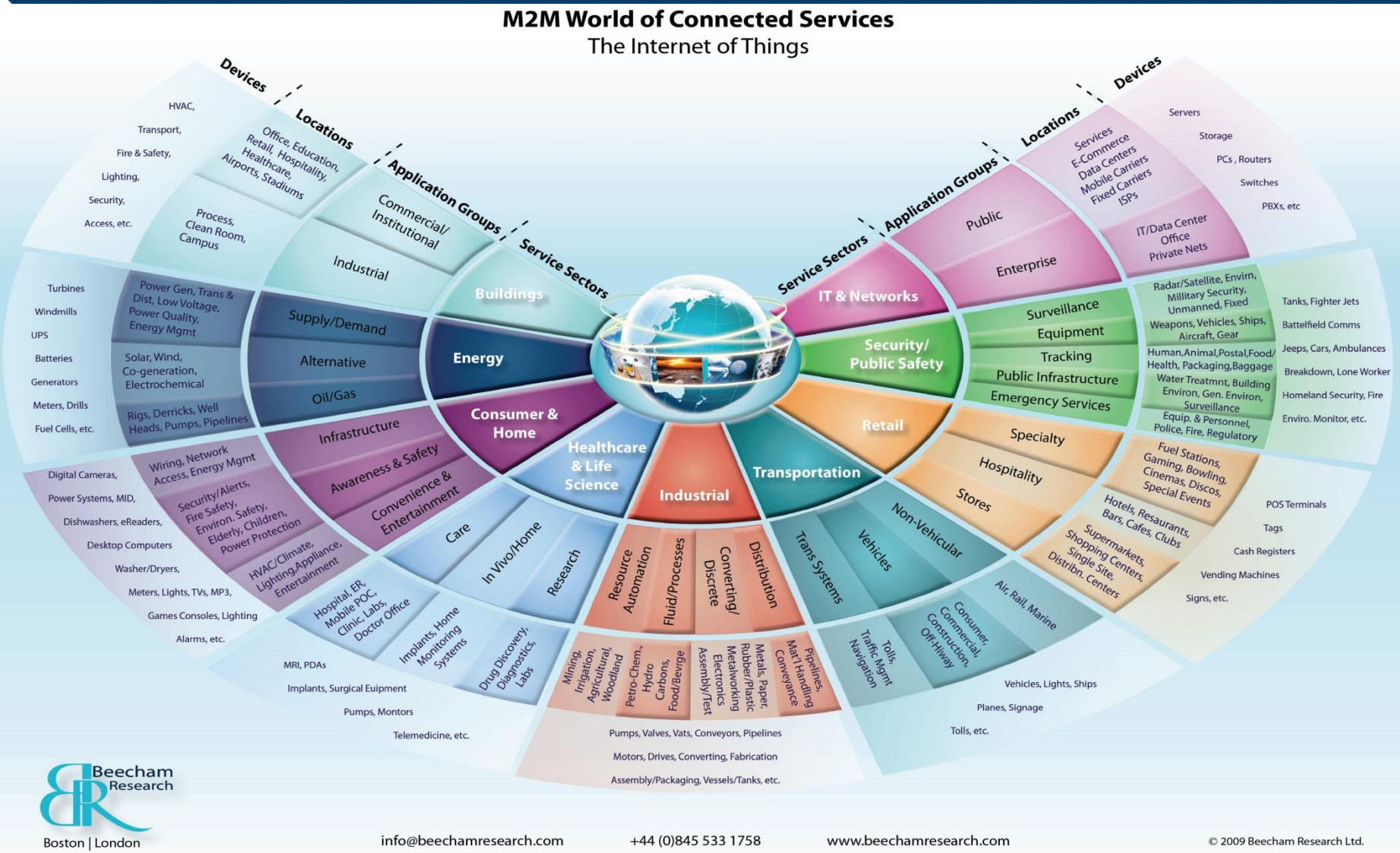
What is Industrial Ethernet?

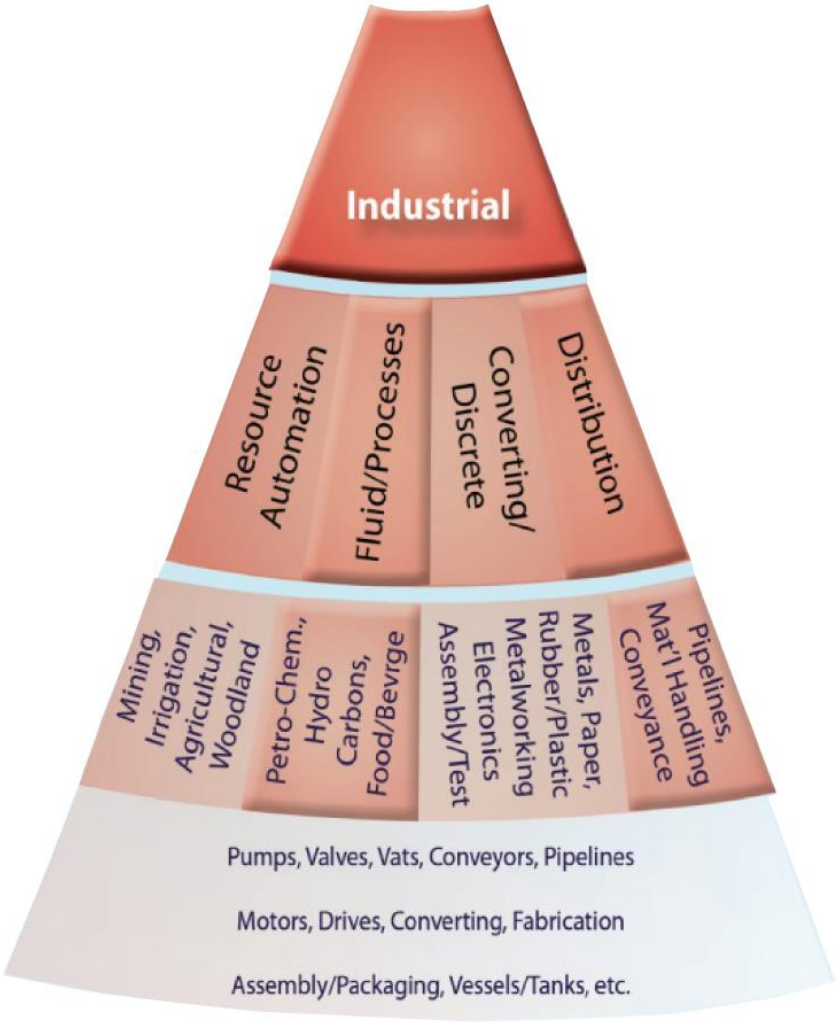
- It's a specific type of "Internet of Things" used to describe Ethernet used on manufacturing plant floors or in process facilities.
- It is rapidly growing already. 23% of the 31.3 million industrial networked nodes in 2011 were based on Ethernet. – IMS Research
- Total economic value of IoT will be $1.9T by 2020 with manufacturing and health care verticals leading at 15% each. – Gartner Inc.

What is Industrial Ethernet



Beecham Research
Boston | London
info@beechamresearch.com
+44 (0)845 533 1758
www.beechamresearch.com

What is Industrial Ethernet



The Internet of Things

Industrial Ethernet Accounts for the Biggest Growth

The Internet of Things

The Industrialization of the Internet … Internet of Things

Total **500 Million**

1/10th of a Device per Person on Earth

2007

Total **35 Billion**

5 Devices per Person on Earth

2010

Total **1 Trillion**

140 Devices per Person on Earth

2013

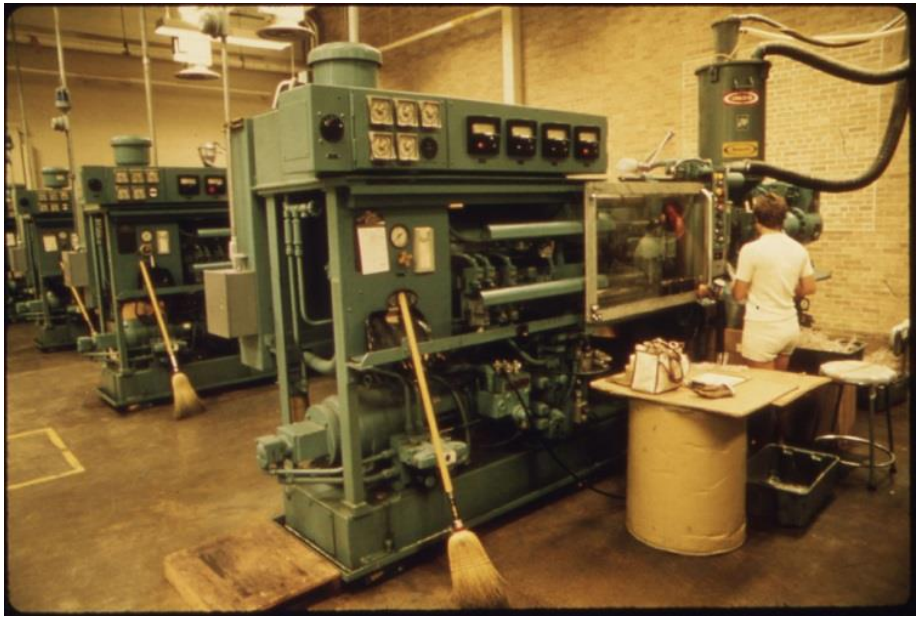
Source: Forester Research, CISCO

"Industrial" Looks Different

- Ethernet is the biggest thing to hit manufacturing facilities but it's a lot different then the typical Enterprise network.
- According to IMS Research only about 40% of installed industrial Ethernet nodes are standard TCP/IP and seems to be decreasing slightly over time.

A Look at the Past

- **Islands of Automation**
  Machines were self contained entities with little communication between each other or the plant facility. Relay logic prevailed.



A Look at the Past

- **Islands of Automation**
  Relays were replaced by PLCs and remained 'stand-alone'. Some specialized networks started to replace the direct wiring but control and information remained locked to that machine.

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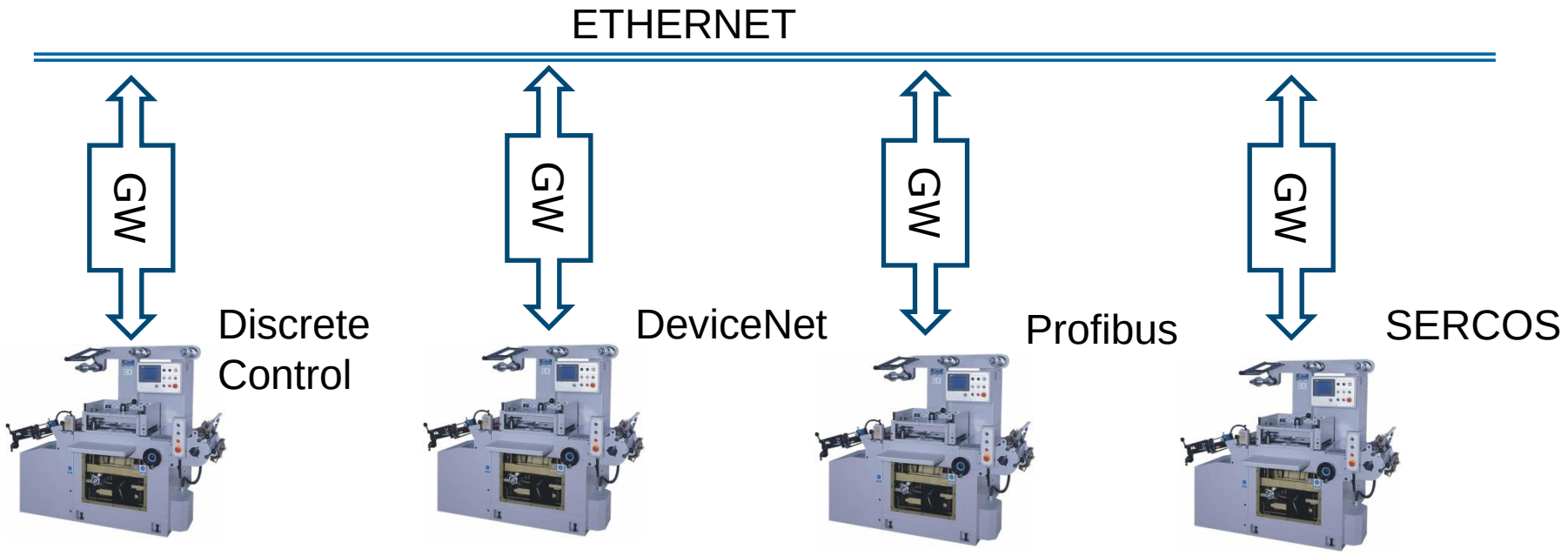
Ethernet to the Rescue

- **Islands of Automation**
  Ethernet was seen as method of extracting information from the PLC and maybe even its I/O so at least reports could be made.



Progression

- **But Why Not All the Way?**

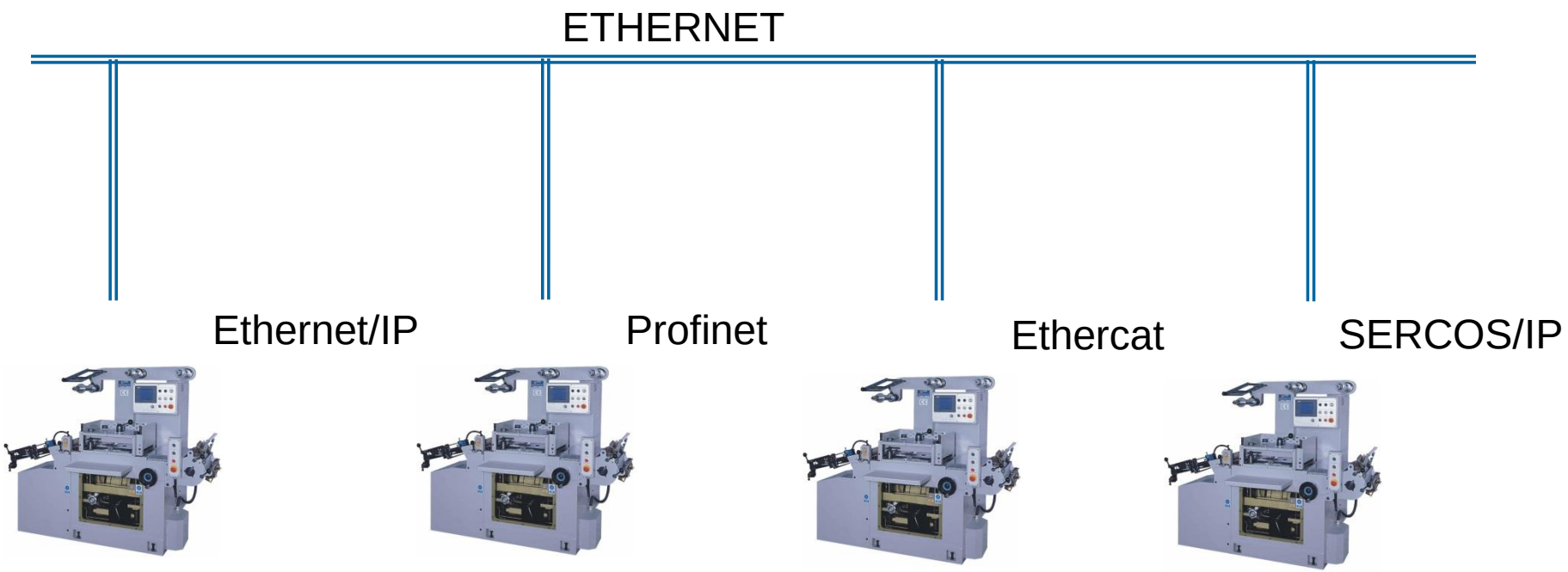
If machines were connected via Ethernet, why couldn't they be CONTROLLED by Ethernet? Little by little, the objections were overcome.

- Ethernet isn't Fast Enough – We need 'Real Time Controls'
- Ethernet isn't Deterministic – We can't have jitter
- Ethernet Topography isn't suitable – Star won't work
- Ethernet isn't redundant – Can't have single Source of failure
- Ethernet Components aren't designed for industry – this presentation!

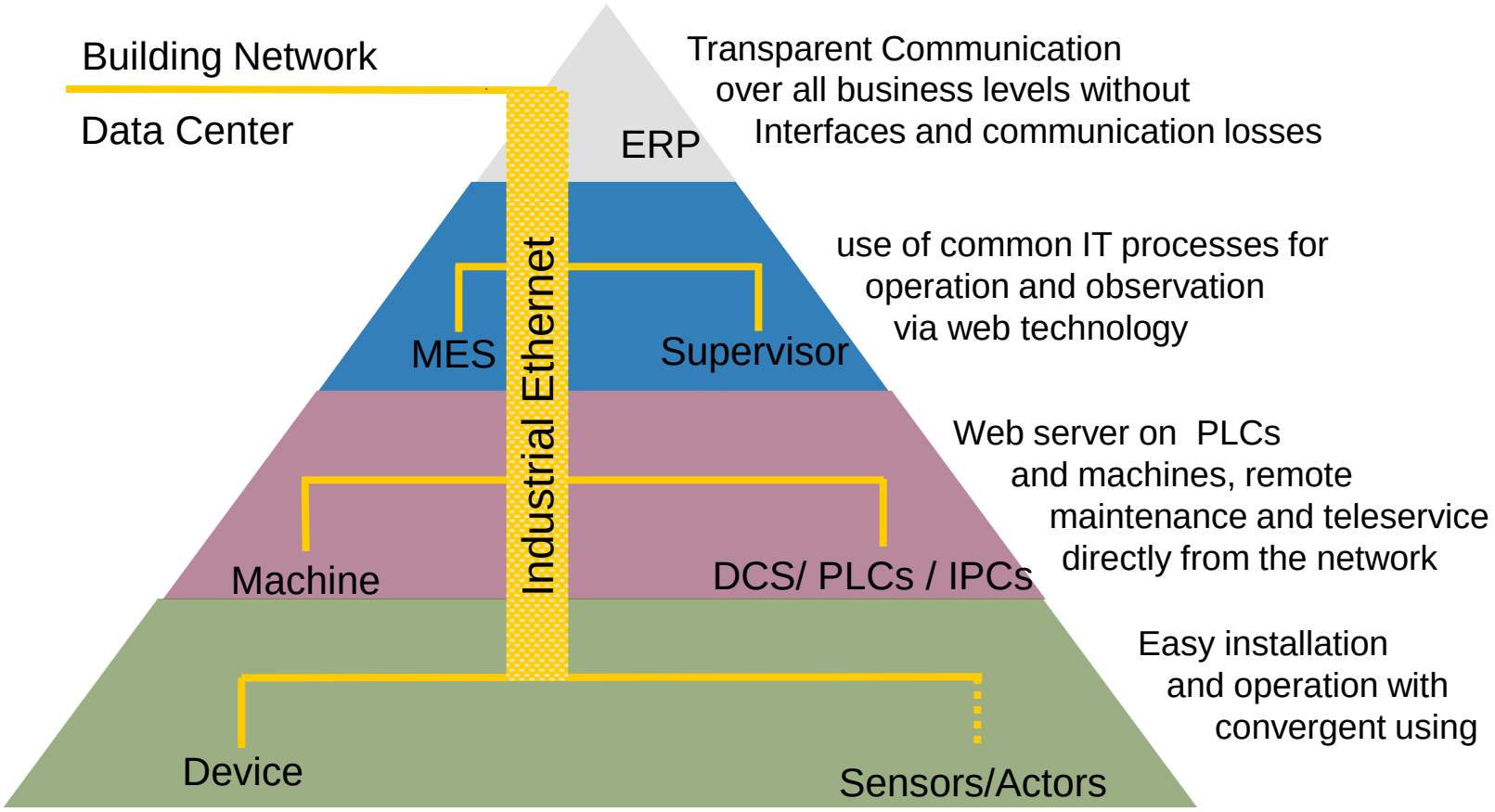
Progression

- **But Why Not All the Way?**

If machines were connected via Ethernet, why couldn't they be CONTROLLED by a variant Ethernet

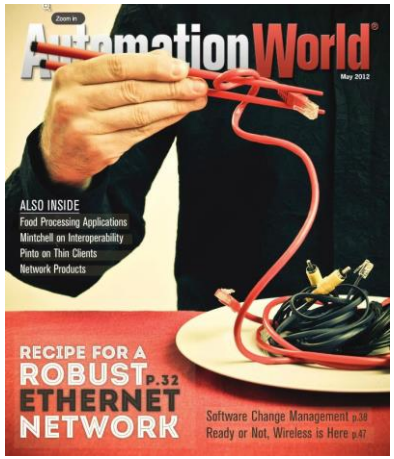


Seemless Infrastructure



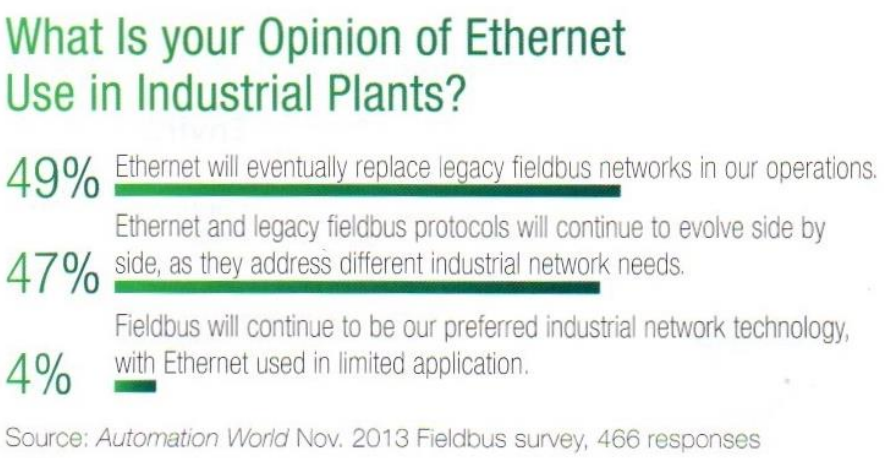
The Buzz Now

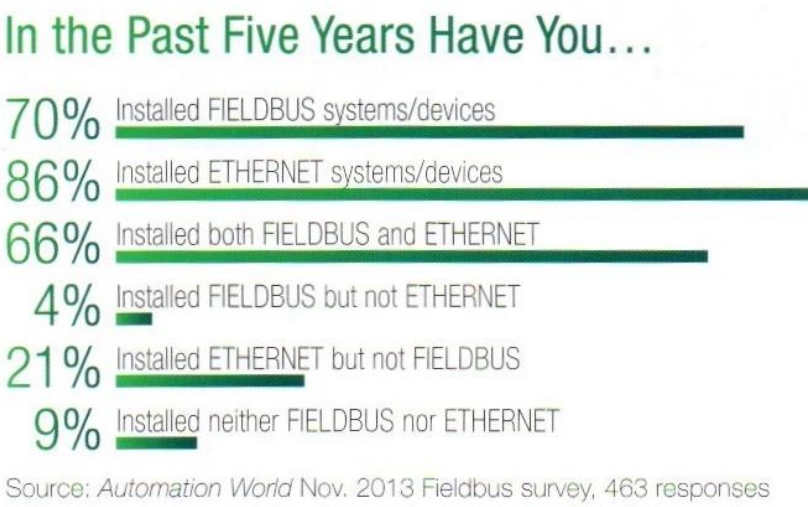
- **Trade Publication**
  Industrial Ethernet is discussed ALL THE TIME



Outlook

- **Outlook of Industrial Ethernet**
  Recent poll from Automation World



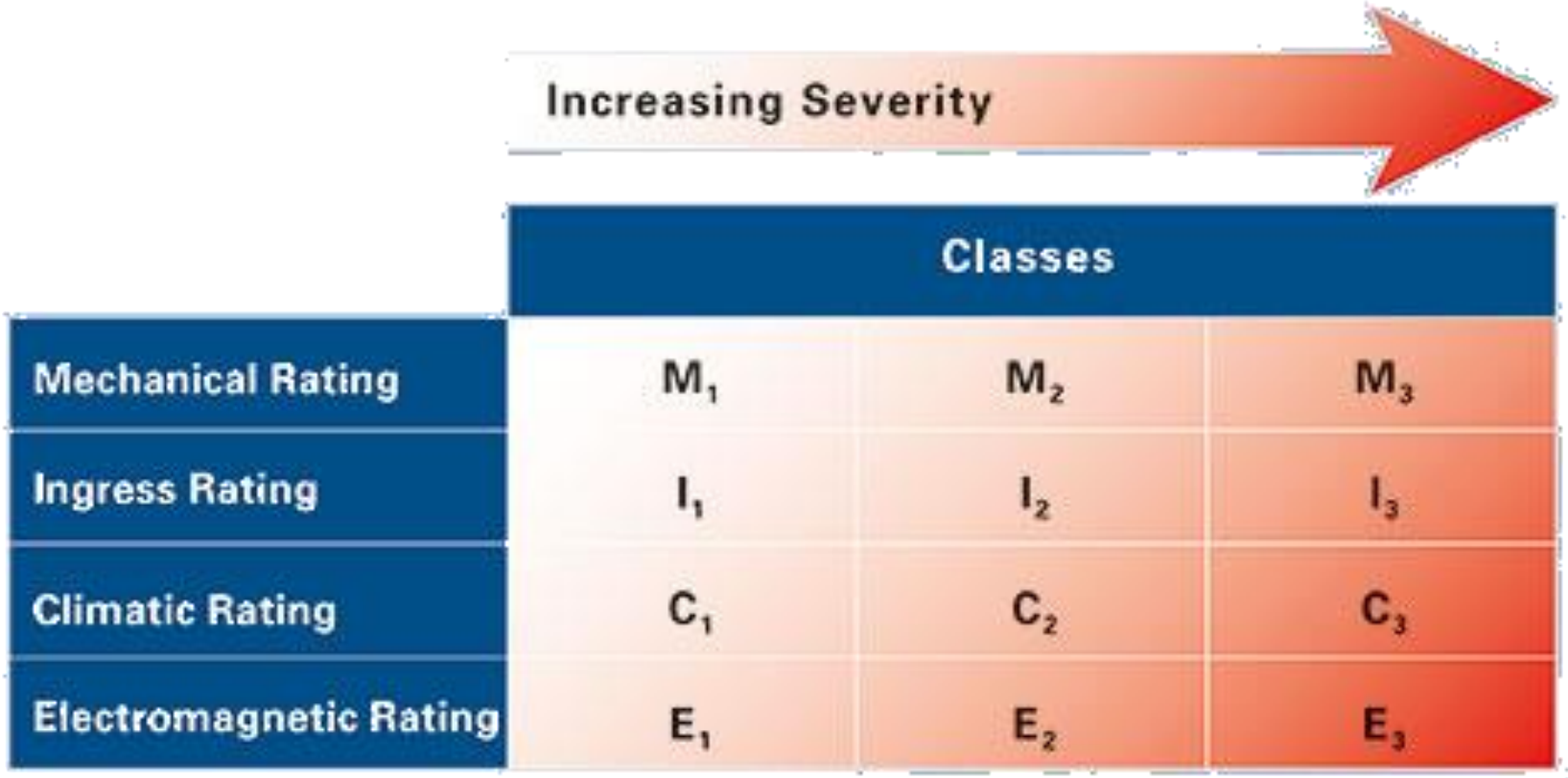


You Aren't in Kansas Anymore

- Users familiar with NEMA / IP ratings and rather than MICE. (Mostly Mice 2 and 3 areas)
- DIN rail mounted devices not 19" Racks
- Supply voltage is 24VDC not -48V
- Classified hazardous areas exist (Division 1 and 2)
- No Plenum/Riser Cables – Oil Resistant or High Flex

IEEE

IP Environmental Ratings



IP Environmental Ratings

- IP20 for components inside control cabinets
- IP65/67 for components outside control cabinets

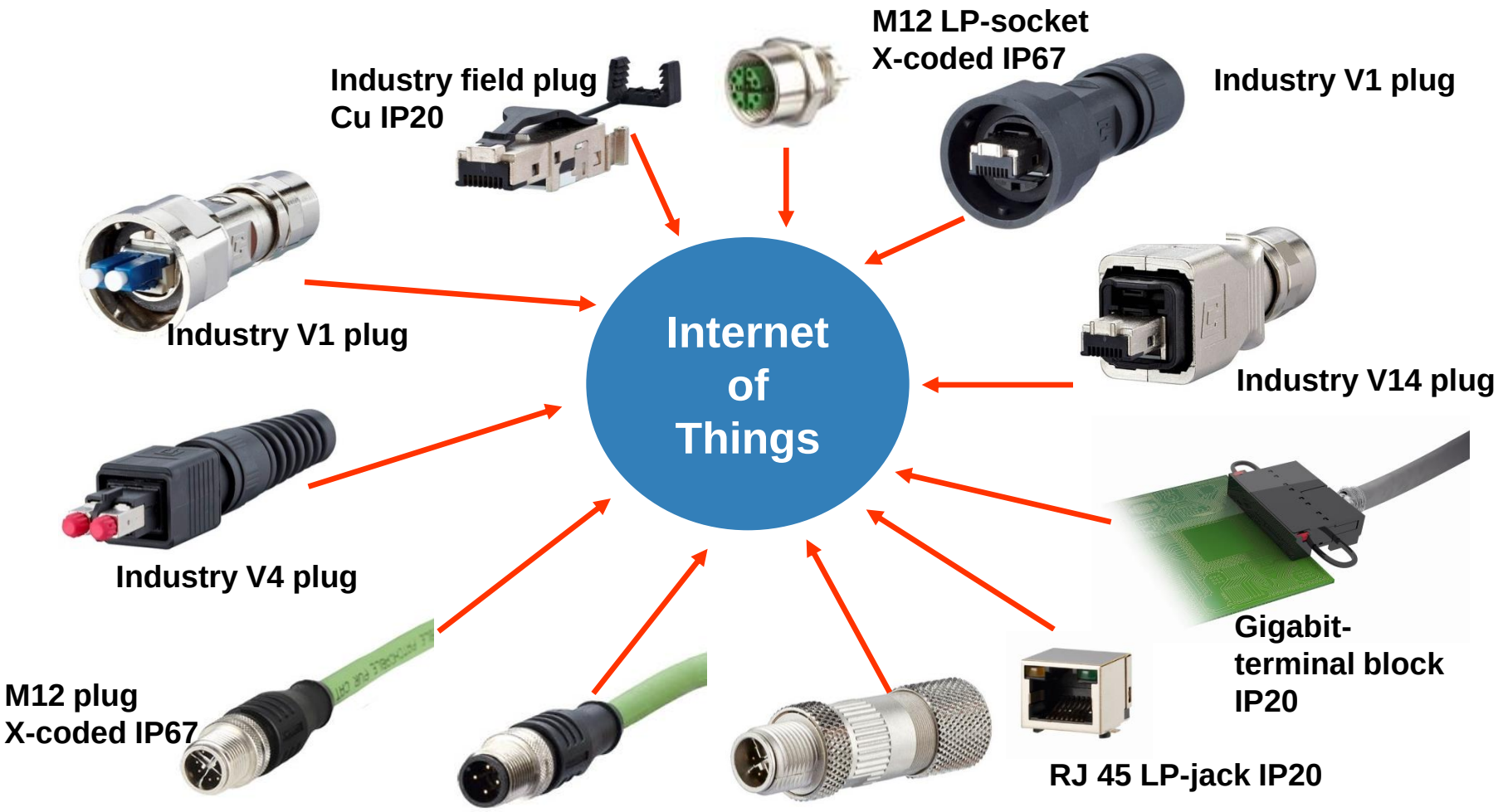
First Number	Definition	Second Number	Definition
Protection against solid objects		*Protection against liquids*	
0	No protection	0	No protection
1	Protected against solid objects over 50mm (e.g. accidental touch by hands)	1	Protected against vertically falling drops of water
2	Protected against solid objects over 12mm (e.g. fingers)	2	Protected against direct sprays up to 15° from the vertical
3	Protected against solid objects over 2.5mm (e.g. tools and wires)	3	Protected against direct sprays up to 60° from the vertical
4	Protected against solid objects over 1mm (e.g. tools, wires and small wires)	4	Protected against sprays from all directions - limited ingress permitted
5	Protected against dust - limited ingress (no harmful deposit)	5	Protected against low pressure jets if water from all directions - limited ingress permitted
6	Totally protected against dust	6	Protected against strong jets of water e.g. for use on shipdecks - limited ingress permitted
		7	Protected against the effets of temporary immersion between 15cm and 1m. Duration of test 30 min.
		8	Protected against long periods of immersion under pressure

General "Industrial" Requirements

Industrial locations include the manufacturing floor, process plant, traffic control, water treatment, and transit systems needing:

- "Real Time" Control Needs
- Multiple levels of redundancy
- More extreme vibration and shock
- Water, Dust, Coolant Exposure

Industrial Device Connections



Industrial Bus Networks

Network	Founder	Organization
Ethernet/IP	Rockwell Automation	ODVA
Profinet	Siemens	PTO
MODBUS-TCP	Schneider Electric	Modbus IDA
Foundation Fieldbus	Fieldbus Foundation	Fieldbus Foundation
SERCOS	Bosch Rextroth	Interest Group Sercos
EtherCAT	Beckhoff Automation	EtherCAT Technology Group

Cable Recommendations

- Profinet recommends Shielded Cables
- Ethernet/IP prefers unshielded systems
  - But Recommends shielding for
    - Induction welding processes
    - RF Sources
    - Electrostatic processes
    - High current devices (more than 100 amps)
  - Uses shields with RC network to prevent DC ground loops

Physical Layer Issues

- According to an ISA.org online article, Physical Layer failures accounted for 35% of total failures in plant automation
- Two ways to provide reliability is to
  - Harden the physical layer
  - Change the network topography

Connector Recommendation

- **Industrial Control Manufacturers**

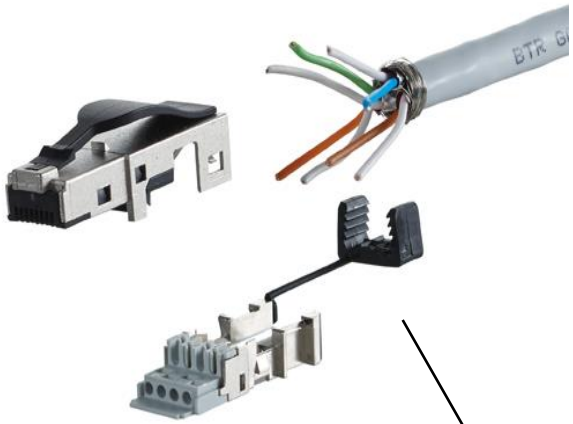
Guidelines are given by the manufacturers, in this case for EtherNet/IP systems.

IP65/IP67 sealed connectors

If your application exposes cable and connectors to liquid, dust or airborne contaminants as described in the MICE table (Table–5.1 on page 5.72), use the appropriately rated connector. IP65/IP67 sealed connectors and bulkhead feed-throughs should be utilized. See Chapter 2.

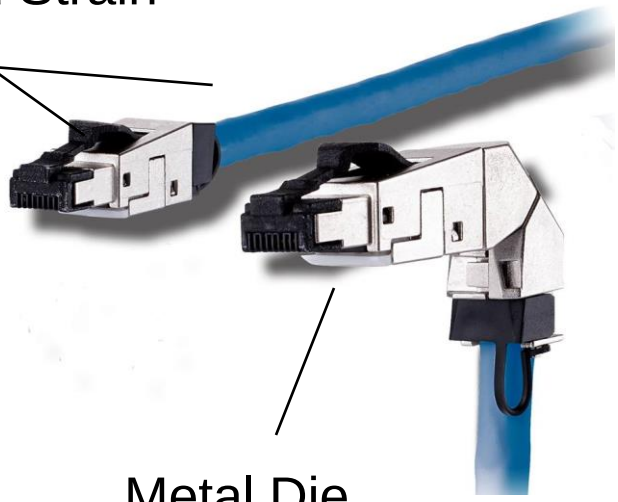
Important: Not all connectors are suitable for harsh environments. Carefully select connectors for the intended environment. Only consider connectors recognized by the ODVA Industrial EtherNet/IP specification.

First Step – Harden RJ45



Need to accomodate large individual conductors

Nylon Locking Tab and Strain Relief



Metal Die Cast Housing

Second Step – Harden Some More

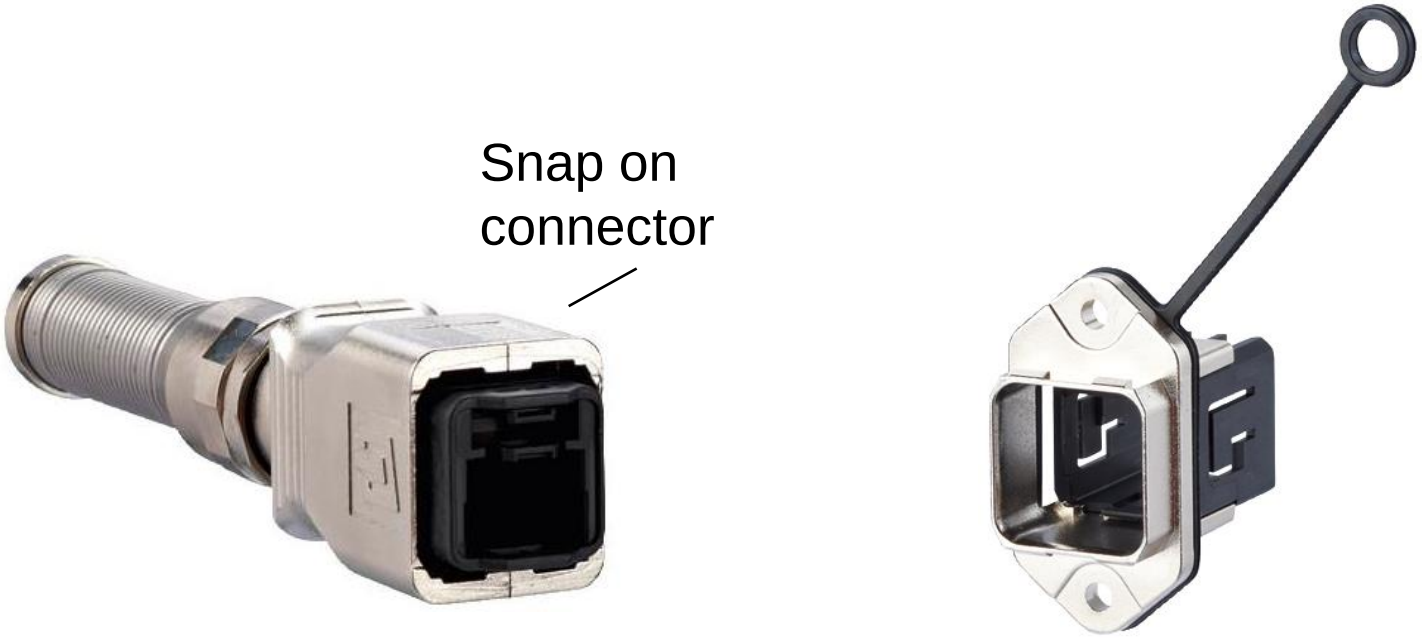
- **Rugged Construction**
  Here is a metal version of the “V1” connector system.

Cable Glands and
Stress Relief

Threads and Gaskets
for Sealing

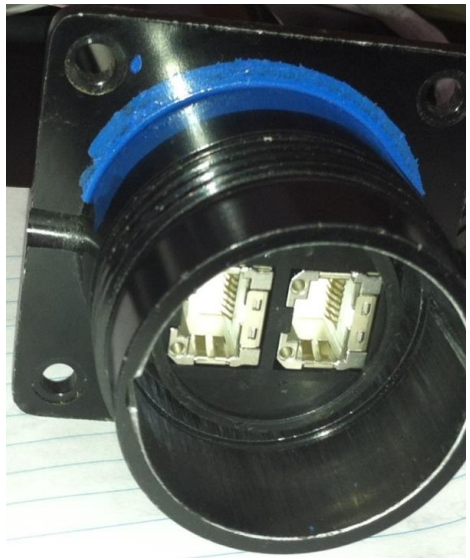
Second Step – Harden Some More

- **Rugged Construction**
  Here is a metal version of the “V14” connector system.



Second Step – Harden Some More

- **Rugged Construction**
  A custom built connector that is explosion proof for the Oil and Gas industry.

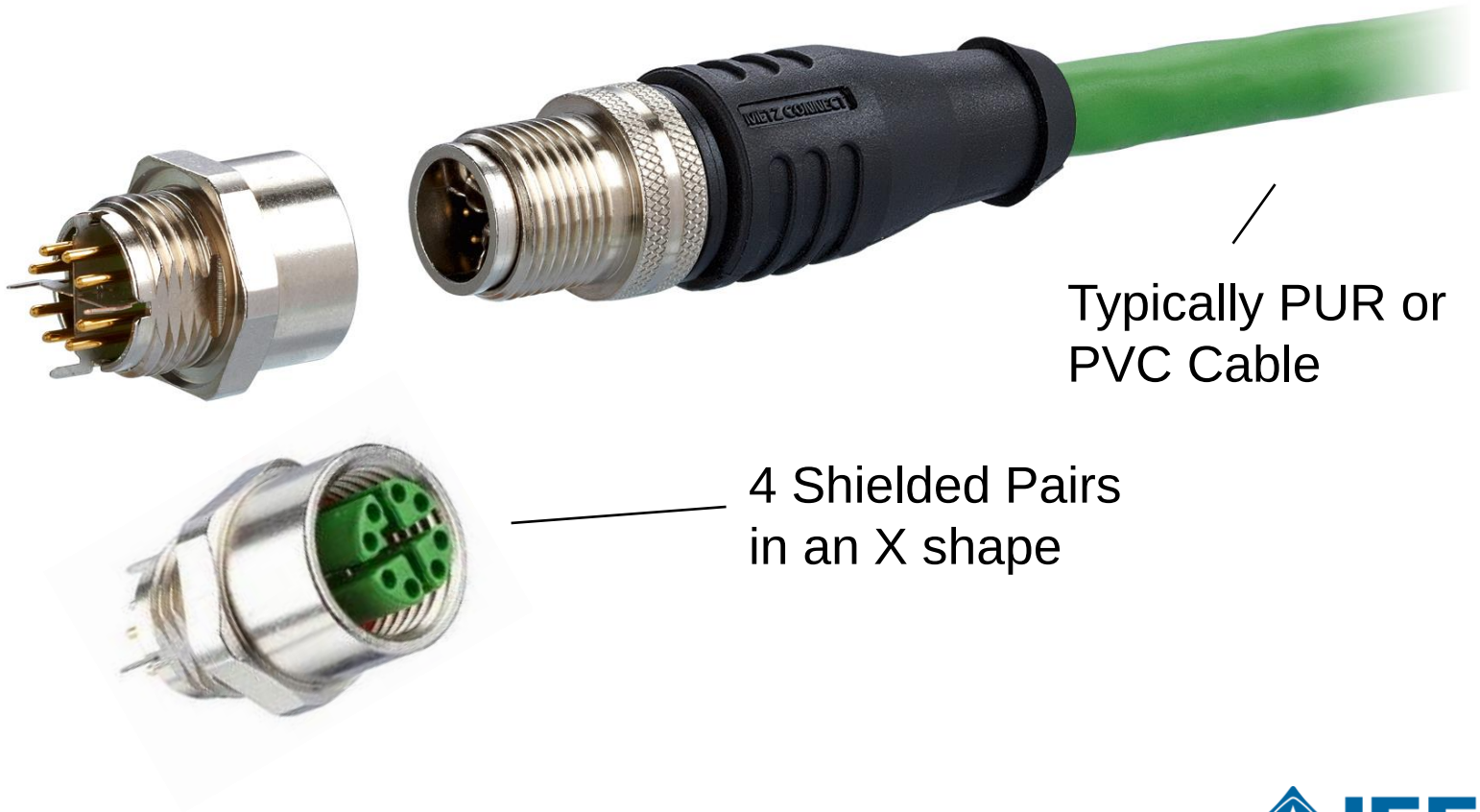


Third Step – Engineer New System

- High Band Width Connectors – M12 Footprint
- “D” Code for 2 Twisted Pairs
- “X” Code for 4 Twisted Pairs

Cutting Edge Standard

- X Code M12 for Industrial Gigabit Speeds

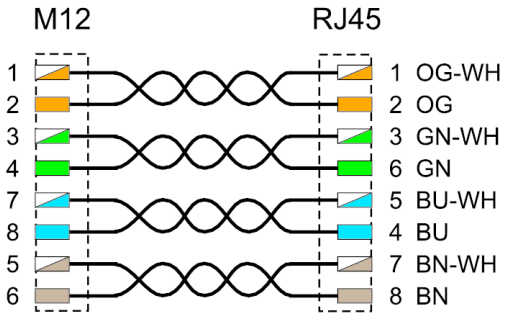


IP67 Ethernet Switch

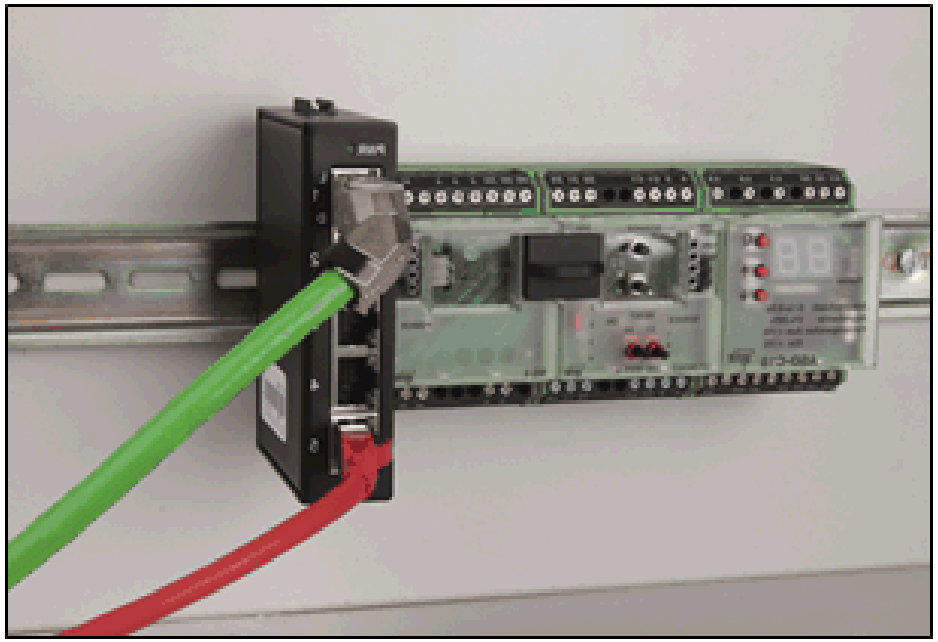
- **Electronics**

  Not only connectors need to be rugged.

Conversion from RJ45 to M12



Inside the Cabinet – DIN Rail



Inside the Cabinet – DIN Rail

- **RJ45 Jack Meets DIN Rail**
  DIN Rail is the defacto mounting method on the plant floor so devices and connectors are needed in this form factor.

Inside the Cabinet – DIN Rail

- **Fiber Optic Meets DIN Rail**

Reliable Extensions and Repairs

- **Practicality**
  Repairs and Extensions to Ethernet cable need to be done on the plant floor – they will not re-run wires through plants or machines with moving parts unless absolutely necessary. Think of it as a type of consolidation point.

Key Take-Aways

- Internet of Things is growing rapidly
- Much of it is in the industrial sector – Industrial Ethernet
- Environmental considerations are much different than office environments
- Physical component failure is the single biggest failure point so the physical layer components have to be well considered