# Rapid Response Command and Control

## SEA Integrated Project


1 June 2006

# Introduction and Systems Engineering Process

LCDR Lisa Sullivan

# Agenda

| | | |
|---|---|---|
| 0745-0800 | Refreshments | ME Aud |
| 0800-1000 | R2C2 Final Presentation<br>-0850-0900 Break | ME Aud |
| 1000-1100 | Model Demonstration | Bu 100C |
| 1100-1200 | Lunch Break | |
| 1200-1400 | Breakout Session | Bu 100C |

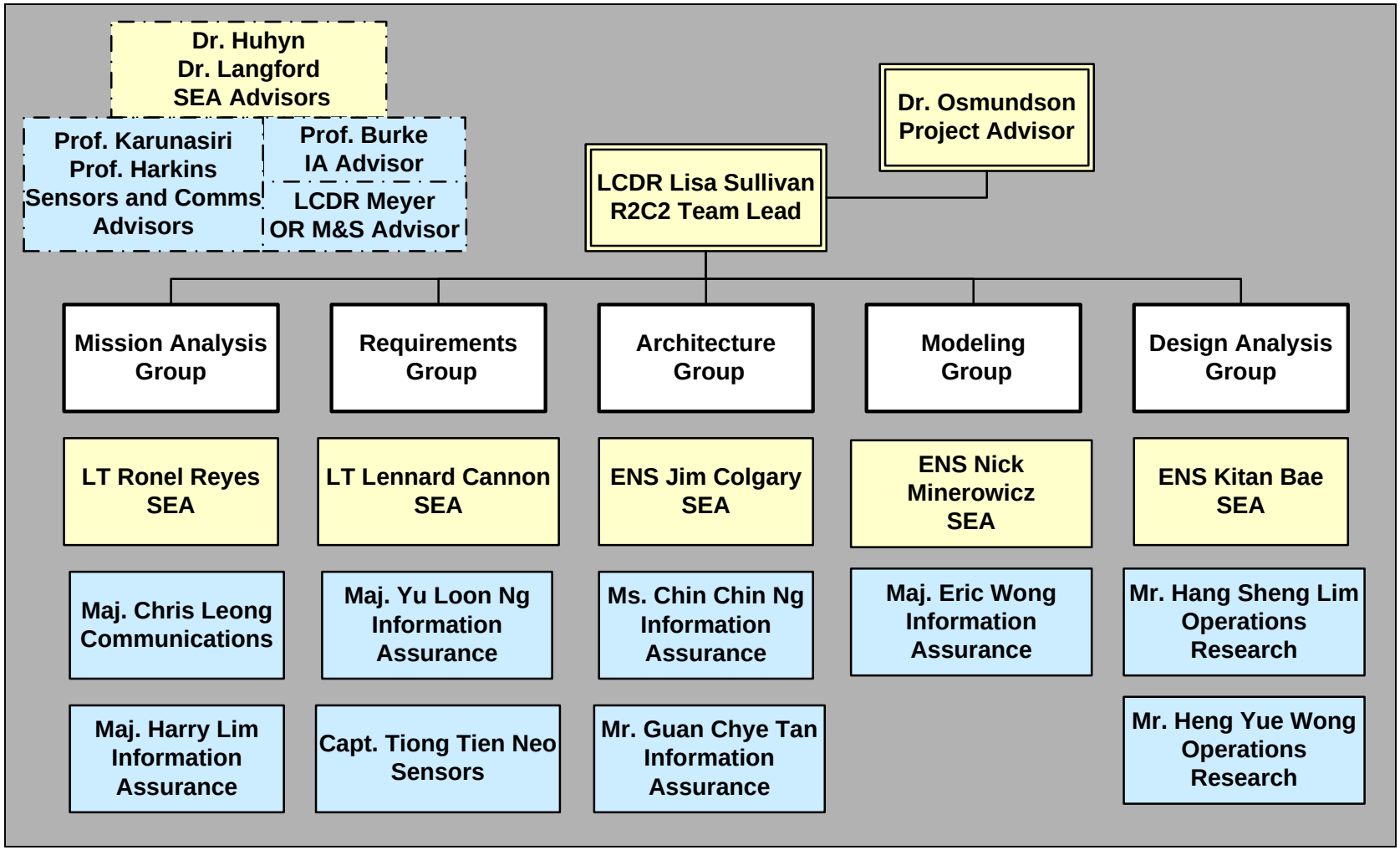
# Outline

- Systems Engineering Process
- Summary of Results
- Mission Analysis
- Requirements
- Architectures
- Information Assurance
- Modeling
- System Analysis
- Conclusions

# Exceeded Educational Expectations

- Completed rigorous Systems Engineering Process to design system architectures
- Fully integrated with Temasek Defense Science Institute students and collaborated with multiple research entities cross campus
- Thoroughly researched strategic publications and current operations' lessons learned to capture joint capability gaps
- Built strong relationships with stakeholders to ensure timely and accurate feedback on project progression and system design
- Learned in depth about new technical areas

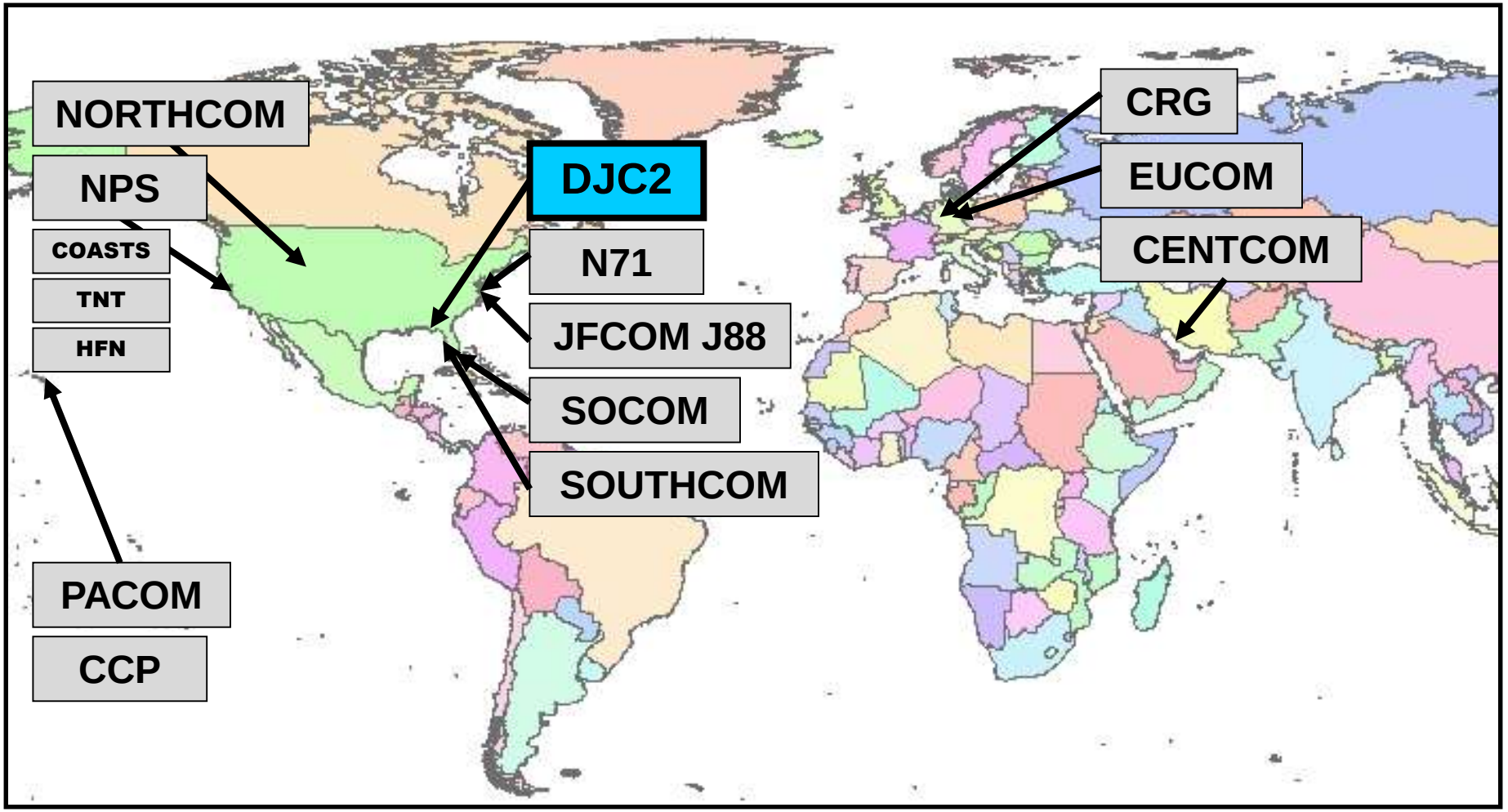
# R2C2 Organization



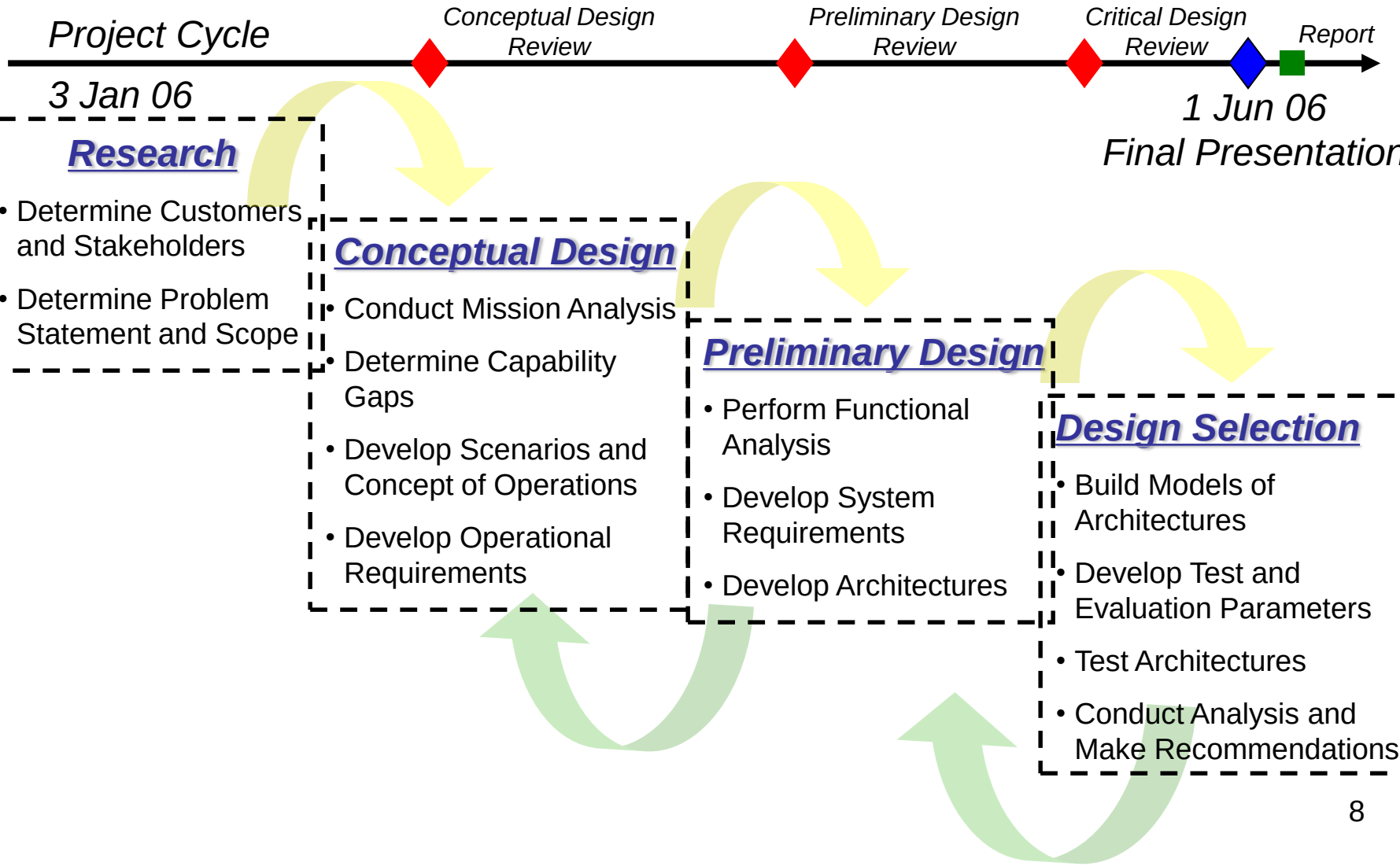

SEA Students and Advisors

TDSI Students and Advisors

# Stakeholders



# Systems Engineering Approach



# Problem Statement

Develop and analyze architectures, and design systems for a rapidly deployable, command and control system to provide Regional Combatant Commanders initial situational awareness and communication capabilities through the range of military operations.

# Architecture Overview (1)

**Primary Suite**

Provides Reachback to the Regional Combatant Commanders and the Global Information Grid

**Routers**
**Switches**

**Laptops**

Satellite Terminal

**Phones**

**Encryption Devices**

**Generator**

# Architecture Overview (2)

**Primary Suite**

Provides Reachback to the Regional Combatant Commanders and the Global Information Grid

**Local Suite**

Provides communication and data transfer capability within the local area

**Military Radios**

**Wi-Max/Wi-Fi**

**Satellite Phone**

**Camera/PDA**

# Architecture Overview (3)

**Satellite Terminal**

**Laptops**

**Primary Suite**

Provides Reachback to the Regional Combatant Commanders and the Global Information Grid

**Local Suite**

Provides communication and data transfer capability within the local area

**Civilian/Military Suite**

Provides internet access for the Civil Military Operating Centers during HA/DR

# Project Results (1)

- Addressed the challenge of multiple users in varying environments
  - Developed five scenarios that cover the Range of Military Operations
  - Received feedback and approval of scenarios
- Utilized a top down approach for developing requirements
  - Developed operational requirements based on capability need
  - Conducted Function Analysis to develop system requirements and traced to strategic guidance
  - Identified additional requirements based on Mission Analysis: Organic Power, Local Communications, and Civilian/Military Link

# Project Results (2)

- Researched and analyzed over 40 options for architectures
  - Conducted market surveys and reduced selection to 8 potential architectures
  - Focused on developing modular suites to define architectures: Primary Suite, Local Suite, and Civil/Military Suite
- Captured architecture performance through multiple models
  - Determined transmission time decreases by 50 minutes with dedicated data link
  - Determined sufficient bandwidth, over 50%, to support integrated CMS
  - Conducted capability vs weight tradeoffs and determined data link capability incurred 50 extra pounds per scout team
  - Determined final architectures were dependent on type of mission: 1) time-critical or 2) normal operations

# Project Results (3)

- Utilized multiple decision aids to compare as-is systems, proposed system, and R2C2
  - Conducted Analytic Hierarchy Process to rate critical operational issues
  - Conducted separate stop light comparison of systems to requirements generated by the team and outlined in the Capabilities Production Document and Broad Area Announcement

| | AHP | Traffic light matrix |
|---|---|---|
| **R2C2** | **42.7%** | **27/28** |
| **Proposed** | 28.3% | 22/28 |
| **As-Is** | 29.0% | 16/28 |

Due to modular design, R2C2 system outperformed proposed and as-is systems

# Mission Analysis

LT Ronel Reyes
Maj. Chris Leong
Maj. Harry Lim

# Mission Analysis Outline

- Characteristics of R2C2 system
- Research conducted
- Needs analysis / capability gaps
- Range of military operations
  - Five scenarios
  - Scenario stress matrix
- Feedback from stakeholders

# Characteristics of R2C2 (1)

2 Categories - System owner and System operator

- Defining the R2C2 system requirement
  - 4 perspectives were identified
  - Demands and limitations from each system perspective were investigated
  - Interdependencies were addressed, in the context of R2C2

System owner:
- Determine the need to bridge info capability gap
- Define information security policies

System operator:
- Relevant operational and technical experience
- Classification
- Military or civilian
- Human system interfaces

Mission Perspective

Environment Perspective

# Characteristics of R2C2 (2)

the R2C equirem

bectives w

ds and limitations from each sys

ctive were investigated

dependencies were addressed, in the c

Mission Perspective

- Openness and hostility of operation
- DoD, U.S. Government, or coalition
- Mission's objectives
- System risk management
- Logistics impact due to duration of mission

Environment Perspective

# Characteristics of R2C2 (3)


- the R2C2 system require
- ectives were identified
- ds and limitations from each
  tive were investigated
- Interdependencies were addressed, in the context of R2C2

Perspective

Mission Perspective

- Location of deployment
- Variable weather conditions

Environment Perspective

- Dependable solutions to infrastructure and logistics support
- Trafficability dictates transportability and packing configuration

# Characteristics of R2C2 (4)

fining the R2C2 system requiremen

perspectives were identified

mands and limitations from each system perspective were investigated

- Interdependencies were addressed, in the context o C2


| User Perspective | Mission Perspective | Environment Perspective | Technology Perspective |
|---|---|---|---|
| •Limited to COTS and GOTS technology<br>•Some sort of database and database template required<br>•Info management suite to facilitate operator<br>•Communication network<br>•Network topology and footprint determine type of technology or protocol<br>•Options drive hardware selection, power requirement, and size | | | |

# Research

1. Why do we need R2C2?
2. Does a capability gap exist?

Avenues of research:

- Lessons learned from Boxing Day Tsunami and Hurricane Katrina
- Quadrennial Defense Review 2006
- Joint publications
- Interviews
- Current NPS efforts
- Deployable Joint Command and Control (DJC2) documents

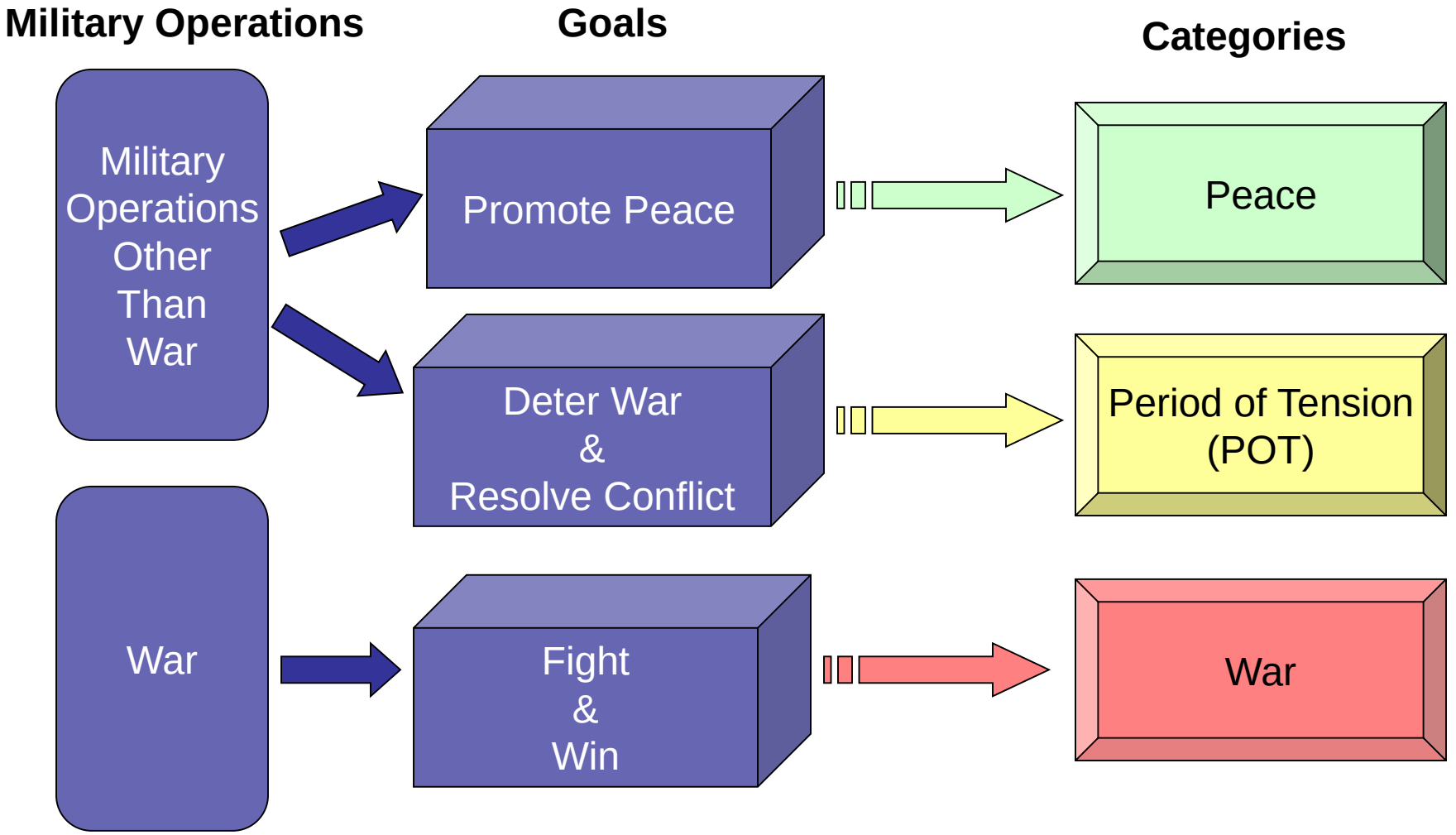
# Needs Analysis and Capability Gaps

- Quadrennial Defense Review 2006
  - Combating Terrorism – Joint coordination, procedures, systems, and when necessary, command and control to plan and conduct complex interagency operations.
  - Homeland Defense and Civil Support Missions – Joint communications, command and control systems that are interoperable with other agencies and state and local governments.

**Capability Gaps**

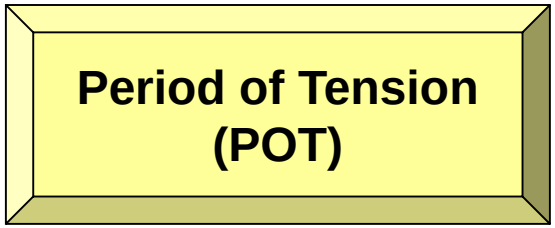
- Standardized C2 system that is:
  - Interoperable throughout Joint, Coalition, and interagency levels
  - Modular and scalable
  - Rapidly deployable
  - Small operational footprint

# Range of Military Operations (1)

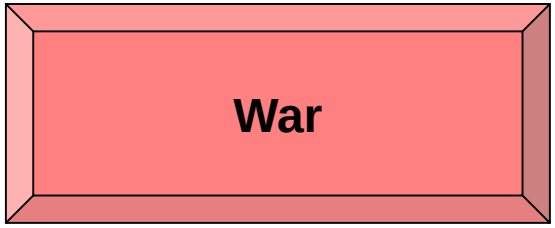


# Range of Military Operations (2)


- **Pandemic – Bird Flu in Singapore**
- **Disaster Relief – Earthquake in El Salvador**




- **Counterterrorism – Southern Philippines**
- **Civil Unrest – Ivory Coast Noncombatant Evacuation Operation (NEO)**




- **Deployment – Iran conflict**

# Pandemic Scenario

- Cases of h
  transmissi
- PACOM de
- Crew esta
  Operations
  coordinate
  disseminat
- R2C2 ope
  on Avian fl
- Collected
  Expedition
  supporting


Singapore
1°22’03.55” N 103°47’58.60” E

# Pandemic Scenario Assumptions

- Crew is properly trained in dealing with the Avian flu
- Singapore has no objections to U.S. forces in country
- Infrastructure support of power, network connectivity, and physical security are readily available

# Disaster Relief Scenario


- Magnitude 8 g mudslides
- SOUTHCOM looses communication with the U.S. Forward Operating Base (FOB), deploys R2C2 crew
- Deploy scouts to fairgrounds to establish a CMOC, port city of Acajutla, and the U.S. Embassy
- R2C2 crew gathers SA for Regional Combatant Commander (RCC) while assisting relief efforts in country

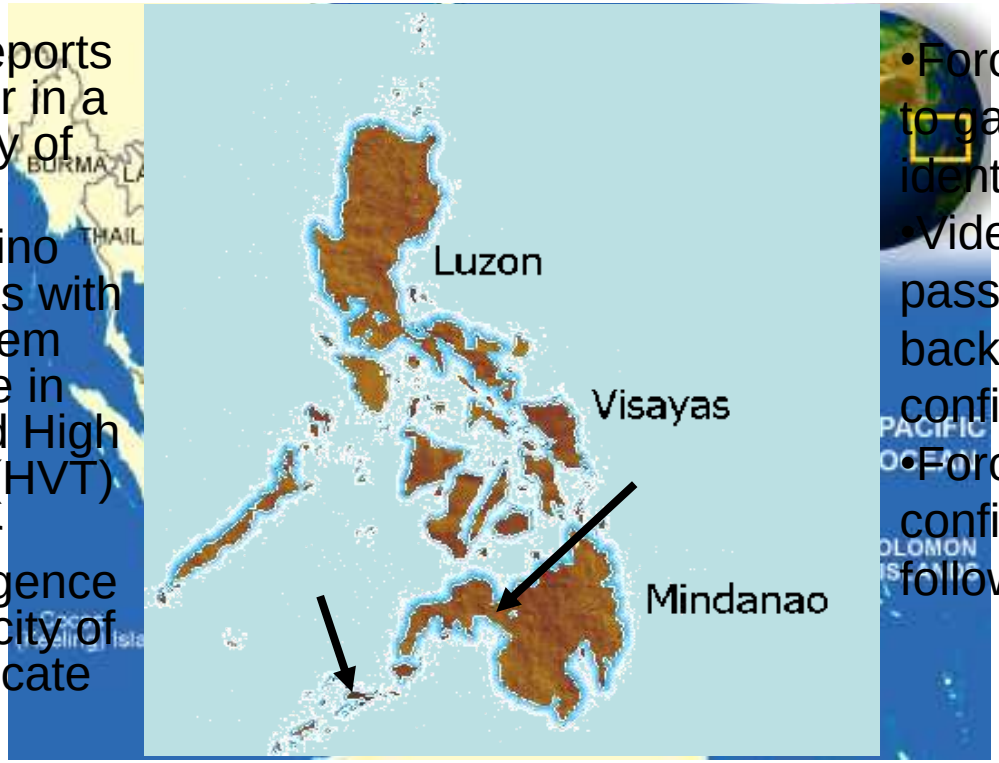
El Salvador, Central America
13°50'00.00"N 88°54'59.99"W

# Disaster Relief Scenario Assumptions

- Salvadoran military will provide transportation for the scouts
- Generator power for R2C2 is only available after first 24 hrs of operations
- ESG is en-route and expected to arrive in five days from the initial earthquake strike

# Counterterrorism Scenario

- Intelligence reports terrorist leader in a camp near city of Buriasan
- U.S. and Filipino Special Forces with an R2C2 system leave exercise in Basilan to find High Value Target (HVT)
- Forces gather Human Intelligence (HUMINT) in city of Buriasan to locate camp




- Forces surround camp to gain positive identification (ID) of HVT
- Video and imagery are passed through R2C2 back to PACOM for confirmation
- Forces await confirmation ID and follow on orders to strike

Buriasan, Philippines
7°54’00.00” N 123°45’00.02” E

# Counterterrorism Scenario Assumptions

- Intelligence received is credible
- The Philippine government supports the coalition team and their efforts
- Buriasan's local population is aware of terrorist activities and are cooperative in supplying information regarding the terrorist camp location
- U.S. and Filipino forces have been conducting exercises utilizing the capabilities of the R2C2

# Civil Unrest Scenario

- UN/French forces b
- EUCOM deploys (2
Embassy
  - Yamoussoukro
  - Abidjan
- Yamoussoukro cre
  - Aide UN/Frenc
  - Monitor rebel a
  crew
- Abidjan crew:
  - Coordinate eva
  with ESG
  - Maintain communication with TOC


Ivory Coast, Africa
7°31’32.45” N 5°35’00.42” W

# Civil Unrest Scenario Assumptions

- ESG is en-route to provide a Marine Expeditionary Unit (MEU) to conduct NEO
- R2C2 crews are able to communicate with ESG
- ESG will be prepared to provide information to support the R2C2 crews
- Adequate to limited infrastructure is available for R2C2 to operate in Yamoussoukro
- Sufficient infrastructure is available to support R2C2 at the U.S. Embassy

# Deployment Scenario

- U.S. – Iranian conflict has begun and U.S. forces have entered the country
- CENTOM deploys R2C2 crew to Shirāz to:
  - Determine a DJC2 staging area
  - Support C2 of ground troops
- Scouts deployed throughout the city to find staging area and conduct battle damage assessment for RCC and ground forces



Shiraz Iran
37°24'49.00" N 45°55'30.99" E

- R2C2 crew conducts coordination with construction battalion for DJC2 staging

# Deployment Scenario Assumptions

- Ground forces will experience light resistance from Iranian forces in the cities of Būshehr and Shirāz
- Insurgent threats in the city are not expected
- Once integrated with the ground forces, the R2C2 will be provide a dedicated power source
- Chemical, Biological, Radiological (CBR) warfare is a viable threat

# Scenario Stress Matrix (1)

- 3 areas of concern that would affect the design of the R2C2 system
- Matrix analyzes R2C2 system, while deployed, based upon a series of stress points

| Mission | User | In Situ |
|---|---|---|
| •Response time<br>•Probability of occurrence<br>•Impact<br>•Prior intelligence/information | •User expectation<br>•Stakeholders<br>•Complexity of operation<br>•Duration (stay + op time) | •Environment<br>•Infrastructure<br>•Trafficability<br>•Special requirements |

# Scenario Stress Matrix (2)

| | | General Goals | Scnearios | Examples | Respond Time<br>1. Adequate (> 1 day)<br>2. Average (< 1 day)<br>3. Short (< 12hrs) | User expectation<br>input (details / freq) | process | output (Detail / freq) |
|---|---|---|---|---|---|---|---|---|
| MOOTW | War | Fight & Win | Combat Ops (Attack)<br>Combat Ops (Defend)<br>Combat Ops (Blockade) | Deployment | 3. short, due to plans to attack U. S. interst, intel is neede for counter-offensive attacks | high / high | high/moderate | very high/high |
| MOOTW | POT | Deter War & Resolve Conflicts | Peace enforcement<br>Noncombatant Evacualtion Operations (NEO) | Civil Unrest (eg. Ivory Coast) | 3. Time is critical. Tensions are increasing and intel is needed to determine scope of operations | High/Very High | High/Moderate | High/Moderate |
| MOOTW | POT | Deter War & Resolve Conflicts | Strikes / Raids<br>Show of forces<br>Counterterrorism<br>Peace Keeping<br>Counterinsurgency | Counter-terrorism (eg. terrorism off southern phillipines) | 1. adequate, caution must be taken to prevent detection | high / high | moderate/moderate | high/moderate |
| MOOTW | Peace | Promote peace, support law & order | Anti-terrorism<br>Disaster relief<br>Peace building | Disaster relief (eg. El Salvador) | 3. time is critical, need to be inserted quickly for intel gathering | high / high | low | high / moderate |
| MOOTW | Peace | Promote peace, support law & order | Counter drug<br>Domestic support<br>Pandemic control | Pandemic (eg. Bird Flu) | 1. Adequate. Should have ample time to access conditions (situations | moderate / high | low | low / moderate |

Low stress  Moderate stress  High stress

# Feedback from Stakeholders

- Received DJC2 JP, N71, and J88 approval of missions and project direction
- CENTCOM, EUCOM, and N71 representatives have stated “the scenarios are viable” for potential R2C2 missions
- “The Contingency Response Group [CRG] could/would deploy for all 5 missions you list. We are manned and equipped to be light and lean, so any effort to reduce manpower or equipment airlift requirements without reducing capability are always being explored.”

  - LT Col Jeffrey Renner, 86th Air Mobility Squadron, 27 April 2006

# Mission Analysis Conclusions

- Identified four perspectives that dictated R2C2 design
  - User, mission, environment, and technology
- Need for R2C2 system was recognized
- R2C2 system compliments Joint Pubs and doctrines for current and future military operations
- Challenged by multiple users, 5 scenarios were developed to meet the user's needs
- Users confirmed the potential R2C2 scenarios

# Requirements

LT Lennard Cannon

Maj. Yu Loon Ng

Capt. James Neo

# Requirements Outline

- Capability Production Document (CPD) requirements
- Broad Area Announce (BAA) requirements
- Purpose of functional flow
  - Functional flow
  - Functional tree
- R2C2 operational requirements
- Timelines
- R2C2 system requirements

# CPD Requirements

CPD 1. Agile, quick response capability with small footprint
CPD 2. Satellite connectivity designed to serve up to four operators
CPD 3. Expandable to up to ten in group collaboration with reachback to internet, NIPRNET, SIPRNET, and required multinational/coalition networks and collaboration tools and services
CPD 4. Transportable on commercial or military aircraft
CPD 5. Transportable by 2 persons
CPD 6. Operable on standard electrical power sources
CPD 7. Capable of operating on small lightweight organic power sources such as host national power grid, facility power or generators
CPD 8. Operable in austere locations
CPD 9. Provide data and voice communications and collaborative capabilities via reachback
CPD 10. Provide two simultaneous networks
CPD 11. Provide local physical storage
CPD 12. Provide limited capability to include SHF, SATCOM, UHF, TACSAT, INMARSAT, and handheld global satellite phone for SA, planning and other C2 functions

# BAA Requirements

BAA 1. Provide capability to connect to two (2) GIG-accessible, crypto-covered networks at once (e.g., NIPRNet, SIPRNet, CENTRIXS)

BAA 2. Provide secure wireless (objective) to clients

BAA 3. Utilize Everything over Internet Protocol (EoIP)

BAA 4. All equipment must meet commercial standards for carry-on luggage for commercial aircraft (Objective: Transport by two persons)

BAA 5. Provide Net Centric operations to the maximum extent possible

BAA 6. Demonstrate multi-mode (data, video, and voice) operations

BAA 7. Provide minimum of four (4) Voice Over IP (VoIP) telephonic instruments and four (4) client computers.

BAA 8. Must be able to use thin or thick clients, and must support 5 clients (threshold)/15 clients (objective)

BAA 9. Provide radio with 1.024 Mbps threshold, 4.196 Mbps objective per network

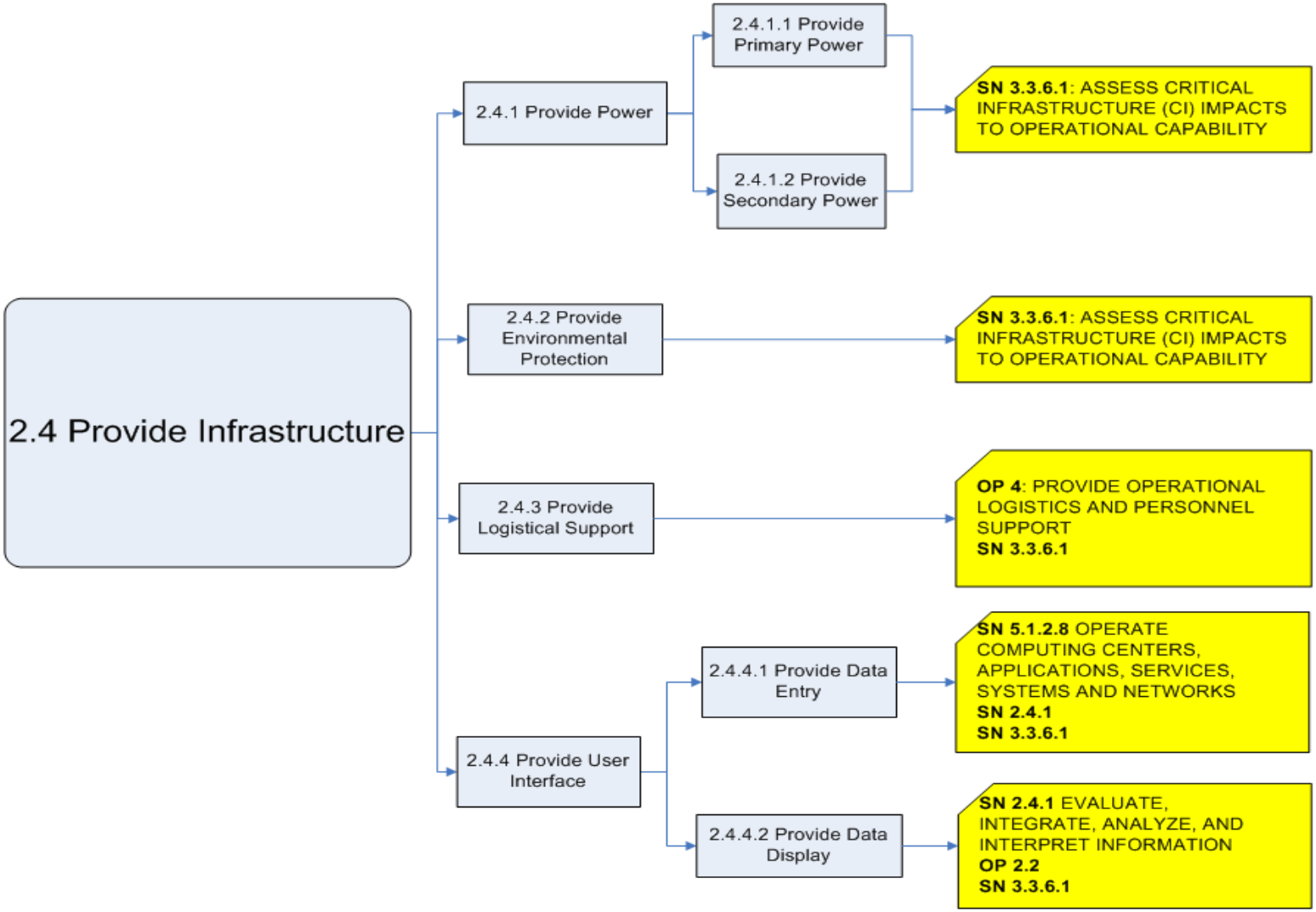
BAA 10. Provide reliability, maintainability, availability, built-in test and logistic support as an objective

BAA 11. Provide compact, ruggedized, protective packaging

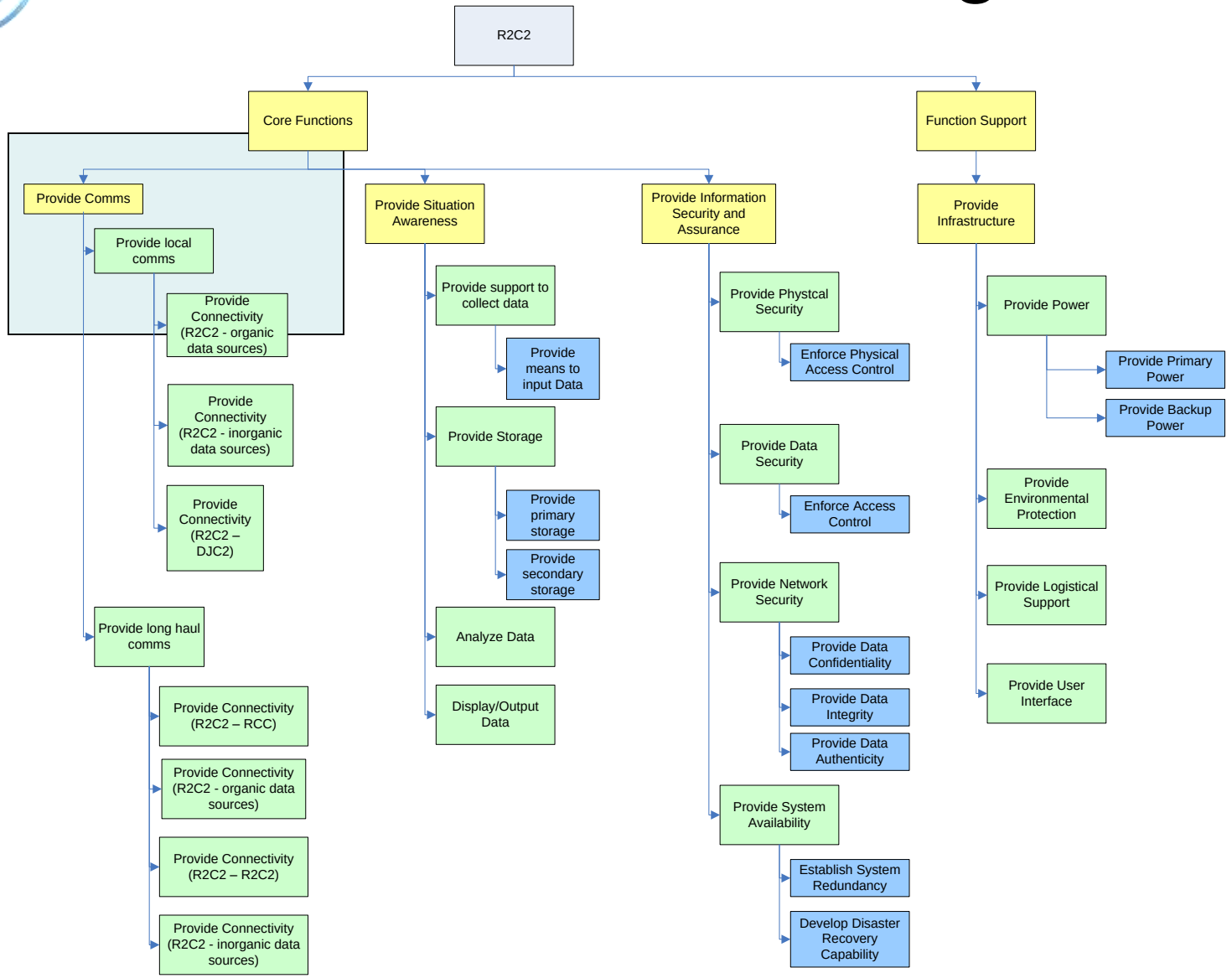
# Purpose of the Functional Analysis

- Determine system requirements
- Determine what the system does
- Determine how system will be used
- Determine range of system operations
- Determine logistical support aspects

# Functional Flow with Universal Joint Task List

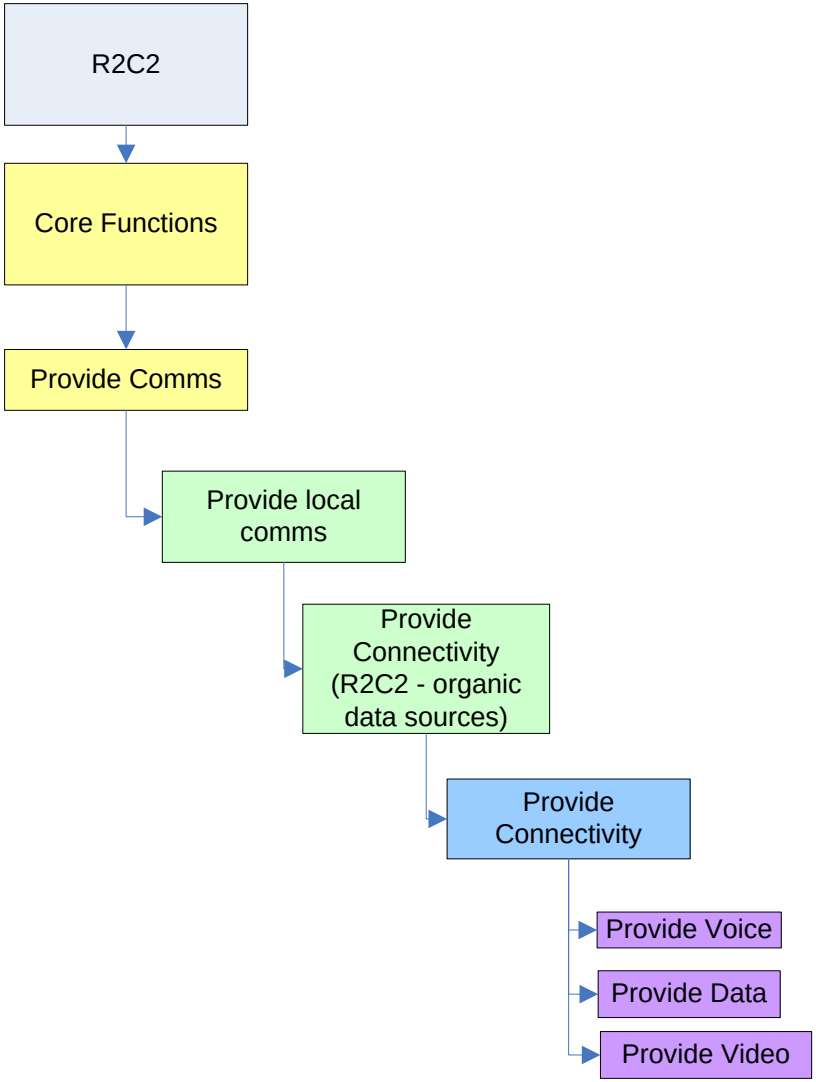


# Functional Tree Diagram



# Functional Tree Diagram

## Provide Communications



# Operational Requirements

OR 1. Provide capability of local and long haul communications to the RCC, DJC2, other R2C2 systems, coalition partners, military assets, and civilian assets

OR 2. Provide secure means, physical security, data security, and network security, of passing tactical information to the supported Commander for situation assessment

OR 3. Provide means of collecting data from organic or inorganic assets

OR 4. Provide self supporting power supply in addition to capability of accessing inorganic power supply for sustained operations

OR 5. Provide capability for operators to receive, display, analyze, filter, and pass simultaneous data from organic or inorganic assets

OR 6. Provide compact, rugged, and mobile packaging

OR 7. Provide flexibility for mission dependent software and hardware configurations

# Disaster Relief Timeline (1)

| | |
|---|---|
| 0+00 | SOUTHCOM receives reports of major earthquake in Central America |
| 0+10 | SOUTHCOM unable to contact Forward Operating Base and Embassy |
| 0+50 | SOUTHCOM alerts R2C2 crew |
| 1+00 | SOUTHCOM configures R2C2 system to include long haul communications, local communications, information management system, video or digital camera, maps, firearms, and translation software |
| 6+00 | R2C2 crew departs |
| 12+00 | R2C2 crew arrives via helicopter to airport |
| 12+20 | R2C2 crew finds U.S. personnel and begins to set up R2C2 |
| 13+00 | R2C2 crew conducts voice and data checks with SOUTHCOM and with organic communications and sensors |
| 13+30 | R2C2 crew sends video clips of the coastline and airfield taken while onboard helicopter to SOUTHCOM |
| 15+00 | R2C2 reports that U.S. military personnel accounted for at airport with minor first aid needs |
| 20+00 | R2C2 scouts find rides with local military to Embassy, fairgrounds, and Acajutla Port |
| 22+00 | Scouts give on-station report to R2C2 |

# Disaster Relief Timeline (2)

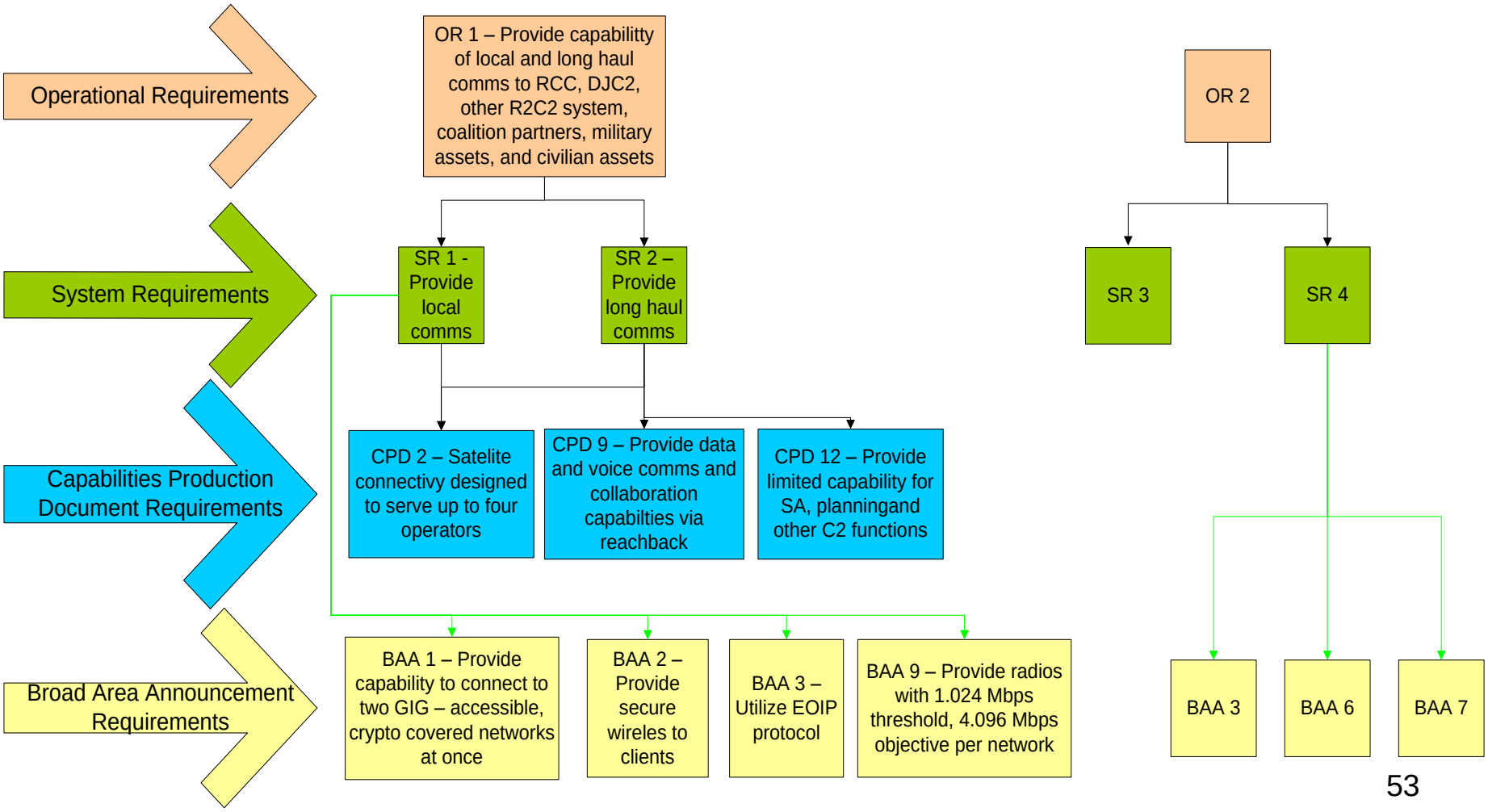
| | |
|---|---|
| +1 day | Scouts give hourly reports |
| | From the port, the scout reports damage and security issues, such as, is it suitable to receive shipments from ESG and other relief ships, are roads |
| from | port to San Salvador open, is it safe to operate? |
| | From the Embassy, the scout reports status of U.S. personnel and medical requirements |
| | From the fairgrounds, the scout reports status of creating a Civil Military Operating Center (CMOC) with Local Government, International Organizations, and NGOs |
| | R2C2 relays port and landing zone data to ESG (pictures/voice) and RCC |
| | R2C2 receives satellite imagery from RCC and shares information with the CMOC |
| | FOB provide mobile generators for power |
| + 5 day | ESG arrives |
| | Scouts pass bi-hourly reports to R2C2 |
| | R2C2 compiles reports and passes status to SOUTHCOM and ESG |
| | R2C2 crew relays evacuation data between CMOC and ESG |
| | R2C2 relays CMOC needs for medical, water, and equipment to SOUTHCOM and ESG |
| | R2C2 operations continue until some local communications have been restored |

# System Requirements (1)

| | Pandemic | Disaster Relief | Counter Terrorism | Civil Unrest | Deployment |
|---|---|---|---|---|---|
| **Bandwidth (local)** | | | | | |
| **Bandwidth (long haul)** | | | | | |
| **Security** | | | | | |
| **Data Types** | | | | | |
| **Power (Required)** | | | | | |
| **Power (Duration)** | | | | | |
| **Information Management** | | | | | |
| **Weight** | | | | | |

| Legend | Bandwidth | Security | Data Types | Power (Required) | Power (Duration) | Information Management | Weight |
|---|---|---|---|---|---|---|---|
| | >2 Mbps | Physical, Data & Network | Streaming Video | High | > 24 Hrs | High | >90 |
| | 1-2 Mbps | Data & Network | Video & Images | Medium | 12-24 Hrs | Medium | 70-90 |
| | <1 Mbps | Data | Voice | Low | < 12 Hrs | Low | <70 |

# Requirements Mapping



# Requirements Conclusion

- Top-Down Systems Engineering approach used to develop requirements
- Mission oriented requirements
- Requirements tied to strategic guidance (UJTLS)
- Functional Analysis uncovered additional requirements (power, scouts, data, and security)


# R2C2 System Architecture

ENS Jim Colgary

Ms. Chin Chin Ng

Mr. Guan Chye Tan

# Architecture Outline

- Communication links
- Architecture Baseline
- Market survey
- Primary, Local, and Civil/Military Suites
- Information Management (IM) tools
- Power

# Identification of Communication Links

**Civilian Communication –**

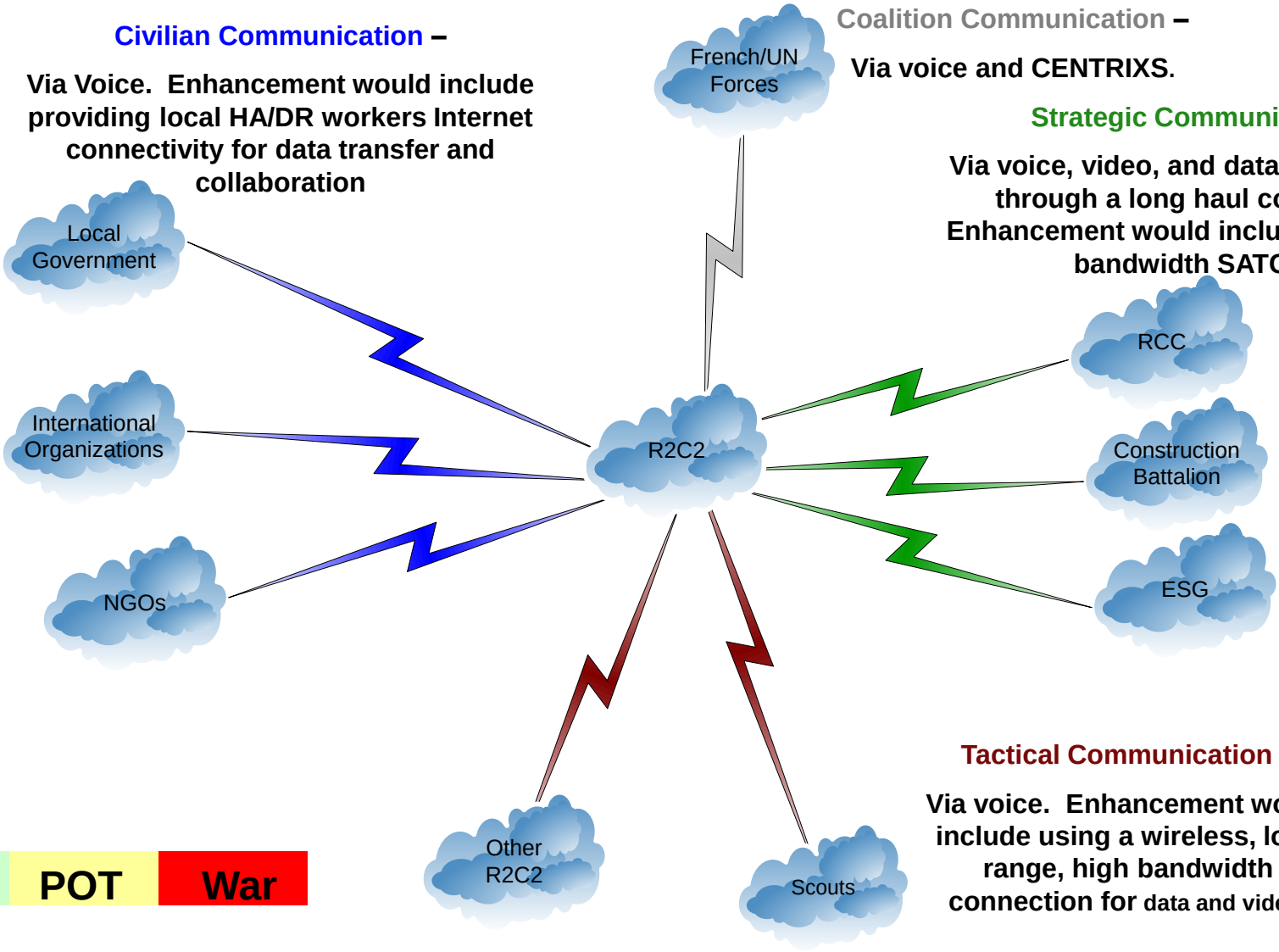
**Via Voice. Enhancement would include providing local HA/DR workers Internet connectivity for data transfer and collaboration**

**Coalition Communication –**

**Via voice and CENTRIXS.**

**Strategic Communication–**

**Via voice, video, and data transmission through a long haul connection. Enhancement would include using high bandwidth SATCOM**

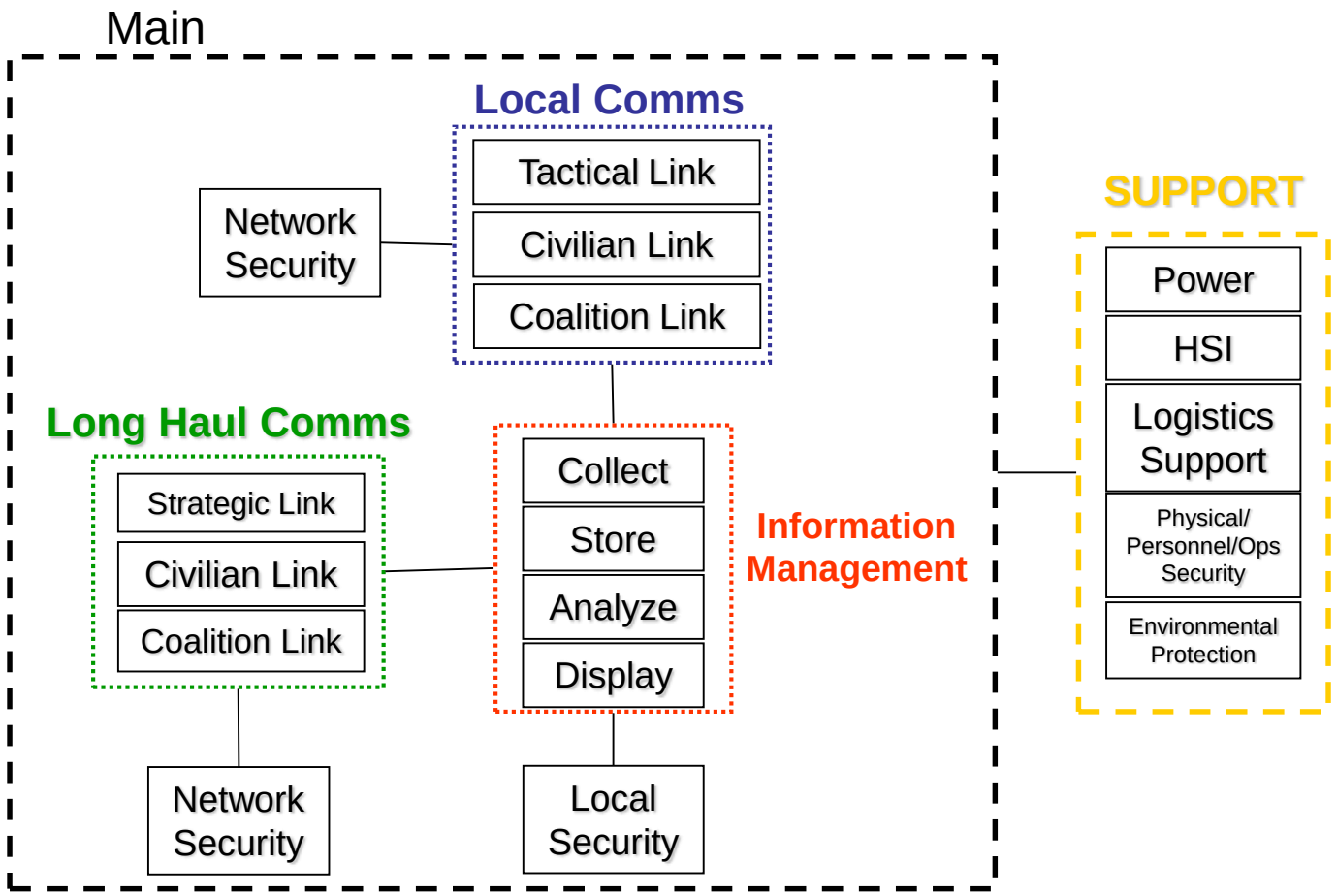



**Tactical Communication –**

**Via voice. Enhancement would include using a wireless, long range, high bandwidth connection for data and video.**

**Peace** **POT** **War**

# R2C2 Architecture Baseline



# Market Survey

- The R2C2 team was divided into smaller groups to research areas of communications, Information Management, power, and sensors
- Conducted to fully identify all methods and equipment necessary to fulfill the five functional areas
- All researched equipment and software were geared towards creating a small, portable unit for use in an austere location
- All results acted as alternatives for each area of research

# Communication Alternatives

| Local Voice COM |
| --- |
| Satellite Phones |
| *GlobalStar* |
| *Iridium* |
| Radio Phones |
| Cell Phones |
| Personal Cell System |
| Military Radio |
| *Manpack Radio* |
| *Land Mobile Radio (LMR)* |

| Local Data COM |
| --- |
| Wireless Personal Area Network (PAN) |
| WiFi: 802.11b |
| WiMax: 802.16 |

| Long Haul SATCOM Terminals |
| --- |
| Norsat Globetrekker |
| Norsat U.P. 5200 |
| Swe-dish IPT-i Mil Suitcase |
| TCS DVM-90 |
| GSI GlobeComm Auto-Explorer (.77m) |

Alternatives were identified and evaluated against each other to determine the best option in each category

# IM, Power, and Sensor Alternatives

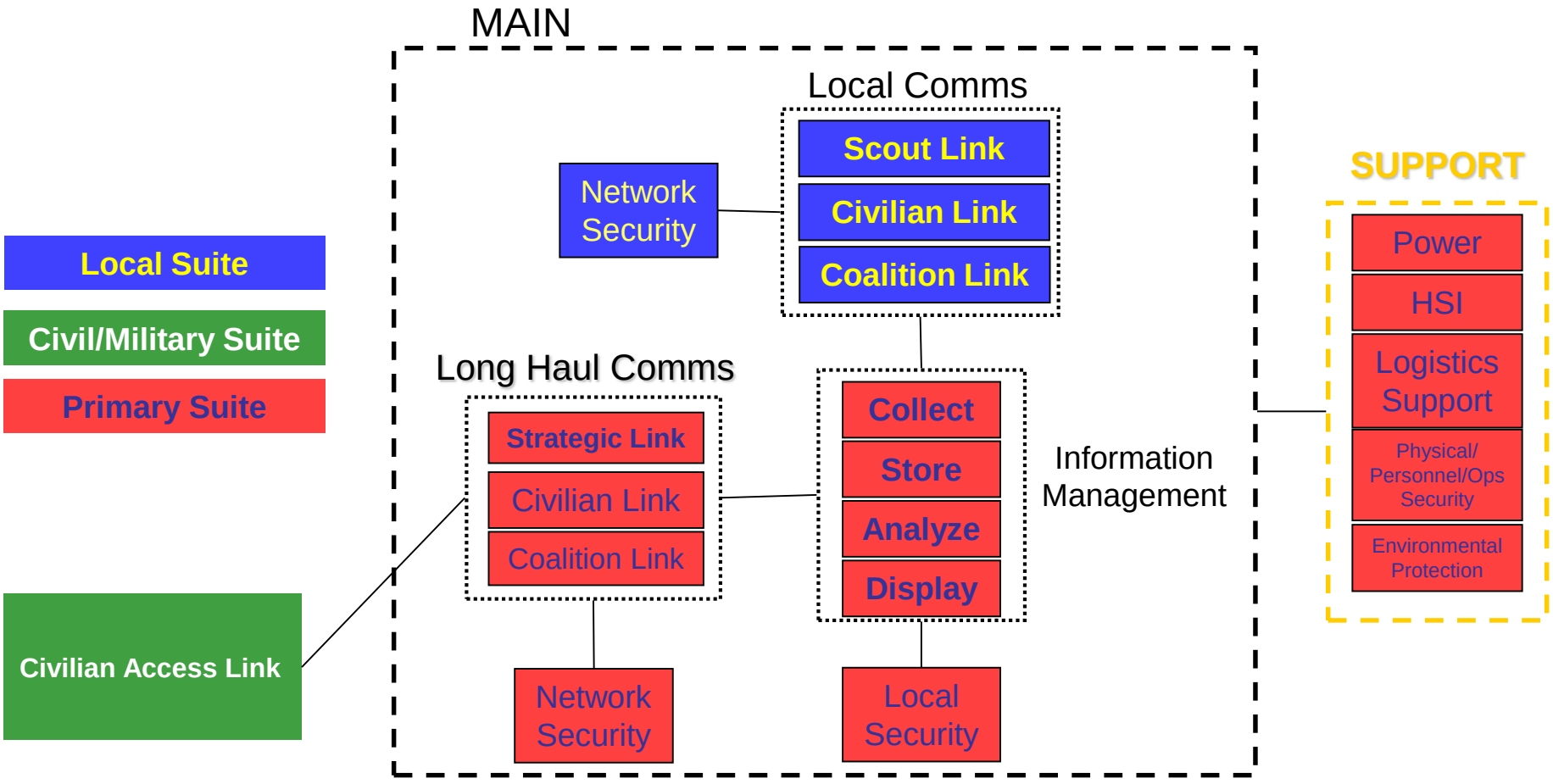
| Information Management |
| --- |
| Geospatial Information Application |
| *Google Earth* |
| *Arc View* |
| *Microsoft Terraserver* |
| *FalconView* |
| *GCCS-J* |
| Collaborative Information Environments |
| *DCTS* |
| *IWS* |
| *Groove* |
| Digital Storage |
| *Magnetic* |
| *Optical* |
| *Flash* |

| Power System |
| --- |
| Generator (portable) |
| External Battery |
| *BA5590 Military* |
| *N-Charge* |
| Micro Fuel Cell |
| Solar |
| Wind |

| Sensors |
| --- |
| Satellite Imagery |
| *Synthetic Aperture Radar (SAR)* |
| *Infrared* |
| *Electro Optics* |
| Aerial Imagery |
| *Unmanned Aerial Vehicle* |
| *On-board systems for UAV* |
| Seismograph |
| Meteorological sensors |
| Biometric Sensors |
| Virus Test Kit |
| Biological Sensors |
| Fix Position Systems |

# R2C2 Architecture Baseline

## Highlighted Suites

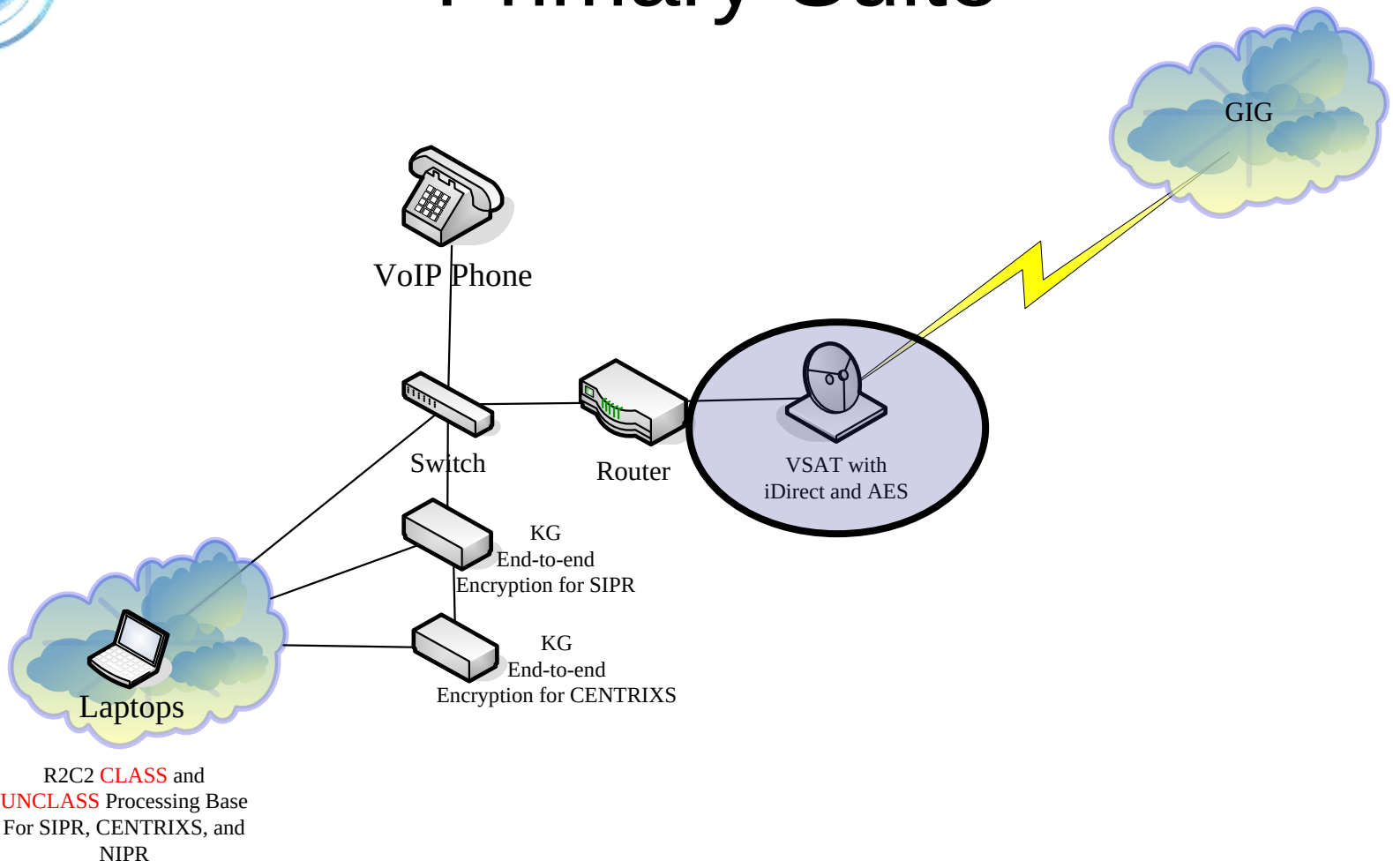


# Suites Design Alternatives

- Reduced to 8 potential combinations through trade offs

| Primary Suite | Local Suite | Civil/Military Suite |
|---|---|---|
| *Alternatives* | *Alternatives* | *Alternatives* |
| •**VSAT Terminal 1** | **Voice**<br>•Satellite Phones or Military Radios (manpack/handheld LMRs) | •**Integrated** |
| •**VSAT Terminal 2** | **Voice and Data**<br>•WiMax/WiFi coupled with SAT Phones or radios | •**Separate Unit** |

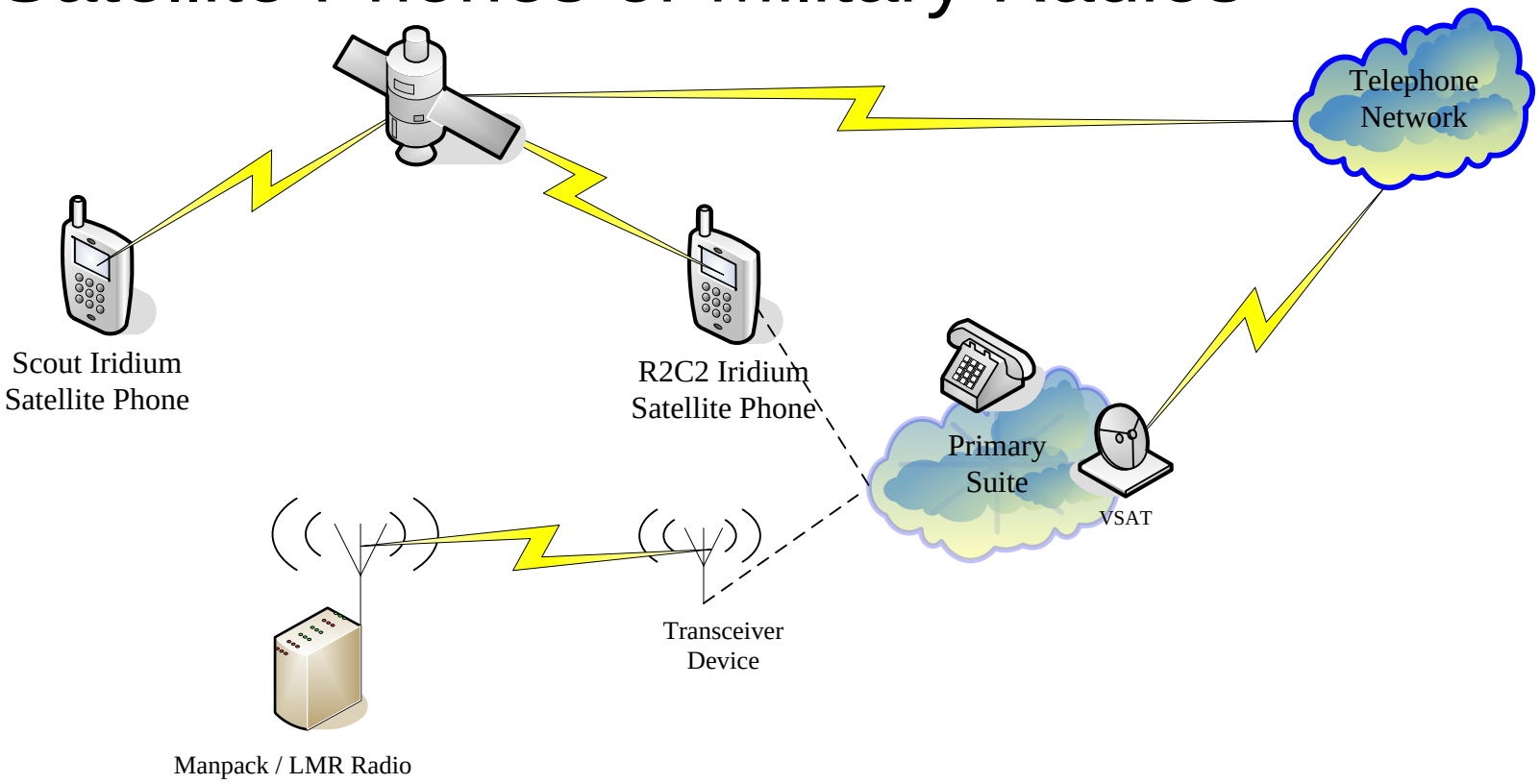
# Primary Suite




The satellite terminal has the most impact on the system performance and was the key component evaluated

# Local Suite – Voice Alternatives

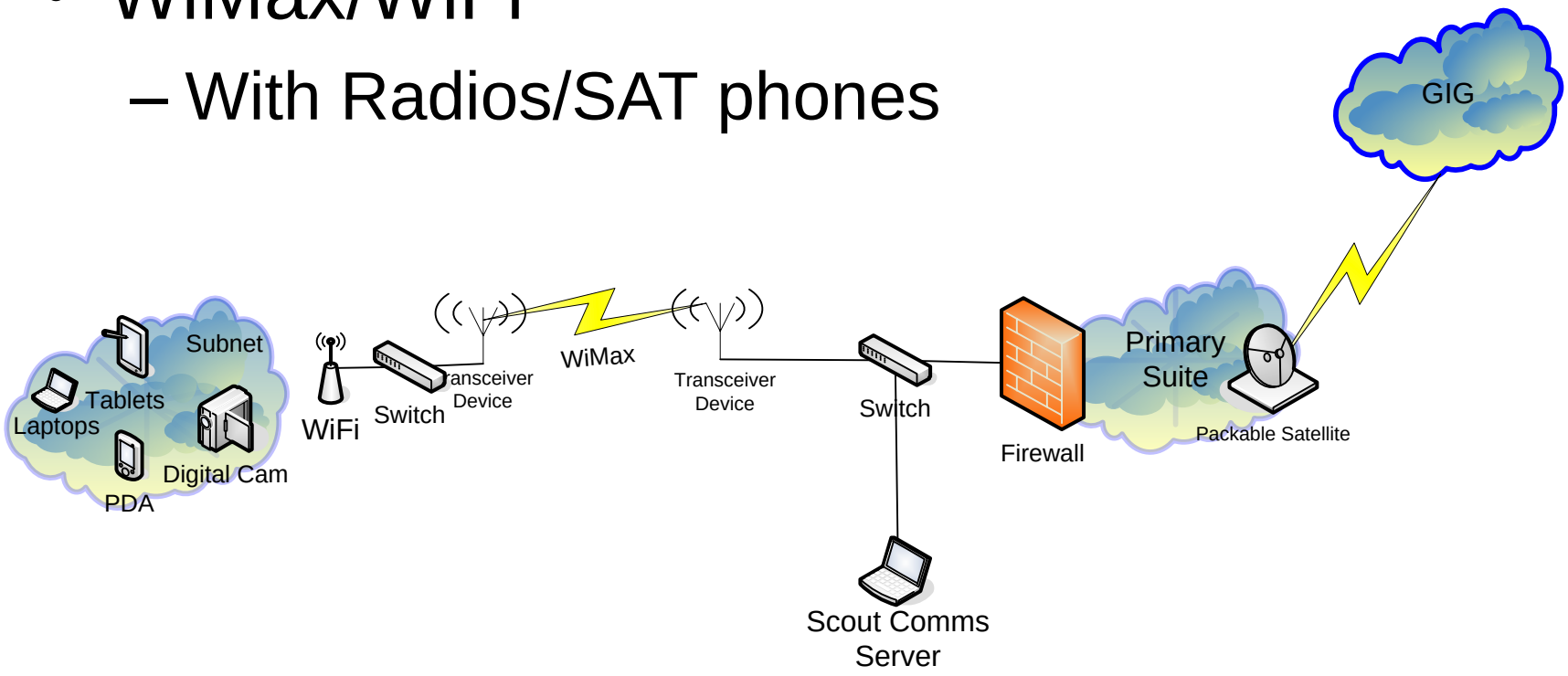
- Satellite Phones or Military Radios




SAT Phones offer voice transmission to another SAT Phone or to the R2C2 VoIP phone. Military radios transmit radio to radio

# Local Suite – Voice/Data Alternative C

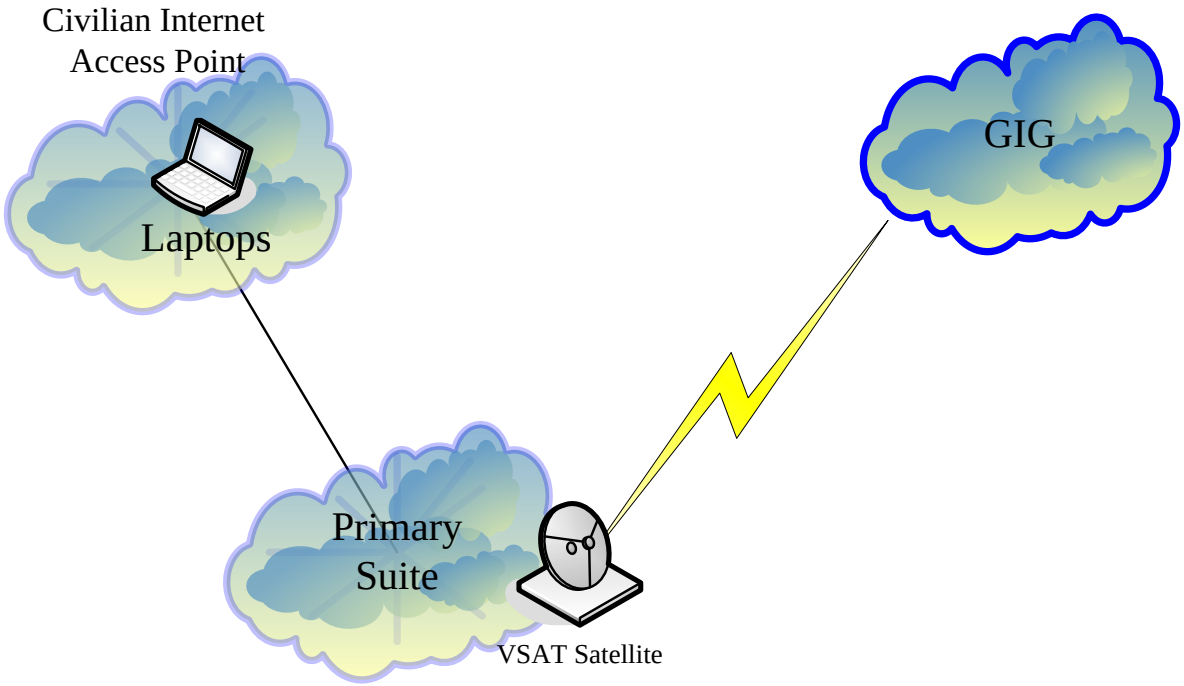
- WiMax/WiFi
  - With Radios/SAT phones




Data Link allows for video, pictures, and data to be transmitted over a long distance. The scout server and firewall protect the R2C2's security and bandwidth

# Civil/Military Suite – Alternative A

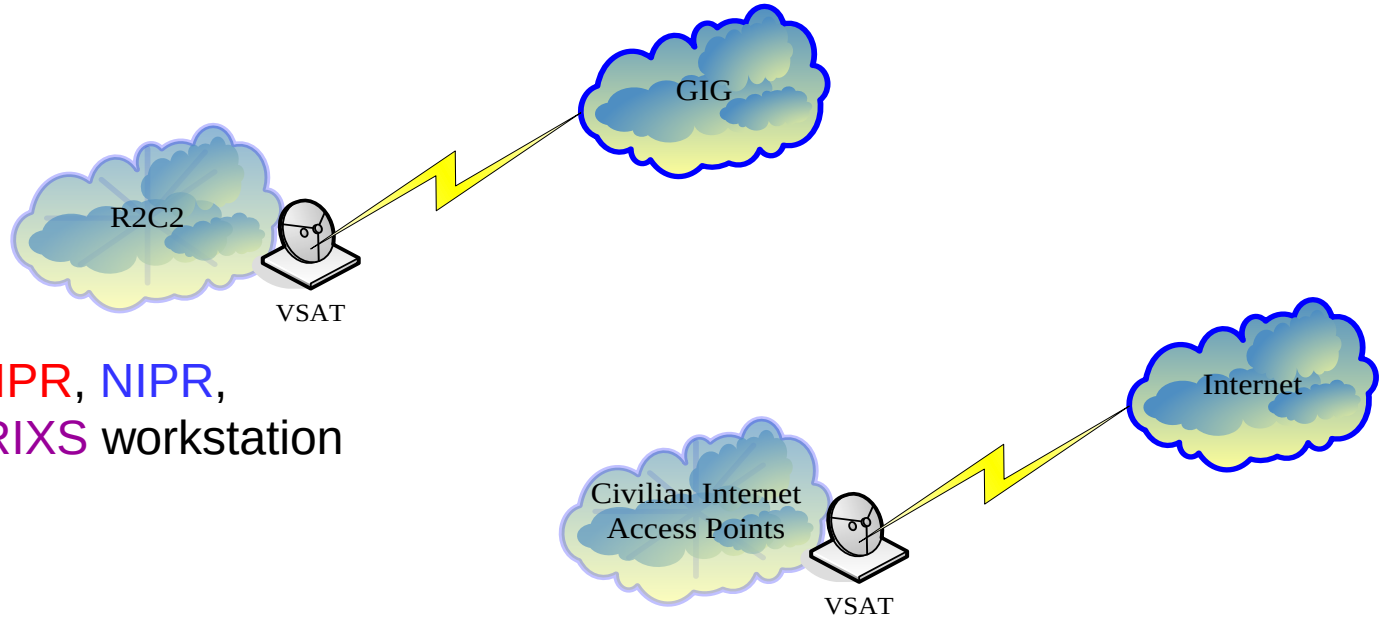
- Integrated Civil/Military Suite




Integrated CMS plugs into the existing PS router allowing civilian use of VSAT to access the internet

# Civil/Military Suite – Alternative B

- Separate CMS




SIPR, NIPR, CENTRIXS workstation

Civilian Internet workstation

Separate CMS utilizes an entirely separate VSAT and package of network gear, segregating military and civilian work

# Information Management Tools

- We have identified that the R2C2 system must incorporate
  - Collaborative Information Environment (CIE)
    - Defense Collaborative Tool Suite (DCTS)
  - Geospatial Information tools
    - FalconView (GIS software for COP and 3D terrain visualization)
  - Non-volatile Digital storage
- Analysis of the DJC2 software suite to be loaded on Core System laptops contains the necessary applications for R2C2 IM
  - Enhances commonality, ease of production, and interoperability

# Power

- System usage power requirements were matched up with power equipment from the market survey
- Trade offs were done to conclude that:
  - Very small, gas generators do exist on the market and are capable of providing the necessary power
  - Batteries containing enough power to sustain the system for the required duration do not exist
  - Solar and fuel cell technology is not mature enough to seriously consider

# Architecture Conclusions

- Overall system design is segmented into three suites
  - PS, LS, and CMS
- PS has two VSAT alternatives
- LS has two voice alternatives and one data/voice alternative
  - SAT phones and Military Radio
  - WiMax/WiFi link
- CMS has two alternatives
  - Integrated or separate
- R2C2 will use DJC2 IM package
- R2C2 must have generator or battery organic power

# Information Assurance

Maj. Eric Wong

Maj. Harry Lim

Maj. Yu Loon Ng

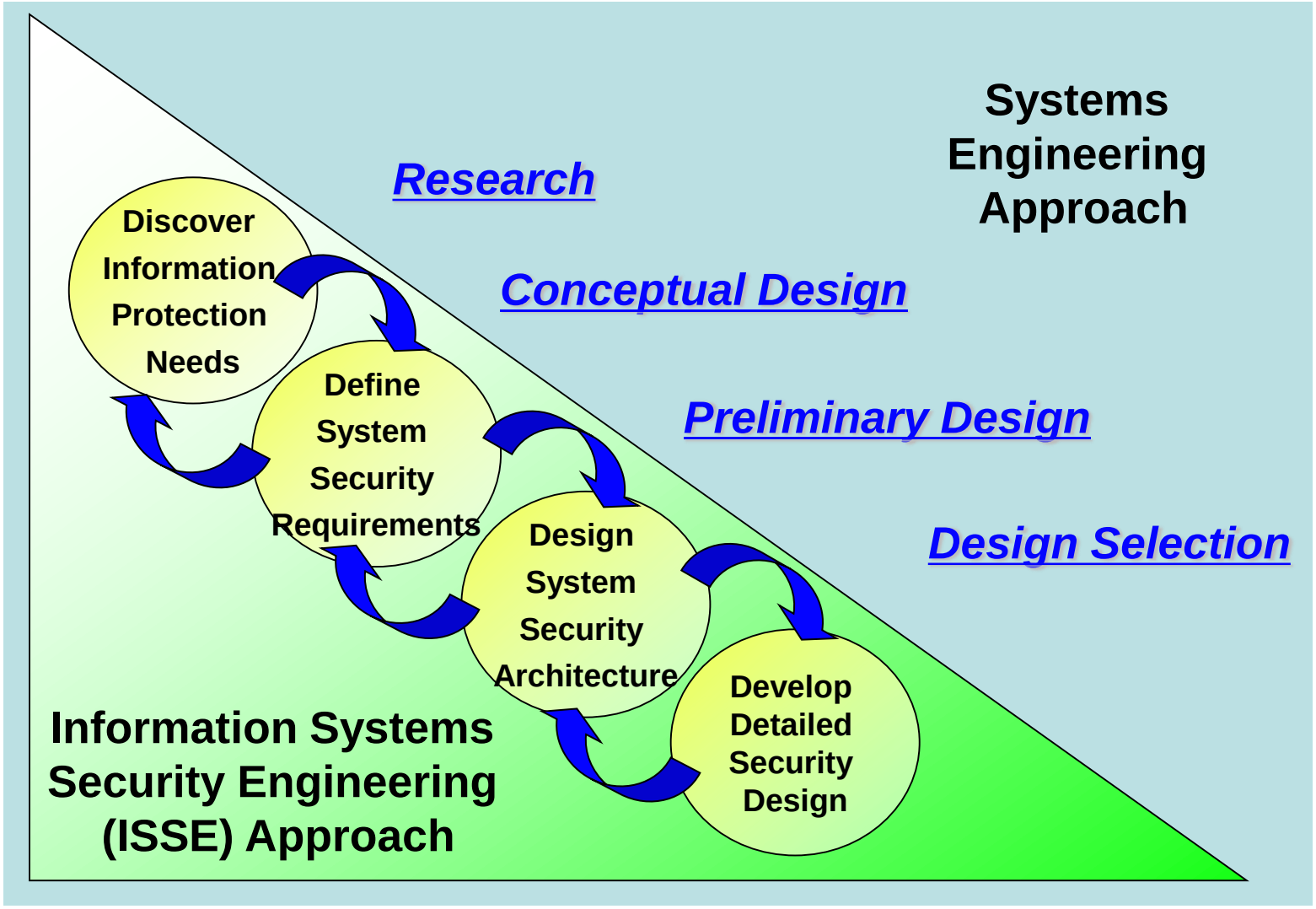
Ms. Chin Chin Ng

Mr. Guan Chye Tan

# Information Assurance Outline

- Security engineering process
- Discover information protection needs
- Define system security requirements
- Design system security architecture
  - Architectural approach
  - Defend the network and infrastructure
  - Protect the boundary
  - Secure the computing environment
- MLS technology research
- Conclusion

# Security Engineering Process



# Discover Information Protection Needs

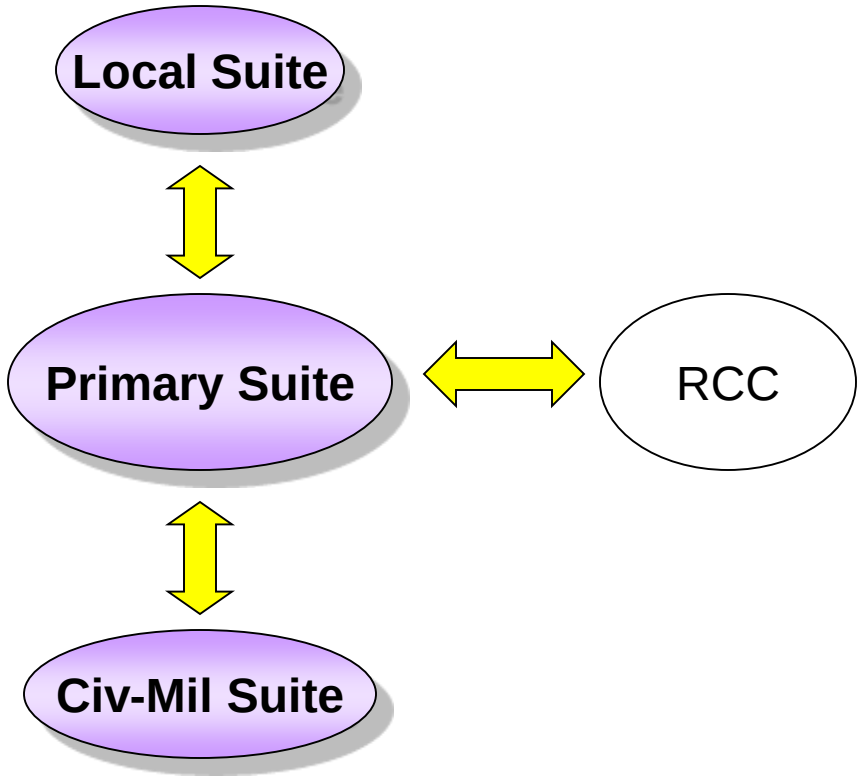
- Mission analysis
- Cyber threats
  - **Passive attack**
  - **Active attack**
  - **Close-in attack**
  - Insider
  - Distribution

# Define System Security Requirements

- Broad Goals
  - Confidentiality
  - Integrity
  - Availability
  - Identification & Authentication
- Connectivity
  - SIPRNET
  - NIPRNET
  - Coalition & Civil/Military

# Design System Security Architecture

- Defining the context
  - Enclaves
    - Primary Suite
    - Local Suite
    - Civil/Military Suite
  - Boundaries
    - Primary – Local
    - Primary – RCC
    - Primary – CMS



# Architectural Approach


Defend the Network

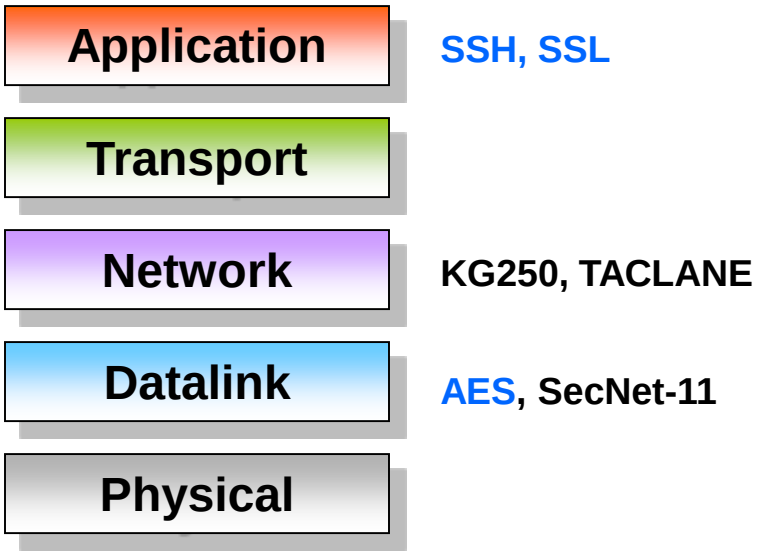
Defend the Enclave Boundaries

Secure the Computing Environment

# Defend the Network

- Communications networks to be defended
  - Satellite
  - 802.11
  - 802.16

- Protection measures
  - Multiple layers of encryption




TCP/IP Model

  - Network Identification & Authentication

# Protect the Boundary

- Firewalls
  - Hardware-based
  - Stateful packet filtering
- Guards
  - Control data flow from Local to Primary suite
  - E.g. scout comms server
- Network monitoring
  - Internal & external connections
  - Host-based IDS
  - Signature-based detection

# Secure the Computing Environment (1)

- Identification & Authentication
  - Use approved I&A mechanisms
- Auditing & Logging
  - Log all critical activities
  - Log analysis
- Operating Systems
  - Current EAL4+ systems
    - MS Windows Server 2003
    - MS Windows XP
    - Sun Solaris 9
- File Encryption System

# Secure the Computing Environment (2)

- Malicious Code Protection
  - Host-based
  - Virus protection
  - Anti-spyware
  - Firewall
  - Internet connection via Teleport
- Vulnerability scanners
  - Remotely by RCC
  - Vulnerability identification & analysis
  - Password cracker

# MLS Technology Research

- Multi-Level Security (MLS)
  - Current
    - Security Enhanced Linux
    - Trusted Solaris 8 (EAL4)
  - Upcoming
    - Active research at Center for Information Systems Security Studies & Research (CISR)
    - Trusted Computing Exemplar (TCX)
- Multiple Independent Level Security (MILS)
  - University of Idaho active in MILS research

# Conclusion

- Defense-in-Depth strategy
  - Defend the network
  - Defend the enclave boundaries
  - Secure the computing environment
- Long term plan
  - Incorporate results of MLS research

# Modeling

ENS Nick Minerowicz

Maj. Eric Wong

# Modeling Outline

- Modeling intro and methodology
- Primary Suite analysis
  - Weights & capability
- Local Suite model
  - Weights & results
- Civil/Military Suite model
  - Weights & results
- Tradeoffs
- Architecture selection

# Why Are We Modeling?

- To test assumptions
  - Do the expectations in the CONOPS fall in line with architectures?
- To answer questions
  - How well do the system requirements and our assumptions match up?
- To drive the analysis process
  - How will our results influence the final choice of architecture?
  - Do we meet the key requirements?

# What Questions Are We Asking?

- What value is there in a dedicated data link between scouts and the R2C2?
- Does the R2C2 utilize too much bandwidth to share, or is a separate Civil/Military system warranted?
- Does our choice of architecture still fit the two-man transportable requirement?

# Methodology

- Analyze the differences between developed architectures using several key criteria
  - Time taken to transmit messages
  - Bandwidth utilization
  - Size / Weight
- Using outputs, determine the architecture that best meets requirements and scenarios

# Primary Suite

- The largest two factors driving the selection of a Primary Suite are:
  - The choosing of a satellite terminal that fulfills outlined requirements
  - Developing a system that maintains the two-man transportable objective

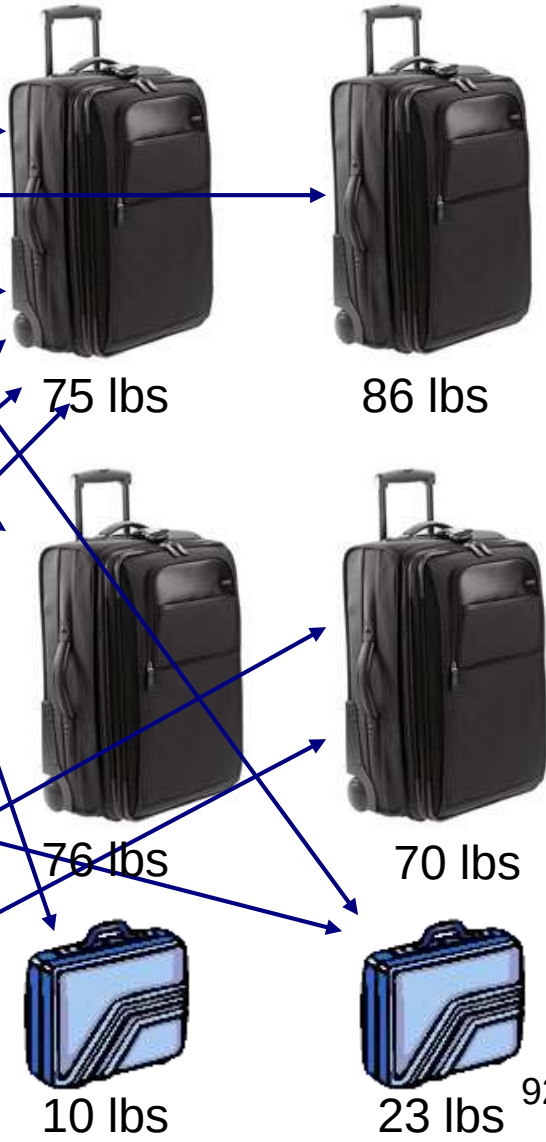
# PS Satellite Terminals

| Sat System | Bands | | | Weight | | Transmit Rate | Receive Rate | License | Power Consumption |
|---|---|---|---|---|---|---|---|---|---|
| | *X* | *Ku* | *Ka* | *lbs* | *# of cases* | *Mbps* | *Mbps* | | *W AC* |
| Norsat Globetrekker | optional | yes | optional | <50 | 1 | 4 | 4 | Pending | 480 |
| Norsat U.P. 5200 | optional | yes | optional | 46/46 | 2 | 8.448 | 8.448 | Pending | 480 |
| Swe-dish IPT-i Mil Suitcase | yes | yes | optional | 86 | 1 | 4 | 4 | Yes | 650 |
| TCS DVM-90 | no | yes | no | 40 | 1 | 2.4 | 2.4 | Pending | 500 |
| GSI GlobeComm Auto-Explorer (.77m) | no | yes | no | 48/50 | 2 | 4.2 | 4.2 | Yes Pending | 375 |

While the Swe-dish IPT best meets our objectives, it does so at the expense of weight and power consumption

# Primary Suite Weight

| Device | Qty | Weight (lbs) |
|---|---|---|
| Laptops & Accessories | 5 | 50 |
| Swe-dish IPT | 1 | 86 |
| Swe-dish cabling/support | 1 | 10 |
| Routers | 2 | 28 |
| Switches | 3 | 33 |
| VTC Gear | 1 | 4 |
| VoIP Phones | 2 | 14 |
| SecNet 11 Access Point | 1 | 2 |
| KG250 | 2 | 13 |
| Packaging | 3 | 45 |
| Network Cables | 1 | 5 |
| Generator & Accessories | 1 | 50 |
| Total | | 340 |

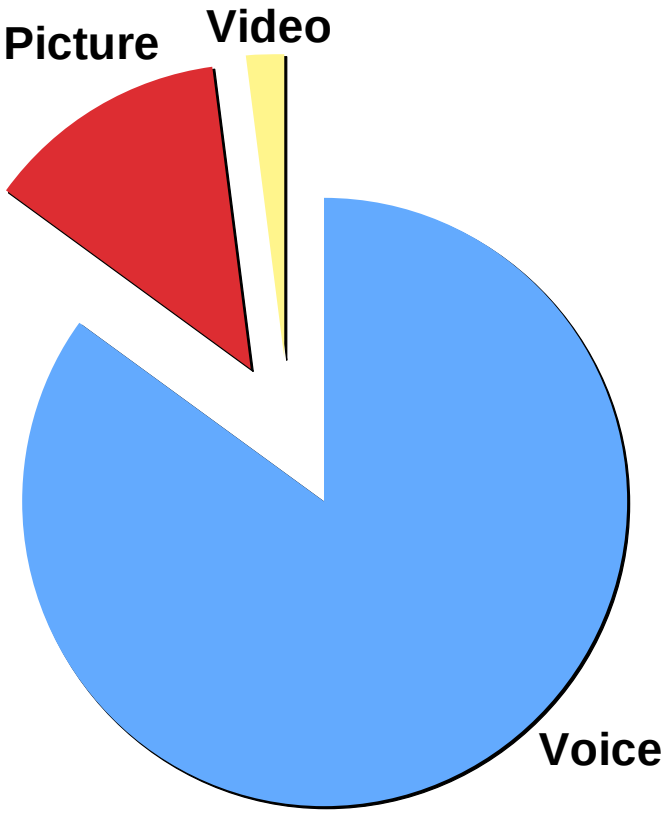


# Local Suite Communications

- Two options were explored
  - Voice communication with a data link
    - Data over 802.16 (WiMax)
  - Voice communication without a data link
    - Data via physical transit
- A model was developed following assumptions using scenario inputs and CONOPS development

# Local Suite Assumptions

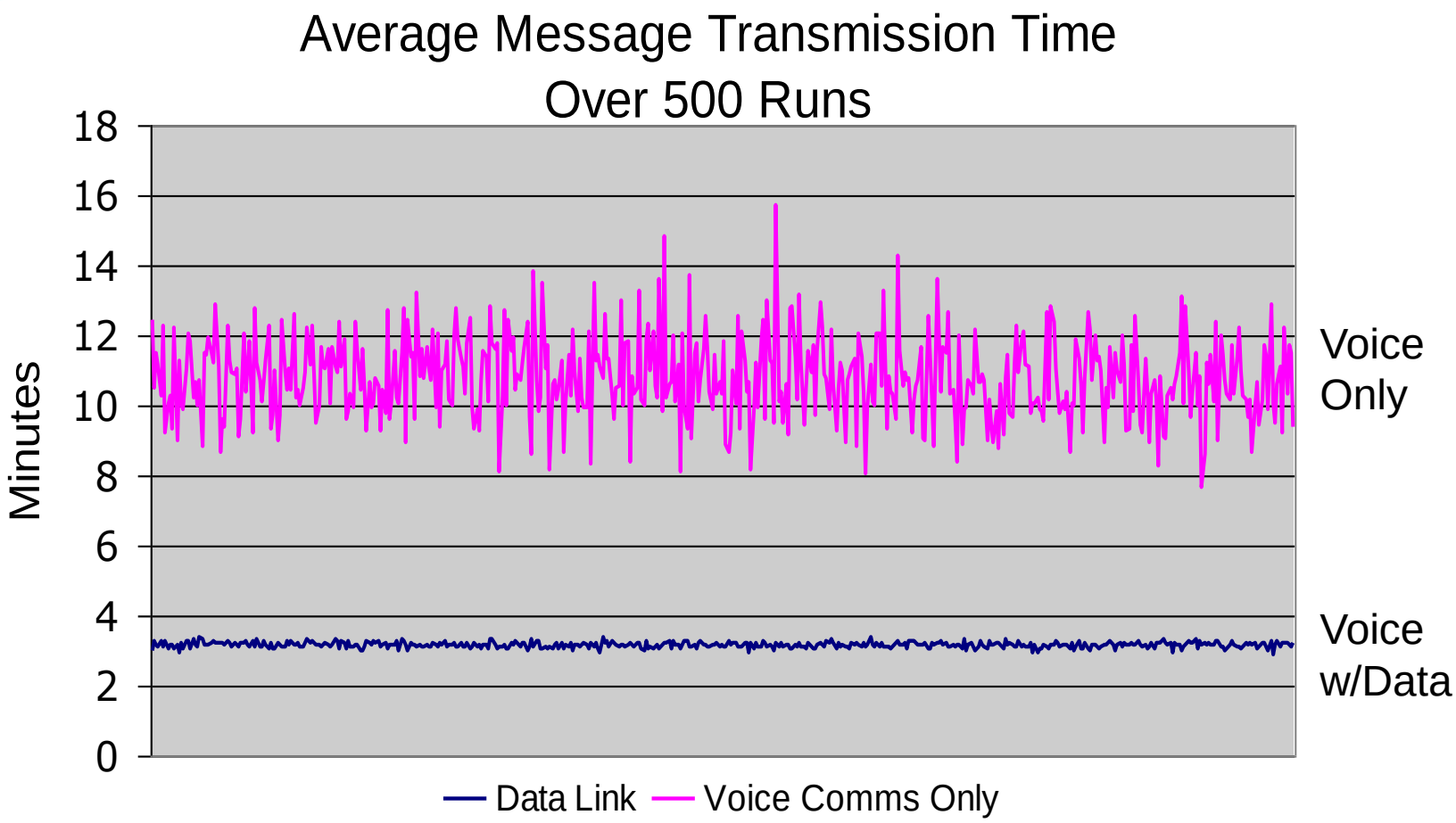
- Basic voice transmissions occur the majority of the time
- There occasionally may be data that needs to be passed back
- The “data link” may be accomplished by a vehicle in some architectures
- All components have electrical power



# Local Suite Assumptions

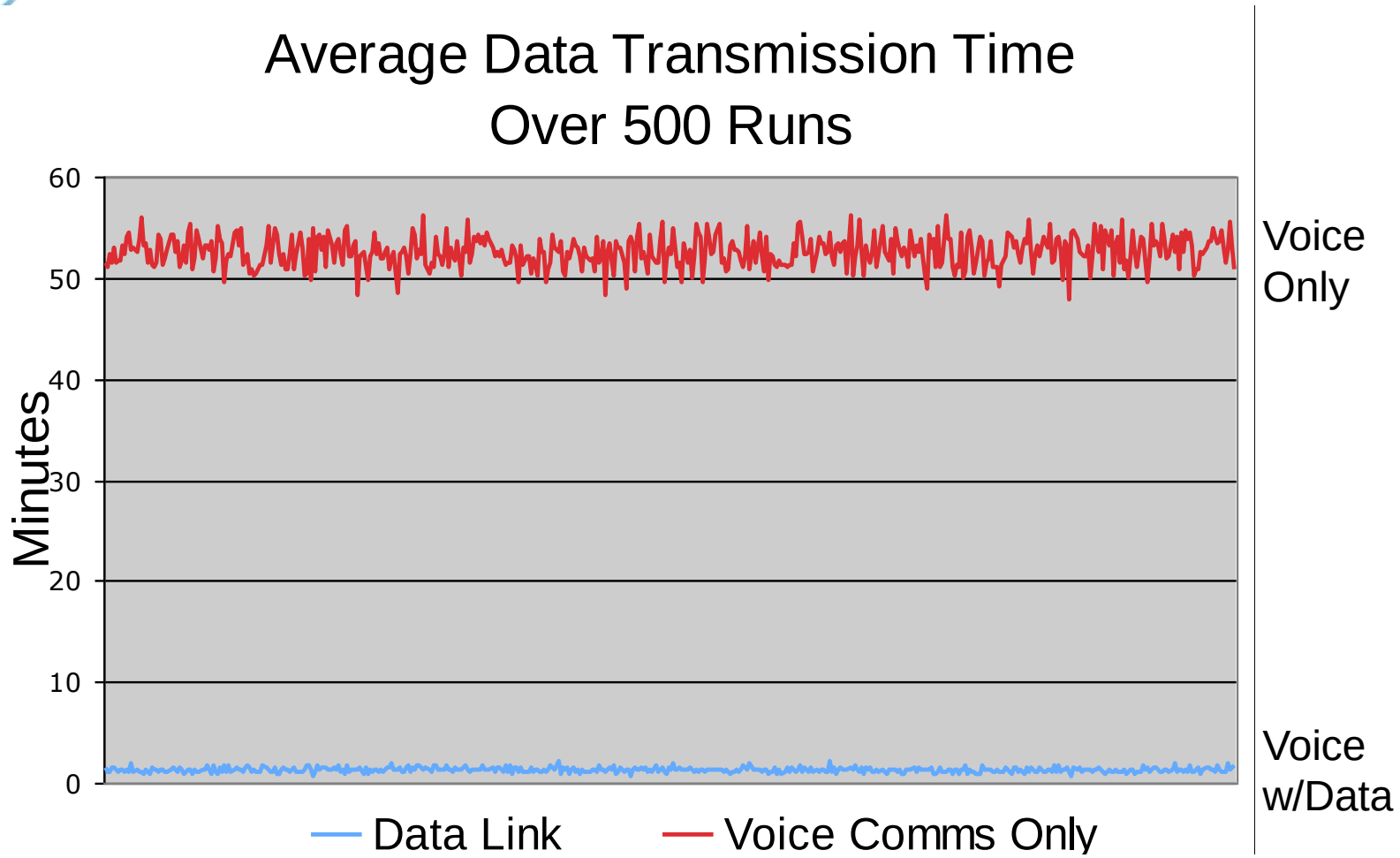
- Hourly scheduled communications from scouts
- Scouts are stationed about 35 miles from the R2C2 Primary Suite and have access to vehicular travel

# Local Suite Results




Data transmission delays are larger without a dedicated data link

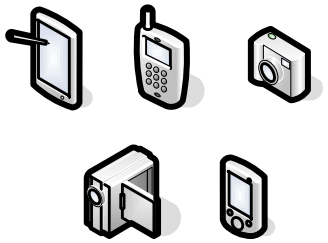
# Local Suite Results




When looking at data transmissions alone, it the difference in delay is approximately 50 minutes

# Voice Only Equipment (per scout team)

| Device | Qty | Weight (lbs) |
|---|---|---|
| Iridium phone | 1 | 0.5 |
| PDA | 1 | 0.5 |
| Digital camera | 1 | 0.5 |
| Video camera | 1 | 1 |
| Package | | N/A |
| Total | | 2.5 |



Satellite Phones/Info Collecting Device

**2.5 lbs**

# Wireless Equipment (per scout team)

| Device | Qty | Weight (lbs) |
|---|---|---|
| Voice Comm. | 1 | 2.5 |
| 802.16 Transceiver | 1 | 9 |
| Additional Laptop | 1 | 8 |
| Networking Gear/Cables | 1 | 5 |
| 802.16 Antenna | 1 | 5 |
| Package | 1 | 3 |
| 802.16 Transceiver | 1 | 9 |
| 802.16 Antenna | 1 | 5 |
| Cables | 1 | 5 |
| Total | | 51.5 |

Wireless Equipments/ Voice Comm & Info Collecting Devices
**51.5 lbs**

# Local Suite Recap

## Capability vs. Weight Tradeoff

| Configuration | Estimated Weight | Characteristics |
|---|---|---|
| Voice-only link | 2.5 lbs. | •Slow data transfer<br>•Lightweight |
| Voice/Data link | 51.5 lbs. | •Rapid data transfer<br>•Heavy |

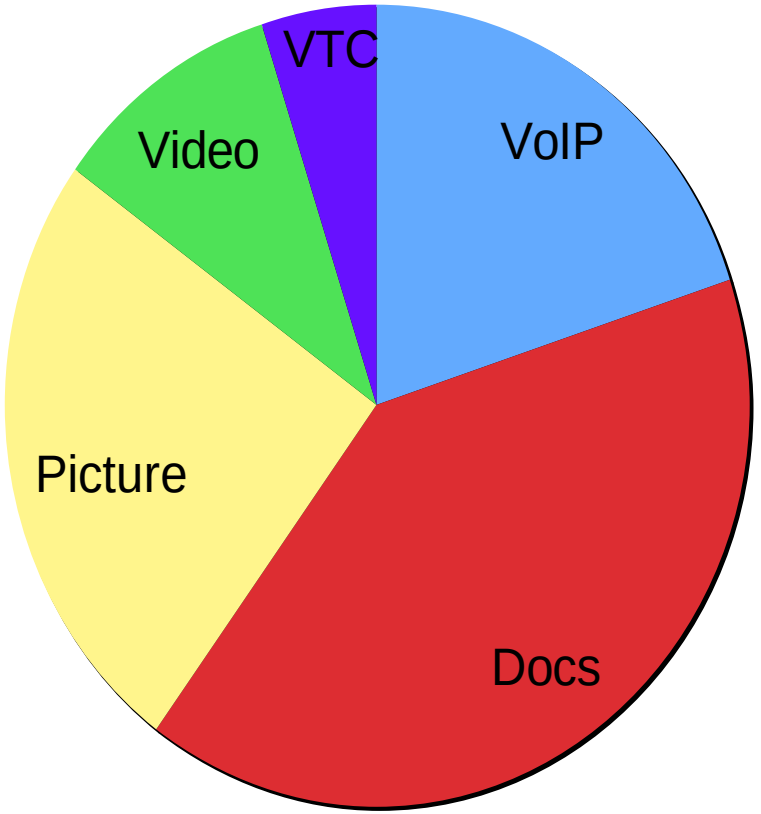
While a data link can rapidly send data, it is done at significant weight increase

# Civil/Military Suite

- The need for a dedicated CMS addendum package depended on understanding bandwidth usage of the Primary Suite
- If bandwidth modeling shows a significant excess, then it will not be necessary to provide a separate satellite link

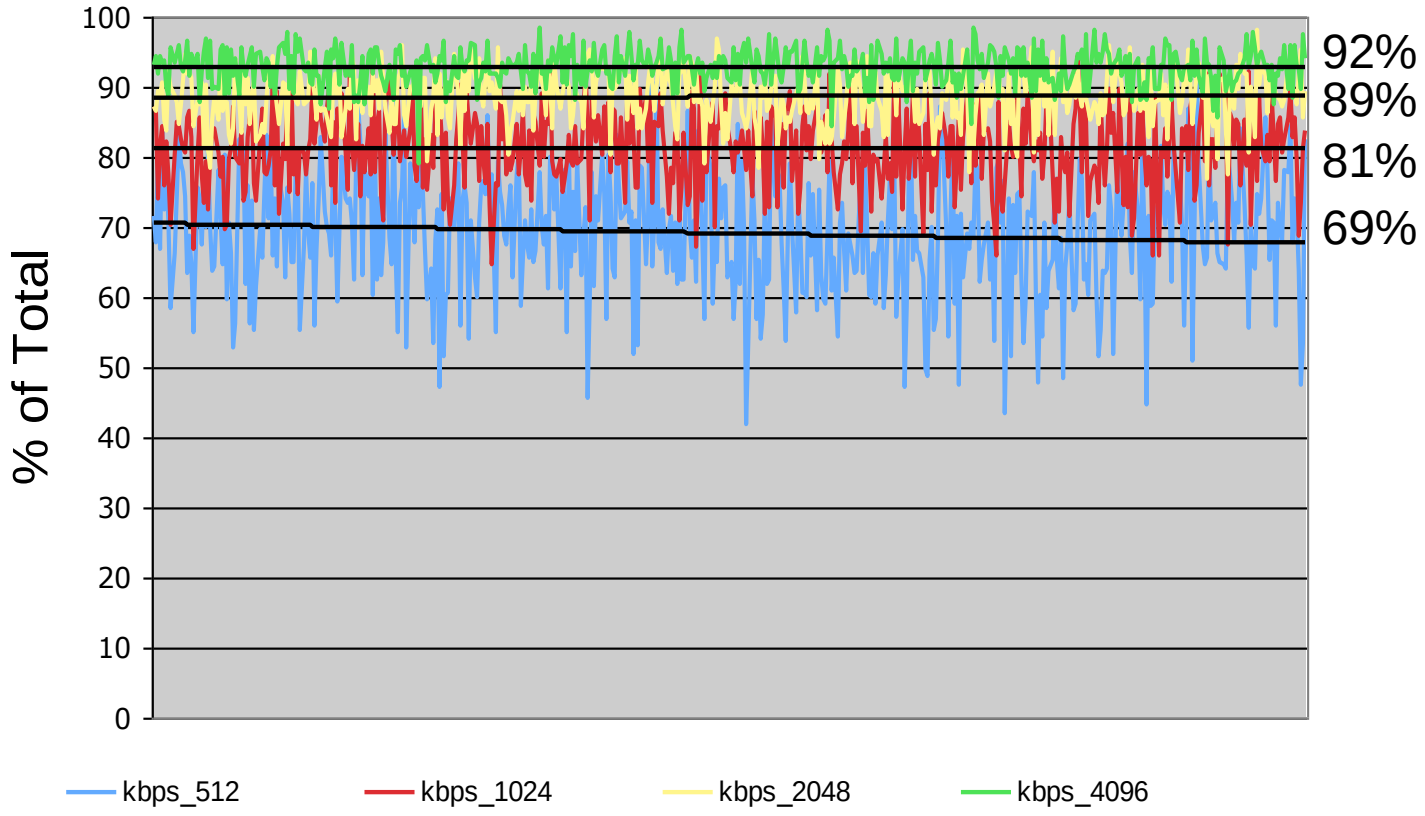
# Civil/Military Suite Assumptions

- Data communication to and from the R2C2 is IP-only data
- Continuous electrical power
- Added overhead to account for satellite communications



# Civil/Military Suite Results

Unused Bandwidth over 500 Runs




Even with a low uplink bandwidth, the R2C2 CONOPS leave a significant excess to be used by others

# Civil/Military Suite Weight

| Device | Qty | Weight (lbs) |
|---|---|---|
| Generator | 1 | 50 |
| Package | 1 | 10 |
| Cable | 1 | 10 |
| Total | | 70 |

70 lbs

| Device | Qty | Weight (lbs) |
|---|---|---|
| Norsat Globetrekker | 1 | 50 |
| Package | 1 | 10 |
| Total | | 60 |

60 lbs

| Device | Qty | Weight (lbs) |
|---|---|---|
| Laptop | 2 | 16 |
| Cable | 1 | 15 |
| Router | 1 | 5 |
| Package | 1 | 10 |
| Total | | 46 |

46 lbs

# Civil/Military Suite Recap

## Capability vs. Weight Tradeoff

| Configuration | Estimated Weight Addition | Characteristics |
|---|---|---|
| Integrated CMS Suite | 0 lbs | Negligible extra equipment needed |
| Separate CMS Suite | 106 lbs (+70 lbs generator) | Provides extra capacity |

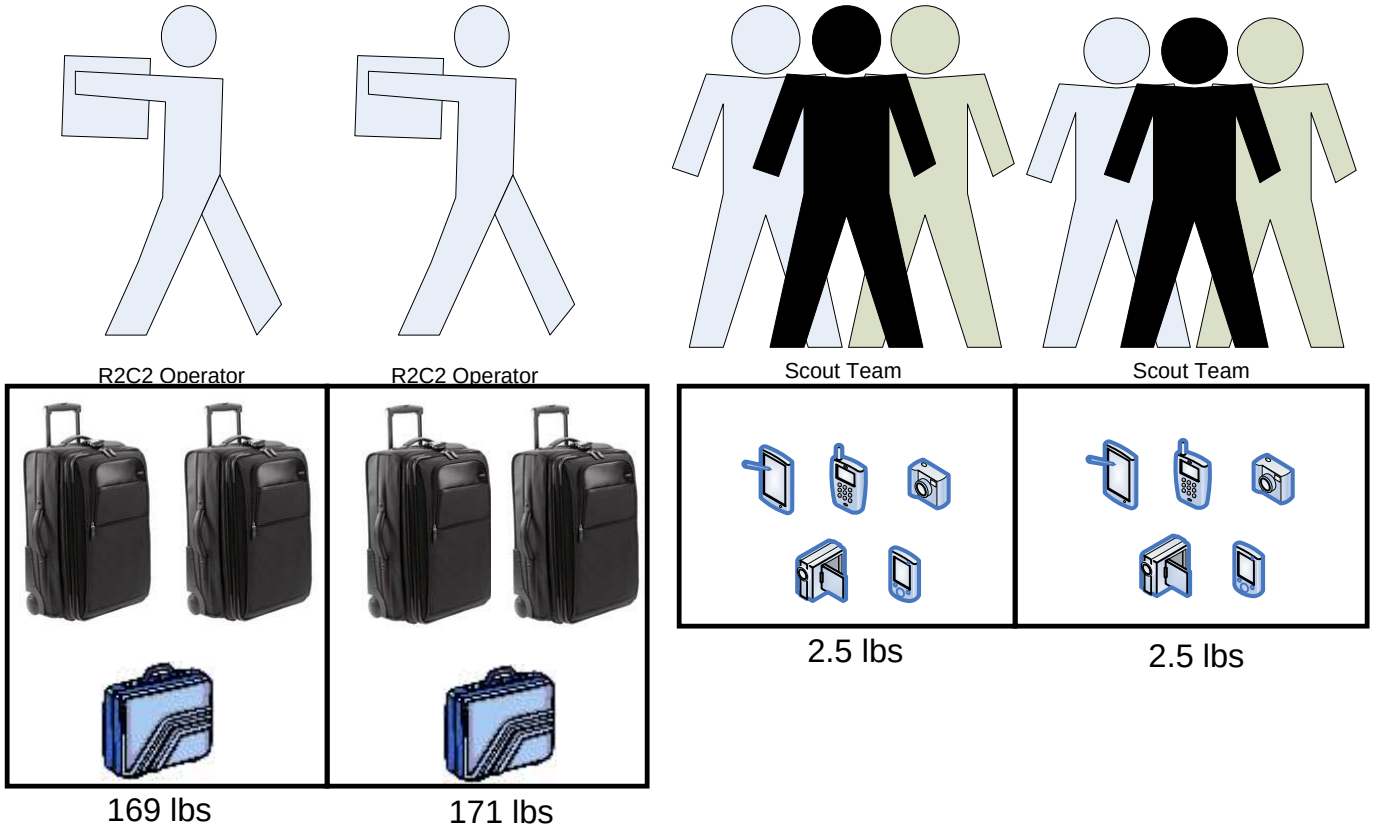
While a separate CMS will provide greater capacity, it is possible to use the integrated solution in most situations

# Choice of Architecture

- For standard operations:
  - R2C2 with voice-only communications
  - Integrated CMS
- For time-critical missions:
  - R2C2 with 802.16 data links
  - Integrated CMS

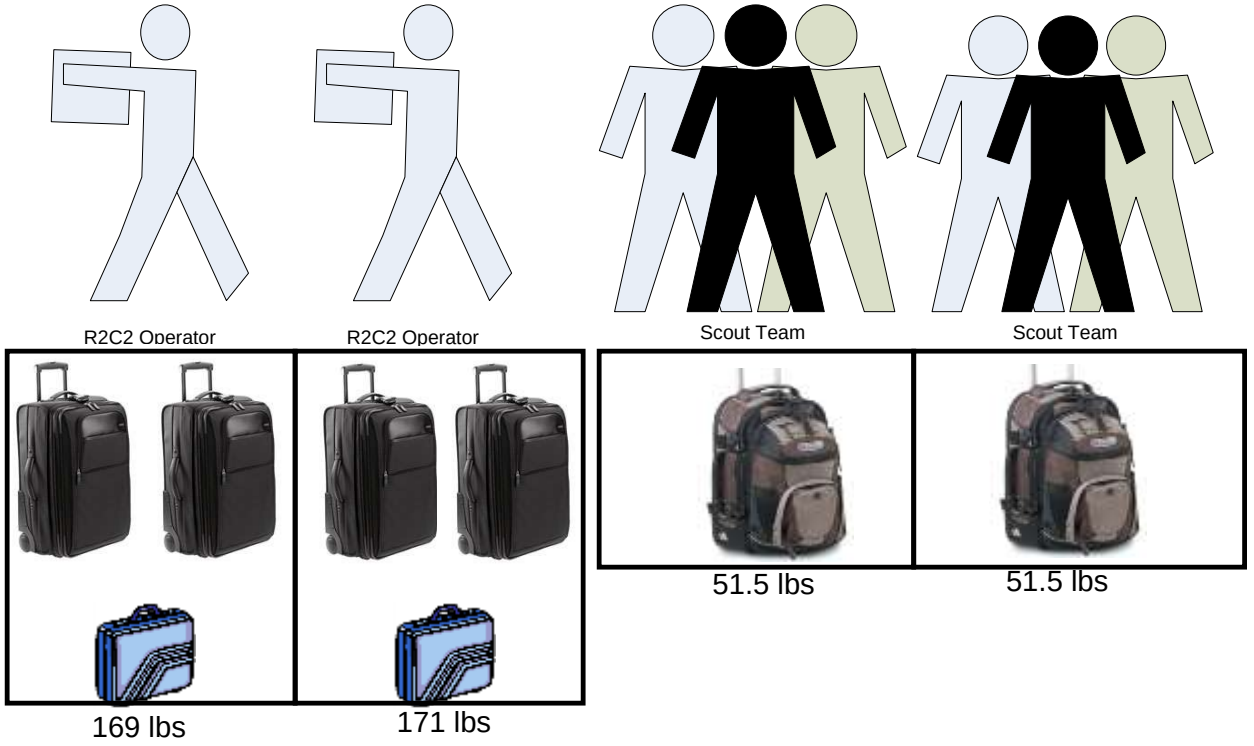
# Standard Operations

- El Salvador Scenario
- Pandemic Scenario



# Time-Critical Operations

- Iran Scenario
- Counter-terrorism Scenario
- Ivory Coast Scenario



# Additional Weight Tradeoffs

| Risk | Weight Change | System Weight |
|---|---|---|
| Lightweight Packaging (less robust and durable) | -27 lbs | 313 lbs |
| Norsat Globaltrekker (not yet certified for use) | -36 lbs | 304 lbs |
| Operate Without Generator (power supply uncertain) | -50 lbs | 290 lbs |
| **Combined Risk Deductions** | -113 lbs | 227 lbs |

Multiple deductions can be combined to reduce weight at increased risk

# Modeling Conclusions

- Inclusion of a field-employable data link will drop data transit times by approximately 50 minutes, better enabling time-critical missions
- A separate CMS is unnecessary, as the R2C2 CONOPS do not show more than 50% usage even for low bandwidth rates
- Multiple risks can be taken to further reduce the deployed weight of this system by over 100 lbs

# System Analysis

ENS Kitan Bae
Mr. Heng Yue Wong
Mr. Hang Sheng Lim

# System Analysis Outline

- Key findings
- Analysis of time-critical R2C2 system architecture
  - Analytic Hierarchy Process (AHP)
    - Baseline for future TEMP
      - COI, MOE, MOS, MOP
    - AHP criteria weighting results
      - Survey taker breakdown
      - Overall results
    - AHP comparison of three systems
  - Traffic light comparison of three systems
    - Review of CPD, BAA, R2C2 team generated requirements
    - Comparison of three systems

# Key Findings

- AHP Criteria weights & rankings
- Three system rankings

| | |
|---|---|
| Operation capability | 48.1% |
| Information Security | 25.9% |
| Interoperability | 17.5% |
| Situational Awareness | 17.5% |
| Technical parameters | 34.8% |
| Local Communication | 61.5% |
| Long haul communication | 38.5% |
| Integrated Logistic Support (ILS) | 17.1% |
| Reliability | 41.0% |
| Maintainability | 21.6% |
| Spares support | 15.2% |

| Method / System | AHP | Traffic light matrix |
|---|---|---|
| **R2C2** | 42.7% | 27/28 |
| **System Y** | 28.3% | 22/28 |
| **JSIC EC2** | 29.0% | 16/28 |

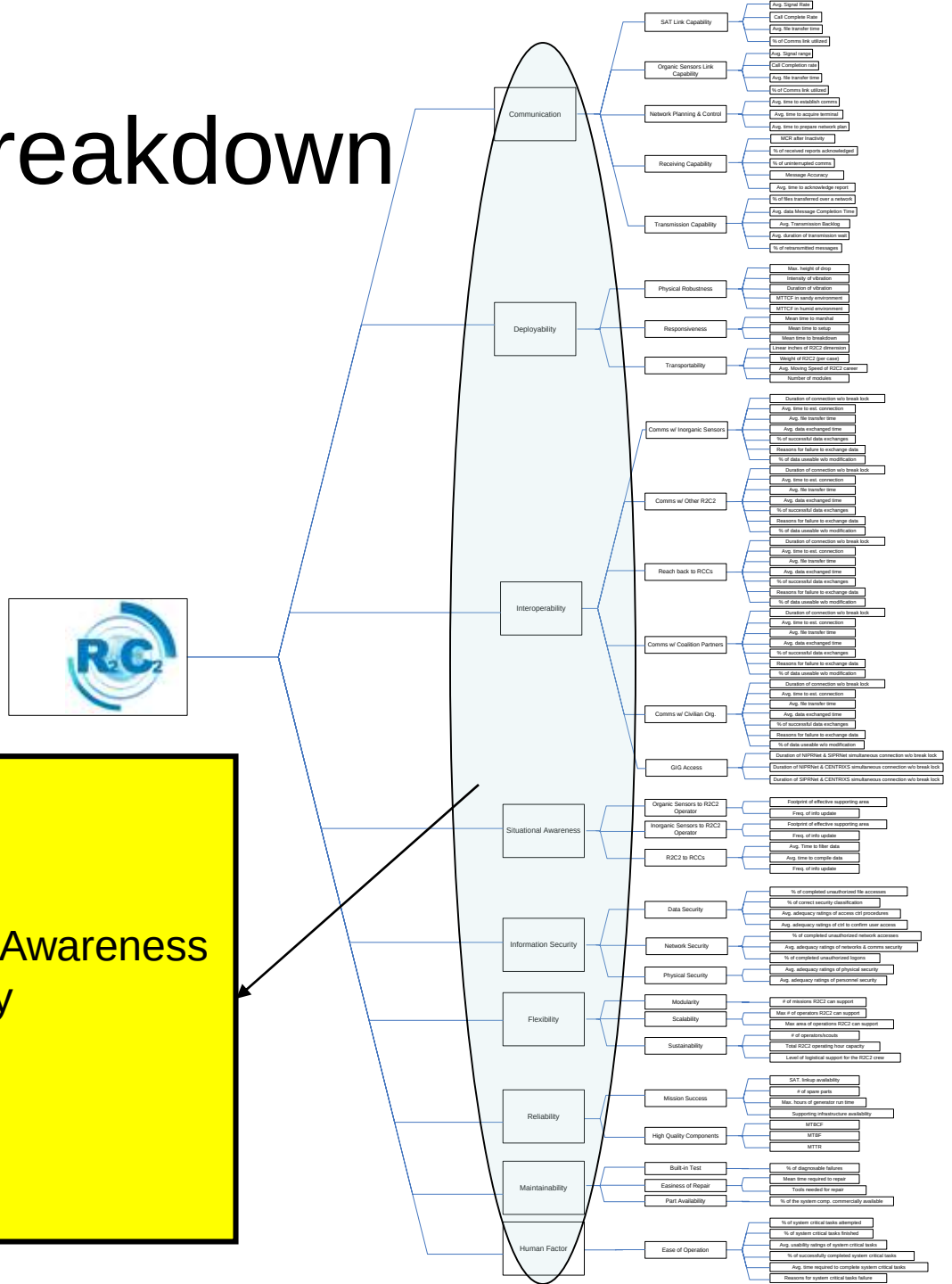
# Analytic Hierarchy Process (AHP)

- Offers the ability to ‘mirror’ human decision making process
  - Structuring issues in a hierarchy, top-down approach.
- Answers questions such as:
  - Which is the best alternative for your decision problem?
  - Provide insights as to how sensitive are your alternatives/choices to changes in the decision criteria?
- Provides a clear, transparent and objective means of arriving at defensible and credible decisions.
- Current users of AHP
  - U.S. Army, Navy, Air Force, Marine Corps
  - Federal Aviation Administration
  - Department of Agriculture (USDA)
  - Social Security Administration (SSA)

# Development of AHP

- Traced back to the scenarios
- Identified Critical Operation Issues (COI)
  - Measure of Effectiveness (MOE)
  - Measure of Suitability (MOS)
  - Measure of Performance (MOP)
- Transform developed parameters into AHP comparison criteria
- Determined the weights of each criterion
  - Various working group survey
- Conduct 3 system comparison

# COI Breakdown




1. Communication
2. Deployability
3. Interoperability
4. Provide Situational Awareness
5. Information Security
6. Mission Flexibility
7. Reliability
8. Maintainability
9. Human Factor

# COI Breakdown

1. Communication
2. Deployability
3. Interoperability
4. Provide Situational Awareness
5. Information Security
6. Mission Flexibility
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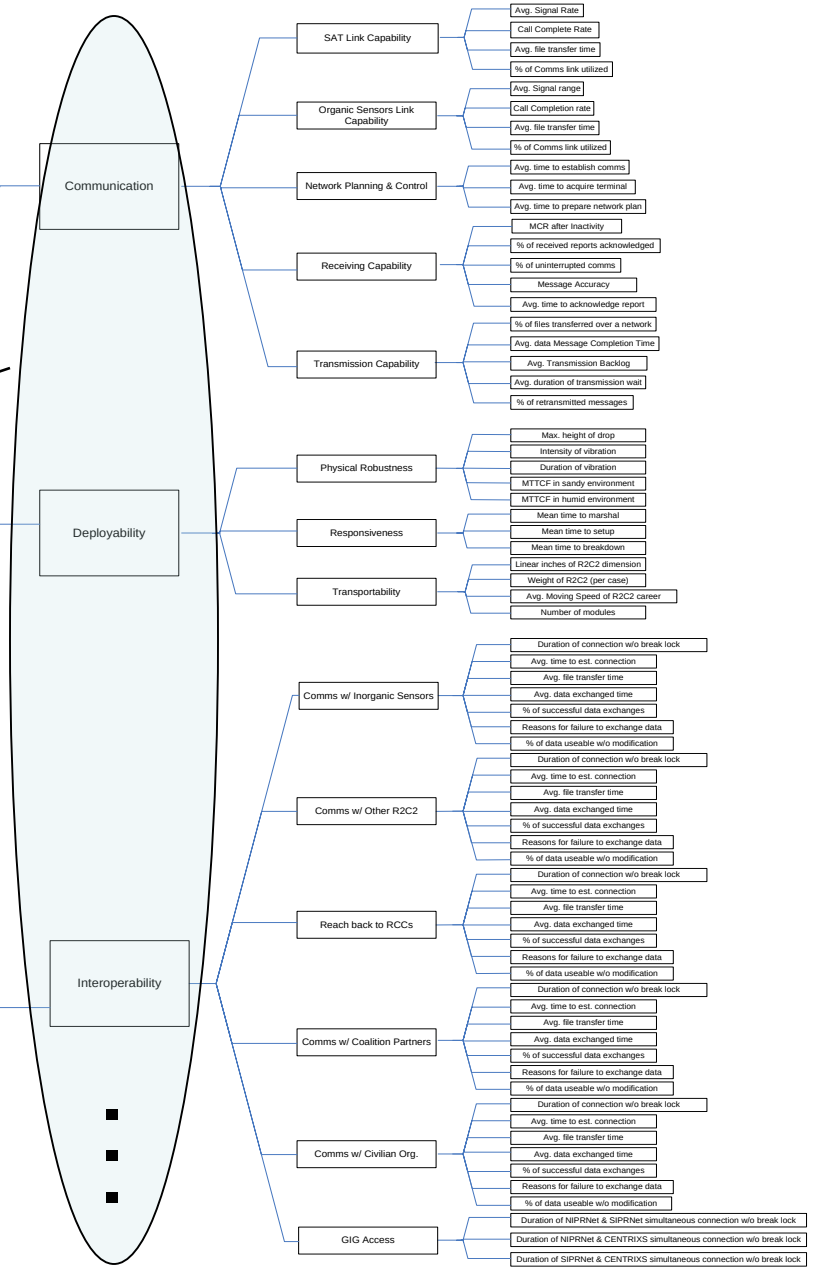
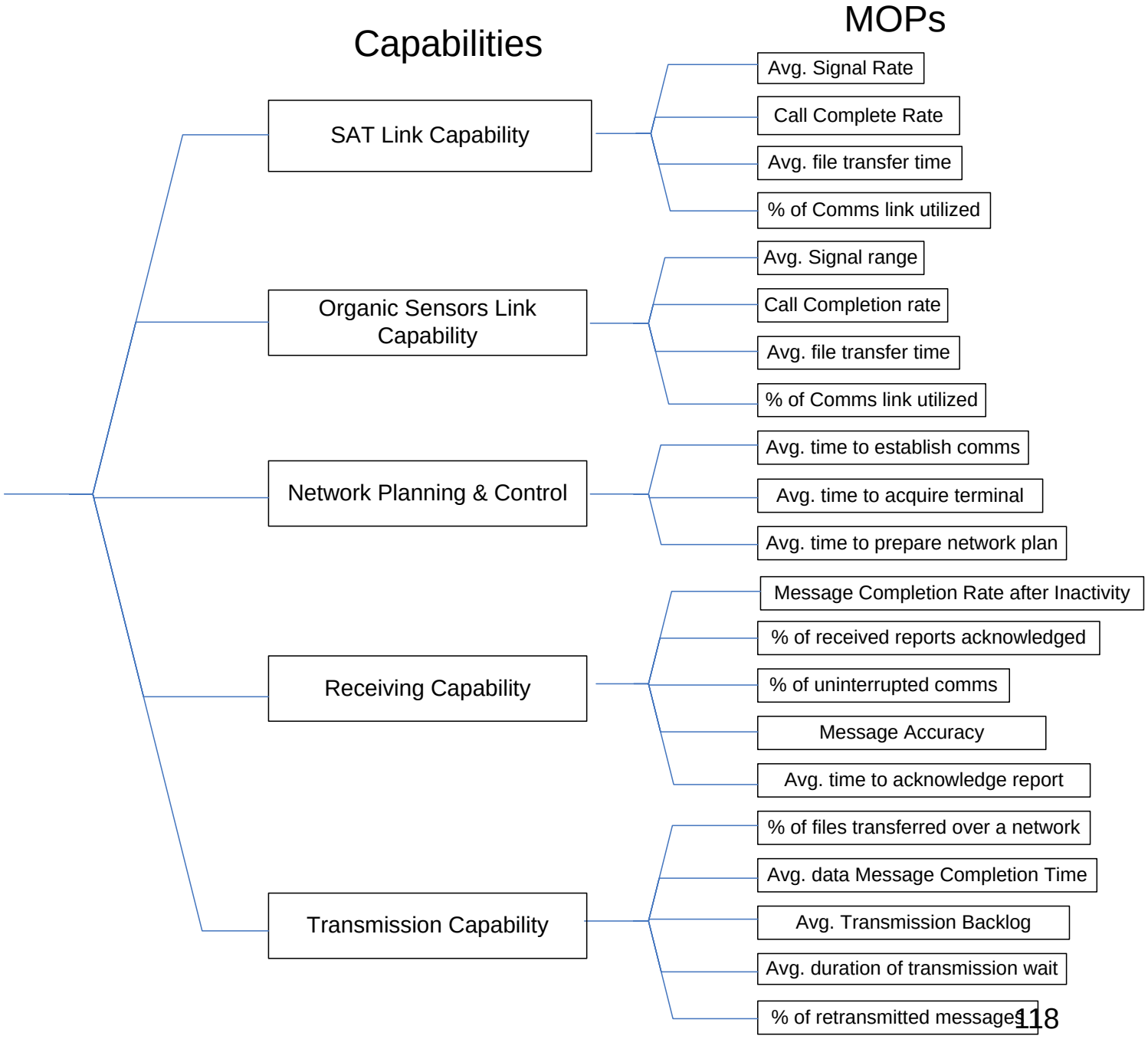
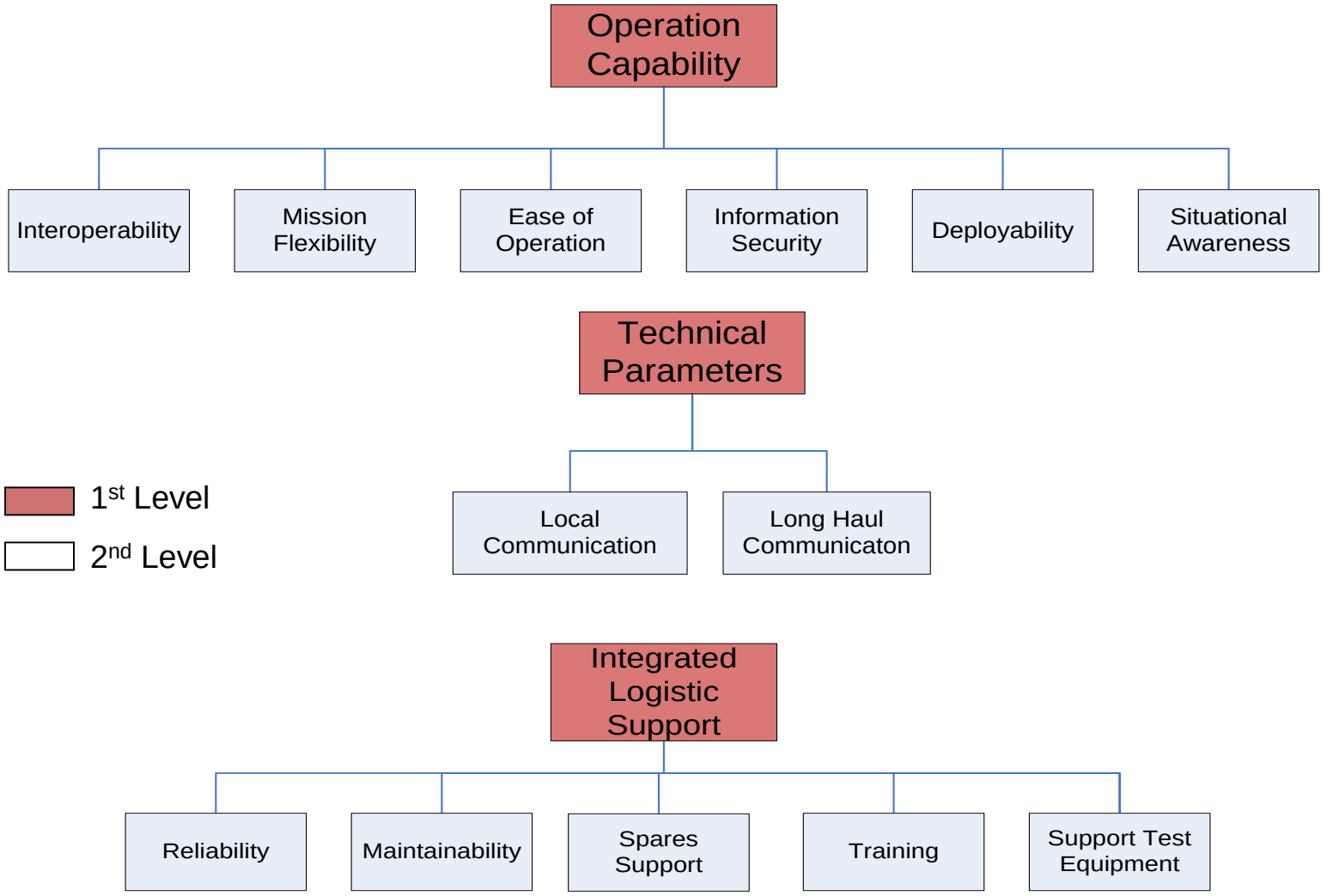
8. Maintainability
9. Human Factor




Function
Communication

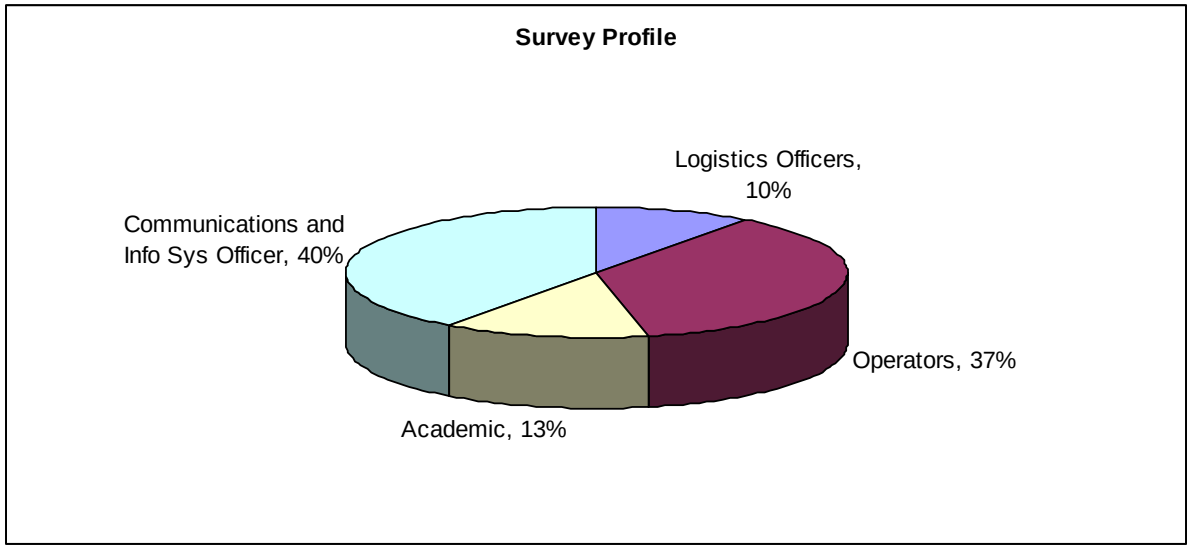

Capabilities
MOPs
SAT Link Capability
Avg. Signal Rate
Call Complete Rate
Avg. file transfer time
% of Comms link utilized
Organic Sensors Link Capability
Avg. Signal range
Call Completion rate
Avg. file transfer time
% of Comms link utilized
Network Planning & Control
Avg. time to establish comms
Avg. time to acquire terminal
Avg. time to prepare network plan
Receiving Capability
Message Completion Rate after Inactivity
% of received reports acknowledged
% of uninterrupted comms
Message Accuracy
Avg. time to acknowledge report
Transmission Capability
% of files transferred over a network
Avg. data Message Completion Time
Avg. Transmission Backlog
Avg. duration of transmission wait
% of retransmitted messages

# AHP Comparison Criteria



# AHP Weights

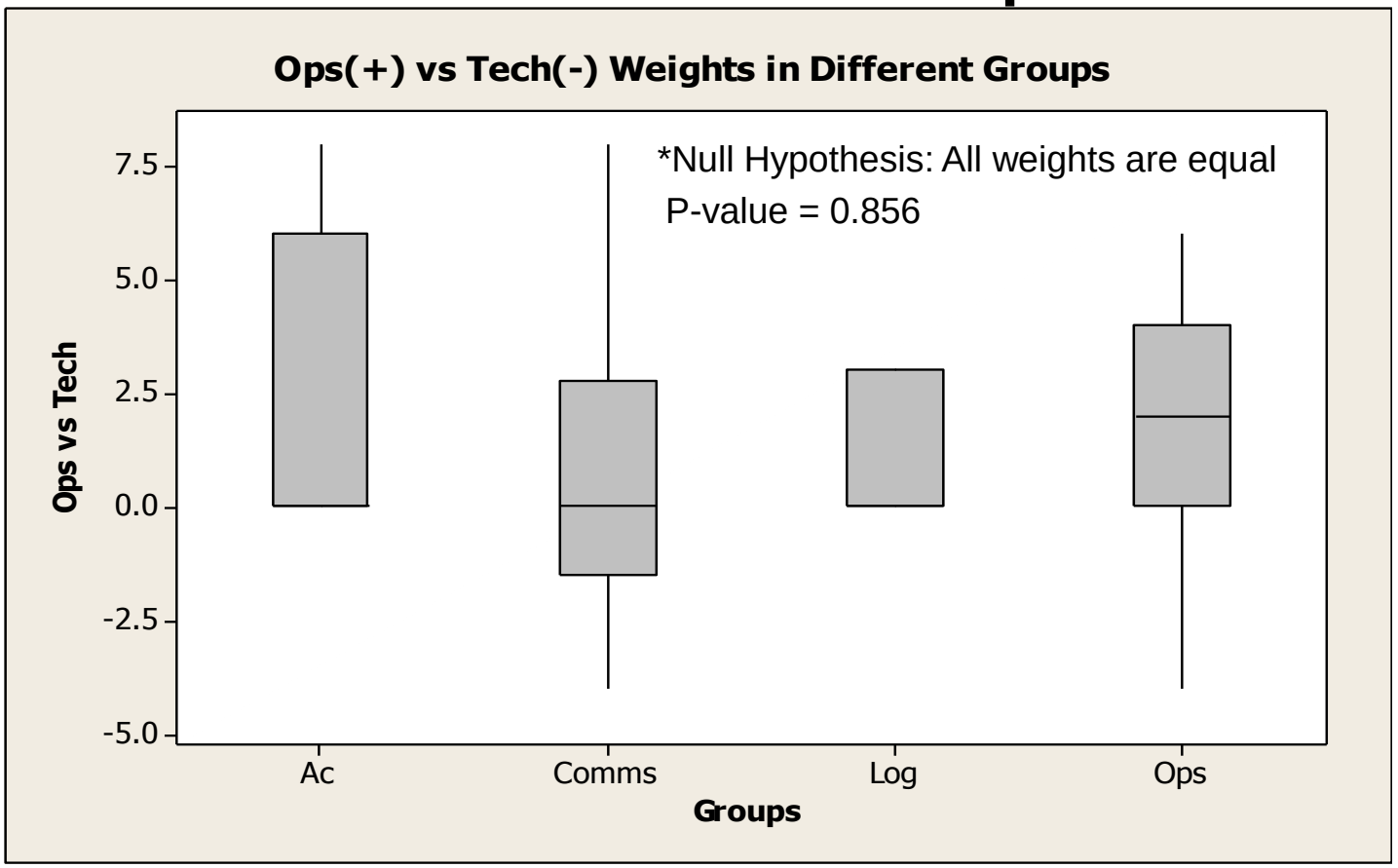
- Method:
  - Campus-wide AHP survey to collect individual judgment
  - Required minimum of 30 samples to achieve statistical significance
  - Every criteria was compared to each other for relative importance
  - Saaty's intensity of importance scale was utilized and averaged geometrically
  - Four different groups were surveyed & compared



# Saaty's Intensity of Importance Scale

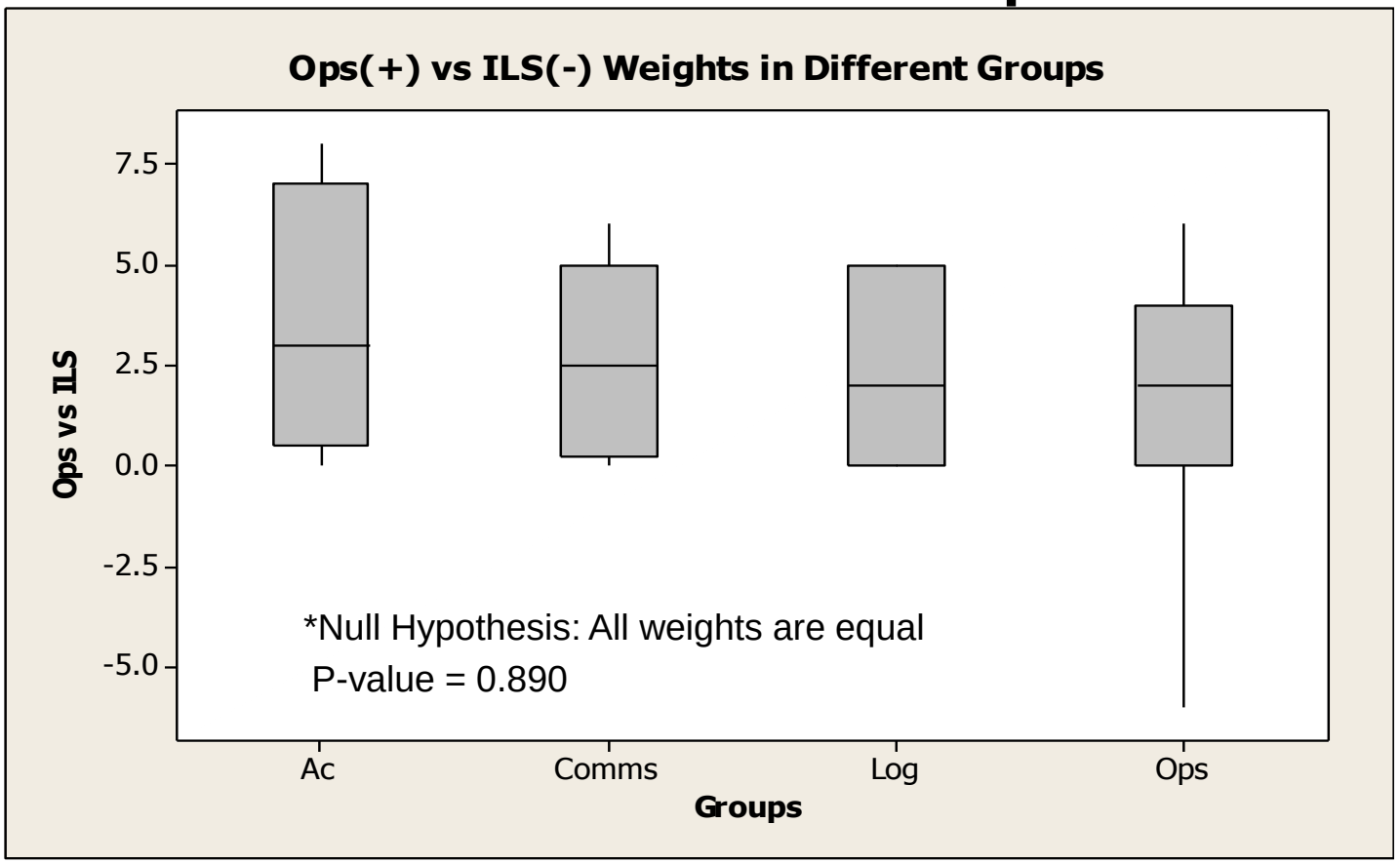
| Intensity of importance | Definition | Explanation |
|---|---|---|
| 1 | Equal importance | Two activities contribute equally to the objective |
| 3 | Weak importance of one over another | Experience and judgment slightly favor one activity over another |
| 5 | Essential or strong importance | Experience and judgment strongly favor one activity over another |
| 7 | Demonstrated importance | An activity strongly favored and its dominance demonstrated in practice |
| 9 | Absolute importance | The evidence favoring one activity over another is of the highest order of affirmation. |
| 2,4,6,8 | Intermediate values between the two adjacent judgments | When compromise is needed. |
| Reciprocals of above non-zero numbers | If activity *i* has one of the above non-zero numbers assigned to it when compared with activity *j*, then has the reciprocal when compared with *i*. | |

# 1st Level Criteria Difference Between Groups



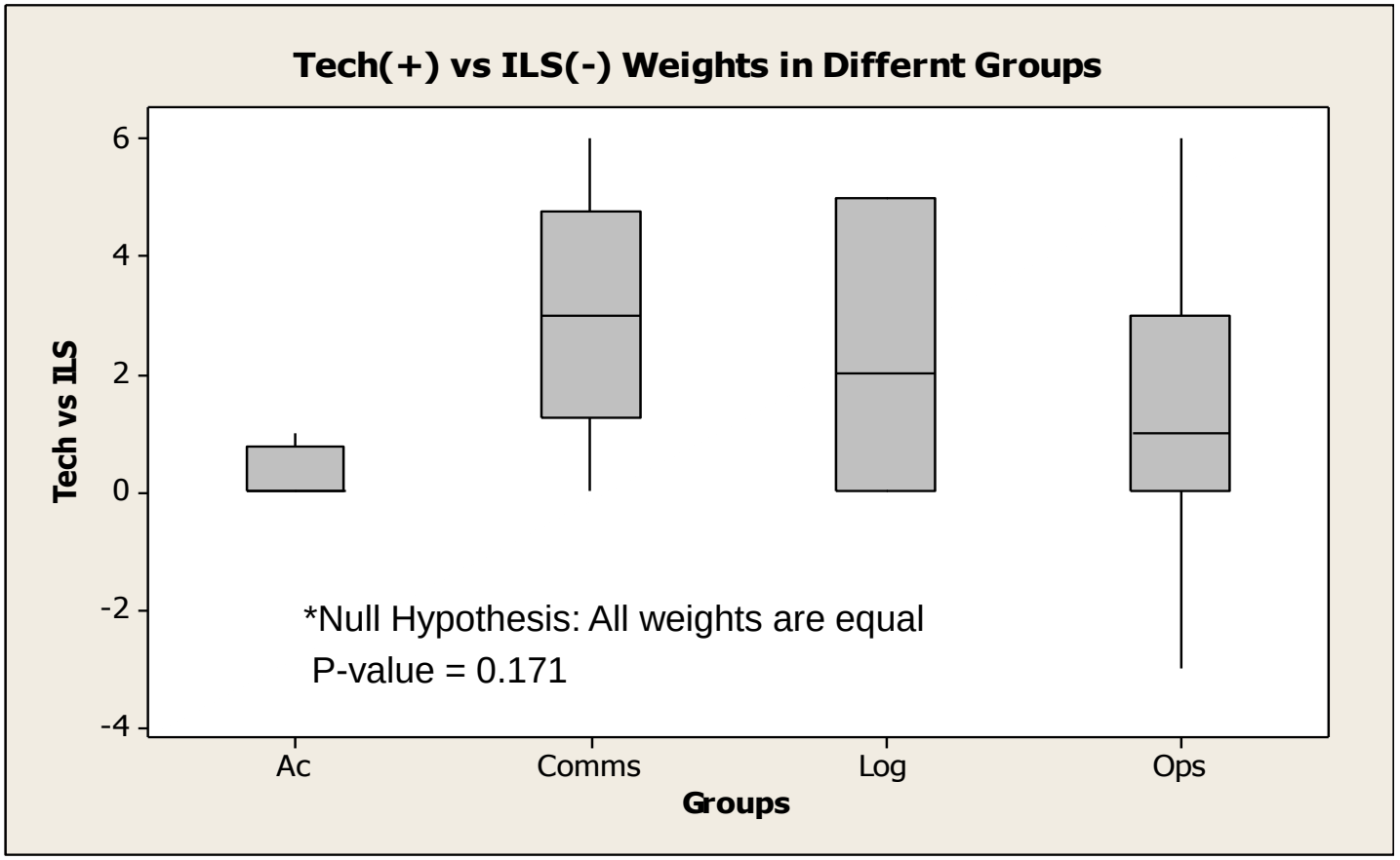

No statistical difference between the groups

# 1st Level Criteria Difference Between Groups



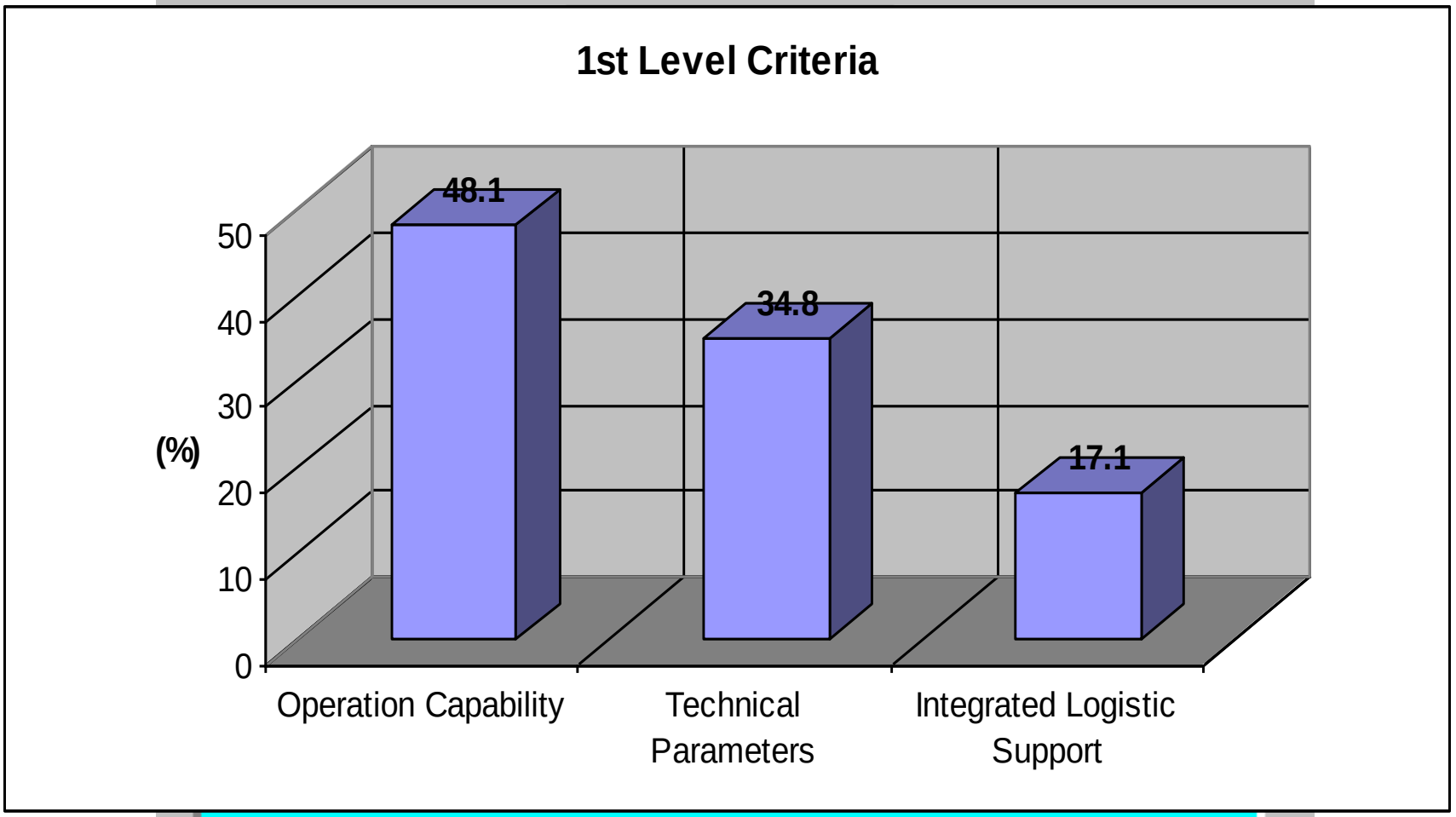

No statistical difference between the groups

# 1st Level Criteria Difference Between Groups



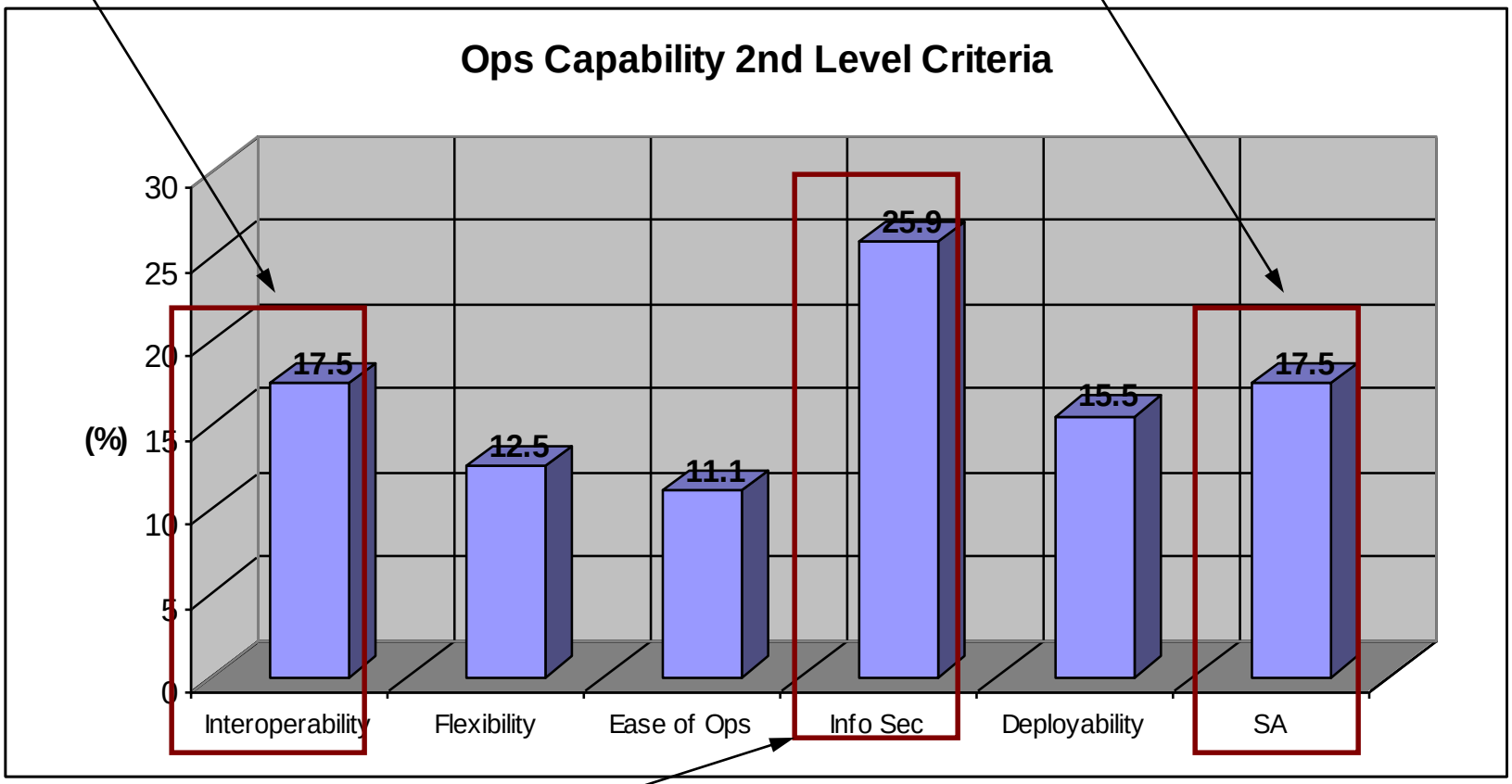

No statistical difference between the groups

# The Overall Results



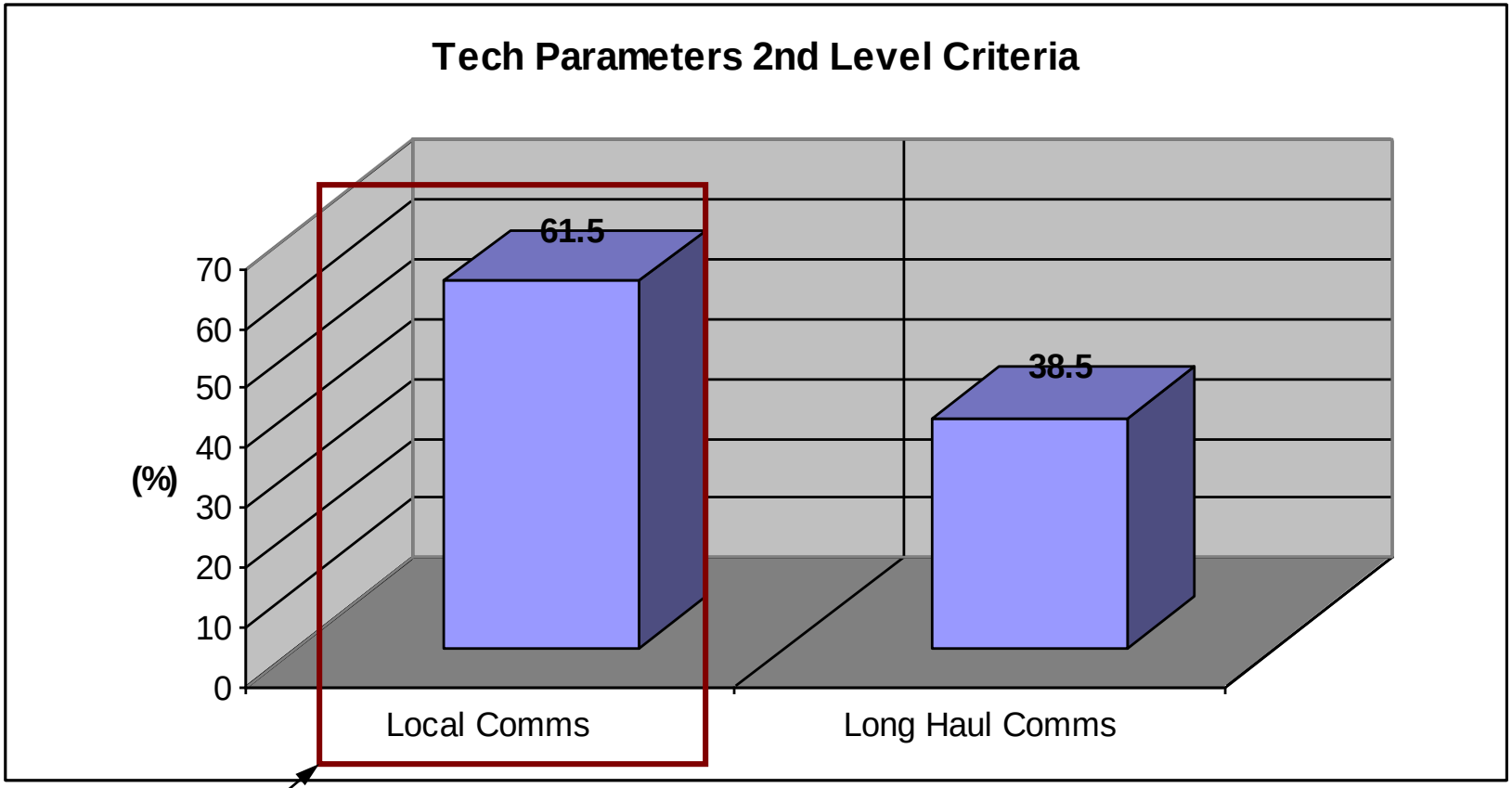
# Ops 2nd Level Criteria

Interoperability & Situational Awareness were ranked the 2nd



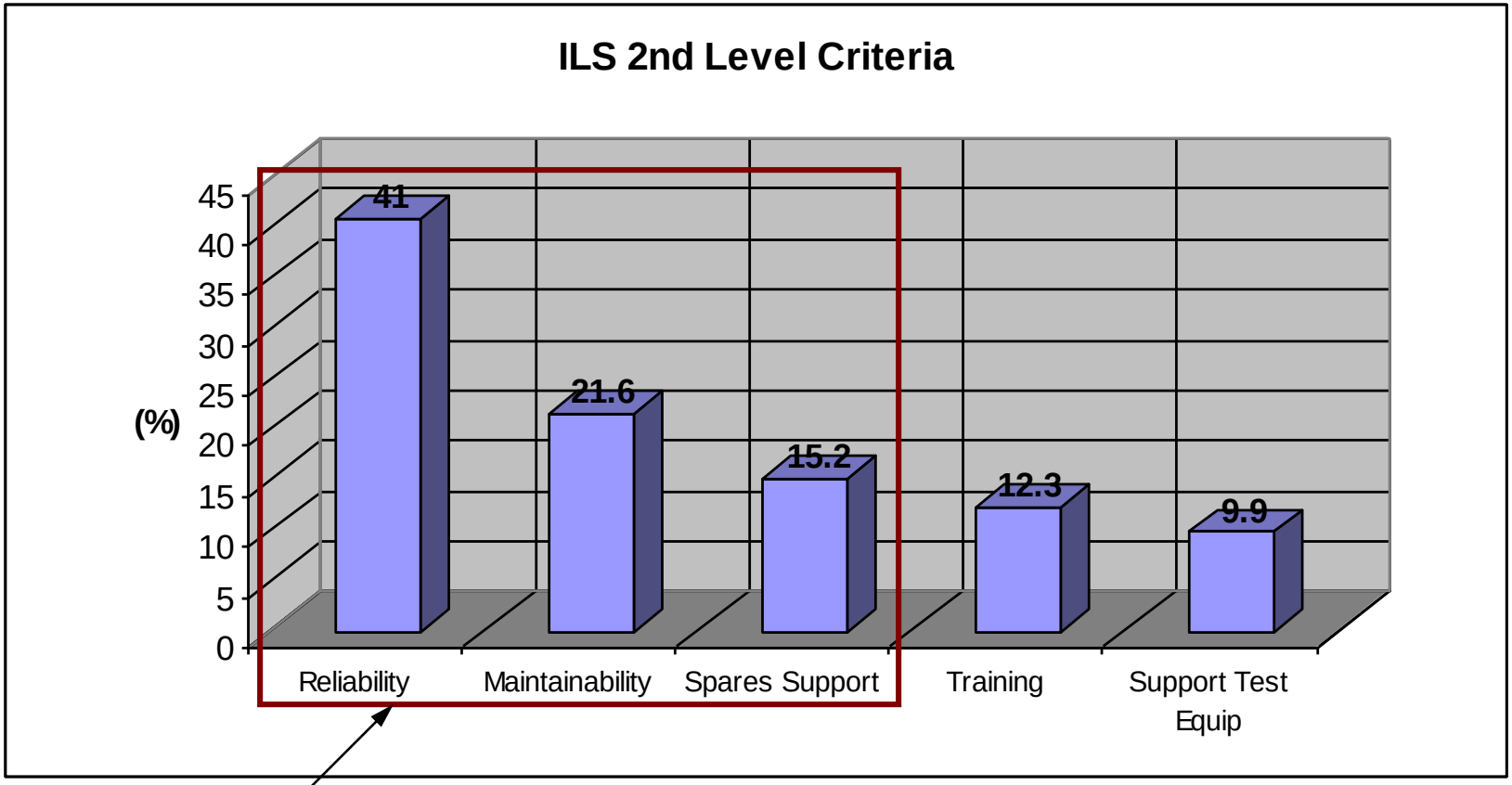

Information Security is the most important criteria

# Technical 2nd Level Criteria




Local communication was more heavily weighted

# ILS 2nd Level Criteria

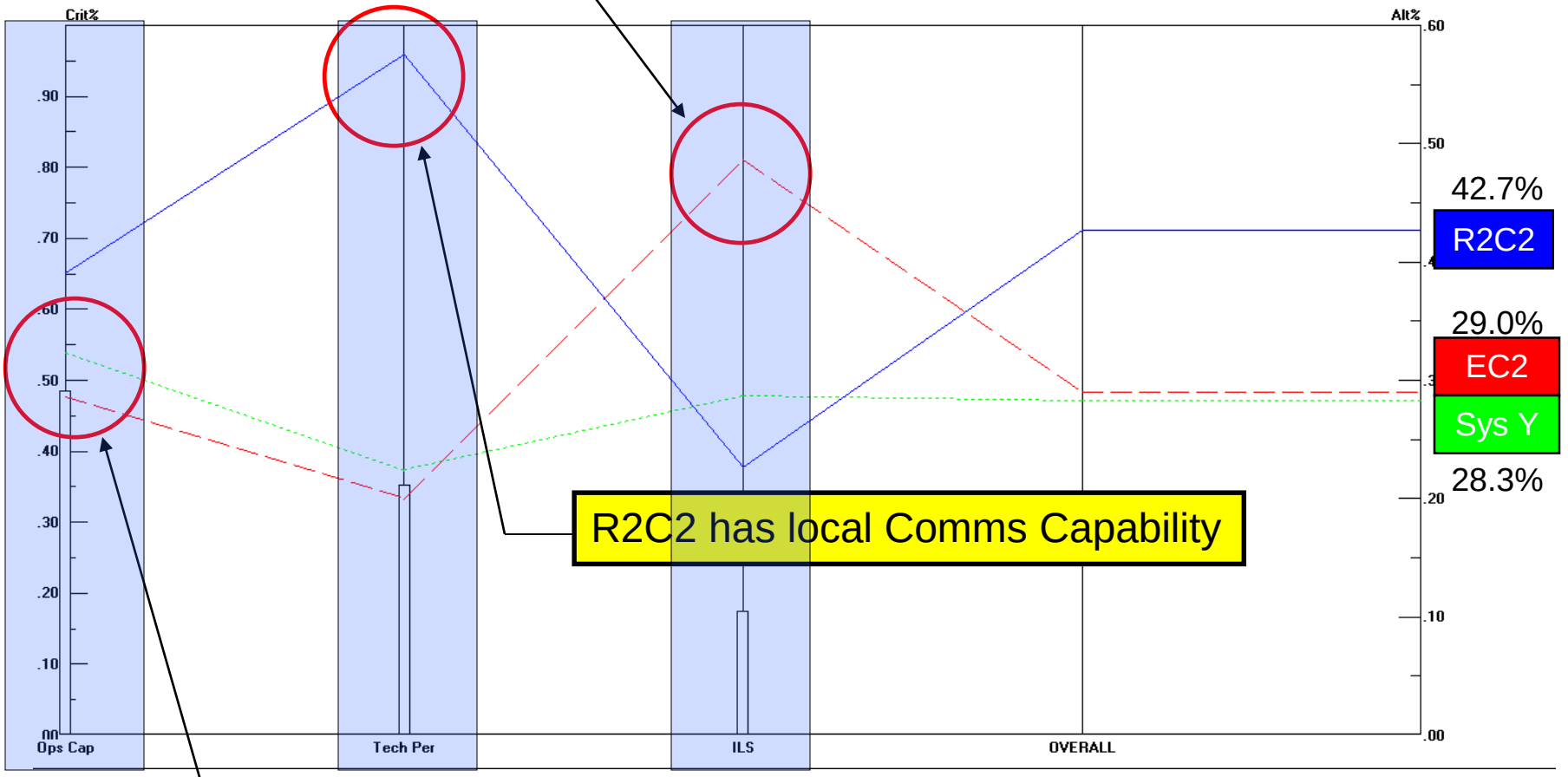



Reliability → Maintainability → Spares Support

# Three Systems

- Executive Command & Control (EC2)
  - Developed in 2003 by Joint Systems Integration Command (JSIC)
  - Designed to provide RCCs and JTF commanders capability to host services on classified and unclassified networks to maintain situational awareness
  - Consists of laptops, routers, and other pieces of equipment that can be easily packed in a hard case
- System Y
  - One of the proprietary systems being proposed to DJC2 office in response to RRK requirements
  - Similar to R2C2 without the local communications capability
- Rapid Response Command & Control (R2C2)
  - Included the Primary, Local, and Civil/Military suites to provide long haul communications and reachback capabilities to the RCC, wireless data link capability for SA, and civil/military links

# C2OTM, System Y, and R2C2 System (AHP)



# JSIC EC2, System Y, and R2C2 System Requirements Matrix (1)

CPD BAA R2C2

| | JSIC EC2 | System Y | R2C2 |
|---|---|---|---|
| State of the art agile and self contained | | | |
| Two Person Transportable | | | |
| Small footprint (Physical) | | | |
| Transportable in commercial and military aircraft | | | |
| Collaboration via reachback | | | |
| Marshall in 30 minutes | | | |
| Operational in 30 minutes | | | |
| Local physical storage (on one or more laptops) | | | |
| Transportable by commercial air or ground by two men | | | |
| Operable on standard electrical power | | | |
| Provide data and voice communications | | | |
| Support and Training Documentation | | | |
| Connect to commercial internet | | | |
| Provide secure means, physical security, data security, and network security, of passing tactical information to supported commander for situation assessment. | | | |
| Provide compact, rugged and mobile packaging. | | | |
| Provide flexibility for mission dependent software and hardware configurations. | | | |

# JSIC EC2, System Y, and R2C2 System Requirements Matrix (2)

CPD BAA R2C2

| | JSIC EC2 | Sys Y | R2C2 |
|---|---|---|---|
| Satellite Connectivity | | | |
| Able to operate in austere locations | | | |
| Two Simultaneous Data Networks | | | |
| Limited rapid response communication capability to include: UHF TACSAT, INMARSAT, SHF SATCOM, Global Sat. Phone | | | |
| Wireless (objective) | | | |
| Utilize EOIP to include VTC | | | |
| Multi-Mode Operations (voice, data and video simultaneously) | | | |
| Provide 1.024 Mbps Threshold per Network (4.096 Mbps Objective) | | | |
| Provide capability of local and long haul communications | | | |
| Provide means of collecting data from organic or inorganic assets | | | |
| Provide self-supporting power supply in addition to capacity of operating on standard electrical power | | | |
| Provide capability for operators to receive, display, analyze, filter and pass simultaneous data from organic or inorganic assets | | | |
| Number of Requirements Met : | 16/28 | 22/28 | 27/28 |

# Analysis Conclusions (1)

- AHP
  - Provided baseline for future Test and Evaluation Master Plan
  - Provided rankings of evaluation criteria
    - No statistical significant difference between the groups
    - Local communications ranked higher than Long Haul

| | |
|---|---|
| Operation capability | 48.1% |
| Information security | 25.9% |
| Interoperability | 17.5% |
| Situational awareness | 17.5% |
| Technical parameters | 34.8% |
| Local comms | 61.5% |
| Long haul comms | 38.5% |
| Integrated Logistic Support (ILS) | 17.1% |
| Reliability | 41.0% |
| Maintainability | 21.6% |
| Spares support | 15.2% |

# Analysis Conclusions (2)

- Traffic light comparison of three systems
  - Verified that R2C2 system met most of the requirements
  - Identified R2C2 to be the most suitable system

| | AHP | Traffic light matrix |
|---|---|---|
| **R2C2** | **42.7%** | **27/28** |
| **System Y** | 28.3% | 22/28 |
| **JSIC EC2** | 29.0% | 16/28 |

# Conclusions

LCDR Lisa Sullivan

# Project Conclusions (1)

- Analyzing decision making tools revealed that the results were consistent and that R2C2 outperformed other systems
  - R2C2 ranked highest in the AHP with 42.7% and captured the highest number requirements, 27 of 28
- Performing operational assessments of mission and environment determined if the operation was time-critical
  - 3 of 5 of the R2C2 briefed scenarios are time-critical
  - Requires additional 50 lbs of data link equipment per scout team
- Conducting additional weight calculations reduced the Primary Suite by 113 lbs, but not without potential risks

# Project Conclusions (2)

- Utilizing a top down approach for developing requirements guaranteed traceability to strategic guidance and identified additional requirements for the system
- Capturing the needs of multiple users working in different missions and environments required in depth mission analysis and development of many scenarios to cover the broad spectrum of potential operations

# Project Conclusions (3)

Due to modular design, the R2C2 provides the RCC with required flexibility and scalability to delivery a rapidly deployable command and control system to meet the range of military operations

# Questions?

# Back-up Slides

# Weight Assumptions

- Airline Standard
  - Checked Luggage:
    - 62 linear inches
    - 100 lbs
  - Carry-on:
    - 45 linear inches
    - 50 lbs
- MIL-STD-1472F
  - Checked Luggage:
    - 18” wide x 18” high x 12” deep
    - 45% of body weight (Approx. 80 lbs) for marching
  - Carry-on:
    - Airline weight restriction is limiting factor in most cases