Modular Radio Architecture

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25 October 2018

The Beginnings of Software Defined Radio Within DoD

- In 1998, the concept was there, but the technology needed development

JTRS began with 32 waveforms
26 form factors

A few of the major technical issues:

a) Distributed processing – CORBA
b) Wideband RF circuitry design
c) Wireless networking waveform design
d) Information Assurance (I/A) architecture design

- Joint Tactical Radio System (JTRS) was initiated with a 'big bang' approach – five largely independent programs (Cluster 1, Cluster 2, Cluster 3, Cluster 4, and JTRS Waveforms)

- In 2005, the DoD created JPEO JTRS to correct program issues

The Need for Tactical Radio Standards

The first waveform was ported to multiple Joint Tactical Radio (JTR) sets and porting effort was 6x expectations.

Porting Deficiency	Corrective Action
Absence of JTR Set Application Program Interfaces (APIs)	JTRS Standards was established for APIs and standards
Missing Files and Documents	JTRS Software Standard specified required documents and directory structure
Missing Functionality	JTRS Software Standard specified required software package content
Absence of Digital Signal Processor (DSP) and Field Programmable Gate Array (FPGA) Specifications	APIs developed for DSPs and FPGAs
Waveform Connection Complexity	Developer education and Software Communications Architecture (SCA) changes
Security Compliance	Developer education and participation by NSA

- The government had waited expectantly six years for industry, Object Management Group (OMG), Software Defined Radio (SDR) Forum, etc., to bring a set of APIs and standards for SDRs, but it didn't happen

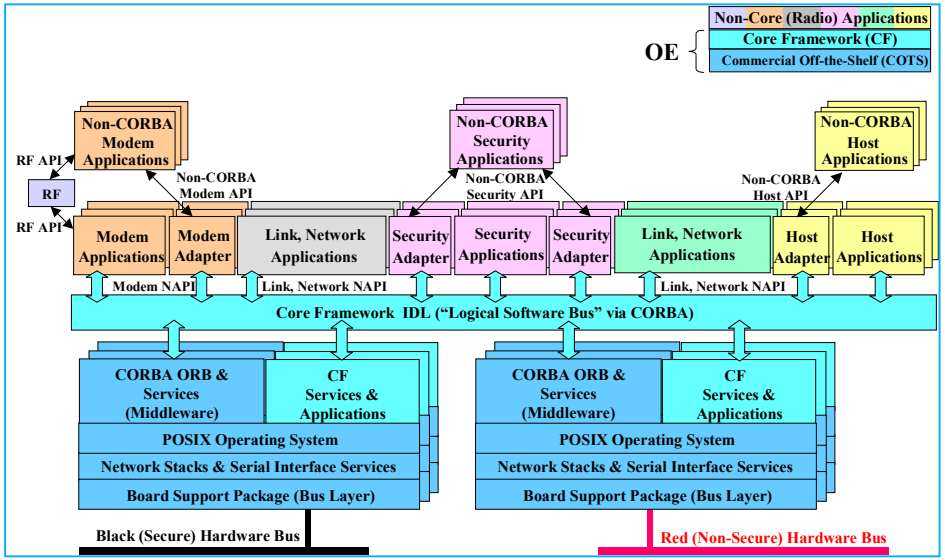
- Consequently the government had to step in and create the standards

Software Communications Architecture (SCA) Framework

The Software Communications Architecture (SCA) was an early product of the Joint Tactical Radio System (JTRS) program, with SCA 0.1 released December 1, 1999.

It was a software-centric vision, with the idea that hundreds of reusable components could be dynamically linked together to form applications and waveforms.

Original SCA Architecture



- The SCA became non-domain specific – no radio-specific interfaces were defined
- The SCA documentation encouraged programs and industry to develop standardized Application Programming Interfaces (APIs)

Looking in the Rear Mirror

Some things we would change with today's light on yesterday's picture

Would recommend more cautious and judicious use of component-level software communication

- The hoped-for collection of small reusable software components was never realized

Would consider larger-module components and waveforms

- Fine-granularity of software is not the commercial model

Would define hardware waveform interfaces

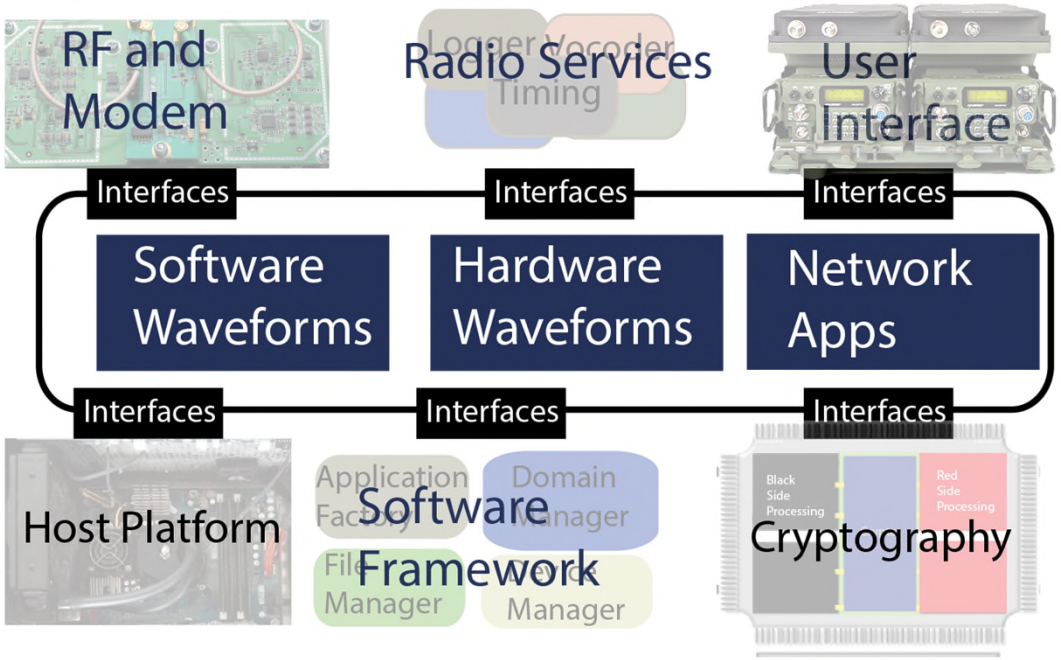
- ASIC versions of WIFI and Bluetooth make software versions a difficult cost and schedule justification
- Imperative to leverage consumer products and technology
- Emerging tactical radio model today is a hybrid of software-defined and hardware implementation

Something Missing

The tactical radio architecture currently fielded is missing 3 emerging features:

- Support for commercial hardware modules/Application-Specific Integrated Circuits (ASICS)
- Support for commercial waveforms
- Support for software defined networking

The Modular Radio Architecture for Tactical Radios

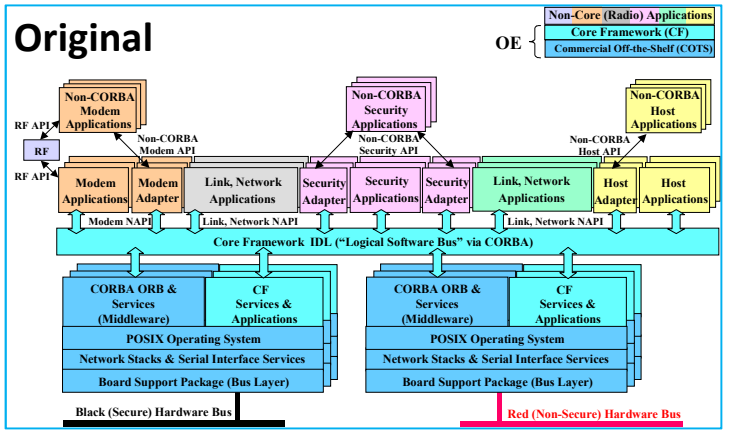


- Not a complete reset, but no longer Software Defined Radio (SDR) only
- Expanded perspective includes higher-level interfaces to reuse commercial technology and components

Modular Radio Architecture vs Current Deployment

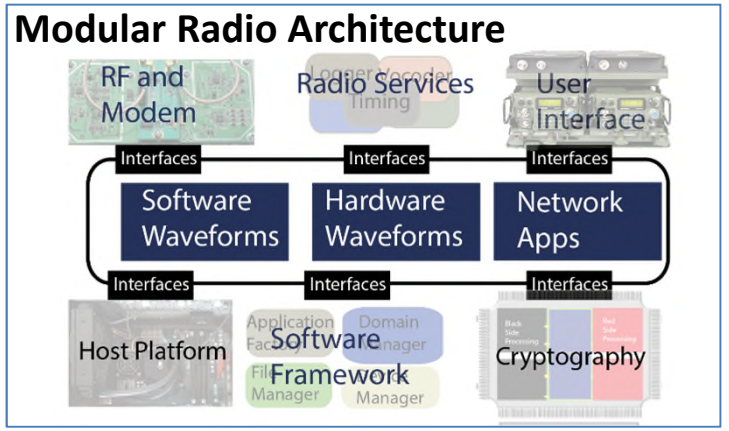
Original Architecture:

- Focused on lower-level individual software component reuse
- Never achieved reuse of waveform components

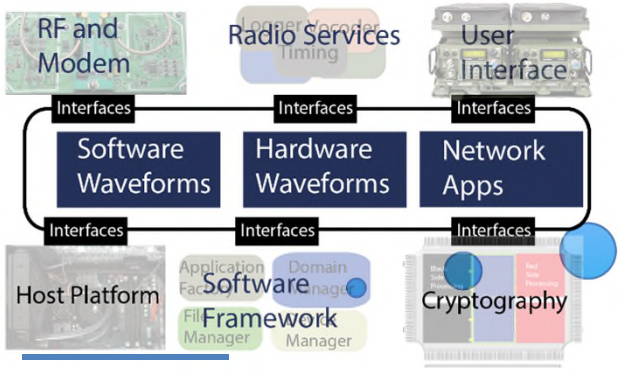


Modular Radio Architecture:

- Software Defined Radio (SDR) is no longer the focus
- Radio has become an edge network device
- A hybrid hardware/software mix of waveforms is supported
- Better utilization of commercial technology
- Allows commercial modules such as LTE and Iridium
  Elevates focus and concern to waveforms and network applications
- Interfaces at a higher, waveform, and module level
- Incorporation of software networking allows endpoint protection and pushes cyber protection to the tactical edge



Modular Software Framework



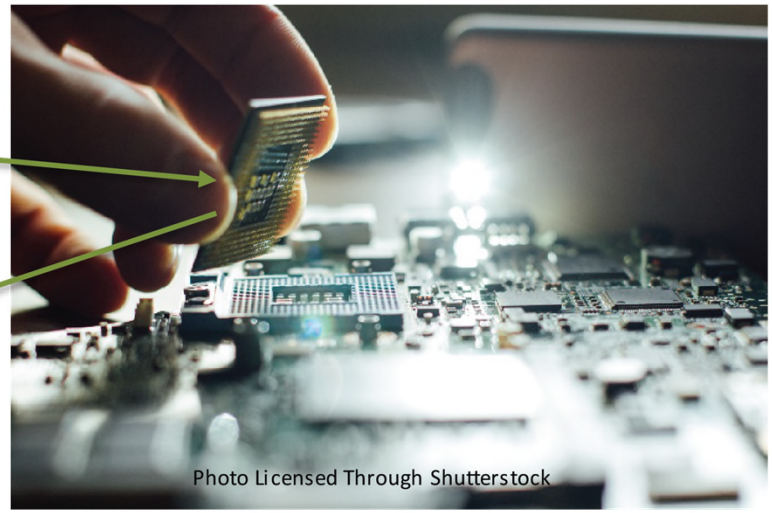
GNU Radio
FACE
REDHAWK
SCA

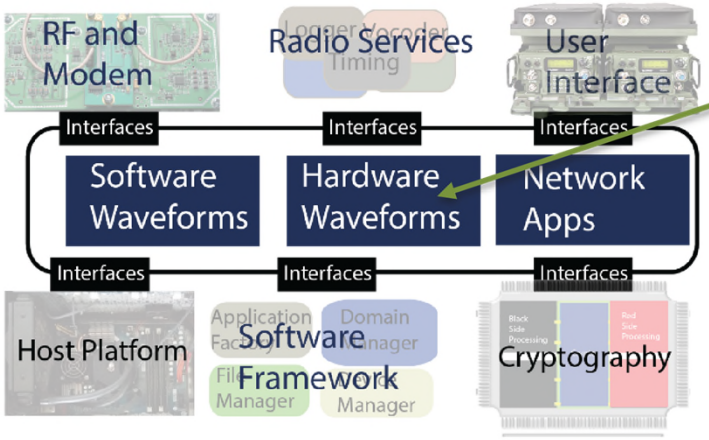
Candidate Frameworks

- A software framework specifies how software components residing on a module are launched, connected, controlled, configured, and torn down
  - Does not specify whether a the implementation is open, Government Purpose Rights (GPR) or proprietary
- Software framework assures scalability and extensibility
- Software framework future-proofs DoD radio acquisitions
- Possible to align existing frameworks to facilitate reuse and interoperability

Use Case: LTE

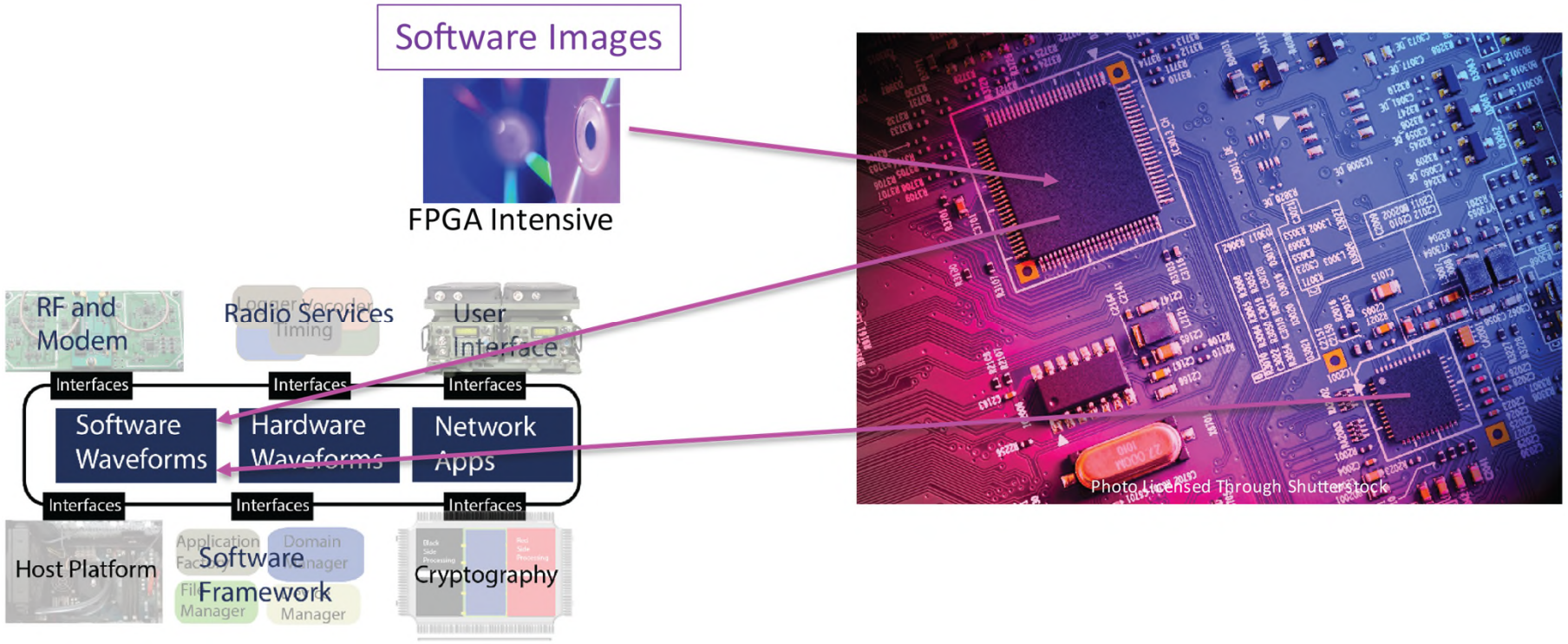
Commercial ASIC is included in the assembly of the tactical radio





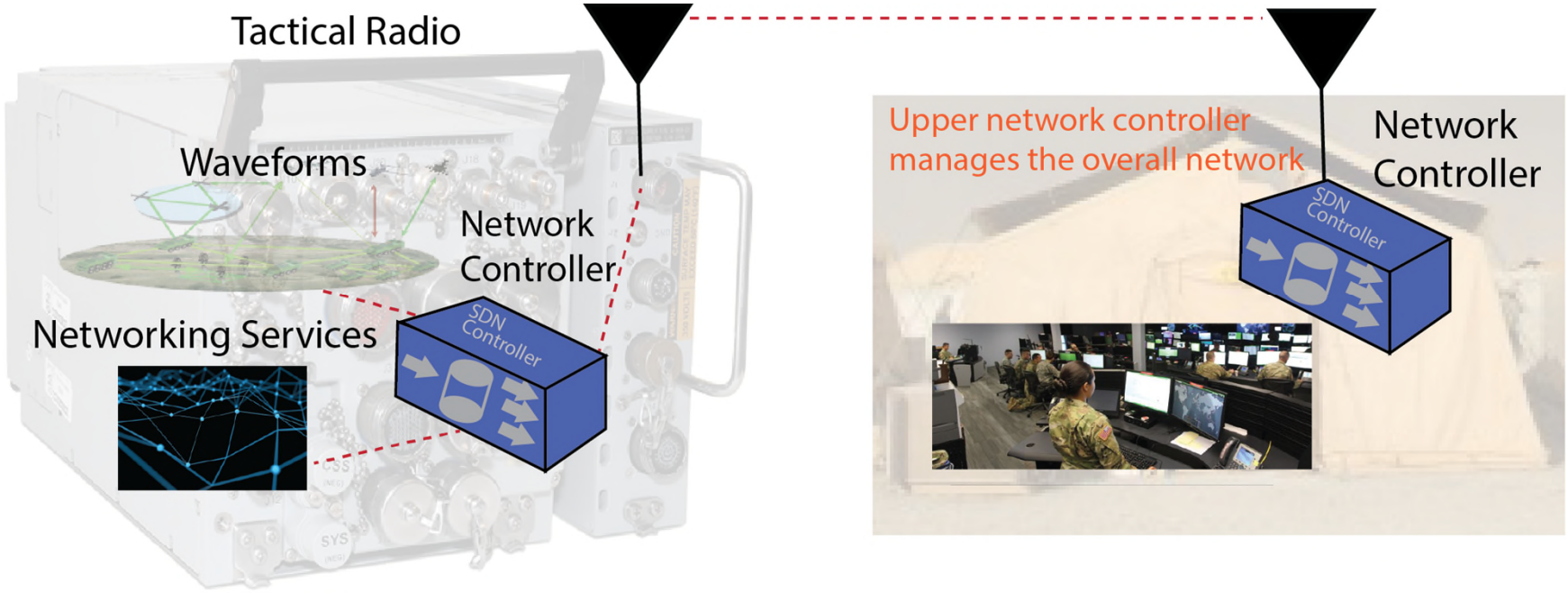
- Modular Radio Architecture would define and extend interfaces defined for hardware module
- Interfaces throughout the radio enable cryptography, networking and other features to the LTE module
- Commercial waveforms and pricing now available to tactical radios

Use Case: New Tactical LPI/LPD Waveform



- DoD industry waveforms anticipated to be SDR rather than commercial ASIC (lower volumes)
- Not anticipated to have fine-grained SCA component implementation
- Modular Radio Architecture allows higher-level management and communication with the waveform's implementation
- Architecture assures fielded radios can be upgraded to the new waveform

Use Case: Software Defined Networking



- Implementation of SDN APIs allows the tactical radio to be controlled as a smart router
- The radio's participation in the larger network is now completely managed

Impact to Fielded Products, Industry, and Government

- Existing SDR waveforms and applications still supported
- Architecture being expanded to include large component hardware and software instead of fine-grained government-compliant software components
- Radio Interfaces have always been independent of the SCA

Use Case	Impact
Fielded Waveforms	None
Fielded Radio Sets	None
Future Radios	New interfaces if product is to use hardware or commercial software waveforms
Commercial Waveform	Can now be incorporated into tactical radios

Next Steps

Develop the Modular Radio Architecture specification

- References Frameworks and APIs
- Because it does not define APIs or frameworks, it is potentially a 20-page document