Large Public Facility Video Surveillance System: China National Convention Center (CNCC), Beijing China

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In the heart of the Beijing Olympic Green, the China National Convention Center (CNCC) is right next to the Bird's Nest (China National Stadium, site of for the Olympic Games opening and closing ceremonies and many track and field competitions), the Water Cube (National Aquatics Center) and National Indoor Stadium. After the Olympic Games the CNCC complex will be reconfigured to consist of a Convention Center, CNCC Grand Hotel, InterContinental Hotel and two office buildings. The revised Convention Center alone will span 398m long, 148m wide, 42m high and include eight upper floors, two basements, and a shopping mall.

The Fencing Hall, also part of the National Convention Center complex, will be a competition venue for both the Olympic and Paralympic Games in 2008. The fencing event and the fencing and air pistol disciplines of the Modern Pentathlon will be held in this hall for the Olympic Games. During the Paralympic Games, the competitions will include Wheelchair Fencing and Boccia. Also, the CNCC will house the International Broadcasting Center (IBC) and Main Press Center (MPC).

The Olympic Games configuration of the CNCC consists of a training hall on the first floor with 14 fencing strips and capacity for 1,800 spectators. Games-time management offices will be located on the second floor. A warm-up hall on the north side of the third floor will feature 12 fencing strips, the athletes' lounge and shower rooms. A television broadcast room is also situated on the third floor, south side, and other sport events will be held in a 7,000-sq m, five-strip competition hall on the south side of the fourth floor, with capacity for 6,000 spectators.

A large facility such as this, designed for high profile visibility and varied applications including mass attendance spectator events with VIP celebrity and state official attendance, requires special security attention. That was certainly the case here with concerned discussions regarding the best techniques and equipment beginning at the very onset of this massive project. All decisions and selections had to meet the strictest scrutiny and high official level approvals.

The Video Surveillance System

The requirements for the CNCC facility are a combination of specifications from several sources. Including; regulations put forth by the IOC, requirements from the Beijing Olympic Committee (BOCOG), requirements from the Sports governing organizations, Chinese government regulations, special event requirements from the Public Security Bureau and finally, venue owner requirements taking into consideration the temporary sporting event and the subsequent convention center and business facility.

Ultimately, the design specifications included the following key requirements; High quality video images, low video latency, temporal and spatial scalability, multiple video streams, real time recording, extensive video storage capability, and integration based on an open platform with a powerful software development kit (SDK) and proven technology with substantial references.

GE's VisioWave Intelligent Video Platform (IVP, shown in Figure 1 below) was the selected product to meet the various regulations, requirements and specifications.

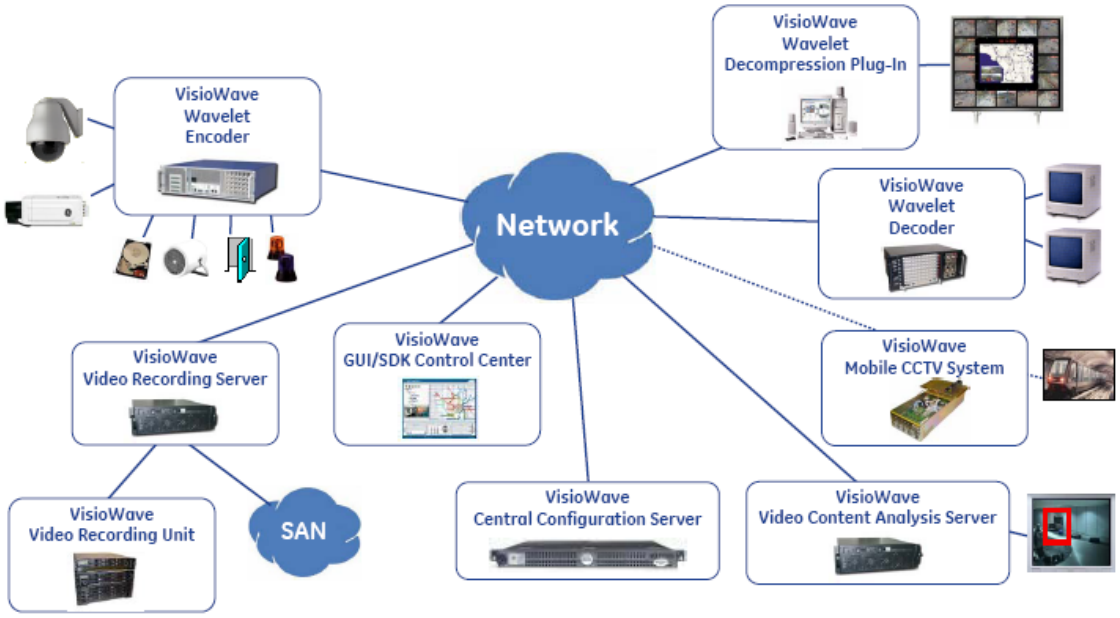

Fig. 1 VisioWave IVP System

High quality video images, low latency

High quality digital video networking requires bandwidth and quality of service (QoS) capable infrastructures along with optimized video compression technologies and content delivery. Bandwidth and quality of service are now available at acceptable costs. But on the video compression side, something is missing.

Existing widely deployed technologies have demonstrated their effectiveness and performances for some applications. But this does not mean that they will be suitable for all applications especially new emerging applications. Table 1 below lists examples of some of the typical characteristics of various video applications.

	Type of data	Nature of data	Target bit rate	Max delay	Minimum quality	Type of comm.	Functionalities
Video Surveillance	Low motion Video	Natural	3-6 Mbps	300 ms	25-50 fps, FULL	MP2MP	Fast frame access
Video telephony	Static Video	Natural	<500 Kbps	200 ms	10 fps, QCIF	P2P	Scalability
Telemedicine	Video Still pictures	Hybrid Text	> 5 Mbps	< 1 sec	50 fps, FULL	MP2MP	Scalability, Editing....
Digital TV	High motion Video	Natural, text, synthetic	< 1 Mbps	< 1 sec	25 fps, FULL	P2MP	Record, fast frame access
Corporate TV	Natural Text Synthetic	Natural, text, synthetic	2 Mbps	< 1 sec	50 fps, FULL	P2MP	Scalability
Video conference	Natural Text	Natural, text, synthetic	512 Kbps	< 1 sec	25 fps, QCIF-CIF	MP2MP	Scalability

Table 1: Major specifications for a few of the most critical applications for video coding. Reads "Mbps" Mega bit per second, "Kbps" kilo bit per second, "fps" frame per second, "MP2MP" multi point to multi point, "P2P" point to point, "P2MP" point to multipoint.

An efficient video coding method attempts to remove all redundancies present in the input signal thereby improving compression and retaining image quality. Three kinds of redundancies can be targeted: spatial, temporal and statistical. Spatial redundancy refers to the similarity between adjacent pixels in the image, whereas temporal redundancy deals with the similarity between successive frames in the sequence. Statistical redundancy is related to the changes of the signal after the spatial and temporal redundancies have been minimized, if not eliminated.

Given a set of video coding methods that have demonstrated their superiority on specific applications, VisioWave Dynamic Coding™ uses a dynamic selection of the most appropriate method according to the nature of the data, the target bit-rate and the other specifications particular to the application at hand. To provide the CNCC with high quality video and low latency, the VisioWave system coding limits redundancies. This results in low latency of less than 150ms, instantaneous video switching, no pixelization (critical for PTZ applications and fast moving scenes), no digital artifacts to distract the viewer.

Temporal and Spatial scalability, Multiple video streams, Real time recording

Today's digital video security systems typically use Wavelet or MPEG4 compression technology. However, there are differences in how these compression technologies are implemented. Most common are those that do not include temporal or spatial scalability.

Temporal Scalability is the ability to provide different frame rates (25fps, 12.5fps, 6.75fps, etc.) from a single video stream. Effectively dual-streaming without the additional bandwidth consumption and the option to reduce storage costs. The CNCC application required temporal scalability to store and view video at multiple locations at different frame

rates. For general surveillance 12.5fps could be used, for alarm or event surveillance real-time 25fps was required.

Spatial Scalability is the ability to provide different image sizes from a single video stream (Full D1, CIF, QCIF, etc.). In the interest of conserving bandwidth, the ability to select differing image sizes is invaluable. For the CNCC the benefit is realized by the multiple channels that need full D1 resolution and 25fps recording.

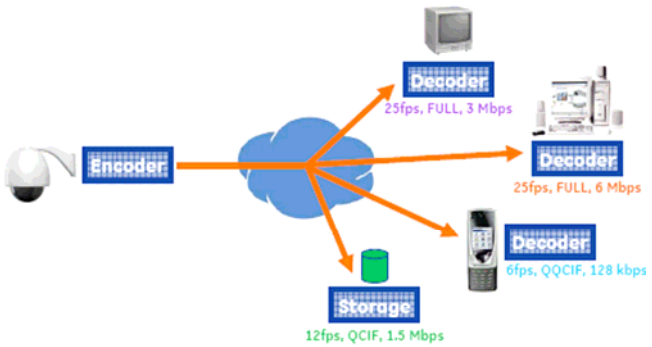

Fig. 2 Example Application using Temporal and Spatial Scalability

Extensive video storage capability

Due to the scope of the CNCC project, with over 1400 cameras and the need to record many in real-time (25fps) at full D1 resolution, the recorded video is a significant challenge. Again the VisioWave solution provided the capability to meet the challenge.

The CNCC required storage redundancy to insure data is never lost and to better manage network traffic including local video storage on the encoder side. This concept prevents the network from being overloaded by video streams. Also, storage is required at the decoder side where VisioWave Evolution is equipped with add-on storage devices. The encoder side has 4TB of storage at each VisioWave Discovery unit. On the decoder side 16TB of RAID5 storage is provided at each VisioWave Evolution.

The Storage Policy Server software service allows setting up the fine details of the storage policy such as video quality, location, scheduling, maximum file size and manages the hard disks as well. This capability is very important at the CNCC due to the varied camera applications, diverse event programs and ultimately wide range of recording practices. Associated with the Event Manager Service, the Storage Policy Server software service also handles on-alarm storage (including pre/post alarm recording).

One of the advantages of the VisioWave solution is that each video port has its unique video processing unit where as with typical DVR the video ports share the same video processing unit. The recorded files are stored using the name of the camera (could include the camera number and the IP address), the date (YMD) and the time (HMS). This format is very useful for retrieval operations. In the CNCC, multiple control locations, including a C3 management system need access to recorded video. The VisioWave SDK provided the search facility to obtain recorded images by camera, date and time of the day, as the recorded video images are time stamped.

The recordings can also be programmed to work in FIFO (Ring Buffer) mode to allow new video clips to over write old clips. However, over-writing protection functions can be programmed that will not allow the user to delete or edit previously recorded video data. Pre/Post event/alarm recording is performed independently from normal recording. You can set specific recording parameters as fps and duration. In the same way, the Pre/Post event recording has its own memory ring buffer. You are simultaneously recording normal activities and event activities. The difference lies in the fact that for Pre/Post recording the recorded video streams are deleted if no event is generated. In case of alarm, the file used for the recorded video stream will be kept and protected against deletion.

Playback of recorded video in the CNCC application uses several tools available. Playback controls include; Stop, pause, play fast or slow motion (1/5 to 5 times normal speed), see image per image forward, backward, and print current frame or download to DVD. Playback frame by frame is possible. You can stream recorded files directly to hardware decoders for display on analog monitors, play back several recorded videos in parallel in fully synchronized mode so events can be tracked through several video channels. The system also will simultaneously record, play back and video stream (triplex mode). Lastly, you can generate an alarm when the storage medium has fallen below a user selectable threshold to prevent stoppage of recordings.

Integration; open platform with a powerful software development kit (SDK) and proven technology with substantial references

An important factor in the CNCC project is the need to integrate into other systems including a C3 management system and overall Olympic Games management systems. A key factor in selecting VisioWave for this project was its flexible and comprehensive software development kit (SDK). The SDK incorporates an extensive library of sample source codes for a short learning curve and inspiration for innovative applications. Object-oriented, ActiveX-based application programming interfaces (APIs) provide a familiar programming environment and compatibility with all standard compilers.

For video analytics software, a plug-in development kit (PDK) is available. The PDK provides a programming environment for developers of third-party analytics to integrate with the VisioWave platform. The PDK makes it easy to share architecture and extends the capability of the security system into various third-party video analytics. As technology improves, new ways to monitor and analyze video will continue to be developed. Applications such as

crowd management, forensics, object left behind, human detection, license plate recognition, people counting, perimeter intrusion detection, smoke detection, suspicious behavior detection, traffic law enforcement, waiting line measure and wrong way movement detection can be integrated with the PDK.

Video Authentication

Protection of the stored video from manipulation of data is a serious concern at the Olympic Games and the CNCC. For digital video, recordings are only as reliable as the ability to verify their integrity. VisioWave provides CNCC with tools for verification of the authenticity of extracted video sequences. For a given sequence, the verification tool outputs a detailed report on the state of all images found. Any image or audio can be categorized as one of the following states: Authentic: It is guaranteed that the image or audio content is the original one and that the image or audio content has been captured by the expected source (expected equipment and camera) at the expected time. It is also guaranteed that the signature is genuine. Altered: The image or audio content and/or its origin are not authentic, or the signature is fraudulent. Missing: The image or audio content is lost. Un-checkable: The image or audio content has not been signed, or the signature is corrupted. With digital signatures and digital certification and authentication tools, video and audio can be verified for use in legal proceedings.

Reliable Video

Another major concern for CNCC was the reliability of the system and the video images. During the Olympic Games the system can not afford to fail; it must consistently provide quality video. The Video Content Analysis (VCA) software within VisioWave provided the assurances needed for the CNCC. The VCA analyzes live or recorded video streams, warns of unusual events and alerts for irregular camera performance, providing security personnel and control room staff more time for critical tasks. Problems such as over and under exposure, blurred images, occluded or obstructed lenses, and displaced or improperly aimed cameras can be detected and prevented, and activity detection with regions-of-interest settings is available.

In addition to VCA software, the VisioWave IVP system can instantaneously access all devices and monitor performance. This includes status of video ports (inputs, outputs, connected, not connected), health of hard drives, including any predictable failures, internal temperature of device, temperature of hard drives, fan speed, network statistics, activity and errors, network traffic (IP unicast, IP multicast and Asynchronous Transfer Mode (ATM), and statistics on connected network interfaces (Ethernet and ATM)

Other important reliability capabilities include: Configuration data can be accessed anywhere on the network using a standard web browser (secured by password if necessary), each Video card is hot swappable, storage using RAID5 technology provides fault tolerant storage solution, all programmable settings are stored in non-volatile RAM, the complete data configuration file can be exported for archive for security purposes and

easily reloaded typically within 15 seconds, every piece of video equipment is able to reload its configuration when replaced for repair or at reboot without human action.

Networking Features

Video is distributed throughout the CNCC facility and therefore numerous network devices are in place to manage the video and data. The VisioWave solution relies on an intelligent usage of standard IP networking technologies and features. Most important is quality of service (QoS), switching or routing. The system supports network adapters for Ethernet 10/100/100 TX network connectivity, IP Multicast (IGMP v1/v2 and v3 when using Windows XP), Unicast, constant quality or constant bandwidth video streaming, guaranteed minimum bandwidth requirements and traffic shaping (dynamic bandwidth management with no image disruption), Ethernet class of service at the layer 2 (Ethernet) 802.1p/Q and at the layer 3 (IP) with the TOS (Type of Service) of the IP datagrams, RSVP and DiffServ (Windows 2000/XP internal QoS engine).

Alarm/Event Management

To obtain an effective security and safety policy, a video security system is often operating in connection with its external environment. In the CNCC there are hundreds of alarm sensors providing information such as door openings and motion detection, as well as fire, smoke, water or gas detection. The system itself is able to send electrical information to external devices according to specified events or situations. In input mode (trigger in) the system executes automated actions such as video switching, start/stop video recording, camera PTZ preset through its connection with other VisioWave Services. In Output mode, the system can generate electrical pulses to any external device for any actions such as triggering lamps, sirens, or activating gates.

Intelligence at Work

While the wide range and scope of security requirements for the Beijing 2008 Olympic Games are a clear challenge, far more challenges lie ahead for security in Asia and the world at large. The Olympic Games are a unique opportunity to showcase highly innovative products and services that undergo extreme scrutiny to prove their world class capabilities. The host cities offer numerous opportunities for GE to provide a broad range of technologies from energy and lighting to water and transportation and security systems that can help build a foundation for successful Games and a safer world.

Appendix – Facility Statistics

Olympic Venue: Fencing Hall of National Convention Center
Location: Olympic Green
Use for Beijing 2008 Olympic Games: Fencing preliminaries and finals, and Modern Pentathlon (fencing and shooting)

Use for Beijing 2008 Paralympics Games: Boccia and Wheelchair Fencing
Floor area (sq m): 56,000
Building area (sq m): 530,000
Temporary seats: 5,900
Groundbreaking date: April 28, 2005

Video Security System Scope for Olympic Games configuration: over 700 cameras, 5 control centers, VisioWave Intelligent Video Platform consists of: 70x Discovery 2400 digital video encoder, 2x Evolution 2800 decoders
Recorded video storage: local storage, central storage
Key CTQs: high quality picture, low latency, multiple video streams, temporal scalability, spatial scalability, powerful SDK for integration