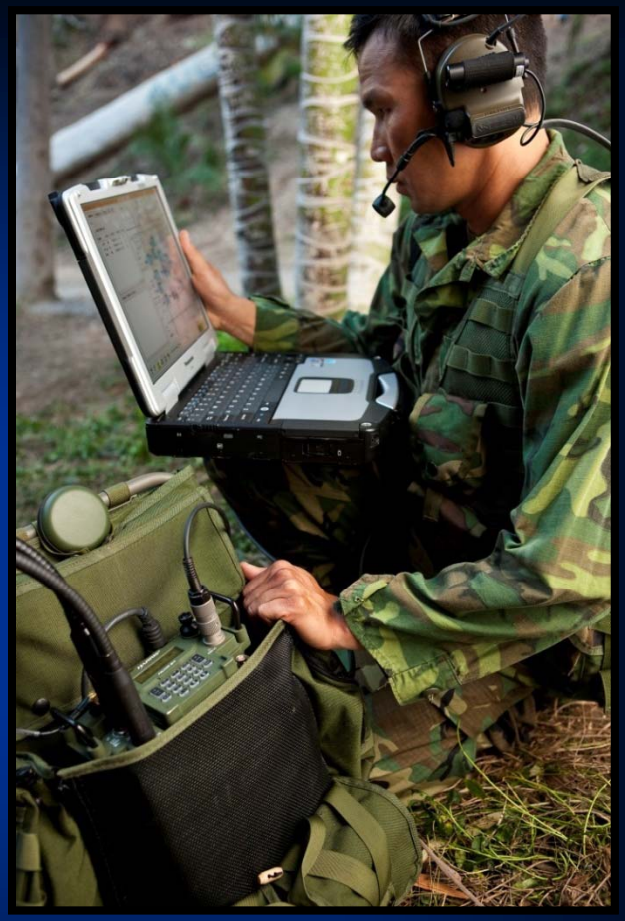
Military Tactical Communications

HARRIS

Practical Experience and Guidance for

Sovereign SCA Based Waveform Development



Mark Turner and Ken Dingman – Harris Corporation

Presentation Overview

- Key tenets of sovereign waveform development.
- Software Communications Architecture provides a standardized foundation.
- Candidate waveform development model.
- Recommendations.
- Conclusions.

Sovereign Waveform Development

Key Tenets – The "What", "How" and "When"

Key Tenets - "The What"

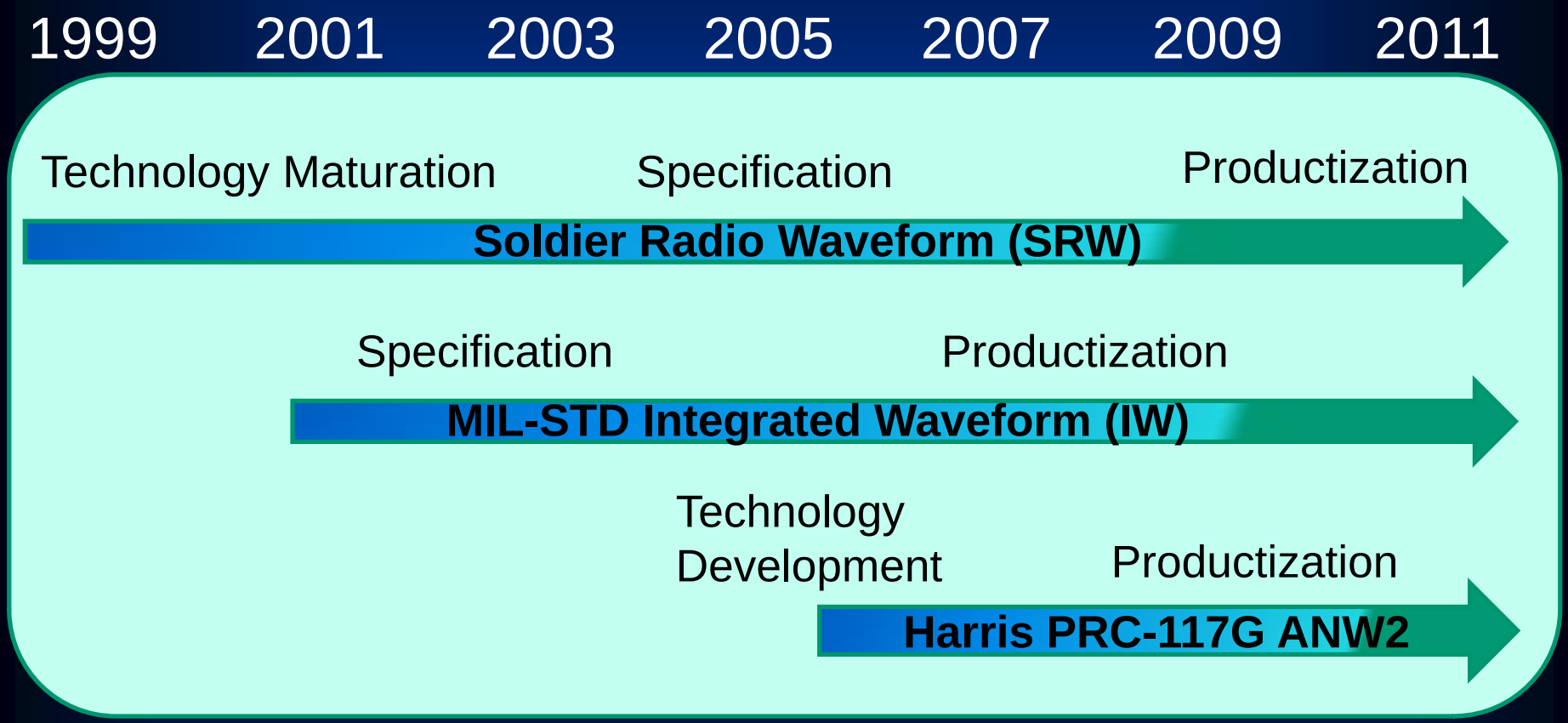
- Definition and understanding of mission goals, system level requirements and associated use cases.
  - Application: Operating range, Line-of-Sight (LOS), Beyond Line-of-Sight (BLOS), Anti-Jam (AJ), Covert.
  - Spectrum: Frequency, bandwidth, etc.
  - Domain: Ground, Maritime, Air, Space, cross-domain
  - Radio Platform Form Factor: Aircraft, Shipboard, Fixed site, Vehicular, Man-pack, Hand-held, Small Form Factor (SFF).
  - IA and Sovereignty Considerations: Domain (i.e., Public, Coalition, National), assurance levels, security mechanisms (relevant encryption algorithms, key management, etc.).
  - Networking (if applicable): Topology, # of users, throughput, communications protocols (standard vs. custom).
  - Mission Planning: Plan creation, updates, platform config.

Key Tenets - "The How"

- Waveform specification considerations:
  - New technology and capabilities, backwards compatibility.
  - Reuse of existing capabilities (organic or 3rd party) at the source code or object code level.
  - System level modeling and simulation.
- Incremental development
  - Base vs. enhanced functionality, backwards compatibility.
- Co-development of hardware platforms and software
  - Reference platform to decouple hardware dependencies.
- Portability
  - Target hardware frameworks, processing capabilities.
  - Common OE; sovereign element separation; CM.

Key Tenants - “The When”

- Understand the continuum and associated timeframe from concept to field usage (can be significant).



Sovereign Waveform Development

SCA Provides a Standardized Foundation

Benefits of SDR Standards

- Facilitates communications interoperability.
- Platform knowledge sharing.
  - Reduce costs and risks associated with innovation (applies collective brainpower of industry, Government, academia).
- Reduce development costs, product time to market.
  - Leverage significant Government and commercial investment.
  - Build less software. Reuse of proven, existing waveform applications and other integrated capabilities.
  - Standardized educational elements (i.e., training courses).
  - Commercial tool suites and software development aids.
- Market competitiveness.
  - Facilitates technology insertion, third-party participation.
- Development and integration of advanced applications.

Software Communications Architecture

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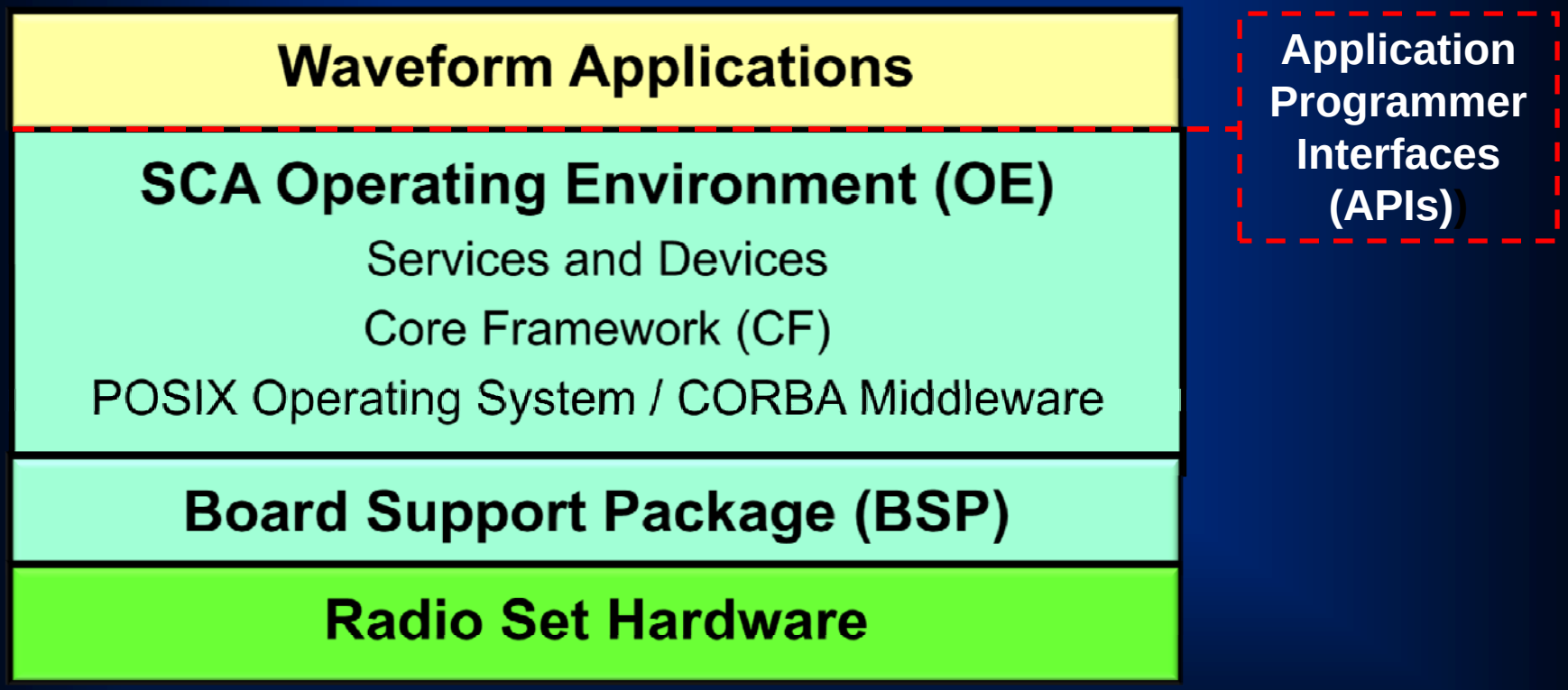
- Set of rules and protocols for SDR applications.
- Component Based Design (CBD) technology.
- Independence of Platform and Applications software.



The SCA Today

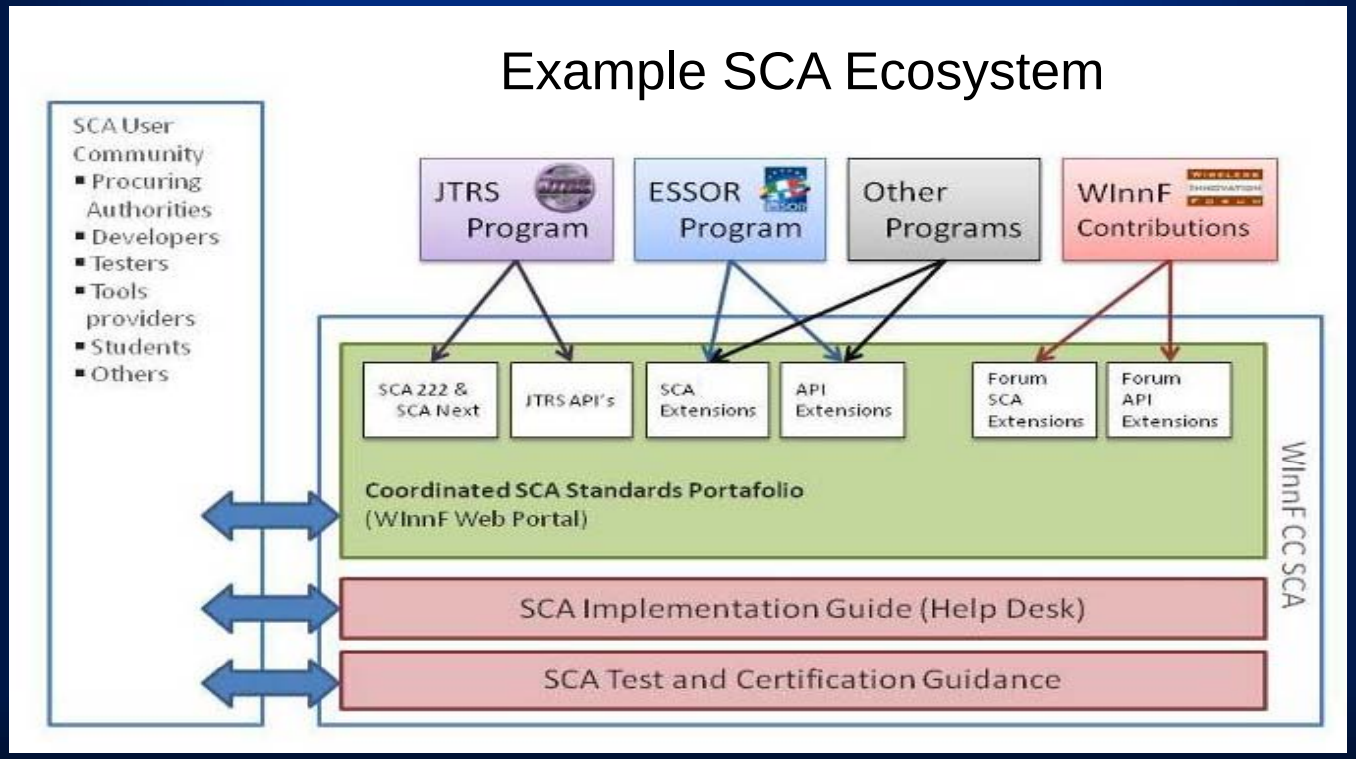
- Becoming “de-facto” standard foundation for military SDRs across the world.
  - Represents significant investment with proven level of maturity (test, evaluation and certification; fielded solutions).
  - Combination of open and controlled elements.
- Developed as part of U.S. DoD JTRS Program.
  - Specification (v2.2.2) & suite of APIs published by U.S. DoD.
  - Evolution continues (“SCA Next” Dec-2010).
  - U.S. DoD configuration manages published baselines.
- Growing international acceptance
  - EDA “Three Category Approach” for API standardization.
  - ESSOR program adoption of SCA v2.2.2 baseline and APIs with extensions and improvement recommendations.

Three Category API Approach

Category 1 International Open Standard Recognized ISO(s)	Category 2 Multi-National Interests Coalition PMOs	Category 3 Specific National Interest National Authorities
~~Unclassified~~ Unlimited distribution Examples: SCA v2.2.2 APIs (profiles in future)	~~Unclassified~~ Controlled and limited distribution Examples: Coalition Waveforms (COALWNW, HDR) Security APIs	~~Classified~~ Controlled and nationally limited distribution Examples: Crypto Algorithms

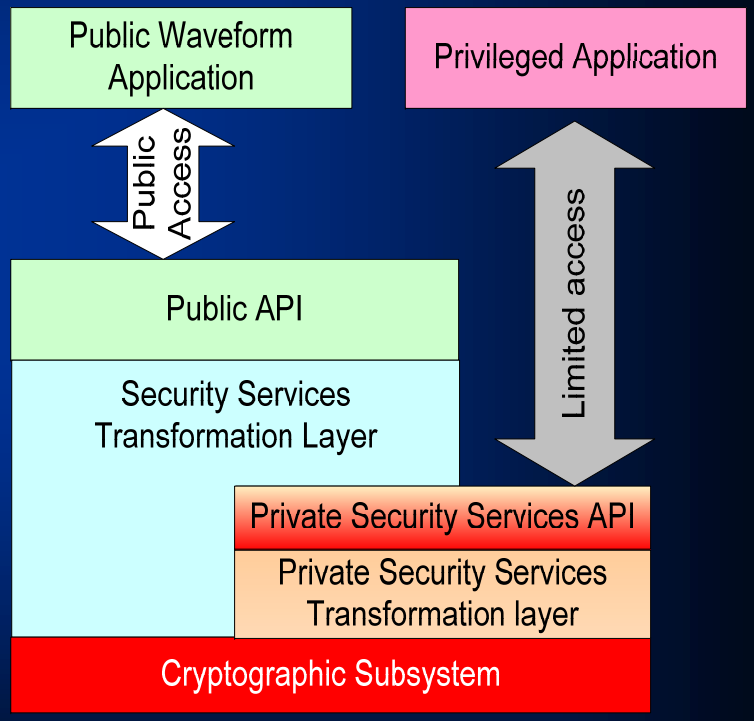
Wireless Innovation Forum (WINNF)

- Established "Coordinating Committee for International SCA Standards"
  - Coordination Model defined for harmonization of world-wide SCA standards portfolio within an overall ecosystem.



Information Assurance and Security

- Standardization possible even for IA and security.
- WINNF International Radio Security Service API Task Group developing a “multi-surface model”:
  - Facilitates open standardization and protected interests.
  - Supports both sovereign and coalition capabilities.
  - Transformation layer can uniquely and securely alter information format and content.
  - Private APIs (national or coalition) exposed only where applicable.

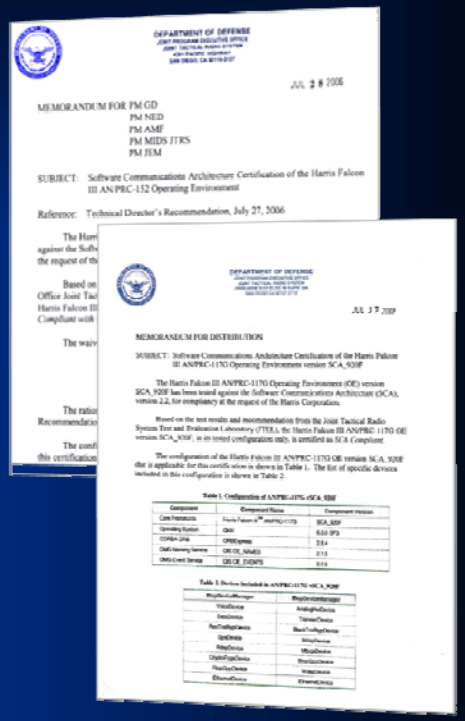


Sovereign Waveform Development

Candidate Waveform Development Model

Harris SCA Pedigree

- 1st radio provider with JTEL SCA certification.
- 1st radio provider to put completed SCA waveform into JTRS Information Repository.
- 1st & only radio provider with JTEL SCA certified radios without waivers – AN/PRC-152 HH and AN/PRC-117G MP radios
- 1st & only JTRS fielded SCA waveforms.
- 1st & only fielded SCA 30-2000 MHz radio with NSA certified wideband networking.
- Official "JTRS Approved" status from JPEO.
- Ported and demonstrated SRW and WNW waveforms from JTRS IR.

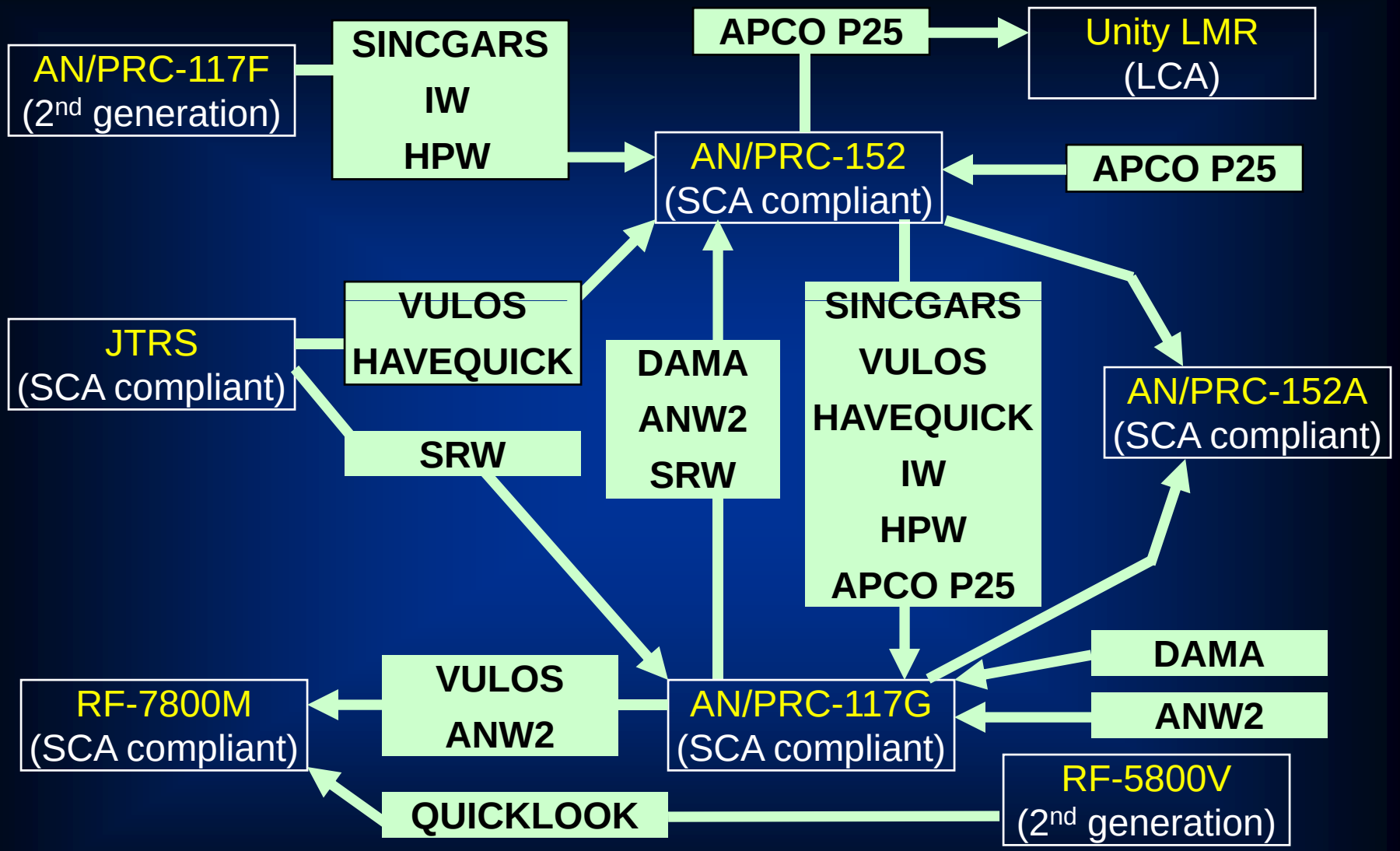


Delivered > 150,000 SCA compliant radios

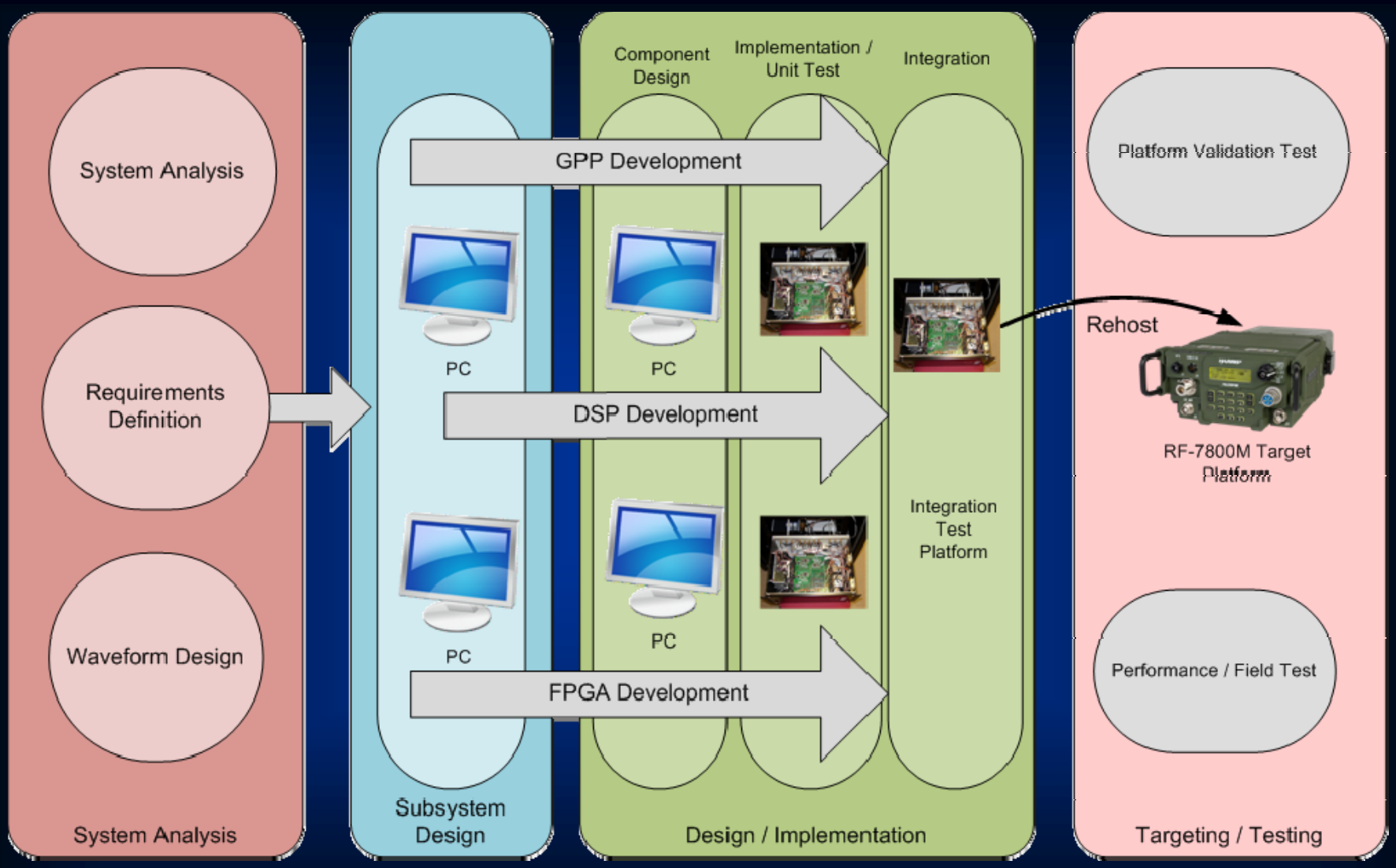
Harris SCA Development Heritage

- Multiple radio domains
  - U.S. DoD military
  - International military
  - Land Mobile Radio
- Diverse development categories
  - 2nd generation (pre-SCA) legacy waveforms
    - Ground, Air, ECCM, SATCOM, others.
  - Third party waveforms
    - SATCOM, Land Mobile Radio
  - Emerging technology waveform applications
    - Wideband networking waveforms
  - Waveform application reference implementations (JTRS IR)
- Multiple platforms and HW architectures

Harris Platforms and Waveforms



Waveform Development Model



Waveform Development Activities

System Analysis and Requirements Definition

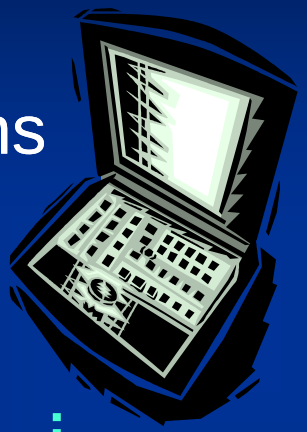
- Evaluation of mission goals and objectives.
- Define system requirements.
  - Applications Domains, Spectrum, IA and sovereignty, platforms, networking (if applicable), mission planning, other.
- System modeling.
  - Use case development.
- Functional partitioning and allocation.

Waveform Development Activities

Communications Planning

- Plan information
- Station information
- Preset configurations
- Key Management
  - TEK Assignments
- IP Addresses
- GPS
- Position Reporting

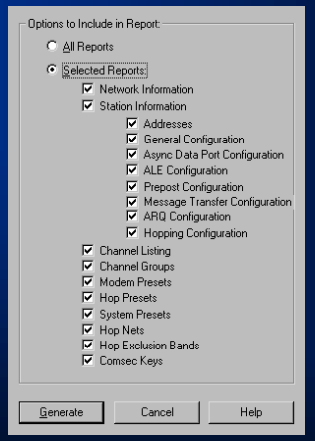
CPA

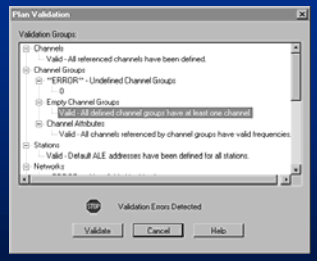


Plan Files

Radio Fill

Reports





Validation

Waveform Development Activities

Waveform Design

- System and platform considerations
  - Allocation of functionality to platform processing elements.
  - Identification, separation and protection of sovereign elements: abstraction, transformation, level.
  - Target platform architectural differences.
  - Requirements refinement.
- Key design considerations
  - Layering: PHY, MAC, Networking (Routing), Applications.
  - Information assurance: COMSEC, TRANSEC, etc.
- Modeling and simulation
  - Signals in space modeling and simulation.
  - Network simulation (i.e., connectivity, mobility, routing).

Waveform Development Activities

Waveform Integration

- Integration of GPP, DSP and FPGA
- Use of Integration Test Platform
  - Expose HW probe points
  - HMI and external interface connections
  - Allow use of GPP and DSP debuggers
- Baseband Digital components
  - Test to waveform intermediate - frequency

Waveform Development Activities

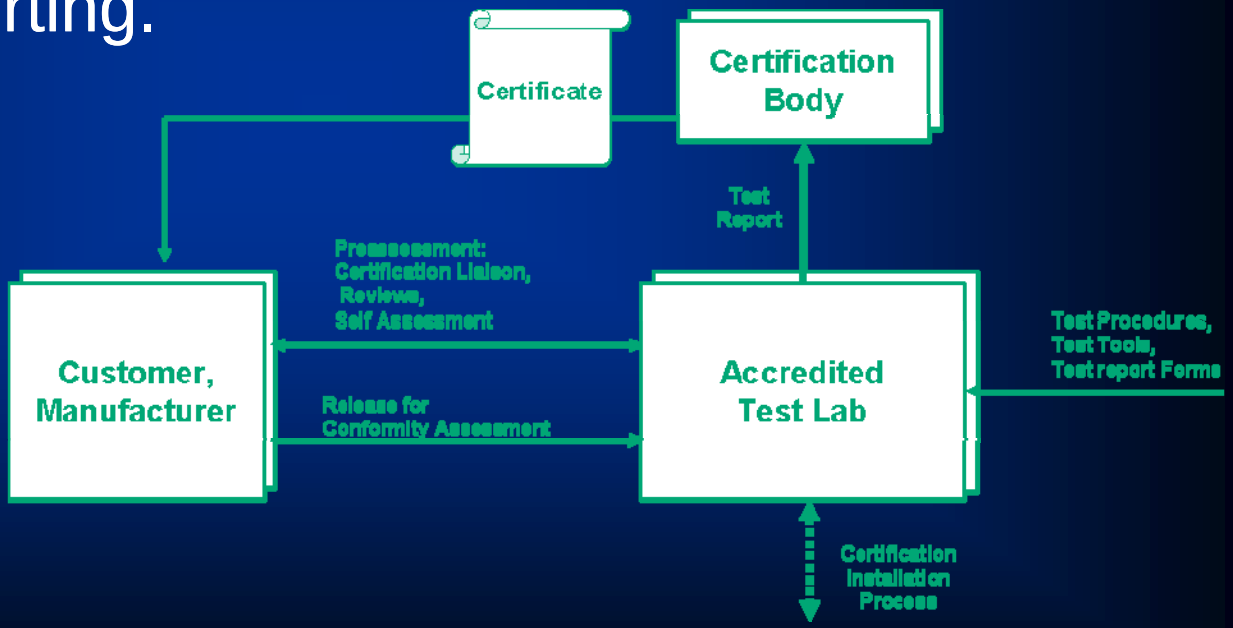
Target Platform Testing

- Closed radio platform
- Integration with RF section
  - RF control, AGC, TGC
  - Spectral performance characterized and adjusted
- Integration with CSS
- Bench testing
- Field testing
- PA Testing

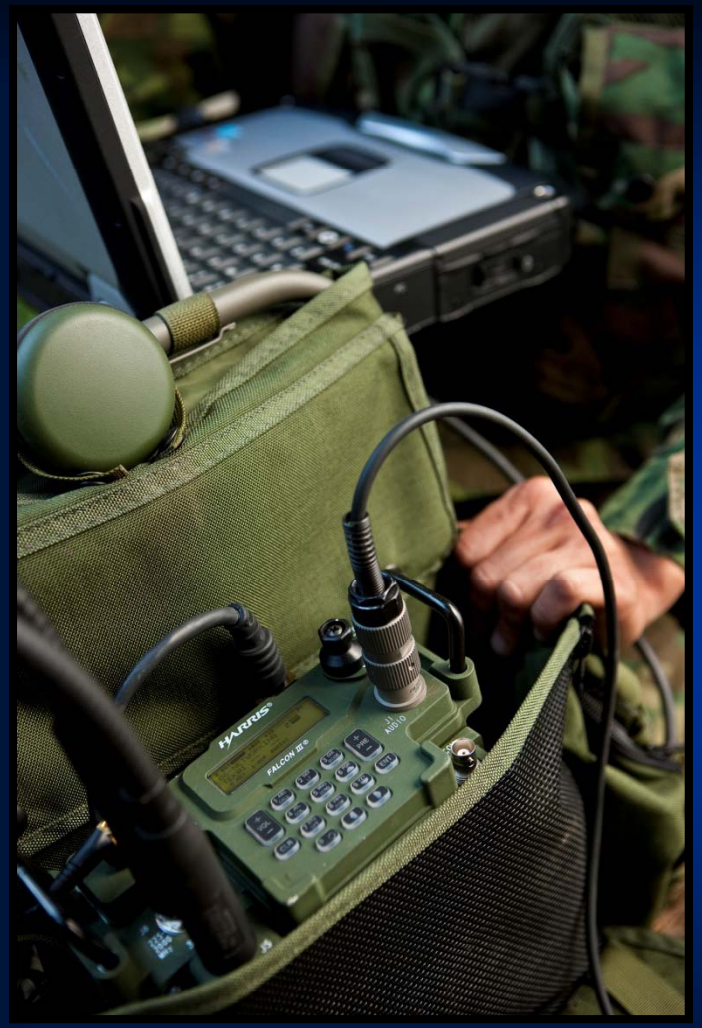
Test, Evaluation and Certification

- Standards based waveform (i.e. TETRA, SATURN) can require interoperability and performance certification prior to deployment.
- Security verification and certification if appropriate.
- SCA waveform compliance evaluation to ensure ease of waveform porting.
- Other

SCA Test, Evaluation and Certification model under development by WINNF



SCA Networking Waveforms



Recommendations

Required Knowledge and Experience

- Communications theory (signal processing).
- Operating domain, waveform unique characteristics.
  - Wireless networking requires broad technical knowledge: media access, protocols, routing algorithms, QoS, other.
- Sovereignty considerations (i.e., specific national interests, security).
- System architecture and design
  - Hardware frameworks, software partitioning and coupling.
  - Real-time considerations (processing allocation, threading).
- Component Based Development (CBD), CORBA.
- Software Communications Architecture.

Required Tools and Equipment

- Development tools
  - Debuggers, compilers, emulators, layout, simulation and modeling tools, test tools, configuration management tool, requirements management, other.
- Supporting equipment
  - O-Scopes, Spectrum Analyzers, Noise Communications Generators, Power Supplies, development PCs, other.
- Test & Validation
  - Radio platforms and full sets of accessories
    - Batteries, cables, antenna, attenuators, VAAs, other.
  - Appropriate facilities
    - Power, access security, GPS and antenna access

Candidate Approaches to Consider

- Develop in-house skills and expertise
  - SCA technology and tools training.
  - Modification of an existing SCA waveform application.
  - Port 3rd party component to SCA based platform and Operating Environment.
- Establish strategic partnerships
  - Experienced radio manufacturer and waveform provider.
  - Experienced 3rd party waveform developer.
  - Domain area expert consultants.
- Incremental waveform development
  - “On-the-Job” experience, increase waveform capabilities in conjunction with expertise.

Conclusions

- Waveforms need to be specified and designed at the system level.
  - Understand the mission, requirements and use cases.
  - Development cycles generally not short or low cost.
  - Incremental development can shorten time to deployment.
- SCA provides foundation for waveform development.
  - Field proven with evolving full eco-system, leverages significant “to-date” investment.
  - SCA technology facilitates porting across multiple platforms.
- Methods to protect sovereign interests.
  - Separation of sovereign functionality.
  - Standard APIs using transformation techniques.

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