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End-to-End Reconfigurability: System Architectures

Marco Fratti, Motorola Labs, marco.fratti@motorola.com

Yann Denef, Thales Communications, yann.denef@fr.thalesgroup.com

Nikolas Olaziregi, King's College London, nikolas.olaziregi@kcl.ac.uk

Andrej Mihailovic, King's College London, andrej.mihailovic@kcl.ac.uk

Karim El-Khazen, Motorola Labs, karim@motorola.com

Didier Bourse, Motorola Labs, didier.bourse@motorola.com

Nancy Alonistioti, University of Athens, nancy@di.uoa.gr

***Abstract*—This paper presents a methodology for having a logical mapping between a "business architecture" and a related "functional system architecture". The methodology refers to the heterogeneous system case, where a wide variety of radio access technologies coexist. Ultimate goal of such methodology is to provide a joint business / technical framework, in which both the functional and the physical system elements of an ecosystem can be considered. The methodology is explained with an exemplary embodiment related to the context of the FP6 End-to-End Reconfigurability (E²R) project.**

***Index Terms*— End-to-end Reconfigurability, System Architecture, Business Models.**

Introduction

Objective of the research work on the reconfigurability management architectures within E^2R [1] project is to assess existing reconfiguration architectures and in general architectures which support reconfiguration in different bodies (e.g. SCA, MWIF, etc.), and analyse their strengths and weakness with the goal to provide a sound basis to define the framework at the system level able to address all reconfigurability issues of all elements of the system. Service, management, computational and application architectures need to be elaborated to realize a functional architecture for reconfigurability. The work performed is also to select technology and technique able to satisfy the requirements and to elaborate the corresponding system reconfigurability model. This model will describe each functional entity, and its open interfaces, needed to achieve the reconfigurability at the system level. The model will be created on a step-by-step approach and will be presented and validated through review process to associate and capture all specificity and views of the different sub-systems.

Business and functional architectures

In order to have a logical mapping between a "business architecture" and a related "functional system architecture" [3], a methodology is depicted. The methodology refers to the heterogeneous system case, where a wide variety of radio access technologies coexist. Ultimate goal of such a methodology is to provide a joint business / technical framework, in which both the functional and the physical system elements of an ecosystem can be considered.

A business architecture provides a solution for value chain mapping in a business ecosystem. A functional architecture provides the foundation for system solution and technical requirements. Typically, business architectures and functional architectures are worked out 'in parallel'. Indeed:

- Business architectures are based on consolidated actors (manufacturer, operator, service provider…) relationships. Sometimes, business architectures are derived naturally from standard descriptions,
- Functional architectures are based on components (including their features and evolutions), standard description for logical interfaces, and protocols and telecom and O&M functions.

In general, business architectures and functional architectures can (jointly) drive the Go-To-Market strategy. Classical methodologies for deriving system architectures typically rely on mono-technology systems (e.g. cellular or broadcast…). Their extension to address heterogeneous systems can become over-complicated, when considering the fact that heterogeneous systems have to deal with coexisting technologies, each of which was originally conceived for specific business cases and having specific characteristics in terms of architectures, features, requirements and functionalities.

System aproach

The approach is based on the following three steps:

- Splitting the system functions into system capabilities supporting specific requirements,
- Identifying the main objects enabling the support of the capabilities,
- Merging the capabilities architectures into the system architecture, developing a system meta-model, highlighting the business control points (e.g. who owns what?) and describing any association among reconfiguration related issues.

System capabilities

The system capabilities [2] currently identified by the E^2R project encompass today:

- Reconfiguration Management,
- Equipment Reconfiguration,
- Security,
- Service Level Agreement (SLA),
- Service Provision,
- Service Adaptation,
- Software Download,
- Vertical Handover (VHO),
- System Monitoring,
- No Radio Interference,
- Dynamic Resource Management,
- Spectrum Transfer.

As illustration, one of the requirements from SLA is the SLA_Download:

Requirement identification: ***SLA_Download****. An SLA agreement SHOULD exist between the network operator of the subscriber and the entity responsible of the software download.*

Each sub-system of the heterogeneous end-to-end reconfigurable system has its particularities which have to be considered first in the model and next in the elaboration of the meta-model. In the top-down approach, the focus is set on actors scenarios. From these scenarios, several capabilities are identified. The first phase of the process consists in the elaboration of an overall model, based on those system capabilities. During this elaboration, every requirements defined from high level scenarios is used to capture objects involved in reconfigurability mechanism. These objects contain information (data) and process functions. At this stage, the objects are not dedicated to a real equipment (user terminal, router, node B, applications server…). The relationships between objects and the type of relationship are also captured during this phase. It has to be noted that different requirements could create similar objects, their views needing to be harmonized in order to build only the necessary items.

When the model is completed, two questions guide the next phase:

1. In which equipment of the network these objects must reside (possibly in several equipments)?
2. Are the object identified enough generic, in the context of reconfiguration, to be put into the meta-model?

Reconfiguration management meta-model

The reconfiguration management meta-model will describe all associations among reconfiguration related issues. Such issues are captured into stereotypes, abstract classes, meta-classes, dependencies and specific constraints. Items are semantically interrelated by introducing association roles. Roles define the concept of any reconfiguration process in which certain semantic item is engaged. The proposed meta-model [4] is a Platform Independent Model (PIM), conformant to OMG - UML specifications, from which platform specific models (PSM) can be derived. The respective models are illustrating the functional entities and inherent interfaces targeting specific architectural assumptions. The interfaces and classes are specified and interactions between entities of the models are defined.

Conclusion

This preliminary research work on end-to-end system architecture is focusing the methodology for having a logical mapping between a “business architecture” and a related “functional system architecture”.

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