

Trans-Atlantic Symposium on ICT Technology and Policy: IoT/CPS Expert Group



IoT/CPS Beyond the Hype: A vision for Connected Smart City Systems & Edge Services

June 2017, Minneapolis, MN, USA

Dr. Martin Serrano

Principal Investigator & Data Scientist
IEEE ComSoc IoT Emerging Technologies
IoT Experimentation Chair
<martin.serrano@ieee.com>



© Copyright 2017 Insight Centre for Data Analytics Galway. All rights reserved.





Dr. Martin Serrano

Principal Investigator & Data Scientist
IEEE ComSoc IoT Emerging Technologies
IoT Experimentation Chair
<martin.serrano@ieee.com>



IEEE ComSoc
Emerging Technologies
Sub-Committee Internet of Things
IoT Experimentation Chapter



siliconrepublic

2016

25 key people influencing the internet of things

by John Kennedy

10 OCT 2015 156 SHARES

2015

Irish and Ireland-based leaders, scientists and technologists are putting the country on the global map in terms of the internet of things (IoT) revolution.

NIST GCTC Smart Cities Project
Technical Coordinator, USA
Santa Clara University
Lecturer, Silicon Valley, USA

2014

NUIG-National University of Ireland
IoT Scientific Director, Galway, Ireland

Irish Software Association
Software Industry Awards outstanding
Academic Achievement Nominee, Ireland

Industry

Design Engineer Supervisor, AKME-BC
NATIONAL Panasonic
Kumamoto, Japan

Research Excellence
President's Award Nominee SFI-NUIG,
Ireland

California State University
Lecturer, San Luis Obispo (CalPoly), USA

2013

WIT-Waterford Institute of Technology
Cloud Computing & Semantics
Post-Doc Researcher, Ireland

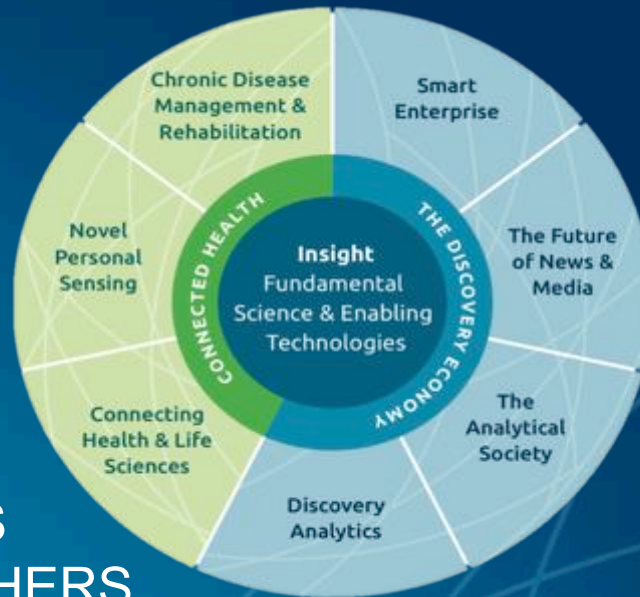
WIT-Waterford Institute of Technology
Autonomic Communications
Research Internship, Galway Ireland



Insight

Centre for Data Analytics

Centre for
Data Analytics



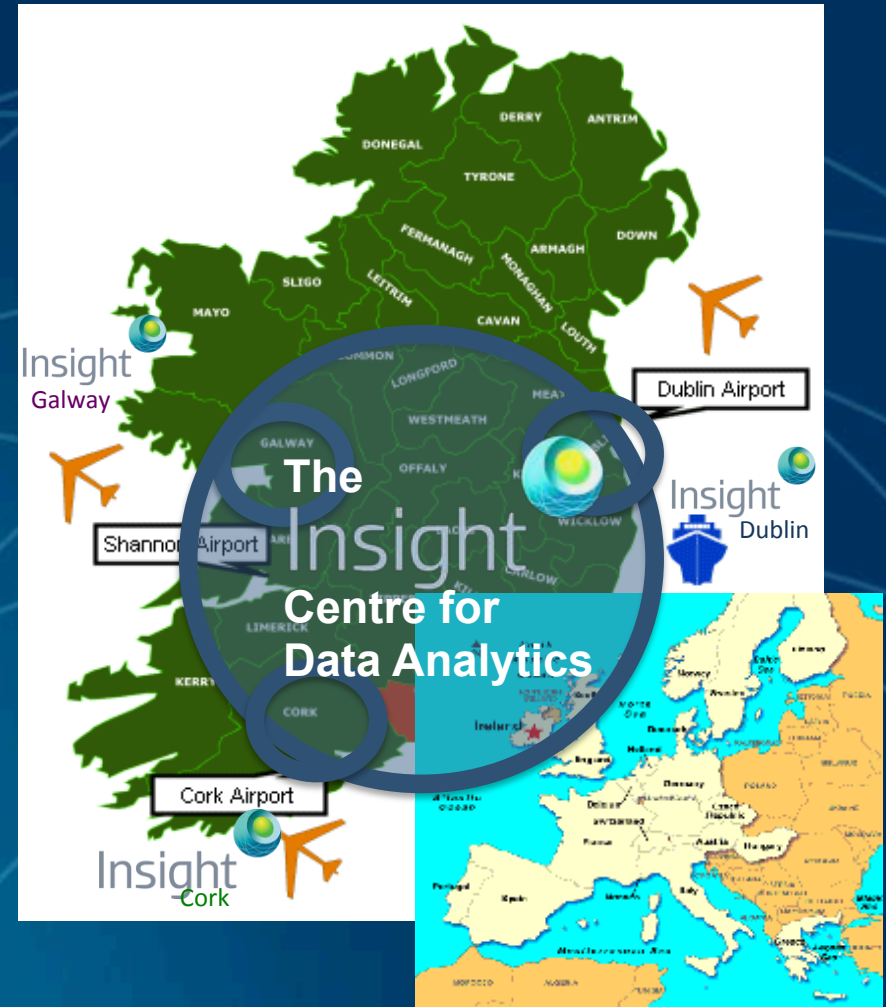
8 INSTITUTIONS
 300+ RESEARCHERS
 30+ INDUSTRY PARTNERS
 €88M FUNDING

Creating a data-driven society

New ways to capture and understand data from the world around us,

Make better decisions for people, communities and industries,

Create a more informed society in a healthier, more productive world.



Smart Cities, Crowd Sensing, LSD
Services and Applications

Insight Centre for Data Analytics

The Internet of Things and Unit

Semantic Web

Stream Processing

Semantics

Big Data

Interoperability

Data Streams

Devices

Technology

Applications

Internet

Cloud Computing

Insight Internet of Things and
Stream Processing Unit





Trans-Atlantic Symposium on ICT Technology and Policy:
IoT/CPS Expert Group

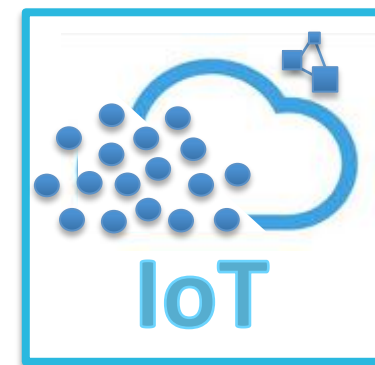
Agenda

Introduction

Smart Systems Convergence & Interoperability

Connected Smart City Systems

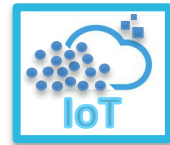
Final Comments



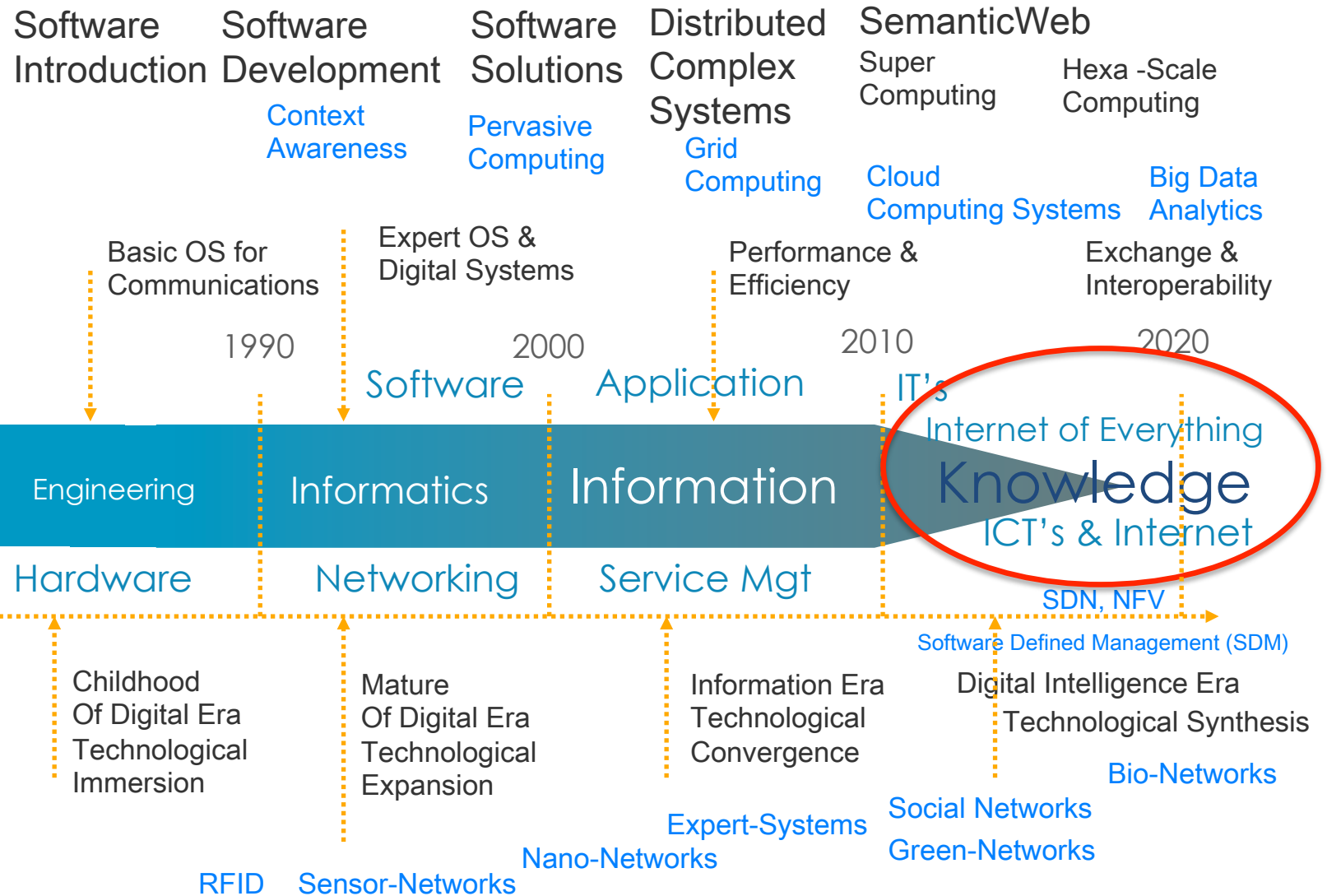
Insight Centre for Data Analytics

Internet of Things Roadmap Vision for Convergence in ICT Technology

Insight Internet of Things and
Stream Processing Unit



A bit of History...



* Updated from Technology and Services Convergence Evolution Diagram, M. Serrano., 2008.

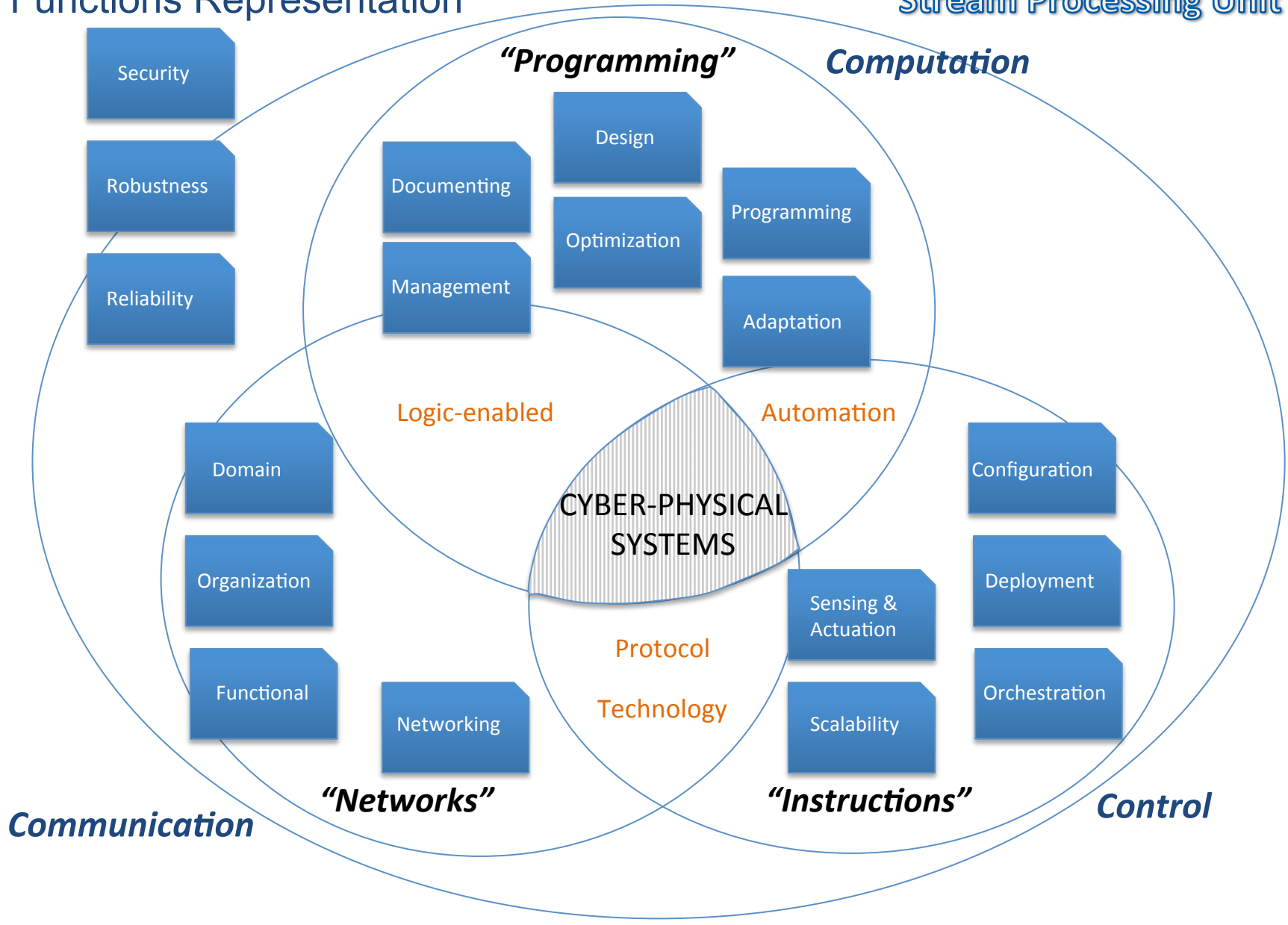
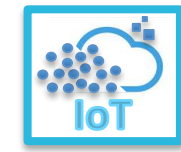
*M.Serrano 2014 OpenIoT



Insight UIoT Contact: Dr. Martin Serrano
martin.serrano@insight-centre.org

Cyber-Physical Systems Main Functions Representation

Insight Internet of Things and
Stream Processing Unit



2015 NUIG-Insight – Cyber-Physical Systems Overview

Dimensions in the Internet of Things

One Vision – Different Dimensions

Insight Internet of Things and Stream Processing Unit

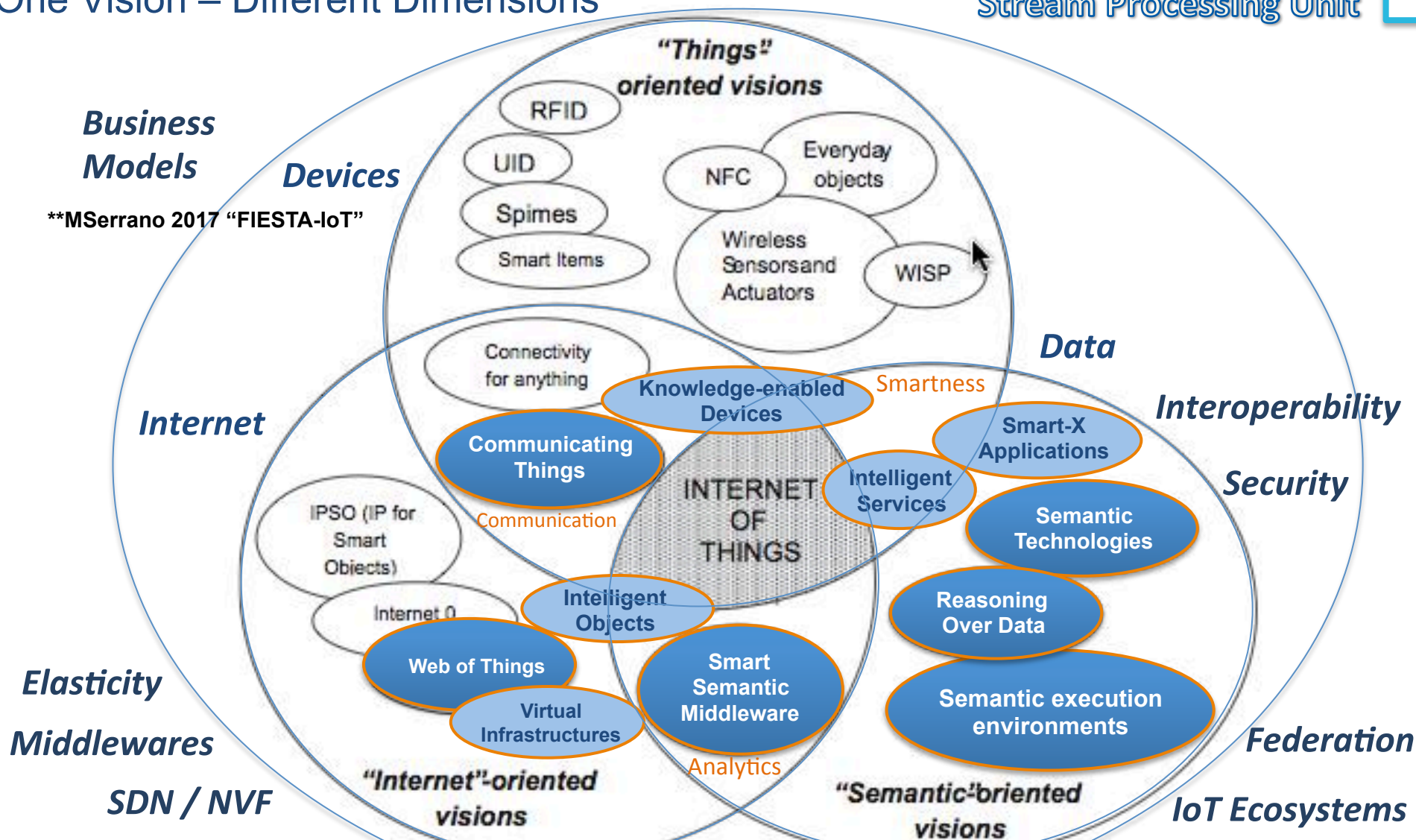


Diagram adapted from L. Atzori et al., 2010, "the Internet of Things: a Survey"

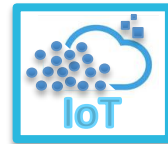
*MSerrano 2013 "OpenIoT"

**MSerrano 2015 "Vital-IoT"

2017 NUIG-Insight - Internet of Things Overview

IoT / CPS Allignment One Example in Manufacturing

Insight Internet of Things and
Stream Processing Unit



Internet of Things / Cyber-Physical Systems

Manufacturing Domain

Smartness

Intelligent Services Intelligent Objects

Knowledge-enabled Devices

Smart-X Applications

Reasoning Over Data

Smart Semantic Middleware Virtual Infrastructures

Analytics

Semantic Technologies

Communication

Protocols
Sensor Networks
Technology

Automation

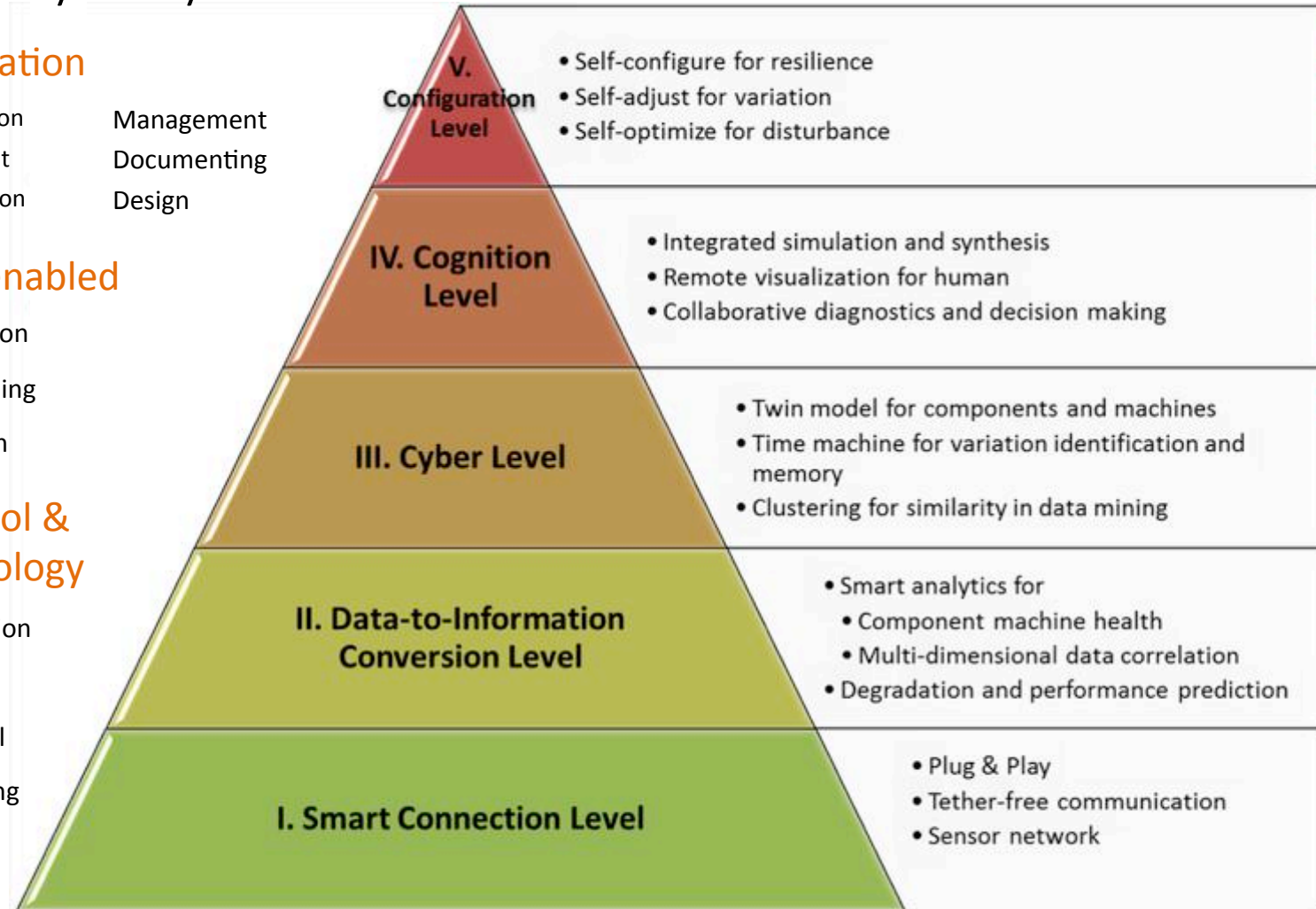
Configuration Management
Deployment Documenting
Orchestration Design

Logic-enabled

Optimization
Programming
Adaptation

Protocol & Technology

Organization
Scalability
Functional
Networking
Sensing & Actuation



*5c Architecture for CPS "Big future for cyber-physical manufacturing systems" September 23, 2015
http://www.designworldonline.com/big-future-for-cyber-physical-manufacturing-systems/#_



Trans-Atlantic Symposium on ICT Technology and Policy:
IoT/CPS Expert Group

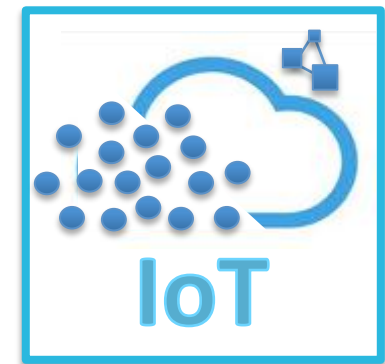
Agenda

Introduction

Smart Systems Convergence & Interoperability

Connected Smart City Systems

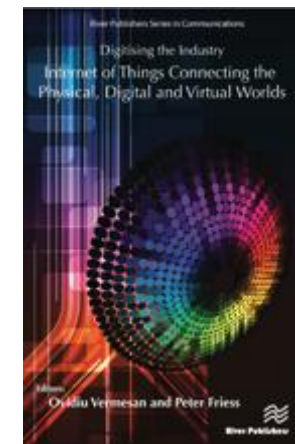
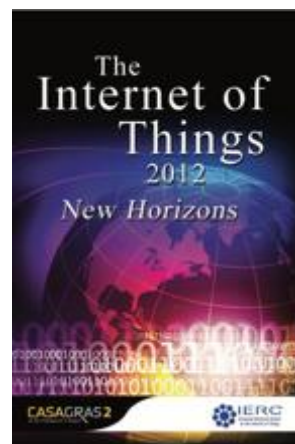
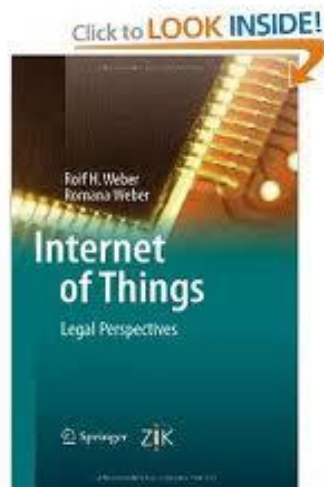
Final Comments



Insight Centre for Data Analytics

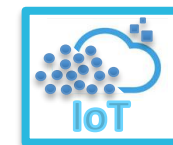
European IoT Modelling and Deployments Research Cluster Evolution (2009-2016)

Insight Internet of Things and Stream Processing Unit



European IoT Communities Landscape (2017)

Insight Internet of Things and Stream Processing Unit



Industry Associations



AIOTI

Working Groups

Alliance for the Internet of Things Innovation

Innovation Actions



European Large Scale Pilots Community

Activity Groups

Research & Innovation Actions



IERC

European Research Cluster on the Internet of Things

Activity Chains



European Platforms Initiative

Task Forces

Experimentation Facilities



Future Internet Research and Experimentation

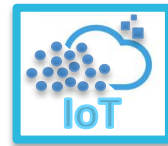
Focus Areas

Standards Organizations and Foundations

2016 NUIG-Insight – IoT European Ecosystem Composition

European IoT Research Time Line 2009-2020

Insight Internet of Things and Stream Processing Unit



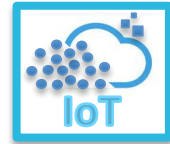
2009 → 2012 → 2013 → 2014 → 2015 → 2016 → 2017 → 2018 → 2019 → 2020



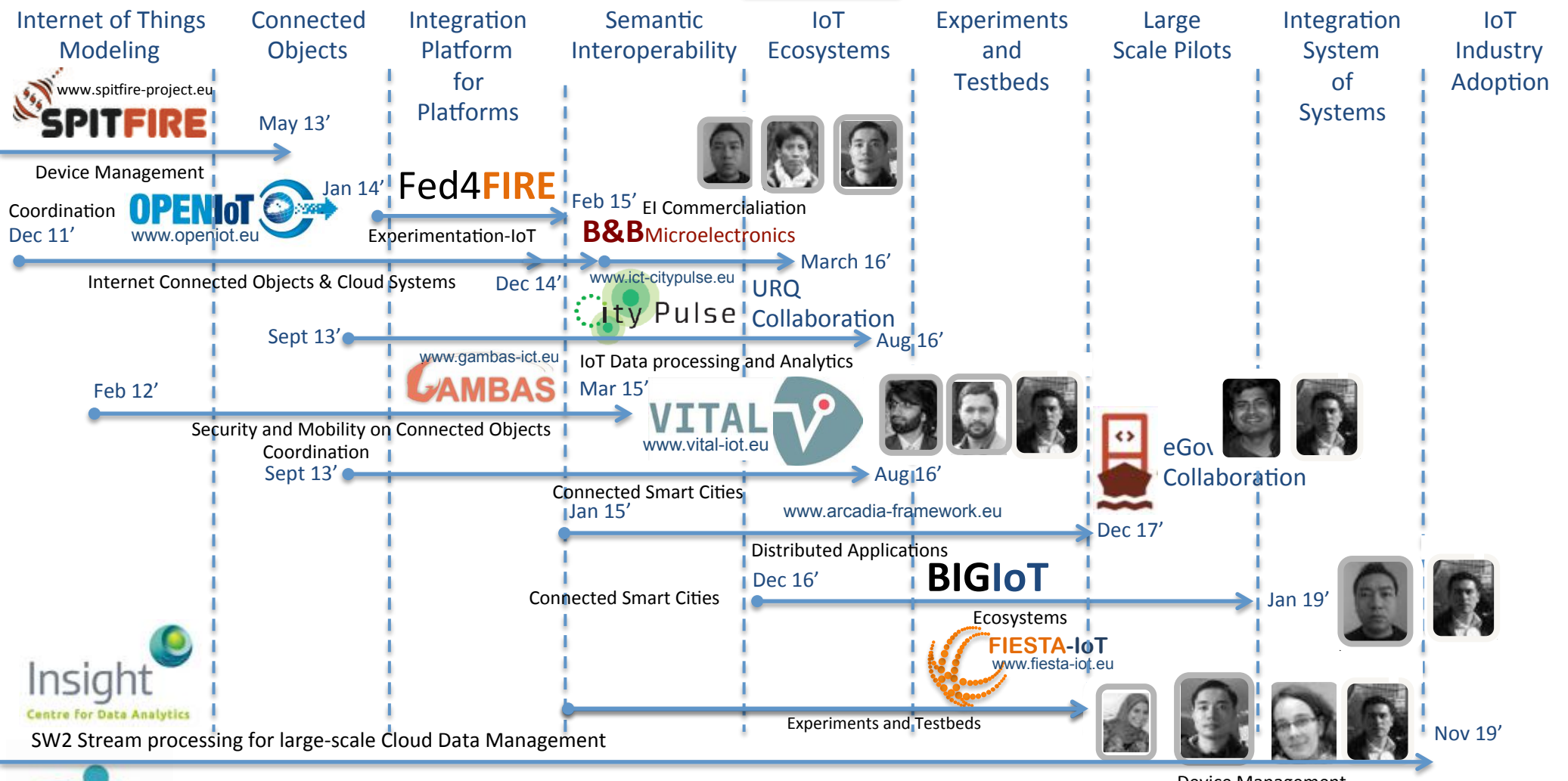


IoT Unit Time Line 2012-2020

Insight Internet of Things and Stream Processing Unit

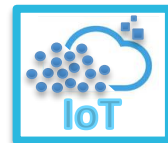


2009 → 2012 → 2013 → 2014 → 2015 → 2016 → 2017 → 2018 → 2019 → 2020



SW2 Stream processing for large-scale Cloud Data Management

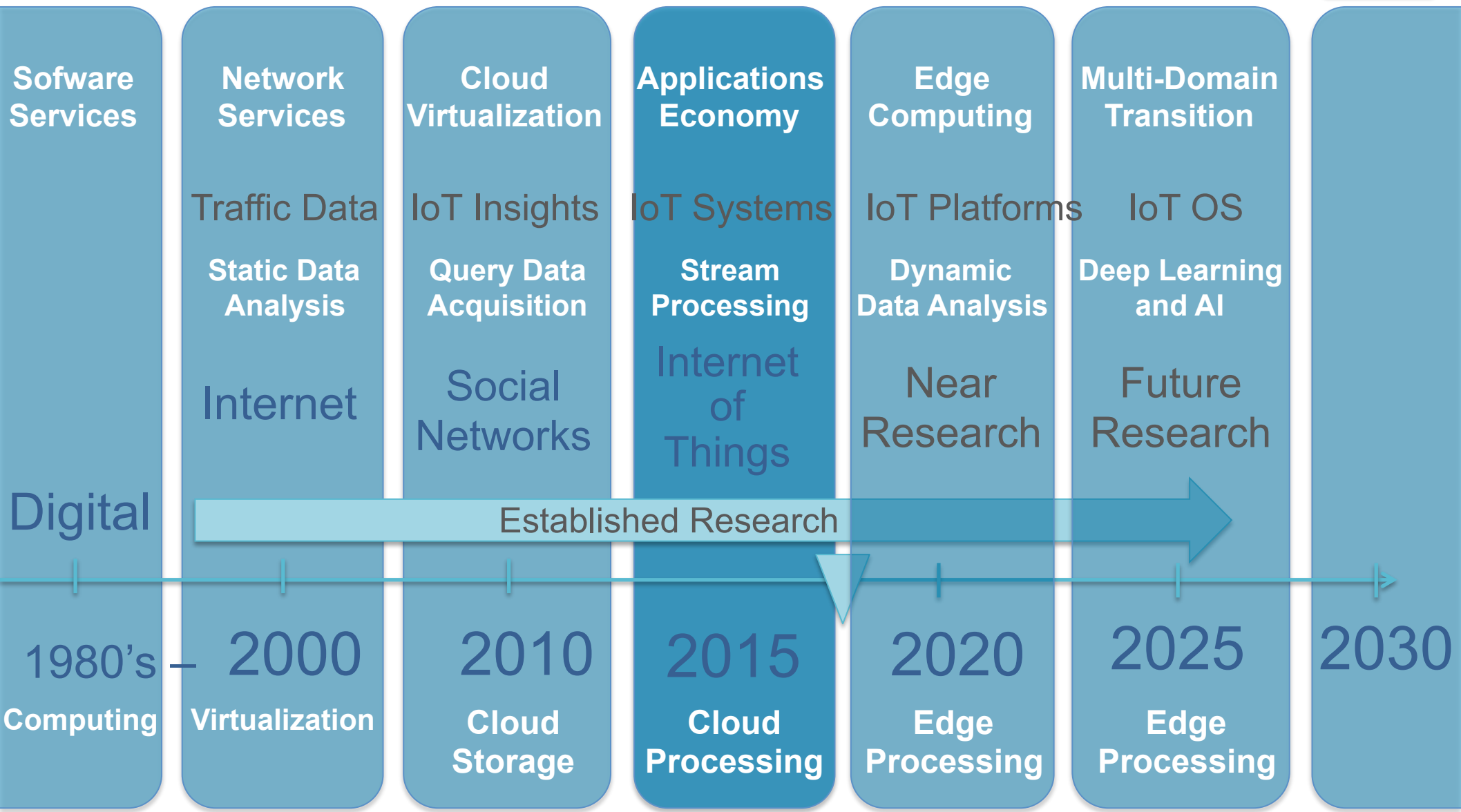




Data / Cloud / Stream Research Timeline

A vision beyond the hype

Insight Internet of Things and Stream Processing Unit





Trans-Atlantic Symposium on ICT Technology and Policy:
IoT/CPS Expert Group

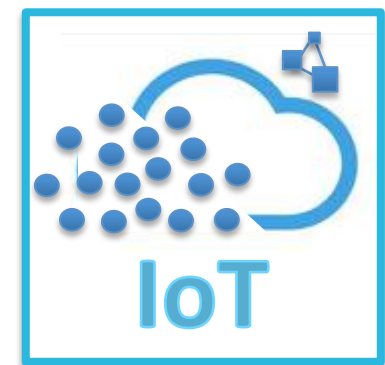
Agenda

Introduction

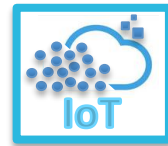
Smart Systems Convergence & Interoperability

Connected Smart City Systems

Final Comments



Insight Centre for Data Analytics



The Future of Smart Cities:

Defragmentation, Connecting & Interoperability

Smart City

Global Smart City, Services and Applications, Challenges for Smarter Cities
Interoperability, Sustainability and Reliability

Smart City Activities

OpenIoT: Smart Campus, Intelligent Manufacturing, Assitance Living
Crowdsensing Data, Large Scale Deployments

Vital-OS: Smarter Traffic, Smarter Working, Smarter City Mobility

FIESTA-IoT: Mobility in the City, Privcy and Secuity on Mobile, Crowdsensing

Linked Open Data: Public Institutions and Policy Making, Open Data



www.big-iot.eu



www.openiot.eu



www.vital-iot.eu



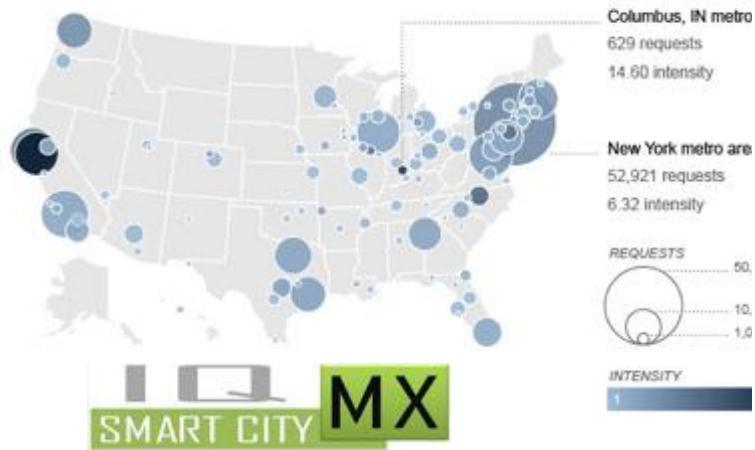
www.fiesta-iot.eu

Global Smart City Up Rising

SMART AMERICA



H-1B requests in high-demand metropolitan areas



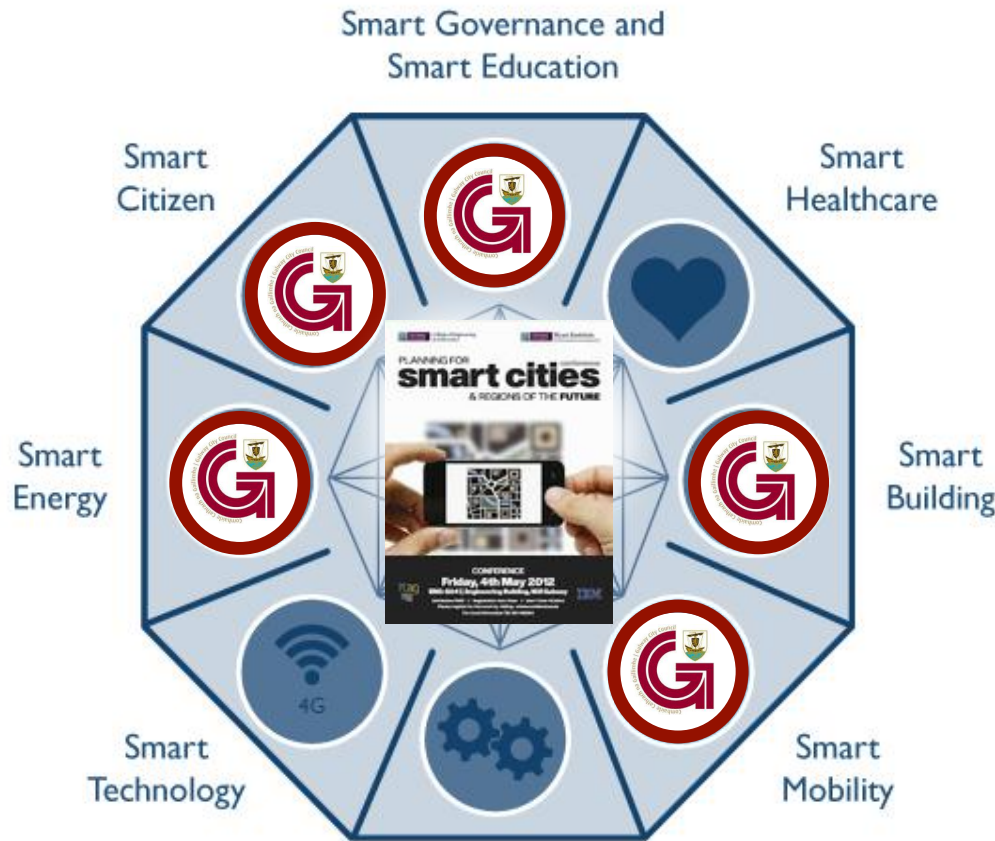
Smart cities in Europe ©Europeansmartcities



Internet of Things Current Status

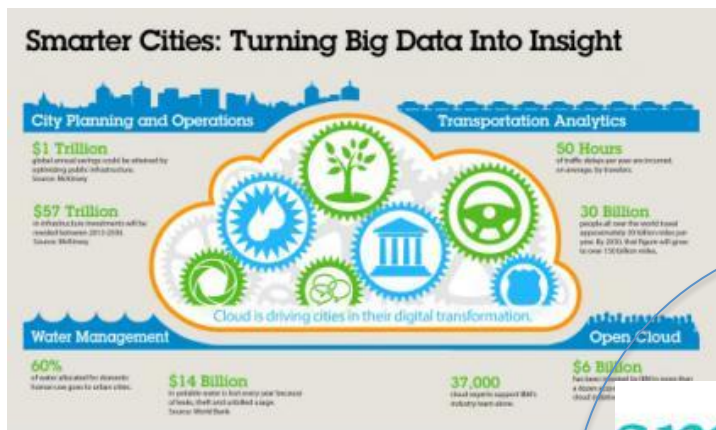
SMART CITY CONCEPTS

GCTC 2016-2017



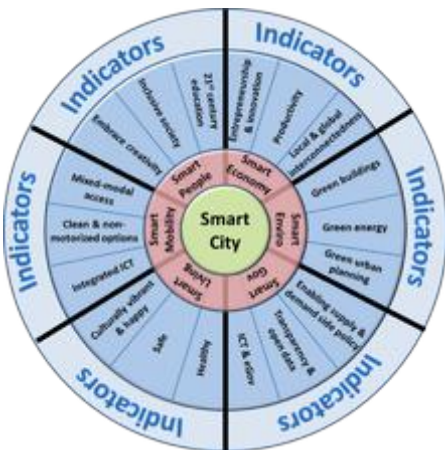
Smart City Challenges

Services and Infrastructure (IoT)

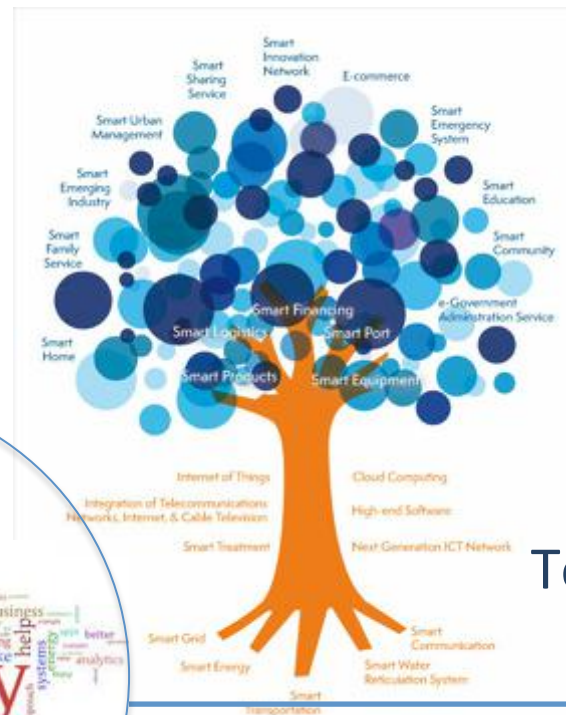


<http://smartcitiescouncil.com>

Organizations & Policy



eGovernment <http://www.enterrasolutions.com>

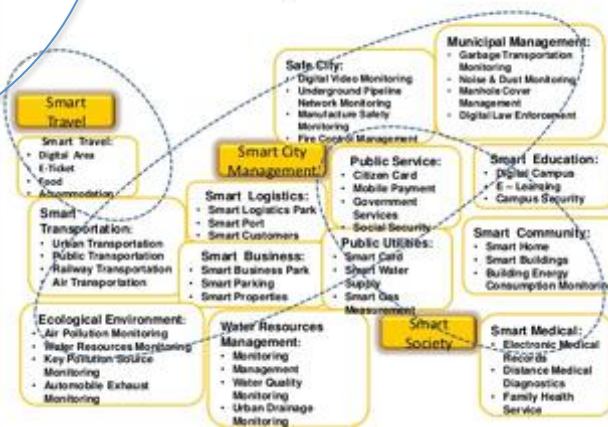


Citizens

Technology

<http://informationstrategysm.wordpress.com/>

Smart City and its Needs



<http://image.slidesharecdn.com> Interoperability

Ireland Smart City Vision

Services and Infrastructure

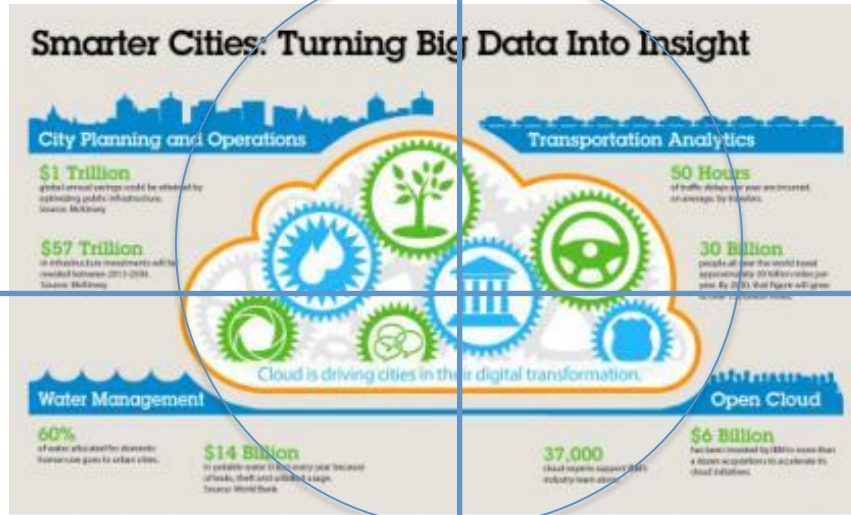
Citizens & Technology



Mobile services / devices for the Citizens' needs



Connecting Sensor Systems to the City



Internet of Things User-Centric Decision Support



Connecting Cities via Data



YourDATA stories



The Web to connect related Smart City data



http://smartcitiescouncil.com



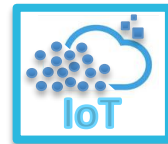
Data Openness & Interoperability

Policy & Good Government

Insight Centre for Data Analytics

The Future of Smart Cities

Insight Internet of Things and Stream Processing Unit

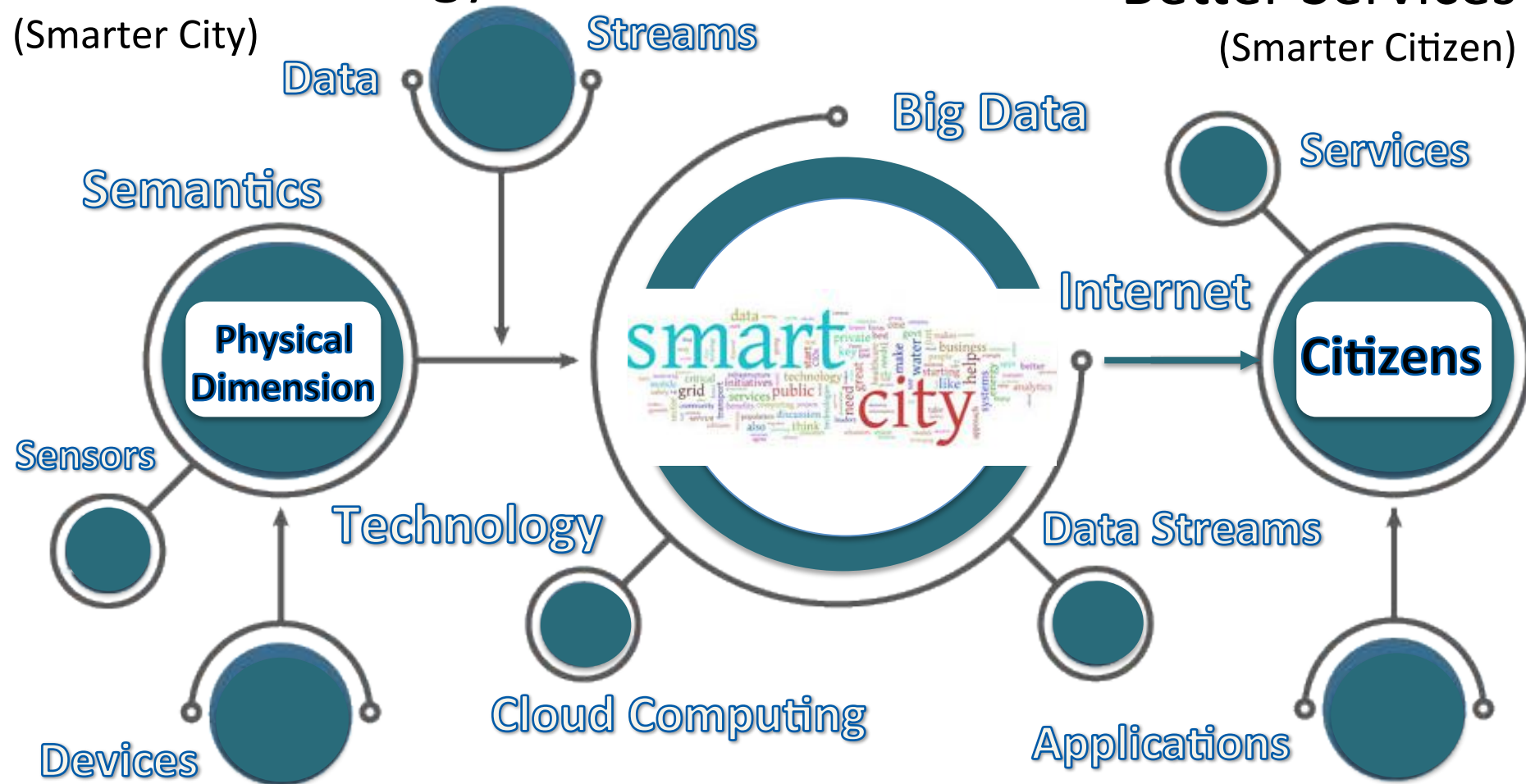


Smart Technology

(Smarter City)

Better Services

(Smarter Citizen)



2015 NUIG-Insight – Connected Smart City Services

Connected Data Systems

The Future of Smart Galway

Insight Internet of Things and Stream Processing Unit



Open Data

eGovernment

Healthcare

Education



Infrastructure

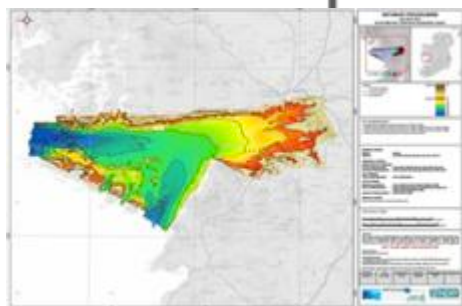


Energy

Technology

City Data

Mobility



Sensors

Transport

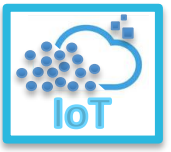
Applications

Devices

2016 GCTC NIST-US Ignite Project - Galway Smart City

Project VITAL www.vital-project.eu

Insight Internet of Things and Stream Processing Unit



The Future of Connected Smart Cities

Smart, Secure & Cost-effective integrated IoT deployments in Smart Cities



Project VITAL www.vital-project.eu

The VITAL-OS Operating Systems for Future of Smart Cities

Real-Time Analytics by Complex Event Processing and Live Stream Data from the City

The screenshot shows the 'VITAL-Healthmap' interface. The main content area displays 'ICO Details' for a 'Temperature Sensor'. It includes a 'vital:Running' status indicator, a description, observations, a location map, and hardware specifications like CPU Type (hard CPU), CPU Max (10 MHz), and Built-in Memory (131,872 KB). A sidebar on the left contains navigation options like 'ICO Details', 'Map', and 'Vital Systems'.



The screenshot shows the 'VITAL-IoT' interface. It features a sidebar with navigation options like 'Governance', 'Vital Systems', and 'Security'. The main area displays a 'List of IoTs/Services' table with columns for Name, Description, and Status. A search and filter bar is at the top.

#	Name	Description	Status
1	CEP IoT system	This is a VITAL compliant IoT system.	Running
2	Insight Centre - Netatmo	This is a VITAL compliant IoT system that provides environmental data from Netatmo sensors, deployed in Insight-Centre NUI Galway.	Running
3	VITAL PPI for Motes	VITAL PPI Developed for Motes deployed in Insight building at NUI Galway.	Running
4	MadridAirQuality	Madrid Air Quality PPI	Running
5	[TO]BIKE	CityBikes [TO]BIKE network operated by Comunicare S.r.l.	Running
6	Coca-Cola Zero [®] Bikes	CityBikes Coca-Cola Zero [®] Bikes network operated by The National Transport Authority	Running
7	Hi Reply virtualizer 1		Running
8	Velib	CityBikes Velib network operated by JCDecaux	Running

The screenshot shows the 'VITAL-CEP Demo Traffic Monitoring' interface. It features a map of a city area with numerous green sensor markers. A tooltip for a specific sensor is visible, showing details like 'Sensor: D100 Metroport' and 'Average Speed: 90 km/h'. The interface includes a search bar and navigation options.

VITAL-OS Management and Monitoring Tool

Real-Time Analytics by Complex Event Processing and Live Stream Data from the City

Istanbul Metropolitan Municipality

The VITAL OS provides tools for Future Connected Smart Cities

Sensors [Start Data] [Stop Data]

Sensor: D100 Metroport
 Sensor Id : vital2-l_TrS_402
 Average Speed: 90 km/h

ICO Details
 Type: Temperature Sensor
 Status: vital:Running
 Observations:
 Hardware:
 CPU Type: Intel CPU
 CPU Max: 10 MHz
 Frequency:
 Built in Memory: 131,872 KB

Smart Working in Cities

Dr. Martin Serrano
<martin.serrano@nuigalway.ie>



VITAL-OS Monitoring and Legacy Integration

VITAL-Healthmap Admin Istrator

Hello, Admin

List of IoTs/Services

Name	Status	Operator	Description
Istanbul Live Traffic Data	http://vital-iot.eu/ontology/ins/Running	arou@itit.edu.gr	This is a VITAL-compliant IoT system that provides live traffic data for Istanbul.

Smart Traffic Monitoring in Cities

VITAL-Healthmap Admin Istrator

Hello, Admin

List of ICOs/Sensors

Identifier	Type	Status
http://104.131.128.70:8080/istanbul-traffic/sensor/12-F	http://vital-iot.eu/ontology/ins/VitalSensor	http://vital-iot.eu/ontology/ins/Running
http://104.131.128.70:8080/istanbul-traffic/sensor/17-F	http://vital-iot.eu/ontology/ins/VitalSensor	http://vital-iot.eu/ontology/ins/Running
http://104.131.128.70:8080/istanbul-traffic/sensor/24-F	http://vital-iot.eu/ontology/ins/VitalSensor	http://vital-iot.eu/ontology/ins/Running
http://104.131.128.70:8080/istanbul-traffic/sensor/25-B	http://vital-iot.eu/ontology/ins/VitalSensor	http://vital-iot.eu/ontology/ins/Running
http://104.131.128.70:8080/istanbul-traffic/sensor/36-F	http://vital-iot.eu/ontology/ins/VitalSensor	http://vital-iot.eu/ontology/ins/Running
http://104.131.128.70:8080/istanbul-traffic/sensor/43-F	http://vital-iot.eu/ontology/ins/VitalSensor	http://vital-iot.eu/ontology/ins/Running
http://104.131.128.70:8080/istanbul-traffic/sensor/5-F	http://vital-iot.eu/ontology/ins/VitalSensor	http://vital-iot.eu/ontology/ins/Running
http://104.131.128.70:8080/istanbul-traffic/sensor/161-F	http://vital-iot.eu/ontology/ins/VitalSensor	http://vital-iot.eu/ontology/ins/Running

VITAL-Healthmap Admin Istrator

Home > Map of ICOs/Sensors

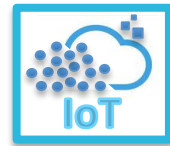
A map of Istanbul showing the locations of various sensors. The map is overlaid with a network of roads and highways. Numerous yellow circular markers with numbers (e.g., 3, 6, 15, 18, 22, 23, 32, 33, 37, 50, 55, 61, 64, 76, 115, 13, 16, 23) are placed across the city, indicating the locations of the sensors. Major roads like D020, O-2, and D100 are visible. Districts such as Beylikdüzü, Eserler, Gaziosmanpaşa, Şişli, Beşiktaş, Üsküdar, and Kadıköy are labeled.

Dr. Martin Serrano
 <martin.serrano@nuigalway.ie>



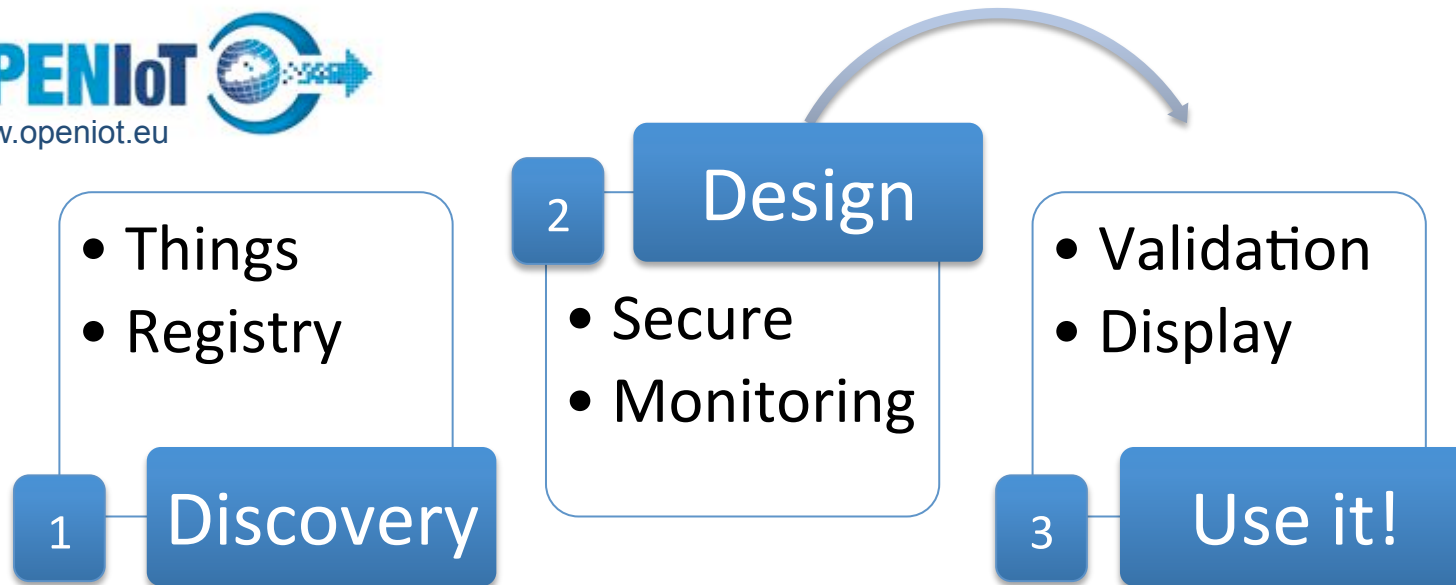
Project OpenIoT www.openiot.eu

Insight Internet of Things and
Stream Processing Unit



The Open Source Cloud Solution for the Internet of Things

Connecting IoT and Services in Different Domains including Manufacturing and Smart Cities

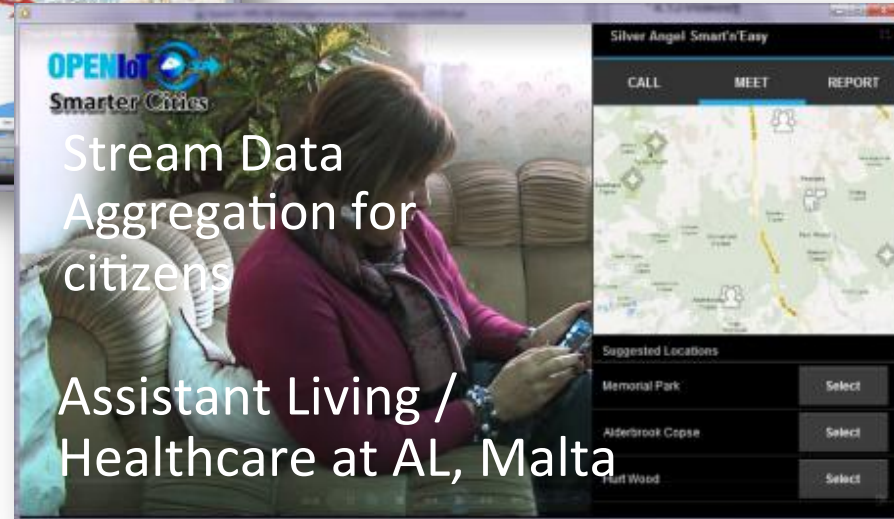
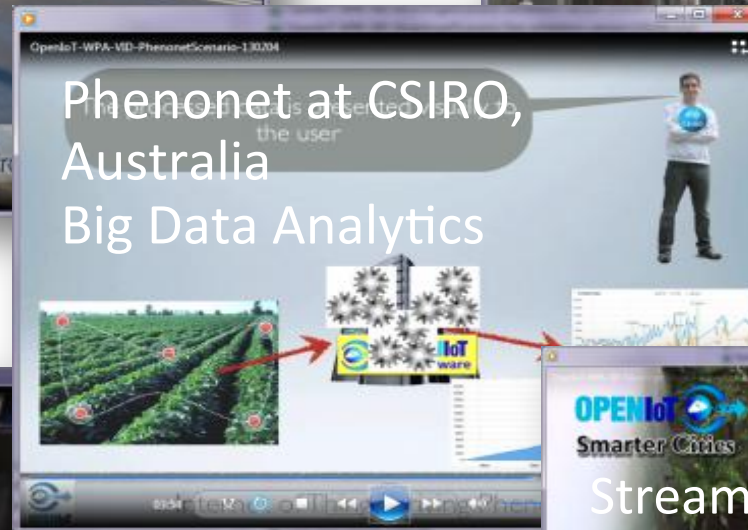
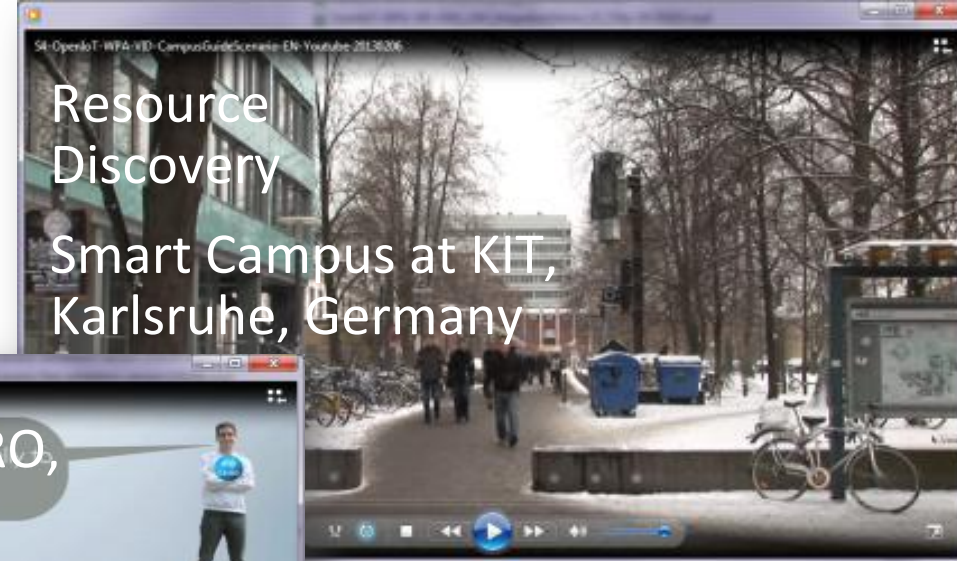


www.openiot.eu



OpenIoT Connects the Internet of Things to the Web

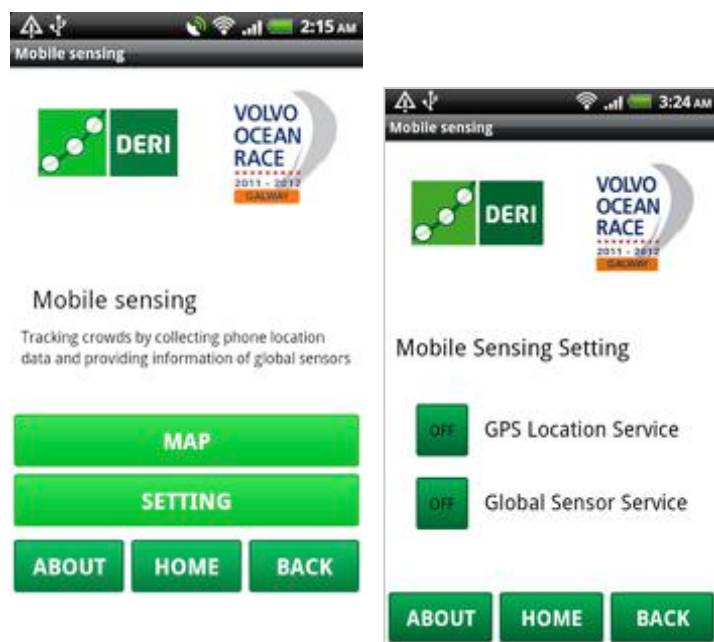
Project OpenIoT www.openiot.eu



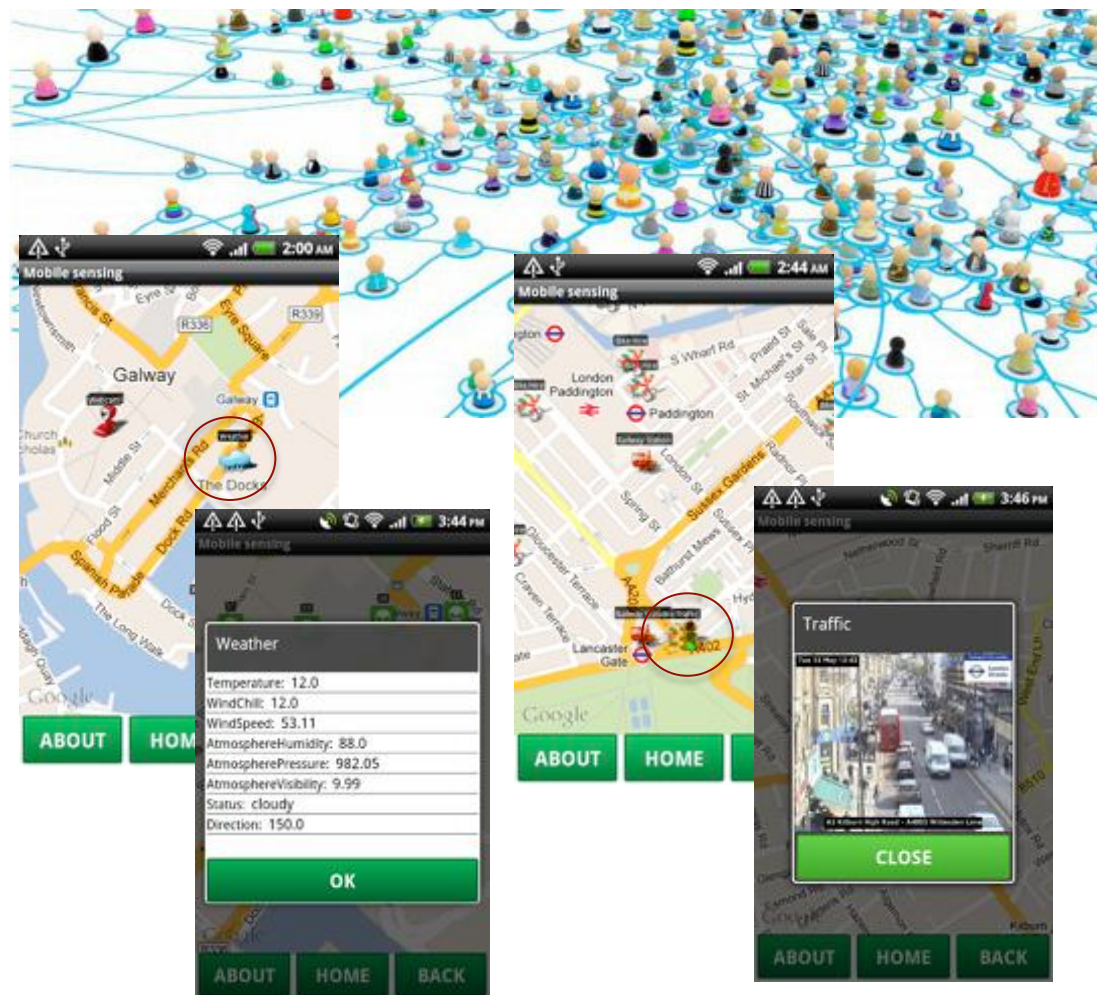
Smart City Visualisation Apps

Clustering algorithms simplifying visualization about big groups of people

Screen shots from the mobile sensing app main menu



Simple and economic!
(Volvo Ocean Race 2012 prototype)



Real-time data collected from weather sensors

Real-time data collected from traffic cams



Trans-Atlantic Symposium on ICT Technology and Policy:
IoT/CPS Expert Group

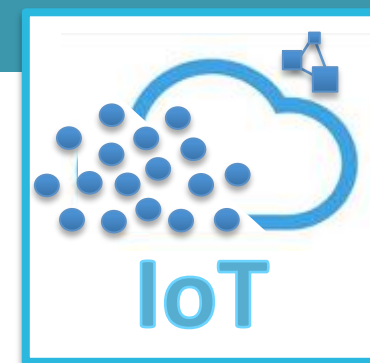
Agenda

Introduction

Smart Systems Convergence & Interoperability

Connected Smart City Systems

Final Comments

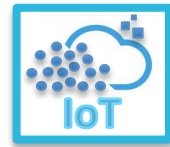


Insight Centre for Data Analytics

Linked Open Data

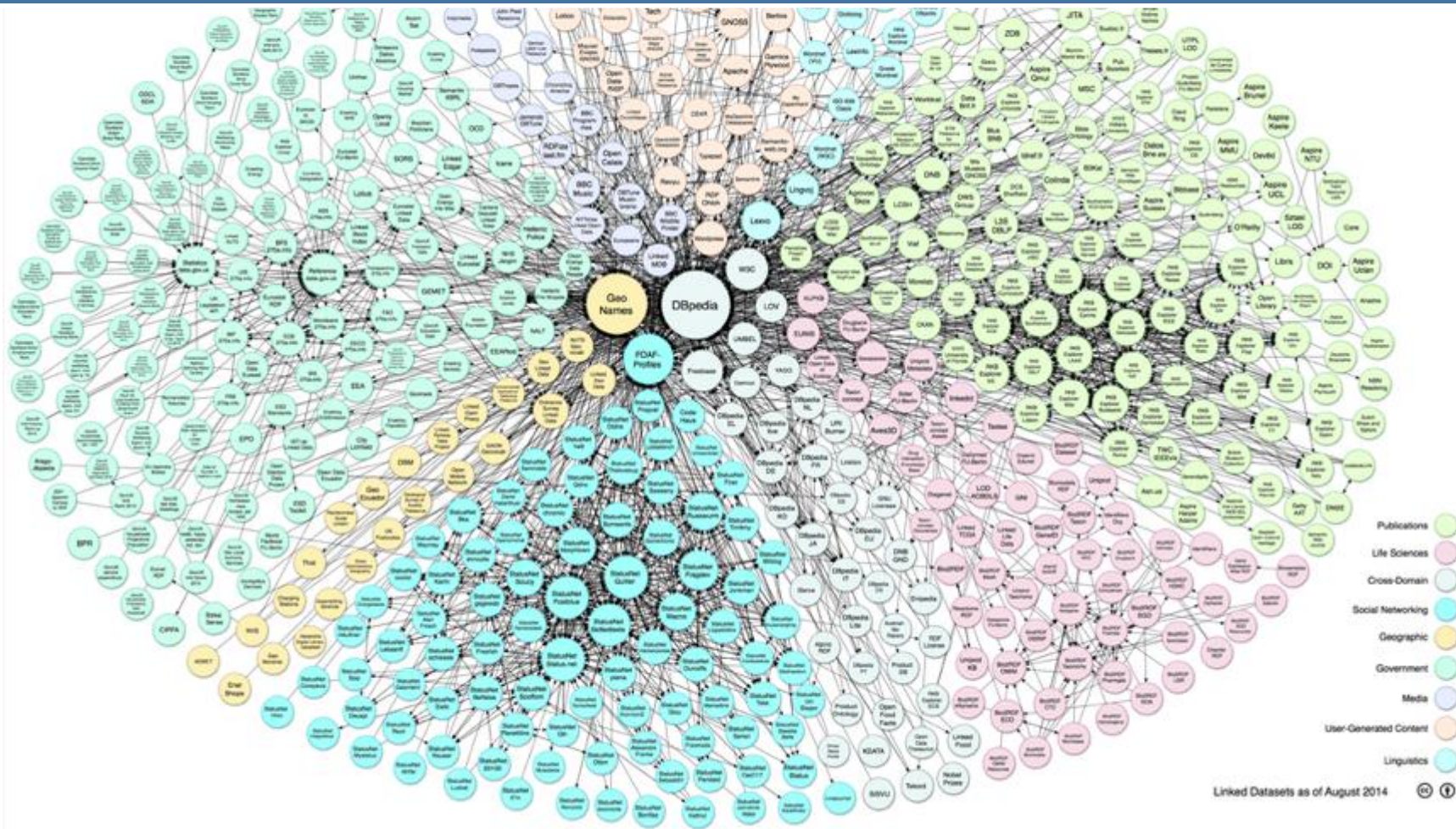
<http://lod-cloud.net>

Insight Internet of Things and Stream Processing Unit



Using the Web to connect related data that wasn't previously linked.

Linked Open Data Cloud – LOD Cloud



Final Comments

Smarter Solutions than Intelligence for the City

Interoperability for IoT Platforms

- Interoperability supporting a broad range of internet-connected devices / objects / things.
- Automated configuration of filtering/fusion/reasoning mechanisms for deployed IoT systems in the City

Fusion of Cloud Computing and IoT Data Clouds

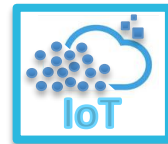
- Support of cloud paradigms for internet-connected objects
- Enable user interaction, configuration, deploy, use IoT based services in the city.

Privacy and Security

- Auditing/Assessing Privacy and Security
- IoT Applications in the Cloud
- Guarantees of usage about the data from the city

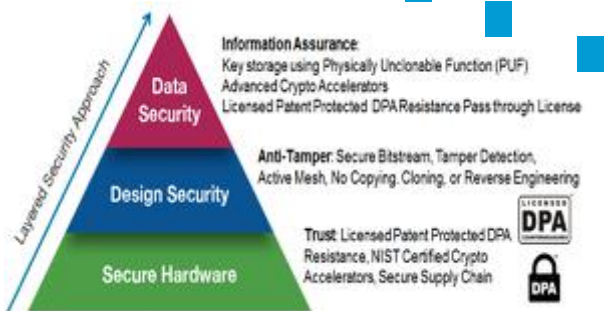
Final Comments

Insight Internet of Things and Stream Processing Unit

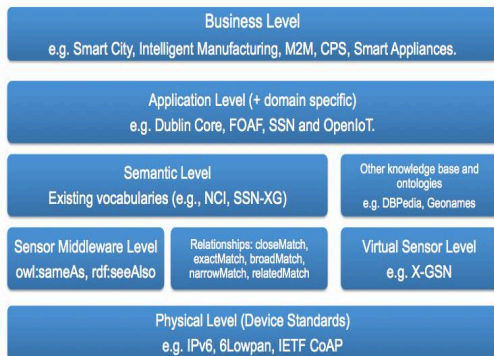


IoT Blockchain

IoT Security



IEEE Internet of Things IoT Stack



IoT CAS Implementations



Data Security

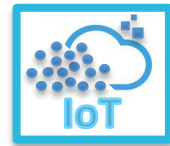
Platform Security

Network Security

Hardware Security

Final Comments

Insight Internet of Things and
Stream Processing Unit



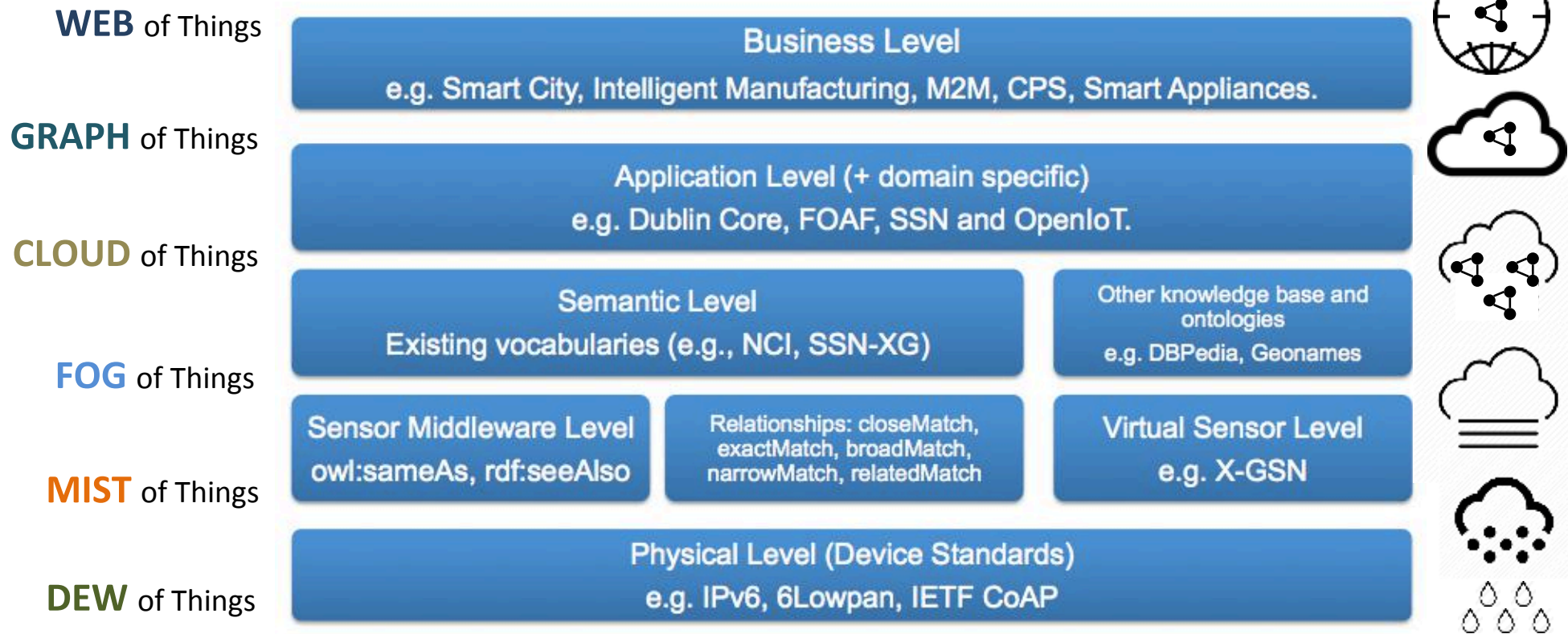
Internet of Things – The Evolution



IEEE
Internet of Things

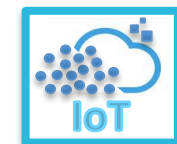
The IoT is More Than Just Connecting
Devices: The OpenIoT Stack Explained

Martin Serrano and John Soldatos, September 8, 2015



Final Comments

Insight Internet of Things and Stream Processing Unit



INTERNET OF THINGS LANDSCAPE

Platforms & Enablement (Horizontal)

Connectivity 	Open Source Platforms 	Software Platforms 	Sensor Networks 	Enabling Networks 	Corporates
-------------------------	----------------------------------	-------------------------------	----------------------------	------------------------------	-----------------------

Applications (Vertical)

Quantified Self Wearable Computing: GLASS, Pebble Fitness: FUEL, amigo, Withings, fitbit, JAWBONE Health: BASIS, LUMO, HAPIfork, wahoo, NuMetrex Family: REST, Lively, Good Night Lamp, Withings, EVADO FILIP	Lifestyle Leisure: blossom, ICA, remee, Thimble, iGrill, HEXBRIGHT, sobi Pets: gifi, FITBARK Toys: sifteo, MakiaLab, KAROTZ, greengoose Music: gtar Gardening: BITPONICS, plantlink, Koubachi Home Improv.: netatmo, Radiator Labs	Connected Home Home Automation: SmartThings, NINJABLOCKS, revolv, Ubi, lapka, electric Imp, Wovyn Energy Efficiency: knut, nest, tado, LIFX, we mo, acobee, belkin, micasaverde Security: Kwikset, ALARM.COM, BOSCH, Lockitron, CANARY, HomeMonitor, iSmartAlarm New Interfaces: NeuroSky, gestigon, sphero, PrimeSense, EQUISO, emotivo, Interaxon, LEAP	Industries Retail: Nomi, euclid, placemeter Healthcare: VISI MOBILE, AdhereTech, AliveCor, TELCARE, intelligentM Automotive: Dashlabs, mojo, SYNC, OpenXC, enture Smart Buildings: APOGEE, Johnson Controls, Schneider Electric	Industrial Internet Robotics: KIVA Systems, Double Robotics, Airware, ROBOTEX, 3D Robotics, MOMENTUM Greentech: BigBelly, Axeda, enlited, GRIDMOBILITY 3D Printing: BOSSYSTEMS, Stratasys, formlabs, shapeways, MakerBot, RepRap, MozzoMill
--	---	--	--	---

Building Blocks

Connection Protocols 	Telecom 	M2M 					
Software 	Mobile 	Hardware 	Parts /Kits 	Services 	Incubators 	Funding 	Distribution

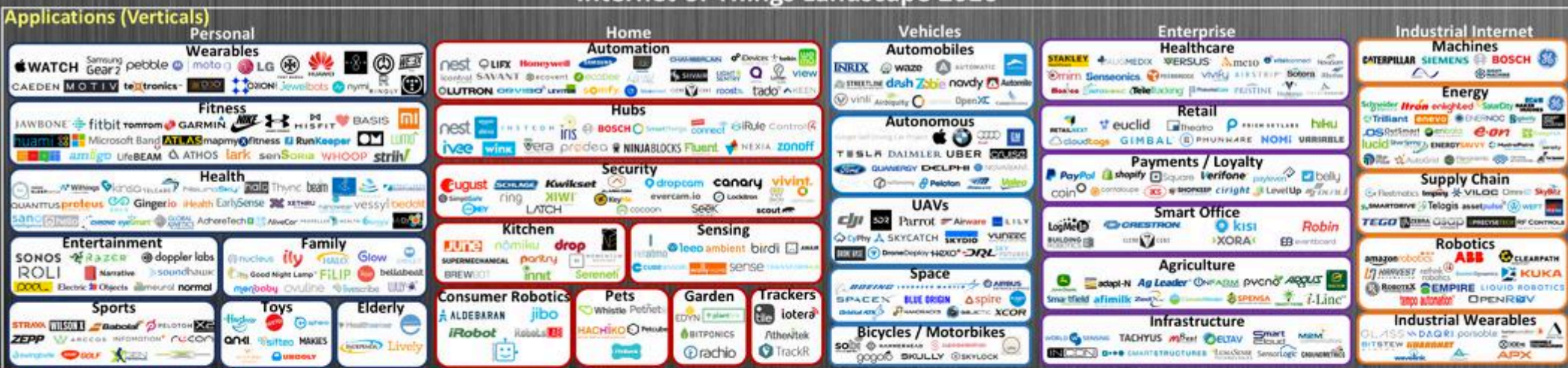
© Matt Turck (@mattturck), Sutian Dong (@sutiangong) & FirstMark Capital (@firstmarkcap)

Final Comments

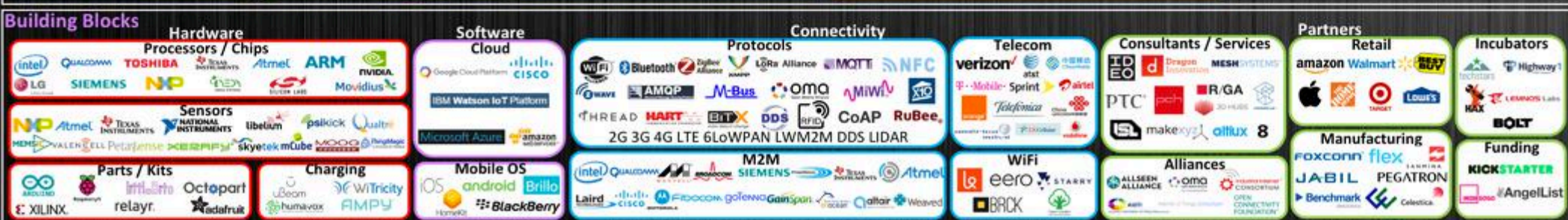
Insight Internet of Things and Stream Processing Unit



Internet of Things Landscape 2016



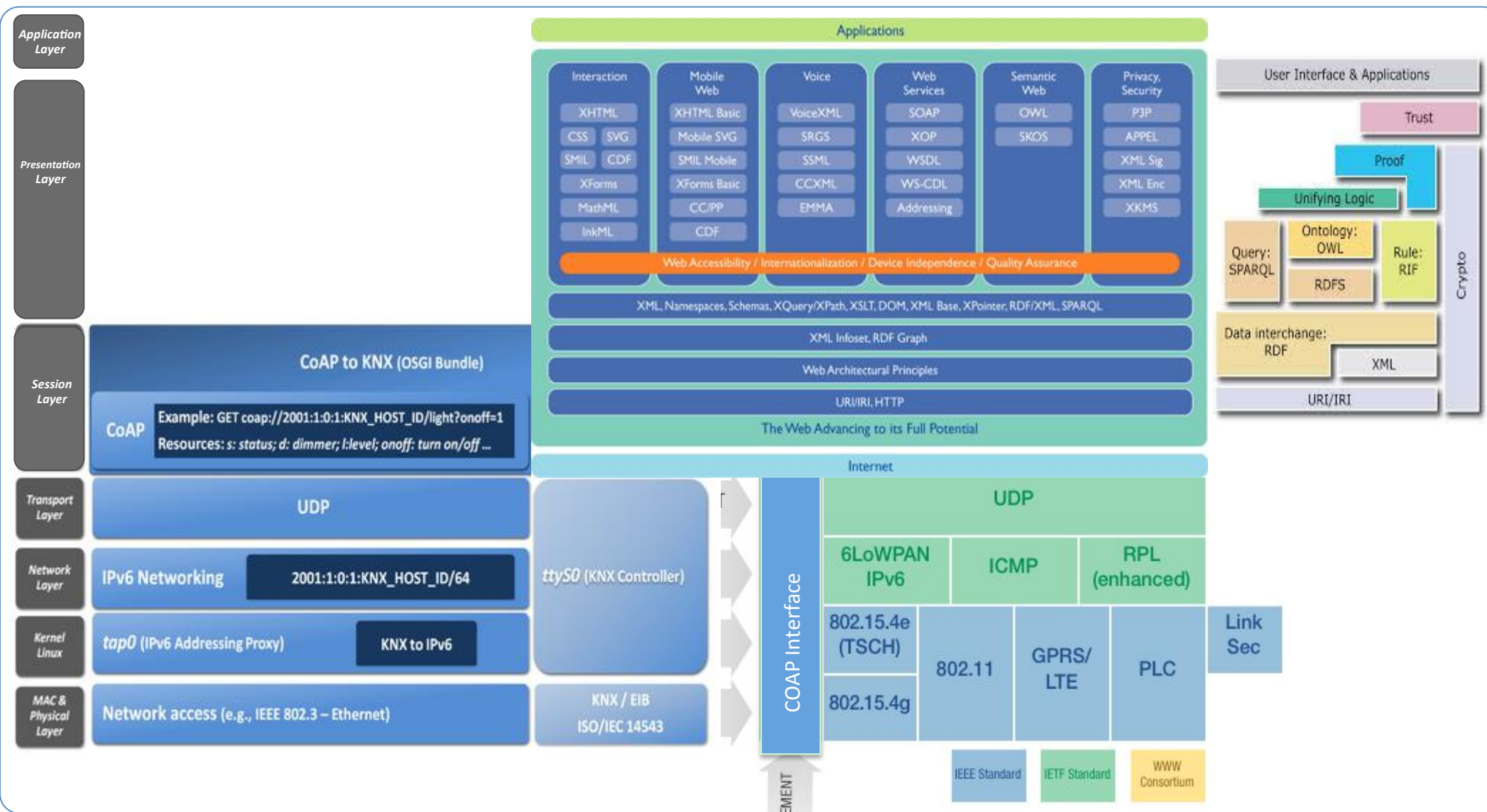
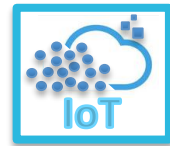
Platforms & Enablement (Horizontal)



© Matt Turck (@mattturck), David Rogg (@davidjrogg) & FirstMark Capital (@firstmarkcap) FIRSTMARK

IoT Stack Overall Existing Standards Summary Table

Insight Internet of Things and Stream Processing Unit



Acknowledgements



EUROPEAN
COMMISSION



SEVENTH FRAMEWORK
PROGRAMME

European Research Cluster on the Internet of Things
(www.internet-of-things-research.eu)

IERC AC1 on Architecture approaches and open platforms

IERC AC2 on Naming, addressing, means of discovery

IERC CA4 on Service Openess and Semantic Interoperability

IERC AC5 on Governance, Privacy and Security



IERC
European Research Cluster
on the Internet of Things



www.openiot.eu

FP7 Projects

An open source blueprint
IoT-Cloud Platform



FIESTA-IoT
www.fiesta-iot.eu



GAMBAS
VITAL



EUROPEAN
COMMISSION



SEVENTH FRAMEWORK
PROGRAMME

2013 "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems

2011 - Internet of Things Technological and Societal Trends.

2010 - Vision and Challenges for Realising the Internet of Things.

SRA Strategic Research Agenda (SRA) IoT

IERC Strategic Research and innovation Agenda (SRIA)



IERC
European Research Cluster
on the Internet of Things

Centre for
Data Analytics



Thanks

Insight

www.insight-centre.org



Trans-Atlantic Symposium on ICT Technology and Policy:
IoT/CPS Expert Group

IoT/CPS Beyond the Hype: A vision for Connected Smart City Systems & Edge Services

June 2017, Minneapolis, MN, USA

Dr. Martin Serrano

Principal Investigator & Data Scientist
IEEE ComSoc IoT Emerging Technologies
IoT Experimentation Chair
<martin.serrano@ieee.com>



© Copyright 2017 Insight Centre for Data Analytics Galway. All rights reserved.

