Development of Reference Model for Enterprise Architecture Leveraging TM Forum Assets

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***Abstract*—Digital transformations (DX) have become more anticipated over the last few years. In this trend, telecommunications carriers have increasingly advanced automated operations. However, it is not easy to increase overall efficiency and automation across domains because conventional services are in silos for each domain. One way of optimizing an entire operation is by developing an enterprise architecture (EA) and visualizing the whole business and information technology (IT) picture to achieve effective governance. It is common to develop a reference model and refer to it to improve work efficiency and quality. The TM Forum (TMF) is advancing assets such as extending the telecom operations map (eTOM), shared information/data model (SID), and open application programming interface (Open API), but it is difficult to use them as reference models because they are not aligned. Therefore, this paper describes a methodology of developing a reference model that clarifies the relationships of TMF assets.**

Keywords—operation, enterprise architecture, reference model

I. INTRODUCTION

Digital transformations (DX) is being promoted to enhance competitiveness in various fields. One of the DX promotion measures telecommunications carriers are promoting is an automated operation such as information technology (IT) open processes and construction, maintenance, and operation processes. [1]. However, the Ministry of Economy, Trade and Industry's guidance on DX [2] indicated that many current DX initiatives cannot be implemented company-wide because each department has its own individually optimized system. Automation of telecommunications business operations is difficult because it is not easy to streamline and automate the entire domain given conventional services are in silos for each domain.

One method of total optimization is the development of enterprise architecture (EA). For example, [3] states that EA's visibility in the business and IT landscape enables optimization and IT governance.

As will be detailed later, a reference model that utilizes industry standards when developing EAs is recommended, but it is difficult to utilize TMF assets as a reference model because they are not aligned.

This paper describes a reference model development methodology using TMF assets to improve the efficiency of EA development by telecommunications carriers. Furthermore, we show the results of developing a reference model for one business scenario.

II. PROBLEMS

A. EA and reference model

EA is a framework for improving operations and systems based on overall optimization that can respond quickly to social and IT changes [4]. In the development of EA, the current (As-Is) model, the ideal (To-Be) model, and the transition plan to reach the ideal are formulated. As [4] states, business architecture (BA), data architecture (DA), application architecture (AA), technical architecture (TA), and their vertical relationship should be clarified. (see Fig. 1).

The Open Group Architecture Framework (TOGAF) standard [5] is a framework that summarizes the methods for developing such EAs. The TOGAF standard arranges the lifecycle that develops and operates EA systematically and mentions the process that develops the above four architectures. In each process, a reference model should be set up as a common dictionary to reduce differences in interpretation and to facilitate the development of a consistent architecture. In addition, a reference model that utilizes industry standards should be set since it is difficult to develop this reference model from scratch.

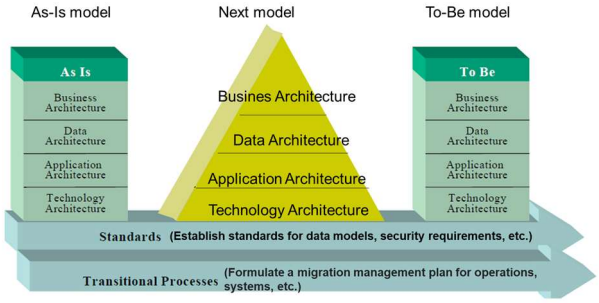

Fig 1 EA framework, quoted from [4] (translated)

B. Current status of reference models in information and telecommunication industries

Many organizations are promoting standardization activities in the telecommunications industry. Typical standards organizations include TMF, the 3rd generation partnership project (3GPP), the Metro Ethernet Forum Lifecycle Service Orchestration (MEF-LSO), and the European Telecommunications Standards Institute Zero-Touch Network & Service Management (ETSI-ZSM). The visualization of the activity areas of each organization is as shown in Fig. 2. Considering this figure is a reference model for the entire operation, proceeding with the study based on the TMF standard that covers the entire activity area is preferable. In addition, there is no business process definition equivalent to BA in documents of organizations other than TMF. Based on these findings, it was concluded that reference model study based on the TMF assets should be promoted.

Frameworx [6] and Open API [7] can be considered as TMF specifications that correspond to a reference model. Frameworx is composed by eTOM [8] that defines the business processes necessary for business management of information and telecommunications carriers, a SID [9] that defines data to be managed and distributed as information models, and a telecom application map (TAM) [10] that defines the application functions that realize business processes. An Open API specifies the API based on the representational state transfer (REST) principle as an interface that links functions.

An example of using these as a reference model is an effort to organize the names and outlines of business processes customized for internal systems based on TMF eTOM [11].

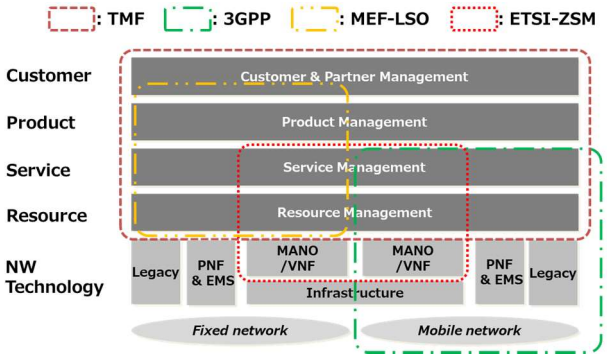

Fig 2 Activity areas of each organization of standards.

C. *Problems when using TMF assets as reference model*

The above efforts are concentrated on defining business processes equivalent to BA to standardize the definition of business processes and eliminate differences in awareness during system development. However, business processes, APIs, and data must be aligned in the whole series of processes that involve many systems to promote automating business operations. Therefore, the definition of business processes and the relationship among defined business processes, APIs, and data need to be clearly defined as a reference model.

However, the relationship between the provisions has not yet been clarified despite the TMF providing for the definition of eTOM, Open API, and SID as described above (see Fig.3). Therefore, it is difficult to understand the relationship between regulations throughout a series of processes when establishing EAs that utilize these regulations.

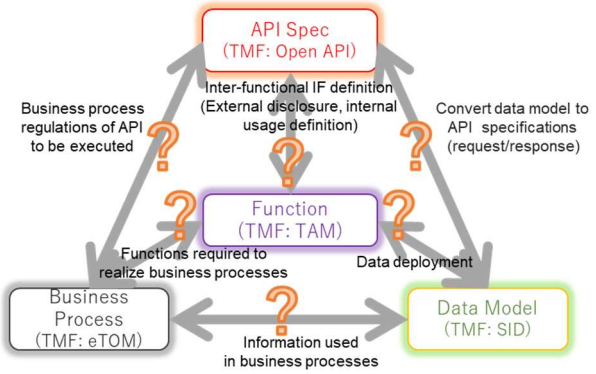

Fig 3 Relationships between TMF assets.

III. PROPOSED METHODOLOGY

With this in mind, we have tried to use a fragmented TMF asset as a reference model that can be easily used to develop EAs. This section describes how to use a reference model, how to express it according to the usage (metamodel), and how to develop a reference model according to the metamodel.

A. *Assumption of how to use reference model*

As a premise of this study, we assume realization by microservices will become mainstream in promoting operation automation, as shown in ETSI-ZSM [12]. When examining the architecture of each system, we assume making it easy to judge if the API of the reference model can be utilized is important. Therefore, we assume clearly expressing the execution timing and purpose in the business flow and the structure of the data handled by the API, centering on the API, is the point of the reference model.

B. *Proposed metamodel*

Based on these considerations, we propose a metamodel (shown in Fig. 4) whose steps are as follows:

Step 1: As elements that correspond to BA, *Business Processes* that realize a business series are described as a flow that can be easily compared with the As-Is and To-Be models.

Step 2: By formulating a flow with a high degree of abstraction and expressing a concrete business flow within it, an association is made according to the degree of abstraction.

Step 3: To clearly express the purpose of the API execution, the information handled by the process is linked to the bottom of each business process as *Business Object*.

Step 4: As an element that corresponds to AA, *API* for managing information handled in each business is linked with *Operation Type* (get, post, etc.) to clarify which API is hit at what timing in a series of business flows.

Step 5: As an element that corresponds to DA, a *Data Entity* handled by API and the *Main Attribute* of the *Data Entities* is linked under *API* to clarify the data controlled by an API.

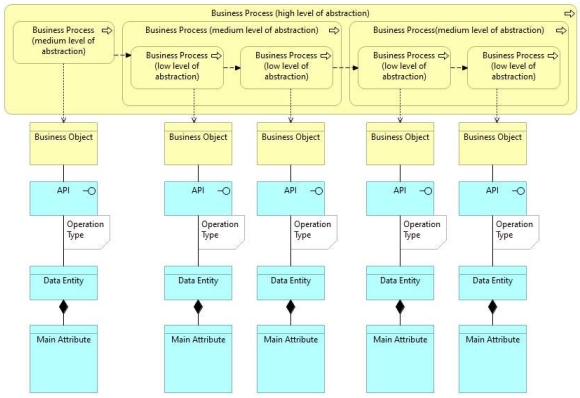

Fig 4 Proposed metamodel.

C. *Developing a reference model according to metamodel*

1) *Business flow*

In TMF, business processes are defined by eTOM, and business flows that realize a business series are defined [13].

In eTOM, business processes are defined in stages, such as Level 1 process groups that are abstracted to provide an

overall picture, Level 2 processes that are broken down into individual processes, and Level 3 processes that are further refined and broken down into Level 2 processes.

In the business flow definition, eTOM Level 3 business processes are defined as flows for 19 business scenarios, such as the "order-to-payment" process that covers order receipt to payment and the "trouble-tickets-to-solutions" process that covers trouble occurrences to solutions. Based on this flow, abstract Level 2 *Business Flow* and concrete Level 3 *Business Flow* were described according to the metamodel.

2) Business Object handled in business processes

The definition of eTOM does not specify the information to be handled by a business; only the business description is shown in natural language. Therefore, we decided to extract the information to be handled by a business by conducting the aspect analysis [14] development method of BA in EA. In this method (see Fig.5), the work content is applied to an aspect analysis table consisting of Active Structure for words that correspond to the subject, Behavior for words that correspond to the verb, and Passive Structure for words that correspond to the object. We applied this method to the business process description defined in eTOM and extracted the Passive Structure as *Business Object.*

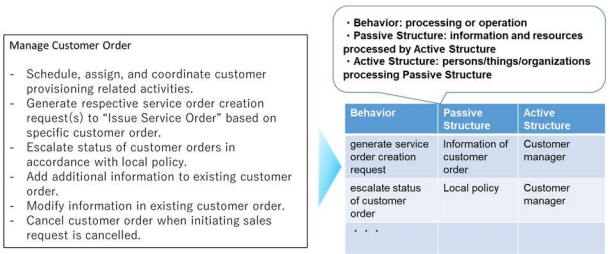

Fig 3 Aspect analysis example.

3) API to realize business process

TMF's Open API currently specifies more than 50 APIs. Each specification specifies the sample use case that the API assumes, the resource model to be handled, and the conformance profile that specifies the mandatory/optional attribute when distributing by the API, but they are not related to eTOM business processes. TMF specifies the result of mapping the business process the Open API is connected to, but mapping is presently limited to an eTOM Level 1 business process with rough granularity [15]. Based on these API specifications and mapping results, we extracted the *API* and *Operation Type* that control *Business Objects* extracted in the previous section from APIs mapped to eTOM Level 1 business processes.

4) Data Entities and Main Attributes handled by API

As mentioned above, the TMF Open API defines the resource model that the API handles, along with the relationships between its components. A similar data model is specified in the SID of TMF. However, these documents are not consistent, and different definitions are defined even if the data names are the same. We decided to take advantage of the Open API resource model, which has been clearly defined for API usage. The main resources defined in each API are set in the *Data Entity* of the metamodel. Since the visibility of the main attribute is reduced when all the attributes related to the main resource are set, we decided to set the attributes that are direct attributes of the main resource and that are mandatory or conditionally mandatory on the conformance profile.

IV. RESULTS

We developed a reference model for "order-to-payment" using the business scenarios of [13] according to the development methodology described in the previous chapter. The results are shown in Table 1. The content set for each component of the metamodel is shown for each order-to-payment business process. This content is visualized by the metamodel shown in Fig. 4, which is the development results of the reference model.

As a result of this mapping, APIs such as the test resource process did not appear in the Open API list. We think it is possible to develop a reference model using this methodology if the Open API is improved. However, regarding business information extraction and business process and API mapping, since we analyzed TMF assets and judged mapping ourselves, the feasibility of providing information necessary to realize each business process as API must be verified.

V. CONCLUSION

We proposed a methodology of developing a reference model of EA that makes the whole operation easy to understand by clarifying the definition of business processes and API and the relationships of business processes, APIs, and data models. Using this methodology, we could develop a reference model using a business scenario. In the future, this methodology will be applied to actual projects to verify its feasibility and confirm its effectiveness.

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Table 1 Mapping results for all processes included in "order to payment"

Business Process eTOM Process(Level 2)	Business Process eTOM Process(Level 3)	Business Object	API	operation type	data entity	main attribute(Mandatory or conditional Mandatory)	other attribute(Optional)
Contact/Lead/Prospect Management	Manage Sales Contact	Sales contact information	-	-	-	-	-
Selling	Acquire Sales Prospect Data	Sales prospect information	-	-	-	-	-
Customer Order Handling	Authorize Credit	Customer credit information	Customer Management API (TMF629)	Get	Customer	-	account contactMedium engagedParty relatedParty creditProfile paymentMethod agreement characteristic
		Risk information	Risk Management API (TMF696)	Get	PartyRollRiskAssessment	partyRoll	riskAssessmentResult place characteristic
	Determine Customer Order Feasibility	Product / service / resource offer decision information	Product Offering Qualification Management API (TMF679)	Post	ProductOfferingQualification	productOfferingQualificationItem relatedParty place category	channel
			Service Qualification Management API (TMF645)	Post	CheckServiceOfferingQualification	serviceQualificationItem relatedParty	-
			Resource Pool Management API (TMF685)	Get	ResourcePool	-	resourceCollection capacity
	Issue Customer Orders	Product order information	Product Ordering Management API(TMF622)	Post	ProductOrder	orderItem relatedParty orderingPrice billingAccount	quate agreement channel payment productOfferingQualification
	Complete Customer Order			Patch			
	Close Customer Order			Get			
	Customer Order Orchestration	Product instance information	Product Inventory Management API(TMF637)	Post	Product	relatedParty place productSpecification productOffering productPrice billingAccount	productTerm agreement product productRelationship productCharacteristic realizingService realizingResource productOrderItem
Customer Bill Invoice Management	Create Customer Bill Invoice	Invoice to customer	Customer Bill Management API (TMF678)	Post	CustomerBill	billDocument financialAccount billingAccount	relatedParty billCycle taxItem appliedPayment paymentMethod
Customer Management	Enable Retention & Loyalty	Customer satisfaction	-	-	-	-	-
Service Configuration & Activation	Issue Service Orders	Service order information	Service Ordering Management API (TMF641)	Post	ServiceOrder	serviceOrderItem	externalReference orderRelationship relatedParty
	Close Service Order			Patch			
	Design Solution	Service instance information	Service Inventory Management API (TMF638)	Post	Service	serviceSpecification	relatedParty place supportingResource serviceRelationship serviceCharacteristic feature relatedEntity serviceOrderItem
	Track & Manage Service Provisioning			Get			
	Allocate Specific Service Parameters to Service			Patch			
	Implement Configure & Activate Services		Service Activation and Configuration API (TMF640)	Patch			
	Test Service End-to-End	Service test information	Service Test Management API (TMF653)	Post	ServiceTest	relatedService testSpecification	testMeasure characteristics relatedParty
Resource Provisioning	Issue Resource Orders	Resource order information	Resource Ordering Management API (TMF652)	Post	ResourceOrder	orderItem	orderRelationship relatedParty
	Close Resource Order			Patch			
	Track & Manage Resource Provisioning	Resource instance information	Resource Inventory Management API (TMF639)	Get	Resource	-	resourceSpecification resourceCharacteristic activationFeature relatedParty attachment resourceRelationship place
	Allocate & Install Resource			Post			
	Configure & Activate Resource		Resource Activation API (TMF702)	Post			
			Resource Function Activation and Configuration API (TMF664)	Post	Resource Function	resourceSpecification	SAP schedule relatedParty place
	Test Resource	Resource test information	-	-	-	-	-
Party Order Handling	Issue Party Orders	Party order information	Product Ordering Management API(TMF622)	Post	ProductOrder	orderItem relatedParty orderingPrice billingAccount	quate agreement channel payment productOfferingQualification
	Track & Manage Party Orders			Get			
	Receive & Accept Party Order			Patch			