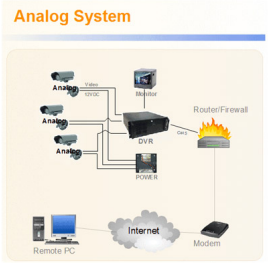
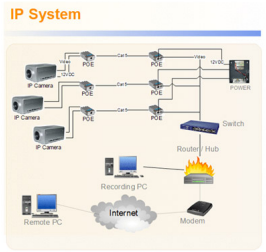
The following diagrams depict the basic setup of an analog camera system and a network-based, or IP camera system.



In the traditional analog CCTV application, security cameras capture an analog video signal and transfer that signal over coax cable to the Digital Video Recorder (DVR). Each camera may be powered by plugging in the power supply right at the camera or by using RG59 Siamese cable which bundles the video and the power cables. The DVR converts the analog signal to digital, compresses it, and then stores it on a hard drive for later retrieval. Intelligence is built into the DVR to handle such things as scheduling, motion detection, and digital zoom. Monitors for viewing the video are connected to the DVR, or it can be set up to publish over an internal network for viewing on PCs. The DVR can also be set up to broadcast over the Internet and can add password protection and other features. When broadcasting over the Internet, the video for all of the cameras is transmitted as one stream (one IP address). Therefore, it is very efficient.



In the IP world, each network camera captures an analog image but immediately converts it to digital inside the camera. Some digital processing can happen right at the camera, such as compression and motion detection. The digital video stream is then broadcast over the IP

network using Ethernet (CAT5) cable. The power supply may be plugged in at the camera or can be run over the ethernet cable by using Power-Over-Ethernet (POE) adapters. The CAT5 cable for each camera is plugged into a switch which feeds into the network hub. As with all network devices, some set-up needs to be done for each network camera to set up its IP address and other identifying attributes.

Software is required on each PC that you want to view the cameras or playback video. Another high powered PC is set up with the appropriate software to record the cameras. Since communication standards are not consistently followed in this industry yet, the viewing and recording software must be purchased from the same vendor that sells the IP cameras. This can make switching or mixing camera vendors very expensive.

The IP camera signal is broadcast over the Internet in the same way that a DVR signal is. However, each camera is a separate stream and has its own IP address or port. This can greatly affect bandwidth as we'll see below. When viewing remotely each camera can be pulled up individually by its IP address. If you want to see all of the cameras side-by-side, additional software (again, from the same camera vendor) must be installed.

Which approach is more cost-effective?

For now, installing analog cameras coupled with DVRs is the most cost-effective approach for most security applications. Later on, a couple of scenarios will be introduced whereby an IP-based solution might be less expensive.

A typical medium quality analog dome camera sells retail for about $100 to $200. A similar quality IP camera sells for at least twice that amount. Analog cameras are available with many different features: varifocal lenses, high resolutions, and long distance infrared, for example. Finding just the right combination of features in a network camera for your application might be difficult and very expensive. Sometimes you may have to buy an analog camera and add a separate video server to do the job. Single-channel network video servers currently start at about $300 retail.

IP advocates will point out that a digital video recorder is not required in an IP solution. That is true, but some device will still be needed to record the camera images. Typically that requires a high-powered PC with considerable hard drive space. Often, that will cost as much as or more than a DVR. Even more significant is the price of the recording software which tends to be expensive. Licenses are typically based on number of cameras, and per user.

IP advocates may also point out that businesses often have IP networks in place and therefore no additional cabling or hardware is needed. However, each camera requires a port to plug into the switch, so more or bigger switches may need to be purchased. POE adapters might need to be added. If the existing network will not handle the load of the additional network devices, upgrades might need to be made, thereby making the installation more expensive.

Finally, bandwidth on the network needs to be considered. Video uses a lot of bandwidth. The bandwidth used by each camera varies by many factors including the resolution, the compression method, and even the amount of movement in the field-of-view. As a general rule, a camera using full CIF (352 x 288) resolution, 30 frames per second (30 fps), and MPEG4 compression will require about 720K bits per second (720Kbps). Therefore, if we put 100 IP cameras on a network, we would use about 72Mbps more bandwidth. This number will double if audio is also transmitted. It should come as no surprise, then, that some companies have gone so far as to create an entirely separate IP network just to run their camera system.

To make bandwidth matters worse for IP - many of the newest IP cameras are coming out with 'megapixel' resolution. This is wonderful from the standpoint of how much clarity and field-of-view can be captured, but it comes at a huge price to bandwidth. A single 2-megapixel IP camera, running 30 fps with MPEG4 compression will use a whopping 6.5Mbps of bandwidth. These high-resolution IP cameras also require a great deal of hard drive space to store the video. The 2-megapixel camera described above would require approximately 67 Gigs of hard drive space to record one day's worth of video.
It's worth noting that DVRs will also use bandwidth if viewed remotely over a network. However, the DVR will only use bandwidth if people are currently viewing the cameras. Otherwise, they will not. Furthermore, a DVR will combine several camera images into one video stream vs. a separate video stream for each camera, as in IP. For example, a typical 16 camera DVR will combine its camera images and throttle its output to a maximum 360Kbps. To run 16 similar IP cameras on a network would generate about 11Mbps

Which approach is better quality?
There are poor quality components and good quality components no matter which type of system is used. That being said, network cameras do offer some technological advances in the areas of video quality and wireless installations. Analog cameras cannot provide resolution above TV standards, the maximum being about 0.4 megapixel. Resolution of IP cameras can be many times higher (currently up to 3 megapixel) and they can capture a clearer image when objects are moving. This could make a difference in high risk applications such as for casinos and law enforcement. Wireless communication over IP networks has fewer problems with interference, and encryption security is built into the technology.

Which approach is easier to install and configure?
If an IP network is already in place at the installation site, and it can handle the additional load of the new cameras, then IP cameras will be easier to install. If additional RJ-45 jacks are needed to plug in the network cameras, then the installer only has to run a CAT-5 cable from the camera to the nearest switch. An inexpensive switch can be installed right at the nearest wall jack. In contrast, each cable for analog cameras must be run all the way back to the DVR. If upgrades need to be made to an existing IP network to handle the additional load, obviously the installation would be more difficult.
The power for the cameras can be handled fairly easily with either technology. For IP networks, use Power-Over-Ethernet (POE) transmitters to send the power through the existing CAT-5 cable. For analog systems, use RG59 Siamese cable to combine the video and power cables into one jacket. Either way, there is no additional cabling for power. POE can run 300 feet without a repeater. RG59 can be run 1000 feet without a repeater.

Once the cabling is in place, configuring the system is less difficult for analog systems. With analog, you plug the cameras into the DVR and you've got video. For IP cameras, you have to assign each camera a network address and open up ports on the router. It's easier to set up cameras for internet viewing using a DVR because access is provided to all cameras at once by using one external IP address to the DVR.

What about wireless?
Analog wireless systems do not work well. This is because the government regulates on which frequencies analog wireless devices can run and how strong the signal can be. Interference from other wireless devices such as cell phones can cause the camera video to be distorted. Interference is especially problematic in buildings with florescent lighting.

Digital IP wireless is much better. The digital transmission does not get interference from other analog wireless devices, and the 802.11x communication standard used has encryption built in. Consequently, there is no problem with unauthorized access to the video.

For what applications should I consider IP?
IP cameras should be considered for large installation sites that already have a high bandwidth network installed - especially if the cameras will be spread out over a wide area, or if wireless cameras will be used.
For large installations with many cameras, some installers still prefer a multiple DVR solution to an IP solution. Software is bundled with higher-end DVRs that allows you to view and record cameras from multiple DVRs. Using analog cameras and multiple DVRs can be less costly than purchasing many IP cameras along with the required software licenses. The multiple DVR

solution also provides better failover protection. If the network goes down in an IP based system, video is lost from all the cameras. If the network goes down in an analog system, the DVRs are still recording the cameras. If one DVR has a problem, only the recorded video from the cameras on that particular DVR is lost. In contrast, if the recording PC goes down in an IP system, all video recording is stopped. An even better solution may be to use a hybrid solution which combines the use of analog and IP technology.