Video Enabling the Combatant Commander's Headquarters

Justin Lee
SPAWAR Systems Center San Diego Code 24241
675 Lehua Avenue, Building 992
Pearl City, Hawaii 96782
Phone: (808) 477-8029
Fax: (808) 471-5837
E-mail: juslee@spawar.navy.mil

Arthur Nakagawa
SPAWAR Systems Center San Diego Code 24241
675 Lehua Avenue, Building 992
Pearl City, Hawaii 96782
Phone: (808) 477-8029
Fax: (808) 471-5837
E-mail: juslee@spawar.navy.mil

Table of Contents

Abstract

A combatant commander's decisions are based on critical and timely information. Today the information is more and more graphical and video based. Video information may take many forms---imagery from intelligence satellites, weather satellites, tactical reconnaissance platforms, biographical information data bases; graphical information including common operational picture, 3D terrain modeling, signals analysis, trend analysis and are all used in formulating courses of action. This is complicated by the need for collaboration among staff, inter agency and through chain of command. The result is that the headquarters for a combatant commander needs to be video enabled to allow the high speed transfer of digital imagery and graphics and use of advanced collaborative technologies.

This paper discusses the audio-visual (A-V) systems which have been designed for the headquarters for United States Pacific Command (HQ USPACOM) and installed in the Nimitz-MacArthur Pacific Command Center (NMPCC), USPACOM's new headquarters building. These systems are being employed through the design and implementation of an integrated A-V systems architecture that enables the proliferation and sharing of video information and promotes collaboration both internally within HQ USPACOM and with external organizations. The A-V systems architecture includes multimedia communications systems that enable advanced internal briefing capabilities, video teleconferencing at multiple security levels, mass multimedia distribution capabilities and an advanced A-V control system that integrates control and access of multimedia information.

Video Capabilities in a Combatant Commander’s Headquarters

A combatant commander's video and graphical information display system must provide the operations team a venue for collaboration in the crisis action decision making process. Understanding this, the Nimitz-MacArthur Pacific Command Center (NMPCC) Command, Control Communications, Computers and Intelligence (C4I) design team knew they had to deliver an integrated audio-visual (A-V) system architecture with advanced collaboration and visualization capabilities. Furthermore, the system needed to support the PACOM mission by allowing:

- Coordination of command and control efforts internally and throughout the PACOM Area of Responsibility (AOR)
- Execution of a range of crisis actions from disaster relief to major theater war
- Execution of more than one crisis at a time through distributed collaboration and the "Battle Cell" concept
- Sharing of information at multiple classification levels and with coalition partners
- Effective utilization of support personnel through central control and management.

Distributed Collaboration through Battle Cells

The operations at PACOM has been refined through the effective use of collaboration of a few but key areas in the headquarters. In the old USPACOM headquarters spaces, there were three “cells” that functioned as one seamless entitiy, the Joint Operations Center (JOC), Operations Planning Team (OPT) and Commander’s Booth (CDR’s Booth). These three areas were adjacent to each other, and, in fact, the CDR’s Booth overlooked the JOC watch floor, making it easier for them to work closely with each other. Operations planning occurred in the OPT. CDR USPACOM and his staff was briefed and made decisions from the CDR’s Booth and the JOC executed and monitored operations.

Maintaining the same flow of operations in the NMPCC meant a few changes needed to occur. In the NMPCC, the JOC watch floor and OPT are still relatively close to each other, but the Executive Conference Room (ECR), the CDR’s new CDR’s Booth, is three floors up. Therefore, it became necessary to ensure that the ECR had “virtual” JOC presence such that the ECR had as much presence and capability in operations in the new building as it did in the old. This entailed the transport of a wide variety of audio and video signals and data to the ECR to give the CDR the same operational picture as the JOC. It also entailed the design and installation of collaboration tools that allows the CDR and his staff to communicate effectively and efficiently with anyone and everyone. The ECR became a physically disparate “cell” from the JOC while still able operate as effectively as the original CDR’s Booth.

The idea of an operational “cell” did not stop at the ECR. It was carried through to all directorates. In the NMPCC, each directorate has a Directorate Conference Room (DCR). BGEN Bryan came up with the idea to design each DCR like the ECR such that it is a virtual extension of the JOC out which battles could be fought, a "Battle Cell". The idea was to create an environment where the JOC watch floor is the center of operations but supported by individual battle cells with "virtual JOC presence".

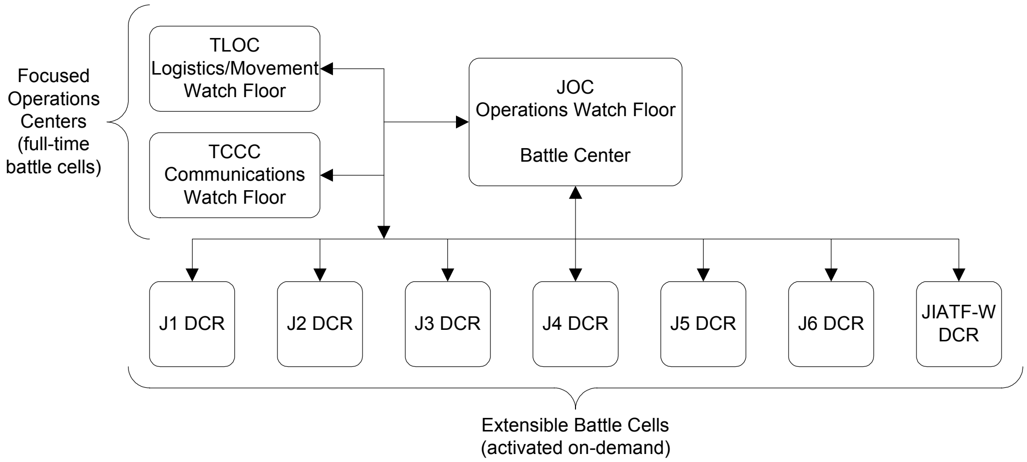


Figure 1: Battle Cell Concept

In addition to being extensions of the JOC floor, Battle Cells needed to have the ability to operate independently from the JOC, as well. Therefore, Battle Cells should have the C4I infrastructure to support such scenarios as:

- Virtual extension of the JOC watch floor
- Quasi-independent cell from the JOC that is handling a distinct portion of the operations (e.g. intelligence cell)
- Entirely independent cell from the JOC that is handling a crisis separate from JOC operations.

Based on HQ USPACOM's A-V requirements and (former USPACOM J6) BGEN Bryan's "Battle Cell" concept, the Headquarters for the 21st Century (HQ21) C4I project developed an integrated A-V systems architecture that enables the proliferation and sharing of video information and promotes collaboration both internally within HQ USPACOM and with external organizations

Battle Cell Capabilities

Most of the battle cells serve as conference rooms, independently operated cells and collaboratively operated cells. Therefore, they needed to be designed to support all such activities. Basically, this meant two distinct types of operations, independent and collaborative.

Independent Operations

The overall A-V systems architecture was designed to take advantage of a distributed environment. That implied designing each battle cell as an independent entity with the ability to communicate with each other as well as with external organizations. The design became an A-V extension of distributed computing. Therefore, each battle cell could function as originally intended, as a conference room. In fact, in most cases, a battle cell in the NMPCC is a directorate-level conference room and is often used for meetings and briefings. This requires the following capabilities:

- Video Display
- Audio Amplification:
  - Voice Reinforcement (i.e. microphones)
  - Media Audio
- Video Sourcing:
  - Computer Display
  - Digital Video Disc/Video Cassette Recorder (DVD/VCR)
- Commercial Access TV (CATV)
- Integrated Control of A-V Systems
- Network Access:
  - Unclassified Network (Non-classified Internet Routing Protocol Network (NIPRNET))
  - Secret Network (Secret Internet Routing Protocol Network (SIPRNET))
  - Top Secret/Sensitive Compartmentalized Information (TS/SCI) Network (Joint Worldwide Intelligence Communication System (JWICS))
- Secure and unclassified voice communications

The idea was to make a full-array of A-V systems available for use within the room to support any type of in-room function. This included having applicable computer network connectivity available within the room, the ability to project computers onto large video displays from multiple locations within the room, voice amplification and media audio sources such as DVD/VCR player and CATV, and then tying it all together with an integrated control unit from which all A-V operations could be carried out.

Collaborative Operations

The true intent of the battle cell concept comes from creating collaborative environments out of the conference rooms described above. This is accomplished by installing communication systems that allow the exchange of audio and video information between battle cells for internal collaboration and with external organizations for external collaboration. Two distinct A-V communications systems were designed and installed to support these requirements, the Command Briefing System (CBS) and Video Teleconferencing (VTC).

The CBS is designed to support multi-screen, intra-building A-V communications. It allows battle cells to share video information and collaborate on audio (i.e. audio conference) on a multiple security level (MSL) platform. The CBS is able to host up to three conferences at a time. The definition of each conference includes a list of participants (defined as rooms) and up to three video sources. The video sources can be a combination of computers, video cameras and DVD/VCRs and can originate from any of the participants. During the conference, the defined conference video sources are shared amongst all participants such that they all see the same video sources (implies that all battle cells have at least three video displays, which is the case). In addition, all participants are audio conferenced to support interactive discussions among participants. The CBS is an MSL system but can only support only one security level at a time. Therefore, all simultaneous conferences must be at the same security level, and all video sources chosen for those conferences must be at or below that security level.

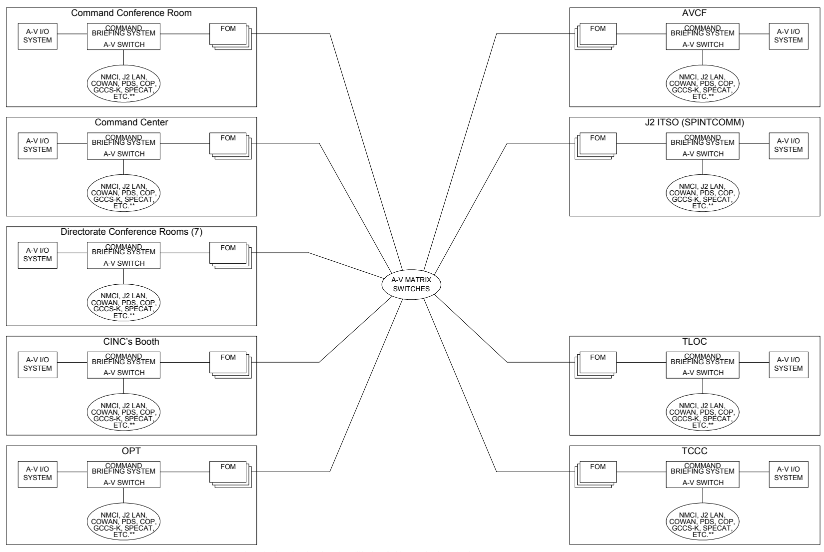


Figure 2: Command Briefing System

The CBS allows A-V collaboration but is not feasible for transport beyond the walls of the NMPCC. Therefore, the A-V systems architecture includes multiple VTC systems for both internal and external collaboration. There are four integrated VTC systems that are installed in the NMPCC, unclassified, secret, special purpose and TS/SCI. Each VTC system supports a distinct security classification, except for the special purpose VTC system, which is designed to support coalition and top secret General Service (GENSER) operations and hence, multiple security classifications, one at a time. Although VTC systems are normally designed primarily for external communications, all four of these VTC systems are also designed to support internal collaboration, as well. Each one has its own Multipoint Control Unit (MCU). This allows hosting of multipoint conferences with all local endpoints or a combination of local and external endpoints. Further, the VTC systems are connected to global VTC networks such as Digital Video Services-Global (DVS-G), Video Information Exchange System (VIXS) and JWICS giving HQ USPACOM worldwide VTC connectivity.

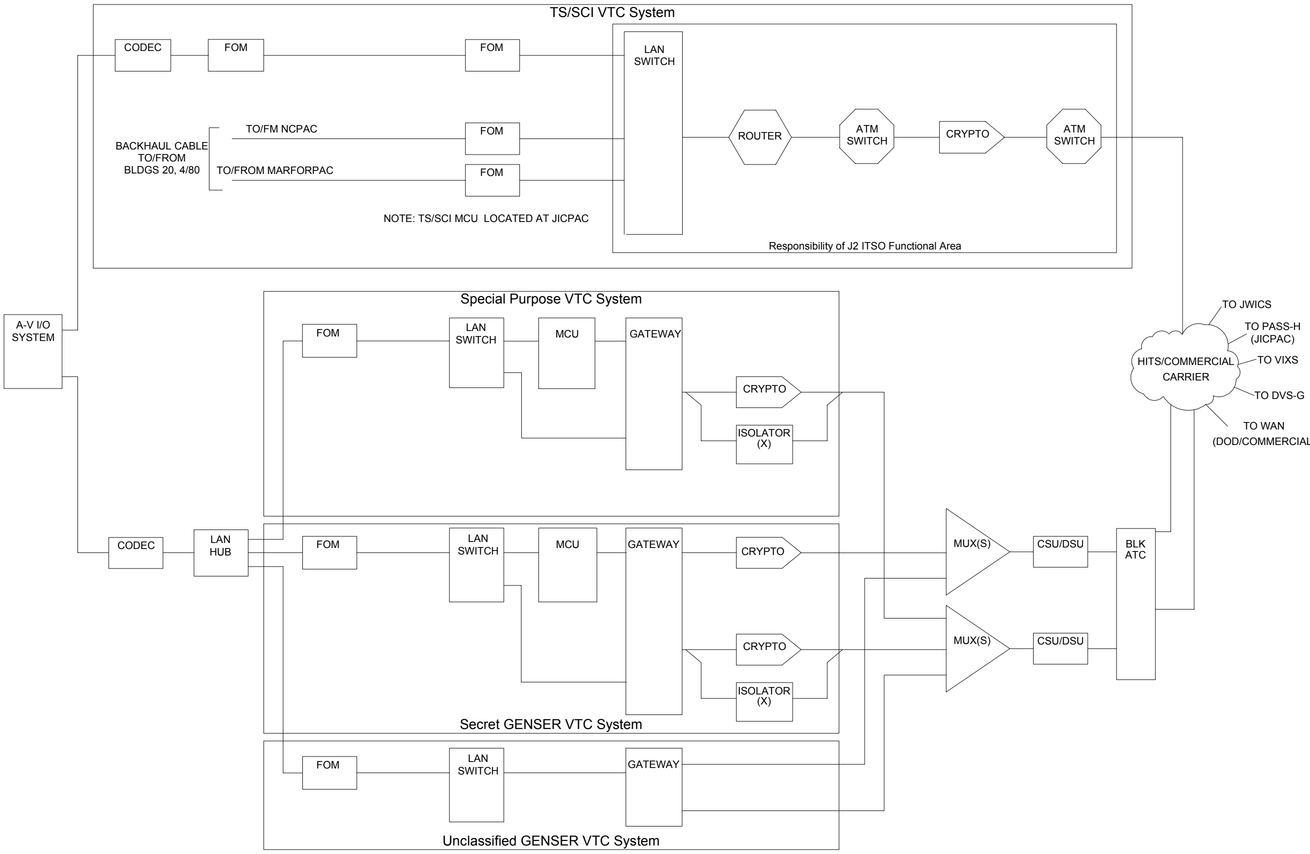


Figure 3: VTC Systems

Battle Cell Hardware

The actual hardware deployed throughout the NMPCC varies slightly from room-to-room, but the basic function of the rooms stays the same. In general, each battle cell has three video displays, multiple microphones and speakers integrated with an echo-cancelling audio mix-minus unit and a variety of video (composite and Red Green Blue (RGB)) and audio switching equipment. This allows viewing of up to three simultaneous video sources and flexible mixing of audio inputs and outputs depending on the current function being performed in the room. From and A-V system standpoint, all DCRs are identical and serve as the basic building block for a battle cell. A simplified block diagram for the A-V systems installed in a DCR is shown in figure 4 below.

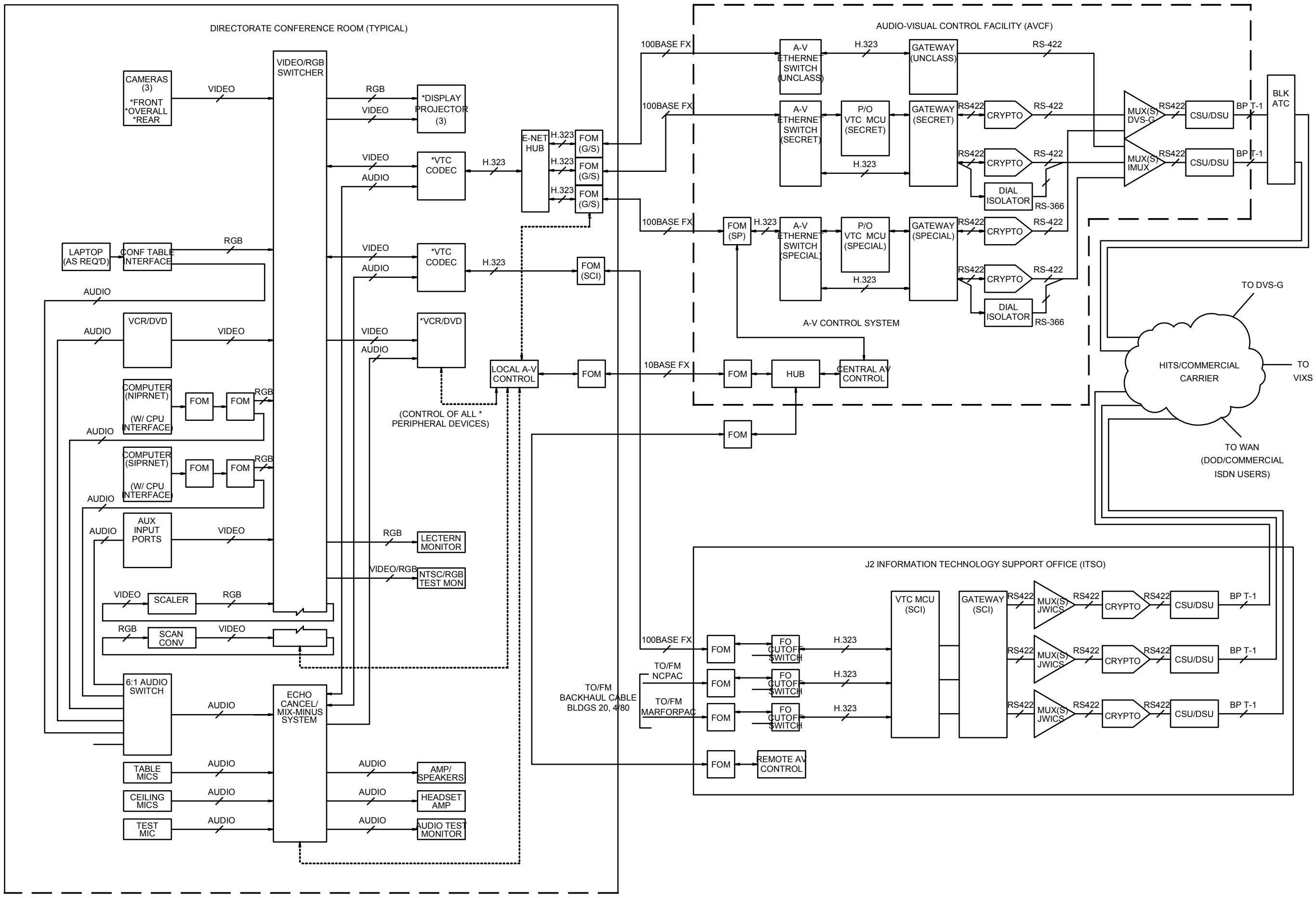


Figure 4: Simplified Block Diagram for a Typical Battle Cell

The most obvious pieces of equipment that change from room-to-room are the video displays. The video displays used throughout the building vary from rear projection screens with Digital Light Projection (DLP) projectors to Liquid Crystal Display (LCD) flat panel displays to video cubes. The majority of battle cells have three large rear projection displays, while smaller rooms have three flat panel LCD or plasma displays.

The biggest anomaly to this rule is the JOC, which has a video wall containing 12 video cubes (2x6) and a video display server that controls the layout and routing of video to the wall. Although one of the most popular video wall layout configurations is a three-screen configuration, it is not the only configuration used and certainly not the only one available. However, during a CBS conference, despite the JOC's increased ability to display more than three simultaneous video sources, the CBS supports a maximum of three video sources.

A-V Service Model

As evidenced by the simple diagrams shown above, battle cells need to bevy of systems in order for them to function as intended. They require complex audio and video systems that need to work in an integrated, seamless manner, all controlled through a user-friendly interface. However, at the same time, it is imperative that they be designed with operations, management and maintenance in mind. Therefore, the A-V service model was developed to ensure that the A-V systems are consolidated, standardized and centrally managed.

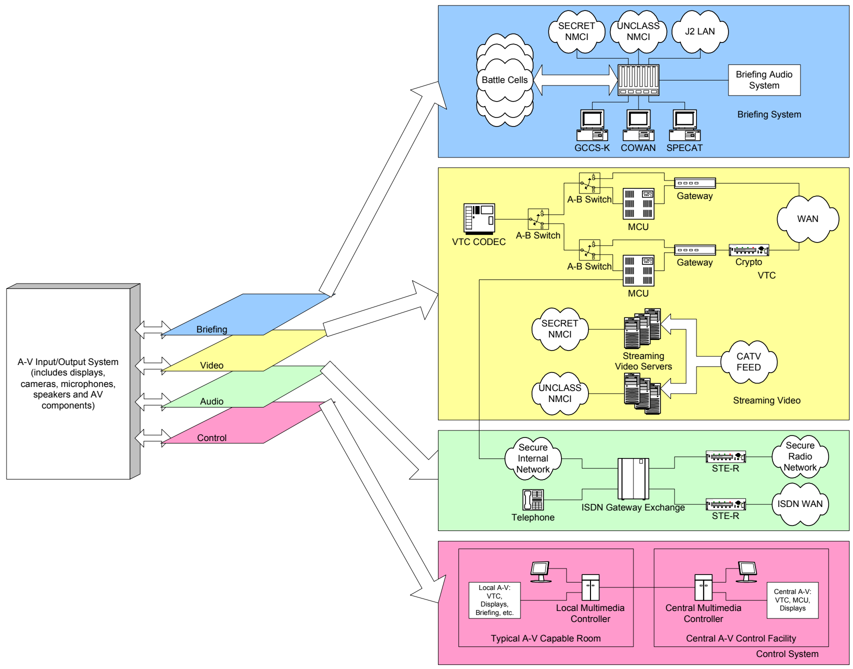


Figure 4: A-V Service Model

A-V services are delivered to a multitude of rooms and managed from central control facilities where communication resources are consolidated and managed. Hence, rather than having separate and distinct conferencing facilities, a large A-V "network" delivers standard services to each battle cell. The network provides services on four planes: briefing, video, audio and control. The service planes feed the audio and video processing and display systems, which basically serve as A-V user interfaces.

Each plane then provides a specific set of standard services to each room. Therefore, secret VTC service delivered to one battle cell is identical to secret VTC service delivered to another battle cell. Furthermore, control systems, including control panels local to each room, should have a nearly identical "look and feel" between battle cells. Staff members who are able to operate A-V systems in one room should feel equally comfortable in other rooms. Finally, the same A-V architecture was used to build the battle cells so that standard sets of equipment are used throughout the building.

The end result of the combination of the integrated A-V architecture and the A-V service model is a headquarters with advanced A-V capabilities that makes efficient use of its limited resources. The resultant A-V systems architecture effectively models that of data networks. In order to efficiently administrate, large data networks, products and services must be standardized. Standard servers deliver standard services to standard workstations containing a standard build. Applications that are common to all users are identical from workstation to workstation, and application servers are housed in central server farms. The same must be true for operations and management of large A-V networks. Standard A-V services must be delivered to standard A-V capable rooms. In addition, significant standardization and configuration management must be maintained in both cases to keep operations and management efficient and effective. Therefore, battle cells are built to a standard architecture that implements a powerful distributed A-V architecture and is centrally managed from control facilities where resources are consolidated to realize manpower efficiencies.

Audio Service Plane

Secure Audio Conferencing

VTCs often include multiple remote participants, and it is not uncommon for external VTC connections to drop in the middle of a conference. In those cases, the secure audio conferencing system can be used to bridge remote participants back into the VTC conference at an audio-only level if they are unable to re-establish a VTC connection. The secure audio conferencing system can also be used for bridging remote participants without VTC capabilities. This system operates only at the secret GENSER level and connects to the Wide Area Network (WAN) through secure dial-up Integrated Services Digital Network (ISDN), secure radio, and Defense Red Switch Network (DRSN). It further has the capability to support a wide range of audio communication systems including secure GSM and Iridium phones for future expansion.

This system uses an Information ISDN gateway exchange (IGX) switch to perform routing of ISDN voice traffic between the secret GENSER MCU and the WAN. Secure WAN connections are made through Secure Telephone Equipment-Remote (STE-R) devices for dial-up ISDN Basic Rate Interface (BRI) lines from the Hawaii Information Transfer System (HITS), secure radio terminals and the DRSN switch. The IGX contains an audio conferencing module allowing audio-only conferences. A connection to the secret GENSER MCU is also made through an ISDN Primary Rate Interface (PRI) to allow for audio conferences to be bridged into VTC sessions.

Video Service Plane

VTC Systems

The VTC systems in the integrated A-V architecture can be broken into two distinct groups, GENSER and TS/SCI VTC systems (see figure 3 in section 3.2 for system diagram). In both cases, the VTC systems are H.323-based and built on IP networks. H.323 is the IP version of the well-established H.320 standard, which uses connection-oriented, circuit-based connections (most often in the form of ISDN) to transport multimedia communications traffic. It offers the same video and audio quality as H.320-based systems, additional operations and management capabilities and more user-friendly interfaces. It also uses a common network infrastructure, Ethernet/IP, simplifying management of the communications infrastructure. Additionally, the convergence of VTC systems onto an IP network allows the use of common network-based tools like web interfaces and Simple Network Management Protocol (SNMP) device management, enhancing VTC network management.

The TS/SCI VTC system is based on the JWICS VTC architecture, which is almost entirely an H.323 VTC network. It uses local MCU services as well as MCU services provided by JWICS and connects to both the worldwide JWICS network and the PACOM theatre-wide intelligence network (PASS) through Quality of Service (QoS)-enabled connections.

The GENSER VTC systems vary from the TS/SCI VTC system in that it requires H.320, specifically ISDN, for external VTC connectivity. At this time, the majority of GENSER VTC communications is still ISDN-based, and, in fact, worldwide VTC networks such as DISN Video Services-Global (DVS-G) and Video Information Exchange System (VIXS) are entirely ISDN-based. Internally, the unclassified, secret and special purpose VTC systems are separate and independent H.323 VTC networks, but they all share external communications connectivity, as seen in figure 4. Each has its own MCU for hosting multipoint conferences, gatekeeper for call admission control, management server and gateway for external connectivity (H.323-to-H.320 translation). They are built nearly identically. The exception to that rule is in the fact that the unclassified VTC system does not require encryption for external communication and, therefore, is able to use an ISDN gateway as opposed to a serial gateway (required for communication via encryption devices).

Externally, the unclassified and secret systems have ISDN connections to various VTC wide area networks (WAN). The unclassified VTC system connects to the DVS-G network and commercial/government ISDN networks. The secret GENSER VTC system have encrypted connections to the DVS-G and VIXS networks and encrypted commercial/government ISDN networks. In addition, the secret GENSER MCU has an ISDN PRI connection to the secure audio conferencing system, as described in section 4.1.1. The special purpose VTC system only has encrypted ISDN dial-up connections. This system is designed to be used at multiple classifications not to exceed top secret GENSER in order to support coalition, bilateral and top secret GENSER VTC requirements. The operating classification of the system is determined by the current keymat loaded in the encryption devices. Internally, the system is treated at the highest classification of data processed by the system, top secret GENSER.

Briefing Service Plane

Command Briefing System

The CBS is an Audio-Visual (A-V) system that enables command-wide, directorate-level briefing capabilities for crises, non-threatening and administrative situations. Its main purpose is to provide a distributed briefing capability on a multi-level security platform. This includes sharing of two-way, interactive audio and video and multiple A-V sources. It is a self-contained system connecting multiple battle cells. See figure 2 in section 3.2 for an overall system diagram.

It provides the capability to share video sources and audio conference between multiple battle cells. The CBS takes up to three video sources, whether they be RGB/Video Graphics Adapter (VGA) video from computers, composite video from a video camera, DVD/VCR or CATV tuner or mix of both, displays those same video sources in any number of battle cells, and creates an audio conference amongst all participants.

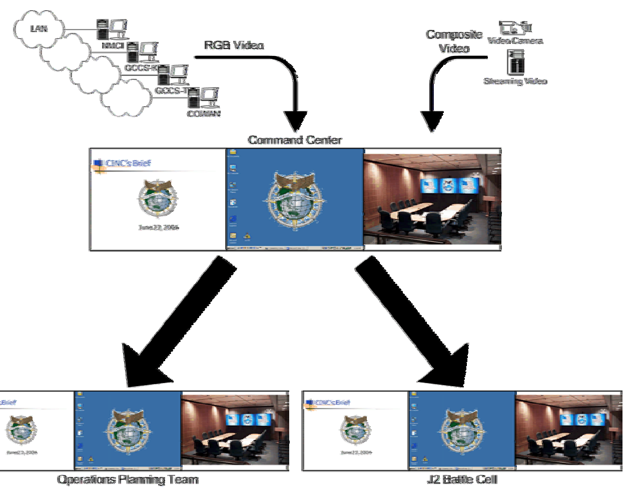


Figure 6: CBS Operations Illustration

In the illustration shown in figure 6 above, RGB video from two computers and composite video from a video camera are taken from the JOC and shared with two other battle cells. Therefore, all three rooms see the same three video sources and audio amongst all three rooms is bridged.

The CBS is able to provide the capability described above through the use of a large A-V switching system and an A-V control system with a custom-built control interface. The CBS audio and video switches are located in the JOC and connect to battle cells through fiber optic modems. The control system provides access control to the CBS and switches the A-V signals between rooms based on configurations created by the users.

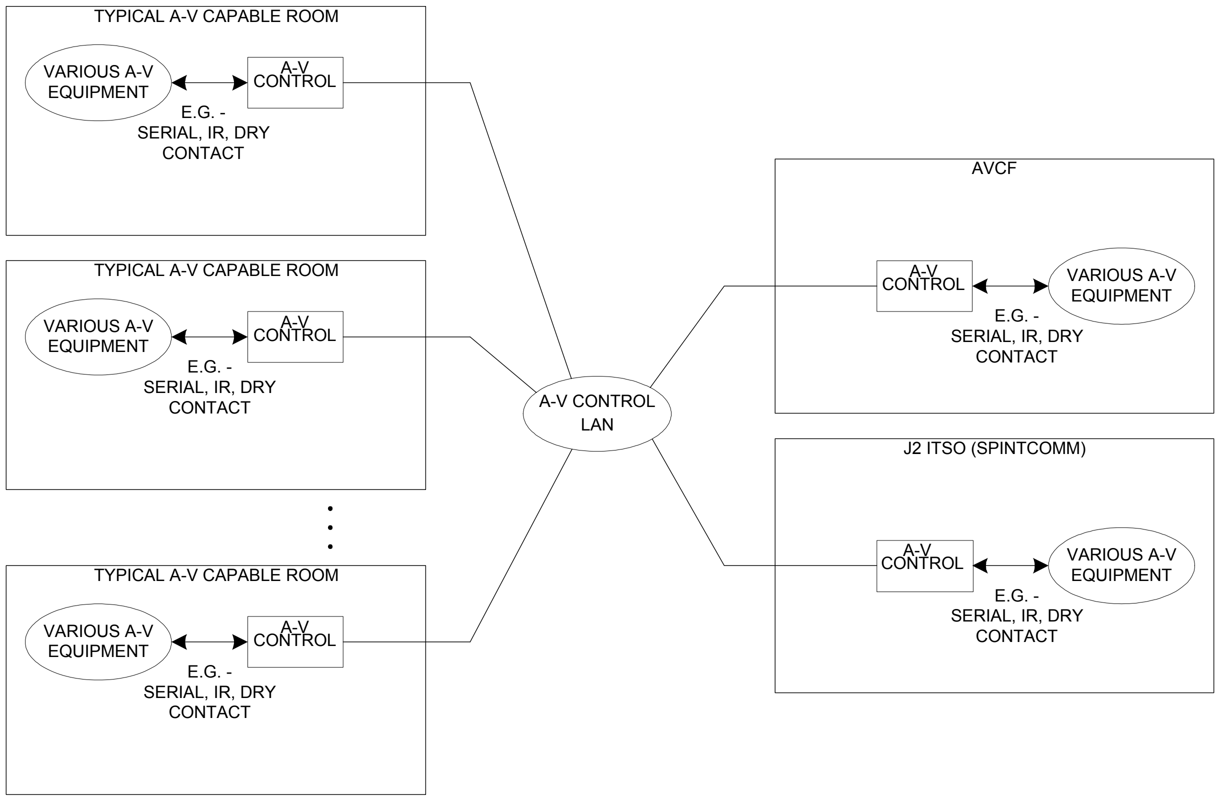
Users configure the sharing of audio and video resources through the creation of conferences on the custom-built control interface. Each conference has rooms (battle cells) and sources associated with it. The rooms are the CBS conference participants and the sources are the video sources that are shared amongst all conference participants. Only those sources that are at or below the classification of the conference can be selected. All conferences on the CBS are held at the security level of the CBS. In order for a room to join a conference, in the room's A-V control panel, the room must be set at the same classification level as the CBS. The CBS verifies the classification of the room before it powers on any of the fiber optic modems, both at the JOC and in the room. If the room requesting connection is a Temporary Secure Working Area (TSWA -- rooms that are normally classified secret but can be elevated to the TS/SCI level for temporary periods of time) and the conference being requested is at the TS/SCI level, the request must also be authenticated by the Special Security Officer (SSO) prior to the fiber optic modems being turned on and the connection being made.

The amount of sources available varies from battle cell to battle cell. The typical battle cell (DCR) is able to provide only a single video source. The JOC, however, has over 20 video sources available for use by the CBS. These sources vary from Common Operational Picture (COP) workstations to JWICS workstations to Processing and Display Subsystem-Migration (PDS-M) workstations. Therefore, the CBS is one of the main systems enabling the battle cell concept. It is able to take the picture from operational computers in the JOC and push them out to the various battle cells located throughout the NMPCC.

Control Service Plane

A-V Control System

Every battle cell requires a significant amount of A-V systems in order to support its mission requirements, including multiple VTC systems, display and audio systems and ancillary A-V equipment that need to be controlled by users who are not necessarily A-V savvy. The A-V control system will integrate control of all of these A-V equipment/systems into a single control panel with a user friendly icon-based interface, that will allow control of all A-V resources individually and through pre-programmed room settings/configurations (e.g. – presentation, training, VTC, etc.). In addition, each local control system in an A-V capable room is connected to the control network. This allows A-V control systems in each of the battle cells to communicate with each other for security and remote operation purposes. Battle cells are able to validate each other's security classification level and authenticate users prior to the activation of higher classification services to ensure secure operations. In addition, central control facilities are able to remotely control battle cells.



Most of the A-V capable rooms have one or more programmable touch panels and a network-based controller with associated interface cards to control the A-V multimedia equipment and devices over an Ethernet network. Examples of such A-V multimedia equipment are as follows:

- VTC Coder/Decoder (CODEC)
- A-V matrix switcher
- Audio mix-minus mixer/echo canceller
- Speakers
- Cameras
- VCR/DVD player
- Tuner
- Lighting presets
- Security classification signs
- Security cutoff switches

Connectivity between control equipment is network-based, but the control system hardware connects to the A-V equipment through more traditional control interfaces such as infrared sensors and RS-232 connections. The control system integrates and automates local control of individual equipment and systems, and enhances and facilitates room setup.

Challenges

Security

By far, the biggest challenge in developing and deploying these systems has been security. There are a number of factors that made security issues more complex and difficult to overcome. First, the battle cells all vary in classification. There are some rooms that cannot be brought up to beyond the secret classification level, others that are normally secret but have the capability to be brought up to the SCI level (TSWA) and others that are full-time Sensitive Compartmentalized Information Facilities (SCIF) and A-V systems and services are deployed to all three types of rooms. Second, A-V systems that go up and down in classification need to be deployed in these rooms, which primarily affects the design of the VTC systems and the CBS.

The VTC systems are all separate and distinct. They all have their own dedicated networks. However, to consolidate resources, only a single VTC CODEC was used to support unclassified, secret and special purpose VTC in the battle cells. Therefore, the problem becomes ensuring that only one VTC service is provided at a time and that the configuration information for that service is erased from the CODEC when the classification of the room is changed. This problem was solved by combining (electrical) power control hardware with software that is aware of the current classification of the room and ensures that only the appropriate VTC service is enabled. In each battle cell, the VTC CODEC is connected to an Ethernet hub. The hub is also connected to up to three Ethernet media converters, one for each classification of VTC supported in the battle cell. The media converters are powered through power controllers. When the battle cell is set to the secret classification level on the A-V control panel, the A-V control system throws the relay on the power controller to switch on the power to the media converter supporting secret VTC and verifies that power to all other media converters is turned off. It then loads the secret VTC configuration information (IP address, gatekeeper address, etc.) into the VTC CODEC. This ensures that the VTC CODEC is connected with the secret VTC network and the secret VTC network only. When the classification of the room is changed, the secret VTC configuration information is replaced by all zeros and rebooted, thereby resetting it with basically no configuration information, before being reconfigured with the VTC configuration information of the classification to which it was just changed. This design allows only one service of VTC to be available at a time, but yet still allows a single CODEC to be shared amongst multiple classifications of VTC services. It also allows customization of which VTC services to install in each room. If a room is secret, only unclassified and secret VTC is installed. If a room is a TSWA, unclassified, secret and special purpose VTC services are installed, but unclassified and secret services are deployed in exactly the same way as in the secret room. VTC essentially becomes a standard service deployed securely and appropriately.

The CBS has a different problem from the VTC systems. It is a true MLS system, whereby it is a single system that supports multiple classifications, one at a time. In addition, it is connected to rooms at different classifications. Therefore, when the CBS itself is at a higher classification level, rooms that are not at that classification level need to be restricted from connecting to it. This problem was solved through the use of several unique security features.

The CBS requires users to login in order to access it. Users must have a CBS account and login with it in order to even request connection to it from the battle cells. In addition, there is a system management panel in the JOC that controls conferencing scheduling, source switching, system security and user account management that requires login with a privileged CBS user account. The CBS user account database is entirely separate from any other system. The user information is further used in an audit log that records CBS activities pertinent to security.

In addition to requiring user login for access, the CBS system also employs self-security checks prior to making connections between battle cells. In order for a battle cell to connect to a CBS conference, both the battle cell and the CBS need to be at the same security level. When a battle cell request to connect to the CBS, the CBS control system queries the battle cell's control system for its current security level. Only if the room's security level matches the CBS' security level are the fiber optic modems connecting the battle cell to the CBS powered on. This prevents battle cells that are connected to the CBS from ever joining CBS conferences that are at higher classifications than the battle cell can be brought up to.

This solves the CBS' problem for rooms that vary in classification. However, the problem is further complicated by the creation of TSWAs and the fact that only the USPACOM SSO has the authority to designate TSWA as a temporary SCI room. In this case, the SSO must really be brought into the loop of verifying a battle cell's security classification prior to a CBS connection being made at the SCI level. A control panel is installed in the J2 Information Technology Services Office (ITSO), a SCIF area controlled by the SSO, that signals the SSO when a TSWA battle cell requests SCI services. The SSO must login to that panel and authorize it in order for SCI services to be made available in the TSWA. This includes CBS at the SCI level. Only the SSO's account can login to that panel and make that authorization.

VTC Protocol: H.320 vs. H.323

The majority of today's VTC networks within the Department of Defense continues to be H.320-based. However, recently, the VTC industry in general has made significant strides towards H.323-based systems/equipment and organizations have begun rapid deployment of IP-based VTC systems. This evident in DIA's redesign of the JWICS VTC network from completely H.320 (ISDN) to completely H.323. Therefore, when it came time to determine what type of VTC system best fits the requirements of the integrated A-V architecture and A-V service model, it really became a question of "H.320 or H.323?"

H.320 is an International Telecommunications Union – Telecommunications (ITU-T) standard multimedia communication over circuit switched systems such as ISDN, Switched-56 networks and other narrow-band communication systems. It is primarily used for video teleconferencing and is the current standard by which future video teleconferencing standards are being based. Therefore, H.320 is a well defined and universally accepted standard, and H.320-based video teleconferencing systems are well developed, providing high quality, reliable VTC sessions. Furthermore, in most wide area video teleconferencing networks such as the DVS-G and VIXS networks, ISDN is the communications link of choice. Finally, the majority of VTC sites continue to use ISDN, and there is really no concerted effort to replace ISDN-connected VTC sites with IP-connected VTC sites.

The despite the wide use of H.320-based systems, the fact of the matter remains that H.323-based VTC systems are able to provide as good or better quality VTCs and more features and capabilities. H.323 is another ITU-T standard from the same family as H.320, but differs mainly in the transport. H.323 is an umbrella standard for multimedia communication over IP networks from the H.32x family of standards. It uses many of the standards as H.320, such as video compression (H.261 and H.263), audio compression (G.711 and G.729) and data collaboration (T.120). However, by the sheer fact of being built on an IP network, H.323-based systems are able to utilize management and access technology already available to other IP devices. This includes the use of Simple Network Management Protocol (SNMP) for device management and web interfaces which are user-friendly and widely understood by users and developers alike. The use of an IP network also makes that step towards converged multimedia networks. Although the A-V architecture uses dedicated networks for VTC, installing, operating and managing an IP VTC system takes that crucial first step towards convergence. Once the network resources and transport requirements for VTC on an IP network are understood, it can easily be migrated to a real multimedia network.

For these reasons and the rapid acceptance of H.323 systems within the DoD, H.323-based VTC systems are used in the integrated A-V architecture. Currently, there are separate initiatives throughout the federal government (inside and outside of the DoD) that are pushing hard on the implementation of IP collaboration tools such as desktop VTC appliances and desktop collaborative tools. Having a VTC system is built on an IP network poises the system for future integration with those other initiatives.

Summary

The integrated A-V architecture and A-V service model were implemented through the installation of the systems described in this paper. The USPACOM staff moved into the NMPCC in February 2004, and we transitioned their operations to the new systems. We expect that these systems will provide the operational capability required by a combatant commander. Further, we have been and will continue to monitor the use of these systems and their effectiveness in exercises and real-world contingencies.