TITLE: SmartCOP – the fusion of collaborative workspaces and the Common Operational Picture

TOPIC: C4ISR/C2 Architecture

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ABSTRACT

It takes a shared workspace to create shared understanding, and it takes a well-designed organizing framework to create useful shared workspaces. It takes innovative concepts and forward-leaning technologies – leveraged within the C4ISR programs of record (PORs) - to rapidly deliver new C4ISR capabilities at reduced cost and risk. The shortest path to achieve network-centric capabilities is to re-capitalized the huge investment and global footprint of C4ISR PORs. This talk will discuss one such initiative, called SmartCOP, that integrates shared workspaces and organizing constructs (based on wikis) with the Common Operational Picture (COP).

A parallel thread of this talk begins with the recognition that C4ISR systems must migrate from platform-centric to network-centric. Stated more harshly, platform-centric is bad and network-centric is good. But the COP is a platform-centric view of the battlespace, consisting of platforms: ships, aircraft, tanks, etc. So, if platform-centric is bad for C4ISR systems, it is likely bad for the COP....leaving unanswered the question of what is good for the COP. Specifically, what is the "network-centric" construct for the COP that replaces its current platform-centric view? This provocative question will be addressed in this paper and converged with the discussion of shared workspaces and organizing constructs.

INTRODUCTION

The Common Operational Picture (COP) is the foundation for Situation Awareness (SA) in today’s C4ISR Programs of Record (PORs). SmartCOP represents an information-rich, collaboration-enabled extension to the COP, indeed an exemplar of Network-Centric Warfare (NCW) and a defining model for the Task, Post, Process, Use (TPPU) concept, based on the simple – though not simplistic - concept of assigning a “wiki” to every track. So what is a wiki and why is it important?

We are familiar with web portals as a powerful tool for publishing information, being the digital version of a speaker “publishing” his ideas during a conference presentation. Wikis – a concept and product category that has been around since 1995 - take portals to the next level, providing a framework for communities to publish and share information. It is the digital version of a collaborative meeting. In short, Wikis are editable portals, requiring only a browser for all user interaction. Wikis remove the key limitation of portals as a one-sided communication environment, instead spawning a collaborative environment for information sharing. Portals are designed for individual users to view information; wikis are designed for teams of users to manage, organize, collaborate and share information. Wikis are among the singularly unique products that work better in practice than in theory. The real value proposition of wikis to SmartCOP will be a signature theme throughout this paper, empowering the warfighter with the resources and tools for decision superiority.

The structure of this paper consists of 4 sections covering each of the 4 phases of SmartCOP, focused on the concept, implementation (in executable terms), and challenges, followed by a section covering the benefits to the warfighter. The relationship to the core tenets of NCW will be threaded throughout the paper.

SmartCOP is an internal research project at Northrop Grumman. For the initial prototype, the host POR is the GCCS 4.x Family of Systems and the wiki server is Microsoft’s SharePoint. Importantly, SmartCOP can be integrated into other existing and emerging C4ISR systems, including NCW prototypes such as the User Defined Operational Picture (UDOP). Likewise, other wiki servers could be used, though the implementation details will differ.
For the remainder of this paper, we will use the term SmartPage to refer to a wiki page that is associated to a track (or other tactical object).

**SmartCOP (Phase 1)**
The first phase of SmartCOP is the (seemingly simple) assignment of a SmartPage to each track in the COP. The implementation consists of adding a URL to the track’s attribute list (supported by GCCS 4.x), where the URL points to a SmartPage server and has an embedded name/value pair to uniquely identify the track. Track information and associated URLs are distributed event-by-event across the COP architecture.

The user accesses a SmartPage via right mouse click on the track, as is standard procedure in GCCS 4.x (see Figure 1). Operationally, it is expected that SmartPage servers will be available across the Global Information Grid (GIG), provisioned according to CONOPS, COI usage, bandwidth constraints, etc.

Assigning a SmartPage to each track enables warfighters and subject matter experts (SMEs) across the enterprise to contribute information on tracks of interest by publishing directly to the track’s SmartPage. All users can cooperatively view, revise, and otherwise comment on the published information, as well as subscribe to updates/changes to the information (as allowed by user permissions). This construct offers a powerful organizing framework for knowledge management (KM), based on the geo-spatial representation of the battlespace COP.

It is a stated goal of DoD net-centric data strategy to tag every data element for discovery across the enterprise. SmartCOP provides an intermediate step toward this goal by recognizing SmartPages as a higher-order “information and context” ID tags, identifying information as associated with a specific track. Users find track-specific information by accessing the assigned SmartPage (see Figure 1). This is not intended to replace the use of search engines, though it could improve the quality of search results by allowing customized searches against a set of track SmartPages, defined by common track attributes or geographic region.

![Figure 1: Accessing the Kitty Hawk’s SmartPage.](image)

*A mouse click on a COP track (left) provides access to the associated SmartPage (right). The Kitty Hawk SmartPage is modeled after the Navy’s Collaboration At Sea (CAS) project.*
Any COP object can have an assigned SmartPage, such as facilities (e.g., hospitals, ports) as shown in Figure 2.

![Figure 2: Sample SmartPages for the Keflavik Naval Hospital & Bandar Abbas Facility](image)

Any COP object can have an assigned SmartPage, providing a shared workspace for warfighters, COIs, and SMEs to publish information and collaborate.

The use of SmartPages as COP-tethered, shared workspaces mitigate some of the concerns associated with chat, email, file servers, and other ad hoc C² channels. Chat and email do not support discovery and search across the enterprise, and are confined to pre-defined invitee lists, in conflict with the fundamental TPPU dictum that information should be shared without a priori knowledge of the consumer. Shared file servers are likewise constrained by not providing an environment that fosters user interaction and collaboration across the enterprise.

In spite of the seeming simplicity of SmartPages, represented by URLs assigned to COP tracks, there are numerous implementation details that we must slog through to achieve a viable operational capability. For example, if a COP track is inadvertently deleted, what should become of the (now orphaned) SmartPage? It seems reasonable to archive an orphaned SmartPage in order to allow retrospective search and analysis. If the same COP track later re-appears, the SmartPage should be automatically reassigned (assuming it still exists), based on
correlation logic that binds a web page to a track, while avoiding incorrect correlations and accommodating “ambiguous” web pages (e.g., correlation to more than one track). If two tracks are merged, then what is the methodology for merging their SmartPages? These issues are being addressed in the SmartCOP prototype. In general, the management of SmartPages should parallel the management of COP tracks in order to ensure integrity and consistency between the COP domain and the web domain.

As another challenge, consider the initial instantiation and assignment of a SmartPage to a COP track. When created, a SmartPage is a template - an organizing framework - into which information can be published and organized according to common topics and themes. For example, the template could provide areas for posting status information, images, documents, links, discussion sessions, etc. Templates can be customized to faithfully represent the best organizing framework to accommodate the type and priority of information relevant to the COP track. For example, the template for a hostile ground unit will be different from the template for a US warship, different from the template for a hospital, and different still from the template for a merchant ship.

An important element of SmartCOP (phase 1) is to define a family of templates to provide a first-order organizing construct for the publication of relevant information associated to the COP. Of course, the editable nature of SmartPages allows users (with appropriate permissions) to redesign templates and even add new templates. Figure 3 shows a sample template, devoid of content (the ship photo is a place holder), for a merchant ship.

Figure 3: SmartPage template for a merchant ship

Templates provide an initial construct, defining the organization for publishing and sharing information.
SmartCOP

Once the template is assigned to a COP track, users and pre-configured “smart agent” software can populate the template’s staging areas with information. In Figure 3, the staging areas for manifest information and ship characteristics would be automatically filled from designated/authoritative data repositories.

SmartPages support access controls, allowing users to have a range of permissions including read-only, read-write, and designer (which allows the user to define templates and change the design of existing SmartPages). The implementation of access controls will be driven by CONOPS and the security features of the SmartPage server.

Finally, SmartPages support user alerts, providing a feedback mechanism for users to be notified when information of interest is added, modified, or deleted. This is especially important in discussion sessions that can be very tedious to monitor continuously. In real-world operations, it is not unusual for a decision-maker or SME to be engaged in numerous chat sessions that must be constantly monitored for new information, forcing the user to work hard for the “system.” In a SmartPage, alerts can be established for the full range of activity and interaction with the page, empowering the system to work hard for the user. The implementation of alerts is dependent on the selected product for SmartPages, but Microsoft’s SharePoint product provides email alerts by default and offers a software development environment to build customized alerts.

SmartCOP (Phase 2)
We begin our discussion of phase 2 by revisiting the transformational right-turn away from platform-centric C4ISR and toward network-centric C4ISR. The promise of network-centric systems and network-centric thinking is well documented and widely promoted. Harshly stated, platform-centric is bad and network-centric is good. From this vantage, we note that the current COP situation awareness display is platform-centric, showing the geographic location of platforms (e.g., ships, aircraft, tanks, patrols, facilities). So if platform-centric C4ISR is bad, then it can be argued that platform-centric SA is also bad….leaving unanswered the question of what is good SA. Specifically, what is the “network-centric” construct for the COP and SA that replaces and transforms its current (legacy, antiquated, old-school) platform-centric representation? The simplicity of this question belies the complexity of the context within which it is posed.

For SmartCOP, phase 2 is focused on answering this question by proposing a mission-centric construct for the COP and SA. To clarify this concept, consider a police commander’s view of his “battlespace”, namely a city street map of his area of responsibility. Now suppose that there are several ongoing missions, consisting of a DUI checkpoint mission in one part of the city, a drug bust in another part, and a crowd-control mission (supporting the fire department) in another part. The police commander’s mission-centric view affords him a view of police activities based on the activities and missions. The platform-centric view is not eliminated, as the police commander may need to drill-down into a mission to show the location of individual police units. Instead, the mission-centric and platform-centric views are integrated, allowing the decision-makers to seamlessly transition between disparate views depending on the operational context and decision-maker’s perspective.
In the warfighter’s battlespace, the mission-centric view will encompass the full range of space, air, land, and sea operations, including surveillance missions, refueling missions, strike missions, interdiction missions, search and rescue missions, humanitarian relief missions, security missions, etc. Users will be able to create missions, create mission hierarchies, and manage these missions and hierarchies (e.g., edit, delete, access permissions). Missions and hierarchies will be distributed across the COP enterprise, using with the same infrastructure for distribution of COP tracks. The SmartCOP prototype, based on GCCS 4.x, will leverage the “general track” object available in the Track Management System (TMS). The general track was designed explicitly to allow 3rd party developers to create new tactical objects, without being bound to the legacy track types available in TMS.

Several tasks and challenges are inherent in the development of a mission-centric COP and SA in order to ensure operational benefits to the warfighter. First, the display mechanics associated to missions must be addressed. Presently, the standard symbol sets (e.g., MIL-STD 2525, NTDS) have very limited support for missions, and although 2525 was recently expanded to include symbology for Missions Operations Other Than War (MOOTW), the symbol set for missions remains inadequate. The SmartCOP prototype will use generic symbols with text labels to clearly identify the specific mission.

Missions generally cover a geographic area, so the mission symbology will need to be amplified with additional display attributes to visually represent the associated geographic area. A mission “contour” is a reasonable approach to define the boundary of the mission, but there may be other viable display mechanisms, depending on the operation, the amount of display clutter, and other considerations. Certainly, display mechanics and complexity is compounded when the visualization includes both 2D and 3D views.

Here is a sampling of other tasks and challenges related to the mission-centric view:

- Missions can move and morph over time, so it will be necessary to support a history of each mission’s geographic progress, including changes in the mission contour.
- Display of mission hierarchies needs to be addressed, with support for drill-down to individual mission operations. Furthermore, support for drill-down to individual units participating in the individual missions will need to be provided.
- Plot controls need to be developed to allow customized views of the battlespace, based on selected missions. For example, the user may elect to display all of the airborne refueling missions, showing each tanker's racetrack, the tanker's position, and every thirsty aircraft in the vicinity demanding a drink.
- Search tools will be developed to provide lists of missions that satisfy search criteria.
- XML schemas need to be developed to support the richness of the mission object. In parallel, data guards will need to be upgraded to ensure the exchange of mission information across security boundaries, and specifically with coalition partners.
- Correlation logic needs to be specified (similar to track correlation logic) to ensure that missions can be correctly merged and associated, depending on mission attributes.
Clearly, there is no dearth of challenges in the creation, management, distribution, and visualization of missions and mission hierarchies, while providing seamless access to the platforms/units participating in the missions. Indeed, this task appears even more daunting when viewed through the lens of the similar challenges associated with the much simpler task of handling COP tracks…and many issues here still remain unresolved.

**SmartCOP (Phase 3)**
Phase 3 assigns SmartPages to mission objects. The assignment of SmartPages to COP tracks (described above in phase 1) and to mission objects (described here in phase 3) provides a broad framework for publishing and sharing tactically-relevant information across the battlespace. The creation and management of SmartPages for missions follows the same engineering design as SmartPages for tracks (described in phase 1) including templates, access controls, manual and automatic population of information, etc.

Figure 4 shows a sample SmartPage for a search and rescue (SAR) mission. The page contains information on the unit in distress, the units participating in the SAR, the SA in the vicinity of the mission, the weather conditions, and the standard SAR checklist (used by the Navy and Coast Guard).

![Figure 4: SmartPage for a Search and Rescue (SAR) mission](image)

SmartPage contains all relevant information associated with the SAR mission.

Here are two examples of operational use of the SAR SmartPage depicted in Figure 4:

- A user can monitor the progress of the SAR by registering an alert on the SAR SmartPage. The alert can be broad, eliciting a notification for any changes to the page, or the alert can be specific (e.g., attached to the SAR checklist), tailored to items of interest (e.g., an update to the checklist).
Suppose a user has a concern about this SAR pertaining to the weather conditions over the next 24 hours. He can post his concern in the form of a question to the current SAR SmartPage (e.g. in an existing part of the SmartPage) or he can add a new “discussion session” to the page (if allowed by user permissions). Since the SAR POC has registered an alert whenever someone contributes to the SAR page, the POC will respond to the posted question, providing the latest update for the 24 hour weather forecast. The user will likewise receive an alert that a response to his question has been posted. Importantly, all of this information is available across the GIG, in contrast to the “stovepipe dialogue” common in chat, email, voice or other point-to-point communications.

Figure 5 is a sample of a revised SAR SmartPage, showing the addition of a discussion session with a posted question about the 24-hour weather forecast.

A mission SmartPage offers an array of opportunities to share relevant information, collaborate and assess information, perform retrogressive search, and achieve new levels of interactive knowledge management, affording the warfighter with the advanced tools for fast/better decision-making. For example, mission planning typically involves the development of candidate courses of action, along with an evaluation of each course. This process is ripe for
collaboration within the COI, and SmartCOP provides the framework to foster this interaction. Once a plan is selected for execution, the other candidate plans are often relegated to the trash bin, along with the metrics and rationale for the decision. However, there is intrinsic value in these discarded options, the evaluation process, and decision criteria.

If battlefield circumstances change (e.g., weather conditions, threat behavior), then it is possible that previously rejected plans may suddenly emerge as viable. By preserving these plans along with the decision process, the warfighter is afforded insight and perspective into new options that may better accommodate the changing conditions. Decision-making is not a discrete process predicated on current information, but a continuous process that monitors and constantly re-assesses new information and events. Decisions are issued as snapshots in time, but are more faithfully viewed within the continuum of information analysis and situation monitoring.

As a final example of a mission SmartPage, we offer the following for Maritime Interdiction Operations (MIO) in the Straits of Hormuz (SOH), shown in Figure 6.

![Figure 6: SmartPage for a Maritime Interdiction Operation in the Straits of Hormuz](image)

*User accesses SmartPage via mouse click on the mission object, providing a shared framework for community cooperation across the battlespace*
Each mission SmartPages is a virtual command center, supporting the key elements of C2, including data collection and assessment, planning and collaboration, development and distribution of C2 orders, and situation monitoring. Future command centers will reside in cyberspace, inhabited by distributed communities of decision-makers and SMEs that review tactically-relevant information and collaborate on courses of action. SmartPages represent the cyberspace transformation of today’s physical command centers.

**SmartCOP (Phase 4)**

Phase 4 incorporates future capabilities that will be realized once SmartCOP has attained sufficient battlespace footprint to contribute to and influence warfighter decisions. When the Internet first began (circa 1992), it would have been difficult to convince businesses to invest since there was no persuasive business case or return on investment analysis. It wasn’t until a critical mass of web servers populated the network and a critical mass of users emerged that businesses began to understand the opportunities for commerce and profit. Likewise, the potential of SmartCOP is difficult to evaluate without a critical mass of SmartPages distributed across the battlespace. However, trends from the Internet suggest trends that should apply to SmartCOP. Below is a sampling of future capabilities for SmartCOP.

- Perform geographic-based searches (e.g., provide the weapon status of all strike aircraft within 100nm of a candidate TCT; provide status of all airborne tankers within a specified area; provide a list of all units involved in maritime interdiction in the Straits of Hormuz over the next 24 hours). The implementation requires that the SmartPages associated to units and missions are populated with the necessary tactical information. For example, aircraft reporting on TADIL-J would also report weapon and fuel status, which would be posted to the aircraft’s SmartPage.

- Provide alerts when thresholds are exceeded (e.g., alert when no 2,000lb bombs are within 5 minutes of an emerging TCT; alert when radar coverage of a threat corridor falls below 99%). The alert infrastructure would monitor updates to SmartPages and, based on analysis of the updates and preset thresholds, provide notification as required.

- Perform metadata searches on one or more SmartPages, including metadata searches associated with user activity on the SmartPages. The concept of metadata is well-understood, consisting of information about information. Most information objects (e.g., Word and PDF documents, images and video) have metadata about their contents, but when the information is posted to a SmartPage, new metadata is created. This consists of:
  - User name (or process name) responsible for posting the information
  - Posting date and time
  - Local posting context, which includes the staging area of the SmartPage into which the data was posted (e.g., area for action items, area for status update); the metadata associated to information in the same area contributes to the overall metadata context.
- COP context, which includes the COP unit or mission (position, attributes, etc.) associated with the SmartPage and the full inventory of information content on the SmartPage
- Battlespace context of the unit as a participant in one or more missions or the mission within a mission hierarchy

The novel use of this expanded metadata environment can enrich the role and value of information search. For example, if a user is an avid contributor to the SmartPages associated with Search and Rescue (SAR) missions, then it is likely he is a SME in this mission area. Further analysis of the metadata derived from his activities could confirm the specifics of his expertise.

It is a stated goal of DoD strategy to tag every data element for discovery by known and unknown users across the battlespace. This is unrealistic in the short term and will likely yield limited value without significant efforts to normalize and standardize the tags (due to variations in the understanding of these tags). An intermediate approach - at the “information object” level of abstraction - is to use the expanded metadata context afforded by a SmartPage as an intermediate step toward DoD’s goal.

More to the point, the winning strategy for information mining may not be in assigning tags to explicitly define structure within each information object, since users will resist the inconvenience of extra steps and fail to realize benefit. Rather, the winning strategy may be in applying data models to discover and exploit the inherent structure of information (e.g., statistical analysis, thematic extraction), in organized collections of information (e.g., common patterns and characteristics), and in the surrounding information context (e.g., embedded into the battlespace, assigned to COP tracks).

- Implement autonomous agents to populate web parts automatically. There is a wealth of information available across the network from well-defined data stores and network-based services, providing weather, intelligence, sensor & weapon characteristics, plans & intentions, doctrine, etc.

As an example, the Navy recently automated their “Reference Publication-1, Environmental Effects on Weapons Systems in Naval Warfare” as a web-based capability. Mission planners can now access this information to assess the impact of weather and ocean conditions on weapons, sensors, and platforms. Based on a platform’s weapon and sensor suite, along with current environmental conditions, the platform’s SmartPage could be automatically populated with information about the capabilities and limitations of its systems. Changes in weather or ocean conditions would trigger re-calculation, re-population of the SmartPage, and re-assessment of the mission plan.

- Implement smart agents to find and analyze information (distributed across SmartPages) for unknown relationships, unseen patterns, and unexpected surprises. There is much research in this area and many COTS products provide partial capabilities. The best
chance for success is to “train” the agents to understand the military domain so they can efficiently mine the information and metadata resident in the SmartPages. The value of smart agents has yet to be fulfilled, but the promise is unbounded.

- Create dynamic workflow processes. When a customer purchases a book from Amazon.com, he is offered recommendations for additional purchases derived from the buying habits of other customers who bought the book (e.g., “The last 50 people who bought this book were also interested in the following books”). When a user clicks on a SmartPage item, he could be offered recommendations to visit other items, predicated on patterns of user activity. Moreover, enterprise architects and analysts may be interested in the navigation/workflow patterns of users within a COI.

Most efforts to automate workflow require a detailed knowledge of the workflow process. This presupposes that tomorrow’s workflow will be the same as yesterday’s workflow, but a dynamic battlefield does not lend itself to this level of predictability. Instead, workflow needs to flex according to the situation. By mining user behavior and navigation patterns, it may be possible to dynamically define workflow templates that can then be tailored by users to address specific mission objectives.

- Support the management and assessment of information uncertainty. An inevitable reality of the battlefield is that information uncertainty cannot be abolished, but it can be mitigated through management, analysis, and understanding. SmartPages provide a collaborative framework for giving visibility to uncertainty, encouraging review and recommendations from across the battlespace. Uncertain information co-located with other information in SmartPages provides an expanded context for analysis. Smart agents can be launched to search for similar patterns of uncertainty (through active and archived SmartPages). User activity to resolve uncertainty can be analyzed for workflow methodologies and best practices, offering the promise of providing feedback to the user to more quickly understand and/or resolve the uncertainty.

As a specific example, the COP allows ambiguous tracks. These appear for a variety of reasons, such as a conflict in time-speed-distance (e.g., a track update is not consistent with the track’s last reported position) or a conflict in track attributes (e.g., the track report correlates to multiple candidates). A SmartPage assigned to a track ambiguity allows a community of users to assist in analysis and decision-making with regard to the ambiguity. Unfortunately, the COP currently does not permit the exchange of track ambiguities, so the SmartPage will only be visible within the GCCS LAN.

- Establish a “Voice COP”. Diverse information can be posted on SmartPages, including voice clips containing status reports and inquiries for information. The TPPU concept typically concerns the rapid sharing of data, not voice. Voice communications among friendly forces are typically point-to-point or conference connections, in conflict with TPPU. The conversations are not posted for access by others, the context and information is not searchable, and any decisions must be repeated to others in the chain of command (in conflict with the “only handle information once” dictum).
When we view video footage of our forces in OIF and OEF, it is rare to see a warfighter using a keyboard and mouse, peering at a computer screen. Instead, we see forces on the ground, eyes up and looking out, bodies moving forward through urban terrain, weapons held tight, radio gear supporting voice communications – not much room for a keyboard and mouse. Voice COP would not supplant the normal lines of communication, but rather provide a complementary conduit for posting and retrieving tactical information.

Here’s how it could work. A ground unit would be represented in the COP as a track, along with an associated SmartPage containing a staging area for voice clips. The ground unit could report information such as a status report by posting voice clips directly to the SmartPage (current technology supports this capability). The ground unit could also post questions (e.g., about the weather forecast) or retrieve voice clips from other ground units (which have likewise posted voice clips to their SmartPages). The voice clips could be automatically translated to text for normal viewing in a browser and to support search and analysis. Alerts could be generated when voice clips are posted. Metadata associated with the voice clips, as described above, would contribute to the metadata repository of the SmartPage (as described above).

Indeed, there are many candidate examples of how the SmartCOP context and organizing construct leveraged. The Internet suggests some trends, but the warfighter will surely identify many non-traditional, even transformational, uses that are beyond this author’s imagination.

**Concept Summary of SmartCOP**

SmartCOP provides a unique and powerful framework for advancing the tenets of FORCEnet, empowering warfighters across the GIG to attach, share, and collaborate on tactically-relevant battlespace information, engendering better and faster decisions with fewer surprises. In our prototype implementation, the seemingly simple assignment of a SmartPage URL to a COP track (and COP mission) belies the underlying complexity of the implementation and the transformational impact of the vision.

Furthermore, as an innovative and compelling enhancement to the platform-centric view of situation awareness, SmartCOP offers a mission construct that provides a higher order perspective of the battlespace in terms of operational activities (replete with associated SmartPages for advanced KM). The warfighter can navigate seamlessly between the platform-centric and mission-centric views and tailor the display with combinations of platforms and missions, as required. COP tracks and COP missions are synchronized (event-by-event) across the COP architecture, along with the SmartPage URLs. No additional bandwidth is required for SmartCOP until a user clicks on a SmartPage URL.

The following subsections provide highlights of warfighter benefits to be accrued from a fully implemented and deployed SmartCOP.

- **Organization.** SmartCOP provides an enterprise-wide integration point and organizing construct for diverse information, within the COP geographic context. Since
commanders think in terms of a geospatial battlespace for situation awareness and decision-making, the supporting information systems should embrace the geospatial context as the core organizing infrastructure. As Edward Tufte observed in his well-known book *Visual Explanations*, “Clarity and excellence in thinking is very much like clarity and excellence in the display of data.” Tufte further notes that when the principles of design replicate the principles of thought, then the act of sharing & organizing information becomes an act of insight & understanding that leads to better/faster decision-making. Just as the brain relies on organizing patterns for processing and storage of information, warfighter information systems must likewise provide organizing patterns that are consistent and consonant with their thinking and decision-making process.

The organizing constructs inherent in SmartCOP addresses the chronic warfighter complaint about information overload. To be clear, the problem is not really the volume of information, but rather our inability to give it structure through organization. Unfortunately, lacking organization we resort to information triage, discarding vast quantities of information because we don’t have the discipline or tools for effective and efficient information management.

*It’s not the load that’s heavy, but how you carry it.* The wisdom of this adage applies directly to information management. For example, our file systems use folders (and folders inside folders) to organize the glut of files we choose to keep….but this only works if we have the discipline and tools to succeed. As a more pedestrian non-IT example, consider the stuff in my house and the stuff in my garage. By inspection, I have much more stuff in my house than my garage, and though I have no problems finding the stuff I want in my house, I’m incapable of finding anything in my garage. In my house, everything is easy to find because it is organized for ease of access according to the context for that use (e.g., cooking stuff in the kitchen, entertainment stuff in the living room, sleeping stuff in the bedroom). In contrast, my garage has no organizing construct, at least none that I use routinely.

Information is data organized according to context. If that context is global, then the information organization empowers the warfighter and accelerates decision-making across the battlespace enterprise.

- **Completeness.** A small percentage of the available information on a track is maintained within the COP (or more accurately, in the data schemas representing COP tracks). The bulk of the relevant information, much of it unstructured, is found outside of the COP context in email, chat, Word, PowerPoint, etc. Furthermore, the growth of unstructured information is on a tear, so the COP is increasingly falling behind in information content on a percentage basis. SmartCOP provides a “container” to capture the myriad inventories of information spread across classified and unclassified networks, and embed it into the COP context.
• **Access.** SmartCOP offers the opportunity to replace silos of information and the unique applications built around these silos. For decades, tactical information has been held in proprietary and/or structured data stores, out of reach to most users. SmartCOP allows access to information by any user with a browser and access rights.

• **Open & Composeable.** There will always be a market for proprietary software, but the future of net-centric capabilities favors radical openness and composeability in both design and implementation. SmartCOP empowers the warfighter to create, tailor, and annotate the battlespace according to their own context, mission objectives, information requirements, and collaborating SMEs. SmartCOP provides more than just a service; it provides an enterprise-wide service factory for the warfighter to dynamically compose and distribute new mission capabilities across the GIG.

In a very strong sense, the entire SmartCOP concept is about radical openness and composeability.

• **Information Integration.** Industry and government are spending a great deal of time and energy focused on the integration of applications (as evident over the last 20 years with technologies such as DCE, CORBA, COM/DCOM, EAI, web services). Unfortunately, we have spent comparatively little time and energy focused on the integration of information, which is regrettable for two reasons. First, information is fragmented across the battlespace. Second, the success of application integration (and by extension, workflow) depends on the organization and orchestration of the information upon which the applications must operate. SmartCOP provides the information integration foundation to consolidate battlespace information and to foster application integration and workflow.

Information without context has little value or content. The meaning and understanding that emerges from SmartCOP – analogous to the human brain – arises from the complex patterns of activity across the enterprise. This is an “emergent” property of SmartCOP and a small step toward Artificial Intelligence.

• **Simplicity.** SmartCOP offers simplicity of design through the extensive use of the web browser for all management and organization of information on a SmartPage. In the middle of a recent SmartCOP brief, a DoD representative proclaimed “that’s exactly what we need,” to which an industry representative asserted “but it’s just the assignment of a URL to a track.” They’re both right….and that’s part of the value proposition of SmartCOP. Simplicity is a key to success, but simplicity is not the same as simplistic. Many of the most compelling innovations in IT are realized through simplicity (as seen by the user). SmartCOP offers simplicity of use to the warfighter, hiding the complexity of implementation.

• **Shared Understanding.** Users don’t just share information, they share themselves (their knowledge, insight, hunches, recommendations, etc.) through their review,
SmartCOP

analysis, and contributions to SmartPages. SmartCOP extends shared presentation to shared understanding – and without shared understanding, there is no collaboration.

In a fully distributed and collaborative battlespace, it is likely that the primary role of the established Centers of Excellence will be to vet posted information and monitor discussion sessions rather than be the fount and purveyor of tactical information. In this spirit, SmartCOP draws on an enterprise of distributed smart guys rather than a few centralized really smart guys to achieve a highly decentralized environment for collaboration and information sharing (with oversight by the Centers).

Who people work with is more important than who they work for, according to the Garner Group. SmartCOP provides COIs with a configurable global infrastructure for battlefield collaboration in order to foster interactions across organization lines by user groups that are not defined or identified within any DoD organizational chart or mission plan.

- **Decision-Making and Risk Mitigation.** SmartCOP provides a collaborative framework for making better decisions by organizing and aggregating all of the available information according to the decision context (e.g., geographic-based, mission-oriented, platform-centric). Once decisions have been made and command orders issued, then the next phase is mission execution and situation monitoring. In this phase, a top priority of the warfighter is to minimize surprises. In business, surprises are expensive. In the battlespace, surprises are life-threatening. SmartPages hold the promise of reducing battlespace surprises through orchestrated information management and smart agents that patrol the cyberspace of SmartPages seeking patterns and events that may lead to mission surprises.

- **Search.** SmartCOP empowers users to find and capitalize on the information and expertise across the battlespace in a well-defined organizing framework. One of the reasons Internet search is problematic is the lack of organization, and specifically, the lack of organization aligned with any specific theme, topic, workflow, decision-making process, or more generally, thinking process. Our mental powers are finely tuned to use patterns for recognition and cognition. We organize files into folders, typically predicated on information patterns, such as subject matter or author. In fact, an argument can be made that the use of a search engine is an admission of failure – failure to organize the information in a manner consistent with the content and use of the information. The popularity of Internet search is a reflection of the chaotic organization of information across the network, much like asking for travel directions when one is completely lost.

Information retrieval boils down to two basic modes: navigation and search. Navigation is typically selected when the user’s context is consistent with the organizational structure of the information. Search is selected when structure is absent or inconsistent with the user’s task and thinking. Search requires luck and guess-work for success.
Navigation is typically the first choice when information is well-organized. Furthermore, navigation places the user in the context of related information.

The typical user experience with Internet search is that most searches return results that are not relevant – and the trend is getting worse for many reasons (e.g., sites are included in the search results because they have references to articles already included in the results). In general, if users don't find what they are looking for in the first few pages of results, they will rephrase the search request or simply give up. The value of “focused” search to constrain the process by targeting a subset of the information would improve the quality and reduce the quantity of results returned. In the early days of Internet search, there were several companies that used humans to create directories of domain-specific information, but these companies did not survive because the associated business model was not profitable – the same fate awaits the Centers of Excellence unless they adapt their “business model”. SmartPages are designed around domain-specific constructs (i.e., platform objects and mission objects) and will rely on automated tools and human-assisted procedures to populate with specific content, along with community support to vet postings and correct errors. Search engines (and smart agents) operating on the SmartCOP environment will provide higher quality results in shorter times.

As a side benefit of search, we can analyze user search activities to discover the what, how, and why of their search, and then refine the search algorithms and information organization to produce more accurate results (e.g., through the use of synonym tables and thematic constructs). Effective and efficient search requires a well-defined context, which is why a localized search on a specific web site returns better results than a global search across the Internet.

- **Context.** The COP provides a snapshot in time, a representation of the battlespace right now. SmartCOP provides the context within which the snapshot resides. When we watch the TV weather report, we are given the current weather conditions, the snapshot of conditions at broadcast time. But this information is of limited value without the context of weather over the next few days, so the weatherman continues to give more information – information about the weather conditions throughout the day, the weather forecast for tomorrow, and the 5-day weather forecast. This is the trend curve (aka the context) within which we place the current conditions.

  SmartCOP provides the staging infrastructure for the platform and mission trend curves, with the COP representing the latest data point in the trend curve.

- **Information Assurance.** SmartCOP provides access controls for security and IA, based on the capabilities of the SmartPage server. Posted information can be protected using access controls or encrypted and signed for added information assurance.

- **Multi-Level Security.** SmartCOP can be enhanced to require users to place the security classification on all information prior to posting (e.g., through a dialogue box from
SmartCOP

which the user would select the classification). The classification label can be written to
the information’s metadata or embedded directly into the information object, depending
on the requirements of the data guard. The posting will then be automatically accessed
from the SmartPage and forwarded to the data guard for release or rejection, based on
the classification label and the guard’s filter logic. In this way, SmartPages can be
replicated across multiple security boundaries.

Currently, the COP is replicated across security boundaries using data guards (e.g.,
Radiant Mercury), but as mentioned earlier, the COP data set represents a small
percentage of the relevant tactical information associated to tracks. The replication of
SmartPages to coalition forces, in concert with COP sharing to coalition forces, yields a
full complement of COP information (constrained only by the data guards). This
approach realizes an important goal of NCW, namely a design that provides an
information-rich, collaboration-enabled, shared C4ISR environment with coalition
forces. With the addition of a language translation module, information replicated to a
coalition’s SmartCOP server could be automatically translated into the appropriate
language (along with access to the original).

To be clear, this design does not suggest that SmartCOP will support MLS, but rather
that data guards will provide the NSA-approved sanitization necessary to replicate
SmartPages across coalition boundaries.

• Collaboration. SmartCOP support for information sharing has already been discussed
at length. Users can also engage in collaborative discussion sessions, as implemented by
a SmartPage server (e.g., Microsoft’s SharePoint). These discussion sessions have
several advantages over standalone chat, IM, and email. By conducting digital
conversations within a SmartPage, other users (known and unknown) can view and/or
participate in the conversations, thereby eliminating the constraints of point-to-point and
multi-point conference communications. Discussion sessions are archived and
searchable within the SmartPage, along with the context and metadata inherited from the
surrounding SmartPage. Importantly, alerts can be configured to notify users when
someone contributes to a discussion session.

Within a command center, warfighters are often engaged in multiple chat sessions.
Unfortunately, the proliferation of chat sessions has imposed a significant effort to
monitor them for activity, requiring the warfighter to work too hard to keep current.
Instead, the system should work hard for the warfighter by providing notification when
contributions are posted. Discussion sessions embedded in SmartPages support user
alerts for new contributions; furthermore, the alerts can be assigned to anything posted
on a SmartPage, allowing users to be notified whenever information of interest is
changed.

Finally, discussion sessions can be enhanced to require users to specify the security
classification of each contribution, as mentioned earlier. In this way, discussion sessions
(as part of the SmartPage replication across security boundaries) can cross coalition
boundaries, allowing participation across a heterogeneous community of coalition partners, each operating within a different security enclave.

- **Mission-Centric.** SmartCOP extends platform-centric situation awareness to mission-centric operational awareness, affording a higher-level of abstraction that more closely resembles how the warfighter thinks and views the battlespace. The mission SmartPage is the portfolio containing all relevant information about the mission. Users can register alerts to be notified for mission updates. Smart agents can monitor mission SmartPages and report mission effectiveness, identify anomalies, and generate alerts for unexpected events.

- **Self-Sustaining.** SmartCOP is self-organizing, self-sustaining, and self-repairing. SmartCOP is the battlespace equivalent of Wikipedia (www.wikipedia.org), a profoundly successful effort to create a free, web-based, community-driven encyclopedia of everything — ambitious in purpose and unique in design. The marquee trait of Wikipedia (and SmartCOP) is the decentralized and self-sustaining nature of the capability. For Wikipedia, this has not been without problems and it could be argued that Wikipedia can’t succeed, the counter argument being that it is succeeding. The belief is that, given enough eyeballs, all information achieves a high level of quality. Errors are quickly detected by COI members and then corrected. Perfect must not be the enemy of good enough.

  It is worth noting that Wikipedia began as Nupedia (circa 1999), an on-line encyclopedia that relied on a roster of academics for contributions, along with a multi-layer regime of vetting and peer review. After 18 months and $250,000, Nupedia had only 12 articles. In early 2001, Wikipedia was launched and within a month, 200 articles were posted. In a year, over 18,000 articles were available. By September 2004, Wikipedia contained over 1 million articles, with an investment of about $500,000. A repeat of this success with SmartCOP will give our forces an overwhelming and sustainable advantage in decision-making and battlespace awareness.

- **Innovation and Analytics.** SmartCOP affords new opportunities to develop innovative capabilities by combining the structure of its information management and organization with analysis tools that can automatically detect unseen patterns and forecast events. Several examples have already been discussed in a previous section (SmartCOP Phase 4), so in the interest of brevity, we offer only two more.

  - Changes in predicted weather can be analyzed in terms of impact on the missions most affected by the weather change. SmartPages associated to missions would contain all relevant information about the mission (goals, schedule, participants, etc.) from which the impact of weather could be assessed and recommendations offered. This approach has the potential to convert weather information into actionable intelligence. For example, suppose an MIO involves a merchant boarding using a Zodiac launched from a US warship. If a predicted weather change will prevent the safe launch and transit of a Zodiac (e.g., 10 foot seas),
then a smart agent could respond to the weather update by reviewing all maritime missions in the vicinity of the 10 foot seas. The use of a Zodiac would trigger an alert to the MIO participants, notifying them of a forecast high sea state preventing use of the Zodiac. This is an example of the potential of SmartCOP to minimizing surprises (as discussed earlier in Decision-Making and Risk Mitigation).

During mission planning, several candidate mission scenarios may be proposed and evaluated, from which one is selected for execution. The rationale for selection is generally not preserved with the plan, preventing continuous assessment during mission execution, according to the decision criteria. Furthermore, the discarded plans and the underlying rationale for elimination are not maintained within the context of mission execution, preventing continuous assessment during mission execution as conditions change (which might change the calculus and argue in favor of a discarded plan). For SmartCOP missions, the associated SmartPage could store the selected execution plan along with the discarded plans, including the pro & con decision factors. Smart agents could continuously compare battlespace progress/status (posted on the SmartPage) with the associated decision criteria.

- **Plug-and-Fight.** SmartCOP fosters Plug-and-Fight: This concept is centered on how warfighters are going to access needed information quickly and efficiently to obtain decision superiority. Net-centricity greatly increases the availability of information and recognizes that users are best able to identify what information they need and when they need it. SmartCOP promotes flexibility for the warfighter to organize, customize, share, and access information across the battlespace.

- **User-Centric.** SmartCOP places the warfighter at the center of mission planning, COI collaboration, battlespace monitoring, and C2 execution, by capitalizing on the information and expertise distributed across the enterprise. Most IT systems are built with the engineer in mind, but SmartCOP is designed for teams of collaborating knowledge workers. SmartPages are inherently user-centric (and team-centric) and anyone with a web browser can access a SmartPage via its associated URL. With SmartCOP, the warfighter will be able to marshal and analyze information on the fly to improve the quality of decision-making and the speed of command.

Creating a blueprint for a fully-equipped, flexible, and collaborative enterprise that aligns information technology with warfighter mission requirements is a critical step on the path toward NCW. As described above, the design of SmartCOP is a core component in the blueprint, providing next-generation capabilities, consistent with the tenets of NCW, compatible with the new breed of NCW prototypes, and easily integrated into the GCCS family of systems. The importance of GCCS cannot be overstated and the DoD’s investment in GCCS is substantial. GCCS cannot be replaced in the short-term, not only because of the great risk and cost, but because we must fight with what we have available now … and GCCS has a global footprint
SmartCOP

across the DoD services and with many coalition partners. SmartCOP leverages the contemporary C4ISR infrastructure and is forward leaning toward NCW.

Final Remarks
Information is increasing at a rate close to Moore’s law (i.e., doubling every 18 months), and the thrust of transformation is using information to advantage in military operations. While technology provides new options, it’s the ability to interconnect forces and exchange information in new ways that has spurred NCW, with information being contributed by everyone on the grid and accessed by anyone who needs it. Decisions about technology investments have never been more critical, and the capital and resources never more scrutinized. New IT architectures and computing paradigms must have direct benefits to the warfighter.

SmartCOP is an innovative concept and progressive implementation, providing the warfighter with the capability to publish, organize, customize, analyze, synthesize, and access (structured and unstructured) information across the battlespace using a browser. It provides user-centric enablers, placing the warfighter in the center of the information-rich battlespace from which to leverage NCW capabilities. That said, this approach falls short of providing “the right information to the right person at the right time in the right format”, but SmartCOP is certainly an enabling capability to provision relevant information in the right shared workspace as soon as available in a customizable format. This is an intermediate step toward the desired goal, upon which we can build smart agents to run the last virtual mile in cyberspace.

To be clear, SmartCOP is only a starting point to rapidly achieve a next-generation NCW capability. There is no easy way to determine the right answer to a tactical problem, since the right answer often depends on the warfighter’s experience and the context of his experience. SmartCOP is not a magic elixir, but rather a catalyst to achieve decision superiority and battlefield dominance.

Of course, the warfighter is the final arbitrator of what works and what doesn’t. The warfighter role never ends as the primary driver for defining NCW requirements and assessing NCW functionality. The concept of effective and efficient mission capabilities is well understood, but the implementation details become the dominant factor when the warfighter uses the system to perform his mission. No explanation of cutting-edge technology or lectures on the value of service-oriented architectures will be acceptable if the C4ISR system does not provide the warfighter with tactically-relevant information and easy-to-use tools to rapidly understand and address mission-critical issues.

Success with NCW in general - and SmartCOP in particular - will come in giving warfighters the ability to optimize their warfighting capabilities, to change them as frequently and as radically as needed, and to access them locally, regionally, and globally.