Industrial Internet as a Service
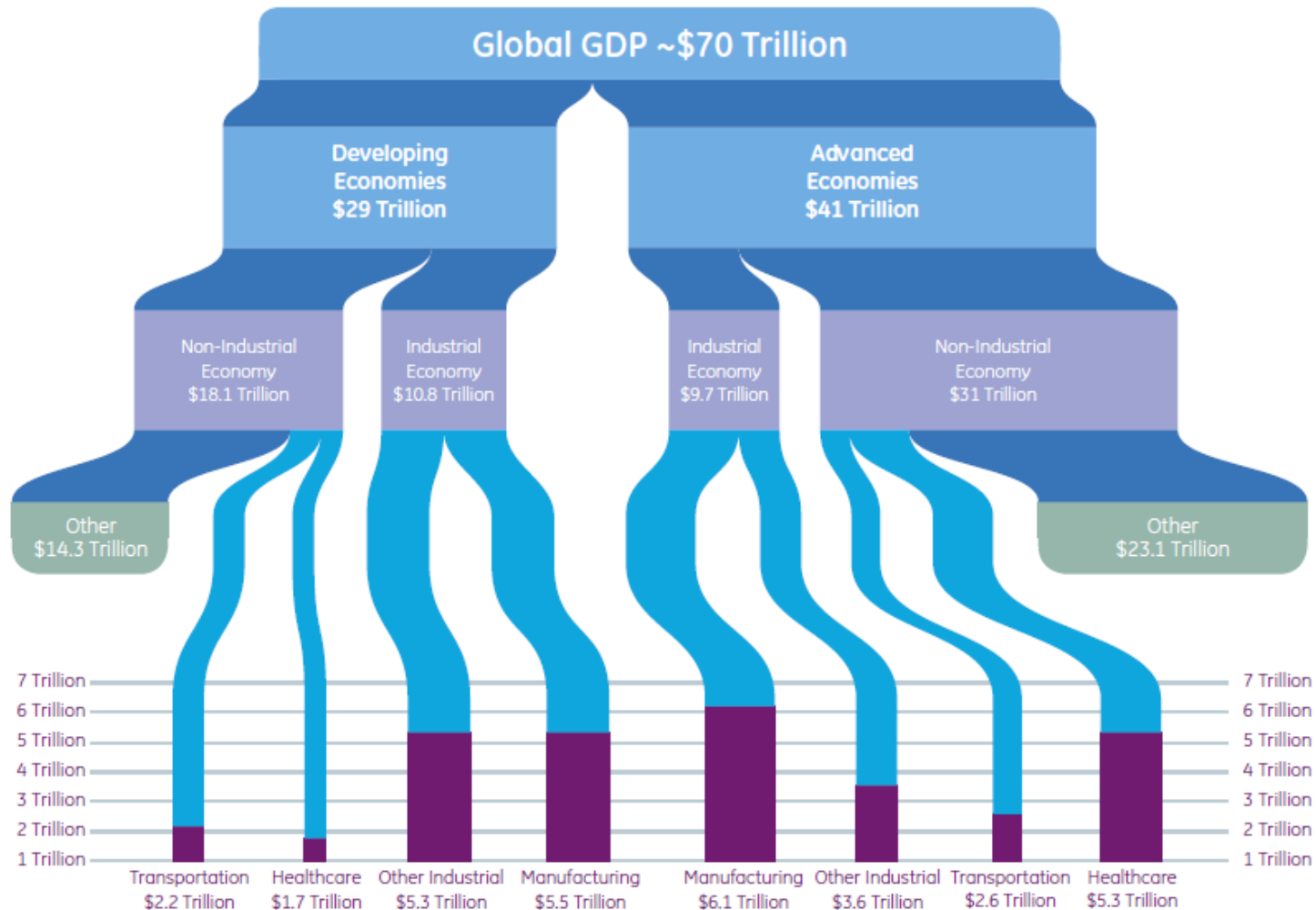
IoT Technology Symposium, San Jose

Julian Keith Loren, Director, External Engagement & Solutions

May 21, 2015

Imagination at work

Industrial Internet Value

Global GDP ~$70 Trillion

Developing Economies $29 Trillion

Advanced Economies $41 Trillion

Non-Industrial Economy $18.1 Trillion

Industrial Economy $10.8 Trillion

Industrial Economy $9.7 Trillion

Non-Industrial Economy $31 Trillion

Other $14.3 Trillion

Other $23.1 Trillion

Transportation $2.2 Trillion	Healthcare $1.7 Trillion	Other Industrial $5.3 Trillion
Manufacturing $5.5 Trillion	Manufacturing $6.1 Trillion	Other Industrial $3.6 Trillion
Transportation $2.6 Trillion	Healthcare $5.3 Trillion	

Industrial Internet opportunity ($32.3 Trillion) 46% share of global economy today

Source: World Bank, 2011 and General Electric

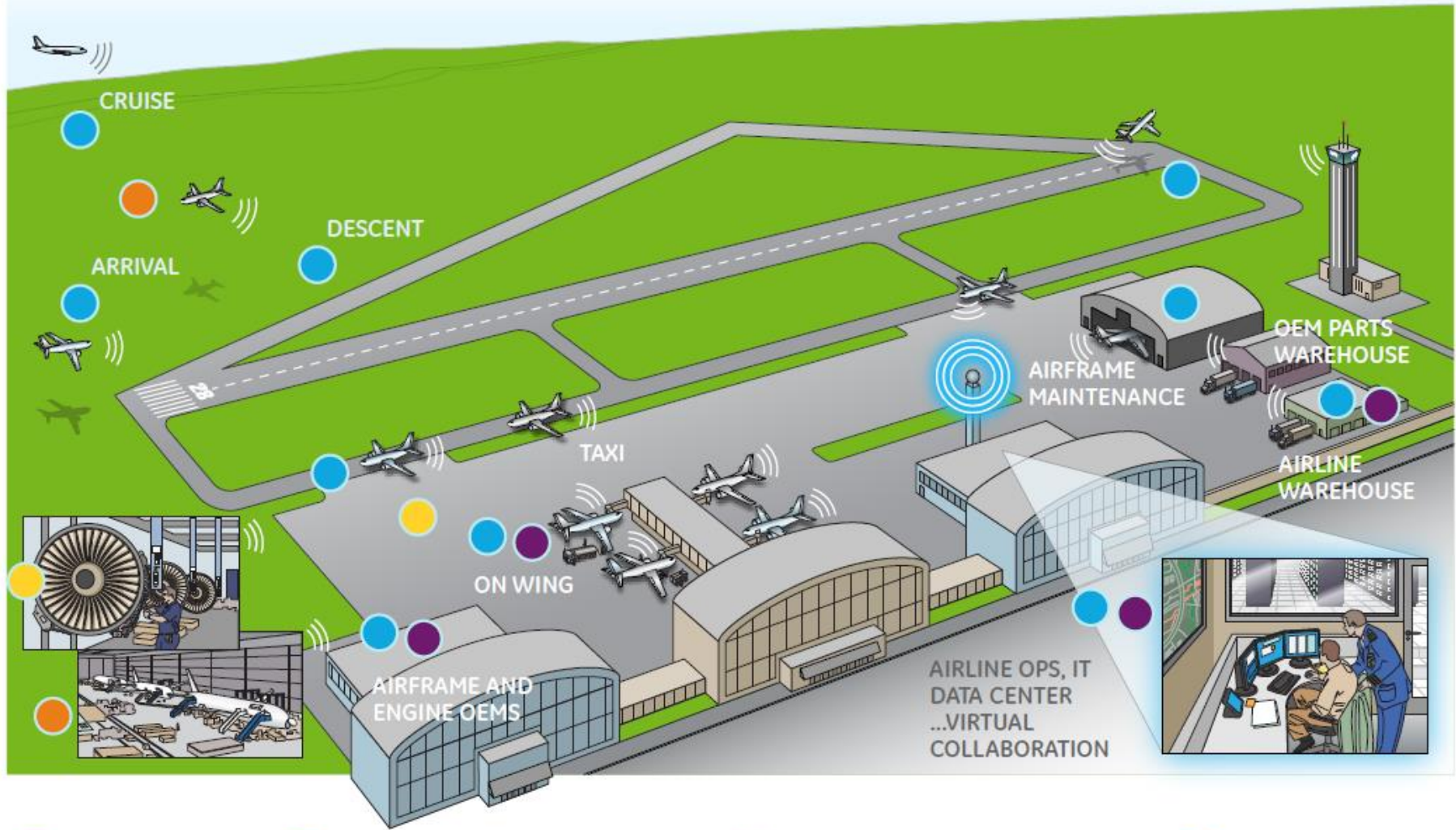# Delivering Value with Predictivity™

Predictivity™ for Aviation

6.3% fuel savings on short flights for GOL Airline.

- Proactive Maintenance
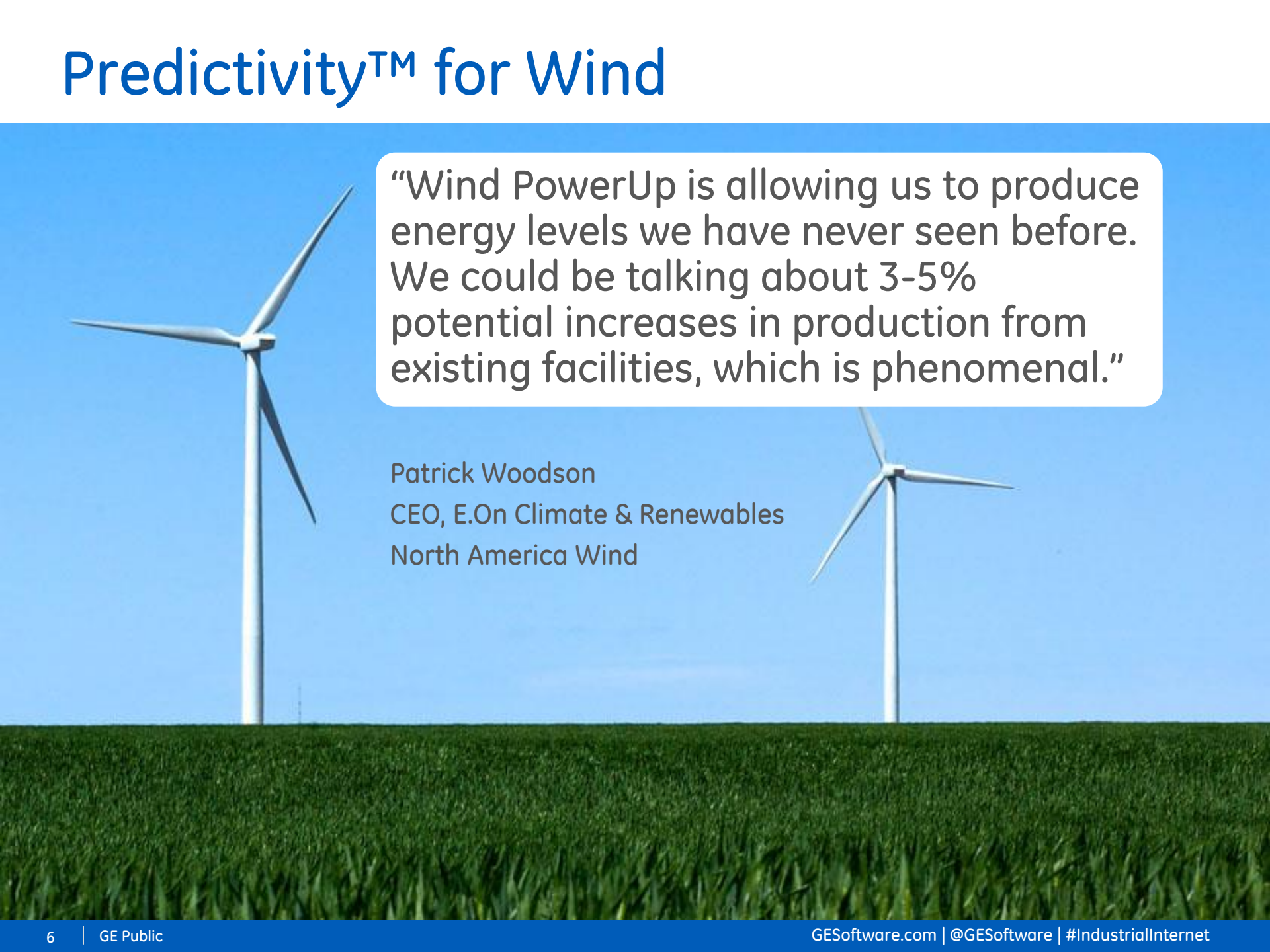- Fuel Efficiency
- Operational Recovery

Predictivity™ for Aviation

Predictivity™ for Wind

"Wind PowerUp is allowing us to produce energy levels we have never seen before. We could be talking about 3-5% potential increases in production from existing facilities, which is phenomenal."

Patrick Woodson

CEO, E.On Climate & Renewables

North America Wind

Predictivity™ for Aeroderivatives

Industrial Internet sensors, analytics, and software enabled 98% uptime guarantee for Queensland Curtis LNG.

Predictivity™ Range

Through GE's Businesses

Aviation

Rail

Oil & Gas

Power Generation

Wind

Power Distribution

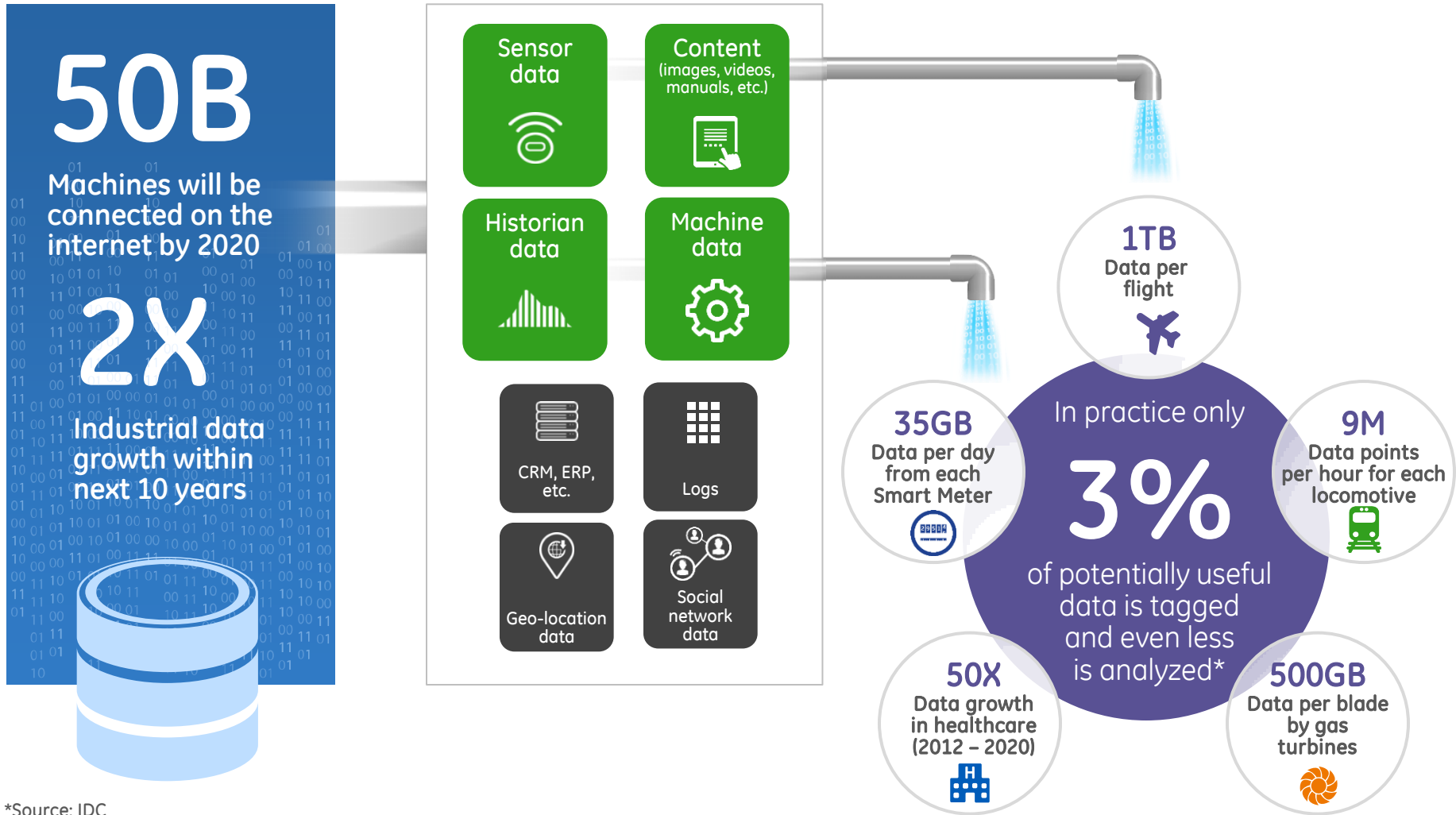Healthcare

Mining

Water & Process Tech

Manufacturing

...

Direct from GE Software

Smart Logistics

Smart Operations

Asset Intelligence

Big Data → $$$

50B

Machines will be connected on the internet by 2020

2X

Industrial data growth within next 10 years

*Source: IDC

Sensor data

Content (images, videos, manuals, etc.)

Historian data

Machine data

CRM, ERP, etc.

Logs

Geo-location data

Social network data

1TB Data per flight

35GB Data per day from each Smart Meter

In practice only **3%** of potentially useful data is tagged and even less is analyzed*

9M Data points per hour for each locomotive

50X Data growth in healthcare (2012 – 2020)

500GB Data per blade by gas turbines

MOST INNOVATIVE COMPANIES 2014   10.4K SHARES in y ...

THE WORLD'S TOP 10 MOST INNOVATIVE COMPANIES IN BIG DATA

ACCORDING TO ONE PROJECTION, THE SALES OF BIG-DATA-RELATED PRODUCTS AND SERVICES GREW TO MORE THAN $18 BILLION IN 2013.
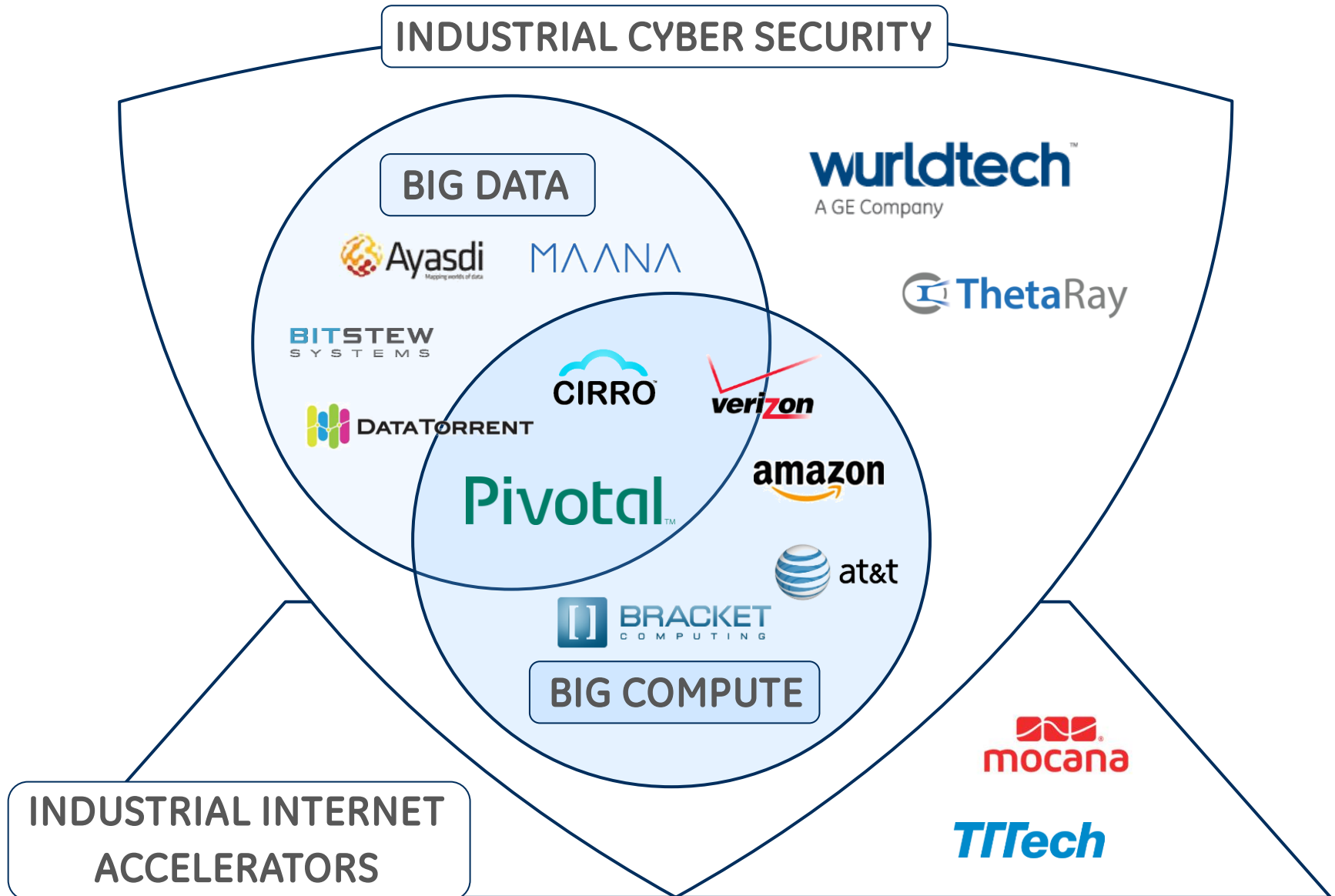
BY FAST COMPANY STAFF

1. GE
For harnessing data from its planes and trains to power a new Industrial Internet, potentially saving billions. General Electric is best known for its machine making, but it's gotten smart and branded itself as a big-data company, too, by pushing its vision for an "Industrial Internet"—the notion that machines should be connected like the web in order to increase efficiency and reduce downtime. In 2012, it launched software to help airlines and railroads move their data to the cloud and partnered with Accenture to form Taleris, a startup that will help airlines predict mechanical malfunctions and reduce flight cancellations. The Abu Dhabi–based Etihad Airways was the first to deploy the tech in November. Read more >>
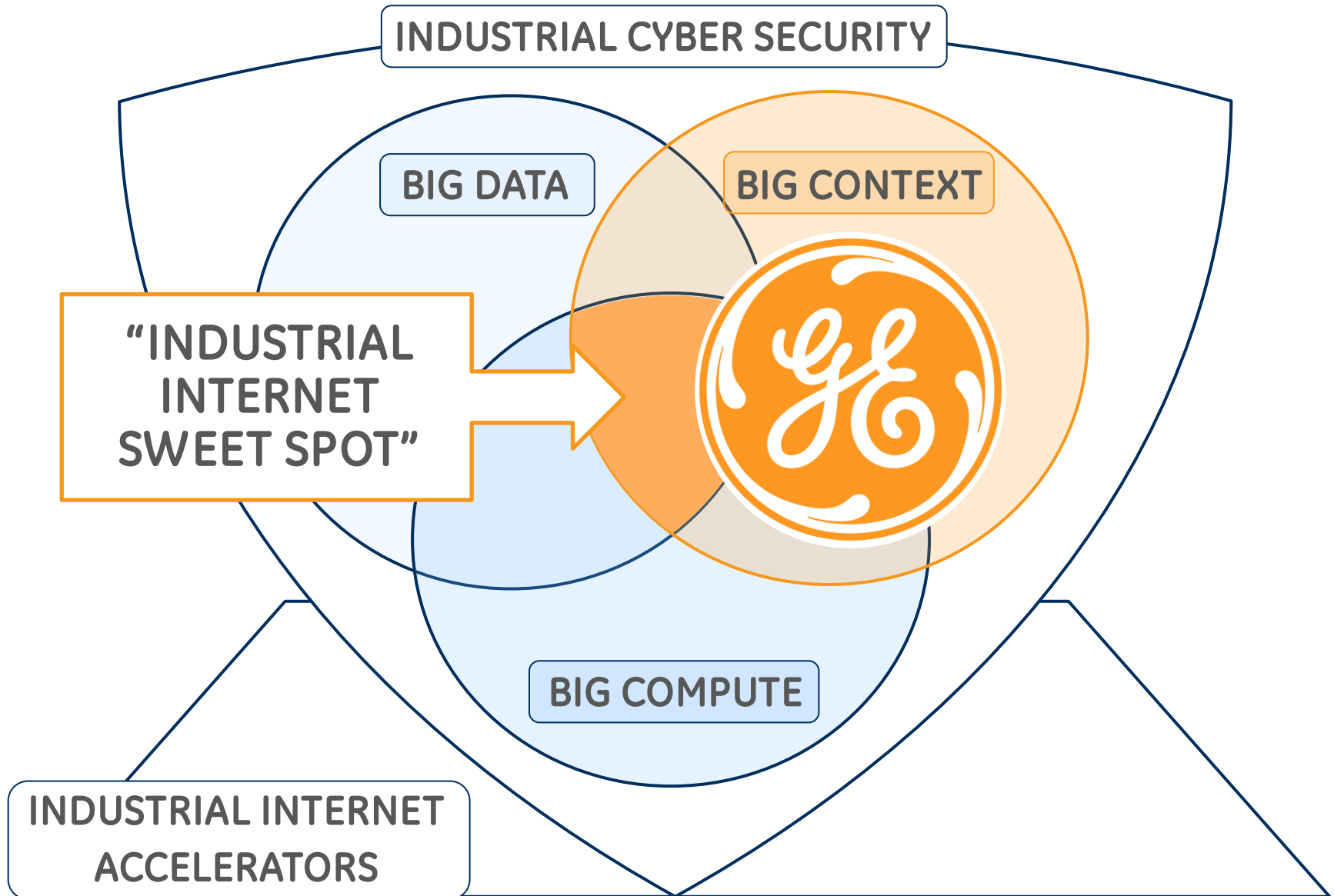
2. KAGGLE
For feeding its DIY data scientists cash-prize challenges (then molding them into a consulting biz). Now more than ever, organizations are turning toward data insights to make big decisions, and with its battalion of 150,000 data scientists, no one is better poised to take advantage of the shift than Kaggle. It farms out complex "data
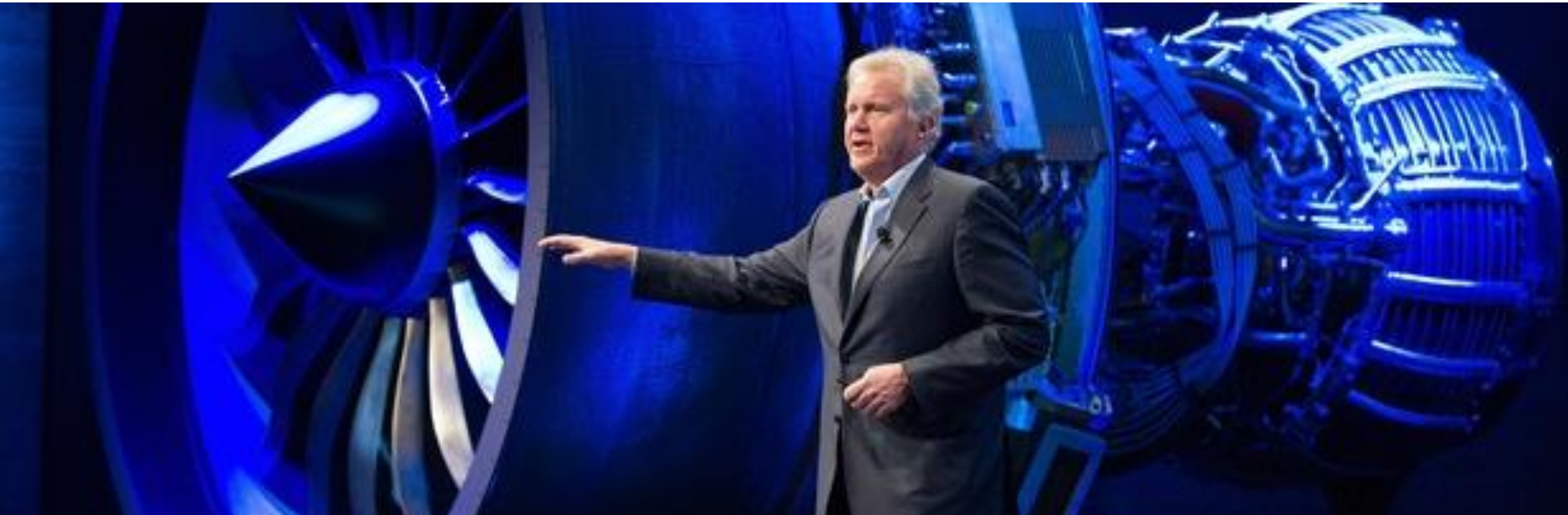
Big Data → $$$

INDUSTRIAL CYBER SECURITY

BIG DATA

wurldtech™
A GE Company

Ayasdi
Mapping worlds of data

MAANA

ThetaRay

BITSTEW SYSTEMS

CIRRO

verizon

DataTorrent

amazon

Pivotal™

at&t

BRACKET COMPUTING

BIG COMPUTE

INDUSTRIAL INTERNET ACCELERATORS

mocana

TTTech

Big Data → $$$

INDUSTRIAL CYBER SECURITY

BIG DATA

BIG CONTEXT

"INDUSTRIAL INTERNET SWEET SPOT"

BIG COMPUTE

INDUSTRIAL INTERNET ACCELERATORS

Predix™ = Industrial Internet as a Service

"By opening up Predix to the world, companies of any size and in any industry can benefit from the investments GE has made." *Jeff Immelt, GE Chairman & CEO*

Predictivity™ and Predix™

Through GE's Businesses	Direct from GE Software
Aviation	Smart Logistics
Rail	Smart Operations
Oil & Gas	Asset Intelligence
Power Generation	
Wind	*Coming this year …*
Power Distribution	*Predix : Industrial Internet as a Service*
Healthcare	
Mining	
Water & Process Tech	
Manufacturing	
…	

Industrial Internet as a Service

GE commitment	Open ecosystem	Advanced research
• $1b+ investments in SW	• Technology Partners	• Cloud Services
• GE Software (CoE)	• Microservices Catalog	• Cyber/Machine Security
• APM solution portfolio	• II Consortium + OIC	• Data Science

"By opening up Predix to the world, companies of any size and in any industry can benefit from the investments GE has made."

Jeff Immelt, GE Chairman & CEO

Industrial Internet as a Service

Predix
fast-tracks idea to industrial innovation.

5x ·····▶	5x ·····▶	Industrial ·····▶	GE
Faster TTM	**Lower Cost**	**Scale and Security**	**Value**
Idea to Industrial Innovation: from years to months and weeks	80% spent on innovation, versus maintaining status quo	Uniquely engineered for the Industrial Internet	Partner eco-system, services model, full commitment

Industrial Internet apps drive outcomes

Opportunity to address

5-10%

range of O&G industry
estimated downtime

Source ge.com/investor-relations/ir-events/ge-oil-gas-investor-meeting

Dashboard

Health

Units   ⦿ Wells   ○ BOPD

All Areas / Southwest Region   **7 DOWN**   **3 WARNING**   **10 COMM ERROR**   **527 RUNNING**

WEST BUILDING (39)	3 · 3	33
FIELD VIJ (4)	1	3
FIELD H (2)	1 · 1	1
FIELD D (2)	1	1
EAGLE FORD FIELD (6)	2	4
AUTO FIELD11 (3)	1 · 2	
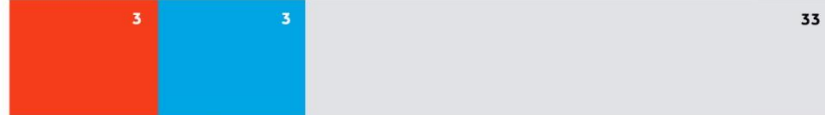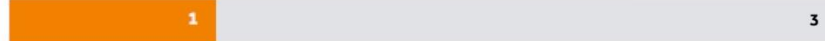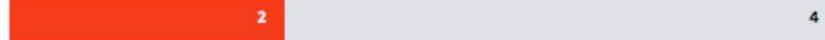
Prioritized Well Index

7 DOWN   **2 WARNING**   **43 COMM ERROR**

Well	Production
▪ AUTO WELL111	16,740
▪ WELL VIJ	14,150
▪ AUTO WELL TEST	14,130
▪ CALI N57	13,120
▪ CHAPMAN 1	12,140
▪ ADOBE 31	12,100
▪ COLLIE E17	11,760
▪ ADOBE 29	11,300
▪ JORDAN WEST	10,150
▪ STEVENSON T3	10,120
▪ ALYX - 22	9,070

Open Case Log   ▾

Asset	Case Title
LABSIM 8006 WELL-008	WELL ALARM

⭐ Favorites   ▾

Well	State
▪ LabSim 8006 Well-008	Active

Dashboard   **Assets**   Logs   Reports   Administration

Well ADOBE 29

Profile | **Overview** | Performance | Log | Latest Data | Control | ⬈

WARNING ★

2875 Hours
Last updated 15 minutes ago

59	150
BOPD	BFPD

Details

API	12345678912
Field	FIELD G
Area	SOUTHERN CALIFORNIA
Country /Region	United States

📍 90.123, 180.123

Well Team

John Tease

Performance

— Frequency — Motor Temp. — Intake Press. — Voltage — Current — Vibration

[1h] [1d] [1w] [1m] [6m] [1y] [All]

OCTOBER 2 2014 01:55:00

Frequency 62.6 Hz
Motor Temp. 144.6 °F
Intake Press. 1,376.1 Psi
Voltage 442.9 V
Current 181.1 A
Vibration 0.200 G
Events & Alarms 673

Events & Alarms

18:00   OCT 2   06:00   12:00

2. Oct   12:00
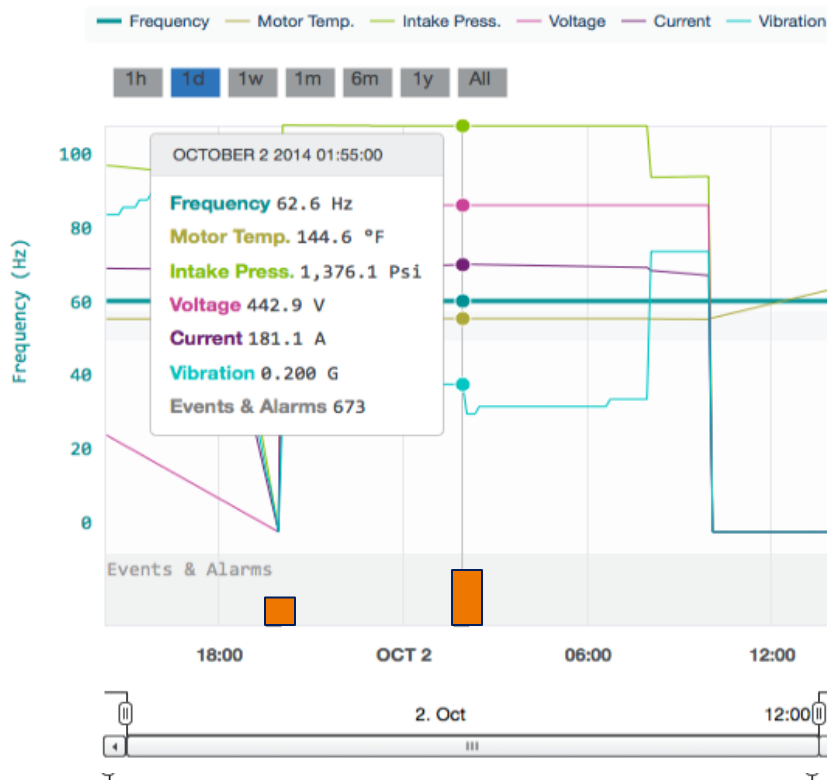
Pump Curve

View	⦿ Live	◯ Historic

Installation Report

View Installation Report

History

WARNING since 2014-06-05 03:47:47.0

KPIs	Last 7 Days	Last 30 Days	Lifetime
Total Down Time	0 Hr	1 Hr	1 Hr
Total Runtime	190 Hr	742 Hr	4469 Hr
Total Starts	0 Hr	1 Hr	1 Hr

Comment

Operational Details. This comment will be displayed in the

Dashboard   Assets   Logs   Reports   Administration

Well ADOBE 29

Profile   Overview   Performance   Log   Latest Data   **Control**   ⬈

WARNING ⭐

2875 Hours
Last updated 15 minutes ago

59	150
BOPD	BFPD

Details

API	12345678912
Field	FIELD G
Area	SOUTHERN CALIFORNIA
Country /Region	United States

📍 90.123, 180.123

Well Team

John Tease

Control

Stop Well   Start Well

Frequency Setpoint

Minimum 35

Maximum 65

Active Setpoint 0

Applied Setpoint

Cancel   **Save**

Industrial Internet as a Service

Predix

All the services you need to build apps fast.

IDEA → **BUILD** → **APP**

| Industrial Microservices | DevOps Deploy/Operate | Industrial PaaS |

From application to apps and API's

YESTERDAY
Industrial APPLICATIONS
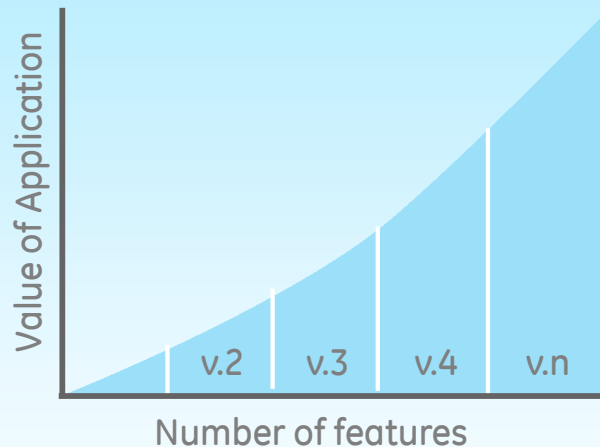
Value is tied to capabilities
10 applications

TODAY
Industrial APPS
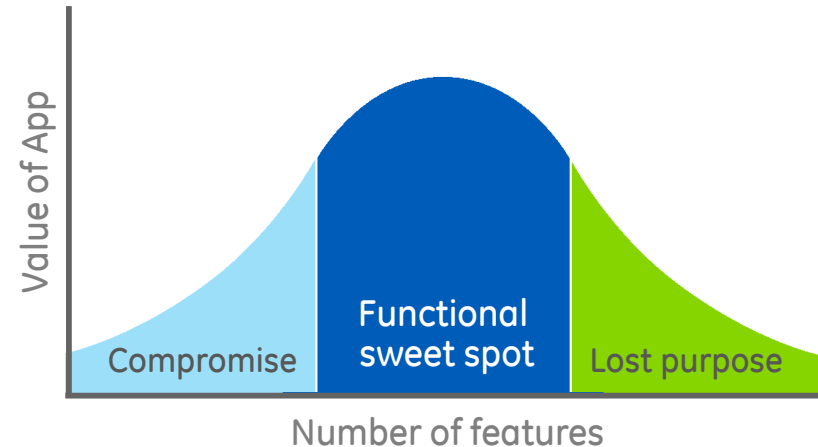
Value is tied to purpose
100+ apps

Predix Industrial Cloud Platform - Architecture

Asset Performance Management (APM)

Industrial Internet apps
powered by Predix

Operations Optimization

predix.io

Discover → Code → Deploy → Operate → Monetize

- BizOps
- DevOps
- Community

Predix-ready MACHINES
and industrial devices

Machine Embedded

GE | Non-GE

Industrial Microservices Catalog

Application services

Infrastructure services

- Built by GE, customers, partners

Cloud Foundry

Cloud Infrastructure

- Scalable
- Elastic
- Reliable
- Trusted end-to-end

Predix Industrial Cloud Platform - Architecture

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- DevOps
- Community

Predix-ready MACHINES
and industrial devices

Machine Embedded

GE | Non-GE

Industrial Microservices Catalog

Application Services

Experience	Security	
Machine	Asset	Analytics

Infrastructure Services

Connectivity	Data	Composition

- Built by GE, customers, partners

Cloud Foundry

Cloud Infrastructure

Development	Production

- Scalable
- Elastic
- Reliable
- Trusted end-to-end

Appendix: Vendor Comparison

	GE		PaaS (IT Vendor)	
Industrial Know-How	●	• In-depth understanding of industrial business and engineering processes • In-depth experience in APM[3]; GE manages customer assets of $1T value	◔	• Does not engineer / deliver / service / support industrial assets and equipment • Industrial knowledge dependent on partnerships with industrial companies
Machine Knowledge	●	• Advanced data science, based on physics, heuristics, statistics (GE/non-GE asset) • Enables SDM[1]: insights to action / policy updates on machines	○	• Focused on traditional predictive analytics, without native understanding of assets • Does not natively support closed-loop scenarios (insight to action) with machines
Industrial Big Data Analytics	◔	• Analytics seamlessly distributed across edge (historian), plant, enterprise (HDFS)[2] • Flexible, modern APM framework with industrial predictive analytics	◑	• Still evolving cloud strategy, based on multiple / overlapping products • Does not natively delivery analytics deployed on industrial equipment
Modern Cloud Architecture	●	• Modern platform, built ground-up on modern design principles; $1b+ revenue • Deployment flexibility (Cloud, managed services, on-premises data center)	◑	• Portfolio not fully integrated, includes many acquisitions & legacy technology • Generic technology, not optimized for industrial use cases
Resilient and Secure	●	• Leading OT security with industrial firewalls and Wurldtech certification • Proven cloud management, support stringent security and data sovereignty	◔	• Security strategy not dedicated to industrial / operational technology • Professional services-based architectures can create one-off customer challenges
Industrial App Factory	◔	• Proven expertise to deliver solutions to customers, with 90 day rapid prototyping • Risk / gain sharing models ensure customer return of investment (ROI)	◑	• Solution model heavily reliant on professional services delivery • "Build versus Buy" can become very expensive (CAPEX and COPEX)

[1] SDM = software-defined machines (https://www.gesoftware.com/software-defined-machines)
[2] HDFS = Hadoop Distributed File System
[3] APM = Asset Performance Management (source: Gartner)

Source: GE

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