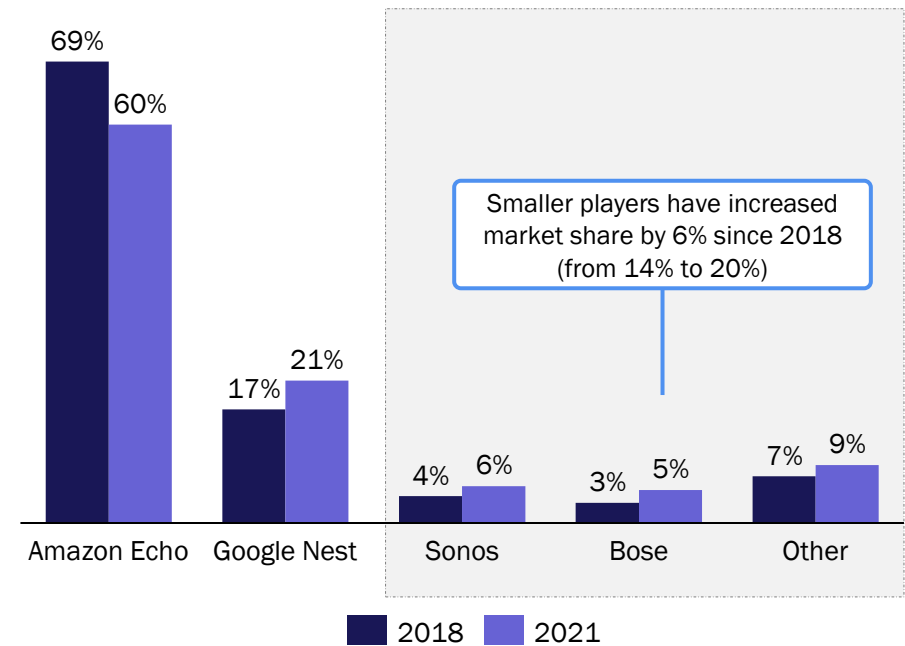
Source: www.summalinguae.com/language-technology/, www.Which.co.uk, Analysys Mason Research

Amazon Echo and Google Assistant dominate the UK smart speaker market with 91% combined market share, but smaller players are slowly gaining share

2021 UK market share of smart speakers



Change in UK market share since 2018



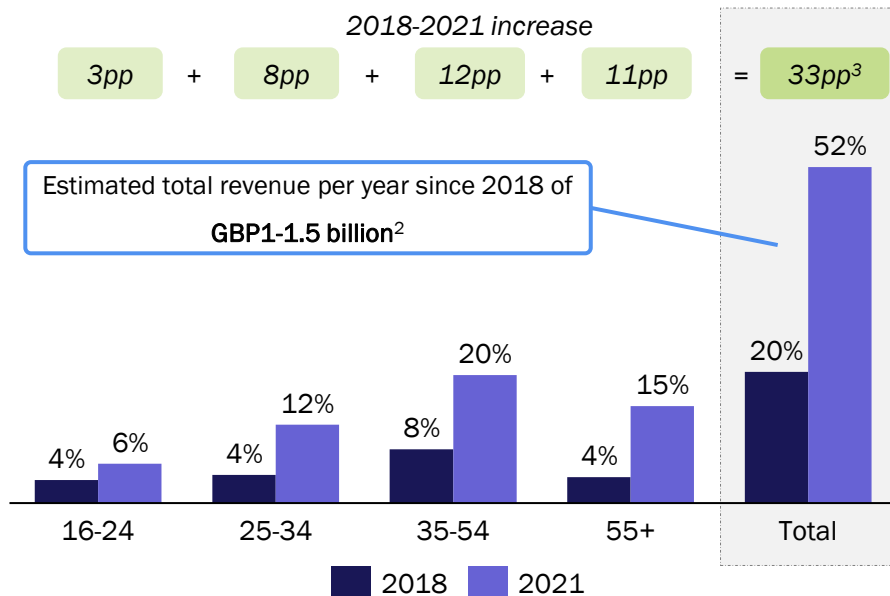
- Amazon Echo had first mover advantage and quickly gained market share by 2018, but lost market share in subsequent years as other brands were released
- The increase in market share for Google Nest has been attributed to its natural language technologies: it is perceived to be better at voice interpretation than Amazon Echo and incorporates 12 different languages (versus eight for Amazon Echo)
- However, as music and entertainment are the biggest uses of smart speakers, sound quality is becoming an important factor for some customers, and Sonos and Bose are perceived to be the market leaders in sound quality

¹ Other category includes Sony (2%), Samsung (2%), Apple HomePod (2%), LG and JBL

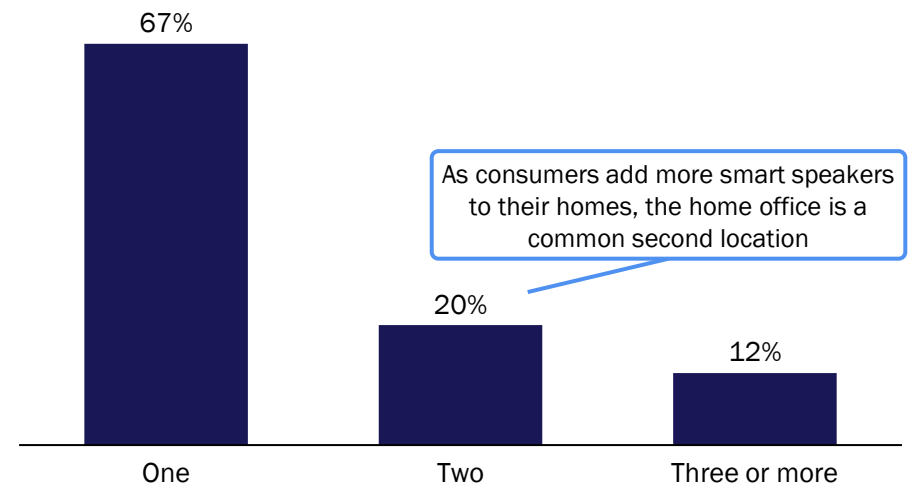
Source: Ofcom Technology Tracker 2021 (14th Jan to 31st March), YouGov.com "The dawn of the connected home", Analysys Mason research

There has been a 33pp rise in the adoption of smart speakers since 2018, with more than 50% of households having at least one speaker in 2021

Total UK household penetration split by age group¹



Number of smart speakers per household (of those with at least one smart speaker)



- A higher penetration with older age groups with higher incomes indicates the price-sensitivity of consumers for a product that is still widely viewed as “nice-to-have”, with households earning above GBP50 000 twice as likely to own one than those below that threshold
- The adoption of smart speakers decelerated in 2020 because of supply constraints, however, the smart speaker is expected to benefit from the after-effects of the pandemic as more people will spend more time at home because of remote working in the coming years

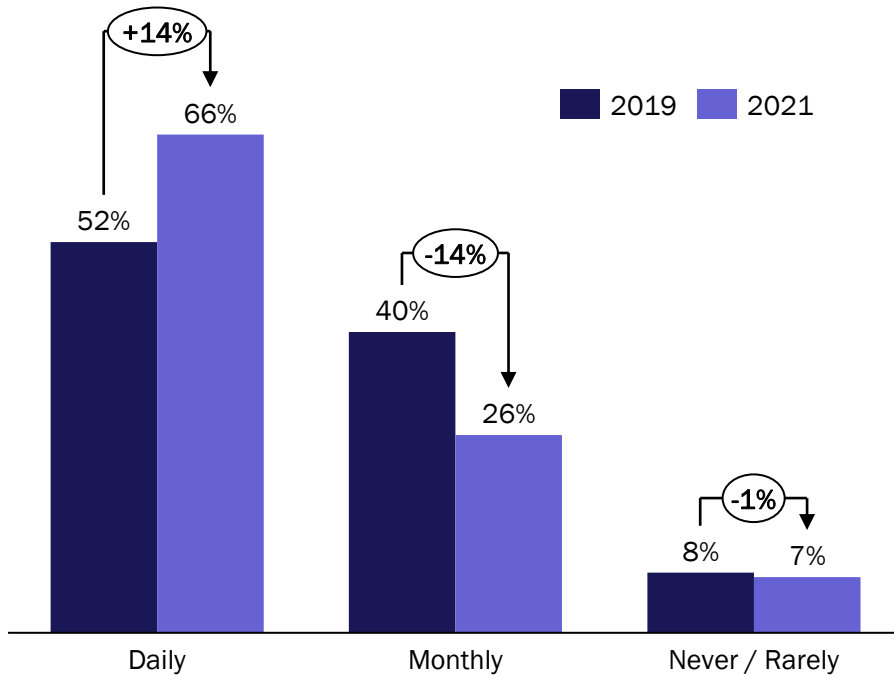
There may be a concern that not only is smart speaker penetration rising, but the majority only use two voice assistants (Alexa and Google Assistant) that can use and collect user data, potentially giving Amazon and Google significant market power in the value chain

¹ With at least one smart speaker per household, ² Assumes average GBP40 per smart speaker, 28 million UK households and approximately 33% of users have two smart speakers, ³ percentage points, ⁴ 52% penetration multiplied by 91% market share

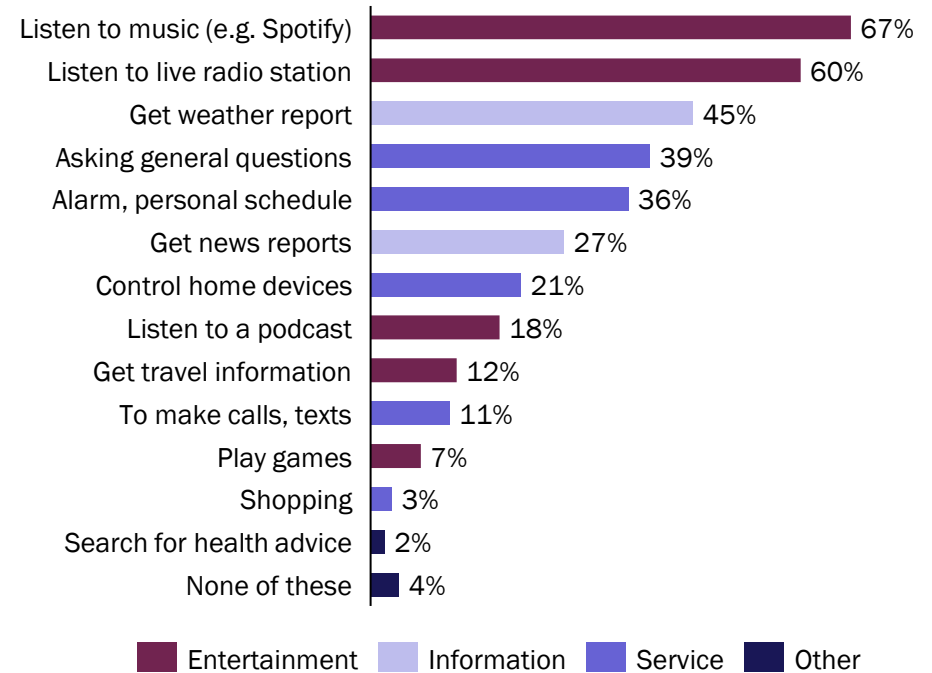
Source: Ofcom Technology Tracker 2021 (14th Jan to 31st March). Ofcom Technology Tracker 2018, YouGov.com “The dawn of the connected home”, Analysys Mason Research, Voicebot Smart Speaker Consumer Adoption report Jan 2019, Deloitte

Since 2019, the daily usage of smart speakers has increased by 14%, with third-party entertainment (music and radio) as the most common use of the device

UK smart speaker frequency of use



Main uses of smart speakers in the UK, 2021



- Whilst the daily usage has increased at the expense of those using it only on a monthly basis, there is still a small proportion of people that have smart speakers that don't use it, with market participants finding other platforms/devices as easier to use and navigate
- Using a smart speaker to provide a service, like controlling a home device, answering questions and shopping is not currently widely adopted yet, and these services are usually vertically integrated with other products within the same business (e.g Amazon Marketplace, Google search, Google Nest smart devices etc)

Voice apps continue to improve user interaction with smart speakers, and more IoT use-cases will increase daily usage which in turn will improve voice recognition

Alexa Skills and Google Actions

- Google Assistant and Amazon Alexa are both platforms that third-party developers can build on to create 'Skills' or 'Actions'
- These are **voice apps** that can be used to play games, order food etc. Alexa skills now exceed 60 000 in the UK and Google Actions exceed 20 000
- To encourage developers to create apps, Google offers *Templates* for Actions and Amazon offers *Blueprints* for Skills to enable anyone to create an app quickly without code and then publish
- **Education is the largest category of Google Actions**, followed by games. **Games and trivia on Alexa is the largest category (21%)**, followed by education and reference (14% of the total)
- However, the growth rate of new Alexa skills has reduced since 2019 indicating a lower developer enthusiasm for the platform:
 - Amazon now focuses on quality over quantity
 - Amazon reduced developer contests and rewards, including changing the rewards allocation formula and scaled back payouts in order to create **incentives for developers to add in-skill purchasing** monetisation such as subscriptions
 - improved functionality on Alexa means skills take longer to develop and maintain
 - there is also a lack of a clear path to monetisation

Improving user experience (use cases)

- In 2019 Amazon and the UK Government announced Alexa devices will use the NHS website (nhs.uk) **to provide information to users seeking health advice**
- The **Church of England launched an Alexa Skill** in 2018 which can read a prayer for the day, or provide details of nearby churches
 - Amazon's '**Alexa for Hospitality**' technology improves the customer experience within hotels and is emerging in the UK (e.g in Village Hotels)

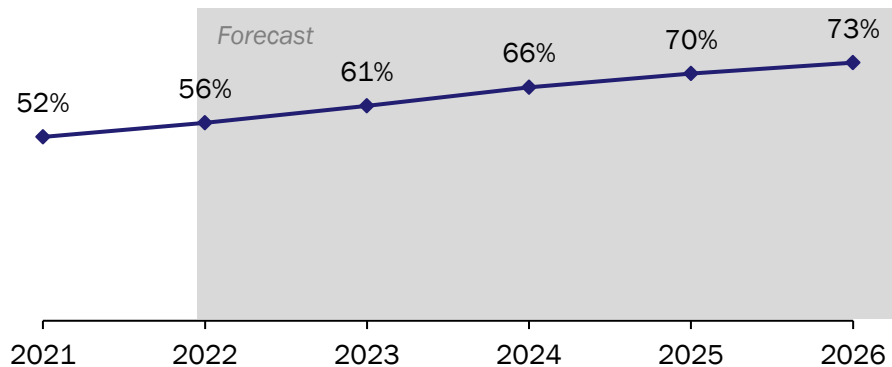
Smart speaker and voice assistant innovations

Smart homes

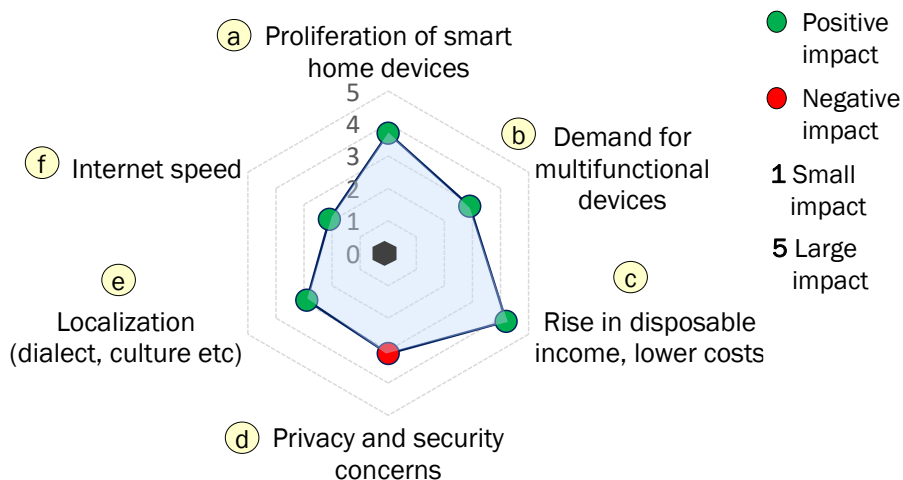
- There is an **increasing number of home devices** that can operate through a smart-speaker including microwaves and kettles
- Google bought Nest in 2014 and Amazon bought Ring in 2018, both to solidify its position in smart devices
- More recently, Amazon purchased Eero, a mesh networking company, for USD97 million in 2019. The purchase was part of Amazon's strategy to offer "frustration-free setup" for smart Amazon devices
- Owners of smart speakers are more likely to own another smart device (e.g. 56% more likely to own a smart-meter), highlighting the **importance of compatibility with other devices for consumers**

The adoption of smart speakers is forecast to rise to 73% by 2026, with emergence of integrated smart home devices and lower costs being the main growth factors

Forecast UK smart speaker penetration



Top impacting factors effecting future growth






- It is expected that the UK penetration of smart speakers will increase by approximately 4% per year by 2026, driven by:
 - (a) **The emergence of more tangible use cases** and smart home devices (central heating, washing machines, TVs) will continue to boost the smart speaker market as they smoothly integrate with each other
 - (b) Features such as listening to music, ordering food and controlling smart devices through **one device** offer more utility to the consumer at minimal incremental cost
 - (c) The cost of smart speakers will expect to reduce further¹, and **disposable income is expected to increase** by an average of 1.5% per year up to 2025 with consumers expected to purchase more technological gadgets
 - (d) **Privacy concerns** relating to personal data, potential regulatory pushback and cultural barriers **could limit the take-up** of smart speakers
 - (e) The **improvement of local knowledge** or culture (music, jokes etc) and voice recognition that can interact with users in their local dialect will influence the adoption of smart speakers
 - (f) The **deployment of high speed 5G infrastructure** is expected to propel the growth of Internet of Things and smart devices, which in turn will boost the adoption of smart speakers

¹ For example, Google Nest Mini reduced by GBP20 in 2019,

Source: Analysys Mason Research, Office for Budget Responsibility, Allied Market Research "Smart Speaker Market 2018-2025", www.Which.com

Concerns surrounding smart speakers originate from their ability to collect and use data, giving them market power to disrupt other services



Market trends and concerns

Type	Description
Data collection 	<ul style="list-style-type: none"> ▪ Much public unease has centered around how smart speakers collect and use data – in particular, the impression that devices are ‘always listening’. For example, in April 2019, Amazon admitted that recordings are reviewed by humans to improve speech recognition ▪ When Alexa hears a “wake” word - it not only records the user’s voice command but conversations in the background. This information could be used to sell other services to third parties ▪ In response to this, Amazon has given users the option to disable human review of their voice recordings and committed to greater clarity about its use of this software training process in future. Google and Apple have suspended the practice altogether in Europe ▪ Google’s ‘My Activity’ hub allows users to review their voice and audio interactions, delete them, and turn off the automatic saving of interactions altogether
Below cost pricing of devices 	<ul style="list-style-type: none"> ▪ It is common for these firms to sell these products at steep discounts, which make it difficult for other smaller companies to compete effectively and has created a significant barrier to entry, and a few firms with a large market share that have access to significant amounts of data
Radio output on smart speakers 	<ul style="list-style-type: none"> ▪ A report published by DCMS in October 2021 reviewed the impact of smart speakers to radio services ▪ It notes there is nothing within the current regulations to prevent technology platforms from being able to limit or restrict access to UK radio services or to charge stations for carriage ▪ Because radio is increasingly listened to via technology platforms rather than traditional radio sets, it recommends new measures to protect UK radio stations’ accessibility so that their content is carried on platforms such as smart speakers ▪ It also highlights the way smart speakers could learn about popular music, themes and trends which it could use to improve their own streaming services (a term called ‘Sherlocking’) ▪ However, if younger generations continue buying smart speakers, radio services could benefit from reaching this audience better, as studies suggest that a third of radio users between 16-34 listen to radio from their smart speakers

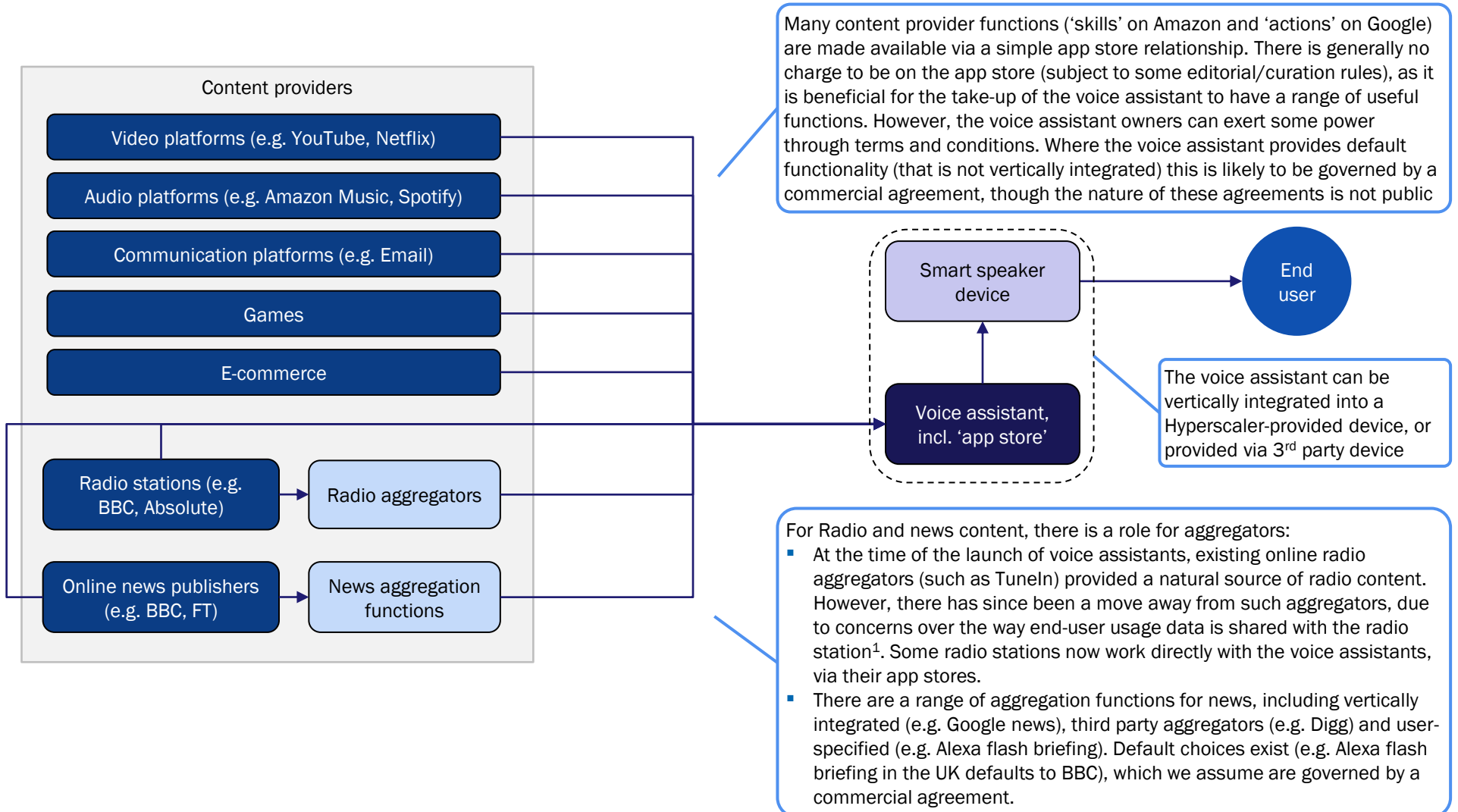
Source: Analysys Mason Research, House Committee on the Judiciary “*Investigation of competition in Digital Markets*”, Ofcom Technology Tracker 2021 (14th Jan to 31st March)

The non-visual nature of smart speakers, combined with default services and sources, may limit access to alternatives

Market trends and concerns

Type	Description
Default or commercially influenced services 	<ul style="list-style-type: none"> ▪ A key dynamic in the voice assistant market is any default or commercially influenced services that are returned when a user makes a request, e.g. when a user requests to buy a product, a voice assistant may suggest a specific website <ul style="list-style-type: none"> – this is of special importance with voice searches, as typically only the first search results is provided to the users, whereas with traditional visual search browsers, the user can more easily view different search results ▪ Alexa favors its own goods and services, including AmazonBasics, Prime Music and its e-commerce platform <ul style="list-style-type: none"> – it is noted that Amazon favors its services in Alexa by making them defaults for common voice commands. For example, Amazon.com is the default store for basic voice commands related to shopping. The New York Times reported in 2018 that when a user says, “Alexa, buy batteries,” Alexa responds with the AmazonBasics option – Amazon minimises concerns about favoring its first-party goods through voice shopping by highlighting how rare it is for people to purchase goods through Alexa ▪ It has been reported that Google may be reporting a small number of sponsored search results via its voice assistant ▪ Although voice assistants may have default or commercially influenced options, their algorithms will learn from users <ul style="list-style-type: none"> – for example, if a user has previously ordered a specific item from a specific vendor, the voice assistant may direct them to the site where they last bought that item rather than an alternative – a user will also be able to override a default or commercially influenced result by making specific requests
Default news sources 	<ul style="list-style-type: none"> ▪ 27% use smart-speakers for news, yet less than a quarter of this group remember the sources used for the news update ▪ During set-up, devices now ask the user to select their preferred news source with suggestions including BBC, NPR, etc. ▪ But there are concerns that users may be limiting their media scope; news from the same news sources leaving no chance that they might stumble across another viewpoint ▪ Google has announced that it will research the origins of fake news and invite developers to submit tools to do the same




The relationship between content providers and voice assistants is similar to any app store, though there is a role for aggregators and default placement



¹ For example, both BBC and Absolute Radio moved away from TuneIn due to concerns over data | Source: Analysys Mason, press search

There are high barriers to entry and low potential for smart speaker substitution, however the bargaining power of users is more uncertain

Porter's Five Forces framework



Metric	Explanation
 <p>Barriers for new entry</p>	<ul style="list-style-type: none"> ▪ High - Requires high upfront investment of software development (especially for voice recognition), connectivity, robust data storage, analytics, security, and product build lines <ul style="list-style-type: none"> – but costs can be reduced if voice assistants are outsourced (like Bose and Sonos) ▪ Reaching scale may prove difficult and deter new entrants as first-movers already have advantages by collecting and accumulating product data and using it to improve products and services and to redefine after-sale service ▪ Smart, connected products can also increase buyer loyalty and switching costs, further raising barriers to entry ▪ Currently, voice assistant software is built on cloud computing infrastructure. Amazon Alexa and Google Assistant own the underlying cloud infrastructure, AWS, and GCP, respectively. But advancements in voice assistant ecosystems are beginning to rely on edge computing technology, which brings the computation and data storage closer to the device and is a technology in which the incumbent cloud market leaders have a head start ▪ Moreover, highly advanced AI, ML and NLP¹ technologies is necessary to succeed, as seen from Microsoft's Cortana's recent market exit due to its less competitive technologies compared to other players
 <p>Potential of substitution</p>	<ul style="list-style-type: none"> ▪ Low - Market participants emphasise that smart speakers represent a “hub” for smart homes and there is no complete substitute product. Consumers have an increasing demand to save time, screen time, and better organise tasks, which smart speakers can cater for ▪ But, the absence of a screen can create some problems and smart speakers are facing challenges from smartphones like Apple which recently launched a simpler, smartphone-based approach to managing the connected home
 <p>Bargaining power of users</p>	<ul style="list-style-type: none"> ▪ Medium - Due to the high intensity of competition and relatively low costs of the smart speaker device, the buyer has the power to go online and compare the prices and features of various products ▪ However, it may be difficult for users to switch between voice assistants because various service and platforms are not always interoperable <ul style="list-style-type: none"> – for example, an Apple user who uses iTunes, iPhone and iMac may find it difficult to switch away from an Apple HomePod to Google Nest – this is exacerbated if a user has several of one type of device in their home ▪ Voice assistant technology is designed to learn its user's preferences over time (like billing information, default services, shopping history). The user may become more dependent on a particular voice assistant and be far less likely to use a rival voice assistant that does not understand the user's preferences

¹ AI = Artificial intelligence, ML = Machine learning, NLP = Natural language processing

Source: <https://apo.org.au/sites/default/files/resource-files/2019-09/apo-nid267081.pdf>, <https://rain.agency/raindrops/brands-can-use-voice-enabled-ads-enhance-message>, <https://uxdesign.cc/advertising-in-voice-interfaces-4b1ca14fa28b>

The Hyperscalers could be exerting their market power over some suppliers, while the competition between these large players is fierce

Porter's Five Forces framework

Metric	Explanation
 <p>Bargaining power of suppliers</p>	<ul style="list-style-type: none"> ▪ Low/Medium – suppliers include app developers and manufacturers of 3rd party devices. While it is beneficial to the Hyperscalers that offer voice assistants to have these suppliers, the size of the Hyperscalers means that can exert some buying power. This relationship may be affected by various dynamics as described below. ▪ Leaders in the voice assistant ecosystem can set the rules for suppliers (like connected smart devices). To make a voice assistant enabled device, market participants must comply with voice assistant platform vendor specifications <ul style="list-style-type: none"> – Sonos notes that “To gain access to the vendor platforms and integrate with their services, these companies issue all manner of take-it-or-leave-it demands, from early and technically detailed access to our product roadmaps, to proprietary business data, including sales forecasts, to waivers of essential contractual rights”¹ ▪ Some voice assistant developers have struggled to gain access to key functionality needed to build their applications, such as unprocessed user commands due to restrictions from voice assistant platforms (i.e. information flow is one way) ▪ Historically, the success of smart speakers depends on the number of quality use cases, increasing the bargaining power for these smart home suppliers as smart speaker manufacturers will try to include as many smart devices as possible <ul style="list-style-type: none"> – but this may change as a new smart home connectivity standard called ‘Matter’ is to be released in 2022 that aims to provide interoperability to ensure all smart devices can work across all smart speakers
 <p>Competitive rivalry</p>	<ul style="list-style-type: none"> ▪ High – Existing competition between services usually depends on few differentiators: <ul style="list-style-type: none"> – scale of use cases – integration with other platforms and smart device applications – language processing – ease of use ▪ Competition between dominant players is fierce as voice-enabled devices are viewed as an opportunity to lock consumers into information ecosystems. Google and Amazon have been willing to forgo profits in smart speakers in order monetise the valuable household data and their potential impacts on search and e-commerce ▪ Privacy concerns can result in some user shifts as happened in the past, though at a very limited scale ▪ With music as the biggest use of smart speakers, sound quality is becoming an important factor, with Sonos and Bose widely perceived to be the market leaders in this

¹ Taken from interviews taking with Sonos management as part of the House Committee investigation on digital markets

Source: Analysys Mason, Porter's Five Forces framework, House Committee on the Judiciary “*Investigation of competition in Digital Markets*”, www.theverge.com

We have also considered some specific dynamics across the value chain

Considerations for relationships across the value chain

Considerations	Explanation
Prospects for substitution to intensify	<ul style="list-style-type: none"> Smart speakers are substituting for traditional radio devices in the provision of access to radio content. Substitution likely to continue as smart speaker offers many more functions than a radio (incl. access to podcasts, control of smart home, reminders/lists) and users will likely retire their duplicative/redundant traditional radios. Counter-substitution of smart speakers by more visual control devices (e.g. use mobile device screen to control home) is still playing out and outcome remains to be seen. We note that smart speakers with visual interfaces (e.g. Amazon Echo Show, Google Nest Hub) are available.
Balance of bargaining power	<ul style="list-style-type: none"> Relationship between voice assistant providers (Hyperscalers) and suppliers (app and content developers) is mutually beneficial, as the voice assistant providers seek to increase the utility and reach of their technology. However, the concentration of the voice assistant market within a small number of very large internet related players likely gives these players some power over their suppliers. We believe there is no charge join an app store or integrate a voice assistant into a 3rd party device, but Hyperscalers can exert some power through the associated terms and conditions. A further mechanism to exert power is in the placing of default services, for which we believe commercial relationships exist (though no public data is available). While default services are important (especially for non-visual audio-only devices), it is likely that a user's preferences (including favorites and subscribed services) has a greater effect. There is limited scope for further concentration (Microsoft's Cortana has already left the market, leaving Amazon, Google and Apple), but there may be a greater impact of concentration, as the voice assistant providers stop competing for new customers as the market saturates and then start expressing market power over their existing subscribers and suppliers We note however, that common interfaces for smart home devices (e.g. Matter) may shift bargaining power
Bundling practices	<ul style="list-style-type: none"> There are numerous examples of voice assistants being bundled with a range of in-home devices (e.g. smart speakers, smart TVs, Wi-Fi boosters) This bundling gives the voice assistant providers increased 'reach' providing increased access to data and increased 'lock-in' to specific information ecosystems
Scope for "horizontal" interconnection and interoperation relationships	<ul style="list-style-type: none"> There is some scope for interoperability between voice assistants (e.g. between Google Nest and Amazon Alexa); requires common apps and/or adjusting device setting by the end-user to play music on different devices at the same time The IFTTT service could be used to create interoperability between different voice assistant ecosystems, but it is only likely to be used by advanced users, so may have a limited impact

In conclusion, we see profitability as a limited driver, the three major providers continuing to compete, and users may rely more on input functions than output

Analysis of possible market outcomes

Aspect of market outcome	Comment
Profitability in the long term	<ul style="list-style-type: none"> Similar to NIICS, voice assistant services are currently not really designed for profit, but are rather a way to provide access to broader ecosystem of products and services There is a question about whether the parties involved will continue to invest in support for different languages and accents, as this type of research and development is quite expensive There are barriers to monetising the service via search, due to the limited number of results that can be 'read out' by the voice assistant
Who is in the best position to succeed	<ul style="list-style-type: none"> We note that Microsoft's Cortana has already been withdrawn, due to concerns of the capability of its natural language processing It would seem that Apple is still undecided as to its strategy with Siri, and we note that some other Apple services have become available on other platforms (suggested a shift away from a rigidly closed ecosystem) Google has a clearer strategy for voice assistants: collection of data, which is can use in its core search and advertising business Amazon's Alexa fits within the "Prime" and wider hardware strategy. We understand anecdotally that shopping via Alexa is more prevalent in the US than here in the UK. Overall, voice assistants help to blur the interface between the internet and the real world, and Alexa gives Amazon a lot of option value (e.g. Amazon also has growing ad revenues)
Prospect of external challenges	<ul style="list-style-type: none"> Privacy is a major concern, and may be preventing users from fully benefitting from voice assistants. There is a fundamental limitation of the voice interface, in that providing rich outputs is hard (see above). This may see the technology become more useful as an input device than for output



Contents



Introduction

High-level value chain map

Granular view of the value chain

One-pager assessments of selected markets

Strategic commercial analysis

NIICS

Smart speakers

Safety technology

Video on Demand

Cloud for telco networks

Connectivity services for enterprises

Content delivery networks (CDNs)

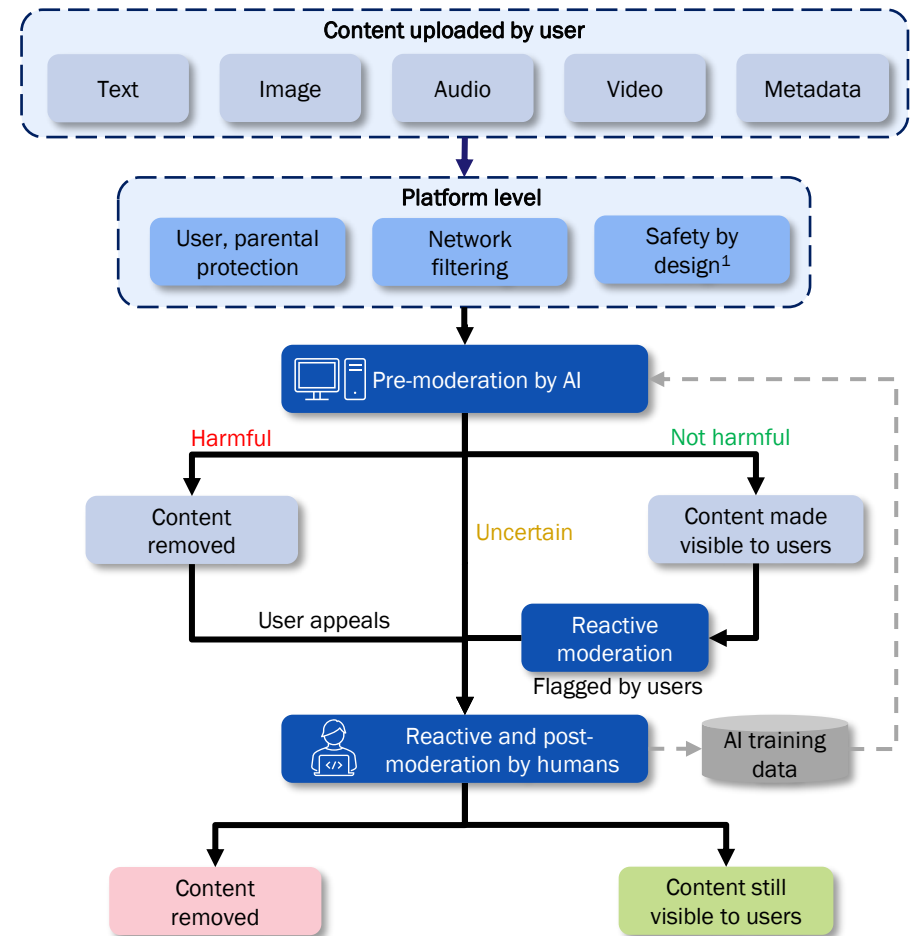
The safety tech industry is still a growing market where artificial intelligence and human moderation are combined to identify harmful content

- Internet use is growing with an expanding threat of online harm, and Covid-19 has increased this even further
- Online safety is provided in two major ways:
 - integrated software in large platforms like Google, Meta, Twitter that have system wide procedures
 - as of 2021, over 90 third party firms with technology that can assist firms by flagging online harm

Major types of safety technology and active UK third party firms

Type	Definition	Firms
AI Pre-moderation	Automated identification and removal of harmful content using AI and other technology	24%
Moderation	Support content moderation through identifying and flagging to human moderators for action	28%
User Protection	User, parental or device-based products installed on devices to help protect the user from harm	16%
Network Filtering	Products that actively filter content or blocking content include solutions provided to schools, businesses, etc.	17%
Information Environment	Flagging of content with false narratives through the provision of fact-checking	16%

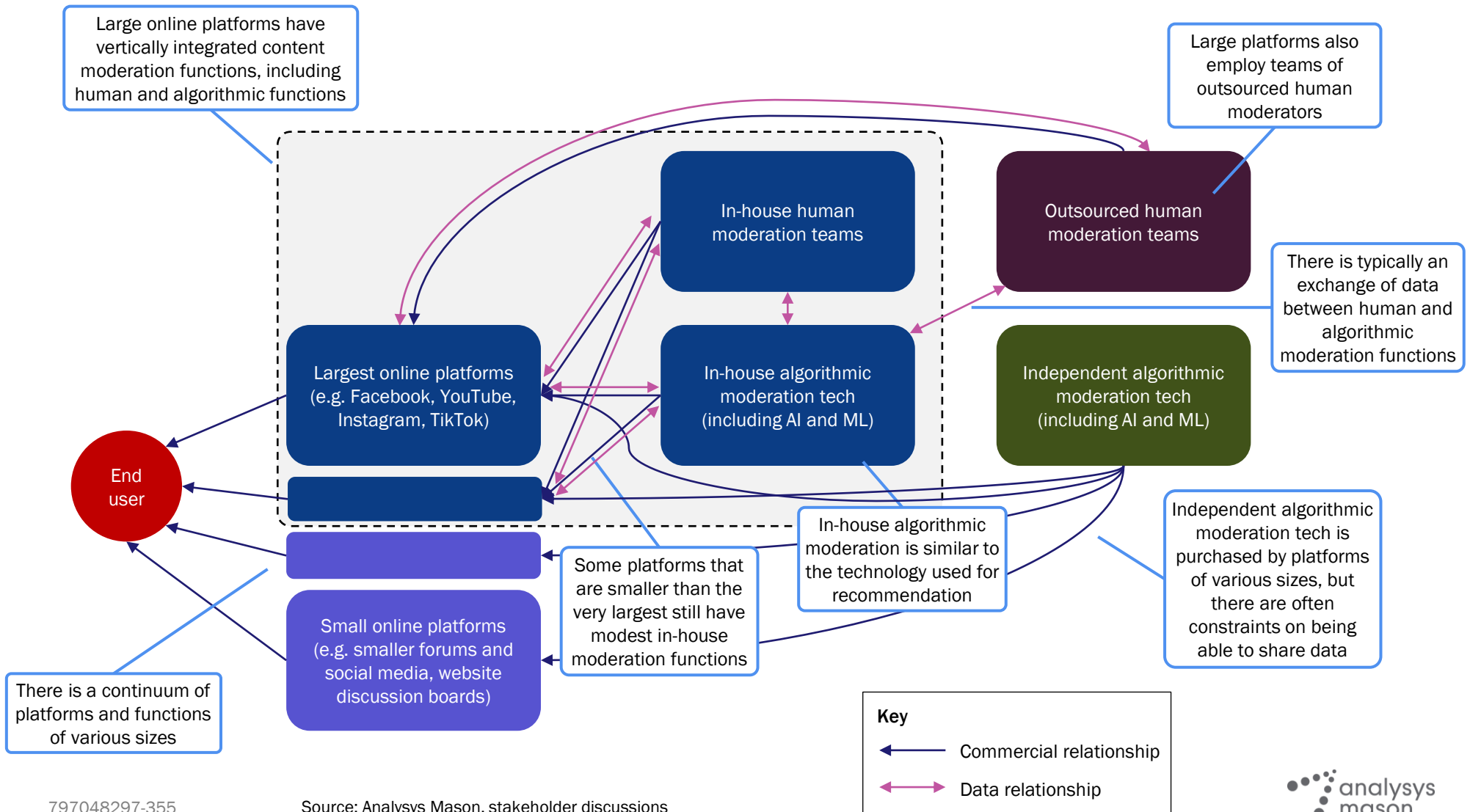
Identifying online harm using safety technology



¹ Safety by design is features built into the platform that minimise harmful content being posted in the first place (rather than removed after being posted). Note: Age orientated safety technology and safety tech services is not included in this analysis, AI stands for artificial intelligence

Sources: Analysys Mason, press search, www.gov.uk "The UK Safety Tech Sector: 2021 Analysis", Analysys Mason Research

The value chain for online safety technology features both in-house and independent functions, complemented by teams of human moderators



With governmental pressure, all major platforms are increasingly prioritising online-safety, and using safety technology (AI/ML) and human moderators to do so

Sample of key providers of system-wide governance & information environment safety technologies

Company	Safety-led divisions	Products/technology/policies	Applicable content
Google/ YouTube	<ul style="list-style-type: none"> Trust and Safety team (content moderation) Government Affairs and Public Policy team 	<ul style="list-style-type: none"> Community guidelines and enforcement policy in place to ensure users' compliance Estimated to employ at least 10 000 human moderators in addition to outsourcing Google's Family Link app allows parents to view how long their children spend on different apps, approve or block apps their children want to download, or recommend specific apps YouTube's '3-strike' policy before the account is terminated Google's Perspective API, which uses machine learning to flag potentially harmful or 'toxic' content to moderators 	<ul style="list-style-type: none"> Disinformation Hate speech Toxic speech Nudity Sexual content Child abuse Terrorist content Drug content Illegal content Violence Fraud Self harm Bullying Promoting crime Trafficking Spam Cybersecurity False news Intellectual property
Facebook/ Instagram (Meta)	<ul style="list-style-type: none"> Online Safety team (child safety, hate speech) Dangerous Organisations Operations team (bans on terrorist and hate groups) Product and Content Policy team 	<ul style="list-style-type: none"> Facebook and Instagram share content policies For example, policy of removing the content, applying a warning screen to the content, or disabling accounts Estimated to have at least human 40 000 moderators in addition to outsourcing To protect victims and survivors, they remove images that depict incidents of sexual violence and intimate images shared without the consent of the person(s) pictured. 	
Microsoft	<ul style="list-style-type: none"> Content Moderation team Policy Operations team 	<ul style="list-style-type: none"> These include Microsoft's PhotoDNA, a shared system for detecting and responding to images of child sexual abuse In November 2018, Microsoft and other companies came together in a 'hackathon' to develop anti-grooming technology called Project Artemis, and as of 2020 has been licensed free of charge to smaller companies worldwide 	
Twitter	<ul style="list-style-type: none"> Trust and safety department 	<ul style="list-style-type: none"> Community guidelines enforcement policy in place to ensure users' compliance For example, Twitter's policy of removing the offending content, terminating or limiting the visibility of accounts and / or notifying law enforcement It is understood that the majority of human moderators are outsourced 	

There are a variety of UK based third-party technology providers which are seeking to address all areas of online harm

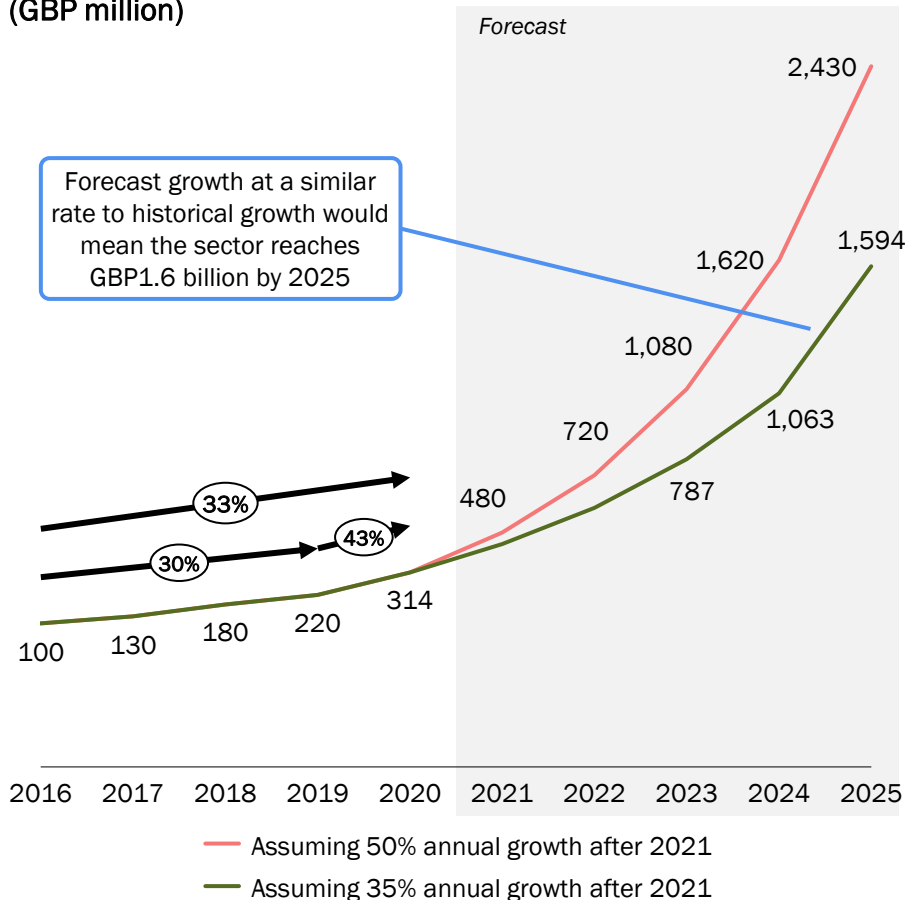
Selected UK providers of system-wide governance & information environment safety technologies

Company	Technology	Products	Applicable content	Maturity of company
CYAN Forensics	Rapid triage scanning	<ul style="list-style-type: none"> ▪ Cyan examiner – for forensic analysts to scan files for known content ▪ Cyan responder – a simplified UI version of examiner that can be used by other frontline staff ▪ Cyan collector – a filter building tool the above technologies can search for ▪ Cyan core – allows cyan filters to be included and updated in automated workflows 	Disinformation, hate speech, toxic speech	Founded in 2016
Crisp	Big data, AI-human moderation systems	<ul style="list-style-type: none"> ▪ Real time crisis defence and reporting, including threat detection and defence and content removal 	Disinformation, illegal content, child abuse	Founded in 2005 to identify online harms to children, founding member of OSTIA ¹
Qumodo	AI-human moderation systems	<ul style="list-style-type: none"> ▪ Q Ecosystem – combining AI & psychology to classify and analyse digital media items ▪ Q Discover – an evidence search engine to find connections between files ▪ Q Insight – track trends across cases to help prioritise objectives 	Child abuse, terrorist content, disinformation, toxic content	Founded in 2016
Super Awesome	Filtering, 'zero data' environment	<ul style="list-style-type: none"> ▪ Child-safe services such as child friendly advertising, platforms and GDPR-K compliance for customers ▪ In September 2020, Epic Games announced the acquisition of SuperAwesome to ensure child safety 	Disinformation, illegal content, child abuse	Founded in 2013
FactMata	AI natural language processing	<ul style="list-style-type: none"> ▪ Intelligence reports to contextualise claims and trends on a certain topic ▪ Moderation – URL blacklist containing domains identified as misleading/false information ▪ Narrative Monitoring API – gives a score to content based on nine categories 	Disinformation, hate speech, toxic speech	Founded in 2017, awaiting a patent but has attracted large investors
Logically	AI algorithms for content analysis	<ul style="list-style-type: none"> ▪ An app for feedback on the credibility of an article ▪ A browser extension for feedback on the credibility of an article ▪ Intelligence reporting on the spread of disinformation and how to combat it 	Disinformation, hate speech, toxic speech, terrorism	Founded in 2017, Mayor of London's tech challenge finalist

¹ OSTIA is Online Safety Tech Industry Association and ensure policy makers and companies have visibility to technology available

New government legislation could drive an increase in the UK third-party safety tech sector to between GBP1.6 billion to GBP2.4 billion revenue in 2025

Estimated revenue and projections of UK third-party tech firms (GBP million)

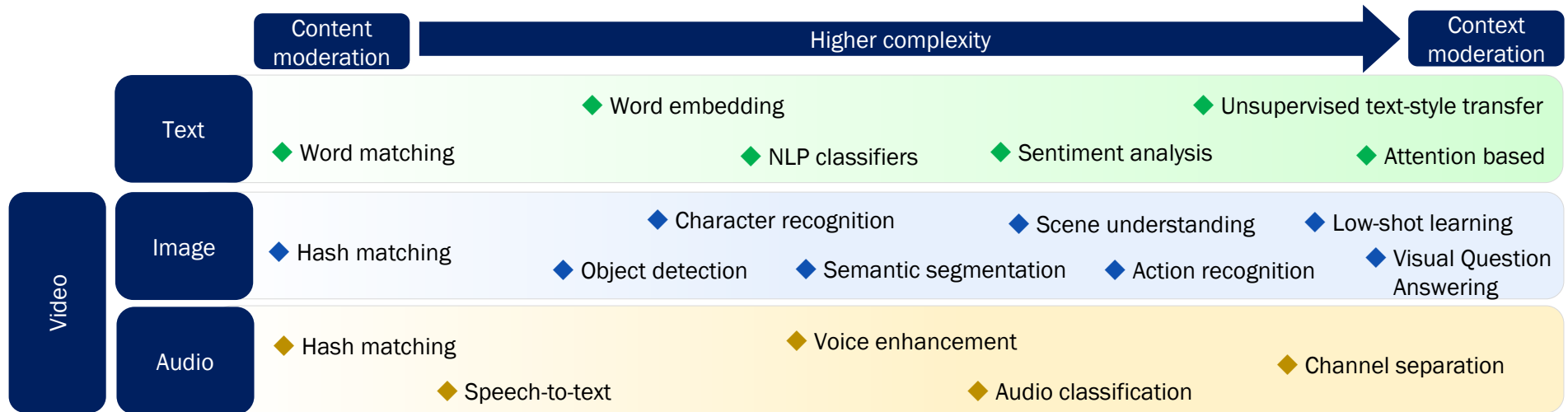


- The annual growth rate of the emerging UK safety tech sector is 33% (average) since 2016
 - this would make safety tech one of the fastest growing technology sectors in the country
- 2020 revenue is estimated to be approximately GBP314 million using a sample of the largest UK safety tech firms
- In 2019, the UK government unveiled new measures to ensure online safety, increasing the importance and need for firms to use safety technology
 - as a result, the annual growth in 2020 increased to 43% from an average of 30% in prior years
- In February 2022, the online safety law was strengthened with a new list of harmful content for tech firms to remove as a priority including controlling behavior and disinformation about hoax Covid-19 treatments
 - the government advised the use of algorithms and moderators to prevent harmful content
 - Ofcom will be able to issue fines of up to 10% of annual worldwide turnover to non-compliant sites or block them from being accessible in the UK
 - this will likely result in a faster annual growth rate in coming years of up to 50%, reaching GBP2.4 billion in 2025

For context, Facebook is reported to have spent USD13 billion on safety technology since 2016 (over USD2 billion per annum on average)

AI safety technology is still developing and is increasingly incorporating complex methodologies that consider not only the content but the context of material [1 of 2]

Complexity of safety technology used by major platforms and third-party firms



Content moderation



- These techniques have seen widespread deployment by online platforms and third-party providers
- Generally simpler in complexity and have lower costs
- Techniques include simple algorithmic tools that identify pre-determined objects against a database of harmful content
- Are seen as a first line of defense – capabilities are limited and cannot detect all harmful content
- E.g. Facebook (PDQ, TMK, PDFQ), Twitter (Quality Filter)

Context moderation

- The techniques are more complex and are increasingly being used by major platforms
- They consider the context in which content appears such as a user's history and identity, location and previous interactions between users
- Harder to implement as it requires an understanding of societal, cultural and political factors
- Ultimately, human moderators will oversee contextual content that is more nuanced but with higher costs

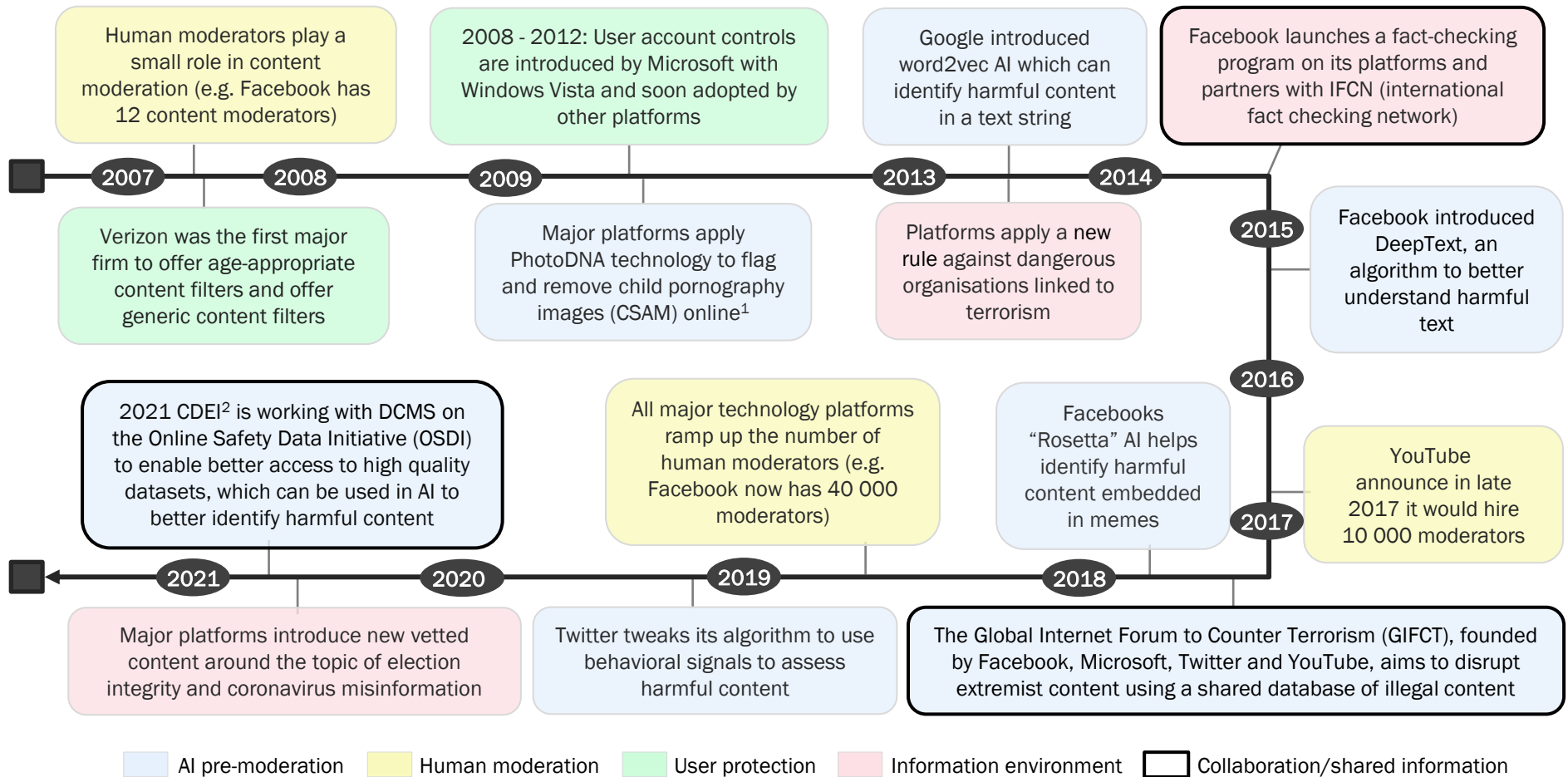
AI safety technology is still developing and is increasingly incorporating complex methodologies that consider not only the content but the context of material [2 of 2]

Content moderation technology used by major platforms and third-party firms

Type	Technology	Description	
Text 	<ul style="list-style-type: none"> Word matching 	<ul style="list-style-type: none"> Techniques to identify words by comparing them to a database of pre-defined words 	
	<ul style="list-style-type: none"> Word embedding 	<ul style="list-style-type: none"> Representing vast number of unique words and sentences with a much smaller number of features 	
	<ul style="list-style-type: none"> NLP classifiers 	<ul style="list-style-type: none"> Natural language processing techniques to process written text 	
	<ul style="list-style-type: none"> Sentiment analysis 	<ul style="list-style-type: none"> Refers to the understanding of intent or emotion behind text 	
	<ul style="list-style-type: none"> Text-style transfer 	<ul style="list-style-type: none"> Technique to transform text into other styles or forms 	
	<ul style="list-style-type: none"> Attention based 	<ul style="list-style-type: none"> Weights given to parts of texts to represent their importance, enabling the overall meaning to be determined 	
Image  Video 	<ul style="list-style-type: none"> Hash matching 	<ul style="list-style-type: none"> Technique to identify images by comparison to previously analysed and classified images within database 	
	<ul style="list-style-type: none"> Object detection 	<ul style="list-style-type: none"> Refers to the identification of specific pre-defined object classes within an image 	
	<ul style="list-style-type: none"> Character recognition 	<ul style="list-style-type: none"> Machine vision techniques to identify text within images 	
	<ul style="list-style-type: none"> Semantic segmentation 	<ul style="list-style-type: none"> The process of analysing an image to identify which pixels belong to which object class 	
	<ul style="list-style-type: none"> Scene understanding 	<ul style="list-style-type: none"> Techniques to identify scenes within images by analysing the dimensional representation of objects 	
	<ul style="list-style-type: none"> Action recognition 	<ul style="list-style-type: none"> Identifying actions of individuals / agents by observing a series of images 	
	<ul style="list-style-type: none"> Low-shot learning 	<ul style="list-style-type: none"> Training computer vision models with low amounts of training data 	
	<ul style="list-style-type: none"> Visual Question Answering 	<ul style="list-style-type: none"> Technique that allows AI systems to answer question about an image or text 	
	Audio 	<ul style="list-style-type: none"> Hash matching 	<ul style="list-style-type: none"> Techniques to identify audio by comparison to previously analysed and categorised audio within database
		<ul style="list-style-type: none"> Speech-to-text 	<ul style="list-style-type: none"> Recognition and translation of speech into text using machines
<ul style="list-style-type: none"> Voice enhancement 		<ul style="list-style-type: none"> Techniques to improve voice quality 	
<ul style="list-style-type: none"> Audio classification 		<ul style="list-style-type: none"> Identifying the classes of audio sources e.g. human speech, sirens or barking 	
<ul style="list-style-type: none"> Channel separation 		<ul style="list-style-type: none"> Techniques to identify and separate audio sources for analysis 	

Collaboration between major platforms to share datasets/technology has increased over time as firms pay closer attention to their safety responsibilities

Content moderation technology used by major platforms and third-party firms

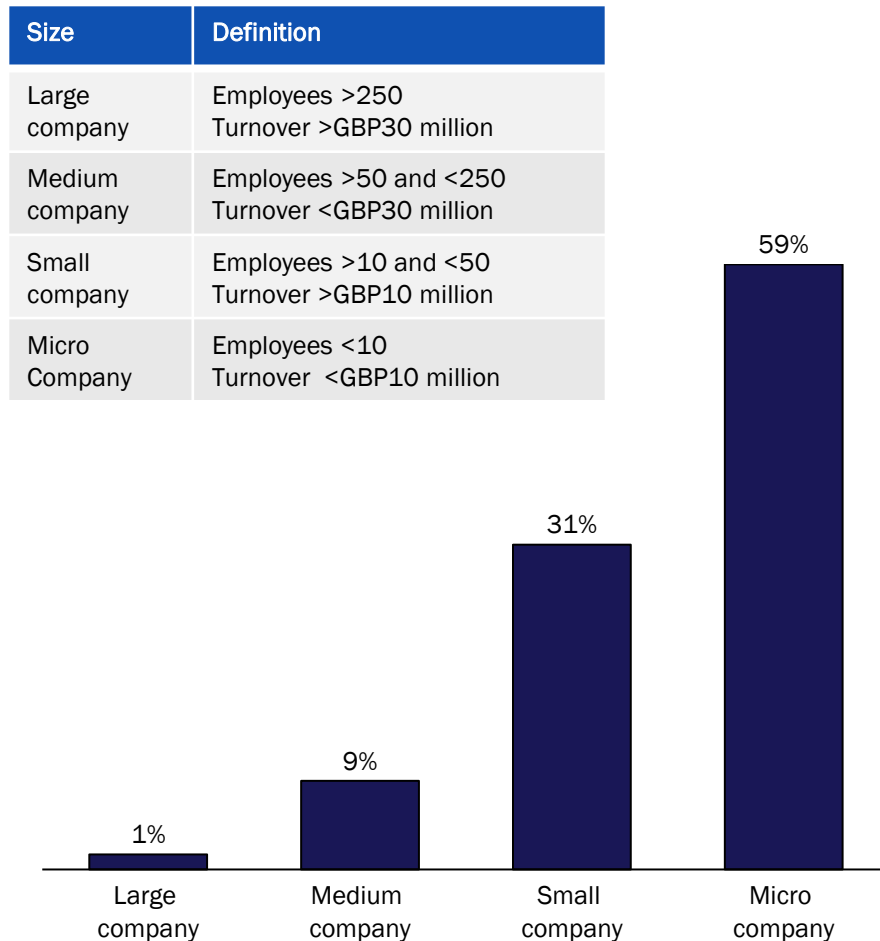


¹ CSAM stands for Child Sexual Abuse Material, ² Centre for Data Ethics and Innovation is a government expert body enabling the trustworthy use of data and AI

Source: www.gov.uk, company websites, Ofcom “Use of AI in online content moderation” 2019, www.gifct.org

The UK third-party safety tech sector is highly fragmented with at least 90 firms, 90% of which are small companies with less than 50 employees

Estimated market share of UK third party safety tech firms

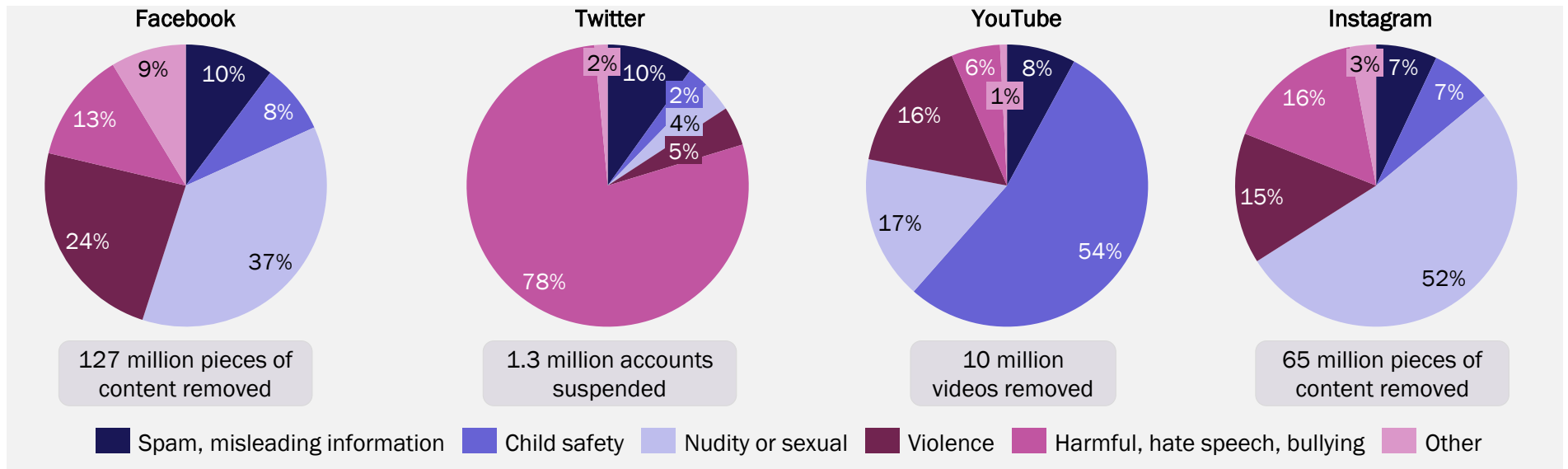


- It is estimated that the UK safety technology sector accounts for approximately 25% of the global market share
- With support initiatives and government funding for the sector, this is likely to grow in future
- More than GBP200 million of investment has been raised by UK safety tech firms since 2019
- It is estimated that over 1700 employees work for the UK safety tech sector, the majority in south-east England
- In terms of employees and revenue, it is estimated that **Crisp** is the largest third-party UK firm in the safety tech sector, with more than 300 employees in 2021 and GBP35 million revenue
- Other large firms include:
 - **Logically**: 200 employees, GBP25 million revenue
 - **SuperAwesome**: 230 employees, GBP28 million revenue (parent company Epic games)
 - **Yoti**: 220 employees, GBP25 million revenue
 - **Cyan Forensics**: 50 employees, GBP2 million revenue

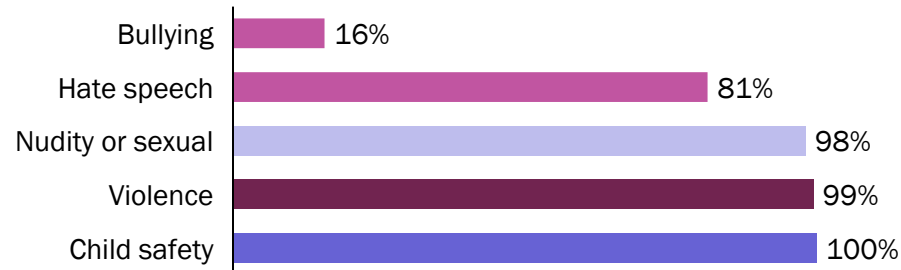
Note that company size is based on estimates from company websites and news articles with data ranging from 2019 to 2021
 Source: Company websites, www.gov.uk “The UK as a world-leader in Safety Tech”

Social media platforms have large differences in the levels and type of harmful content, meaning various safety technologies are needed

Content removed by type for select social media platforms, Q1 2021, all countries



Content removed by Facebook AI technology, Q1 2021¹

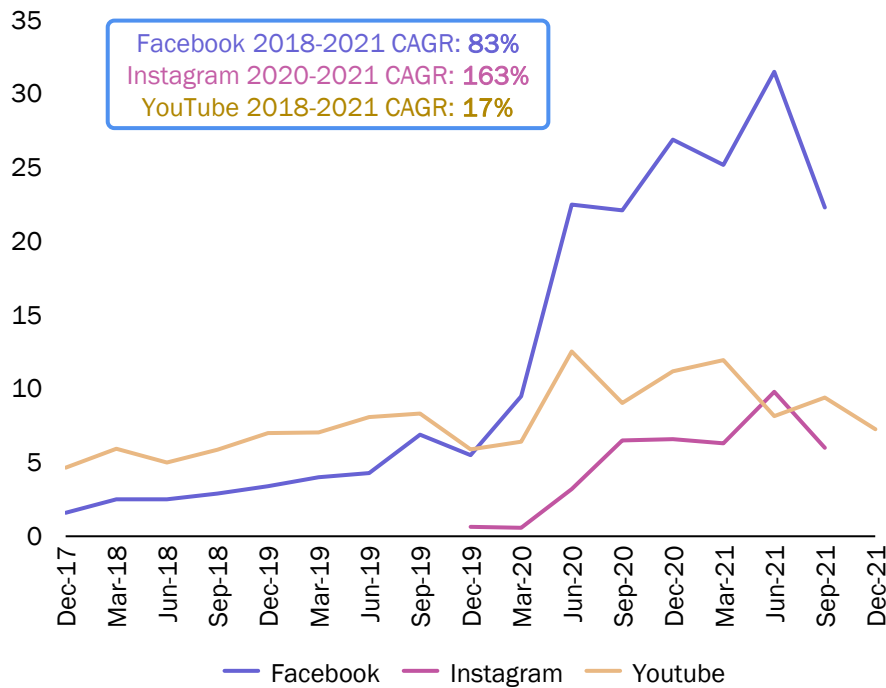


- Bullying and hate speech is more difficult to pre-moderate as it can be largely context driven
- In the last year, the platforms have cracked down on hate speech with recent AI/ML databases that have been expanded to cover more ‘scenarios’
- Human moderators are heavily used to determine context/ evaluate slang but it is increasingly being incorporated into automated systems
- Child safety has historically been a focal point for large platforms since 2009 with PhotoDNA technology

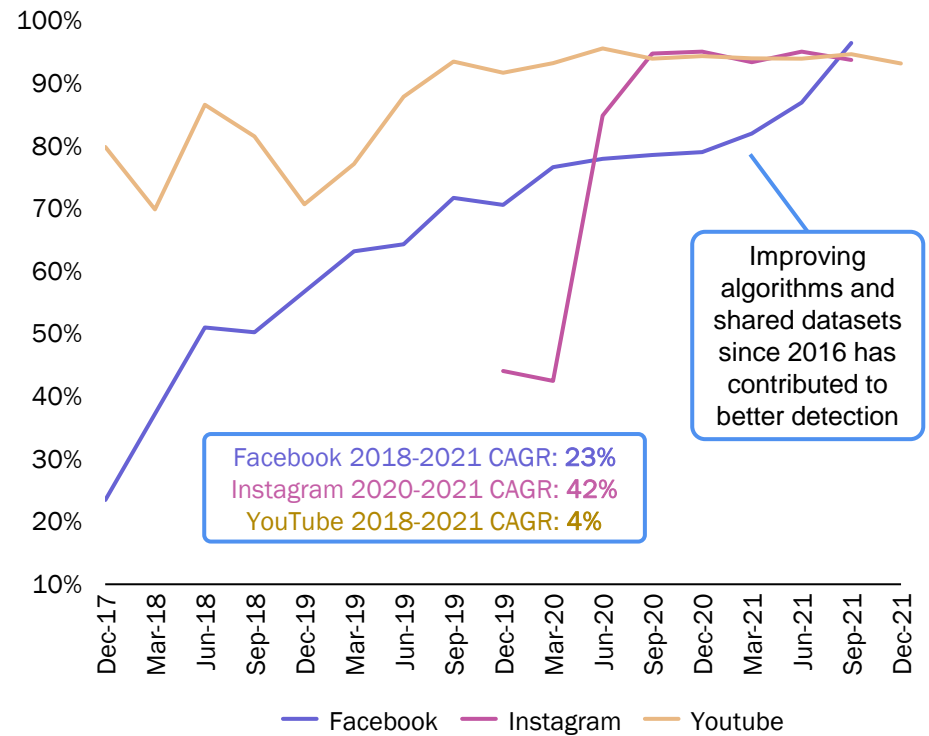
¹ Absolute values can be deduced from Facebook’s pie chart
Source: Company transparency reports

As internet use is growing on social platforms, so is the reliance on AI to detect harmful content

Amount of removed content for key platforms, million pieces of content, all countries¹



% of removed content that was detected by AI, all countries^{1,2}



- With a significantly fast rise of harmful content online on some platforms, the importance of detecting such content through automated flagging is becoming paramount, with an average increase of AI detection of 23%
- Facebook has approximately 40 000 employees dedicated to online safety (including moderators and data scientists), compared to 10 000 employees 10 years ago

¹ Facebook and Instagram figures represent the number of hate speech content that was removed; ² The amount of harmful content not detected by AI was flagged by users that were either then moderated by AI or humans

Source: Meta and YouTube transparency reports, Reuters






We have identified nine key qualitative trends for the sector

Key market trends

#	Description
1	The demand for content moderation is growing significantly, as the use of social media and consumption of user generated content grows , coupled with an increase in extreme or harmful content making its way online (see previous page)
2	Human involvement is likely to continue to play a significant role in moderation, either through training of the ML models, setting thresholds or final review. There will always be users that try to game the algorithm or try to defeat it. One basic example is the hiding of extreme content within snippets of harmless content. Example, Facebook Live suicide video in August spread through 4chan and recently flooded TikTok (hidden within “harmless”, “safe” content / video snippets). The concern for human moderators will continue and further steps made to ensure their well-being (in 2020, Facebook reached a settlement in a class-action lawsuit filed by its content moderators who claimed to have experienced post-traumatic stress disorder)
3	Regulatory and governmental pressure (from the UK and other countries) will ensure platforms continue to increase their focus on safety technology and employment in these divisions will increase. The reliance of smaller platforms on third party safety tech firms will increase
4	There is collaboration between major platforms in terms of harmful content database sharing (GIFCT, THORN) but this still has limited membership and is opaque to the outside world. Collaboration is expected to increase in the coming years as governmental pressure will encourage enhanced detection
5	Investment in AI/ML in moderation will continue to increase as this is viewed as the long-term cost-effective way to reduce harmful content. Currently investment is usually focused on recommendation and amplification algorithms now focused towards increasing human engagement and thus advertising revenue.
6	Localised content moderation is growing in demand to understand local context, slang, political environments and ethnic and cultural relationships
7	There is increased demand for increased transparency from platforms into their decision-making processes and insight into the statistics and labelling decisions. This has resulted in transparency reports, but these are either too vague or too technical to be useful to most people
8	Adoption of content moderation is still limited in smaller, largely unmoderated platforms (8kun, 4chan etc.) where there is less incentive for moderation
9	Pre-moderation of content is likely to become the focus of future technologies as platforms try to restrict the level of unwanted content on their platforms. Pre-moderation can be at the app level but is highly dependent on having the resources to train and constantly update AI / ML moderation systems

The market is still developing and the strength of most of the market forces is still being developed

Porter's Five Forces framework

Metric	Explanation
 <p>Potential of new entrants</p>	<ul style="list-style-type: none"> ▪ Medium – Requires upfront capital investment of software development (including AI / ML), data storage, analytics, and security ▪ Access to data is a key issue: third party technology providers need extensive datasets on harmful content (to develop their technology) but this is a) typically personal data and b) typically held within social media services ▪ Related to the data point above, platforms with large numbers of users provide the richest source of data to develop the technology to identify harms and improve products and services ▪ Safety tech is typically developed from academic research, and as new technologies and techniques are researched, there is an ongoing source of newly commercialised offerings
 <p>Potential of substitution</p>	<ul style="list-style-type: none"> ▪ Medium – Safety tech is complementary to (and is usefully substituting) human-based moderation. As safety tech becomes more sophisticated, human moderators will be needed less and less ▪ However, should the form of harmful content become more complex and/or difficult to detect, the role of human moderators will need to substitute back again and pick up more of the load
 <p>Bargaining power of users</p>	<ul style="list-style-type: none"> ▪ Medium - In-house safety tech of the big platforms is vertically integrated, but for third party providers, the users are the internet platforms themselves (which can include large platforms and smaller platforms) ▪ When large platforms are buying in third party tech, these platforms may potentially hold large bargaining power, and could decide to either buy the technology or develop their own (subject to constraints around IP ownership)
 <p>Bargaining power of suppliers</p>	<ul style="list-style-type: none"> ▪ Medium – See previous for where third party providers are supplying large platforms: ownership of IP could be critical
 <p>Competitive rivalry</p>	<ul style="list-style-type: none"> ▪ Market is split into two broad categories: <ul style="list-style-type: none"> – Low – There is some competition between the in-house safety tech of the big social media platforms (whereby that safety tech contributes to the attractiveness of the platform, e.g. if one big platform were to become known for allowing harmful content, most reasonable users would start to avoid that platform) – High – In the other category, there is more explicit competition between smaller third party providers, as they seek to monetise their technology for identifying harmful content

The Hyperscalers hold a lot of power because they hold the data needed to develop and prove that new technology can work at scale

Considerations for relationships across the value chain

Considerations	Explanation
Prospects for substitution to intensify	<ul style="list-style-type: none"> There is likely to be a continual substitution, back and forth, between algorithmic and human-based moderation, as threats evolve, and these two techniques learn to deal with new threats It is hard to see anything that will enter the safety tech market as fundamentally new, due to the nascent and developing nature of the current market. There may be further step changes in AI capability, but it is (again) hard to predict the effect this could have
Balance of bargaining power	<ul style="list-style-type: none"> Data is an enormous asymmetry and gives the Hyperscalers large bargaining power The intellectual property (IP) held by smaller companies does give some countervailing power, but the technology needs data to be proven. Very often Hyperscalers will ask if a technology can work at their scale. Often it has not been tested at scale, so the Hyperscaler offers to 'partner', and exerts constraints (e.g. blocking working with other Hyperscalers as they consider knowledge of how they work themselves to be commercially confidential)
Bundling practices	<ul style="list-style-type: none"> Bundling is expected to happen more over time. Market forces will drive solutions to be bundled (decision makers don't want to have to deal with dozens of providers; they want one provider with dozens of options)
Scope for "horizontal" interconnection and interoperation relationships	<ul style="list-style-type: none"> Access to data is a problematic issue: most of the data is held within large platforms, and often smaller developers of new and interesting tech solutions are not able to get access. Without access to the data, it is hard to know what the art of the possible is (and whether things that are claimed to be impossible by large platforms are indeed so). It is therefore likely that the lack of access to data is hindering the development of new online safety technology and techniques This issue is not just about the large platforms being unwilling to share their value; there are huge problems around data protection, control and ownership. Lots of data is very sensitive, and it must not become open source. For example, the release of chat data showing grooming could lead to even more victims, if bad actors could gain access to this data

In conclusion, regulation in the online safety tech market will have a large impact on how it develops commercially, and Hyperscalers are in a good position to succeed

Analysis of possible market outcomes

Aspect of market outcome	Comment
Profitability in the long term	<ul style="list-style-type: none"> Human content moderation is a low margin business, and providers are facing increased mental support costs due to the psychological toll on employees. So, profit is unlikely to pool on the human moderation side Where the profit pools elsewhere in the value chain (i.e. which technology solution) remains to be seen and is likely to be strongly driven by the precise content of relevant regulations
Who is in the best position to succeed	<ul style="list-style-type: none"> The market is very nascent, and regulation will have a big impact on how it develops It is hoped that over the next 10 years, the safety tech industry will have a 'seatbelt' moment, whereby platforms will stop seeing safety as a burden and a cost to be avoided, and will start competing on the safety features they can provide Access to data causes a risk to the existence of independent technology providers. Furthermore, Hyperscalers could choose to start bundling safety tech with other services, to provide route in to sell cloud services to new customers.
Prospect of external challenges	<ul style="list-style-type: none"> It is hard to see anything that will enter the safety tech market as fundamentally new, due to the nascent and developing nature of the current market. There may be further step changes in AI capability, but it is (again) hard to predict the effect this could have Continued moves to encryption could create challenges. There are effectively three levels of how public content is on the internet: <ul style="list-style-type: none"> Public (e.g. Twitter, which derives its value from being public) Semi-Private (e.g. Facebook, which includes semi-closed groups of contacts) Encrypted (e.g. WhatsApp, which includes end-to-end encryption) Most of the effort in the safety tech market is targeted at the middle layer. Solutions to deal with the encrypted layer and very nascent indeed



Introduction

High-level value chain map

Granular view of the value chain

One-pager assessments of selected markets

Strategic commercial analysis

NIICS

Smart speakers

Safety technology

Video on Demand

Cloud for telco networks

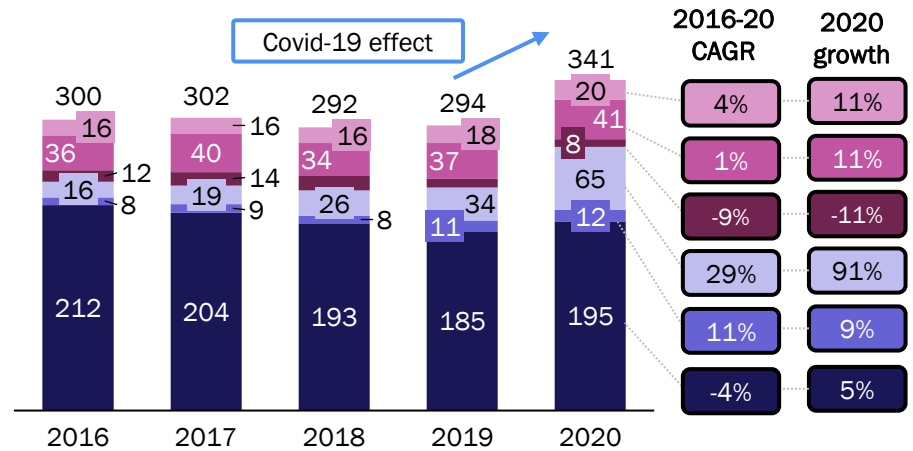
Connectivity services for enterprises

Content delivery networks (CDNs)

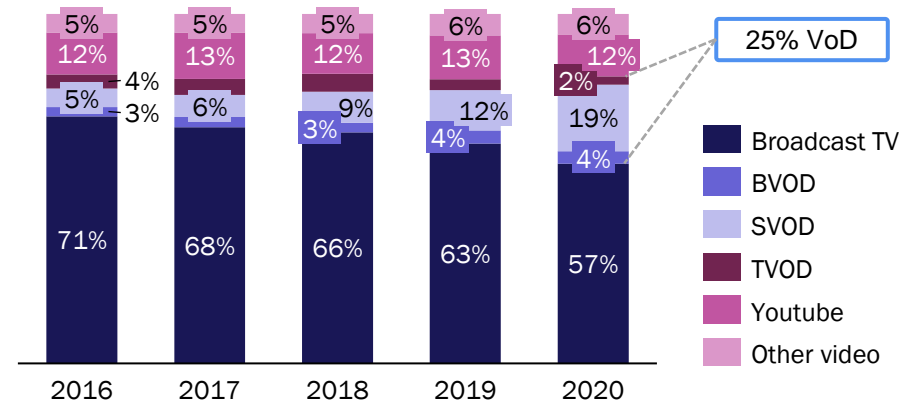
Existing viewing trends were accelerated by the pandemic with subscription video on demand (SVoD) viewing share increasing at the expense of broadcast TV

- Before the pandemic, average viewing time per person was reasonably stable at approximately 5 hours per day but increased in 2020 to 5 hours 41 minutes
 - this includes broadcast TV (57% of total time), VoD (25%), YouTube (12%) and other online video (6%)
 - VoD can be further segmented into broadcaster (BVoD, 4%), subscription (SVoD, 19%) as the most popular VoD service, and transactional (TVoD, 2%)
- The pandemic has caused an acceleration in existing viewing trends as people spent a larger proportion of their viewing time on VoD at the expense of broadcast TV
 - broadcast TV market share has reduced from 71% in 2016 to 57% in 2020, whilst VoD has increased from 12% to 25% over the same period
 - in particular SVoD viewing time increased by an average of 29% per year up to 2019, and then took a 91% jump in 2020 during lockdown conditions
- International players (e.g. Netflix and Amazon Prime Video) dominate the SVoD market and provide large budget and more diverse, and riskier content
- BVoD's 4% share of total viewing is much smaller than SVoD and involves more local content from traditional TV broadcasters, e.g. BBC iPlayer, ITV Hub, All 4, My5

Average minutes of viewing per day in the UK, all devices



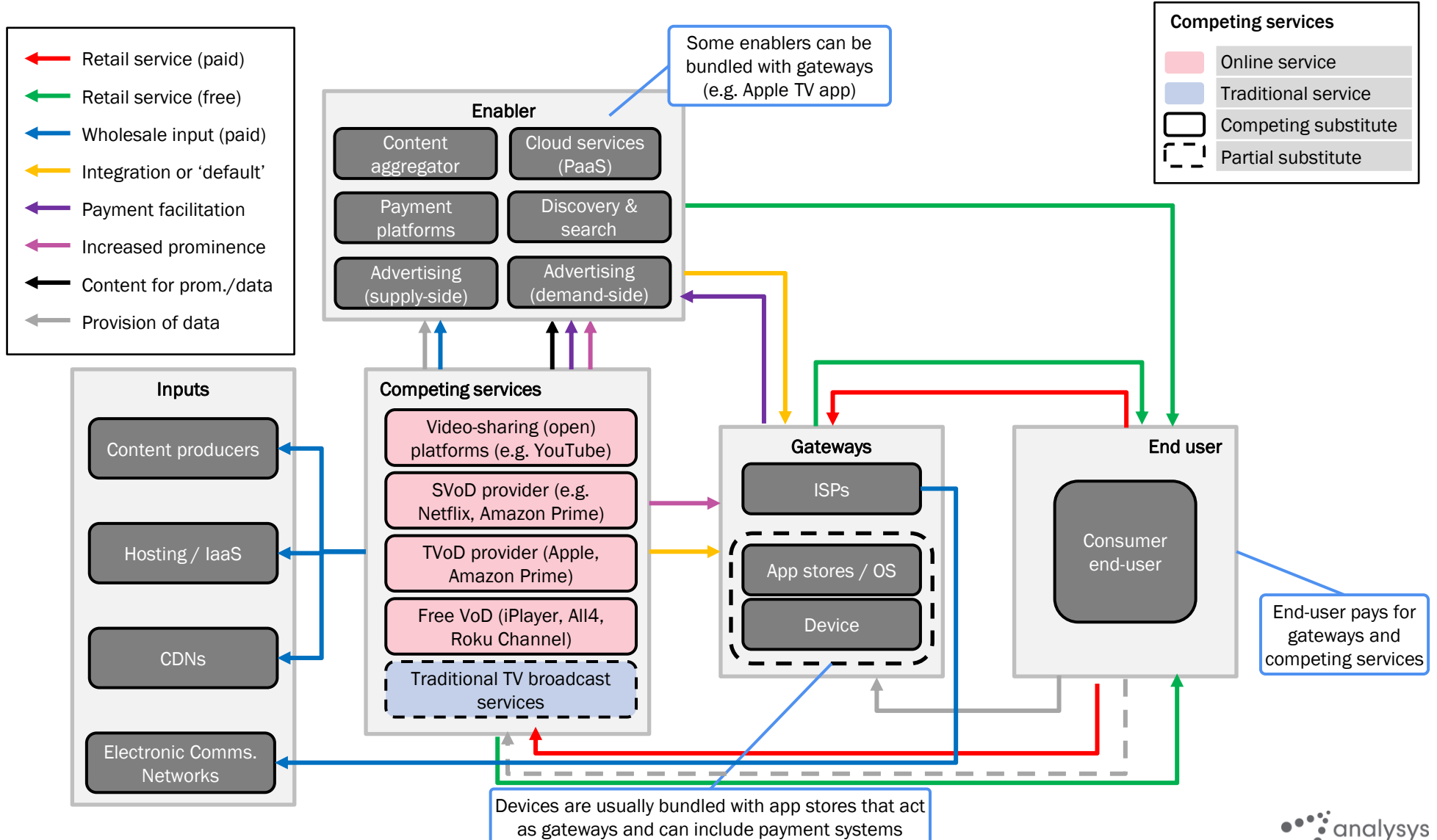
UK Market share of viewing time for all forms of TV, all devices



Note: TVoD allows consumers to purchase on a pay per view basis (like Amazon's video store) and has the smallest share of all VoD services and is not included in further analysis. Broadcast TV includes recorded playback. Other includes DVD, games console

Source: www.ofcom.org.uk "Media Nations" reports 2017-2021, BARB

The value chain for VoD includes competition with other types of AV content, and complex relationships with inputs, enablers, gateways and end-users



Compared to SVoD, BVoD has higher UK-origin content and more diverse genres, but is currently targeted towards catch-up TV with fewer films and less overall content

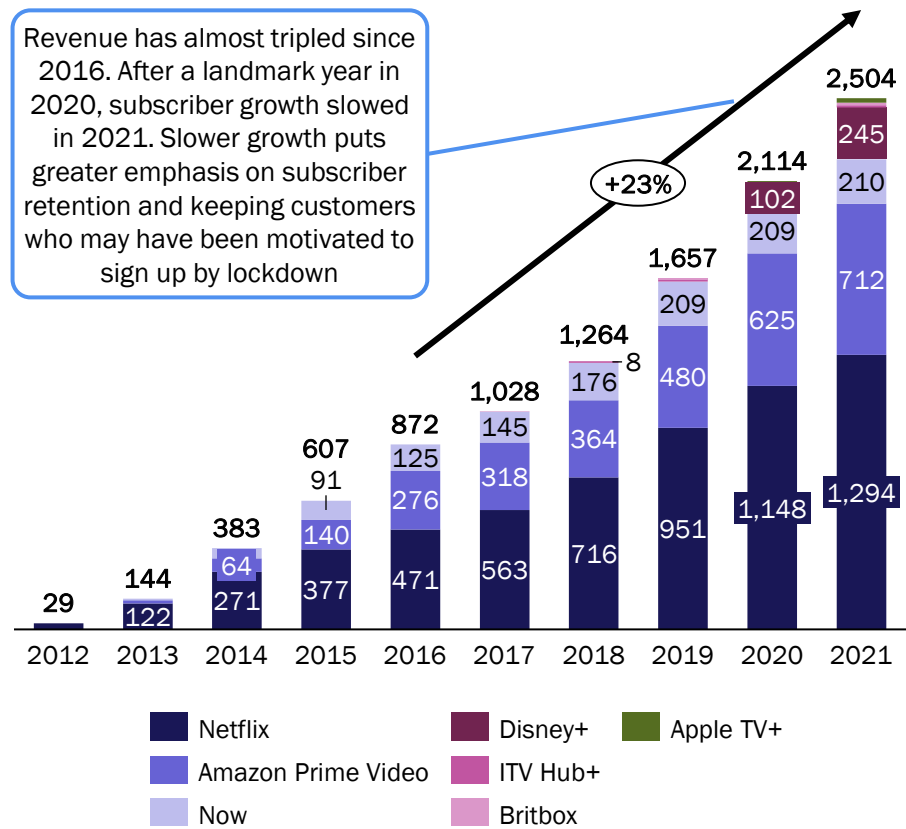
Comparison of the six main VoD platforms in the UK

	Netflix	Amazon Prime Video	Disney+	BBC iPlayer	ITV Hub	All 4
Households	16.8 million (Q4 2021)	12.6 million (Q4 2021)	5.5 million (Q4 2021)	10.7 million accounts used in Q4 2021	32.6 million registered accounts ¹	24 million registered accounts ¹
Price per month	<ul style="list-style-type: none"> GBP6-12 based on package 	<ul style="list-style-type: none"> GBP6 (Prime Video) Free with Amazon prime membership (GBP79 per year) 	<ul style="list-style-type: none"> GBP8 per month GBP80 per year 	GBP159 standard TV license to watch any <i>live</i> TV online. TV license is not required for ITV Hub and All4 for on-demand or catch-up		
Max # of screens	1-4 screens based on package	3	4	None	<ul style="list-style-type: none"> None (Ad based) GBP4 (No ads) 	<ul style="list-style-type: none"> None (Ad based) GBP4 (No ads)
Content hours²	38 000	41 000	9 000	Unlimited	Unlimited	Unlimited
Content of UK origin²	8%	12%	3%	80%	79%	70%
Top 3 genres	58% drama, 17% comedy, 13% children's	51% drama, 14% factual, 13% children's	40% children's, 35% drama, 14% comedy	24% factual, 24% reality, 21% children's	24% reality, 22% drama, 24% entertainment	25% entertainment, 22% reality, 20% drama
Original content³	34%	5%	4%	Mostly original content (though not necessarily exclusive, with average 46% of content is at least 5 years old)		
Features	<ul style="list-style-type: none"> TV shows and movies Good search functionality Highly rated content 	<ul style="list-style-type: none"> More recent films Able to make ad-hoc purchases on top + Includes 'Prime Music' streaming via music app 	<ul style="list-style-type: none"> Family friendly Highly rated content 	<ul style="list-style-type: none"> Catch up TV, box sets, fewer movies versus SVoD 	<ul style="list-style-type: none"> Catch up TV, box sets, fewer movies versus SVoD 	<ul style="list-style-type: none"> Catch up TV, box sets, fewer movies versus SVoD

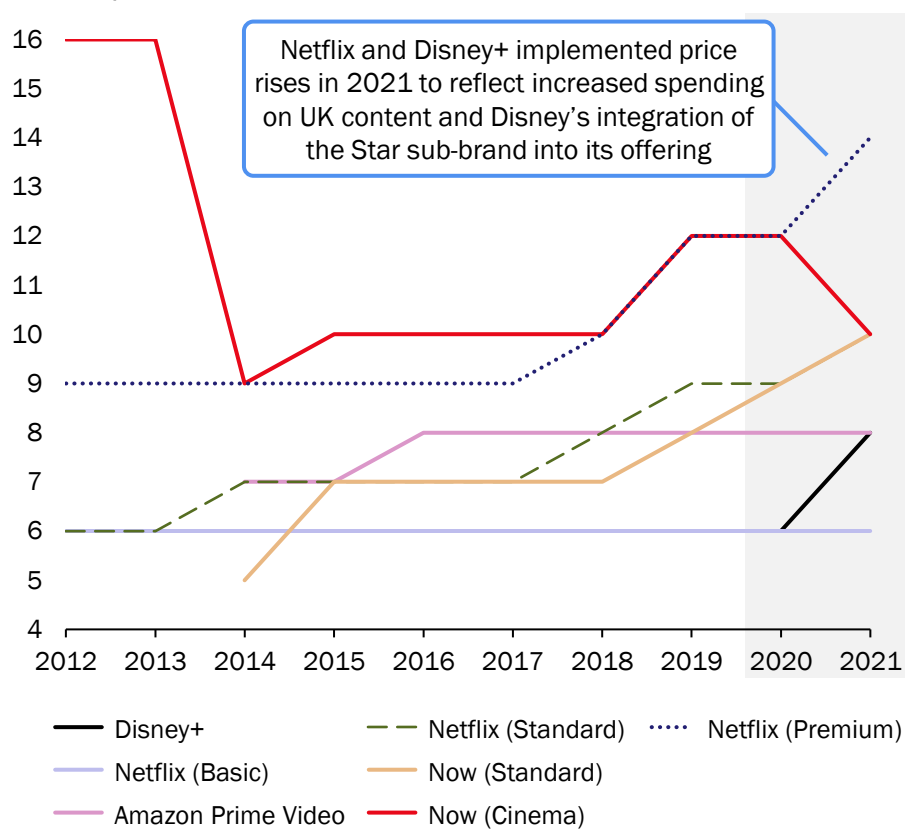
¹ Registered accounts includes accounts that are not actively used, ² As of April 2021, ³ Original content includes original material and refers to content that has not been released (historically or otherwise) on other platforms and services (including cinema), as of April 2021, i.e. was produced specifically for that platform

UK SVoD revenue is expected to have reached GBP2.5 billion in 2021 driven by a further increase in subscriptions and price increases for Netflix and Disney+

Subscription revenue for major UK SVoD services (GBP million)¹



Monthly price of selected SVoD services and tiers (GBP / month)²

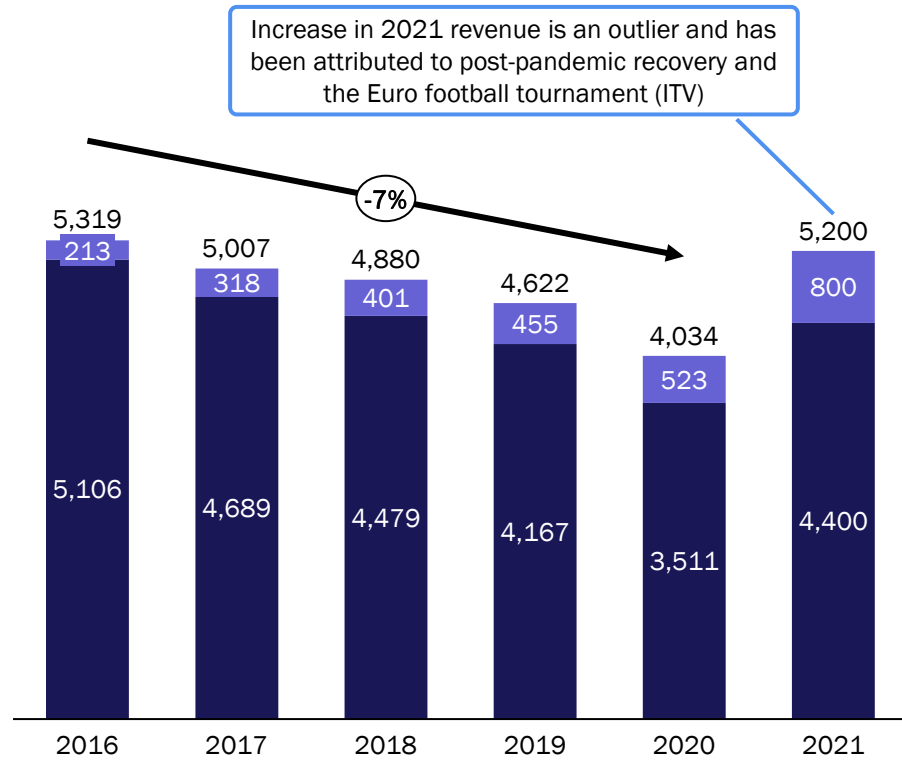


- Revenue from BVoD advertising in the UK (ITV Hub, All4, My5) generated only 14% of broadcaster TV advertising revenue in 2020 and 2021, but by 2026 this is set to climb to 24% (GBP1 billion) while annual linear TV ad revenue is set to fall by GBP1.2 billion over the same period

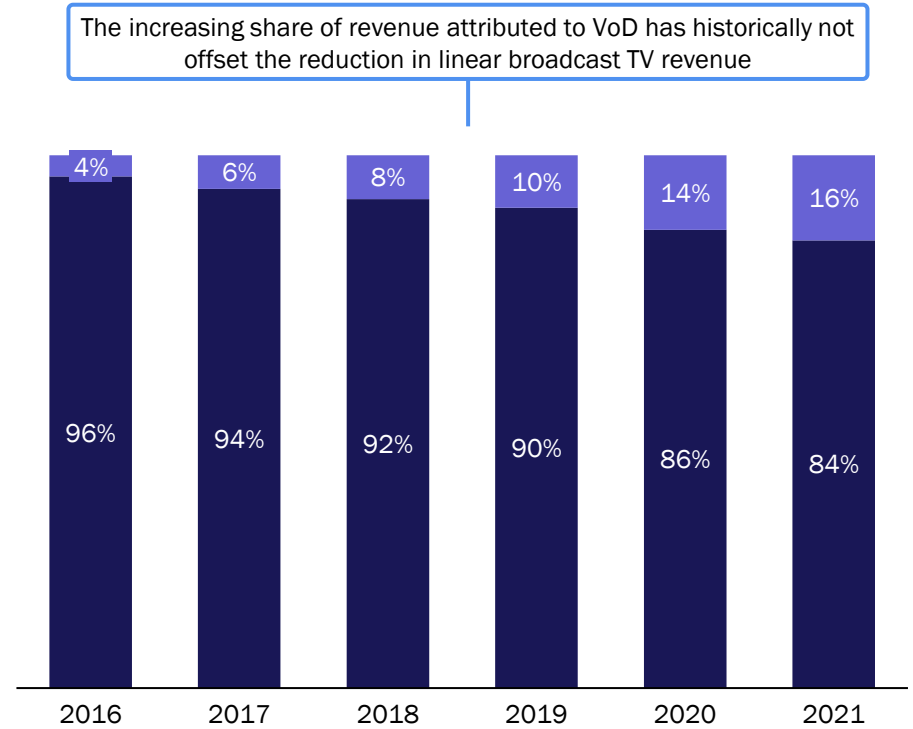
¹ Estimated from number of subscriptions per platform and average price per subscriber. Disney was launched in March 2020 and the revenue reflects this; ² Now (Cinema) price reduction attributed to fewer new films released on the platform in 2021, Disney prices only shown since 2019 and changed from DisneyLife to Disney+ in 2020

BVoD advertising is taking an increasing share of total broadcaster revenue, but total advertising revenue is slowly reducing which will constrain BVoD investment

Total advertising revenue for broadcasters (GBP million)



Share of total advertising revenue for broadcasters



■ Broadcast TV advertising revenue ■ BVoD advertising revenue

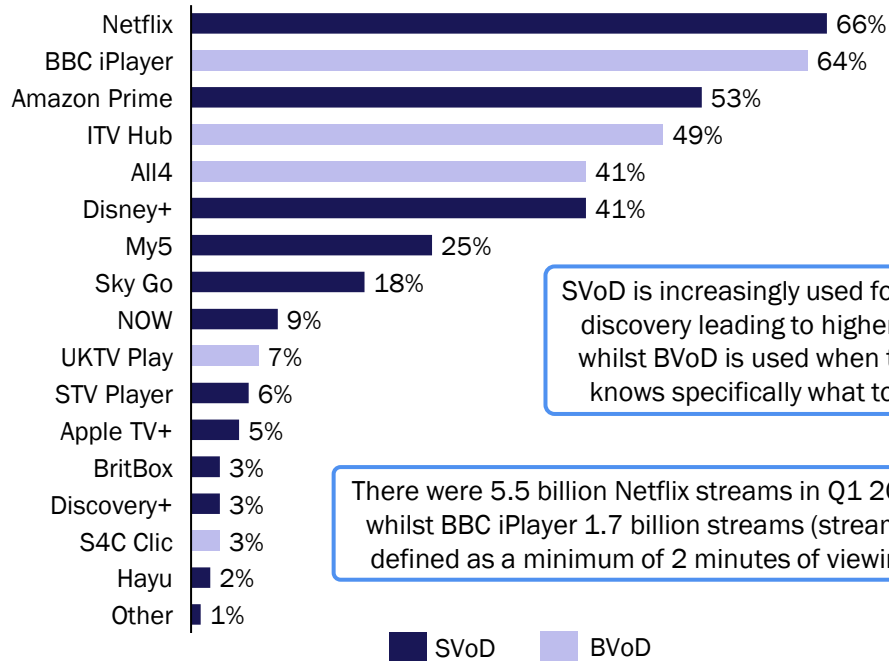
As SVoD takes a large share of average viewing time, broadcast TV viewing time has reduced up to 2020 which has resulted in a reduction in broadcast revenue, which will adversely affect BVoD content quality and reduce BVoD viewing time (and BVoD revenue)

Note: Charts include ITV, Channel 4 and Channel 5. 2021 figures are estimates based on press releases for the first 9 months of 2021

Source: www.ofcom.org.uk "Media Nations" report 2021, Ampere Analysis, Analysys Mason, PWC

SVoD has a higher average viewing time versus BVoD, and the number of SVoD households rose from 17.7 million in 2020 to 19.1 million in 2021 (67% households)

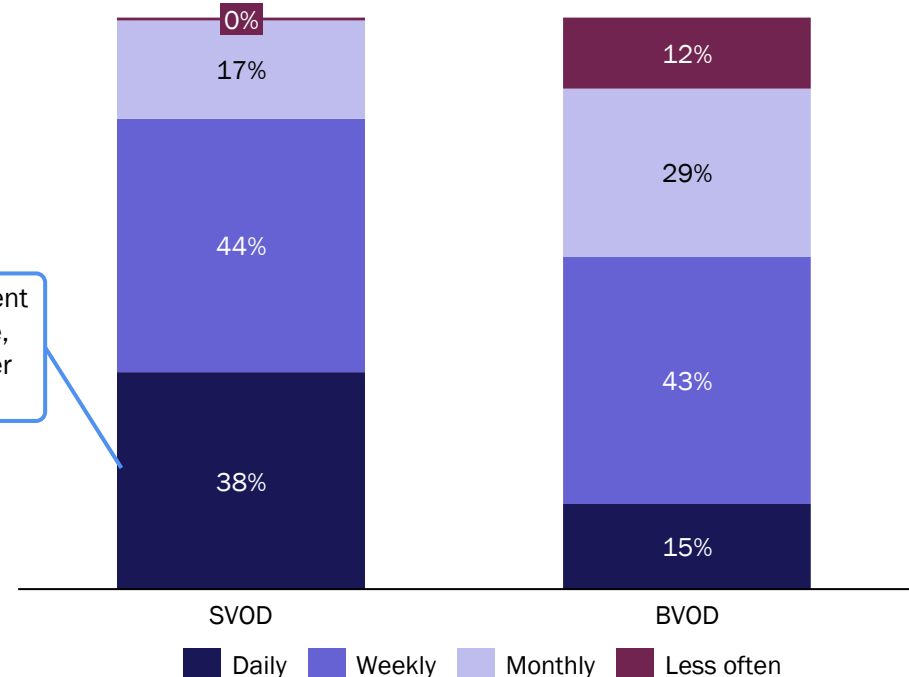
VoD services used in UK households, Q1 2021¹



SVoD is increasingly used for content discovery leading to higher usage, whilst BVoD is used when the user knows specifically what to watch

There were 5.5 billion Netflix streams in Q1 2021, whilst BBC iPlayer 1.7 billion streams (stream is defined as a minimum of 2 minutes of viewing)

Usage frequency of respondents per VoD services¹



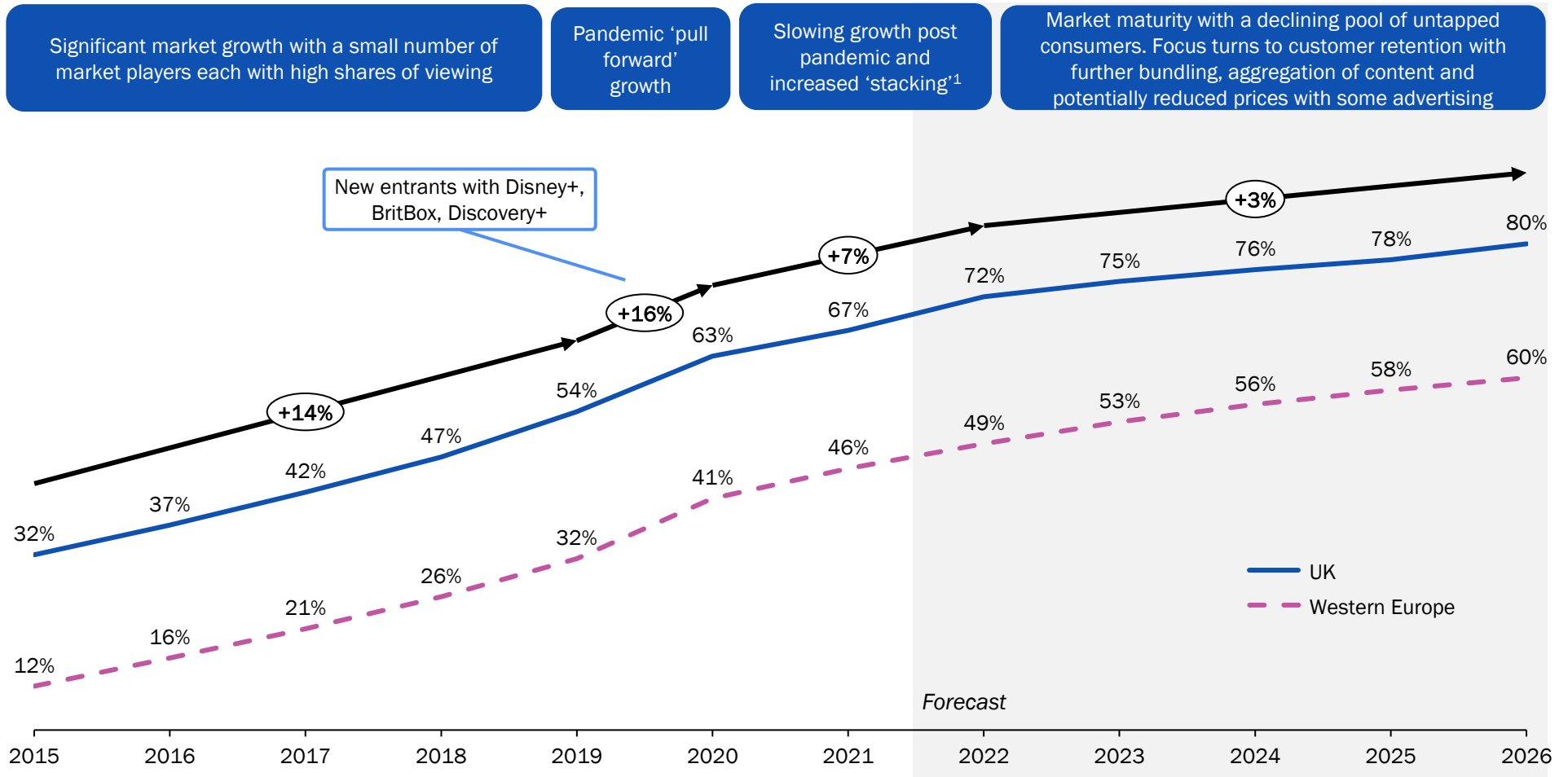
- Netflix and BBC iPlayer were the biggest VoD platforms in 2021 and this is expected to continue for the next few years, with the diverse high budget content as the major pull for Netflix, and local quality content as the major pull for BBC iPlayer
- UK households subscribing to two or more SVoD services rose to 12.4 million homes (43%) in Q4 2021, of which 84% had both Netflix and Amazon Prime. 9% of households use three or more SVoD platforms and this has stayed relatively stable over the last three years, which indicates the arrival of new platforms recently (e.g Disney, Apple TV+) has not encouraged households to go from 2 to 3 platforms²

¹ Based on the respondents in the BBC performance tracker, ² Note that some customers would swap services

Source: BARB, www.ofcom.org.uk "Media Nations" 2021, www.gov.co.uk "consultation on a potential change of ownership of channel 4 Television" 2021, BBC Performance tracker 2020-21, <https://mediatel.co.uk>, www.mediaagencygroup.com/

The growth in the SVoD market is expected to slow as the market reaches maturity

Penetration of households using SVoD

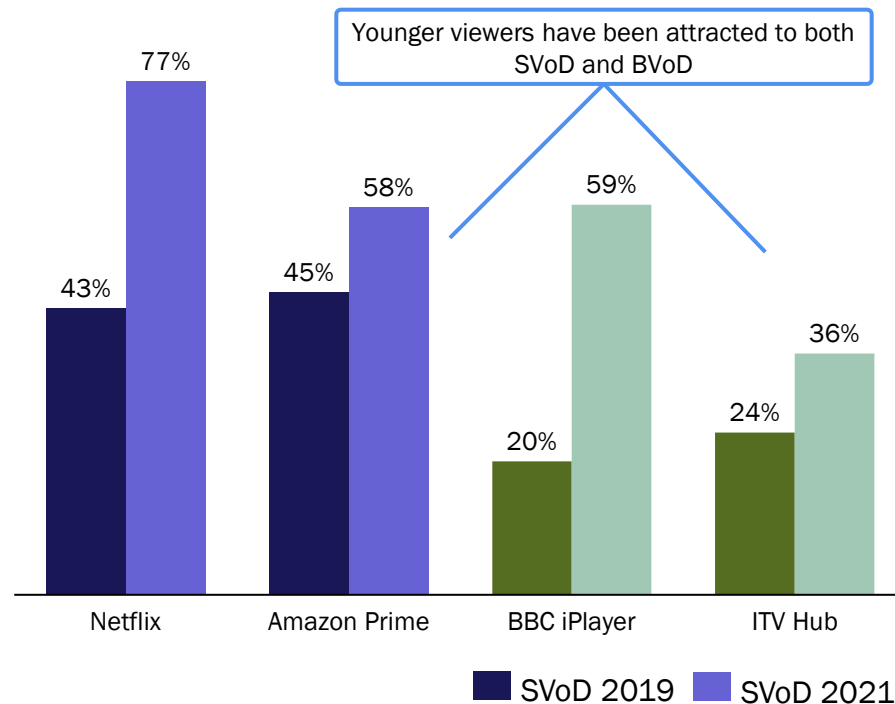


¹ Stacking refers to multiple SVoD subscriptions per household

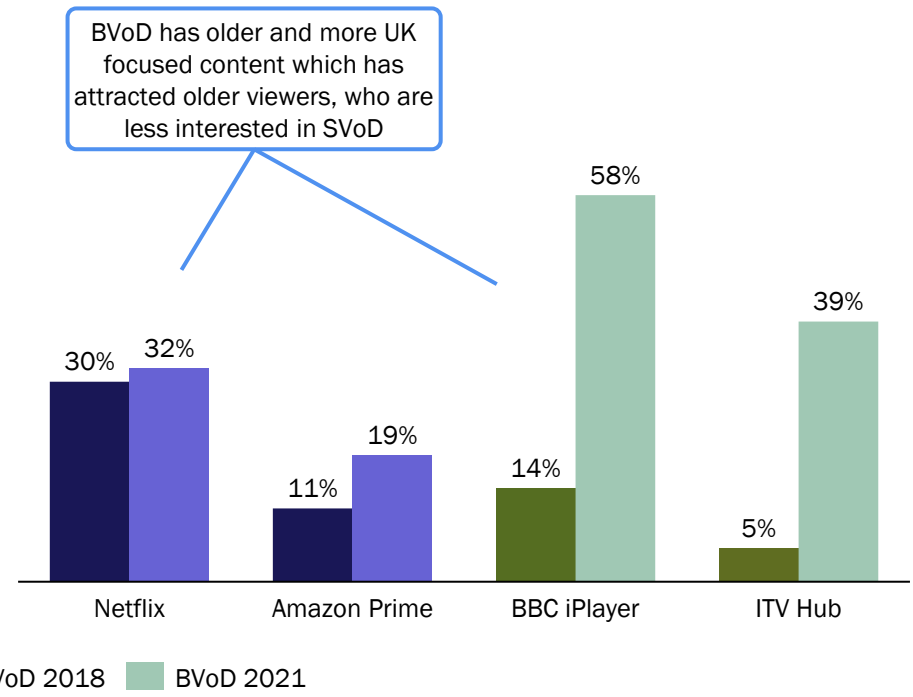
Source: Analysys Mason Research

Younger viewers have driven SVoD's historic subscriber increase, but the high penetration for this segment is also contributing to slowing of subscriber growth

Usage of VoD services for viewers aged less than 55 years¹



Usage of VoD services for viewers aged greater than 55 years¹



- In an increasingly saturated market and an already high penetration across younger age groups, some SVoD platforms in 2021 reported the smallest overall growth in subscribers in a decade (e.g. Netflix)
 - this has led an increased focus on attracting older age groups who have seen a 66% surge in internet usage during the pandemic

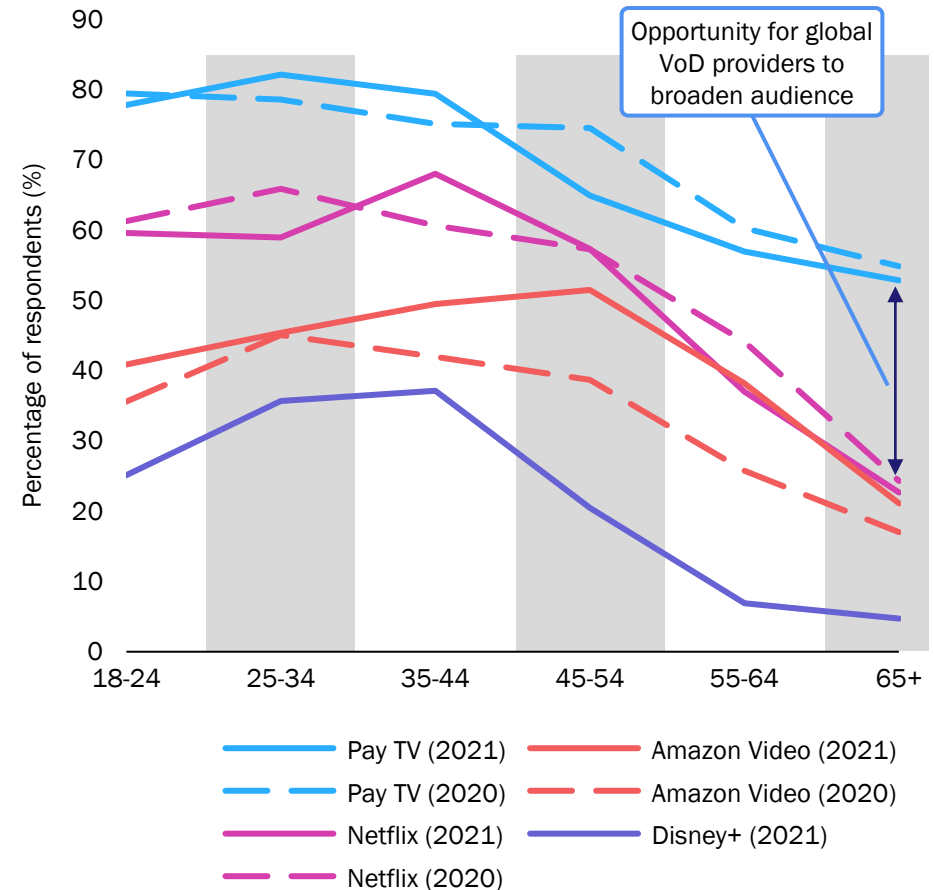
¹ Data from BBC performance tracker and calculated from % of respondents (by age group) that use VoD platform; ² Based on the number of respondents in the 2021 BBC performance tracker

Source: Deloitte "Online entertainment accelerates, boosted by lockdown", www.ofcom.org.uk "Media Nations" reports 2021, BBC Performance tracker 2020-21, Analysys Mason Research

Global players can benefit from UK providers' existing base in older segments; but they could also outcompete local players through significant investment in content

- Global VoD services can benefit from forging relationships with local (UK) Pay-TV providers and operators in order to reach older audiences
- There is a clear disparity between the level of engagement that users aged 55 and over have with VoD services versus Pay-TV
 - major VoD providers all have significantly lower penetration than Pay-TV and the penetration for the age groups over 54 decreased for Netflix
- Proportion of users that use someone else's account details for Netflix in the UK increased from 17% in 2020 to 27% in 2021, partly due to price increases
- Pay-TV providers and telecoms operators may be able to help streaming video providers to reduce password sharing
 - integration and aggregation of streaming video services would also reduce the opportunity for password sharing
- Content is a significant factor that drives user growth and churn
 - it is reported that around half of HBO's key audience (aged 18-49) in the US dropped in 2020 after the end of the fantasy TV show "Game of Thrones" in 2019¹
- Global brands can leverage their financial position and invest in content, which can act as a differentiator and strengthen their position against local / UK players (and their content)

Age distribution of users by major VoD services, UK, 2020 and 2021

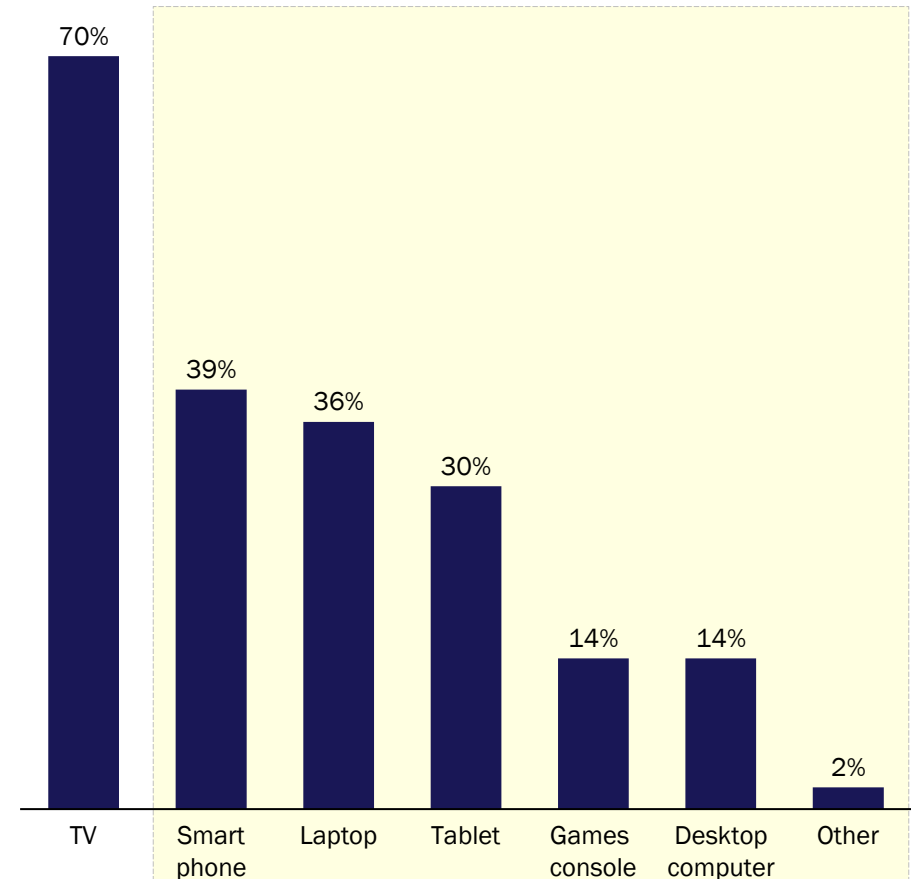


¹ <https://screenrant.com/hbo-2020-ratings-viewers-decrease-game-thrones-impact/>

As well as the pandemic ‘pull forward’ of viewers, the increase in SVoD and BVoD viewing time is also due to changes in content, platforms and technology

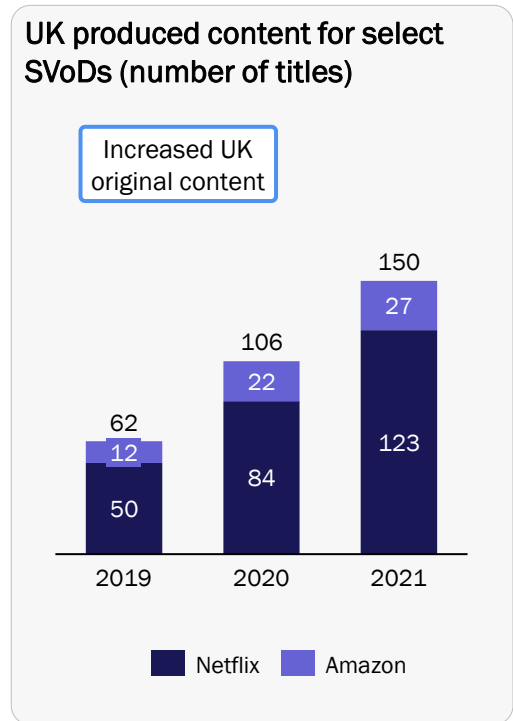
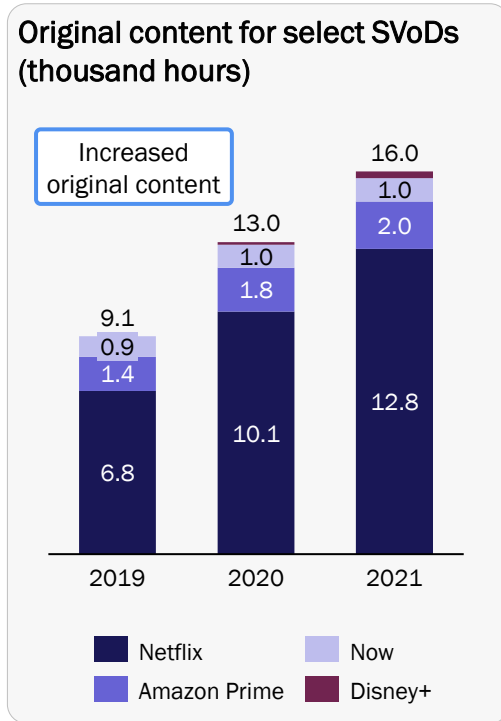
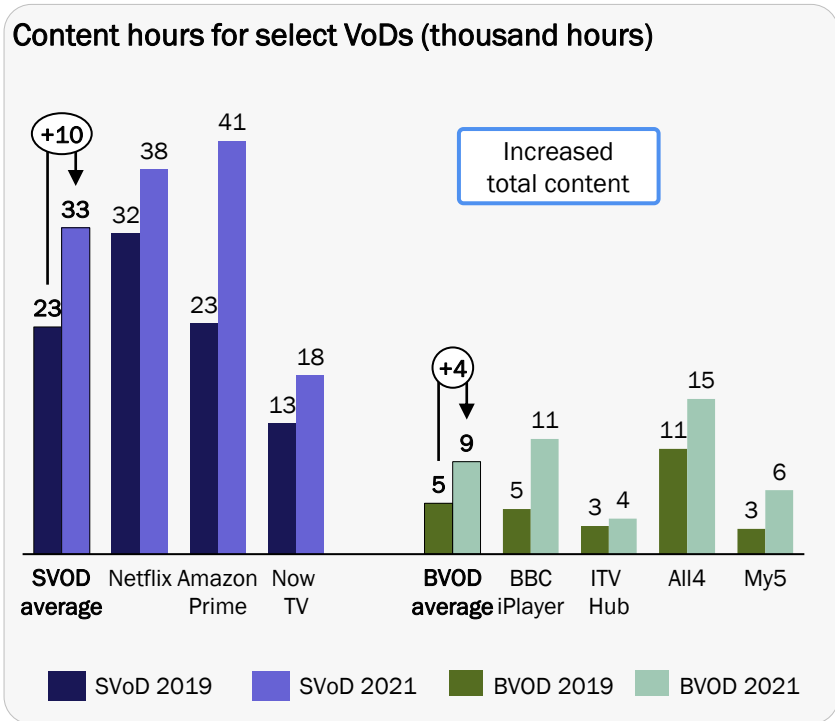
- The main reasons for the surge in viewing time for VoD in recent years have been:
 - Covid-19 and the ‘pull forward’ of users that signed up due to lockdown conditions have remained once lockdown has lifted
 - the growing investment in VoD content, not only in terms of total content but also in original and UK based content (see next slide)
 - the launch of major new platforms (e.g. Disney+) which has also increased the number of user that are ‘stacking’ multiple subscriptions
 - technological enhancements
 - with the increase of superfast broadband, the ownership of connected devices capable of streaming VoD services has also increased which has thus encouraged subscription

Ways of watching VoD in UK households



With SVoD customer retention being a major area of focus post-pandemic, there is an increased attention to the total content, local content and original content

- Investment in content (original and non-original¹) has helped SVoD keep customers who may have signed due to lockdown conditions
 - for example, Amazon Prime invested USD11 billion in 2020, up from USD7.8 billion in 2019. In 2021 Amazon announced a deal to buy MGM studios² for USD8.5 billion, which if approved would give it access to 4000 films and more than 10 000 hours of content
- BVoD platforms are actively responding to changing audience habits and making their services more than just catch-up TV, including streaming some live events exclusively online, providing content ahead of broadcast schedule and including more box sets
 - recent growth in BVoD catalogues has come from older box-sets (in 2021, 46% was older than 5 years vs 38% in 2019)



¹ Original content includes exclusive content and refers to material that was produced specifically for a particular SVoD platform

² The deal has not yet closed and is still to be approved by regulators

Source: www.ofcom.org.uk "Media Nations" reports, BBC Performance tracker 2021

The VoD race to grow customer numbers and keep existing ones will give higher focus on bundling and partnerships in future years

Bundling

- Many SVoD platforms already partner with UK telecom operators or cable TV to provide in order to tap into a large proportion of the population
 - this can help VoD providers trim distribution and customer management costs, and incentives for people to stay with a bundled option
- **15% of all partnerships now include ‘soft-bundling’** where there is a limited-time, promotional discount for the OTT service, which is partially subsidised by the operator
 - strategies like these have helped SVoD growth, with the long trial periods also designed to build loyalty and ‘stickiness’ before asking customers to eventually pay a regular subscription fee
 - in July 2021, Discovery was bundled with Vodafone, offering its pay-monthly mobile customers six months access to Discovery+ at no extra cost
- **A fast-growing model is ‘Super bundling’** but currently has low prevalence in the UK market. Here, multiple OTT video subscriptions are bundled into a single plan for a discounted price
- Short-cut buttons for SVoD players are often included on the remote control of a Smart TV

Partnerships

- The market for VoD is incredibly crowded with some platforms expected to combine and/or simplify
- This includes partnerships between platforms. For example:
 - SkyShowtime was created in 2021, a partnership between Sky (Comcast) and ViacomCBS
 - Roku and Apple with their connected TV platforms
- **The consolidation of multiple brands owned by the same company into one portfolio is expected to continue** over the next few years to broaden the appeal to a wider audience
 - for example, in Feb 2021, Disney+ integrated Star sub-brand into its offering providing content from FX, etc.
- **‘Compounding’ or ‘nesting’** is an emerging partnership model where SVoD platforms are integrated into another platform, rather than existing as standalone apps, for example:
 - Netflix and Discovery+ content is nested in the Sky interface. **28%** of households with Sky pay for Netflix service through Sky
 - ITVHub+ and BritBox content is available through search on Amazon Prime Video

The VoD race could also encourage advertising in some pricing tiers to lower subscription fees or consolidation of content to ensure a good user satisfaction






Consolidation

- As of 2021 **SVoD churn was 15% and is expected to rise to 20%** in coming years as competition continues to increase
- As the number of SVoD services grows and the pool of untapped consumers declines, acquisition costs will rise, making retention even more important
- To retain existing customers, it is expected **that content aggregation will rise** as many consumers will be looking to services that give them a broader range of programmes
- 2019 saw the first of such consolidation between Disney and Fox. There have been two further deals since:
 - in 2021, Discovery merged with WarnerMedia for USD48 billion which would then match with Netflix and Amazon in terms of content volume
 - Amazon closed a deal to buy MGM studios (still to be approved) giving it access to premium films including the James Bond franchise
- As of November 2021, **UK broadcasters are reportedly looking to create a single streaming app** that would build upon BritBox, and would contain content from all broadcasters
 - content could be viewed directly via the app or take viewers through to the individual streaming services

Advertising Video on Demand (AVoD)




- Given the **rising cost of stacked SVoD** (43% have two subscriptions), consumers are less likely to pay for additional streaming platforms
- The current average VoD monthly spend per household is GBP15-GBP20, with research showing consumers are not willing to pay much more than this, indicating that **to attract new customers, pricing may need to be reduced**
- To manage costs, consumer appetite for AVoD has been growing steadily, with a hybrid model of SVoD + AVoD expected to have a larger market share within 3-5 years
- A study shows that **85% would prefer to watch advertising in exchange for free/reduced subscriptions**
- This means for some SVoD players it would give rise to subscription revenue and **potential advertising revenue for low tiered offerings**, with additional VIP tiers and access to exclusive content such as first-run movie premieres
- One of the market leaders in AVoD is Viacom-owned Pluto TV which has almost doubled its total users to over 30 million worldwide since 2020
- Although neither Netflix or Disney appear likely to implement this, **Now has already started including advertisements on its platform**

Recent innovations in VoD aim to ensure revenue is maintained amid an expected increase in churn, by introducing new functions, algorithms and interactive services

Innovation	Commentary
Search and discovery 	<ul style="list-style-type: none"> Most VoDs continue to fine-tune their recommendation algorithms to reduce churn by targeting smaller customer segments which can be essential to developing more effective content personalisation. It can make it easier to predict when a customer might leave due to growing cost sensitivities or indifference to content and even lower the risk of developing new content through a better understanding of what will succeed for different segments Netflix introduced the 'Play Something' feature in April 2021, designed to offer subscribers a more automated, passive means of discovering content. Currently they recommend films based on their similarity with other films a user has preferred. But Netflix is exploring ways that it can recommend some variety to the user to keep them engaged and lead to increased content discovery, but not too much variety that users become frustrated with long discovery times
Gaming 	<ul style="list-style-type: none"> In 2021, Netflix announced it is investing in gaming as a driver of new growth. Given the high-investment, high-risk nature of gaming, analysts are still unsure of how the strategy will play out with the technical and competitive challenges involved to make it a success
Advertiser data 	<ul style="list-style-type: none"> ITV has recently begun using 'Planet V' technology that enables the blending of advertisers' own data with that of ITV Hub's, to ensure that the right audiences, locations and sectors are targeted with advertising campaigns
E-commerce and interactive services 	<ul style="list-style-type: none"> One aspect of ITV's VoD strategy is e-commerce and interactive services, such as the Love Island mobile game, through which users can purchase digital merchandise, as well as 'shoppable TV' which was announced in 2021. This new service allows users of LG smart TVs to purchase products featured in programmes, with cosmetics retailer Boots the first to partner with ITV on the new venture
Other 	<ul style="list-style-type: none"> Netflix is also making its user experience more social with the addition of 'Fast Laughs', a TikTok-like feature for mobile devices that provides a stream of short form video clips from Netflix to encourage users to watch the full series



A high potential for substitution, a highly competitive VoD landscape, and negligible switching costs gives rise to end-users with high bargaining power

Porter's Five Forces framework

	Metric	Explanation
	Potential of new entrants	<ul style="list-style-type: none"> ■ Medium – Relatively low barriers to entry (i.e. 'free' delivery to the home via ISP) mean that new entrants are an ongoing prospect especially for those suppliers with their own backlog of content (e.g. Disney in 2020) ■ But large scale and/or access to winning content is required to move up from the 'long tail' and gain a material share of the market ■ Reaching scale may prove difficult and deter new entrants as first-movers already have advantages by collecting and accumulating user preferences and using it to improve programming and content discovery
	Potential of substitution	<ul style="list-style-type: none"> ■ High – VoD forms one of a range of content services vying for the scarce resource of end-users' attention, and is therefore substitutable by (and capable of substituting for): conventional TV, video sharing platforms, social media, gaming, etc. ■ This can already be seen with younger generations who are increasingly spending more time on TikTok, Instagram and YouTube and prefer shorter content that is more user-specific and varied
	Bargaining power of users	<ul style="list-style-type: none"> ■ High – Customers (end-users) appear to have strong bargaining power due to high levels of competition: high expectations of varied content at affordable prices which are usually cancellable at any time with negligible switching costs ■ However, algorithms learn users' preferences over time (like programming history). As these are enhanced, users may become more dependent on a particular platform that understands them with its suggestions for new content ■ Also, bundling with other services will deter some users from switching (e.g., Amazon Prime delivery bundled with Amazon Prime Video) ■ Free trials of some VoD platforms (e.g. Amazon Prime Video) ensure that users can 'test out' the content before committing longer term, although this is being phased out (e.g. Netflix and Disney+)

In a maturing market with increased focus on reducing churn, good quality content suppliers have high bargaining power but it is reducing as original content increases

Porter's Five Forces framework

Metric	Explanation
 <p data-bbox="271 675 513 736">Bargaining power of suppliers</p>	<ul style="list-style-type: none"> ■ Medium – The largest rights holders can exert significant power (e.g., holders of sport rights, major film studios), but smaller rights holders less so ■ Some content suppliers have created their own streaming service which increases the scramble by SVoD players to get additional content that production studios would have otherwise been more eager to license out ■ However, bargaining power is reducing across all suppliers as many platforms continue to invest significantly in original content ■ VoD platforms may also gain greater leverage given their relationships with end users and access to usage data <ul style="list-style-type: none"> – as VoD players capture more usage data from end users, they can also provide new, better targeted programming to them and rely on supplier content less ■ Large VoD providers are likely to be able to agree better deals with CDN operators than smaller ones
 <p data-bbox="271 1120 513 1150">Competitive rivalry</p>	<ul style="list-style-type: none"> ■ High – Significant levels of competition between players, which can be split into three categories: <ul style="list-style-type: none"> – large international; Netflix, Amazon, Google, Apple, Disney – local incl. PSB related; BBC, ITV, Ch4, UKTV – other; Rakuten, Peacock, Now, BritBox, Discovery ■ With a reducing pool of consumers left to attract to VoD services and ‘stacking’ of multiple VoD platforms per household means there is an increased focus to reduce churn and keep customer satisfaction high <ul style="list-style-type: none"> – this in turn increases supplier power as good quality content becomes important for user satisfaction

There are various value chain relationship for VoD but bundling and horizontal interconnection to create more access points are becoming increasingly important

Considerations for relationships across the value chain

Considerations	Explanation
Prospects for substitution to intensify	<ul style="list-style-type: none"> Subscription VoD services have shown the greatest increase in share of viewing time, fueled by the stay-at-home restrictions of the Covid-19 pandemic, at the expense (in proportionate terms) of broadcast TV The ongoing shift in viewing preferences (from scheduled to on-demand) and the ability of large international VoD providers to acquire or produce internationally appealing content is likely to continue this substitution from scheduled TV to VoD, even after total viewing minutes have returned to normal But substitution away from VoD to other platforms such as TikTok and YouTube, especially in younger age groups, is likely to increase further as these platforms cater for user specific user demands
Balance of bargaining power	<ul style="list-style-type: none"> Bargaining power of end-users is supported by strong competition On the supplier side, large international VoD providers may hold significant power over their suppliers, which may become reinforced over time. Large international VoD players have the largest customer base and largest source of revenue. This allows them to spend the most on acquiring or creating the best / most expensive content, which has the biggest stars. They can take the biggest risks, and when 'hit' content is found, it can be monetised over the largest addressable market, retaining / attracting more users, which reinforces the overall effect. Access to end-user viewing data has a similar effect (see later)
Bundling practices	<ul style="list-style-type: none"> There are mixed approaches to bundling with no one model being an obvious winner, e.g., Amazon Prime Video is bundled with delivery services, Sky's on-demand services are bundled with their Pay-TV services, Amazon Prime Video includes the option to consume other VoD services via the same platform (e.g. Britbox, so-called 'nesting'), Netflix short-cut buttons are often included on the remote control of a Smart TV
Scope for "horizontal" interconnection and interoperation relationships	<ul style="list-style-type: none"> Some examples of being able to access content from multiple VoD providers from within a single platform (e.g. Netflix from within Sky Go, Discovery+ from within Amazon Prime, BBC iPlayer from within Apple TV etc.) This is likely to increase as platforms compete for visibility from users and do this by providing more 'access points'

In conclusion, VoD providers with a hybrid strategy across rights ownership and distribution are well placed and may put acquisition pressure on other providers

Analysis of possible market outcomes

Aspect of market outcome	Comment
Profitability in the long term	<ul style="list-style-type: none"> Users decide which services to purchase based on the content available, not for other reasons, e.g. the user interface. Therefore, profitability is significant for rights holders who effectively have a legal monopoly Those that have a hybrid strategy across rights holding and distribution (e.g. Disney and Paramount) are well placed: if a provider owns more content, it has more flexibility over how to monetise that content, and there are therefore strong benefits of vertical integration. Consequently, profitability for 'pure play' VoD providers (such as Netflix) is unlikely to increase materially
Who is in the best position to succeed	<ul style="list-style-type: none"> We expect multi-homing to continue, which is likely to support a vibrant and competitive market Big rights holders (e.g. Disney, Paramount, Amazon has just acquired MGM) could have an advantage (see above) and may encourage further acquisitions (e.g. Netflix buying some of the producers with which it has output agreements, so converting this liability to an asset) Audiences are likely to continue to consume a mix of 'internationalised' content (which major global brands can provide) and more local content (which UK players are established at providing). There is a question about whether PSB providers could make the shift to only production (and away from distribution), though we think this unlikely: inherent to the PSB responsibilities are ensuring content reaches end-users, and distribution allows some control over how content is received
Prospect of external challenges	<ul style="list-style-type: none"> Requirements for quotas of local content could have an impact, but VoD providers could adjust their catalogue to compensate A more material challenge is users' attention shifting to other forms of content, such as gaming, social media, video sharing and meta-verse style services



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Telcos are moving towards more software-based network functions, which are designed to reduce costs and facilitate new streams of revenue

- In this section we analyse the market for **cloud services for the operation of telecoms networks**
- Faced with ongoing competitive pressure (including from new entrants such as Hyperscalers), telecoms operators (telcos) are pursuing a strategy of **digital transformation** to:
 - generate new revenue, i.e. **launch new types of services**
 - **improve time to market** for new products
 - manage traffic growth by making **more efficient use of networks**
 - **reduce the total cost of ownership** of networks and products
- Key to the transformation of telco networks is the ‘*softwarisation*’ of network and associated functions
 - the main technology elements are shown on the right
- Three technology elements are key enablers to the digital transformation of telcos:
 - **NFV** covers virtualising network functions by migrating from dedicated hardware appliances to software applications on commercial off the shelf (COTS) hardware (i.e. either vendor x86 or ‘white box’ hardware)
 - **SDN** is the physical separation of the network control plane from the user plane, which allows a centralised controller (SDN controller) to gather information about the network and take automatic actions based on defined policies
 - **Cloudification** – communication providers have a choice of deploying and hosting their virtualised network functions and service capabilities in private- or public-cloud infrastructure, or a hybrid public/private cloud

The overall aim is to make better and more flexible use of the underlying computational infrastructure. By moving to a software- and cloud-based model, functions can be deployed and updated very flexibly, and utilisation of that underlying infrastructure can be increased (which in turn lowers costs).

The greatest gains can likely be delivered through the economies of scope and scale offered by ‘cloud’ infrastructure.

5G is expected to be a major driver of the move to cloud-based services:

- 5G architecture has been designed to be more software-based and disaggregated than previous generations
- new use cases which are envisaged to monetise the additional capacity fit well with the increased flexibility and scalability offered by cloud-based networks
- 5G investment cycle is coincident with the availability / prominence of a range of large cloud providers

The value chain landscape for providing cloud services is complex, in terms of both functions and types of market players

Summary structure of value chain landscape for providing cloud services to telcos

	Network equipment providers (NEP)	Hyperscalers	'Challenger' vendors	Systems integrators (SI)
Professional services (integration, on-going '24/7' support ¹)	✓ E.g. Nokia, Ericsson			✓ E.g. Tech Mahindra
Software functions (network, operational, digital services)	✓ E.g. Nokia, Ericsson	✓ E.g. Microsoft	✓ E.g. Mavenir	
Cloud orchestration and automation (IaaS, CaaS)	✓ E.g. Nokia, Ericsson	✓ E.g. Microsoft, Google, Amazon	✓ E.g. VMware, Wind River	
Underlying hardware (compute, storage, networking)	✓ E.g. Nokia, Ericsson	✓ E.g. Microsoft, Google, Amazon		

¹ A prime integrator would assume the responsibility of the whole deployment as a professional service. While each component vendor (including Hyperscalers) provides their own support/maintenance services, the prime integrator is the one that interfaces with and manages them and provides a single point of contact to the telco. The prime integrator could be a NEP or SI.

There are a range of technical concepts which are useful to keep in mind to understand the ‘cloud for telco networks’ space

Summary of selected technology advances underpinning changes in the telco value chain

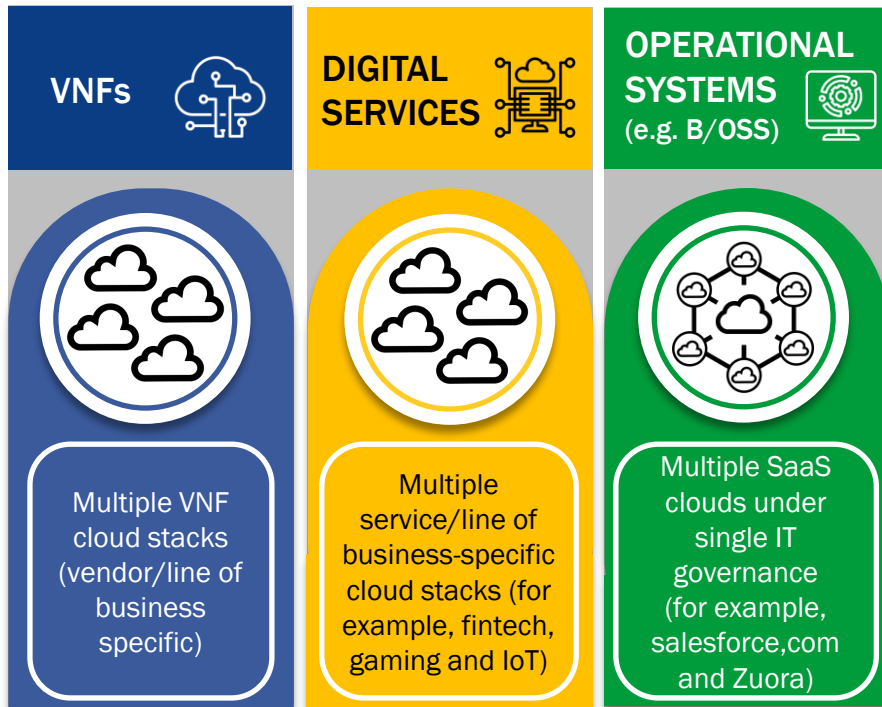
Technology	Description	Impact on telco network value chain
Microservices	Small modular applications which can be built up quickly to develop complex network functions and other applications. There are different views on what constitutes a microservice. For example, Verizon has previously defined: routing, WAN acceleration, load balancing, firewall etc. Amazon has defined a microservice as being no bigger than a ‘two pizza’ team.	The combination of microservices, containers and orchestration was pioneered by internet ‘Hyperscalers’ (e.g. Google, Amazon, Facebook and Netflix). Their use in telecoms is a natural evolution of NFV, allows functions to be run on cloud-based infrastructure and are known as cloud-native functions.
Containerisation	Each microservice is packaged in its own software ‘container’, that encapsulates the entire application run time. Containerisation lets applications run independently and portably across different cloud infrastructures ¹ . The prevailing standard for containerisation is Kubernetes (K8s)	The benefits of a cloud-based network include service agility, resource flexibility and scalability , all of which will help operators to extend their 5G business models to new markets. They have the capability to rapidly replaced if they fail , though there are general concerns about whether the reliability of the technologies is ‘carrier grade’ .
Orchestration	Orchestration systems automate the scheduling and allocation of containers to the available underlying computing infrastructure resources	As network functions start to be run on cloud-type platforms and infrastructure, it provides an opportunity for Hyperscalers which offer such infrastructure as a service (public cloud providers, PCPs) to enter the mobile value chain. PCPs will not necessarily host network functions on their infrastructure, but can offer their cloud stack technology to run functions at MNOs’ on-premises locations.
vRAN	The vRAN is a version of the radio access network (RAN) in which some or all of the digital baseband functions are implemented in software on a cloud platform, which is commonly distributed across many edge locations. In most cases, the cloud-based functions are shared by multiple cell sites, which is where the physical radio/antennas reside. This enables the flexible allocation of RAN resources to many sites, as required.	Significant progress has been seen in the core domains, but the RAN remains largely untouched , and migration in this domain comes with daunting performance and integration challenges . However, it will be difficult to achieve the full benefits of 5G if as much of the network as possible is not deployed in the cloud. Open RAN is a related set of standards to allow connections between the disaggregated components of the base station via standardised interoperable interfaces. This could increase supply chain diversity , supporting multiple (new) vendors and potentially increasing the role for systems integrators.
Network slicing	The concept of dividing up end-to-end network capacity (from core to RAN) and assigning a ‘slice’ of that capacity to a particular use case, end user or application, with assured bandwidth, latency and reliability characteristics	Allows MNOs to provide new use-case services to specific industry verticals, e.g. healthcare, automotive and manufacturing. There is some debate in the industry about whether network slicing or private networks is the best approach to serve these new use cases.

¹ While there are different types of containers (e.g. AWS does provide their own versions), they are largely standardised, and there is a strong incentive to not use proprietary versions (to realise the benefits of cloud functions)

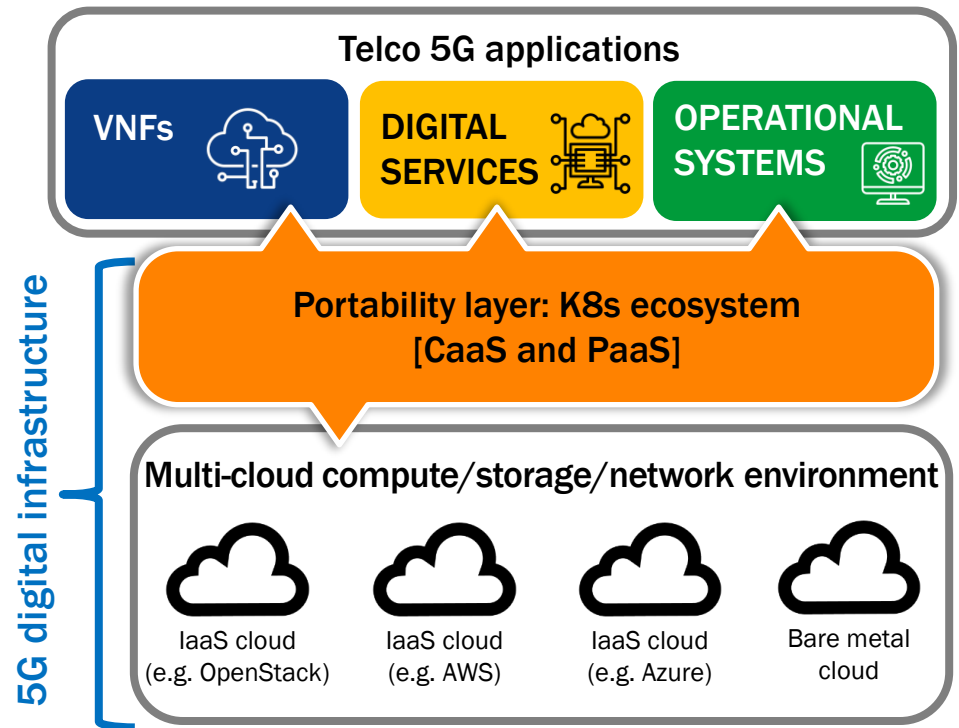
Source: Analysys Mason

Cloud-native functions will allow an operator's services to be run on multiple clouds, which has benefits for cost, performance and adhering to regulation

Telcos' first-generation cloud environments are based on specific virtualisation stacks, which creates silos



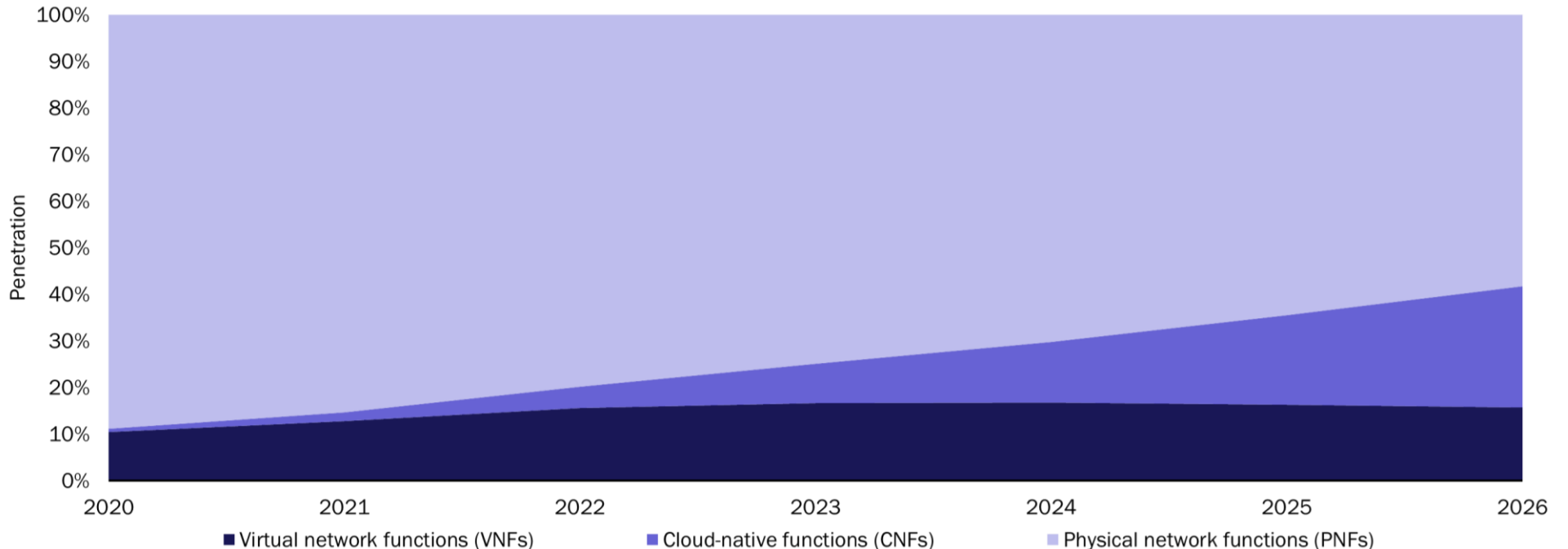
With containerisation, applications can be run across multiple cloud infrastructures



- The use of multiple clouds allows the telco to match all types of applications (across VNFs, digital services, operational services) to underlying infrastructure based on: cost, performance and regulatory requirements
- **These developments in the underlying technology provide a natural opportunity for Hyperscalers to enter the value chain to get a share of telco IT spend,** because telco applications can be run on any cloud infrastructure (not just the infrastructure of the application provider)

Despite the transition towards technology that works across multiple clouds, we see a relative slow migration towards the use of cloud native functions (CNFs)

Forecast of the rate of virtualisation/cloudification of network functions (based on split of telco spend), 2020–2026



Source: Analysys Mason

- The total addressable mobile market for network cloud includes mobile core and RAN network hardware and software only, and excludes management, control and orchestration software and all professional services
 - the forecast includes only things that can be virtualised (e.g. the baseband and core functions; it excludes things like antennas)
- By 2026, c.60% of spend will still be on 'physical network functions', i.e. integrated equipment. This is predominantly in the RAN, which is 8-10 years behind the cloudification of the core

¹ The total addressable mobile market for network cloud includes mobile core and RAN network hardware and software only, and excludes management, control and orchestration software and all professional services.

² Our definition of cloud-native is aligned with CNCF's definition: <https://github.com/cncf/toc/blob/master/DEFINITION.md>.

There are a number of barriers which mean that progress towards cloudified networks will be slow (and even slower for networks carried on the Hyperscalers)

General barriers to the adoption of cloud native network functions

Demand for new 5G use cases is slow

- Demand for new 5G use cases has been slow to materialise: no killer app yet defined
- Operators are still focusing on improving coverage (mainly for mobile broadband)
- Some debate as to best serve new use cases (network slicing vs. private network)

Operators are not yet ready

- Telcos generally lack the internal skills to design, build and operate cloud native networks: there are challenges around integration, orchestration and automation complexity and costs
- Telcos are also struggling to decide on the right cloud strategy: building horizontal, disaggregated clouds; using pre-integrated single vendor clouds and using PCP clouds

Established vendors are not yet ready

- Telcos have a general view that vendors 'CNFs' are generally not fully cloud ready
- Vendors have made clear progress in making their 5G core network functions cloud-native, but there are challenges associated with the vRAN (incomplete standards, stringent requirements and more complexity)

Further barriers to use of Hyperscalers for cloud network services

Further barriers to use of Hyperscalers for cloud network services

- There are some trust issues with telcos relinquishing control of their networks (especially seen in European operators)
- Regulatory requirements also mean that the clouds may not be able to leave the operator's area of control, and give rise to the need for 'sovereign clouds'
- Hyperscalers' offerings are considered to be unproven (in terms of being carrier grade, SLAs) etc. Core-related offerings are improving, but there are (again) more questions around the RAN.

Hyperscalers recognise these concerns, but are also taking advantage of the telco's lack of internal expertise. In contrast to the 'step change' approach being pushed by some vendors, Hyperscalers are taking a more incremental approach to working with telcos by hosting small amounts of non-critical functions on their platforms first. This approach is welcomed by some telcos, but migration will take time.

Overall, we expect the migration of telco network functions towards cloud-based technology to take place over the next 5-10 years

Our analysis suggests that the Hyperscalers will take a very small proportion of the spend on network functions, within a complex and fragmented part of the value chain

Overview of vendor ecosystem in the 5G cloud-native value chain

Services	Global estimated annual spending on mobile cloud network functions, 2026	Example players
Professional services	USD4.5 billion	Network Equipment Providers (NEPs, e.g. Ericsson, Nokia) Consulting and systems integrators
Virtualised and containerised network functions (xNFs)	USD10.3 billion	NEPs and new entrants (Altistar, Casa, Enea, Mavenir, Parallel Wireless)
Infrastructure as a Service (IaaS) and Containerisation as a Service (CaaS)	USD4.5 billion	NEPs, Red Hat, VMware, Robin.io, Wind River, SUSE, Mirantis
SDN control	USD1.0 billion	NEPs, Cisco, Juniper, VMware and open source
Hardware ²	USD7.0 billion	NEPs, Dell, HPE, Lenovo, Intel, Nvidia, Arm, Qualcomm, FPGA/smartNIC
Total	USD27.3 billion	

Analysis covers public 5G network functions (including RAN and Core), but excludes other IT spending (OSS/BSS and digital services) and spend on private enterprise networks

Spend with Hyperscalers

- We estimate that Hyperscalers could account for c.20% of spending on the ‘cloud network stack’ by 2026
 - estimate based on primary research into operator strategies
 - the total of the network stack services is estimated to be USD12.5 billion per annum, so the value attributable to Hyperscalers is USD2.5 billion per annum by 2026
- We also estimate that the total global network spend by mobile telcos (both capex and opex) will be c.USD883 billion per annum in 2026¹
 - so Hyperscalers’ share of 5G mobile network services will account for around 0.2% of total mobile spend

Structure of the value chain

- NEPs are expected to provide services in all areas of the 5G cloud native value chain
- Hardware can also be provided by large international IT vendors
- The Hyperscalers (PCPs) can operate in some parts of the value chain
- There are a large number of smaller providers

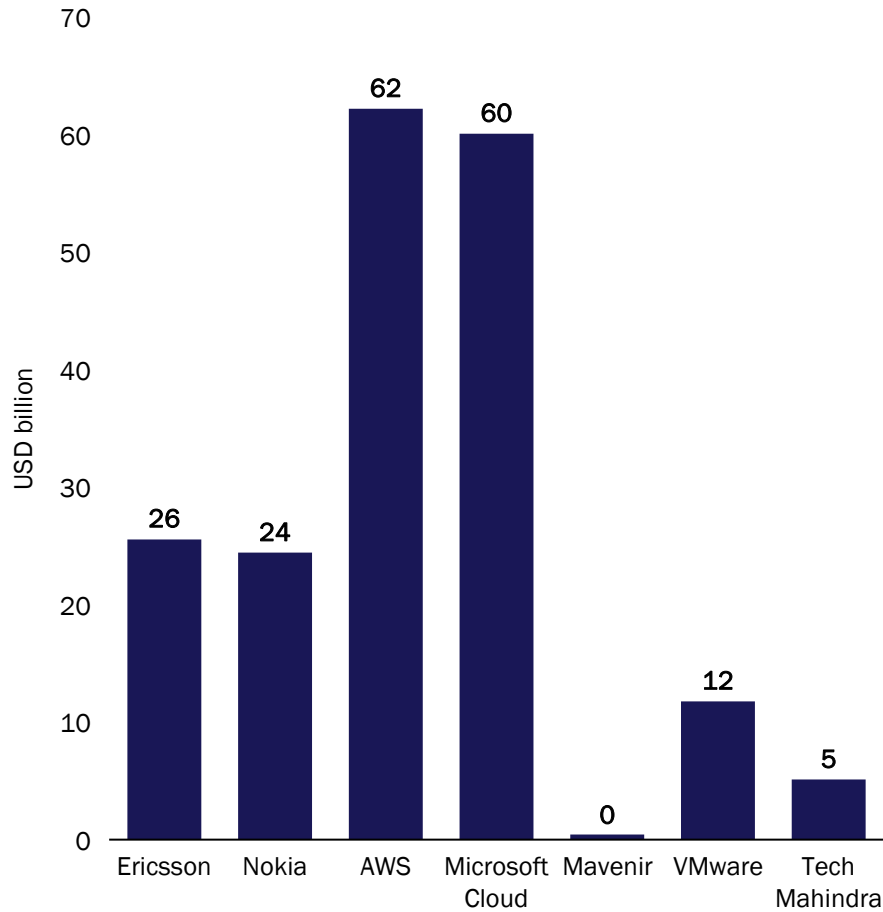
Market players can be split into four types: ‘incumbent’ network equipment providers (NEP), Hyperscalers, challengers and systems integrators

Comparison of selected players in the 5G cloud-native value chain

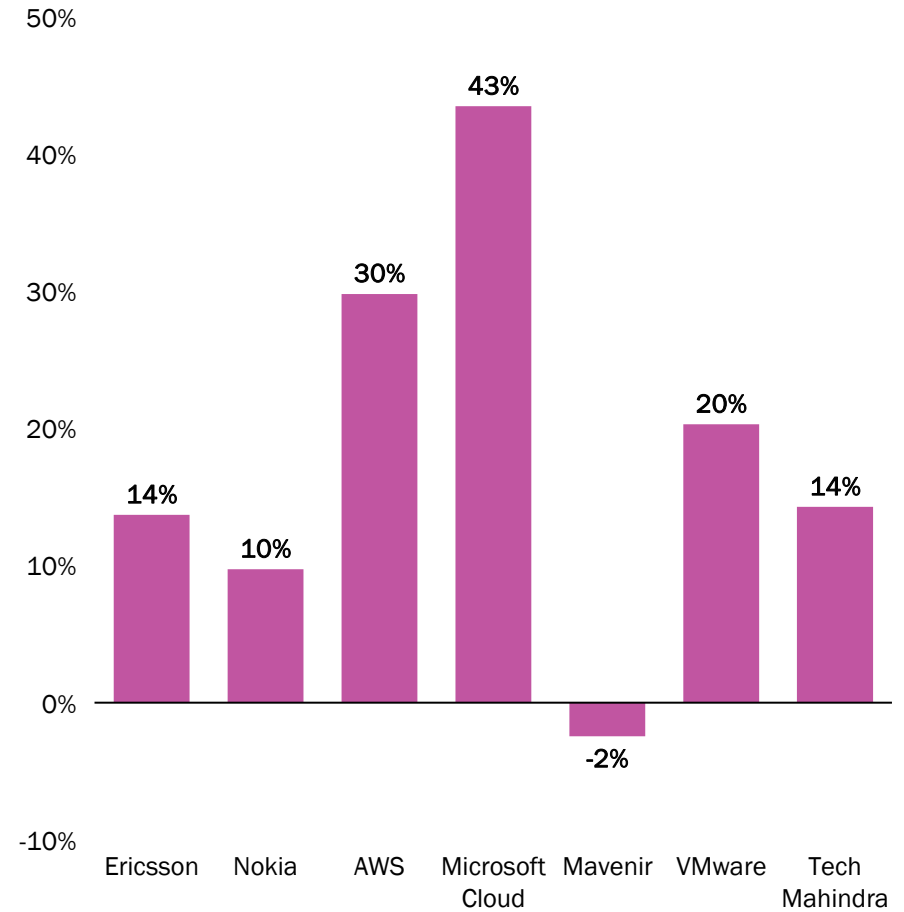
Operator	Ericsson	Nokia	AWS	Microsoft Cloud	Mavenir	Wind river	VMware	Tech Mahindra
Type of player	NEP	NEP	Hyperscaler	Hyperscaler	Challenger	Challenger	Challenger	Systems integrator
Description	One of the 4 major network equipment providers	One of the 4 major network equipment providers	Largest public cloud provider, offering compute power, database storage, content delivery, and other functionality	Large public cloud provider, offering AI, virtual machines and containers and DevOps tools	Mavenir is an end-to-end network solutions provider with a focus on cloud-native software	Provides virtualisation and cloud software solutions to a variety of industries and technologies	The first company to commercially virtualise x86 hardware. Now provides a range of cloud, app, and networking solutions	A large multinational information services and technology group
Founded in	1876	1991	2006	2010 (Azure)	2005	1981	1998	1986
Total revenues	USD26 billion (2021)	USD24 billion (2021)	Total: USD470 billion (2021) AWS revenue: USD62 billion (2021)	Total: USD168 billion (2021) Cloud: USD60 billion (2021)	USD427 million (2020)	[privately owned]	USD11.8 billion (2021)	USD5.1 billion (2021)
Professional services	✓	✓						✓
xNFs	✓	✓			✓			
IaaS and CaaS	✓	✓	✓	✓		✓	✓	
SDN control	✓	✓	✓	✓			✓	
Hardware	✓	✓	✓	✓				
Comments	Ericsson is a global telecoms and ICT vendor serving the network operator and service provider market	Nokia is a global telecoms and ICT vendor, providing solutions across mobile, fixed and cloud networks	AWS is prioritising partnerships with CSPs for edge computing but it is competing with MNOs for enterprise 5G private network business	Microsoft is targeting 5G-enabled Industry 4.0 use cases, 5G networks and edge network locations	Mavenir is a strong proponent of open RAN and was a founding member of the O-RAN Alliance. It markets its 5G vRAN solutions as open virtualised RAN solutions	Key player in vRAN. Only challenger that has core and RAN offerings. Recently acquired by Aptiv (focuses on connected mobility, software defined vehicles)	VMware's Telco Cloud Platform manages / orchestrates cloud-native and virtual network functions (CNFs and VNFs, respectively)	Tech Mahindra is a large systems integrator. Their role would be to combine solutions from separate vendors (including challengers and Hyperscalers)

The Hyperscalers financials stand out in terms of revenues and profit, though these businesses have a scope much larger than providing services to telcos

Comparison of total revenue, 2021^{1,2}



Comparison of operating profit, 2021^{1,2}



¹ Note: Mavenir shown for 2020; ² Wind river's financial information was not available at time of report writing

Source: Annual Reports

Each of the types of market player has certain advantages and disadvantages driven by factors such as size and existing expertise

Summary of advantages and disadvantages of different types of market player

	Advantages	Disadvantages
Network equipment providers	<ul style="list-style-type: none"> NEPs such as Ericsson and Nokia have deep telecoms network expertise and excellent relationships with the telcos; indeed, some telcos have become quite dependent on these vendors over the years 	<ul style="list-style-type: none"> NEPs are being slow to adopt to an open ecosystem, which could see them being caught up if telcos show a general preference for disaggregated network solutions
Hyperscalers	<ul style="list-style-type: none"> Understanding of how cloud technology works, with large existing cloud offerings The prevalent containerisation standard (Kubernetes, K8s) was invented by Google, and Hyperscalers are very good at automation and orchestration, and the provision of the underlying infrastructure Very open to, and comfortable with, solutions having several vendors (i.e. ecosystem approach) and do not have to worry about losing existing revenue (like NEPs) 	<ul style="list-style-type: none"> Hyperscalers main disadvantage is that their telco-specific expertise is still lacking
Challengers	<ul style="list-style-type: none"> Challengers main advantage is that they started from scratch in developing cloud native offerings and are not constrained by trying to transform legacy solutions. This has given them the most modern development tools and methodologies, and made them nimbler and more open 	<ul style="list-style-type: none"> There are issues with trust (telcos feel safer choosing one of the big NEPs) and some concerns about financial viability Challengers are typically only interested in their own application layer, and therefore to partner to be part of a complete solution
Systems integrators	<ul style="list-style-type: none"> Systems integrators have a good understanding of how telecoms networks work They are looking to take advantage of opportunities from an open approach to creating network solutions (e.g. OpenRAN) and by combining multiple vendors, they can offer 'best of breed' 	<ul style="list-style-type: none"> SIs are also developing automation software, but this is not as good as that from the Hyperscalers

While a large number of telcos are already working with Hyperscalers to run their IT services, relatively few are making the move cloud-based network functions

Rakuten Mobile, Japan

- World's first commercial end-to-end cloud-native network
- Rakuten is best known as a provider of online services
- Upgraded from MVNO to fully owned 4G/5G network
- Network designed to support increased (mobile) use of video content, e-commerce and banking
- Leveraging its cloud knowhow from online business; acquired challenger vendor robin.io
- Estimates of total cost of ownership are less than half of traditional networks (though includes site and fibre sharing)

Dish Network, USA

- First nationwide operator to commit to running its entire 5G network, even virtualised elements of RAN, on public cloud
- Dish is partnering with AWS for the public cloud infrastructure, plus a range of other vendors, including Fujitsu, Mavenir, and Altiostar
- Strong contrast to some other operators, which are pursuing running OSS/BSS on public cloud, but keeping RAN and core functions on their own telco cloud
- Some concerns over the lack of internal expertise (running a national 5G network, cloud deployments)

AT&T and Microsoft Azure strategic alliance, USA






- AT&T have a strategic alliance that involves the transition of AT&T's 5G mobile network to Microsoft's Azure for Operators cloud, starting from the 5G core
- As part of the deal, Microsoft will acquire AT&T's Network Cloud technology and engineering team
- Have been working together since 2019, and AT&T had already moved its IT workload to the Microsoft cloud
- AT&T move away from in-house to Hyperscaler-based cloud efforts could be influential on direction of the industry as AT&T has been a pioneer in cloud transformation

Swisscom, Switzerland

- Swisscom announced that is planning to move a range of services to the AWS cloud platform, including enterprise resource planning, operational support system, and analytics and contact center
- The two players are also planning to explore creating a new cloud-based 5G core, as part of Swisscom's move to a *standalone* 5G network

While the cloud-services for telcos market is currently fragmented and competitive, future consolidation could give market power to a small number of players

Porter's Five Forces framework

Metric	Explanation
 <p>Potential of new entrants</p>	<ul style="list-style-type: none"> ▪ The softwarisation of telco networks has allowed a range of 'challenger' new entrants into the vendor space, who can build on the software technologies developed in other markets to support the transition to 5G ▪ The scope for further entrants is unclear. While there is always the possibility of further disruptive entry by players with the right IP, there is likely to be a reducing scope for entry, as the market moves to an acquisition and consolidation phase, and larger players (such as the incumbent vendors and Hyperscalers) develop their offerings
 <p>Potential of substitution</p>	<ul style="list-style-type: none"> ▪ Cloud-based services for the operation of telecoms networks are substituting for traditional network services and functions, albeit at a gradual rate ▪ It is unlikely that anything new will substitute for cloud-based services themselves, at least in the current technology cycle
 <p>Bargaining power of users</p>	<ul style="list-style-type: none"> ▪ Users of cloud-based services are the telcos themselves, including fixed and mobile operators. Suppliers include the equipment vendors ▪ The bargaining power of telcos was historically quite high: these companies had large national customer bases and vendors had to compete for their business. However, vendor consolidation in recent years (coupled with the recent exclusion of Chinese vendors) has left a small number of vendors with high bargaining power
 <p>Bargaining power of suppliers</p>	<ul style="list-style-type: none"> ▪ Cloud-services enable a more multi-(small) vendor approach, and while this should increase the bargaining power of telcos, it brings added integration costs for the telcos (potentially handing power back to the large vendors or new SI players) ▪ Although their influence at the moment is small, if telcos gradually become more dependent on Hyperscalers (at least for ancillary services), the small number of Hyperscaler players, combined with added services that create stickiness, could give these players high power over time
 <p>Competitive rivalry</p>	<ul style="list-style-type: none"> ▪ The cloud-services for telco networks market is potentially quite competitive with a wide range of players (and types of players) ▪ However, depending on how the market evolves, it could potentially become rather uncompetitive. If acquisitions and consolidation, and a reduced appetite for disaggregated vendor strategies, reduce the number of challenger players, the market could end up being split between a small number of large vendors (for critical network services) and a small number of Hyperscalers (for ancillary services)

In conclusion, we see the NEPs seeking to protect their revenues/profits from challenger vendors, while Hyperscalers can gain from moving into this new sector

Analysis of possible market outcomes

Aspect of market outcome	Comment
Profitability in the long term	<ul style="list-style-type: none"> Established equipment vendors will seek to hold on to their profits by shifting the value up from the hardware into their network software functions. Challenger vendors will seek a share of this profit too For the cloud platforms, there is a question about whether the investments they will need to make in reliability to host certain functions risk making their move into telcos unprofitable (though don't expect this to be major issue) We note that Systems Integration is typically a moderate margin business, and we would expect this to continue For the telcos themselves, the move to using cloud should help them to maintain profits. While the move may not end up being cheaper overall, cloud services should provide more flexibility to launch new services
Who is in the best position to succeed	<ul style="list-style-type: none"> Overall, the industry is likely to move to competing 'ecosystems', which will be combinations of cloud functions and activities that are proven to work together. Some ecosystems could be led by the established NEPs, while others could be more disparate propositions that are led by a Systems Integrator The Hyperscalers probably have most to gain by entering the sector, which is a big user of IT and is supporting digital transformation across a range of industries Progress will be held up by cautious telcos and resistant incumbent vendors (NEPs) who are seeking to protect their existing revenues and profits (see above)
Prospect of external challenges	<ul style="list-style-type: none"> There is limited prospect for external challenges (there are a range of internal barriers discussed earlier in the section, across demand, readiness and trust)



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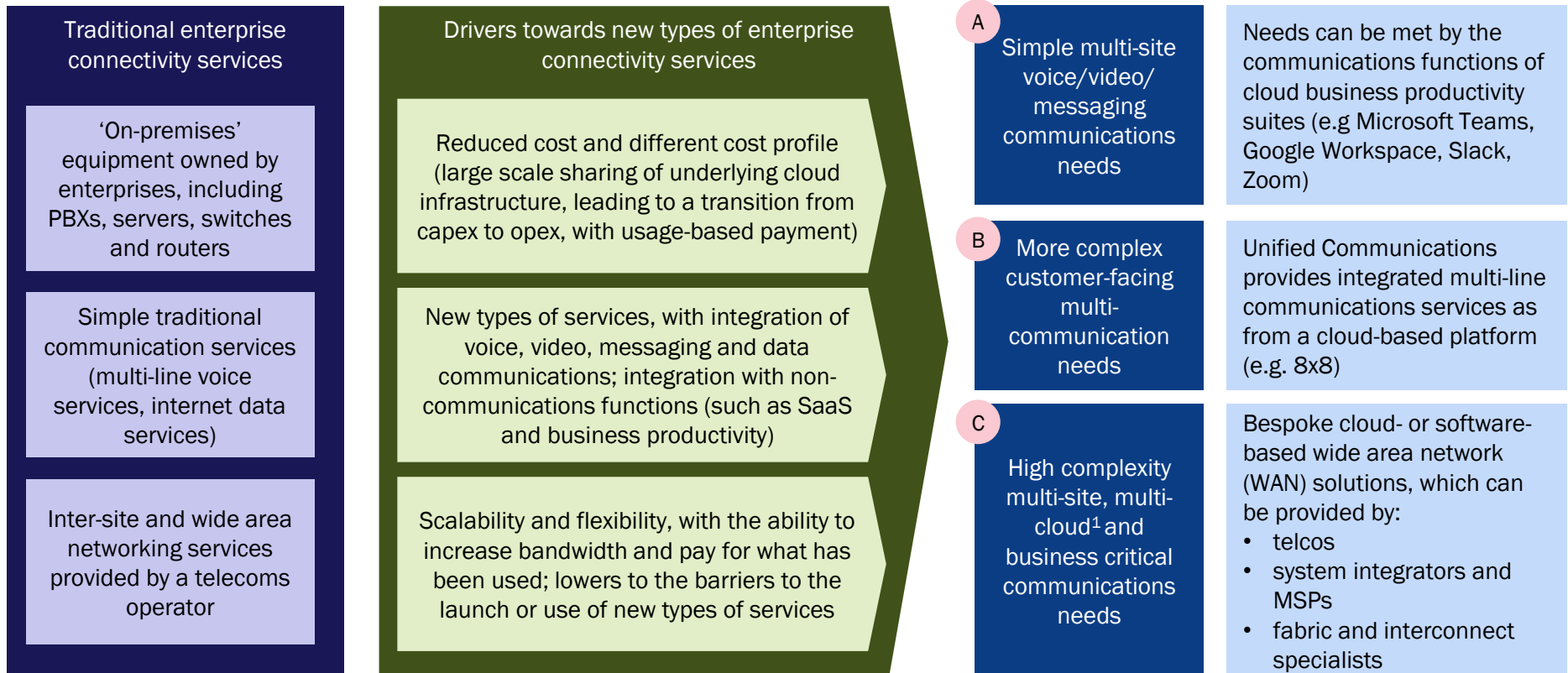
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Enterprise connectivity services have been undergoing a transition from traditional services to more software/cloud based alternatives

Summary of evolution and landscape of the enterprise connectivity space



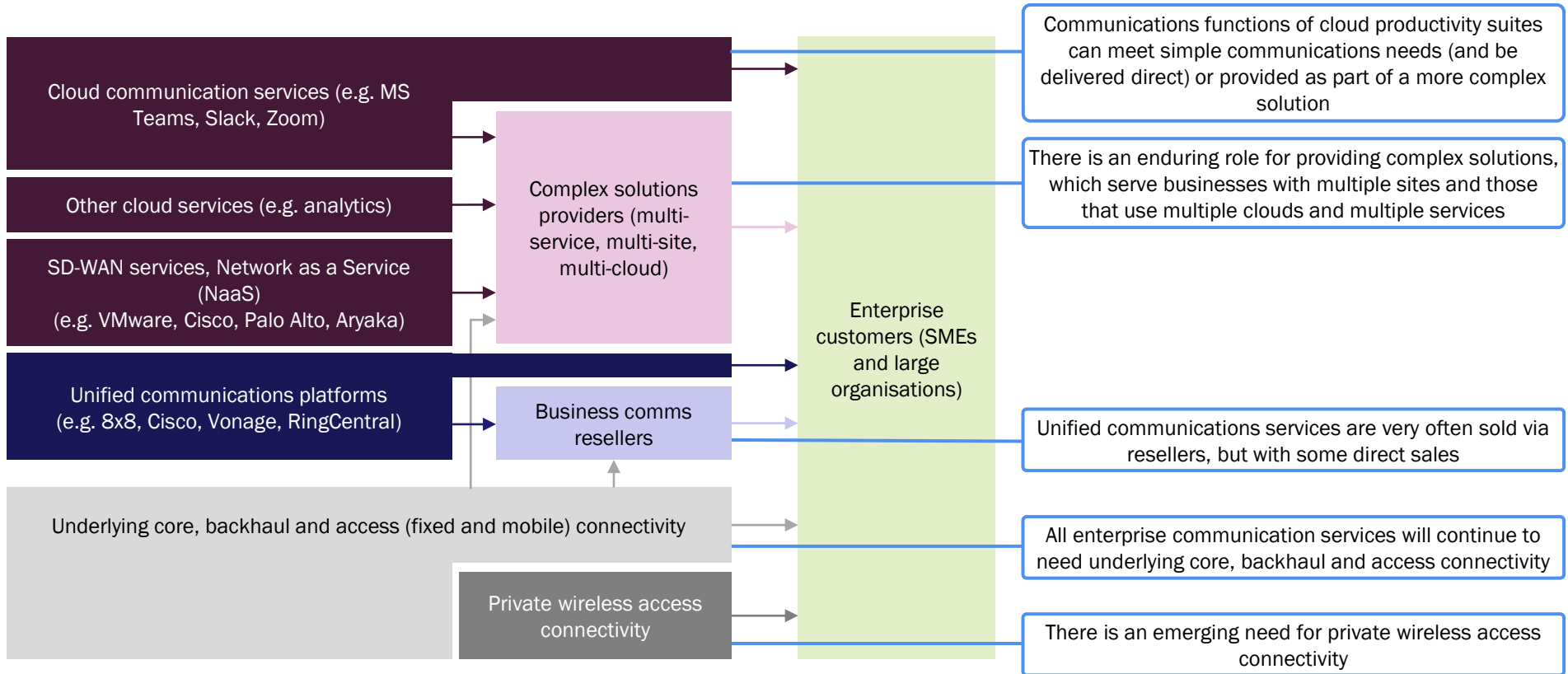
The underlying connectivity, of which most of the value is in local access connections, is still provided by telcos

However, telcos are potentially facing competition in the provision of private networks, where the driver for change is increased automation and digitalisation of enterprise processes and advances in wireless connectivity. The proposition is a private network integrated with other IT processes

¹ Multi-cloud refers when an enterprise uses more than one public cloud provider. For example, enterprises might choose Google Cloud Platform for its data abilities (to train machine learning), identity on Azure and the rest on AWS

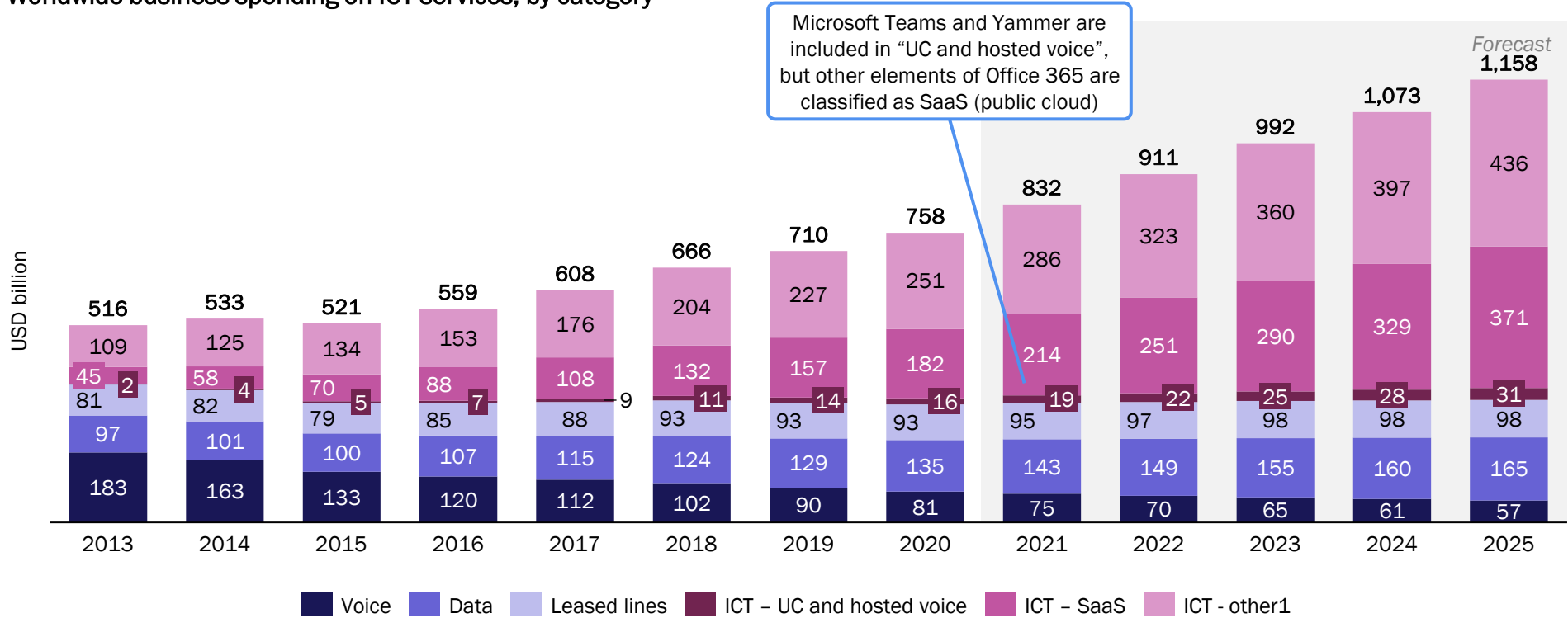
The connectivity needs for enterprise connectivity are expected to support growth in the complex solutions space, whereby the role of telcos is evolving but enduring

Illustrative map of enterprise communications solutions space



Business spending on voice has been declining, partially driven by a reallocation of spend to ICT services such as unified communications (UC) and SaaS platforms

Worldwide business spending on ICT services, by category



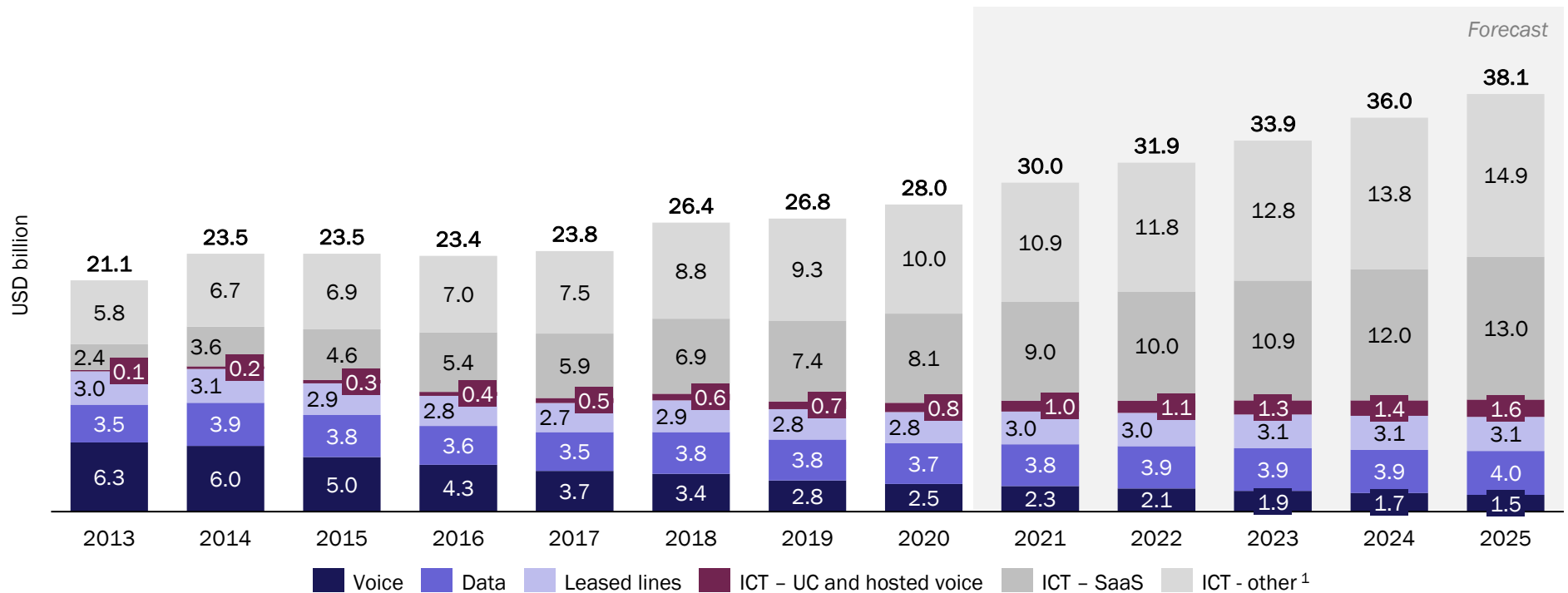
- Voice spending has been more than halved since 2013 to USD75 billion in 2021 and is expected to continue its decline until 2025
- On the other hand, total ICT services spend has been increasing rapidly due to developing technologies and products such as security, desktop management, unified communications (UC)
 - specifically UC and hosted voice has been replacing the need for, and the spending on, traditional voice services
 - other non-communications ICT areas have also been experiencing a rapid growth, especially SaaS applications

¹ Other includes security, IaaS/PaaS, colocation, enterprise mobility and desktop management

Source: Analysys Mason

Similarly in the UK, connectivity revenues have been declining due to voice with some of that shifting towards ICT services incl. unified comms and SaaS platforms

Business spending on ICT services in the UK, by category



- Voice revenue declined from USD6.3 billion in 2013 to USD2.3 in 2021, and is expected to keep decreasing over the forecast period
- Data and leased line spending is expected to be more or less stable until 2025
- Recent growth in the ICT sector is expected to continue over the forecast period, with communications services (including those illustrated within the UC and the hosted voice market) expected to grow by 60% between 2021 and 2025

¹ Other includes security, IaaS/PaaS, colocation, enterprise mobility and desktop management

Source: Analysys Mason

Hyperscalers are directly addressing this market now through cloud infrastructure and services

From previously, where A: Comms features of productivity suites; B: Small comms platforms for UC; C: Complex connectivity products; and D: underlying connectivity

Summary of key enterprise services providers

		Operator	Revenue, 2021 (USD billion)	Enterprise services products	A	B	C	D
Hyperscalers	Amazon	Total: 470 (AWS: 62)	<ul style="list-style-type: none"> Most of its revenues come from e-commerce and Amazon Prime bundles More than 10% of Amazon revenues come from cloud services (AWS) which include some cloud-based networking products including Cloud WAN, Virtual Private Cloud, Elastic Load Balancing, Global Accelerator, Direct Connect, Route 53, Connect (cloud contact centre) Amazon Chime is company's UC as a service product, allowing meetings, file sharing, and calls <ul style="list-style-type: none"> Salesforce Anywhere application uses Amazon Chime's for video communications Amazon introduced AWS Private 5G services in late 2021, which is one of the first solutions to provide a complete package that includes the spectrum, radio, core and compute platform <ul style="list-style-type: none"> although this is a nascent market, and the potential of such products to replace other services is unproven Unlike Microsoft and Google, Amazon has limited partnerships with other enterprise solutions providers 	✗	✓	✗	✓	
	Microsoft ¹	Total: 168 (Intelligent Cloud: 60.1 Productivity: 53.9)	<ul style="list-style-type: none"> Microsoft focuses more on the enterprise market and software licences than other Hyperscalers <ul style="list-style-type: none"> almost half of Microsoft revenues come from licences including commercial Office 365 It offers cloud-based networking products for enterprises including Azure Virtual WAN, ExpressRoute (for virtual private cloud connections) One of its most successful products is the productivity suite Microsoft 365 commercial which includes Office 365 (with Teams, Yammer, PowerPoint, Excel, OneDrive) <ul style="list-style-type: none"> the bundling with Teams and effects of the pandemic has seen Microsoft pick up a large share of enterprise communications traffic Microsoft is the leading partner for other enterprise providers such as telcos 	✓	✗	✗	✗	
	Google	Total: 258 (Google Cloud Platform: 19)	<ul style="list-style-type: none"> Google has a smaller focus on the enterprise market compared to Amazon and Microsoft, but its productivity tools are still widely used Google has also targeted its cloud-based applications as a productivity suite under the name Google Workspace for enterprises including Sheets, Docs, Slides, Meet and Calendar Only 7% of Google revenues come from cloud services which include networking products such as Virtual Private Cloud, Cloud VPN, Network Connectivity Centre, Private Service Connect Similar to Microsoft, Google also partners with other enterprise providers such as telcos 	✓	✗	✗	✗	

¹ Latest full year ending in June 2021

Source: Analysys Mason, company websites, press search

Smaller communications-focussed players provide either productivity suites or UC; telcos provide UC and more complex enterprise services

From previously, where A: Comms features of productivity suites; B: Small comms platforms for UC; C: Complex connectivity products; and D: underlying connectivity

Summary of key enterprise services providers

	Operator	Revenue, 2021 (USD billion)	Enterprise services products	A	B	C	D
Small comms players	Slack ¹	Total: 0.9	<ul style="list-style-type: none"> Owned by Salesforce, Slack offers a platform for enterprises with multiple locations voice/video/messaging communications services Slack is the main competitor to Microsoft Teams collaboration environment 	✓	✗	✗	✗
	Zoom	Total: 4.1	<ul style="list-style-type: none"> Zoom focuses on video calls and conferences, especially for inter-company communications Unlike Microsoft, Google and Slack, Zoom does not provide a bundle of products with the communications application (e.g. no built-in file management features) Therefore, Zoom can be seen more as a direct competitor to Cisco's Webex application 	✓	✗	✗	✗
	8x8 ¹	Total: 0.5	<ul style="list-style-type: none"> Smaller provider focusing on SaaS solutions for voice, video, contact centre and communication APIs Most of its revenues come from services through UCaaS, CCaaS and CPaaS 	✗	✓	✗	✗
Telcos	BT ¹	Total: 29 (Enterprise and Global: 12)	<ul style="list-style-type: none"> BT has the largest enterprise services in the UK with two segments: <ul style="list-style-type: none"> Enterprise which offers voice, messaging and data products to UK businesses; this unit has USD7 billion revenues, serving 1.2 million businesses in the UK and the Republic of Ireland Global which serves larger enterprises with needs across the world; this unit has USD5 billion revenues BT's enterprise portfolio focuses more on connectivity with some UC, managed services and cloud including SD-WAN, IoT and security 	✗	✓	✓	✓
	AT&T	Total: 169 (Business Solutions: 36)	<ul style="list-style-type: none"> AT&T's Business Solutions division is one of the largest enterprise services providers as part of a telco, with USD36 billion revenues in 2021 The division focuses more on connectivity products (leased lines, fibre products, VPNs, WANs), as well as software-defined products such as SD-WAN, FlexWare 	✗	✓	✓	✓
	Verizon	Total: 110 (Business: 31)	<ul style="list-style-type: none"> Verizon's Business unit is another large enterprise services provider as part of a telco, with USD31 billion revenues in 2021 where one-third comes from SMEs, and one-third from global enterprises It provides UC as a service, Webex calling and Teams calling As a telco unit Verizon Business offers connectivity products but appears to put more significance on cloud-based applications with a wide variety of products including network security, access management, cyber risk management and web security 	✗	✓	✓	✓

¹ Latest full year ending in January 2021 for Slack, March 2021 for 8x8 and BT

Source: Analysys Mason, company websites, press search

IT equipment vendors, system integrators and cloud-based security providers also offer communications services to enterprise

From previously, where A: Comms features of productivity suites; B: Small comms platforms for UC; C: Complex connectivity products; and D: underlying connectivity

Summary of key enterprise services providers

	Operator	Revenue, 2021 (USD billion)	Enterprise services products	A	B	C	D
Large technology companies	IBM	Total: 57 (Software: 18)	<ul style="list-style-type: none"> As a global IT company, 27% of IBM's revenues come from Infrastructure and cloud applications Its cloud-based enterprise products include Virtual Private Cloud which offers isolated network segments on the IBM Cloud for enterprises to deploy and manage cloud resources 	✗	✗	✓	✗
	Oracle ¹	Total: 40	<ul style="list-style-type: none"> Oracle mainly provides cloud and licences which make up 84% of its total revenues Cloud and licence products include Oracle's SaaS and IaaS products such as Oracle Applications, Oracle Database, Java Oracle offers cloud-based Unified Communications Suite, as well as other cloud services including Virtual Cloud Networks (VCNs), ClientVPN, FastConnect Load Balancers, Networking Gateways 	✗	✓	✓	✗
	Cisco ¹	Total: 50	<ul style="list-style-type: none"> As a vendor, Cisco provides various products and services, where Infrastructure products (switching router and data centre) make up 54% of revenues Offers different applications (UC, teleconferences and Webex) which make up 11% of total revenue The company offers various cloud solutions including CloudCentre, Workload Optimisation Manager, Container Platform, AppDynamics 	✗	✓	✓	✗
	VMware ¹	Total: 12	<ul style="list-style-type: none"> VMware provides various cloud-based connectivity services including NSX data centre, VMware SD-WAN, load balancers and SASE products 	✗	✗	✓	✗
	Equinix	Total: 7	<ul style="list-style-type: none"> Equinix is the leading provider of data centre and it can connect enterprise customers on-demand to any cloud platform or other customer at any Equinix location Provides Network Edge and other managed services, in addition to access to global cloud platforms 	✗	✗	✓	✗
	Fortinet	Total: 3	<ul style="list-style-type: none"> Fortinet mainly focuses on security products and services; it also has some networking services including LAN Edge, SD-WAN, business communications It provides UC under the product FortiVoice Unified Communications 	✗	✓	✓	✗
	Aryaka	Total: 0.1 (2019)	<ul style="list-style-type: none"> Aryaka's investors include Goldman Sachs and Deutsche Telekom's investment management group It was founded in 2009 as a pioneer in delivering cloud-based networking-as-a-service, and provides various cloud-based enterprise services including SD-WAN, Multi-Cloud Networking, Remote VPNaaS 	✗	✗	✗	✗
	Cato Networks	N/A	<ul style="list-style-type: none"> Privately owned, Cato Networks provides cloud-based services including SD-WAN, security access service edge (SASE) and other security as a service products 	✗	✗	✗	✗

¹ Latest full year ending in May 2021 for Oracle, July 2021 for Cisco, January 2021 for VMware

Source: Analysys Mason, company websites, press search

And finally, large network equipment providers are active in offering private 5G network solutions

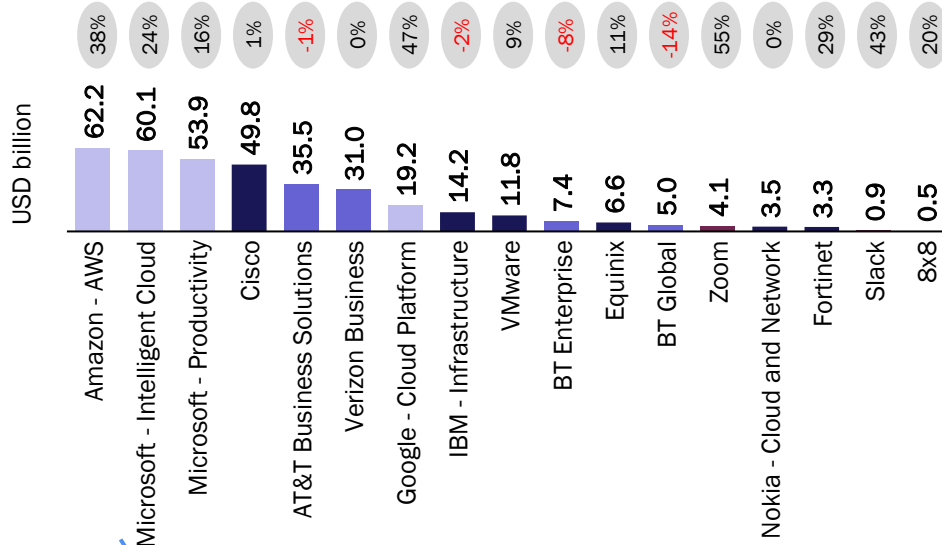
From previously, where A: Comms features of productivity suites; B: Small comms platforms for UC; C: Complex connectivity products; and D: underlying connectivity

Summary of key enterprise services providers

	Operator	Revenue, 2021 (USD billion)	Enterprise services products	A	B	C	D
Network equipment vendors	Ericsson	Total: 23	<ul style="list-style-type: none"> Ericsson is a global telecoms and ICT vendor serving the network operator and service provider market Offers private 4G/5G wireless solutions to industries such as manufacturing, ports, mining, airports and energy Offers solutions direct to enterprises (including IT integration) or could also be sold via a telco's solution 	✗	✗	✗	✓
	Nokia	Total: 63	<ul style="list-style-type: none"> Nokia is a global telecoms and ICT vendor, providing solutions across mobile, fixed and cloud networks Offers private wireless network solutions (including both 4G and 5G) to provide connections to "industrial machines, IoT sensors, autonomous vehicles and connected workers" Offers solutions direct to enterprises ("industrial partners") or could also be sold via a telco's solution 	✗	✗	✗	✓

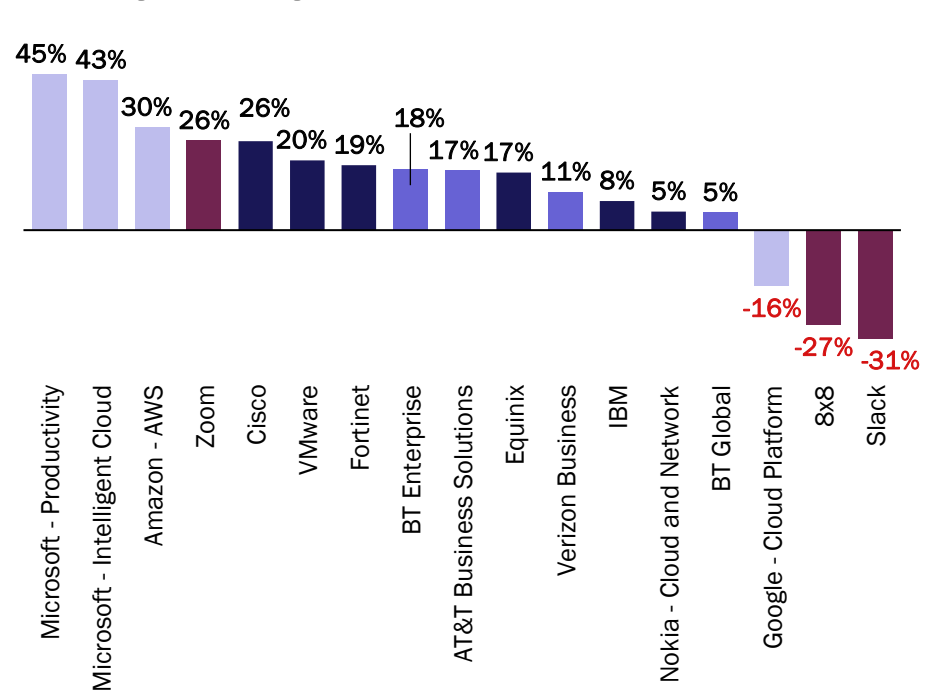
Financial performance of players in the enterprise space has been varied, with some Hyperscalers and large tech players achieving good profit margins

Revenue, 2021



Amazon and Microsoft are leading in terms of both revenue and operating profit

Operating profit margin, 2021



■ Telco
 ■ Large tech
 ■ Hyperscaler
 ■ Small comms
 ● YoY revenue growth (%)

- Hyperscaler revenue and profitability for cloud and enterprise segments are typically higher than those of large telco enterprise providers
- telcos enterprise units have experienced stagnant or decreasing revenues over the last two years, likely to have impacted by the increasing competition and the development of new cloud-based products such as edge computing and SASE
- Enterprise services are complex and varied in nature and hence have a wide range of operating margins
- Capex spending is not always reported but appears to be around 25% for BT Enterprise and 5% for BT Global

Note: Figures relate to calendar year except for Microsoft – year ending in June 2021, VMware, Slack and Zoom for the year ending in January 2021, 8x8 and BT year ending in March 2021, Oracle year ending in May 2021, Cisco July 2021

Source: Analysys Mason, operator websites and annual reports

We assessed potential network architectures, to consider whether a large share of enterprise traffic could be carried on a small number of hyperscale cloud providers

Illustration of WAN and VPN

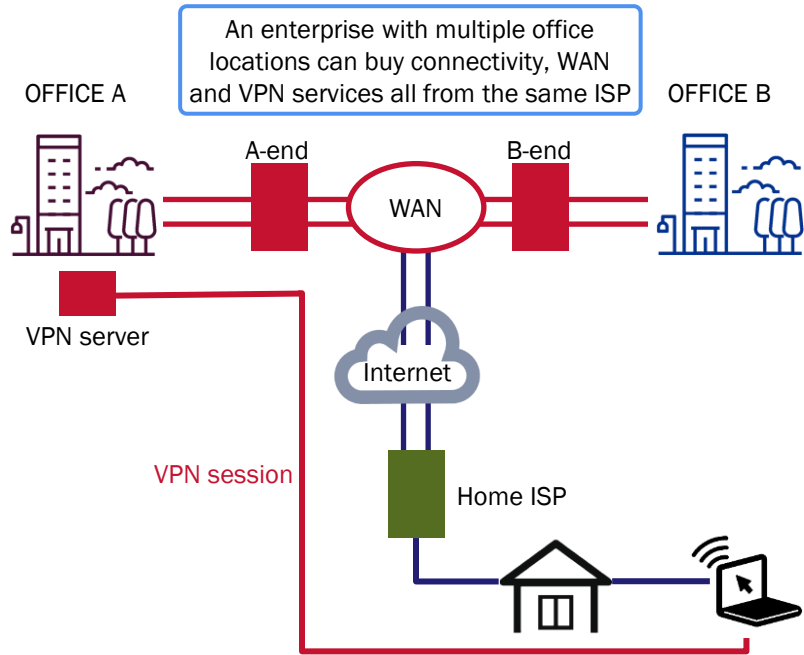
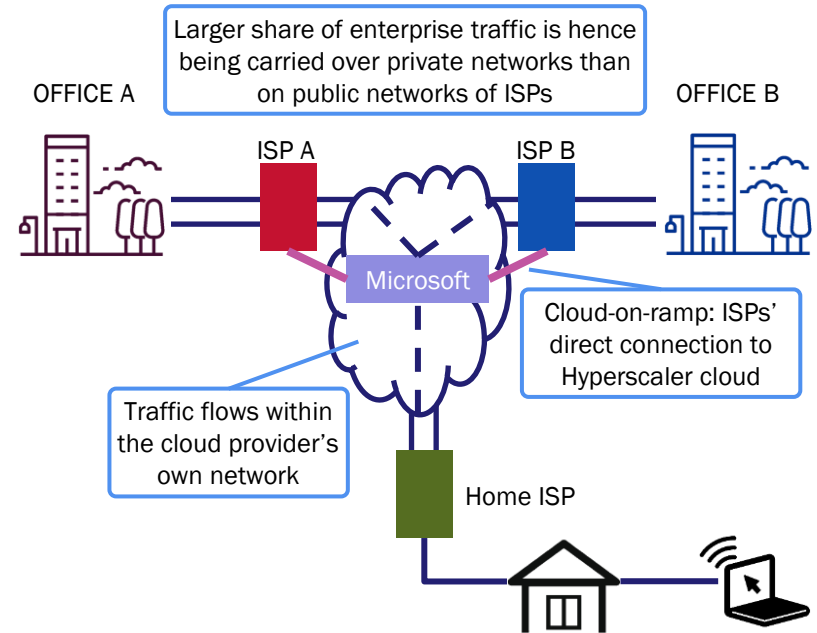


Illustration of cloud-based applications for enterprises



While there is currently a focus on use of Hyperscalers, further growth may be limited by complex customer needs, channel strategy, and (current) pricing

Drivers of Hyperscalers becoming major players

- Microsoft offers a popular bundled product with some scope for customisation, and has been getting very popular recently
 - Teams is used by 91 of the Fortune 100 companies and by 90% of the UK businesses¹
 - its customers include E&Y, Accenture, SAP and Pfizer
- Hyperscalers such as Microsoft may keep bundling new features for enterprise needs under one product such as Office 365, and become the major players in the market
- Originally, Office 365 (including Teams) was a product with fewer features and a more simple pricing system
 - as disruption to the market grew, Microsoft begun to invest more heavily in the product and added more features as the popularity of the product increased (despite the technology not being fully ready at the time)
 - with the rate of development of the technology having outgrown growth in the user base growth, Microsoft now has a product that is on par or even better than its competitors
- A similar trend may continue in the future, where Hyperscalers add new features to their products, offer simplified solutions and then become the major players in the enterprise market

Inhibitors of Hyperscalers becoming major players

- A lot of enterprises, especially large ones, are using different public cloud providers for different features (multi-cloud solutions)
 - the need to integrate or provide managed services for complicated systems with multiple providers may always exist, and system integrators and telcos may always be needed
 - this would inhibit Hyperscalers from becoming the major players in the enterprise services unless they gain such capabilities
- Hyperscalers appetite to address the complete portfolio of enterprise services, especially connectivity, and become the go-to-market players is not certain
 - Hyperscalers may not want to sell directly to enterprises, however this may change due to
 - increasing shift towards digital sales channels
 - move towards more standardised products
- Hyperscaler pricing is not always the most competitive
 - The calling product on Teams is not as competitive as others and often requires a telco partner to provide PSTN break-out

¹ We note that these usage statistics also include the free versions of the Teams application and does not represent enterprise subscriptions

Source: Analysys Mason, Stratechery

AWS announced a new cloud-based private 5G network product, illustrating the potential for Hyperscalers to benefit from value creation in connectivity products

- Enterprise digital transformation activities are creating new demand for any-to-any, multi-cloud connectivity
- Digitalisation and other trends (Industry 4.0, IoT and AR/VR) are transforming some verticals' needs which may support growth in the market for wireless private networks
 - private 5G networks with cloud-based configurations may better serve the needs of some verticals, especially with a high number of devices, as opposed to Ethernet and Wi-Fi
 - such verticals can include transport, logistics, warehouse operations and robotics
- AWS announced AWS Private 5G in Nov-21, which is one of the first solutions to provide a complete package that **includes the spectrum, radio, core and compute platforms**
- AWS's announcement implies the potential of private 5G networks, as well as Hyperscalers' ability to formulate an end-to-end solution and compete with telcos
- Due to regulation and licensing, spectrum is the hardest component for an end-to-end solution; although this can be mitigated with shared / local spectrum
 - AWS Private 5G uses CBRS spectrum in the USA, which is shared by three tiers of different stakeholders
 - in the UK, Ofcom has introduced "Shared Access Licences" for local spectrum use, in and recently published a consultation to extend this to the upper 6GHz band

Overview of private 5G developments

Operator	Private 5G network developments
Amazon	<ul style="list-style-type: none"> Introduced AWS Private 5G in the US which is an end-to-end solution with a payment based on bandwidth rather than number of devices / SIMs
Microsoft	<ul style="list-style-type: none"> Microsoft only offers a core 5G offer (Azure Private 5G Core)
Google	<ul style="list-style-type: none"> Google's strategy has been to partner with MNOs, and it does not currently offer enterprise 5G network functions We understand it has been looking at developing these products, however
Telcos (BT, Vodafone etc.)	<ul style="list-style-type: none"> For telcos, 5G and private networks are high-growth markets but they do not yet provide cloud-based 5G private networks BT launched Division X as part of Enterprise unit to address areas such as 5G private networks, IoT and edge computing
Mobile vendors (Nokia, Ericsson, Samsung)	<ul style="list-style-type: none"> All three vendors have established private 5G network products and services, however these are not completely based on the cloud

Spectrum and private 5G networks

- Products such as AWS Private 5G can be developed in other geographies than the US, due to the availability of shared licences
- More spectrum is expected to be released for local / shared licences to avoid MNOs becoming bottlenecks
- In the UK, 4 bands are included in shared access licences
- 6GHz might also be included for low-power, indoor use which is particularly useful for industrial business uses

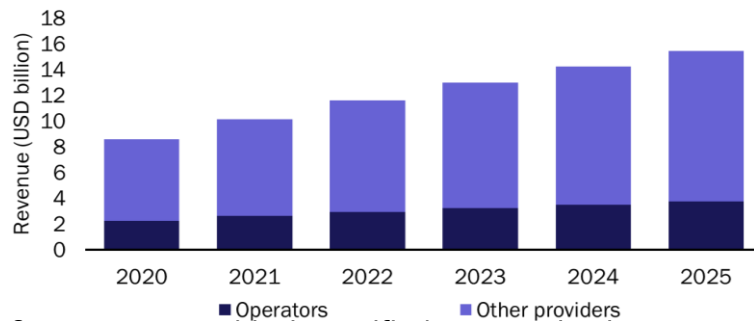
UK Shared access licence bands				
1800MHz	2300MHz	3800-4200MHz	24.25-26.5	6GHz

Potential inclusion of upper 6GHz band

Telcos are losing market share in the traditional hosted voice and UC markets; hybrid cloud will contribute to the need for managed services (and role of telcos)

Overview of the unified communications market

- The UC market is becoming increasingly competitive
 - many UC providers are seeking to expand geographically into new markets
 - 8x8 grew its number of channel partners from around 100 in 2018 to more than 1000 by mid-2020
 - cloud-based players replacing older products such as PBX
 - vendors are coming up with proprietary solutions, that often focus on user experience

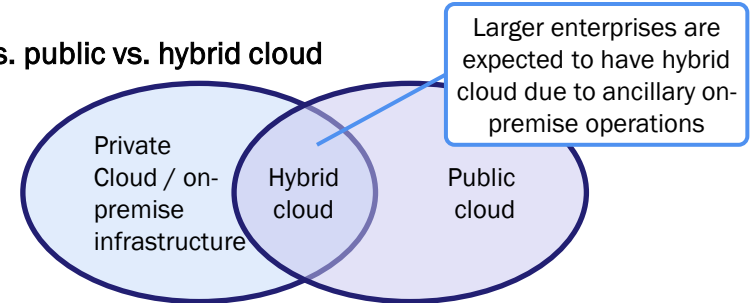


- Operators are achieving unified communications revenue growth, but their growth rates are not as fast as those for the market as a whole
- Operators command a strong position in the hosted voice market but will need to invest in new partnerships and capabilities to maintain this role in the broader UC market

¹ Multi-cloud refers when an enterprise uses more than one public cloud provider, for example, enterprises might choose Google for machine learning abilities, manage identity on Azure and the rest on AWS

Source: Analysys Mason, Futurium

Private vs. public vs. hybrid cloud



- Private: Private clouds provide dedicated processing support to applications and data that belong to a single organisation
- Public: Shared by multiple organisations
- Hybrid: When enterprises deploy both private cloud / on-premise infrastructure and public cloud
 - Google's Anthos allows management of applications and infrastructure across on-premises and public clouds
 - hybrid clouds are common, especially for larger enterprises, where enterprises can choose to move some operations to public cloud while leaving others such as business logic or data storage in on-premise private cloud
- Managed solutions (that can be provided by telcos) are likely to use a Hybrid (and multi-cloud¹) approach
 - this allows the cost savings of public cloud to be realised, while keeping some business-critical applications in a safer and more managed (private) environment

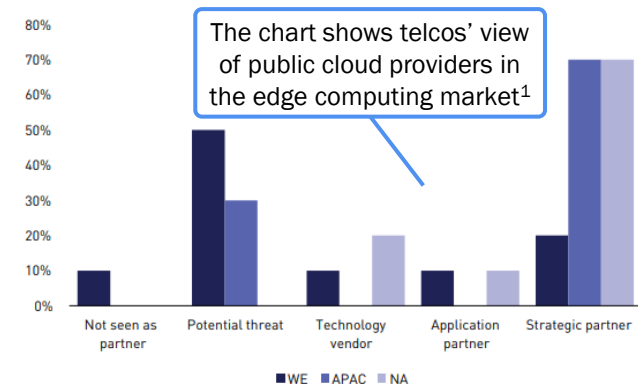
SASE and edge computing are both relatively new trends, brought around by digitalisation of enterprises and the need for secure and low-latency operations

Secure Access Service Edge (SASE)

- SASE describes a group of products that are bundled to protect enterprises against security challenges, representing the convergence between cloud networking and security services
- Security is becoming ever-important with the development of new networking technologies, and is a key driver for SASE
 - when asked, 120 enterprises mention security as the key differentiator for SD-WANs
- SASE can include the integration of various services including secure web gateways, firewall-as-a-service (FWaaS), and zero trust network access (ZTNA)
- Many players have started offering SASE from networking players to SD-WAN vendors, CDN and security players
 - Palo Alto Networks announced Prisma SASE in Sept-21
 - Cisco bundles all its SASE offers under Cisco Umbrella
 - AT&T Cybersecurity launched AT&T SASE Branch with Fortinet in March 2021, and Verizon announced Advanced SASE in June 2021
 - BT is investing in Quantum Key Distribution, which is tightly connected to the physical network

Edge computing



- Edge computing refers to moving digital applications to the edge of the network, closer to the user or connected device
 - this can enhance user experience and enable the delivery of low-latency applications
- Growing demand from telcos and other players is expected to allow the market to reach a size of ~USD34 billion by 2025, with at least 50 telecoms operators having publicly announced interest in edge computing in August 2021
- Many telcos are choosing to partner with Hyperscalers, with existing scale and capability to develop edge technology²
 - but, partnering brings in limited opportunities and hence most operators see public cloud providers as a threat



¹ Based on Analysys Mason Research survey carried out with 30 operators (10 in each region), in 2020; ² A key question is whether network edge (e.g. RAN) and enterprise edge can be combined. For the moment, telcos are keeping these functions separate (mainly due to different business units), and it will take time for any convergence to happen

This market exhibits a high degree of substitution; unlike cloud, connectivity services can be bundled by relying on regulated or competitive wholesale inputs

Porter's Five Forces framework [1/2]




Metric	Explanation
 <p>Potential for new entrants</p>	<ul style="list-style-type: none"> ▪ Limitations to the entry into the physical connectivity space ('underlay') include: <ul style="list-style-type: none"> – the investment required, although in some areas it may be economically feasible – the regulatory implications of offering connectivity (general authorisation and associated regulations – note that this barrier would disappear if cloud providers were considered ECS providers) ▪ Entry into the services space (SD-WAN and UC) is relatively open, with many suppliers offering solutions; this is often leveraging existing customer relationships and tied or bundled with other ICT offerings or solutions ▪ Entry into the cloud infrastructure and platform space is becoming increasingly onerous as the hyperscale providers grow, although it should be noted that: <ul style="list-style-type: none"> – this is still a rapidly-growing market – there are hyperscale suppliers with specific geographic focus who may look to expand – investment is going into niche providers of colocation and IaaS, with opportunities to leverage open platforms¹ ▪ Private network solutions are attracting interest from cloud providers, traditional vendors, telcos, and new vendors in the Wi-Fi / Open RAN ecosystem; barriers to entry are relatively low, as costs are borne directly by the enterprise customers, but spectrum and roaming can act as barriers in some cases ▪ Accessing skilled workers trained and proficient in cloud is difficult for all market participants, which may favour the most profitable or fastest-growing actors
 <p>Potential for substitution within the market</p>	<ul style="list-style-type: none"> ▪ Substitution is apparent in several respects: UC (and hosted voice) is replacing telco voice, SD-WANs are providing connectivity solutions to multi-site / multi-cloud enterprises without the need, cost and complexity of managing complex physical networks or changing their underlying connectivity architecture, and finally cloud services reduce wide area networking needs for a growing number of enterprises (as networked demand is handled within the cloud provider's own private network) ▪ Private network solutions are growing as a way to provide dedicated infrastructure to enterprises, without having to rely on shared public networks; network slicing, when commercially ready (post 2023) will be a substitute to these

¹ Open platforms include Kubernetes

Source: Analysys Mason, Porter's Five Forces framework, discussions with two UK MNOs (more details to be added over the coming days)

Within the ongoing growth phase, users have a relatively high level of choice and bargaining power, but this is likely to reduce; co-opetition is expected to prevail

Porter's Five Forces framework [2/2]

Metric	Explanation
 <p>Bargaining power of users</p>	<ul style="list-style-type: none"> ▪ Shift towards new forms of enterprise connectivity is ongoing, as part of a broader trend towards digital transformation; a similar evolution is ongoing in cloud, where different segments of the market (size of enterprise, sectors) are migrating at different paces ▪ This growth, combined with a relatively large number of suppliers (compared to traditional connectivity) gives a degree of choice and countervailing buying power to sophisticated users, who can choose their solutions and suppliers ▪ The cloud market is currently relatively concentrated, with market leaders growing the fastest (AWS and Microsoft); going forward, this is likely to reduce the bargaining power of users; combined with the complexity of cloud offering, information asymmetry on needs and prices, and barriers to switching once onboarded onto a cloud platform, this could result in much reduced CBP of users, once the migration is complete and if self-supply options (on-prem, private cloud) become too complex or uneconomic
 <p>Bargaining power of suppliers</p>	<ul style="list-style-type: none"> ▪ There is currently a relatively high degree of collaboration between connectivity providers and cloud providers, as both benefit from sharing technology and customer relationships ▪ Similarly, the suppliers / customer relationships in this market are typically two-way: cloud players are large buyers of connectivity and benefit from being able to deploy edge infrastructure in operator's network nodes, and connectivity providers (including of SD-WAN and other cloud-based solutions) are large buyers of cloud services ▪ Other supplier relationships (e.g. data centre infrastructure players) appear neutral from a market dynamic perspective; some network vendors (e.g. Nokia) are explicitly addressing the private network market by going directly to users
 <p>Competitive rivalry</p>	<ul style="list-style-type: none"> ▪ Enterprise customers have relationships with suppliers across the value chain, including telcos (for connectivity), cloud players (typically at CxO level due to the strategic nature of the transition to cloud), and systems integrators and solutions providers (who handle large digital transformation projects) ▪ Unlike most connectivity providers, cloud players are global, fast growing and well-funded and staffed, which gives them an advantages in relationships with multi-national companies and sophisticated buyers, whereas connectivity providers have long-standing relationships with all enterprises, irrespective of scale and sector, and can leverage this to upsell cloud-based solutions; this 'co-opetition' is likely to remain the norm until and unless cloud players decide to vertically integrate with connectivity (which would be possible but difficult – the reverse is highly unlikely) ▪ Other solutions providers (e.g. SD-WAN and other connectivity and multi-cloud 'fabrics') combine existing customer relationships with a focus on independence from a given connectivity or cloud provider, to offer composite solutions ▪ Private network solutions are being explored by providers of connectivity, cloud, and systems integrators, which suggests this may become a commodity component to the overall enterprise digital solutions market

Source: Analysys Mason, Porter's Five Forces framework, discussions with two UK MNOs (more details to be added over the coming days)

Considering substitution and bargaining power, we again see a situation where telcos and cloud co-exist (at least for the time being)

Considerations for relationships across the value chain

Considerations	Explanation
Prospects for substitution to intensify	<ul style="list-style-type: none"> ▪ Connectivity 'on demand' is already available to cloud customers (on ramp and CDN), but does not include physical connectivity / local access, which remains the exclusive purview of connectivity providers ▪ These connectivity providers are, in parallel, trying to move up the value chain by offering integrated solutions to their customers; this relies on cloud as an input, but does not try to act as a substitute to cloud ▪ The transition of enterprise IT to cloud should in principle significantly reduce individual enterprises' demand for wide-area connectivity, and increase the demand for connectivity by cloud players (who have the option to self-supply using low level inputs such as dark fibre or new subsea cables); in the short to medium term, intermediary and large enterprises have to manage complex transitions that involve multiple infrastructure and clouds, which will limit this trend ▪ Network slicing may act as a credible substitute to private network solutions in the medium to long term, but there are significant cost and complexity barriers to making this happen
Balance of bargaining power and impact of bundling	<ul style="list-style-type: none"> ▪ As long as cloud providers are keen to avoid being seen as connectivity providers (and are not being considered as such by regulators), telcos retain a degree of bargaining power by keeping customer relationships across the enterprise space within the whole economy; this may change if more competition on connectivity infrastructure (including the entry of new 'neutral host' players for example) leads to a more liquid on-demand wholesale connectivity market that cloud providers can bundle into their offering ▪ On private 5G networks, currently the ability of any supplier (telcos, Hyperscalers, SIs) to exert control in the value chain is low, and this is likely to remain the case as the technology is standardised, many different parties are able to address this requirement, and tying with other markets (e.g. cloud or software solutions) may be relatively loose; this may not be the case if automation and quality assurance in the private network is very bespoke and deeply integrated with the private network ▪ The level of concentration and stickiness of cloud services is likely to remain relatively high, whereas connectivity inputs are commoditised (although competition and choice depends greatly on location)

In conclusion, there is a risk that Hyperscalers could start to take profit from the enterprise communications value chain, but telecoms operators can maintain a role

Analysis of possible market outcomes

Aspect of market outcome	Comment
Profitability in the long term	<ul style="list-style-type: none"> ▪ There is expected to be value (and profit) to be won in providing complex solutions, with telecoms operators expected to be able to provide these services, despite facing growing competition from systems integrators (SIs) ▪ Cloud players have achieved varying levels of profitability, with AWS and Microsoft Azure achieving good margins (which Google is still making investments to gain scale, leading to lower margins) ▪ Assuming that cloud services are a profitable business in the long term, there is a risk that telecoms operators may become intermediated by cloud platform providers (leading to lower profits within the more commoditised underlying connectivity segment of the value chain)
Who is in the best position to succeed	<ul style="list-style-type: none"> ▪ While many businesses with simple communications needs may choose to buy cloud communications services., such as Microsoft Teams, Zoom and Slack, there is likely to be an enduring but evolving role for telecoms operators in this space ▪ There is an increasing role for providing high value complex solutions, which serve businesses with multiple sites and those that use multiple clouds and multiple services <ul style="list-style-type: none"> – to realise the potential of increasingly advanced connectivity, the best-positioned solutions providers are expected to be those that are able to respond to the emerging needs within the broader digital solutions ecosystem – while SIs may take some share in this part of the market, telecoms operators are expected to play a key role in providing these integrated solutions to large businesses, leveraging their existing customer relationships. ▪ All enterprise services require underlying core, backhaul and access connectivity (in which there is a lot of value) and this is likely to be continued to be provided by fixed and mobile telecoms operators. ▪ There is an emerging need for private wireless access connectivity for certain industrial use cases (e.g. connected factories, ports, mines) <ul style="list-style-type: none"> – while there has been some move by cloud-technology providers to offer end-to-end solutions, conventional mobile network operators (MNOs) are well placed to offer these solutions, as part of a portfolio which could also include network slicing.
Prospect of external challenges	<ul style="list-style-type: none"> ▪ There are expected to be limited barriers or challenges to enterprise players evolving their existing use of cloud

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Safety technology

Video on Demand

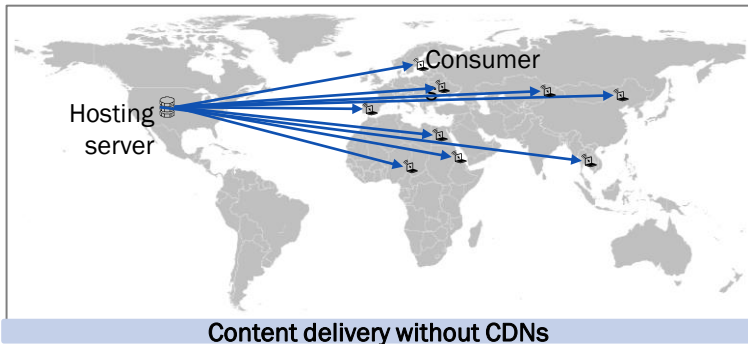
Cloud for telco networks

Connectivity services for enterprises

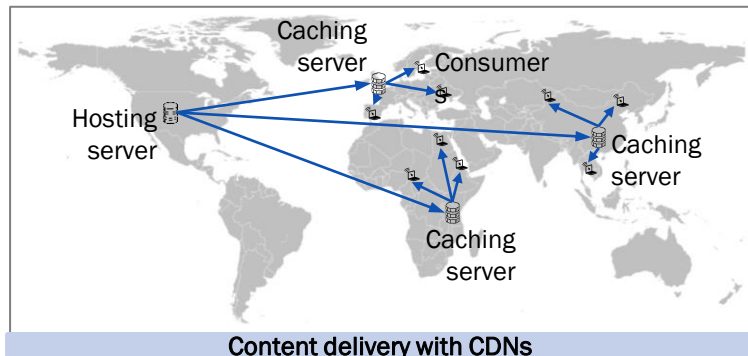
Content delivery networks (CDNs)

CDNs help bring content close to consumers and have are typically paid by content providers, and may or may not pay ISPs and IXPs

Diagrams of content delivery with and without CDNs

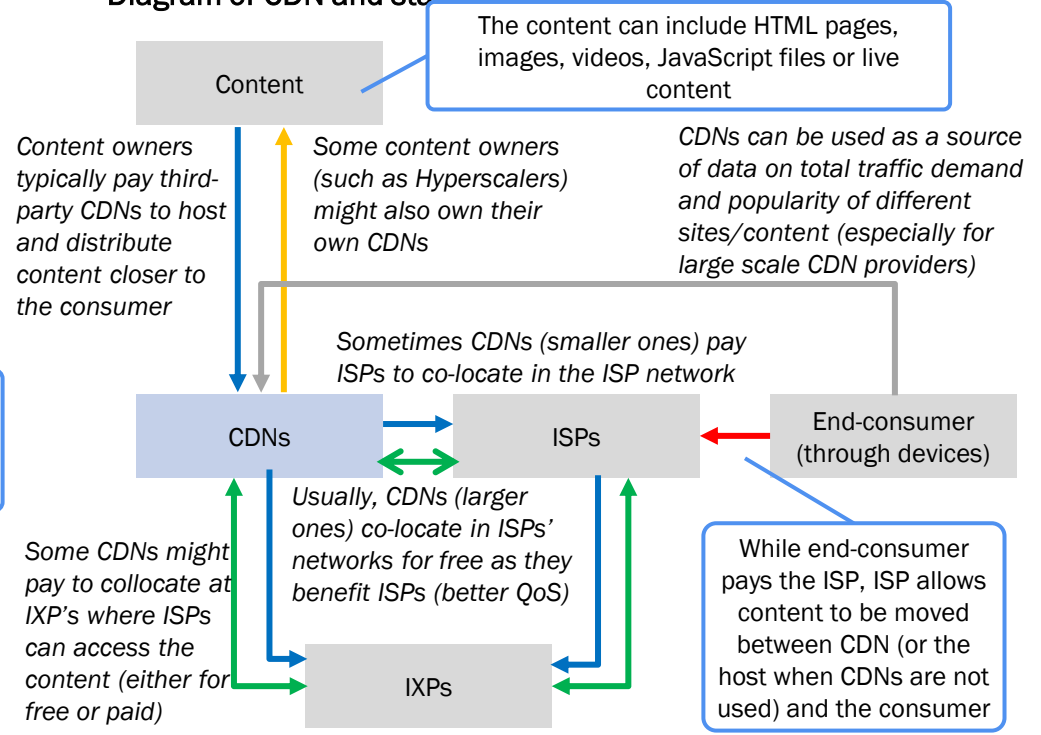


CDNs are key enablers to the internet; while websites can technically function without CDNs, a slow user experience on international sites/content would likely drive people towards local content only
Traffic demands (and costs to the ISP) are high



CDNs include a network of Points of Presence (PoPs) where the CDN's network (Autonomous System) interconnects with other networks, and caches that store and serve content, which can be either in the CDN's network (typically in PoPs) or in an ISP's network. PoPs are part of the CDN's network, which also includes links that distribute content across this network. **Traffic demands (and cost to the ISP) are much reduced**

Diagram of CDN and stakeholder value chain



While end-consumer pays the ISP, ISP allows content to be moved between CDN (or the host when CDNs are not used) and the consumer

- ← Retail service (paid)
- ← Service (free)
- ← Wholesale input (paid)
- ← Integration
- ← Provision of data

CDNs are used internally by content providers, and offered externally by suppliers including cloud players and ‘pure play’ CDN providers

- Content delivery networks (CDNs) use multiple geographically-distributed PoPs and caches, and high-capacity links between these locations, to help content providers deliver content efficiently to consumers
 - this content can include HTML pages, images, videos, JavaScript files and live content
- CDNs improve quality of experience, increase network efficiency, and allow for a more dynamic innovation and competition between content providers
 - the increases in network efficiency save money for ISPs
- Live streaming can also be facilitated by CDNs, bringing a source of live content closer to end-users and optimising the load on the internet (especially for large audience events)
- CDNs can be for internal use (Netflix’s has its own network of caches, though uses Amazon CloudFront to fill these), or for external use (e.g., Cloudflare provides commercial CDN services)
 - some content providers who built their CDNs for internal use are also offering them to third parties – this is primarily the case for cloud players such as Google, Amazon or Microsoft
- Some CDN providers have been offering cloud-based solutions to diversify their revenues, incl. protection against Distributed Denial of Service (DDoS) attacks and edge computing (e.g. Fastly’s DDoS protection, Cloudflare Workers)

¹ In addition to Google Cloud CDN which is a commercial CDN, Google also has Google Global Cache which embeds Google’s own content caches into ISPs’ networks

Source: Analysys Mason, press search, Ofcom-commissioned report about CDNs

There are three types of commercial CDN providers: large-scale ‘pure play’ providers, Hyperscalers and smaller challengers

Summary of key CDN providers

There are many CDN providers; here we show examples of those that are most relevant for the UK

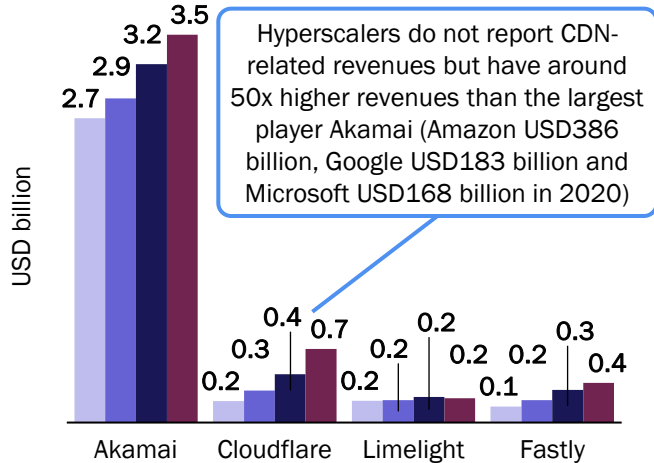
		Large ‘pure play’ commercial providers				Hyperscalers			Smaller commercial challengers		
Operator		Akamai	Limelight	Cloudflare	Fastly	Amazon CloudFront	Microsoft Azure CDN	Google Cloud CDN ¹	KeyCDN	ImageEngine	PageCDN
Ownership		Listed	Listed	Listed	Listed	Amazon (listed)	Microsoft (listed)	Google (listed)	Part of Proinity LLC (private)	Part of ScientiaMobile (private)	Private
Founded in		1998	2001	2009	2011	2008	N/A	2015	2012	2015	2018
Services	CDN	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Security (incl. DDoS protection)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗
	Edge computing	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗
Revenue, 2021 (USD million)		3461 (+8% YoY)	218 (-5% YoY)	656 (+52% YoY)	354 (+22% YoY)	N/A	N/A	N/A	Est. 1.3 (2020)	N/A	N/A
Infrastructure	PoPs	365 000 servers globally	140 PoPs	N/A	72 PoPs	310 PoPs	N/A	146 PoPs	40 PoPs	18 PoPs	N/A
	Countries	135	N/A	100	26	47	N/A	N/A	N/A	N/A	N/A
	Networks connected	1350	1000	10 000	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Features / differentiators		Largest CDN provider, diversifying revenues through acquisitions, with large customers such as LinkedIn and Twitter	Focus on video and streaming; and promotes its private network as a key differentiator against competition	As a later entrant, initially focussed on smaller customers, offering free products; with more flexible network than Akamai	Later entrant to the market, with more flexible network and products; Amazon also uses Fastly as a CDN providers for its website	Advanced features, and potential integration with Amazon AWS	Offers four products: one from Microsoft, one from Akamai, and two from Verizon; potential integration with Azure	Uses Google’s global network, with potential integration with other Google services such as Google Cloud Platform	Rather small company targeting smaller customers with “pay as you go” options	Focussed on image CDN with device detection and image optimisation	Smaller company, focussed on open source CDN

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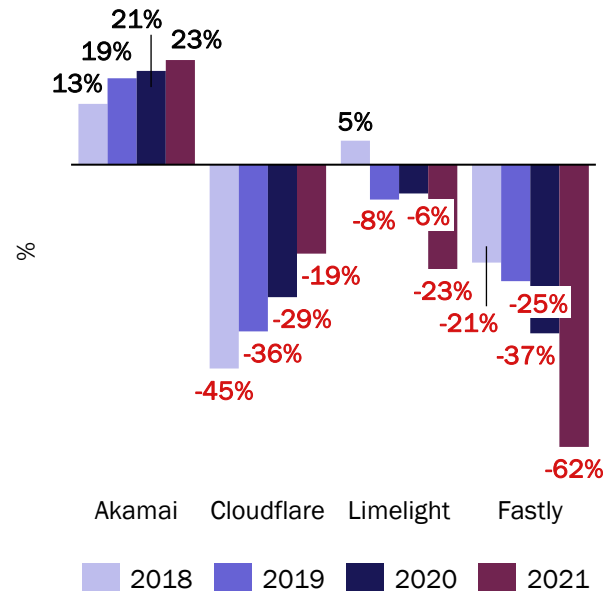
Source: Analysys Mason, company websites, press search

Akamai generates by far the highest revenue among the large commercial providers, and is the only one with positive operating profits

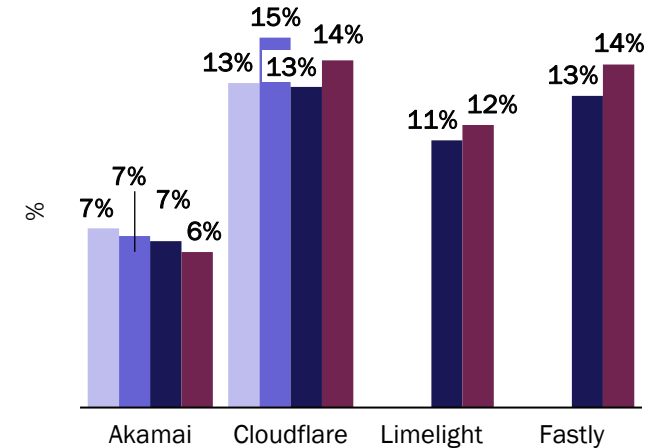
Revenue



Operating profit



Capex as a % of revenue



- All players have experienced increasing revenues over the last three years, and the other three players apart from Akamai have relatively similar revenue levels
- Akamai had a first move advantage over the other players and was able to expand more quickly so now likely enjoys the benefits of scale
- Three smaller commercial providers all have negative operating profits due to the costs needed to develop new technologies, and operate and expand their networks
- There may also be an effect of Hyperscaler traffic being remove from these networks (e.g. Amazon withdrew custom from Limelight) to be carried on their own networks

Overall, the smaller commercial players are investing in new technology and services in the face of competition from the Hyperscalers. Akamai is less threatened (due to its size) but is starting to invest too (see later slide on acquisition)

Key additional technical and business model developments include security, edge computing, bundling with cloud and backbone connectivity access

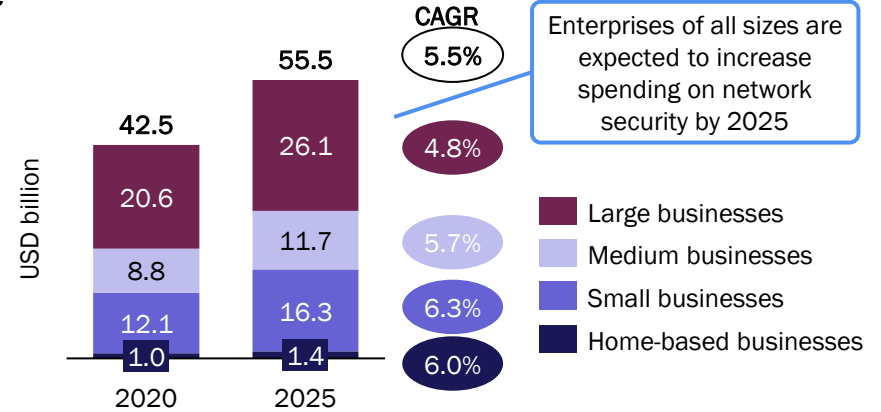
Key technical and business model innovations



The architecture of high capacity nodes close to end users makes CDNs ideal for DDoS protection, and providers now offer a range of security services

- CDN networks add an additional layer in content delivery which places providers in a good position to offer enterprise-level security services – including protection from common network attacks such as distributed denial of service (DDoS)
 - most CDN service providers offer security services which help stop potential data leaks before they happen
- Security services can include DDoS (distributed denial of service) protection, web application firewalls (WAFs), TLS/SSL encryption, content security and support services
- Large companies such as Akamai are investing in their security services through both new propositions and acquisitions of smaller players
 - similarly, other large players such as Limelight, Cloudflare and Fastly offer various security products and services
- Hyperscalers (Amazon, Microsoft and Google) have the ability to leverage their existing cloud services and hence offer cloud security together with CDNs
- Other smaller CDN players such as Sucuri, StackPath, and Rackspace focus specifically on such products with more emphasis on ‘Security products’ on their website offerings

Global spending on network security and appliances by business size



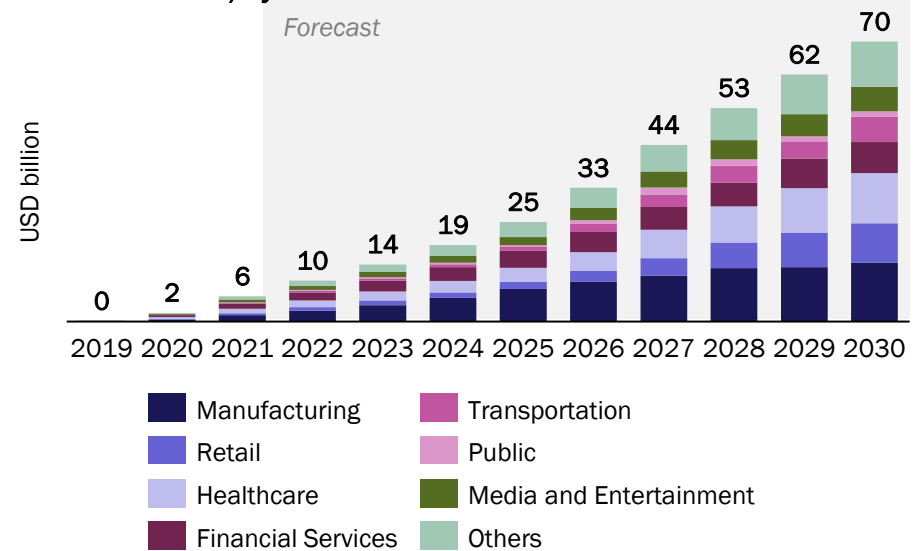
Akamai’s developments around security products

Provider	Recent developments
Akamai	<ul style="list-style-type: none"> Intends to mostly invest in security innovations In March 2021, the company plans to report revenue under two groups: ‘Edge Technology Group’ and ‘Security Technology Group’ Cloud Security Solutions revenue increased from 24% of total in 2018 to 33% in 2020, and 39% in Q3 2021 Acquired multiple companies such as Asavie, ChalameonX in the last few years to strengthen its security services

Edge computing follows a similar principle to CDNs, and aims to bring computing power closer to end-users and their devices

- Edge computing describes cloud-enabled application and data processing that takes place in multiple, highly distributed locations that are far closer to the users than private and public cloud computing locations are today
 - the need for edge computing has been increased by developments and new use cases around 5G and IoT (which require lower latency)
- Enterprise spending on public edge cloud services is expected to increase rapidly by 2030, reaching around USD70 billion
- Similar to other networks, edge clouds can be deployed privately (for a single organisation) or publicly (serving multiple customers on-demand)
- Public edge computing is a logical extension to a traditional CDN business and many third-party CDN providers are positioning themselves as edge service providers
 - CDN service providers are well-positioned to capitalise on the initial investments in edge-based services by extending their current capabilities and customer relationships
 - all large commercial players, Hyperscalers and some smaller CDN providers (StackPath, ImageEngine) provide edge computing services

Global enterprise spending on public edge cloud services (IaaS, PaaS and SaaS) by vertical



Some aspects of CDNs may make them less able to compete with Hyperscalers in providing edge services:

- Too much focus on their familiar use cases (media and entertainment, security)
- Highly specialised infrastructure (lack of flexibility)
- Need to acquire SaaS capability (which is expected to be the main delivery model for edge services)

Akamai's acquisition of the IaaS player Linode acts as a good example of CDN providers willingness to achieve wider scope and bundle CDNs with other services







- From the CDN customer perspective, the choice of provider can be impacted by the content and services the CDN customer is looking to use / create / distribute
- CDN customers are more likely to choose a provider that also provides them the platform services that they need
 - for example, enterprise developers using Google Cloud Platform would be more likely to buy CDN services also provided by Google to avoid integration challenges arising from different using providers
- The Hyperscalers are often bundling their own CDN services alongside the various cloud services (IaaS, PaaS, SaaS) they provide
 - in order to compete, and also as a new source of revenue / customers, CDN players are also considering how they can expand their offerings to also offer cloud services (see right)

Overview of Akamai's Linode acquisition

- Akamai (a large CDN player) acquired Linode (a cloud computing (IaaS) provider) in February 2022 for c.USD900 million
- Akamai's acquisition of Linode represents an appetite for the CDN provider to diversify its revenues further (after security services) and combine operations with cloud services
- Akamai's CEO stated that this acquisition would enable them to provide "end-to-end solutions" from computing, to delivery, together with security services
- Akamai aims to scale Linode cloud infrastructure to its 365 000 CDN servers around the world, and provide an alternative runtime environment to the public cloud for both enterprise edge applications and telecom operator network functions
- Akamai stated that cloud services such as Linode's IaaS platform were demanded by its large enterprise customers

There are various market trends that are expected to increase demand for CDNs, but also shape the market

Overview of key market trends

Driver	Change	Impact on CDNs
Internet traffic 	2019 Total traffic: 201 EB/month Video: 60% of total 2022 Total traffic: 396 EB/month Video: 82% of total	Increased need for CDNs to distribute growth in IP traffic, especially for games and videos – driven by higher take-up and higher definition content
Device diversity 	2019 60 000 mobile device types 2022 20% growth in device types each year Each device requires content to be processed to make it suitable for delivery to that device	Increased need for CDNs to help content providers deliver content quickly and efficiently to diverse consumer devices
Depth of caches 	Caches located in 1-2 national locations (e.g. IXPs) → Caches located in 10s of locations (ISPs' core and metro nodes)	Increased need for caching deployed 'deep' within networks, close to the border between networks and consumer devices, especially with new technologies being developed such as edge computing
Nature of traffic 	Static Two users see the same content Dynamic Two users see customised content	Increased need for solutions which can pair distribution and processing of user data to provide dynamic content (video, live content and gaming) to consumers
Multi-provider solutions 	Single provider Hosting server → CDN server → User devices Multiple provider Hosting server → Multiple CDN servers → User devices	Increasing demand for multi-provider solutions with geographically diverse CDNs with different features, to ensure resilient service delivery with high availability
Bundling cloud and CDNs 	E.g. recent acquisition of Linode by Akamai E.g. launch of Cloudflare Workers ¹	Increased importance to manage ingress and egress from cloud application (that may work in real time, running on a complex, distributed compute fabric, with have users anywhere in the world) through CDNs is very important

CDNs are increasingly bundled with other cloud services such as security, and content owners can have competitive advantage from their existing networks

Considerations for relationships across the value chain

Considerations	Explanation
Prospects for substitution to intensify	<ul style="list-style-type: none"> ▪ The nature of traffic demands (huge amounts of traffic from video services) means that CDNs are picking up a greater proportion of total traffic, and therefore effectively substituting for transit and peering services. ▪ Potential for further shift to use of 'closed' caches held deep in ISPs networks could reduce the need for CDNs (though these caches would still need to be filled) <ul style="list-style-type: none"> – e.g. BBC iPlayer using its own caches deep in ISPs' network – e.g. Netflix has its own network of closed caches – e.g. Disney+ may be using a commercial CDN initially, but may move to using its own caches
Balance of bargaining power	<ul style="list-style-type: none"> ▪ Hyperscaler CDN services could shift the balance of power in the market by taking more market share, and offering more sticky services and making use of some vertical integration with their own undersea cables ▪ The ISPs have bargaining power as they are required for content providers to get their customers, however this is offset by the cost savings and improved latency that CDNs provide to ISPs and their customers.
Bundling practices	<ul style="list-style-type: none"> ▪ CDN services are increasingly bundled with security services and other cloud services to increase revenue diversification <ul style="list-style-type: none"> – e.g. Akamai's recent acquisition of Linode aims to combine Linode's IaaS platform with Akamai's large-scale CDN ▪ From the other direction, the Hyperscalers are bundling their CDN services with their core cloud offerings

In conclusion, 'pure play' CDNs are facing pressure from Hyperscalers, who can afford to run their networks at very low margin

Analysis of possible market outcomes

Aspect of market outcome	Comment
Profitability in the long term	<ul style="list-style-type: none"> ▪ Hyperscale providers have the ability to offer their CDN services at very low or no margin, as they offer CDN services as complementary or bundled products. This is putting pressure on pure-play CDN providers to develop new services to compete ▪ Furthermore, integrated CDN/content providers (e.g. Hyperscalers) have a key advantage over 'pure-play' CDNs. Hyperscalers often host the content, and a pure-play CDN must pay an egress fee to get the content from the host. Integrated providers can avoid this fee
Who is in the best position to succeed	<ul style="list-style-type: none"> ▪ There is a sense among some CDN players that the market for basic CDN services is becoming increasingly commoditised, due to the large amounts of competition between the major providers (see above) ▪ In addition to being able to run at low margin, Hyperscale providers also have their own content as very large anchor tenants (Amazon has Prime Video; Google has YouTube) ▪ On the other hand, there is a (very) long tail of web-based content which is likely to be able to support a competitive and diverse market for CDN services for the foreseeable future, and 'pure play' CDN providers are innovating to offer a range of additional value-added services ▪ We note that Amazon's eCommerce pages are actually hosted on Fastly's network, suggesting that even the hyperscale providers recognise the value of competing CDN services
Prospect of external challenges	<ul style="list-style-type: none"> ▪ There are limited external challenges. Any shift towards data localisation regulations (i.e. for data to stay within a country) could have an impact, but this is not seen a big risk

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