Putting IPv6 to work

North American IPv6 Summit

Plaza Tower One Conference Facilities
Greenwood Village, CO
April 22-23, 2015

Rocky Mountain IPv6 Task Force

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IP address management for IoT

- The Internet of Things and sample applications
- IP addressing in an IoT environment
- When IPv6 addressing is necessary
- Automating IoT address assignments
- IP address management strategies for IoT

IoT sample applications

- Homes/Autos/Personal
  - Energy, security, monitoring, controls
- Buildings
  - HVAC, security, energy
- Transportation
  - Traffic routing, shipping, supply chain, parcel tracking
- Municipalities
  - Traffic, parking, surveillance, public safety, emergency services
- Healthcare
  - Patient care, monitoring, remote diagnostics, bio wearables
- Enterprise
  - Automation, manufacturing, process monitoring

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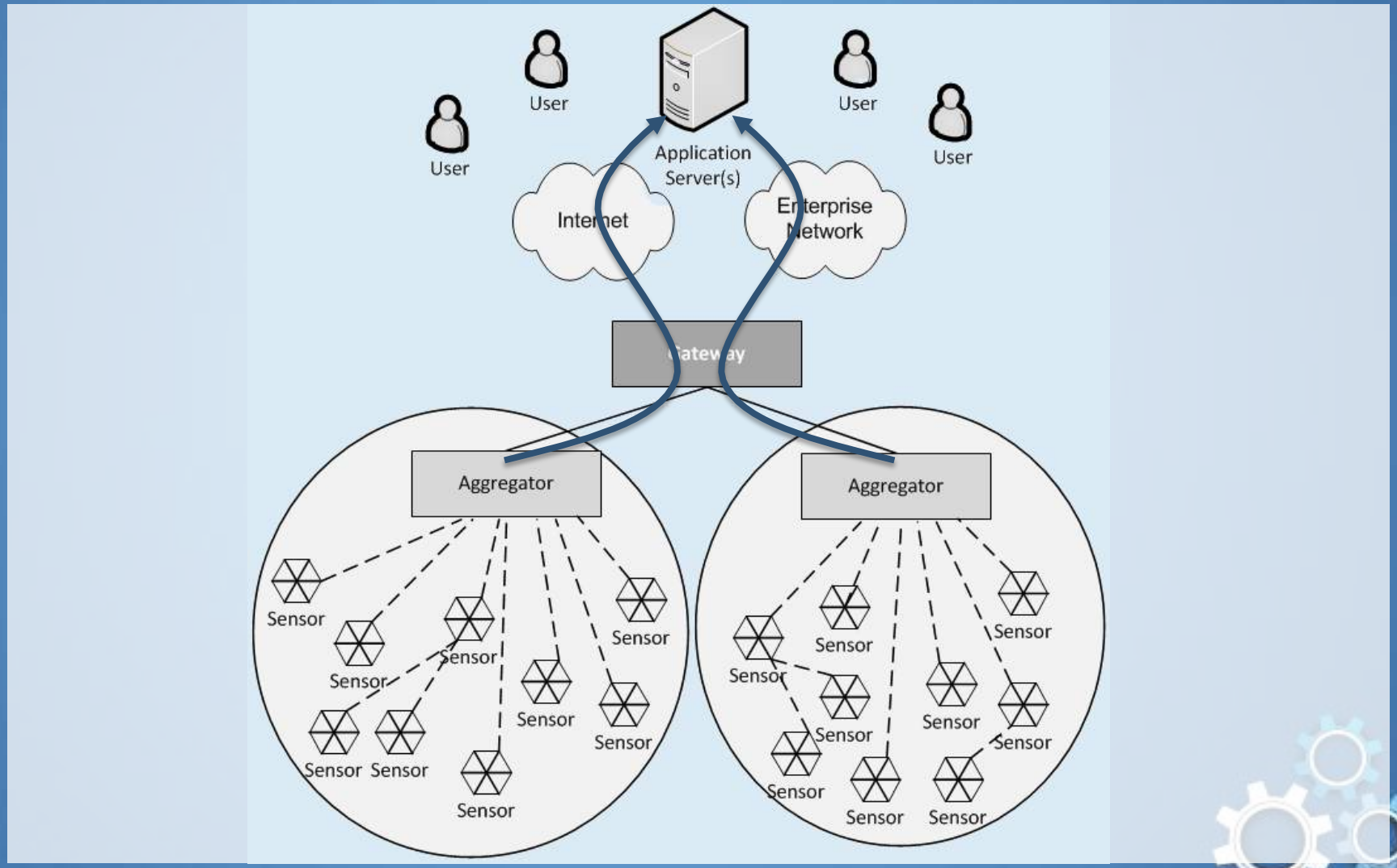
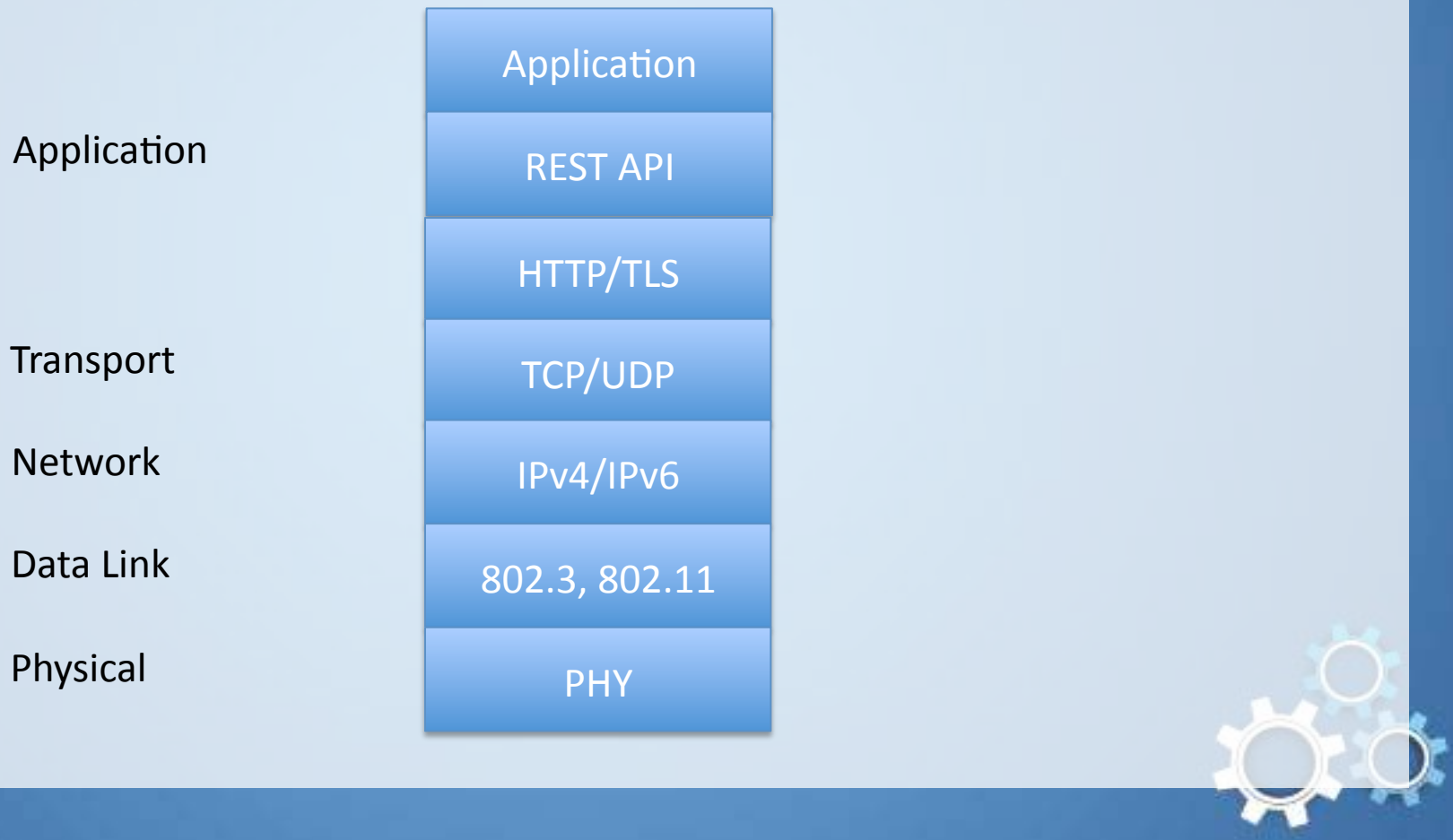
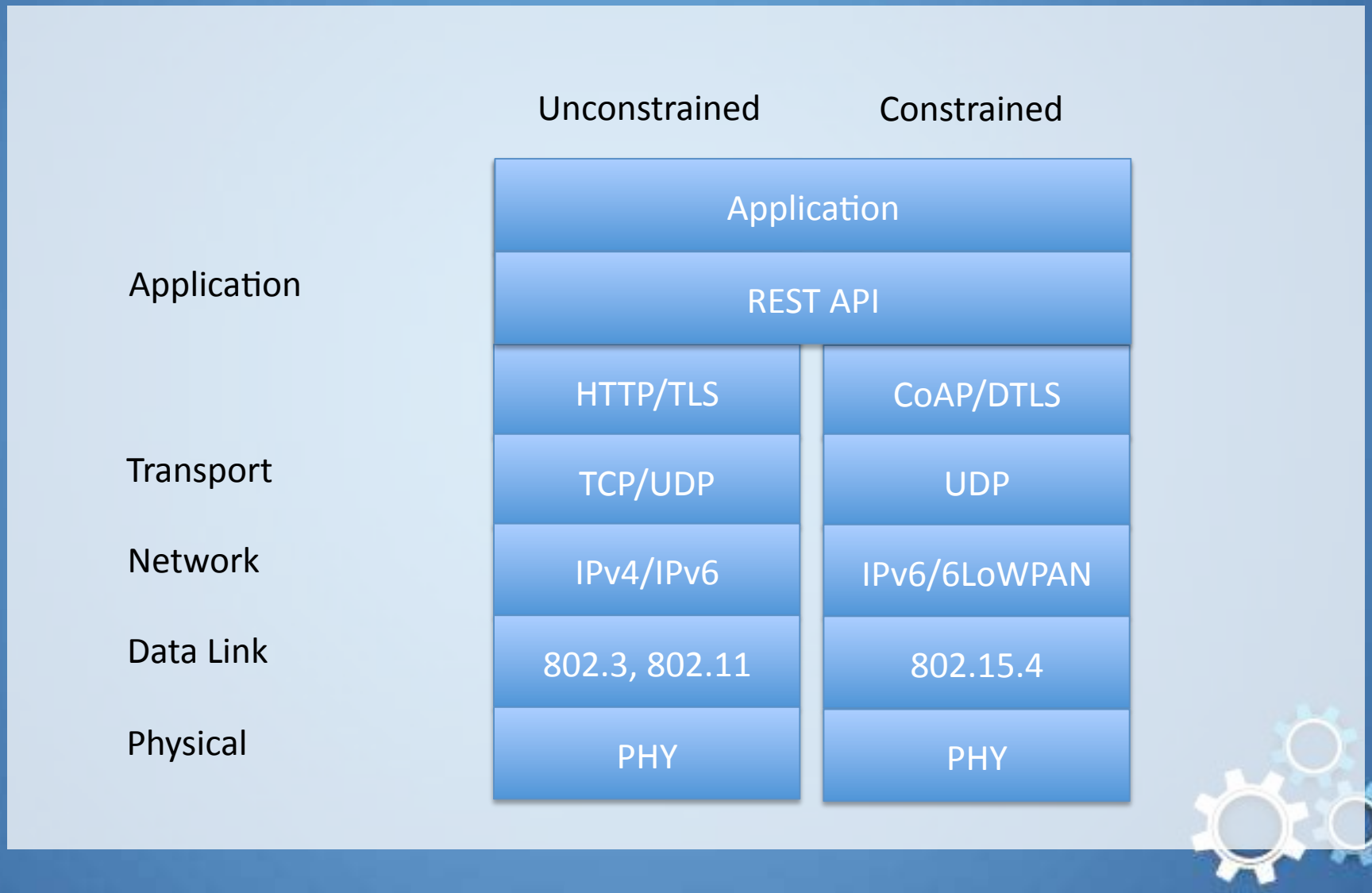
IoT General Architecture



Internet Stack



Internet of Things Stack



Potential IoT network impacts

- Scale
  - Quantity, geographic scope, private/public nature of things
- Network infrastructure
  - Routers, switches for fixed access
  - Wireless for mobility and anywhere access
- Security
  - Network access and accessibility
  - Device security
- Network management
  - SNMP, logging
- IP addressing
  - IPv4, IPv6, addressing plan

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IPv4 or IPv6 for IoT?

- IPv4
  - No need for Internet access
  - Sufficient private space exists
  - Static, internal deployments
- IPv6
  - Scale
  - Internet access
  - Agility, ad hoc applications
  - Constrained environment support
  - Self initialization
  - *The* Internet Protocol

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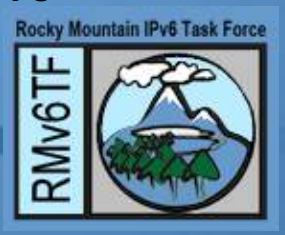
Goals of an IP address plan

- Provide IP addresses to end nodes in order to…
- Enable end nodes to communicate…
  - with other nodes across the organization (or not)
  - with Internet or partner nodes (or not)
- Enable end nodes to communicate via supported media
- Facilitate network management
- Facilitate security management



Management facilitation

2001:db8::/32

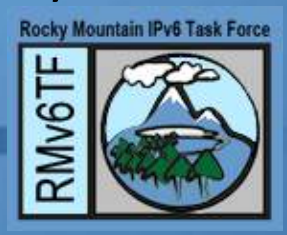
- By application
  - Data: 2001:db8:0000::/36
  - Voice: 2001:db8:8000::/36
  - Wireless: 2001:db8:4000::/36
  - Management: 2001:db8:c000::/36
- By region (core network)
  - Voice – HQ: 2001:db8:8000::/40
  - Voice – Philly: 2001:db8:8800::/40
  - Voice – Dublin: 2001:db8:8400::/40
  - Voice – Tokyo: 2001:db8:8c00::/40
- By business unit
  - Voice – Tokyo – Engineering: 2001:db8:8c00::/48
  - Voice – Tokyo – Finance: 2001:db8:8c01::/48

Policy impact:

- Application packet treatment
  - bits 33-36
  - Same router policy network wide per application
- Core network routers
  - Analyze first 40 bits
  - Core routing table ~2^4 entries
- Each BU is allocated:
  - {apps} X {regions} blocks
- Security policies
  - Fewer entries if by app
  - More entries if by region, more by BU

General IPv6 block allocation guidelines

- Define IP addressing requirements
- Define your addressing hierarchy layers
  - Routing topology – core/division/regional/access
  - Application-specific routing treatment based on IP
  - Network segmentation
  - Administrative delegation
  - Management controls based on IP
- Allocation strategies
  - Allocate on 4-bit (nibble) boundaries
    - Simplifies reverse DNS configuration to hex digit boundaries
    - Simplifies association by sight for hex digit meanings
  - Sparse allocation at upper layers
  - Best-fit or random at lower (subnet) layers

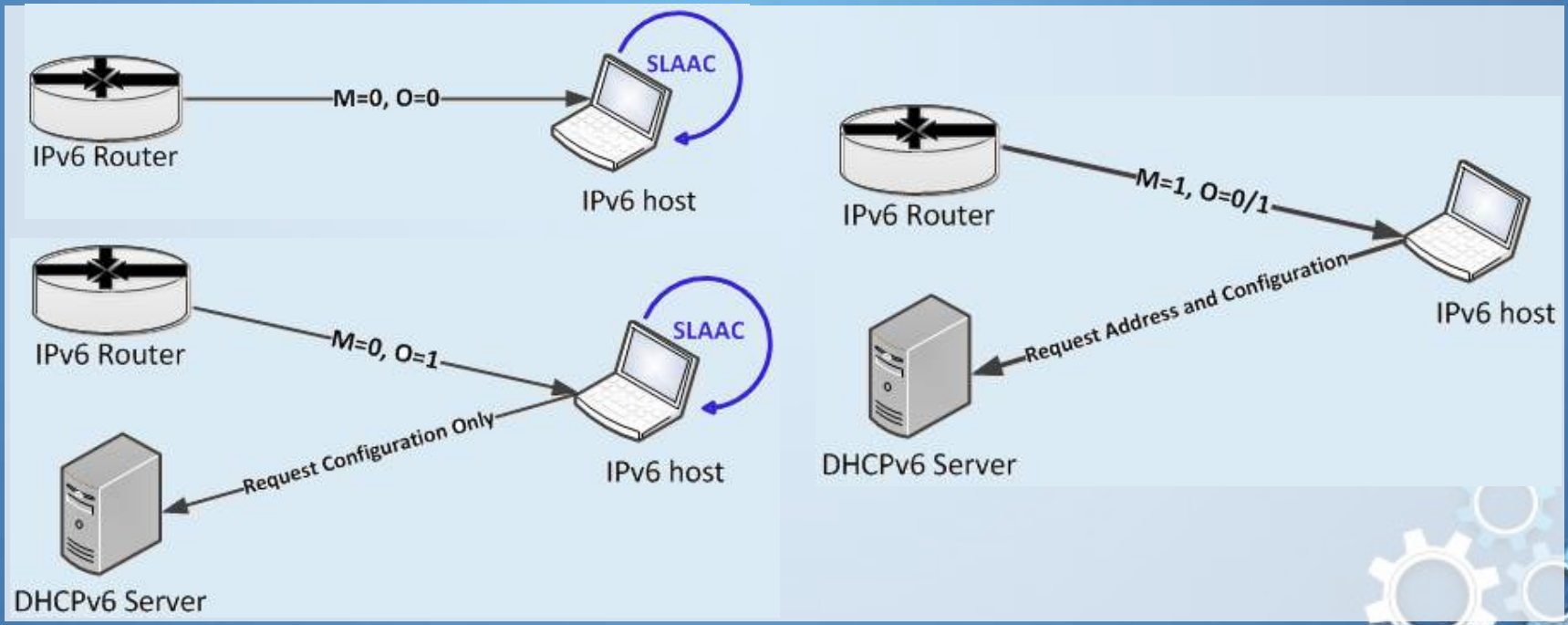


Thing IP address assignment

- Manual
  - Tedious, error-prone, doesn't scale
- SLAAC (StateLess Address AutoConfiguration)
  - Device identifies access subnet address (RA)
  - Device defines Interface ID (IID)
  - Duplicate Address Detection
- DHCPv6 (Stateful Address Autoconfiguration)
  - Network provisioned server with address pools
  - DHCPv6 server assigns IP address and related parameters
- Hybrid Stateful-Stateless
  - Device uses SLAAC to autoconfigure IPv6 address
  - Devices uses DHCPv6 for additional parameters

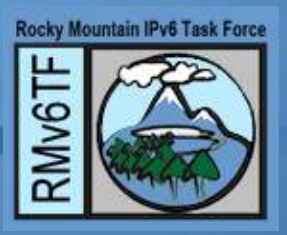
SLAAC availability via RAs

Flag	O=0	O=1
M=0	No DHCPv6	DHCPv6 for configuration information only
M=1	DHCPv6 for address and configuration information	DHCPv6 for address and configuration information



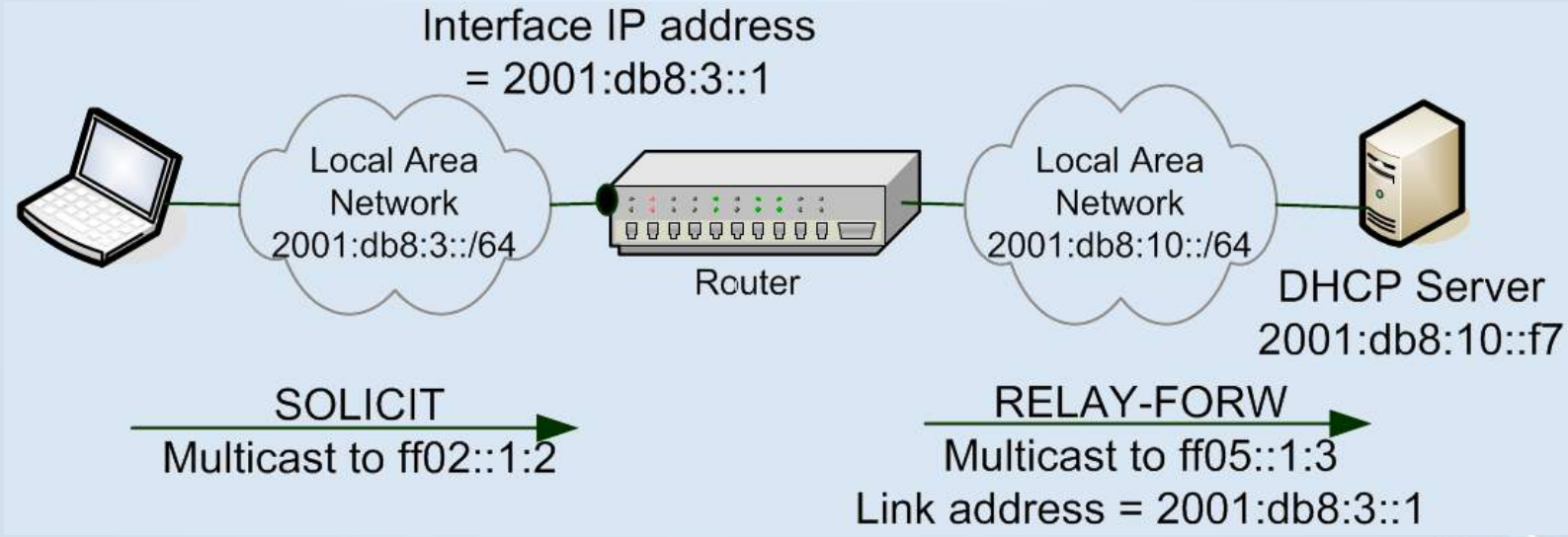
SLAAC Considerations

- Pros
  - Self initializing, ad hoc
  - No need to deploy and configure DHCPv6
- Cons
  - Inability to initialize beyond IP address
    - Network services
    - Thing-specific parameters
  - Network access permissiveness



DHCPv6


SOLICIT
ADVERTISE
REQUEST
REPLY
DHCPv6 Client
DHCPv6 Server


Interface IP address
= 2001:db8:3::1
Local Area
Network
2001:db8:3::/64
Router
Local Area
Network
2001:db8:10::/64
DHCP Server
2001:db8:10::f7
SOLICIT
Multicast to ff02::1:2
RELAY-FORW
Multicast to ff05::1:3
Link address = 2001:db8:3::1

DHCPv4 - DHCPv6 Messages

Feature	DHCPv4	DHCPv6
Destination IP address of initial client message	Broadcast (255.255.255.255)	Multicast to link-scoped address: All-DHCP-Agents address (FF02::1:2)
DHCP Relay Support	Yes by configuring DHCP server addresses in each relay agent	Yes either by configuring DHCP server addresses in each relay agent or using the All_DHCP_ Servers site-scoped multicast address (FF05::1:3)
Relay Agent forwarding	Same message type code but inserts giaddr and unicasts to DHCP server(s)	Encapsulates client message in RELAY-FORW to DHCP server(s) and RELAY-REPL from server(s)
Message to locate server to obtain IP address and configuration	DHCPDISCOVER	SOLICIT
Server message to engage client	DHCPOFFER	ADVERTISE
Client message to accept parameters	DHCPREQUEST	REQUEST
Server acknowledgement of lease binding	DHCPACK	REPLY
Client message to leasing DHCP server to extend lease	DHCPREQUEST (unicast)	RENEW (unicast)
Client message to any DHCP server to extend lease	DHCPREQUEST (broadcast)	REBIND (multicast)
Client message to relinquish a lease	DHCPRELEASE	RELEASE
Client message to indicate that an offered IP address is already in use	DHCPDECLINE	DECLINE
Server message to instruct client to obtain a new configuration	DHCPFORCERENEW	RECONFIGURE
Request IP configuration only, not address	DHCPINFORM	INFORMATION-REQUEST

DHCPv4 - DHCPv6 Features

Feature	DHCPv4	DHCPv6
Dynamic address assignment	Yes	Yes
Fixed address per “client” (Manual DHCP)	Yes	No
Subnet allocation via DHCP	No	Yes
Client identifier	Client-identifer (hardware address in practice)	DUID
Client class support	Yes	Yes
DDNS	Yes	Yes
Rapid commit	Yes	Yes
Authentication	Yes	Yes
DHCP failover support	Yes	In progess
Relay agent identification option	Yes	Yes
LeaseQuery support	Yes	Yes

Prefix Delegation

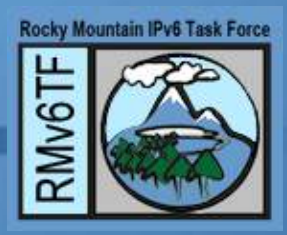
- Subnet assignment via DHCPv6
- Pool of subnets
- Same message flow as address assignment
  - Downstream router requests prefix
  - Upstream “router” allocates a routable prefix
- Potential applicability to provisioning IoT “area networks”

DNS Considerations

- ip6.arpa zones
- *Thing* name resolution for outbound connections or existence validation
- *Thing* name publication for inbound connections

  thing.bt.com IN AAAA 2001:db8:a04:3c:250:4ff:fe5c:b3f4
- Maps IP addresses to domain names

  4.f.3.b.c.5.e.f.f.f.4.0.0.5.2.0.c.3.0.0.4.0.a.0.8.b.d.0.1.0.0.2.ip6.arpa.
  IN PTR thing.bt.com.

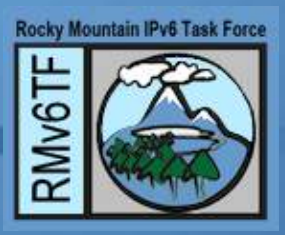


IP address management for IoT

- IoT block space strategy
- IP address assignment strategy
- *Thing* parameter initialization
- Network services deployment
  - DHCP/DHCPv6
  - DNS
  - Other network services - NTP, FTP, TFTP, SCP, etc.

Selecting an IPAM methodology

- Define IoT application IPAM requirements
  - Scale – number of things planned
  - Scope – internal vs. Internet and geographic span
  - Speed – ad hoc vs. stationary
  - Services – network services requirements
  - Security – access control requirements (to start)



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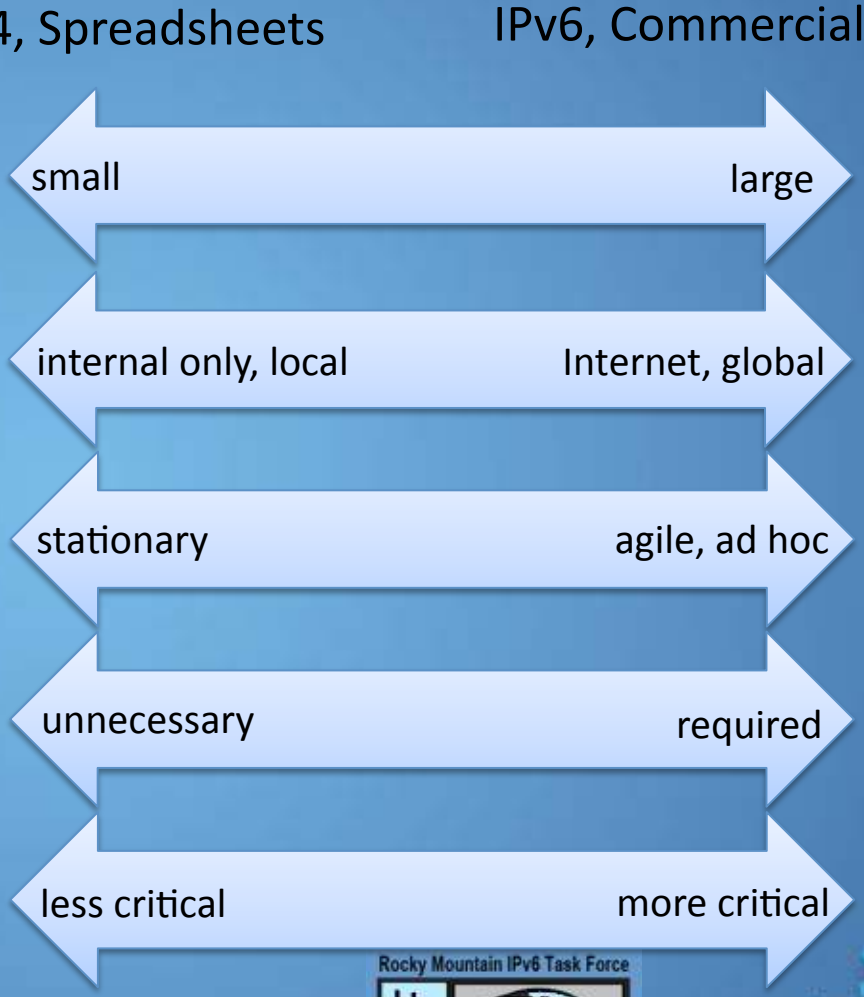

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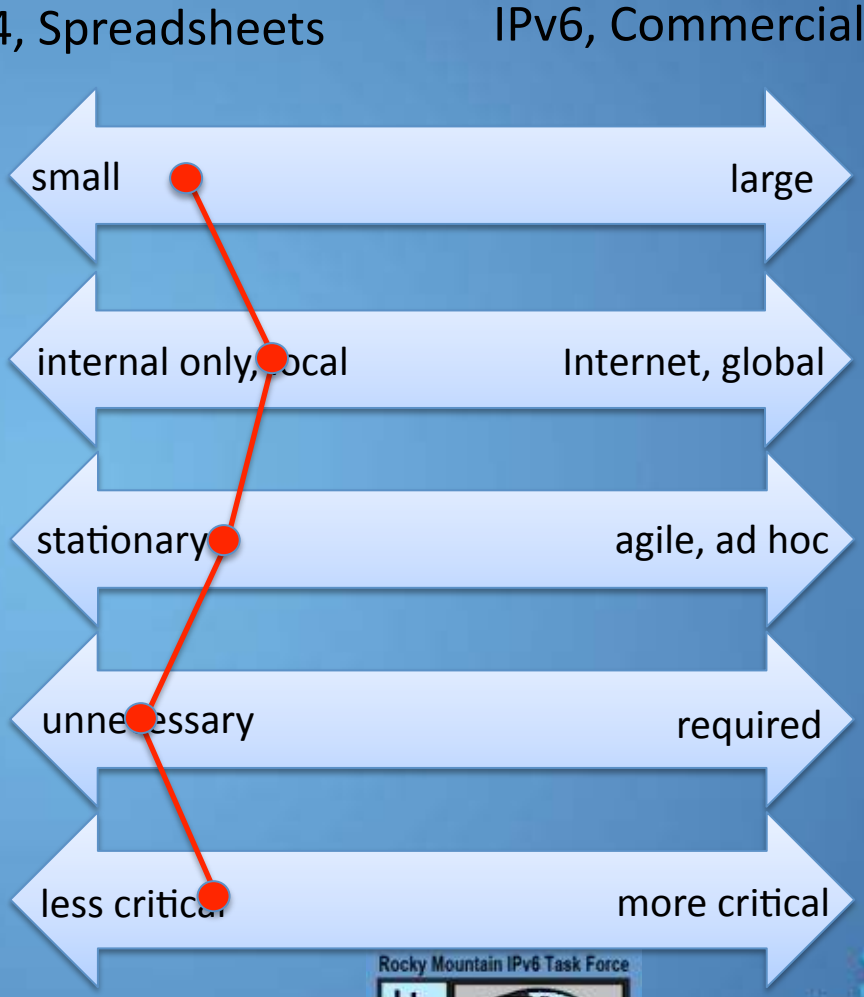

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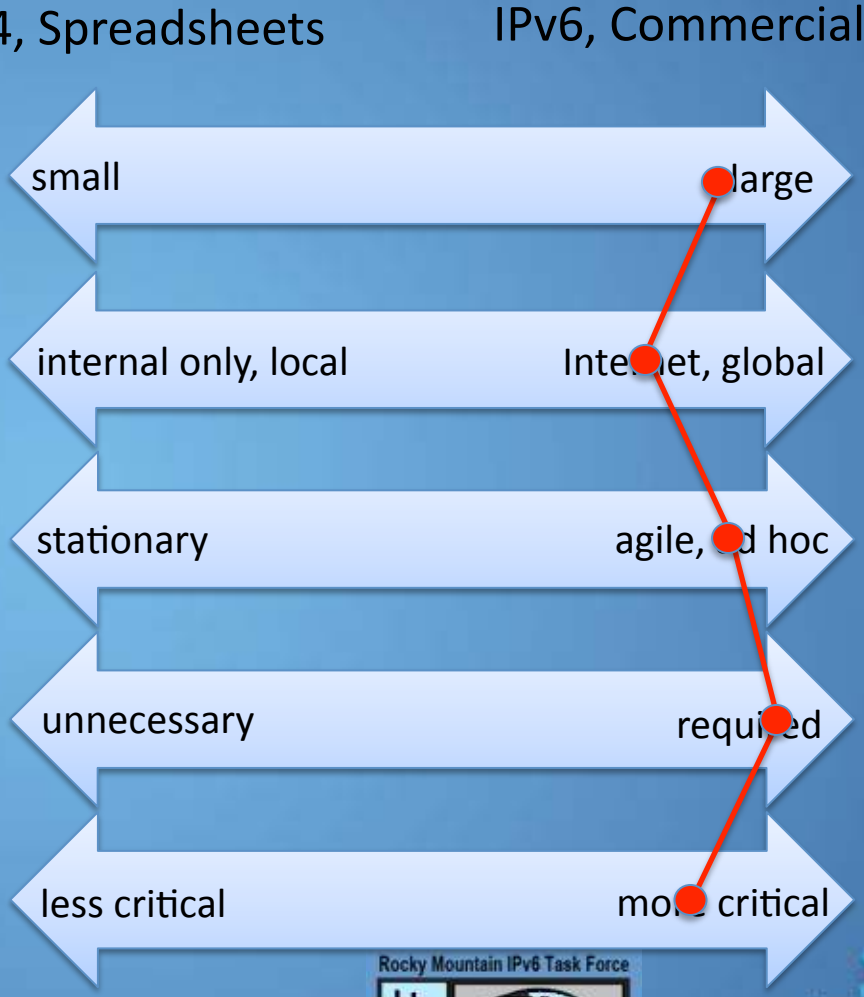

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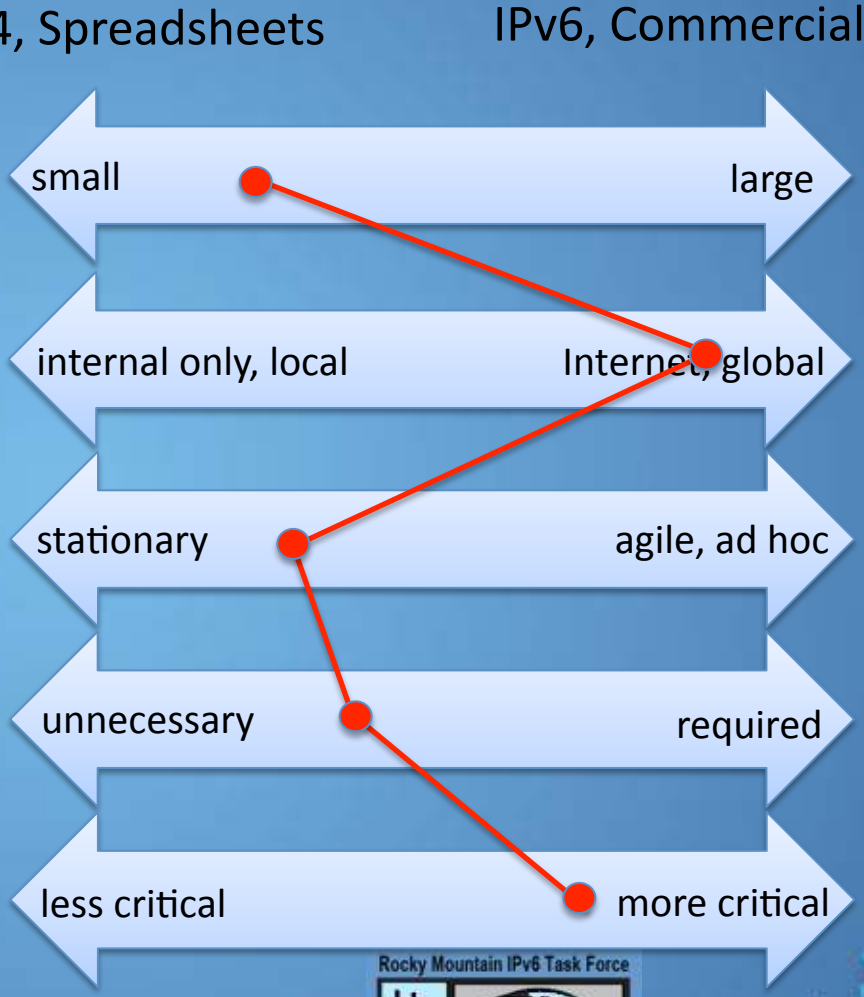

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IPAM Summary

- IPAM is a strategic management function
  - Organize IPv4/IPv6 address space in one cohesive inventory database
  - Manage your hierarchy, block types, naming policies and more
- Simplify address allocations
  - Perform address allocations hierarchically and logically without typing in the address!
  - Maintain single authoritative address space inventory for change control
  - Template based subnet allocation and IP address assignment within subnet
- Track IPv6 Deployment
  - Manage current IPv4 network, IPv6 deployment, ongoing IPv4/IPv6
  - Track dual stack host IPv4/IPv6 addresses
- Manage Accountability
  - Scope and delegate administrator access
  - Track administrator and IP address history for troubleshooting and audit reporting
- Automate through IT integration
  - APIs/CLIs facilitate inter-system automation

Additional resources

- IPv6 white papers
- IPv6 Survey Report
- IPv6/IPAM books
- Free IPv6 tools - http://goo.gl/18GUUA
- LinkedIn - follow us!
- Blog – ipamworldwide.blogspot.com
- Web
  - www.btdiamondip.com
  - www.ipamworldwide.com

IPv6 book signing

Stop by booth 6 during beer garden for a signed copy of our IPv6 book

Please note: quantities are limited

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Thank you

Tim Rooney

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