Using Digital Video and Audio for Surveillance and Monitoring

A.J.Chaney

Managing Director, Telemedia Systems Ltd.

Overview

In a Digital CCTV system cameras are connected to network endpoint devices which are provided with mechanisms for the digitising and compression of video and audio. The resulting digital data is then distributed throughout the system using local area networks (LANs) and/or wide area networks (WANs).

Typically the data is routed either to:

a) digital decompression and video output devices; or

b) digital storage devices.

The system operators will sit at consoles connected to personal computers. It will be possible for them to monitor any of the connected network devices, and control or define the behaviour of the system in response to a number of possible events, such as movement in the picture, or an external alarm stimulus.

Data which has been recorded to hard disc storage devices may be archived to digital magnetic tape media. Digital storage provides much greater data security and availability, and allows ease of use and much more rapid access. It is possible to provide multimedia databases which allow additional information to be provided.

Digital Video and Compression

The digital data rates required to represent video signals can be very high. The CCIR specification for digital video requires a typical bandwidth of 20.25 MByte/sec. This would require a very expensive network and vast amounts of storage for even modest length recordings. Fortunately, a typical video signal has a large amount of redundancy, and it is possible to employ compression techniques which reduce the amount of data by 15 to 20 times.

There are three commonly available video compression formats:

- MPEG-1
- JPEG

- H.261

JPEG is “intra-frame” compression, in that all the compression occurs within one video frame.

JPEG can provide fully variable compression from between 2:1 to 100:1. JPEG is not widely accepted as a format for video due to the lack of a definition of protocols and file formats which would make it possible to produce interworking between equipment from different manufacturers. It was originally proposed as a static image compression technique.

MPEG and H.261 are “inter-frame” compression, and use the similarities between frames to reduce the amount of data transmitted. They are forms of “delta” compression. MPEG-1 is specifically designed for the distribution of TV quality signals in digital form. H.261 is a compression standard developed for video conferencing purposes.

Advantages of MPEG are:

- high levels of compression
- wide-spread adoption
- fully specified software architecture
- both video and audio compression.

The major disadvantages of MPEG-1 and H.261 are:

- inherent low resolution (SIF = 320 x 280)
- high latency (typically 0.7s).

Developments in MPEG compression technology are currently in progress. MPEG-2 is defined as a far higher bandwidth compression for up to HDTV purposes, and MPEG-4 provides real time compression overcoming the MPEG-1 latency problems.

ATM Network

TSL uses the ATM (Asynchronous Transfer Mode) network technology to interconnect components of the system. ATM is a new networking technology which is optimised for continuous multimedia traffic, such as digital video and audio.

TSL has developed a self-contained multimedia interface unit, or “endpoint”, which is directly connected to the ATM network. This is called the N-Point 1000, and up to two multimedia interface options, such as digital video capture and compression, or decompression and display, may be fitted to the same unit.

Each TSL N-Point 1000 module is equipped with an ATM-25 interface. This is a 25.6 Mbps duplex point-to-point network connection. ATM is a connection oriented technology, similar in concept to a telephone exchange. ATM networks are star-connected, with end-to-end connections comprising a number of nodes which are connected by point to point connections. Each endpoint has an identifying name, and tables control the routing through the nodes. This

routing is software controlled, and as each connection path may be different, the principle is that of “switched virtual circuits”—or SVCs.

ATM is not limited to any one transmission speed. There are a number of standard speeds of which 25.6 Mbps and 155 Mbps are common. Typically an N-Point 1000 is connected to a switch which will have a 155 Mbps ATM interface to a backbone network.

Image Capture

The N-Point 1000 can be fitted with either JPEG or MPEG/H.261 options. Each option is provided with video and audio digitising and compression. Each N-Point 1000 has an ARM 610 RISC processor which is used to control the capture and display hardware and interface with the ATM network.

N-Point 1000s are intelligent devices, and the properties of the captured or displayed multimedia data can controlled by the software provided.

Storage

Digital video storage for security applications provides real advantages compared to existing analogue solutions. Data may be stored in a digital form using a number of technologies. These include hard discs and DAT drives. The major advantage of hard discs is the almost instantaneous random access to the stored data. The major disadvantage is cost. Currently a hard disc storage system costs about $300/Gigabyte including fileserver. Each gigabyte represents about one hours recording time of full frame rate video compressed using MPEG-1.

Each frame can be recorded with information encoding its date, time, sequence number and its origin. Data can be recalled from the storage sub-system and displayed on any of the monitoring points. It is possible to display the same data on different monitoring points simultaneously.

The storage system can be programmed to provide information at different frame rates and resolutions. This can be controlled by external stimuli, changes in the picture content, the time of day and other programmable controls, as well as by direct operator intervention.

Monitoring & Display Points

Information may be displayed on television monitors or on PC displays. The appropriate hardware decoder must be provided for each display device.

TSL can provide three display solutions:

	MPEG-1	H.261	JPEG	Multistream
N-Point 1000				
PC Display				
Set Top Box				

Alarms and Access Control

A fully digital system can be interfaced to other security systems such as access control systems and alarm systems. As this technology is developed, it should be possible to produce fully integrated surveillance, security and access control systems.

Advantages of a Digital System

Fully digital systems have a number of significant advantages to offer users. This is particularly true where the scale of the system increases.

Digital systems coupled with digital storage will allow the distribution and retrieval of information to be far more flexible and far faster than the existing conventional systems. For example, information captured at one point may be made available at a remote point some miles away. This may be useful in apprehending criminals, or as part of search and identification systems.

Additionally, the ability to access a multimedia database which may be associated with the system can also be very beneficial. For example, operators will be able to recall photographs of known persons from the database and quickly compare these with stills which have been captured from video sequences stored in the system.

Storage can be “degrading”, in that every camera could capture continuous video for a short period of time, and then the effective stored frame rate could be reduced by systematically deleting information from the hard disc.

It will be possible to record audio as well as video data. Also audio information may be monitored, and this may be used to control the behaviour of the system.

An additional benefit of the system may be the integration of two way communications and this will extend to members of the security team.

Telemedia Systems Limited System Components

Telemedia Systems is developing a wide range of networked multimedia peripherals, and the management and control software to build systems which employ them. The following example illustrates the potential use of these components. The example uses:

- a number of TSL N-Point 1000 network interface modules c/w MPEG compression option to provide video capture
- an ATML Virata Store c/w TSL media server software
- a number of ATML Virata ATM-25 workgroup switches c/w 155 Mbps interface modules
- a PC c/w network boot and control software using an ATML Virata Link PC interface card
- a number of TSL N-Point 1000 network interface modules c/w MPEG decompression which are used to drive display modules.

Data sheets for some of these products have been attached - further information will be shortly available.

TSL can make available the N-Point 1000 with either JPEG or MPEG-1/H.261 capture and display options. The display option can produce either one large image or a number of small images. Displayed images and stored images from the same camera can have different characteristics if this is required.

An important aspect of TSLs development program is the provision of a software architecture which is specifically designed to simplify the development of applications which use multimedia data in a networked computing environment. The combination of software and hardware components is called the “Open Media Toolkit”.

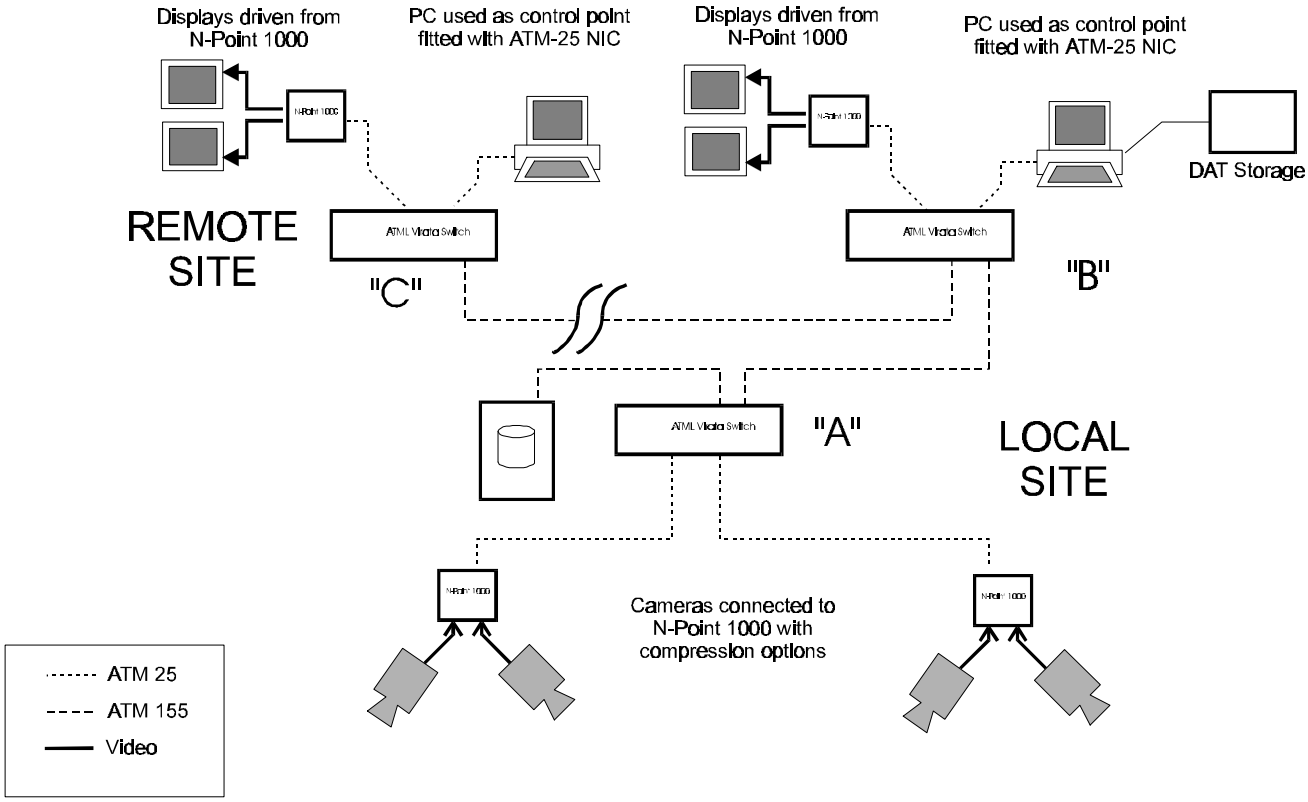
An Example Installation

Four colour CCTV cameras are connected to two TSL N-Point 1000s. Both N-Point 1000s are connected to ATM switch “A” which is also connected to a high-capacity RAID array storage system which provides up to 24 hours storage for four cameras. Connected to the network is a high capacity DAT tape system which is used for long term storage of data.

A second DAT tape system is provided for the purposes of reviewing previous days recordings

A local monitoring site is provided with a controlling PC. One stream of digital video may be displayed on the PC and two additional monitors are provided driven by an N-Point 1000 with two display options. Each display option may display up to four streams of video data in windows, or one stream of video as a full screen image.

The TSL Surveillance Application will be provided which allows cameras to be selected and streams recorded, and also will allow for the number of frames per recording to be selected.



Recorded information is buffered in the hard disc, and can be downloaded to DAT tape on a timed interval basis. Information can be retrieved from the hard disc and displayed directly on one of the monitoring points. Also it will be possible to identify which DAT tape contains information from the last 28 days, as the hard disc will contain a catalogue of what was recorded.

Connection between switch “A” and switch “B” is 155 Mbps. Switch “C” is connected by a long distance fibre to a remote point by another 155 Mbps link. At the remote monitoring point a PC, an N-Point 1000 and two display options are provided to allow further monitoring.

