

# E<sup>2</sup>R and P<sup>2</sup>SRC : some fruitful research opportunities ?



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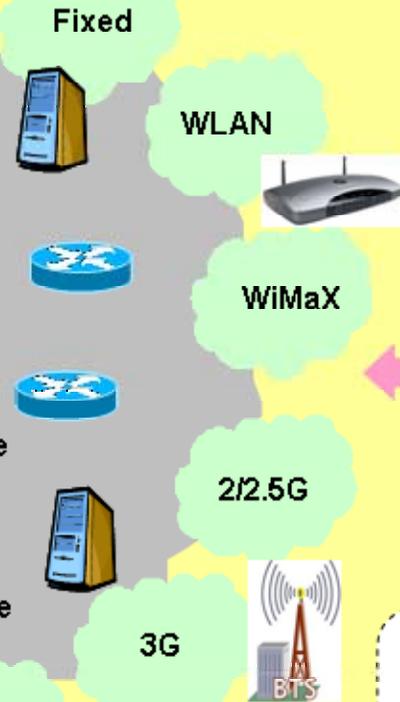
- **Keynotes on End-to-End Reconfiguration (E<sup>2</sup>R) programme**
  - **The Programme as a whole**
  - **Work Package 4 (WP4)**
  
- **Comparison of E<sup>2</sup>R and P<sup>2</sup>SRC achievements**
  - **Respective technical areas**
  - **Detailed semantics analysis**
  
- **Yes, many fruitful research opportunities !**
  - **Respective strengths and weaknesses**
  - **Identified technical opportunities**
  - **What can be done**

# E<sup>2</sup>R : Enabler of the Seamless Experience

## End-to-End Reconfigurability: Enabler of the Seamless Experience

Heterogeneous Systems

- Ubiquitous Access
- Pervasive Services
- Dynamic Resource Management



Heterogeneous Environments and Contexts



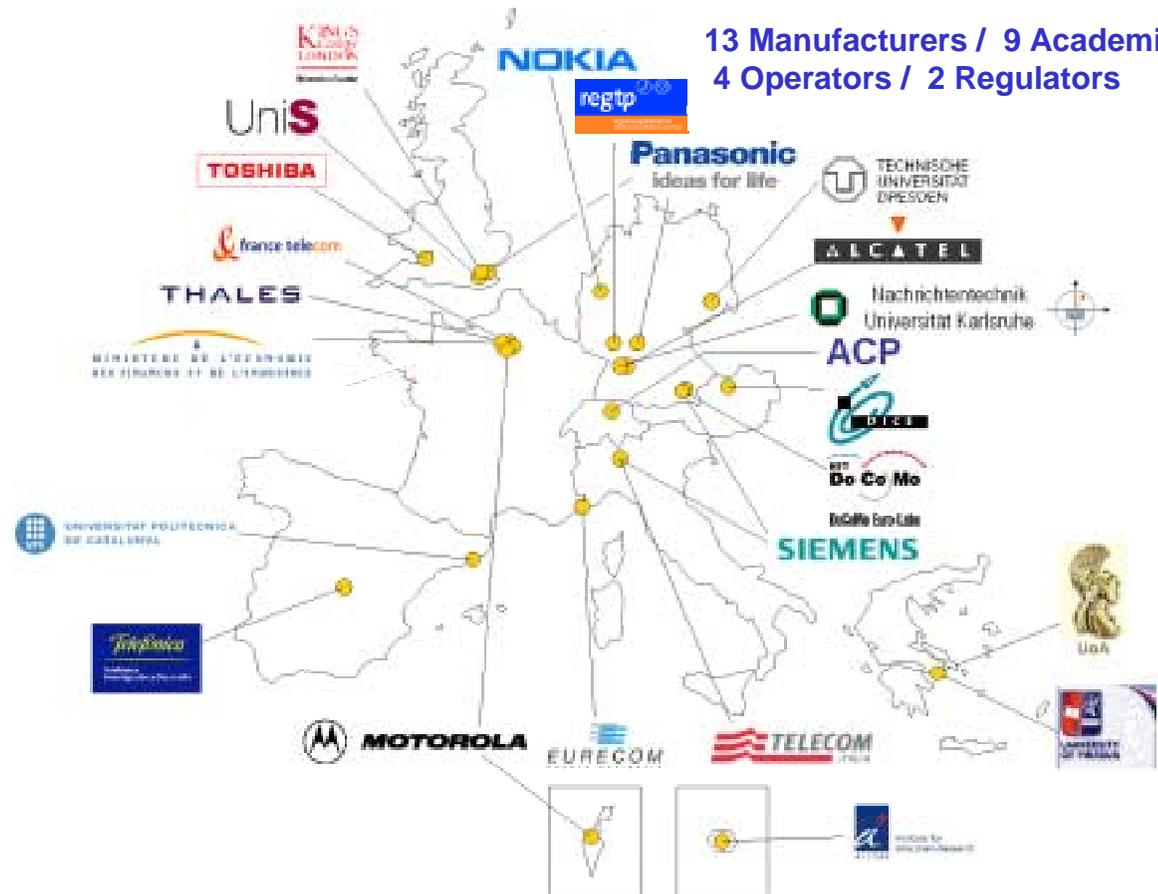
Heterogeneous Devices

# Rationale of E<sup>2</sup>R

- ❑ **Operators: Scalable and reconfigurable infrastructure** that optimises resource usage. New applications and technologies offered more efficiently. High return on investment, **reduction of CAPEX and OPEX costs**.
- ❑ **Service and Application Providers: Open flexible platforms** and associated execution environments. Deployment of enhanced features in reduced TTM.
- ❑ **Users: Integrated telecommunication environment**. Variety of services and applications at affordable prices. Ability to use **reconfigurable equipments** to reach required services at times and places when / where they need them.
- ❑ **Manufacturers: Wider markets** by offering customised solutions. Development of “**plug and play**” technology will ease migration to new standards, protocols and applications unknown as for today. Customer support facilitated.
- ❑ **Regulators: Consolidated framework** wherein the wireless environment should evolve. **Easier access, better spectrum management**, follow-up of ethical and technological rules.

## E<sup>2</sup>R Project Highlights

- ✓ E<sup>2</sup>R Phase 1 Duration  
Jan. 04 – Dec. 05
- ✓ Consortium (Phase 1)  
28 Organizations  
10 Countries
- ✓ Budget (Phase 1)  
16.2 MEuros
- ✓ EU Budget (Phase 1)  
8.9 MEuros
- ✓ Resources (Phase 1)  
1308 PM (~55 PY/Y)



- ✓ Contractual Outcomes (Phase 1) : 44 Deliverables and 77 Milestones

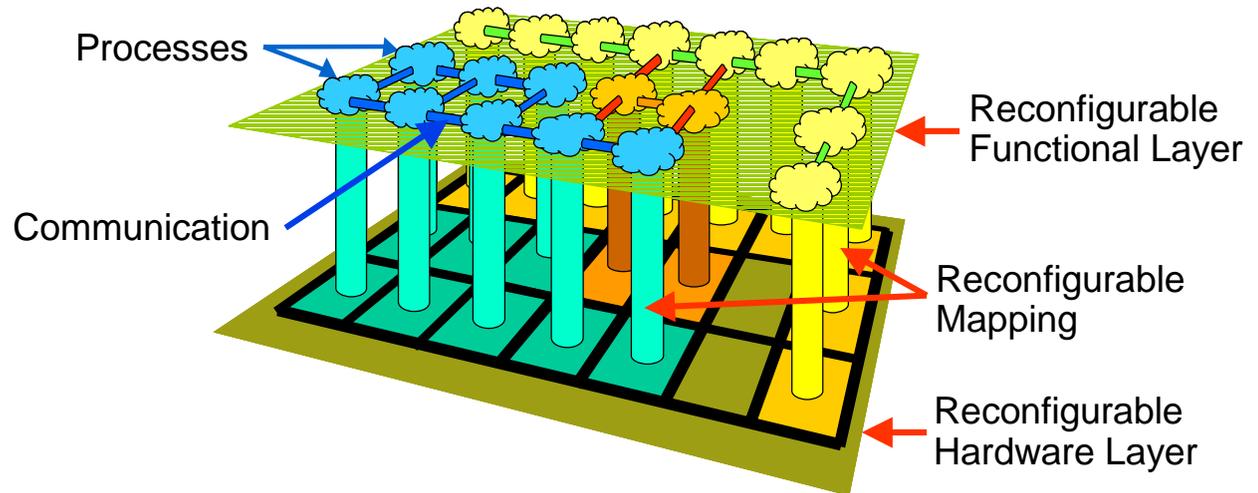
# E<sup>2</sup>R Project Structure

- ✓ **WP1: E<sup>2</sup>R System Research** aims to build and develop the System Research for end-to-end Reconfigurability, aggregating the technical, business and regulatory Visions from the different Actors of the Project across the Project WPs
- ✓ **WP2: Equipment Management** aims at enabling secure, reliable and seamless Configuration and Reconfiguration of Equipment (Terminal, BS, AP, Gateway)
- ✓ **WP3: Network Support for Reconfiguration** aims at defining the Support of Reconfigurability for Network Entities and Terminals by Network Functions for secure Download, Reconfiguration Management and Validation
- ✓ **WP4: Radio Modem Reconfigurability** aims at developing local Configuration Control Concepts and Mechanisms for the Physical Layer Resources, Reconfiguration Strategies and the Development of the Reconfigurable Physical Resources
- ✓ **WP5: Evolution of Radio Resource and Spectrum Management** aims at developing the Mechanisms for dynamic Allocation of Radio Resources, combining reconfigurable Technology and Support Structures with novel Resource Management Techniques
- ✓ **WP6: E<sup>2</sup>R Proof of Concept Evolutionary Environment** aims at developing and validating an experimental Proof of Concept Environment capable of demonstrating E<sup>2</sup>R Features in an all-IP heterogeneous Network Architecture

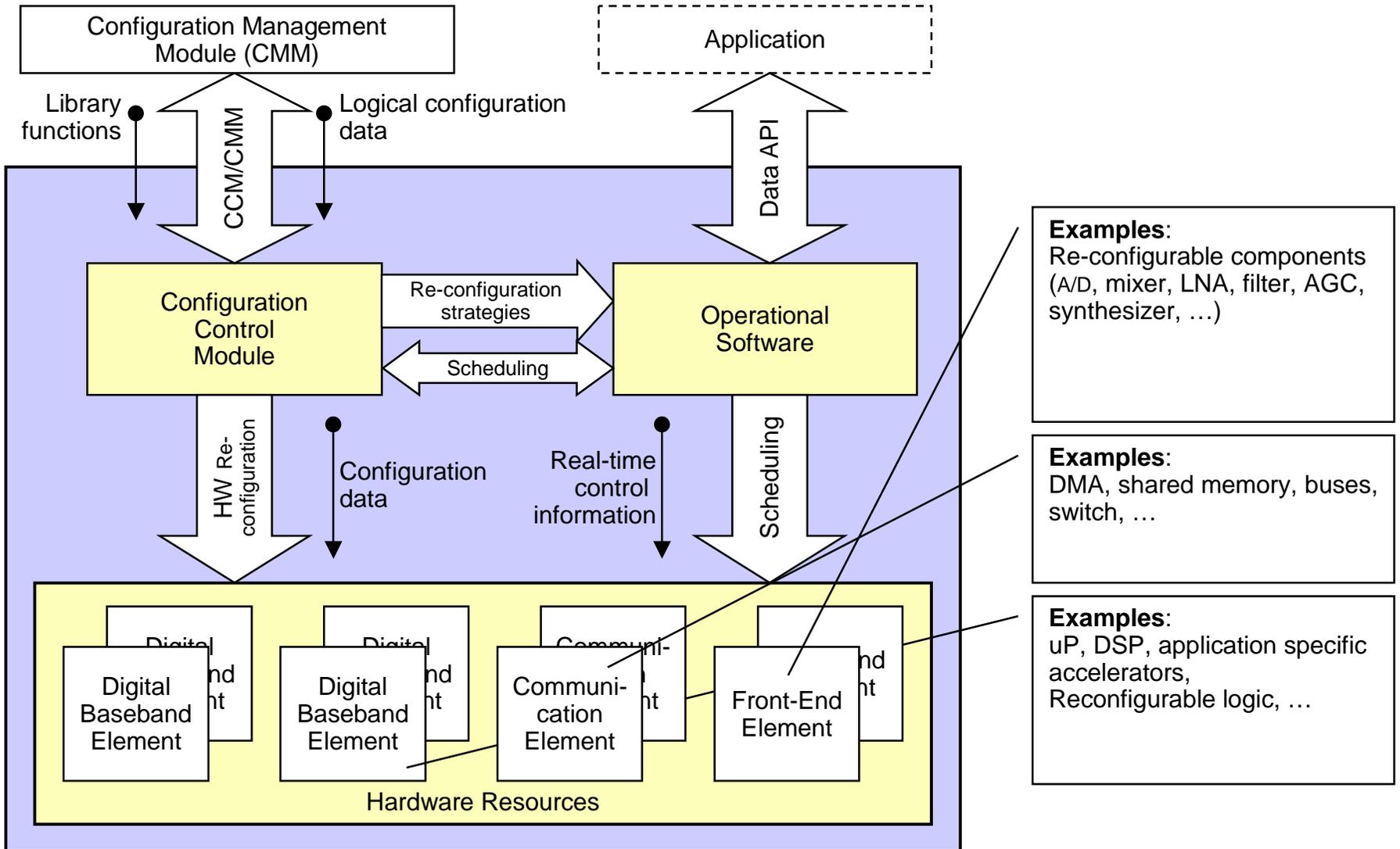


# E<sup>2</sup>R WP4 Objectives

- ❑ Evaluate a technological perspectives, scenarios and requirements of software radio with respect to the physical layer
- ❑ Develop a framework supporting power efficient dynamic reconfiguration of the radio modem (network and terminal)
- ❑ Definition of open interfaces and abstractions to support standardization of the reconfiguration process
- ❑ Support multiple levels of configuration granularity and the evolution of reconfigurable equipment into the commercial market place



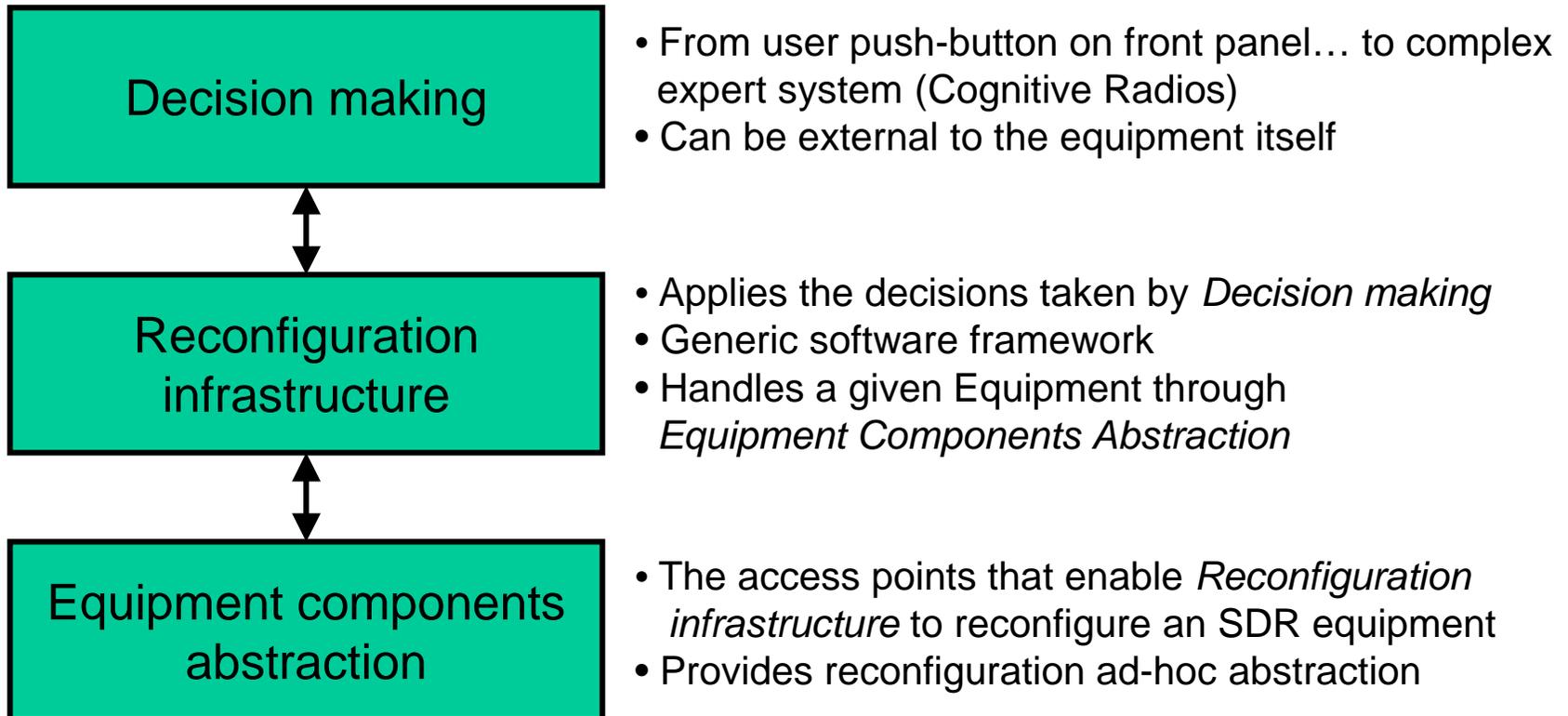
# E<sup>2</sup>R WP4 Scope



# Comparison of E<sup>2</sup>R and P<sup>2</sup>SRC achievements

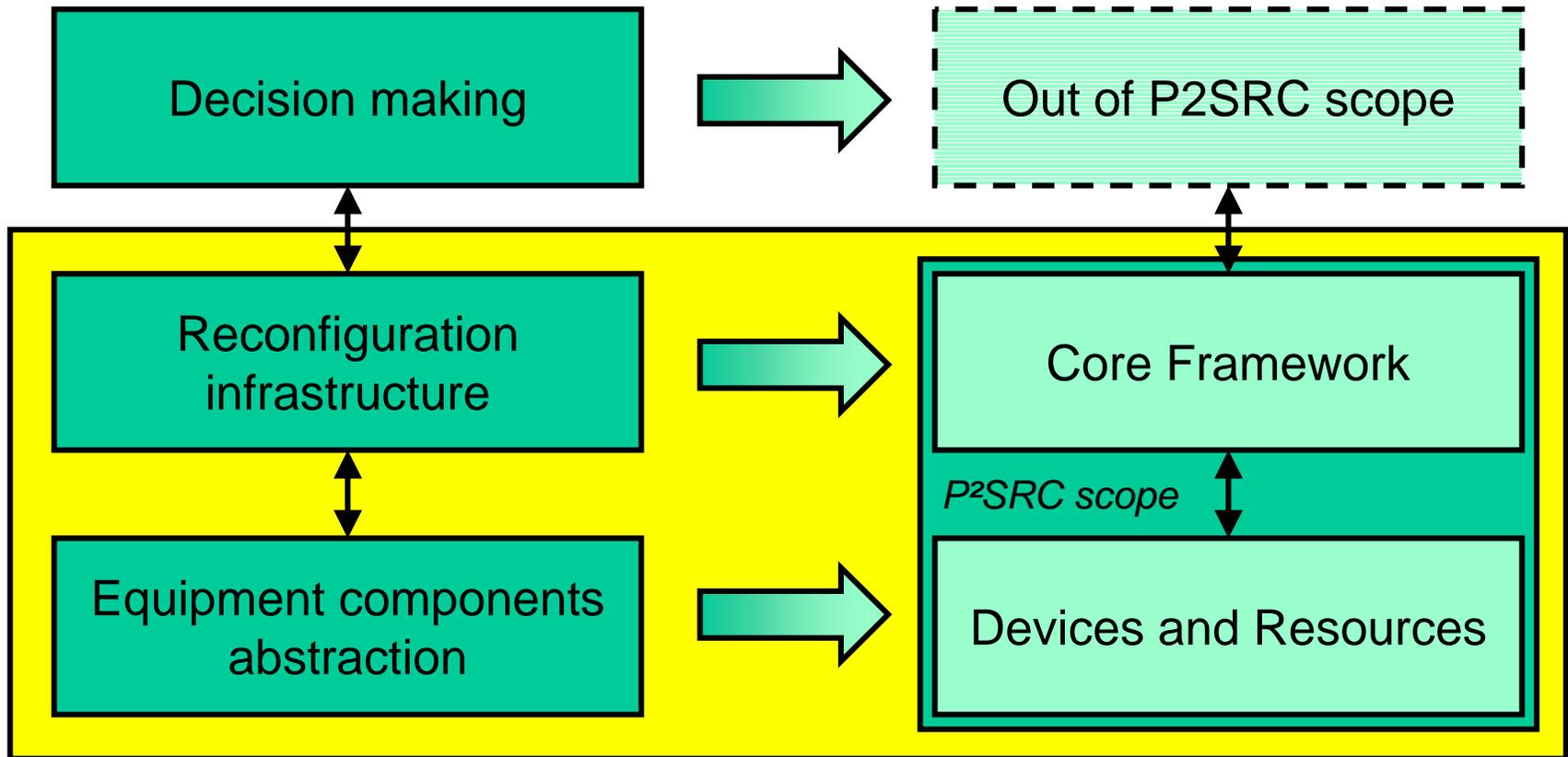


# Reference model for a SDR equipment



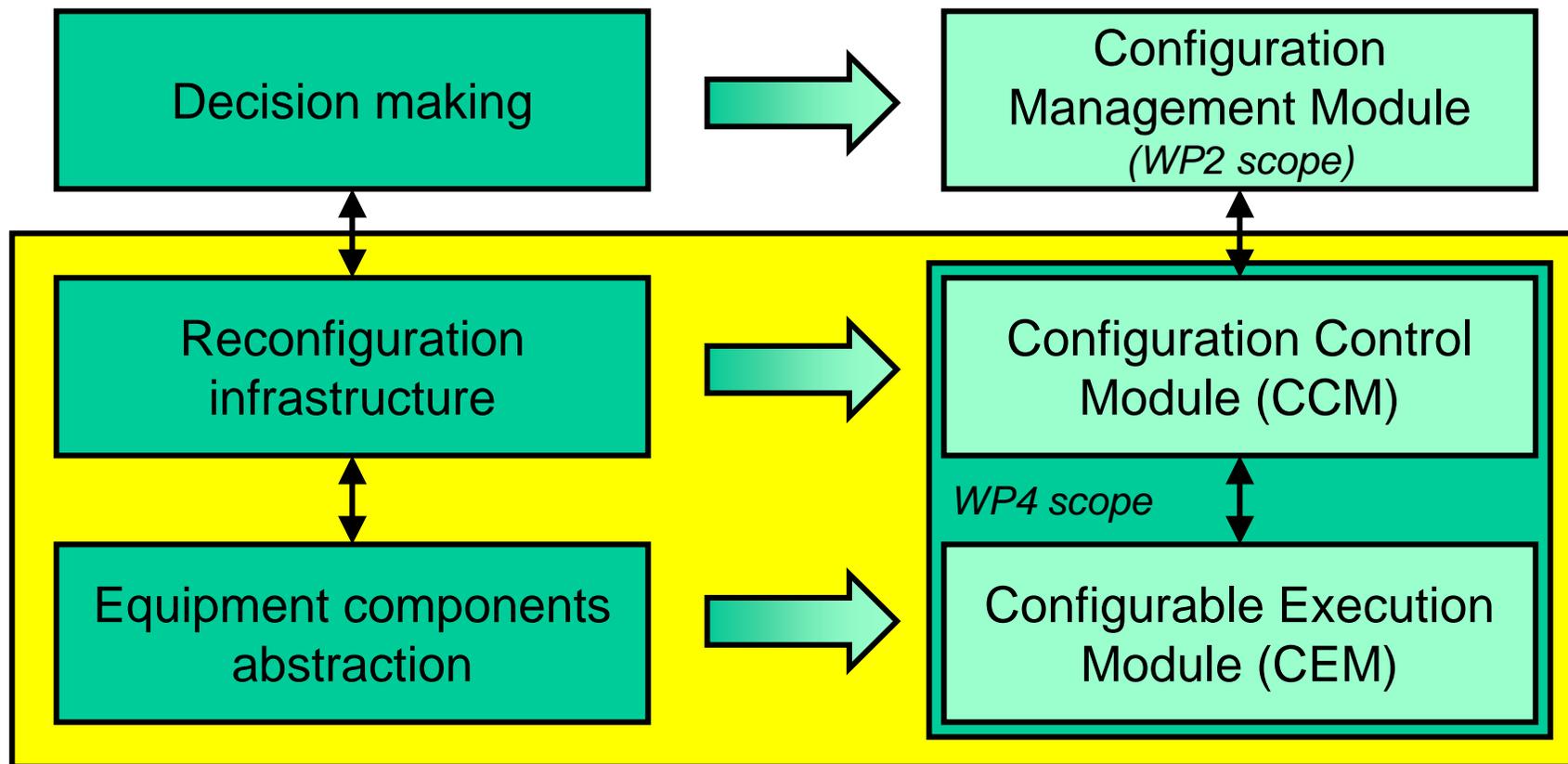
# P<sup>2</sup>SRC Mapping

- « The CF interacts with Devices and Resources to enable deployment and configuration of Waveform Applications »



# E<sup>2</sup>R Mapping

- « The CCM interacts with CEM to enable deployment and configuration of RAT application »



# Overlapping technical areas

## □ Reconfiguration infrastructure

- The software actually reconfiguring an equipment
- Respective approaches
  - E<sup>2</sup>R : Configuration Control Module (CCM), controlled by Configuration Management Module (CMM)
  - P<sup>2</sup>SRC : Core Framework, Application factory, ... with PIM decoupling ; CORBA-based PSM
  - SCA : same concepts but interleaved PIM and CORBA-based PSM

## □ Equipment components abstraction

- The way the elements composing the equipment are seen by reconfiguration infrastructure
- Respective approaches
  - E<sup>2</sup>R : Configurable Execution Module (CEM), handled by CCM
  - P<sup>2</sup>SRC : Devices, Resources, Base Application Interfaces, ...
  - SCA : same concepts but interleaved PIM and CORBA-base PSM

# Specific technical areas

- **E<sup>2</sup>R addresses, while P<sup>2</sup>SRC does not**
  - Overall End-to-end view
  - Architecture, business model and regulatory issues (WP1)
  - Reconfiguration decision making (WP2)
  - Network reconfiguration issues (WP3)
  - Emphasis on real-time and power consumption constraints (WP4)
  - Spectrum management (WP5)
  - Demonstration aspects (WP6)
- **P<sup>2</sup>SRC addresses, while E<sup>2</sup>R does not fully address**
  - Portability of RAT software applications
  - Data path APIs

☞ **We are far from a total overlapping ...  
but wide overlapping between E<sup>2</sup>R WP4 and P<sup>2</sup>SRC !**

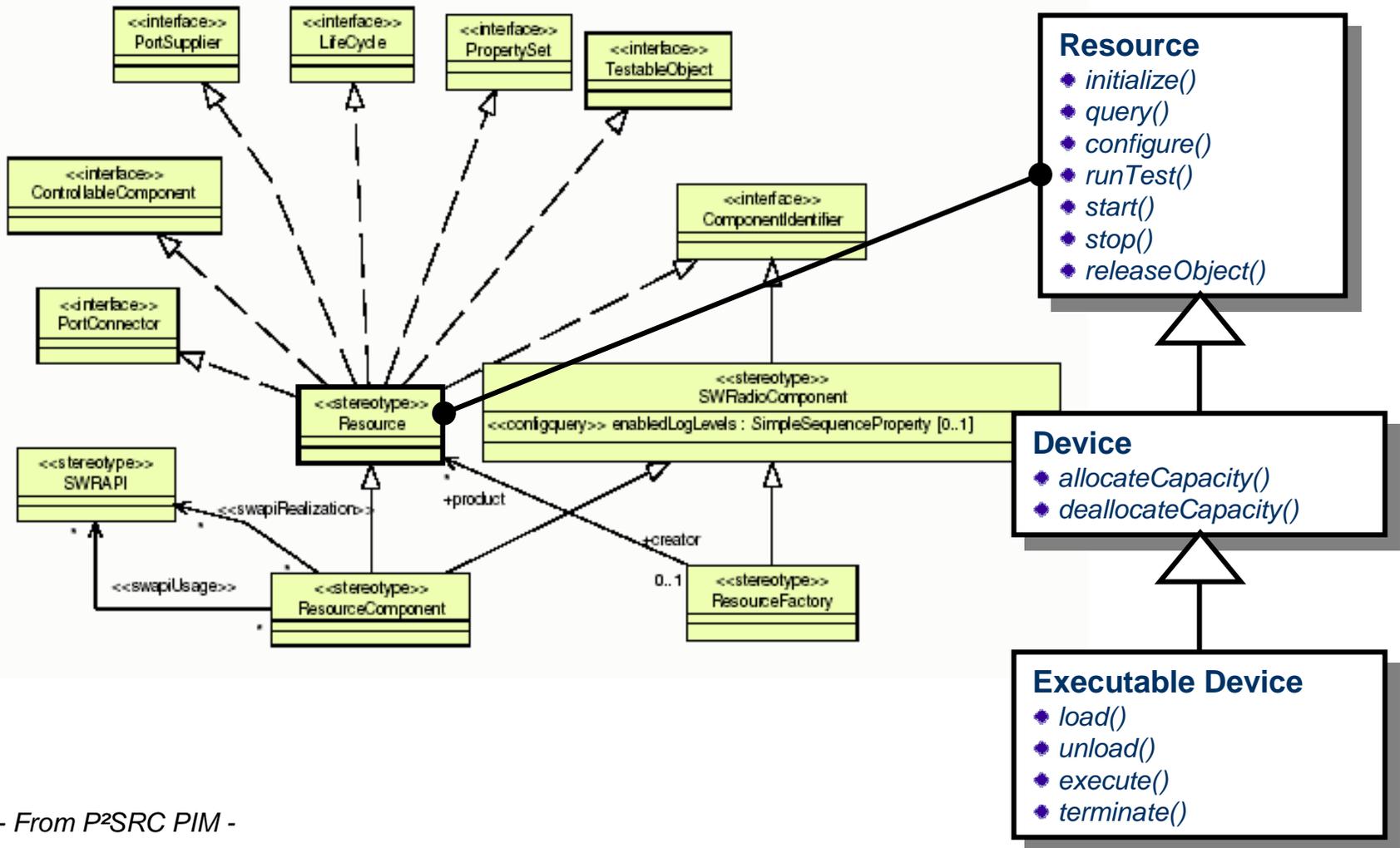
## □ Reconfiguration of a **Device**

- Examples : an analogue tunable element, a Viterbi decoder, ...
- E2R terminology = **Configurable Execution Module (CEM)**
- Key steps
  - Allocation, Initialization, Configuration, Test
  - Real-time operation

## □ Deployment and Configuration of a **WF Component**

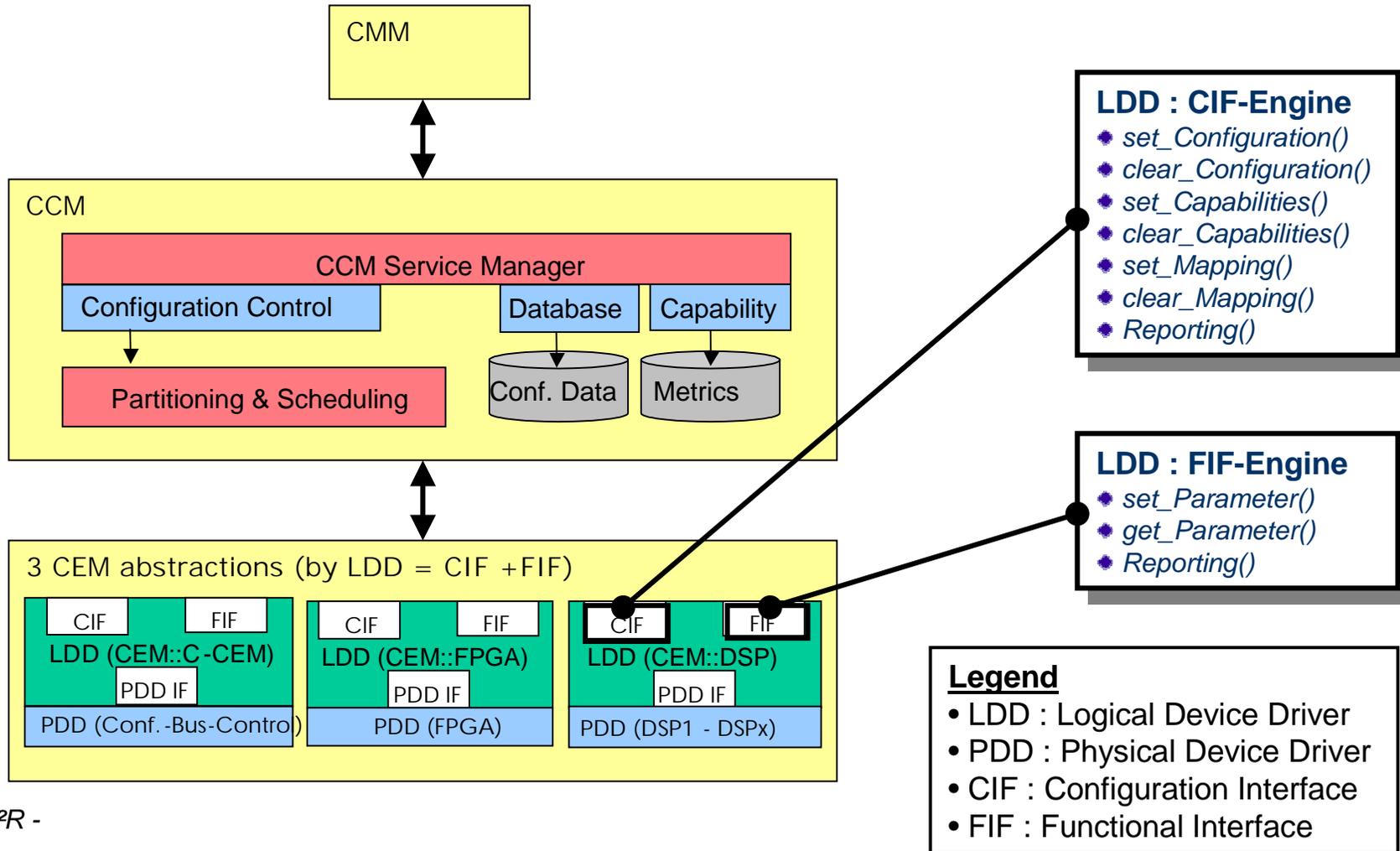
- Examples : the MAC layer of UMTS TDD, the PHY layer of a GSM stack, ...
- E2R terminology = **RAT Module**
  - **RAT : Radio Access Technology**
- On an Executable Device
- Key steps
  - Image Load and Execution, through Executable device
  - Component Initialization , Configuration, Test
  - Real-time operation

# P<sup>2</sup>SRC – Resource and Devices interfaces



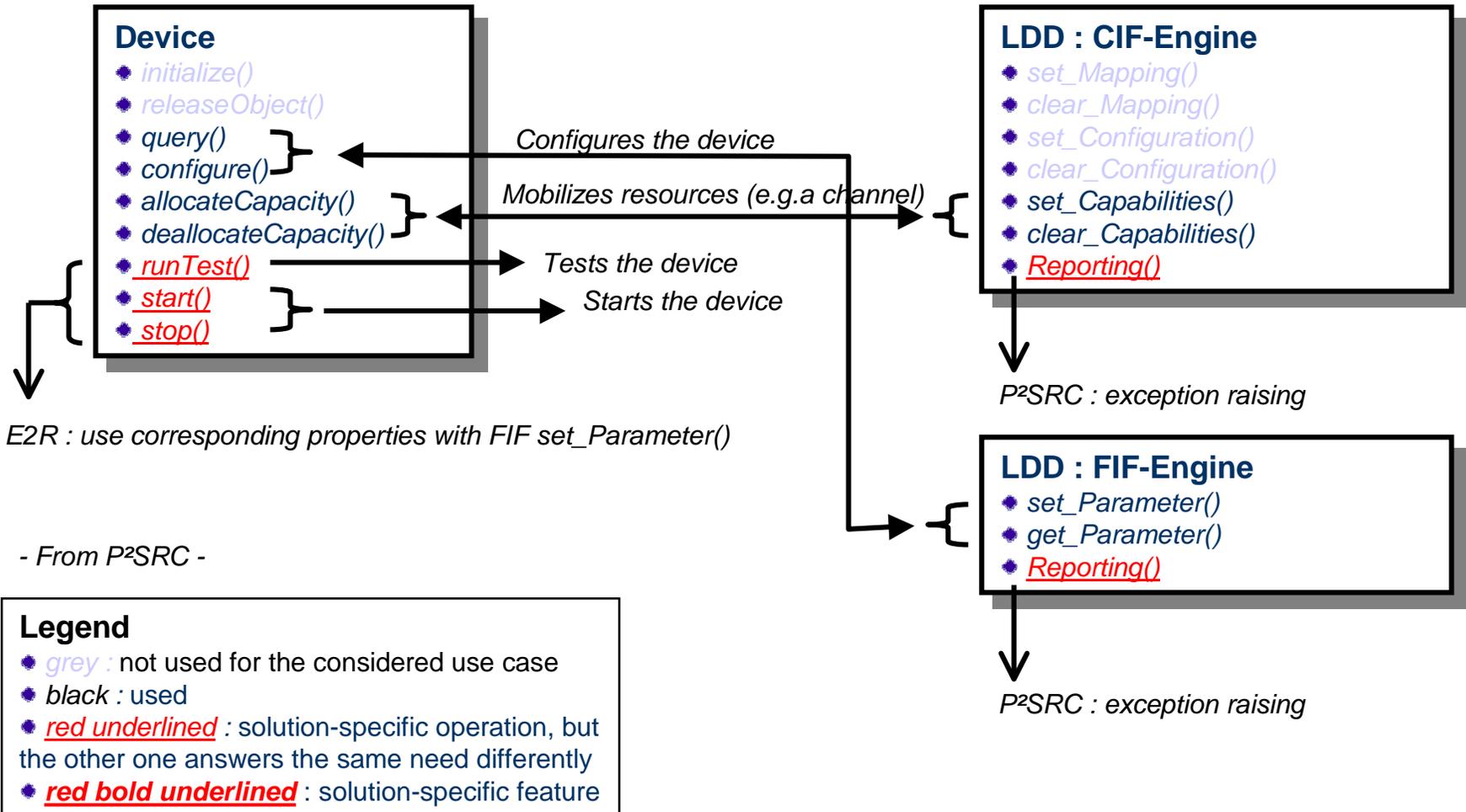
- From P<sup>2</sup>SRC PIM -

# E2R – CCM to/from CEM interfaces



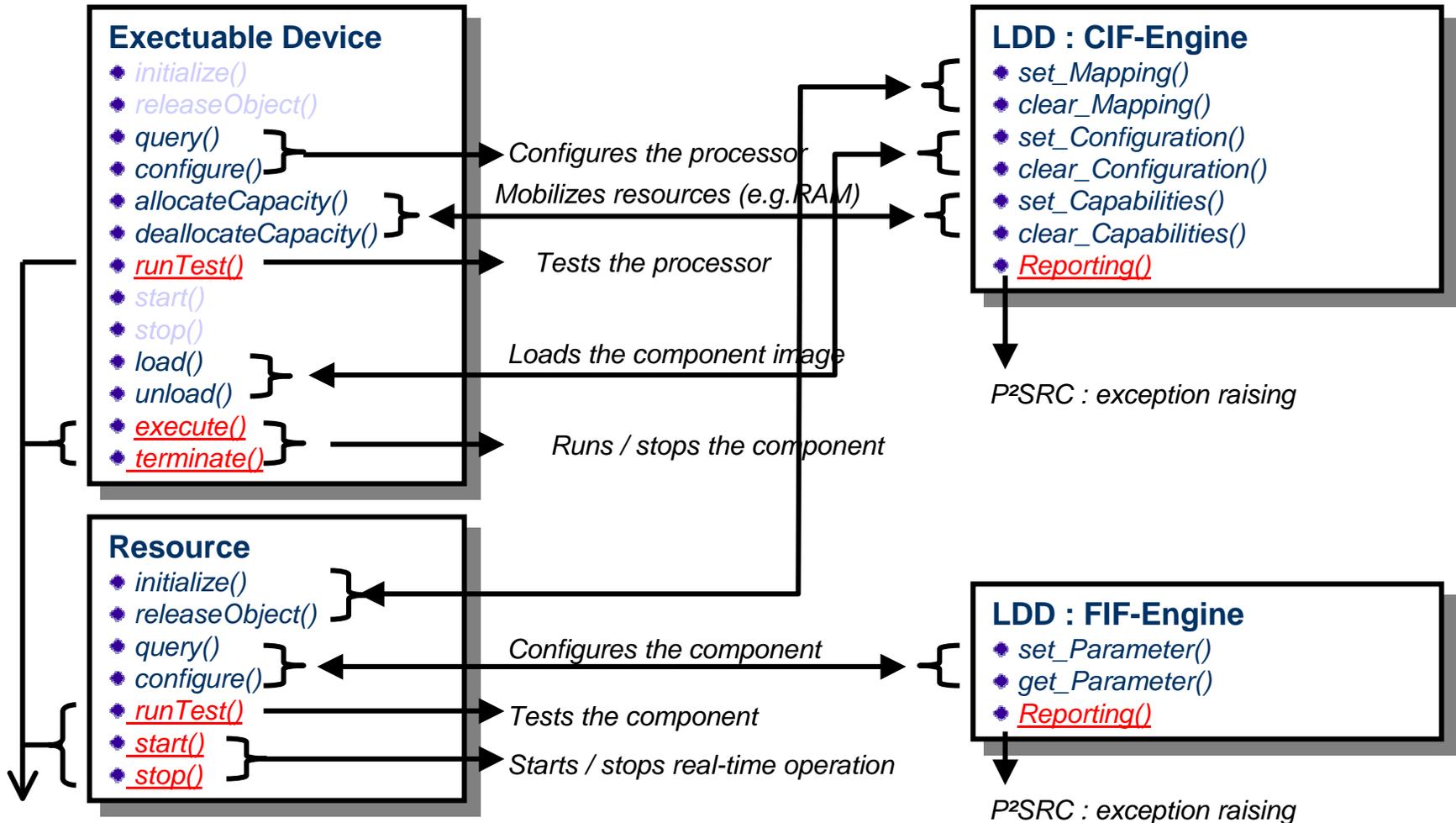
- From E<sup>2</sup>R -

# Compared Configuration of a Device / CEM



- From E<sup>2</sup>R -

# Compared Deployment and Configuration of a WF / RAT Component

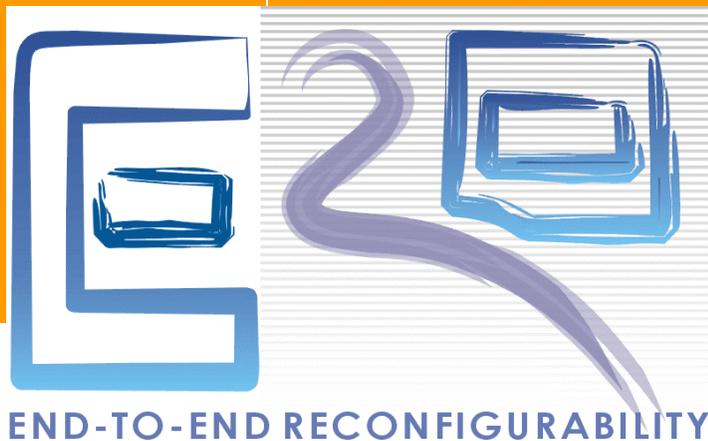


E2R : use corresponding properties with FIF set\_Parameter()

- From P<sup>2</sup>SRC -

- From E<sup>2</sup>R -

**Yes, many fruitful research opportunities !**



# Strengths and weaknesses of P<sup>2</sup>SRC

- 😊 **P<sup>2</sup>SRC provides a very strong technical framework**
  - **OMG Specification experience**
  - **Strength of MDA Approach**
- 😊 **P<sup>2</sup>SRC PIM**
  - 😊 **Reconfiguration Infrastructure is stable (SCA CF Heritage)**
  - 😊 **Radio facilities are good, but to be improved**
    - **For Physical Layer**
    - **For Communication Equipment**
- 😞 **P<sup>2</sup>SRC PSM : CORBA & AEP are not applicable on all equipments**
  - **Other embedded Operating Environments (e.g. Symbian-based)**
  - **Insufficient maturity on DSPs and FPGAs**
  - **Lightweight implementations still too demanding for terminals**
- 😊 **P<sup>2</sup>SRC exists but depends on participants involvement to progress!**

# Strengths and weaknesses of E<sup>2</sup>R

- ☺ **E<sup>2</sup>R is a key international R&T program on Commercial end-to-end reconfigurability issues**
- ☺ **E<sup>2</sup>R spends significant effort on Radio Modem reconfigurability issues**
  - **For many commercial equipments connected to radio media**
    - **Mobile phone User Equipments**
    - **Mobile phone Base Stations**
  - **Efficient resource usage**
  - **Power consumption issues**
- ☺ **E<sup>2</sup>R addresses the End-to-End Commercial industry stakes**
  - **From Business cases...**
  - **... to implementation issues**
- ☹ **E<sup>2</sup>R lacks reference implementation in Phase 1**
- ☹ **E<sup>2</sup>R will propose solutions and concepts for standardization, but will not standardize on its own !**

# Identified technical opportunities

- **P<sup>2</sup>SRC can be improved to fulfil Commercial SDR needs**
  - **Addition of Commercial-specific improvements to PIM**
    - Deployment reliability and real-time performance
    - Power and resource management features
  - **Derive *ad hoc* PSMs for Commercial Industry**
    - For Operating Environments of Terminals and Base Stations
    - For other OE answering to other sorts of Equipments
  - **All this can bring increased interest and momentum to P<sup>2</sup>SRC**
- **E<sup>2</sup>R outputs can take benefits from OMG achievements**
  - **Benefiting of MDA approach strengths (PIM / PSM structure)**
  - **Avoiding to re-design solutions of Reconfiguration Infrastructure while comparable solutions exist**
  - **Using proven API Building Blocks**
  - **Using when/if appropriate the CORBA-based PSM**

# What can be done

- **OMG SBC can provide the frame**
  - **P<sup>2</sup>SRC Revision Task Force may integrate E<sup>2</sup>R areas of interest**
  - **Other SBC activities can benefit of cooperation (e.g. Digital IF)**
- **E<sup>2</sup>R Phase 2 can provide the inputs**
  - **Spans on years 2006-2007**
  - **Can contribute to SBC P<sup>2</sup>SRC**
- **Multi-level cross-fertilization is at hand**
  - **EU ⇔ USA**
  - **Commercial ⇔ Military**
  - **R&D Programme ⇔ Standardization**
- **Increased impact for SDR technologies and MDA approaches**
  - **Across Industrial Domains**
  - **Inside Physical Layer area**
  - **Contributing to SCA 3.x initial objectives**

**Thank you for your attention**



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