Big Data's Impact on Facilities Operations & Organizations

Don Guckert, P.E., APPA Fellow

Associate Vice President for Facilities Management

The University of Iowa

“If the rate of change outside your organization is greater than the rate of change inside your organization, the end is in sight .”

Jack Welch – former CEO of General Electric

What is Big Data?

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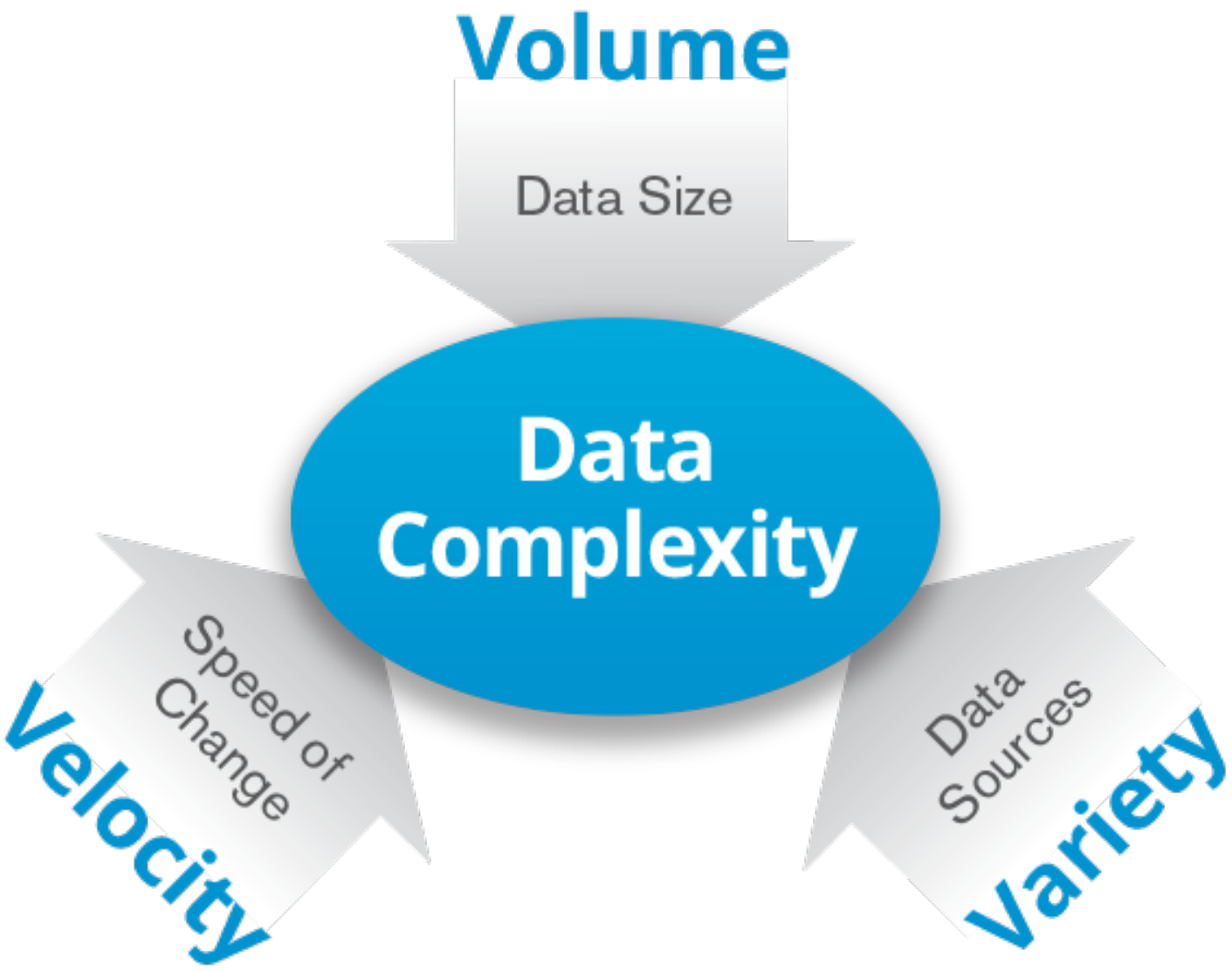
Merriam-Webster's Collegiate Dictionary added Big Data in 2014….

Definition of *BIG DATA*: an accumulation of data that is too large and complex for processing by traditional database management tools

What is Big Data?

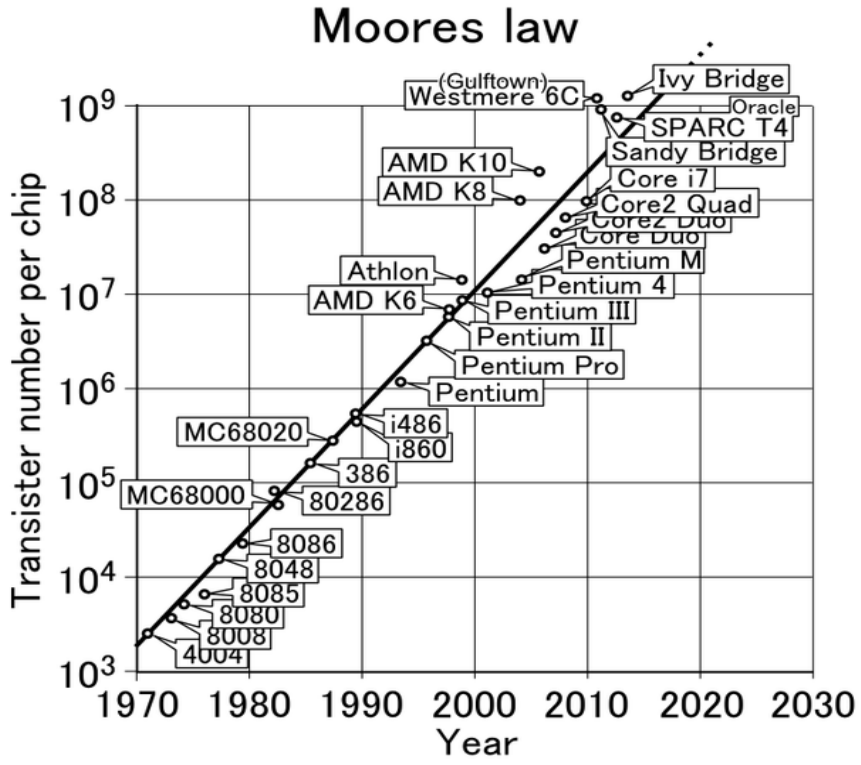
Industry Definition:

High volume, high variety and high velocity of information assets that demand cost effective and innovative forms of information processing for enhanced insight and decision making.


Volume
Data Size
Data Complexity
Velocity
Speed of Change
Variety
Data Sources

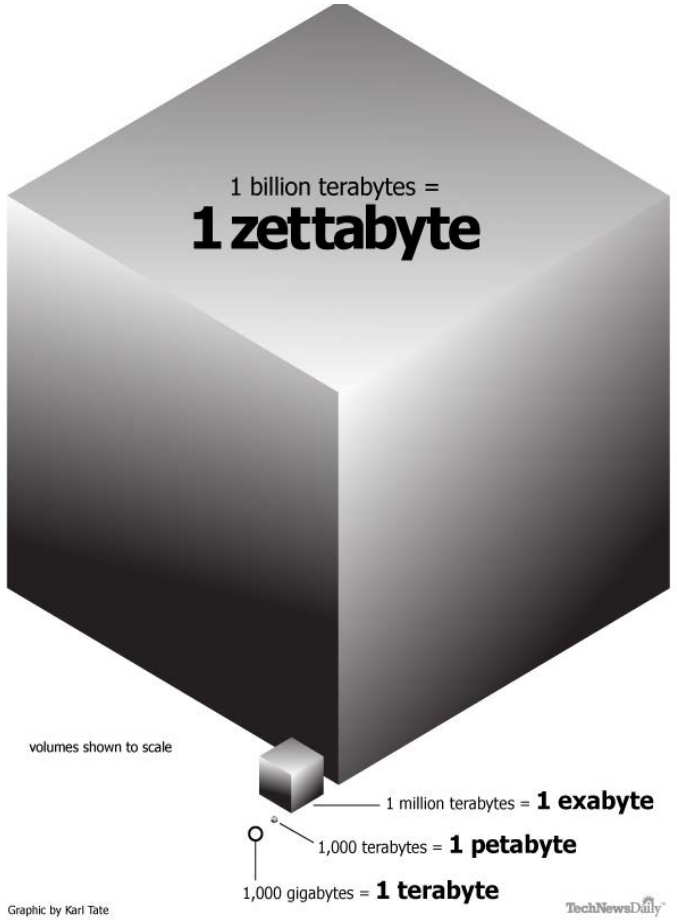
Velocity

Moore's Law: microprocessor processing power doubles about every 18 months.



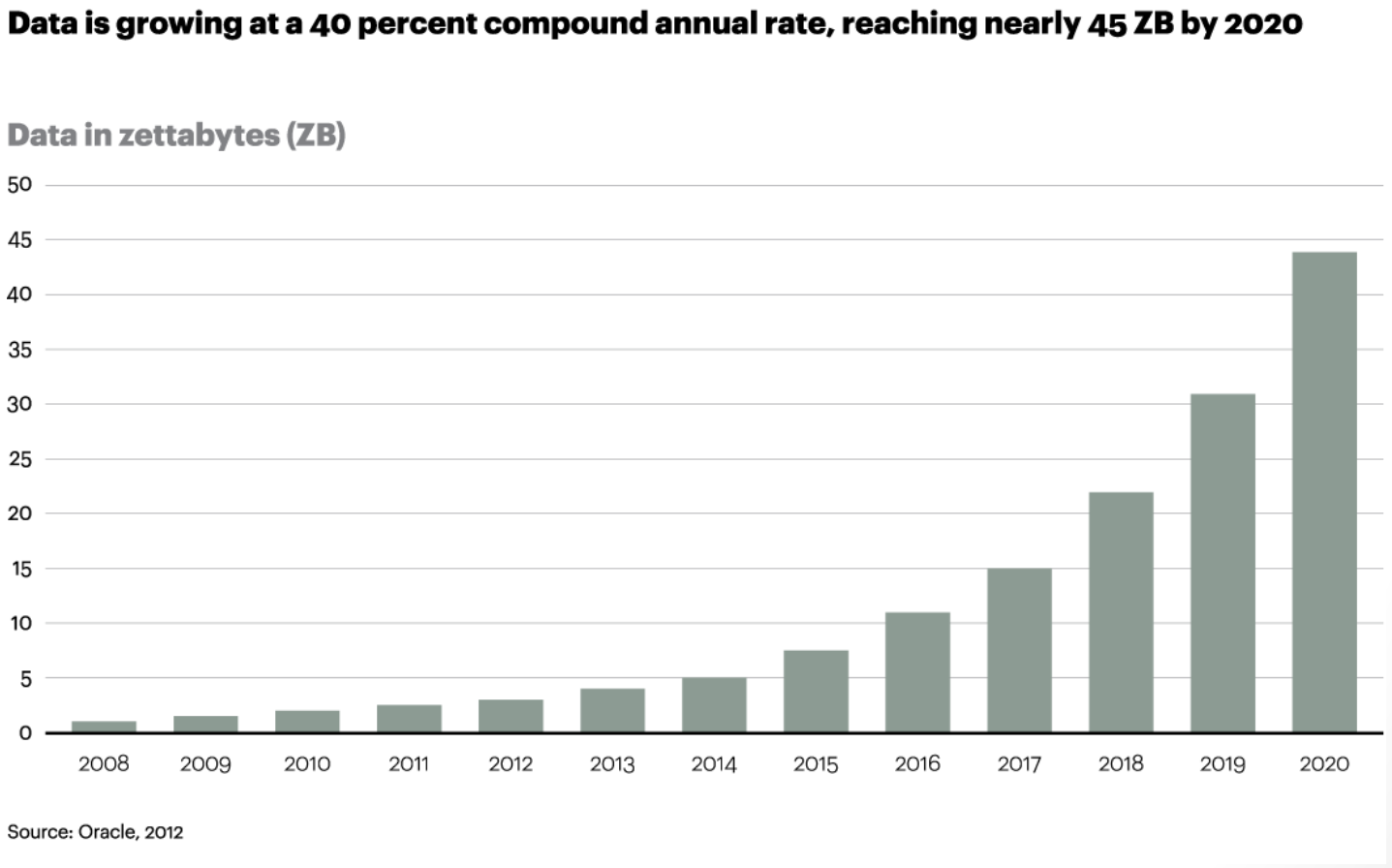
Volume

Humanity passed the 1 Zettabyte mark in 2010.



Volume

Capacity to store data is growing exponentially.



Volume


Volume
Data Size
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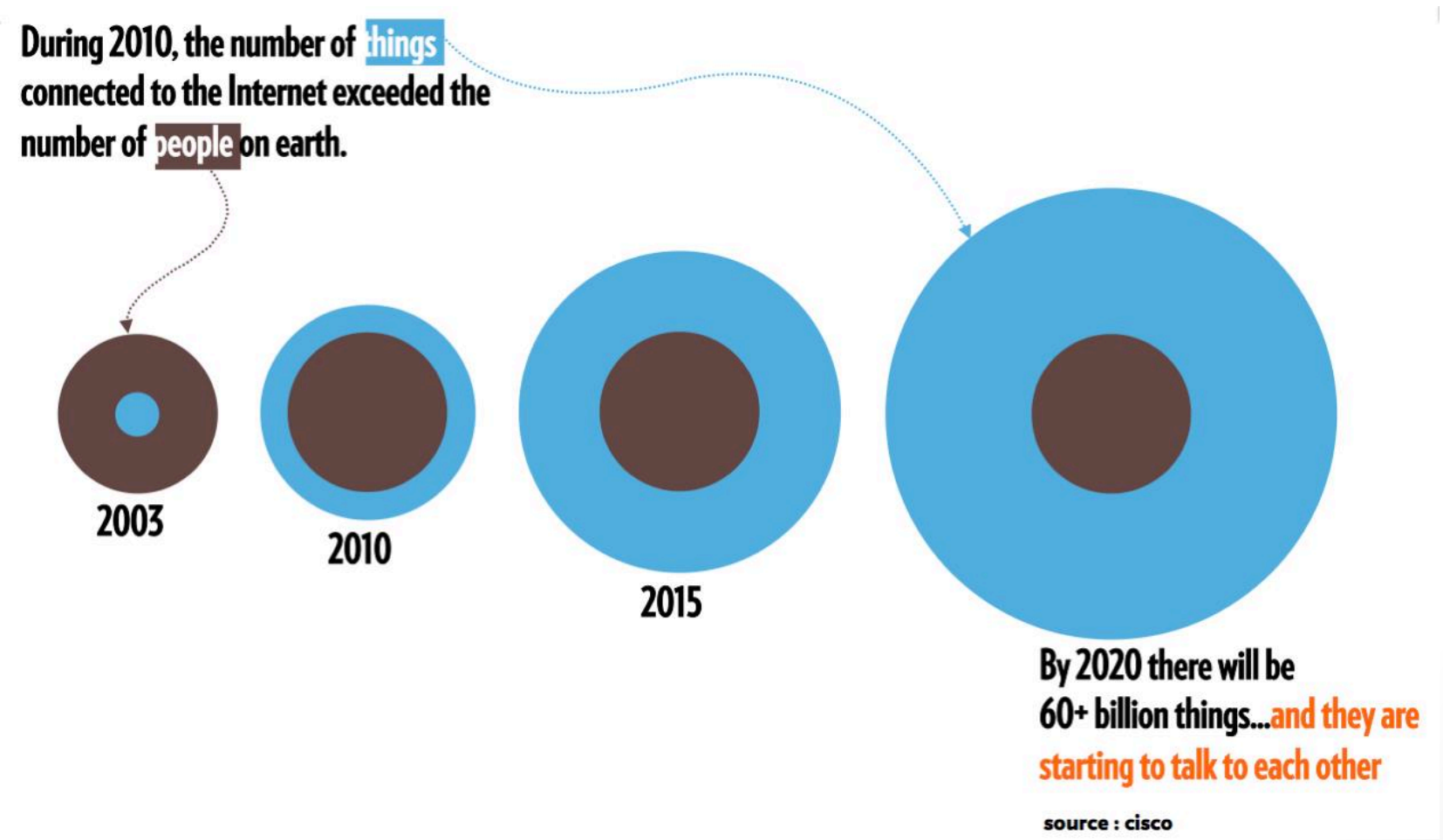
Variety


During 2010, the number of things connected to the Internet exceeded the number of people on earth.
2003
2010
2015
By 2020 there will be 60+ billion things...and they are starting to talk to each other
source : cisco

Variety


Volume
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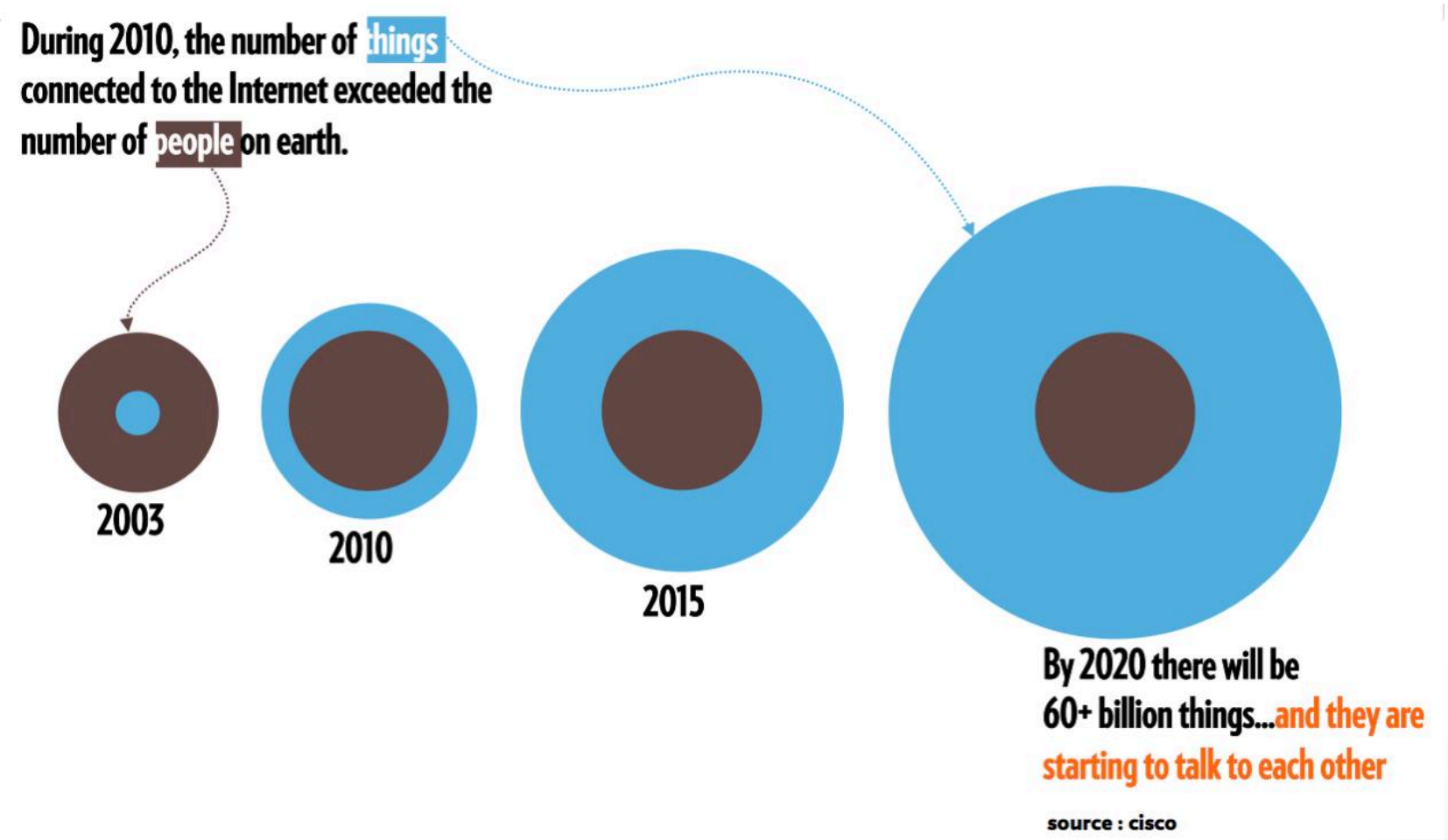
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Variety

The ability to to install sensors everywhere is helping to make possible the “industrial Internet” by enabling every “thing” to carry a sensor that broadcasts how it is feeling at any moment, thus allowing its performance to be immediately adjusted or predicted in response.

Thank You for Being Late
An Optimist’s Guide to Thriving in the Age of Accelerations
Thomas L. Friedman

Variety

The vast expansion of our ability to sense our environment and turn it into digitized data was made possible by breakthroughs through materials science and nanotechnology.

…we are now able to digitize four senses - sight, sound, touch and hearing - and are working on a fifth: smell.

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Variety

When the Internet of Things gets to scale, machines will be talking to machines everywhere and always.

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It is expected that the global Smart Building Market will grow from $7.3 billion in 2015 to $36.4 billion by 2020.*

*source: MarketsAndMarkets

Variety

Credit: IBM

Variety


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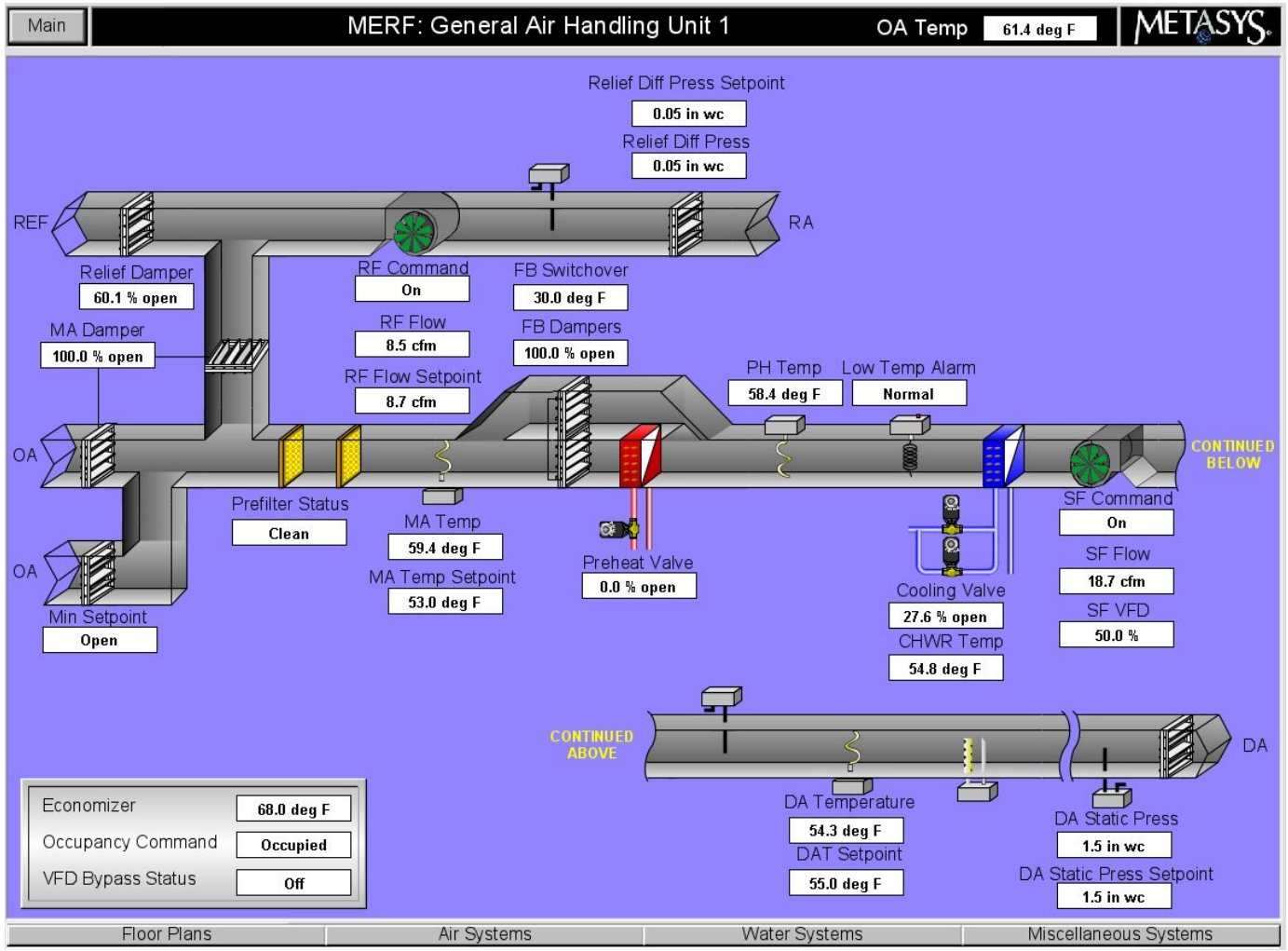
Main
MERF: General Air Handling Unit 1
OA Temp
61.4 deg F
METASYS
Relief Diff Press Setpoint
0.05 in wc
Relief Diff Press
0.05 in wc
REF
RA
Relief Damper
60.1 % open
RF Command
On
FB Switchover
30.0 deg F
MA Damper
100.0 % open
RF Flow
8.5 cfm
FB Dampers
100.0 % open
RF Flow Setpoint
8.7 cfm
PH Temp
58.4 deg F
Low Temp Alarm
Normal
OA
CONTINUED BELOW
Prefilter Status
Clean
MA Temp
59.4 deg F
MA Temp Setpoint
53.0 deg F
Preheat Valve
0.0 % open
SF Command
On
SF Flow
18.7 cfm
OA
Min Setpoint
Open
Cooling Valve
27.6 % open
SF VFD
50.0 %
CHWR Temp
54.8 deg F
CONTINUED ABOVE
DA
DA Temperature
54.3 deg F
DA Static Press
1.5 in wc
DAT Setpoint
55.0 deg F
DA Static Press Setpoint
1.5 in wc
Economizer
68.0 deg F
Occupancy Command
Occupied
VFD Bypass Status
Off
Floor Plans
Air Systems
Water Systems
Miscellaneous Systems

Variety

Air Handler Performance

- Fan Runtime
- Fan Power
- VFD Control
- Static Pressure
- Heating Control
- Cooling Control
- Ventilation Air Control
- Economizer Control
- CO2 control

- Outside Air Temperature
- Return Air Temperature
- Make-up Air Temperature
- Supply Air Temperatures
- Freeze Stat Alarms
- Smoke/Fire Alarm
- Pressure Drop Alarm

Benefits of Leveraging Big Data

Benefits of Leveraging Big Data

Business Intelligence: Understand what has happened in the past.

In-memory Processing: Understand what is happening now.

Predictive Analytics: Understand what will probably happen.

All three processes require intense data collection in order to make accurate predictions based on the past, present and presumably the future

Institutional Knowledge

Understanding what has happened in the past, happening now, and what will probably happen is foundational for predictive analytics.

In our profession, that understanding of what has happened in the past, happening now, and what will probably happen has been valued in the form of “Institutional Knowledge.”

Predictive Analytics is displacing Institutional Knowledge.

Weak Signals

"The intuition about how a machine is operating on a factory floor used to come from working there thirty years and being able to detect a slightly different sound signature emanating from the machine, telling us something is not exactly right. That is a weak signal. Now with sensors, a new employee can detect a weak signal on the first day of work – without any intuition."

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Weak Signals

"Experienced workers knew how to process weak data. But now with Big Data, with a much finer grain of fidelity we can make finding a needle in the haystack the norm - not the exception. And we can augment the human worker with machines so they work as colleagues and enable them to process weak signals together and overnight become like a thirty year veteran."

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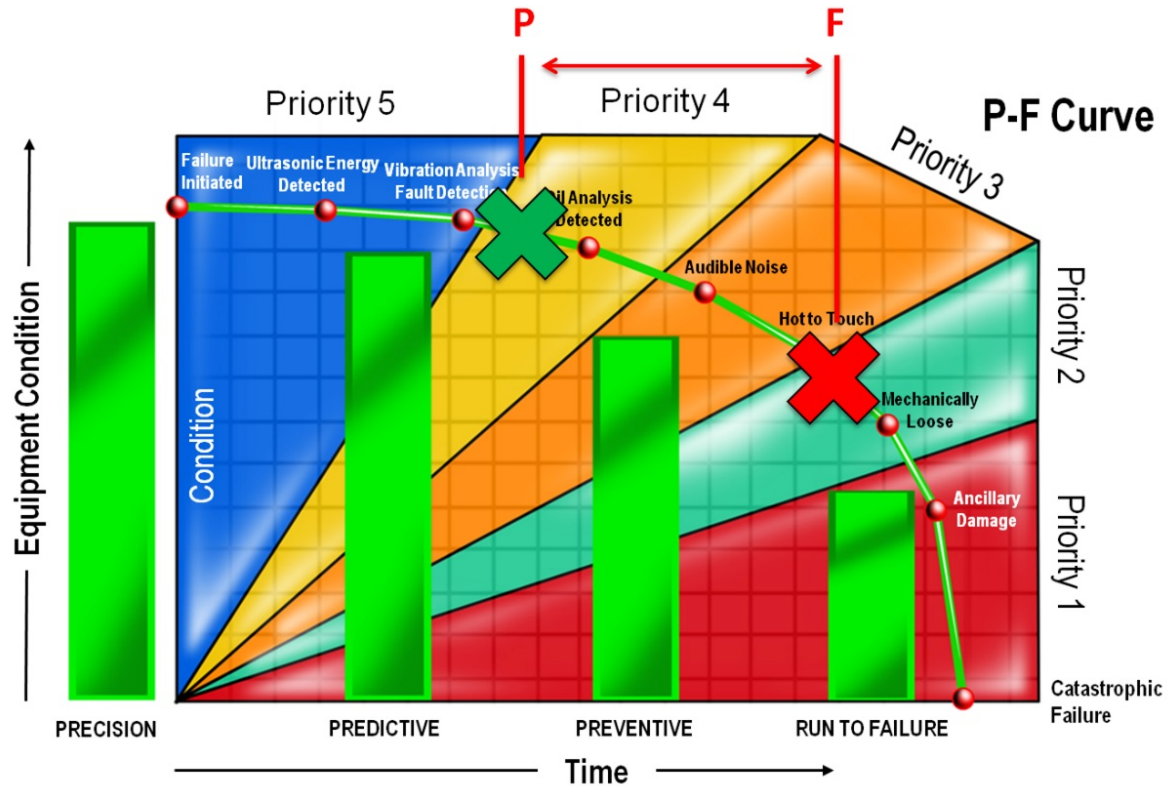
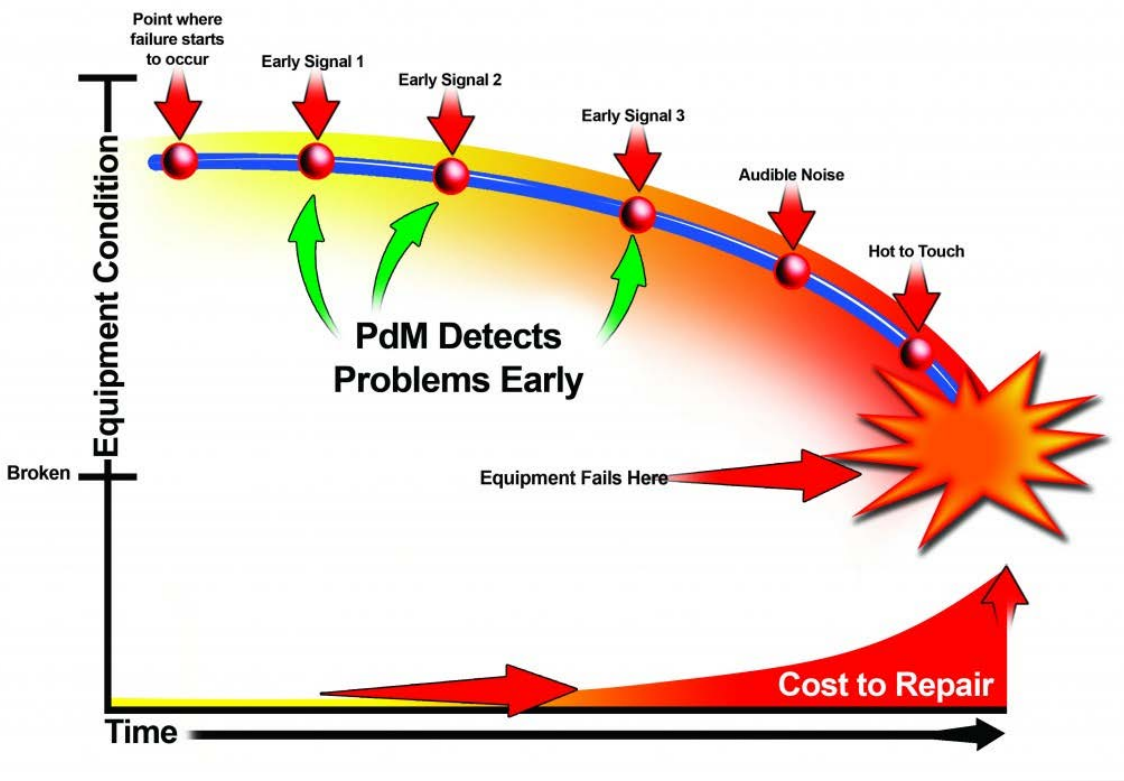
Weak Signals

Early warning signs, often in the form of “Weak Signals” provides the basis for predicting impending system failure.



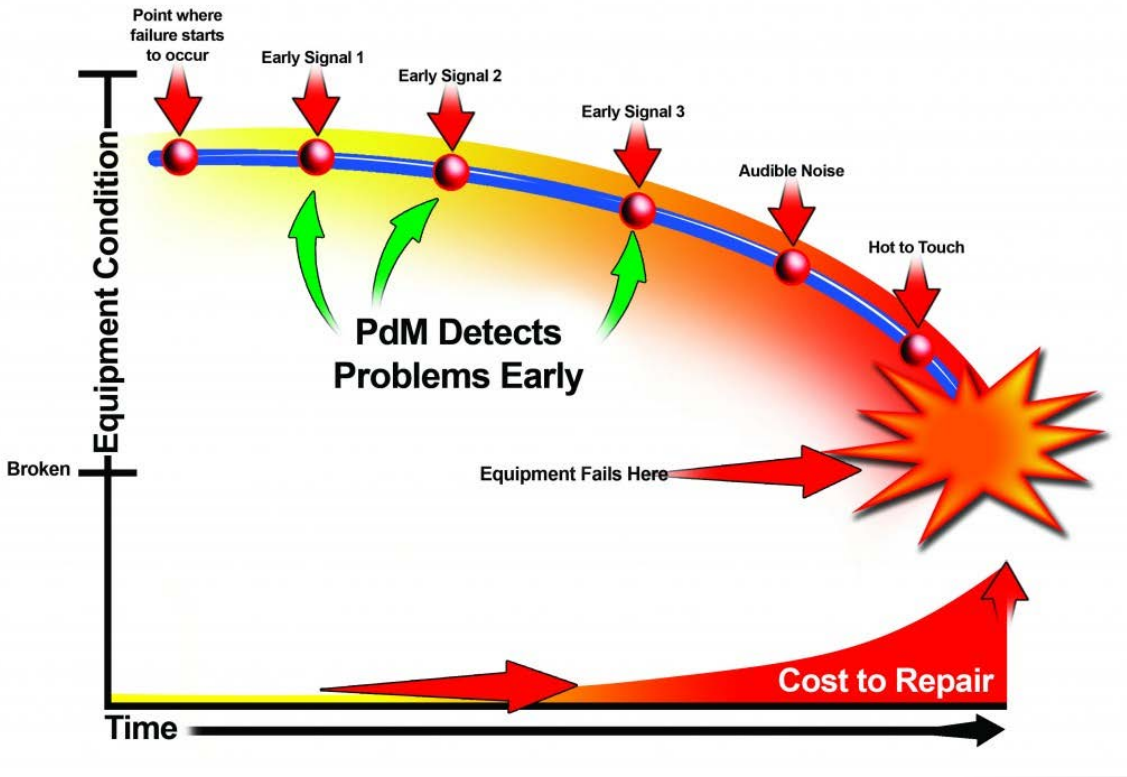
Managing Risk & Costs

Predicting impending failure, and preventing that failure, mitigates business continuity risk and financial risk.

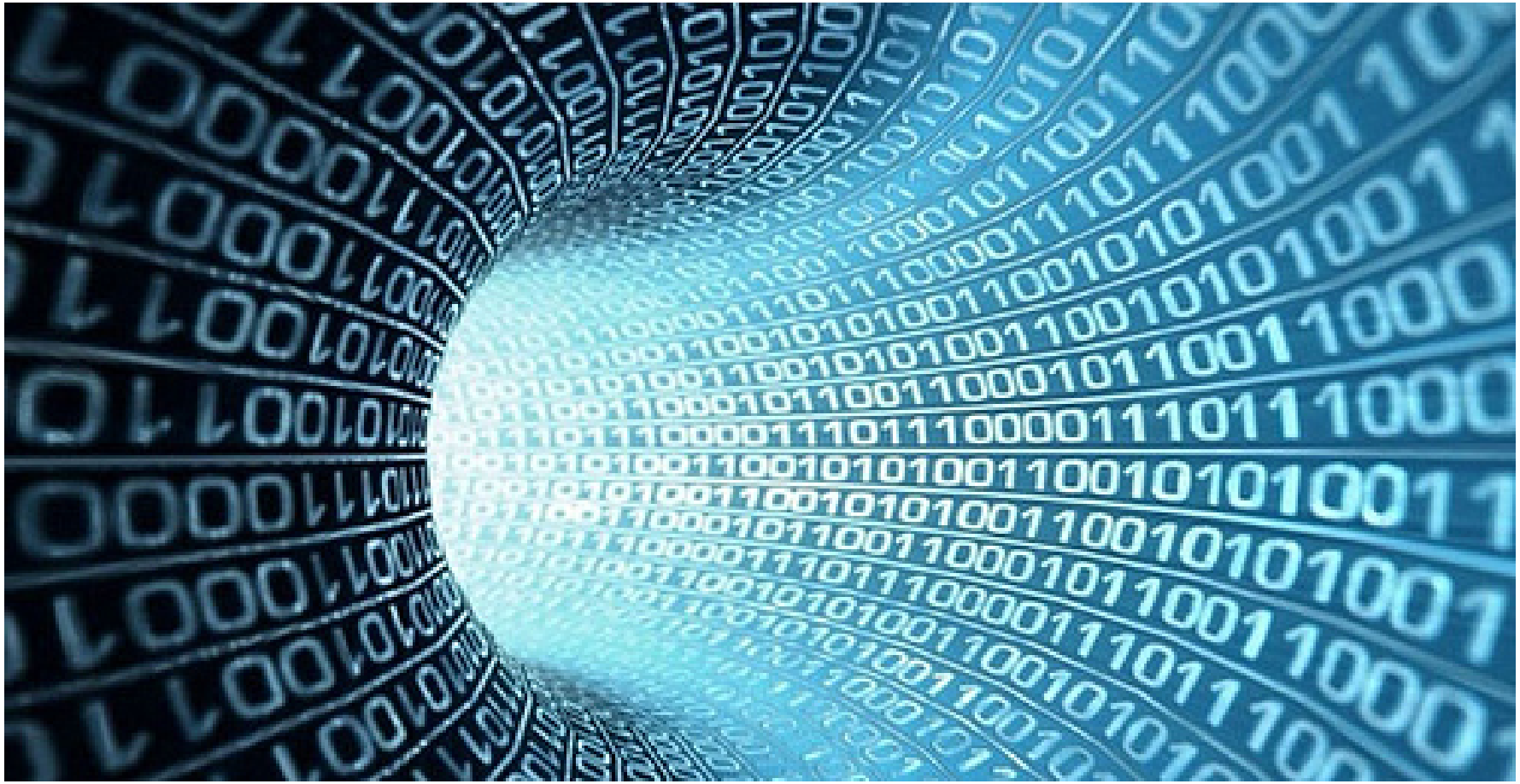


Investing versus Spending

The dollar outlay shifts from productivity losses, repair costs and wasted energy to investments in infrastructure and technology and active monitoring.



The University of Iowa's Journey into Big Data



Energy Control Center

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In 2009 the Energy Control Center was established, serving as a central information center to view all that was happening in energy production, distribution and consumption.

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Business Intelligence: Understand what has happened in the past.

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Building Systems Optimization Hub

Commissioning

Optimization begins with Commissioning.

Our retro-commissioning and re-commissioning efforts have revealed the drift our systems experience over time.

Continuous Commissioning

New building commissioning and re-commissioning efforts are now being viewed as essential first steps for continuous commissioning.

Continuous Commissioning

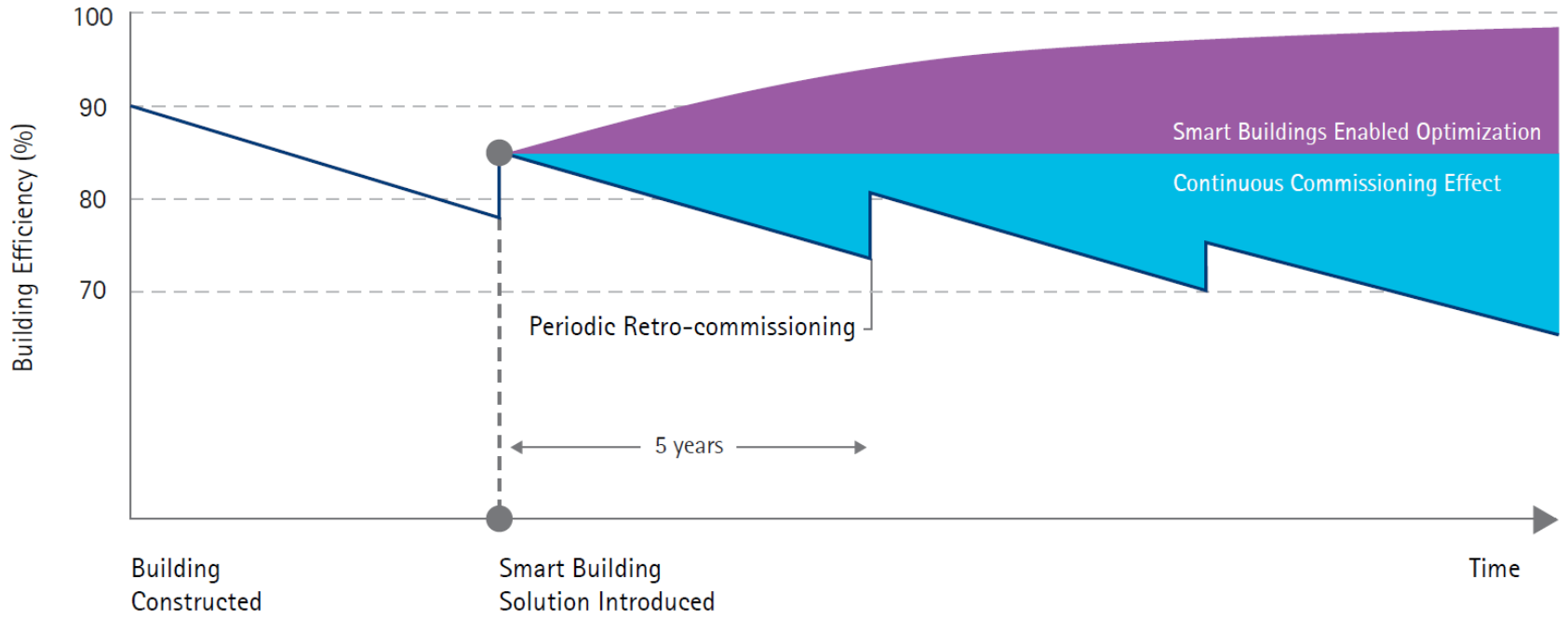
By establishing operating parameters for commissioned or recommissioned buildings systems, we can manage systems drift.

Degradation of energy performance is avoided – and operational performance is maintained.

Continuous Commissioning

Continuous Commissioning Benefits (Illustrative)

Figure 3: Continuous commissioning benefits (illustrative)



Microsoft Smart Buildings White Paper 11/2011

Fault Detection & Diagnostics (FDD)

Iowa's journey in pursuing continuous commissioning led us to Fault Detection & Diagnostics (FDD).

FDD is a used to proactively discover building system problems and identify optimization opportunities before they lead to alarms, excessive waste of resources, occupant discomfort or system failure.

Possible Faults for AHU

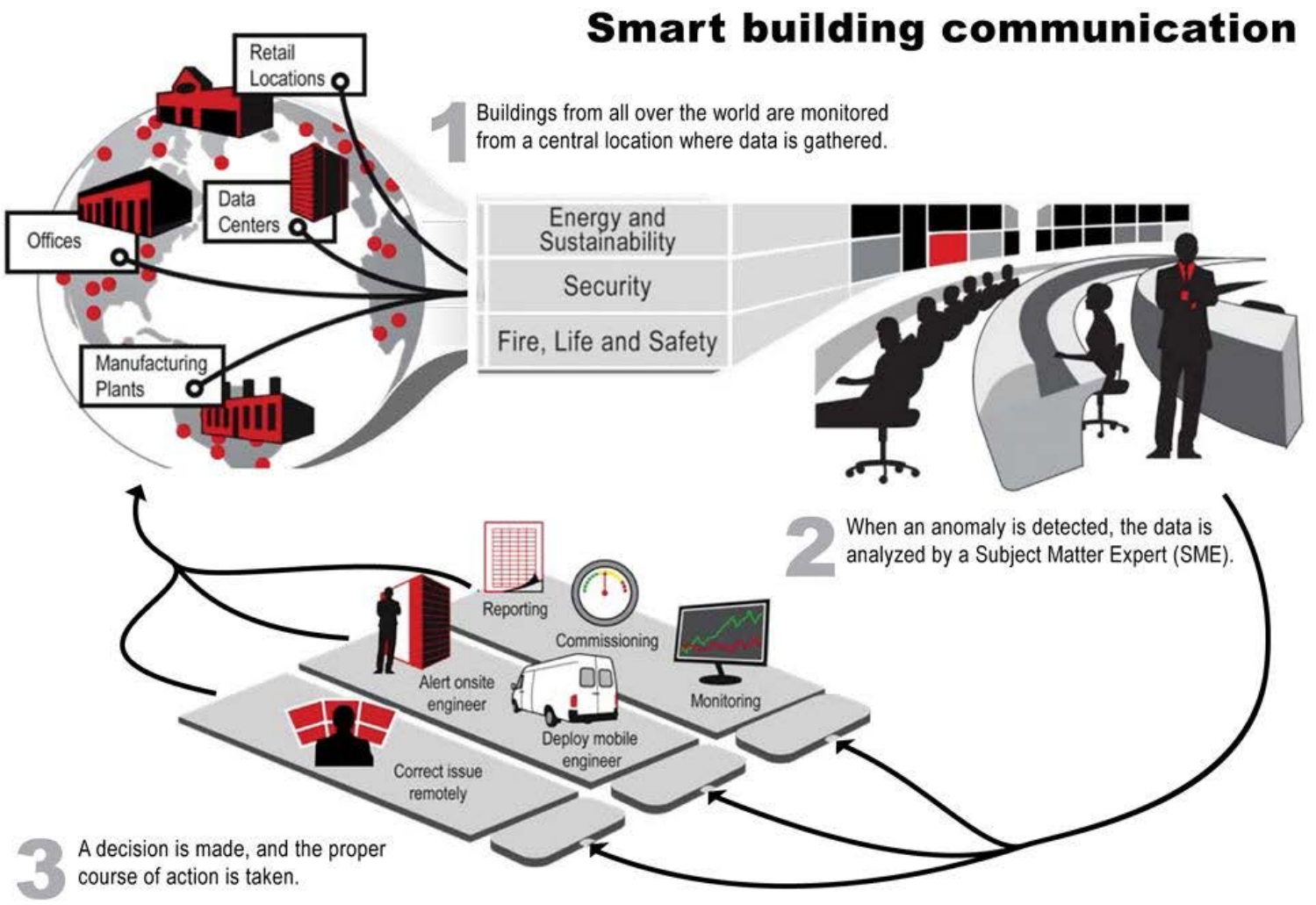
- CHW valve leaking by
- Steam valve leaking by
- Heat rec. running when it shouldn't
- Heat Recovery leaking by
- Simultaneous heating and cooling
- Dirty filters
- Not maintaining static
- CHWS temp too high
- DAT off set point
- Humidification when it shouldn't
- Not meeting humidity set point
- Humidity high limit
- CO2 sensor out of calibration
- Any current senses zero for a fan
- Multiple units running out of sync
- Air flow thru unit that is off
- Ave valve position versus OAT
- Economizer Optimization
- CW valve staging incorrectly
- Ave CHW delta T versus OAT

Responding to Faults

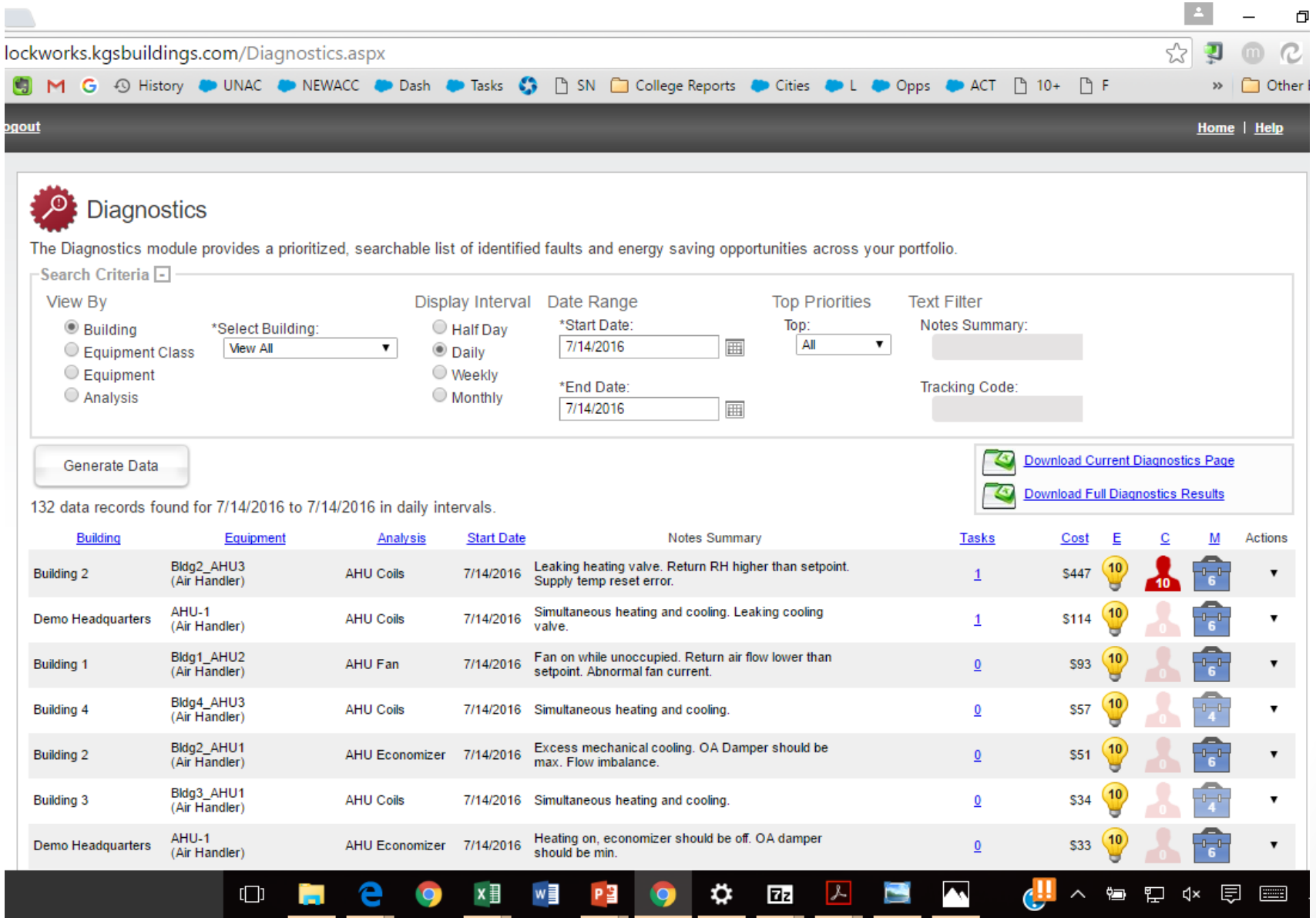
Faults are categorized and prioritized and then responded to accordingly:

- Does the fault indicate a threat to **health and safety**?
- Does the fault threaten **mission critical** functions?
- Does the fault reveal an **ongoing expense**?
- Does the fault impact **performance**?

Responding to Faults

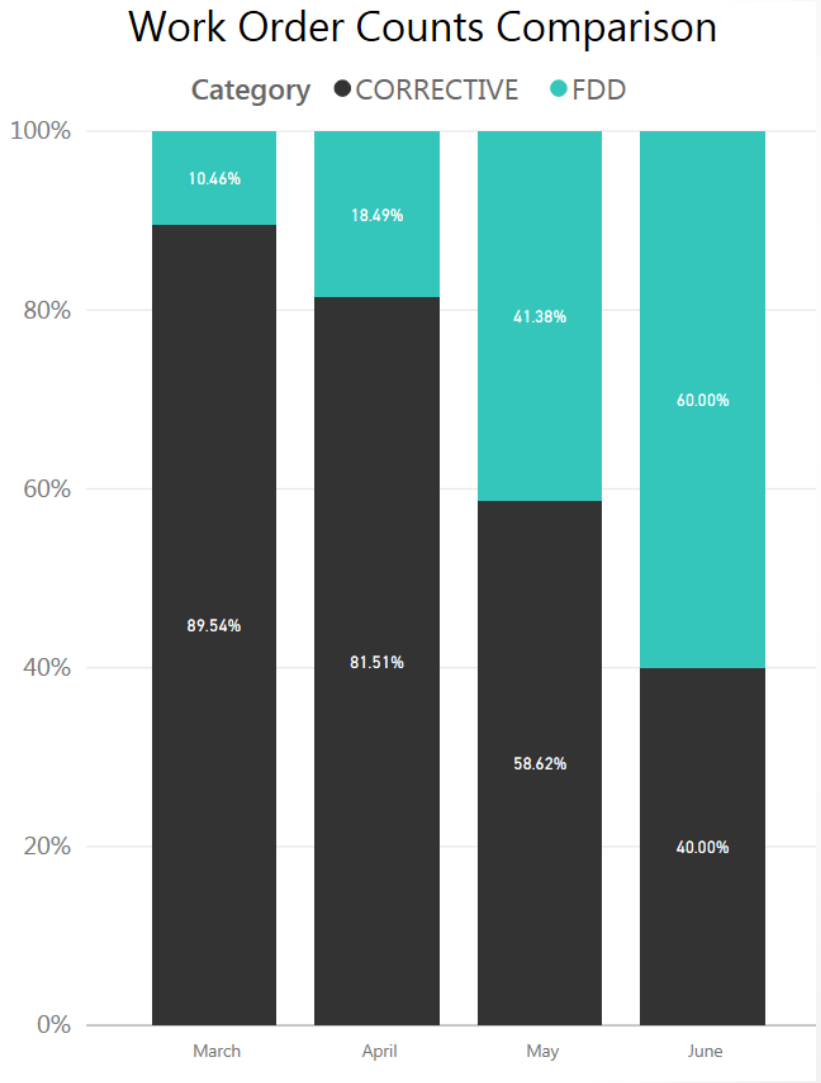


System Level Analytics



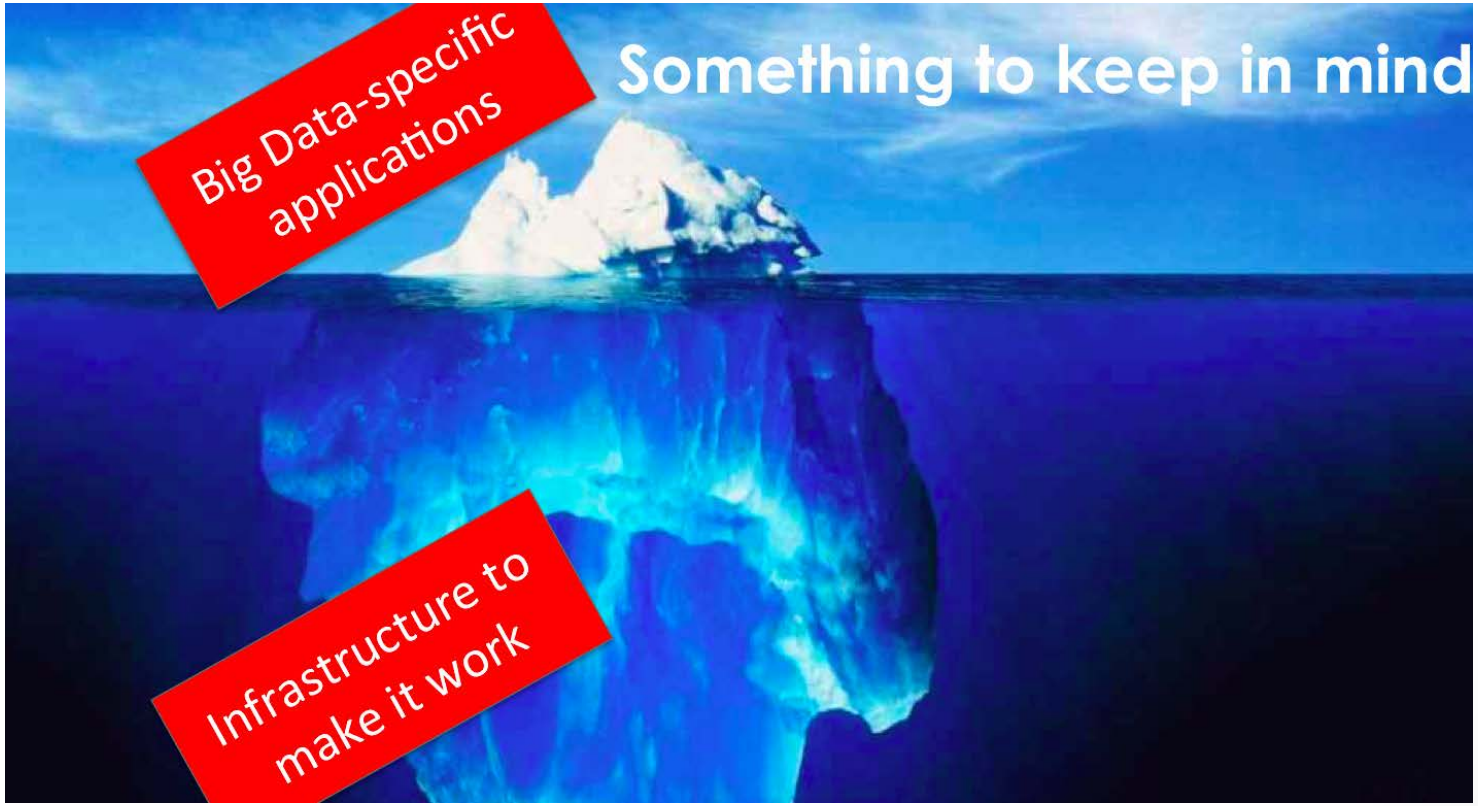
Building	Equipment	Analysis	Start Date	Notes Summary	Tasks	Cost	E	C	M	Actions
Building 2	Bldg2_AHU3 (Air Handler)	AHU Coils	7/14/2016	Leaking heating valve. Return RH higher than setpoint. Supply temp reset error.	1	$447	10	10	6	▼
Demo Headquarters	AHU-1 (Air Handler)	AHU Coils	7/14/2016	Simultaneous heating and cooling. Leaking cooling valve.	1	$114	10	0	6	▼
Building 1	Bldg1_AHU2 (Air Handler)	AHU Fan	7/14/2016	Fan on while unoccupied. Return air flow lower than setpoint. Abnormal fan current.	0	$93	10	0	6	▼
Building 4	Bldg4_AHU3 (Air Handler)	AHU Coils	7/14/2016	Simultaneous heating and cooling.	0	$57	10	0	4	▼
Building 2	Bldg2_AHU1 (Air Handler)	AHU Economizer	7/14/2016	Excess mechanical cooling. OA Damper should be max. Flow imbalance.	0	$51	10	0	6	▼
Building 3	Bldg3_AHU1 (Air Handler)	AHU Coils	7/14/2016	Simultaneous heating and cooling.	0	$34	10	0	4	▼
Demo Headquarters	AHU-1 (Air Handler)	AHU Economizer	7/14/2016	Heating on, economizer should be off. OA damper should be min.	0	$33	10	0	6	▼

Work Order Integration



Big Data Challenges

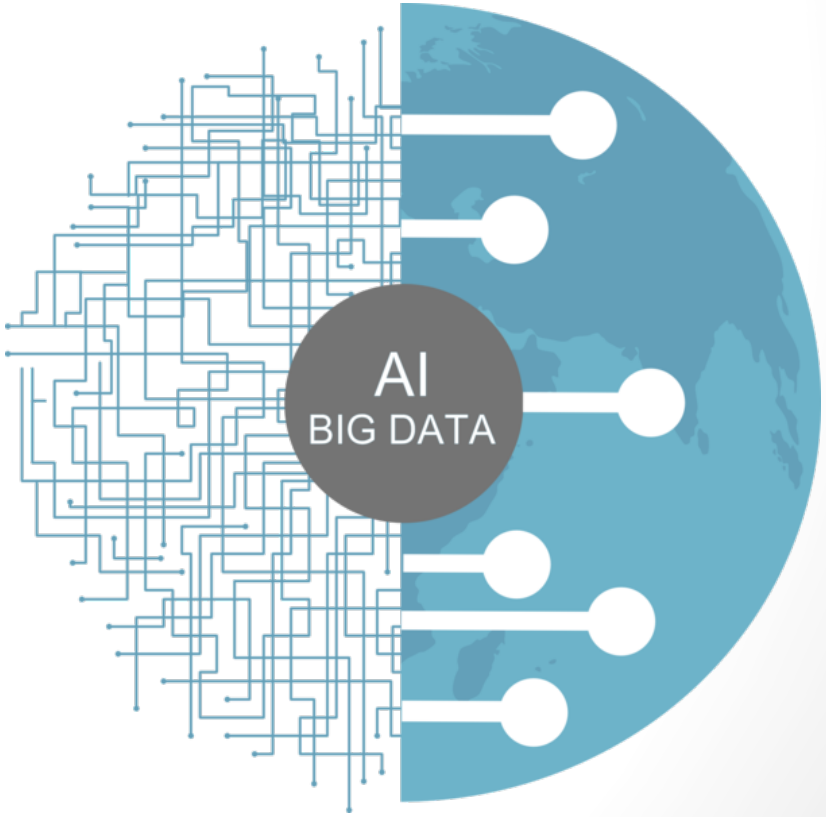
Connected infrastructure



Big Data Challenges

Connected infrastructure

Building the artificial intelligence

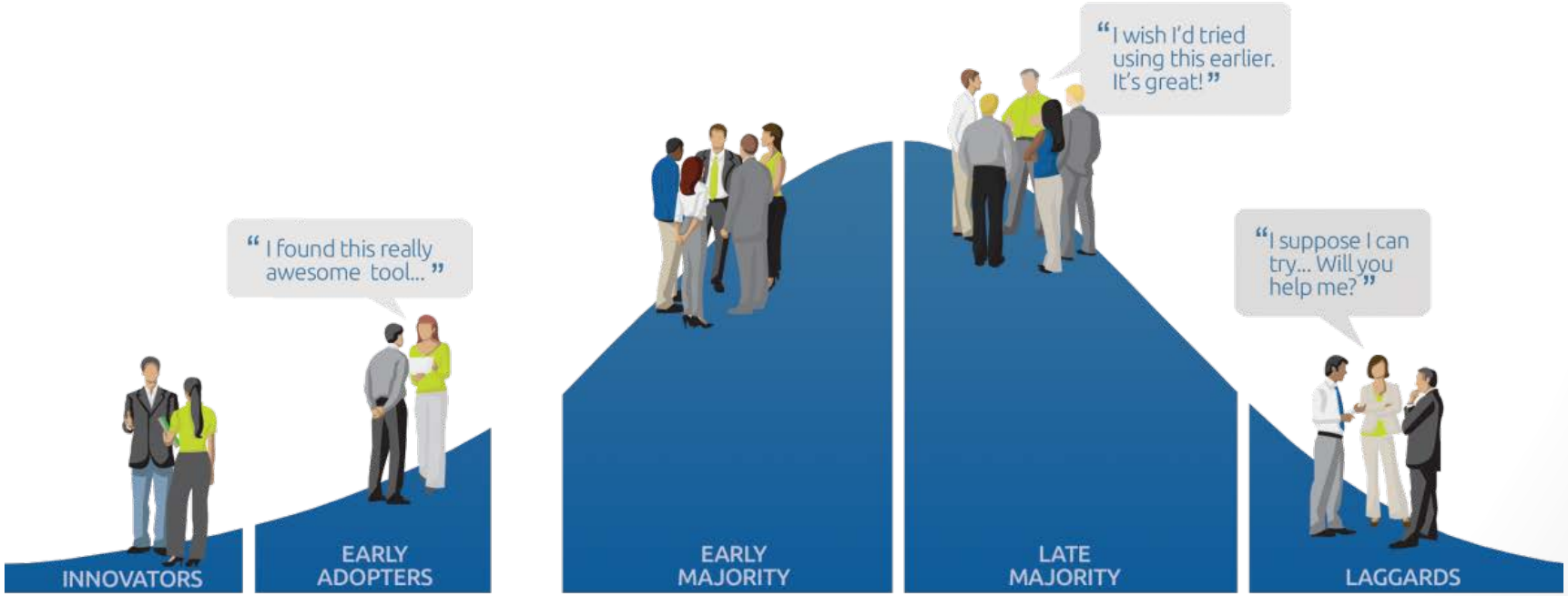


Big Data Challenges

Connected infrastructure

Building the artificial intelligence

Overcoming cultural entrenchments



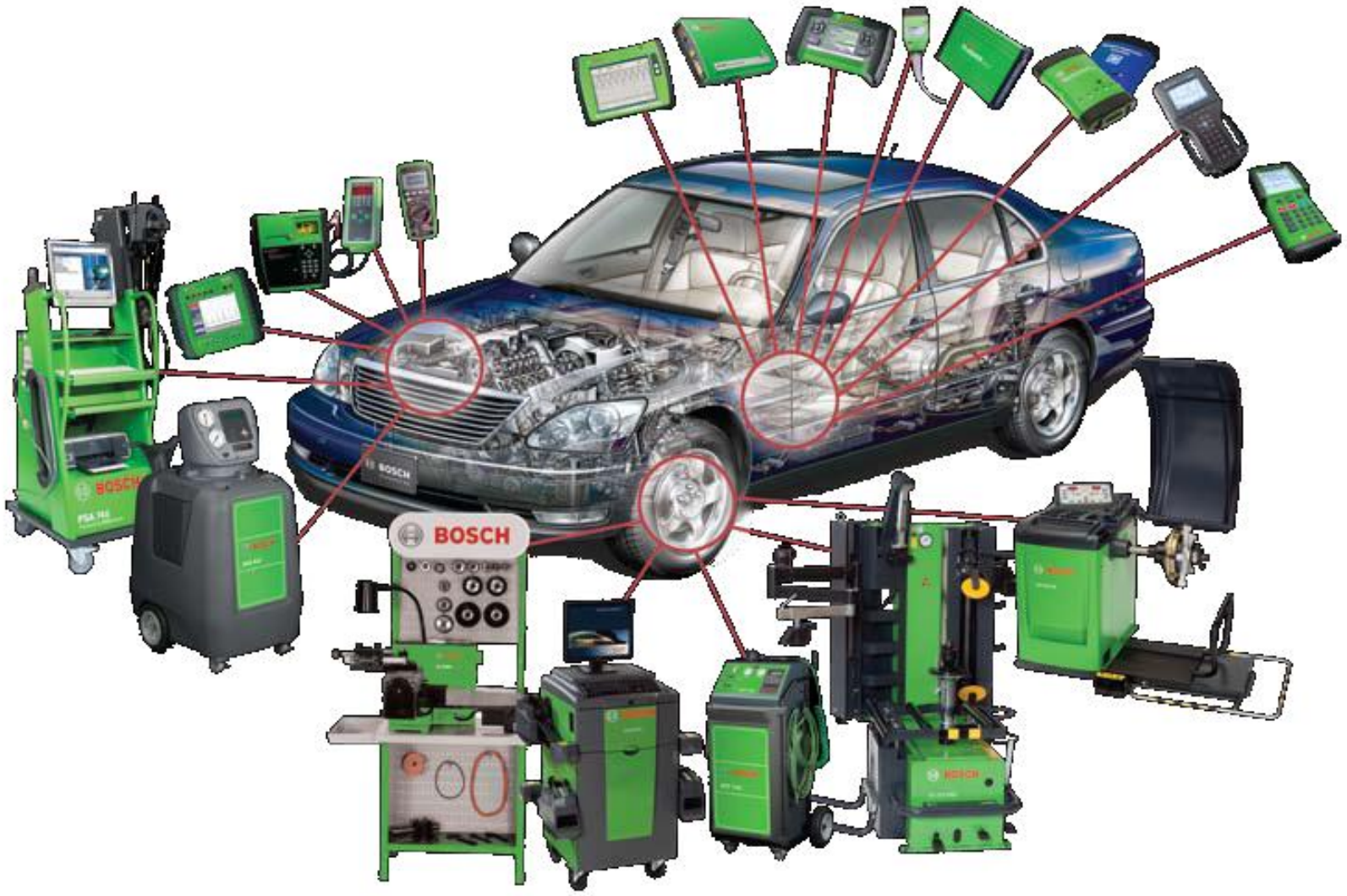
Big Data Challenges

Connected infrastructure

Building the artificial intelligence

Overcoming cultural entrenchments

Workforce readiness


BOSCH

Big Data Driven Megatrends

“If the rate of change outside your organization is greater than the rate of change inside your organization, the end is in sight .”

Jack Welch – former CEO of General Electric

Big Data Driven Megatrends

From operations expenses to capital investments

From mechanics to technicians

From component diagnostics to systems diagnostics

From systems drift to systems hold

From reactive response to predictive response

From managing failures to managing uptime

From institutional knowledge to shared knowledge

From valuing expertise to valuing collaboration


Welcome To
The Future

Thank You

Don Guckert
Associate Vice President
don-guckert@uiowa.edu

Facilities Management
The University of Iowa


APPA
INSTITUTE FOR FACILITIES MANAGEMENT