Implementation
Design Choices for
the SWRadio
Specification

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Overview

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

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

```plaintext
<<swrap i>>
IStream

<<configquery>>
- sourceAddress : AddressType
- destinationAddress : AddressType
- priority : Integer

<<query>>
- streamID : Octet

establishStream(sourceAddress : AddressType, destinationAddress : AddressType, priority : Integer) : Octet
releaseStream(streamID : Octet)
localSetup()
```
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
• 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
- RF/IF Interfaces

- Allow controlling the parameters of hardware devices as defined in the UML Profile: Communication Equipment
- 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
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
Connectionless link (packet based) does not have any extra interfaces, other than the common layer ones

Has its own pdu definitions, derived from IPriorityPdu
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
● 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
• 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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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
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
UML Profile: Resource Components

- `<<interface>> PortSupplier`
- `<<interface>> LifeCycle`
- `<<interface>> PropertySet`
- `<<interface>> TestableObject`
- `<<interface>> ControllableComponent`
- `<<Interface>> PortConnector`
- `<<stereotype>> SWRAPI`
- `<<stereotype>> SWRadioComponent`
- `<<configquery>> enabledLogLevels : SimpleSequenceProperty [0..1]`
- `<<swapiRealization>>`
- `<<swapiUsage>>`
- `<<stereotype>> Resource`
- `<<stereotype>> ResourceComponent`
- `<<stereotype>> ResourceFactory`
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

- Multiple Channel Modem DSP and Co-site, Co-channel Interference Cancellation
- Other Adaptive Processing (Smart Antennas)

Computational Complexity

Waveform Complexity

Platform Complexity

Complexity Threshold
• 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

- Comp A
- Container A
- Container B
Platform Architecture

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

Container A

Comp A

Container B

Comp B
• 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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• 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
● Was issued in Aug 2004, by SBC DTF
● RFP solicits additional antenna PIM definition that will build upon the SWRadio spec, antenna interfaces
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.