ITU Kaleidoscope 2015

Trust in the Information Society

A Required Security and Privacy Framework for Smart Objects

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Outline

- Introduction
- Motivation
- The Lifecycle of Smart Objects
- IoT-A as a baseline for IoT Architectures
- Integral Security and Privacy Framework
- Conclusions

Introduction

- Current Internet evolving towards a global network of interconnected *smart objects* affecting our **everyday lives**
  - IT developments **accelerating** this trend
  - Unprecedented economic and social **opportunities**

- **Security** and **privacy challenges** as main barriers for broad scale IoT deployment
  - Need to **conciliate** interests from different stakeholders (citizens, governments, companies,…)
  - It is not all about security and privacy → It is about **SAFETY**

Motivation

- Security and privacy concerns were **always** there…
  - … but we need to move from an enterprise-centric, to user-centric approaches to **smart object-centric solutions**
  - IoT testbeds are not labs, but cities involving **citizens** and their devices!
- The data sharing paradox in IoT - **To share or not to share, this is NOT the question…**
  - People want/like/need to share (Facebook, Twitter,…)
  - … the question is how, what, why and under which circumstances!

Motivation

- The data sharing paradox in IoT - **To share or not to share, this is NOT the question…**
  - I want to share my energy consumption, but not if I am at home!
  - Who **owns** the information on a Smart City? Citizens? City Council?

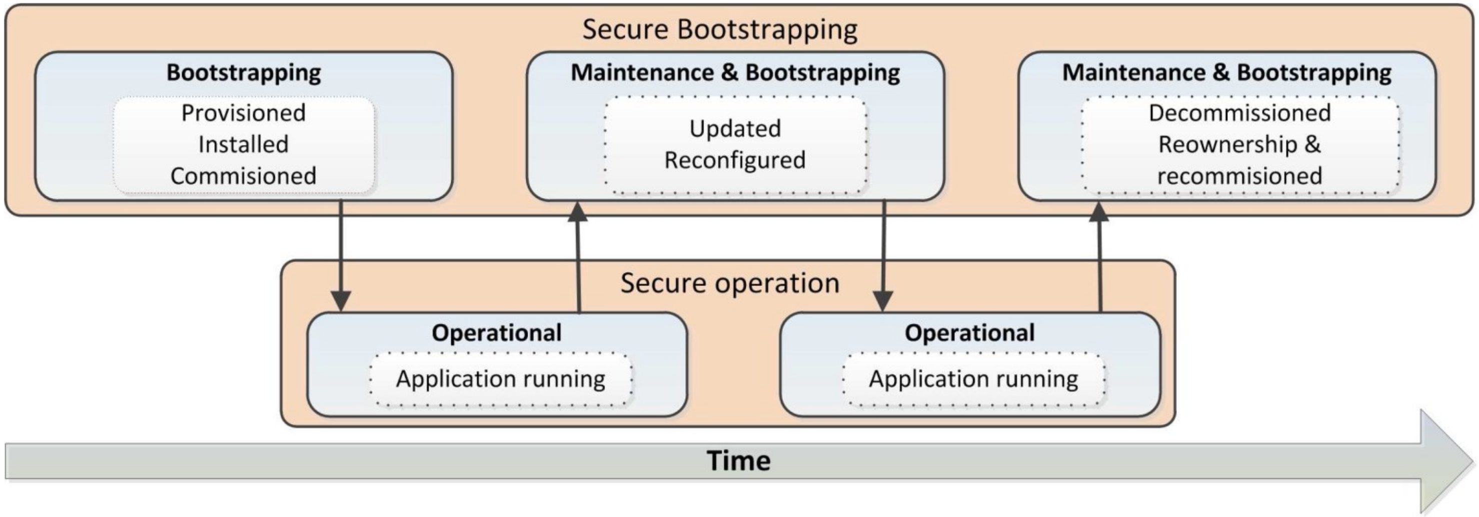
- Need for **cross** and **multidisciplinary** approaches:
  - **Involvement** of citizens is crucial → Smart Cities are for them!
  - Able to address the **lifecycle** of Smart Objects
  - Security and privacy are **cross** → Operational concerns do not matter if smart objects were given fake credentials!

The Lifecycle of Smart Objects

- **Bootstrapping:** Implies installation and commissioning
  - Need for identification before connecting to the network
- **Registration and Discovery:** Smart Objects must be registered to be discovered by others
  - Need for naming, resolution, networking and addressing features
- **Operation:** Machine-to-Machine (M2M) vs Group communications
  - Need for Privacy by Design (Pbd) and Minimal disclosure principles

The Lifecycle of Smart Objects

- **Let’s start from the beginning!**



IoT-A as a baseline for IoT Architectures

- IoT-A project was intendended to define an **Arquitectural Reference Model** (**ARM**) for IoT systems by providing:
  - **IoT Reference Model** (**RM**) to promote common understanding at high abstraction level
  - **IoT Reference Architecture** (**RA**) to describe essential building blocks and build compliant IoT architectures
  - **Best Practices/Guidelines** to help in developing an architecture for a specific system based on the RA

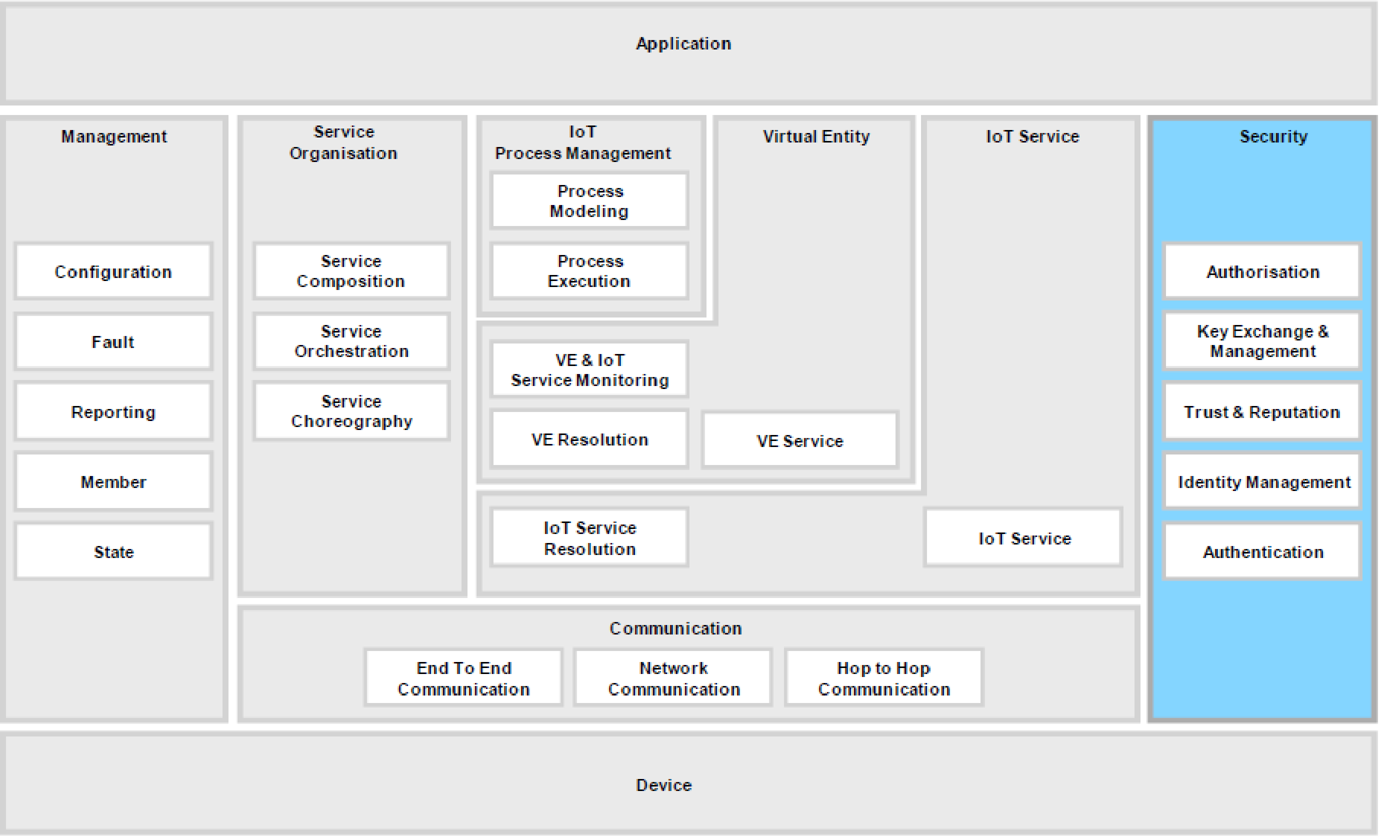
IoT-A as a baseline for IoT Architectures

- Key step to move from “**Intra**nets of Things” to a real “**Inter**net of Things”

- Different architecture views from architecture models
  - **Functional View** describing functionality and interfaces among **Functional Groups** (FG) composed by **Functional Components** (FC)

IoT-A as a baseline for IoT Architectures

- **IoT-A Functional View**



Integral Security and Privacy Framework

- IoT-A **compliant** architecture to promote applicability and interoperability
- **Instantiation** of the Functional Components from the Security FG
  - Definition of functionality and interfaces among Security FCs
  - By considering security and privacy requirements of the lifecycle of Smart Objects

Integral Security and Privacy Framework

- **Extension** of the Security FG to be leveraged by future security and privacy IoT Architectures:
  - **Context Manager**: IoT is pervasive → need for *adaptive security and privacy*
  - **Group Manager**: addressing the need for flexible data sharing models among Smart Objects

Integral Security and Privacy Framework

- **Bootstrapping**
  - Smart object must be installed and commissioned **before** sending data
  - How it is identified at the beginning? ***root identity/root*** *of trust*
  - Who **imprints** the RI (owner, manufacturer)?
  - Implies authentication and authorization mechanisms

- **Registration and Discovery**
  - One it is bootstrapped, smart object must be registered to be discovered (**self-management** approaches?)
  - Security and privacy concerns → Do I want my car to be discovered by everyone?

Integral Security and Privacy Framework

- **Operation – M2M approaches**
  - **Efficient** and **interoperable** approaches → M can be a cloud server or a sensor!
  - Privacy-preserving mechanisms require **accountability** and **traceability** → We need to trust someone!

- **Operation – Group approaches**
  - It will be often smart objects will operate as a group (smartphones, sensors, drones,…) → how to **manage** with billions of heterogeneous devices?

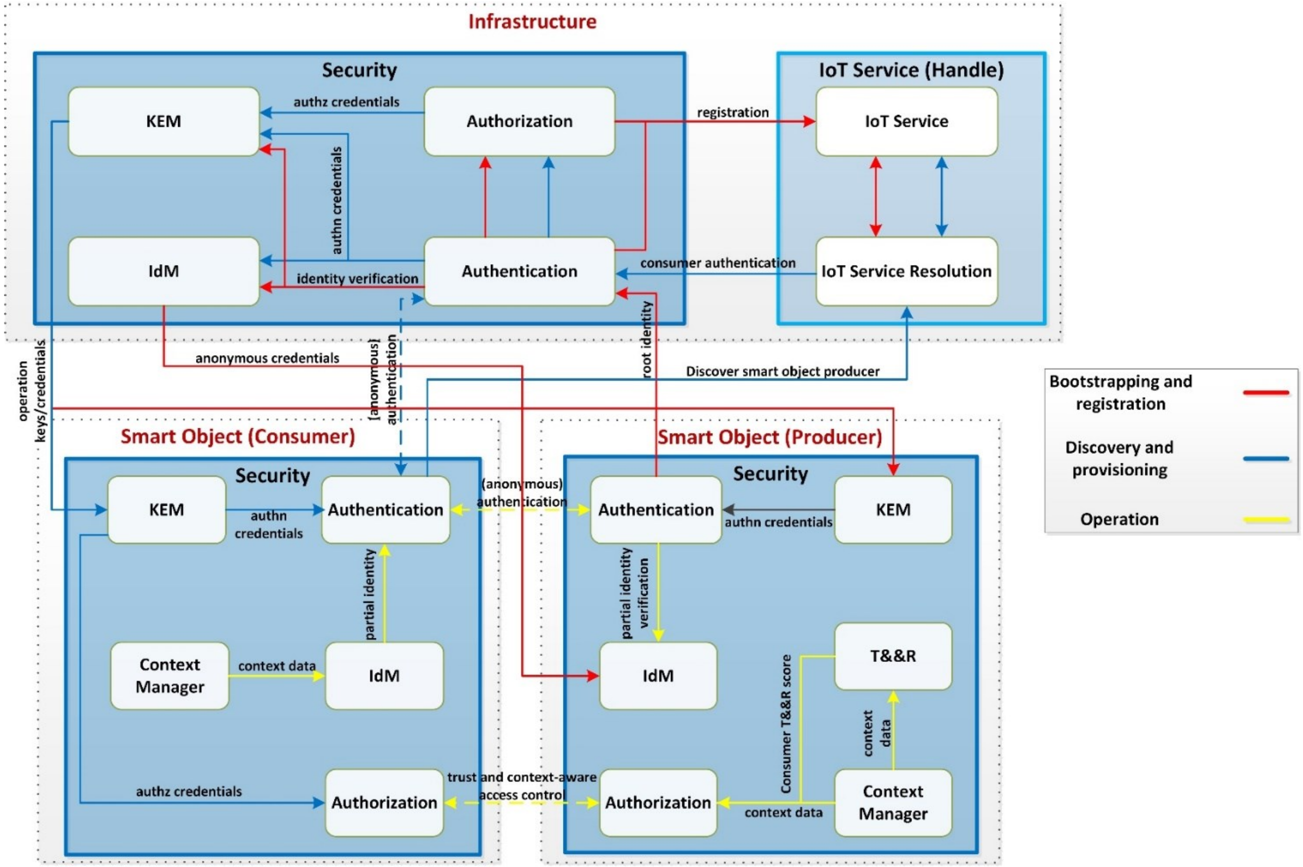
Integral Security and Privacy Framework

- A plethora of technologies intended to be “IoT”, which to pick?
  - Different ITU, ETSI or IETF WG are there
  - **Heterogeneous** environments demand heterogeneous solutions
  - Many of them will **coexist** at different lifecycle stages

- **Framework approach**
  - Smart Objects as information **producers/consumers**
  - **Infrastructure** components enabling smart objects to be registered, discovered and provisioned for secure and privacy-aware (M2M and group) operation

Integral Security and Privacy Framework

- **Framework Interactions**



Integral Security and Privacy Framework (Bootstrapping)

- *Root identity* as a root of trust: symmetric key/certificate

- Anonymous and group credentials derived from *root identity* → accountable and traceable anonymity

- Based on **PANA** (RFC 5191) as a starting point to define the *bootstrapping for IoT*
  - Currently used by **ZigBee Alliance** and **ETSI M2M**
  - **Extension** of the *Authentication/Authorization* phase
  - **Addition** of new AVPs to carry anonymous and group credentials

Integral Security and Privacy Framework (Registration)

- **Registration** in infrastructure as a consequence of a successful (authenticated/authorized) bootstrapping

- Based on the **Handle** System (RFC 3650):
  - Smart Objects represented as *Digital Objects* (DO)
  - **Supporting** naming, resolution an addressing
  - **Instantiating** IoT Service and IoT Service Resolution IoT-A FC
  - **Favoring** addition of security and privacy features

Integral Security and Privacy Framework (Registration)

- Different *handles* representing different security and privacy aspects:
  - Derivation of anonymous credentials based on Handle attributes during registration
  - Flexible approach enabling *producers to* make subsets of services available to subsets of *consumers* (***selective discovery***)

Integral Security and Privacy Framework (Discovery and Provisioning)

- Privacy-aware discovery enabling *consumers* to discover *producers* through the use of anonymous credentials previously obtained

- **Provisioning** as an additional previous step to get credentials (keys, tokens,…) to use them against the discovered smart object
  - **Extended semantics** of PANA notification message during the *Access* phase
  - **Addition** of new AVPs to carry such credentials
  - Use of lightweight and flexible tokens based on **DCapBAC** to be used even in constrained environments

Integral Security and Privacy Framework (Operation)

- Based on **lightweight** and **flexible** security approaches to make them available even for M2M ***constrained environments*** (CE):
  - IETF **ACE**, **DICE WGs** focused on security for CE
  - Use of the *Constrained Application Protocol* (**CoAP** - RFC 7252) as an application protocol
  - Use of Datagram Transport Layer Security (**DTLS)** (RFC 6347) based on *ECC Raw Public Keys* for authentication
  - Use of the *Distributed Capability-Based Access Control* (**DCapBAC)** approach for authorization

Integral Security and Privacy Framework (Operation)

- Use of advanced and flexible cryptographic schemes enabling secure group communications:
  - Based on certificateless public key cryptography (**CP-ABE**)
  - CP-ABE keys obtained during the **registration** associated to smart object's attributes
- Additional use of **partial identities** for minimal PII disclosure → integration *Proof-of-Possession* (PoP) based on anonymous credentials systems (e.g. Idemix) with DCapBAC tokens

Conclusions

- Security and Privacy are a **MUST** for IoT adoption
  - Different stakeholders → different views on them
  - Security + Privacy in IoT → The Internet of MY Things
  - But People care about privacy? In IoT, your car or health devices will be connected! Need for **education** on it.

- Security and privacy demand different concerns during the **lifecycle** of IoT devices
  - It is not all about **technology** → we need **cross** and **multidisciplinary** approaches!

- Our framework to provide a holistic view on IoT security and privacy
  - Developed under **SocIoTal** and **SMARTIE** EU Projects
  - Different developments on **FI-WARE** platform

THANKS FOR YOUR ATTENTION

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