iKaaS: intelligent Knowledge as a Service platform

9 May 2017

Stylianos Georgoulas
Shinsaku Kiyomoto

Table of Contents

Table of Contents

iKaaS

- EU-JP collaboration
- Duration 3 years (1st October 2014 – 30 September 2017)
- 15 partners (9 EU and 6 JP)
- Budget: ~3 million euros

iKaaS


UNIVERSITY OF SURREY
INNOTEC 21
OULUN YLIOPISTO
UNIVERSITY of OULU
HITACHI
Inspire the Next
www.ikaas.com
@iKaasH2020
RIKEN
Atos
ikaas
EMT
¡MADRID!
TOHOKU UNIVERSITY
¡MADRID!
Comunidad de Madrid
10 years
CREATE-NET
WINGS
ICT Solutions
KDDI
KDDI R&D LABS
KDDI
KDDI Research Institute

iKaaS

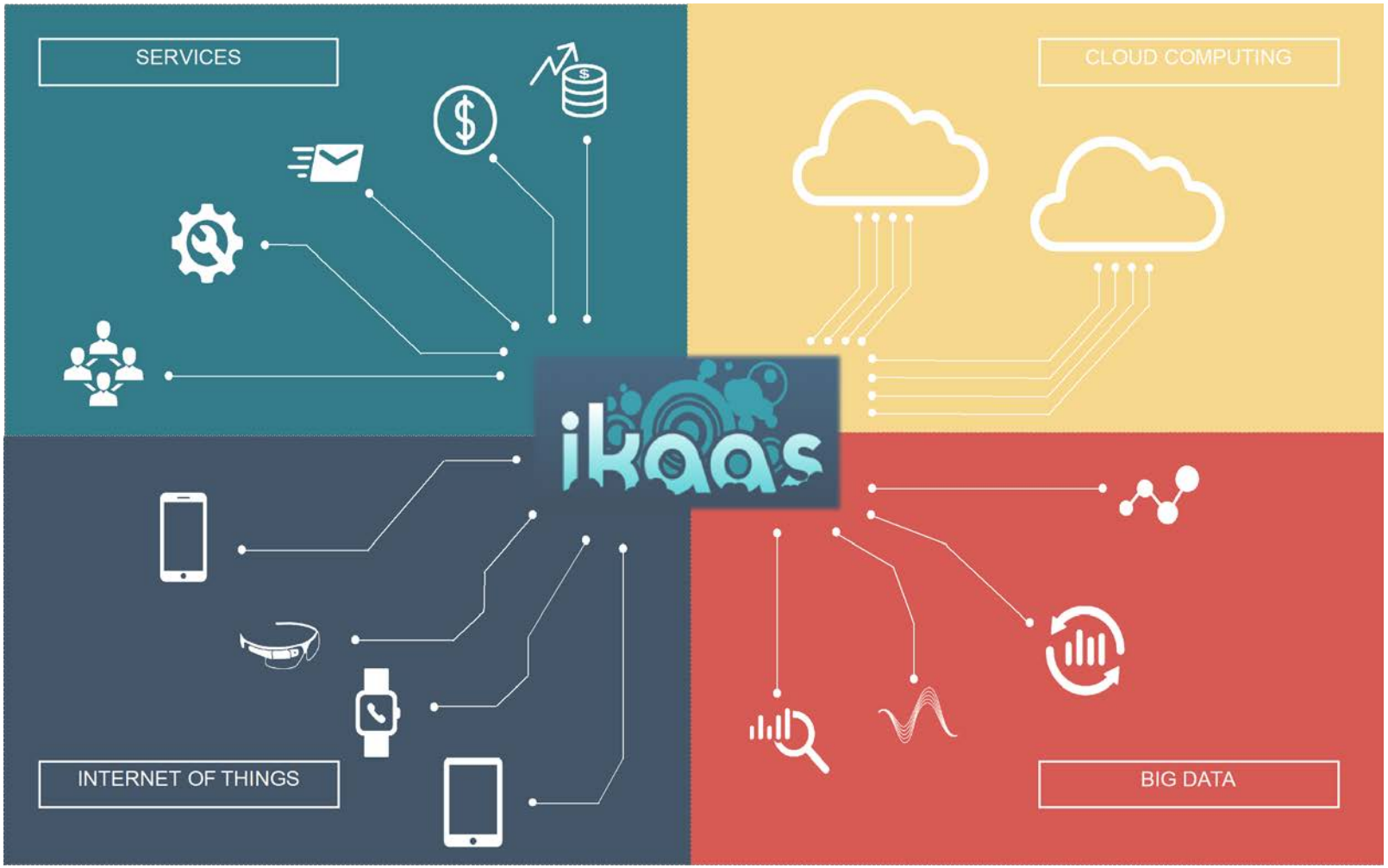

SERVICES
CLOUD COMPUTING
ikaas
INTERNET OF THINGS
BIG DATA

Table of Contents

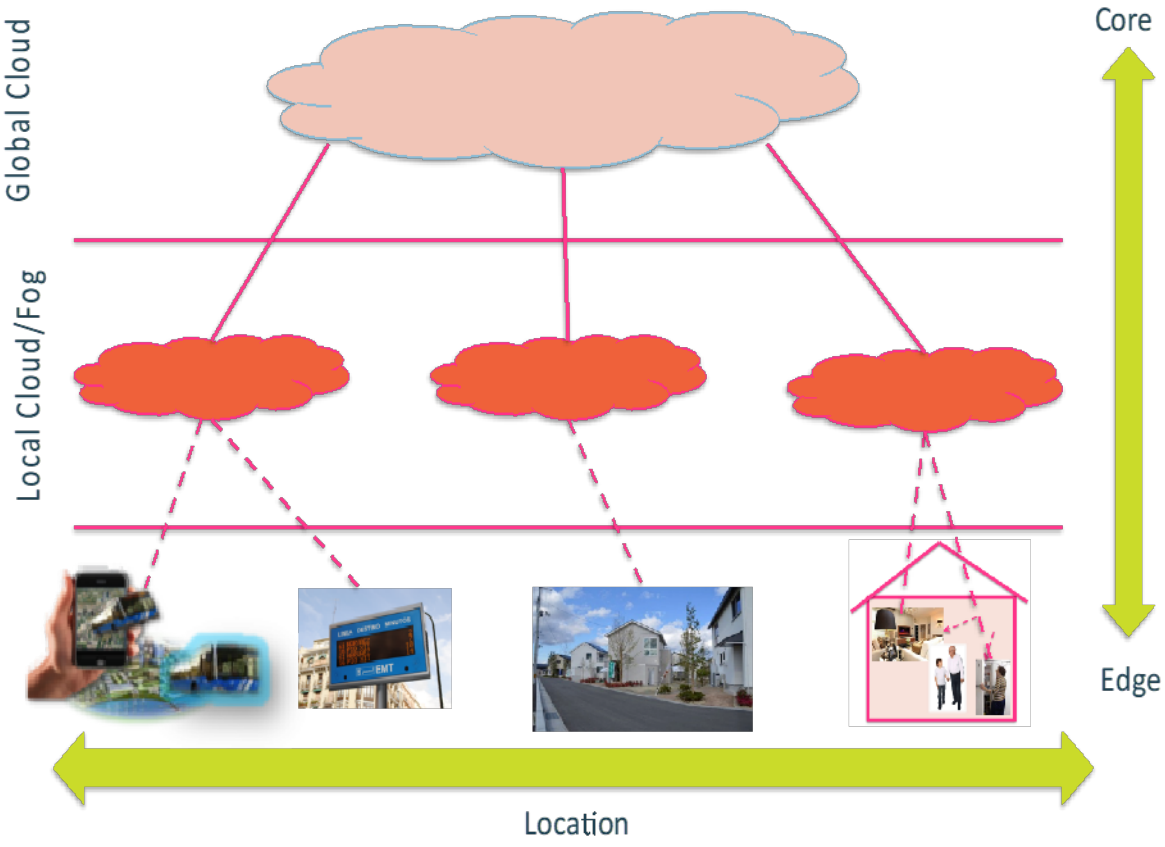
- **Requirements coming from IoT + Big Data + Cloud (1/2)**
  - Vast amount of IoT devices and data
  - Topological fragmentation of IoT endpoints
  - Heterogeneous in nature devices and data; need to be understood; need to be discovered
  - Security and privacy of data

- **Requirements coming from IoT + Big Data + Cloud (2/2)**
  - Quality and trust of data and processing; data sources not strictly controlled; software/hardware issues
  - Expose data (raw and processed) and knowledge generation functionalities
  - Re-use of data and services
  - Autonomic management and orchestration

iKaaS

- **iKaaS approach**
  - Multi cloud environment; maximize coverage and amount of resources to be offered
  - Global Cloud; legacy cloud computing paradigm
  - Local Clouds; formed on demand to extend coverage and capabilities

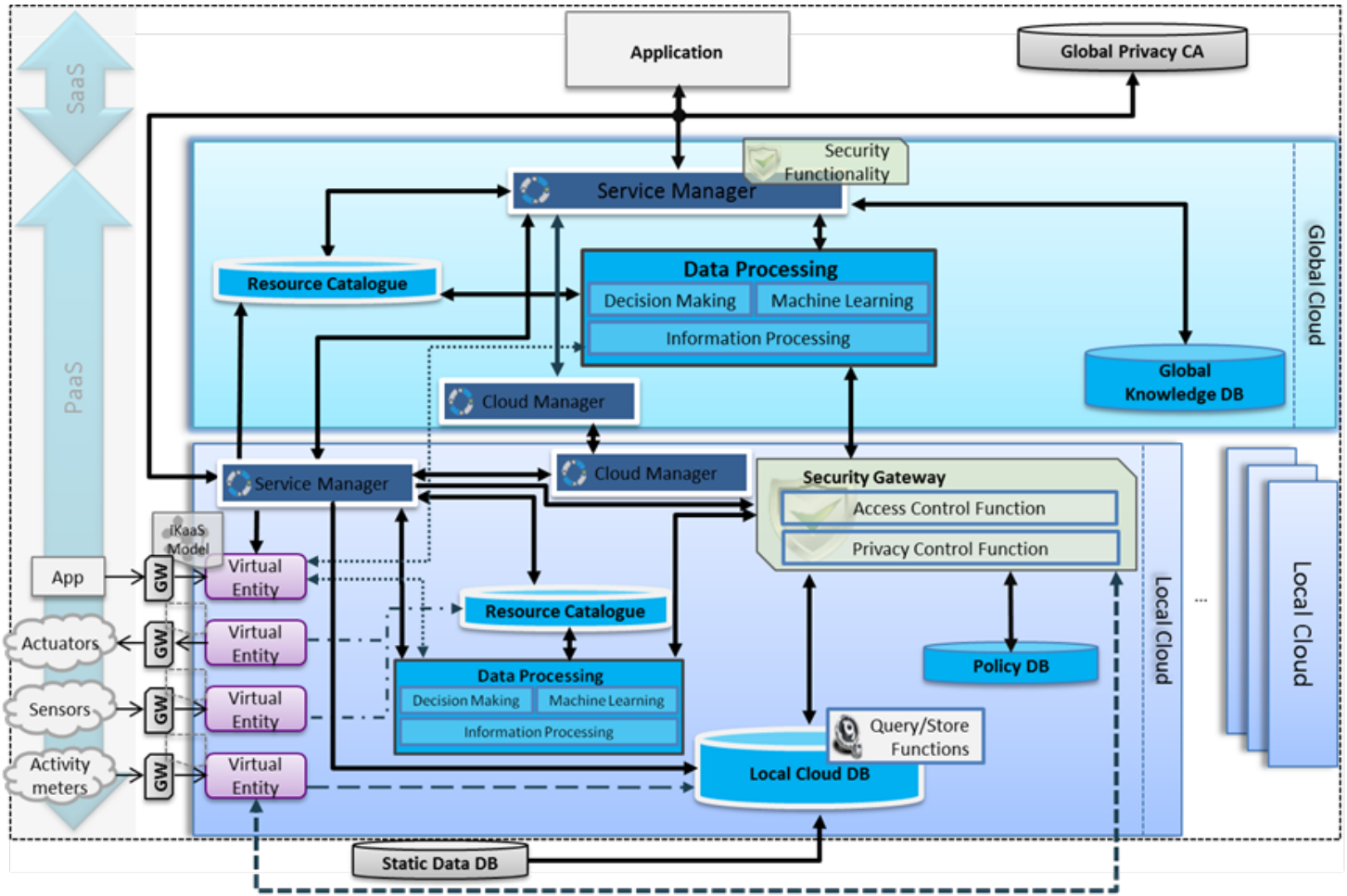
iKaaS



iKaaS

- **iKaaS platform features**
  - Efficient management of heterogeneous IoT devices
  - Unified representation of data/services and platform capabilities
  - Distributed data storage and processing
  - Security and privacy of data
  - Quality of data and trust
  - Knowledge-as-a-Service
  - Autonomic cloud-aware service management

iKaaS


SaaS
PaaS
Application
Global Privacy CA
Security Functionality
Service Manager
Resource Catalogue
Data Processing
Decision Making
Machine Learning
Information Processing
Cloud Manager
Global Knowledge DB
Global Cloud
Service Manager
Cloud Manager
Security Gateway
Access Control Function
Privacy Control Function
iKaaS Model
App
Actuators
Sensors
Activity meters
GW
Virtual Entity
Resource Catalogue
Data Processing
Decision Making
Machine Learning
Information Processing
Policy DB
Query/Store Functions
Local Cloud DB
Local Cloud
Static Data DB

iKaaS

Platform features	Components of the iKaaS architecture
Efficient management of heterogeneous IoT devices	Virtual Entity
Efficient and unified representation of the data from IoT devices	iKaaS data model, Local Cloud DB, Virtual Entity, Resource Catalogue
Distributed data storage and processing	Local Cloud DB, Global Knowledge DB, Local and Global Data Processing
Security of data and information	Security Gateway, Privacy DB, Global Service Manager
Quality of data and information	(Local) Data Processing
Knowledge-as-a-Service (KaaS)	iKaaS knowledge model, Global and Local Data Processing, Global Knowledge DB, Local Cloud DB
Consolidated description of service components and platform capabilities	iKaaS service and platform model, Resource Catalogue
Autonomic service management/orchestration	Global and Local Service Manager, Global and Local Cloud Manager

- **Key points to keep in mind (1/2)**
  - Multi-cloud architecture; allow anyone with infrastructure to contribute it (edge/fog computing ++)
  - Knowledge-as-a-Service; ease sharing of data/algorithms; expose data and software capabilities
  - Docker container implementations with Kubernetes as the cloud manager

- **Key points to keep in mind (2/2)**
  - Docker vs VMs
    - lower overhead than traditional VMs by making use of kernel features
    - comparable with VMs in terms of performance
    - much faster instantiation/decommission of instances compared to VMs
    - supported by main free/commercial cloud management products (not only Kubernetes)

Table of Contents

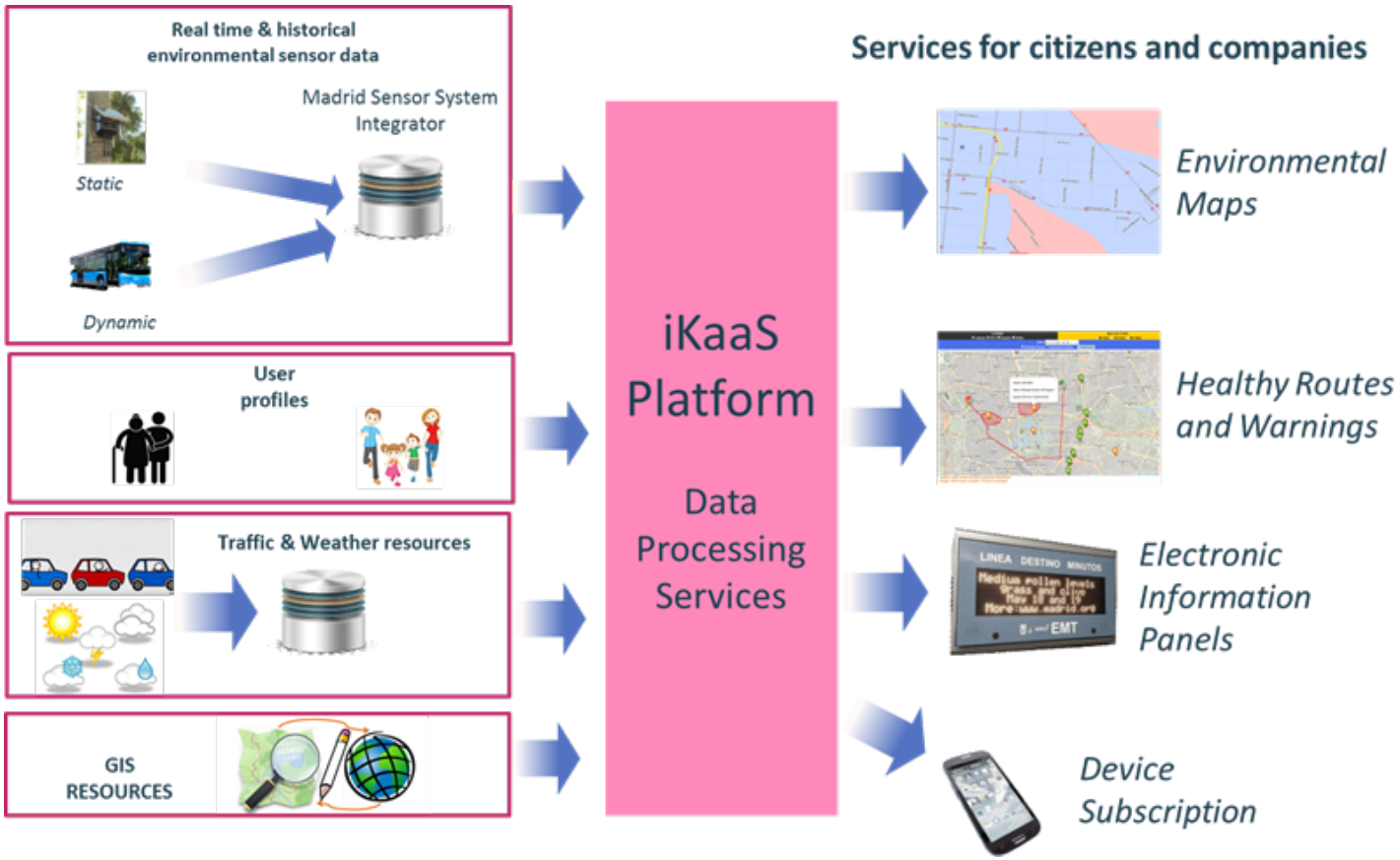
iKaaS


ikaas
Environmental Health-care
Assisted living
Town management

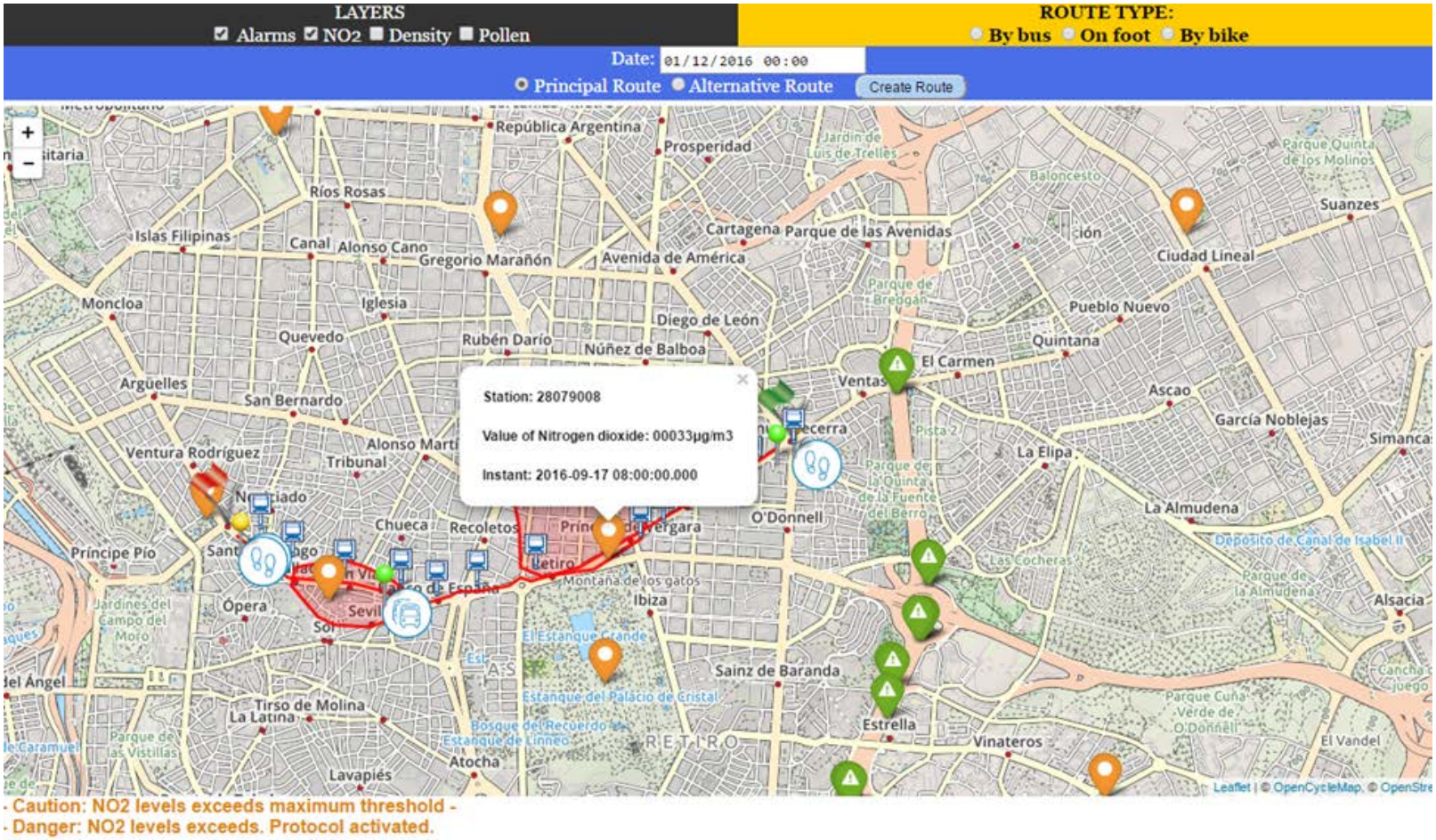
iKaaS

- **Service of Environmental Health in Madrid**
  - Use real-time and historical environmental data, user profiles, traffic and other resources
  - Provide warnings and recommendations to citizens

iKaaS


Real time & historical environmental sensor data
Madrid Sensor System Integrator
Static
Dynamic
User profiles
Traffic & Weather resources
GIS RESOURCES
iKaaS Platform
Data Processing Services
Services for citizens and companies
Environmental Maps
Healthy Routes and Warnings
Electronic Information Panels
Device Subscription

iKaaS

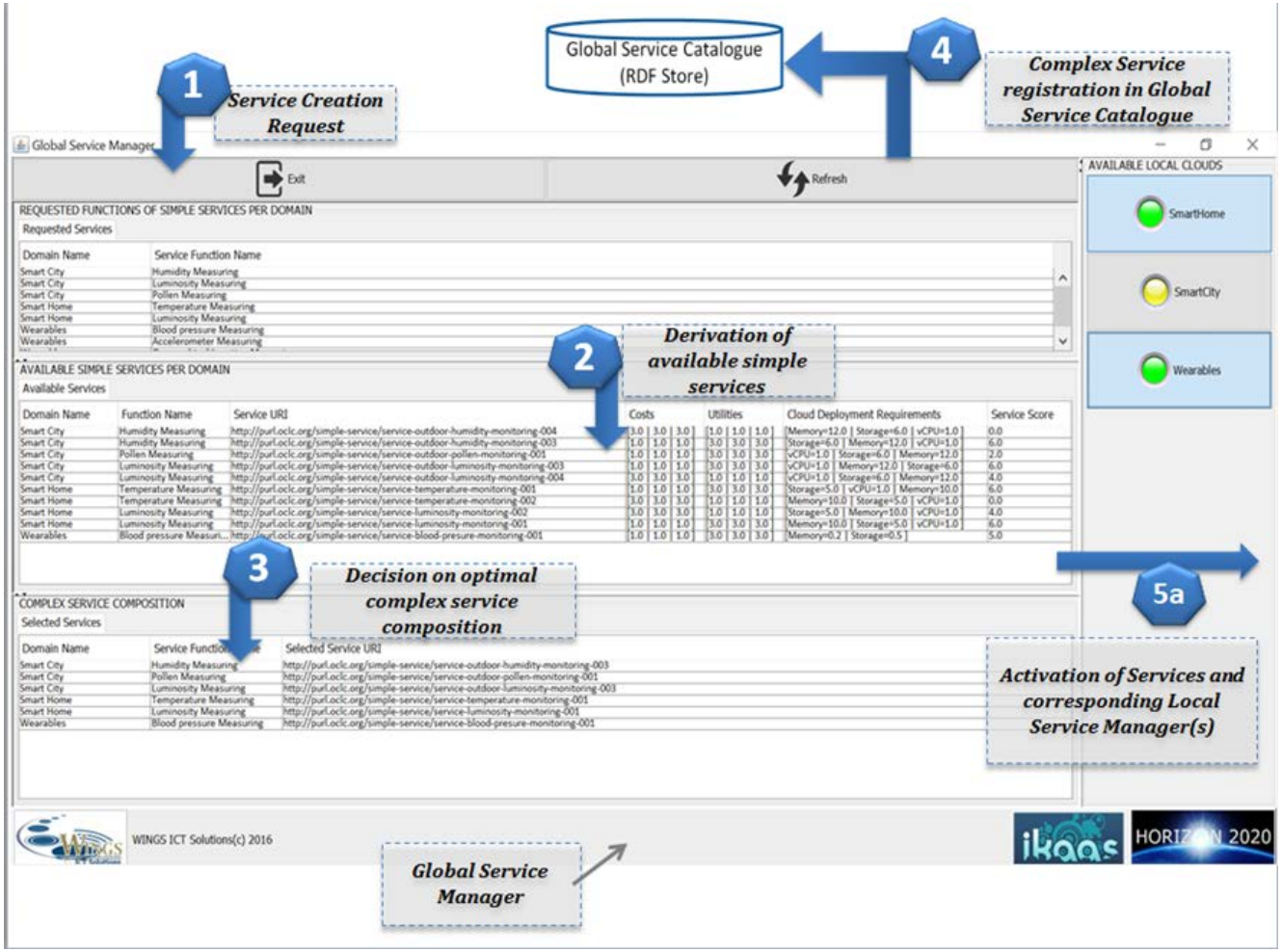

LAYERS
Alarms NO2 Density Pollen
ROUTE TYPE:
By bus On foot By bike
Date: 01/12/2016 00:00
Principal Route Alternative Route
Create Route
Station: 28079008
Value of Nitrogen dioxide: 00033µg/m3
Instant: 2016-09-17 08:00:00.000
- Caution: NO2 levels exceeds maximum threshold -
- Danger: NO2 levels exceeds. Protocol activated.
Leaflet | © OpenCycleMap, © OpenStre

- **Ambient Assisted Living in Smart City**
  - Use indoor condition, activity meter and external data (e.g. weather, traffic)
  - Support home automation
  - Support Smart City navigation
  - Support remote health monitoring

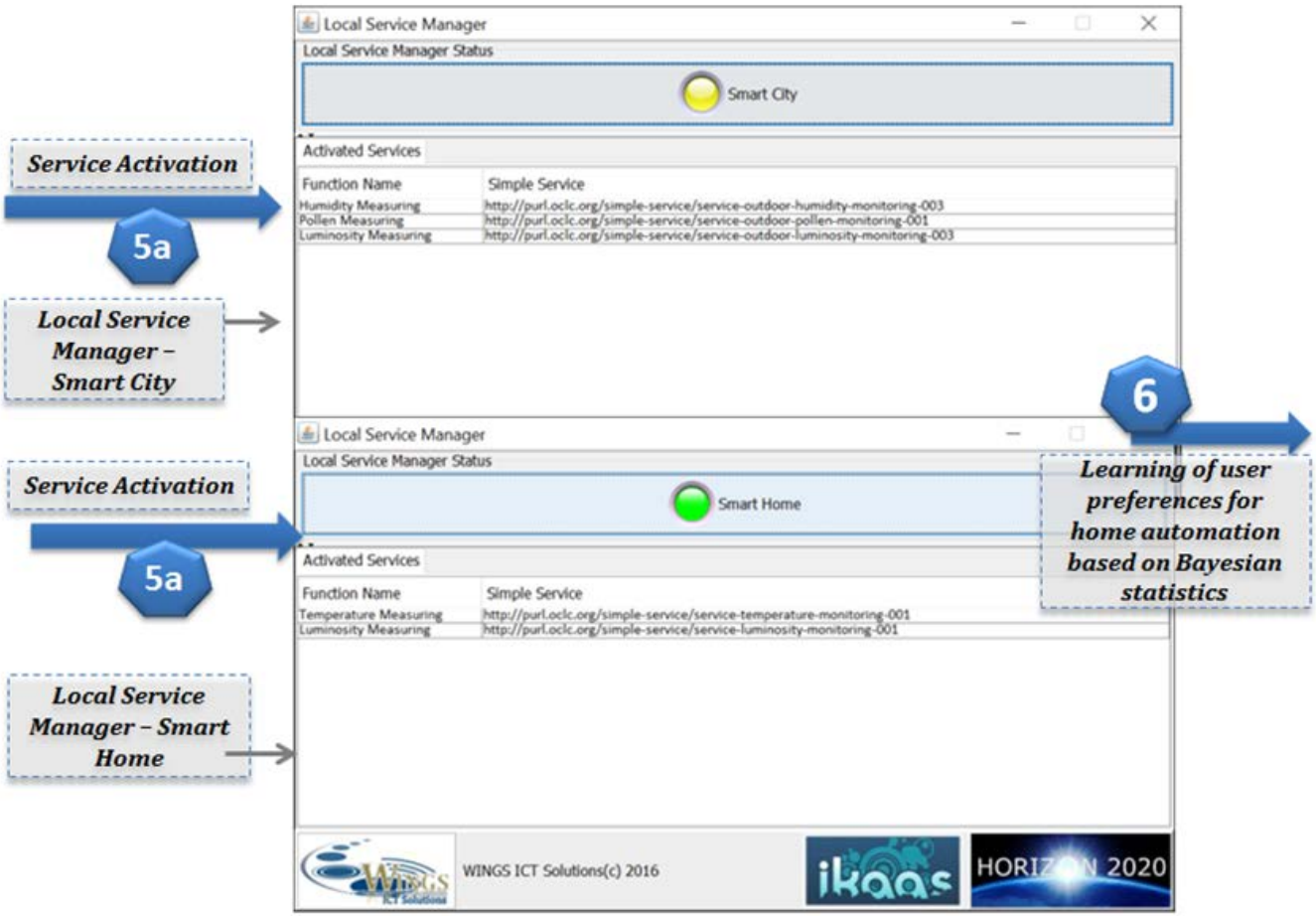
iKaaS


Smart Home IoT devices (environmental monitoring and adjustment)
User Profiles (preferences, personalized services, etc.)
External APIs for Smart Cities (IoT devices, Traffic data, weather, etc.)
API
Wearable Devices (e-Health devices, vital signs monitoring, etc.)
iKaaS Platform
Knowledge-as-a-Service
KaaS for Home Automation
Home Automation - Machine Learning
KaaS for Smart City Navigation
Find Optimal Route
KaaS for Smart Health monitoring and prediction
Health Status Warning!

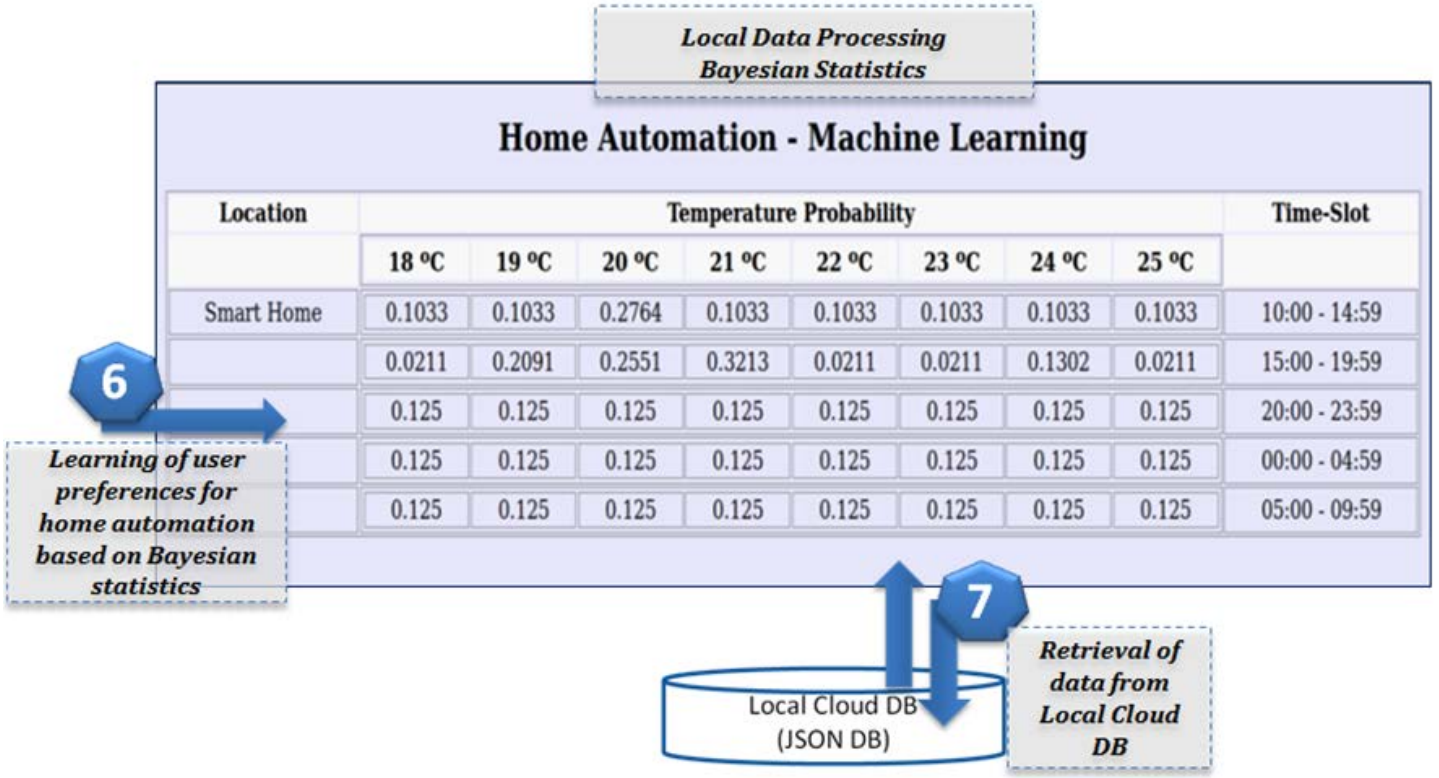
iKaaS


Global Service Catalogue
(RDF Store)
1
Service Creation Request
4
Complex Service registration in Global Service Catalogue
Global Service Manager
Exit
Refresh
AVAILABLE LOCAL CLOUDS
SmartHome
SmartCity
Wearables
REQUESTED FUNCTIONS OF SIMPLE SERVICES PER DOMAIN
Requested Services
Domain Name
Service Function Name
Smart City
Humidity Measuring
Luminosity Measuring
Pollen Measuring
Smart Home
Temperature Measuring
Luminosity Measuring
Wearables
Blood pressure Measuring
Accelerometer Measuring
2
Derivation of available simple services
AVAILABLE SIMPLE SERVICES PER DOMAIN
Available Services
Domain Name
Function Name
Service URI
Costs
Utilities
Cloud Deployment Requirements
Service Score
3
Decision on optimal complex service composition
5a
COMPLEX SERVICE COMPOSITION
Selected Services
Selected Service URI
Activation of Services and corresponding Local Service Manager(s)
WINGS ICT Solutions(c) 2016
Global Service Manager
ikaas
HORIZON 2020

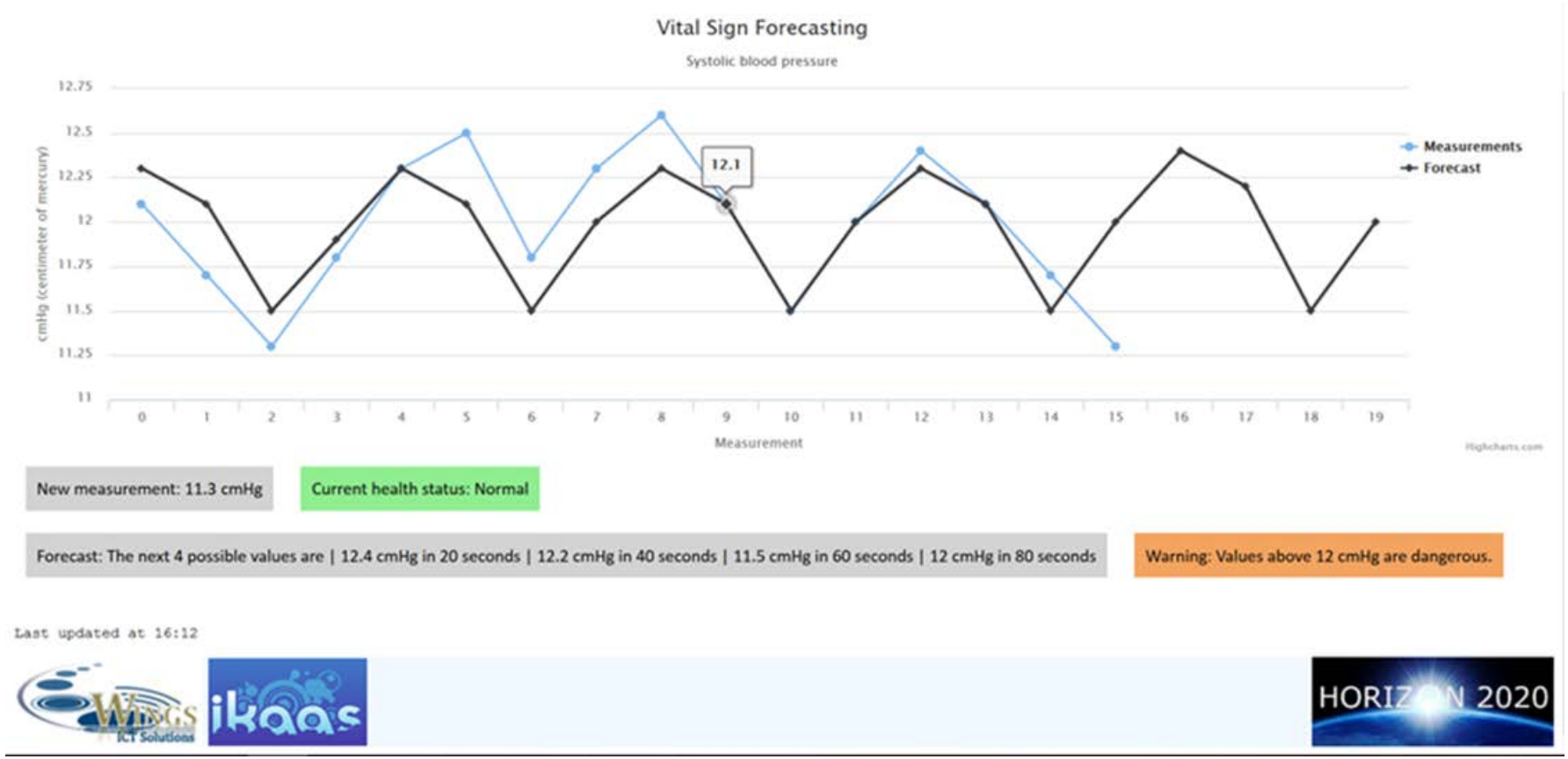
iKaaS


Service Activation
5a
Local Service Manager – Smart City
Service Activation
5a
Local Service Manager – Smart Home
Local Service Manager
Local Service Manager Status
Smart City
Activated Services
Function Name
Simple Service
Humidity Measuring
http://purl.oclc.org/simple-service/service-outdoor-humidity-monitoring-003
Pollen Measuring
http://purl.oclc.org/simple-service/service-outdoor-pollen-monitoring-001
Luminosity Measuring
http://purl.oclc.org/simple-service/service-outdoor-luminosity-monitoring-003
Local Service Manager
Local Service Manager Status
Smart Home
Activated Services
Function Name
Simple Service
Temperature Measuring
http://purl.oclc.org/simple-service/service-temperature-monitoring-001
Luminosity Measuring
http://purl.oclc.org/simple-service/service-luminosity-monitoring-001
WINGS ICT Solutions(c) 2016
ikaas
HORIZON 2020
6
Learning of user preferences for home automation based on Bayesian statistics

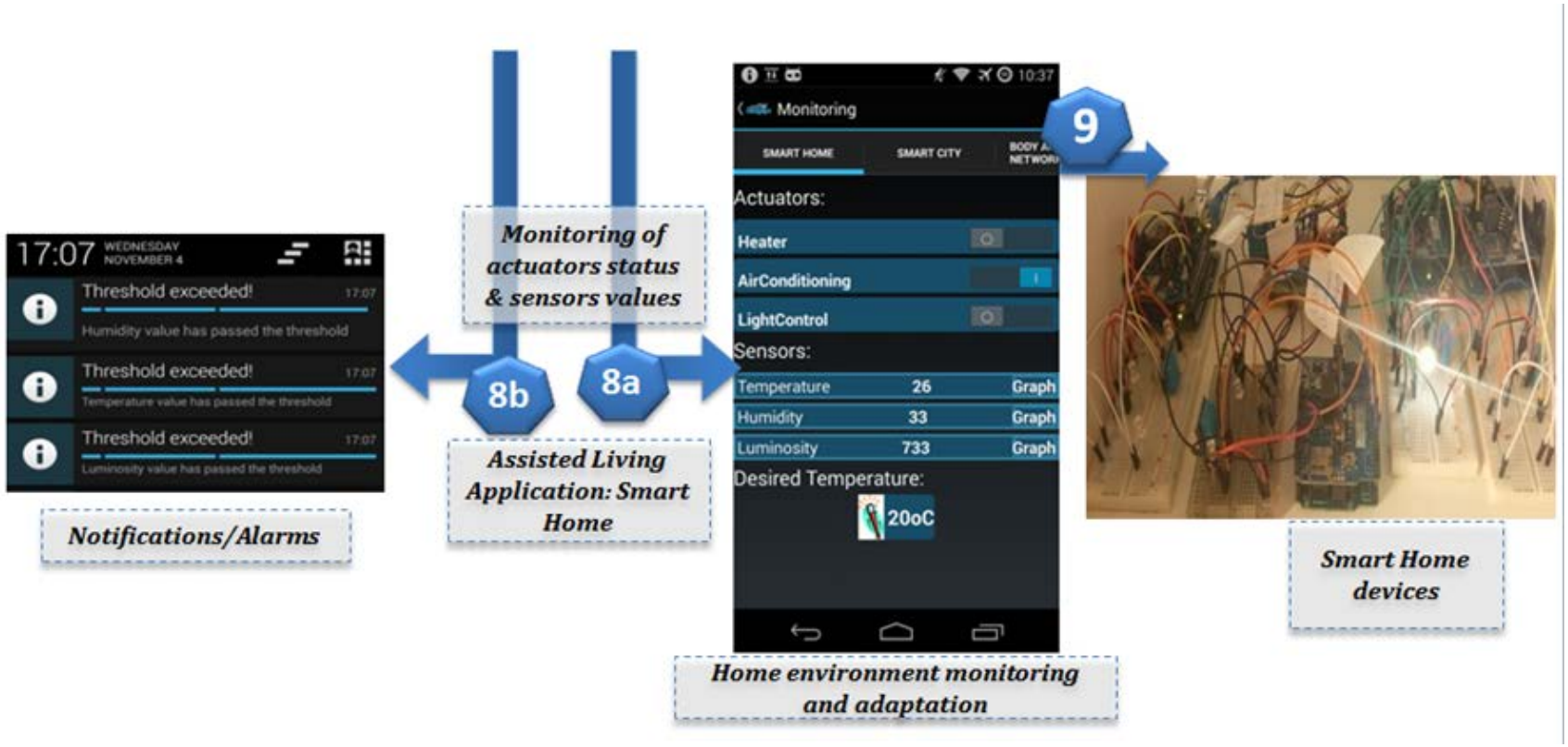
iKaaS


Local Data Processing
Bayesian Statistics
Home Automation - Machine Learning
Location
Temperature Probability
Time-Slot
18 °C
19 °C
20 °C
21 °C
22 °C
23 °C
24 °C
25 °C
Smart Home
0.1033 0.1033 0.2764 0.1033 0.1033 0.1033 0.1033 0.1033 10:00 - 14:59
0.0211 0.2091 0.2551 0.3213 0.0211 0.0211 0.1302 0.0211 15:00 - 19:59
0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 20:00 - 23:59
0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 00:00 - 04:59
0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 05:00 - 09:59
6
Learning of user preferences for home automation based on Bayesian statistics
7
Retrieval of data from Local Cloud DB
Local Cloud DB
(JSON DB)

iKaaS


Vital Sign Forecasting
Systolic blood pressure
cmHg (centimeter of mercury)
Measurement
Measurements
Forecast
12.1
New measurement: 11.3 cmHg
Current health status: Normal
Forecast: The next 4 possible values are | 12.4 cmHg in 20 seconds | 12.2 cmHg in 40 seconds | 11.5 cmHg in 60 seconds | 12 cmHg in 80 seconds
Warning: Values above 12 cmHg are dangerous.
Last updated at 16:12
HORIZON 2020

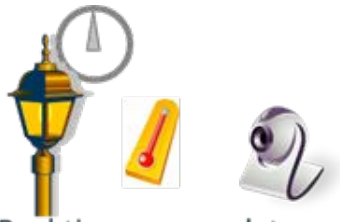
iKaaS


17:07 WEDNESDAY NOVEMBER 4
Threshold exceeded!
Humidity value has passed the threshold
Threshold exceeded!
Temperature value has passed the threshold
Threshold exceeded!
Luminosity value has passed the threshold
Notifications/Alarms
Monitoring of actuators status & sensors values
8b
8a
Assisted Living Application: Smart Home
10:37
Monitoring
SMART HOME
SMART CITY
Actuators:
Heater
AirConditioning
LightControl
Sensors:
Temperature 26 Graph
Humidity 33 Graph
Luminosity 733 Graph
Desired Temperature:
20oC
Home environment monitoring and adaptation
9
Smart Home devices

iKaaS

- **Town Management Service in Tago-nishi**
  - Use static, environmental and energy management data
  - Predict weather and energy consumption
  - Assist town management personnel in identifying dangerous areas in the city in advance

iKaaS



Real time sensor data

Public open data set

User profiles

HEMS data set

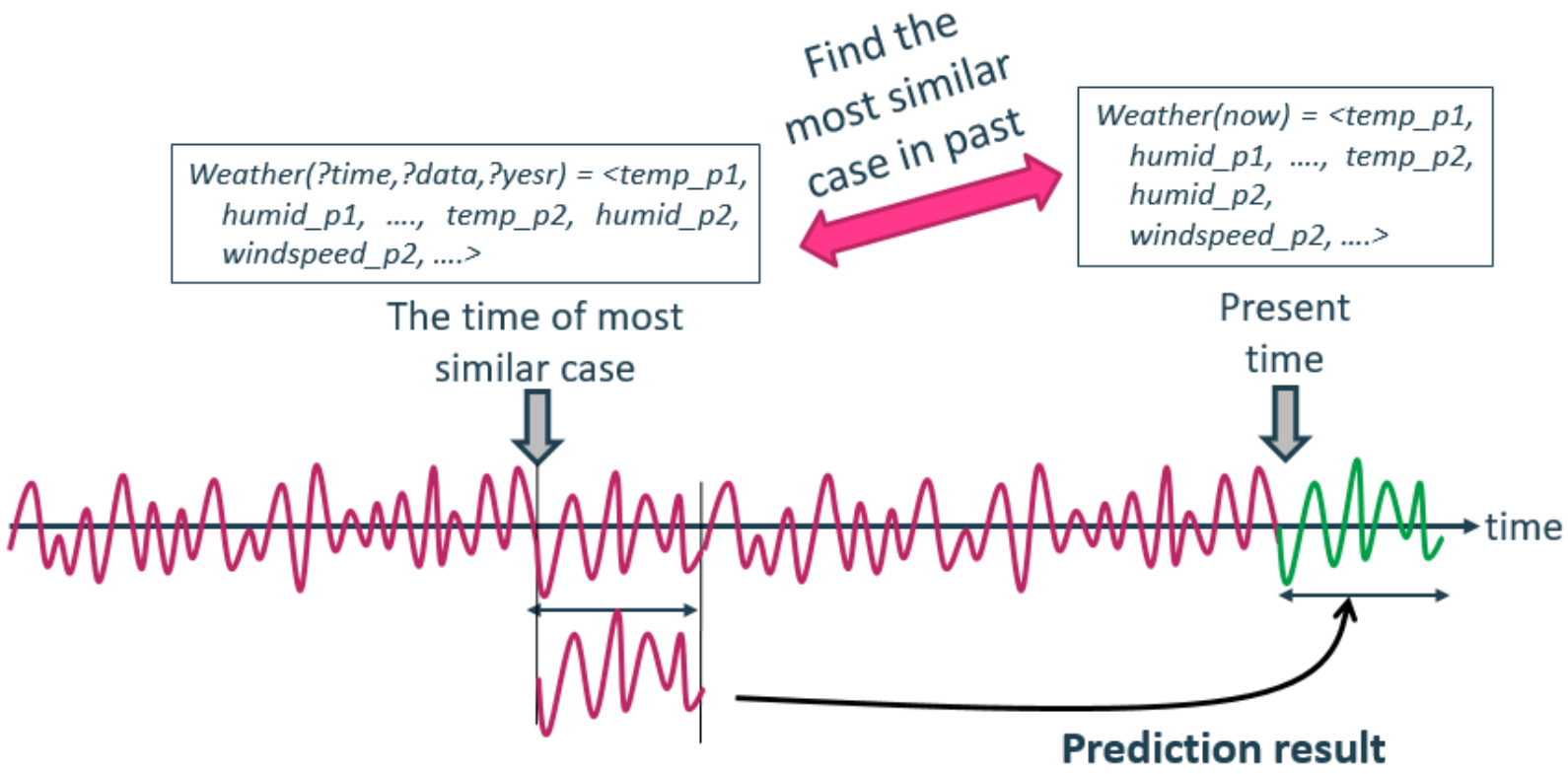
Geographical information / Town asset information

iKaaS Platform

Knowledge-Based Integration

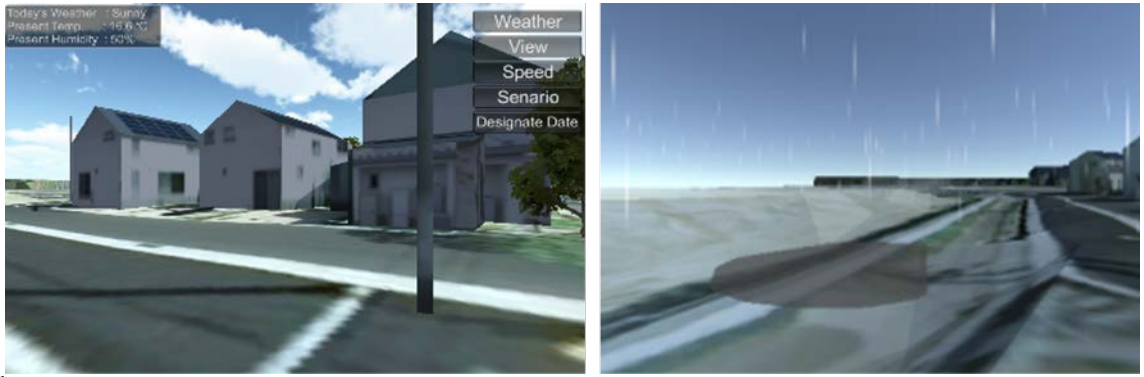
Town Management Application for personnel of town management organization

iKaaS


Find the most similar case in past
Weather(?time,?data,?yesr) = <temp_p1, humid_p1, ..., temp_p2, humid_p2, windspeed_p2, ...>
Weather(now) = <temp_p1, humid_p1, ..., temp_p2, humid_p2, windspeed_p2, ...>
The time of most similar case
Present time
time
Prediction result

iKaaS


2015/01/30 09:00 -0.1°C
Snowing Heavily
Rain : 4.0mm/h
Snow : 4 cm/h, 16cm Accum.
Back
2015
1
30
9
0
OK

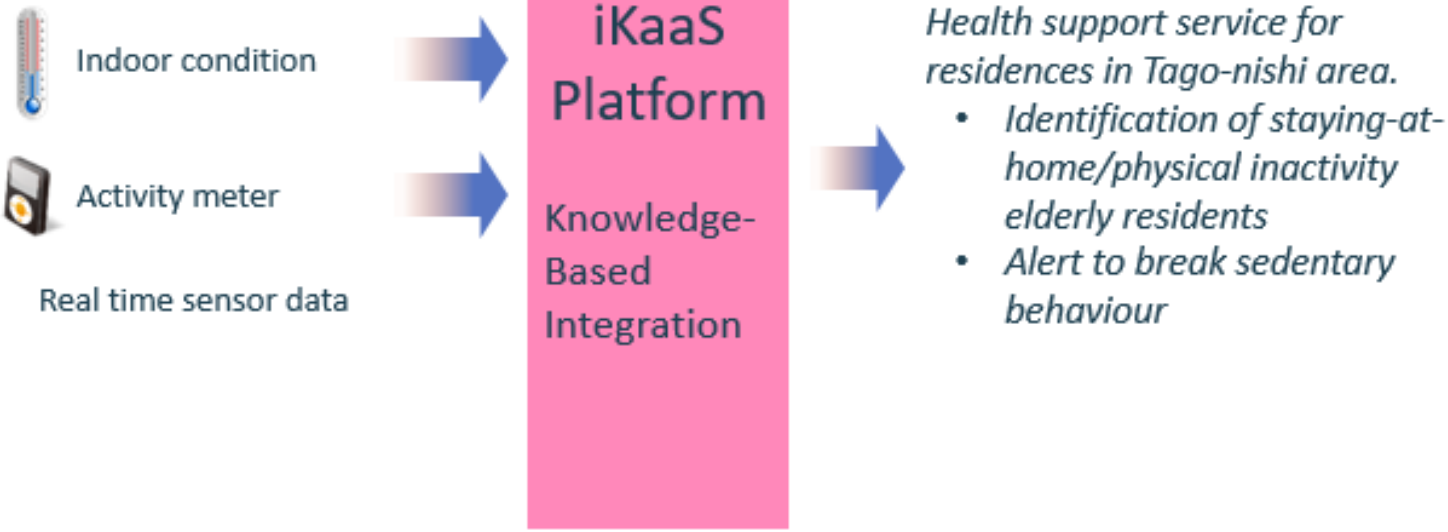

Weather
View
Speed
Senario
Designate Date

iKaaS

- Virtual walkthrough in the town in different simulated seasons and from the "eyes" of different people

- **Health Support Service in Tago-nishi**
  - Use indoor condition and activity meter data
  - Identify physical inactivity
  - Alert to break sedentary behaviour

iKaaS


Indoor condition
Activity meter
Real time sensor data
iKaaS Platform
Knowledge-Based Integration
Health support service for residences in Tago-nishi area.
• Identification of staying-at-home/physical inactivity elderly residents
• Alert to break sedentary behaviour

iKaaS

- This use case is conceptual focusing mostly in the data acquisition aspects
- Evaluate how much elderly people would be willing to allow personal data collection

- 20% of elderly people asked refused completely
- 20% of elderly people agreed only to indoor environmental sensor data collection

Table of Contents

iKaaS

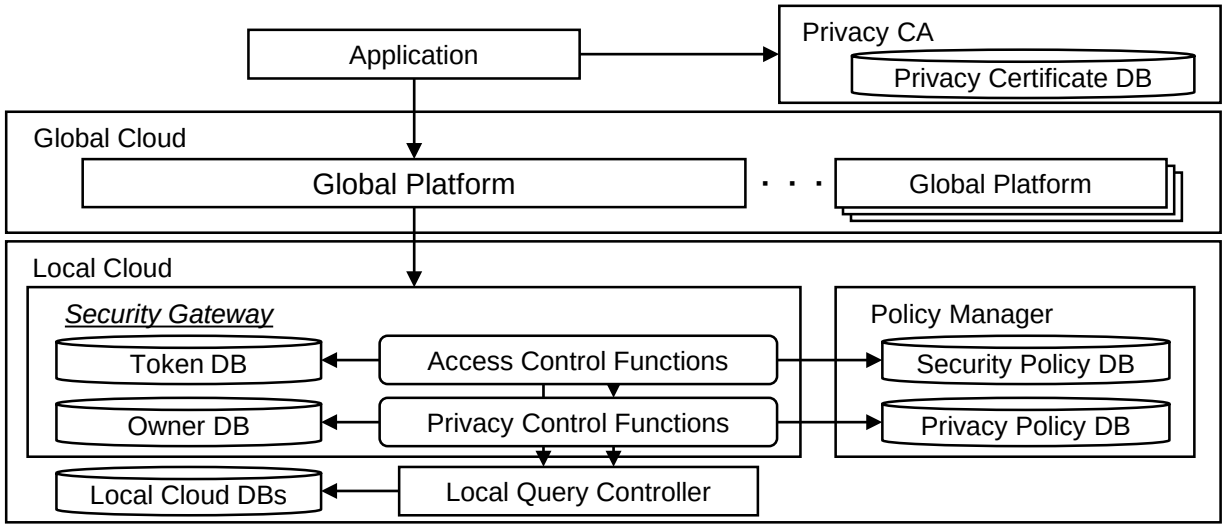
- **Technological issues**
  - Data format/structure needs to be aligned; therefore the need for the iKaaS model
  - Docker only recently through Flocker started supporting migration of data together with the container-based application
- **Security/privacy of data**
  - Differences in regulations between different countries
  - Additional constraints when it comes to transfer of personal data
  - It can affect not only transfer of data but even migration of containers/VMs when loaded with data

- **Transfer of general data**
  - GDPR (General Data Protection Regulation) to come in effect in EU from May 2018 will set out a single rule within EU
    - mainly for personal data
  - Legal fragmentation can be a problem (e.g. data retention period differences)
  - Data localization issues; some countries (e.g. Russia, Brazil, China) require storage of data within national borders

- **Transfer of personal data (1/2)**
  - GDPR to set out a single rule within EU
  - Personal data can be transferred to a third country
    - on the basis of an adequacy decision (i.e. the third country ensures an adequate level of protection); this can take a long time
    - binding corporate rules, within the same corporate group in countries that do not provide an adequate level of protection; costs money and take time
    - standard data protection clauses, needs a contract for each data transfer
    - **uncertain legal situation in Japan for these 3 options**

- **Transfer of personal data (2/2)**
  - Personal data can be transferred to a third country
    - on the basis of explicit consent from the data subject; limits the use of data for purposes and by parties not known at data collection time
    - on the basis of anonymization, so that data are not classified as personal; location is considered as an identifiable feature so datasets may become too limited; merging of datasets may allow for indirect identification
  - APPI Bill in Japan requires explicit consent or adequate data protection system in the third country
  - **Explicit consent is the preferred option**

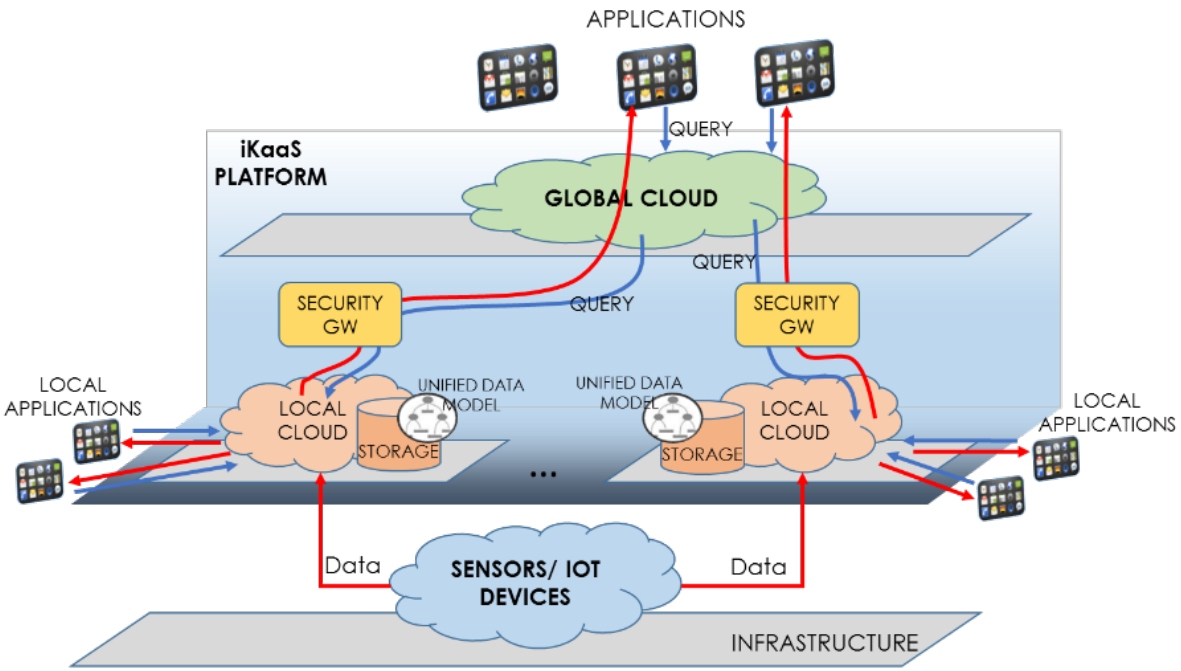
- **Transfer of data in iKaaS (1/4)**
  - Handled through the Security Gateway in collaboration with the Privacy CA



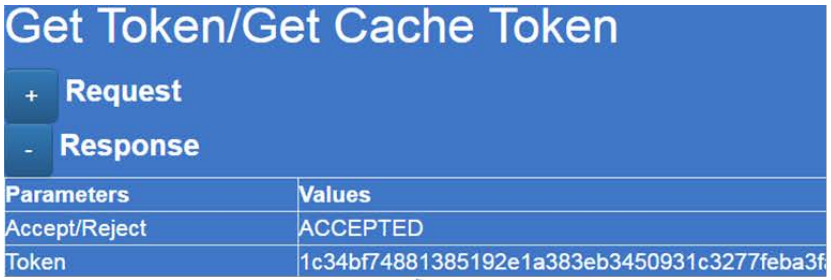
- **Transfer of data in iKaaS (2/4)**
  - Privacy CA issues certificate to be used by the Security Gateway to interpret the rules in the country of the originating Application
  - Security Policy reflects the rules for access to data in Local Cloud DBs based on national/regional regulations
  - Privacy Policy indicates the consent status for personal data
  - Application is issued a token and can access the data using the same token many times

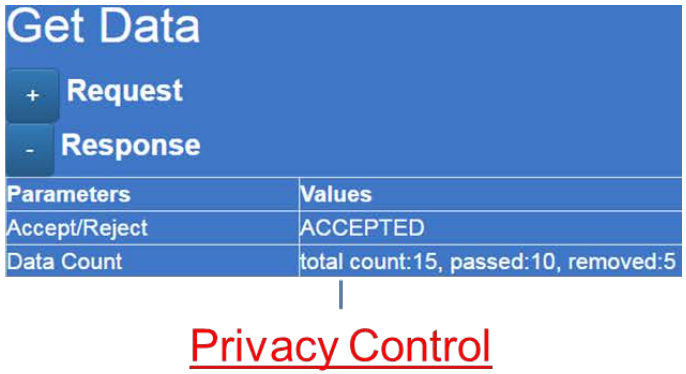
iKaaS

- **Transfer of data in iKaaS (3/4)**



- **Transfer of data in iKaaS (4/4)**
  - Data are filtered according to the status of the consent of the data owner

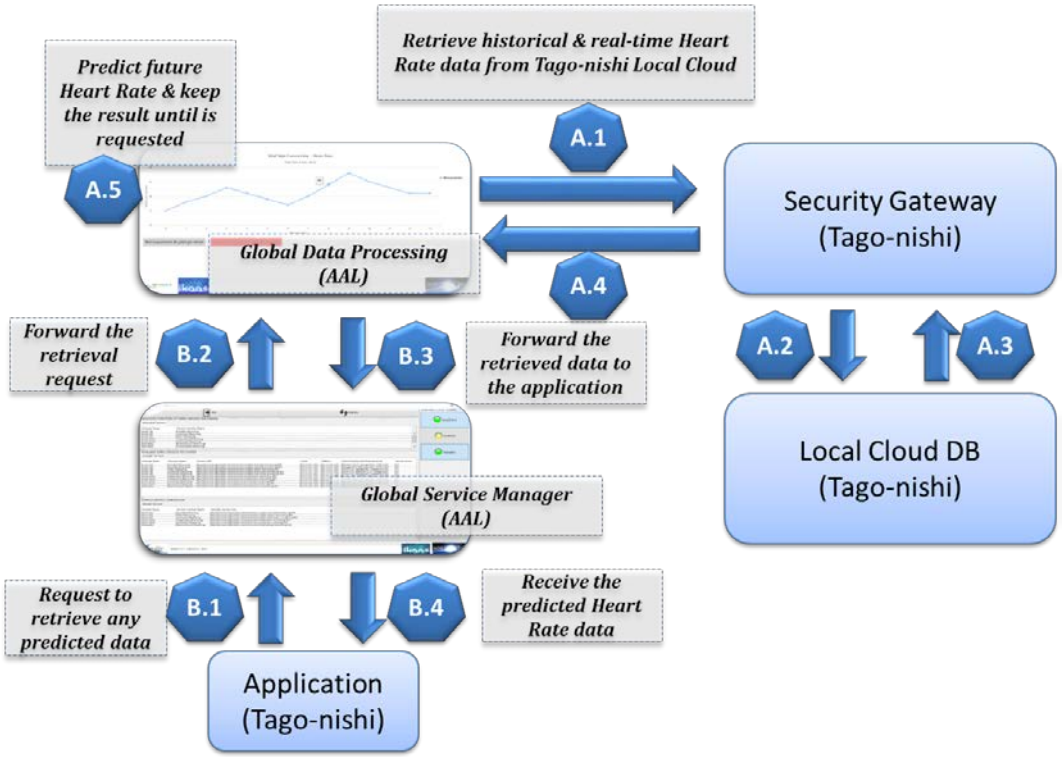




iKaaS

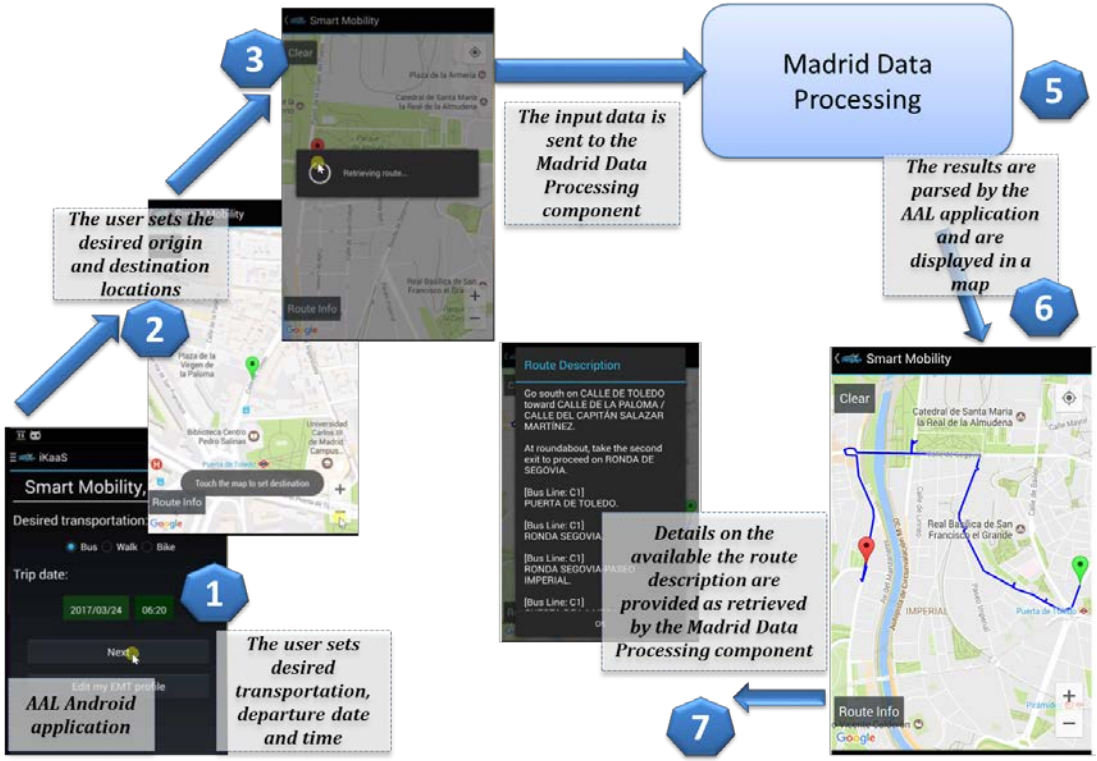
- Cross border scenarios in iKaaS
  - Health Support Service; a person from Japan visits EU and there is need for health monitoring
  - Environmental Support Service; a person from Greece visits Madrid and needs to use location-based services

- Health Support Service (1/2)



- **Health Support Service (2/2)**
  - Need to access personal data stored in Tago-nishi and transfer them to a Data Processing component in a different country
  - To overcome this privacy issue, the Security Gateway is exploited, which authorizes the request for the Heart Rate data retrieval process and keeps the data protected.
  - Similar scenario implemented with room settings retrieved from JP to be used for environmental adaptation while in EU

- # Environmental Support Service (1/2)



- **Environmental Support Service (2/2)**
  - No security or privacy issues with respect to data transfer; only local data are used
  - Optimal route is derived based on data stored in the Madrid local cloud
  - Once the person is back in Greece, a request for a similar route in Greece will use the corresponding data and Data Processing component in Greece

Table of Contents

iKaaS

- **Development of modules for (1/2)**
  - making data from various sources understandable
  - registration of:
    - services
    - physical hosts capabilities
    - user profiles
    - data/knowledge
  - analysis of service requests
    - cloud awareness complemented with IoT service awareness

- **Development of modules for (2/2)**
  - data processing and knowledge generation in smart city / smart home scenarios
    - online and offline
  - ensuring trust and secure flow of IoT data among multiple clouds
    - reputation management of IoT sources and services
    - social trust calculation ("my cloud is your cloud")
    - security gateway and supporting components

iKaaS

- **APIs for 3rd party access to exposed platform functionalities and data**
  - "knowledge as a Service" for all
  - third parties as consumers and providers
- **Provide iKaaS components (toolbox) as PaaS services**
  - components as containers for wide market take-up
  - take advantage of monitoring and configuration/deployment tools offered by (open-source) cloud management tools

- **Who can benefit from us**
  - Public Administrations, Health Support Service Providers, Town Management Service Providers, Technology/Solutions Providers
    - from the iKaaS toolbox
  - Citizens
    - as users of Smart City services
    - as users of the iKaaS toolbox to build their own home cloud installations
  - Cloud communities
    - from our real life testing of cloud technologies in Smart City contexts

iKaaS

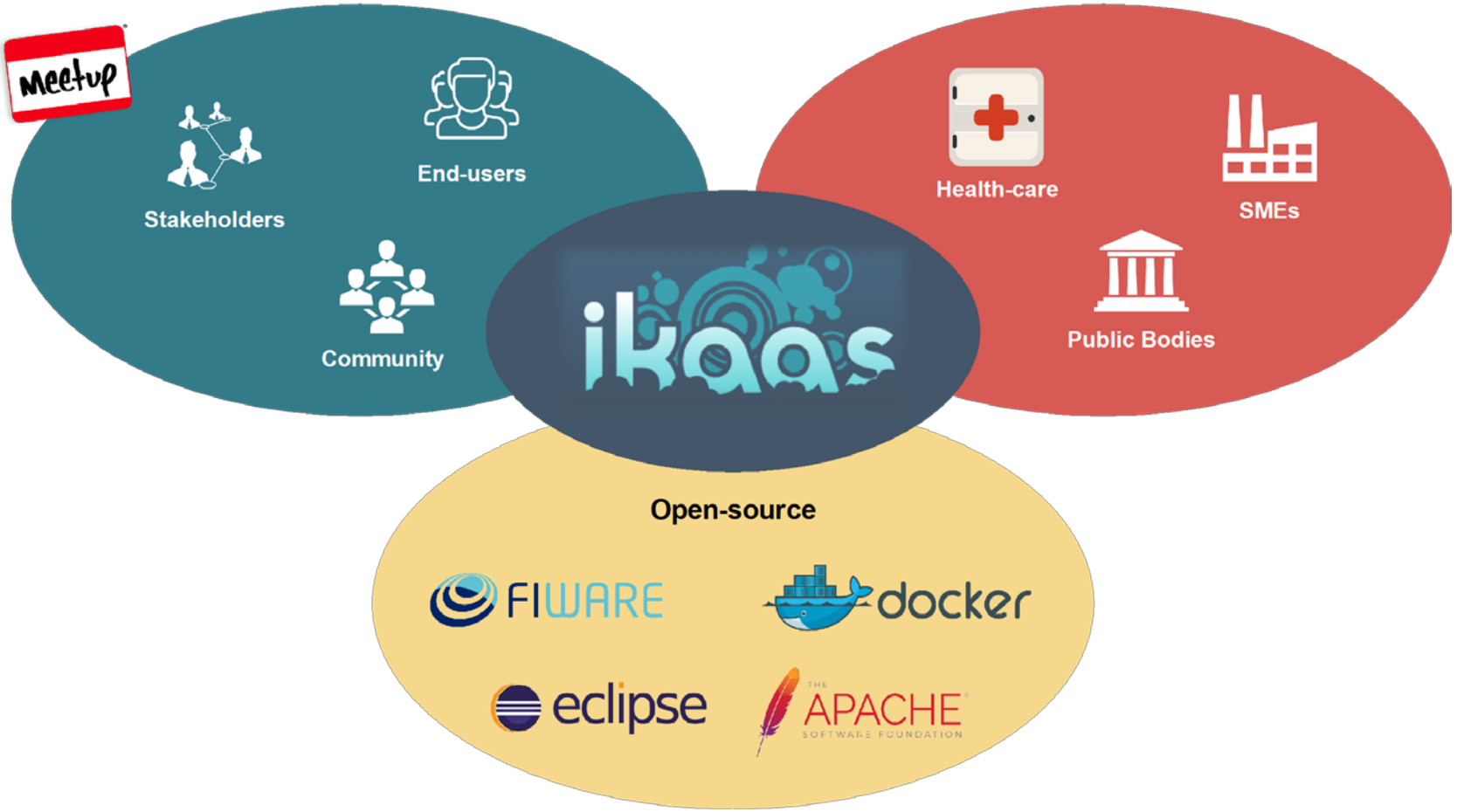

Meetup
Stakeholders
End-users
Community
Health-care
SMEs
Public Bodies
ikaas
Open-source
FIWARE
docker
eclipse
APACHE
SOFTWARE FOUNDATION

Table of Contents

iKaaS

- IoT + Big Data + Cloud combination has a lot of potential but also challenges that need to be addressed
- Contribution of data sources, actuators, software functionalities as well as hardware infrastructure are key to support knowledge generation and services
- Cross-border issues especially due to regulation/privacy of data issues are not to be ignored **(security gateway has been accepted for standardization in oneM2M)**
- iKaaS has been developing the toolbox and APIs to empower several application domains

iKaaS

- Further details
  - Web: www.ikaas.com
  - Twitter: @ikaasH2020
  - Email: s.georgoulas@surrey.ac.uk
    kiyomoto@kddi-research.jp

iKaaS