AIOTI

ALLIANCE FOR INTERNET OF THINGS INNOVATION

Internet of Things - Digitising the Economy

EU-US Expert Group Meeting, NIST, Department of Commerce

20 May 2016, Washington DC, USA

Dr. O. Vermesan, Chief Scientist, SINTEF, Norway, Chair AIOTI WG01

Internet of Things – Hyper-connected Society

❖ Everything connected, everything analysed,

❖ Embedded intelligence everywhere

➤ Autonomous Systems

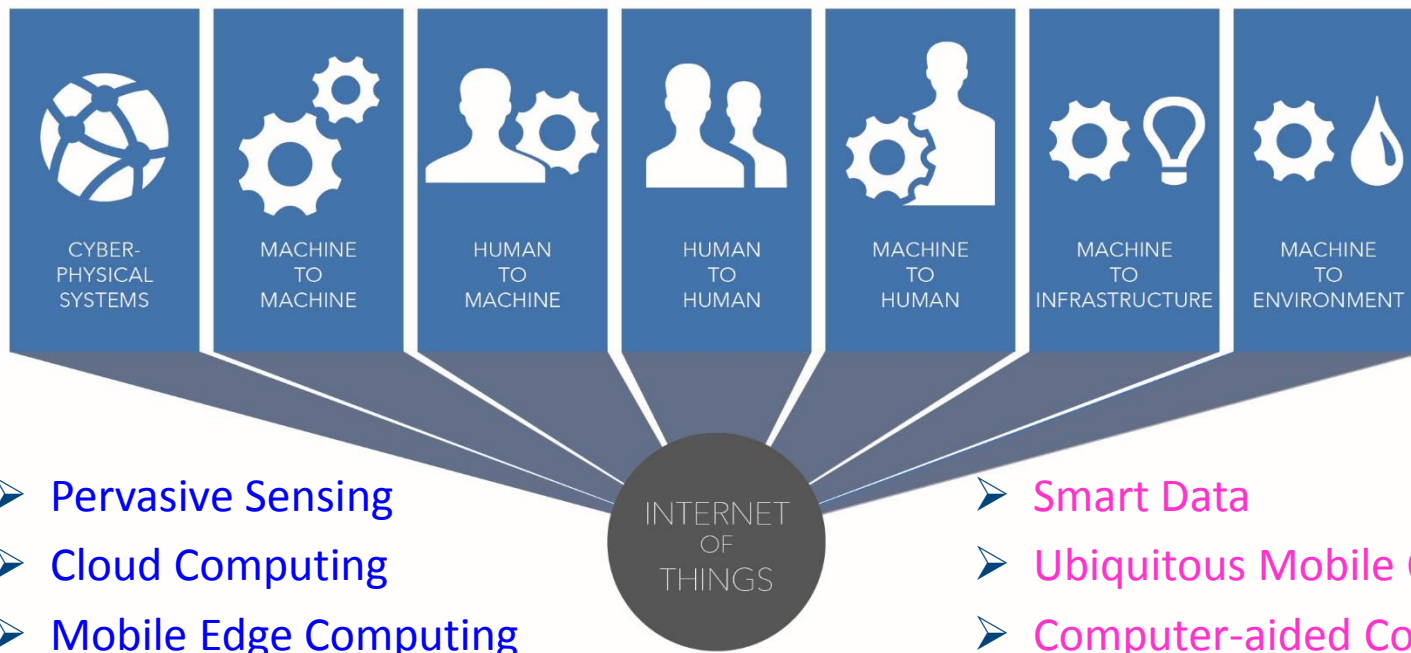➤ Electricity Everywhere

➤ Digital Shadow

➤ Physical, Digital, Virtual

➤ Cognition/Artificial Intelligence

➤ Sustainability Energy Efficiency

| CYBER-PHYSICAL SYSTEMS | MACHINE TO MACHINE | HUMAN TO MACHINE | HUMAN TO HUMAN | MACHINE TO HUMAN | MACHINE TO INFRASTRUCTURE | MACHINE TO ENVIRONMENT |

INTERNET OF THINGS

➤ Pervasive Sensing

➤ Cloud Computing

➤ Mobile Edge Computing

➤ Smart Data

➤ Ubiquitous Mobile Computing

➤ Computer-aided Collaboration

Systems Complexity in Hyper-connected Society

❖ IoT – Systems of Systems – Scale of Connectivity

1 **Internet of Things – Systems of Systems**

Interconnected Intelligent Environments

2 **Intelligent Environment Smart Spaces**

Intelligent Environments
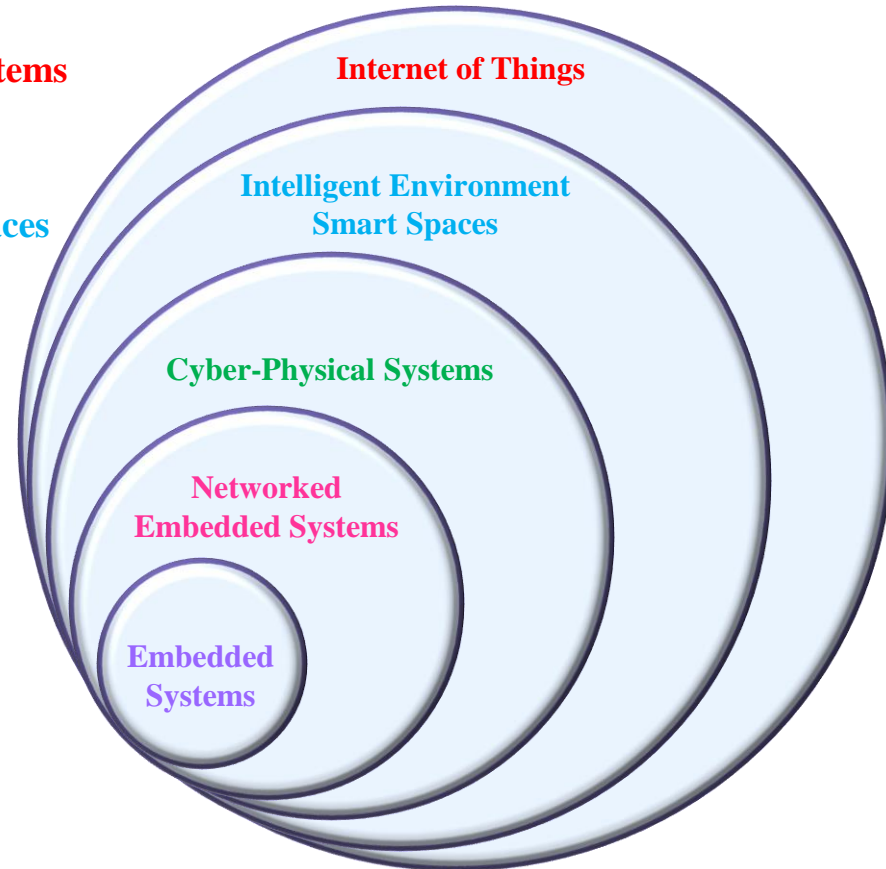Smart Spaces

3 **Cyber-Physical Systems**

Medical Device Systems
Intelligent Manufacturing Line

4 **Networked Embedded Systems**

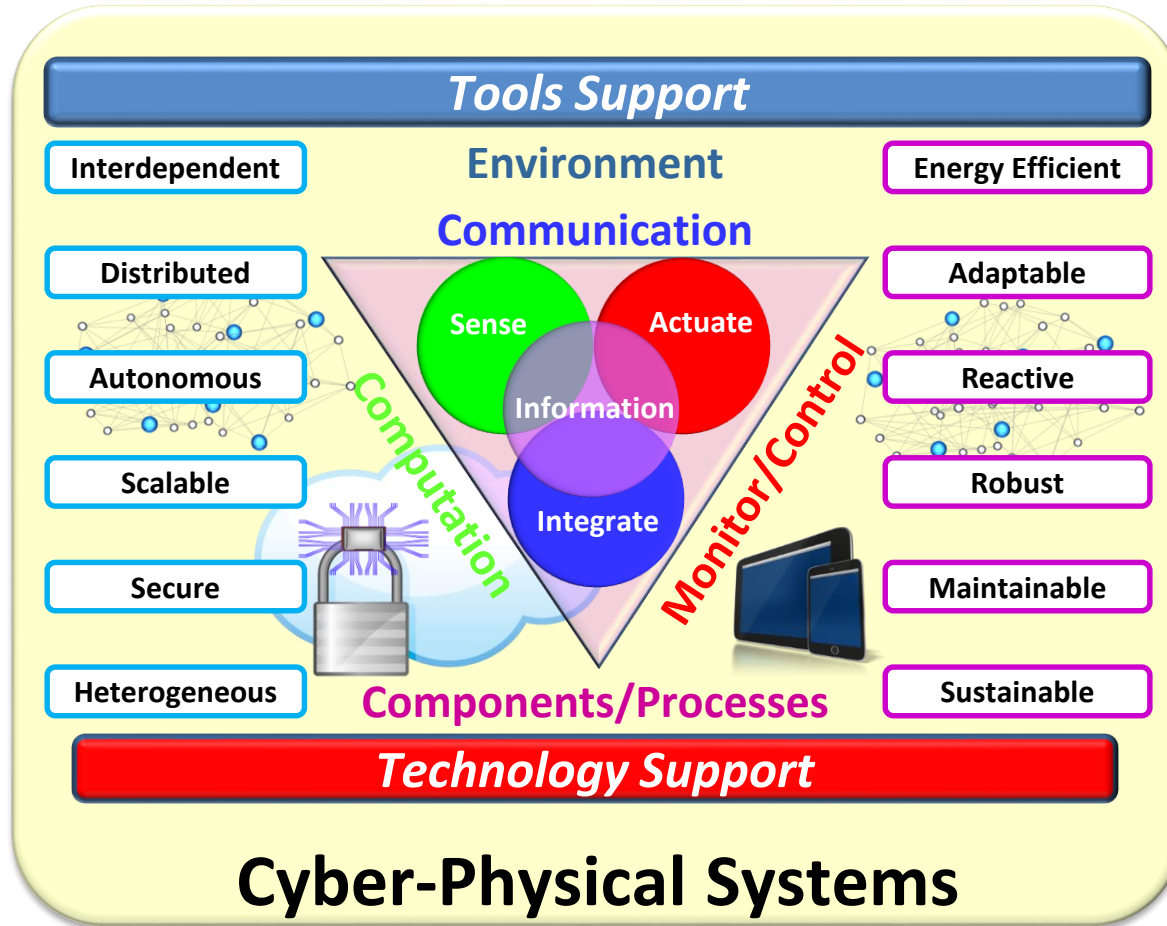Communication Vehicle Controller
Intelligent Street Crossing

5 **Embedded Systems**
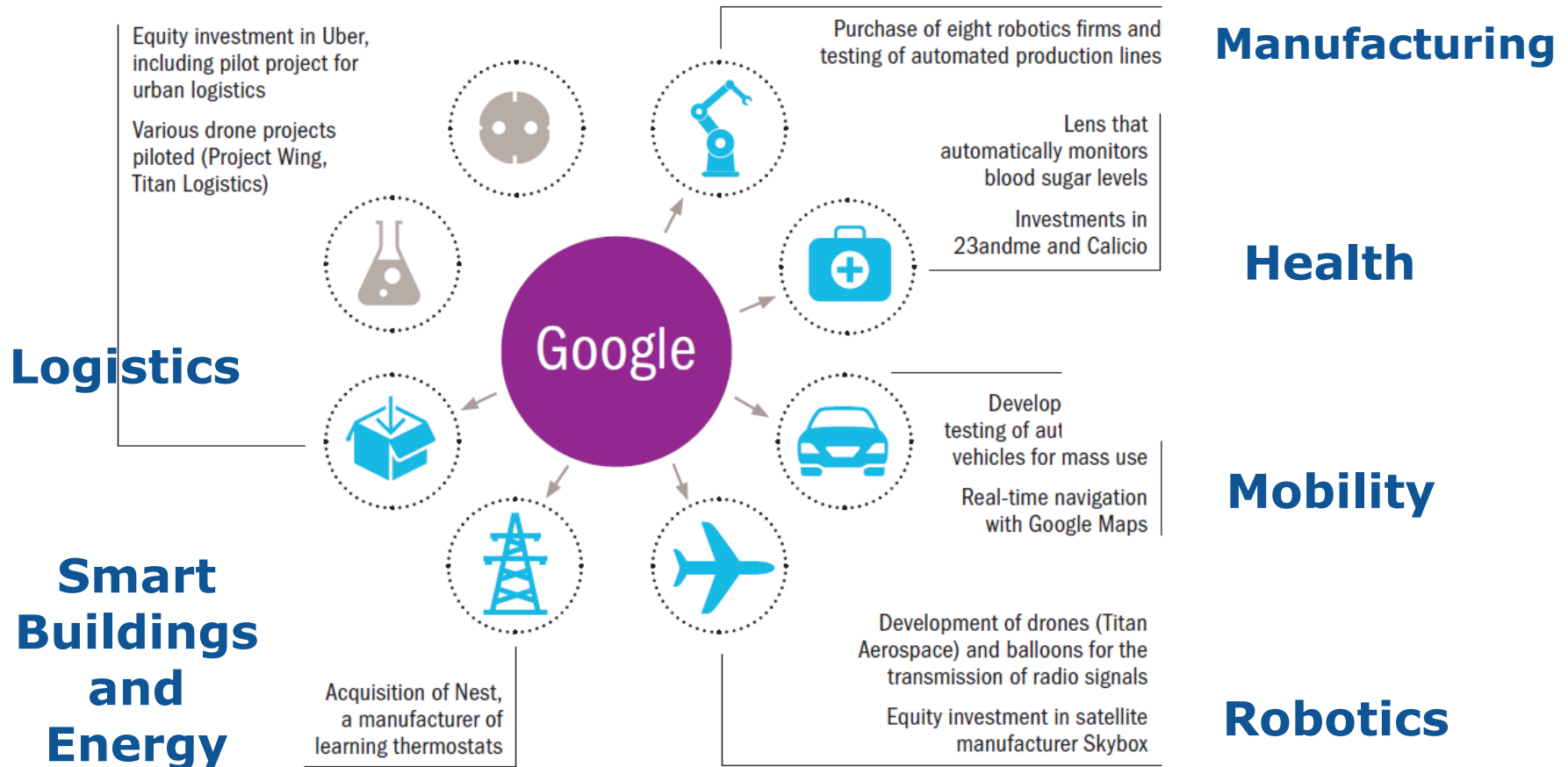
ECUs, Airbag, ABS, Sensor/Actuator Nodes

Internet of Things

**Intelligent Environment
Smart Spaces**

Cyber-Physical Systems

**Networked
Embedded Systems**

**Embedded
Systems**

Cyber-Physical Systems

Cyber-Physical Systems

IoT - Systems of Systems in Hyper-connected Society

❖ Driving Explosive Growth in Connected Devices

➢ **IoT, technologies, architectures, and services**

Equity investment in Uber, including pilot project for urban logistics

Various drone projects piloted (Project Wing, Titan Logistics)

Purchase of eight robotics firms and testing of automated production lines

Manufacturing

Lens that automatically monitors blood sugar levels

Investments in 23andme and Calicio

Health

Google

Logistics

Develop testing of aut vehicles for mass use

Real-time navigation with Google Maps

Mobility

Acquisition of Nest, a manufacturer of learning thermostats

Development of drones (Titan Aerospace) and balloons for the transmission of radio signals

Equity investment in satellite manufacturer Skybox

Robotics

Smart Buildings and Energy

Source: Roland Berger

Internet of Things - Challenges

❖ **The Internet of Things is the next digital revolution**

➢ IoT, Industrial IoT, Internet of Everything

➢ Everything Connected = Convergence + Physical + Digital + Virtual + Cyber

➢ IoT + Cloud and Edge Computing + Smart Data + Real Time Smart Analytics

➢ Cyber-Physical Systems - Robotics - Augmented Reality

➢ Smart products and services – Smart Environments

❖ **The Internet of Things Technology**

➢ Nanoelectronics, Communication, Software
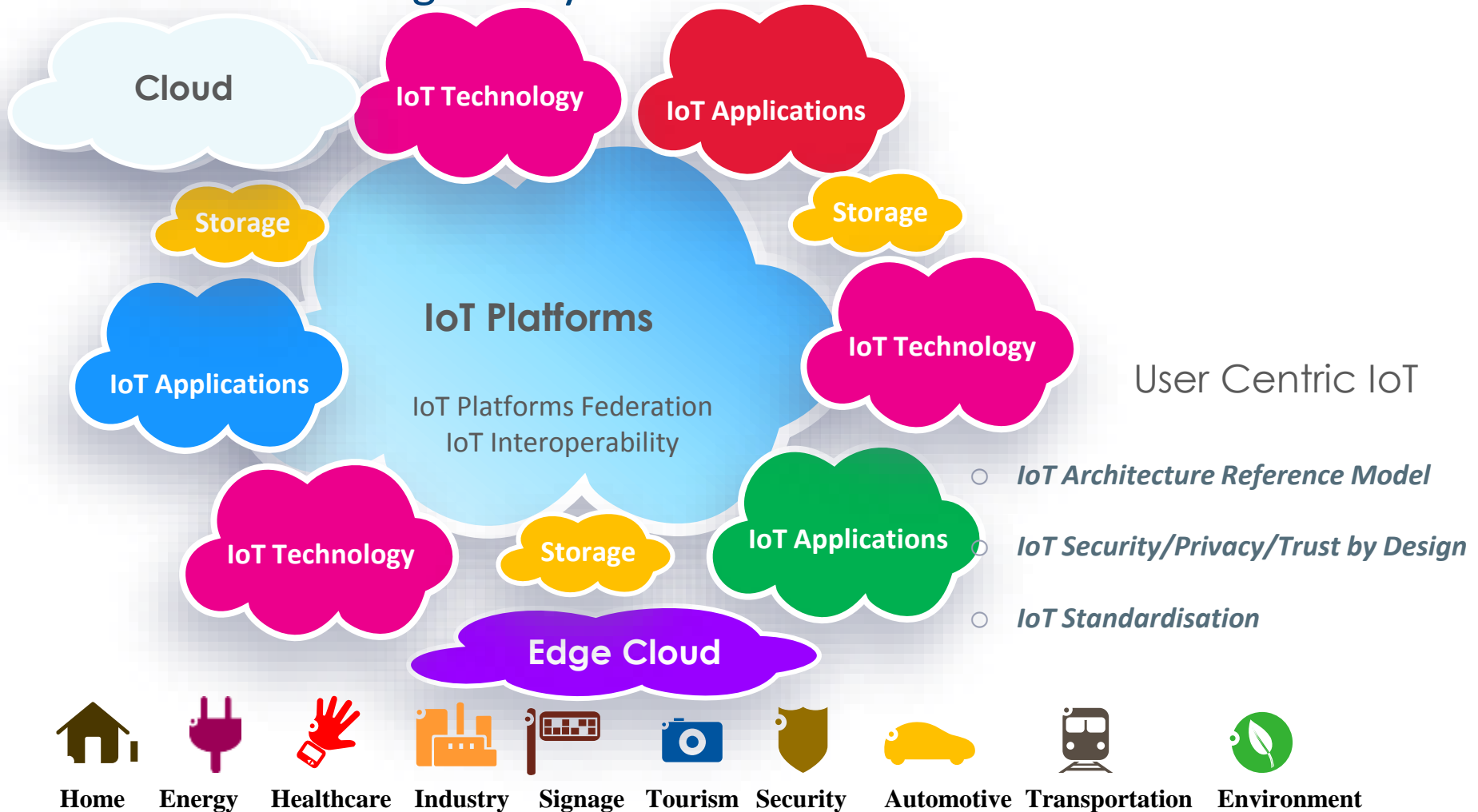
➢ Platforms

➢ Architecture

➢ Interoperability

❖ **Internet of Things Governance**

➢ Security, privacy, trust

➢ Safety, dependability

➢ Legal issues

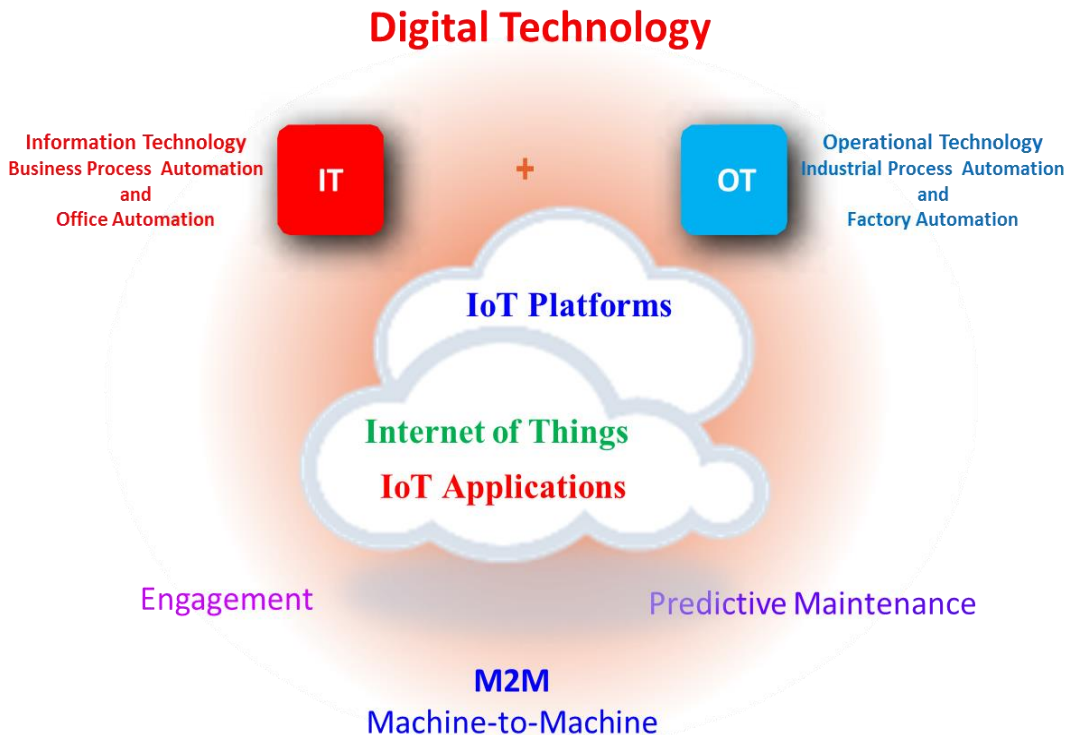# IoT Technology Interplay

❖ Internet of Things Ecosystems

Cloud

IoT Technology

IoT Applications

Storage

Storage

IoT Platforms

IoT Platforms Federation
IoT Interoperability

IoT Applications

IoT Technology

User Centric IoT

IoT Technology

Storage

IoT Applications

○ *IoT Architecture Reference Model*

○ *IoT Security/Privacy/Trust by Design*

○ *IoT Standardisation*

Edge Cloud

Home   **Energy**   **Healthcare**   **Industry**   **Signage**   **Tourism**   **Security**   **Automotive**   **Transportation**   **Environment**

Internet of Things – State of Play

❖ IoT Enabler for Digital Economy

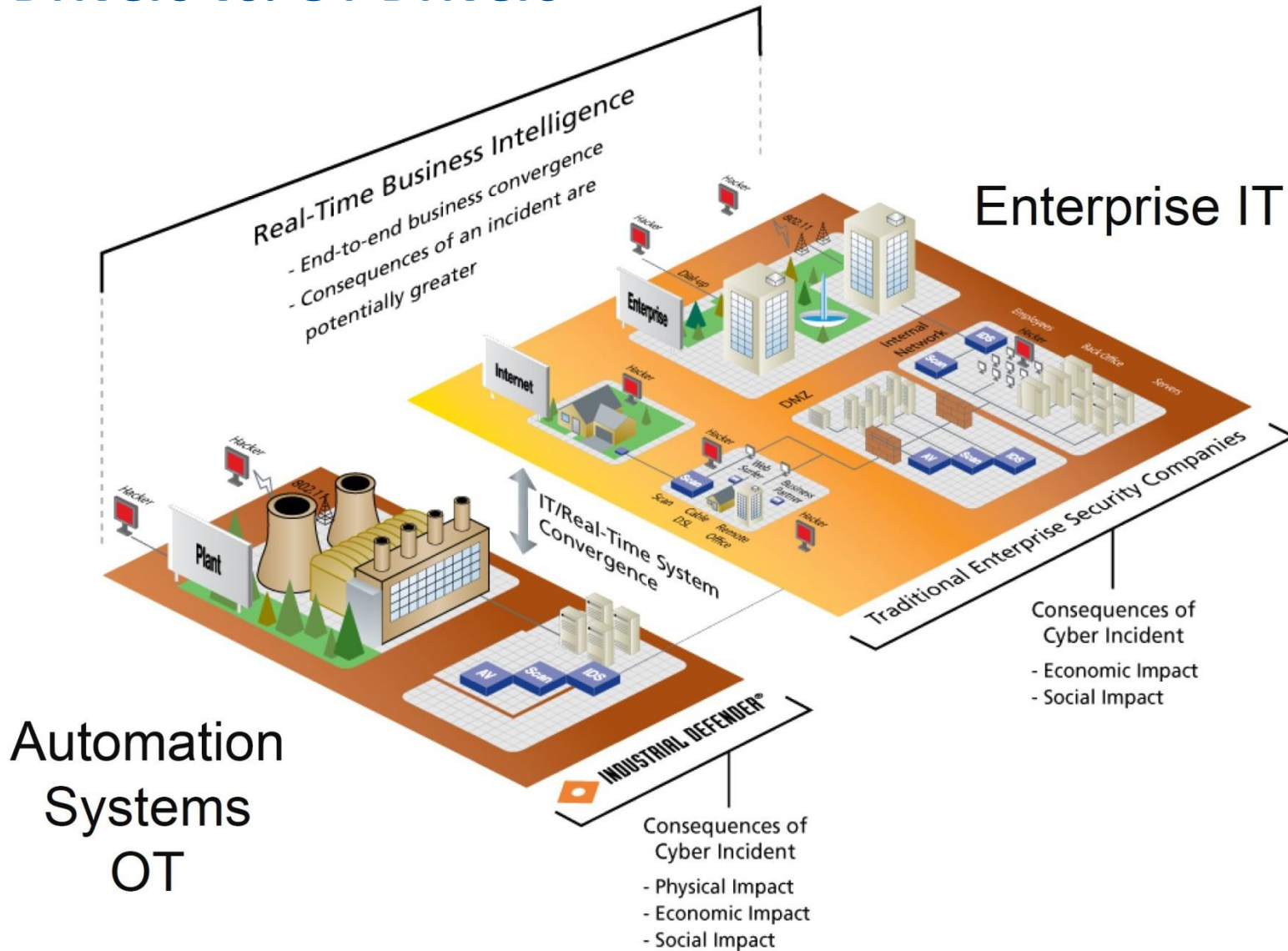➢ IoT Providing the Core Structure for Integration of IT and OT.

Digital Technology

Information Technology
Business Process Automation
and
Office Automation

IT

+

OT

Operational Technology
Industrial Process Automation
and
Factory Automation

IoT Platforms

Internet of Things

IoT Applications

Engagement

Predictive Maintenance

M2M
Machine-to-Machine

IT Drivers vs. OT Drivers

Source: ABB, Siemens

Security Challenges Facing IoT

IoT Security

Information technologies: conventional computers, operating systems, networking components and software platforms.

Operational technologies: industrial control system and networks.

OT Security

IT Security

Dependent Devices
- Authentication
- Authorisation
- Communication Encryption
- Monitoring
- Snooping – Data Leakage
- Spoofing

Quasi Intelligent Devices
- Access Control
- Data Encryption
- Firmware security
- Patch Management
- Intrusion Detection

Intelligent Devices and Controllers
- Device Provisioning
- OS Security

SIEM and Analytics
Security Information and Event Management

Data Security

Application Security

Network and Communications

Device Authentication
Access Provisioning and Monitoring

OT+IT threat models, control points and response processes

AIOTI
ALLIANCE FOR INTERNET OF THINGS INNOVATION

IoT –System of Systems in Smart Environments

Physical Object + Cyber Capabilities → **Internet of X**

Cyber-Physical System
Embedded System with Communication Capabilities
Intelligent Edge-Point

- Sensors/Actuators
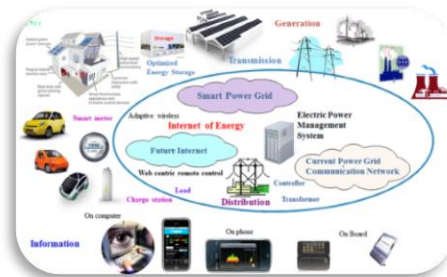- Storage
- Programmability
- Control
- Processing
- Connectivity
- ID

1 Physical Object

2 Embedded System

3 Backend Services

4 Network Connectivity

5 Cyber-Physical Capabilities

Internet of Energy
Internetworked Intelligent Systems

Internet of Lighting
Internetworked Intelligent Systems

Internet of Buildings
Internetworked Intelligent Systems
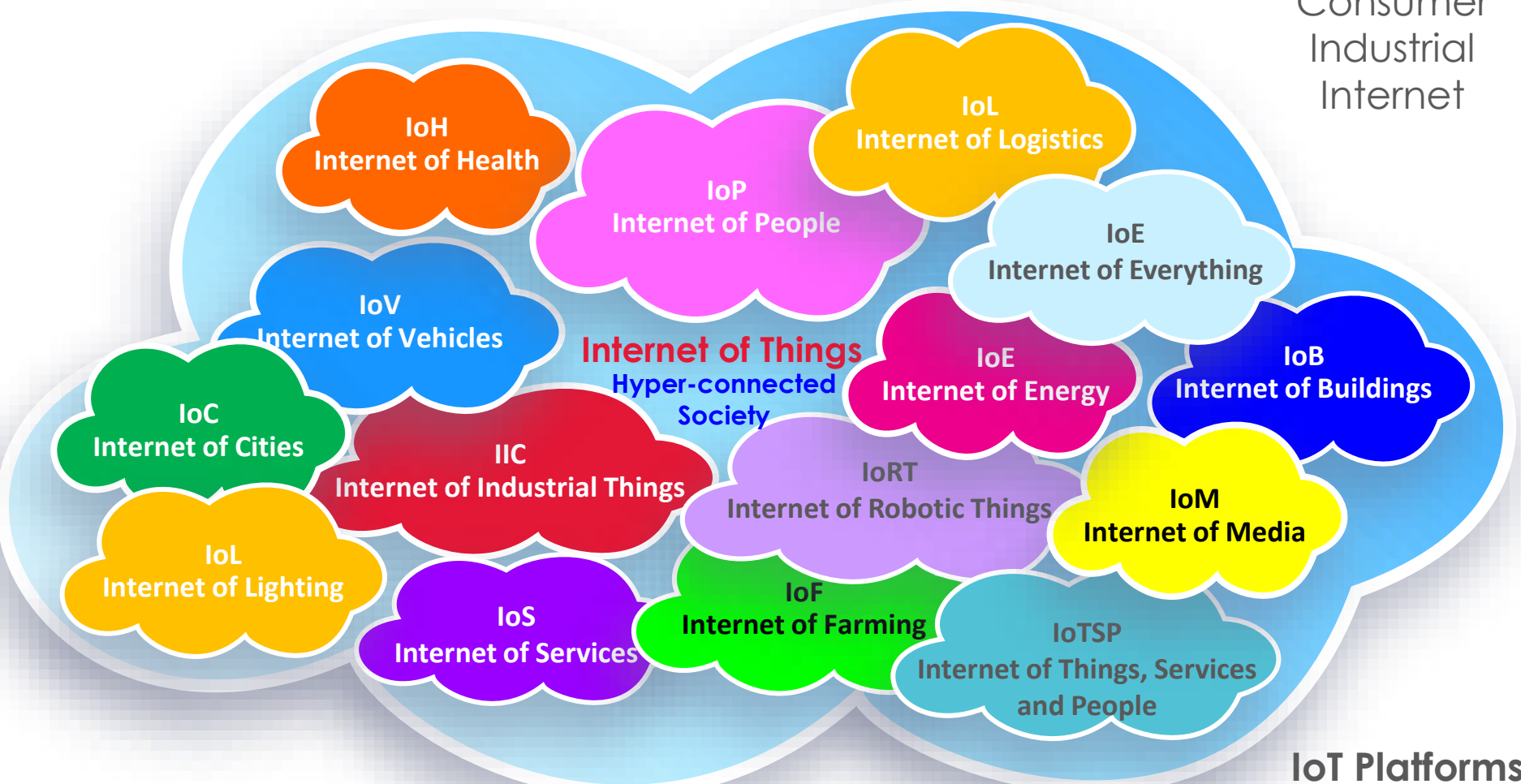

Internet of Vehicles
Internetworked Intelligent Systems

Industrial Internet
Smart Manufacturing

Internet of Things – System of Internet of X
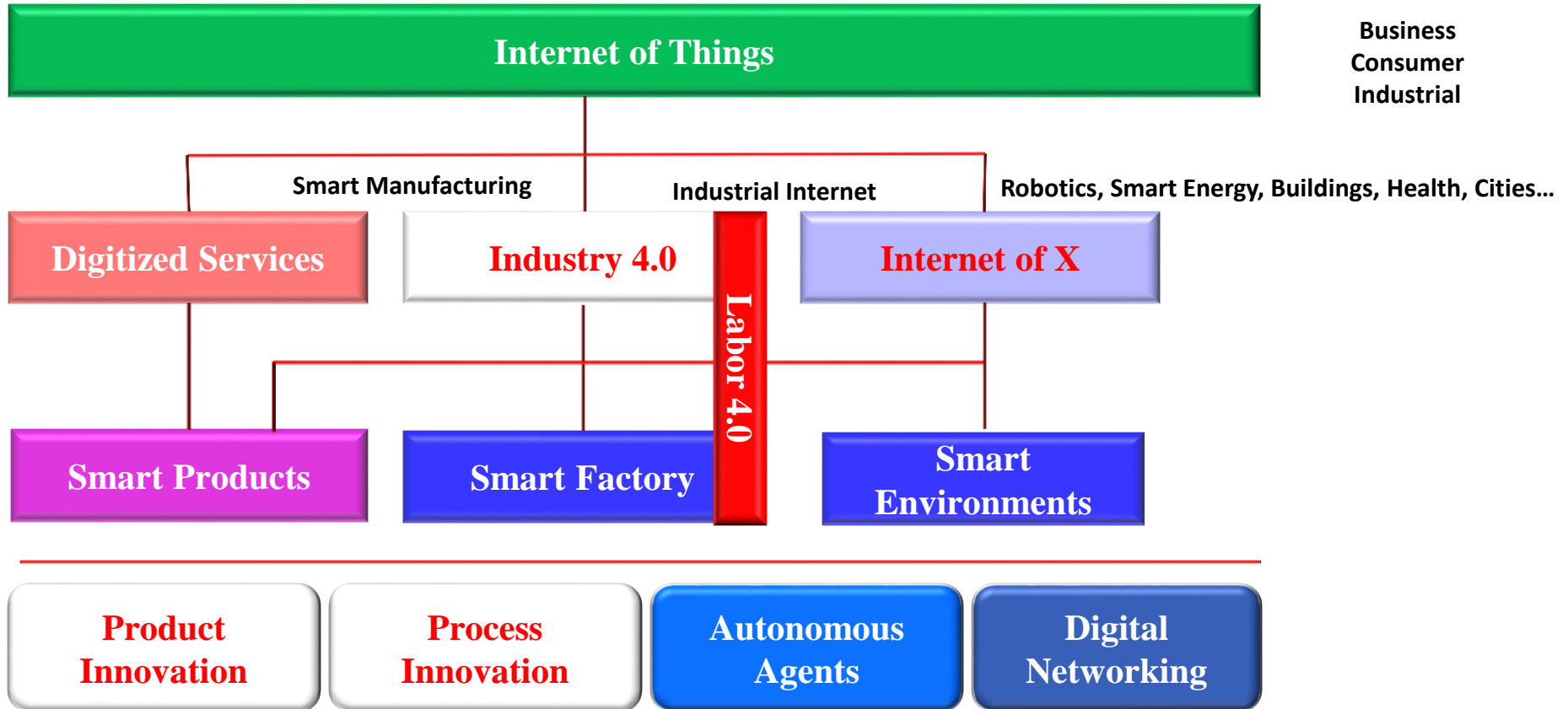
Business
Consumer
Industrial
Internet

IoH Internet of Health

IoP Internet of People

IoL Internet of Logistics

IoE Internet of Everything

IoV Internet of Vehicles

Internet of Things Hyper-connected Society

IoE Internet of Energy

IoB Internet of Buildings

IoC Internet of Cities

IIC Internet of Industrial Things

IoRT Internet of Robotic Things

IoM Internet of Media

IoL Internet of Lighting

IoS Internet of Services

IoF Internet of Farming

IoTSP Internet of Things, Services and People

IoT Platforms

Home   Energy   Healthcare   Industry   Signage   Tourism   Security   Automotive   Transportation   Environment

AIOTI
ALLIANCE FOR INTERNET OF THINGS INNOVATION

12

Internet of Things – State of Play

❖ IoT Enabler for Digital Economy

➢ IoT – Part of digitized Economy and Enabler of Digital Single Market.

Internet of Things	Business Consumer Industrial

Smart Manufacturing — **Industrial Internet** — **Robotics, Smart Energy, Buildings, Health, Cities...**

Digitized Services	Industry 4.0	Labor 4.0	Internet of X

Smart Products	Smart Factory	Smart Environments

Product Innovation	Process Innovation	Autonomous Agents	Digital Networking

Source: Adapted from Christian Brunkhorst, IG Metall, Presentation at IndustriAll auto meeting Toronto Oct. 14th 2015

AIOTI
ALLIANCE FOR INTERNET OF THINGS INNOVATION

13

State of Play – Industrial Internet Consortium IIC

❖ European companies members of IIC

❖ Active role of companies like Bosch, Schneider Electric, Siemens, SAP, ABB in both alliances (AIOTI and IIC).

❖ Exchanging views on the architecture reference models appealing from both sides of the Atlantic.

IoT Integration

Cloud Services

Big Data Analytics

IoT Data Services

IoT Platforms

Device Connectivity Platforms

Device Clouds

IoT Applications

Business Applications

Social Services

Industrial Systems and Protocols

Human Interface

Sensors, Devices, Gateways, Equipment, Mobile Assets

Home   Energy   Healthcare   Industry   Signage   Tourism   Security   Automotive   Transportation   Environment

Internet of Robotic Things IoRT - Pervasive Technology

❖ IoRT – Systems of Systems

➢ IoT and robotics technologies combine to provide for Ambient Sensing, Ambient Intelligence and Ambient Localization, which can be utilized by new classes of applications to deliver value.

Companionship

Pets

Household Chores

Mobile Devices

Support with Strategic Planning and Business

Friends and Nannies

Waiters

Industrial Internet of Things (IIoT)

❖ IoT - Systems of Systems Integration applied in industrial environments

➢ Companies in aviation, power generation/distribution, oil and gas, manufacturing provide product and service hybrids.

➢ Intelligent physical goods are capable of connecting, capture and producing "smart" data for use in digital services.

➢ Physical equipment have measuring, communication capabilities, data consciousness and processing capabilities.
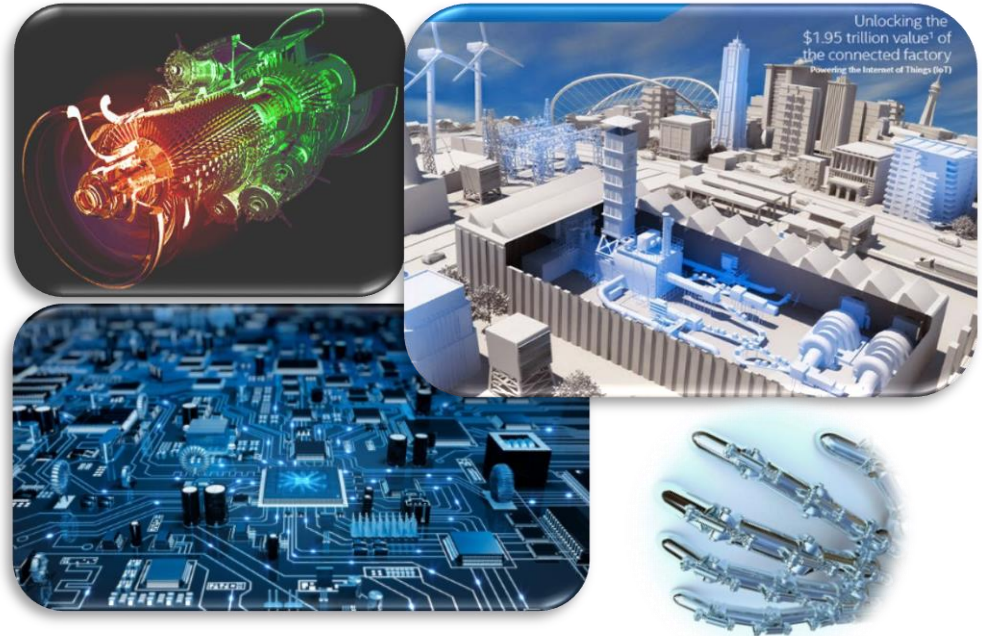
❖ New business models and product-service are aligned with customers that are integrating the concept of product-as-a-service.

Internet of Robotic Things (IoRT)

❖ The ways IoT infrastructure and services intersect with robotic technologies to deliver advanced functionality, along with novel applications, and new business and investment opportunities.
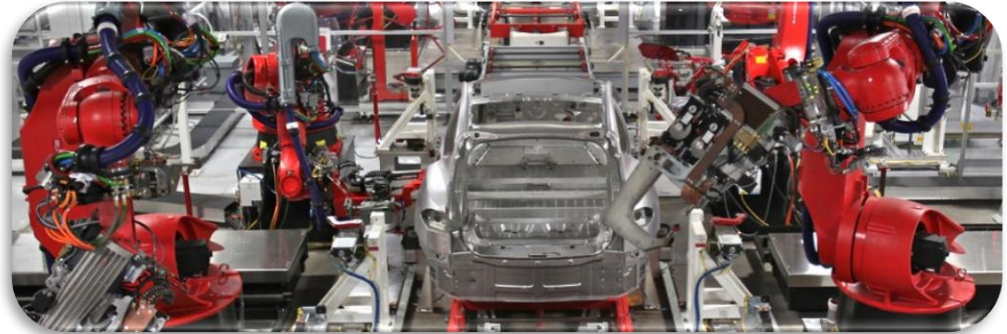
Source: ABI Research
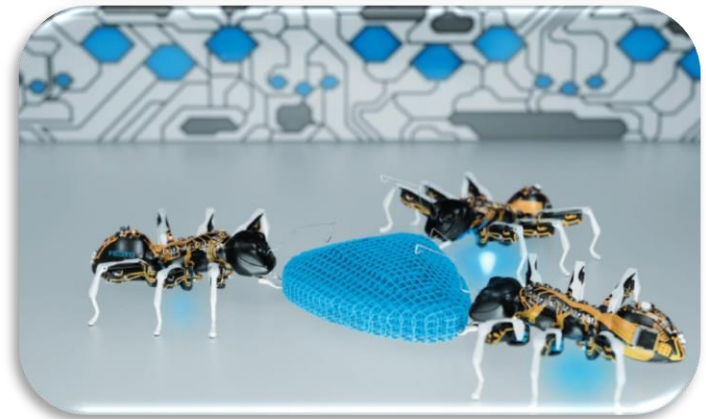
Internet of Robotic Things (IoRT)

❖ IoRT – Systems of Systems - Knowledge Integration

  ➢ Robotics technologies are a unique class of IoT objects

  ➢ Key features of robotics technology, namely movement, mobility, manipulation, intelligence and autonomy, are enhanced by the Internet of Things paradigm, and how, in turn, the IoT is augmented by robotic "objects" as edge devices.
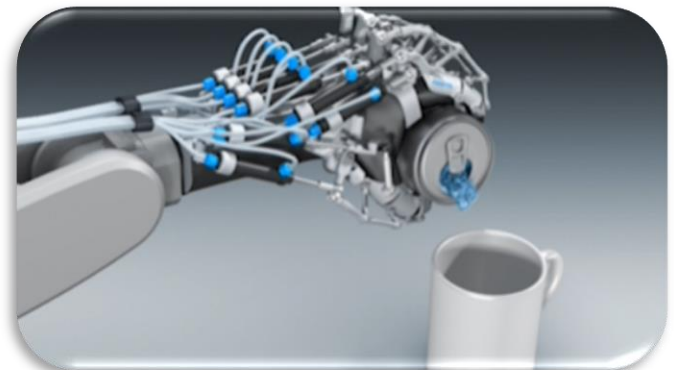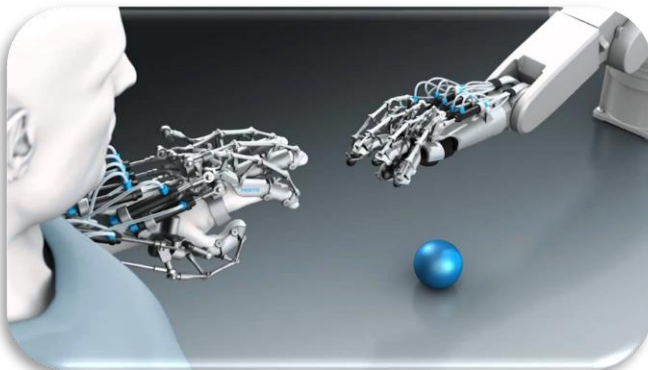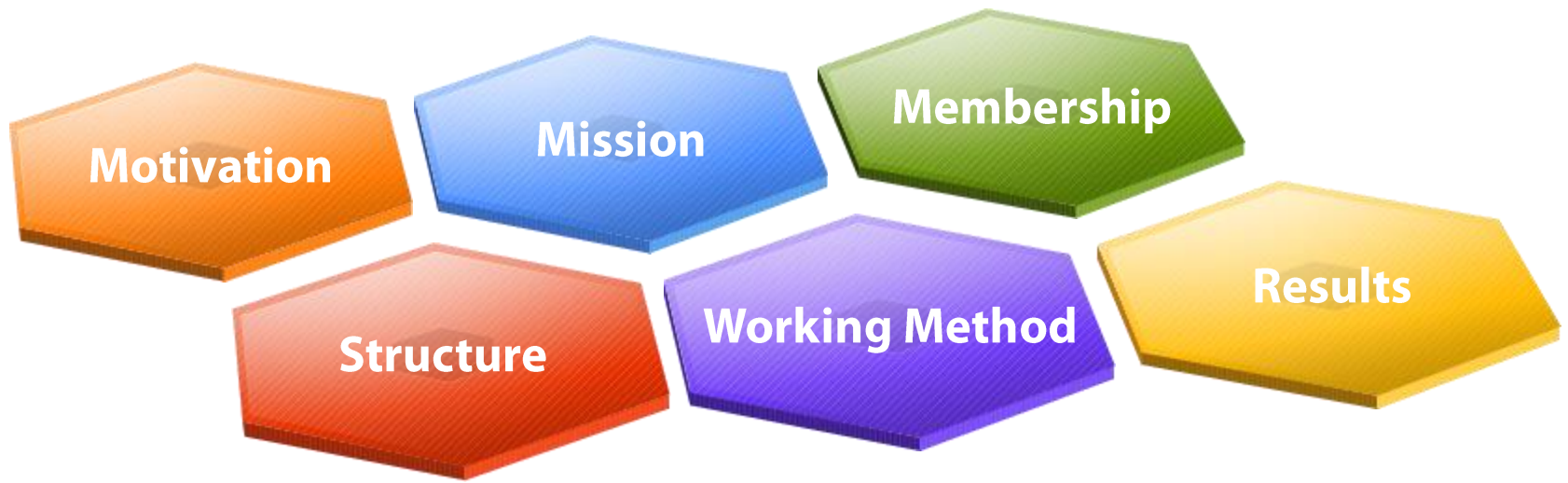
AIOTI
ALLIANCE FOR INTERNET OF THINGS INNOVATION

❖ AIOTI aim is to create and master sustainable innovative European IoT ecosystems in the global context to address the challenges of IoT technology and applications research, innovation, development and deployment including standardisation, interoperability and policy issues, in order to accelerate sustainable economic development and growth in the new emerging European and global digital markets.

Motivation

Mission
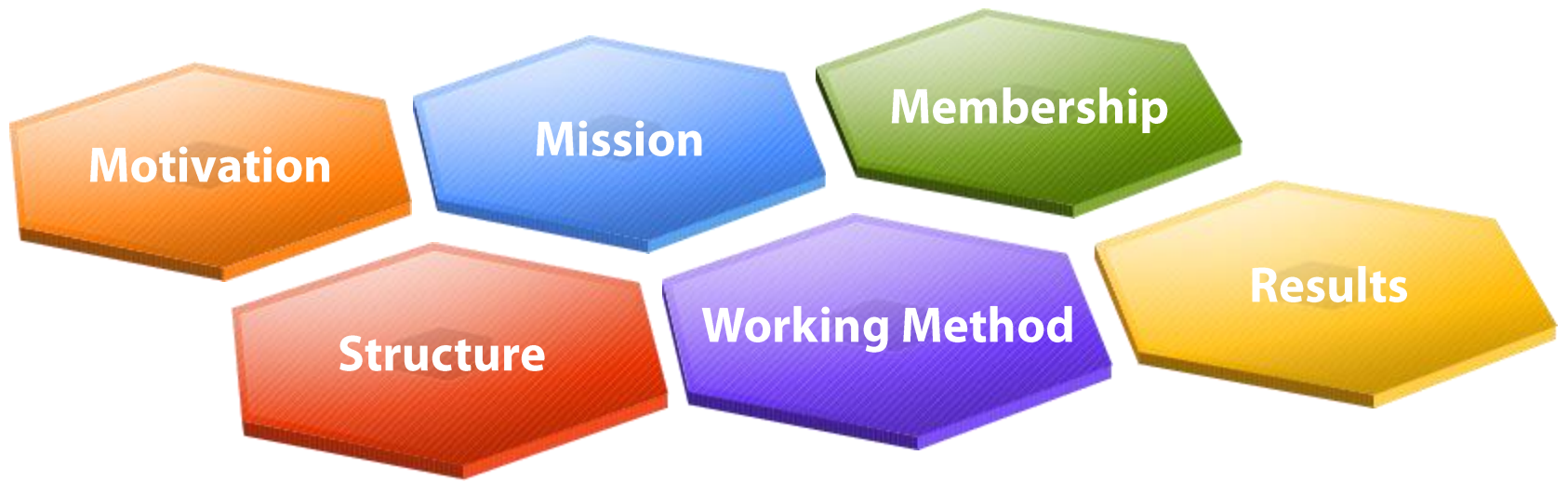
Membership

Structure

Working Method

Results

AIOTI
ALLIANCE FOR INTERNET OF THINGS INNOVATION

AIOTI Motivation - Why AIOTI?

❖ AIOTI launched by the European Commission (EC) in March 2015 to create an **IoT ecosystem in Europe**, and aims notably at **breaking silos between leading vertical IoT application areas**.

❖ AIOTI will be an important tool for **supporting the policy and dialogue** within the IoT ecosystems and with the EC.

❖ AIOTI builds on the work of the IoT European Research Cluster (IERC) and **expands activities towards innovation within and across industries**.

❖ AIOTI offers an opportunity to **discuss legal obstacles** to further IoT take up, and to **forge consensus**.

❖ The Alliance helps the Commission **prepare future IoT research and innovation, standardization and policy programmes**.
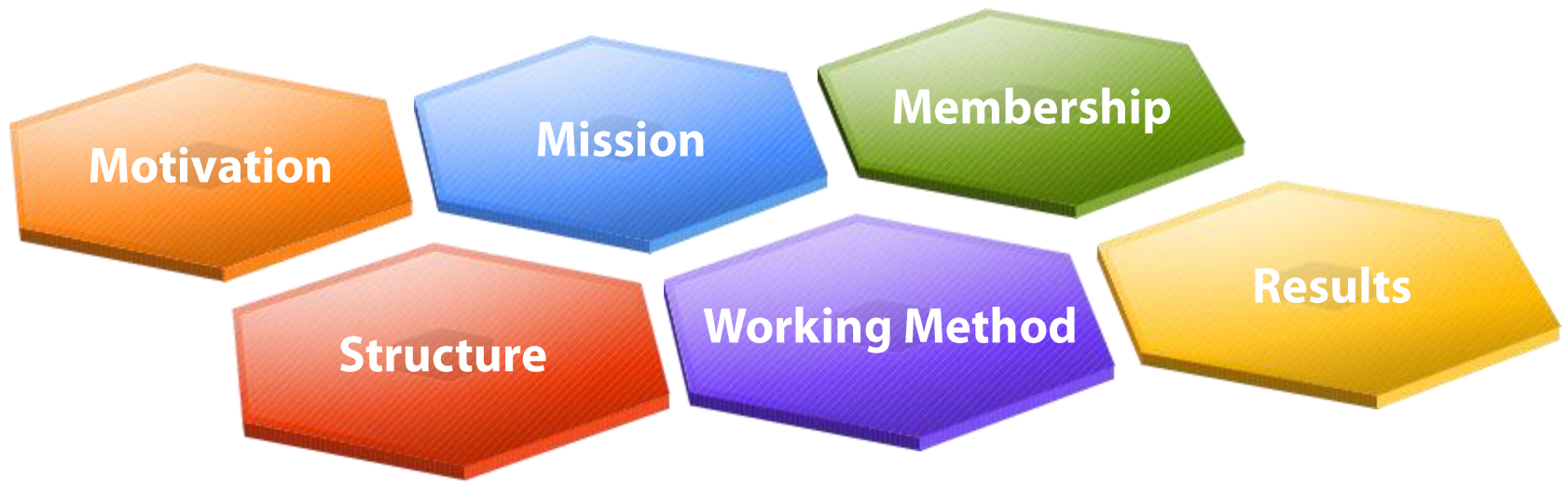
AIOTI
ALLIANCE FOR INTERNET OF THINGS INNOVATION

Motivation

Mission

Membership

Structure

Working Method

Results

AIOTI Mission

❖ **Develop IoT ecosystems across vertical silos including startups and SMEs**.

❖ Identify, communicate and champion EU spearheads to **speed up the take up of IoT.**

❖ **Mapping and bridging** global, EU and Members States' **IoT innovation activities**.

❖ Gather **evidence on market obstacles** for IoT deployment in a Digital Single Market context.

❖ **Contribute to Large Scale Pilots** to foster experimentation, replication and deployment and to support convergence and interoperability of IoT standards.
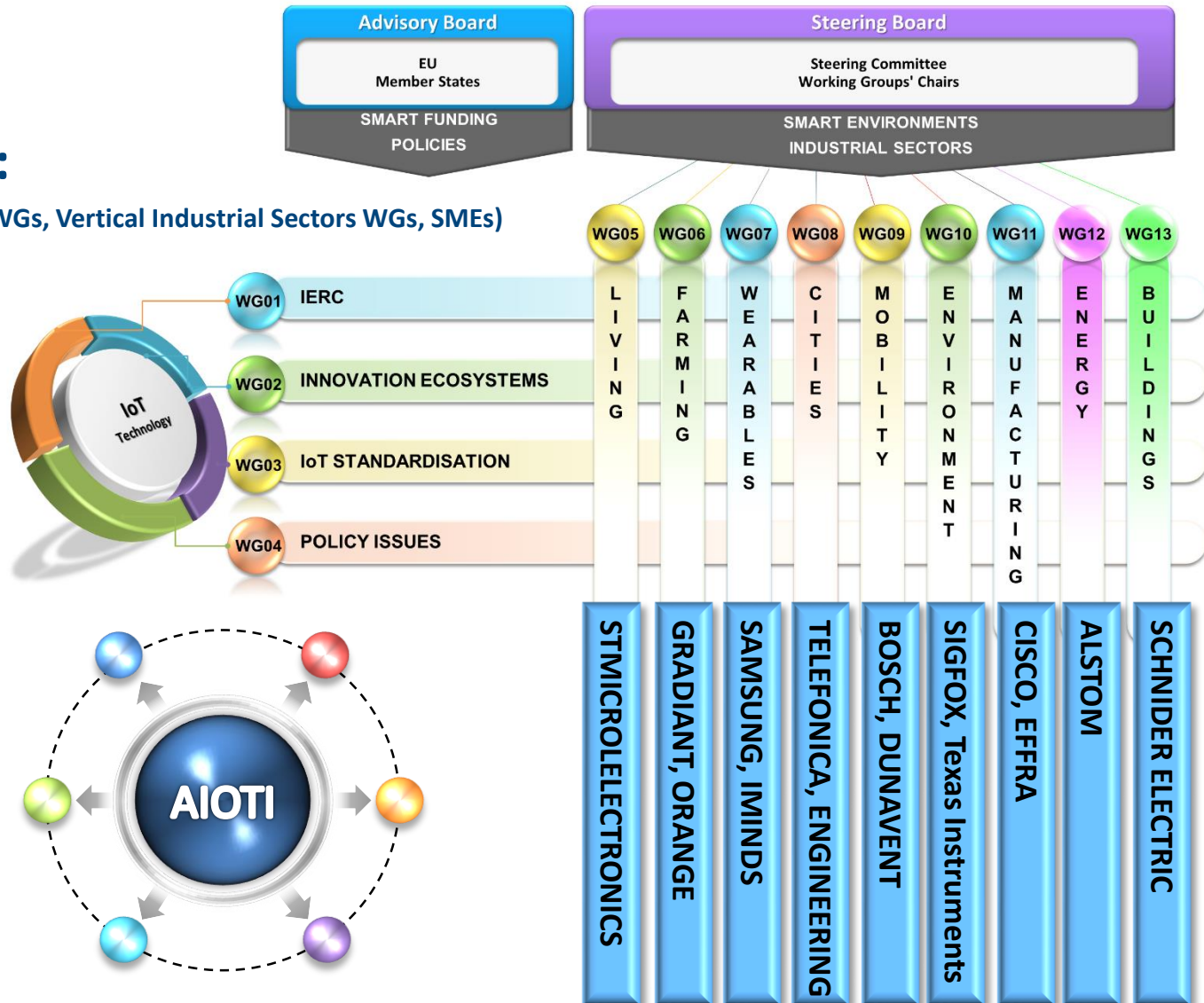
AIOTI
ALLIANCE FOR INTERNET OF THINGS INNOVATION

Motivation

Mission

Membership

Structure

Working Method

Results

AIOTI
ALLIANCE FOR INTERNET OF THINGS INNOVATION

AIOTI Structure

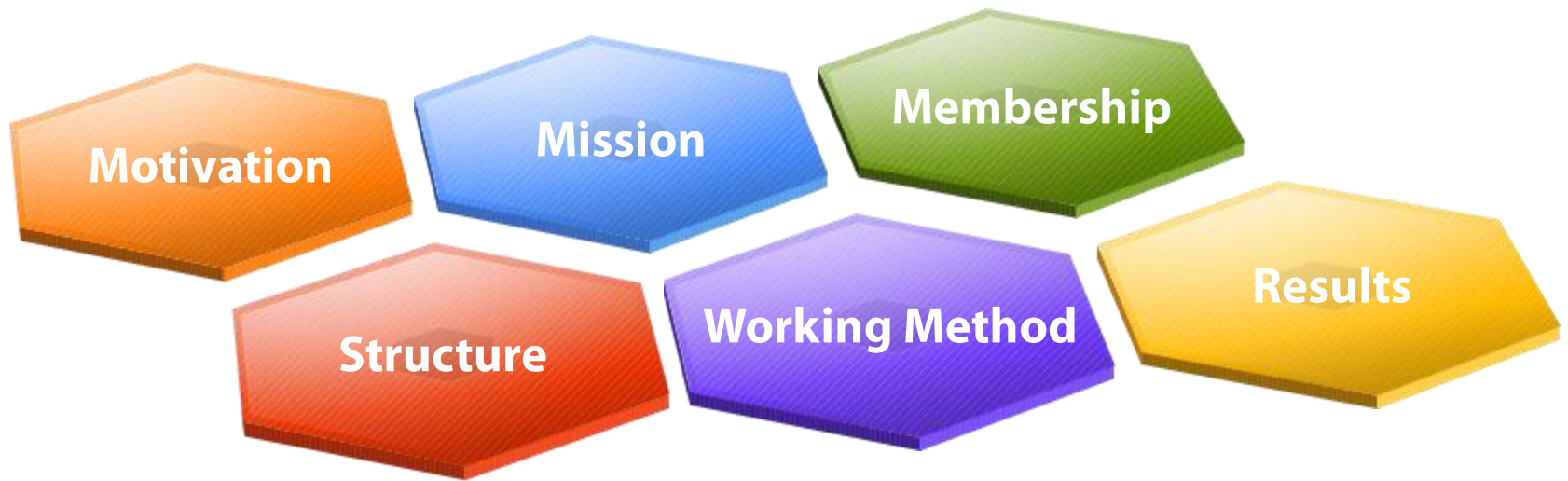❖ **Steering Board:**

➢ **WG Chairs (Horizontal WGs, Vertical Industrial Sectors WGs, SMEs)**

SINTEF, EU

PHILIPS, STROMATOLITE

ETSI, HAUWEI

VODAFONE, ARTHUR's LEGAL

Advisory Board
EU Member States
SMART FUNDING POLICIES

Steering Board
Steering Committee
Working Groups' Chairs
SMART ENVIRONMENTS
INDUSTRIAL SECTORS

WG01 IERC
WG02 INNOVATION ECOSYSTEMS
WG03 IoT STANDARDISATION
WG04 POLICY ISSUES

IoT Technology

WG05 LIVING — STMICROLELECTRONICS
WG06 FARMING — GRADIANT, ORANGE
WG07 WEARABLES — SAMSUNG, IMINDS
WG08 CITIES — TELEFONICA, ENGINEERING
WG09 MOBILITY — BOSCH, DUNAVENT
WG10 ENVIRONMENT — SIGFOX, Texas Instruments
WG11 MANUFACTURING — CISCO, EFFRA
WG12 ENERGY — ALSTOM
WG13 BUILDINGS — SCHNIDER ELECTRIC

Digital Single Market

AIOTI

Motivation

Mission

Membership

Structure

Working Method

Results

AIOTI
ALLIANCE FOR INTERNET OF THINGS INNOVATION

AIOTI Membership

❖ 500 Members

❖ From 24 European Countries

❖ Over 20 sectors represented

Become a Member

❖ Membership is open to any entity (firm/corporation/association) recognised by law and have a distinct legal personality, that demonstrates having a legitimate interest in being part of the AIOTI.

Motivation

Mission

Membership

Structure

Working Method

Results

AIOTI
ALLIANCE FOR INTERNET OF THINGS INNOVATION
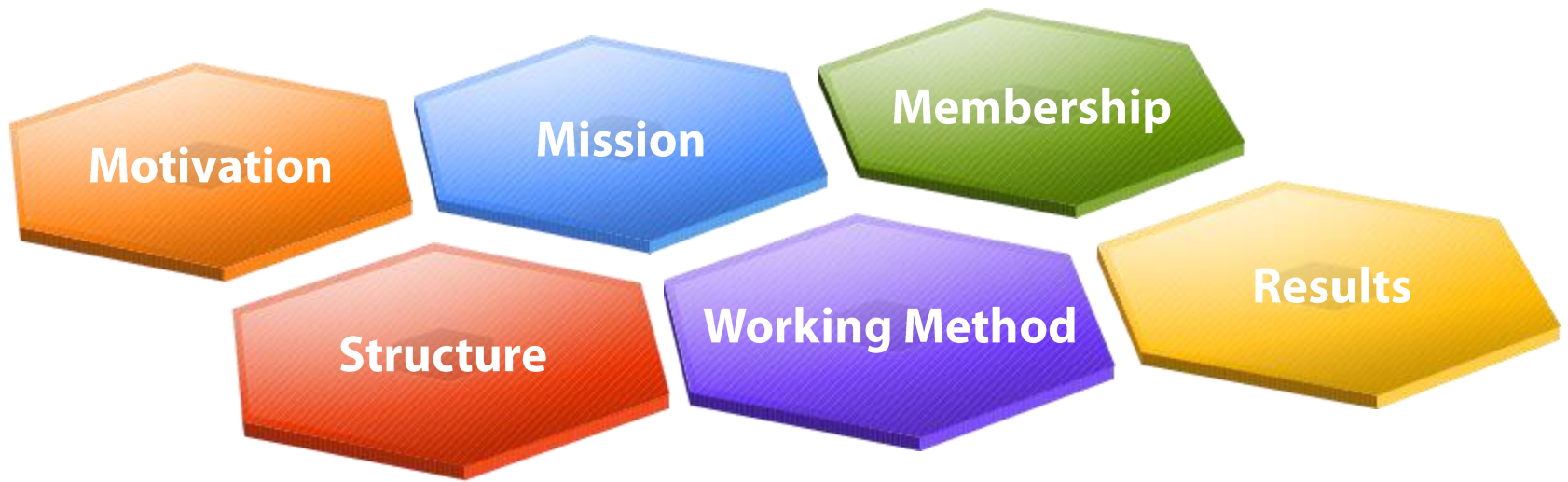
AIOTI Working Method

❖ Working Groups meetings and activities
  - ➢ 2 Face-to-face meetings for each WG
  - ➢ Frequent call-conferences

❖ Steering Board meetings and activities
  - ➢ 2 Face-to-face meetings for the SB
  - ➢ Call-conferences (every two months)

❖ Two General Assembly meetings per year

❖ AIOTI Communities
  - ➢ Technical reports, white papers, recommendations, large scale pilots/test beds/experiments
  - ➢ Match making, ecosystem building, communication

❖ Contributions accepted from any registered member

❖ Maximum two representatives per Company in each WG

❖ Decision taken by consensus

AIOTI
ALLIANCE FOR INTERNET OF THINGS INNOVATION
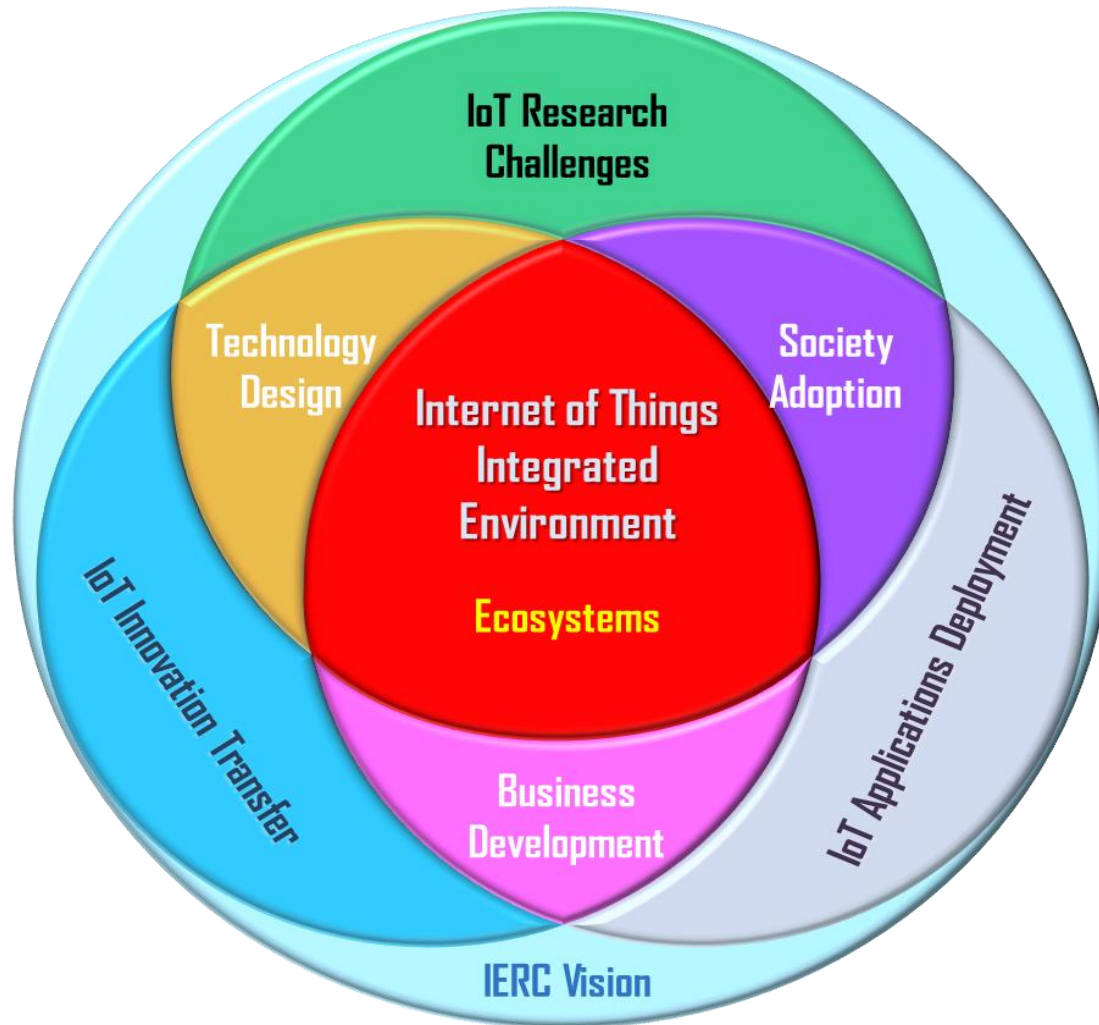
WG01 IERC - IoT European Research Cluster

❖ Bring together the EU-funded projects and policy activities with the aim of:

*Sustaining Europe's leading position in the future Internet of Things within a global context*

Vison for IoT Integrated Environment and Ecosystems

IERC 2015 Results

❖ Cluster Book 2015

➤ The book provide insights on the state-of-the-art of research and innovation in IoT and exposes the reader to the progress towards building ecosystems and deploying Internet of Things technology for various applications.
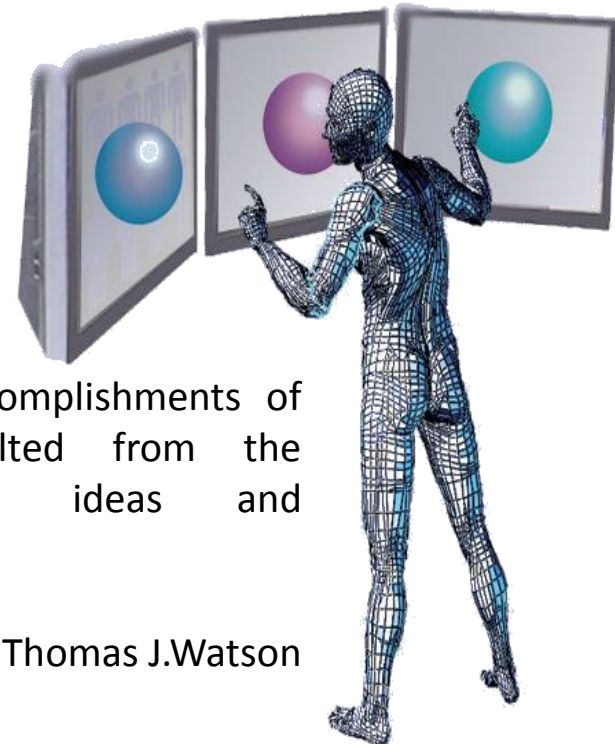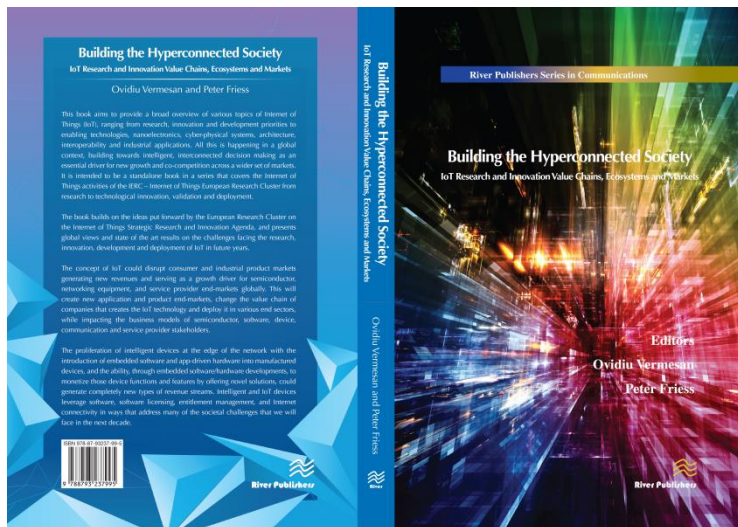
"The greatest accomplishments of man have resulted from the transmission of ideas and enthusiasm."

Thomas J.Watson

Download at:

www.internet-of-things-research.eu

IERC 2015 Results

❖ Overview of the research and developments results of the IERC projects and the key elements related to the IoT technology developments and deployments for the domains covered by the future IoT LSPs.

AIOTI
ALLIANCE FOR INTERNET OF THINGS INNOVATION

IERC
European Research Cluster
on the Internet of Things

Internet of Things Applications

AIOTI WG01 – IERC

Release 1.0

15th October 2015

2015
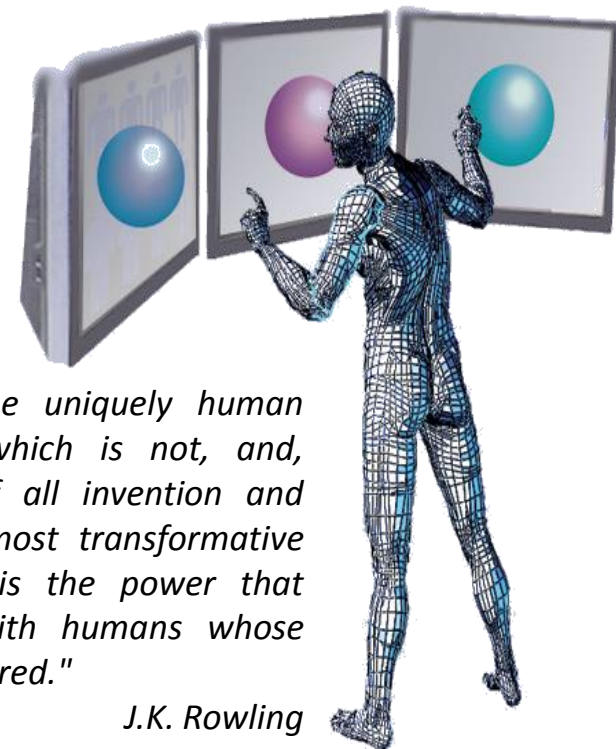
"Imagination is not only the uniquely human capacity to envision that which is not, and, therefore, the foundation of all invention and innovation. In its arguably most transformative and revelatory capacity, it is the power that enables us to empathize with humans whose experiences we have never shared."

J.K. Rowling

Download at:

www.internet-of-things-research.eu

Motivation

Mission

Membership

Structure

Working Method

Results

AIOTI
ALLIANCE FOR INTERNET OF THINGS INNOVATION

AIOTI Results

❖ The WGs have produce comprehensive Reports on the IoT industrial deployment, policy, and standardisation challenges to be used as a support for the Large Scale Pilots (LSP) implementation.

❖ The reports are open and published at the AIOTI Website

❖ The structure of the reports includes the following items:

➢ Scope and focus of WG

➢ Mapping of existing initiatives in the relevant area of the WG

➢ Investigation of the technological dimension for the large scale pilot

➢ Recommendations for the testing of business models and of user acceptability

➢ Investigation of the operational dimension for the large scale pilot

AIOTI
ALLIANCE FOR INTERNET OF THINGS INNOVATION

IoT Architectural View – Links with other Initiatives
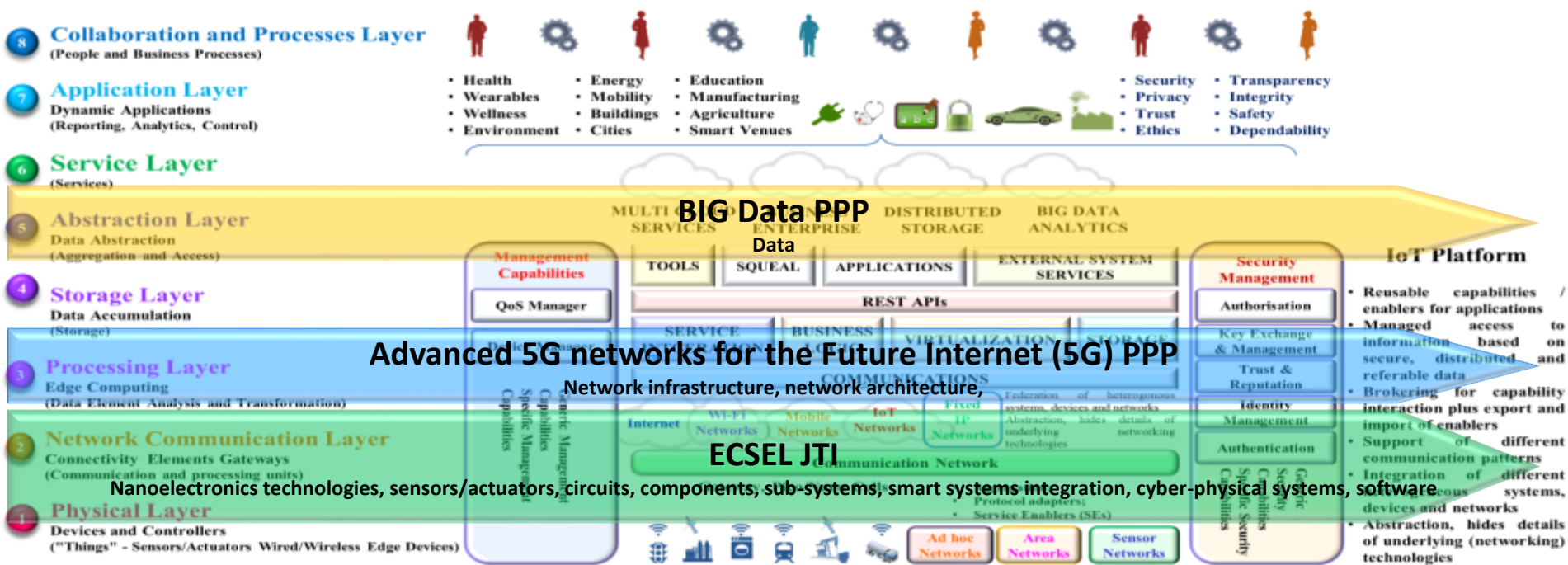
Energy-efficient Buildings (EeB) PPP
Smart buildings

Ambient Assisted Living

EIPs on Active and Healthy Ageing, Agricultural Sustainability and Productivity, Smart Cities and Communities, Water
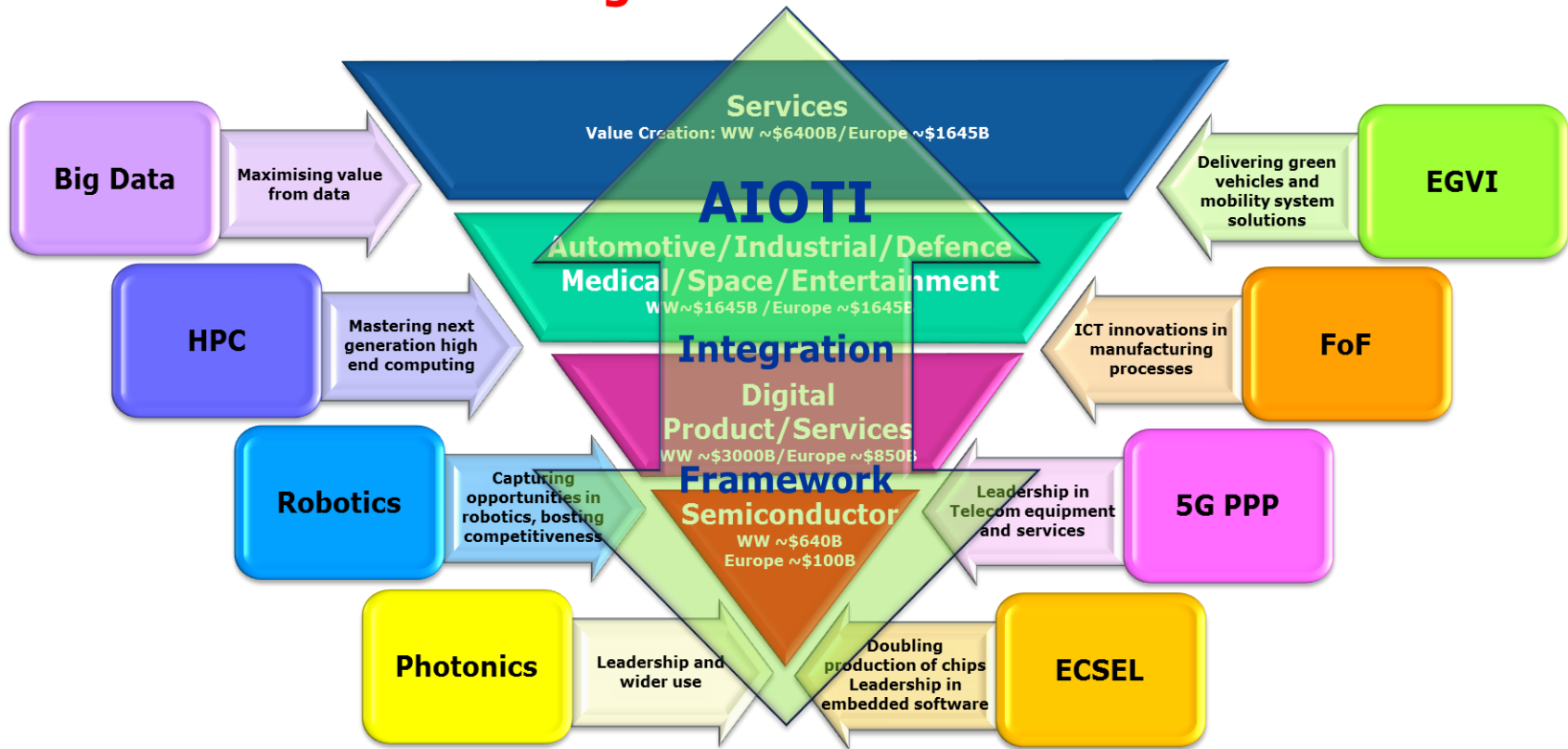
Robotics PPP

European Green Vehicles Initiative (EGVI) PPP
Applications automotive

Factories of the Future (FoF) PPP
Smart manufacturing

8 Collaboration and Processes Layer
(People and Business Processes)

7 Application Layer
Dynamic Applications
(Reporting, Analytics, Control)

- Health
- Wearables
- Wellness
- Environment
- Energy
- Mobility
- Buildings
- Cities
- Education
- Manufacturing
- Agriculture
- Smart Venues
- Security
- Privacy
- Trust
- Ethics
- Transparency
- Integrity
- Safety
- Dependability

6 Service Layer
(Services)

5 Abstraction Layer
Data Abstraction
(Aggregation and Access)

BIG Data PPP
Data

MULTI CLOUD SERVICES / DISTRIBUTED STORAGE / BIG DATA ANALYTICS / ENTERPRISE

4 Storage Layer
Data Accumulation
(Storage)

3 Processing Layer
Edge Computing
(Data Element Analysis and Transformation)

Advanced 5G networks for the Future Internet (5G) PPP
Network infrastructure, network architecture,

2 Network Communication Layer
Connectivity Elements Gateways
(Communication and processing units)

ECSEL JTI

1 Physical Layer
Devices and Controllers
("Things" - Sensors/Actuators Wired/Wireless Edge Devices)

Nanoelectronics technologies, sensors/actuators, circuits, components, sub-systems, smart systems integration, cyber-physical systems, software

IoT Platform
- Reusable capabilities / enablers for applications
- Managed access to information based on secure, distributed and referable data
- Brokering for capability interaction plus export and import of enablers
- Support of different communication patterns
- Integration of different heterogeneous systems, devices and networks
- Abstraction, hides details of underlying (networking) technologies

AIOTI
ALLIANCE FOR INTERNET OF THINGS INNOVATION

38

AIOTI Integration Framework

Connecting/Integrating across the Digital Value Chain

IoT-01-2016: Large Scale Pilots

❖ Pilot areas:

➢ Pilot 1: Smart living environments for ageing well (EU funding up to 20 MEUR)

➢ Pilot 2: Smart farming and food security (EU funding up to 30 MEUR)

➢ Pilot 3: Wearables for smart ecosystems (EU funding up to 15MEUR)

➢ Pilot 4: Reference zones in EU cities (EU funding up to 15MEUR)

➢ Pilot 5: Autonomous vehicles in a connected environment (EU funding up to 20 MEUR)

❖ Total budget:

➢ 100 MEUR

AIOTI
ALLIANCE FOR INTERNET OF THINGS INNOVATION

Alliance for Internet of Things Innovation

Smart Homes Buildings

Independent Living

Smart Energy
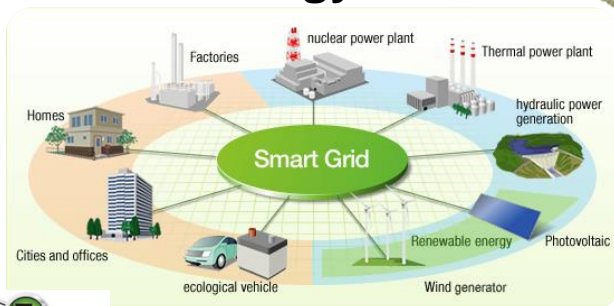
Wearables

Smart Appliances

Healthcare

Intelligent Spaces

Wellness

Smart Manufacturing

Intelligent Traffic Autonomous Driving
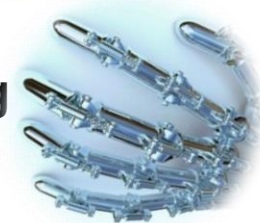
Smart City

Water Management

Lighting Control
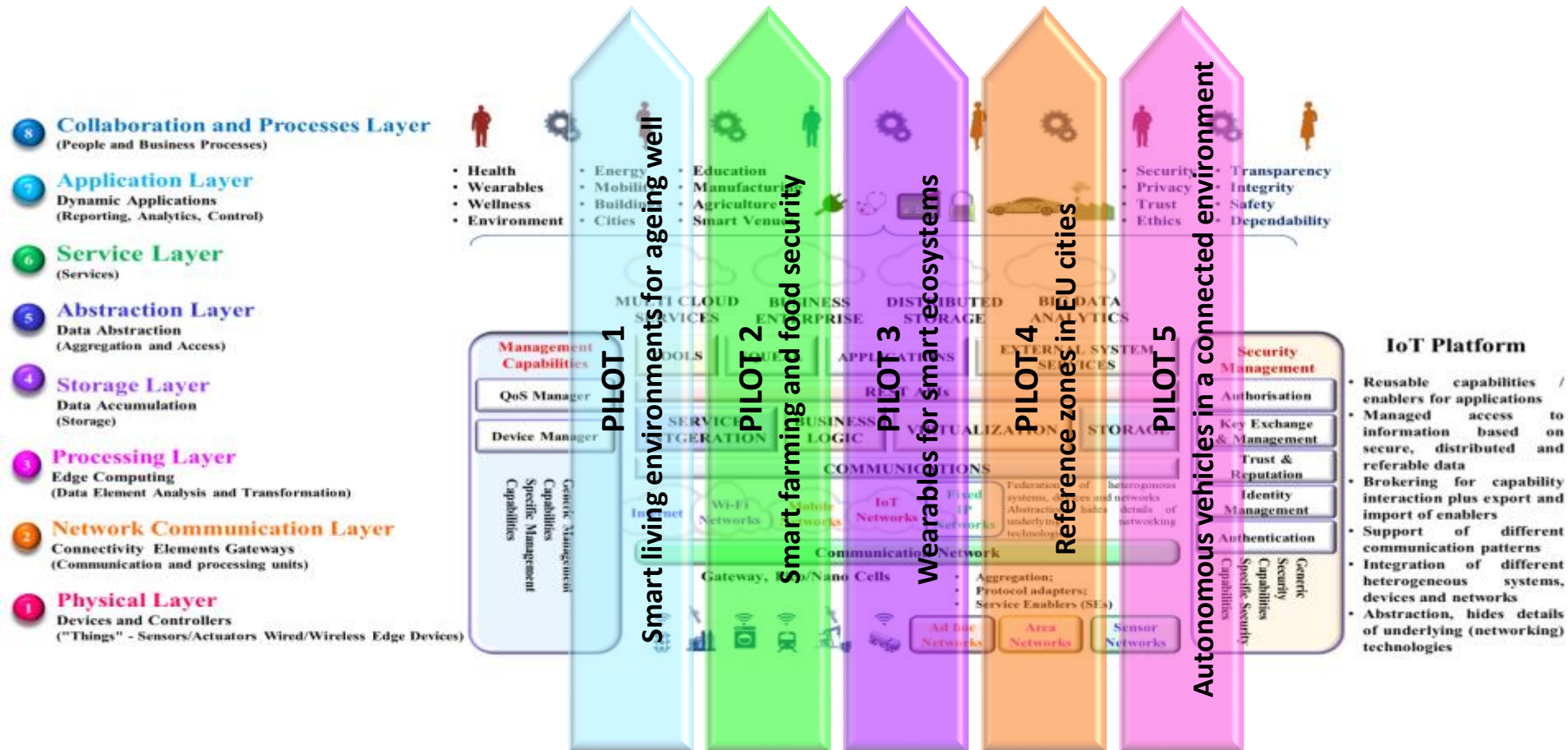
www.aioti.eu

IoT Architectural View – Mapping LSPs

European Platforms Initiative

- ❖ The IoT-EPI program includes the research and innovation consortia that are working together to deliver an IoT extended into a web of platforms for connected devices and objects.

- ❖ The platforms support smart environments, businesses, services and persons with dynamic and adaptive configuration capabilities.

- ❖ The goal is to overcome the fragmentation of vertically-oriented closed systems, architectures and application areas and move towards open systems and platforms that support multiple applications.

- ❖ IoT-EPI is funded by the European Commission with EUR 50 million over three years.

AIOTI
ALLIANCE FOR INTERNET OF THINGS INNOVATION

IoT European Platforms Initiatives IoT-EPI

UNIFY - IoT

❑ **Supporting IoT activities on innovation ecosystems**

Be IoT

❑ **The business engine for IoT projects**

symbIoTe

❑ **Symbiosis of smart objects across IoT environments**

TAG IT SMART

❑ **Connect mass-market products with the digital world across multiple application sectors**

bIoTope

❑ **Building an IoT Open Ecosystem for Connected Smart Objects**

iot-epi.eu

IoT European Platforms Initiative

VICINITY

❑ **Open virtual neighbourhood platform for connecting IoT infrastructures and smart objects**

BIG IoT

❑ **Bridging the interoperability gap of the Internet of Things**

interiot

❑ **Interoperability of heterogeneous IoT platforms**

AGILE
Adaptive Gateways for diverse muLtiple Environments

❑ **Adoptive gateways for diverse multiple environments**

IOT-EPI Cooperation framework through Task Forces

Innovation

International Cooperation

Platforms Interoperability

1

2

6

European Platforms Initiative

3

5

4

Educational Platforms
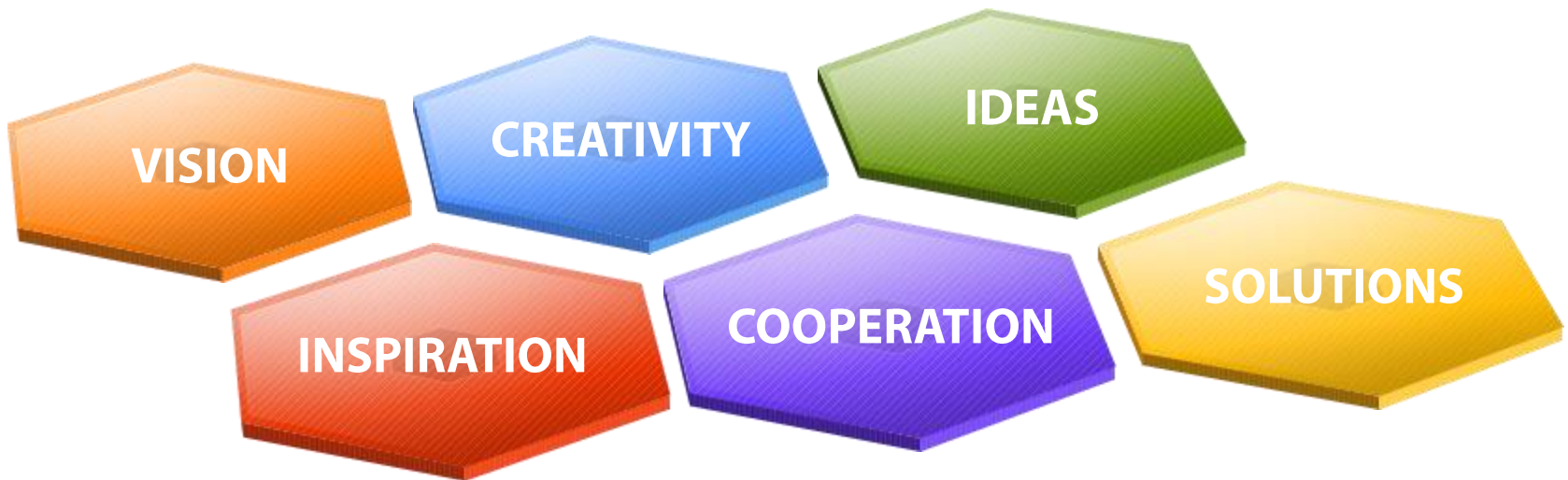
IoT Accelerators

IoT Business Models
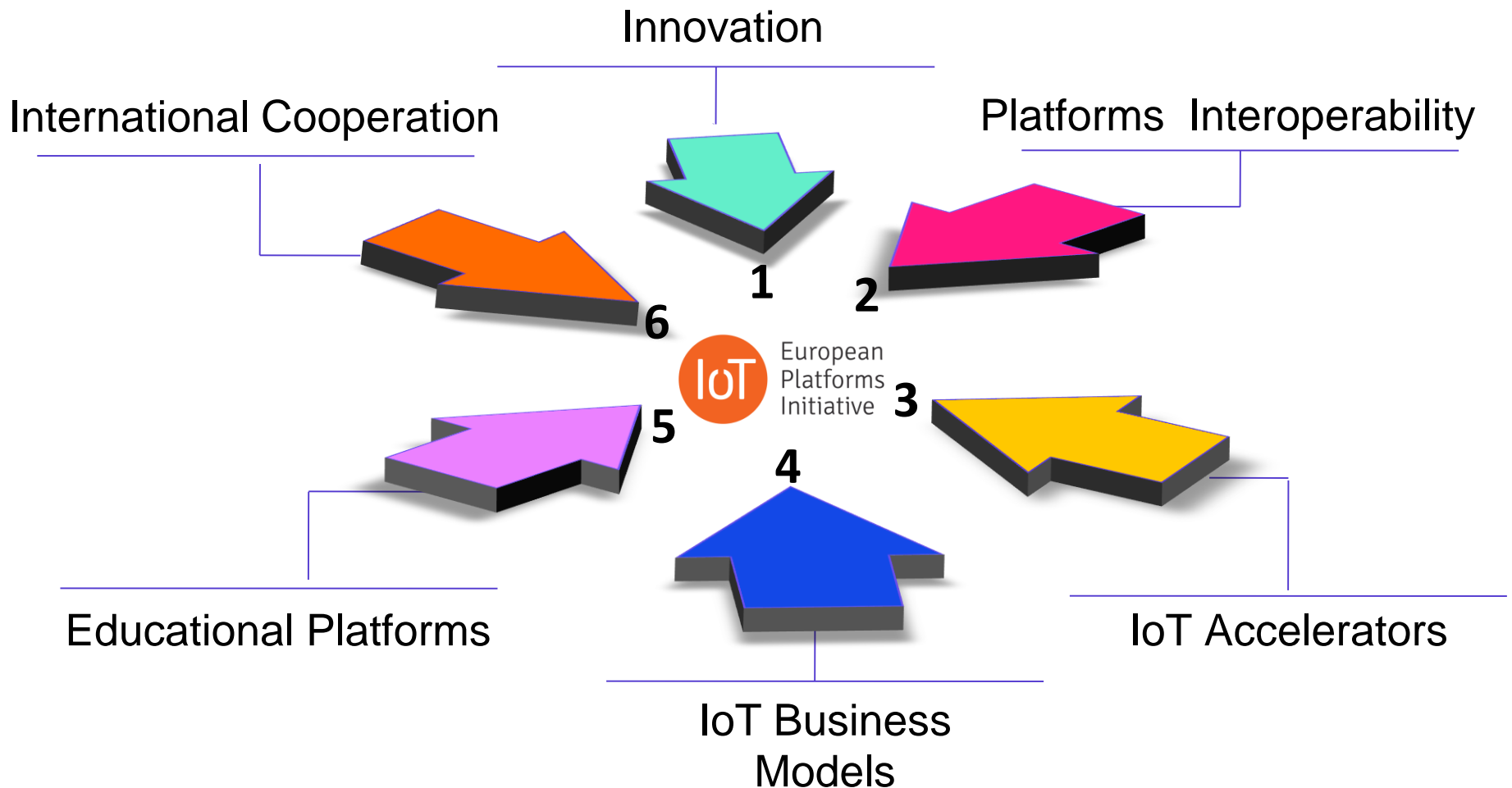
UNIFY-IoT

❖ Stimulate the collaboration between IoT projects, between the potential IoT platforms and support these in sustaining the IoT ecosystems developed by focusing on complementary actions, e.g., fostering and stimulating acceptance of IoT technology as well as the means to understand and overcome obstacles for deployment and value creation.
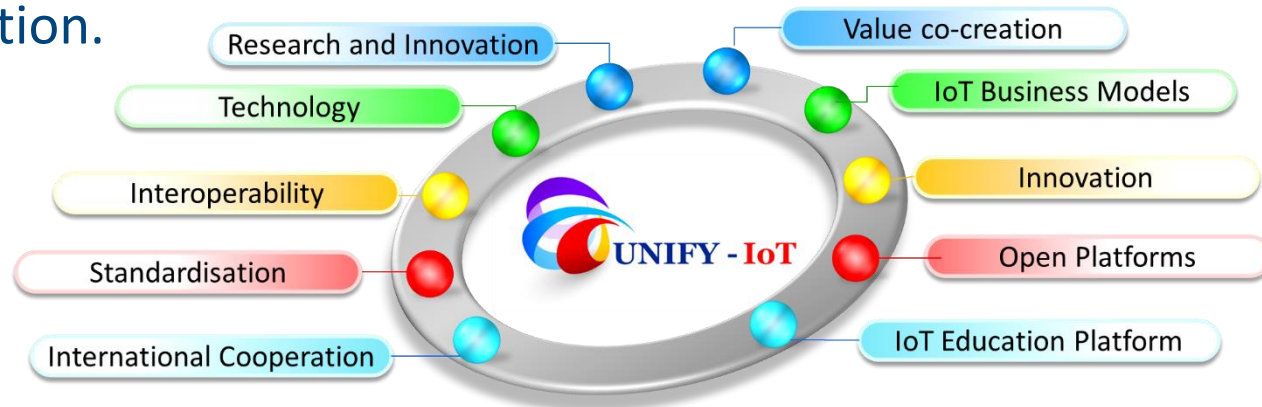
❖ UNIFY-IoT is the "working partner" of the Alliance for Internet of Things Innovation (AIOTI) and the Internet of Things European Research Cluster (IERC) by coordinating and supporting the activities on innovation ecosystems, IoT standardisation, policy issues, research and innovation.

AIOTI
ALLIANCE FOR INTERNET OF THINGS INNOVATION