

Advanced Commercial-Off-The-Shelf Technology For Joint Task Force DISN Deployed Multimedia Communications (JDDMC) [JW-051]

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Abstract: The current tactical communications requirement, in terms of increased bandwidth and more communications functionality, is forcing the tactical communications community to search for near-term technological improvements. These technology improvements, using Commercial-Off-The-Shelf (COTS) and/or Government-Off-The-Shelf products, is part of a long term Department of Defense cost reduction strategy for modernizing currently fielded tactical systems. The goal is to acquire commercially based C4I systems that can be expeditiously deployed to warfighting elements. This broad strategy allows DOD services and agencies to deploy current, standards based, commercial technologies with a minimum of up-front development effort and associated costs. During JWID, high speed digital services were extended beyond the traditional DISN boundary in support of forward deployed JTF using the state-of-the-art commercial switching equipment. The COTS products used in this demonstration served as a proof of concept for using commercial technologies for tactical multimedia applications. All of the devices used, with the exception of the encryptors, were commercial-of-the-shelf products. They are designed with a wide variety of physical and logical interfaces. The network consisted of four mobile switching nodes forming a meshed backbone linking demonstration sites at MacDill AFB, Ft. Bragg, Ft. Gordon, and Shaw AFB. The enabling technologies are ATM cell switching, ISDN telephony, and transparent ATM support for legacy IP router networks. ATM switches interfaced with three types of ISDN PABXs. The PABXs in turn interoperated with a wide range of voice terminals (analog, tactical, digital, ISDN, STU-III), computer terminals, and ISDN desktop products.

Introduction. The current tactical communication needs in terms of more bandwidth and more functionality is forcing the current tactical communications technology to search for improvements. These technology improvements

using Commercial-Off-The-Shelf (COTS) and/or Government-Off-The-Shelf products is a long term Department of Defense cost reduction strategy for modernizing the current tactical switches and communications devices. The goal is to have capabilities to deploy the most current commercial technology to the warfighter based on open/civil standards. This strategy allows the deployed tactical force to field current and emerging commercial technologies with minimal developmental cost. A deployable tactical communications system using COTS technology/products was deployed as an ATM Infrastructure during JWID' 96. This demonstration was about bandwidth economy and optimization. It provides a reliable example of maximizing the warfighters ability to manage and conserve scarce digital bandwidth entering and within the tactical area of operations (AO). It supports JWID-96 objectives by demonstrating extension of Defense Information Infrastructure (DII) and Defense Information System Network (DISN) next generation high-capacity multimedia services to a deployed Joint Task Force (JTF). The JDDMC demonstration was assessed qualitatively from the user's perspective. Network performance data was collected electronically for assessment purposes.

Network Configuration. The network consisted of four mobile switching nodes forming a meshed backbone linking sites at MacDill AFB, Ft. Bragg, Ft. Gordon, and Shaw AFB (Figure 1). The enabling technologies are Asynchronous Transfer Mode (ATM) cell switching, Integrated Services Digital Network (ISDN) telephony, and transparent ATM support for legacy IP router networks. The installed network integrates switched voice, packet data, and digital video traffic over a common, bandwidth agile, ATM backbone. It is based on advanced cell switching technology, dynamic bandwidth management and allocation, and provides a flexible network environment supporting advanced multimedia applications such as VTC and on-line collaborative planning, in addition to secure tactical voice telephony.

JWID Objectives and JDDMC Support

JWID Objective #1: "Demonstrate how... Defense Information Systems Network (DISN) systems can use asynchronous transfer mode (ATM) and advanced multiplexing technology to provide automatic dynamic bandwidth allocation and enhanced services using theater tactical bandwidth. For example, using Global Command Control System (GCCS) over ATM, demonstrate E-mail with binary attachments, file transfers, desktop VTC, and imagery dissemination."

Response: The JDDMC demonstration supported JWID 96 objective #1 by demonstrating extension of Defense Information Infrastructure (DII) and Defense Information System Network (DISN) ATM-based high-capacity multimedia services to a deployed JTF.

A. Interconnect and configure ATM switches. The JDDMC demonstration successfully configured and interconnected the Nortel Passport ATM switches at the CINC Fwd location (MacDill), and the AFFOR location (Shaw). The Passports were also internetworked with AT&T demonstration JW-007 at Ft. Bragg and Ft. Gordon. The circuits used were a combination of on-base and commercially provided 1.544 Mbps paths.

B. Connect and configure IP Routers. The JDDMC demonstration successfully installed the CISCO 4000M routers, providing a BGP-4 over Ethernet connection to the site SIPRNET premise router at each JW-051 location. This Ethernet connection provided bandwidth over which other demonstrations accessed remote JWID sites. The routers at each site interfaced with the Passport over V.35 into a standard, fully meshed, virtual frame relay network. The connection to the SIPRNET premise router was accomplished after the network security devices were installed and operational.

C. Connect and configure ISDN PABX and terminal devices. Each JDDMC site successfully installed and configured a Nortel Meridian 1 Option 11 ISDN PABX. Each PABX interfaced to the Passport ATM switch via a standard ISDN primary rate interface (PRI) using Q.931 signaling.

D. Install LAN and Multimedia Desktop Terminals. Each site installed a Windows NT file server and a single workstation interconnected by an Ethernet

LAN segment. The LAN segment used local router port E0 as the gateway to the ATM network. The workstation doubled as the desktop ISDN video terminal using a COTS VTC package produced by Intel Corp. known as Proshare System 200, software version 2.0.

E. Install and Configure Network Security Devices. At a point in time when the Passport ATM switches could be centrally managed across the network, KG-194A encryptors and NSA approved T-1 COMSEC interface adapters (TCIA) were inserted into each link. The TCIA envelops the encryptor on the red and black sides, providing red to black framing bit integrity, frame resynchronization, and variable timing source selection from the front panel.

F. Enhanced warfighting capabilities. The JDDMC ATM backbone enhances the warfighters ability to transport information into and out of theater, and around the battlefield, by consolidation of all traffic types (voice, data, imagery, and video) over a common cell bearing network. An integrated network architecture using the features inherent to ATM technology enables the communications manager to optimize the utilization of existing theater bandwidth. The bandwidth consumers reap benefits in the form of increased quality of service (QoS), reduced network latency, and more bandwidth available at the desktop for today's bandwidth intensive applications.

JDDMC Interoperability. All of the devices used in the JDDMC demonstration, with the exception of the encryptors, are commercial-off-the-shelf (COTS) products. As such, they are designed with a wide variety of physical and logical interfaces. In the JDDMC demonstration, the Magellan Passport ATM switches interfaced flawlessly with three types of ISDN PABXs (Nortel Meridian 1 Option 11, and the AT&T Definity and Merlin Legend). The PABXs in turn interoperate with an even wider range of voice terminals (analog, digital, ISDN, STU-III), computer terminals, and ISDN desktop multimedia products. As an integral part of the overall JWID-96 ATM network, as illustrated in Figure 1, the Passports in the MacDill and Ft. Bragg nodes interconnected directly with the DISN Leading Edge Services (LES) Network, a Government run pilot ATM project comprised largely of Fore Systems ATM switches. This interface is a significant achievement in ATM interoperability in particular because the LES is clocked asynchronously by node, whereas the JWID ATM network requires a more synchronous approach

to network timing in order to adequately process voice and video services. Once the switch fabric and port timing parameters were determined, in part by trial and error, the disparate networks interworked as intended.

In addition to the LES network interface, a second Fore Systems ATM demonstration was connected via DS3 (45 Mbps) to the MacDill Passport, joining a Central Imagery Office (CIO) sponsored demonstration (JW-071/29) to the JWID ATM network. The CIO sponsored demonstration used a Fore Systems ATM switch as an access device, to transit the Passport network to the DISN LES point of presence (POP) at USCENTCOM Hqtrs (See Figure 1). This interconnection permitted JW-071/29 to invoke a Fore proprietary, non-standard multicast capability, not currently supported in the Magellan Passport line of products. The seamless unification of demonstrations JW-051, JW-007, and JW-071/29 displayed an unprecedented level of ATM interoperability. Integration of these three COTS based demonstrations further supports the assumption that seamless, Multivendor ATM service to the warfighter is available today.

The Wireless Broadband System (WBS) at Shaw AFB, SC, was also used successfully to transport the ATM Ft. Gordon-to-Shaw T1 signal from the demonstration site to the air base's dial central office (DCO). Normally, the signal was transported across the air base over buried copper cable. Experiment ended at 0900 hours on August 23, after one hour of operation, because a storm with heavy rains moved through the area and caused the radio link to fail. The T1 signal was moved back onto the copper cable so that the ATM network would not suffer unnecessarily from the outage. Subsequent attempts to route the T1 signal over the WBS failed due to undiagnosed difficulties with the NET IDNXs. These difficulties may have been related to damage suffered from a lightning strike during the infrastructure setup week. The IDNXs were used to multiplex multiple signals onto the WBS radio link between the demonstration site and the DCO.

JWID Objective # 6: "Demonstrate a deployable suite of distributed collaborative planning tools, models and simulations that facilitate development of an operationally sound, logistically feasible war plan. This suite must interoperate with Windows and GCCS, as well as provide desktop VTC, whiteboard, common map display, automated planning tools and shared applications."

Response: This demonstration provided an ATM based, multimedia-capable infrastructure, extended forward from the fixed DISN to the CINC, CJTF, and Component Forces, supporting desktop multimedia applications including voice, data, video, imagery and collaborative planning capabilities. The following functional flows were successfully demonstrated.:

A. Establish point-to-point and point-to-multipoint multimedia calls between each compatible node. During each day of the demonstration, many ISDN video sessions were established between other compatible sites on the JWID ATM network. Although many comparable desktop video applications are available, VTC COTS package was selected by system planners for JW-051 and JW-007 for its simplicity, robust capability, and affordability. The video and sound quality at the required 128 Kbps were very satisfactory for routine information sharing. An H.320 compliant video bridge was installed at Ft. Bragg by JW-007 that enabled up to four video terminals to conference simultaneously. In the multipoint conference mode, the image of the speaking party is displayed on the non-speaking party remote windows. The projected image follows the party that produces the strongest audio signal. In cases where the video calls traversed the JW-007 VSAT link, a slight video degradation was induced. Otherwise the overall quality of most calls was more than acceptable. Innumerable voice calls were made over the ATM network during JWID-96 and almost all were of commercial quality. Secure voice calls using STU-III telephones were remarkably clear and understandable, with a high degree of voice recognition even at 2.4 Kbps encryption speed.

B. Repeat each call over ISDN, Desktop ATM, Net BIOS address, and IP address. All dial up video calls were enabled via the PABX ISDN basic rate interface. Desktop ATM was not demonstrated, although there are no indications that this capability would not have been successful had the resources to acquire the necessary hardware been available. The VTC session is capable of initiating video calls over LAN connections using Net BIOS destination addresses. Wide area video calling over IP was not attempted.

C. Activate Video, Whiteboard, and Shared Application features of multimedia workstation software. During each ISDN video call, one or more of the attendant features were activated. The

whiteboard capability within Proshare allows simultaneous annotation (marking, pointing, typing) of an active window by each connected party. The connected parties can import maps or other digitized files into the notebook window for collaborative planning. In cases where only one party possesses application executable files, a view of the running application can be sent by the terminal on which it is running. Muting either the voice, video, or both, frees bandwidth for use by the whiteboard or for transferring files from one point to another. The file transfer capability is highly efficient (128 Kbps minus call maintenance overhead) when all other features are muted or deactivated.

Interoperability. Commercial standards that govern ISDN interworking and videoconferencing are mature and the number of available products implementing these standards is on the increase. The JDDMC demonstration's use of a video bridge installed by another demonstration is an example of successful interoperability using commercial standardization. The variety of PABXs, voice terminals, routers, ATM switches, video applications, and backwards compatibility with the Tri-Tac switching architecture are other examples of interoperability at its best.

JDDMC Success Criteria. The criteria used to determine success was largely subjective. Voice and video quality were measured qualitatively by demonstration personnel, evaluators, and visitors. Network performance was measured by capturing daily statistics from the ATM network management platform.

Demonstration Procedures. As an infrastructure demonstration, JW-051 was turned over for JCCC management when the network became secure and fully operational. Telephone traffic was processed between nodes in a conventional manner giving the user the same generic sensory functions as commercial/DSN service in garrison. Data traffic throughput (SIPRNET) was controlled by the JCCC by redirecting premise router traffic off the traditional Ground Mobile Forces (GMF) links and onto the JDDMC ATM backbone. In order to adequately demonstrate multimedia desktop capabilities of ATM/ISDN, a VTC application (Proshare) was used at each site. It must be made clear that virtually ANY video application, Ethernet or ATM data terminal (Windows, Unix, etc), or network access device could have been supported by a JDDMC node.

Data Collection. Data collection was performed by automated and manual means on a daily recurring basis. The quantity of ATM cell traffic traversing the network, including SIPRNET traffic, in and out of each ATM switch was recorded. The procedure utilized the Performance Monitor tool on the NORTEL Network Management station. Voice and video calls placed by internal demonstration personnel were recorded on custom forms citing time, date, called location, and a subjective judgment on call quality.

Results and Lessons Learned. Interoperability of various vendors equipment came together to provide seamless services to the warfighter. Three different ATM switches, three different PBX's, two different routers, two different video applications providers all worked harmoniously at providing voice, video, and data services. Bandwidth management techniques utilizing NORTEL's ATM switch demonstrated how efficient ATM can be in bringing multimedia applications to the warfighter. Voice compression, speech activation detection (silence suppression), and dynamic bandwidth allocation allowed these services to coexist harmoniously on one link. Following lessons were learned during the demo.:

a.) The network management system used to support the ATM network during JWID-96 was a SUN SPARC 5 running Solaris 2.5.1. NORTEL's network management software was loaded on top of the Solaris operating system. This architecture represents an open architecture in that any network management software can share the same platform. HP Openview, Sunnet Manager, Cisco works, or Foreview could have just as easily been loaded on the same platform. b.) When COTS equipment is powered directly by generators, the results are often less than desirable. c.) Network timing. An ATM network designed specifically for transmission of delay tolerant traffic, such as IP data, need not be clocked as precisely as the same network designed to support voice, video, *and* data. While ATM network timing does not have to be perfect, optimum transmission of voice and video requires that the network be timed more synchronously. The T-1 circuits interconnecting the various JDDMC nodes were ordered without derivable network timing installed. Under normal conditions, the ATM switches would have been set to "slave" off the "network", or line side, rather than using DTE or internal timing. Because no timing was available, the network had to be deterministically timed, that is, one ATM switch was declared master and all others drew

clock from that network location. This arrangement proved marginally workable but timing slips, voice cracks, freeze frames, and other network anomalies occurred each time a crypto resync or local key update initiated. Eventually, derivable timing was added to the transmission paths by MCI, WorldCom, the ATM switches were able to clock off the same timing source yielding a quantum improvement in network serviceability.

The JDDMC demonstration showed efficient method of processing voice and data traffic using variable bit rate (VBR) service. VBR service is synonymous with ATM Adaptation Layer 5 (AAL5). The nature of digital voice and video transmission has traditionally required a path with dedicated bandwidth, or at minimum a guaranteed bit rate that allows the signal to reach it's destination with few delays, errors, or interruptions. Processing voice along with data within AAL5 permits highly efficient bandwidth allocation by taking advantage of the inherent bursty nature of the typical voice conversation. With up to 50% of each voice call spent in silence, voice processing permits allocation and consumption of bandwidth only when there is a voice signal present. The result, even without services such as voice compression, is a freeing of bandwidth for other users, such as data, during the idle 50% of each voice call. A combination of silence suppression *and* voice compression permits an aggregate reduction of required voice bandwidth

per call approaching 1/8th that of a standard digital voice connection. During the JDDMC demonstration, voice traffic was compressed to 32 Kbps with potential compression to 16 Kbps. Voice processing combined with the dynamics of an ATM network permits instantaneous, on-the-fly, rate adaption in response to network traffic conditions in accordance with controllable service parameters known as Peak Bit Rate and Guaranteed Bit Rate.

Conclusions and Recommendations. All JDDMC objectives were either met or exceeded. The demonstration successfully established functional interoperability between three ATM switches, two routers, three PBXs and encryption equipment over terrestrial, satellite, and line-of-sight radio links, providing a fully integrated, flexible, reliable, and manageable backbone service to the warfighter. It is highly recommended that system commands, research and development agencies, and service C4I laboratories should continue tracking ATM products, related technologies, field assessments, and constantly evaluate their readiness for insertion into warfighting systems. Innovative solutions to many bandwidth utilization challenges facing today's warfighters are currently available and are ready for implementation on a limited scale. They should be given serious consideration for inclusion into existing systems and for new acquisitions where appropriate.

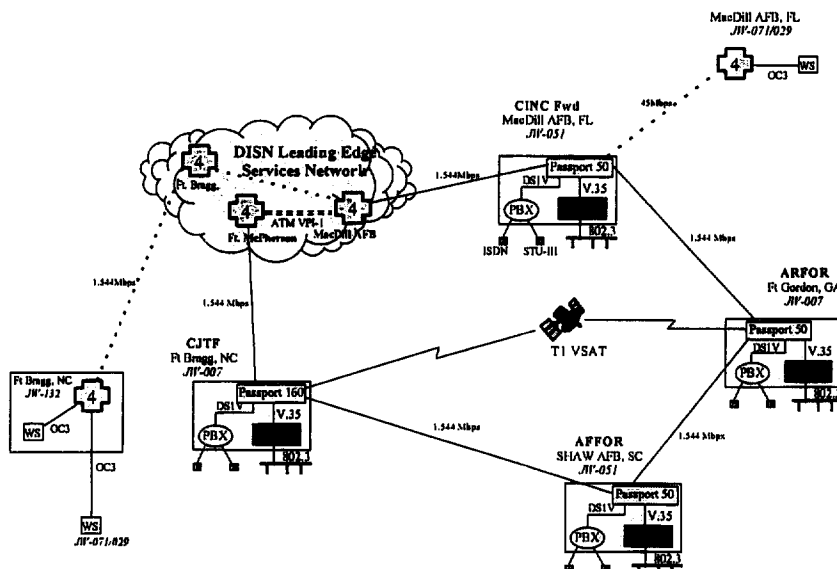


Figure 1. JDDMC Multimedia Network Configuration