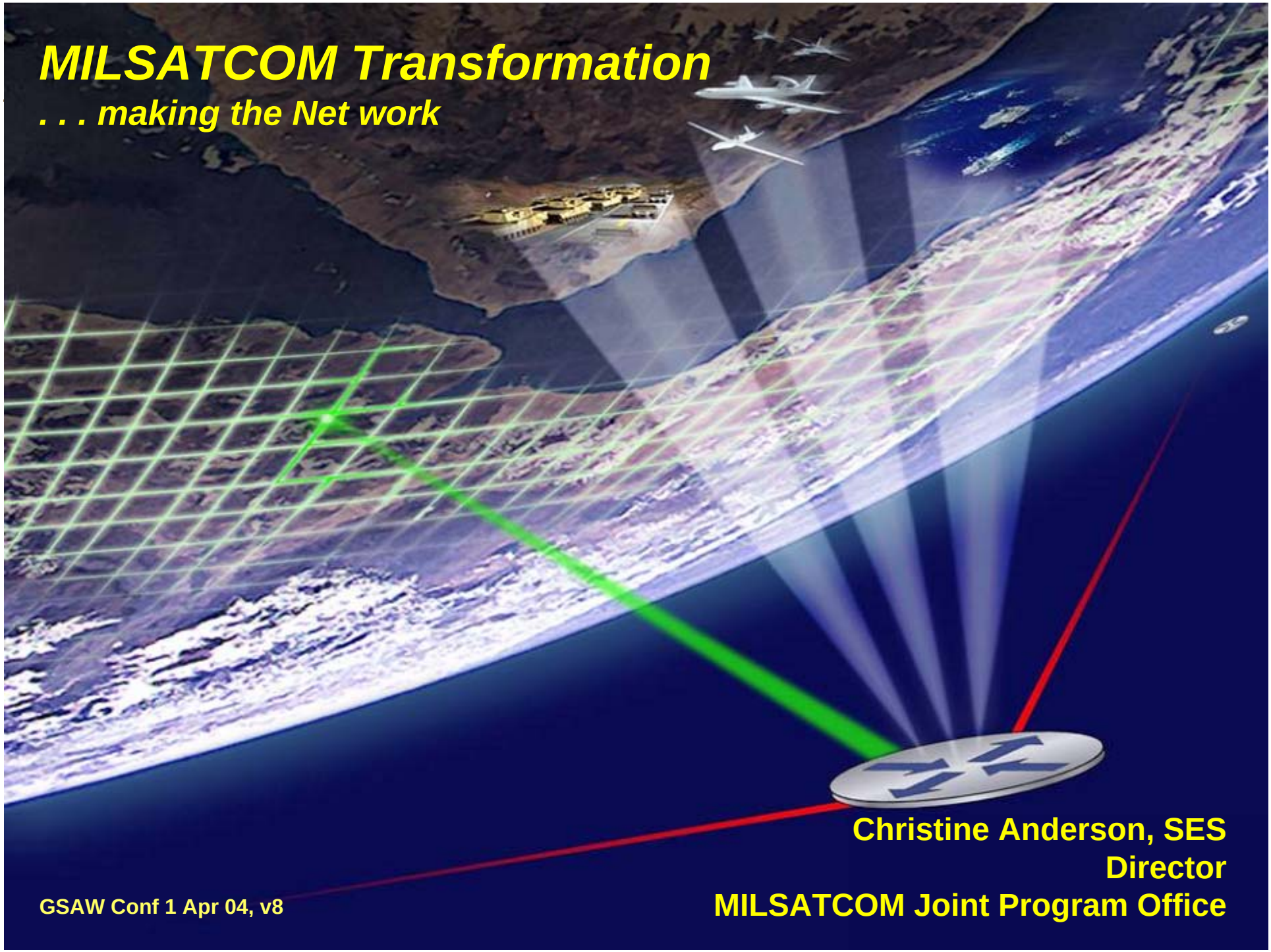
MILSATCOM Transformation

. . . making the Net work



Christine Anderson, SES
Director
MILSATCOM Joint Program Office

"Battlefield communications have gone through dramatic transformation over the years, perhaps more than any other military field. In fact, last Friday night, National Defense University paid tribute to one of my predecessors as Chairman, General Jack Vessey, who began his military career carrying secure dispatches on a motorcycle."

General Richard B. Myers
Chairman
of the Joint Chiefs of Staff
3 March 2004
on the occasion of the
Smithsonian National Air & Space Museum Trophy Award
to the Milstar Team

Military Satellite Communications

circa now -- 2010

Wideband

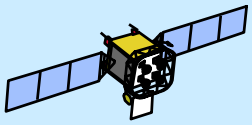
- DSCS
- WGS

- 5 Primary DSCS
- 5 WGS
- Augment w/commercial

Protected

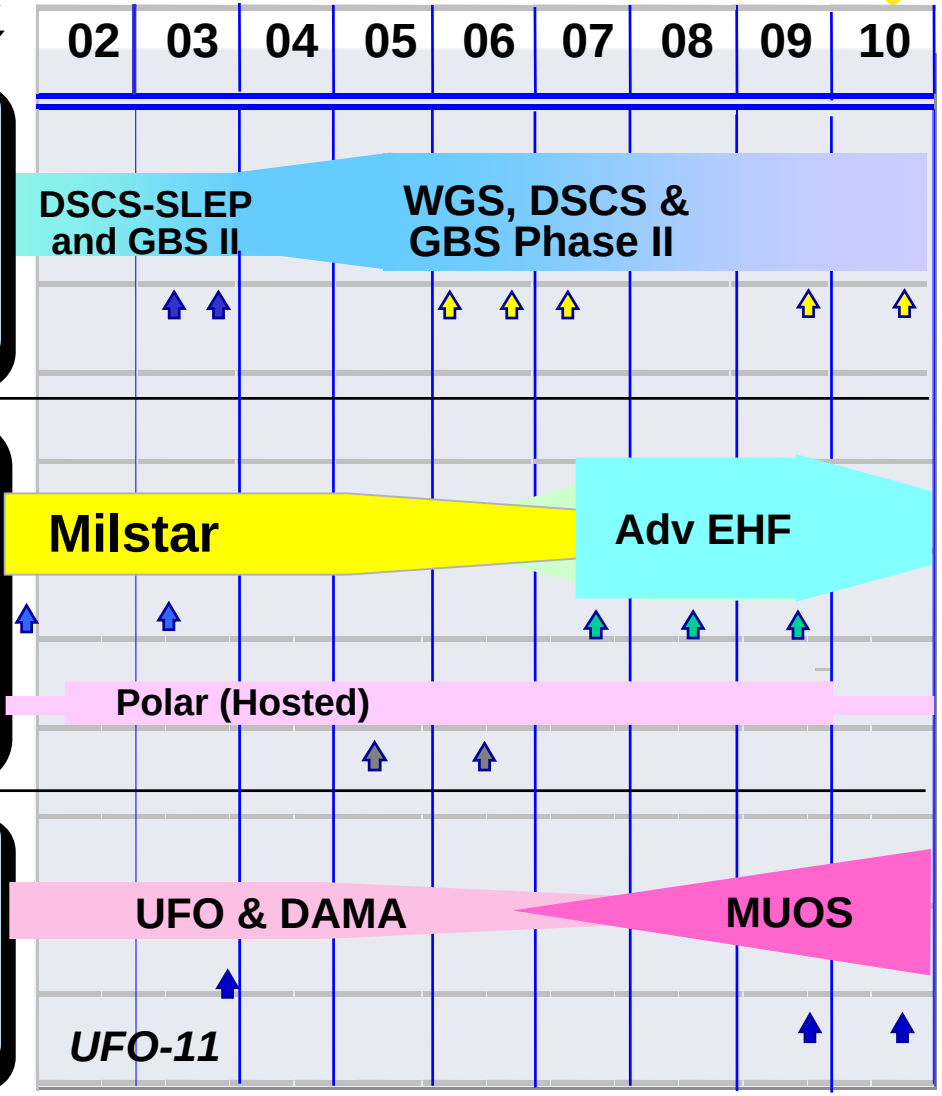
- Milstar
- AEHF
- Int Polar

- 5 Milstar
- 3 Advanced EHF
- Interim Polar 2, 3, & 4 (TBD)



Narrowband

- 10 UFO
- 5 MUOS



Military Satellite Communications

circa now -- 2010

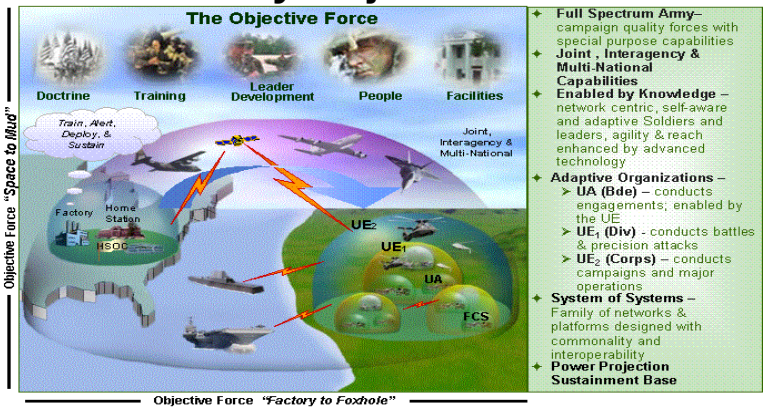
SATCOM	1994 MS I *EHF LDR*	2001 Milstar II *EHF MDR*	2007 AEHF *EHF XDR*
 **Visible Image*** 8x10 image 24 Mbytes	22.2 hr	2 min	24 sec
 **Radar Image** Global Hawk* (120 Mbytes) SBR* (1 Gbytes)	110 hr 880 hr	12 min 88 min	2 min 17 min
 Comm On The Move*	No Service	No Service	18 Links 64 kbps

* Terminal Developments Required

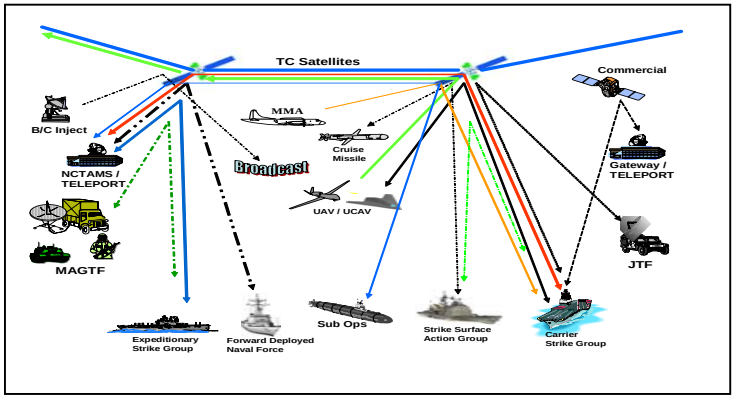
Circuit based / RF systems have served us well but . . .

The Challenge

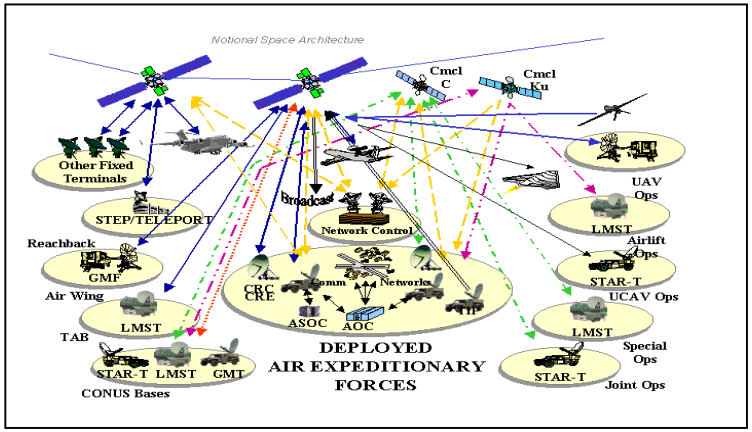
Army Objective Force



Navy SeaPower 21



AF Air Expeditionary Force



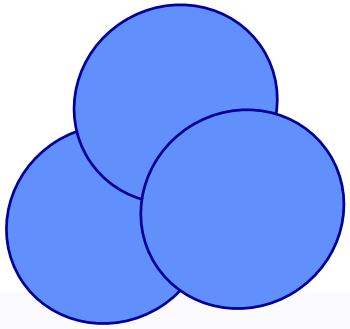
All Service Visions require more communications connectivity and capacity

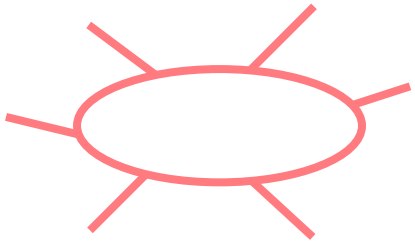
Transformation to Net-Centric Ops

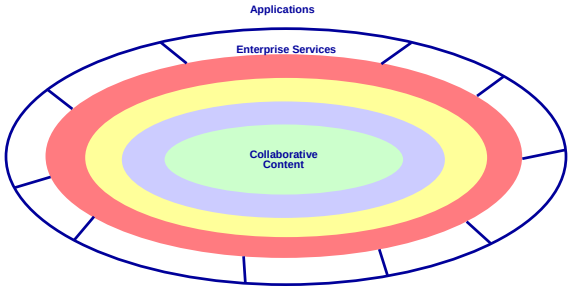
C4ISR Net-Centric Integration

Net-Centric Infancy

System-of-Systems







1995 **2003** **2010** **2015**

CONOPS Transition

Transformational Communications Architecture (TCA)

Post-Gulf Architecture

Cold War Imperatives

Desert Storm

Pressures for Transformation

Operation Iraqi Freedom

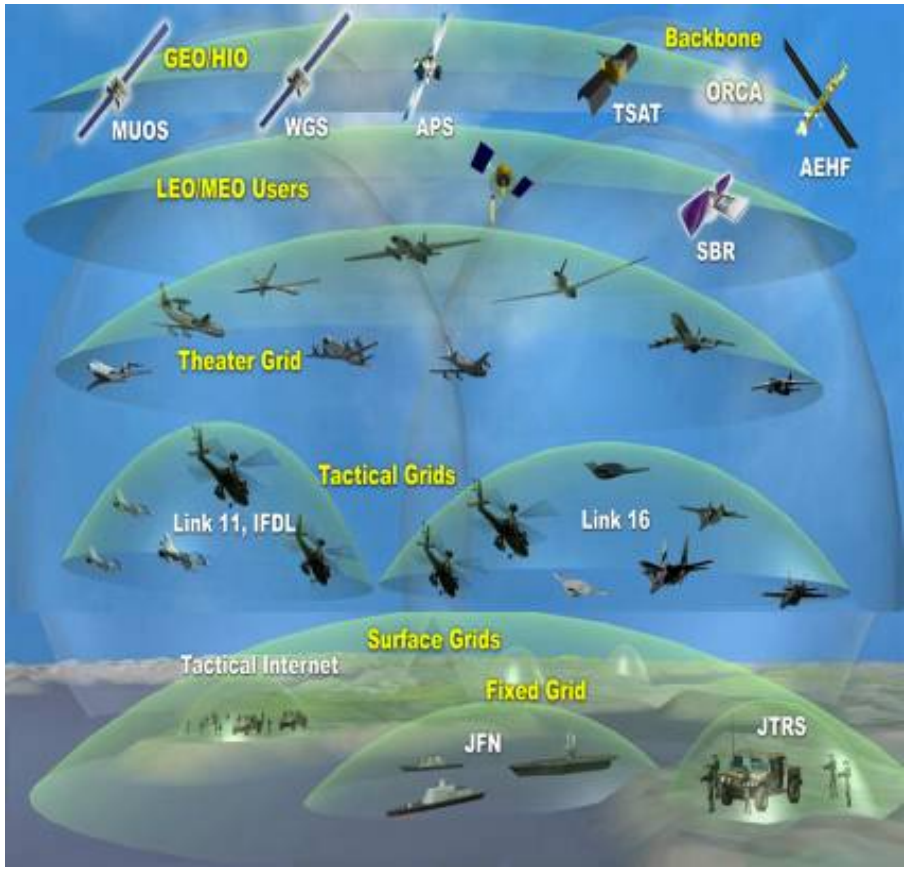
Static **Static/Dynamic** **Dynamic**

Transformational Communications Architecture (TCA) Vision

An internet-like transport architecture between space, air and ground nodes

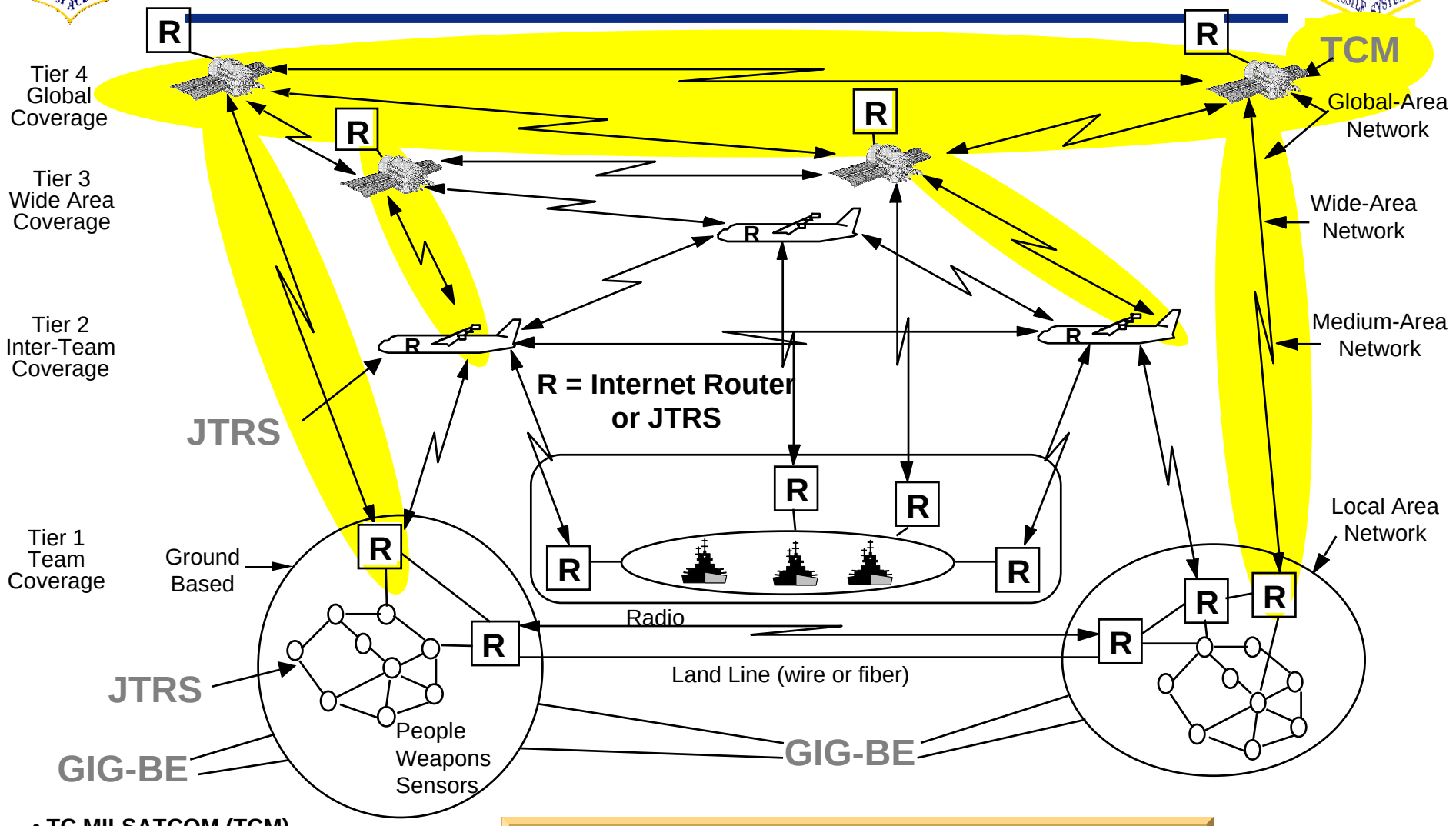
- Integrated Space, Air and Ground Networks
- Global access to deployed / mobile Users (COTM)
- Timely delivery of air and space data to Theater and CONUS (AISR, SISR support)
- Automated, dynamic, high assurance network operations
- Increased capacity and connectivity: RF and laser communications network

Network of Networks



Enable Future Innovations and Growth Through A Flexible Yet Secure Network Architecture

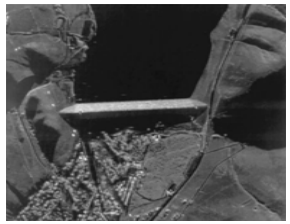
Global Information Grid (GIG) Transport Layer



- **TC MILSATCOM (TCM)**
- **GIG-Bandwidth Expansion (GIG-BE)**
- **Joint Tactical Radio System (JRTS)**

Build the Net

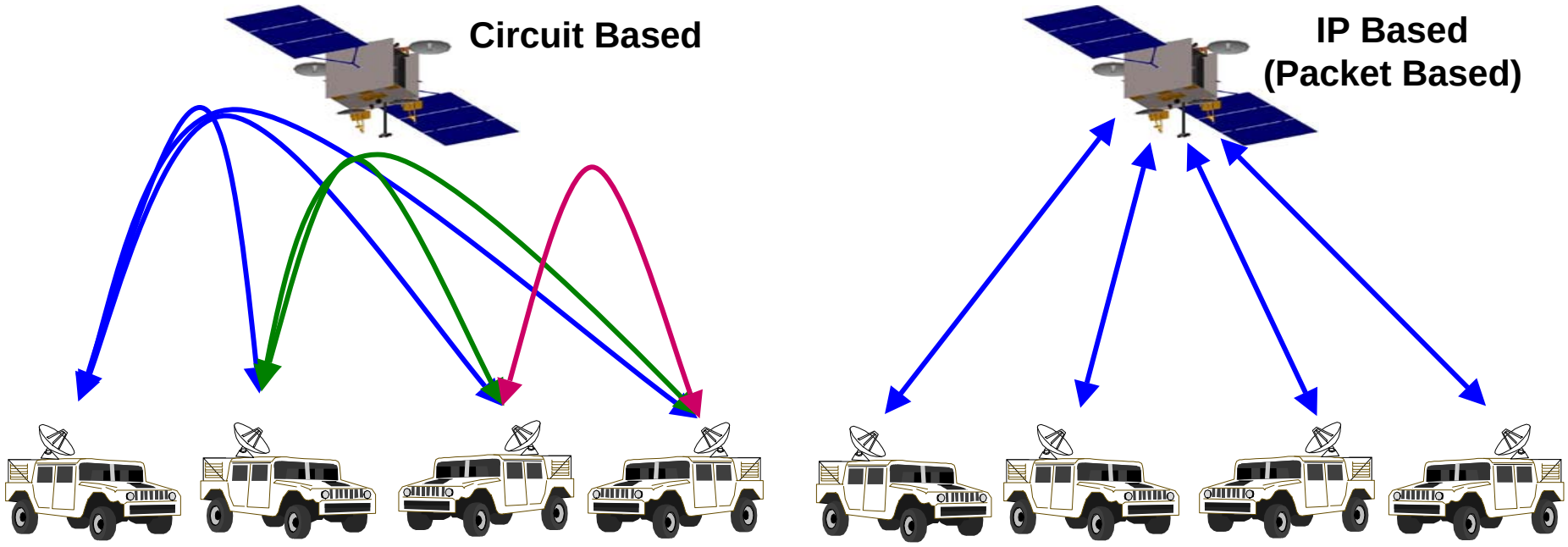
TCM Capability Impacts

SATCOM	1994 MS I *EHF LDR*	2001 Milstar II *EHF MDR*	2007 AEHF *EHF XDR*	2011 TSAT *EHF XDR+*
 **Visible Image*** 8x10 image 24 Mbytes	22.2 hr	2 min	24 sec	<1 sec
 **Radar Image** Global Hawk* (120 Mbytes) SBR* (1 Gbytes)	110 hr 880 hr	12 min 88 min	2 min 17 min	<1 sec
 **Comm On The Move***	No Service	No Service	18 Links 64 kbps	1,500 Links 1' antenna 1.5 Mbps

* Terminal Developments Required

Facilitates Shorter Kill Chain

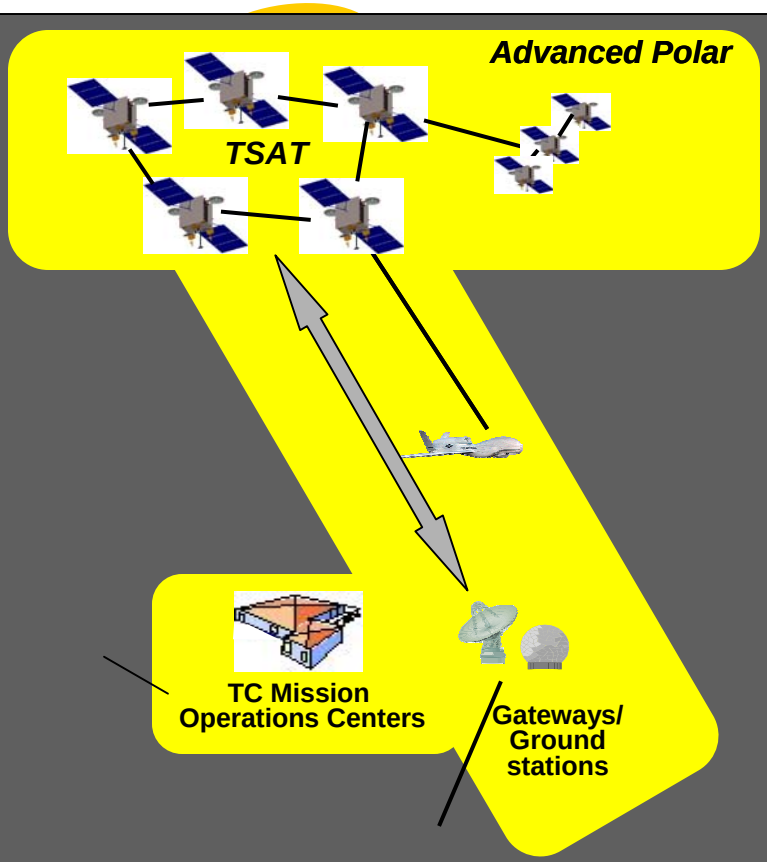
Connectivity



- Circuit Model
  - Point-to-point circuit for each connection
  - Double hop to connect hubs
- Internet Protocol (IP)
  - Single circuit to satellite provides ubiquities connectivity
  - Simplifies mission planning

IP enables the right packet to transit the right satellite, on the right antenna, with the right quality, to the right User!

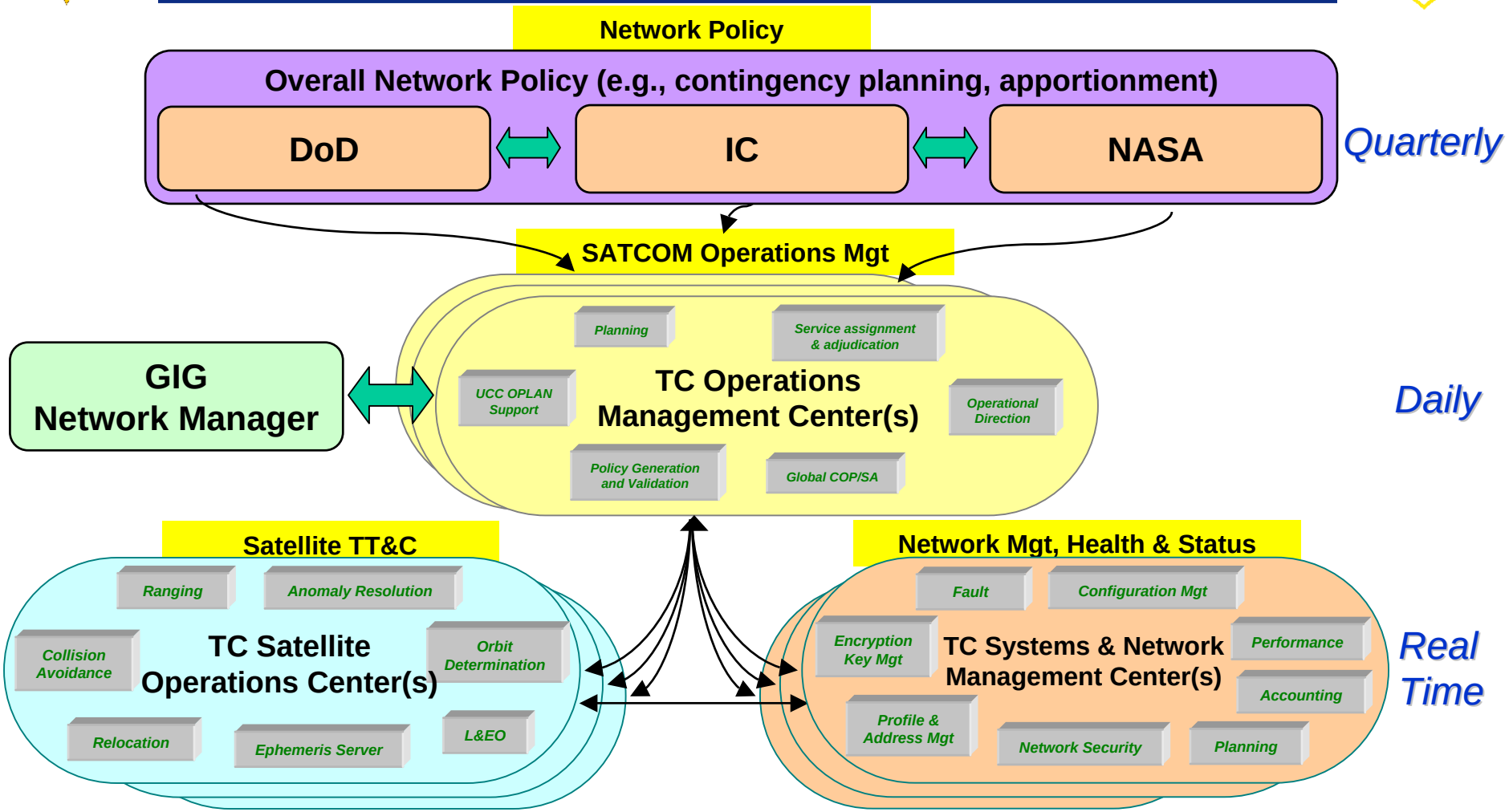
TC Architecture Circa 2015



Plus SE&I Support

AF TC Acquisitions

TC Network Management



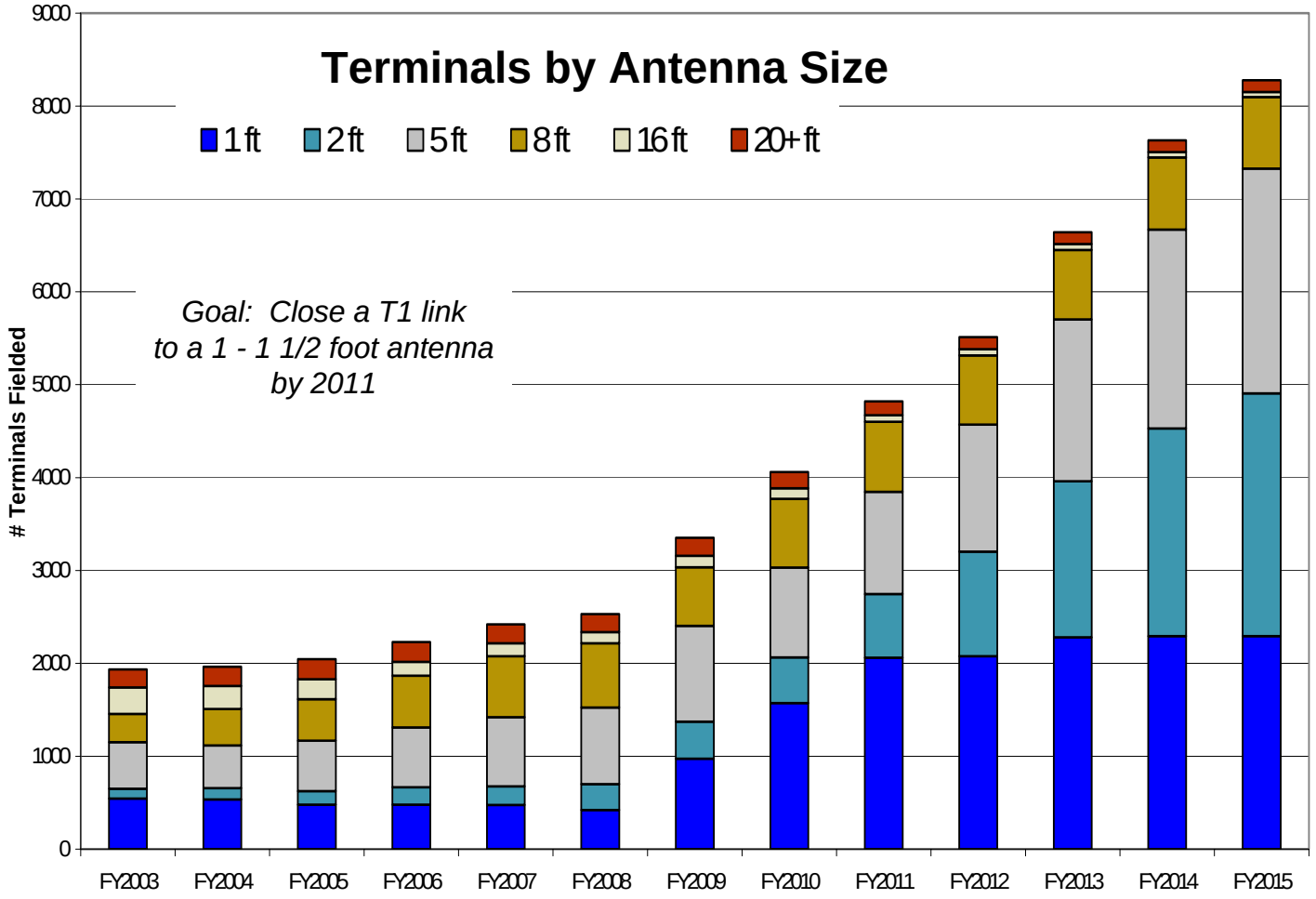
From Policy to Action in Real Time

TC Network Software Functionality

- **Policy Management Implementation**
  - **Provides the specific TCM software to implement the policy management protocols used by the GIG for the TCM system**
- **Network Management Reporting**
  - **Provides commercial standards based data and control plane interfaces to commercial / terrestrial tools and equipment**
- **SATCOM Management**
  - **Controls the satellite's payload configurations, operations and fault responses**
- **Mission Planning**
  - **Provides the mission planning tools to determine satellite resource allocations for the space portion of the network**
- **SATCOM Key Management**
  - **Provides software for "over the air" distribution of TRANSEC keys**

SATCOM Terminals

-- Software Communications Architecture (SCA) compliant



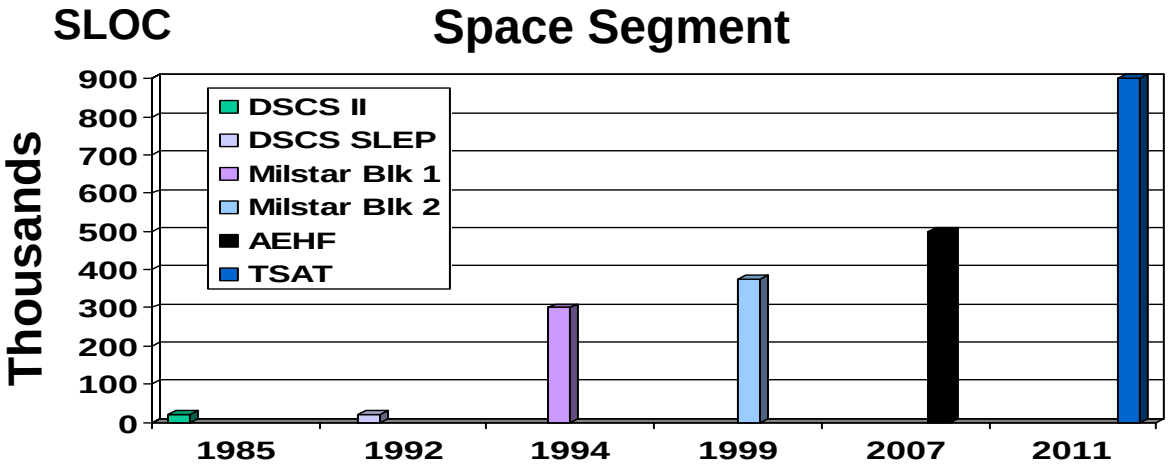
Service Terminal Quantities
Based on SDB, FCD and Doctrine

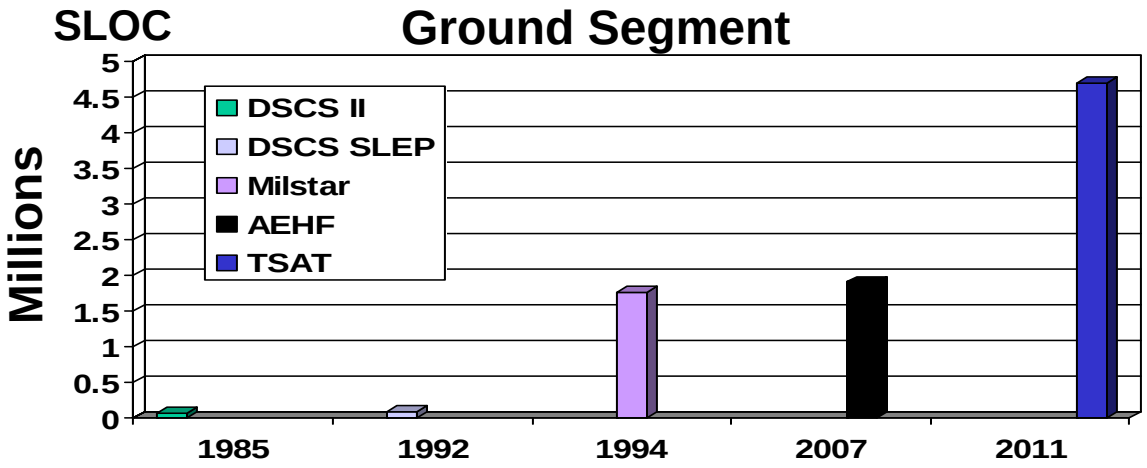
Enables mobile, smaller terminals

TCM Software Technical Challenges

- **Many complex interfaces**
  - **Key external interfaces – GIG, AISR / SISR, WIN-T / JTRS, DoD security management, AEHF, Teleports, Global Network Ops System Center, others (TBD)**
  - **Internal interfaces:**
    - **Payload to Terminal**
    - **Network to Terminal**
    - **Sat Ops Center to Satellite (TT&C)**
    - **Network to Satellite**
    - **Network to Sat Ops Center**
    - **Key Management to All**
  - **Multiple organization involved: DISA, NSA, NRO, Army / Navy / AF / Marine TC and Terminal programs . . .**
- **Space Segment: network protocol processing and network management**
- **Ground Segment: management and control of a world-wide distributed mission critical network**

MILSATCOM Software Growth
1985 - 2011





What Can We Learn From Our Past?

Defense Science Board Software Task Force

Software Task Force Membership

Co-Chairs

Robert Nesbit — The MITRE Corporation
Marc Hansen — Lockheed Martin Corporation

Members

Steve Cross — Software Engineering Inst.
Michael Dyer — Lockheed Martin Corporation

Executive Secretary

Lt.Col. Dave Luginbuhl, USAF

DSB Secretariat

Ten Best Practices for Software Development

1. Aggressively limit development time to no more than 18 months.
2. Minimize complexity. Minimize complexity. Minimize complexity.
3. Highly incentivize development teams – time to market, call rate, product sales.
4. Allow program management to trade functionality for time and stability.
5. Make sure development team has a process but value past performance over process.
6. Set clear goals and decision points that force early termination of off track projects.
7. Use iterative not waterfall development process.
8. Develop an executable architecture first.
9. Use component architectures, model visually, use tools for initial code inspection, not people
10. Evolve requirements with the design. Don't freeze requirements first. Don't rigorously trace requirements to design.

7

Independent Expert Program Reviews and the

IEPRs/Tri-service Assessment Initiative (TAI)

Recurring Program Symptoms

IEPRs/Tri-service Assessment Initiative (TAI)

What Causes These Symptoms?

IEPRs/Tri-service Assessment Initiative (TAI)

Prospective Recurring Patterns

- *Inadequate Change Management*
- *Poor Technology Refresh Management*

Program Assessment Toolkit – Common Problem Area

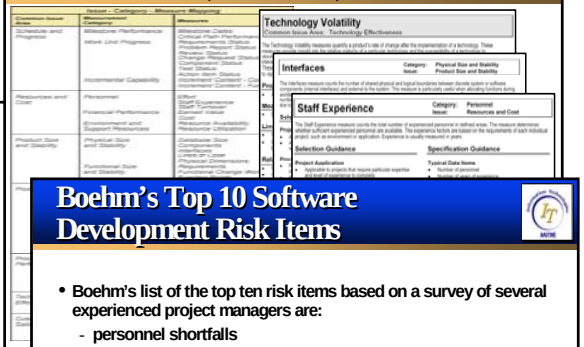
- Program management
- Multi-organizational collaboration
- Requirements/Systems Engineering
- Funding
- Staffing (of both Government and contractor)
- New technology
- Development Processes
- Schedule

·MITRE

16 Critical Software Practices for Performance-based management

Project Integrity	Construction Integrity	Product Stability & Integrity
• Adopt Continuous Risk Management • Estimate Cost and Schedule Empirically • Use Metrics to Manage • Track Earned Value • Track Defects against Quality Targets • Treat People as the Most Important Resource	• Adopt Life Cycle Configuration Management • Manage and Trace Requirements • Use System Based Software Design • Ensure Data and Database Interoperability • Define and Control Interfaces	• Inspect Requirements and Design • Manage Testing as a Continuous Process • Compile and Smoke Test Frequently

Practical Software & System Measurement (Continued)



Boehm's Top 10 Software Development Risk Items

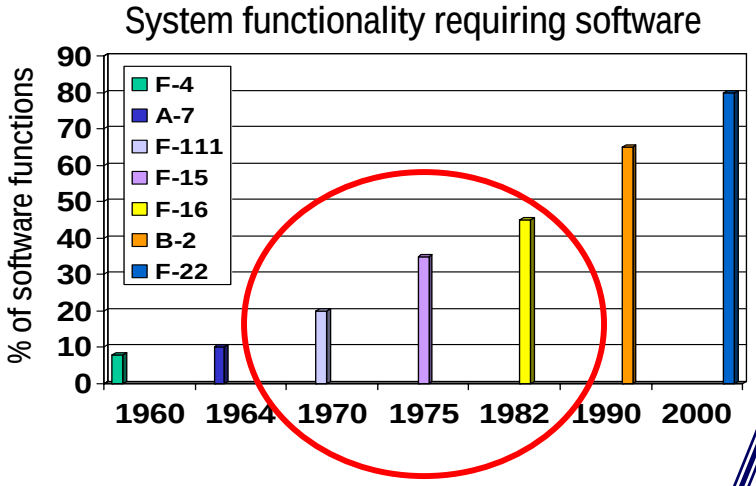
- Boehm's list of the top ten risk items based on a survey of several experienced project managers are:
  - personnel shortfalls
  - unrealistic schedules and budgets
  - developing the wrong functions and properties
  - developing the wrong user interface
  - gold plating
  - continuing stream of requirements changes
  - shortfalls in externally finished components
  - shortfalls in externally performed tasks
  - real-time performance shortfalls
  - straining computer-science capabilities

·MITRE

Avoiding a "Software Crisis"

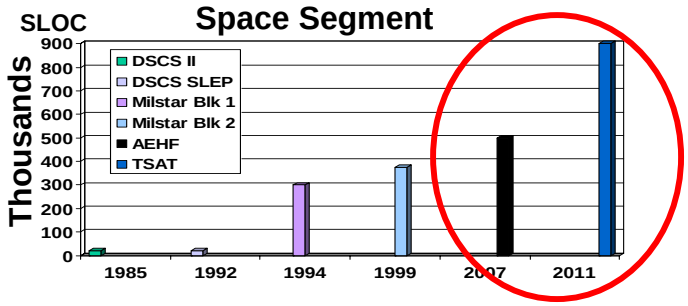
Mid 70s "Avionics Software Crisis"

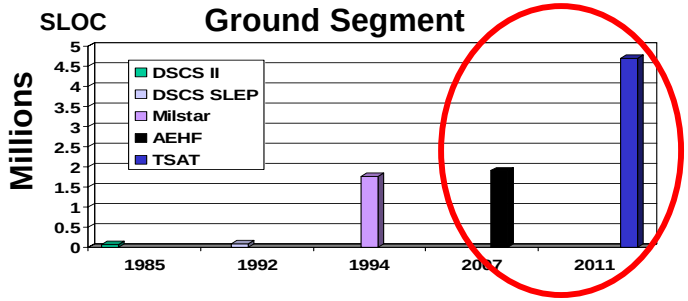
- Analog to digital avionics
- Rapid increase in software size and complexity



Industry / government not prepared

2000 "Space Software Crisis"?





- Transponded to processed SATCOM
- Circuited vs Internet Protocol (IP)
- Circuit based vs net-centric
- Rapid increase in software size and complexity

Are aerospace industry and government prepared?

Software Intensive System Acquisition Best Practices Assessment Framework

Project Management	Product Construction	Product Stability & Integrity
▪ Adopt a Program Risk Management Process	▪ Adopt Life Cycle Configuration Management	▪ Inspect Requirements and Design
▪ Estimate Cost and Schedule Empirically	▪ Manage and Trace Requirements	▪ Manage Testing as a Continuous Process
▪ Use Metrics to Manage	▪ Use Systems Based Software Design	▪ Compile and Smoke Test Frequently
▪ Track Earned Value	▪ Ensure Data and Database Interoperability	
▪ Track Defects against Quality Targets	▪ Define and Control Interfaces	
▪ Treat People as the Most Important Resource	▪ Design Twice, Code Once	
▪ Improve Software Skills of Acquisition Managers	▪ Assess Reuse Risks and Costs	
▪ Adopt Effective Contract Incentives	▪ Use Executable Architectures	
▪ Stress Past Performance and Process Maturity	▪ Employ Iterative Design / Development Cycles	
▪ Exploit Independent Expert Reviews	▪ Maintain a Strong Technology Base	

Ref: "Software Intensive System Acquisition Best Practices & Assessment Framework," MITRE, 30 Jan 2003

Top TCM Program Risks

1 - Information Assurance

2 - Software

3 – GIG Network Interoperability

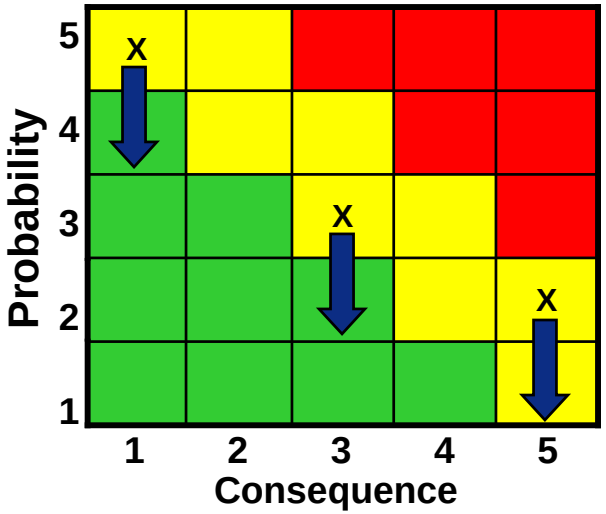
4 - Digital Processing and IP Routing

5 - Laser Communications Productization

6 – Schedule

7 – Systems Integration & Testing

8 – Requirements Management



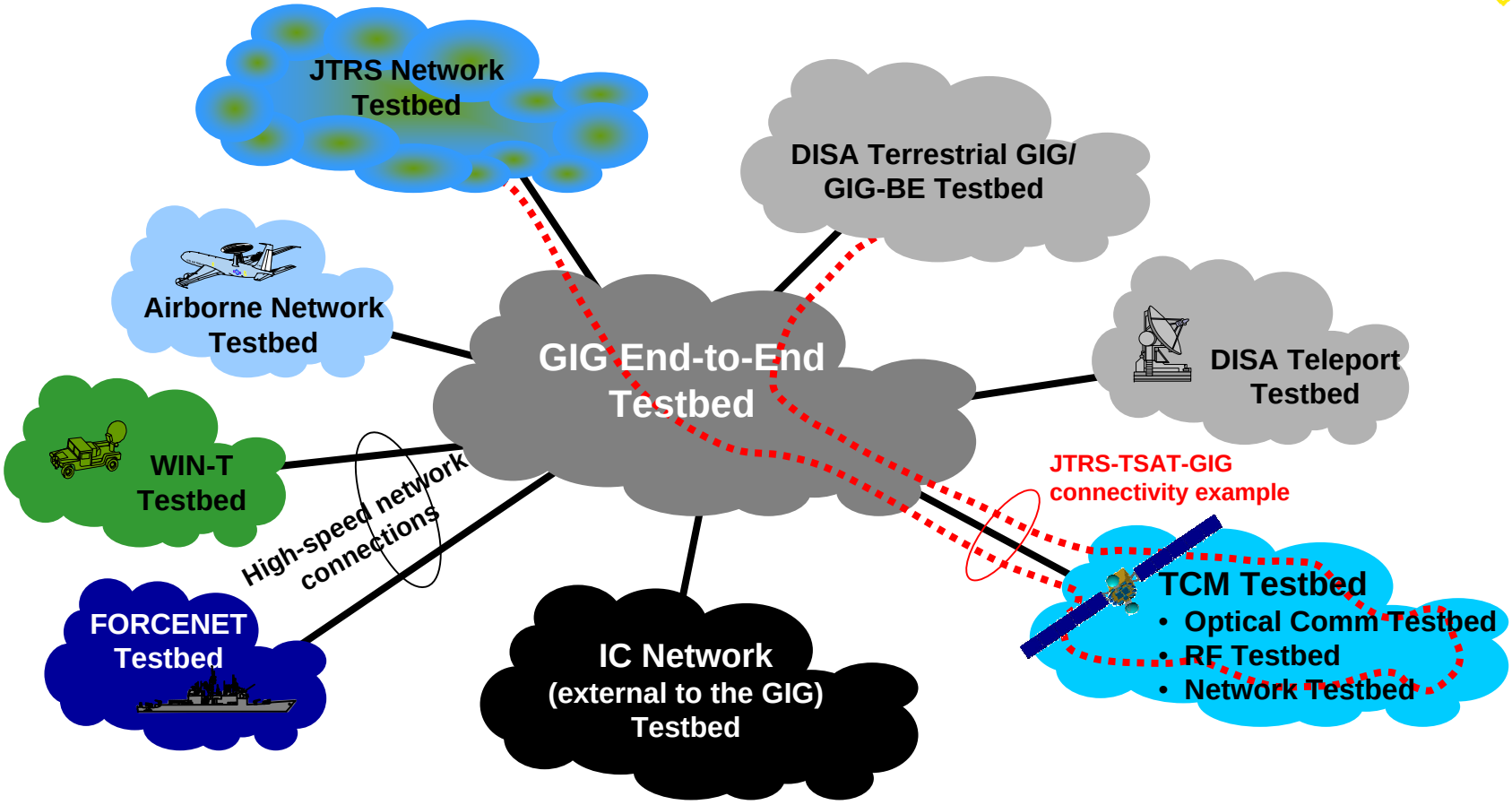
Robust risk management plans for each area

TCM has a very robust risk management approach

TCM Requirements Management Approach

- Develop detailed requirements, baseline and manage
  - Capstone Requirement Document – JROC approved Jan 03
  - Transformational Communications Architecture – JROC approved Sep 03
  - TSAT Capabilities Development Document – JROC approved Jan 04
  - TCM Technical Requirements Document (TRD) – draft Mar 04
  - TSAT Space Segment TRD – draft Mar 04
  - TSAT Network TRD – Oct 04
- New requirements are vetted through HQ AFSPC, STRATCOM and ultimately Joint Requirements Operations Council

Testbed Approach



Test the way you operate

Summary

- **MILSATCOM systems are transforming from circuit based systems to internet protocol based networks; the associated software is growing exponentially**

- **Metrics based disciplined systems engineering and software engineering are essential in achieving mission success**

A day without software