Eaton’s approach to digital solutions in a connected world

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Our approach highlights our priorities for digital solutions

1. Add *sensors and sensing* capabilities within assets – the things and the processes
2. Invest in *data science* to turn data into knowledge
3. Integrate our *domain and application expertise* to develop opportunities for services and customer engagement models
4. Use open industry communications, IT standards and leverage cloud infrastructure partners

Our digital solutions are already solving real customer problems
For today’s conversation:

• **Share** Eaton’s harmonized approach to digital solutions
• **Show** how our capabilities make these digital solutions work
• **Speak** about the digital solutions we are delivering
For today’s conversation:

• **Share Eaton’s harmonized approach** to digital solutions

• **Show how our capabilities** make these digital solutions work

• **Speak about the digital solutions** we are delivering
We help the world use electrical, fluid and mechanical power more \textbf{safely, reliably} and \textbf{efficiently}.
Significant forces are changing the nature of power management in a digital world

Industry convergence
IIoT, Factory of the Future, Industrie 4.0

End-to-end solutions
Creating business value during service life

Solid-state electronics
LED lighting, drives, contactors, power conversion

Open innovation
Technology adoption rates globally, external partnerships

Flexible energy management
Future of the grid in developed & emerging nations

Advanced materials & manufacturing
Polymer & nano-science, 3D printing
Eaton has put together a unique set of technology solutions

We own a substantial footprint of the “power real estate”
The “things” we make are being digitally transformed to extract increased value for our end users

Eaton circuit breaker

20th century design

Protects people and assets

Eaton Energy Management Circuit Breaker (EMCB)

21st century design

Protects people and assets with more intelligence

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In a connected world, our digital solutions are created on the following tenets:

**Assets**
- Sensors & sensing in the “things” and the processes that generate the data

**Connectivity**
- Industry standard protocols & telecom to aggregate and disseminate data

**Intelligence**
- Data science to transform data into actionable information and knowledge

**Business model**
- Ecosystem to develop & deploy solutions to create business value

Intelligent power is the essence of Eaton’s digital solution.
A perspective of our typical power management asset with sensing capabilities

Assets

Sensors & sensing in the “things” and the processes that generate the data

• Current
• Voltage
• Frequency
• Power factor

Electrical

• Pressure
• Flow rates
• Displacement
• Contamination

Fluid

• Force
• Pressure
• Displacement
• Speed

Mechanical

• Time
• Temperature
• Humidity
• GPS location
• Optics

Ambient

Decoding power by analyzing its fundamental makeup
Our approach to connectivity relies on industry standards and available infrastructure.

Connectivity

- Process automation: Modbus, Profibus, HART, Ethernet/IP…
- Industrial control system: OPC UA…
- Building automation: BACnet, Wi-Fi, DALI…
- Power system automation: IEC 61850, IEC 60870, IEC 62351…
- Automatic meter reading: Wi-Fi, RF…
- Transportation: CAN, J1939…
- Telecom & cloud computing: ATT, MS Azure, AWS…

Industry standard protocols & telecom to Aggregate and disseminate data.

Use industry standard and telecom backbone.
Intelligence is the cornerstone of intelligent power

The first element of intelligence is the creation of digital twins...

Digital twins are a digital model that mimic physical assets in the real world over time

- **Heuristics**
  - Models that are rules, based on experience

- **Numerical**
  - Models that use some sort of numerical time-stepping procedure

- **Empirical**
  - Models based on real-world observations

- **Black-box**
  - Model that does not use any particular prior knowledge or physics

- **Physics based**
  - Models based on first principles
Intelligence is the cornerstone of intelligent power
The second is the range of analytics to interrogate the digital twins

Data analytics is the interdisciplinary field to extract knowledge from data.

Digital twins and analytics are the differentiators within our digital solutions
For today’s conversation:

• Share Eaton’s harmonized approach to digital solutions

• **Show how our capabilities** make these digital solutions work

• Speak about the digital solutions we are delivering
Our digital solution capabilities are built on three key pillars

1. Information model
2. Reusable building blocks
3. Connectivity
4. Global skills & footprint

Foundation to *efficiently* deliver digital solutions
A digital framework for creating interoperable solutions

Eaton’s digital information model

- Build on open, secure architecture based on IT and industry standards
- Integrate information from assets into business processes with ease
- Drive novel automated field services and customer engagement models

Technology platform

Factory | End user | Field service

Services

Applications

Assets

Power quality | Meters & breakers | Lighting & sensors | Industrial controls | Transmissions, pumps, valves
Reusable technology platforms power our information blueprint

- Hides complexity and provides consistency, modularity & scalability
- Reduces engineering costs and time to market
- Leverages established technology partners

Technology partners:
- Microsoft Azure
- IBM
- Oracle
- Cisco
- Amazon Web Services

Open standards:
- IEEE 802.15
- ZigBee
- Modbus
- BACnet
- EtherNet/IP

User experience
Cloud and IoT
Embedded systems
Cybersecurity
Eaton technology platforms
Scalable platforms in action, reducing cost and delivering greater value

1st generation: Cloud through gateway

Motor control drive

Gateway

2nd generation: Direct to cloud

20% cost reduction

Motor control drive w/ IoT connectivity

Microsoft Azure

Mobile and cloud-based analytical services

Embedded systems

Eaton technology platforms

Cybersecurity

Embedded systems + IoT functionality

Cloud & IoT

User experience

Productivity powered by scalable platforms
We make the things that matter “secure by design”

Cybersecurity is a critical capability

- Cyber attacks are becoming more sophisticated and autonomous
- Enterprise wide capabilities – people, tools, processes and platforms are a differentiator
- Provides opportunities for new service models for industrial assets
# Building the right technical capabilities through global investment and partnerships

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## External ecosystem

- [National Energy Technology Laboratory](#)
- [Horizon 2020](#)
- [CzechInvest](#)
- [Microsoft](#)
- [IBM](#)
For today’s conversation:

• Share Eaton’s harmonized approach to digital solutions
• Show how our capabilities make these digital solutions work
• Speaking about the solutions across various segments
A look at examples of the real world digital solutions we have deployed globally

Process industry
Increased oil yield and factory productivity

Transportation - commercial vehicles
Improved asset uptime for fleet owners

Machine OEMs
Integrated and optimized machine control for increased efficiency

Outdoor lighting
Connected intelligence for unparalleled experience and business value

Electrical grid
Improved power resilience, uptime and cost of energy

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Process industry: Palm oil
Improving oil yield and factory productivity

- $60B global palm oil industry
- Geographically isolated industry (~85% Malaysia & Indonesia)
- Processing mills today predominately labor intensive vs automated (10-20%)

Customer benefits:
- Throughput Improvement → 20-30%
- Safety → 90% reduction in employees on site

Eaton growth opportunity:
- Technical Support
- System Upgrades
- Downstream User Application Opportunities (e.g. refining plants)

50-100 signals processed:
- System fault codes
- Machine alerts
- Machine shutdown’s
- Commissioning

Customer benefits:
- Throughput Improvement → 20-30%
- Safety → 90% reduction in employees on site

Eaton growth opportunity:
- Technical Support
- System Upgrades
- Downstream User Application Opportunities (e.g. refining plants)
Transportation: IntelliConnect™
Improved asset uptime for the fleet owner

- > 30,000 trucks currently being remotely monitored
- Our domain expertise coupled with on-board telematics enables us to quickly isolate issues and minimize customer disruption

Customer benefits:
- Reduced Downtime ➔ 20-30%
- Unscheduled to scheduled maintenance

Eaton growth opportunity:
- Service & technical support
- Lower product failure rates
- Future service contract opportunities

60 signals processed:
- Actionable insights ➔ Real time fault action plans
- Predictive maintenance
- Vehicle health history

IntelliConnect – Remote Diagnostics

1. Data is sent...
2. Data is collected...
3. Data distributed to the fleet.

IntelliConnect Value

- Eaton receives vehicle fault code data.
- Uses holistic systems approach.
- Provides comprehensive Fault Code Action Plan.

In-vehicle device ➔ Cloud computing ➔ Vehicle

Data enabled smart products

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Machine OEM: Electro-hydraulic solution
Integrated & optimized machine control for increased efficiency

- Combines Eaton’s hydraulic and electrical solutions for MOEM system solution
- $1.2B global MOEM hydraulics market
- Intelligent motor control equipment, starters, soft starters, and variable speed drives
- Digitization down to low-level sensors and actuators
- Intuitive operator interface
- Enables smarter fluid-power solutions for advanced energy management
- Cloud connectivity for remote machine control

Customer benefits:
- Improves machine reliability and intelligence
- 20% time reduction in machine installation, wiring, and commissioning
- Reduces machine footprint

Eaton growth opportunities:
- System solution provider with both hydraulic and electrical content
- Increased service capability
- Improves sales and organizational synergies

- SmartWire-DT enabled quick installation and commissioning
- Variable pump speed for optimal system energy usage
- Components fault codes for fast trouble shooting and maintenance
- Cloud connectivity for remote machine control

Energy Management
Fluid-Power Generation

Remote Service Solutions
Mechatronic Solutions

Data Connectivity Solutions
Decentralized Digitization

Operator Interface Solutions

Power generation: speed, torque, pressure, flow
Power distribution voltage, current, temp, position, proximity
Remote access for all signals in lean connectivity

Hydraulics

Assets

- HPU, pumps, valves, actuators …
- HMI, switch gear, motor control, light, button, sensor …

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Outdoor lighting: Stadium lighting
Connected intelligence for unparalleled experience & business value

Rich experience for fans, operators, and broadcast companies

- Advanced controls enhance the in-game experience for fans and the quality of the broadcast production
- Auto Commissioning and adjustment of lights for installation and/or specific events
- Precision illumination reduces number of fixtures required and saves 75% on energy consumed
- Predictive diagnostics and health monitoring to avoid costly downtime – over 2200 lights in typical installation

Customer benefits:
- Reduced total cost of ownership
- Increased performance
- In-game experience

Eaton growth opportunity:
- Service & Technical Support
- Installation & commissioning
- Data analytic services

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Electrical grid: Microgrid
*Improved power resilience, uptime and cost of energy*

**Customer benefits:**
- Energy supply stability
- Lower Cost of Energy
- Environmental & regulatory sustainability

**Eaton growth opportunities:**
- Service & technical support
- Future service contract opportunities

**Microgrid schematic**

- Utility Grids
- Communities and Facilities of Refuge
- Military & Government Facilities
- Campus Settings
- Critical Infrastructure & Industrial
- Remote Locations

**Business Model**

**Intelligence**

**Connectivity**

**Microgrid modeling & simulation**

**Real-time configuration & diagnostics**

- Hardened controllers
- IEC 61850 communications
- Cybersecurity

**Nature of grid is changing in developed and emerging nations**
We opened our conversation with ...

• Sharing our approach for digital solutions
• Showing how we make it work
• Speaking about the solutions across various segments
Key takeaways from our approach to digital solutions in a connected world

We continue to:

- Grow our portfolio of digital assets
- Deepen our efforts in data science
- Build internal global capabilities and partnerships

We have:

- Harmonized our approach to digital solutions for consistency, scale and speed
- Deployed a series of real solutions across various segments already creating business value

Intelligent power…integrating the physical and digital worlds to drive growth