OPEN TRANSPORT NETWORK (OTN)
SEPTA HIGH SPEED BACKBONE FOR CCTV, VOICE AND DATA

Introduction
As one of the largest transit authorities in the US, SEPTA (South Eastern Pennsylvania Transportation Authority) provides commuter rail, metro, rapid transit, bus and customized community transportation services to the Philadelphia metropolitan area.

By 2011 more than 50 stations at SEPTA will be modernized under the Smart Stations project and will have a new communications infrastructure. This includes the installation of the latest CCTV technology and improved ADA (Americans with Disabilities Act) compliant electronic visual and public address communications systems as well as new life safety systems at each station.

This article explains why the Open Transport Network (OTN) is ideally suited to support these communications and security improvements at SEPTA.

Challenge
The main challenge for SEPTA’s new communications backbone is the integration of voice, data, and video communications along with the modernization of station communications infrastructures.

With this new communication network SEPTA wanted to satisfy the following business needs:

- **Support of all applications**
  Applications range from operational needs such as Telephony, Intercom, Supervisory Control and Data Acquisition (SCADA), LAN networks, Passenger Information Systems and Public Address, to passenger security related services such as emergency call boxes or CCTV (Closed Circuit Television) surveillance. On top of all this, the network must also be capable of supporting new applications as they will appear in the future.

HIGHLIGHTS

- Total solution for the transport of CCTV, voice and data including a redundant Network Video Recorder, NVR
- High Speed 10 Gbps OTN-X3M backbone
- +800 camera CCTV solution including redundant full resolution full frame rate recording
- Use of latest hardened H264 Codec OTN interface card
- 100% separation of services by using segmented LANs, SLAN
- Fully redundant and fail proof solution
• **State of the Art CCTV network**
  To ensure the ever growing security needs to protect passengers and personnel at all times SEPTA needs an open and state of the art high available CCTV network solution.

• **Bandwidth in abundance**
  Because of the high number of video cameras and other bandwidth consuming applications, SEPTA needs a high capacity backbone that provides plenty of room for future expansions and additional applications.

• **Bandwidth guarantee**
  To support all of SEPTA’s applications in a single network, the network needs to guarantee a dedicated amount of bandwidth to each application while maintaining strict separation between the different applications.

• **Reliability**
  As SEPTA’s communications backbone needs to carry back all the vital information to the control center(s), it is mandatory that the network provides the necessary redundancy features to survive component failures (e.g. loss of power supply) or cable breaks.

• **Simplicity**
  The operation of SEPTA’s large transit system is in itself a complex business, so the configuration and management of the communications network must be designed to be as simple as possible.

• **Low operating cost**
  SEPTA has a multitude of systems installed to ensure the daily operations. For SEPTA it is of the utmost importance that the communications backbone is very reliable, robust and maintenance free.

• **Future Proof**
  Unlike office network equipment, which is usually replaced after 3 years, networks for transit systems require a life span of 10 to 15 years or more.

**Solution**

**Open High-Speed Communication Backbone**
  SEPTA selected the OTN Systems OTN-X3M-10G communications backbone as the best solution for its communications backbone and CCTV challenges. The OTN Systems solution includes the N42C nodes with BORA-X3M-10G Network Cards, the UNIVOICE and T1 voice cards, ET100DAE Ethernet cards and H.264/AVC video interface cards.

The OTN communications backbone is able to support Ethernet/IP, video, voice and data legacy applications directly, without the need for external adapters or signal convertors.

OTN provides an integrated network management system, which manages everything from the optical fiber connection down to the application interface port being an Ethernet/IP port, H264 video codec port, low speed data port or a voice port. This makes the network management easy and facilitates maintenance, which in turn further decreases operational costs.

**Result**

**Secure Backbone for Ethernet**

In a traditional Ethernet network the applications share the same cloud and every network element in the cloud is responsible for traffic shaping. Via priority VLAN queues quality of services is provided but no bandwidth per service can be guaranteed.

In a Segmented LAN or SLAN, OTN Systems considers the cloud as nonexistent. Each application has its own ‘lane’ or layer in the network, with guaranteed bandwidth. This is possible because of a technology called Time Division Multiplexing (TDM). Thanks to the SLAN concept OTN can guarantee total network virtualization that can be controlled and provisioned by a few simple clicks in the management system. This way SCADA, CCTV, voice telephone and other applications run 100% separated on the OTN, without interfering with each other.

**Cyber Security**

By separating application data from the network management communication channel, the network can provide better resistance against hackers.

The use of dedicated network technology rather than office or public telephony equipment, also limits the number of potential hackers with the right knowledge and tools to disturb the transit system’s operations.

**Reliability**

To avoid impact on the operation, back-up features are operational within 200ms. Because the OTN network is designed to guarantee high reliability and redundancy even in the harsh environment of an outdoor cabinet or tunnel equipment shelter, the OTN network has a huge impact on reducing cost of operation and increasing passenger comfort.

The use of an optical fiber infrastructure also provides an excellent immunity to electromagnetic noise, caused by the trains or other trackside equipment.

**Future Proof**

Unlike office network equipment, which is usually replaced after 3 years, networks for transit systems have a life span of 10 to 15 years or more, during which period OTN guarantees product support. Furthermore, downtime for upgrades or updates has to be avoided or must be limited to a strict minimum, usually during the night. Therefore the design of SEPTA’s network is such that it can grow with the increasing need for new applications, with limited or no downtime. Also intermediate firmware updates are kept to a strict minimum and are designed not to disrupt the network communication.

**State of the art CCTV concept**

An important issue in SEPTA’s daily operations is passenger safety. Using a dedicated amount of bandwidth on the backbone, more than 1500 camera images are transported redundantly over the network.

The camera images are encoded by high quality H.264 video encoders, which are integrated in the OTN network nodes. The encoded digital video information is then transported over the OTN network to two different locations where the images are recorded on redundant storage servers of hundreds of Terabyte each. This provides the necessary capacity to record all cameras for a minimum period of 10 days. The total system can be easily extended to support more cameras and more storage.
The live and recorded images can be viewed by means of an NVR (Network Video Recorder), which also allows live monitoring. The NVR can be used to search for specific events in the recorded footage. In case of an incident, the NVR is used to provide proof to the proper authorities.

SEPTA’s innovative choice for a redundant centralized video recording solution based on the newest NVR technology rather than the classical DVR solutions provides some important advantages:

- Full redundant centralized storage in 2 location: disaster proof, TCO (Total Cost of Ownership) optimized
- First of all, the recorded video images can be stored on standard IT hardware. This means that standard RAID (Redundant Array of Inexpensive Disks) technology can be used to avoid the loss of recorded images in case a storage hard disk fails.
- As the number of cameras increases over time, or if the images have to be stored for a longer period, the NVR’s capacity can easily be upgraded (flexible & optimized scalability) by installing additional storage disks in the storage array. By comparison: if a DVR’s single hard disk fails, all images recorded on that DVR will be lost; if the number of cameras in a station exceeds the capacity that can be handled by the DVR, an additional DVR will have to be installed in that station.
- The fact that the recording solution is centralized also means that it is easy to maintain, low TCO and high ROI (Return on investment). The OTN network nodes that are installed in the field and which contain the video encoders are designed for the harsh conditions of a trackside or station based equipment enclosure. The most sensitive part of the solution (the storage disks) can be installed in a suitable location close to the operations control room(s). In case a (redundant) hard disk fails, it can easily be replaced by a disk from the spare stock which is maintained centrally. This eliminates the need to go on site to the station as would be the case if distributed DVR’s were used at each station.
- Central management that monitors the end-to-end solutions and helps to lower installation, management and replacement costs.
The OTN Systems H.264 Video CODEC Integrated into the OTN-X3M Backbone

The H.264 AVC video card is plugged directly into the OTN-X3M backbone. The analog signals coming from the cameras are first being digitized and after compression mapped into Ethernet packets and send over the OTN-X3M 10 Gigabit backbone in a segmented LAN.

Advantages of having the H.264 Video CODEC Integrated in the Backbone
- There is a complete overview of the network including the CODEC’s in the OTN Management System.
- The OTN Management System constantly monitors the network and receives data related to the operation of the different nodes and the interface cards installed including the H.264 AVC video interface card. The alarm messages indicate the nature and location of errors. Time and efforts will be saved in locating these errors and immediately solving the issues.
- The configuration setting of the H.264 AVC video interface card is in the system card. This is an advantage in case the H.264 AVC video interface card needs to be replaced. The actual replacement can be done by an electrician and no configuration occurs at the remote site.
- The most expensive and fragile part of the IP security is in a controlled environment. The cheaper analog cameras can be put in a vandal rich environment and the investment has optimal protection.
- A throughput of 3.1 Gigabit per second per segmented LAN is available.

Advantages of using the OTN Systems H.264 AVC interface card
- H.264 (= MPEG-4 part 10) is the latest efficient compression technique which saves bandwidth and provides accurate detailed pictures.
- 16 Channel H.264 AVC is the smallest 16 channel encoder/decoder in the world thanks to its unique way of using a special connector cable (DB50).
- The 16 channels can be used as input (encoder) or as output (decoder). One interface card has both functionalities and can be used for different applications. The images on the output can be switched through a Video Management Software.
- The 16 channels are independent of each other; one video stream cannot influence another stream. Multiple encoders can be assigned to one video input. This will provide multiple streaming with different settings.
- The two control ports are used to send the PTZ data from the transmitter to the receiver.

H.264 AVC interface cards
The H.264/AVC cards are used to transmit up to 16 PAL or NTSC video signals via OTN-X3M.

Analog CVBS video signals are digitized and compressed by the video input circuit, and transmitted over the OTN-X3M network to one or more analog or IP video outputs. For IP outputs, the compressed digital video data is mapped into IP packets, while for analog outputs, the compressed digital video data is decompressed and converted to an analog PAL or NTSC signal. A single H.264/AVC card can be used both as input and output (analog & IP).

For more information regarding the H.264/AVC card refer to the spec sheet.

ET100DAE card (10/100/1000 Mbps)
The ET100DAE interface card is fully compliant with the IEEE 802.3 standards and allows to create fully transparent Ethernet networks through the OTN-X3M.

The ET100DAE card supports 12 independent Ethernet segments (SLAN) over an OTN-X3M network. The 12 front panel ports can be configured for separate operation, each over its own Ethernet segment, and can also be interconnected in different modes.

The bandwidth through the OTN-X3M is selectable from 1 Mbps to 784 Mbps via the OMS. The 784 Mbps aggregate bandwidth of an ET100DAE-card can be subdivided over its maximum 12 independent Ethernet segments (SLANs). For more information regarding the ET100DAE card refer to the spec sheet.

SEPTA & OTN Systems: Long-Time Relationship
SEPTA’s successful implementation of OTN’s innovative networking and CCTV solution is based on more than just technology. It is also a matter of people and trust. Based on OTN’s successful track record at SEPTA over the last 10 years, the choice for the new 10 Gbps OTN System is proof of this long term commitment.

Since 1990 OTN Systems has developed and deployed dedicated fiber optic communications networks for metros, light rail systems, people movers and railways in 34 countries all over the world. This long term relationship with more than 100 leading transport authorities has led to the continuous innovation of the Open Transport Network, so that it meets today’s and future requirements.

For more information about SEPTA, please refer to http://www.septa.org

If you would like to learn more about OTN System’s products such as the new OTN-X3M 10 Gbps platform, or if you would like to visit a company that uses OTN in your area, please contact us at info@otnsystems.com or visit www.otnsystems.com