Data Center Connection Design Technologies - Stop Doing What You are Told

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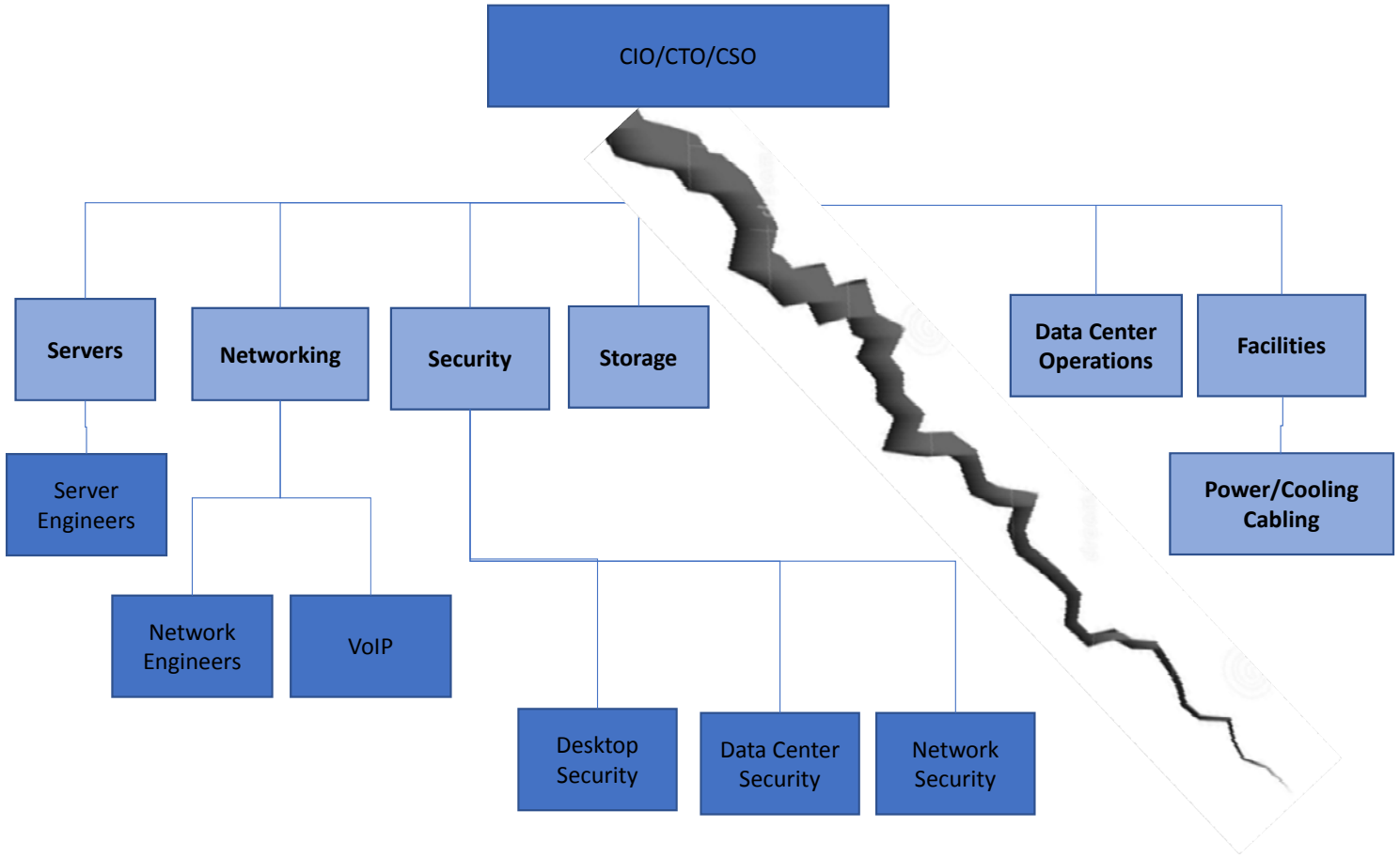
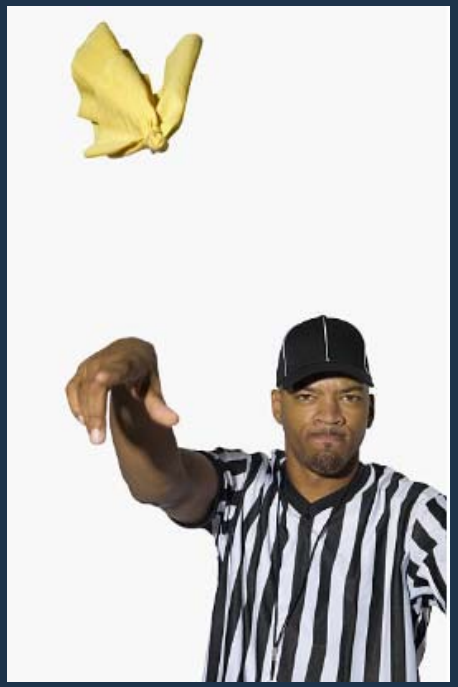
Background Info

- Review to some, new to others
- There is NO one size fits all
- There is NO one size fits all in a single site
- New data center types are coming online
  - Hyperscale
  - Edge
  - Core
  - Colo,
  - Etc.


CIO/CTO/CSO
Servers
Networking
Security
Storage
Data Center Operations
Facilities
Server Engineers
Power/Cooling Cabling
Network Engineers
VoIP
Desktop Security
Data Center Security
Network Security

Roll as a Facility Manager

- Referee
- Gatekeeper
- Babysitter
- Stepchild
- May have more responsibility than authority
- “I put in what I’m told”



What the Facility Manager Should Be

- Advocate
- Devil's Advocate
- Consultant
- Active participant

Outages

- Delta Cancels 280 Flights Due to IT Outage (Jan 2017) second outage in 6 months $170 M
- 150M from August outage
- More than 200 United Airlines flights were affected by an IT outage on January 29
- An outage at Southwest in July was estimated to have cost the airline at least $177 million
- JetBlue, United, BT, China Air

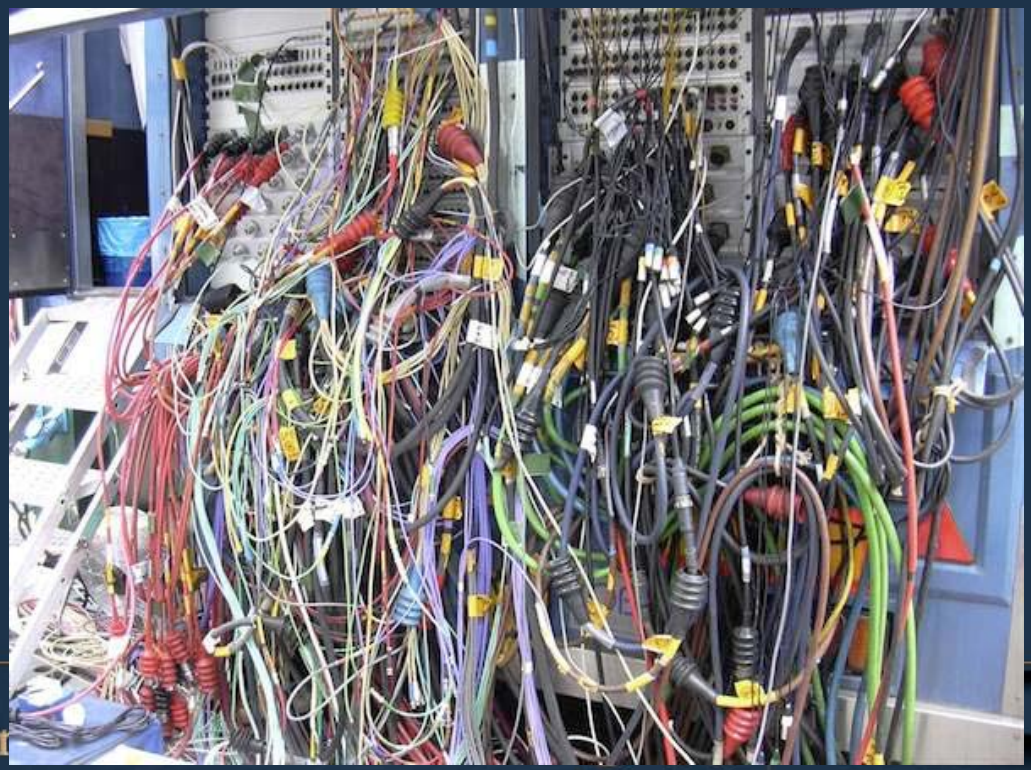
Outage Costs

- Tangible
- Intangible
- Average cost $730,000
- Highest reported cost in 2016 $2.4M

Downtime Costs

- Employee Salaries Weighted
- Revenue / Number of employees / Hours worked
- Costs to recuperate
- Costs to repair
- Damage control
- Reputation
- Overtime for personnel to fix and secure a site
- Time to triage the problem
- Time to update DR plans and test

STUPID HUMAN TRICKS

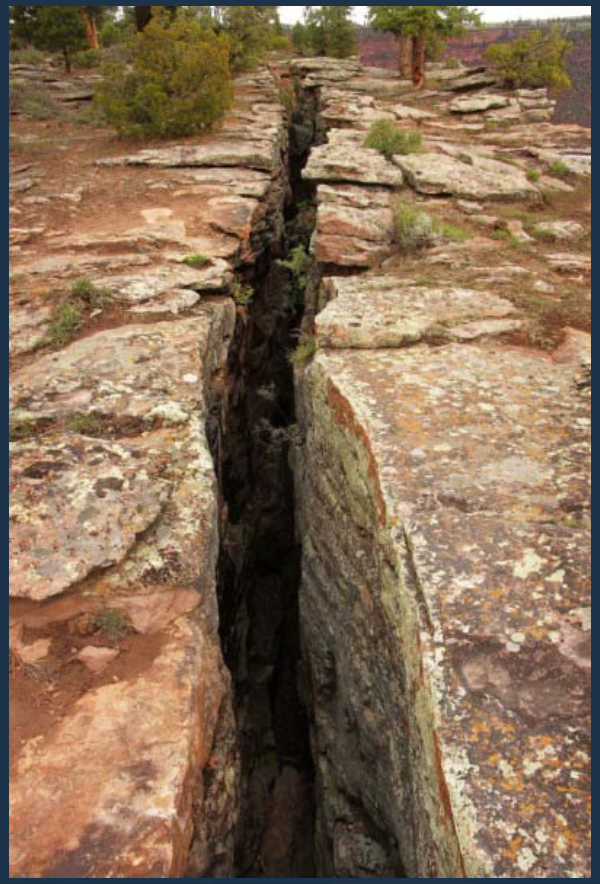


STUPID HUMAN TRICKS

Redundancy

Facilities

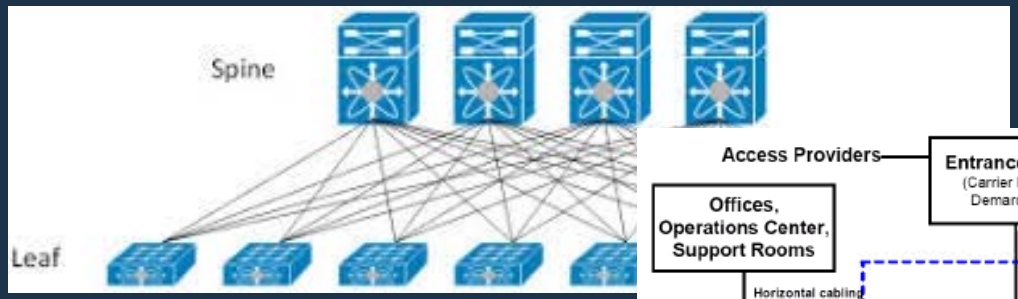
- UI
- BICSI
- TIA
- ISO
- IEEE
- Engineers

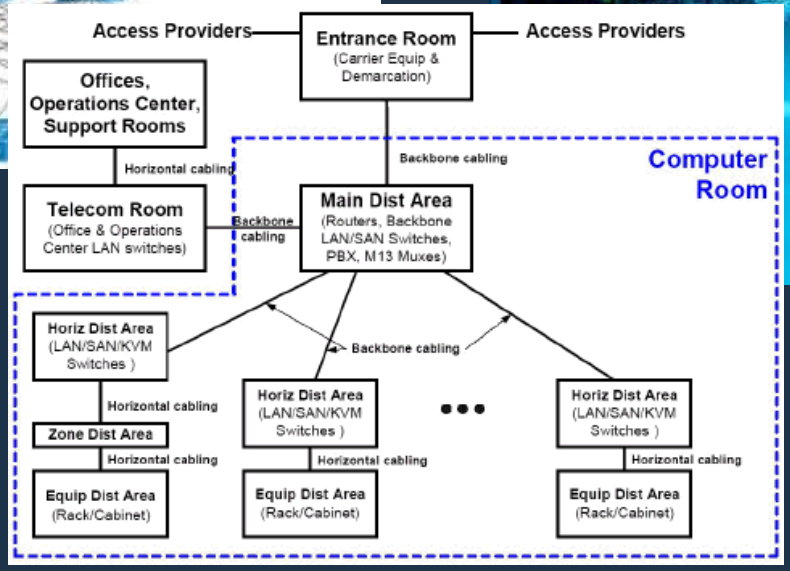


IT

- Software Fail over
- Hardware Failover
- Redundant data
- Virtualization

The Anatomy of a Data Center



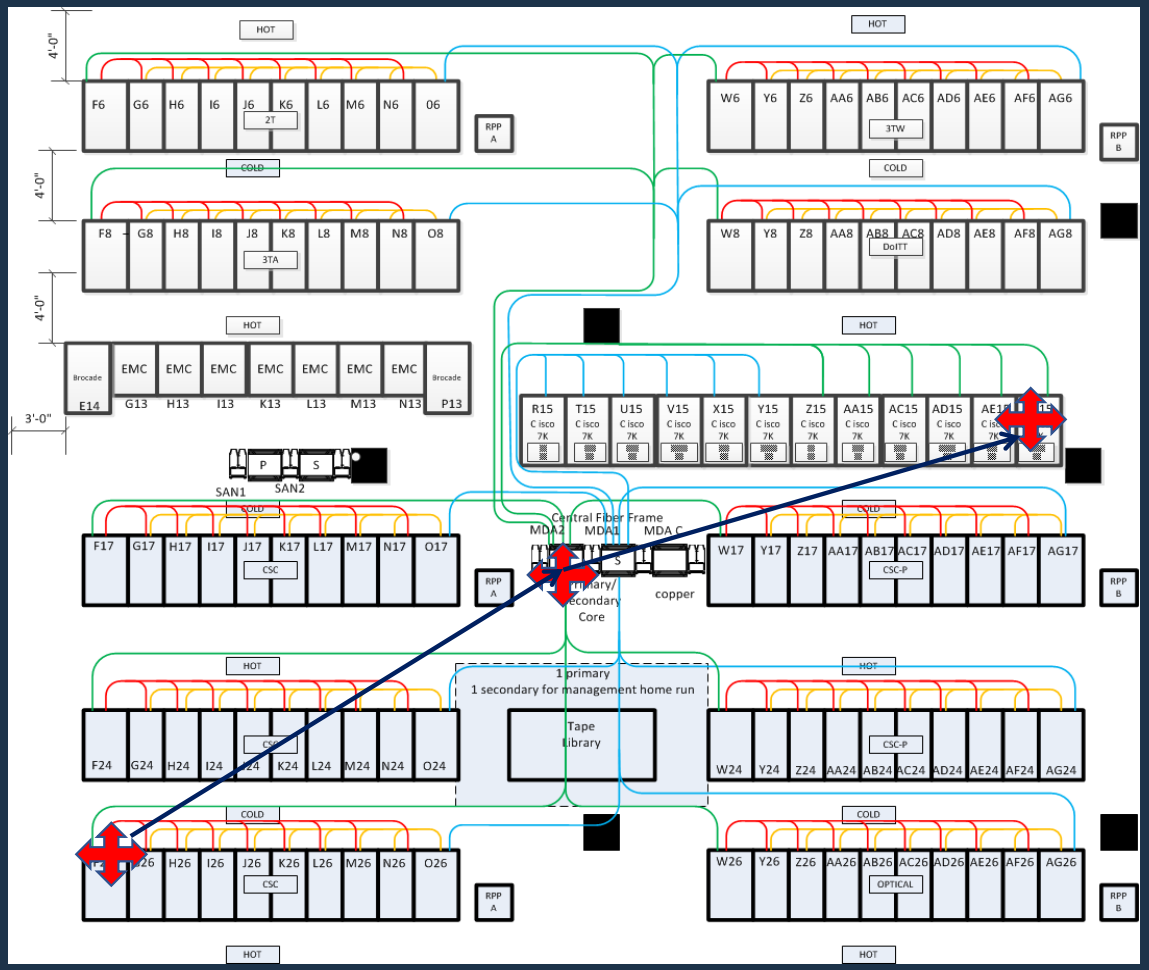


Impacts of the Pieces and Parts

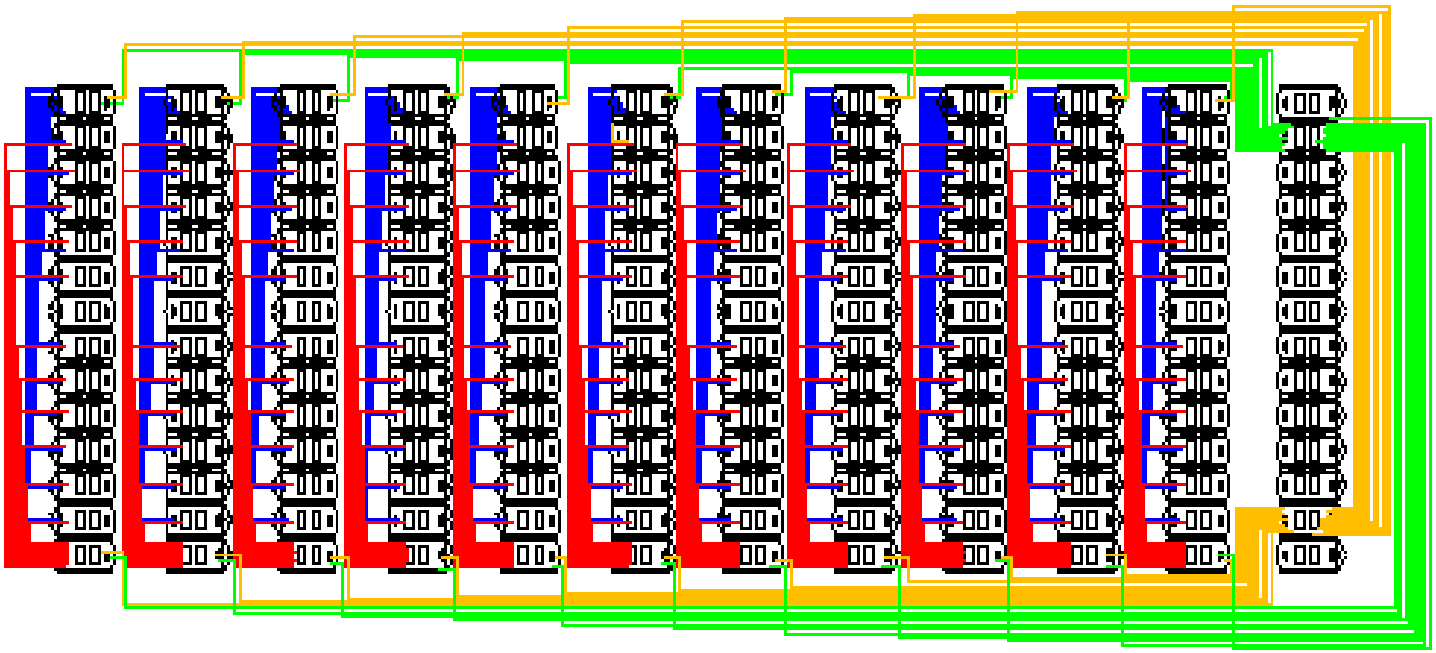
- Power
- Cooling
- Water
- Networking
- Servers
- Storage
- WAN
- Security
- Wireless (yes)
- Pathways and spaces

Budget
Lengths (Lengthonomics)
Locations
Influence
Operating Costs / Capital Costs
Maintenance

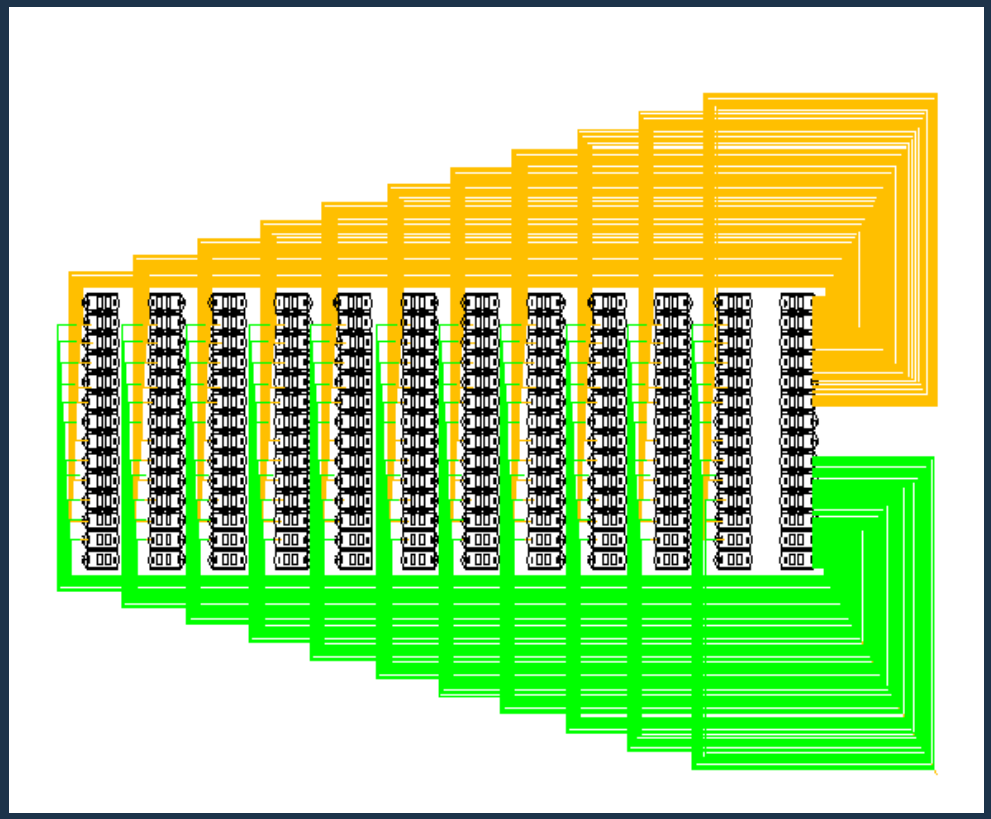
- Image courtesy of iDesign


HOT
4'-0"
F6 G6 H6 I6 J6 K6 L6 M6 N6 O6
2T
RPP A
COLD
W6 Y6 Z6 AA6 AB6 AC6 AD6 AE6 AF6 AG6
3TW
RPP B
F8 G8 H8 I8 J8 K8 L8 M8 N8 O8
3TA
W8 Y8 Z8 AA8 AB8 AC8 AD8 AE8 AF8 AG8
DoITT
Brocade E14 EMC G13 EMC H13 EMC I13 EMC K13 EMC L13 EMC M13 EMC N13 Brocade P13
3'-0"
R15 T15 U15 V15 X15 Y15 Z15 AA15 AC15 AD15
C isco 7K
P S
SAN1
SAN2
Central Fiber Frame
MDA2
MDA1
MDA C
F17 G17 H17 I17 J17 K17 L17 M17 N17 O17
CSC
W17 Y17 Z17 AA17 AB17 AC17 AD17 AE17 AF17 AG17
CSC-P
copper
Primary/
Secondary
Core
1 primary
1 secondary for management home run
Tape
library
F24 G24 H24 I24 J24 K24 L24 M24 N24 O24
W24 Y24 Z24 AA24 AB24 AC24 AD24 AE24 AF24 AG24
H26 I26 J26 K26 L26 M26 N26 O26
W26 Y26 Z26 AA26 AB26 AC26 AD26 AE26 AF26 AG26
OPTICAL

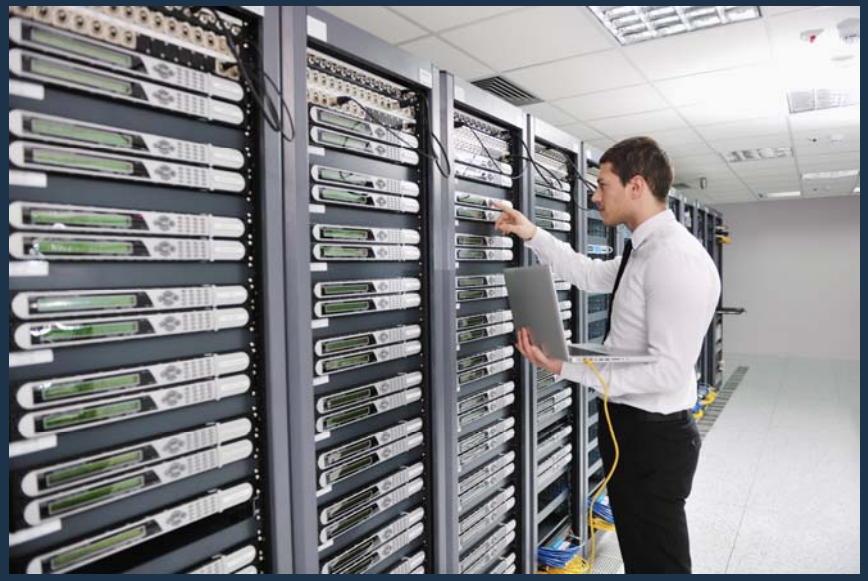
Fabric Layout with 10GBASE-T.....



Edge to Core is Essentially This



What the Server Team Sees



I NEED……..

Can I have this yesterday, please?

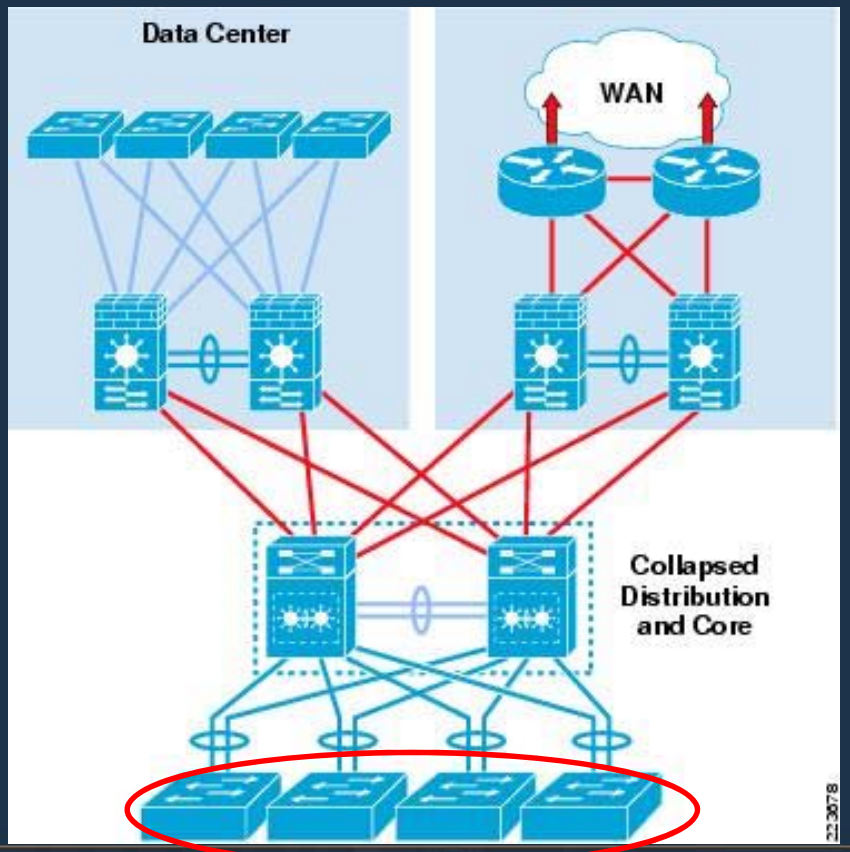
They think in terms of virtual machines and % of virtualization.

CPU Utilization sometimes…

Power consumption of servers…ish

Number of network ports, number of storage ports, number of power ports, number of management ports

What the Networking Team Sees



$44,402 Annual Power Cost

End of Row
- Fewer Switches
- Fewer uplink ports
- Lower power

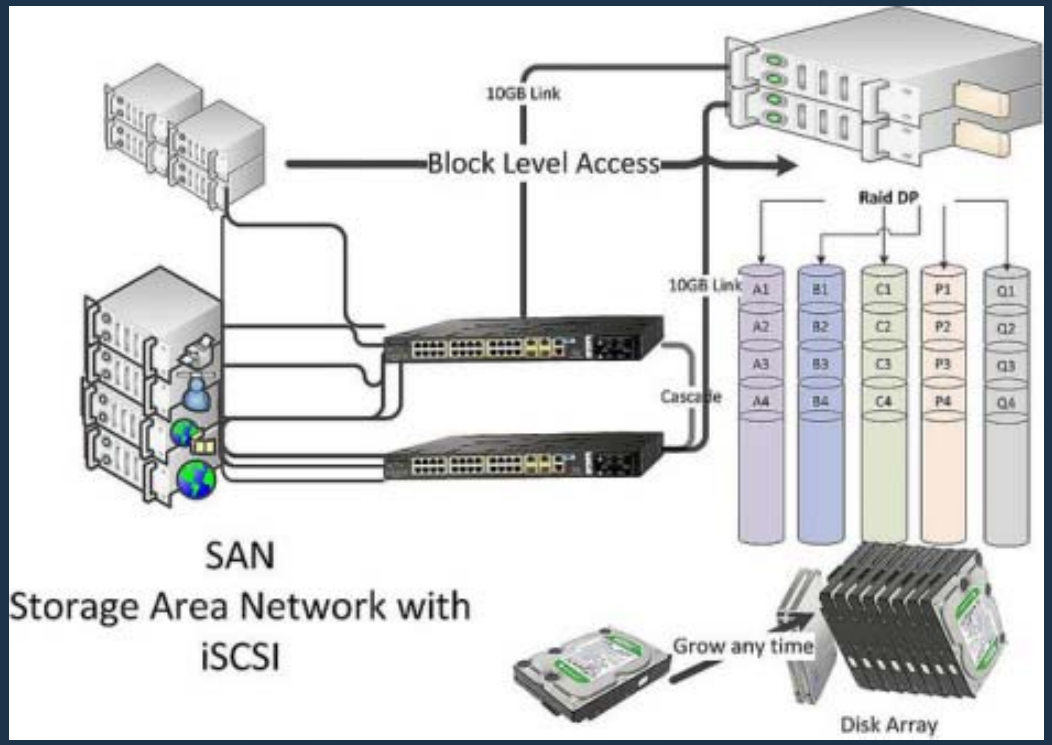
Purchased 12288 used 7680

$101,419 Annual Power Cost

Top of Rack
- More switches
- Probably more unused ports
- More uplinks
- More uplink switch ports
- More power

Purchased 4608 – used 4608

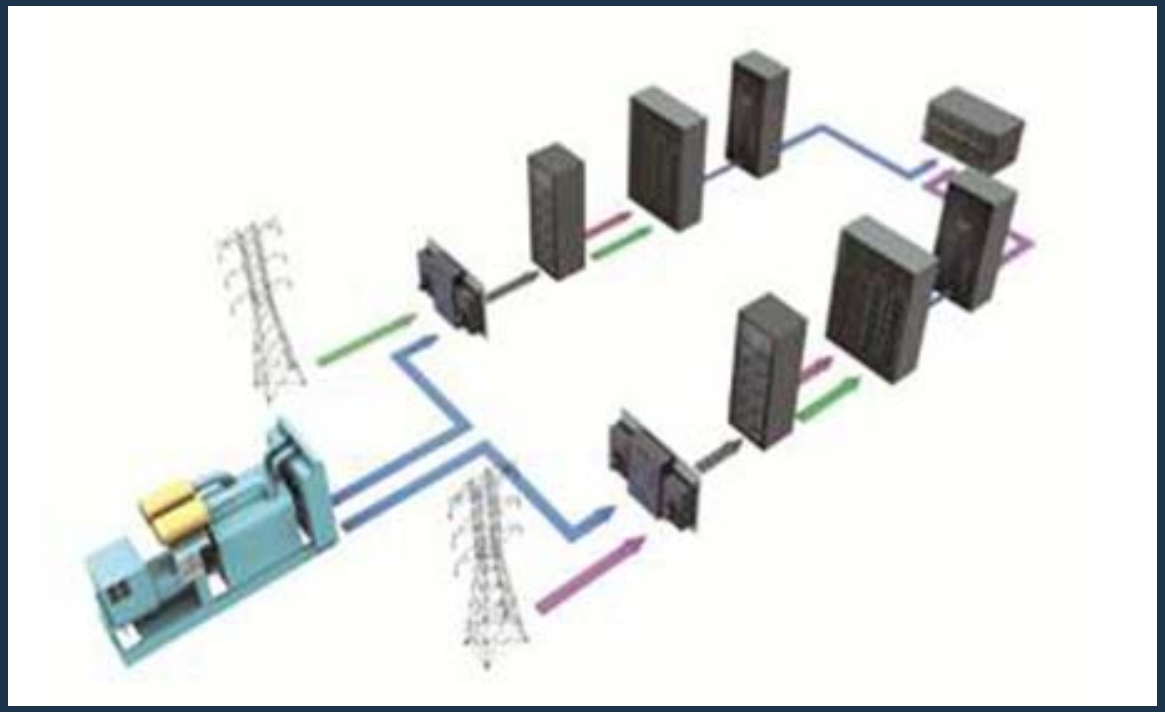
What the Storage Team Sees



Ports per server
Backup ports
Backups
Where it sits?
Deduplication strategy

Disks?
SSD?

What the Facilities Team Sees



2N

2N+1

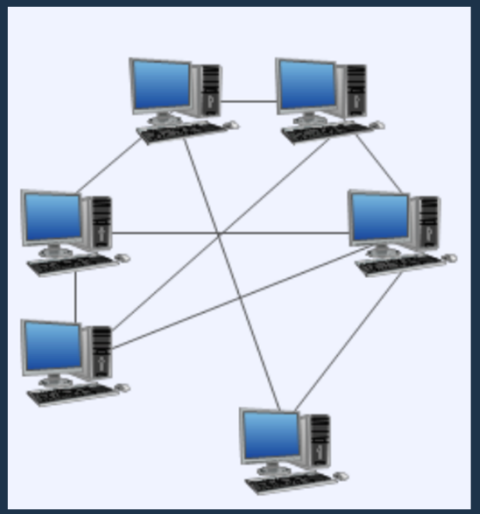
N+1

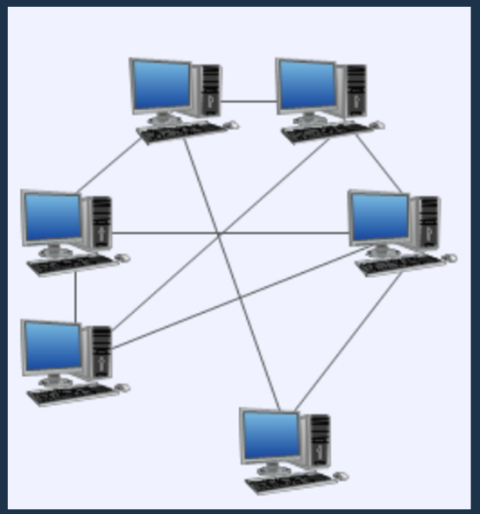
2N+2

N

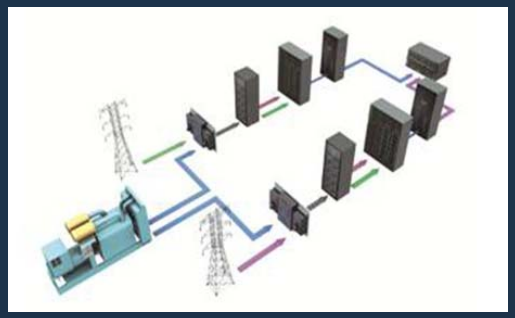
What an Application Sees

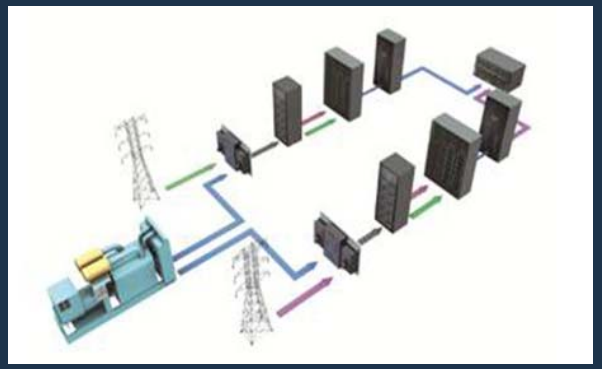
- Failover from Server to Server

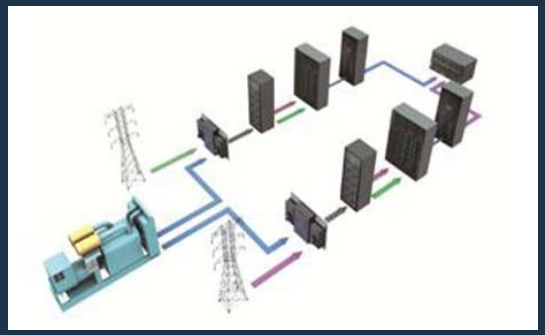


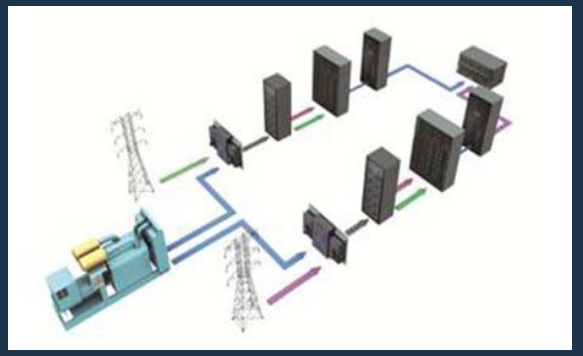


Multiple Sites with Failover



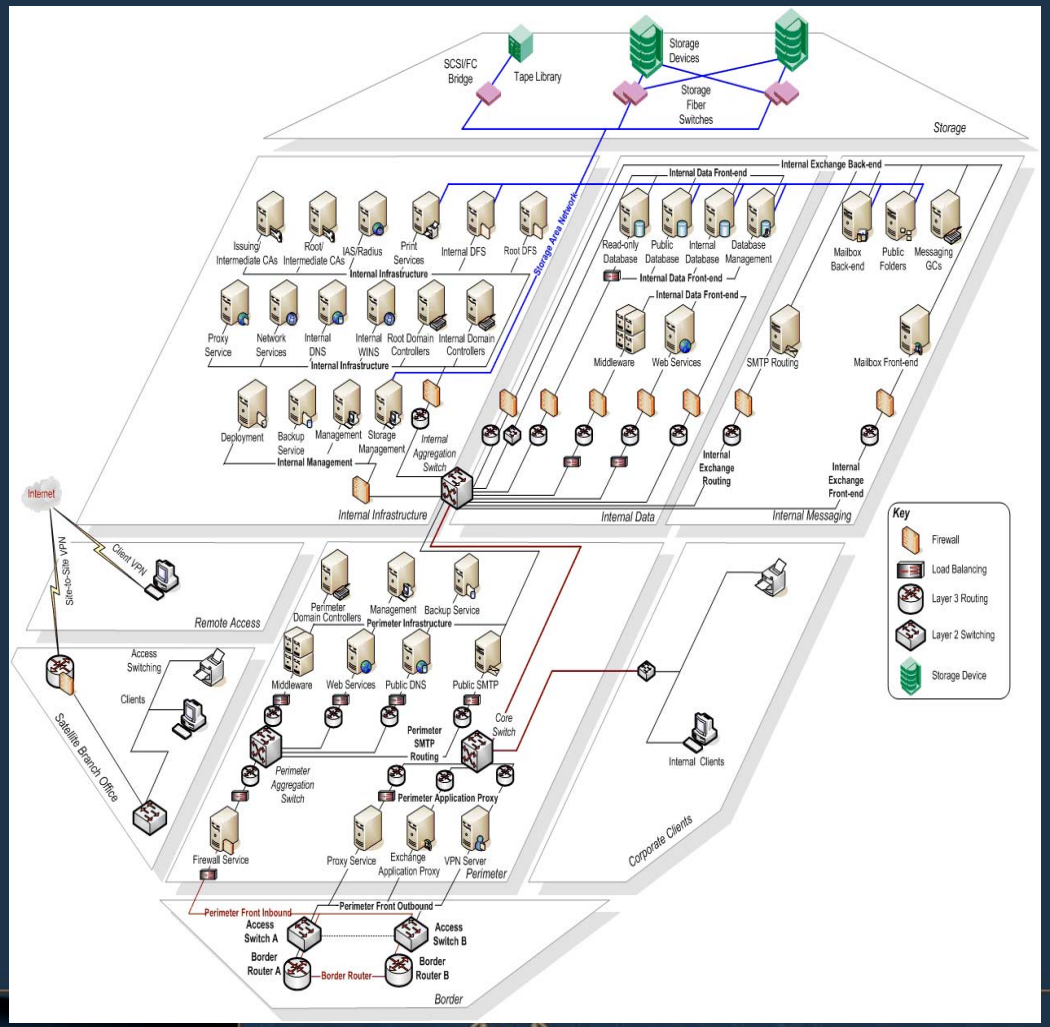


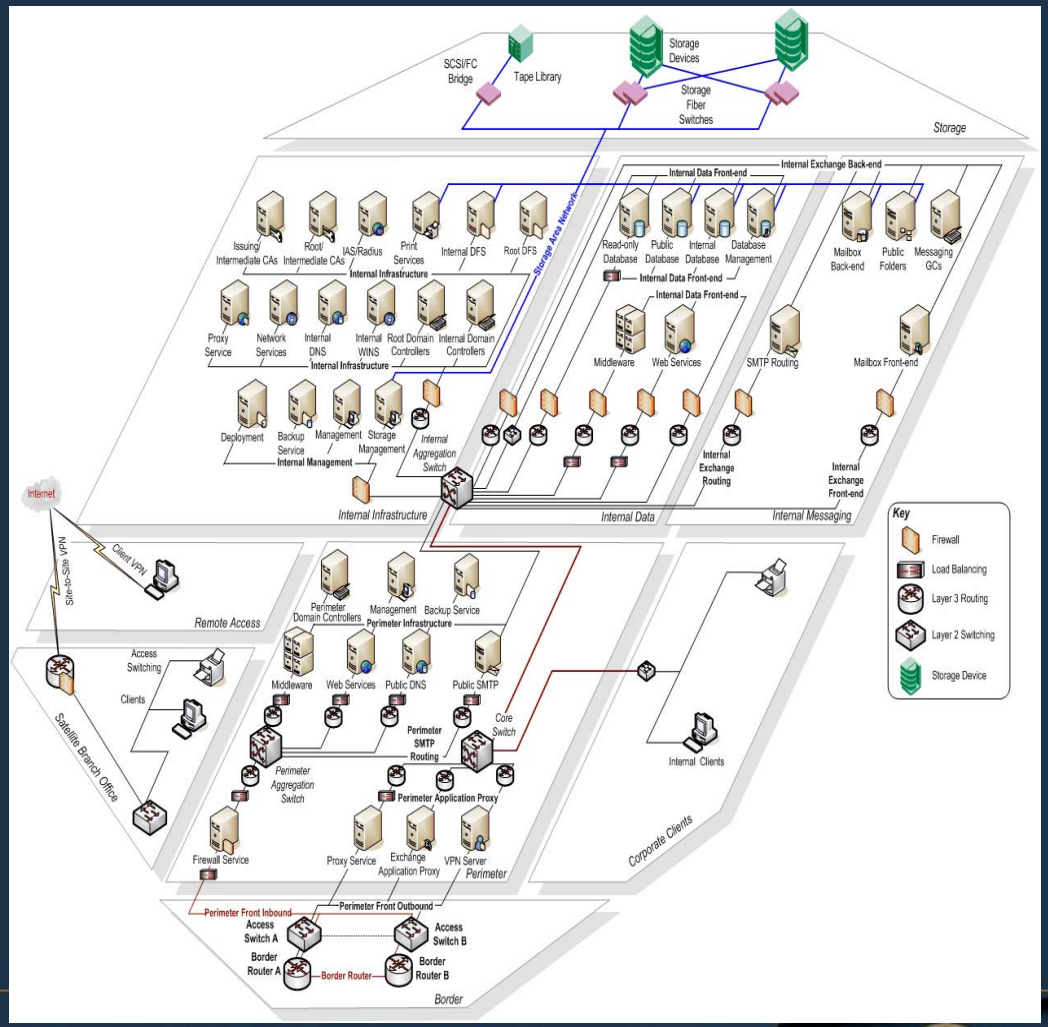




The Reality

- Every application needs hardware
- All hardware must live in the same space
- Hardware is connected to other hardware
- Hardware draws energy
- Silos lead to bad decisions


SCSI/FC Bridge
Tape Library
Storage Devices
Storage Fiber Switches
Storage
Storage Area Network
Internal Data Front-end
Internal Exchange Back-end
Issuing Intermediate CAs
Root/ Intermediate CAs
IAS/Radius
Print Services
Internal DFS
Root DFS
Internal Infrastructure
Read-only Database
Public Database
Internal Database
Database Management
Mailbox Back-end
Public Folders
Messaging GCs
Proxy Service
Network Services
Internal DNS
Internal WINS
Root Domain Controllers
Internal Domain Controllers
Middleware
Web Services
SMTP Routing
Mailbox Front-end
Deployment
Backup Service
Management
Storage Management
Internal Management
Internal Aggregation Switch
Internal Exchange Routing
Internal Exchange Front-end
Internet
Site-to-Site VPN
Client VPN
Remote Access
Perimeter Domain Controllers
Management
Backup Service
Perimeter Infrastructure
Access Switching
Clients
Satellite Branch Office
Middleware
Web Services
Public DNS
Public SMTP
Perimeter SMTP Routing
Core Switch
Perimeter Aggregation Switch
Perimeter Application Proxy
Internal Clients
Firewall Service
Proxy Service
Exchange Application Proxy
VPN Server
Perimeter
Corporate Clients
Perimeter Front Inbound
Perimeter Front Outbound
Access Switch A
Access Switch B
Border Router A
Border Router B
Border Router
Border
Key
Firewall
Load Balancing
Layer 3 Routing
Layer 2 Switching
Storage Device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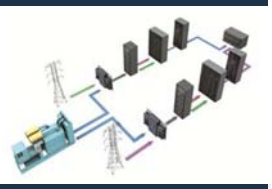
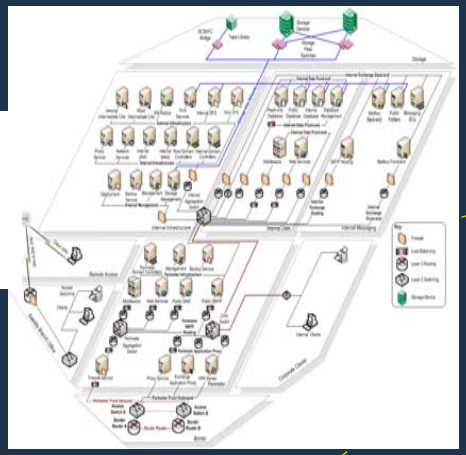
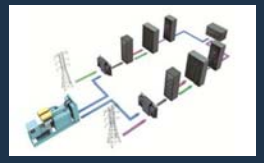
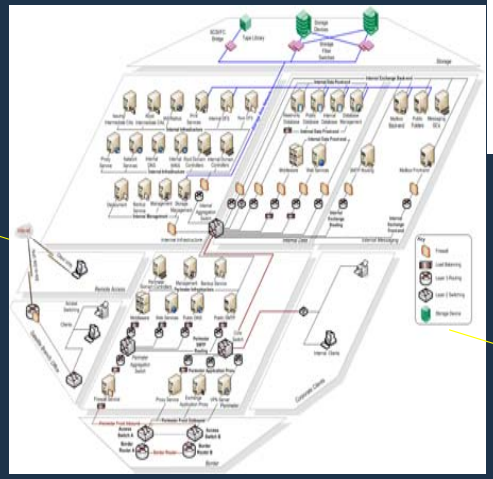




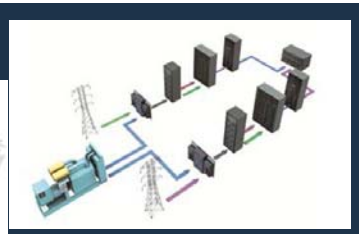
CHICAGO

DENVER

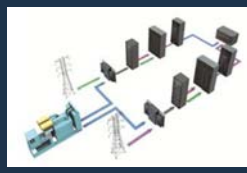




SAN JOSE

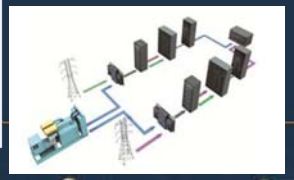


HONG KONG

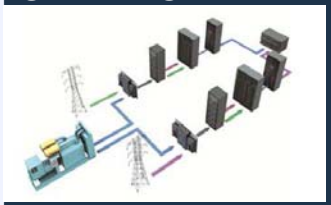


NEW YORK

JACKSON



ORLANDO



When Applications Fail Over One Server to One Server

- Each Application is Backed by
  - 4 Network Connections
  - 4 Power supplies
  - 4 Storage Connections
  - Mirrored Management Connections

Costs

- Tier IV is higher than other tiers by a significant margin
- Cost per square foot rental is higher in upper tier data centers
- Large market of people that are willing to co-op their extra DC space
- Purpose is important
- New tax laws make OPEX less of a benefit
- Power and stranded power are a continuous problem
- The cost of a server doubles in 18 months due to power costs

Tangible Costs

- Additional Network Ports
- Additional Switches
- Addition PDUs
- Increased Cooling Demand
- Additional Power
- Additional Additional UPS capacity
- Increased Generator requirement

What are We Really Supporting in a DC?

- Applications for Business
- Business Data

Time to Step Back

- What do you really need?
- Who is making the decision
- 5-Why's
- Stop making decisions in a vacuum
- Top down matters
- Real estate may not understand DC contracts or needs

How do Colo Contracts Get Negotiated?

- Needs during the contract period
  - Facilities
  - IT
  - Finance
  - Real Estate
  - Brokers

New Accounting Rules

- Beginning in 2019 Lease costs must be reported on the balance sheet.
- This includes operational costs (OPEX) lease costs.
- Expected to have a $3 Trillion impact on balance sheets alone
- Likely to change colocation lease agreements

Surprises

- New rules require you to disclose the full lease obligation regardless of the amount of capacity that you use.

- Ramp up periods don’t matter

A Better Measure….

- Start at the application
- Understand that all applications are NOT alike
- All applications will not have the same needs

IT Factors to Consider

- Connectivity
- Waste
  - kW per cabinet
  - Reach of connections
- Lifecycle
- Location
  - More applications to the cloud
- Software defined EVERYTHING

Healthier Way to Start

- Application
- Redundancy
- Server
- Network
- Power

Application

- Risk – What happens if it goes down?
- How to mitigate that risk?
  - Additional Server
  - Failover
  - Site to site failover
  - Manual
  - Edge
  - Additional Communication Lines
  - Cloud
- What is necessary to keep it running?

Risk Level Things to Calculate

- Catastrophic Failure to low risk
- Time to recover
- Time to repair
- Security risks
- Job risks
- Power
- Cooling
- Building

Server Cost Multiplier

- Cost of server (hardware and virtual)
- Cost of software and licenses
- Cost of network ports
- Cost of power ports
- Cost of storage ports
- Allocated cost of switches
- Allocated cost of storage
- Allocated Security
- Cost of power
- Building capital, rent and leases

Who to Involve

- IT
- Department Heads
- CIO/CTO/CDO
- Security
- CEO – Top down is key

IT Resources

- Ethernet Alliance
- IEEE
- FCIA (Fibre Channel Industry Association)
- Peers
- MOOC

Strategies for Evaluating Different Solutions

- You don’t have to know it all
- You do have to make your vendors work for you
- Sole sourcing can be dangerous
- Purpose built solutions can hinder growth and be expensive
- Be wary of solutions where you have to throw the baby out with the bath water

Why Use ”Or Equal”

- Allows substitution of like products
- Allows alternate vendors and integrators to respond
- Opens the specification for greater competitive bidding
- Many consultants see this as their “value add”
- Perceived as an equalizer
- Stops sole sourcing
- Is greatly ignored (lip service)

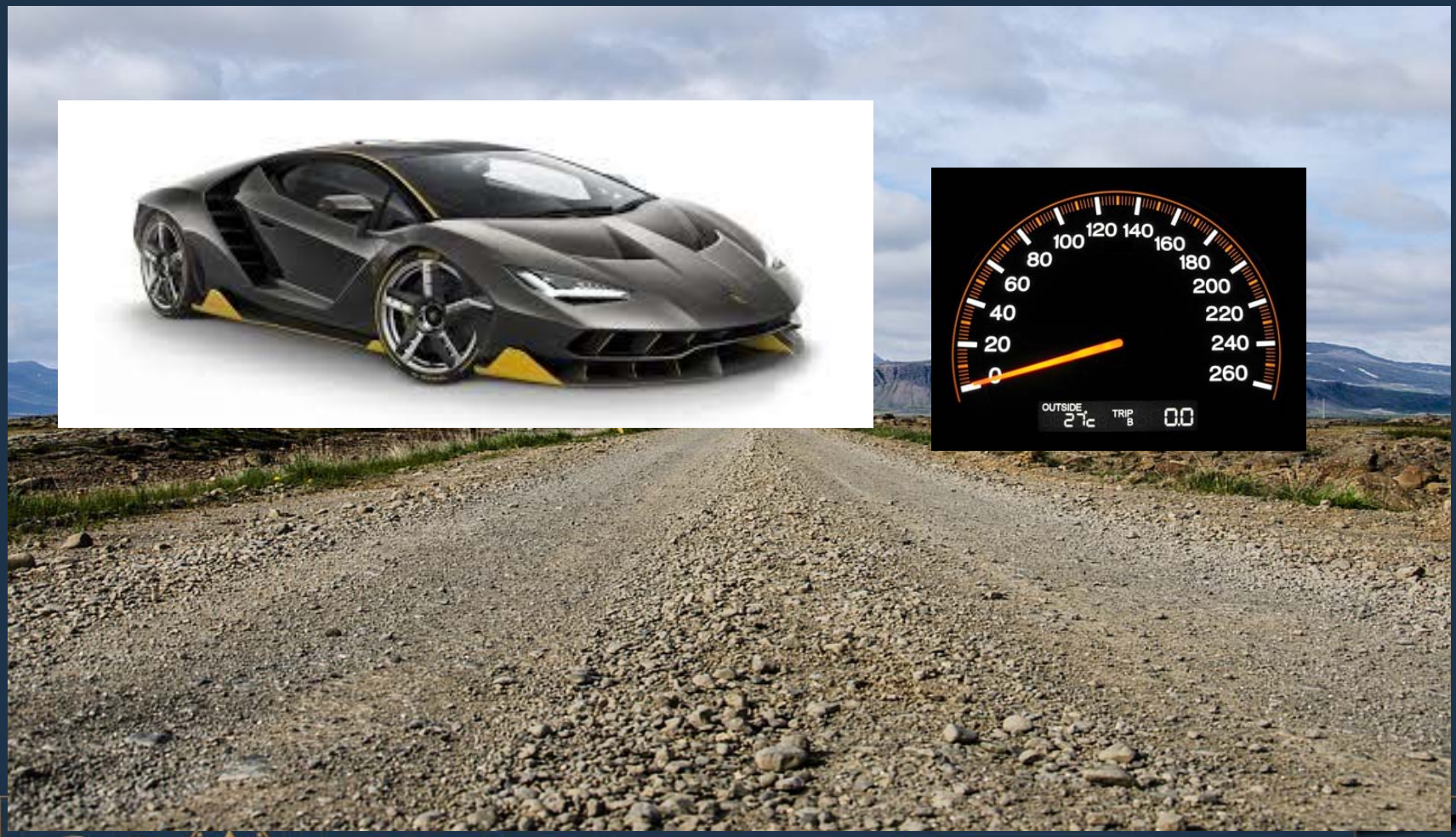
What Exactly is “Or Equal” Technology

- All products have some unique feature
- All vendors have support personnel
- A balanced scorecard can provide a better means of evaluation
- Understand the value of the unique features

- If it’s standards compliant, it’s standards compliant!
- Features are nice buy only if they really do something

Unique Features

- What is the value of the feature?
  - Is it a nice to have? Or is it a must have?
  - Is it used to circumvent fair and equal bidding?
- Do you have a full understanding of this feature?
- Could you evaluate bids based on this feature?
- Can IT fully articulate this feature?
- Has it been vetted?


0
20
40
60
80
100
120
140
160
180
200
220
240
260
OUTSIDE
27c
TRIP
B
0.0

Selective Text…Examples

- Lower Power consumption
  - Is this true for the entire communication chain or is it just one port?
  - Is this a constant feature or only during certain conditions?
  - Is this claim independently verified?
  - Does it matter?
  - Can something else do it better?

Mom, can I have a huge bowl of ice cream smothered in chocolate?

Anatomy of a Ball

- Part of the UEFA Champions League Collection 1:1 take down in color and panel design from the Official Match Ball
- Machine stitched construction and internal nylon wound carcass for maximum durability and long-lasting performance
- Butyl bladder for best air retention to keep the ball's shape and stay inflated longer, and Special TPU exterior material is designed to resist abrasion and last longer
- 2016 colors have revolutionary tonal printing on ball for extra pop and style
- Size 3 ball suggested for ages 8 and under; size 4 ball suggested for ages 8-12; size 5 ball (official size) suggested for ages 12+. Size 1 is a mini ball. Check with your local league for size requirements.

Is This Ball Better?

- Alternating dark and light color scheme allows you to see ball better when it rolls around the pitch or comes at you in the air
- Butyl bladder of 380-420g inside keeps everything together and inflated properly
- Ball comes in size 5 for ages 12 and above
- Exterior is made of 2.5 mm PVC which resists abrasion and makes the ball more durable
- Machine stitching keeps the panels together on this typical soccer ball and give a soft feel

What About This One?

- 32-panel design for durability.
- Machine-stitched TPU casing for consistent play.
- High-contrast graphics for easier visual tracking.
- Reinforced butyl bladder increases the speed off the foot and enhances air and shape retention.
- 60% RUBBER 15% POLYURETHANE 13% POLYESTER 12% EVA

What Technical Specs

- 12 to 20 panels some premium-grade 32-panel balls
- The ball's panel pairs are stitched along the edge; manually or by machine
- The size of a football is roughly 22 cm (8.65 inches) in diameter
- The ball's weight must be in the range of 410 to 450 grams (14 to 16 oz) and inflated to a pressure of between 0.6 and 1.1

What Actually Matters?

- Quality of the ball
- Color of the ball
- Stitched construction
- Material of the ball
- Use case

$184.00

$12.79

$43.00

How many balls are there?

- 119,864 on Amazon®
- Which specification matters?
- Which parameter matters?
- If someone's bid says they meet that spec can you verify it?
- And the biggest question…..Can you trust your experts to know the difference?

What do standards provide?

- Least common denominator
- Fair and impartial
  - Compliant
  - Compatible
- In IT they are pretty much the law
- IEEE, TIA, ISO/IEC, ANSI/TIA/EIA, FCIA
- COMPLIANCE IS KEY!

What does Compliant Mean?

- Means that the product complies to all requirements of the standard
- Products can exceed, but should at minimum comply
- Proprietary products won't be compliant, but may be beneficial
- Interoperability (or lack thereof) introduces risk

Exceeding the Standards

- New materials for longer channels
- Tranceivers
- Extenders
- More centralized switch locations (yes we used to)

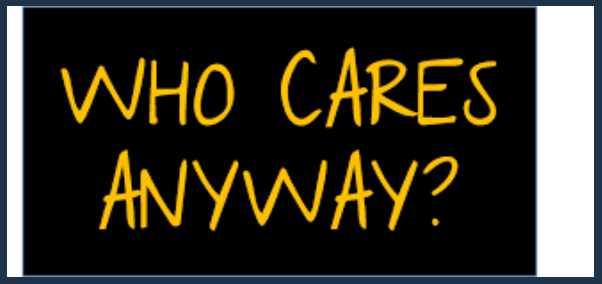
Option A GameChanger	Option B Cat6 with Port Extenders	Option C With Extenders & Transceivers	Option C Without Transceivers
$22,305	$104,525	$126,170	$116,934

Vendor Backstories are Telling

- Do they create standards compliant products?
- Can your IT department defend why they have to have a non-compliant product?
- Do you purchase the standards to know what they contain?
- Do you ask for interoperability testing?
- Do you test yourself?
- Will they help with testing?

What You Should Ask IT

- Why does this spec matter?
- What will the “or equal” statement do to this bid?
- What parameter is a competitor not likely to be able to match?
- Why is that specific parameter important?
  - Don’t let them blow smoke
- What would happen if that couldn’t happen?



Understanding the Supply Chain

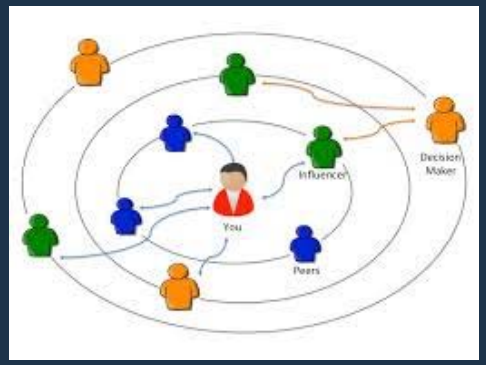
- Who manufactures the product?
- Trends are towards outsourced/contract manufacturing
  - Less expensive
  - Controls are in place to assure quality
  - Tax breaks for various world regions
- REBATES
- Who is influencing the decisions on your end?
- Relationships

Set Up Vendor Interviews

- Gut check and fact check
- Understand the difference between belief and reality
- Nice to have is not necessary
- Ask for alternates to your idea!

Sphere of Influence

- Who touches the product?
- What is the difference between a sourcing distributor and a stocking distributor?
- What processes are in place to assure stock?
- What is the alternative brand if stock is not available?
- What is the availability of the alternative brand?
- Did you get bids on that brand?
- Is it in fact ”or equal?”



Who do you ACTUALLY pay?

- Understand mark-up
- Is it worth adding another vendor?
- Find the right test
  - Dollar to donuts so to speak
  - It is worth it if it saves xxxxx
- Hard specifications often carry higher pricing
- Social consciousness

What is the Real Value?

- Understand what is in every dollar
- Do you need the $184 ball, or would it be just as good to kick the $12.99 one?
- Is the value perceived or tangible?
- Who will use the ball?
- What is the expected life of the ball?
- Are features necessary or “want to”
- Ask yourself, “If I could keep 10% of the savings, would it be worth it?”

Buying a Soccer Ball

- ✓ Ball is manufactured by xyz
- ✓ Sold to store A
- ✓ Store A has a storefront on site B
- ✓ Site B collects sellers fees and advertising fees
- ✓ Site B maintains stock (some risk)
- ✓ Site B makes it easy to find the ball (convenience)
- ✓ Site B provides a front end order entry/payment processing service
- ✓ Would you wait a day or two to save?

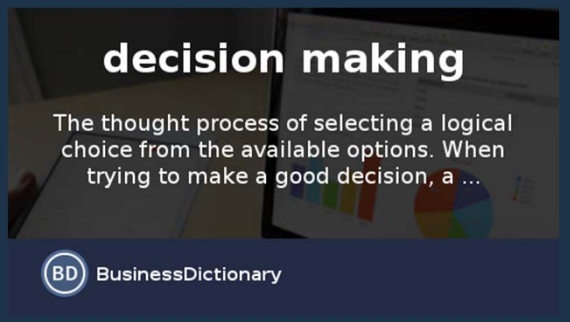
Should You Buy From A or B?

- What is the convenience worth to you?
- What if they can't meet delivery?
- What if it arrives and is damaged?
- Who resolves the complaint?
- Would holding some stock at our own place be cost effective?
- *If you wait until the last minute you limit your options!*

Top Tips

- Create a score card
  - Use it for bid evaluation
  - Use it as follow up evaluation
  - Before, during and most importantly
- AFTER
  - **How did they support the team?**
  - **How did they support the business needs?**
  - **Were their claims true?**
  - **Did they follow through?**

Procurement Specific

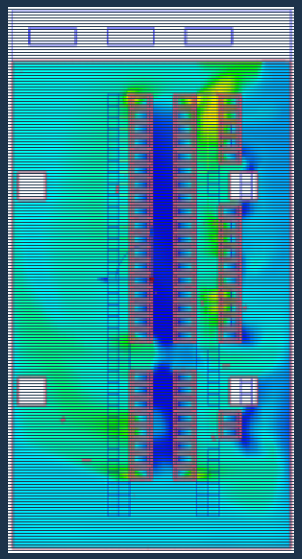


- No one is an expert at everything
- People hate change
- Who are you to question my decision?

Steps for success…

- Do an RFI first!
- Tell your vendor it will be an open spec
- Encourage options
- Have vendor interviews
- Ask one vendor about features of others
- Ask how they go to market
- Ask if they provide direct pricing
- Ask independents for help

In a Perfect Data Center World…



- Budget Silos would not exist
- Reconfigurations would not be required
- Updates would not be required
- Decommissioning/Commissioning would be easier
- Vendors would cooperate
- Open systems would reign
- Vendor Lock-in would not exist
- Power and cooling would be easier to manage
- Vendors would have your best interests at heart
- The data center floor would remain stable

Understanding the Data Center Ecosystem

- Data Centers Include
  - Power
  - Cooling
  - Cable plant
  - Servers
  - Switches
  - SAN/storage
  - Wide Area
  - Overall room systems/monitoring
  - Miscellaneous systems

Why do we care?

- The data center is an ecosystem
- The more equipment we add, the more power we consume
- The more power we distribute, the more losses we have
- The more power we consume, the more cooling we need
- The more cooling we need the more power we need
- The more power we need the more $$$$$$
- Power is about 50% of the data center ongoing costs

Things That Impact Power

- Number of powered devices
- Number of redundant connections
- Air movement
- AC versus DC
- Stranded/phantom power
- Room arrangement
- Equipment arrangements
- Allocations (may not be the same across the DC)

Rated/Tier

Rating/Tier* Level

ANSI/TIA-942 describes four Rating/Tier* levels in which data centers can be classified. Below is the high level description of each Rating/Tier* level. Detailed specifications are given in the ANSI/TIA-942 standard.

- **Rated-1/Tier-1*: Basic Site Infrastructure**
  A data center which has single capacity components and a single, non-redundant distribution path serving the computer equipment. It has limited protection against physical events.

- **Rated-2/Tier-2*: Redundant Capacity Component Site Infrastructure**
  A data center which has redundant capacity components and a single, non-redundant distribution path serving the computer equipment. It has improved protection against physical events.

- **Rated-3/Tier-3*: Concurrently Maintainable Site Infrastructure**
  A data center which has redundant capacity components and multiple independent distribution paths serving the computer equipment. Typically, only one distribution path serves the computer equipment at any time. The site is concurrently maintainable which means that each and every capacity component including elements which are part of the distribution path, can be removed/replaced/serviced on a planned basis without disrupting the ICT capabilities to the End-User. It has protection against most physical events.

- **Rated-4/Tier-4*: Fault Tolerant Site Infrastructure**
  A data center which has redundant capacity components and multiple independent distribution paths serving the computer equipment which all are active. The data center allows concurrent maintainability and one (1) fault anywhere in the installation without causing downtime. It has protection against almost all physical events.

What's Wrong with Redundancy

- Address critical facilities and paths
  - Power
  - Cooling
  - Transfer Switches
- Addresses some level of uptime expectation
- Ignores circuits for IT
- Ignores the application and failover expectations
- Ignores the IT side of things

Data Center Power

- Don’t assume that teams will select the most power conscious equipment
- Challenge what you see
- Be a smarter consumer

- AVOID CAPACITY PROBLEMS THROUGH UNDERSTANDING

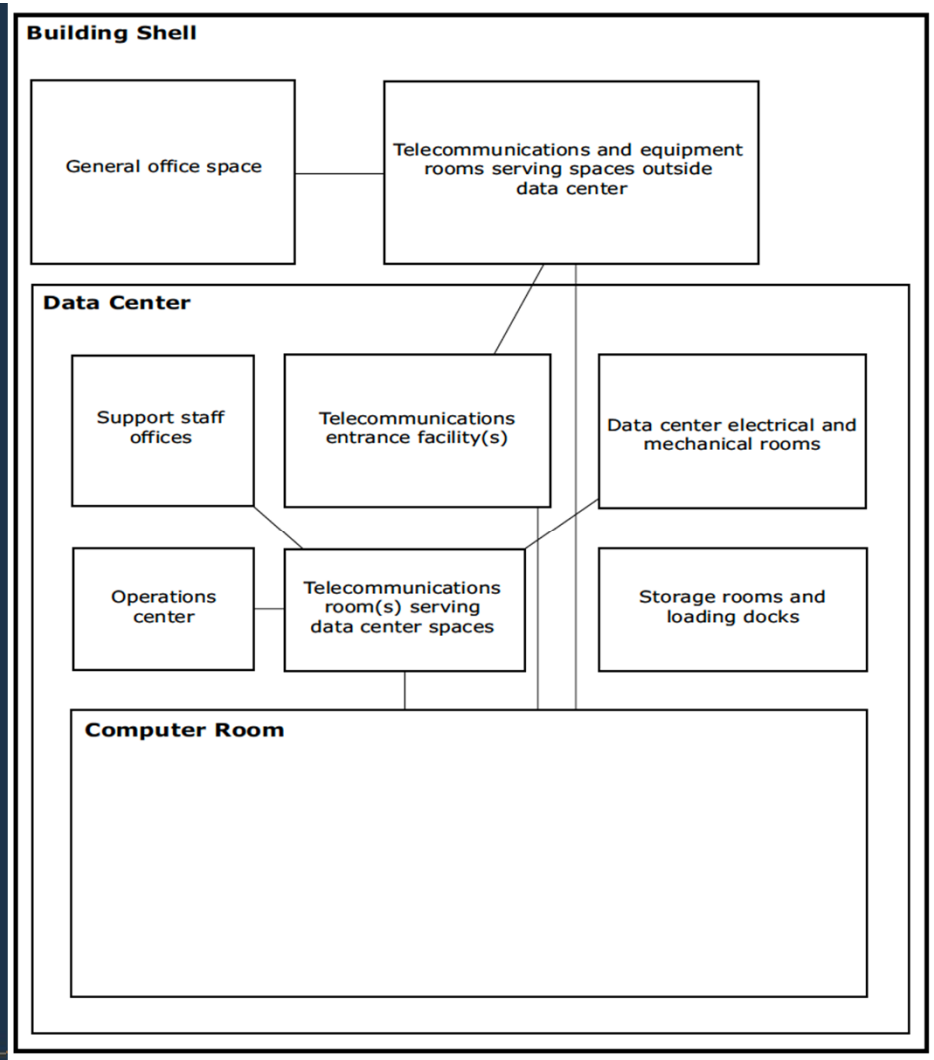
Support Systems – Where they Come Into Play

- Mechanical
- Electrical
- Plumbing
- Telecommunications
- Security
- Management
- Maintenance

Key Design Elements

- Redundancy (don’t be overly redundant)
- Technology Strategy
- Racks and Cabinets
- Cabling- note Cabling is NOT the enemy
- Room limitations/size
- Capacity (Electrical and Cooling)
- Pathways
- Suppression systems/Fire systems / Alarms

Pieces and Parts

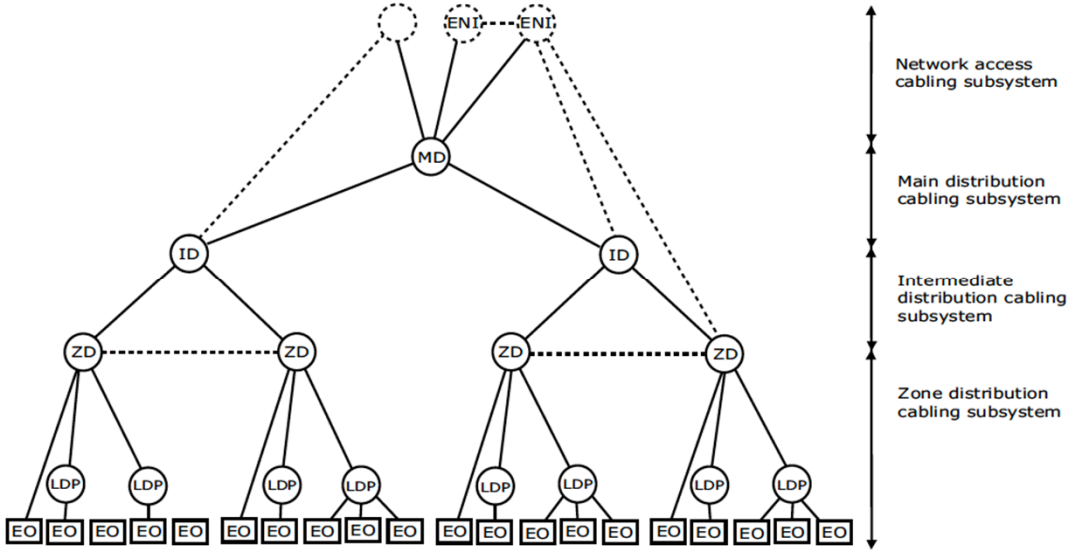


ISO/IEC
TIA Similar

Structured Cabling Hierarchy for Data Centers, continued

Figure 18.2 shows the CENELEC EN 50173-5 and ISO/IEC 24764 hierarchical structure.

Figure 18.2
Hierarchical structure of a data center from CENELEC EN 50173-5 and ISO/IEC 24764



---------- = Optional cabling
EN = European norm
ENI = External network interface
EO = Equipment outlet
ID = Intermediate distributor
LDP = Local distribution point
MD = Main distributor
ZD = Zone distributor

- Image courtesy of iDesign

Facilities

Networking

Procurement

Vendors

Security

CIO/CTO

Standards and Code Bodies

• ANSI/TIA/EIA	North American standards
• ISO/IEC	International standards
• IEEE	Electronics standards
• BICSI	Standards and best practices
• NEC	National Electrical Code
• NFPA	Fire Codes

Consortiums and .orgs

- BacNet.org
- ASHRAE
- Modbus.org
- ISOC, IAB, IESG, IETF, IRSG, IRTF

New Standards

- https://beyondstandards.ieee.org
  - Full section on IoT
  - Connected vehicles
  - Industry publications

Why It's Helpful

- Showcasing new standards applications in the marketplace
- Featuring new and emerging technologies
- Highlight innovative new areas of standards development
- Celebrate innovators and disruptors who collaborate to advance standards and technology
- Encourage participation in standards development
- Events and educational opportunities

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- eHealth
- Event
- Green Tech
- Humanitarian Efforts
- IoT
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- Open Source
- Power and Energy
- Privacy
- Robotics
- Semiconductors
- Sensors
- Smart Cities
- Smart Home
- Software Define Network
- Standards University
- Tech Ethics
- Virtual Reality
- Wearables

2018 Roadmap

February 27| 2018

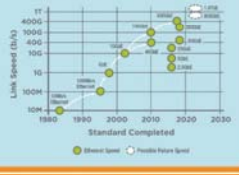
NEXT ETHERNET ERA

ethernet alliance

2018 ETHERNET ROADMAP

THE PAST, PRESENT AND FUTURE OF ETHERNET

ETHERNET SPEEDS



NEXT ETHERNET EA

ethernet alliance

www.ethernetalliance.org

Designed by Scott Kipp and John D'Ambrosia

$9.95

INTEROPERABILITY AND CERTIFICATION

The Ethernet Alliance is committed to leading the charge to instilling industry confidence in Ethernet standards through its multivendor interoperability demonstrations and plugfests. Our PoE Certification Program takes this mission to the next level!

Our industry-defined PoE Certification Test Plan is based on the Ethernet PoE standard, and products passing this test will be granted the Ethernet Alliance PoE Certification Logo. This logo will provide instant recognition for products that based on the IEEE 802.3 PoE standard, and provide confidence in the multi-vendor interoperability of those products bearing it. The logos will also provide clear guidance on which devices will work with each other.

The first generation of the program certifies Type 1 and Type 2 products that use 2-Pair of wires. The second generation of the program will tackle the forthcoming IEEE 802.3bt PoE standard. This table explains the capabilities of the Types.

PoE Types and Classes	2-Pair PoE = Type 1				4-Pair PoE = Type 2			
Class	0	1	2	3	4	5	6	7	8
PSE Power (W)	15.4	4	7	15.4	30	45	60	75	90
PD Power (W)	12	3.84	6.49	12	25.5	40	51	62	71.3
	4-Pair PoE-Type 3							4-Pair PoE Type 4	

EA Certified™

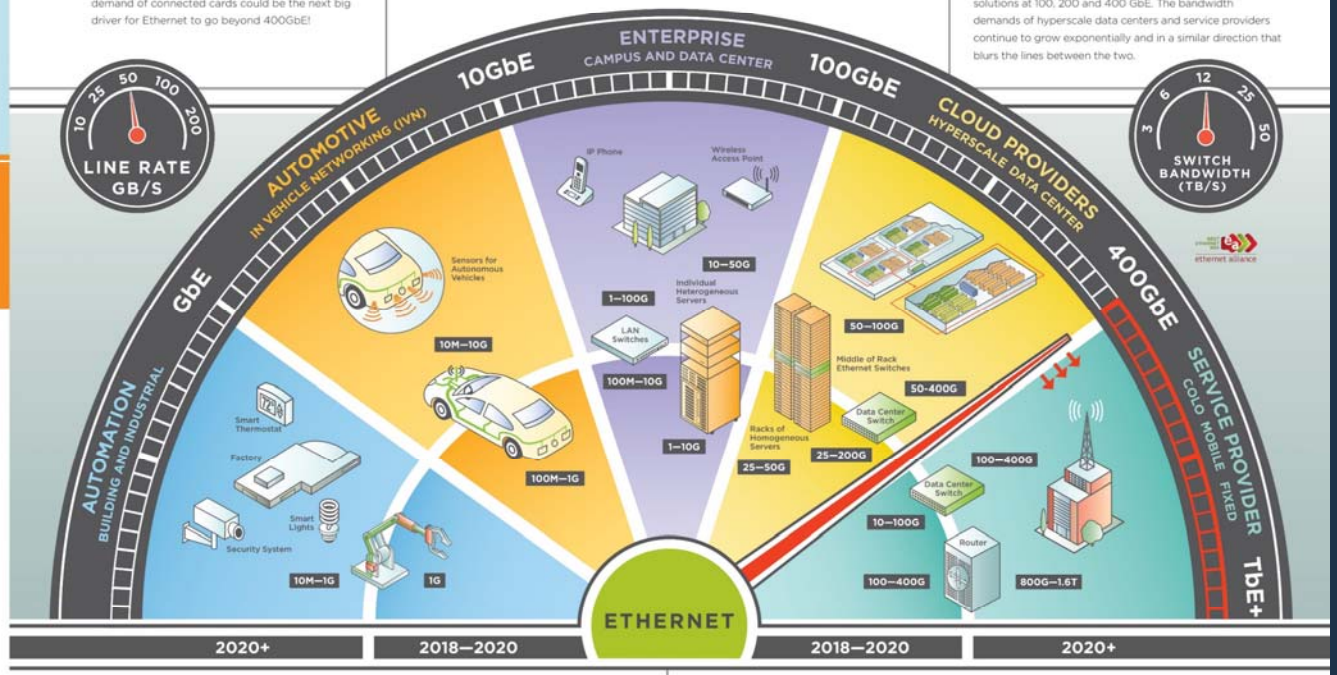
https://ethernetalliance.org/poecert/

ETHERNET APPLICATIONS

AUTOMOTIVE Ethernet is one of Ethernet's latest success stories. Forecasts predict up to 500 million ports of Ethernet will ship in 119 million vehicles by 2019. Ethernet links within cars provide data and power to reduce the cost and weight in vehicles while providing economies of scale and interoperability. And the bandwidth demand of connected cards could be the next big driver for Ethernet to go beyond 400GbE!

ENTERPRISE and Campus applications drive the bulk of Ethernet port shipments with hundreds of millions of ports shipping per year. Ethernet's roots are in enterprise local area networks (LANs) where the entire Ethernet family, including the BASE-T products, can be found. LANs are rich in copper where over 70 Billion meters of cable have been deployed over the past 15 years. Enterprise data centers are very cost sensitive and most servers deploy GbE and 10GbE.

CLOUD PROVIDERS were the first to adopt 10GbE servers on a large scale in 2010 for hyperscale data centers. With voracious appetites for east-west traffic, hyperscale servers have moved to 25GbE today and will move to 50GbE by the end of 2018. Unique networking architectures within these warehouse scale data centers have driven multiple multimode and single-mode fiber solutions at 100, 200 and 400 GbE. The bandwidth demands of hyperscale data centers and service providers continue to grow exponentially and in a similar direction that blurs the lines between the two.



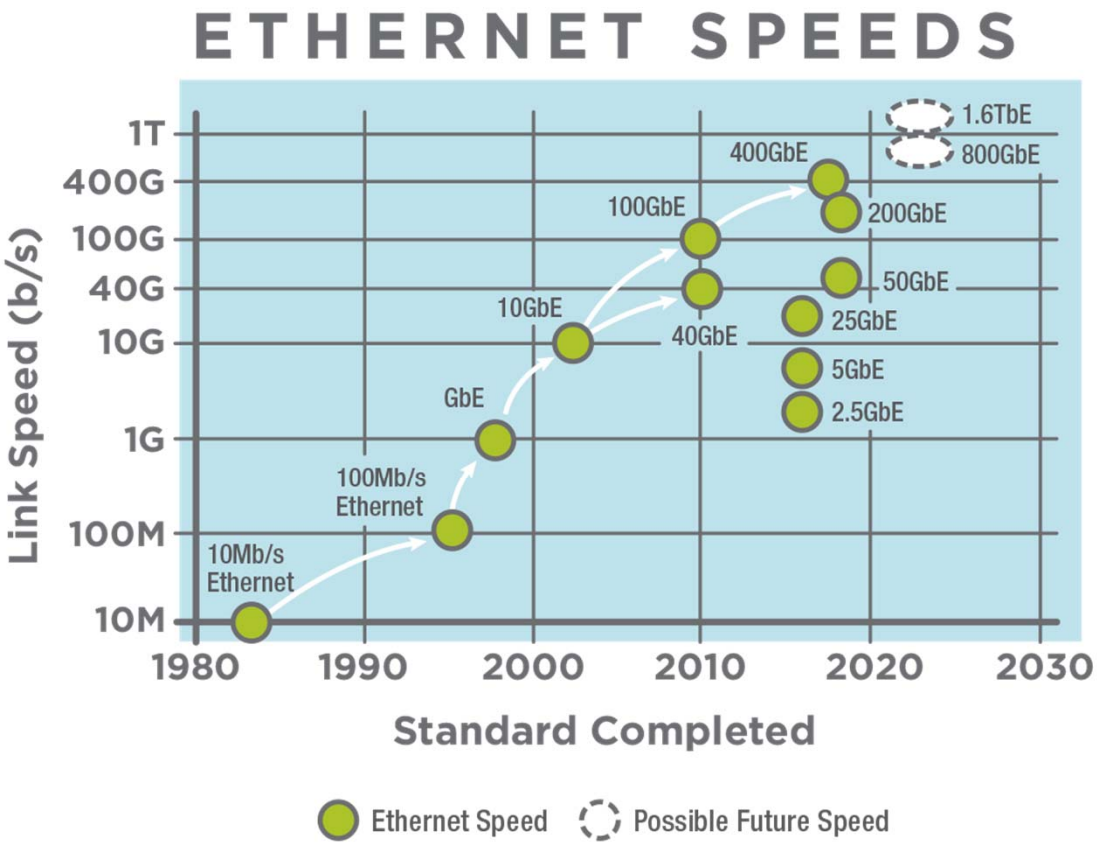
BUILDING AND INDUSTRIAL applications highlight the need for lower speed Ethernet solutions in harsh environments. The Ethernet community is working to define a single standard for 10 Mb/s operation plus power delivery over a single twisted pair. This will consolidate a landscape of multiple legacy protocols, driving the promise of Ethernet's multi-level interoperability to new heights for these spaces, as 2019 forecasts point to 165 million ports per year.

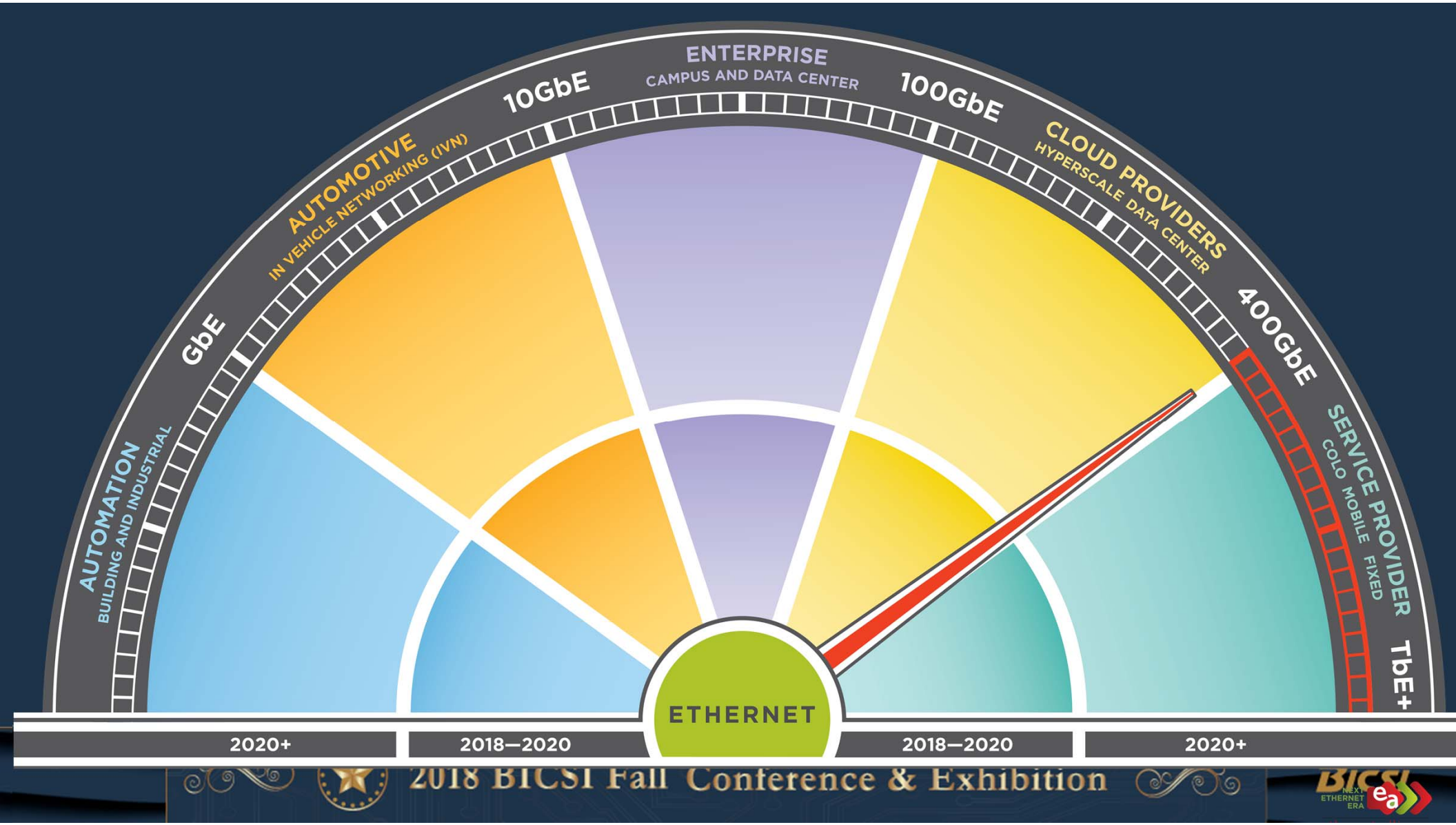
SERVICE PROVIDERS have driven higher speed Ethernet solutions for decades. Router connections, client side optics for optical transport networks (OTN) equipment, and wireless backhaul have continually pushed Ethernet to higher rates and distances to meet the demands for wireless connectivity. And with global demand by consumers for video, this shows no signs of changing.

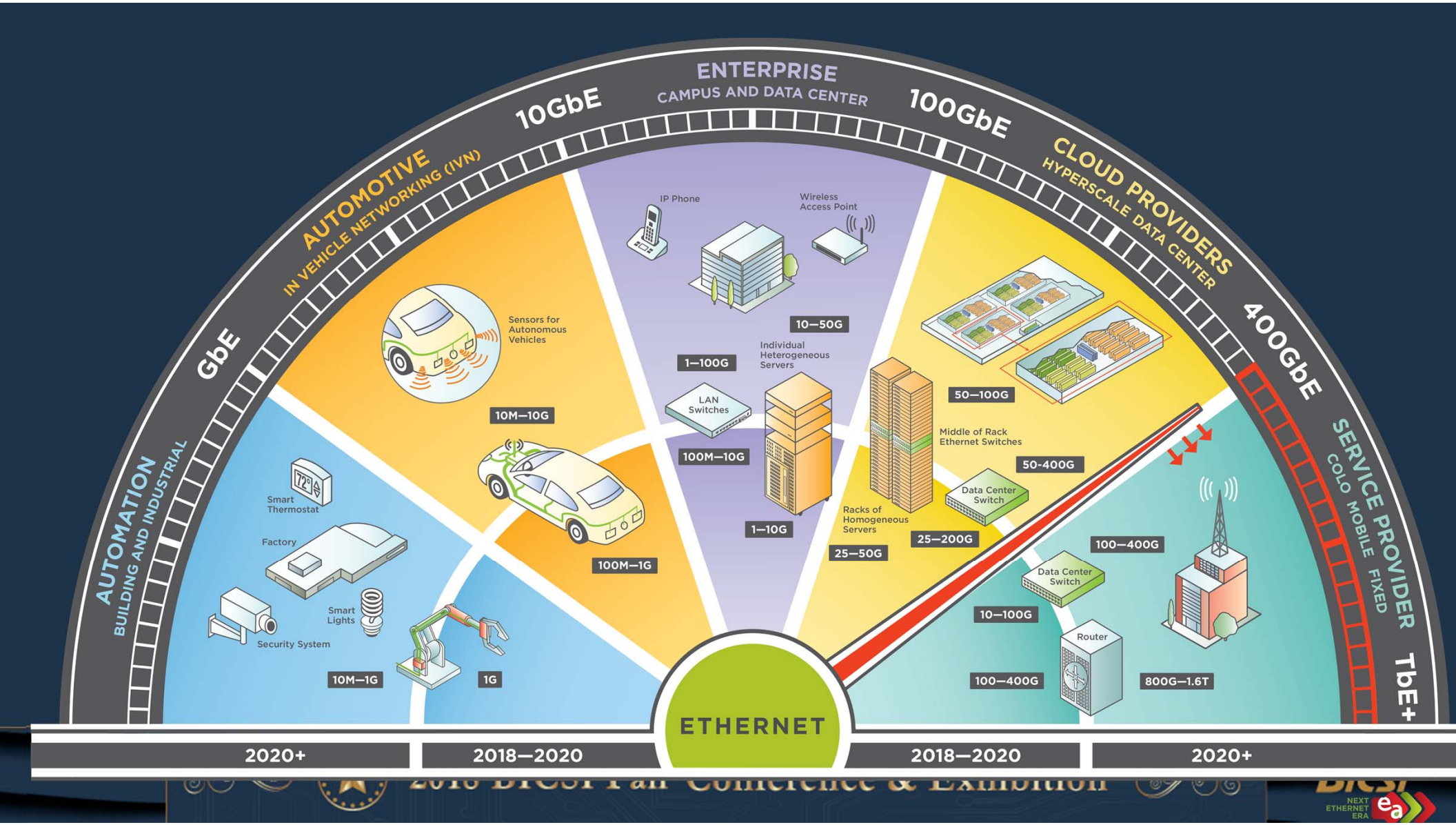
To get a PDF version of the roadmap and to find out more about the roadmap, please go to: **www.ethernetalliance.org/roadmap/**

PoE Types and Classes	2-Pair PoE – Type 1				2-Pair PoE+ – Type 2	4-Pair PoE in Standardization			
Class	0	1	2	3	4	5	6	7	8
PSE Power (W)	15.4	4	7	15.4	30	45	60	75	90
PD Power (W)	13	3.84	6.49	13	25.5	40	51	62	71.3
				4-Pair PoE–Type 3				4-Pair PoE Type 4	

NEXT ETHERNET ERA
ethernet alliance




AUTOMATION
BUILDING AND INDUSTRIAL
GbE
AUTOMOTIVE
IN VEHICLE NETWORKING (IVN)
10GbE
ENTERPRISE
CAMPUS AND DATA CENTER
100GbE
CLOUD PROVIDERS
HYPERSCALE DATA CENTER
400GbE
SERVICE PROVIDER
COLO MOBILE FIXED
TbE+
ETHERNET
2020+
2018—2020
2018—2020
2020+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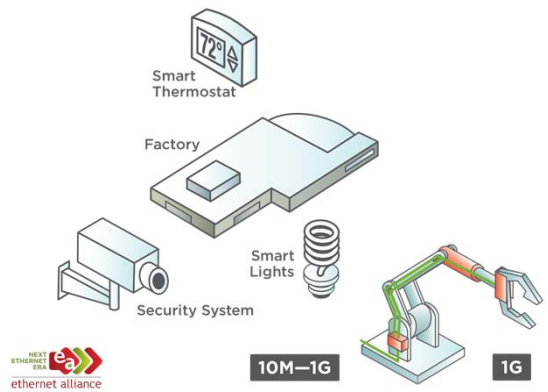
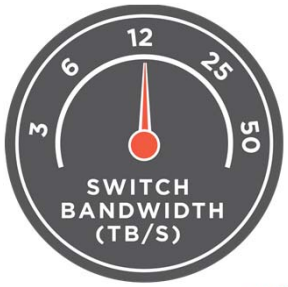
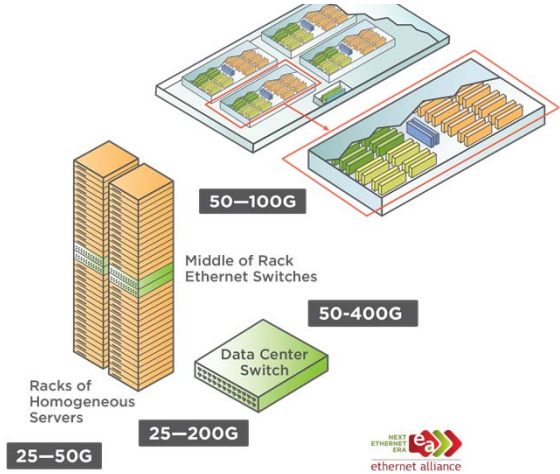
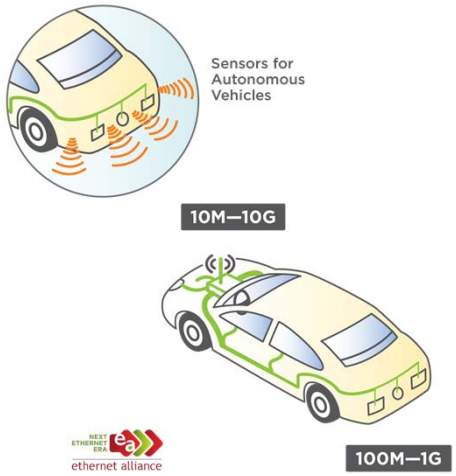
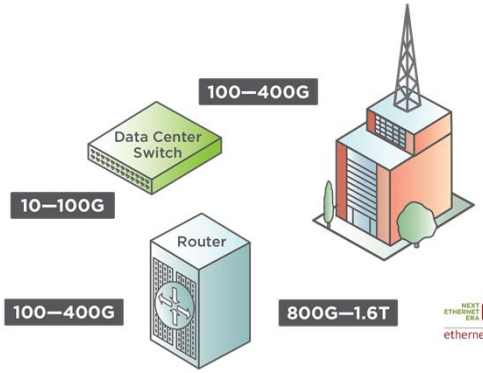
HYPERSCALE DATA CENTER
400GbE
SERVICE PROVIDER
COLO MOBILE FIXED
TbE+
Sensors for Autonomous Vehicles
10M—10G
100M—1G
IP Phone
Wireless Access Point
10—50G
1—100G
Individual Heterogeneous Servers
LAN Switches
100M—10G
1—10G
50—100G
Middle of Rack Ethernet Switches
50-400G
Data Center Switch
Racks of Homogeneous Servers
25—200G
25—50G
100—400G
Data Center Switch
10—100G
Router
100—400G
800G—1.6T
Smart Thermostat
Factory
Smart Lights
Security System
10M—1G
1G
ETHERNET
2020+
2018—2020
2018—2020
2020+

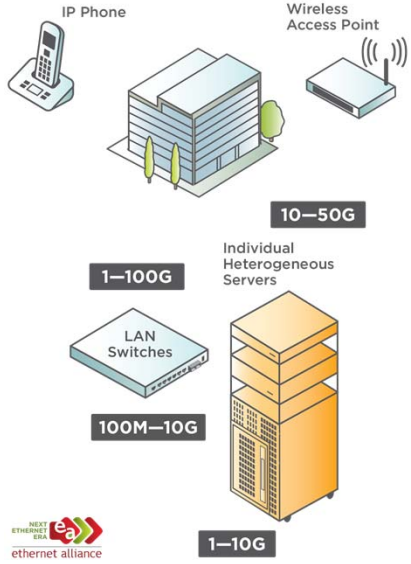










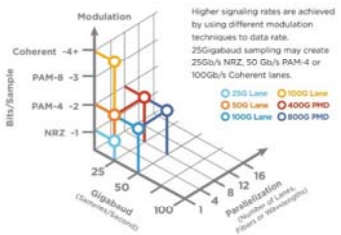


EMERGING INTERFACES AND NOMENCLATURE

	Electrical Interface	Backplane	Twinax Cable	Twisted Pair (1 Pair)	Twisted Pair (4 Pair)	MMF	500m PSM4	2km SMF	10km SMF	40km SMF	80km SMF
10BASE-		T1S?		T1S/TTL							
100BASE-				T1							
1000BASE-				T1	T						
2.5GBASE-		KX		T1S?	T						
5GBASE-		KR		T1S?	T						
10GBASE-				T1S?	T						
25GBASE-	25GAUI	KR	CR/CR-S		T	SR			LR	ER	
40GBASE-	XLAUI	KR4	CR4		T	SR4/eSR4	PSM4	FR	LR4	ER4	
50GBASE-	LAUI-2/50GAUI-2 50GAUI-1	KR	CR			SR		FR	LR	ER	
100GBASE-	CAUI/10 CAUI-4/100GAUI-4 100GAUI-2 100GAUI-1	KR4 KR2 KR1	CR10 CR4 CR2 CR1			SR10 SR4 SR2	PSM4 DR	10X10 CWDM4 CLR4 100G-FR	LR4 4WDM-10 100G-LR	ER4 4WDM-40 ?	?
200GBASE-	200GAUI-4 200GAUI-2	KR4 KR2	CR4 CR2			SR4	DR4	FR4	LR4	? ?	?
400GBASE-	400GAUI-16 400GAUI-8 400GAUI-4	KR4	CR4			SR16	DR4	FR8 400G-FR4	LR8 ?	?	?

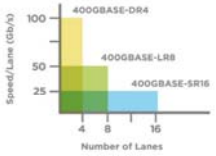
Gray Text = IEEE Standard Red Text = in Standardization Green Text = in Study Group
Blue Text = Non-IEEE standard but complies to IEEE electrical interfaces

HOW TO GO FASTER



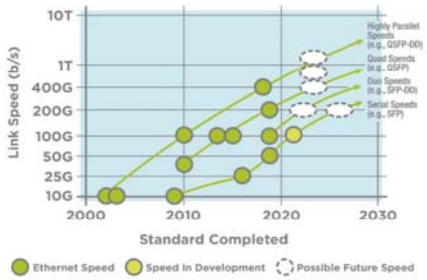
Higher signaling rates are achieved by using different modulation techniques to data rate. 25Gigabaud sampling may create 25Gb/s NRZ, 50 Gb/s PAM-4 or 100Gb/s Coherent lanes.

25G Lane 100G Lane
50G Lane 400G PMD
100G Lane 800G PMD



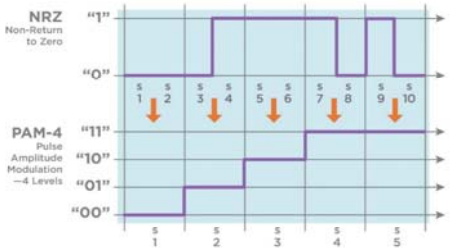
After the data rate/lane is chosen, the number of lanes in a link determines the speed. This chart shows how 4, 8 or 16 lanes can be used to generate 400GbE links.

TO TERABIT SPEEDS

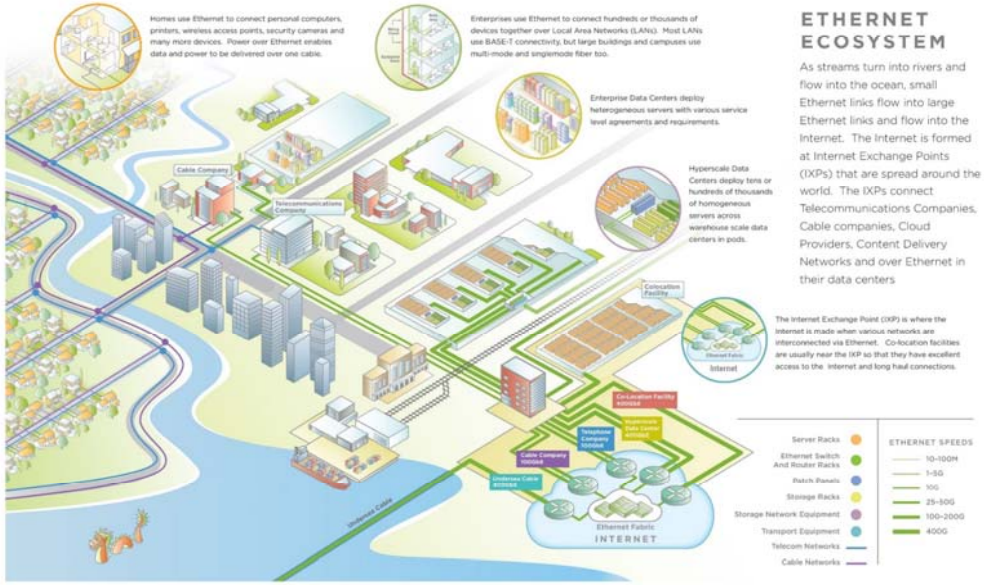


SIGNALING METHODS

Most high speed Ethernet signaling has been Non Return to Zero (NRZ), but Pulse Amplitude Modulation 4 Level (PAM-4) signaling delivers twice as many bits per sample.



ETHERNET ECOSYSTEM



As streams turn into rivers and flow into the ocean, small Ethernet links flow into large Ethernet links and flow into the Internet. The Internet is formed at Internet Exchange Points (IXPs) that are spread around the world. The IXPs connect Telecommunications Companies, Cable companies, Cloud Providers, Content Delivery Networks and over Ethernet in their data centers

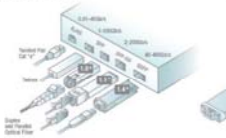
The Internet Exchange Point (IXP) is where the Internet is made when various networks are interconnected via Ethernet. Co-location facilities are usually near the IXP so that they have excellent access to the Internet and long haul connections.

FORM FACTORS

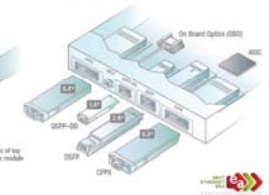
This diagram shows the most common form factors used in Ethernet ports. Hundreds of millions of RJ45 ports are sold a year while tens of millions of SFP and millions of QSFP ports ship a year.

This diagram shows new form factors initially designed for 100GbE and 400GbE Ethernet ports. All have 4 or 8 lanes and the OBO has up to 16 lanes. The power consumption of the modules is proportional to the surface area of the module.

1–4 Lane Interfaces



4-16 Lane Interfaces



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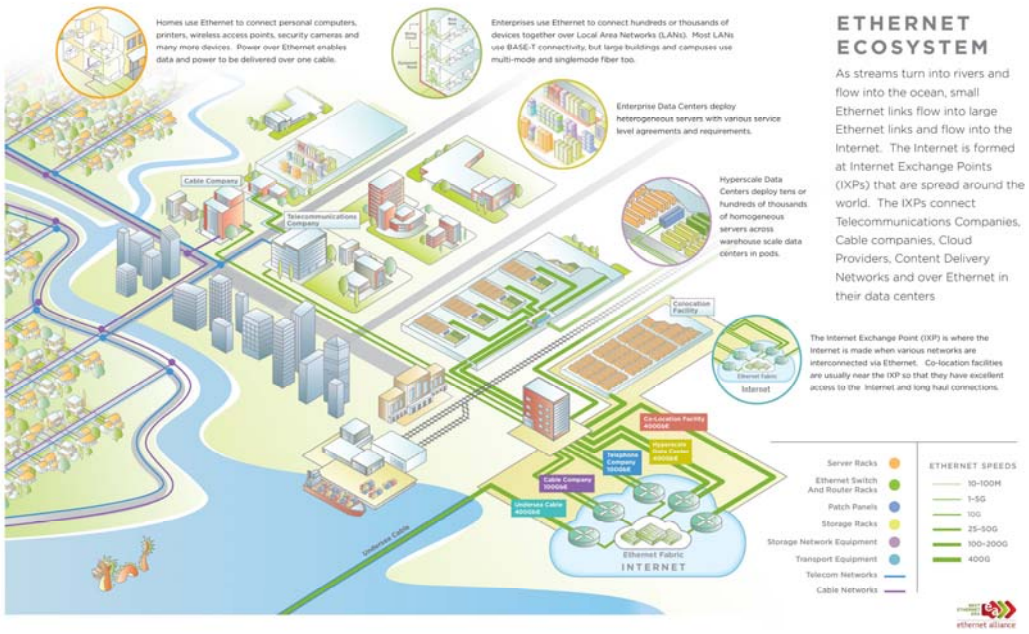
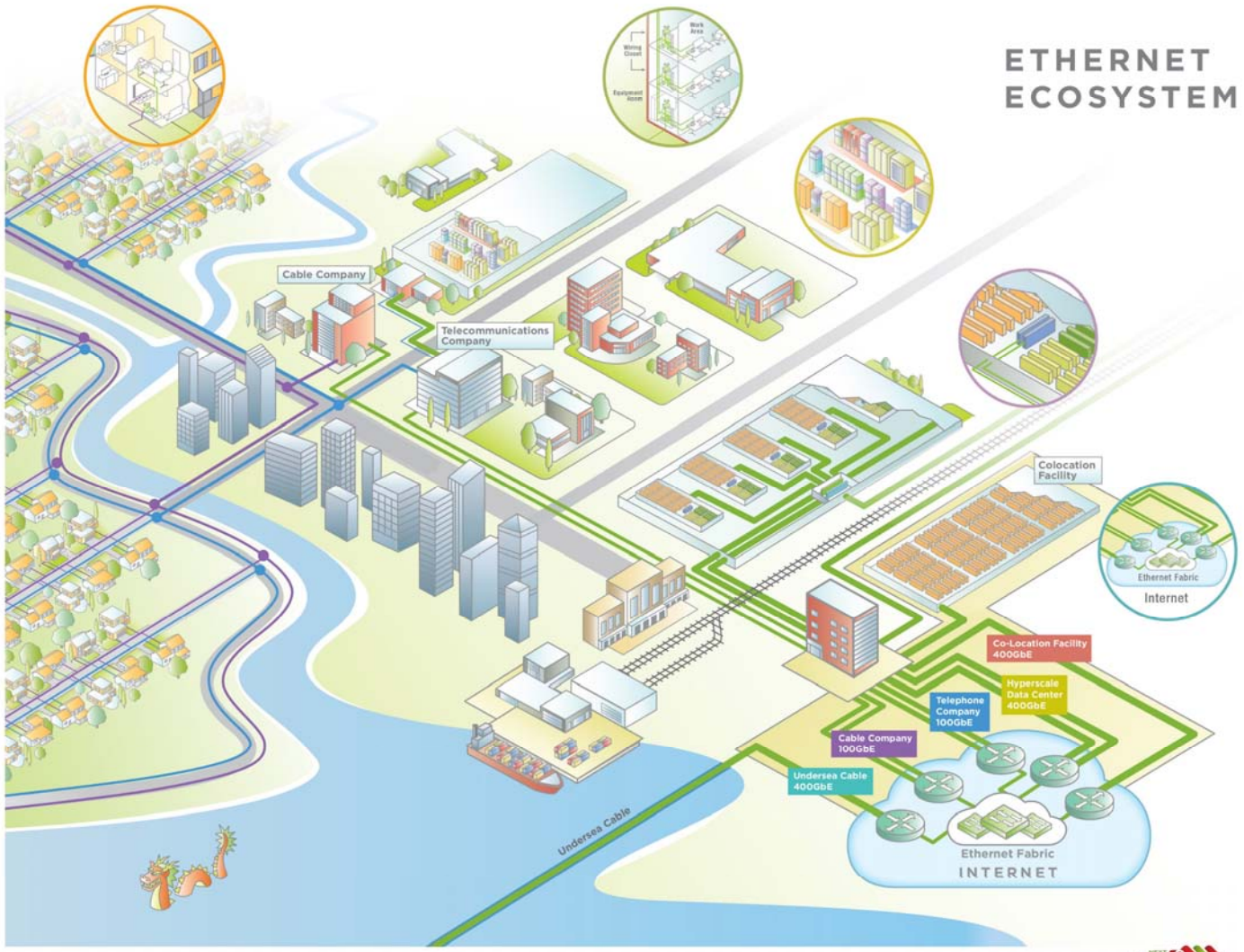


ETHERNET ECOSYSTEM

As streams turn into rivers and flow into the ocean, small Ethernet links flow into large Ethernet links and flow into the Internet. The Internet is formed at Internet Exchange Points (IXPs) that are spread around the world. The IXPs connect Telecommunications Companies, Cable companies, Cloud Providers, Content Delivery Networks and over Ethernet in their data centers



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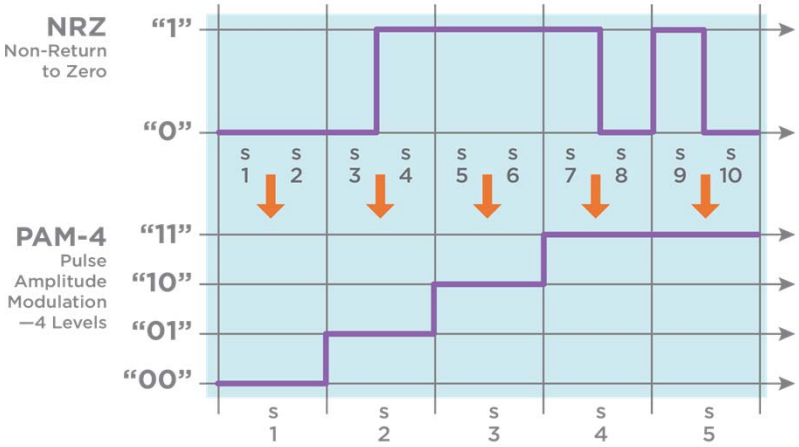
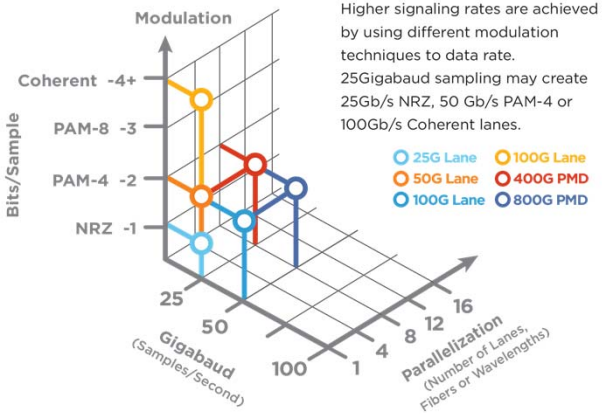
SIGNALING METHODS

Most high speed Ethernet signaling has been Non Return to Zero (NRZ), but Pulse Amplitude Modulation 4 Level (PAM-4) signaling delivers twice as many bits per sample.

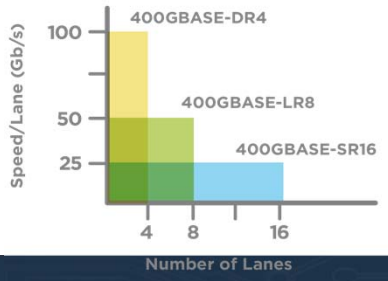


HOW TO GO FASTER



Higher signaling rates are achieved by using different modulation techniques to data rate. 25Gigabaud sampling may create 25Gb/s NRZ, 50 Gb/s PAM-4 or 100Gb/s Coherent lanes.

- 25G Lane
- 50G Lane
- 100G Lane
- 100G Lane
- 400G PMD
- 800G PMD



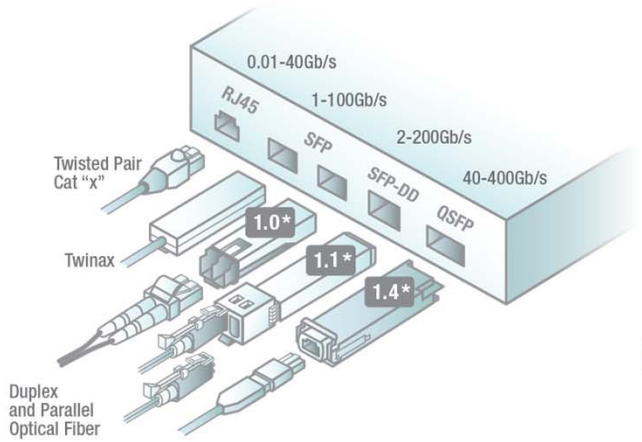
After the data rate/lane is chosen, the number of lanes in a link determines the speed. This chart shows how 4, 8 or 16 lanes can be used to generate 400GbE links.

FORM FACTORS

This diagram shows the most common form factors used in Ethernet ports. Hundreds of millions of RJ45 ports are sold a year while tens of millions of SFP and millions of QSFP ports ship a year.

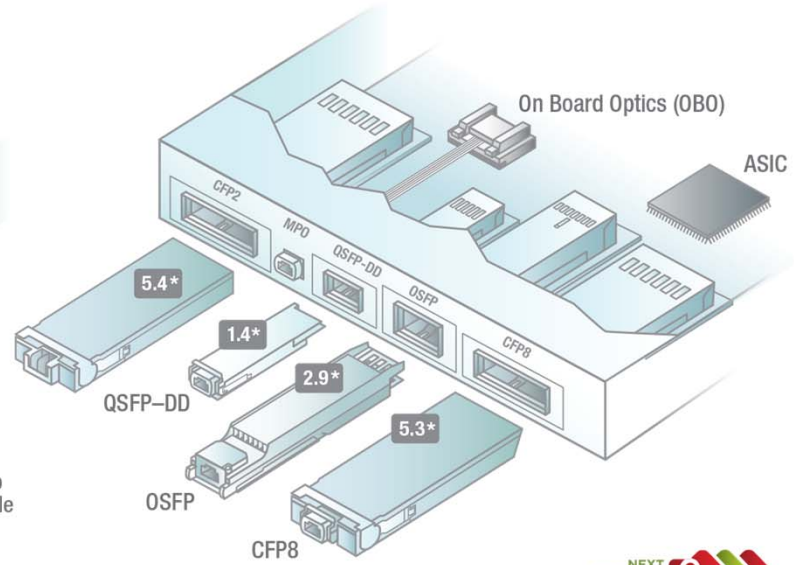
This diagram shows new form factors initially designed for 100GbE and 400GbE Ethernet ports. All have 4 or 8 lanes and the OBO has up to 16 lanes. The power consumption of the modules is proportional to the surface area of the module.

1–4 Lane Interfaces



*Square inches of top surface of the module

4-16 Lane Interfaces



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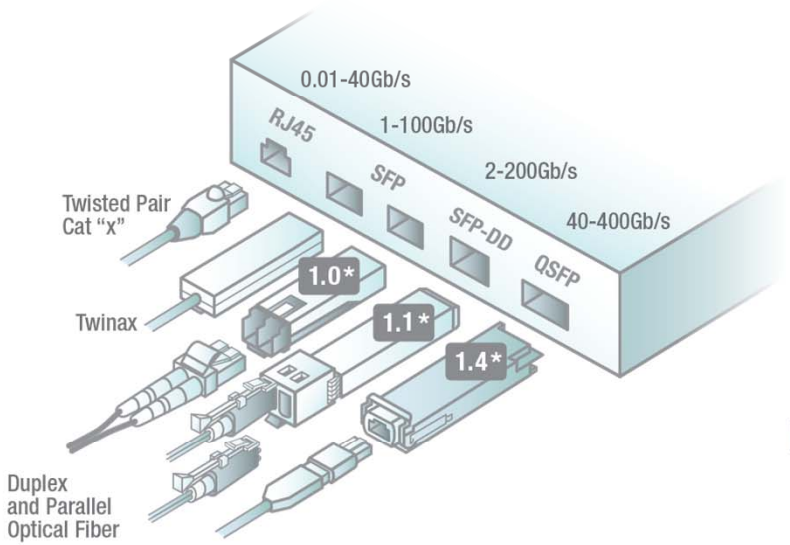
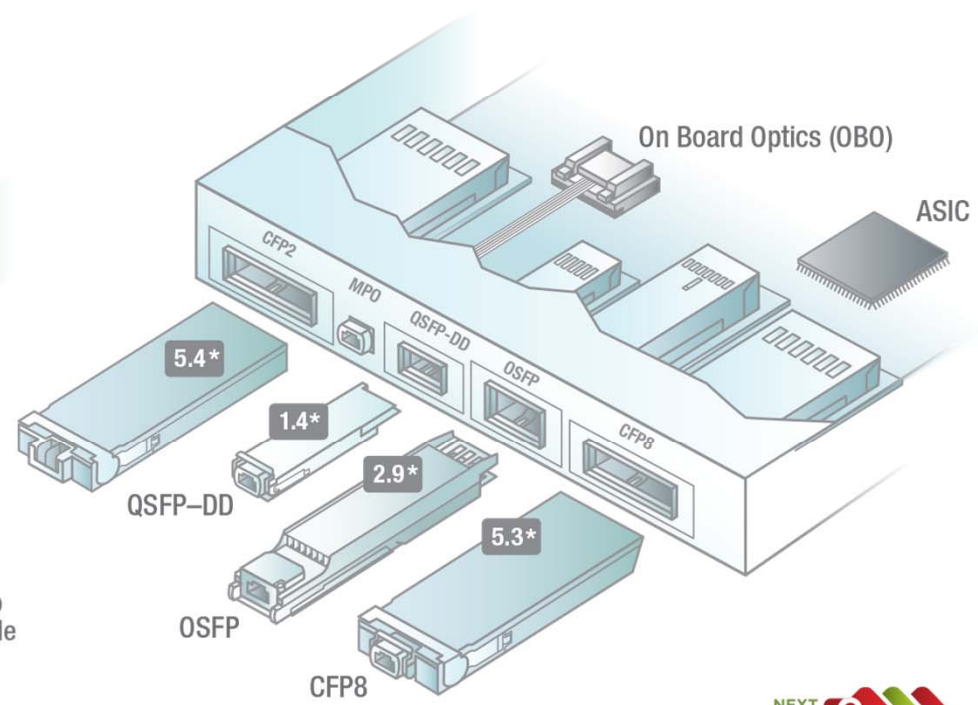
FORM FACTORS

1–4 Lane Interfaces



*Square inches of top surface of the module

4-16 Lane Interfaces



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EMERGING INTERFACES AND NOMENCLATURE

	Electrical Interface	Backplane	Twinax Cable	Twisted Pair (1 Pair)	Twisted Pair (4 Pair)	MMF	500m PSM4	2km SMF	10km SMF	40km SMF	80km SMF
10BASE-		T1S?		T1S/T1L							
100BASE-				T1							
1000BASE-				T1	T						
2.5GBASE-		KX		T1S?	T						
5GBASE-		KR		T1S?	T						
10GBASE-				T1S?	T						
25GBASE-	25GAUI	KR	CR/CR-S		T	SR			LR	ER	
40GBASE-	XLAUI	KR4	CR4		T	SR4/eSR4	PSM4	FR	LR4	ER4	
50GBASE-	LAUI-2/50GAUI-2 50GAUI-1	KR	CR			SR		FR	LR	ER	
100GBASE-	CAUI/10 CAUI-4/100GAUI-4 100GAUI-2 100GAUI-1	KR4 KR2 KR1	CR10 CR4 CR2 CR1			SR10 SR4 SR2	PSM4 DR	10X10 CWDM4 CLR4 100G-FR	LR4 4WDM-10 100G-LR	ER4 4WDM-40 ?	?
200GBASE-	200GAUI-4 200GAUI-2	KR4 KR2	CR4 CR2			SR4	DR4	FR4	LR4	?	?
400GBASE-	400GAUI-16 400GAUI-8 400GAUI-4	KR4	CR4			SR16	DR4	FR8 400G-FR4	LR8 ?	?	?

Gray Text = IEEE Standard Red Text = In Standardization Green Text = In Study Group

Blue Text = Non-IEEE standard but complies to IEEE electrical interfaces

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Bicsi

Uplinks

Type	Fiber Type	Power Consumption Max W
10GBASE-SR	MMF	1
10GBASE-LR	SMF	1-1.5
40GBASE-SR4	MMF	1.2 - 1.5
40GBASE-LR4	SMF	3.5
100GBASE-SR10	MMF	3.5 - 4
100GBASE-LR4	SMF	3.5 - 5

Power is only part of the equation
Unused ports draw power
Central power supplies can be more efficient even though they draw more power

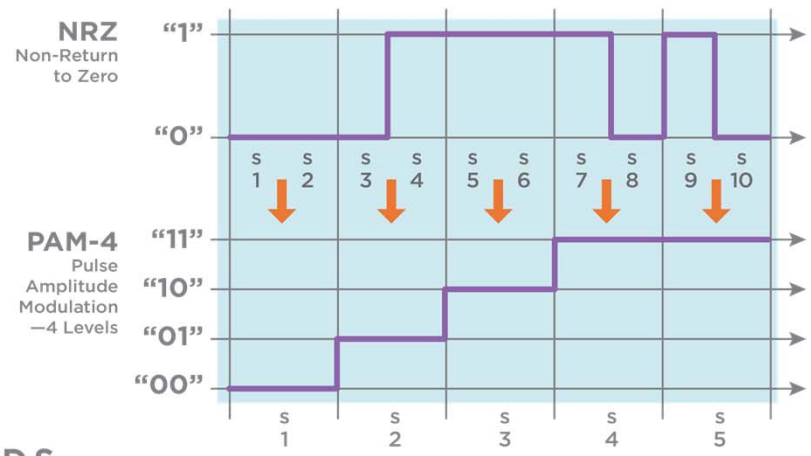
IEEE Single Mode Projects

Data Rate	Project	Type of Module	Nomenclatures	Reach (km)	Ratified
10	802.3ae	SFP+	10GBASE-LR, ER	10,40	2002
25	802.3cc	SFP28	25GBASE-LR, ER	10,30	2017
40	802,3ba, bm	QSFP+	40GBASE-LR, ER	10,40	2010, 2015
50	802.3cd	SFP56	50GBASE-FR, LR	2, 10	2018
100	802.3ba	QSFP28	100GBASE-DR	.5	2010
100	802.3cd	QSFP28	100GBASE-LR4, ER4	10,40	2018
200	802.3bs	QSFP56	200GBASE-DR4	.5	2017
200	802.3bs	QSFP56	200GBASE-FR4, LR4	2, 10	2017
400	802.3bs	TBD	400GBASE-DR4	.5	2017
400	802.3bs	CFP8	400GBASE-FR8, LR8	2, 10	2017
800	?	?	800GBASE-FR8, LR8	TBD	~2021

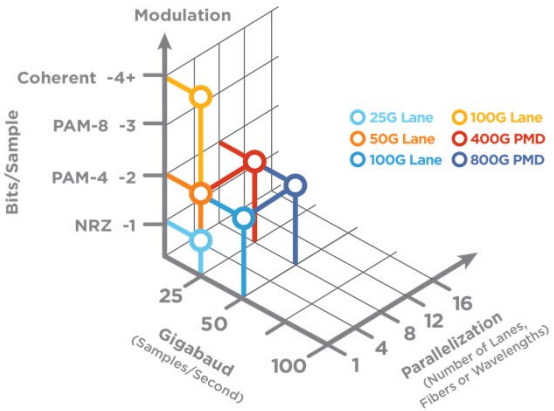
What is QSFP56?

- **Overview**
- 200Gbps hot pluggable transceiver in a compact QSFP56 form factor
- Optical connectivity based on two Singlemode Fiber (SMF) LC connectors
- Optical engine combining uncooled 4 X 50 Gbps CWDM DFB lasers with integrated MUX/DeMUX
- The optical signals are modulated using a 4-level pulse amplitude modulation (PAM4) format
- Optical Reach: up to 2km
- Built in digital diagnostics – Transmitter Power Monitoring (TPM) and Receive Signal Strength Indicator (RSSI)
- RoHS-6 compliant
- Operating case temperature range of 0 to 70°C
- Based on IEEE P802.3bs standard for 200G FR4 and on QSFP656 baseline specification

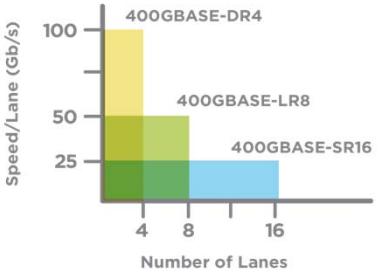
SIGNALING METHODS



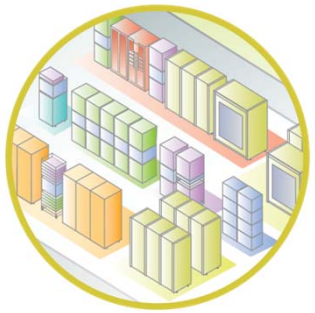
HOW TO GO FASTER

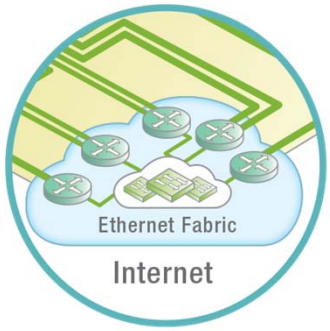


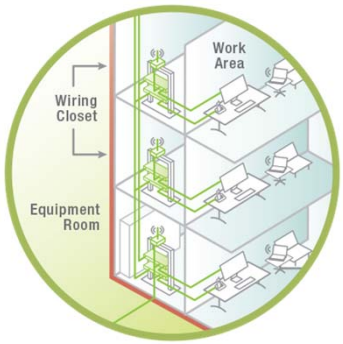
TO TERABIT SPEEDS

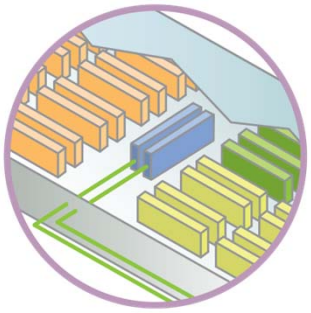


Ethernet Speed Speed in Development Possible Future Speed



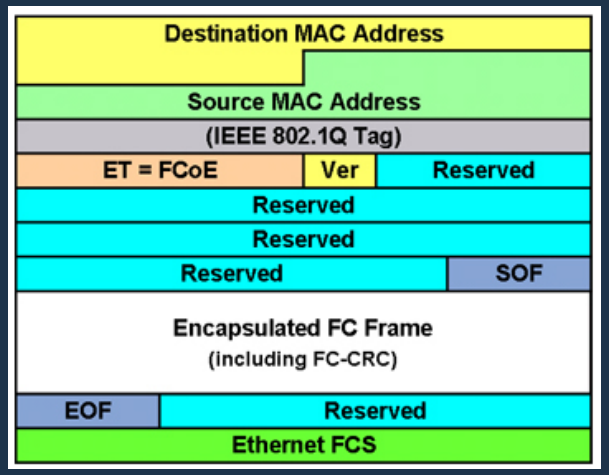

Ethernet Fabric
Internet


Work Area
Wiring Closet
Equipment Room



Fibre Channel Over Ethernet FCoE

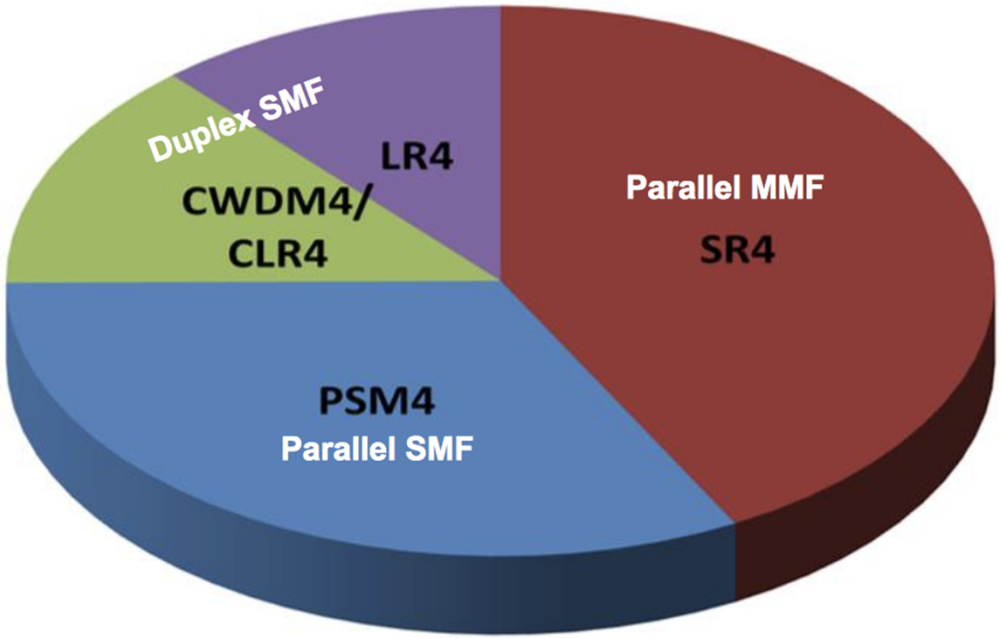
- Allows all Ethernet traffic in the data center
- Encapsulates Fibre Channel information over Ethernet (802.3)



Fibre Channel Roadmap

Fibre Channel Speed Roadmap — Inter-Switch Link				
Product Naming	**Throughput** (MBps)	**Equivalent Line Rate** (Gbaud)†	**T11 Spec Technically Completed** (Years)‡	**Market Availability** (Year)
10GFC	2400	10.52	2003	2009
20GFC	4800	21.04	Not Applicable	2008
40GFCoE	9600	41.25	2010	2013
100GFCoE	24000	10X10.3125	2010	Market Demand
100GFCoE	24000	4X25.78125	2015	Market Demand
128GFCp	25600	4X28.05	2014	2016
256GFCp	51200	4X57.8	2017	2019
400GFCoE	96000	8X51.5625	2017	Market Demand
1TFCoE	240000	TBD	TBD	Market Demand

100GbE QSFP28 Consumption in 2016



- Units shipped
- SR4 modules had the greatest contribution to 2016 shipments of QSFP28 modules

Chart courtesy of Dale Murray, LightCounting

Singlemode versus Multimode versus Copper

- Total channel cost Day One
  - Switch Cost, Server NIC cost, uplink port cost, fiber
- Total costs day two
  - Power, Cooling, maintenance
    - This does not always take a front seat, but should

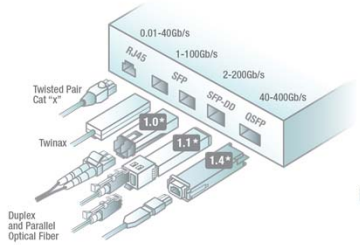
- Image courtesy of iDesign

FORM FACTORS

This diagram shows the most common form factors used in Ethernet ports. Hundreds of millions of RJ45 ports are sold a year while tens of millions of SFP and millions of QSFP ports ship a year.

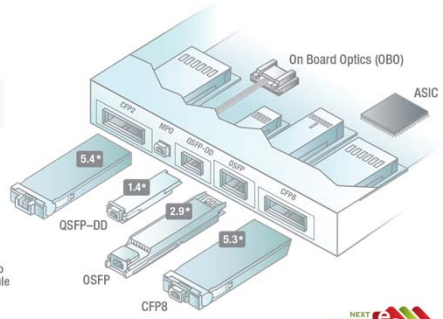
This diagram shows new form factors initially designed for 100GbE and 400GbE Ethernet ports. All have 4 or 8 lanes and the OBO has up to 16 lanes. The power consumption of the modules is proportional to the surface area of the module.

1–4 Lane Interfaces



*Square inches of top surface of the module

4-16 Lane Interfaces



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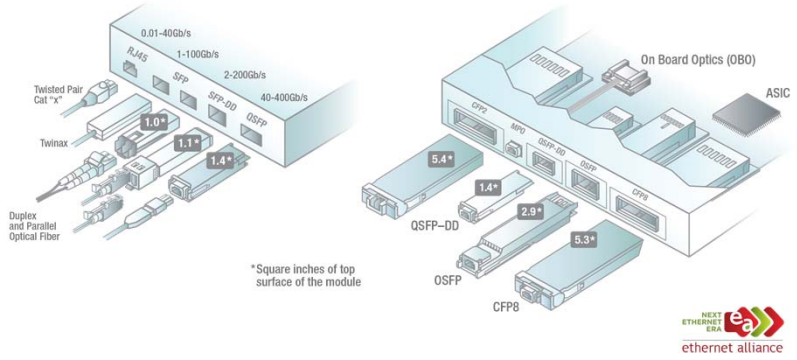
FORM FACTORS

1–4 Lane Interfaces

4-16 Lane Interfaces



*Square inches of top surface of the module

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Slide courtesy of SNIA/Microsoft

3 Main Types of DC High-Speed Interconnects

SNIA ESF | ETHERNET STORAGE

Direct Attach Copper (DAC)

Copper Wires
Key feature = Lowest Priced Link
25/50/100GbE: 3m-5m reach

Copper Cables

Active Optical Cables

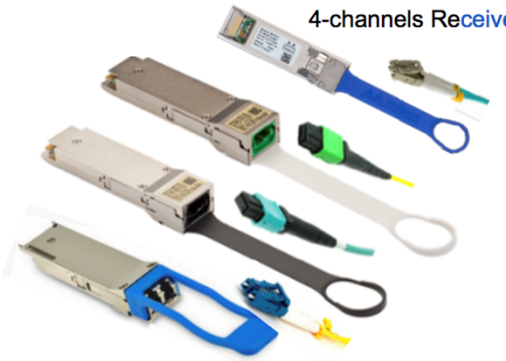
2 Transceivers w/optical fiber bonded inside
Key feature = Lowest Priced Optical Link
100m/200m Reaches

Transceivers with Integrated Fibers

Optical Transceivers

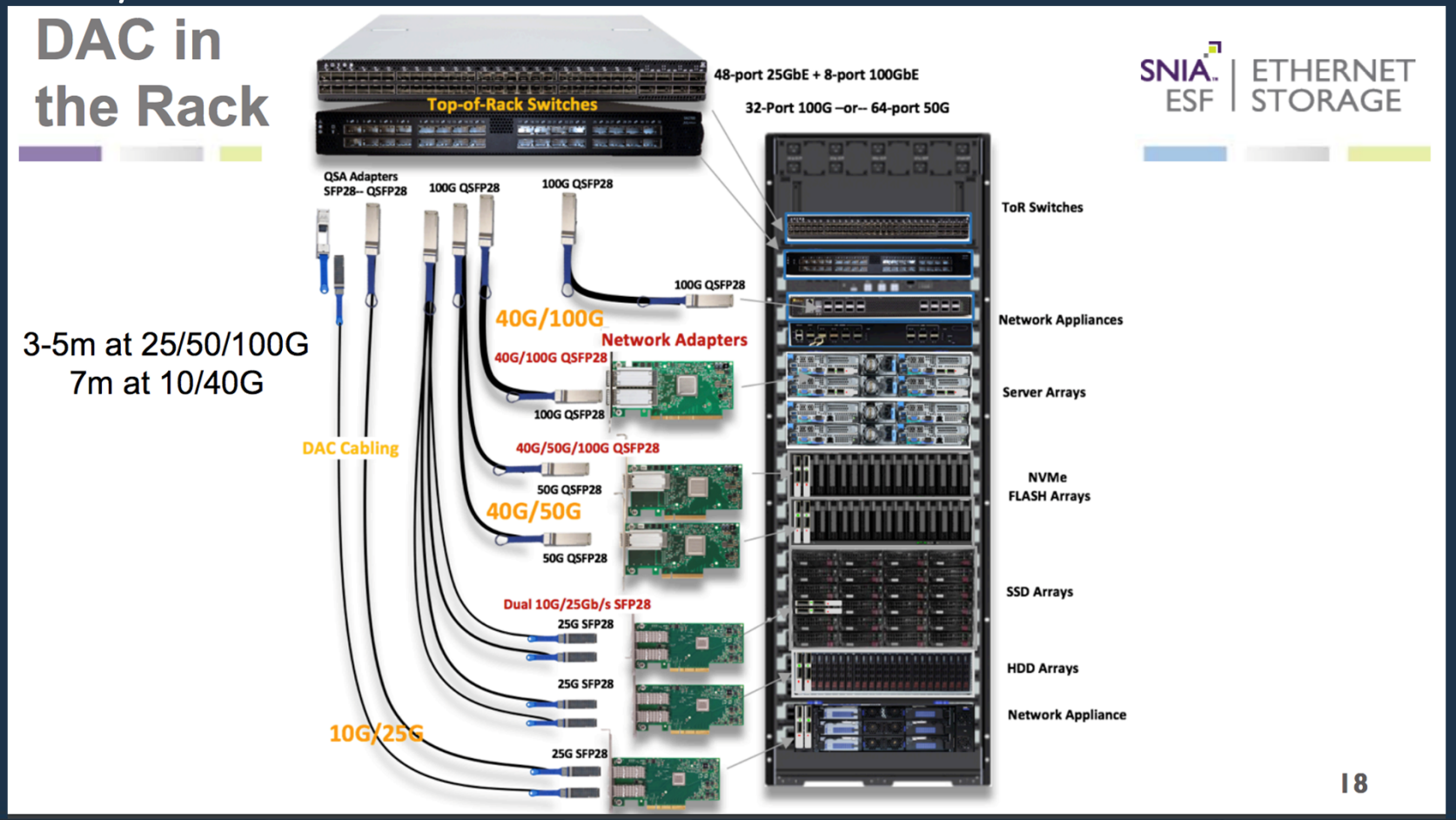
Converts electrical signals to optical laser light sent over optical fibers
Key features = Connectors & Long Reaches

"Transceiver"
4-channels Transmiter
4-channels Receiver

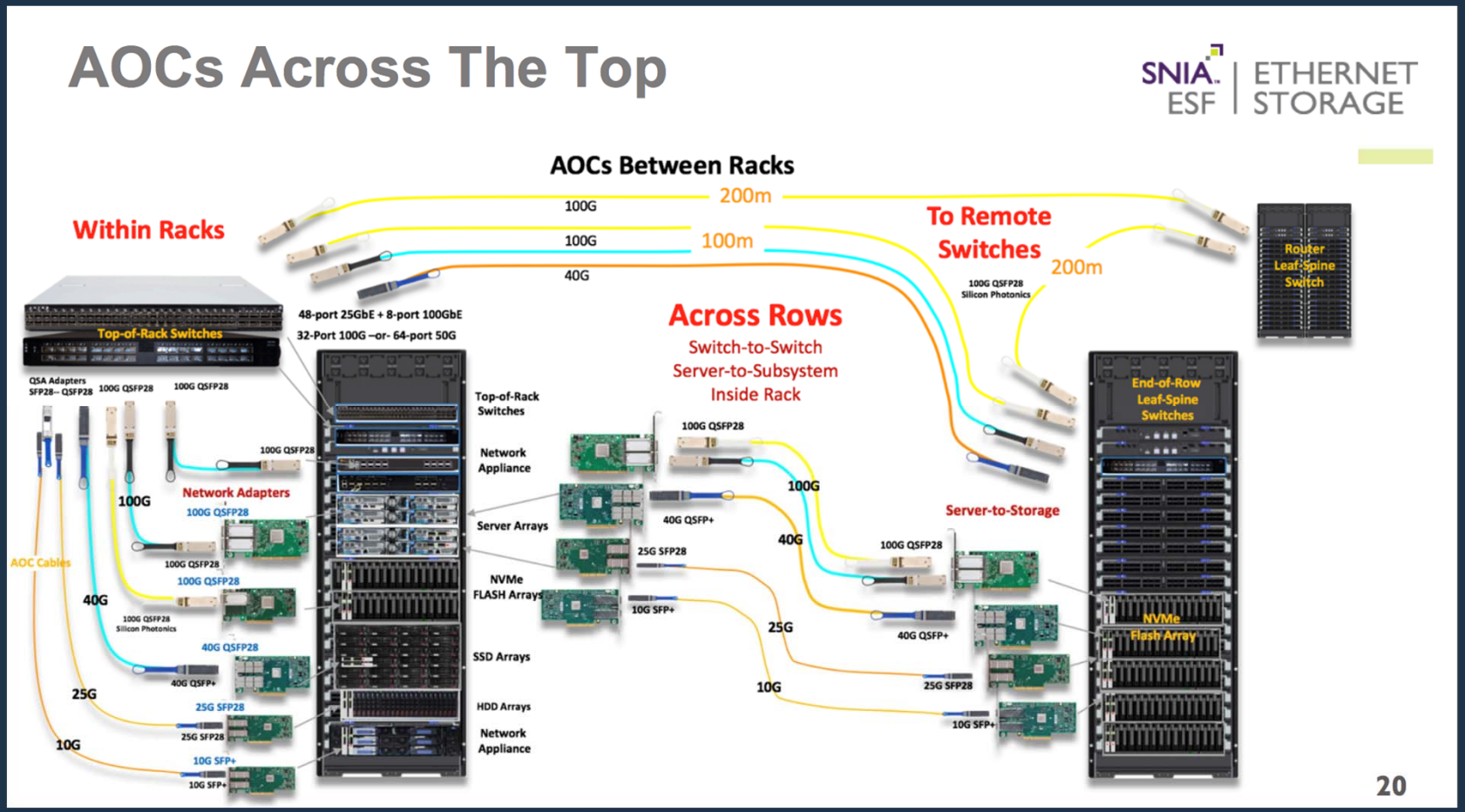


Transceivers with Detachable MPO or LC Connectors

Slide courtesy of SNIA/Microsoft



Slide courtesy of SNIA/Microsoft



From CCCA

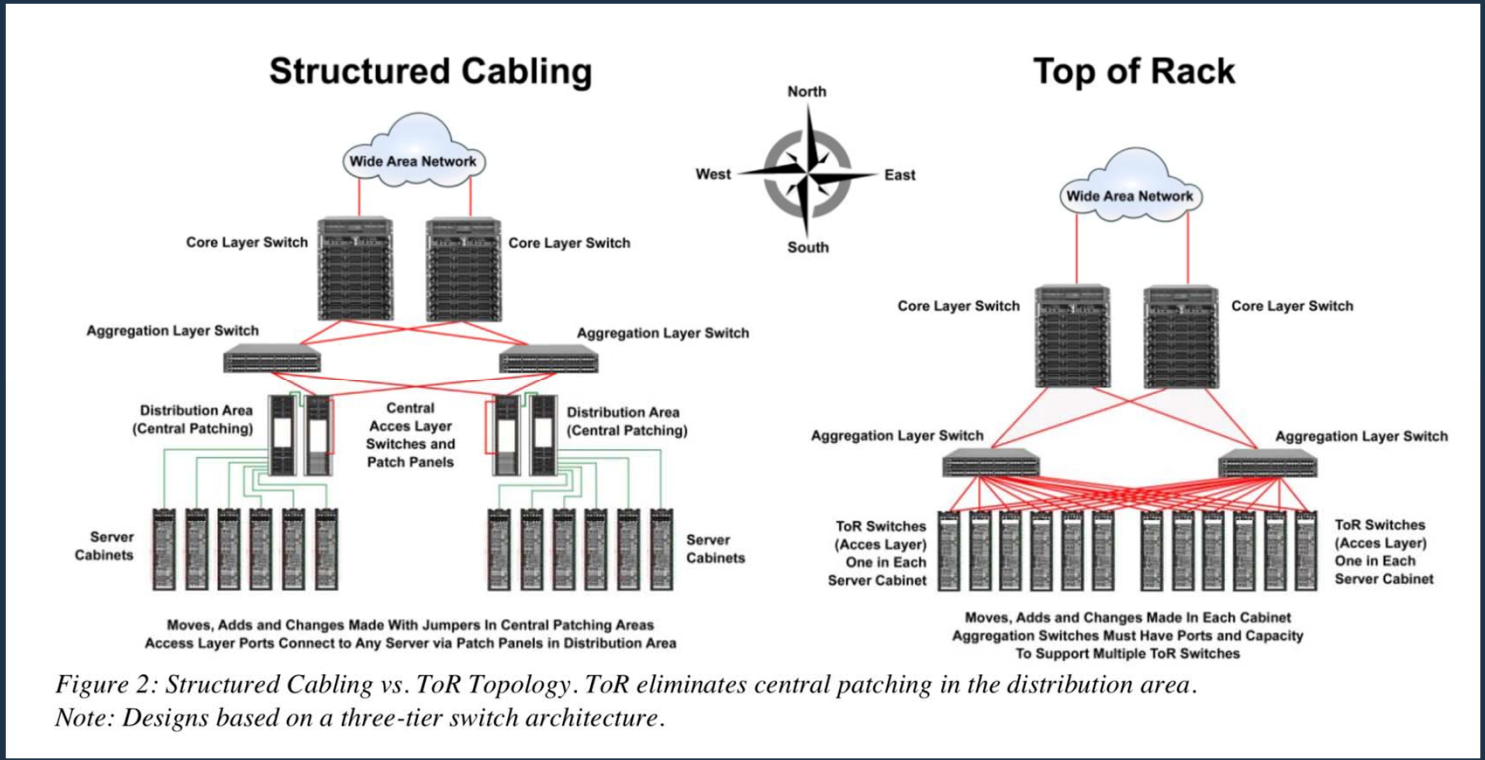


Figure 2: Structured Cabling vs. ToR Topology. ToR eliminates central patching in the distribution area.
Note: Designs based on a three-tier switch architecture.

From CCCA

Equipment and Unit Price	ToR		Structured Cabling		Total Savings
	Units	Price	Units	Price	
32-port 10G ToR Switches ($15,000)	78	$1,170,000	35	$525,000	$645,000
Redundant Power Supplies ($500)	78	$39,000	35	$17,500	$21,500
SFP+ Uplink Ports ($1500)	312	$468,000	140	$210,000	$258,000
32-Port Aggregation Switches ($25,000)	10	$250,000	5	$125,000	$125,000
SFP+ Modules ($5000)	80	$400,000	40	$200,000	$200,000
Redundant Power Supplies ($500)	10	$5,000	5	$2,500	$2,500
Core Switches ($80,000)	2	$160,000	2	$160,000	0
Redundant Power Supplies at ($7,500)	2	$15,000	2	$15,000	0
Fiber Cards for Uplinks at ($70,000)	4	$280,000	2	$140,000	$140,000
Cabling Total		**$240,000**		**$110,000**	**$130,000**
Equipment Total (not including software)		**$2,787,000**		**$1,395,000**	**$1,392,000**
3 Years Maintenance		**$1,200,000**		**$570,000**	**$630,000**
TOTAL		**$4,227,000**		**$2,075,000**	**$2,152,000**

Figure 3: ToR vs. Structured Cabling Cost Comparison (based on MSRP at time of print) for an actual 39-cabinet data center (assumes average 5 to 6kW per cabinet, dual network, redundant power supplies, 14 servers per cabinet, four uplinks per switch, 2.5-meter SFP+ direct attach cable assemblies for each used ToR port, and category 6A UTP for structured cabling).

From CCCA

Equipment	ToR				Structured Cabling			
	Units	Total Ports	Used Ports	Unused Ports	Units	Total Ports	Used Ports	Unused Ports
32-port 10G ToR Switches	78	2496	1092	1404	35	1120	1092	28
32-Port Aggregation Switches	10	320	312	8	5	160	140	20
Fiber Cards for Core Uplinks	4	128	40	88	2	64	20	44
TOTAL PORT USAGE		**2944**	**1444**	**1500**		**1344**	**1252**	**92**

Figure 4: Switch port utilization for ToR vs. Structured Cabling for an actual 39-cabinet data center (assumes average 5 to 6kW per cabinet, dual network, redundant power supplies, 14 servers per cabinet and four uplinks per switch).

Comparison

	Leaf/Spine DAC	Leaf/Spine 10GBASE-T
Low density 14 Servers/Cab		
Total Equip/Cabling Cost	$ 11,944,235.65	$ 8,638,321.02
Average Cost/Server Cab	$ 71,096.64	$ 59,988.34
Annual Power cost Networking	$ 101,419.78	$ 57,017.09
Total Cabling Cost	$ 481,250.59	$ 70,327.30
High Density 40 Servers/Cab		
Total Equip/Cabling Cost	$ 26,394,022.02	$ 21,596,114.19
Average Cost/Server Cab	$ 157,107.27	$ 149,973.02
Annual Power cost Networking	$ 177,610.75	$ 106,717.82
Total Cabling Cost	$ 5,123,942.02	$ 2,078,260.76

The Beginning of ToR Architectures

Figure 1. Traditional Three-Tier Data Center Design

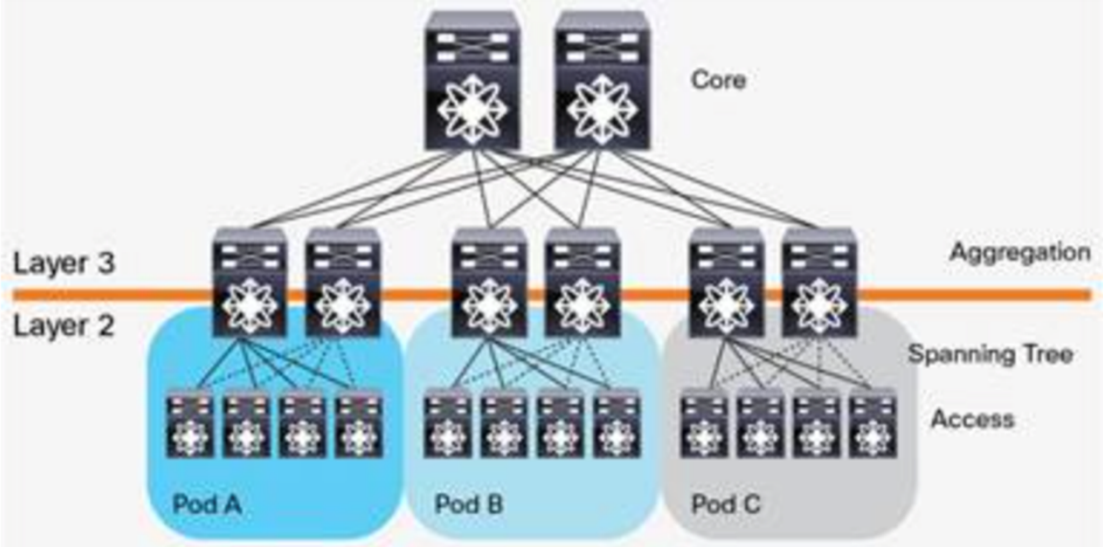


Diagram Courtesy of Cisco®

- Image courtesy of iDesign

Longevity

• OS1 (OS2 over 2km)	FDDI, OM1, OM2, OM3, OM4, OM5
• Category 6A	3, 4, 5, 5E, 6, 6A

Point to Point

- Single use
- Non-negotiating
- Sometimes closed (proprietary)
- Now running 30-50% of Capital $

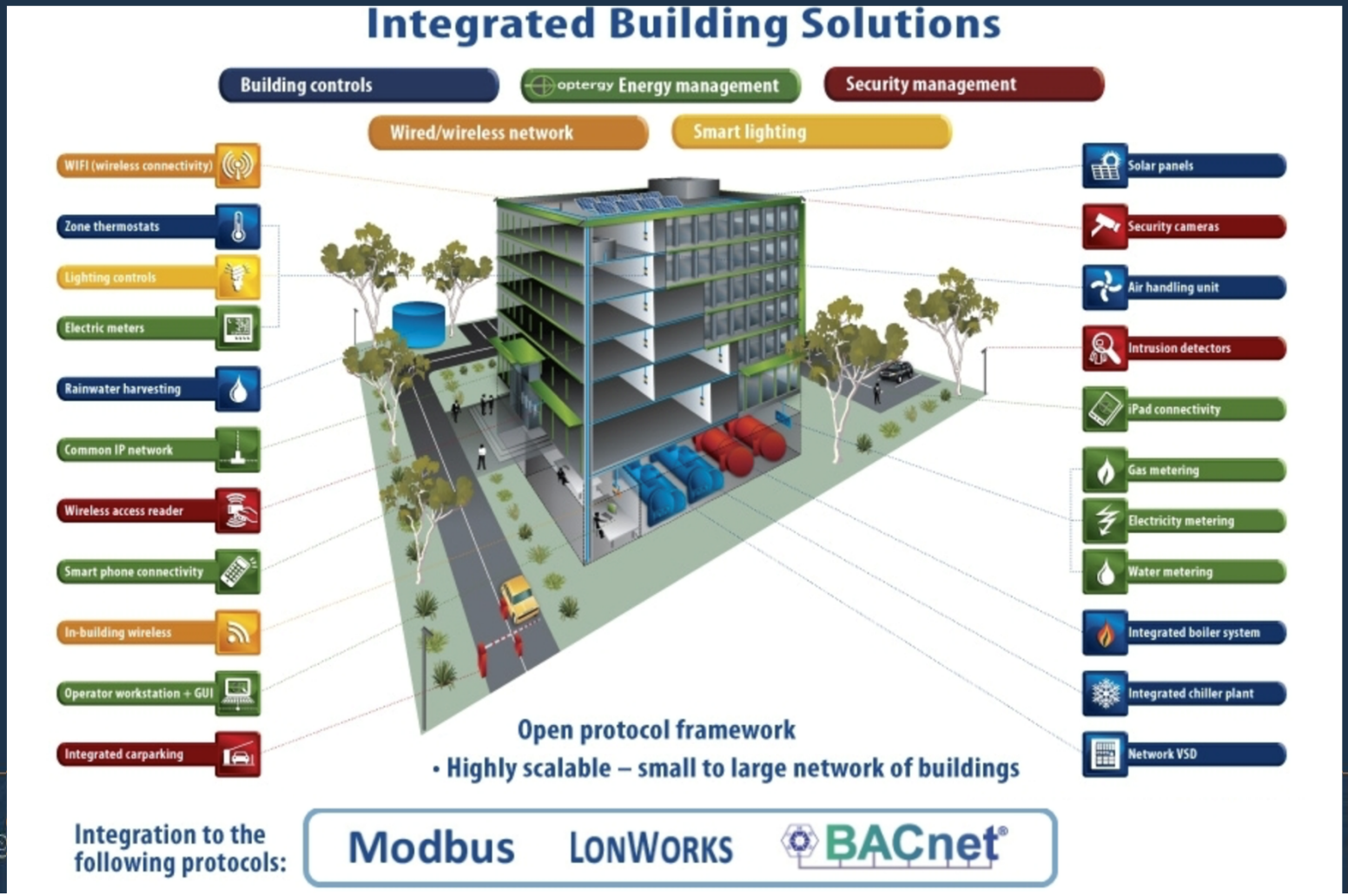
- High ticket item for Electronics manufacturers
- Often purchased by the networking team

Points to Remember – Number of Servers Restricted by….

- Power is your limiting factor for # of servers per cabinet
- Cooling capacity
- Weight
- Height of Cabinet

- Budget

http://optergy.com.my/solutions/integrated-solutions/



NEC 240-3

- Continuous loads
- Conductor ampacity
- Terminal temperature ratings
- System voltage
- Conductor insulation
- Special application

- Power Loss Hazard
- Fire Alarm System Circuit Conductors
- Devices Rated 800 Amperes or Less
- Remote-Control, Signaling, and Power-Limited Circuit Conductors
- Tap Conductors
- Transformer Secondary Conductors
- Motor-Operated Appliance Circuit Conductors
- Air-Conditioning and Refrigeration Equipment Circuit Conductors
- Motor and Motor-Control Circuit Conductors
- Phase Converter Supply Conductors
- Capacitor Circuit Conductors
- Electric Welder Circuit Conductors

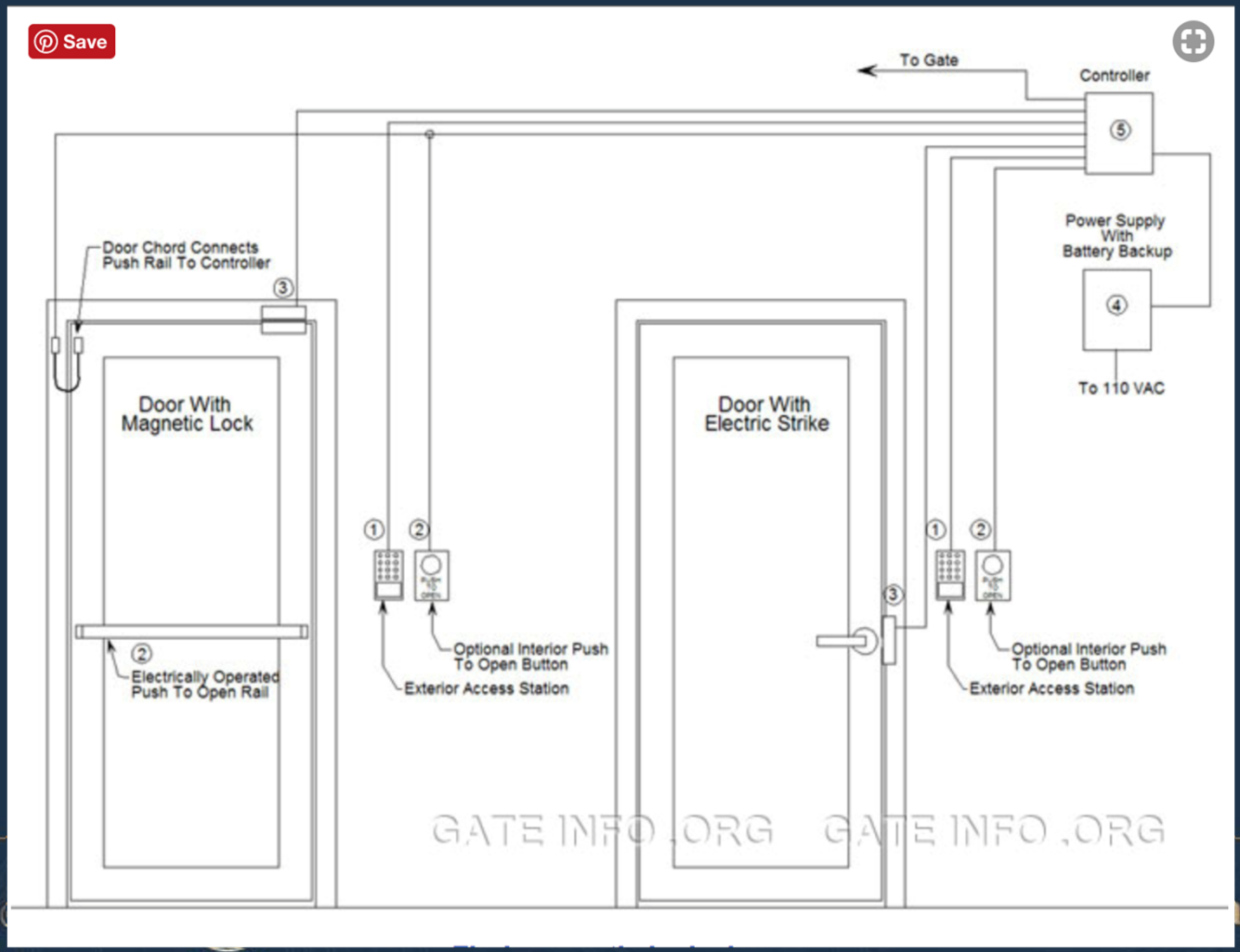
How Far Can it Go?

- 44000/500 = 88
- Distances shown versus category cable- 8 stands (4 pair) ≤100m
- Category cable limited to 100m for Ethernet

Volt Ampere (VA) at 24VAC

Wire Size	Device VA	Maximum Length (feet)
16 AWG	100	100
	75	150
	50	250
	25	500
18 AWG	50	150
	25	300
	15	500
	5	1000

Door Controls

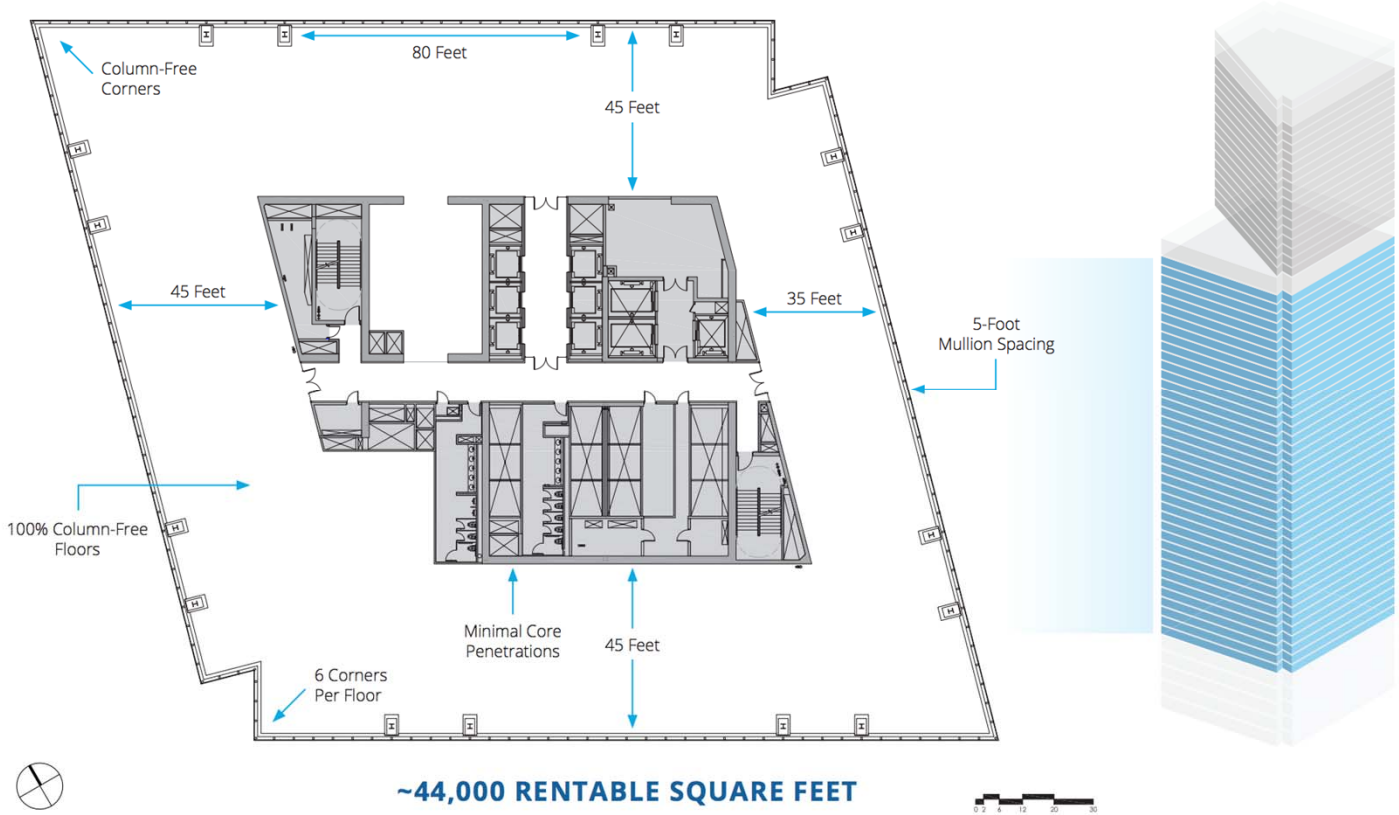


Are all Cables the Same?

- Electrically different
- Conductor size depends on power and signal
- Composite cables lower labor
- Will talk to different systems
- Category 5E or 6 cables can NOT run everything in an intelligent building
- 4 Category cables = 4 sets of twisted pairs
- Not all conductors are the correct size
- Waste of unneeded pairs/conductors
- 32 conductors when 16 are required
- Will still need control cables for electrical reasons

Thermostat

- 16 or 18 AWG 4/5 strand wire to thermostat
- 1 Thermostat / 5 offices = ~1/500sq’


Column-Free
Corners
80 Feet
45 Feet
45 Feet
35 Feet
5-Foot
Mullion Spacing
100% Column-Free
Floors
Minimal Core
Penetrations
45 Feet
6 Corners
Per Floor
~44,000 RENTABLE SQUARE FEET

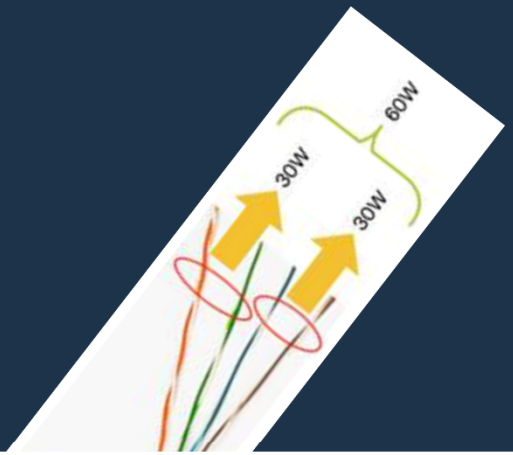


Table 2. Test Results from TIA TR-42 and ISO/IEC

TIA TR-42 Recommendation			ISO/IEC Recommendation		
Temperature Rise	**Max Current per twisted Pair**	**Max Power @ 50V**	**Temperature Rise**	**Max Current per twisted Pair**	**Max Power @ 50V**
5	420mA	37.5W	5	420mA	37.5W
7.5	520mA	45.2W	7.5	550mA	47.4W
10	600mA	51.0W	10	600mA	51.0W
12.5	670mA	55.8W	12.5	680mA	56.4W
15	720mA	59.0W	15	720mA	59.0W

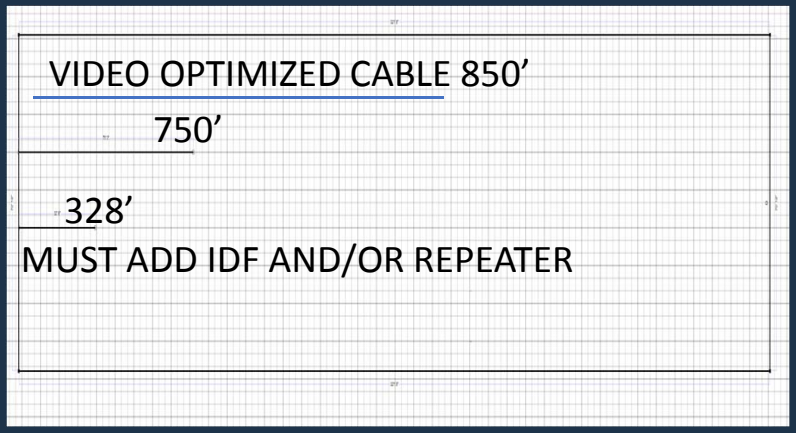
With maximum 51W UPOE capacity, temperature for 100-cable bundle increased 10 degrees. This is as required by PoE Plus cable standard request defined in 802.3at.

Cable Considerations

- Don’t run more than you need if there is not a real possibility that you will use it.
  - Don’t run 4 pair cables if two will due long term
  - Know your distances
  - Sometimes it pays to operate outside of the standards

CCTV Change to IP

- RG cables go approximately 750’
- Traditional category cables go 100m (328’)
- Video Optimized cable 850’ with PoE+

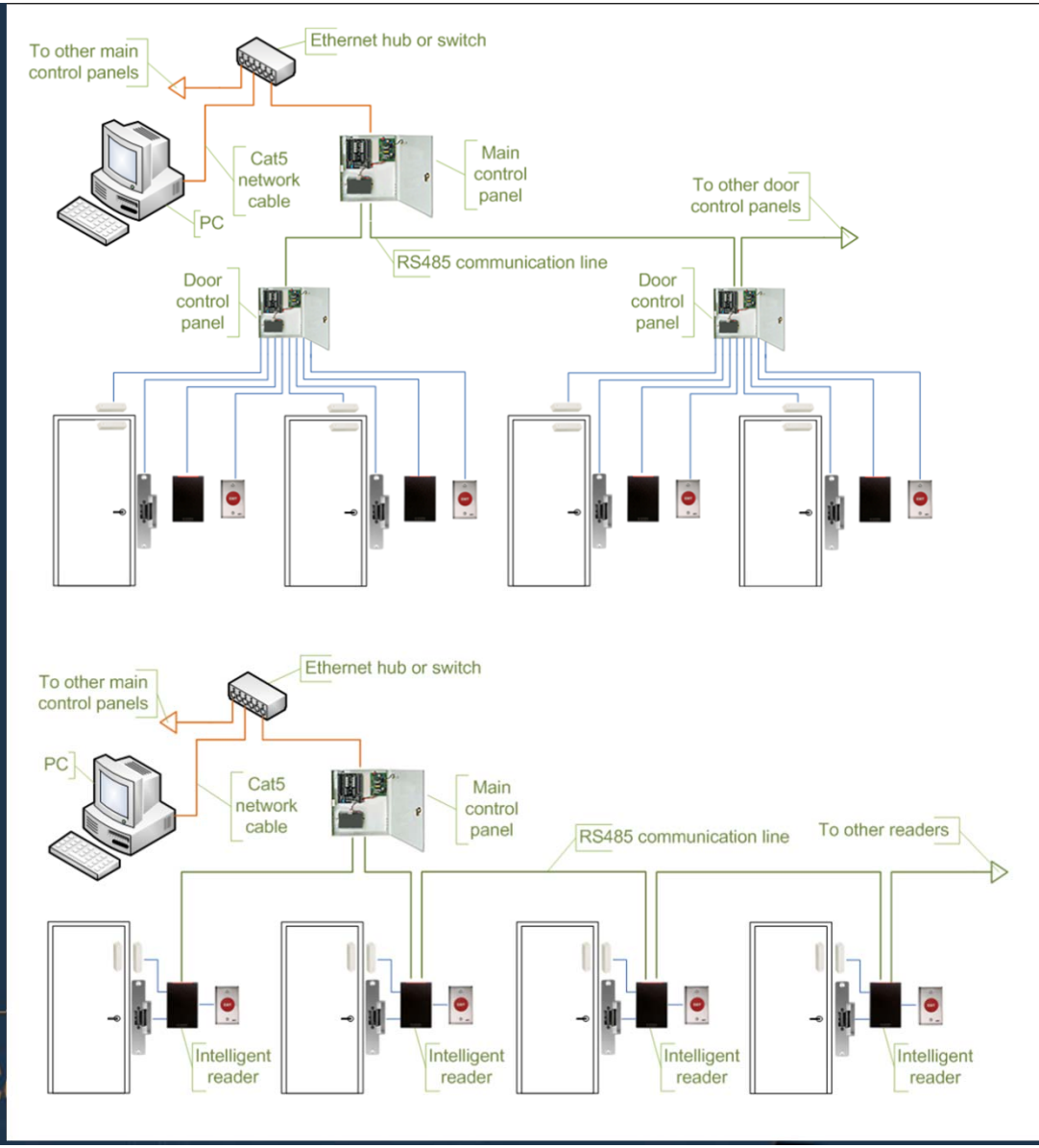


Cost with Transceivers

	Materials from 328' to 750'	Each	Extended	Additional Cost per Run
2	Cost of Tranceiver	$ 800.00	$ 1,600.00	
2	Cost to Add Power	$ 250.00	$ 500.00	
422	Additional Fiber, connectors, etc.		$ 506.40	
			$ 2,606.40	$ 2,006.40
	Additional IDFs			
3	Power, Switch, Enclosure	$ 1,500.00	$ 4,500.00	$ 3,900.00
	Cable Option			
1000'	Cost of Video Optimized Cable		$ 600.00	$ -

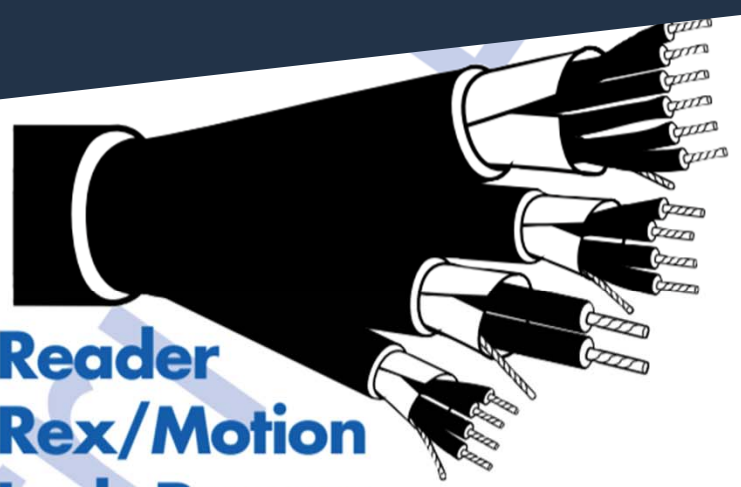
- GameChanger Cable Optimized for Video 850’ no repeater

Doors Only


To other main control panels
Ethernet hub or switch
Cat5 network cable
PC
Main control panel
To other door control panels
RS485 communication line
Door control panel
Door control panel
To other main control panels
Ethernet hub or switch
PC
Cat5 network cable
Main control panel
RS485 communication line
To other readers
Intelligent reader
Intelligent reader
Intelligent reader
Intelligent reader

Composite Cable Example

ACCESS CONTROL
ALL-IN-ONE / COMPOSITE CABLE



6 CONDUCTOR 18 AWG SHIELDED – **Reader**
4 CONDUCTOR 18 AWG SHIELDED – **Rex/Motion**
2 CONDUCTOR 16 AWG SHIELDED – **Lock Power**
4 CONDUCTOR 22 AWG SHIELDED – **Door Contact**

Not all Composites are the Same

- You must verify all components
- Look at shielding of all components
  - Unshielded cables next to magnetic doors
  - Unshielded cables next to noise sources
  - Not all of these cables are balanced
  - Not all pairs are twisted

NEC Sections

- Article 725 – Remote Control, Signaling Circuits
- Article 770 Optical Fiber Cables and Raceways
- Article 800 Communications Circuits
- Article 820 Community Antenna Television (CATV)

Coatings and Jackets

- Not limited to plenum and riser
- Ceramic Reactive Coatings for Fire
  - Circuit Integrity Cable
  - Turns to ceramic when exposed to Fire/Water
  - Maintains integrity of circuit for 2 hours
    - Higher hour ratings require conduit encasement

New Circuit Integrity Requirements

- 72.F requirements section 3.3.188 which states “the ability of a conductor, optic fiber, radio carrier, or other means for transmitting system information to remain operational during fire conditions. The required functionality is tested and verified by UL 2196 and is one of the most stringent tests conducted to verify operation during fire events

Shielded and Not Shielded Applications

- Composite Cables may or may not have the right combination
- Vary within states/countries due to governance
- Not having a shield for some applications is a big thing

Why you Don’t Need Category Everywhere

- Wasted pairs
- Electrically insufficient
- Code insufficient
- Application insufficient

Do We Need IP Everywhere?

- Many kinds of data and protocols
- Not all are IP
- Not all are needed

Miscellaneous Protocols

- Consider a gateway
- Consider if solution sets will do
- Consider whether real-time communications between systems is needed
- Reach out to your vendor/integrators and ask about solutions
- Do your own research!
- Beware over planning for information that will not hit your data center

A Word About the Information

- Not all information is useful
- The more you store the more you have to process
- Some information will be M2M only
- The more you capture, the more you will want to capture
- Give info a litmus test
  - Is it useful?
  - Is it actionable?
  - Can it be measured?
  - Can changes be measured?
  - Is it in your disaster recovery/business continuity plan?

Build a Chart – Expect it to Change

- What information will be gathered by each system
- Where will that information be stored?
  - Locally
  - Centrally
  - Cloud
- How long will it need to be stored?
- Will the information need to be backed up?
- What other systems will interface with each system?
- Will the interfaces require full information or partial information?

Information You Don’t Need…

- Personal device information
- Active Noise (calls, etc.)
- Passive noise (M2M)
- Nearfield Communications (maybe)

What is Near-field Communication?

- Generally mobile device to fixed device
- Generally quick bursts of data
- Normally command based

Near Field Hybrid Example

- Apple Pay
- Phone communicates to reader (Near Field)
- Reader processes payment (Network Communication)

Data Center Considerations

- Segmentation of networks
- Amount of storage
- Location of data
  - Cloud?
  - Colo?
  - In house?

Considerations for Location of Data

- Latency
- Availability
- Interfaces with other data/systems
- Longevity
- Privacy
- Personally identifiable information

How Many Data Centers

- Edge
- Centralized
- Warm/Hot site
- Some combination
- Data Centers in 2018 will be different!

Little Known Nuggets of Info

- Rebates and Relationships Exist
  - Who benefits?
  - Does it sway product recommendations?
  - How do you check them?
  - What value comes as a result of markup?
- What are other sources of information?
  - Power companies can be a great source and also can provide grants
  - Trade Associations
  - A&E's, Consultants

Understanding your Supply Chain

- No one works for free
- No one stocks everything
- You can benefit from flexibility
- Price several options
- Understand how the standards can work for you
- Know the difference between a code and a standard
- Know what you need ahead of time. If you are constantly reacting you are not part of the process and doomed to fail
- Know other solutions ; there is NO one size fits all

Myth Busters (shameless rip off) 101

- If communications are IP then you must use 4 pairs of category cable
- You must re-cable your building
- You need new systems for IoT
- You need to quintuple (at least) capacity for everything
- IoT is going to break the bank
- Plan for the worst, expect the best

If communications are IP then you must use 4 pairs of category cable

You can not have your fire system talk to other systems

The amount of traffic will kill my network

All communications are IP

- M2M
- Near field protocols

All of the IoT traffic will traverse my main network

My Vendor is the best source of information

Understand the Where, What and How of Communications

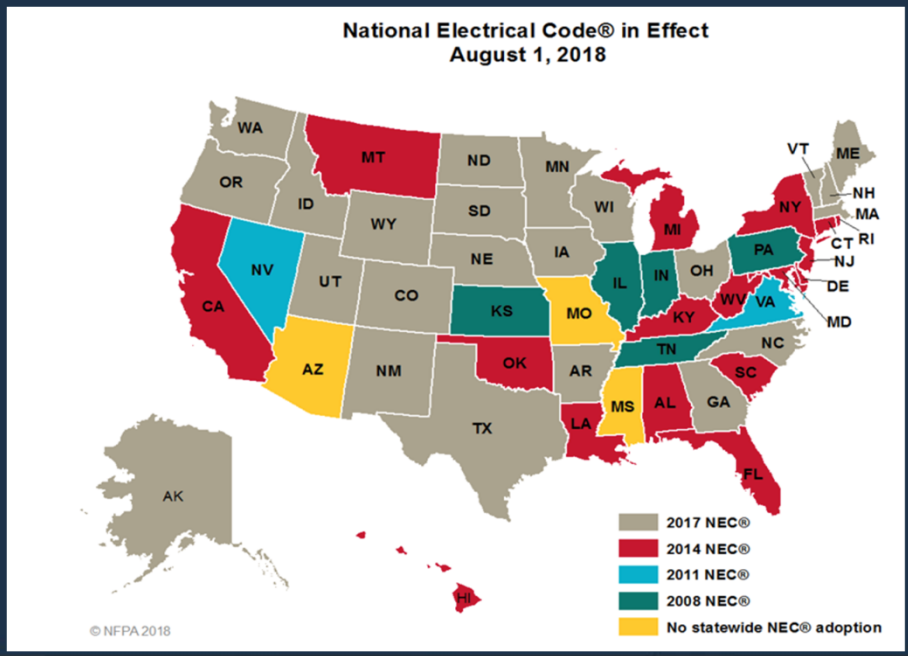
- Gateway – leaves end systems intact
  - Think translator
- Native – systems share a network (generally IP)
- Wireless is part of the equation
- Switches will determine which network
- The most secure network is one no one can get to from the outside

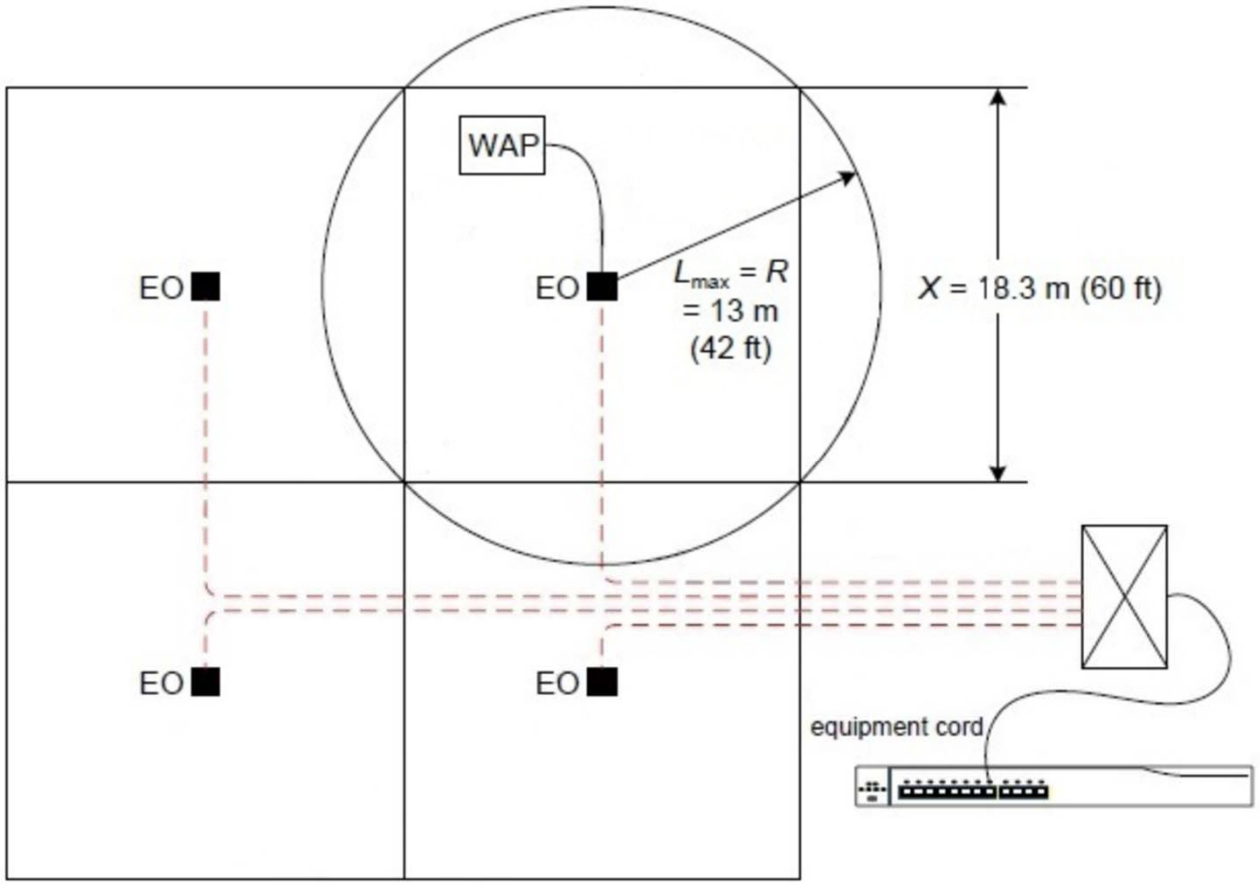
Make a Roadmap of Your Own

- The right vendor questionnaire
  - Ask about interoperability
  - Ask about resources available to you
  - Will the vendor support directly or will they rely on integrators/installers
  - Ask about knowledge transfer
  - Ask for direct pricing
  - Don’t forget forward looking questions

New Code Changes for PoE/PoE+

- LP Cables are an OPTION
- Ampacity –governs 725.144
  - New in 2017
  - Max current a conductor can carry continuously without exceeding temperature rating
- 802.3bt
  - Type 3 60W PSE, 51W PD
  - Type 4 90W PSE, 71.3W PD
  - Classes 1-4 (previous generation)
  - Classes 5, 6 (Type 3)
  - Classes 7, 8 (Type 4)





Typical Uniform Coverage Area Grid Pattern

Conclusions

- Determine what devices will be on or near your networks
- Plan for the bandwidth within reason
- Plan for changes – status as usual won't work
- Don't plan in a vacuum
- Be prepared to reevaluate often

QUESTIONS?

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