Next-Generation IT Architecture for Telecommunication Companies – a Factory based Approach

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Abstract: The IT landscape of telecommunications companies is far more dynamic than IT landscapes in most other application domains. The main reason for this is the fast development of new technologies that form the basis of new telecommunications products. These products very often require new or adapted technological devices as well as IT processes for production, operation and assurance of new or existing products. The factory based approach presented in this paper tackles this problem by separating those parts of a process in production, operation or assurance affected by specific technologies from other processes. In the factory based approach all processes affected by a technology are bundled in a factory and all factories have a common interface that enables relatively effortless replacement of one factory by another factory that supplies equivalent services.

1 Introduction

Innovative technologies like Voice over Internet Protocol (VoIP) and Internet Protocol Television (IPTV) have a huge impact on the requirements for the IT of a telecommunication provider. New products based on these All-IP technologies require further adoption of the IT. The requirements by new technology-independent products and the interoperability of different related products in a flexible distributed production are hard to accomplish with the existing IT architecture [RM10]. Though the evolved IT landscape of telecommunication companies is rather complex and traditional network structures, with separate fixed voice and data communication services handicaps an easy adaptability. Therefore an increasing number of telecommunication companies is migrating to Next Generation Networks (NGN) [ITU09][TMF11].

erschienen im Tagungsband der INFORMATIK 2011
Lecture Notes in Informatics, Band P192
ISBN 978-3-88579-286-4
weitere Artikel online:
http://informatik2011.de/519.html

Strong dependencies of prospective products, existing IT systems and the technical platform lead to very complex correlation. To be successful in future markets, a flexible IT architecture model is indispensable. One approach to deal with these challenges of telecommunication companies is a factory based concept for IT architecture introduced in this paper. This approach allows the separation of components and the cooperative interaction of replaceable building blocks that represent different parts of a telecommunications product. The approach follows the component governance models described in [RBM09]. The business of a telecommunication company is a mixture of trading, production and usage of services for providing products. This is taken into account in the trading / production / usage (TPU) model as a significant part of the factory based IT structure proposed in this paper.

The next section gives an overview of the factory based approach. In section 3 we describe and analyze the factory based approach on the basis of a case study at the Deutsche Telekom AG and give a deeper insight into its functionality. The last section finishes with a conclusion and an outlook on future research fields.

2 Factory based approach - introduction

Factory based concepts are enhancements of approaches originating in the area of service oriented architecture (SOA [BCK98] [HWSD07] [RFPK07]). The factory based concept follows the component governance model [RBM09], which combines the advantages of functional and product governance methods and enables a breakdown of large IT-landscapes into manageable sub-components.

As opposed to the classic domain based approach the component governance model is characterized by a hierarchical product and service structure. Point-of-sale products and services are composed of underlying lower-level services.

Reinisch et al. suggest a functional encapsulation, for example one functional component for IP access service and another one for TV service. With reference to manufacturing processes the unit for the production of a component is described as a factory. Supported business transactions are described for each factory for trading, production and usage of the provided components. Furthermore it is recommended, that all factories follow a central structure with reference to the product and service structures, production plans and error handling.

This paper describes the further development of the factory based approach and its application to the design of a new IT platform of the Deutsche Telekom AG. Next, the service structure of the so called “customer facing services” (CFS) is explained as a key element for the factory based approach.

erschienen im Tagungsband der INFORMATIK 2011
Lecture Notes in Informatics, Band P192
ISBN 978-3-88579-286-4
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CFS: customer facing services in brief

Globally considered the operations support system (OSS) generates an amount of technical services (customer facing services = CFS) for the business support system (BSS). The CFS themselves can be composed of miscellaneous other technical services.

As mentioned earlier the CFS's are generated by the components of the OSS-landscape. In principle CFS are completely generated by one component. That is, the necessary processes for production, operation and assurance are not distributed among multiple components. Hence, the structure of the OSS-landscape is arranged along the provided CFS.

Factory based IT-structures are relatively new concepts in the field of organization theory. Therefore not all properties of the model are known yet. The utilization in the field of telecommunications companies is partly breaking new ground, with consequent challenges in design and implementation. Existing trends in standardization of data and process models are only partially prepared to factory based structures. The integration of factory based IT architectures for telecommunication services is a challenging tasks and requires consequent changes in the software design and realization processes.

A huge task of the architectural design process is the integration of legacy systems and the design of consistent integrated IT processes, which support existing and new products and required platform technologies. This can effect a better allocation of benefits and costs, so that a stronger business alignment of IT-structures is achieved. The so called business transactions of the components are similarly designed following the trading/production/usage (TPU) concept, which is described in the corresponding section. The application of the TPU concept is a core element of the factory based approach. This causes a further unification of the underlying business comprehension. Marketplace oriented models enable a good interchangeability of components that locally limits the time and effort of launch, change and retirement of components. [RBM09]

3 Case study – factory based OSS architecture at the Deutsche Telekom AG

With the Next Generation Service and System Management (NGSSM) approach the Deutsche Telekom AG introduces one logical IT platform for the management of "Next Generation Networks" (NGN [ZF07]). The related introduction of a factory based IT architecture is significant for the whole NGSSM approach. Considering the complexity of the existing IT infrastructure, which consists of several big IT systems and dependencies between systems, the switch to a factory based approach is a huge step. Thus, the factory based NGSSM architecture is introduced stepwise, starting with a few core factories at first and adding more factories in the next steps.

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Lecture Notes in Informatics, Band P192
ISBN 978-3-88579-286-4
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The IT infrastructure for the network of the Deutsche Telekom AG can be divided into the following layers - with reference to the NGOSS model [NGO11]:

- Business Support Systems (BSS): e.g. customer relationship management and order management systems
- Operations Support Systems (OSS): e.g. for production, assurance and operations support and readiness
- Platform Systems: e.g. systems for network elements

The following description of the factory approach focuses on the OSS, as early adopters of the NGSSM approach.

The NGSSM Factory Architecture

Figure 1 shows core elements of the IT-landscape.

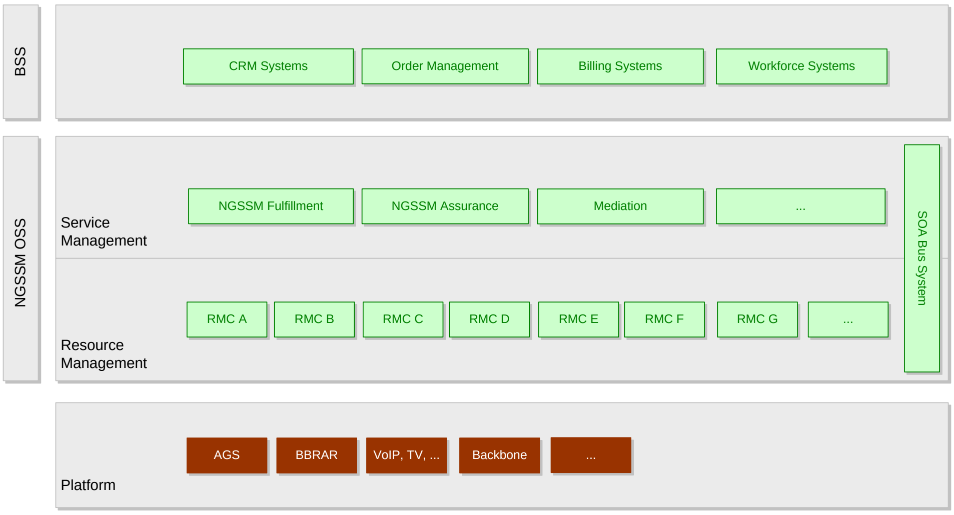

Figure 1: Components Overview

BSS are located northbound to the OSS. Mainly triggered by customers they initiate fulfillment or assurance requests to the OSS.

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ISBN 978-3-88579-286-4
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With reference to the business process framework of the telemanagement forum (eTOM) the NGSSM OSS is divided into service management and resource management layers [eTOM11]. The implementation of the CFS provided to the BSS takes place within a factory based component, so called "service management component" (SMC). A SMC receives service requests from the BSS by complex CFS. In general, these complexes CFS are composed out of multiple other CFS. The SMC coordinates the required steps by integrating the required "resource management components" (RMC) via cooperative fulfillment and assurance processes. Finally, the SMC delivers the response to the BSS.

Many services, provided to the BSS, require manual work (e.g. connecting devices, cables etc.) or access to platform functionality, for instance to configure or activate a port of a platform device in order to provide a certain service.

Resource management components (RMC) manage the resources of the technical platform at the southbound side of the OSS, such as platform elements with relevance to access, VoIP and TV services. In addition further resources, such as workforce for platform management, is handled by a RMC.

All mentioned factory based components are logical IT-structures and not necessarily congruent with organizational units.

Factory based OSS components

The basic concept characterizes the IT-Landscape consisting of independent production units, operating as (virtual) factories. The Factories are independent logical components of the OSS-landscape and are managed and developed separately. This does not exclude the use of the same IT-products (and therefore the same licenses) for different components.

In the NGSSM architecture the SMCs and RMCs are designed as factories. All factories support north-bound the same interface called "operations support system internal services" (OIS), which support fulfillment and assurance processes for CFS.

The individual components interact with each other by a predefined set of business transactions. These business transactions are described in terms of general IT-services, which are expressed independent of the concerned CFS, so that all components have the possibility to provide the same IT-services. This establishes a logical (IT)-business transaction model, which is divided into trading, production and usage business transactions. This mechanism is part of the component governance model. It is described as Trading/Production/Usage (TPU) concept later on.

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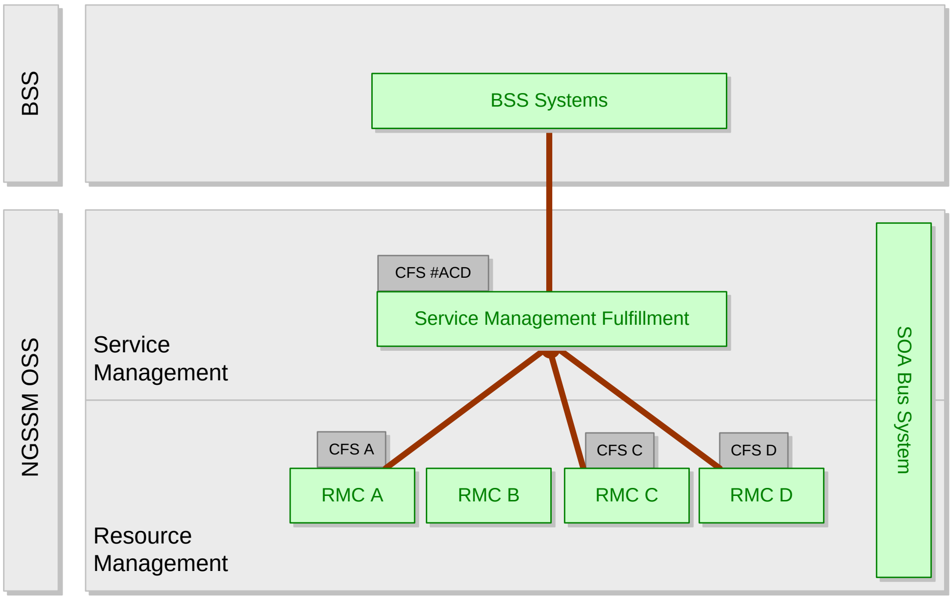

Figure 2: Cooperative fulfillment process with interaction of SMC and RMCs

The RMCs have the responsibility for producing and managing their provided CFS. In addition to the execution of required activation and configuration tasks for platform elements, the management aspect also includes the administration of CFS inventory information required for CFS management. Therefore the RMCs own a local inventory system. The master of the data and the CFS lifecycle is the responsible RMC.

According to basic modularization principles [BAH09] details for the realization of a CFS are encapsulated in its responsible factory component. Factories basically only exchange certain CFS characteristics, for example performance promises. In particular cases (e.g. during the cooperative production planning) the exchange of further characteristics is required. However, their exchange of CFS information is limited to the minimum and it is ensured that only one factory is responsible for the management of a certain type of CFS.

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Lecture Notes in Informatics, Band P192
ISBN 978-3-88579-286-4
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Offering certain CFS via a standardized service model a factory has the following characteristics:

- A factory is an encapsulated component which provides all functionalities needed to provide its CFS.
- A factory is responsible to obtain all required resources for its CFS and to perform all required tasks to generate and manage a CFS. A CFS is generated by exactly one factory, which is also responsible to manage its lifecycle.
- A factory has an internal inventory, containing specifications and instances of CFS.
- With reference to the eTOM business process framework [eTOM11] a factory supports fulfillment, assurance and operations support and readiness (OS&R) processes, which are related to its CFS.
- A factory is connected to a SOA bus system and supports a standard set of functional IT-services following the TPU model.

Trading/Production/Usage (TPU) Model

The NGSSM OSS factories follow a common business transaction model, which consists of trading, production and usage (TPU [RBM09]) business transactions and corresponding IT-services (so called "OIS"). Following a general approach, the TPU model does not contain any CFS or factory specifics. The TPU model is used by all factories for cooperative production planning, cooperative production and cooperative assurance of CFS as well as usage processes. A typical functionality is for example: "Can I reserve an instance for CFS type ***A*** with specified ***characteristics***".

The same business transaction can be applied for all CFS types. Product-specific properties are only determined by CFS type and its parameters (e.g. bandwidth = "50MB/s"; location = <Location-Identifier>).

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The following table shows some examples of TPU business transactions, which refer to CFS for a specified customer/access:

Trading / Production / Usage	**Business transaction/OIS**	**Description**	**Provider**
T	T_Reservation	Reservation (and / or change) of a certain CFS entitiy with specified properties	SMC
T	T_Activation	Activation (and /or change) of a reserved CFS entity	SMC
P	P_Order_Completion	Completing a production plan by inserting the required action items and parameters for the production of a CFS	RMC
P	P_Order_Execution	Execution of a specified action item	RMC
U	U_Diagnostic	Execute a diagnosis for a specified CFS	SMC, RMC

Table 1: Examples of TPU Business transactions

Trading business transactions are generally only supported by SMCs, which provide corresponding IT services to BSS.

RMCs provide production services, for example for the reservation (“P_Order_Completion” as a part of the cooperative production planning process) or activation (“P_Order_Execution”) of CFS, to the SMCs or to other RMCs. Each RMC is responsible to manage and configure the required resources of the platform.

The “U_Diagnostic” business transaction supports a cooperative diagnosis process for a specified CFS. The process is coordinated by an assurance SMC and the status of the specified CFS is diagnosed by one or more relevant RMCs.

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Operations Support System Internal Services (OIS)

The TPU business use cases are supported by a predefined set of corresponding IT services, called operations support system internal services (OIS). The interfaces of IT-services are defined CFS-independent. Thus, they can be used for all CFS within the OSS-landscape.

All SMCs and RMCs support a set of these interfaces in order to fulfill the cooperative process for production planning, production and assurance. So the OIS define a unified virtual business model for the cooperation of the components of the OSS-landscape as well as for the cooperation between OSS and BSS.

In a purely technical perspective this is a setting for communication primitives on a middleware. This idea is a central element in the philosophy of service oriented systems (SOA). Therefore OIS can easily be mapped on a SOA by simply declare/arrange a (arbitrary) technical data model that describes the encoding of the business transactions. The description can take place e.g. via Web Service Description Language (WSDL). In modeling of the technical data model existing industry-specific characteristics (such as SID) can be used as base. Theoretically, it is possible to use several physical data models.

The OIS is de facto a simple and robust SOA concept, which tries to avoid the disadvantages of a SOA by not determining a technical data model. OIS rather describes the semantics of a virtual commercial business model which physical coding is not primarily relevant. In this context, the question is not “How is the data coded and transferred”, the question is “How do the components transact with each other to support a company’s business”. It builds a bridge between the business requirements and the IT realization. These concepts can continue to be used even if the physical realization will be changed in a further development.

Despite the fact, that this approach is relatively new, however, it contains no direct technical risks since it only creates a new semantic level. This level can be mapped with the current methods of a classic SOA without problems. Nevertheless, in practice realization it turned out that the response time in combination with the coordination effort can be a performance risk.

As all components of the OSS-landscape use OIS, a unification of the communication is achieved. This approach supports the interchangeability of components. Some components communicate with the platform as well as with further systems around, e.g. for management of manual work or for configuration of devices. These communications must not necessarily use OIS, but rather can use individual task-based communication primitives.

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ISBN 978-3-88579-286-4

4 Conclusion

This paper shows a factory based IT architecture for telecommunication services. The factory approach, described in the case study of the Deutsche Telekom AG, is based on CFS, a SOA bus, independent, encapsulated factories and a trading production / usage (TPU) model supporting cooperative production and assurance processes. Although the introduction of this new IT architecture is a huge task, which requires a considerable amount of changes and adaptations, the case study shows that the applied factory based approach brings several advantages.

With the concept of CFS and the separation between service management and resource management layer the OSS supports the separation between customer services and their underlying transport network technologies. Thus, the OSS is prepared to support flexible, innovative NGN products defined by business.

The TPU model allows the integration of different factories for cooperative fulfillment and assurance processes. The process complexity is limited by two facts. First, each resource management factory is an encapsulated component, which is responsible for the lifecycle and the resource management of its CFS. Second, each factory supports a set of common IT services, which makes it possible to integrate and manage several factories connected by a bus system.

Of course, several design aspects must be considered in order to achieve a high-performance IT architecture, which fulfills high non-functional requirements. For example, highly efficient processes and (bus) technologies are required to support cooperative planning processes for availability check and reservation processes. The exploration and optimization of cooperative production and assurance processes is an area to be investigated in further research.

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ISBN 978-3-88579-286-4
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Lecture Notes in Informatics, Band P192
ISBN 978-3-88579-286-4