LIFE CYCLE COST ANALYSIS For C4ISR SYSTEMS

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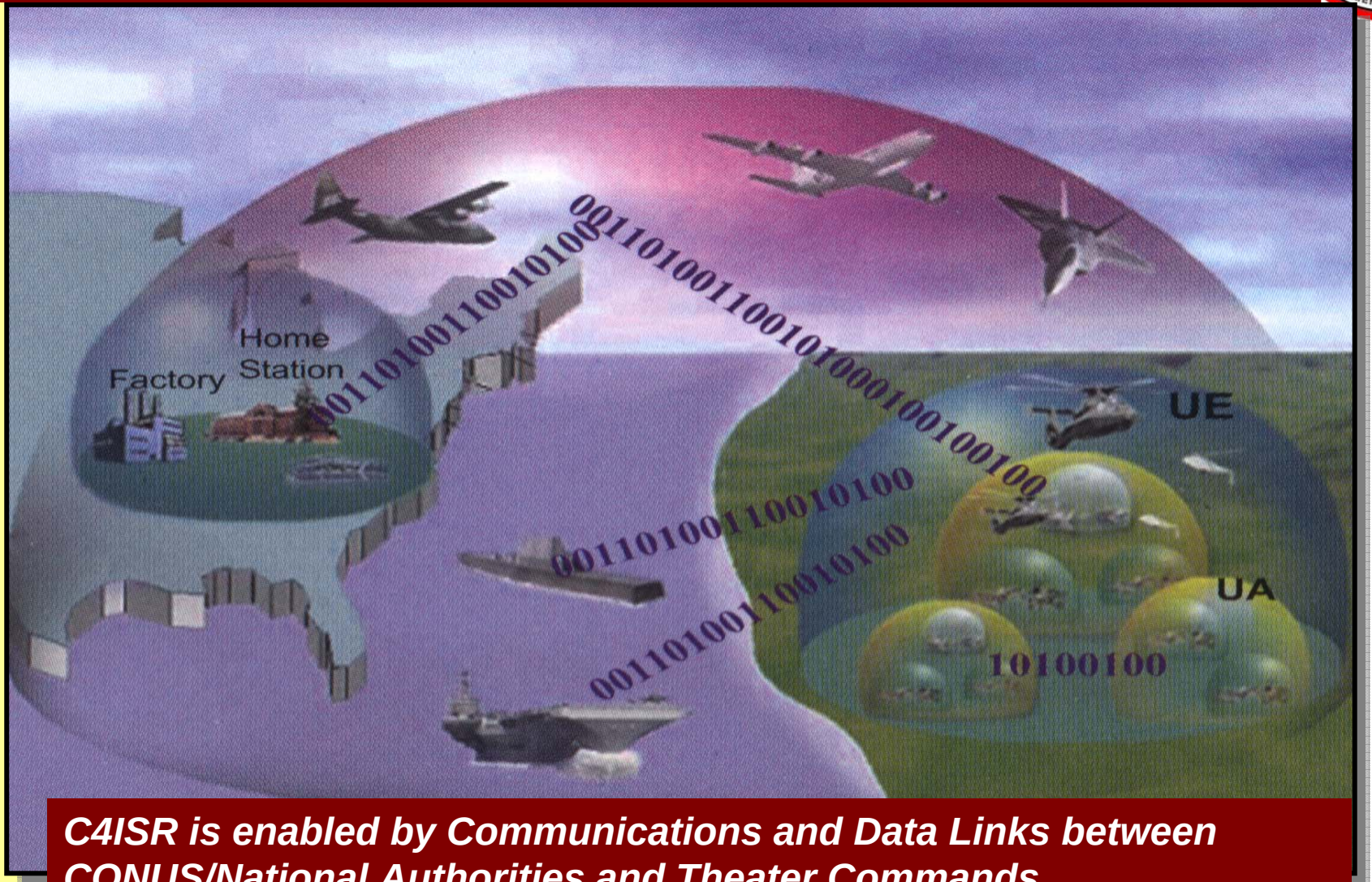
AGENDA

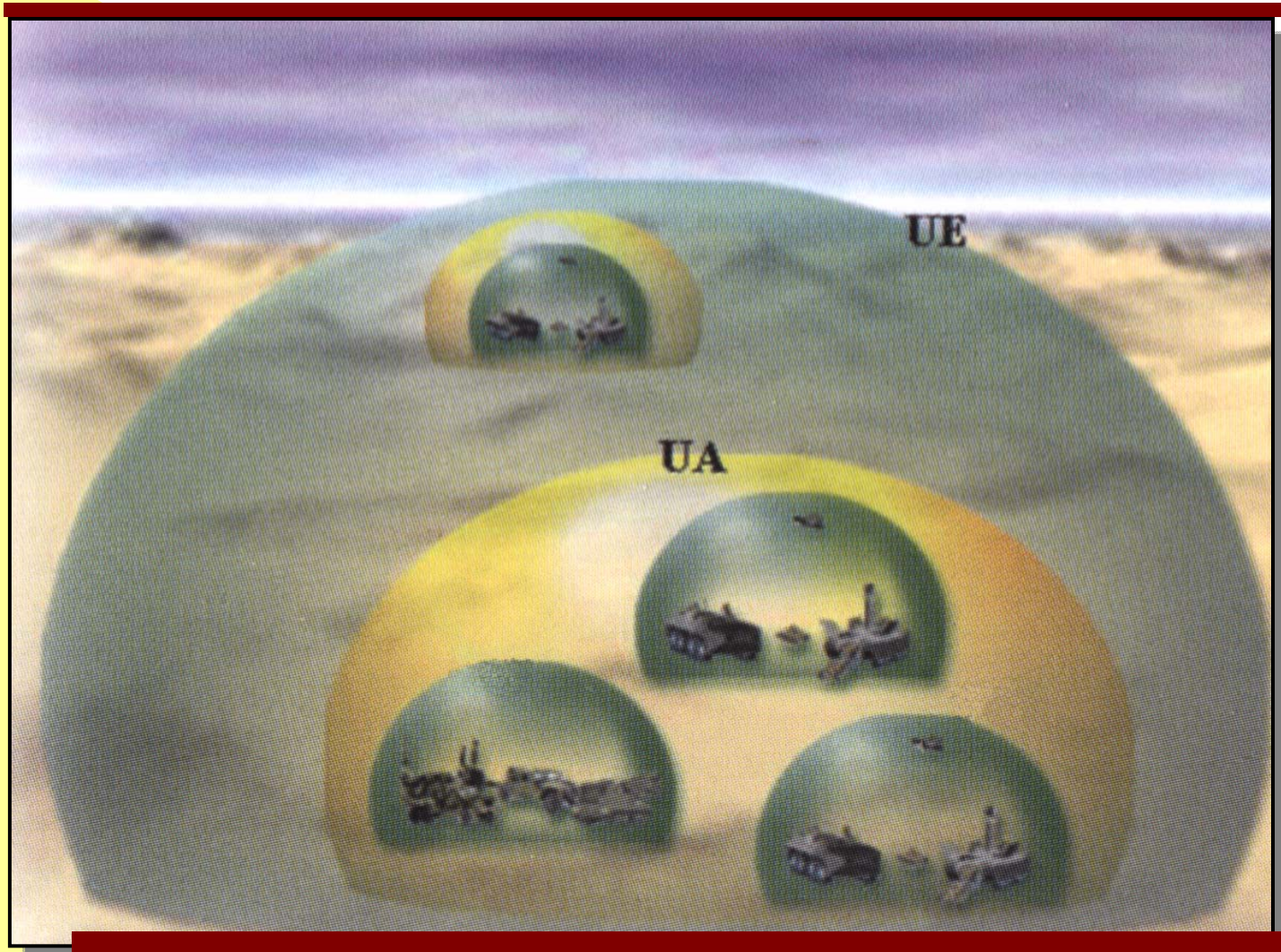
- C4ISR OVERVIEW
- C4ISR SENSOR PLATFORMS
- C4ISR COMMUNICATIONS INFRASTRUCTURE
- C4ISR NETWORK CENTER
  - NETWORK CENTER HARDWARE
  - NETWORK CENTER SOFTWARE
  - SUPPORT INVESTMENTS
  - OPERATIONS PHASE
- MISSILE DEFENSE AGENCY C4ISR
- C4ISR RECOMMENDATIONS AND CONCLUSIONS
- REFERENCES

C4ISR Conceptual Overview



C4ISR is enabled by Communications and Data Links between CONUS/National Authorities and Theater Commands.

C4ISR Conceptual Overview



Theater Commanders (Unit of Engagement/UE) are linked to Fighting Units (Units of Action/UA)

C4ISR Functions – Joint Command Level

C3 OPERATIONS	INTELLIGENCE OPERATIONS	WEAPONS OF MASS DESTRUCTION OPS
JOINT FORCE Command and Control	Enemy Order of Battle	Chemical Operations
Land Forces Control	Enemy Force Locations	Chemical Defense & Mitigation
Maritime Forces Control	Enemy Plans & Intensions	Biological Operations
Air Forces Control	Enemy Logistics Assessment	Biological Defense & Mitigation
Indications, Warnings, & Alerts	Target Characteristics (Military/Economic)	Nuclear Operations
Electronic Warfare	Target Recognition	Nuclear Effects Mitigation
Intelligence Coordination & Integration	Target Effects (Military/Economics)	
Sensing & Reconnaissance Tasking	Security Operations	
Information Interpretation & Fusion		
Forces Identification & Tracking		

THEATER OR JOINT COMMAND LEVEL

C2BM Functions – Joint Forces

JOINT FORCE C2BM

MARITIME OPERATIONS

- Broad Area Maritime Surveillance
- Surface to Surface Situation & Engagement
- Subsurface to Surface Situation & Engagement
- Naval Blockade Operations
- Naval Cooperative Engagements
- ASW Operations (Sub on Enemy Sub)
- ASW Operations (Ship on Enemy Sub)
- ASW Operations (Aircraft on Enemy Sub)
- Mine Warfare
- Counter Mine Warfare
- Naval Fire Support (Amphibious Ops)
- Amphibious Operations
- Maritime Sustainment
- Convoy Operations

AIR OPERATIONS

- Air Sensor Operations & Reconnaissance
- ATO Planning (Defensive/Offensive)
- Air Defense (Air to Air)
- Air Defense (Surface to Air)
- Suppression of Enemy Air Defenses
- Air Strike (Short Range/Long Range)
- Time Critical Targeting
- Close Air Support
- Cruise Missile Strike
- Cruise Missile Defense
- Aerial Refuling Operations
- Air Unit Status/Sustainment

LAND WARFARE OPERATIONS

- Maneuver & Mobility Planning
- Maneuver & Mobility Execution
- Direct Fire Control and Effects
- Indirect Fire Control and Effects
- Airborne Operations
- Helicopter Operations
- Rear Area Security Operations
- Land Forces Sustainment

SUBORDINATE OR SERVICE COMMAND LEVEL

C2BM Functions – Joint Forces

SPECIAL OPERATIONS	SPACE OPERATIONS	TBMD OPERATIONS
Special Reconnaissance	Space Sensor Operations & Reconnaissance	TBM Sensor Operations & Cueing
Direct Action/Forcible Entry	Space Asset Task Management	TBMD Battle Management - C2
Long Range Fire Control	Counter Space Operations	TBMD Boost Phase Interceptor Management
	Information Warfare	TBMD Mid-Course Interceptor Management
		TBMD Terminal Interceptor Management

SUBORDINATE OR SERVICE COMMAND LEVEL

Logistics Support Functions

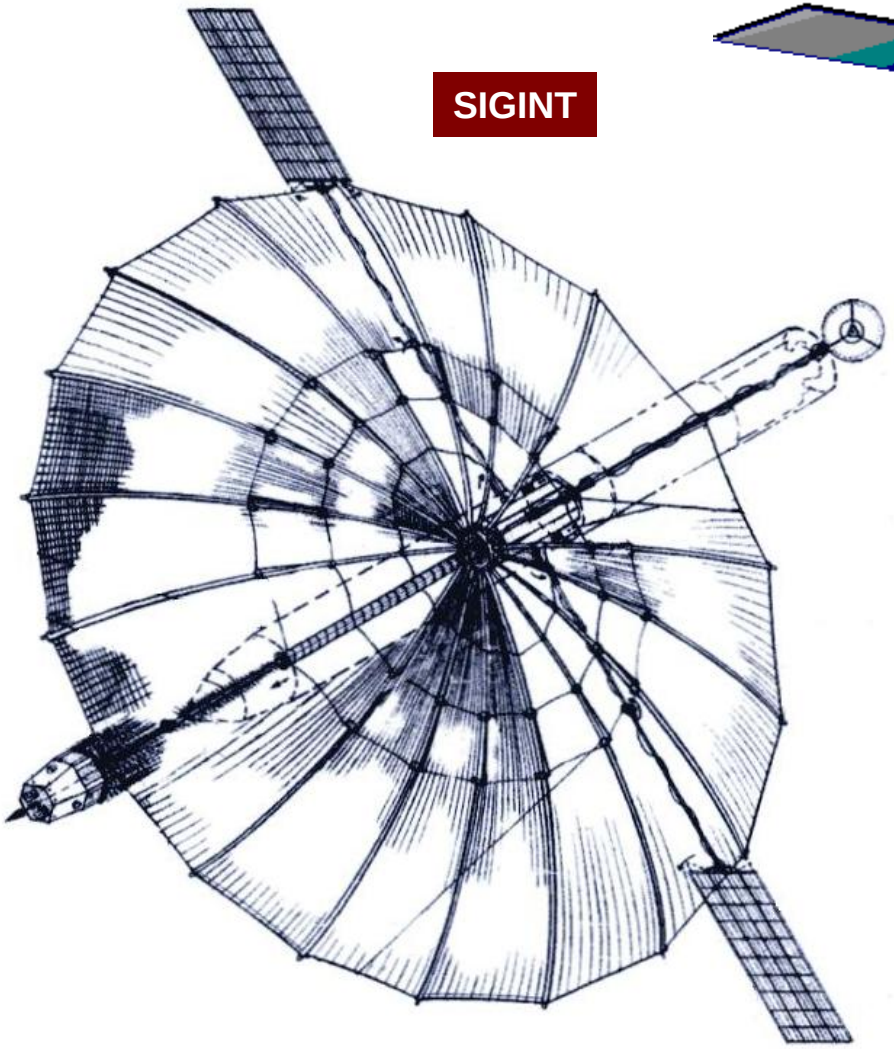
JOINT FORCE LOGISTICS

THEATER LOGISTICS
- Road/Rail/Air Transport Status & Management
- Sustainment (Inventory Status/Reorder)
- POL Status & Management
- Host Nation Support
- Maintenance and Service Support

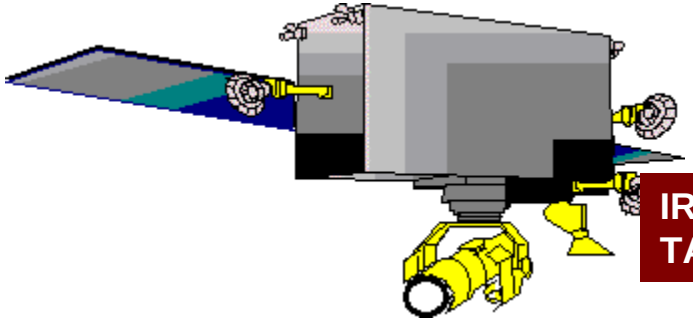
INTERTHEATER LOGISTICS
- Intertheater Lift Planning
- Intertheater Lift Execution
- Aerial Port & Seaport Operations
- Logistics Command and Control

SUPPORT COMMAND LEVEL

C4ISR Sensor Platforms (Space) National Assets



SIGINT

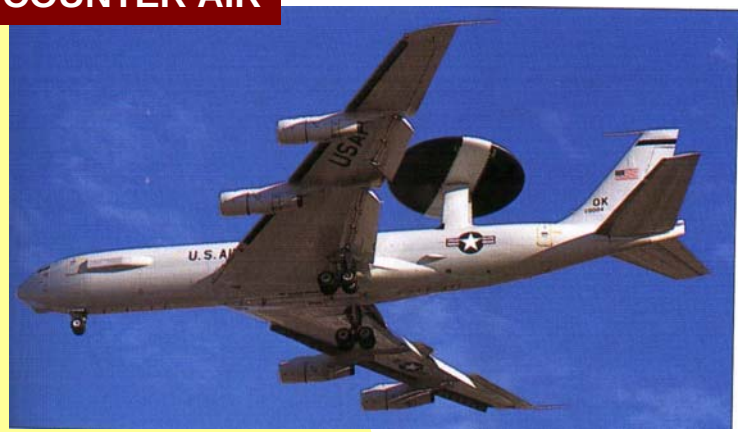


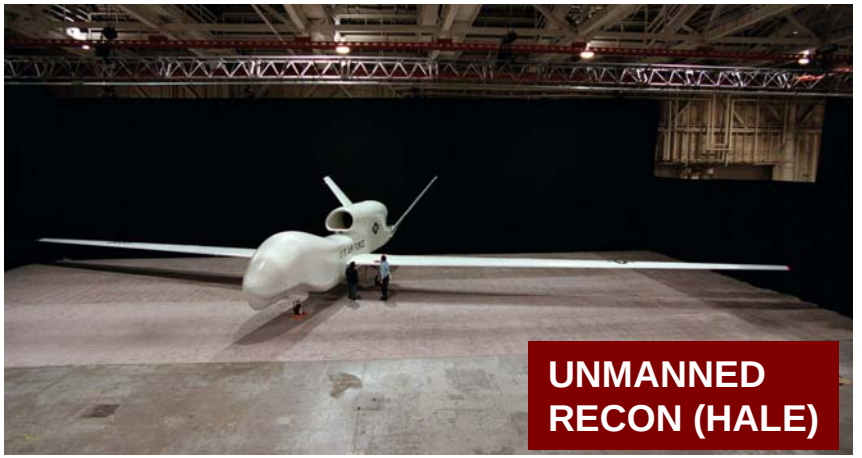
IR SURVEILLANCE
TARGET TRACKING

IMAGERY

C4ISR Sensor Platforms (Air)
Usually Under Theater Command

COUNTER AIR





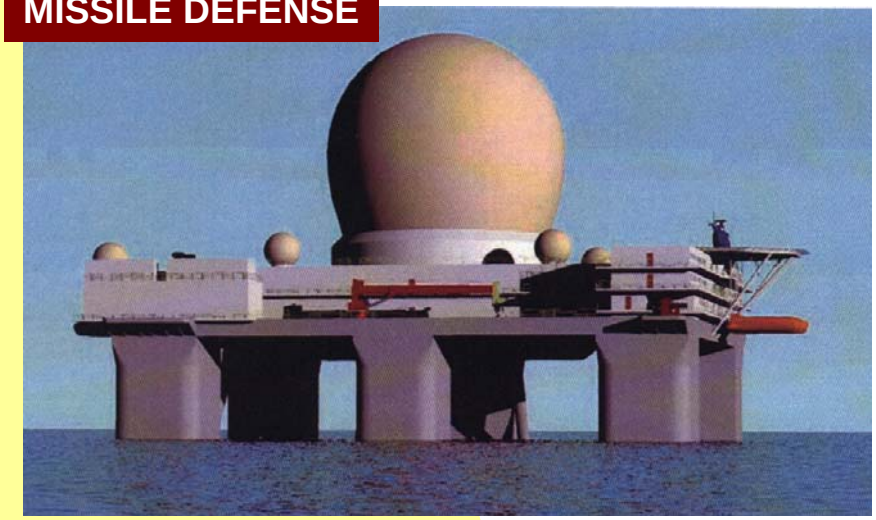
UNMANNED RECON (HALE)

SURFACE STRIKE

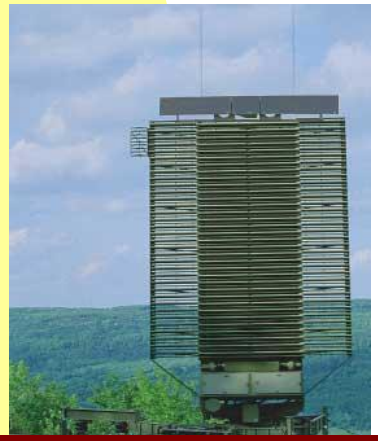
ELINT/SIGINT

C4ISR Sensors (Surface)
Usually Under Theater Command

MISSILE DEFENSE

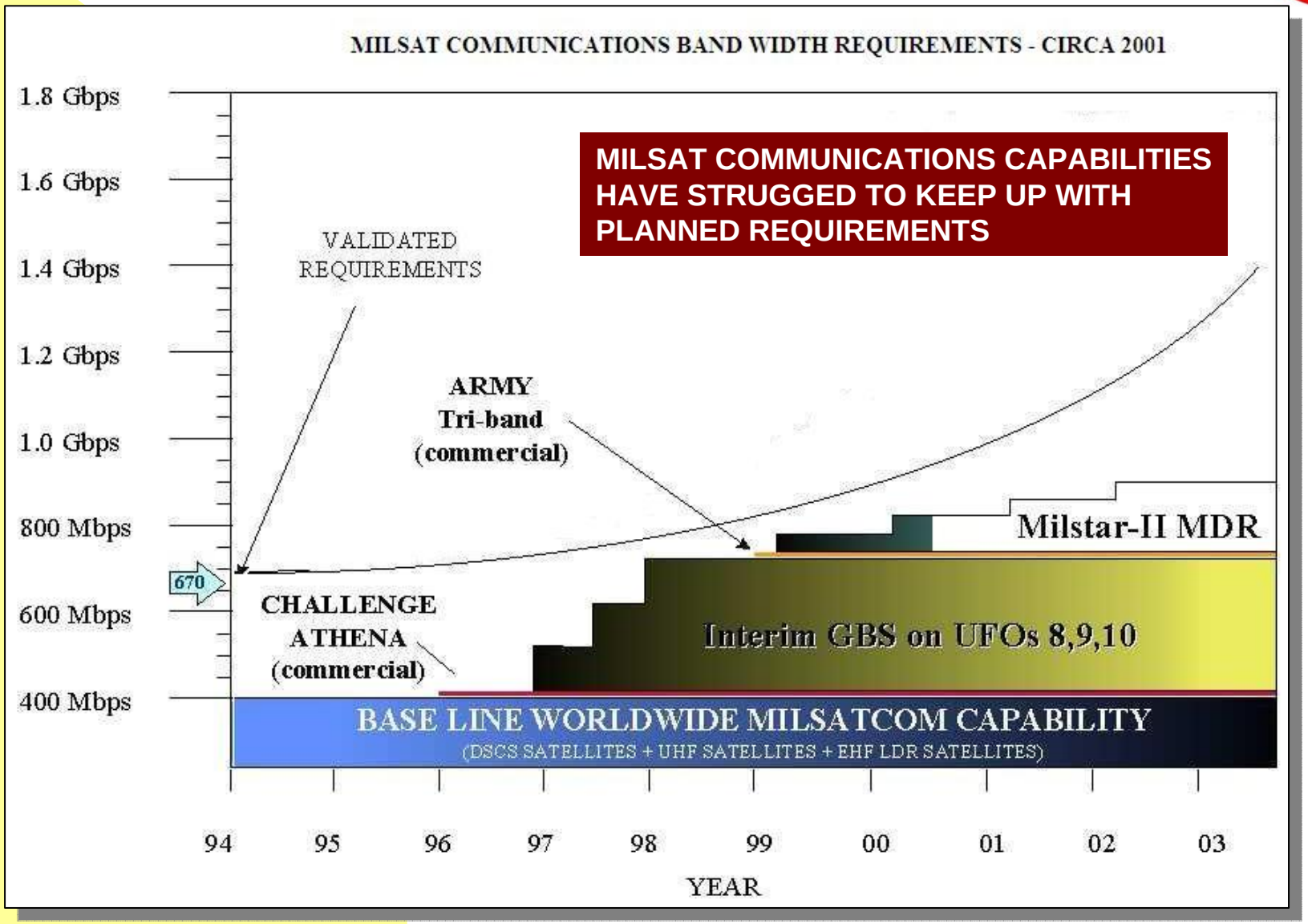


UNMANNED SURFACE SENSING

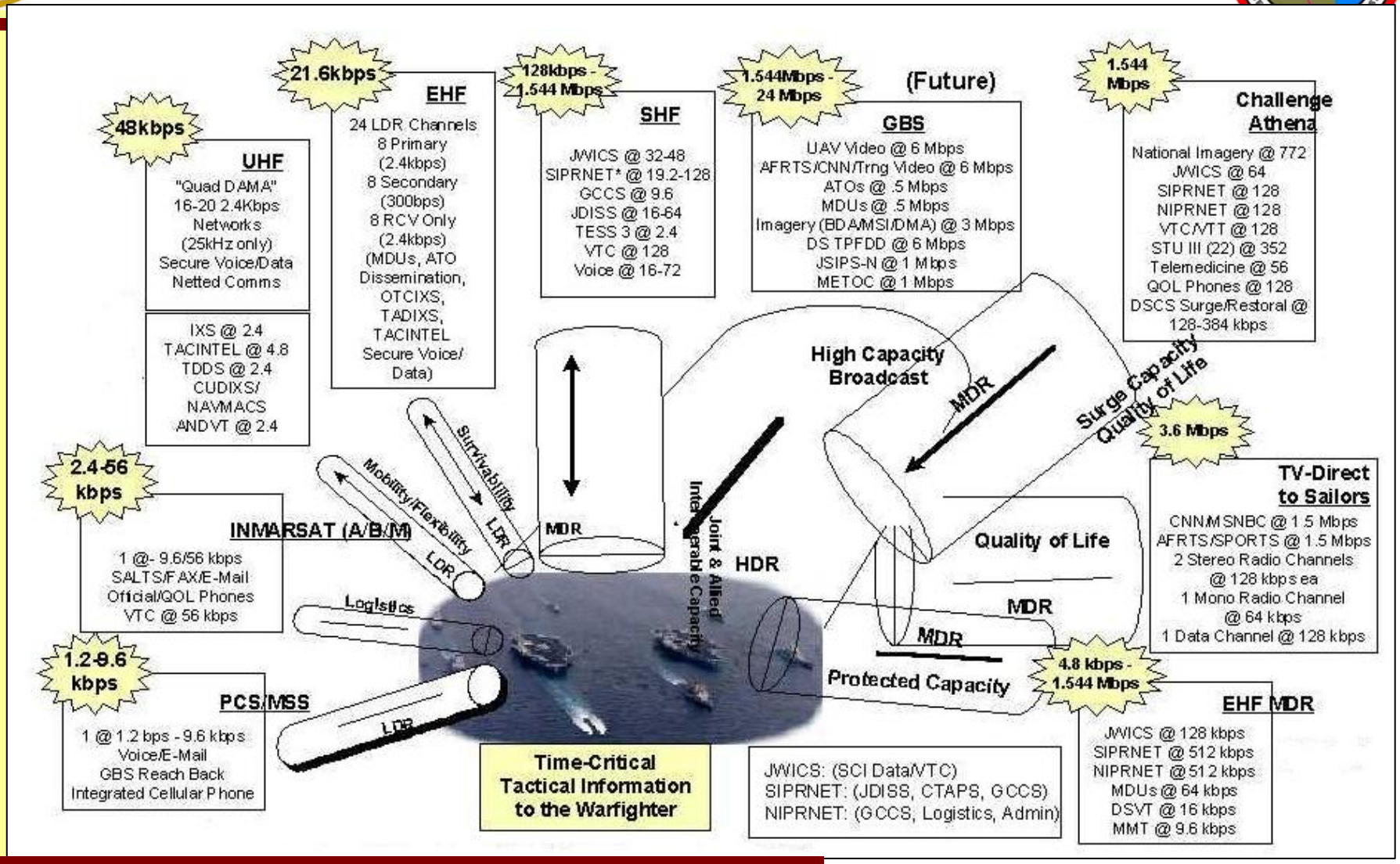


AIR DEFENSE, ARTILLERY LOCATION

C4ISR Communications Infrastructure

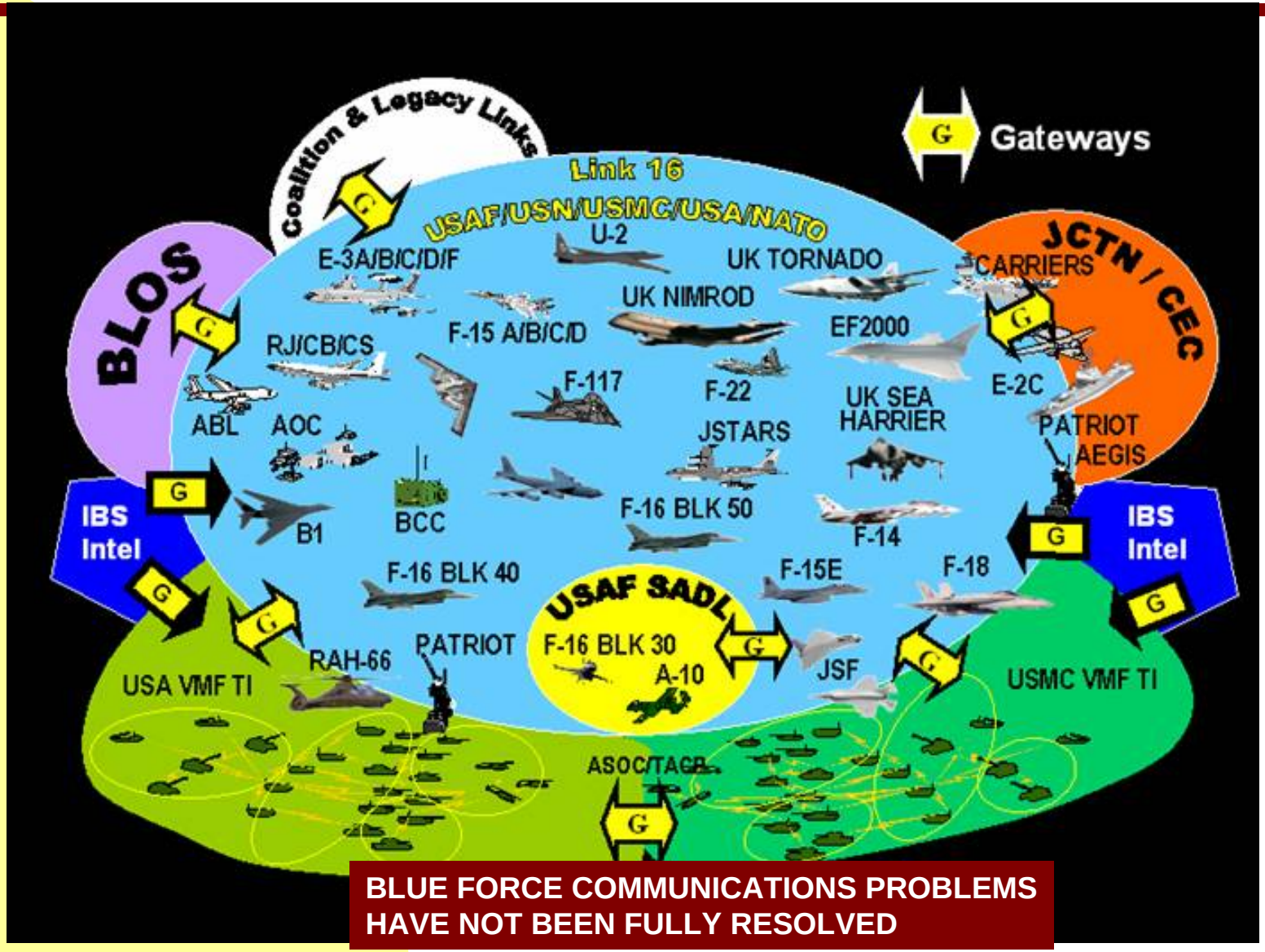


C4ISR Communications Infrastructure



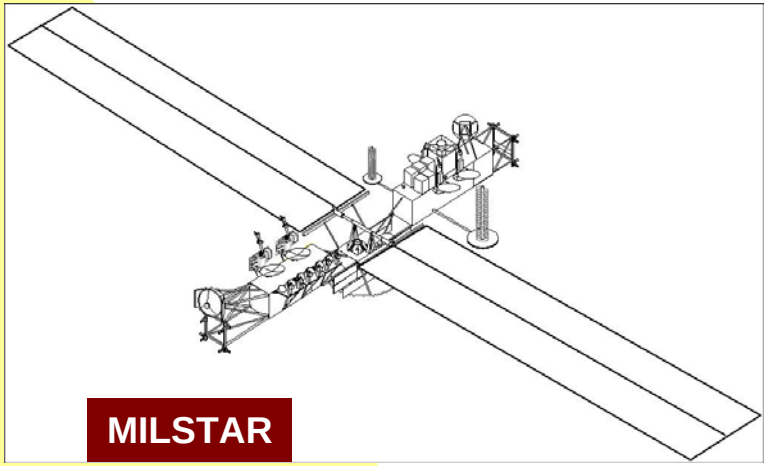
THE REQUIREMENT FOR MORE BANDWIDTH (PIPE SIZE) CONTINUES TO GROW.

C4ISR Communications Infrastructure

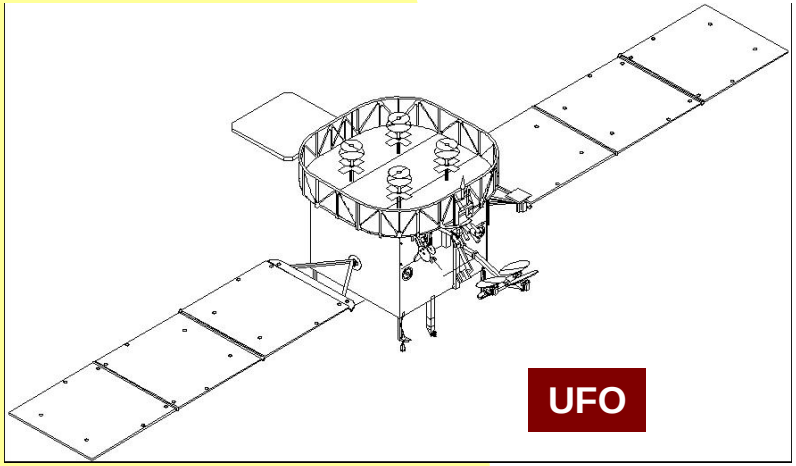


BLUE FORCE COMMUNICATIONS PROBLEMS HAVE NOT BEEN FULLY RESOLVED

C4ISR Communications Infrastructure (Space)



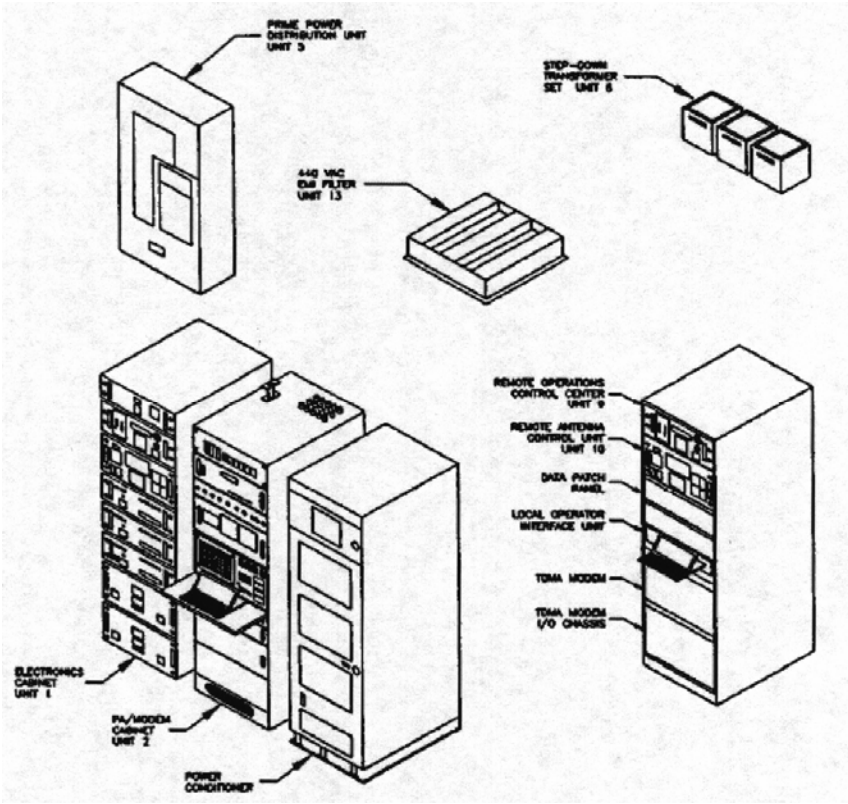
MILSTAR



UFO

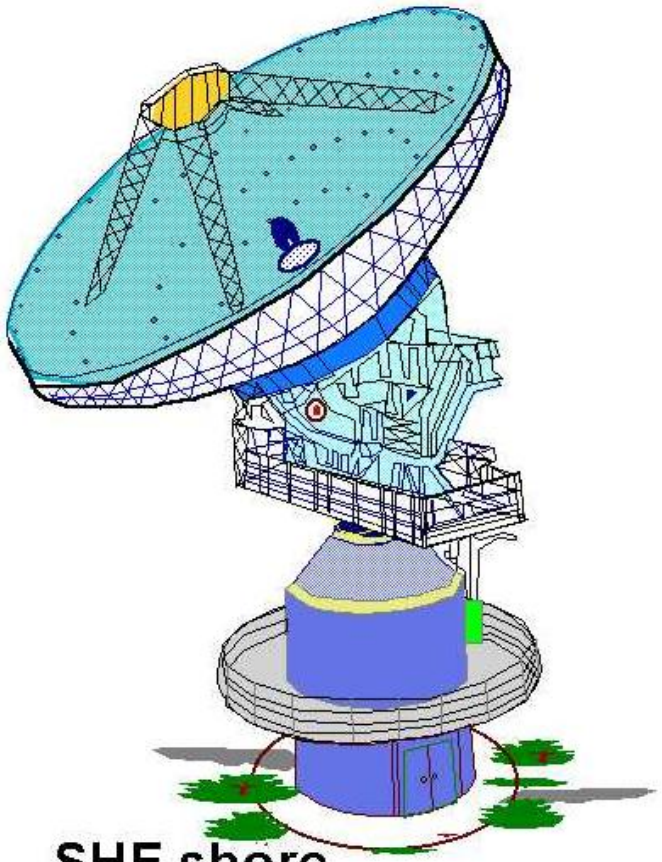
WBGF

C4ISR Communications Infrastructure (Surface)



WSC-6 SATCOMM TERMINAL (SHIPS)

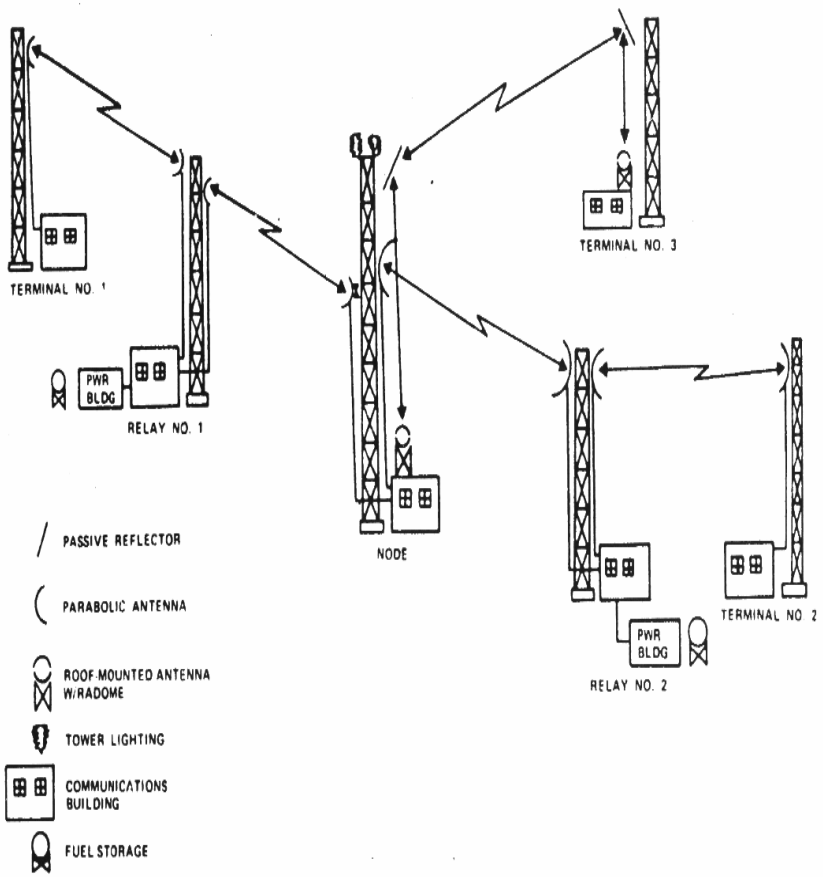
C4ISR Communications Infrastructure (Surface)

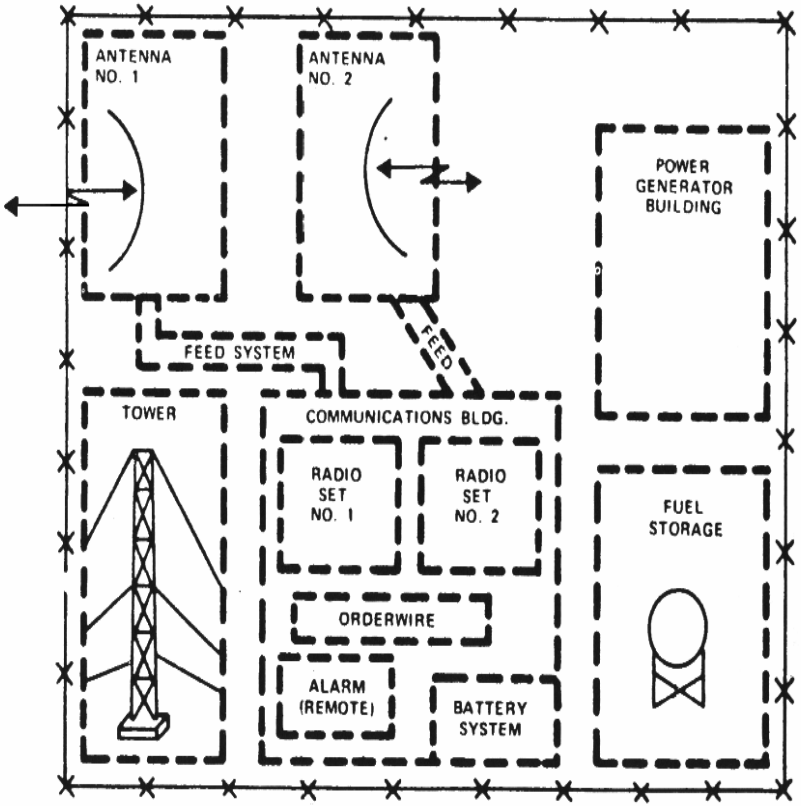


SHF shore
60 ft dish
Tens of Mbps

TYPICAL GROUND ENTRY POINT/SATCOMM TERMINALS (GROUND UNITS)

C4ISR Communications Infrastructure (Surface)





LINE OF SITE (LOS) COMMUNICATION TERMINALS (GROUND UNITS)

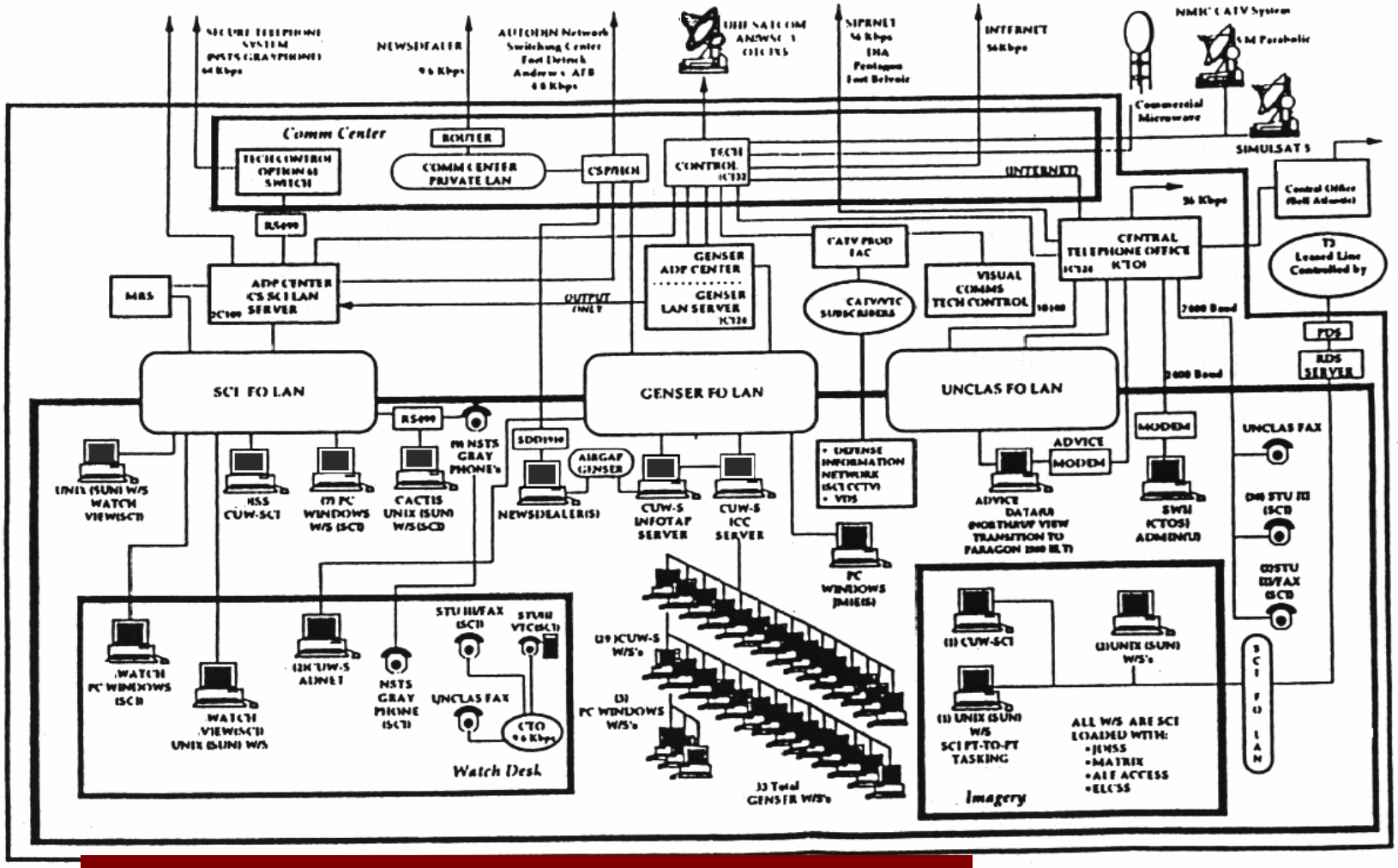
C4ISR Network Center

- ***The C4ISR Network Center Includes:***
  - ***The HARDWARE needed to support multiple command functions and operations, including work stations, digital equipment, peripheral systems, security systems, communications systems, and support installations, shelters, and auxiliary equipment.***
  - ***The SOFTWARE needed to support complex C2 functions, Communications functions, ISR Functions, Logistics Management functions, and Simulations supported by robust IT infrastructure.***
  - ***The HUMAN component, comprised of highly trained personnel needed to operate, manipulate, and fuse data, to create situation awareness, assess objective truth, and generate decisions and courses of action for joint forces.***

C4ISR Network Center Hardware

TYPICAL NETWORK C4ISR COMMAND POST (TEMPORARY AOC, DESERT STORM VINTAGE)

C4ISR Network Center Hardware



TOPOLOGY DIAGRAM, NEEDED TO CREATE FIRST ORDER EQUIPMENT LIST OR BILL OF MATERIAL

C4ISR Network Center Hardware

NOMENCLATURE	UNIT COST HIGH (FY04 $)	UNIT COST LOW (FY04 $)	MEDIAN COST (FY04 $)
WORK STATIONS			
WORK STATIONS	$12,000	$7,000	$9,500
PC TYPE WORK STATIONS	$3,900	$1,250	$2,575
CORE DIGITAL EQUIPMENT			
SERVERS	$65,000	$32,000	$48,500
PROCESSORS	$18,500	$11,500	$15,000
MEMORY UNITS	$23,000	$15,500	$19,250
GIGABIT STORAGE DISKS	$1,200	$900	$1,050
CHASSIS GROUP	$42,000	$30,000	$36,000
PERIPHERAL SYSTEMS			
PRINTERS	$3,000	$950	$1,975
ENCODERS/DECODERS	$25,000	$15,000	$20,000
FIBER OPTIC MODEMS	$10,000	$6,500	$8,250
GPS RECEIVER SYSTEM	$20,000	$12,000	$16,000
T1 MUX GROUP	$20,000	$15,000	$17,500
ENCRYPT CONTROLLER	$20,000	$15,000	$17,500
ETHERNET SWITCH GROUP	$25,000	$14,000	$19,500
ETHERNET SWITCH GROUP	$25,000	$14,000	$19,500
ROUTER GROUP	$15,000	$5,000	$10,000
SECURITY GROUP			
Encrypt/Decrypt Units	$28,000	$18,500	$23,250
STU III Telephones	$35,000	$22,000	$28,500
GROUND ENTRY POINTS			
ANTENNA	$3,500,000	$750,000	$2,125,000
PEDESTAL	$1,500,000	$250,000	$875,000
DRIVE GROUP	$500,000	$125,000	$312,500
TRANSCEIVER GROUP	$2,000,000	$350,000	$1,175,000
PROCESSOR	$75,000	$35,000	$55,000
ETHERNET LAN GROUP	$75,000	$20,000	$47,500
ETHERNET ROUTER GROUP	$25,000	$16,000	$20,500
ENCRYPT/DECRYPT UNITS	$75,000	$25,000	$50,000

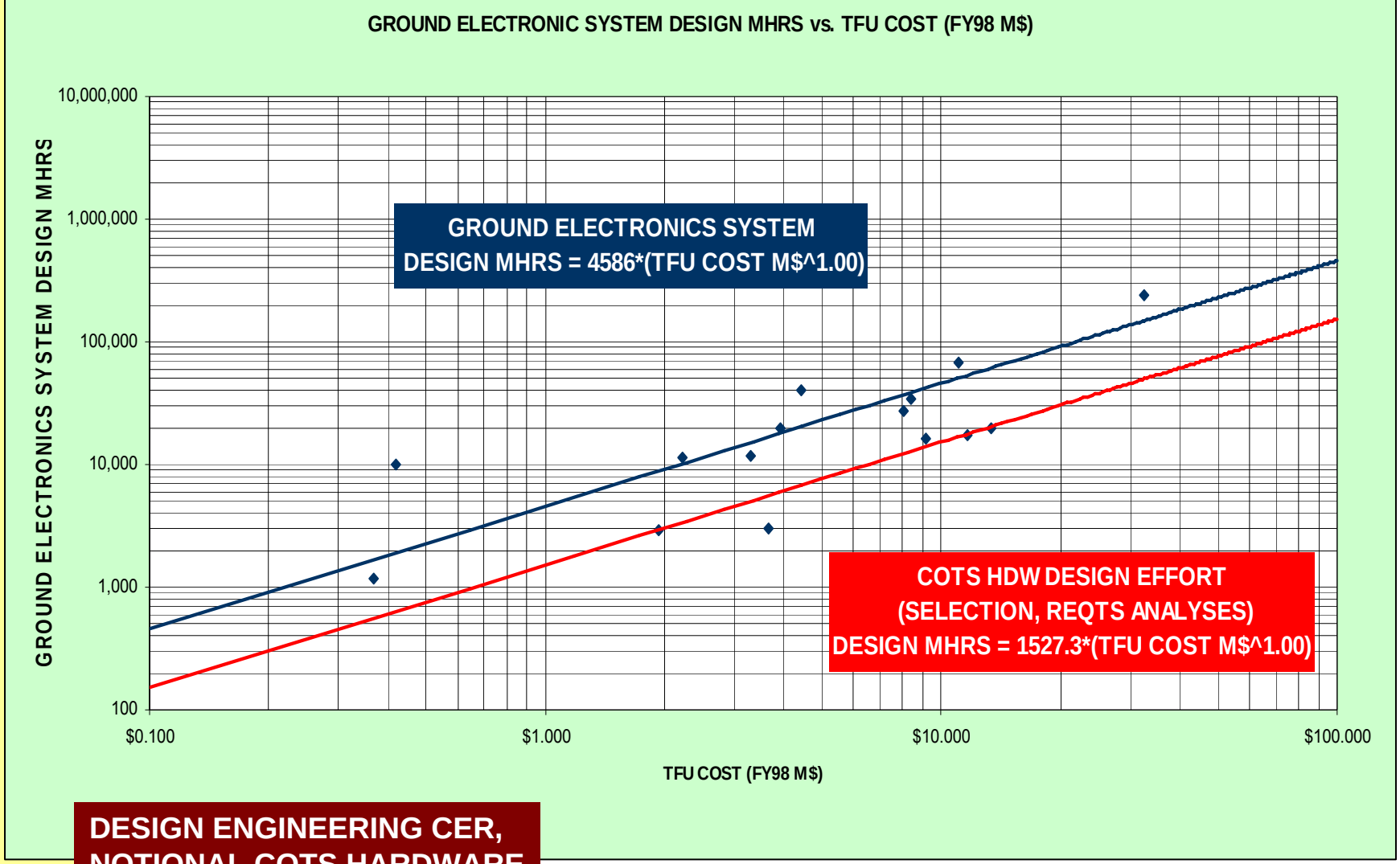
NOTIONAL COTS HARDWARE COST RANGES

C4ISR Network Center Hardware

NOMENCLATURE	UNIT COST HIGH (FY04 $)	UNIT COST LOW (FY04 $)	MEDIAN COST (FY04 $)
SHELTERS & AUXILARY GRP			
GICHNER S250 SHELTER	$50,000	$32,000	$41,000
20 kW GENERATOR SYSTEM	$18,750	$12,000	$15,375
50 kBTU ENVIRON CNTL	$18,750	$12,000	$15,375
POWER CONDITIONING	$25,000	$16,000	$20,500

NOTIONAL COTS SHELTER AND AUXILIARY GROUP HARDWARE COST RANGES

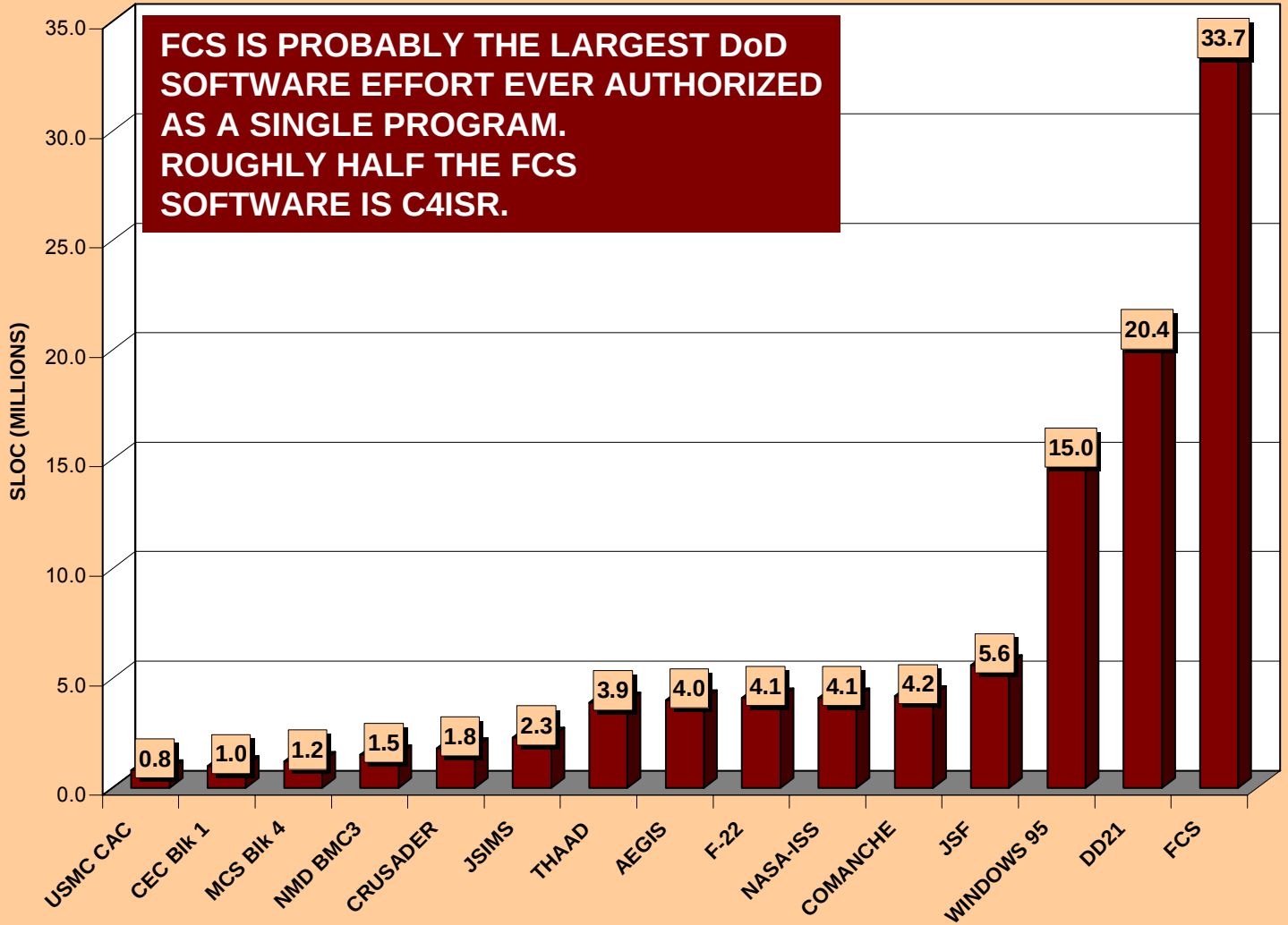
C4ISR Network Center Hardware



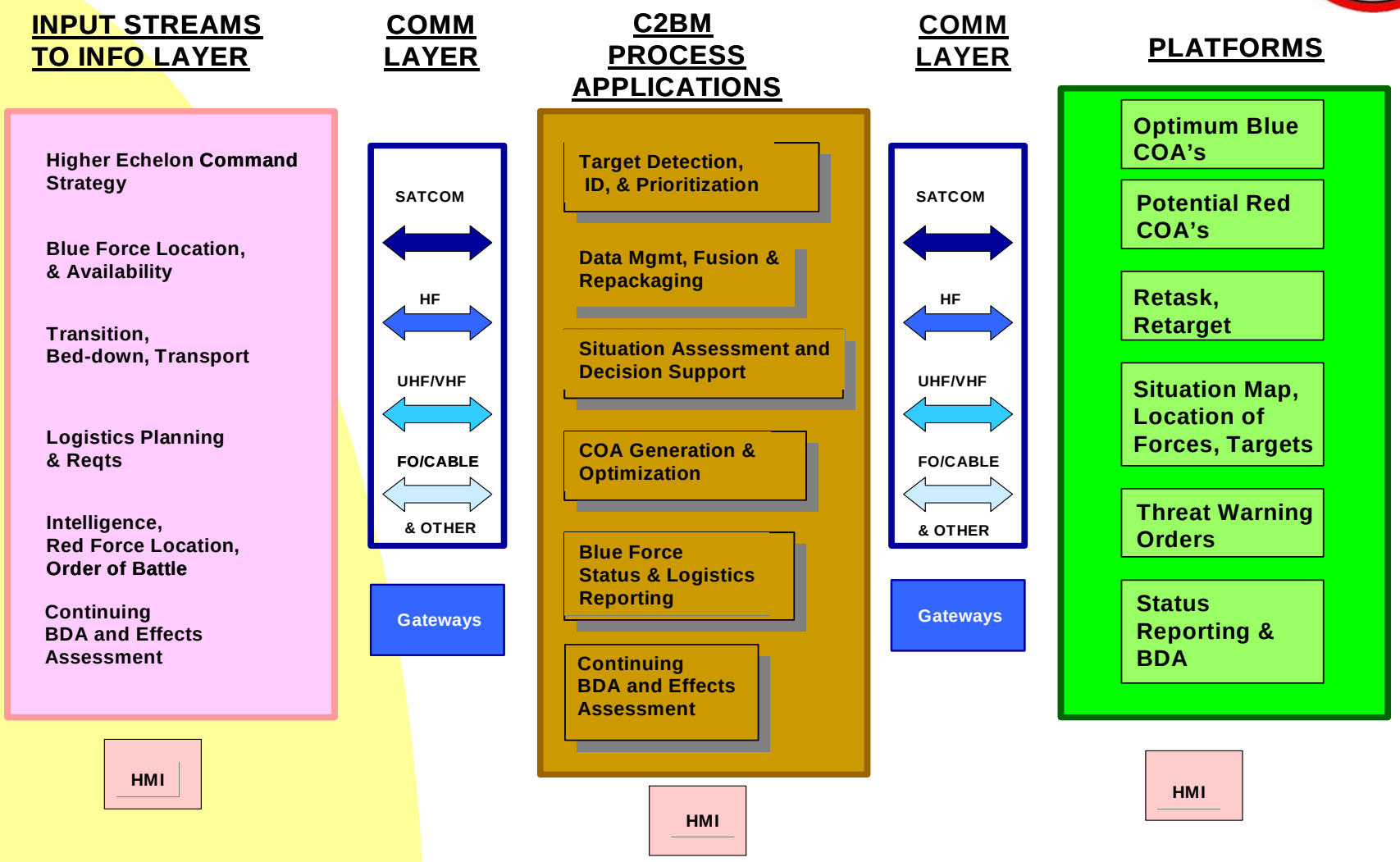
DESIGN ENGINEERING CER, NOTIONAL COTS HARDWARE

C4ISR Network Center Software

FCS IS PROBABLY THE LARGEST DoD SOFTWARE EFFORT EVER AUTHORIZED AS A SINGLE PROGRAM. ROUGHLY HALF THE FCS SOFTWARE IS C4ISR.



C4ISR Network Center

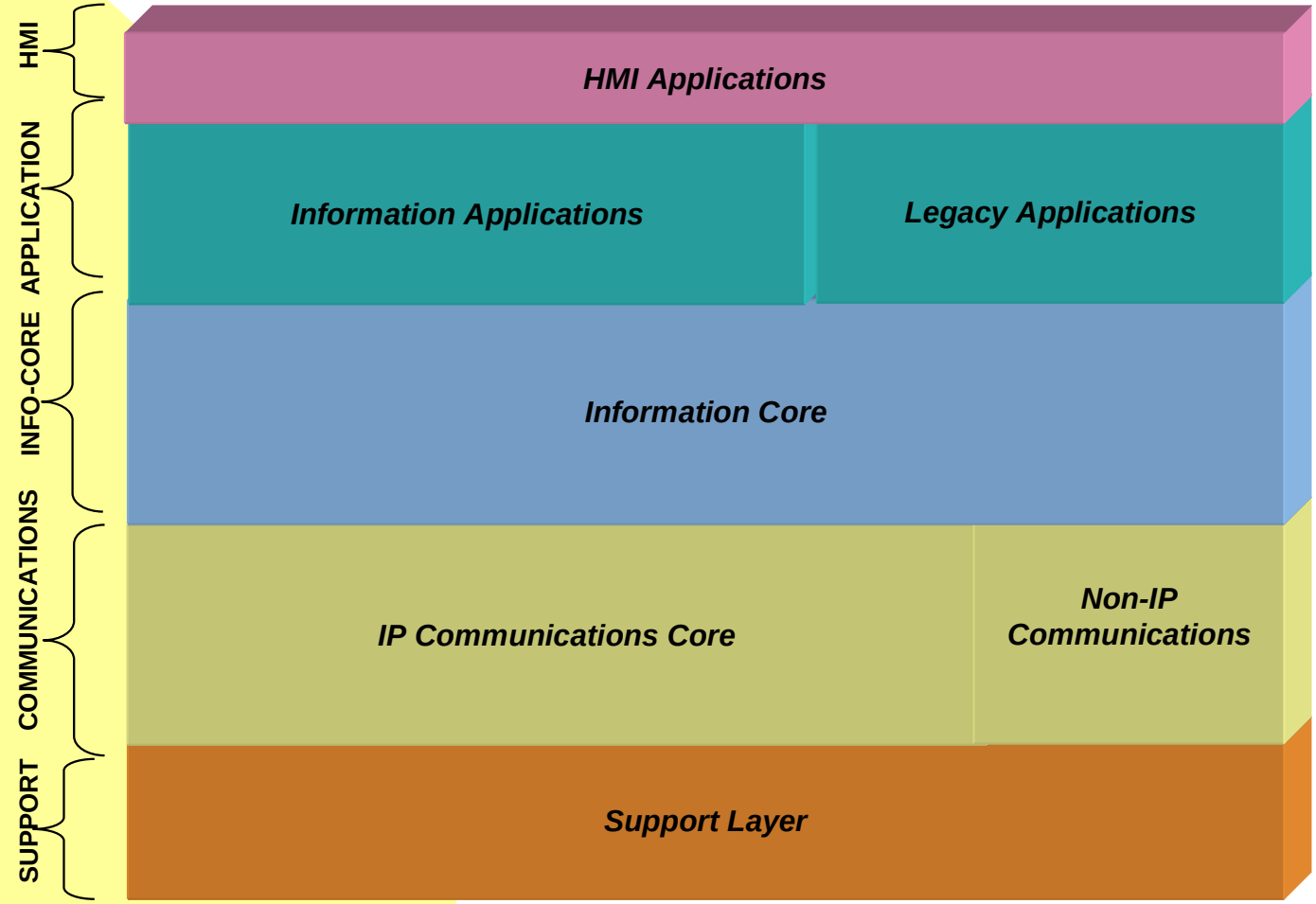


CONCEPTUAL FRAMEWORK FOR SOFTWARE DEVELOPMENT: FUNCTIONAL LAYERS, IPUTS/OUTPUTS, INTERFACES.

C4ISR Network Center

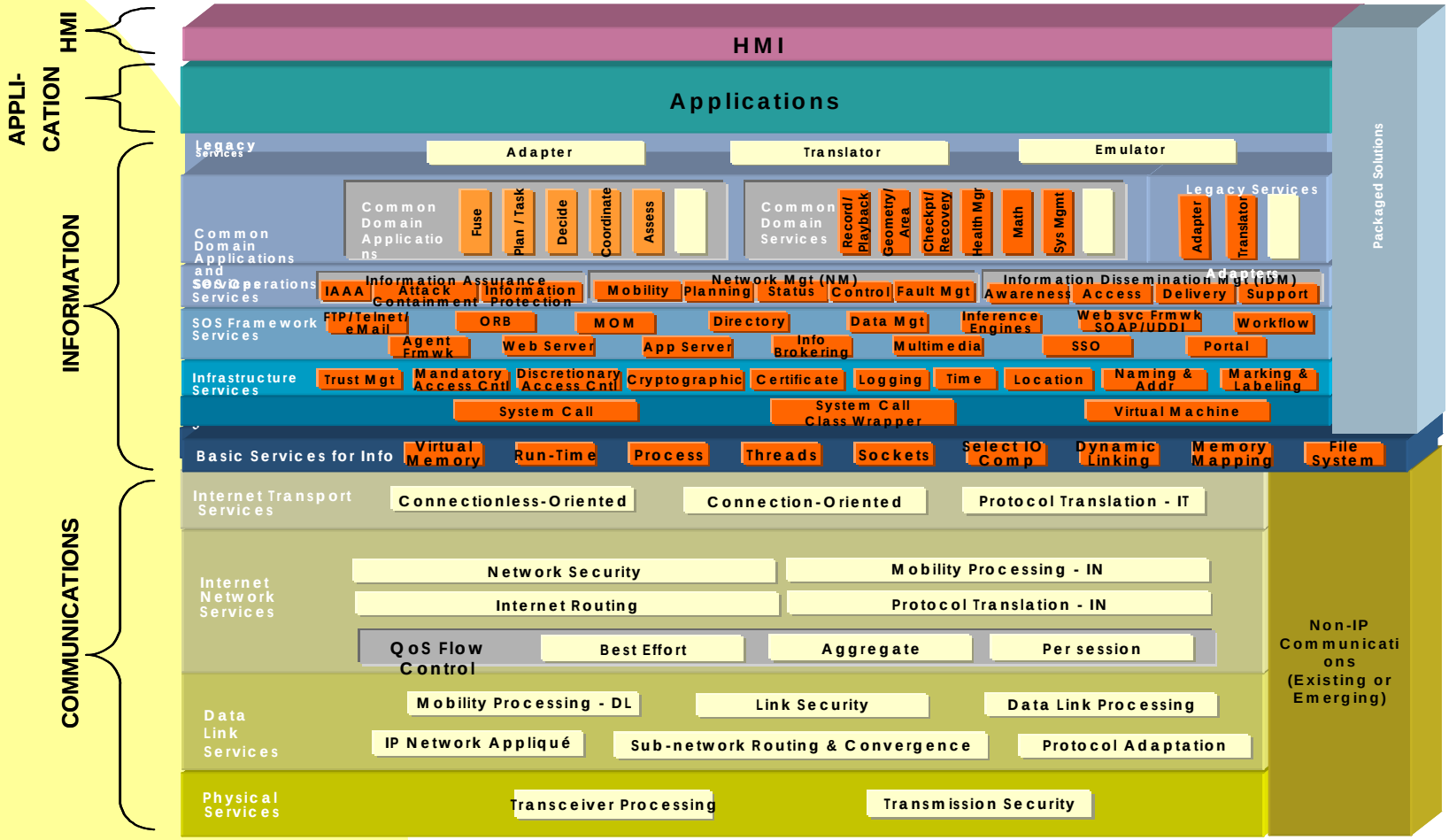
C4ISR's PRODUCT: STRIKE OPERATIONS, BDA, AND RESTRIKE TASKING UNTIL SUCCESS IS ACHIEVED.

C4ISR Network Center Software



CONCEPTUAL FRAMEWORK FOR SOFTWARE DEVELOPMENT: FUNCTIONAL LAYERS.

C4ISR Network Center Software



LAYERS BECOME POPULATED WITH "BRICKS" REPRESENTING THE CSCIs AND CSCs TO BE DEVELOPED AND INTEGRATED.

C4ISR Network Center Software C2 Functions

CONCEPTUAL SIZING FOR C4ISR SOFTWARE CODES	HIGH KSLOC	LOW KSLOC	MEDIAN KSLOC
COMMAND & CONTROL FUNCTION			
SITUATION UNDERSTANDING	900	150	525
PLANNING & PREPARATION	1350	225	788
BATTLE MGT & EXECUTION	600	100	350
COLLABORATION MGT	200	35	118
LEVEL 1 DATA FUSION	600	100	350
PLATFORM COMM & CONTROL	300	50	175
OTHER PLATFORM SOFTWARE	450	75	263
C4ISR LAB SOFTWARE	300	50	175

C2 Functions: At the heart of the network center's function, the C2 effort uses information from multiple data streams to create commander "situation awareness." Situation awareness encompasses the all the information elements within the objective space and over a time span that includes past, present, and a forecast of near-future status. It encompasses a full spectrum of information about friendly and enemy forces, the terrain and environment, and provides what commanders are likely to need to engage enemy forces and win. Also included in this bundle of codes are tools needed to generate detailed courses of action for subordinate units. Situation awareness is a basis for issuance of "orders" or courses of action to the joint forces.

C4ISR Network Center Software Communications Functions

CONCEPTUAL SIZING FOR C4ISR SOFTWARE CODES	HIGH KSLOC	LOW KSLOC	MEDIAN KSLOC
COMMUNICATION FUNCTION			
JTRS SUO WAVEFORM	300	50	175
JTRS WLAN WAVEFORM	300	50	175
RADIO GATEWAYS	150	25	88
IP STACK SOFTWARE	250	40	145
NETWORK INFRASTRUCTURE	200	30	115

Communications Functions: **Communications services must be managed to insure that diverse forms of traffic and flows of information are accommodated and are secure. Diverse traffic can include intelligence links with local or in-theater sensors and various organizations responsible for providing intelligence from national sources. Traffic also includes links to local fighting and units responsible for logistics. Communications links should be robust and redundant.**

C4ISR Network Center Software IT Functions

CONCEPTUAL SIZING FOR C4ISR SOFTWARE CODES	HIGH KSLOC	LOW KSLOC	MEDIAN KSLOC
COMPUTING INFRASTRUCTURE			
CNTL & DISPL GRP	450	75	263
CORE SERVICES	300	50	175
NETWORK MGT	150	25	88
I&T SOFTWARE	75	15	45
DISTRIBUTION MIDDLEWARE	675	115	395
ADMIN APPLICATIONS	150	25	88
SOS DOMAIN SERVICES	30	5	18
SOS FRAMEWORK SERVICES	300	50	175
OPERATING SYSTEMS	30	5	18
KNOWLEDGE MGT SERVICES	375	60	218

IT Functions: Underlying the specific computing functions are the Information Technology (IT) utilities. These include such vital items as operating systems, memory management, HMI utilities, display and graphical utilities, middleware that creates interfaces between applications and utilities, and other IT "services" such as security management. The IT support software suite is usually a mix of COTS and peculiar code.

C4ISR Network Center Software ISR Functions

CONCEPTUAL SIZING FOR C4ISR SOFTWARE CODES	HIGH KSLOC	LOW KSLOC	MEDIAN KSLOC
ISR FUNCTION			
PLATFORM MGT	450	75	263
ISR SENSOR PLAN/TASKING	900	150	525
ISR SENSOR PRODUCT MGT	1350	225	788
ISR SENSOR INTEGRATION	450	75	263

ISR Functions: As discussed here, ISR software is primarily concerned with tasking of sensors under direct theater command and integrating the flow of national ISR information into the network center's "in-box." Features that manipulate ISR information (e.g., target recognition and discrimination) could be included here or could be part of the situation awareness function described above in C2.

C4ISR Network Center Software Embedded Logistics

CONCEPTUAL SIZING FOR C4ISR SOFTWARE CODES	HIGH KSLOC	LOW KSLOC	MEDIAN KSLOC
EMBEDDED LOGISTICS			
LOGISTICS MGT	600	100	350
LOGISTICS STATUS	750	125	438
EMBEDDED TRAINING - C4ISR	375	60	218
VIRTUAL TRAINING	1400	250	825
LIVE TRAINING	500	85	293
MAINTENANCE TRAINING	200	30	115
CONDUCT OF FIRE TRAINING	1000	180	590
INSTRUCTION MGT SOFTWARE	750	125	438
EMBEDDED TRNG OTHER	300	50	175

Embedded Logistics: An important part of the network center's situation awareness is represented by logistics status, flows, and the initiation of material and human resource requests to CONUS organizations responsible for acquiring and transporting these people and items to the theater force. Important examples of logistics management include the flow of munitions and fuel to the fighting units. The inventories on hand, stocks ordered, stocks in transit, location of stocks at specific times, consumption, and other status measures are rigorously tracked at the network center. These represent a template for thousands of other material items. Human resources are also tracked in terms of numbers present, numbers needed, training and readiness status, and other HR measures. The network center's logistics management functions acquire information through interfaces with large CONUS logistics software systems provided by the separate armed services.

C4ISR Network Center Software Simulations

CONCEPTUAL SIZING FOR C4ISR SOFTWARE CODES	HIGH KSLOC	LOW KSLOC	MEDIAN KSLOC
SIMULATION SOFTWARE			
AIR BATTLE SIM	500	90	295
LARGE UNIT BATTLE SIM	2900	500	1,700
COMMAND ORGANIZATION GRID	200	30	115
TACTICS SIM	500	90	295
ENEMY FORCES SIM	900	150	525
VERTICAL MANEUVER SIM	200	30	115
ARTILLERY & MISSILE SIM	450	75	263
ATCOM-SLAMEM	200	30	115
BATTLEFIELD DYNAMICS SIM	450	70	260
SMALL UNIT BATTLE SIM	450	70	260
ENVIRON CONDITIONS SIM	200	30	115
FIRST ORDER ANALYSIS	450	70	260

Simulation Software: A recent development in C4ISR network systems is the use of large and capable embedded simulations. These are used for war-gaming and training purposes but more importantly serve to evaluate alternative courses of action to allow commanders to select the best ones for the engagement. The simulations are also valuable because they allow the commanders to simulate enemy operations and alternative enemy responses to U.S. strikes. Multiple simulations are incorporated, because the different combat modes have unique dynamics, logic, and requirements.

C4ISR Network Center Software Communication Functions - Details

FUNCTIONS SLOC DATABASE			GROUND
OBJECT	NAME-FUNCTION	DOMAIN	SLOC
ISN13	Antenna Mgt	COMM	0
P307	Cmd & Telemetry	COMM	54400
ISN9	Collaboration Mgt	COMM	220000
P272	Comm Interface	COMM	72360
P210	Comm Mgt	COMM	15608
G3	Comm Mgt	COMM	10275
G48	Comm Mgt	COMM	45700
P74	Delivery Mgt	COMM	6974
P373	External Intf	COMM	34752
ISN14	Gateways	COMM	100000
ISN18	IP Stack SW	COMM	150000
ISN11	JTRS Mgt 1	COMM	200000
ISN12	JTRS Mgt 2	COMM	200000
G28	Message Mgt	COMM	1552
ISN25	Network Infrastructure	COMM	25000
ISN32	Network Infrastructure	COMM	10000
ISN16	Network Mgt	COMM	83400
ISN19	Other Comm Sw	COMM	0
G36	Station Acquisition	COMM	1900
P348	Telecomm SW	COMM	13530
G9	Telemetry Mgt	COMM	29574
G39	Telemetry Mgt	COMM	2771
P242	Telemetry SW	COMM	31870
P273	Telemetry SW	COMM	44447

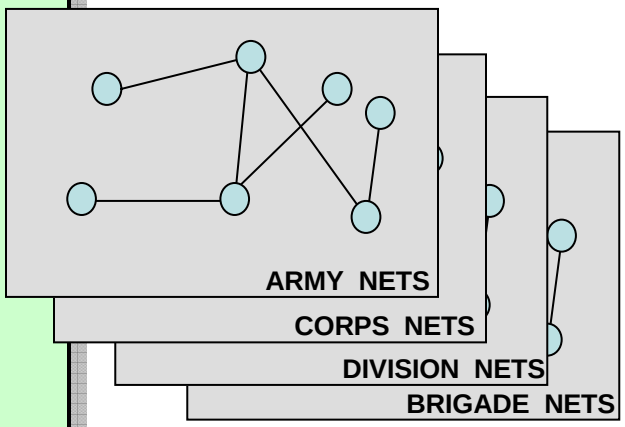
EXAMPLES OF SW SIZE VARIATION FOR CODES WITH "SIMILAR" FUNCTIONALITY.

C4ISR Network Center Software Size Variation for "Similar Function"

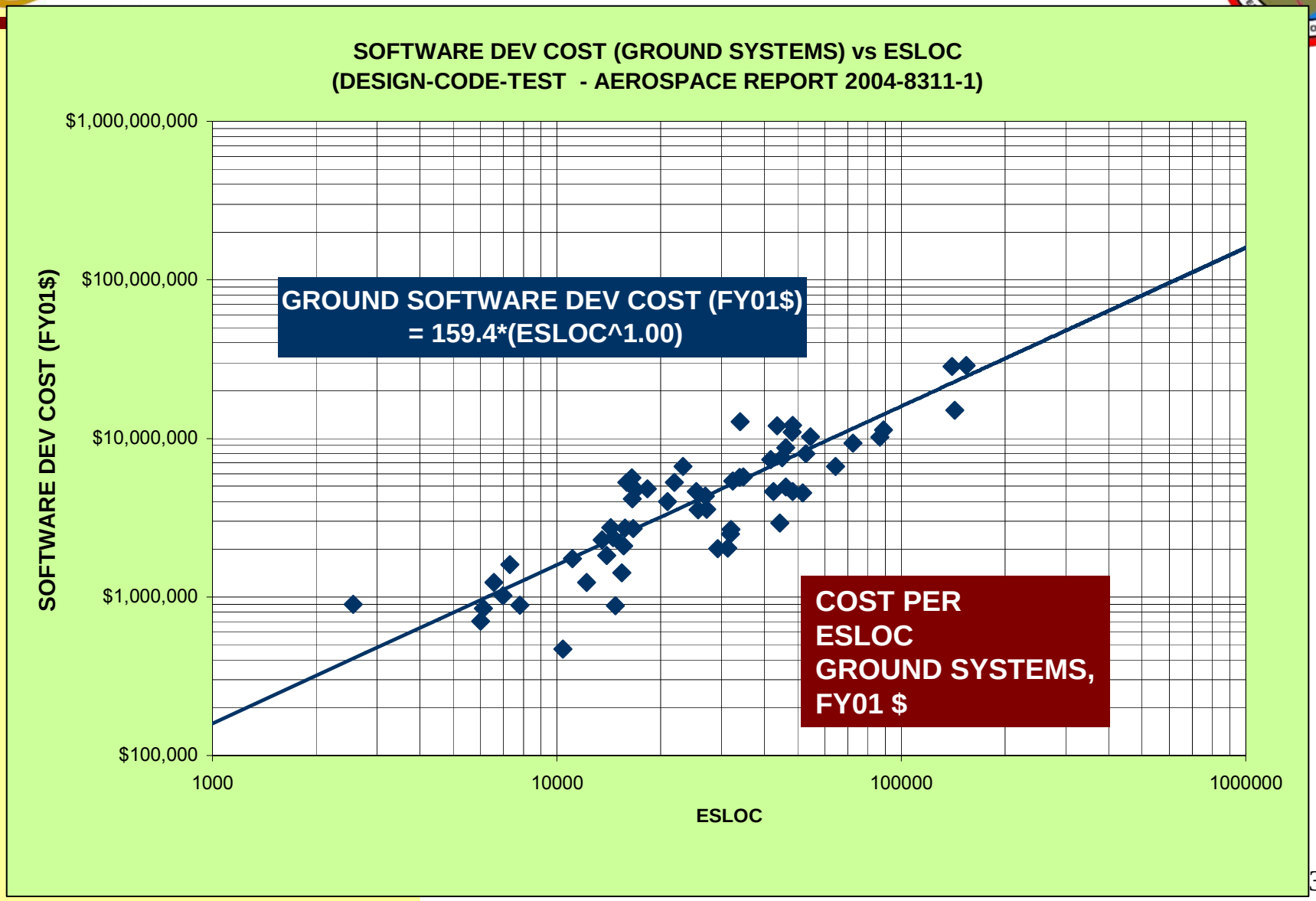
FUNCTIONS SLOC DATABASE			GROUND
OBJECT	NAME-FUNCTION	DOMAIN	SLOC
G17	Mission Planning	APP	12367
ISN2	Mission Planning	APP	1015000
P255	Mission Planning	APP	41703
P387	Mission Planning	APP	29326

EXAMPLES OF SW SIZE VARIATION FOR CODES WITH "SIMILAR" FUNCTIONALITY.

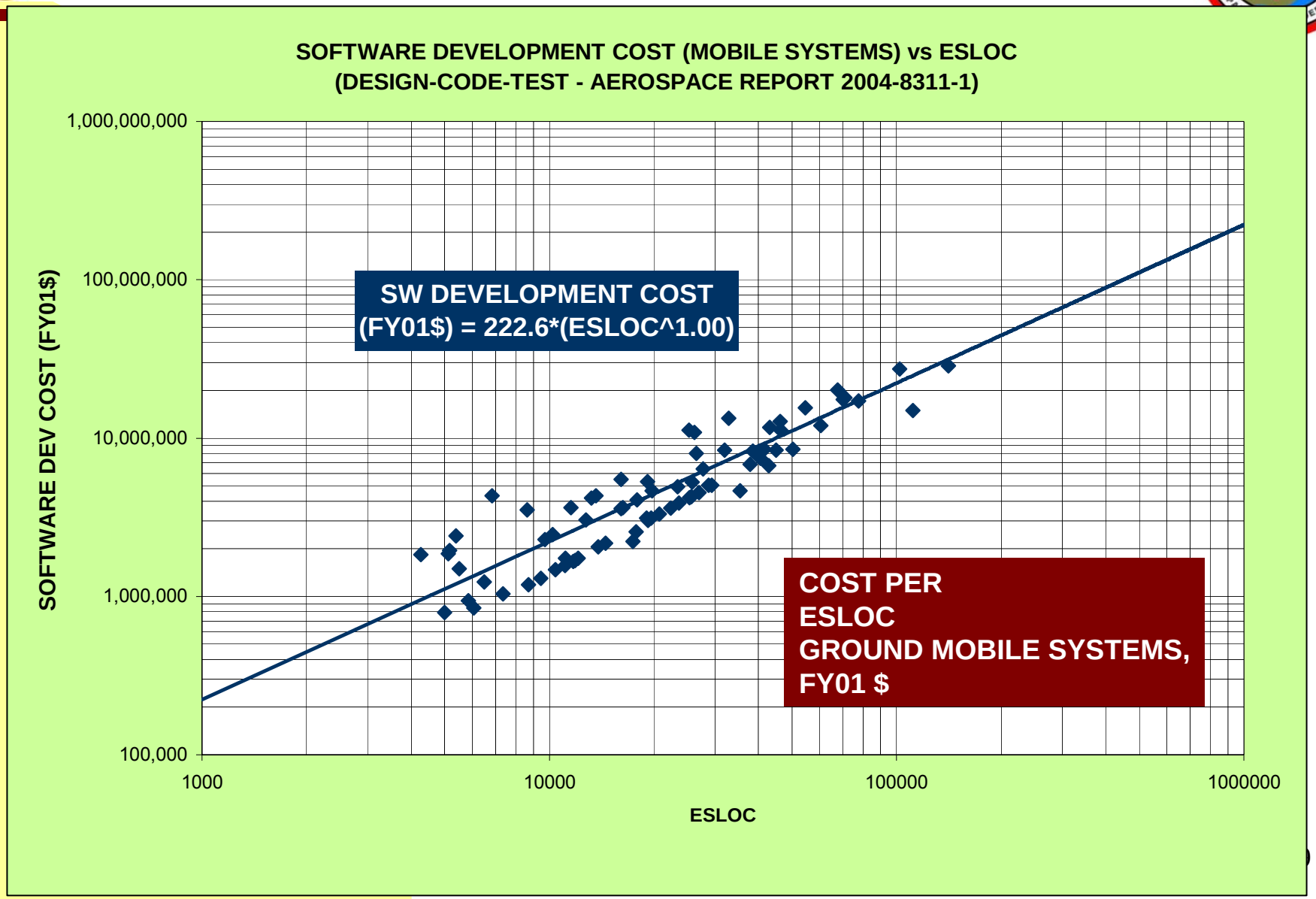
GROUND PLATFORM C2BM SITE	KSLOC	ECHELON
Decision Support 1	10	COMPANY HQ
Decision Support 2	15	COMPANY HQ
Decision Support 3	20	COMPANY HQ
Decision Support 4	100	BDE HQ
Decision Support 5	150	BDE HQ
Decision Support 6	250	DIV HQ
Decision Support 7	400	DIV HQ
Decision Support 8	400	CORPS HQ
Decision Support 9	750	THEATER HQ
Decision Support 10	1000	CENTRAL HQ



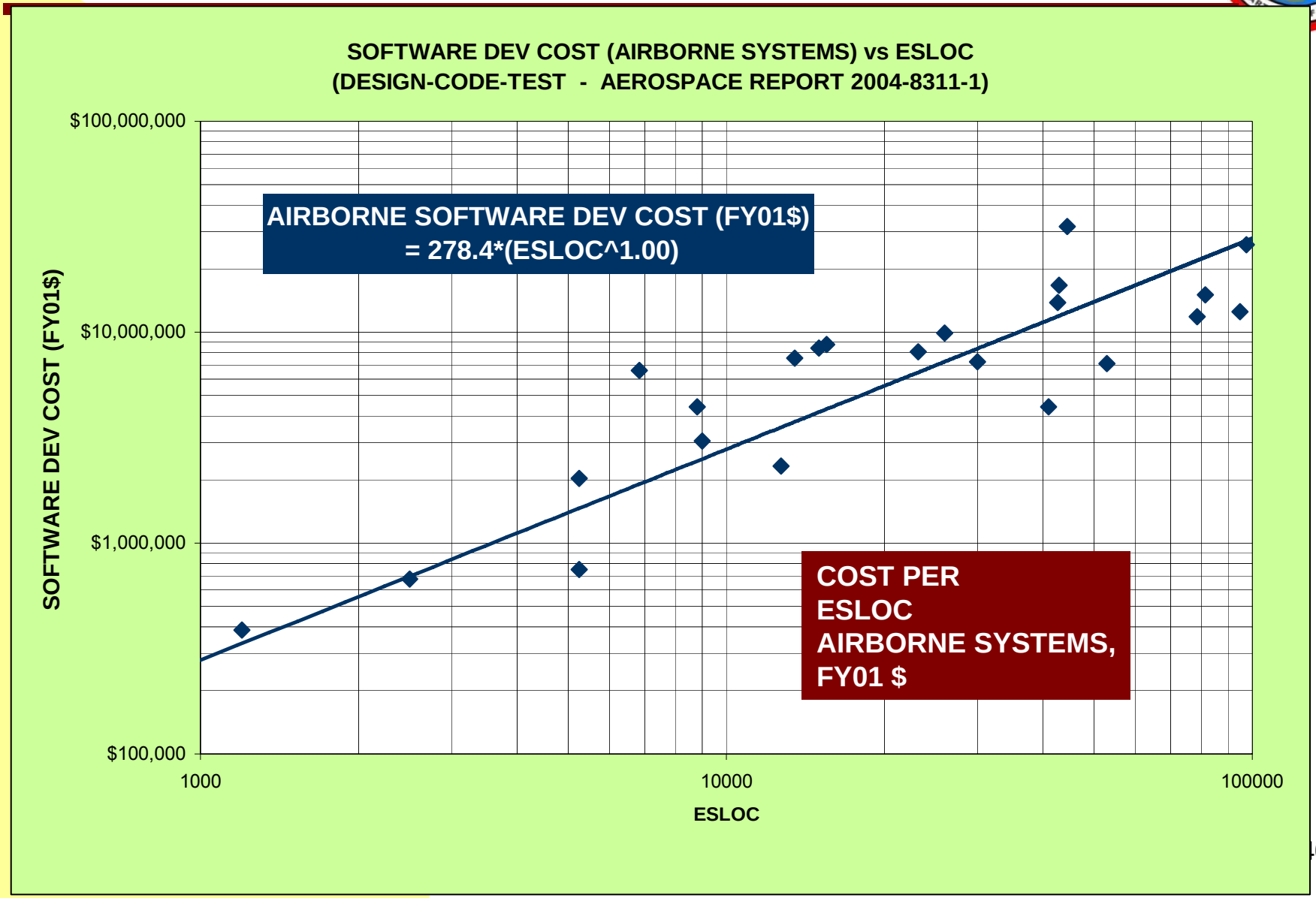
C4ISR Network Center Software



C4ISR Network Center Software



C4ISR Network Center Software



C4ISR Network Center Software

(FY04 M$) S2 14-Feb-05

WE		COST ELEMENT	FCS SW SUITE INPUT	MARKUP	CFE SUITE COST	GFE SUITE COST	REF
110 SW ENG NEW		SOFTWARE ENGINEERING NEW CODE	10797439	$156.02	$1,684.647		L1
	0.04	ODC $	$61.822	1.09	$67.386		
		110 SW ENGINEERING - NEW CODE			$1,752.033	$0.000	
120 SW ENG REUSED		SOFTWARE ENGINEERING REUSED CODE	9470383	$156.02	$1,477.596		L1
	0.04	ODC $	$54.224	1.09	$59.104		
		120 SW ENGINEERING - REUSED CODE			$1,536.700	$0.000	
130 COTS NR		COTS SUPPLIER N.R. $	$170.779	1.00	$170.779	$0.000	M5
	0.04	ODC $	$6.267	1.09	$6.831		
		130 TOTAL COTS SW SUPPLIER N.R.			$177.611	$0.000	
140 COTS LICENSES		COTS SUPPLIER $	$1,111.243	1.00	$1,111.243	$0.000	M5
	0.04	ODC $	$40.780	1.09	$44.450		
		140 TOTAL COTS LICENSES			$1,155.693	$0.000	
150 SOSSIM TEST & DEVEL		EQUIPMENT & COTS SW LICENSES $	$50.000	1.00	$50.000	$0.000	
		ENGINEERING TEST	126720	$151.92	$19.251		L3
		DEVELOPMENT	76032	$100.04	$7.606		L3
		MANUFACTURING	0	$92.21	$0.000		
		MANUFACTURING SUPPORT	760	$101.43	$0.077		
		QUALITY ASSURANCE	8592	$115.05	$0.988		
		TOOLING M & R	1673	$110.05	$0.184		
	0.04	ODC $	$2.866	1.09	$3.124		
		150 TOTAL SOSSIM TEST & DEV			$81.231	$0.000	
160 ILS REQTS ANALYSIS		ILS REQTS ANALYSIS	273616	$144.51	$39.539		L1
	0.04	ODC $	$1.451	1.09	$1.582		
		160 ILS REQUIREMENTS ANALYSIS			$41.121	$0.000	
170 QA ANALYSIS		QUALITY ASSURANCE ANALYSIS	456026	$115.05	$52.465		L1
	0.04	ODC $	$1.925	1.09	$2.099		
		170 QA ANALYSIS			$54.564	$0.000	
180 SYS ENG PROJECT MGT		SYSTEMS ENGINEERING	2471040	$156.02	$385.539		L8
	0.04	PROJECT MANAGEMENT	360000	$166.74	$60.025		L8
		ODC $	$16.351	1.09	$17.823		
		180 TOTAL SYS ENG/PROJECT MGMT			$463.387	$0.000	
		SW DEV COST	(FY04 M$)		$5,262.338	$0.000	
		SW DEV PRICE	(FY04 M$)		$6,051.689		

Code Generation

COTS Acquisition

Other Cost/Codes:

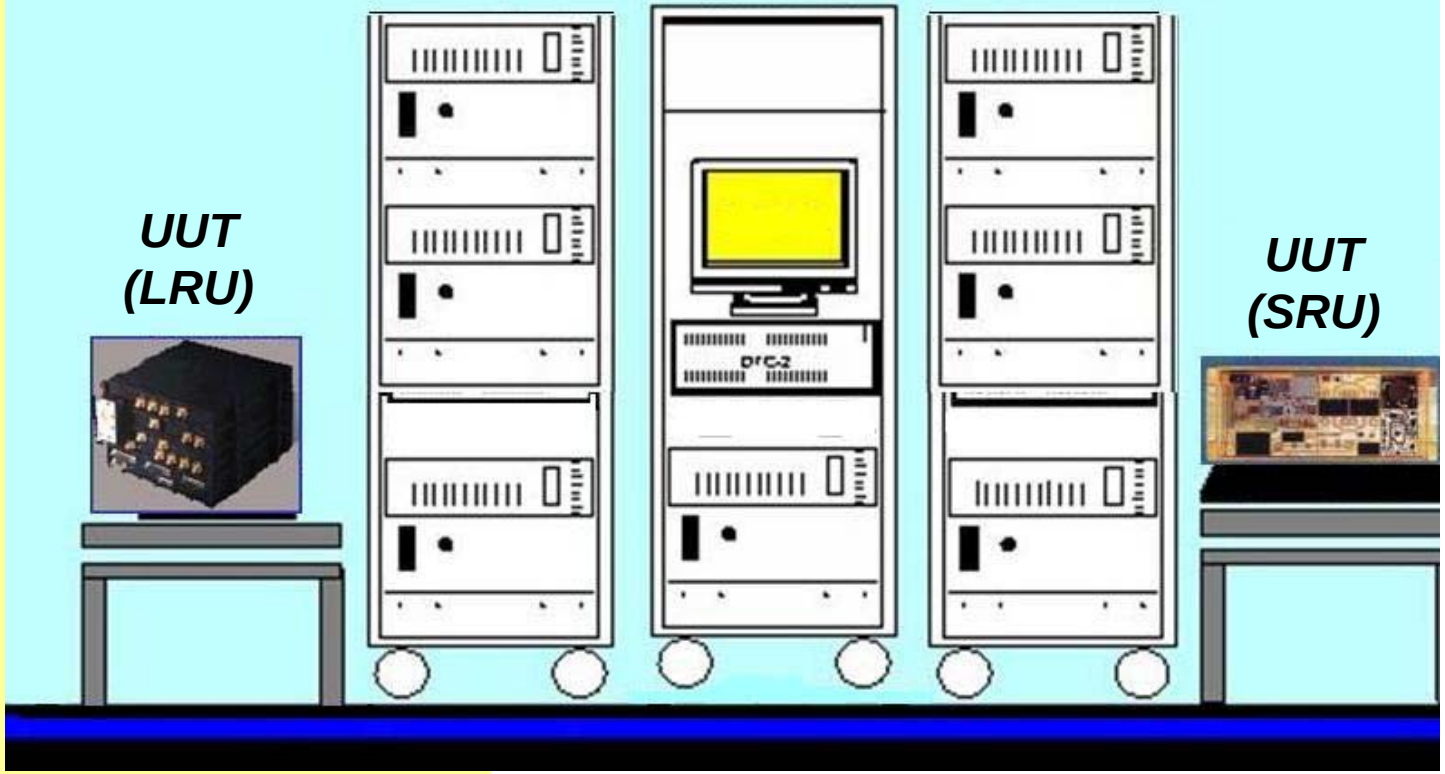
- *SOSIM,*
- *Test & Eval*
- *ILS for SW*
- *QA*
- *System Eng & Integ*

Network Center Support Investment

- ***The Network Center Support Investment Includes:***
  - ***The Concept of Logistics (CONLOG) governs the scope and depth of investment in classic logistics cost elements. Since C4ISR network centers have moved away from Mil-Peculiar hardware designs and toward COTS hardware designs, there is generally more reliance on forms of Contractor Logistics Support (CLS) and less reliance on MIL-Organic maintenance and support.***
  - ***In spite of the trend toward more reliance on CLS, the military continues to stress a requirement for robust training systems and data and documentations. These components of Support Investment remain as significant contributors to Life Cycle Cost.***

C4ISR Network Center Support Investments

AUTOMATIC TEST EQUIPMENT FOR DEPOT LEVEL REPAIRS



C4ISR Network Center Support Investments

C4ISR SUPPORT INVESTMENT FACTORS - f(PMP COST)

	HIGH	LOW	MEDIAN	REMARKS
GSE (ORGANIC DEPOT)	15.00%	7.50%	11.25%	f(HARDWARE COST)
GSE (CONTRACTOR DEPOT)	1.00%	0.50%	0.75%	f(HARDWARE COST)
GSSE	0.75%	0.25%	0.50%	f(HARDWARE COST)
DATA	5.00%	2.50%	3.75%	f(HDW & SW COST)
TRAINING	3.00%	1.50%	2.25%	f(HDW & SW COST)
INITIAL SPARES	20.00%	9.00%	14.50%	f(HARDWARE COST)
SPARES (LIFETIME)	75.00%	30.00%	52.50%	f(HARDWARE COST)

Network Center Operation & Support Cost

- ***The Network Center Operation & Support Cost Includes:***

  - ***Unit Level Manpower (ULM):*** ***ULM includes the cost of commanders, operators, maintainers, and other support manpower assigned to the C4ISR network center operating units. Unit-level manpower can include active and reserve military, government civilian, and contractor manpower costs. The topology diagram that describes the network center layout can serve as a useful check for manpower estimates. It is reasonable to assume that 70-80% of the center's work stations would be manned on a 24/7 basis. The balance would be reserved for surges, maintenance or upgrade cycles, or for personnel training operations. Using this approach, the operator complement can be derived.***

  - ***Command staff, security officers, organization level maintainers, and base support staff would be calculated separately and additive to the operator headcounts. Estimating the size of the unit maintenance staff, usually involves separate projections for preventive (scheduled) and corrective (unscheduled) maintenance actions.***

O&S - ULM

Network Center Operation & Support Cost

COMMAND SHIP - NOTIONAL STAFF

COMMAND STAFF	OFFICERS	=	2	ENLISTED =	6
OPS STAFF	OFFICERS	=	83	ENLISTED =	57
STDS/EVAL TEAM	OFFICERS	=	1	ENLISTED =	6
TRAINING STAFF	OFFICERS	=	1	ENLISTED =	7
MAINTENANCE				ENLISTED =	42
TOTAL MILITARY PERSONNEL			87		118

O&S - ULM

Network Center Operation & Support Cost

Typical Reliability Values

Communications Equipment	MTBF (Hours)
Ground Radio	5,000–20,000
Portable Ground Radio	1,000–3,000
Airborne Radio	500–10,000
Ground Jammer	500–2,000
Computer Equipment	**MTBF (Hours)**
Ground Computer	1,000–5,000
Ground Monochrome Display	15,000–25,000
Ground Color Display	2,500–7,500
Ground Hard Disk Drive	5,000–20,000
Ground Tape Storage Unit	2,500–5,000
Ground Printer	2,000–8,000
Ground Modem	20,000–50,000
Miscellaneous Equipment	**MTBF (Hours)**
Ground Power Supply	10,000–50,000

O&S – ULM: USE FAILURE EVENTS AND MTTR DATA TO FORECAST MAINTENANCE MANNING AND D-LVL REPAIR ACTIVITIES.

Network Center Operation & Support Cost

- ***The Network Center Operation & Support Cost Also Includes:***
  - ***Operations Costs (OC): OC includes the cost of unit operating material (e.g., fuel and training munitions), unit support services, and unit travel. OC excludes all maintenance and repair material. Of possible importance for mobile C4ISR network centers is a requirement to generate electricity using POL fueled generating systems.***

O&S - OC

Network Center Operation & Support Cost

- ***The Network Center Operation & Support Cost Also Includes:***

  - ***Non-Operating Unit Maintenance (NOUM): Includes the cost of all maintenance other than maintenance manpower assigned to operating units. For hardware, this includes organic depot level maintenance and contractor maintenance support. The cost of depot maintenance should be linked to the reliability parameters of the equipments and the frequency of failure events. Failure events produce either a repair action (with associated labor costs and transportation expenses) or a condemnation followed by a replacement item outlay.***
  - ***For software, this includes correction of software deficiencies and upgrades that are planned within the original scope of the system's performance envelope and requirements. As an average, software maintenance can affect between 3% and 8% of the software SLOC per year. C4ISR systems are specially impacted by this, because of dynamic changes in system platforms and interfaces, requirements for HMI performance, threat characteristics, and advances in C4ISR practices. Apart from the large initial investment in C4ISR software, we encounter a true affordability challenge with maintaining the software suite over an extended life cycle.***

O&S - NOUM

Network Center Operation & Support Cost

- ***The Network Center Operation & Support Cost Also Includes:***

  - ***Sustaining Support & Investment (SS&I):*** ***These costs include contractor technical support, maintenance of a Government program office and a host of special infrastructure support costs including Defense Systems Information Agency (DISA) connectivity fees.***

  - ***Also included are COTS software license fees, utility costs for fixed sites, commercial telephonic and satellite communications fees, leases and facility related costs, and hazardous materials disposal costs. Also included are operations costs for help desks and mega-centers, needed when the C4ISR network has centers throughout the theater and significant numbers of users and organizations are linked.***

  - ***Some types of SS&I costs are not universally applicable; they are present where needed and in accordance with the operational scenario and configuration specified for the C4ISR network center under study.***

O&S – SS&I

Network Center Operation & Support Cost

		TOTAL ANNUAL O&M COST (FY05 $)	
COTS SOFTWARE			
TOTAL COTS LICENSE COST	$622,000		
		$622,000	
UNIQUE DOD SOFTWARE APPLICATIONS			
TOTAL BLK 1 SW MAINT COST	$0		
TOTAL BLK 2 SW MAINT COST	$2,309,938		
		$2,309,938	
OTHER SOFTWARE			
TOTAL SW SLOC	0		
ANNUAL CHANGE TRAFFIC	0.00%		
TOTAL SW CHANGE SLOC GENERATEI	0		
TOTAL SW CHANGE ENG MHRS	0.0		
TOTAL PRICE PER ENG MHR	$120.00	$0	
COMM, INFRASTRUCTURE & DOD FEES			
DISA FEES	$225,000		
DoD NETWORK FEES	$175,100		
ACQ SECURITY SUPPORT	$267,000		
C&A (DITSCAP) FEES	$39,500		
IAVA FEES	$150,000		
OTHER FEES	$0		
		$856,600	
TOTAL SOFTWARE MAINTENANCE			$3,788,538

O&S – SS&I Example of Fees in Software LCC

Network Center Operation & Support Cost

- ***The Network Center Operation & Support Cost Also Includes:***

  - ***Continuing System Improvements (CSI): This cost includes evolutionary insertion of new hardware and software technology to keep the system operating and operationally current. Included here are new or expanded capabilities, new interfaces with emerging national C4ISR systems, new ISR platform nodes, and so forth. Here again, we encounter a true affordability challenge keeping the C4ISR network center technically current and responsive to threat changes and technology shifts over an extended life cycle.***

  - ***After the system achieves an IOC milestone, CSI can amount to between 5% and 20% of PME/SW investment per year for hardware upgrades and new software applications.***

O&S – CSI

Network Center Operation & Support Cost

- ***The Network Center Operation & Support Cost Also Includes:***
  - ***Indirect Support:*** ***These costs cover support activities that are general in nature and cannot be directly attributed to the C4ISR network system. Indirect support includes such items as change of stations expenses, medical benefits for military staff, personnel recruitment and basic skill training, and others.***

O&S – IS

Missile Defense Agency C4ISR

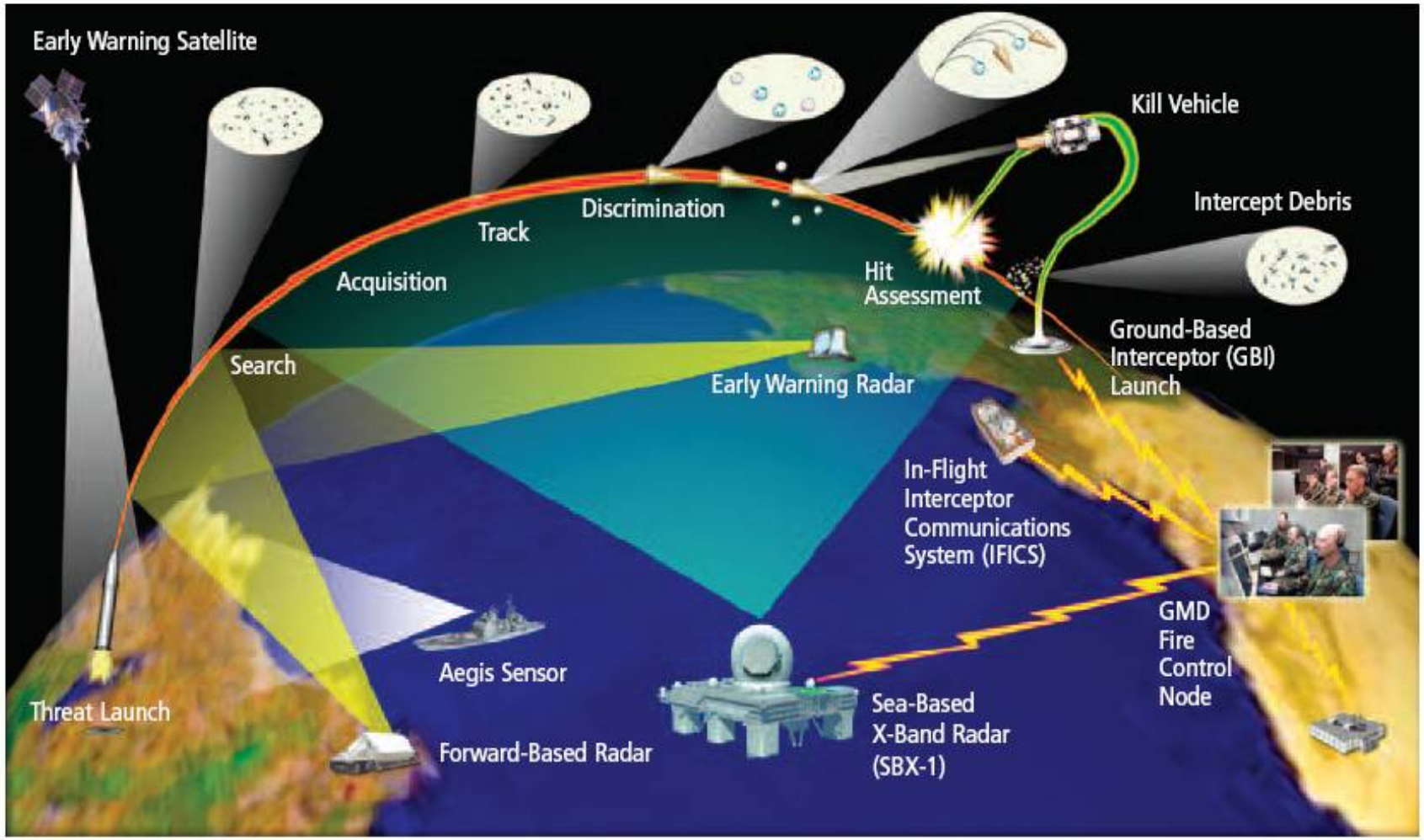
- ***MDA C4ISR Essentials – Layered Defense, Managed Engagements:***

  - ***MDA C4ISR performs an essential role of Command, Control, and Battle Management (C2BM), using appropriate information obtained from national sources. The system is always "on" (24/7), and higher readiness states and alerts are initiated when national assets observe threatening activities conducted by hostile nations.***

  - ***Positioning and Cueing of MDA Assets:*** ***In times of alert or crisis, MDA positions interceptor platforms to assure a robust response to threats. MDA also provides channels for direct sensor-to-shooter connectivity or centralized shooter cueing.***

  - ***Layered Engagement Management:*** ***A missile defense engagement takes place as discrete phases, using a number of interceptor systems operating from different localities. The MDA C4ISR center observes the engagement at different stages, assesses success based upon continuous sensor tracking, helps to identify target objects of interest, and manages hand-off of the battle from boost phase to mid-course to terminal phase interceptor systems.***

Missile Defense Agency C4ISR



Notional Engagement

Recommendations & Conclusions

- ***C4ISR Hardware:***

  - ✓ ***Since COTS plays a significant role in hardware cost, it is useful to acquire and maintain a library of catalogs from IT and communications equipment suppliers.***

- ***C4ISR Software (Peculiar):***

  - ✓ ***We can never have enough analogy data for code sizing. Where possible, organize software databases by function and by echelon.***

- ***COTS Software:***

  - ✓ ***The Government uses COTS software when it is a cost effective alternative to developing new military peculiar code. Initial license fees and recurring/annual renewals can become large LCC outlays. Collect and maintain a database for COTS fees.***

Recommendations & Conclusions

- ***C4ISR Support Investment:***

  - ✓ ***An important trade involves long term logistic support of COTS hardware vs. replacement via tech refresh or a "life-time" buy scheme. All flavors have been tried, with varying degrees of success.***

- ***C4ISR O&S Phase:***

  - ✓ ***Justification of Operational Staff manning should be based upon a decomposition of functions. Maintenance manning at the unit should be driven by the number of projected failure events (MTBF) and mean time to repair efforts (MTTR) based upon a pull-and-replace concept.***

  - ✓ ***Annual software maintenance cost is a large driver, and where possible should be based upon documented experience. Software maintenance databases should be developed to support C4ISR O&S cost estimating.***

References

References

[1] AOC Weapon System Block 10 Baseline Systems List, 31 May 2001, USAF (Air Combat Command, Air Force Material Command).

[2] Measuring the Effects of Network-Centric Warfare, Volume 1, 28 April 1999, Booz, Allen & Hamilton.

[3] Cebrowski, Arthur and Gartska, John, Network Centric Warfare: Its Origin and Future, Naval Institute Proceedings, 1997.

[4] Realizing the Potential of C4I, Fundamental Changes, National Research Council, National Academy Press, Washington, D.C., 1999.

[5] Bell, G.C. , Observations and Notes, Proprietary Cost Analysis Studies, Future Combat System (FCS), 2004.

[6] Bell, G.C. , Observations and Notes, Proprietary Cost Analysis Studies, USAF Air Operations Center (AOC), 2004.

References

References

[7] Bell, G.C. , Observations and Notes, Proprietary Cost Analysis Studies, USAF Airborne Command Post, 2002-2003.

[8] Bell, G.C. , Observations and Notes, Proprietary Cost Analysis Studies, USN Command Ship Replacement, 2000-2001.

[9] Bell, G.C. , Observations and Notes, Proprietary Cost Analysis Studies, USCG Integrated Deepwater System (IDS), 1999-2000.

[10] Bell, G.C. , Observations and Notes, Proprietary Cost Analysis Studies, USMC C2PC Software System, 2005.