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# *CHOOSING THE CORRECT CABLE FOR SECURITY CCTV*

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Cabling a security CCTV system used to be a straightforward proposition. Since security cameras were based on commercial video technology, security video networks used coaxial cable and components. Coax is still an overwhelmingly popular choice for security CCTV.

However, advances in video imaging, transmission technology, video compression and the cables themselves present the designer with a choice of traditional 75Ω RG59 and RG6-style coax, Cat 5e/Cat 6 twisted pair or fiber optic cables. Each is a viable transmission media; each has its advantages. But which is the correct cable for your application?

## CABLE CHARACTERISTICS

Coaxial cable has been the standard of video transmission for years. It consists of a conductor (usually bare copper) surrounded by a polyethylene dielectric. Coax is shielded with a metal braid and/or foil to protect against electromagnetic interference (EMI).

Coax is a popular and proven technology. Because almost all CCTV cameras and monitors accept coax connections, no media conversion is required. Coax's low attenuation and resistance to EMI makes it an excellent choice for transmission distances of as long as 1500 feet (and longer if repeaters are used). Both inbound video and outbound PTZ (Pan, Tilt, Zoom) commands can travel over the same cable.

Unshielded twisted pair (UTP) is a newcomer to the CCTV industry although it is the cable of choice for structured wiring data networks. A pair of insulated copper wires is twisted together to improve transmission performance. The twisting reduces crosstalk and offers some protection against EMI (though typically not as much as a coaxial cable).

UTP requires media conversion (baluns) to modify 75Ω video RF signals for transport over 100Ω UTP. Not all baluns permit PTZ commands to travel to the camera. However, UTP offers reasonable performance up to 1000 feet and longer if the baluns are powered (active). UTP cable is finding a role as the cable of choice for integrated security systems, where video, alarm monitoring, access control and asset tracking are all carried over a single network. UTP's small diameter, light weight, low cost and broad acceptance in data transmission makes it a viable competitor to coax.

Fiber optic cables carry pulses of light over hair-thin strands of glass. Optical cable is light, small in diameter, unaffected by EMI and very difficult to tap. Multimode fiber can carry signals up to 2 km (about 6300 feet); singlemode fibers can carry signals for distances of up to 60 miles. Fiber is well suited for outdoor applications.

If cost is no object, fiber is the perfect CCTV media; however, media conversion is required in the form of electro-optical transmitter/receivers, which are relatively (if not prohibitively) expensive.

Chart 1 offers a quick comparison of the three types of cables.

## SYSTEM CONFIGURATION

A typical CCTV system is configured like Figure X. A camera is connected by coaxial cable to a PTZ controller and digital video recorder (DVR). Camera power is supplied by an 18 AWG pair attached to the coax. Video signals terminate at the monitor, which may be B&W or color. This example shows a coax system; no media converters are required. Generally, one cable is required per camera.

Figure Y shows a UTP system using baluns at both ends of the link to convert the camera's RF video transmission. While four twisted pairs make up a standard Cat 5e UTP data cable, only two pairs are needed for CCTV (one pair for transmission, another for PTZ control). If the baluns are active, low voltage power is supplied by a third pair of 16 or 18 AWG conductors. (It should be noted that some baluns do not permit PTZ control.)

An advantage of UTP is that video from several cameras can be routed to an active hub where they can be multiplexed and sent to the control room

**Chart 1: Coax, UTP, and Fiber Comparison**

| | Cable Diameter (inches) | Cable Weight (lbs/1000') | Attenuation @ 5 MHz (dB/100') | Shielding Effectiveness (dB) | Rated Distances (feet) |
|---|---|---|---|---|---|
| Mini Coax | .146 | 16.0 | 1.3 | 80 | 350 |
| RG59 Coax | .242 | 35.0 | .58 | 80 | 750 |
| RG6 Coax | .272 | 42.0 | .47 | 80 | 1500 |
| Cat 5e UTP (passive) | .200 | 20.9 | 1.22 | 40 | 1000 |
| Cat 5e UTP (active) | .200 | 20.9 | 1.22 | 40 | 3000 |
| Fiber (multimode) | .13x.23 | 13.5 | <0.5 | N/A | 6500 |

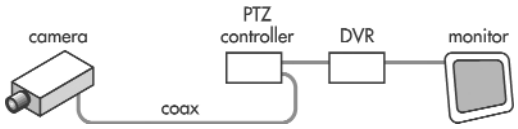


Figure X

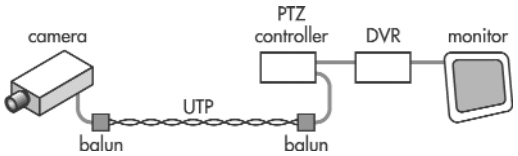


Figure Y

over a single multipair UTP cable. UTP is well suited for high density camera installations where space is at a premium.

Like UTP, fiber systems need media converters (electro-optic in this case) to adapt the RF video signal for travel over fiber. Two fibers are required (one for transmission, another PTZ control). The converters also require power, so copper conductors may be used to provide it. Like UTP, optical signals can be multiplexed through an active hub.

## COMPARATIVE PERFORMANCE

Deciding which media to use involves three factors; transmission distance, signal quality and component cost. Commscope has tested various media over several distances and has graded their performance on a 10-point scale (with 1 being very poor and 10 being excellent). The media are compared to a short, direct connection from camera to DVR and monitor. The DVR data was taken from video material transmitted to the DVR via the media under test, then replayed directly to the monitor. This produces a somewhat poorer quality picture; digital artifacts are sometimes created when analog signals are stored in a digital format. Fiber was not tested for this comparison in that it offers performance equal or better to the direct connection but at a much higher cost.

## COMPARATIVE COST

Distance plays a role in the cost comparison of different CCTV media. For instance, RG59 coaxial cable costs more than a 4-pair UTP cable. However, that cost can be outweighed by the price of the extra electronics needed to operate a UTP-based system. Over short distances, the limiting factor is the electronics cost; over long distances, the limiting

| | Connectivity | B&W Quality | Color Quality | DVR Quality | PTZ |
|---|---|---|---|---|---|
| Direct Connection | | 7.0 | 7.0 | 6.5 | yes |
| UTP 24 AWG | passive | 6.0 | 5.5 | 4.0 | yes |
| Coax RG59 | passive | 7.0 | 7.0 | 6.0 | yes |

**At 500 feet, coax performs measurably better in signal quality delivered to the monitors and the DVR:**

| | Connectivity | B&W Quality | Color Quality | DVR Quality | PTZ |
|---|---|---|---|---|---|
| Direct Connection | | 7.0 | 7.0 | 6.5 | yes |
| UTP 24 AWG | active | 4.0 | 3.5 | 3.0 | yes |
| UTP 24 AWG | passive | 4.0 | 2.0 | 2.0 | no |
| Coax RG59 | passive | 7.0 | 6.5 | 4.5 | yes |

**At 1000 feet, coax still offers better performance than UTP (note the higher grade for the active system):**

| | Connectivity | B&W Quality | Color Quality | DVR Quality | PTZ |
|---|---|---|---|---|---|
| Direct Connection | | 7.0 | 7.0 | 6.5 | yes |
| UTP 24 AWG | active | 4.0 | 3.0 | 2.0 | yes |
| UTP 24 AWG | passive | 1.0 | 0.5 | 0.5 | no |
| Coax RG59 | passive | 4.0 | 2.5 | 2.0 | yes |

**However, at 3,000 feet, coax performance drops off sharply, almost equaling that of the active UTP system:**

| | Connectivity | B&W Quality | Color Quality | DVR Quality | PTZ |
|---|---|---|---|---|---|
| Direct Connection | | 7.0 | 7.0 | 6.5 | yes |
| UTP 24 AWG | active | 3.0 | 2.5 | 1.5 | yes |
| UTP 24 AWG | passive | 1.0 | 0.0 | 0.5 | no |
| Coax RG59 | passive | 3.0 | 2.0 | 1.5 | yes |

**At 4,000 feet, the system has become unusable with either coax or UTP. Coaxial performance could be improved by using amplifiers along the route, but fiber offers the best performance at these and larger distances.**

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factor is the cost of the cable.

This graph (Figure Z) is based on list prices of an eight camera CCTV system using either coaxial and UTP cable and components. For shorter distances, the coax system is more economical. However, at distances of 1500 to 2000 feet, the higher price of coax and the need for more repeaters becomes a factor and the UTP system becomes more economical. A typical fiber system would cost more than the coax or UTP systems.

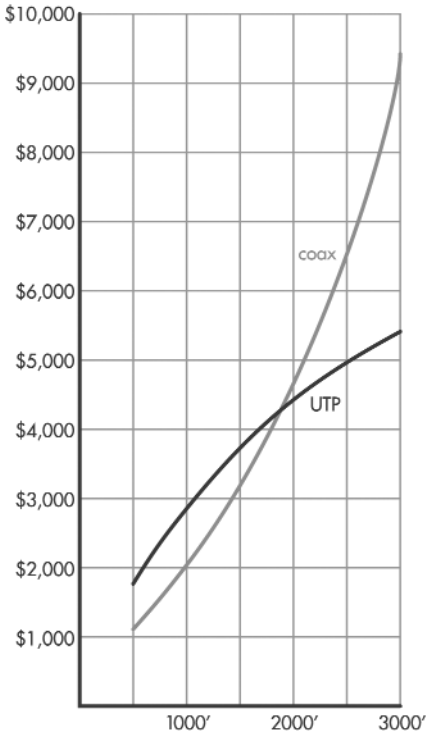

Figure Z

## SUMMARY

Coaxial cable is a widely used technology that works both well and inexpensively at distances of up to 1500 feet. Because it does not require conversion electronics, it has fewer connection points that could lead to signal loss or breakdown. It is also well shielded against EMI. Coax also tends to introduce fewer digital artifacts than UTP.

UTP is emerging as a viable CCTV media. An active UTP system offers reasonable performance over distances of up to 1500 feet and is comparable to coax at distances between 1500-3000 feet. UTP's big advantage is that it works well in the world of structured wiring; a UTP CCTV network can integrate into a campus data network using protocols like Ethernet. While the present cost of baluns and hubs is a factor, those costs should come down over the next few years. Its disadvantages are that conversion electronics are required and UTP offers only minimal protection against EMI. Higher category UTP (i.e. Cat 6) offer somewhat better EMI protection than medium to lower category UTP (i.e. Cat 3).

If it weren't for the cost of electro-optical media conversion, fiber would be the overwhelming choice for CCTV applications, especially those over long distances. Fiber is difficult to tap and is immune to EMI and lightning. Despite the electronics cost (which is gradually dropping), fiber is becoming the media of choice for outdoor applications.

In closing, coax remains a very robust media for CCTV. Continued advances in lower-cost electronics will increase the performance of UTP and decrease the price of fiber systems.