כנס יועצי מערכות תקשורת

22-24 אוקטובר - מלון דניאל ים המלח

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Cables for modern new Applications and Data Centers

Presenter

Jacob Ben Ary

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Presenter - Jacob Ben Ary

- Project leader and editor of IEC balanced pair cable standards IEC 61156-2 to 8
- Editor of IEC cable specification 1200 MHz IEC 61156-7 and 8
- Israel Expert representative in IEC-46C/WG7
- Israel Expert representative in IEC-46A/WG3
- Member IEEE-SA
- Member IEEE-EMC
- Member ISA

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LAN/cabling Applications

LAN Protocols	1 Mbps	10 Mbps	100 Mbps	1 Gbps	10 Gbps	40/100 Gbps
Cabling Category		3 (4)	5	5e, 6	6_A, 7, 7_A	7_A, 8?
Bandwidth (MHz)		16	100	100	500, 600 1000	IEEE 802.3ba >1000 ?

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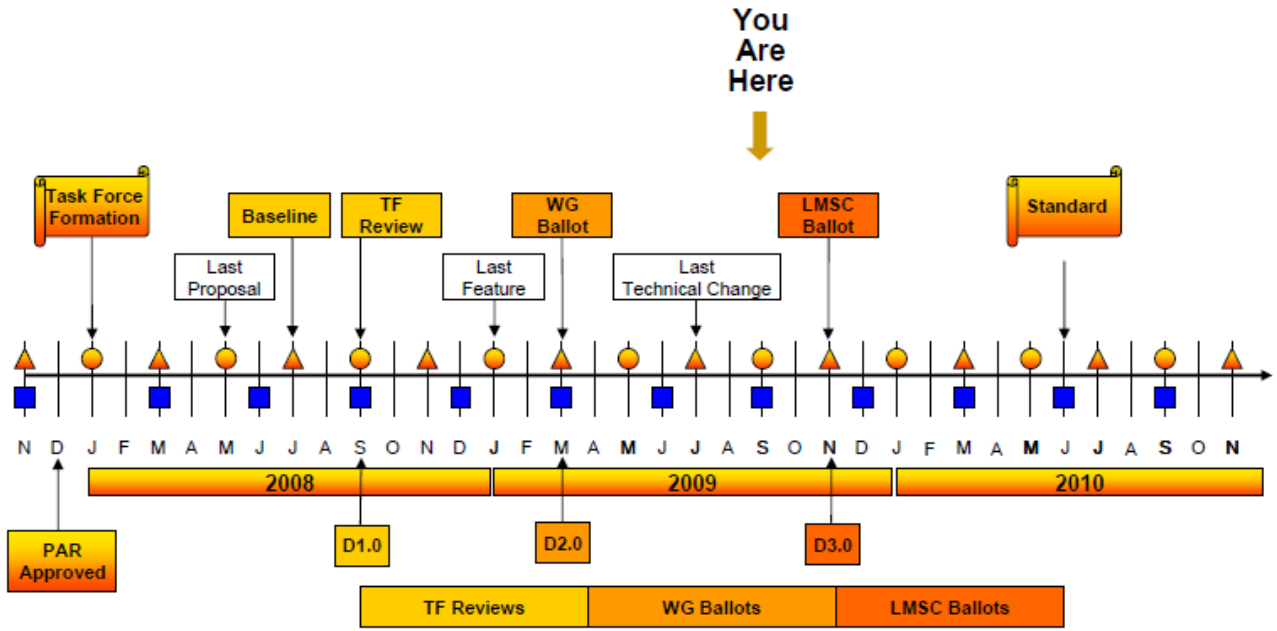
IEEE P802.3ba 40Gb/s and 100Gb/s Ethernet Task Force

Agenda and General Information

Chicago, IL
September, 2009

IEEE P802.3ba Task Force Timeline



* Adopted by IEEE P802.3ba TF at March 08 Plenary

Legend
- IEEE 802 Plenary
- IEEE 802.3 Interim
- IEEE-SA Standards Board

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Standards

Bandwidth (MHz)	Application	Category	Standard	Notes
100	100 BASE-T 1 GBASE-T	5e	IEC 61156-5/6	Published
	100 BASE-T 1 GBASE-T	5e	TIA 568B	Published
250	100 BASE-T 1 GBASE-T	6	IEC 61156-5/6	Published 1 GBASE-T only
	100 BASE-T 1 GBASE-T	6	TIA 568B.2-1	Published 1 GBASE-T only

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Standards

Bandwidth (MHz)	Application	Category	Standard	Notes
500	10 GBASE-T	6_A	IEC 61156-5/6	Published
	10 GBASE-T	6_A	TIA 568B.2-10	(TIA 568C)
600	10 GBASE-T	7	IEC 61156-5/6	Published
1000	10 GBASE-T	7_A	IEC 61156-5/6	Published
1200	10 GBASE-T Multiservice	Exceeds 7_A	IEC 61156-7/8	7 – Published 8 - FDIS

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Common Transmission Terms

- Primary parameters
  - *Resistance* (Resistance unbalance)
  - *Capacitance* (Capacitance Unbalance)
  - *Inductance* (Self, Circuit)

  Note: the Unbalance issues bring the unbalance transmission characteristics (TCL, common mode noise) and a poor EMC.
- Secondary parameters
  - *Attenuation*
  - *Impedance*
  - *Return Loss*

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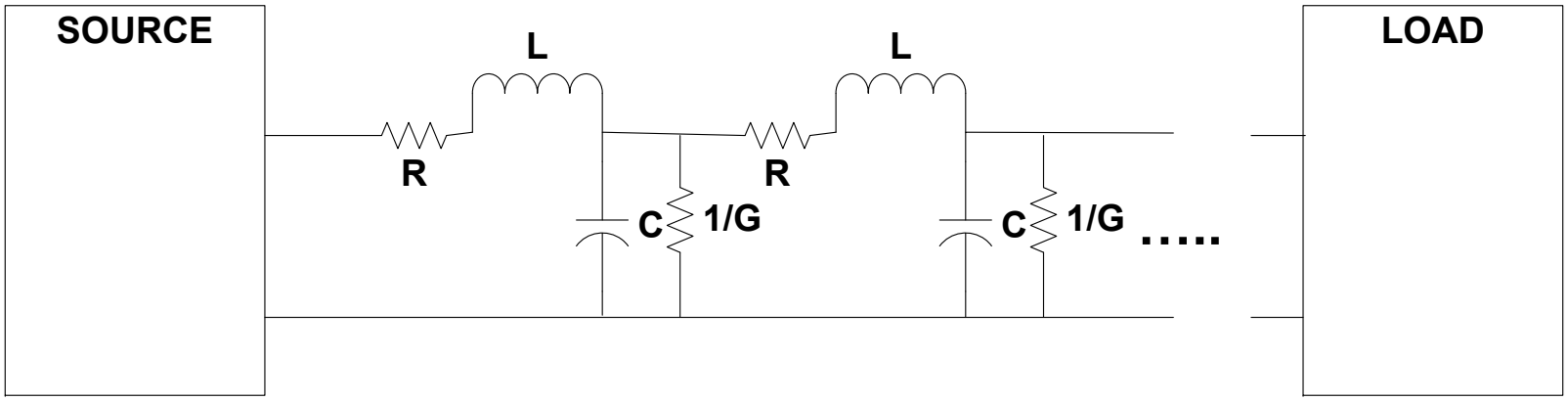
- Electrical noise
  - *Cross Talk* (Near end, Far end)
  - *EMI/RFI*
  - *Alien Cross Talk*

Transmission line Model

TRANSMISSION LINE



Return Loss RL

Return Loss (RL)

- Whenever an electromagnetic wave encounters a change in impedance, some of the signal is reflected
- The difference between the impedances determines the amplitude of the reflected and the transmitted waves
- RL is the amount of reflection due to impedance changes relative to the characteristic value expressed in dB

$$RL = 20\log\frac{Zin - Zo}{Zin + Zo}$$

Impedance Z

- The characteristic impedance is defined by the line primary parameters and the geometry of the wires.
- The common approximation equation of Characteristic impedance is:

$$Z = \sqrt{\frac{R + jWL}{G + jWC}}$$

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RL (impedance mismatch) effects

- **Reflection can cause over-shots**

- **Reflections occur at any point within the line where the impedance has mismatch values**
- **The reflected wave can be sensed as signal at the source**
- **In short lengths, reflections may affect CrossTalk (phantom CrossTalk)**

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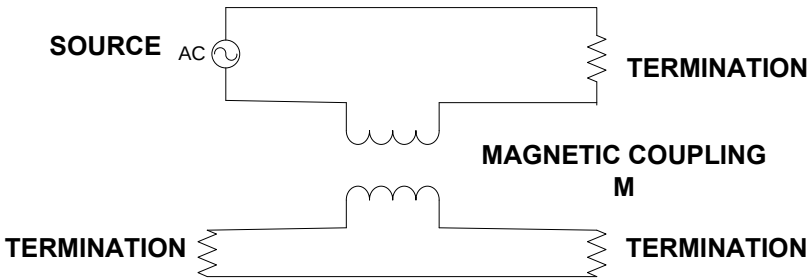
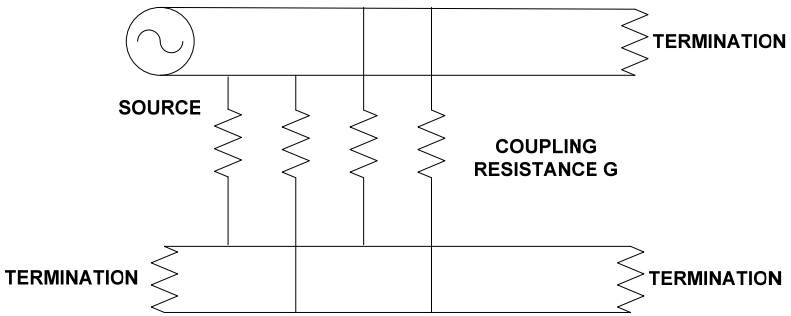
Visual RL effects

Magnetic, Resistive and Magnetic Coupling

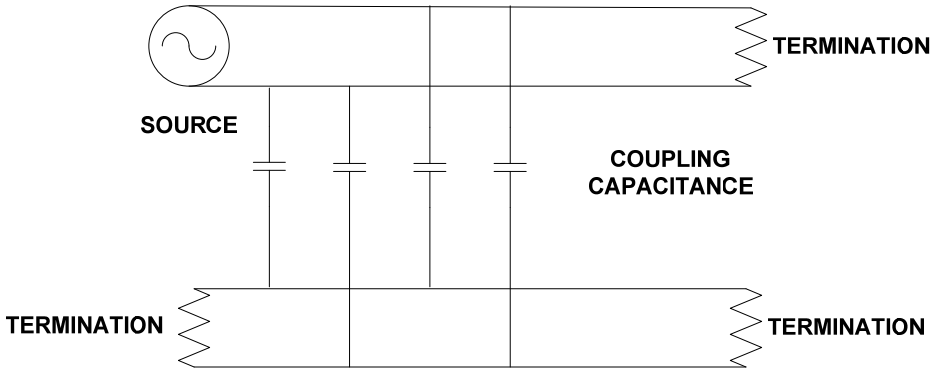
MAGNETIC COUPLING



RESISTANCE COUPLING



CAPACITANCE COUPLING



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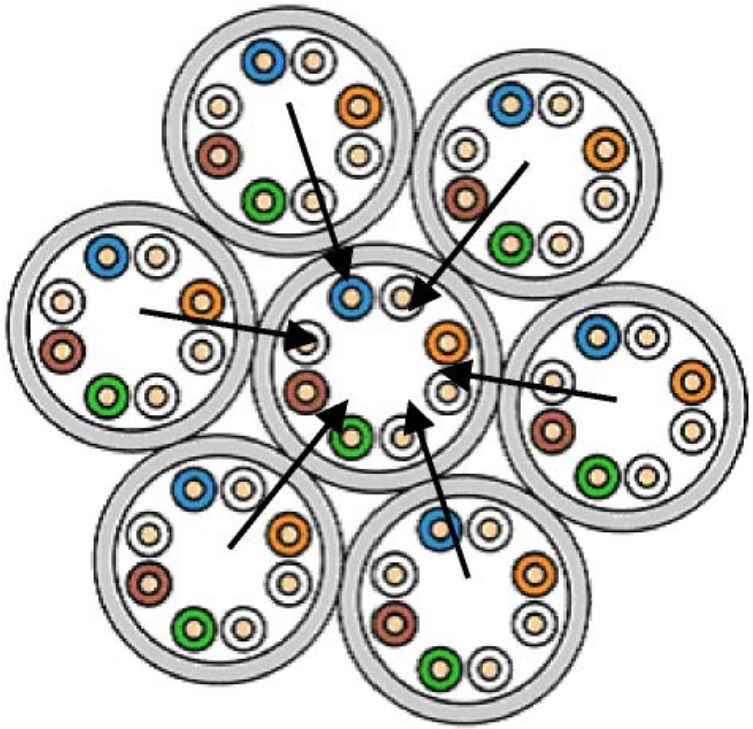
AXT (Alien Cross Talk)

Each cable must be certified for AXT

Horizontal and Work-area cables



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Power over Ethernet (Plus)

- IEEE 802.at defines an option of power over the data pairs
- The new definitions may define a supply voltage of 65 Vdc and higher
- The new voltage level may not be called low-voltage use, it may require a ground and earth connections as "mains"
- "Mains" earth and ground connections requires low impedance connection
- Usually aluminum-foil has higher impedance to ground than the "mains" ground requires
- **The "best" cable structure for the "mains" ground is the S/FTP**
- PoEP when activated will allow powering of end units (i.e. NICs, Routers, HUBs, Switches)
- Two main issues must be considered
  - Connecting hardware (hot plug, spikes)
  - Cabling heating due to the conductor current

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Temperature rise effect on attenuation

- The affect is proportional to cable length
- δ is the temperature coefficient of attenuation increase of the horizontal cable (average values are 0.2% for screened cables, 0.4% for unscreened)

$$A(T) = l \cdot A(20^{o})\left[1 + (T - 20) \cdot \delta\right]$$

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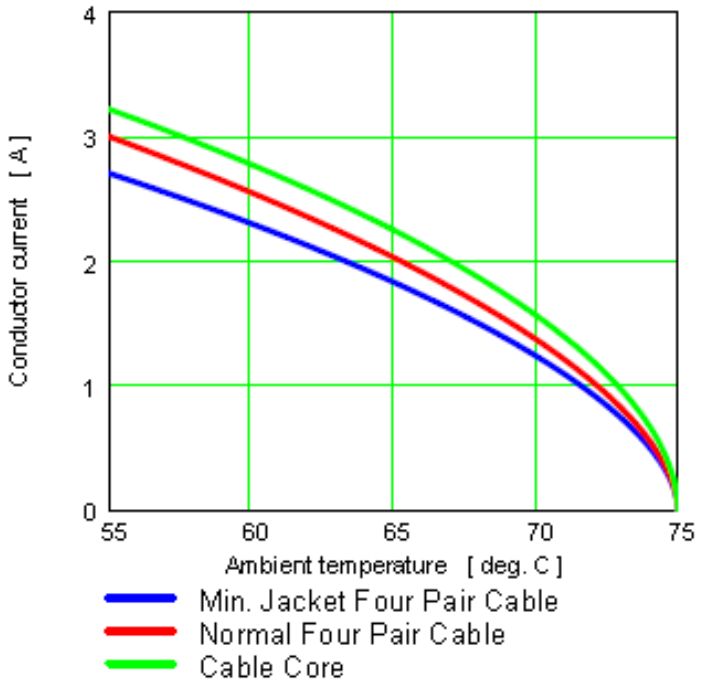
Heating of cables due to PoEP

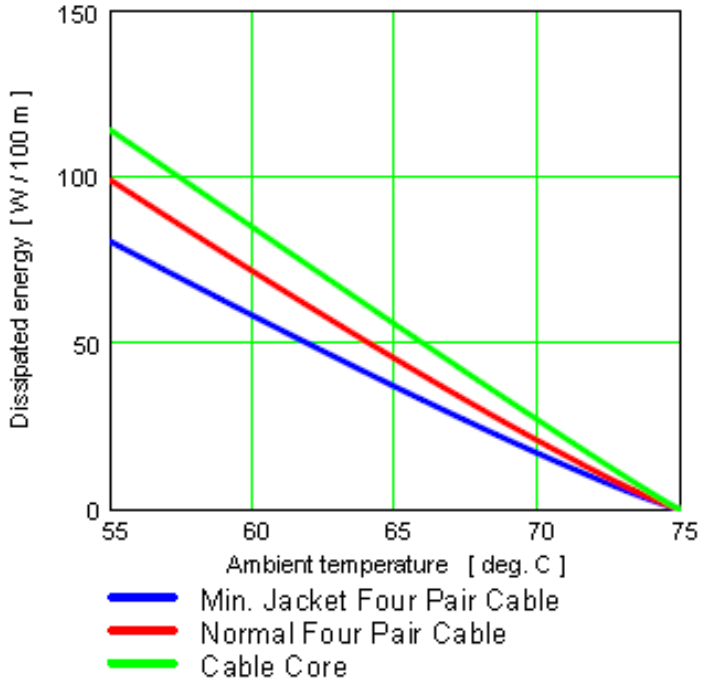
- The maximum operational temperature is the conductor surface temperature. It is NOT THE AMBIENT TEMPERATURE
- A "heating due to current" model was developed for standardization activities
- For copper conductors and common known insulation and jacketing materials, the maximum temperature is 75°C

Heating

Maximum current per conductor vs. ambient Temp. (model result)



Energy to be dissipated per conductor (model result)



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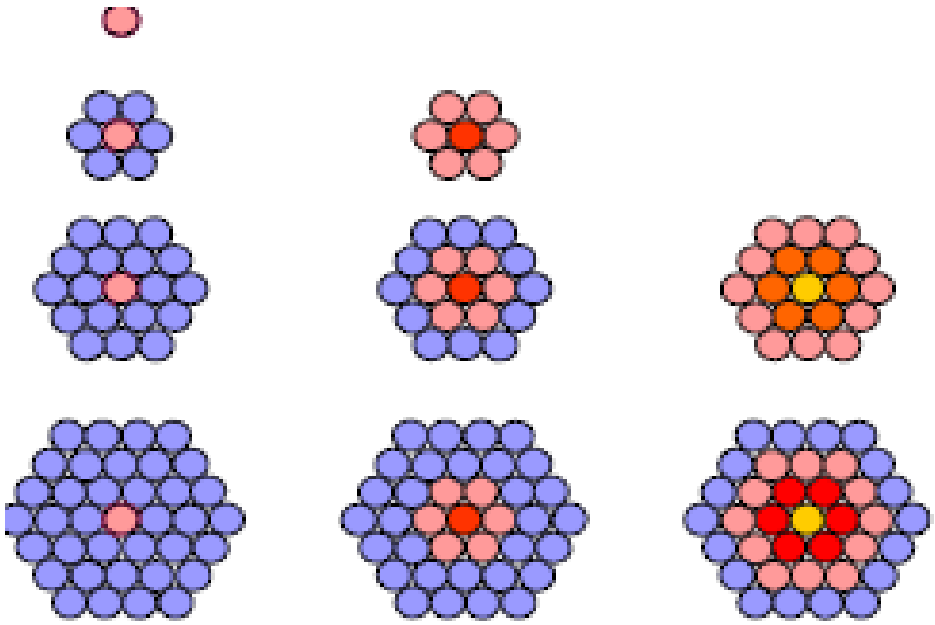

For bundled configurations the “ambient” temperature is not constant for all the cables

Every bundle may be simulated as a layer of cables

Internal layers are located in hotter “ambient”

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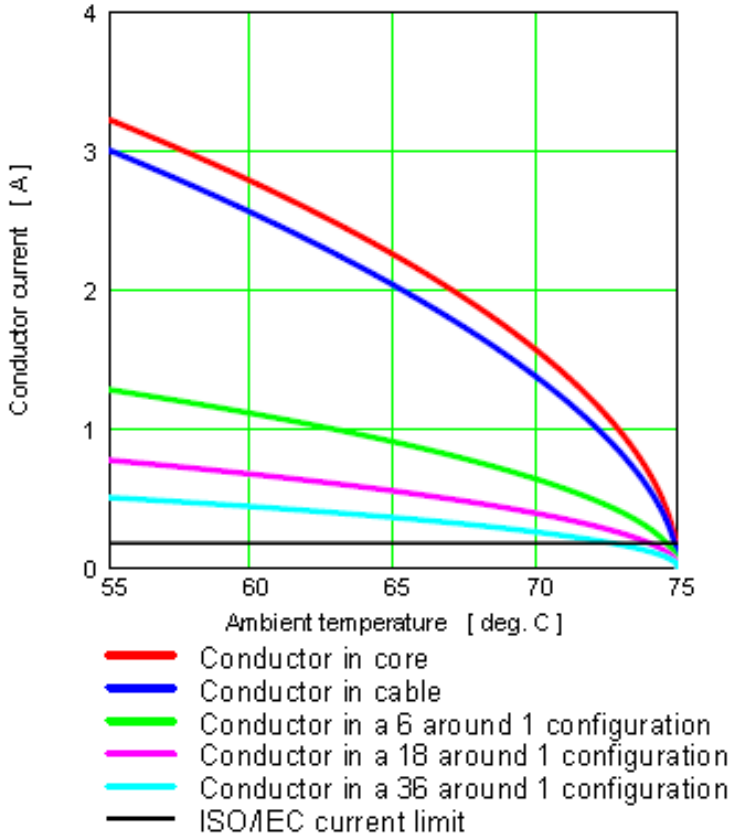
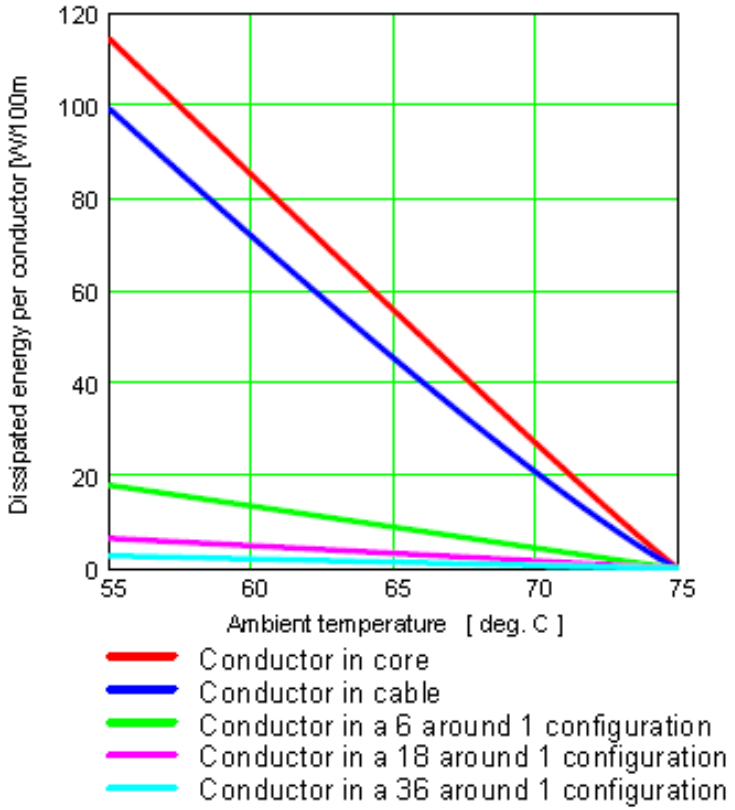
Model result of current capacity in a bundle configuration

Current



Power dissipation



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What is a "Data Center"?

- A collection of active units, power-supplies, **very high bandwidth cabling**, equipped cabinets and cooling units

- Key consideration is a very high power dissipation in a small volume

- For high reliability, transmission cables are one of the main items to cool (hot installed length in bundles)

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Data Center Standards

- TIA 942: Telecommunication Infrastructure Standard,
- EN 50173-5: Information technology
  - Data Centers
  - Smaller scope, European perspective
- ISO/IEC Draft 24764: Information technology Global Generic Cabling for Data Centers
- ISO/IEC 11801: Information technology generic cabling for customer premises

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Data Center Applications & Technologies Today & Tomorrow

GigaBit Ethernet

- OM1/OM2/OM3/OM4 for fiber (1000Base-SX/LX)
- Cat.5e for copper (1000Base-T)

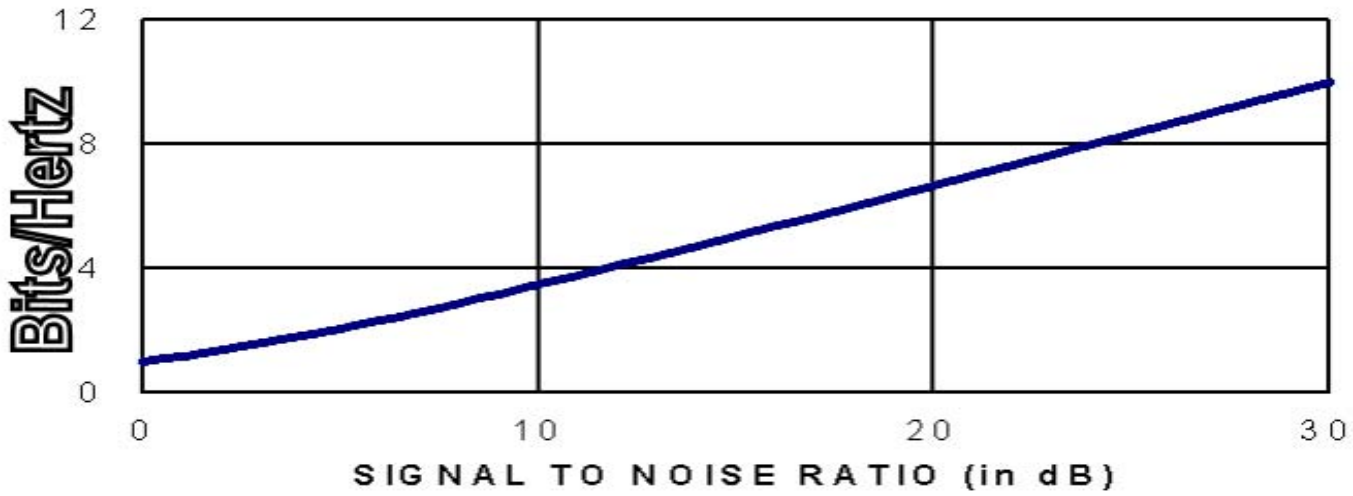
10GigaBit Ethernet

- OM3/OM4 recommended for fiber (10GBase-SR)
- Cat.6_A/Cat.7/Cat.7_A /IEC 61156-7/8 for copper (10GBase-T)
- Note: Cat 7 is the recommended level per IEEE 802.3 for 100m use.

Shannon's law

$$C = BW \log_2 (1 + S / N)$$

- C maximum data rate
- BW bandwidth
- S signal power
- N noise power



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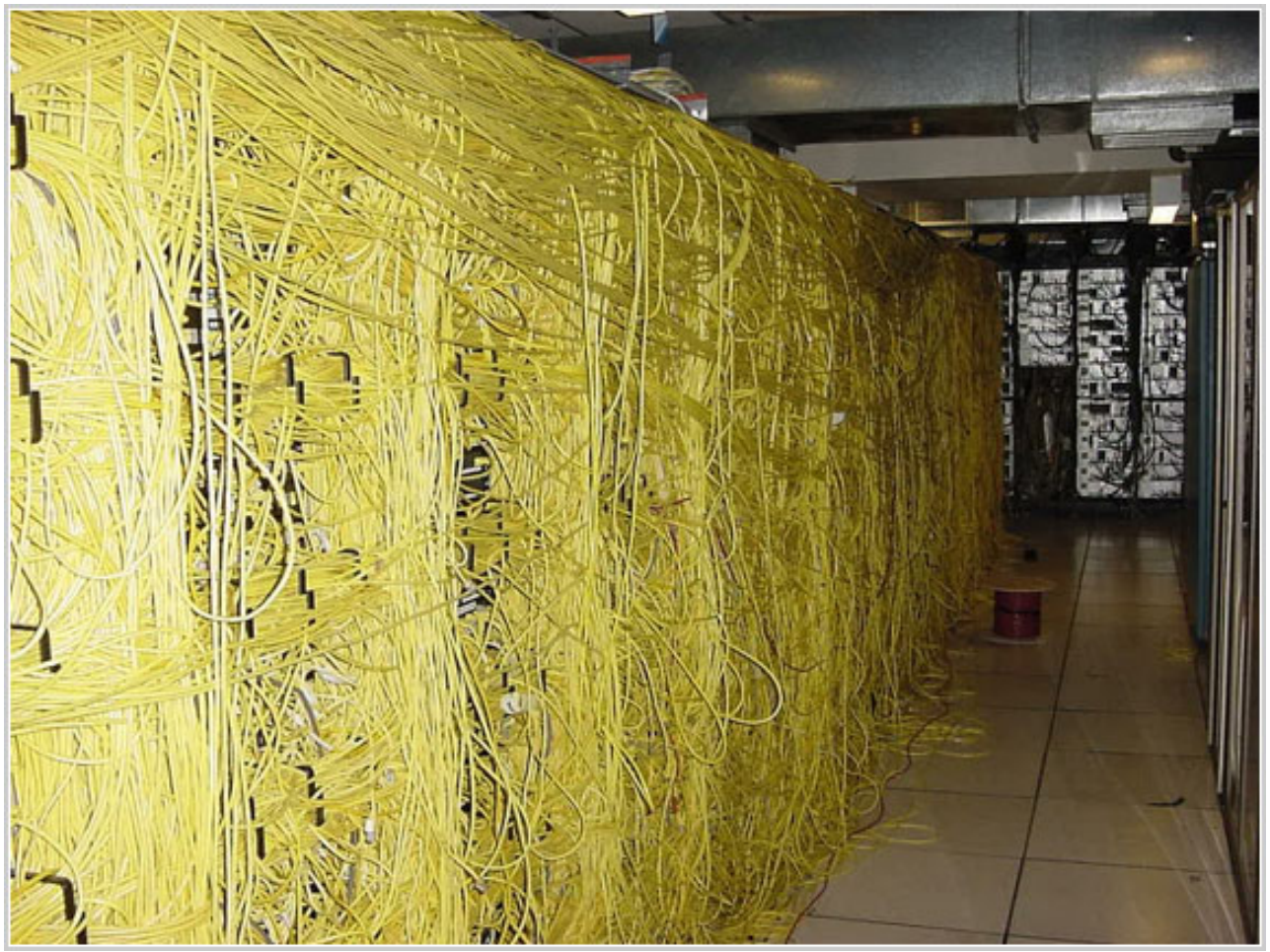
A sample of cabling (a bad one)



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What is bad…..from thermal point of view

- No free space for air cooling
- No preferred direction to allow natural heat flow (heat goes up)

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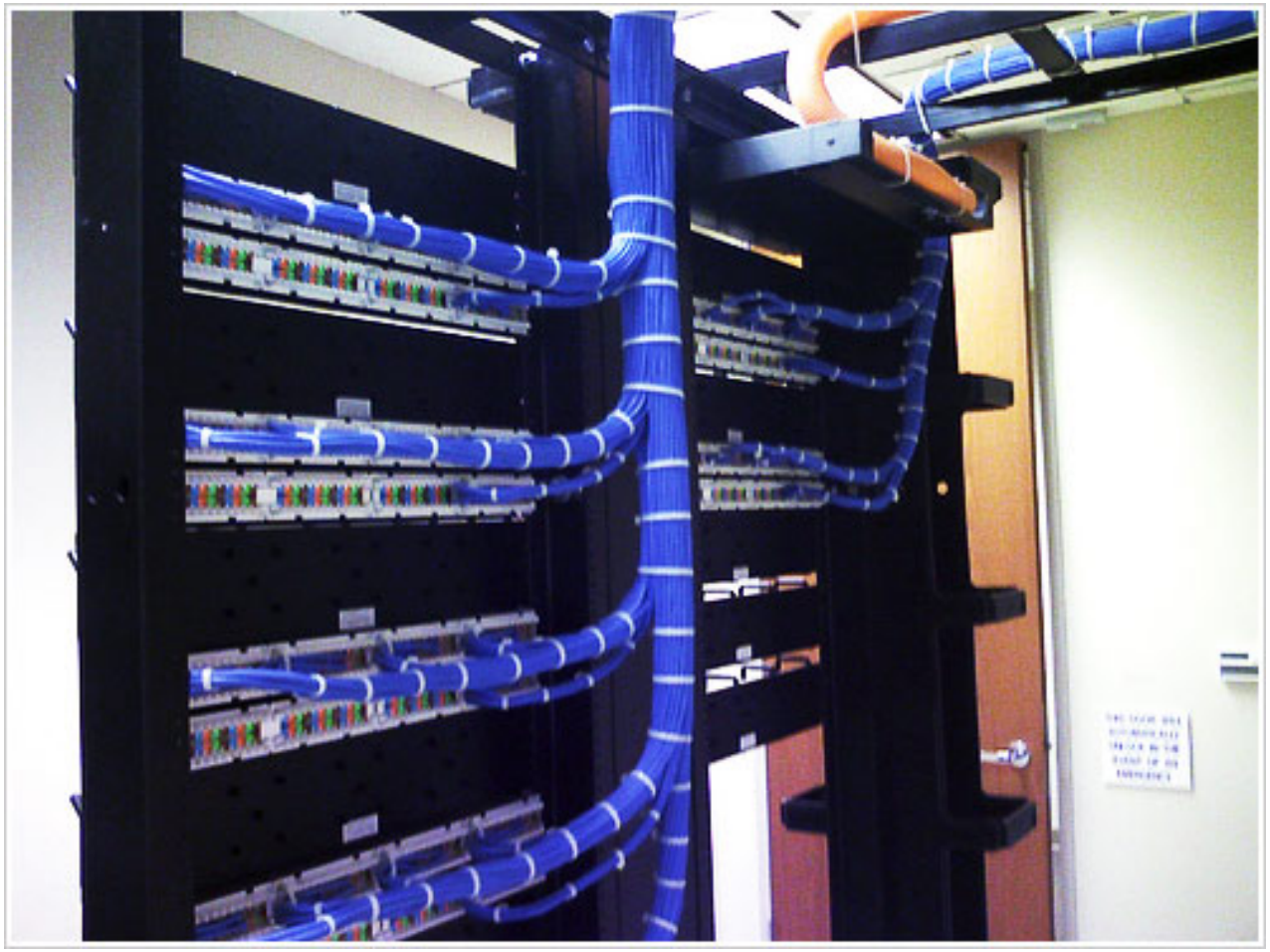
A sample of cabling (a good one)



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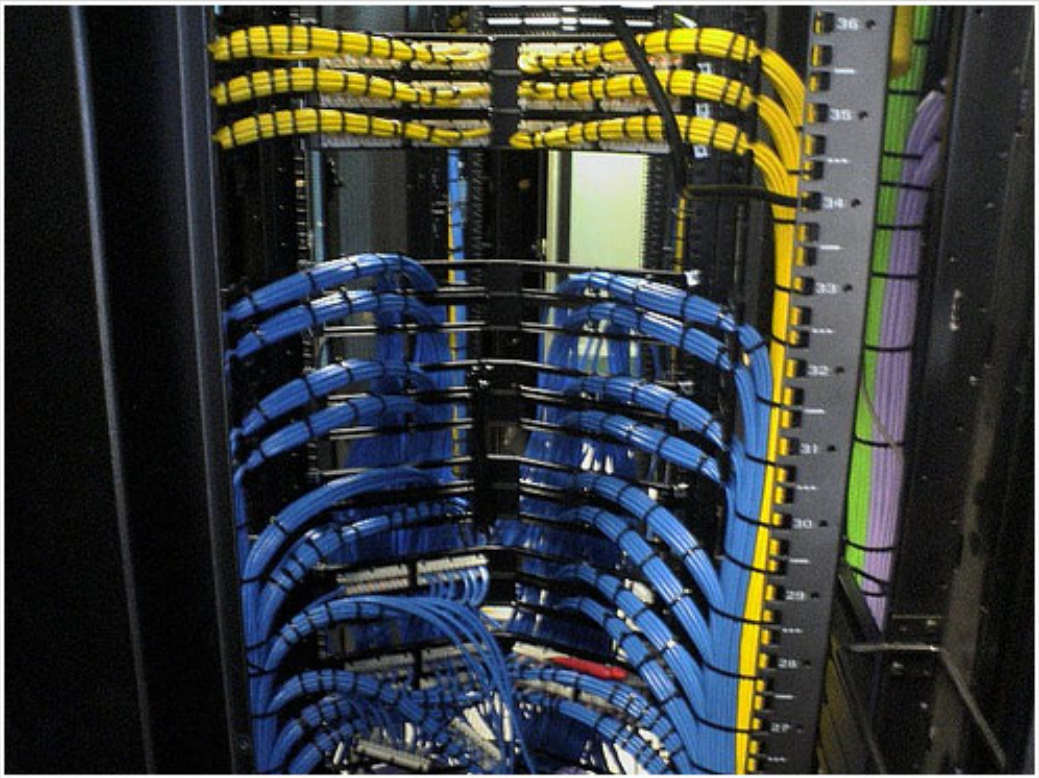

Premium Data Center Cabling Solutions

Premium Data Center Cabling Systems have to meet or exceed

- The Data Center Cabling Standard Definitions
- The Data Center specific Cabling Requirements
- Technology & Application Requirements (today & tomorrow)

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Recommended cable type

- For high bandwidth use a higher Category cable available which complies with the earthing and ground regularity
- The higher Category cable is Cat.7_A 1000 MHz
- The higher bandwidth specified cable is 1200 MHz (IEC 61156-7/8)
- Alien cross-talk is proven by design (x/FTP)
- Covered by IEC 61156-5, 7, 8 (ISO/IEC 11801 class F_A)
- Attenuation thermal coefficient 0.2%/^oC max
- Work area cable to comply with RJ45 connectivity

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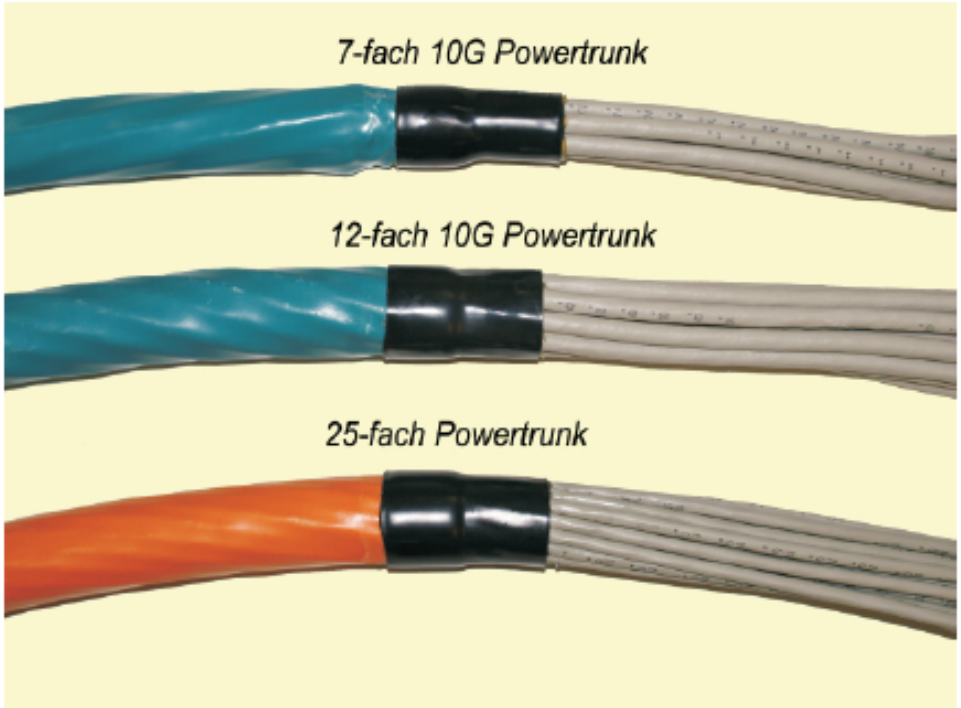
Bundled cables - a modern solution



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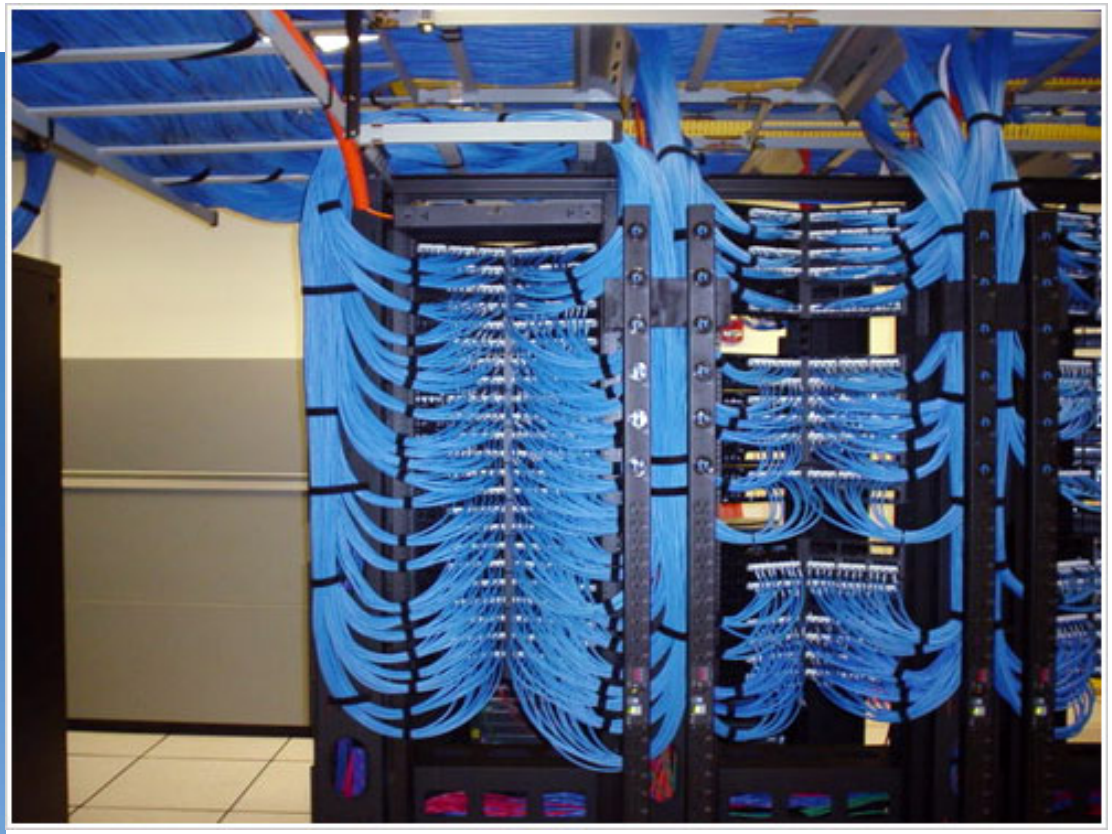
Cat.7_A Bundle cables - a modern solution

Use these “bundles” and then……

This nice installation will be easy to achieve



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Thank you for your time