



Federated and scalable data management in the Almanac cloud

<http://www.almanac-project.eu>

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ALMANAC

Reliable Smart Secure Internet Of Things
For Smart Cities



The ALMANAC Project

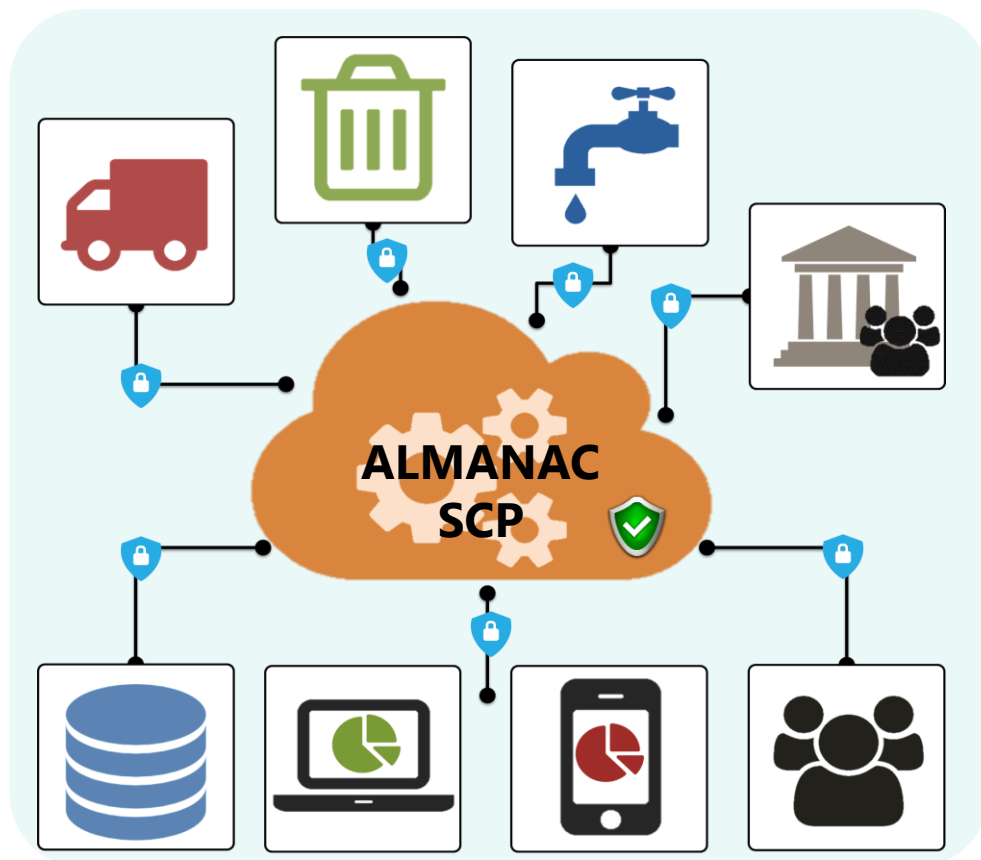
- ALMANAC aims to develop a **service delivery platform** with technologies that integrate Internet of Things (IoT) capillary networks with Telco's metro access networks

enabling



Smart City Information System for
green and sustainable Smart City applications

Connecting City operations with IoT



Technical Challenges

- Large scale sensor and device connectivity
- Efficient messaging and event management solutions
- *Scalable Data Management and Business Integration*
- Big Data Analytics

Smart City Data Management Challenges

- Integrating IoT Data with Business System Data
- Linking heterogenous and distributed information systems in different organisations
- Providing uniform data model and programming interfaces



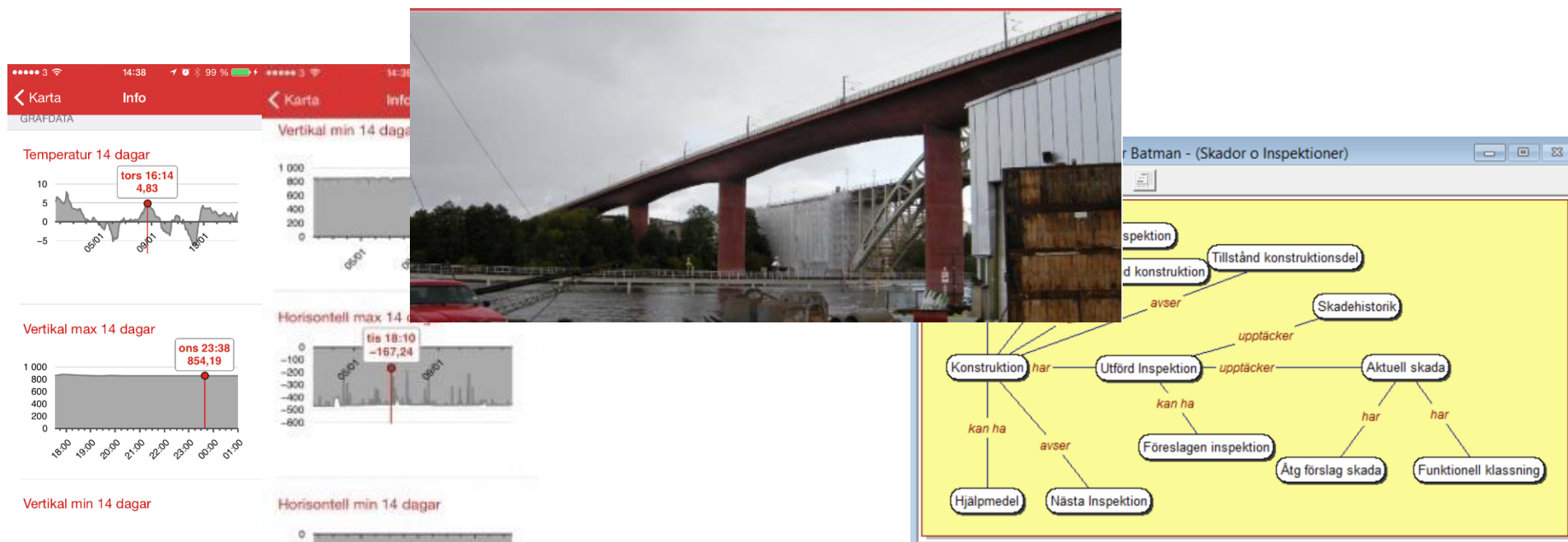
Integrating IoT Data and Business Data

● IoT Data

- Simple Observations
- Large amounts
- Time series oriented
- New data models
- No-SQL database technologies (column stores, document, graph databases,...)

● Business Data

- Complex structures
- Entity Relationship Data models
- SQL databases
- Stored in heterogeneous and distributed information systems



Integrating OGC with ER models

Open Geospatial Consortium

OGC SensorThings Observation Data Model

```

-Thing: [374]
-0: {
  id: "110a0ad0acc8c2a6ddaca81d210ff43fe5ab3fc0d0bde84bc7940c2f2f2236"
  Description: "The WasteBin connected to the WasteBinSimulator network."
  Metadata: "http://almanac-project.eu/ontologies/smartcity.owl#WasteBin"
-Locations: [1]
-0: {
  Time: "2015-06-10T08:14:27.557Z"
-Geometry: {
  type: "Point"
  -coordinates: [1]
  0: 7.6516933
  1: 45.07272101
}
}
-Datastreams: [1]
-0: {
  id: "b4b7498b91cb17fd34192e51f96dcf98c07"
-ObservedProperty: {
  id: "928a844b0ef650ee51ebee32e27e592"
  URI: "http://almanac-project.eu/onto"
  UnitOfMeasurement: "c"
}
}
-1: {
  id: "5679d6e7692b5f453b08e07dceb28bd23ct"
-ObservedProperty: {
  id: "f9fa6a0ed4cb36284bc4173a14ad885"
  UnitOfMeasurement: "unknown"
}
}
-2: {
  id: "9a02db93c01e7cbfb40a7424ac714c6c53e"
-ObservedProperty: {
  id: "90e7376bb75442b759aaa22fb77f74c"
  URI: "http://almanac-project.eu/onto"
  UnitOfMeasurement: "%"
}
}
}
}

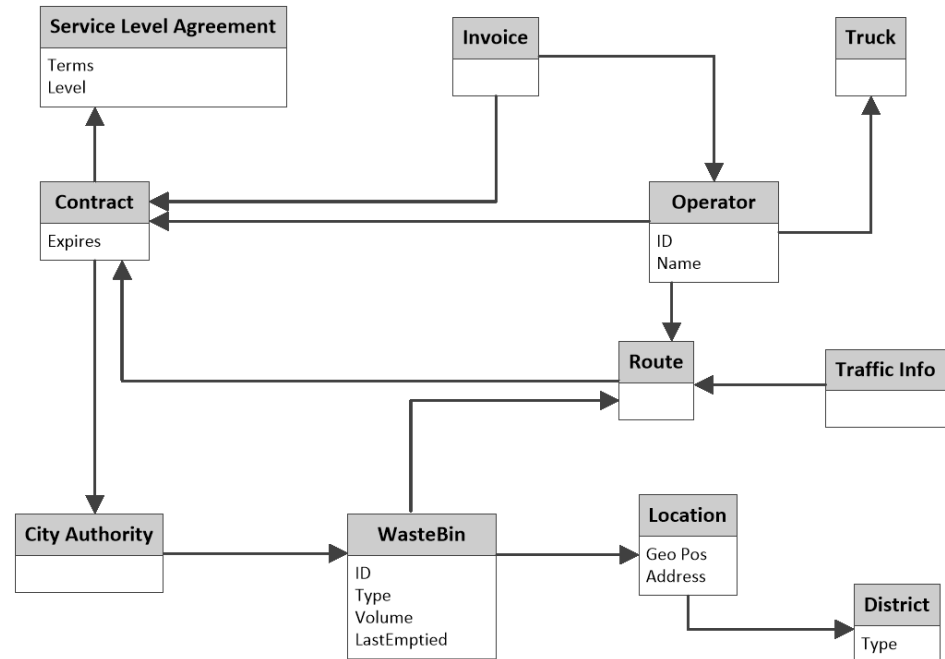
```

```

"Observations": [
  {
    "Datastream": {
      "ID": "c2867563cf3de234736cd29e9ca0af765"
    },
    "Result Value": "33.00208883101852",
    "Time": "2015-09-22T09:50:43.606Z"
  },
  {
    "Datastream": {
      "ID": "f7dfa44f0fa9245fff01b1909f8e51524abc"
    },
    "Result Value": "93.0011832010582",
    "Time": "2015-09-22T09:50:41.574Z"
  },
  {
    "Datastream": {
      "ID": "39537b3106f6cc8ad859f543a5ce41cd5"
    },
    "Result Value": "34.00207262731482",
    "Time": "2015-09-22T09:50:39.607Z"
  }
]

```

Entity Relationship Model

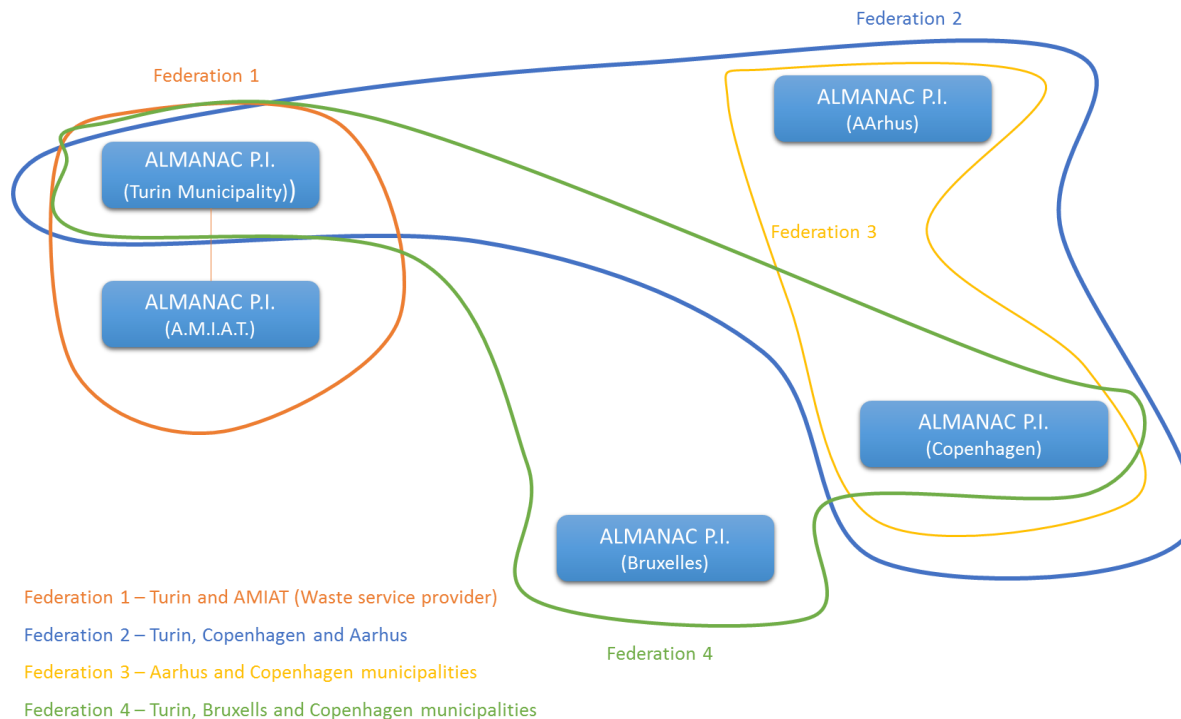


Federation of heterogeneous information system

- Organisational Federations
- Storage Federations

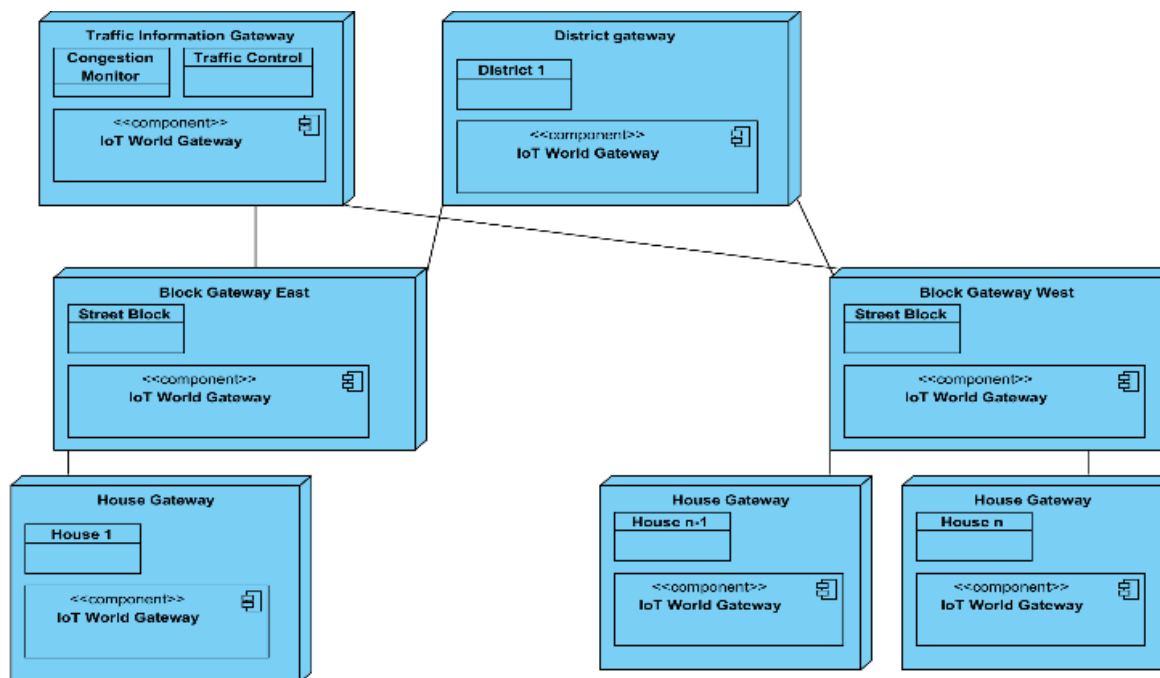
Organisational Federations

- Agrees to share certain information and services inside the federation
- From the outside the federation looks like one single entity
- Implemented using the LinkSmart Open Source



Storage Federations

- A network of federated ALMANAC nodes (instances)
- Collected sensor data can be aggregated and stored in different federated nodes
- Approach to scalability



Data Management and API Framework

- IoTEntity data and event model
 - The physical things/properties we want to know something about
- IoTWorld
 - A subset of the physical world, a set of IoTEntities that belongs together
 - Described by an ER schema
 - Federated architecture construct
- IoTResource
 - IoTDevice, IoTSensor, IoTThings, IoTDataStream...
 - Provides a set of IoTServices

Example cloud-API

- [http://almanac.cnet.se/Location\(street eq Vittorio Emanuel\)/WasteBin/fillLevel](http://almanac.cnet.se/Location(street eq Vittorio Emanuel)/WasteBin/fillLevel)
 - “Get fillLevel of all wastebins on the street of Vittorio Emanuel”
- [http://almanac.cnet.se/Location\(within 100 7.693145,45.061375\)/WasteBin/fillLevel](http://almanac.cnet.se/Location(within 100 7.693145,45.061375)/WasteBin/fillLevel)
 - “Get fillLevel of all wastebins within 100 meters of position 7.693145, 45.061375”
- [http://almanac.cnet.se/SLA\(level eq notfull\)/WasteBin/max\(2015,fillLevel\) eq 100](http://almanac.cnet.se/SLA(level eq notfull)/WasteBin/max(2015,fillLevel) eq 100)
 - “Get the wastebins which has been full sometime during 2015 but has a SLA not to be full”
- [http://almanac.cnet.se/Route\(3\)/WasteBin\(type eq Organico\)/predict\(fillLevel eq full\)](http://almanac.cnet.se/Route(3)/WasteBin(type eq Organico)/predict(fillLevel eq full))
 - “Get the forecast for when wastebins of type Organico along route 3 will be full”

Thanks for your attention

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