

***Software Radio
Cooperative Research Project
(SRCRP)***

OMG SBC

March 8, 2006

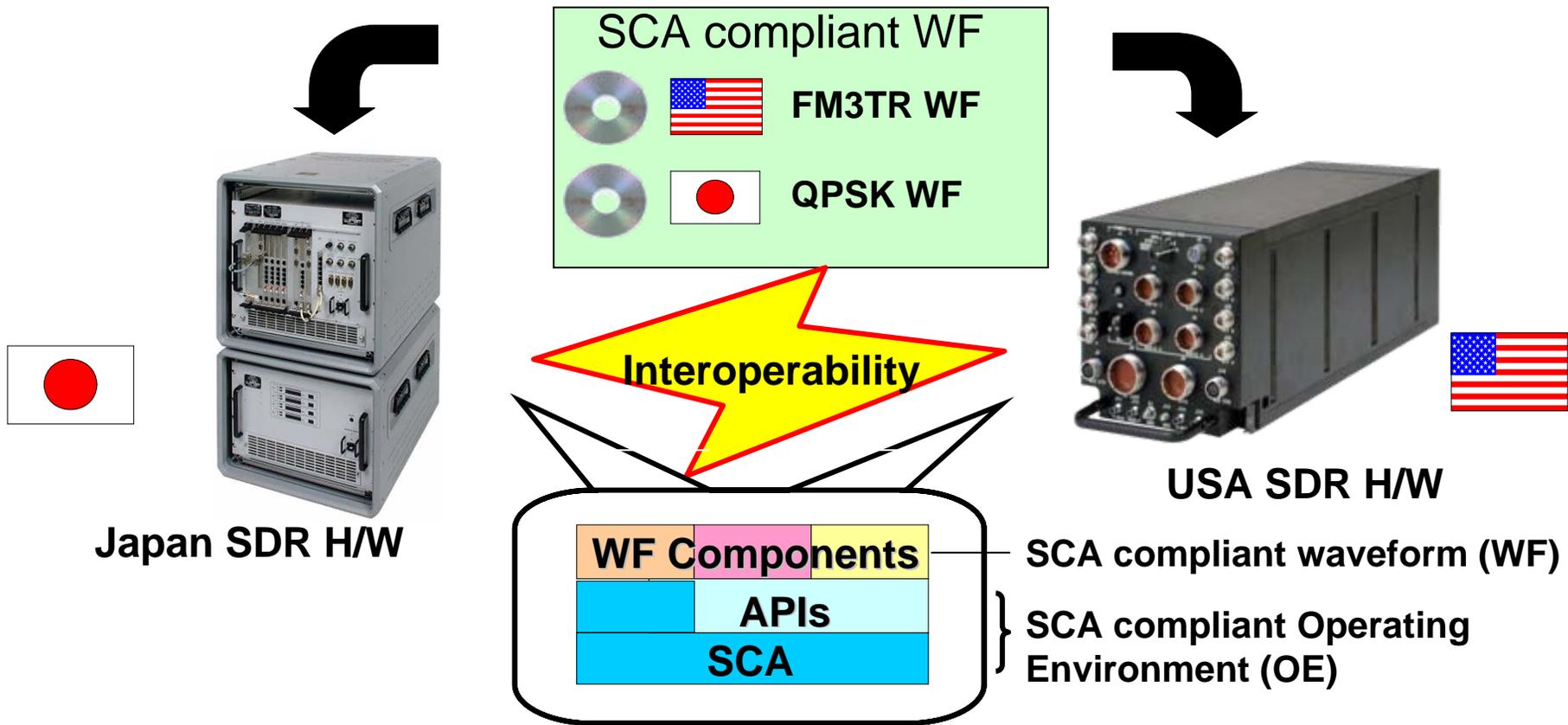
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Raytheon

Agenda

- Program Overview
- Architecture Overview
- QPSK Porting
- FM3TR Porting
- Summary

Software Radio Cooperative Research Project (SRCRP)



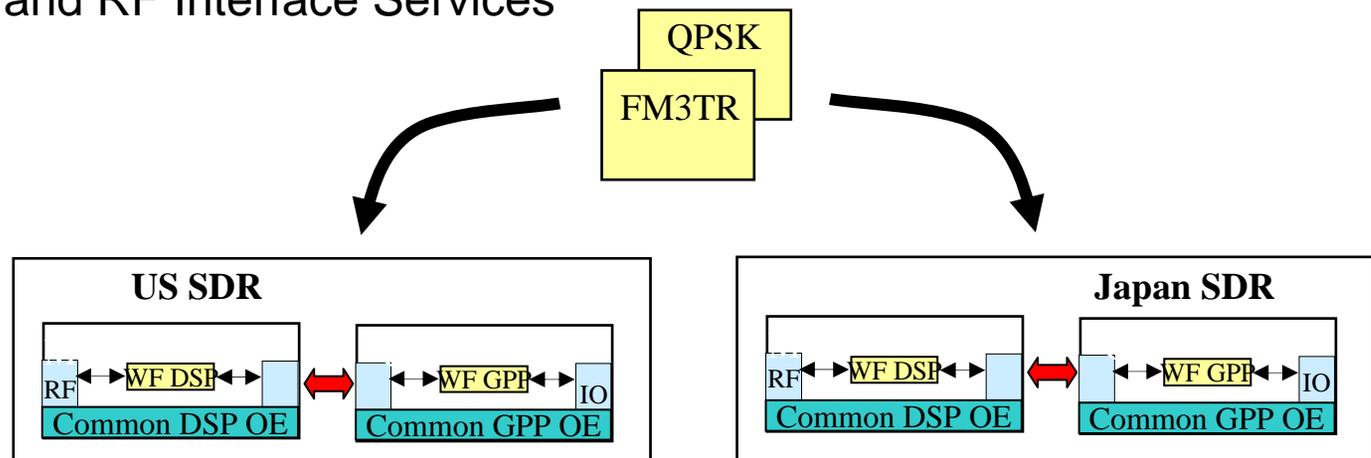
**Bi-lateral project sponsored by the JTRS
JPEO to promote SDR / SCA concepts
Internationally**

SRCRP Goals

- Promote the Software Communication Architecture (SCA) internationally
- Demonstrate SDR concepts (i.e. common architecture, portability and interoperability)
- Discover what prevents waveform applications from being portable
 - Develop guidelines to avoid portability issues
- Learn what savings in cost and time are possible when using portable waveforms
- Evaluate whether certification improves portability
 - Core Framework Certification
 - Waveform Application Certification
- Create waveform applications that are truly portable

SDR Architecture

- SCA 2.2 defines the architecture:
 - Common OS services, Middleware & Radio Framework (CF, Log, etc.)
 - Common Application and Devices interfaces
- SCA does not provide specific Control & Data APIs for Devices and Services
- SRCRP developed Interfaces (Common API) to facilitate WF porting
 - GPP Services (defined in IDL; C++ mapping)
 - I/O and Modem Interface Services (i.e. Serial, Audio and Modem).
 - DSP Services (derived from IDL; C mapping)
 - GPP and RF Interface Services



 The key to the porting was the jointly developed “Common API” specification which was realized by both SDRs

Japan SDR

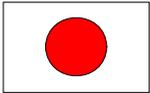


- **Multi - mode Modem**
 - 4 independent channels in 19“ rack
 - 4 independent PAs in lower chassis
- **COTS with Custom 3u cPCI or 6u module**
 - **PowerPC750(G3)**
 - **DSP Sub board on GPP x3**
 - TMS320C6415/6416(TI)
- **LYNXS OS version 3.1.0a**
- **CORBA - OSPEE v1.8**
- **NEC Core Framework**



- **Airborne Multi-Band, Multi-Mission radio**
 - **Configurable for 1 to 4 channels**
 - **ARINC-404A $\frac{3}{4}$ ATR Long form factor**
 - **COTS with Custom 3u cPCI and 6u modules**
 - Pentium (x86)
 - TMS5416 DSP
 - **49 lbs fully loaded w/tray**
 - **Conduction cooled chassis**
- **VxWorks OS v5.5.1**
- **CORBA - ORB Express v2.6.1**
- **Raytheon Core Framework**

Summary of SDR Differences

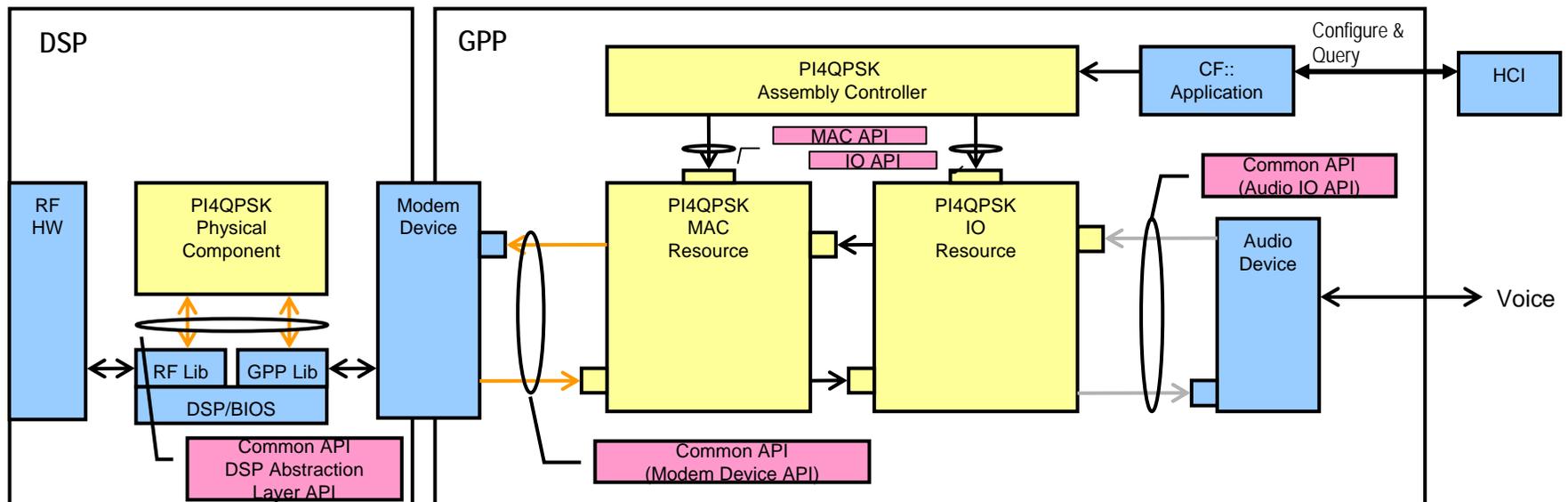


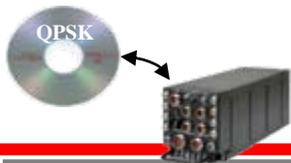
- Power PC GPP
 - 466 MHz, 16 MB Flash, 256 MB RAM
- Lynx OS (SEGMENTED Memory)
- OSPEE ORB
- TI-6416 DSP
 - 600 MHz , 512KW(16bit) RAM

- Pentium GPP
 - 450 MHz, 96 MB Flash, 64 MB RAM
- Vx Works OS (FLAT Memory)
- Orb Express RT ORB
- TI-5416 DSP
 - 120 MHz, 128KW(16bit) RAM

Pi/4 DQPSK Overview

- Frequency hopping (100 hops per second / hop every 10 ms)
- VHF and UHF military bands (30 MHz- 400 MHz)
- Voice Capability
 - 16Kbps CVSD modulation for voice digitizing
- Specification contains data capability
 - 9600bps rate
 - Reed-Solomon error correction with Interleaving for error spreading





QPSK SLOC Metrics

GPP Components	Pre-Port (V1.3) SLOC	Post-Port (V1.4.1) SLOC	
		Reused SLOC	Changed SLOC
QPSK Assembly Controller	4087	2766	1173
QPSK IO	4307	2990	1332
QPSK MAC	4635	3333	1311
Total	13029	9089	3816
	100%	70%	29%

DSP Component	Pre-Port (V1.3) SLOC	Post-Porting (V1.4.1) SLOC	
		Reused SLOC	Changed SLOC
QPSK Physical	2765	2348	458
	100%	85%	17%

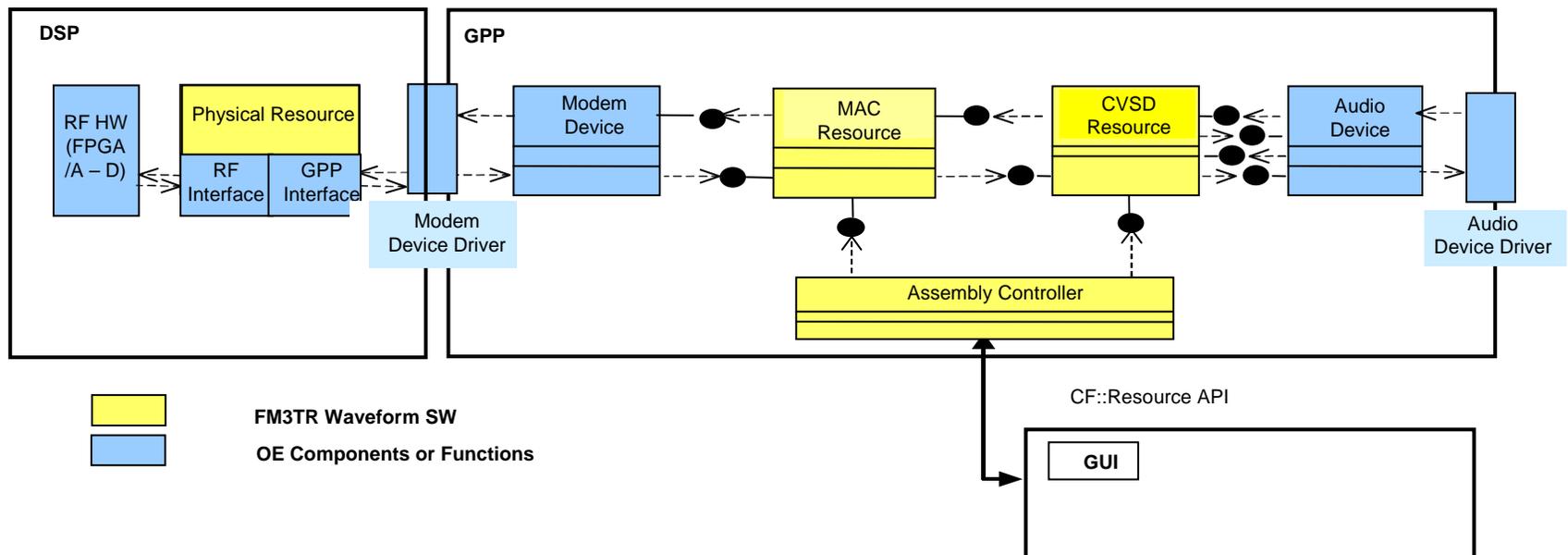
QPSK Porting Issues

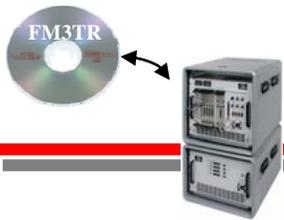
Porting of the QPSK WF encountered the following issues:

- The change from single process to multi-process memory model forced changes in implementation of Portable Object Adapter (POA) and use of Global variables
- Native vs. Environment Variable for exception handling
- Include path Issues related to development tools environment differences (i.e. case sensitivity)
- DSP Resource Sizing and Processor Utilization
 - Movement of filter for I&Q data to FPGA

FM3TR Overview

- The FM3TR waveform is a international test waveform initially developed by the Air Force Research Labs (AFRL)
- The FM3TR waveform provides:
 - Frequency hopping (250 hops per second / hop every 4 ms)
 - VHF and UHF military bands (30 MHz- 400 MHz)
 - Voice capability utilizing CVSD modulation for voice digitizing
 - Specification contains data capability





FM3TR SLOC Metrics

GPP Components	Pre-Port (V2.1) SLOC	Post-Port (V2.2.1) SLOC	
		Reused SLOC	Modified and New SLOC
FM3TR Assembly Controller	1,465	1,459	306
FM3TR CVSD	2,033	2,027	642
FM3TR MAC	2,806	2,799	455
Total	6,304	6,285	1,403
	100%	99%	22%

DSP Component	Pre-Port (V2.1) SLOC	Post-Porting (V2.2.1) SLOC	
		Reused SLOC	Modified and New SLOC
FM3TR Physical	2,342	2,206	472
	100%	94%	20%

Porting of the QPSK WF encountered the following issues:

- Changes to configuration of Portable Object Adapter caused by the difference of memory model
 - Flat memory model vs. Separate memory model.
- Changes caused by difference of byte order (endian)
- Changes of exception handling
 - Use of CORBA Environment Variable vs. native exception handling
- Changes of stub and skeleton file name related to difference of development tool

Summary

- USA-Japan Gov't to Gov't MOU to demonstrate SCA with international partner in 2002
- Program started in 2003 with SCA introduction to Japan
- SDR HW and OE development in 2004
- Successful SCA compliance testing of both Operational Environments (OE) - CF, RTOS, CORBA middleware
 - USA Radio OE (Raytheon CF) certified in Dec 05 - DoD Cluster 2 Handheld.
 - Japan Radio OE successfully tested for SCA 2.2 compliance in Jan 2005
 - Approximately 2 weeks each for certification period
- QPSK and FM3TR development in 2004-2005

Summary (cont.)

- Successful completion of QPSK & FM3TR ports in 2006
- Successful SCA compliance testing of both waveforms
 - Included performance and interoperability testing
 - QPSK Porting Metrics
 - 70% Code Reuse
 - 3 calendar months approx. 12 mm
 - FM3TR Porting Metrics
 - 90% Code Reuse
 - 3 calendar months approx. 9 mm
- Delivery of FM3TR & QPSK documentation (WDS, SDD, SRS, etc.)
- Performed Japan–USA Over-the-Air interoperability demos in Nov. 2006

Conclusion