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# OMG SBC Workshop: Realizing the Vision

## SCA Evolution and Standardization

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**Date:** *March 7th 2007*

# Agenda



- Software Radio Spec Overview
- Software Radio  Flexibility and Optimizations
- SCA Compatibility
- Software Conformance

# Software Radio Specification



- To define a common language for building Software Radios for commercial and military that can be extended and/or constrained, and transformed and implemented in any technology.
- To enable the use of Model Driven Architecture (MDA) and Model Driven Development (MDD) technologies for developing radio systems to address today's problems:
  - General Purpose programming languages and tools have not kept pace with the growth of platform complexity[1]
  - Families of systems are the order of the day
  - Systems and requirements have become more complex
  - Exchange information with other tools in a standard format.

[1] *Model Driven Engineering, Douglas C. Schmidt, IEEE Computer Magazine, February 2006*

# Software Radio Specification



- Software Radio Specification (DTC/2006-04-17 & 18) consists of Multiple Volumes that describe:
  - UML Profile for Software Radio
  - Software Radio Facilities
  - Platform Specific Technologies

Note: the Information being presented represents the Revision Task Force (RTF) changes that is being voted on for formal adoption.

# Software Radio Specification – UML Profile Volumes



- Software Radio Domain Specific Language (UML Profiles)
  - Component Framework Specification Volume (DTC/2006-04-04 & 19)
    - A language to describe and model a waveform application, and platform infrastructure and services.
    - Component Framework Profile.xml (DTC/2006-04-09)
  - Communication Channel and Equipment Specification Volume (DTC/2006-04-05 & 20)
    - A language to describe and model a specific hardware platform (Radio Set, Channels, Comm. Equipment) upon which applications execute
    - Communication Channel Profile.xml (DTC-2006-04-10)

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# Software Radio Domain Specific Language



- UML Profile mechanism is used to specific the Software Radio Domain Specific Language (DSL) since UML already has existing elements such as:
  - Artifact
  - Component
  - Device
  - Interface
  - Port
  - Property

# Software Radio DSL - UML Profile



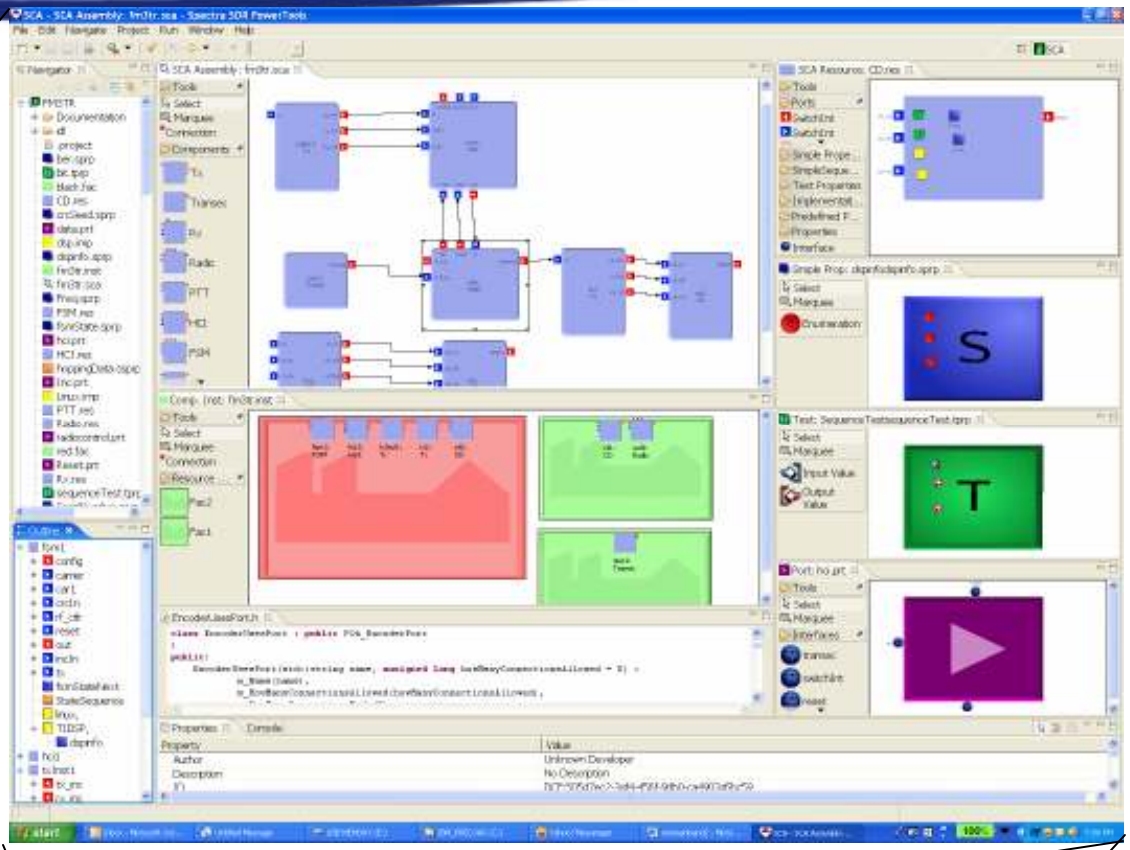
- UML Stereotypes were used to extend the UML Elements with specific semantics and constraints.
  - Object Constraint Language is used to express constraints where practical
- The profiles also contains M1 level elements in model library packages
  - These are mostly interfaces that the component definitions are constrained to.
- The profile is captured in XMI 2.1, which allows for GDSL tool to exchange information in a standard format.
  - Work that was completed in the RTF

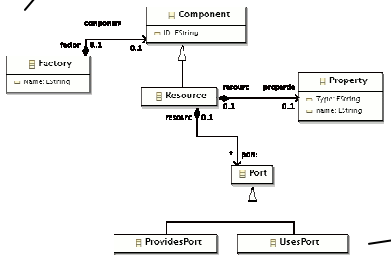
# Software Radio Domain Specific Language Illustration



*Images, layout, organization based on meta-model*

GDSL






DSL

```
<components Name="BitFlipper" organization="PrismTech"
id="DCE:8f647411-91a1-4295-bbc6-6d3eff4982f7">
<ports xsi:type="com.prismtech.spectra.sdr.sca2_2.models:UsesPort"
    instanceName="TX" name="Data"/>
<ports xsi:type="com.prismtech.spectra.sdr.sca2_2.models:ProvidesPort"
instanceName="RX" name="Data"/>
</components>
</com.prismtech.spectra.sdr.sca2_2.models:Assembly>
```

PIM



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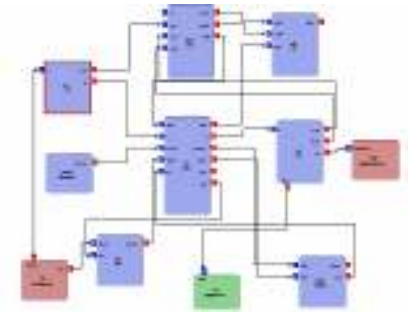
## *Model Driven Development!*

***Tools should be designed specifically to support the SW Radio domain***

***Not just simple computer aided S/W engineering tools***



## *Transform the Model directly into what you need*

# Software Radio Specification – Facilities Volumes



- Software Radio Facilities PIM
  - Component Framework Specification Volume
    - Generic interfaces and types for deploying and managing application and platform service components.
  - Common and Data Link Layer Facilities Specification Volume(DTC/2006-04-08 & 23)
    - Defines related data and control PIM interfaces that can be used to define a waveform or platform component.
    - Based on the “Extended” OSI Model, ISO 7498-1: Open System Interconnection – Basic Reference Model
    - Product of a survey of existing specs such as: 3GPP, DLPI, GLoMo, OBSAI, CPRI, 802.x, X.200e
    - Common and Data Link Layer Facilities.xml (DTC/2006-04-11)
  - Communication Channel and Equipment Specification Volume
    - Physical Layer Facilities PIM
      - *Modem Facilities*
      - *RF Facilities*
      - *IO Facilities: SerialIO and Audio Device Components*

# Common and Data Link Layer Facilities PIM



- Common Radio Facilities
  - Provides common service definitions that are applicable for all applications (waveforms or radio control)
    - OMG Lightweight Services (log, event, naming, etc.)
- Common Layer Facilities
  - Provides interfaces that cross cut through facilities that correlate to layers. These interfaces can be viewed as building blocks for SWRadio components that realize multiple interfaces.
  - Protocol Data Unit, Error Control, Flow Control, Measurement, Quality of Service, and Stream Facilities
- Data Link Facilities
  - Link Layer Control (LLC) facilities. LLC layer provides facilities to upper layers, for management of communication links between two or more radio sets.
  - Data Link Layer (Connectionless, Ack ConnectionLess, Connection), and Medium Access Control Facilities

# Software Radio Specification - Platform Specific Technologies



- At this time only CORBA interfaces, XML descriptors and POSIX profiles are defined
  - These definitions are non-normative.
  - Component Document Type Definitions Specification Volume (DTC-2006-04-07 & 22)
    - XML DTD Files (DTC/2006-04-13)
  - POSIX Profiles Specification Volume (DTC-2006-04-06 & 21)
    - Two Profiles are defined which are a subset of the Real-time Controller System Profile (PSE52) Standardized Application Environment Profile - POSIX® Realtime Application Support (AEP), IEEE Std 1003.13-2003
      - *The application environment profile (AEP), which is for constrained embedded general purpose processing, is the preferred profile for embedded processing and its utilization is encouraged for all processing environments.*
      - *The lightweight application environment profile (LwAEP) is more constrained than the AEP and is targeted towards environments with limited computing support such as embedded processors like Digital Signal Processors (DSPs) and micro-controllers.*
- The normative is captured in the XMI SWRadio profiles and Facilities.
- Transformations rules are specified for PIM to PSM in the specification
- Other PSMs could be defined along with their transformation rules

# Software Radio PSM – CORBA Modules



- UML Interfaces map to CORBA IDL
  - The Component Framework Profile interfaces map to the CF CORBA module
    - CF
      - *StandardEvent, PortTypes, FileServices*
  - The Software Radio PIM Facilities map to the DfSWRadio CORBA module.
    - DfSWRadio
      - *CommonLayer, DataLinkLayer, CommonRadio, PhysicalLayer, RadioControl*
  - CF (DTC/2006-04-16) and DfSWRadio (DTC/2006-04-14) IDL files has been broken apart into multiple files to reduce foot print sizes for unneeded client and skeleton code.

# Software Radio Flexibility and Optimizations



- Component Definitions
- Application Deployment Optimizations

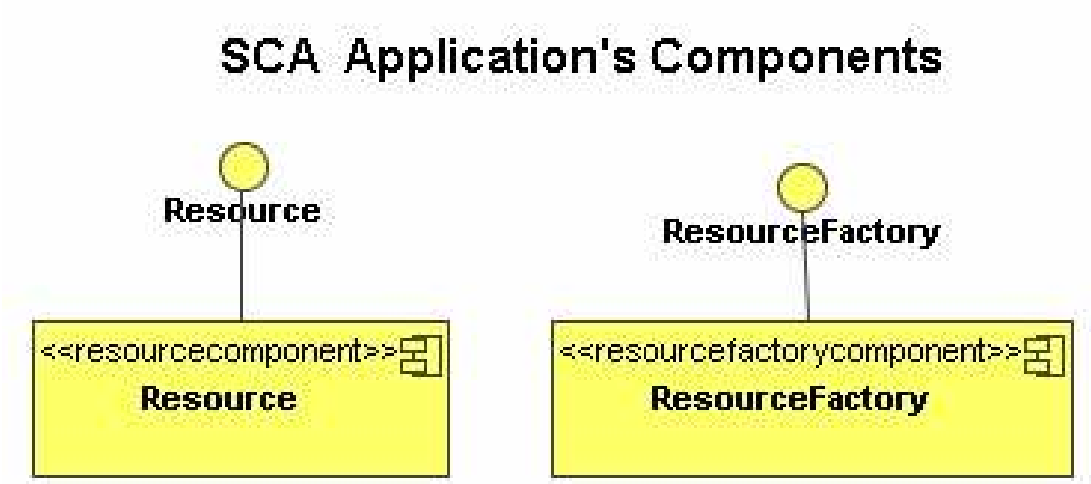
# Component Definitions



- Flexibility
  - Includes options for PIM level specification of Lightweight component definitions
    - Lighter weight Application Components than Resource Component can be defined. Minimal set of interfaces needed for deployment are: Lifecycle, PropertySet, PortSupplier, PortConnector
      - *If they exist for a component then deployment machinery uses them.*
    - Domain and Device Management allow for port definitions to specific interfaces which are supported
    - Lighter weight Device components support
      - *a configurable combination of states and statuses*
        - *StateManagement Interface*
      - *Minimal set of interfaces needed for deployment are: Lifecycle, PropertySet, PortSupplier, PortConnector,*
      - *CapacityManager Interface*
        - *what capacities, if any, it manages*

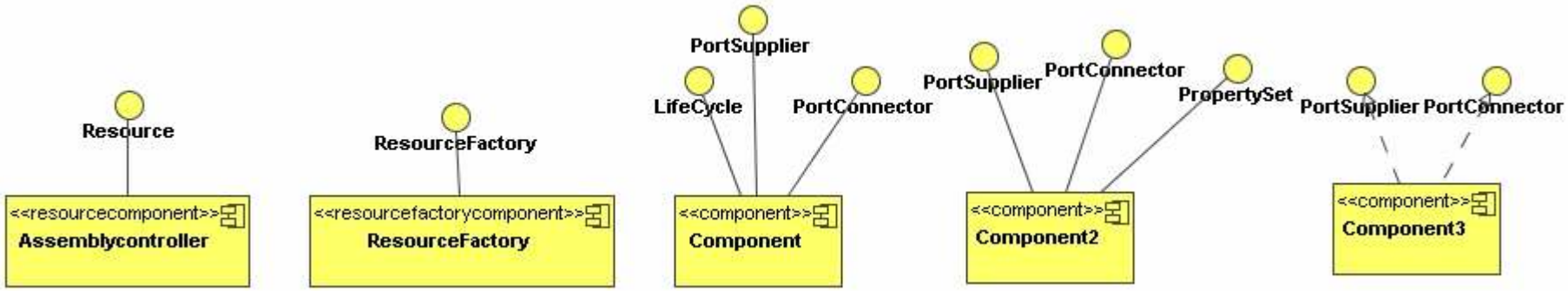
# Application Components





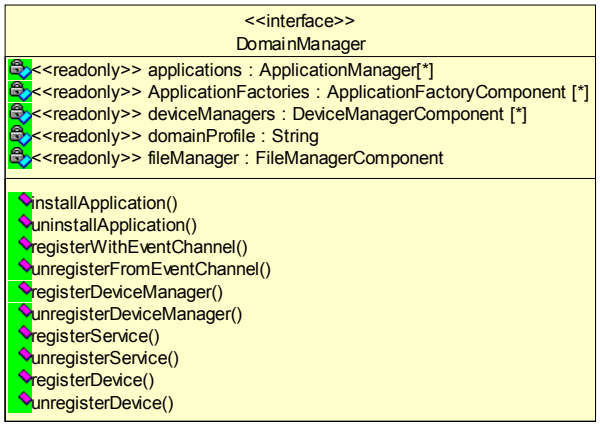

*Versus*

**OMG SWRADIO Application Component's**



# Domain Manager Component

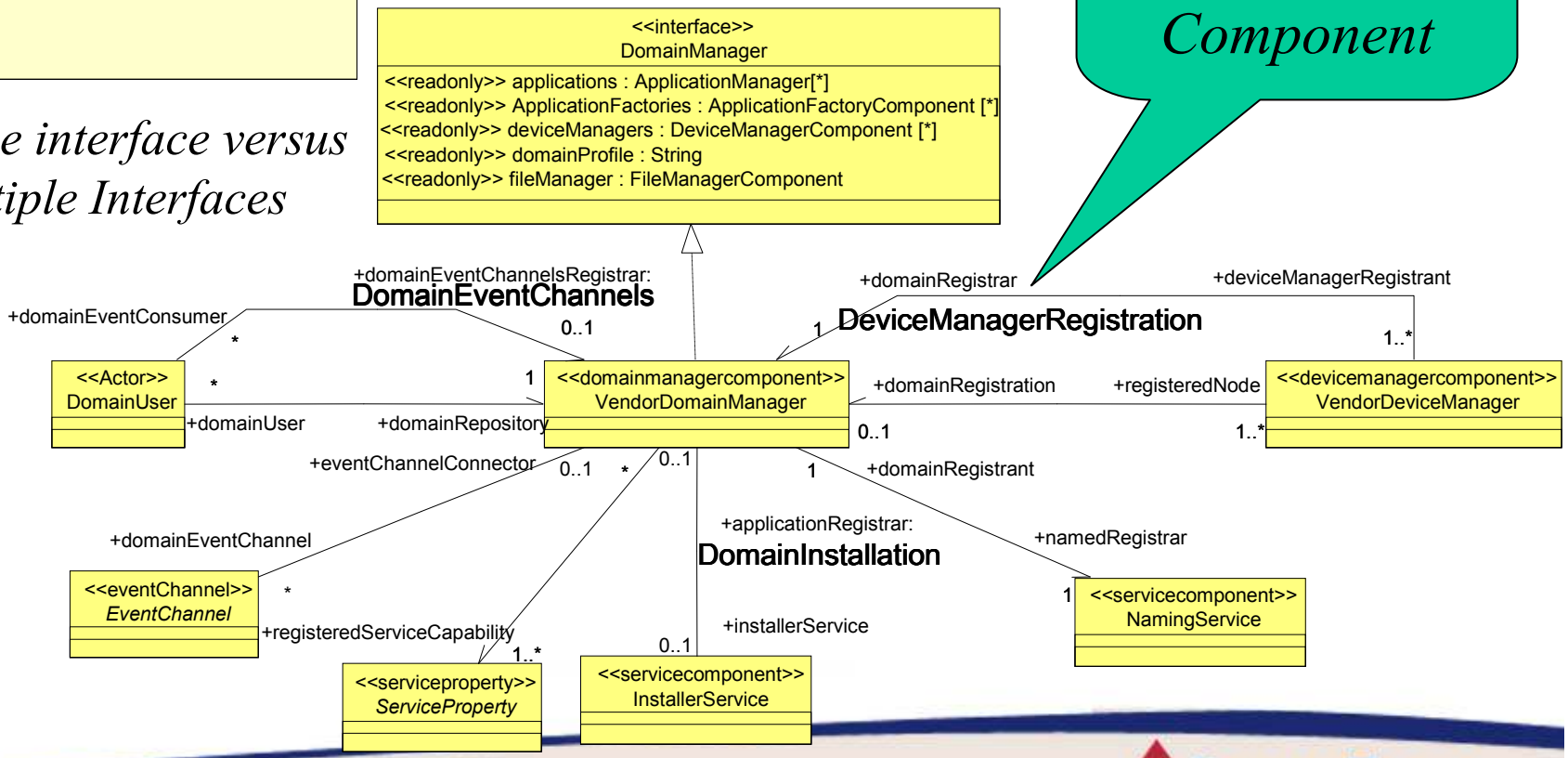





*SCA one interface versus Multiple Interfaces*

*Software Radio*

*Registration of any Service Component*



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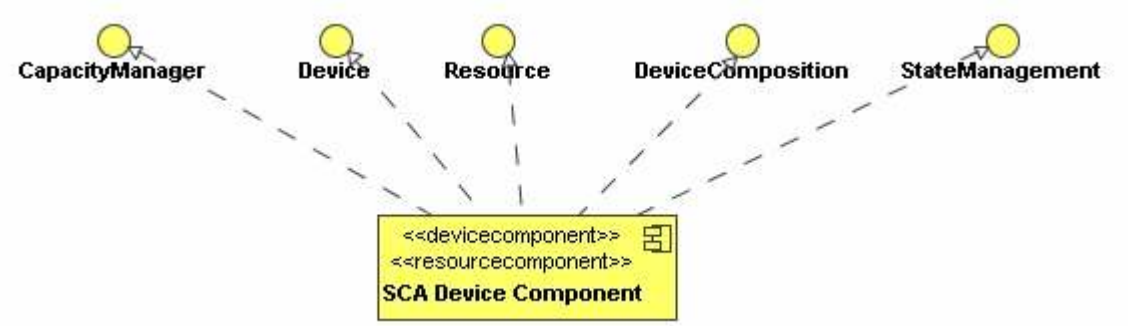
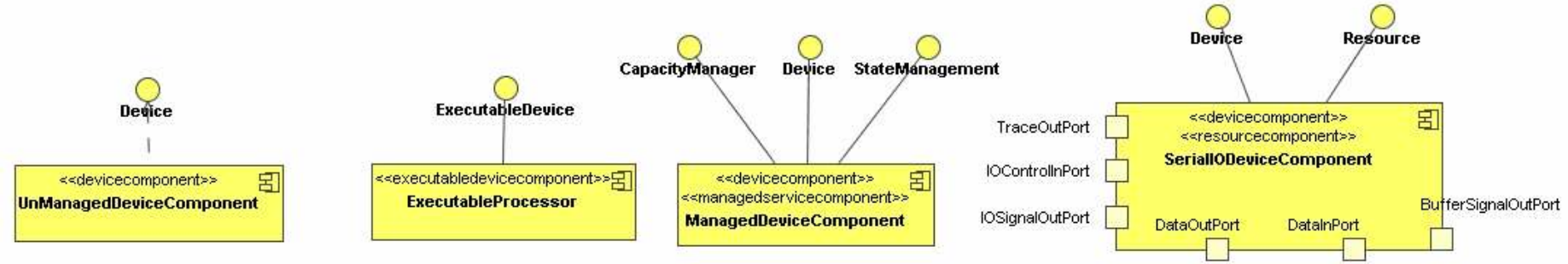
# Device Components

## SCA Device Components




*Versus*

## Software Radio Device Components



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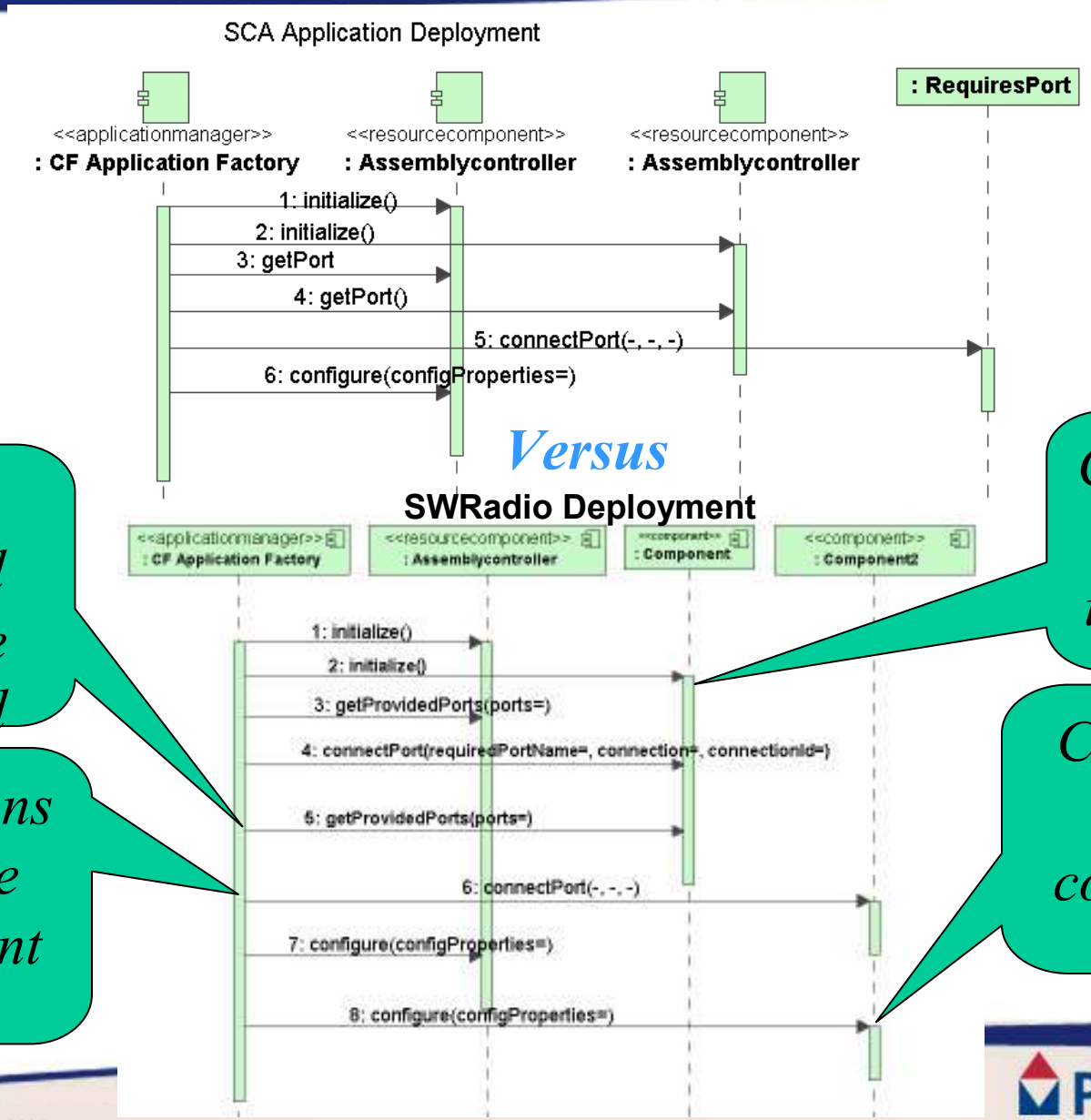
# Application Deployment Optimizations



- Application Deployment Optimizations
  - Connection Behavior is simplified
    - Connections are managed at the component level not at uses port level
    - Able to retrieve a list of provided interfaces at one time.
  - Application Factory Component can make all devices' characteristic and capacities decisions
- Teardown Optimization
  - Disconnection Behavior – disconnections are only necessary for radio services (not deployed components)

# Application Deployment Optimizations






*Only Provided Ports are Obtained*

*Components may be initializable*

*Connections are at the Component Level*

*Components can be configurable*



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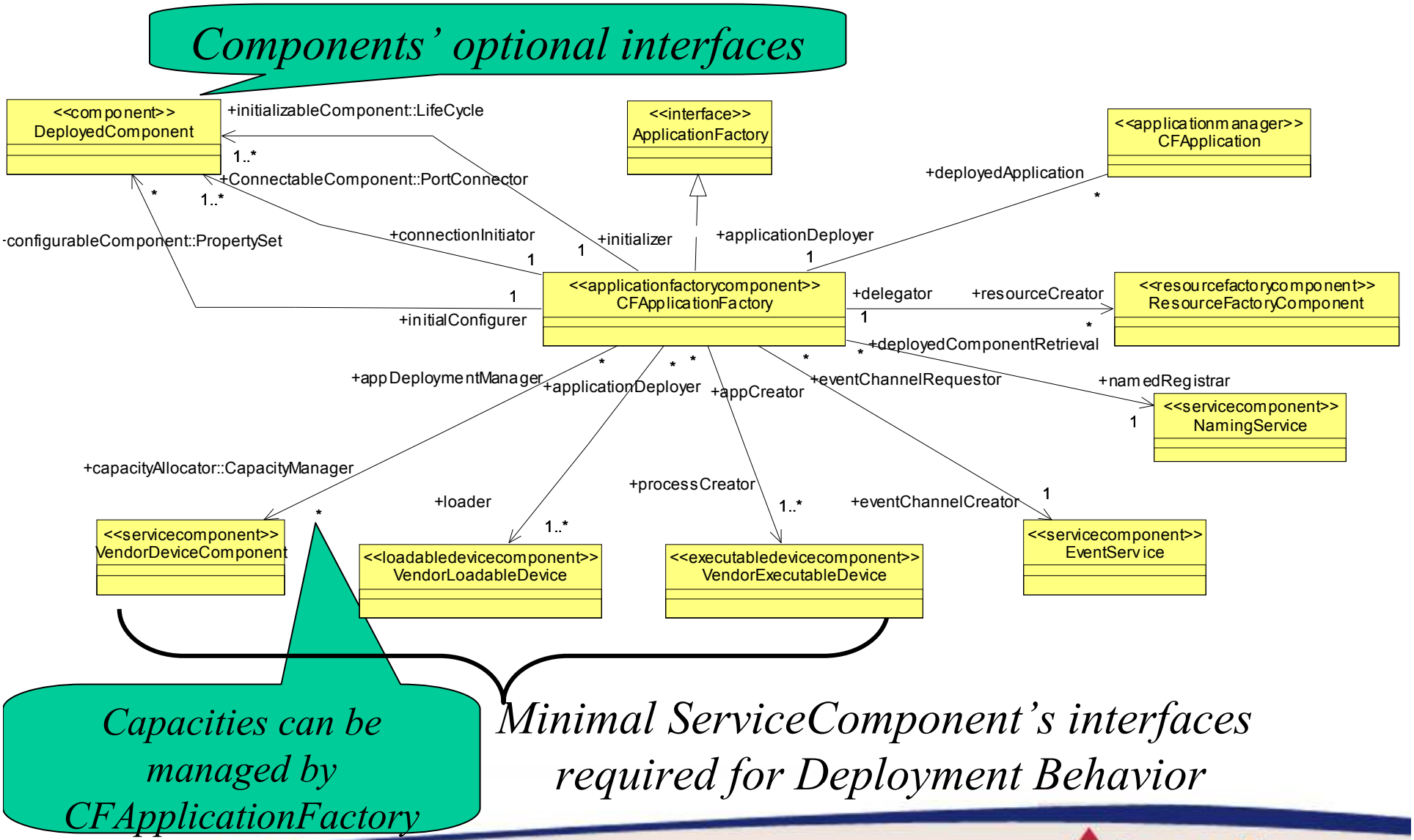
# Application Deployment Optimizations, cont'd





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# SCA Compatibility



- Functionally Equivalent to SCA
  - Defines SCA Infrastructure and Application interfaces but as UML interfaces
  - Extends SCA Hardware support with additional System Engineering concepts
    - Communication Equipment, Communication Channel
  - Extends the SCA domain management concept with radio and channel management interfaces and components.
  - Lightweight AEP for signal processing components
- XML DTDs are backwards compatible with corresponding SCA DTDs
  - Extensions added such as nested component, an implementation can be an assembly
  - More complex deployment requirements can be expressed.
  - Allows for any Service Component to be deployed and referenced in the Domain.
- Core Framework Interfaces
  - Slight changes to Resource interface, connection behavior
  - Changes to Device interfaces, State and Capacity Operations broken out into separate interfaces and not directly inheriting from Resource. Execute operation behavior for runtime requests and user threads creation inside a non-user (OE) process
  - DeviceManager and DomainManager component implementations are equivalent to their SCA counterparts when interfaces are realized.
  - When all of the individual CORBA CF and PortTypes IDL files are included they parallel the specification of the SCA CF and PortTypes IDL files.
- POSIX Operating System Application Environment Profile (AEP)
  - Added LW AEP.

# Conformance



- Simply put, conformance is defined at level of component and interface usage.
  - No requirement on what components are required for a radio set/system.
  - One needs to determine what radio components along with their interfaces are required for a software radio being built based upon the radio requirements and level of portability one is striving for.
- The OMG Software Radio specification defines three levels of portability like the SCA, which are at the:
  - Radio domain level,
  - Radio's node level and
  - Application level.

# Summary



- Provides a flexible Software Radio DSL and facilities to model and capture waveform and platform designs independently of technology that can be transformed to any technologies
- The Software Radio DSL can be easily extended or constrained for other domains
- The OMG Software Radio specification maps to the SCA