
# Service Oriented Architecture Case Study – Automotive Supply Chain

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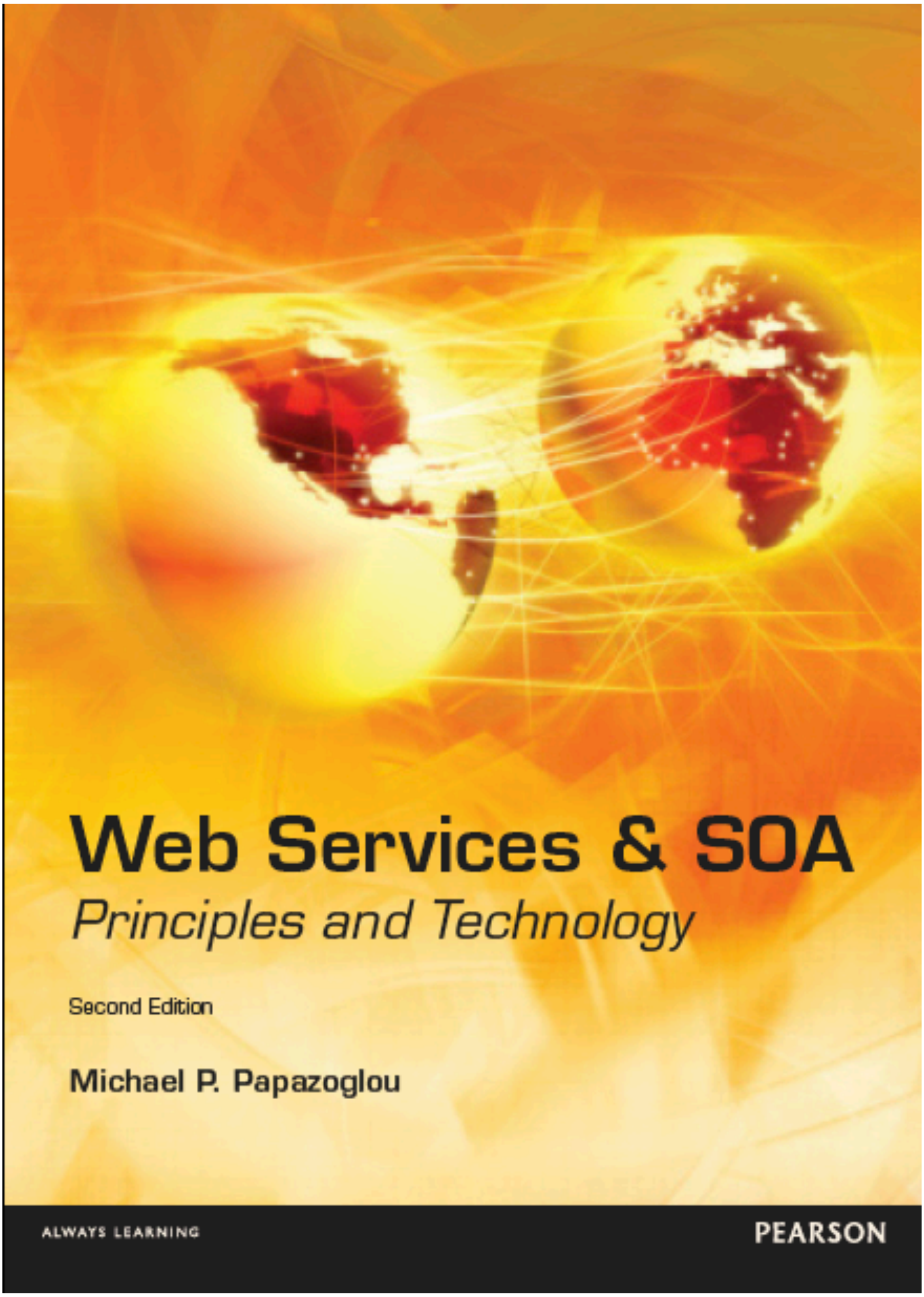
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# Comprehensive case study:

# Original Equipment Automotive Supply Chain[1]

## CASE STUDY PREVIEW

The objective of this chapter is to provide a comprehensive case study based on the production of Original Equipment (OE) automotive parts used in the assembly of a new motor vehicle. This case study demonstrates how a number of small projects need to be applied in sequence and how to gradually develop an SOA solution for effectively processing activities in Original Equipment automotive supply chains.

## 1 Overview of case study

The majority of examples in this book revolves around a company called AVERS (Advanced automotiVE paRtS), a hypothetical manufacturer of specialty automotive parts. The parts AVERS produces includes power train components, electrical equipment and steering and braking systems, to name a few.

Due to the diversity of the automotive parts manufacturing industry, there is a wide variety of processes and materials embodied in the finished parts, such as those AVERS makes. Carmakers once made many of these parts in-house, but now mostly procure them from independent producers such as AVERS. As a diversified supplier of automotive parts, AVERS provides its customers, e.g., automotive parts dealers and car assemblers, with a global, single-point sourcing capability and automotive parts and systems tailored to meet their specific needs.

## 2 Background: Automotive supply chain

The Manufacture of motor vehicles requires vast quantities of materials such as steel, rubber, plastics, glass and other basic materials. The automotive supply chain touches nearly every other industry, including steel, plastics, textiles, electronics, and more.

AVERS embraces different business units including sales, logistics, and manufacturing, and collaborates with partners like suppliers, distributors, banks, transportation carriers, etc. In particular, it works with a number of second tier suppliers an extended dealership chain that usually sends records of customer details, orders, sales figures and stock positions to AVERS.

Today's car manufacturers adopt a global perspective in their operations. Cars are primarily sourced out to produce various sub-assemblies in a multitude of disparate locations around the world. This means a vehicle production plant is an active assembly point, where skilled workers and robotic systems bring together all of the necessary loose components to create a final product on a "just-in-time" basis.

Central to the car assembly process is the concept of the automotive supply chain. As we shall see in section 14.1, a supply chain essentially has three main parts: *supply*, *manufacturing*, and *distribution*.

1. The supply side concentrates on how, from where, and when raw materials are procured and supplied to manufacturing.
2. Manufacturing converts these raw materials to finished products.
3. Distribution ensures that these finished products reach the final customers through a network of distributors, warehouses, and retailers.

Over time, the automotive supply chain has evolved from a model in which most parts were built by the primary auto manufacturer, to a highly-functional segmented model in which Original Equipment Manufacturers (OEMs) provide finished parts for automotive assembly lines. Figure 1 shows a simple automotive supply chain involving interacting processes cross organization boundaries.

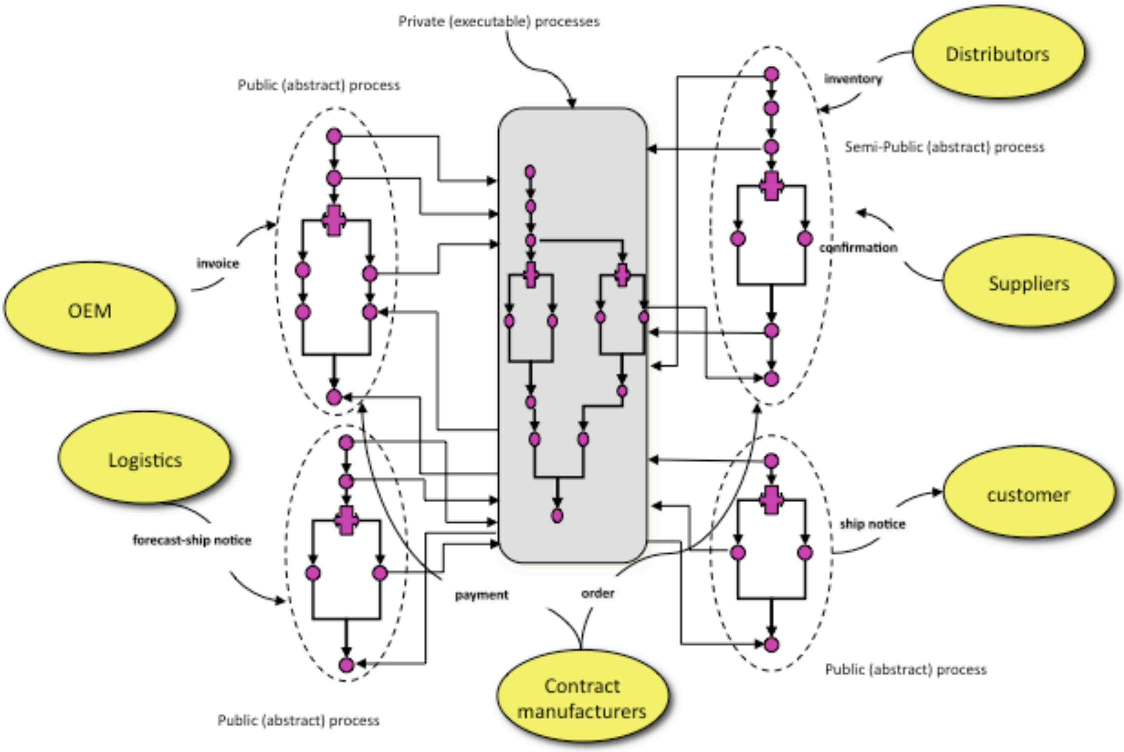


**Figure 1 Simple automotive supply chain**

The case study is a fairly complex project that examines the production of Original Equipment (OE) automotive components to be used in the assembly of a new motor vehicle (e.g., automobile, light truck or truck).

Suppliers of OE parts are organized in three levels. First-tier suppliers manufacture and supply finished components (e.g., the fuel pump) directly to the vehicle manufacturer. Second-tier suppliers produce some of the simpler individual parts that would be included in a component manufactured by a first tier (e.g., the housing of the fuel pump), and the third-tier suppliers would mostly supply raw materials (e.g., the steel and plastic to make the fuel pump).

The growing system complexity, either at an OEM or first-tier supplier is inducing the introduction of a new type of supplier that does not supply physical products, but rather services, particularly in design and engineering [Veloso 2002]. An important service role that emerges from these relationships is that of an aggregator and intermediator. The Internet and software service technologies now enable firms to perform the electronic mediation of supply relationships, either on a one-to-one basis, or by aggregating demand for particular automotive goods or services.

## 3 Case study objectives

The intent of the case study is to help demonstrate how AVERS can develop an SOA-based solution that captures automotive parts-related information more quickly, helps analyze trends in their business to establish how each supplier and dealership is performing and, in general, to streamline and control its supply chain more effectively and efficiently.

The final objective will be to provide the AVERS supply chain with visibility into end-to-end business processes and to help it increase profit margins and lower costs wherever they may exist.

### 3.1 The current situation

Currently, customer, financial, business process and inventory data is captured in a traditional Enterprise Resource Planning system that integrates internal and external management information from the various business units of AVERS. However, the data and information contained in the systems is entered and updated manually, which is a time-consuming, slow and prone to error. Furthermore, the current implementation does not manage production planning nor inventory levels, suffers from poor performance and unreliability, and does not provide the level of detail or accuracy required. Due to the ERP systems proprietary nature, it also cannot not be easily extended to include the Customer Relationship Management (CRM) tools for managing the company's interactions with customers and sales prospects as AVERS requires. The lack of integration and co-ordination between the ERP and CRM systems is causing information delays and discrepancies in management information, such as sales, operations , future forecasts and inventories. As a result of these problems, there is a negative impact on supply chain processes such as manufacturing, logistics and billing.

## 3.2 The desired SOA solution

The solution to this case study solution is built using an SOA-based approach that resolves the current deficiencies with an end-to-end business process solution to manage purchase orders submitted by customers, e.g., car dealers, to a specific OE supplier, such as AVERS.

The SOA solution presented (in this directory) covers the entire course of the OE production process - i.e., from when a distributor orders vehicle parts through production to shipment and, finally, delivery. The central goal of using an SOA approach is to provide all stakeholders with complete visibility of an order's progress. An SOA approach also help update distributors' systems to facilitate their dispatch planning and facilitates the electronic transfer of orders and acknowledgements, communicates the daily progress of production plans and dispatches status updates to the distributor.

The Order Management Solution (OMS) presented requires cross-functional integration within AVERS and across the network of second-tier suppliers and distributors that comprise its whole supply chain. The OMS needs to collect the information generated by disparate systems, e.g., ERP, CRM and in-house inventory management solutions, etc, to produce a common format for data transfer and unify disparate processes into one consistent order process flow across all business units, product lines and trading partners.

The order management solution will be crafted in such a way so as to interlace the Web service principles and concepts covered in this book.

### 3.2.1 Processing steps in the SOA solution

The OMS scenario is triggered when a customer submits a purchase order. Upon receiving a purchase order from a client, several tasks are performed at the OE supplier's site: the credit worthiness of the customer is checked, the product inventory is consulted to determine whether or not an ordered part is available, a shipper is selected, the production and final shipment to the dealers of the part(s) is scheduled, the final price for the order is calculated and the customer's account is billed. AVERS responds with either acceptance or rejection that is based on a number of criteria, including the availability of the part(s) and the credit history of the customer.

To achieve a robust SOA solution the following (simplified) processing steps are introduced in the OMS:

- The purchase order received from the (customer) is registered with the date of receipt and a newly assigned, internal order identification number used to keep track of the order within the OMS.
- AVERS verifies whether the order contains sufficient information for processing, including the necessary customer data, the list of ordered items and the price that the customer has already been quoted.

  - If the order verification fails, then an order cancellation is sent back to the customer.
  - Otherwise, an order confirmation will be sent to the customer and the order is passed for further processing.
- During the next step, the AVERS CRM checks whether the order comes from a long-term customer, which could be a "preferred" or "standard" retailer, or simply from an incidental customer. The OMS then performs a credit check. If the credit check fails the purchase order is rejected, otherwise the order is passed for further processing.
- The purchase order is annotated with customer profile details and all ordered items purchased from a single customer are consolidated on a single purchase order
- A bill is created.
- The Inventory is checked against the appropriate quantities required by the purchase order. If there is insufficient stock of the parts required, an inventory replenishment process can be initiated to move stock from centralized warehouses to subsidiary warehouses.
- The inventory results are then sent to a logistics service provider to determine delivery dates, shipment, loading, timing, and routing data - possibly offering multiple shipping options. The logistics provider is responsible for routing the shipment from the warehouses to the customer, which may include many shipment routes.
- Shipment details are then relayed to AVERS for approval. When a shipment schedule is available, the final price for the order is calculated including shipment charges and the OMS notifies the customer by sending the customer an updated invoice.
- Finally, arrangements for payment are made at the customer's site.

While some of the above processing steps can proceed concurrently, there are synchronization dependencies between these tasks. For instance, the customer's creditworthiness must be ascertained first before accepting the order, the shipping price is required to finalize the price calculation, and the shipping date is required for the complete fulfillment schedule. When these tasks are completed successfully, invoice processing can proceed and the invoice will be sent to the customer.

# 4 SOA work plan stages

To realize the OMS, the work it requires will be divided into four sequential stages until the complete solution is built. The stages of the OMS work-plan are described below.

## 4.1 Modeling the Service-Oriented Architecture

The first stage in the work plan is to model the entire OMS scenario using a standard graphical notation for analyzing, expressing and visualizing business processes, business process operations and data flows. The OMS model should describe the interaction between sub-processes of the AVERS business units and those of the external stakeholders, i.e., customers/retailers, logistics providers and financial institutions, etc.

For this purpose we can first use the design techniques from section 16.12 to design the appropriate types of services and processes for the OMS. Then we can employ the Business Process Modeling Notation (BPMN) introduced in Section 16.4 for capturing the elements of business processes and business process interactions in the automotive SOA development project.

## 4.2 Specifying design patterns in XML Schema

During this stage all simple and complex canonical data types and message structures in the OMS will be specified using the XML Schema. This will include data and messages such as orders, shipment and delivery notices, payment requests, customers, receivables and sales data.

The objective is to design XML schema document patterns that can be then used as a basis to develop service interfaces, service message exchanges and service orchestrations. The XML schemas will be designed with the following characteristics:

- Potential for reuse within a single service interface.
- Potential for reuse across services and service interfaces.
- Potential for future service modification or enhancement and later extension of the service interface.
- Service interface simplicity, modularity and maintainability.

## 4.3 Describing services in WSDL

During this stage the service interface definitions within the OMS will be developed according to information provided in Chapter 5 using the XML Schema types developed in the previous project stage.

Each business unit may have one or more service interface definitions (hence one or more WSDLs) since it may expose one or many software functions as services. Each service interface definition will contain:

- One (or more) PortType(s) that expose a set of (one or more) service operations.
- Each service operation may follow one of the following interaction patterns: one-way-request (asynchronous invocation) or two-way request-response (synchronous invocation).

## 4.4 Service orchestration in BPEL

During this final project stage, Business Process Execution Language (BPEL) processes for all participants in the OMS will be developed according to information provided in Chapter 9 using the WSDL service descriptions developed in the preceding project stage.

The BPEL service orchestration created will demonstrate how the services developed in the previous project stage can be composed to support the entire supply chain -

from when a distributor orders a vehicle parts through to production and shipment. It will also capture all OMS processing steps introduced in section 3.2.1.