Architecture of Standard-based, Interoperable and Extensible IoT Platform

Slavko Žitnik, Marko Janković, Klemen Petrovčič and Marko Bajec

University of Ljubljana
Faculty for computer and information science

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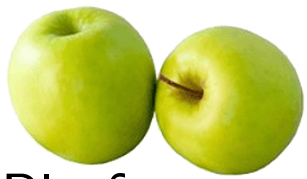
Agenda

1. Introduction into IoT
2. IoT Platforms Landscape
   - IoT Platform Architectures
   - Reviewed Platforms
3. IoT Standardization
4. The Proposed Platform
   - oneM2M & OM2M Platform
   - Prerequisites
   - Reference Implementation

Introduction into IoT

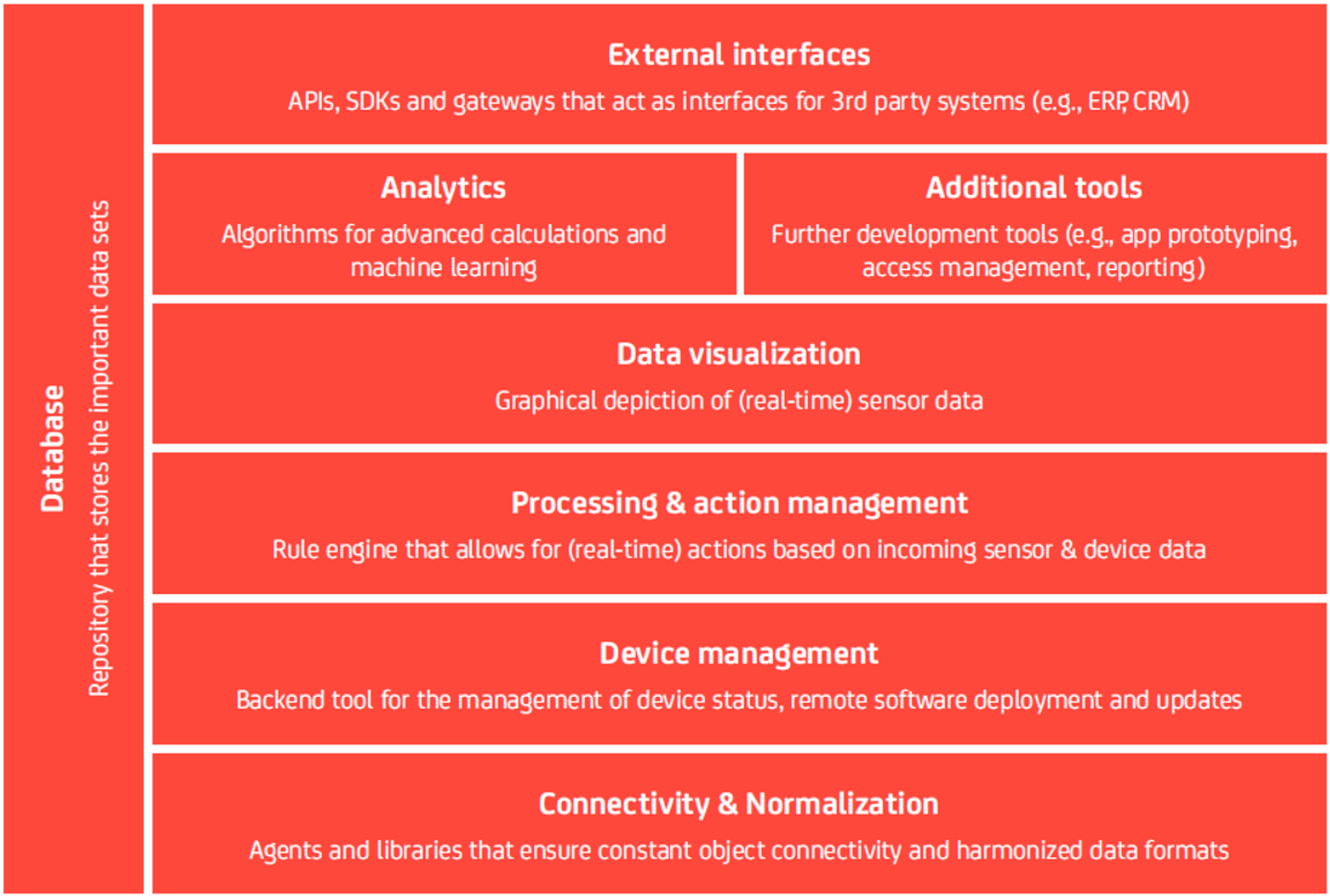
- Kevin Ashton (1999)
- Number of Internet-connected devices enormously increasing
- Gartner: 21 billion devices by 2020
- Conventional device usage with “smart” mechanisms will be taken for granted
- A whole new technology ecosystem with its own problems
  - Security
  - Data and analytics complexity
  - Standardization
  - Pollution
- Technology advances in hardware and software

IoT Platforms: Apples vs. Oranges



- Different platforms referred to as an IoT Platform
  - Connectivity / M2M platforms
    - Purely connecting IoT devices
  - IaaS backend platforms
    - Optimizing hosting and processing services to support IoT ecosystem
  - Hardware-specific software platforms
    - Proprietary hardware and software components
  - Consumer/Enterprise software extensions
    - Enterprise packages (middleware) and operating systems

A Modern End-to-end IoT Platform Architecture



IoT Platforms Ecosystem

- Commercial platforms
  - Watson (IBM)
  - HANA (SAP)
  - Jasper (Cisco)
  - AWS IoT (Amazon)
  - Azure IoT (Microsoft)
  - HomeKit (Apple)
  - Brillo (Google)
  - IoTivity (Intel)
  - AllJoyn (Qualcomm)
- Open-source platforms
  - ...

IoT Platforms Ecosystem

- Open-source platforms
  - Domoticz
    - Z-Wave, RF, PUSH, IFTTT
    - Definition of custom scripts.
  - Kaa
    - Bluetooth, ZigBee, Z-Wave
    - Its own SDK with analytics integrations.
  - HomeAssistant
    - Bluetooth, Z-Wave, PUSH, IFTTT, Media
    - Developer API.
  - OpenHAB
    - Bluetooth, Z-Wave, ZigBee, WiFi, etc.
    - Modular OSGi framework with GUI and rules definition.
  - OM2M
    - CoAP and HTTP by default.
    - Modular OSGi framework with admin following oneM2M standard.

IoT Standards Initiatives

- Thread Group
  - Wireless-centric standard addressing networking, power conservation, security and product compatibility.
  - Devices default to IPv6 within IP-based mesh network.
  - Samsung, Philips and more than 80 partners.
- AllSeen Alliance/AllJoyn
  - Framework for connectivity and service layer operations.
  - Goal to discover, connect and interact among IoT devices regardless of transport layer, device type, platform or OS.
  - Qualcomm, Microsoft, Sony, Lowe and more then 170 partners.
- Open Interconnect Consortium/IoTivity
  - Will deliver an open source reference implementation of the Open Connectivity Foundation (RAML descriptions) standard specifications.
  - Cooperates with DLNA and UPnP Forum.
  - Group with more than 100 members as an Intel's alternative to Qualcomm's AllJoyn.

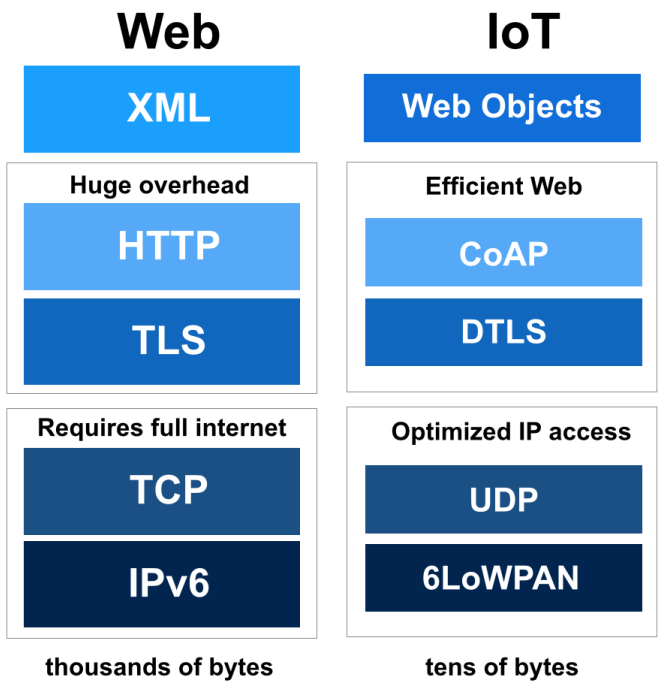
IoT Standards Initiatives

- Industrial Internet Consortium
  - Not developing standards but is to "bring together the organizations and technologies necessary to accelerate growth of the Industrial Internet by identifying, assembling, and promoting best practices."
  - Mainly backed by GE, IBM, Cisco, AT&T and Intel.
- IEEE P2413
  - An umbrella project for more than 350 IoT-related IEEE standards. Goal is to build a reference architecture along with all building blocks.
  - At early stage but building liaisons with IIC and oneM2M.
- oneM2M
  - A standard for common service platform that defines architectural blocks, standardized messages and a Semantic Web schema for further automatic interconnection.
  - Actively developed by standard organizations (TTA, ETSI, TIA, ATIS, TTC, ARIB, CCSA and TDSI).

IoT Standards and Protocols

Different levels of protocols

- Infrastructure (6LowPAN, IPv4/IPv6, RPL)
- Identification (EPC, uCode, IPv6, URIs)
- Comms / Transport (Wifi, BT, LPWAN)
- Device Management (TR-069, OMA-DM)
- Discovery (Physical Web, mDNS, DNS-SD)
- Data Protocols (MQTT, CoAP, AMQP, Websocket)
- Semantic (JSON-LD, Web Thing Model)
- Multi-layer Frameworks (Alljoyn, IoTivity, Weave, Homekit)

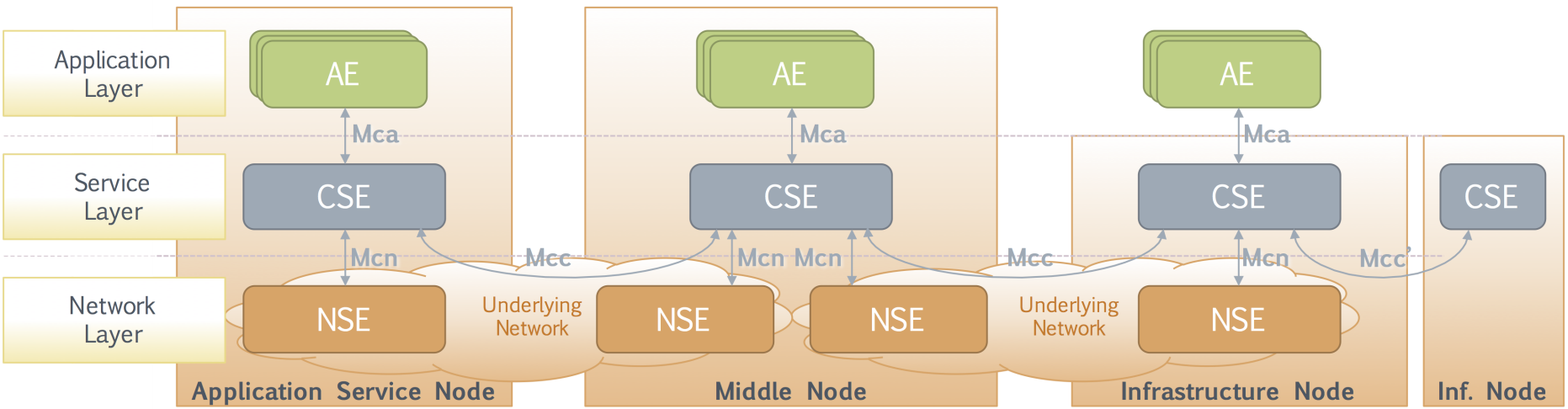


oneM2M & OM2M Platform

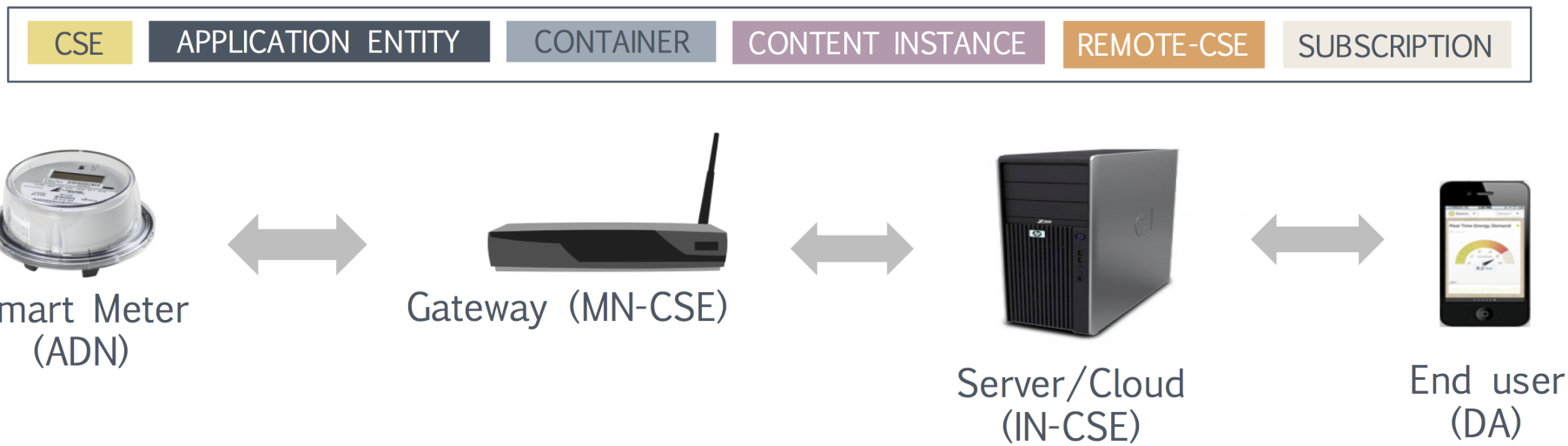
- Standard-based, interoperable and extensible IoT framework ?
  - oneM2M
    - IoT standard
    - Definition of standard architectural blocks with messages
    - Used in various companies and large-scale IoT projects (e.g. Busan Smart City)
  - OM2M
    - Extensible reference implementation of oneM2M
    - KNU Open Health Platform
    - Sensinov Global IoT Platform

oneM2M & OM2M Platform

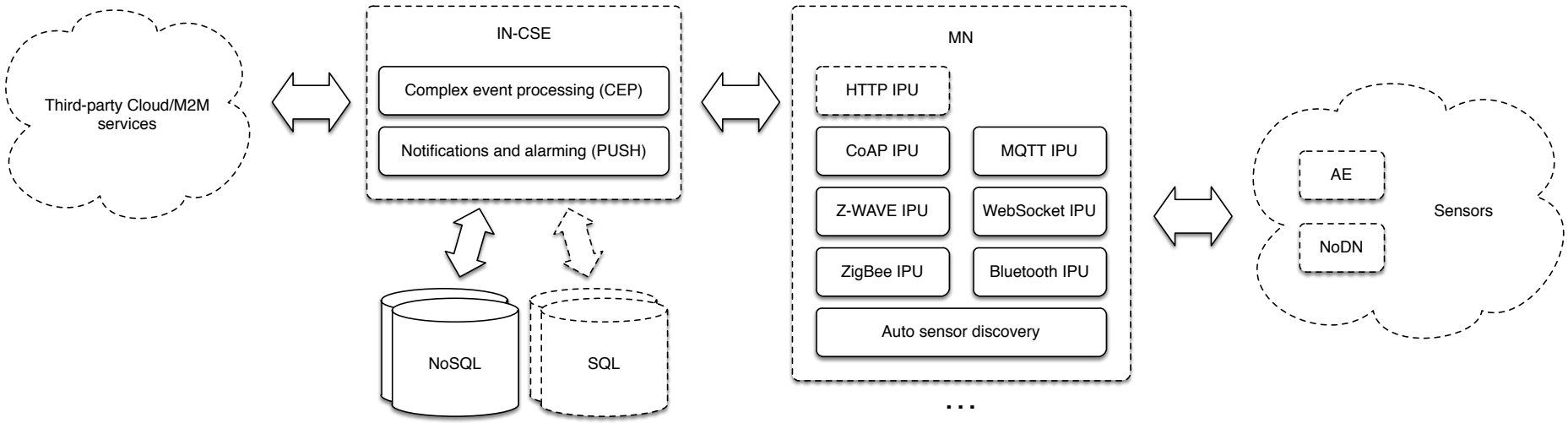
- Since 2013
- First official release v1.0 (2016)



oneM2M & OM2M Platform

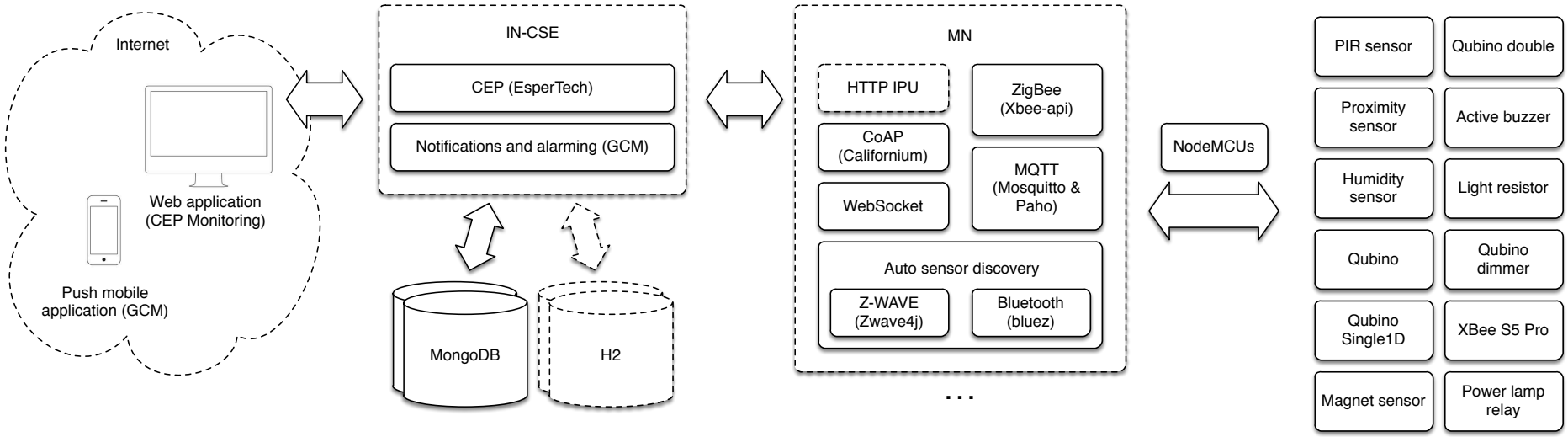


Our Framework Prerequisites



- OM2M: admin interface, data representation, device registration and discovery, device and group management, security and notifications.
- oneM2M: interconnection with OIC and AllJoyn along with base ontology. Eclipse Vorto already defines information metamodels, code generators and model repository.
- Goal: use of a standardized definition of application-level messages regardless of physical protocol.

Reference implementation



- Added practical functionalities: arbitrary (No-/SQL) database support, CEP (EsperTech), 3rd party subscriptions and notifications (PUSH), automatic sensor discovery.
- IPUs: CoAP (standardized), MQTT, Z-Wave, ZigBee, Bluetooth.

Conclusions & Further Directions

- The proof of how to use theoretical IoT models and standards for generally useful and really interconnected internet of platforms.
- Learn from history and act accordingly!
  - OSI/TCP-IP
  - Semantic Web
  - e-mail
- The prototype along with module implementations and other IoT experiments available at `http://iot.data-lab.si/`.

Thanks!

@szitnik