TECHNOLOGY ENABLED PREDICTIVE MAINTENANCE

Kalman Tiboldi
Chief Business Innovation Officer

TVH GROUP

2 business units

TVH PARTS | **TVH EQUIPMENT**

6 business lines

- Material handling parts (MPA)
- Industrial equipment parts (IPA)
- Agricultural equipment parts (APA)
- Sales (trade & domestic)
- Rental
- Service & repair

Facts & figures

- > 25 000 customers
- We sell in 172 countries
- Parts for over 250 makes

Shipments by: Road, Air, Sea

- 95% Next-day delivery
- 77% Orders via e-commerce
- 99,8% Orders delivered within the promised time frame

- > 15 000 orders per day, > 47 000 order lines per day
- > 21 000 000 known references
- > 600 000 different stock items
- > 500 000 m² of warehousing

Facts & figures

Rental fleet

- Scissor lifts 47%
- Boom lifts 31%
- Forklifts 11%
- Truck-mounted aerials 4%
- Telehandlers 4%
- Warehousing 3%

Every day 200 trucks on the road to deliver rental machines

> 17 500 machines in our rental fleet

Rental branches

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> 6000 colleagues worldwide

Consolidated turnover € 1,34 billion

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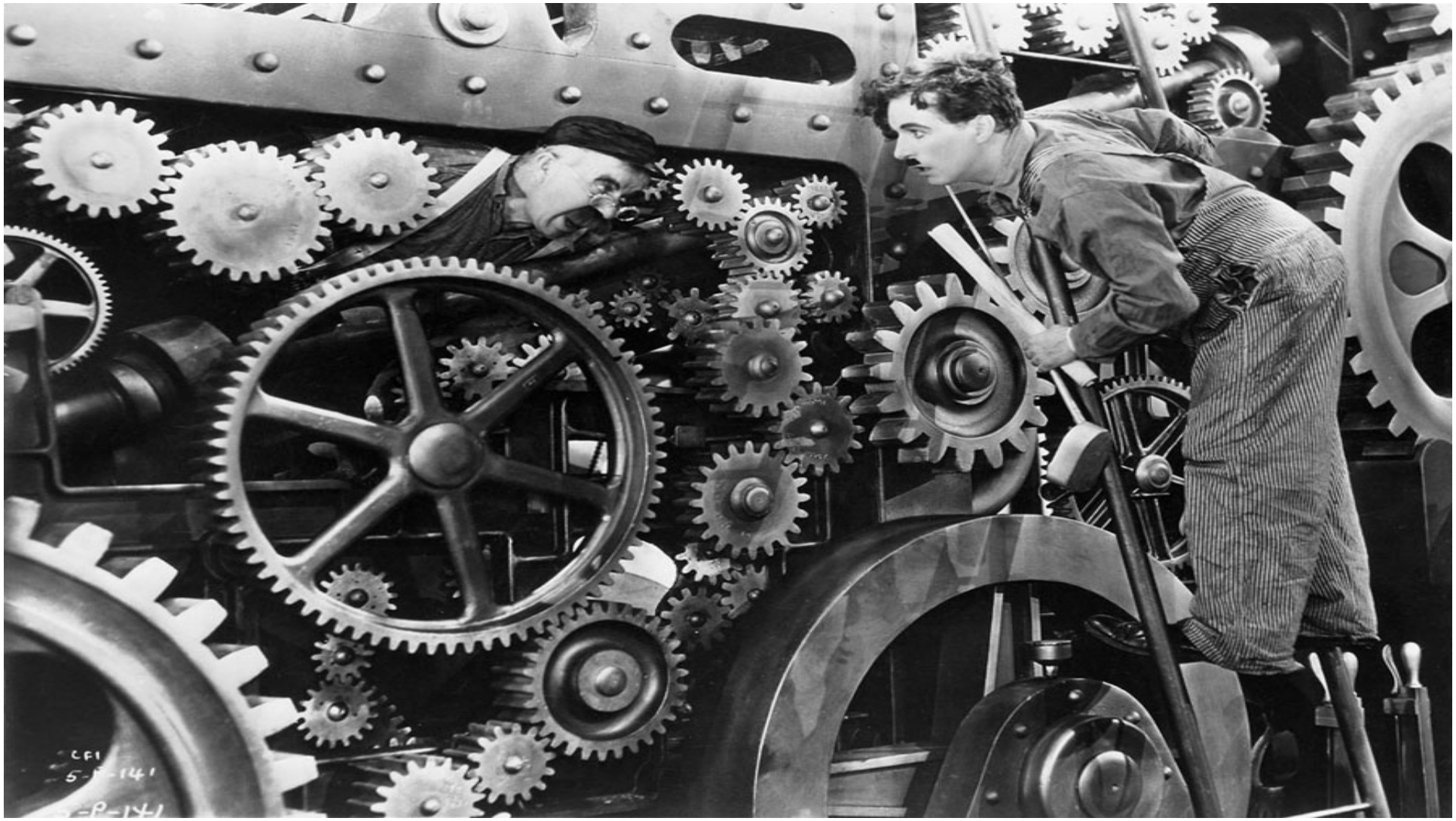
CFI
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TYPES OF MAINTENANCE

Correctieve Maintenance

Performed to identify, isolate, and rectify a fault so that the failed equipment, machine, or system can be restored to an operational condition

Preventive Maintenance

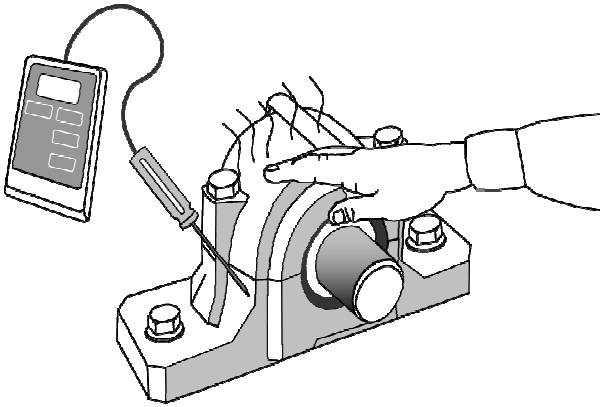
Schedule of planned maintenance actions aimed at the prevention of breakdowns and failures. Preserve and enhance equipment reliability

Predictive Maintenance

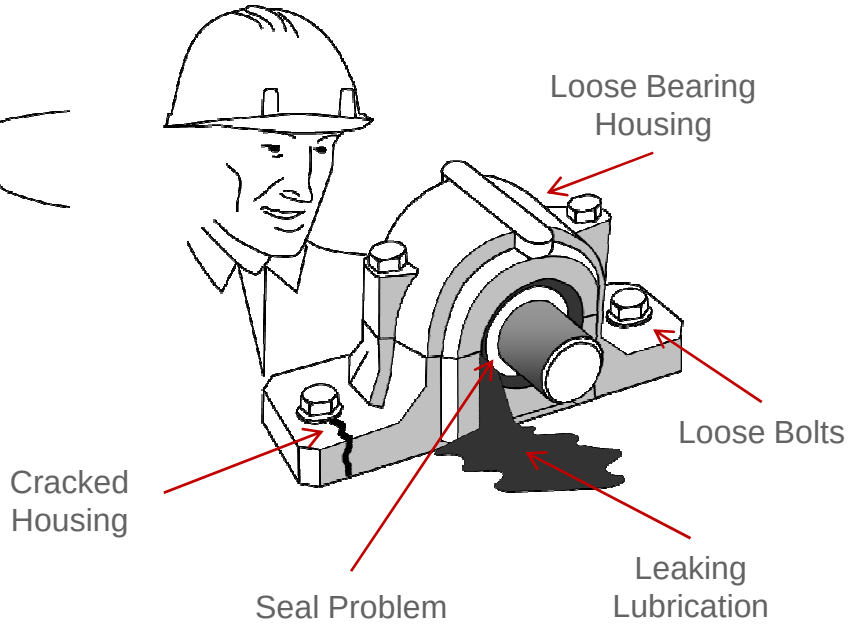
Techniques that help determine the condition of in-service equipment in order to predict when maintenance should be performed. Minimize disruption of normal operations, while allowing right time repairs.

CONDITION MONITORING

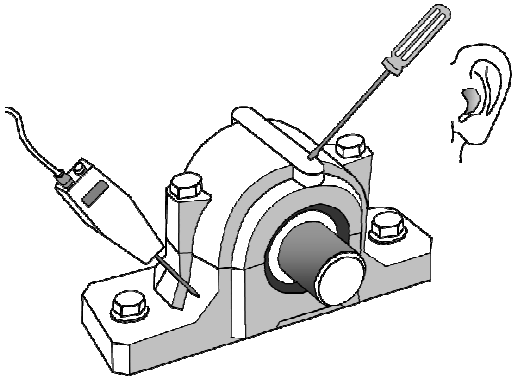
Temperature



Sight



Vibration



PERIODICAL vs. CONTINUOUS OBSERVATION

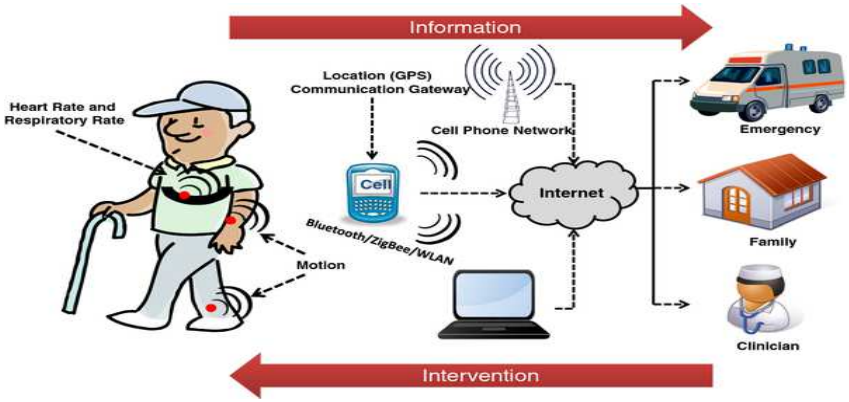
40.000.000 heartbeats / year

100 heartbeats / observation

1 observation / 4 years

Probability of 1: 1.600.000 to detect a failure for the first time

Continuous monitoring



PREDICTIVE MAINTENANCE

Your equipment tells you precisely what kind of service it needs, where, why, and what its estimated life time will be without that service

Remote monitoring and self optimizing

Sense — Raw data is collected from hundred or thousands of sensors, locally processed or transmitted wireless to remote monitoring

Decide — Analyse the data, take decisions locally or through remote analytical services. Private and public data are combined using cloud –based services

Act — Adapt and optimize the performance of the process locally or take actions to replace the part causing problems

Predictive, condition-based Maintenance

Allocate and plan maintenance tasks according to the anticipated, measured or calculated condition of a component, device or system

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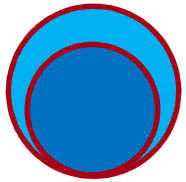
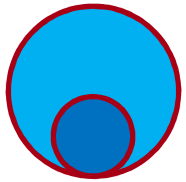
BUSINESS OPPORTUNITY

IBM

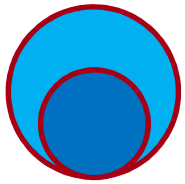
Reduction in maintenance costs
25-30%



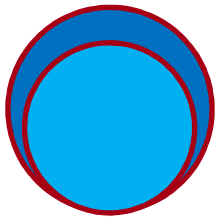
Elimination of breakdown
70-35%



Reduction of downtime
35-45%



Increase in production
35-45%



Source: IBM – Published on Oct 27, 2016

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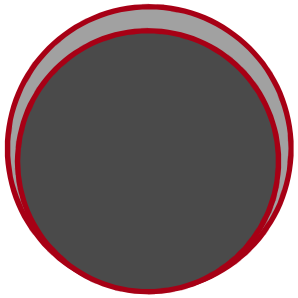
Gartner

Average cost reduction moving from preventive to predictive maintenance
10-20%

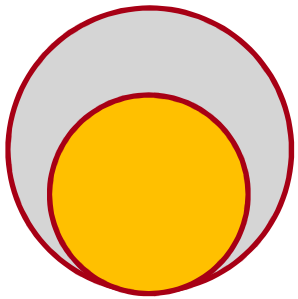


By 2022, IoT will save consumers and businesses $1 trillion a year in maintenance, services and consumables.

Source: Gartner – Published on Oct 17, 2016

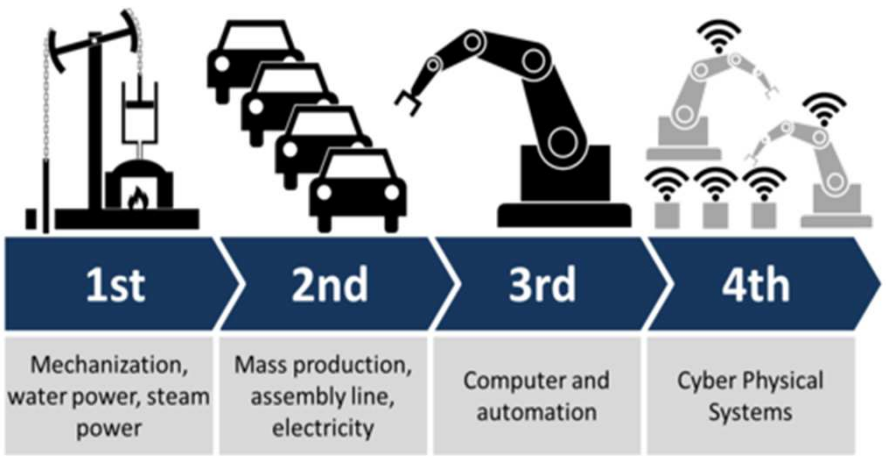
VOLVO

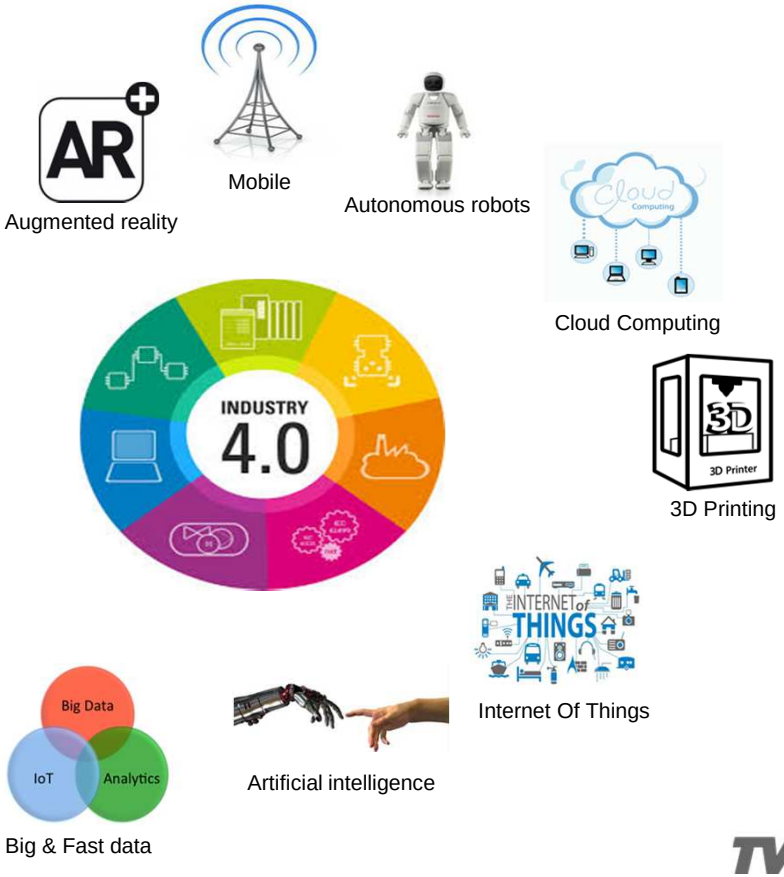
Repair cost reduction vs. average 2011-2014
49-51%



Source: Volvo Construction Equipment 2016

SUPPORTING TECHNOLOGIES





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SMART PRODUCTS

Physical Components
Mechanical and
Electrical Parts

STILL CUBEXX

Smart Components
Sensors, chips, storage, software,
embedded operating system…

Connectivity Components
Ports, antennae, protocols,
wired or wireless connections

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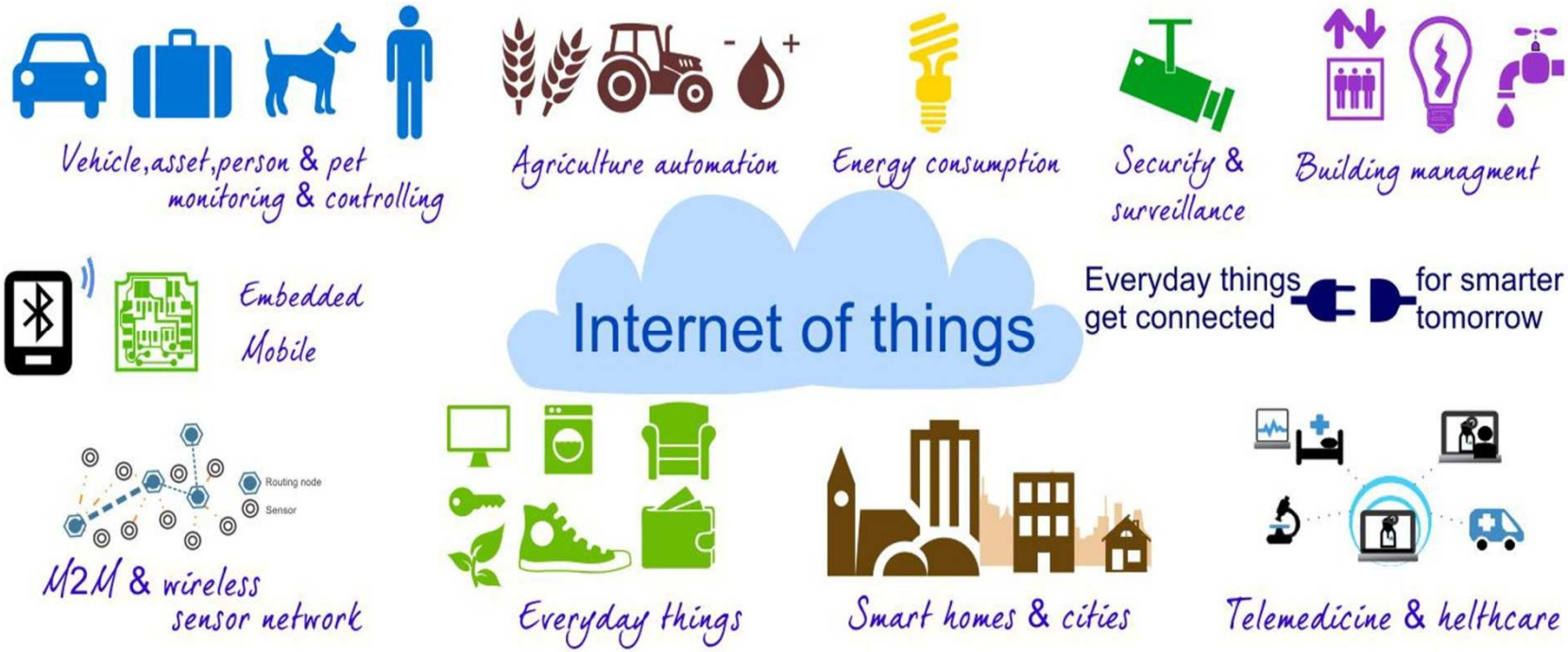
CYBER-PHYSICAL WORLD



MERGING THE REAL AND VIRTUAL WORLDS

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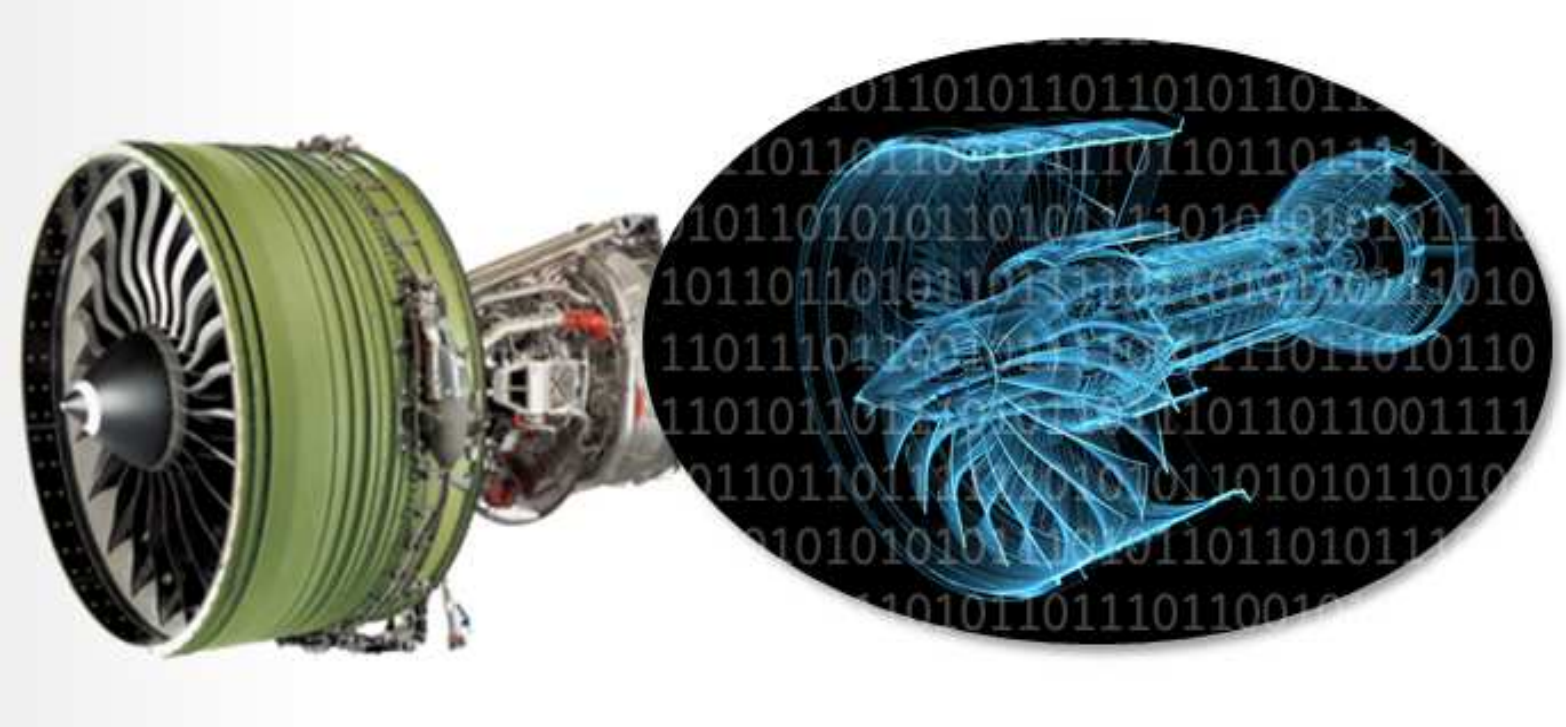
DIGITAL TWINS

SENSORS **DATA** **ANALYTICS**



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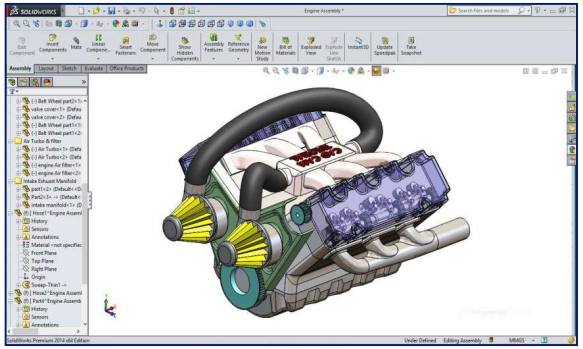
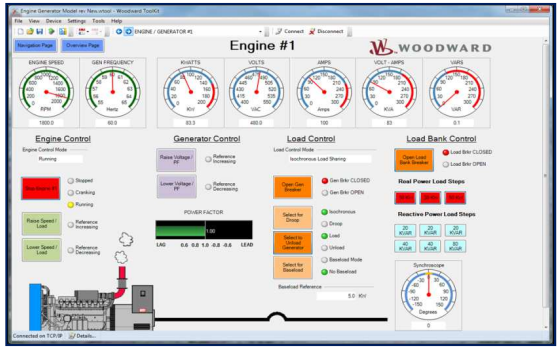
VIRTUAL MODEL FOR PHYSICAL PRODUCTS

DESIGN – BUILD - OPERATE





Design
3D CAD twin

Simulate
First born digital twin

Monitor
Physical asset twin

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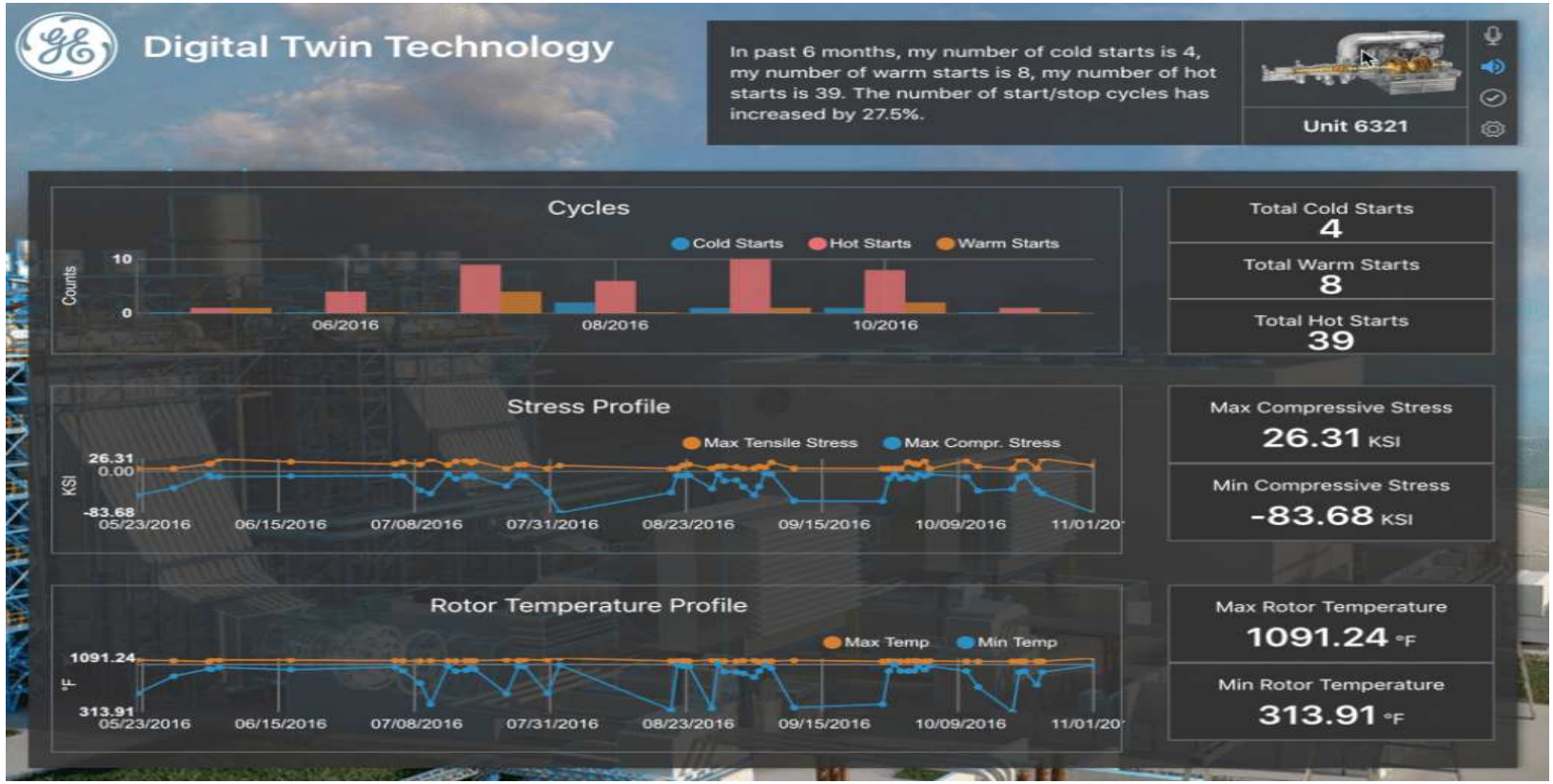
CONTINUOUS ASSET MONITORING



Source: GE Digital

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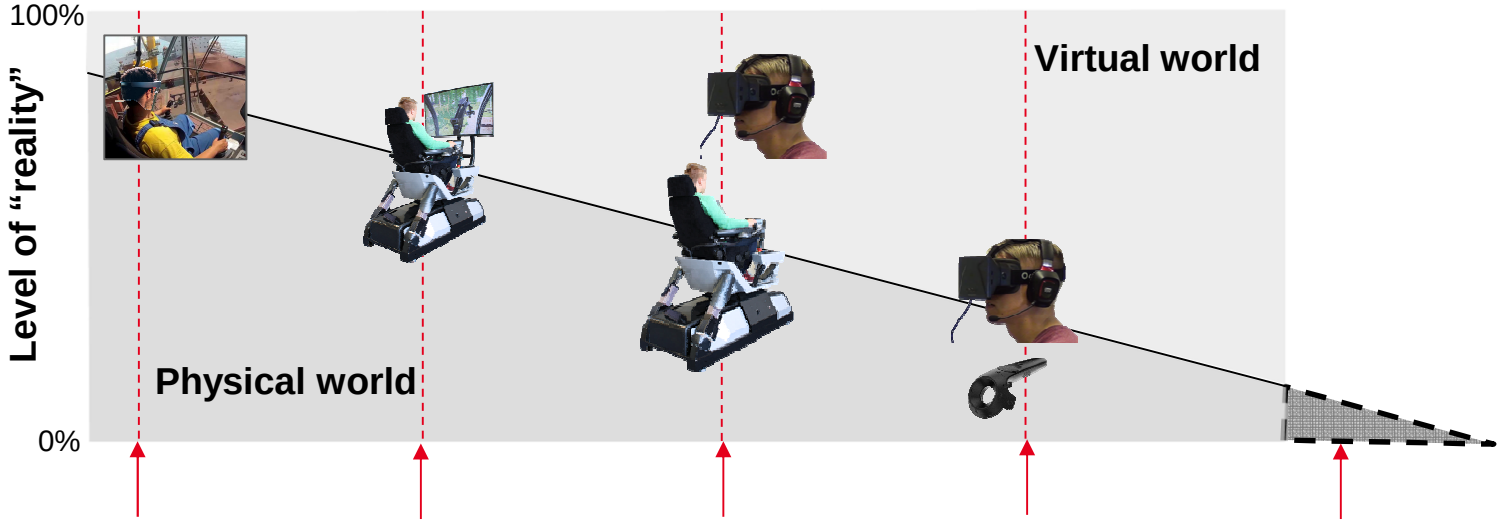
IMMERSION INTO THE VIRTUAL WORLD



AR / Mixed Reality Headset
- Physical world is augmented with some "virtual items"
- Real controls etc.

Traditional Simulator:
- Virtual world etc.
- Real controls etc.

VR Headset & Camera
- Virtual mach. & env.
- Real controls etc.
- Virtual world is augmented with some "physical items"

VR Headset
- Virtual mach. & env.
- Real controls (not visible) or virtual controls.

? The future ?

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Source: Mevea Ltd.

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MAJOR BENEFITS OF THE DIGITAL TWIN

Physical Asset

Real-time data

Digital Twin

Ecosystems
Collaborative product development

Asset performance
Analytics-based performance optimization

New digital business model
Based on the data produced by the Twin

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HOW TO BUILD DIGITAL TWINS ?

Integrate smart components
such as sensors, software, computing power, or data storage into new or existing products

Connect the product
to a central location where you can capture sensor data and enrich that sensor data with business and contextual data

Analyze that data
on an ongoing basis to identify opportunities for product improvements, new products, or even new business models.

Leverage these digital
insights to transform your company — for example, by reducing costs through proactive avoidance of business interruptions, or by creating new business opportunities

SERVITIZATION

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EQUIPMENT-AS-A-SERVICE

Lifting capacity as a service

Reducing downtime
Extending asset life

Measuring the residual value

Pay-per-usage

Detecting and avoiding overloading

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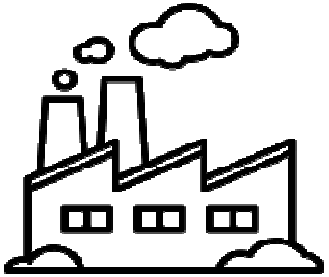
MOVING FROM PRODUCT TO SERVICE

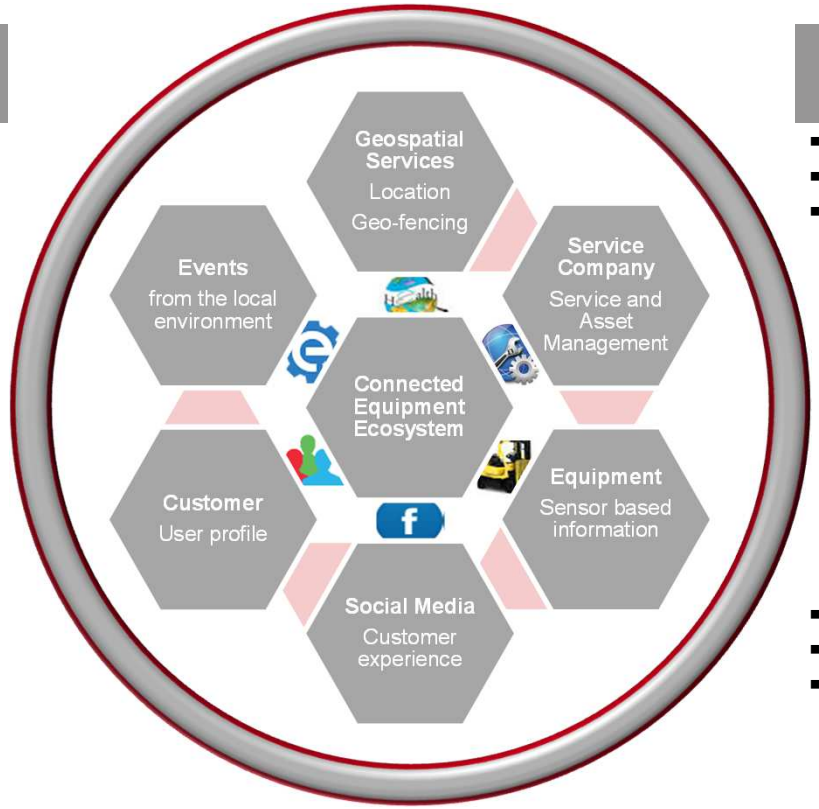
CONNECTED EQUIPMENT ECOSYSTEM

ORIGINAL EQUIPMENT MANUFACTURER (OEM)

- Real-time alerts
- Consolidated view
- Improvement proposals

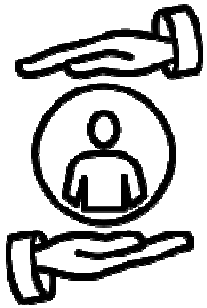


- Technical specifications
- Maintenance procedures
- Digital twin API



CUSTOMER

- Real-time alerts
- Maintenance and service issues
- Data produced by equipment



- Real-time alerts & updates
- Maintenance services
- Improved user experience

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SMART LIFT TRUCKS

GPS

Camera

Speed & Accelerometer

Heavy load position

Mast & steering sensor

Engine data

Load presence

Fuel

Proximity sensor

Temperature

Mast Tilt Angle

Tyre pressure

Oil condition

Battery

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MAKING THE LIFT TRUCK SMARTER

speedshield technologies

Safety & Security

cascade™

POWER BY PROXI™

Weight-sensing fork blade assembly for engaging pallets in different alternative directions of approach

power designers
innovative charging technology

EMROL BATTERIES & CHARGERS

Battery Monitoring

TOTALTRAX, INC.

Usage Monitoring
Impact sensing

I.D. Systems™

Sensors for Lift Trucks

Access
Measure, Manage, Maximize

Access control
Battery Management

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Putting more intelligence on existing machines

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CONNECTED TVH EQUIPMENT

IoT Endpoints

Data Ingestion

IoT Edge Gateways

Local Filtering & Analytics

Service Engineer

Data Ingestion

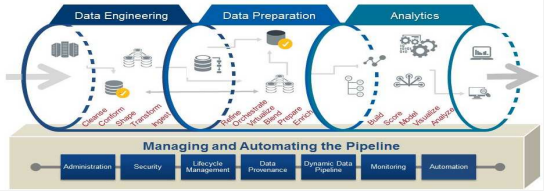
Device Control

IoT Platform

Data Streaming

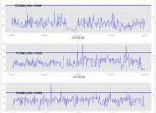
Data Repository

External data services



Data Analytics & Event Processing

Decision Management



Data Visualization

Device Management

Enterprise Applications

- Fleet Management
- Service Management
- Business Intelligence
- Predictive Model Development
- Product Engineering

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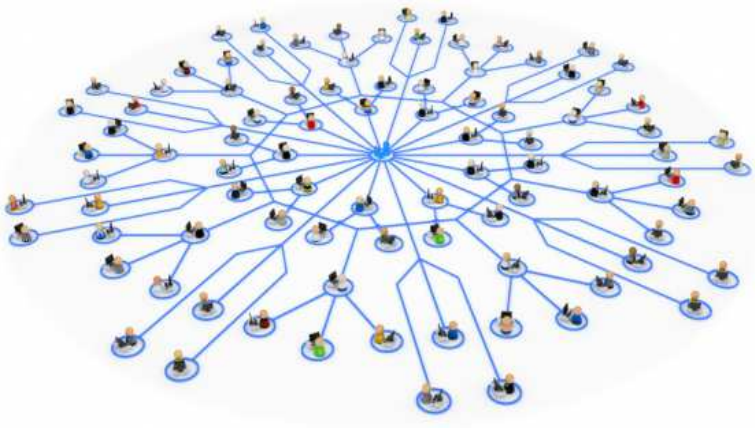
More than 6000 connected machines

IoT - SOURCE OF BIG DATA

The ***Value*** comes from the ***Information*** that's hardest to manage

IoT ***generates large quantities of data*** that need to be processed and analyzed in real time



Data aggregation and processing ***at the Edge***. Relevant data is forwarded to central site for additional processing

In ***Maintenance Mode*** a lift truck generates more than **3 MB / min** through CAN-bus

The ***massive scale*** and ***highly dynamic*** nature of the IoT, the huge amounts of data streamed from the physical world, and new communication patterns demand novel programming, content delivery, and network management.

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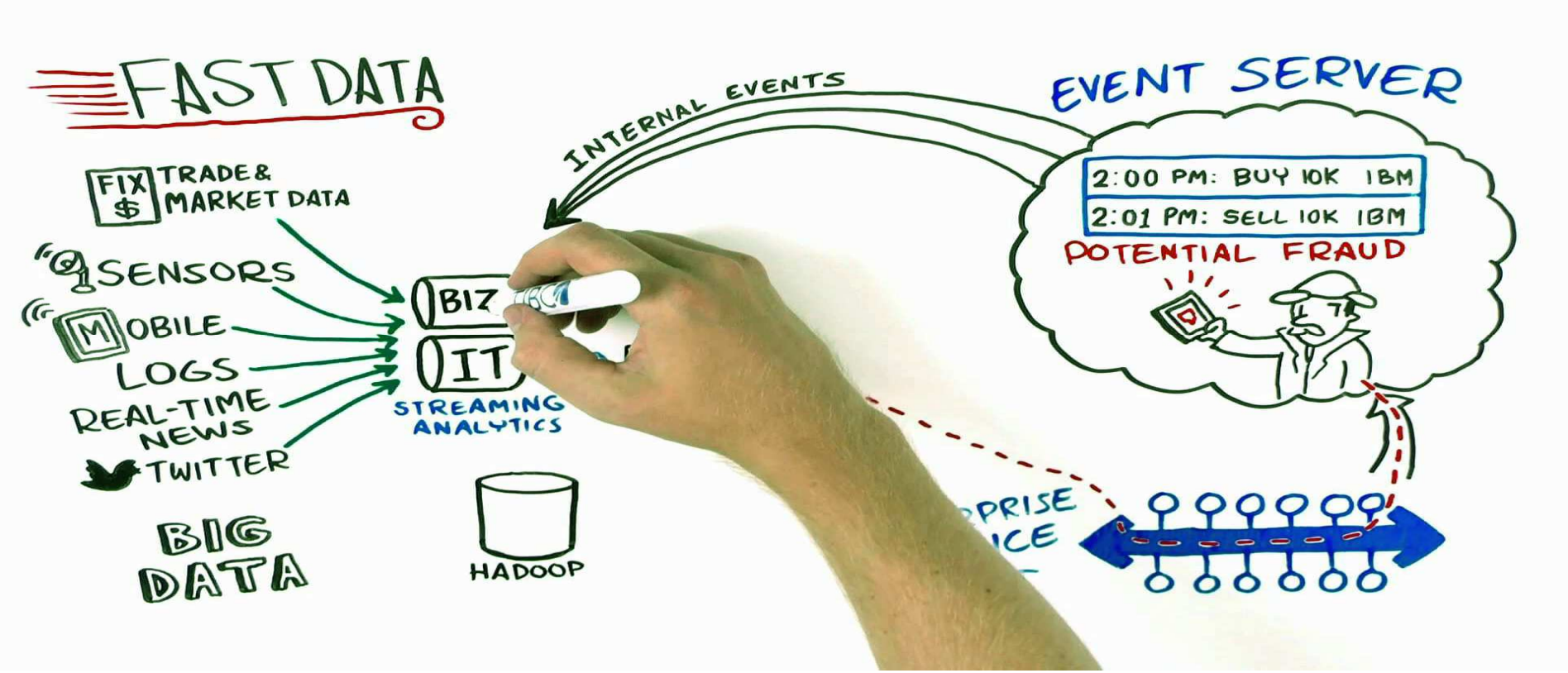
FAST DATA


FAST DATA
FIX $ TRADE & MARKET DATA
SENSORS
MOBILE
LOGS
REAL-TIME NEWS
TWITTER
BIG DATA
BIZ
IT
STREAMING ANALYTICS
HADOOP
INTERNAL EVENTS
EVENT SERVER
2:00 PM: BUY 10K IBM
2:01 PM: SELL 10K IBM
POTENTIAL FRAUD

MOVING TOWARDS ADVANCED ANALYTICS

BI & Reporting

Descriptive

What is happening ?

- Business Reporting
- Dashboards
- Metrics
- Scorecards
- Mobile BI

Information Portal

BI Specialist

Business Analytics

Diagnostic

Why did it happen ?

- Data discovery
- OLAP
- Ad-hoc query
- Location analytics
- Basic predicative modelling

Analytics Workbench

Information Analyst

Advanced Analytics

Predictive

What will happen ?

- Predictive analytics
- Support for BigData
- Advanced data access
- Experimentation

Prescriptive

What should we do ?

- Decision modellig
- Expert systems
- Simulation
- Optimization
- Innovation

Data Science Laboratory

Data Scientist

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IoT & PREDICTIVE ANALYTICS

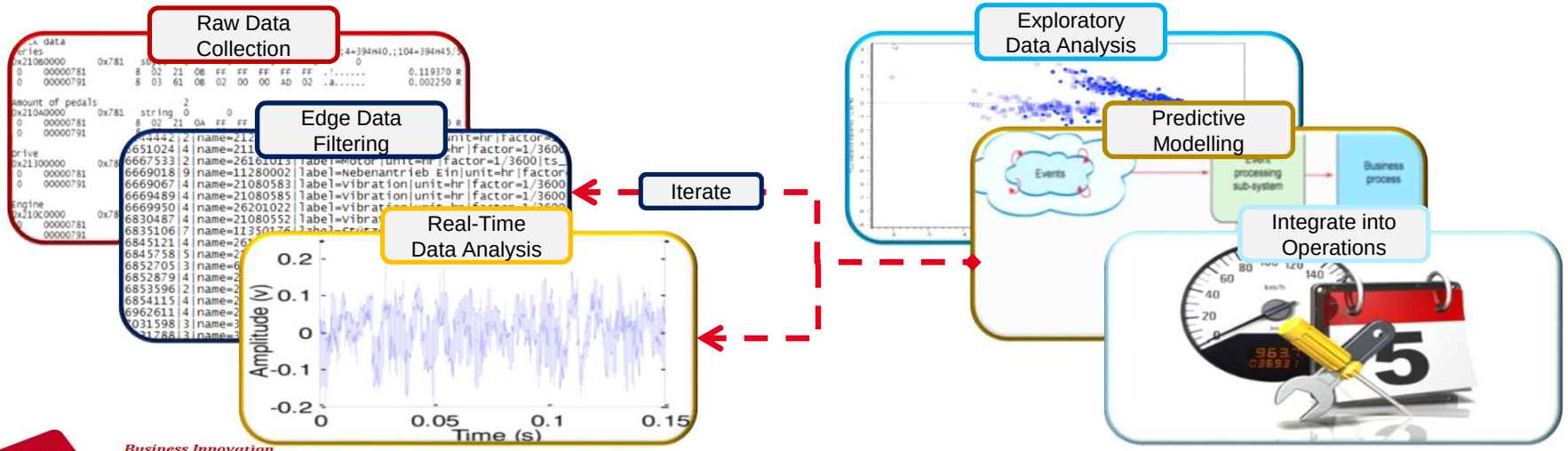
Signal Analysis

Event Analysis

Root Cause Analysis
Sensor value distribution analysis
Linear regression …

Event Tracking & Filtering
Event Correlation
Event Aggregations …

PREDICTIVE ENGINE



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NEXT GENERATION SERVICE ENGINEERING

AUGMENTED REALITY

NATURAL LANGUAGE PROCESSING

CHAT BOTS

ADVANCED TECHNICAL SUPPORT

ARTIFICIAL INTELLIGENCE

PARTPIC

IMAGE RECOGNITION

SMART GLOVES

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COMBINING HUMAN AND ARTIFICIAL INTELLIGENCE

MAJOR BENEFITS FOR TVH

One-Step Maintenance
Moving from Two-Step to One-Step maintenence

Increase the availability of equipment
optimize the usage and reduce the operational cost

Improve driver safety
promote responsible driving

Empowering Equipment Maintenance
combining Human Intelligence with Machine Learning

New business model
offering Lifting Capacity as a Service

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MY FINAL POINTS…

*The Internet of Things is about the transformation of physicals object into a **digital data products**. It is radically changing the way businesses operate and people interact with the physical world.*

*The benefits of Predictive Maintenance are significant. Its implementation requires more than just technological choices. It has impact on the **organizational structure and culture**.*

*New digital business models require **ecosystems** of people, businesses and technologies that must scale beyond the enterprise*

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Thank You

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