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Implementation Design Choices for the SWRadio Specification

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The Ultimate Performance Machine

Overview

- Brief overview of the SWRadio Specification
- PIM Facilities (waveform, channel)
- Waveform Example using APIs
- Real-time Aspects
- Additional RFPs for waveform services

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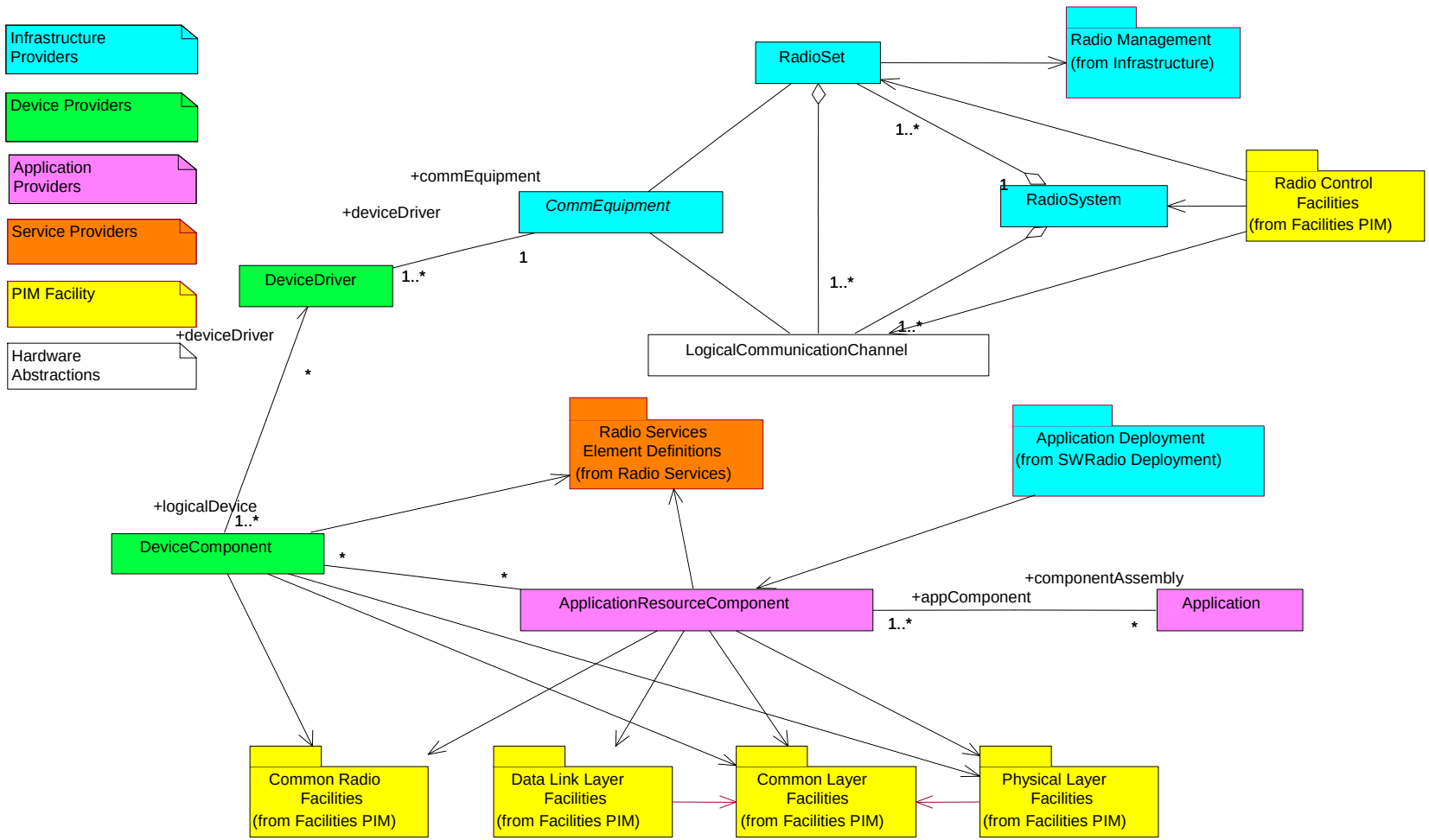
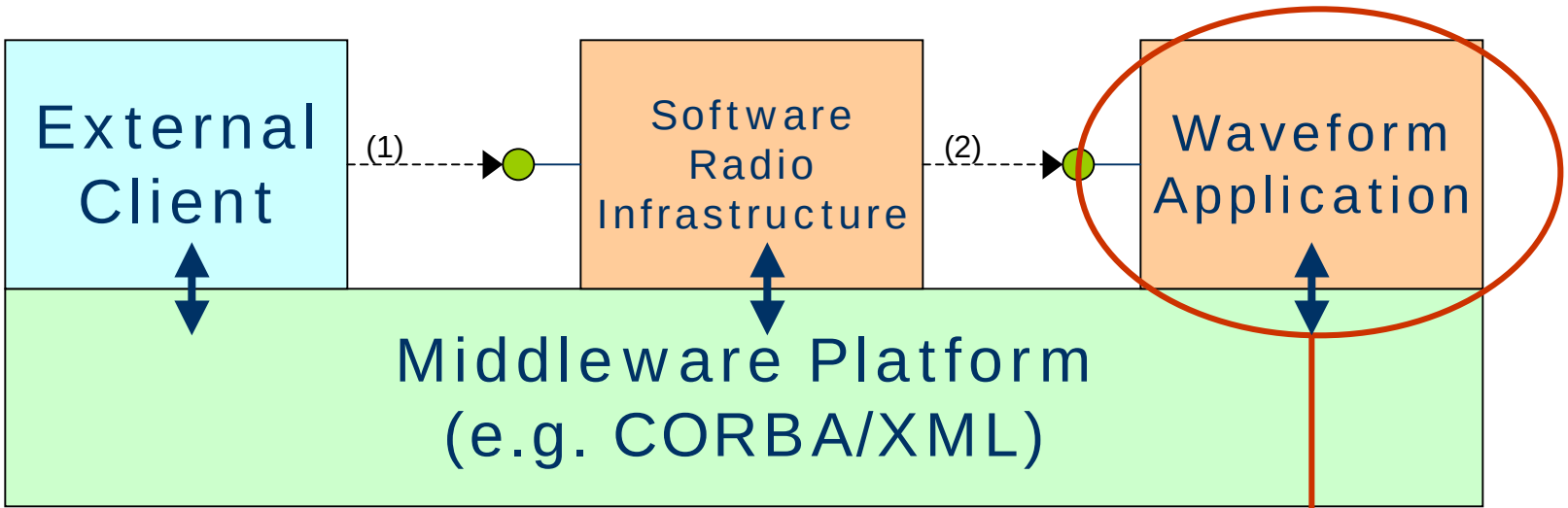
SWRadio Products Overview



Scope of SWRadio Spec



(1) External client calls software radio infrastructure to request the services of a waveform application

(2) Infrastructure calls waveform application to request initiation

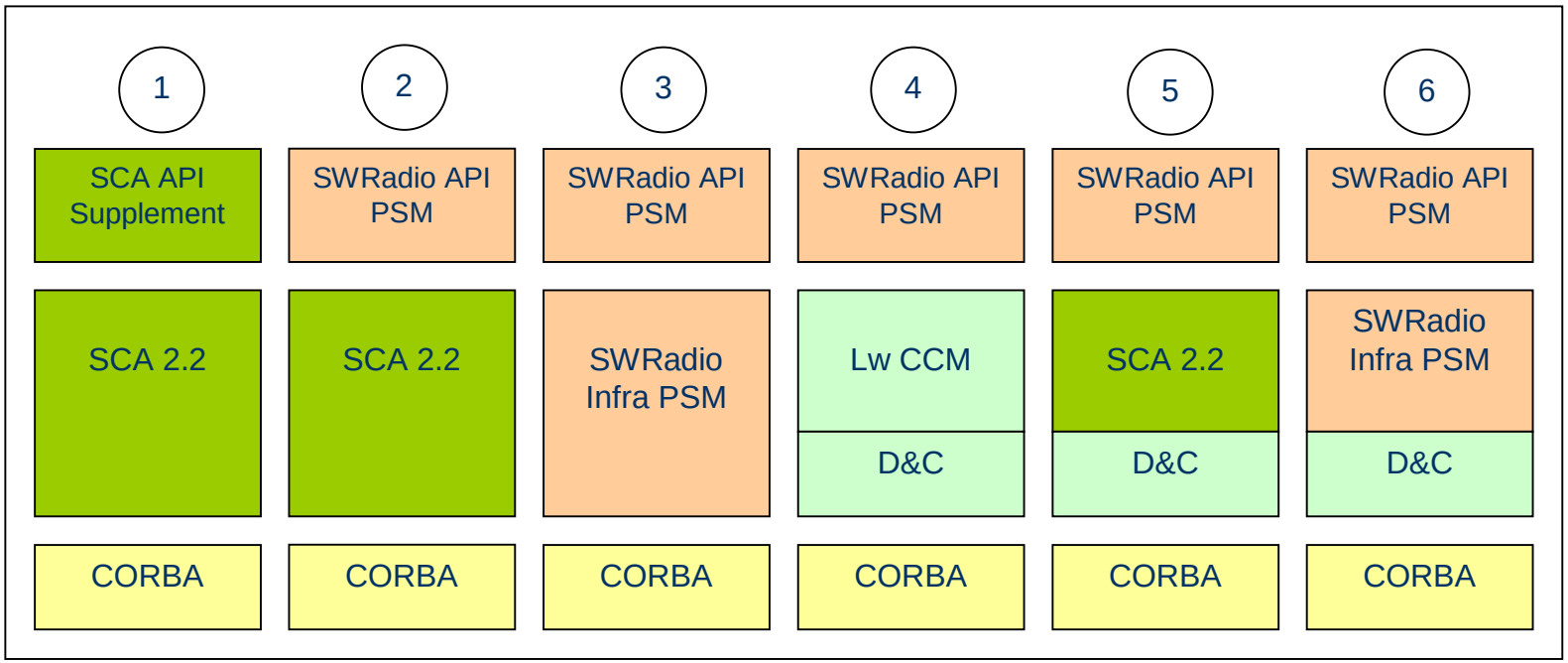
contains interfaces specified by SWRadio spec

We will concentrate on this part

SWRadio Waveform Application

- A Waveform application compliant with the SWRadio specification **shall**:
  - Implement the related CORBA interfaces defined by Waveform Applications PSM
  - Implement the related XML Serialization formats defined by Waveform Applications PSM
  - Implement the related semantics defined by Waveform Applications PIM

Waveform API Realization Options



- **Waveform APIs can be realized independent from the underlying SDR infrastructure**
- **Only need to realize the Waveform interfaces**

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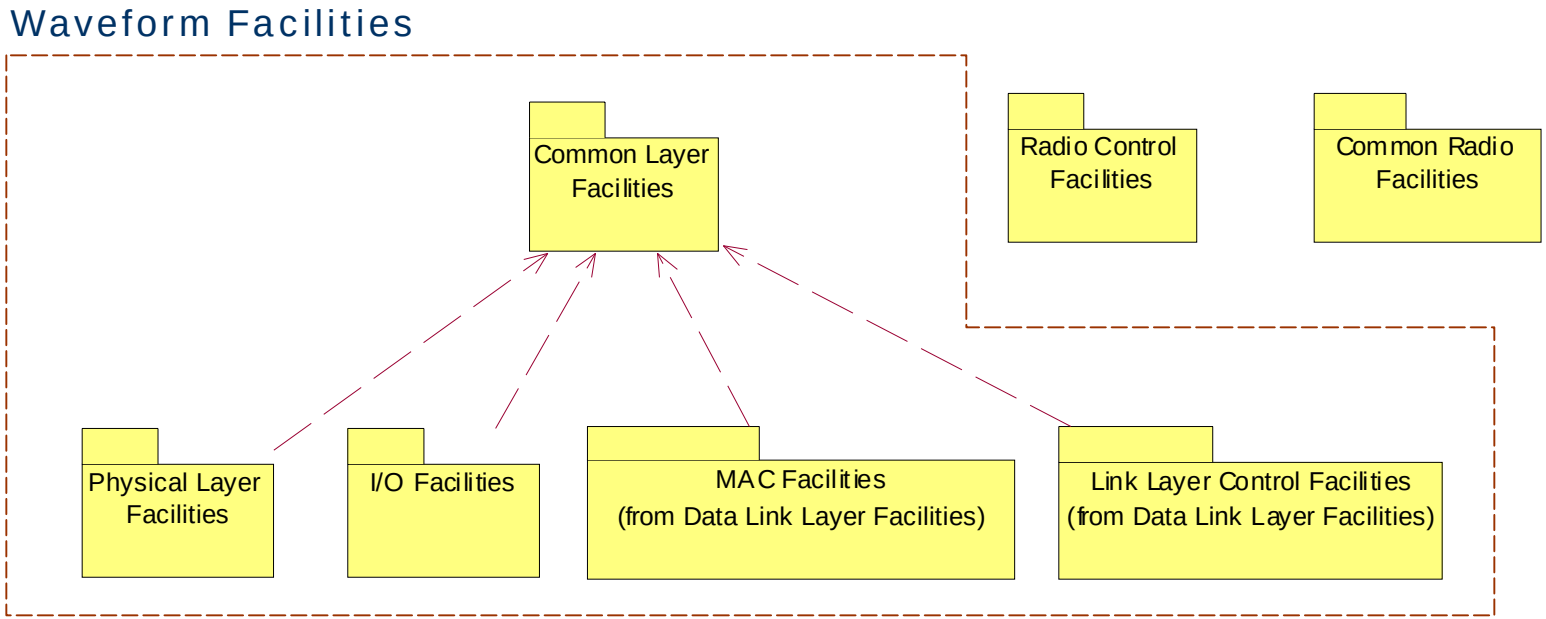
PIM Facilities



- Common Layer Facilities cut through layers
- Radio Control Facilities include channel management, radio management
- Common Radio Facilities are non-WF related services
- Physical, I/O, MAC, LLC are based on OSI defns

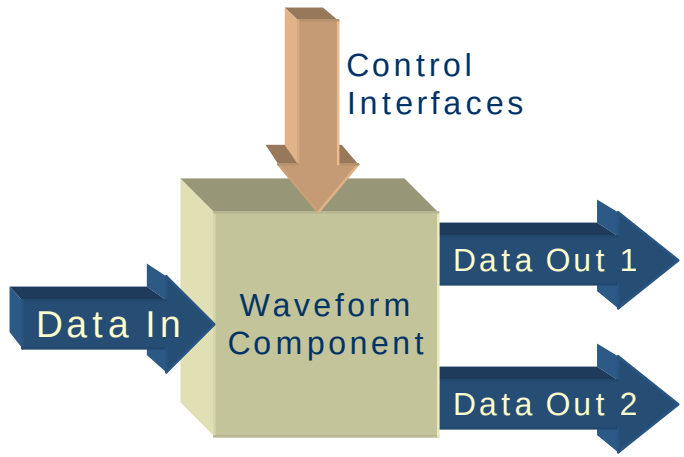
Waveform PIM

- Defines waveform related data and control interfaces
- Based on the “Extended” OSI Model*
- Semantic descriptions for the components realizing the interfaces
- Product of a survey of existing specs such as: 3GPP, DLPI, GLoMo, OBSAI, CPRI, 802.x, X.200e

* ISO 7498-1: Open System Interconnection – Basic Reference Model

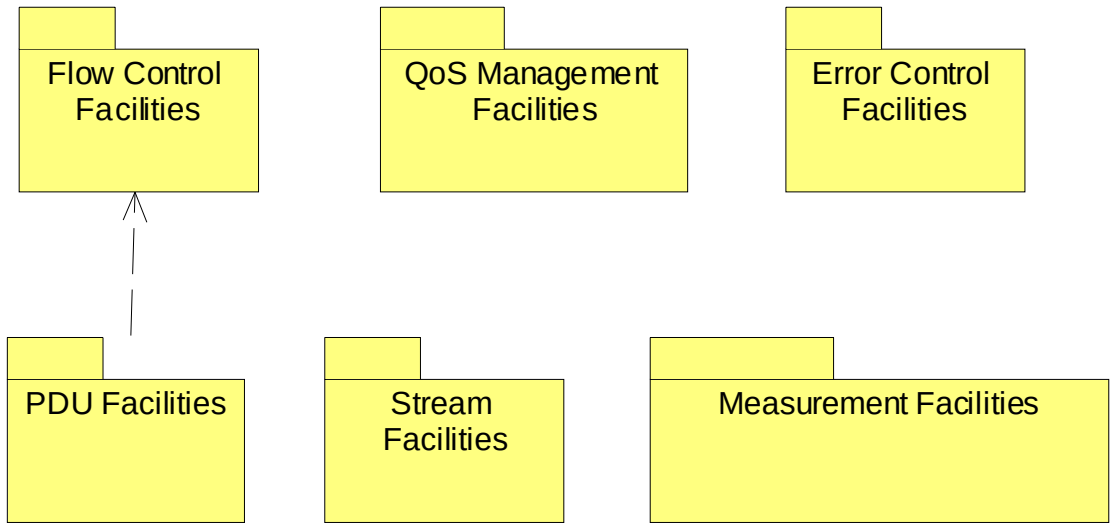
How are they used?

- Component based programming model
- Similar to Flow-Based Programming*
- Waveform elements realize control interfaces and achieve "*configurable modularity*"
- Waveform PIM definitions aim to provide a complete set of configuration parameters



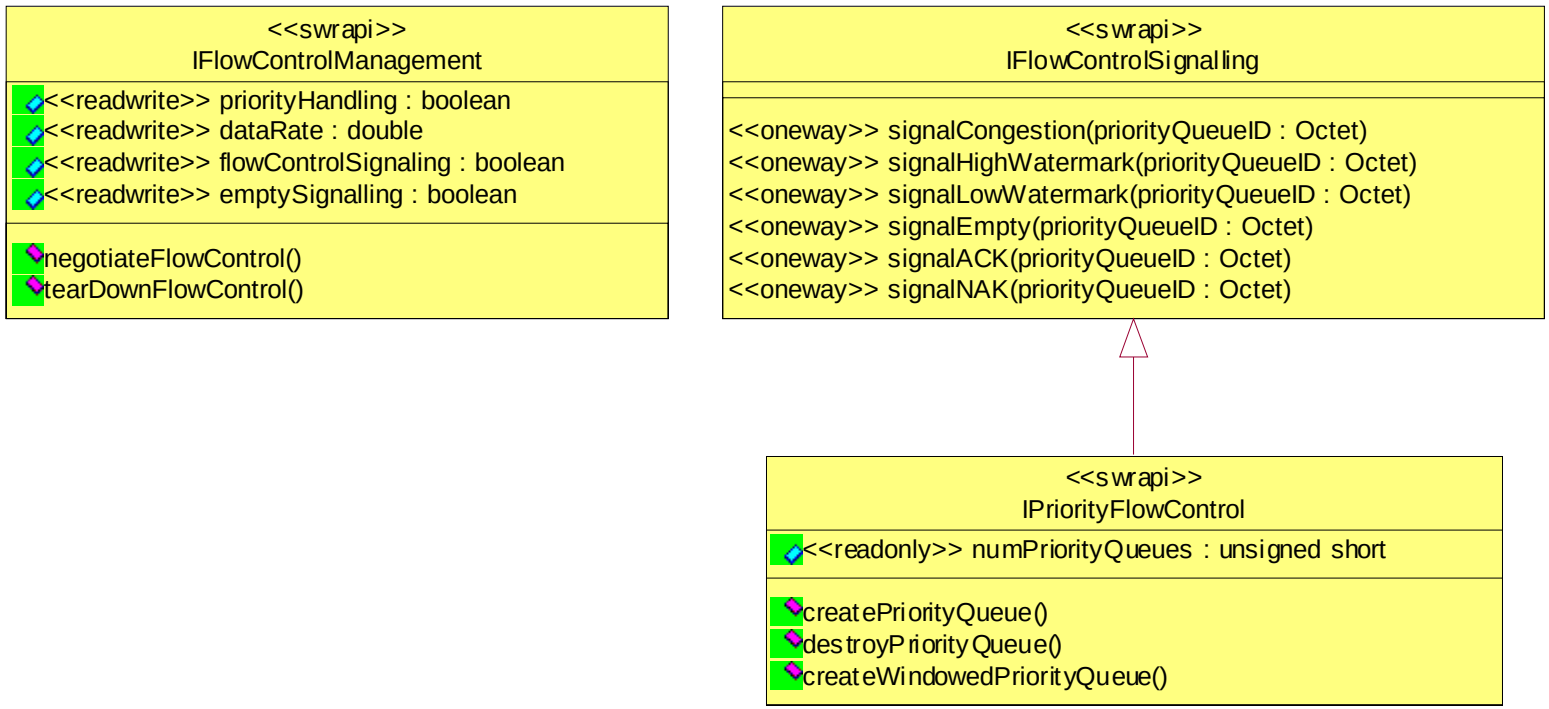
* "Flow-Based Programming: A New Approach to Application Development", J. Paul Morrison, Thomson Publishing, 1994

PIM Facilities: Common Layer



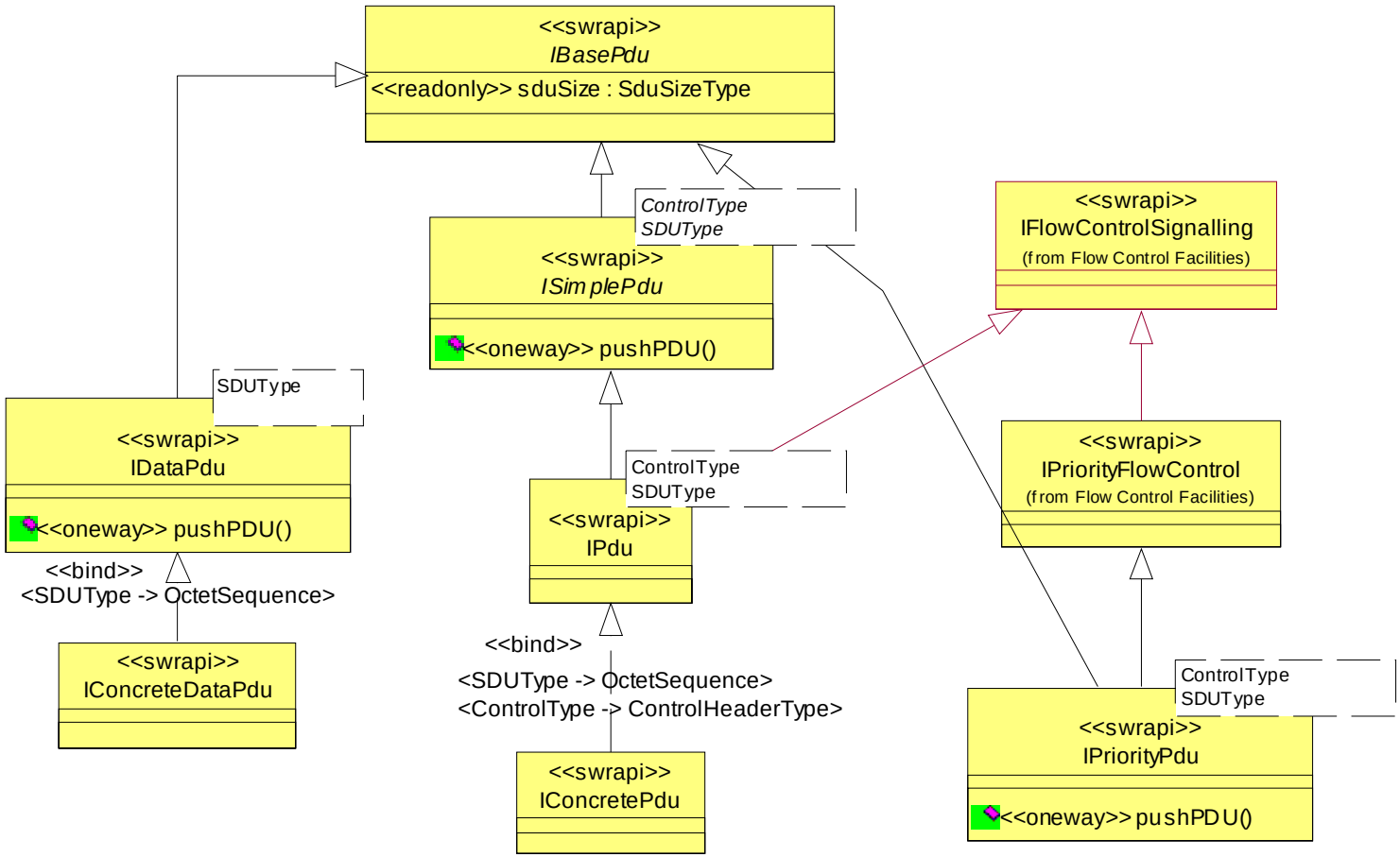
- **Flow Control – control communication flow so that a sender does not transmit more packets than a receiver can process.**
- **QoS Management – control quality of service related parameters.**
- **Measurement Facilities – set up and schedule measurement parameters.**
- **Error Control Facilities -- allows the Receiver to tell the Sender about frames damaged or lost during transmission, and coordinates the re-transmission of those frames by the Sender.**
- **PDU Facilities – Protocol Data Units (PDU) are used as information packets both within and between radio sets**
- **Stream Facilities – used in connection oriented communication among radio sets as well as inter-component communication within a radio.**

PIM: Common Layer: Flow Control

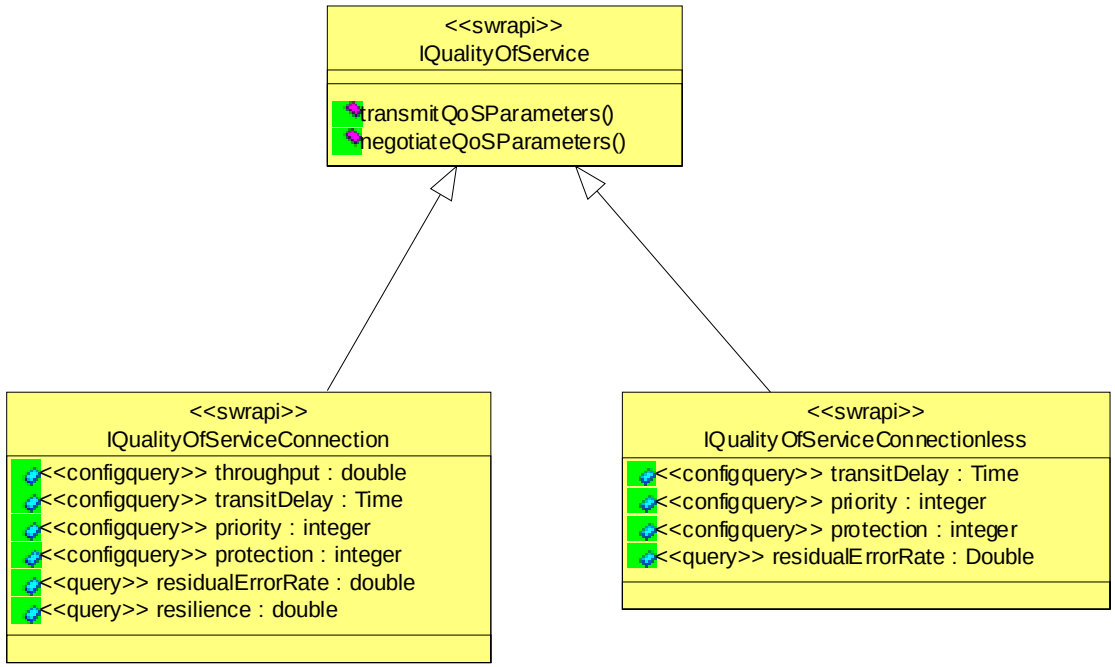


- Separate signaling and management interfaces
- One flow control manager component per waveform, one signaling component for each channel
- Can be implemented by both transmitter and receiver
- Prevents overflow of data, ensures proper handling of data packets

PIM: Common Layer: PDU



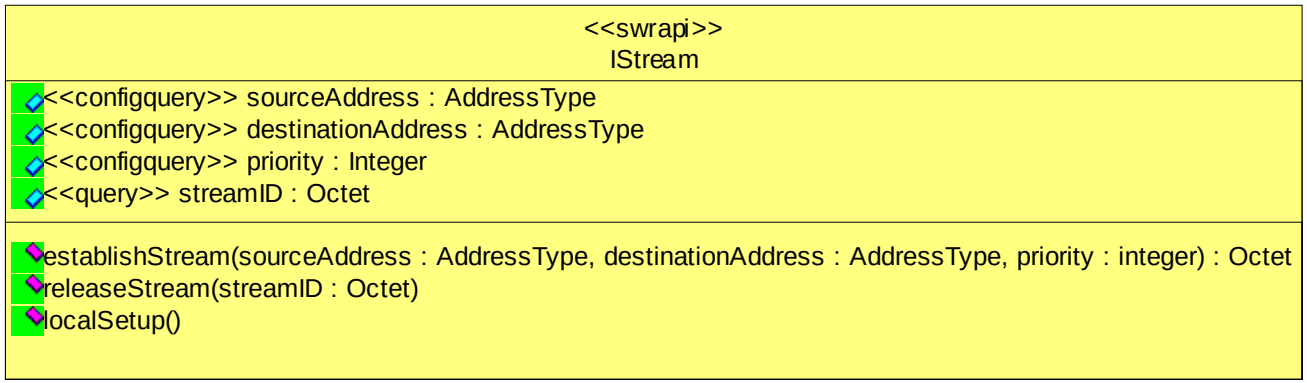
PIM: Common Layer: QoS Management



- **Based on DLPI specification**
- **Allows the Radio Resource Controller to config/query QoS parameters**
- **Interface does not mandate any underlying protocol for transmitting and negotiating QoS parameters with the peer RadioSet**

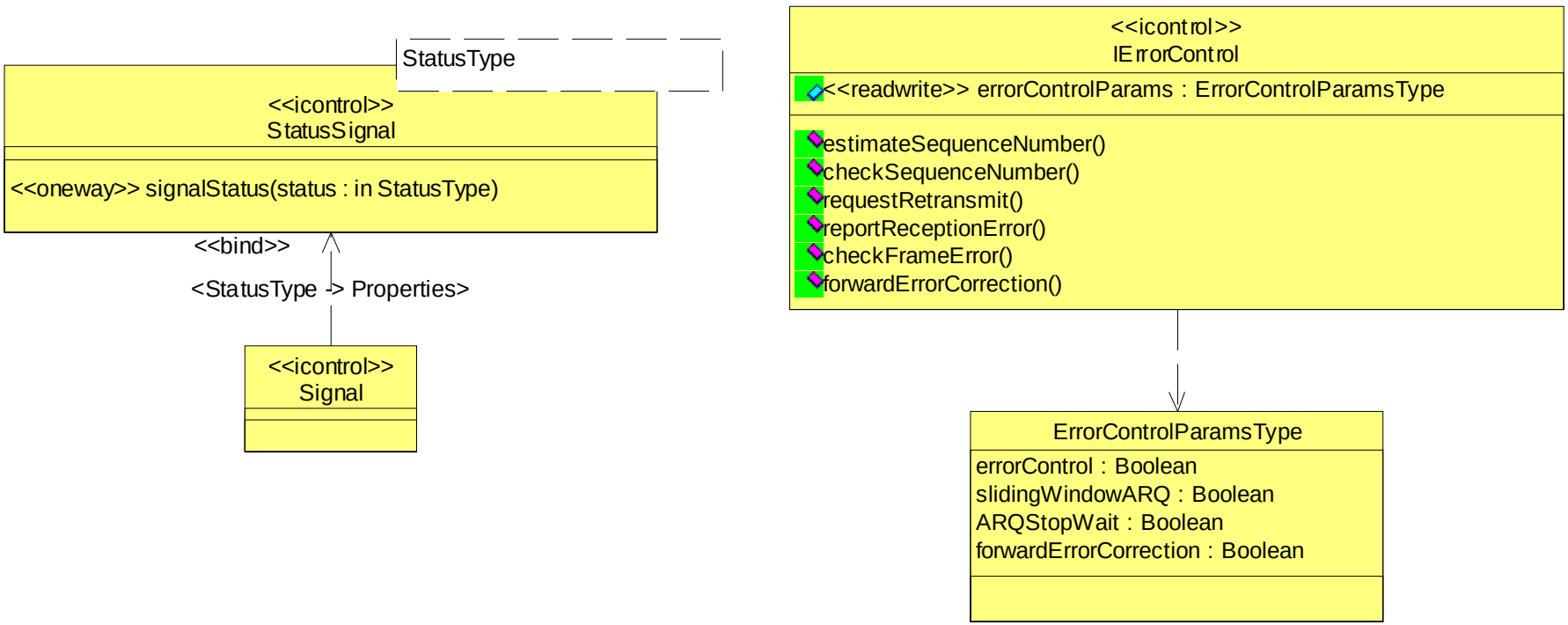
* “Data Link Provider Interface”, The Open Group, 1997

PIM: Common Layer: Stream



- Intended for setting up connectionless streams
- Can be used for setting up a data stream between two components in the same radio set (vertical communication)
- Can be used for setting up a data stream between two radio sets (horizontal communication)

PIM: Common Layer: Error Control

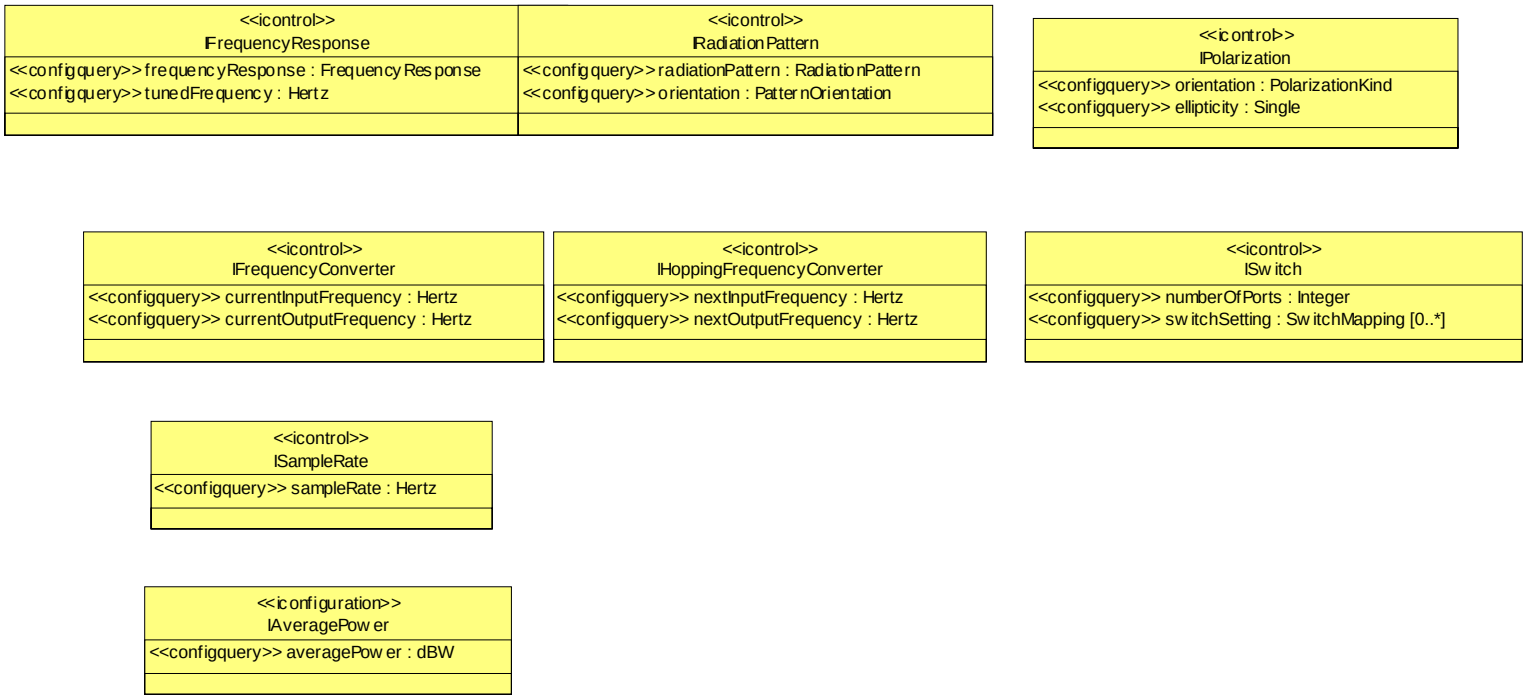


- StatusSignal interface provides a mechanism to report transmission/reception errors
- IErrorControl interface provides operations that the waveform controller can use to instruct different levels of error control on a component

PIM: Physical Layer

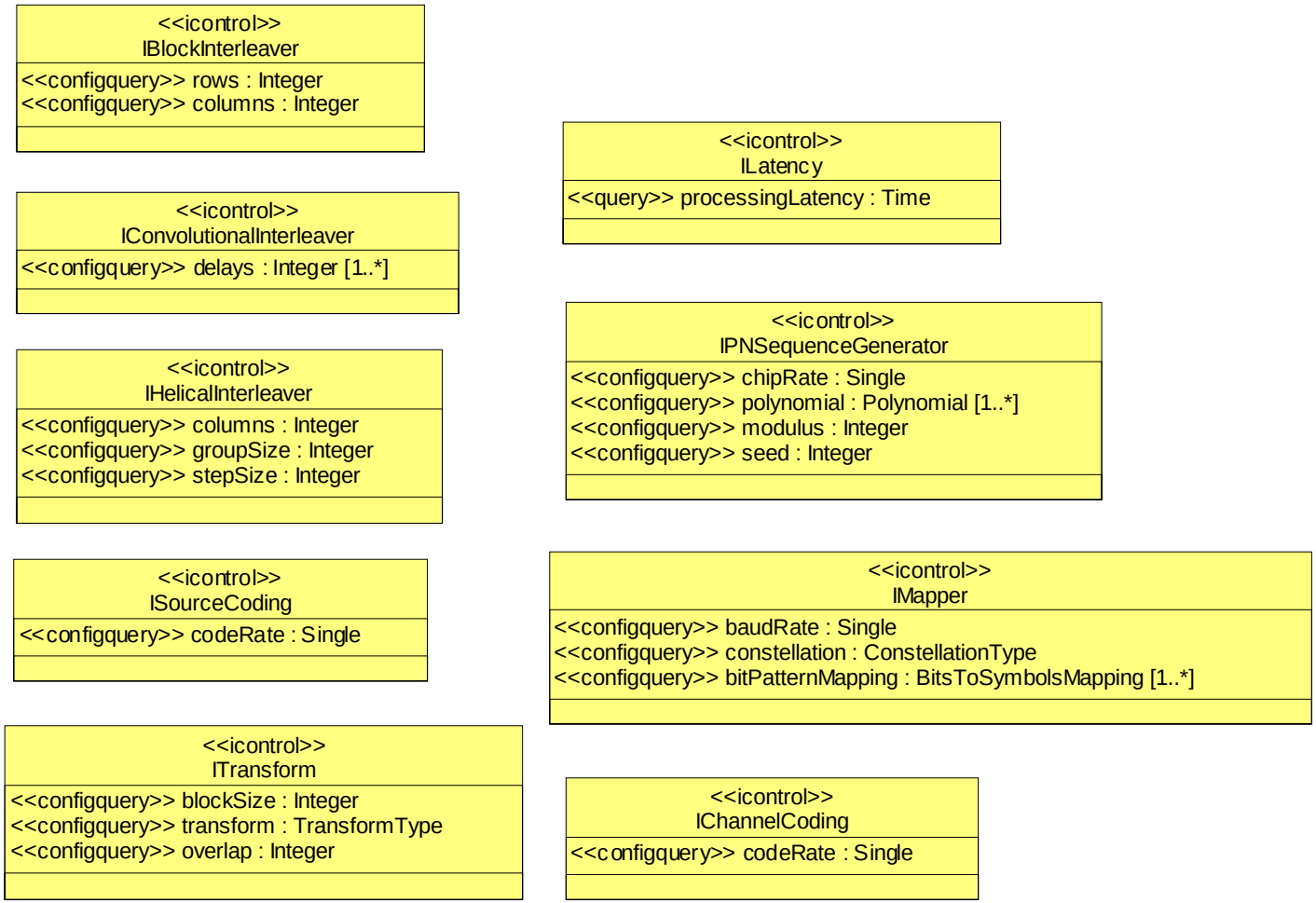
- Interfaces on both control and data planes
- Most of the signal processing is done at this layer
- Provides parameterization of waveform algorithms for portable, modular code
- Used to control the communication equipment device attributes defined in the UML Profile
- Partitioned into:
  - Modem Facilities
  - RF/IF Facilities

PIM: Physical Layer: RF/IF

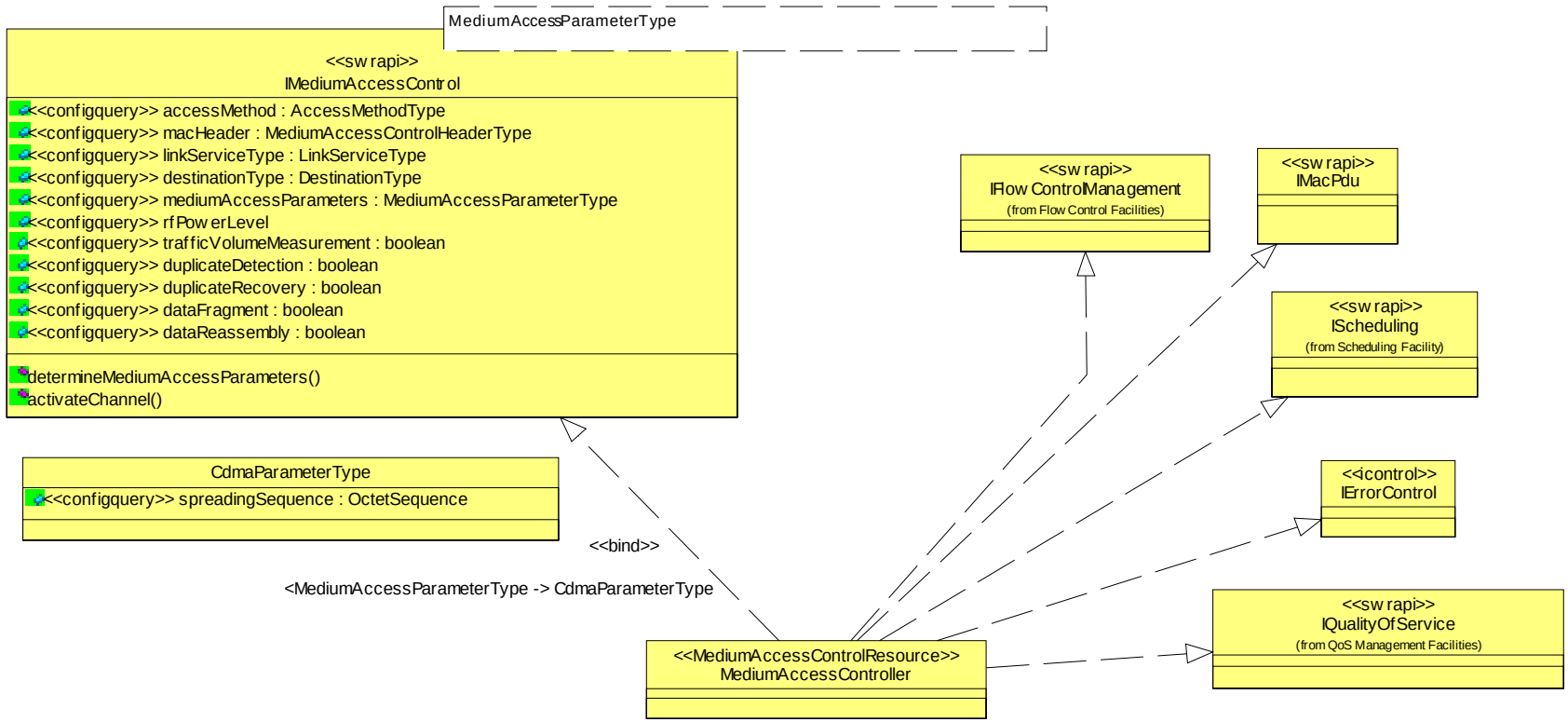


- **RF/IF Interfaces**
- **Allow controlling the parameters of hardware devices as defined in the UML Profile: Communication Equipment**

PIM: Physical Layer: Modem

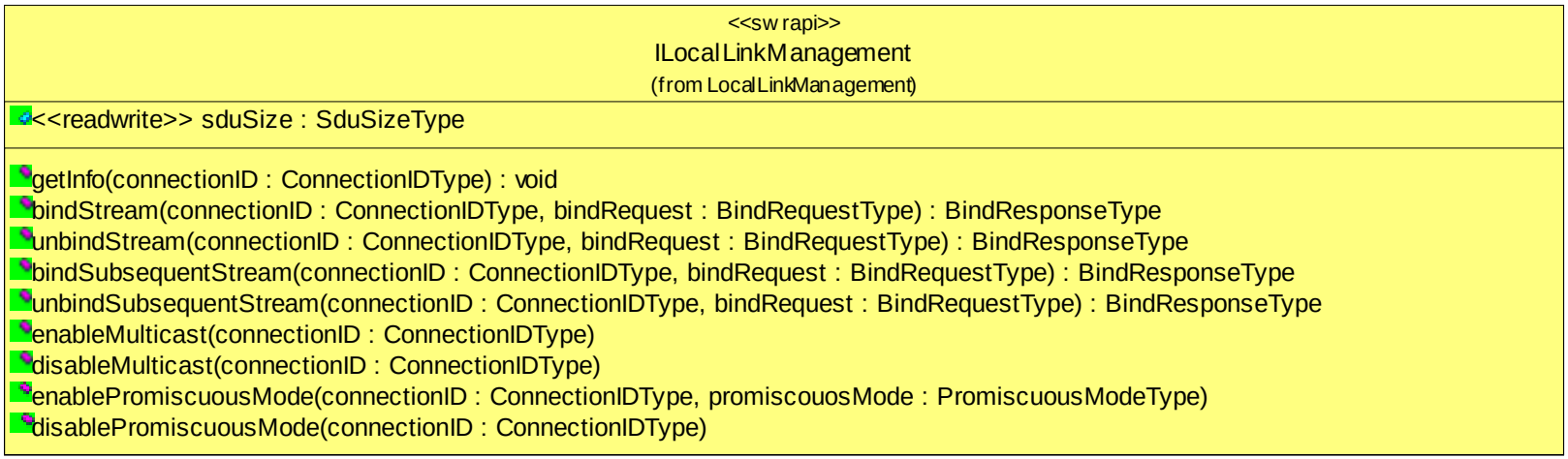


PIM: Data Link Layer: MAC



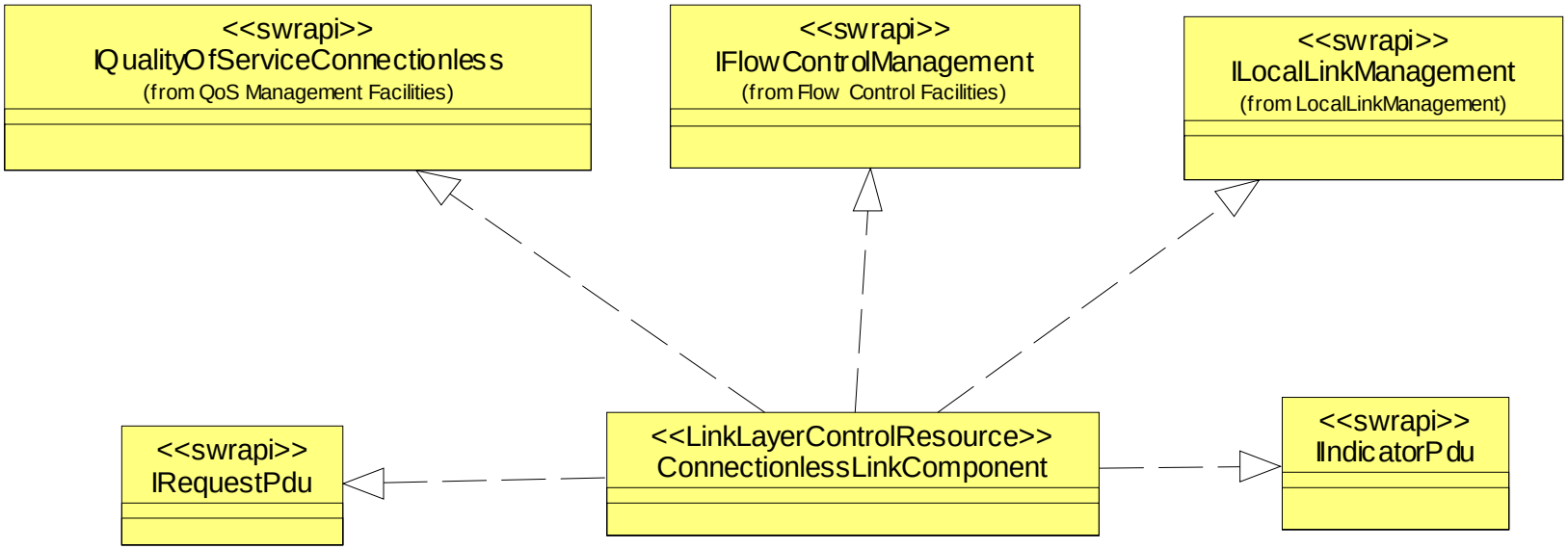
- Provides control over medium access parameters
- A MAC Component realizes interfaces that are defined in the Common Layer Facilities, as well as the IMediumAccessControl
- IMacPdu specializes IPdu by binding its own header and SDU types
- MAC Component provides Flow Control, Scheduling, Error Control, QoS, as well as services given by IMediumAccessControl

PIM: Data Link Layer: LLC



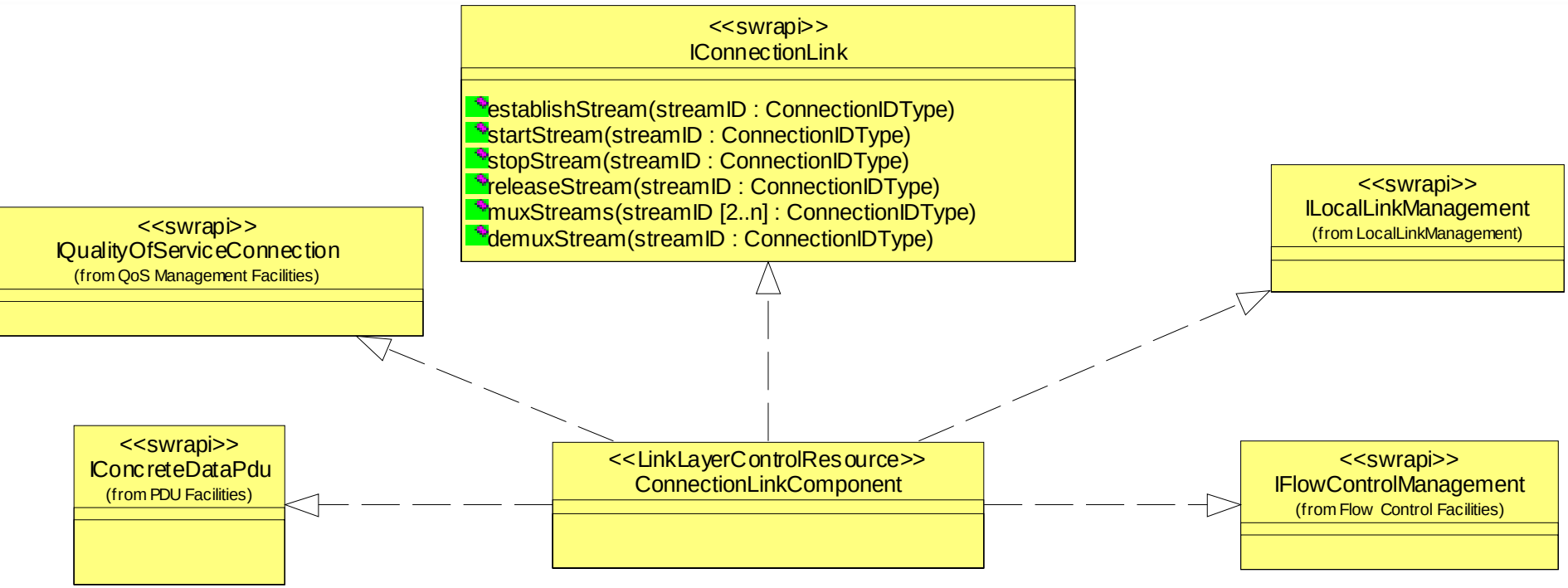
- ILocalLinkManagement is common for both connection oriented and connectionless link protocols
- Enables controlling the link parameters that only affect the local radio set
- Typically realized by the same component that realizes all of the link related interfaces for a given WF

PIM: Data Link Layer: LLC



- **Connectionless link (packet based) does not have any extra interfaces, other than the common layer ones**
- **Has its own pdu definitions, derived from IPriorityPdu**

PIM: Data Link Layer: LLC



- **IConnectionLink provides the functionality to mux/demux/establish multiple data (circuit switched) streams**
- **Once a data stream is started, it is treated as a continuous pipeline of data**

PIM: Radio Control: Radio Management

- Management of the radio (domain management)
- Management of devices and services within a radio (device management)
- Communication channel interfaces provide a mechanism for specifying the connection of WF components, and the general properties of the instantiated WF

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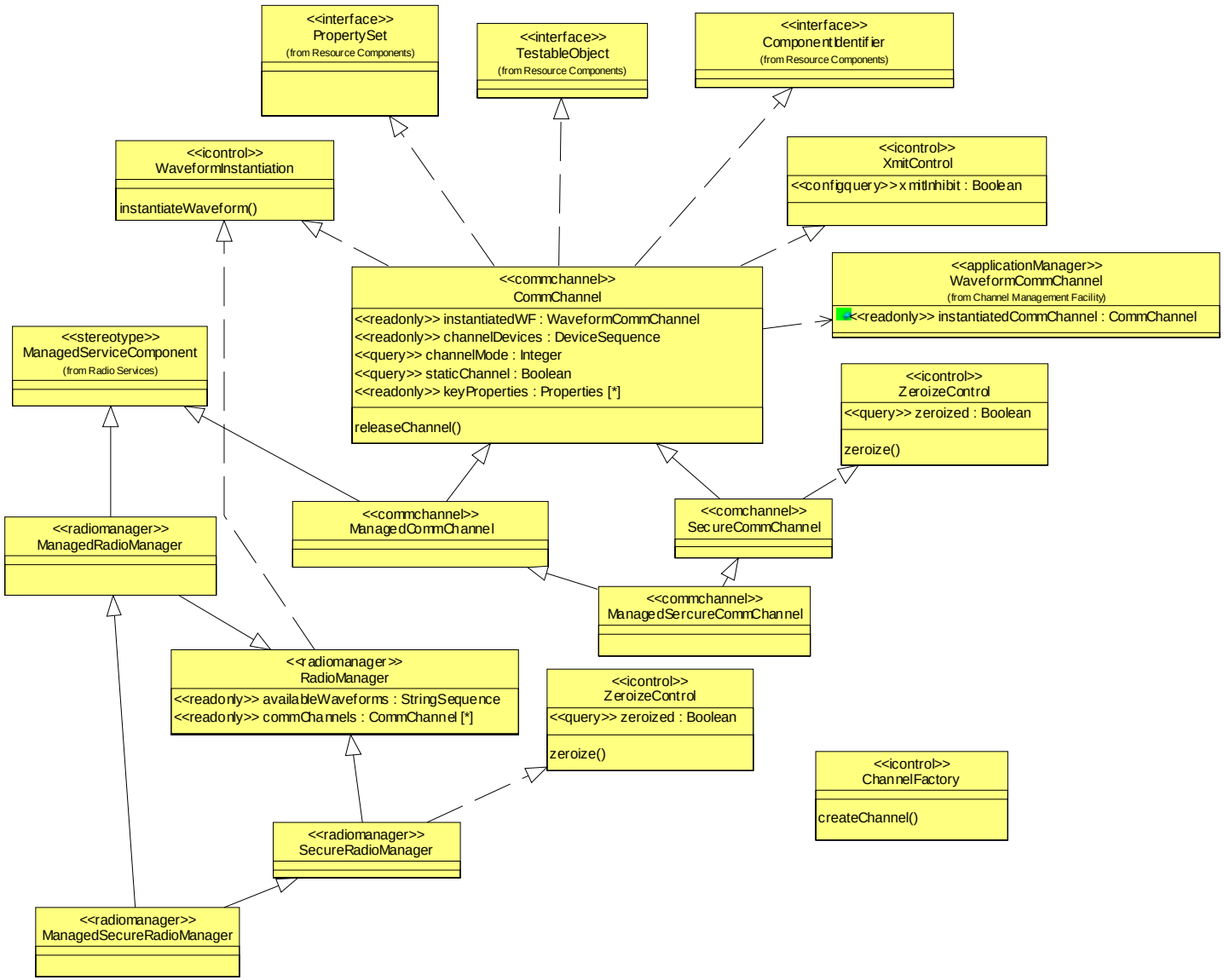
PIM: Radio Control: Radio Management



Conclusion – PIM

- Provides waveform portability through standard software interfaces Organized as in OSI model
- Does not require layered implementation
- Coherent with key characteristics of UML model
- Can be extended to create vertical I/O models

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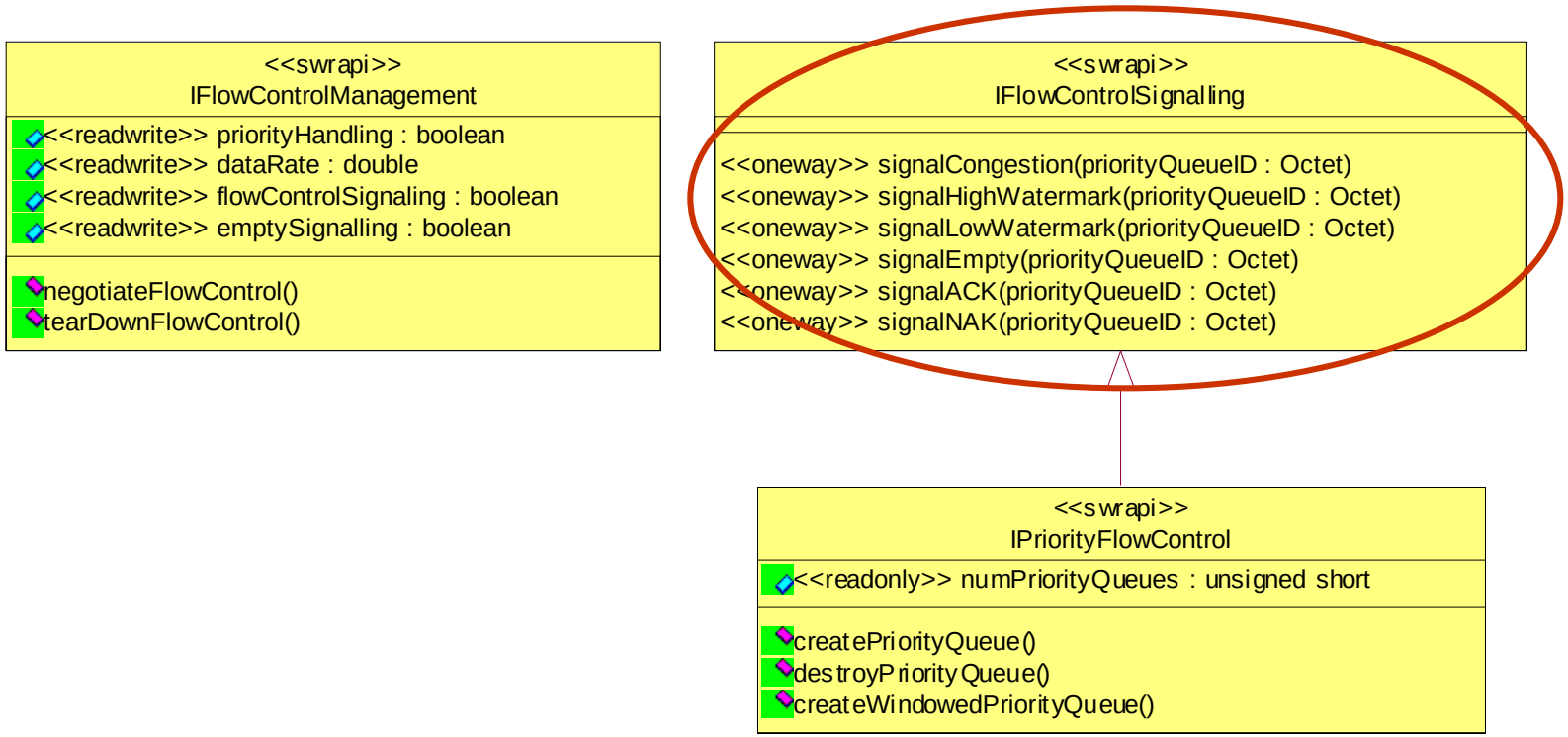
Example

- A simple component example that realizes IPdu interface
- Stereotyped as <<ResourceComponent>>
- Has one output port
- Illustrates how a waveform component can be implemented by realizing the interfaces

PIM: Common Layer: Flow Control



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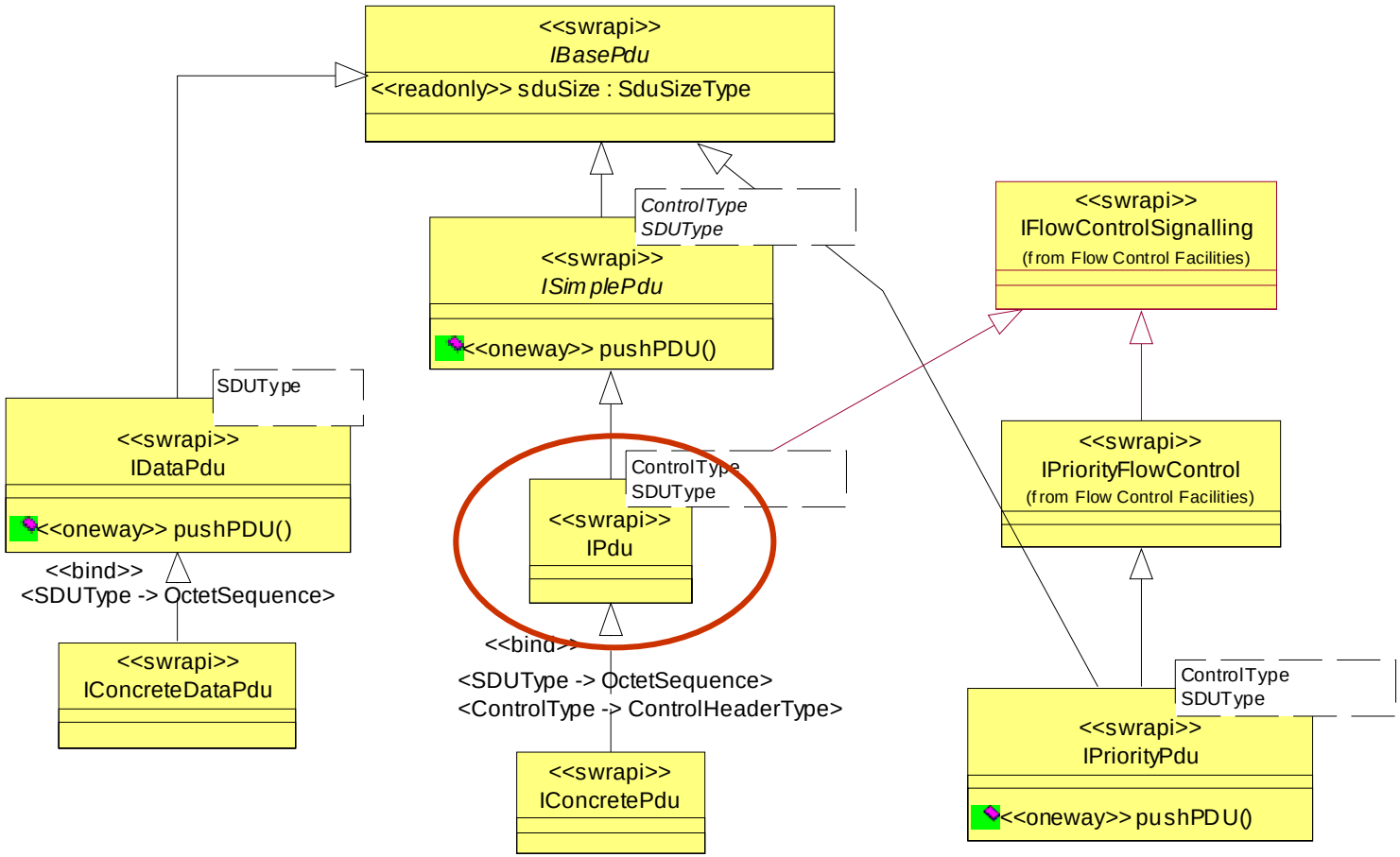
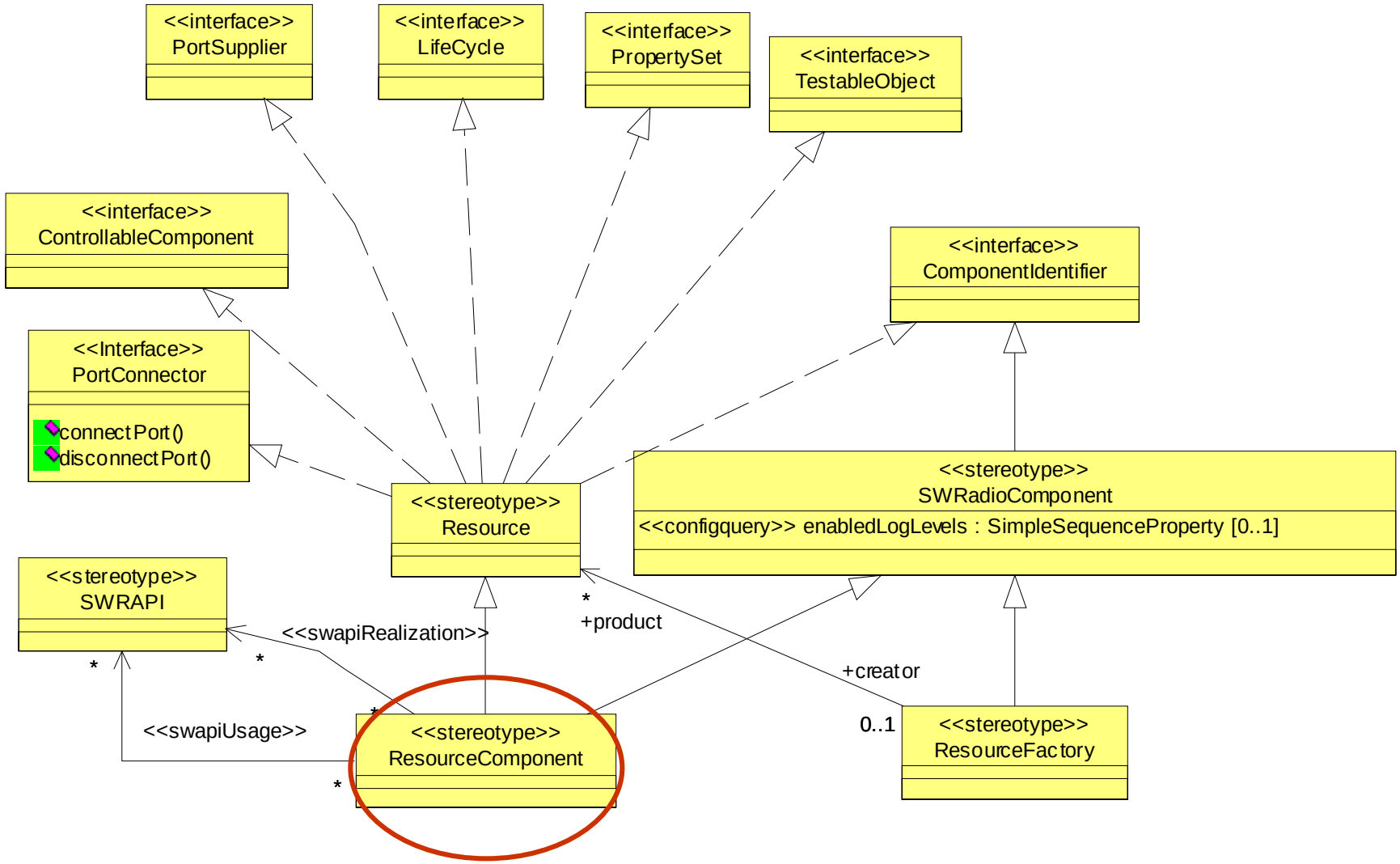
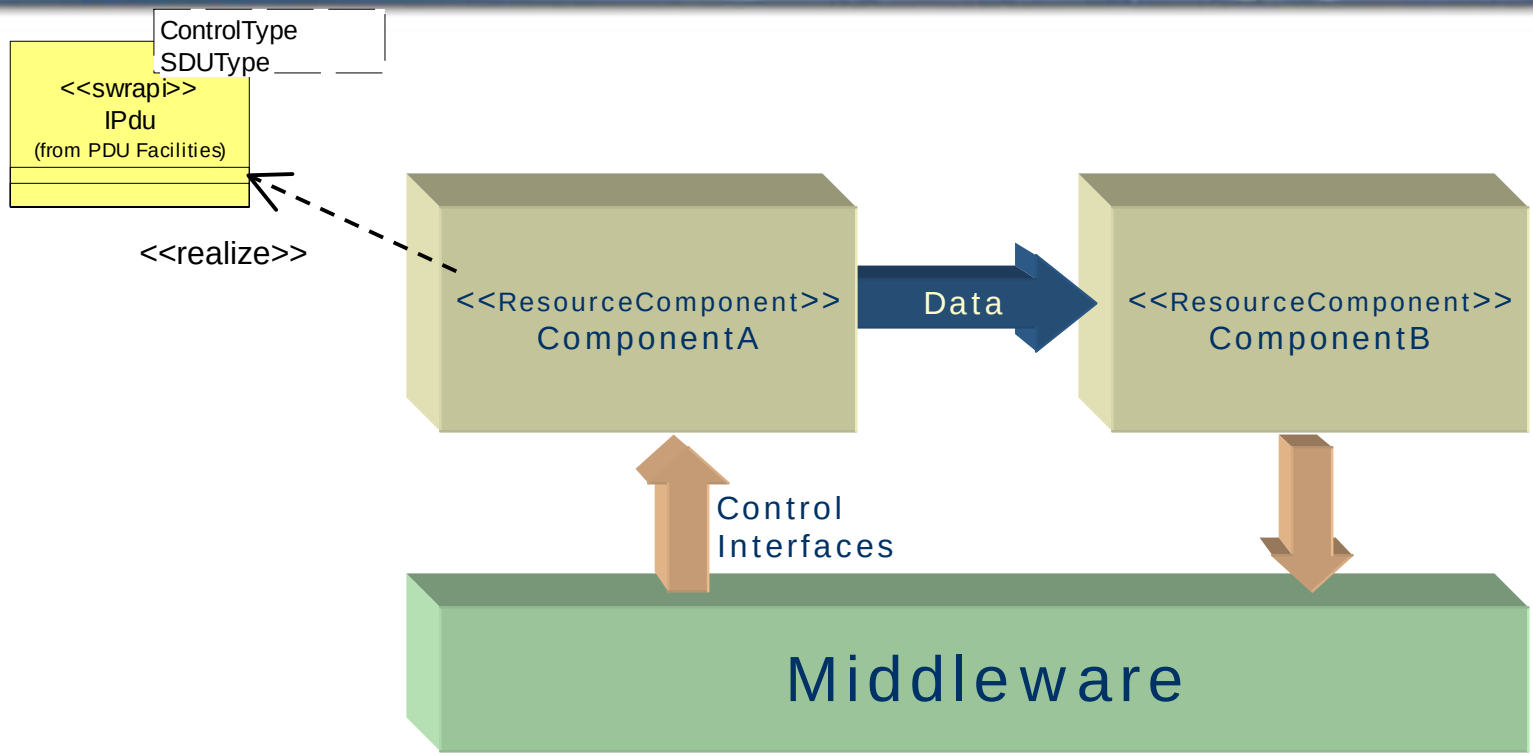


UML Profile: Resource Components





- ComponentA realizes IPdu interface, which inherits from ISimplePdu and IFlowControlSignalling interfaces
- It is stereotyped as a ResourceComponent, so it provides the required interfaces PortSupplier, PropertySet, ControllableComponent, etc. These interfaces are used in realizing swrapi's
- ComponentB can send flow control related signals to ComponentA, by using IPdu interface
- Another upstream component can control ComponentA to send its data using pushPdu operation
- Data can be marshaled by the middleware, or it can by-pass the middleware for performance reasons

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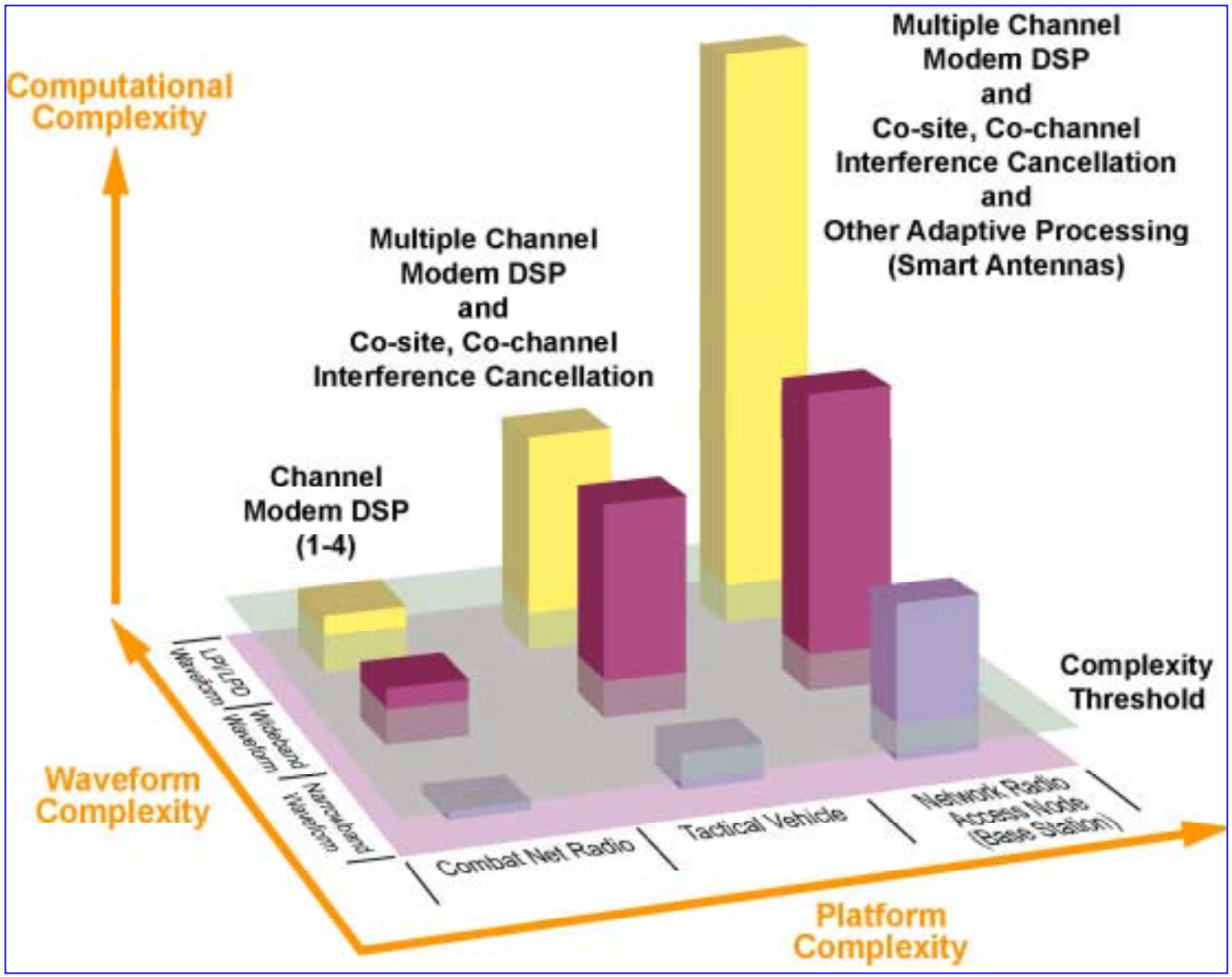
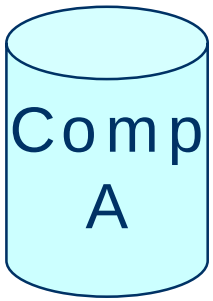
Processing Power



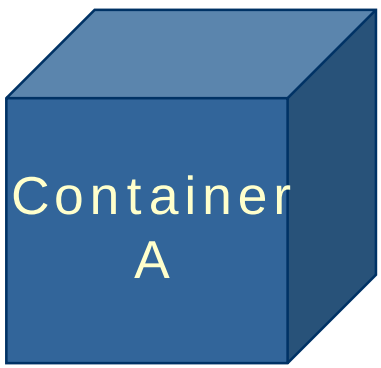
Platform Architecture

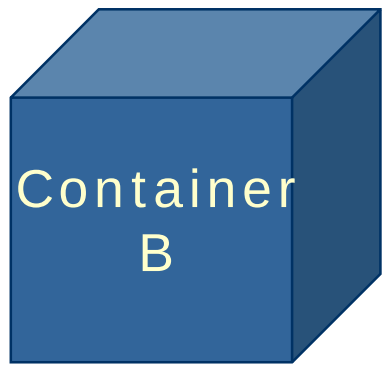
- Each container has a single processing element
- Components with different timing requirements should run on different containers

Platform Architecture

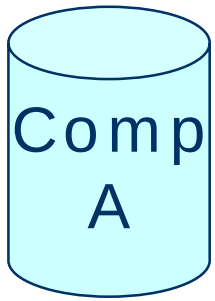


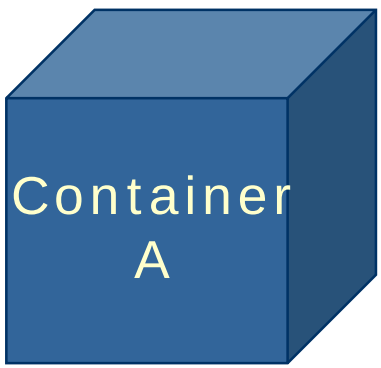
- Runs once every 20ms
- Each execution takes 8ms

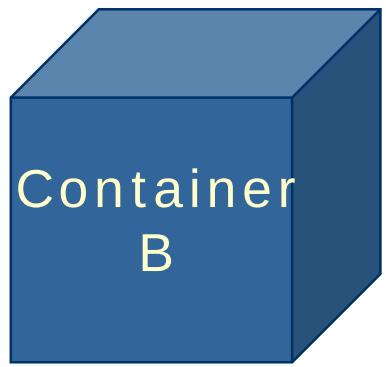




Platform Architecture

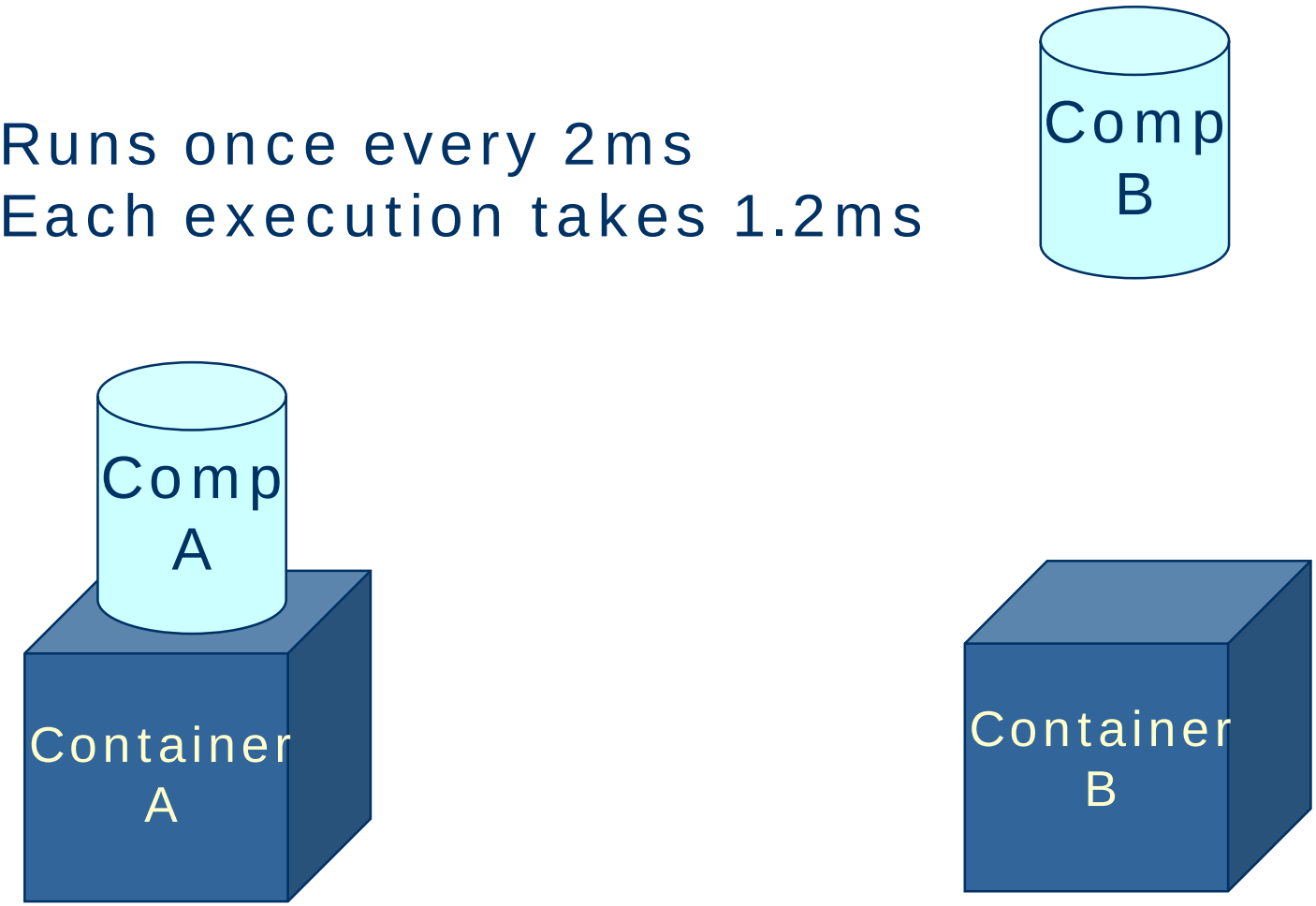




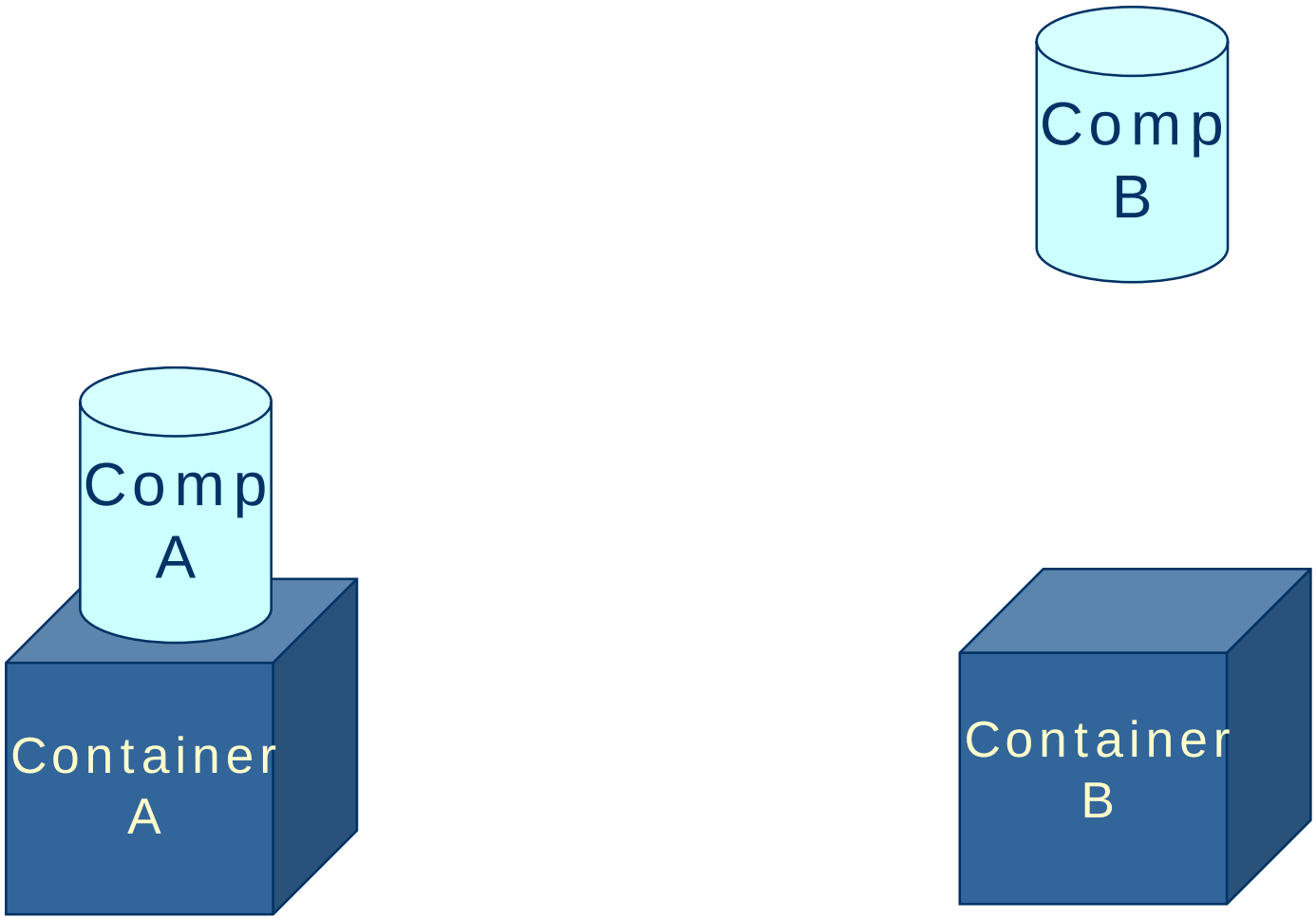


Platform Architecture

- Runs once every 2ms
- Each execution takes 1.2ms

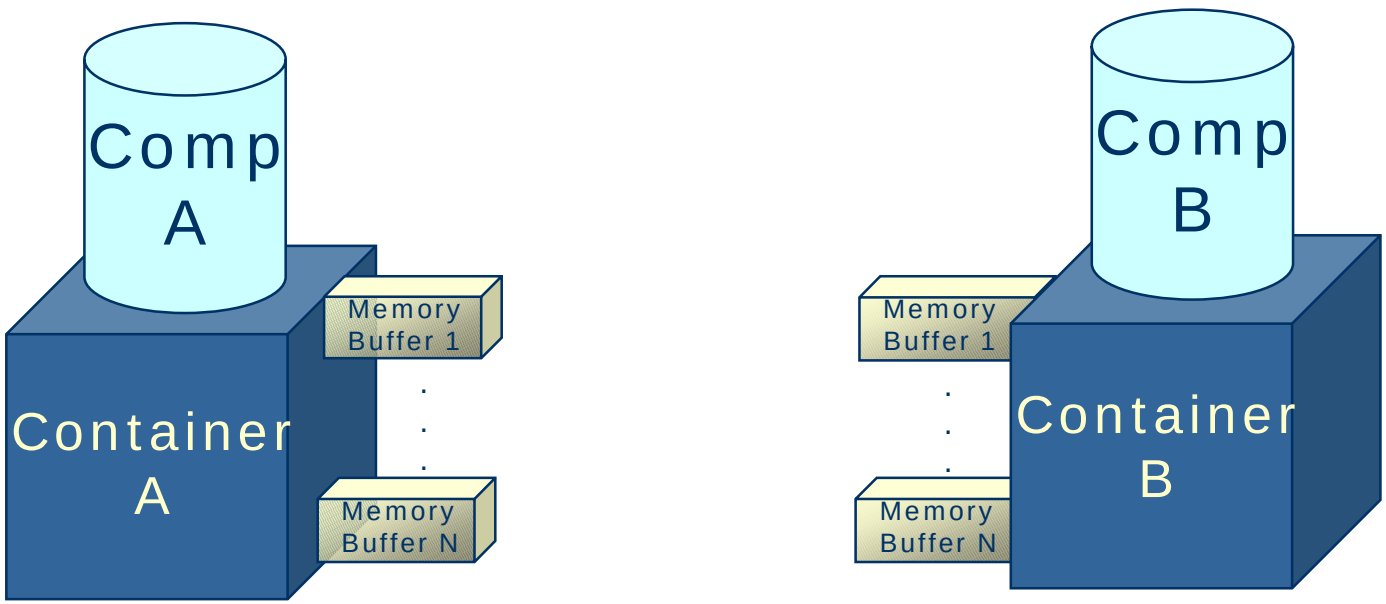


Platform Architecture



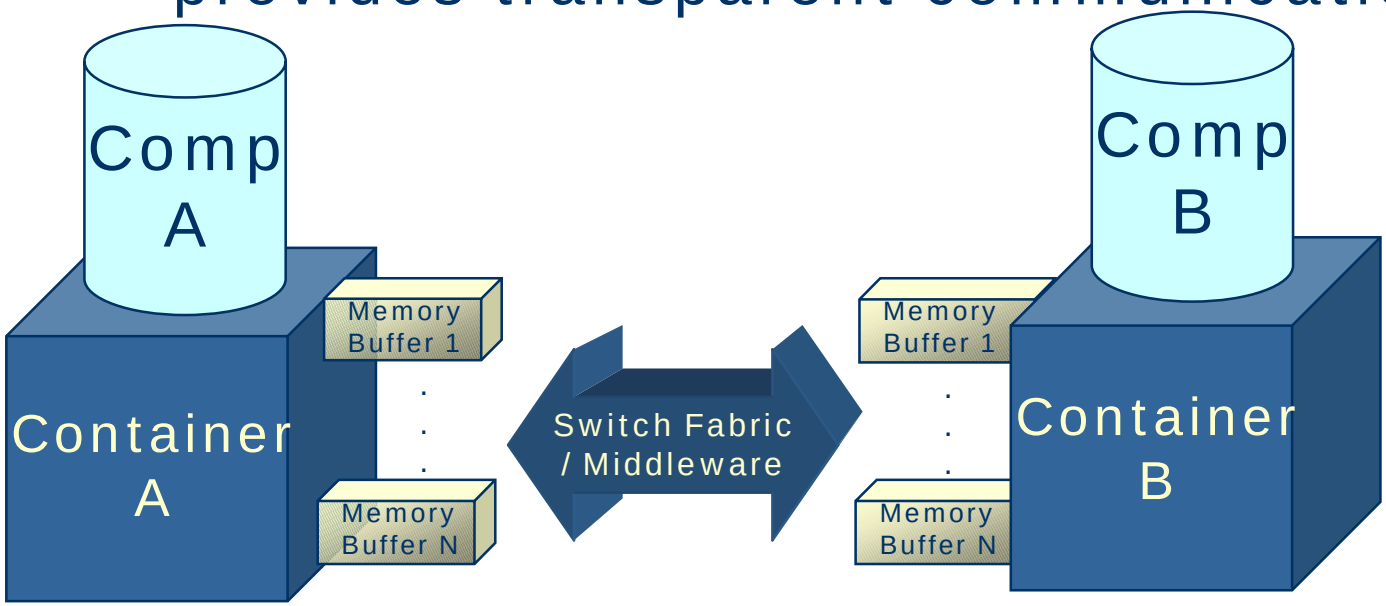
Platform Architecture

- Multiple memory buffers enable components to run independently, without waiting for buffers to fill



Platform Architecture

- Fabric handles congestion management and priority based routing
- Switch fabric & Middleware provides transparent communication



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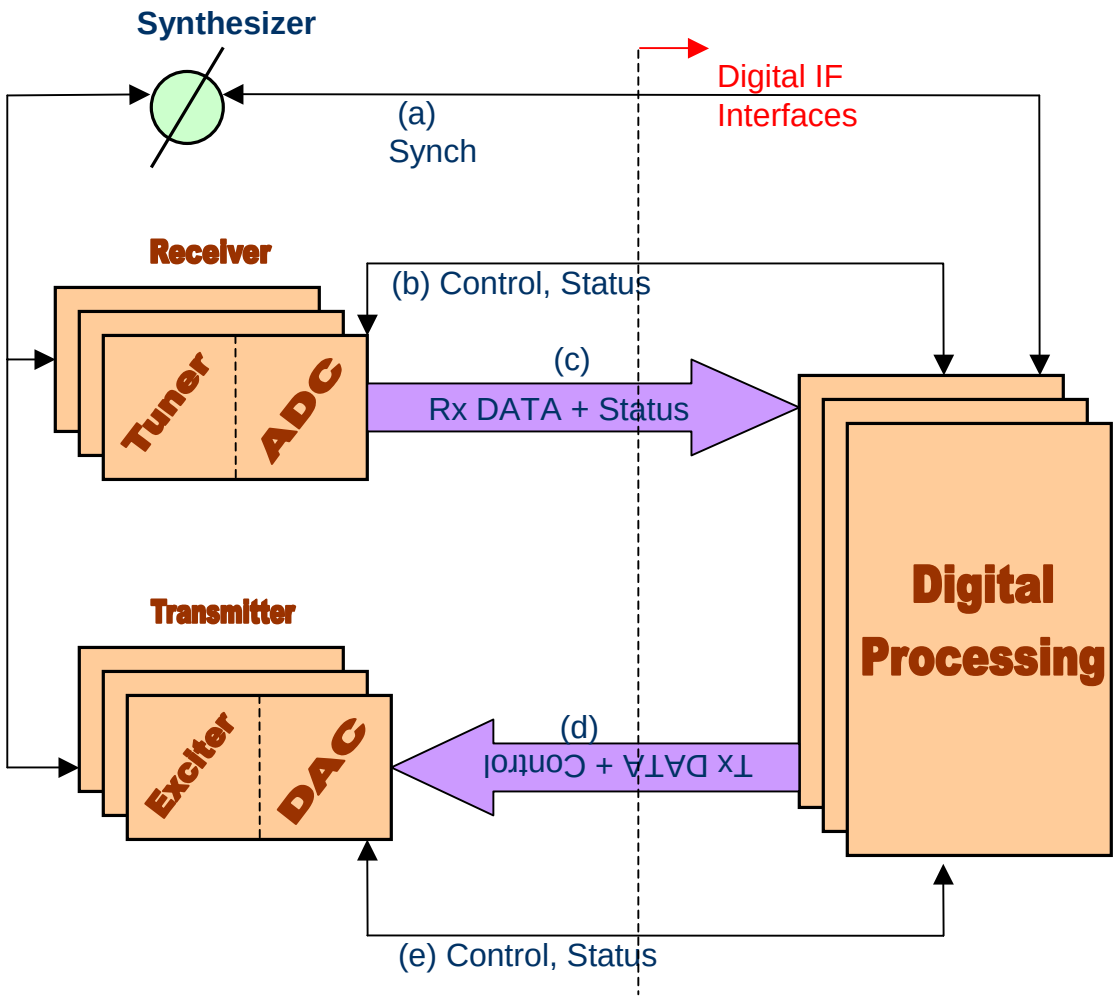
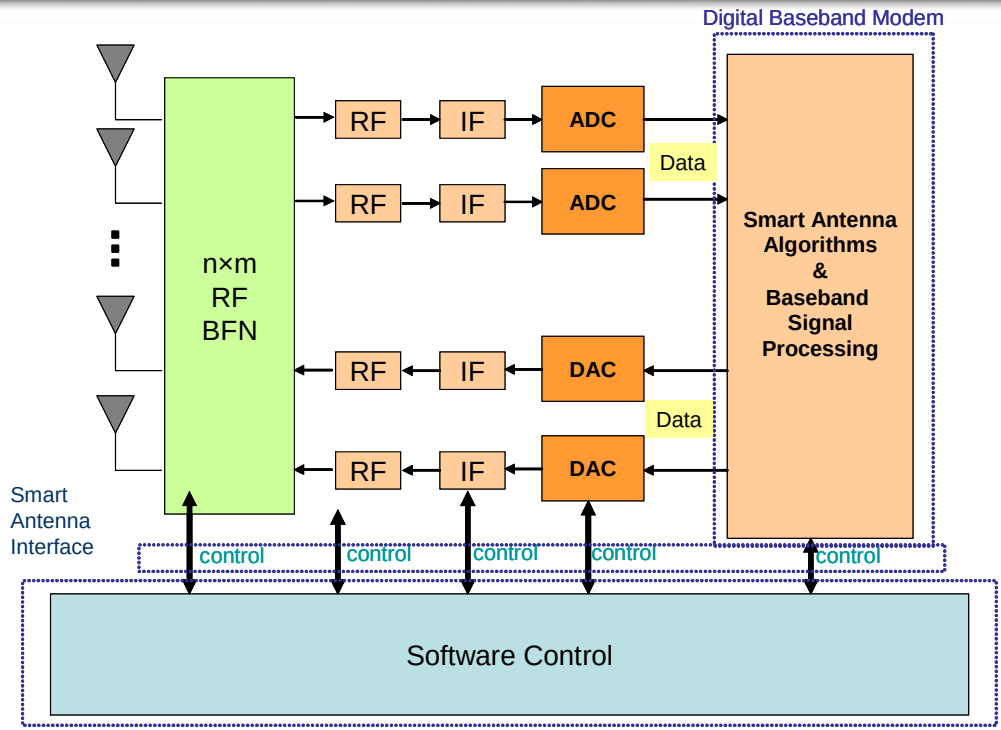
Digital IF RFP

- Was issued in Aug 2004, by SBC DTF
- PIM for control interfaces of tuners and exciters in a high bandwidth digital streaming system
- Data descriptors for the messages passed across the digital Intermediate Frequency (IF) platform
- A UML 2.0 compliant profile that allows the modeling of system aspects, topology and data flow

Digital IF RFP



Smart Antenna RFP



- Was issued in Aug 2004, by SBC DTF
- RFP solicits additional antenna PIM definition that will build upon the SWRadio spec, antenna interfaces

Security RFPs

New RFPs underway:

1. **key management (generation, distribution, storage, lifecycle, certificates, etc. including group keying support),**
2. **crypto algorithm selection & management,**
3. **secure audit,**
4. **transmission security.**