# Representing Advanced Services

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**Abstract**

An increasing number of organisations are wishing to move to a servitization business model, both within and outside of manufacturing, due to the many benefits to taking a service-based approach (e.g., better relationship with customers, the ability to differentiate market offerings, increased revenues and improved sustainability of products). Advanced services represent the most advanced form of servitization with examples found in software delivery and manufacturing (e.g., Rolls-Royce's 'Power by the hour' and Xerox's print management offering). Based on the key features of Advanced Services that have been identified in existing literature, this paper explores how they differ from the services that are represented in the Goal-Based Service Ontology (GSO), and the research questions that must be addressed to develop an ontology of Advanced Services.

**Keywords**

Servitization, Advanced services, Outcome-based contract, Ontology

## 1. Introduction

Typically confined to the manufacturing sector, servitization sees an organisation move from a product-centric view to a services-centric view [1, 2]. One of the earliest definitions of servitization was provided by Vandermerwe and Rada [3] who defined the concept as an organisation adding services to their core business offerings to ensure competitive advantage. An increasing number of organisations, both within and outside manufacturing, consider servitization as their explicit strategy [4] due to the many benefits to taking a service-based approach (e.g., better relationship with customers, the ability to differentiate market offerings, increased revenue and profit [5]). Servitization can also be seen as a way of maximising the life of a product [3] thus improving the sustainability of a product [6].

Baines et al. [7] refer to three levels of servitization: Base, Intermediate and Advanced Services. Each level sees a more complex type of service, with a transition from supporting the goods, to supporting the customer [7]. Base level represents post sales service (e.g., provision of spare parts [8]), intermediate level would include ongoing maintenance in the service delivery (e.g., training, repair and maintenance [8]). Advanced Services would focus on the delivery of an outcome to a customer, resulting in customer support agreements or Outcome Based Contracts (OBCs). Advanced services represent the most advanced form of servitization and

*SoLEE 2021: 2nd International Workshop on Ontology of Social, Legal and Economic Entities, held at JOWO 2021: Episode VII The Bolzano Summer of Knowledge, September 11-18, 2021, Bolzano, Italy*
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are what many companies aim for when transitioning to a service-based approach. Examples of Advanced Services from manufacturing include Rolls-Royce's 'Power by the hour' and Xerox's print management offering [4].

Based on the key features of Advanced Services that have been identified in existing literature, this paper explores how they differ from the services that are represented in the Goal-Based Service Ontology (GSO), and the research questions that must be addressed to develop an ontology of Advanced Services. GSO has been selected for comparison since it includes the concept of satisfying a desired outcome as part of service delivery, which is a key component of Advanced Services. The outputs of this work will help form part of the ontology of servitization. Work has begun in understanding the servitization process and its core features independent of sector [9]. We wish to provide a resource for researchers within digital servitization, in the form of an ontology, that will help facilitate multidisciplinary research and make the field more accessible to both researchers and practitioners. Practitioners, who wish to establish a servitization business model within their sector, could use the ontology to better understand the transformation process and what is needed to make it a success. The ontology would need to be sector agnostic so could be applied in sectors such as transportation, charity, manufacturing, financial services.

Based on existing work, section 2 identifies the key features of an Advanced Service and introduces the example of 'Power-by-the-hour'. Section3 gives a brief overview of the Goal-Based Service Ontology (GSO). Section 4 explores the theoretical issues in representing Advanced Services and how they differ from services represented in GSO. The paper concludes with a list of further research questions (section 5) that must be addressed to develop an ontology of Advanced Services.

## 2. What is an Advanced Service?

Servitization can be considered as a continuum [10] depending on the degree to which product offerings are replaced with service offerings. Advanced Services are considered the most complex offering within servitization [11].

Existing literature often refers to the concept as representing a form of bundle that satisfies the aligned objectives of both the manufacturer and the customer. Ziaee Bigdeli et al. [11] define an Advanced Services as "a complex bundling of products and services" where outcomes and capabilities are offered by a manufacturer. Baines and Lightfoot [8] define an advanced service as: "a capability delivered through product performance and often featuring: relationship over (an) extended life-cycle, extended responsibilities and regular revenue payments". Three components are considered to form a typical bundle [8, 11]: (1) revenue payments based around offering; (2) performance incentives where penalties are incurred when there is a performance failure); and (3) a long-term contractual agreement which will include commitments relating to costs.

The term Product-Service-System (PSS) has also been used in the literature to refer to systems which make use of product-service bundles. The differences between servitization and PSSs are still being explored. Kryvinska et al. [12] note that although the two concepts are founded on the same motivations and drivers, the difference between them lies in how the final result is

perceived. When the products and services merge to form the PSS, their combination provides their value. In servitization, there is a further step where the manufacturer becomes a service provider, corresponding with the concept found in SD-logic [13, 14, 15, 16]. Advanced Services goes beyond simply providing a set of services that complement a product. Instead, an Advanced Service would represent an integrated solution that satisfies a particular need for a customer and where the majority of the risk and responsibilities are transferred from the customer to the manufacturer (or service provider if outside manufacturing).

Advanced Services focus on the delivery of outcomes, which are typically based on the capabilities of a product. The value of the service will come from use [9, 16]. The desired outcome will form the basis of an Outcome-Based Contract (OBC), where the customer pays based on a result, output, performance and/or outcome. Two types of OBCs can be considered: those based on availability and those based on functional result of products. This is a similar distinction to that of use-orientated and result-orientated PSS [17]. There is debate whether both types of OBC exist [18]. However, this debate is left for further work at this stage.

The use of an OBC can be one factor that distinguishes Advanced Services from other types of services [4, 19]. With an OBC, the service provider must guarantee a certain level of availability and participation with the cost of the service typically related to usage or a certain level of performance. The provider will have to take on the risks and responsibilities of ongoing maintenance. This is different to the selling of a product with an add on support service [4]. In an Advanced Service there will be penalties (typically a pause in payment) if the performance/outcomes are not met. The provider will have to continuously monitor the device and move to a preventative model of failure instead of a reactive one (typical with traditional support services).

Many of the definitions of service rely on the presence of a customer. Unlike PSSs, not all definitions of service require the presence of a product. Although some Outcome Based Contracts will refer to an outcome that is reliant on a product (e.g., Rolls-Royce's 'Power by the hour'), there are some examples where this would not be the case (e.g., tourism services, or public services as defined by Guarino [20]). It is possible that the delivery of a service will makes use of a set of products that are not directly related to the desired outcome (i.e., would not be considered a PSS). Consider the service offered by a barber. A customer pays for a service, which has a haircut as its outcome. To do this the barber will need to use scissors or clippers to cut the hair. However, this would not be considered as a PSS or noted in the associated OBC. Further research is needed to establish whether these products need to be considered for Advanced Services.

Although services are often considered between a service provider and service customer, Advanced Services will typically require a network of partners to ensure service delivery. A manufacturer will require a good relationship and knowledge of their customer but intermediaries may be needed to develop the necessary infrastructure around the customers to facilitate this. In the example of 'Power-by-the-hour', Rolls-Royce is the sole provider. However, in some cases, additional support may be needed to provide parts to maintain a product or the sensors for monitoring the usage of a product. In some cases, a wider supply chain may be to be considered, which would include the Original Equipment Manufacturer (OEM) who sells a product to the Service Provider (if not produced by the Service Provider themselves).

A review of the existing literature has identified the following key features of Advanced

Services:

- an integrated solution, which comprises product(s) and associated services,
- if the service relies on a product, that product may be material (e.g., an engine) or digital (e.g., a piece of software),
- focuses on the delivery of a measurable customer-desired outcome,
- value comes from use and is determined by consumer,
- outcome forms the basis of a form of Outcome-Based-Contract (OBC),
- performance incentives (including penalties) form part of the OBC,
- regular payment structure (whilst outcome is being delivered),
- the actors that are involved will include, at minimum, the Operator (service provider) and Customer (service consumer) but may also include an Original Equipment Manufacturer (service supplier) and intermediaries (additional agents required for service delivery e.g., for infrastructure).

### 2.1. An Example: 'Power-by-the-hour' [4]

Rolls-Royce is a major UK aerospace manufacturer. Smith [4] presents the case study of Rolls-Royce plc to show the importance of technology as a driver for servitization. This section will give an overview of the case study in terms of the Advanced Service that is offered.

Advances in technology resulted in Rolls-Royce jet engines being much more reliable and by the end of the 1990s, this led to reduced demand for spares, a decrease in revenue for the company and the need for a new business customer-focused business strategy [4]. This new performance-based contract was referred to as 'Power-by-the-hour'. The service was fully integrated with maintenance offered at a fixed-price based on engine availability. Previously maintenance had been costed on a time and materials basis (i.e., the amount of staff-time and cost of materials required for repair/maintenance).

Power-by-the-hour was offered for the US navy, where Rolls-Royce received a fixed price for each hour their engines were in the air. Rolls-Royce had to provide all logistics, maintenance, parts and trouble-shooting. A performance metric of 80% Ready-for-issue (RFI) engine availability was stipulated in the contract. TotalCare® [21] is the equivalent Advanced Service that is offered in the civil aviation sector.

## 3. GSO

Using UFO as the foundational ontology, the Goal-based Service Ontology (GSO) [22] links goals, tasks and services. The ontology focuses on concepts that are independent of any domain within Persuasive and Service-Orientated Computing. In GSO a service is defined as *"a temporal entity related to the commitment (a service agreement) that a Service Provider will perform a task (a type of action) on behalf of a Service Client whose outcome satisfies a Service Client's goal"* [22]. Agents include *Service Client*, *Service Provider* (has responsibility for the service) and *Service Executor* (agent who performs service task). A *Goal* is defined as 'the propositional content of a service client's intention'. A *Task* is a specialization of Action Type (UFO concept where at least one agent performs an event to satisfy a goal). A goal is satisfied if a task is successfully executed.

Services are considered intangible; production and consumption are considered inseparable. The value of a service is determined by the beneficiary (i.e., the Service Client) according to how their goal has been satisfied. Service agreements (the constraints of the service provision) and service execution are both bounded by time. A *Service Profile* is used to advertise an overview of the service. A service may have *Input* and *Output*.

## 4. An ontological analysis of Advanced Services

This section will consider how an Advanced Service might be represented in GSO and the theoretical challenges in doing so. Section 2 identified the following key features of Advanced Services:

- an integrated solution of product(s) and associated services,
- if the service relies on a product, that product may be material (e.g., an engine) or digital (e.g., a piece of software),
- focuses on the delivery of a measurable customer-desired outcome,
- value comes from use and is determined by consumer,
- outcome forms the basis of a form of Outcome-Based-Contract (OBC),
- performance incentives (including penalties) form part of the OBC,
- regular payment structure (whilst outcome is being delivered),
- the actors that are involved will include, at minimum, the Operator (service provider) and Customer (service consumer) but may also include an OEM (service supplier) and intermediaries (additional agents required for service delivery e.g., for infrastructure).

Like services in GSO, an Advanced Service is a temporal entity, the value of which is determined by the beneficiary. The agents that are included in GSO (i.e., Service Client and Service Provider) align with the Service Consumer and Service Provider in Advanced Services. We would consider Advanced Services to be dependent on the existence of a Service Provider and a Service Consumer. GSO defines Service Executors as those agents that actually performs the task, which could be the same as the Service Provider or different (da Silva Santos et al. [22] gives an example of freelancers that are hired by a cleaning company to fulfill a cleaning contract). It is possible that the intermediaries could be considered a form of Service Executor. However, in the servitization literature intermediaries are often considered partners in service delivery instead of a hired provider. We propose the consideration of the terms Service Enabler or Service Partner to better characterise this relationship. One could consider a supply of services between neighbouring actors in the supply chains. However, the consideration of the wider supply chain, and the addition of a Service Supplier, is currently left as part of future research.

GSO does not explicitly consider the inclusion of products. Although, an Advanced Service represents an integrated solution, any product that the service revolves around should be represented. Many of the Advanced Services that are discussed in the literature involve the use of sensors to monitor product usage to help determine maintenance schedules, likely failure points and general usage patterns. Although the value is determined by the consumer, it

ultimately comes through usage (typically for services that involve a product). The provider must ensure availability, capability and resilience (i.e., minimum downtime and proactive when failure occurs) of any related product through services. The delivery of the sensors and the monitoring of the data that is collected from them could be undertaken by the service provider or an intermediary that has the required skills.

In GSO a service relates a commitment, in the form a service agreement, that specifies the tasks that a Service Provider will perform in order to satisfy a Service Client's goal. A service agreement is bounded by time. Goals can be structured to include sub-goals, which either all have to be fulfilled, or at least one does, for the overarching goal to be satisfied. GSO also allows the degree to which a goal is satisfied to be determined. The question arises as to whether a service agreement, as characterised by GSO, can be used to represent an OBC.

A service agreement sets out the terms and conditions of service and would include examples such as a streaming service or telephone provider. An Advanced Service focuses on the delivery of a measurable outcome for the duration of the OBC. The outcome may relate to one or more performance/result metric (e.g., the requirement of 80% Ready-for-issue (RFI) engine availability in 'Power-by-the-hour'). Payment is received based on that outcome being delivered and penalties given when it is not. The service consumer also has responsibilities in the delivery of an Advanced Service, namely they must allow data collection, continued use and payment. With technologies such as smart contracts [23], payment, compliance and penalties could be worked out automatically through the use of data analytics and the detection of trigger events (e.g., when the measurable outcome falls below a specified threshold). The measurable outcome could be represented in GSO as a goal or set of sub-goals. It is possible that the degree of satisfaction could help establish triggering events for the smart contract but the impact on payment would need to be represented.

## 5. Further Work

Initial analysis has shown where Advanced Services align with the Goal-Based Service Ontology and which features cannot be fully represented. To move towards an ontology of Advanced Services, based on GSO, the following research questions must be addressed:

- How much of the supply chain must be considered when representing Advanced Services?
- What is the role of Advanced Services in PSSs?
- Extended responsibilities see changes in the risks that are taken on by the different actors that are involved in Advanced Services. What are these risk profiles and how do these impact an ontology of Advanced Services (e.g., could they form a separate domain ontology)?
- The use of data-driven technologies provide a mechanism to potentially semi-automate the process of identifying the outcomes that are desired by the customer through the use of data analytics. This degree of automation could allow service providers to quickly adapt to evolving customer needs and behaviour but would have implications for Outcome-Based-Contracts. A contract is generally very specific and fixed. This implied contract would be flexible and responsive, but no less long term since.

- Should Service Customer should be split into Service Consumer and Service Payee to reflect that one paying for a service might be different to the one benefiting from it?
- Existing research has highlighted the possibility of different types of OBC. Research is needed to understand their roles in Advanced Services and whether a distinction of the type of OBC is needed. Existing ontologies that focus on service contracts (e.g., [24, 25]) should be considered to see how they relate to the different types of OBC.
- This paper has focused on GSO. However, different ontologies have been developed for services (e.g., UFO-S [26], the Service Ontology [27], and Onto-ServSys [28]). Although these ontologies do not focus on servitization, service is an essential component, and aspects of these ontologies and conceptual models could be brought into an ontology of servitization.

## 6. Conclusion

An increasing number of organisations are wishing to move to a servitization business model, both within and outside of manufacturing, due to the many benefits to taking a service-based approach. Advanced services represent the most advanced form of servitization with examples found in software delivery and manufacturing (e.g., Rolls-Royce's 'Power by the hour' and Xerox's print management offering). As part of ongoing work in developing an ontology of servitization, this paper has considered how Advanced Services differ from services represented in the Goal-Based Service Ontology (GSO). Although many of the features of Advanced Services can be represented in GSO, some features, (namely the inclusion of products and Outcome-Based Contracts), require further consideration.

## Acknowledgments

The authors are grateful for the support of the Engineering and Physical Science Research Council through the 'Digitally Enhanced Advanced Services Network Plus' (grant ref EP/R044937/1), and Innovate UK Made Smarter through the 'Digital Servitization Demonstrator: From Sensor to Service to Business Success' (grant ref 40693/105814), which this work has been supported by.

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