Recently, I had the pleasure of delivering a joint presentation on streaming media with Judy Hubbard of Sandia National Laboratories to the Corporate Media Managers Association (CMMA). As someone who has successfully implemented high-volume streaming services using advanced video compression - both MPEG-4 and Windows Media 9 - in her organization, Judy's insights and experiences proved to be invaluable: Especially, regarding her understanding of, and dealings with, the nuances of deploying video services over IT networks. We thank Judy for graciously allowing us to include her case study in POE.

Edward Behan

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Delivery Selection: Terrestrial Corporate WAN/LAN & Internet

Driving Applications: Training

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Video Streaming Implementation at Sandia National Laboratories

Background Information

Sandia National Laboratories develops science-based technologies that support national security. Sandia is operated by Lockheed Martin for the Department of Energy. Besides the Department of Energy, Sandia also does work for other government agencies such as the Department of Defense, the Department of Justice, and the Department of Homeland Security. Sandia's primary location is in Albuquerque, NM where there are 7,300 employees and 1,500 on-site contractors. The physical site in Albuquerque is spread out across 10,000 acres of land and over 300 buildings. Sandia also has a facility in Livermore, CA, which has 1,000 employees and 450 on-site contractors. There are several other small sites with a few dozen employees each; these are located in Nevada, Washington DC, Texas, and Hawaii. The annual operating budget for all sites is $1.9 billion.

I manage the Video Services Department, which provides professional video productions and related services to the Laboratory. We are part of the Employee Communications and Public Relations organization at Sandia. We are located at the Albuquerque site. The majority of our services are offered on a chargeback basis; however, some services such as operation of the corporate auditoriums and video streaming are both funded by the corporation as overhead activities.

Implementing Video Streaming at Sandia

Video streaming crosses many disciplines and requires a team effort for successful implementation in a large enterprise. At Sandia a team was formed to address the benefits of streaming that included members from Video Services, Video Conferencing, Corporate Education and Training, Knowledge Preservation, Computer Networking, Strategic Web Infrastructure Framework & Technologies, Information Technology Training Group, Web Page Design, Computer Support Units, Corporate Computing Help Desk, and Computing Infrastructure. The majority of the organizations involved are part of our corporate Information Technology (IT) organization.

The team viewed video streaming as a strategic communication tool that would become essential to effective communication Sandia. By focusing on this as the common goal, we avoided turf battles and organizational agendas.

We had several corporate communication goals that we wanted to accomplish through video streaming, including the need to:

- Distribute information across all sites quickly so that all employees got the same information in a timely manner.
- Be easy to use – convenient.
- Save travel time – not only between different sites, but also within the sites themselves.

Since we are quite spread out at the Albuquerque site, it can take 15 minutes to walk to an auditorium, and many have to drive since they are so far away. The ability for an event or communication product to come to the audience at their desktop would be a tremendous time saver.

The implementation had three phases; planning, deployment, and improvement. We spent over a year in the planning phase. Then deployed streaming in September 2002. After deployment we moved almost immediately to the improvement phase, which is where we remain today. I anticipate that we will be working on improvements for as long as streaming is used as a communication tool at Sandia.

We implemented streaming on 3 computer networks, the Sandia Restricted Network (SRN) which is our intranet, the Sandia Open Network (SON) for external users which is at www.sandia.gov, and the Sandia Classified Network (SCN) which is another intranet and very highly controlled for access. This case study will only deal with implementation on Sandia's SRN and SON.

Although the high level corporate communication needs were our priority, we also had IT requirements that had to be met in order to make streaming practical on our computer network. Since Sandia is a large organization, long ago IT standardized what type of software was on each desktop. Having this "Common Operating Environment" ensured that computer systems were compatible, worked well on the network and could be easily maintained and upgraded. Our streaming solution had to be compatible with the operating environment and use low bandwidth to not interfere with other network applications. In order to minimize the number of calls to the computing help desk, streaming had to be very user friendly.

The primary role for IT during the planning phase had to do with streaming research and development. This included investigations into a standards-based video streaming solution,

evaluation of hardware and software, determination of servers and investigation of multicast solutions. IT also worked to determine techniques to use video streaming for Web-based training and to integrate video streaming with PowerPoint slides. At the time of deployment IT monitored the network to determine if performance problems were occurring and maintained the streaming server. Now that we are in the improvement phase, IT is working to get more subnets multicast enabled and helps users when they have computer related difficulty playing a video stream.

The needs from the Video Services Department were primarily customer and content oriented, which fit nicely into the goal of creating a strategic communication tool. We wanted streaming to be an integrated project that provided one solution with well-managed content. If it was not easy to use and of high enough image quality, employees (we call them customers) might implement their own streaming solution. We needed standards for encoding so that all videos played properly, and we took responsibility for doing all encoding, whether we originated the content or not. It was critical for us to obtain corporate funding so that we could do this without charging each customer –Strategically, this approach made it impractical for anyone to consider doing it themselves, since we were providing the service at no charge. Having one solution with specific standards and specifications eliminated duplication of effort and multiple streaming efforts that would bog down the network causing problems with all network applications and reducing satisfaction of all users.

During the planning phase we worked closely with IT to investigate streaming technology and streaming applications, and determine which encoders and players we would use, along with establishing the encoding specifications. Our primary role during the end of the planning phase and throughout the deployment phase involved content creation and management. This included encoding existing video products utilizing the agreed upon standards to ensure quality of products and network integrity. We set up an index so that content could be searched using our Web based corporate document management system and search tool. Shortly after deployment we discovered our index was not robust enough, so we teamed with Sandia's technical librarians to develop a more thorough taxonomy in order to better categorize content.

Currently, we are the primary interface with customers – we inform them about using streaming as a communication tool and help troubleshoot problems they may encounter. We continue to encode video streams, maintain and upgrade our encoding equipment (how often?) and the standards that we use, and we monitor usage of various content. We thought that we would remove seldom used and untimely products from the server as part of our content management process; however, we have found that our customers like to use the streaming server as an archive. We have removed some streams, only to get requests to put them back up. As a result, at this time we are not removing any content and we are trying to determine how those decisions will be made in the future.

Streaming Standards and Specifications for the SRN (Intranet)

At Sandia we encode Windows Media 9 and MPEG-4 at 450 kbs to play a 320 x 240 image. Windows Media 9 plays on PCs seamlessly from the Microsoft Media Server and it plays on Macs via HTTP delivery through a Web server. We cannot deliver to Unix and Linux, which are used by a handful of individuals at Sandia that have specialized computing needs. We are currently evaluating the effect on the performance of the network of raising the bit rate to 750 kbs to play a 640 x 480 image in order to improve quality. For our purposes 640 x 480 is considered to be full screen – it is full frame, but won't quite cover the entire screen.

Streaming Standards and Specifications for the SON (www.sandia.gov)

Part of the challenge of streaming on the SON is that we do not have the benefit of the Common Operating Environment or the bandwidth of our intranet. Streams must play for anyone that visits, regardless of whether they are using dial up or a high-speed connection. In order to meet these diverse needs, we initially established 3 encoding standards. After about 6 months, we reduced it to 2 standards as the lowest one wasn't used to any significant extent. We now encode each stream at 150 kbs to play a 180 x 120 image and 300 kbs for a 320 x 240 image. The Windows Media Server automatically delivers the appropriate file for the highest resolution the client's machine can play. MPEG-4 doesn't incorporate multiple bit rates into one encoded file, but Windows Media does, so we only encode Windows Media 9 for the SON.

Issues with setting the Standards and Specifications

Windows Media is proprietary; MPEG-4 is an open standard. We went with Windows Media originally as a way to test capabilities of the network, but we did not think it would be the permanent solution. We added MPEG-4 capability within 6 months of the deployment of streaming in order to improve quality, particularly for text in PowerPoint presentations. We have had difficulty with the MPEG-4 implementation, as the player is not part of the Common Operating Environment. A plug-in must be pushed to each desktop in order to play MPEG-4 files. This has not occurred due to higher priority corporate IT needs. Windows Media 9 remains the most universal player, as it is already part of the Common Operating Environment for all users.

At Sandia, we define Multicast to mean that the server delivers one stream to the routers where it is duplicated and sent out. The advantage of multicasting is that it reduces bandwidth usage, so it is easier on network. The network must be "multicast enabled" to do this, so there is additional expense associated with implementing multicast site-wide. Although much of our site is multicast enabled, there are some subnets that are not. Lack of funding has caused the delay in multicast enabling the entire site.

We define Unicast to mean everyone that logs on to a stream gets their own stream directly from the server. This takes more bandwidth, may require multiple servers, and has a negative impact on network capacity. With Windows Media, everything is multicast as the default, and then it automatically rolls over to unicast wherever the computers are not on a multicast enabled part of the network. We are limited to 2000 simultaneous Windows Media streams in our environment, which has served us quite well. MPEG-4 currently won't roll over from multicast to unicast; instead we must choose multicast or unicast at the server. This has forced us to use unicast since we are not fully multicast enabled across the entire network. We are limited to 500 simultaneous unicast streams from the MPEG-4 server.

Streaming Content

We stream live events and presentations as well as video on demand content. The primary content for both live and on demand is training related. An average of 63% of SRN streams each month are training related. Other types of content include corporate events, meetings, speeches, and general information. Streaming this type of content enables people to see presentations and events that didn't fit into their schedule. These are streamed live and/or on demand afterwards, depending on the requirements of the speaker. Video on Demand is more popular, but interest in live streams is beginning to grow. Initially, there was a fear that people wouldn't attend the live

events and the speaker would be presenting to an empty auditorium. Although this fear still exists, the size of audiences has been steadily declining over the past 10 years and cannot be attributed to streaming alone. People simply don't have time to come and attend the session at a specific location. However, tuning into the presentation at their own desktop can often be done, especially since they can continue doing other work on their computer while the stream plays.

Some content is available on demand only. This is because either there is no live source or viewership needs to be limited to certain groups or individuals. Our video on demand on the SRN can be set up with password access controls. This enables the speaker to give access to specific groups, such as all managers, or certain departments, or whatever user group they set up. A live stream has no such access control capability, so video on demand is the option that is used when information has any kind of sensitivity. Aside from content that requires control of who can view it, other video on demand content includes existing video products that are encoded for streaming. Major sources of this content are video programs produced for employee communication purposes for our internal closed circuit video network called Video Sandia. We produce 3 different shows each week (human interest, technology advances, upcoming events, historical footage, etc.) and play them several times a day on a network of video monitors. The Video Sandia network is only available in 35 of the 300 buildings at SNL in Albuquerque and not to any of the other sites so viewership is quite limited. We have used streaming as a secondary distribution mechanism for these productions in order to increase the ability of employees to view these programs.

We maintain metrics on viewer habits and have found all trends to be positive. Employee communication videos produced for Video Sandia (described above) averaged less than 400 plays per month in 2003, and grew to an average of 1500 plays per month in 2004. When we looked at all streaming content we averaged 8,035 plays per month in 2003 and that average had grown to 13,772 plays per month in 2004.

We had a major training initiative in November of 2003 and used streaming as the primary method to distribute 20 different video presentations. During this training campaign, viewership spiked from an average of just over 8,000 streams played per month to over 174,000 streams played in November alone. This event gave us a chance to demonstrate the viability of streaming as a fast, efficient, and inexpensive method to get corporate information out to widely dispersed audiences.

Lessons Learned–What we did right

The major thing we did right was that we made video streaming a corporate communication tool. The following list highlights what I believe to be the critical success factors that helped us get streaming up and running as a viable communication tool. At Sandia we:

- Focused on streaming as a corporate communication solution
- Got Executive Management interest and support
- Teamed with appropriate groups
- Developed standards that were network friendly
- Obtained corporate funding which enabled us to:
    - Maintain corporate standards for encoding
    - Have the same quality for all streams
    - Minimize dysfunctional behavior of duplication from the line (no need to do it yourself)
    - Minimize complaints about streams that don't play properly

    - Make it easier to manage content since it is all on one media server
- Gathered metrics to measure success

Lessons Learned – What we Could Have Done Better

- With hindsight firmly in hand, these are the recommendations I have to make the process go smoother.
- Invest time setting up the team before you start
    - Determine which organizations are decision makers in the streaming process and be sure that they have representation on the team
    - Determine which organizations have a legitimate interest and need to be kept informed, but are not in a decision making role. Do not include those that simply need to be informed on the planning team.
- As you proceed, if some team members aren't helping, get them out of the process early on
- Keep the team small, it's too hard to make decisions by large committee
- Don't overly rely on key individuals
    - If a key person leaves you are in trouble
    - Have knowledgeable back-up and management support for each team member
- Don't change technology too quickly
    - Get it right for a while before you improve or add capability
    - We added MPEG-4 before we were ready and we are now going back to WM
- Develop taxonomy early – Taxonomy
    - File management is a big deal, do it right from the start or you'll spend a lot of time reorganizing files

Strategic Advantage of Streaming

Video streaming truly provides a strategic advantage to the company. The same information is immediately available site wide for all employees. Remote sites are treated the same as primary site. There is consistency of content in the messages as the content does not have to be digested by a few and shared with many – all can access the content first hand through the video streams. It is convenient – viewers can get the information they want, when they want it at their own desktop.

We thought that travel time (walking or driving to an auditorium) would be the big reason people would like streaming, but it turned out that schedule conflicts were more of a driver for why people need to stream meetings and events. Streaming is a highly valued service, not only by the receivers but by the senders – streaming makes it extremely fast and easy for them to distribute their messages.

Streaming builds an incredible amount of goodwill with customers. They are always delighted when we offer them streaming as an avenue to distribute their information. It has elevated the value of my department at the company; customers view us as a provider of extremely useful solutions to their communication needs. Being involved with the implementation of streaming at Sandia has resulted in an incredible amount of positive feedback from customers.

Aside from delighting customers, there are additional benefits. Streaming enables us to leverage existing communication products and build business. By streaming our existing productions, we not only inform and/or train viewers, but we also advertise the capabilities of our department. We

stream Video Sandia shows from the Video Services Department homepage on the SRN. By placing these streams on our Website it helps Sandia employees learn about the other products and services my department provides and reinforces our involvement with streaming. Another benefit is that we can control access to the actual video files. We are able to protect the information since viewers cannot download/change the production. This eliminates "theft" and prevents copyright problems, which can be costly to the corporation.

We have had a decrease in tape/CD/DVD duplication. This is a reduction in business for our department, but it is the right thing to do for the company since it reduces costs. It is important to wear a "corporate hat" rather than worry about a small amount of lost income. Despite the decrease, duplication service is still needed for many customers. Streaming requires a network connection so it does not serve customers who travel and/or need to show videos at off-site locations. Those individuals need physical media they can have in hand as do those that distribute copies of the media (conference presenters, employment recruiters, etc.)

In summary, video streaming has been invaluable both to the corporation and to my department. Streaming was not easy or quick to implement and it continues to be a challenge to manage, but it has definitely been worth all of the effort.