

***17TH ICCRTS:
Operationalizing C2 Agility***

**“A STRUCTURED, YET AGILE APPROACH TO DESIGNING C2
OPERATING ENVIRONMENTS”**

*Primary Topic: Topic 2 – Approaches and Organizations
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ABSTRACT

Command and Operations (COMOPS) Centers represent some of DOD's most technologically advanced and costly operating environments leading to significant Defense, Intelligence, Security, and Safety investments. COMOPS Centers also tend to be some of the most rigid environments, inflexible to match the ever-evolving operations tempo of today's DOD Mission.

COMOPS Centers are planned, designed, and built around mission. Mission Architectures are conceived as an idea, instantiated and refined, and almost invariably face dynamic change conditions including security, defense, or threat conditions changes, advancements in methods and technologies, as well as fiscal realities. While the mission is dynamic, the COMOPS Centers that hosts the social, technical, and physical architectures to execute the mission are often inert with inflexibilities that lead to misalignments in supporting environments, inefficiency/ineffectiveness in mission execution, and, ultimately, compelling needs to redefine, rejuvenate, retrain, or retire often under demands for rapid responsiveness.

A Structured, yet Agile Approach to Designing C2 Operating Environments discusses the innovative methods of developing architectures best aligned to future needs. Then, as missions change, presents ideas for how to instantiate and modernize the COMOPS Centers in manners that are less disruptive and that deliver performance improvement at reduced acquisition costs and timelines.

1. INTRODUCTION

What is C2 Agility?

In his book, *The Agility Advantage: A Survival Guide for Complex Enterprises and Endeavors*,¹ David S. Alberts describes the complex challenges in today's dynamic world making agility an imperative. Alberts defines Command and Control (C2) Agility as the ability to maintain mission effectiveness, proactively, in the face of changing circumstances and stresses, including the ability to conceptualize, design, create, deploy, and support a successful endeavor. He continues to describe C2 operational agility as a reflection of the achievement of end states by an organization that is complementary to capability strength and capability depth in contributing to that organization's mission effectiveness. Lastly, he identifies the mechanisms for C2 agility, enabled by people, processes, information, systems, technologies, and facilities, including Responsiveness, Robustness, Resilience, Flexibility, Adaptability, and Innovation

The C2 Operating Environment: The COMOPS Center

The nerve center for C2 is the Command/Operations (COMOPS) Center. COMOPS Centers represent some of the DOD's most complex, technologically advanced, and costly operating environments reflecting significant Defense, Intelligence, Security, and Safety investments.

The COMOPS Center is a facility from which a Commander directs operations, controls forces, and coordinates operational activities and/or a facility that is organized to gather, process, analyze, dispatch, and disseminate planning and operational data. The COMOPS Center definition encompasses all single and joint agency Command & Control Operations Centers, Operations Coordination Centers, Emergency Operations/Emergency Management Centers, Public Safety/Regional Dispatch Operations Centers, Security Operations Centers, Intelligence Operations Centers, Information Fusion Centers, and Network Operations Centers.² The COMOPS Center extends beyond the facility to include the people working in the environment, the processes they employ, and the information that gives the COMOPS Center purpose.³

The Challenge of Dynamic Change Conditions

COMOPS Centers are planned, designed, and built around mission. Mission Architectures are conceived as an idea, instantiated and refined, and almost invariably face dynamic change conditions including security, defense, or threat condition changes, advancements in methods and technologies, as well as fiscal realities. While the mission and mission context are dynamic, the COMOPS Center that hosts the social, technical, and physical architectures to execute the mission is often inert and inflexible leading to misalignments in support environments, inefficiency/ineffectiveness in mission execution, and, ultimately, compelling needs to redefine, rejuvenate, retrain, or retire the Center.

Along with the dynamics of mission change, technology advancement, and fiscal realities, COMOPS Centers historically have been delivered through a long and rigorous acquisition cycle. In many cases, the COMOPS Center need is identified, the required capabilities are planned, and the acquisition and delivery occurs over multiple years. This leads to an operational capability instantiation years to several years after the identification of the initial need. With the dynamics of

¹ Alberts, David S. *The Agility Advantage, A Survival Guide for Complex Enterprises and Endeavors*. DoD CCRP, September 2011.

² DoD Dictionary, www.dtic.mil/doctrine/dod_dictionary.

³ DISA Command Center Design Handbook, September 1991.

the mission and technology shifts during that delivery period, there is often a substantial gap between the actual capability needed versus what was initially identified and acquired.

In the face of these challenges, factors that lead to inadequate and inflexible COMOPS Centers that fail to deliver the capability required include:

1. *Inability to sufficiently identify and baseline operationally based, multi-discipline requirements early in the capability acquisition lifecycle.* COMOPS Center Operating Environments are mission-critical capabilities with complex, multi-discipline, and integrated requirements often coming from cross-discipline stakeholders. The inability to coral multiple stakeholders, build consensus around common operational objectives, and represent requirements in concepts that make sense to the stakeholders leads to poor requirements, longer timelines for requirements development, and, ultimately, insufficient COMOPS Center capabilities. This becomes increasingly critical in the Military Construction (MILCON) circumstance where the planning and delivery of the facility component of the COMOPS Center occurs well in advance of the systems and technology acquisition. The failure to provide good, operations based systems requirements to inform the MILCON planning will lead to insufficient physical COMOPS Center environments.
2. *Failure to forecast future needs.* As the mission dynamics of an organization change, so do the COMOPS Center capability needs. Too often COMOPS Center requirements and planning center around the “As-Is” conditions of today’s mission. The failure to forecast mission dynamics and the associated changes in capability needs leads a COMOPS Center solution that is out of phase with the operations it must execute.
3. *Lack of full context considerations in planning.* The COMOPS Center is the amalgamation of the people, processes, information, knowledge, systems, and facility coming together to execute the mission. These core capabilities are often analyzed, planned, and acquired in a segregated fashion. The failure of connecting the physical COMOPS Center needs to the cognitive activities that occur within the COMOPS center often lead to insufficient requirements, capability gaps, and eventually a failed environment.
4. *Lack of standardization in the definition, design, and delivery of capabilities.* As COMOPS Centers have varying degrees of configurations and capability needs, a lack of standardization and governance in the definition, design, and delivery of these capabilities results in lengthy timelines for requirements development, cost estimating, and acquisition processes as well as a reduction in overall integration and interoperability once these capabilities are operational.
5. *Failure to plan for flexibility and adaptability in environments.* Regardless of efforts to nail down solid, operations based requirements early in the lifecycle, to develop requirements around forecasted future needs, and to develop requirements based on full context planning, the COMOPS Center condition will invariably require change. As the conditions change, failure to plan for these flexible and adaptable environments will force the COMOPS Center into an inert state increasing the risks of mission failure.
6. *Fragmented delivery model.* COMOPS Centers are planned from the operational capability down and are delivered from the bottom up, beginning with the facility, then the infrastructure, then the systems, then the information/processes/people. The historical DOD acquisition processes often lead to delivery of COMOPS Center capabilities in a fragmented, non-integrated manner. Furthermore, the delivery model often decouples the planning and design aspects of the COMOPS Center from the build, operate, and maintain aspects. This

decoupling leads to a loss in overall accountability for COMOPS Center capability delivery and, ultimately, produces less efficient (cost and schedule) results.

Legacy methods of COMOPS Center Operating Environments requirements development, planning, acquisition, and delivery fail to address many of these challenges.

The Need for an Agile Approach to Designing COMOPS Center Environments

The demand for agility in designing COMOPS Center Operating Environments leads to the imperative need for an innovative, standardized methodology that forecasts future COMOPS needs, takes into account full COMOPS Center context in planning, develops “accurate” requirements as early in the acquisition planning lifecycle as possible, compresses the define/design/build lifecycle thereby reducing acquisition costs and leveraging a highly rapid deployment to meet dynamic needs and mission changes with a high degree of flexibility.

2. COMOPS CENTER ENVIRONMENTS

Prior to the introduction of a structured, yet agile approach to designing COMOPS Center environments, a more technical analysis of the COMOPS operating environment provides a better understand of the unique challenges and constraints.

The System of Systems

The COMOPS Center is a technically advanced, highly interconnected, complex net-enabled system of systems. The COMOPS Center is the combination of:

- The **Social Architecture** –the *people* who occupy, command, support, and are served by the Center; the *processes* by which the Center operates and conducts its mission; the functional *adjacencies* of how individuals and groups are organized within the Center, and the operational *context/communications/collaboration* of entities within the Center and outside the Center.
- The **Knowledge Architecture** – the *data* and *information* received by the Center, processed, analyzed within the Center and through collaboration with entities outside the Center, and disseminated within the Center and from the Center.
- The **Technical Architecture** – the *systems* and *services* employed within the Center; in other words, the equipment and technology used to conduct the mission and operations.
- The **Physical Architecture** – the actual *facility and physical infrastructure* as well as the layout of the Center.

The Technical Architecture of the COMOPS Center can be further decomposed by its integrated Command, Control, Communications, Computing, Collaboration, and Intelligence (C5I) subsystems:

- Visual Information System – audio-visual systems including outputs (displays, speakers, etc.), inputs (sources such as individual desktops, cable television, etc.), processing of the inputs and outputs, as well as control of the inputs and outputs to support briefing and display capabilities. VIS also includes collaboration capabilities such as video-teleconferencing.
- Automated Information System – systems that enable processing and display at the desktop (computers, monitors, desktop peripherals) as well as supporting systems (printers, scanners, etc.).
- Integrated Furnishing Systems – systems that support equipment and operators within a COMOPS Center (desks, chairs, conference tables, watch floor pods, etc.).
- Active Infrastructure – systems and networks including infrastructure, services, bandwidth, storage, and availability that provide information to, within, and from COMOPS Centers.
- Passive Infrastructure – infrastructure that delivers systems and networks to required locations within the COMOPS Center including outside plant, entrance facilities, telecommunications rooms, vertical/horizontal cabling, zone distribution, and work area outlets/drops.

- Security/Life Safety – electronic security, physical security, information security, fire alarm, sprinkler systems that enable the required operational classification levels and provide the security and protection of COMOPS Center resources (people, information, and equipment).

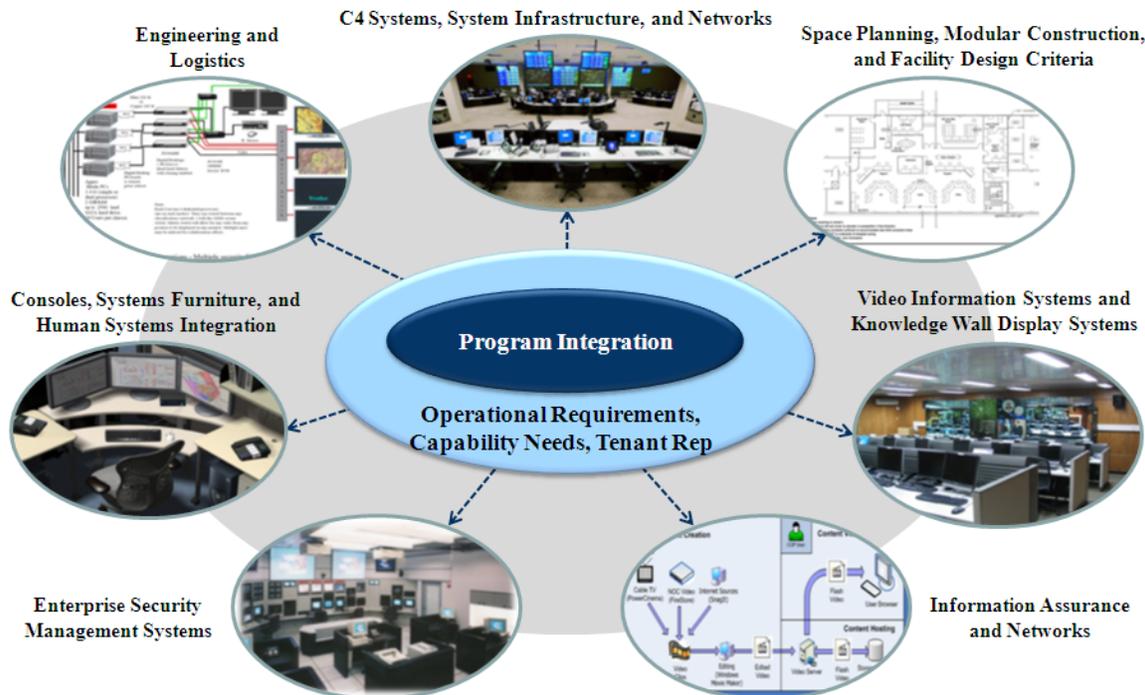


Figure 1 COMOPS Center System of Systems

Additional Challenges

As previously mentioned, the dynamic mission and technology advancement juxtaposed against an inert, inflexible COMOPS Center leads to misalignments in support environments, inefficiency/ineffectiveness in mission execution, and, ultimately, compelling needs to redefine, rejuvenate, retrain, or retire the Center.

Additional COMOPS Center complexity challenges include:

- COMOPS Centers include the tight integration of mission operations with the systems they use to execute the mission and the facility within which they operate.
- COMOPS Centers center around robust information sharing, information management, and communications.
- COMOPS Centers have a dynamic program of requirements including mission shifts, multiple use-case scenarios, and variable staffing, shifting, systems, facility, and security needs.
- COMOPS Centers have high densities of electronic equipment and staff in the program of requirements.
- COMOPS Centers have heavy power and cooling requirements.

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- COMOPS Centers run mission critical operations, require 24x7 survivable infrastructure, and require mission continuity through upgrades and transitions.
- COMOPS Centers work across multiple security enclaves and compartmentalizations.

3. STRUCTURED, YET AGILE APPROACH

Understanding the dynamic mission and Program of Requirements inherent to a COMOPS Center, the speed of technology advancement and replacement, and the legacy acquisition cycles from which to design and deploy a Center, agility in designing C2 operating environments is not simply an ideal but an imperative need.

The Advent of Change

Over the last 15 years, SPAWAR has delivered over 50 single and joint agency COMOPS facilities for military, Government, public and commercial sectors. Historically (based upon the authors experiences with designing and implementing COMOPS Centers) whether the mission aim was command and control, public safety, emergency operations/emergency management, regional coordination, network operations, security operations, intelligence operations, or information fusion, the difference between a COMOPS Center meeting the need, achieving innovation, and delivering long-term mission success can be attributed to the following factors:

1. *Speed and Quality of Requirements.* Requirements are an area where the most value can be derived from the acquisition.
 - a. Requirements should be based around the anticipated missions and operations that will be executed by the COMOPS Center owners.
 - b. Requirements should build consensus among multiple project stakeholders.
 - c. Requirements should be integrated between and among all COMOPS Center disciplines.
 - d. Requirements should be developed around the As-Is and forecast towards the To-Be COMOPS Center capability needs.
 - e. Requirements should be iteratively developed and presented around concept intent.
 - f. Requirements should link to COMOPS Center scope, schedule, and budget.
 - g. Requirements should lead to reduced schedule and cost overruns while optimizing utility and useful service life.



Figure 2: COMOPS Center Integrated Requirements

2. *Structured, yet Agile Analysis and Planning.* The basic tenets of the legacy approaches to COMOPS Center architecture and capability analysis and planning, such as DODAF and JCIDS, are solid. The content requirements identified in these approaches are exactly what are needed for robust planning. However, these approaches often impose a rigidity that is counter to agility. These approaches also tend to find themselves caught up in analysis and planning while losing focus on the principal objectives...to deliver COMOPS Center capability to the operator. The structured, yet agile approach should be done in a “DODAF-Lite” fashion, should focus on mission and operations as the basis, and should address capability across all COMOPS Center layers. Figure 3 presents a standard systems engineering mission based methodology to deliver COMOPS Center capability.

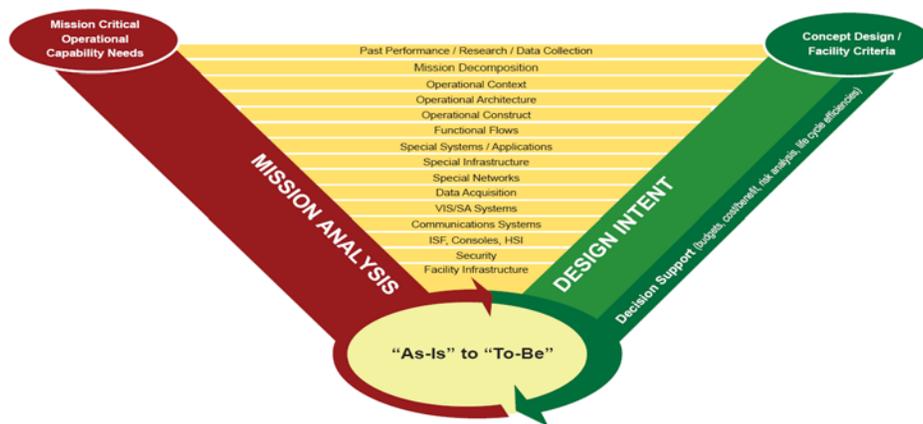


Figure 3: Mission-Based Methodology

3. *Standardization of COMOPS Center Operating Environments.* Traditionally, COMOPS Centers have been designed leveraging standard processes but with limited standardization around requirements, concepts, and architectures. They are typically designed specific or unique to each customer. Developed around experience, COMOPS Center configuration and governance standards provide the ability to quickly and accurately develop the COMOPS requirements, architectures, and budgets.
4. *Integrated Define/Design/Delivery Cycle.* Fragmenting operations, systems integration, and facility construction leads to sub-optimal COMOPS Center environments, inflated costs, and extended delivery schedules.

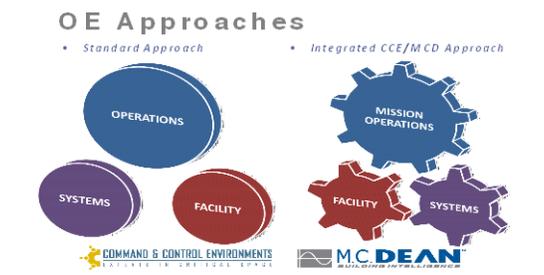
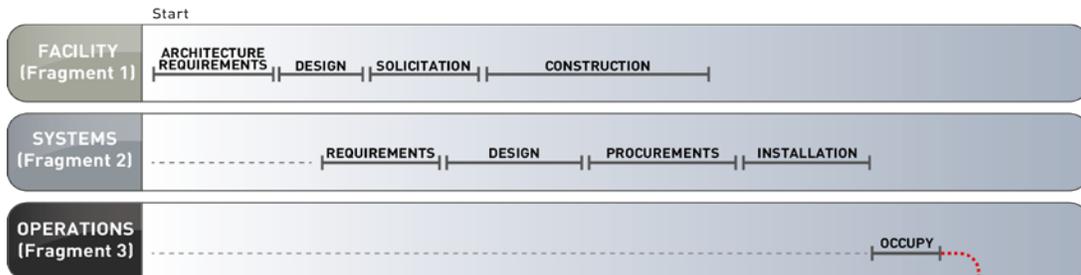


Figure 4: Integrated Approach

Integrating requirements and coordinating systems delivery with facility construction is measurably more efficient.

Fragmented Time Line



Integrated Time Line

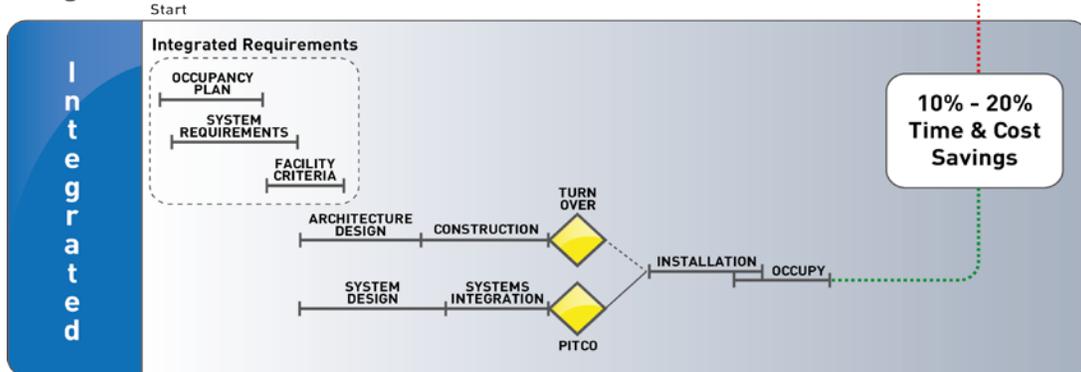


Figure 5: Efficiencies of the Integrated Approach

Modified Lifecycle Approach

In response to the inherent challenges of a COMOPS Center operating environment and as a result of a strong depth of experience from which to analyze both successes and shortcomings, a modified lifecycle approach to COMOPS Center design and delivery that definitively achieves C2 agility is proposed.

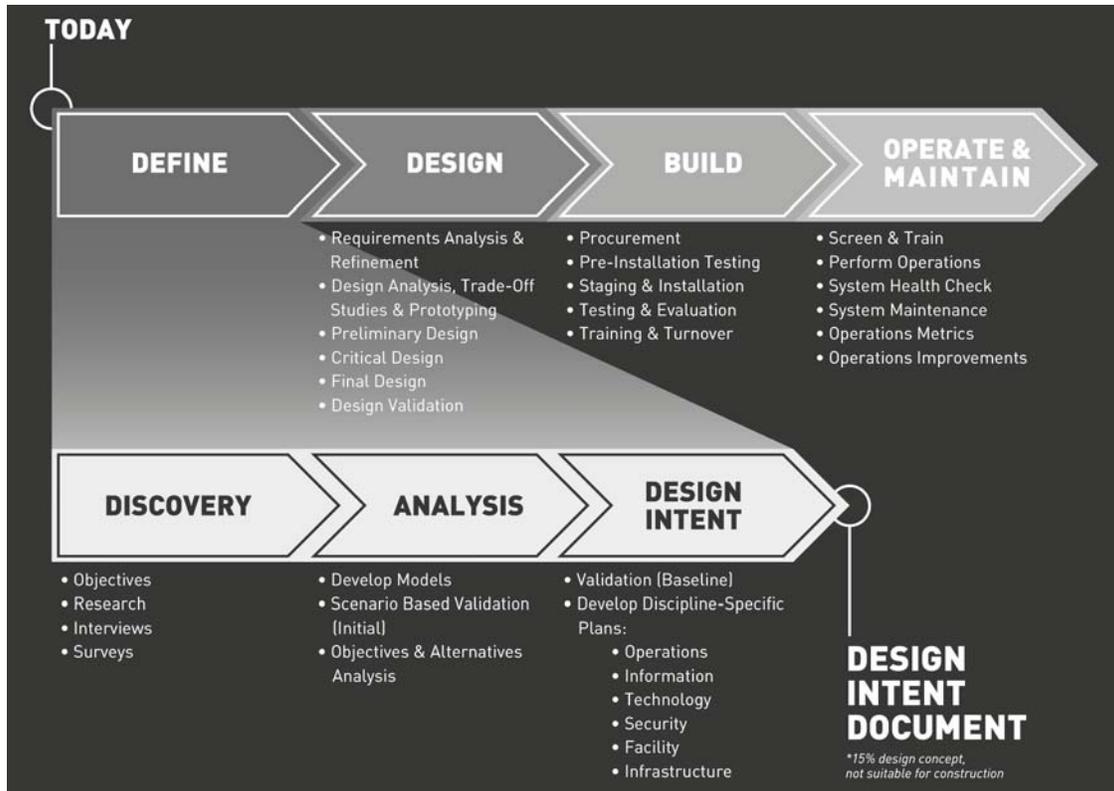


Figure 6: Structure, yet Agile COMOPS Center Approach

Modified Lifecycle Approach: Define

The Define Phase of the Modified Lifecycle Approach includes a Preliminary Discovery with the objective of developing a mission and operations basis for identifying needs and ultimately developing plans to address those needs. Preliminary Discovery includes data calls to capture

- Mission Statements
- Programs of Requirements
- Organization Charts
- Entity Descriptions
- Concept of Operations
- Standard Operating Procedures
- Manuals and Training Documentation
- Systems Inventories/System Lists
- Application Inventories/Application Lists

Preliminary Discover also includes open source research on doctrine, policy, mandates, standards, trends, and best practices to further the baseline understanding around mission and operations.

Next the Define Phase includes a more in depth Discovery and Needs Analysis with the objective of further developing the mission and operations basis for identifying needs and to capture goals, objectives, and priorities from key stakeholders as the basis for developing plans to address the needs.

Discovery includes performing:

- Interviews with Key Operational Stakeholders to:
 - Capture Goals/Objectives (operational, technical, fiscal)
 - Identify success (Measures of Effectiveness for each Objective)
 - Discuss High-Level Operational Scenarios with focus on info needs and info presentation
- Interviews with Operational Unit Leads and/or Deputies to:
 - Discuss Roles and Responsibilities
 - Discuss Operational Scenarios and Core Functional Activities with focus on info collection, info assembly, info analysis, info presentation, and info dissemination, collaboration, and communications
 - Discuss areas and ideas for improvement
- Interviews with Primary Support Entities (Chief Information Officers, Security Managers, Facility Managers) to:
 - Discuss current and planned architectures and projects that may have impact on the COMOPS Center design
 - Discuss areas and ideas for improvement
- Detailed Surveys with focus on:
 - Surveying the existing COMOPS Center facility and physical infrastructure (if they exist)
 - Surveying the existing COMOPS Center systems and technologies (if they exist)
 - Surveying the existing COMOPS Center services and applications (if they exist)
 - Observe current COMOPS Center operational processes through both routine and stressing use-case scenarios (if they exist)

Next the Define Phase includes an Analysis of data collected and captured with the objective of assessing identified needs and forecasting future needs. Specifically, Analysis includes:

- Mission Analysis (as the basis for COMOPS Center operational capability needs)
 - Defines the “What” the COMOPS Center is supposed to do
 - Decomposes the mission through the organization into a full mission mapping
 - Forecasts potential mission changes and integrates those potential changes into the mission mapping to drive future operational capability needs
- Operational Capability Analysis
 - Defines the “How” the COMOPS Center executes the mission
 - Detailed through models of the current COMOPS Center Architecture (As-Is) through DoDAF-Lite views
 - Identifies opportunities for improvement (gaps)
 - Models the future forecast COMOPS Center Architecture (To-Be) via updates to the DoDAF-Lite Views
- Document capability needs across:

- People
- Process
- Data/Info
- Systems/Services
- Physical Infrastructure

Finally the Define Phase includes Capability Planning with the objective of producing a set of capability needs organized into concept design intent for solutions to the needs. Capability Planning includes:

- Planning the Integrated Systems and Infrastructure by:
 - Preparing a Capability Needs definition that addresses the operating environment, operating systems, information processing, data connection, and security capability needs of COMOPS CENTER.
 - Determination of facility needs, including architectural, interior, integrated furnishings, electrical, mechanical, lighting and other key facility attributes on selected alternative.
 - Determination of equipment / engineering systems modification needs, including PC workstations, telephony, IT system, audio visual, and low voltage communications on selected alternative.
 - Determination of security compartments and electronic security control requirements on selected alternative.
 - Developing a High-Level Design Intent Document with the objective of translating the COMOPS Center capability needs into systems requirements. These system requirements are presented in a plan view, overlaid onto the COMOPS Center building footprint. This “Three-Dimensional” representation of requirements enables stakeholders to view and understand the dynamic, multi-disciplined, and integrated nature of the system requirements as opposed to the traditional “Two-Dimensional” static requirements document representation. The system requirements are presented in a manner that is understood by the operational user, sufficient to convey the facility and base-building intent (Architectural, Mechanical, and Electrical) to an Architect/Facility Contractor, and sufficient for a systems integration engineering and implementation (design-build) team to develop design documentation across the major systems engineering disciplines (Audio-Visual, Desktop AIS, Furniture, Active Infrastructure, Passive Infrastructure, and Security).
 - The Design Intent Document includes:
 - Operational Intent – The operational intent is a reflection of the operational capability needs and objectives includes program information, and functional/operational blocking information.

- Security Intent – The security intent identifies the customer requested classification levels within each area of the building and highlights required security capabilities.
- Audio Visual Intent – The AV Intent documents the high level display requirements (display locations, and information needed on each display – CATV, presentations, etc.), AV control concepts, audio concepts, and VTC concepts.
- Desktop AIS Intent – The Desktop AIS Intent identifies the equipment (phones, computers, desktop peripherals, printers, scanners, etc.) to be placed at each office, workstation, and printer station.
- Furniture Intent – The furniture intent identifies the location and configuration of offices, specialized rooms (VTC conference rooms, OPS floors, production rooms, etc.) and workstations throughout the COMOPS Center.
- Active Infrastructure Intent – The Active Infrastructure Intent identifies the fundamental requirements (inventory of systems being initially deployed, common infrastructure required for the facility as well as initial specifications for consolidated bandwidth, connectivity, common / shared network services, common / shared data storage, availability / redundancy, security / IA / enclave, supportability / maintainability, space (rack space, etc.), power, and environmental) to support the systems and networks coming into the COMOPS Center and supporting COMOPS Center operations.
- Passive Infrastructure Intent – The Passive Infrastructure Intent identifies the required locations for data and voice communication drop clusters. The Passive Infrastructure Intent also details the type of work area outlets required at each location.
- Architectural/Mechanical/Electrical Intent – The architectural/electrical/mechanical intent identifies the high level concepts that drive systems support requirements. The intent also document the finishes, HVAC zoning, and critical power required throughout the facility.
 - Developing the corresponding Site Requirements Package (Facility Design Criteria provided to the Facility Designer to inform their designs and to insure the adequacy of infrastructure to support the systems).
- Planning Around Managed Information by:
 - Preparing a Capability Needs definition that addresses the knowledge and information management infrastructure required to support intended

operational architectures (both As-Is and To-Be) and to ensure that the facility physical layout, desktop AIS, AV and other active infrastructure design concepts are consistent with the requirements and capabilities of the information management systems to be employed in the COMOPS Center.

- Developing a High-Level Design Intent Document with the objective translating the COMOPS Center capability needs into systems requirements. These system requirements are presented in a module view and are demonstrated through the concept of employment of the integrated systems and infrastructure to provide a fully capable information environment. This “Three-Dimensional” representation of requirements enables stakeholders to view and understand the dynamic, multi-disciplined, and integrated nature of the information requirements as opposed to the traditional “Two-Dimensional” static mechanism of representing requirements in a simple document or table. The system requirements are presented in a manner that is understood by the operational user and sufficient to convey the intent to a systems integration and development team to develop formal design documentation on the solution.
 - The Design Intent Document includes:
 - Operational Activities Model – The model reflects the COMOPS Operational Concept and identifies the key existing and planned operational activities that involve operational information sharing, collaboration, and communication among the components of the organization. The Operational Activity Model serves as the foundation for analysis of the information management systems and services needs and capability requirements.
 - System Functions Description, and Operational Activity to System Function Traceability Summary – The model defines the information management and collaboration systems – existing or intended, - that support the activities identified by the Operational Activities Model. The operational needs and scenarios allow the identification of the system functions of the knowledge/information management systems. The Operational Activity to System Function traceability allocates functions to each required knowledge/information management sub-system. The Traceability Summary specifically identifies the existing systems and services gaps and deficiencies identified as part of the Operational Activity analysis. The identified gaps and deficiencies allow for future systems and services capabilities planning and acquisition.
 - Systems and Services Interfaces –Identifies the key internal and external interfaces of the existing and/or intended

information management systems, the activities and data exchanges they support.

- Systems and Services Infrastructure Requirements and Dependencies – For each of the identified information management and collaboration systems, defines the AV (source inputs, display locations, information processing and controls – VTC, presentations, and others), desktop AIS (phones, computers, desktop peripherals, printers, scanners, and others), and communications infrastructure (network connectivity, capacity, common / shared network services, common / shared data storage, availability / redundancy, security / IA / enclave, supportability / maintainability, space (rack space, etc.), power, and environmental), and facility layout requirements and dependencies.

Approach to Standardization

Traditionally, COMOPS Centers have been designed leveraging standard processes but with limited standardization around requirements, concepts, and architectures. They are typically designed specific or unique to each customer. Developed around experience, COMOPS Center configuration and governance standards provide the ability to quickly and accurately develop COMOPS Center requirements, architectures, and budgets.

15 years of definition and delivery of over 50 complex, integrated, and mission critical COMOPS Centers has yielded a set of standard typologies that meet most, if not all, of the COMOPS Center Operating Environment capability needs experienced by the authors. Each of the standard typologies includes multiple variations of size, security enclave, and fundamental system complexity meeting a variety of operational capability needs. These standard typologies include:

- Workstations – One-person operating environments, typically in a cubicle or other integrated furniture system configuration
- Single-Person Offices – One-person operating environments typically enclosed for privacy
- Multi-Person Offices – Enclosed office area in which multiple staff typically work together. Typically all staff within a Multi-Person Office are working on similar tasks and have a need for verbal or face-to-face communication and collaboration
- Multi-Purpose Environments – Flexible operating environments for multiple people to gather for training, meeting, collaboration, or strategic planning purposes
- Conference Environments – Operating environments for staff to hold meetings with a variety of audiences. Technological variations available
- Command Environments – Operating Environment which uses advanced technology to monitor, strategize, and transmit intelligence to others outside of the Operating Environment
- Data Environments – Support spaces to house IT data processing and storage equipment. Ancillary space is typically provided for IT professionals to perform maintenance and repair

- Supplemental Packages – Additional products offered as accessories to other packages available within the SPAWAR Product Catalog, including, but not limited to, printers, plotters, libraries, and conference room accessories

15 years of definition and delivery of over 50 complex, integrated, and mission critical COMOPS Centers has also yielded empirical rough order of magnitude cost budgeting information for each of the standard typologies and their variations. The empirical cost information is developed through a parametric model and provides the ability to determine COMOPS Center project budgets very early in the lifecycle and to iterate on budgets as concept planning matures. The ability to identify basic, but sound project budget information very early and then often in the requirements process allows stakeholders to make critical decisions on priorities and tradeoffs leading to more efficient, effective, and accurate capability delivery.

Finally, the same experience and past performance that has led to the development of parametrically based cost budgeting information for each standard typology has also yielded empirical heat and power budgeting information for each typology. The empirical heat and power information provides the ability to determine the COMOPS Center heat and power loads very early in the lifecycle and to iterate on these loads as concept planning matures. The ability to identify detailed heat and power loads and to iteratively translate these heat and power loads over to the engineering activity responsible for the architecture and engineering of the facility to support the COMOPS Center systems ensures an adequate supporting infrastructure solution.

The below section describes a simple walkthrough of the COMOPS Center standardized Definition:

- Clearly define requirements as captured through the initial Define steps in the lifecycle approach.
- Identify the Conceptual Floor Plan
 - Upon requirements definition, the ideal starting point for designing the standardized COMOPS Center “concept intent” is to start with a floor plan. This can be an existing space or conceptual drawing, which serves as a framework for identifying which typologies best fit and satisfy the requirements. An example of a Conceptual Floor Plan is shown below:

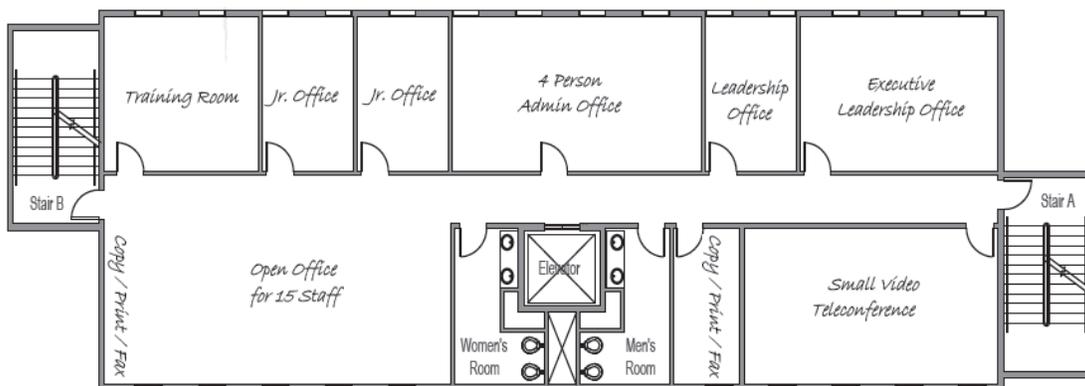


Figure 7: Conceptual Floor Plan

- Apply the Standard Typologies

Approach to Flexible and Adaptable Planning

Many federal and defense entities find themselves continually in the midst of major realignment or organizational modernization efforts. As they restructure in response to new and evolving threats and hazards to the United States, federal and defense entities recognize the need to transform their operational structures to be more agile, flexible and responsive. Support of current and future reorganization is a significant part of the modified project planning and design approach. The operating environment must then also be agile, flexible, and responsive to organizational evolution and command operational needs—executive management, command and control, and mission support capabilities—at move-in and in years to come. The strong planning capabilities that are inherent to the COMOPS Center Operating Environment Define process join together:

- Operational, analysis-based programming,
- Flexible planning methods, and
- Flexible infrastructure of building systems.

This integrated approach produces high performance operational work environments that support operationally-based programming requirements and provide the appropriate level of flexibility. The comprehensive solution includes:

- Added variation in space types tied directly to mission functions and based on specific operating environments
- Flexible infrastructure of planning systems (structural, mechanical, electrical, telecommunications, lighting, ceiling, and partitioning) and electronic tenant systems
- Integration of systems furniture elements into the flexible planning solution

The adaptable planning methodology supports dynamic changes in organization and space utilization over time without major modification to the building or its interior components. This is achieved through a consistent planning module, a universal lighting layout, a distributed utility grid, multiple circulation options, and flexible floor to ceiling planning zone. Specifically, the planning approach enables:

- Low cost of future modification
- Rapid response to change
- Easily modified mix of open plan to enclosed spaces
- Minimal construction waste over the life of the project
- Maximized space utilization due to pre-defined circulation
- Minimal change to utilities when modifying space
- Maximized views and access to natural light
- Ability to create suites, including secure areas

Benefits of the adaptable planning methodology include:

- Lower risk of “scope creep” and increased potential for user-acceptance during TFO
 - The operational analysis approach creates tailored work environments that support

functions derived directly from command missions, while limiting variations in requirements across similar organizational/functional entities.

- De-linked base-building construction and TFO schedules – The adaptable planning method and flexible infrastructure will allow continued reorganization and program modification in response to potential command restructuring during base building construction.
- Reduction in long-term renovation costs – The efficient use of space and its adaptability result in less disruption of surrounding spaces and infrastructure as renovations occur in response to organizational changes.
- Planned potential for moderate occupant density – The proposed space modules accommodate a smaller typical workstation that can be used to increase density in some areas if an individual’s function does not require the larger module; using the smaller module can increase the number of workspaces in an area.
- Reduction in long-term operating costs – The flexible, highly efficient and maintainable design for mechanical, electrical and telecommunications is less costly to operate and maintain over time.

Delivery (Design-Build-Operate-Maintain)

Once COMOPS Center Operating Environment requirements and concepts are developed, the inherent capability identified in these requirements/concepts must be delivered. Over the past 15 years the majority of COMOPS Centers have been executed through Design-Bid-Build or Design-Build Delivery Models. Figure 10 below provides a simple compare and contrast of the two delivery models.

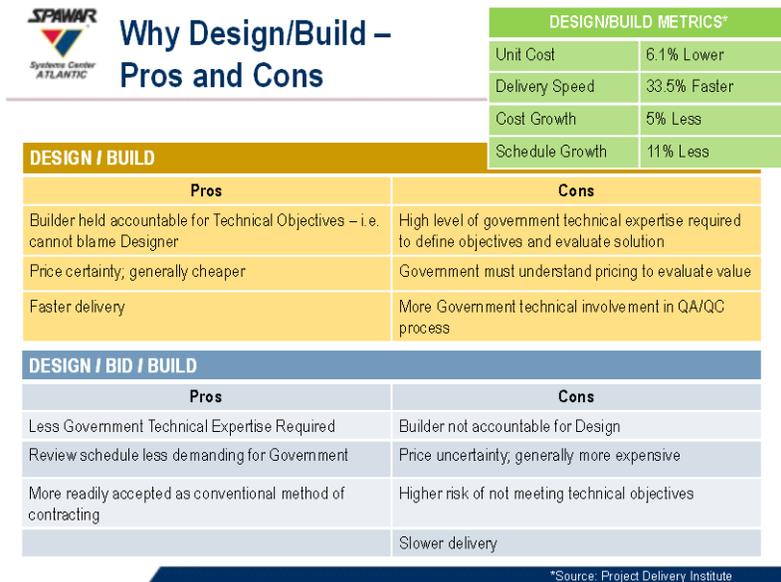


Figure 10: Comparison of COMOPS Center Delivery Models

Performance-Based, Firm Fixed Price (FFP), Design-Build delivery is the delivery model best suited

for fast track, high risk projects including COMOPS Center Operating Environment projects. This model lowers costs on all fronts (administration, procurement, change management, oversight, solicitation, project duration, and implementation) and limits exposure to cost increases. It facilitates a faster project schedule as it allows for concurrent activity in requirements finalization, planning, design, and build, eliminates bidding time and project delay, saves administrative overhead, and incentivizes proper contractor resourcing, schedule performance and cost efficiency. It transfers responsibilities to the organization/entity best-suited to mitigate specific risks. Lastly, past performance confirms a significant cost savings, schedule advantage, and a track record of minimal change conditions, schedule extensions, and scope creep realized through the Performance-Based, FFP, Design-Build delivery model..

4. LEAN FORWARD – OPERATIONALIZING COMOPS CENTERS

This paper has focused on agile definition and delivery of COMOPS Center Operating Environments. Leaning forward, COMOPS Centers will continue to have to be highly adaptable and agile to meet the needs of the increased (and broader) operational pace while still maintaining a focus on gaining efficiencies in manpower, time, and fiscal resources. Beyond the concept of defining and delivering agile, adaptable, and flexible COMOPS Center Environments, the COMOPS Center needs to become operational to support the intended mission. Too often the COMOPS Center is developed as a facility or infrastructure or collection of systems but not actually operationalized.

The current COMOPS Center focus is on providing specific systems inside of specific spaces for specific users – a one desk-one user model. Instead they should provide an environment that allows multiple users to use multiple systems at multiple desks ultimately enabling an agile mission to occur. To deliver on this capability, designers must gain an understanding of the differing missions that may occur inside these centers and provide capabilities that enable operation of these multiple missions to occur. Integrating Knowledge Management (KM) principles and technologies into the design of COMOPS Centers leads to the operationalization of the center and, ultimately, agile mission execution.

Typically a COMOPS Center is designed around a pre-existing, or pre-conceived, seating layout consisting of a specific user base that incorporates a broad swath of organizational capability (i.e. J39, J4, J5, J6, etc) that might be needed in a crises. These layouts typically drive a very static plan for all of the remaining IT requirements to follow (e.g. Cabling Infrastructure, AIS, etc). These COMOPS Centers also typically house video walls that display several differing commercial news feeds, a Common Operating Picture, and other static feeds.

With the integration of KM principles and doing a detailed analysis of missions, the operators involved, the lines of operations, and their supporting data feeds COMOPS Centers can be better designed to address the multiple missions that might occur. It also allows for a better discovery phase that will allow designers to develop solution sets to existing capability gaps. Some beneficial examples that have been discovered applying this approach include:

- Creating seating layouts within the COMOPS Centers that are more conducive to collaboration amongst operators for a given problem set.
- Developing “pre-sets” for Video/Knowledge Wall Layouts so that the data routed to them are laid out so that they are Mission Specific (i.e. Non-Combatant Evacuation Operation (NEO) vs. Ballistic Missile Defense (BMD)). This allows operators to reconfigure a video-wall within seconds.
- Developing corresponding Concepts of Employments (CONEMPS) to Concepts of Operations (CONOPS) that detail how technology deployed on the COMOPS Center is to be utilized.
- Utilization of online collaboration technologies (i.e. DCO) to flatten the chain of command during daily/weekly update briefs so that entirety of command hears the Commander’s direction. These update briefs can also be replayed in order to ensure accuracy of information in response to Commander’s requests for information.
- Utilization of new Video Switching technologies to overcome the “one user-one desk” paradigm currently in place. These technologies allow any user to login to any computer system, which is connected to the video switch, at any location within the COMOPS Center.
- Integrating solution sets for “system of systems” throughout the chain of command of COMOPS Centers that decrease current reporting time cycles.

5. CONCLUSION

Agility Through an Improved Systems of Systems Design Process

The bottom line benefits of the structured, yet agile approach to designing C2 Operating Environments impact every phase of the project lifecycle and directly address the challenges of agility:

- Expedited Requirements, Expedited Budget Analysis, Expedited Scope Development and Design Build Delivery Model = Speed to COMOPS Center Capability
- Well-Defined Requirements = Effective and Efficient Delivery of the Right COMOPS Center and Managed Risk
- Structured, yet Agile Analysis of Current and Forecast Needs = COMOPS Capabilities that Enable the Mission through the Life
- Standardization = Speed to Project Justification and COMOPS Center Capability
- Flexible, Adaptable Planning = Ability to Absorb Unforeseen Dynamics
- Integrated Define, Design, Build Delivery Model = Effective and Efficient Delivery of the Right COMOPS Center and Managed Risk

APPENDIX A: SUPPLEMENTAL MATERIAL

SPAWAR COMOPS Past Performance

The Space and Naval Warfare Systems Command (SPAWAR) mission is to make the Navy’s Information Dominance vision a reality. As one of three Department of Navy major acquisition commands, this means acquiring, installing, delivering and maintaining advanced communication and information technology capabilities to the warfighter to keep the warfighter one step ahead of adversaries. To succeed, SPAWAR remains at the forefront of research, engineering, acquisition, and support services that provide vital decision superiority to our forces at the right time and for the right cost.

Since its inception, SPAWAR has been working to improve, innovate, and standardize delivery of COMOPS Centers making SPAWAR an expert in the complex, integrated operating environments. The following table provides a snapshot of selected SPAWAR COMOPS projects:

OPERATION CENTER	TYPE	DESCRIPTION
Department of Homeland Security Operations Center (HSOC) and National Operations Center (NOC), Washington, DC	Federal Coordination and Information Fusion Operations Center	<ul style="list-style-type: none"> – Performed mission research – Developed operational construct and organizational plans – Designed, procured, and installed unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, Equipment, and Electronic Security and performed facility modernization to support a 74 day implementation schedule
Department of Homeland Security Common Operational Picture (COP), Washington, DC	Federal Coordination and Information Fusion Operations System	<ul style="list-style-type: none"> – Developed and deployed a DHS Common Operational Picture (COP) to improve situational awareness for DHS leadership and coordinate incident response following Hurricane Katrina – Developed applications, acquired data sources – Operated and maintained systems during national incidents and National Special Security Events – Developed a comprehensive set of system requirements and transitioned the system to the DHS CIO office for public solicitation
Department of Homeland Security Intelligence Analysis and Infrastructure Protection Center, Washington, DC	Federal Intelligence Operations Center	<ul style="list-style-type: none"> – Developed operational construct and staff planning – Designed, procured, and installed requirements for unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, Equipment, and Electronic Security – Provided tenant representation services and organizational analysis during standup and post IOC
Federal Emergency Management Agency (FEMA) National Response Coordination Center (NRCC), Washington, DC	Multi Function Federal Law Enforcement, Intelligence Analysis, Emergency Operations Coordination and Information Fusion Operations Center	<ul style="list-style-type: none"> – Performed mission research – Developed operational construct and organizational plans – Designed, procured, and installed unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, Equipment, and Electronic Security Controls planning
U.S. Army Corp of Engineers (USACE) Operations Center (Headquarters), Washington, DC	DoD Command and Control, Engineering Support Operations/ Federal Security, and Emergency / Emergency Management Operations Centers	<ul style="list-style-type: none"> – Developed operational construct – Designed, procured, and installed unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, and Equipment – Performed installation and facility modernization as well as information sharing analysis – Developed interoperability data sharing and visualization requirements
U.S. Library of Congress Headquarters Security Operations Center, Washington, DC	Federal Security and Law Enforcement Operations Center	<ul style="list-style-type: none"> – Developed operational construct – Designed, procured, and installed unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, Equipment, and Electronic Security – Performed installation and facility modernization – Provided sustainable power sources
U.S. Library of Congress Headquarters Emergency Management Center, Washington, DC	Federal Emergency Management Operations Center	<ul style="list-style-type: none"> – Developed operational construct – Designed, procured, and installed unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, Equipment, and Electronic Security – Performed installation and facility modernization – Provided sustainable power sources

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OPERATION CENTER	TYPE	DESCRIPTION
U.S. Mint Headquarters Security Operations Center, Washington, DC	Federal Security and Law Enforcement Operations Center	<ul style="list-style-type: none"> – Developed operational construct – Designed, procured, and installed unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, Equipment, and Electronic Security – Performed installation and facility modernization – Provided sustainable power sources
Washington DC Unified Command Center, Washington, DC	Public Safety and Transportation Management Joint Operations and Public Dispatch Center	<ul style="list-style-type: none"> – Designed, procured, and installed Passive Infrastructure and Critical Power systems
Patent and Trademark Headquarters NOC, Alexandria, Virginia	Network Operations and Security Center	<ul style="list-style-type: none"> – Performed mission research – Developed operational construct and organizational plans – Designed, procured, and installed unclassified and classified Cable Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, and Equipment
Pentagon Resources and Situation Awareness Center, Arlington, Virginia	DoD Operations, Coordination and Intelligence and Crisis Management Center	<ul style="list-style-type: none"> – Performed mission research – Developed operational construct and organizational plans – Planned unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, and Visual Information Systems and Integrated Furnishings Requirements – Developed Executive Agent Concept of Operations and Policy Guide for the shared resources
Transportation Security Intelligence Operations Center, Arlington, Virginia	Federal Intelligence Operations Center	<ul style="list-style-type: none"> – Developed operational construct – Designed, procured, and installed unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, Equipment, and Electronic Security
Fairfax County Public Safety and Transportation Operation Center, Fairfax, Virginia	Public Safety and Transportation Management Joint Operations Center	<ul style="list-style-type: none"> – Designed, procured, and installed Passive Infrastructure and Critical Power systems
Transportation Security Operations Center, Reston, Virginia	Federal Coordination and Information Fusion Operations Center	<ul style="list-style-type: none"> – Developed operational construct – Designed, procured, and installed unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, Equipment, and Electronic Security – Performed installation to support a 97 day implementation schedule
Federal Air Marshal's Mission Operations Center Reston, Virginia	Federal Law Enforcement Operations Center	<ul style="list-style-type: none"> – Developed operational construct – Designed, procured, and installed unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, Equipment, and Electronic Security – Performed installation and facility modernization – Provided sustainable power sources
Baltimore County Regional Security Operations Center, Baltimore, Maryland	Public Safety and Low Enforcement Joint Operations Center	<ul style="list-style-type: none"> – Performed mission research – Developed operational construct and organizational plans – Designed, procured, and installed unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, Equipment, and Electronic Security – Performed facility modernization to support a 120 day implementation schedule – Developed Intelligence-Surveillance System
Joint Harbor Operations Center (JHOC), Jacksonville, Florida	DoD Command and Control Security, and Emergency / Emergency Management Operations Center	<ul style="list-style-type: none"> – Developed operational construct – Designed, procured, and installed unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, Equipment – Performed installation and facility modernization
Five (5) U.S. Mint Regional Security Operations Centers: 1. West Point, New York 2. Philadelphia, Pennsylvania 3. Denver, Colorado 4. San Francisco, California 5. Fort Knox, Tennessee	Federal Security and Law Enforcement Operations Center	<ul style="list-style-type: none"> – Developed operational construct – Designed, procured, and installed unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, Equipment, and Electronic Security – Performed installation and facility modernization – Provided sustainable power sources
AFRICOM Intelligence & Knowledge Management Information Center, Undisclosed Location	DoD Joint Operations and Intelligence Center	<ul style="list-style-type: none"> – Designed, procured, and installed unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, Equipment, and Electronic Security

17th ICCRTS: Operationalizing C2 Agility

A STRUCTURED, YET AGILE APPROACH TO DESIGNING C2 OPERATING ENVIRONMENTS

OPERATION CENTER	TYPE	DESCRIPTION
Undisclosed Client, Technical Security Operations Center, Undisclosed Location	Technical Security Countermeasures monitoring Center	<ul style="list-style-type: none"> – Developed operational construct – Designed, procured, and installed unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, Equipment, and Electronic Security – Performed installation and facility modernization
United States Secret Service Directors Operations Center, Undisclosed Location	Federal Security, Law Enforcement, Emergency Management Center	<ul style="list-style-type: none"> – Designed, procured, and installed unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, Equipment, and Electronic Security – Performed installation and facility modernization
United States Secret Service Intelligence Division Duty Desk, Undisclosed Location	Federal Security, Law Enforcement, Intelligence Analysis Center	<ul style="list-style-type: none"> – Designed, procured, and installed unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, Equipment, and Electronic Security – Performed installation and facility modernization
United States Secret Service Joint Operations Center, Undisclosed Location	Federal Security, Law Enforcement and Information Fusion Operations Center	<ul style="list-style-type: none"> – Developed operational construct – Designed, procured, and installed unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, Equipment, and Electronic Security – Performed installation and facility modernization
United States Embassy, Berlin, Germany	Diplomatic Mission	<ul style="list-style-type: none"> – Designed, procured, installed, tested, and commissioned primary power distribution, critical power, lighting, telecommunications, life safety, SCADA, and electronic security systems for the new Embassy
U.S. Africa Command Kelley Barracks, Stuttgart, Germany	DoD Command and Control Center	<ul style="list-style-type: none"> – Developed operational construct and organizational plans – Designed, procured, and installed unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, Equipment, and Electronic Security
Special Operations Command (SOC) Africa, Kelley Barracks, Stuttgart, Germany	DoD Command and Control and Intelligence Center	<ul style="list-style-type: none"> – Developed operational construct and organizational plans – Designed, procured, and installed unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, Equipment, and Electronic Security – Provide operations support and for mission-critical sustainment
SPAWAR Network Operations Center, Stuttgart, Germany	Network Operations and Security Center	<ul style="list-style-type: none"> – Developed operational construct – Designed, procured, and installed unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, Equipment, and Electronic Security – Performed installation and facility modernization – Provided sustainable power sources
Commander, Navy Region Europe, Regional Operations Center (CNRE ROC), Naples, Italy	DoD Command and Control, Intelligence and Security Operations Center	<ul style="list-style-type: none"> – Designed, engineered, and installed a Command Center as well as a Visual Information System to support three offices, two conference rooms, one multi-security coalition space and a watch floor – Carried out the electronic systems EFI&T (Engineer, Furnish, Install & Test) work in accordance to enterprise ROC baseline standards and requirements and CNRE site specific standards and requirements (where applicable)
Navy C4I Building 440 - NIPR/SIPR and Protected Distribution System Upgrade, Naples, Italy	DoD Command and Control, Intelligence and Security Operations Center	<ul style="list-style-type: none"> – Designed, engineered, and deployed mission critical telecommunications and network infrastructure in order to consolidate three NOCs into one C4I Theater Network Operations and Security Center
Combined Forces Command, Afghanistan (CFC-A) Joint Operations Center (JOC), Kabul, Afghanistan	DoD Command and Control, Intelligence and Security Operations Center	<ul style="list-style-type: none"> – Designed, built, installed, and tested a critical Command and Control (C2) Center for CFC-A and Coalition Forces in an active war zone under a very compressed schedule for unclassified and classified Active Infrastructure and Desktop Automated Information Systems Facility, Visual Information Systems and Integrated Furnishings, Equipment, and Electronic Security

APPENDIX B: ABOUT THE AUTHORS

DONOVAN LUSK

Mr. Donovan Lusk is currently acting as the Lead Systems Engineer, and Joint, COCOM, and Other Agency Integrated Product Team Lead (JCA IPT), for the Command and Operations (COMOPS) Center Sub-Portfolio at Space and Naval Warfare Systems Center Atlantic (SPAWAR SYSCEN LANT). Mr. Lusk has been working in the Command Centers arena for over 12 years and has held roles from Command Control Subject Matter Expert (C2 SME), Deputy Chief Engineer, Chief Engineer to Project Manager on several large scale Command Centers to include NAVCENT HQ, CENTCOM HQ Tampa, COMUSNAVEUR/NAVAF and several others. The JCA IPT itself included work at USEUCOM, USAFRICOM, ISAF SAR, Department of State Tactical Operations Centers and several more. Mr. Lusk has also served as a Knowledge Management Officer (KMO) at the USAFRICOM Joint Operations Center (JOC), the Deputy for Computer Network Operations at USAFRICOM, and as a C2 technical expert on the watch floor of the Department of Homeland Security's National Coordination Center.

GERARD SKINNER

Mr. Gerard Skinner is currently acting as the Senior Systems Engineer and Group Lead for the M.C. Dean, Inc. C4I Group Center for Capabilities Assurance, which is dedicated to the application of Command, Control, Computers, Communications, Intelligence, Surveillance, and Reconnaissance (C4ISR) operations, information, and technologies to the definition, design, delivery, and operation of COMOPS Center. Mr. Skinner has been working in the COMOPS arena for 10 years and has acted as Lead Systems Engineer on several projects including: Pentagon Renovation Program Resource and Situational Awareness Center (RSAC) Concept Definition, Arlington, VA; US Africa Command (AFRICOM) Headquarters Standup, Stuttgart, Germany; US European Command (EUCOM) Headquarters Modernization, Stuttgart Germany; LA County Sheriff's Department (LASD) National Operations Center (NOC) Connectivity Project, Los Angeles, CA; Commander Naval Region Europe (CNRE), Regional Operations Center (ROC) Project, Naples, Italy; Commander Naval Region Southeast (CNRSE), Regional Operations Center (ROC), Jacksonville, FL.; National Geospatial Intelligence Agency Chemical (NGA) SWASN Data Center, Manama, Bahrain; NGA New Campus East (NCE) Integrated Security Program, Fort Belvoir, VA; and Army C4ISR Aberdeen Proving Grounds (APG) Integrated Security Program, Aberdeen, MD.