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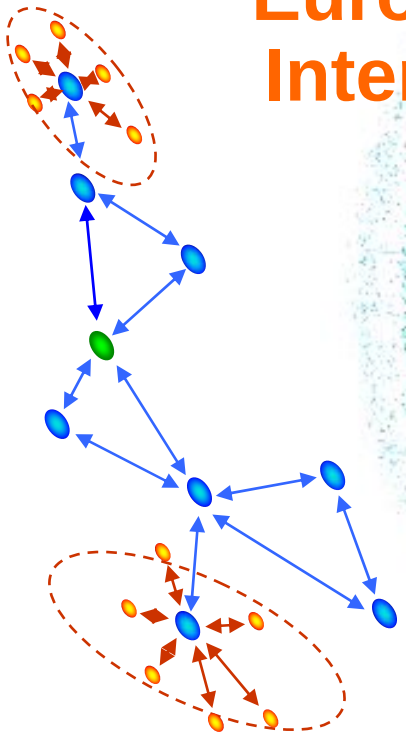
Workshop: ”RFID and the Internet of Things - Are you ready?”
10-11 May 2010, Radisson Blu Scandinavia Hotel, Oslo, Norway.

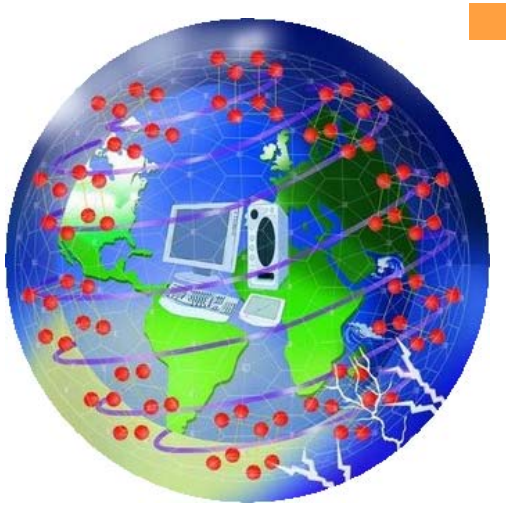


European Research Cluster on the Internet of Things –Outlook of IoT Activities in Europe

Dr. O. Vermesan
SINTEF, Norway

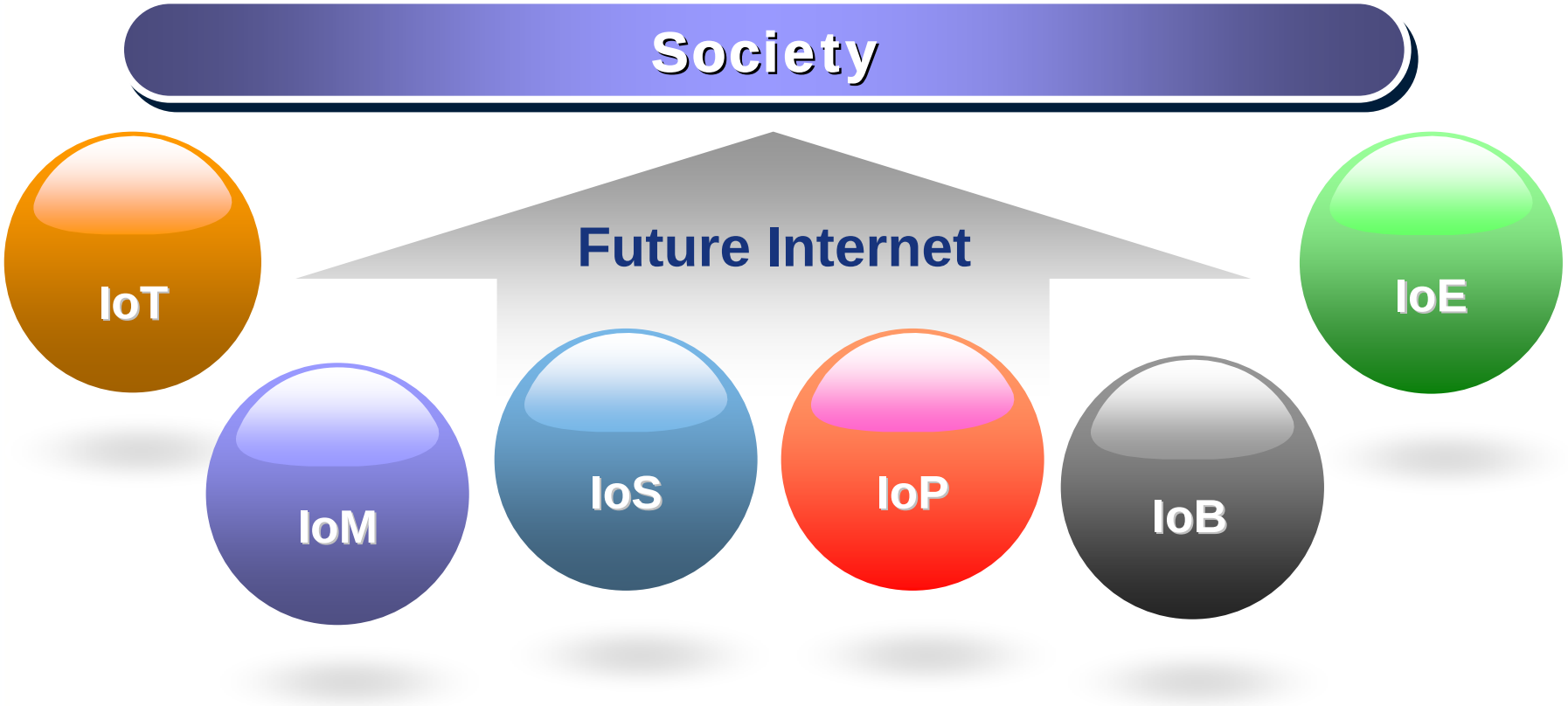
Future Internet Vision

- The Future Internet vision is that “all network and service platforms technologies called upon to constitute the Internet are looked at as part of a single system that seamlessly integrate various Internets of “X” into a knowledge network that is based on trust, security and privacy, address the socio-economics needs of individuals for the benefit of whole human society.



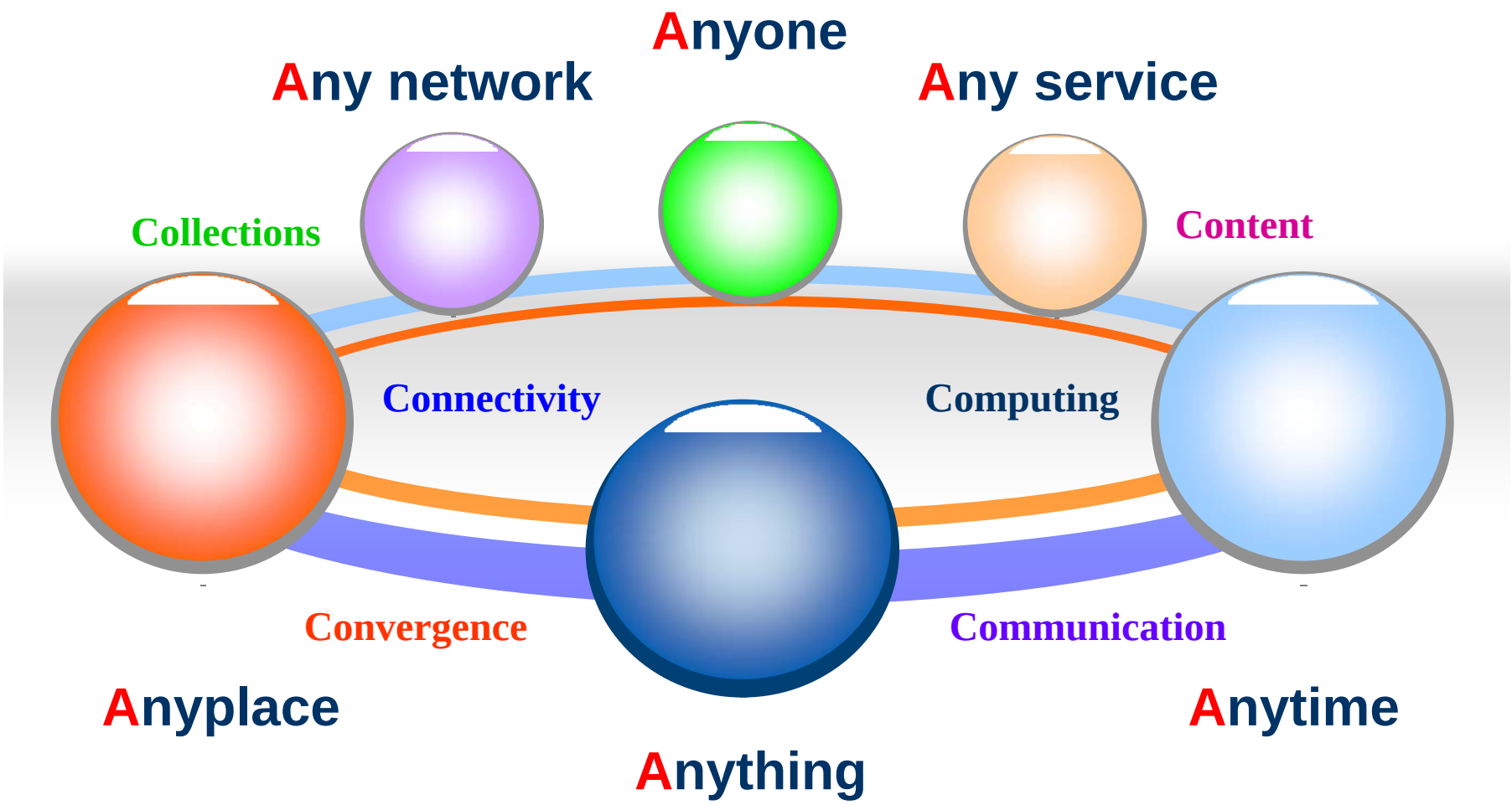
  - Challenges:
    - Scalability
    - Support of mobile and wireless devices, ubiquitous embedded sensors
    - Network management
    - Service aware networking
    - Built in security

Future Internet



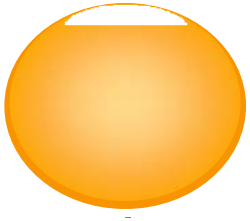
- IoT - Internet of Things
- IoM - Internet of Media
- IoS - Internet of Services
- IoP – Internet of People
- IoB – Internet of Businesses
- IoE – Internet of Energy

Connecting

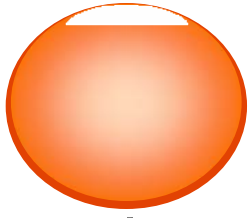

Anyone
Any network
Any service
Collections
Content
Connectivity
Computing
Convergence
Communication
Anyplace
Anytime
Anything

Future Internet Challenges

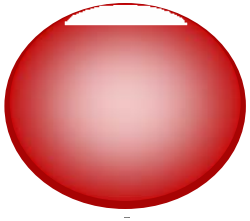
- Capacity



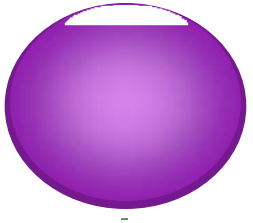
More Storage



More Addresses

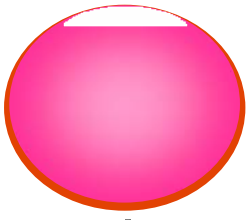


More Transport Capacity

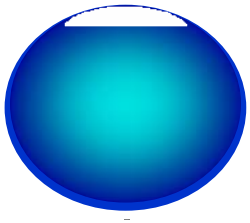


Making Technology Compatible

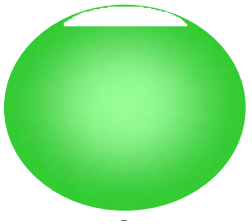
- User friendly



Internet For All



Better Search Tools

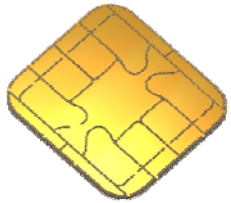


From Data To Knowledge

- Secure, safe, trustworthy
- Auto and self management
- Network aware, network agnostic, content aware

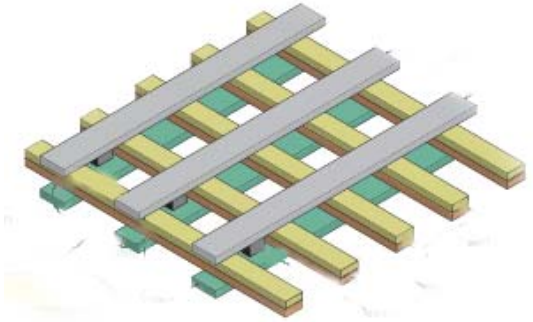
Internet of Things

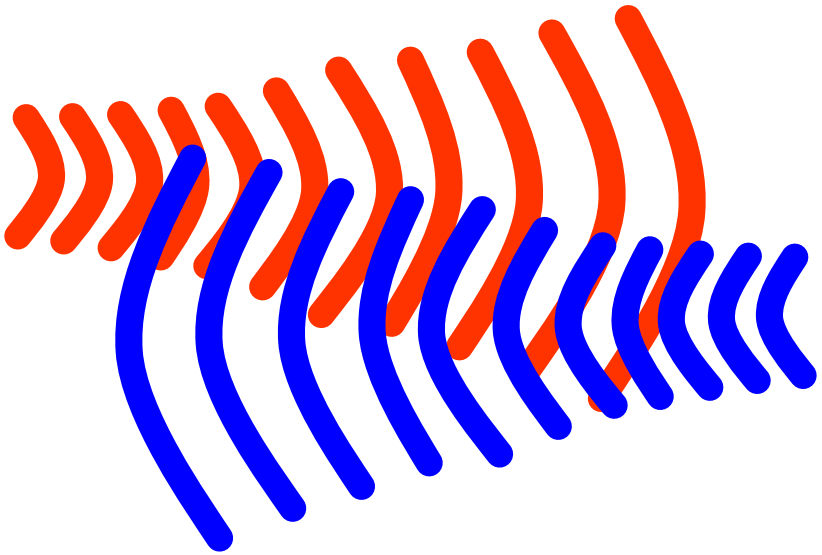
- Internet of Things (IoT) is an integrated part of the Future Internet and was defined by European Research Cluster on IoT:
- as a **dynamic global network infrastructure** with self configuring capabilities based on standard and interoperable communication protocols where
- physical and virtual **“things” have identities**, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network.



EC’s lines of action

- **Governance**
- **Monitoring of the personal data questions**
- **The ‘silence of the chips’ issue**
- Identification of emerging risks
- IOT as a vital resource to economy and society
- **Standards Mandate**
- **Research and Development**
- **Public Private Partnership**
- Innovation and pilot projects
- Institutional Awareness
- **International dialogue**
- RFID in recycling lines
- Measuring the uptake
- Assessment of evolution





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European IoT Research Portfolio

IoT, Enterprises	From research to market~5-10 yrs
Novel applications capabilities	Strong EU Opportunities & know how
Markets 2020: > 150 Bn€	Objects connectivity, FI Enterprise
Networked Media	From research to market~5-8 years
Key domain of convergence	Strong EU know how & successes
Large EU market , ~200 Bn€	3D, Search, media-network integration
Software and Services	From research to market~5 years
Strategic industry	Strong EU Opportunities
Large EU SW/Scemarket 210 Bn€	Versatile service platforms, Clouds
Network Infrastructures	From research to market~10 years
Key Asset of providers	Strong EU know how & successes
Large EU service market , 400 Bn€	Broadband, mobile, Internet

Activities

- ICT-FP7: Internet of Things & Enterprise Systems
  - Call 1: 10 projects (8 ongoing, 2 completed)
  - Call 4: 4 projects
  - Call 5: (11 new contracts)
- 2 “clusters”
  - **IERC** (Internet of Things European Research Cluster)
  - **FInES** (Future Internet based Enterprise Systems)
- ICT PSP(CIP): RFID
- Follow-up to RFID Recommendation
- Follow up to IoT Communication
- Follow-up to RFID Standards Mandate (M/436)

Future Internet PPP

- **Towards a 'smarter' World** - Making applications of high socio-economic value more intelligent, more flexible, more efficient.
- **Smart energy grids** - Internet connectivity, computing power, digital sensors and remote control of the transmission and distribution system.
- **Smart environmental information systems** - the use of sensor networks for collecting real or near real time environmental data is a growing field of application.
- **Smart systems for transport and mobility** - Putting 'intelligence' into the roads and cars with Intelligent Transport Systems (ITS)– with e.g. sensor networks, radio frequency tags, and positioning systems offer a promising alternative.
- **Smart healthcare systems** - Current research experiments aim to develop technologies (sensors, actuators, special hardware and equipment, networks and service platforms) for 'ambient' environments capable of assisting patients and satisfying their information and communication needs.

PPP Technological Approach

- Generic, open and trusted communication and services platform… (standardised and) providing cross sector services through common enablers…
- Multiple use case scenarios. It is anticipated that Internet-enabled smart infrastructures and processes require at least to capitalise on:
  - Sensor Networks
  - Cloud like service infrastructures
  - Wireless capabilities
  - Information “search/find/processing” capabilities

- Open to “user” driven innovation through multiplicity of Use Cases – SME Innovation platform.
- Leveraging previous activities in the field.

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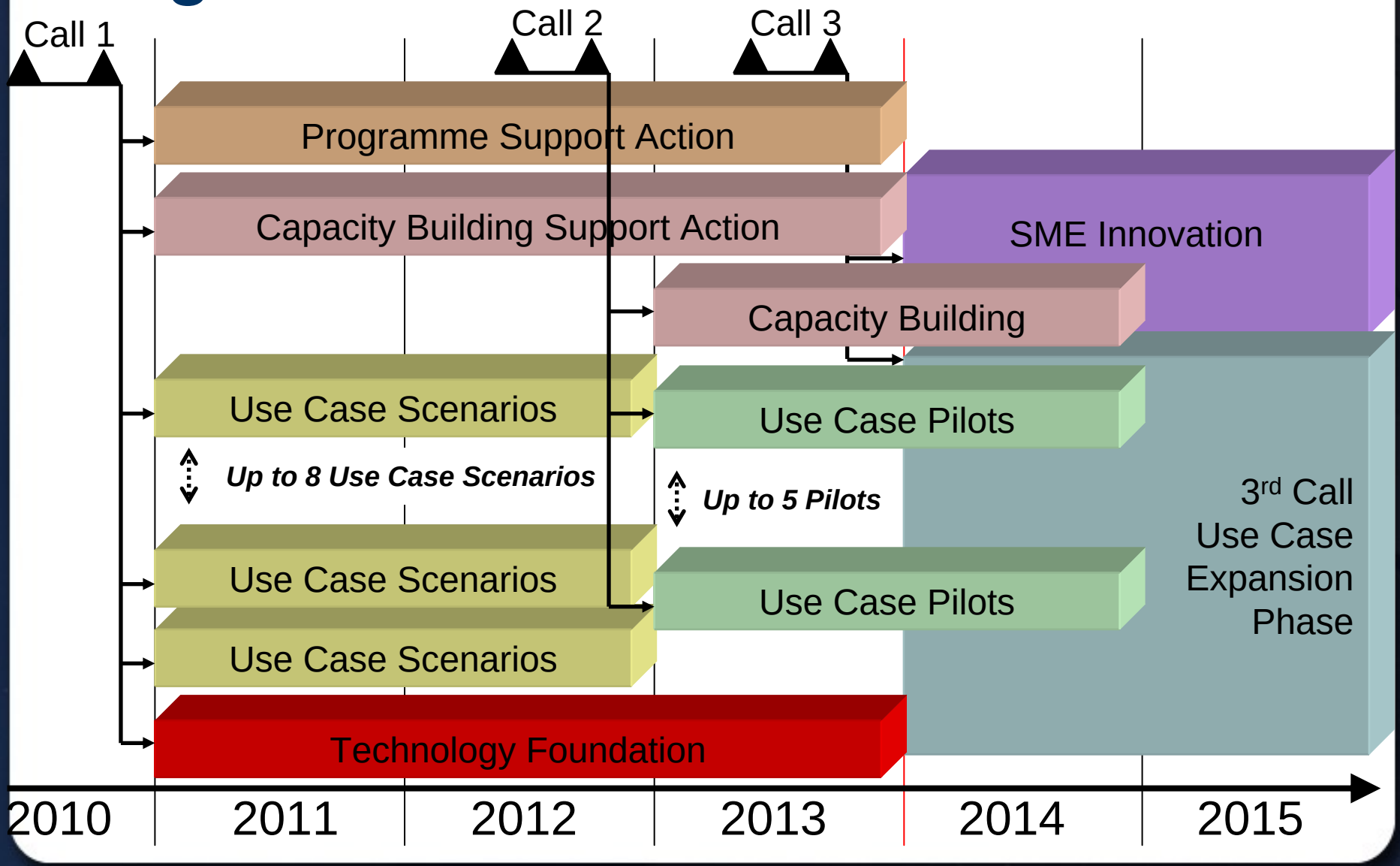
Program Architecture



Draft Implementation Roadmap*

- Call 1 (July - October 2010) – budget 93 MEuro
  - Technology Foundation (one IP, 40 MEuro, 3 years, 30% flexible)
  - Use Case Scenarios – Phase 1 (7-8 areas, IP, 5 MEuro, 2 years)
  - Capacity Building (one CSA, 3 MEuro, 3 years)
  - Programme support (one CSA, 10 MEuro, 3 years)
- Call 2 (3rd quarter 2011) – budget 77 MEuro
  - Use Case Scenarios Pilots – Phase 2 (5 areas, 13 MEuro, 2 years)
  - Capacity Building (one IP, 12 MEuro, 2 years)
- Call 3 (mid 2012) – budget 130 MEuro
  - Devoted to the expansion and enlargement of many test beds and pilots (several areas, ~100 MEuro, 2 years)

Subject to MS approval in June ‘10

Mandate Implementation Planning

- RFID Mandate - To support the EC Recommendation
  - Logo and sign design
  - Privacy Impact Assessment
  - Applications
  - Spectrum, Identifiers
- IoT Mandate - To support Commission Communication
  - “Silence of the chips”
  - Governance standards
  - Security/resilience standards
  - Applications (e.g., smart metering)
  - Sensor networks

Mandate Implementation Planning

- EC RFID Mandate and Recommendation
- RFID Mandate M/436 Assigned to CEN, CENELEC and ETSI
- Supporting the Recommendation
- Phase 1
  - 2009/2010 work program in response to identified gaps
  - Development of Recommended Steps for Phase 2
  - PIA Framework with RFID system enhancements
  - Signage & logos for application areas & system components
- Phase 2 – Creation of Missing Standards

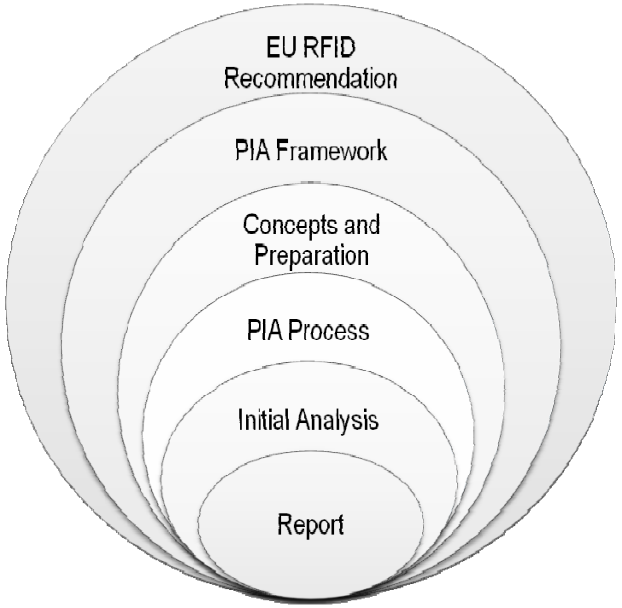
Mandate Implementation Planning

- PIA (Privacy Impact Assessment) Framework: an indispensable tool for Implementing the EU Recommendation

PIA FRAMEWORK

PIA TEMPLATE (optional)

PIA REPORT or INTERNAL ANALYSIS



Identifies the objectives, components, common structure and elements of a PIA

Provides industry based, application based, or other specific formats for PIAs and resulting PIA reports

Documents PIA process on the basis of the Framework

Mandate Implementation Planning

- RFID Sign - Race networkRFID - ESO
- **Selected Requirements:**
- **Requirement 3:** Signs should be able to coexist with established signs that fulfill at least the same objectives and provide relevant information to the consumer
- **Requirement 4:** Signs should be part of a broader awareness and consumer information strategy
- **Requirement 6:** Operators should be granted sufficient flexibility with respect to the exact placement of such signs
- **Requirement 9:** The signs should offer sufficient flexibility to be combined with different technologies offering additional information and to use different communication technologies for public notification

Presentation of Existing Signs

- ISO emblem
- EPCglobal emblem
- contest winner logo, Germany
- other signs

Race networkRFID

- **European Union Thematic Network Project -** *positioning the EU as a world leader in RFID excellence*
- The **Race networkRFID** is designed to be a **federating platform** to the benefit of all European Stakeholders in the development, adoption and usage of RFID.
- The network mission is to **creates opportunities and increases the competitiveness of European Member States** in the area of RFID thought leadership, development and implementation.
- **International co-operation** will help to position RFID technology within the mainstream of information and communications technology (ICT).

Call for CIP pilot on “Smart Cities”

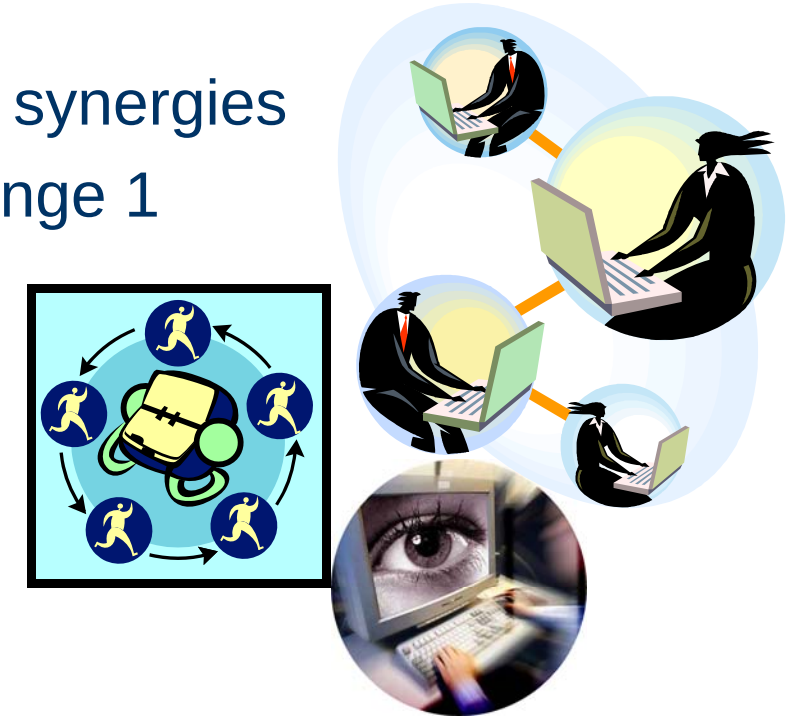
- Budget for one pilot with focus on RFID and Internet of Things is around 3M€EU funding; duration 2 to 3 years
- Local city ecosystems, networked across Europe
  - Suggested key innovation areas: **Smart living** –co-design of smart homes and living spaces
  - **Green digital agenda** –supporting a low carbon economy
  - **Open platform** with levels of security and privacy (tourists, residents, public administration)

Clusters Definition and Scope

- The bringing together of people and their organizations or projects:
  - to profit from each others knowledge and experience
  - to coordinate/encourage the convergence of ongoing work on the most important issues
  - to build a broadly-based consensus on the ways to realise IoT in Europe
- Scope
  - Plenary meetings of all Project Coordinators, convened 3 or 4 times per year
  - Technology-oriented R&D domains, meeting in parallel after a plenary, and formed around the main technical areas
  - Objective-driven chains, each supporting a defined objective, and contributing to a specific result (e.g., a “guideline”, a complex demonstration etc) acknowledged to be useful to the wider IoT community

IERC- IoT European Research Cluster

- The IoT European Research Cluster is bringing EU-funded projects together to define and promote a common vision of the Internet of Things
  - A very important process
  - Minimise overlaps, maximise synergies
  - Contribution to overall Challenge 1
  - Technological challenges
  - Policy objectives
  - Links to IoT Expert Group



IERC- IoT European Research Cluster

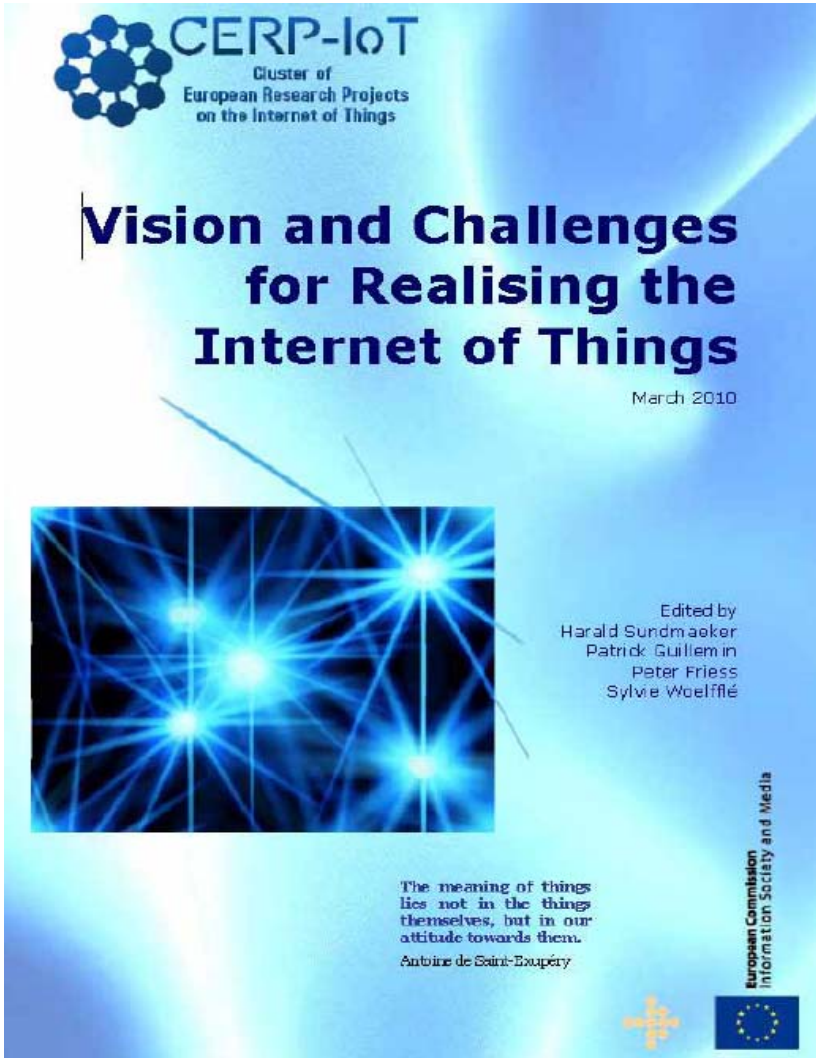
- EU-funded projects
  - ASPIRE, BRIDGE, CASCADAS, CONFIDENCE, CuteLoop, DACAR, ETP EPoSS, EU-IFM, EURIDICE, GRIFS, HYDRA, IMS2020, Indisputable Key, iSURF, LEAPFROG, PEARS Feasibility, PrimeLife, RACE networkRFID, SMART, StoLPaN, SToP, TraSer, WALTER, IOT-A, INTREPID, IOT@Work, ELLIOT, SPRINT, NEFFICS, IOT-I, CASAGRAS2.
  - Stakeholders of closed projects AITPL, AMI-4-SME, CE-RFID, CoBIS, Dynamite, PRIME, PROMISE and SMMART stay active in the Cluster

IERC- IoT European Research Cluster

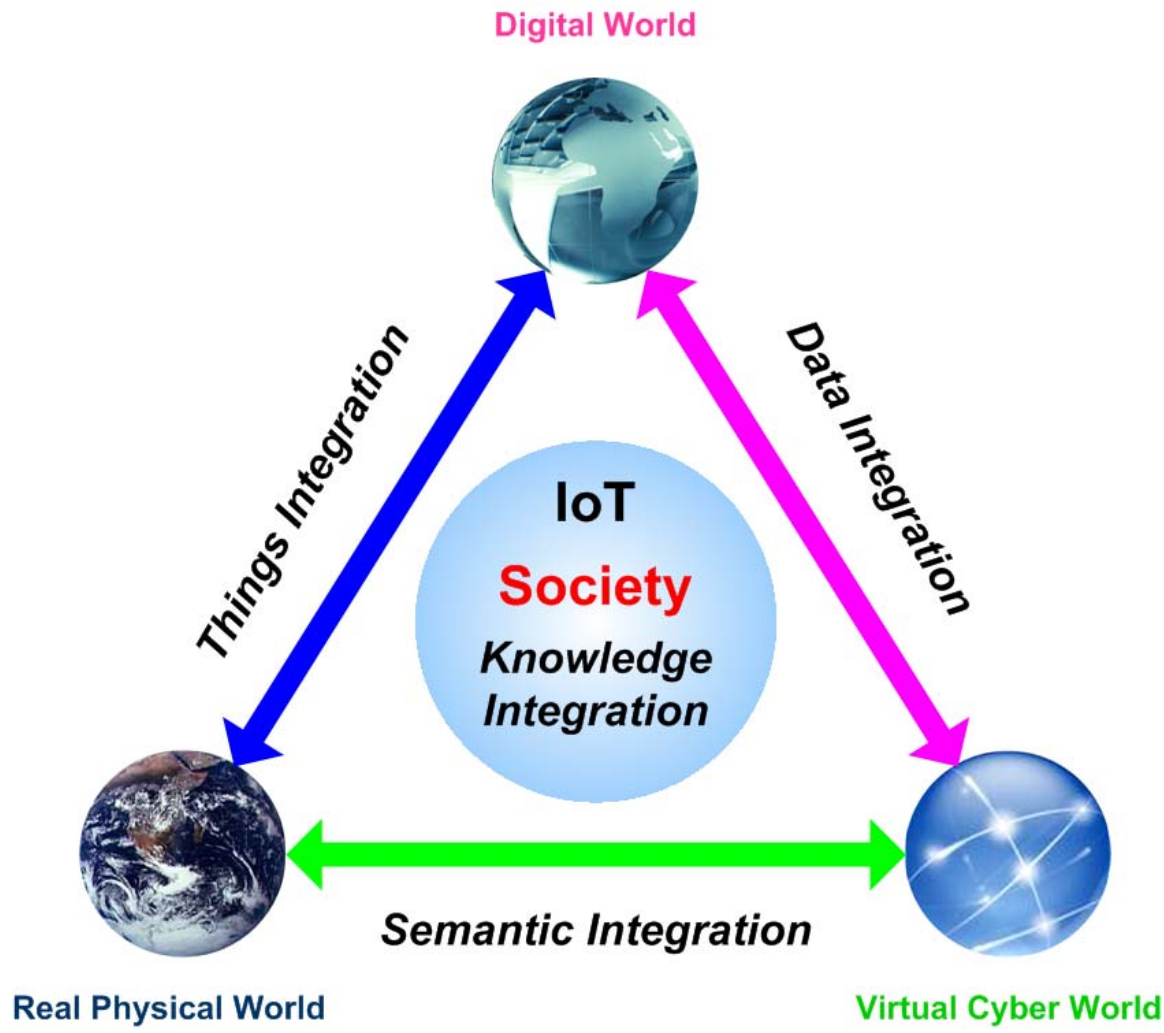
- New EU funded IOT projects (budget 43 Mil €, funding 28 Mil €)
  - Architecture approaches and models,
  - Naming & addressing schemes, means of search & discovery,
  - Privacy & Security issues
  - Service openness and interoperability issues
  - Pre-normative and/or pre-regulatory research
  - Governance issues and models

- Connection to FIA –Future Internet Assembly

IoT Research Agenda



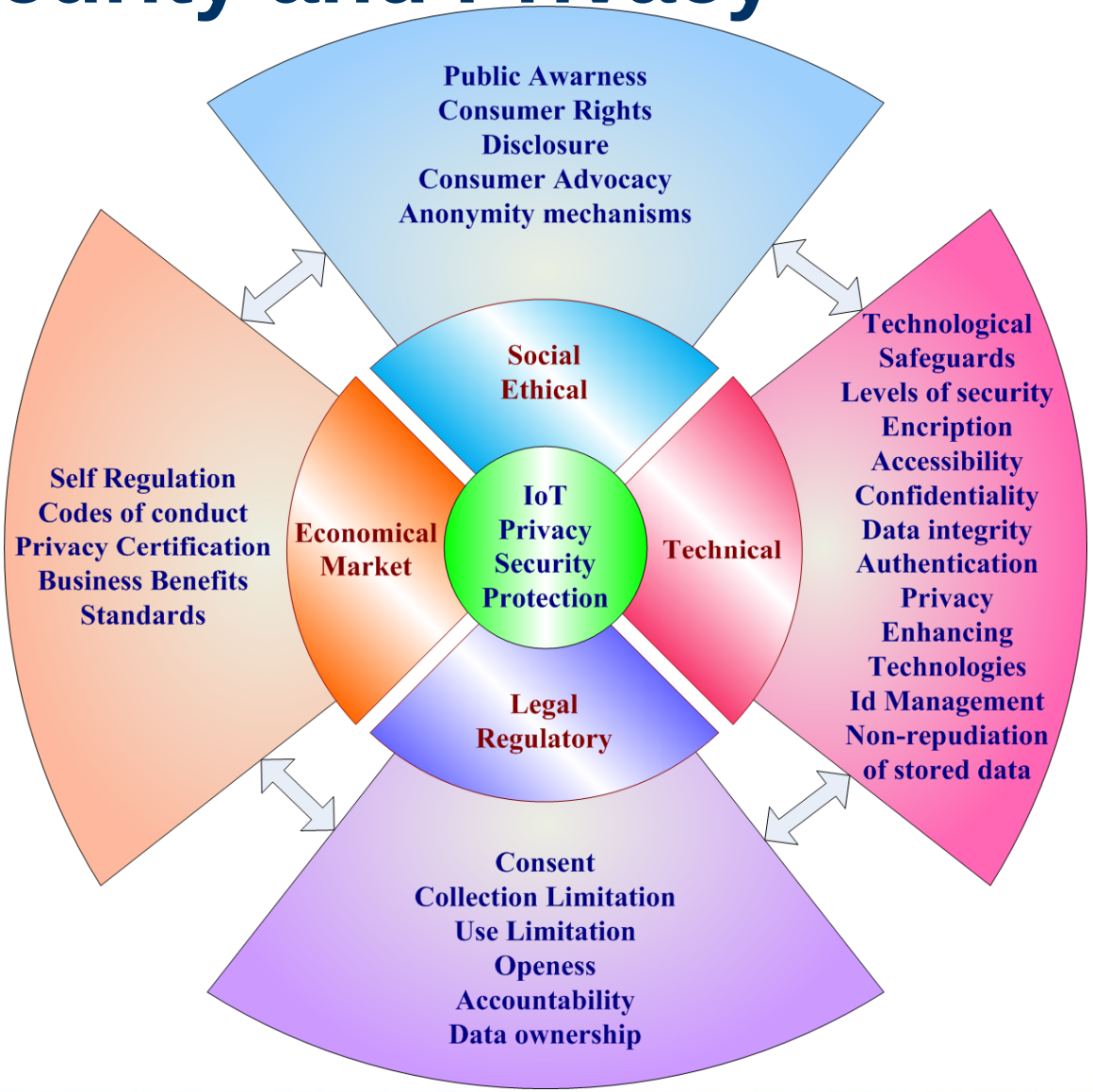
IoT Connecting different Worlds



IoT Devices


Bandwith
Sideband
Transmitt Power
Frequency/Wavelength
Range
Protocol Complexity
Protocol Complexiry
Power
Gate Density
Memory
Standards
Application
Environment
Requirements
IoT Devices
Cost
Data Rate
Power
Size
Silicon
Technology
Medium
Omnidirection
Antenna Type
Antenna Gain
Sensitivity
Range
Operating Voltage
Capacitance
Mixed Signal Interface
Gate Density
Memory/EEPROM
Rectifier Efficency
Total Power
Size
Sensor
Technology
Size
Cost
Sensitivity
Power

IoT Security and Privacy



IoT Research Needs

Research Needs		Before 2010	2010-2015	2015-2020	Beyond 2020
	Identification Technology	• Different ID schemes customised for application domains • Convergence of IP and RFID IDs and addressing schemes	• Unique ID • Multiple IDs for specific cases • Extend the ID concept (more than ID number) • Electro Magnetic Identification - EMID	• Beyond EMID	• Multi methods-one ID
	IoT Architecture	• Intranet (Intranet of Things) (single controlling administrative entity of the IoT infrastructure, controlled environment and business cases, thousands/millions of things)	• Extranet (Extranet of Things) (partner to partner applications, basic interoperability, billions-of-things)	• Internet (Internet of Things) (global scale applications, global interoperability, many trillions of things)	
	SOA Software Services for IoT	• Basic IoT services (Services over Things)	• Composed IoT services (IoT Services composed of other Services, single domain, single administrative entity)	• Process IoT services (IoT Services implementing whole processes, multi/cross domain, multi administrative entities, totally heterogeneous service infrastructures)	
	Internet of Things Architecture Technology	• Low cost crypto primitives – hash functions, random number generators, etc. • Low cost hardware implementation without computational loss • Smaller and cheaper tags • Higher frequency tags • RFID tags for RF-unfriendly environments (i.e. water and metal) • 3-D localisation	• Adaptation of symmetric encryption and public key algorithms from active tags into passive tags • Universal authentication of objects • Graceful recovery of tags following power loss • More memory • Less energy consumption • 3-D real time location/position embedded systems • IoT Governance scheme	• Code in tags to be executed in the tag or in trusted readers. • Global applications • Adaptive coverage • Object intelligence • Context awareness	• Intelligent and collaborative functions
	Communication Technology	• Sensor networks, ZigBee, RFID, Bluetooth, WirelessHart, IAA100, UWB	• Long range (higher frequencies –tenth of GHz) • Protocols for interoperability	• On chip networks and multi standard RF architectures • Plug and play tags	• Self configuring, protocol seamless networks

IoT Research Needs

			• Protocols that make tags resilient to power interruption and fault induction. • Collision-resistant algorithms	• Self repairing tags	
	Network Technology	• Broadband • Different networks (sensors, mobile phone, etc.,) • Interoperability framework (protocols and frequencies) • Network security (e.g. access authorization, data encryption, standards etc.)	• Grid/Cloud network • Hybrid networks • Ad hoc network formation • Self organising wireless mesh networks • Multi authentication • Networked RFID-based systems – interface with other networks – hybrid systems/networks	• Service based network • Integrated/universal authentication • Brokering of data through market mechanisms	• Need based network • Internet of **Everything** • Robust security based on a combination of ID metrics • Autonomous systems for non stop information technology service

	Software and algorithms	• Service oriented architectures
		• Embedded software
		• Generation of domain specific events
		• "Things" Semantics / Ontologies
		• Filtering
		• Probabilistic and non-probabilistic track and trace algorithms, based upon the analysis of tracking data concerning some kind of unique ID.
			• Self management and control
			• Micro operating systems
			• Context aware business event generation
			• Interoperable ontologies of business events
			• Scalable autonomous software
			• Software for coordinated emergence
			• (Enhanced) Probabilistic and non-probabilistic track and trace algorithms, run directly by individual "things".
			• Software and data distribution systems
				• Evolving software
				• Self reusable software
				• Autonomous things:
				  ○ Self configurable
				  ○ Self healing
				  ○ Self management
				• Platform for object intelligence
					• Self generating "molecular" software
					• Context aware software

	Hardware Devices	• MEMS • Low power circuits • Silicon devices • Smart multi band antennas • Beam steerable phased array antennas • Low power chip sets • Low cost tags • Small size, low cost passive functions • High-Q inductors • High density capacitors, tuneable capacitors	• Paper thin electronic display with RFID • Ultra low power EPROM/FRAM • NEMS • Polymer electronics tags • Antennas on chip • Coil on chip • Ultra low power circuits • Electronic paper • Devices capable of tolerating harsh environments (extreme temperature variation, vibration and shocks conditions and contact with different chemical substances)	• Polymer based memory • Molecular sensors • Autonomous circuits. • Transparent displays • Interacting tags • Collaborative tags • Heterogeneous integration • Self powering sensors • Low cost modular devices	• Biodegradable antennas • Autonomous "bee" type devices

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Thank you!