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White Paper

Internet of Things (IoT)

Technology, economic view and technical standardization

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*06/07/2018*
ILNAS-ETSI workshop
Luxembourg

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Ministère de l'Économie

- Internet of Things (IoT), refers to an emerging paradigm consisting of a continuum of uniquely addressable things communicating with each other to form worldwide dynamic networks

- Predictions of exponential increment of the number of connecting devices to the internet witness its rapid growth
    - This growth opens an era of new services that can bring noticeable changes to the individual citizens, society, economy and environment and huge number of business opportunities
    - Promising technology to be adopted by numerous applications across different domains

- Vertical development of technology needs technical standardization for its future sustainability

- To provide a broad view of the developments around IoT and related technologies

- Review of IoT basic concepts and its driving technologies
  - What is the concept behind IoT, application domains and driving technologies?
- Economic and business prospects
  - What are current trends of IoT and how will IoT impact the economy at large?
- Technical standards watch
  - What are the recent developments in IoT related technical standardization?
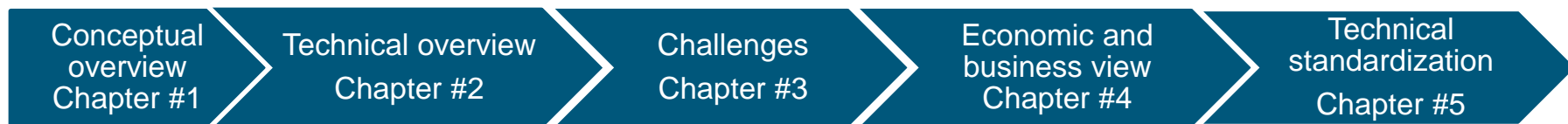 - Which set of standards are relevant?

Working group
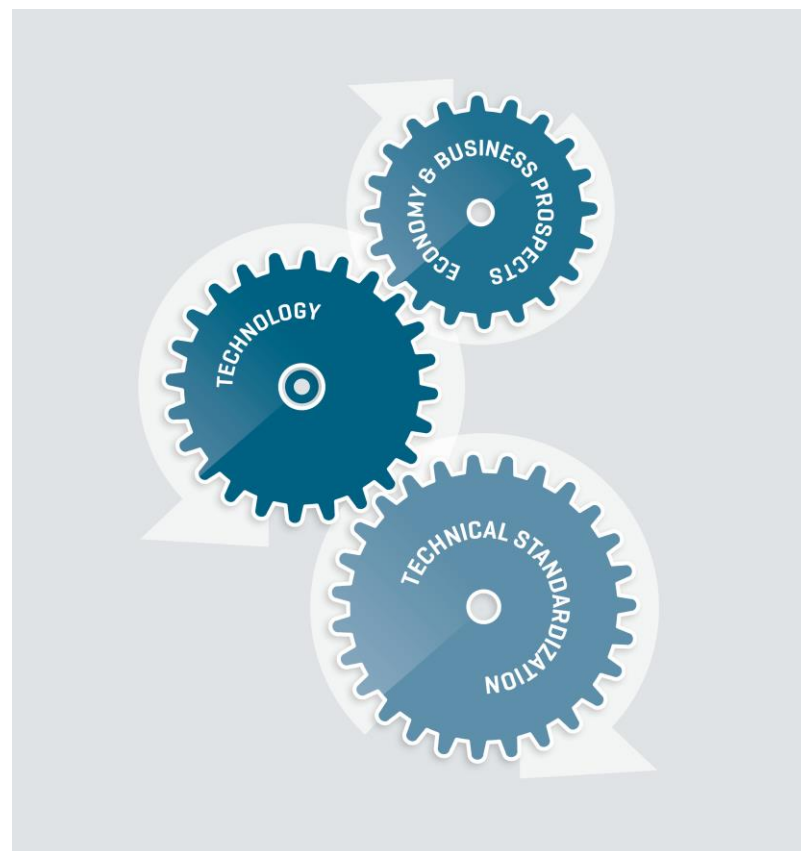
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Acknowledgements

We would like to thank all the people who have helped and supported us, in different ways, in developing this white paper.

- Ms. Marianne HOFFMANN, Ministry of the Economy
- Mr. Lex KAUFHOLD, Ministry of the Economy
- Mr. Daniel LIEBERMANN, Ministry of the Economy
- Dr. Marcin SEREDYNSKI, E-Bus Competence Center, Luxembourg
- Mr. Stefan LATSCH, Luxair S.A. LuxairCARGO
- Mr. Patrick SILVERIO, Luxair S.A. LuxairCARGO
- Dr. German CASTIGNANI, Motion-S, Luxembourg
- Mr. Manal El IDRISSI, Motion-S, Luxembourg
- Mr. Guido von SCHEFFER, Motion-S, Luxembourg
- Dr. Francesco VITI, University of Luxembourg

Outline of the whitepaper

- **Understanding** of the basic concepts

- Setup of the basic architecture of data flow in IoT environment
- **Review** of supporting, driving technologies including recent computing paradigm

- **Outline** the strengths and its limitations (technical, security/privacy, regulatory)

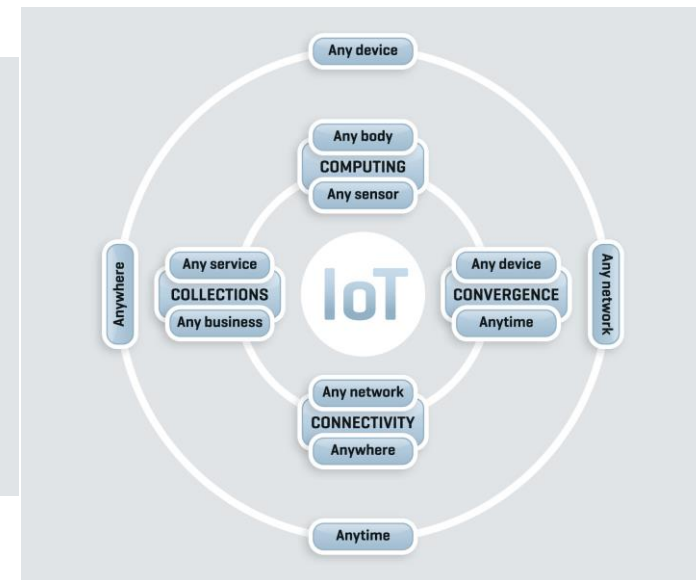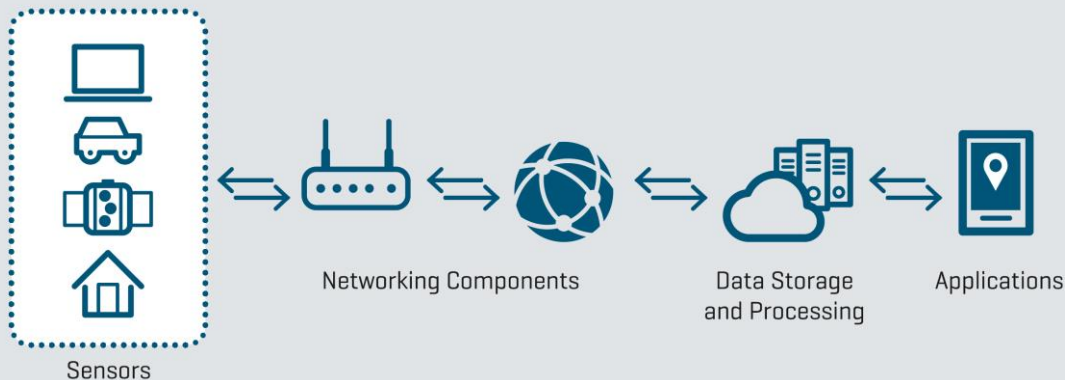| Conceptual overview Chapter #1	Technical overview Chapter #2	Challenges Chapter #3	Economic and business view Chapter #4	Technical standardization Chapter #5

- **Global review** of economic impact
- Application domains with **high** impact on economy

- Need of technical **standardization**
- **Overview** of SDOs and their activities

Internet of Things: Conceptual overview, technical landscape and challenges

Internet of Things – A conceptual overview

- **Surrounded** by **things** – eg. basic electronic devices, smart devices, automated vehicles, smart buildings and so on

- The **term** IoT is popular to **realize** the **scenario** where internet connectivity and computing capability extends to a variety of objects

- **Massive** volumes of data is **processed** and **turned** into **valuable** information to be utilized by different applications running on the IoT components

- Concept of **A**s and **C**s

Sensors — Networking Components — Data Storage and Processing — Applications

Any device / Any body — COMPUTING — Any sensor
Any service / COLLECTIONS / Any business — Anywhere
IoT
Any device / CONVERGENCE / Anytime — Any network
Any network / CONNECTIVITY / Anywhere
Anytime

- **Application domains**
  - **Smart city**
    - Smart mobility/transport – eg. intelligent transport systems (ITS), connected and automated driving
    - Utilities – eg. smart meter, public safety and environment monitoring
    - …..

  - **Industrial services**
    - Eg. smart industry, logistics and supply chain management, agriculture and breeding
    - ….

  - **Health-well being**
    - Eg. medical and healthcare, independent living
    - ….

- Set up of common architecture and defined data flow in IoT environment

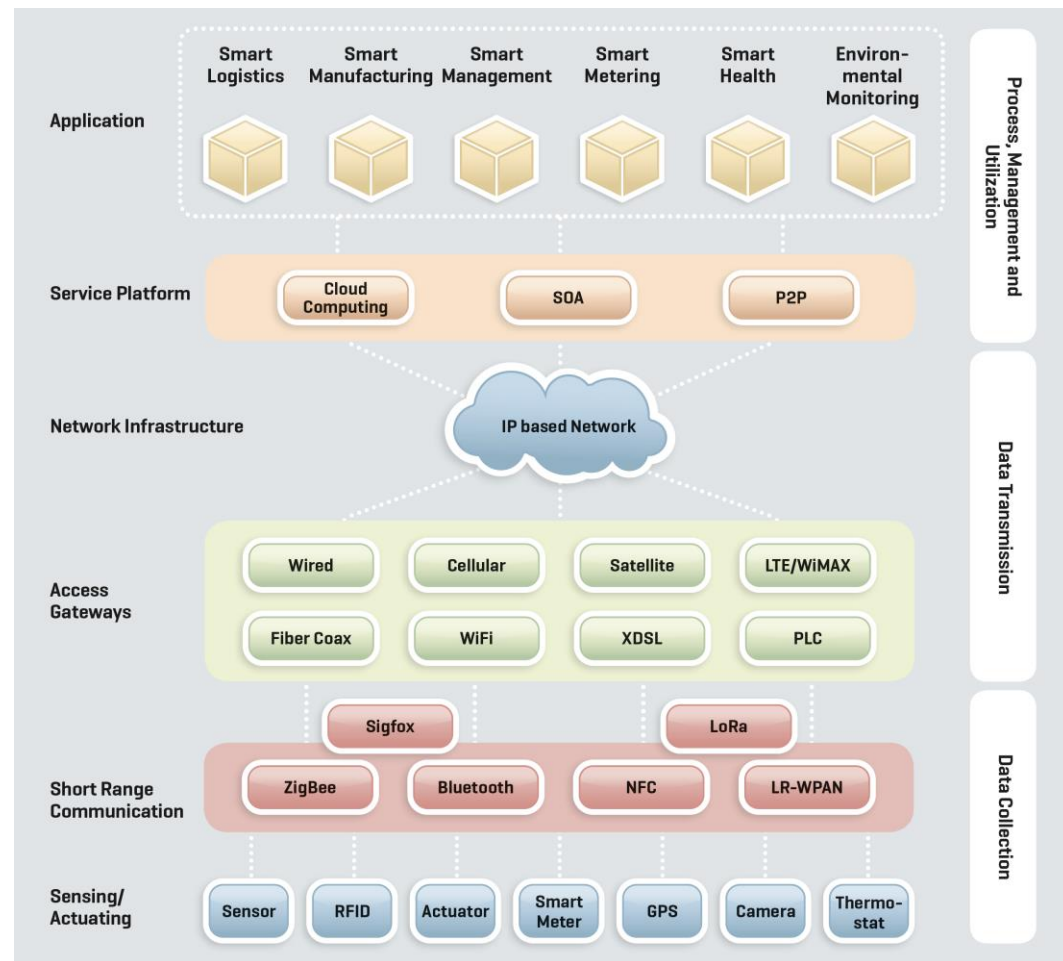 o **Data collection phase**
     - Sensors, RFID, smart meters
     - Short range communications

  o **Data transmission phase**
     - Wired and wireless communications
     - Network infrastructure

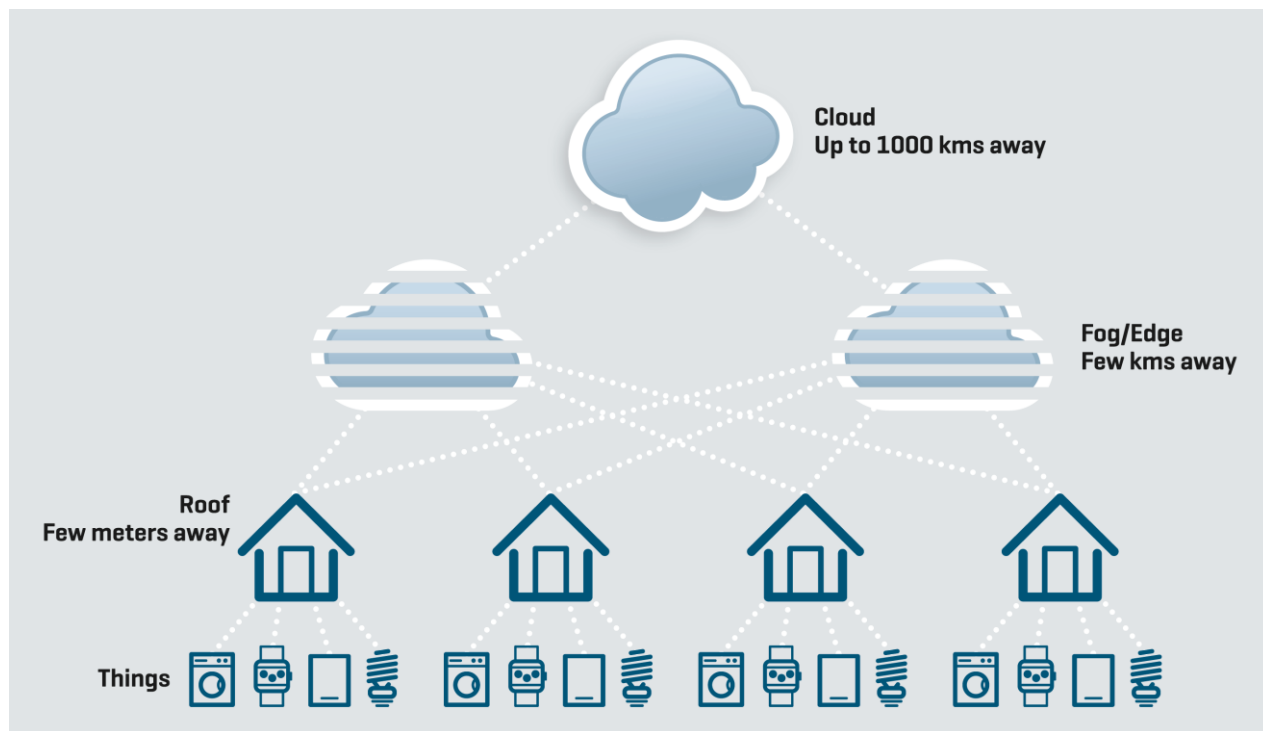 o **Processing, management and utilization phase**
     - Service platform - eg. Cloud Computing
     - Utilization of data/information

Source: E. Borgia, "The Internet of Things vision: Key features, applications and open issues," Computer Communications, vol.54, pp. 1-31, 2014 -- page 34, Figure 7 of whitepaper

- **Concept of Edge computing**
  - A method of optimizing computing systems by performing data processing at the end/edge of the network, near the source of the data
  - Integrates network, computing, storage, and application core capabilities and providing edge intelligent services
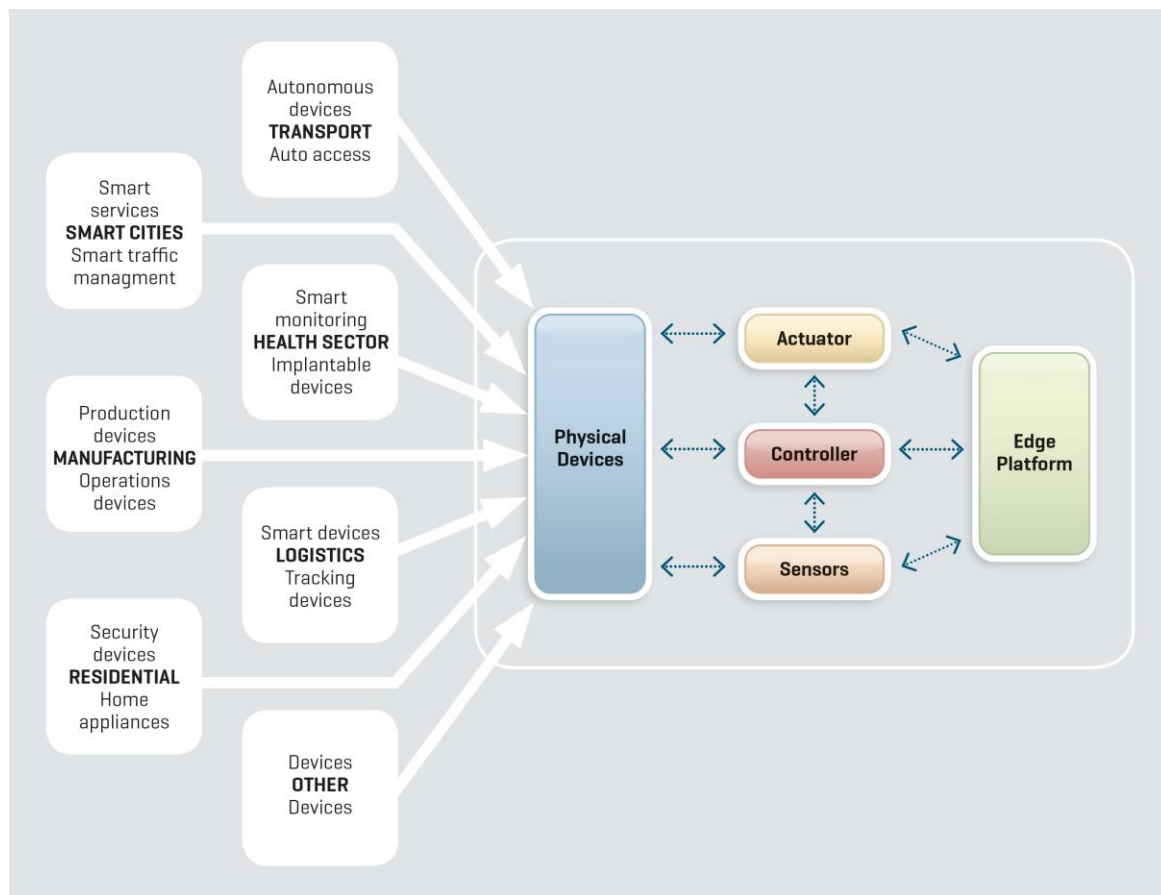
- **Computing technology**
  - Cloud computing
  - Fog/Edge computing
  - Real-time Onsite Operations Facilitations (ROOF) computing
- Insights on IoT related developments
- Comparisons

Source: https://electronicsforu.com/technology-trends/must-read/the-roof-computing/-- page 44, Figure 11 of whitepaper

- Technical issues
  - Interoperability
  - Precision
  - Data volume and scalability
  - Internet-connectivity
- Security, privacy and trust issues
  - Security vulnerabilities in overall IoT system
  - Security vulnerabilities at different layers of IoT architecture
- Regulatory issues
  - Data ownership and Data collection management
  - GDPR and IoT
- Standardization gap

Economic analysis and business prospects

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- **Key trends and overall findings**
  - More connected devices than **people**
  - **Continuous** market growth
  - **Opportunities** for established companies and start-ups

Key trends and insights	Explanation
More connected devices than people	• Even if different organizations provide a wide range of estimates on IoT devices over the next decade, it can be clearly seen from their prediction that IoT connected devices in 2017 has already superseded the population of the world, 7.48 billion [99]. • Fast growth of web-connected physical devices, such as smart devices, connected and automated cars, automated farms, and many more sectors shows its acceptance, adoption and business applicability is on rise [98].
Continuous market growth	• Gartner [57] predicts more than 52% spending on IoT in business from overall IoT spending in 2018. • Nearly 1 billion smart meters will be connected globally by most of the energy providers throughout the world to measure and manage the rising demand of energy by 2020 [2]. • The continuous global market growth (from $ 170.57 billion in 2017 to $ 561.04 billion by 2022 [100]) will positively motivate its stakeholders to invest more in IoT, which helps to create more jobs across many sectors, such as manufacturing industries, transportation, energy as well as healthcare and medical. • Global economic impact of $ 11.1 trillion per year is expected in 2025 due to IoT applications [93].
Opportunity for the established companies and start-ups	• IoT can play vital role to continually build and develop new products in various sectors, such as infrastructure, smart homes, Smart Cities, smart cars and many others for both established companies and start-ups of the country [98]. • The data used today is used mostly for abnormality detection and control but not for optimization and prediction, which can provide the greatest value in the ecosystem [93], [95], [96]. • Manufactures, oil and gas companies and other businesses have already seen the initial payoff of IoT technology in their operations [93].

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Source: page 65, Table 23 of whitepaper

- Examples of projections and high impact on economy
  - Smart manufacturing
    - 53 % of smart sensors are expected to be used by manufacturer by 2020
  - Smart transportation
    - Over 220 million connected cars are expected on the road by 2020
  - Smart utilities
    - Nearly 1 billion smart meters will be connected worldwide by 2020
  - Smart logistics
    - Sensors placed on shipping containers and parcels will further reduce the associated cost
  - Connected building and smart homes
    - Majority of home devices are expected to be connected to the internet by 2030
  - Healthcare
    - 646 million IoT devices are expected to be used in healthcare industry worldwide by 2020
  - …..

- **Strengths and business opportunities in IoT**
  - Enlighted the strengths and opportunities for companies in Luxembourg
    - Internet connectivity
    - Use of M2M cards for various applications and RFID for product tracking
    - An ideal testbed for innovative companies:
      - Eg. central location in Europe, size of the country, agility, etc.
  - The digital cross-border testbed among Germany, France and Luxembourg
    - Testing of driverless and connected vehicles in a real setting
  - …..

- Enlightened strategic plan of the Third Industrial Revolution Luxembourg
  - It aims to make the existing economic model more sustainable and interconnected for future generations by working with ICT, energy and transport as part of an intelligent network

- Build up and scale up of the Third Industrial Revolution of Internet of Things (IoT) platform
  - Enabling businesses by increasing aggregate efficiencies across their value chains, namely industry, mobility, energy, buildings, food, and finance

- Industrial Revolution of Internet of Things (IoT) platform
  - Industry
    - Smart IoT integration
    - IoT-enabled prognosis in industry and manufacturing;
    - Internet of things, services, and networks (IoT, IoS and IoN) for enabling radical makeovers in products and their delivery

  - Mobility (transport and logistics)
    - IoT can help the nation to shift from a fragmented, carbon intensive individual transport to active mobility combined with renewable energy and multimodal transportation as in the Vision for 2050:
      - A driverless road, rail, water, and air mobility internet

- Industrial Revolution of Internet of Things (IoT) platform
    - Energy
        - A large-scale roll out of smart metering - all necessary legal and regulatory frame work
            - more than 95% smart electricity metering by end of 2019 and
            - more than 90% smart gas metering by end of 2020
        - The Energy System 2050
            - Significant reduction of energy consumption
            - The mobility sector will essentially rely on electricity
            - …
    - Buildings
        - Buildings connected to the IoT infrastructure would play significant role in data handling, green power production, energy storage
        - Can act as transport and logistics hubs to manage, power, and move economic activity in a smart Luxembourg

- Industrial Revolution of Internet of Things (IoT) platform
  - Food
    - Proliferation of wireless smart sensor networks, and other tools and techniques for tracking data throughout the entire farming operation for smart farming or Internet of Agriculture
  - Finance
    - The convergence of the communication, renewable energy, and automated transportation and logistics internet on top of the IoT infrastructure
      - Could transform every aspect of financial services, foster new business models, and reshape the industry
      - Could be an enabler for issuing of virtual currencies by banks, investment funds, insurance and reinsurance companies

Technical standardization

- Background on technical standardization and the national context

	General Standardization	Electrotechnical Standardization	Tele-communications Standardization
International level	ISO	IEC	ITU
European level	cen	CENELEC	ETSI World Class Standards
National level	ILNAS	ILNAS	ILNAS

- **IoT alliances and SDOs landscape**
  - ISO/IEC JTC1/SC 41: Internet of Things and related technologies
  - ETSI/TC Smart M2M: Smart Machine-to-Machine Communication
  - ITU-T SG 20, JCA IoT and SC&C, FG-DPM
  - And other fora and consortia

Source: AIOTI, "IoT LSP Standard Framework Concepts - Release 2.8," 2017 -- page 79, Figure 18 of whitepaper

- **ISO/IEC JTC 1/SC 41: Internet of Things and related technologies**
  - o WG 3: IoT Architecture
  - o WG 4: IoT Interoperability
  - o WG 5: IoT Applications

Technical standardization
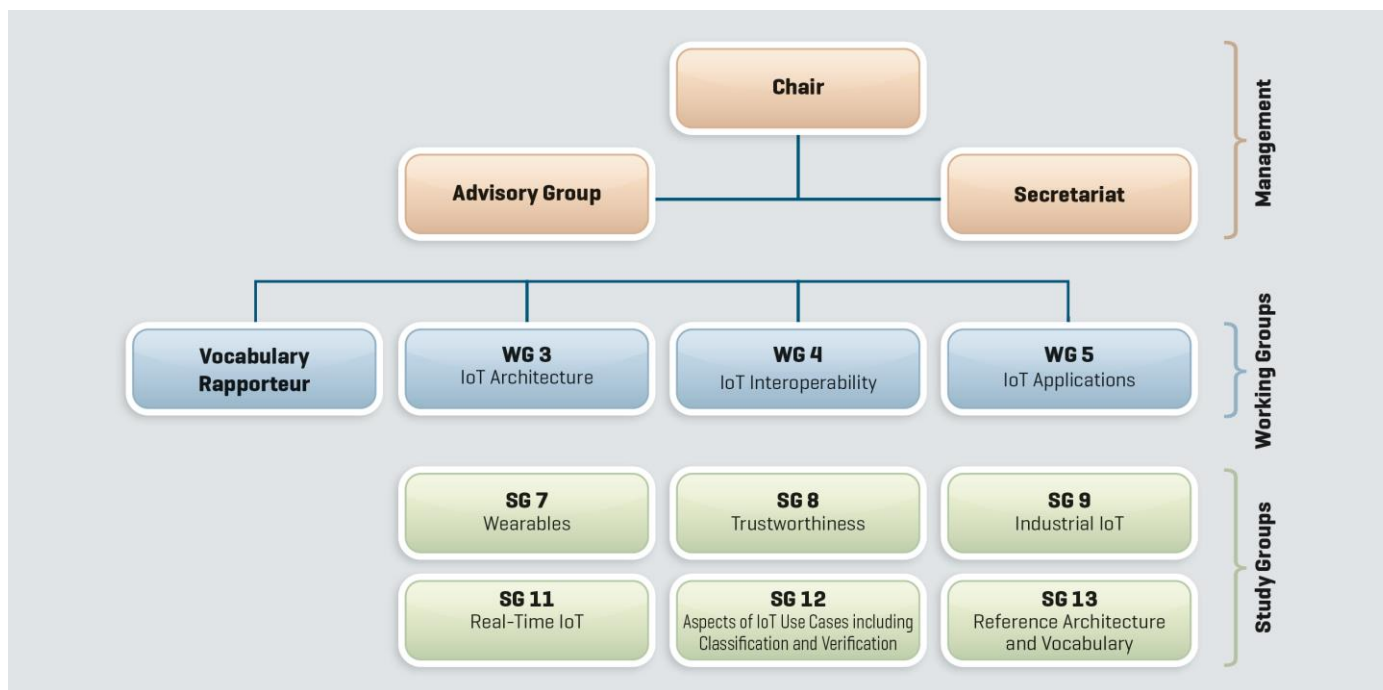
- **Liaisons with other technical committees**
  - ISO/TC 184 - Automation systems and integration in the Industrial IoT
  - IEC/TC 124 - Wearable Electronic Devices and Technologies in wearable technologies
  - ISO/IEC JTC 1/SC 27 - IT security techniques in the security, privacy and trustworthiness
  - ISO/IEC JTC 1/SC 31 - Automatic identification and data capture techniques (AIDC) in the AIDC, including barcodes, RFID or NFC
  - ISO/IEC JTC 1/SC 38 - Cloud Computing and Distributed Platforms in the edge computing

- **In Luxembourg, ILNAS manages ISO/IEC JTC1/SC 41 National Mirror Committee**
  - Currently 12 experts are registered and are actively participating in standardization activities (e.g., voting and commenting on proposals)
  - ILNAS takes initiatives to keep the national stakeholders informed about various developments

- ETSI initiatives
  - ○ ETSI/TC SmartM2M
    - It is responsible for providing specifications to M2M services and applications, including IoT and smart cities
    - Examples of list of published standards related to IoT and M2M
  - ○ Involvement of ETSI in
    - oneM2M – founding member
    - Third generation partnership project (3GPP) – founding member
    - Alliance for IoT (AIOTI) – chairing WG 3: IoT standardization

- ITU-T initiatives
  - ○ SG 20: ITU-T SG 20 - Internet of things (IoT) and smart cities and communities (SC&C)
  - ○ ITU-T FG-DPM - Focus Group on Data Processing and Management to support IoT and Smart Cities & Communities
  - ○ ITU-T JCA IoT and SC&C - Joint Coordination Activity on Internet of Things and Smart Cities and Communities

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- **Introducing fora and consortia in the context of IoT standardization**
  - Third Generation Partnership Project (3GPP) initiatives
    - Prepare, approve and maintain globally applicable technical specification and reports, such as for
      - ✓ 3GPP technologies – UMTS, HSPA+, LTE, etc.
      - ✓ 3rd generation and beyond mobile system (3G, 4G, 5G, …)
  - Alliance for Internet of Things Innovation (AIOTI)
  - Association for Automatic Identification and Mobility (AIM)
  - Global Standards One (GS1)
  - Institute of Electrical and Electronics Engineers (IEEE)
  - Industrial Internet Consortium (IIC)
  - oneM2M
  - Open Geospatial Consortium (OGC)
  - Open Connectivity Foundation (OCF)
  - World Wide Web Consortium (W3C)

Conclusions and outlook

- The IoT describes a world where anything can be connected and can interact in an intelligent fashion

- The IoT technologies are applied to enhance the quality of life of the citizens (end users)

- It is rapidly evolving, with numerous platforms under development and wide-ranging application domains – reduce cost of operation and improve quality of services
  - Eg. smart manufacturing, smart transportation, smart utilities, smart logistics followed by many other sectors, such as connected home, health sectors, banking and financial sectors

- Technical standardization addresses issue of interoperability, risk of vendor lock-in in IoT for its sustainable growth

- ILNAS – with the support of ANEC G.I.E. – is strengthening national ICT sector's participation in standardization work

  o Developing market interest and involvement

  o Promoting and reinforcing market participation

  o Supporting and building education about standardization and relevant research activities

- You can actively follow standards development process becoming a national delegate including ISO/IEC SC 41

  o On-demand awareness and training sessions about technical standardization

Thank you
Merci
Danke

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