Future Internet Applications: The next trillion to be connected

4th Biennial Conference

Presented by: Dr. Louis Coetzee

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Phenomenon

- Cost of connectivity – **decreasing** dramatically
- Cost of computation – **decreasing** dramatically
- Cost of storage – **decreasing** dramatically
- Size of computation devices – **decreasing** dramatically

… whilst ...

- Number of Internet connected devices – **increasing** dramatically
- Amount of data generated – **increasing** dramatically
- Need for making faster, better choices – **increasing** dramatically

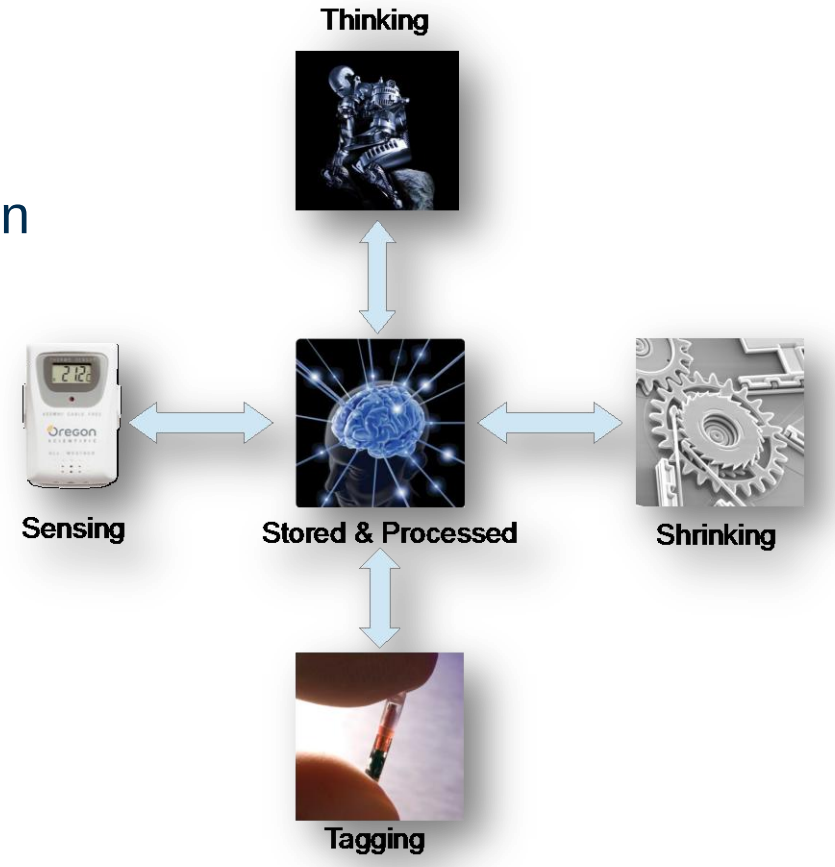





Reality: Every- and Any- Thing are being Connected

The physical world is increasingly integrated into the Internet

- 1990s – connecting Information
- 2000s – connecting People
- 2010s – connecting Things



Images from:
http://www.learning-mind.com/interesting-facts-about-human-memory/ http://www.electronic-replicant.com/2010/02/desktop-friday-thinker/
http://homoartificialis.wordpress.com/category/nanotechnology/
http://popsci.typepad.com/popsci/2007/09/rfid-implants-m.html
http://www.weathershop.co.uk/shop/replacement-temp-sensor-thr228n-sensor

IoT == Phenomenon

This phenomenon is called...

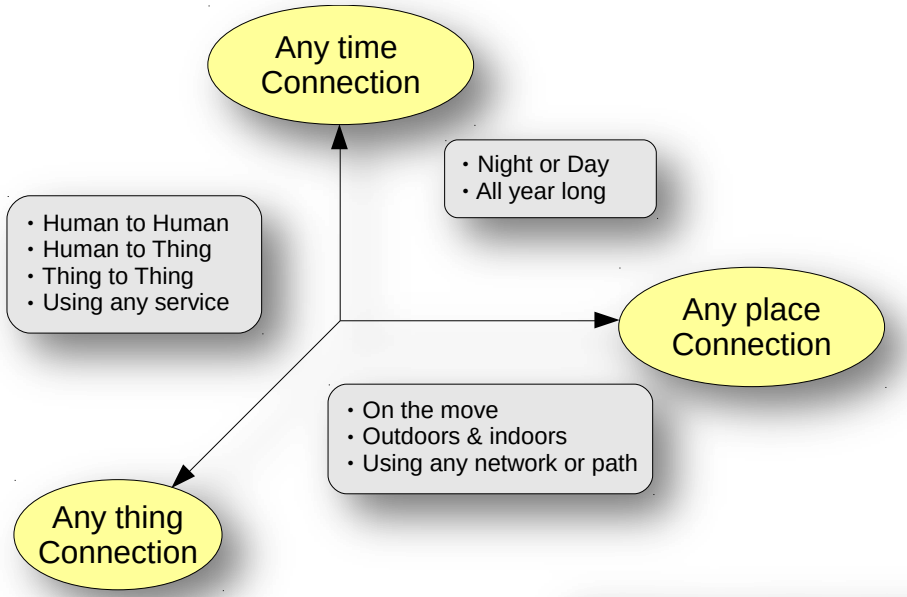
The Internet of Things

Imagine the Possibilities..

...when

Any-one,
Any-thing,
Any-time,
Any-place,
Any-path/network,
Any-service,

is Internet connected...



*Adopted from ITU Internet Report 2005: The Internet of Things

- ...where **Physical**, **Digital** and **Virtual** worlds are converged into a **smarter environment**
- ...and addresses the **needs (social and economical)** for the benefit of the whole society

Exploiting IoT Requires Complex, In-time Decisions

- To benefit from a well-connected world
  - Better **decisions** need to be made **faster**
- But:
  - Decisions are becoming more complex
  - Decisions are becoming more urgent
  - Decisions are influenced by more data from the connected heterogeneous world

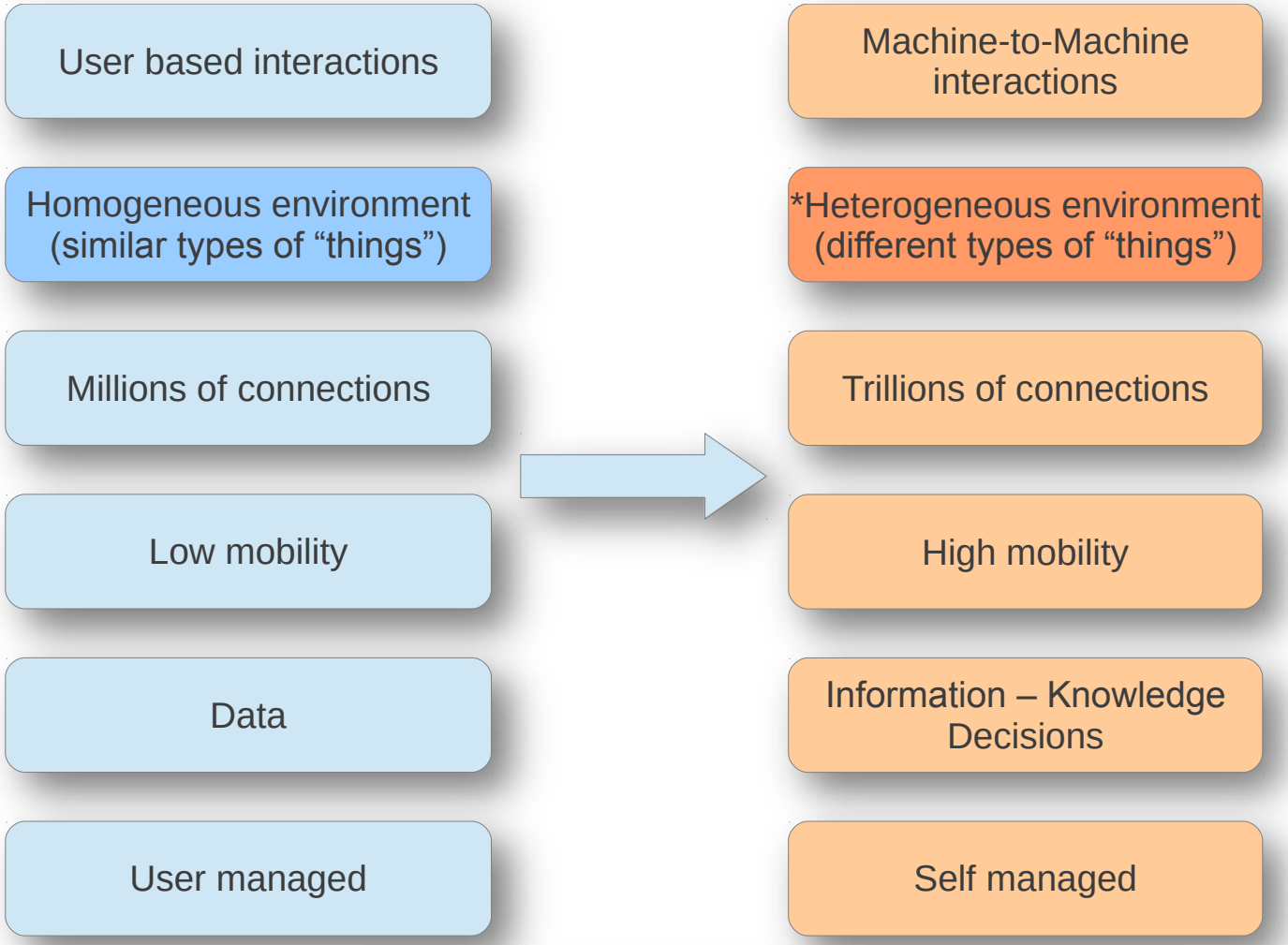
*Image from http://epthinking.blogspot.com/2011/09/on-internet-of-things-iot.html

Why? – Because Real-time Decision Making is Getting Complex

- Society needs:
  - Better efficiency
  - Greener environments
  - Better service
  - Better cost effectiveness
  - Less waste
  - Effective economy
  - Appropriate knowledge
- Complexity is increasing:
  - Billions of structured and unstructured messages
  - Billions of sources of data
  - Billions of terabytes of data
  - Billions of heterogeneous devices
- Technology drivers are changing the landscape:
  - Technology laws: size, power, storage, bandwidth, cost
  - Ubiquitous sensors and actuators are increasingly self-configuring

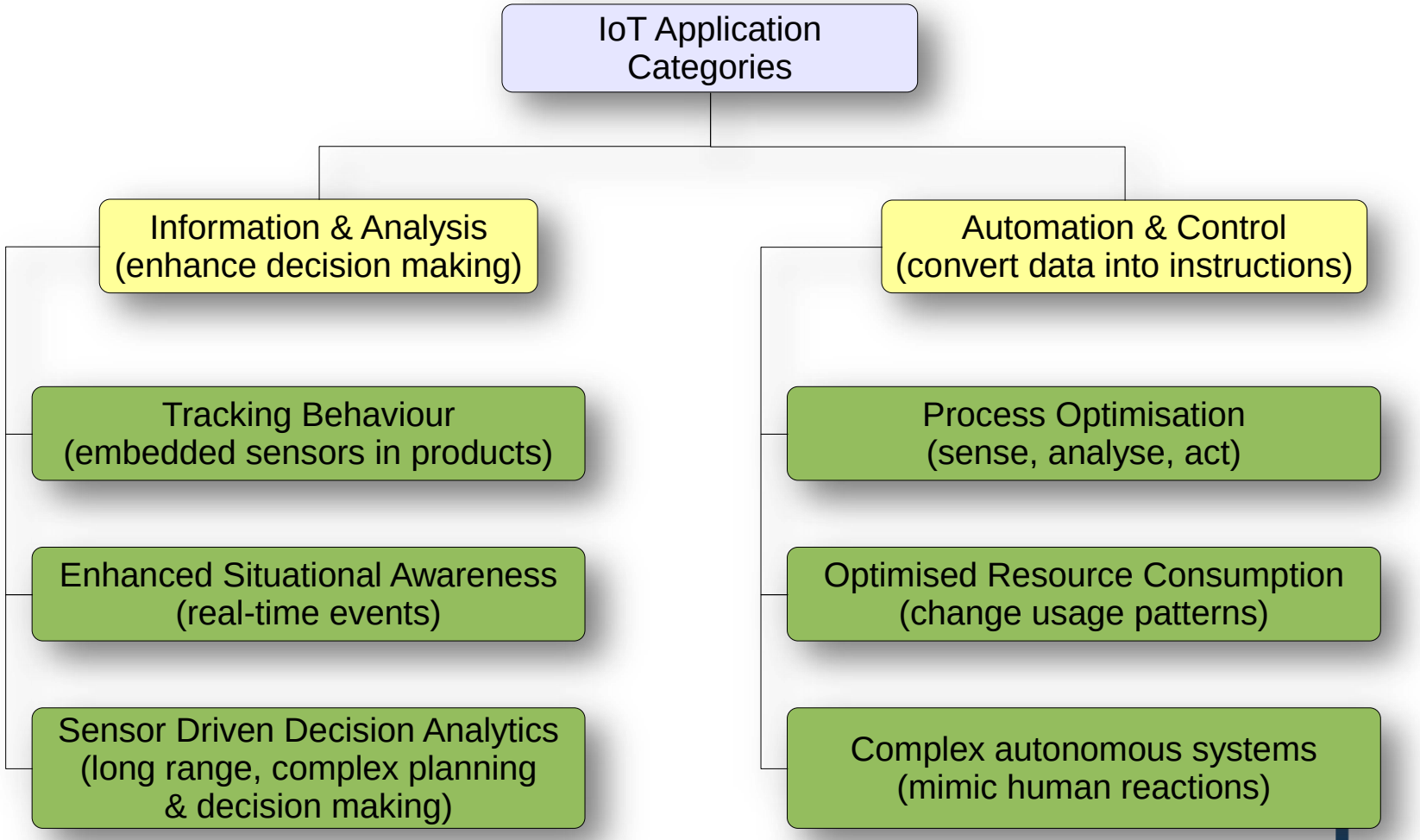
Needs are related to Assets, Resources and the Environment

IoT Challenges



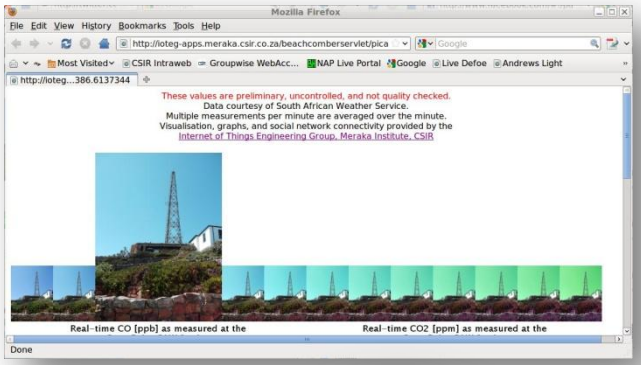
Slide adapted from IERC presentation “IoT Research and Development” by Dr. Ovidiu Vermesan
*Ranges from different sensors, actuators, devices, smart technologies, cloud back-end services

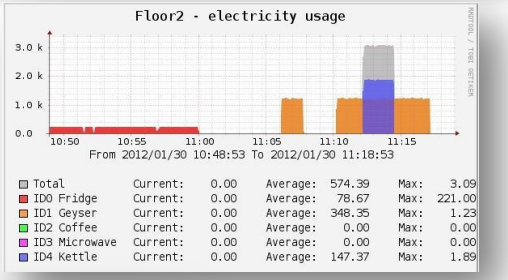
IoT Application Categories

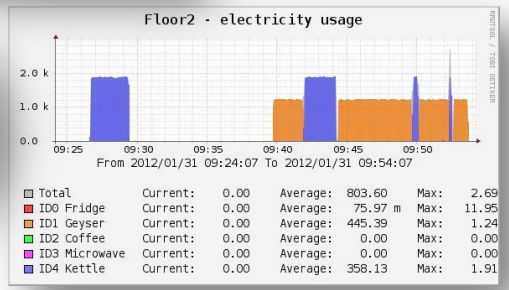


*McKinsey Quarterly

IoT Demonstrations







Industry

RFID
QR codes

Environmental
Control

Natural
Environment

Smarter
(IoT)

Built
Environment

Carbon, Water
pollution

Energy

Society

Social media
dissemination

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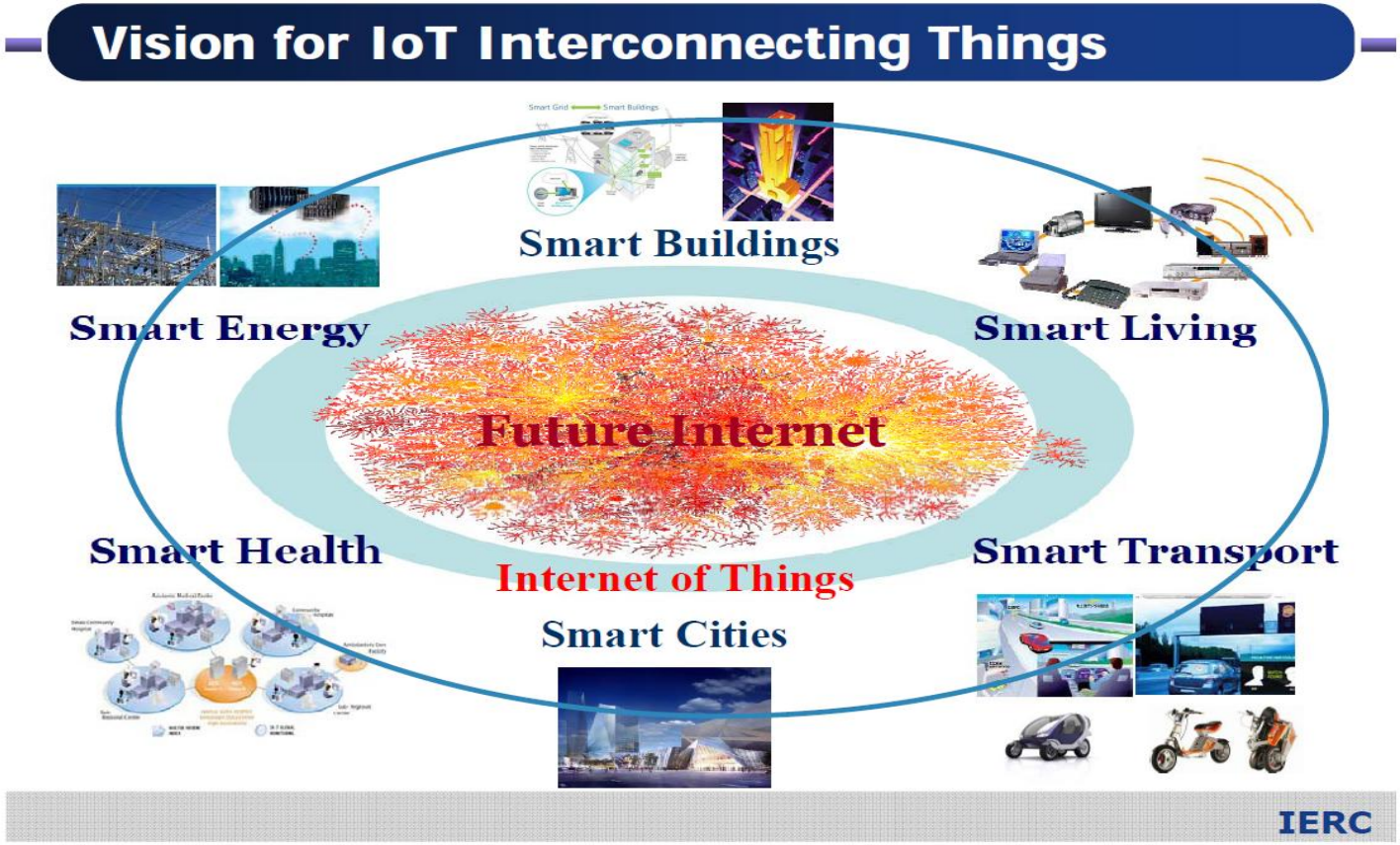
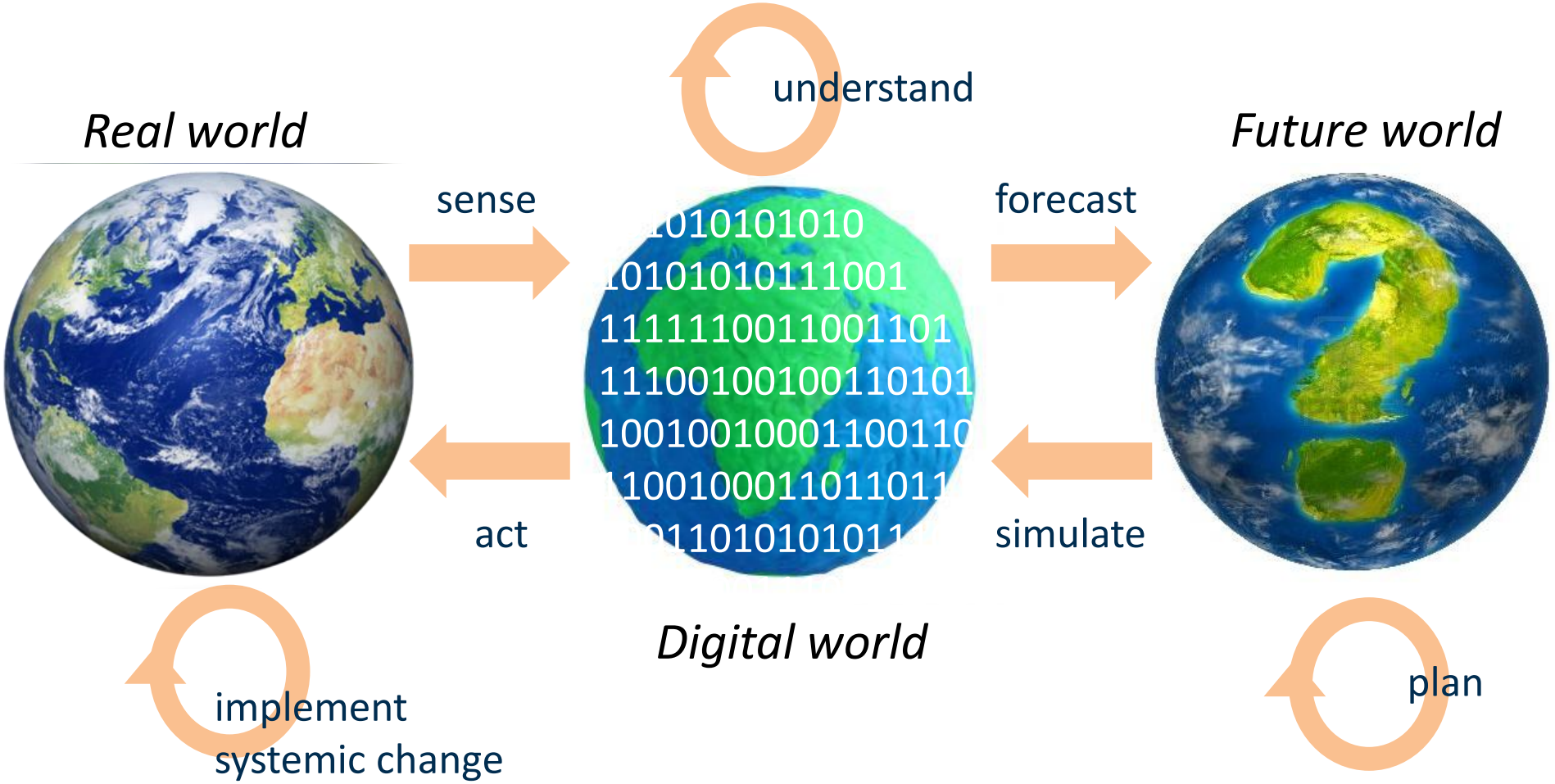
IoT Vision



Slide from IERC presentation "IoT Research and Development" by Dr. Ovidiu Vermesan

Real and Digital world become one => Smarter world



CSIR
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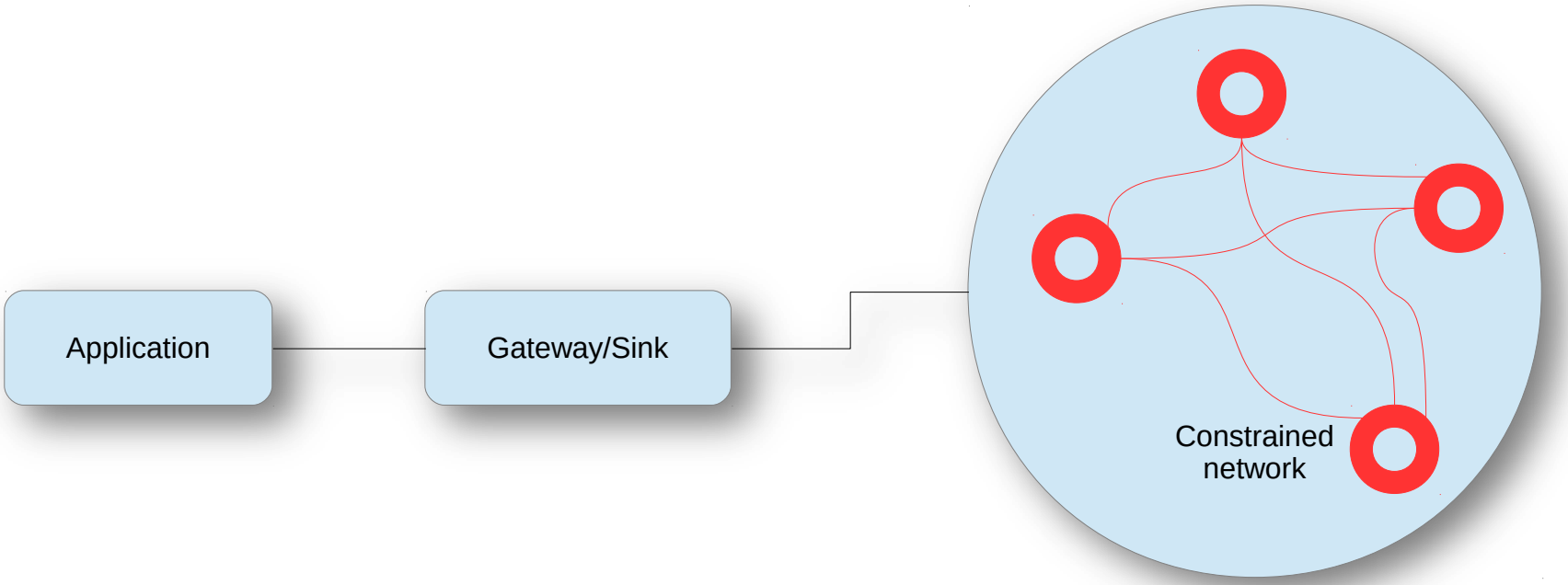
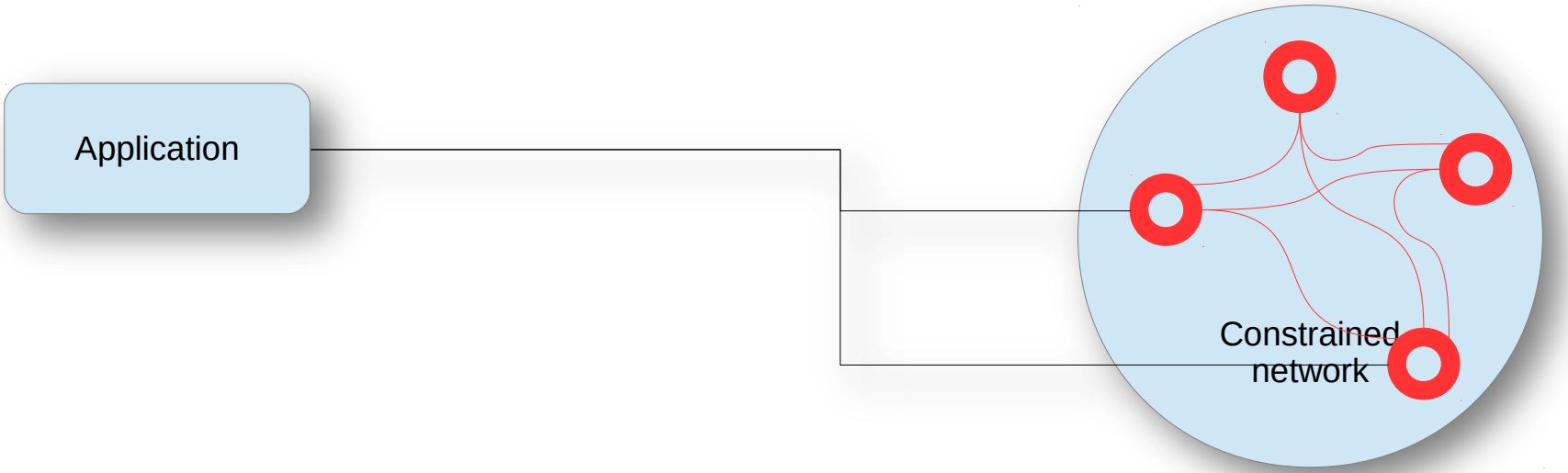
Architecture Progression: Sensor Networks



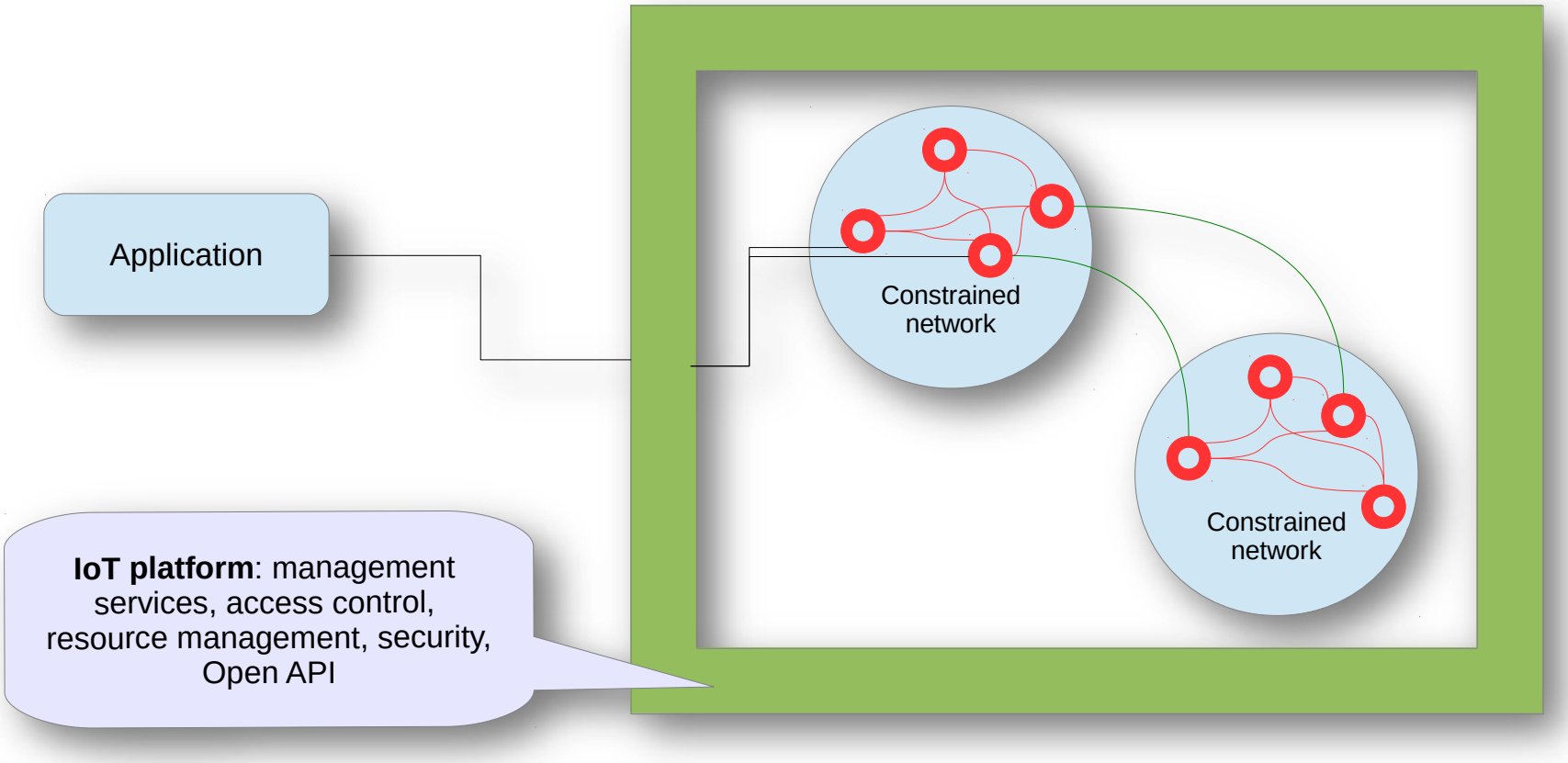
- Gateway/Sink node acquires and aggregates data from constrained network and pass it to applications
- Direct access to a node in constrained network is impossible (constrained network nodes are invisible beyond gateway/sink)

Architecture Progression: Fully Addressable Objects



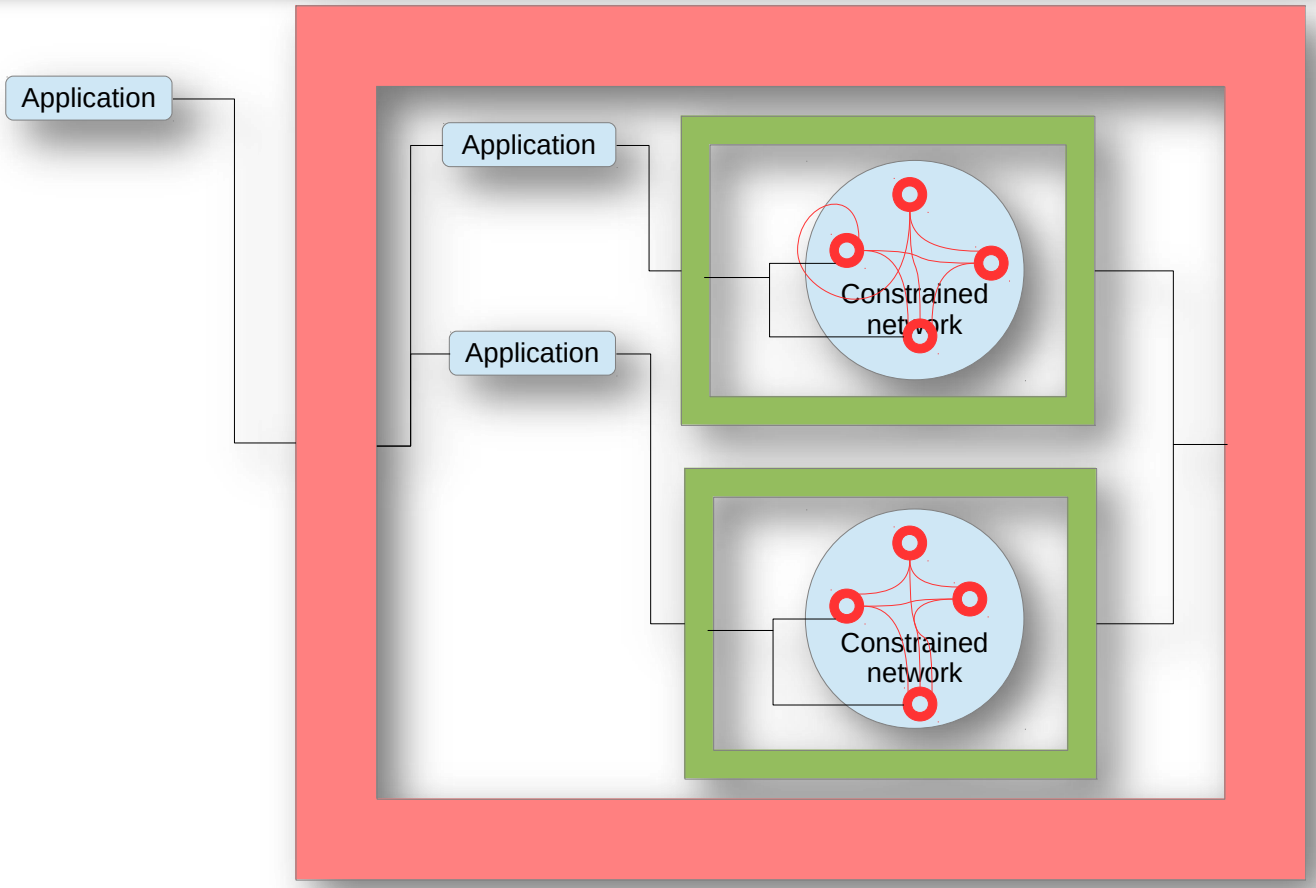
- Each node is unique and atomic and visible to application
- Nodes are provider and consumer at the same time
- Application interfaces only with nodes of interest

Architecture Progression: Full IoT Platform



- Platform manages resources and provides enabling services and open APIs
- Provides for software deployment and updates
- Orchestration and composition of device groups (strategies for better data retrieval)

Architecture Progression: Federated IoT Platform



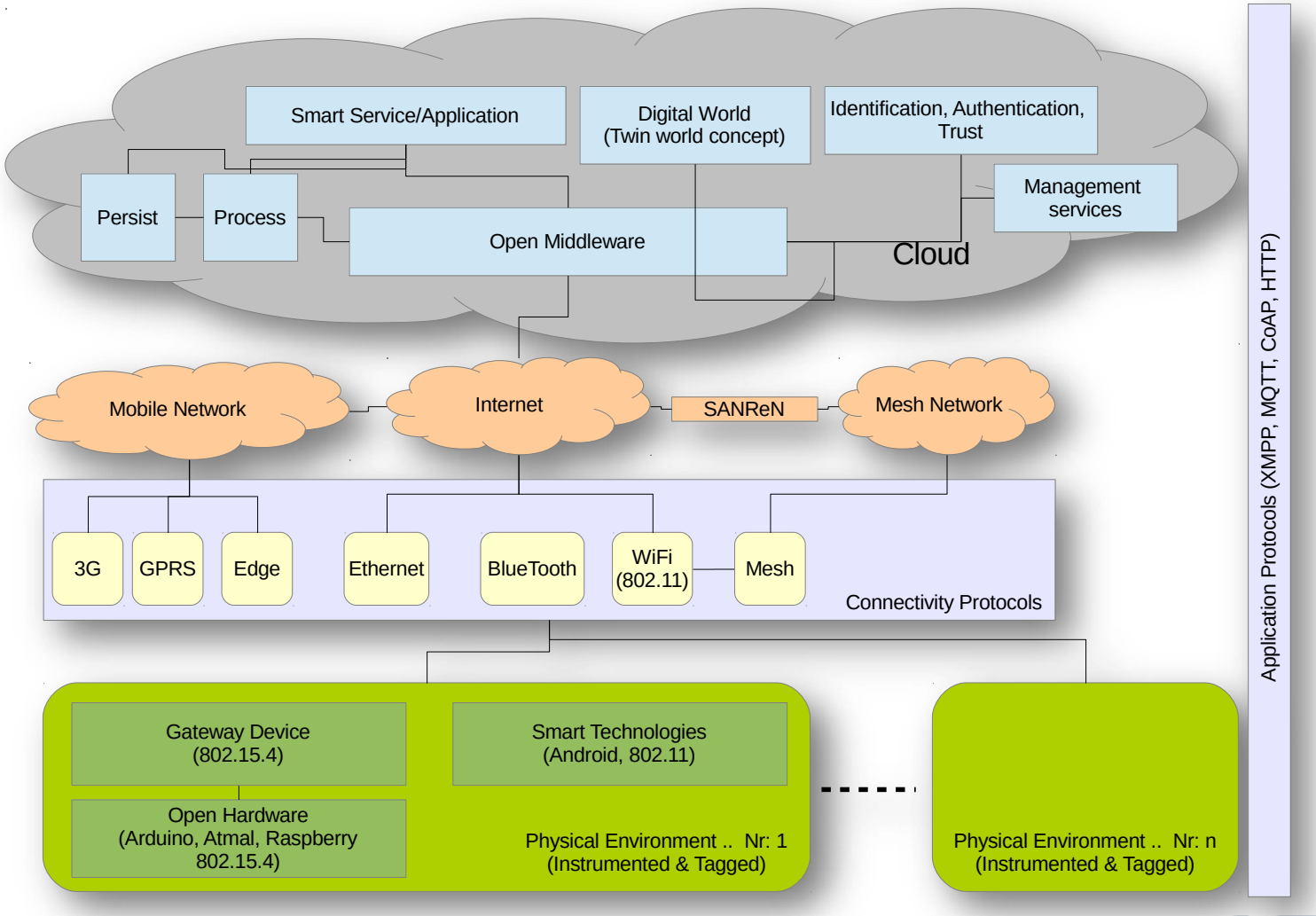
- Merges several platforms from different deployments
- Provides data to applications from several deployments
- Enables added-value and new services through open APIs (previously impossible with data from only one platform)

Managing the next Trillion Connections for a Smarter Environment: Integrated Testbed

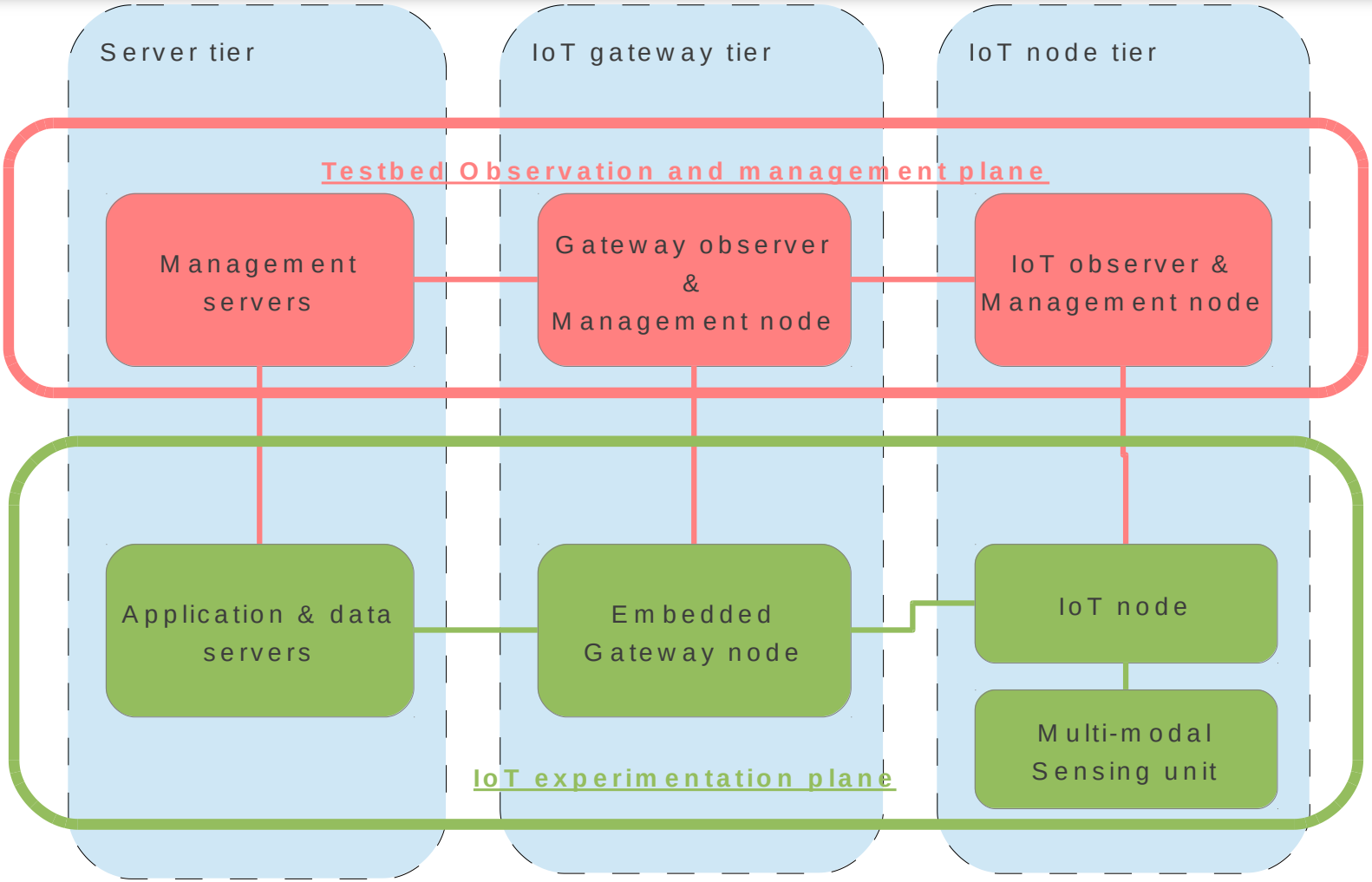
- To overcome the challenges of widescale IoT deployments developers require repeatable evaluation of IoT solutions using interdisciplinary, multi-technology, large-scale and realistic testbeds
- Test IoT solutions on a larger scale and outside of research laboratories (real environments with real users)
- Accelerate IoT research and deployment for the benefit of society
- Empower industry and academia

Testbed == a real-world scaled development and experimental environment

Internet of Things: Testbed



Internet of Things: Testbed Logical View



*Slide adapted from Dr. Alexander Gluhak, University of Surrey, FP7 SmartSantander Presentation

Final Thoughts

- New possibilities because of everything being connected
- Opportunity to radically impact on our society and economy through these connection of everything
- CSIR well positioned to exploit the window of opportunity
  - Competences spread across CSIR:
    - Meraka
    - MSM
    - MDS
    - BE
    - DPSS
  - Require a cross-cutting initiative to make a reality:
    - Testbed enabling a Smarter World
- Several possible large scale initiatives:
  - Smarter World
  - Bio-degradable house

Thank you

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