Advanced Wireless Technologies at DARPA

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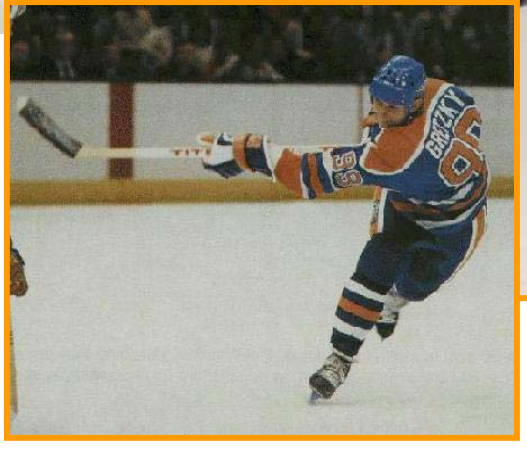
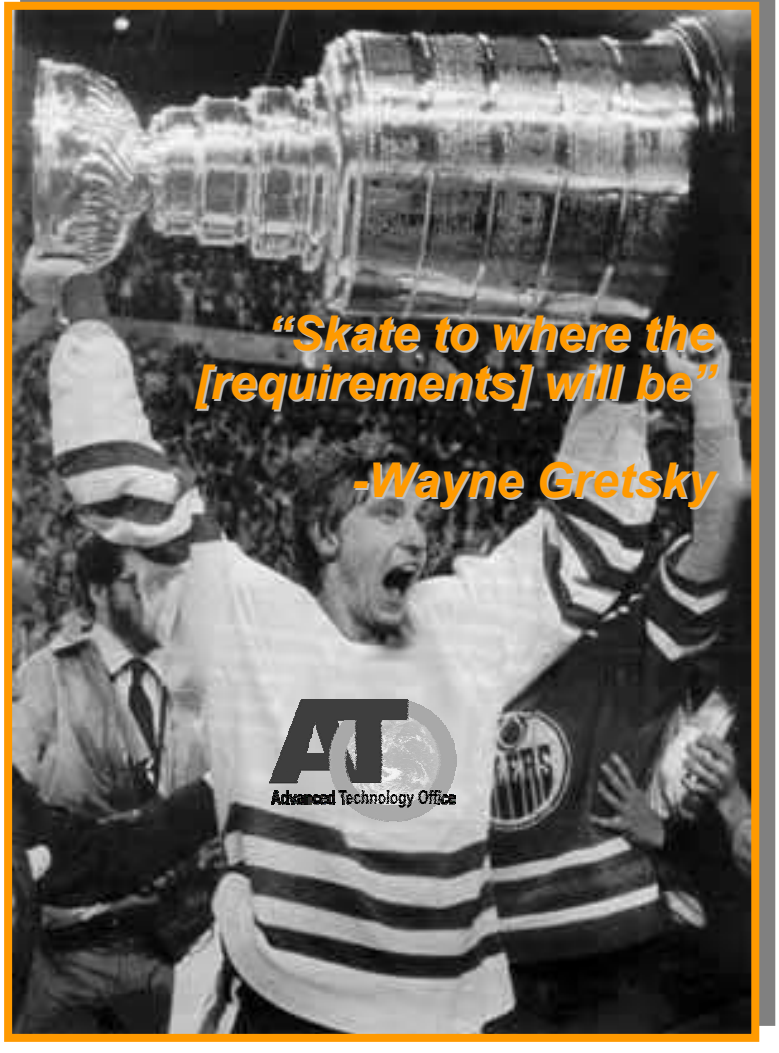
DARPA Mission

Innovation in Support of National Security

- **Solve National-Level Problems**
- **Enable Operational Dominance**
- **High Risk Technology Development, Exploitation -- *Avoid Surprise***

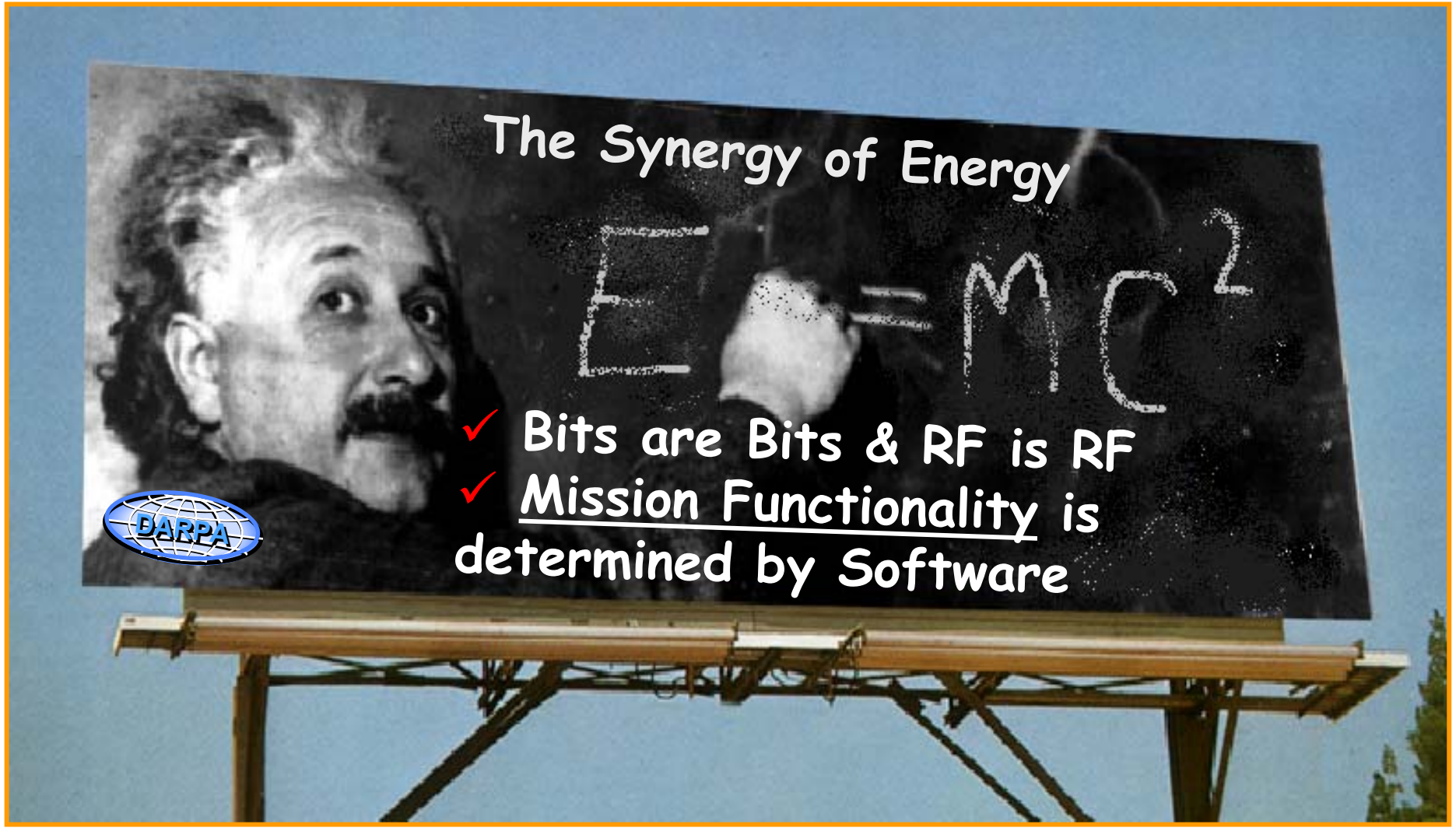
The Secret to Scoring





Think Differently!

Revolutionize the way we exploit RF

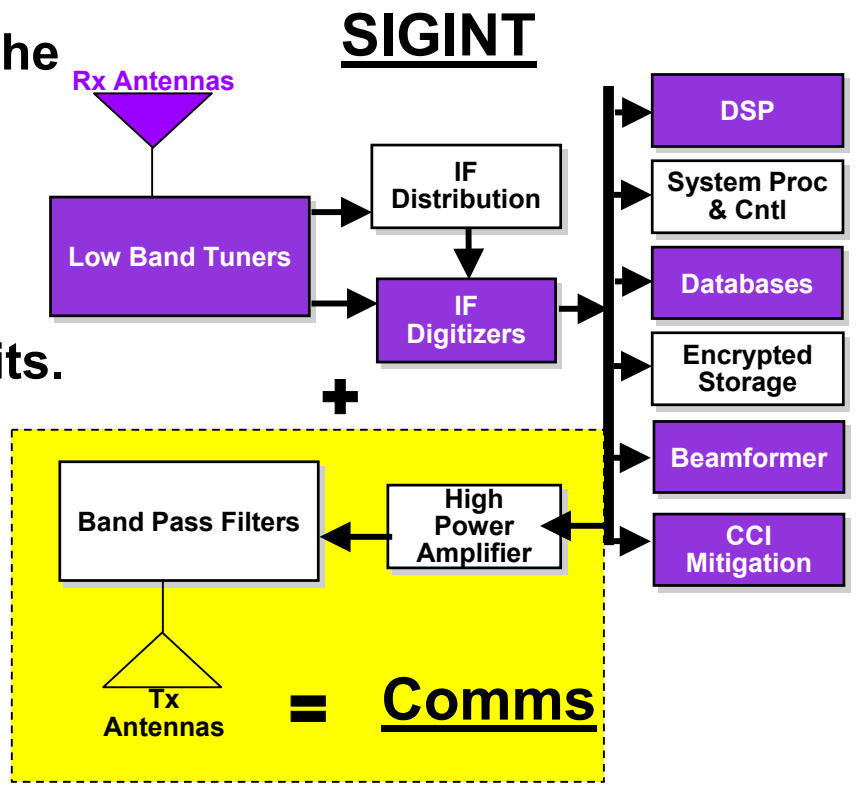


Exploiting all the RF Energy

Premise: As RF disciplines become digital the opportunity exists to exploit, completely, the information contained in the electromagnetic wave

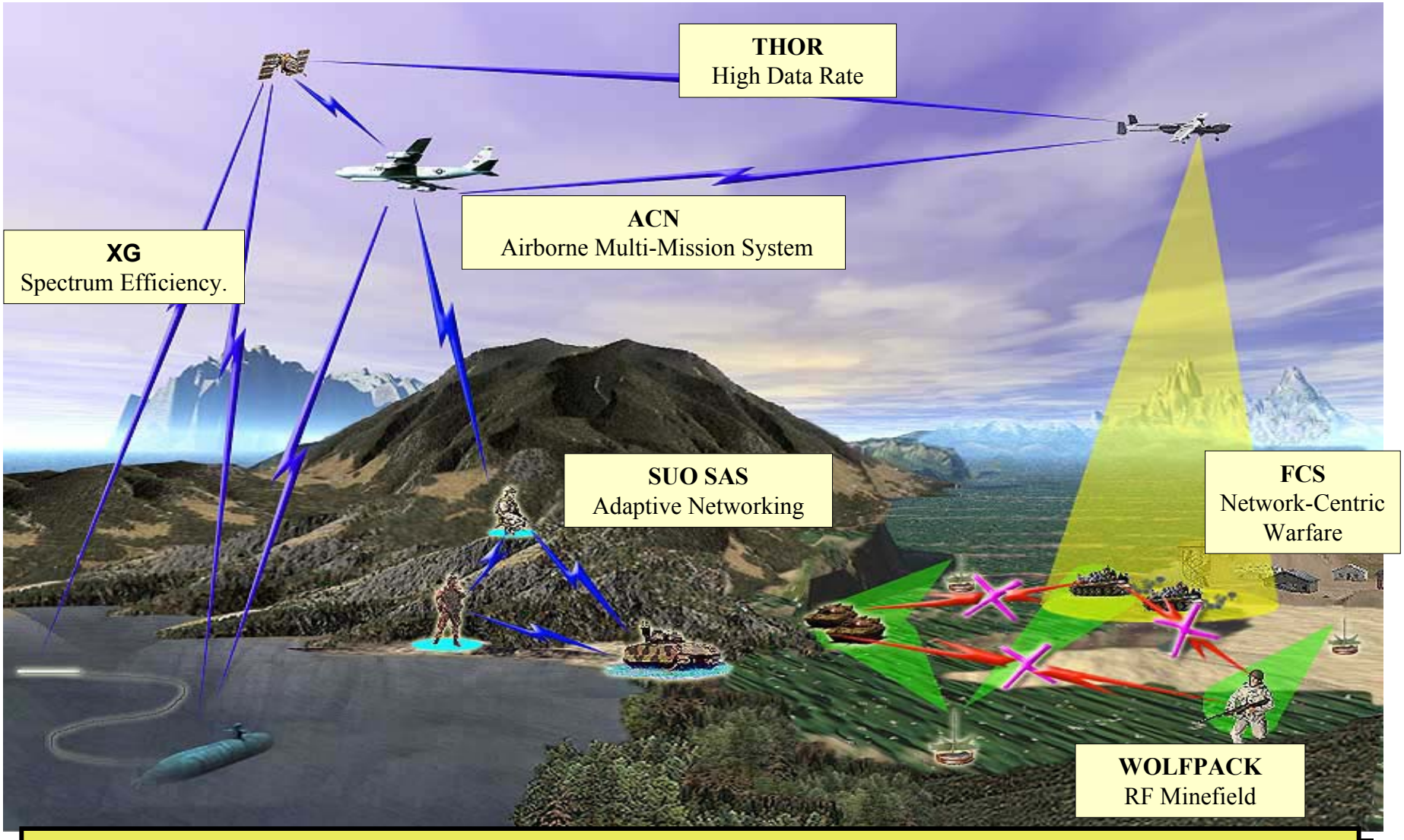
DARPA Philosophy: RF is RF. Bits are Bits. Fusion of Communications/SIGINT/EW/IW enabled by:

- Software definable radios
- MEMS Technologies
- High power amplifiers
- Broadband antenna advances
- Robust interference cancellation



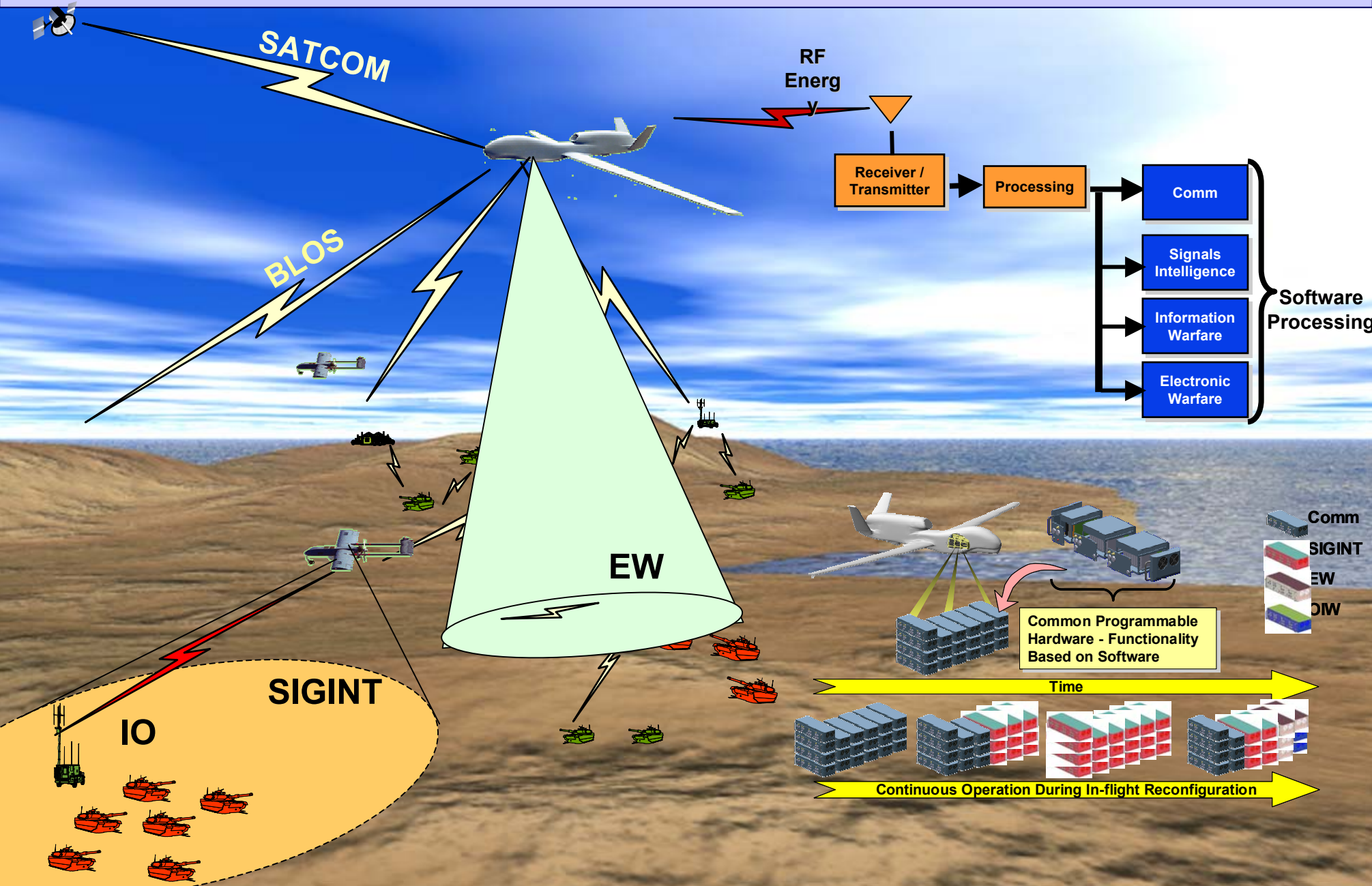
Multi-mission capability in a single system breaks down traditional stovepipes and makes interoperability straightforward

ATO Wireless Communications

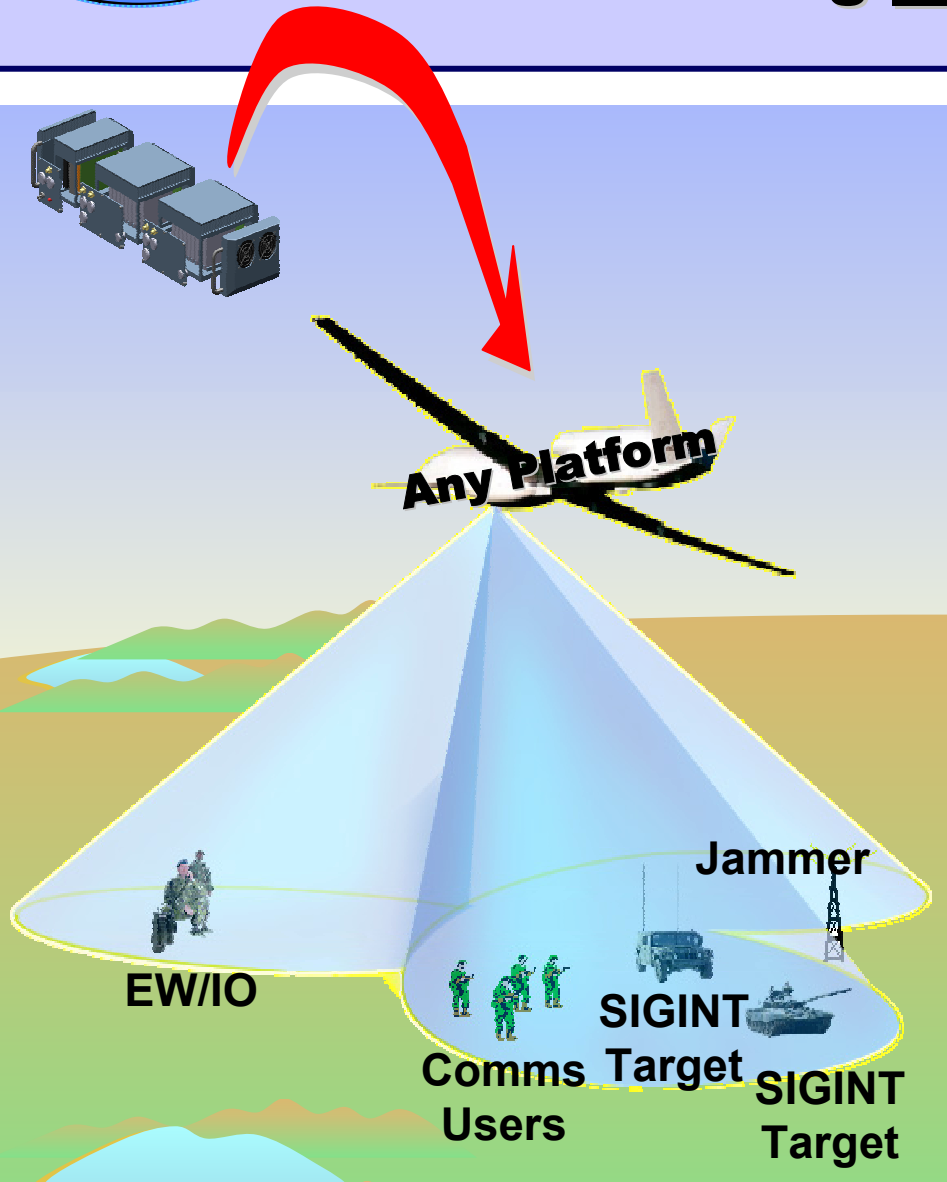


Assured communications anywhere in the world without infrastructure and zero setup time

ACN Concept 2000-2002



ACN: A Single System Servicing Many Missions



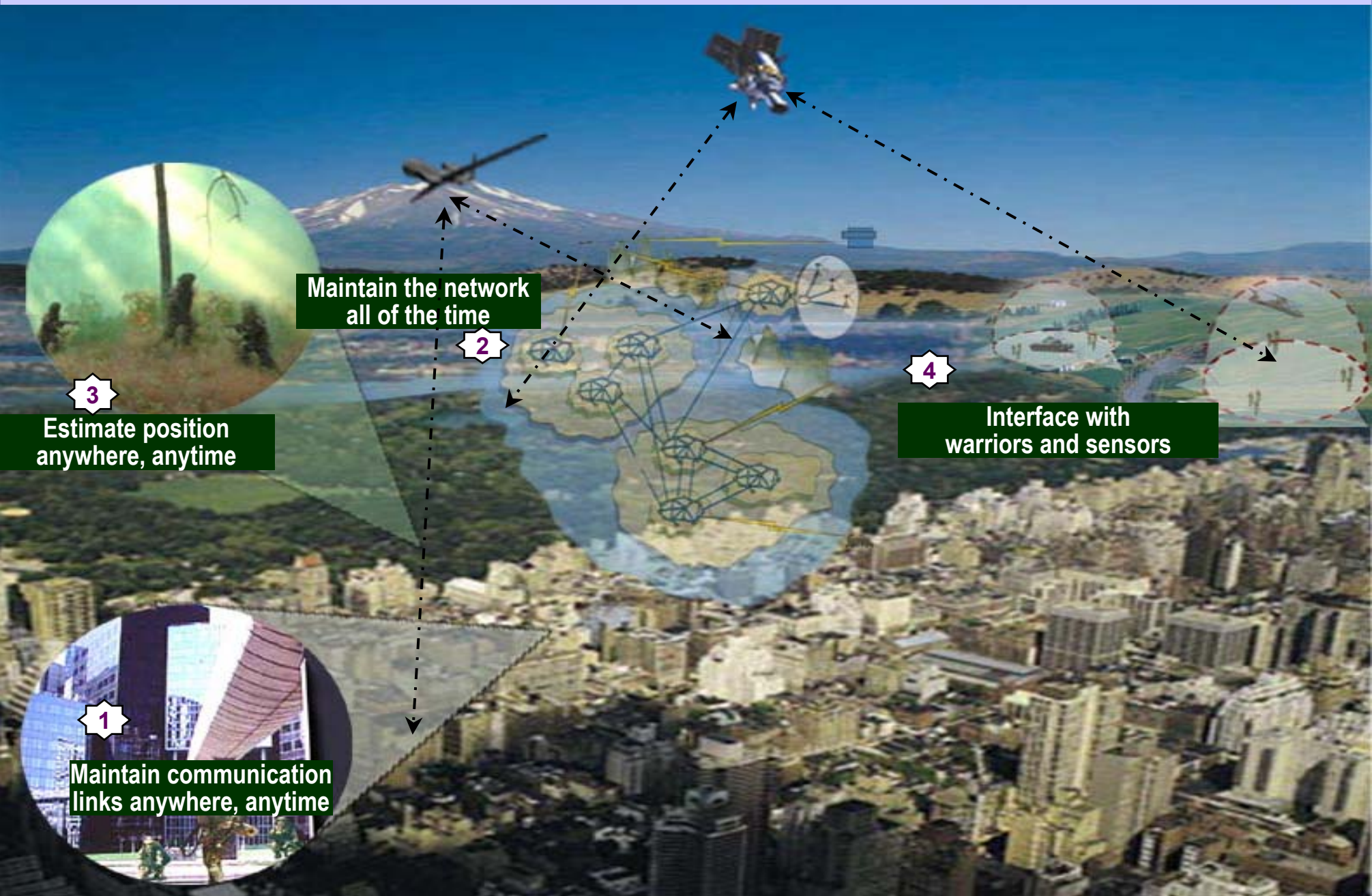
Approach

- Develop a Real-Time Programmable, Platform Agnostic, Multi-Mission (Communications, SIGINT, EW & Electronic Attack) Payload
- Develop, Mature & Demonstrate Technologies Necessary to Implement the Design.
- Demonstrate End-to-End System Design in Laboratory

Top Technical Challenges

- Simultaneous Multi-Mission Operation
- Scaleable Size,Weight, and Power - Modular/Scaleable Design Supporting Integration on Multiple Platforms (25 lbs. to 900 lbs.)
- Co-Channel Interference Mitigation/Jamming Mitigation
- Autonomous Mobile Ad-Hoc Networking
- Information Assurance - Robust Operation Against Jamming and Intrusion

Small Unit Operations Situation Awareness System Program



SUO SAS Concepts

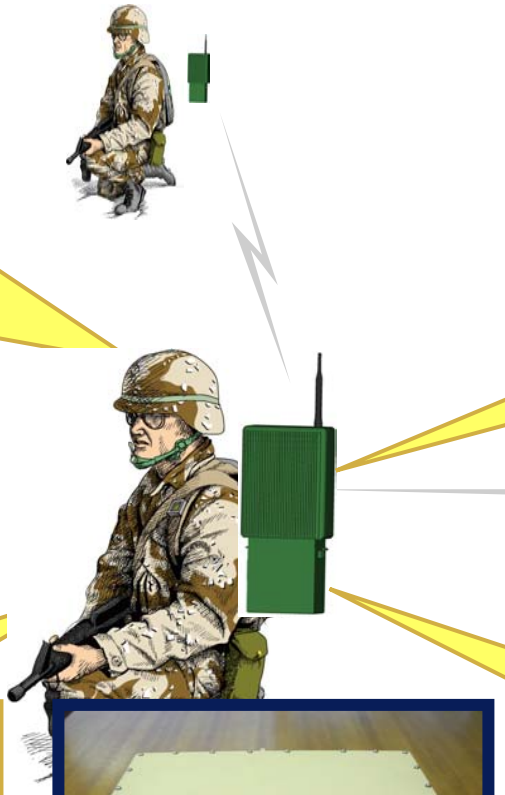
Develop secure, robust communication and information management prototype to enable information superiority for *individual warfighter*

Highly Adaptive Radio

- Extreme Frequency Agility (20 MHz – 2,500 MHz)
- Data Rate (up to 2 Mbps)
- AntiJam, Low Probability of Detection

Mobile, AdHoc, Peer-to-Peer Networking

- Mobile Networking
- Scaleable to 10,000 entities
- Voice and Data Transmission



Precision Navigation without GPS

- Radio ranging inside buildings, urban canyons etc. without GPS
- 2m range precision in 3D

SUO SAS is Built!

Distributed Information Management

- Data/Voice to Groups managed by organization, tasks, and position
- Situational Awareness Data (Red and Blue) filtered by organization, tasks, position and threat status

FCS-Communications

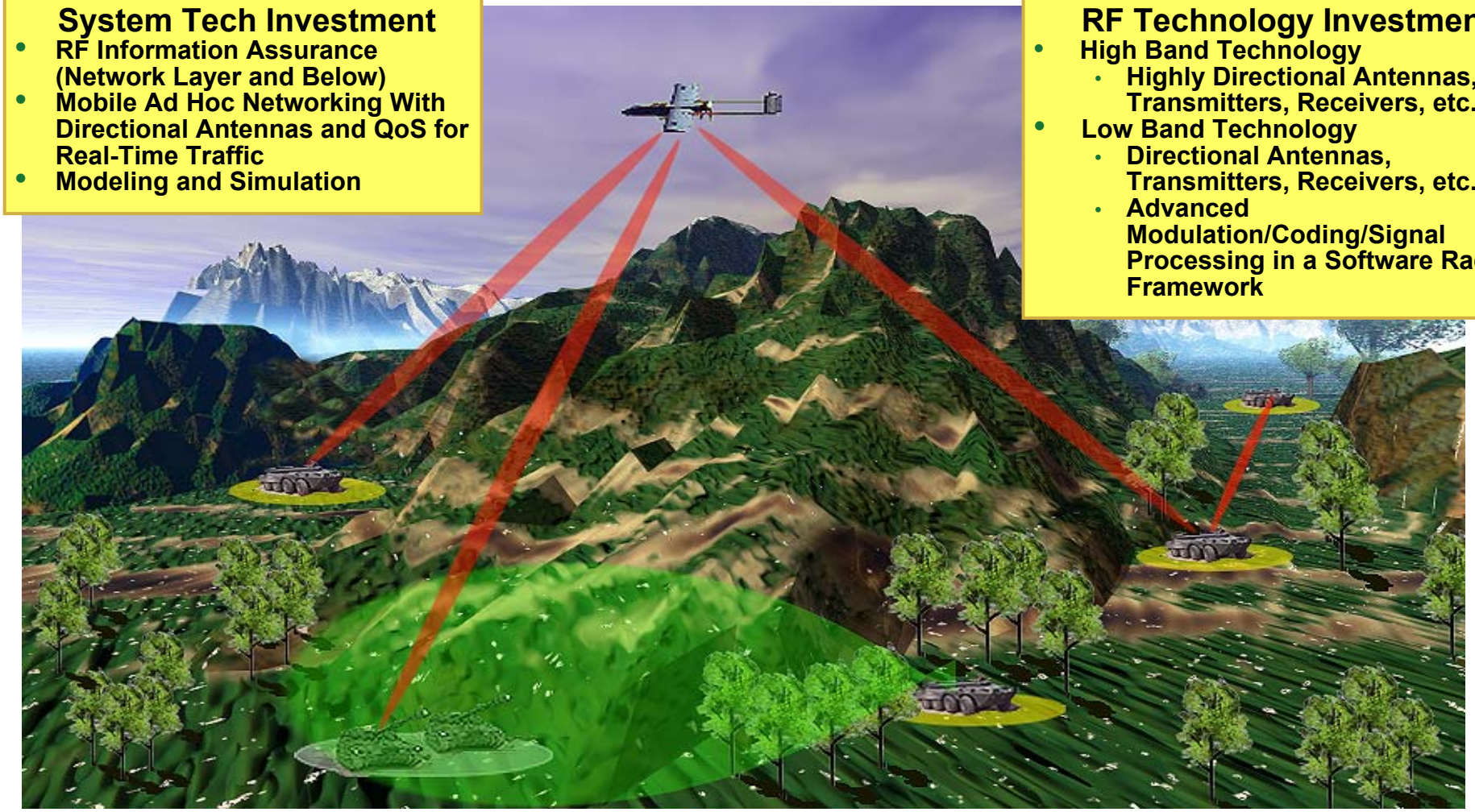
Assured communications for Army Future Combat System

System Tech Investment

- RF Information Assurance (Network Layer and Below)
- Mobile Ad Hoc Networking With Directional Antennas and QoS for Real-Time Traffic
- Modeling and Simulation

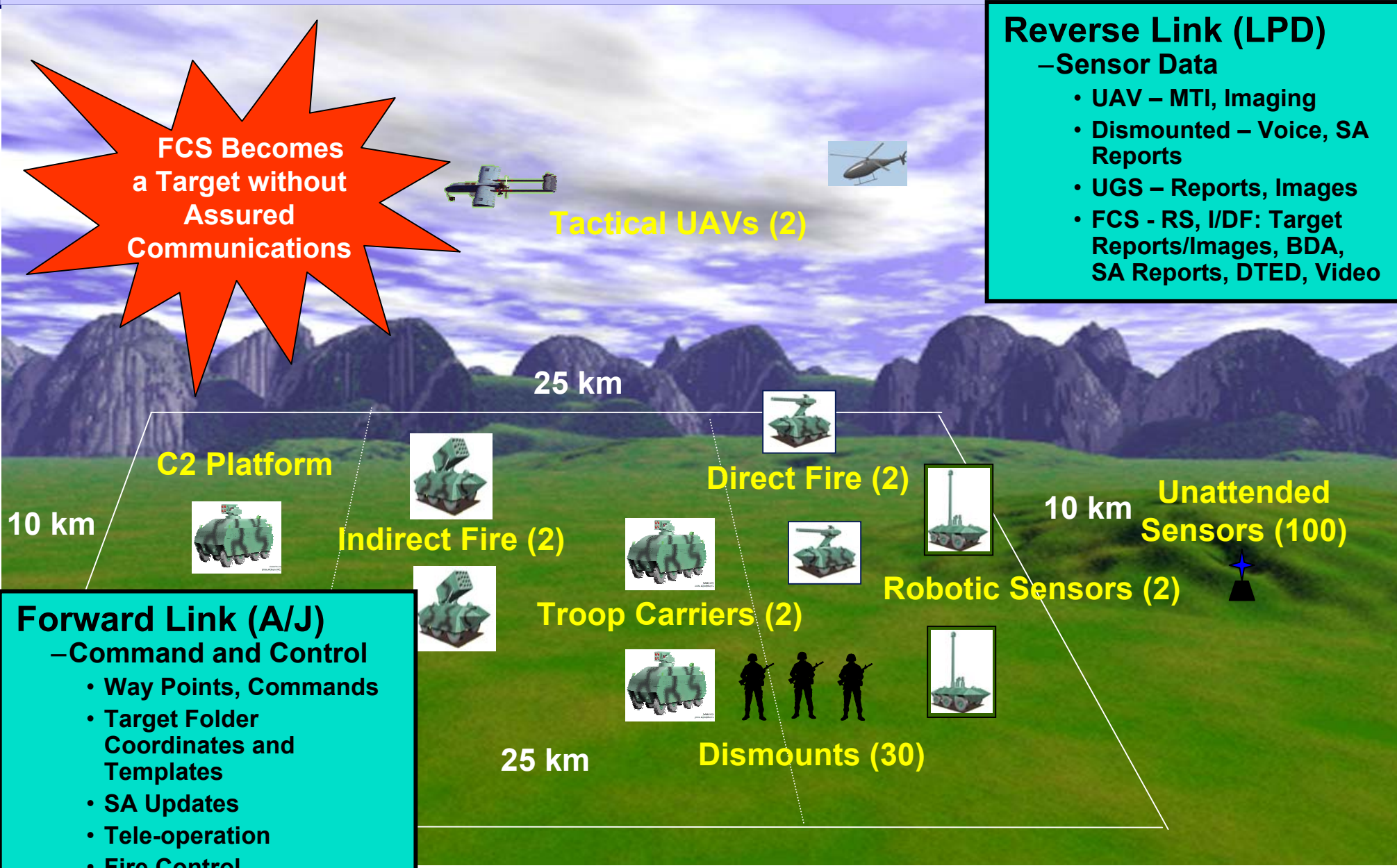
RF Technology Investment

- High Band Technology
  - Highly Directional Antennas, Transmitters, Receivers, etc.)
- Low Band Technology
  - Directional Antennas, Transmitters, Receivers, etc.
  - Advanced Modulation/Coding/Signal Processing in a Software Radio Framework



Enabling Network-Centric Warfare

Future Combat Systems
Notional Cell Communications Traffic Attributes



Reverse Link (LPD)
- –Sensor Data
  - UAV – MTI, Imaging
  - Dismounted – Voice, SA Reports
  - UGS – Reports, Images
  - FCS - RS, I/DF: Target Reports/Images, BDA, SA Reports, DTED, Video

Forward Link (A/J)
- –Command and Control
  - Way Points, Commands
  - Target Folder Coordinates and Templates
  - SA Updates
  - Tele-operation
  - Fire Control

WolfPack Program Vision

Close, Distributed, Networked RF Spectrum Dominance

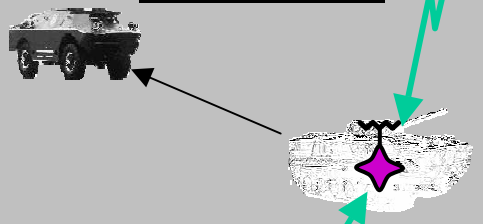
Advanced Technology Office

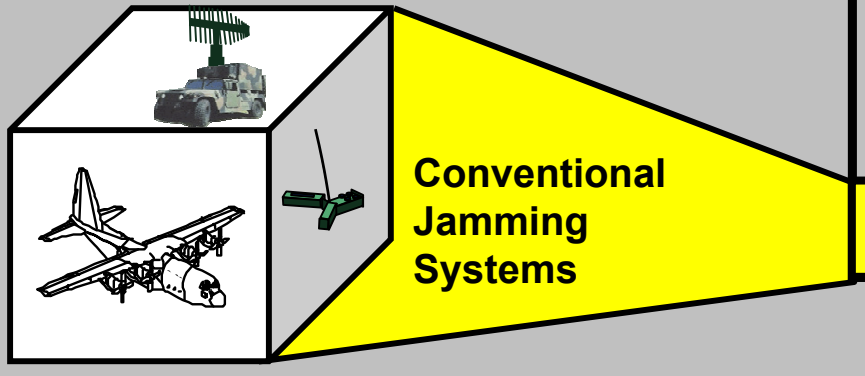
Precision...

Detection

Denial

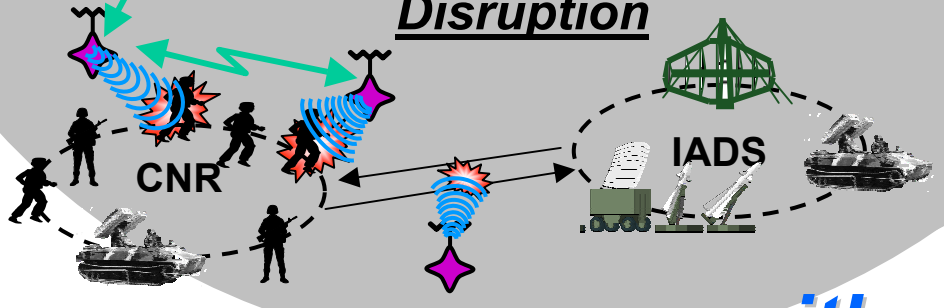
Deception





Conventional Jamming Systems

Disruption



Communication Service Layers

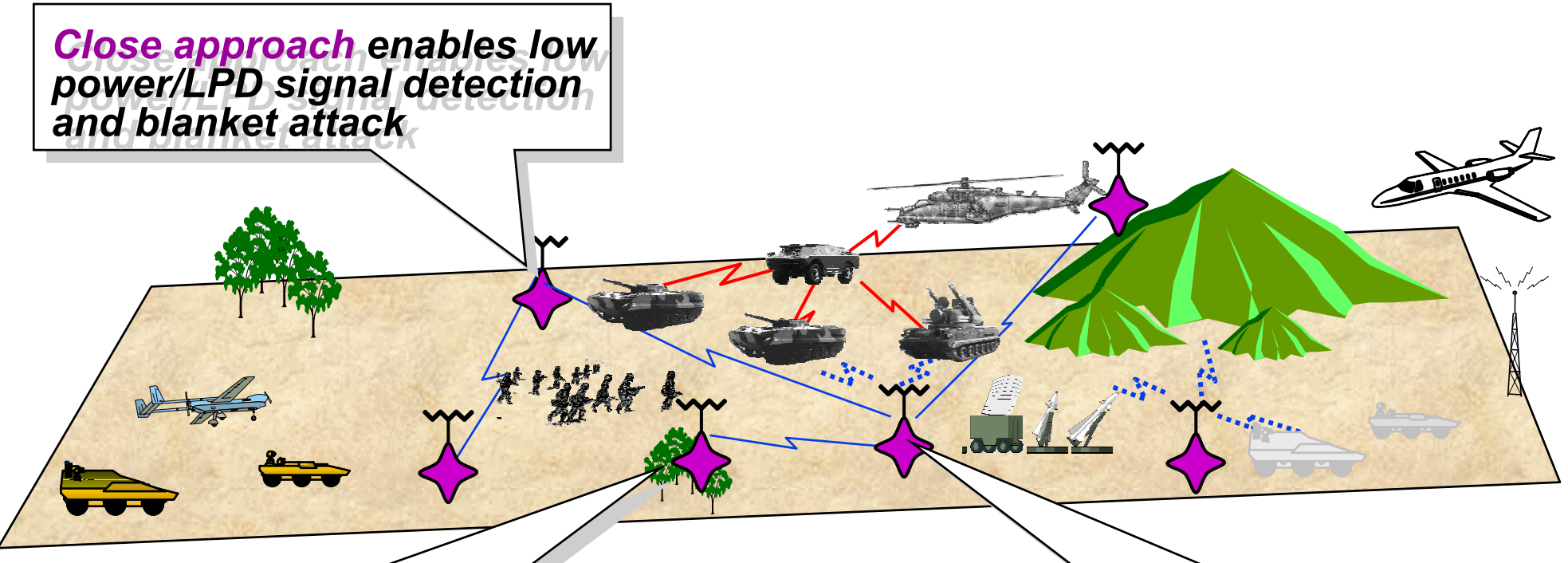
Application
Presentation
Session
Transport
Network
Data Link
Physical

"The Challenge"

- Develop technology enablers
- Implement innovative techniques

...with no Fratricide!

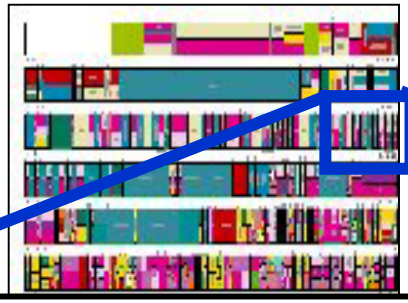
WolfPack
Operational Concept

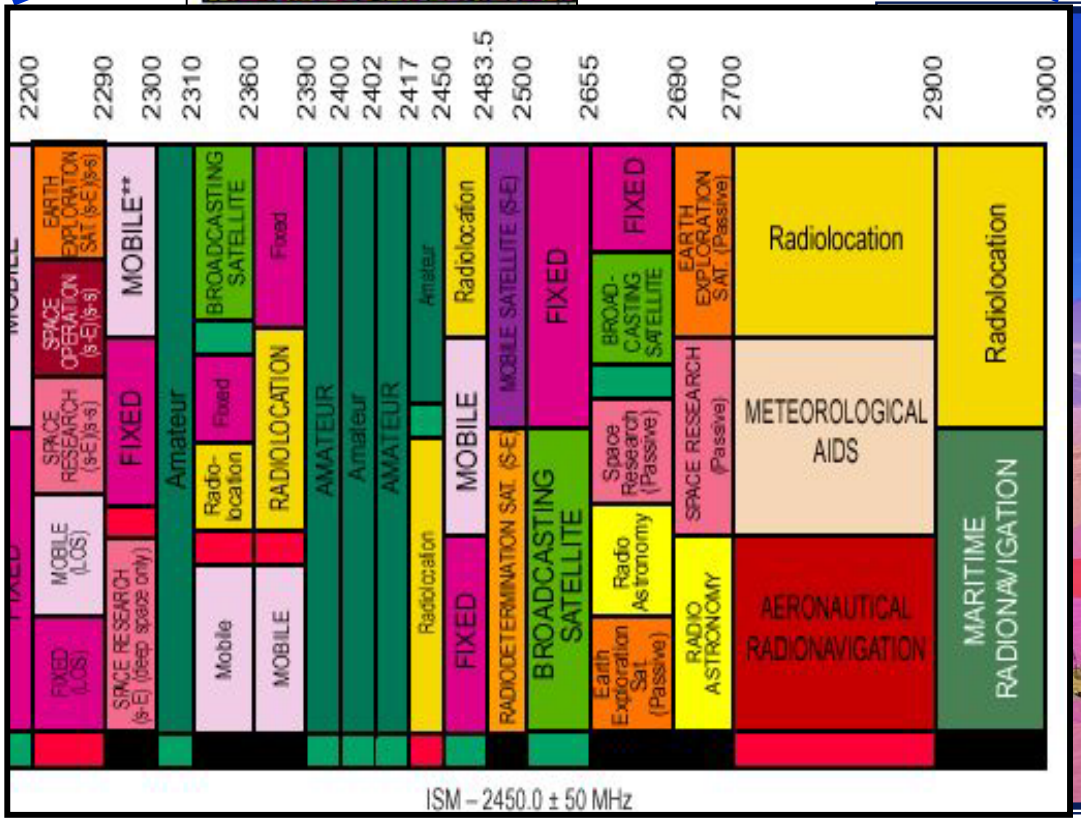


WolfPack Technology responds to advanced LPD/LPI, Packet Network Radios

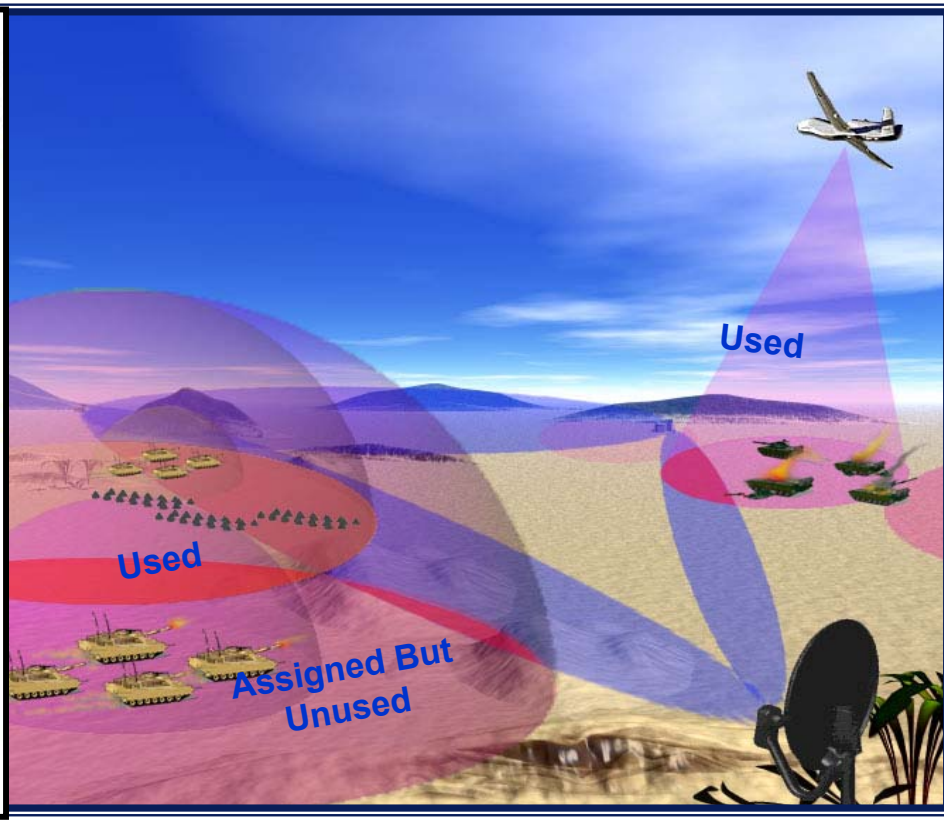
neXt Generation (XG) Communication Program

TODAY: **Spectrum statically allocated**

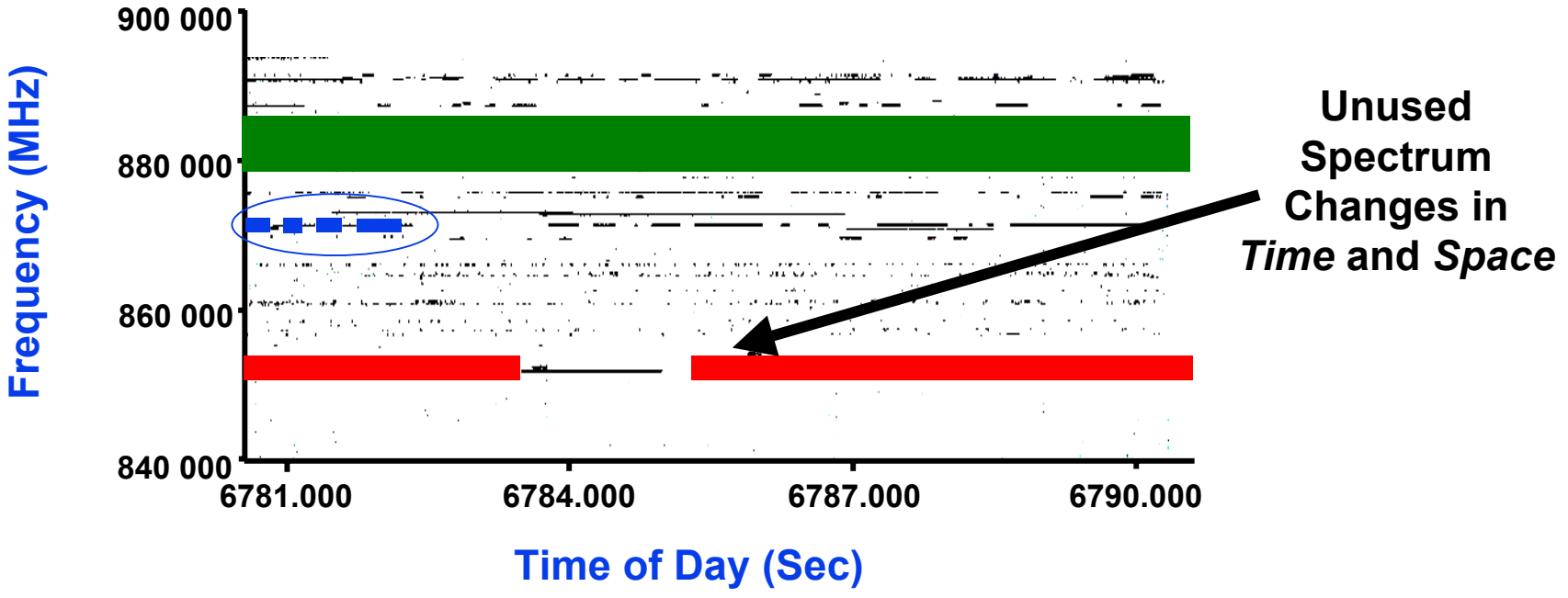




FUTURE : **Dynamically allocating spectrum in frequency, space, and time may improve utilization by a factor of 10**

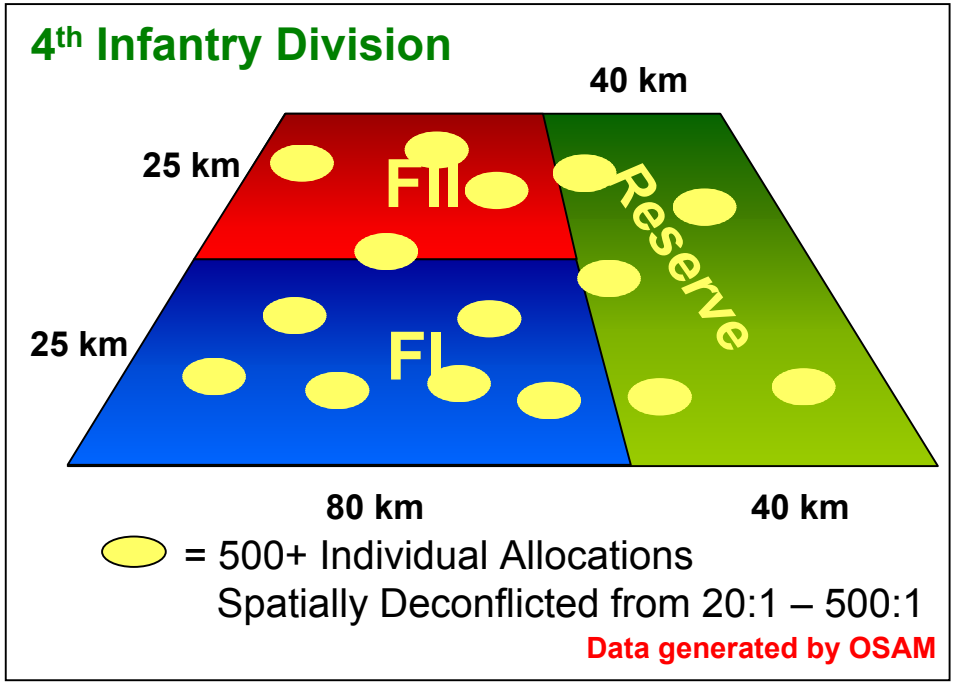


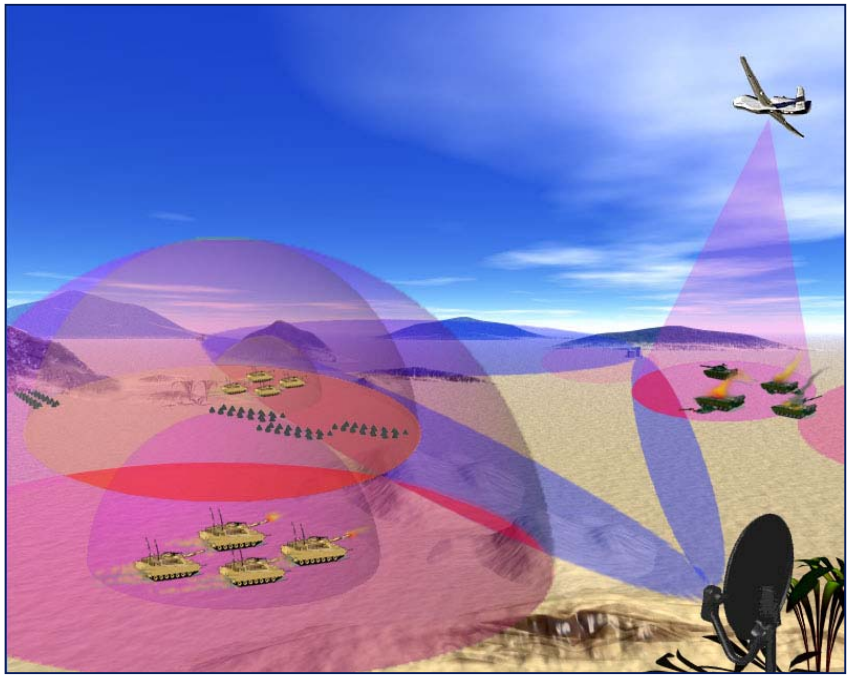
XG Initiative



- **Develop both the Enabling Technology and the System Concepts to *Dynamically* Allocate Spectrum**
  - **Improve Efficiency (<<1 %) of Current, Static Allocations to voice and data by a Factor of 20 (as measured by MHz km^2)**
  - **Provide Capability to Share Spectrum with Other Providers**

XG Spectrum Planning





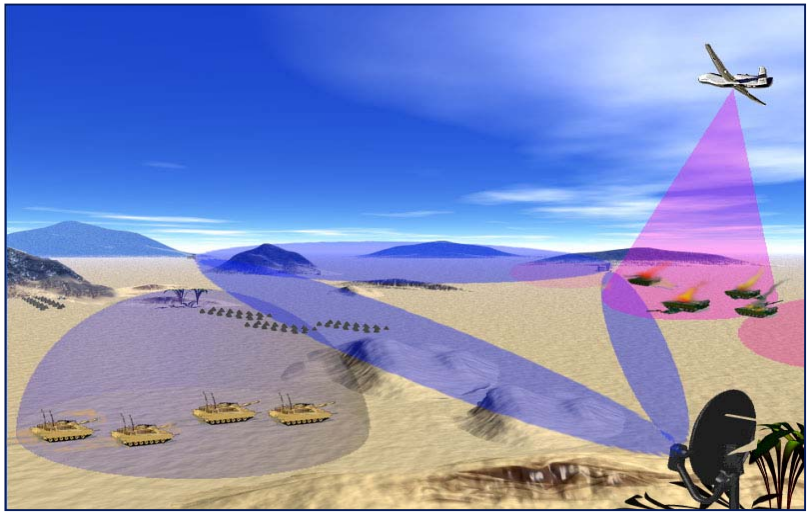
Current War Plans incorporate J-12 Input on Spectrum Allocation that is *Static* for the "Entire" Theater

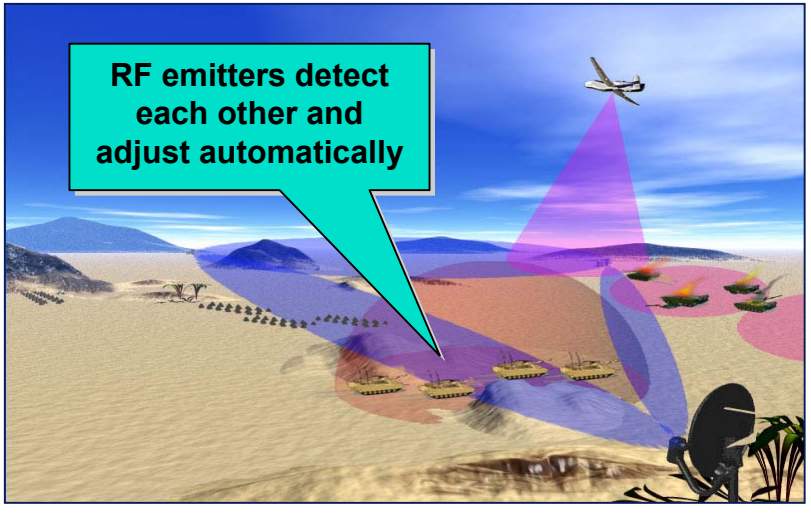
- **Allocations are Made to be Risk Adverse**
  - **99.9% Allocation Reliability**
  - **97% Connection Reliability**
- **Planning can Take up to Months to Deconflict**
  - **e.g. Naval Group will use Same Allocations for 6 Month Deployment**

XG Technology Challenges

Predict or React to the Available Spectrum through Dynamic MAC Layer …

… Invest in Heterogeneous, Wideband MAC Subsystems



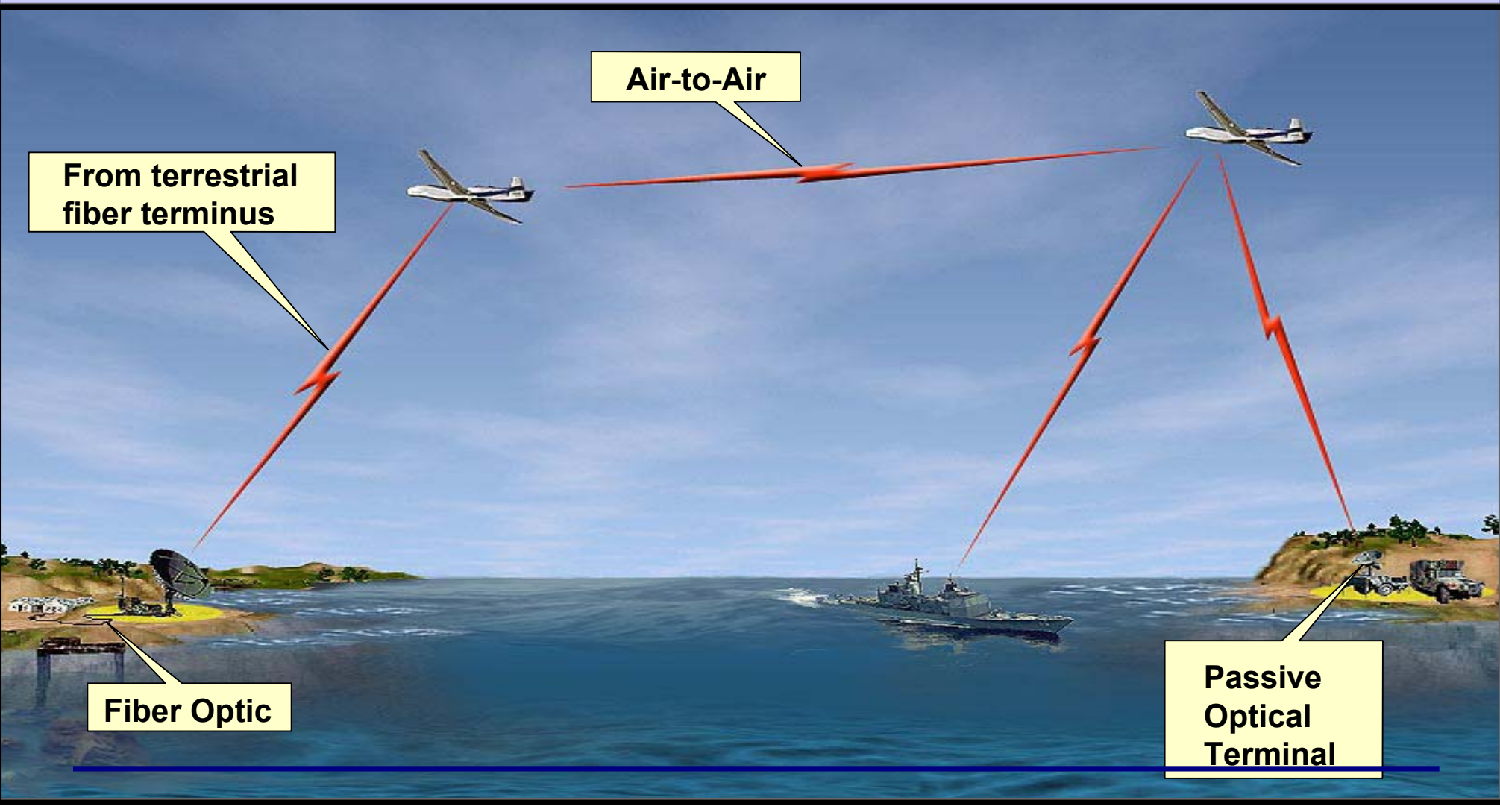


Either Move in Frequency or Become Malleable …

… Invest in multiple time-frequency agile waveforms

XG Requires Integration of New Control Techniques and Agile Waveforms That Balance Complexity and Capacity

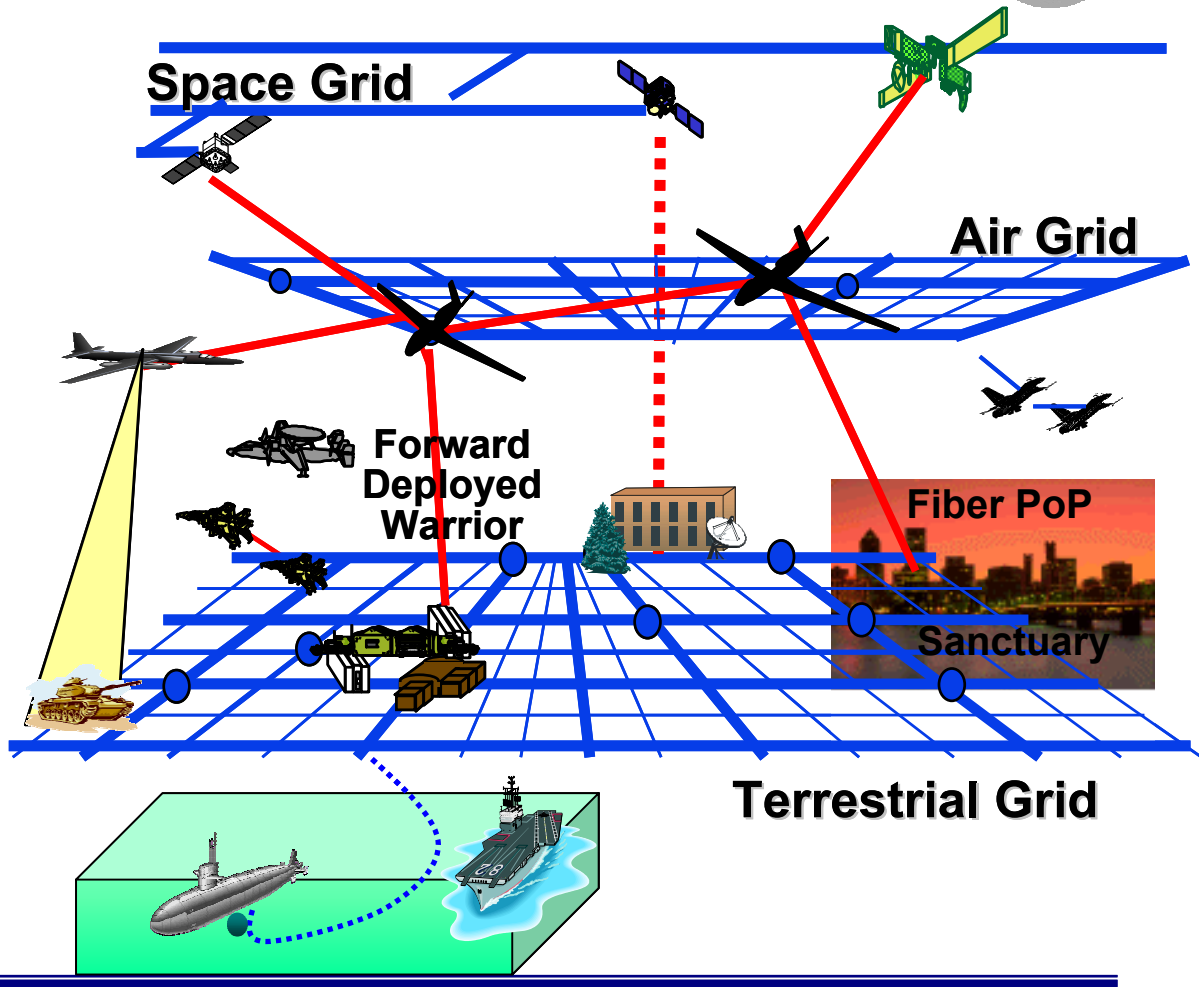
Tera-Hertz Operational Reachback (THOR)



Connect the warfighter, in theater, to the fiber optic infrastructure using mobile free space optical communications

Free Space Optical Communications

- Enable the Deployed Warfighther to enjoy the same level of connectivity that is enjoyed while not deployed
- Off load high demand and scarce space communications assets by exploiting connectivity via ubiquitous terrestrial fiber
- Complete the global grid by tying space-air-surface-subsurface platforms together



THOR Vision

"Fiberless Fiber" will complete the Global Grid and provide secure, assured, high data rate and end-to-end communications to airborne, terrestrial, surface, and subsurface warfighters by developing, integrating and demonstrating innovative optical system concepts and technologies.

Briefing Complete