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National IoT Activities in Finland Overview 2012-2013

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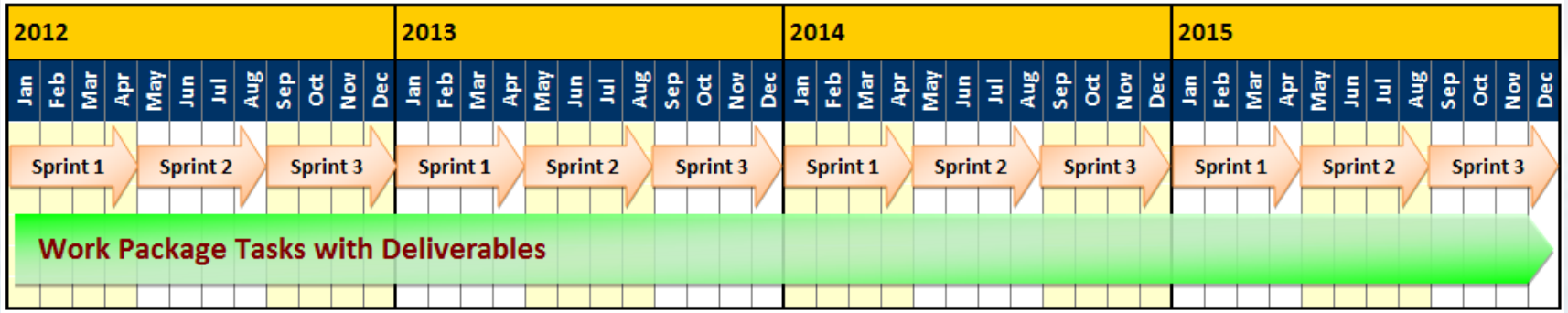
T O P I C S

- IoT program overview
- Background information
- An attempt to categorize IoT
- IoT program challenges
- Program activities 2012
- Program achievements 2012
- IoT Forecast 2010-2020

IoT Program Overview

[Overview] Setup

- 4-year-program
- Subsidized by the Finnish government
- Program started Q1/2012
- Program ends Q4/2015



- Agile Teams
- 3 sprints per year
- More than 230 experts involved
- Estimated program budget (4 years): 50 - 60 million €
- Around 30 consortium partners from industry and research organizations

[Overview] IoT Program Partners 2012/2013

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Big companies

- Elektrobit
- Ericsson
- Finnpark
- F-Secure
- Intel
- Metso
- Nokia
- Polar Electro
- Renesas Mobile
- TeliaSonera

SMEs

- 4G-Service
- Arch Red
- Componentality
- Cybercube
- Finnet Group
- Finwe
- FRUCT
- Laturi
- Mattersoft
- Mikkelin Puhelin
- Mobisoft
- Refecor
- There Corporation

Research Organizations

- Aalto University
- Laurea University of Applied Sciences
- Tampere University of Technology
- University of Helsinki
- University of Jyväskylä
- University of Oulu
- University of Tampere
- VTT Technical Research Centre of Finland

[Overview] Vision

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Background Information

[Background] Ok, but what is IoT?

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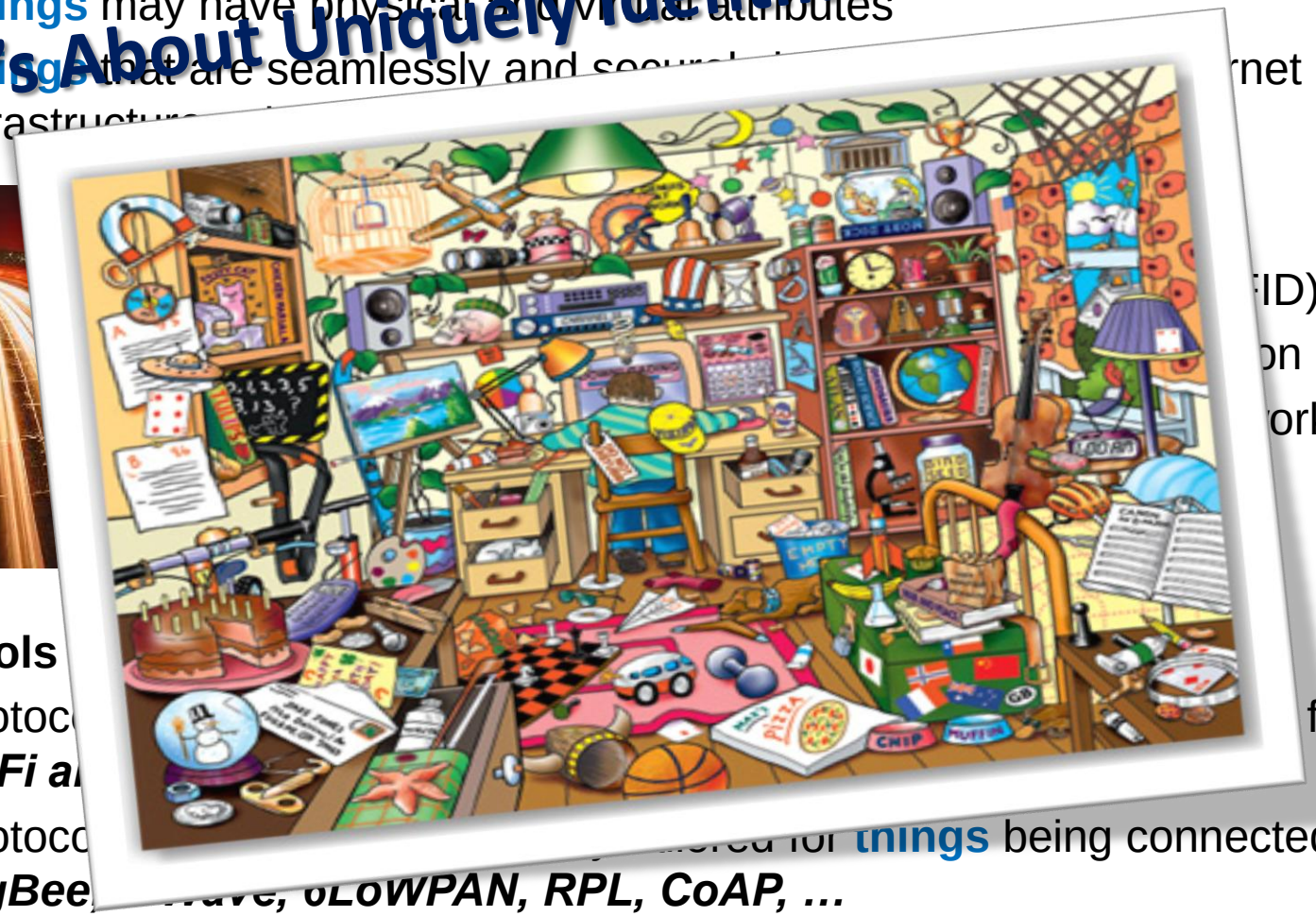
- **What are we actually trying to build?**
  - A world of heterogeneous **things** with identities
  - **Things** may have physical and virtual attributes
  - **Things** that are seamlessly and secured
  - infrastructure

It's About Uniquely Identifiable Objects



- **Protocols**
  - Protoc… fields: ***WiFi a…***
  - Protoc… for **things** being connected: ***ZigBee…, 6LoWPAN, RPL, CoAP, …***

…ID)
…on (M2M)
…orks (WSAN)

[Background] So let's connect everything?

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Ericsson:

„In the networked society everything that will benefit from a connection will be connected.

The vision is not about connecting things per se but what will happen in society when everybody and everything is connected."

Urban population is growing fast with many challenges:

- **Water**
- **Energy**
- **Transportation**
- **Pollution**
- **Urban divides**
- **Public safety**
- **Health**
- **Corruption**
- **Housing**
- **Jobs**
- **...**

Key question:
How can IoT improve our daily life?

[Background] How about traffic?

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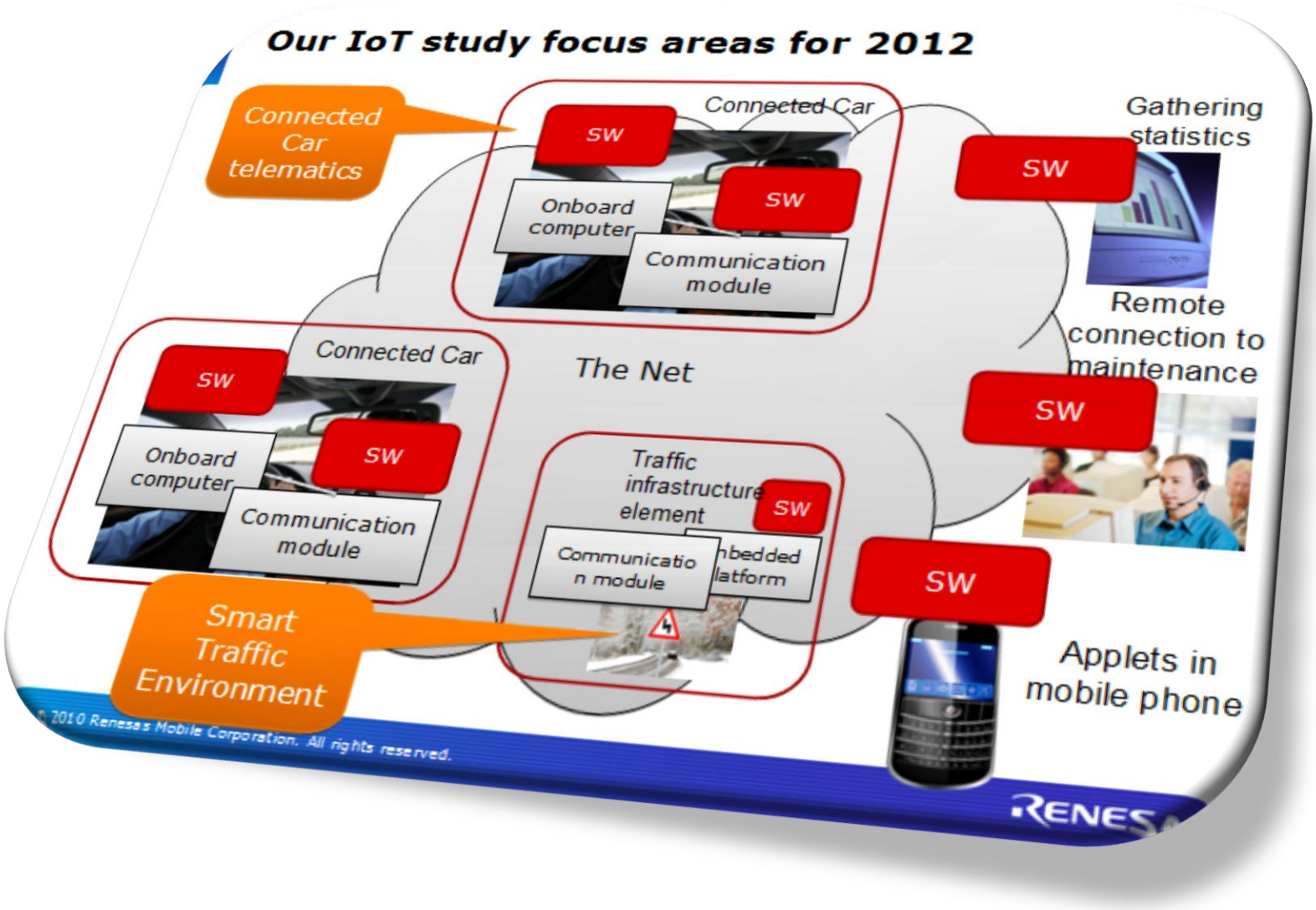
- **An example use case from the IoT program (Renesas Mobile)**



An Attempt to Categorize IoT

[Categorization] What can you do with Things ?

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- **One way to categorize IoT**
  - The variety of IoT technologies could be conventionally categorized as follows: **Tagging of things**, **sensing of things** and **embedding of things**

- **Some of the key challenges**
  - The IoT field is still relatively young
  - Development is still dominated silos
  - Incompatible technologies with relatively limited marked penetration
  - Missing standards and legal regulations for:
    Interoperability, connectivity, access control, service discovery, privacy
  - Need of energy-efficiency

[Categorization] IoT Sectors

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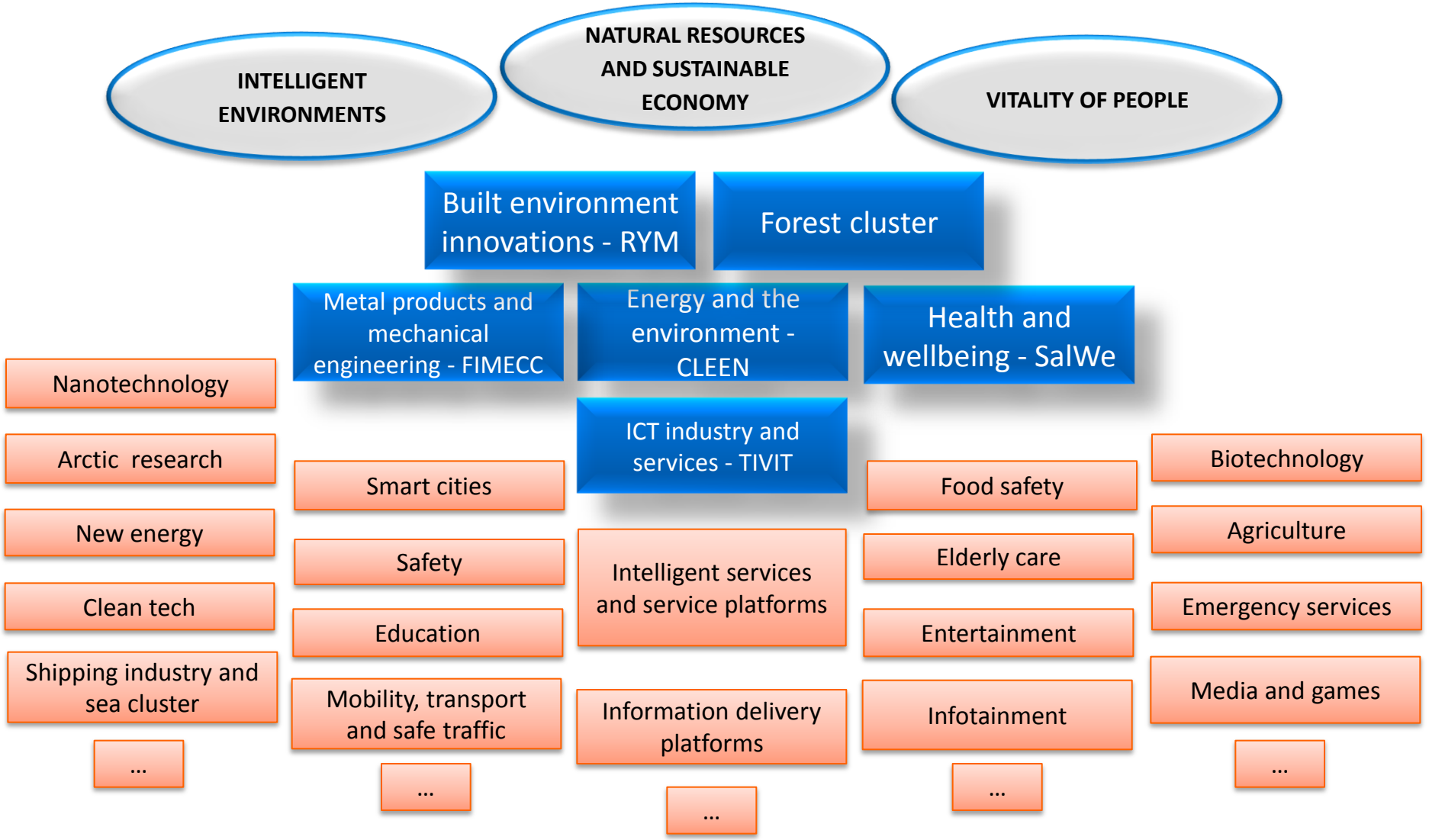
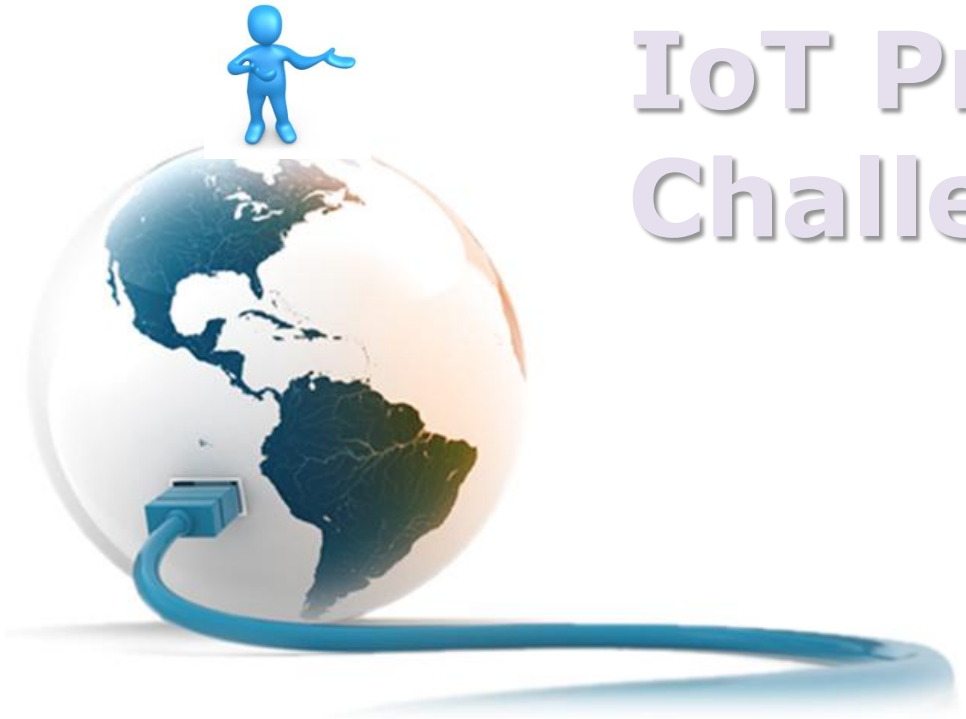
- **IoT sectors in a nutshell**
  - Intelligent environments
  - Natural resources and sustainable economy
  - Vitality of people

- **Revenue generation through**
  - IoT applications and service providers
  - IoT platform providers and integrators
  - Telecom operators
  - Software and hardware vendors
  - …
- **Example verticals**
  - Consumer electronics
  - Automotive industry
  - Healthcare sector
  - Smart home suppliers
  - Farming industry
  - Security sector
  - …

[Categorization] Potential Areas of Cooperation





IoT Program Challenges

[Challenges] Program Challenges and Goals

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- **Establishing a competitive IoT ecosystem**
  - New revenue models for participating companies in the emerging IoT market.
  - Local ecosystem formed for proof of concept, initial market, and critical mass for international business.
  - Solutions for establishing and sustaining global IoT ecosystems.
  - Develop generic horizontal solutions that can be used across verticals.
- **Creating IoT business enablers**
  - Generate IoT product concepts and prototypes and test them in real-life environments.
  - Supply critical components for IoT proliferation (such as gateway/border router to connect IoT with Internet).
- **Improving Finland's global IoT visibility**
  - Demonstrate Finnish cutting-edge IoT technology in pilots and prototypes.
  - Impact recognition of Finnish research partners as top-level institutions in IoT domain, high-impact publications.
- **Impacting IoT technology evolution and standardization**
  - Significantly influence IoT standards at IETF, 3GPP, IEEE, W3C, and other relevant forums.
  - Bring IoT technology to pilot implementations (prototypes, showcases, testbeds etc.).

[Challenges] The Way from Silos to Platforms

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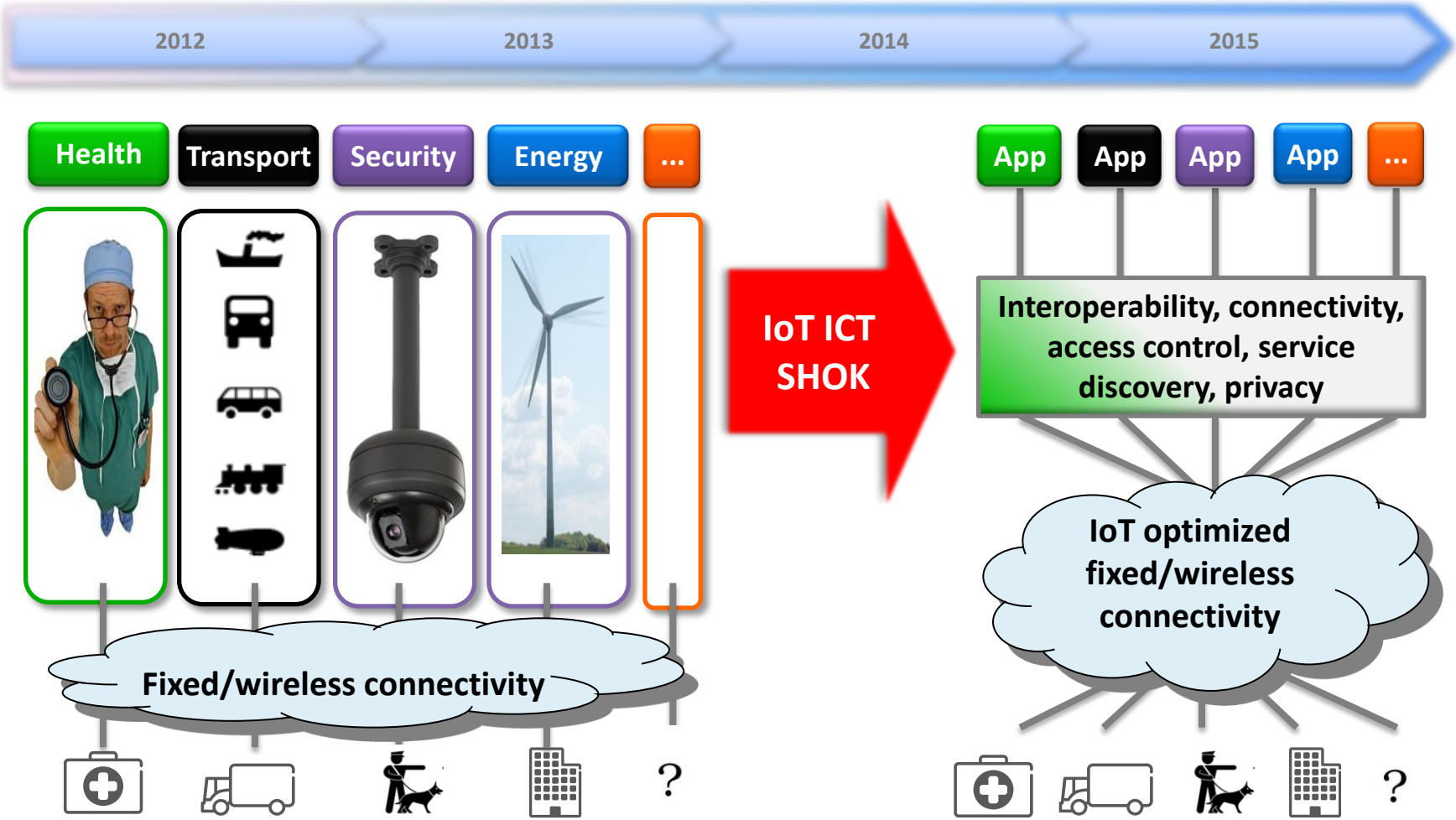

Within 4 years the foundations for new horizontal solutions shall exist!
Goal is to move from silos towards horizontal solutions.

Program Activities 2012

[Activities 2012] Teams

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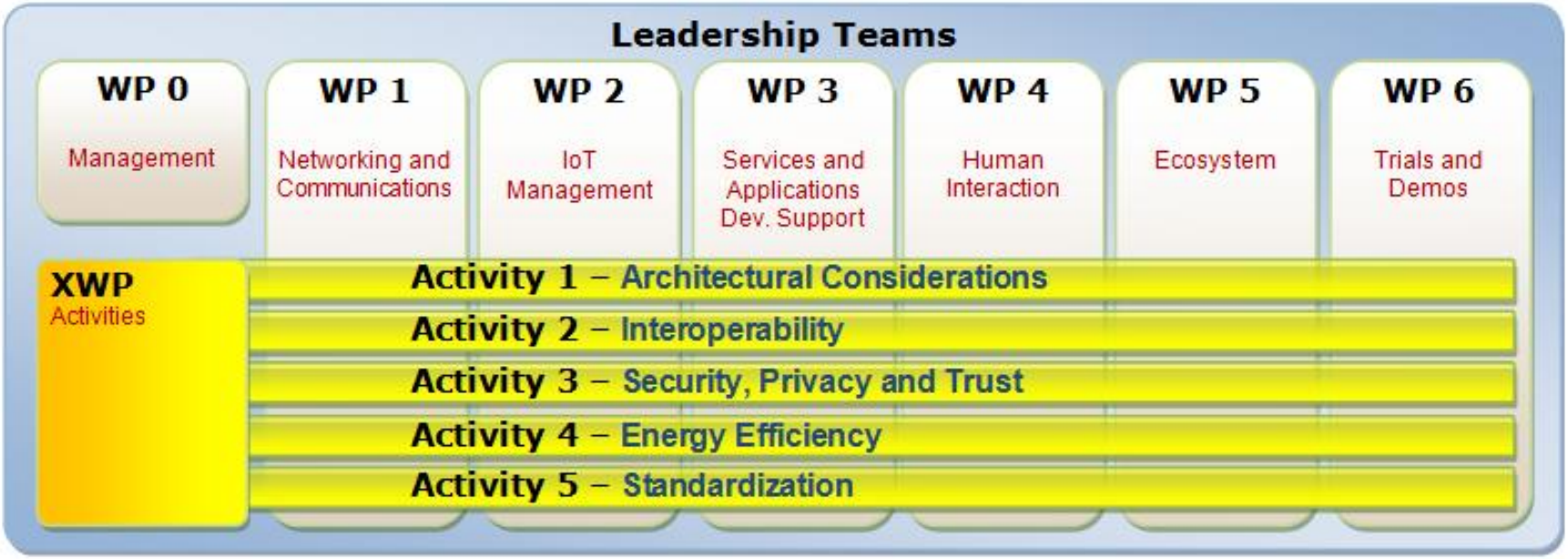

[Activities 2012] Task Overview

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- **WP1: Networking and Communications**
  - 1.1 Radio technologies
  - 1.2 Networking
  - 1.3 Security, privacy and trust
- **WP2: IoT Management**
  - 2.1 Monitoring and controlling devices
  - 2.2 Network configuration and management
  - 2.3 Mobile Wireless end-to-end security
  - 2.4 Car communication module architecture & interfaces
- **WP3: Services & Applications Dev. Support**
  - 3.1 Integration with Web
  - 3.2 Service Enablers
- **WP4: Human Interaction**
  - 4.1 Co-creation & validation of IoT UI's
  - 4.2 Intuitive configuration of IoT (home) environments
  - 4.3 Interactive solutions for authentication of users in IoT
  - 4.4 3D visualization of IoT for the crowd
  - 4.5 General 3D visualization of IoT
- **WP5: IoT Ecosystem**
  - 5.1 IoT evolution and diffusion
  - 5.2 IoT value networks vs. technical architectures & platforms
  - 5.3 Business models of IoT firms
  - 5.4 Value networks and business models for trials
- **WP6: Trials and Demos**
  - 6.1 Trial & demo evaluation & set-up
  - 6.2 Reliable connectivity of industrial systems
  - 6.3 Secure and automatic IoT service provisioning
  - 6.4 IoT with Cognitive Radio – trial
  - 6.5 IoT for Intelligent Traffic System
  - 6.6 High Definition Positioning in new service domains
  - 6.7 Extending Industrial Communications (in Mines)

[Activities 2012]
Work Package Topics

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- **WP1: Networking and Communications**
  - 1.1 Radio technologies
  - 1.2 Networking
  - 1.3 Security, privacy and trust

- **WP2: IoT Management**
  - 2.1 Monitoring and controlling devices
  - 2.2 Network configuration and management
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  - 2.4 Car communication module architecture & interfaces

- **WP3: Services & Applications Dev. Support**
  - 3.1 Integration with Web
  - 3.2 Service Enablers

WP 1 – Networking and Communications: The main objective of WP1 in Phase 1 is to work on the underlying communications and networking technology. The goals in Phase 1 include improving the scalability and the energy efficiency of the existing wireless and wired communication networks and networking mechanisms in order to enable secure connectivity for the large amounts or small battery powered devices.

WP 2 – IoT Management: The purpose of WP2 is to propose and solve those technical issues which are important for the management of the IoT. In the first phase, mainly the management architecture issues will be surveyed and preliminary solutions will be suggested. Besides new technologies, the application of existing technologies such as LTE in certain application scenarios will also be evaluated. WP2 is tightly coupled with the trials and demonstrations suggested in WP6.

WP 3 – Services and Applications Development Support: The main objective of WP3 is to bridge the gap between the underlying infrastructure, including a plethora of IoT devices and networks and the Internet's dominant information-level infrastructure, i.e. the Web. When IoT devices are connected to Web, the first challenge is to adjust the basic connectivity and Web technologies to the characteristics of IoT. On the protocol level, the state of practice is for applications to control IoT devices through RESTful versions of HTTP POST and PUT, and query them through HTTP GET.

[Activities 2012]
Work Package Topics

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- **WP4: Human Interaction**
  - 4.1 Co-creation & validation of IoT UI's
  - 4.2 Intuitive configuration of IoT (home) environments
  - 4.3 Interactive solutions for authentication of users in IoT
  - 4.4 3D visualization of IoT for the crowd
  - 4.5 General 3D visualization of IoT

WP 4 – Human Interaction: This work package concentrates on end-user aspects. IoT enables tangible and ubiquitous interaction between people, objects, locations and services. The first focus is on transferring from graphical user interfaces to direct interaction with the real physical environment and its everyday objects. This kind of interaction has a significant potential in enabling easy-to-use services that intertwine into our everyday life. The second focus is on communicating to users the state of complex, distributed IoT systems and on efficient ways on controlling such systems.

- **WP5: IoT Ecosystem**
  - 5.1 IoT evolution and diffusion
  - 5.2 IoT value networks vs. technical architectures & platforms
  - 5.3 Business models of IoT firms
  - 5.4 Value networks and business models for trials

WP 5 – Ecosystem: The current IoT field can be characterized as fragmented. The IoT marketplace is still in its early "embryonic" phase, with co-existing incumbents (Cisco, IBM, SAP) and new entrants (Arduino, Pachube) holding market niches. The main objective of the WP is to support Finnish firms in forming a successful IoT ecosystem by identifying their role in the ecosystem and developing suitable business models.



[Activities 2012]
Work Package Topics

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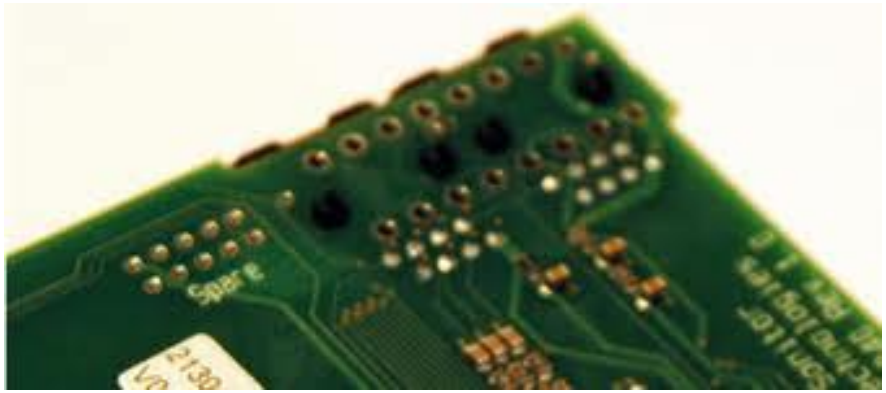
- **WP6: Trials and Demos**
  - 6.1 Trial & demo evaluation & set-up
  - 6.2 Reliable connectivity of industrial systems
  - 6.3 Secure and automatic IoT service provisioning
  - 6.4 IoT with Cognitive Radio – trial
  - 6.5 IoT for Intelligent Traffic System
  - 6.6 High Definition Positioning in new service domains
  - 6.7 Extending Industrial Communications (in Mines)

WP 6 – Trials and Demos: The purpose of WP6 is to link IoT technology research and development and the business domains needing and utilizing IoT: WP6 links research and development to innovation. Trials and demos are the means to achieve this. In the trials, or verticals, we extract requirements from real-life IoT application domains, so that the requirements can be used in technical WPs to find the common denominators and needs and thus guide the planning; when the technical WPs produce solutions they are experimented and tested in the trials to give further feedback for research and development and to verify or falsify the assumptions made. Thus this WP is an important part of the iterative development process.



Program Achievements 2012

[Achievements 2012] Publications

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By 2017 the Finnish ICT industry is a recognized leader in the IoT domain due to its expertise in standards, software, devices, and business models integrating various vertical industry segments

- *The program has published or submitted a considerable amount of scientific articles*
- *Accepted articles include IEEE SECON, ACM SIGCOMM workshop on Mobile Cloud Computing, IEEE Globecom workshop on IoT, ACM ExtremeCom*
- *Submitted articles to IEEE Communications, IEEE Network magazine, IEEE Transactions on Mobile Computing, and many conferences*
- *Significant contributions to IETF CoAP and HOMENET, IEEE 802.11ah, 3GPP LTE, …*

[Achievements 2012] Publications

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Examples:

On Mobile Vehicular LTE Relay Node Suitability for the Internet of Things
Modeling Energy Consumption of Data Transmission over Wi-Fi
A Usability Test of Whitelist and Blacklist-based Anti-Phishing Application
User Controlled Body Sensor Network Security
Overview of User-centred Quality Assurance Methodologies for Anti-phishing Software and Phishing-resistant Systems
New Usability Metrics for Authentication Mechanisms
Energy and Delay Analysis of LTE-Advanced RACH Performance under MTC Overload
User-assisted Semantic Interoperability in Internet of Things
Metrics Driven Security Management Framework for E-Health Digital Ecosystem Focusing on Chronic Diseases
Towards Metrics-Driven Adaptive Security Management in E-Health IoT Applications
Adding Semantics to Internet of Things

[Achievements 2012] Publications

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Examples:

Security and Privacy Threats in IoT Architectures
Reducing Energy Consumption of LTE Devices for Machine-to-Machine Communication
RAN overload control for Machine Type Communications in LTE
Feasibility Study of IEEE 802.11ah Radio Technology for IoT and M2M use Cases
On IEEE 802.16m Overload Control for Smart Grid Deployments
Android Security Software Needs More Privileges
An Applicability Assessment of IEEE 802.11 Technology for Machine-Type Communications
Defining an Internet-of-Things Ecosystem
Management Architecture for the Internet of Things
Energy-Aware Keyword Search on Mobile Phones
Maximizing Timely Content Advertising

[Achievements 2012] Research and Prototypes

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- Evaluation of cryptographic libraries and algorithms
- Feedback to COAP resource directory and mirror proxy drafts at the IETF
- Research and prototypes for low-power, low-cost sensor networking design for snow environments

- State-of-the-art review of M2M communications in the LTE-context from traffic point of view
- Literature review related to security and energy efficiency of various resources-constrained networks

- World's first implementation of IETF HOMENET technology; a routed network that configures the routing protocols, network prefixes, router advertisements, DNS, and even NAT64 automatically

[Achievements 2012] Research and Prototypes

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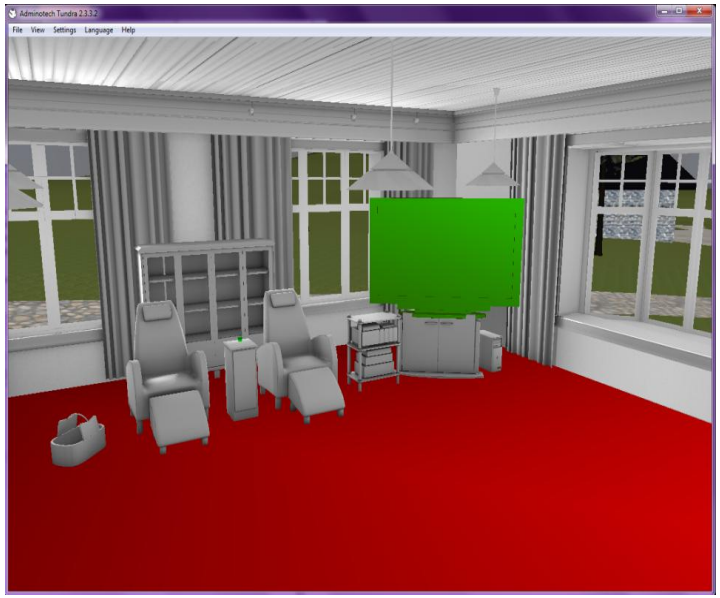
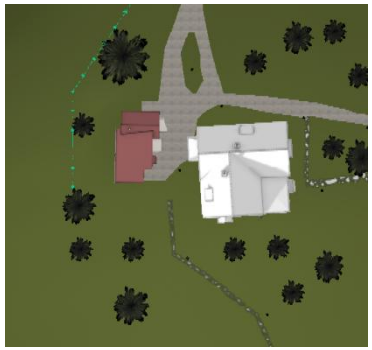
- General 3D visualization prototype of IoT (Task 4.5)



- Sensor data values are mapped to attributes of 3D objects
- Objects can change their color, opacity, size, velocity etc.
- Current prototype changes colour of objects
- Data read directly from providers to 3D visualization
- Implementation includes a map and a single 3D house
- Prototype uses power consumption data from There's sensors
- Lock status data available from Finwe



- Possibility to move in a 3D environment using a map of the world
- 3D objects are updated based on real data from sensors Current prototype has still limited functionality

[Achievements 2012] Research and Prototypes

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- Virtual Aquarium prototype (used for a commercial product)

- “Activarium” is a new product by Polar
- Results are based on research collaboration with University of Oulu and City of Oulu
- Enhanced user experience through a fun and engaging game
- Teachers and students collaborate to create an aquarium by achieving daily activity targets
- Allows students work together in building a personalized environment while providing a tool for teachers to help reinforce the benefits of being active.

[Achievements 2012] Research and Prototypes

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- Device management application scenarios, use cases and requirements
- Proposal for IoT identification scheme that works regardless of access method (3GPP vs. non-3GPP)
- Participation in the international evaluation contest OAEI 2011.5
- IoT market, value networks, and business models: the state of the art evaluation (SOTA report)

- New national and international IoT partnerships (French Cluster, IoT Forum, collaboration targets with China etc.) and plans to organize conferences and meetings with them

[Achievements 2012] Internatinal Cooperation with Tivit as Gateway between Europe and China

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TIVIT PROMOTES
THE FINNISH ICT CLUSTER IN EU

- FUTURE INTERNET PPP
- ICT BASED GROWTH
- PROFITABILITY
- KEY R&D PARTNERS
- KEY BUSINESS PARTNERS
- ACCESS TO POLICY-MAKERS
- GOVERNMENTAL SUPPORT
- INDUSTRIAL SUPPORT

TIVIT PROMOTES
THE FINNISH ICT CLUSTER IN CHINA

- CHINA FINLAND ICT ALLIANCE
- ICT BASED GROWTH
- PROFITABILITY
- KEY R&D PARTNERS
- KEY BUSINESS PARTNERS
- ACCESS TO POLICY-MAKERS
- GOVERNMENTAL SUPPORT
- INDUSTRIAL SUPPORT

IoT Forecast 2010-2020

[Forecast] Market Predictions 2010 – 2020

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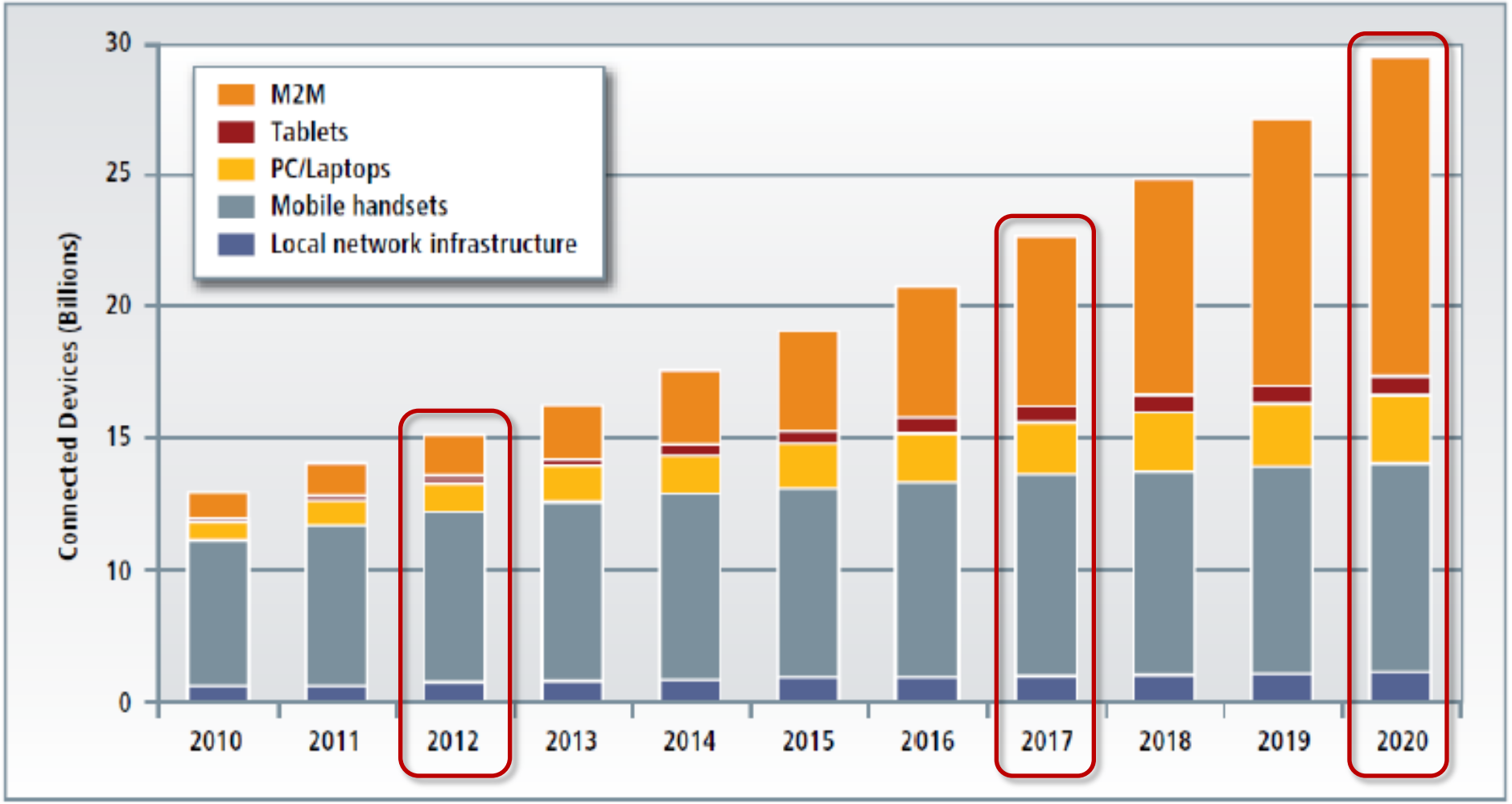
- **Prediction of connected devices worldwide**
  - Amount of connected devices in billions



[Forecast] Market Predictions 2010 – 2020

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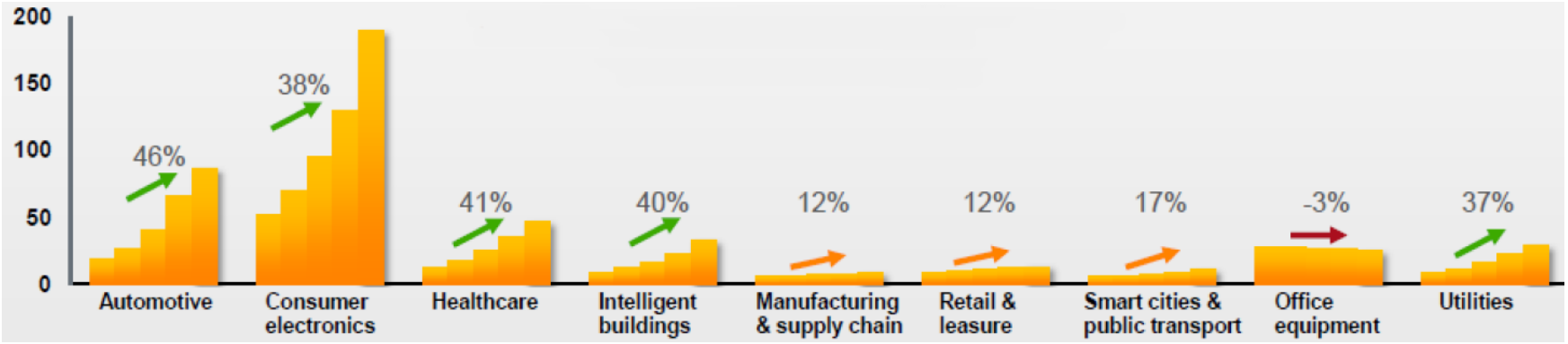
- **How about the revenues?**
  - M2M communication generates more than 700 billion EUR in revenues by 2020
  - M2M market is expected to be the largest submarket within IoT market
  - Some verticals with possible double-digit growth in the upcoming years
  - Most prospective verticals in terms of the growth rate and revenues are:
    - **Consumer electronics** (revenue opportunity $B445)
    - **Automotive** (revenue opportunity $B202)
    - **Healthcare** (revenue opportunity $B97)
    - **Intelligent buildings and utilities** (revenue opportunity $B36)
- **Expected revenue growth in different M2M vertical segments**



Global revenue forecast 2011-2015 (Machina, M2M Global Forecast & Analysis)

[Forecast] Market Predictions 2010 – 2020

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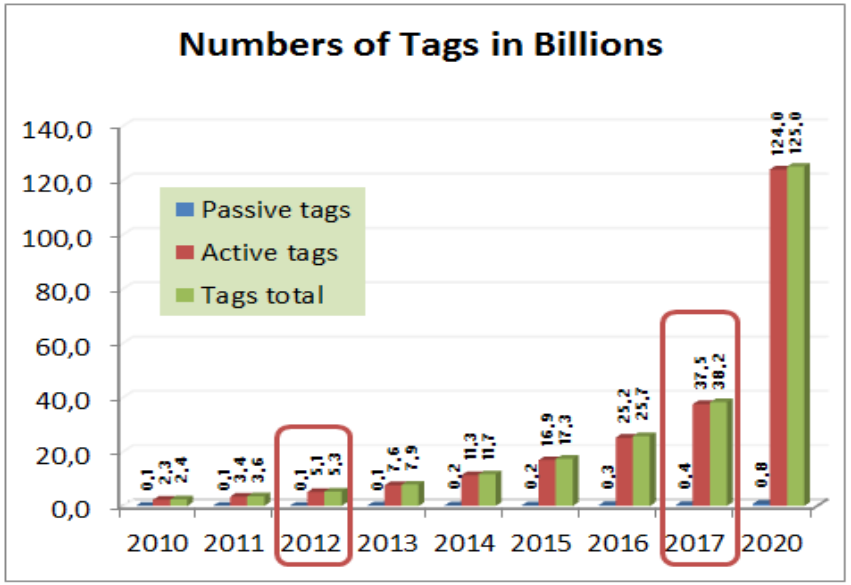

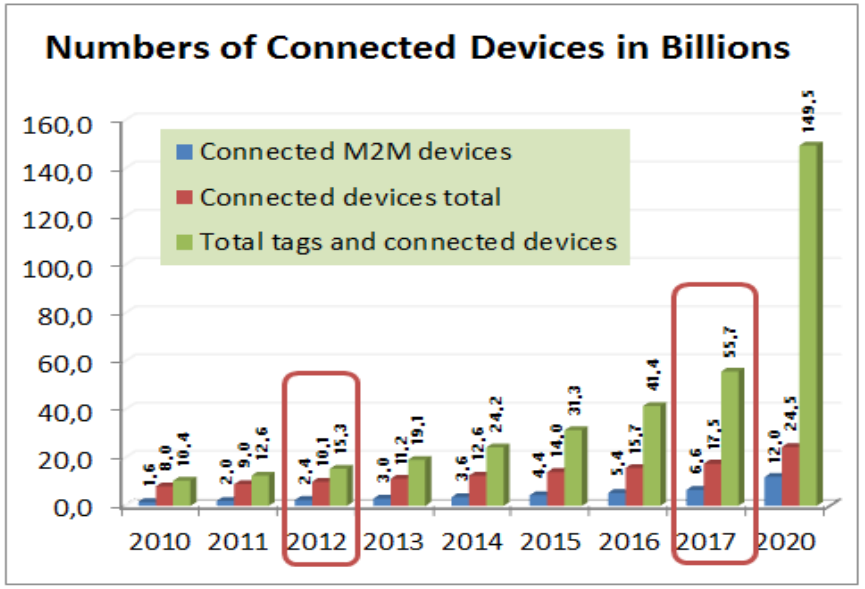

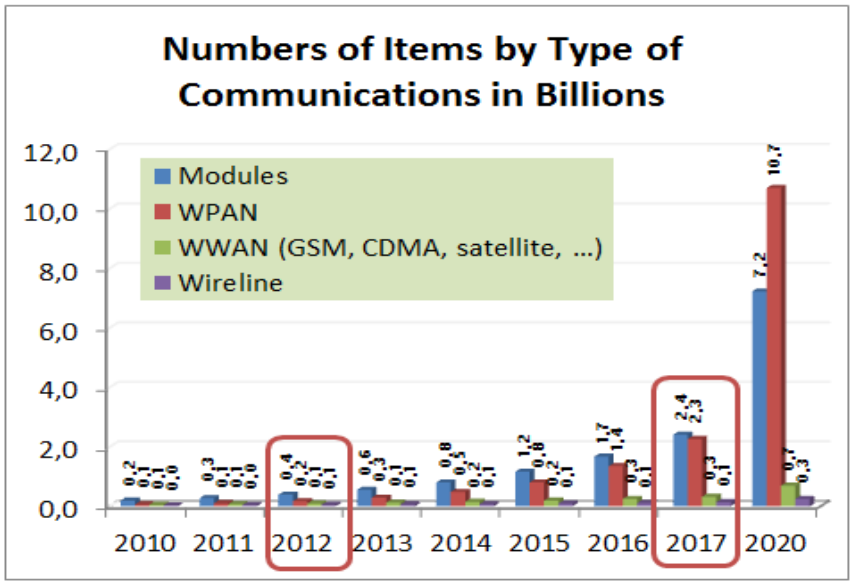

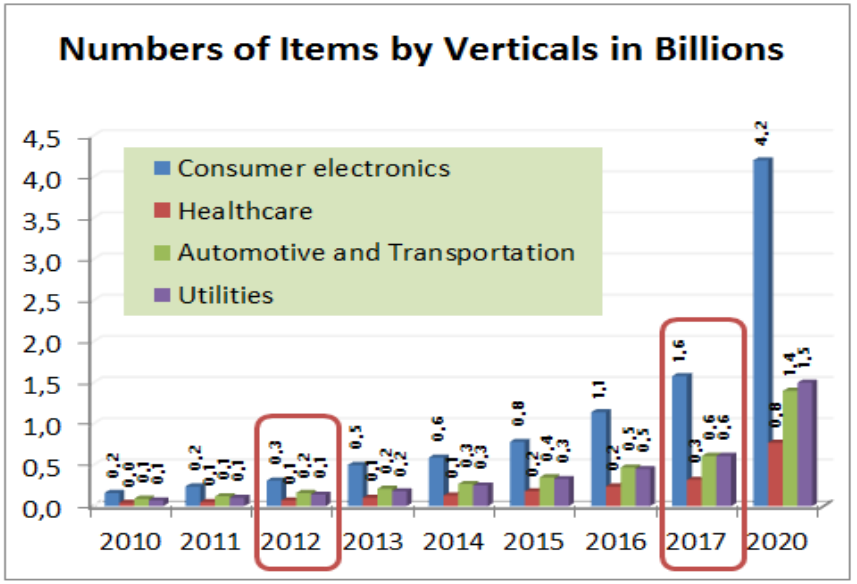

[Forecast] Market Predictions 2010 – 2020

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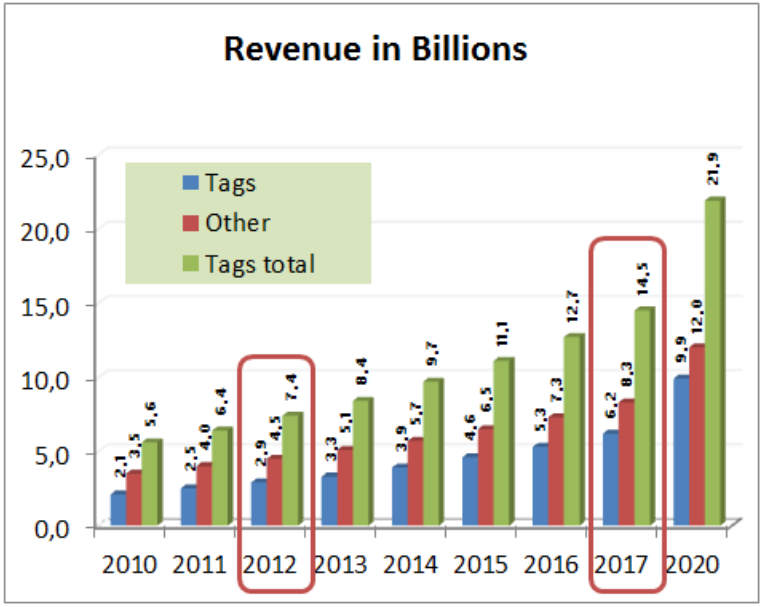

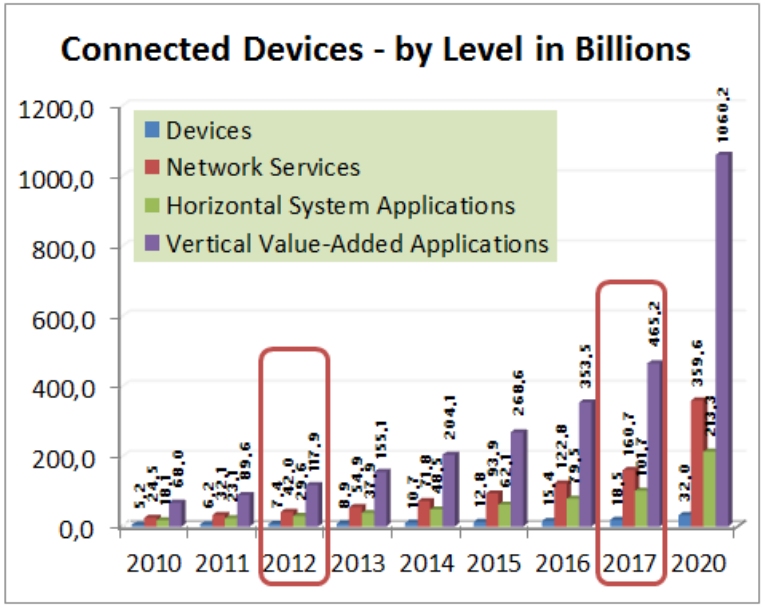

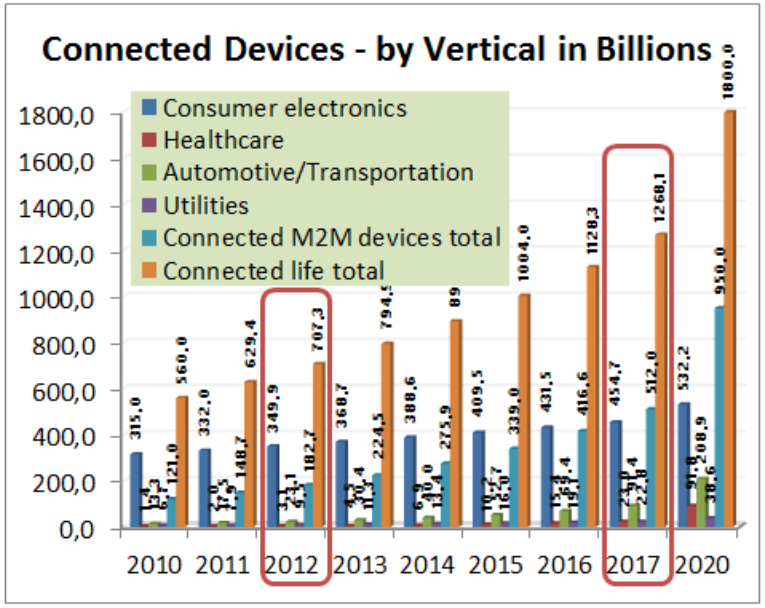

Thank you!

Any comments?

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