Enhanced Mission Record and Review System (EMRRS) for Distributed Mission Operations

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ABSTRACT

This paper describes the advantages of implementing enhanced mission recording and review capabilities during networked debriefings or live training events. Based on data from the recent implementations of enhanced mission record and review capabilities for Combat Air Force (CAF) Distributed (Training and Live) Mission Operations DMO) using the CAF Distributed Mission Operations Network (DMON) at three USAF AWACS bases, Tinker (Oklahoma), Elmendorf (Alaska), and Kadena (Japan), this paper identifies the critical components necessary to build a state-of-the-art networked debrief solution. Additionally, the paper presents a path for future capabilities. The implementation of this capability has been dubbed an enhanced mission record and review system.

This paper covers the latest features of training systems with state-of-the-art networked brief/debrief stations that offer real-time capture and review of high-quality critical mission data. An enhanced mission recording and review system can capture essential media data during a training session including DIS/HLA data, computer/video screens (out the window, god's eye view, instrument panel, radar, pilot position), and audio communication. Advanced features of this system include live bookmarking and annotation for accessing key events during After Action Review (AAR) briefing/debriefing, the ability to review and replay training events using multi-window synchronized video playback with Personal Video Recorder (PVR) control, and archiving of mission videos to external media like DVD for future review and training. Additionally, this paper covers the networked debriefing systems' ability to easily scale and extend the visual collaborative training from LAN to WAN environment.

Introduction

"Train to Fight - Fight to Win" indicates the utmost importance of a training system. Papers such as "CAF DMO Standards-Based Approach for Achieving M&S Interoperability" from Aldinger & Keen explain in detail the importance of Combat Air Force (CAF) Distributed Mission Operations (DMO), which is "the foundation for revolutionizing training for the United States Air Force (USAF). DMO is critical to USAF readiness and is the cornerstone of Air Force training transformation in accordance with Joint National Training Capability Initiatives, as directed by the Office of the Secretary of Defense (OSD)".

The efficiency of these training systems can be increased manyfold by complementing the system with the capability to record and review the training session. This ability provides an in-depth learning experience through better and clearer event correlation, and with quicker access to key events. The multi-site/multi-type, synchronized brief/debrief makes expensive training and simulation systems much more effective by better preparing the students for the battlefield.

Background

According to Aldinger and Keen, CAF DMO Mission Training Centers (MTCs) provide the capability for simulation systems (for example, Virtual AWACS, F-15C, E-3, F-16CJ, JSTARS, A-10, and B-1) to participate in distributed training events. These MTCs provide high fidelity simulation environments for pilots, weapon system officers, and C2ISR crew stations. These MTCs also provide training aids which include manned threat stations, instructor-operator stations, environment generators, and brief/de-brief solutions. These MTCs are connected via the Distributed Mission Operations Network (DMON) as a federation of systems; a Wide Area Network (WAN) that facilitates global connectivity between the MTCs as well as the means for continuous monitoring and control of the CAF DMO Federation. Some key discriminators of the CAF DMO system include:

- Training is available 24/7.
- State-of-the-art, high fidelity man-in-the-loop virtual cockpits for pilots, and C2ISR crew stations.
- Manned threat stations that provide man-in-the-loop friendly/adversary forces.
- Integrated scheduling system in support of coordinated multi-site Aerospace Expeditionary Force (AEF).
- (AEF) training and rehearsal.
- Support for multiple/simultaneous training events.
- Rapid mission execution in support of user training.
- MTCs are located at home bases of aircrews to be trained.

Requirements for Enhancing The Mission Record and Review Capabilities

Modern training systems use the latest audio-visual technology, such as high-resolution screens driven by powerful computers. Being able to capture all the ongoing actions and data (audio, high-resolution, high frame rate video, and data streams), during a training session, is a challenging task that makes building efficient and powerful brief/debrief systems a daunting undertaking. However, this is exactly what a new generation of enhanced mission record and review systems are now capable of doing. Augmenting existing and new brief/debrief installations with enhanced mission record and review systems, provides additional capabilities that intensify the brief/debrief experience and mission training as a whole.

State of the art local brief/debrief stations with enhanced record and review have to include:

- Local training mode, where instructors can observe "on-going collaborations" real-time in a briefing room. This allows "overflow" students to observe their peers in an academic setting while missions are taking place in the next room. Instructors can pause the real-time display when needed and use the PVR (Personal Video Recorder) functions of the system to illustrate a specific event without interfering with the actual recording. During debriefings, instructors can display several crew stations side by side for comparative purposes. The inclusion of the DIS/HLA data allows for a mission truth or "god's eye" view that can be manipulated in pan, zoom, and perspective.

- The ability to capture a set of media data during the training session including DIS/HLA data (from simulators), computer (video) screens (out the window, god's eye view, instrument panel, radar, etc.), video (pilot position, etc.), and audio channels. All video must be captured directly from the screens the student is seeing in full resolution, frame rate, and visually lossless quality so that during the debrief or AAR he/she can immediately identify with the content. Real-time capturing and reviewing of critical visual data in high quality is essential for training success. It is vital to be able to compare side by side the actual truth data (for example, the unaltered "gods eye" view of the battle space) and a student's perception of that truth. A perfect example of this in practice today is the method employed by the USAF AWACS Mission Training Centers. All crew consoles are recorded in sync and stored alongside a DIS recording of the same mission. During playback, instructors can display a DIS viewer that exploits the recorded DIS data stream in real-time. This gives the instructor the ability to pan, zoom, and tilt the view of the unaltered truth data in the viewer, while simultaneously displaying the student perspective of that same data. A typical finding in this venue might be how a student missed a critical event due to an inappropriate radar sensor setting or perhaps the student simply was not looking in the proper geographic location.
- Capturing of all media (data, video, audio) in a way that can later be played back in full synchronization. For example, recording DIS/HLA audio allows playback for comparison between what the student heard, versus what actually was transmitted. The student might not have had his/her radio tuned to the correct frequency.
- Bookmarking capabilities during recording and/or playback for quick access to key events so that during the brief/debrief, one can play from/to these events. This makes the preparation of After Action Review (AAR) quick and efficient.
- Auto-indexing of events, based on PDUs or data provided by the simulators. This can further help in getting quick access to key events during the training mission.
- The ability to make notes can help in the preparation of AAR for accessing key events.
- Multi-window playback to view the playback of video and audio from different streams with synchronized control on pause/resume, skip back/forward, and bookmark playback.
- Audio and video playback from multiple training and simulation systems to correlate events across these systems, providing a more in-depth learning experience.
- The ability to make annotations so that during the AAR it is possible for the instructor to visually explain these correlations or make other notes.
- The ability to record the brief/debrief session itself and archive it for later (offline) review or provide it on portable media, like DVD, for the student to further review on a PC.

The ability to take specific mission events that are of particular interest and store them onto a DVD for future use in training seminars and lectures. This feature provides a great advantage that plays directly into the vision of being able to provide milestone mission recordings as part of a student's electronic training record. Each successive block of instruction a student must pass a criterion referenced scenario. Each of these missions could be archived as part of a student's permanent training record.

In addition to the needs of a local brief/debrief system with enhanced record and review capabilities, in the CAF/DMO context, synchronized recording and playback of combined mission videos (radar, HUD, out the windows), audio, and DIS/HLA data require:

- Distributed Mission Review over CAF DMON.
- Synchronized data playback at multiple sites whereby initially audio/video streams will be local but control is distributed.
- Time stamped synchronization and PVR control.
- Archiving mission and brief/debrief videos to DVD for review and training.

This perfectly complements other tools providing "simple collaboration", like Smartboard products that allow the sharing of ideas via annotation. These tools work fine locally, but without the ability to sync local videos and data with remote participants who are watching their own videos during a distributed mission review/debriefing, there is no relevant information to collaborate upon.

Other, possibly longer-term requirements include elements such as:

- Easily scalable and extendable approach of "enhanced features" such as bookmarking might only be available to local sites in first instance, but the approach should later allow easy extension in a multi-site environment.
- Mixing of live and recorded content.

- Exchange of metadata such as bookmarks.
- Ability to share video or audio streams across sites.

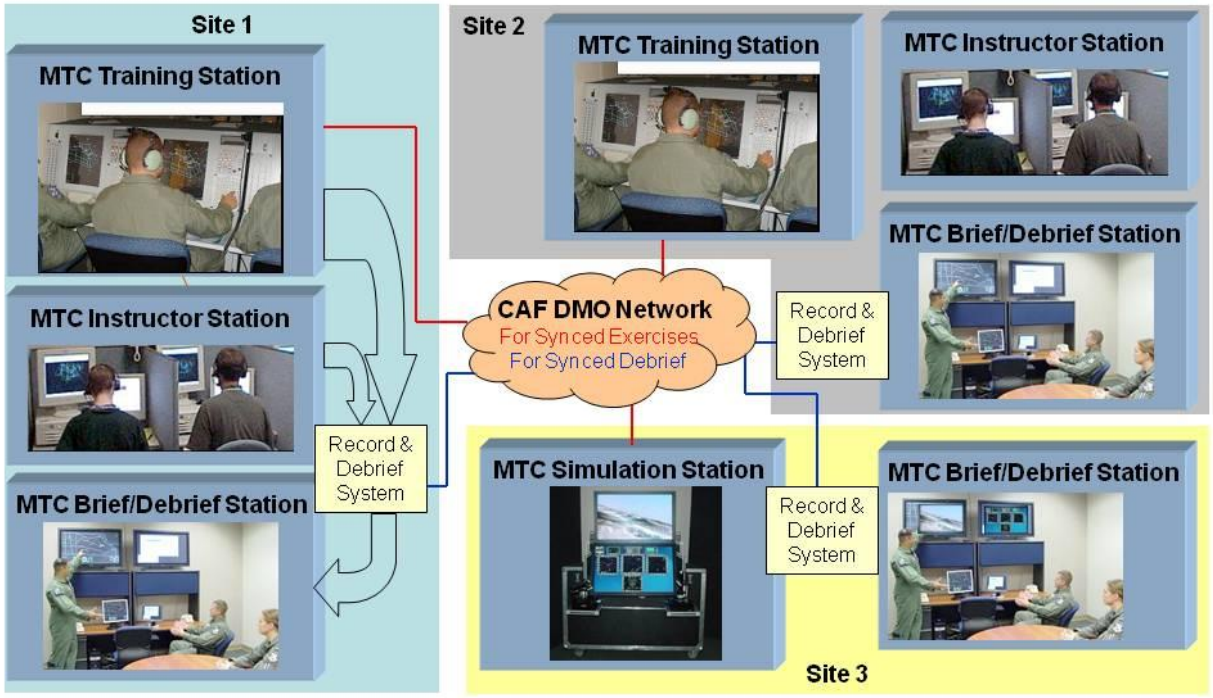
The next section of this paper describes use cases of the technology behind the implementation and functionality of an enhanced mission record and review system using UHD encoder/decoders, digital media servers, and management servers available today.

Basic Set Up and Use Case

A key setup requirement is that these systems have to work across training systems and sites. Therefore, the only way to capture and later play back information is to have the information on a network. Since Ethernet and IP are now ubiquitously available, the most logical way is to make training information available on IP networks. In CAF DMO, DIS/HLA data is already flowing on the CAF DMON network. Therefore adding an IP-based record and review system is the most logical step.

Figure 1 shows a very simplified view of a training mission environment. The MTC Training Station can compose of single fairly static radar screens or multi-screen, high-resolution, high-frame rate flight simulators.

Figure 1: Overview of Enhanced Record and Review System within MTC Context



Independent of the type of the simulator, the “Record and Debrief System” can capture all the video and audio that is generated at all participating sites in the training mission.

Each MTC uses Instructor Stations which are generally the truth engine in a simulation. At times there is an interest in sharing the truth data that generated the student’s interaction, with the student. From the Instructor Station, the instructor has the capability to place bookmarks and notes in the recording so that as soon as the exercise is finished, a debriefing can be accomplished from that bookmark.

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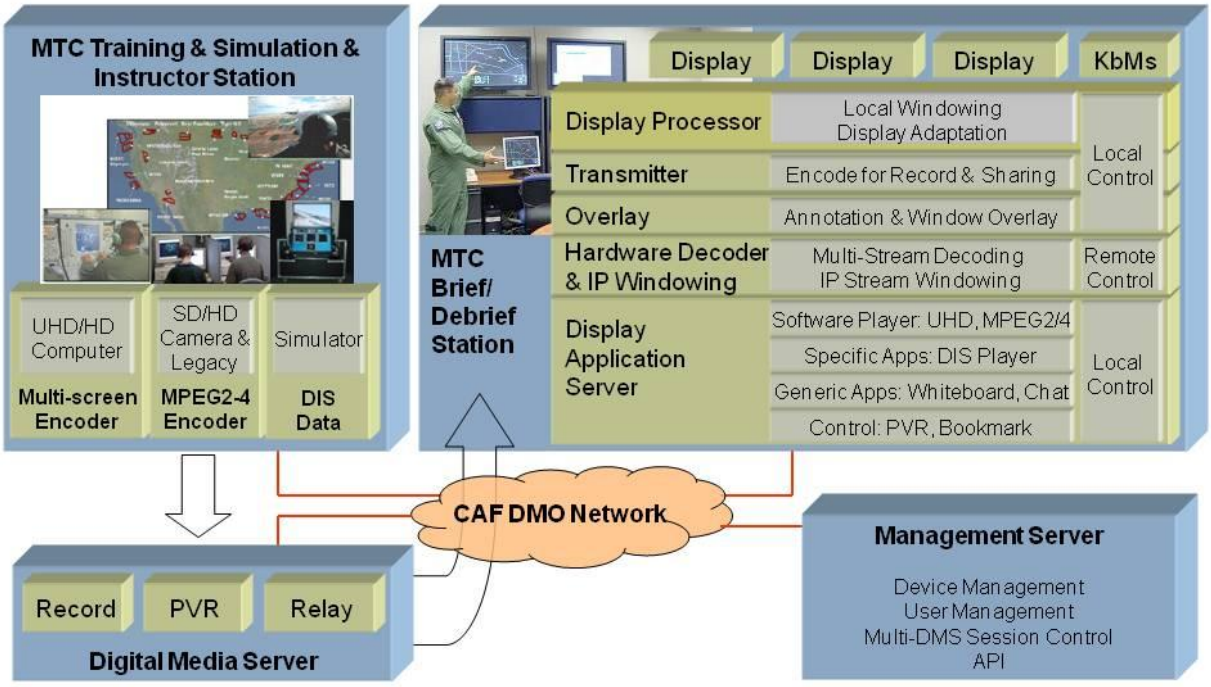
Figure 2: MTC with Enhanced Mission Record and Review Solution



In some cases, there are observers who require a live view of the ongoing exercise. These observers not only have the ability to monitor, but they also have the ability to skip back to review previous events. This capability offers observers and instructors a method of fine tuning the exercise.

Once the training mission is finished, instructors and students go to the MTC Brief/Debrief Station for exercise debrief. They can now immediately start playing back all captured audio, video, and data from all simulation devices that participated in the exercise. The instructor can jump to the bookmarks that he/she added during the training, add/modify bookmarks for later reviews, and make on-screen annotations. The whole debriefing could be recorded again on the same system and transferred to portable media for future use by the students or instructors.

Figure 1 shows that all MTC and Record and Debrief Systems are directly connected to the CAF DMO Network. This is a great simplification since every site will have its own LANs and filters before connecting to the DMON network but this is totally transparent to the Record and Debrief System.

Overview Enhanced Mission Record and Review System

Figure 2 shows the components in the different parts of the network, which are discussed in more detail in the following sections.

MTC Training, Simulation, and Instructor Recording Station

On the MTC Training and Simulation side (including both Student and Instructor Stations) some data, such as DIS/HLA data, is already in IP, and can be directly captured. All other information that one needs to capture must be converted into IP so that it can be recorded for later playback.

Computer video sources are the most demanding, and most will run a resolution of minimally 1280 x 1024 at 60 or 75 Hz, but more and more modern simulators use resolutions of up to 1920 x 1200 at 60 Hz. Some are even moving in the direction of using 2560 x1600 at 60-Hz screens. Therefore, encoders that transform video into IP data need to be able to handle these "Ultra High Definition" (UHD) video inputs while still maintaining a high frame rate and visual high quality. Encoders must also be able to handle high-fidelity audio in the case of recording sound effects.

Although there is no immediate vision to use control from a remote site (for example, keyboard/mouse control), but having this capability is interesting. Even if this capability is not used operationally, it may still be used for maintenance, upgrade, and other support activities.

Standard and High Definition cameras, and other legacy sources can also be routed through the UHD encoders, but in many cases, cheaper solutions based on MPEG2/MPEG-TS and MPEG4/RTP will be available (for example, SD RTP network cameras as overview camera). If these are used, the recording system captures these streams from the network and later replays them in sync with UHD streams. One caveat is that most MPEG encoders/decoders have a much higher latency than the UHD encoders needed for an enhanced mission record and review system, so care must be taken with correlation between these encoders and the UHD encoders. If this is a concern, if one wants to correlate a pilot action captured on a camera with events on the screen, then the best solution is to send the camera video through a UHD encoder so that both computer screen and camera video have the same latency. Having interactive controls will add functionality, for example, to use the PTZ (Pan Tilt Zoom) capabilities of a camera through RS232 control.

Once the data is on the network, a Digital Media Server attached to the network will ensure that the data can be:

- Recorded for later playback.
- Viewed locally or remotely including PVR functions (TiVo-like control for multiple synchronous streams) such as pause/resume, skip back/forward for instructors and observers.
- Relayed to different destinations with different stream characteristics (unicast/multicast, different bandwidth). This can be done both for live events and during playback of training missions.

The system must use removable media so the ability to change out security levels is available. Also, if DIS/HLA data is not included as part of a distributed playback or of a DVD, then only human readable format (HRF) information is present. HRF information can be easily screened for security release as opposed to complex DIS/HLA Protocol Data Units.

MTC Brief/Debrief Station

The MTC Brief/Debrief Station is where the more elaborate part of the enhanced mission record and review capabilities are implemented. There are many ways to compose a complete solution, but the main components are in Display Application Servers, Decoders, Windowing and Overlay solutions, Encoders, and a Display Processor driving the displays. Depending on the size and required functionality, a MTC Brief/Debrief Station may contain some or all of these main components, or some other site-specific components can be added.

The Display Application Server provides:

- Control over playback sessions: From the Brief/Debrief Station, one will be able to start the playback of an exercise and control the exercise by executing commands like pause/resume, skip back/forward, play to or from bookmarks, add and change bookmarks, switch streams, write DVD, and so on.
- Generic applications such as whiteboard, chat service, and so on.
- Specific applications such as DIS/HLA viewer/player which will render the playback of DIS/HLA data.
- Software decoders that can play back SD/HD (camera) video streams as well as UHD/HD (computer, HD camera) video streams. The main advantage over hardware playback is the reduced cost.

Hardware decoders perform playback of the UHD/HD (computer, HD camera) streams at full resolution and full-frame rate at which they were encoded. These systems can overlay the scaled video on top of incoming video (see Figure 3), for example, the output of the Display Application Server or the output of a previous Hardware Decoder. The main advantage of Hardware Decoders is that they can overlay as many windows as practically possible on one or more screens without any performance degradation.

Figure 3: Multi-window Display

Once all the windows are composed, this can be sent through an Overlay Module that will provide annotation on live or static video. Also other overlays such as window borders and name can be draw over the video.

The user then has the option to send this video through another transmitter so that this output can be recorded or the whole windowed and annotated image can be shared with another party.

Finally, in order to view the content, this output is sent through a Display Processor to one or more displays. There are simple solutions that split a 3840 x 1200 output into two 1920 x 1200 monitors, or 5040 x 1050 output into three 1680 x 1050 monitors. However, there are much more enhanced solutions that can drive smaller or larger walls composed of blended projectors or display cubes (see Figure 4).

Figure 4: Display Wall

The Display Controller can also provide further overlays of local sources and other systems such as legacy videoconferencing.

All of the above systems have some kind of control, and it is important that the “Interactive Display” provides control capabilities for multiple users at the same time. Therefore, it must be possible to connect multiple keyboards and mice or other input devices to the MTC Brief/Debrief Station in order to:

- Interact with the applications running on the Display Application Server (“Local Control”)
- Control remote computers through the Decoders and Encoders
- Annotate and control other overlays
- Control the Display Controller

Besides video and control, the solution also integrates audio mixing. The solution allows audio from local sources running on the Display Application Server, multiple remote sites decoded in software or hardware, and other systems like phones and videoconferencing to be mixed together.

Not every MTC needs an elaborate Record and Review System with all the capabilities in the Brief/Debrief Station. In its' simple form, the system can consist of only the Display Application Server running software players, and specific applications like the DIS/HLA viewer.

Management Server

The Management Server includes all the functions necessary to make the record and review environment operational and controllable. It includes configuration and management of all devices that compose the solution. The main function however is to facilitate the training and simulation sessions. The following is the list of the Management Server functions:

- Setup of all connections at the start of a session: this is simple for small local environments, but can become complicated in larger, multi-site environments. Therefore, it is important that key sessions can be saved so that they can be set up quickly without any further configurations.
- Once the session is started, the Management Server continues to provide "presence information" to all parties involved, showing them the state and health of the session and devices.
- The Management Server also serves as the controller for a multi-recorder and playback situation. It will make sure that all PVR actions from all persons involved will be executed in a synchronized way.
- The Management Server allows fast switching of streams towards software or hardware decoders, so that instructors can quickly switch from one view to another in order to correlate events and views.
- The Management Server also keeps the central repository of recordings, (names and meta-data, not the actual recording) and bookmarks.
- Bookmarking is one of the key functions provided by the Management Server, as it allows the instructor to place bookmarks during the recording, or during playback.
- Bookmarks, as well as recording and stream names, are searchable so that at a later point in time, specific recordings or events can be found quickly.

The Management Server can be further enhanced by incorporating sophisticated policy-based media management for strong access control of all devices in the solution. Initially this might be less important since each site provides "physical security".

To make the solution more secure, scalable, and manageable in global environments, it is important that a multi-domain concept be integrated in the solution.

Through the Management Server, it is possible to export/import recordings for off-line storage (back up) Segments, or whole recordings can be exported to portable media such as DVD/HD-DVD, and potentially be given to students for later review on their PCs.

The Management Server also provides an API (Application Program Interface) for integration into legacy brief/debrief solutions allowing actions during recording that were previously discussed, (for example adding bookmarks from training system or teacher console/application). More details are discussed in the next section.

Implementation Technologies

UHD Codec

The first very critical technology is future-safe, advanced encoding that can interface to DVI and dual-link DVI video interfaces to encode UHD video (4 megapixel and beyond). The encoding can safeguard the visual quality, run at a high-frame rate to retain smooth motion, and work at low latency. The compression can also be easily adapted to different network situations, and offers the possibility of reducing bandwidth on-the-fly so that different destinations can be served with different bandwidths.

Obviously, achieving high compression at visually lossless levels is very important to minimize bandwidth on networks, but also to limit required storage capacity on recorders. This also has a very high impact on how many simultaneous streams can be handled on the recorder since one of the big limiting factors is disk read/write bandwidth, especially when the system reads/writes different streams at the same time.

Syncing-Up Streams

The next piece of core technology is a Recording and Review System that can manage many simultaneous streams. Because simulators can have many video channels, in order to be cost-effective the recording system can record many streams in sync. It also can playback all these streams synchronously with all playback capabilities (pause/resume, skip back/ forward, and so on).

The system also provides these sync capabilities between the different media types, so that any type of data can be played to any receiving device in sync with any other receiving device that is part of the same session. Consequently, UHD video and SD camera video, each with their own audio, will all be played synchronously with the DIS/HLA data viewer. Synchronously, instructors can skip back/forward, and play from/to bookmarks, while analyzing the performance of the students during the training mission.

Since larger environments will eventually require the recording and playback of potentially hundreds of streams, one system will never be able to scale to these levels. Therefore, the solution has the ability to record to and playback from multiple recording systems while preserving all the sync features inherent in a single system.

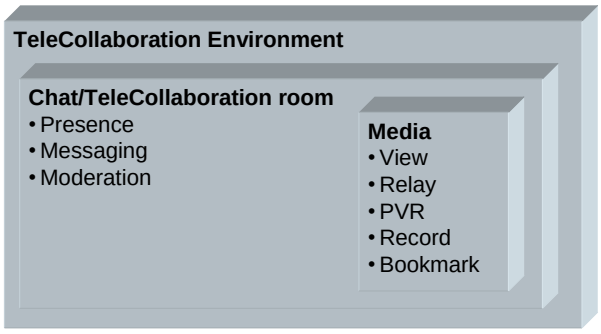
The multi-recorder solution is also important since initially each site will record its own streams and playback its own streams. Only the PVR control information will be shared so that synchronized, multi-site brief/debrief is possible.

XMPP-based Control Protocol

The control protocol glues all the devices together in one complete solution, and provides or activates the key functions. The closest existing control paradigm is that of a chat room. A chat room is increasingly used as the primary collaboration platform when users want to collaborate on text-based information. For the purpose of an enhanced record and review system, the chat room is extended to a "TeleCollaboration room". This can be seen as an extension of the chat concept, where users can view and manipulate any type of rich media in a collaborative manner.

The use of chat rooms for the TeleCollaboration room implementation automatically provides all the collaboration functions and features available in the chat room to the TeleCollaboration room (Figure 5). One of the major elements that differentiate the TeleCollaboration room from a simple chat room is the handling of multiple synchronized streams of different media types on distributed platforms.

Figure 5: Enhanced Mission Record and Review is Build on TeleCollaboration Room Concept



The definition of XMPP (from xmpp.org website) is as follows: "The Extensible Messaging and Presence Protocol (XMPP) is an open technology for real-time communication, which powers a wide range of applications including instant messaging, presence, multi-party chat, voice and video calls, collaboration, lightweight middleware, content syndication, and generalized routing of XML data."

XMPP, as control layer, introduces little or no performance overhead so that PVR and other media actions are quickly distributed to the right entities for execution. The PVR Media Actions are broadcast into the room, which forwards the Actions only to the scoped entities, avoiding any processing bottlenecks related to a centralized model or potential overload of control messages on entities. The federated model allows for the entities to do their part to fulfill the request. This ensures that the media collaboration can scale to a large number of sources, relays and viewers, which then work in pairs to fulfill the request.

The use of presence to detect if a source, relay, or destination goes down ensures that all such events are broadcasted into the room. This allows for automatic or operator-based intervention to repair streams as soon as there are problems.

XMPP is a standard endorsed by the government as explained on http://www.chips.navy.mil/archives/06_Jan/web_pages/XMPP.htm:

"… Nov. 30, 2005, the DoD Information Technology (IT) Standards Council (ITSC) unanimously approved the inclusion of XMPP as a mandatory standard in the DoD IT Standards Registry (DISR)…

…

Use of an XML-based chat solution will allow the Navy to leverage XML cross domain data guards (e.g., the USJFCOM XML data guard, part of its Cross Domain Collaborative Information Environment project currently in testing with the National Security Agency). ..."

Further examples and applications are explained in this article. Additional information can be found on http://www.tridsys.com/whitecollgate.htm which explains an XMPP-based Collaboration Gateway for military, and http://www.sensornet.gov/net_ready_workshop/Boyd_Fletcher_CDCIE_XMPP_Overview_for_NetReadySensors_Conf.pdf shows how a cross domain gateway is used in an application. See also a list of other government programs on page 16 of the referenced document.

API

A final piece of key technology is an Application Program Interface (API) for distributed media control. The API provides CAF a simple and powerful way to control DMO brief/debrief from external devices through integrating the enhanced record and review capabilities with third-party applications.

The API allows the following main functions:

- Distributed PVR control: the common definition of PVR is to be able to control (pause, resume, skip back/forward, play to/from bookmark, rewind, fast forward) a single stream from a live or playback source. The media collaboration application extends this definition to the control of multiple streams that are grouped together, originating from multiple live and playback sources, by distributed controllers, in a synchronized way.
- Record control: record, start, stop, pause, or resume multiple streams on multiple recorders by distributed controllers.
- Other media control activities: bookmark control (create, edit, list), obtaining lists and information about recordings, recording filename management, stream switching, search, and so on.
- Controlling "events" ("sessions", "media rooms", "simulations", "collaborations" or whatever name is given to specific engagements by the user/participant): create/edit (configure data/audio/video "streams" with "profiles"), start/stop, delete, and schedule events.
- Exchange of presence information: status of events, streams, users, and devices.
- Device information, monitoring, and configuration.
- Time synchronization between devices.

Though the above list of media control seems quite complete, it is by no means exhaustive and final. However, since this is built as an extension to XMPP, it is extendible.

Lessons Learned From Initial Deployments

The Enhanced Mission Record and Review System (EMRRS) is deployed in three locations, one AWACS MTC in Tinker, second AWACS MTC in Elmendorf, and third AWACS MTC in Kadena.

The initial feedback in using the new system is very positive. These are some of the comments of the staff who used the system:

- "The Chenega bubbas spent three hours debriefing the IRON TRIAD yesterday and found some holes in their mission that need correcting. Holes they haven't seen before EMRRS."
- "Our crews are also responding well to the new install. They are seeing value in this system and use after almost every mission."
- "I think down the road having EMRRS available to all CAF DMO players will be a big help and the brief/debrief front, not to mention standardization of systems!"
- "EMRRS is providing awesome debriefing capabilities."
- "According to our resident Instructor ECO, Capt Cynthia Foley, they have received more training in the last two days than they have in the last three years. The real-time viewing and debriefing capabilities have stepped training up to a new level."

- "The 962 Commander went out of his way to say that we are in danger of providing more and better training than they get on the airplane."
- "Our combined DIS/HLA and EMRRS playback is what makes the system work for our customers."

Path Forward

In conclusion, an enhanced mission record and review system is a realization of a new generation of TeleCollaboration solutions. It uses state-of-the-art capturing techniques to archive all activities in multi-site, multi-station, networked simulations. It can play any part of an exercise, correlate events by syncing streams, quickly access key events, and allows annotation and distribution of local or synchronized debriefings.

Initial systems have been successfully used in the CAF DMO environment. The following are steps towards wider deployments:

- Simple deployment without any policies where the current DMO Portal just opens more ports on a per exercise basis so that the control is passed; the Portal would only allow DIS/HLA data flow between sites as well as control data. One "Management Server" would control the whole environment.
- As a second step, one could start using the policies on the single Management Server, allowing different bases to participate or not. In this way, the Management Server would take over some of the Portal control, but the data that flows between sites is still the same (DIS/HLA and control).
- As a next step in distributing control (and still keeping the same data flows), cross-domain management could be implemented; one Management Server per site or base would control what is allowed to go in and out. The Management Server would become part of the Portal for controlling who does what.
- In parallel to the above gradual distribution of control, it is possible to implement distribution of streams whenever this would be deemed necessary and appropriate. These additional streams (besides DIS), can be text streams (chat messages between sites/participants), audio, and/or video from cameras for communication, or audio and/or video from computer screens.

As indicated above, the protocols, UI and API are flexible and scalable and allow gradual implementation in a fully scalable and secure way.

It should be obvious that synchronized recording and playback of mission audio/video and DIS is a valuable tool for both local and distributed training alike. Likewise, this is not just a Combat Air Forces DMO application. Operational surveys conducted with the US Army Apache and Longbow programs clearly define a need for such a system. This capability would greatly enhance local training value by providing comparative examples between pilots and mission execution results. The distributive qualities via the WAN sync playback are also a factor in this venue. It is a reasonably safe assumption to say that all branches of the U.S. military share common training goals that a synchronized recording and playback system would enhance.

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References

Michael Aldinger and Scott Keen CAF DMO Standards-Based Approach for Achieving M&S Interoperability

http://xmpp.org/

http://www.chips.navy.mil/archives/06_Jan/web_pages/XMPP.htm

About the Authors

Johan Pirot, President of IP Video Systems, brings together more than 25 years of experience in data networking and digital video. Mr. Pirot is the key strategist leading new product development and innovation. Formerly, as President of TeraBurst Networks, Mr. Pirot successfully launched the company in the visualization networking market. Previously, as vice president of IP strategy at Alcatel, Mr. Pirot successfully developed and implemented strategic relationships and acquisitions of IP companies. Mr. Pirot holds an MSEE from the Catholic University Leuven, Belgium and an MBA from the Handelshogeschool Antwerpen, Belgium (associated with Northwestern's Kellogg School of Management).

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