

Above 2 GHz Common Communication System Architecture

Presented by:
Eric Johnson
Raytheon Company

Presentation Overview

- Challenges for above 2GHz System Architecture
- Definition of Terms
- Building an >2GHz Terminal
- Managing Diverse Requirements
- Functional Decomposition Methodology
- Example Decomposition - Waveform
- Component Validation
- Next steps

Challenges for >2GHz Architecture

- Diverse **Performance** Requirements
 - Low Data Rates to 100's Mbps (Broadband modulations requiring precision timing)
- Requires integrated HW/SW solution – a **Systems Solution**
- Diverse Service/Mission Requirements (Air Force/Navy/Army)
 - Tactical vs. Strategic
- Diverse Physical Constraints (**Size/Weight/Power**)(SWAP)
- Diverse Antenna Requirements
- Diverse **Mobility**/Tracking Requirements
 - Communication-on-the-move to Stationary, narrow beamwidths
- Diverse Security Requirements
- Complex SATCOM waveforms
- Simultaneous Multiband Capability

➤ Top Priority on Extensible & Scalable

Working Definitions

- **Architecture**

- “The structure of components, their relationships, and the principles and guidelines governing their design and evolution over time”*

- **Waveform**

- The set of all HW/SW components required to implement the functions associated with interfacing to the Satellite(s).

- **Network**

- All HW/SW components required to implement the functions associated with interfacing to the ‘Baseband’ (Example EIA-422, Ethernet, T1)

- **Platform**

- All HW and SW components required to host/support a waveform and network to create a radio (e.g., BIT/BITE, operator interface, antennas, etc.)

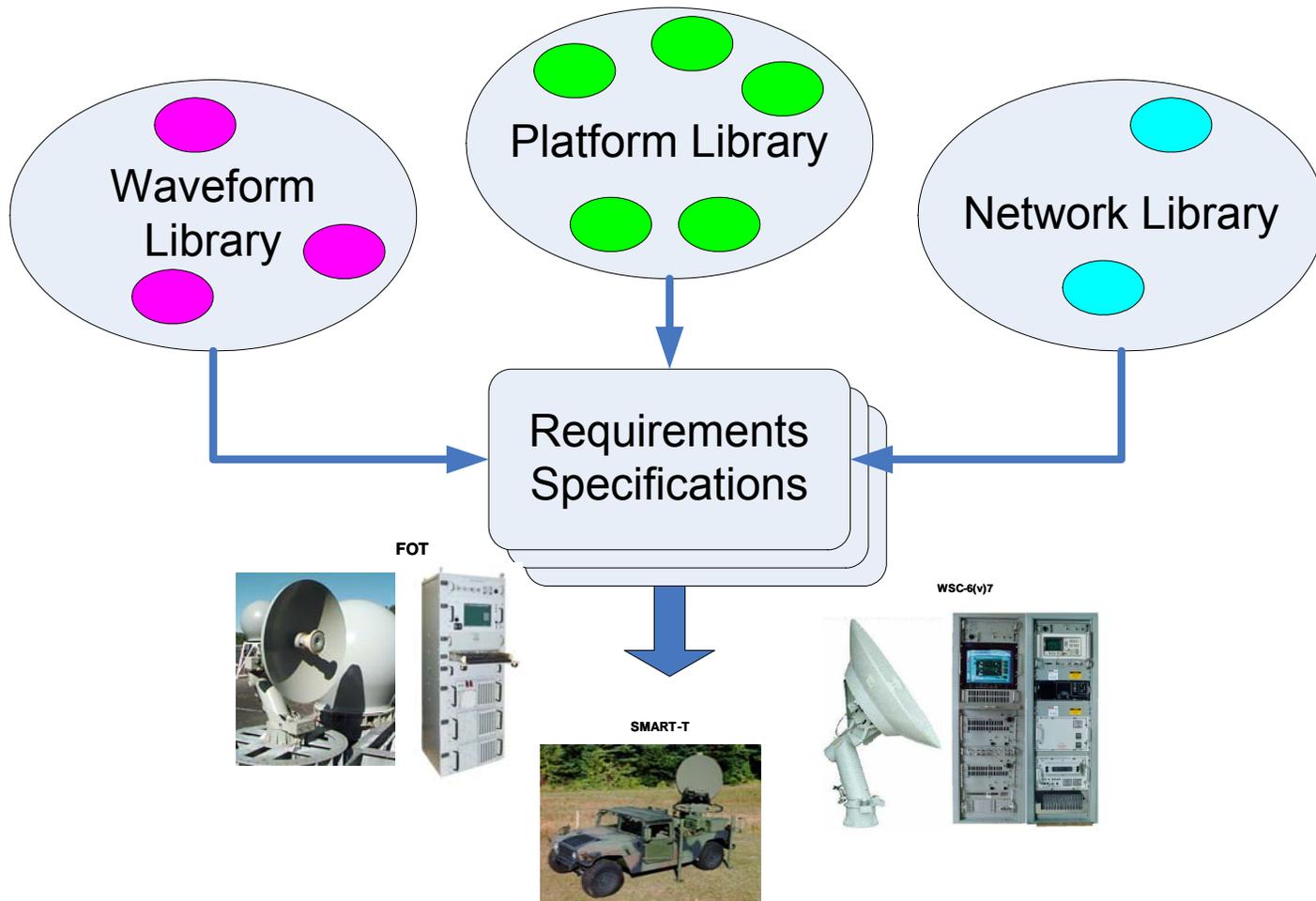
➤ **Terminal = Waveform + Network + Platform**

*IEEE STD 610.12, as extended by the Integrated Architecture Panel (IAP) of the C4ISR Integration Task Force (ITF)

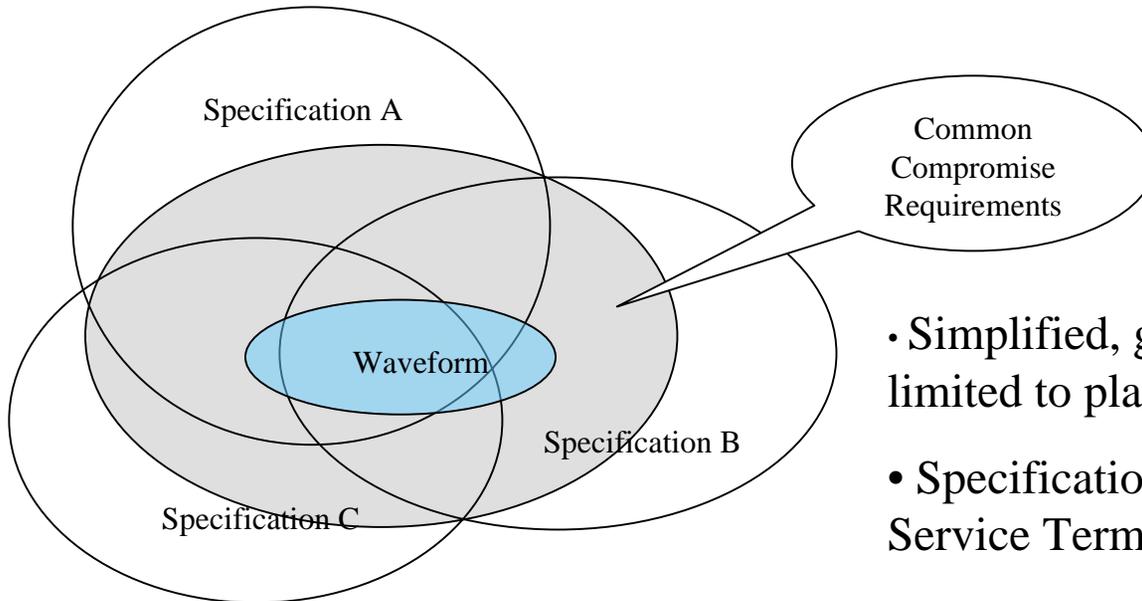
Building a Terminal

- Old Approach
 - Terminal specified as a monolithic entity for every Service
 - Specifications optimized for service capability and mission requirements
 - Emphasis on custom solution
- New Approach
 - Terminal specified in terms of components – Platform, Waveform, Network
 - Component requirements support terminal requirements
 - Components are selected from libraries to satisfy functional and non-functional requirements (Portability/Extensibility/Scalability/Reusability)
 - The Terminal is built from derived platform, waveform and network components

Building a Terminal – Result of New Approach



Managing Diverse Requirements



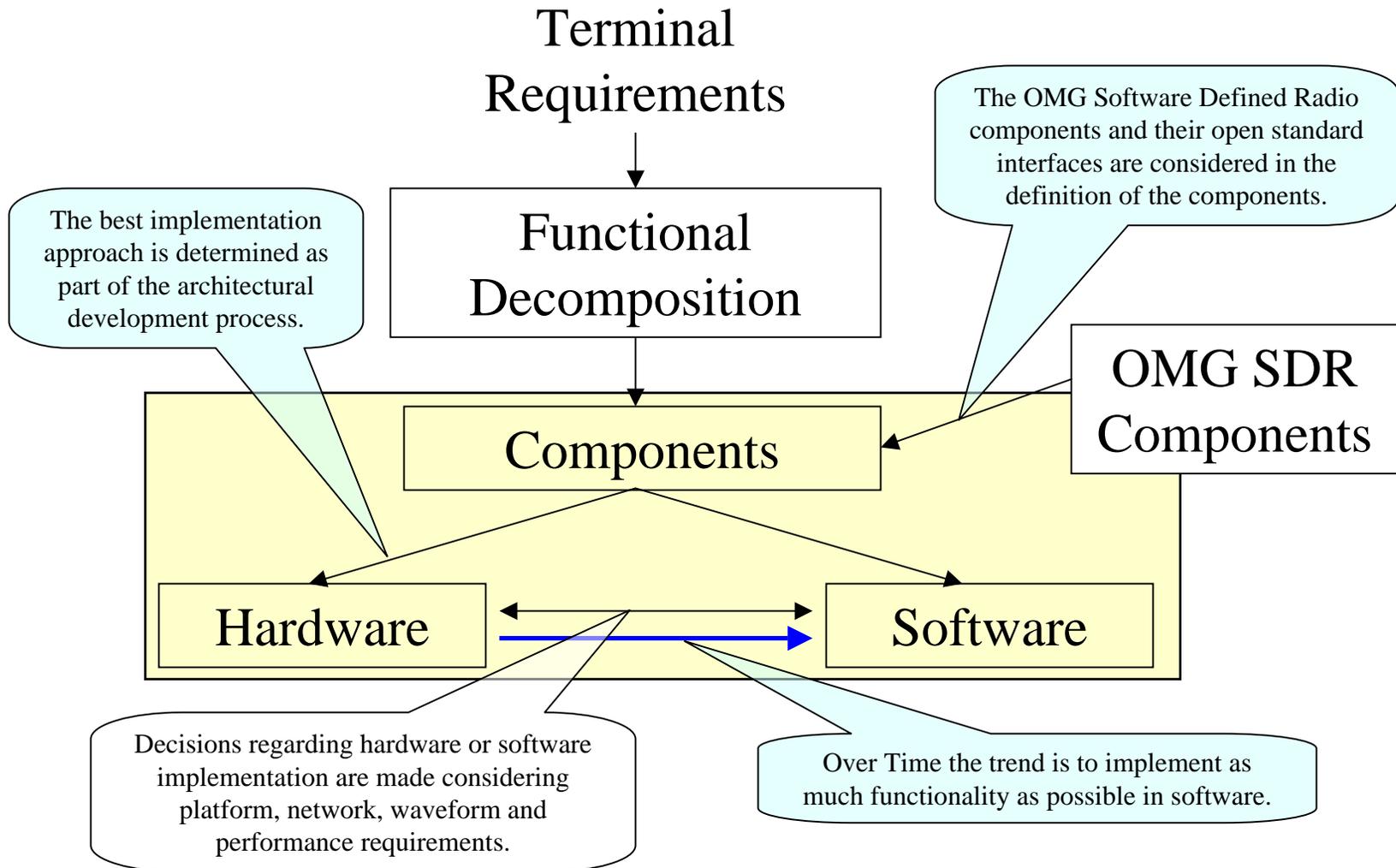
***Platform and Waveform Must
be Carefully and Precisely
Defined as Separate Entities
Since Platform Can Be
Reconfigured to Support
Different Waveforms***

- Simplified, generic requirements representation limited to platform and waveform
- Specifications A, B, and C represent different Service Terminal requirements
- Assume only one Waveform to keep picture simple
- Intersection of requirements is primarily due to Waveform
- Entire Waveform is not required by most terminal specifications

Creating Common Terminal Requirements

- **Approach 1** - Superset of all terminal requirements for all platforms, waveforms, and networks
 - Includes functions not needed
 - Expensive, Inefficient, Contentious
- **Approach 2** - Compromise across terminal requirements
 - Expand the common set of requirements and specify those
 - Negotiations, Agreement
- **Approach 3** – Componentization of terminal requirements supports non-functional requirements, such as **modularity, reconfigurability, flexibility, scalability, commonality, portability, etc.**
 - Provide support for multiple, simultaneous waveforms
 - Provide capability to participate in common networks
 - Provide mechanism to meet specific mission requirements

Decomposition Methodology



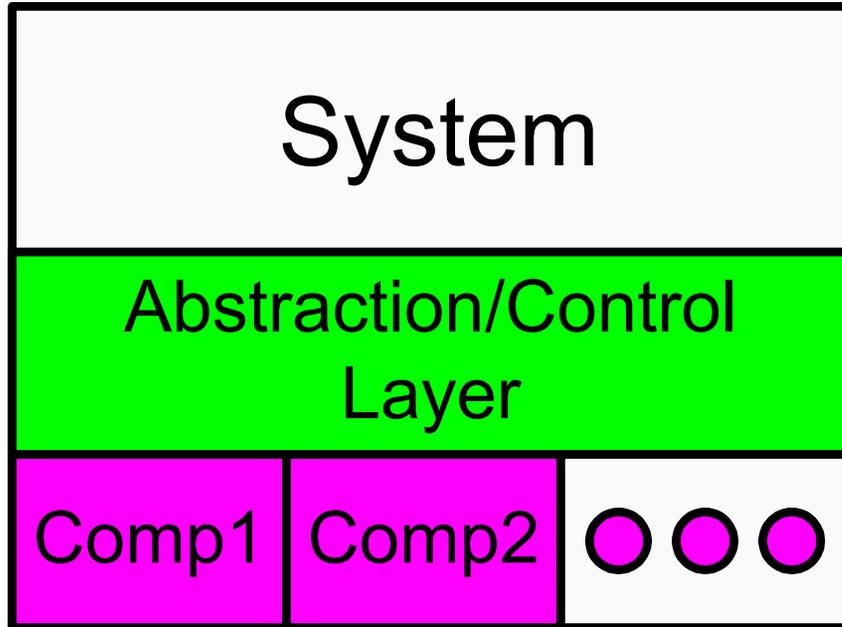
Decomposition Rules

- Assign requirements to functions
- Assign functions to components
- Identify dependence of components on categories of requirements
 - Platform, Waveform, Network
- Reduce dependencies to single category
 - Develop components with capabilities that reduce dependencies (example - A tracking algorithm that works for a platform under motion should also work for a stationary platform!)
 - Push multiple dependency functions to lowest decomposition level to separate dependencies
 - Want common controls for platform, waveform, network or performance dependent objects

Decomposition Rules - Cont

- Decompose to primitive component capabilities
 - Uses building block APIs
 - Enables portability of components
 - Enables flexibility to meet specific terminal requirements

Resulting Architectural Form

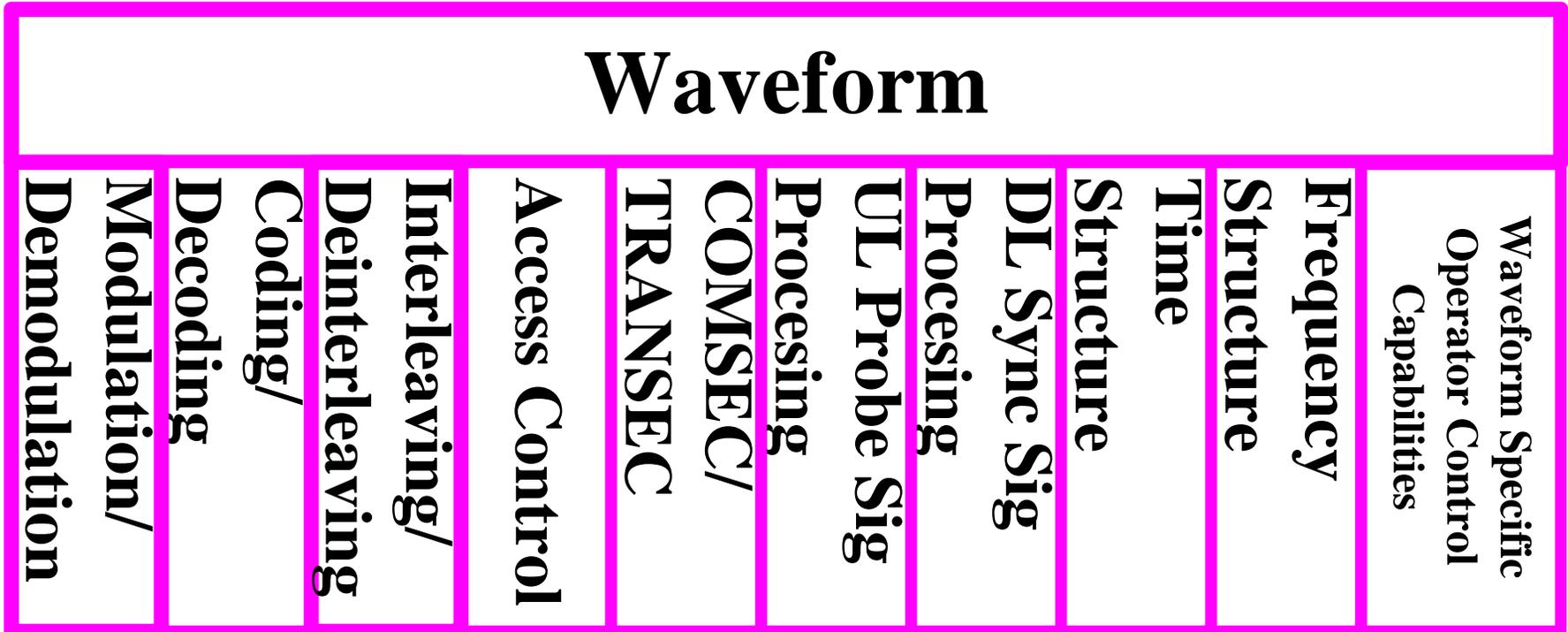


Platform Abstraction
Component

Ex. Waveform Components
of a particular type

Example Decomposition – Let's Drill!

Waveform



➤ Applying Decomposition Methodology Yields Concrete Results

Example Decomposition Continued – Access Control

Access Control Message Processing										IP Format Processing			
LDR Waveform Formatting		Reportback Waveform Formatting	MDR Waveform Formatting			XDR Waveform Formatting				XDR+ Waveform Formatting			
Protocol Engine													
Basic LDR Waveform Protocols		Basic Reportback Waveform Protocols	Basic MDR Waveform Protocols			Basic XDR Waveform Protocols				Basic XDR+ Waveform Protocols			
Beam Manager/ Alternate Beam Manager	Beam Member		Comm Controller	Antenna Controller	Spot Beam TM Controller	Comm Controller	Antenna Controller	Fence Controller	Ad Hoc TM Protocol	Comm Controller	Antenna Controller	Fence Controller	Ad Hoc TM Protocol

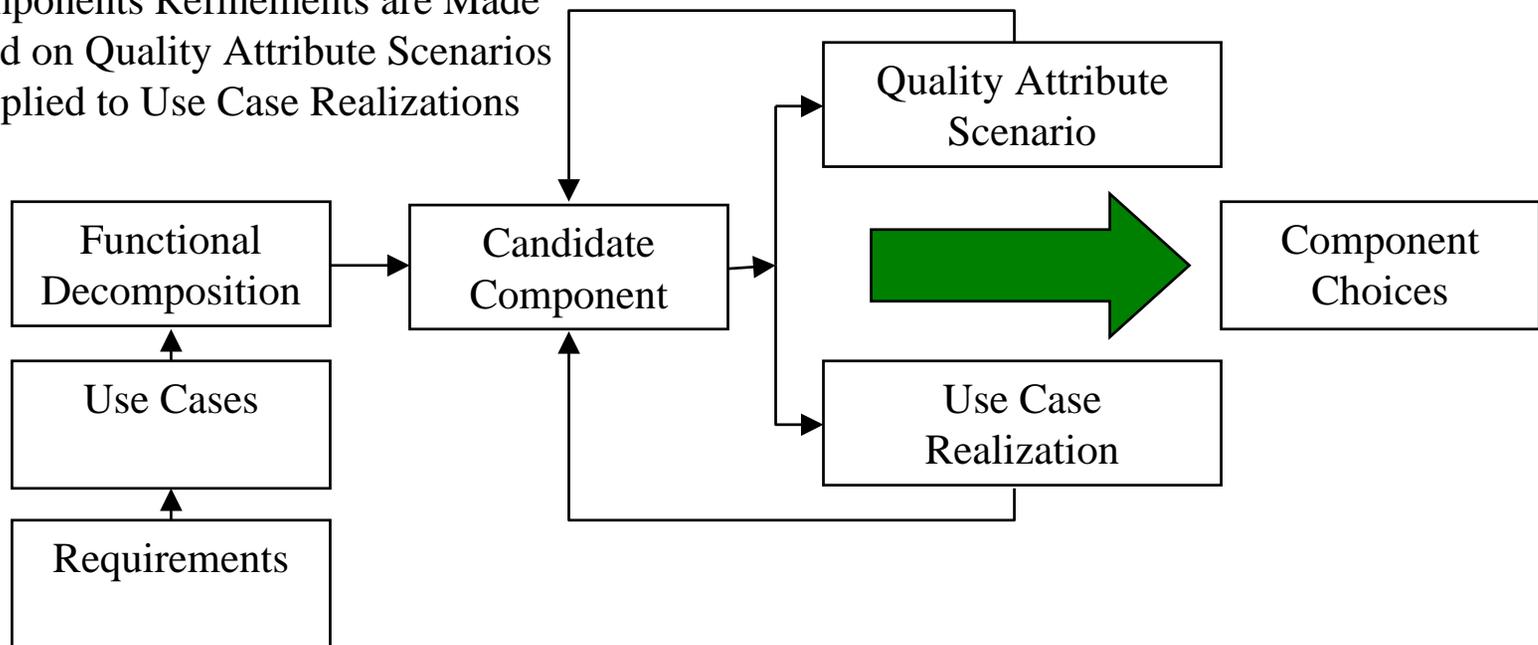
SMART-T Requirements

- Complex SATCOM Waveform Access Control Decomposition Example
 - Not all terminals use all waveform functions – can construct variants
 - Decomposition demonstrates extensibility to new waveform protocols using existing common processing elements – can add XDR+ protocol components
 - Modularity demonstrates capability to meet specific terminal requirements - can add new Ad Hoc protocols and/or can remove LDR and MDR protocols to meet terminal variant requirements

Validating Component Selection

- Component Development and Validation Methodology

Components Refinements are Made
Based on Quality Attribute Scenarios
Applied to Use Case Realizations



➤ **Selection of Components is an Iterative Process**

Functional Decomposition Agreement

- Agreement on Common Decomposition Across Platform, Network, and Waveform is Vital
 - Maximizes portability – minimizes porting costs
 - JTRS application SW is being developed using an evolutionary model to converge to a common decomposition
 - Approach avoids >2GHz application SW from being developed many times
- Focus on broad definition of Re-Use
 - Component Requirements
 - Component Designs
 - Interface Specifications
 - Component Implementations (HW/SW)
 - Test Plans
 - Test Cases
 - Test Procedures

Next Steps

- Raytheon has been working with industry to define standards for below 2 GHz Software Defined Radios
- Raytheon is contributing to the enhancement and extension of those standards to above 2 GHz capabilities
 - Providing comments to OMG RFIs and RFPs
 - Working on providing recommendations for additional and enhanced facilities
- Continued efforts to refine optimal component sets
- Work to extend validation methods and techniques
 - Develop simulation and use case models