Enhanced Ethernet Technology (ePoE)

White Paper by Dahua Technology

Release 1.0

Table of contents

Dahua Enhanced Ethernet Technology (ePoE)

1   Application Scope

This white paper is not product specific and can be applied to all related Dahua products. The white paper is to guide to enhanced Ethernet technology (ePoE) and its practical applications.

2   Standard Reference Documentation

The following standard is essential for this text:
YD/T 1947-2009 PRC communication industry standard.

3   Term and Definitions

The following terms and definitions are applied to the text:

3.1   2D-PAM3 Encoding

A type of coding modulation technology also called two dimensional three-level Pulse Amplitude Modulation technology that converts 3 bits into 2 three-level signals which are used to transmit information.

3.2   Time Base Sync

This technology achieves simultaneous action among different devices via acquiring and synchronizing to a shared time marker.

3.3   Mode Negotiation

Confirms the best available communication mode in the current environment via mutual exchange of information.

4   Background Introduction

4.1   Industry Development

The current strongly developing surveillance industry has given rise to a significant number of solutions and technologies which can be divided into two main areas: analog technology and network surveillance technology.

Analog surveillance systems adopt a point-to-point connection to transmit data directly from one device to another – namely, an analog camera connected by coaxial cable to the port of a DVR allows the camera feed to be viewed, thus achieving its surveillance functionality. If the camera feed is to be viewed remotely, a remote network connection must be established through the DVR as shown in the
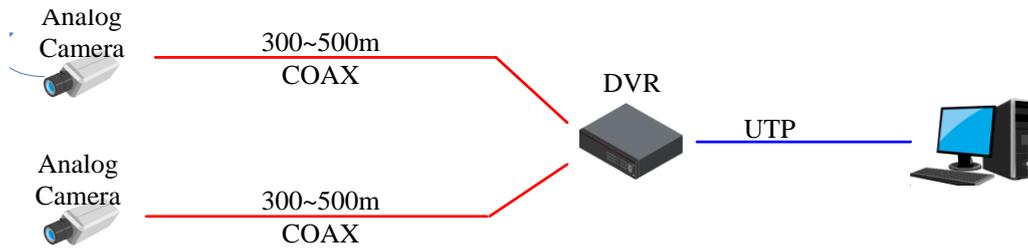
figure below:

Figure 1 Analog Video System

A network video monitoring system adopts modern Ethernet technology and uses a LAN connection between camera devices and an NVR. All front-end network cameras and back-end network storage devices are connected to the same Ethernet network, which is then used for communication between the devices. Any node on the network may access any device on the network as long as it obtains authorization from the accessed device. This type of system is displayed in the below image:
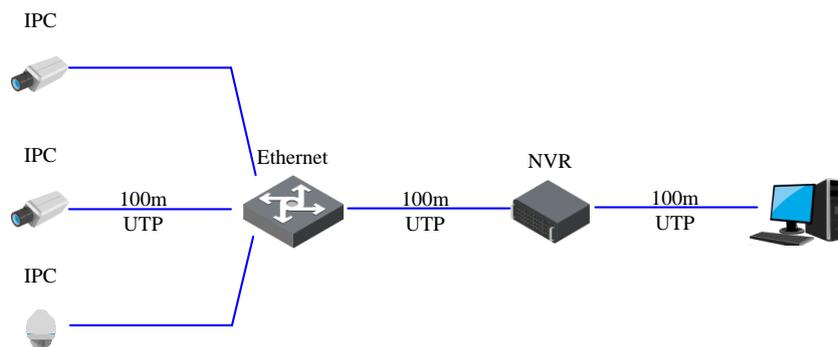

Figure 2 Network Video System

4.2　Pros and Cons

The main advantages of an analog video system are convenient plug-and-play connections and no delays in transmission. Disadvantages include that it is difficult to improve resolution and it is hard to achieve unified management in large-scale system solutions. In order to overcome these disadvantages, a new generation of analog monitoring technologies have emerged in the industry, including CVI, AHD, and TVI, which provide HD resolutions for analog systems. As for unified system management, hybrid DVRs have been created alongside other unified management platform product solutions.

In a network video monitoring system, its advantages lie in easy unified management, flexible upgrade to higher resolutions, and remote PoE power supply. However, disadvantages include long video feed delays and network bottlenecks

caused by multiple devices sharing the same amount of bandwidth. As with analog devices, with the development of the industry, network video monitoring technologies are also continuously being upgraded. For example, the new generation of H.265 encoding technology has greatly reduced network bandwidth usage and stronger encoding processers have lessened video codec delay. Currently network camera video delay has been reduced to just 150ms, basically unnoticeable when viewing video feeds.

On the whole, along with differentiation of the industry and technological development, two systems are constantly merging. In a word, it is nothing more than merging of the best of both technologies.

Speaking from a macro perspective, there are mainly two main appeals in the development of security industry – higher resolutions and greater networking. However, there are currently still a large number of HD analog monitoring systems on the market which adopt standard resolution basic coax wiring, and in addition to this, due to many factors, the cost of labor for transforming such a system is continuously increasing while the device costs are decreasing, which has led to a situation where reconstruction during the system upgrade or transformation process has become less and less viable, giving way to a new requirement: coaxial upgrade. However, so far the new generation of HD analog technologies, such as CVI, AHD, and TVI, has only satisfied the first and third requirements (HD and coaxial upgrade).

In accordance with the future development of the Internet of Things (IoT), connecting devices over LAN is becoming an irresistible trend. Therefore, it is necessary that analog monitoring is transformed into network management in order to improve the operability of centralized management and dispatch, which is the second requirement in networking. As for current analog technology, it is hard to meet this second requirement. Equally, for network technology, it is hard to achieve the third requirement of coaxial upgrade. Coaxial Ethernet technology which converts network into coax already exists on the market, but the technology is only achieved through multiple parts and at a high cost, making it unviable as a universal technology. Therefore, the most urgent need in the current market is a technology which provides network coaxial functionality at a low cost.

5   ePoE Introduction

5.1   Overview

Dahua's patented enhanced Ethernet technology (ePoE) consists of two core technologies:
One is that it adopts advanced physical layer 2D-PAM3 coding modulation, and it can achieve full duplex transmission over 800 meters at a speed of 10Mbps or 100Mbps at shorter distances via one pair of twisted-pair or coaxial cable media. In addition, it supports PoE and PoC power supply technology for both twisted-pair and coaxial cable as the transmission media, greatly simplifying construction and wiring.
The other is that it adopts a Dahua-patented application-layer synchronous

negotiation mechanism that guarantees self-adaptive compatibility of enhanced Ethernet via implementing time base sync first and then mode negotiation. When connecting to matching devices via any media, it can automatically determine the current mode of use whether it is enhanced mode or general network mode. Thus, the system is fully self-sustaining and requires no manual configuration, achieving true plug and play.

5.2   Application Scenarios

Traditional Mixed Networking Application

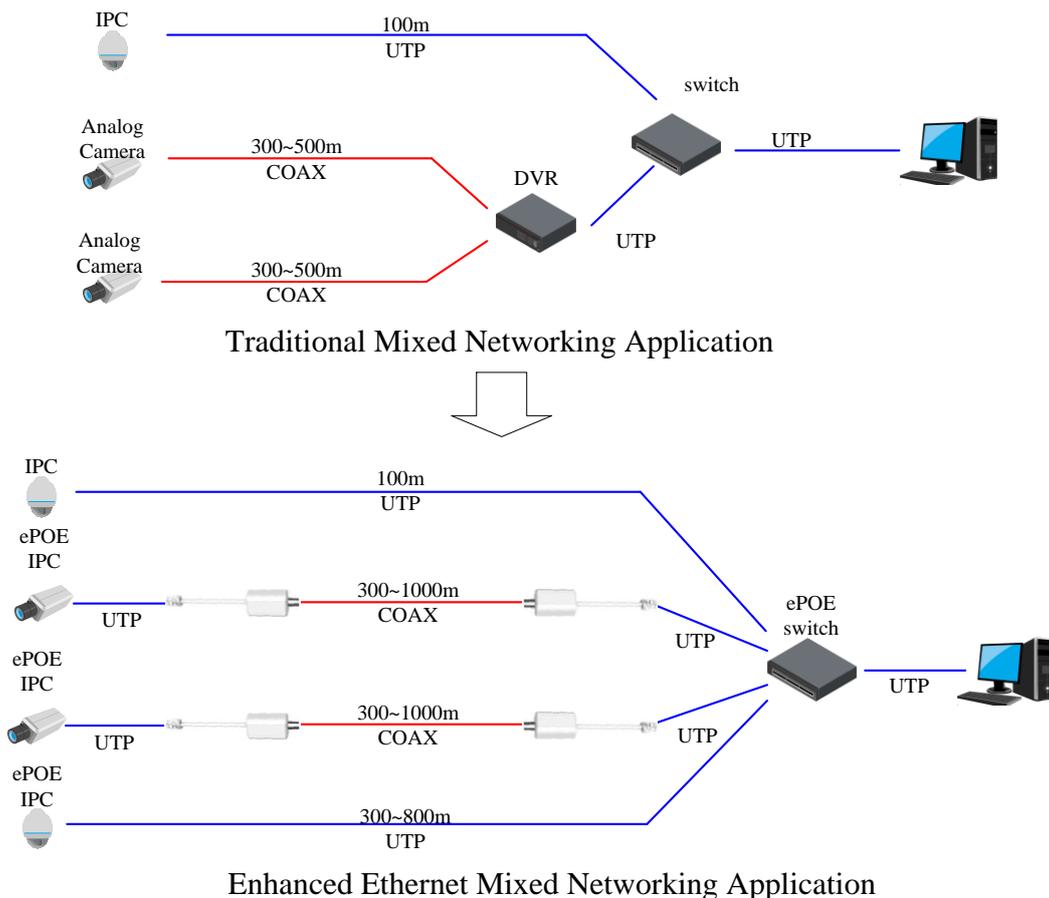Enhanced Ethernet Mixed Networking Application

Figure 3 Migration from Traditional System to ePoE IP System

Enhanced Ethernet technology (ePoE) is automatically compatible with three connection modes operating over the same network at the same time – traditional network, long-distance network, and coaxial network. As shown in the figure above, for traditional HD upgrade projects, in order to reduce wiring and construction, it uses the original analog coaxial wiring, equipped with HD analog cameras and HD DVR, and connecting to back-end services via network switch. Meanwhile, additional network cameras (IPC) are connected to the back-end via network switch, and a centralized surveillance system has been formed.

This makes the mixed monitoring of both analog and digital possible, though it is quite complex for centralized management of configurations. However, the new

generation of Dahua enhanced Ethernet technology (ePoE) can reuse original switches, IPCs, and other network devices because enhanced Ethernet technology (ePoE) is compatible with traditional Ethernet networks, requiring no large-scale device upgrades. In addition, enhanced Ethernet technology (ePoE) directly converts network signals to and from coax through a passive converter, which allows the reuse of existing coaxial wiring, greatly reducing upgrade costs. Power over Coax (PoC) functionality provided by this technology eliminates the need for renovations to add power wiring for new cameras. Finally, future surveillance area expansion can be performed without need of adding additional repeaters. Simply use additional cables to add new monitoring devices into the 800m-capable network. Introducing ePoE makes systems scalable.

5.3   Core Technology Theory Introduction

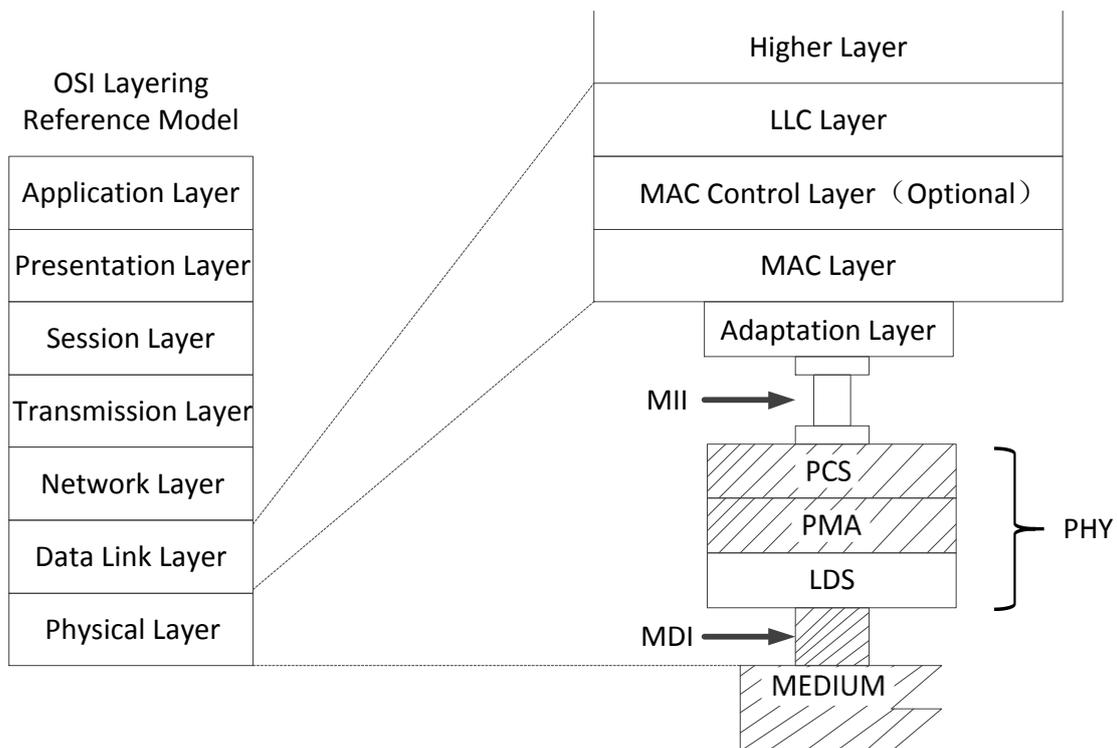### 5.3.1   Physical Layer Technology

Figure 4 Physical Layer Technology

The physical layer of enhanced Ethernet lies in the bottom-most layer of the OSI reference mode, which acts as the physical port connecting devices. It provides mechanical, electrical, functional, and regulating features for creating, maintaining, and releasing the physical connection of binary bit transmission among data links. The function includes establishing, maintaining, and dismantling physical circuit, realizing transparent transmission of the physical layer bit stream. The physical layer includes three function layers and two layer ports. The two layer ports are physical media irrelevant interface (MII) and physical media relevant layer interface (MDI),

the higher layer of MII is logic data link layer, while the lower layer of MDI is directly connected to the transmission media, which is shown in Figure 4.

2D-PAM3 circuit encoding is a method in which the physical layer adopts encoding modulation technology. In principle, it encodes three pieces of binary data into two 3-level signals and is equipped with a mixer and neutralizer to realize full duplex baseband signal transmission, as shown in Figure 5. The physical layer port employs continuous signal mode, and will transmit an IDLE signal when there is no data transmission. The signal delivers information from the local physical layer reliably so that the synchronizers on connected devices accept the descrambler.
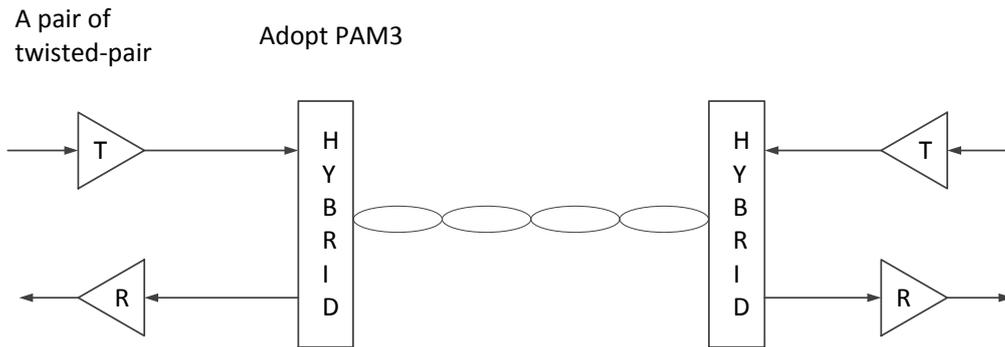

Figure 5 2D-PAM3 Encoding

This physical interface can be configured in Master and Slave mode. The master/slave relation on both sides of the link can be established via LSD, or can also be manually configured. In Master mode, the interface uses a local clock transmit data. In Slave, it recovers the clock from the received signal and uses it as the clock when sending data.

In regards to specific dataflow encoding transmissions, the physical layer first receives 4 bit data from the MII, and then it completes 4B3B conversion, converting 4 bit data into 3 bit. Afterwards, data undergoes bypass stream scrambling, and finally it is mapped into the bi-vector of a third-level symbol. During each symbol period, PCS sending function generates a code block (An, Bn) and delivers it to PMA. After the An and Bn symbols have been driven, they are delivered via twisted-pair, completing data conversion. Here the integer n is used as the time index, which means the time sequence of different symbol period. However, it needs to be emphasized that PCS will replace the corresponding 3 symbol vector of the first 9 bits of data in the initial SSD code block when the network data package first begins to send; encoding the following 3 bits of data. When transmission ends, it will insert an ESD code block after the frame. If an error occurs, PCS will insert an error symbol vector at the end of the frame in which the transmission error occurs. Detailed data transmission reference is shown in Figure 6.
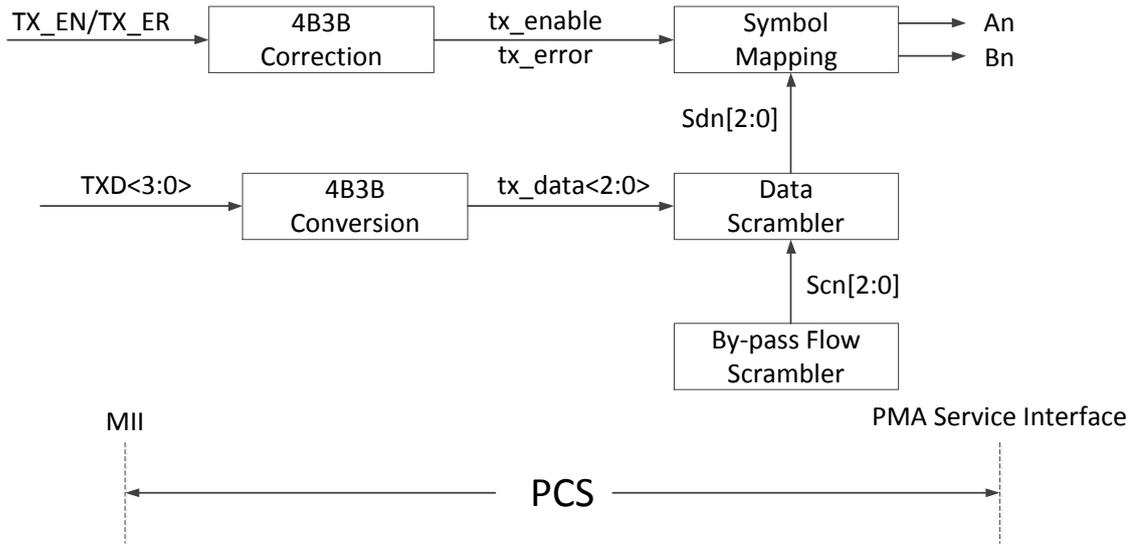
Figure 6 Data Transmission Reference

2D-PAM3 encoding technology has a low bit error rate and ultra-strong anti-interference capabilities, which are tough enough to deal with various types of noise in real-life environments. It is especially useful for existing analog coaxial networks and improves the reliability and safety of coaxial network data transmission.

5.3.2 Application Layer Technology

On the application layer, Dahua has developed an original synchronous negotiation mechanism in order to achieve self-adaptive compatibility throughout various modes. A high-speed polling mechanism guarantees time base sync between master and slave devices.
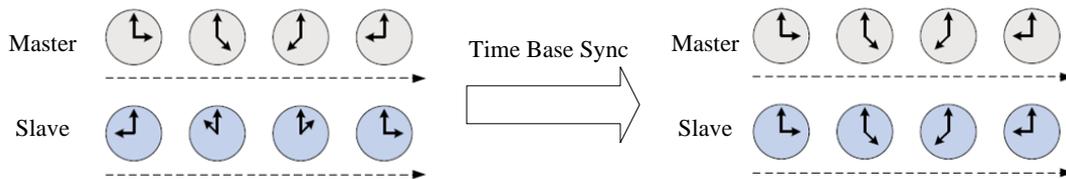

Figure 7 Time Base Sync

After master and slave device synchronization has completed and both ends can engage in synchronous operation, it then attempts to synchronize the connection beginning from the highest bit rate mode to lowest bit rate mode, preserving the mode in which a successful connection was made, thus completing mode negotiation.
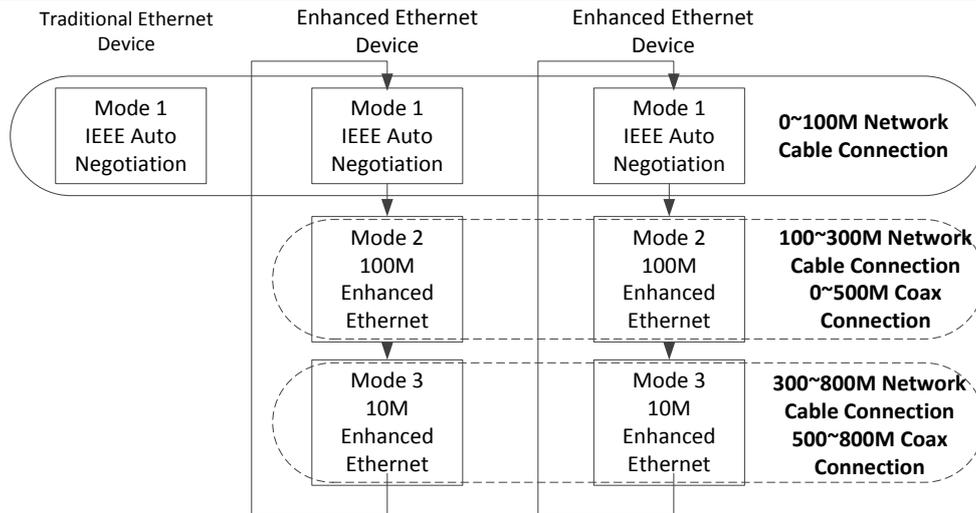
Figure 8 Mode Negotiation

5.3.3 Long-Distance Coax and Network Cable Power Supply Technology

The network cable power supply technology known as PoE technology works through imposing a 36~57V common-mode voltage signal over 12, 36 line pair or 45 and 78 line pair cables via common-mode transmission. Data is sent through difference-mode transmission, so power supply and data do not interfere with each other, as shown in the following figure.
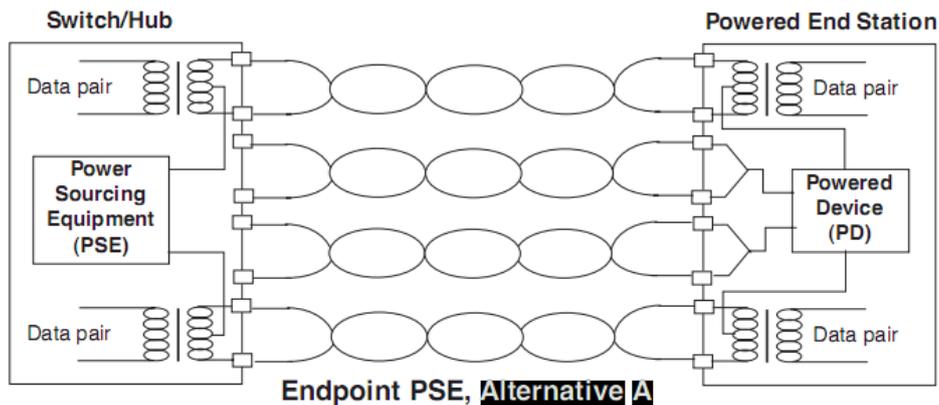

Figure 9 PoE Technology

The PoE power supply technology adopted by enhanced Ethernet is the unique HiPoE high-power power supply technology owned by Dahua. It guarantees the power supply over long distance network cable connections through increasing power from the supply. Load capacity and bandwidth for specified distances are listed in the following table:

Cable (m)	Bandwidth (Mbps)	POE Load Capacity (W)	Hi-PoE Load Capacity (W)	Working Mode
100	100	25.5	53	IEEE/E100M
200	100	25.5	33	E100M
300	100	19	19	E100M
400	10	17	17	E10M
500	10	13	13	E10M
800	10	7	7	E10M
ePoE switch supply voltage 48V CAT5E/CAT6, max. DC resistance < 10Ω/100m				
Cable (m)	Bandwidth (Mbps)	POE Load Capacity (W)	Hi-PoE Load Capacity (W)	Working Mode
100	100	25.5	60	IEEE/E100M
200	100	25.5	50	E100M
300	100	25.5	32	E100M
400	10	25.5	26	E10M
500	10	20	20	E10M
800	10	13	13	E10M
ePoE switch supply voltage 53V CAT5E/CAT6, max. DC resistance < 10Ω/100m				

Table 1 ePoE Transmission Parameter over Network Cable

In coaxial power supply technology, also called PoC technology, power and data are transmitted via difference mode transmission because there is only one pair cable transmission for coax (copper core and shielding layer). The difference is that power lies in the low frequency band while data lies in the high frequency band. Therefore the core of PoC technology lies in transmission over divided frequency bands. In this system, Dahua uses another patented technology developed on the foundations of enhanced Ethernet - a passive converter device with a PoC power supply.
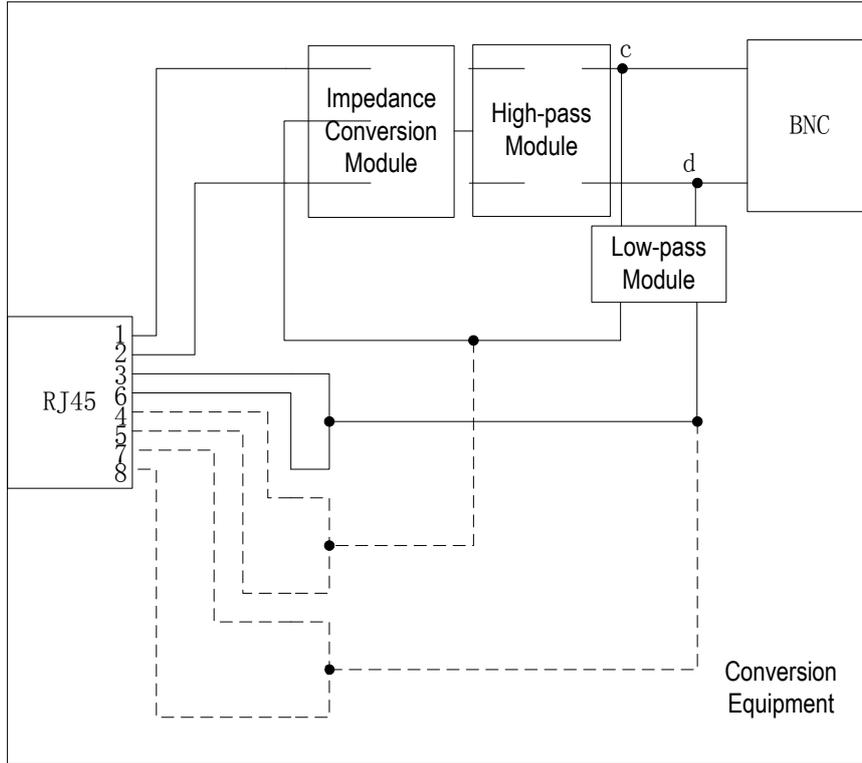
Figure 10 PoC Technology

It can easily convert the data and power of original PoE system to coax via common mode extraction, high and low frequency division, and impedance transformation. It guarantees the stability of coaxial transmission. In the original analog system, it is impossible to achieve a coaxial power supply due to the low band frequency of the data signal being too low, which is affected by interference from noise by the low frequency power signal. This explains why traditional analog PoC systems have not been widely used. On the contrary, enhanced Ethernet adopts 2D-PAM3 coding modulation, which places the data in the high frequency band, separated from power noise from the low frequency band, therefore achieving flawless coaxial power supply functionality. Load capacity and bandwidth speeds at specified distances are shown in the following table:

Cable (m)	Bandwidth (Mbps)	POE Load Capacity (W)	Hi-PoE Load Capacity (W)	Working Mode
100	100	25.5	58	IEEE/E100M
200	100	25.5	40	E100M
300	100	24	26	E100M
500	10	15	15	E10M
800	10	10	10	E10M
1000	10	8	8	E10M
ePoE switch supply voltage 48V RG-59, max. DC resistance < 5Ω/100m				
Cable (m)	Bandwidth	POE Load	Hi-PoE Load	Working

	(Mbps)	Capacity (W)	Capacity (W)	Mode
100	100	25.5	60	IEEE/E100M
200	100	25.5	51	E100M
300	100	25.5	37	E100M
500	10	18	23	E10M
800	10	14	18	E10M
1000	10	11	13	E10M
ePoE switch supply voltage 53V				
RG-59, max. DC resistance < 5Ω/100m				

Table 2 ePoE Transmission Parameter over Coaxial Cable

6 Summary

Below is a summary of the seven core advantages of enhanced Ethernet as described above:

1. 800m-capable PoE long distance Ethernet replaces the need for repeater devices.
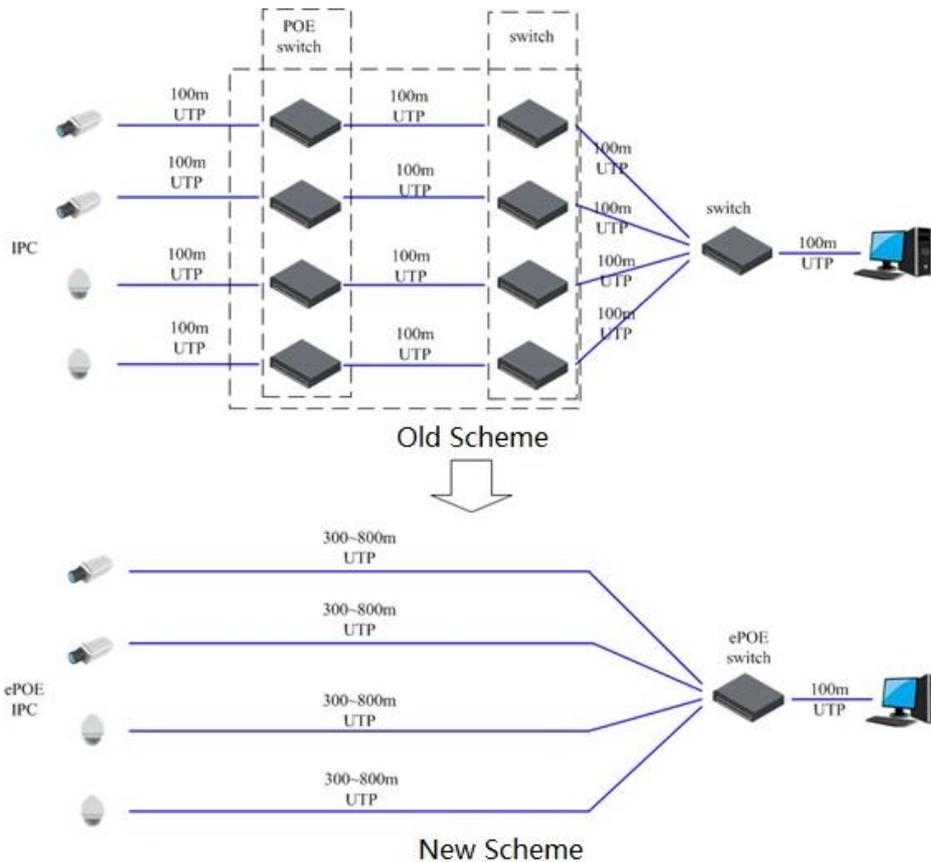
Figure 11 Advantage of ePoE IP System

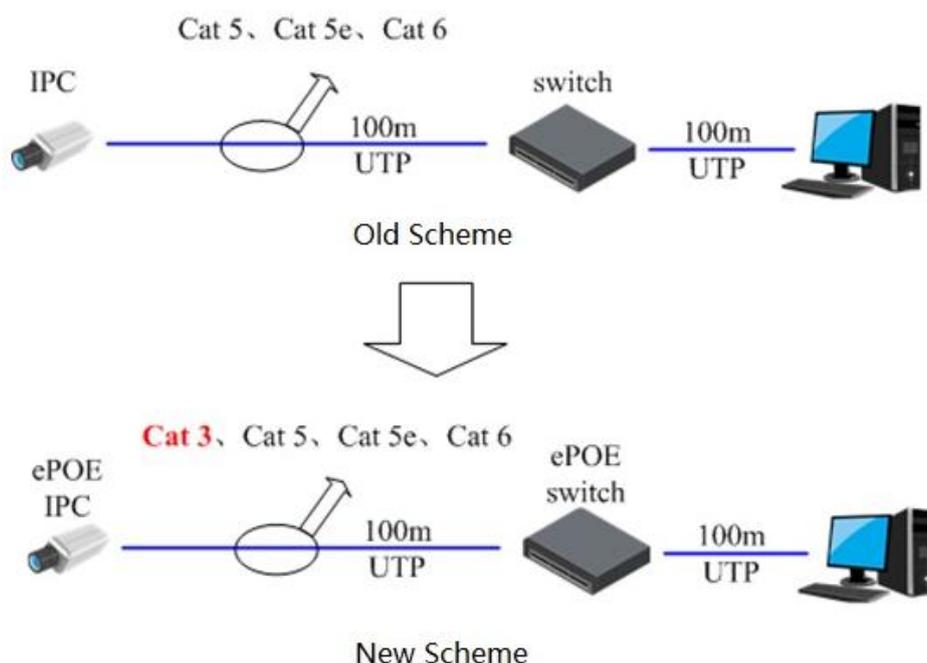2. Lower network cable specification requirements reduces cable costs.

Figure 12 Advantage of ePoE IP System

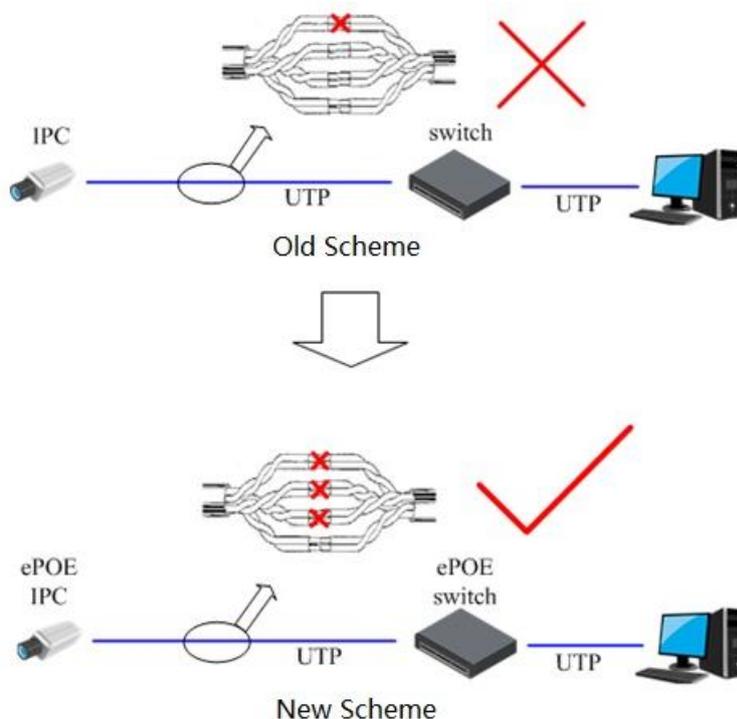3. Single cable pair transmission lowers network cable fault rate.

Figure 13 Advantage of ePoE IP System

4. Full network compatibility. Self-adaptation is compatible with common Ethernet. No need to upgrade original basic devices / lower upgrade costs.
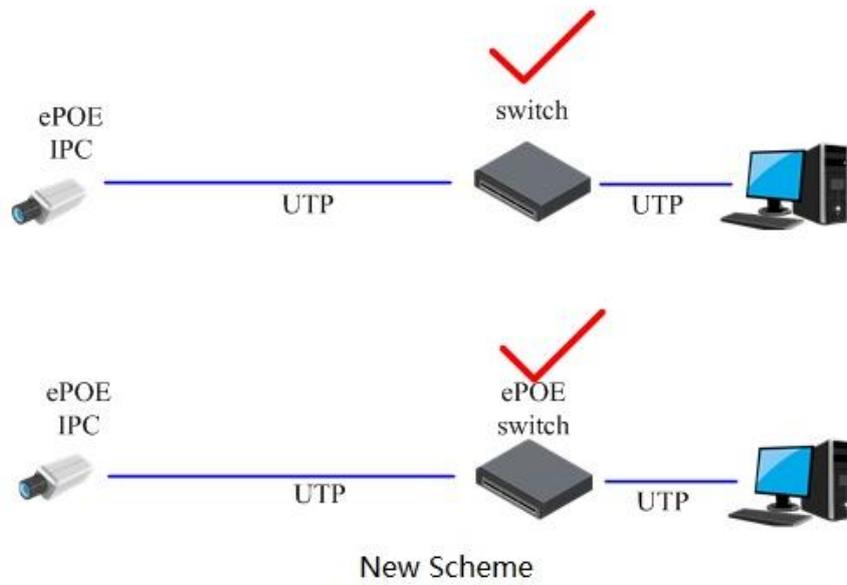
Figure 14 Advantage of ePoE IP System

5. Passive coaxial conversion fully utilizes original analog coaxial wiring. Seamlessly upgrade IP networks and significantly lower analog upgrade costs.
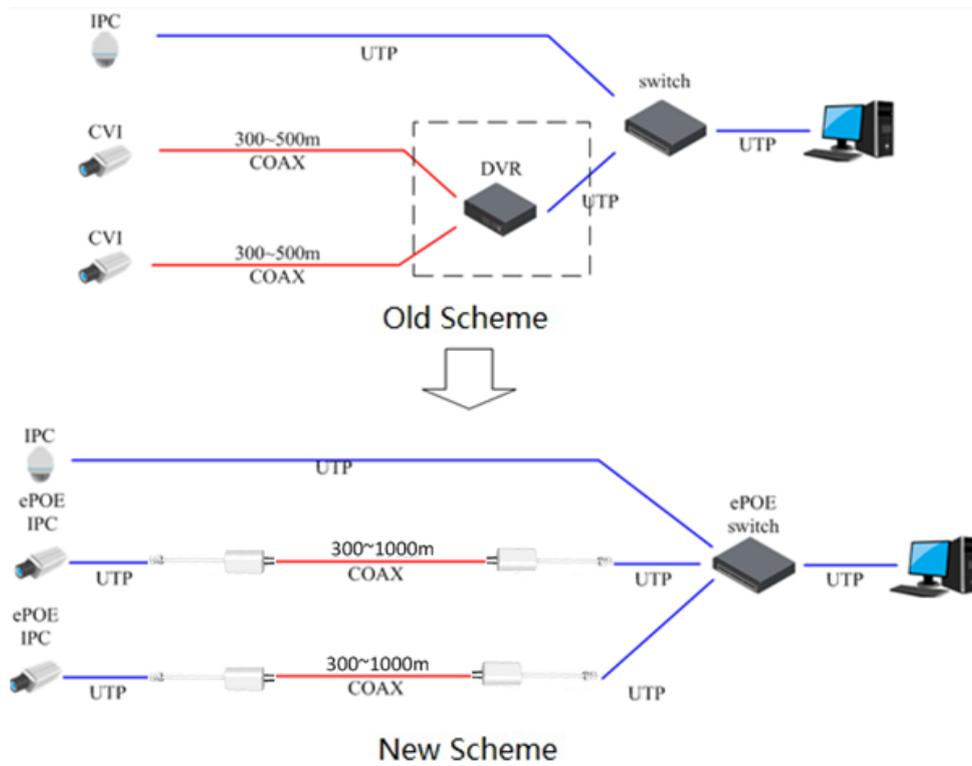

Figure 15 Advantage of ePoE IP System

6. Over-coax transmission supports Power over Coax (PoC), eliminating need to install power supply cabling, simplifying installation.
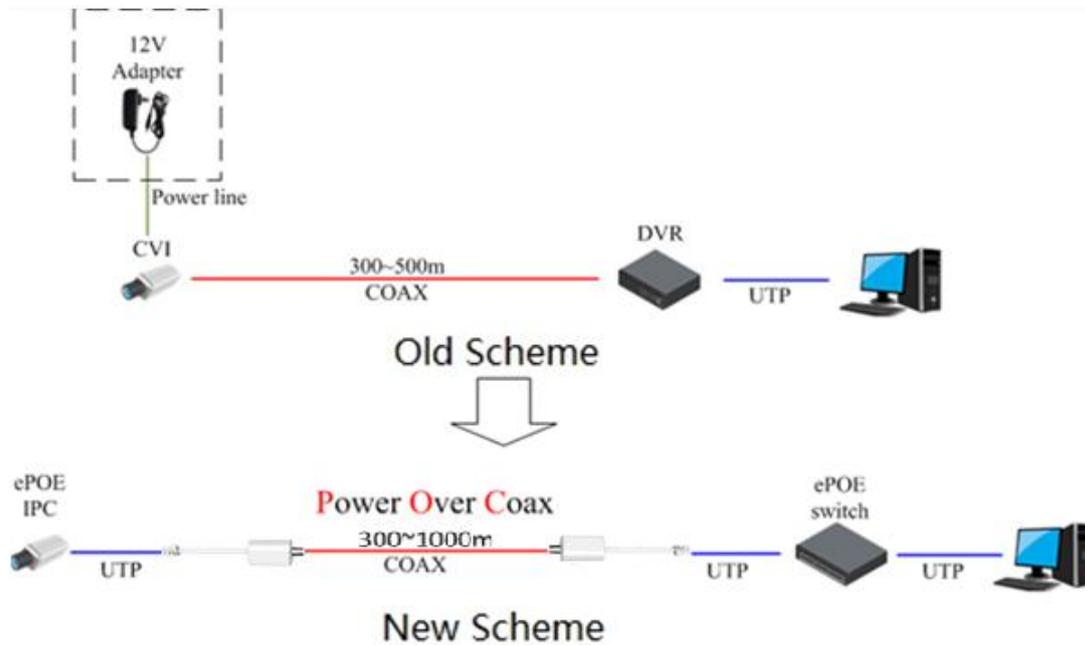

Figure 16 Advantage of ePoE IP System

7   Reference Documentation

IEEE Std 802.3af-2003.pdf
YD/T 1947-2009 Communication Industry Standard of PRC.pdf
IEEE Std 802.3-2005.pdf

About Dahua Technology

Zhejiang Dahua Technology Co., Ltd. Is a leading solution provider in the global video surveillance industry. In 2016, Dahua was ranked 4th in the "Security Top 50" by a&s international.

Dahua is committed to providing the highest quality product with the latest technologies to enable our end users to perform their business successfully. The company has more than 6,000 R&D engineers and technical staff working on cutting-edge technologies in camera lens, image sensor, video encoding & transmission, embedded processor, graphic processing, video analytics, software reliability, network security, and other technologies.