“Huawei Storage”

Video Surveillance Journal

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HUAWEI

Huawei Storage — Solutions for the New Age

Huawei Storage Makes Cities Safer

Gathering the Power of Smart Converged Storage to Build a Safe City

VSD Technologies in the Future of Storage and Application Development in Safe City

IT Enablement in Video Surveillance

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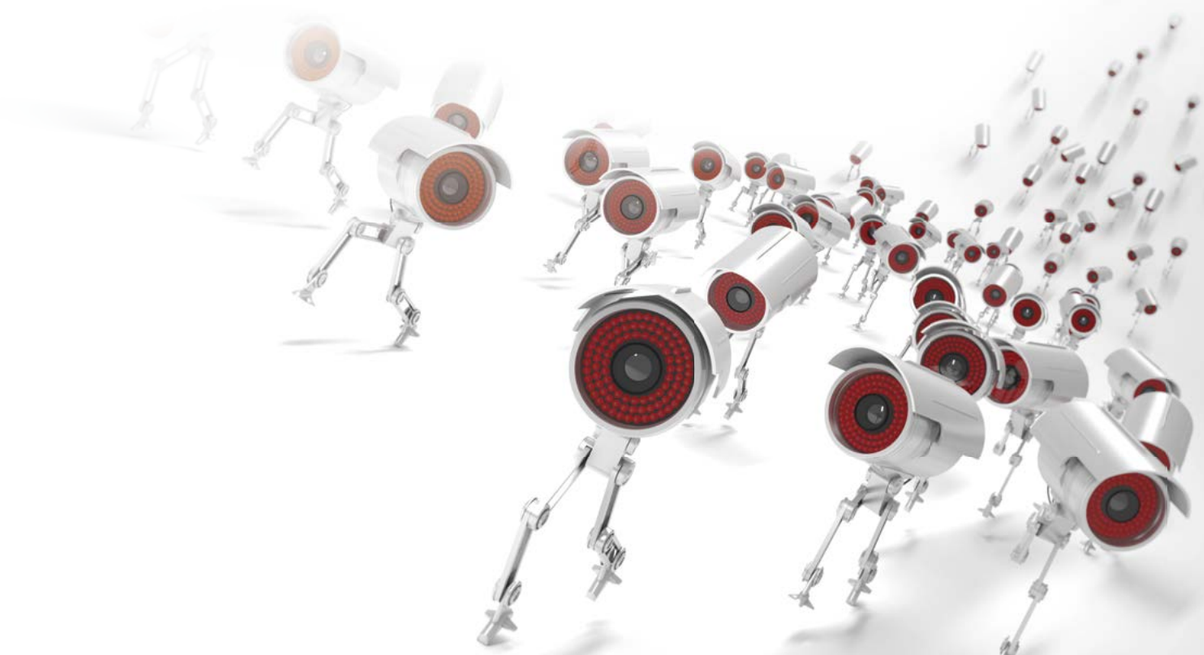


Huawei Storage
— Solutions for the New Age

Technology is evolving at impressive speeds to manage and support the explosive amounts of information in our new era. With intense demands on concurrent processing and data analytics, video surveillance is no exception to this equation of mushrooming data and need for technical solutions to respond.

Focused on "Gathering the Power of Video, Unlocking the Wisdom of Images", Huawei is driving full bore ahead into the "data mine" of video surveillance. Huawei's passion for delivering best-in-class performance and functionality, convenience in operation, and the highest of security assurances has made it the first choice among many customers.

Convergence — — Driven by the rapid development of video imaging and digital network technologies, many innovations like Big Data analytics and virtualization are being infused into video surveillance applications. With this trend towards high convergence, Huawei is applying its mature and cutting-edge technologies to form the perfect balance between performance and protection. The dynamics of the video surveillance field require solutions featuring easy scale-out, high reliability, and future-proof flexibility, and Huawei delivers the designs, networks, and devices to help ensure continued protection of life and property well into the future.

Insight — — We have entered a new era of video surveillance in which applications are becoming network based, everything is moving towards HD, and intelligence-rich functions are enabling us to see broader, clearer, and deeper. With its extensive technological expertise and intense understanding of the challenges and opportunities facing customers, Huawei is partnering with industry vendors to build a comprehensive information and telecommunications ecosystem. Through these partnerships, Huawei is finding new and better ways to apply technological innovations to suit the particular requirements of the video surveillance industry, helping customers extract important data from the vast information "mine".

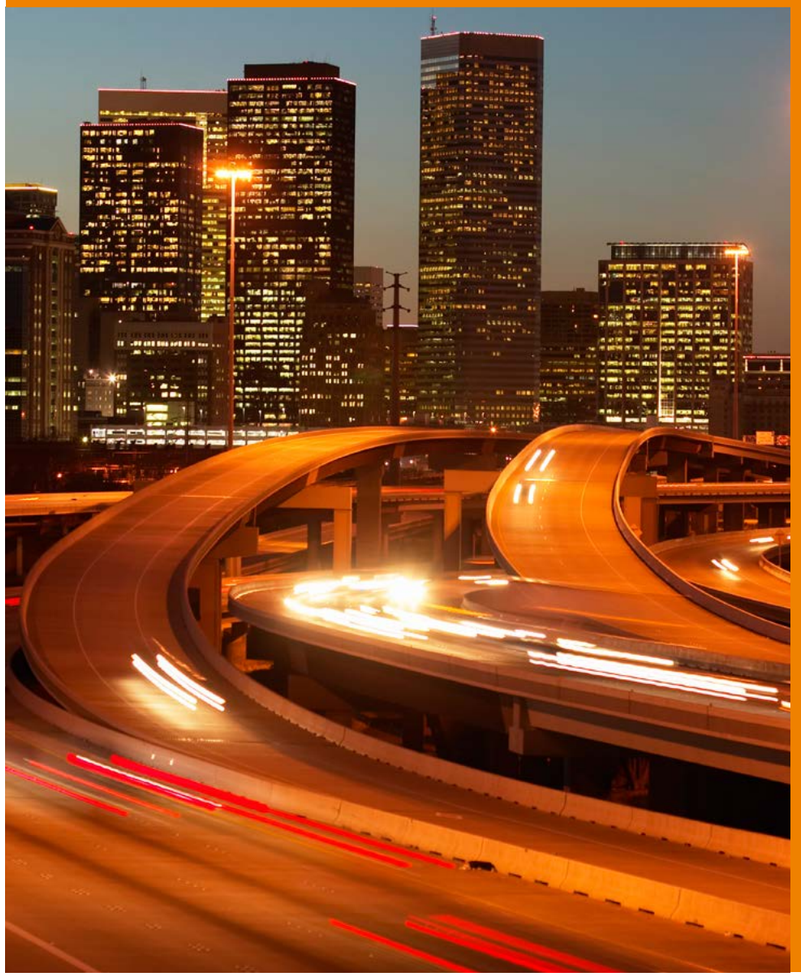
As the new world in video surveillance unfolds, Huawei Storage stands ready to navigate the waves of data and storms of the cloud with the exact solution for you needs. Huawei Storage — Solutions for the New Age!

Deng Xing
Marketing Director of Huawei Storage Product Line

VSD Technologies in the Future of Storage and Application Development in Safe City

VSD Technologies in the Future of Storage and Application Development in Safe City

By Dai Jie / from the Third Institute of the Ministry of Public Security



As IT enablement continues to intensify, the public security sector is also applying significant updates to its system with accelerated rollout of Safe City initiatives. Video surveillance comprises a key component of these build-outs as evidenced by the increased density of such equipment in the streets and byways of many municipalities. Deployment of surveillance devices helps contribute to maintaining law and order, combating crime, and safeguarding social stability. With these installations, however, there comes a massive increase in the amount of data generated and stored in addition to the ways in which data is accessed and applied, applying tremendous pressure to already over-worked systems. This situation makes ease-of-application and effective management of such huge amounts of data all the more important. Video structured description (VSD) technologies provide a breakthrough needed to keep up with the demands, poised to become a mainstay in future development of Safe City projects.

Capacity is not the only storage bottleneck

Network-based HD video surveillance systems have become the norm in Safe City deployment in recent years. Many vendors are now offering NVR, CVR, and a variety of other types of equipment able to provide video browsing, storage, playback, and a variety of other applications and management utilities over the network with access to front-end digital video streams. In these distributed architectures, interconnections are implemented through IP networks complying with ONVIF, GB28181, and other domestic and international communications standards. Open communication protocols and interfaces allow the video surveillance platform to connect with more types of devices while also allowing for enhanced scalability.

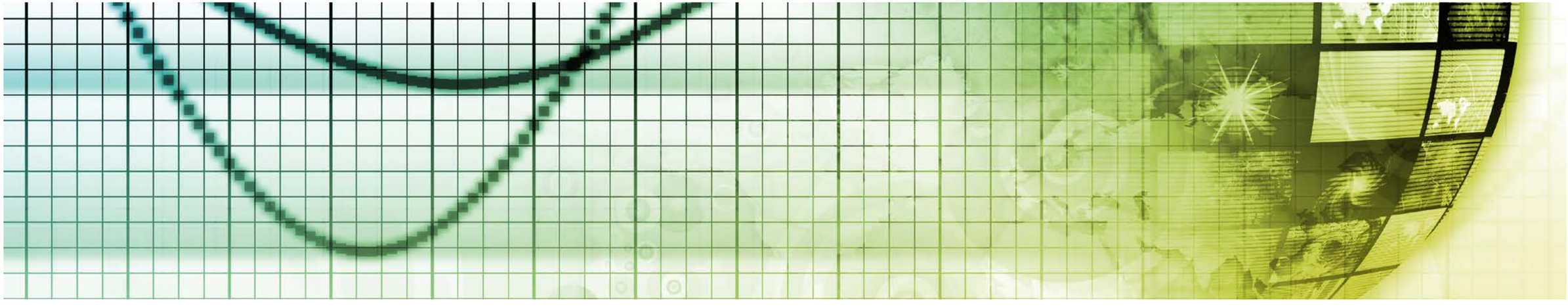
Network-based HD video surveillance systems are also benefiting from the advances in cloud computing and cloud storage technology. Most of the existing cloud platforms are able to deliver strong computing capabilities and mass storage resources, providing a viable platform for management and applications in video surveillance. The powerful storage capabilities of the cloud platform can be further leveraged for the interconnections in the surveillance network, solving some of the existing resource shortages in storage of video.

That said, even if the network interconnection transmission capacity and video storage capacity are upgraded, there is still enormous pressure in storing HD video surveillance content. For example, 1080P HD video typically uses a H.264 high compression ratio for the video encoding format, and the encoded HD digital video stream is maintained between 4 Mbps to 8 Mbps. Consequently, each video channel will produce nearly 3 GB in data per hour, which amounts to around 50 GB per day considering the flux in activity and recorded content. For a municipality deploying tens of thousands of cameras, conventional storage systems prove incapable of handling the network traffic or accommodating the storage requirements. Storing such vast amounts of data cannot be eliminated with expansion to storage capacity alone, alleviating the bottleneck also greatly depends on the efficiency and speed at which the applications are executed. The following subsections will outline each main assumption to this argument.

» Conflict between the vastness of redundant data and ability to extract useful infomation

Video data contains lots of redundant information. Unlike other types of data, it is visualized, complicating effective execution of search tasks. Given its visual attributes, there are few workable automated approaches to processing video data with high efficiency as system processing capabilities are rather limited. As a result, vast amounts of manpower must be expended to monitor the video feeds in real time or to browse through recorded content. Monitoring personnel are often

VSD Technologies in the Future of Storage and Application Development in Safe City



responsible for viewing the real-time feeds on several or even dozens of surveillance cameras, and those in charge of monitoring public venues with hundreds or thousands of cameras are forced to choose a handful of the more important or incident-prone areas to monitor. The level of alertness, skill in operating the cameras, and other factors of the monitoring personnel are also contributing influences on the effectiveness of the video surveillance task. These and other factors make it difficult to pick up on irregular events occurring at the monitored sites, especially considering the lack of automated video processing technologies available to help with the filtering, resigning video surveillance in its current static state. This situation not only complicates rapid response in security monitoring, it also leaves early detection and intervention capabilities far off from the level needed to ensure complete safety during large-scale civic events.

» Lack of efficient and accurate means to search and retrieve video data

At present, a dedicated, highly efficient, and accurate means to search through and retrieve video data has yet to be appear, which means that primitive manual browsing must be relied on to search the resources. This means that the extensive public surveillance activities in Safe City must rely on personnel to find the desired video clips, requiring lots of manpower – a rather inefficient approach leading to high costs.

» Difficulties in data silos, resource integration, and interoperability

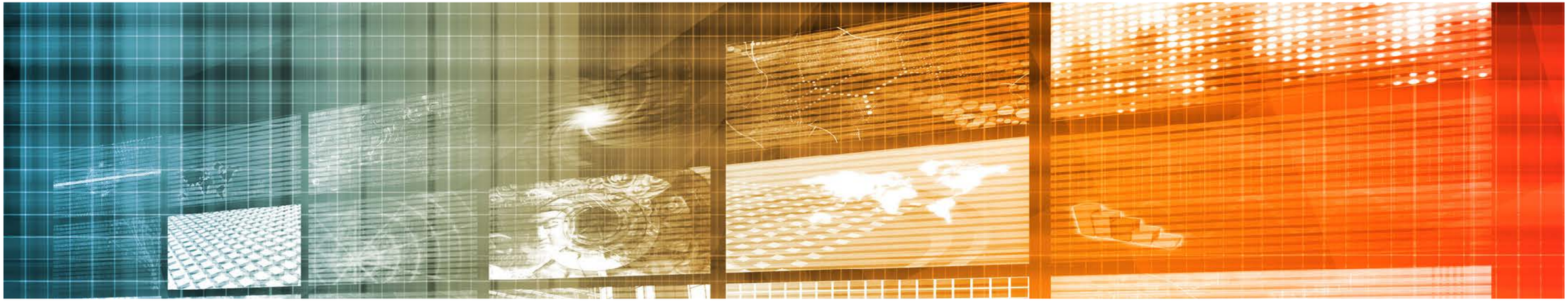
A major issue limiting data sharing between channels is that vast amounts of video data already compete for the limited shared bandwidth. Further complicating this situation is the added competition for that bandwidth from other sensory data being integrated into the surveillance system in an effort to reduce data silos and make police work more effective. For example, integrating the RFID authentication system and synthesizing multiple sources of information from the digital law enforcement systems with the inputs from beat officers, detectives, and other police department personnel can help provide the needed information and analysis for early detection and decision-making. To be effective, these multi-dimensional inputs are needed, yet they also add strain to surveillance system and present challenges in resource integration and interoperability.

Effective solutions in VSD-based technology

In looking at the present operations in the existing video surveillance systems, the video capture and simple storage models lack an effective way for sifting through and accurately obtaining the desired information from the massive amounts of video resources. This leads to considerable waste in storage space and complicates leveraging the value of the content as application is rather top heavy. Video structured description VSD technology can solve the existing dilemmas in storage and application.

VSD uses time segmentation, object recognition, and other means to extract key features in the footage and determine the syntactic relationships. The technology then collates that information into text that computers and people can interface with. There are two main layers: applying text to the video content and then associating the video resources. In the first layer, video content is collated into standardized descriptive formats so that the objects of interest and their identified behavior and features in each video can be put into text form. This layer is an intelligence-based process to extract and organize the information in the video resources. The second layer applies syntactical associations to the video resources captured from cameras at different locations or filmed from different angles. The second layer uses data mining tools for highly efficient analytic capabilities, making retrieval of pertinent and syntactic information across the entire surveillance system as well as from other information systems possible. Layer two is a process that collates, manages, and mines the data in the video resources and also assists in other tasks with other systems. VSD technology uses a model that allows video content to be understood in formats that can be processed and leverages the accumulated information in the databases to collate and analyze the objects of interest, behavior, and events in the video archives. VSD provides a structured description of the video content according to the pre-built object types, features, and associations to extract the useful syntactic relationships between the elements. More simply, VSD extracts the data from the video and places it into a standard syntactic structure during the pattern recognition process. These constructs allow the information to be effectively extracted and integrated; thereby enabling correlative analysis and other video applications on the indexed, retrieved, and digested video data within the surveillance system

VSD Technologies in the Future of Storage and Application Development in Safe City



and associated external systems. With this model, the system can also be set to store only the key target images and text features, consolidating the video data and considerably reducing the pressure on existing systems.

VSD applications in storage models

Structured descriptive data is applied to video content, image data, video data, and other types of data during the VSD application process. This application forms the basis for analyzing the various and copious types of data on the platform. The data for video analysis, processing, retrieval and other process each have their respective and distinctive input and output modes in addition to access rules. As the application data associated with VSD will continue to mushroom, system design must fully consider these attributes from the very start to ensure the entire system is able to operate efficiently.

Coupling computing with storage is an important trend in video surveillance and other Big Data platforms, which means full consideration must be given to the computing model and how the mass amount of data is accessed and analyzed when designing the data storage policy to avoid bottlenecks on the entire storage system. The storing of video and image data must first consider how to most efficiently apply the structured descriptions. This type of data usually occupies much of the storage space which also means considerable network bandwidth is occupied when accessing the video and image content. In order to improve the efficiency of the structured descriptions, the burden on processing real-time video content should be shared across multiple services nodes while considering the access model and capacity of the system architecture. At the same time, the computing node should be placed as close as possible to the original video feed to reduce the I/O overhead associated with moving the data within the processing cluster.

In the VSD system, the structured descriptive data in the video content is the most important data structure, and the design of the storage policies will have a significant impact on overall system performance. Various statistical and discovery (search and retrieval) applications as well as the stock to view the content need to access the structured descriptive data, and each of these applications has their own distinct computing model, seriously complicating storage system design. For text-based search applications, the descriptive data is more applicable to the storage system database or the text-search server because the output description is the desired objective of the structuring. For image-based retrieval, the descriptive data should be stored in file format in the distributed file system to facilitate concurrent processing for the algorithms comparing the attributes in the images.

To further mine the data in the structured descriptions and associated systems, analytical applications require a description on the category or column of the data to implement the statistical analysis. To meet this common requirement, relational database column stores or HBase-type column stores can be considered to improve the efficiency of the applications. Different from the line-sequencing in traditional relational databases, the core design of these two methods is on sequential access of the column data. Avoiding the reads on all the rows of recorded data ensures efficiency in accessing data of a particular type during global analysis.

For these applications, an appropriate data redundancy and replication level can ensure rapid access to the particular type of data on the computing node. An appropriate redundant storage policy can enhance fault tolerance while also enabling a high level of adaptability to different application models. However, the scale at which redundancy is implemented must also be weighed to avoid consistency issues during updates to data.

Conclusion

Video surveillance systems are an important component in Safe City construction. Incorporating VSD significantly improves storage efficiency and the benefits from applications in network-based video surveillance systems. VSD makes for highly efficient storage models and can be applied to a wide range of application scenarios. VSD-based systems and off-shoot products are sure to become a major pillar in Safe City deployments.

IT Enablement in Video Surveillance

IT Enablement in Video Surveillance

By Xiang Liangbi / from HC International

1. Important role of the video surveillance system and general application scenarios

Early forms of video surveillance were mainly used in industrial management, becoming known as industrial TV. With the feeds to the centralized control room from the video cameras placed at different locations throughout the production site, irregularities in production could be discovered and promptly addressed, thereby reducing the incidence of major accidents while also providing the means to better identify the causality of events and ascribe clear accountability in a timely manner. Video surveillance equipment became especially useful in difficult-to-access areas or spots that personnel could not continuously monitor throughout the production process. With the ability to provide evidence as to what actually happened during and post-event, video surveillance became widely applied to public security and other fields, gaining the general appellation of closed-circuit TV (CCTV).

Early in the 21st Century, many countries initiated pilots to promote enhanced public security with Safe City projects that place video surveillance at the core of the platform. Without a doubt, video surveillance has become the largest segment of the security field. High-ranking officials in many countries have stressed that IT is a main feature of the modern revolution in science and technology bringing profound change to work, social, and family life. Many of these same officials have indicated that IT enablement also injects new vitality into the Safe City effort, without which it would be next to impossible to make cities safer – the higher the IT, the more secure the community and nation. To this end, law enforcement and other governmental departments are at the forefront of integrating advances in science and technology supported by information support processes to build up Safe City with continued infusion from innovation. The alarm and surveillance systems going into Safe City rollouts integrate security and protection, computer applications, network communications, video transmission, access control, and other technologies into one platform. Public security, traffic management, and other agencies rely on these platforms to further enhance their ability to maintain social stability, prevent and combat crime, ensure public safety, settle disputes, handle civil and criminal cases, manage traffic flow, and provide evidence in solving cases and in responding to traffic accidents or even relieving traffic congestion.

With the digitalization of video surveillance products, developments in network-based deployments and applications, and advances in technology, video surveillance systems are becoming more sophisticated and are being more extensively deployed in public security, transportation, urban management, energy, rail, finance, water resource management, mining, education, and a long list of other industries and sectors. In one example, the China Ministry of Housing and Urban-Rural Development released the "Notice on Initiating Pilot Projects in the National Smart City Agenda" on December 5, 2012. This release marked the start of Smart City construction in China for which the city-wide video surveillance system is an integral part. These systems combine cloud computing, the Internet of Things, Big Data, and other forms of new-gen information technology while enhancing cross-departmental innovations in the field of urban management to improve the efficiency of municipal operations.

2. IT and Video Surveillance Build-Outs

Video surveillance technology, like any other component in information technology, is a combination of various elements (in this case, a combination of software, audiovisual and text data, digitized utilities, and other components). When video and monitoring technologies were first applied outside the realm of television broadcasting, monitors were the main vehicle used to view the feeds, coaxial cable was the main medium for transmitting those images, and tape was the major storage media – there was rather little IT going into these original models. IT-enabled video surveillance is a natural byproduct of the new technological revolution as IT found its way into just about every form of application. And, IT has certainly allowed for video to absorb the advances in technology integration, greatly enhancing surveillance capabilities. As video surveillance technology has become more digitized, network-based, high-def, and intelligent, the application layer of the security system has also expanded. Connectivity is becoming more and more a part of what happens in security industry operations, and video surveillance is also taking this deep route in its IT enablement.

In looking at how Big Data technology can be applied to produce sharp advances in the surveillance field, four main items stick out: intelligent analysis, distributed processing, data mining and analysis, and visual representation (visualization). Intelligent analysis technology uses computer-based image recognition algorithms to analyze video content and generate a structured or semi-structured description (text-based) on the content and behavior displayed in the images to provide the format needed for Big Data analytics. Distributed processing technology is based on large parallel or distributed processing technologies such as Hadoop and Hbase to form large distributed data storage and data management frameworks; provide real-time and batch ETL; and enable data cleansing, conversion, and load balancing functions – adding tremendous value to the gathering of information.

Data mining and analysis technology enables highly precise utilization of converted video data through intelligent analysis, data mining, and other analytical processes in the retrieval of metadata. This technology greatly enhances how video data is used with integrated analysis capabilities on non-video data (elements in the video data converted to text-formats) in addition to mining the correlation in events and patterns in the content. Visual representation (visualization) technology efficiently searches, compares, and displays video content, significantly enhancing the usefulness of the images and data in terms of how it is presented on GIS, information analysis, emergency response, and other platforms.

3. Advances in video surveillance and trends in how IT is applied

Surveillance videos and images contain huge amounts of information, making it a prime candidate for IT applications early on, especially with the massive information processing focus of IT technology. As video surveillance comes into wider use and as the push behind Safe City rollout throughout many regions intensifies, video surveillance systems are starting to make the transition to digitalization, network-based operation, HD resolution, high integration, and intelligent-rich functionality with sharing of video assets and ability to support multiple services also being placed on the agenda for improving public security. HD video transmission, forwarding, storage, and use of supporting software and hardware platforms pose intense challenges. As a result, system stability, reliability, and practicality of application become of the focus of concern for customers in the public security sector. Conventional IT architectures, let alone primitive CCTV monitoring systems, cannot meet the large-scale deployment needs of HD video surveillance applications. To fill the modern-day requisites, Internet technology, cloud storage, cloud computing, Big Data, and other cutting-edge forms of IT technology are being applied on much larger scales in the surveillance field, making the trends in IT enablement for video surveillance all the more evident.

These trends in IT enablement for video surveillance are most noticeable in three marked events. First, the transition from analog to digital and then to IP networking that has made IT technologies – cloud computing, cloud storage, Big Data, video analysis, and intelligent surveillance technology in particular – the main propeller behind the advances in video surveillance technology. Second, many large IT companies are entering the video surveillance industry and cooperating with security companies in multi-faceted areas. Third, a growing number of technology-based security companies are noticeably on-boarding large numbers of IT professionals and focusing on digital signal processing, cloud storage, video analysis algorithms, Big Data, and other core technologies.

IT enablement in video surveillance technology relies heavily on Internet connectivity to support the required long-distance transmission of video images in the modern systems. Most mainstream network monitoring systems require a powerful platform for control and scheduling management, and the software and hardware infrastructure adopt an extensive amount of IT technology. In addition, the move to HD, high integration, and intelligent-rich functionality; the massive amount of information that must be transmitted and stored; application of video analysis technology; and the deployment of cloud storage, cloud computing, and Big Data are also having a profound effect on the development of video surveillance technologies – "cloud-based surveillance", or the Video Cloud, is here and creating a storm.

Cloud storage and cloud computing are based in distributed networks and provide storage and computing resources "as a service". Customers store data and execute their computing operations in the cloud, encapsulating the "the network is more like a computer" concept. Being more energy efficient and reliable, cloud storage technology is set to become a fundamental part of Safe City and any other surveillance effort of scale. Analysis of surveillance video in Safe City entails a large amount of data that must be processed at high speed. Consider the vast number of features and individuals that must be compared in facial recognition applications. Even if multiple high-performance servers are used with a conventional parallel processing scheme, the computation speed is still not enough to satisfy the time requirements for some customers. Cloud computing provides the solution in such instances to deliver vastly enhanced efficiency in the calculations.

The cloud storage and computing model will continue well into the future for the data-intensive video surveillance field. However, one concern is that data is processed and stored on a remote cloud, which lacks the security of a physical boundary and means that subscriber data management rights and ownership are separated; making this model more prone to data leaks and tampering. Network security and privacy issues have become a major hindrance to the continued development of cloud storage and computing, and these issues will continue to be a major point of attention until a fully viable solution can be provided.

Big Data refers to copious amounts of data involved in an analysis event that makes

review from a human or even group of analysts lack any sort of efficiency in terms of intercepting, handling, collating, or processing the information. Most of the data generated in video surveillance is unstructured data and the volumes of content are usually loosely coupled together, challenging traditional approaches and mechanisms in data management. The whole basis of Big Data-based architecture relies on putting vast amounts of data into smaller, easier to access batches of data then processing that data on multiple servers with parallel analysis capabilities. This model is highly applicable to the processing of video data, providing a huge advantage in turnaround and quantitative analysis over that of the human model.

Big Data can be summarized with four "V"s: volume, variety, velocity, and value. "Volume" because of the sheer amount of data; "variety" indicating the wide variety of coding and data structure types; "velocity" due to the intense processing involved; and "value" referring to the difficulty in extracting useful information. In video surveillance, the value of the data is often inversely proportional to the size of the data volume and the density of the data. In one hour of video content, there may only be a couple of seconds of useful data. Using powerful algorithms to accelerate "clean up and filtering" and then extract the value content is something that Big Data tries to solve, and it is paramount that this analysis on video content be completed with efficiency and accuracy. Again, since most of the information in the surveillance videos and images are not of much value to the sifting event while the pertinent information is found only in a few short segments, the higher-density information is often the most valuable information. Mathematical and statistical theory also points to this general phenomenon. In terms of video footage, it goes to reason that a higher-density clip with movement would likely be more pertinent than a static segment without any events or movement in the footage. Real-time digesting of huge amounts of surveillance data produces large amounts of "dormant" or "static" data, which in turn wastes a considerable amount of storage resource. At the same time, accuracy and efficiency of the video analysis determine the value that is able to be extracted from the data. Customers involved with Safe City commonly require low latency and enhanced accuracy. The video surveillance field is in urgent need of Big Data technologies able to intelligently analyze and extract value from the voluminous frames and segments then provide summarized information to reduce the amount of data the human analyst must process. To this end, the analytics must provide a metadata repository to improve the efficiency in utilizing the information and to add value to the video surveillance industry.

4. The move to IT in video surveillance

The move to IT enablement in video surveillance is first demonstrated in improved functionality and feature-rich applications. After Safe City becomes fully digitalized, network-based, high def, and intelligence-rich, the overall layout will become more expansive in coverage, feature hyper-connectivity, and become highly accurate and efficient with smart capabilities. The application layer will possess powerful Big Data processing capabilities able to digest and collate massive amounts of information found in the video feeds and archives. These capabilities will help enable preemptive warnings and early intervention. Converging Big Data and video surveillance technology with the perfect blend of cloud computing and storage technology specifically geared toward video and image processing can achieve the purposes in the Safe City agenda. Cloud computing, cloud storage, and Big Data are currently the fastest growing areas in IT technology. These technologies are also the tools that must be applied more vigorously in the surveillance industry to enable further development.

In addition, IT-based developments in video surveillance technology are sure to add momentum to enterprises involved in home security and Safe City, especially as monitoring companies and IT enterprises cooperate more closely. Companies with backgrounds in IT are more apt at product upgrades as technology continually updates than security companies because those with the IT know-how understand the technologies involved. At the same time, IT companies may not necessarily possess the necessary level of knowledge to engage in the security industry. For this reason, it would be rather problematic to depend solely on IT enterprises to apply Big Data applications to the security monitoring industry just as it would be to for security vendors to attempt system integration without the help of highly proficient IT counterparts. In the Big Data era, almost every field is becoming interrelated in one way or another with the dozens of others in its immediate and overlapping circles. Video surveillance is no exception. Video surveillance must continue in its technological and industry integration as it accelerates IT enablement in the effort to find more viable Big Data analytic and storage solutions. Enterprises engaging in the video surveillance arena need to understand customer requirements and market trends if they hope to give full play to their innate advantages. These enterprises must also team up with IT companies to step into the Big Data era early on. Law enforcement and public security agencies must also allow those with the know-how to provide the solutions and services they need in order to bring in the best practices from each industry and supply the best social services to citizens.

The need of society is the most compelling driving force in technological development. Safe City and Smart City rollouts the world over are deploying the largest, multi-faceted video surveillance network systems even seen. This hotbed of activity provides an excellent platform for video surveillance and IT companies to learn from the related IT technologies, designs, and deployment and operations practices going into this tech. Practice makes perfect, as the saying goes; and, practice helps improve on theory. Applying IT to video surveillance will in turn help drive IT technology in general. Through learning from the experience of others and with the concerted efforts of all stakeholders, the levels of productivity and positive outputs from the IT going into the video surveillance fields will be raised to even higher heights.

Huawei OceanStor 9000: High Data Reliability in Video Surveillance Applications

Huawei OceanStor 9000: High Data Reliability in Video Surveillance Applications

Introduction

Storage capacity is vital to the operational capabilities of video surveillance systems, and requirements on this critical component continue to escalate as the industry continues to develop at impressive speed. More storage capacity and better performance are required as the number of HD video channels increase and as video data is being stored for longer periods. These factors along with the growing importance of data also place heightened demands on the reliability of the storage system.

Huawei OceanStor 9000 offers robust data reliability with SecureRAID, SecureVideo, and SecureData technologies for the storing, restoration, and disaster recovery (DR) of massive amounts of data.

SecureRAID Enables Improved Data Protection

» Introduction

Erasure coding is a popular data encoding scheme that splits data into blocks of specified sizes. The scheme uses specified encryption algorithms to reconstruct redundant data pieces. If a fault occurs, the scheme is able to restore the complete data set from the subset in the data block. Compared with traditional RAID technology, erasure coding achieves improved restoration capabilities with less overhead, making it ideal for storage of massive amounts of data. Given its advantages, many well-known storage equipment manufacturers, open source systems, and e-commerce sites are now using the redundancy scheme.

» Working principles

The SecureRAID technology in the OceanStor 9000 uses an erasure coding scheme that splits the data in files into strips of the same size. The file and parity data are then written to different disks on different nodes after undergoing a parity-check operation. If a disk becomes damaged or a node goes down, the original file data can be restored from the parity data, thereby helping to ensure data is not lost. Administrators can set the redundancy level according to the importance of the file, with +4 redundancy being the highest level.

SecureRAID implements N+1 to N+4 data protection schemes (N indicating the number of copies). See Figure 1 and Figure 2.

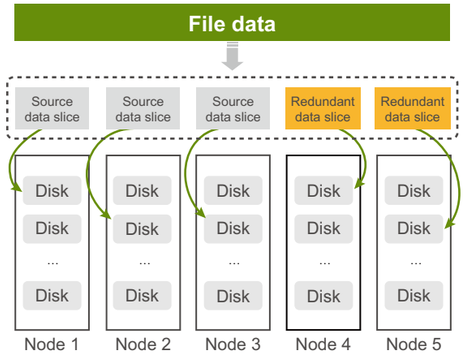


Figure 1 Data write process

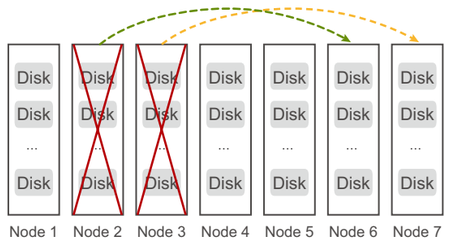


Figure 2 Data restoration process

» Highlights

High efficiency

SecureRAID splits file data into specific strip sizes, and a certain number of strips then form data stripes – the original number of tokens created from the coding process (N). SecureRAID uses erasure coding algorithms to perform check operations on these data strips to generate the required number of parity data blocks, or the extra or redundant tokens added to ensure protection of data (M). The system sends N and M data blocks to different and respective nodes, achieving faster write speeds as the operations are executed simultaneously.

If a disk or node in the system becomes corrupted, data can be restored from elsewhere in the storage array. Huawei OceanStor 9000 restores data objects on corrupted disks to different locations in the array to implement concurrent restoration, thereby minimizing the time needed to reconstruct data.

High reliability

SecureRAID delivers the highest level of reliability in any available NAS offering. The Huawei system can ensure data remains protected even if four of the five disks used to back up the data become corrupted (depending on the redundancy level set for the data file). Flexibility in configurations allows users to set their own performance and backup preferences based on the importance of the data files.

High utilization rate

SecureRAID technology ensures high reliability while improving system space utilization based on the number of nodes and redundancy level set by the user (M number of parity blocks for the N number of data strips that need to be stored). SecureRAID can achieve up to 94% utilization of storage space, far more than other RAID- or replication-based data protection schemes.

SecureVideo Enhances Data Restoration Capabilities

» Introduction

The SecureVideo technology in the OceanStor 9000 uses new erasure coding technology for its data protection scheme to suit the backup requirements of the video surveillance scenario. In the event of a disk failure, data block integrity is still assured as the data is directly reconstructed from the redundant copies if the redundant copies contain all the data that needs to be restored. If some data that needs to be restored is not retained in the redundant copies, the data that cannot be read is cleared from the space while other data is retained to the extent possible, avoiding the total loss of data across the entire grouping with conventional RAID approaches.

» Working principles

The SecureVideo technology in the OceanStor 9000 optimizes file reads for video based on the SecureRAID data protection scheme. When a video file is being stored to the OceanStor 9000, SecureRAID technology is used to split data in files into strips of the same size. After executing the check algorithm, file and parity data is written to different disks on different nodes. When reading video files, SecureVideo checks whether the redundant copies contain complete data. If the amount of corrupt data is larger than that in the redundant copies, the remaining integral data is read to the extent possible. The data that cannot be read is cleared from the space and returned to the upper-level application system, thereby avoiding loss of all data and comprised playback ability with traditional RAID groupings. SecureVideo dramatically improves reliability of video data, maximizing continuous playback and minimizing distorted or missing frames. The difference in reliability between RAID and SecureVideo is demonstrated in the following figures.

Figure 3 Completely intact video sequence

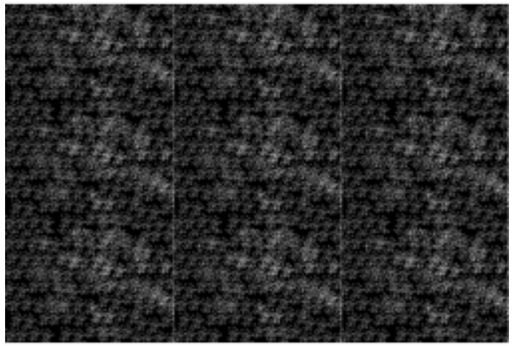


Figure 4 Traditional RIAD groupings lead to total data loss and inability to playback video

Figure 5 SecureVideo ensures playback with minimal frame loss

SecureData Ensures Disaster Recovery for Video

» Introduction

SecureData implements offsite backup in video storage to ensure data reliability. If the storage system at the production center fails, the video monitoring media server accesses the backup files at the DR center through the IP network, ensuring maximized service continuity. Data backed up to other sites can also be used to restore the data in the event of a disaster or system failure at the primary site, avoiding data loss.

Synchronous backup is implemented only on critical data from certain lower-level monitoring sites if not all data needs to be backed up to the primary site. When configuring remote backup, critical data is remotely backed up to the specified path. The SecureData technology in OceanStor 9000 is able to suit the particulars of the video surveillance scenario and implement remote backup across different locations to achieve off-site disaster recovery.

SecureData is completely transparent to the upper-level video surveillance platform, removing any issues in compatibility. SecureData can be considered a remote mirroring utility for video surveillance data. If the upper-level platform needs to access the backup data, only the data storage path of the backup destination in the video surveillance platform needs to be configured, providing quick and easy access to backup data when most needed.

» Working principles

The SecureData DR technology for video applies to two main application scenarios:

Scenario 1: OceanStor 9000 systems are deployed at the primary and secondary sites.

Scenario 2: OceanStor 9000 is combined with third-party storage systems to form the DR solution.

The SecureData working principles for each scenario are described separately.

In scenario 1, the asynchronous remote replication of video files is implemented between the source (home) and destination (secondary) directories with directory-based snapshots.

When replicating data for the first time, the system will create a mirrored snapshot of the video files being stored on the home directory at the time of the replication, which will serve as the reference snapshot for video file synchronization. After each subsequent synchronization, the system will take another mirrored snapshot of the home directory then compare and record any differences between this latest snapshot and the previous snapshot. Any change to the video files on the home directory will be synchronized to the secondary directory, eliminating the need for the system to transverse the entire directory tree and thereby improving the efficiency of the incremental synchronization operation. Any video files changed after this point-in-time snapshot will not be sent to the secondary directory until the next initiated full or incremental backup to ensure consistency of data and avoid overlap in ongoing processes.

For example, a customer implements synchronized replication on the video files in the home directory at 14:00, and the operation does not complete until 14:10. At 14:05, the user modifies video file A in the home directory. However, this change to the file in the home directory will not be copied to the secondary directory until the next synchronization operation. Once data synchronization is complete, the system will compare the video files in the secondary directory with that of the reference snapshot of the home directory to see if there are any differences. Because the synchronization only considers the files in the directory at the time the process is initiated, the snapshot of the secondary directory will match that of home directory.

» Expanded explanation

The synchronization interval can be set to 15 minutes for this function, which also means the recovery point objective (RPO) can be achieved in as little as 30 minutes with the condition that there is ample bandwidth and the settings for load-balancing, access, and other features allow.

By default, the secondary directory is in the write-protection state, which means that the directory can only receive data synchronized from the home directory, and will deny any other write requests to it. If the primary site fails or needs to go offline for maintenance, the data in the secondary directory will be automatically rolled back to the latest snapshot point when the home and secondary directories were consistent, and then the secondary directory is ready to take over the services of the home directory.

When the primary site recovers to normal, SecureData switches roles between the sites. In this situation, the primary site will automatically roll back the original home directory (which is the acting secondary directory) using the latest consistent snapshot, and restores the data in this directory to the state generated at the most recent consistent snapshot point.

Scenario two uses open source rsync software to enhance task configurations, logical control, and other functions. With this feature, OceanStor 9000 is able to implement remote synchronization of the video files on the local and remote systems (which can be heterogeneous storage systems).

The rsync-based remote replication of video files compares any differences in the source directory and destination directory. If a video file is modified or added, the video file is copied to the secondary directory during the next scheduled or initiated synchronization event.

Push or Pull synchronization modes can be implemented in scenario 2.

Push: OceanStor 9000 replicates the video files in the local directory to the backup directory. This mode is mainly used to backup local video files.

Pull mode: OceanStor 9000 replicates the video files in the backup directory to the local directory. This mode is mainly used to restore video files on the local directory that have become corrupted.

In both Push and Pull mode, the local OceanStor is the initiating end of all synchronization operations.

In Push mode, the OceanStor 9000 is the NFS client and the backup system serves as the NFS server. The NFS protocol must be used to back up video files to the backup system. The local directory is the source directory for the video files and synchronizes basic attributes to the destination directory (backup directory) in the backup system. In Pull mode, the backup directory serves as the source directory to synchronize video files to the OceanStor 9000 in Pull mode.

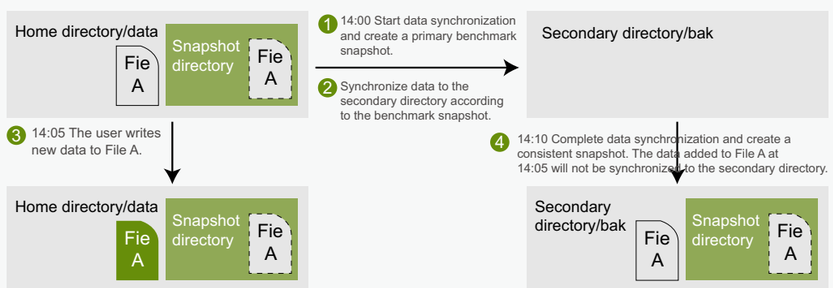


Figure 6 Snapshot-based asynchronous remote replication

Conclusion

With the ever-increasing value of data, customers are attaching more importance to the reliability of their video assets. Huawei OceanStor 9000 provides full-dimensional assurances in data reliability, delivering compelling benefits to ISVs in enhancing their core competencies.

Huawei OceanStor 9000 for Video Cloud Center Storage

Designed for Big Data, the Huawei OceanStor 9000 storage system uses a symmetric distributed architecture to deliver cutting-edge performance, large-scale horizontal expansion capabilities, and a super-large single file system, providing shared storage for structured data and unstructured data.

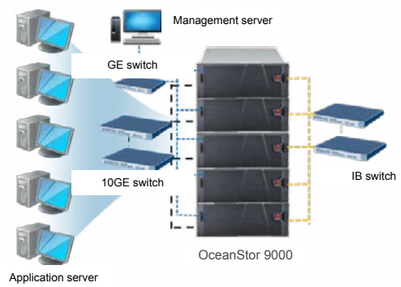
In the video surveillance field, OceanStor 9000 serves as the video cloud. Applications include Safe City, banking, rail transport, and other layouts requiring large-scale video surveillance systems. Huawei OceanStor 9000 consolidates storage, archiving, and analysis capabilities, making it ideal for interworking with the upper-layer service system in providing real-time access to video feeds, intelligent analysis, image detection, facial recognition, and geographic information system (GIS) services among the many other applicable utilities.

» Product Design

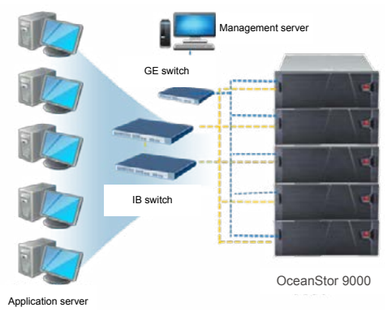
OceanStor 9000 - front

OceanStor 9000 - rear

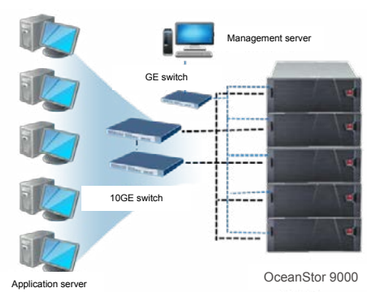
» Networking Applications



10GE networking



Internal network: IB;



External network: 10GE

» Highlights

Smart Convergence

- Big data life cycle integration
- Management integration

Outstanding Performance

- High-speed internal interworking
- SSD-based metadata access acceleration
- 55 TB global cache
- Dynamic storage tiering
- Intelligent load balancing

Flexible Expansion

- Linear expansion from 3 to 288 nodes
- 40PB Global namespace

High Reliability and Availability

- RAID-based N+M data protection technology
- Restore data at a speed of up to 1 TB/hour

Simplified Management

- Flexible space quota
- Automatic statistics collection and analysis
- Automatic deployment

» OceanStor 9000

Model	OceanStor 9000 Capacity Node
Hardware Specifications	
System architecture	Symmetric distributed architecture (4U)
Number of nodes	3 - 288
Cache per node	Standard configuration: 48 GB, expandable to 192 GB
Number of disks per node	Standard configuration: 1 x 3.5-inch 200 GB SSD + 35 x 3.5-inch 4 TB SATA disks (Based on actual performance requirements, the SSD/HDD configuration ratio can be adjusted.)
Disk type	3.5-inch SSD, SATA, and NL-SAS
RAID levels	0, 1, 3, 5, 6, 10, 50
Front-end network type	10GE or 40GE InfiniBand
Internal network type	10GE Ethernet or 40GE Infiniband
Software Features	
Data protection level	N+1, N+2, N+3, N+4
File system	Wushan distributed file system, which supports global namespace and can be dynamically expanded up to 40 PB
Value-added features	Dynamic storage tiering (InfoTier) Automatic client connection load balancing (InfoEqualizer) Space quota management (InfoAllocator)
Thin provisioning	Configuration-free thin provisioning
Data self-healing	Automatic, concurrent, and quick data restoration; maximum restoration speed of 1 TB/hour
System expansion	One-click online expansion; single node expansion in 60 seconds
Global cache	Up to 55 TB
Supported operating system	Windows, Linux, Mac OS
Supported protocol	NFS, CIFS, HDFS, NIS, Microsoft Active Directory, LDAP, and SNMP
System management	Support for users of different management rights; domain- and rights-based user management; alarm notification by email, SMS, SNMP, and Syslog
Free from instant maintenance	Automatic bad disk detection and alarm notification; centralized batch replacement of bad disks; avoiding instant replacement and reducing manual maintenance

Huawei OceanStor 2800V3: Converged, Efficient, Reliable

Preface

Safe City projects are being rolled out worldwide to reduce crime and make communities safer. As a core component of these projects, the video surveillance solution is transitioning from SD to HD to offer the clarity needed while the number of monitored video streams and required time of data retention continues to increase exponentially. To address these demanding requirements, most solution providers implement direct or forwarding storage of video streams on customers' IP SANs. However, this practice has its inherited shortcomings: The forwarding storage mode requires a huge number of servers to forward requests while the direct storage mode needs a massive stack of storage devices to record the huge amounts of HD video data.

To shatter the conventional restraints in video surveillance, Huawei launched a revolutionary converged virtualization solution, which adopts a proprietary converged storage virtualization platform based on IP SAN to reduce the number of servers, optimize data storage paths to increase the number of HD video streams processed by each device, and deliver a virtual machine (VM) cluster technology to protect video continuity. With all these leading-edge technologies, the Huawei solution is the best-in-class choice for independent software vendors (ISVs) in provisioning their services for Safe City projects.

Hyper-converged storage virtualization platform

Holding fast to its product design concept of guaranteed data reliability, Huawei constantly ups its investments in full-dimensional reliability assurance technologies. Ground-breaking technologies include:

- Dual-controller redundancy and power failure protection, eliminating data loss in the event of an unexpected failure
- Hot-swappable modules, achieving non-disruptive capacity expansion and parts replacement
- Disk technologies (bad sector repair, pre-copy, anti-corrosion, and shock-proofing), reducing the disk failure rate by more than 50%

As a technology trailblazer, Huawei incorporates the industry's first kernel-based virtual machine (KVM) platform into its converged virtualization solution, which is capable of converging storage and applications as well as storage and computing resources.

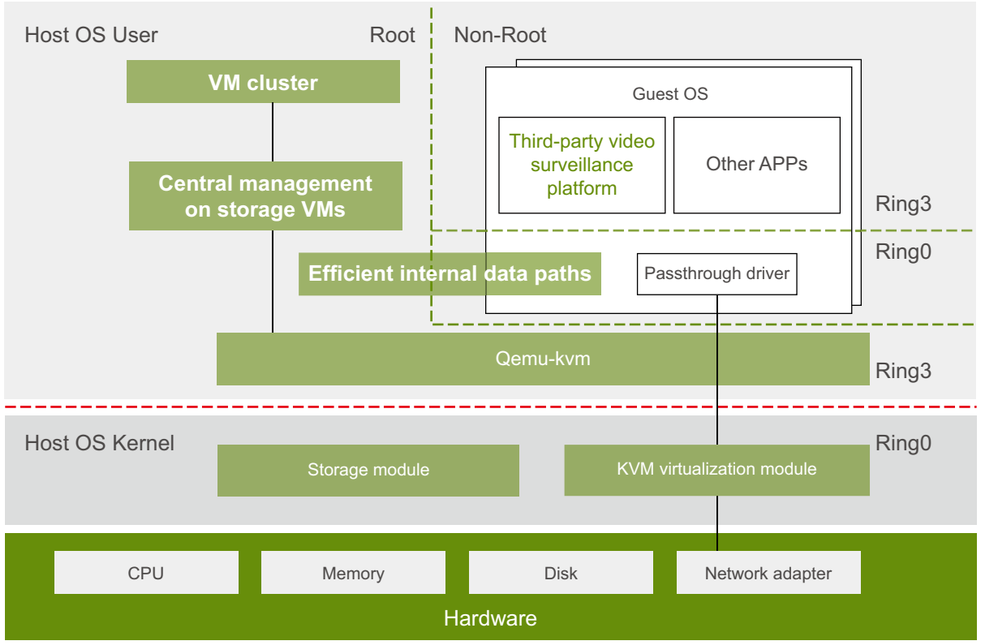


Figure 1 Architecture of the converged virtualization solution

As shown in Figure 2, KVM functions as a hypervisor running in the Host OS Kernel. It is a physical simulator for CPU, memory, and I/Os, and monitors the operating status of VMs. Qemu is a process running in the Host OS User. It integrates the features of KVM and kernel, and simulates CPU, memory, and I/O hardware for Guest OS. The storage module also runs in the Host OS Kernel and delivers such functions as RAID creation, LUN creation, and LUN mapping. Guest OS and Host OS exchange data through the internal data paths. The two controllers provide a VM clustering function.

Huawei's converged virtualization solution breaks down the technical barriers in conventional direct storage approaches for video streams, allows video surveillance software from different vendors to centrally operate on the Guest OS, and delivers direct storage for popular stream media protocols like RTSP, ONVIF, PSIA, SIP, GB, and T28181 in addition to storage protocols like iSCSI, NFS, CIFS, and FTP. The solution also physically isolates storage equipment from the virtual platform, thereby eliminating nearly every impact from failure affecting other components while significantly enhancing the reliability in direct storage.

Efficient data paths

Internet Small Computer System Interface (iSCSI) is a popular TCP/IP-based protocol used for establishing and managing IP SANs and linking storage devices and front-end hosts. By encapsulating and carrying SCSI commands over IP networks, iSCSI facilitates block-level data transfer among high-speed data storage networks. SCSI adopts a client/server structure that connects adjacent devices with SCSI buses.

This protocol allows for encapsulation and reliable transfer of

massive amounts of data between hosts (called initiators) and storage devices (targets) over TCP/IP networks.

On the converged virtualization platform, VMs need to exchange data with storage devices. If the protocol flowchart is not optimized for VMs, data is written to VMs after it is captured by front-end cameras. In this scenario, the VMs require four steps to forward the data to storage devices over iSCSI (see Figure 2):

1. iSCSI encapsulates TCP/IP data packets.
2. Physical network ports send data packets.
3. Physical network ports receive data packets.
4. iSCSI decapsulates data packets.

This conventional approach leads to two problems: A time consuming data exchange process and VMs and storage devices occupy many physical network ports and disable them from providing external data services.

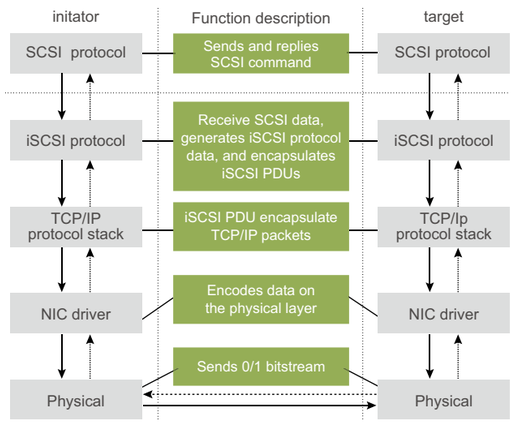


Figure 2 iSCSI protocol flowchart

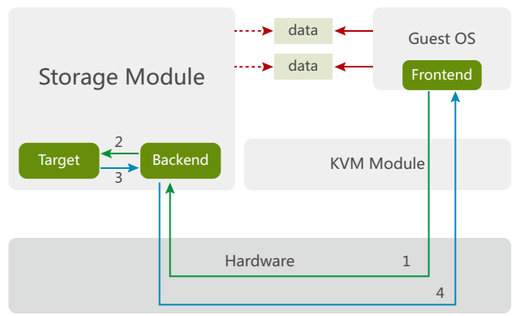


Figure 3 Working mechanism of SCSI over Memory

To cope with these two issues, Huawei's converged virtualization solution offers a SCSI over Memory (vSCSI) technology for optimizing data paths between VMs (Initiators) and storage devices (Targets). This technology virtualizes one SCSI device for Initiators (Frontend) and one for Targets (Backend). All commands sent to Frontend are automatically forwarded to Backend, which then interconnects with Targets. At the same time, Initiators share the data pages in its memory with Targets, so no physical data needs to be copied. This revised data exchange process relieves the needs to encapsulate TCP/IP data packets and forward data through physical ports, thereby greatly improving the exchange performance between Initiators and Targets.

According to the test data provided by Huawei Storage Lab, under the same test conditions, vSCSI, in comparison with iSCSI, delivers higher network bandwidths, enhanced stability, higher CPU and disk utilization rates, and reduced I/O latency. Summing up the main benefits, the converged virtualization solution employs the vSCSI technology to optimize front-end and back-end data exchange paths, free up physical network ports, and significantly increase the number of HD video surveillance streams that can be processed.

VM cluster technology

The majority of platform software suites provided by video surveillance ISVs are standalone, and only a few of them can support the cluster mode. This makes front-end servers prone to single points of failures, which may lead to denial of video data recording services for several hours or even days. The converged virtualization solution combines a dual-controller redundancy architecture and a VM cluster technology to realize the cluster function for the video surveillance platform software. Therefore, if one controller encounters an unexpected fault, VMs and LUNs ascribed to this controller will be automatically taken over by the other controller, avoiding impact to continuity of video surveillance services.

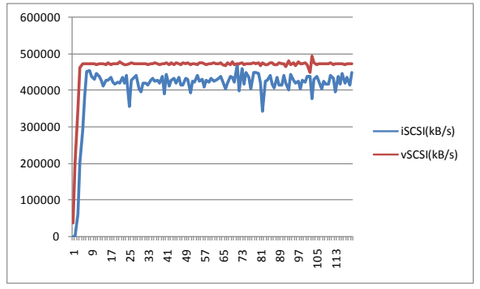


Figure 4 Comparison of network bandwidths

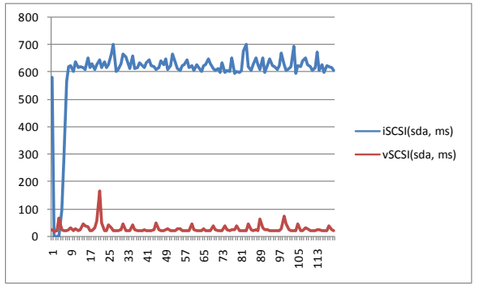


Figure 6 Comparison of VM I/O latencies

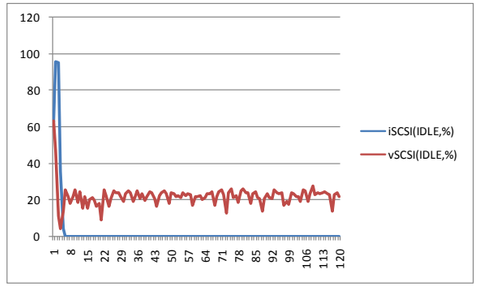


Figure 5 Comparison of CPU utilization rates

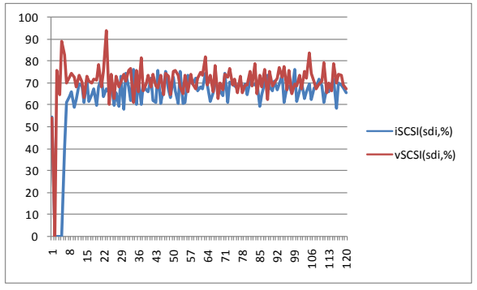


Figure 7 Comparison of disk utilization rates

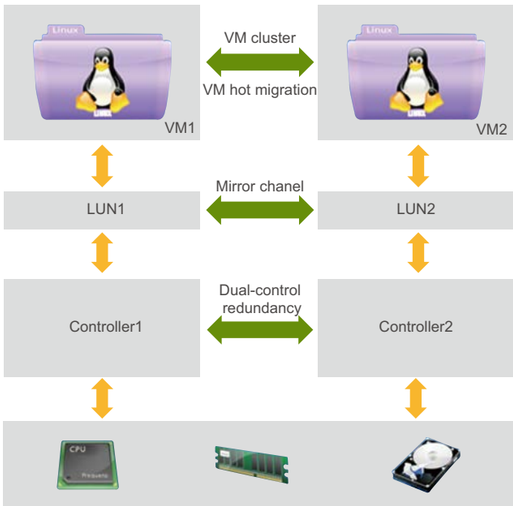


Figure 8 VM cluster architecture

As shown in Figure 8, LUN1 and VM1 are ascribed to Controller1 while LUN2 and VM2 are ascribed to Controller2. LUN1 is mapped to VM1 while LUN2 is mapped to VM2 for video data reads and writes. If Controller1 encounters a fault, the ascribed controller on LUN1 is switched to Controller2, and then the system notifies the virtual platform to restart VM1 on Controller2. After the VM startup, video surveillance services are also started and will be restored within two to three minutes. After Controller1 comes back online, the system notifies the virtual platform to start a VM hot migration process, which switches the ascribed controller of VM1 and LUN1 back to Controller1. The hot migration process does not cause any interruption to video surveillance services.

Core component of Huawei converged virtualization solution: OceanStor 2800 V3

Huawei OceanStor 2800 V3 is a next-gen video surveillance storage array designed for end-point surveillance centers. It is built on Huawei's latest V3 storage array architecture that delivers excellent capabilities in IP SAN access, scalability, reliability, and performance.

The OceanStor 2800 V3 further incorporates VMs to make full use of the computing resource of storage controllers and migrate third-party applications that once ran in physical machines to storage controllers, observably reducing the total cost of ownership (TCO) and physical footprint.

Huawei's proprietary RAID2.0+ technology is also employed in the OceanStor 2800 V3. By dynamically balancing workloads among all disks in a disk domain and abandoning the use of hot spare disks, the OceanStor 2800 V3 achieves a low dual-disk failure rate, improved performance, and simplified management.

» Working mechanism of OceanStor 2800 V3 native VM technology

The OceanStor 2800 V3 uses a resident VM technology to create an independent domain to accommodate storage software running on controllers and to allow VMs to carry third-party applications. This technology realizes superb isolation between Huawei and third-party software, and fully utilizes the excess computing resources of the storage array. Let's have a detailed look on how the OceanStor 2800 V3 delivers direct storage of video streams:

Applications receive video surveillance data: Third-party video surveillance applications running on VMs receive video data captured by IP cameras over a GE/10GE IP network. Each network port serves a specific purpose to eliminate service conflicts. Each controller supports a maximum of 12 GE network ports or 8 10GE network ports.

Writes video surveillance data to storage: The VMs exchange data with the storage software domain through high-speed internal memory channels (using DDR3-1600 memory bars). Compared with conventional IP network-based data exchanges, the memory channels deliver higher performance and avoid the complexities associated with physical connections.

Writes video surveillance data to disks: Compared with its predecessor S2600T that uses 6 Gbit/s SAS connections, the OceanStor 2800 V3 adopts the next-gen 12 Gbit/s SAS interconnects in its back end, which enables higher performance and lower latency in video data reads and writes.

Mirrors video surveillance data: The OceanStor 2800 V3 utilizes a dual-controller architecture to reinforce data reliability, and advanced PCIe 3.0 mirror channels are established between the two controllers, providing a bi-directional bandwidth of up to 8 GB/s.

Furthermore, the virtualization technology offers superior compatibility and isolation capabilities, allowing the storage, forwarding, and indexing services in the video surveillance component to be deployed in storage controllers, reducing TCO.

» High-density disk enclosures

In a high-density disk enclosure, the conventional horizontal disk slots are replaced with vertical slots, and the size of its expansion board is reduced to half that of a traditional expansion board, which means more enclosure space is reserved for disks. To improve heat dissipation, the air channel design and fan speed control policies are optimized, which also reduce noise and power consumption. With the revised design, a 4 U high-density disk enclosure can accommodate a maximum of seventy-five 3.5-inch disks.

A high-density disk enclosure has the following advantages over a conventional 4 U 3.5-inch disk enclosure:

- 3-fold increase in disk density
- 2-fold improvement in performance for every space unit (1 U)
- 20% reduction to operating expense (OPEX) for every disk
- 50% reduction in power consumption for every disk

Conclusion

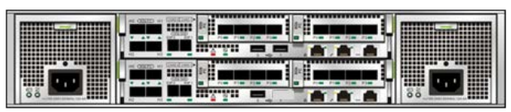
Direct storage technology for video streams is being widely applied in the video surveillance industry. Holding fast to the "Being Integrated" strategy, Huawei has launched a converged virtualization solution to help video surveillance ISVs enhance their core competence with eliminations to data loss, full-dimensional reliability assurance, improved performance, and reduced power consumption, among the many other benefits in OceanStor 2800V3.

Huawei OceanStor 2800 V3: video cloud converged storage system

Huawei OceanStor 2800 V3 is a next-gen high-performance virtualization storage device developed for the video surveillance arena. Its storage controllers inherit the IP SAN access capability and also accommodate a virtualization platform to fully utilize the computing resources. In this way, the video applications that were deployed on physical servers can now be migrated to storage controllers for operating. Its outstanding features including open and direct storage of video streams, fast video aggregation, and data protection. It can easily integrate with ISV service platforms to build a large-scale video cloud storage system, significantly reducing users' TCO.

» Product exteriors

Front view of OceanStor 2800 V3



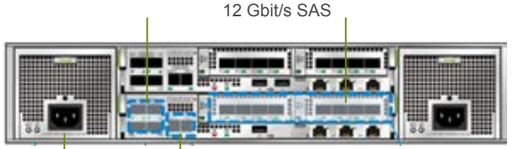
Rear view of OceanStor 2800 V3

Onboard interfaces

- 4 x GE per controller
- 4 x 8 Gbit/s FC per controller

Interface modules

- 2 x hot-swappable interface modules
- Interface types: 8 Gbit/s or 16 Gbit/s FC, GE, 10GE, TOE, 10GE FCoE, 12 Gbit/s SAS



Power/BBU/Fan three-in-one modules

- 1+1 redundancy
- Conversion efficiency up to 94%
- -48 V DC and 240 V high-voltage DC

SAS expansion interfaces

- 2 x SAS expansion ports per controller

» System architecture

- Up-to-date Pangea hardware platform
- Integration of controllers and disks in a 2 U enclosure
- Active-active dual controllers

» Highlights:

High performance and scalability

- Industry-leading hardware structure
- Host interfaces supporting multiple protocols
- PCIe 3.0 high-speed bus and SAS 3.0 high-speed I/O channels
- Hot-swappable I/O interface modules
- 4 x hot-swappable interface modules + 2 x onboard interface modules in every 2 U space

Open and virtual converged platform

- The only proprietary virtual storage platform in the industry
- Convergence of computing and storage for open and direct storage of video streams
- Most flexible configuration template

Excellent efficiency and ease of use

- Optimized data access paths
- Simple management and maintenance tool

Robust reliability and usability

- Image and video restoration
- Fast data recovery
- Full redundancy design
- Built-in BBUs and data coffers

Intelligent quality of service (QoS)

- QoS protection at multiple layers
- Tailored policy priorities

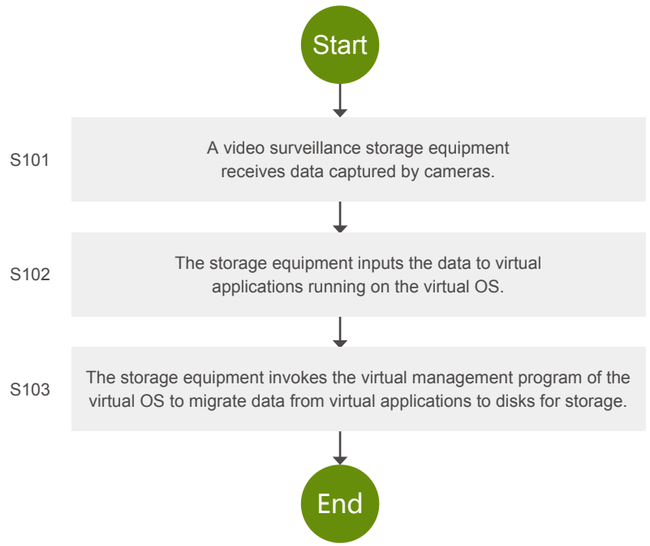
Energy conservation

- 16-level fan speed control
- CPU frequency control

Huawei OceanStor 2800V3: Converged, Efficient, Reliable

» Major specifications

Model	OceanStor 2800 V3
Hardware	
Number of controllers	Dual controllers (a 2 U enclosure with integration of disks and controllers)
Cache size	96 GB
Type of disk enclosures	Disk enclosure (3.5-inch disks x 24): 30 high-density Disk enclosures (3.5-inch disks x 75): 10
Max. number of disks	750
Types of disks	4000 GB 7.2k rpm NL-SAS disks (3.5-inch) 4000 GB 7.2k rpm SATA disks (3.5-inch)
RAID levels	0, 1, 3, 5, 6, 10, and 50
Max. number of front-end host ports	16 x 10GE or 24 x GE
Max. number of back-end I/O ports	12 x 4 x 12 Gbit/s SAS
Software	
Video input/output capability	384-lane HD (1080P) recording and 128-lane HD playback
Max. number of VMs	6



[Invention publication] Video surveillance storage method and equipment

- Publication number: CN104144327A
- Publication date: Nov. 12, 2014
- Application number: 2014103647028
- Application date: Jul. 28, 2014
- Applicant: Huawei Digital Technologies (Chengdu) Co., Ltd.
- Developer: Li Xin
- Address: 611731 Qingshuihe Area, West Park, High-Tech District, Chengdu, Sichuan
- Category number: H04N7/18(2006.01)I; H04N5/781(2006.01)I

Abstract: This invention is about a video surveillance storage method and equipment. This method includes: A video surveillance storage equipment receives data captured by cameras, the storage equipment inputs the data to virtual applications running on the virtual OS, and then the storage equipment invokes the virtual management program of the virtual OS to migrate data from virtual applications to disks for storage.

Reliability Analysis on Video Surveillance Storage Systems

Video surveillance technologies are now penetrating every aspect of modem life. With the huge surge in security protection demands and wide application of high-speed networks, video surveillance systems are being transformed from simulated surveillance to digital and network-based surveillance. Conventional storage devices like tapes, digital video recorders (DVRs), and network video records (NVRs) cannot cope with the new challenges arising in this process, and professional storage arrays are called on to provide larger storage capacity, higher performance, and improved reliability.

A storage array allows multiple physical disks to form a virtual group, which is called a Redundant Array of Independent Disks (RAID) group. Data to be written to a RAID group is first sliced into blocks and then placed to the virtual member disks of the RAID group, and verifications are routinely performed. In addition, these member disks can work in tandem to handle a data read or write request, significantly reducing response latency and helping to protect data security. A common practice is to combine two storage arrays into a highly reliable storage array (dual-controller storage array), which enables mirrored channels to achieve service failover and failback in real time.

Huawei's approach to achieving robust storage reliability

As an enterprise with the most solid R&D capability in China, Huawei has invested billions into research and development of storage equipment. By inheriting the advantages of conventional storage arrays, Huawei's storage arrays are further optimized for video surveillance systems and Safe City projects, incorporating a variety of cutting-edge technologies in equipment, software, and disks to achieve zero loss of video data.

Huawei storage adopts a highly reliable design, precise manufacturing processes, and impressive protection and maintenance utilities, providing end-to-end assurance to ensure stability in system operations. Disks are the most critical component of a storage array and are used for processing data read and write requests. In a large-scale Safe City project, the video surveillance system usually accommodates a huge number of surveillance cameras. Surveillance data is retained in the system for long periods, imposing even higher requirements on the disks. To better serve Safe City agendas everywhere, Huawei thoroughly analyzed project requirements and then optimized its disks and other relevant components according to the general deployment scenarios involved. The optimized storage arrays achieve a disk failure rate far lower than the industry average of around 10%. The mechanisms Huawei applies to its reliability design, disk optimizations, and component enhancements are generalized in Figure 1.

A disk, or a hard disk drive (HDD), is a mechanical device with magnetic media used to store information. Its major components include platters, magnetic heads, an actuator motor, a spindle motor, interfaces, and a printed circuit board assembly (PCBA).

A disk is not a sealed device but connects to the external environment through a small breather hole (the hole is usually covered with a breather filter to prevent dust from entering). The fastest disks spin at 15,000 rpm.

The air density generated during the disk's high-speed rotation causes the heads to rotate at a flying height of 10 nm. The actuator motor swings

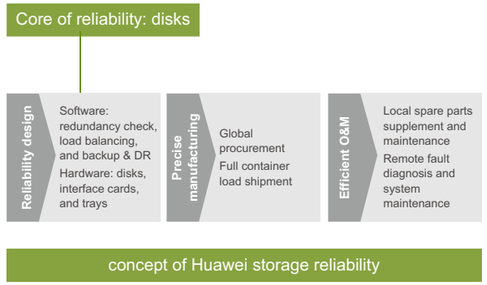


Figure 1 concept of Huawei storage reliability

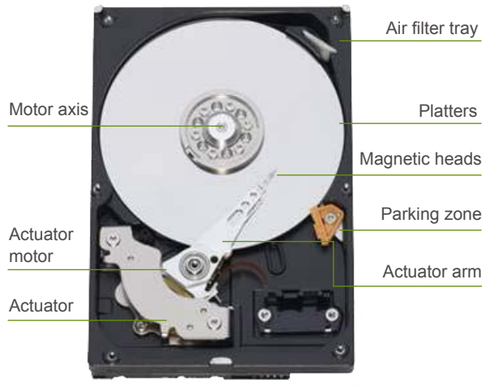


Figure 2 hard disk structure

the heads fro and back along the disk radius and precisely places the heads at an optimum position for data reads and writes (see Figure 2).

» Major factors causing disk faults:

1. The flying height of heads is only 10 nm; therefore, vibrations may cause the heads to collide with platters.
2. If dust particles fall into the sealed enclosure of a disk, or collide with the heads or patters, the patter surfaces may become scratched.
3. Temperature, humidity, environment contamination, and working altitude are the other factors that may result in disk failures.

» Table 1 lists the factors leading to disk faults

Factor	Impact	Source
Vibration	Interferes with the heads flying, prevents heads from precise data locating, causes heads to collide with platters.	Vibration
Dust particle	Causes heads to collide with platters, scratches platter surface.	Air dust, smoke
Temperature	Accelerates heads aging.	Excessively high temperature
Humidity Air pollution Sulfur	Corrodes disk circuit boards.	Excessively high humidity Volatile materials like sulfur
Voltage	Interferes with the heads flying, prevents heads from precise data locating, causes heads to collide with platters.	Altitude

Huawei technologies improving disk reliability

» Quality control in precision manufacturing and inspection procedures

Based on its accrued experience in manufacturing electronic products and detailed analysis on disk characteristics, Huawei has worked out a series of stringent disk manufacturing and inspection procedures, and utilizes such advanced technologies as environment stress screening (ESS), aging testing, and built-in testing to locate disks at risk of failure. Figure 3 illustrates Huawei's disk inspection procedure.

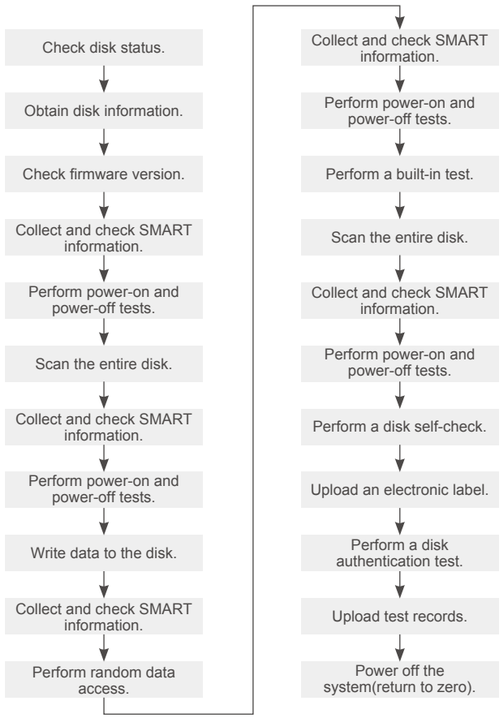


Figure 3 Huawei disk inspection procedure

Based on these precise procedures, up to 99.99% of potential disk faults are discovered before a fault event actually occurs, greatly reducing the disk failure rate.

» Anti-vibration design

Storage systems are often deployed in complex and even adverse environments, and disk vibration becomes even more of a concern for systems using mechanical disks because the high-speed rotations of the disks will cause vibrations that lead to head and platter movement that in turn may shorten disk service life. To resolve these intrinsic defects, Huawei continuously looks for ways to optimize disk trays and overall system structures to eliminate the impacts from vibration and improve disk reliability.

Isolation of disk vibrations: By monitoring and analyzing disk vibrations, Huawei redesigns disk tray structures and improves its anti-vibration performance. This innovative disk tray design can efficiently absolve the vibration energy generated by both disk rotation and the external environment (see Figure 4).

Insulation of fan vibrations: Horizontal and vertical cushioning materials are placed around the fans, brackets, and the enclosure, removing 40% or more of the vibration from fans (see Figure 5).

High-density design of enclosure and disk guide rail: The double-deck structure improves the strength of enclosures by more than 20% and guide rails are made of die-cast zinc alloy, helping keep disks in place and the closure intact in extremely adverse environmental conditions. The shock-resistant design of the material helps reduce the vibration transmitted from enclosures to disks, extending service life and improving system stability. Huawei equipment has passed magnitude-9 earthquake resistance testing, another testament to the level of engineering and precision in manufacturing that goes into each piece of Huawei storage.

Real-time monitoring of operating environments: The vibration sensor integrated on the midplane monitors vibration and shock in the system environment in real time. If a vibration or shock value exceeds the threshold, the network management system immediately notifies the administrator to take corrective measures, thereby preemptively avoiding system shutdown (see Figure 7).

» Huawei special designing

Figure 4

Figure 5

Figure 6

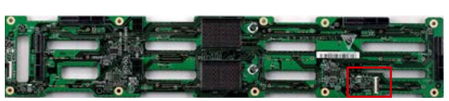


Figure 7

» **Non-disruptive disk diagnosis**

Storage systems typically accommodate a huge number of disks and carry mission-critical data, thereby requiring fault diagnosis and rectification tasks to be transparent to services. How to promptly detect and efficiently handle disk faults to minimize the impact on service continuity is a challenge. Huawei storage arrays employ a disk fault management mechanism that integrates proactive prevention, partial isolation, and fast recovery to improve disk fault tolerance.

Preemptive prevention

Disk fault diagnosis and warning provided by Disk Health Analyzer (DHA): Disks are an important component of a storage array and become more prone to failure with the increase to service time, especially after long-term operation. The Huawei proprietary DHA is used to set up a disk fault model to monitor key indicators. It adopts advanced algorithms to assess disk health and predict disk faults. The DHA can dynamically use different assessment algorithms according to the working status of disks and service models of the storage system. Currently, Huawei employs the following three DHA modeling technologies to determine disk status:

- Routine SMART information collection (single factor): uses disk SMART information for analysis and prediction.
- Weibull distribution probability analysis (multiple factors): uses disk Power on Hour (POH) indicators for analysis and prediction.
- Fuzzy comprehensive evaluation (multiple factors): uses comprehensive indicators including disk SMART information and I/O models for analysis and prediction.

Background bad sector scanning: Bad sectors are a common cause of disk faults; however, bad sectors cannot be proactively reported to the host, only detected during data reads and writes. Huawei provides a background bad sector scanning function that proactively detects and recovers bad sectors without affecting services or disk reliability, thereby reducing the risk of data loss. This function also allows users to set scan policies for specific scanning periods based on the physical parameters of disks and according to site particulars.

Online disk diagnosis: Huawei introduces online disk diagnosis into the disk troubleshooting process to analyze causes and impact scope of disk faults. If a disk becomes faulty, it will not be deleted immediately. First, fault diagnosis is implemented to check whether the disk is really faulty. In addition, the mechanism offers a variety of measures to restore disks and bad sectors, greatly improving service continuity and system reliability.

Partial reconstruction: Huawei provides a function called partial reconstruction to minimize the impact caused by a disk removal. If a disk is removed without going through the proper removal procedures and checks, data increments are recorded until the disk is reinserted into the system, and only the incremental data is written to the disk after it is reinserted. This function significantly reduces the amount of data to be reconstructed, shortens the reconstruction period, and minimizes risk of data loss.

Thin reconstruction: Generally, storage space assigned to users will not be used up immediately; that is to say, most storage space is in the idle state. Therefore, if a disk permanently fails, it is a waste of time and resources to reconstruct the unused space. Thin reconstruction only reconstructs valid user data, thereby reducing the construction time and impact on reliability.

Huawei Video Cloud Storage Builds 360-Degree Ecosystem With Partners to Usher in a New

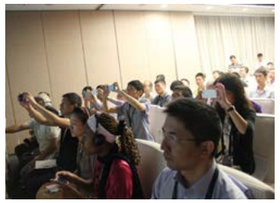
Huawei Video Cloud Storage Builds 360-Degree Ecosystem With Partners to Usher in a New

Age in Video

Holding strong to "Make IT Simple, Make Business Agile", Huawei has invested heavily in technology and application innovation, and has successfully created an open ecosystem with its global partners to deliver top-notch video cloud storage solutions and services. During Huawei Cloud Congress 2014 (HCC2014), Huawei hosted a special session to discuss topics concerning the application of video cloud storage in Safe City projects. Customers, special guests, and project partners from such areas as public safety, IDC, IT development, and telecommunications attended the seminar. During the session, attendees exchanged views on topics like Smart City, intelligent video analysis technologies, smart law enforcement, and public security platform rollout. Their discussions provided insights into how to leverage IT to make cities and all of the society safer as technology continues to develop.

Group photo of partners in video cloud storage at HCC2014.

Participants crowd into the video cloud storage session.



Huawei's partners delivering speeches.

Huawei video cloud storage embraces the strategy of "Being Integrated and Open".

Developed cities over the globe have rolled out their Safe City initiatives in one form or another over the past several years or even decades. Driven by public and private partnership, the security protection industry has witnessed many breakthroughs in both theory and practice. As the initiatives and technologies involved become more mature, Safe City will be rolled out in smaller and less well-developed cities while large metropolises with systems already in place are adding such intelligent functions as smart analytics and preemptive warning (early intervention) to their Safe City arsenals.

Safe City requires collaboration between people, physical facilities, and technologies, with security protection and monitoring systems at the core. The system functions as the "eyes" of the city, which means a simple and flexible structure is required to adjust to the ever-changing urban dynamics. The surge in demands for high quality, reliability, and security of video data raises the need for an intelligent video storage solution. In response, Huawei launched its video cloud storage solution.

The overall Safe City architecture is comprised of many elements, and the video cloud storage system is a key component of the security protection and monitoring system forming the core. Therefore, the storage system must be integrated into the whole project and be open enough to work with other video surveillance services. In addition, security protection and monitoring is a basic capability of Safe City, so it must be compatible with the overall project to maximize return on investment (ROI) and improve system competence. In this sense, Huawei's video cloud storage system must integrate with its ecosystem partners and even with upper-layer partners. "Being integrated" makes Huawei's solution future-proof.

As an extension of "Being Integrated", "Being Open" provides the following advantages:

- Allows the system to easily access existing resources, reducing initial investment.
- Removes concerns over incompatibility issues.
- Enables upper-layer ISVs to focus on designing and optimizing upper-layer service software rather than managing storage systems.

Huawei places a high premium on the importance of being integrated and open when designing video cloud storage solutions. Its next-generation converged video cloud storage solution, the OceanStor 2800 V3, adopts an open design and is built on a virtual platform. In this way, the solution can be integrated with third-party ISV software and deliver open and direct storage for video streams. In addition, Huawei's storage product portfolio provides eSDK open interfaces for storage management, which allows customers and partners to use their own network management systems to manage Huawei storage devices, lowering the total cost of ownership (TCO) and achieving a simple and centralized management approach.

Huawei Video Cloud Storage Builds 360-Degree Ecosystem With Partners to Usher in a New

Huawei has completed more than 80 interoperability tests along with its 38 ISVs.

By 2015 Q1, Huawei had worked alongside with its 38 ISVs to implement more than 80 interoperability tests and customer verification tests, and summarized best practices based on the test results to guide future project rollout. The results and superior functionality speak for themselves, making Huawei video cloud storage solutions the ideal choice for customers with demonstrated best-in-class openness and compatibility.

All these interoperability tests were conducted at Huawei's IT OpenLab, which provides a video storage test environment with more than 1000-PB in capacity and 100,000 disks, and has witnessed the birth of 24 world records in storage performance. This lab is able to simulate:

- An ultra-large solution verification scenario
- An end-to-end solution verification scenario in which hundreds of thousands of video streams are recorded, forwarded, and accessed
- A video cloud in which video data flows from edge nodes to the center

华为 IT Openlab 开放实验室

With its ground-breaking capabilities, Huawei IT OpenLab stands ready to collaborate with partners in finding the solutions that work best for customers.

Huawei video cloud storage builds a 360-degree ecosystem with partners and ushers in a new age in video

As urbanization expands and as global economic patterns continue to change, Safe City has the potential to be rolled out in every corner of the world. To date, Huawei's video cloud storage solution has been successfully applied in more than 100 cities in over 30 countries around the world, serving more than 400 thousand residents. Huawei will continue to invest in developing innovative technologies and enhancing the ecosystem with its ISV partners, aiming to deliver more customer benefits and optimal solutions in the new age of video.

Huawei Storage Makes Cities Safer

New trends in Safe City

Urban residents want to feel absolutely safe in their communities. To make their cities more appealing and safer, local governments are implementing Safe City initiatives for heightened security assurance. As part of these roll-outs, cutting-edge video surveillance technology is being applied to routine police work and criminal investigations, demonstrating a new model in how the network and technology help law enforcement work smarter. Special emphasis is being placed on the digital video surveillance platforms going into the Safe City programs to give local police forces an upper hand in their arsenal to combat crime. As the technologies evolve and as integration methods and requirements become clearer, project focus has transited from merely wanting to provide a basic level of safety to one in which intelligent applications combine to strengthen deterrence and augment enforcement. Especially with the emergence of new technologies like 4K ultra-high definition (UHD), cloud computing, and Big Data in recent years, and with the government's quest for more extensive security approaches, the future of Safe City is unfolding right in front of us.

» Security and stability are top priority.

Security and reliability are prominent factors in assessing any system, and they are especially critical to any Safe City agenda as safeguarding people's lives is of paramount importance. These projects incorporate tens of thousands of surveillance cameras and generate several petabytes of information. In one example, the Guangdong Province "Safe City Corridor" project has deployed a surveillance network comprising over one million cameras over the first five years. That number is expected to increase significantly over the coming years, making it the largest such type deployment among any municipal public security entity.

Considering the importance and sheer scope of Safe City, the following security and reliability requirements must be achieved for the project to be successful:

- Secure access platform must be built between internal and external networks.
- Monitoring network must adopt redundancy design.
- Core databases must employ an active-active hot-backup design.
- Central management units of large systems require hardware load balancing approaches to ensure optimum operation.
- Components responsible for transmitting streaming media must employ N+1 or even N+M backup.

The popularity of network-based and HD video surveillance, and the massive amounts of data that come along with these trends, place even higher requirements on the core of these surveillance systems: the storage platform. Therefore, the security, stability, and reliability of that platform are key to supporting criminal investigations and achieving higher levels of public safety.

» Ability to share video surveillance resources is integral to collaboration

Recent years have witnessed a huge surge in video surveillance requirements, and collaboration between agencies has become essential to achieving Safe City objectives. Surveillance on local networks cannot cope with the emerging needs, which is why municipalities, regions, and even nations are making the move over to network-based surveillance systems. In the Safe City projects that are being carried out in many locales, a vast number of video surveillance systems need to be deployed; however, if the systems use conventional digital video recorders (DVRs) and network video recorders (NVRs) for data storage, the stored video resources cannot be shared across systems. Therefore, a central storage model such as a storage area network (SAN) or cloud storage is required to eliminate information silos.

» The call for innovative video technologies.

As project success is demonstrated in more and more Safe City rollouts and as more and more public security departments are using video surveillance in criminal investigations, conventional recording and storage methods are proving ineffective, especially considering the many new application requirements being raised. Based on visual analysis technologies, these requirements cover the need for analyzing, diagnosing, searching, tracking, and splicing videos in an intelligent manner. Under this trend, the traditional storage systems offering a 1:1 read/write ratio become a bottleneck, and video analysis capabilities must be further developed to deliver higher concurrent video read/write capabilities.

In summary, the stability in storing and ability to efficiently analyze video surveillance data will be the major issues that face Safe City builds in the next few years. Following its philosophy of "Gathering the Power of Video, Unlocking the Wisdom of Images", Huawei provides a future-proof video surveillance storage solution that speaks to these issues.

New data storage initiative in Safe City

In the public security organization chart, local police stations are the most fundamental unit while public security bureaus perform supervisory roles. In this sense, local police stations are directly in charge of the data captured by surveillance cameras while public security bureaus guide and manage the operation of the stations. Therefore, two levels of video surveillance systems need to be built for a Safe

City project: the first level is constructed for the local police stations and the second level for the public security bureaus.

» Level-1 storage: central data storage for local police stations

Build-outs of the video surveillance systems in the past usually adopted approaches like VCR and DVR recording, but these approaches had limited transmission distances and expensive cabling, so they could only be used for storing data locally. In the past, surveillance data was scattered in different places and only the most critical data could be saved in local police stations.

Since 1997, as IP network technologies become mature, digital and network-based video surveillance initiatives have come into being, NVR and IP SAN storage solutions dominate the market, and the method of surveillance data transmission has changed from simulated signals to IP network-based digital signals. With these improvements, the construction of video surveillance systems is no longer restricted by transmission distances, and the once scattered data can now be saved to a centralized repository. In addition, the surveillance data allows for remote access by public security bureaus, so the data is well managed and fully utilized. The performance bottleneck of this storage mode lies in the IP bandwidth, for the network capabilities in most cities are insufficient for large-scale data transmission. This level of capability in central data storage for local police stations is what we refer to as level-1 storage.

The level-1 storage devices used in the initial stage were DVRs and NVRs. These devices feature ease of deployment and low cost, but their capacities are limited, reliability is poor, and data integrity is not assured. With the popularity of network-based and HD video surveillance, Safe City projects have been experiencing exponential growth in the amount of video surveillance data, and any leakage of the data may cause social instability and even political unrest. To eliminate these risks, stringent capacity and reliability requirements are imposed on level-1 storage devices, and professional storage manufacturers are called on to provide viable solutions to address the needs for secure data storage.

At present, level-1 storage devices deliver only basic functions, but it is foreseeable that, with the advances in networking, video sharing, and intelligent video analysis, these devices will incorporate many value-added applications (such as data computing capabilities) as level-1 storage develops towards the convergence of storage and computing. Leveraging its vast expertise in technology and penetrating analysis into video surveillance, Huawei offers the first solution to converge data storage and computing in this area with its release of the powerful IP SAN-based video surveillance storage solution.

» Level-2 storage: central data storage for public security bureaus

The year 2005 was a milestone for IP technologies. Higher bandwidth was the most notable advantage, and improved transmission and storage capabilities meant that public security bureaus could now centrally store video surveillance data with the new network builds or upgrades. This leap made level-2 storage possible. The storage devices selected for this model are mainly manufactured by professional storage vendors and capable of providing massive storage capacities and robust reliability assurance, with typical devices including IP SAN devices and cloud storage systems. The level-2 model delivers the following advantages:

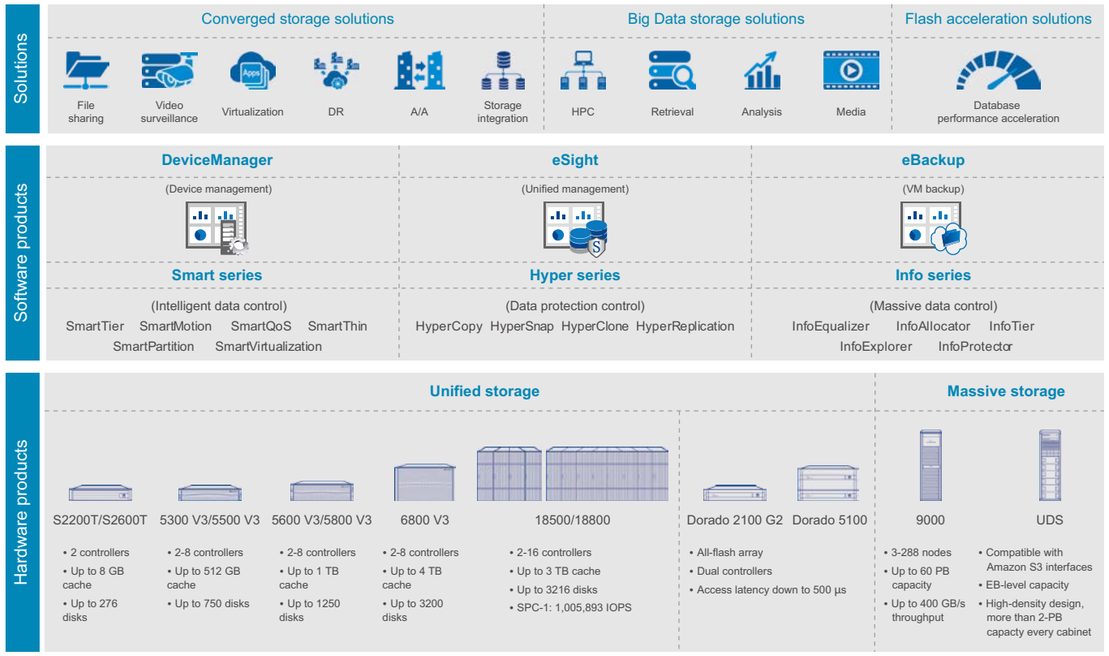
- Centralized data storage facilitates management and utilization while reducing costs associated with video and image ingesting.
- Storage systems able to handle enterprise-level applications, and the equipment room environment can be better controlled to protect data.
- Massive amounts of video can be saved, which are valuable for high-tech public security applications like video compression, face recognition and search, vehicle search, and people/vehicle tracking, improving the efficiency in criminal investigations and raising the standards in urban management.
- Video data can be shared across public security departments, and all the data can be centrally managed and scheduled.

Huawei has a solid track record in developing both conventional IP SAN storage and cutting-edge cloud storage, so it is capable of providing flexible and reliable solutions to address level-2 video surveillance needs.

» Future trends in video surveillance storage for Safe City

Network capabilities in many areas remain under-developed, and considerable distance separates police stations in many rural regions. Level-2 storage in surveillance data is not feasible at present for some locales, making level-1 storage the only viable option. In contrast, level-2 video surveillance systems have been built to centrally store data for public security bureaus in developed cities with good network quality and police stations that are located close to each other. These systems are also playing a significant role in urban management. In the future, as intelligent video analysis, Big Data, and cloud storage technologies become more mature, more level-2 storage systems will be constructed to work alongside the level-1 systems, with a goal of providing the means to better guard every corner of our cities.

OceanStor Convergent Storage Portfolio



Video analysis approach in Safe City

If the mushrooming amounts of video data can be centrally managed, intelligent analysis can then be applied to such data. At present, video analysis technologies fall into two main categories: behavior analysis and feature analysis. Behavior analysis is based on background modeling that can separate moving objects from the static background and filter out irrelevant objects. This method can generate alarms if an usual trajectory or anomaly in behavior or operation is discovered based on preset rules. Feature analysis matches the captured images with those in the feature database of the target object to provide accurate results and determine if further analysis or alarming is required.

Intelligent analysis with use of applications (automated analysis) will also become a trend in the future. Automated analysis will eventually replace manual analysis thanks to such technologies as intelligent track analysis, intelligent object retrieval, face recognition, movement detection, video abstracting, visual display and analysis, as well as graphic rendering and layout analysis. These technologies drastically reduce the time required for video scanning and retrieval as well as the costs associated with criminal investigations, infusing the intelligence capabilities of technology into crime fighting and making police work much more efficient.

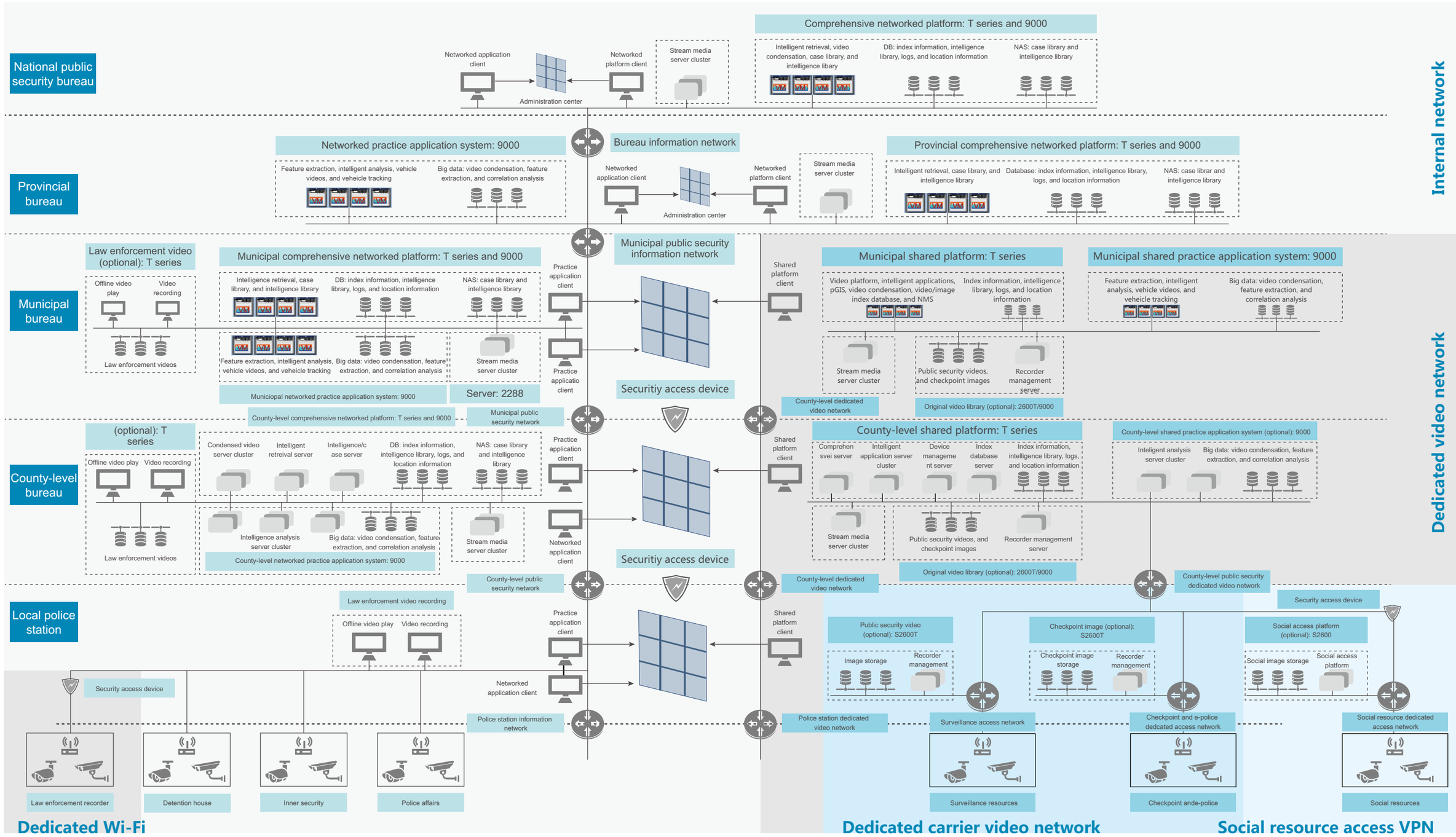
Huawei's video surveillance storage systems deliver a read/write ratio of up to 4:1, which efficiently eliminates the performance bottlenecks caused by concurrent access to multiple video streams. Huawei's solutions can further integrate with cutting-edge video analysis systems to form an elastic, efficient, and reliable video analysis solution.

Conclusion

Being a technology trailblazer in the storage arena, Huawei provides a video surveillance solution that speaks to all the associated requirements in Safe City, helping law enforcement and urban management achieve higher levels of efficiency and accelerated response with the infusion of modern technologies.

Huawei, with its specialized storage capabilities, makes cities safer.

Huawei Storage Makes Cities Safer



Huawei Converged Virtualization Solution: Redefining the Future of Video Surveillance Virtualization

Video surveillance technologies have transitioned from simulated video surveillance to digital video surveillance and are now moving toward network-based video surveillance. Mirroring this trend, the storage devices used for video surveillance have evolved from tapes and digital video recorders (DVRs) to network video records (NVRs). However, even the most up-to-date storage devices are stretched in capacity and can only be used to store local surveillance data. These devices fail to meet the video sharing requirements as the number of video surveillance systems deployed in Safe City projects continues to expand. The ever-demanding project requisites in performance, reliability, and openness require a new approach in the video surveillance solution.

At present, there are two mainstream solutions able to handle large-scale video surveillance applications. The first is a standard storage solution that adopts storage servers and IP SAN (also called a forwarding storage solution), and the second is a direct storage solution for video streams that combines video surveillance software and storage devices. The most commonly used direct storage devices are central video recorders (CVRs) that are actually standard IP SAN storage devices running video surveillance platform software. Compared with the forwarding storage solution, the direct storage solution eliminates the use of storage servers, thereby reducing the total cost of ownership (TCO). However, CVR technologies are immature and have the following shortcomings:

- CVRs entail high technical barriers, so only a few video surveillance vendors are able to design and develop them.
- Most CVRs deploy enclosed system architectures that inflexibly bind hardware and software, resulting in poor compatibility and lack of openness.
- As CVRs run only one operating system but comprise multiple system modules, these modules frequently compete for system resources, significantly deteriorating system performance (50% reduction to performance when direct storage of video streams is adopted) and compromising system reliability.

Huawei Converged Virtualization Solution: Redefining the Future of Video Surveillance

[Note] Direct storage of video streams, also called direct storage of stream media, is realized by installing a variety of video surveillance platform software on CVRs. It supports stream media protocols like RTSP, ONVIF, PSIA, SIP, GB, and T28181 as well as storage protocols like iSCSI, CIFS, NFS, and FTP.

Huawei, with over 10 years of accumulated experience in the storage arena, offers an innovative converged virtualization solution for monitoring and storage of video streams. This ground-breaking solution adopts standard IP SAN storage devices to deliver cloud computing virtualization and direct storage of video streams, and functions as the next-generation central storage platform for video surveillance applications. With its excellent capabilities in openness, stability, and efficiency, the Huawei solution is a highly viable choice in the video surveillance component for Safe City, solving the pain points associated with other offerings limited by enclosed system architectures, incompatibility among heterogeneous video surveillance software, and low storage reliability.

Huawei's converged virtualization solution outperforms conventional CVRs in many ways. Topping the list of benefits from the Huawei offering is complete compatibility with all third-party video surveillance platform software. The most important attribute of the central storage platform in a video surveillance solution is its openness, as the software suites running on that platform are usually tailored operating systems and configurations. Huawei employs virtualization technology to create various virtual hosts out of the IP SAN device controllers, and enables the hosts to cooperate with third-party video surveillance software and deliver direct storage of video streams based on such popular stream media protocols as RTSP, ONVIF, PSIA, SIP, and GB- T28181.

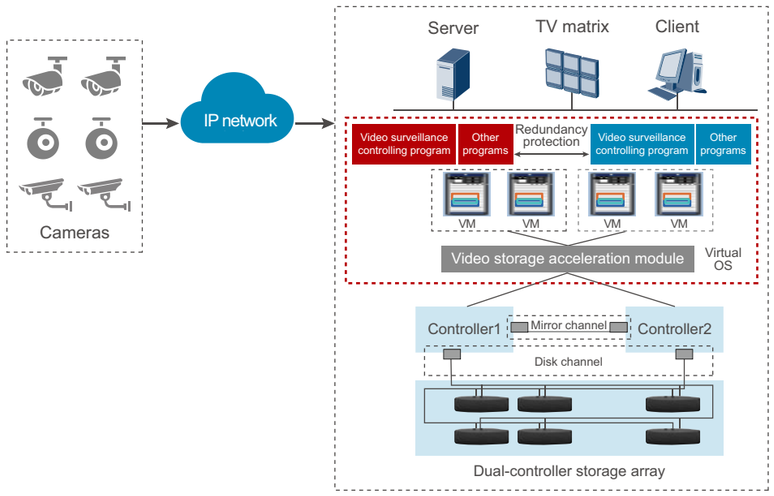


Figure 1 Architecture of Huawei converged virtualization solution

The second highlight of Huawei's solution is its robust reliability made possible with a wide range of advanced technologies:

- The fault isolation technology limits the extent of impact from errors like deadlock, infinite loop, and unexpected exit, helping ensure the highest level of stable operations for storage devices.
- Virtual clustering technology ensures the high availability of controller resources in IP SAN storage devices. In the event of a virtual resource or controller failure, the workload is dynamically switched to another controller, helping ensure continuity of video surveillance services.

Another advantage that makes Huawei's solution stand out is its capability to isolate hardware resources for different video surveillance and storage software suites, mitigating competition for system resources and ensuring high-level performance.

Compared with traditional DVRs and NVRs that are built on standalone structures, Huawei converged virtualization solution leverages the redundancy of a dual-controller storage platform, and employs mutual-backup controller units and virtualized backup technologies to achieve clustering for video surveillance software suites running on the two controllers. On this highly reliable platform, faults in the video surveillance software will not interrupt system operations as services are automatically taken over by counterparts running on the other controllers.

As video surveillance technologies continue to evolve, storage devices become stretched with workloads and other pressures, which means new innovations must be applied to compensate. The following cutting-edge technologies in the Huawei solution helps alleviate such pressures.

- Multi-controller technology: combines multiple IP SAN storage devices into virtual devices and enables video surveillance platform software that was running on standalone devices to operate in a distributed architecture, thereby significantly improving the processing and redundancy capabilities of the video surveillance platform software.
- Big data analysis technology: transforms IP SAN storage devices from simple video storage devices to sophisticated storage nodes that can deliver video analysis capabilities. By installing such Big Data software as Hadoop in virtual machines, video data can be indexed and labeled when it is being saved. This technology makes Big Data and video analysis capability a reality without the need to upgrade legacy devices.

Huawei's converged virtualization solution applies revolutionary technologies that speak to the issues in video surveillance deployment and operation. Huawei intends to remain at the forefront with heavy investments into this area.

Profile: Distributed Video Data Storage in Local Police Stations

Profile: Distributed Video Data Storage in Local Police Stations

Origins and survey of Safe City

Safe City leverages science and technology to help law enforcement work smarter. As part of these worldwide rollouts, the 3111 Pilot Project in China builds alarming and monitoring systems into the Safe City initiative. This project was first carried out in four pilot cites and then, after the success of the first phase, was further promoted to 22 provinces. With the expansion of the Safe City Project, video surveillance systems have been deployed nationwide, and become a critical part of the project.

The wide application of video surveillance systems has significantly strengthened the power of criminal investigations, however, the huge number of cameras installed for the project generate copious amounts of data every day, adding huge pressure to the centralized storage of data. Therefore, most surveillance data is stored locally in different police stations, causing information silos.

Mainstream storage technologies and requirements in video surveillance

With the continued rollout of the Safe City Project, video surveillance technologies are called on to provide more digital, network-based, HD, and intelligent capabilities. Along with the trend, surveillance images are transitioning from simulated and SD to HD video, and relevant storage devices are changed from VCRs, DVRs, and NVRs to the current SANs.

With the move to HD and just about everything becoming network-based and intelligence-capable, the storage systems in the Safe City Project that are used to store vast amounts of unstructured surveillance data are now put under ever-growing pressure.

Robust reliability: The storage system is the key component of the video surveillance system and thus must incorporate such mechanisms as redundant backup, parts protection, and data recovery to provide powerful reliability assurances.

Superior performance: Video surveillance streams are transcoded by front-end cameras and then aggregated in the storage system, so the storage system must deliver equally high write performance as that of the network aggregation points. At the same time, video surveillance data must be quickly retrieved, so the storage system must offer superb read performance as well.

Compelling cost efficiency: Although the HD technology makes image displays more vivid and lifelike, it magnifies the pressure on storage, network processing, and decoding. With the increased workload, the need to reduce storage costs of every terabyte of data becomes all the more important.

Ease of operation and maintenance: Video surveillance systems being deployed in Safe City at present usually include at thousands of surveillance cameras, and such a large-scale system requires a user-friendly GUI to make the operation and maintenance of core devices simple.

Mature IP SAN technology offers a viable solution to cope with the demanding storage requirements on capacity, reliability, and performance. IP SAN adopts the Internet Small Computer System Interface (iSCSI) protocol, an IP-based storage network standard for linking data storage facilities. By carrying SCSI commands over IP networks, iSCSI is used to facilitate data transfers over intranets and to manage storage over long distances. iSCSI can be used to transmit data over local area networks (LANs), wide area networks (WANs), or the Internet and can enable location-independent data storage and retrieval. An IP SAN inherits the advantages of IP networks in remote replication and disaster recovery, and can span long distances using existing network infrastructures, making it the most suitable network structure for the Safe City Project.

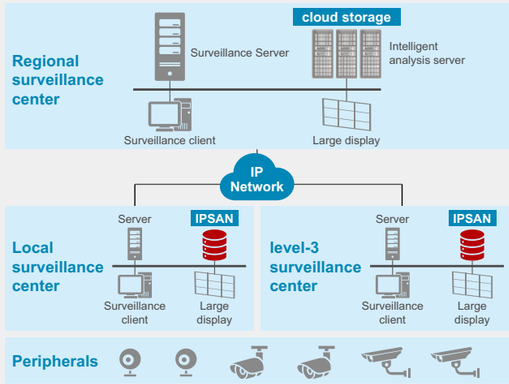


Figure 1 Huawei converged storage solution

Huawei converged storage solution

Committed to providing secure, efficient, economical, and future-proof storage approaches for video surveillance services, Huawei released a top-notch video surveillance storage solution featuring excellent capabilities in reliability, convergence, and expansion to answer the dilemmas in the move to HD and Big Data.

» Robust efficiency and reliability

- Delivers 2000-lane 1080P concurrent reads and writes (1600-lane reads and 400-lane writes, reaching a read/write ratio of 4:1), addressing the demanding concurrent read/write performance required by intelligent video surveillance.
- Mitigates impacts on service provisioning from faults on one controller with its ability to have two controllers work in tandem.
- Adopts a clustering model for both services and storage systems, achieving zero interruption of services.
- Introduces RAID 2.0+ into the rapid restore technology for video, achieving 20-fold improvement in the data reconstruction time and minimizing risk of RAID degradation.
- Employs image repair technology to increase data recovery efficiency by 90% or more, ensuring data security.

- Provides disaster recovery for key video assets and can be configured to keep multiple duplicates (N+1; N+2, N+3, N+4) for important surveillance data, minimizing loss of critical data.

» Converged architecture

- Convergence of protocols and networks: The array controllers and file engines are developed based on the same hardware platform, and the supported network types include IP SAN, FC SAN, and NAS with support for iSCSI, FC, NFS, CIFS, HTTP, and FTP network protocols. Huawei video surveillance storage solution is specifically designed for video surveillance scenarios and is applicable to IP SAN environments, delivering the needed storage capabilities for video surveillance services.

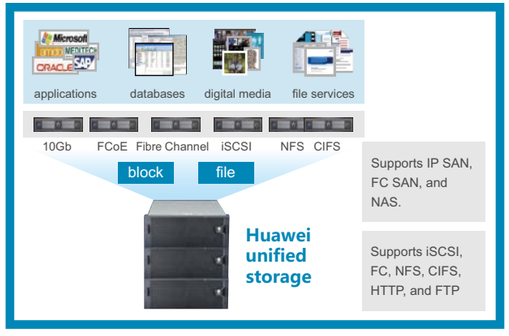


Figure 2 Convergence of protocols and networks

- Integrated management: Huawei provides an Integrated Storage Manager (ISM) to centrally manage devices and resources while monitoring performance and status.

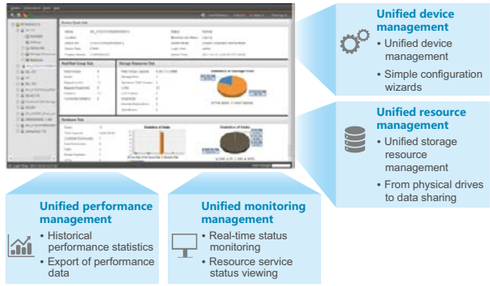


Figure 3 Integrated management

» Elastic expansion

- Completely addresses service needs in SD, HD, and intelligent analysis, achieving smooth service evolution.
- Fully enables elasticity in system upgrades, seamless capacity expansion, and non-disruptive addition of surveillance points.
- Dynamically relocates data on SAS, NL-SAS, SATA, and SSD disks according to the security level and level of importance ascribed to the data, meeting the needs in data protection while reducing maintenance costs.
- Specifically designed to meet the enterprise-class disk requirements in video surveillance services, providing 24/7 reliability assurances for video stream recording and analysis while lowering total cost of ownership (TCO) by 20% and more.

- Dynamically expands RAID groups with a proprietary function that allows customers to add new disks to an existing RAID group (without interrupting ongoing services) and increase the physical capacity of the RAID group without changing its RAID and LUN configurations.
- Dramatically improves disk utilization rates, frees up unused physical space, maintains disks at optimal read/write levels, and prolongs disk service life thanks to the disk defragment function that consolidates scattered fragments into contiguous physical spaces.
- Fully compatible with the most recent Internet Protocol, the IPv6, making the system future-proof.

Conclusion

Huawei remains on the throttle in the video surveillance arena as it continues to intently study the current future needs of the video surveillance technologies going into Safe City projects. In answering the demands for a storage system that provides large capacity, high reliability, and superior performance, Huawei stands above the competition and provides a future-proof storage solution that ensures usability both now and well into the future.

Profile: Central Video Data Storage in Public Security Bureaus

Profile: Central Video Data Storage in Public Security Bureaus

As HD video surveillance technologies become more sophisticated as Safe City continues to expand, demands for higher video resolutions are also increasing. An increased number of cameras are deployed for the project, capturing vast amounts of data, which magnifies the pressure on data storage. The amount of surveillance data that needs to be stored for a medium-sized city deploying Safe City averages tens of petabytes every year while that for a large city averages hundreds of petabytes. In addition to the huge data storage requirement, extracting the most value from the data generated by enabling sharing among systems and users is a critical to Safe City success.

With the increased threat from terrorism and its impact on social stability in recent years, accelerating Safe City rollouts has become all the more important. The vast majority of video surveillance systems in these projects are now producing digital signals instead of simulated signals, adopting a dedicated video surveillance network to transfer data captured by the HD cameras. A full spectrum of intelligent technologies are also introduced into the system, covering such areas as facial recognition and behavior analysis. These technologies dramatically enhance the capabilities of the video surveillance system. Driven by the thrust from Big Data, video surveillance systems are migrating to cloud platforms to store the ever-increasing amounts of data. Big Data analytics helps enable law enforcement "nip crime in the bud" with early intervention – one of the main objectives in Safe City.

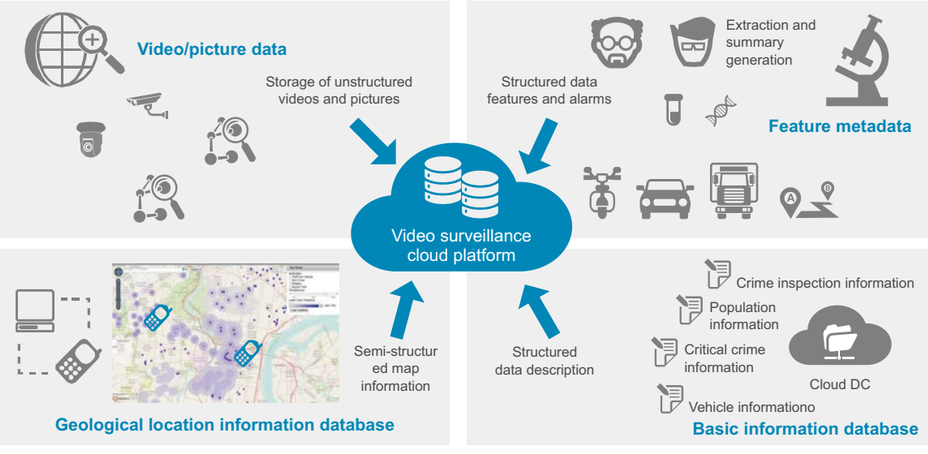


Figure 1 Application scenarios of the Big Data platform in video surveillance

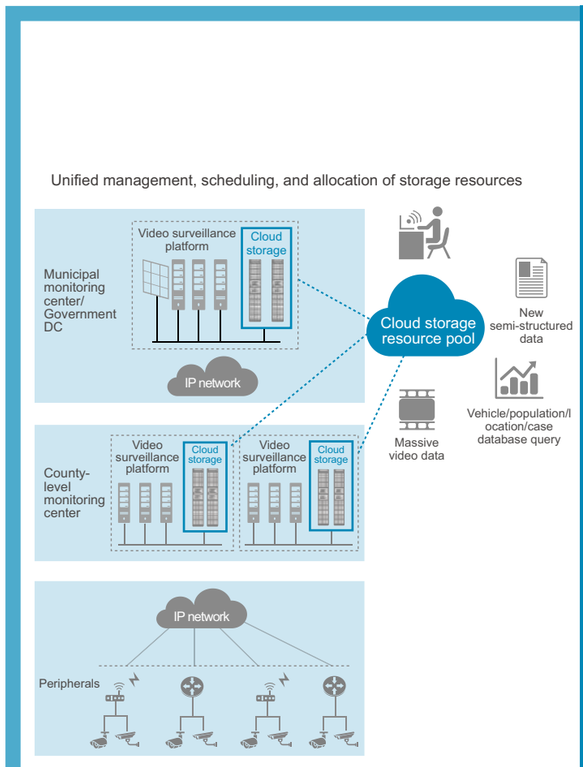


Figure 2 System architecture of the Huawei video surveillance cloud storage solution

Recognizing the video analysis and Big Data analytic needs of the public security sector both now and for the future, Huawei develops many innovative technologies in cloud computing, cloud storage, virtualization, parallel databases, and data mining, and employs an open and expansive data platform to replace the previous scattered service platforms and to address the storage and analysis needs for structured, semi-structured, and unstructured data.

Huawei leads the industry with video surveillance cloud storage solution

The Huawei video surveillance cloud storage solution is built on a Big Data storage platform and is specifically designed to store and analyze the vast amounts of data produced by video surveillance applications. The innovative symmetric distributed architecture allows the system to provide impressive capacity and a complete compatibility with both Oracle structured data and Hadoop Map/Reduce semi-structured data. The Huawei-proprietary data redundancy algorithms provide data protection mechanisms of different redundancy levels to generate one to four duplicates for a piece of data based on its priority level, significantly reducing risk of data corruption and loss.

Virtual and unified resource pool

The Huawei video surveillance cloud storage solution shatters the technical restrictions in conventional video surveillance storage devices by employing a 10GE IP network to connect storage nodes and a Huawei-proprietary storage operating system to centrally manage storage resources. All video surveillance services like data storage,

geographic information, and personnel/vehicle track analysis can access the unified resource pool of the Huawei solution through such data interfaces as NFS/CIFS (for unstructured data), SQL (for structured data), and Map/Reduce (for semi-structured data). The resource pool functions as a powerful data platform for efficient data sharing and utilization.

Parallel processing of structured data

The Huawei video surveillance cloud storage solution employs the massively parallel processing (MPP) technology to upgrade the conventional central database system to a distributed parallel database system (Wushan-SQL), significantly accelerating database processing capabilities. The distributed nodes can collaborate to respond to billions of write and query requests on structured data. In the video surveillance Big Data systems of the future, each video image will contain descriptive information on the personnel, vehicles, location, and other attributes in each frame, which will generates copious amounts of structured data. These next-gen video surveillance Big Data platforms must deliver distinctive performance in processing structured data. Built upon the MPP technology, the Huawei video surveillance cloud storage solution is ready to meet the challenges in the future of video surveillance.

Parallel processing of unstructured data

With the increasing degree of Big Data applications in video surveillance, conventional storage systems are choked by the following performance bottlenecks:

- Performance and capacity cannot be expanded at the same time.
- System management becomes complicated after expansion.
- Conventional RAID groups cannot deliver sufficient reliability.

The Big Data storage system in Huawei's video surveillance cloud storage solution delivers the needed scalability, performance, reliability, and ease of management to resolve all these pain points. Its core component for handling unstructured data, the Wushan distributed file system, integrates three logical layers (file systems, volume manager, and RAID) into the software layer, and then builds an intelligent file system that covers all nodes in the storage system. The system can process up to 5 million operations per second (OPS) with a maximum bandwidth of 200 GB/s, meeting the storage and analysis requirements of 1080p HD video data.

Parallel processing of semi-structured data

Safe City video surveillance systems must process complex and diversified surveillance data, and semi-structured data is a substantial part of that processing. The Hadoop system is the ideal solution for storing and utilizing semi-structured data. By optimizing the open-source Hadoop codes, Huawei developed a proprietary Hadoop system, the FushionSight Hadoop, and introduced this system into the video surveillance cloud storage solution. This system delivers excellent performance, reliability, stability, and all the processing and other capabilities required in the Safe City rollout.

Intelligent and automated management

The larger the system, the more important simplified management becomes. The Huawei video surveillance cloud storage solution is capable of processing huge amounts of complicated services, and achieves near-effortless system management through such automated functions as software pre-installation, dynamic software and hardware recognition, plug-and-play devices, and fast service provisioning.

The solution is also equipped with a unified management system to centrally manage nodes, monitor resource status, and generate alarms. In this way, users can perform management operations via PCs, smart phones, and tablets at anytime and from just about anywhere.

Conclusion

The Big Data storage system in Huawei's video surveillance cloud storage solution incorporates the storage, analysis, and retrieval functions for mass data and provides tailored data redundancy technologies at the network layer to build a virtual resource pool, facilitating resource management and maintenance. With the brilliant convergence of cloud computing, Big Data analytics, and massive storage, this solution is ideal for any Safe City rollout, both now and well into the future.

Gathering the Power of Smart Converged Storage to Build a Safe City

– Developing a Video Surveillance Solution with Smart Converged Storage

Background: Intelligent video analysis becomes the norm

The Chinese economy continues to develop steadily after many decades of rapid growth thanks to the many policies put in place to stimulate progress. With this progress, the Chinese government has also placed much focus on strengthening social stability by leveraging science and technology to help law enforcement work smarter as Safe City rollouts continue nationwide. As part of this focus, ever-increasing numbers of surveillance cameras are being deployed to make communities and metropolises safer, resulting in exponential growth in image data. Given the ineffectiveness of conventional manual approaches to processing these images and the time and labor needed to complete these tasks, the video surveillance component of Safe City requires intelligent video analysis capabilities.

Intelligent video analysis helps operators identify events, attributes, and patterns of behavior through video analysis of monitored environments, and generates alerts on any anomalies detected. In Safe City, intelligent video analysis is mainly used to enhance video image processing, image quality, behavior detection, classification of indexed video data, and extraction and query of key objects (such as people and vehicles) in the data. With this technology, vast amounts of redundant and useless information can be filtered out, thus reducing much of the need for intensive manual monitoring and its associated costs.

Pain point: Restrictions encumbering deployment of intelligent video analysis

The technologies and devices going into intelligent video surveillance have been optimized over the last ten years, and now it is widely used for video analysis and recognition. Although even wider application will come in the future, it is still hampered by many technical obstacles.

» Lack of a universal platform

The current intelligent video analysis technologies fall into two categories: front-end solutions and back-end solutions. Back-end solutions based on intelligent video processors introduce intelligent analysis into front-end cameras and video recorders, and are mainly used for transportation management and behavior recognition. Back-end solutions intelligently analyze the video data aggregated onto storage nodes. The most typical practice nowadays is to revamp hardware devices with computing capabilities into dedicated platforms to deliver intelligent analysis functions. However, each of the platforms is designed to address a specific need, and a large number of platforms are needed if diversified video analysis is required. In addition, as the intelligent algorithms and technologies are becoming more sophisticated, these platforms are becoming harder to upgrade and maintain while collaboration between these platforms is becoming more problematic, which means these platforms are incapable of meeting the huge surge in video analysis needs. Fortunately, with the development of software-defined technologies and the wider acceptance of openness and integration in the public security arena, many software products have been developed for intelligent video surveillance and are answering the need for a common platform. These improvements are creating the approaches needed to apply intelligent video analysis on a broader scale.

» Need to process and store enormous amount of surveillance data

Continued expansion of the Safe City Project requires a vast amount of surveillance cameras. The area under the jurisdiction of each local police station has about 100 lanes of 1080P HD cameras deployed on average, and this number will increase to 500 lanes in the near future. 100 TB in storage capacity will be required for each sub-district if the video images captured by the 500 lanes of cameras are retained for 30 days. Let's assume that the police station needs to investigate around ten crimes at the same time and 30 cameras have recorded some sort of evidence, event, or object helpful to the investigation. Let's further assume that the videos captured by these cameras must be analyzed for 3 hours and retained for 90 days. In this case, 120 TB of storage capacity must be available. Furthermore, the analysis of each crime must be completed within 60 minutes and cannot affect ongoing video recording and retrieval, which magnifies the need for tiered data storage, elastic capacity expansion, and concurrent read/write performance.

» Limited computing capabilities fail to address parallel analysis needs

Intelligent video analysis involves a series of complicated algorithms and formulas, and CPU processing capability becomes the bottleneck to overall computing performance. The previous isolated devices must be combined into a system to deliver concurrent analysis capabilities and improve efficiency.

The solution to the problems lies in

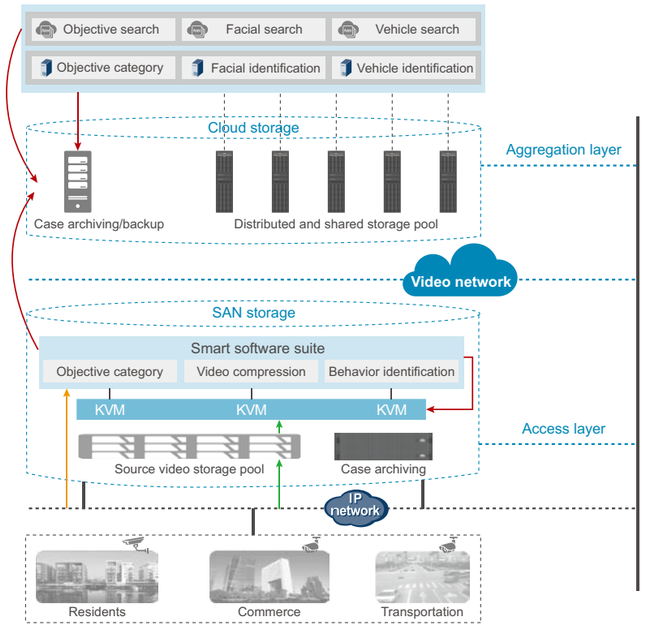


Figure1: Huawei's converged storage and intelligent analysis solution

convergence

Having thoroughly analyzed the needs in the Safe City Project, Huawei designed a two-layer storage architecture. On the access layer, SAN storage devices are deployed for local police stations and communities to receive video streams. On the aggregation layer, storage cloud devices are deployed for public security bureaus to aggregate the video streams. This architecture also converges two types of intelligent analysis services to deliver a variety of functions, including data storage, intelligent analysis, and application archiving.

The access layer incorporates video recording and analysis storage systems as well as leading-edge intelligent analysis service software based on kernel-based virtual machine (KVM). It not only addresses the basic needs in data recording and playback, but also uses advanced functions like quality of service (QoS) to allocate CPU computing resources to intelligent analysis services. This layer prioritizes memory and bus resources to mission-critical and real-time services, and allocates other resources to the other non-real-time services to maximize resource utilization. In addition, real-time video streams can be analyzed and scheduled, and any exceptions occurring during the analysis process are identified, while archived video records can be intelligently retrieved and associated to provide evidence for the criminal investigation. In this way, this layer perfectly converges the capabilities of video storage and analysis.

The aggregation layer adopts a distributed cloud storage architecture to store and analyze the vast amount of video data. Every storage node on the layer is leveraged to condense the video content, identify attributes in the footage, and extract valuable data. After removing the useless content, useful summaries are categorized, retrieved, and scheduled on a universal IT platform. The data in the summaries can then be used to search for clues and provide evidence to help solve crimes. The aggregation layer achieves the convergence of video storage, analysis, and archiving, thereby significantly improving the video analysis and concurrency capabilities as well as the efficiency of the criminal investigation.

In addition to the impressive convergence performance in video storage and analysis, this two-layer storage architecture also delivers the following technological advantages.

» Convergence of hardware and software on a universal IT platform

Compared with conventional platforms that can only address specific needs, the universal IT platform provides intelligence-rich analysis capabilities and can better serve the application purposes of criminal investigations. Adding to the appeal, these universal platforms also require less hardware, which in turn reduces the physical footprint, conserves power, and lowers construction and management costs.

» Elastic capacity expansion

The access layer adopts Huawei T series SAN storage devices, which can be stacked for capacity expansion and provide access and analysis capabilities for up to 2000 lanes of video. The aggregation layer employs a distributed cloud storage system that can be scaled up to simultaneously process 100,000 read and write requests and provide 40 PB in storage capacity. All the devices and systems on the two layers can be utilized and expanded on demand to address video storage requirements both now and in the future.

In addition, a variety of storage protocols are supported as the T series support SAN while the cloud storage devices support NAS and HDFS, fulfilling diversified storage requirements in intelligent video analysis and Big Data.

» Efficient and parallel analysis capabilities

With such cutting-edge technologies as video stream consolidation, intelligent prefetch, and I/O passthrough, Huawei achieves an efficiency in video image retrieval 24 times higher than the industry average, and increases the read/write ratio to 4:1, demonstrating the viability of the solution's ability to handle the copious number of read requests in intelligent video analysis. The two-layer architecture for video storage and analysis allows video data to be stored and analyzed in a distributed manner while being managed centrally. Under pressure to concurrently process thousands of video streams, system workloads are evenly distributed to achieve a balance between capacity and performance. The Hadoop Big Data platform archives the original footage, videos and images generated during the analysis process, as well as videos and images associated with crimes separately, which helps the public security sector manage video data in an orderly fashion and locate the needed information efficiently.

» Intelligent reliability assurances

The powerful backup and reliability capabilities of Huawei storage devices provide all-around reliability assurances for video data. Such top-notch functions as disaster recovery for important cameras, N+1 to N+4 data protection, file-level data protection, node redundancy, and QoS assurance make Huawei storage devices immune to single points of failure and ensure continuity in recording, playback, and intelligent analysis.

Huawei also delivers enhanced flexibility in data lifecycles to resolve the previous pain points in inflexible and short video retention periods. With the revolutionary fade-in and fade-out functions, the level of importance of certain types of data gradually degrades as the data ages, and when the threshold is reached, the data will be discarded if the data is not categorized as higher-level or critical data. These functions allow for certain types of surveillance data to be retained longer and ensure highly reliability throughout the data lifecycle.

Gathering the Power of Smart Converged Storage to Build a Safe City

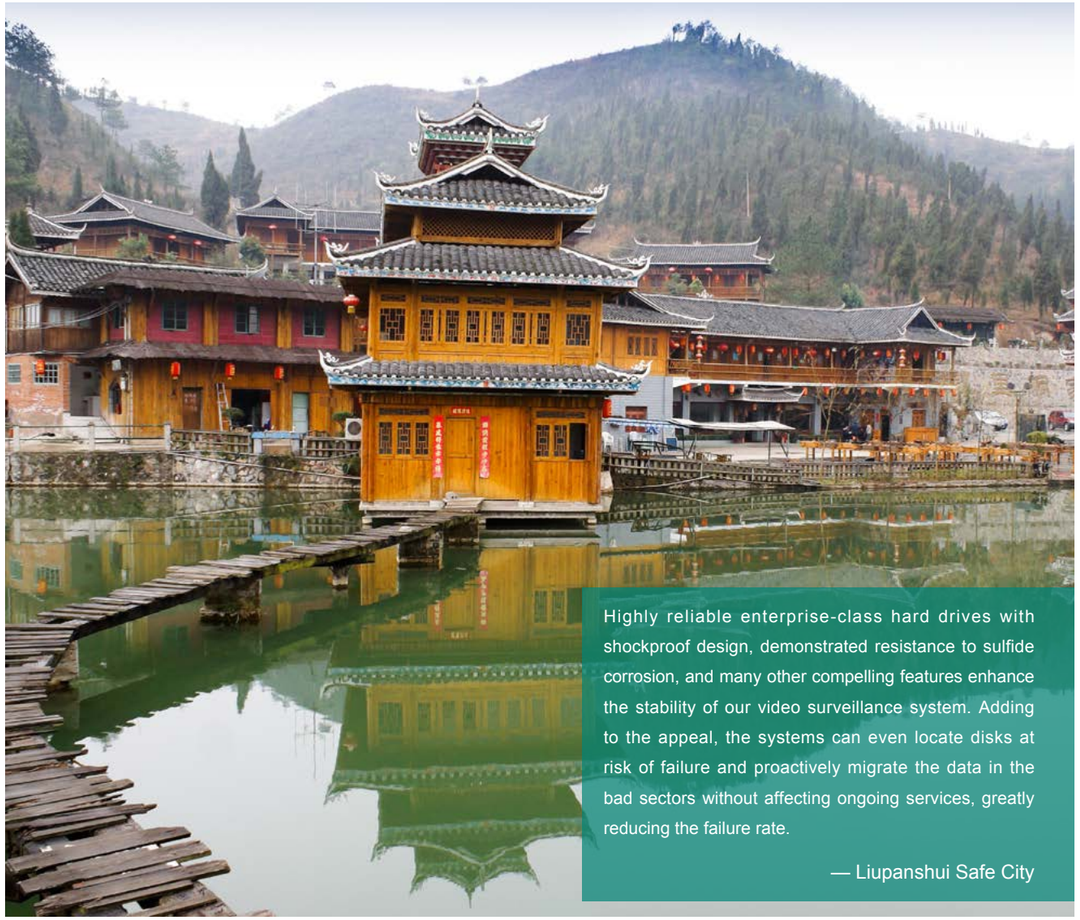
Huawei's two-layer architecture for video storage and analysis improves performance, capacity, reliability, and management capabilities across the board. By leveraging its technical advantages in cloud storage and backup, intelligent storage of video streams, and integration of IT utilities, Huawei is enhancing the intelligence level of its storage devices and extracting new value. With to the drive to deliver elastic, efficient, and reliable video analysis solutions for customers, Huawei is committed to developing world-class technologies for application in the video surveillance field.

Case Study

Case Study

Our project deploys a cloud storage architecture. The systems achieve high disk utilization and balanced storage bandwidth, fully satisfying massive capacity and future expansion needs for the thousands of HD cameras to be added on top of our already sizeable range.

— Shaanxi Provincial Procuratorate



Highly reliable enterprise-class hard drives with shockproof design, demonstrated resistance to sulfide corrosion, and many other compelling features enhance the stability of our video surveillance system. Adding to the appeal, the systems can even locate disks at risk of failure and proactively migrate the data in the bad sectors without affecting ongoing services, greatly reducing the failure rate.

— Liupanshui Safe City

The public security agencies in Lishui required a specialized video surveillance system in the Smart Checkpoint Project. We ultimately decided on Huawei storage for its many advantages. The equipment has been running smoothly for the 18-plus months since being placed online.

— Lishui Traffic Safety Bureau

The Huawei platform featuring storage tiering and unified storage management exceeds all the requisites we placed on the video surveillance system. The platform delivers high performance, high capacity, high reliability, and simplified management while also dramatically improving disk utilization. The Huawei solution effectively reduces the disk failure rate and lowers maintenance costs by 30%.

— Zhuhai Safe City Project

The video surveillance system being built by the Qinghai Public Security Department is a key construction project for the province. We awarded the build for the IT infrastructure platform to Huawei Storage. Huawei has ensured on-time delivery and the highest of quality for all items and phases.

— Yushu Safe City Project

The high-def surveillance systems going into our project required higher accuracy and enhanced video applications with improved image resolution and more precise analytics. The real-time intelligent analysis and high-def video aspects place high requirements on IT system performance and reliability. Efficiency has improved in all categories with the Huawei IT solution that plays a pivotal role in project rollout and operation.

— Chongqing Rail Transit Authority