GE Oil & Gas Digital

Digital Transformation Journey

The Next Productivity Conundrum

Digital Transformation

Step Change Opportunity

4%

1991-2010

1%

2011-2016

3/5%

Today's Opportunity
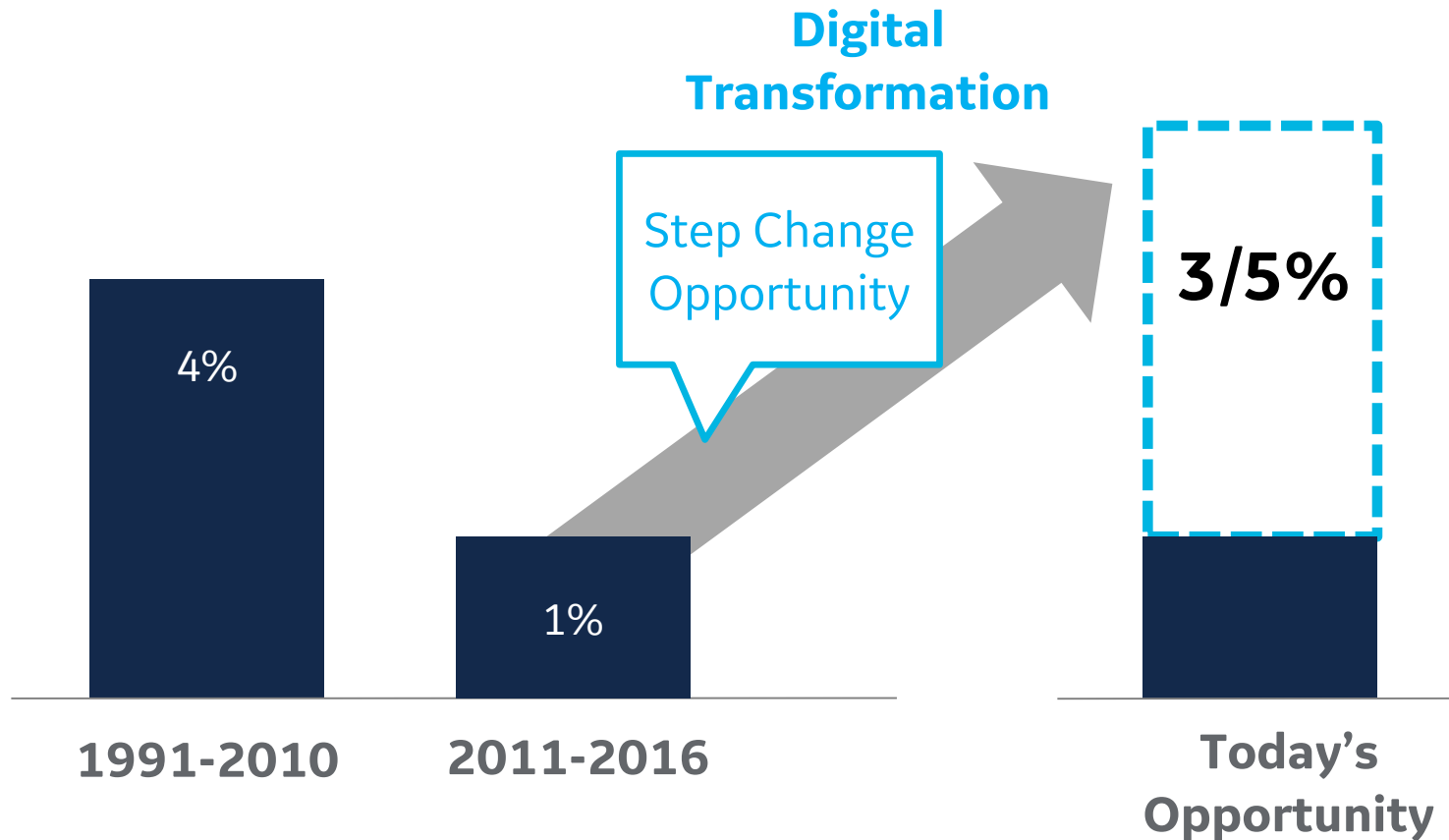
Unleashing 3-5% Productivity Gains

- Cloud based Technology Stack

- Agile Mindset

- Data Analytics & Machine learning

- New and broad way of engaging with customers, employees & ecosystem

- Entirely new way of doing business

The promise of Digital Industrial Transformation

|					
Assets		**30B** Asset Performance Management		Reducing Equipment Outages & NPT
People		**18B** Services Transformation		Working Smarter
Process		**23B** Operations & Process		Driving Operational Efficiency
Ecosystem		**2/3** Cost Determined during design		Eliminating Silos Across Design, Build & Operate Lifecycle
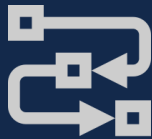
Digital Industrial Transformation will break down silos, <u>Changing Everything</u>
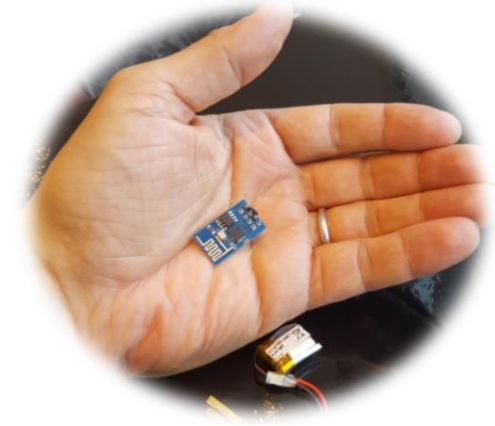
Hardware is cheaper and cheaper

Sensor
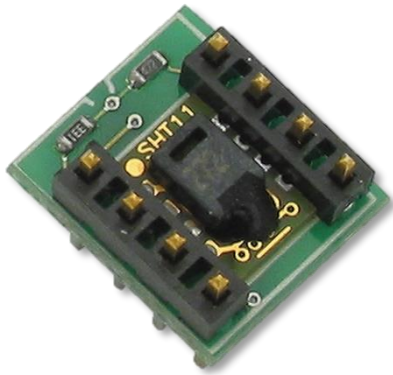
Accelerometer
$0.60

Data storage

1 GB < $0.01 / month

Processing power

160 MIPS + Wifi
4000 x Apollo 11
Cost: $2...

Mountains of data can be collected ... but need to be processed

Genome
202, 375,168 KB

Video
5,000,000 KB / movie

3D Images
35,000 KB / study

2D Images
1,500 KB / image

Rich Text
500 KB / record

Simple text
5 KB / record

GE's Predix
PURPOSE-BUILT FOR THE INDUSTRIAL INTERNET OF THINGS

Cloud-based operating system for Industrial Internet

- CONNECTED ASSETS
- INDUSTRIAL DATA MANAGEMENT
- INDUSTRIAL DATA SCIENCE
- CLOUD & MOBILE

+

Optimized for Industrial Requirements

- ASSET PERFORMANCE MGMT
- OPERATIONS OPTIMIZATION
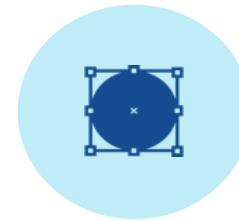- INDUSTRIAL ANALYTICS
- DIGITAL TWIN
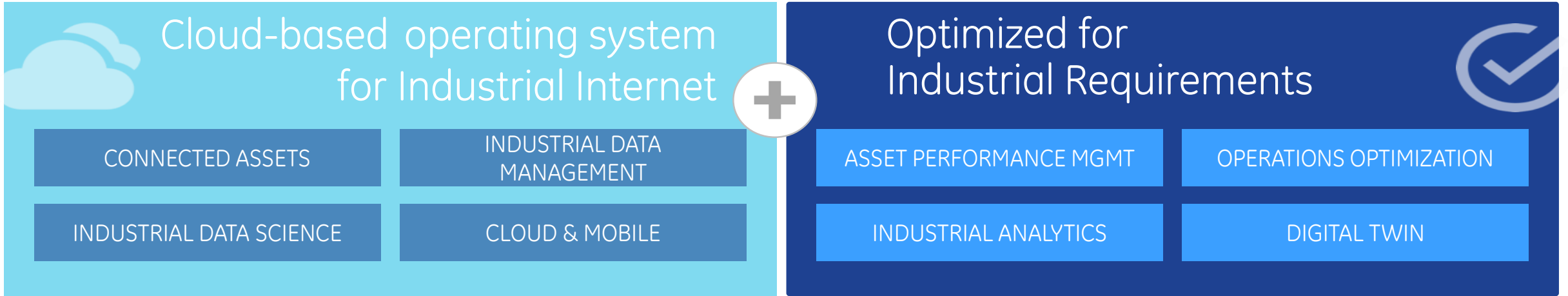
Industrial-grade technology
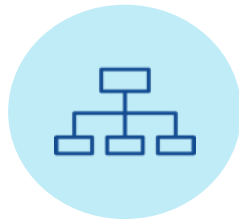
Optimized for asset data models and operational workflows
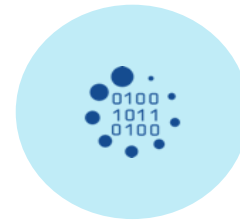
Designed for Industrial Big Data and Analytics

Modern Development tools for faster Innovation

Predix-Powered Oil & Gas world
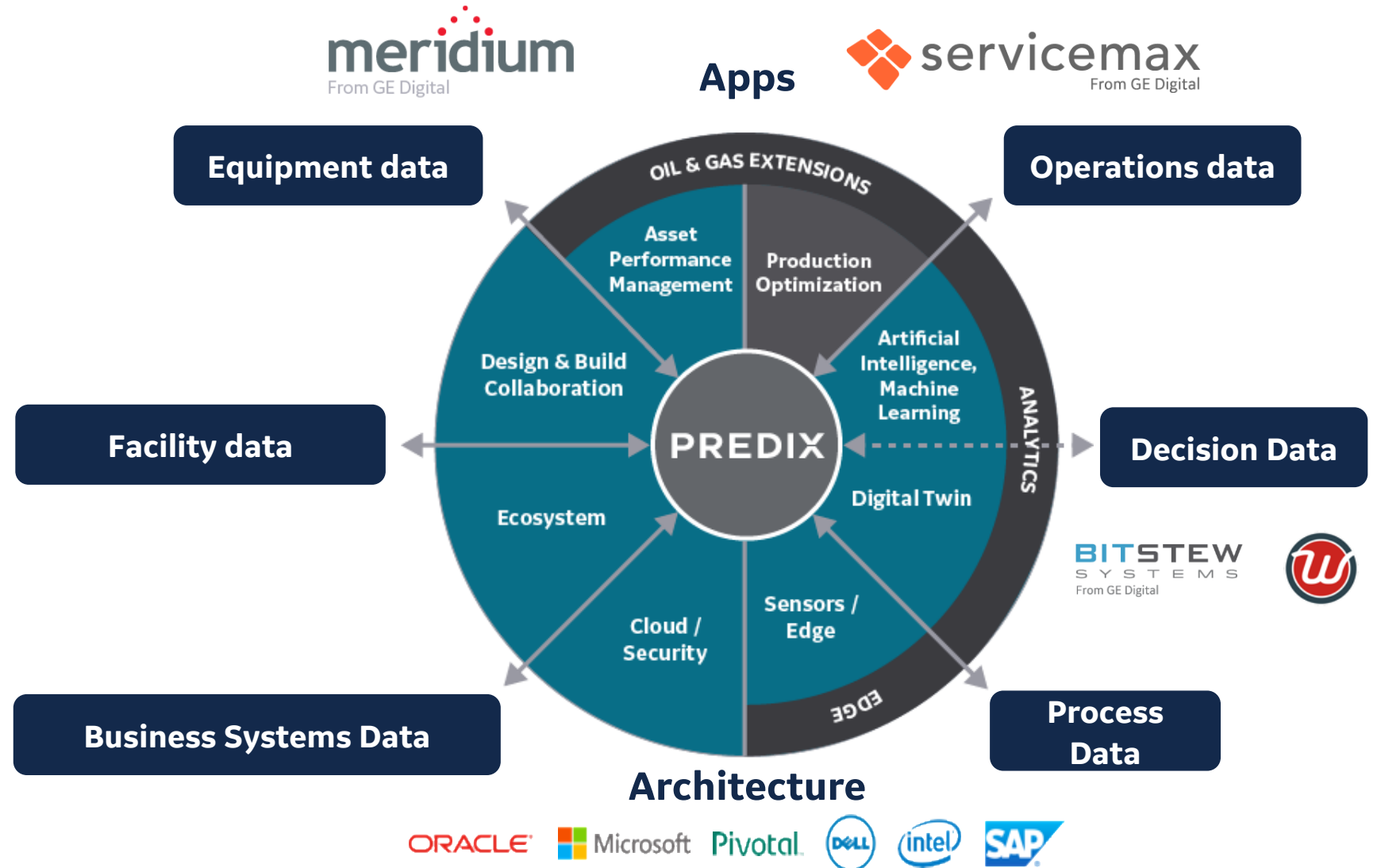
The journey to value – sequencing is key

Enterprise value

Autonomous / De-manned operations

Artificial intelligence

Optimization & prediction

Analytics

Monitoring & diagnostics

Data collection & visualization

Phase 4
Autonomous Plant Operations

Phase 3
Optimize Unit Operations

Phase 2
Reduce Equipment Outages

Phase 1
Accelerated Response

Level 0   Level 1   Level 2   Level 3   Level 4   Level 5

Digital maturity

Digital Twin – Delivering Business Value

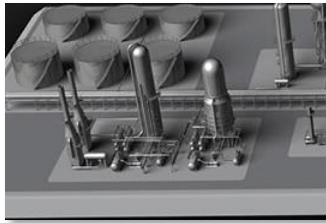| Physical	+	Digital	→	Outcomes

Parts
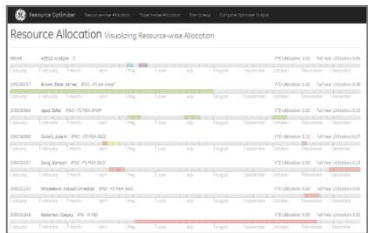Frame-5 Stage1 Nozzle

Product
Hydrocracker

Process
Field engineer scheduling

System
Field Optimization

Material science and physics

Data and analytics

Change management

- Continuous learning

- Think, see & act like top talent

- Drive proactive business operations

- Eliminates manual, ad-hoc decision making

- Increase productivity

- Improve speed, and efficiency

Digital Field Service

Digital Documentation & Reporting Platform

Digital Measurements tools

Digital Communication system

WIRELESS HEAD UNIT
WIFI 2.4 / 5 GHz

WIDE- ANGLE CAMERA
HD READY

BINOCULAR
NEAR- EYE DISPLAY

INDUSTRIAL HEADSET
BLUETOOTH WITH NOISE
SUPPRESSION

WIRELESS HANDCAM
WIFI 2.4/ 5 GHz

Asset Performance Management for Offshore

Largest Predix APM deployment at scale covering systems + platforms

Machine learning + digital twin analytics

Events, alerts, workflows

Full deployment ... cover 400-600 assets and asset classes, deployed 20MM+ tags

Next steps: Expansion into reliability management + inspection

$100MM+
Bottom line impact per 1% efficiency improvement

Customer challenge	Solution	Outcomes and value
• Siloed business operations • Safety concerns • Reactive to process upsets	Predix APM + O&G extensions providing fleet-wide insights for real-time visibility of global plant operations 1) Excursion and anomaly management 2) Equipment monitoring and analysis 3) Process Surveillance 4) Knowledge repository ... best practice sharing	Connected | Insights | Optimized

Improved safety, engineering productivity, data visibility and efficient decision making

Reduced production deferrals

Contributing to 2-4% higher global operations efficiency

Asset Performance Management for LNG

Solution overview

APM ... Cloud deployed solution providing:
- Single unified Platform & User experience
- Analytics & Reporting ... real time & mobile
- Alarm & collaborative Alert Management

Integration with RasGas IT infrastructure

Project highlights

- LNG operator
- Leveraging one GE Store
- Discovery, analysis, solution design in partnership with the customer

Scope	Capabilities	Outcome	Customer Value
Train 5: Reliability - Mixed gas & Propane refrigeration units - Dehydration unit	- Increase reliability through "google-like" predictive analytics	- Lower LNG Volumetric Downtime (VDT) - Lower cost of maintenance	
Train 6+7: Optimize - Mixed gas & Propane Refrigeration units - Nitrogen rejection unit - NGL extraction	- Optimize by comparing trains & analyzing process leakages	- Decrease flash gas (by 50%) - Reduce excess chilling power	

Driving productivity on non-GE equipment as well ...leading to full plant APM solutions

Leapfrog Digital Transformation … GE's Learnings

Data Analytics

- First-of-its-kind layering of complex data sets

- Data compression, ingestion, shaping, abstraction remains a core challenge

Edge to Cloud Industrial Computing

- Computing power, security, architecture of large, distributed data sets

- Edge analytics

- Machine applications

Value is in Digital Twin – Physics + Analytics

- Every asset to operate like the most productive asset

- Create knowledge repository and continuously improve

Industrial-grade cloud OS Predix

- Micro-service architecture

- Best in class UX / Design

- Mobility

- Built for Industrial workloads

Power of Ecosystem

- Scale and Speed are key

- Moving from System of Record to System of Engagement

imagination at work