Achieving A Common Operational Picture

A New Approach to Battlefield Management Systems

Harris Corporation
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ACHIEVING A COMMON OPERATIONAL PICTURE

The Need for Fully Informed Command and Control

Effective battlefield management requires a crystal clear operational view based on accurate, timely information.

The information must be prioritized and organized to ensure that time-sensitive data is not only transmitted and delivered, but also appropriately filtered to raise the most critical information to the forefront of the decision-maker. It must then be shared up and down echelons and across joint operational units to ensure mission success and the protection of tactical units.

This is no simple task. It means all tactical information – Friendly Force Tracking, Situational Awareness (SA), alerts, chats, messaging, files and video – must be collected, aggregated and disseminated in a usable form, and in real-time, across all echelons. A further complication when communicating across echelons with joint force operations is that the radio communications equipment is multi-generational and from a mix of vendors. This requires full control over the communications infrastructure to deliver both voice and data, with robust, integrated tools that prioritize, plan and execute missions.

While various command and control systems exist today, most do not provide or integrate voice and data elements to deliver a true and complete operational picture. Some of these shortcomings include:

- Inability to ensure an uninterrupted flow of information during battle
- Limitations in scalability
- A proprietary approach to radio hardware and network design that only allows select brands to be part of the network
- Lack of a consistent user experience across multiple software applications
- Integration and interoperability with existing command and control systems

![Figure 1. Command center](image-url)
This white paper examines these challenges, the technology, processes and capabilities required to manage today’s modern battlefield and how operational insight and advantage delivers the following benefits:

- A Common Operating Picture (COP) for informed decision-making
- Scalability for a dynamic battlefield
- Seamless integration of Command and Control (C2) with a communications network, regardless of equipment, manufacturer or location
- An intuitive, at-a-glance user interface that is common across all C2 applications
- Expanded integration of C2 with Intelligence, Surveillance and Reconnaissance (ISR) capabilities

Key Capabilities Required for Total Command and Control

A Common Operating Picture

While today’s battlefield is more technology-rich and better connected than ever before, significant gaps still remain:

- Commanders are not getting all the critical, real-time information they need from the tactical edge; nor do they have an ability to aggregate and store the information.
- Commanders on the move are unable to stay connected and informed.
- Dismounted soldiers may not have real-time visibility through blue and red force tracking, so they lack accurate situational awareness about the location of other troops.
- Multinational forces are often unable to share critical mission data required for mission success.

The challenge has been how to aggregate, distill, manage and share information so that all functions and operational levels have the same COP, despite different networking and communications requirements across echelons and platforms.

The key to achieving a true COP is having the ability to expertly manage C2 data within complex Command, Control, Communications, Computers and Intelligence voice and data networks.

The Battlefield Management System (BMS) has emerged as a means to achieve full C2. However, many BMS solutions are built using single-customer program funding that narrowly addresses customer’s needs. Typically, for the solution to advance, the BMS supplier waits for the next stream of funding to introduce the next round of capability enhancements. This intermittent investment often results in a disjointed solution lacking key elements of a comprehensive cross-echelon BMS. These elements include:

Scalability – Every mission has unique properties. The number of soldiers, amount and type of equipment used and the range of the operation can shift – sometimes minute by minute. A BMS must be capable of delivering relevant information between higher HQ and the tactical edge (Figure 2); and from smaller missions to larger coalition operations. The BMS must also incorporate new features and capabilities quickly, to meet a customer’s changing mission needs.
Table 1. C2 requirements from higher HQ to the tactical edge.

<table>
<thead>
<tr>
<th>Higher HQ</th>
<th>Large-scale mission communications requires total visibility of the operational environment; sharing information with coalition/allied forces provides a clear picture for informed decisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tactical Operations Center</td>
<td>Decisions must be made rapidly in changing operational environments; information must be disseminated from command to tactical edge to HQ</td>
</tr>
<tr>
<td>Mobile Operations Center/Convoy</td>
<td>If command needs to change vehicles or location, there is no time to reregister in the network. Network availability and access to operational information must be instantaneous; critical communications must be made beyond a radio’s specified range and despite buildings/terrain</td>
</tr>
<tr>
<td>Dismounted Soldier</td>
<td>Sending/receiving up-to-date and accurate Position Location Information/ Situational Awareness is essential at the tactical edge; collection of data to be shared with other forces and command provides the foundation for COP</td>
</tr>
<tr>
<td>Airborne/Maritime Platforms</td>
<td>Images and video required by command to fully understand COP and guide local forces around danger; ability to relay large amounts of information ship-to-shore and Beyond-Line-Of-Sight to moving platforms is critical to coastal/border security</td>
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</tbody>
</table>

Integration of Differing Network Elements – A high degree of technical maturity is required to integrate different radios, waveforms and frequencies into a complex network. Challenges faced by less experienced suppliers include bringing together different radio types, a variety of waveforms and narrowband and wideband frequencies. Radio and networking expertise is required to bridge communications technologies to permit variations in communication distances/ranges and the number of users in the tactical network.

Simplified User Interface – When BMS systems are built and deployed at different intervals to different levels – command, patrol and dismount – and without a plan to interconnect them, it is impossible to achieve a unified user experience. This results in additional training and impacts the readiness and efficiency of the BMS deployment.

Expanding C2 and ISR – As technology continues to advance, more data can be collected from an operation. The data is in the form of images, chats, full-motion video, and sensor data and must be collected and aggregated into meaningful information. This aggregation is the job of the BMS. Few systems fielded today have the capacity to process and properly filter the ever-increasing volume of data that is available to make highly informed decisions.

A New Approach to Command and Control

A new strategy that integrates tactical communication network design with battlefield management has emerged to address the challenges discussed above. Unlike other current C2 offerings, this one enables users to access the most up-to-date COP using both tactical and commercial networks on a variety of platforms, including Internet browsers, PCs and Android™ edge devices.

The system acts as a true coalition gateway. By adhering to a multitude of worldwide interoperability standards, the system can feed external data into the COP and output track feeds to other systems. It utilizes MIL-STD-2525 symbology – a NATO standard for military symbols for land-based systems – offering familiarity and expediting the learning process.

This new integrated system is the Harris hC2™ Software Suite. Details of this new solution and how it is creating a new perspective of the future of BMS are discussed below.
A New Approach to Battlefield Management Systems

Harris hC2™ Overview

The Harris hC2 Software Suite is a comprehensive set of Battlefield Management System products. Designed for command, control and connectivity across all echelons, hC2 integrates the expertise of Harris Corporation, a global leader in tactical radio technology, and Systematic, a leading supplier of military Command and Control solutions for defense forces worldwide.

hC2 is a commercial off-the-shelf solution that is designed holistically as a platform solution with two releases per year. The platform uses a Service Oriented Architecture (SOA) and provides a Software Development Kit (SDK) supporting the addition of new capabilities/features quickly, delivering scalability. This SOA approach also allows the integration of radio and networking capabilities into the C2 solution.

hC2 combines a mature Command and Control solution with Immediate Response Information System (IRIS) messaging software tools, optimized for operation over Harris narrowband and wideband tactical radios and waveforms. Users have tools and capabilities not previously aggregated into a single BMS offering across all echelons and in multinational operations:

- Pertinent information about the location and status of both friendly and enemy forces
- Integrated Geographical Information System with support for standard military symbology, tactical sketching graphics, geospatial analysis tools and display management
- Current operations situational display and management, allowing for a comprehensive Command and Control evaluation of the operational situation
- Management of multiple plans and orders, including annexes and appendixes
- Sharing of the situational picture between multiple hC2 command sites (server-to-server) as well as exchanging plans and orders
- Interoperability of data messaging formats, including Multilateral Interoperability Programme (MIP), NFFI, Link 16 and other international data exchange standards
- Data sharing between networks and subnets via Tactical Communications networking protocol application, creating a collaborative battle planning environment
- Use of an open API to incorporate add-on modules and customized features to meet customer-specific C2 requirements and Standard Operational Procedures
Three Integrated Components: Command, Patrol and Dismount

hC2 delivers data to and from higher HQ to the tactical edge and anywhere in between, no matter the size or type of organization. It does this through three applications integrated for complete mission support for every unit on the battlefield – Command, Patrol and Dismount.

Command is designed for use at higher echelons, with full mission planning capabilities and a joint COP. Patrol and Dismount provide the battle and crisis management system for the mounted and dismounted frontline commander.

Each application empowers users with the precise tools they need to design, implement and share critical intelligence and mission plans. All are designed for easy installation, deployment, maintenance and upgrades without the need for specialized personnel.

**hC2 Command**

**Common Operational Picture and Applications**

Command is a web-based application available through any browser on the network. The application depicts thousands of data feeds on a detailed image of large-scale operations, including land, maritime, air, and joint operations. Plans from underlying C2 systems are also included.

Some Command features include:

- **Dynamically adjustable window panels** for users to drag and drop panels, view multiple maps, and customize the window layout
- **Custom user profiles** to save layout designs and switch between profiles depending on current operational needs
- **IP video stream** from IP cameras connected to the network
- **Geofencing** guard zones to alert users when tracks violate guard zone settings
- **Smart layers** to create rule-based filters for any combination of track properties, such as geographical location or the newness of the report
- **Dynamic terrain analyses** using Digital Terrain Evaluation Data (DTED) to include elevation data in the map
Full layer management allows users to select or deselect operational layers to share specific information at any given time. Sketching tools within each application can quickly modify plans to share with subordinates or send back up echelon. The messaging tool allows users to quickly and easily communicate with each other through private or group messaging and chat rooms.

**Figure 4. Common Operational Picture map**

**Higher Echelon Tasks**

Command is a C2 Information System supporting operational staff with all HQ tasks, preferably in a desktop environment. These include:

- **Organization Viewer**: Users can load and place Order of Battle (ORBAT) (friendly and hostile) and Task Organization units on a layer using a symbol toolbox.

**Figure 5. Organization Viewer**
Collaborative mission planning: Multiple Command installations can work on the same mission plan, at the same time.

- **ORBAT definition for order distribution:** An organization’s hierarchical structure is outlined in this application through definition of its ORBAT, making it easy to categorize assets and determine with whom to share information.

- **ORBAT Editor:** An ORBAT in hC2 Command refers to the military organizations (friendly as well as correlated enemy) as a hierarchical structure. In hC2 Command, the ORBAT is used for:
  - Viewing the organizational command structure of all units on the battlefield
  - Describing each organizational unit’s logistic status in terms of nominal holdings (equipment, personnel and consumables)
  - Correlating the organizational structure of enemy and unknown combatants
  - Establishing a foundation for a task organization

- **Flexible window layouts:** The window layout is flexible, allowing users to arrange window panels to suit current operational use.

- **Customizable toolboxes:** Symbol toolboxes can be customized for specific or tactical graphics and organized in groups, maximizing accessibility to the most frequently used symbols. Custom unit symbols can also be integrated.

- **Terrain analyses:** DTED elevation data included in the map empowers users to execute geospatial terrain analysis such as Line of Sight and Area of Sight, even allowing adjustments for height offset.

![Figure 6. Terrain Profile](image)

- **Briefings and presentations:** The Bookmarks and Briefings feature allows authorized users to identify particular views of the map (zoom level, selected layers, etc.) and ‘bookmark’ them for reference later.

- **Synchronization Matrix:** Complex, task-based mission planning often involves scheduling and de-conflicting individual unit and sub-unit tasks and sub-tasks. The Synchronization Matrix tool automatically generates an overview based on the task and timing information defined in the plan and overlays the resources assigned from the plan’s task organization.
Holdings Management: Holdings reports provide commanders and staff officers with pertinent information, including desired/remaining levels of equipment and consumables and relevant personnel.

Clip and Ship map feature: Maps can be exported using the “Clip and Ship” map feature, allowing users to create area-specific maps from the large-scale maps already used in the application. These maps can be exported into a format that is importable into other hC2 applications such as Patrol and Dismount.

Multilateral Interoperability with Shared COP

Most military operations today are conducted by multilateral forces and coalitions. To address this, hC2 Command is compliant with Multilateral Interoperability Programme 2.0, 3.0 and 3.1 standards. This facilitates interoperability with other MIP-compliant C2 systems to support multinational, combined, and joint operations.

The MIP Solution core is the Information Exchange Data Model, which models the information in an exchangeable format and allows users to select which information to share, with whom, and at what time.

This information is synchronized with other systems to create a shared COP and is accurately maintained by the MIP Data Exchange Model, which will only update and share data that has been amended, optimizing bandwidth usage.
hC2 Patrol

Patrol provides the benefits of a BMS to the mounted and dismounted commander through a two-part solution – Patrol User Interface and hC2 Tactical Communications. Patrol has unique features not available in other BMS offerings, such as:

- **Mobility**: The client/server design facilitates mobility, enabling operators to change vehicles easily.
- **Plan and Execute Operational Modes**: Plan mode is designed for quickly preparing the next mission phase. Execute mode furnishes operators with tools to make changes to the current mission and redistribute new orders with ease.

- **Touchscreen**: Field observations are rapidly reported and shared using the tactical reporting tool
- **Terrain Analyses**: Various geotools enable close terrain analysis, including performing Line of Sight and Area of Sight analysis (assuming appropriate Digital Terrain Elevation Data information is included in the map files)
- **Geofencing**: Geofencing rules can be setup relative to the user’s position. Alerts inform users when new objects are reported or existing objects move into the defined Area of Interest (AOI).
- **Honesty Traces**: Recorded and exported into a GPX file format for delivery to a higher command
- **Holdings Information**: Holdings management reports are updated when structured messages are received from the higher command center and filled out to identify nominal and actual holdings
- **Night Mode**: The ergonomic “Night Mode” adds a red filter on top of the C2 for improved viewing in darker environments
How the Server Layer Creates Mobility

Patrol supports commander mobility through the server layer hC2 Tactical Communications. As the communications core of the hC2 Suite, this server layer establishes a network connection among deployed units using the existing data network technologies. This design eliminates the need for predefined point-to-point contacts or end-to-end routing of an underlying network, offering a dynamic network easily adaptable to unforeseeable changes. Radio Situational Awareness is integrated into the system through Tactical Communications, including Harris radios and radios from other providers.

Figure 11. hC2 Patrol provides the benefits of a BMS to the mounted and dismounted commander

- Tactical Communications is installed before mission execution, ensuring assets are connected to the network at all times
- When installing the Patrol application into a computer with Tactical Communications pre-installed, the Patrol application will launch automatically, connecting the user to the network without any prompts
- The COP updates the Tactical Communications address to the unique call sign of the connected user
- If at any point the user needs to change vehicles, the thumb drive can be removed and the user can reconnect to the network through any other installation of Tactical Communications, offering full commander mobility and flexibility

hC2 Dismount

Dismount is a battle management system providing a mobile COP to the dismounted commander. It is designed for compact Android® edge devices optimized for touch screens varying from 4” to 10”. hC2 Dismount provides commanders with up-to-date plan overlays and information, enhancing force protection. Users can illustrate complex maneuvers, exchange plan overlays, and share vital information with subordinates.

- Spot reporting is accomplished by simply pressing down on the screen, prompting a menu to identify characteristics of the reported unit
- Geofencing filters can be created by defining an Area of Interest radius relative to user’s own position
- Alerts will be received whenever any new objects are reported within the AOI
**Shared Digital Information:** The Tactical Communications network automatically shares FFTs as well as spot reports over the tactical network with other users of the hC2 Dismount, hC2 Patrol or hC2 Command, provided that their application devices hold the appropriate credentials for receiving the information (Figure 13). hC2 Dismount also sends and receives command layers over the tactical network, allowing commanders to draw complex tactical maneuvers otherwise requiring precious minutes to verbally explain and verify the commander's orders.

*Figure 12. Example of Dismount user interface*

*Figure 13. hC2 Dismount concept architecture*
The Importance of Add-on Modules

The hC2 system can be tailored to meet the changing needs of an organization through add-on modules. The potential for customization is significant and is accomplished through the use of hC2’s Software Development Kit. Some of the tailored solutions include integration between Harris radios and BMS software in order to optimize the communication network, further enhancing the accuracy and real-time nature of the BMS.

Specific add-on modules include: Radio Drivers, Interoperability Gateways, Data Messaging Gateways and Harris Radio Applications. Future capabilities are planned for applications ranging from simplification of the radio and network planning; visualization of the hC2 network topology; integration of electronic warfare, video feeds, and ISR sensor systems; and the convergence of homeland security and public safety Situational Awareness applications.

Conclusion

For much of the 20th century, radio voice communication delivered most battlefield intelligence and orders between commanders and warfighters.

As the nature and immediacy of the battlefield changed, so did communications technology. Today’s advanced tactical radios now support voice, data and video, through internet-like tactical networks.

The remaining challenge is how to aggregate, process and disseminate in real-time the information gathered across various platforms, so that each echelon has exactly the same view of the battlefield.

Until today, command and control solutions have solved some aspects of this problem but there are still major gaps. Whether driven by insufficient tactical radio network integration, lack of expertise in processing large volumes of data in challenging environments, or inadequate interfaces that make the use of BMS data and tools cumbersome, commanders and the dismounted soldier are still at a disadvantage when it comes to seeing the whole picture.

The Harris hC2 Software Suite, integrated with a Harris tactical communications network, offers a new approach to filling these gaps. hC2 is a mobile BMS system designed to work across all echelons. The hC2 system delivers a complete COP, collaborative mission planning, and C2 interoperability that is compliant with multilateral force and coalition standards.

The platform approach of hC2 simplifies the process of integrating new data sources into the system and sharing the data across the network. Data sources can range from radar tracks, EO/IR systems, navigation systems, soldier sensors and laser range finders. Within a vehicular environment, the C2 system can integrate with status indicators for fuel levels, supplies, battery levels, or weapon systems.
The modular design of hC2 allows it to be enhanced and tailored to each customer with add-on modules that optimize radio integration, incorporate C2 information from other systems, and provide localized language support. hC2 creates a new model for battlefield management that provides:

- Robust networking protocols
- Integrated C2 capabilities – up and down echelon
- Shared Common Operational Picture
- Collaborative planning and order management
- Multinational interoperability
- Low-risk COTS product
- Customization using a Software Development Kit

**hC2 Key Features and Benefits**

*Table 2. The Harris hC2 software is fully supported with logistics, training and ongoing software support and upgrades*

<table>
<thead>
<tr>
<th>hC2 Features</th>
<th>User Benefit</th>
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<tbody>
<tr>
<td>Coalition Partner</td>
<td>Interoperability with external C2 systems through adherence with worldwide standards such as MIP, NFFI, AIS, OTH-Gold, and Link-16.</td>
</tr>
<tr>
<td>Interoperability</td>
<td></td>
</tr>
<tr>
<td>Battle Management</td>
<td>Three BMS applications suitable for organizations of all levels, sizes, and types from combined joint forces to divisions to platoons to single soldiers.</td>
</tr>
<tr>
<td>Across All Echelons</td>
<td></td>
</tr>
<tr>
<td>Network Integration</td>
<td>Harris delivers the hC2 Suite fully integrated into a complete system solution. Users can work real-time on a Harris network with an unmatched BMS solution, tightly integrated with Harris’ marketing-leading radios.</td>
</tr>
<tr>
<td>and Optimization</td>
<td></td>
</tr>
<tr>
<td>Platform Support</td>
<td>hC2 provides easy access to the COP and pertinent information on a variety of platforms.</td>
</tr>
<tr>
<td>Robust Networking Protocol</td>
<td>The network can support any number of installations of the four applications. Instances of the application can be added or removed to the network without having to redeploy the network in its entirety.</td>
</tr>
<tr>
<td>Protocols</td>
<td></td>
</tr>
<tr>
<td>Collaborative Mission Planning</td>
<td>Multiple Command installations can work on the same mission plan concurrently, expediting the planning process.</td>
</tr>
<tr>
<td>Mobility</td>
<td>Patrol users can connect to the network through any hC2 tactical communications installation, offering full mobility in the event there is a need for a vehicle transfer. The COP will update with the user’s unique call sign at reconnection.</td>
</tr>
</tbody>
</table>