END-TO-END RECONFIGURABILITY – CONVERGENCE OF UNIFIED BUSINESS MODEL (UBM) AND RESPONSIBILITY CHAIN

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ABSTRACT

The system research in E^2R II supports the project by bringing together business and technology aspects and by showing opportunities of how reconfigurable technology and systems may be deployed in a commercially viable and sustainable way. This paper brings together the regulatory and responsibility aspects that come along with reconfigurability with the possible economic exploitation. The approach documented implements the convergence between the E^2R II Unified Business Model (UBM) and the E^2R II Responsibility Chain (RC) concept.

1.   INTRODUCTION

Reconfigurability comes at a cost, while there are undeniable advantages and opportunities arising out of the technology, the question about its commercial viability and how regulation impacts this viability remain open. E^2R II [1] has been investigating both regulatory [2] as well as economic [3] aspects.

Purpose of the projects research into the economic aspects was to depict business models (also for reconfigurable entities) as well as technology and deployment roadmaps. At the same time, the aim was to provide a coherent business path which embraces the technology evolution towards reconfigurability for each identified actor within the value chain. The research is based on existing standards that enable emerging techniques and technologies, and as result will propose a business model to the scientific community with regard to the end-to-end reconfigurability concept.

E^2R I has defined a "Unified Business Model" (UBM), the model is still under development and further definition within E^2R II. The basic business roles and relations in the context of end to end reconfigurable systems have been identified and defined. A stable version of the UBM (version 2.0) for reconfigurability has been developed, it identifies the potential interoperations and relations between the individual roles involved and defines possible business cases for each of these roles. The model distinguishes between the classical actors (i.e. as known from the classical telecoms value chain) and the actual roles actors may be able to play. This distinction was necessary because of the fact that reconfigurations may actually change the role

assignment within a communication system. An analysis has been undertaken concerning each role's economic viability, its positioning against the relevant 'consumers' of (the roles) service and ultimately, the 'roles' positioning against the user as the main consumer. The UBM also describes the level of embedding within the discrete roles. More specific scenarios are evaluated in E^2R II in order to further improve the reconfigurable business ecosystem in terms of role's viability and revenue sharing.

The flexibility and value added by reconfigurability are based on the capability to introduce new operational software into equipment and to change the basic (radio) functions within a reconfigurable platform. This however implies that all new introduced software (downloaded or otherwise introduced) needs to be verified for its suitability and authenticity. And all resulting configurations will need to be verified and declared as being fit for purpose (i.e. conformant to the applicable standard). Invariably, the reconfiguration process will involve different actors. Depending on the software provision model, the software may be obtained from different sources, including unspecified third parties; thus the assignment of responsibilities for configurations becomes rather important. The different actors partaking in a reconfiguration process and that may have some influence and responsibilities throughout the reconfiguration processes can be involved in both the operational and/or administrative dimensions. Connected to the concept of value chain in the definition of the business models for end-to-end reconfigurable systems, the responsibility chain identifies the dynamic interactions between actors encompassing information data, control data and a penalty scheme giving incentives for standard conform operation of reconfigurable equipment.

By convoluting the business and responsibility models, additional economic justification for some of the supporting roles can be provided. As mentioned, reconfigurability relies on the capability to install, during runtime, new low level operations software. This software needs to be authenticated, securely downloaded and correctly installed and it needs to implement functionalities that conform to the standards applicable for its intended use. The remainder of this paper explains the roles, the interactions and the mechanisms designed to capture both the responsibilities as well as economic relations between entities (actors and roles) within reconfigurable systems.

2. A BUSINESS MODEL FOR RECONFIGURABLE SYSTEMS

Reconfigurability business modeling research activities focus on defining/updating the business relationships between the involved actors in the context of end-to-end reconfigurable systems and are being carried out in two stages. The first stage includes the identification of a stable version of the so-called Unified Business Model for reconfigurability (UBM) through business analysis of different technical scenarios/use cases as facilitated by the Business System Architecture Process (BSAP) methodology [4]. The second one addresses the common understanding in business roles and relations to the Wireless World Initiative (WWI) [1] context by coordinating the corresponding WWI Business Models Cross-Issue (led by E^2R II) towards the identification of a harmonized approach for business modeling for the B3G telecommunications era. As defined by BSAP, a Business Role is an abstract object that performs a set of actions providing a set of discrete functions to another role. Further, a Discrete Role sells its produced value to customers whilst an Embedded one being integrated within a discrete one and get funded by its business owner. The following paragraphs provide a brief description of the functionality allocated to the main roles as well as an identification of the various inter-role relations. A more detailed description can be found in [6].

As presented in Fig.1, the User / Buyer is the final consumer of the ecosystem and the main source of revenue. The Home Network Business Owner (HNBO) provides network services to customers in a provision area, being compensated by subscribers. Customers are provided geographic coverage by the Home Network Operator through Network Business Owner that also compensates the operator. A Mobile Virtual Network Operator (MVNO) provides customers network services without owning resources and infrastructure. The Reconfiguration Manager coordinates the reconfiguration process and respective interactions between the roles involved in a reconfiguration process, whereas the Resource & Spectrum Manager cooperates with peer roles for dynamic spectrum and resource management aspects. A Spectrum Broker handles the allocation of different spectrum bands to different Network Operators. An Access Broker can be considered as a type of an MVNO when dealing with brokerage of access capacity and maintaining a direct relationship with the subscribers. Alternatively, it is included in the role of Spectrum Broker in case it acts as a wholesale access broker.

The Manufacturer role is extended to address the development and distribution of software modules and/or value added services for a specific product. In this sense, a Platform Modules Developer is a type of manufacturer whose products include sub-atomic elements being sold or consumed by a Manufacturer as subcomponents of Manufacturer's products. As an embedded role within the Manufacturer, the Platform Modules Developer develops software modules to be installed and run on reconfigurable network elements and/or user devices.

An Outsource Service Provider may be commissioned for value added service development, Identification Management or Device Management or Certification Management. The Application Service Provider (ASP) provides User application services either for free or on a subscription basis. Such a provision may be performed in a personalized way, being enabled by the ContextMgr, UserProfiler and IdentityMgr roles. A Content Owner maintains content repositories and sells content and/or application services to service providers (HNBO, ASP…) as well as end users. The Content Aggregator in its turn packages content (coming from Content Owners) for re-use or sale, including advertisements and taking into account variables such as context information. Additionally, a Store may market and sell these finished products to producers or consumers.

Advertiser stands for a revenue source that pays for advertisement capabilities. Finally, a Subsidizer may initiate revenue streams to any part of the ecosystem, enabling (certain categories of) users, such as consumers, subscribers to actively participate in this ecosystem.

3. ROLES AND RESPONSIBILITY IN RECONFIGURABLE SYSTEMS

The E^2R II project addresses the technical but also administrative roles of the different actors that may influence the (re)configurations of radio equipment. These roles and the relationships between the actors are determined by the part they are playing when radio equipment is reconfigured. The Fig.2 illustrates these relations. Reconfigurability has to be seen in an end-to-end system context. During reconfiguration procedures there are points where reconfigurability may force actors to take responsibility for the system state, these moments may occur at any time when operation of the radio interface may be altered or even compromised. The main affected functions are discussed in [5].

Main assumption in the Responsibility Chain model is that regulation defines for the RATs the policies and the limits that are to be applied in defined geographical area and timeframe. The second assumption is that equipment can not be altered without consent from the controller of the reconfiguration space. And finally the third assumption is the introduction of a penalty scheme, where the individual

actors (according to the roles they implement during a reconfiguration procedure) may be held accountable if a misconfiguration appears during a reconfiguration process.

Main problem is to achieve a system view where responsibilities can be assigned to mirror the actual potential threat that may occur during system/device reconfiguration; the Responsibility Chain model defines a number of "spaces", each of which has its own scope and functional or administrative meaning.

Reconfiguration Control Space: Denotes the part of the system in which reconfiguration support mechanisms are to be deployed to ensure reliable, trustable and secure reconfiguration of radio equipment. This space encompasses not only the reconfigurable equipment itself, but also any network resident reconfiguration support entity (e.g. software stores, or the "reconfiguration support service provider"). In addition, a "Reconfiguration Controller" may be implemented to act (on behalf of the regulatory authority) as monitor to trace reconfigurations and reconfiguration history, and where necessary, to act as policing entity, if reconfigurations lead to system corruption.

Reconfiguration Space: All forms of radio reconfigurations take place in this space, this includes reconfigurations of the air interface as well as reconfigurations within the immediate backbone of the access network.

Regulation Space: In contrast to the reconfiguration space, the regulation space covers only reconfigurations of the air interface. Regulation (at least in Europe) is not concerned about the configurations of the network part of communication systems, the regulatory interest only covers the air interface and emission altering reconfigurations of the air interface. While, reconfiguration as well as regulation space need to provide secure and reliable reconfigurations, only the regulation space is crucial to get regulatory consent for reconfigurability.

All actors involved in a reconfiguration (within the reconfiguration space) may be held accountable for misconfigurations, a penalty scheme [5] can be implemented and this may become part of the value chain within reconfigurable communication systems.

4. BUSINESS MODEL AND RECONFIGURATION RESPONSIBILITY

The viability of business models for reconfigurability not only critically depends upon the structure of the value network and the associated revenue streams, as depicted in the Unified Business Model (UBM), but also upon a clear and agreed risk and responsibility sharing model. In this respect it is a crucial task to identify and define the roles

and actors guaranteeing the quality and integrity of the (re)configuration process and the services delivered. The E^2R Responsibility Chain (RC) introduced a slightly differentiated perspective of identifying new business actors as well as incorporating emerged business roles within existing actors. However, a unified set of roles for reconfigurability is needed as a coherent outcome of E^2R business research activities. For this reason, a mapping procedure has been initiated in order to produce a dictionary between the two perspectives and the corresponding role languages. On a medium term basis, after the two perspectives have been integrated, a well defined common role language will be available for use in both business modeling and regulatory research. This section provides a brief description of the main issues in the mapping between the UBM business roles and the Responsibility Chain. A more detailed description can be found in [6] In the paragraphs below, regulatory roles are taken as a starting point, and are then compared with their respective counterparts in the UBM.

From regulatory perspective an Equipment Manufacturer is responsible for hardware and software provision, for software updates arrangement and initiation as well as for the proper operation of the provided hardware and software. In the UBM, a Manufacturer is to be liable for the provided products, both hardware and software. A Reconfiguration Manager may be embedded to address software updates coordination.

The Network Operator's responsibilities include provision of the infrastructure and secure connectivity for communication, signalling, SW downloads and the proper operation of equipment within its administrative domain. Alike, the UBM HNBO is liable for radio connectivity services and management. Further, the UBM Reconfiguration Manager within the UBM HNBO has to fulfil the secure and proper operation of the device after a reconfiguration process. Within the UBM, all infrastructural activities (i.e. not related to commercial service offering) are performed by the network operator role, which might be embedded in the HNBO role or –in case of MVNO operations- be discrete.

A Software Provider stands for a third party providing application software, as well as low level configuration, protocol and application software. The Software Provider has to implement/provide an established authentication mechanism (preventing impersonation), and to implement security features when providing software products. For configuration software provision the UBM Manufacturer is still liable for such a product even in the case that it outsources such an activity to an UBM Platform Modules Developer. The security features may be addressed by either the Manufacturer or the corresponding Reconfiguration Manager.

The responsibilities of the Reconfiguration Support Service Provider include mechanisms for coordinating the reconfigurations actions performed and correspond to UBM Reconfiguration Manager.

Finally, the Reconfiguration Controller is considered to integrate the certification, security, and spectrum management responsibility roles. In this context such an actor integrates the UBM Certification Manager, Resource and Spectrum Manager (embedded) roles. Regarding the security aspect, within UBM the Infrastructure and Device Managers encompass such roles.

6. CONCLUSIONS

The real-world viability of reconfigurability not only critically depends upon the structure of the value network and the associated revenue streams, as depicted in the Unified Business Model, but also upon a clear and agreed risk and responsibility sharing model, as modeled in the Responsibility Chain. This paper has brought together the regulatory and responsibility aspects that come along with reconfigurability with the possible economic exploitation. The approach documented implements the convergence between the E^2R II Unified Business Model (UBM) and the E^2R II Responsibility Chain (RC) concept.

7. ACKNOWLEDGMENTS

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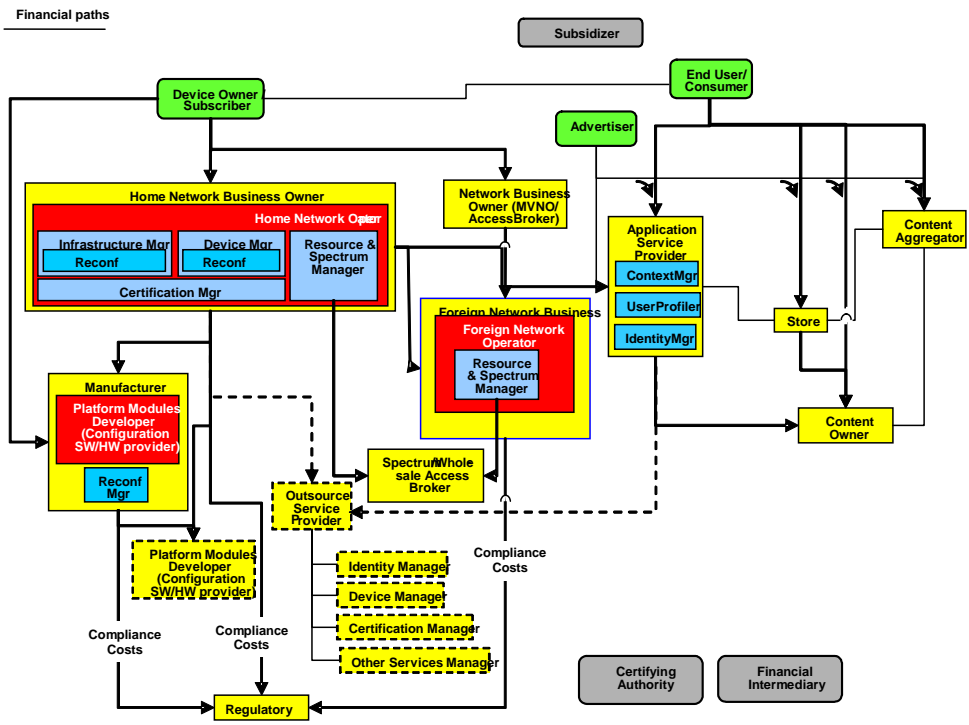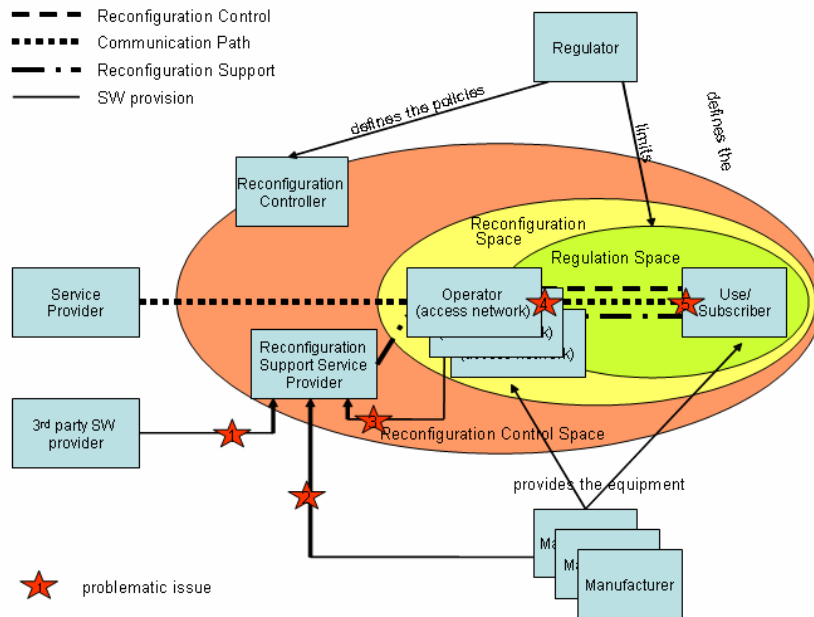[6] E^2R II White Paper on Business Models – Release in October 06.

Fig. 1: E²R II Unified Business Model (UBM)

Fig. 2: E²R II Responsibility Chain (RC)