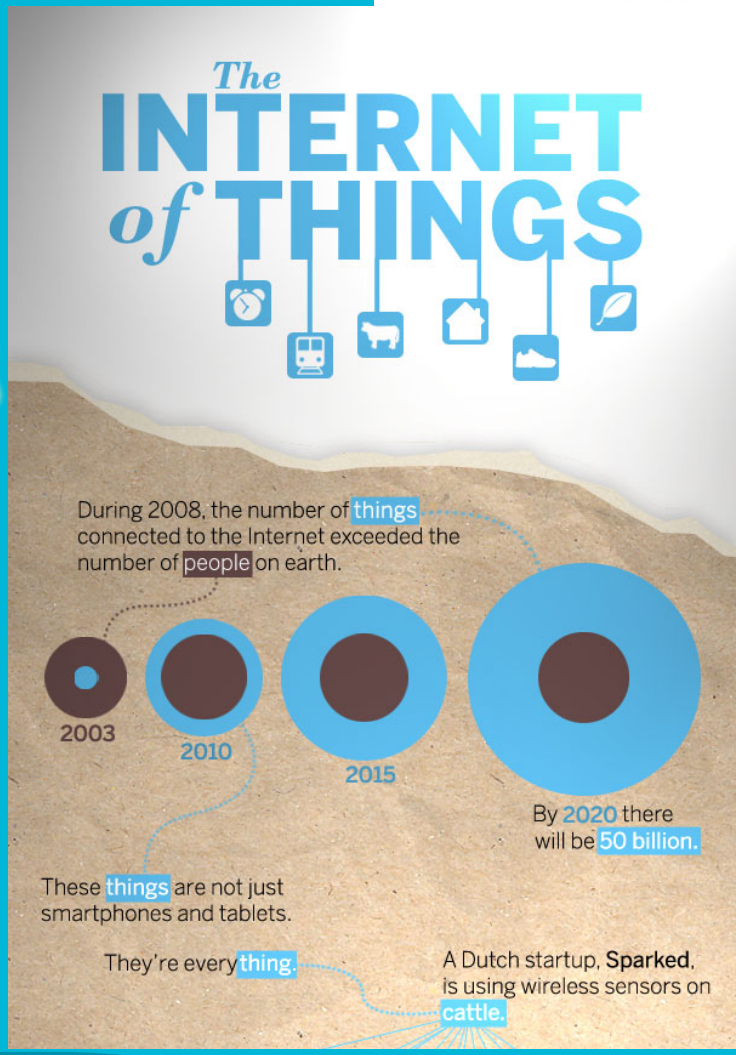
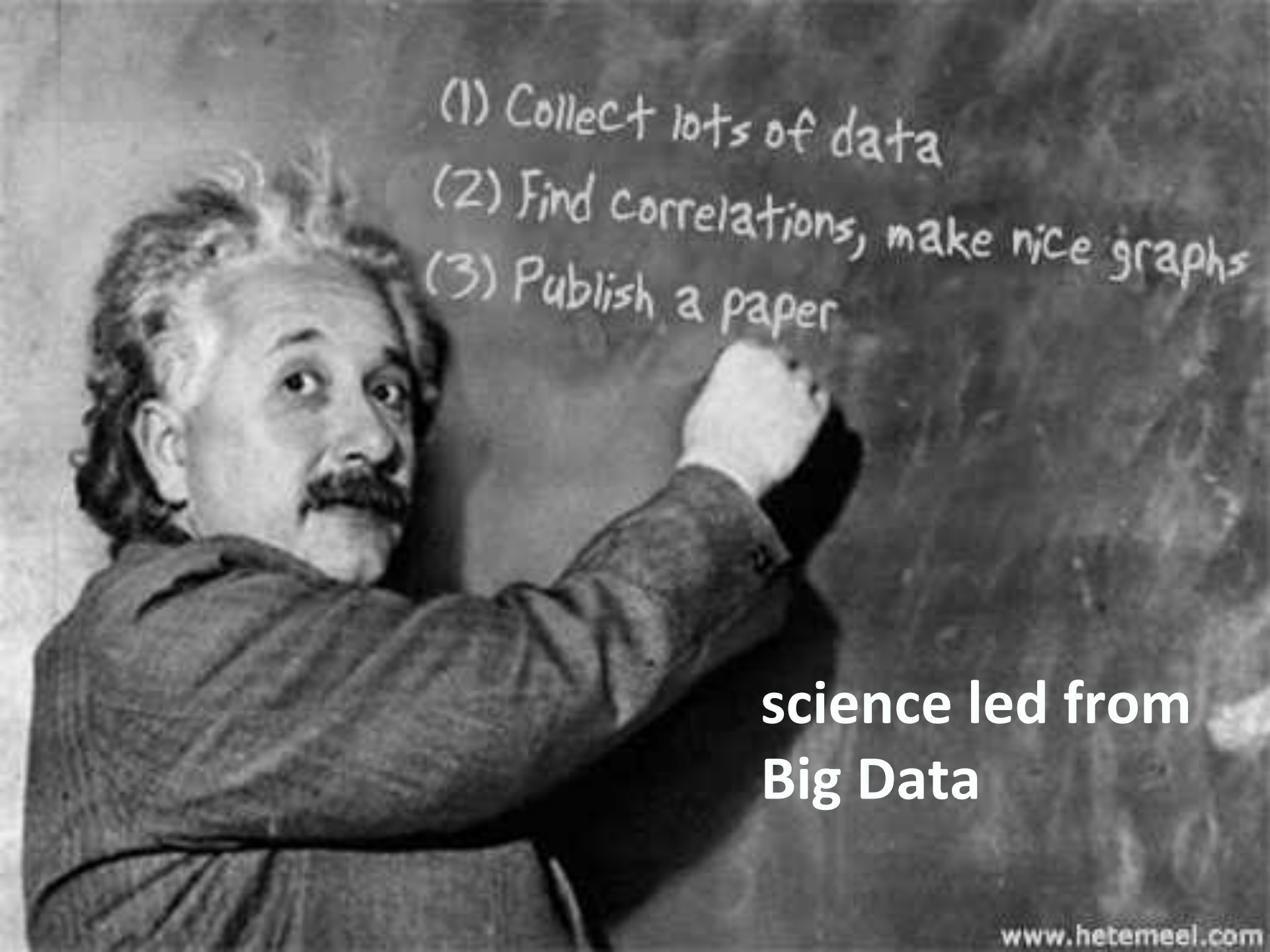
How much Big Data is in the Internet of Things ?

Arkady Zaslavsky



IEL, CSIRO COMPUTATIONAL INFORMATICS
www.csiro.au

Technical University of Braunschweig, 1 November, 2013



science led from Big Data

Outline

- Setting the scene - IoT & Big Data
- Motivating scenarios
- OpenIoT & other CSIRO solutions
- Conclusion

About CSIRO

People	6500
Divisions	12
Locations	58
Flagships	11
Budget	$1B+

Top 1% of global research institutions in 14 of 22 research fields

Top 0.1% in 4 research fields

62% of our people hold university degrees

2000 doctorates

500 masters

With our university partners, we develop **650** postgraduate research students

CSIRO: Commonwealth Scientific and Industrial Research Organisation, Australia

Google how much big data in the internet of things

More Search tools

About 214,000,000 results (0.21 seconds)

Big Data Analytics - intel.com.au
www.intel.com.au/
Extract Real Time Business Value from **Big Data** Analytics.Learn More!

How the "**Internet of Things**" May Change the World
news.nationalgeographic.com/.../130830-**internet-of-things**-tech...
by Clark Howard - in 701 Google+ circles
Aug 30, 2013 - We know that **Big Data** is the only way to handle the volume and speed required for "**Internet of Things**" data collection and analysis, but **many** ...

Big Data Gets Bigger as **Internet of Things** Awakens
www.itbusinessedge.com/.../**big-data**-gets-**bigger**-as-**internet-of-things**-a...
Aug 23, 2013 - Let's look at what makes the **Internet of Things data** a bit different from ... on how the **Internet of Things** will affect customer service, but **much** of it ...

Internet of Things Event
iotevent.eu/
Internet of Things and **Big Data** are very **much** a technology driven activity applied by hard- and software developers, whereby competing technologies offer ...

The '**Internet of things**' will mean really, really **big data** | ITworld
www.itworld.com/**internet**/.../**internet-things**-will-mean-really-really-**big**-...
Jul 29, 2013 - By Bob Violino, InfoWorld | **Big Data**, **internet of things** ... as it's **much** more efficient than people running all over the hospital to take medications ...

The **Big Data** Implications of the **Internet of Things** - The Extra Mile ...
www.theextramilewithcharlie.com/.../the-**big-data**-implications-of-the-**int**...
Aug 23, 2013 - So **much** discussion abounds around Emerson concerning **big data** and the **Internet of Things** (**IoT**) when we consider everything from ...

The **Internet of Things** will mean really, really **big data** ... - CMO
www.cmo.com.au/.../**internet_things**_will_mean_really_really_**big_data**/
Jul 29, 2013 - The **Internet of Things** will mean really, really **big data** ... as it's **much** more efficient than people running all over the hospital to take medications ...

Internet of Things - Switch
www.switchlv.com/.../is-the-current-**internet**-ready-to-become-t...

Ads

Demystifying **Big Data**
www.hcltech.com/**big-data**
How CIOs are turning **Big Data** challenges into opportunities.

EMC **Big Data** - Free eBook
australia.emc.com/**Big-Data**-eBook
Maximize The Value of Your **Big Data** & Boost ROI. Free eBook & IDG Guide

New: **Big Data** in 2013
www.tableausoftware.com/**big-data**
7 **Things** you Need to Do About **Big Data** in 2013. Get the Free Article!

Big data explained
www.oracle.com/**BigData**
Learn how to maximize the value of **big data** with Oracle

Data Analysis Software
www.ibm.com/**data**-analysis-software
Make Fast, **Data**-Driven Decisions w/ IBM **Data** Analysis Software. See How

Big Data White Paper
www.lavastorm.com/**big-data**
Top 3 Challenges & Opportunities for **Big Data** Analytics & Management

Big Data Dashboards
www.qlikview.com/Free-Download
In-Memory Business Intelligence. Direct Path from **Data** to Decision!

Big Data Analytics
www.quantium.com.au/
Talk to the industry experts. Contact us today!

Se
- I

www.csiro.au

CSIRO

Internet of Things IoT

based on standard & interoperable communication protocols

where physical & virtual "things" have identities, physical attributes,

virtual personalities, use intelligent interfaces, and

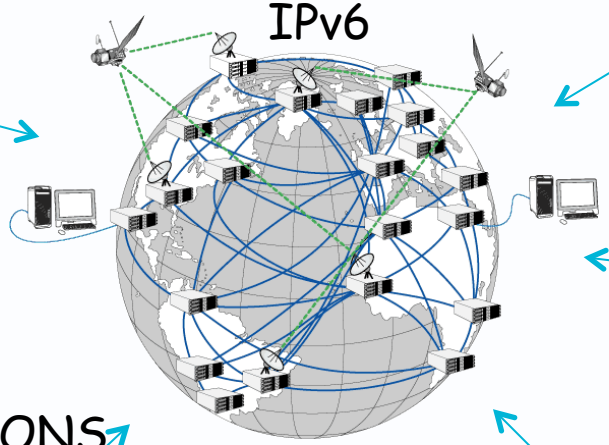
are seamlessly integrated into the information network.

A dynamic global network infrastructure with self configuring capabilities

Rather : a network of converging networks

Data matrix

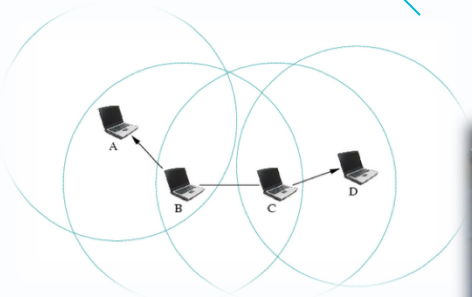
Internet :
IPv6



GPS

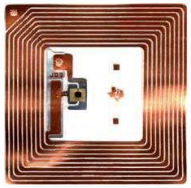
Mobility

ONS



ad hoc networks

Sensors



RFID, tags
& readers

The Internet of Things is composed of Smart Objects (SO) Or Internet Connected Objects (ICO)

Smart Objects: *abstract* vision

Objects that are able to **sense** the environment, **interpret** the environment, **self-configure**, **interact** with other objects and exchange information with people.

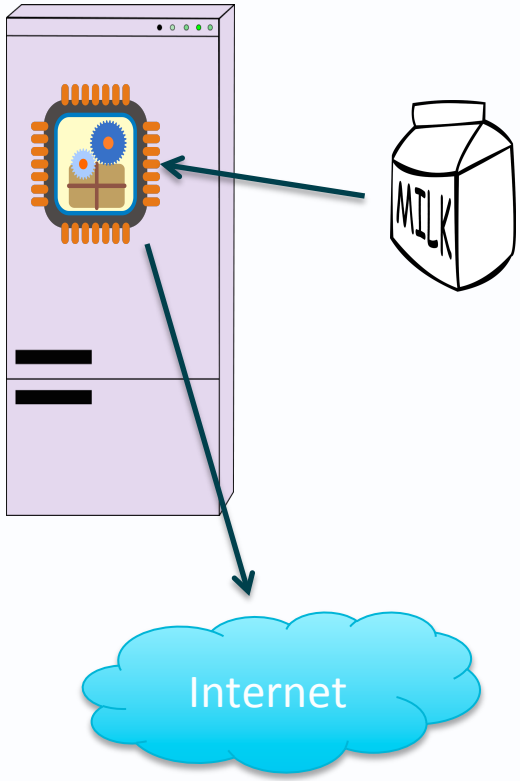
www.samsung.com

Smart Refrigerator

The Internet of Things is composed of Smart Objects (SO) Or Internet Connected Objects (ICO)

Smart Objects: *implementation* vision

- Objects have **communication** capabilities
- Objects have **storage** capabilities
- Objects have **unique** ID
- Objects can be **addressable** on Internet (URI/IP)



Smart Spaces → Ecosystems of Smart Objects

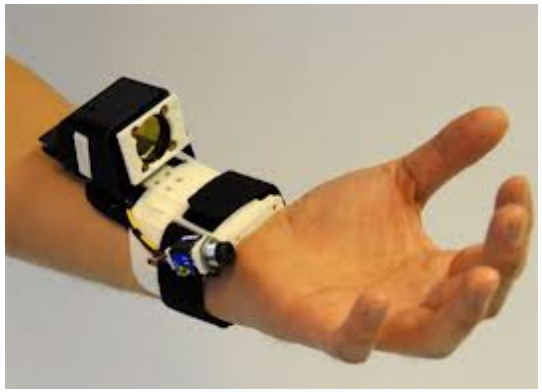
Environments (apartments, offices, museums, hospitals, schools, etc) that are enabled for **co-operation of smart objects** and provide advanced **context-aware functionalities** to the visitors..

IoT Connectivity

Devices connected through the Internet: Internet of Things

Today the idea of devices with computing capabilities able to process data in real time is a reality,



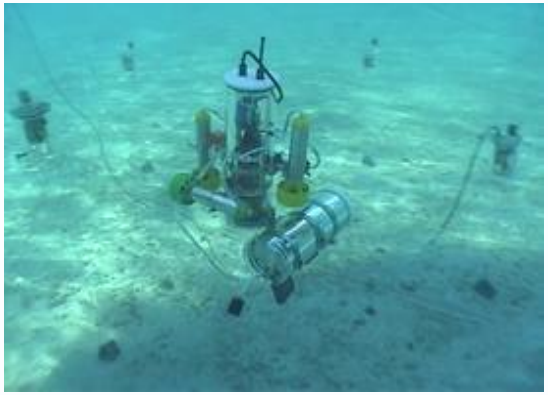



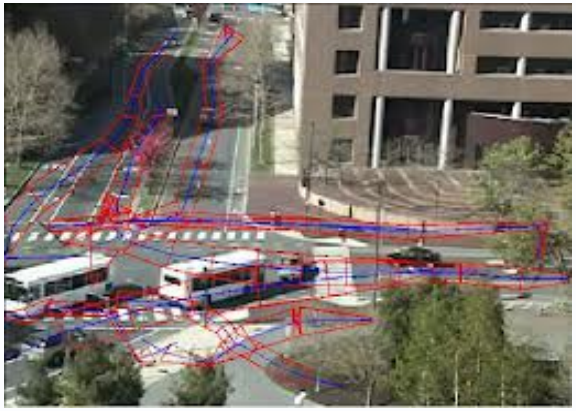



Smart Applications

Different Data Sources for Integration:

There is a need for combining information sources into easy to use data resources for applications.

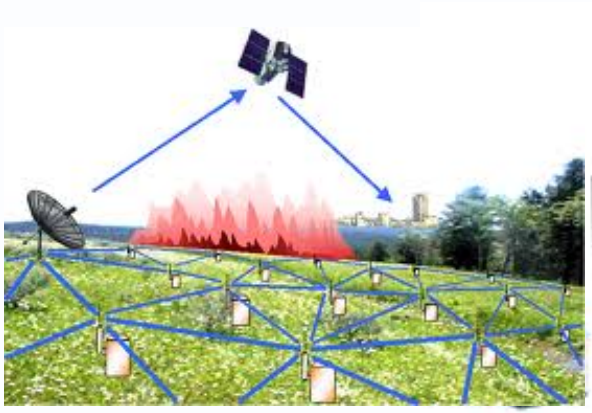


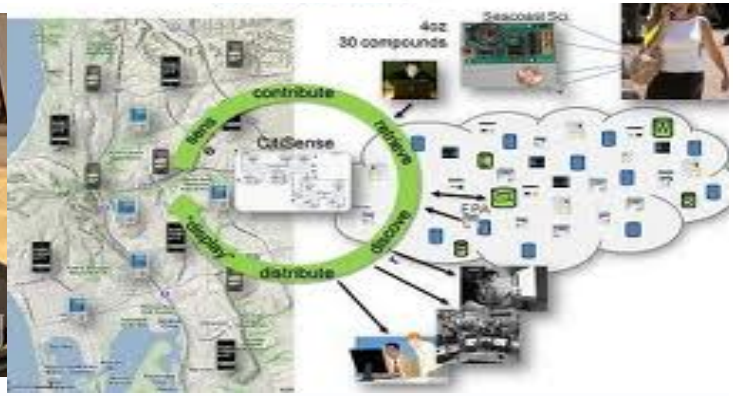


Exchange of Information

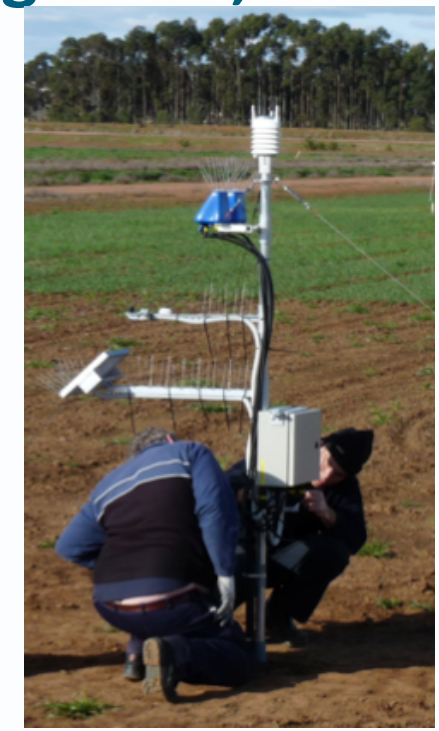
The world goes Interconnected: IoT, M2M, E2E.

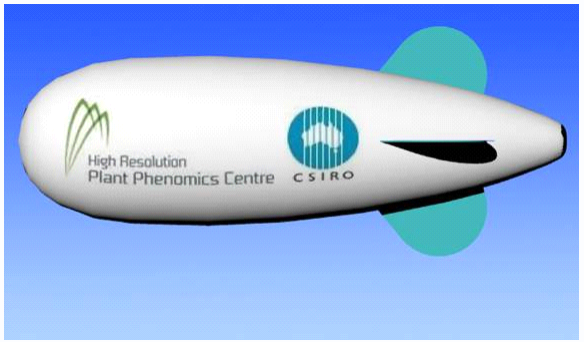
else daily-life objects or virtual sensors, the common feature is to share and exchange information.

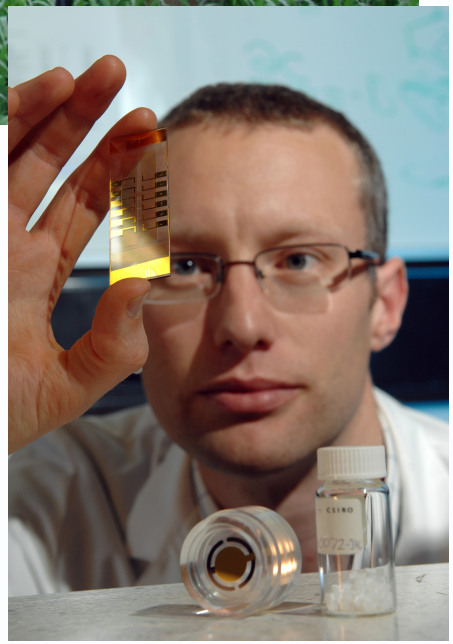




CSIRO Things – Sensors, cameras, nanosensors on the ground, ocean, autonomous vehicles & airships







Other Things – Other Smart Internet Connected Objects

Nike shoe sensor

CSIRO virtual fence

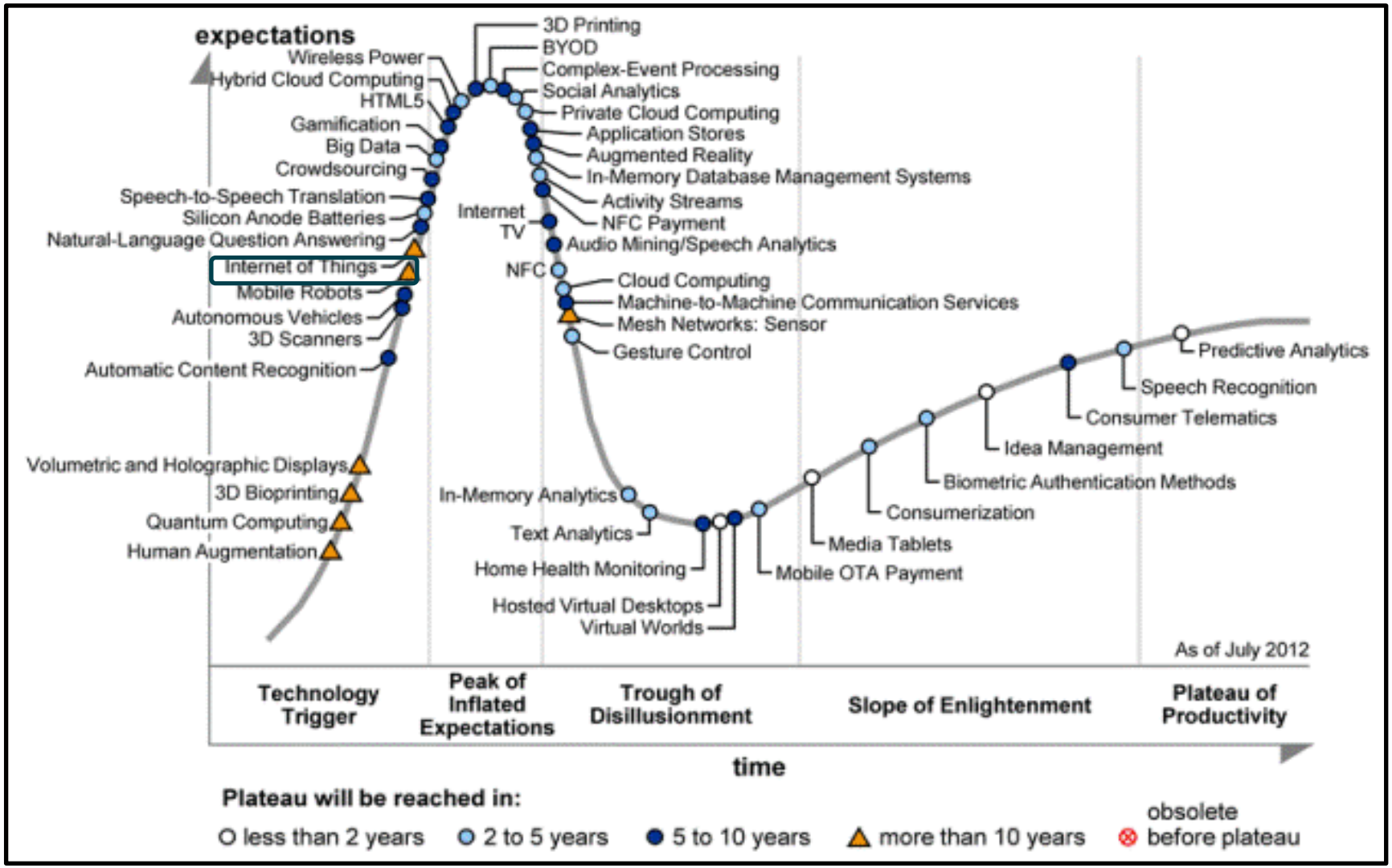
Stick on RFIDs

Olinda radio

Smart meter

Proteus pill

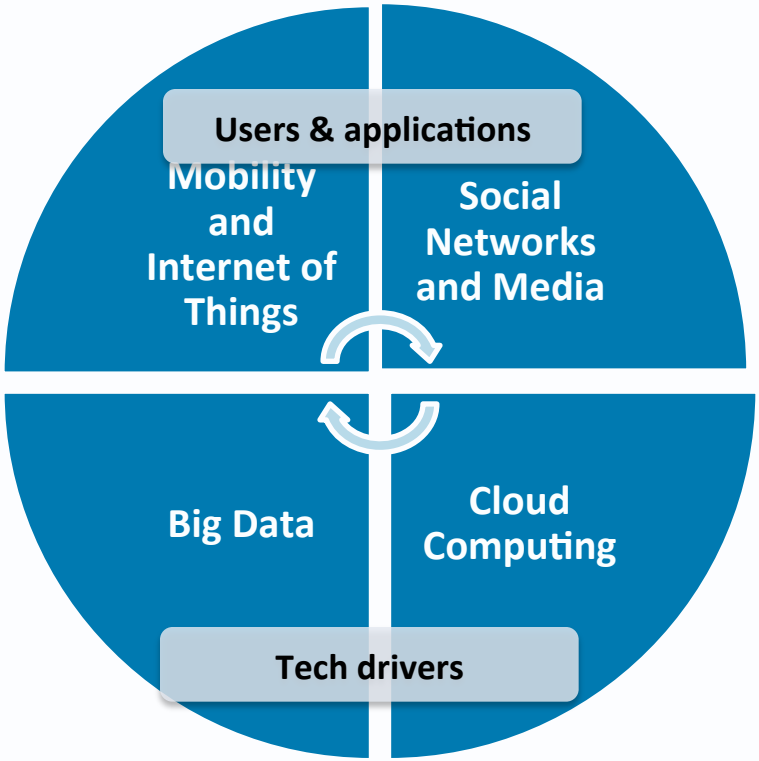
Where is The Internet of Things



Fonte: Gartner, 2012

Important economic and IT trends are shaping a "new transformation"

▶Main IT trends



▶ Main economic trends

Economic power changing towards emerging economies

The debt crisis leads to cost pressure

The IPR* are more valuable than ever to keep the competitive advantatge

* Intellectual Property Rights

The “Zettaflood” is just the Beginning of the IoT Traffic

Total IP Traffic on the global Internet:

- 2003-1.8 Petabytes
- 2007- 161 Exabytes
- 2009- 487 Exabytes
- 2010- ½Zettabyte
- 2011- 1 ZettaByte (540,000 X increase from 2003)

> “By 2011, 20 typical households will generate more traffic than the entire Internet did in 2008.”
>
> Jim Cicconi, VP, AT&T

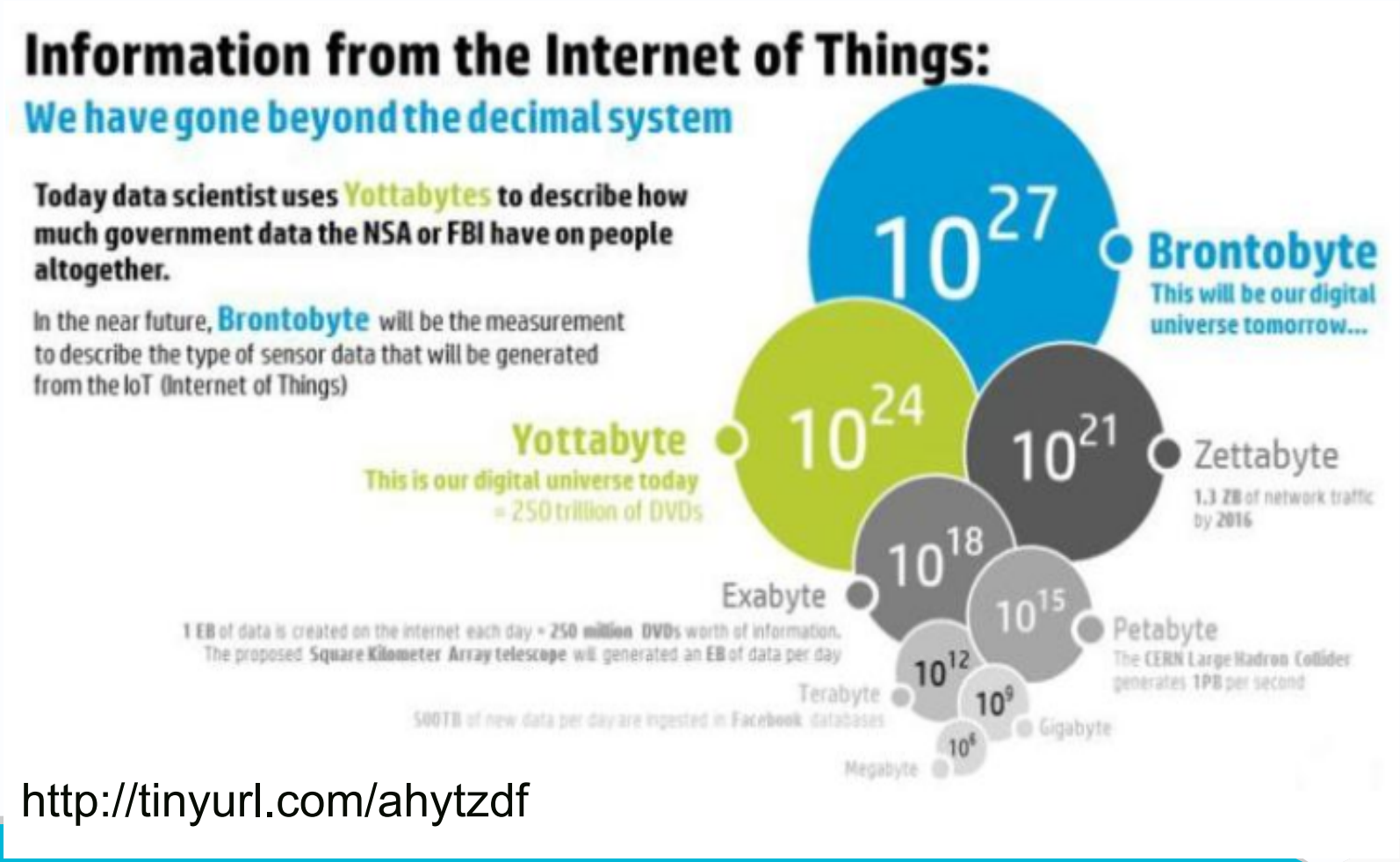
Expected to double over the next 18 months

2012- 91% expected to be video

Source: VentureBeat, IDC, C|Net, TheGuardian, UK

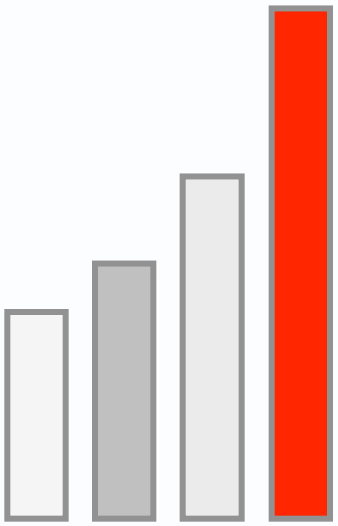
Welcome to the new information age

Some predict that the Internet of Things will soon produce a massive volume and variety of data at unprecedented velocity. http://tinyurl.com/ahytzdf



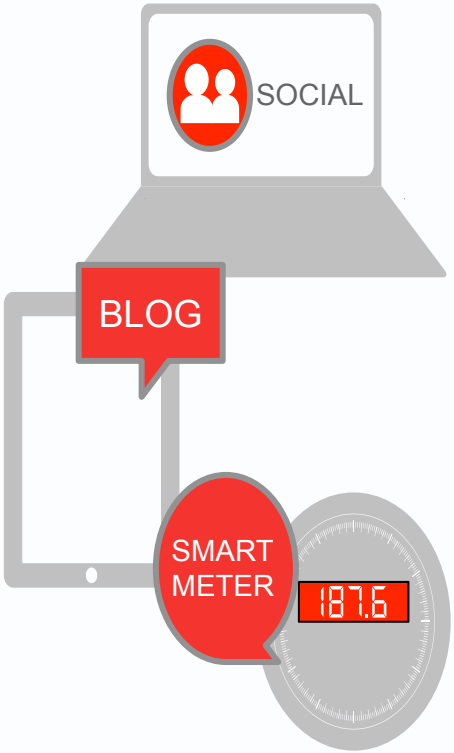
http://tinyurl.com/ahytzdf

What Makes it Big Data?

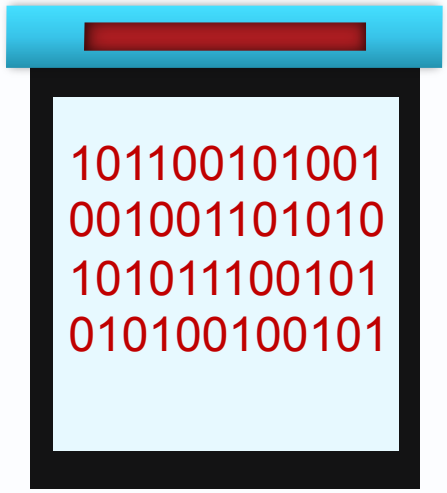


VOLUME

VELOCITY

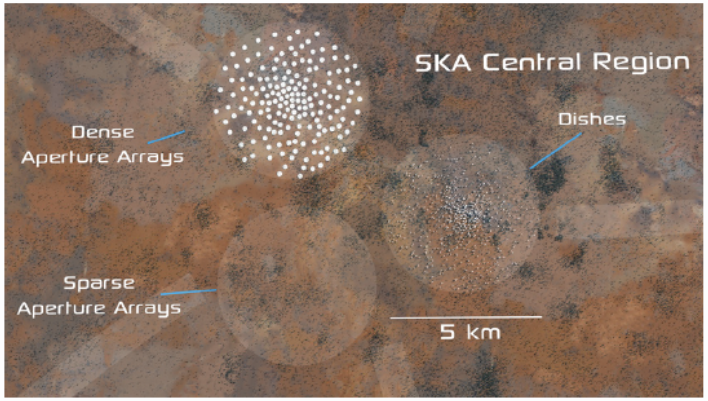


VARIETY



VALUE

The Square Kilometre Array



2020 era radio telescope

Very large collecting area (km^2)

Very large field of view

Wide frequency range (70MHz - 25 GHz)

Large physical extent (3000+ km)

International project

Telescope sited in Australia and South Africa

Headquarters in Jodrell Bank, UK

Multiple pathfinders and precursors now being built around the world

The large Hadron Collider at CERN produces so much data that scientists must discard most of it, hoping they haven't thrown away anything useful.

Weather prediction combines data from multiple earth satellites with massive computing power.

Most of the satellites belong to the U.S., but the Europeans have a more powerful computer.

Our weather satellites are old. **http://tinyurl.com/cvpz5qe**

Digital Information: Created, Captured, Replicated Worldwide

Source: IDC, 2008

Internet of Things: Big Data is coming

Units Installed Worldwide (millions)

8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0

2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2016 2017 2018 2019 2020

Computers
Handhelds
Networking
Industrial/automotive
Embedded
Household

Source: IDC Everything Network

Internet of Things: Big Data is coming

Source: IDC Everything Network

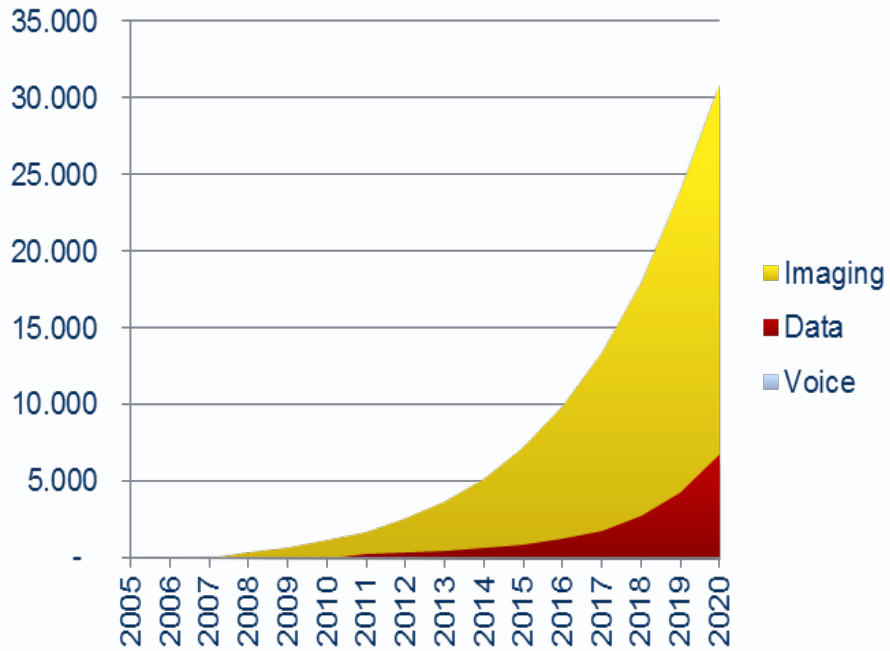
IoT: Really Big Data

►Data generation rate and storage needs is rising faster than net bandwidth.

►Video-on-demand services occupied 30% of Internet bandwidth in December 2012.

►YouTube received 72 hours of new video every minute, which required 17 petabytes of new storage in 2012.

- Mobile devices will both consume and generate much of this data. By the end of 2012, mobile devices generated 25% of Internet traffic.
- According to Cisco, video will account for 86% of all wireless traffic by 2016.
- Mobile devices also generate lots of sensor data, such as GPS location data. Thus, they are the primary source of the machine-to-machine (M2M) traffic that comprises the Internet of Things.
- An IDC report forecasts that machine-generated data will represent 42% of all data by 2020 (up from 11% in 2005).



Data is the new Oil

Gerd Leonhard

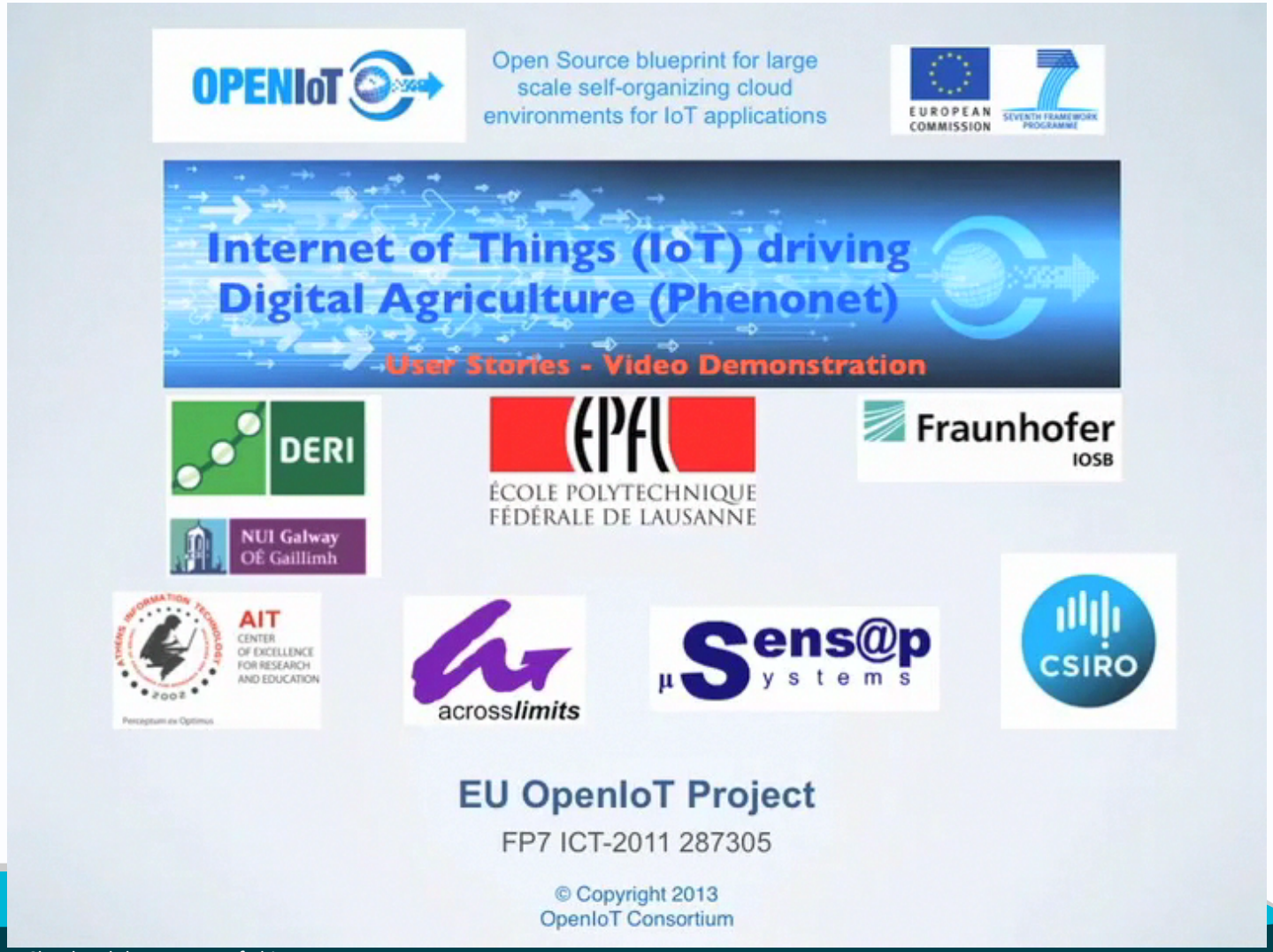
Motivating scenarios

Aquaculture monitoring and decision support

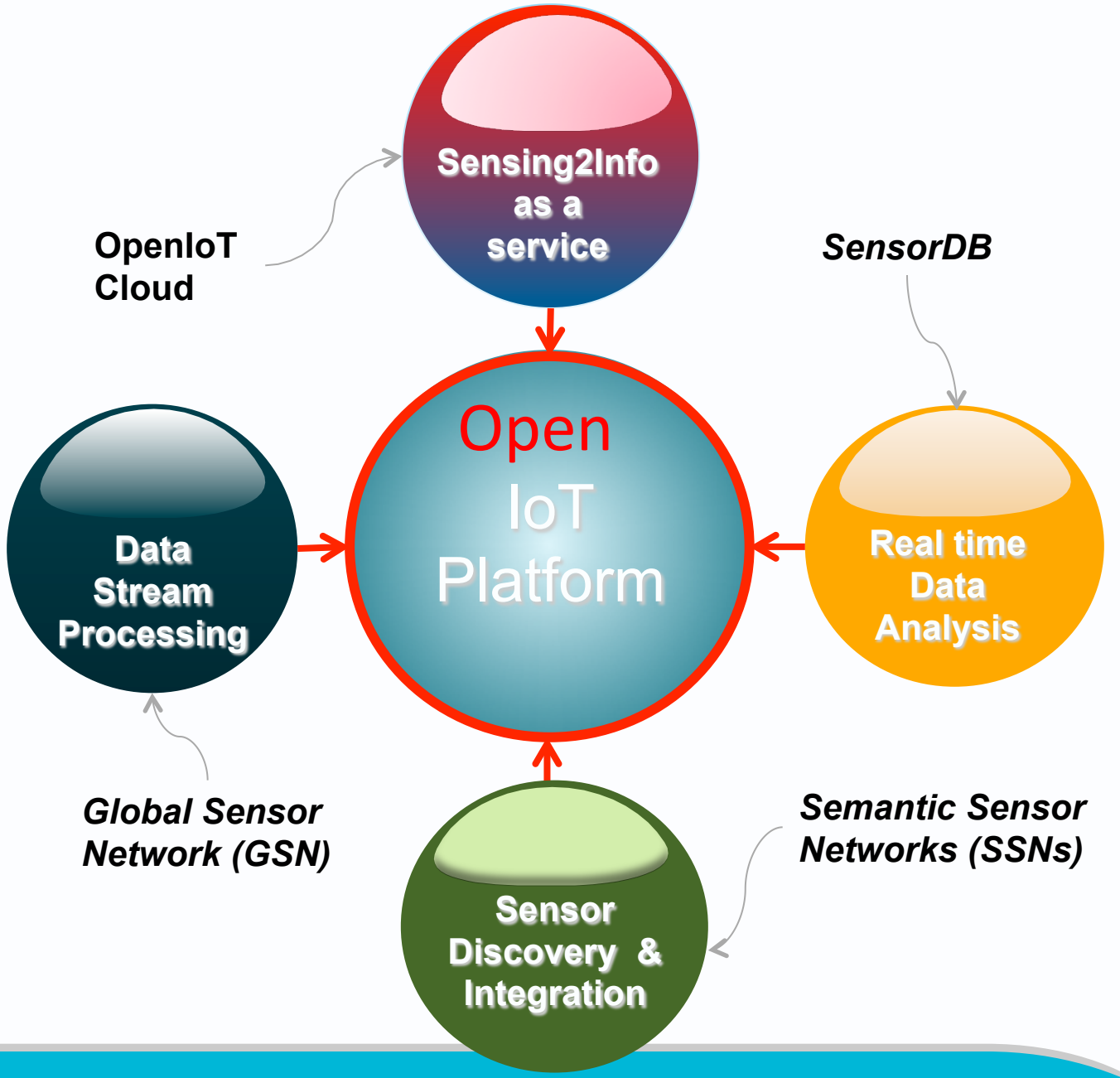
- Strategic relevance
  - Improve productivity of the salmon and oyster aquaculture industry through provision of real-time awareness of critical environmental variables.
  - Build supply chain resilience to natural events (e.g. harmful algal blooms) that may force temporary closure of some production facilities.

- Impact
  - Tasmanian aquaculture industry groups (Oysters Tasmania and Tasmanian Salmon Growers Association)
  - Tasmania Department of Human and Health Services

What Phenonet can do for its customers and stakeholders



OpenIoT & other CSIRO solutions


Sensing2Info as a service
OpenIoT Cloud
SensorDB
Open IoT Platform
Data Stream Processing
Real time Data Analysis
Global Sensor Network (GSN)
Semantic Sensor Networks (SSNs)
Sensor Discovery & Integration

OPENIoT

Open Source Cloud Solution for the Internet of Things

EUROPEAN COMMISSION

SEVENTH FRAMEWORK PROGRAMME

OpenIoT Project

FP7 ICT-2011 1.3: Internet-connected Objects

http:\\www.openiot.eu

DERI

NUI Galway OÉ Gaillimh

National University of Ireland (NUIG), Digital Enterprise Research Institute (DERI), Ireland

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Ecole Polytechnique Fédérale de Lausanne (Switzerland

Fraunhofer IOSB

Fraunhofer Institute of Optronics, System Technologies and Image Exploitation IOSB, Germany

AIT CENTER OF EXCELLENCE FOR RESEARCH AND EDUCATION

Research and Education Laboratory in Information Technologies - Athens Information Technology, Greece

CSIRO

Commonwealth Scientific and Industrial Research Organization, Australia

Sens@p systems

SENSAP S.A (SME), Greece

acrosslimits

AcrossLimits (SME), Malta

CSIRO

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The OpenIoT Objectives

Open-source middleware platform for IoT

- Support of a broad range of internet-connected objects
- Automated configuration of filtering/fusion/reasoning mechanisms

Fusion of Cloud Computing and IoT: Sensor Clouds

- Support of cloud paradigms for internet-connected objects
- Enable user to configure, deploy, use IoT based services

Ontologies and annotations of internet connected objects (ICOs)

- Enable semantic interactions and interoperability

Data privacy and security

- Auditing/assessing privacy of IoT apps in the Cloud

Towards Web 3.0

- Offering access to computing environments including “things” or ICOs

OpenIoT Architecture: Design & Implementation

The OpenIoT Architecture specifies a blueprint solution for IoT / Cloud integration

OpenIoT will implement the blueprint based on specific (Open Source) technologies e.g.:

- Sensor middleware: GSN
- Directory Service: W3C SSN/ LSM
- Real time data analysis/visualisation: SensorDB (CSIRO proprietary)
- User Interface: JSF PrimeFaces
- Utility & Metering: jBilling

Other Integrators or solution providers could implement/ extend the architecture based on alternative implementation technologies

Main Elements and Functionalities

Cloud Computing Infrastructure

- Directory Service
- Linked Sensor Data

(Global) Scheduler

Service Delivery & Utility Manager

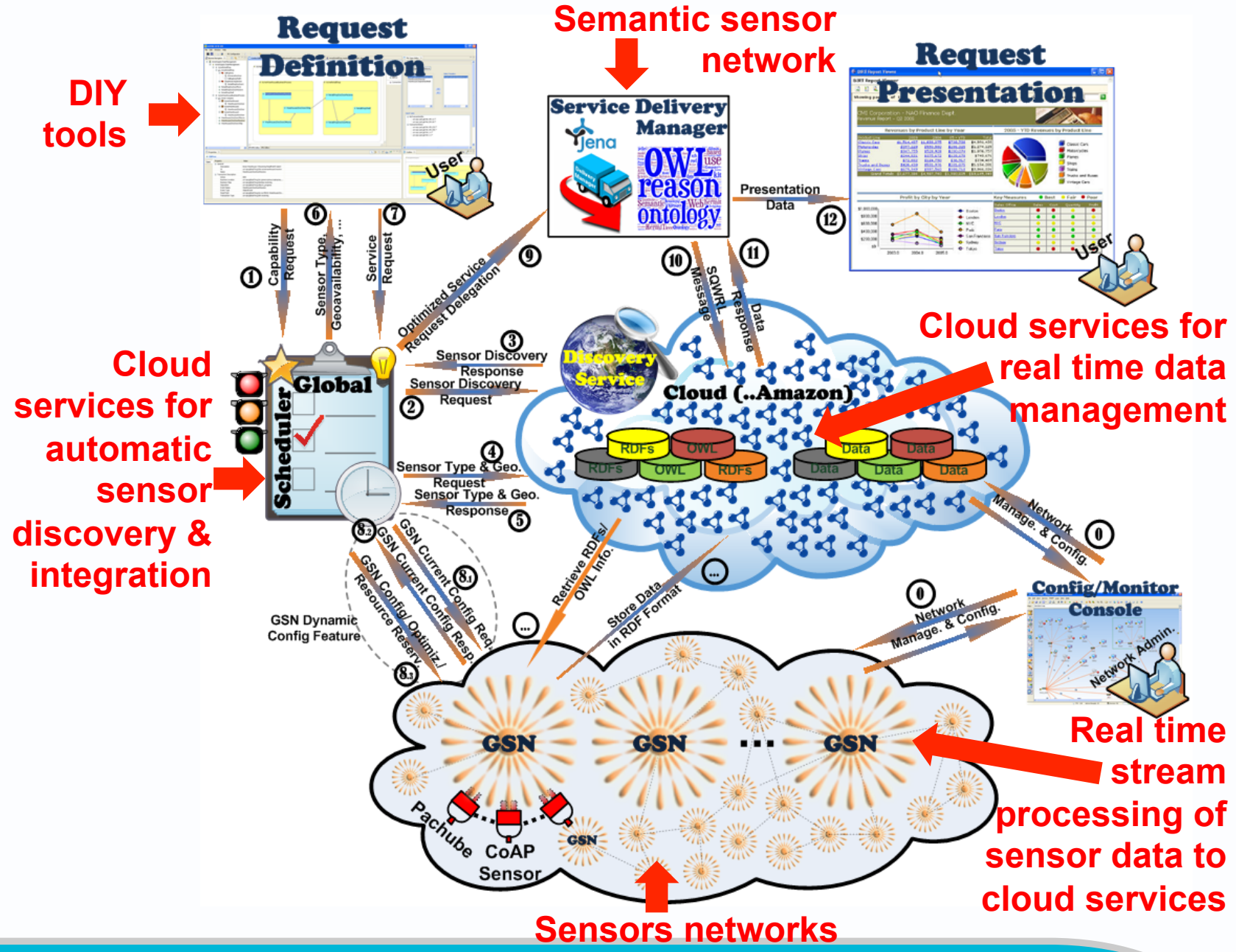
Sensor Middleware

- Local Scheduler

User Interface

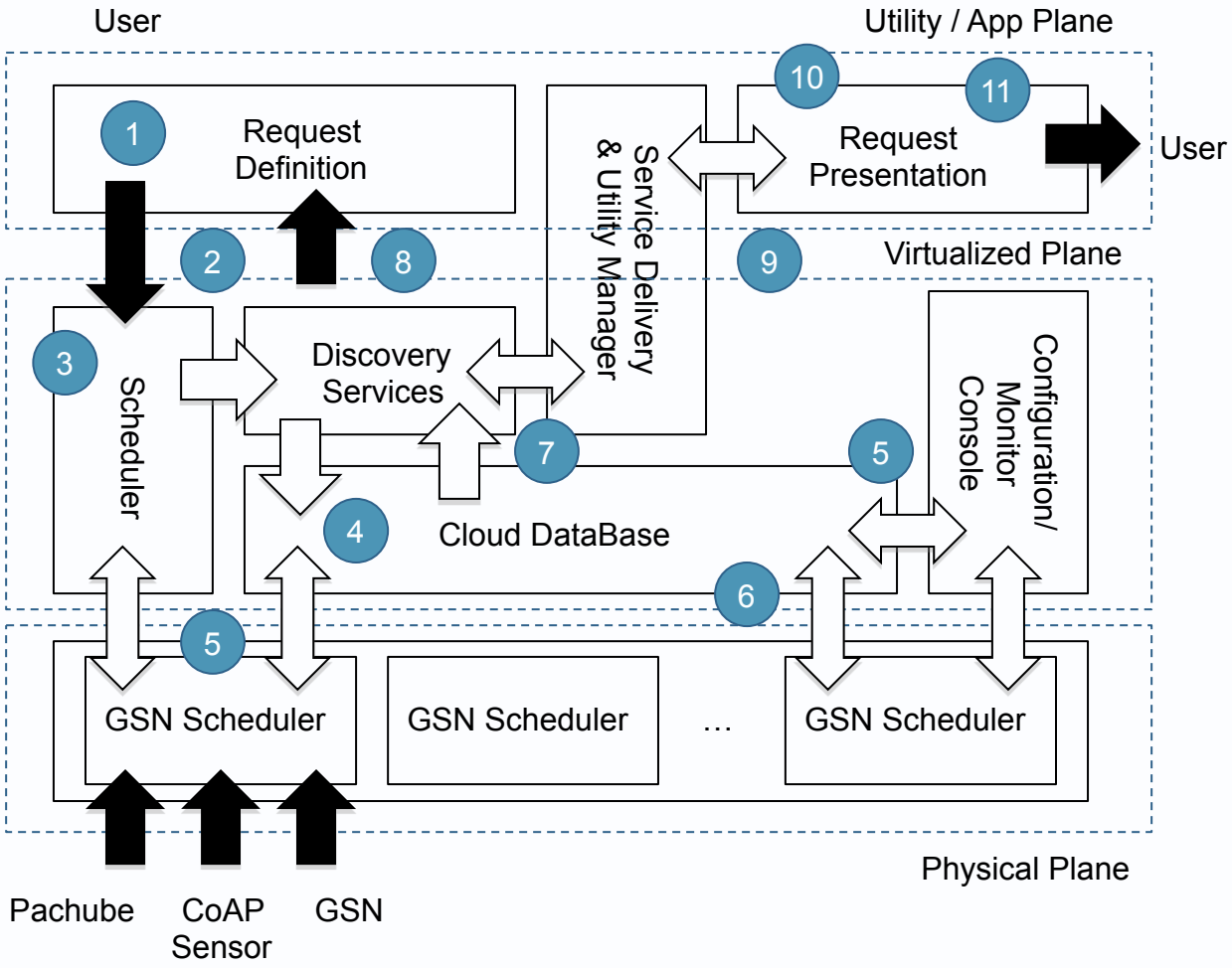
- Request Definition
- Request Presentation
- Configuration and Monitoring

OpenIoT High Level Architecture

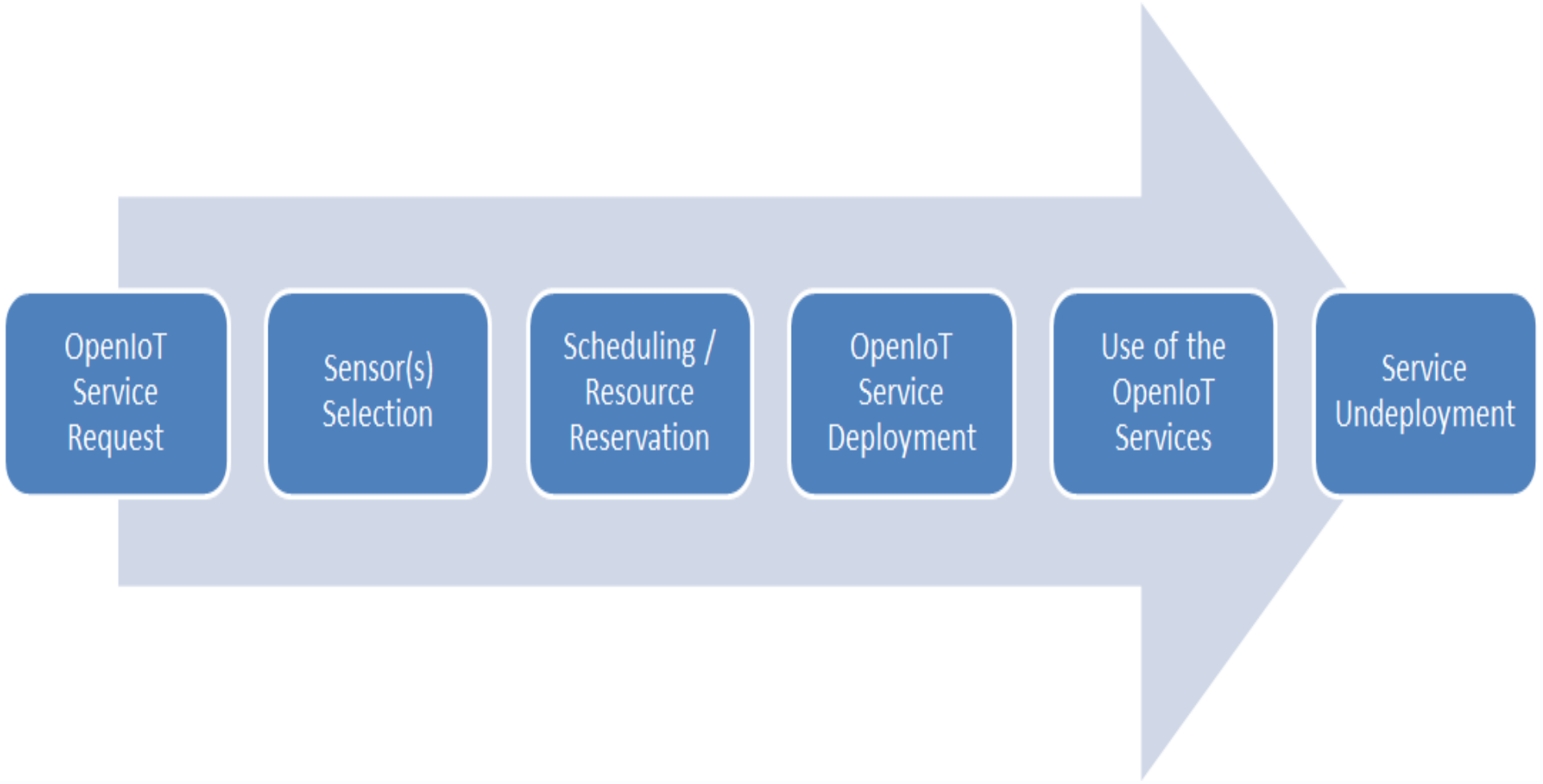


OpenIoT Services Achitecture

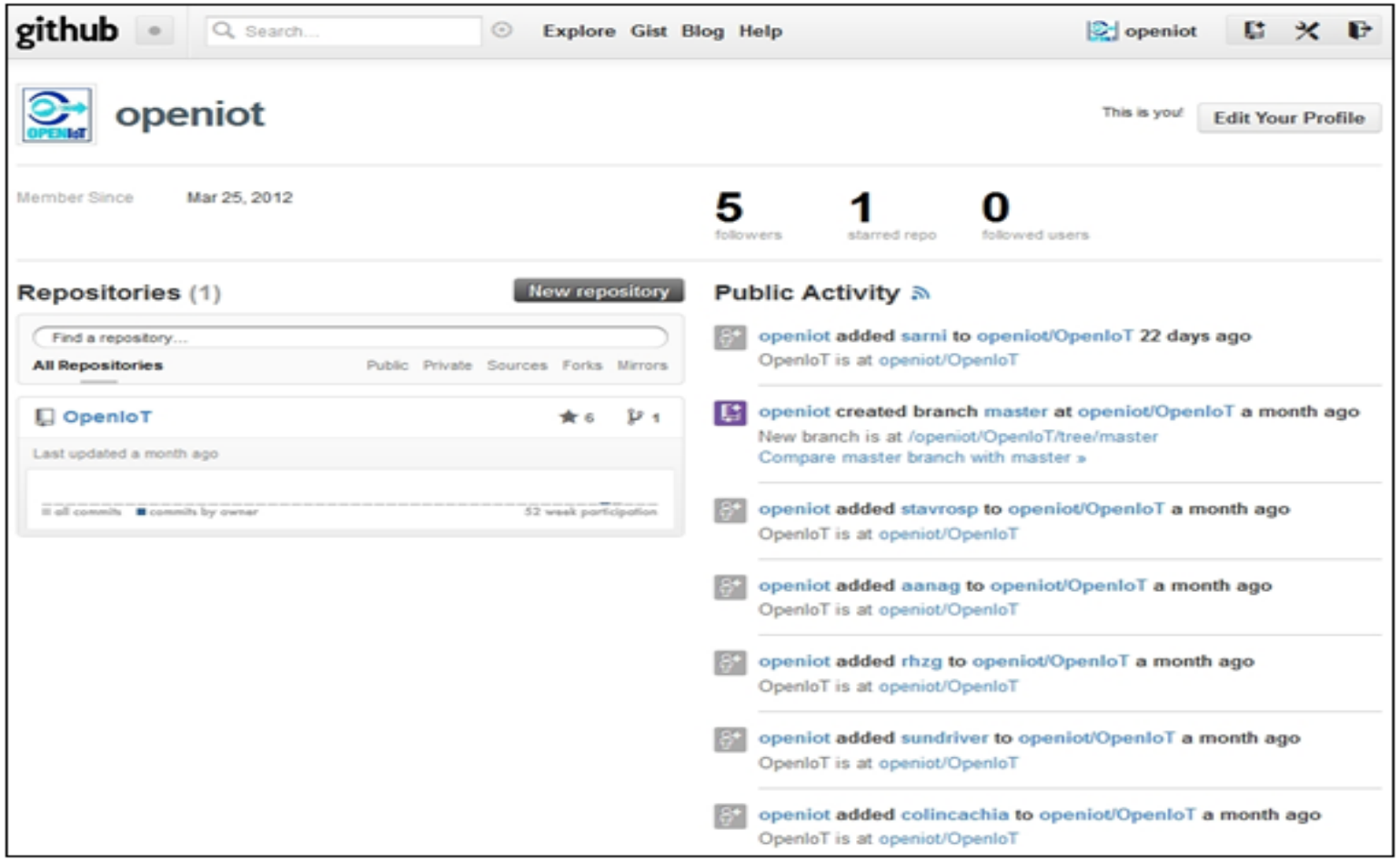
1. End User Request
2. Query Content
3. Discover Services
4. Sensor Configuration
5. Collect Content
6. Content Adaptation
7. Utility Service Feedback
8. Service Delivery
9. Service Visualization
10. Get Visualization
11. Data Presentation
12. Utility Metrics



Typical OpenIoT Service Lifecycle



OpenIoT is an Open Source project



https://github.com/openiot

CSIRO Phenonet – A case study illustrating the application of our IoT platform to agrofood production increase in Australia

CSIRO Phenonet
A case study for OpenIoT in agriculture

Increase crop yield using

- novel sensor-based monitoring
- sophisticated data analysis
- interactive assessment of crop performance
- Improve yield by improving crop selection process

"It is really hard for me to comprehend that in the next 50 years, we will need to produce as much food as we have ever produced in the entire human history." Dr Megan Clark, CEO CSIRO

Why Increasing Crop Yields Matters

Australian Agriculture

- 12% of GDP ($155 billion); 1.6m people
- Fourth largest wheat and barley exporter after US, Canada and EU
- Climate change forecast to cause decreased precipitation in Australia
- $1.2 billion spent annually for agriculture research

Australia is facing drought, water scarcity, low soil fertility, climate change caused by global warming

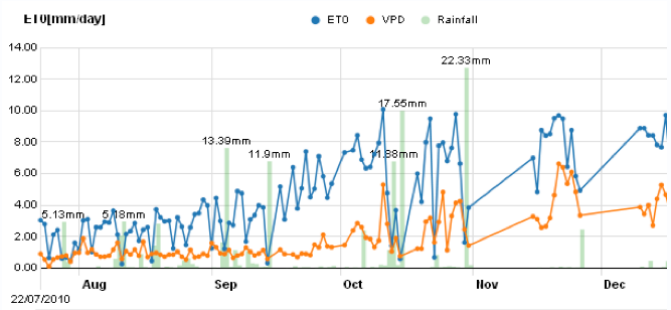
Why a new approach is needed

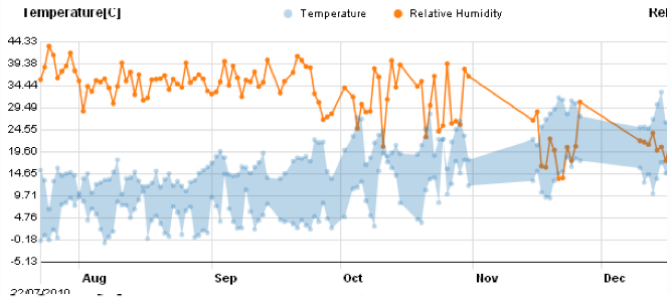
Current practice is expensive and often inaccurate

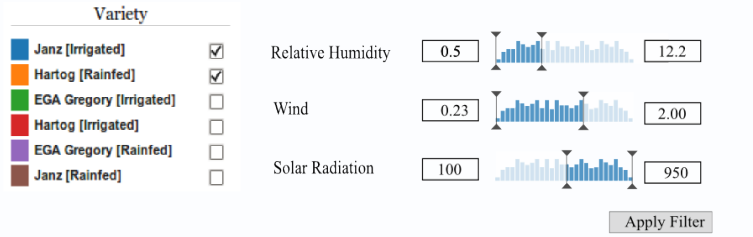
- GDRC plants 1 million $10m^2$ plots annually
- Information gathered from site visits and BOM
- Site visits are expensive and time-consuming (e.g., 400km away)
- Gathering "golden measurements" is difficult
  - Data does not have the required resolution
  - Missing key performance indicators

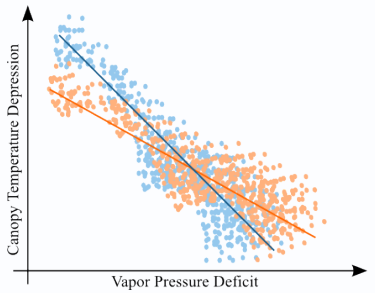
Lack of accurate information limits the quality of results

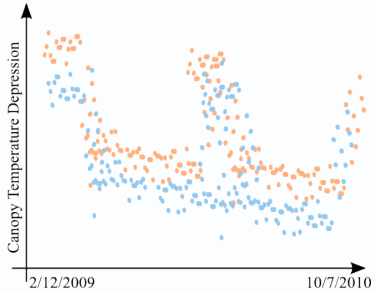
CSIRO Phenonet
Presentation & visualisation portal

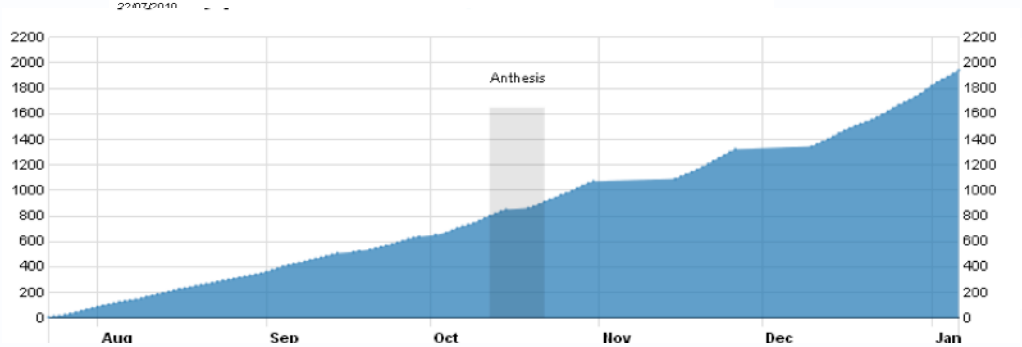


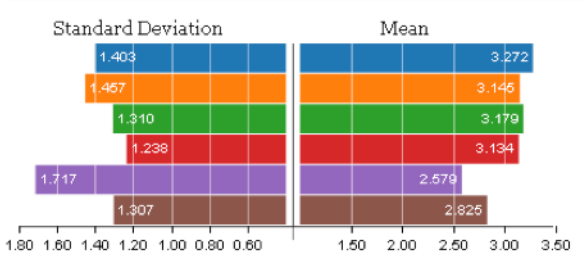








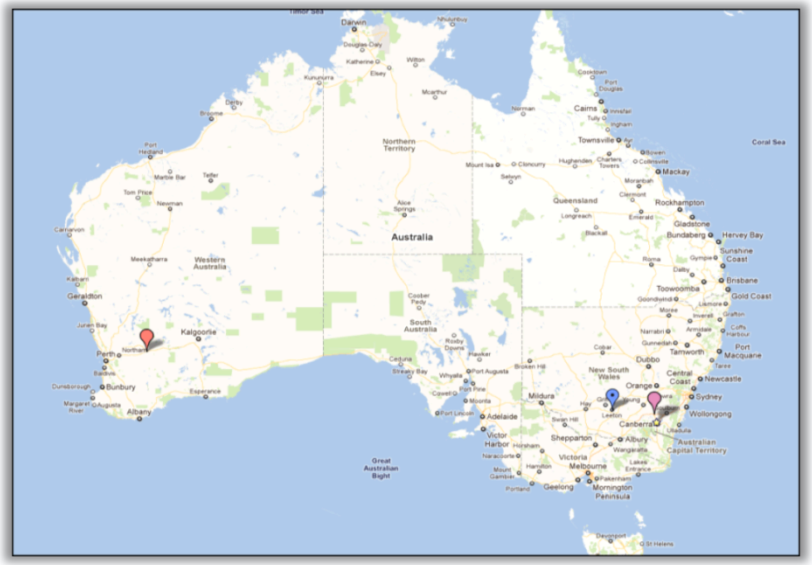




Online data analysis and visualization available at http://phenonet.com/

CSIRO Phenonet
First platform for crop selection globally

- helps farmers to identify varieties suitable for:
  - Poor quality soils (e.g., salt tolerance)
  - Drought tolerance (e.g., efficient water use)
  - Seasonal weather forecast (e.g., next year's weather)
  - Adaptation to climate change

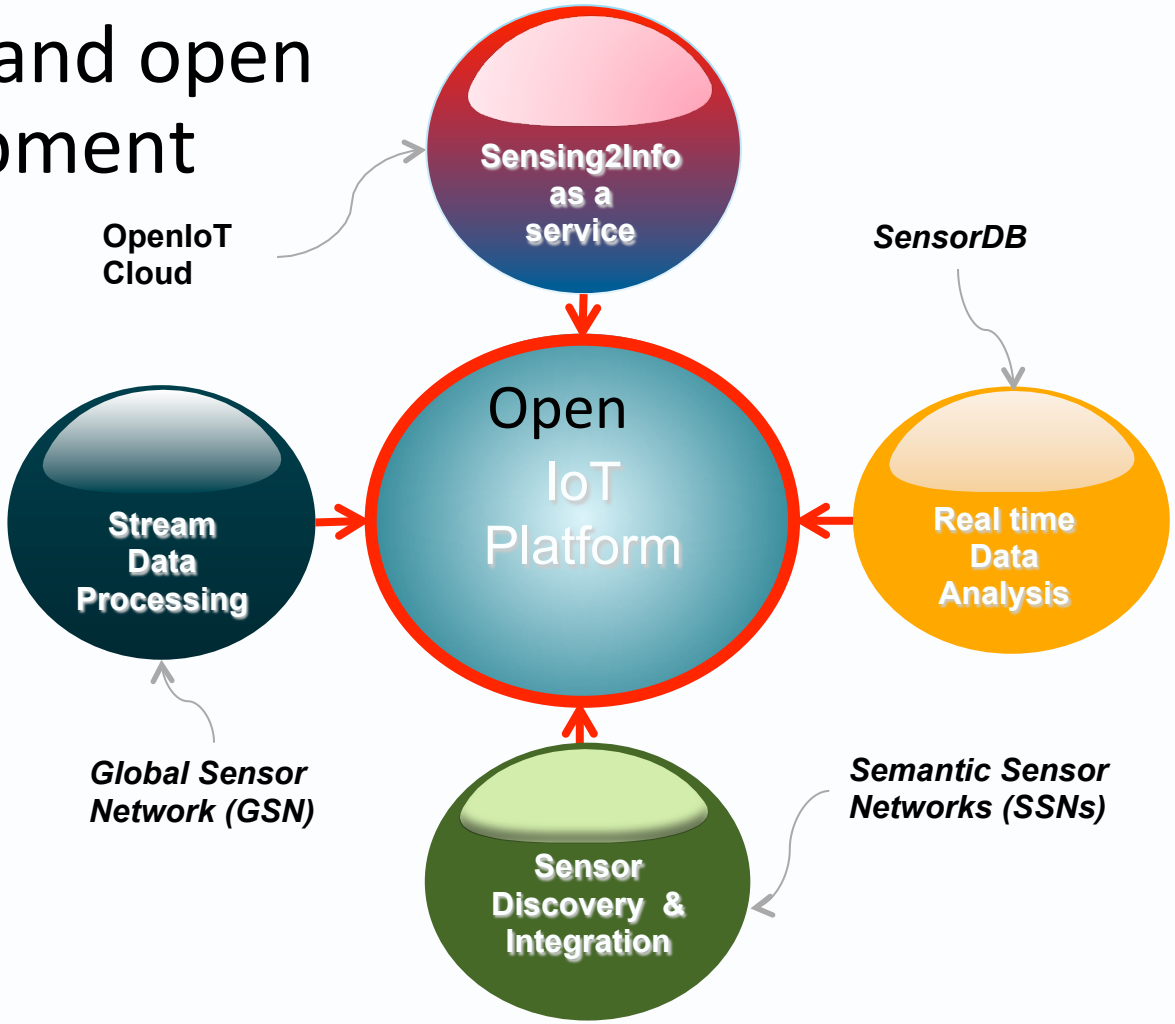


- By better utilizing land and water resources:
  - Phenonet increases crop yields
  - In Australia 1% improvement in wheat yield = $50M export earnings (2010)

"Phenonet … will have a major impact on Australian wheat breeding and in the longer term on global food security Dr Bob Furbank, Director of High Resolution Plant Phenomics Centre

CONCLUSION

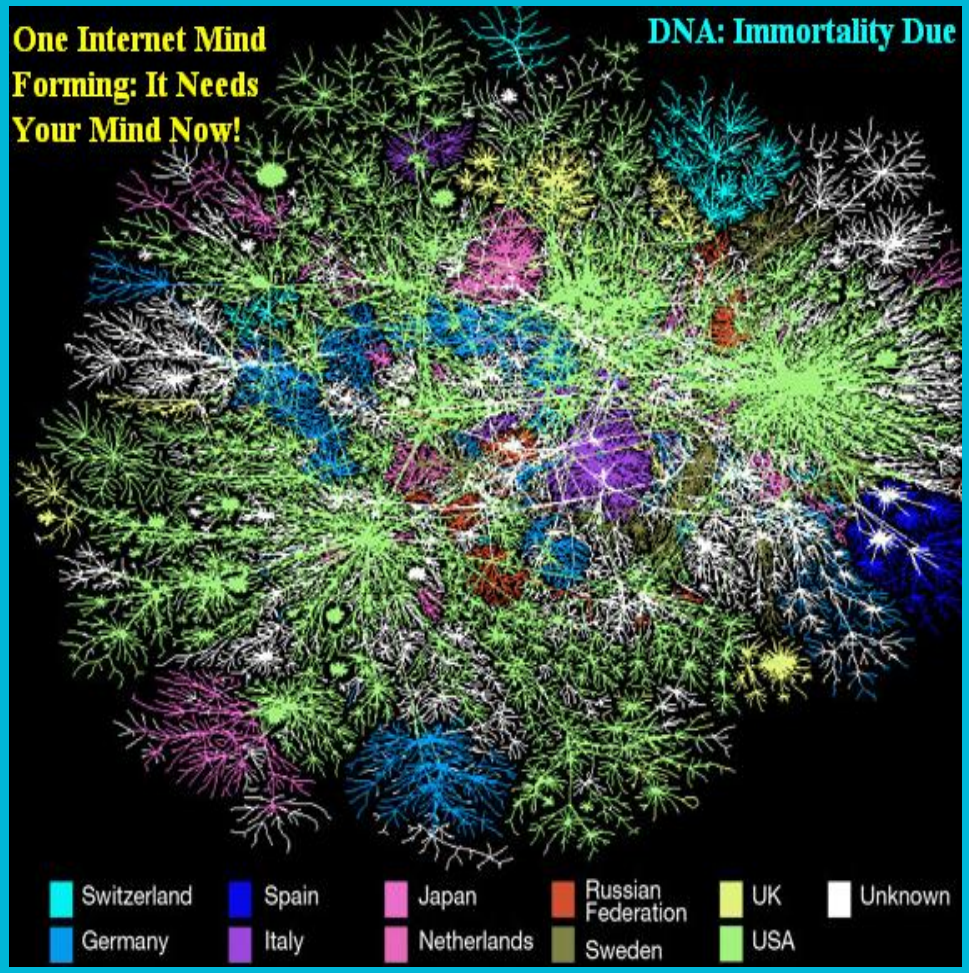
- Joint research and open source development addresses the big data issue in IoT



- Case study/impact in agriculture

PREDICTION IS VERY DIFFICULT, ESPECIALLY ABOUT THE FUTURE.

Niels Bohr



Thank you !

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