# Connected Factory

Driving Business Value for the IoT Connected Enterprise

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# Connected Factory—What's on Your Mind
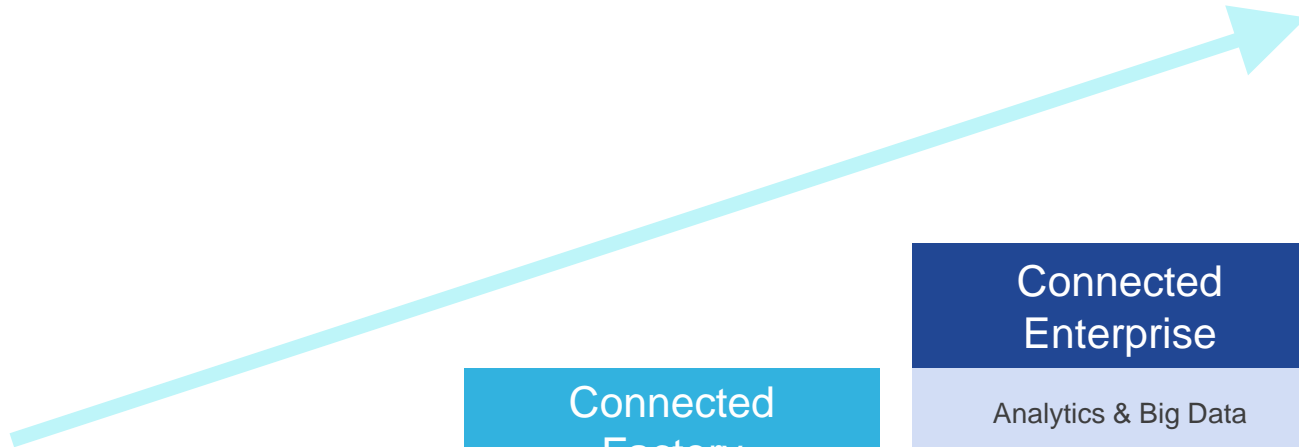
Asset Optimization… Improving Flexibility, Uptime, Efficiency

Faster Time to Market and NPI (New Product Introduction)

Workforce Productivity, New Skills, Safety, Aging Workforce Dilemma

Lower Total Cost of Ownership

Security, Security, Security

# Digital Manufacturing Journey

- 49% Defects

+ 16% OEE

+ 23% NPI

- 48% Downtime

- 35% Inventory

## Off-Line

## Connected Factory
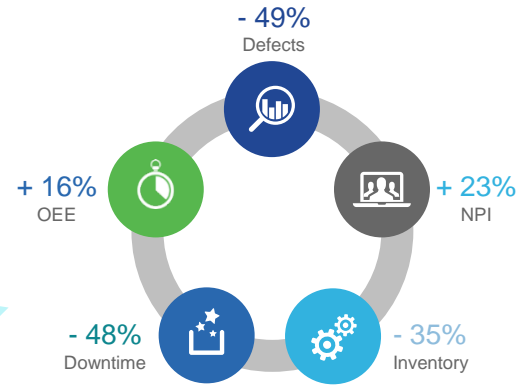
Factory Network

Factory Security

Factory Wireless

## Connected Enterprise
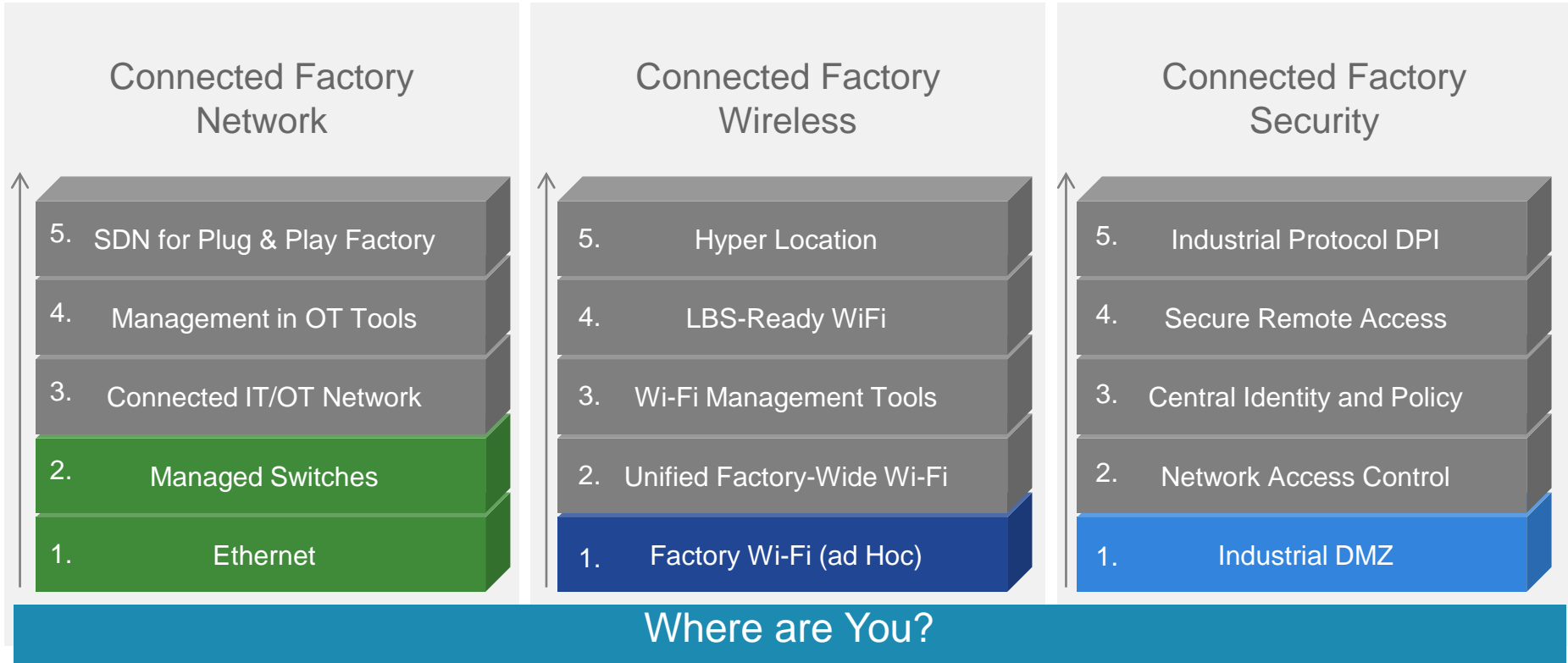
Analytics & Big Data

Virtualization & Compute

Connected Machines

Factory Collaboration

Location Services

## Supply Chain Orchestration

Supply Chain Collaboration

Design Collaboration

# IoT-Readiness in Today's Typical Factory

## Connected Factory Network

5. SDN for Plug & Play Factory
4. Management in OT Tools
3. Connected IT/OT Network
2. Managed Switches
1. Ethernet

## Connected Factory Wireless

5. Hyper Location
4. LBS-Ready WiFi
3. Wi-Fi Management Tools
2. Unified Factory-Wide Wi-Fi
1. Factory Wi-Fi (ad Hoc)

## Connected Factory Security

5. Industrial Protocol DPI
4. Secure Remote Access
3. Central Identity and Policy
2. Network Access Control
1. Industrial DMZ

## Where are You?

# Digital Manufacturing Solutions

| Apps | | |
|---|---|---|
| Analytics & Big Data | Supply Chain Collaboration | Factory Collaboration |

| Compute | |
|---|---|
| Factory Virtualisation | Data Center and Cloud |
| Connected Machines & Edge Compute | |

| Connected Factory Infrastructure |
|---|
| Factory Wireless |
| Factory Security |
| Factory Network |

CISCO
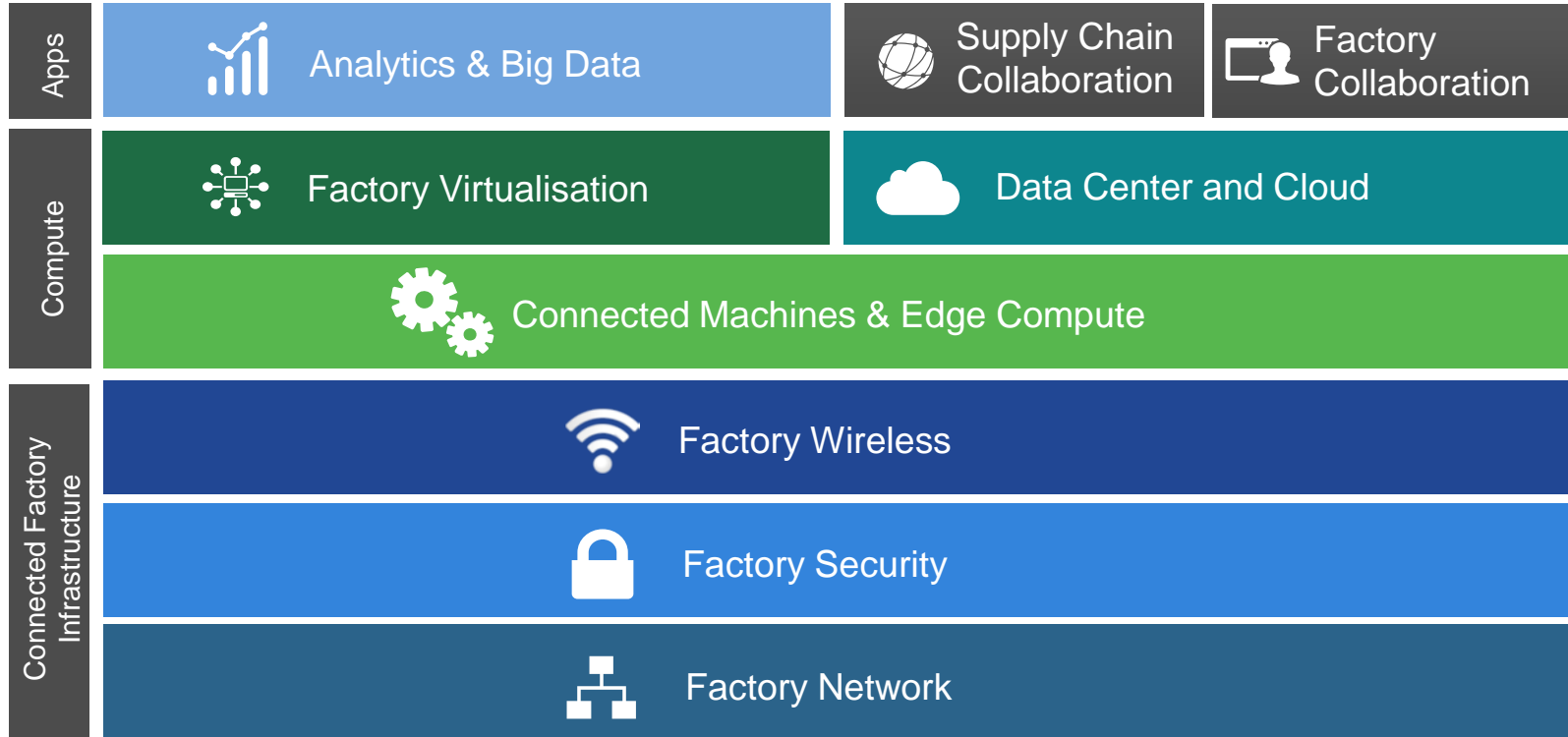
# Factory Network

## WHAT IS IT

## Unified Converged Factory Network

### CHALLENGE

Complex network silos creating downtime, data isolation and vulnerabilities. Inflexible and high TCO.

"Network issues took us hours and sometimes days to troubleshoot. The downtime associated with these issues was extremely costly." *- Dave Gutshall – Harley Davidson*

### CRITICAL NEEDS

- Converged Network for Flexible Automation
- Rapid Fault Isolation
- Resiliency (REP, MRP)
- Ease of use (NAT)
- App / Data Integration

### CISCO PORTFOLIO

IE 2000, 3000 CGS2000

IP67

IE 4000

IE 5000

Cisco IND

CGR 2000

ASR 903

ASR 902

**Industrial Switching**

**Industrial Routing**

### BUSINESS OUTCOMES

**OEE Improvement**

**Reduced Downtime**

# Factory Network Maturity

**Starting Point:**

Proprietary Serial Islands

## Phase 1

### Unmanaged, unconverged Ethernet

- Richer sensor data
- Still siloed
- No security

## Phase 2

### Converged Plantwide Network

Converge siloed networks for IOT visibility & cost savings
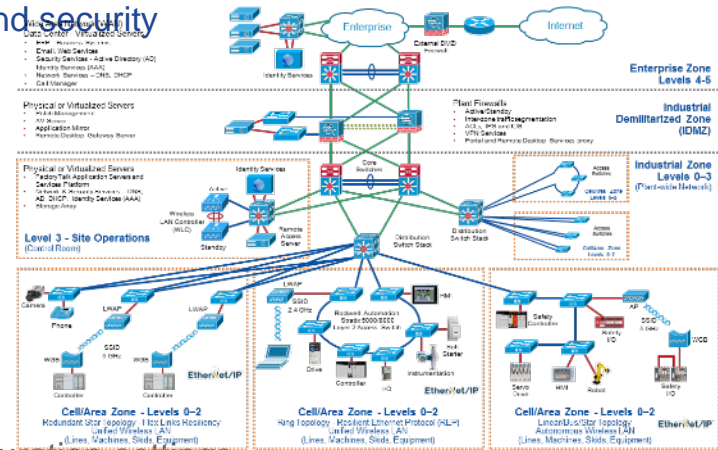
## Phase 3

### Flexible, Multi-Service Platform

- Controls security
- Controls Mobility
- Video & Collaboration
- Remote Monitoring
- CLOUD, FOG
- Software Defined Factories

Increasing Value

# Reference Architectures

- Tested, validated and documented reference architectures
  - Developed from use cases - customer and application
  - Tested for performance, availability, repeatability, scalability and security
  - Comprised of nine (9) Cisco® and Rockwell Automation® Validated Designs
- Built on technology and industry standards
  - "Future-ready" network design
- Content relevant to both OT and IT Engineers
- Deliverables
  - Recommendations, best practices, design and implementation guidance, documented test results and configuration settings
  - Simplified design, quicker deployment, reduced risk in deploying new technology
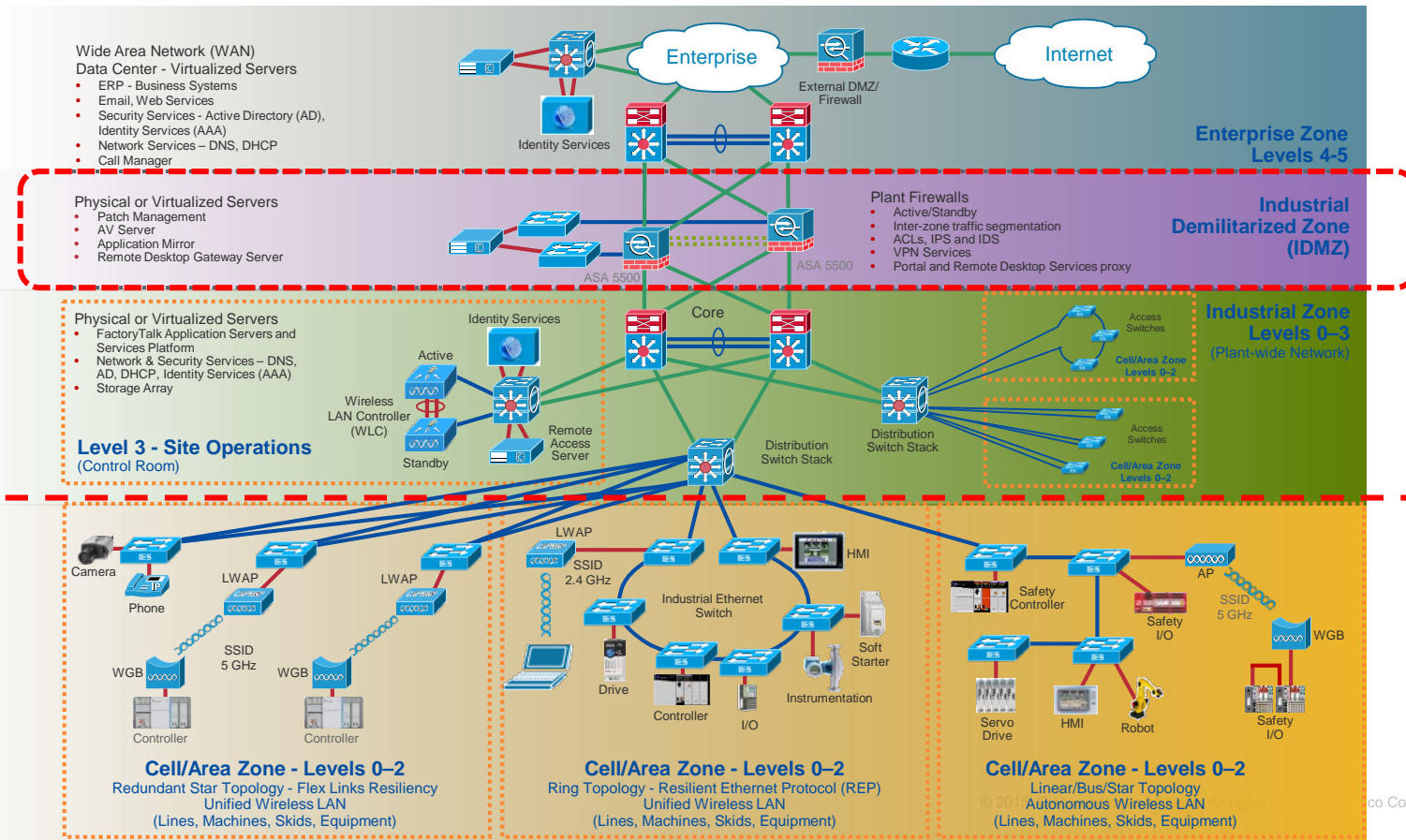
# Cisco Validated Designs

https://www.cisco.com/c/en/us/solutions/design-zone.html?stickynav=3

| Industry | Solution | Design Guide Description |
|---|---|---|
| Manufacturing | enter search terms | enter search terms |
| Manufacturing | Connected Factory-CPwE | Solution to assist manufacturers seeking to integrate or upgrade their Industrial Automation and Control System (IACS) networks to standard Ethernet and IP networking technologies. |
| Manufacturing | Connected Factory - PROFINET | Solution for PROFINET-based industrial environments to integrate Cisco Industrial Ethernet switches into the automation network. |
| Manufacturing | Connected Factory - CC-Link IE | Solution for CC-Link IE-based industrial environments to integrate Cisco Industrial Ethernet switches into the automation network. |
| Manufacturing | Connected Machine | Enable rapid and repeatable machine connectivity, providing business improvements such as overall equipment effectiveness (OEE) and machine monitoring. |
| Manufacturing | Connected Factory - Network Management for Operational Technology | Discusses the use of Cisco's Industrial Network Director application for monitoring industrial network assets and discovering automation devices within the context of the Connected Factory solution. |

## Design guides by category

### Networking
Campus wired and wireless LAN
Data center networking
Digital Network Architecture (DNA)
Evolved programmable network
Branch/WAN and Internet edge

All networking guides

### Security
Cisco AnyConnect
Enterprise campus security
Security in the branch
Security integrated infrastructures
Security in WAN

All security guides

### Data
Big da...
Data ...
Deskt...
FlexP...
SAP

All ...

### Mobility
All mobility guides

### Archive
IPv6
Application performance
IP video surveillance
Medianet

### Industries
Compliance
Manufacturing
Oil and Gas
Transportation
Utilities

All industries guides

### Collaboration
Remote Expert

All collaboration guides

# Converged Plantwide Ethernet (CPwE)
## Reference Architecture

ISA 95 principle of levels
ISA 99 (IEC62443) principle of strong segmentation
Use of an IDMZ



Enterprise

Internet

Wide Area Network (WAN)
Data Center - Virtualized Servers
- ERP - Business Systems
- Email, Web Services
- Security Services - Active Directory (AD), Identity Services (AAA)
- Network Services – DNS, DHCP
- Call Manager

External DMZ/Firewall

Identity Services

**Enterprise Zone Levels 4-5**

Physical or Virtualized Servers
- Patch Management
- AV Server
- Application Mirror
- Remote Desktop Gateway Server

Plant Firewalls
- Active/Standby
- Inter-zone traffic segmentation
- ACLs, IPS and IDS
- VPN Services
- Portal and Remote Desktop Services proxy

ASA 5500

ASA 5500

**Industrial Demilitarized Zone (IDMZ)**

Physical or Virtualized Servers
- FactoryTalk Application Servers and Services Platform
- Network & Security Services – DNS, AD, DHCP, Identity Services (AAA)
- Storage Array

Identity Services

Core

Access Switches

Cell/Area Zone Levels 0–2

**Industrial Zone Levels 0–3 (Plant-wide Network)**

Active

Wireless LAN Controller (WLC)

Standby

Remote Access Server

**Level 3 - Site Operations**
(Control Room)

Distribution Switch Stack

Distribution Switch Stack

Access Switches

Cell/Area Zone Levels 0–2

Camera

LWAP

LWAP

Phone

WGB

SSID 5 GHz

WGB

Controller

Controller

LWAP

SSID 2.4 GHz

HMI

Industrial Ethernet Switch

Drive

Soft Starter

Controller

I/O

Instrumentation

Safety Controller

AP

SSID 5 GHz

Safety I/O

WGB

Servo Drive

HMI

Robot

Safety I/O

**Cell/Area Zone - Levels 0–2**
Redundant Star Topology - Flex Links Resiliency
Unified Wireless LAN
(Lines, Machines, Skids, Equipment)

**Cell/Area Zone - Levels 0–2**
Ring Topology - Resilient Ethernet Protocol (REP)
Unified Wireless LAN
(Lines, Machines, Skids, Equipment)

**Cell/Area Zone - Levels 0–2**
Linear/Bus/Star Topology
Autonomous Wireless LAN
(Lines, Machines, Skids, Equipment)

CISCO

# Factory Security

## WHAT IS IT

## Pervasive Physical and Cyber Security for the Factory

### CHALLENGE

Manufacturing ranks annually among top three targeted industries for cyber attacks

"…a number of cyber espionage campaigns discovered in 2014 targeted key sectors—such as manufacturing—that use industrial control system (ICS) technologies to automate physical processes." - *Symantec Internet security Threat Report 2015*

## CRITICAL NEEDS

- Identity Services
- Physical Security
- Machine / controls security
- Secure Remote Access
- Unlock Plant Floor data

## CISCO PORTFOLIO

Industrial Routers

Cisco Firewalls
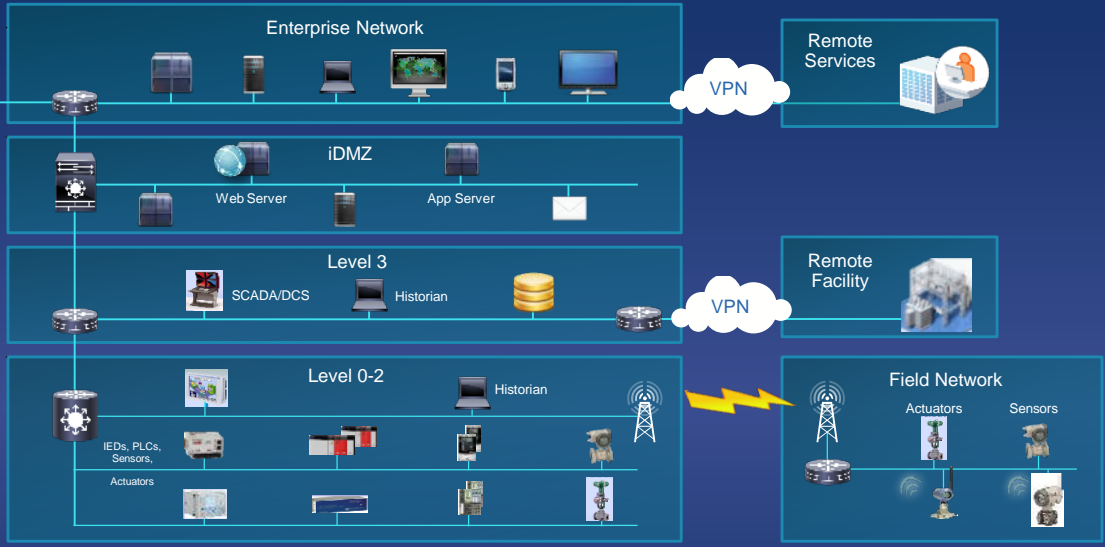
Video Surveillance Manager

Physical Access Manager

Industrial Ethernet

Software Defined Segmentation (TrustSec)

Cisco ISE

AMP, Sourcefire Defense Center, Cloud Security

IP Cameras

**Cyber Security**

**Physical Security**

## BUSINESS OUTCOMES

**Reduced Risk**
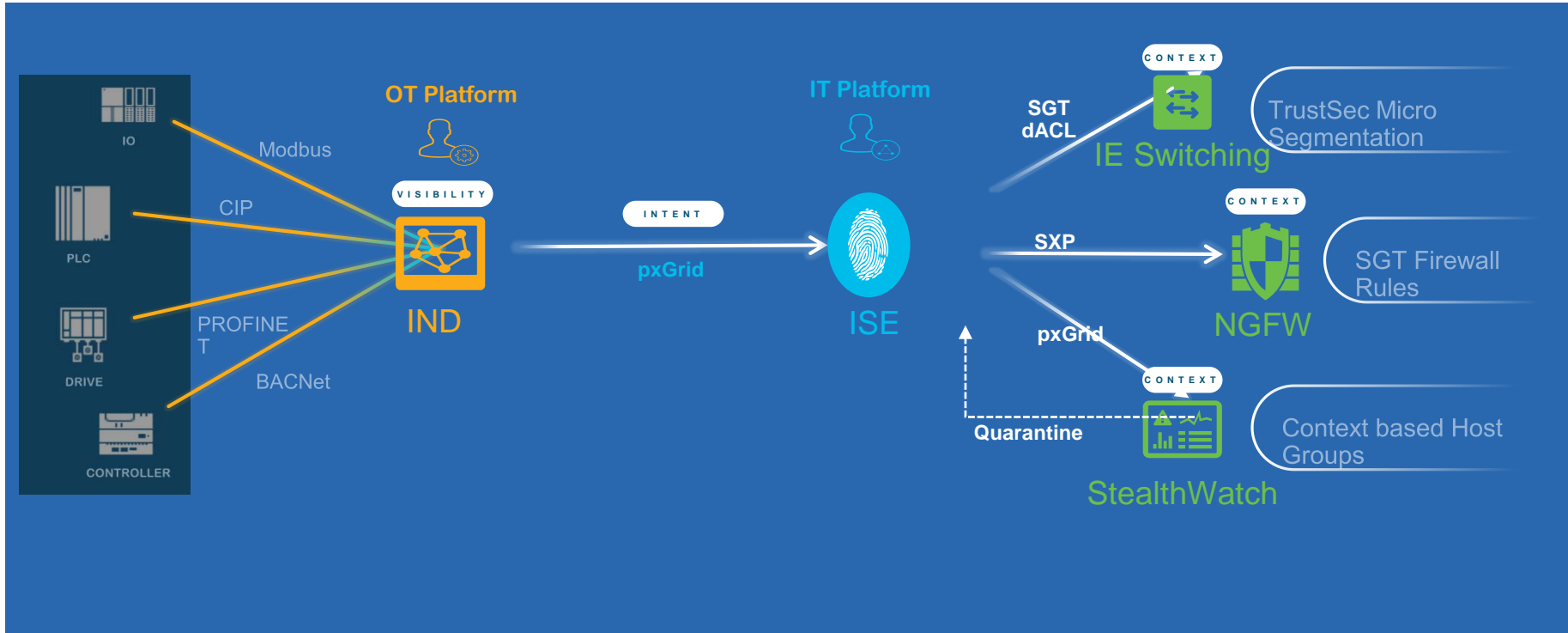
**Reduced Downtime**

CISCO

# Connected Factory: Cyber Security Protection

# IoT Threat Defense Solution

# Factory Wireless

**WHAT IS IT**

## Unified Wireless for Mobile Visibility and Productivity

**CHALLENGE**

Lack of mobile visibility and access to machines and tools. Disparity between wired and wireless networks.

"In the factory, the ability to locate major parts and tooling on a timely basis is critical… WiFi LBS will streamline our production environment, by not having to replicate tooling and pieces of gear.." *- Jim Farrecker - Boeing*

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## CRITICAL NEEDS

- Centralised Management
- Reliability
- Simple Deployment
- Integrated Security
- Lower Total Cost vs. Ad Hoc Deployments
- Location-Based Services

## CISCO PORTFOLIO

Field AP 1552

Manufacturing WGB/AP

Industrial AP IW 3700 802.11ac

Mobile IP Gateway

RFID and BlueTooth for Location-Based Services

## BUSINESS OUTCOMES

**Reduced Downtime**

**OEE Improvement**

CISCO

# Unified Architecture

## Features

- Centralized management and control
- Failover and self-healing mechanisms
- Foundational services: secure enterprise user, contractor and guest access

## Benefits

- Zero-touch deployment
- Reduced operational expenses
- Support for IACS Applications
- Increased Reliability & Security
- Support for plant-wide mobility and scalability



Cisco Unified Architecture
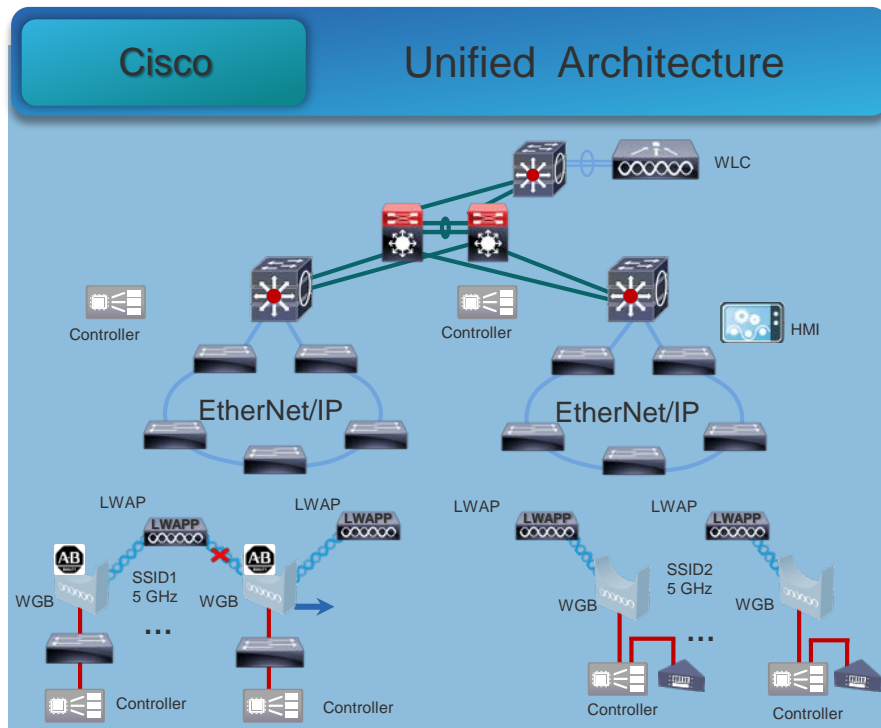
# Connected Machines & Edge Compute

## WHAT IS IT

Embedded Switching, Security & Compute to Enable Connectivity and Edge Data Capture and Analytics

## CHALLENGE

Lack of visibility to machine data (temp, torque, hours, etc) to monitor and predict machine-related downtime.

"We have cases where downtime is costing over $20,000 per minute. The ability to predict service requirements will have a tremendous impact." - *Rick Schneider – NA CEO FANUC Robotics*

## CRITICAL NEEDS

- Machine Monitoring, OEE
- MTConnect, OPC UA integration,
- Scalable data acquisition
- Enterprise security compliance and policy
- Open Machine Architecture
- Time-sensitive deterministic communications

## CISCO PORTFOLIO

- Cisco IOT Gateways
- Cisco IOx/Devnet
- Cisco UCS Server
- Security Appliances

- TSN
- Cisco IND (Net Mgmt)
- IE-2000/IE-4000

## BUSINESS OUTCOMES

**OEE Improvement**

**Reduced Downtime**

# What is IOx?

## Application Framework
provides a **simple** and **consistent** way for hosting application on Cisco edge devices.

## Fog Director
provides **open and scalable** Application Lifecycle Management and Monitoring capability.

## IOx SDK & Cisco Devnet
provides the Development Environment for application developers.

Devnet provides online documentation, code and sandbox environment.
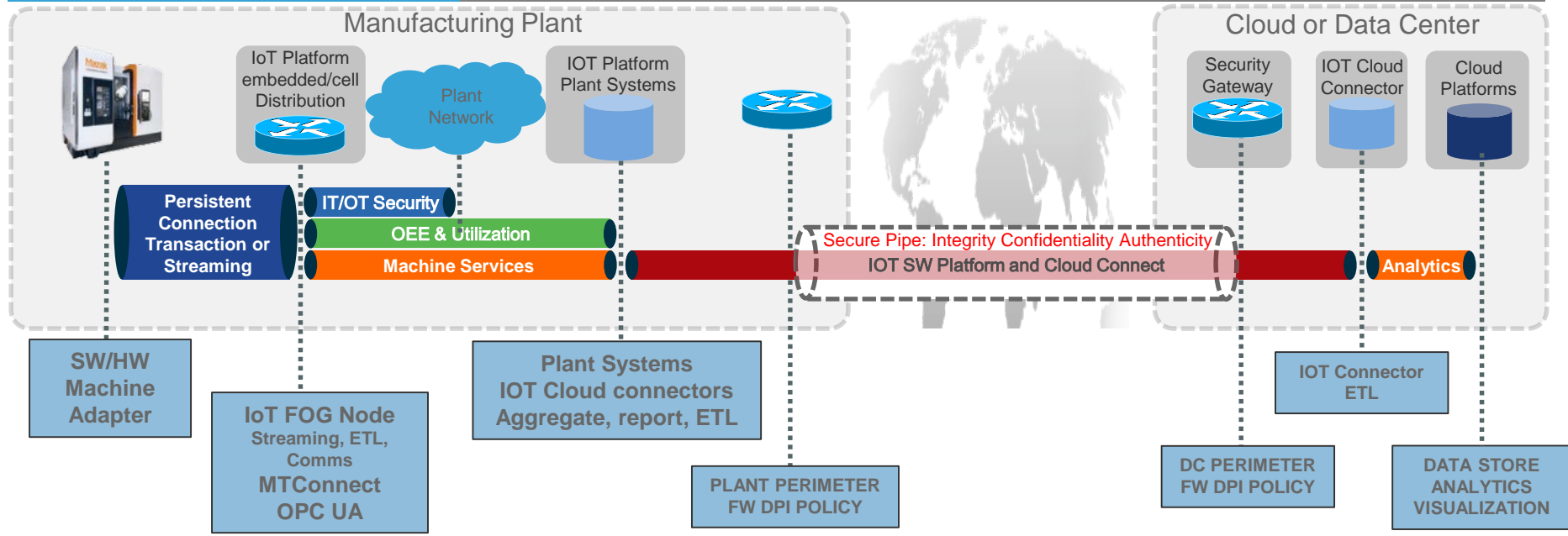
# Connected Machines Solutions

**Machine as a Service**

**Machine monitoring** — green light, utilisation, OEE streaming analytics

**Connected Machines** — Rapid Provisioning, IT/OT Interface, security

Zero Down Time like Services
Condition based Monitoring
New OEM services models w/ SLA's
Machine, Process, & Quality Optimization
Advanced Analytics

## Manufacturing Plant

IoT Platform embedded/cell Distribution

Plant Network

IOT Platform Plant Systems

**Persistent Connection Transaction or Streaming**

**IT/OT Security**

**OEE & Utilization**

**Machine Services**

Secure Pipe: Integrity Confidentiality Authenticity
**IOT SW Platform and Cloud Connect**

## Cloud or Data Center

Security Gateway

IOT Cloud Connector

Cloud Platforms

**Analytics**

**SW/HW Machine Adapter**

**IoT FOG Node**
Streaming, ETL, Comms
**MTConnect OPC UA**

**Plant Systems IOT Cloud connectors Aggregate, report, ETL**

**PLANT PERIMETER FW DPI POLICY**

**IOT Connector ETL**

**DC PERIMETER FW DPI POLICY**

**DATA STORE ANALYTICS VISUALIZATION**

# Factory Virtualization

## WHAT IS IT

Massively reduce the number of plant floor PCs to improve efficiency and reduce risk.

## CHALLENGE

Hundreds of PCs for data collection, interfacing to machine Each one independently managed, patched, recovered, secured

"…each factory machine has its own flavor of laptop and software required for tooling changes or updates. Maintenance has to carry around a set of laptops, each with its own OS, software, and hardware that differs depending on their machine. Most laptops have outdated software, hardware, and have security vulnerabilities."  - Plant Engineer - Major Automotive Manufacturer

## CRITICAL NEEDS

- Reduction in Operating Systems
- Reduce hardware footprint
- Reduced attack footprint
- Headless workstations
- Thin or Zero Clients
- Flexible Edge Analytics
- Scalable Compute

## CISCO PORTFOLIO

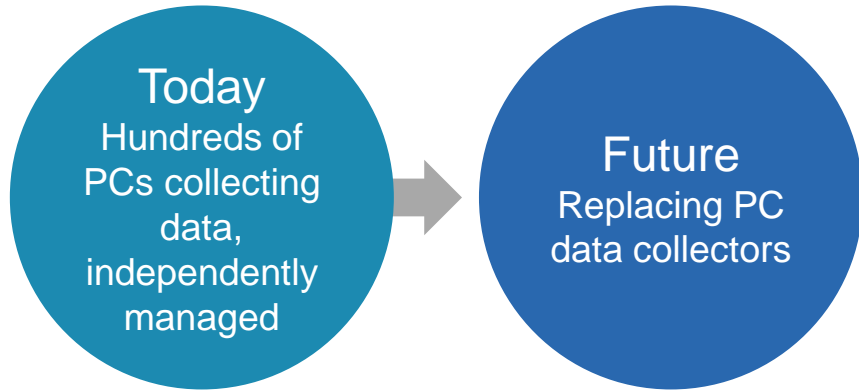IE 4000

UCS

**Switching**

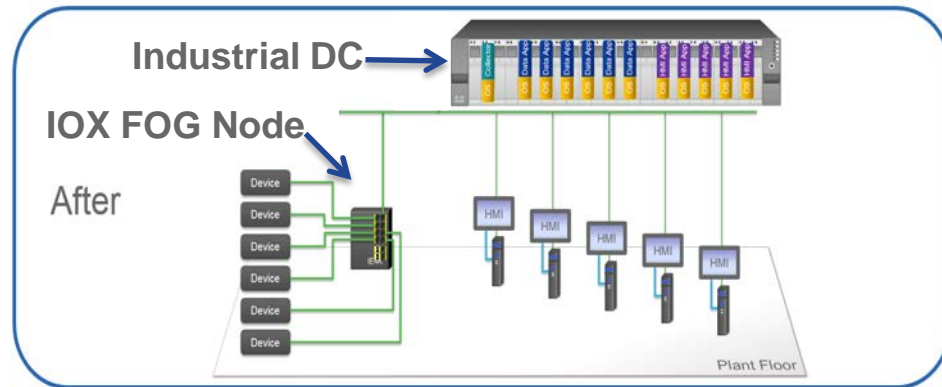**Compute**

## BUSINESS OUTCOMES

**Reduced Risk**

**Reduced Downtime**

# Factory Virtualisation Solution

**Today**
Hundreds of PCs collecting data, independently managed

**Future**
Replacing PC data collectors

Scalable Compute:
IOX > Industrial DC > Cloud



**Industrial DC**

**IOX FOG Node**

After

Plant Floor

# Data Center and Cloud

**WHAT IS IT**

Data center and secure cloud platform for virtual management of factory test, quality and traceability data worldwide

**CHALLENGE**

Unified, scalable compute at the data center and secure cloud access for offsite data and analytics

## CRITICAL NEEDS

- Real-time visibility
- Higher security
- Improved integrations
- Faster ramp up of new factories – 80 % less time

## CISCO PORTFOLIO

- Data Center Compute
- Data Center Security
- Data Center Switching

## BUSINESS OUTCOMES

OEE Improvement

Reduced Downtime

# Analytics & Big Data

**WHAT IS IT**

Harness the power of big data analytics to quickly solve assembly machines production and quality issues

**CHALLENGE**

Capture production data in realtime to see opportunities to cycle down machines or adjust supply chain

**CRITICAL NEEDS**

- Velocity, volume and variety of data hinders proactive business decisions
- Limited access to data
- Factory floor machine downtimes

**CISCO PORTFOLIO**

**Fog Data Services**

**IOx**

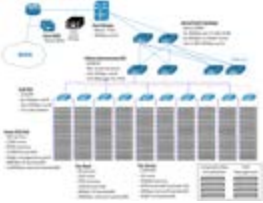**Cisco Connected Streaming Analytics**

**BUSINESS OUTCOMES**

**OEE Improvement**

**Reduced Downtime**

# Cisco Multi-Tier Analytics



### Corporate Cloud
*HPC & DV*
Data Mining & Modeling
Inter-Cloud Data Lake

### Factory
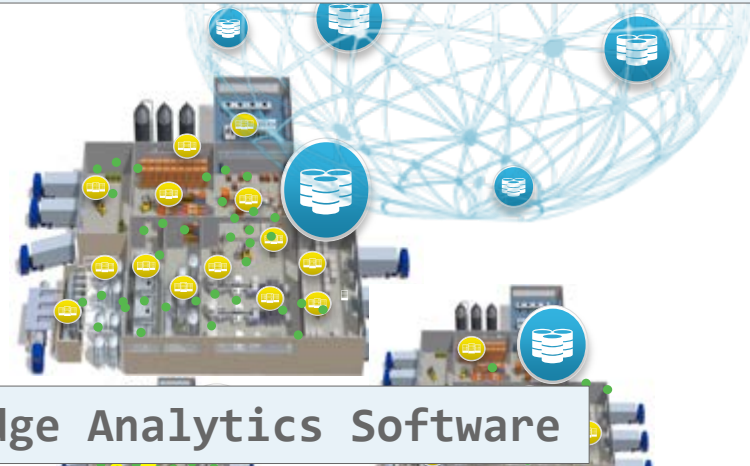*Fog Aggregation Nodes*
Factory History & Trends
Reports & Dashboards

### Plant Areas
*Fog Node*
Real-Time Dashboards
Alerting

### Robots & Cells
*Sensors*
*Devices*
Edge Analytics

**Applications and Platform**

Deployed in Customer Data Center or Plant

**Edge Analytics Software**

Deployed on Cisco IOX Devices

# Factory Collaboration

**WHAT IS IT**

Video, Voice and Digital Signage Solutions that Enable Secure Factory Collaboration

**CHALLENGE**

Experts in remote locations and need for design and engineering collaboration. Visibility to key metrics on the plant floor

## CRITICAL NEEDS

- Remote Expert Access

- Real-time visibility to plant metrics

- Cost effective voice communications

## CISCO PORTFOLIO

- Cisco IP Video

- Librestream Virtual Collaboration

- Rugged VOIP Phone Systems
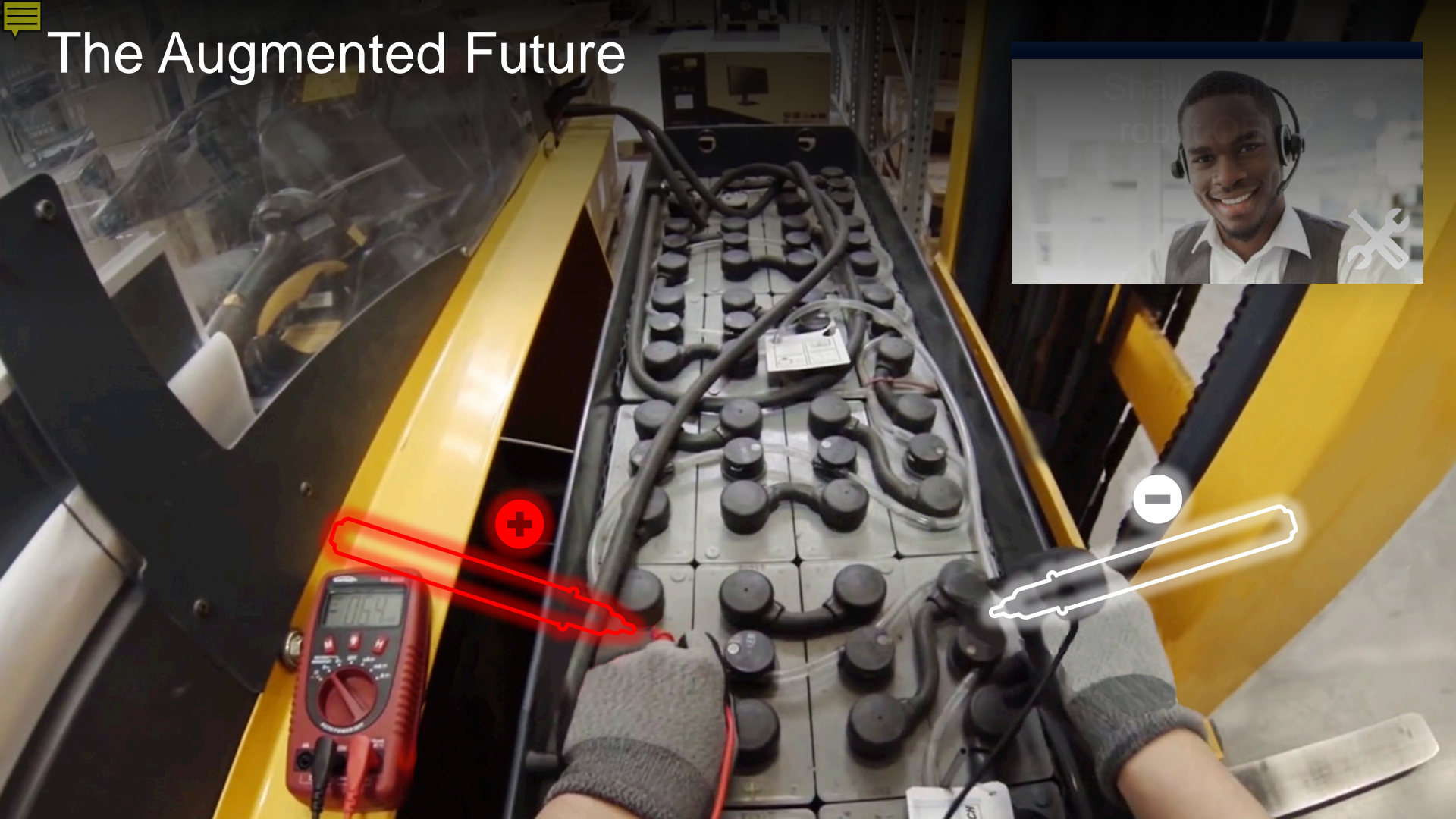
- Digital Signage

- Webex

## BUSINESS OUTCOMES

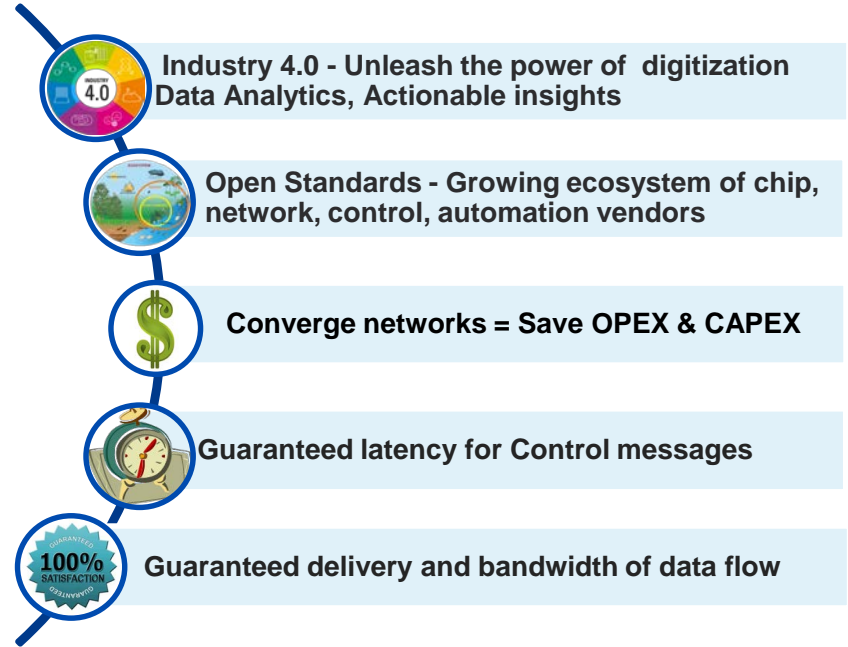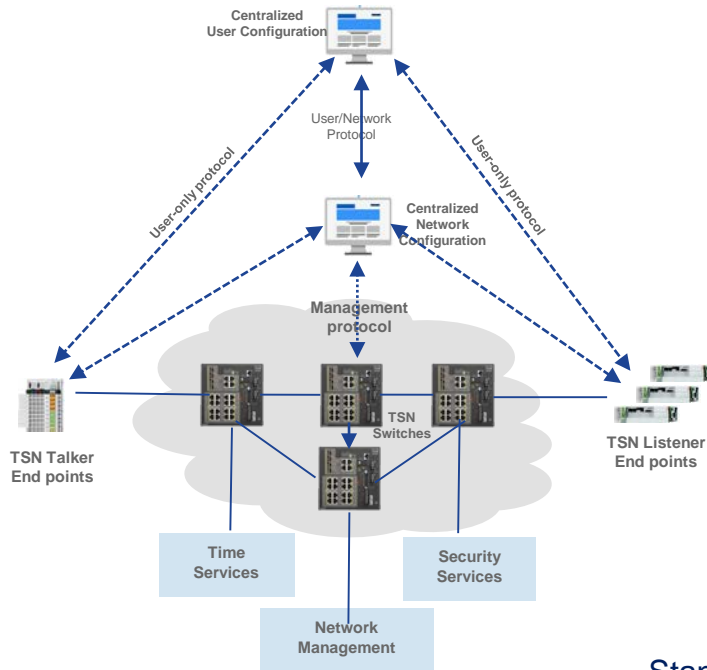**OEE Improvement**

**Reduced Downtime**

The Augmented Future

Thank you.

# Deterministic Ethernet with IEEE 802.1 TSN
## Open Standards based solution, secure and easy to use

Centralized
User Configuration

User/Network
Protocol

User-only protocol

User-only protocol

Centralized
Network
Configuration

Management
protocol

TSN
Switches

TSN Talker
End points

TSN Listener
End points

Time
Services

Security
Services

Network
Management

**Industry 4.0 - Unleash the power of digitization**
**Data Analytics, Actionable insights**

**Open Standards - Growing ecosystem of chip,**
**network, control, automation vendors**

**Converge networks = Save OPEX & CAPEX**

**Guaranteed latency for Control messages**

**Guaranteed delivery and bandwidth of data flow**

Standards - IEEE 802.1AS, IEEE 1588, IEEE 802.1Qbv, IEEE 802.1Qcc

Available at Launch on IE 4000 on 15.2(5)E2

# Connected Machines with IOx
## Predictive Maintenance use case



Connected Streaming Analytics

Fog Application

**MTConnect**

IOx Services to Connect to Sensors and Cloud

IOx
IOS
Application Framework
Linux

Application-ready Infrastructure Enabled By IOx

**Mazak**

**17%**
Increased Machine Productivity

**6%**
Increased Machine Utilization

Lower Machine Downtime

Securely Connect  ⟩  ⟩ Immediately Transform ⟩  ⟩  Deliver Insight

cisco

Confidential   29