

**The U.S. Army of 2010
Command, Control, Communications, Computers and Intelligence
Surveillance And Reconnaissance (C4ISR)
"An Integrated Approach"**

21 June 2000

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Introduction

In an effort to focus limited Department of Defense (DoD) resources, the U.S. Army has chosen to utilize commercially available systems and equipment to meet its military requirements for the future. Radically increased lethality and mobility, wide disparities in the size and nature of conflicts, expansive urbanization and a global information environment will characterize the future military environment. The US Army's vision for the future is that everyone in the battlespace can interact at anytime using all the tools necessary to convey thoughts, orders, or plans to any system, mounted or dismounted; on the battlespace in real time. The day of separate land, sea and air operations is gone forever. Operations will be joint service and certainly include multinational components.

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.					
1. REPORT DATE (DD-MM-YYYY) 01-06-2000		2. REPORT TYPE Conference Proceedings		3. DATES COVERED (FROM - TO) xx-xx-2000 to xx-xx-2000	
4. TITLE AND SUBTITLE The U.S. Army of 2010 Command, Control, Communications, Computers and Intelligence Surveillance And Reconnaissance (C4ISR) "An Integrated Approach" Unclassified				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Perricelli, Robert F. ; Corea, Patricia ;				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Communications-Electronics Command Research Development And Engineering Center Fort Monmouth, NJ07703-5000				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME AND ADDRESS Director, CECOM RDEC Night Vision and Electronic Sensors Directorate, Security Team 10221 Burbeck Rd. Ft. Belvoir, VA22060-5806				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT APUBLIC RELEASE					
13. SUPPLEMENTARY NOTES See Also ADM201258, 2000 MSS Proceedings on CD-ROM, January 2001					
14. ABSTRACT In an effort to focus limited Department of Defense (DoD) resources, the U.S. Army has chosen to utilize commercially available systems and equipment to meet its military requirements for the future. Radically increased lethality and mobility, wide disparities in the size and nature of conflicts, expansive urbanization and a global information environment will characterize the future military environment. The US Army's vision for the future is that everyone in the battlespace can interact at anytime using all the tools necessary to convey thoughts, orders, or plans to any system, mounted or dismounted; on the battlespace in real time. The day of separate land, sea and air operations is gone forever. Operations will be joint service and certainly include multinational components.					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:		17. LIMITATION OF ABSTRACT Same as Report (SAR)		18. NUMBER OF PAGES 6	19. NAME OF RESPONSIBLE PERSON Fenster, Lynn lfenster@dtic.mil
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified	19b. TELEPHONE NUMBER International Area Code Area Code Telephone Number 703767-9007 DSN 427-9007		
					Standard Form 298 (Rev. 8-98) Prescribed by ANSI Std Z39.18

The 2010 Battlespace and Beyond

The 20th century combat paradigm of fixed lines with tied-in flanks, secure rear areas, echeloned formations, phased operations and direct-fire engagements executed by large maneuvering formations is subject to radical change in the future. There will be few if any in-theater sanctuaries, forces deployed to any region in the theater will be vulnerable to a blend of conventional and unconventional attack by air, missiles, Information Operations (IO), Special Operations Forces (SOF) and space-based weapons. Warfare will be characterized by the almost immediate massing and integrating of effects and by variable range fires from a wide variety of air/ground and sea-based platforms. In addition, Non-Line-Of-Sight (NLOS) systems will exert an influence on battlespace outcomes far greater than that of direct-fire systems. Any offensive action based on large-scale maneuver will entail considerable risk of destruction from a fire-storm of precision munitions.

Beyond 2010 the battlespace will be characterized by widely separated forces and non-contiguous areas of operations. Distributed operations will be decentralized in execution and carried out in accordance with a centralized, fully integrated Joint plan. This plan will be orchestrated and supported by a pervasive and resilient C4ISR Infrastructure. The tempo of operations will increase sharply from today and tactical objectives will be achieved in remarkable short periods of time. Tactical successes obtained simultaneously across the battlespace could then lead, under the right circumstances, to the rapid operational-level disintegration of the enemy as plans are first foiled then shattered. Achieving dominance across the air/land/sea/space and cyber-domains are essential prerequisites to achieving success in the battlespace of the future.

Three broad capabilities form the foundation for this dominance: knowledge, speed and power.

Knowledge encompasses battlespace information and situational awareness. Knowledge about one's own forces, other friendly forces and the enemy's forces is essential to battle effectiveness. As the primary and universal enabler for virtually all battlespace functions, knowledge is paramount; it affects everything. Conversely, the absence of sufficient knowledge, puts everything at risk. Although uncertainty will always remain a feature of future conflicts, the unprecedented level of battlespace awareness significantly reduces both the fog and friction of war.

Knowledge will shape the battlespace and create conditions that will permit the distributed, decentralized, noncontiguous operations described previously. Through the identification of enemy strengths, weaknesses and centers of gravity, coupled with near complete visibility of friendly force status and capabilities, knowledge will underwrite the most efficient application of all elements of military power - enabling higher tempos of operations. In addition, knowledge will be focused on streamlining the logistics support required to maintain high tempo of operations.

Beyond 2010, knowledge will be obtained from a "living internet" of a jointly-integrated multi-layered C4ISR infrastructure that permits the fusion of information products from the national to the tactical level. Employing automated filters, continuously updated feeds and data/information fusion we will create a coherent, near real time, common picture of the battlespace across the entire theater of operations. Achieving and maintaining dominance over the enemy will be an absolute imperative for rapid, effective decisions in the battlespace. The vulnerability of the various components of the C4ISR infrastructure demands comprehensive protective measures. Redundancy will be indispensable and will be obtained through sensor webs and communications routes to include the inherent capability for rapid reconstitution of layers or components destroyed by enemy action.

Decision Dominance

Decision Dominance in the battlespace is critically dependent upon the availability of accurate and timely information. To achieve this capability, the U.S. Army is focusing on C4ISR advanced digital information technology as a significant force multiplier in the battlespace of 2010 and beyond.

The U.S. Army's vision for the future is that everyone on the battlefield can interact at anytime using all the tools necessary to convey thoughts, orders, or plans to any system, mounted or dismounted in the battlespace in real time. The day of separate land, sea and air operations is gone forever; operations will be joint service and certainly will include multinational forces.

In order to achieve Decision Dominance, raw data can no longer be transported around the battlespace and/or around the globe. Processing must be accomplished as close as possible to the source of the data (e.g., sensor). Data becomes information and is transitioned into knowledge by both man and machine. The final objective is to have understanding leading towards wisdom that allows warfighters to seize the initiative and exploit success.

Information will propagate from a robust, flexible network of intelligence systems via a robust, flexible communications infrastructure extending from surface to space. Surface sensors will be connected electronically to a series of interlinked unmanned reconnaissance, intelligence, surveillance and target acquisition aerial vehicles ranging from low to very high altitudes as well as to space-based systems. The airborne vehicles and space systems will provide a constant presence over the battlespace and will aid in connecting the combat force with its distant support and sustainment base.

The C4ISR 2010 Battlespace and Beyond Environment

Radically increased lethality and mobility, wide disparities in the size and nature of conflicts, expansive urbanization and a global information environment will characterize the battlespace. The environment of 2010 and beyond will erase the theater boundaries; all conflicts will involve a globally dispersed force, even if physical combat is confined to a limited geographical area. A plethora of terrestrial, airborne and space based sensors will provide up-to-date information providing a common picture for the warfighter decision maker. The command and control (C2) systems will use this information to present a highly intuitive, interactive, tailored, three-dimensional representation of the battlespace to commanders. Distributed operations will be decentralized in execution but will be carried out in accordance with a centralized, fully integrated joint plan that will be continuously and automatically updated.

The C4ISR Integrated Approach

The U.S. Army Communications-Electronics Command, Research Development and Engineering Center, Fort Monmouth, New Jersey has conducted studies to investigate and develop C4ISR concepts, capability requirements and notional system descriptions for the 2010 and beyond timeframe and also identify key enabling technologies. The result of this effort was the development of an Integrated C4ISR Information Sphere or InfoSphere.

The C4ISR InfoSphere provides ubiquitous information transport and information services to warfighters, independent of location, degree of mobility or platform dynamics. Systems are integrated into a seamless, dynamic and extensible information transport system that is scaleable and secure to the appropriate level of the military mission.

Every platform in the battlespace will receive from and contribute to the InfoSphere. This will include all C2, Maneuver, Soldier, Combat Support and Service Support platforms of all Services/Forces participating in the battlespace as well as all information/data sources. Those resources and capabilities that are being effectively shared and managed within the InfoSphere are:

- Transport Resources
- Computing Resources
- Collection Resources
- Service Common Software Agents and Tools
- Application Software Agents and Tools

These resources and capabilities will be managed and allocated in a manner which will always match the user's needs and demands as well as providing an effective and knowledgeable response to changes in needs and conditions. The InfoSphere will effectively provide managed communications, appropriate computing power and unrestricted information availability while supporting all operations in a seamless and transparent manner. The C4ISR concepts that describe the InfoSphere are presented in the subsequent narratives.

Communications/Distribution: The Communications/Distribution functions for the proposed 2010 and beyond era Communications infrastructure is divided into functional horizontal and vertical zones; terrestrial; airborne; near-space, far-space and deep-space. Horizontal links will be used to interconnect individuals or vehicle groups that are relatively close to each other via elevated platforms, e.g., a variety of Autonomous Aerial Vehicles (AAVs), Low Earth-Orbit (LEO) and Medium Earth-Orbit (MEO) communications satellites. The AAVs form a redundantly interconnected, ad hoc network that provides area coverage for everyone on the battlefield (e.g., C2, Intelligence, Sensors, Logistics). Everyone and everything with a communications suite and processor is part of the communications infrastructure. Everyone and everything acts as a "node" allowing for redundancy and seamless connectivity in case a "platform" is destroyed. Since every platform will essentially be a node, we can say that we have a nodeless architecture. Many, many nodes can be equated to nodeless. The space and high-altitude airborne backbone layers and near-vertical direction of the links make the system inherently suited to communicate with fast-moving air and surface vehicles. The space layers of the system cover the globe providing on-demand service to in-transit units and Special Operations Forces that may be covertly deployed. The integrated, layered infrastructure allows traffic to flow efficiently and dynamically providing service-on-demand wherever and whenever it is needed in the battlespace.

The communications infrastructure is based on three fundamental design concepts. They are Virtual Circuits/Networks, Service-on-Demand and assured Quality-of-Service (QoS). This design does not provide direct user access nor dedication of any transport assets such as bandwidth, radio links and ad hoc network configuration. Instead, users are provided more flexible and reliable assets, i.e., virtual networks for information and voice applications. The network uses both anticipatory and reactive distributed management to continually reallocate its assets in the manner that produces the highest throughput consistent with its current traffic QoS requirements. The network provides service-on-demand. When a soldier or automated system needs to send a large quantity of information, the communications system will immediately respond with an allocation of capacity fully adequate to obtain delivery of that information within the perishability, reliability, etc. parameters defined in the QoS criteria assigned to the military function. This additional capacity is a totally separate uplink which exists for the duration of the data transmission. The capacity allocation terminates automatically when the service request has been fulfilled.

All communicating platforms will be fully location-aware. This ubiquitous location awareness will enable new paradigms in routing, antijam capabilities and Low Probability of Detection (LPD). High-gain electronically steered beams will be widely used between platforms. Dynamic multihop routing will be efficiently applied to ensure delivery of information to its intended recipient and location with a minimum of required overhead.

Command and Control: The Command and Control conceptual objective is to provide the warfighter with knowledge and cognitive support. As previously discussed, data must become information that is then translated into knowledge to achieve understanding and wisdom. To achieve these objectives, a notional Battle Force Command and Control System (BFC2S) was conceived to accomplish C2 requirements and capabilities. Seven non-exclusive C2 modules encased in a Mobile C2 Environment Module (MC2E) are described as a means of defining the C2 Systems capabilities. The Battlespace Information Module (BIM) provides the Information Management function for the entire C4ISR Systems Architecture; it resides on every platform that possesses a communications suite and a processor. MC2E provides the hardware/software infrastructure and interfaces. The other modules of the C2 System are application modules that use the information collected/processed and distributed from throughout the InfoSphere. The C2 application modules are scaleable and tailorable to the operational requirements and the functions of the platform on which they reside. The C2 computer processing,

common software and application software provide the source of up-to-date knowledge for successful warfighter decisionmaking. C2 Systems traditionally reside in Command Posts (CPs) and Tactical Operation Centers (TOCs) occupying buildings, vehicles, tents, etc., where Commanders and Staffs tend to be centered to accomplish mission planning and battle command. This creates concentrations of people and equipment substantially increasing vulnerability and reducing mobility. The vision for the future is to reduce these operational masses. The goal is towards virtual TOCs where mission planning is collaboratively accomplished via virtual staffs. The future C2 Nodes (CPs or TOCs) need to be dispersed and in some cases can have critical pieces located in sanctuaries oceans away. The supporting systems need to be operable and scaleable through the total continuum of military operations, humanitarian assistance, peace-keeping and high intensity conflicts and be capable of support to the commander while on the move.

The commander will be able to interface with his staff by direct human interface, teleconferencing and the use of collaborative software and capabilities resident in the InfoSphere. The Commander's staff may be totally virtual, simulated by intelligent software agents residing within the C2 System that accomplish the tasks required to gather, analyze, project and support the visualization of the combat situation. Decision aids, tailored based on the Commander's intent and information profiling, will support the development, analysis and comparison of viable courses of action.

A very valuable application of the C2 System is the ability of a user to establish a "Profile" prescribing the future information to be automatically received from the InfoSphere. The user can define his area of interest, the type/kind of information he desires and the time interval over which the profile will remain valid. The profile is entered and is then stored and merged with all other user profiles in the Integrated InfoSphere. Whenever any information matching the profile is received or located, it is sent automatically or "PUSHED" to the user's systems.

The "Query" may also be used to request information that was not included in a profile. Additionally, the user may want to use a query to request information which falls outside the time window or geographic area specified in a profile. Whenever a query is entered, the query is researched, the database is searched and if available, an appropriate response is sent to the user. Using a query, the desired information is considered to be "PULLED" by a user.

Intelligence Infrastructure:

a. **Tactical Sensors:** Tactical sensors will provide real time enemy threat information, afford ubiquitous coverage, terrain assessment, threat prioritization and battle damage assessment through a full spectrum of integrated sensor webs. Data processing will occur at the sensor to enable transport of information through the battlespace. Sensor suites (active and passive) and counter measures will be able to achieve full coverage of the battlespace. Tactical sensor suites will include:

- Unattended Sensor Networks
- Robotic Vehicles
 - Ground
 - Airborne
- Advanced Reconnaissance Vehicle (Future Scout)
- Advanced Combat Platform (Tank/Helicopter)
- Soldier Sensor Systems

Each of these suites is envisioned to be multifunctional with plug-in modular packages of sensors. The Unattended Sensor Network will be comprised of inexpensive, lightweight Unattended Ground Sensors that can be employed to provide accurate target information at choke points, at areas inaccessible to other sensors and in urban environments. Robotic vehicles will be both airborne and ground based. The airborne robotic vehicle will be designed to conduct reconnaissance and surveillance, target acquisition, lethal attack and act as a communication relay. The ground robotic vehicle will be designed to conduct reconnaissance and surveillance on the ground. Both the air and ground robotic vehicles can deploy unattended ground sensors into a network grid. In addition, the ground robotic vehicle will be able to move them from place to place. The modular plug-in sensor suite with Automatic Target Recognition (ATR)/sensor fusion will provide all weather vision, defeat Camouflage and Coating Detection (CCD) and

jam, intercept and determine exact location and tracking of targets in the battlespace. The Advanced Reconnaissance Vehicle's primary mission is to precisely locate, identify, report and track a large number of targets. Theater and national assets will cue the ATR to the location of enemy forces. This cueing will enable the ATR to narrow down the area of uncertainty which must be searched for potential targets. The vehicle will function as the processing center for reports from the unattended sensor network and the command center for deployment of unattended ground and air vehicles. The plug-in modular sensor packages will automatically defeat CCD, detect buried mines, penetrate clutter, provide rapid target assessment and location and indicate enemy intent. The main mission of advanced combat platforms (aircraft/tank) is fast search/detection/classification and tracking of targets so that target identification can be effected beyond the threat's engagement range. These platforms are interlocked into the information infrastructure with secure communications capabilities and can be made mission specific by using the appropriate plug-in multi-functional sensor packages. The Soldier Sensor System consists of a helmet with embedded sensors and a see-through display. These sensors give the soldier situational awareness that could include night vision, chemical agents, biological agents, acoustic, GPS, ATR, sensor fusion and a micro laser rangefinder. The soldier will also be equipped with non line-of-sight sensors for special applications. A micro communications link keeps the location of the soldier known to the command structure. Bio-medical sensors monitor the soldier's physical condition and send back data in cases where the soldier is in medical danger while a wearable computer projects maps, instructions, etc., on the soldier's display. The soldier's communication's suite also functions as a RF sensor for awareness and warning.

b. Intelligence Sensor Systems: Traditional intelligence disciplines; Measurement and Signature Intelligence (MASINT); Human Intelligence (HUMINT); Signal Intelligence (SIGINT); Imagery Intelligence (IMINT); the intelligence function of Counterintelligence (CI); and sensors that collect battlefield information for the purpose of target acquisition and fire control, (e.g., the sensor array on an advance attack helicopter or a targeting robotic air vehicle functioning as a forward observer for artillery) are all part of the intelligence infrastructure that will be designed to integrate, analyze and synthesize the information collected by all of these sensors. Uninterrupted seamless communications will provide connectivity through the full spectrum of the multi-layered communications infrastructure fully supporting all intelligence operations in the battlespace. Intelligence will be enhanced through the timely seamless integration of sensors from all domains, land, air, sea and space-based capabilities. Information Operations (IO) and Intelligence Preparation of the Battlespace (IPB) are critical for success. Use of an integrated, multi-level, C4ISR system employing automated filters continuously updating feeds and data/information fusion are essential to creating a real-time common picture of the battlespace. Fully integrated, multi-layered C4ISR connectivity will allow for this seamless interdependence and the fundamental means of its achievement. Strategic maneuver also depends on these advanced C4ISR capabilities. Forces moving from garrison into active operations will have the capability for enroute planning, analysis, simulation-based training and mission rehearsal. The goal of Army Intelligence will be to tailor all source intelligence and support to Information Operations (IO) enabling ground combat units to dominate their portion of the battlespace at the right time and be at the right place with the right weapons.

Conclusion

All of the components of the Integrated C4ISR Information Sphere (InfoSphere) are intelligently shared across the battlespace. Every platform is part of the C4ISR Infrastructure and all components are distributed, allocated and shared in a manner that is fully transparent to the user/platform. Each platform will receive from and contribute to the InfoSphere. It will include all C2, Maneuver, Combined Coalition Partners, Soldier, Combat support and Service Support platforms of all Services/Forces participating in the battlespace.

C4ISR is the embodiment of information technology and allows the U.S. Army and its allies to achieve information dominance in the battlespace. The combined effectiveness and integration of C4ISR systems will permit the successful conduct of rapid and sustained operations in any environment under any environmental conditions. Information technology has and will continue to revolutionize the way we operate and fight in the battlespace. How we exploit and adapt this technology will be the measure of our success in the battlespace of the 21st Century and beyond 2010 towards the 2025 timeframe.