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SDR WAVEFORM PORTABILITY

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Software Defined Radio

- **SDR concept provides for a segregation between hardware providers, software developers, and system integrators**
  - Reduces stovepipe acquisition process
  - Facilitates development and distribution of new applications
    - Make use of third party software

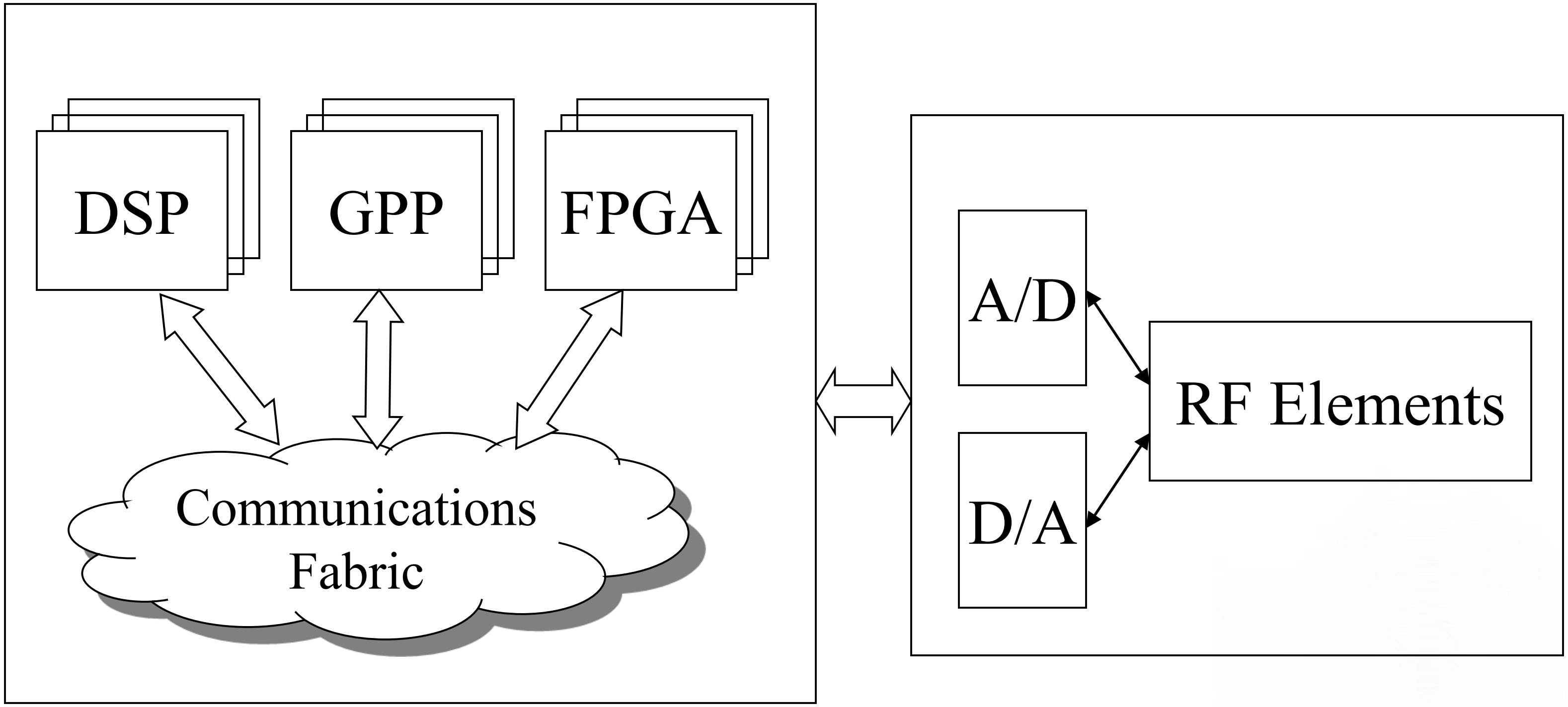
- **Deployment and execution of software on different vendor platforms must be made possible**
  - Software deployment rather than software configuration

- **Application portability becomes essential**
  - With minimum software modifications to minimize cost

Application Portability

- **Current implementations of SDRs do not lend to portability**
  - The three SDR development responsibilities are still tightly integrated
  - Implementation is based on proprietary architectures that uniquely define the roles of hardware providers, software developers and system integrators
  - Limited application expansion possible through COTS software
- **The development of portable applications faces a number of challenges**
  - Heterogeneous digital and RF platforms provided by different vendors
  - Standardization of software development architecture

Platform Configuration



SDR Platform Components

- **SDR platforms are composed of heterogeneous components**
  - **Signal processing components**
    - Digital Signal Processors (DSP)
    - General Purpose Processors (GPP)
    - Field Programmable Gate Arrays (FPGA)
  - **Operating Systems**
    - Multiple vendors
    - Real time vs non-real time
  - **Inter-component communications**
    - Protocols
    - Bus, Star fabric…
  - **RF front end**
    - A/D, D/A, oscillators, filters, antennas

Portability Options

- **Deployment and execution of software on different platforms can be done in a number of ways:**
  - Interpreter with source code (e.g. Postscript)
  - Virtual machine with byte code (e.g. Java)
  - Multiple compile with native code

- **Multiple compile is the only approach that can offer the performance required by modern radio applications**
  - Data rates, modulation formats, error correction, frequency hopping

Portability via Multiple Compile

- **Each application component is compiled for the different platform configurations to be supported**
  - Processing devices
  - Operating systems
- **Provides optimum performance since applications can draw on the full potential of platform components**
  - Not limited to single configuration
- **Software can be ran where it is most efficient, if available. For example:**
  - Synchronization and DDC/DUC on FPGA
  - Filtering and modulation/demodulation on DSPs
  - Error correction and interleaving on GPP

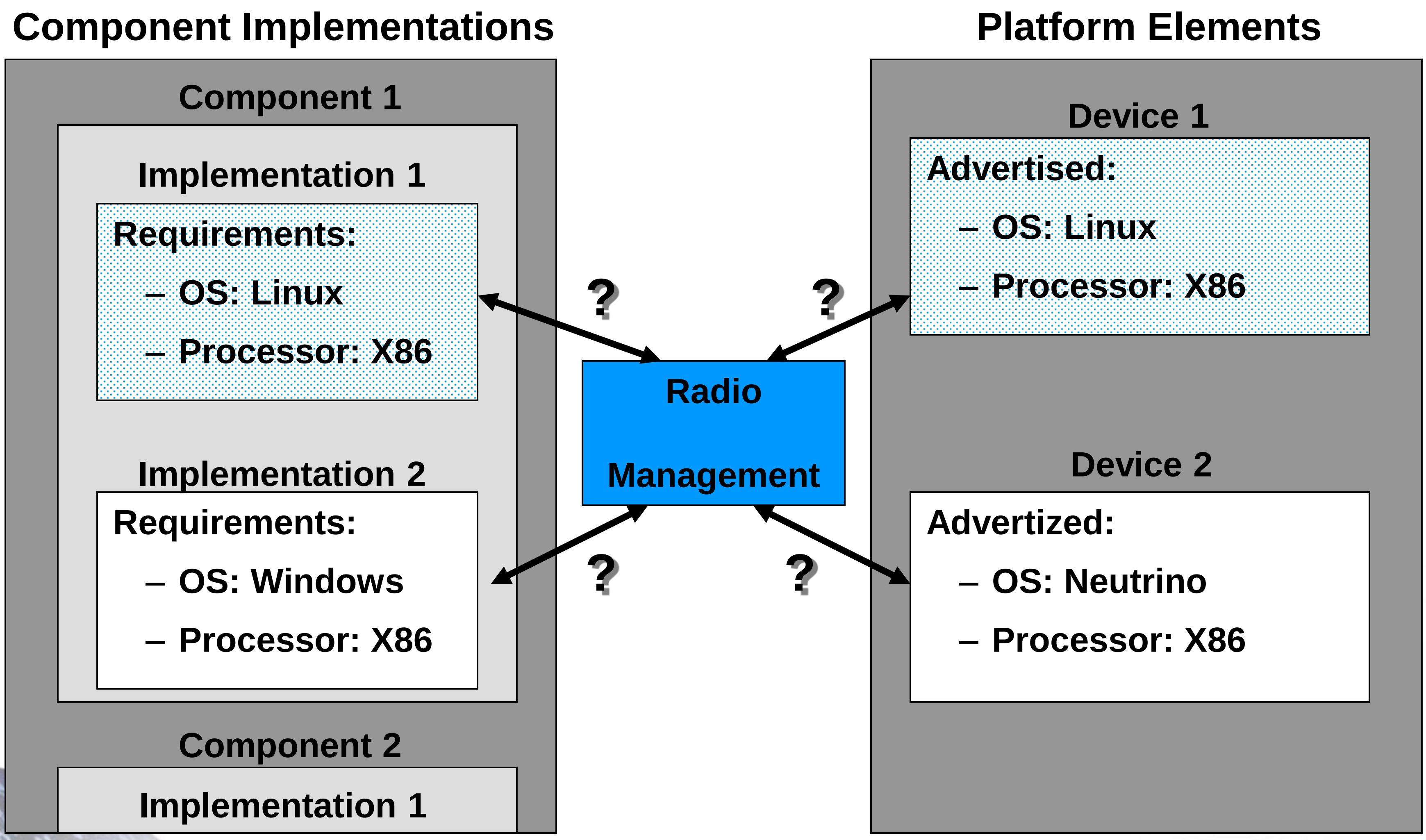
Portability via Multiple Compile (2)

- **Will most likely require different software implementations for different platform configurations**
  - E.g. GPP vs FPGA software

- **A deployment architecture is required to <u>automatically select</u> the proper application component implementation compatible with platform configuration**
  - Comparison between platform capabilities and component implementation requirements

- **Allows hot swap capability**
  - If a device becomes inactive, software can be redeployed elsewhere
  - Increase application reliability

Automatic Component Selection



Standardization for Portability

- **To reduce the development cost of the different component implementations, code reuse should be maximized**

- **This can be achieved with a standard development framework that defines:**
  - **A set of Application Programming Interfaces (API)**
    - API for OS
    - API for access to RF equipment
  - **Communications middleware**
    - Between components provided by different developer categories
  - **Deployment Architecture**
    - Component selection,
    - Application load, initialize, execute

Software Communications Architecture

- **The SCA is a radio framework developed to facilitate portability**
  - **Open Architecture**
    - Based on commercial standards
  - **Created by a consortium of companies**
    - Raytheon, BAE System, ITT, Rockwell Collins, Motorola, Harris…
  - **Improved through an open public change proposal process**
    - http://jtrs.army.mil/
  - **An open source reference implementation exists**
    - http://www.crc.ca/scari

Portability with the SCA

- **The SCA addresses the standardization process with:**
  - **Open specification deployment architecture**
    - Based on CORBA Component Model (CCM)
      - XML assembly descriptor defines application component requirements
      - Performs platform capability and capacity verification
      - Component selection based on component requirements
  - **Application Programming Interfaces**
    - POSIX compliancy for OS APIs
    - Device state management ITU X.731 ISO/IEC 10164-2
    - SCA API Supplement
    - Public submission process for new API
      - SDRF and OMG initiative
  - **Communications Middleware**
    - Minimum CORBA

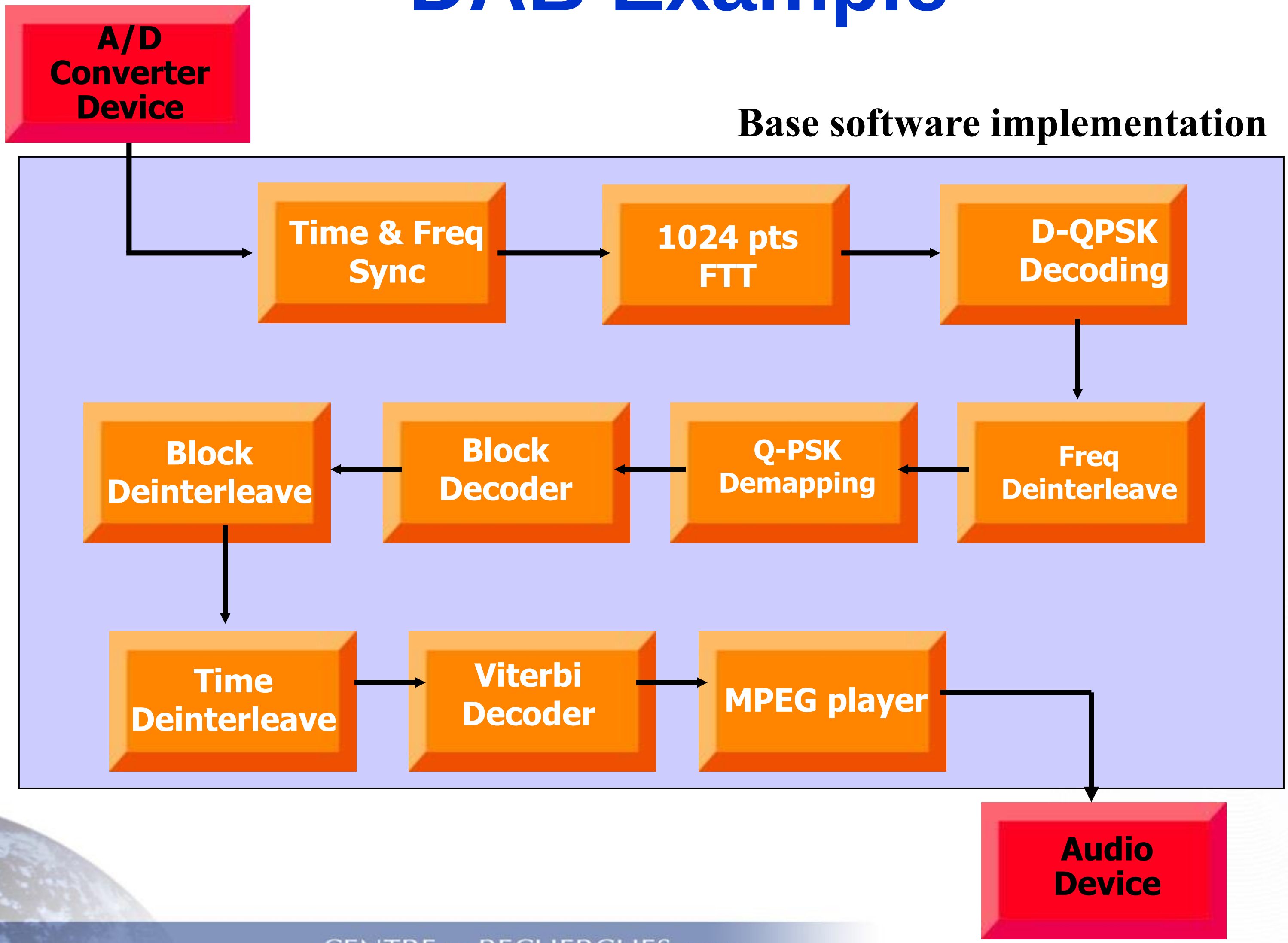
Component Implementation Granularity

- **For ultimate portability, each component should be recompiled for every possible platform element configuration**
  - Various combinations of processors, OS, and middleware !!!
  - Deployment manager selects proper combination

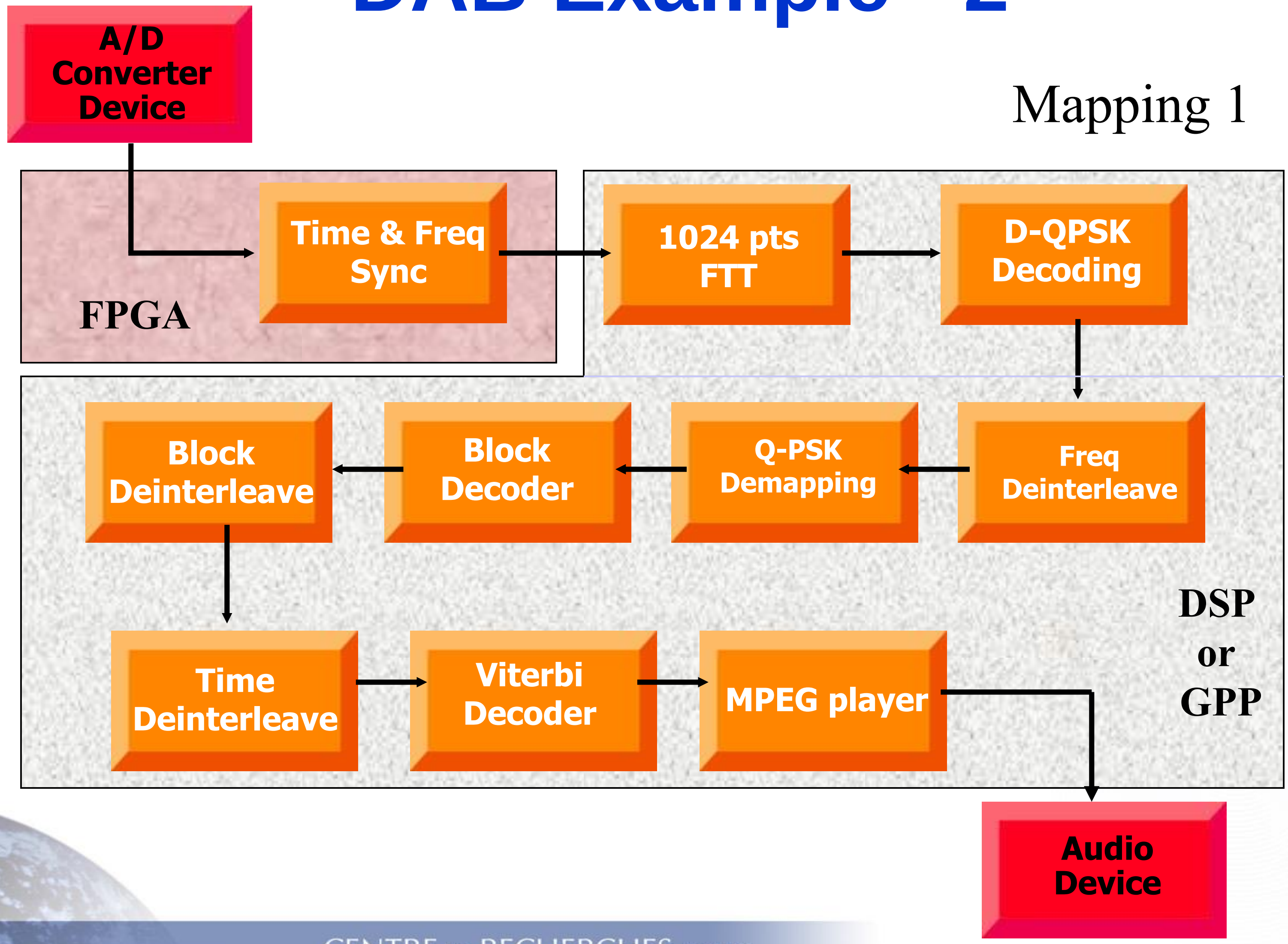
- **When FPGAs are used, a certain level of component aggregation is required**
  - No Dynamic Loader available for FPGAs
  - Components must be combined into a single loadable image
    - otherwise one component per FPGA

- **Implementation granularity depends on FPGA capabilities and radio reconfiguration flexibility required**
  - FPGA image can be composed of many application components providing increasing application performance but decreasing reconfiguration flexibility and increasing development cost

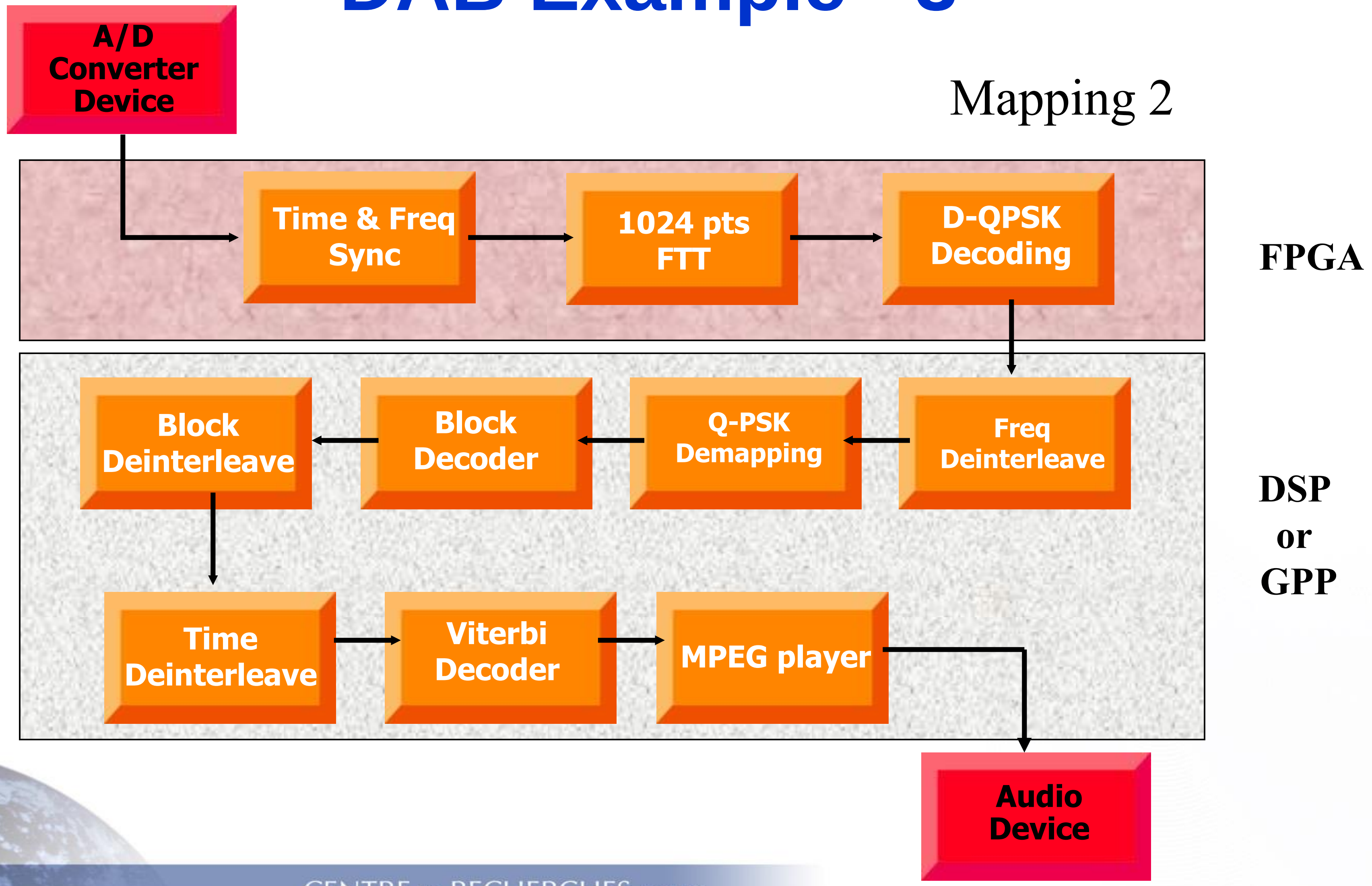
Component Implementation
DAB Example



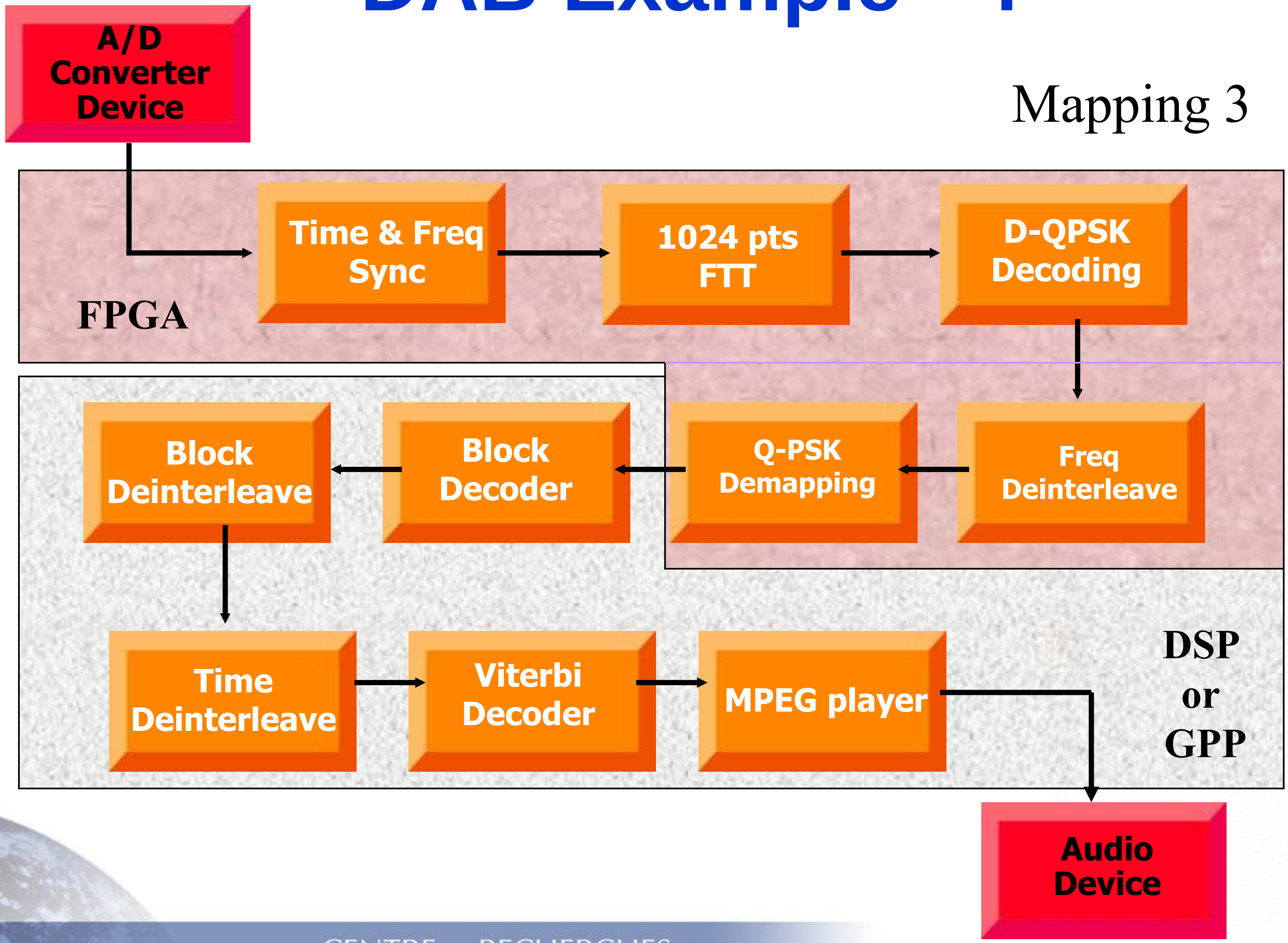
Component Implementation DAB Example - 2



Component Implementation
DAB Example - 3



Component Implementation
DAB Example - 4



Quality of Service

- **In some instances, the platform configuration could support multiple implementations of a same component**
  - Java or C++
  - FPGA or GPP code
- **SCAv2.2 does not offer a QoS mechanism to select best implementation**
  - SCA loads components according to assembly descriptor file
- **Modifications to the SCA is needed**
  - QoS requirements to be included in SAD
- **Tools such as the CRC Waveform Application Builder (WAB), Component Editor and Waveform Optimizer could be used to address QoS requirements**

Software Accelerators

- **While FPGA offer increased performance (processing speed and lower power consumption) over DSP and GPP, current use limits portability**
  - Development cost is increased since FPGA programming is platform specific
  - Optimum granularity level is difficult to estimate

- **A better use of FPGA would be to consider them as a bank of selectable signal processing functions**
  - Similar to math coprocessor, DirectX, MMX

- **Deployment manager compares application component list with Software Accelerator functions provided by the FPGA**
  - When a match is made, FPGA component is used instead of loading DSP or GPP component

Software Accelerators – 2

- Software accelerator concept requires certain modifications to current SDR implementations
- FPGA implementations require the use of an internal data bus to individually address each function and connect them as defined in the application description
- A standard component descriptor is required to identify functions provided by the FPGA

Conclusion

- **Application Portability is an essential element for SDR technology**
  - It is the mean by which true segregation of development roles wil be acheived

- **Multiple compile is most suitable approach for heterogeneous platforms**
  - One implementation per platform element configuration
    - Processor + OS

- **Portability requires a certain level of standardization, offered by the SCA.**
  - Open specification Deployment Architecture
  - Application Programming Interfaces (*)
  - CORBA middleware

- **The concept of Software Accelerator in FPGA should be explored to provide higher application performance without reducing portability**