CCTV Convergence: The Path To IP
CCTV Convergence: Structured Cabling

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Berk-Tek, a Nexans Company
## Changing Trends in CCTV

<table>
<thead>
<tr>
<th>Traditional CCTV System</th>
<th>Evolving CCTV System</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Analog cameras and VCRs</td>
<td>• Analog and digital cameras utilizing network storage capability</td>
</tr>
<tr>
<td>• Human observer and “forensics” – what happened?</td>
<td>• Real time software-based analysis/response</td>
</tr>
<tr>
<td>• Video image archives on tape</td>
<td>• Video data mining</td>
</tr>
<tr>
<td>• Separate applications using separate cabling</td>
<td>• Connected functions over common cabling</td>
</tr>
</tbody>
</table>
Convergence through Structured Cabling

- Interoperability through a standards-based architecture
- Network integration
- UTP/Fiber optic cable vs. coax
- Investment Protection: Provides future migration path to emerging technologies
TIA-568B Structured Cabling Standard

- Recommended cabling and connectivity components that will support a wide variety of existing and future services
- Centralized “Star-wired” topology
- Defines performance levels for Category 5e, 6 and fiber channels
- 100-meter channel distance for twisted pair
  - Backwards compatible
De-centralized Systems

Centralized Structured Cabling for Data and Voice
Centralized (Star) Topology

- Ethernet IP
- Centralized Switch
- Camera
- Access Control
- Phone
Design Criteria for Structured Cabling for CCTV

- Camera Type
  - Analog or IP
  - Resolution
- Location of Cameras
  - 100 meter rule
- Media Type & Connectivity
- Power
  - Local or PoE
- Termination equipment (Active)
  - Switches, hubs
## UTP Copper Cable Selection

<table>
<thead>
<tr>
<th></th>
<th>Category 5e</th>
<th>Category 6</th>
<th>Enhanced Category 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Distance: IP Enabled</strong></td>
<td>328 ft.</td>
<td>328 ft</td>
<td>328 ft</td>
</tr>
<tr>
<td><strong>Distance: Analog or non IP-enabled</strong></td>
<td>750 ft</td>
<td>3,000 ft</td>
<td>5,280 ft (active balun)</td>
</tr>
<tr>
<td><strong>PoE Enabled</strong></td>
<td>Best suited for: IEEE 802.3 af PoE 15W</td>
<td>Best suited for: IEEE 802.3 af PoE 15W</td>
<td>Is ready for: IEEE 802.3 at PoE Plus up to 30W Scalable for future high def &amp; bandwidth</td>
</tr>
<tr>
<td><strong>Bandwidth</strong></td>
<td>155 MHz</td>
<td>250 MHz</td>
<td>+400 MHz</td>
</tr>
<tr>
<td><strong>Futureproof</strong></td>
<td>5 years</td>
<td>5-10 years</td>
<td>10+ years</td>
</tr>
</tbody>
</table>
# Recommended UTP and Fiber Optic Cables for CCTV

<table>
<thead>
<tr>
<th>CCTV System</th>
<th>Cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog ≤328 ft with local power or midspan power</td>
<td>Category 5e or 6</td>
</tr>
<tr>
<td>IP ≤328 ft with PoE</td>
<td>Category 6</td>
</tr>
<tr>
<td><strong>Analog &gt;328 ft. with local power</strong></td>
<td>Category 6 – (up to 8,000 feet; power to 1200 feet)**</td>
</tr>
<tr>
<td>IP &gt;328 ft. with local power</td>
<td>Fiber optic cable</td>
</tr>
</tbody>
</table>

** Not standards’ compliant
Cable Selection

• Category 5e and Category 6 (vs. coax):
  – UTP has a much smaller diameter
    (RG59 = .280”, Category 5e = .165”)
  – Lower cost in materials and labor
  – Balanced cable vs. unbalanced coax cable
    (eliminates ground loop, less susceptible to EMI/RFI)
  – Power over Ethernet (PoE)

• Fiber Optic Cable
  – Secure cable
  – EMI/RFI resistant
  – Long Haul
Why Category 6 vs. 5e

- Bandwidth – picture quality and speed
- Better attenuation – less susceptible to noise
- PoE (Plus) – increased wattage and heat
- Supports future applications
- Minimal difference in size & cost (10-30%)
Signal Integrity
Analog Cameras at 3,000 ft.

Coax
HyperPlus (CAT 5E)
LANmark-2000 (CAT 6)

OK
Good
Best
Quality Cable Matters!

• Berk-Tek LANmark-1000 vs. Sub-standard Grade:

BEWARE: Dropped packets and latency can occur!

Source: Test results from transmitting CATV in the DCCC Lab in Berk-Tek (New Holland, PA)
Fiber Optic Cable for CCTV

- Distance
- Bandwidth
- Smallest diameter
- Variety of constructions
- Associated costs
PoE (Power over Ethernet)

- PoE (IEEE 802.3af)
  - 2-pair
  - 13 Watts
- PoE Plus (IEEE 802.3at)
  - 3rd Q 2008 under “comment resolution”
  - Expected to ratify 1Q 2009
  - Problems with 30 W – now at 24 W over 2-pair
  - Rise in heat within cable (+10°) will create insertion loss
Cabling Design Considerations for CCTV

- **Bandwidth**
  - Data and Signal Integrity
- **Distance**
  - Maximum Limitations
- **Location**
  - Indoors/Outdoors
- **Diameter**
  - Pathways
- **Costs**
  - Materials (active & passive)
  - Labor
Path to IP

Analog CCTV over Structured Cabling

IP CCTV over Structured Cabling
Path to IP: Analog CCTV

- Analog Camera
  - Balun
  - Patch Cord
  - UTP Cable

- Main Distribution Frame/Headend
  - 25-pair backbone cable
  - Patch Panel
  - NVT Receiver
  - Hybrid DVR/NVR

- Telecom Room/IDF
  - Patch Panels
  - NVT Hub/Transceiver

- Workstation
Path to IP: Analog CCTV

Analog Camera
Patch Cord
Balun

UTP Cable
100 meters = IP Ready
Up to 8,000 feet with NVT
(not IP)

25-pair backbone cable
Main Distribution Frame/Headend

Telecom Room/IDF

Patch Panel
NVT Receiver

Hybrid DVR

Berk-Tek
NVT
JVC
Bicsi
Path to IP: Analog CCTV

- Analog Camera
- Patch Cord
- Balun
- UTP Cable
- Patch Panels, NVT Hub/Transceiver
- 25-pair backbone cable
- 100 meters = IP Ready
- Up to 8,000 feet with NVT (not IP)
- Telecom Room/IDF
- UTP Cable
- 25-pair backbone cable
- Main Distribution Frame/Headend
- Patch Panel
- NVT Receiver
- Hybrid DVR

Berk-Tek
NVT
JVC
Bicsi
Path to IP: IP CCTV

- UTP Cable
- 100 meters = IP Ready

Diagram:
- Main Distribution Frame/Headend
- Telecom Room/IDF
- Switch
- Patch Panel
- 25-pair backbone cable
- UTP Cable
- Patch Cord
- NVR
- Workstation
Path to IP: IP CCTV

UTP Cable
100 meters = IP Ready

Fiber Optic Cable
Up to 2 km

Components:
- Main Distribution Frame/Headend
- Telecom Room/IDF
- Patch Panel
- Switch
- NVR
- Workstation

Brands:
- Berk-Tek
- NVT
- JVC
- Bicsi
Path to IP: IP CCTV

- **UTP Cable**
  - 100 meters = IP Ready

- **Fiber Optic Cable**
  - Up to 2 km

- **Multi-fiber Backbone Cable**
Analog and IP (Hybrid)

Analog CCTV over Structured Cabling

IP CCTV over Structured Cabling
Planning for the Future

- Network Security
- HVAC Building
- Transmission
- Fire/Safety Alarms
- Access Control
Summary: Planning for Total IP Convergence

• Converging applications will require a more sophisticated network system (UTP and fiber) and an open standards/centralized platform

• Pre-planning with both I.T. and a security integrator

• Select quality cable with guaranteed performance!!
CCTV Convergence:
Analog Video Transmission on UTP

George Wojtan
NVT
Industry Trends
Past

• Early Days
  ✓ Coax dominant
  ✓ Other technologies were used to solve problems
  ✓ Convergence was a term used in other industries
Present

• Today
  ✓ UTP has gained widespread acceptance
  ✓ IP has experienced much hype
  ✓ All technologies growing at the expense of coax
Future

• **Tomorrow**
  - Hybrid solutions will be a “sweet spot” in the market
  - IP will continue to experience growth
  - Convergence of IT and physical security accelerates
  - Plenty of opportunity for growth in all markets
## Analog vs. IP CCTV Cameras

<table>
<thead>
<tr>
<th>Year</th>
<th>IP CCTV Camera Units (000)</th>
<th>Analog CCTV Camera Units (000)</th>
<th>Total CCTV Camera Units (000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>524</td>
<td>24,881</td>
<td>25,405</td>
</tr>
<tr>
<td>2006</td>
<td>1,235</td>
<td>28,590</td>
<td>29,825</td>
</tr>
<tr>
<td>2007</td>
<td>2,655</td>
<td>32,359</td>
<td>35,014</td>
</tr>
<tr>
<td>2008</td>
<td>5,576</td>
<td>35,531</td>
<td>41,107</td>
</tr>
<tr>
<td>2009</td>
<td>10,874</td>
<td>37,386</td>
<td>48,260</td>
</tr>
<tr>
<td>2010</td>
<td>20,225</td>
<td>36,432</td>
<td>56,657</td>
</tr>
<tr>
<td>2011</td>
<td>34,382</td>
<td>31,339</td>
<td>65,721</td>
</tr>
<tr>
<td><strong>CAGR</strong></td>
<td><strong>100.83%</strong></td>
<td><strong>3.92%</strong></td>
<td><strong>17.17%</strong></td>
</tr>
</tbody>
</table>

Source: iSuppli, May 2007
However...

<table>
<thead>
<tr>
<th>Year</th>
<th>% of Analog CCTV Cameras on UTP</th>
<th>Total Analog CCTV Cameras on UTP (000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>2.5%</td>
<td>622</td>
</tr>
<tr>
<td>2006</td>
<td>5.0%</td>
<td>1,430</td>
</tr>
<tr>
<td>2007</td>
<td>7.5%</td>
<td>2,427</td>
</tr>
<tr>
<td>2008</td>
<td>10.0%</td>
<td>3,553</td>
</tr>
<tr>
<td>2009</td>
<td>12.5%</td>
<td>4,673</td>
</tr>
<tr>
<td>2010</td>
<td>15.0%</td>
<td>5,465</td>
</tr>
<tr>
<td>2011</td>
<td>17.5%</td>
<td>5,484</td>
</tr>
<tr>
<td>CAGR</td>
<td>38.3%</td>
<td>43.73%</td>
</tr>
</tbody>
</table>
### How do you bridge from analog today to IP tomorrow?

#### COAX

1. Coax is not recognized by EIA/TIA as an installable media.
2. Coax not used today/not recommended for Ethernet/IP transport.
3. Cost of installing media today to be removed in $x$ years prohibitive.
4. “Abandoned Cable” concerns

#### UTP Structured Cabling System

1. EIA/TIA compliant
2. Being adopted for more building systems
3. Proven life span, 10 years minimum
4. Does not need to be removed to run other applications
UTP CCTV Technical Benefits
Terminology: Balance

• UTP balance reduces/eliminates interference from:
  – Neighboring cables/cable pairs within bundle
  – Active telephone ring voltages
  – Fluorescent and high intensity lighting
  – Electric motors and transformers
  – Radio and RF sources
  – High voltage (440V)
Terminology: Transceiver (Balun)

- Balun is short for balanced – unbalanced
- Converts unbalanced 75 ohm baseband video signal to balanced 100 ohm signal and vice versa
- Allows the use of UTP instead of coax
High quality Transceiver vs Balun

Features to look for:

- Video Interference Immunity
  Over a wide frequency range

- Surge and Lightning Protection
  that meets ANSI/IEEE 587 C62.41
Cost Comparison
Factors to Consider

UTP vs. Coaxial

- Labor rate
- **Cable pulling speed** (feet per hour)
- Cost of cable
  - PVC C5e $72 / 1,000ft
  - PVC C5e 25 pair $x /1kft
- Conduit size
- Number of cameras
  - Cost of transceivers

- **Home running cable**
- Cost of cable
  - PVC RG-59 $156 / 1,000ft
- Conduit size
- Number of cameras

**Cost of:**
- Video distribution amplifier
- Transient protection
- Ground loop isolator
UTP vs. Coax & Fiber
UTP vs. Coax

1,100 pairs C3 UTP

100 pairs C3 UTP

100 RG6 Coax
UTP vs. Coax

- UTP is higher density and 1/10 the size of coax
- UTP has lower labor costs (1 x 25 pr. = 1 coax)
- UTP color coding makes installation easier
- UTP is a future proof infrastructure
- Potential use of existing cabling plant
- Lower costs for cable (1/3 of coax, plenum even more), conduit, cable trays, etc.
- Longer video transmission distances (up to 8K’)
- UTP is more resistant to interference
- UTP- 1/10dB loss per connection, Coax- 1dB loss
- Coax does make a good pull string!
**UTP vs. Fiber**

- Fiber has more bandwidth than UTP or coax
- Fiber is a great choice for distances > 8K’
- Fiber is immune to transient spikes
- UTP utilizes lower cost Tx and Rx devices
- UTP doesn’t require power at both ends
- UTP has lower and less complicated installation costs
- Fiber is great if budget permits
Structured Cabling Background

• EIA/TIA Compliant
  – Formalized practices and procedures
    • Installation
    • Testing and certification
    • Performance
• De-facto standard for an increasing number of building applications
• Long lifespan
  – Replace devices, not infrastructure
Old Technique for Delivering Camera Power, Video and Data

Old Technique: not future proof!
Path to IP: Analog CCTV

- Patch Cord
- UTP Cable
- Patch Panels
- Telecom Room/IDF
- 25-pair backbone cable
- Patch Panel
- Main Distribution Frame/Headend

Diagram showing the connection between different components of a network infrastructure.
Structured Cabling CCTV System

• Deliver multiple functions on one 4-pair cable with RJ-45
  – Plug & Play Connectivity with RJ-45
  – Power, video and data:
    • 2 pairs for power, 1 for video, and 1 for data
• Significant power distances satisfy most indoor applications
• Uses testable, structured cabling principals
• Follows EIA/TIA standards
• Easy to combine CCTV and LAN drops by using same contractor/crew
• Provides future proof migration path to emerging technologies
Path to IP: Analog CCTV

Analog Camera → Patch Cord → NVT Transceiver → UTP Cable → Patch Panels → 25-pair backbone cable → NVT Power Supply Cable → Integrator Hub → Telecom Room/IDF → Main Distribution Frame/Headend → Patch Panel → NVT Hub/Receiver → DVR → Computer

Brands: Berk-Tek, NVT, JVC, Bicsi
Single Channel Devices

Transceiver for Fixed Cameras

Transceiver for PTZ Cameras
## Single Channel Devices
### 12VDC Converter

<table>
<thead>
<tr>
<th>Extended Distance</th>
<th>NV-226J-PV at the 12 VDC Camera</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply Voltage</td>
<td>24 VAC</td>
</tr>
<tr>
<td>B&amp;W Camera 12 VDC, 100 mA, 1.2 W</td>
<td></td>
</tr>
<tr>
<td>2-pair 24 AWG</td>
<td>3,000 ft (1 km)</td>
</tr>
<tr>
<td>2-pair 23 AWG (Cat6)</td>
<td>3,000 ft (1 km)</td>
</tr>
<tr>
<td>Color Camera 12 VDC, 200 mA, 2.4 W</td>
<td></td>
</tr>
<tr>
<td>2-pair 24 AWG</td>
<td>1,569 ft (478 m)</td>
</tr>
<tr>
<td>2-pair 23 AWG (Cat6)</td>
<td>1,978 ft (602 m)</td>
</tr>
<tr>
<td>Color Camera 12 VDC, 300 mA, 3.6 W</td>
<td></td>
</tr>
<tr>
<td>2-pair 24 AWG</td>
<td>1,046 ft (318 m)</td>
</tr>
<tr>
<td>2-pair 23 AWG (Cat6)</td>
<td>1,319 ft (402 m)</td>
</tr>
<tr>
<td>Color Camera 12 VDC, 400 mA, 4.8 W</td>
<td></td>
</tr>
<tr>
<td>2-pair 24 AWG</td>
<td>789 ft (239 m)</td>
</tr>
<tr>
<td>2-pair 23 AWG (Cat6)</td>
<td>989 ft (301 m)</td>
</tr>
</tbody>
</table>

**Single Channel Passive Power-Video Transmitter with AC to DC Converter for Fixed Cameras**

Power Cameras at Extreme Distances over a single C5 or C6 cable.
RJ-45 pin out

+ Video ↔ 1
- Video ↔ 2
+ Data ↔ 3
- Power ↔ 4
+ Power ↔ 5
- Data ↔ 6
+ Power ↔ 7
- Power ↔ 8
Path to IP: Analog CCTV

Analog Camera

Patch Cord

NVT Transceiver

UTP Cable

25-pair backbone cable

Patch Panels

NVT Power Supply Cable

Integrator Hub

Telecom Room/IDF

Main Distribution Frame/Header

Patch Panel

NVT Hub/Receiver

DVR

NVT Hub/Receiver

DVR

NVT Hub/Receiver

DVR

NVT Hub/Receiver

DVR
How do I inject power onto the 4-pair?

Cable Integrator

16 Channel Power Supply

or

Power Supply Cable Integrator Hub
## Power Distance Limitations

Camera power distances? Depends on the camera

<table>
<thead>
<tr>
<th>Power Supply Voltage</th>
<th>28 VAC</th>
<th>24 VAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 mA B&amp;W Camera</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-pair 24 AWG</td>
<td>2,150 ft</td>
<td>920 ft</td>
</tr>
<tr>
<td>2-pair 23 AWG (Cat6)</td>
<td>2,700 ft</td>
<td>1,160 ft</td>
</tr>
<tr>
<td>300 mA Color Camera</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-pair 24 AWG</td>
<td>710 ft</td>
<td>300 ft</td>
</tr>
<tr>
<td>2-pair 23 AWG (Cat6)</td>
<td>900 ft</td>
<td>380 ft</td>
</tr>
<tr>
<td>1 Amp P/T/Z Camera</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-pair 24 AWG</td>
<td>210 ft</td>
<td>90 ft</td>
</tr>
<tr>
<td>2-pair 23 AWG (Cat6)</td>
<td>270 ft</td>
<td>110 ft</td>
</tr>
</tbody>
</table>
Things to look for in a power supply:

• Independently selectable 24 or 28VAC w/1 Amp max/channel
• Automatic-reset fault protection, transient protection
• Diagnostic LEDs show load/no load, mis-wires and overload conditions
• Individually floating outputs ensure total ground-loop immunity
• 1U high, 12 inches deep; wall, desk or rack-mountable
• Supplies camera power and pass-through video & telemetry
• Data connectivity for up to 16 cameras, each via a single RJ45 4-pair UTP cable
Path to IP: Analog CCTV

Analog Camera

Patch Cord

NVT Transceiver

UTP Cable

25-pair backbone cable

Patch Panels

NVT Power Supply Cable Integrator Hub

Telecom Room/IDF

Main Distribution Frame/Headend

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NVT Hub/Receiver

DVR

NVT Hub/Receiver

Main Distribution Frame/Headend

Telecom Room/IDF

Patch Panels

NVT Power Supply Cable Integrator Hub

DVR

Analog Camera

Path to IP: Analog CCTV
Converting back from UTP to Coax

Multi-Channel Active Receiver Products

Features and Benefits

- Receive manually equalized video signal for cable loss
- Some have Distribution Amplifier (DA) built-in
- 8-Channel Hubs have 4 outputs per camera
- 16-Channel Hubs have 2 outputs per camera
- DA feature can eliminate need for “looping” & separate distribution amps
- Built-in transient protection and ground lifting
- Can save significant cost and equipment space needs (uses only 1 RU)
Auto Equalization Active Receiver Distribution Amplifier Hubs

- 8 Channel, 4 outputs per input channel (back view)

- 16 Channel, 2 outputs per input channel (back view)
Things to look for in a receiver:

- Continuous and automatic digital adjustment for cable attenuation/loss
- Built-in transient protection and ground lifting
- Per channel video quality diagnostic LEDs & Automatic polarity control
- Distribution amplifier built-into 8 & 16 Channel versions
- High density 19” 1U high enclosure