NORTHROP GRUMMAN

15,000+ Networks, 5 Million+ Users:

T&E Net Centric Challenges

March 1, 2010

John Illgen

Sector Director, Modeling & Simulation

Topics

NORTHROP GRUMMAN

- Why, How, What, Result
- Simulation and T&E Example
- Where have we come from?
- Where are we going?
- Common Network Challenges
- Goals
- Large Scale Network (LSN) Design Problems
  - Vision
  - Problems
  - Solutions
- Test & Evaluation
  - Predictive
  - Traditional vs. New
  - Balanced Approach
  - Application of M&S to Test Process
- Recommendations

Network Centric Warfare

NORTHROP GRUMMAN

Why ?

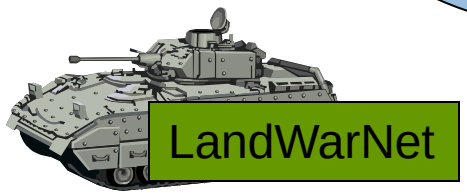
- Info Superiority
- Enhanced Situational Awareness
  - COP
- Faster Decision Making
  - Shorten Sensor-to-Shooter Cycle

Attributes

- Affordable
- Efficient
- Interoperable
- Secure
- Robust
- Reliable

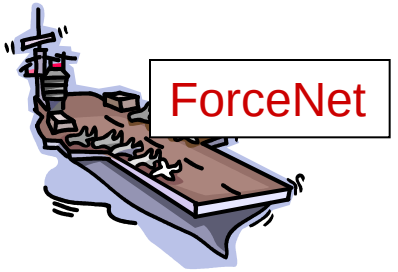
How ?

- Info Sharing
- Horizontal vs. Hierarchical
- Increased Bandwidth
- Nets on Demand
- LPD / LPI
- Jam / Anti- Jam



What ?

- Command and Control
- Communications
- Computers
- ISR
- Weapons



Problems

- Net Manage
- Access Control
- Diversity of Equipment
- Harsh Environment

Result ?

- Mobile Force
- Diversity of Operations
- Time Critical Targeting
- Coordinated Response
  - Netted Weapons

Where have we come from?

NORTHROP GRUMMAN

History:

- **WW I - Telephone Traffic – transfer of ~30 words per minute**
- **WW II - Radios doubled above rate**
- **Vietnam - Expanded to 100 wpm**
- **Gulf War - Information Transfer Rates of 192,000 wpm**
- **2010 - 1.5 trillion wpm (potential information paralysis of sensors, deciders, and shooters)**

Today's challenge is data overloaded warfighters operating in a "camouflaged" information environment

Where are we going?

NORTHROP GRUMMAN

- Large scale networks able to keep up with the following:
  - Track user preferences
  - Track preferred communications devices
  - Mobility
  - Speech – speech to text
  - Sensor networks
    - IP enabled sensors
    - Machine to machine
  - Human is removed

  - And much more...

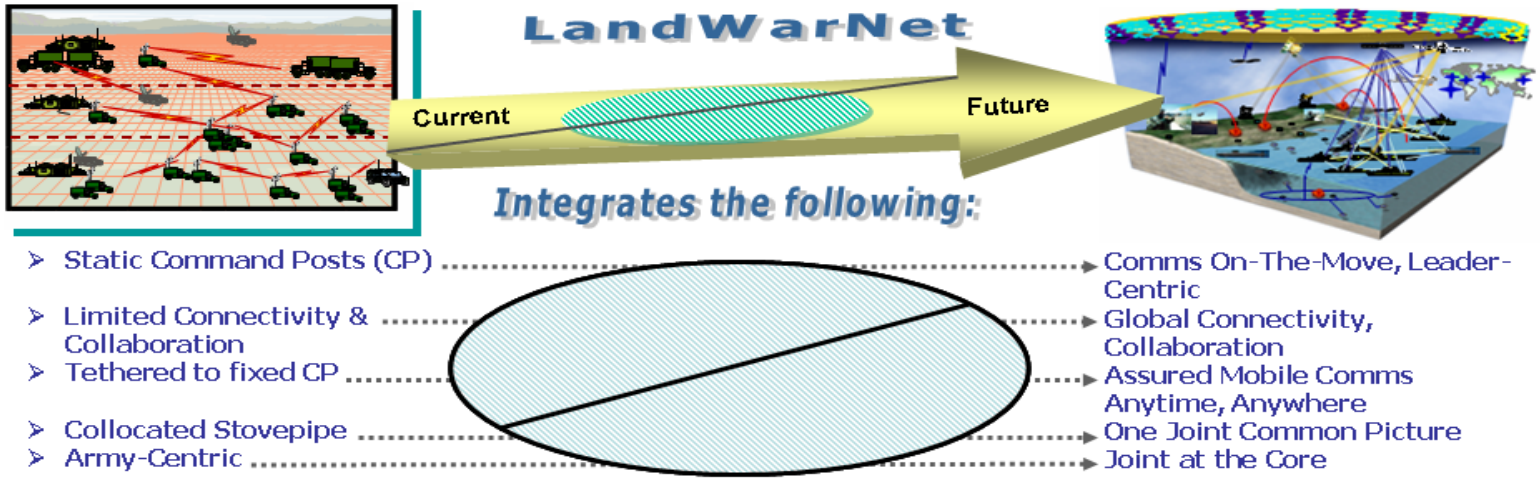
LandWarNet

NORTHROP GRUMMAN

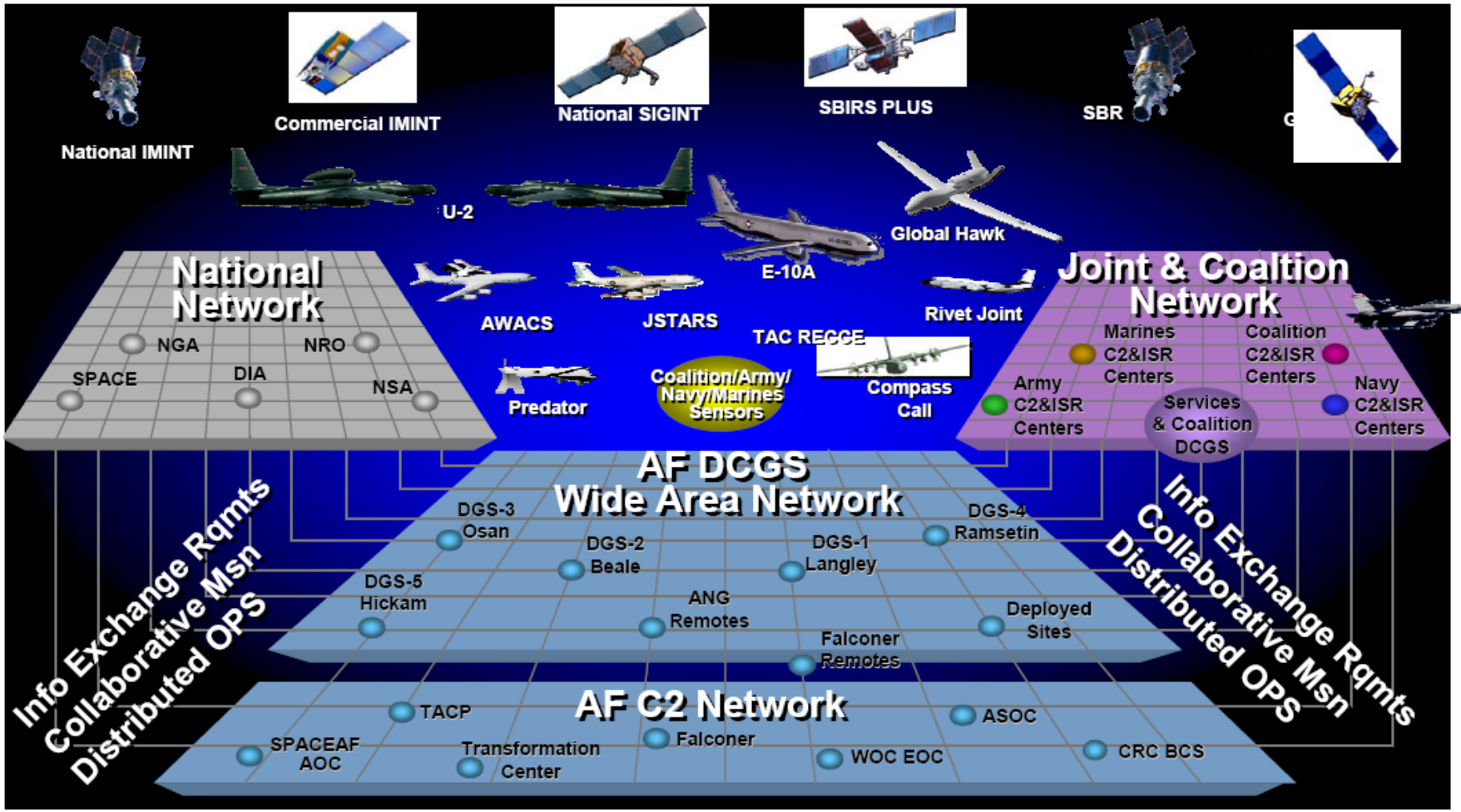
FOCUSED on the Joint Warfight

LandWarNet is the Army's contribution to the Global Information Grid (GIG) that consists of all globally interconnected, end-to-end set of Army information capabilities, associated processes, and personnel for collecting, processing, storing, disseminating, and managing information on demand supporting warfighters, policy makers, and support personnel. It includes all Army (owned and leased) and leveraged DOD/Joint communications and computing systems and services, software (including applications), data security services, and other associated services.

1. LandWarNet enables Global, Strategic, Operational, & Tactical C2
2. LandWarNet is a commitment to a policies & permissions-based global network
3. LandWarNet is a Modernization Strategy



C2 Constellation: Network Centric C2 and ISR Environment



Network Centric Environments, continued

NORTHROP GRUMMAN

- C2 Constellation
  - A network-centric family of systems
  - Seamless information to command and control forces
  - Air/Space/Surface/Manned/Unmanned Vehicle integration
  - Modernize and integrate Operations Center and Distributed Common Ground Center
- FORCEnet
  - Network Centric Warfare is the theory
  - Net-centric operations is the concept
  - FORCEnet is the process of making the theory and concept a reality
  - "FORCEnet is the operational construct and architectural framework for Naval Warfare in the Information Age which integrates Warriors, sensors, networks, command and control, platforms and weapons into a networked, distributed combat force, scalable across the spectrum of conflict from seabed to space and sea to land."*

*CNO's Strategic Study Group -XXI definition from 22 July 02 CNO Briefing

Common Network Challenges

NORTHROP GRUMMAN

- Each Platform has its own Network
  - Thousands of networks currently exist
  - Standards and protocols differ
  - Vertical / Stovepiped
  - Not scalable
- Traditional interrelated problems exist:
  - BW
  - Network Delays
  - Throughput
  - Querying and Transmission Delays
  - Network Packet Delay
  - Percent Utilization
  - Scalability
  - And more...

Challenges, continued

NORTHROP GRUMMAN

Problem:

- Vertical Integration Information Flow
  - Sensors - Operations
  - Platforms - Intel Centers
- C2 Survey (OSAN, CPTANGO, I&A)
  - Each network stovepipe produces a separate “picture” of the battlespace
    - Only members of that group can decipher and explain their hieroglyphics to other groups
- Forcing Information through these stovepipes
  - Time consuming
  - Info flows from multiple sensors back to the deciders in the C2 Centers
  - Info from these diverse, unconnected sources is correlated, fused, turned into a target folder and forwarded to shooters

OFTEN: Fleeting targets are already gone before the kill chain “find, fix, target, track, engage, and assess” is completed

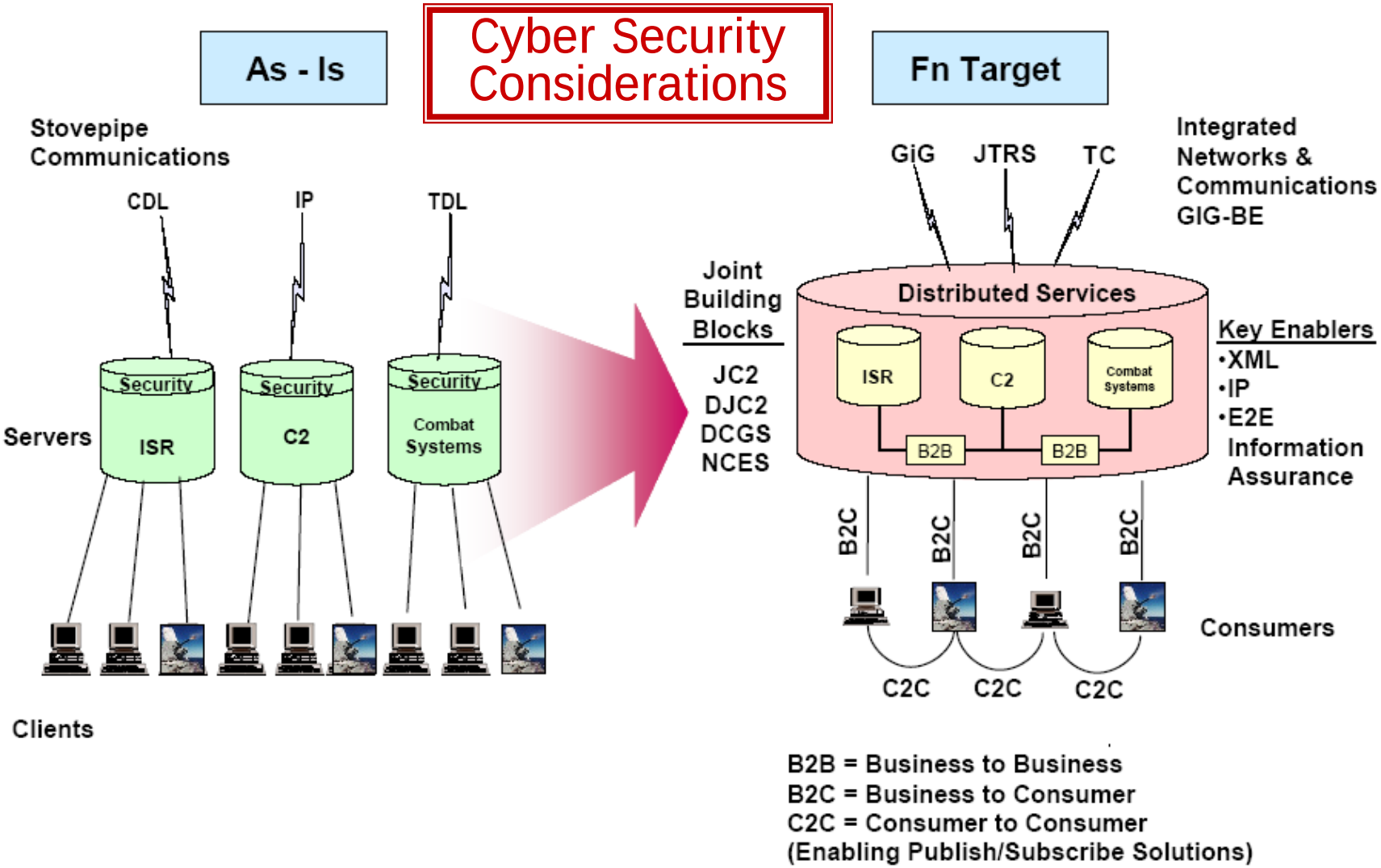
Network Centricity Goal

NORTHROP GRUMMAN

- Accelerate process through Vertical and Horizontal information sharing
  - Vertically between sensors and command centers
  - Horizontally among the sensors and platforms
- BMC2 to turn vast amounts of information that C2ISR sensors produce into “knowledge” (about the battlespace)
  - Machine to Machine exchanges can speed the flow of information from sensor to shooter (via decider) but also even directly from sensor to weapon

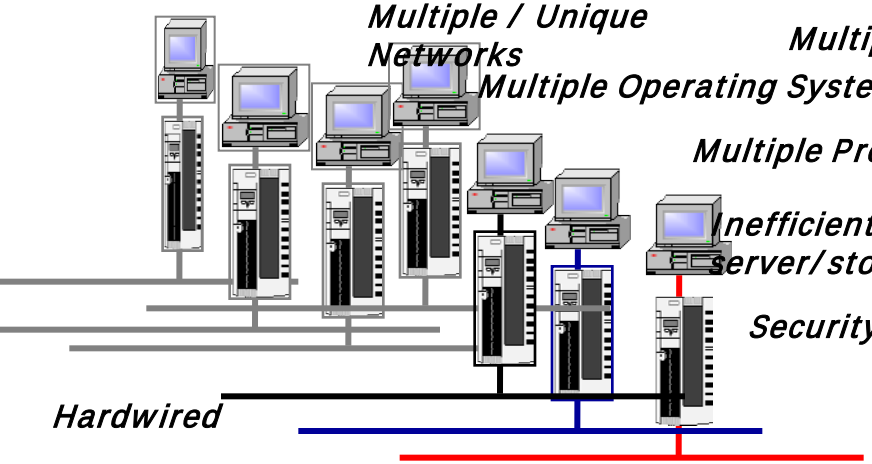
Battlefield knowledge is the basis for Precision Engagement

Push to a Common Environment



Consolidated Afloat Networks and Enterprise Services (CANES)

Today's C4I Architecture



Multiple / Unique Networks

Multiple Classification Levels

Multiple Operating Systems

Multiple Protocols

Inefficient use of server/storage resources

Security Vulnerabilities

Hardwired

No enterprise network mgt

Today's Network is not adaptable to the user (User must adapt to the network)

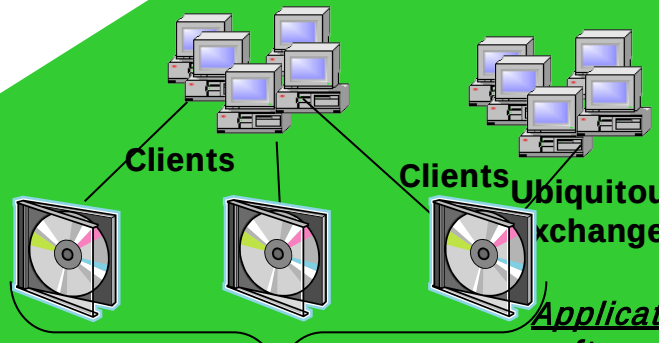
CANES Afloat C4I Architecture

Common POR Network

Inoculated Network

Cross Domain Interoperability

Service Levels



Clients

Clients

Ubiquitous Information Exchange using SOA

Applications just bring software

Hotel Services (Core Services)

Wireless

Network Operations Center

CANES adapts to users with role-based ID mgt

Large Scale Network (LSN) Design Problems

NORTHROP GRUMMAN

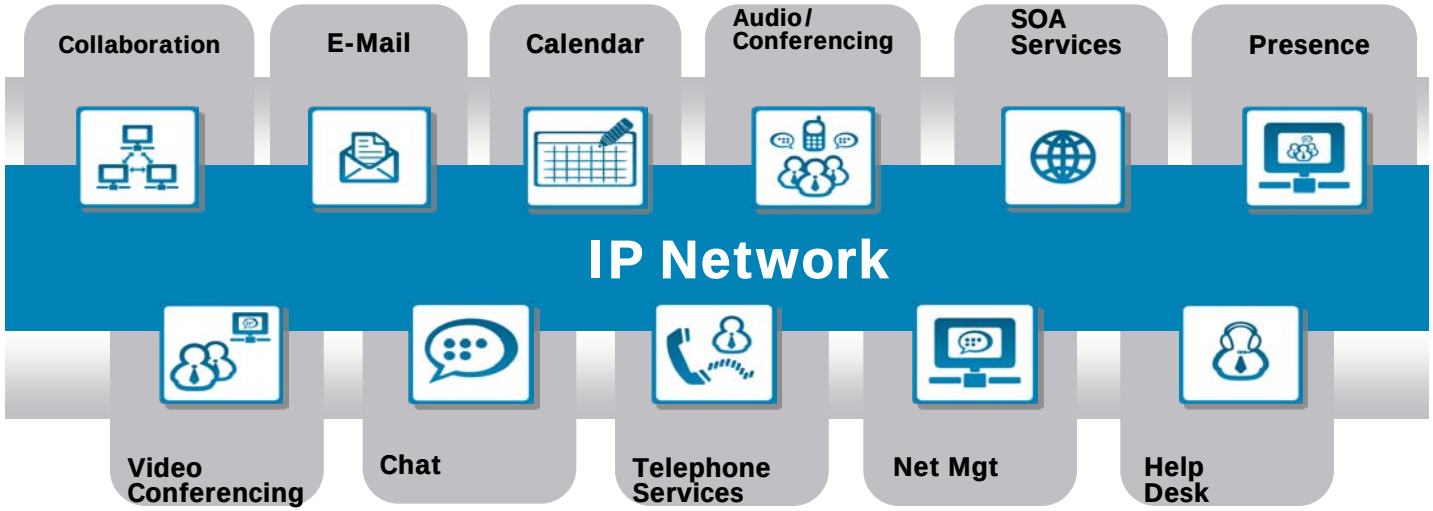
- Problems in designing large scale networks have largely confounded existing theory
  - Innovation based on intuition has dominated design
    - Sterling example: the Internet
      - Design of protocols was based largely on intuition
      - Brilliant innovation ➡ enormous success thus far
      - Approach is definitely not adequate in the long run for large-scale network designs
  - Potential pitfalls using this practice
    - Underestimating the importance of certain system features is usually only revealed in surprising failures after implementation
- Theoretical and methodological research can be applied to network design and verification
  - Choice of models and simulations (M&Ss)
    - Need to account for uncertainty generated by modeling abstractions
  - Challenges of dealing with network scale
    - Integration of heterogeneous modules and their complex interactions make the problem seem intractable

LSN Example: Network-Centric Warfare (NCW) Communications

NORTHROP GRUMMAN

- The Vision: Get the right information to the right person at the right time.

- Ideal Network Characteristics
  - Dynamic membership, limited to authorized users
  - Mobile sub-networks, not just mobile nodes
  - Automatic reconfiguration
  - Guaranteed Quality of Service in a secure environment
  - Ready access to gateways for reach-back connections
  - Anti-jam and low probability of detection/intercept modes available



Network-Centric Communications: Some of the Problems

NORTHROP GRUMMAN

- Networks are not underutilized; over provisioning is not an option
- Traffic shaping policies must work over an extremely large dynamic range
- Quality of Service (QoS) issues
  - Must have dynamic Service Level Agreements
  - Customized QoS for each security domain
- Difficulty of using commercial technologies and protocols over unreliable and dynamic military links
- Packet overhead is excessive for small packet sizes used by the military

Network-Centric Communications: Some Solutions

NORTHROP GRUMMAN

- NCW networks have characteristics that transcend the current state of the art in networking today.
- There is a reluctance of most governments to invest in large-scale hardware test beds where communications performance can be scientifically studied.
- Therefore, network simulations may be the only way to make real progress in achieving the vision of ubiquitous voice, video and data being available to the warfighter in the field.

Test & Evaluation Needs

NORTHROP GRUMMAN

- Predictive Network Performance
  - What's the impact of adding:
    - Another user
    - Another application
    - More network traffic
    - Etc.
  - Where are the bottlenecks
    - Performance over bandwidth constrained, high latency, etc.
  - How do the networks interact with the applications
- What's the warfighting value of our network capabilities

T&E (Traditional vs. New SOS Testing)

NORTHROP GRUMMAN

- Traditionally involved independent platform testing
  - Perform test
  - Data gathered
  - “Quick look” data reduction and processing
  - Move system to the next test center
- Process is time consuming, inefficient and insufficient for network-centric systems
- For future systems (SOS), interoperability and networking are prime concerns, and testing requirements must be reconsidered
- T&E of net centric systems will take new strategies like “Platform” as a Network Node (PANN), capability testing, SOS testing and joint testing

Balanced Approach Process, “The Use”

NORTHROP GRUMMAN

Simulation Process During	Test Impact	Laboratory	Range	M&S
PLANNING				
• Pre-Test Analysis	• Identify parameters to be measured, modeled and simulated	X	X	X
• Test Design	• DSI	X	X	X
• Test Plan	• DSS	X	X	X
	• Range of values	X	X	X
	• Ground/airborne/site/flight path/vessel track rationale		X	X
TEST CONDUCT				
• Test Execution	• Predictions for use during test – check test trends – M&S confidence check, M&S fine tuning, “quick look”	X X X	X X X	X X X
ANALYSIS				
• Data reduction, processing, and data analysis	• Interpolate	X	X	X
• Subsystem/ system evaluation/analysis	• Extrapolate	X	X	X
	• Culmination of the above provides more complete use of M&S and test to evaluate subsystem/system	X	X	X

Application of Communications and Network Modeling

NORTHROP GRUMMAN

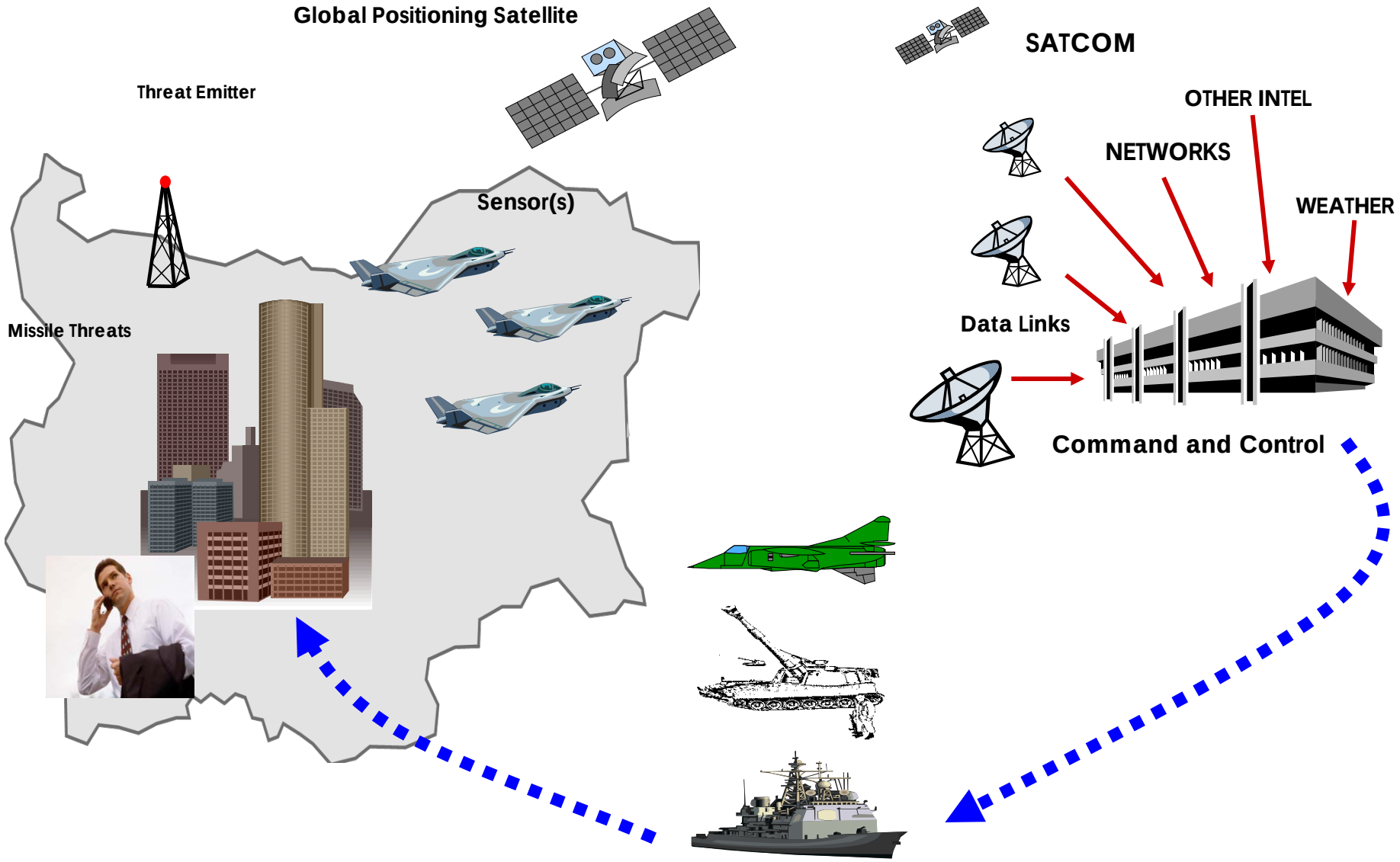
- Subject Areas
  - Satellite Communications
  - Terrestrial Communications
  - Performance Analysis
  - Trade Studies
  - Link Budgets
  - Protocol analyses - OSPF, BGP, MPLS, ATM, 802.11
  - Multi-port Radio Link, capacity and traffic modeling
  - Propagation analysis and directional antenna gain
  - Waveform simulations
  - Phase noise effects
  - Contention/Collision analysis
  - Network performance
- Scenarios for Network Connectivity/ Traffic Studies
  - Land, sea, and air platforms and communications
  - Animation / Visualization
  - Mobile, multi-node scenarios including Terrain and Access model effects
  - Integrated SOTM models
  - Effects based traffic models

M&S for LSN Test and Analysis

NORTHROP GRUMMAN

- Developing robust models for LSNs is the first, very important step both for analysis and test
  - Models of varying complexity can be constructed ranging from
    - Stochastic multi-scale models
    - To simple deterministic models
- Necessary modeling approximations often needed
  - Very detailed models can be simplified into ones that current analysis tools can handle
  - Simplification process should account for all the approximations made
  - Verification and Validation required

Simulation Example



T&E Recommendations

NORTHROP GRUMMAN

- Predictive network approach required
  - Balanced approach using modeling, simulation and test
- Impact of adding...
  - Another user
  - Application
  - More network traffic
  - Scalability
  - Etc.
- Where are the bottlenecks?
  - Performance over bandwidth, high latency, etc.
- What is the warfighting value of our network capabilities?
- For future systems (SOS) interoperability and networking are of prime concern and testing requirements must be reconsidered
- T&E will take new strategies
  - Platform as a Network Node (PANN)
- Problems in designing large scale networks have largely confounded existing theory
- Re-address V&V


NORTHROP GRUMMAN