A Pair is a Pair is NOT a Pair

Carrie Goetz, D.MCO
RCDD, NTS, CDCP, CDCS, 1st Degree IM
Paige DataCom Solutions

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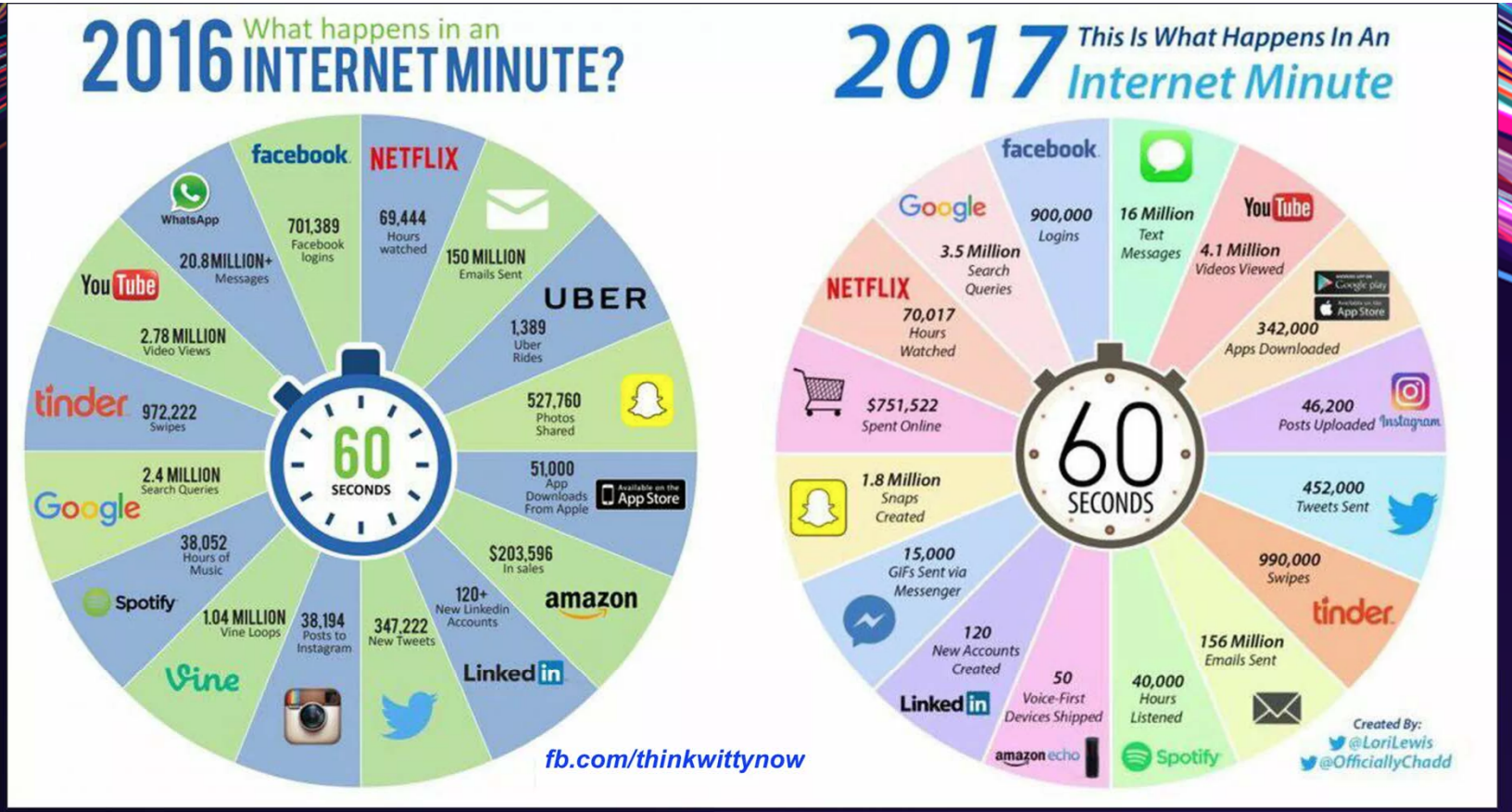

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Gartner Says 8.4 Billion Connected "Things" Will Be in Use in 2017, Up 31 Percent From 2016

Table 1: IoT Units Installed Base by Category (Millions of Units)

Category	2016	2017	2018	2020
Consumer	3,963.0	5,244.3	7,036.3	12,863.0
Business: Cross-Industry	1,102.1	1,501.0	2,132.6	4,381.4
Business: Vertical-Specific	1,316.6	1,635.4	2,027.7	3,171.0
Grand Total	**6,381.8**	**8,380.6**	**11,196.6**	**20,415.4**

Source: Gartner (January 2017)

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What are these Things?

- Sensors
- Controls
- Thermostats
- Command Chips
- Consumer Devices
- Security Devices
- Safety Devices
- Cameras
- Thermostats
- Controllers
- Lighting Controls
- Etc.!

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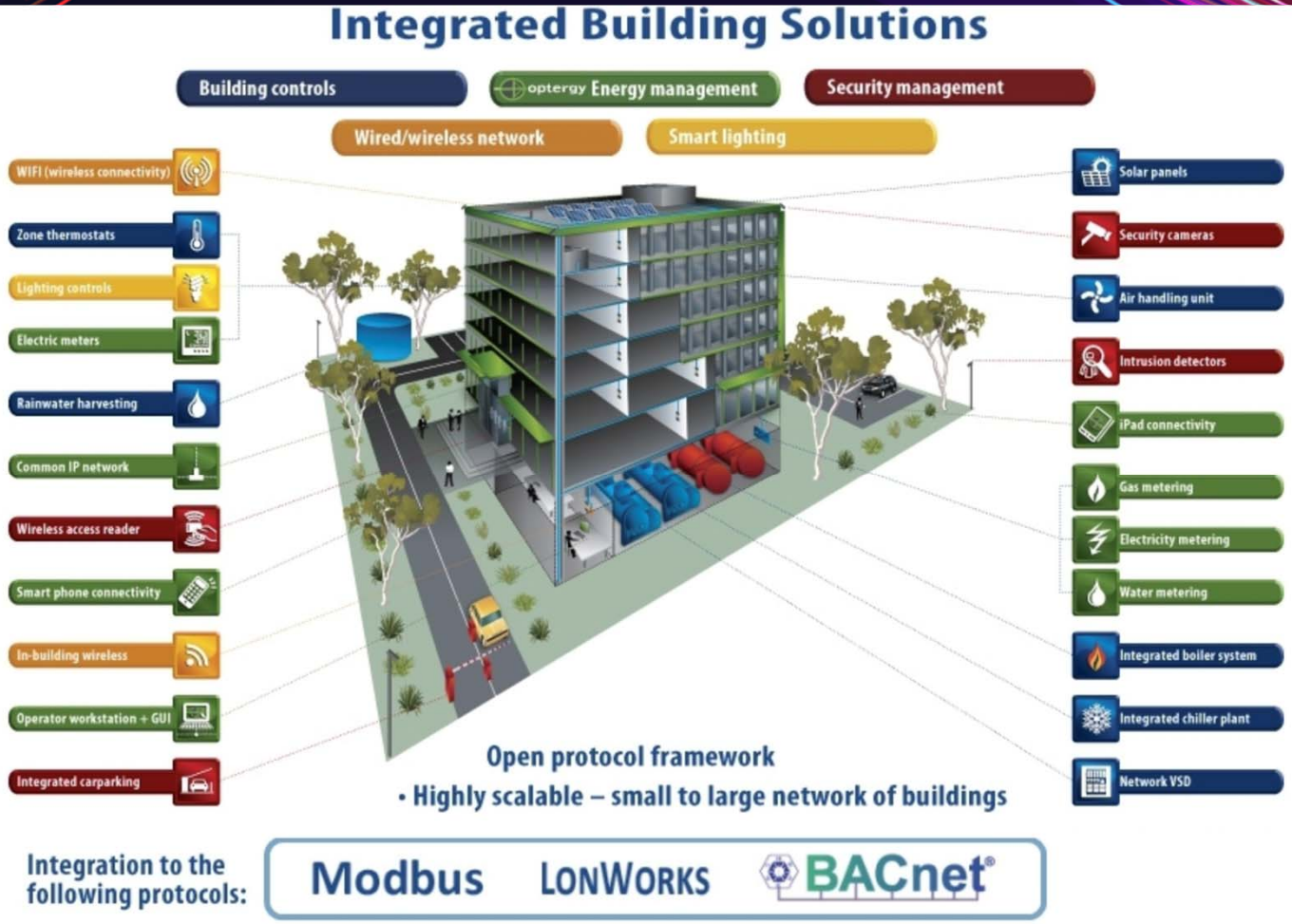
[Diagram by: http://optergy.com.my/solutions/integrated-solutions/](http://optergy.com.my/solutions/integrated-solutions/)



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Facilities
Networking
Procurement
Vendors
Security
CIO/CTO
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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

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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

Standards and Code Bodies

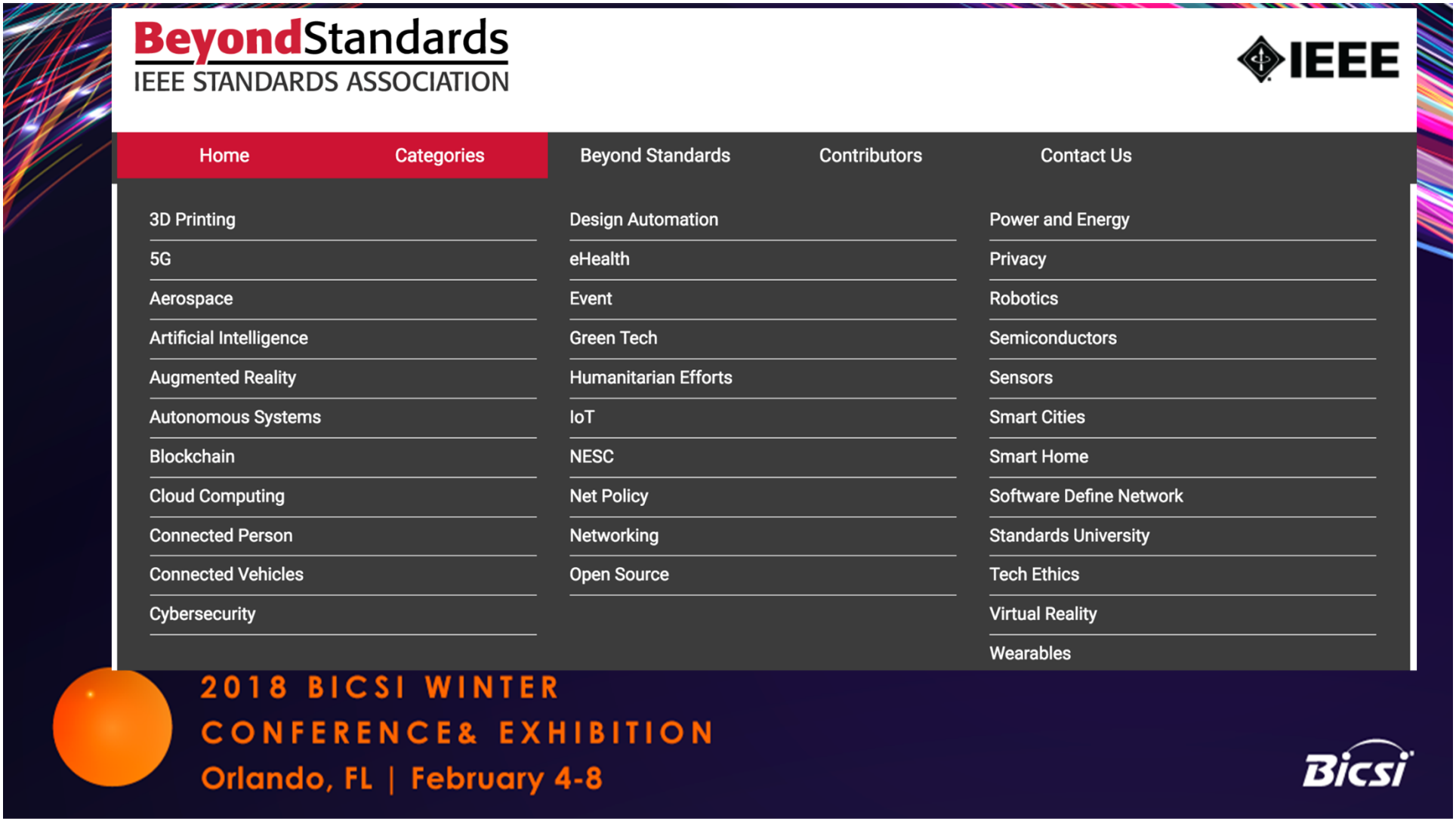
- ANSI/TIA/EIA North American standards
- ISO/IEC International standards
- IEEE Electronics standards
- BICSI Standards and best practices
- NEC National Electrical Code
- NFPA Fire Codes

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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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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New 1 Pair Standards

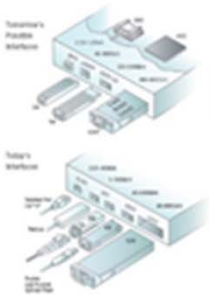
Single pair Ethernet standards under development

- 802.3bp 1000BASE-T1 (published)
  - 1 Gbps Ethernet over at least 15 m and up to at least 40 m on one pair of balanced cabling
- 802.3bw 100BASE-T1 (published)
  - 100 Mbps Ethernet up to 15 m on one pair of balanced cabling (Automotive)
- 802.3cg 10BASE-T1 (in progress, June 2019)
  - 10 Mbps Ethernet up to 1 km on one pair of balanced cabling with power target - industrial
- 802.3bu (2016)
  - power over data lines on one pair of balanced cabling
  - Class 0-9 ranging from .5 to 50W

MEDIA AND MODULES

Ethernet is wired technology and supports a variety of media including backplanes, twisted pair, twinax, multimode fiber and single-mode fiber. Most people know Ethernet by the twisted pair or Cat "x" cabling with RJ45 connectors because close to a billion ports a year are sold.

The graphic below shows multiple types of modules that may be used for copper or optical links. The upper modules are being developed to support ultra-high density port counts. The μQSFP shrinks the QSFP down to an SFP size while the QSFP-DD doubles the lane count to 8. On Board Optics (OBO) enable the highest port counts on switches.



2016 ETHERNET ROADMAP

THE PAST, PRESENT AND FUTURE OF ETHERNET

ethernet alliance

www.ethernetalliance.org

Designed by Scott Kipp

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$5.95

2016 ETHERNET ROADMAP

FLEX ETHERNET (FLEXE)

Defined by the Optical Internetworking Forum (OIF), FlexE is often called a new generation of Link Aggregation (LAG) and may provide a path to speeds higher than 400G without an IEEE standard. Proponents of FlexE claim that higher speeds like 800GbE are not necessary since these speeds just aggregate many lanes that run at lower speeds. FlexE can aggregate individual Ethernet links and creates a FlexE Mac that connects to another FlexE MAC. The illustration below shows a 500G FlexE group that bonds five 100GbE links together.

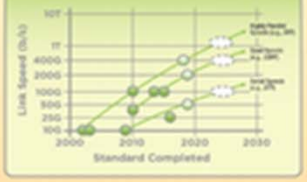
The FlexE Group refers to a group of from 1 to n bonded Ethernet PHYs. A FlexE Client is an Ethernet flow based on a MAC data rate that may or may not correspond to any Ethernet PHY rates. The FlexE Shim is the layer that maps or demaps the FlexE clients carried over a FlexE group. In the example illustration below, three 100GbE and one 50GbE FlexE clients connect over the transport network via a FlexE Group that supports 350Gb/s of bandwidth over 2 wavelengths of 175Gb/s.

Ethernet Speed

Speed in Development

Possible Future Speed

TO TERABIT SPEEDS



ETHERNET INTERFACES AND NOMENCLATURE

	Electrical Interface	Backplane	Twinax Cable	Twisted Pairs	MMF	Parallel SMF	Duplex SMF	Duplex SMF	WDM SMF
10BASE-				T					
100BASE-				TX	FX			LX	
1000BASE-		KX	CX	T	SX			LX	
2.5GBASE-		KX		T					
5GBASE-		KR		T					
10GBASE-	SR, LR,	KX4, KR	CR	T	SR			LR	ER
25GBASE-	25GAUI	KR	CR	T	SR			LR	ER
40GBASE-	XLAUI	KR4	CR4	T	SR4		FR	LR4	ER4
50GBASE-	50GAUI-2/1	KR	CR		SR		FR	LR	
100GBASE-	CAUI10	KR4, KR2	CR10,		SR10	PSM4	10X10	LR4	ER4
	CAUI4		CR4,		SR4		CWDM4	10X10	10X10
	CAUI-2		CR2		SR2		CLR4		
200GBASE-	200GAUI-4	KR4	SR4		SR4		FR4	LR4	
400GBASE-	CDAUI-16				SR16	DR4	FR8	LR8	
	CDAUI-8								

Gray Text = IEEE Standard Red Text = In Standardization Green Text = Under consideration in IEEE

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

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

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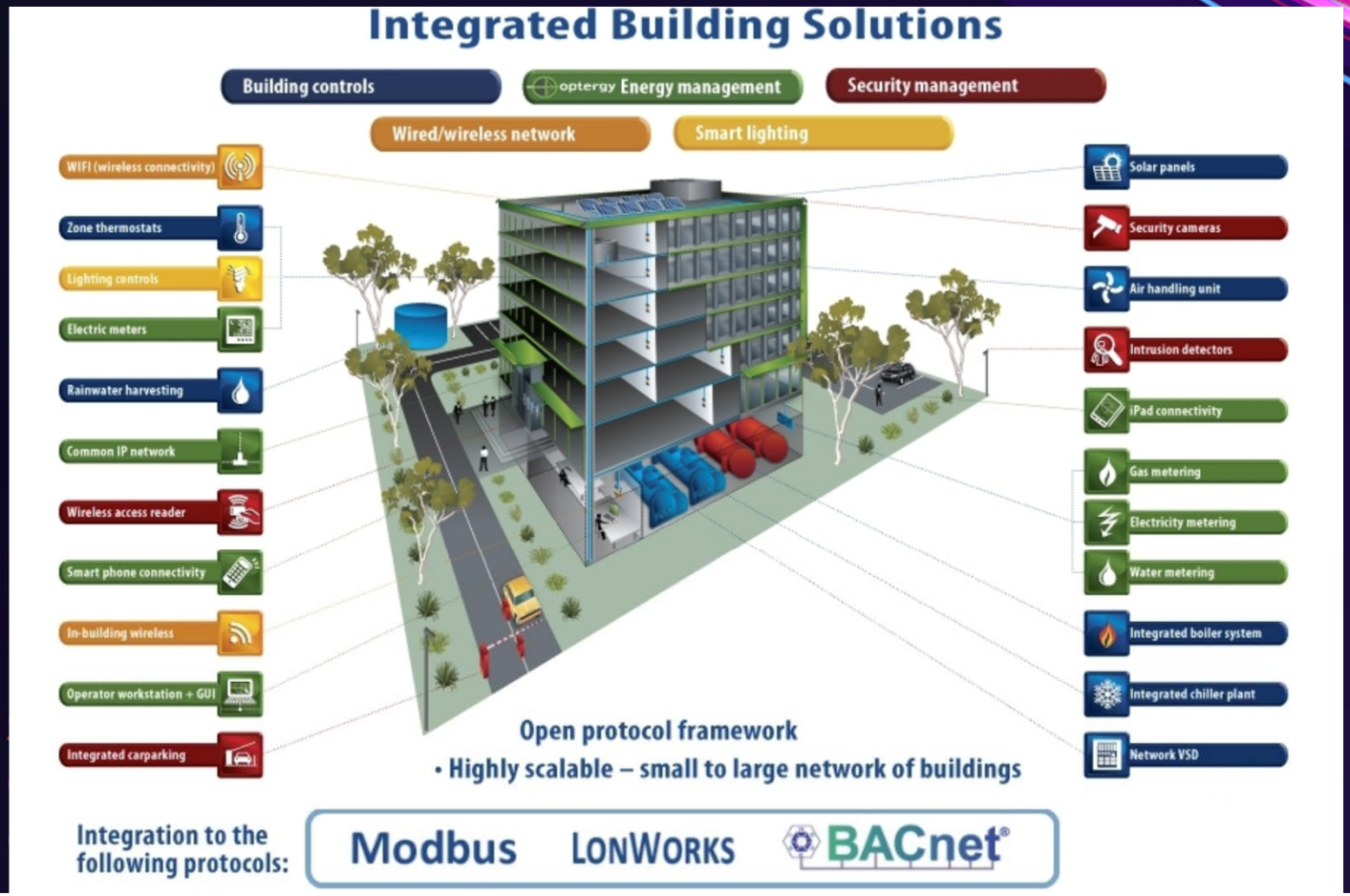
http://optergy.com.my/solutions/integrated-solutions/



IoT and Types of Communication

M2M (Machine 2 Machine)

Nearfield communications

ZigBee, RFID, Bluetooth, BACnet, ANT 802.15.4e, LoRaWAN, 6LoWPAN, RPL, CoAP, MiWi, ISA100.11a, Wireless HART, etc.

Cellular

A Quick Word about Wireless

- Pay attention to the environment
- Saturation can be an issue
- Multipath can cause problems
- As communication needs increase, balance will be key
- Don’t assume that grids automatically work

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

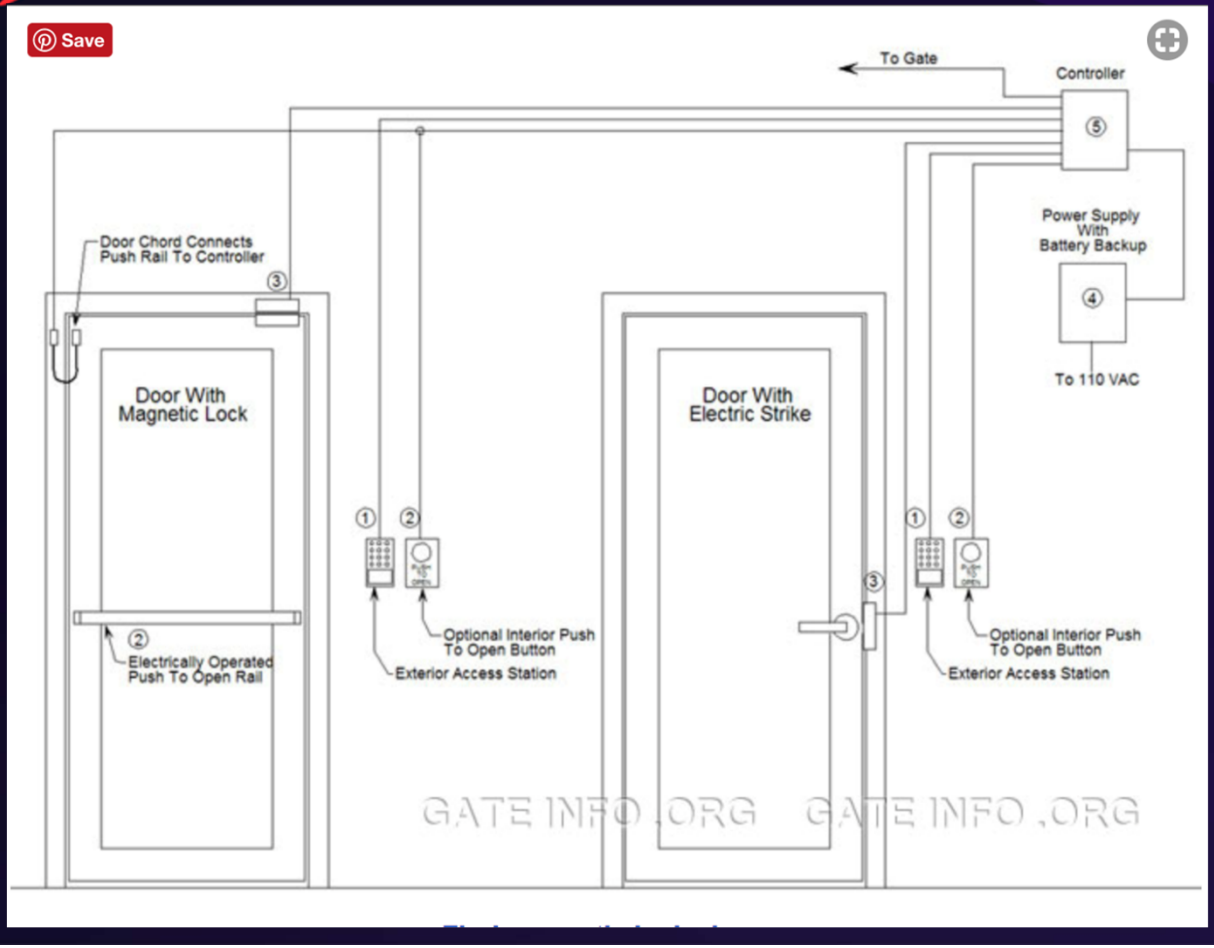
How far can it go?

- 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’

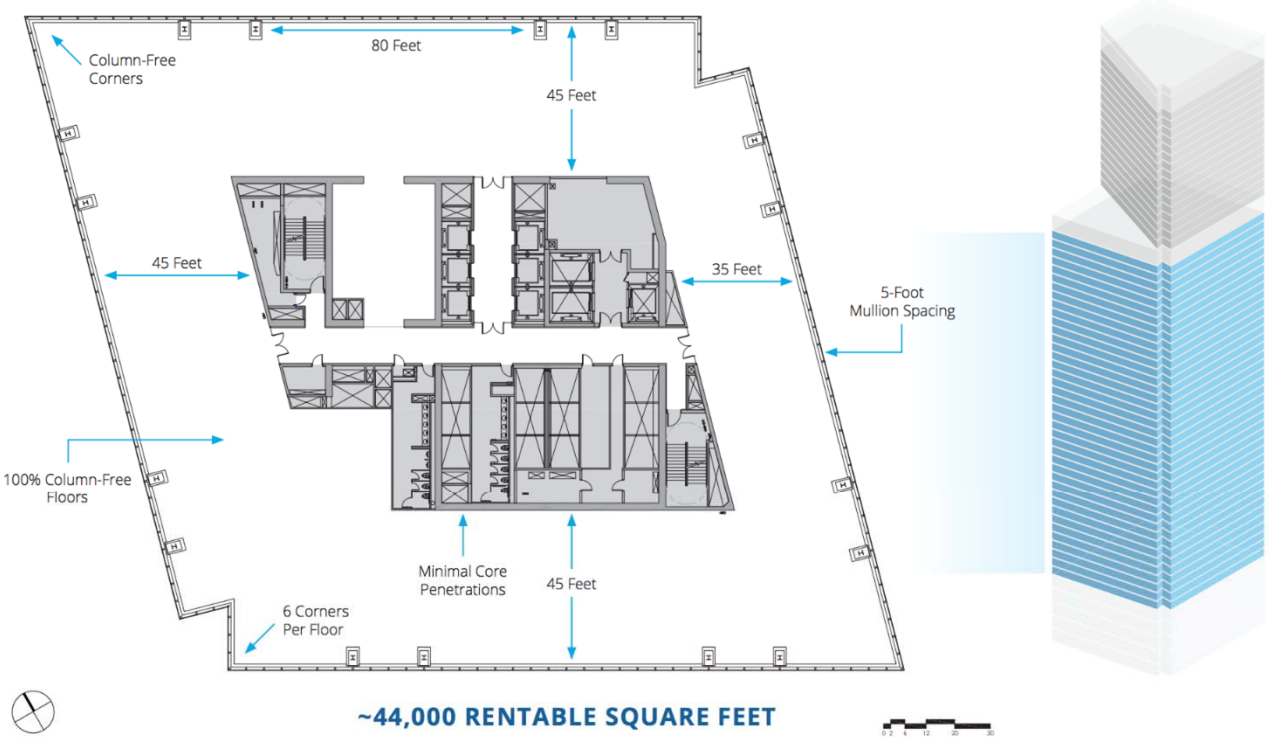


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Table 2. Test Results from TIA TR-42 and ISO/IEC

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.

PoE, PoE+, PoE++, LP Cable

LP Cabling is not required
May prevent some testing, but TBD
Bundling constraints based on power

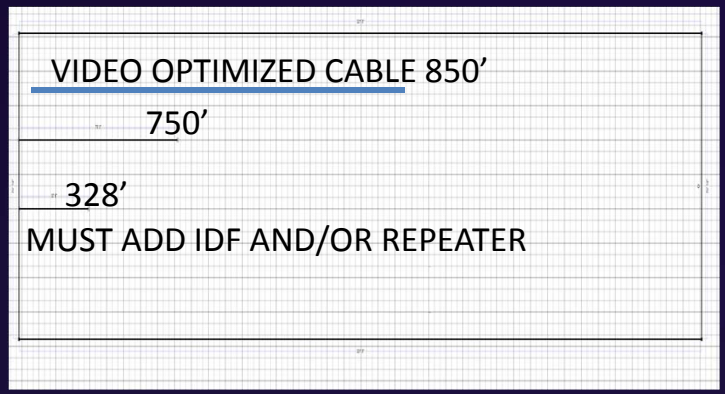
AWG	Number of 4-Pair Cables in a Bundle																			
	1			2-7			8-19			20-37			38-61			62-91			92-192		
	Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating		
	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C
26	1	1	1	1	1	1	0.7	0.8	1	0.5	0.6	0.7	0.4	0.5	0.6	0.4	0.5	0.6	NA	NA	NA
24	2	2	2	1	1.4	1.6	0.8	1	1.1	0.6	0.7	0.9	0.5	0.6	0.7	0.4	0.5	0.6	0.3	0.4	0.5
23	2.5	2.5	2.5	1.2	1.5	1.7	0.8	1.1	1.2	0.6	0.8	0.9	0.5	0.7	0.8	0.5	0.7	0.8	0.4	0.5	0.6
22	3	3	3	1.4	1.8	2.1	1	1.2	1.4	0.7	0.9	1.1	0.6	0.8	0.9	0.6	0.8	0.9	0.5	0.6	0.7

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+

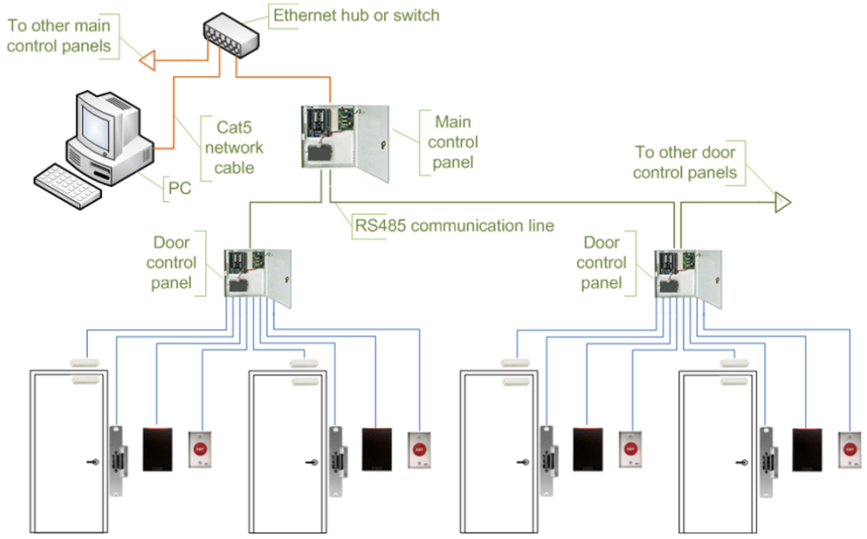


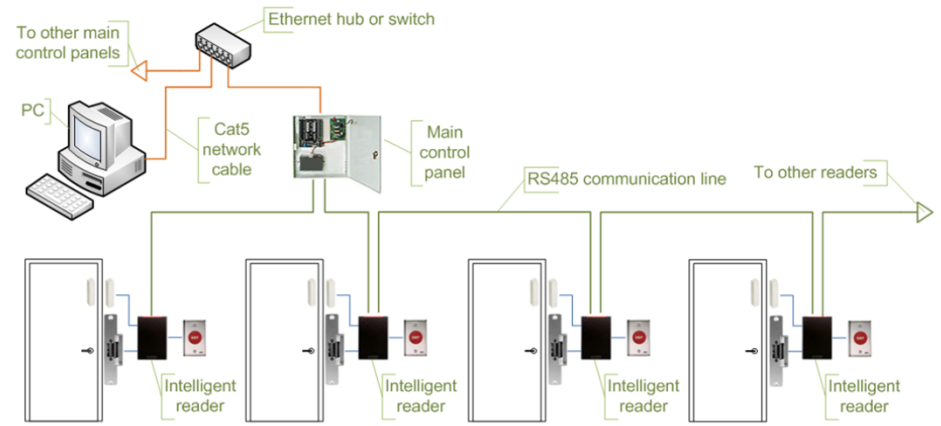
Cost with Transceivers

	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





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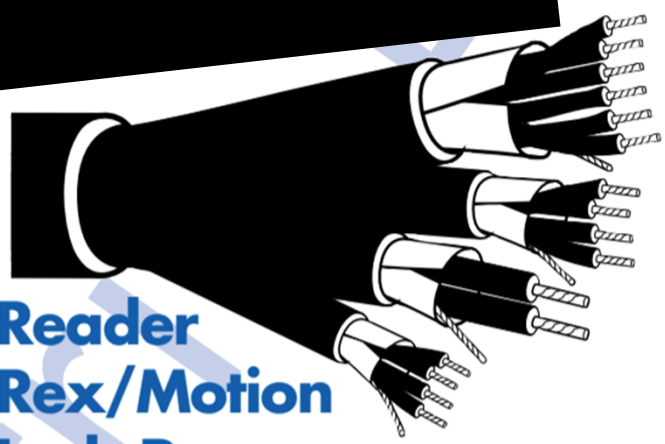
Composite Cable Example



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?

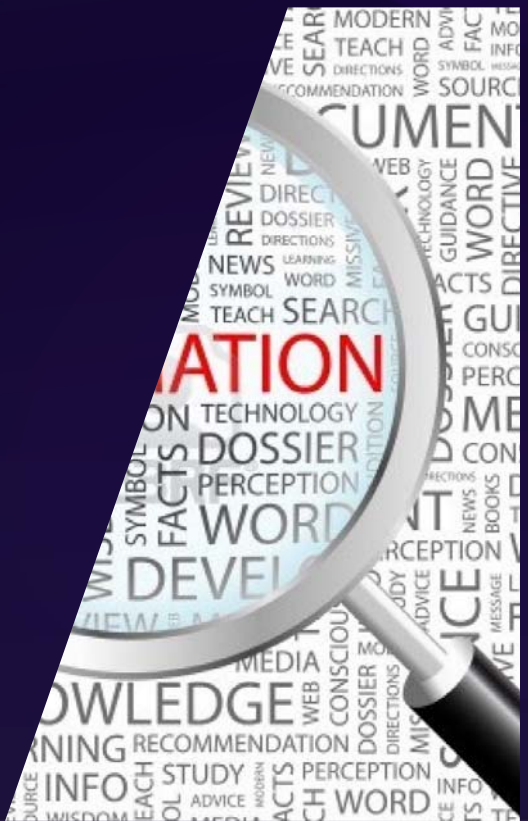
- Many kinds of data and protocols
- Not all are IP
- Not all are needed

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?



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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

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www.nearfieldcommunication.org

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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!

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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