

White Paper

**Wisenet7**

# Next level Cybersecurity

17<sup>th</sup> 01, 2024

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# 1. Background and Introduction

Concerns about the ability of hackers to access live images or retrieve recorded images captured by video surveillance cameras located in security sensitive areas have been around for a while. Many manufacturers of professional level cameras have responded to the threat by introducing device network set-up protocols which do not allow for a default password, or one that has consecutive letters or numbers, to be used. However, hackers are likely to continue to look at other ways to gain access to data, including via a camera's 'back door'.

Regardless of whether it is for criminal or malicious purposes, or just seen as a challenge by amateur hackers, it is essential that end-users' confidential data is kept secure. This applies just as much to the many thousands of small businesses that entrust video surveillance solutions to protect their assets, people and property, as it is for high security and mission critical end-users, such as airports, banks, local authorities, government, military and emergency services.

Amid this environment, Hanwha Vision has been working continuously to strengthen the security level of its products. And in 2020, robust security functions and technologies are implemented to the products equipped with Wisenet7, Hanwha Vision's own developed SoC (System on Chip).

First, the introduction Hardware security technology has overcome the limitations of security enabled by Software security technology. Secure Storage provides a space for secure data, and based on this, it enables the expansion of Hardware security functions such as Secure Boot, Secure OS, and Secure JTAG.

Second, the ultimate goal of end-to-end protection is to prevent unauthorized users from intercepting or falsifying sensitive information by intervening in the middle of communication, or accessing the device to falsify or tamper with sensitive information. To do this, identification and authentication between devices are required, and access control and authorization based on authentication and protection of system and data through encryption logic are also required.

Third, it is very important that product design specifications and configuration options must consider the security as a top priority. Sometimes implementing the high-level of security functions can degrade performance and backward compatibility of the products, but given the importance of security and the trends in the ecosystem of the industry or society, it is inevitable.

Some of these features and technologies are new and have been developed specifically to combat cyber-attacks whilst others, which were originally intended simply to make chipsets more efficient, are also able to contribute to camera security.

This document is designed to help users better understand Hanwha Vision's next level cybersecurity technologies implemented to products equipped with Wisenet7.

## 2. Standard Security Requirement

Since there is no independent security standard for network surveillance cameras, it is recommended to consult the guidance of security standards referenced by other industries or IoT standards.

The IEC 62443-4-2 standard provides detailed technical security requirements for IACS<sup>1</sup> components and the OWASP<sup>2</sup> Top 10 IoT provides a specialized list that can help manufacturers, developers, and consumers better understand the security issues associated with the Internet of Things.

Wisenet7 security features can be mapped to the cybersecurity requirements provided by the IEC 62443-4-2 standard and the OWASP Internet of Things Top 10 as follows.

Security Requirement	Summary	Wisenet7 Security Feature
IEC 62443-4-2 CR 1.2 – Software process and device identification and authentication	<ul style="list-style-type: none"> <li>● Identify themselves and authenticate other devices.</li> </ul>	<ul style="list-style-type: none"> <li>● Device Certificate</li> <li>● Mutual Authentication</li> </ul>
IEC 62443-4-2 EDR/NDR 2.13 Use of physical diagnostic and test interfaces	<ul style="list-style-type: none"> <li>● Protect unauthorized use of physical interfaces (such as JTAG).</li> </ul>	<ul style="list-style-type: none"> <li>● Secure JTAG</li> </ul>
OWASP IoT Top 10 2018 I10 Lack of Physical Hardening	<ul style="list-style-type: none"> <li>● Lack of physical hardening measures, allowing potential attackers to gain sensitive information that can help in a future remote attack or take local control of the device.</li> </ul>	

<sup>1</sup> Industrial Automation and Control Systems

<sup>2</sup> Open Web Application Security Project

## 2. Standard Security Requirement

Security Requirement	Summary	Wisenet7 Security Feature
IEC 62443-4-2 CR 3.1 Communication integrity RE (1) Communication Authentication	<ul style="list-style-type: none"> <li>● Protect Integrity of transmitted information.</li> <li>● Verify Authenticity of information received during communication.</li> </ul>	<ul style="list-style-type: none"> <li>● Apply the latest version of TLS protocol</li> <li>● Provide Secure Cipher Suites</li> <li>● Mutual Authentication</li> </ul>
OWASP IoT Top 10 2018 I2 Insecure Network Services	<ul style="list-style-type: none"> <li>● Unneeded or insecure network services running on the device itself, especially those exposed to the internet, that compromise the confidentiality, integrity / authenticity, or availability of information or allow unauthorized remote control.</li> </ul>	
IEC 62443-4-2 EDR/NDR 3.10 RE (1) Update authenticity and integrity	<ul style="list-style-type: none"> <li>● Verify Authenticity and Integrity of firmware when updates.</li> </ul>	<ul style="list-style-type: none"> <li>● Verify Firmware Forgery</li> </ul>
OWASP IoT Top 10 2018 I4 Lack of Secure Update Mechanism	<ul style="list-style-type: none"> <li>● Lack of ability to securely update the device. This includes lack of firmware validation on device, lack of secure delivery (un-encrypted in transit), lack of anti-rollback mechanisms, and lack of notifications of security changes due to updates.</li> </ul>	
IEC 62443-4-2 EDR/NDR 3.12 Provisioning product supplier roots of trust	<ul style="list-style-type: none"> <li>● Protect Confidentiality, Integrity, and Authenticity of the manufacturer's product key and data to be used as roots of trust when device manufacturing.</li> </ul>	<ul style="list-style-type: none"> <li>● Secure Storage</li> </ul>
IEC 62443-4-2 EDR/NDR 3.13 Provisioning asset owner roots of trust	<ul style="list-style-type: none"> <li>● Protect Confidentiality, Integrity and Authenticity of the user's key and data to be used as the roots of trust when using.</li> </ul>	<ul style="list-style-type: none"> <li>● Secure Storage</li> <li>● Secure OS</li> </ul>
OWASP IoT Top 10 2018 I6 Insufficient Privacy Protection	<ul style="list-style-type: none"> <li>● User's personal information stored on the device or in the ecosystem that is used insecurely, improperly, or without permission.</li> </ul>	

## 2. Standard Security Requirement

Security Requirement	Summary	Wisenet7 Security Feature
IEC 62443-4-2 EDR/NDR 3.14 -Integrity of the boot process RE (1) Authenticity of the boot process	<ul style="list-style-type: none"> <li>● Verify Integrity of firmware when device booting.</li> <li>● Use manufacturer's roots of trust to verify the authenticity of the firmware when device booting.</li> </ul>	<ul style="list-style-type: none"> <li>● Secure Boot</li> <li>● Verity Chain of Trust</li> </ul>
IEC 62443-4-2 CR 4.1 Information confidentiality	<ul style="list-style-type: none"> <li>● Protect Confidentiality of information at rest.</li> <li>● Protect Confidentiality of information in transit.</li> </ul>	<ul style="list-style-type: none"> <li>● Encrypt Video Image (when at rest and backup)</li> <li>● Apply the latest version of TLS protocol</li> <li>● Provide Secure Cipher Suites</li> </ul>
OWASP IoT Top 10 2018 I2 Insecure Network Services	<ul style="list-style-type: none"> <li>● Unneeded or insecure network services running on the device itself, especially those exposed to the internet, that compromise the confidentiality, integrity / authenticity, or availability of information or allow unauthorized remote control.</li> </ul>	
OWASP IoT Top 10 2018 I7 Insecure Data Transfer and Storage	<ul style="list-style-type: none"> <li>● Lack of encryption or access control of sensitive data anywhere within the ecosystem, including at rest, in transit, or during processing</li> </ul>	
IEC 62443-4-2 CR 4.3 Use of cryptography	<ul style="list-style-type: none"> <li>● Use cryptographic security mechanisms officially and internationally proven.</li> </ul>	<ul style="list-style-type: none"> <li>● Apply the latest version of TLS protocol</li> <li>● Provide Secure Cipher Suites</li> </ul>
OWASP IoT Top 10 2018 I3 Insecure Ecosystem Interfaces	<ul style="list-style-type: none"> <li>● Insecure web, backend API, cloud, or mobile interfaces in the ecosystem outside of the device that allows compromise of the device or its related components. Common issues include a lack of authentication/authorization, lacking or weak encryption, and a lack of input and output filtering.</li> </ul>	

## 2. Standard Security Requirement

Security Requirement	Summary	Wisenet7 Security Feature
IEC 62443-4-2 CR 7.7 Least functionality	<ul style="list-style-type: none"><li>● Restrict the use of unnecessary features, ports, protocols and / or services.</li></ul>	<ul style="list-style-type: none"><li>● Raise the level of security settings</li></ul>
OWASP IoT Top 10 2018 I9 Insecure Default Settings	<ul style="list-style-type: none"><li>● Devices or systems shipped with insecure default settings or lack the ability to make the system more secure by restricting operators from modifying configurations.</li></ul>	

Table 1. Comparison between Security Requirement and Wisenet7 Security Technology

# 3. Technology and Feature

## 3.1. Hardware Security

Employing hardware security technology is very important in improving the security level of a product, as hardware security technology can better protect vulnerabilities than software-based approaches. Cybercriminals find it hard to alter trusted software ("root of trust") that stems from a secured hardware. Starting with Wisenet7 products, Hanwha Vision applies four major hardware security technologies as follows:

### 3.1.1. Secure Boot

Starting with Wisenet7, Hanwha Vision has implemented Secure Boot.

Secure boot is a mechanism that verifies the integrity of the software running on the camera during boot up, ensuring that the software is not forged from external malicious code or malware.

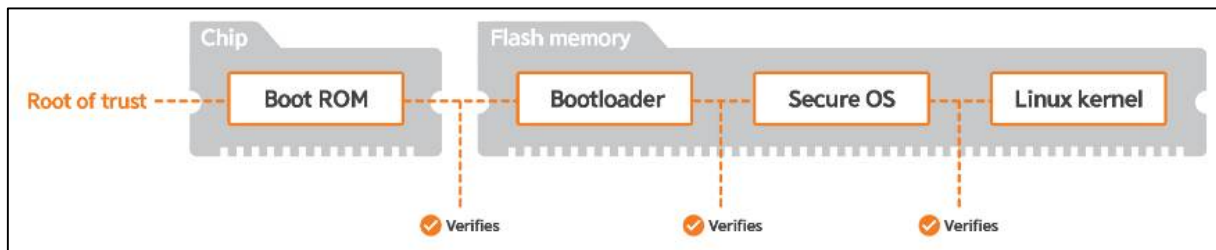


Image 1. Secure Boot in Wisenet7 Products

### 3.1.2. Secure Storage

Wisenet7 also supports an independently secure hardware module called HTPM (Hanwha Trusted Platform Module). HTPM consists of crypto-processor (a dedicated microcontroller designed to secure operation), random number generator, Secure Storage, Secure OS, etc.

Secure Storage area of HTPM consists of OTPROM (One Time Programmable Read-Only Memory) and EEPROM (Electrically Erasable Programmable Read-Only Memory) and stores important information in the camera. Important information constituting the root of trust is programmed into the OTPROM during the manufacturing process, and important operational information is securely stored in the EEPROM.

### 3.1.3. Secure OS

A separate Secure OS must be used to securely process important information stored in the Secure Storage.

There is no way to access the Secure OS from outside the camera. To access the Secure OS or Secure Storage, you must use a separate API through the Linux OS. The Secure OS provides independent encryption and decryption functions, reducing the task load on the main OS as well as providing another layer of protection and separation. Applications used in the Secure OS are verified to prevent forgery and alteration.



## 3. Technology and Feature

### 3.1.4. Secure JTAG

Most electronics and IoT (Internet of Things) devices have a physical debug and test connector, known as JTAG, designed for use during manufacturing, QA, and service. The best way to prevent unauthorized access through these interfaces is to disable them. However, this would also block tracking the cause of failures that may occur on the chip or board during the product development or production phases.

To prevent above issue, a secret key-based authentication mechanism has been implemented in Wisenet7 that enables the use of JTAG securely while achieving a high level of security. Only the manufacturer has the corresponding authentication key which allows an access to only system related information not the customers' personal information. And in case of product failure, the cause can only be analyzed by local access using the authentication key owned by manufacturer, not remote, so there is no need to worry about access from unauthorized users.

## 3.2. End-to-End Protection

In addition to access control based on traditional passwords, it is possible to upgrade the level of secure communication using a device certificate inserted for device authentication between devices. This prevents unauthorized users from eavesdropping or tampering during communications. Also, by introducing digital signature and encryption functions, End-to-End data security can be enhanced during data storage and backup, as well as in firmware update and boot up.

### 3.2.1. Device Certificate (Pre-installed)

Hanwha uses Thales HSM equipment to generate certificates / private keys for each Wisenet7 device and programs each device during the manufacturing process. When you create a certificate, it is digitally signed by our private Root CA, so you can prove it was issued by Hanwha. With this certificate, you can perform secure communications without a security alarm in your web browser. Using your web browser, one can easily view the certificate to verify its' origin and authenticity.

### 3.2.2. Mutual Authentication

Performing mutual authentication for secure communications is a good way to enhance the confidentiality, integrity, and authenticity of communications security. Hanwha Vision Wisenet7 products support Client Authentication for Mutual Authentication between our cameras and client devices in HTTPS (HTTP over TLS, RTSP over HTTPS) communication.

In general, Mutual Authentication can be performed either by a user or by a device. Hanwha Vision has implemented Mutual Authentication performed between devices manufactured by Hanwha Vision.

# 3. Technology and Feature

Authentication of the camera acting as a server in Mutual Authentication is called Server Authentication, and authentication of client devices (NVR, VMS, client workstation) is called Client Authentication. Server Authentication is performed on the client, and Client Authentication is performed on the server. Client Authentication is provided as an option on the premise of Server Authentication, thus providing Mutual Authentication by authenticating clients in a comprehensive sense.

### 3.2.3. Verify Chain of Trust

The Root CA certificate exists to guarantee the Root of Trust in the camera, and the chain of certificate is verified using the Root CA certificate. There are two types of Root CA certificate in Wisenet7 products. One is the Root CA certificate for Device Certificate, and the other is the Root CA certificate for Open Platform Applications.

The Root CA certificate for Device Certificate is used when installing the device certificate on the camera or performing client authentication using a client (PC, NVR) device certificate. The former serves to prevent the installation of any certificate without the manufacturer's permission by verifying the certificate chain when the device certificate is installed on the camera. The latter serves as a reminder that it is a trusted device manufactured by Hanwha by verifying the certificate chain of client devices.

The Root CA Certificate for Open Platform Applications prevents unauthorized applications from being installed by verifying the certificate chain that each different signing key and certificate used to sign Wisenet7 Open Platform Application is generated and distributed by Hanwha. This ensures that only secure, authorized, and non-tampered software is running on the camera. This ensures that malicious software does not have access to the camera or network.

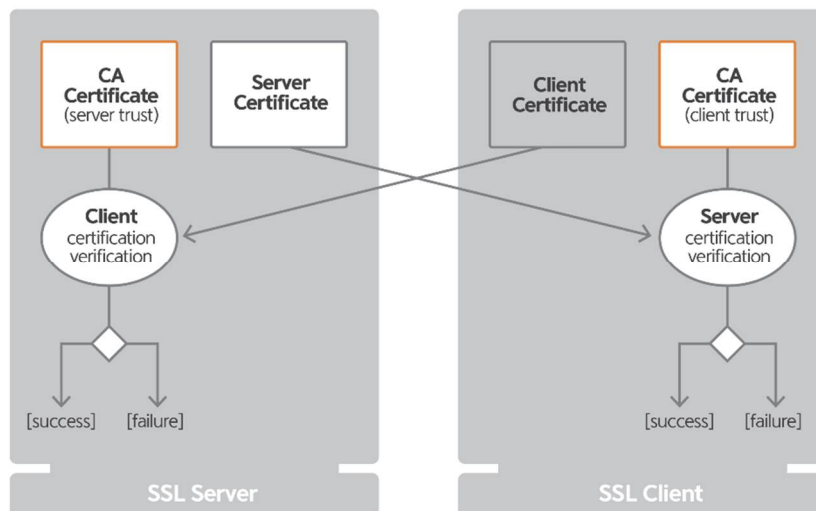


Image 2. Chain of Trust Concept

# 3. Technology and Feature

## 3.2.4. Verify Firmware Forgery

Hanwha Vision’s Signed Firmware technology is a secure way to update firmware. By including a digital signature in the firmware and verifying the signature value upon update, you can trust that the firmware has not been forged or tampered.

The digital signature of the firmware is generated with a private key through a key server securely managed by Hanwha Vision, and the public key that verifies the digital signature is safely stored in the Wisenet7's Secure Storage area (HTPM).

Using digital signatures is a better way to improve security than using simple hashes, CRC checksums, etc. to verify firmware integrity. This is because the hash or checksum of a tampered firmware can be easily recalculated.

## 3.2.5. Encrypt Video Image (when at rest and backup)

Video images generated from the camera must be treated as important user data. Therefore, not only must secure communication be used when transmitting video images, but also security mechanisms must be applied when storing images on an external storage medium and when backing up video from the camera to a PC/VMS/NVR.

Wisenet7 products support file system encryption when recording to an SD Card.

By encrypting the file system, itself rather than individual encryption for each file, there is no load required for separate decryption during video transmission and playback. In addition, AES encryption is performed using the password set by the user as an encryption key, so that even if the SD card is stolen, the stored video can be safely protected.

Wisenet7 products support Video Encryption at backup. They protect the video by encrypting the ZIP file when backing up the video saved in the camera or manually recording the live video on the PC.

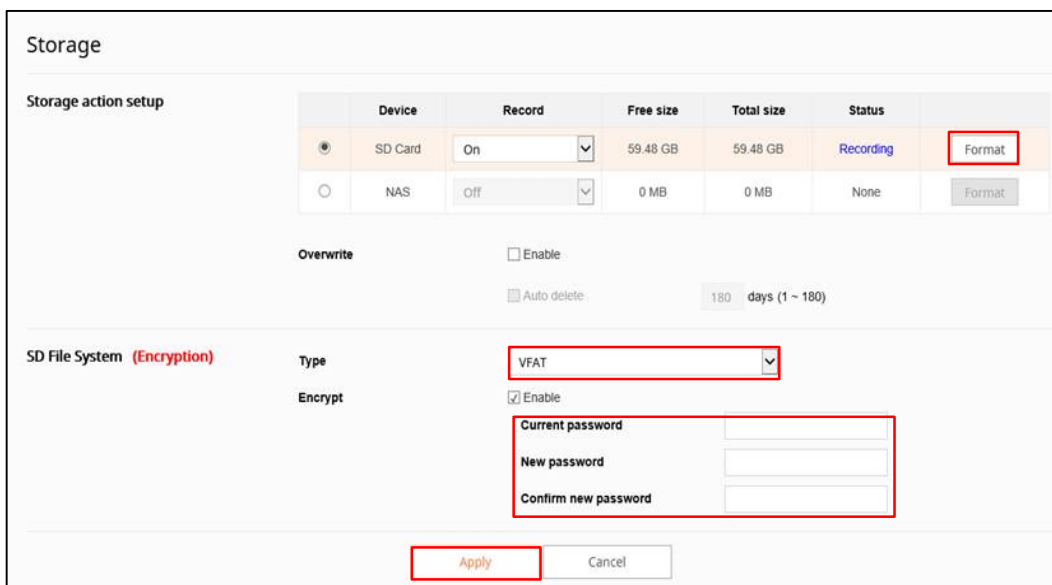


Image 3. UI on SD Card Encryption

## 3. Technology and Feature

### 3.3. Secure by Default/Design

When developing products, manufacturers need to keep in mind security standards to ensure the confidentiality, integrity, and authenticity of the system and user sensitive data. It is necessary to reflect these security standards from the product design stage, which is called “Secure by design”.

“Secure by default” means that the default configuration settings are the most secure settings possible, which are not necessarily the most user-friendly and backward compatibility settings. Therefore, the user must analyze the security risk according to the setting change suitable for usability and compatibility in each secure by default setting.

#### 3.3.1. Raise the level of security settings

Wisenet7 products provide enhanced security out of the box at factory default settings. By default, the HTTPS mode is enabled, and unnecessary initial services are disabled, including SNMP (Simple Network Management Protocol), Link-Local address, UPnP discovery, and Bonjour. In addition, the SUNAPI & ONVIF protocols are disabled by default until a user password is configured. All Hanwha Vision products ship without a default password. During initial installation, the user must set a complex password using the Wisenet Device manager utility before viewing video or making other configuration changes. The password is securely transmitted using encryption.

#### 3.3.2. Apply the latest version of TLS protocol

Wisenet7 products support the latest TLS version 1.3. By default, only safe TLS versions (1.2, 1.3) are enabled for communications. TLS 1.2 is still secure and although it has faults, it is widely adopted and is currently the standard for IoT devices.

Additional options for specific TLS versions (1.0, 1.1) and HTTP communications are available when needed such as backward compatibility but not recommend.

The most noticeable differences in the TLS 1.3 version include Faster performance and Enhanced security.

#### 3.3.3. Provide Secure Cipher Suites

Previously, some weak cipher suites are provided for compatibility in TLS mode. but, Wisenet7 products provide initially security-enhanced cipher suites and then they provide option to apply weak cipher suites for compatibility.

A weak cipher is defined as an encryption/decryption algorithm that uses a key of insufficient length. Using an insufficient length for a key in an encryption/decryption algorithm opens up the possibility (or probability) that the encryption scheme could be broken (i.e. cracked). The larger the key size the stronger the cipher. Weak ciphers are generally known as encryption/ decryption algorithms that use key sizes that are less than 128 bits (i.e., 16 bytes ... 8 bits in a byte) in length.

To understand the ramifications of insufficient key length in an encryption scheme, a little background is needed in basic cryptography. Cryptography is the process of converting ordinary information (i.e., plaintext) into a scrambled unintelligible mess (i.e., cipher text).

# 3. Technology and Feature

This conversion process is called encryption. The second process of cryptography is called decryption which takes the cipher text and recreates the plaintext. These processes (encryption/decryption) are controlled by a 'key.' The key is a secret that is shared between the two communicating parties. The key is used to cipher the plaintext and to decipher the cipher text.

Secure communications revolve around four basic components. These four components are: the encryption/decryption algorithm to use on the data to be exchanged, the encryption/decryption algorithm to use for the shared key exchange, the authentication type and the message authentication code. And, if more than one of these four elements is used, it could be classified as a weak cipher suite.

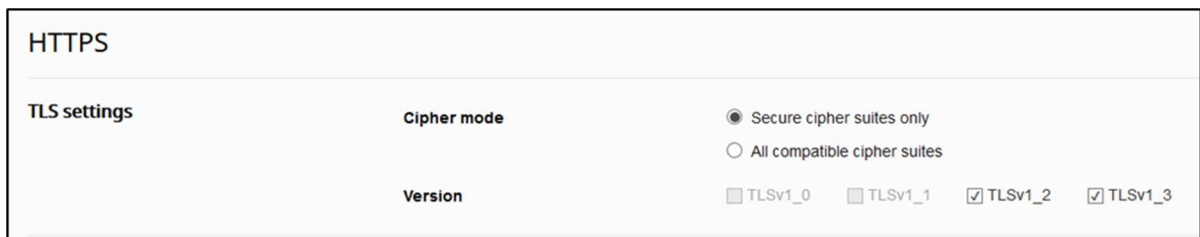


Image 4. TLS Setting option

## 4. Security in depth

To further strengthen the cybersecurity of the camera, it is recommended to use multiple layers of security. This ensures that if one layer is breached, other layers are still present to protect your network and devices. It is recommended to have collaboration between IT, video security, the system integrator, and the end user to determine the system requirements as well as the responsibilities of each group. The following is a list of cybersecurity related features that can be implemented in your network devices to enhance your network security, including cameras, switches, etc.

- Create user-level accounts with least privileges required
- Disable guest / non-authenticated RTSP access
- Change passwords regularly & do not share passwords with other systems
- Update system clock/NTP, DST, time zone
- Enable 802.1x certificate-based access control
- Enable Multicast only if needed
- Enable DDNS only if needed
- Enable Bonjour only if needed
- Enable UPnP only if needed
- Enable link-local address only if needed
- Enable FTP only if needed
- Use SNMP v3 when SNMP is needed
- Use secure SMTP when e-mail is needed
- Enable QoS only if needed
- Enable VLANs on network
- Ensure camera is out of reach, cables are protected
- Change default ports from well-known ports to high ports
- Enable IP Filtering
- Ensure cameras are on a separate network from corporate/production network/ Internet
- Enable SD card recording as a backup in case of VMS or network disruption
- Document configuration and create an export/backup
- Save a snapshot of camera view
- Place a recognizable setting to indicate tampering/defaulting
- Utilize VPN or secure cloud for remote access

## 4. Security in depth

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- Use proprietary video file format for SD recording and exporting video
- Ensure all network switches, NVRs/VMS, & PoE midspans/injectors are protected by a UPS
- Enable tampering, defocus detection analytics
- Enable network disconnect detection if using low voltage power
- Check device logs regularly

## 5. Conclusion

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Wisenet7 offers end-to-end cybersecurity with the industry's highest levels of cybersecurity policy with Secure boot/OS/storage, a signed firmware/open platform app, Secure JTAG and more. Hanwha Vision established its own device certificate issuing system to embed certificates into the product not only in the development progress but also in the manufacturing progress. With the next-level cybersecurity features of Wisenet7, users can now build the surveillance solution that has never been safer before.





**HEAD OFFICE**

6, Pangyo-ro 319beon-gil, Bundang-gu, Seongnam-si, Gyeonggi-do, 13488, South KOREA

TEL +82.1588.5772 [www.hanwhavision.com](http://www.hanwhavision.com)