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The SCA: Myths vs Reality

Is the SCA what you think it is?

Steve Bernier
Researcher, Project Leader
Advanced Radio Systems

Canada

CRC

CENTRE DE RECHERCHES SUR LES COMMUNICATIONS RESEARCH CENTRE

Outline

1. Overview of the Software Communications Architecture (SCA)
2. Is the SCA too slow ?
3. Is the SCA too fat ?
4. Summary

1. SCA Overview

- **The SCA was developed to assist in the development of SDR for the Joint Tactical Radio System (JTRS). As such, the SCA has been structured to:**
  - Provide for portability of applications between different SCA platforms
  - Leverage commercials standards to reduce development costs
  - Reduce software development time with the ability to reuse design modules
  - Build on evolving commercial frameworks and architectures
- **The SCA is not a system specification but an implementation-independent set of rules that constrain the design of systems to achieve the above objectives**

1. SCA Overview

- **Myth #1: The SCA is only for military Radios**
  - While its true the SCA specification was developed for the US DoD JTRS program, the reality is the core framework specification contains no military features at all !

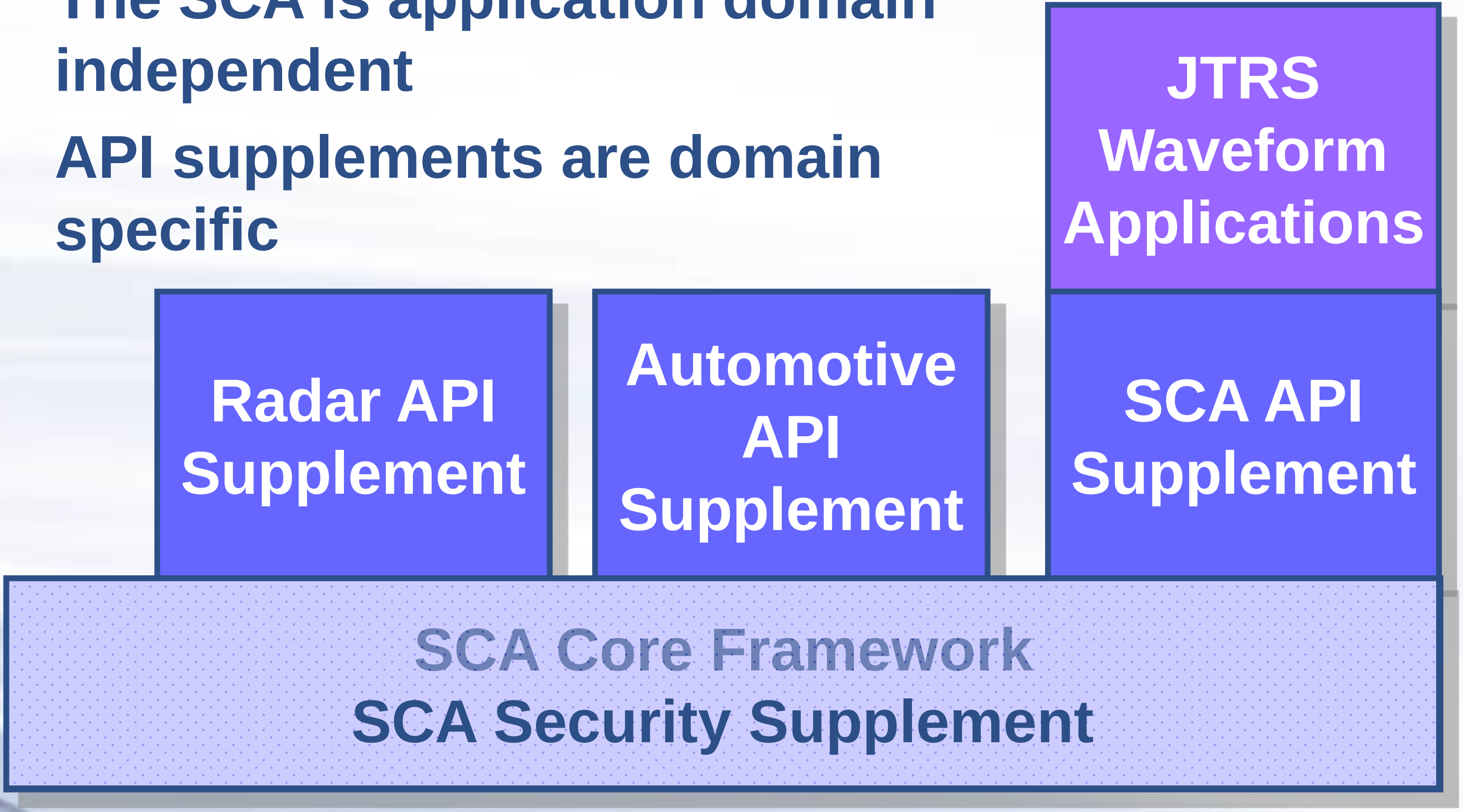
- **Myth #2: The SCA is for building Software Defined Radios**
  - None of the core framework APIs are radio specific !
  - An SCA platform can host any kind of application
    - radar, medical imagery, test equipment, etc.

1. SCA Overview

- **The SCA Core Framework specification (version 2.2.2) is made of five documents:**
  - Main document (130 pages)
  - Appendix B – Application Environment Profile (21 pages)
  - Appendix C – IDL (41 pages)
  - Appendix D – Domain Profile (64 pages)
  - Appendix D – Attachment 2 – Common Properties (4 pages)
- **Previous releases of the SCA specification had two extra documents named Security Supplement and API Supplement**
  - These documents were last published in 2001
  - The security supplement adds RED/BLACK centric APIs
  - The API supplement adds communications/radio centric APIs

1. SCA Overview

- The SCA is application domain independent
- API supplements are domain specific



JTRS Waveform Applications

Radar API Supplement

Automotive API Supplement

SCA API Supplement

SCA Core Framework

SCA Security Supplement

1. SCA Overview

- **The SCA specification describes how to create a platform that can host SCA-compliant applications**
  - It describes how a platform makes its devices and services available to applications
  - It also describes how applications are deployed

- **The SCA describes an architecture capable of doing what every real-time operating systems does:**
  - Load and execute applications
  - Specify priorities and stack sizes for individual tasks

1. SCA Overview

- **So what is so unique about the SCA ?**
  - It is platform independent
    - Supports any operating system*, processor, and file system
  - It is a scalable distributed system
    - Supports single processor applications the same way it supports multi-processor applications
  - An SCA platform can be made of several nodes with different processor architectures running different operating systems supporting different file systems
- **The most unique attribute of the SCA is that it's actually a *Component Based Development architecture !***

* OS must meet a subset of POSIX APIs

1. SCA Overview

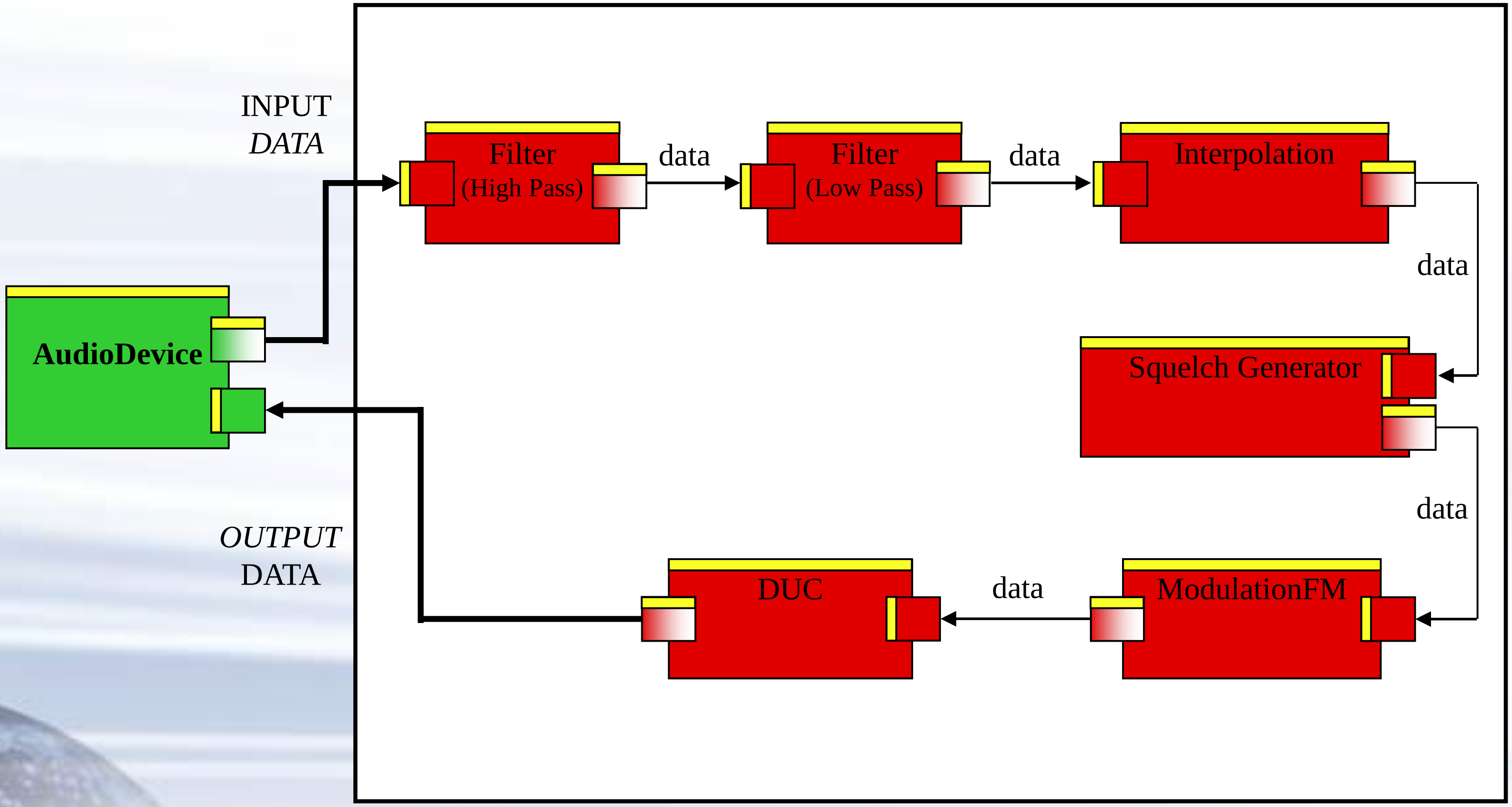
- **What is Component Based Development (CBD) ?**
  - **Definition:** an architecture which allows the creation, integration, and re-use of components of program code
  - CBD is a new development paradigm where the smallest unit of software is a **component**
  - With CBD, an application is ‘assembled’ using **software components** much like a PCB is populated with hardware components
- **CBD is a very popular paradigm for application development**
  - **‘.Net’** (from Microsoft) and ‘**EJB’** (from Sun Microsystems) are two very popular CBD architectures
  - The OMG CORBA Component Model (**CCM**) is another example of a CBD architecture

1. SCA Overview

- **Software Component**
  - **Definition:** is a small, reusable module of executable code that performs a well-defined function. It is designed, implemented, and tested as a unit prior to integration into an application
  - It is **not a function** compiled and stored in a static library; it's executable code which provides a service
- **A software component is a "black box"**
  - Application designer is concerned with what a component does, not how it does it
  - Creating an application requires component assembly-level information; the equivalent of a "spec sheet"
    - With the SCA, this information is located in a database called the "domain profile"

1. SCA Overview

- **Here's an example of a component assembly**
  - FM modulation application



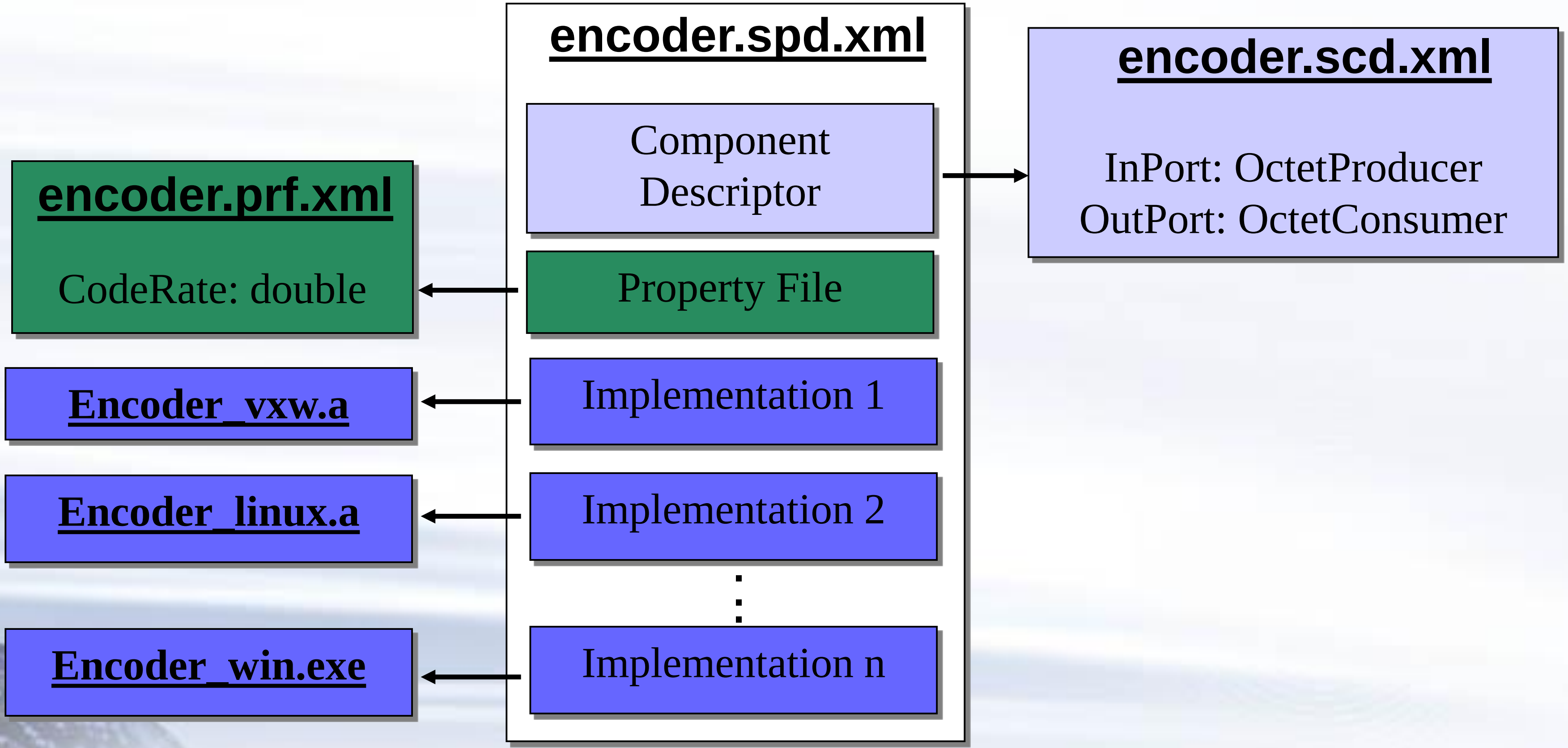
1. SCA Overview

- **How is the SCA different as a CBD ?**
  - As opposed to **EJB**, the SCA supports native components
  - As opposed to **.Net**, the SCA is platform-independent
  - As opposed to **CCM**, the SCA is device-centric
    - Provides fine control over the deployment of components

- **With the SCA, a software component can be packaged with several implementations**
  - Each implementation is characterized by **capacity** requirements (run-time memory, mips, channels, etc.) and **capability** requirements (OS, processor, etc.)

1. SCA Overview

- **Here’s what the definition of an SCA software component (spec sheet) looks like:**



1. SCA Overview

- In summary, the SCA is a Component Based Development architecture which is platform-independent and device-centric

- The SCA is <u>not</u> specific to SDR or military applications

Outline

1. Overview of the Software Communications Architecture (SCA)

2. Is the SCA too slow ?

3. Is the SCA too fat ?

4. Summary

2. Is the SCA too Slow ?

- **In order to measure the speed of the SCA, lets look at different common use cases for an SCA platform:**
  - Use Case 1: Booting an SCA platform
  - Use Case 2: Installing an application
  - Use Case 3: Running an application
- **Use Case 1 involves starting a number of SCA components**
  - Starting software components means creating a number of process/tasks
  - This is not unique to the SCA, it's required for any SDR platform
  - How fast can your RTOS create/spawn a process/task ?
  - How fast can application artifacts be copied from storage memory to run-time memory ?

2. Is the SCA too Slow ?

- **Use Case 2 involves loading all the artifacts associated with an application into storage memory of an SCA platform**
  - Again, this is not unique to the SCA
  - Depends on the speed of the bus/memory and the size of the artifacts
  - Installation of an application is typically done at the factory when time is not very critical

2. Is the SCA too Slow ?

- **Use Case 3 involves starting application software components**
  - A target device must be chosen for each component
    - This may take some time, but the SCA offers a way of avoiding run-time decisions
  - The chosen implementation for each component must be loaded into the runtime memory of the target device
    - Depends on the speed of the bus/memory
    - This can be an issue; not unique to the SCA
    - Better SCA implementations can alleviate this problem

2. Is the SCA too Slow ?

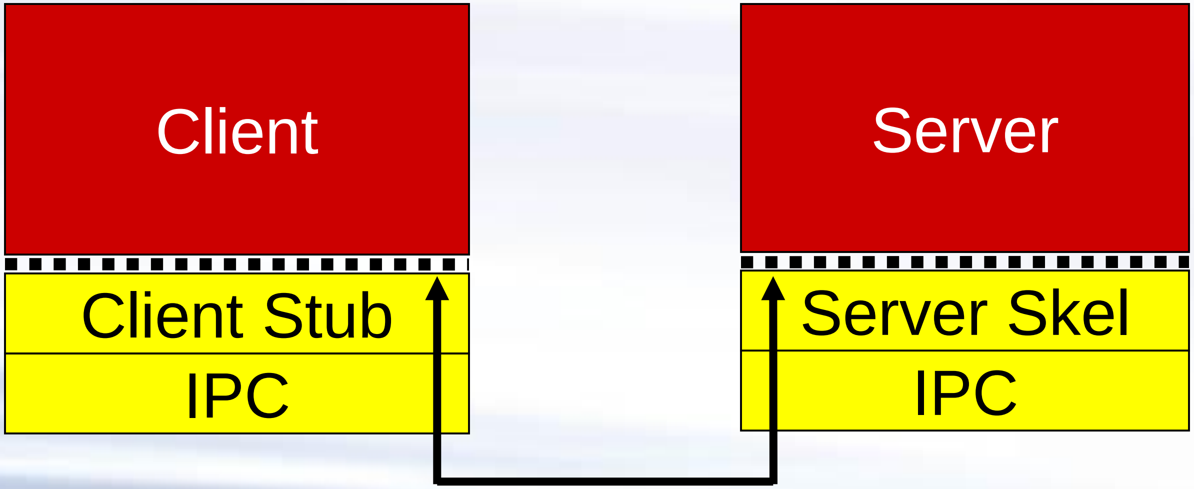
- **Use Case 3 also involves data processing**
  - SCA application components must communicate with each other to perform signal processing
  - With the SCA, communications are normally implemented using CORBA
  - Application throughput is therefore limited by CORBA
  - How fast is CORBA?

2. Is the SCA too Slow ?

- **CBD requires inter-process communications (IPC) to allow components to interact**
  - A software component can run as a process or task
  - Cannot assume components always run in a process
- **The SCA mandates the use of CORBA as the primary form of communications between software components**
  - CORBA is very scalable and provides a single model for component communications
    - Communications APIs are the same whether components are across the network, on the same board, or in the same process
  - CORBA is COTS

2. Is the SCA too Slow ?

- CORBA supports several IPC mechanisms
- However, most commercial CORBA products are implemented using the Socket IPC mechanism for TCP/IP



2. Is the SCA too Slow ?

- **Myth #3: CORBA is slow!**
  - The speed of communications between components is directly related to the IPC mechanism being used
  - Using TCP/IP can be slow and it’s often a bad choice for embedded systems
  - In reality: CORBA is NOT slow but TCP/IP can be.
- **Real-time CORBA products typically support several IPC mechanisms**
  - UDP, Multicast, Shared Memory, etc.
  - Developers can add support for other IPC mechanisms

2. Is the SCA too Slow ?

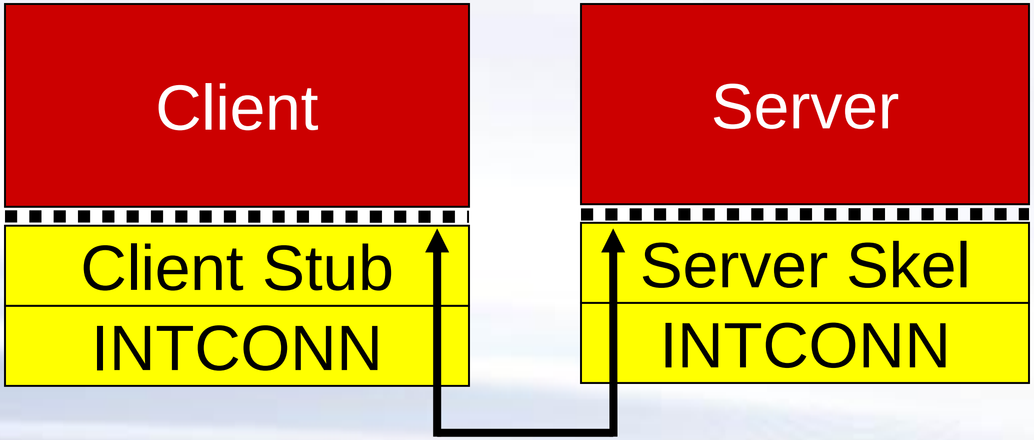
- **Using a Real-time ORB makes a great difference!**
  - For instance, ISR Technologies manufactures an SCA radio which comes with two applications: Voice over IP and Video
  - Using the ORBexpress (i.e. CORBA) and the INTCONN IPC, they were able to lower the ping delay between two radios to ~10µsec vs ~300 µsec for TCP/IP

iSR TECHNOLOGIES

CRC SCARI++ CF

Green Hills SOFTWARE, INC.

OBJECTIVE INTERFACE



2. Is the SCA too Slow ?

- **Is CORBA slow?**
  - The real question is: How fast is your IPC mechanism?
- **If there's an IPC mechanism that's fast enough for your application, then you should use CORBA!**
  - no learning curve for the IPC
  - Provides IPC independence
    - if a new and faster IPC becomes available, you can use it without changing any source code
- ***Conclusion:* The SCA is as fast as the CORBA product being used**
  - The SCA does not get involved in the communications between application components; only CORBA does!

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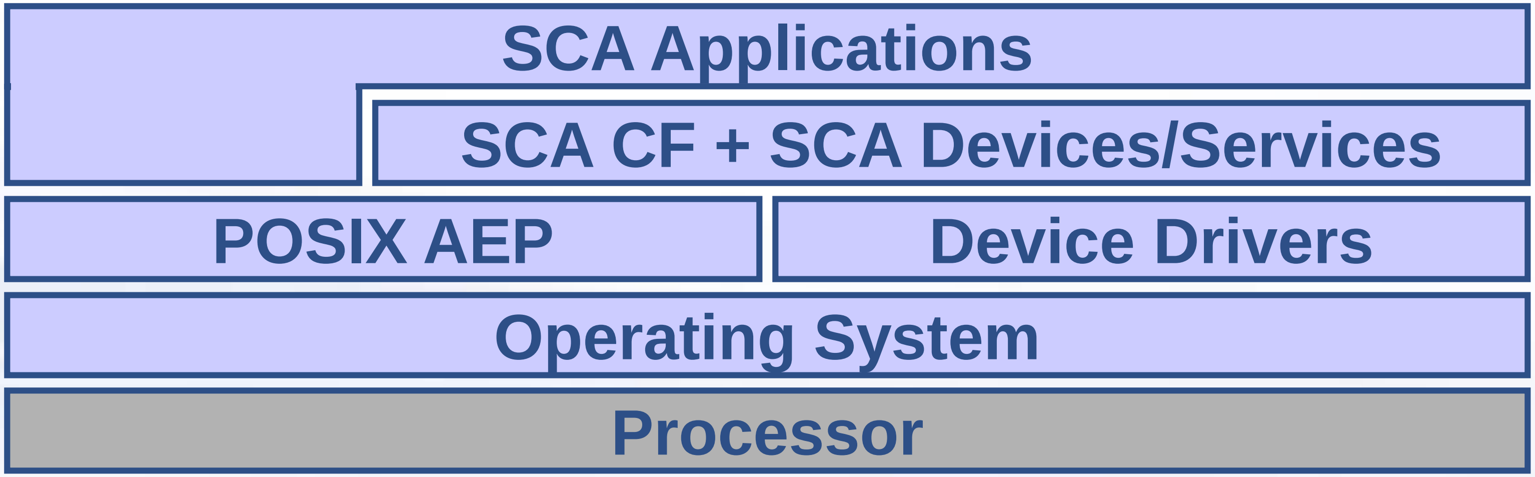
3. Is the SCA too Fat ?

- **Here’s a block diagram of an SCA platform**



SCA Applications

SCA CF + SCA Devices/Services

POSIX AEP

Device Drivers

Operating System

Processor

- **The SCA requires an operating system capable of loading new code dynamically**
  - Many SDRs only use a simple scheduler/kernel which only supports static images
  - Essential to support new applications without rebooting

3. Is the SCA too Fat ?

- **The SCA does not require just any OS**
  - OS must provide a subset of the POSIX APIs
  - Essential to enhance application portability
- **The SCA Core Framework**
  - Provides platform control
    - Install/launch applications
    - Start node components to gain access to devices
  - Requires an XML parser
    - Xerces-C++ requires 2.6 MB of static footprint and typically around 4 MB of dynamic footprint
  - Requires CORBA generated code
    - Static footprint: 750K (ORBexpress) or 3.3 MB (TAO)

3. Is the SCA too Fat ?

- **SCA Application**
  - Is an assembly of several software components
  - Each component requires CORBA generated code
    - Static footprint: 730K for ORBexpress or 3.3M for TAO

- **Quantifying the footprint requirement for an SCA radio is difficult**
  - Is directly related to the number of software components required by the platform and the applications
  - Currently, a full featured SCA CF and a node with a couple devices and services will require around 25 MB of footprint
    - The Xerces-C++ XML parser will use ~40%
    - CORBA generated code ~30%

3. Is the SCA too Fat ?

- **The CRC AudioEffect demonstrator runs in ~50 MB of total footprint**
  - Embedded Planet PPC405 board (EP405), 128MB RAM
  - CRC' SCARI++ CF for INTEGRITY/ORBexpress
  - Node description:
    - Full featured *DeviceManager*
    - *ExecutableDevice*
    - *Log* service
  - Application with 3 components which perform Echo and Chorus effect on an input voice signal
  - Xerces-C++ XML parser
  - INTEGRITY Kernel with POSIX and VFS/NFS support
  - ORBexpress Name Service

3. Is the SCA too Fat ?

- **The ISR JTRS Demo Set requires ~51 MB of total footprint**
  - VoIP 256 Kbits/s BFSK, Video Waveform1024 Kbits/s BFSK
  - Xilinx Virtex-4 FPGA, 128MB RAM
  - CRC' SCARI++ CF for INTEGRITY/ORBexpress
  - Node description:
    - *DeviceManager*, *DDCDevice*, *DUCDevice*, *EthernetDevice*, *FGPAExecutableDevice*
  - 2 SCA applications of 2 components each
  - Xerces-C++ XML parser
  - INTEGRITY Kernel with POSIX and VFS/FFS support
  - ORBexpress INTCONN support
  - ORBexpress Name Service

3. Is the SCA too Fat ?

- **Is the SCA is too fat?**
  - Reality: the SCA can be large for a small form factor SDR which will never be upgraded post-manufacturing
  - Won’t fit on a cell phone…yet!

- **SCA CF Implementations can be made “lighter” while maintaining compliance with the SCA**
  - Its just a question of time…

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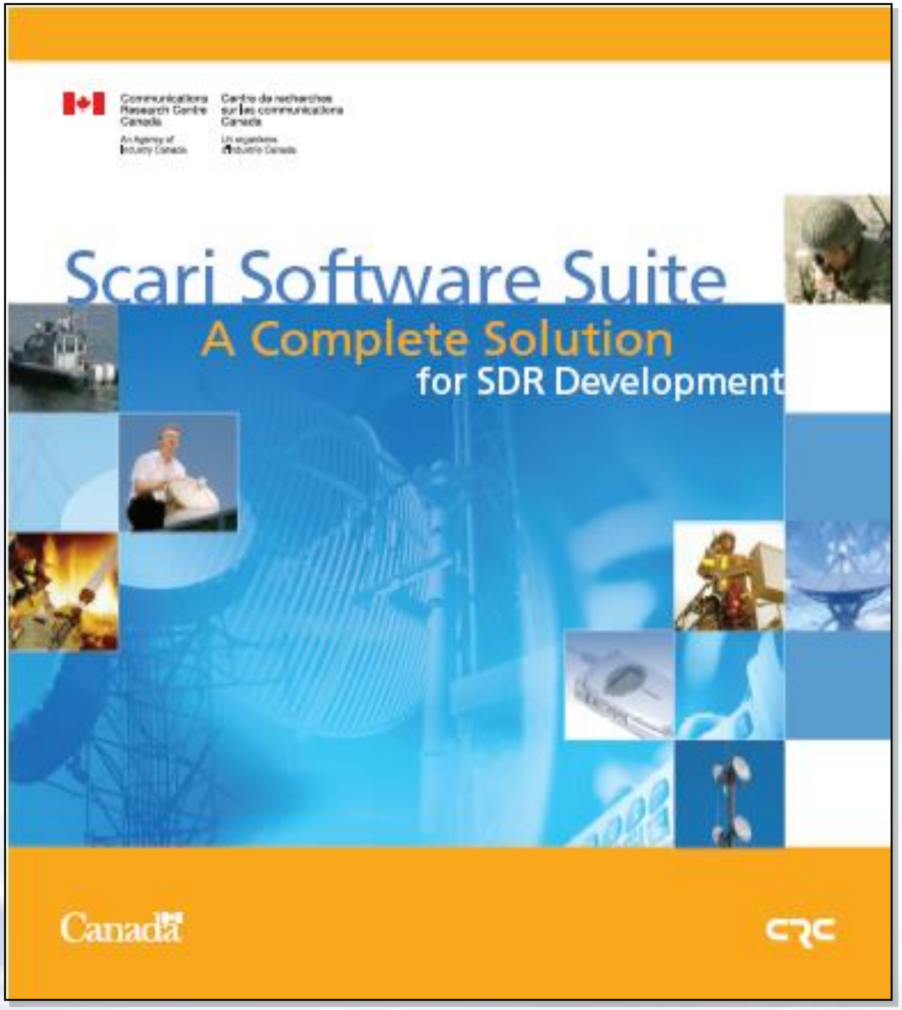
4. Summary

- **The SCA is a Component Based Development architecture**
  - Not specific to military SDR
  - Can be used for any embedded application
- **The SCA can be slow**
  - Using a Real-Time CORBA product is essential
- **The SCA footprint is reasonable and will improve with time**
  - 64 MB is enough for many platforms
  - The SCA can be made smaller without having to change the specification

Questions ?

SCARI++ Software Suite

- **CRC offers the most complete solution for SCA development**
  - Development tools
  - Monitoring tools
  - Core Framework
  - Training
  - Consulting
  - Certification expertise



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Scari Software Suite

A Complete Solution for SDR Development

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SCARI++ Software Suite

- **Team has over 6 years of SCA experience**
  - CRC trained companies from around the world
  - CRC helps companies to gear-up for the SCA market

- **CRC's SCARI++ Core Framework is available for the most popular operating system and processors**

- **CRC will soon offer a completely new Eclipse-based Integrated Development Environment (IDE)**

IDE Highlights

- **CRC offers an complete Integrated Development Environment (IDE) for the SCA**
  - Core Framework Independent
- **Implements real-time model validation; prevents you from creating invalid XML descriptors**
  - Validation messages are hyperlinked to models
- **Provides model re-factoring capabilities**
  - Common model validation errors can be fixed through suggested re-factoring
- **Can reverse-engineer models for existing components**
- **CRC's development tools have been designed with an intimate knowledge of the SCA specification**

IDE Highlights

- **Based on the widely adopted Eclipse framework**
  - Provides platform independence (Windows, MAC, Linux, etc)
  - Every major vendor of the embedded domain support Eclipse
  - There is a enormous number of plug-ins to choose from to help with every aspect of software development (code authoring, documentation, unit test, configuration management, UML, etc.)

- **Simplifies Configuration Management**
  - Perform CM tasks at the model level instead of at the artifacts level

SCARI++ CF Highlights

- **CRC also provides a Core Framework: SCARI++**
  - Built from the ground-up for embedded platforms
  - Implementation of the SCA version 2.2
  - Very portable POSIX implementation
  - Implemented with lessons learned from the JTRS Certified SCARI Core Framework
  - Comes with a POSIX Executable Device, an AudioDevice and demo applications

SCARI++ CF Highlights

- **Provides extra APIs for introspection**
  - Optimized way of obtaining deployment information
  - Can show established connections during run time
- **Supports the deployment of components on standalone remote *Devices***
  - *Devices* can be started manually and report to a remote *DeviceManager*
- **Allows *Devices* to be collocated in a same address space**
  - Dramatically increase rate of communications between *Devices*

SCARI++ CF Highlights

- **Transparently optimizes connections so they can be performed as fast as possible**
  - Indirect connections are transformed into direct connections which requires much less CORBA interactions

- **Supports orderly shutdown of devices even when running applications**
  - A Device can be released or killed while it is running an application

SCARI++ CF Highlights

- **Available for different operating systems:**
  - INTEGRITY
  - VxWorks
  - Linux
  - Yellow Dog
  - and soon for LynxOS

- **Available for different ORBs:**
  - ORBexpress
  - TAO