Data, Metadata & Wisdom.
What can Data Analytics tell us about the Decisions People make?

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Tourism Policy Workshop Nov 18th 2016

E&CE Department of Electronic & Computer Engineering

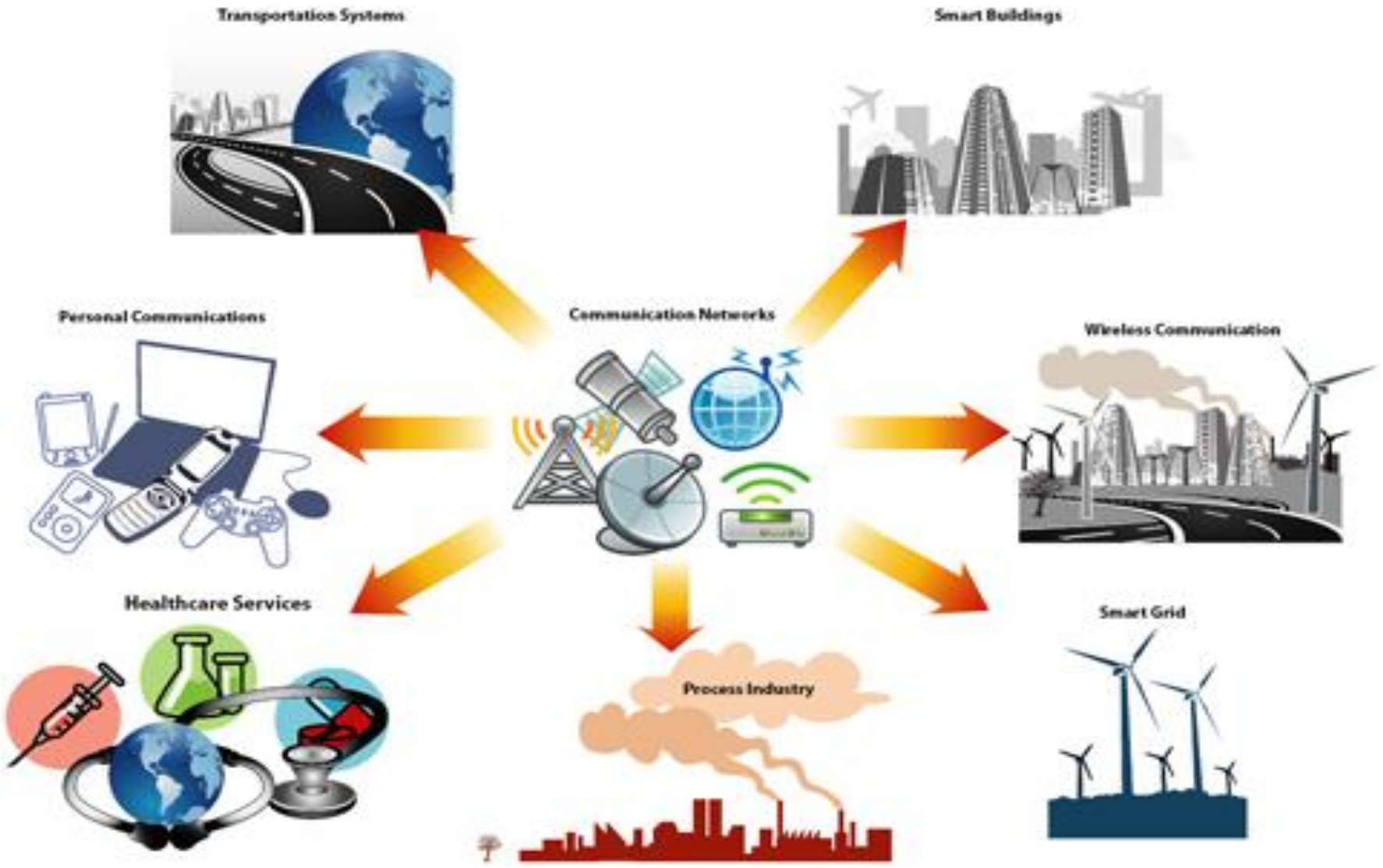
University of Limerick
Ollscoil Luimnigh

Structure of this Presentation

- What is Data Engineering ?
- What Relevance has Data Engineering to the Internet of Things (IoT)?
- Practical IoT Case Studies
  - The IoT Light bulb (Sharepoint)
  - Smart Grid / Energy (ESB)
  - Agriculture (Analog Devices)
  - Sport (Analog Devices)
  - Cognitive Campus/Visitor Attractions (IBM)
- Big Data – Machine Learning
- Big Data based Decision Making Example
- Some thoughts/advice on IoT adoption in the Tourism Sector

What is an IoT \ Data Engineer?

- Computer Engineering?
- Electronic Engineering?
- Data Engineer?
  - It might also be nice to have some application specific skills!!



ActionPoint

DELL

BT

ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™

Cauwill

ESB

RAPID7

IBM

intel

ARCH
Applied Research for Connected Health

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VT NETWORKS

vmware

IDA Ireland

SIGFOX

APPLIED TECHNOLOGY

Hewlett Packard Enterprise

Data Engineering Positions advertised by these companies in 2015/6

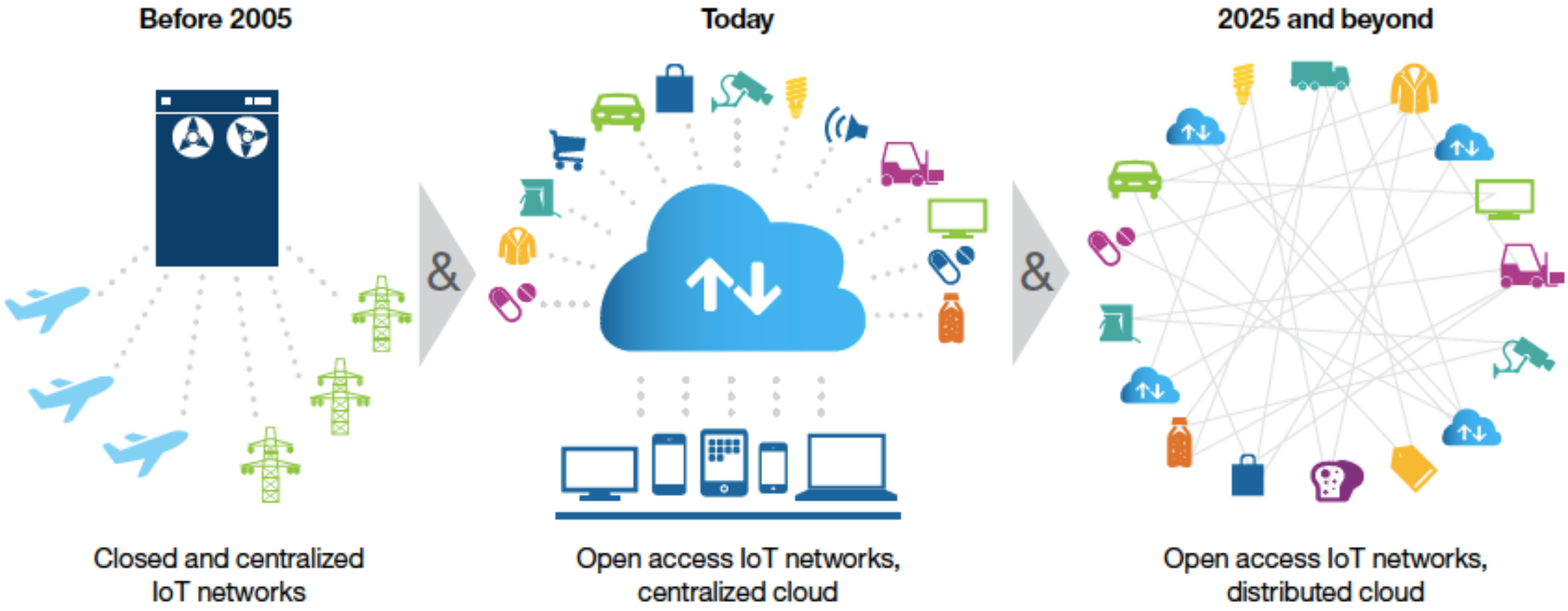
- Data Engineer
- Data Scientist
- Data Analyst
- Data Architect
- Data Visualization
- Data Mining
- Data Wrangling / Munging
- Data Scraping
- Data Cleansing
- Data Plumbing
- Data Warehousing

Management Challenge :
How to avoid being dragged into the weeds of technical detail?

What is Data Engineering?

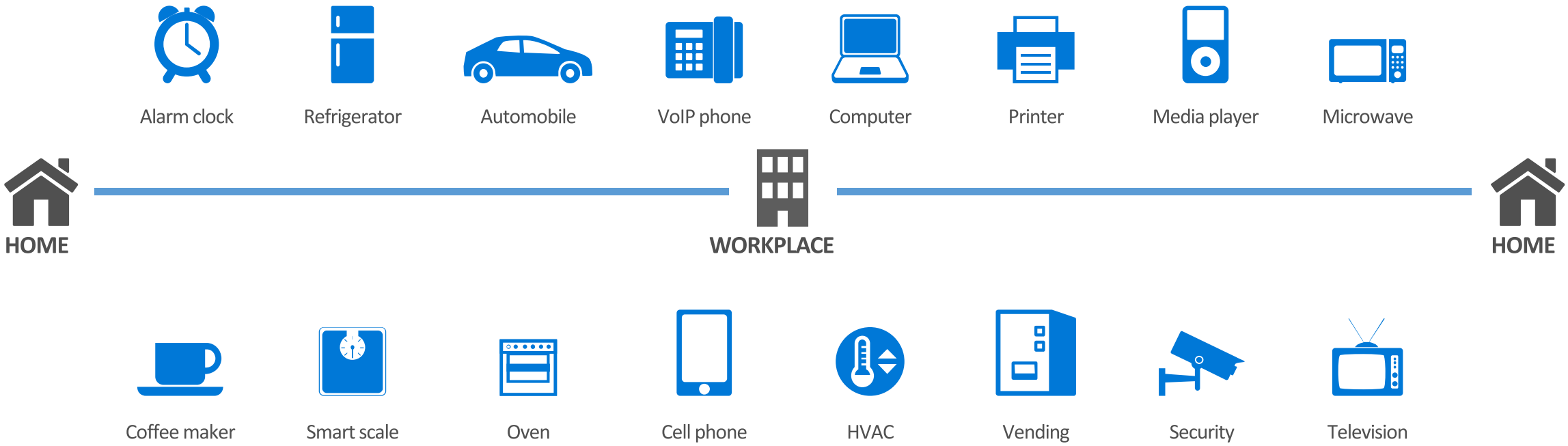
- Data Engineering / Data Science
- "The exploration and quantitative analysis of all available structured and unstructured data to develop understanding, extract knowledge and to formulate actionable results"
  - Edx / MITx Data Science Essentials MOOC
- Metadata is some subset of the Raw Data set that it is hoped imparts more Information and Knowledge
- Data science asks how much useful information can be derived from such a dataset?
- Data Engineering asks how a metadata set can be constructed so as to maximise the utility of this information.
- Data Engineering also attempts to 'close the loop' – make decisions on the basis of data. How do we get more 'good' decisions?
- We will consider a Sports based example of this later.

How has IoT evolved and what will it look like?



- Machine-to-Machine (M2M) Technology
  - Objects that connect themselves to the Internet with sensor-embedded devices are commonly referred to as the *Internet of Things* (IoT).

Evolution of IoT (The World in 2011)



IoT in 2016

Medication adherence

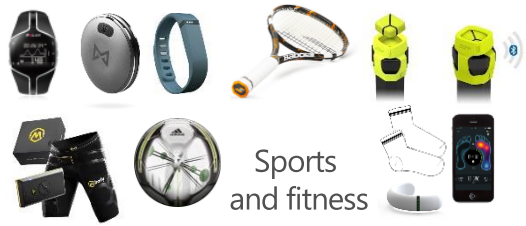
Health monitoring

Pet tracking

Behavior modification

Object tracking

Child and elder monitoring


Sports and fitness

Smart lighting

Indoor navigation

Beacons and proximity

Trip tracking and car health

HOME — **COMMUTE** — **WORKPLACE** — **COMMUTE** — **HOME**

Smart appliances

Food and nutrition tracking

Identity

Office equipment

Smart vending machines

Bike ride stats and protection

Sleep tracking

Air conditioning and temperature control

Environmental sensors

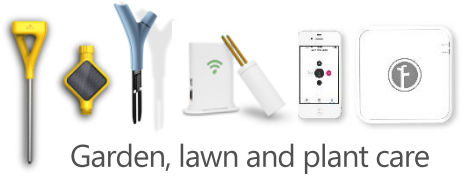
Information capture

Control

Home security

Home automation

Leak detection


Garden, lawn and plant care

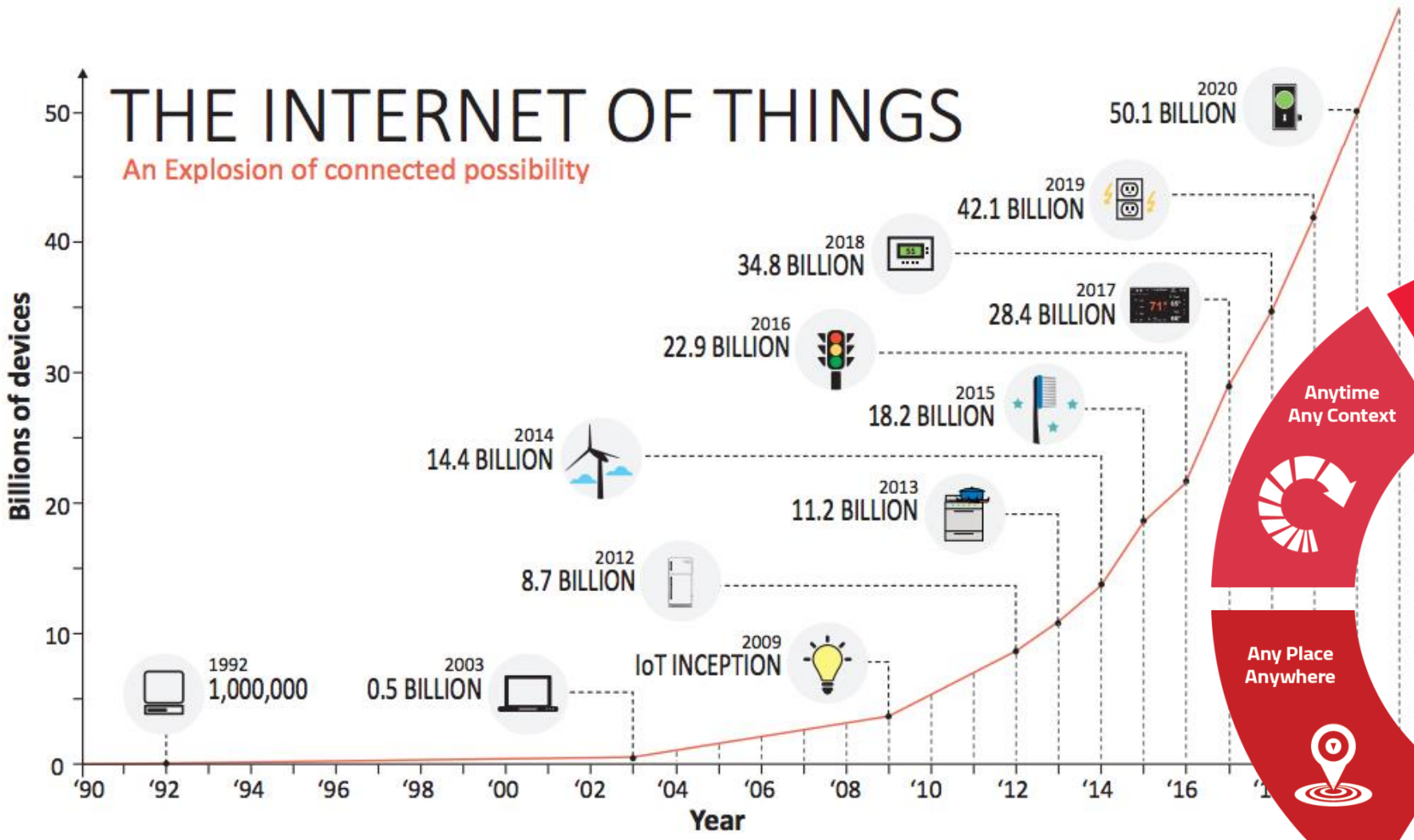
New devices and sensors

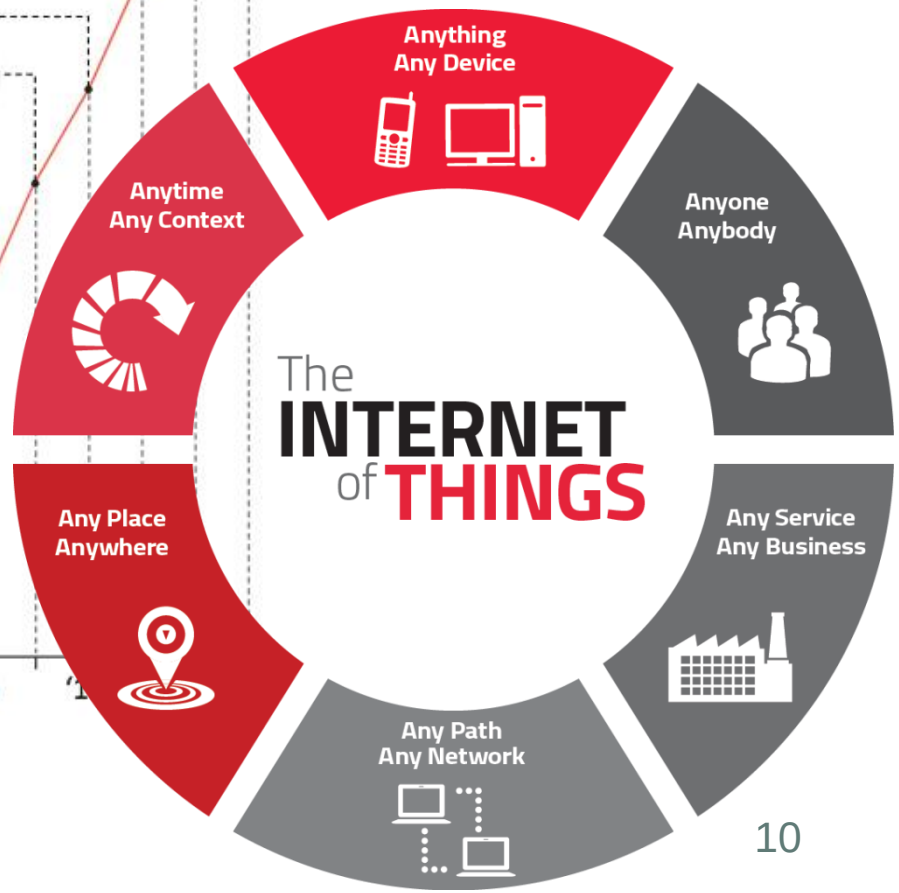
Entertainment systems

IoT History

1999
The IoT Gets a Name

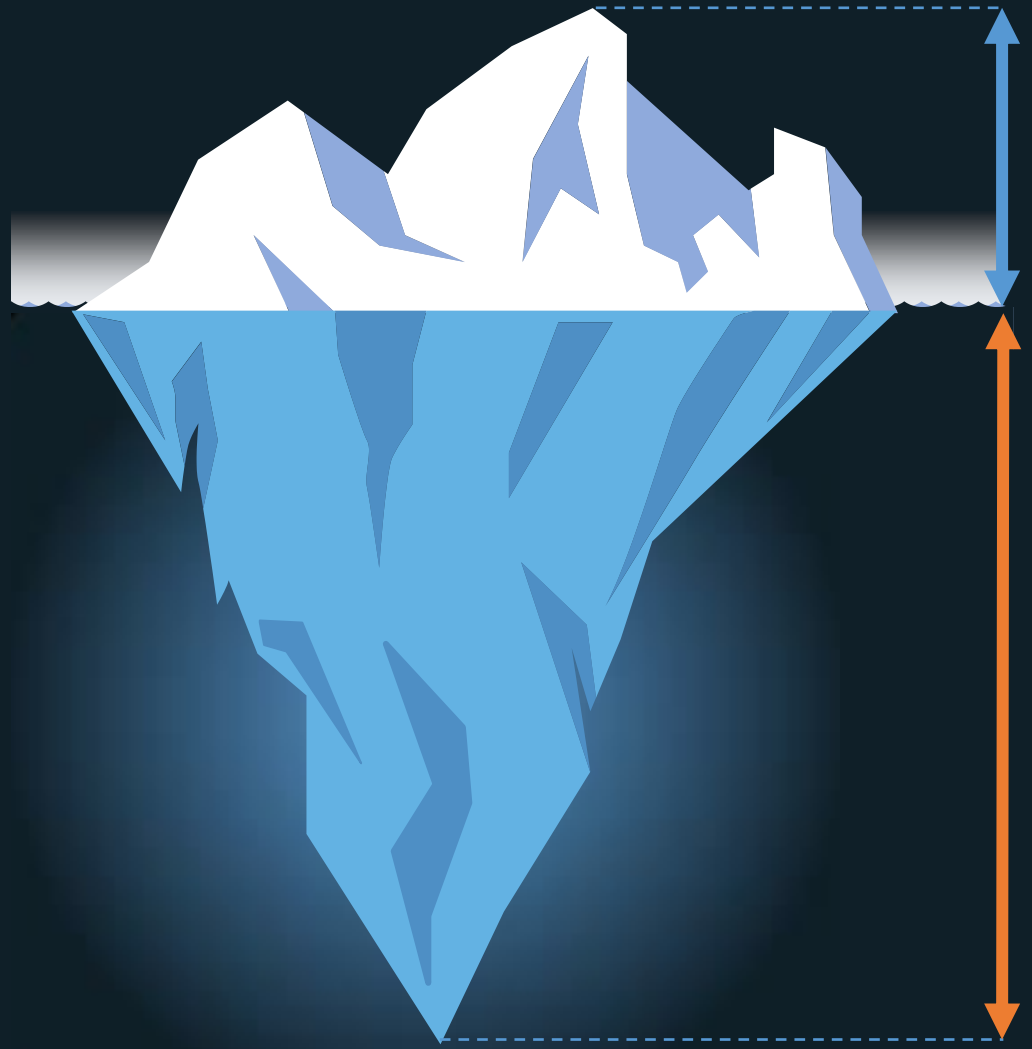
Kevin Ashton coins the term "Internet of things" and establishes MIT's Auto-ID Center, a global research network of academic laboratories focused on RFID and the IoT.





Hewlett Packard Enterprise

The Dark Side of Big Data



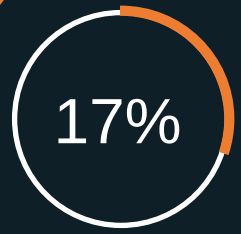
USED DATA

DARK DATA

sensor data that is never utilised

Analysis tools not setup

No analysis of unstructured data



Tools can't make sense of data

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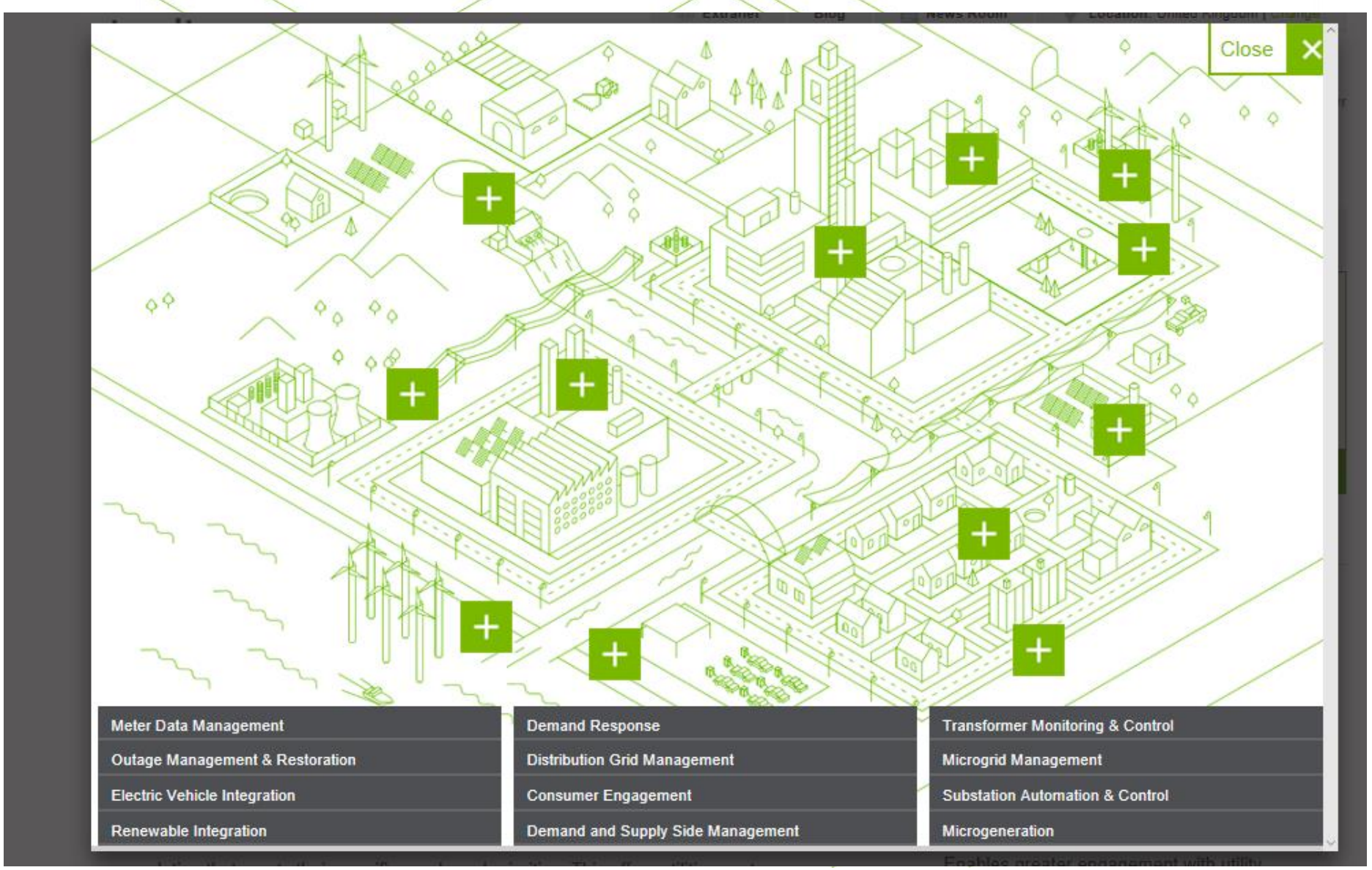
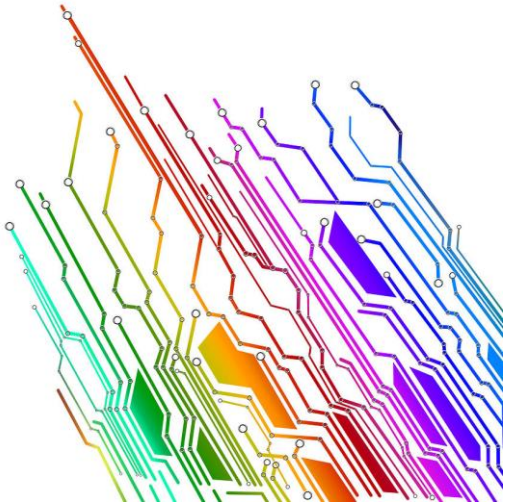
Smart Grid Applications - www.landisgyr.co.uk/gridstream-solutions/



Energy for generations

2016 Design Challenge

- IDA ‘connected’ industrial estate.
- Shared/co-operative Heating & Lighting
- Retrofit ‘smart’ solar PV panels to existing roof structure
- Smart Meter Connectivity
  - ‘Nest’ thermostats
- Tesla Powerwall deployment
- Smart , Connected Storage Heaters (Glen Dimplex)
- ESB Vehicle charging points
- High Speed Fibre Optic Network – SIRO



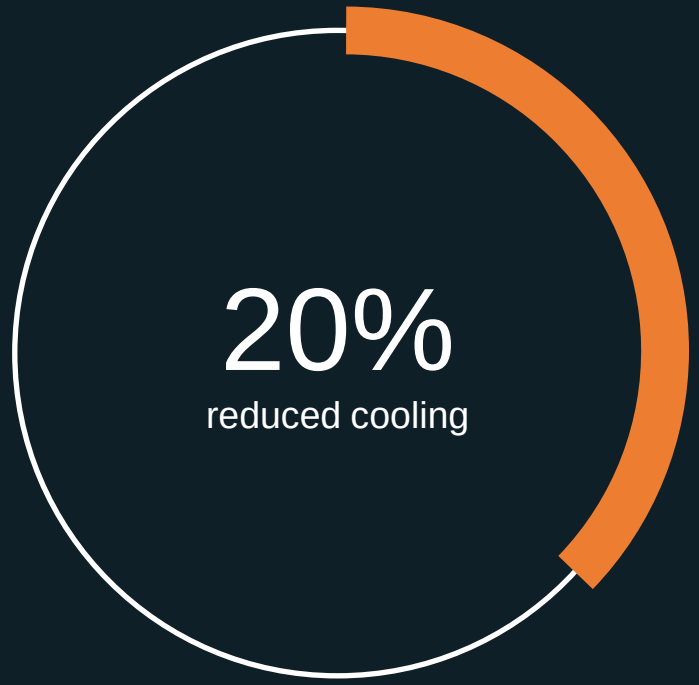
Example – Tesco Ireland

- Tesco invested strongly in monitoring infrastructure within stores to make them more energy efficient
- The collected data was so big that they did not know what to do with it
- IBM Research helped them to analyze their data and identify saving potential

160
Stores

110.956
Data Objects

678 TB
Data per annum



25 million Dollar savings per annum

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IoT Light Bulb Example

- With thanks to John Savage - Action Point
- An IoT app is required for a Lightbulb – Pretty easy 'toe in the water' introductory example to illustrate what's involved…
- Undergraduate Computer Engineers can design the Hardware,
  - LEDs,
  - DC-DC Converters,
  - Power Control,
  - IoT Socket.
- IoT app ..and we're done – How much will all this cost ?

The commercial reality behind the “Bright” Idea

Development Costs
Platform Choices
(Desktop, iOS, Android etc.)
Architecture Design
UI/UX Design
Development
Testing

Operational Costs
Server/Storage
Infrastructure
Support
Updates

IOT Device Management
Connectivity (WiFi, BLE, Sigfox, Zigbee)
Logistics
Manufacturing
Provisioning
Field Engineering Support
Billing Engine

Customer Service
Support
Device & System Updates

Roadmapping
MVC vs Go-live vs future enhancments

So how do you budget for this?

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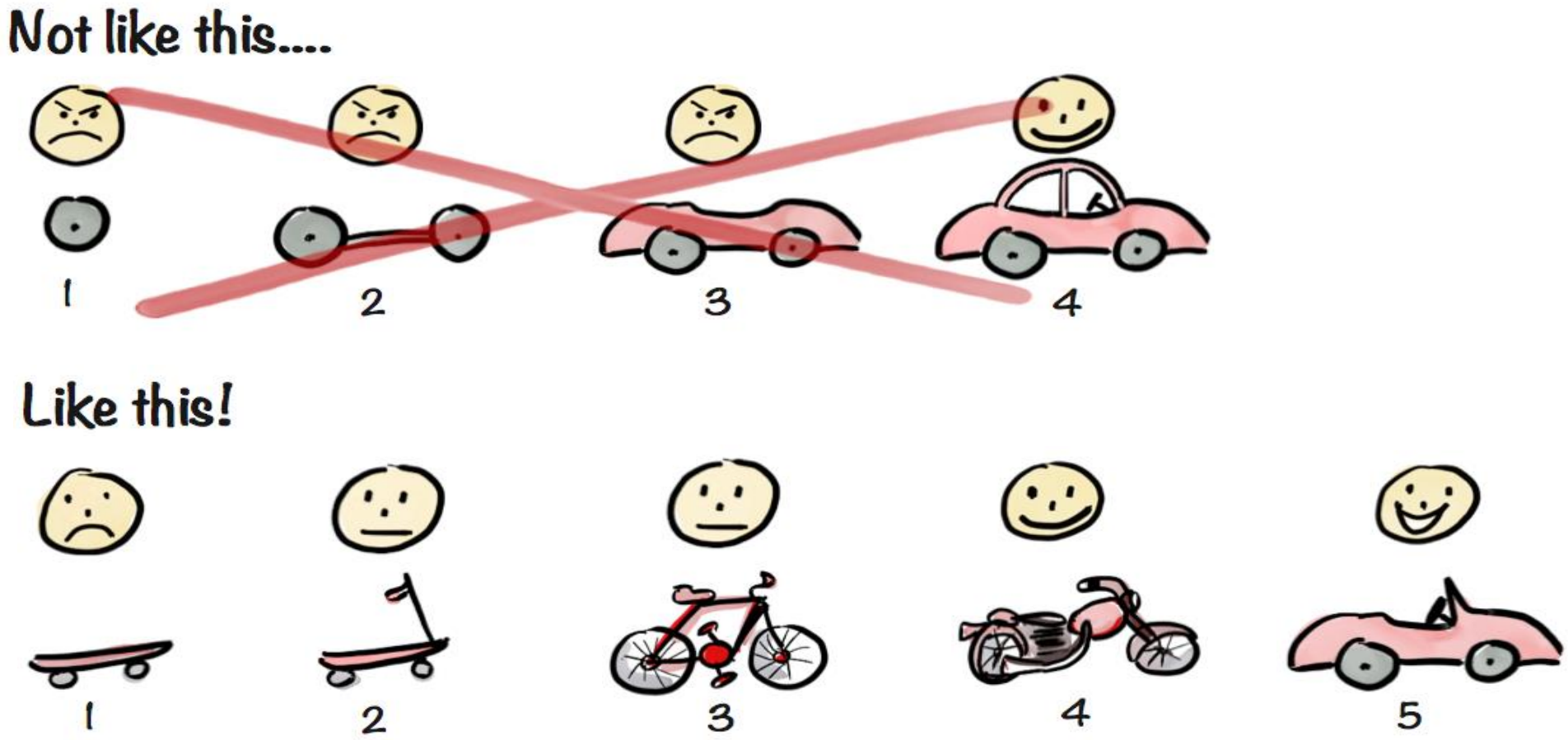
IoT Light Bulb Example – Incrementalism is Key!!



First Responder Example - Analog Devices

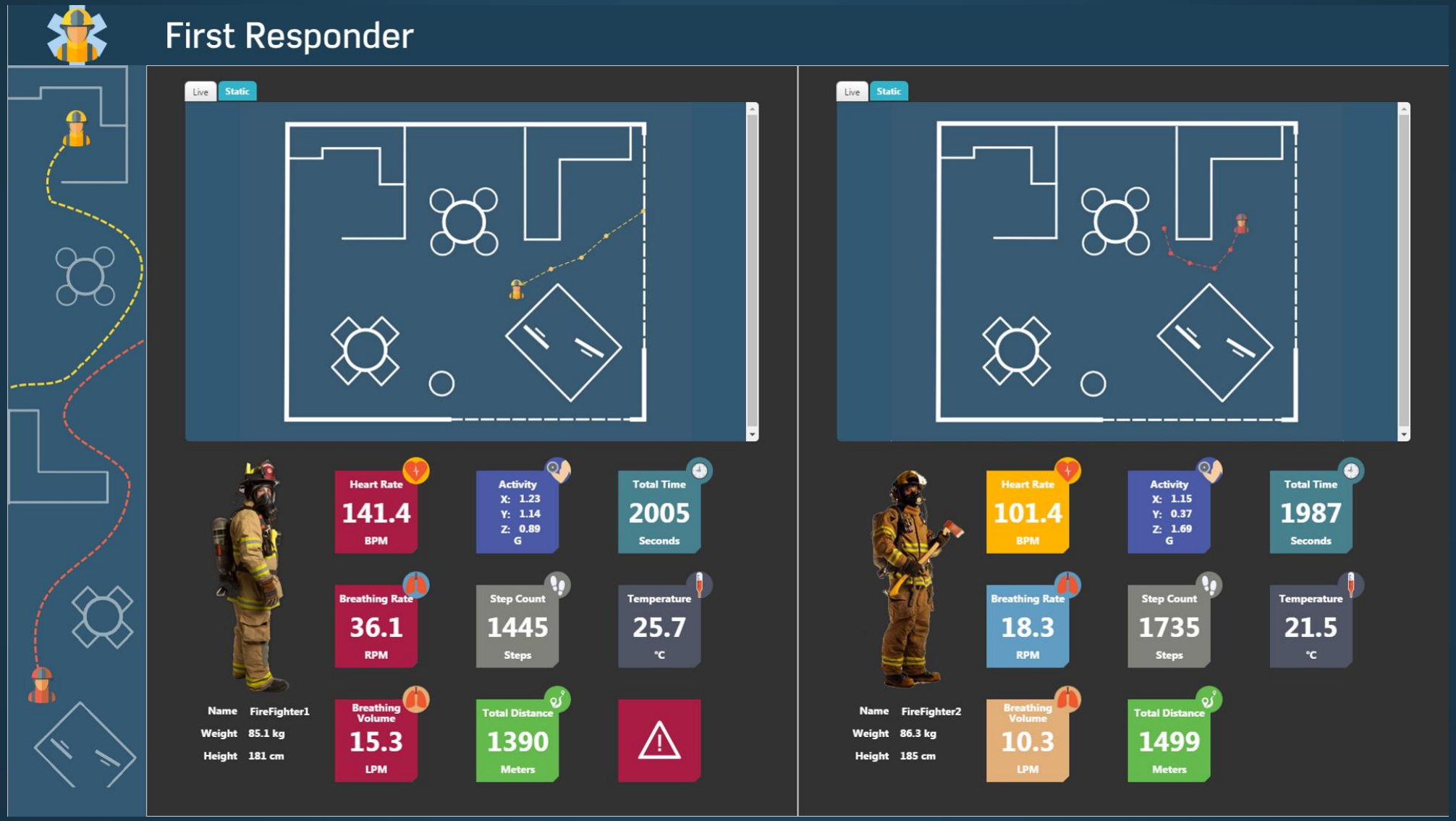
Central Hub
- UWB **Radio Ranging** Reference Anchors
- Main computer/ central processing

Arm Unit
- UWB Radio Ranging Tag
- Bluetooth Radio
- Comm. to Hub
- Battery

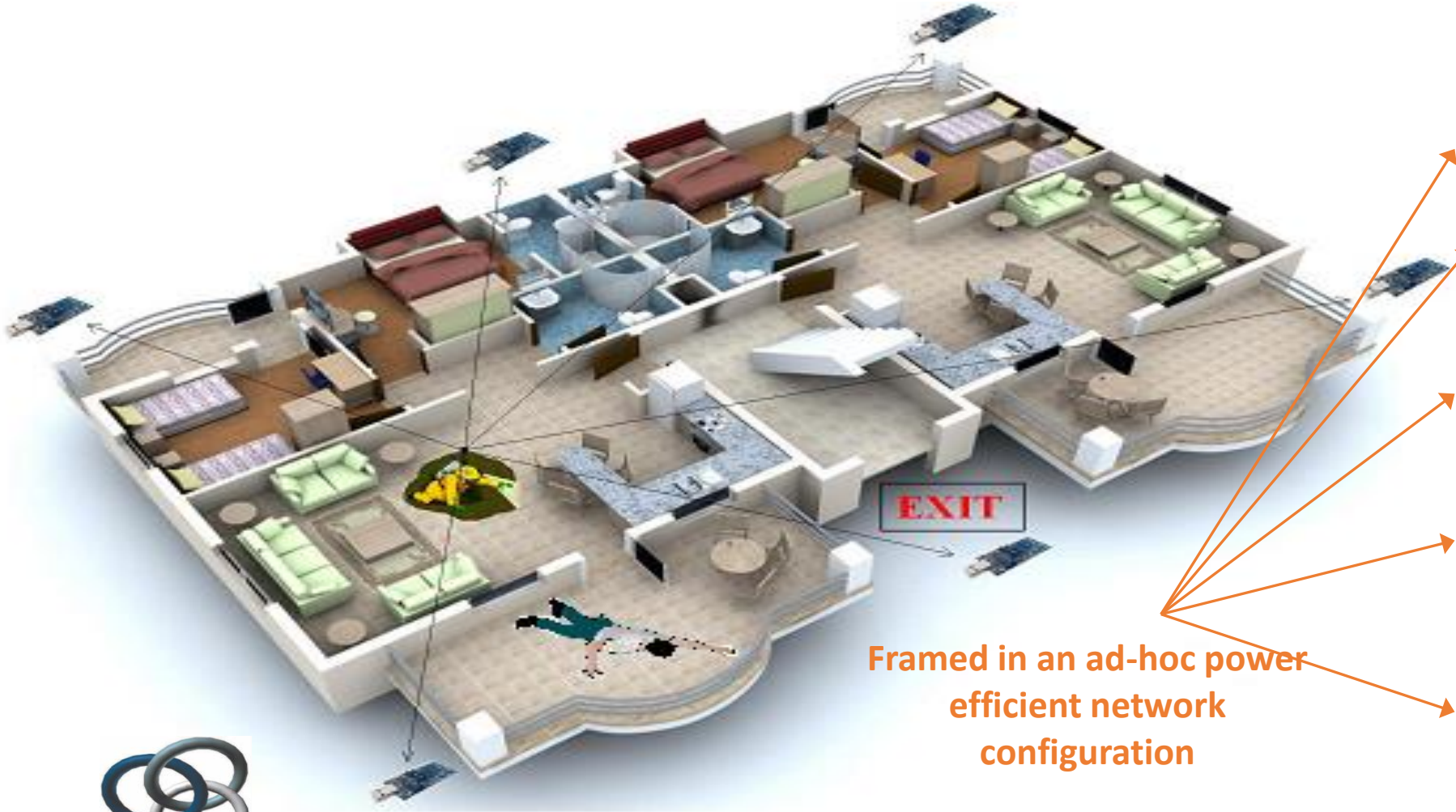
Boot Module
- High Performance IMU
- Processor Board
- Bluetooth Radio
- Battery

GPS Fix + Radio Ranging + IMU + SLAM software delivers Sensor Fused “Holy Grail” Solution

First Responder



First Responder Example – How is Decision Making Improved?



– Localise rescue worker position

– Monitor structural integrity

– Access temperature in each room in the building prior to entry

– Communicate a possible escape route to rescue worker

– Observe injured parties vital signs

Inform (NOT make!) decision regarding who to treat first)

Framed in an ad-hoc power efficient network configuration

THE INTERNET OF TOMATOES

SENSOR NODE: → **MEASURES**

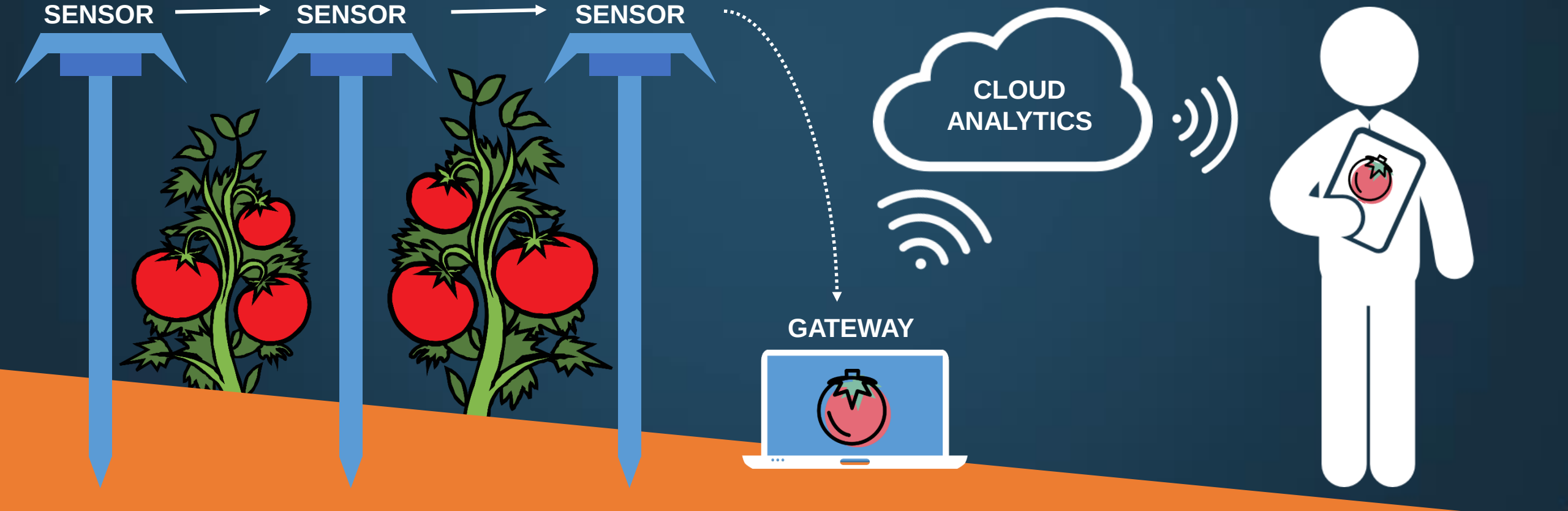
Sensing | Processing | Connecting — **Motion | Light | Temp | Humidity**

FROM SEED TO SIGNAL

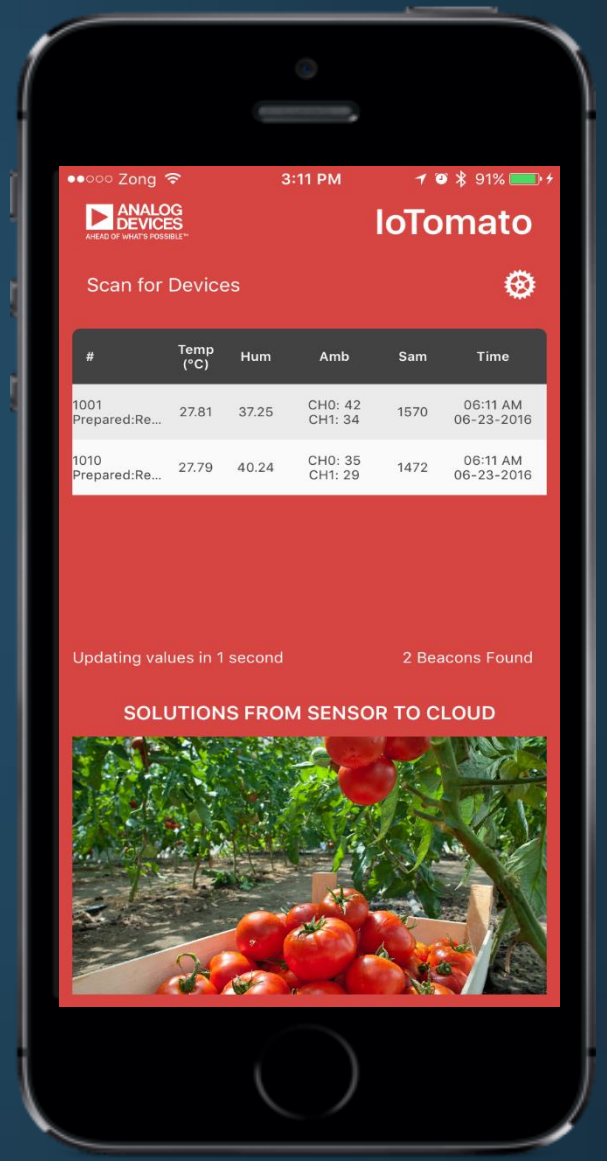
Analog devices' technology measures growing conditions and aggregates to a remote gateway.

FROM FIELD TO FARMER

Information is transmitted to the cloud to be analyzed and shared remotely.

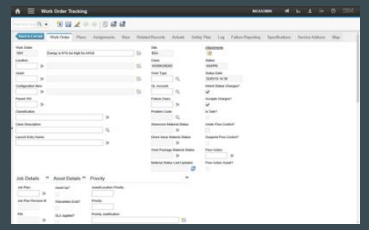


FIELD TO FARMER



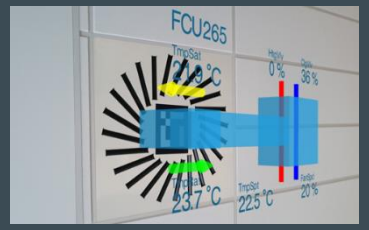
CLOUD ANALYTICS

The Cognitive Campus / IoT Attraction - Various Opportunities and Challenges



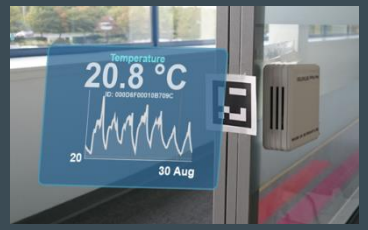
Digital Asset Lifecycle

The manual input of data into a maintenance system for thousands of assets is a costly, error prone process.



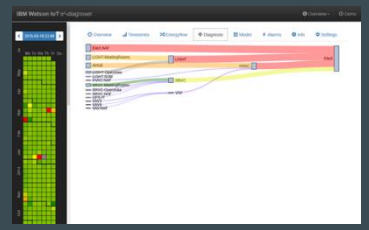
Real Time Asset Location

Finding assets and their relevant data is challenging, in particular when you are in the field.



Cognitive Asset Health

Predictive and preventive maintenance are imminent to reduce operation costs, but, lack the required sensors.



Self-Learning Energy Diagnoser

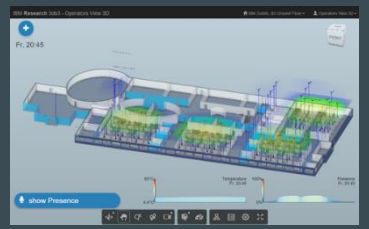
Energy consumption has many influences and it is hard to detect and diagnose abnormal consumption.

Cognitive Concierge

Guiding people to their rooms and answering their questions is a central requirement of hospitality.

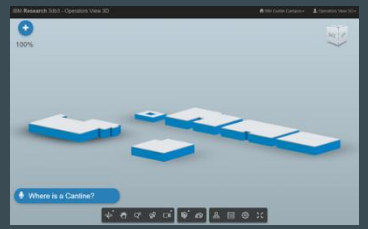
Semantic Insights

Analyzing thousands of IoT devices cannot provide meaningful insights without a semantic method.



Fluid Spaces

The lack of real-time occupancy information within a building inhibits effective energy and space performance.



My Cognitive Campus

Increase productivity of teams by providing a comfortable environment and easy navigation.

My Artefact

Maintaining the perfect environment for art galleries and museums is critical.

Scalable IoT Platform

Cognitive Buildings require a highly scalable platform for data integration and analysis.

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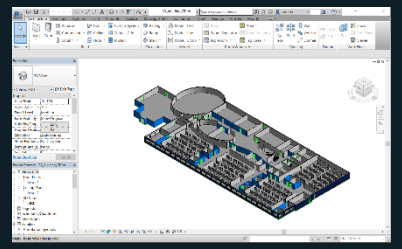
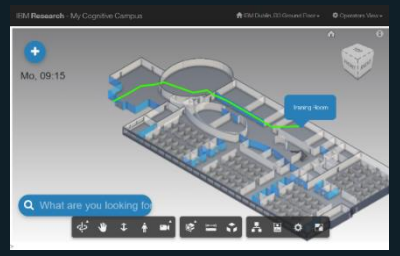
Cognitive Concierge

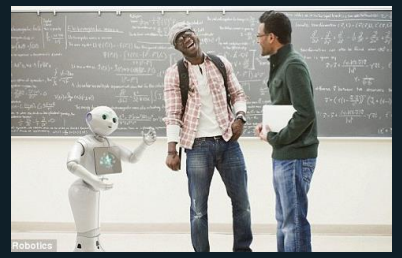
BIM Geometry



Find path



Guide People



Localize Robot

Presence Insight

Speech to Text

Text to Speech

Environment Highlights

Insights for Twitter

Natural Language Classifier

Dialog

INSTRUMENT

INTEGRATE

LEARN & REASON

INTERACT

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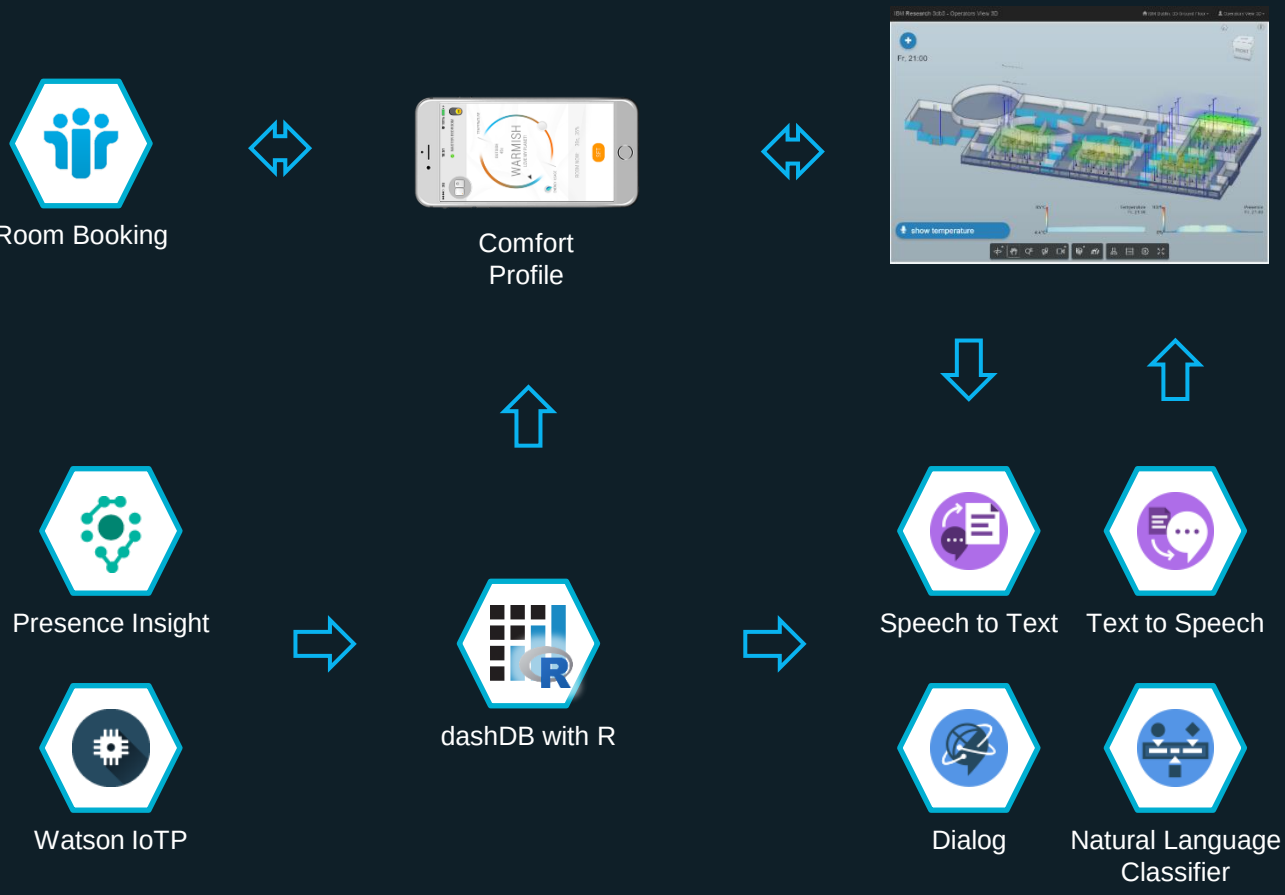
How can the Cognitive Campus concept add value to an attraction?



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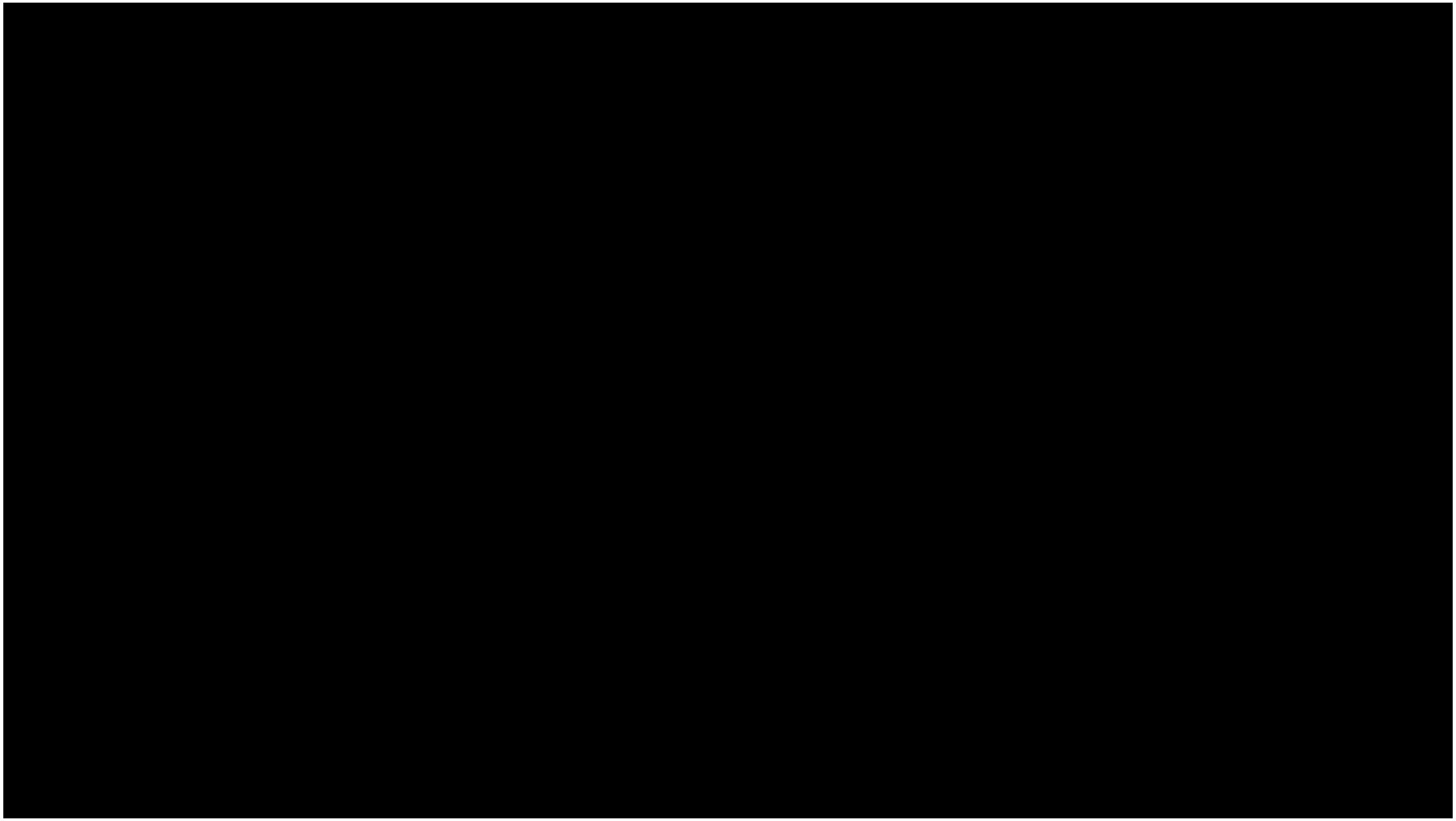
Decision Making – Coping with Humans (IBM)



Closing the Loop - Decision Making

- Big Data analysis requires a brain—a central analytics hub, to make decisions.
- Data scientists and model builders can build this hub. Accessing such talent using an outsourcing model is probably the most sensible option for tourism enterprises.
- An enterprise will therefore need "translators," people able to connect the needs of the business with the technical skills of the modelers/analysts.
- The well established co-operative competence centre idea can help small enterprises pool resources and derive benefit from IoT.
- Investment should be in intuitive highly relevant tools with easy-to-use interfaces that can help frontline/front of house managers integrate data into day-to-day processes.

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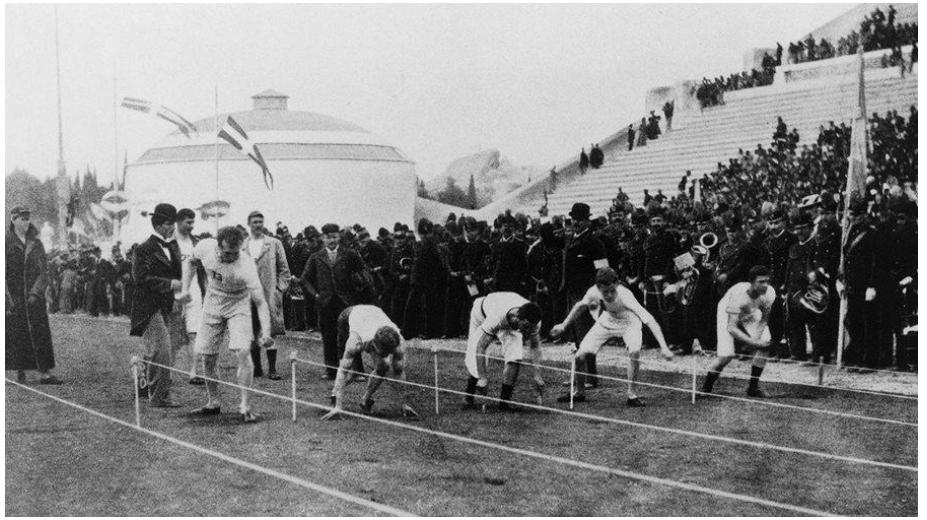
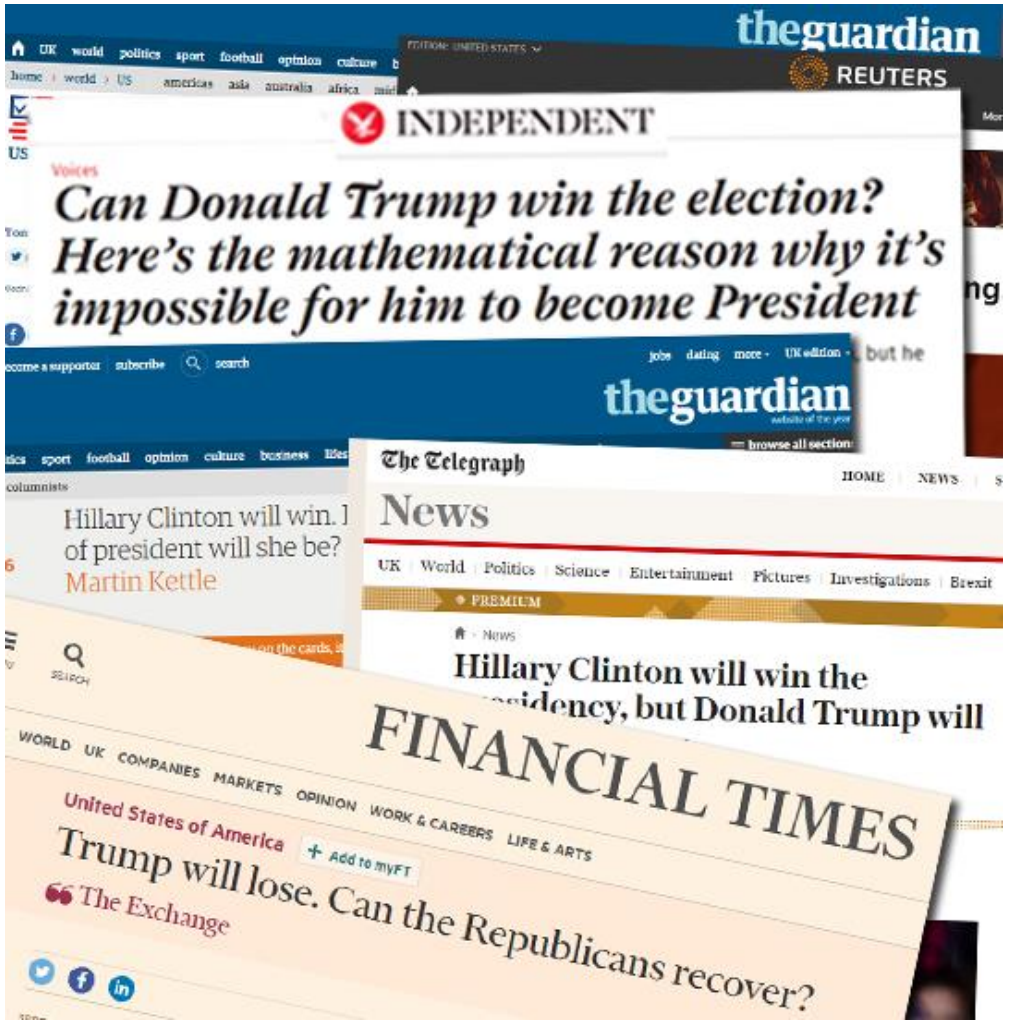


Closing the Loop - Decision Making

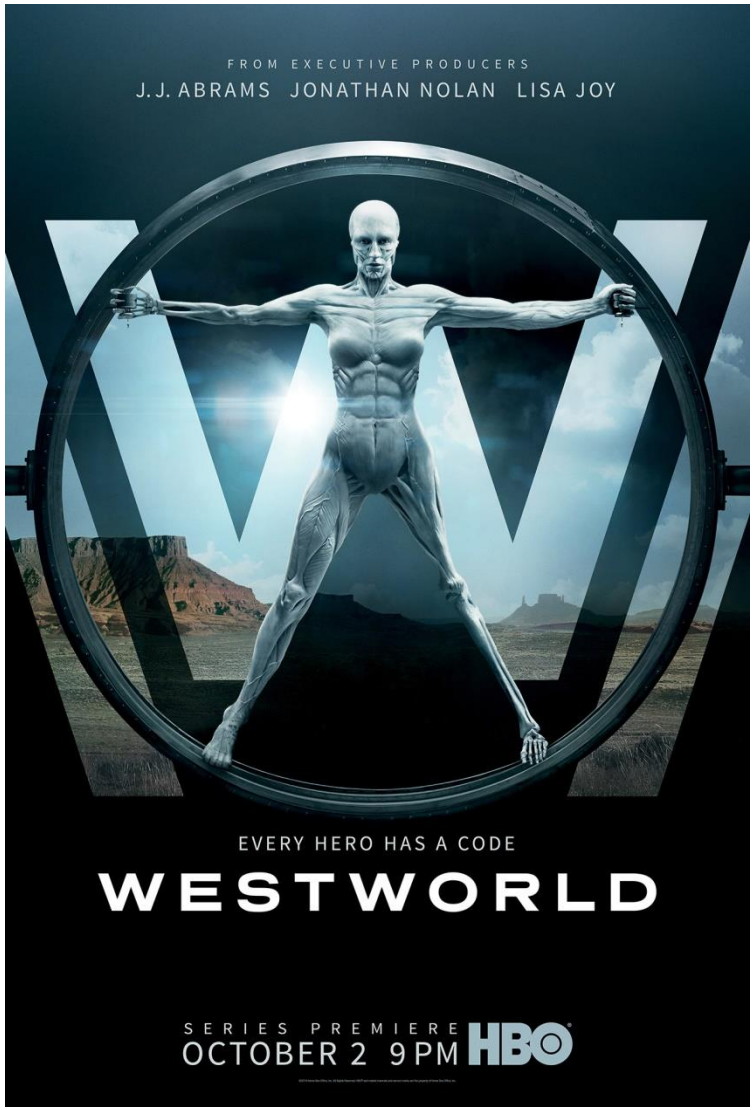
- Thus far data and analytics based Decision making incorporates machine learning, artificial intelligence and requires significant Human involvement
- Best practice thus far has neither been humans or machines alone, but rather humans working in tandem with machines.
- Movement beyond big data to“soft AI” systems, such as IBM’s Watson. Such systems are capable of taking on more and more of the tasks that human labour used to conduct.
- Health warnings apply!



Big Data Based Decision Making

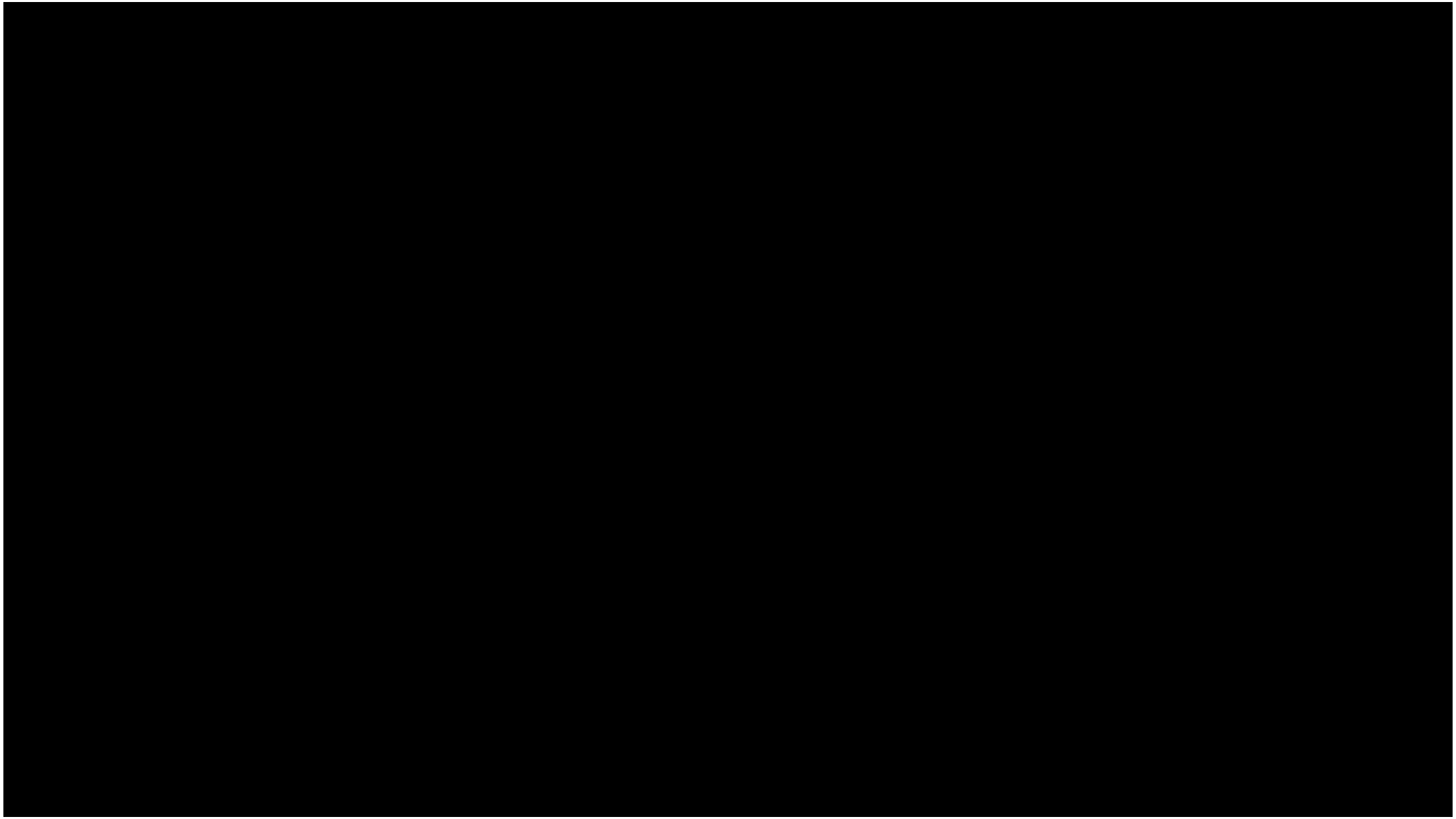
- Data based Decision making moves immediately into the realms of Machine Learning or Artificial Intelligence.
- What are Machines good at?
- How to win?
- What does a Malevolent attack on this system look like??

The future of AI (What do we want from our Machines?)



The future of AI (What do we want from our Machines?)

What do we get? (DARPA)



Data Engineering based Decision Making Example

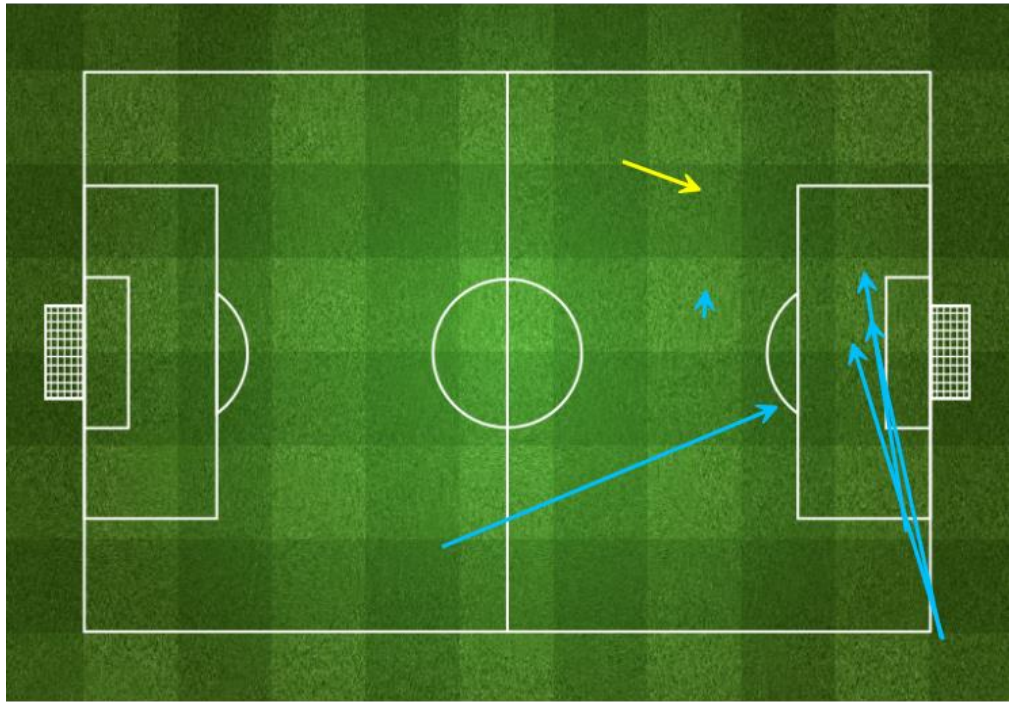
- Data Analytics in Sport.
- In 2005 The NFL collected approximately 16MB of performance related player data *across an entire season.* Today far more is collected each game.
- In 2014 Manchester City had 11 full time data analysts as part of its sports science team
- GPS based raw data plus Prozone Metadata available for all training sessions and matchdays.
- Spikes in Workload, Fatigue and Fitness now routinely integrated within training programmes to prevent injury and to improve Athlete Strength and Conditioning .
- No longer the preserve of the elite athlete!! Schoolboy and Junior game data is now also routinely collected.
- How much useful information is being collected?
- An Example
  - "It is dangerous to mention any subject having high emotional content without hastily saying whether you're for or agin' it." (from *How to Lie with Statistics – Darrell Huff* p.46)

Some Decisions are Straightforward…….

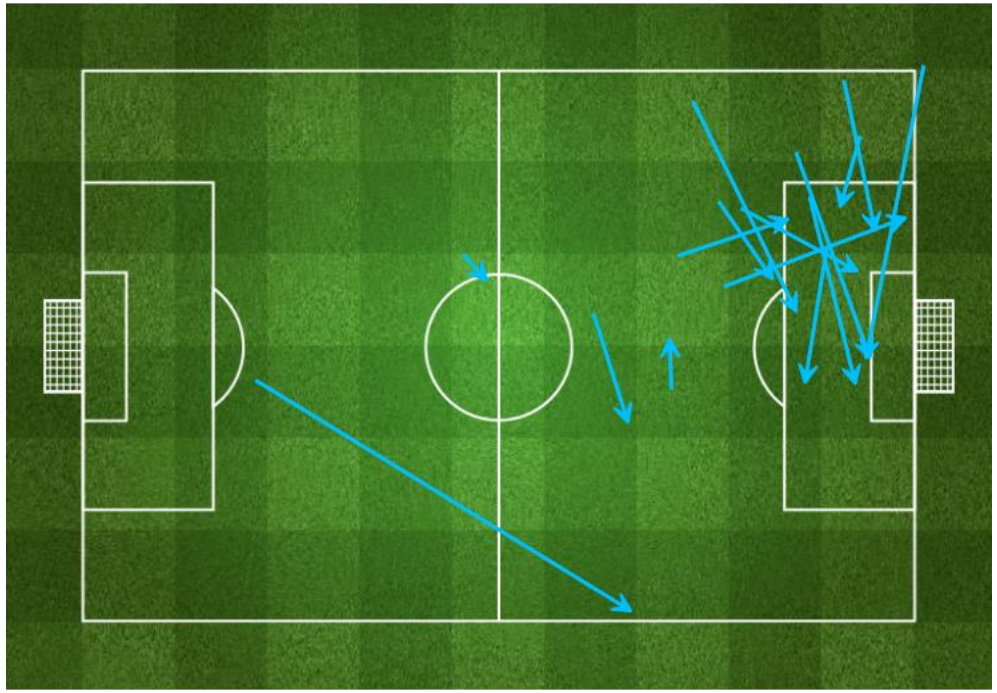
Some not so much

- Why did France Lose?
  - France couldn't score a goal.
  - France couldn't prevent Portugal scoring
  - Portugal defended better than France
  - France underperformed on the day.
  - France's organisation was poor.
  - All of the above?
- Can Data Analytics help ?
  - Add value to coaching
  - Identify weaknesses
  - Suggest changes in personnel/formation
  - Enhance the spectator experience

Data says France created more chances – Portugal took theirs!!



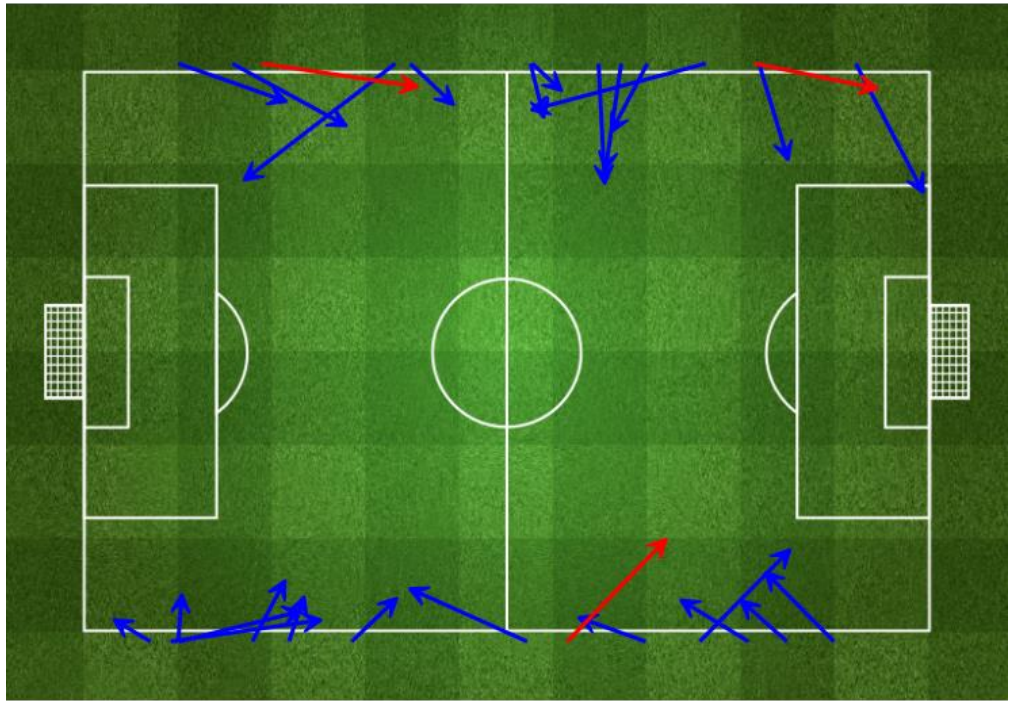
Portugal Chance Creation
Blue = Shot on Target Resulted
Yellow = Goal Assist



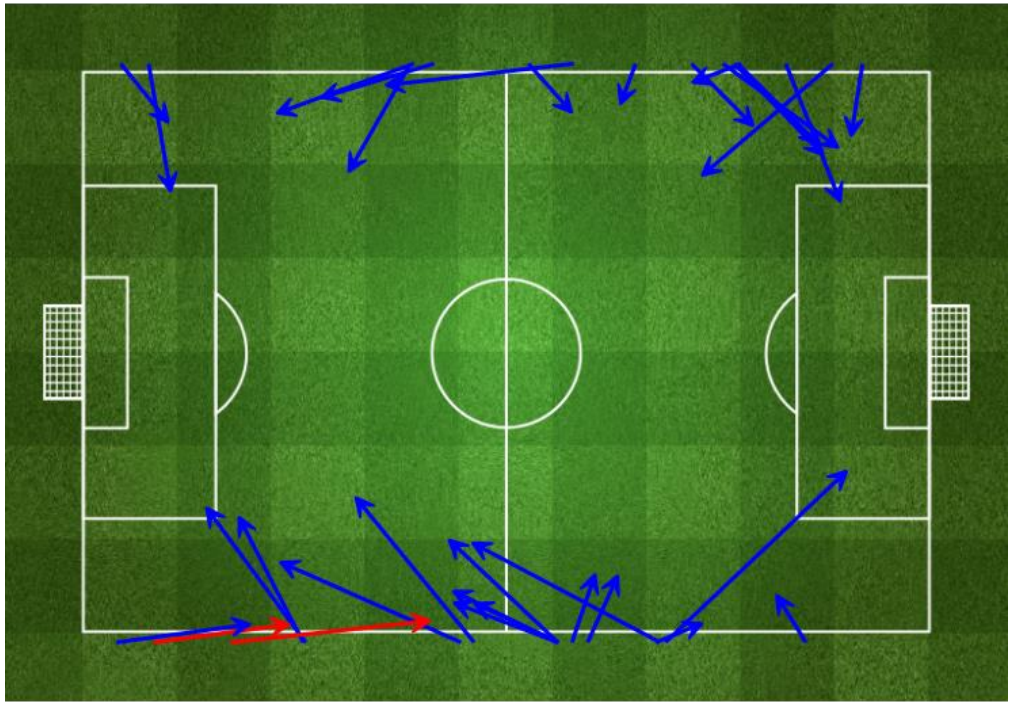
France Chance Creation
Blue = Shot on Target Resulted
Yellow = Goal

- France created far more shots on target during the course of the game but could not convert any of them.

Throw-in analysis



Portugal Throws
Blue = Success
Red = Turnover of Possession



France Throws
Blue = Success
Red = Turnover of Possession

- France turned possession over only twice on their own throw in, whereas Portugal lost possession three times on their own throw.

What is Data Engineering?

- Sure those throw in stats are grand – nothing to see here.....(23:20).

Advice for IoT Adoption

- Set aside a percentage of your R&D budget for investment in Innovation.
- Internal or External? Can you pool resources? Some type of Hybrid approach is generally best.
- Dan Kaufman (Google): Question what the fundamental innovation issue is in your business and think about how you would go about solving it as if technology adoption costs were not an issue. It is quite possible the Internet of Things will be a solution. It's a mistake to do it the other way around.
- You'll never own the cloud!! Therefore whatever platform you end up in make sure you can jump to another if costs / service / innovation are not satisfactory.
- Always make sure you can bring your Data with you!!

A bright future for IoT/AI enabled Tourism ?? ;-)

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Thank You!!!

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