Large surveillance systems
System Overview Document
# Table of contents

Overview 3  

1. Purpose and motivation 3  

2. Overview of the networks 4  

2.1 Outdoor network 4  
2.1.1 The Core 4  
2.1.2 The Outdoor Stations 6  
2.1.3 Milestone VMS 6  

2.2 Indoor network 7  
2.2.1 The Control Center 7  
2.2.2 The Core 7  
2.2.3 The floors 9  
2.2.4 Allied Telesis switch network configuration 9  
2.2.5 Genetec VMS 10  

3. Further reading 10  

Appendix I 11  
Appendix II 14
Overview

During May 27-31, 2013, Axis Communications AB hosted a global technical conference with participation and cooperation from partners including ABB, Allied Telesis, Firetide, Genetec, HP, NetApp, Microsemi, Milestone, Moodifier, Raytec, Veracity, and Weidmuller. The conference theme was Large Surveillance Installations. Two separate and fully operational Video Surveillance Systems (VSS), deploying different technologies, was set up and tested; one indoor network and one outdoor network, each with 1000 cameras.

It is important to know that the naming of the 2 systems depends only on the cameras. In the outdoor system both indoor and outdoor Axis cameras were used, whereas in the indoor system only indoor cameras were used. The other components in the VSS works well with both indoor and outdoor installations.

This paper describes the purpose and goal of the conference and provides an overview of the two video surveillance systems. More detailed papers on the configuration and setup of each system will also be made available.

1. Purpose and motivation

Video surveillance has moved to the forefront globally to serve the security needs within military, government, utilities, corporate, medical, retail, hospitality, transportation, education, and more.

Today, large IP Video Surveillance Systems (VSS) consisting of over 1000 cameras are becoming more common. In a large campus network, or Metro-Area Network (MAN), the IP video surveillance system is typically overlaid on an infrastructure that has been designed to carry multiple applications and services. Such a network, supporting a significant number of end users, needs to be very reliable, manageable, and scalable.

The demand from users of a system that delivers high-resolution, high-definition, real-time results also put higher requirements on a reliable high-speed IP network infrastructure. To ensure this, network equipment, cameras, the server/data center, the monitoring center, as well as the Video Management Systems (VMS) all must be working together effectively in harmony. This presents great challenges for the system integrators and engineers. There is no one solution that fits all.

During the Global Technical Conference, a state-of-the-art, large scale digital video surveillance system with 1000 cameras was deployed. The purpose of the deployment was to highlight the critical components of this kind of system through testing and troubleshooting to identify bottlenecks, limitations for network design, configuration, reliability and scalability.

Another objective was to clearly identify building blocks that can be easily copied in order to design a highly reliable, manageable, as well as scalable system. During the conference, tests to identify the minimum memory and storage configuration to support such large networks were conducted. As two separate technical solutions were set up, we had the ability to compare the performance of Blade versus Rack servers. We also tested how to make better use of the servers by adding on Hypervisors to increasing the number of VMS recording servers per physical server. These findings are presented in two separate white papers. Please refer to “Large surveillance systems – An Allied Telesis, Axis, Genetec and NetApp joint solution guide” and “Large surveillance systems – An Axis, HP and Milestone solution guide” for more details. The system integrators and engineers will be able to refer to these papers as solution guidelines.

The stakeholders of the event were experts of leading companies within the following fields: IP cameras, network switching, computer servers, fiber interfaces, VMS providers, wireless manufacturers, structured cabling and network storage.
2. **Overview of the networks**

During the conference, two completely separate networks supporting two VSS was configured and tested with different technologies. The two VSS setups varied in both hardware and software. One network was installed for outdoor – and the other one for indoor environment. Each network consisted of 1000 cameras. It was not physically possible to test with 1000 cameras during the one week conference period. To build the 1000 camera solution a combination of real- and simulated cameras were used. Axis Virtual Camera (AVC), a software application that generates multiple virtual cameras streams from an actual physical camera was used to replicate. About 50 to 70 physical cameras were installed in each network; the rest were virtual cameras generated to simulate the actual data traffic and bandwidth requirement for such a large system.

2.1 **Outdoor Network**

The network was divided in different outdoor stations connected via fiber, wireless and copper. The core of the network was located in a customized 40ft shipping container. The container contained servers, storage, core switch, power supply, workstation, video screens, cameras, lighting, cooling and heating system, i.e. all the necessary equipment to support the 1000 camera network. The network had 52 physical cameras installed. Of these, 22 of them were installed inside the container and 30 were distributed among the four outside stations. Please see the diagram in Appendix II for details. The rest of the cameras were simulated through Axis Virtual Cameras (AVC).

2.1.1 **The Core**

The core of the network consisted of two racks with the equipment illustrated in Figure 1

*Figure 1. The core of the network consisted of two racks with the equipment.*

1. HP BL460c Gen8 E5-2660 2P 96GB blade servers

2. HP BLc7000 Blade enclosure, the enclosure supports up to 16 blade servers.

At the conference, seven HP BL460c Gen8 E5-2660 2P 96GB blade servers was mounted in the blade enclosure. On each server, Hypervisor from Microsoft HyperV was used to manage the virtual machines. Each server ran 2 virtual machines with Windows Server 2008 and Milestone XProtect® Corporate software VMS on top to manage the video data. Each virtual machine supported 150 cameras.
3. HP 3PAR P7400 SAN Storage System

4. HP R12000/3 UPS

5. Microsemi PD-9524G/ACDC/M-1 Midspan Rack Power injector 60w per port X 24 ports

6. Veracity rack with 2 Longspan – Long Range Ethernet and PoE extended Ethernet range up to 600 meters with PoE

7. HP 3800-48G-PoE+-4SFP+ Core Switch connecting camera data streams to the servers

8. HP Z420 Workstation

9. AXIS Q7900 Rack with 2 T8647 coax converters for PoE over coax, and 1 Q7406 encoder blade for coax connection to analog cameras

10. Power supply for coax conversion

11. 3 HP DL360e Gen8 E5-2430 8SFF Perf EU Servers for AVC

The outdoor network had a centralized virtualization of cameras. 52 cameras were connected though access switches to the system and the virtualization was managed at a single location from these three AVC servers.

Figure 2 provides a rear view of the HP network, server and storage solution in the rack.

Figure 2. Rear view of the HP network.
2.1.3 The HP 3800-48G-PoE+-4SFP+ core Switch is connected to 4 HP 2530-24G-PoE+ networks switches coming from the 4 outdoor stations.

2. The HP Blade System c7000 enclosure with 7 server blades and 2 Virtual Connect FlexFabric modules, installed in I/O Bay 1 & 2.

3. HP 3PAR P7400 SAN array using the FlexFabric feature of the HP Blade system, eliminating the need for SAN switches in the configuration.

The configuration provided a highly reliable solution that used a small number of 10Gb uplinks into the network from the blade system and four fiber cables to connect the storage array holding the video data. As can be seen in the configuration shown in Figure 2, using this technology, the performance required by 1000 cameras can be contained within a single rack. Only four cables were coming from the rack to the network, as the uplinks to the cameras and all other network and SAN cables required by the multiple rack servers were configured inside the blade server through a single web-based interface. As a consequence, the power and cooling required, as well as the floor space, are radically decreased. This makes the setup a much greener solution for a typical customer environment.

2.1.2 The Outdoor Stations

A total of four outdoor stations with different cameras were set up to run different workshops for testing the Axis camera products. Each of the stations was connect through 1 Gbps copper cable from a HP 2530-24G-PoE+ Switch to the core switch in the container. The stations were also daisy-chained together via fiber cable. A total of 30 cameras were installed in the four outdoor stations.

2.1.3 Milestone VMS

For the outdoor network the Milestone XProtect® Corporate suggested solution was deployed to manage and operate 1000+ cameras. Figure 3 illustrates this solution.
As the foundation for this, we provided a standard installation, with one physical Management Server / SQL Server, five physical Recording Servers with two virtual machines of each server. In addition, the setup included one Fail-over server with two virtual machines.

We even installed and configured a Mobile Server on the same machine as the Fail-over Server in order to provide a wireless network (FireTide). This allowed for clients connecting to the Mobile Server.

To demonstrate the options for centralized solutions, we also will installed Milestone’s Smart-wall solution which addressed the market for tactical/situation rooms, monitoring centers, etc.

Once operational we were able to demonstrate features such as:

> Easy-to-use daily operation using XProtect® Smart Client and Smart Wall
> Scenarios for using SD card in cameras
> Secure connections and exports using HTTPS
> How to change settings for multiple cameras in one shot!
> Cost-efficient solutions using 64-bit technology and multi-stage storage
> Alarm management

2.2 Indoor Network

In order to recreate the processing and bandwidth demands of a 1000 camera indoor network, 68 physical cameras were installed and distributed over four Axis buildings in Lund. AVCs were installed on one HP DL360p server and laptops in the network to replicate streams from actual cameras. The indoor network was managed from the control center on the first floor of the J building in Axis’ headquarters at Emdalanvägen (J1). This network used multicasting and all switches supported IGMP.

2.2.1 The Control Center

The control center was located in J1. There was a video wall with five HP monitors, eight cameras and eight AT-8000GS/24PoE or AT-x610-24Ts-PoE+ in two lab rooms. Two HP Z420 workstations with Genetec Security Center client software were also installed in the control center.

2.2.2 The Core

The core of the indoor network was located in the H building (H0) and consisted of five high-end servers by HP, running Windows Server 2008. There was a storage system by NetApp, with raw capacity of 180 TB, and a core switch with two SwitchBlade x908s switches in stack configuration by Allied Telesis. The switches provided connectivity to the system elements, hosts and cameras. Figure 4 illustrates the rack view.

1. One HP DL360p Gen8 Server. The server ran Windows server 2008 with AVC and NetApp SANtricity 10.84 on top. The SANtricity management client configured and administrated the NetApp E-5460 storage system installed in the core of the indoor network.

2. Five HP DL 360p Gen8 E5-2650 servers. On each server VMware ESXi 5.1.0 U1 HP branded release was installed as the hypervisor. Each server was virtualized into four virtual machines running Windows Server 2008 with Genetec Security Center 5.2 VMS on top. Each virtual machine had four file archivers with 240 Mb/s throughput per archiver handling 50 cameras per archiver.
3. The core switch in stacking configuration with two Allied Telesis SwitchBlade x908. This powerful Allied Telesis core switch was an extremely feature-rich Quality of Service switch that can manage the characteristics of over 1,000 separate data streams simultaneously. This made the servers ideal for the provisioning of shared service networks involving real-time applications at low-latency switching capability. The two AT-SBx908 switches formed the "virtual" network core. 16 access network switches were connected to the core with two aggregated links, one to each member of the stack. The use of link aggregation was made possible because the two switches were in a single virtual chassis. Such a topology creates a loop-free network with link, and core switch carrier-class resiliency. From the core switch, four fiber cables connected towards NetApp Storage System E5460. Each port could work up to 10Gb/s and supports iSCSI protocol. The core switches could easily be configured by CLI (Command Line Interface) or Web browser with industry standard syntax command configuration.

4. NetApp Storage System E5460, the NetApp E-Series storage array, is targeted for the video surveillance market. It is a sixth-generation storage array that includes patented mechanical engineering, providing dense, scalable, and highly reliable bandwidth and capacity. The disk controller firmware supports an optimal mix of high bandwidth, large-block streaming and small-block random I/O.

The E5460 is targeted at Fiber Channel deployments. The solution deploys dual controllers for high availability. All components of the E-Series are hot swappable; firmware upgrades can be completed while the system is operational. The E5460 also features dual-active controller with automated I/O path failover. Both controllers have a data path to all shelves and drives in the array. Both controller models deploy cache memory for read and write buffering. In the rack, four Twinax Direct Attach SFP + cables connect the 10 Gb/s fiber ports in the two controller cards back to the core switch's optical interfaces. A total of 60 disk drives are installed in the enclosure, 58x HDD spindles with 3TB capacity each and two 800 GB Solid State Drives each.

Figure 4. The rack view of the core of the indoor network.
2.2.3 The floors

A total of 68 physical cameras and 20 laptops ran AVC to generate additional cameras streams to meet the 1000 camera network bandwidth usage. Cameras and laptops were placed out on the 14 floors of the Axis Communications HQ, in the F, G, H and J buildings. On each floor, one AT–GS950/16PS network switch was installed to connect to the cameras and laptops through copper cables. These switches were then connected via 1Gbs fiber cables to the patch panels of each building and further connected to the core two SwitchBlade x908s through 1Gbs fiber cable.

2.2.4 Allied Telesis switch network configuration

To support the IP video network and enable remote camera control and operation, a high-speed IP/Ethernet network with its design and functionality tailored to IP video applications was required.

The requirements for this kind of network infrastructure are best met by a network design in which different services are split into different VLANs, and transported over resilient links or rings protected by an extremely fast failover mechanism.

Figure 5 illustrates the network configuration proposed by Allied Telesis.

Figure 5. The network configuration by Allied Telesis

As real-time video is sensitive to latency and buffering, no service downtime is allowed. The Allied Telesis fast failover network protection solution is the Ethernet Protected Switched Ring (EPSR, a ring protection protocol) and Virtual Chassis Stack (VCStack). Please see more information in WP3. These are extremely reliable, high-performance protection mechanisms that can restore connectivity within <50ms of a link failure being detected. Services such as IP video surveillance can each be provisioned with one or more VLANs running over the EPSR rings or Aggregated Links (LAGs) with data on Layer 2 or Layer 3 switched between the rings, the links and the central site facility.

A reliable, scalable design was achieved by subtending multiple rings of two SwitchBlade x908s with VCStack providing the gateway between the rings and central site.
Robust access as AT-GS950/16PS WebSmart network switches or AT-x610/14TsPoE+, both featuring PoE+ for connectivity with security cameras integrating simplicity with the performance and reliability of managed switch; thus providing an inexpensive yet secure and reliable solution for users to integrate management at the edge networks.

2.2.5 Genetec VMS

The VMS chosen for the indoor surveillance system was Genetec Security Center 5.2. It was dimensioned to manage about 1000 cameras by 20 archivers distributed over five physical servers. Please see Appendix I for more information of Genetec’s system design.

3. Further reading

The purpose of this paper has been to provide an overview of the actual setup of the two systems at the conference. To learn more about installation, configurations, and best practices, please refer to the white papers “Large surveillance systems – An Allied Telesis, Axis, Genetec and NetApp joint solution guide” and “Large surveillance systems – An Axis, HP and Milestone solution guide.”
Follow the steps for:

1. HP BL460c Gen8 E5-2660 2P 64GB servers
   - Handling 150 cameras per server
   - Milestone XProtect Corporate
   - Microsoft Hyper-V

2. HP BLc7000 Blade enclosure
3. HP 3P AR P7400 SAN Storage
4. HP R12000/3 UPS
5. Microsemi PD-9524G/ACDC/M-1 Midspan Rack Power injector 60w per port X 24 ports
6. HP 3800-48G-POE+-4SFP+ Core Switch
   - Connecting camera data streams to the servers
7. HP Z420 Workstation
8. AXIS Q7900 Rack with
   - 2 x T8647 Coax converters, PoE over coax
   - 1 x Q7406 encoder blade for coax connection to analog cameras
9. HP DL360e Gen8 E5-2430 8SFF Performance Server for AEC

Figure 1. Outdoor Network Container view

Figure 2. Outdoor Network Container Rack View
Figure 3. Outdoor Network Milestone VMS Configuration

Figure 4. Outdoor Network Station View
Figure 5. Indoor Network Diagram
The Security Center is a unified security platform. It seamlessly blends Genetec’s IP license plate recognition, video surveillance, and access control systems into one innovative yet simple solution. With an intuitive interface, the Security Center facilitates the seamless management of multiple security and safety systems, regardless of installation size.
System Design Assumptions

Network
A fully IGMPv2 & v3-compliant multicast network backbone is required for this system architecture.

Archiver SQL Databases
Archiver SQL databases are to be stored locally on each server to improve performance. SQL Express will be used for each archiver.

Server Requirements
High-End server hardware is required for each Genetec server. Virtualization will be used in this system design. Vmware ESXi 5.1 will be used. Dedicated NIC cards are necessary for each virtual machine set up.

Each Genetec server shall meet the minimum system requirements shown below.

- Quad core Intel Xeon E5640 2.66 Ghz or better
- 8 GB of RAM or better
- 80 GB SATA II hard drive or better for the OS and Security Center applications
- Standard SVGA video card
- 1024x768 or higher screen resolution
- 100/1000 Ethernet network interface card
- DVD ROM drive
- Windows Server 2008 SP2/R2 (64-bit)

The Archiver Server
The Archiver server and bandwidth requirements have been calculated with the following assumptions:

- All cameras shall record continuously and display the same video quality: H264, 30 fps, maximum resolution.
- The maximum network throughput is 5 Mbps per camera. 21 archivers are necessary to handle the 1000 cameras in a virtualized environment. An additional server will be used for the Directory.

Client Workstations Requirements
A number of 30 clients' workstations will be deployed and they shall meet the system requirements shown below.

- Intel Core i7 2600 @ 3.4 Ghz or better
- 8 GB of RAM or better
- 80 GB SATA II hard drive for OS and Security applications
- 1 GB PCI-Express X 16 dual head video adapter
- 1600X1200 or higher screen resolution
- 100/1000 Ethernet network interface card
About Axis Communications

Axis offers intelligent security solutions that enable a smarter, safer world. As the global market leader in network video, Axis is driving the industry by continually launching innovative network products based on an open platform - delivering high value to customers through a global partner network. Axis has long-term relationships with partners and provides them with knowledge and ground-breaking network products in existing and new markets.

Axis has more than 1,600 dedicated employees in more than 40 countries around the world, supported by a network of over 65,000 partners across 179 countries. Founded in 1984, Axis is a Sweden-based company listed on NASDAQ OMX Stockholm under the ticker AXIS.

For more information about Axis, please visit our website www.axis.com.