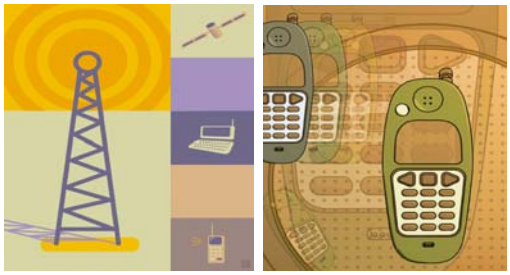
Management of Reconfigurability



Dr. Nancy Alonistioti

University of Athens
Communication Networks Laboratory

nancy@di.uoa.gr
http://cnl.di.uoa.gr

Reconfigurability: An Enabler of Seamless Experience

End-to-End reconfigurability is the most important enabler for providing a seamless experience to the end-user and the operators:

- Managing and increasing resilience of growingly complex architectures
- Reducing costs of communication systems
- Providing flexibility to developers of services and applications

E²R – Global International Landscape

- ✓ **Competition**
  - ✓ DARPA and DoD are spending B$ on SDR/CR
  - ✓ CR is funded as the next step of SDR
  - ✓ IT industry has developed E2E and reconfigurable solutions in the last 10 years
- ✓ **European leadership**
  - ✓ Bring reconfigurability technologies into the telecom space
  - ✓ SDR/CR: Trust, Scout, Mobivas, MuMoR, OverDRiVE, Credo, Cast, Mobydick
  - ✓ E²R: From SDR/CR to Reconfigurability towards End-to-End Reconfigurability

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"Meanwhile, in Europe the E2R research program took a brisk approach and is studying end-to-end reconfigurability. This could effectively position them to control the intellectual property of CR. If the United States wants leadership in software development it may be necessary to set a more aggressive pace in software development."
Bruce Fette (General Dynamics) EE Times CommsDesign Aug. 04 http://www.commsdesign.com/showArticle.jhtml?articleID=29100657

E²R will:
- Develop methods and tools for managing complex architectures
- Pave the path towards cognitive, autonomous and reflective communications
- Provide opportunities to develop and experiment rapidly new services and applications
- Enable a seamless experience for the end user and the operators

Roadmap

Evolution of policy based management mechanisms

Evolution of decision making procedures and mechanisms

Evolution of context- and self-awareness

How to deal with increasing complexity?

Motivation

- **End-to-end reconfiguration**

  Reconfiguration: *the action of modifying the operation or behaviour of a system, a network node, or functional entity.*

  Scope: *spans across end-user devices, network equipment, software, and services. Target reconfigurable elements include, in the mid-term, the User Equipment (UE) and Base Stations or Access Points, Network nodes, Services.*

  End-to-end notion: *dictates that, in certain cases, user and control plane interactions may occur from source to destination in order to modify the system, the equipment, the application/service, or the content. Such interactions should be coordinated by an* ***integrated management plane****, aiming at diverse service offering.*

  Reconfiguration Management Plane (RMP): *coordinated management and control functions that govern the interactions between the involved entities, and for governing the decision-making and enforcement of mechanisms supporting reconfiguration in a dynamic fashion.*

RMP: A *Reconfiguration Support Plane (1/6)*

1. Plane- and layer-based approach

Traditional *Plane Management (vertical plane)*

ITU FCAPS (Faults; Configuration; Accounting; Performance; Security)

3GPP additional "management areas": roaming mgmt; fraud mgmt; software mgmt; UEM; QoSM; SuM; Subscriber & Equipment Trace Management

Usually network-initiated scenarios, but not always (e.g., fault management is element-initiated)

Traditional *Layer Management*

Operations, Administration & Maintenance (OA&M) functions per layer

Interfaces to all protocol layers both in the Control and in the Management Plane

RMP: A *Reconfiguration Support Plane* *(2/6)*

2. It is a *Logical model*

A Logical Model defines an ***abstract view of a network or network element*** by means of information objects representing network element, aggregations of network elements, the topological relationship between the elements, endpoints of connections (termination points), and transport entities (such as connections) that transport information between two or more termination points

The information objects defined in the Logical Model are used, among others, by connection management functions. In this way, a ***physical implementation independent management*** is achieved.

RMP: A *Reconfiguration Support Plane* *(3/6)*

3GPP IRP (Integration Reference Point) specification stages

1) **IRP Requirements** (conceptual and use cases definitions) => **Business model & Reconfiguration Meta-model**

2a) **IRP IS:: Interface IRP** (operations and notifications in a **network agnostic, protocol-independent** manner) => **RMP: logical model**

2b) **IRP IS:: NRM** (**network aware; protocol independent**) =>

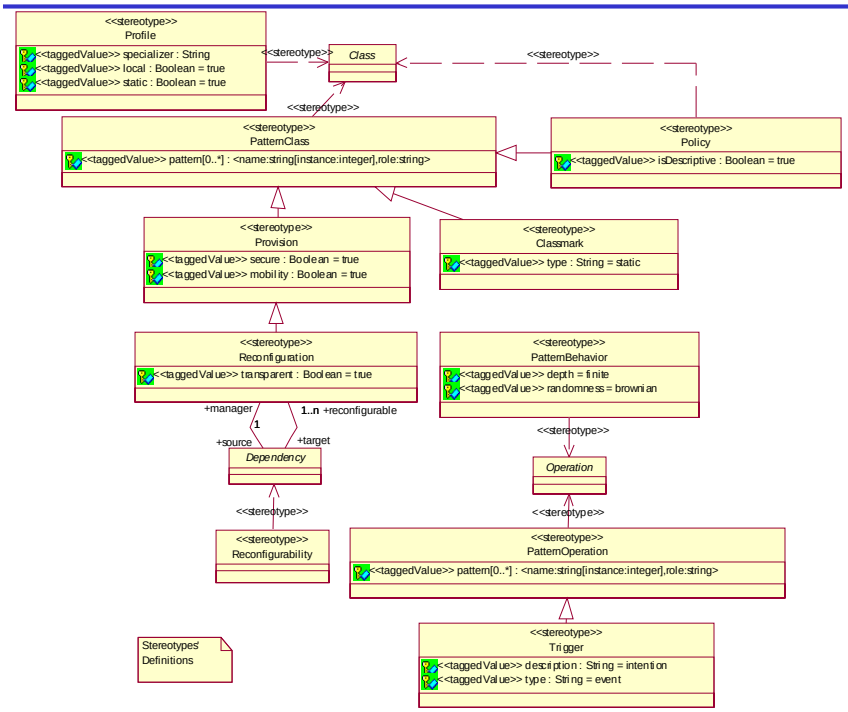
Network Resource Model for E²R NW Architecture: **RCM (ReConfiguration Manager), R-RSF (RAN Reconfiguration Support Function) CRM (Composite RAN Manager)**

2c) **IRP IS: DD (Data Definition)** (**network-aware; protocol-independent**)

3) **IRP SS (Solution Set)** [**network-aware; protocol-aware**]: **CORBA/IDL**

Stage 2: map the core RMP logical model to a network entity beyond the network access server (3GPP GGSN), or Access Router, targeting terminal reconfiguration ➔**RCM – ReConfiguration Manager**

RMP: A *Reconfiguration Support Plane* *(4/6)*



A New UML Profile for Reconfiguration:

describes ***concepts*** required to define reconfigurable entities and their ***behaviour***.

Reconfiguration: a set of policy-driven tasks, which includes the way to efficiently adapt, apply, evolve and upgrade the functionality that an entity supports, to any expected or potential change of its state, situation, and activity.

Can be used as a guideline for defining an information model to support reconfiguration, as well as for producing ***models*** specific to reconfiguration topics, such as context management and service provision.

RMP: A *Reconfiguration Support Plane* *(6/6)*

3. It is a *Reconfiguration Support* Plane - It does not replicate existing management/control functionality

Includes ***only reconfiguration-related functional entities*** (although the list is quite long… reconfiguration does increase the problem space and parameter space…)

No fault management (self-healing; terminal-initiated) for the RCM instance

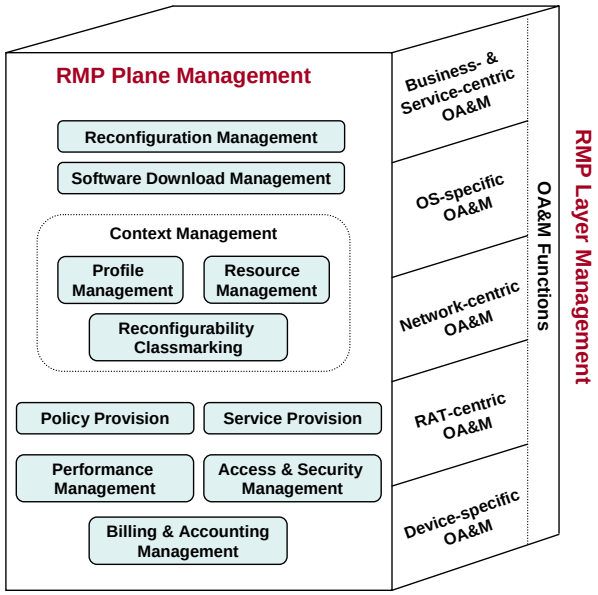
NOTE: RMP is a model which should be network-agnostic. Can interwork with systems not offering all areas of traditional management & control (e.g., WiFi/WiMMAX)

4. It includes *control and management entities and reference points*

Can be seen as ***an intermediary between legacy control and management planes***

Q: What is the functionality tailored to reconfiguration?

RMP: Reconfiguration Management Plane



- **RMP plane management:**
  - ⇒ Reconfiguration Management
  - ⇒ Software Download Management
  - ⇒ Context Management
  - ⇒ Policy Provision
  - ⇒ Service Provision
  - ⇒ Performance Management
  - ⇒ Access and Security Management
  - ⇒ Billing and Accounting Management
- **RMP layer management** (OA&M functions):
  - ⇒ Business- and Service-centric O&M
  - ⇒ Operating System specific O&M
  - ⇒ Network-centric O&M
  - ⇒ RAT-centric O&M
  - ⇒ Device-specific O&M

RMP as a new plane

- Separate reconfiguration support plane => “Passive/offline” enhancements to legacy control functions & management systems
- Minimised impact on models, state machines, timers defined, etc. => ease of specification and testing procedures (SDL simulation modelling; TTCN tests)
- No direct extensions of legacy planes; only “outband” hooks for the new plane
- No additional cost in introducing a new plane, if new functionality is to be added after all
- Independent evolution paths and refinements: allows the next-generation architecture to be adjusted with no or limited impact to other subsystems.
- Enables the addition of other planes to cover future demands.
- Whether RMP interfaces are implemented or not shall have limited impact on other entities of a PLMN, in the same way the Gs interface can be deployed in the background.

RMP as extension of current planes

- If no new plane, then how to distribute the reconfiguration-related functionality to different planes?
- If extensions/evolution of legacy planes, these extensions should be continuously under update wrt. reconfiguration functionality

Conclusions and Standardisation efforts

- Management of Reconfiguration needs to be tackled in a concrete manner in NGNs
- RMP provides the basis for the introduction of distributed policy-based reconfiguration (e.g., in protocols, services, nodes, applications) functionality, self-management, self-awareness, self-organisation, self-healing functionality.
- RMP can pave the path for the introduction of autonomous and cognitive communications emergence and management
- RMP contributions to standards bodies:
  - Object Management Group – SBC workgroup
  - TeleManagement Forum (TMF)

END-TO-END RECONFIGURABILITY

Thank you

Contact: nancy@di.uoa.gr

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