JAMA_部品表情報交換タスク
BOM Basic Concept

V1.0

2021 年 7 月

変更履歴

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1. Foreword

Since several years, for resource optimization or provision of the new value, Automotive industry has set up new business scenarios between an OEM and other partners such as OEMs, Joint Ventures, Design partners. These new scenarios require a high level of collaboration between companies, and increased needs for data exchange in many domains.

In engineering domain, the exchange of Bill Of Materials (BOM) and Digital MockUp (DMU) data is crucial to support the collaboration between partners. If DMU data exchanges are already used, BOM data exchange is an emerging requirement, and is very complex. This can be explained by the fact that each company implements their own principles, rules and mechanisms for BOM data management, which introduce issues for data compatibility and mapping.

Together, the Japanese Automotive Manufacturers Association (JAMA) and Groupement pour l'Amélioration des Liaisons dans l'Industrie Automobile (GALIA) have initiated bilateral discussions to a project on this topic which has been transformed into a SASIG workgroup, supported by AIAG.

The SASIG Collaborative BOM Data eXchange (SASIG-CBDX) Project is developing a set of recommendations to guide companies to effective and efficient data exchange practices. The recommendations are partitioned into four topics areas: 1) Introduction - White paper, 2) Use Case and 3) BOM Basic Concept.

This document contains description of Basic Concept of BOM data and consisting of 3 layers concept, 3 layers are respectively product specification, part specification and product configuration and the functions and roles of each layer is described. To understand these contents of BOM basic concept is important for a company to consider and prepare for BOM data exchange between partners.

2. INTRODUCTION

BOM Basic Concept aims to define common basic concepts and principles which BOM data exchange contents and mechanisms are based on.

These basic concepts are directly derived from OEMs use case and experience and defined by using neutral language inspired from STEP standard.

3. 3 LAYERS CONCEPT

3.1. Introduction

This part defines each BOM data exchange basic concept that are splited into 3 categories called Layer that fulfills a specific role:

- Product Specification Layer that aims to manage car family diversity.
- Part Specification Layer that aims to manage elementary components (single part, assembly of parts) that are used in a car assembly.
- Product Configuration Layer that aims to bind elementary components with car family diversity.

Documents (3D models, 3D Drawing, specification etc) involved in part and product specification are out of scope.

3.2. Product Specification Layer

Automotive product is very complex because of its technical and commercial diversity. This diversity is such that the explicit composition of parts for each manufacturable car cannot be managed and controled.

Then, most of car manufacturers use the concepts of car family and diversity dictionary to manage the underlying diversity of a car product.

Car family corresponds to the master level of diversity desciption for a car product. Car family may be broken down into sub-classes to make easier the control of the overall diversity. Developing sub-classes thus enables to simplify the diversity expression. Product family and associated sub-classes implement a diversity dictionary.

The figure 1 shows an example of car family decomposition into sub-classes according to levels that correspond to :

- Country: Japan, France, North America
- Body: 4 doors, 2 doors, SUV
- Engine: Gasoline, Electric, Hybrid Gasoline

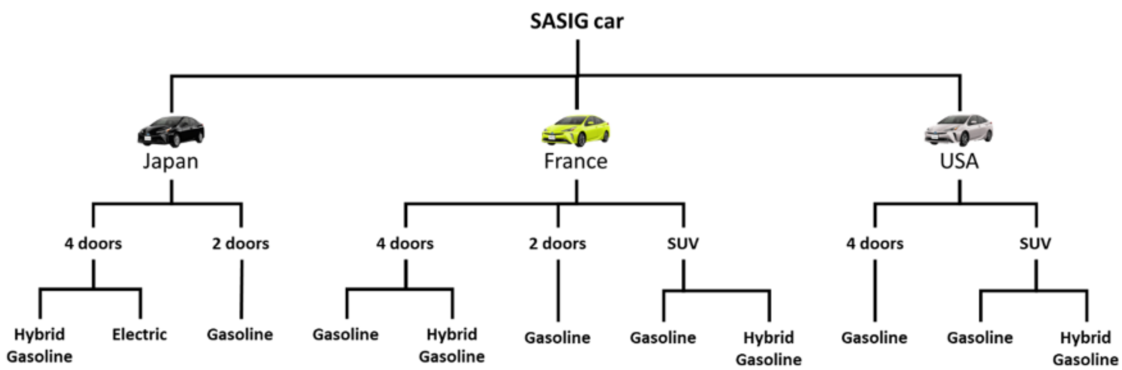

Figure 1 – Example of car family decomposition into sub-classes

Diversity dictionary aims to provide a high level description of every technical or commercial combination of features and options that are available within a car family. This description is based on categories and specifications. A category represents an homogeneous group of technical or commercial features (or options). A specification represents one of those features (or options) and refers to one category.
In some cases, specifications may have dependency relationships. Then, dependency rules may be implemented to guarantee the overall the consistency of specifications within a car family.

The table below provides an example of categories and related specifications, followed by an example of related dependency rules.

Categor	Country			Driving side		Window opening system		Door locking system		Electric package	
Specificatio	Japan	France	USA	Right	Left	Manual	Electrical	Manual	Electrical	Without	With
Code	CNJP	CNFR	CNUS	DS00	DS01	WS00	WS01	DL00	DL01	PE00	PE01

Table 1 – Product Specification

Example of dependency rules:

- If CNJP then DS01 ⇨ If Japan Country is selected, then Left Driving Side shall be set
- If (CNFR OR CNUS) then DS00 ⇨ If France or USA Country is selected, then Right Driving Side shall be set
- If PE00 then (WO00 AND DL00) ⇨ If Without Electric package is selected, then Manual Window opening system and Manual Door locking system shall be set
- If PE01 then (WO01 AND DL01) ⇨ If With Electric package is selected, then Electrical Window opening system and Electrical Door locking system shall be set

Finally, a car that is ordered by a customer is described by a set of specifications. This set of specifications may thus be used to identify the corresponding set of parts to be used in the assembly of the car. Product Configuration has then to be used.

3.3. Part Specification Layer

Part specification aims to define and manage elementary components that are used in a vehicle. These components may be either a single part or an assembly of parts. They are defined by a set of attributes, documents, and classifications.

Part

A part is an elementary item that can be either single part or a component of an assembly. A part is defined by a set of attributes.
Each part shall be unique inside a company. The uniqueness of a part can be defined by a combination of attributes, called core attributes. Recommendations for these core attributes are:

- Part number: Unique identifier of a part within a company.
- Part version: Unique identifier that identifies a level of part modification. Usually, part version is used for minor modification on behalf a part number. Each company usually relies on internal condification, and rules.
- Part type: Classification that aims to categorize a part according to its nature. Typical example of part type in automotive industry: mechanical part, sheetmetal part, tool, etc. Each company usually relies on an internal classification.

Additional/complementary attributes may be used for providing additional information to a part that aims to better define, classify, and describe it. These attributes may then be considered as optional, meaning they don't affect the uniqueness of the related part. Attributes are company specific and are defined to meet business needs. For each attributes, companies have defined standards and rules that applies to ：

- Attribute name
- Attribute codification:
- Length
- Allowed values
- Attribute structure
- Attribute classification.

Example of part attributes:

Core attributes:

- Part Number: 75001-1254-AZ
- Part Version: A
- Part Type: Mechanical part

Complementary attributes:

- Name: Cylinder block

- Classification: Functional part
- Description: Cylinder block for 1.2 liter Gasoline engine
- Breakdown: K2B07001
- Material: Z05D001
- Mass: 20 kg

Instance

An instance is used to identify a specific usage of a part in context of a complex product. In BOM domain, instances are usually characterized by a quantity.
In case of single part, the term of single instance is used, and the quantity of parts is 1. In case of part with quantity, the term of quantified instance is used. Then, the associated unit can be either the number of parts, or a volume size (ex: liter of oil), or a length (ex: length of wire cable).

Assembly

An assembly is characterized by a set of single parts. It consists of an explicit structure that is defined by means of relationships which describe the decomposition of parent assembly component into child components.
The figure 2 describes how an assembly (left part of the figure) is described by means of References (blue boxes), Instances (red circles), and relationships (right part of the figure). Thus, each individual node of the assembly is defined by a Reference (Ref A, Ref B, Ref C, Ref D). The decomposition of a Reference (Ref A, Ref C) into sub-assemblies (Ref C) or singles parts (Ref B, Ref D) is defined by relationships between the parent Reference, and an Instance (I1, I2, I3, I4) of the child Reference. An Instance defines and identifies each usage of the Reference of a component (sub-assembly or single part) within an assembly.

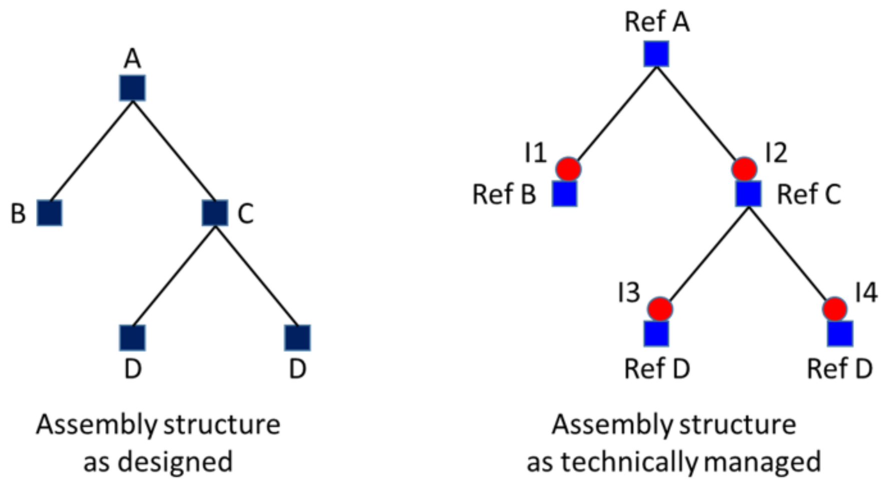

Figure 2– Assembly description with references and Instances

A positioning matrix may be assigned to an assembly relationship. This positioning matrix is mainly required for CAD data exchange related use cases.
In BOM domain, positioning matrix is not mandatory within an assembly structure.

Variant
A variant is a concept that is used to identify a design solution (specific composition of parts).
Design solution aims to address a specific functional and/or technical requirement(s) derived from commercial diversity of the car family.
Usually, a variant is associated to a breakdown element of a car family. Then, a breakdown element may be associated several variants. Depending on companies, the breakdown may be functional, zonal, physical, or a combination of them.

The figure 3 provides an example on how Variants are designed and managed within Part Specification, along with Product Specification in a car family. This example explains how Variants are designed by using appropriate Categories (Seat material, Seat heater) and related Specifications in the context of a car family.
Thus, according to the expected commercial diversity for the car family, 6 variants of the seat have been identified, by considering its material and heater system. These variants are associated to the same Breakdown element. Then, Product Configuration of each Variant will be defined according to related Specifications.

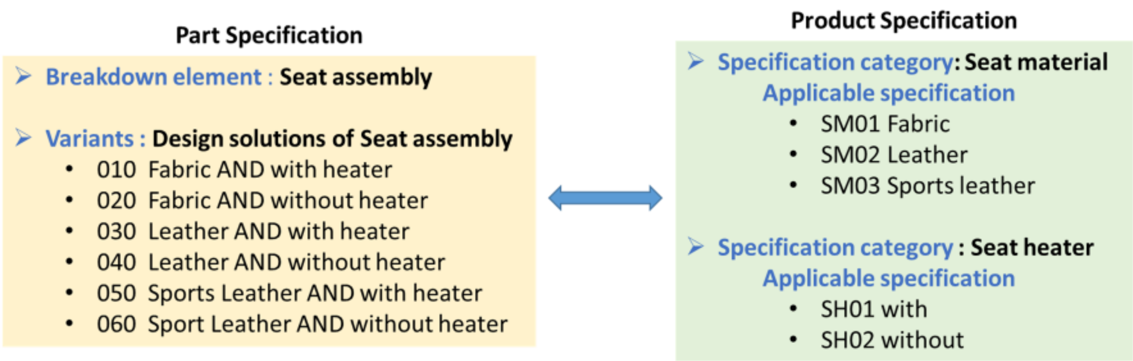

Figure 3– Example of Variant management within a car family

3.4. Product Configuration Layer

Product Configuration aims to define the condition of usage of single parts, assemblies or variants in a car family. Indeed, Product Configuration is a way to bind Part Specification with Product Specification by means of specification, or boolean expression based on specifications.

Depending on company standards, Product Configuration may be controlled by an effectivity information. The latter defines a temporal validity of the single parts, assemblies or variants that are referenced in Product Configuration.

The following paragraph provides an example on how Product Configuration can be managed into a car family according to Product Specification and Part Specification.

Product specification:

- Car family : SASIG
- Specifications : Driving Side (Right or Left), Country (UK, Japan, France, USA)
- SASIG car will be commercialized in Japan and USA from 2021, in UK and France from 2022

<table>
<tr><td>Car family</td><td colspan="6">SASIG</td></tr>
<tr><td>Category</td><td colspan="4">Country
CN</td><td colspan="2">Driving side
DS</td></tr>
<tr><td>Specification</td><td>UK
01</td><td>Japan
02</td><td>France
03</td><td>USA
04</td><td>Right
01</td><td>Left
02</td></tr>
</table>

Table 2 – Product Configuration

Part specification:

- Part : Dashboard
- 1 variant for UK and Japan
- 1 variant for France and USA

Product configuration:

- Without effectivity :
  - Variant for UK and Japan : (CN01 OR CN02) AND DS02
  - Variant for France and USA : (CN03 OR CN04) AND DS01
- With effectivity :
  - Variant for UK : CN01 AND DS02 AND Effectivity = 2022-∞
  - Variant for Japan : CN02 AND DS02 AND Effectivity = 2021-∞
  - Variant for France : CN03 AND DS01 AND Effectivity = 2022-∞
  - Variant for USA : CN04 AND DS01 AND Effectivity = 2021-∞

3.5. Layers concept summary

The figure 4 provides an overview of the 3 Layers concept approach. Each layer are described based on the main object/information that have been detailed in the corresponding sections.

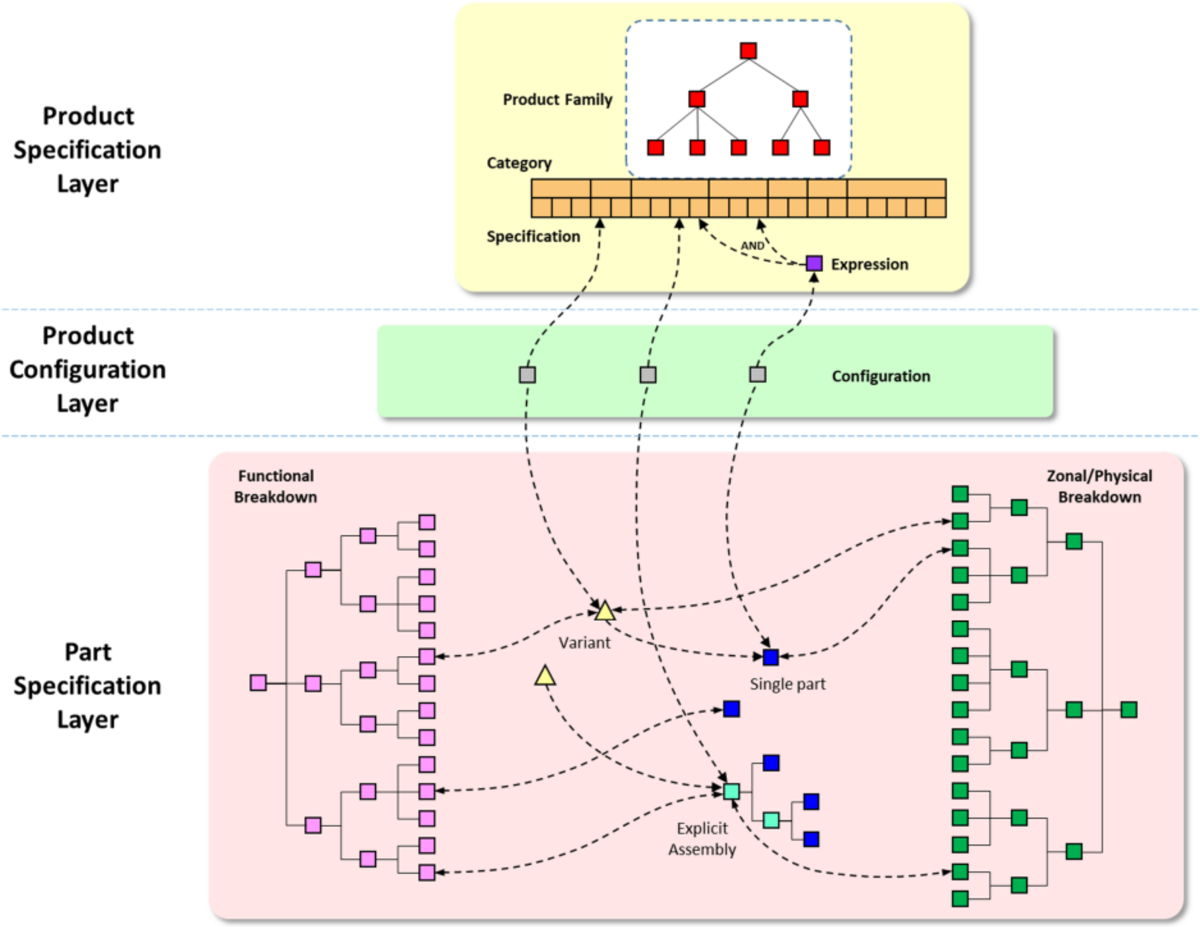

Figure 4 – 3 Layers concept overview

4. PRODUCTCLASS APPROACHES

4.1. Introduction

Based on experience sharing between automotive OEMs, it was observed that different approaches are applied for BOM data management in a car development.

Indeed, 2 main approaches are used :

- Single ProductClass approach where the diversity of a car family is managed through a unique ProductClass. Then, this ProductClass carries out its own diversity dictionary, composed of the full set of required specifications.
- Multiple ProductClass approach where the diversity of a car family is managed through several (sub) ProductClass. Then, each (sub) ProductClass provides a reduced complexity that is obtained by the selection of applicable specifications.

4.2. Single ProductClass approach

Single ProductClass approach is characterized by the usage of a unique ProductClass to manage the whole diversity of a car family. This ProductClass uses a diversity dictionary that contains the complete and exhaustive list of categories and specifications that are required to manage the underlying diversity of components.

Single ProductClass approach implies a huge complexity of Product Configuration management. Thus, it usually requires to use complex expressions to define use cases of a part in a car family.

Usually, OEMs have to implement rules:

- Consistency rules that aim to ensure the compatibility of specifications. Example: specification Driving side = right cannot be selected if Country = Japan.
- Dependency rules that aim to force/set specifications depending of the value of another one. Example: If Electrical Pack specification is selected, then Electrical Power Window specification is selected.

4.3. Multiple ProductClass approach

Multiple ProductClass approach is characterized by the decomposition of a car family into sub ProductClass. Depending on company rules, this decomposition may done on multiple levels.

Then, each level is obtained by selecting a unique specification for one or more categories of the car family diversity. These categories are considered as « Base » category (Example: Engine, Drive, Body type, etc.).

Thus, each sub ProductClass is assigned a diversity dictionary that contains less categories.

The assignment condition of specifications in a sub ProductClass may rely on Standard/Optional classification. Then, Standard means that the specification is the default one, and Optional means that the specification is driven by a commercial option.

Multiple ProductClass approach usually leads to simplify specification management inside a car family, and thus reduce the complexity of Product Configuration management.

The figure 5 provides an example of multiple ProductClass approach. The left hand side part describes how the Car Family ABC is decomposed into sub ProductClass (Car Model). Thus, each Car Model is defined by a combination of Basic Specifications. Then, the right hand side part defines the available specifications of each category, for each Car Model. In this case, specifications are either of Standard or Option type.

Car Family: ABC

	Basic Specification								Category/ Specification								
									CAF SEAT MATERIAL			CAH SEAT HEATER		DGH AUDIO			…
	ENGINE	YEAR	STRG WHL	BODY	T/M	GRADE	DRIVE	…	LOW FAB	LEATHER	SPORT LEATHER	WITH	WITHOUT	WITHOUT AUDIO	JP"AVN", WIFI, B/T	US"AVN", B/T	…
									CAF**B**	CAF**C**	CAF**D**	CAH**B**	CAH**I**	DGH**B**	DGH**E**	DGH**F**	…
Car Model	ZV	5	L	H	X	E	W	…	STD				STD	STD		OPT	
	ZV	5	R	H	X	E	W	…	STD				STD	STD		OPT	
	ZV	5	R	H	X	E	W	…	STD				STD	STD		OPT	
	ZV	6		H	X	B	W	…		STD			STD	STD	OPT		
	ZV	6		H	X	E	F	…		STD	OPT	OPT	STD		STD		
	ZV	6		H	X	G	F	…		STD	OPT	OPT	STD		STD		
	ZV	6		H	X	H	F	…		STD	OPT	OPT	STD		STD		
	ZV	5	L	H	X	E	W	…		STD	OPT	OPT	STD			STD	
	ZV	5	L	H	X	E	W	…		STD	OPT	OPT	STD			STD	
	ZV	5	L	H	X	G	F	…		STD			STD			STD	
	ZV	5	R	H	X	E	F	…		STD			STD			STD	

Assignment - STD:Standard / OPT:Option

Figure 5– Example of specification management for multiple ProductClass approach

5. プロジェクト参画メンバ

部品表情報交換ワーキンググループのメンバ（委員は会社名で五十音順）

リーダ	千古　崇夫	本田技研工業（株）
サブリーダ	鍵和田　玄	日産自動車（株）
委員	中山　一樹	スズキ（株）
委員	野田　圭太朗	スズキ（株）
委員	河方　威典	スズキ（株）
委員	斎藤　靖志	トヨタ自動車（株）
委員	小島　新護	トヨタ自動車（株）
委員	里見　厚史	日産自動車（株）
委員	下川　恭平	日産自動車（株）
委員	横田　亮	マツダ（株）
委員	水野　雅之	三菱自動車工業（株）
委員	工藤　宗一郎	三菱自動車工業（株）
ｺﾝｻﾙﾀﾝﾄ	田中　敬昌	デジタルプロセス（株）
ｺﾝｻﾙﾀﾝﾄ	長友　琢	（株）富士通九州システムズ
ｺﾝｻﾙﾀﾝﾄ	外山　克也	（株）富士通九州システムズ

APPENDIX A – SASIG-CBDX LAYERS MAPPING WITH STEP AP242 DOMAIN MODEL

Introduction

This appendix aims to identify the objects of STEP AP242 Edition 2 that correspond to the requirements of SASIG-CBDX layers. The expected target is to provide the subset of STEP AP242 standard required to support SASIG-CBDX requirements.

The figure 6 provides an overview of the capabilities of STEP AP242 Ed. 2 Domain Model.

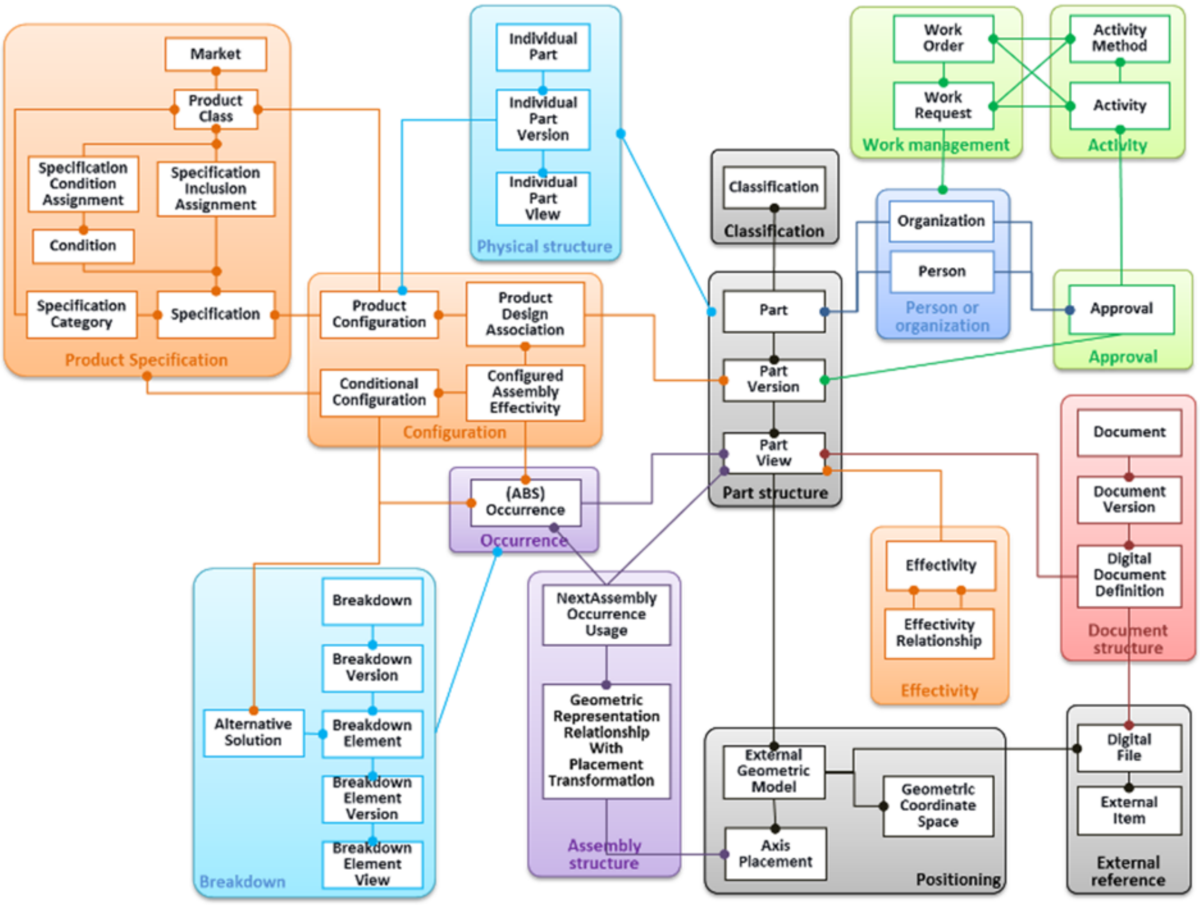

Figure 6– Overview of STEP AP242 Ed. 2 Domain Model capabilities

APPENDIX B – BOM 3 LAYERS CONCEPT 補足説明

BOM 3 Layers Concept とは

３レイヤーコンセプトは、表形式の部品表において、以下のように表現することもできる。

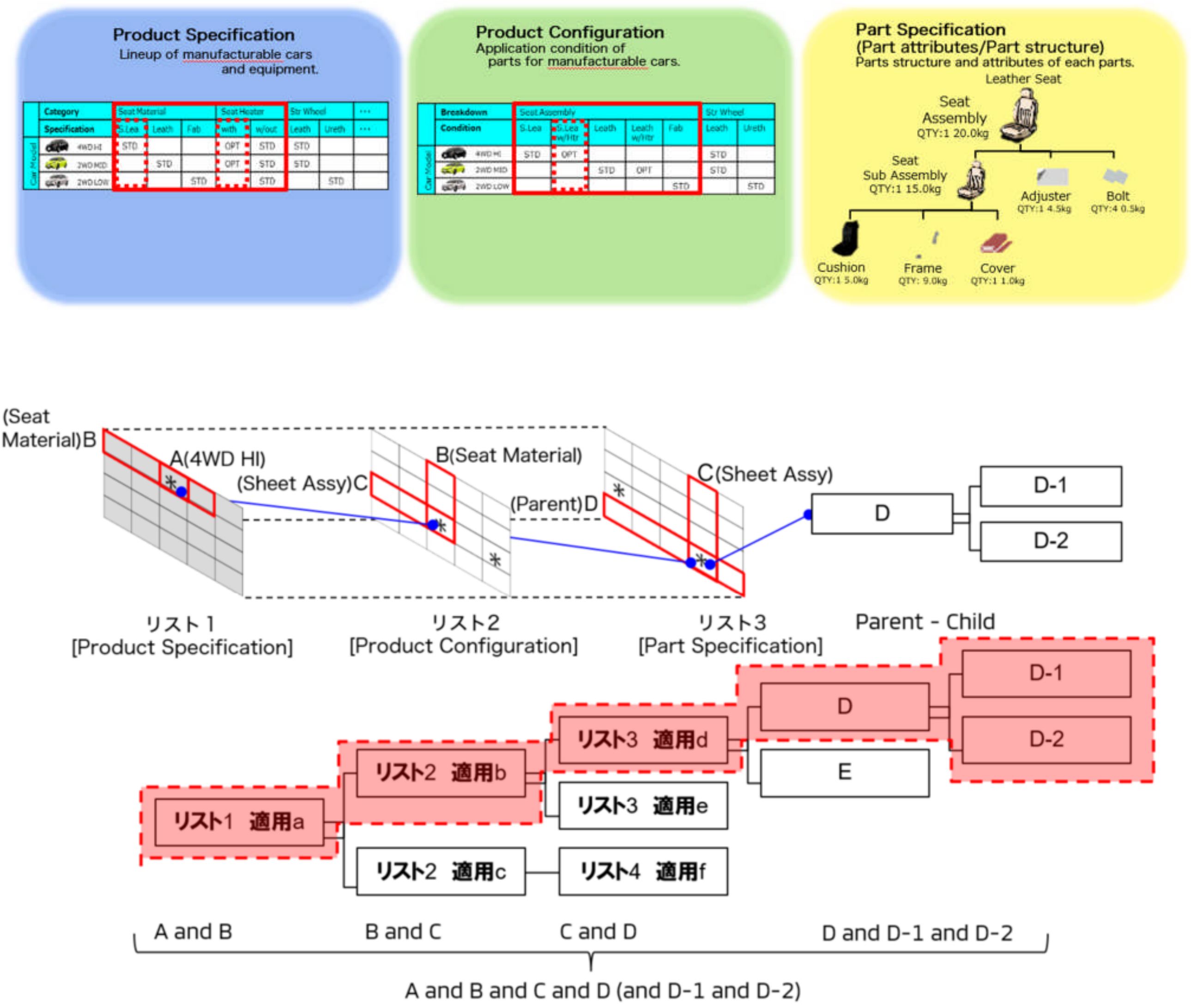

Figure 7– 3 Layer 補足説明