Future of SDR in Tactical Networks

30 October 2008

SDR Forum Technical Conference

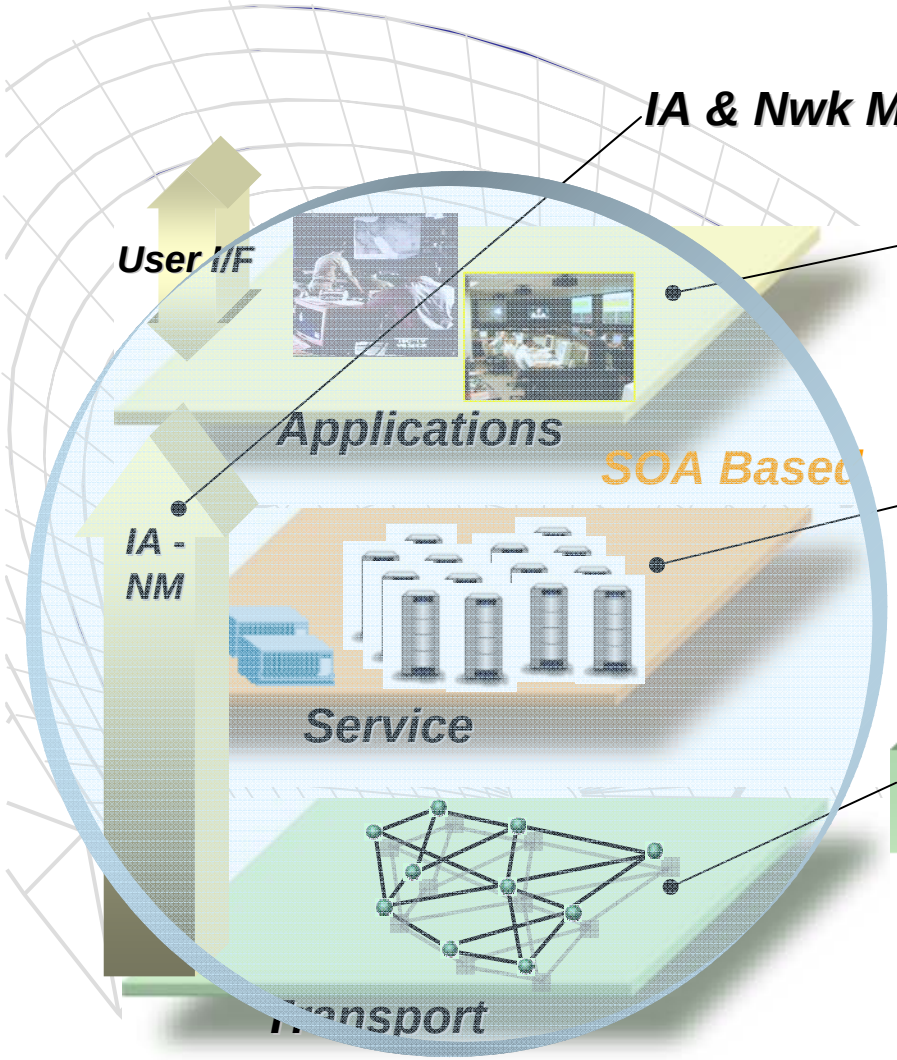
People throughout the trusted, dependable and ubiquitous network are empowered by their ability to access information and recognized for the inputs they provide.

Build, Populate, Protect

Topics

- First – SDR / Software Communications Architectures (SCA) are critical to DoD
- DoD networks and SDR
  - Understanding tactical networks
  - Networks – why these are important – the real rationale for SCA based SDR unification
  - Networks relationships SDR/SCA
  - DoD rationale for using SDR
- Challenges
  - Acquisition – SDR and the DoD acquisition process
  - Perspective on when DoD uses SDR
  - SCA implementation issues and solutions

Information & the GIG - Layered Perspective



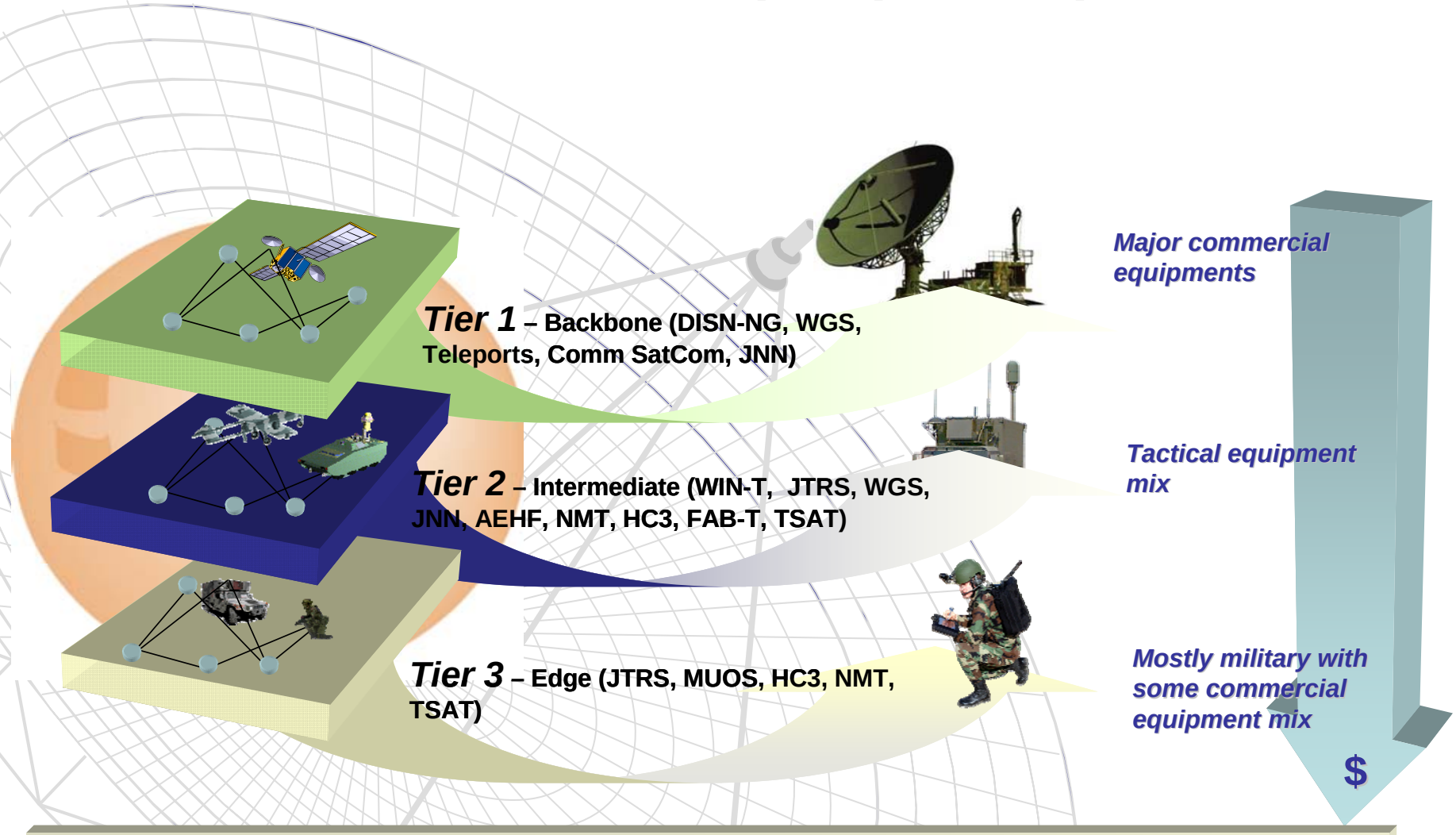
- ✓ Loosely coupled applications based upon SOA/SLA
- ✓ Enabled applications are highly adaptive and flexible

- ✓ Defined data strategy – attributes set by applications
- ✓ XML driven by DoD directives
- ✓ SOA enterprise environment with managed services

- ✓ IP based with QoS established by applications
- ✓ Multi-media for highly available communications

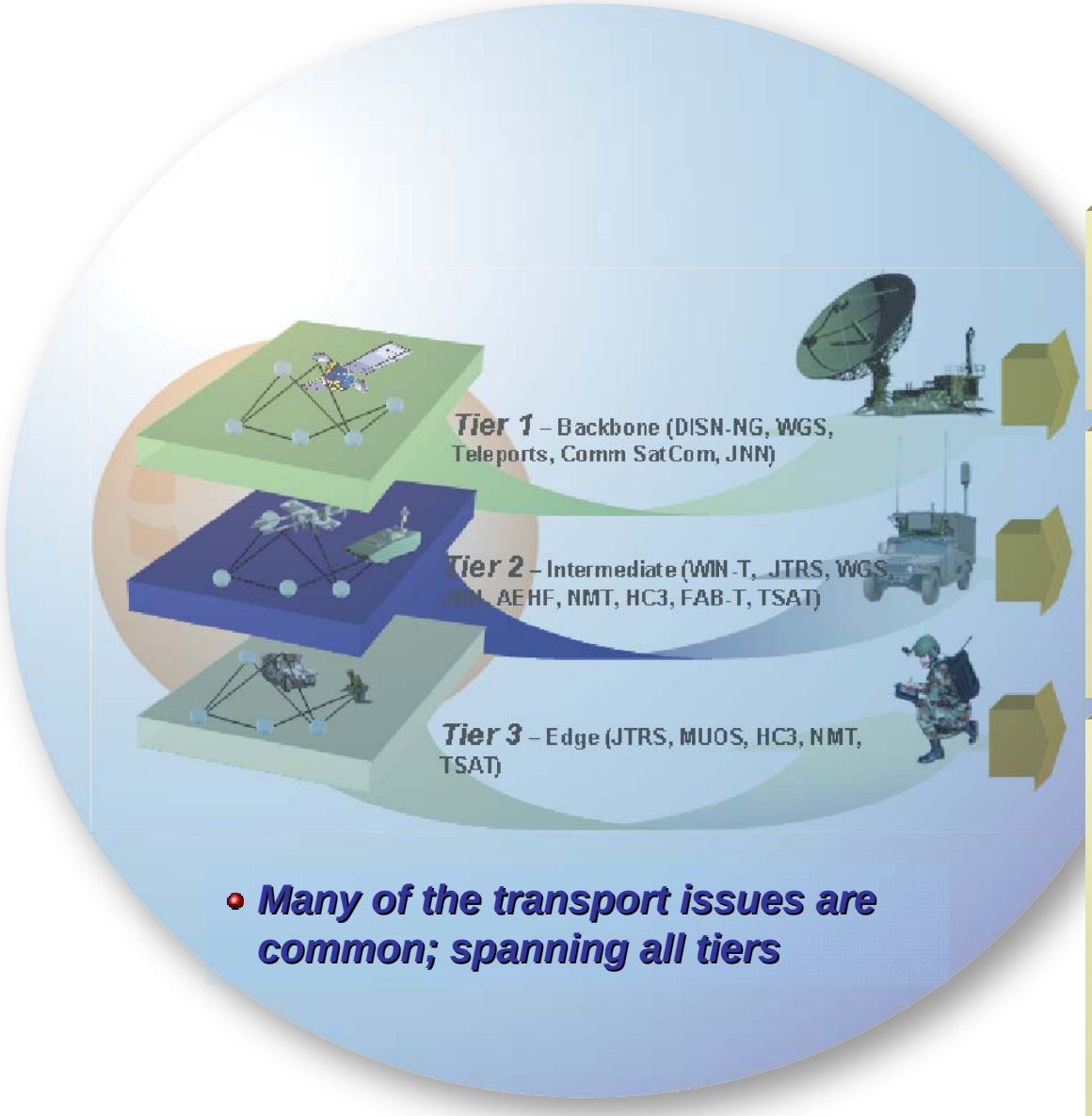
Assured information (data) access is the critical concept – the user sets the information access requirements

Global Information Grid (GIG) Transport Tiers



- GIG is an **IP unified** network having a BLACK routing and switching basis – **tiered** in many respects as commercial networks; with cost **significantly increasing** towards the edge

Transport Issues



- ***Many of the transport issues are common; spanning all tiers***

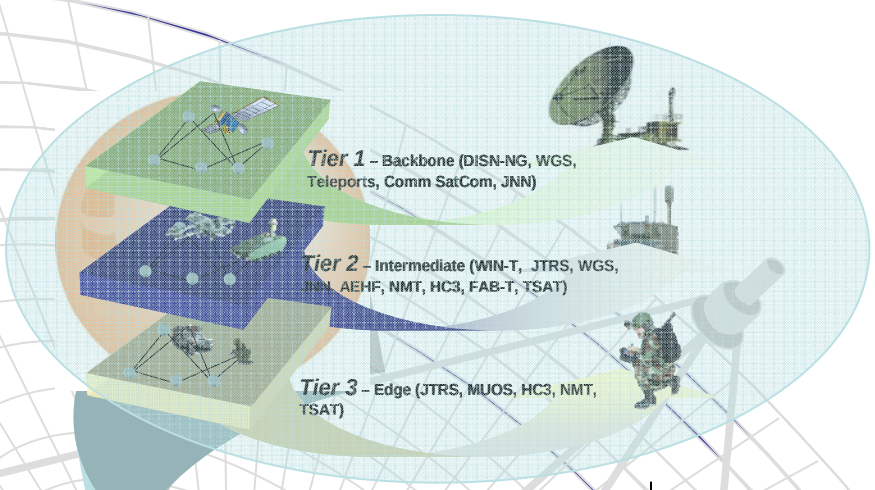
Issues

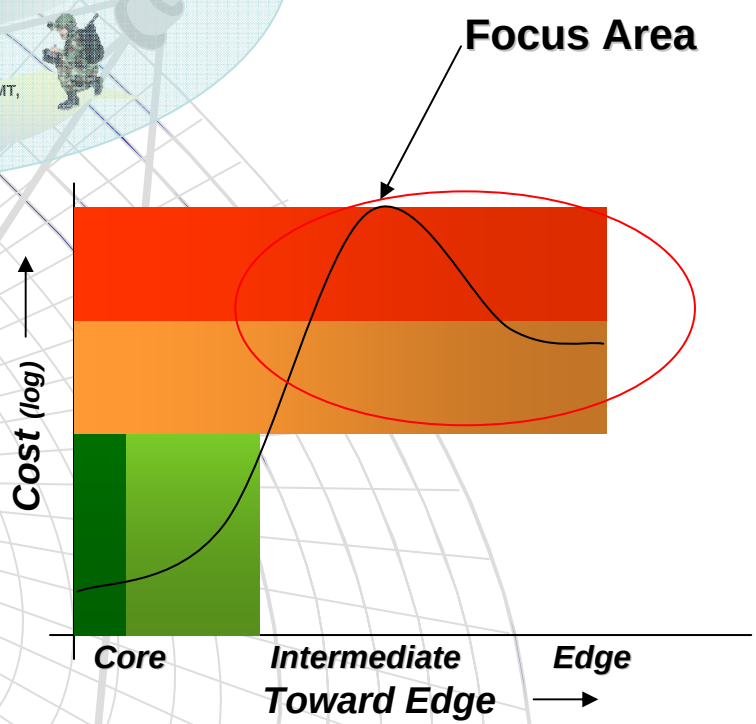
- **IP discovery** and BLK core routing
- **Diversity** in links
- **Balanced IP** core
- Achieving a secure **Wireline IA**

- Satellite access & efficiency - **COTM**
- **Diversity** in link capabilities
- Eliminate the **multiplexers**
- Solution **delivery and cost**
- Unified **tactical ES & IA** support

- Ad Hoc nwks – **performance & capability**
- **Diversity** in link capabilities
- Tactical radios – **cost and timing**
- Waveforms – **type, number, & performance, SCA implementation**
- **Spectrum** and BW **efficiency**
- **GW** number and application
- **Security** boundaries & **IA**

Identification of Investment Focus Areas

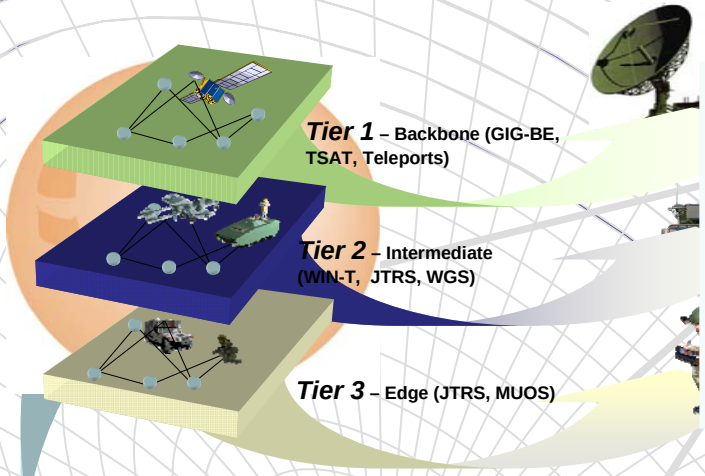


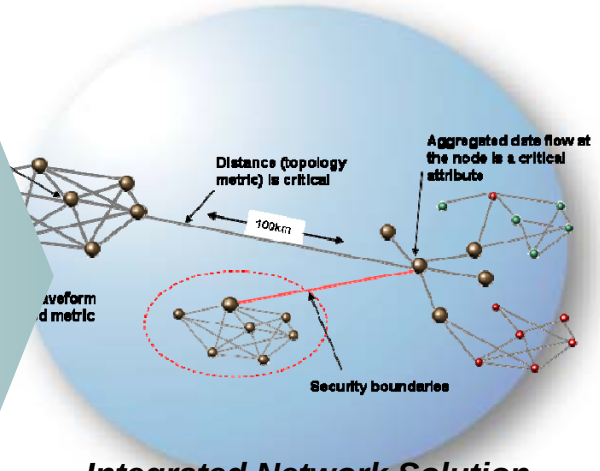


- The largest generic terrestrial cost driver is the intermediate level followed by the edge
- The wireline core is critical, but the total investment cost in wireless significantly outweighs all other netcentric costs – SDR is important since it represents the fundamental DoD future implementation approach

Incomplete Network Solution - Losing Sight of the Network

Network Topology Relationships

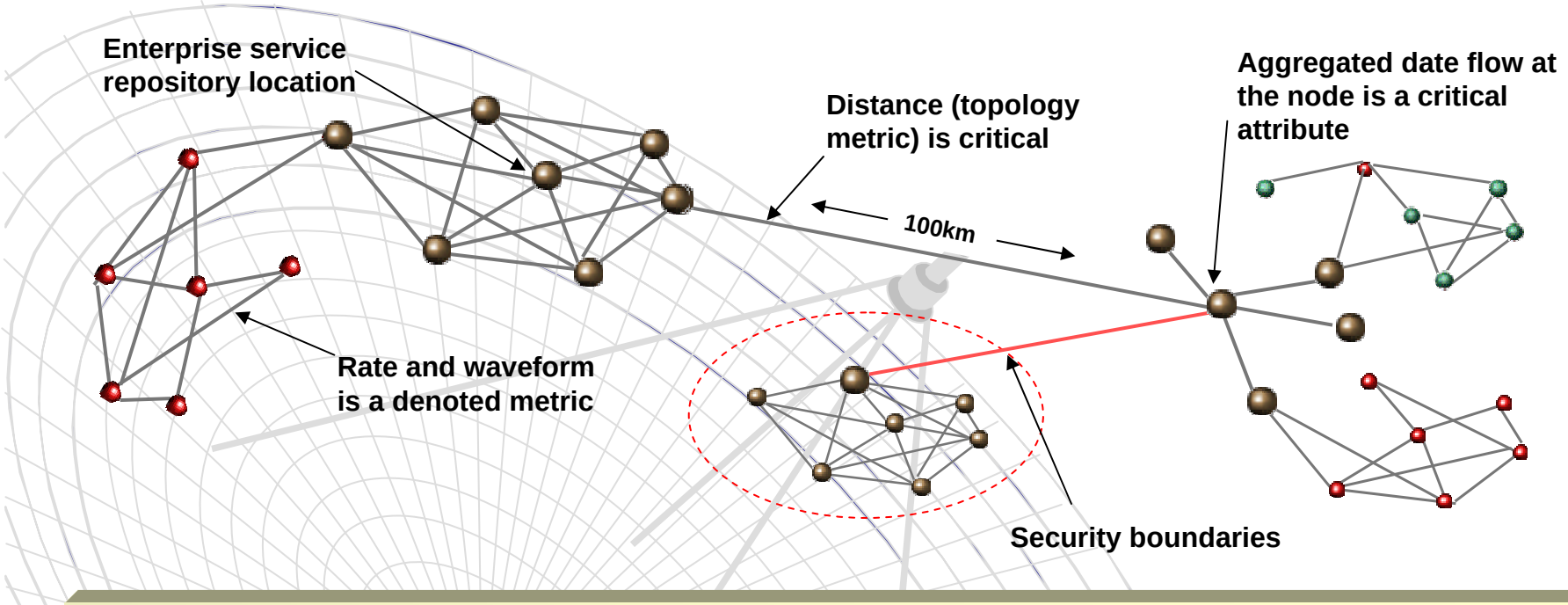




Integrated Network Solution

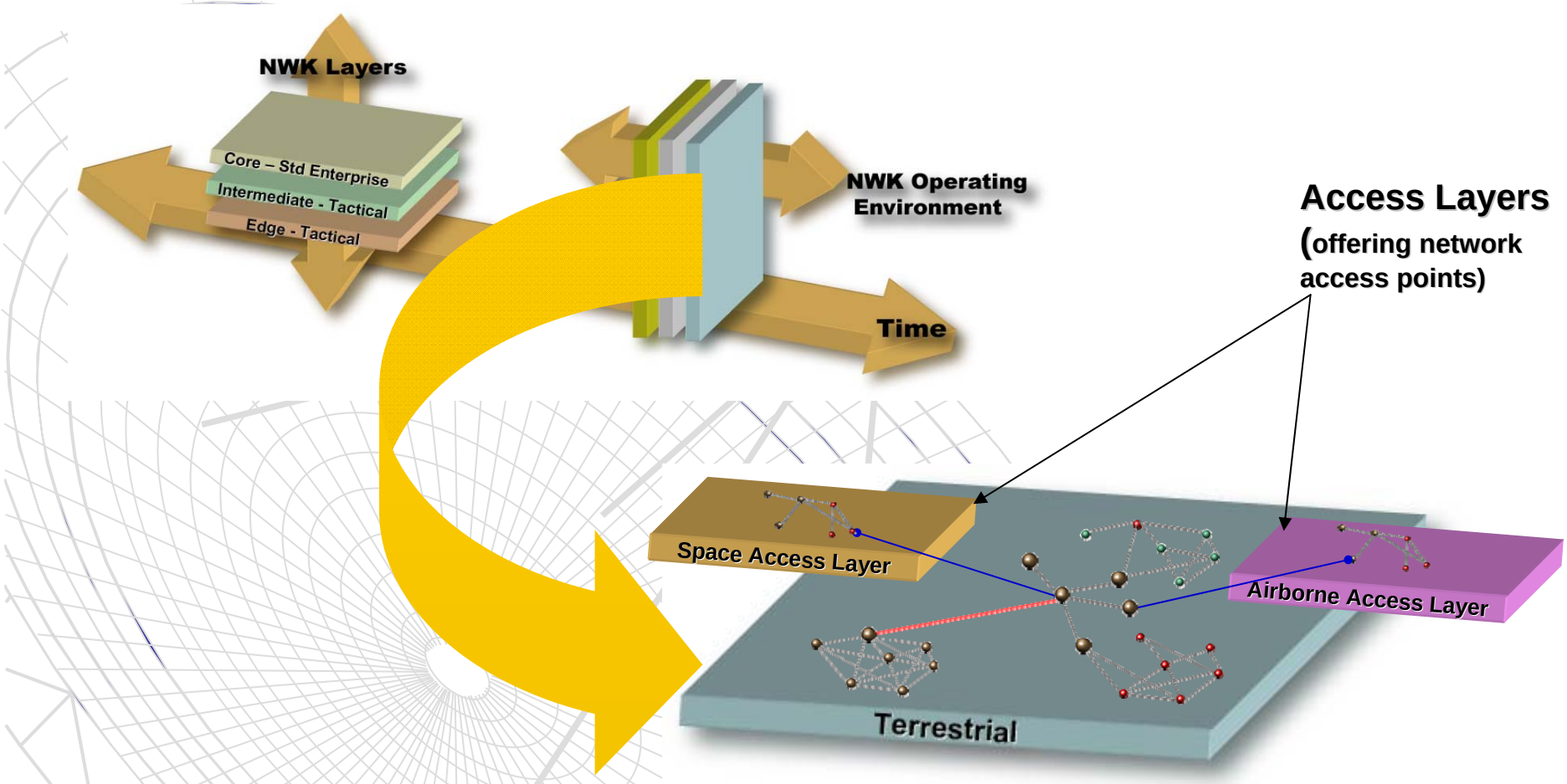
- Understanding the entire network is critical so to not compromise a cost and warfighter effective solution (Interoperability)
- Forcing the core and tactical edge networks to be addressed an integrated structure
- Network and Enterprise programs are NOT independent
- Network is part of the GIG – requires relationship to the services and applications, BUT information (data) is the critical element
- Interoperability with more than a single Service element or a partial force – total force including the all Services and coalition forces

Network Topology Architecture



- Understanding the network topology is critical for determining the network performance and application – also to address the fundamental network requirements
  - The aggregated nodal information flow in relationship to the enterprise services point provides a architectural construct to the network
  - Mobility of the nodes and the connectivity characteristics relative to path / link characteristics is required
- The network topology becomes an important tool for determining SDR attributes as well as the waveform requirements
  - Understanding the network topology provides a vehicle to address the interoperability issues with legacy subnets / radios, nodal constraints and addressing coalition networks
  - IA considerations including fundamental interoperability and security boundaries for deploying the SDR unit

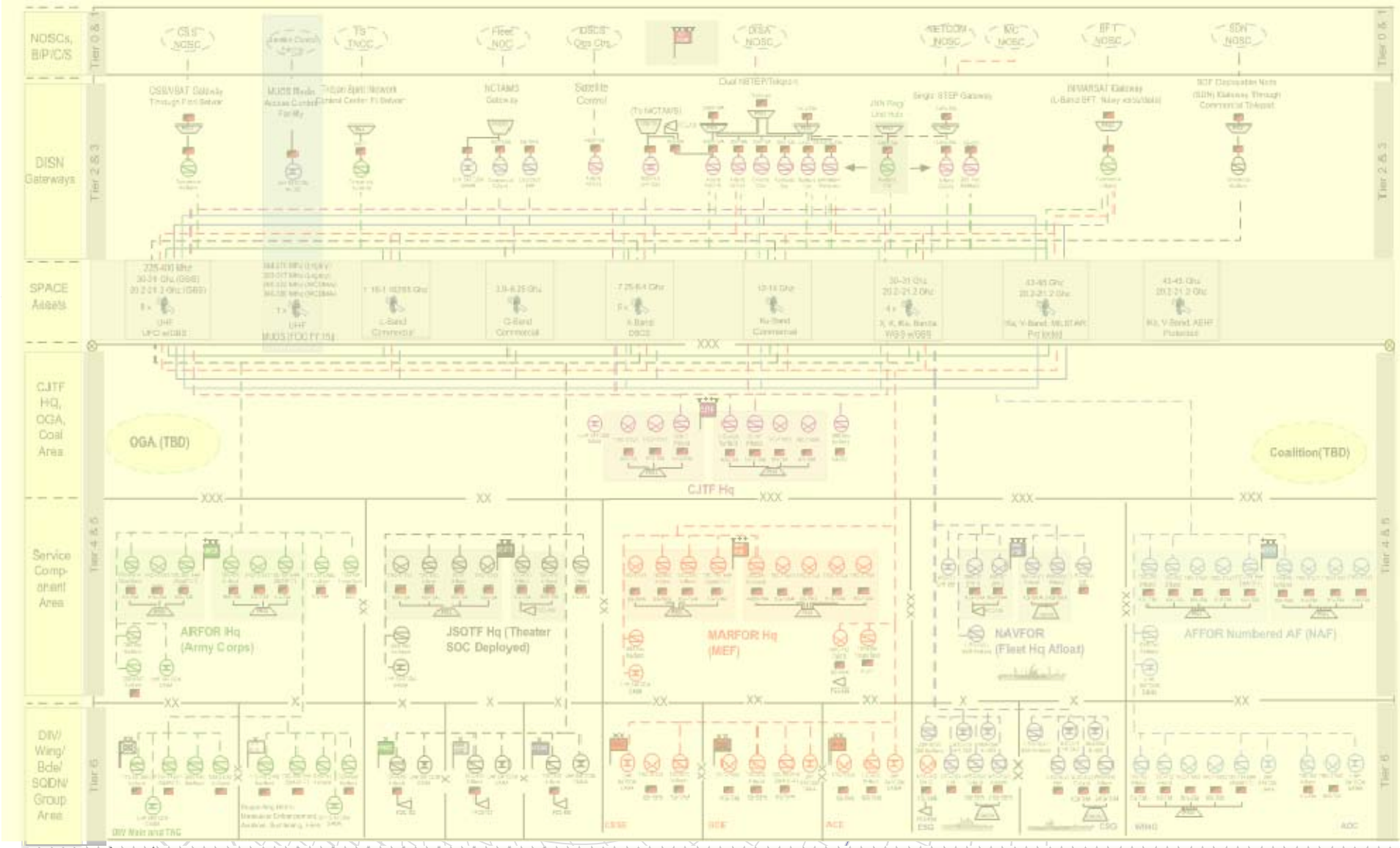
Tactical Network Architectures



- Tactical networks differ in operational environment constructs
- Time is a critical consideration – SDR offers considerable flexibility in addressing the detailed network nodal implementations
- SDR nodes are being addressed in the tactical intermediate and edge tiers, all operational elements and in the airborne access layers

Combined Joint Task Force (CJTF) Model [2012]

DRAFT – WORK IN PROGRESS



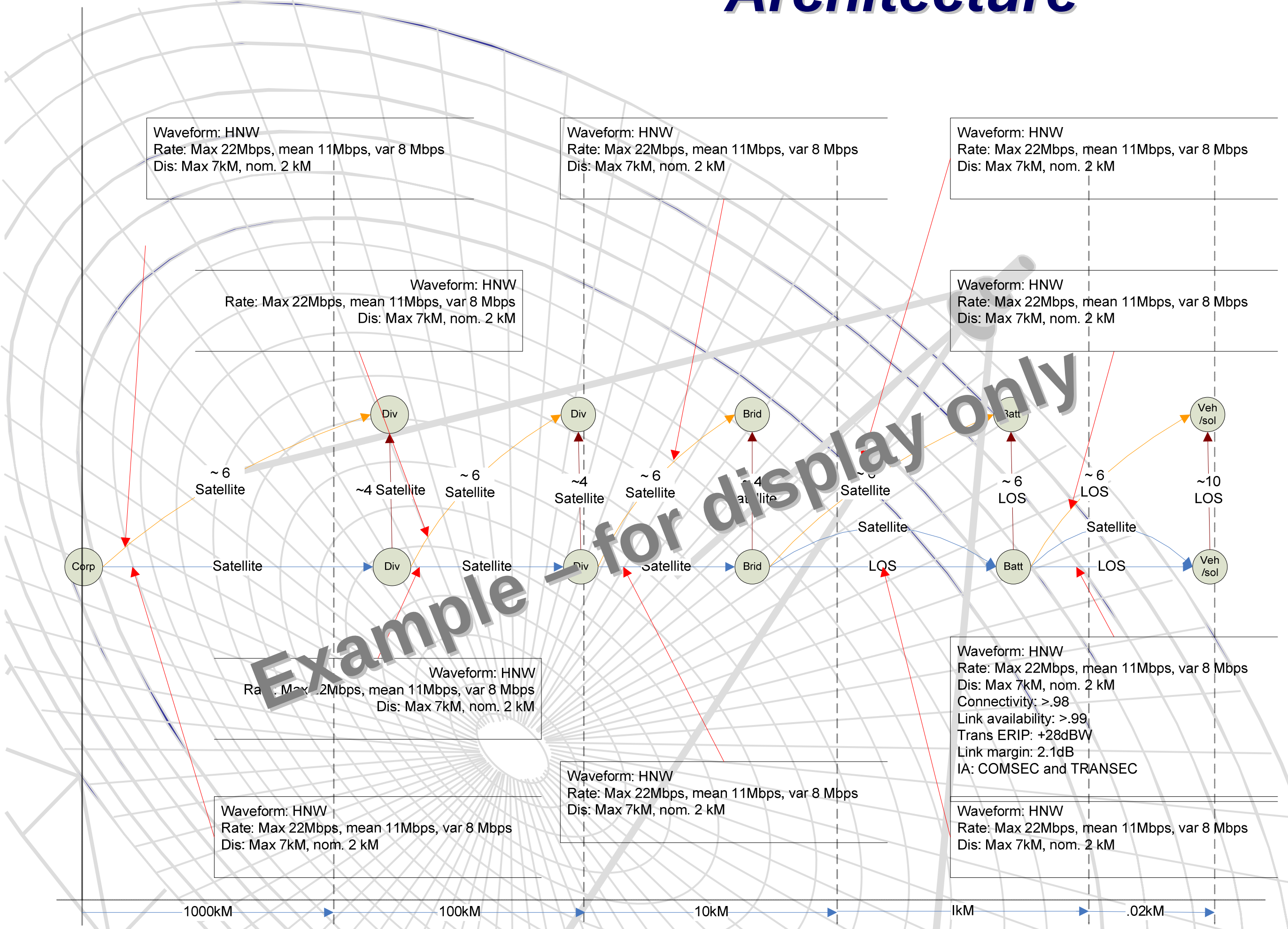
References:

1. Operational Area Network Version 4.5, ICJCSM 6231
2. Tactical Networks for Ground Forces Study
3. JCS Publication 6-02, 3.0
4. AMD Modular Force Operational Architecture 2/15/2006
5. Landwarnet Evolution Version 7.0
6. AMD Horseblankets HBCT, IBCT, SBCT 12/5/2006

JNO CPM Architecture Product

Title: CJTF Top Level Architecture
Date: 5/31/2007
Version: 0.7
R. Conroy

The Characteristics of a Terrestrial Tactical Network Architecture



Terrestrial NWK

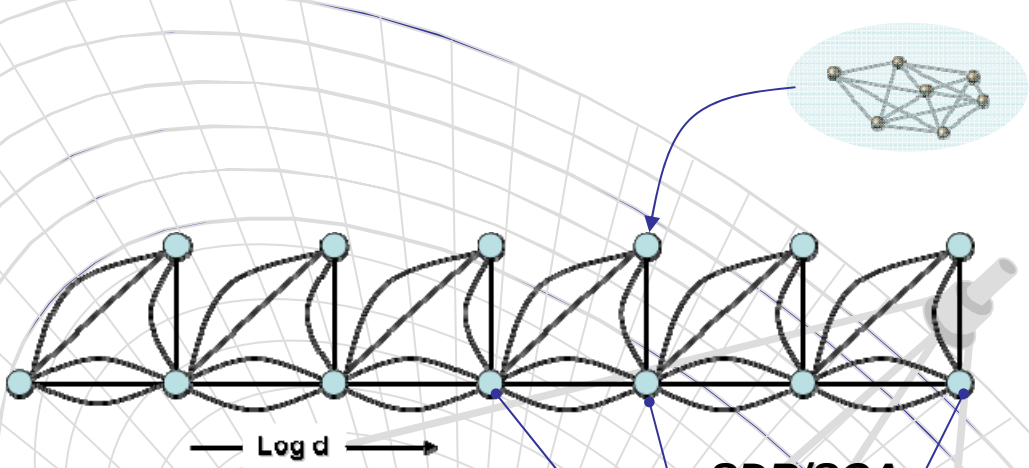
- Network is hierarchical in structure
- Distance is critical with hierarch topology
- Diversity is key
- Space is an extension of terrestrial

Airborne Nwk

- Distance is in terms of near and far
- Diversity is important
- C2 nodes with ES are critical
- Position in air space relative to permissive environment is key

- **Do not forget the network – in a tactical environment, understanding the network is essential: NOT just waveforms but aggregates rates, diversity, ES locations, security boundaries, etc.**
- **The architecture is a critical portfolio and system design tool – represents the framework & way forward**

Ground and Airborne Tactical Networks Characteristics



Terrestrial

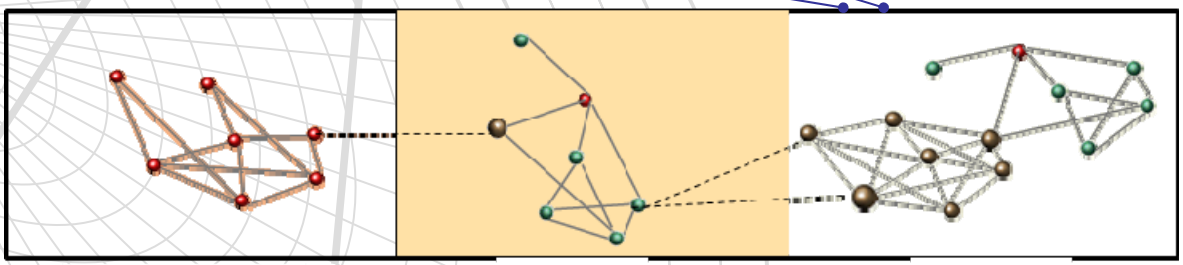
- Network structure is hierarchical
- Multiple waveforms – large legacy waveform number
- AJ is important
- Wide terminal physical size variations
- Edge terminals are often remote
- Edge rates are less, but network size very large
- Subnets are unstructured
- Key airborne and satellite dependency

SDR/SCA

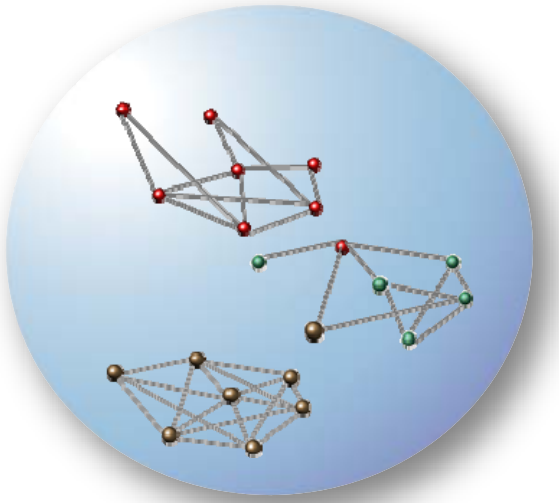
- JTRS HMS
- JTRS GMR
- JTRS AMF
- WIN-T
- FAB-T

Airborne

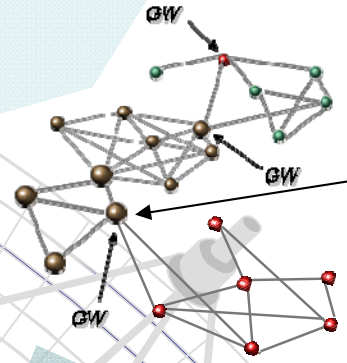
- Consists of three network spaces
- Operating distances are long
- AJ and LPI waveforms are required
- Large subnet member numbers
- Key C2 node locations
- Networks are highly unstructured
- Significant nodal/link rates
- Minimal waveform types
- Groups of nodes, movement in groups



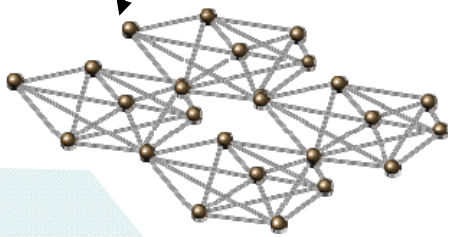
Why SCA is Important to DoD – Network Perspective



Current – numerous incompatible networks



Effective GW – virtual ubiquitous network



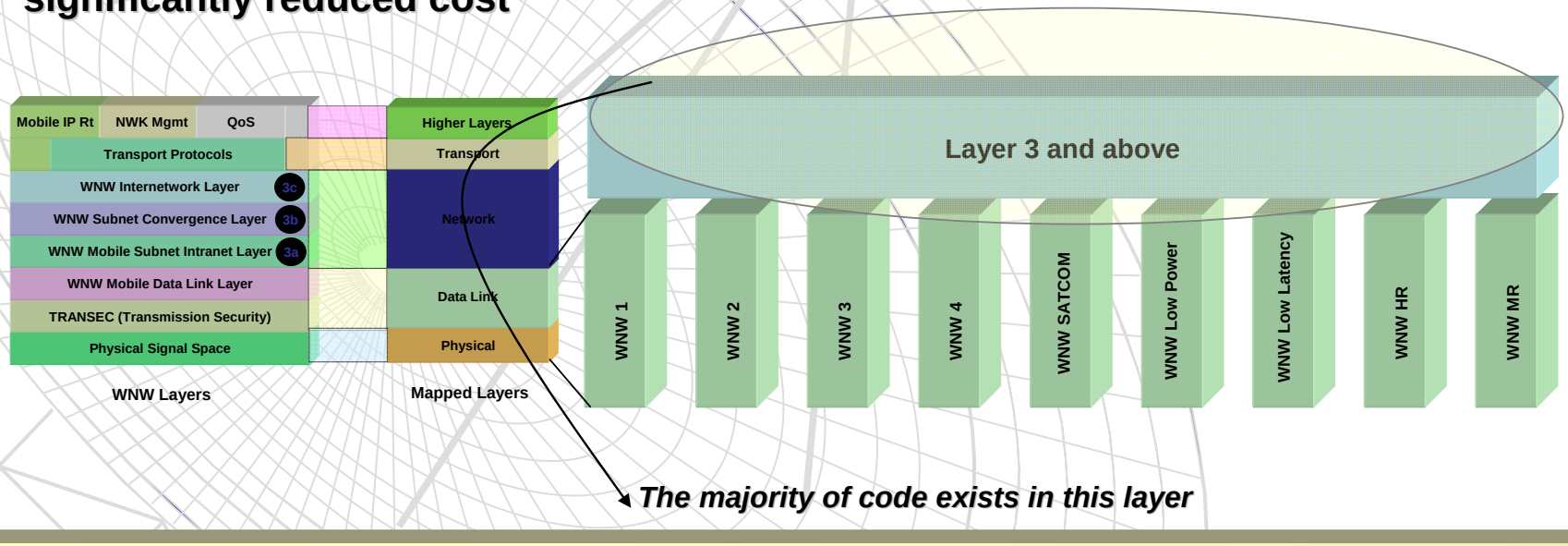
Unified Network

- SDR-SCA offers a unified method of transport for the GIG to enable information sharing
- Migration from a highly disconnected legacy network structure can be accomplished using conventional and SCA routing/gateways
- Key – given the DoD network structures and acquisition process, SDR-SCA offers a means to achieve a unified network
- SDR-SCA also offers a unique ability to upgrade network performance over the extensive DoD radio life cycle

SDR - Waveform Issue

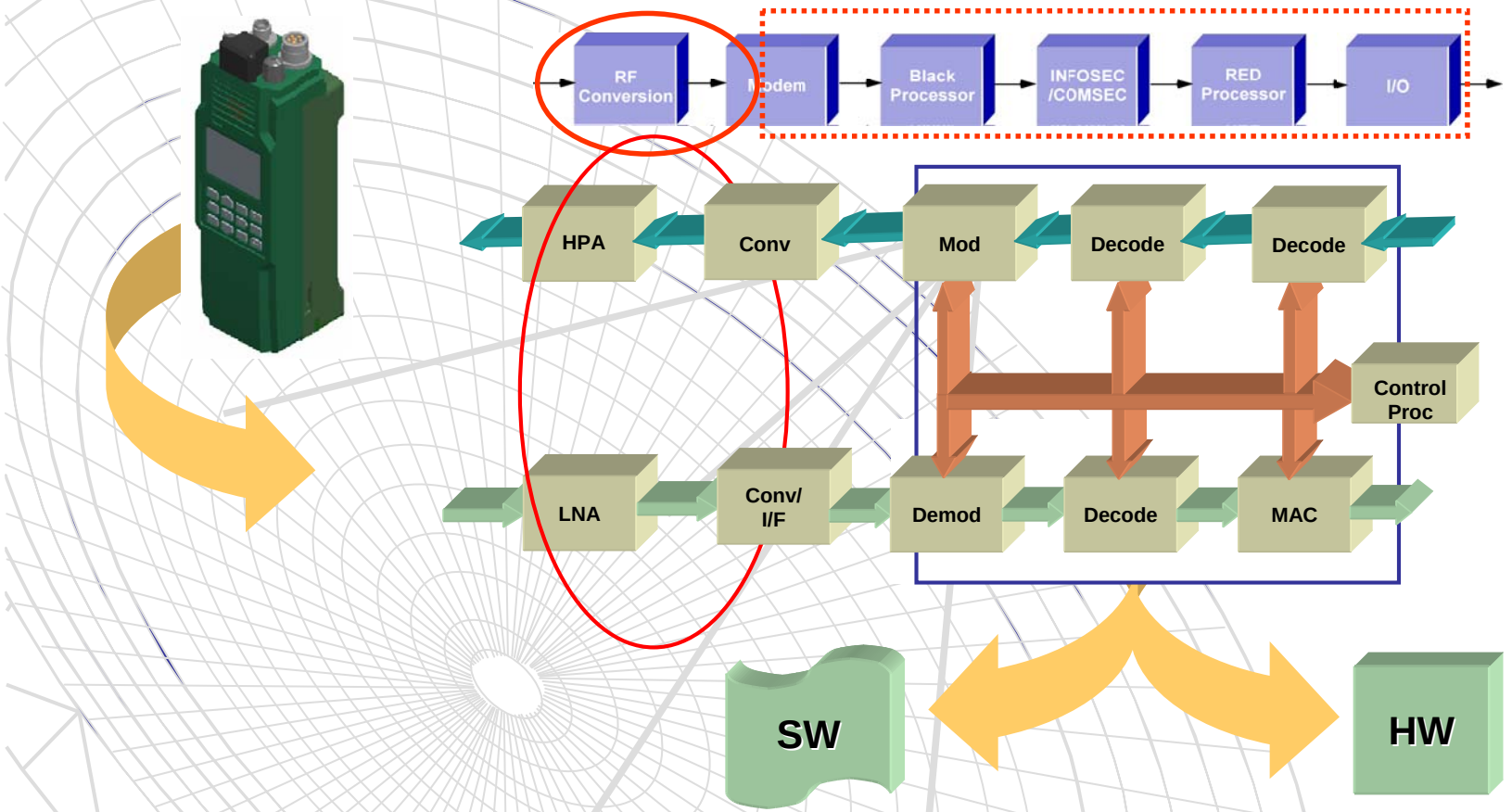
- DoD has a very large number of different waveforms which in turn result in massive interoperability issues – opposing information sharing
- SDR - SCA is often thought within DoD as a means to enable multiple new waveforms
  - Increased interoperability issues
  - Waveforms gains are minimal translating into significant increased costs and interoperability issues

- SDR- SCA is a actually means for network convergence – a migration path to an integrated network
- Reuse of layer 3 and above (massive code area) enables a common structure and significantly reduced cost



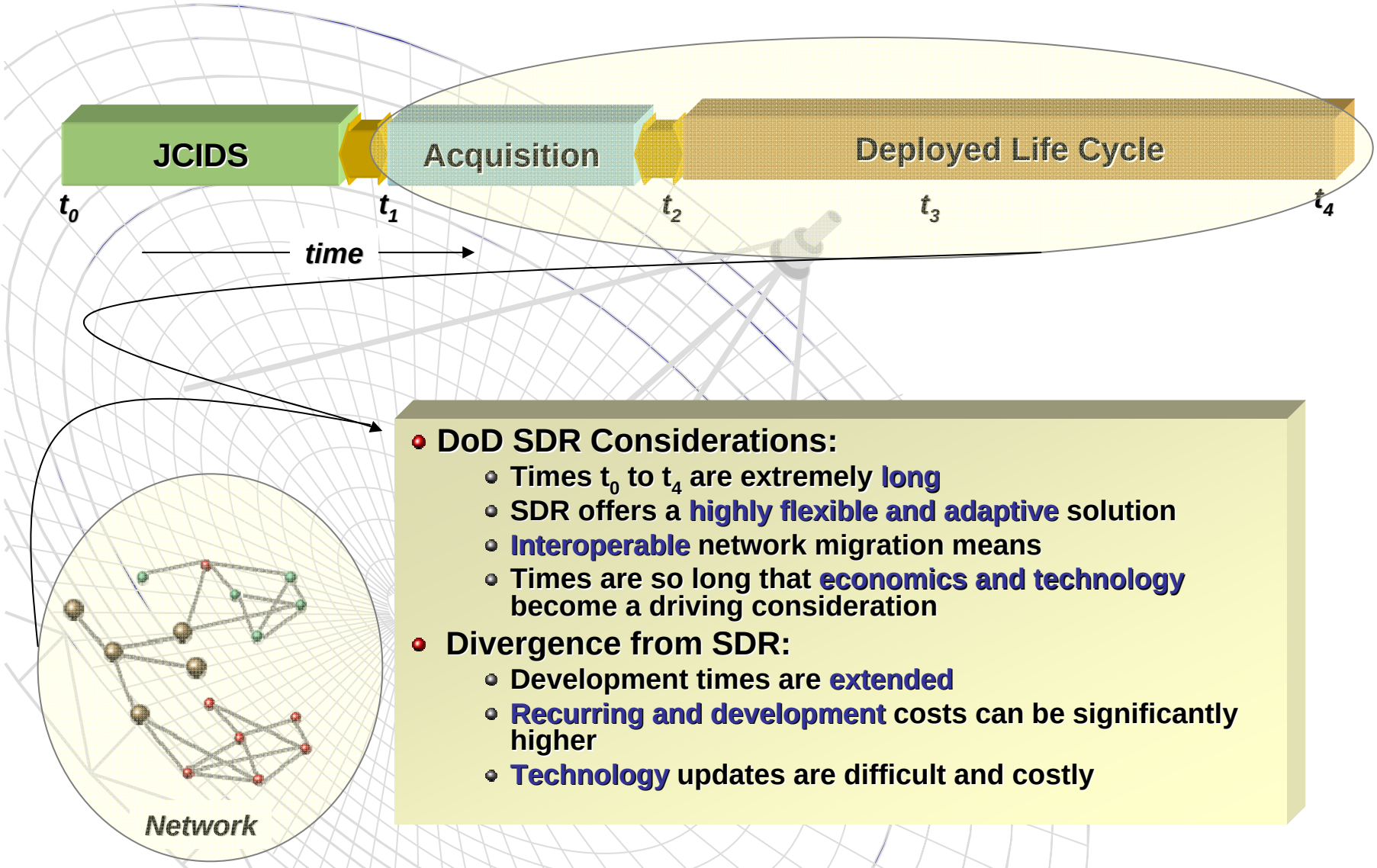
The tactical network strategy is to use SDR-SCA as a means to integrate the network and enable future planned common waveform upgrades

Implementation of DoD Tactical Network Radio – Enter SDR



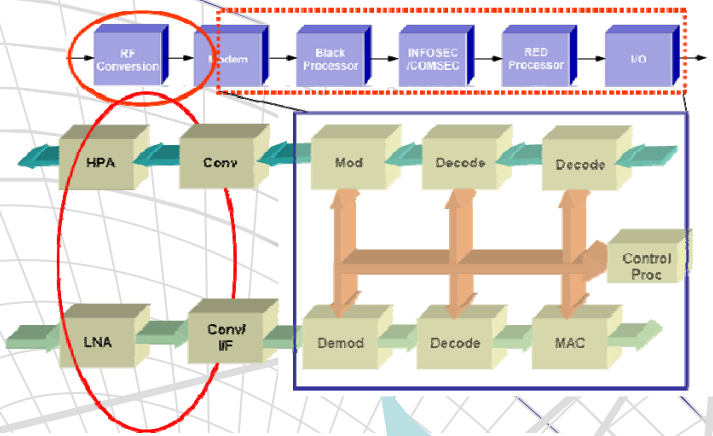
- The decision to implement SDR may at first seem like the most flexible approach and hence the most cost effective
- At issue is the equipment hold time, technology progression / advancement, and the potential for updating the radio software/waveform

A Perspective on SDR Use in DoD

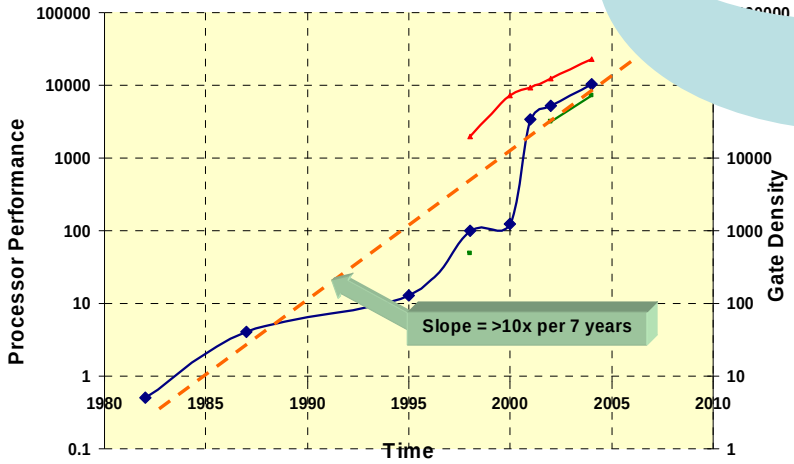


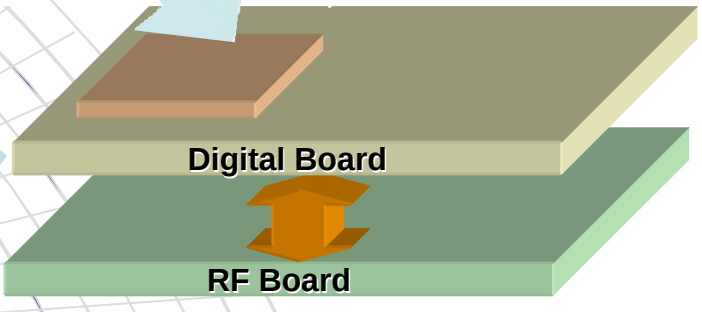
- **DoD SDR Considerations:**
  - Times t_0 to t_4 are extremely **long**
  - SDR offers a **highly flexible and adaptive** solution
  - **Interoperable** network migration means
  - Times are so long that **economics and technology** become a driving consideration
- **Divergence from SDR:**
  - Development times are **extended**
  - **Recurring and development** costs can be significantly higher
  - **Technology** updates are difficult and costly

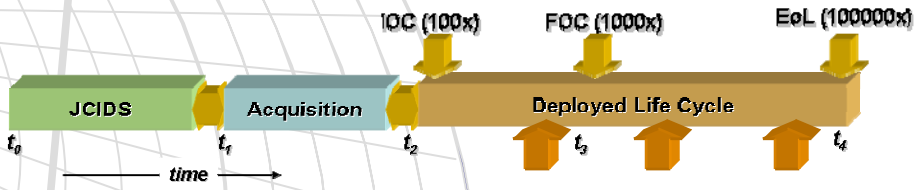
Key DoD SCA Radio Structure Approaches



Upgradeable processing components



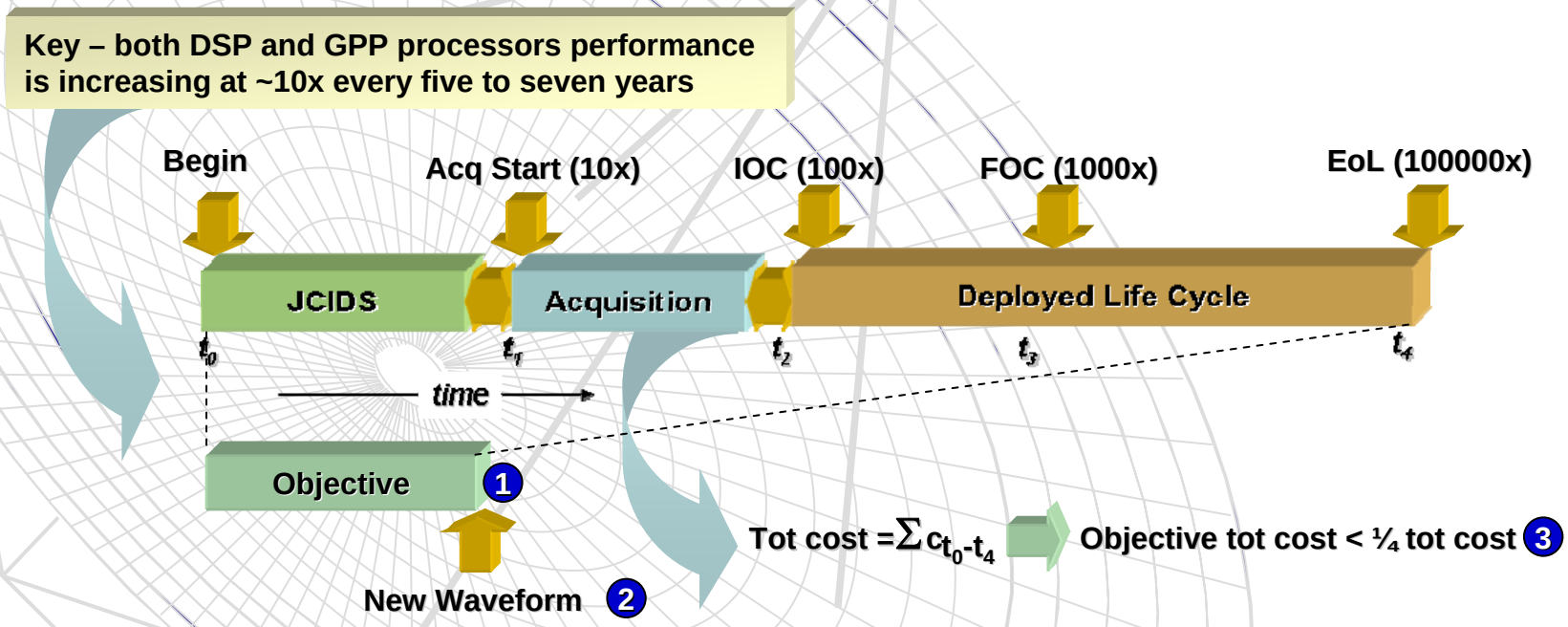




- DoD requires upgradeable SCA processing elements to insure waveform compatibility in future waveforms and network migration
- The upgrade requires a minimal cost means enabling different increments through the radio life

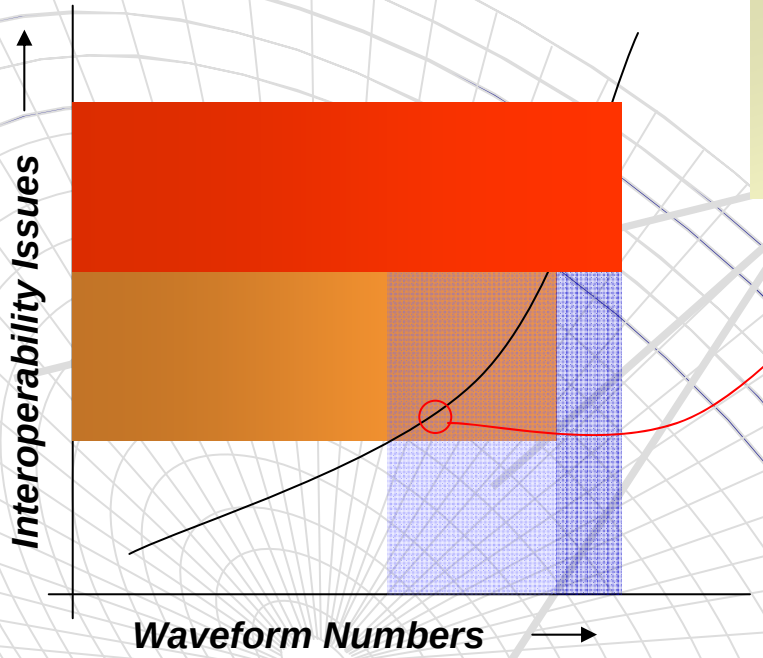
DoD Decision Point on SDR-SCA

- The DoD decision point for SCA implemented radios involves network structure, transport performance, and cost
- Schedule becomes an important consideration and a means of obtaining a different perspective
- Decision factors
  - Processor driven new waveform network performance
  - Network structure and interactions with new waveform – the introduction ease of a new waveform
  - Cost – new radio and waveform (separation or together)
  - Does an SCA implementation make performance and economical sense



- There exists some applications which offer rapid solutions other than SDR – these are likely very low cost implementations and must be evaluated against the potential of improved SDR structures

The Interoperability of Large Waveform Numbers



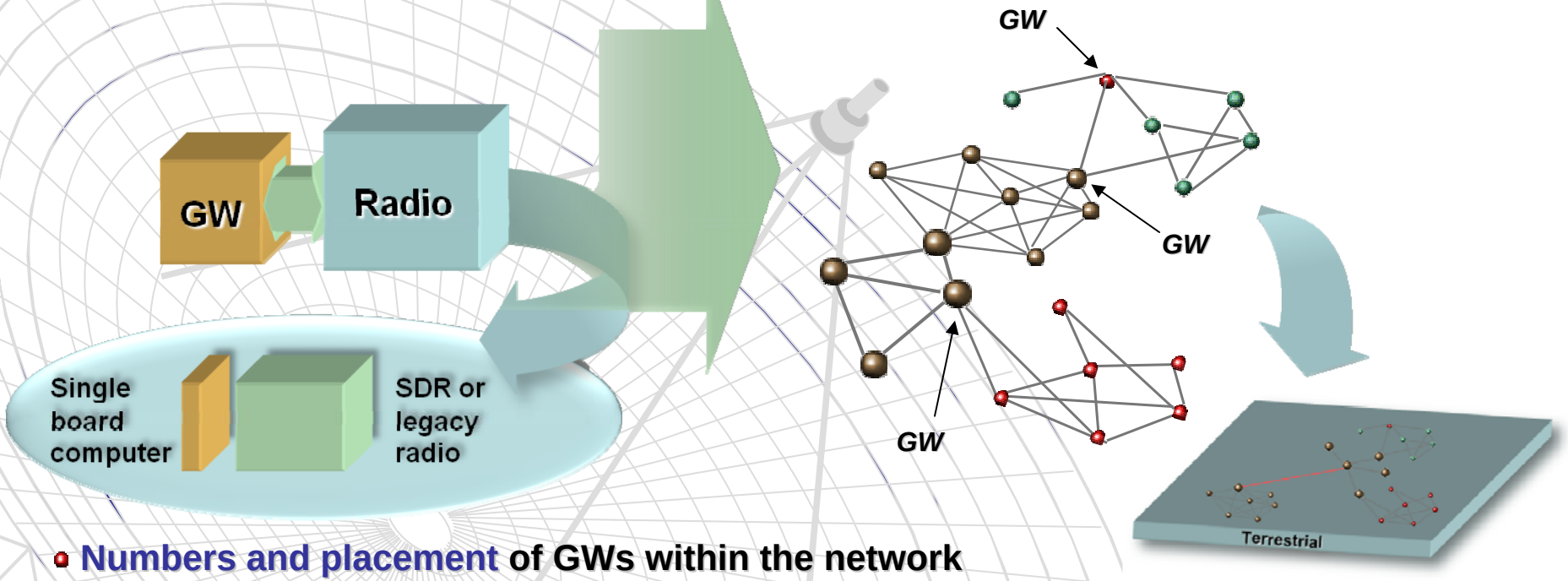
- The right operating point is one which –
  - Low cost or high ROI
  - Significant gains in performance
  - Minimal implementation effort
- Establish a criteria for new waveforms

- Network topology impacts
- SDR/SCA implications
  - Processing upgrades
  - GW – routing functional considerations
  - Associated channel and IA aspects

- Maximum waveforms yields negative gain
- Cost is a major evaluation factor – performance gains against funding and interoperability costs
- Solutions involving GWs only offer a partial interoperability bridge

GW SDR Solutions

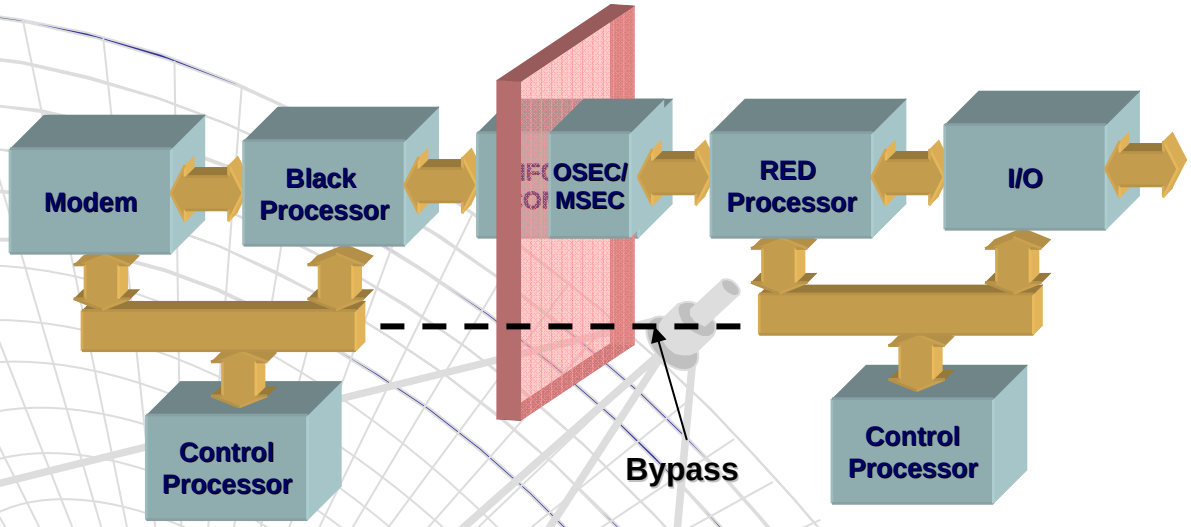
- Tactical radio GW solutions have limited interoperability improvements given cost and size constraints – but remain a valuable component



- Numbers and placement of GWs within the network
- Size and cost of the GWs – internal routing and interface latencies (functional service within the SDR)
- GW should not outnumber the radios

The use of GWs is certainly a viable solution to interoperability and spanning the subnet boundaries – but requires network and operational SEs analysis

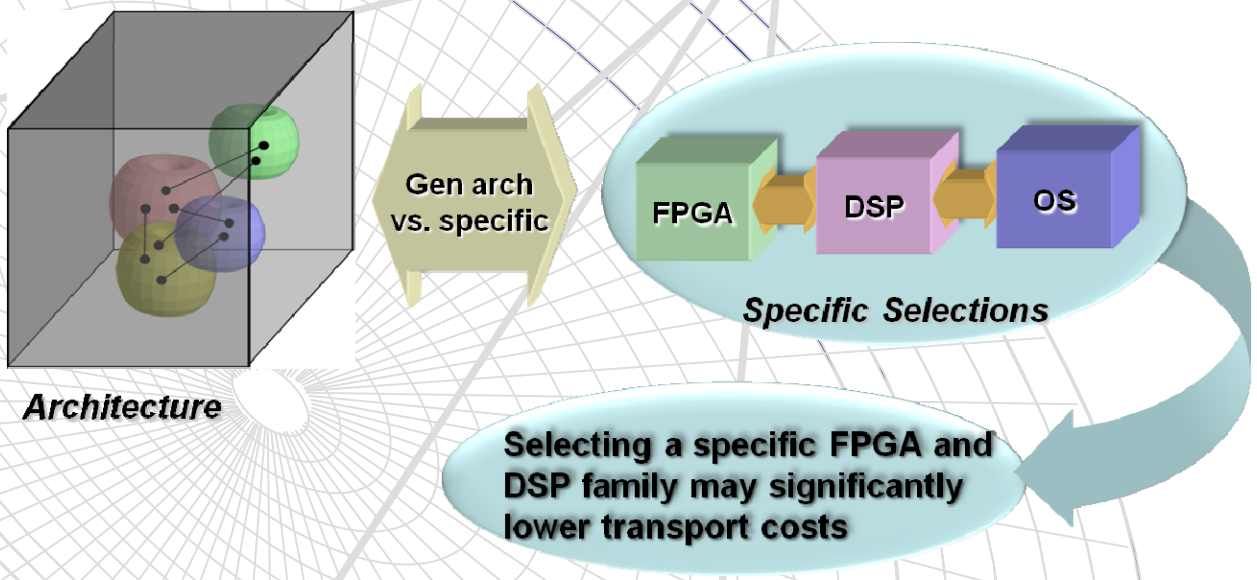
Common SCA Radio Network Security Issues



- DoD SDR implementations have INFOSEC/COMSEC requirements which require not only SE hardware structure assessment but also software and network considerations
- Transversing the RED/BLACK interface must be accomplished in a minimal BW manner resulting in highly structured and carefully engineered software
  - Use of some common software operations and OS features may result in high speed information movements through the bypass
- Future DoD SDR/SCA architectures must set constraints on waveform software structures establishing a HW and SW structure consistent NSA requirements

The Balance of SE Constraints for GIG SDR Elements

- Single SDR solution within DoD are not feasible since the operational environment and network tiers require differing implementation demands
- DoD consumption for different physical SDR formats may translate into multiple different radio structures for a common set of waveforms
- Multiple FPGA, DSP and OS can result into interoperability and proprietary issues as well as excessively elongated development times



- Keeping a generic architecture may increase development time and costs – specific selections may increase portability and may reduce future interoperable waveform/network operations impacts

Summary

- SDR/SCA is critical to future DoD tactical networks
- Using network topology architectures and performance requirements is required to insure the network is unified by the SDR/SCA nodes
- End objective is an integrated network having minimal waveforms yet SDR adaptable to the insertion of new waveforms
- SDR/SCA implementations must incorporate a means of simply upgrading the processor structures for new waveforms
- SCA may not necessarily be solution for all DoD tactical radios, especially those having very low costs
- Key DoD SDR/SCA issues need to be addressed
  - Consistent GW routing functions
  - SCA waveform software constraints
  - SCA HW/OE constraints