Industrial Communications & Controls

ANIXTER®

IC²

ANIXTER®

Anixter

Industrial Communications & Control

Industrial Ethernet Network Design

The Company - Who is Anixter?

- **Anixter** is the global leader in the value-added distribution of:
  - Communications and physical security systems
  - Industrial electrical and electronic wire and cable products
- We help our customers specify solutions and make informed buying decisions based on technologies, applications and relevant standards.
- All around the world we offer innovative **Supply Chain Service Solutions** that reduce the total cost of production and execution of projects and programs for our customers.

"Service is Our Technology"

Our Global Presence

Anixter's Global Presence

Anixter is located in 263 cities around the world in 50 different countries.

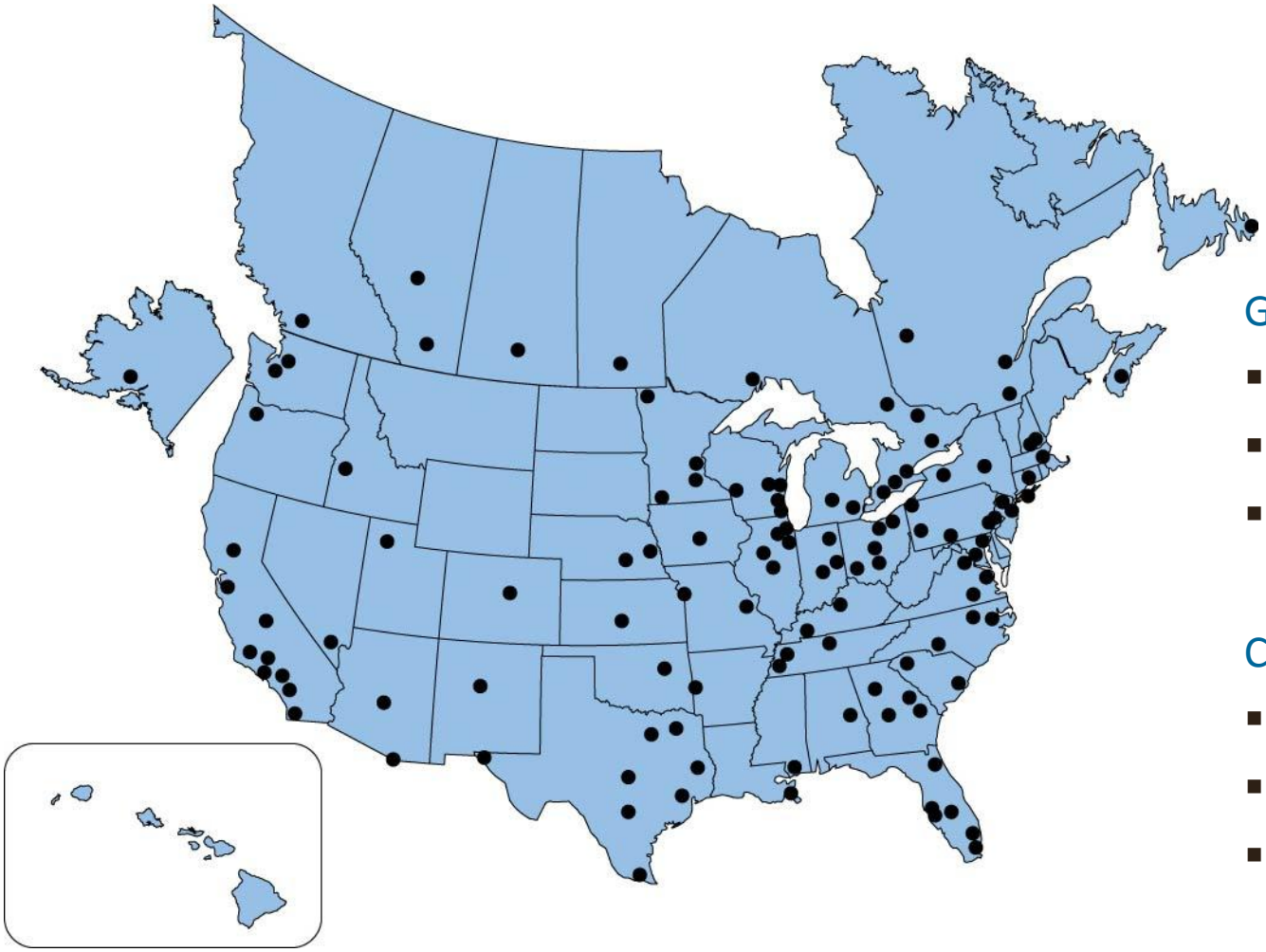
Corporate Snapshot:

Year founded: 1957
Number of employees: Over 7,900
2010 Revenues: $5.5 billion
Products: 450,000
Inventory: Over $1 billion
Customers: Over 100,000
Stock symbol: AXE
Countries: 50

Anixter Notable Achievements and Awards:

- Fortune 500 List
- BusinessWeek's Top 100 Info Tech List
- Forbes' Global Superstars List
- Forbes' Best Managed Companies List
- Fortune's Most Admired Companies List
- InformationWeek 500
- B-to-B Magazine's Top 500 eBusinesses List

Global Capabilities - North America



Global/US HQ: Glenview, IL

- 78 sales locations
- 71 warehouses
- 4.9M sq. ft

Canada HQ: Toronto

- 18 sales locations
- 13 warehouses
- 635.6K sq. ft.

Customer Value Proposition

- **Global operational consistency and infrastructure**
  - Same systems, process and services provided globally but with local personnel, language and currency
- **Supply chain optimization to reduce customers' overall costs**
  - Preinstallation product preparation
  - Feed the job just-in-time
  - Direct line feed
  - Industry-leading customized electronic tool sets
- **Technical expertise**
  - Infrastructure design support
  - Product recommendation based on applications
  - Proof of concept and quality testing in the Anixter Lab
- **Global supplier partnerships**
  - Relationships with the leading manufactures in our industry
  - #1 or #2 customer globally
  - We have leverage to "make it happen"

Anixter's Supply Chain Solutions

- Our solutions help our customers:
  - ✓ Reduce Costs
  - ✓ Enhance Competiveness
  - ✓ Improve Quality
  - ✓ Fulfill Sustainability Objectives

READY. BY ANIXTER
MATERIAL MANAGEMENT SERVICES

READY!℠ Material Management Services by Anixter leverage our distribution and Supply Chain Services to help our customers optimize a just-in-time material management program in their production facility. Our replenishment solutions lower the total cost of ownership, improve productivity and scale to meet production demands.

READY. BY ANIXTER
DEPLOYMENT SERVICES

READY!℠ Deployment Services by Anixter maps our distribution and Supply Chain Services to the construction or deployment process of any technology project. We combine sourcing, inventory management, kitting, labeling, packaging and deployment services to simplify and address the material management challenges at the job site(s). READY! Deployment Services by Anixter will help you improve the speed to deployment, lower your total cost of deployment and ensure the customer's product specification are delivered as planned.

Markets Served

OEM
- Cable Assbly/Wire Harness
- Contract Mfg.
- Panel Shops
- Electrical Equipment Mfg.
- Electronic Equipment Mfg.
- Communications Equipment Mfg.

Contractors
- EPCs
- Electrical – Industrial
- Electrical – Commercial
- Security / Audio Video
- Telecom
- Automation

Industrials
- Chemical
- Food & Beverage
- Shipbuilding
- Steel
- Pharmaceutical & Biotech
- Automotive

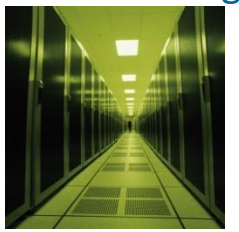
Power Generation
- Fossil Fuel
- Wind / Solar
- Nuclear

Natural Resources
- Oil, Gas, Petroleum
- Pulp & Paper
- Mining

Other
- Government
- Entertainment
- Broadcasting
- Transportation
- Services

Redistribution
- Electrical Wholesale
- Electronic
- Data Comms
- Automation
- Broadcast






Our Industrial Communication & Control Vendor Partners

Industrial Communications & Control

- Cellular Wireless Routers
- Hardened Ethernet Switches
- Ethernet Connectivity for utilities, OEM's and machine builders
- Industrial Cyber-security Solutions
- Wireless Point to Point and AP's
- Serial Connectivity
- Industrial Cordsets

Industrial Communications & Controls:
Industrial Networking Products & Solutions

HIRSCHMANN
A BELDEN BRAND

The Hirschmann line of networking devices manages virtually every communication connection requirement among the various layers of the network: information, control and device. There are products that support both copper and optical fiber media, with data speeds as high as 10 Gigabitss per second. The Hirschmann brand represents experience and expertise in automation technology, developed since pioneering the development of Ethernet as a common standard for industry networks. Today, Hirschmann products ensure hassle-free and secure data communication under the toughest conditions.

Tofino Xenon and Eagle Firewall Routers

TOFINO SECURITY
A BELDEN BRAND

GarrettCom
A BELDEN BRAND

GarrettCom manufactures networking solutions designed for industrial applications. Products provide the much needed migration path for industrial customers to transition from their current network, which contains a mix of legacy interface and protocols and IP-based technology, to full IP-based network. Comprehensive product portfolio including Multi-protocol L3 routers, L2 Managed and Unmanaged Switches, media converters, and terminal servers. For mission critical applications under harsh conditions, GarrettCom's networking products which come with advanced cyber security features and follow the latest industry's security standards. GarrettCom's focus vertical markets include power utility substations, Smart Grid operations, surveillance and physical security, traffic control, oil and gas, water and waste- water management.

TRANSITION NETWORKS

Transition Networks, With over 25 years of growth and expertise in fiber solution manufacturing, Transition Networks offers the ability to affordably integrate the benefits of fiber optics into any data network – in any application – in any environment. Offering support for multiple protocols, any interface, and a multitude of hardware platforms; Transition's portfolio gives you the power to deliver and manage your network traffic reliably over fiber. Based in the US, Transition Networks provides 24-7, American-based Tech Support, Life-Time Warranties on many of their branded products, exceptional and responsive Sales and Customer Service teams, and an overall 99% quality rating on their copper to fiber networking equipment.

Industrial Communications & Controls:
Industrial Networking Products & Solutions

B&B Electronics designs, builds and delivers connectivity and communication solutions optimized for an ever-expanding range of applications. B&B is an expert in connecting and network-enabling your legacy equipment. The main products they manufacture are gateways, serial devices, wireless, media converters, and surge protection.

ComNet Communication Networks is a Fiber Optic communication and hardened Ethernet product manufacturer. ComNet focuses on providing innovative communications networking solutions to the Security Market. The product line consists of fiber optic video, data and audio transmission products as well as a broad fiber optic, copper and wireless Ethernet product line, designed to the specific requirements for Access Control, Intrusion, Burglar and Fire Alarms and CCTV Surveillance/ Incident Detection and the Intelligent Transportation System Market.

Comtrol Corporation has been a manufacturer and provider of quality networking and industrial data communication products. Since introducing the industry's first multi-port serial card, Comtrol has not only continued to offer and expand this product line but has also launched other innovative solutions such as DeviceMaster® Ethernet device servers and gateways, RocketLinx® industrial grade Ethernet and Power over Ethernet switches and most recently IO-Link master industrial gateways. By providing a variety of unique product capabilities, features and options, Comtrol has the ability to solve many data connectivity requirements. Through exceptional product and technical support, Comtrol has established solutions for a wide range of industrial automation, security, energy and traffic and transportation applications.

Digi International provides mission critical M2M solutions. Digi provides the industry's broadest range of wireless products, a cloud computing platform tailored for devices, and development services to help customers get to market fast with wireless fevices and applications. Digi has a very diverse breadth of products including cellular routers and gateways, wireless communication adapters including ZigBee, Wi-Fi and proprietary RF, serial and terminal servers, console servers, multi-port serial boards, USB connected products and cameras. Digi offers targeted vertical specific solutions for the nergy, Government, Medical, Industrial, Retail and Transportation markets.

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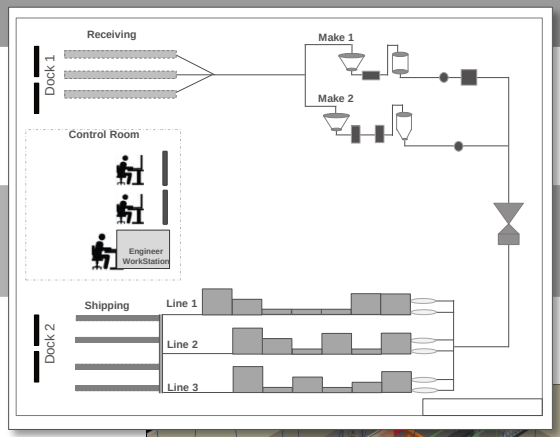
Industrial Ethernet Network Design Workshop

Objectives

- Complete the steps to design Industrial Ethernet networks
- Specify and select active and passive network components
- Identify and plan project and operational success factors

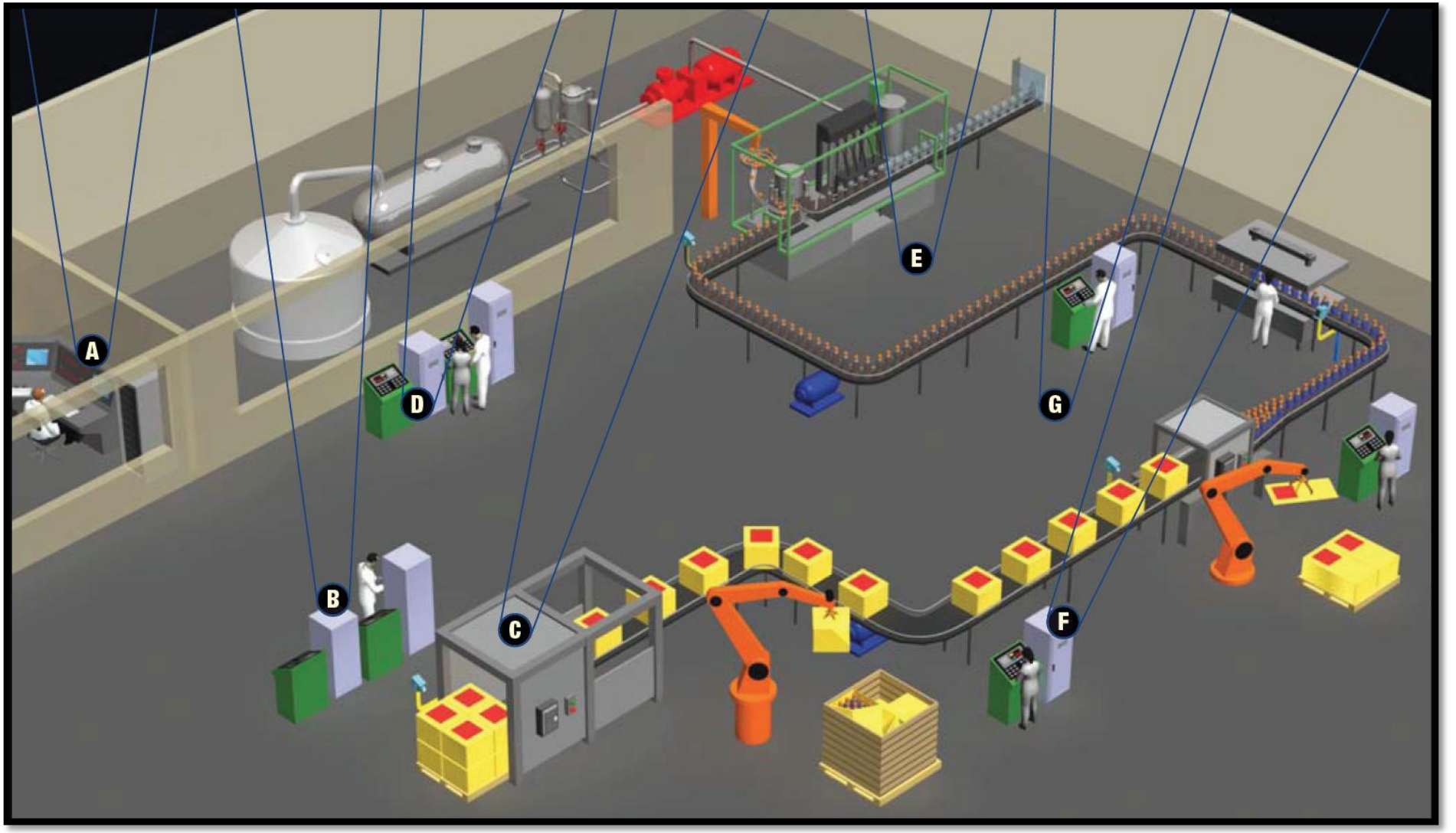


Agenda:

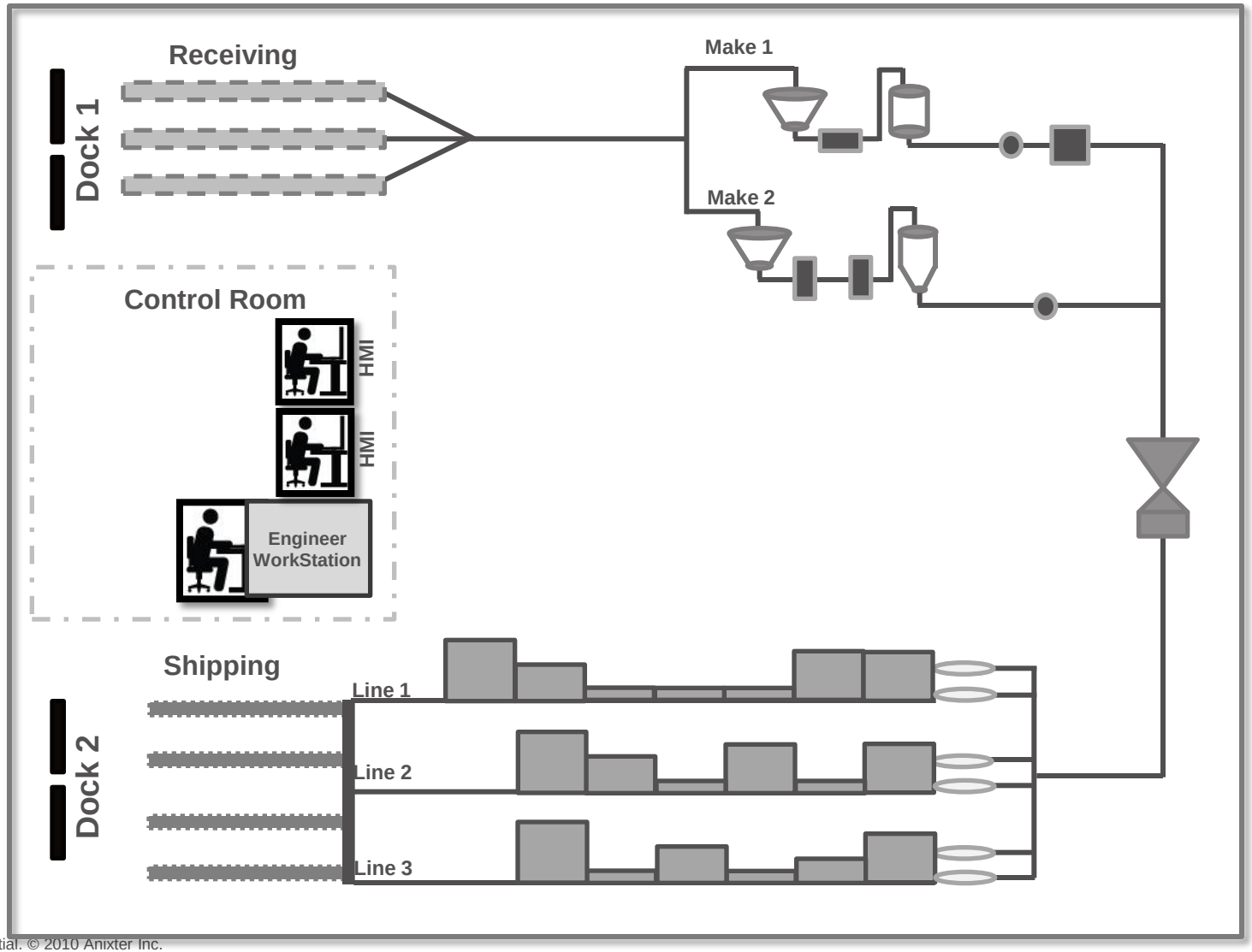
- **Logical Design**
  - Collect information
  - Segment
  - Add routers and switches
  - Add network security
  - Add redundancy / resiliency
- **Physical Design**
  - Determine critical factors
  - Conductors, shield, jacket,
- **Project and Operations Success**

We'll focus on mainstream and easy. We can help with the exceptions afterwards.

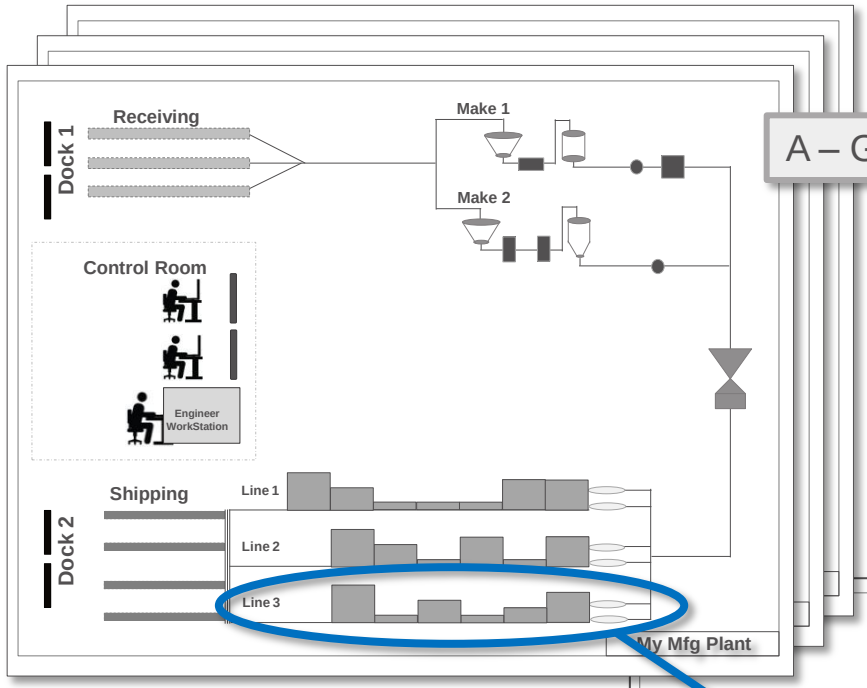
The Application - Manufacturing



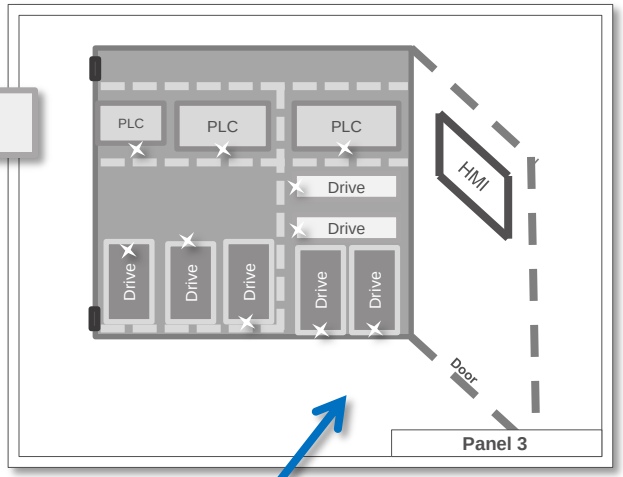
The Application - Manufacturing



Step 1 – Collect Information



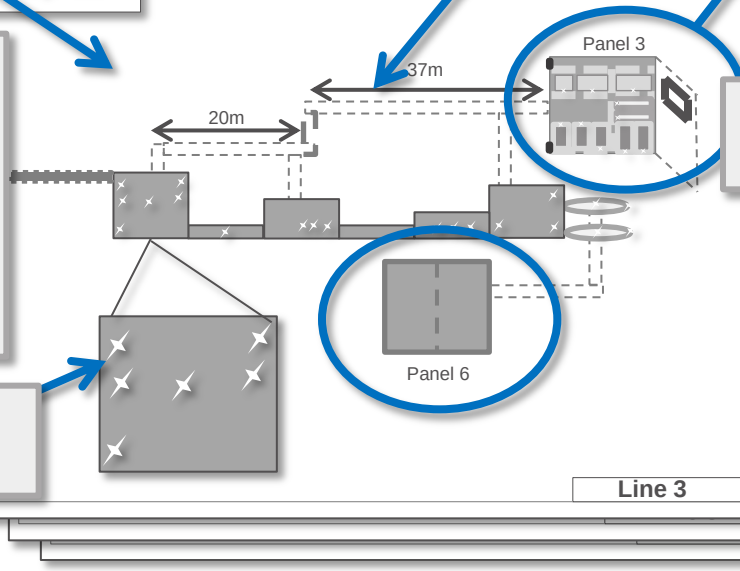
A – Get physical drawings



E - Identify cable routing options and distance information

D – General understanding of what each part of the network needs to **DO**

- HMI
- Control I/O
- High-speed motion
- Video / voice
- Physical security
- Business apps



C – Identify panel locations and detail

B – Identify location and number of end devices to network

Step 1 – Collect Information

Switch / Router List - Network Design

Project	*My Factory*
Project Engineer	*David Adams*

Use	Location /Name	L2	L3	10G ports	1G ports	10/100 ports	PoE ports	PoE Watts	1588	IP-67	2x power	Redun nets	USB memory	special requirements	Model	Catalog Number	Accessories	Accessory Catalog Numbers
Backbone	Control Room / Ship / Receive	x		3														
	Make Area	x		3														
	Packaging Area	x		3														
L3	Control Room / Ship / Receive L3		x	1	3													
	Make Area L3		x	1	2													
	Packaging Area L3		x	1	3													
L2	Make 1 East	x																
	Make 1 West	x																
	Make 2 East	x																
	Make 2 West	x																
	Line 1 East	x																
	Line 1 Central	x																
	Line 1 West	x																
	Line 2East	x																
	Line 2Central	x																
	Line 2 West	x																
	Line 3 East	x																
	Line 3 Central	x																
	Line 3 West	x																
	Control Room North	x																
	Control Room South	x																
	Receiving West	x																
	Receiving NorthEast	x																
	Receiving SouthEast	x																
	Shipping North	x																

Excel sheets to keep track of your design choices

Physical Media List - Network Design

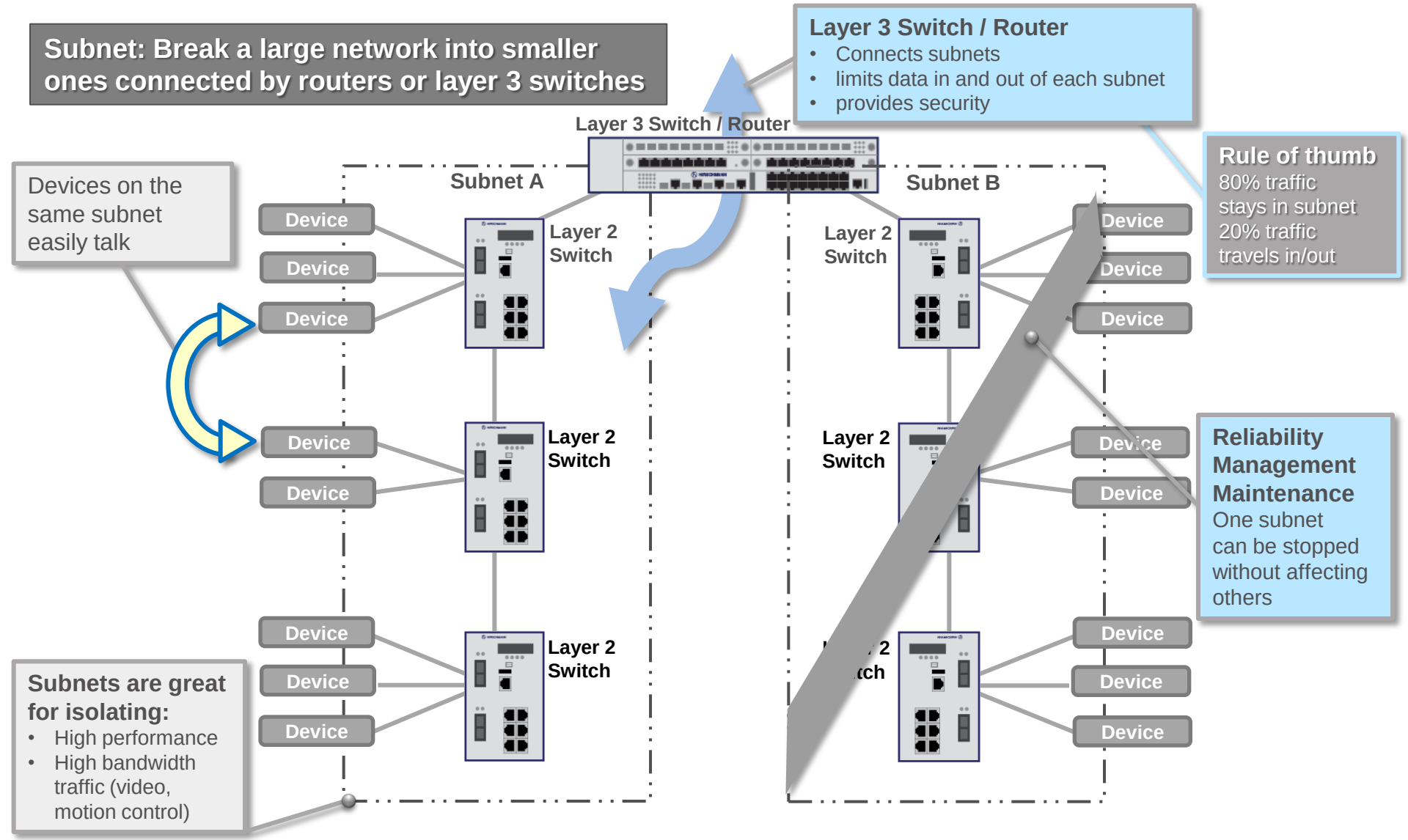
Project	
Project Engineer	

								Considerations					
Switch	Port #	speed	connector	distance (meters)	To switch or device	To port #	connector	Electrical Noise	Temp	Chemical	Hi Flex	other	Industrial Ethernet Cordset
Make 1 East	1	100	IP-67 m12	0.3	Make Area1 FW	sec	RJ-45	x	x	x			M224PVCSTJG00.3M
	2	100	IP-67 m12	10	Make 1 West	3	IP-67 m12	x	x	x			M224PVCSTMU10.0M
	3	100	IP-67 m12	2	I/O block 22	1	IP-67 m13	x	x	x			M224PVCSTMU02.0M
	4	100	IP-67 m12	2	I/O block 23	1	IP-67 m14	x	x	x			M224PVCSTMU02.0M
	5	100	IP-67 m12	7	I/O block 24	1	IP-67 m15	x	x	x			M224PVCSTMU07.0M
	6	100	IP-67 m12	6	Flowmeter 8	1	IP-67 m16	x	x	x			M224PVCSTMU06.0M
	7	100	IP-67 m12	spare									
	8	100	IP-67 m12	spare									
Receiving NorthEast	1	1g			Receiving SouthEast	2							
	2	1g			GigE camera		fiber		x				
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												

Step 2 – Segment Communications into Groups (Subnets)

Subnet: Break a large network into smaller ones connected by routers or layer 3 switches

Layer 3 Switch / Router
- Connects subnets
- limits data in and out of each subnet
- provides security



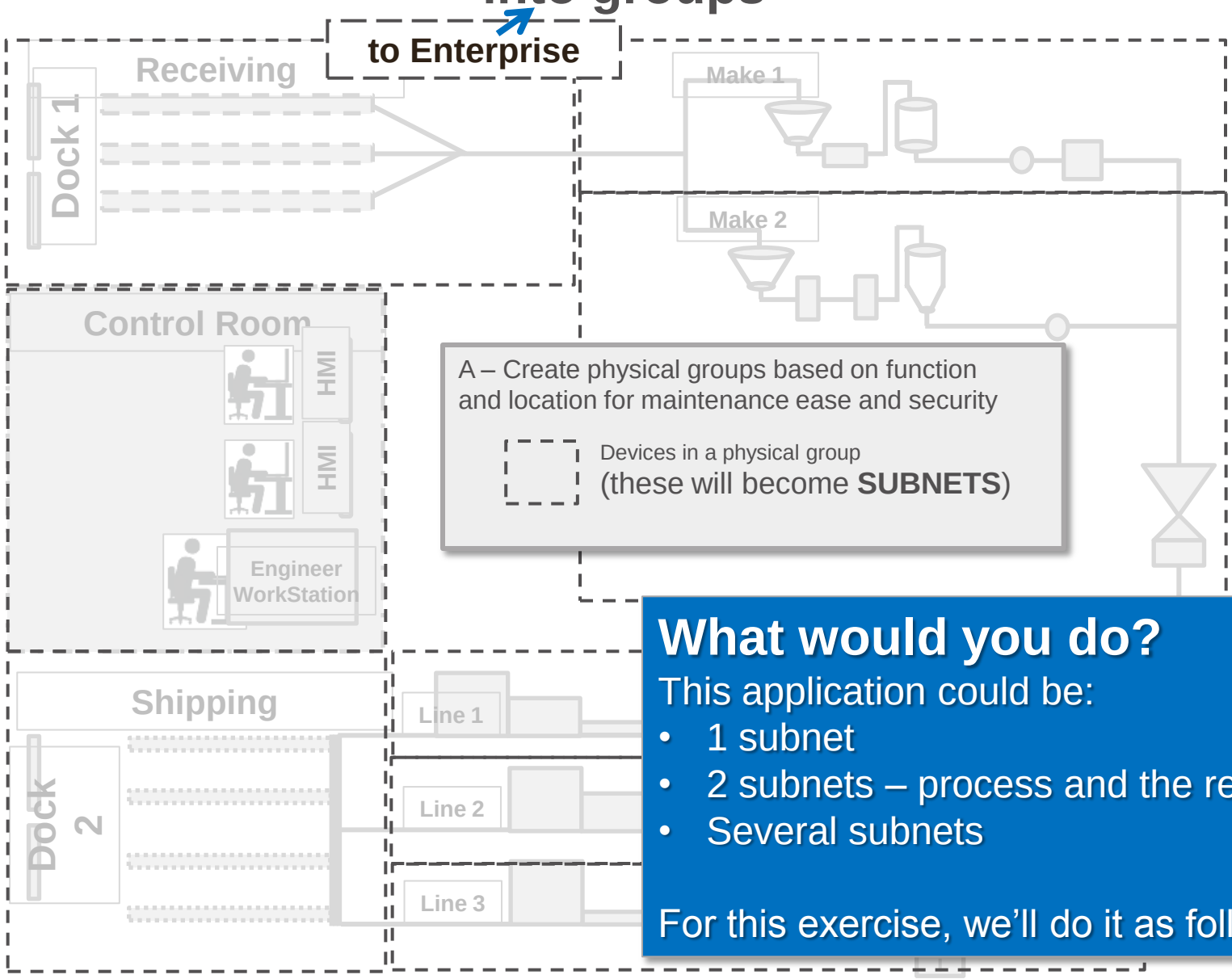
Devices on the same subnet easily talk

Rule of thumb
80% traffic stays in subnet
20% traffic travels in/out

Reliability Management Maintenance
One subnet can be stopped without affecting others

Subnets are great for isolating:
- High performance
- High bandwidth traffic (video, motion control)

Step 2 Example – Segment communications into groups



What would you do?

This application could be:

- 1 subnet
- 2 subnets – process and the rest
- Several subnets

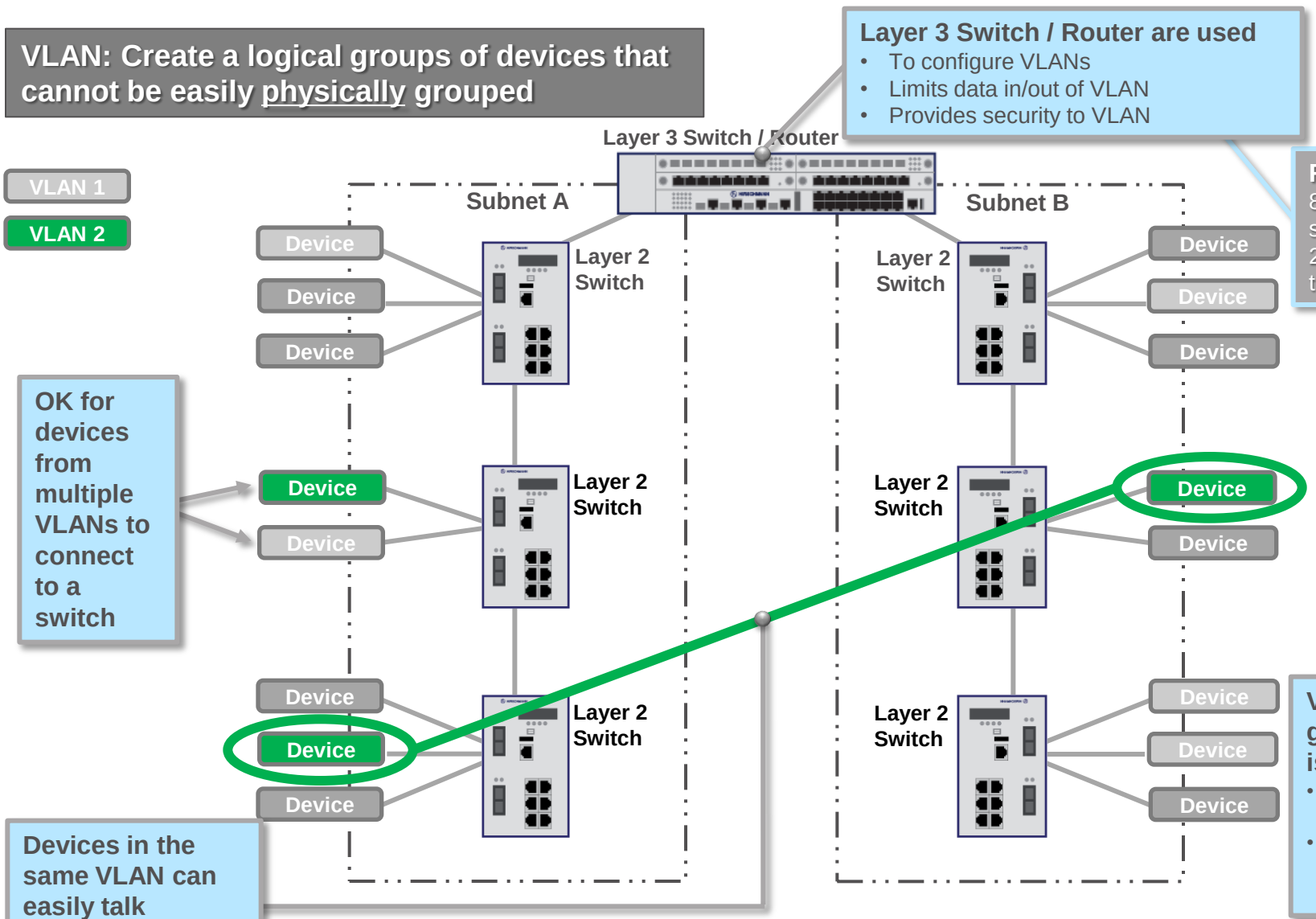
For this exercise, we'll do it as follows…

Step 2 – Segment Communications into Groups (VLANs – Virtual LANs)

VLAN: Create a logical groups of devices that cannot be easily physically grouped

Layer 3 Switch / Router are used
- To configure VLANs
- Limits data in/out of VLAN
- Provides security to VLAN

Rule of thumb
80% traffic stays in VLAN
20% traffic travels in/out

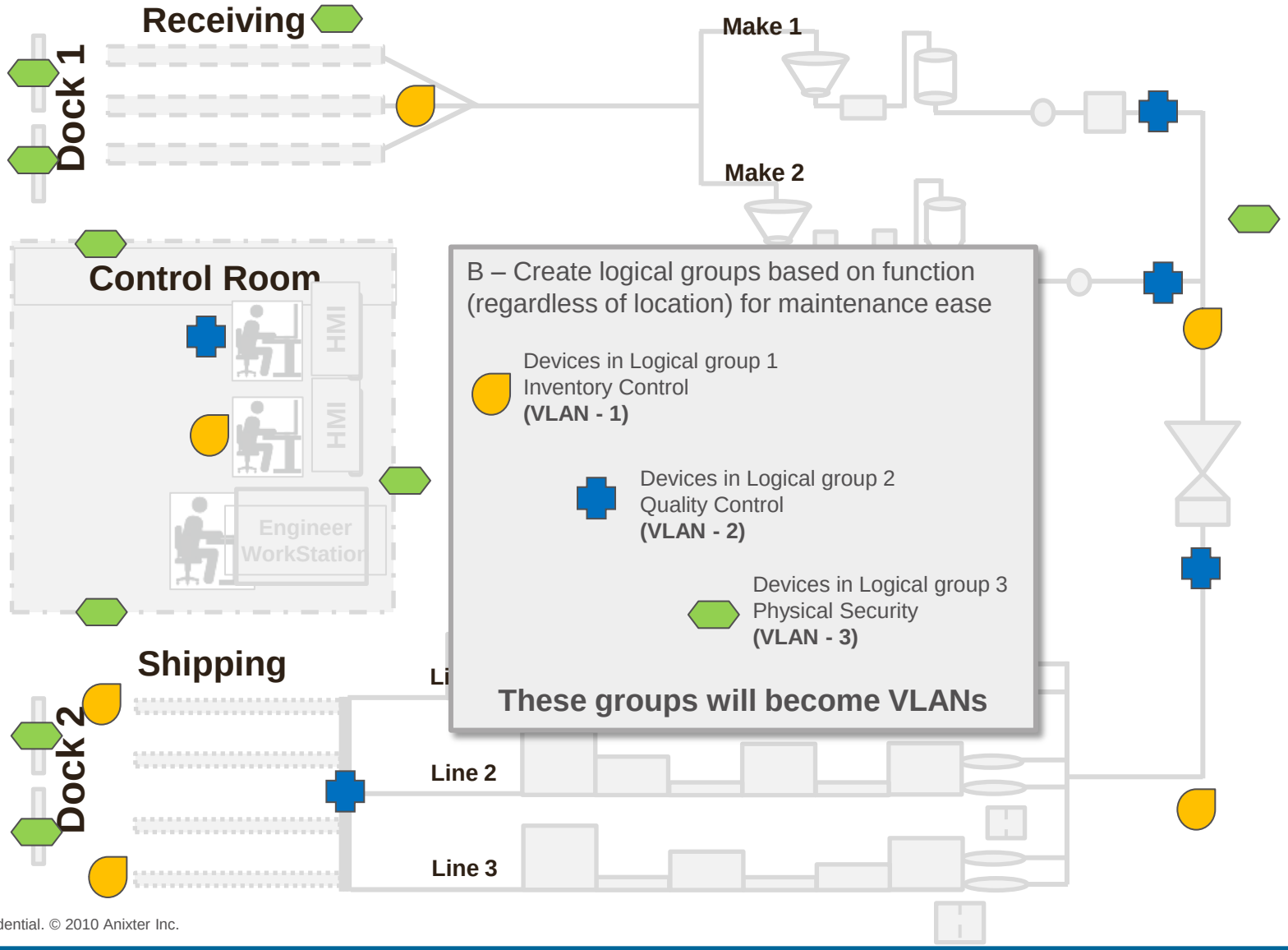


OK for devices from multiple VLANs to connect to a switch

Devices in the same VLAN can easily talk

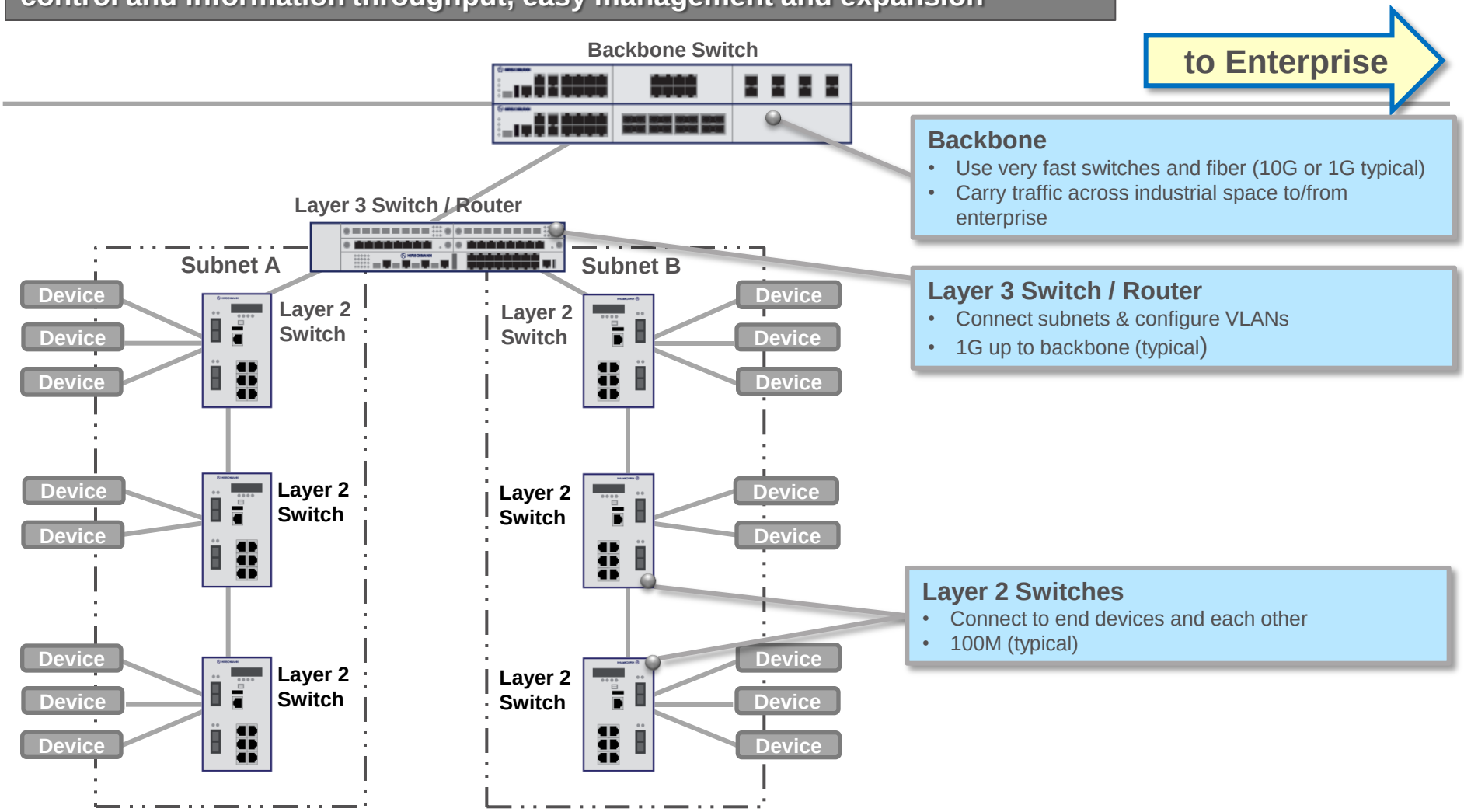
VLANs are great for isolating
- High performance
- High bandwidth traffic (video, motion control)

Step 2 Example – Segment Communications into Groups

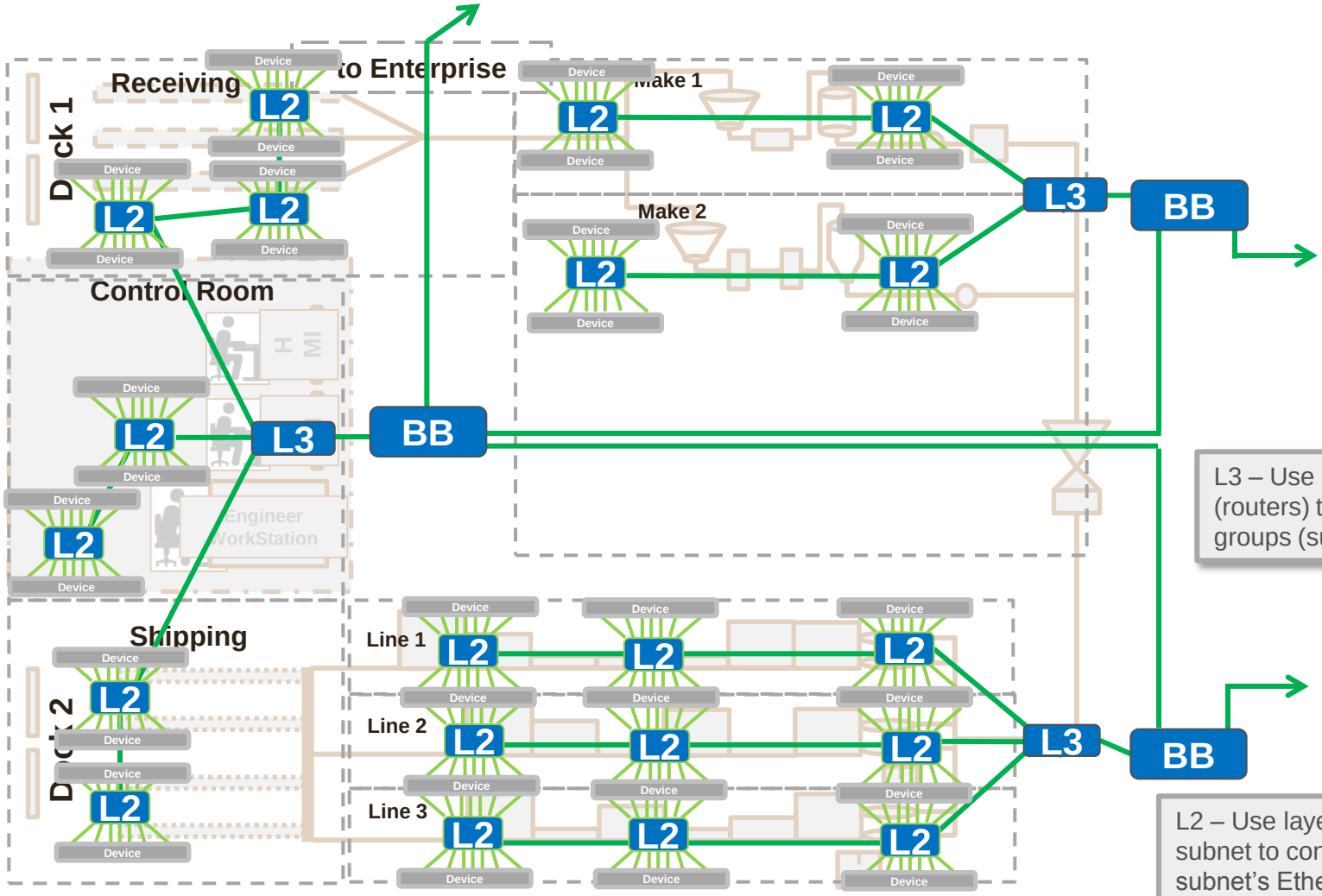


Step 3 – Create a Network Infrastructure

Network Infrastructure: Layout switches, routers and cabling to support control and information throughput, easy management and expansion



Step 3 Example – Create a Network Infrastructure (add routers and switches)



BB – Create a Communications Backbone using high-speed/high throughput switches - including connections to Enterprise and other facilities on campus

L3 – Use layer 3 switches (routers) to connect physical groups (subnets) together.

L2 – Use layer 2 switches inside a subnet to connect to all of that subnet's Ethernet devices. OK to connect layer 2 switches together.

Step 3 Example – Record Your Choices

Create a list of switches by use and location and note key attributes needed for each

Switch / Router List - Network Design

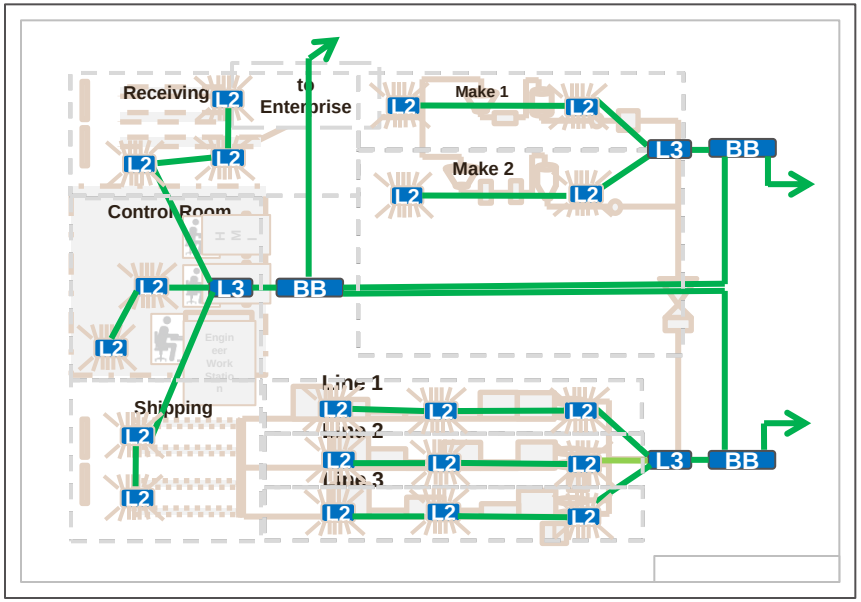
Project	*My Factory*
Project Engineer	*David Adams*

Use	Location /Name	L2	L3	10G ports	1G ports	10/100 ports
Backbone	Control Room / Ship / Receive	x		3		
	Make Area	x		3		
	Packaging Area	x		3		
L3	Control Room / Ship / Receive L3		x	1	3	
	Make Area L3		x	1	2	
	Packaging Area L3		x	1	3	
L2	Make 1 East	x				8
	Make 1 West	x				8
	Make 2 East	x				16
	Make 2 West	x				6
	Line 1 East	x				6
	Line 1 Central	x				10
	Line 1 West	x				20

Use and Location information

and speed of ports
– account for expansion!

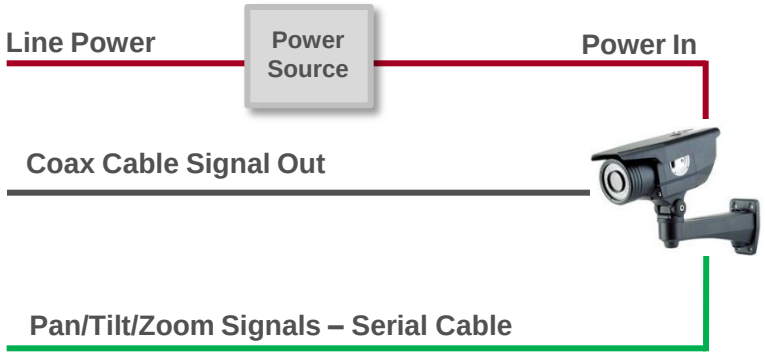
Choose Layer 3 to connect subnets together, Layer 2 for the rest



Step 4a – Determine Other Switch Requirements – Power over Ethernet (PoE)

Power over Ethernet (PoE) : use a single industrial Ethernet cable to provide power and Ethernet communications to devices

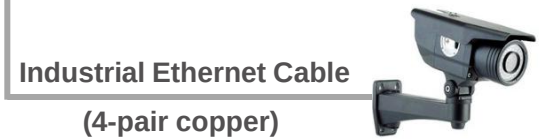
Traditional Approach



PoE Approach

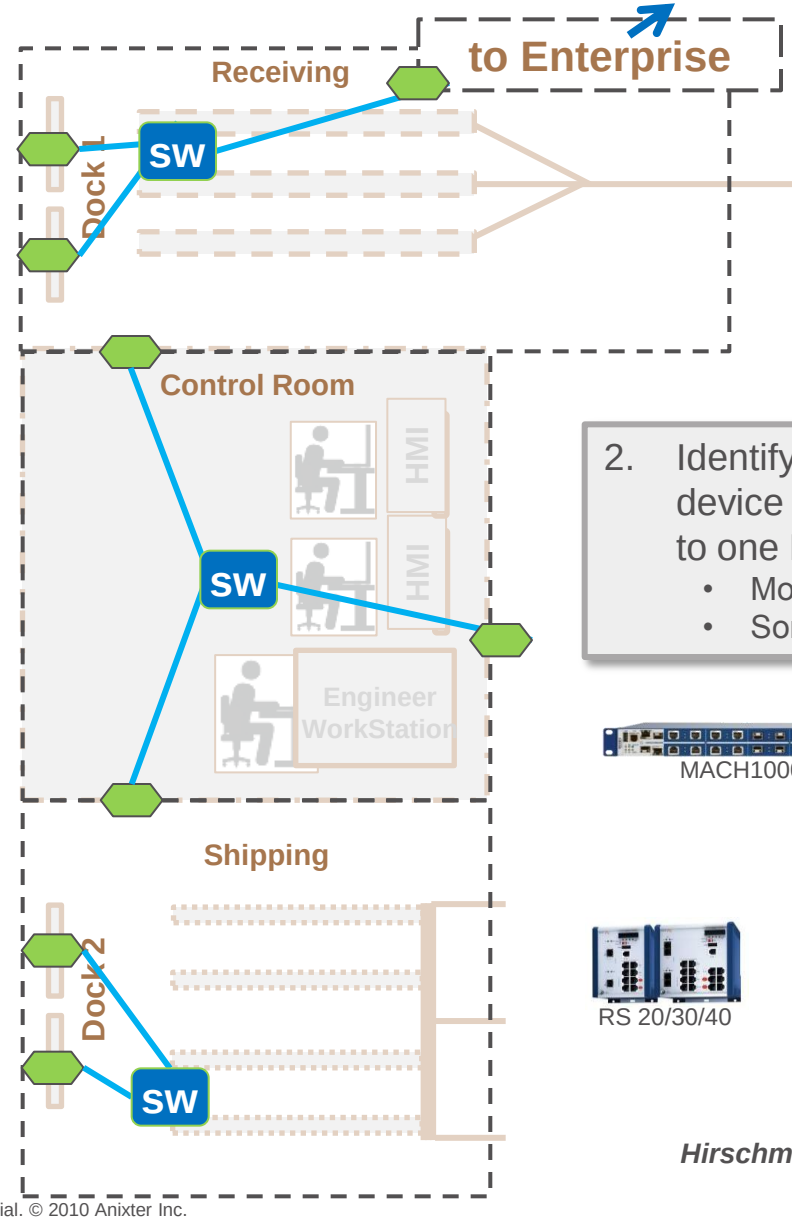
Switch With PoE

- Fewer pieces/lower cost
- Mix in existing network infrastructure
- Low voltage with isolation



Common Examples of PoE Devices

Step 4a – Determine Other Switch Requirements
Power over Ethernet (PoE) – How to…



1. Identify PoE devices you will use (cameras, telephones, etc.) and the switch it will connect to:
   - PoE Devices
   - SW Switches

2. Identify the power consumption (in watts) of each device and total the power for all PoE devices wired to one PoE switch
   - Most devices are “standard” PoE – up to 13 Watts
   - Some devices are “PoE+” - up to 25.5 Watts.

MACH1000


MACH4000


MACH100


Magnum 10KTS

RS 20/30/40


MS 20/30


Spider II


Octopus IP67

Hirschmann and Garrettcom switches with PoE support

Step 4a – Record your choices

Create a list of switches by use and location and note key attributes needed for each

Switch / Router List - Network Design

Project	*My Factory*							
Project Engineer	*David Adams*							
Use	Location /Name	L2	L3	10G ports	1G ports	10/100 ports	PoE ports	PoE Watts
Backbone	Control Room / Ship / Receive	x		3				
	Make Area	x		3				
	Packaging Area	x		3				
L3	Control Room / Ship / Receive L3		x	1	3			
	Make Area L3		x	1	2			
	Packaging Area L3		x	1	3			
L2	Make 1 East	x				8		
	Make 1 West	x				8		
	Make 2 East	x				16	1	7
	Make 2 West	x				6		
	Line 1 East	x				6		
	Line 1 Central	x				10		
	Line 3 West	x				20		
	Control Room North	x				20		
	Control Room South	x				20	3	21
	Receiving West	x				12		
	Receiving NorthEast	x				12	3	21
	Receiving SouthEast	x				12		
	Shipping North	x				10		
	Shipping South	x				10	2	8

PoE - # of watts switch must deliver

# of PoE ports

Step 4b – Determine Other Switch Requirements Time Synchronization (IEEE-1588)

What?

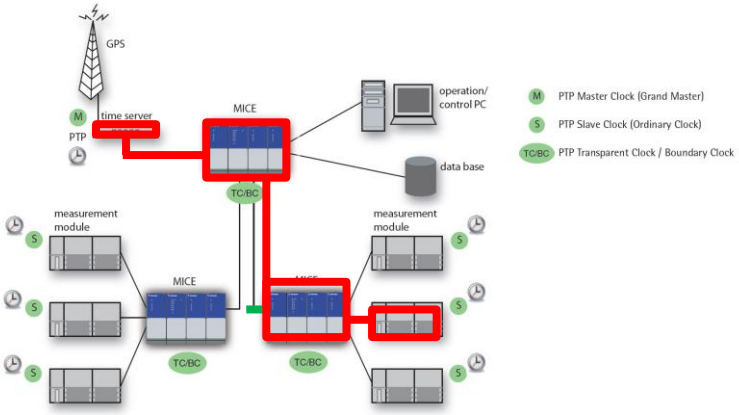
- IEEE 1588 is designed for devices on a LAN requiring extremely precise timing accuracy (<1 microsecond). A similar older technology used is IRIG-B. These signals often are synchronized to a GPS or another master clock.

Typical Applications

- Motion control / automation
- First-fault detection
- Measurement and Testing

How?

- Determine if application needs sub-millisecond time accuracy
- Select devices for application that support IEEE-1588
- Identify/select device to provide timing reference (example: GPS)
- Ensure all switches in the path between devices needing synchronization support IEEE-1588



MACH1000

Magnum 10KT

MS 20/30

Magnum 10KG

Hirschmann and GarrettCom switches with IEEE-1588 support

4b – Record Your Choices

Create a list of switches by use and location and note key attributes needed for each

Switch / Router List - Network Design

Project	*My Factory*									
Project Engineer	*David Adams*									
Use	Location /Name	L2	L3	10G ports	1G ports	10/100 ports	PoE ports	PoE Watts	1588	IP-67
Backbone	Control Room / Ship / Receive	x		3						
	Make Area	x		3						
	Packaging Area	x		3						
L3	Control Room / Ship / Receive L3		x	1	3					
	Make Area L3		x	1	2					
	Packaging Area L3		x	1	3					
L2	Make 1 East	x				8				x
	Make 1 West	x				8				x
	Make 2 East	x				16	1	7		x
	Make 2 West	x				6				x
	Line 1 East	x				6				
	Line 1 Central	x				10				
	Line 1 West	x				20			x	
	Line 2East	x				10				
	Line 2Central	x				10				
	Line 2 West	x				20			x	
	Line 3 East	x				12				
	Line 3 Central	x				12				
	Line 3 West	x				20			x	
	Control Room North	x				20				
	Control Room South	x				20	3	21		

Support of IEEE-1588 for high-speed motion control

Step 4c – Determine other requirements

Choose IP Ratings for your switches and routers

What?

- IP ratings describe a device's protection against solids and liquids

Why?

- Ensure industrial network infrastructure devices will survive in their environments
- Ratings can enable installation without control cabinets, reducing cost and space

Level	Object Size Protected Against	Details
0	—	No protection against contact and ingress of objects.
1	>50 mm	Any large surface of the body, such as the back of a hand, but no protection against deliberate contact with a body part.
2	>12.5 mm	Fingers or similar objects.
3	>2.5 mm	Tools, thick wires, etc.
4	>1 mm	Most wires, screws, etc.
5	Dust protected	Ingress of dust is not entirely prevented, but it must not enter in sufficient quantity to interfere with the satisfactory operation of the equipment; complete protection against contact.
6	Dust tight	No ingress of dust; complete protection against contact.

Level	Protected Against	Details
0	Not protected	—
1	Dripping water	Dripping water (vertically falling drops) shall have no harmful effect.
2	Dripping water when tilted up to 15°	Vertically dripping water shall have no harmful effect when the enclosure is tilted at an angle up to 15° from its normal position.
3	Spraying water	Water falling as a spray at any angle up to 60° from the vertical shall have no harmful effect.
4	Splashing water	Water splashing against the enclosure from any direction shall have no harmful effect.
5	Water jets	Water projected by a nozzle against enclosure from any direction shall have no harmful effects.
6	Powerful water jets	Water projected in powerful jets against the enclosure from any direction shall have no harmful effects.
7	Immersion up to 1m	Ingress of water in harmful quantity shall not be possible when the enclosure is immersed in water under defined conditions of pressure and time (up to 1m of submersion).
8	Immersion beyond 1m	The equipment is suitable for continuous immersion in water under conditions which shall be specified by the manufacturer. *Note: Normally, this will mean that the equipment is hermetically sealed. However, with certain types of equipment, it can mean that water can enter but only in such a manner that produces no harmful effects.*

Step 4c – Determine Other Switch Requirements

Choose IP ratings of your switches and routers – How to:

If your switch will be inside an enclosure: IP20, NEMA 1 or 2

If your switch is exposed to washdown or submerged in water: IP66, 67 or 68, NEMA 4, 4X, 6, or 6P

IP54 and 67

Ethernet Connectors and Cordsets

Octopus On-Machine Ethernet Switches

IP52

Magnum 6KM Ethernet Switches

Our other switches are IP20

Hirschmann and GarrettCom switches with extreme IP ratings

4c – Summary Record Your Choices

Create a list of switches by use and location and note key attributes needed for each

Switch / Router List - Network Design

Project	*My Factory*									
Project Engineer	*David Adams*									
Use	Location /Name	L2	L3	10G ports	1G ports	10/100 ports	PoE ports	PoE Watts	1588	IP-rating
Backbone	Control Room / Ship / Receive	x		3						
	Make Area	x		3						
	Packaging Area	x		3						
L3	Control Room / Ship / Receive L3		x	1	3					
	Make Area L3		x	1	2					
	Packaging Area L3		x	1	3					
L2	Make 1 East	x				8				67
	Make 1 West	x				8				67
	Make 2 East	x				16	1	7		67
	Make 2 West	x				6				67
	Line 1 East	x				6				
	Line 3 Central	x				12				
	Line 3 West	x				20			x	
	Control Room North	x				20				
	Control Room South	x				20	3	21		
	Receiving West	x				12				
	Receiving NorthEast	x				12	3	21		
	Receiving SouthEast	x				12				
	Shipping North	x				10				
	Shipping South	x				10	2	8		

IP-67 or 52 required?

Step 5 – Add Network Security

What?

- Design appropriate security into your network infrastructure, including:
  - Layer 3 switches
  - Firewalls
  - Features in layer 2 switches

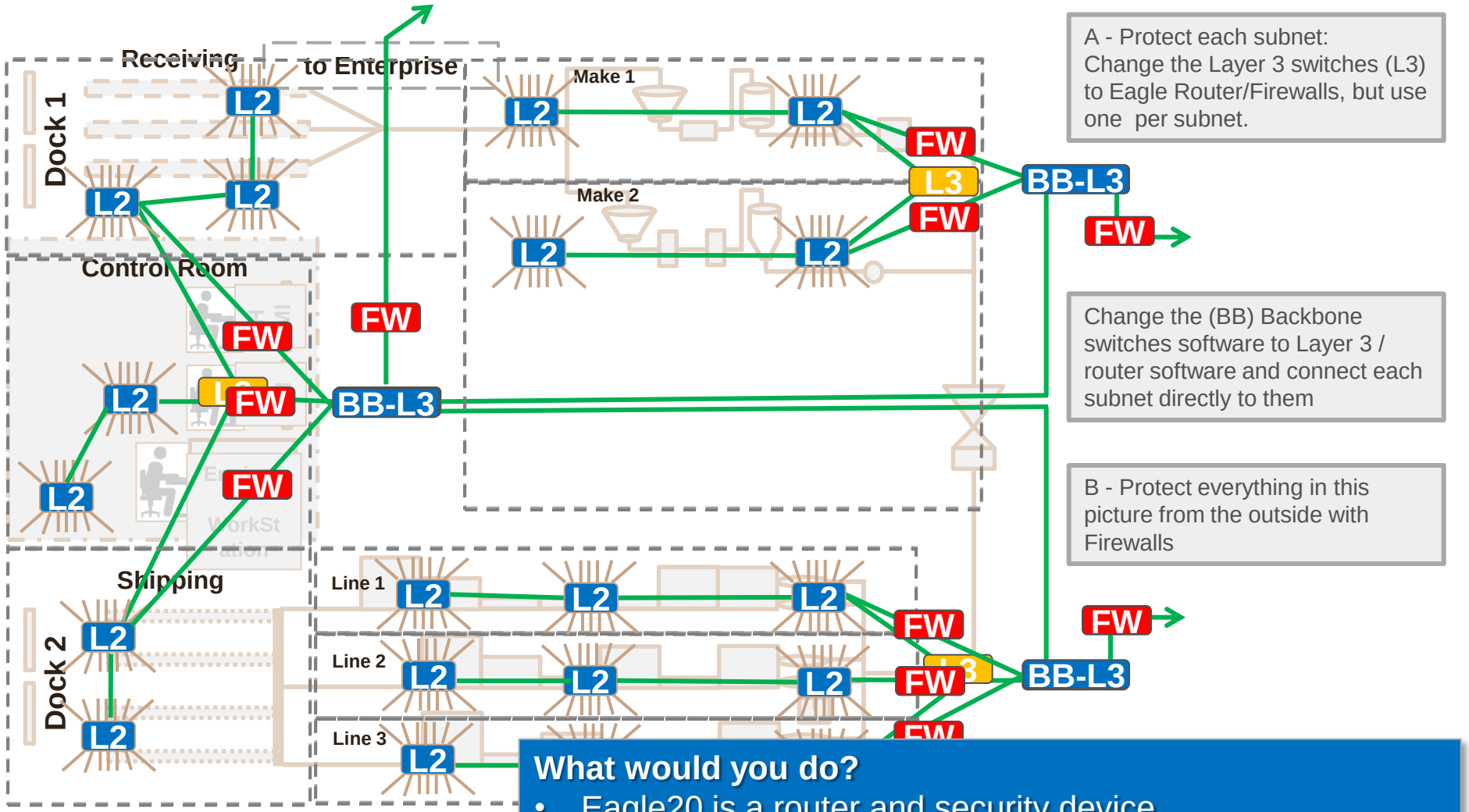
Why?

- Physical security + network security + computer security + policies/procedures help protect your process, equipment and people
- A risk assessment helps you to match your security solution to your needs
- Security - especially if designed in - can be easy and unobtrusive

Why Not?

- Adds some cost (but prevents a lot more)

Step 5 – Add Network Security – How to:



A - Protect each subnet: Change the Layer 3 switches (L3) to Eagle Router/Firewalls, but use one per subnet.

Change the (BB) Backbone switches software to Layer 3 / router software and connect each subnet directly to them

B - Protect everything in this picture from the outside with Firewalls

What would you do?

- Eagle20 is a router and security device
- Eagle Tofino is a security device only

…after risk assessment, we will want to protect each subnet.

Step 5 – Record your choices

Switch / Router List - Network Design

Project	*My Factory*
Project Engineer	*David Adams*

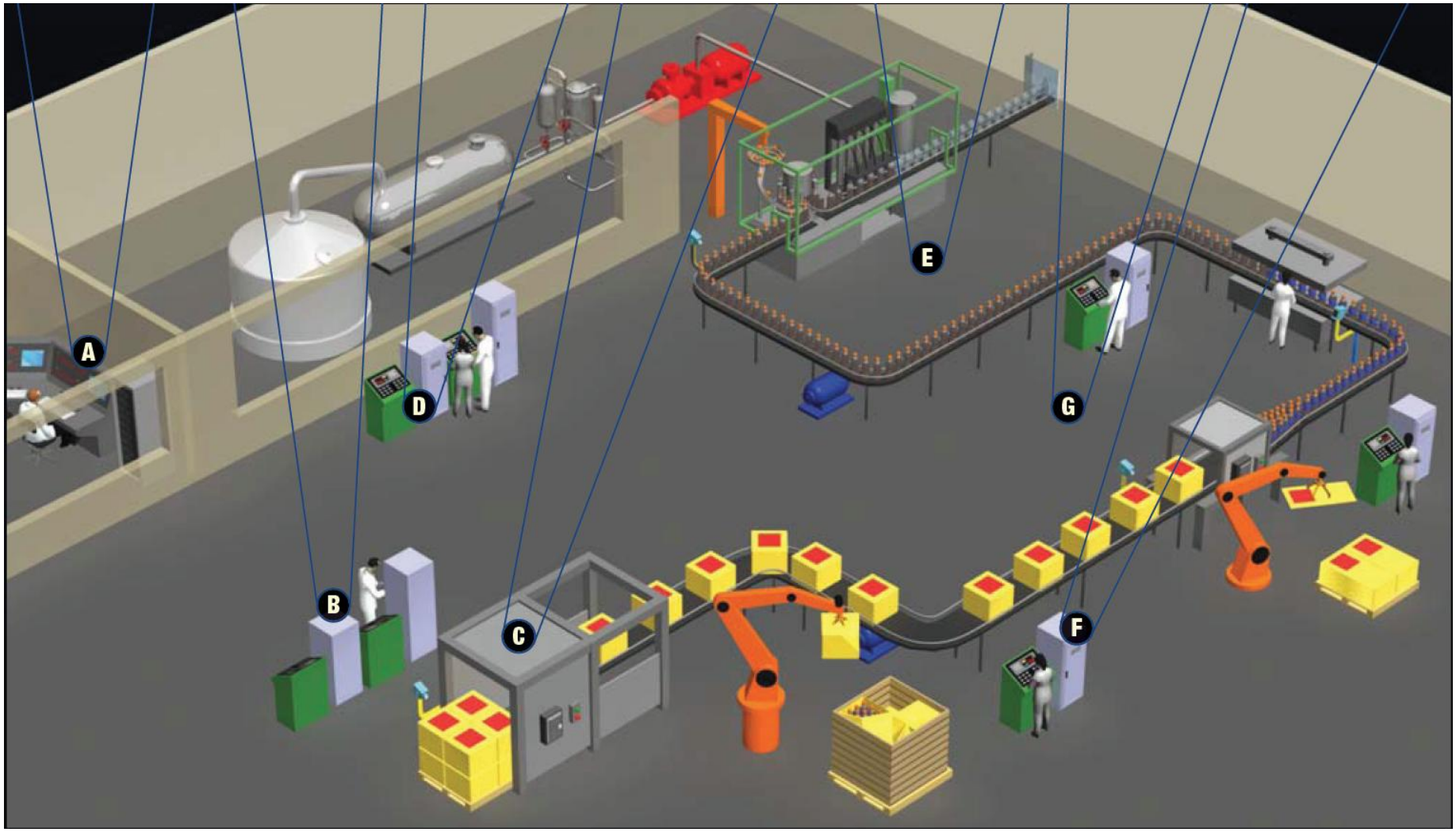
Use	Location /Name	L2	L3	10G ports	1G ports	10/100 ports	PoE ports	PoE Watts	1588	IP-67
Backbone	Control Room / Ship / Receive		x	3						
	Make Area		x	3						
	Packaging Area		x	3						
Firewalls	**Control Room FW**		?							
	Shipping FW		?							
	Receiving FW		?							
	Make Area 1 FW		?							
	Make Area 2 FW		?							
	Line 1 FW		?							
	Line 2 FW		?							
	Line 3 FW		?							
	Enterprise Edge FW		x							
	NorthEast Edge FW		x							
	SouthEast Edge FW		x							
L2	Make 1 East	x				8				x
	Make 1 West	x				8				x
	Make 2 East	x				16	1	7		x
	Make 2 West	x				6				x
	Line 1 East	x				6				
	Line 1 Central	x				10				
	Line 1 West	x				20			x	
	Line 2East	x				10				
	Line 2Central	x				10				
	Line 2 West	x				20			x	
	Line 3 East	x				12				
	Line 3 Central	x				12				
	Line 3 West	x				20			x	
	Control Room North	x				20				
	Control Room South	x				20	3	21		
	Receiving West	x				12				
	Receiving NorthEast	x				12	3	21		
	Receiving SouthEast	x				12				
	Shipping North	x				10				
	Shipping South	x				10	2	8		

Change the (BB) Backbone switches software to Layer 3 / router software and connect each subnet directly to them

B - Protect everything in this picture from the outside with Firewalls

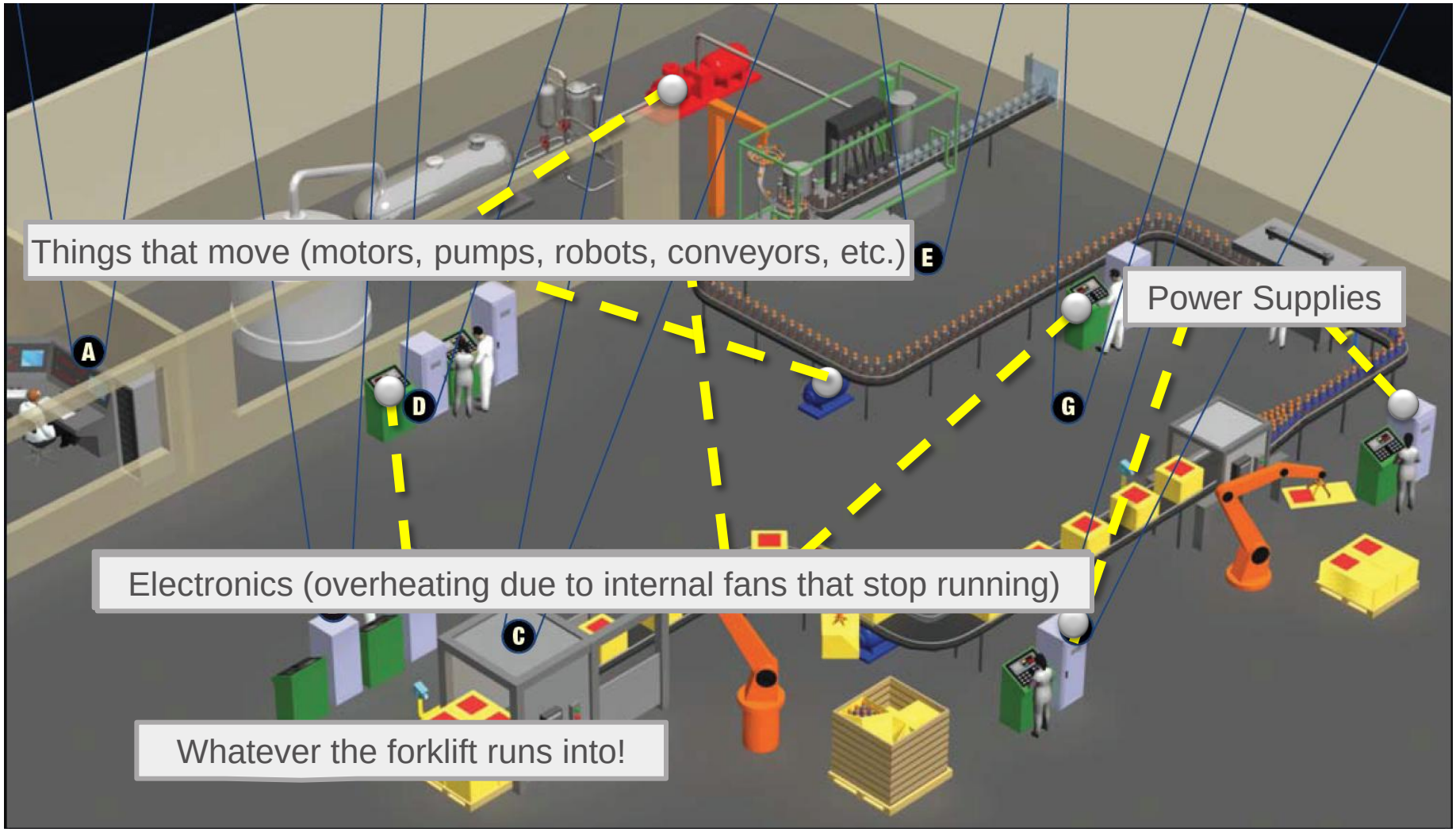
Step 6 – Evaluate Redundancy Needs

Identify the most critical parts of your system



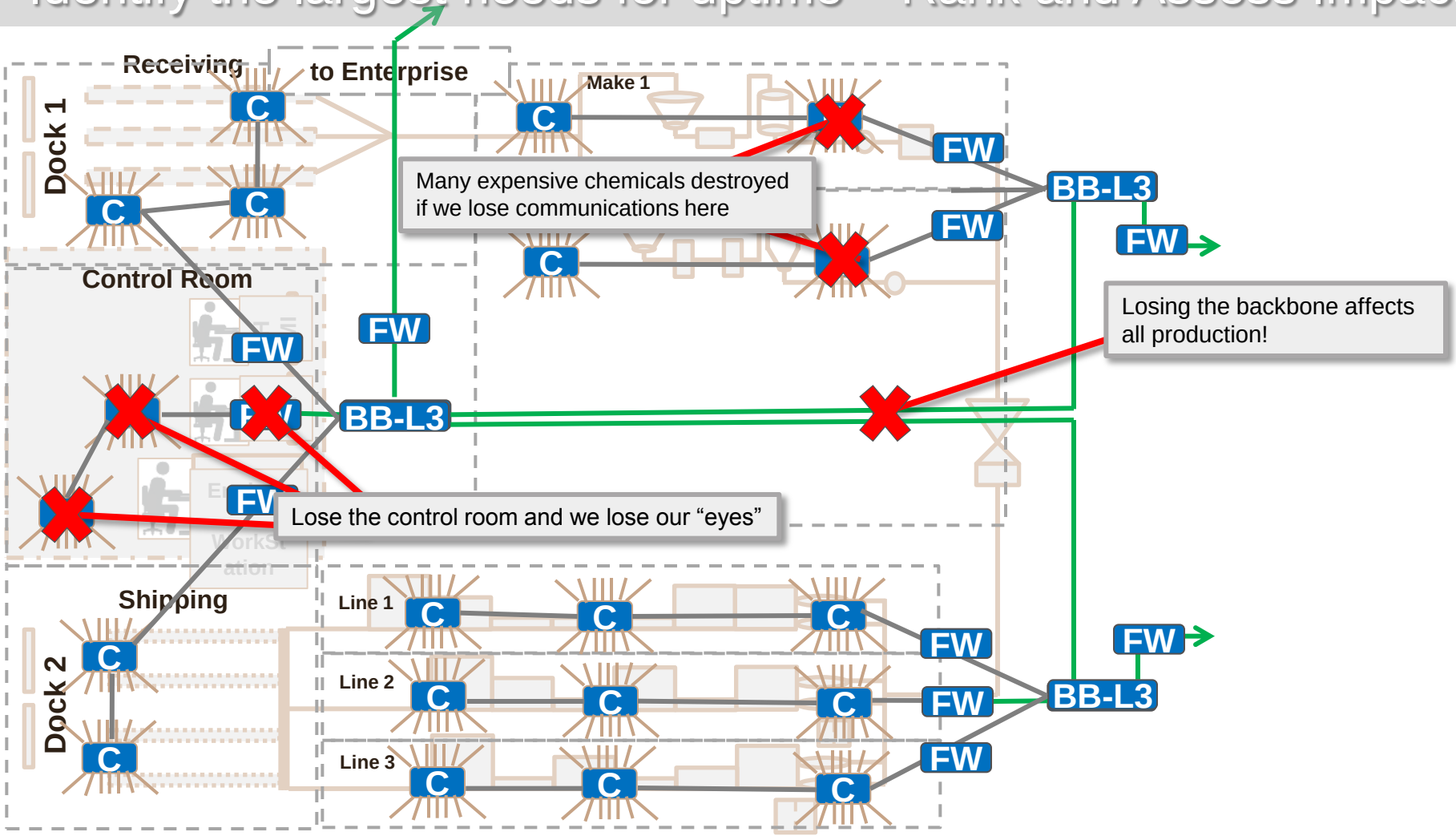
Redundancy Needs and Evaluation

What are potential points of failure?



Step 6 – Evaluate Redundancy Needs

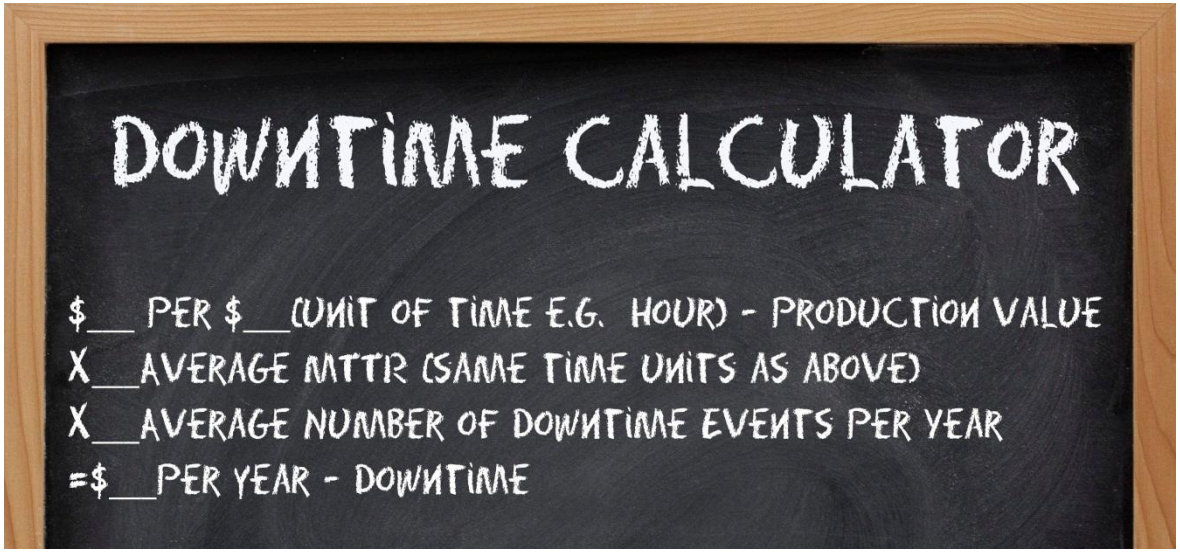
Identify the largest needs for uptime – Rank and Assess Impact



Step 6 – Evaluate Redundancy Needs

Math you can do to justify an investment in redundancy

- Unplanned downtime calculator
  - How long will production be **impacted**?
  - Will product be **lost**?
  - How much effort is needed to **recover** and **restart** your process?
- Calculate your downtime cost per minute, per hour, per day



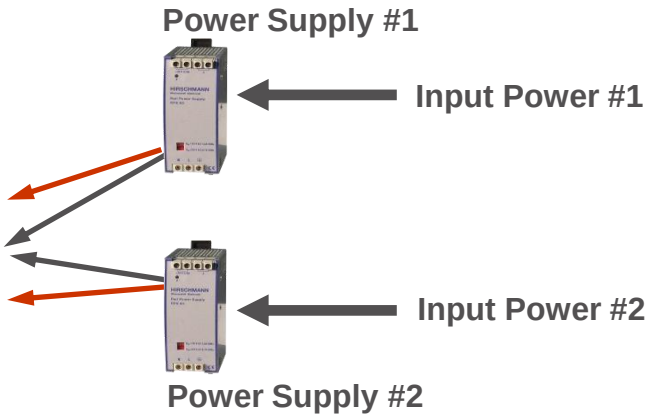
Step 6 – Evaluate Redundancy Needs

Redundant (backup) Configuration

- ACA for any Hirschmann switch

Redundant Power Supplies

- Power Supply options for any Hirschmann switch

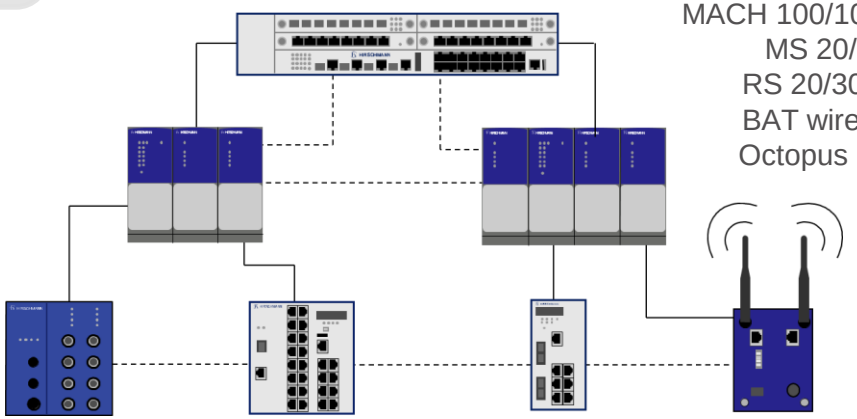


Redundant Ethernet Network

- Ring or Tree

"Ring"

MACH 100/10004000
RS 20/30/40

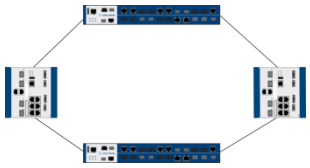


Tree

MACH 100/1000/4000
MS 20/30
RS 20/30/40
BAT wireless
Octopus IP67

Step 6 – Record Your Redundancy Choices

Use	Location /Name	L2	L3	10G ports	1G ports	10/100 ports	PoE ports	PoE Watts	1588	IP-67	2x power	Redun nets	USB memory
Backbone	Control Room / Ship / Receive		x	3							X	ring 1	X
	Make Area		x	3							X	ring 1	X
	Packaging Area		x	3							X	ring 1	X
Firewalls	Control Room FW		?								X	ring 2	X
	Shipping FW		?										
	Receiving FW		?										
	Make Area 1 FW		?										
	Make Area 2 FW		?										
	Line 1 FW		?										
	Line 2 FW		?										
	Line 3 FW		?										
	Enterprise Edge FW		x										
	NorthEast Edge FW		x										
	SouthEast Edge FW		x										
L2	Make 1 East	x				8				x	X		X
	Make 1 West	x				8				x			X
	Make 2 East	x				16	1	7		x	X		X
	Make 2 West	x				6				x			X
	Line 1 East	x				6							
	Line 1 Central	x				10							
	Line 1 West	x				20			x				
	Line 2East	x				10							
	Line 2Central	x				10							
	Line 2 West	x				20			x				
	Line 3 East	x				12							
	Line 3 Central	x				12							
	Line 3 West	x				20			x				
	Control Room North	x				20					X	ring 2	X
	Control Room South	x				20	3	21			X	ring 2	X
	Receiving West	x				12							
	Receiving NorthEast	x				12	3	21					
	Receiving SouthEast	x				12							
	Shipping North	x				10							
	Shipping South	x				10	2	8					



Add any additional standards, specifications, concerns

Switch / Router List - Network Design

Project	*My Factory*																
Project Engineer	*David Adams*																
Use	Location /Name	L2	L3	10G ports	1G ports	10/100 ports	PoE ports	PoE Watts	1588	IP-67	2x power	Redun nets	USB memory	(corrosive, moisture) Conformal Coating	Ether-Net/IP	Profi-net	special requirements
Backbone	Control Room / Ship / Receive		x	3							x	ring 1	x				
	Make Area		x	3							x	ring 1	x				
	Packaging Area		x	3							x	ring 1	x				
Firewalls	Control Room FW		?								x	ring 2	x				
	Shipping FW		?														
	Receiving FW		?														
	Make Area 1 FW		?														
	Make Area 2 FW		?														
	Line 1 FW		?														
	Line 2 FW		?														
	Line 3 FW		?														
	Enterprise Edge FW		x														
	NorthEast Edge FW		x														
	SouthEast Edge FW		x														
L2	Make 1 East	x				8				x	x		x	x	x		
	Make 1 West	x				8				x			x	x	x		
	Make 2 East	x				16	1	7		x	x		x	x	x		
	Make 2 West	x				6				x			x	x	x		
	Line 1 East	x				6									x		
	Line 1 Central	x				10									x		electrical noise?
	Line 1 West	x				20			x						x		
	Line 2East	x				10									x		
	Line 2Central	x				10									x		electrical noise?
	Line 2 West	x				20			x						x		
	Line 3 East	x				12									x		
	Line 3 Central	x				12									x		electrical no
	Line 3 West	x				20			x						x		
	Control Room North	x				20					x	ring 2	x		x	x	
	Control Room South	x				20	3	21			x	ring 2	x		x	x	
	Receiving West	x				12										x	temp extremes
	Receiving NorthEast	x				12	3	21								x	temp extremes
	Receiving SouthEast	x				12										x	temp extremes
	Shipping North	x				10										x	temp extremes
	Shipping South	x				10	2	8								x	temp extremes

Area includes corrosive gasses & extreme moisture

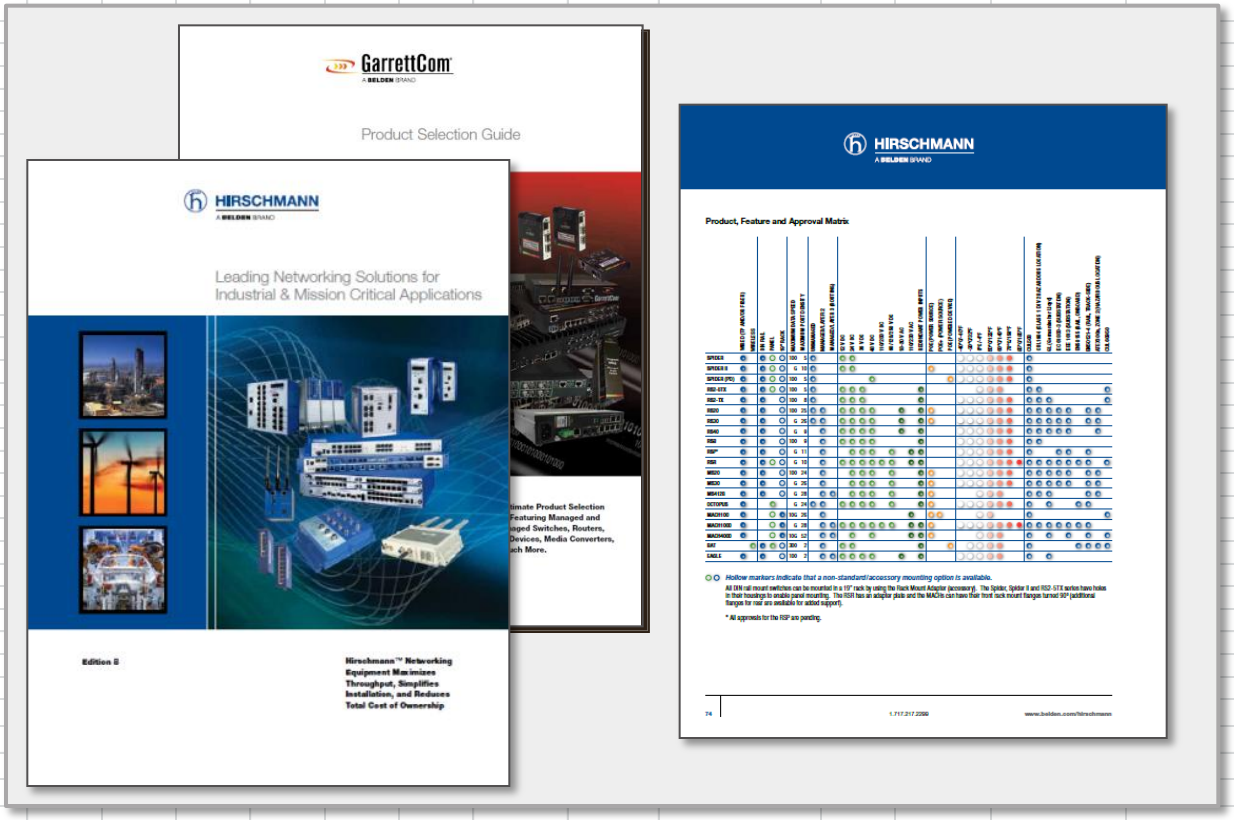
EtherNet/IP and PROFINET I/O

Expecting electrical noise near some very large drives in these areas

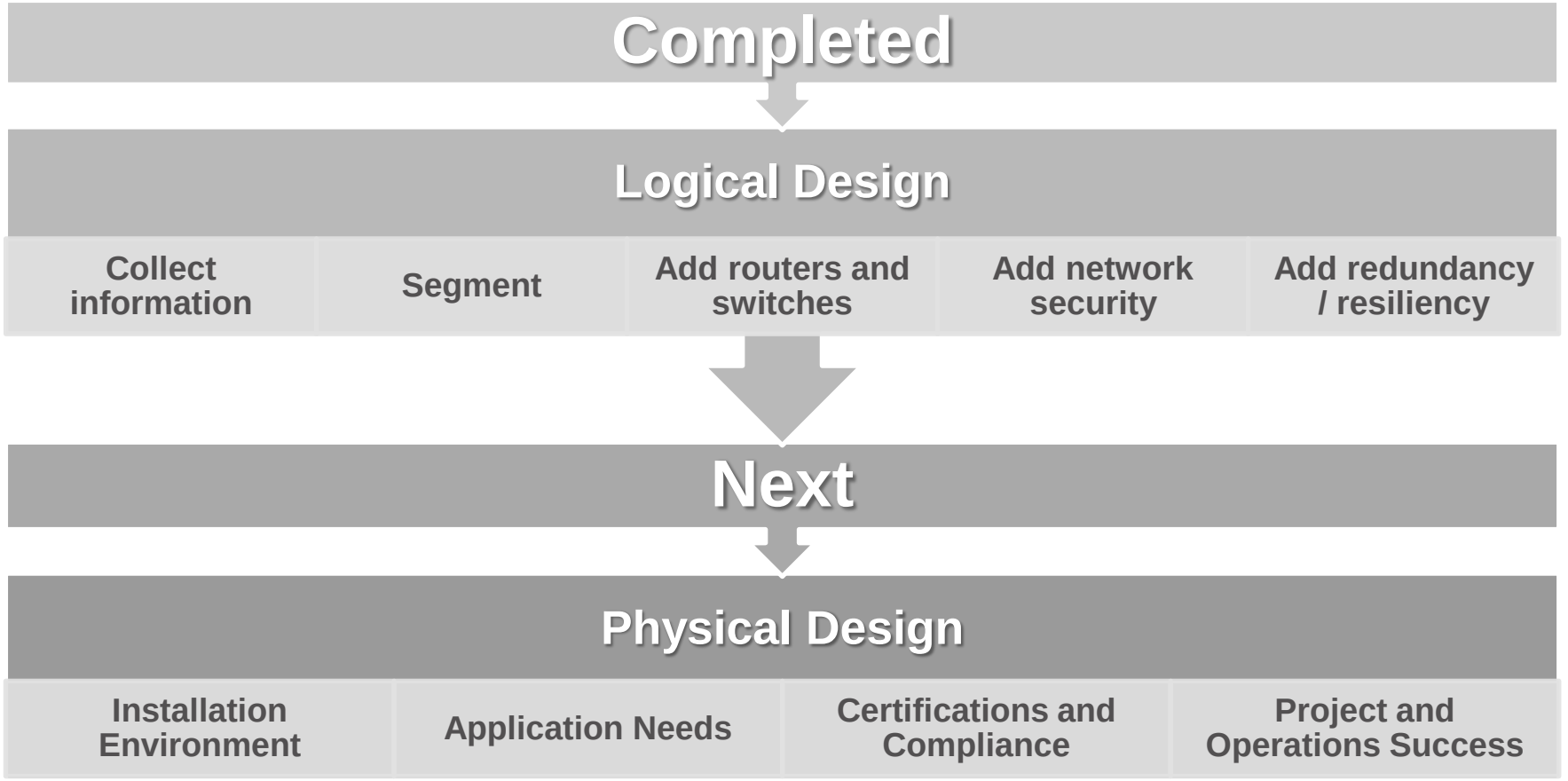
Expecting huge temp extremes in dock areas

Choose Products and Record Your Choices

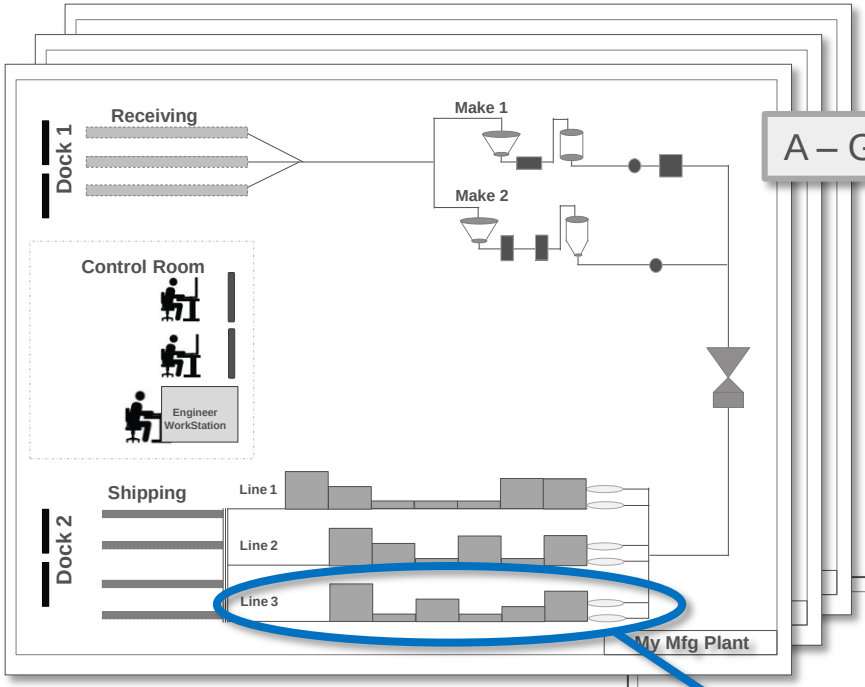
Use	Location /Name	L2	L3	10G ports	1G ports	10/100 ports	PoE ports	PoE Watts	1588	IP-67	2x power	Redun nets	USB memory	special requirements	Model	Catalog Number	Accessories	Accessory Catalog Numbers
Backbor	Control Room / Ship / Receive		x	3							X	ring 1	X					
	Make Area		x	3							X	ring 1	X					
	Packaging Area		x	3							X	ring 1	X					
Firewalls	Control Room FW		?								X	ring 2	X					
	Shipping FW		?															
	Receiving FW		?															
	Make Area 1 FW		?															
	Make Area 2 FW		?															
	Line 1 FW		?															
	Line 2 FW		?															
	Line 3 FW		?															
	Enterprise Edge FW		x															
	NorthEast Edge FW		x															
	SouthEast Edge FW		x															
L2	Make 1 East	x																
	Make 1 West	x																
	Make 2 East	x																
	Make 2 West	x																
	Line 1 East	x																
	Line 1 Central	x																
	Line 1 West	x																
	Line 2East	x																
	Line 2Central	x																
	Line 2 West	x																
	Line 3 East	x																
	Line 3 Central	x																
	Line 3 West	x																
	Control Room North	x																
	Control Room South	x																
	Receiving West	x																
	Receiving NorthEast	x																
	Receiving SouthEast	x																
	Shipping North	x																
	Shipping South	x																



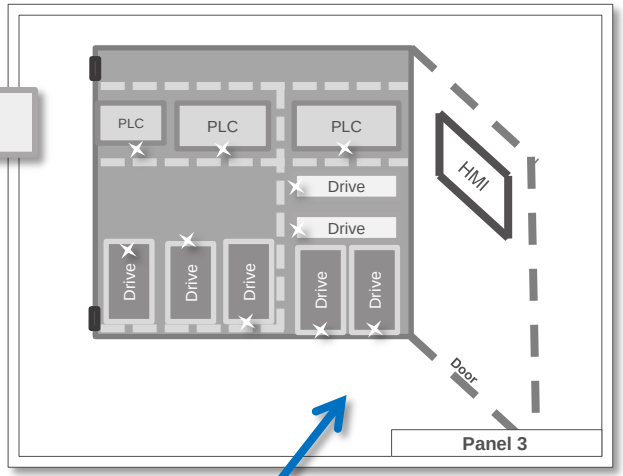
Summary – Logical Design



Step 1 – Collect Information (from Part 1)



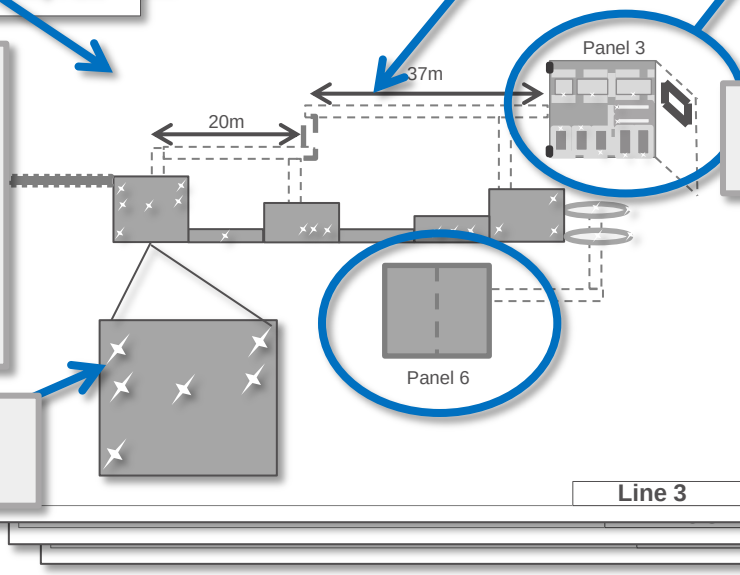
A – Get physical drawings



E - Identify cable routing options and distance information

D – General understanding of what each part of the network needs to **DO**

- HMI
- Control I/O
- High-speed motion
- Video / voice
- Physical security
- Business apps



C – Identify panel locations and detail

B – Identify location and number of end devices to network

And your spreadsheet of Switch/Router Choices…

Switch / Router List - Network Design																				
Project	*My Factory*																			
Project Engineer	*David Adams*																			
Use	Location /Name	L2	L3	10G ports	1G ports	10/100 ports	PoE ports	PoE Watts	1588	IP-67	2x power	Redun nets	USB memory	(corrosive, moisture) Conformal Coating	Ether-Net/IP	Profi-net	special requirements	Model	Catalog Number	Accessories	Accessory Catalog Numbers
Backbone	Control Room / Ship / Receive		x	3							x	ring 1	x								
	Make Area		x	3							x	ring 1	x								
	Packaging Area		x	3							x	ring 1	x								
Firewalls	Control Room FW		?								x	ring 2	x								
	Shipping FW		?																		
	Receiving FW		?																		
	Make Area 1 FW		?																		
	Make Area 2 FW		?																		
	Line 1 FW		?																		
	Line 2 FW		?																		
	Line 3 FW		?																		
	Enterprise Edge FW		x																		
	NorthEast Edge FW		x																		
	SouthEast Edge FW		x																		
L2	Make 1 East	x				8				x	x		x	x	x						
	Make 1 West	x				8				x			x	x	x						
	Make 2 East	x				16	1	7		x	x		x	x	x						
	Make 2 West	x				6				x			x	x	x						
	Line 1 East	x				6									x						
	Line 1 Central	x				10									x		electrical noise?				
	Line 1 West	x				20			x						x						
	Line 2East	x				10									x						
	Line 2Central	x				10									x		electrical noise?				
	Line 2 West	x				20			x						x						
	Line 3 East	x				12									x						
	Line 3 Central	x				12									x		electrical noise?				
	Line 3 West	x				20			x						x						
	Control Room North	x				20					x	ring 2	x		x	x					
	Control Room South	x				20	3	21			x	ring 2	x		x	x					
	Receiving West	x				12										x	temp extremes				
	Receiving NorthEast	x				12	3	21								x	temp extremes				
	Receiving SouthEast	x				12										x	temp extremes				
	Shipping North	x				10										x	temp extremes				
	Shipping South	x				10	2	8								x	temp extremes				

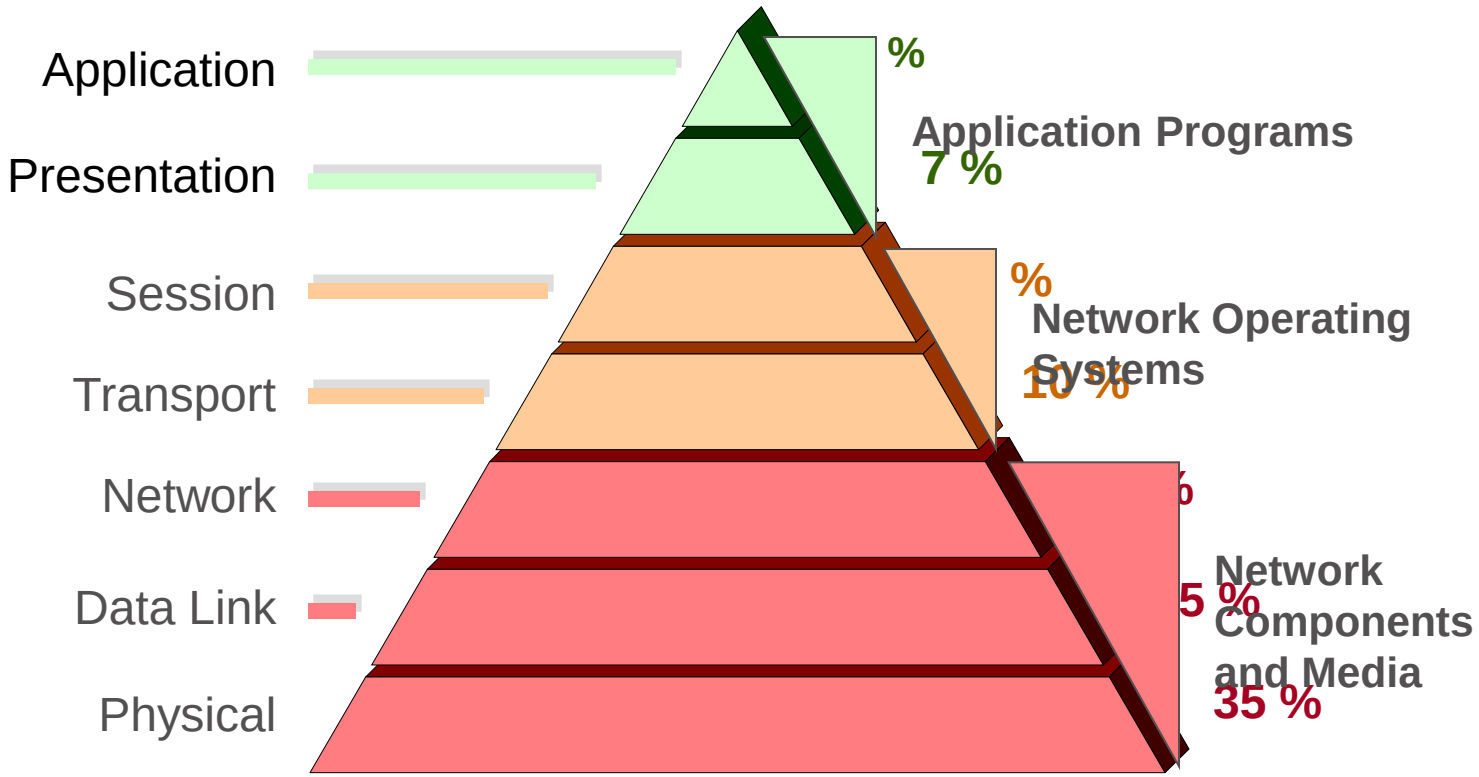
Step 2 - Specify Ethernet Cables and Connectors

Why?

- Failures can occur at Ethernet switch, connectors or cabling
- Which of these is most difficult to replace?
  - Switches - have backup configurations
  - Connectors - are usually easy to access
  - Cables - are the most difficult to replace.
- So, make good Ethernet cable design decisions.
- Specify what is critical now!

Network Reliability

What causes network faults?



Source: Datacom, Network Management Special

Choices, Choices, Choices…

Factors to consider

- distance
- performance
- environment
- application
- regulations & specifications

Choices to make

- Conductors
- Shield (or not)
- Jacket
- Connectors
- Pre-terminated or field-installable

We'll make this easy…

Specify Cable/Cordset Requirements

	Factors
	< 80m
	< 100m
	< 5000m
	< 100,000m
	10/100M rate
	1G rate
	10G rate
	Power over Ethernet
	electrical noise (motors, drives, welders)
	standard bend radius (8-10x wire diameter)
	tight bend radius
	high flex
	outdoor
	UV (sun)
	washdown
	moisture
	Underground burial
	Tray installation
	Physical stress - cut-through, abrasion, crushing
	hazardous environment
	temp >20C or <0C
	chemicals
	low smoke zero halogen
	regulations & standards (many)

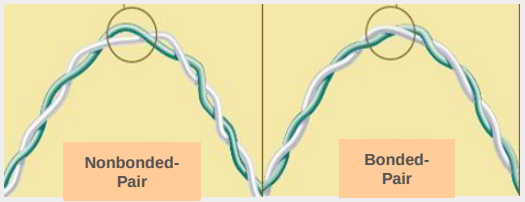
1. Specify ALL of these things that affect you or else installers will pick what they want.

Step 7a - Specify Copper / Fiber Requirements

	Factors	Copper								Fiber				
		Stranded Alloy	Solid	Cat 5	Cat 5e / Cat 6	2 pair	4 pair	Shielded	Unshielded	multi-mode	single-mode	OM3/4	always tight buffer	always plenum
	< 80m	√	√	√	√	√	√	√	√	√	√		√	√
	< 100m		√	√	√	√	√	√	√	√	√		√	√
	< 5000m									√	√		√	√
	< 100,000m										√		√	√
	10/100M rate	√	√	√	√	√	√	√	√	√	√		√	√
	1G rate	√	√		√		√	√	√	√	√		√	√
	10G rate										√	√	√	√
	Power over Ethernet	√	√	√	√		√	√	√					
	electrical noise (motors, drives, welders)	√	√	√	√	√	√	√		√	√	√	√	√
	standard bend radius (8-10x wire diameter)	√	√	√	√	√	√	√	√	√	√	√	√	√
	tight bend radius	√												
	high flex	√												

Industrial Copper, ALWAYS spec:

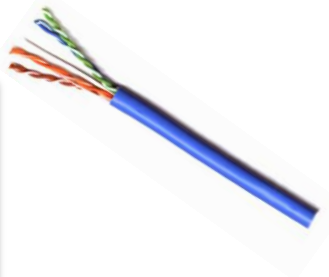
- Bonded Pair (see "9 tests" data)
- CAT5e or higher



Things shaded in orange drive each decision

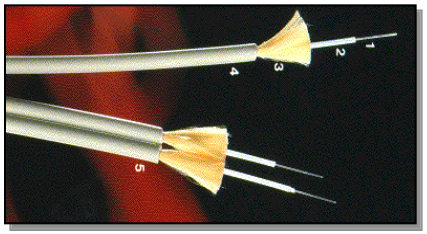
Industrial Fiber, ALWAYS spec:

- Tight buffer
- Plenum
- OM3/4



Step 7b - Specify Jacket Requirements

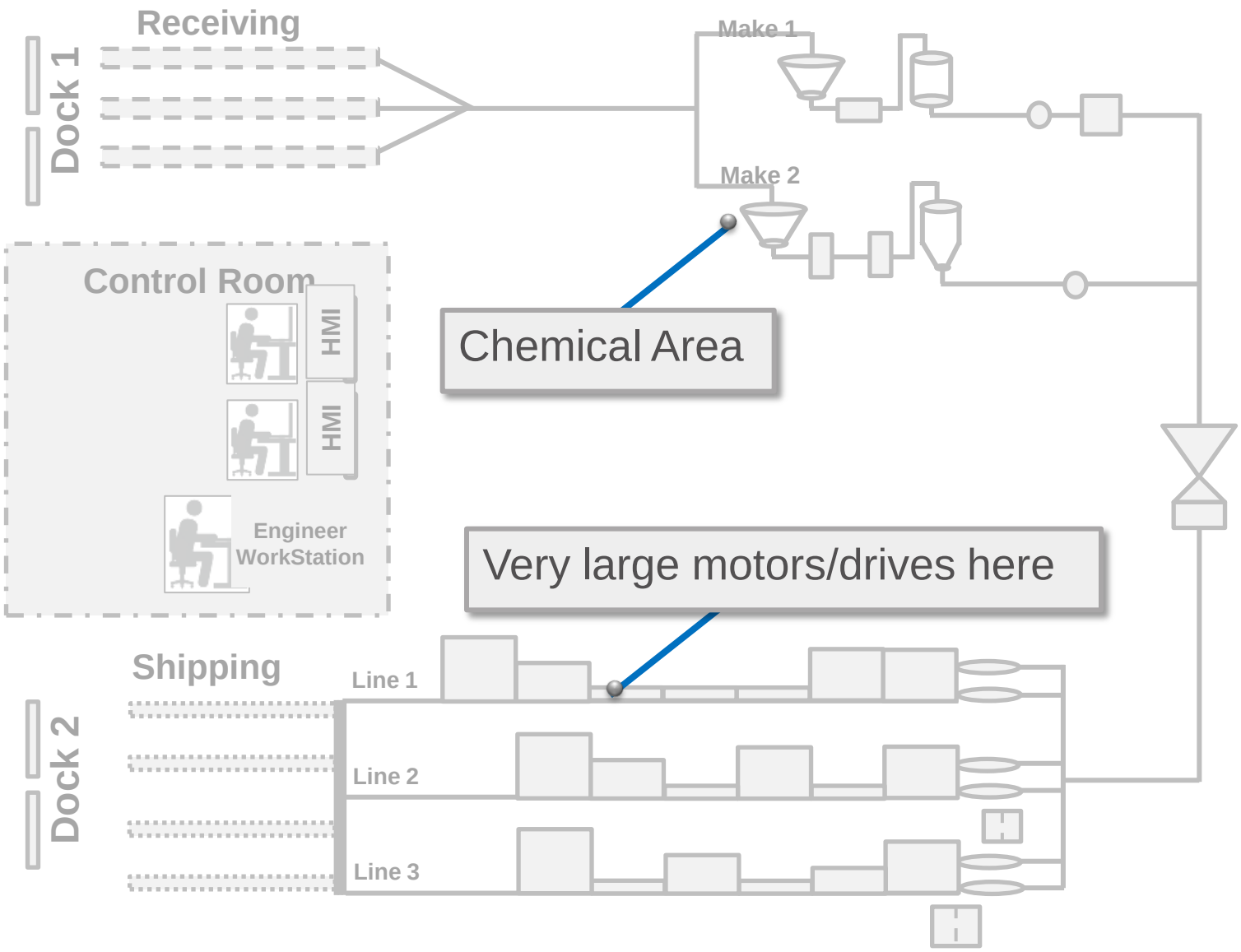
		Jacket							
	Factors	UV	Armor	PUR jacket	Expose Run	FEP insulation & jacket	TPE insulation & jacket	PE jacket	CPE jacket
	outdoor		√						
	UV (sun)	√							
	washdown								√
	moisture								
	Underground burial							√	
	Tray installation				√				
	Physical stress - cut-through, abrasion, crushing		√	√					
	hazardous environment		√						
	temp >20C or <0C					√	√		
	chemicals						√		
	low smoke zero halogen								
	regulations & standards (many)								



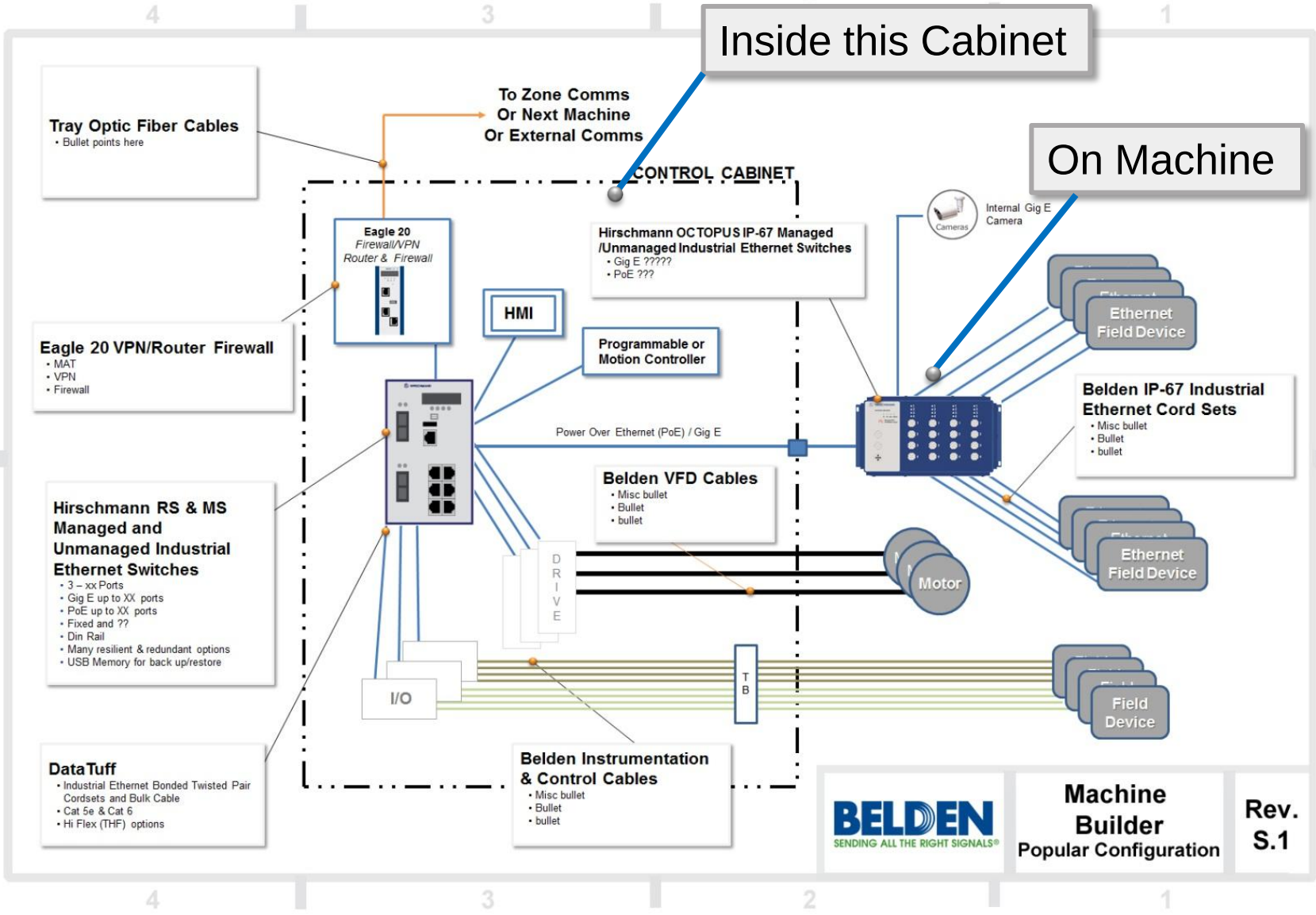
Step 7c - Specify Connector & Buy vs. Build Requirements

		Connector / Cordset				
	Factors	RJ-45	RJ-45 with seal overmold	M12	Field-installable connectors	premade cordset
	outdoor		√	√		
	washdown		√	√		
	moisture		√	√		
	chemicals		√	√		
	time					√
	material cost				√	
	precision length				√	

What considerations?



What considerations?



What cable choices will you use for…

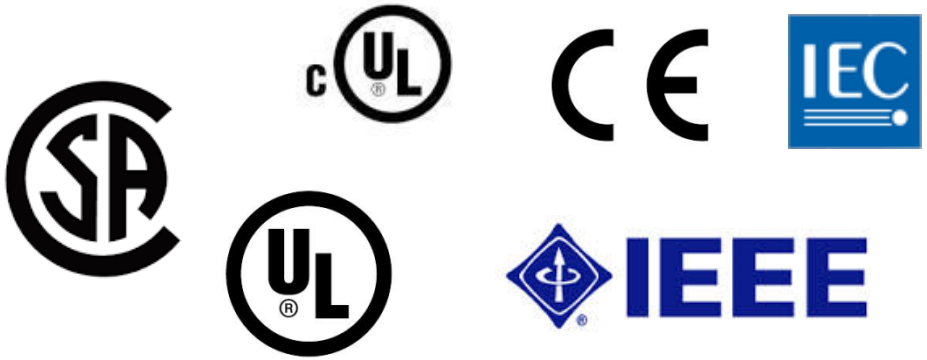
Switch / Router List - Network Design																					
Project	*My Factory*																				
Project Engineer	*David Adams*																				
Use	Location /Name	L2	L3	10G ports	1G ports	10/100 ports	PoE ports	PoE Watts	1588	IP-67	2x power	Redun nets	USB memory	(corrosive, moisture) Conformal Coating	Ether-Net/IP	Profi-net	special requirements	Model	Catalog Number	Accessories	Accessory Catalog Numbers
Backbone	Control Room / Ship / Receive		x	3							x	ring 1	x								
	Make Area		x	3							x	ring 1	x								
	Packaging Area		x	3							x	ring 1	x								
Firewalls	Control Room FW		?								x	ring 2	x								
	Shipping FW		?																		
	Receiving FW		?																		
	Make Area 1 FW		?																		
	Make Area 2 FW		?																		
	Line 1 FW		?																		
	Line 2 FW		?																		
	Line 3 FW		?																		
	Enterprise Edge FW		x																		
	NorthEast Edge FW		x																		
	SouthEast Edge FW		x																		
L2	Make 1 East	x				8				x	x		x	x	x						
	Make 1 West	x				8				x			x	x	x						
	Make 2 East	x				16	1	7		x	x		x	x	x						
	Make 2 West	x				6				x			x	x	x						
	Line 1 East	x				6									x						
	Line 1 Central	x				10									x		electrical noise?				
	Line 1 West	x				20			x						x						
	Line 2East	x				10									x						
	Line 2Central	x				10									x		electrical noise?				
	Line 2 West	x				20			x						x						
	Line 3 East	x				12									x						
	Line 3 Central	x				12									x		electrical noise?				
	Line 3 West	x				20			x						x						
	Control Room North	x				20					x	ring 2	x		x	x					
	Control Room South	x				20	3	21			x	ring 2	x		x	x					
	Receiving West	x				12										x	temp extremes				
	Receiving NorthEast	x				12	3	21								x	temp extremes				
	Receiving SouthEast	x				12										x	temp extremes				
	Shipping North	x				10										x	temp extremes				
	Shipping South	x				10	2	8								x	temp extremes				

What is Levels

- History of Category cable and Anixter involvement in defining the standards for Category cable.
- Category is based on performance and Levels is based on survivability in a particular application.
- Making it easier to identify specific cables, connectors, network switches and power supplies for the environment.
- End users and internal sales tool to make specifying cable and equipment faster and easier.

Current rating systems: Industrial Infrastructure

- Individual Safety Ratings
  - UL
  - CE
  - IEEE
  - IEC
  - CUL



- TIA-1005
- MICE
  - Mechanical
  - Ingress
  - Climate
  - Electromagnetic

MICE	Classes		
Mechanical	M1	M2	M3
Ingress	I1	I2	13
Climate	C1	C2	C3
Electromagnetic	E1	E2	E3

Complexity of the MICE table

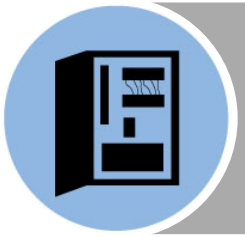
Climatic	C1	C2	C3
Ambient temperature	-10 to +50°C	-25 to +70°C	-40 to +70°C
Rate of change of temperature	0.1°C/minute	1°C/minute	3°C/minute
Humidity	5 to 85% (non-condensing)	5 to 95% (condensing)	5% to 95% (condensing)
Ultraviolet radiation	ffs	ffs	ffs
Solar radiation	700W/m^2	1120W/m^2	1120W/m^2
Sodium chloride	None	ffs	ffs
Sodium stearate	None	ffs	ffs
Detergent	None	ffs	ffs
Oil	None	ffs	ffs
Conductive materials in solution	None	Temporary (condensation)	Present
Gaseous pollution contaminants (ppm)	Mean /Peak	Mean /Peak	Mean /Peak
Hydrogen sulphide	0.003/0.01	0.005/0.05	10/50
Sulphur dioxide	0.01/0.03	0.1/0.3	5/10
Sulphur trioxide	0.01/0.03	0.1/0.3	5/10
Chlorine wet	0.0005/0.001	0.005/0.03	0.05/0.3
Chlorine dry	0.002/0.01	0.02/0.1	0.2/1.0
Hydrogen fluoride	0.001/0.005	0.01/0.05	0.1/1.0
Ammonia	1/5	10/50	50/250
Oxides of Nitrogen	0.05/0.1	0.5/1	5/10
Ozone	0.002/0.005	0.025/0.05	0.1/1.0

ffs: fit for service

Matching Components and Cabling to the Environment

Anixter has defined LEVELS that encompass the majority of industrial conditions (not 100%) based on economical and readily available products

Level 1: A controlled area located inside an industrial facility where cabling components are secured from physical damage and protected from harsh or industrial environments.



Level 2: Located inside an industrial facility where cabling and components are subjected to more extreme ambient temperatures, humidity and potential damage.

Level 3: Located in a harsh industrial area where cabling and components are exposed to oil, solvents, cleaning agents, lubricants, water, wide varying temperatures, humidity and dust.

Anixter levels – Product selection guide

To view information on products, click on the product sets below.

1. Industrial Ethernet Cables
2. Copper Ethernet Patch Cords
3. Copper Ethernet Connectors
4. Industrial Power Supplies
5. Industrial Ethernet Switches
6. Industrial Fiber Optic Cables
7. Fiber Optic Patch Cords
8. Fiber Optic Connectors

Selection Guide for Copper Ethernet Cable

							
Cable Type	Color	Plenum or Non Plenum	Level 1	Level 2	Level 3	Solid or Stranded	Unshielded or Shielded
Cat 5e 10/100	Blue	Non Plenum	L1-5E-S0L-UTP-06	—	—	Solid	Unshielded
		Plenum	L1-5E-S0L-UTP-06	—	—	Solid	Unshielded
	White	Non Plenum	L1-5E-S0L-UTP-01	—	—	Solid	Unshielded
		Plenum	L1-5E-S0L-UTP-P-01	—	—	Solid	Unshielded
	Black	Non Plenum	—	L2-5E-SOL-UTP-02	L3-5E-SOL-UTP-02	Solid	Unshielded
Modifiers to Cat 5e							
EMI (Shielded)	Blue	Non Plenum	L1-5E-S0L-SHD-06	—	—	Solid	Unshielded
		Plenum	L1-5E-S0L-SHD-P-06	—	—	Solid	Unshielded
	Black	Non Plenum	—	L2-5E-SOL-SHLD-02	L3-5E-SOL-SHLD-02	Solid	Shielded
Flexibility (Stranded)	Black	Non Plenum	—	L2-5E-STR-UTP-02	L3-5E-STR-UTP-02	Stranded	Unshielded
EMI & Flexibility (Shielded & Stranded)	Black	Non Plenum	—	L2-5E-STR-SHLD-02	L3-5E-STR-SHLD-02	Stranded	Shielded

Anixter Levels Product Mix

Anixter's Levels for Industrial Environments uses technology and environment requirements to simplify product choices and deliver performance, scalability and reliability for mission-critical systems.

- ✓ Industrial Ethernet Cables
- ✓ Copper Ethernet Patch Cords
- ✓ Copper Ethernet Connectors
- ✓ Industrial Power Supplies
- ✓ Industrial Ethernet Switches
- ✓ Industrial Fiber Optic Cables
- ✓ Fiber Optic Patch Cords
- ✓ Fiber Optic Connectors

https://www.anixter.com/levels

Part 3 – Keys to Project and Operations Success

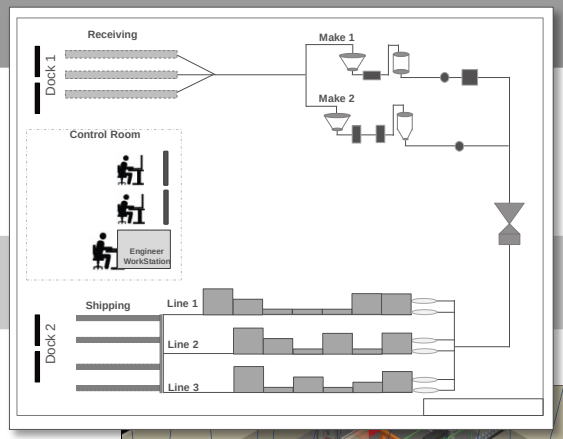
Industrial Networking Project Checklist

Need			How Belden Can Help	Price
Manage	☐	Manage my entire project	Provide a dedicated resource to work as customer staff	Quote
Design	☐	Review my design & highlight areas of risk	Fax & phone consultation	FREE
	☐	Assist with my design in a few key areas	Fax & phone consultation	FREE
	☐	Assess my situation & create my design	Onsite meeting & comprehensive network design	Quote
Install	☐	Preconfigure switches / routers		Variable
	☐	Provide industrial installation guidelines		FREE
	☐	Create custom installation instructions & drawings	Recommend experienced Belden System Integrator or partner	via SI
	☐	Peform the installation	Recommend experienced Belden System Integrator or partner	via SI
	☐	Peform security vulnerability testing	Onsite testing and assesment	Quote
	☐	Peform network validation	Onsite testing and assesment	Quote
Startup	☐	Perform startup	Recommend experienced Belden System Integrator or partner	via SI
	☐	Provide troubleshooting	Onsite troubleshooting	
Operate	☐	Dedicated onsite engineering service		Quote
Maintain	☐	Stock spares	We review your application & needs & provide recommendations	FREE
	☐	Stock preconfigured spares		Quote
	☐	Firmware	Keep your hardware current	Variable
	☐	Switch warranty	Lifetime Warranty	FREE
	☐	Industrial HiVision Service Contract	Keep your software current	Variable
	☐	Advanced replacement for faulty devices		FREE
	☐	Remote troubleshooting		Quote
	☐	Dedicated technical support contact	Get help from someone that knows you and your application	Quote
	☐	On-site troubleshooting		Quote
	☐	Troubleshooting procedures		FREE
	☐	Troubleshooting tools		Variable
	☐	Training for maintenance team		Variable
Upgrade	☐	Assess planned network changes & highlight areas of risk	Fax & phone consultation	Variable
	☐	Onsite visit if needed		Variable

Seminar Summary

Objectives

- Complete the steps to design Industrial Ethernet networks
- Specify and select active and passive network components
- Identify and plan project and operational success factors



Agenda:

- **Logical Design**
  - Collect information
  - Segment
  - Add routers and switches
  - Add network security
  - Add redundancy / resiliency
- **Physical Design**
  - Determine critical factors
  - Conductors, shield, jacket,
- **Project and Operations Success**

Questions?

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