Introduction to the Software Communications Architecture

Wireless Innovation Forum

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Outline

- SCA is Component Based Development
- SCA Overview
- SCA APIs
- Summary

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Component Based Development Overview

- From a software development perspective, the SCA is a Component-Based Development architecture
- What is Component-Based Development ?
  - An architecture for the creation, integration, and re-use of software components
  - A software development paradigm where the smallest unit of software is a **component**
  - With CBD, an application is 'assembled' using software **components** much like a board is populated with hardware **components**
- CBD is currently the most popular programming paradigm
  - Microsoft's CBD is the ".NET" framework
  - Sun Microsystem's CBD is the "EJB" framework
  - OMG's CBD is the "CCM" framework
  - Software Defined Radio CBD is the "SCA" framework

Component Based Development Overview

- CBD's goal is to apply the hardware development paradigm to software
  - Select software components from a 'spec-sheet' catalogue
    - Describe how to influence behaviour (configuration properties)
    - Describe how to interface (ports)
    - Describe resource requirements (capability properties)
    - Describe resource consumption (capacity properties)

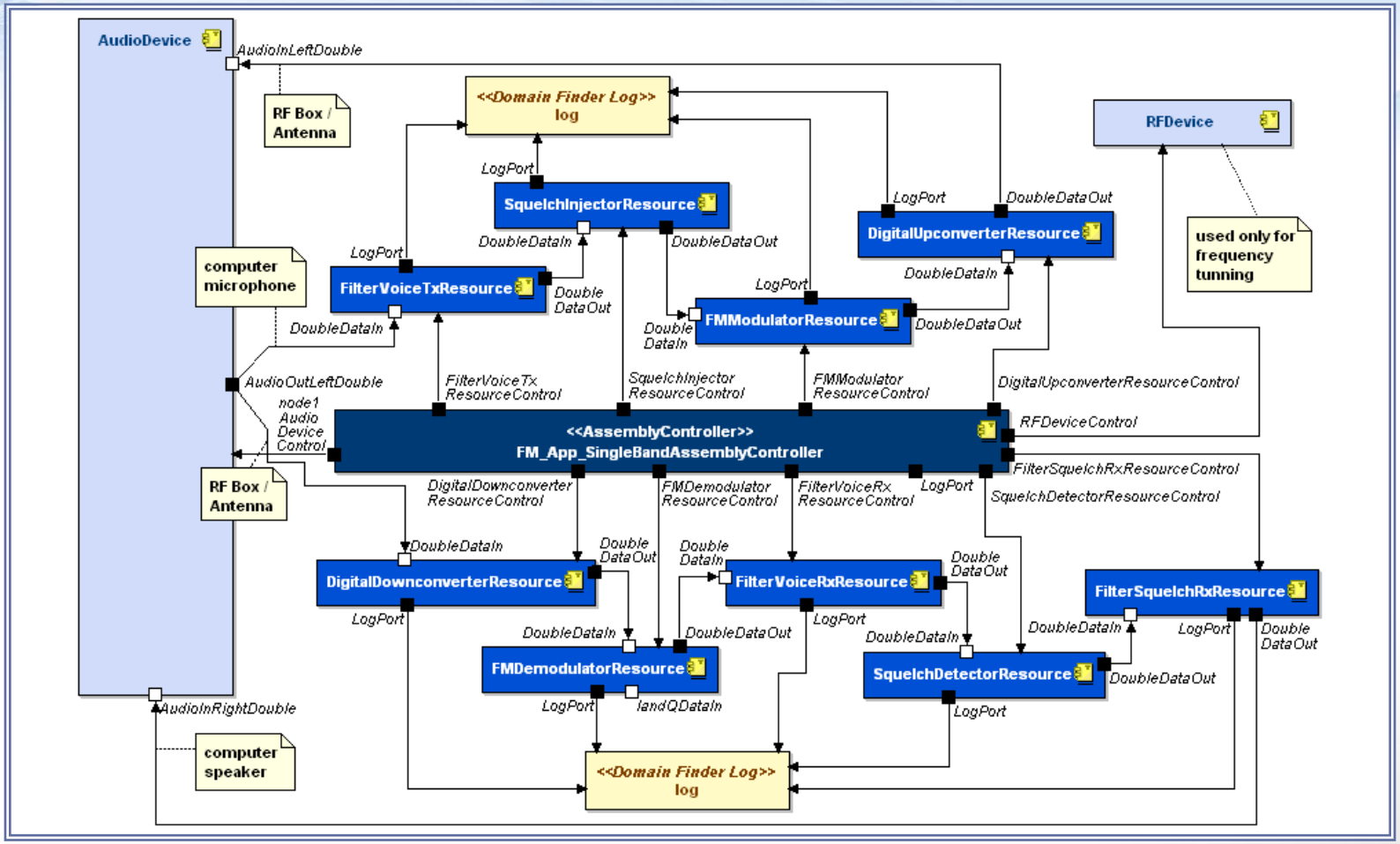
- CBD Requirements:
  - Component Model
    - Well defined standards and conventions
    - Design rules that must be obeyed by all components
  - Component Framework
    - Support and enforce component models (development and runtime)
    - Support infrastructure (runtime)
    - Can be seen as a mini Operating System

Component Based Development Overview

- Characteristics of a Software Component
  - A small, reusable module of binary code that performs a well-defined function
  - A black-box that hides the component internal implementation, but explicitly exposes its external interfaces
  - Designed, implemented, and tested as a unit before it is used in an application
  - Predictable, reusable, replaceable, upgradable, extendable, etc.
- Interfaces of a Software Component
  - Clean separation between interfaces and implementations
  - Interfaces become contracts between components that ‘require’ access to certain operations and components that ‘implement’ them

Component Based Development Overview

FM Single Band Waveform



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Software Communications Architecture Overview

What is the SCA?

- The SCA was created for the US DoD Joint Tactical Radio System (JTRS) program
  - Created by the Modular Software-programmable Radio Consortium (MSRC): Raytheon, BAE Systems, Rockwell Collins, and ITT
- The goal of the SCA is to facilitate the reuse of waveform applications across different radio sets
- Central software piece in a radio, the "SDR operating system"
- The SCA is not a system specification!
  - Provides an implementation-independent set of rules that constrain the design of systems

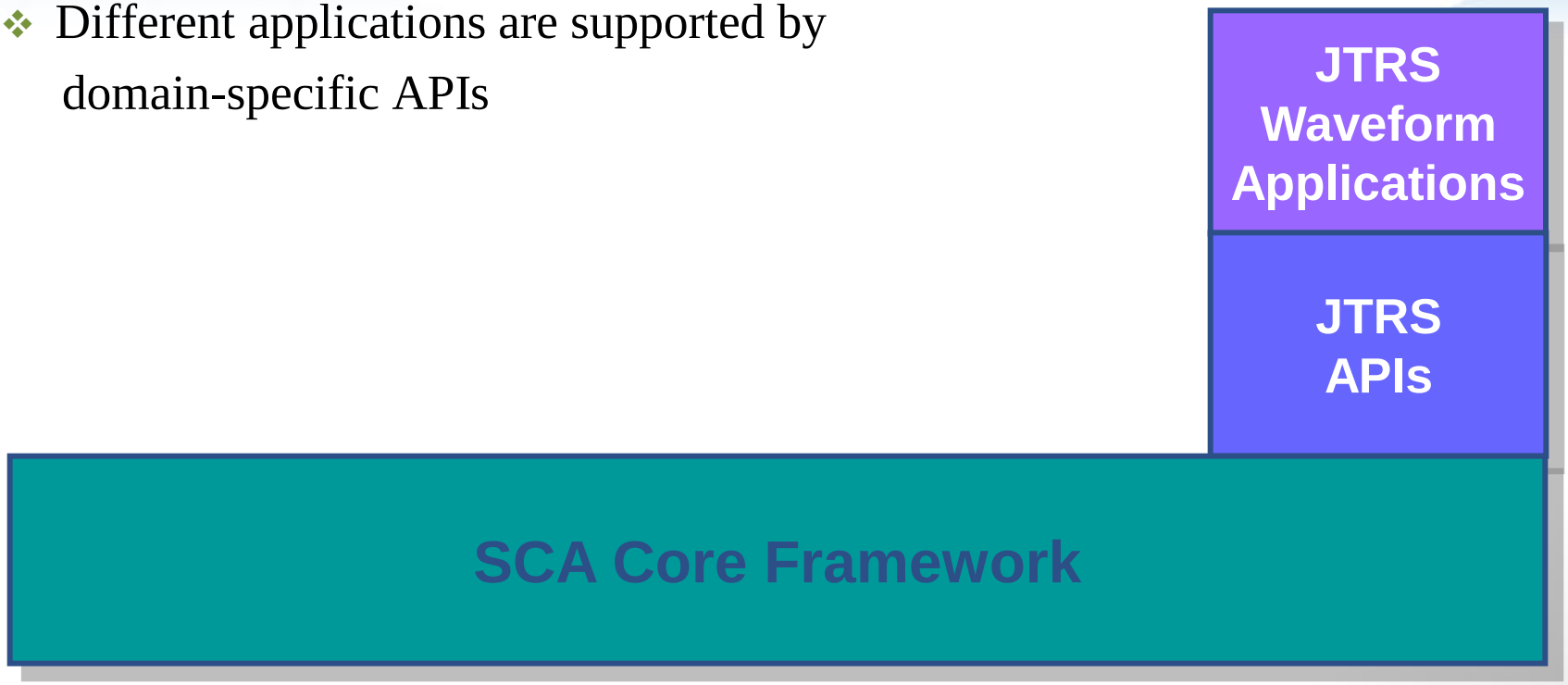
Application Domains

- The SCA is independent of the application domain

SCA Core Framework

Application Domains

- The SCA is independent of the application domain
- Different applications are supported by domain-specific APIs



Software Communications Architecture Overview

Application Domains

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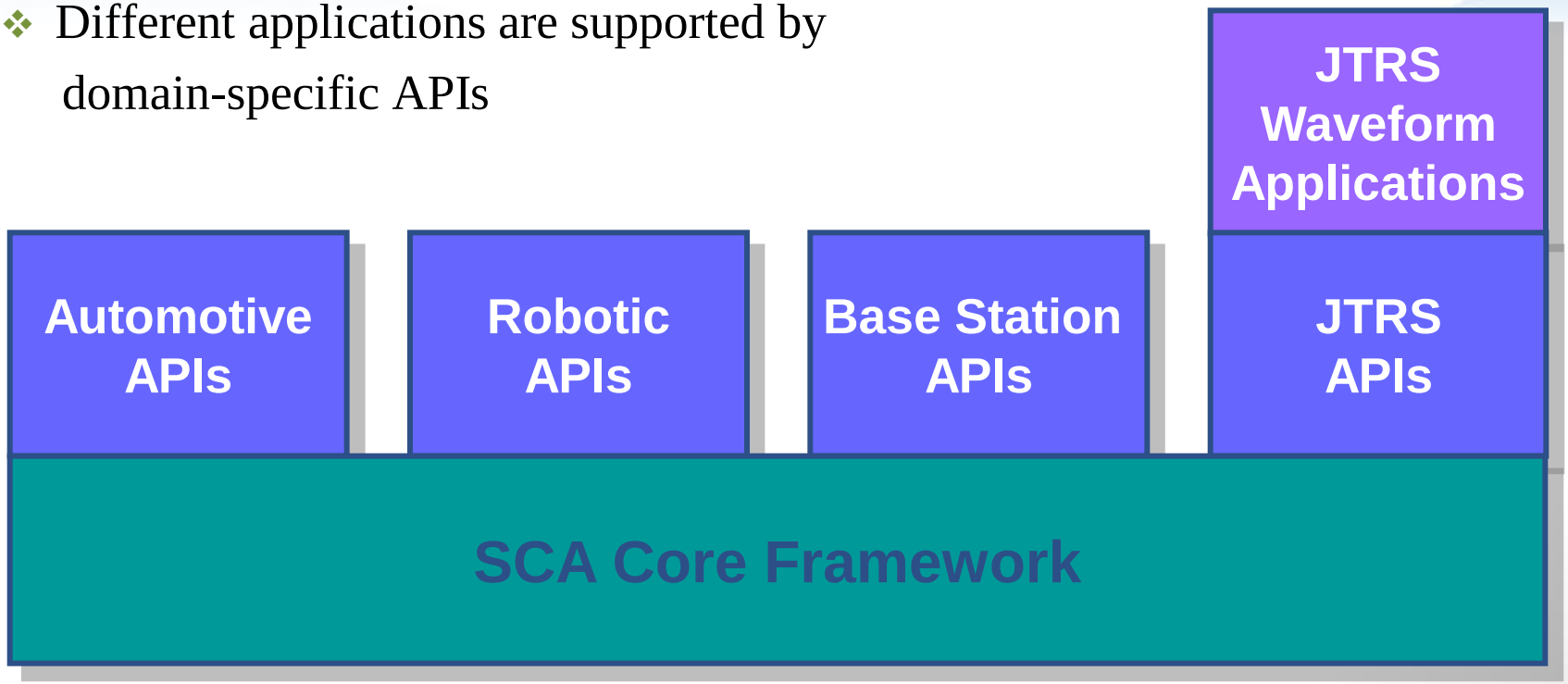
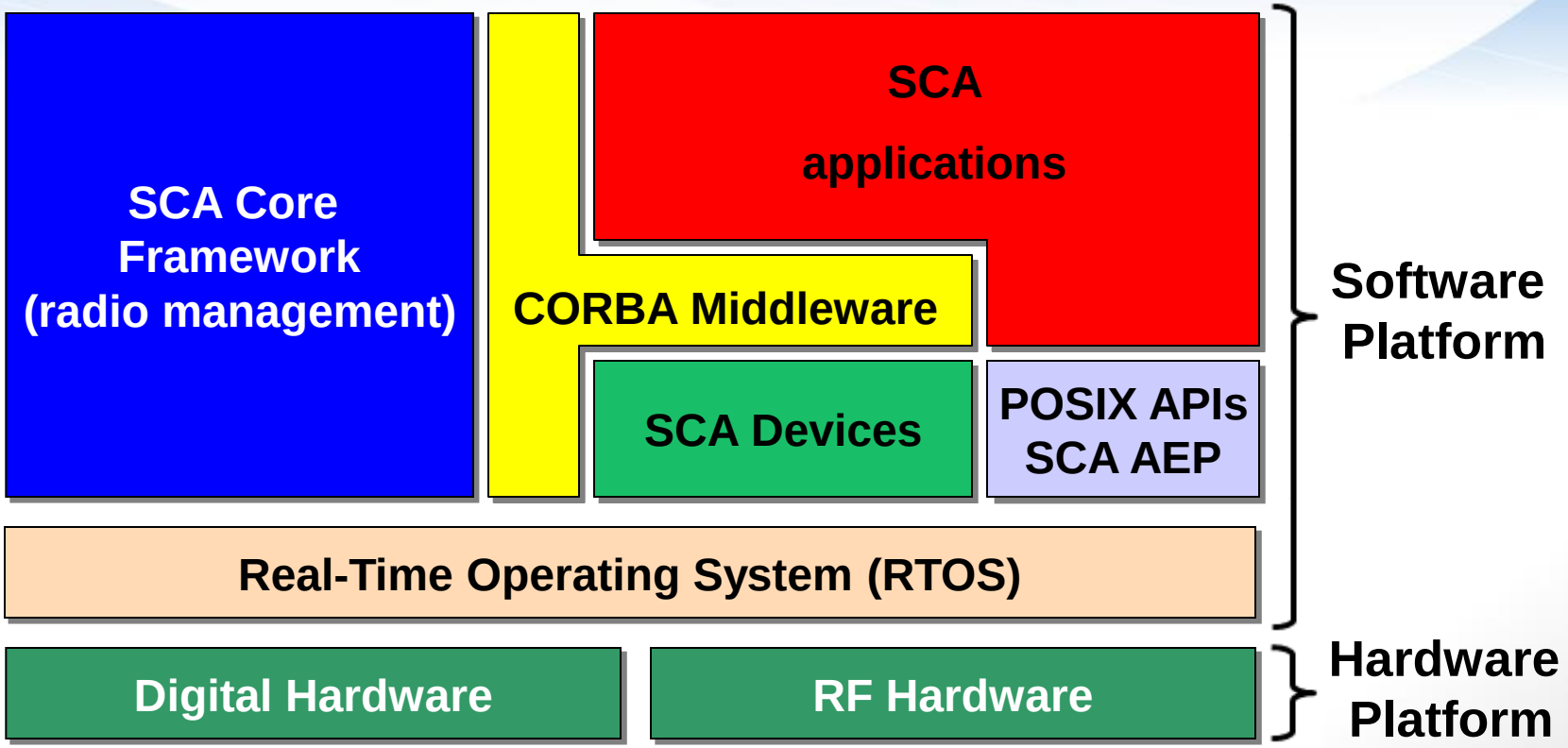


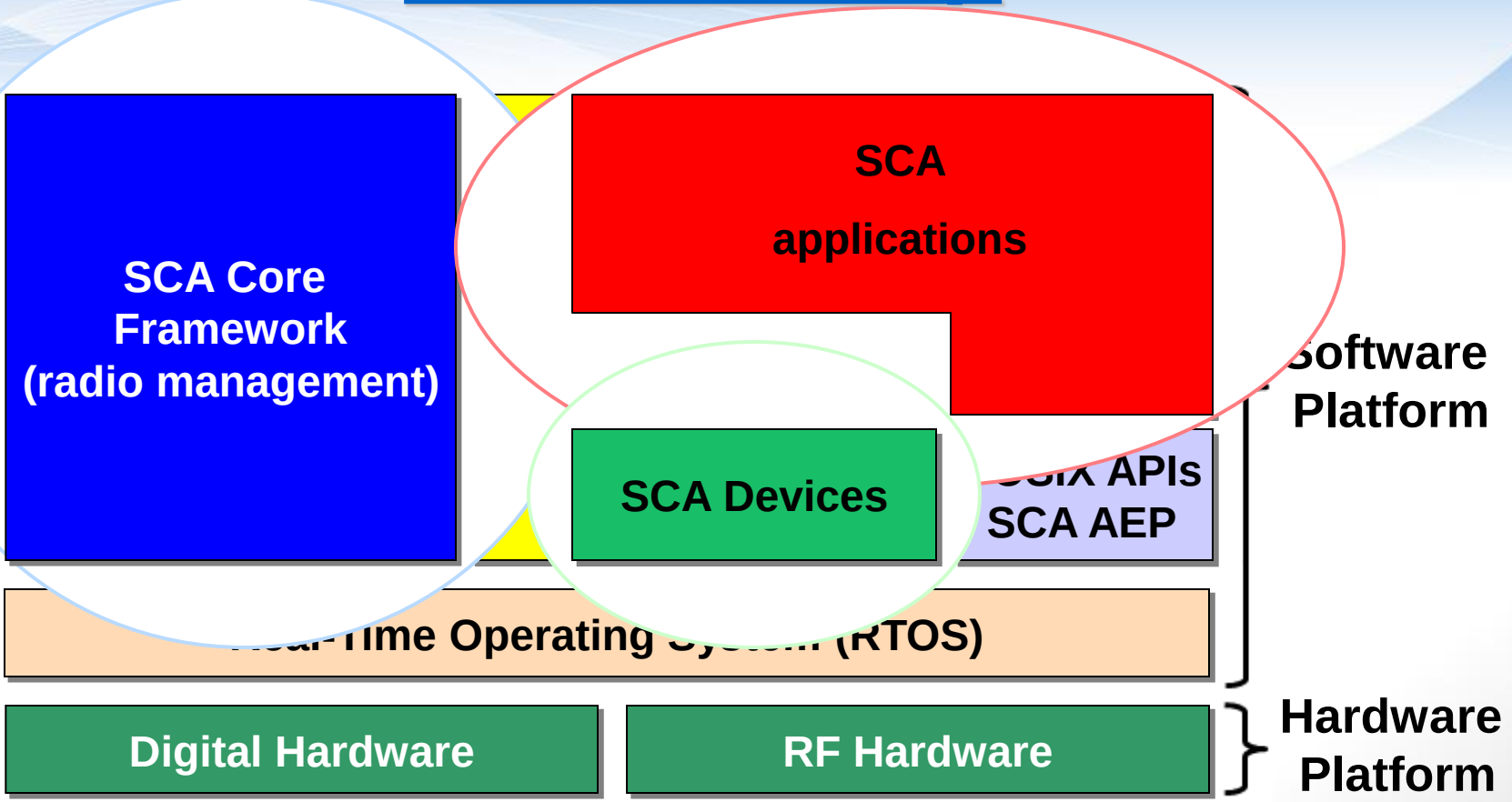
Software Communications Architecture Overview

SCA Functional Groups



Software Communications Architecture Overview

SCA Functional Groups

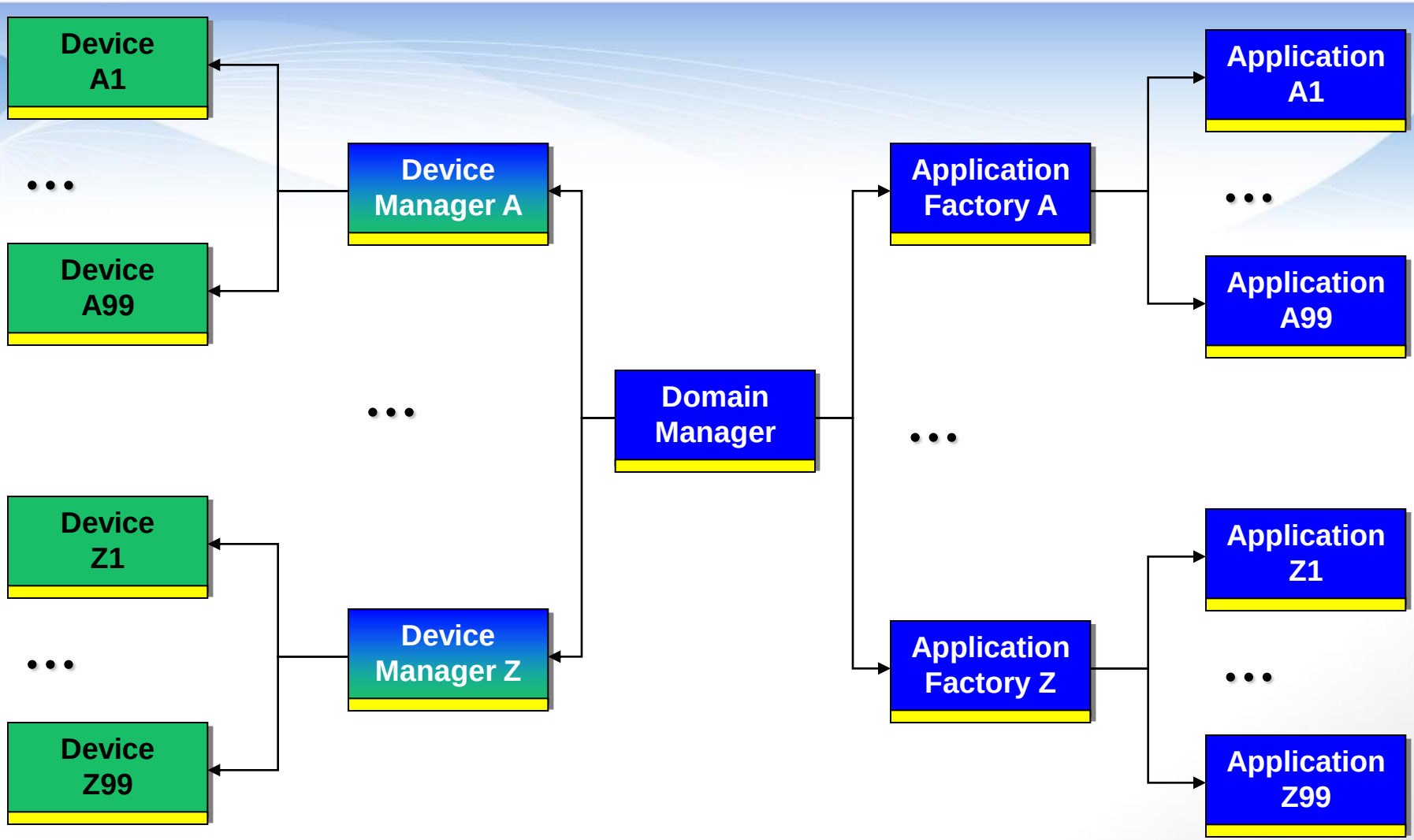


Software Communications Architecture Overview

SCA Functional Groups

- Software components are partitioned into three groups: Radio Management, Devices and Applications
  - 1. Radio Management
    - DomainManager, DeviceManager, ApplicationFactory, Application
    - Used to install/uninstall/deploy/configure applications, health monitoring, introspection, etc.
    - Used to enforce the lifecycle of SCA Components
  - 2. Devices
    - Device, LoadableDevice, ExecutableDevice (provide access to hardware components)
    - DeviceManager (used to control radio nodes)
    - Devices can be started, stopped, configured, queried, tested, etc
  - 3. Applications
    - An application is composed of Resources
    - Deployable software implementation of communication standards: FM LoS, EPLRS, Link 16, etc
    - Applications can be started, stopped, configured, queried, tested, etc

Software Communications Architecture Overview



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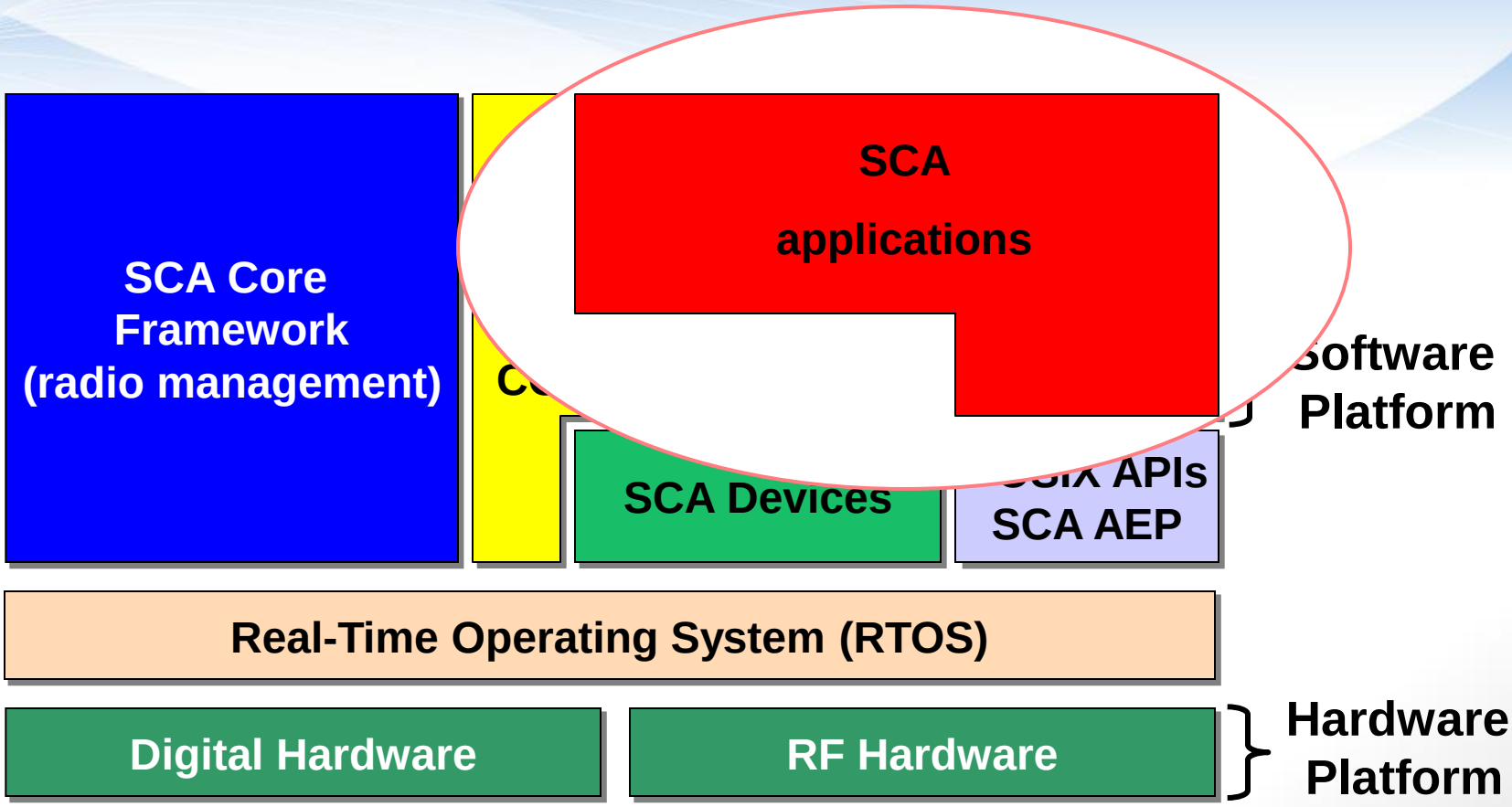
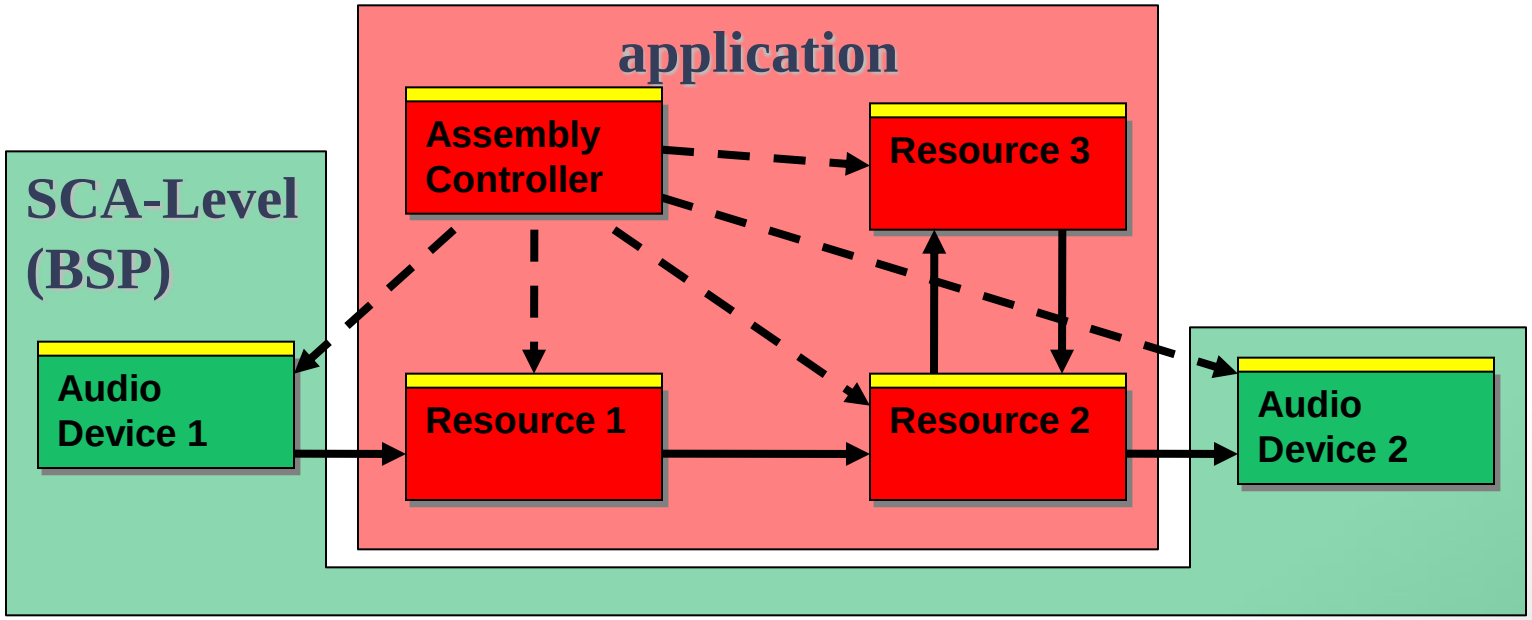
SCA APIs – Application Control



SCA APIs – Application Control

SCA applications (cont)

- An application can be viewed as a single *Resource*:
  - It has a certain combination of input, output, and control ports that need to be connected to other components
  - Its behavior can be altered through configuration properties



SCA APIs – Application Control

SCA Resource

- A *Resource* is much like a hardware component
  - It has a certain combination of input, output, and control ports that need to be connected to other components
  - To use a *Resource* in an application, it must be deployed onto a *Device*
  - A *Resource* has requirements a *Device* must meet
    - Capability requirements: OS, Processor, etc.
    - Capacity requirements: MIPS, kilo bytes of memory, etc.
- The behavior of a Resource can be altered by changing the value of its configuration properties
  - Ex: code rate

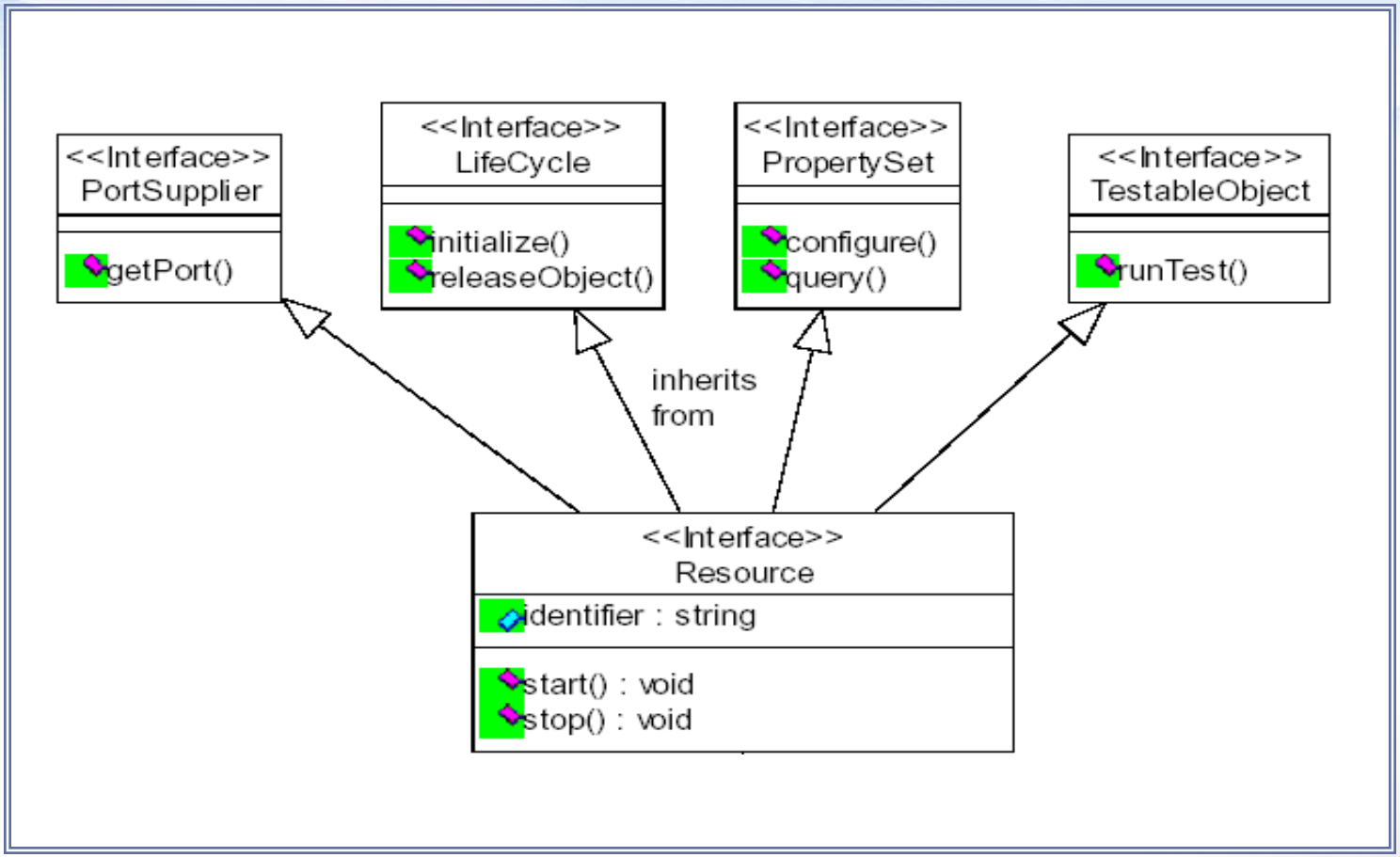
SCA APIs – Application Control

SCA Resource (cont)

- Simple or complex signal processing function
- Granularity: fine or large
  - An FFT Resource or a DAB™ Resource
- A Resource is always a port supplier
  - API to get a port
  - A port is identified by a named string
  - May provide ports for connection to other components
  - May provide ports to give access to a particular API

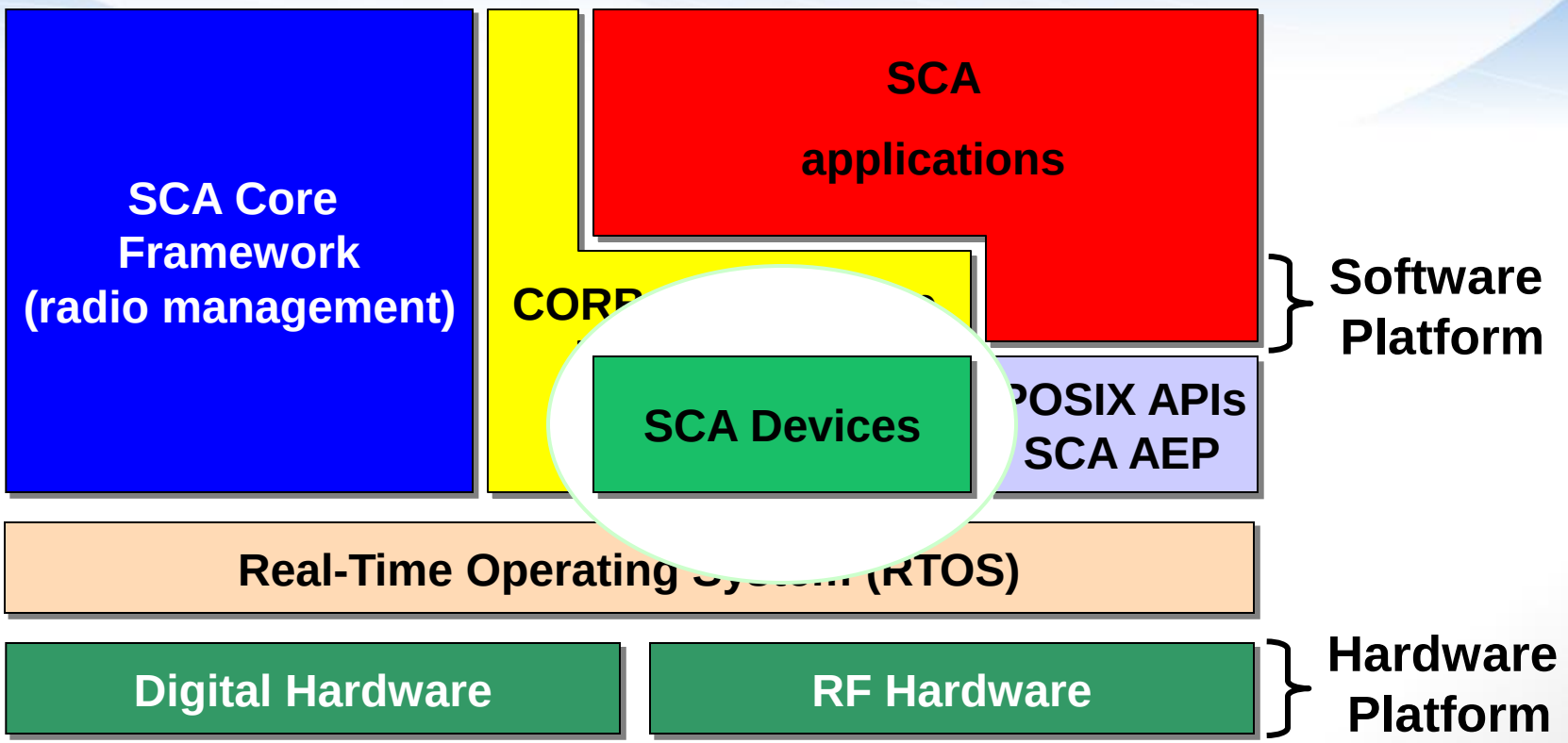
SCA APIs – Application Control

SCA Resource (cont) API



SCA APIs – Device Control

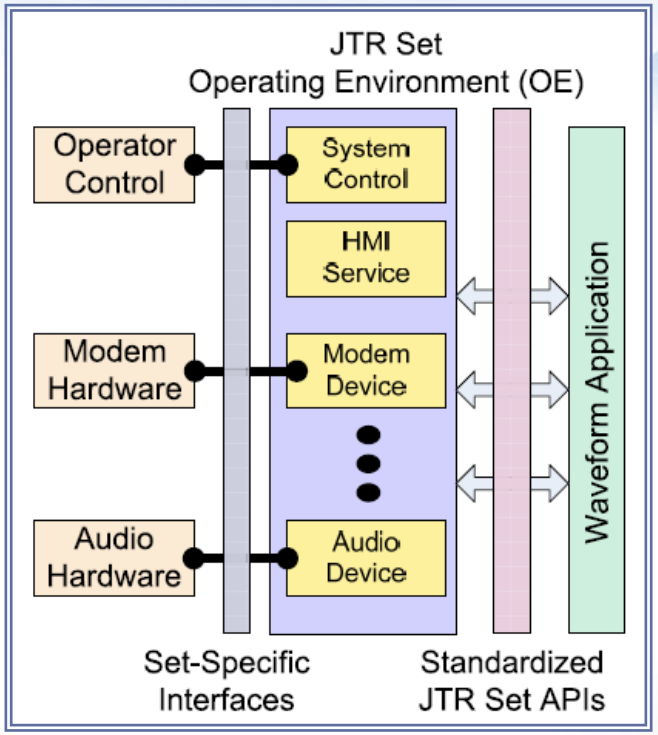
Device Overview



SCA APIs – Device Control

Device Overview

- *Devices* are software proxies for hardware devices and/or can be target for software deployment
- There are three kinds of *Devices:*
  - *Device:*
    - This kind of *Device* is generally used for getting access to autonomous hardware device (ex: Modem, Audio, GPS receiver)
  - *LoadableDevice:*
    - This kind of *Device* is generally used as a proxy for a device like an FGPA
  - *ExecutableDevice:*
    - This kind of *Device* is generally used as a proxy for GPP



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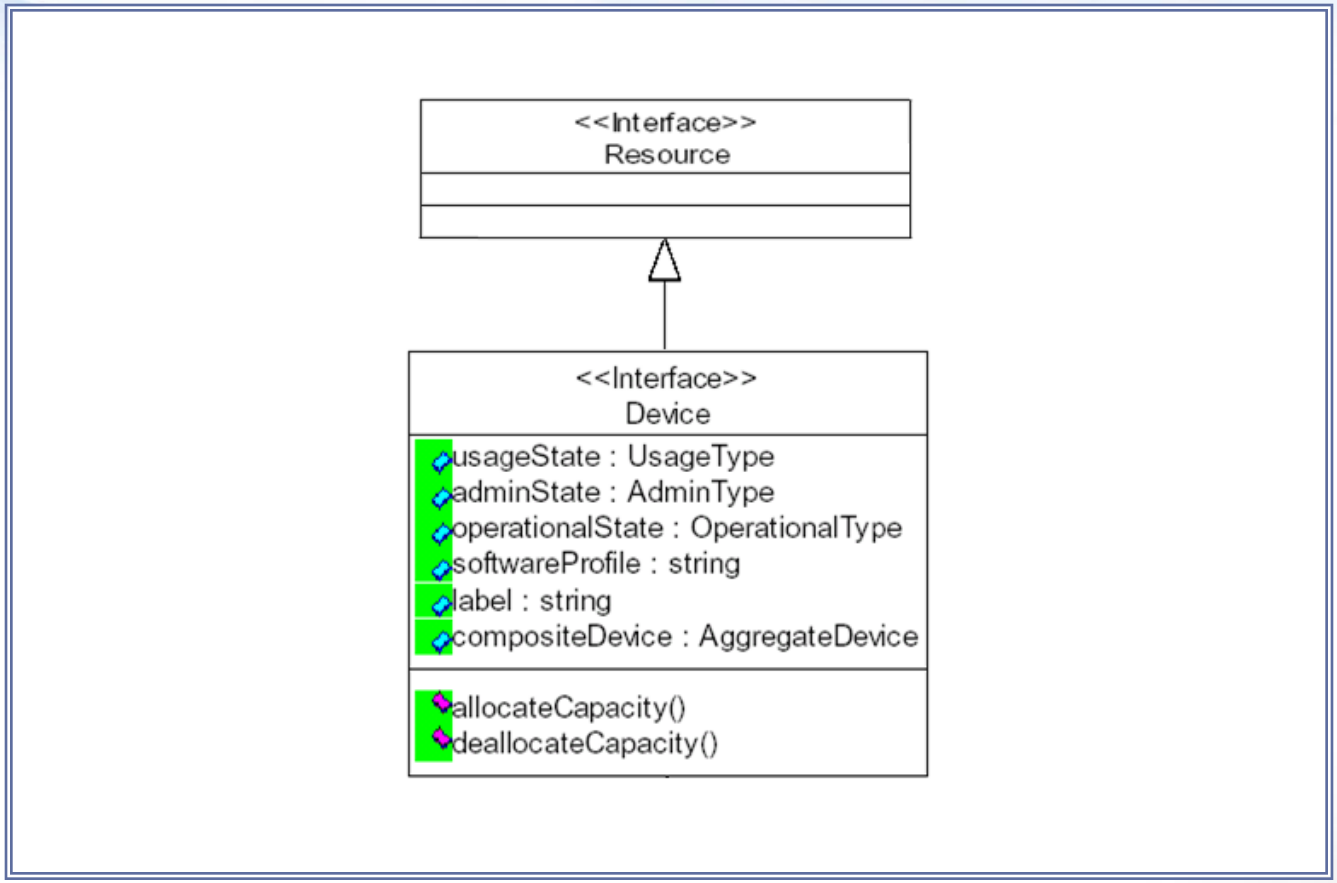
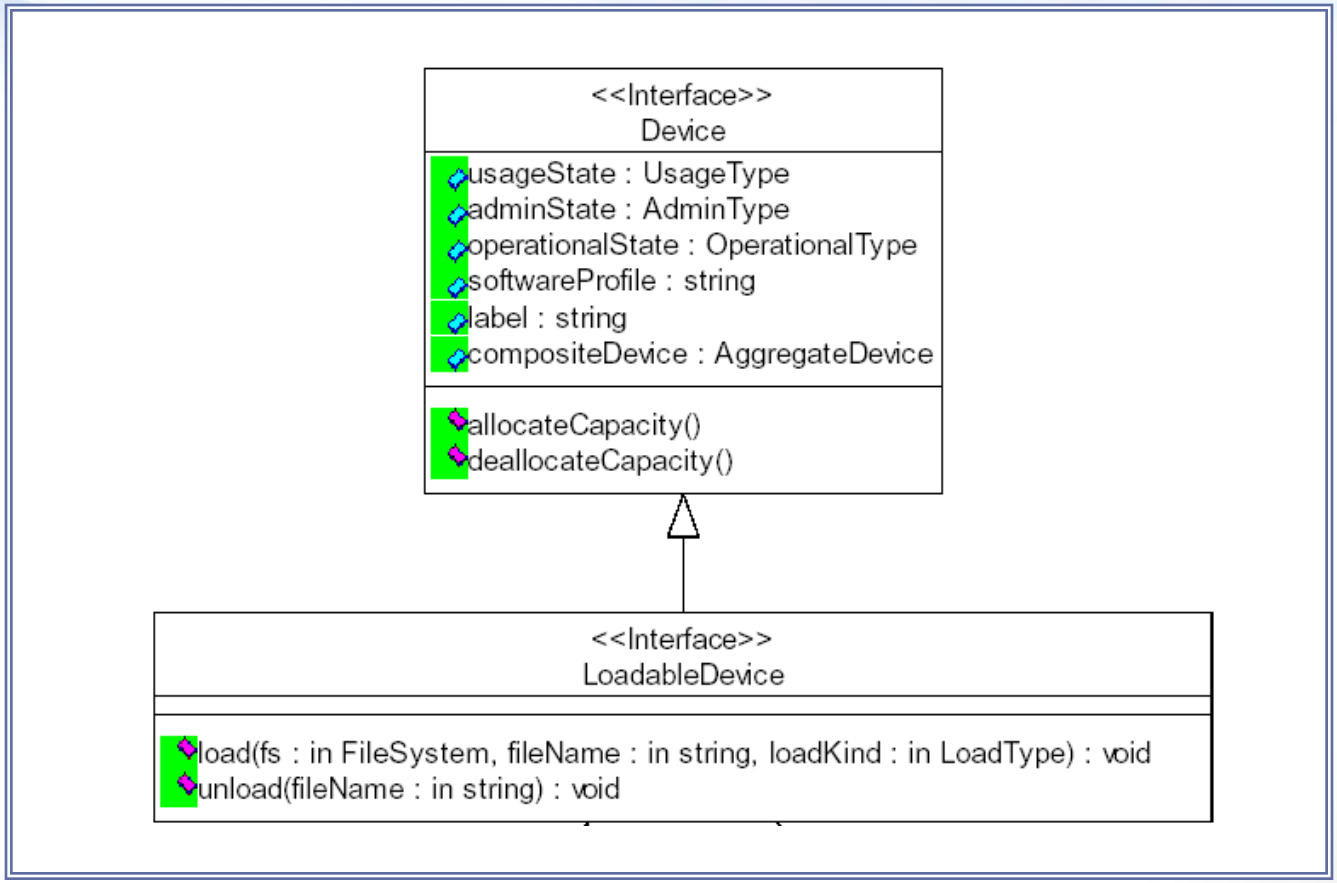
SCA APIs – Device Control

Device API



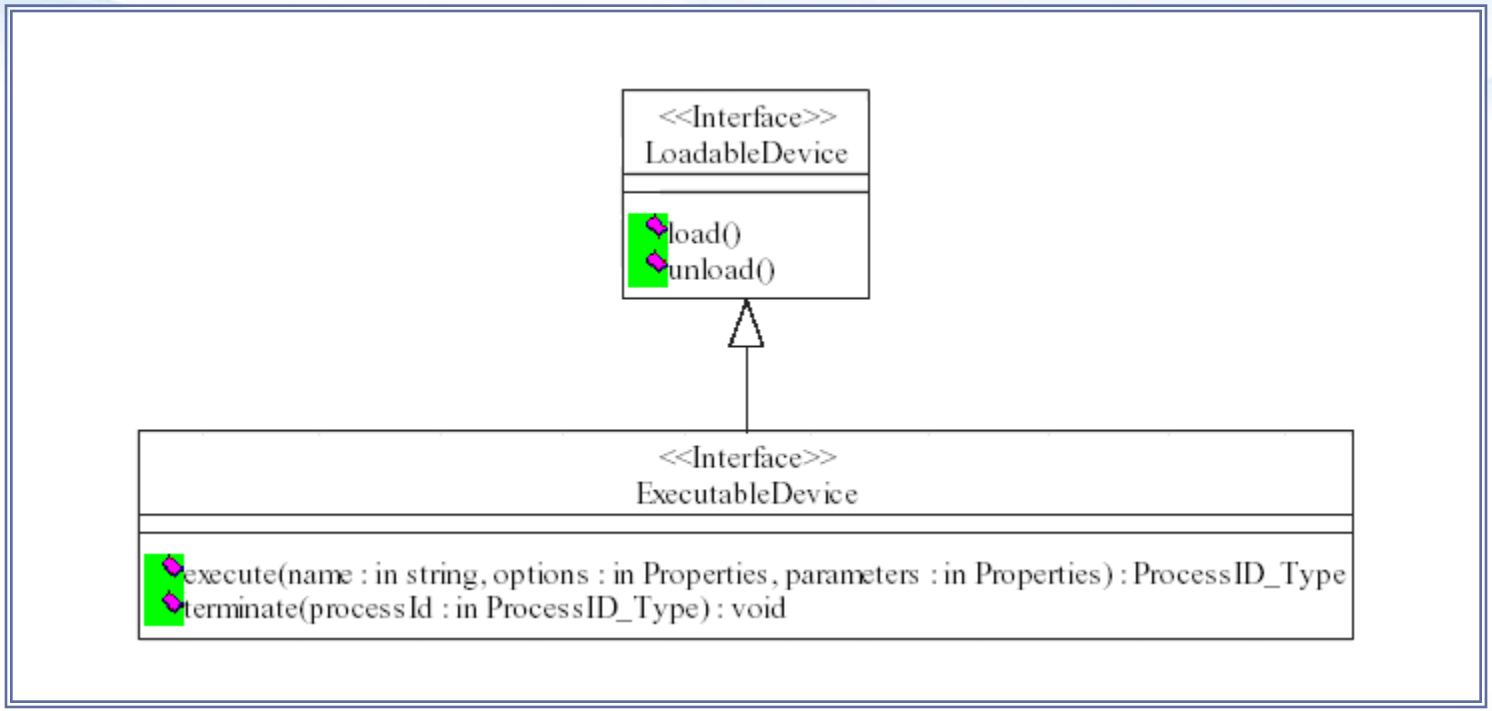
SCA APIs – Device Control

LoadableDevice API



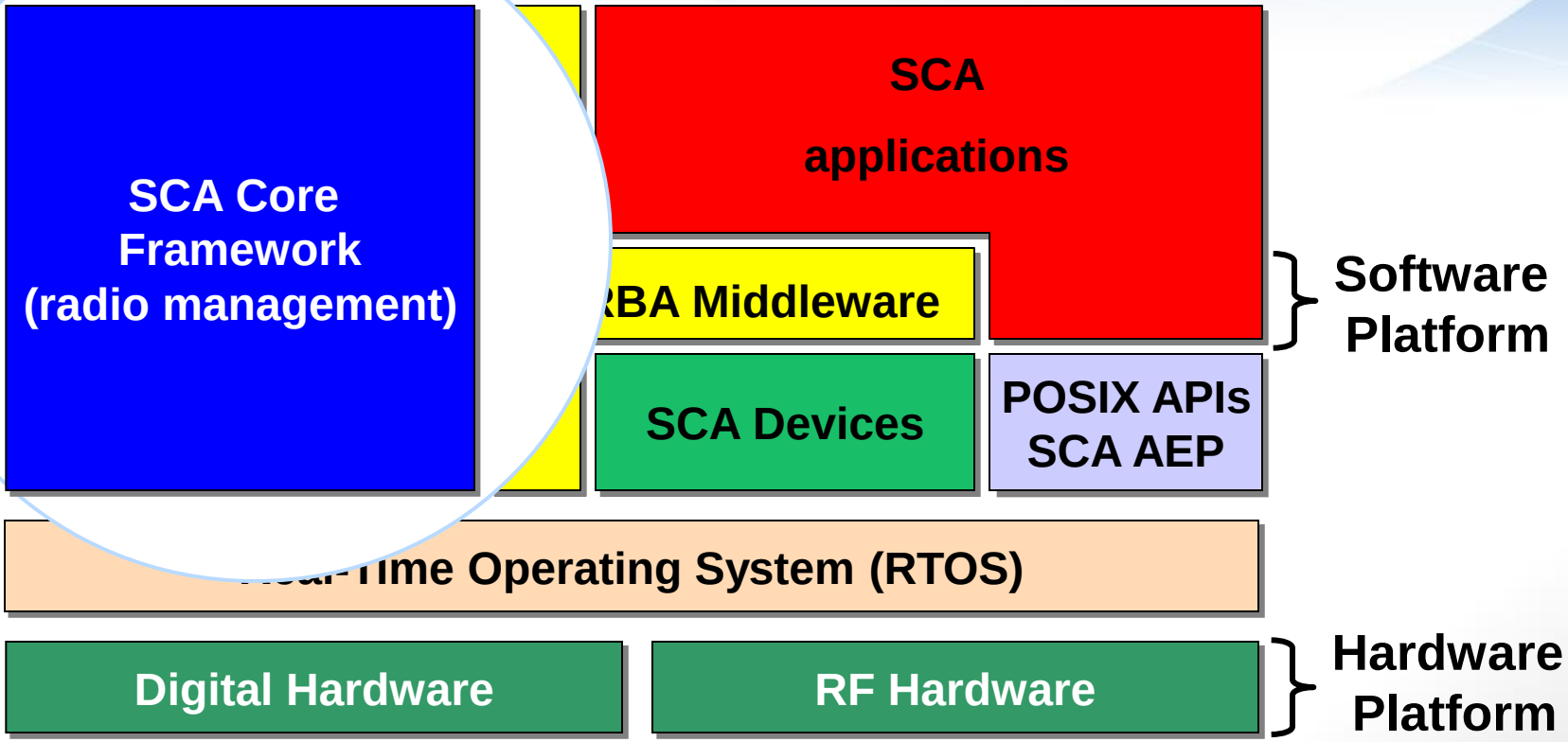
SCA APIs – Device Control

ExecutableDevice API



SCA APIs – Radio Management Control

SCA Radio Management



SCA APIs – Radio Management Control

Radio Management Components

- The Radio Management is performed by four components:
  - *DomainManager*, *ApplicationFactory*, *Application*, *and DeviceManager*
- *DomainManager* is the controller of the radio
- *ApplicationFactory* is used to instantiate an application and to provide an *Application* component
- *Application* is used to control a deployed application

SCA APIs – Radio Management Control

DomainManager

- *DomainManager* is the central component for radio management
  - Accepts registration of *DeviceManagers and Devices*
  - Performs interconnections between node components when specified by a *DeviceManager*
  - Responsible for the installation of applications
  - Offers introspection services
  - Used by UI to control/monitor the radio

SCA APIs – Radio Management Control

DomainManager (cont)

- Can be started at any time during the boot of a radio
  - Can be started using a script or a *DeviceManager*
  - There is no SCA requirement regarding the boot sequence of a Domain Manager
  - SCARI allows the *DomainManager* and the *DeviceManager* to be booted in parallel
- Used to install applications
  - Validates application package for existence of all files referred
  - No standard for the format of an application package
    - SCARI approach uses an archive file (e.g. zip)
  - Creates an *ApplicationFactory* for the installed application

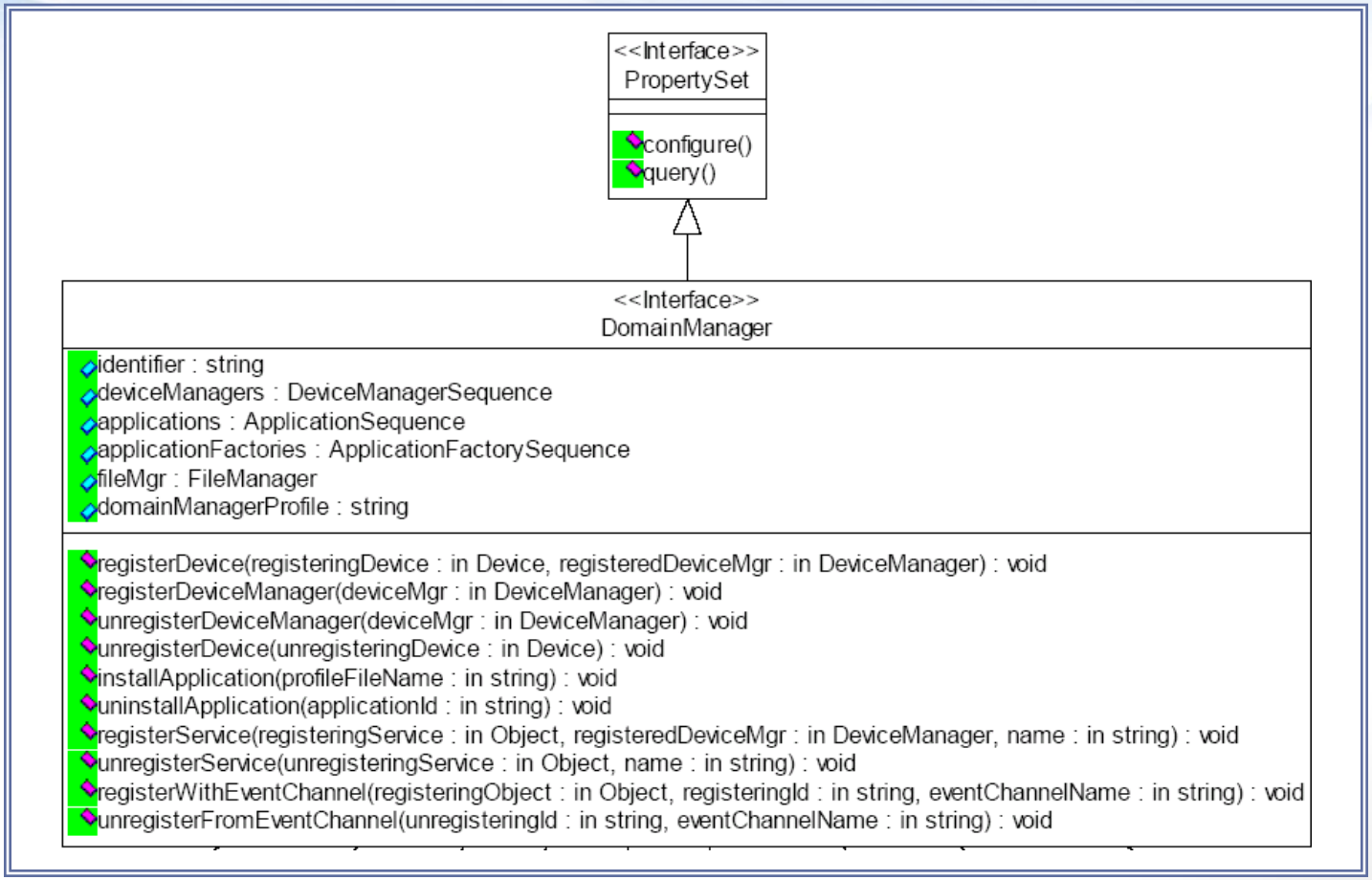
SCA APIs – Radio Management Control

DomainManager (cont)

- Receives registration of every *DeviceManager*, *Device*, and *Service*
- Provides two event channels
  - One that every *Device* must use for reporting state changes
  - One that reports radio management events
- Used for introspection of the radio
  - Listen to events being generated
  - Get list of installed applications
  - Get list of instantiated (deployed) applications
  - Provide a list of registered *DeviceManagers*
  - Etc.

SCA APIs – Radio Management Control

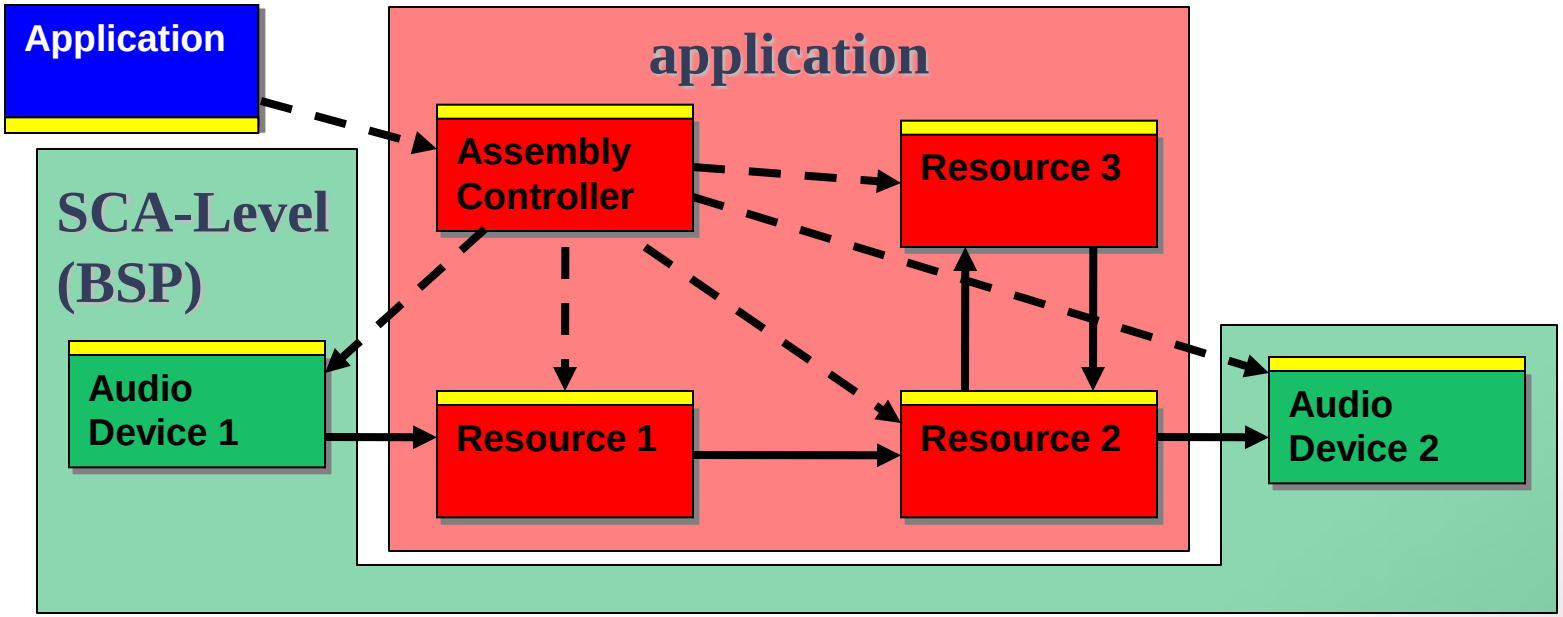
DomainManager API



SCA APIs – Radio Management Control

ApplicationFactory

- *ApplicationFactory* is responsible for instantiating specific types of applications
  - Deploys an application
  - Creates an *Application* object for each instance (deployed) application
  - *Application* object is used as a proxy to the deployed application



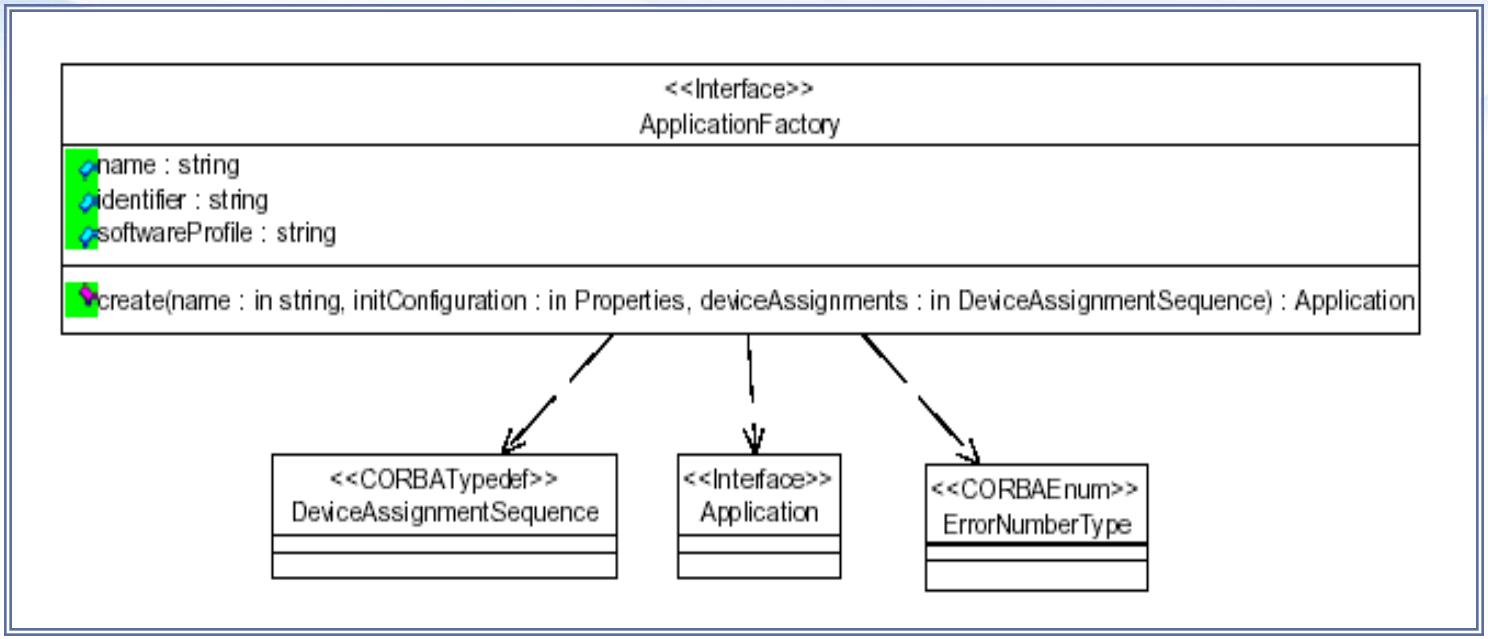
SCA APIs – Radio Management Control

ApplicationFactory (cont)

- *DomainManager* creates an *ApplicationFactory* for each type of installed application
  - Each *ApplicationFactory* manages one type of application
    - Ex: FMLoS, EPLRS, Link 16, etc
- *ApplicationFactory* can create several instances of a same type of application
    - Ex: FMLoS 1, FMLoS 2, etc.

SCA APIs – Radio Management Control

ApplicationFactory API



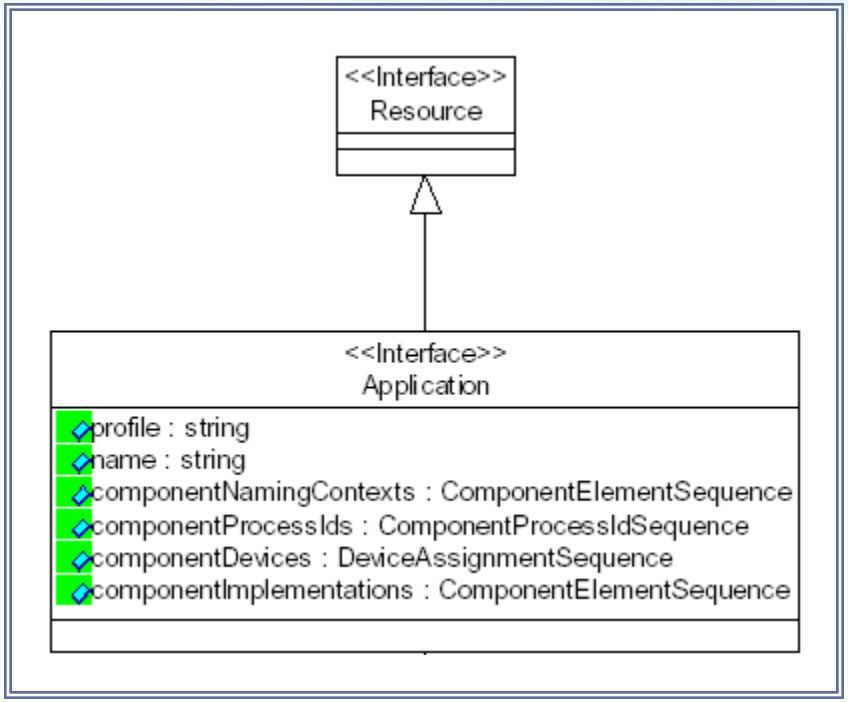
SCA APIs – Radio Management Control

Application

- An *Application* component is used to:
  - Start/stop the signal processing (delegates to Assembly Controller)
  - Change the behavior of the application through configuration (delegates to Assembly Controller)
  - Release the application which terminates components and frees acquired capacity

SCA APIs – Radio Management Control

Application API



SCA APIs – Radio Management Control

DeviceManager

- A radio is composed of many nodes
- Each node runs a *DeviceManager*
  - CRC has submitted a change proposal to allow any number of nodes to report to a same *DeviceManager*
- Each *DeviceManager* is responsible for booting a node as described in the node assembly descriptor
- Each *DeviceManager* must register to their *DomainManager*

SCA APIs – Radio Management Control

DeviceManager (cont)

- A Radio Node
  - Provides access to a set of collocated *Devices*
  - For example, a PowerPC board in a Compact PCI Chassis can be considered a radio node in a SDR platform
  - In fact, any device capable of running some CORBA enabled code upon power-up can be considered a node
- A *DeviceManager* is responsible for a single radio node
  - Launch/shutdown node components (*Devices* and *Services*) as the *ApplicationFactory* does for the components (*Resources*) of an application
  - Registers to a *DomainManager*, making its node components known to the radio where they become available to applications

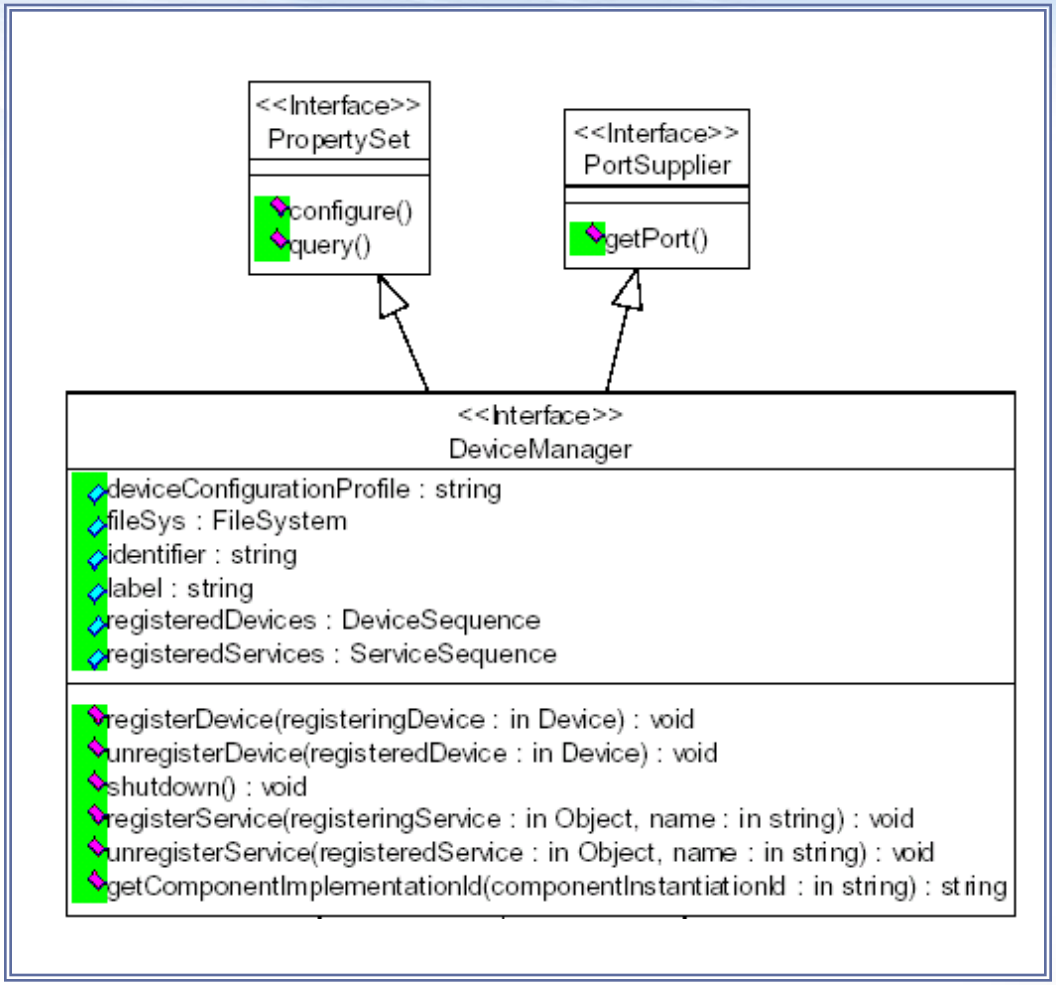
SCA APIs – Radio Management Control

DeviceManager (cont)

- Booting a node:
  - Reads the node assembly descriptor and launches all components of the node
  - DeviceManager waits for registration of the launched Devices and Services components
  - DeviceManager reports to a DomainManager
    - Can wait for its DomainManager to be started
    - Accepts registration of its components even when not registered with its DomainManager

SCA APIs – Radio Management Control

DeviceManager API



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Summary

- The SCA is a Component-Based Development architecture
- SCA components are ‘assembled’ in SCA applications
- The SCA is independent of the application domain
- The goal of the SCA is to facilitate the reuse of waveform applications across different radio sets
- Software components are partitioned into three functional groups:
  - Devices, Applications and Radio Management
- Devices are software proxies for hardware components

Please submit comments and/or questions about this session to:

sca.mentoring@crc.gc.ca

Thank You!