VN-Matrix Combines Real and Virtual Training Cross Country for AFRL

VN-Matrix streaming and recording products provided AFRL with collaborative capabilities and cost savings which were previously not possible.

The Air Force Research Laboratory – AFRL faced several significant technical and operational challenges when it set out to produce a real-time, real-world demonstration of a training simulation system, cross country. The demonstration required real-time distribution and display of multiple high resolution image sources from a secure facility to a public exhibition using an unsecured network. Increasing the challenge, limited network bandwidth existed between locations. The demonstration would have to happen in real-time, while preserving the image quality of critical visualizations. To accomplish its goals, AFRL Mesa selected a system that combined Extron's VN-Matrix™ real-time image streaming and recording technology and a Quantum™ Elite™ videowall processor.

An Important Demonstration

The AFRL's Human Effectiveness Directorate, located in Mesa, Arizona, conducts research into leading-edge human performance methods and supporting technologies. AFRL is the Air Force's only organization wholly dedicated to leading the discovery, development, and integration of warfighting technologies for our air, space, and cyberspace forces.

In the summer of 2007, AFRL had the opportunity to demonstrate its Joint Theater Air-Ground Simulation System "live" at the Air Force Association – AFA Exhibition at the Marriott Wardman Park Hotel in Washington, DC. The demonstration was designed to use real aircraft and real command and control assets combined with virtual systems to improve the quality and efficiency of training.

Technical Challenges

Linking the real and virtual elements located across the USA in both secure and unsecured environments presented several technical challenges. A public unsecured, uncorrected network with limited bandwidth was used, so the system would have to overcome quality of service issues and would need to be compatible with network encryption systems.

Key elements of the demonstration included two F-16s in flight over Arizona and two manned high-fidelity F-16 simulators located on the AFA show floor. A virtual, ground-based targeting soldier was also integrated into the demonstration, using a five meter diameter immersive projection dome. Ground communications and command and control staff contributed from both locations.

VN-Matrix® 200 Series Codecs
Stream AFRL High-Resolution Simulation Images with Visually Lossless Quality in Real Time

The Streaming, Recording, and Display Solution

Extron VN-Matrix VNC 200 DVI codecs were used to stream tactical mission display information produced in Mesa. Aircraft instrument display and mission data captured at VGA and SXGA resolutions were streamed along with radio transmissions on two T1 connections supplied by a regional telecommunications provider.

The encoded Multi-Function Display - MFD Link 16 and Tactical Display Framework - TDF images each used only 350 kbps on this low bandwidth connection. The network routers provided 128-bit encryption to secure the video streams and mission data.

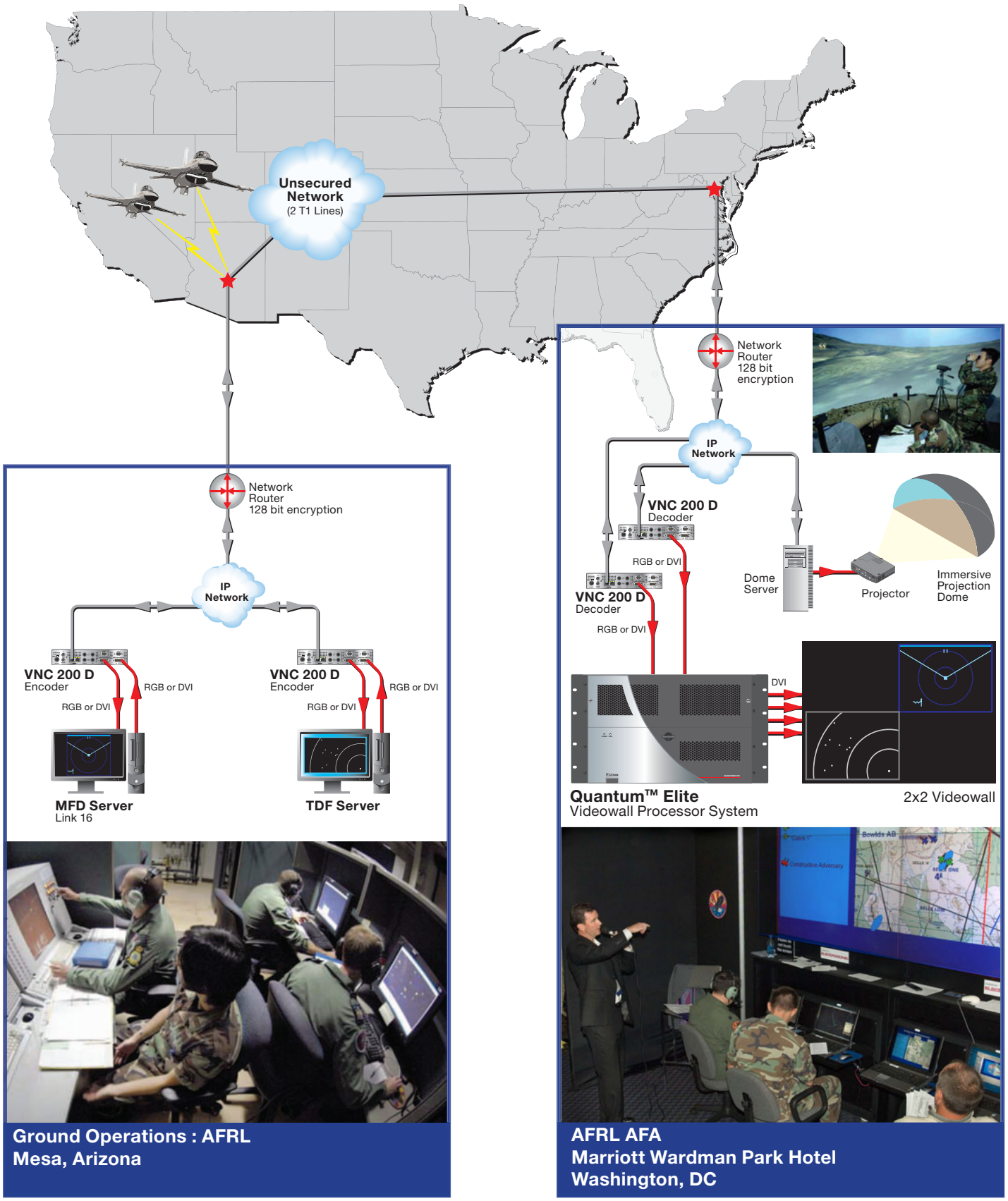
VN-Matrix was also used to encode and stream the Heads-Up Display - HUD and instrument panel imagery with 1920x1080 resolution from one of the F-16 trainers operating at the exhibition. A VN-Matrix Recorder was used during each experiment to record the HUD, instrument panel, MFD Link 16, and TDF images, all time-synchronized with each other. Following each experiment, the four recorded images were played back to review the training mission and demonstrate the After Action Review - AAR capabilities of the system.

VN-Matrix® Recorder
Captures VN-Matrix Streams for Playback in Training and After Action Review Applications

A Quantum Elite videowall processor was also used during this event to present up to 12 computer graphic images of live or recorded tactical mission data simultaneously on a 140-inch diagonal 2×2 projection cube videowall with a combined resolution of 3840×2160. The Quantum Elite was selected by AFRL because it is capable of presenting a large number of DVI and RGB computer sources while preserving the real-time image performance a simulation environment requires.

Streaming Capabilities and Performance

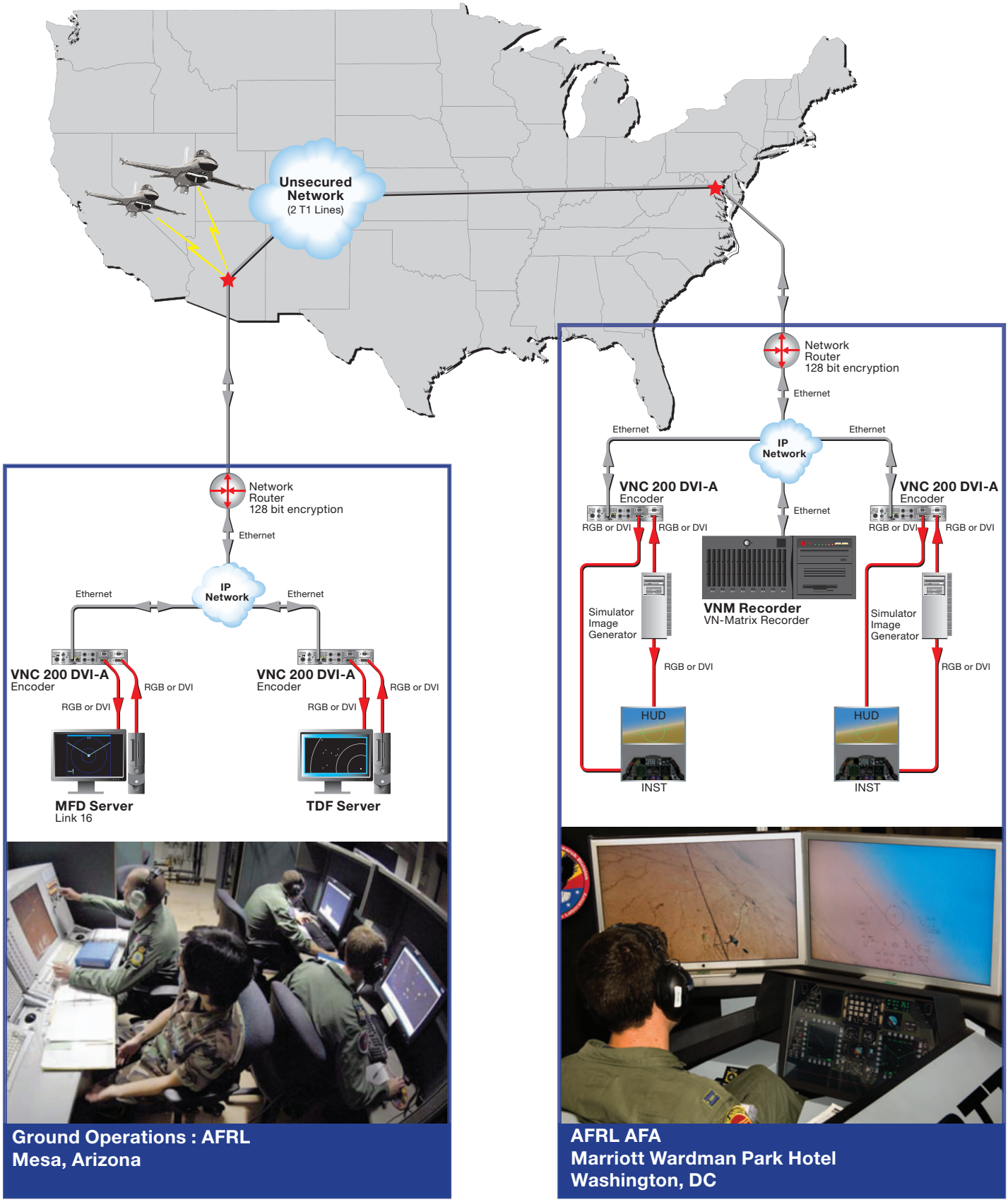
The VN-Matrix system allowed the imagery produced by equipment operating in a secure location using classified data to be encoded, encrypted, and then distributed across a non-secure network connection to a live, public event. This was accomplished with very low latency. Low latency is critical to team members collaborating in



Ground Operations : AFRL
Mesa, Arizona

AFRL AFA
Marriott Wardman Park Hotel
Washington, DC

Real time streaming of MFD and TDF mission imagery cross country



Ground Operations : AFRL
Mesa, Arizona

AFRL AFA
Marriott Wardman Park Hotel
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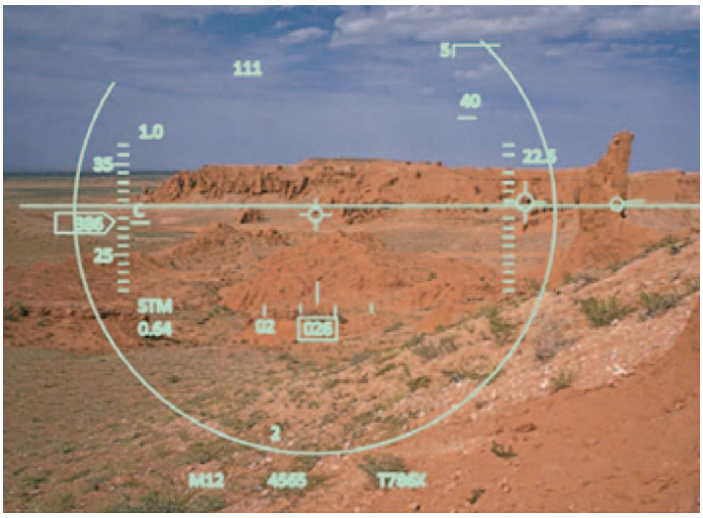
Recording of MFD, TDF, Heads Up Display and instrument panel



Example of HUD image

Videowall presenting many real-time graphic inputs

an experiment across a vast geography. It allows them to operate with confidence they are all acting on the same data during critical operations. If tactical imagery is not presented simultaneously to all participants, communication is hampered, decisions are delayed, and the team is not as effective as it should be.

The VN-Matrix codecs provided unprecedented flexibility and performance during this demonstration. Not only were high resolution images streamed across the country at very low bit rates, but incredible resilience was demonstrated during periods of poor network performance. During system testing, the T1 connections experienced packet loss in excess of 20%. Extron's PURE3® codec with embedded error concealment ensured reliable, artifact-free images were maintained during this extreme situation. Packet loss such as this can be catastrophic to some video/graphic encoding products.

The visually lossless compression in the PURE3 codec also made preservation of the F-16 trainer's HUD targeting overlay possible. The detail in the fine instrument and targeting overlays on a HUD were maintained lossless and artifact free, even when presented against backgrounds with relatively low contrast. Preserving this level of detail, without producing artifacts, was a feat AFRL had not seen from other compression codecs. Maintaining image detail down to the pixel level is essential for many simulation applications.

Recording Training Missions and Experiments

Playback of real and simulated material recorded with VN-Matrix allowed mission events and pilot decisions to be compared from mission to mission. Recorded content can be archived on external storage or played back on demand when stored locally on VN-Matrix Recorder.

Quantum™ Elite Videowall Processor
Provides Real-Time Performance for AFRL Simulation Imagery

After Action Review

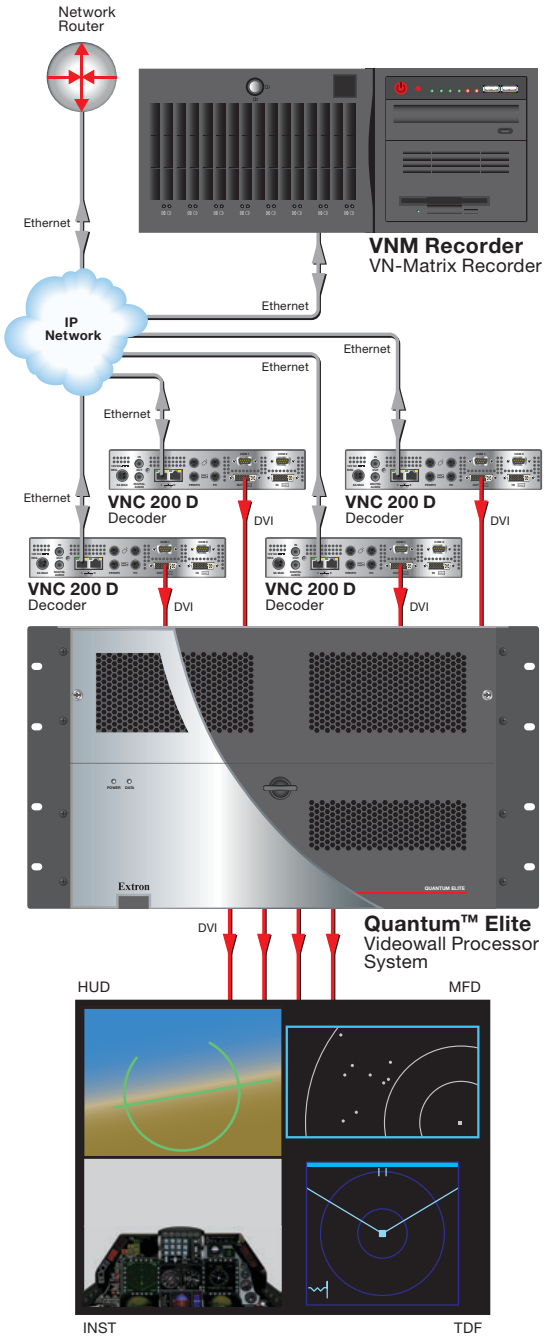
During the AFA exhibition, recorded mission data was played back from the VN-Matrix Recorder twice per day. The after action review capabilities provided by the VN-Matrix Recorder allowed AFRL to easily identify mission events, pilot decisions, and the system capabilities this live and virtual environment made possible. The compression performed by the PURE3 codec in VN-Matrix preserved the image detail and motion experienced during the original event and the playback of the four video streams maintained tight synchronization screen to screen. Synchronized playback of recorded content is valuable for data presented on multi-screen presentation systems used in simulation, training, command and control, or videowall systems. The accuracy provided in this playback quality allowed AFRL to be confident they were analyzing accurate information.

VN-Matrix Recorder offers additional transport control over recorded streams, including: search, locate, variable speed playback, forward, reverse, or single frame advance. This control allows the user to efficiently review the recorded material, scanning quickly through the content or examining fine detail by stepping backwards or forward, frame by frame.

Advancing Training Capabilities and Lowering Operational Costs

VN-Matrix streaming and recording products provided AFRL with collaborative capabilities and cost savings that were previously not possible. Streaming allowed important mission data normally confined to the operations facility in Mesa to be visible at the AFA event in Washington, DC. The recording of mission data and simulator images improved after action review capabilities by providing more visual data and an organized method for replaying and viewing data from experiments. Costs were reduced by operating two live aircrafts instead of four and by running the mission twice per day instead of four times. This also reduced safety risks associated with flight operations.

The AVA demonstration was so effective that it was repeated at the I/ITSEC Convention held at the Orange County Convention Center in Orlando in November 2007. Today, AFRL continues to use VN-Matrix, VN-Matrix Recorder, and Quantum Elite products in training and simulation programs it manages.



Playback of mission data using VN-Matrix Recorder

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