FIWARE: transforming Smart Cities into engines of growth

Juanjo Hierro
Telefonica I+D. FIWARE Coordinator and Chief Architect
juanjose.hierro@telefonica.com, @JuanjoHierro (twitter)

http://www.fiware.org
http://lab.fiware.org
Follow @FIWARE on Twitter!
Cities are where daily life and businesses actually happen …

Smart Cities are not simply about more efficient municipality services but *transforming Cities into the ICT platform* enabling economy growth and improvement of the well-being through innovation.
FIWARE Mission

- **Goal:** capture opportunities derived from the new wave of digitalization of life and businesses that is coming

- **Strategy:** Build a sustainable innovation ecosystem around open standards supporting development of smart applications in multiple sectors

- **Pillars:**
  - **FIWARE**: a generic, open standard platform which serve the needs of developers in multiple domains
  - **FIWARE Lab**: a meeting point where innovation happens and data providers plus entrepreneurs can be engaged
  - **FIWARE Accelerate**: a program that funds developers and entrepreneurs, and ignites roll-out of the ecosystem
  - **FIWARE Mundus**: reach a global footprint, opening to regions that share the same vision and ambition
  - **FIWARE iHubs**: provide local support to the community
## FIWARE PPP: main figures

<table>
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<tr>
<th>2010-2016 (FP7)</th>
<th>122 = 85 + 37 M€</th>
<th>18 = 17 + 1</th>
<th>24 partners</th>
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<tr>
<td>FIWARE budget</td>
<td>FIWARE Lab nodes</td>
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<tr>
<td>99 = 76 + 23 M€</td>
<td>21 Innovation Hubs</td>
<td>9 Countries</td>
<td>6,5 M€ marketing</td>
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<td>FIWARE funding</td>
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<tr>
<td>80 + 20 M€</td>
<td>16+ Accelerators</td>
<td>1300 Startups/SMEs</td>
<td>95/66 M€ budget/funding of Vertical Use Cases</td>
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### 2016-2017 (Horizon 2020)

<table>
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<tr>
<th>Statement</th>
<th>Program</th>
<th>Budget</th>
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<tr>
<td>&quot;Proposers are encouraged to use FIWARE for some or all of their platform developments, when relevant. Projects aiming to develop specific platforms, are encouraged to make them interoperable with FIWARE.&quot;</td>
<td>ICT</td>
<td>1876 MEuro</td>
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<td>Greening the Economy</td>
<td>326 MEuro</td>
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<td>Agrifood, marine, bio</td>
<td>410 MEuro</td>
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Why FIWARE?
Because it brings the right standards for developing “Smart” apps/services

Because it allows your city to join forces with others to build a sustainable market

Because it’s not just about technology
Because it brings the right standards for developing “Smart” apps/services
Does this guy look “smart”? … why?
In the “Smart” City, applications are “Aware” of what’s going on in the city at any time

- Smart City Applications requires gathering and managing context information, referring to values of attributes characterizing entities relevant to the application

- **City Services**
  - Bus
    - Location
    - No. passengers
    - Driver
    - Licence plate

- **Citizen**
  - Name-Surname
  - Birthday
  - Preferences
  - Location
  - ToDo list

- **Shop**
  - Location
  - Business name
  - Franchise
  - Offerings
Multiple system/apps can exploit context info

- Systems dealing with management of city services or third-party apps (subject to access control policies) can both consume and update context information.

- Overall city governance can rely on context information available (real-time and historic) to monitor KPIs and run BigData analysis.

City Services

- Bus
  - Location
  - No. passengers
  - Driver
  - Licence plate

Citizen
- Name-Surname
- Birthday
- Preferences
- Location
- ToDo list

City Governance System

Third-party Apps

Shop
- Location
- Business name
- Franchise
- Offerings
Different sources of context need to be handled

- Context info may come from many sources which may vary over time:
  - Existing systems dealing with management of municipal services
  - Sensor networks (Internet of Things)
  - Third-party smart city apps

- Source of info will be transparent to applications accessing context info

What’s the current traffic in street “X”?  Notify me the changes of traffic in street “X”?

Street = “X”, traffic = high

The Public Bus Transport Management system
A sensor in a pedestrian street
Citizen’s car app or smartphone
Different sources of context need to be handled

- Context info may come from many sources which may vary over time:
  - Existing systems dealing with management of municipal services
  - Sensor networks (Internet of Things)
  - Third-party smart city apps

- Source of info will be transparent to applications accessing context info

What’s the current temperature in place “X”?

Notify me the changes of temperature in place “X”

The Public Bus Transport Management system

A sensor in a pedestrian street

Citizen’s smartphone

Place = “X”, temperature = 30°

It’s too hot!

Standard API
A non-intrusive approach is required

- Capable to integrate with existing or future systems dealing with management of municipal services without impact in their architectures
- Info about attributes of one entity may come from different systems, which work either as Context Producers or Context Providers
- Applications rely on a single model adapting to systems of each city
Connecting to the Internet of Things

- Capturing data from, or Acting upon, IoT devices should be as easy as to read/change the value of attributes linked to context entities using a Context Broker

GET <Oauth token> /V1/contextEntities/lamp1/attributes/presenceSensor

PUT <Oauth token> /V1/contextEntities/lamp1/attributes/status “light on”

Issuing a get operation on the “presenceSensor” attribute enables the application to get info about presence of people near the lamp

Setting up the value of attribute “status” to “light on” triggers execution of a function in the IoT device that switches the lamp on
Smart Cities as platforms for innovative apps

- The city may export part of the context information to third-parties.
- Going further, it may allow third-applications to enrich context information, by means of adding new attributes and entities.
- This leads to potential innovative business models and fuels the Economy of Data.

Third-party applications

standard API

Context Information

Bus
- Location
- No. passengers
- Driver
- Licence plate

Citizen
- Name-Surname
- Birthday
- Preferences
- Location
- ToDo list

Shop
- Location
- Business name
- Franchise
- offerings
FIWARE NGSI materializes a cornerstone Pivotal Point of Interoperability (PPI)

- NGSI brings a simple yet powerful Restful API enabling access to context information, supporting Linked Data
- Any web developer can build applications the very first day

Context Information

- Citizen
  - Name-Surname
  - Birthday
  - Preferences
  - Location
  - ToDo list

- Shop
  - Location
  - Business name
  - Franchise
  - Offerings

- Bus
  - Location
  - No. passengers
  - Driver
  - Licence plate
FIWARE NGSI materializes a cornerstone Pivotal Point of Interoperability (PPI)

- **Simple yet powerful API** enabling updates and access to context information from different sources (not just IoT!) which may vary over time
  - Existing systems dealing with management of municipal services
  - Sensor networks (Internet of Things)
  - Third-party smart city apps

- Enables a key concept which was missing: **real-time open data**

What’s the current traffic in street “X”?  
NGSI Standard API

Street = “X”, traffic = high

Notify me the changes of traffic in street “X”

- The Public Bus Transport Management system
- A sensor in a pedestrian street
- Citizen’s car app or smartphone

updates
Integration with sensor networks

- FIWARE NGSI is capable to deal with the wide variety of IoT protocols today
- Rather than trying to solve the battle of standards at IoT level, it brings a standard where no standard exists today: context information management
Once context information is gathered, a lot of useful complementary FIWARE enablers can be used:

- **Advanced Web-based UI (AR, 3D)**
- **Open data publication**
- **Data/Apps visualization**
- **IoT-enabled Context Information Management**
- **Complex Event Processing**
- **Multimedia processing**
- **Big Data Analysis**
Context Processing and Analysis

Applications

Simple Processing (aggregation, averages, …) Sensor2Things

Complex Event Processing (CEP)

Context Broker

Context Management Processing and Analysis

NGSI-9/10

Programming of rules

BigData Analysis (Hadoop-based)

Context Sources
Data analytics
Open Data publication

Context Sources

NGSI

NGSI standard adapter

Context Broker

Traditional “static” historic data

NGSI

ckan
NGSI resources in CKAN

Santander
Smart Santander Open Data
read more

Followers: 2
Datasets: 10

Organizations
Santander (10)

Show More Organizations

Groups
There are no Groups that match this search

Datasets
Activity Stream
Data Requests
About

Search datasets...

10 datasets found

Tusbic real time
Real time information of bike renting (TUSBIC) stations. Every time a resource is previewed, a query of that station is sent to the Orion Context Broker in order to get the last...

FIXED SENSORS
List of entities which are deployed at static locations of Santander. Each entity provides a sound level measurement and also information about its geolocation, battery...
Target Smart City platform

- Smart city platform as a Data/Knowledge Hub
- Non-intrusive, open to third parties

Specific Enablers

Generic Enablers

- City Services
- Inventory
- GIS
- Rules Definition Tool
- Operational Dashboard
- KPI Governance
- Open Data
- Portals
- Context Broker
- Operational Dashboard
- Short-term historic data
- Big Data
- Accounting & Payment & Billing
- IDM & Auth
- Open Data publishing
- CEP
- Service orchestrator
- Context Adapters
- Real-time processing
- Data Quering/Action, Publish/Subscr
- BI ETL
- Open Data publishing
- IoT Backend
- Device Management
- Real Time Media Stream Processing
- IoT Broker & Config Management (from sensors to things)
- measures / commands
- Media streams
- actuators
- IoT/Sensor
- Open Data

FIWARE
Because it allows your city to join forces with others to build a sustainable market
Why OASC? the chicken & egg dilemma

Cities & Communities

Developers & integrators

De facto standards (platform)
The Open and Agile Smart Cities (OASC) initiative

- Common APIs → FIWARE NGSI to start with
- Standard Data Models → CitySDK and more
- Platform for Open Data/API publication
- Driven by implementation approach

More info:
http://connectedsmartcities.eu/open-and-agile-smart-cities/
Open & Agile Smart Cities initiative principles

Common API (FIWARE NGSI)

Open Platform: FIWARE Driven by Implementation
(Fiware, Fiware Lab, accelerator...)

Open Data (CKAN)

City Model (CitySDK)
Open & Agile Smart Cities initiative principles

Adoption of a lightweight, open-license standard API to gather, publish, query and subscribe to real-time context information describing what’s going on in the city, enabling portability.
Open & Agile Smart Cities initiative principles

Adoption of a flexible, easily-distributable open data publication platform which any organisation can set up at a low cost.

- Open Platform: FIWARE Driven by Implementation
  (Fiware, Fiware Lab, accelerator…)
- Open Data (CKAN)
- City Model (CitySDK)

Common API (FIWARE NGSI)
Adoption of a simple initial standard data model required for effective interoperability when exchanging context information, also portability.
Open & Agile Smart Cities initiative principles

Adoption of a “driven by implementation” approach towards experimental consolidation of initial and new standard data models. The goal is that communities and developers can (1) co-create their services based on basic but commonly-defined data models, (2) influence the definition of new models by implementing and experimenting, and (3) help “curate” existing data models.
The Open and Agile Smart Cities (OASC) initiative

- Coopetion:
  - Competition at platform level
  - Collaboration: de-facto standards (APIs, models)

- Digital Single Market for Smart Cities
  - Portability
  - Interoperability
Launch of the OASC initiative

- 1st wave of OASC cities* announced at CeBIT:
  - Denmark: Copenhagen, Aarhus and Aalborg
  - Finland: Helsinki, Espoo, Vantaa, Oulu, Tampere, Turku
  - Spain: Valencia, Santander, Málaga, Sevilla
  - Portugal: Porto, Lisbon, Fundão, Palmela, Penela and Águeda
  - Belgium: Brussels, Ghent and Antwerp
  - Italy: Milan, Palermo and Lecce
  - Brazil: Olinda (Recife), Anapólis (Goiás), Porto Alegre (Rio Grande do Sul), Vitória (Espírito Santo), Colinas de Tocantins (Tocantins) and Taquaritinga (São Paulo)

- Background document describing the vision

- Cities have to sign a Letter of Intent (LoI) where they:
  - Endorse OASC principles
  - Prove their capacity to implement the principles

(*) Ordered by country and date of incorporation
Open and Agile Smart Cities (2nd wave, Sep 2015)

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<th>FINLAND</th>
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<td>Rio das Ostras</td>
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## Open and Agile Smart Cities (3rd wave, Nov 2015)

### Australia
- Brisbane
- Gold Coast
- Springfield

### Belgium
- Antwerp
- Brussels
- Ghent
- Leuven

### Bosnia and Herzegovina
- Mostar
- Sarajevo
- Tuzla

### Brazil
- Anápolis (Goiás)
- Colinas do Tocantins (Tocantins)
- Olinda (Recife)
- Porto Alegre (Rio Grande do Sul)
- Rio das Ostras
- Taquaritinga (São Paulo)
- Vitória (Espírito Santo)

### Croatia
- Dubrovnik
- Split

### Denmark
- Aalborg
- Aarhus
- Copenhagen
- Vejle

### England
- Bristol
- Leeds
- Manchester

### Finland
- Espoo
- Helsinki
- Oulu
- Tampere
- Turku
- Vantaa

### France
- Amiens
- Arras
- Saint-Quentin
- Valenciennes

### Ireland
- Cork
- Dublin
- Galway
- Limerick

### Netherlands
- Amersfoort
- Amsterdam
- Eindhoven
- Enschede
- Rotterdam
- Utrecht

### Portugal
- Águeda
- Fundão
- Lisbon
- Palmela
- Penela
- Porto

### Scotland
- Aberdeen
- Dundee
- Edinburgh
- Glasgow
- Inverness
- Perth
- Stirling

### Spain
- Guadalajara
- Las Palmas de Gran Canarias
- Malaga
- Murcia
- Sabadell
- Santander
- Sevilla
- Valencia
Open and Agile Smart Cities (4rd wave, Feb 2015)

MOST RECENT CITIES TO JOIN THE OASC INITIATIVE

NEW COUNTRIES:

AUSTRIA - GRAZ, LINZ, SALZBURG, VIENNA

MEXICO - CUAUTLA, LEÓN.

POLAND - GDANSK, GRUDZIADZ.

SLOVENIA - IDRIJA, KOPER

FROM THE EXISTING COUNTRIES:

ENGLAND - MILTON KEYNES, CAMBRIDGESHIRE.

NETHERLANDS - DRECHTSTEDEN.

ITALY - GENOA.
How can standard Smart City data models easing common solutions be defined? The problem

- Existence of a single API (FIWARE NGSI) reduces costs when porting Smart City apps from one city to another

- Without standard data models, Smart City apps would need to come with adapters that transform data made available by the city so that it complies with the data model handled by the app but that has proven to be easy with FIWARE NGSI (overall if NGSI is at both ends)

- Creation of standard Smart City data models would allow to avoid performing this kind of adaptation and make portability of Smart City apps across Smart City platforms a pretty straightforward task

- How creation of these standard Smart City data models can be fostered?
How can standard Smart City data models easing common solutions be defined? The solution

- A “design by committee” approach would not be the best approach:
  - Such kind of approach has proven to be wrong in many other standardization efforts in the past
  - Who grants that the defined model is suitable for what apps need and developers want to have?

- We need a “driven by implementation” approach:
  - Identify real applications that solve a real problem and cities would like to see running in their cities
  - Check what data models they have been designed to work with and take them as input
  - Carry out a “data curation” process where input data models converge into a single common model

- You will end with a set of standard data models and soon a portfolio of killer Smart City apps working!
How are standard Smart City data models going to be defined within the OASC initiative?

- **Leverage on existing work:** CitySDK

- **Leverage on initiatives like the FIWARE Accelerator programme** to identify killer Smart City apps
  - These applications can serve as basis for definition of new Smart City data models
  - Involvement in this process becomes also an incentive for the entrepreneurs to join identified initiatives (“I want to influence the standard so that my app can easily align with it”, “I want to provide one of the first example applications”)
  - There are 80 M€ for entrepreneurs in the FIWARE Accelerator programme that can be put at work!

- **Cities would play a key role:**
  - Their data models will be contrasted/analyzed against those coming from the apps and other cities
  - They would get involved in the data curation process
Smart car navigation: we started with Porto

At SCEWC, taking place in Barcelona from November 17-19, the companies will showcase how real-time open data can be displayed on HERE maps.

The cities of Porto and Aveiro in Portugal, partnering with local SME Ubiwhere, are providing access to data (environmental and events information, and public parking slots information, respectively) using the FIWARE NGSI open standard API (Application Programming Interface).

"FIWARE is an open initiative, targeted to create a sustainable ecosystem that will allow Europe, also other regions who wish to join Europe in this endeavor, to capture the opportunities that will emerge with the new digital wave," explains Jesús Villasante, Net Innovation at the European Commission.

The first cities that joined the Open and Agile Smart Cities (OASC) hack in March this year, Porto has been a pioneer city adopting FIWARE with the support of Ubiwhere, a Portuguese company experienced in the ms. A key instrument in the development of Porto’s open city platform is the as developed under the European funded project Future Cities Project.

The partnership between the University of Porto and the City Council aiming to create a smart city in the city of Porto. A key component in the Citibrain joint- nationwide have developed the contextual environmental its (monitoring stations) augmented by scanners set of vehicles, creating a providers like the city’s rs, social media data and to explore, travel, and to leverage the results of E/OASC-compliant urban

1 Its new integrated management and control center. Another example of the SC initiative, the city of Porto has just created a competition the development of applications on top of its integrated management and control center platform. With this competition, the city, in partnership with 4 large companies (NOS, CEIIA, EDP and EY) will fund up to 4 solutions with a total of 250 thousands of euros available.
Smart car navigation: now extending to other cities

City of Porto

City of Santander
It’s time to execute!

FIWARE Accelerator Programme, other programmes

Solutions coming from major Solution providers

OASC cities

City 1   City k
City 2   ... 
City 3   City n

Standard information models

Transference to Market

App 1 + City 1 + City 3 = Showcase 1
App i + City 2 + City n = Showcase m
Joint FIWARE-TMForum collaboration

TM Forum and FIWARE join forces to speed the development of new smart city services

BY NEWS ROOM | OPEN DIGITAL ECOSYSTEM & IOT 1 NOVEMBER 19, 2015

TM Forum has today announced that it is working with FIWARE, an open cloud-based platform for the creation and delivery of applications and services, to deliver the key building blocks for enabling and connecting smart city ecosystems.

TM Forum is supporting FIWARE NGSI REST-based APIs for real-time access to contextual information for cities. This enables more efficient management of municipal services in areas such as mobility, water, waste, energy and environmental management, and also paves the way for the development of smart applications by third parties.

“Valuable real-time information will be shared across vertical management solutions currently working as silos, while at the same time fueling new innovative services when published as real-time open data,” said Juanjo Hierro, coordinator and chief architect of FIWARE & CTO Industrial IoT, Telefónica. Cities can therefore make better decisions based on data from multiple sources, such as real-time environmental data and traffic management patterns.

In turn, TM Forum’s Ecosystem APIs, including Product Catalog, Product Ordering and Product Inventory, will be incorporated within the specifications and open source reference implementation of the FIWARE Business Framework. This Framework enables the management and the monetization of different kinds of digital assets involving multiple partners. TM Forum’s lightweight REST-based APIs have been crowdsourced from within TM Forum’s diverse membership over the past three years and leverage more than 25 years of TM Forum’s complex management systems expertise in billing, catalog management, service level agreements and policy. FIWARE will launch the new Business Framework, powered by TM Forum’s Ecosystem APIs, at Mobile World Congress 2016.

“Leveraging TM Forum’s APIs and FIWARE’s real-time city data creates a vibrant environment for third party developers to thrive within an open innovative ecosystem,” said Joann O’Brien, vice president of Industry Collaboration, TM Forum.
FIWARE and the European Data Portal are proud to announce the beginning of a collaboration creating synergies between the two initiatives for even better serving users’ needs. Data are the fuel of any smart services and open data in particular are a treasure trove for new services and applications. FIWARE is the European open service platform for building interoperable and smart Internet based services. With growing adoption comes growing demand for access to data. The new European Data Portal launched on 16 November 2015 is the major European data asset available free to use for anybody, with already around 250,000 datasets referenced through a harmonised and multilingual interface. Users are allowed to easily download data at the source or directly consume them through interactive visualization. The collaboration with FIWARE will help bringing these data even closer to the fingertips of the growing open community of thousands of FIWARE developers, startups and new users in Europe and world-wide. In the future the two initiatives will jointly consider ways to harvest the trend towards more real-time open data by using the de-facto standard FIWARE NGSI.

This collaboration among two leading European ICT initiatives shows the interest of the public and private partnership supporting these and, our capacity to set standards and is clearly another step towards a European single digital market.
FIWARE PARTNERSHIP WITH THE NIST GLOBAL CITY TEAMS CHALLENGE 2016 PROGRAM NOW OFFICIAL!

19th November 2015.- FIWARE is proud to announce that the FIWARE’s participation as a Partner in the National Institute of Standards and Technology’s, NIST, Global City Teams Challenge 2016, GCTC 2016, program has been officially confirmed on the 12th November 2015 at the GCTC 2016 Kick-Off Workshop in Gaithersburg, Maryland, USA.

As explained by Jacques Magen, responsible for FIWARE globalization activities (FIWARE Mundus Programme), “FIWARE and GCTC share common objectives in providing cities and their stakeholders with an environment and a program that can help them replicate Smart Cities solutions and services that are efficient and scalable through replicable, standards-based collaborative platforms. This also represents a great opportunity for the FIWARE community to expand its reach internationally and contribute to boost innovation for the development of Smart Cities’ applications and services all over the world”.

“Cities around the world are looking to advanced Internet of Things concepts to make their communities safer, more vibrant, and more livable and workable,” said Chris Greer, Senior Executive for Cyber-Physical Systems at the US National Institute of Standards and Technology. “We can best achieve these goals by working together on interoperable smart city architectures that can serve as the foundation for innovation in cities worldwide and we are pleased to join with FIWARE through our Global City Teams Challenge in an international, cooperative effort.”
FIWARE ecosystem of SMEs/startups in Europe

- Currently total of 831 startups and SMEs
- Good geographical coverage (except France)
- 60% < 5 years experience (14% no experience at all!)
- 60% by small team (< 5 people)
- 63% bring a solution not available in the market
- 45% close to market delivery
- For 30% this is their “first job”
Because it’s not just about technology
Building a successful ecosystem requires ...

Creating a **vibrant community of active contributors** who commit a sustainable investment over time

**FACTS**

- Fully open source platform
- OS community ready since summer 2015

- 7430+ PMs devoted to development activities in 5 years (122/76 M€ of budget/funding)

- Funding opportunities available in several R&D programs during 2017-18 (e.g., Horizon 2020)

- Each FIWARE component is considered strategic in the portfolio of contributing partner

**MOBILE WORLD CONGRESS**

BARCELONA 2-5 MAR 2015

Telefonica, Orange, Engineering and AtoS join forces to push common standards for Smart Cities based on FIWARE platform
Building a successful ecosystem requires …

engaging cities

31 cities from 7 different countries launch the Open and Agile Smart Cities (OASC) initiative committing to adopt common principles:

- Open APIs
- Standard Data Models
- Open Data/APIs publication platform
- Driven by implementation

Now, 89 cities from 19 countries were announced as part of the 4th wave in Puebla.
Building a successful ecosystem requires ...

Bringing incentives for entrepreneurs and developers

**FACTS**

80 M€ in grants to startups/SMEs in the last 2 years (FIWARE Acceleration Programme)

20 M€ to support involvement of 16 accelerators across Europe

3100+ startups/SMEs applied to 1st Open Call of the FIWARE Acceleration programme

1300 startups/SMEs to be funded (~400 as result of 1st Open Call)

FIWARE Acceleration programme now expanding beyond Europe

Opportunity for real showcases with cities
Building a successful ecosystem requires …

Creating a **meeting point** where demand connects to offering and innovation takes place

**FACTS**

FIWARE Lab environment with 3000+ Cores, 16+ TB RAM, 750+ TB HD

2600+ open datasets from cities published and growing fast!

Multiple nodes across Europe

1st node in LATAM deployed in Mexico. New nodes being setup: Brazil and Chile
Building a successful ecosystem requires …

Scale and go global while being able to act local

21 Innovation Hubs in Europe devoted to provide local support

First FIWARE Lab nodes in Mexico and Brazil

1,4 M€ funding assigned to FIWARE mundus activities targeted to build links with US, Mexico, Brazil, Chile, Japan, Canada, Korea, BRIC countries …
FIWARE Mission

- **Goal:** capture opportunities derived from the new wave of digitalization of life and businesses that is coming

- **Strategy:** Build a sustainable innovation ecosystem around open standards supporting development of smart applications in multiple sectors

- **Pillars:**
  - **FIWARE:** a generic, open standard platform which serve the needs of developers in multiple domains
  - **FIWARE Lab:** a meeting point where innovation happens and data providers plus entrepreneurs can be engaged
  - **FIWARE Accelerate:** a program that funds developers and entrepreneurs, and ignites roll-out of the ecosystem
  - **FIWARE Mundus:** reach a global footprint, opening to regions that share the same vision and ambition
  - **FIWARE iHubs:** provide local support to the community
Thanks!

http://fiware.org
http://lab.fiware.org
http://www.youtube.com/user/fiware
@FIWARE