



# Measurable cities, smart cities and cultural heritage

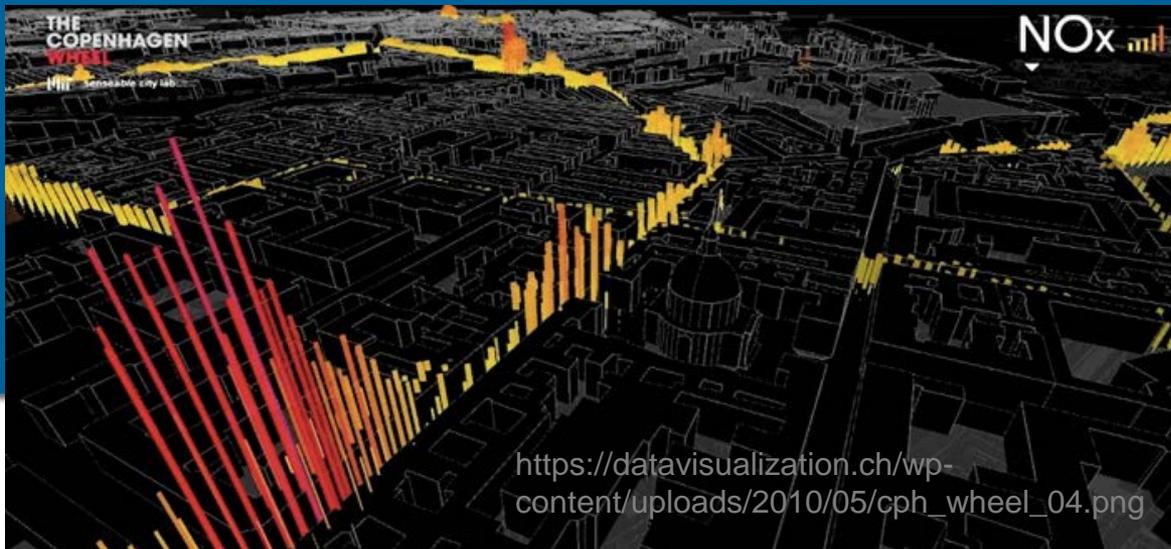
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IEEE IoT Initiative Chairman, Telecom Italia Lab

# Abstract

- ▶ Internet of Things is promising to be a set of technologies able to have a high impact on how people live, produce, modify and interact with the environment. Such a transformation is driven by increasing technologies capabilities of sensors/actuators, communications, general purpose hardware, availability of software and programmability of devices. The integration of so different technologies is a problem in itself and IoT is also trying to solve cogent issues of specific problem domains, such as e-health, transportation, manufacturing, and so on. Smart cities stand on their own because the *smartness* requires integration of different technologies, processes and different administrative domains creating the needs to see the city as a large complex system. In addition to technological and problem domain specific challenges, there exist further challenges that fall in business, social and regulation realms. They can greatly impact the deployment and the success of IoT deployment within smart cities. The speech aims is to provide a view on some major **technologies challenges of IoT** and to cover a few **critical business and social issues** that could hamper the large deployment of IoT systems within smart cities by providing some examples related to the **creation of a future city that leverages its cultural heritage and specific needs** as Venice.

# Cities and the Quest For Data

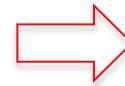


# How do we understand and reason about Cities ?

## THE CITY, TECHNOLOGY, AND HISTORY\*

PAUL MEADOWS

University of Nebraska



The City, Technology, and History

Paul Meadows

*Social Forces*

Vol. 36, No. 2 (Dec., 1957), pp. 141-147

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[https://www.jstor.org/stable/2573850?seq=1#page\\_scan\\_tab\\_contents](https://www.jstor.org/stable/2573850?seq=1#page_scan_tab_contents)

### THE APPROACH THROUGH INTRA-URBANISM

OVER two decades ago a leading United States urban sociologist, Professor Niles Carpenter, opened a discussion of urban sociology with this statement: "Recent trends in the field of sociology might be epitomized in a four-word phrase—the quest for data."<sup>1</sup> In retrospect, one might, while accepting the importance of this empirical bent, still ask the elementary question, data about what? So far as urban sociology is concerned, it is perfectly obvious that so long as it is data about some relationship concerning social life within the American city—whether trend, stage, cause-effect, fact-implication, problem-policy—which is to be discovered, nothing else has ever seemed to count. Urban sociology has been and is yet literally (and without reservation apparently) the sociology of life within the city.

This approach to urban sociology, which we may designate as the sociology of intra-urbanism because of the manner in which social phenomena are interpreted solely in terms of the city itself, has been characterized by both purely intellectual as well as markedly pragmatic interests. As an intellectual curiosity, urban sociology represents

the emergence of the city as in itself a legitimate object of sociological study. The city is *sui generis*: hence, the sociology of city life. This perspective was proclaimed in an extraordinarily influential volume of papers published by the University of Chicago Press in 1924: *The City*, edited by R. E. Park, E. W. Burgess, and R. D. McKenzie. The theoretical position taken by these authors is indicated in the initial paper by Professor Park: "The City: Suggestions for the Investigation of Human Behavior in the Urban Environment." The subsequent ecological, personality, and institutional investigations of a generation of urban sociologists are foreshadowed in some of the other papers in this volume: McKenzie's "The Ecological Approach to the Study of the Human Community"; Park's "The Mind of the Hobo," and his famous paper on the metropolitan daily newspaper. Since then, the classroom texts in urban sociology<sup>2</sup> follow rather closely this thematic organization of this field. The much later, masterful essay by Professor Louis Wirth, summarizing and organizing the theory of a sociology devoted to the study of intra-urbanism and significantly titled "Urbanism as a Way of Life,"<sup>3</sup> has been one of the

<sup>2</sup> For example, compare Nels Anderson and E. C. Lindeman, *Urban Sociology* (New York: F. S. Crofts, 1930) and T. L. Smith and C. A. McMahon, *The Sociology of Urban Life* (New York: Dryden Press, 1941).

<sup>3</sup> *American Journal of Sociology*, 44 (July 1938), pp. 1-25.

\* Read at the Seventh Annual Congress of Sociology of the Mexican Association of Sociology, December 3-7, 1956, Universidad de Nuevo Leon, Monterrey, Mexico.

<sup>1</sup> In L. L. Bernard (ed.), *Fields and Methods of Sociology* (New York: Long and Smith, 1934), p. 328.

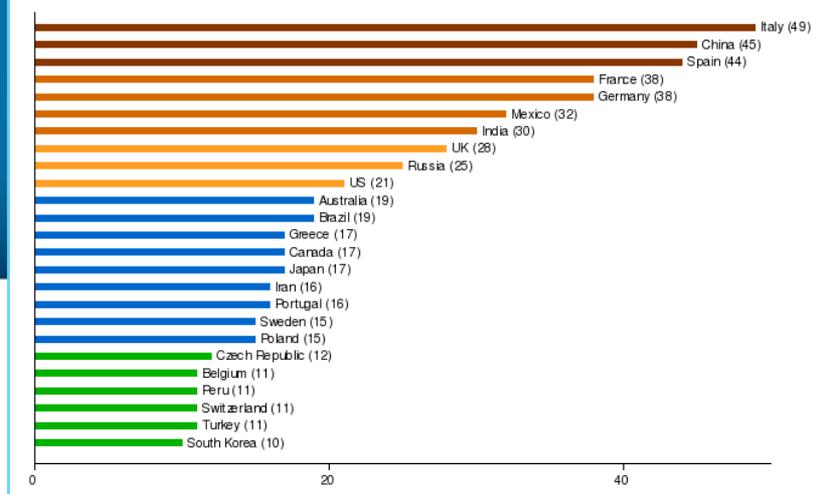
# What Kind of Data we need for understanding a City?

- ▶ Flow related measures
  - People, cars/vehicles/trains/airplanes, goods, ...
  - Money, phone calls, ...
- ▶ Status of city resources
  - Air, water, heating, ...
  - Pollution
  - Building and general infrastructures (lightning, gas, traffic lights, ...)
- ▶ Ecosystem measure
  - How the city relates to other cities and the territory around
- ▶ Economical measures
- ▶ Events and activities
  - Concerts, trade shows, political meetings, ...
- ▶ People Personal Data and Profile
  - A very «difficult» issue
- ▶ ...
- ▶ History and Cultural Heritage
  - Of the City and the surroundings



# Why Cultural Heritage is important in Italy – a few indicators

- ▶ Italy is at the first place in the World for the presence of sites defined as World Heritage by UNESCO but it is at the fifth place as touristic destination
- ▶ Italy is visited each year by 90 millions of tourists (50% from abroad) and this is a revenue source for over 100 B euro
- ▶ The tourism industry in Italy gives a job to up 2M of people
- ▶ Venice and its Lagoon is a World Heritage Site:
  - About 1,5 M of «arrivals» in the City in the 1H2013
  - Typically a short stay



| CITTA' D'ARTE                 |             | GENNAIO-LUGLIO   |                  |             |
|-------------------------------|-------------|------------------|------------------|-------------|
|                               |             | ARRIVI           | PRESENZE         | P.MEDIA     |
| <b>VENEZIA</b>                | <b>2013</b> | <b>1.434.476</b> | <b>3.646.939</b> | <b>2,54</b> |
| <b>CENTRO STORICO</b>         | <b>2012</b> | <b>1.431.915</b> | <b>3.582.601</b> | <b>2,50</b> |
| differenze assolute           |             | 2561             | 64338            | 0,04        |
| differenze percentuali        |             | 0,18%            | 1,80%            |             |
| <b>MESTRE</b>                 | <b>2013</b> | <b>887.881</b>   | <b>1.579.002</b> | <b>1,78</b> |
| <b>E MARGHERA</b>             | <b>2012</b> | <b>811.725</b>   | <b>1.444.559</b> | <b>1,78</b> |
| differenze assolute           |             | 76.156           | 134.443          | 0,00        |
| differenze percentuali        |             | 9,38%            | 9,30%            |             |
| <b>VENEZIA (NO LIDO)</b>      | <b>2013</b> | <b>2.322.357</b> | <b>5.225.941</b> | <b>2,25</b> |
|                               | <b>2012</b> | <b>2.243.640</b> | <b>5.027.200</b> | <b>2,24</b> |
| differenze assolute           |             | 787.17           | 198.741          | 0,01        |
| differenze percentuali        |             | 3,51%            | 3,95%            |             |
| <b>RIVIERA DEL BRENTA (*)</b> | <b>2013</b> | <b>125.000</b>   | <b>206.607</b>   | <b>1,65</b> |
|                               | <b>2012</b> | <b>124.140</b>   | <b>206.421</b>   | <b>1,66</b> |
| differenze assolute           |             | 860              | 186              | -0,01       |
| differenze percentuali        |             | 0,69%            | 0,09%            |             |
| <b>TOTALE</b>                 | <b>2013</b> | <b>2.447.357</b> | <b>5.432.548</b> | <b>2,22</b> |
|                               | <b>2012</b> | <b>2.367.780</b> | <b>5.233.621</b> | <b>2,21</b> |
| differenze assolute           |             | 79577            | 198927           | 0,01        |
| differenze percentuali        |             | 3,36%            | 3,80%            |             |

**(\*) RIVIERA DEL BRENTA - Comprende i comuni di Dolo, Fiesco d'Artico, Mira, Stra, Vigonovo e Vidor.**

# Nice Places, but what are these (ruins)?

(and why should I care ... apart from writing in the walls ...

«Roberto was here»)



[http://it.123rf.com/archivio-fotografico/ostia\\_antica.html?media\\_popup=61625210](http://it.123rf.com/archivio-fotografico/ostia_antica.html?media_popup=61625210)

We will come back to these later on ...



<http://www.panoramio.com/photo/72521167>

# Let's go to Venice. What do you typically visit in Venice ?



Basilica di San



Piazza San  
Marco



Palazzo  
Ducale



Campanil  
e di San  
Marco



Canal Grande



Ponte di Rialto



Ponte dei  
Sospiri

You get a bit of this ...

# A lot of this: a standard tourist experience



Many people follow recommendations or the “usual” path

# ... A lot more of this ...



A «where to pee» app in Venice is actually needed (even with a function for booking the toilet)!

## DYING FOR A PIAZZA Brit slammed by Italian papers after being caught on camera peeing in Venice's iconic St Mark's Square

The woman was snapped by a furious gondolier as he went past in his boat

EXCLUSIVE | THE DAILY POST | 22nd August 2016, 10:04 pm



THIS is the shocking moment a British tourist was caught peeing in one of the world's most famous locations.

The woman dropped her trousers by Venice's iconic St Mark's Square in broad daylight and in full view of tourists and passers by.



The giraffe was snapped by a furious gondolier

Standing just yards from the luxury five-star Hotel Danieli the woman was snapped by a furious gondolier as he went past in his boat.

A local shopkeeper said: "The gondolier shouted at her to stop and she swung back at him in English. She wasn't very polite at all but I don't blame him for having a go at her."

"There was a street of bars up the road and a public convenience nearby she could have gone in there. This sort of behaviour is ruining the city."

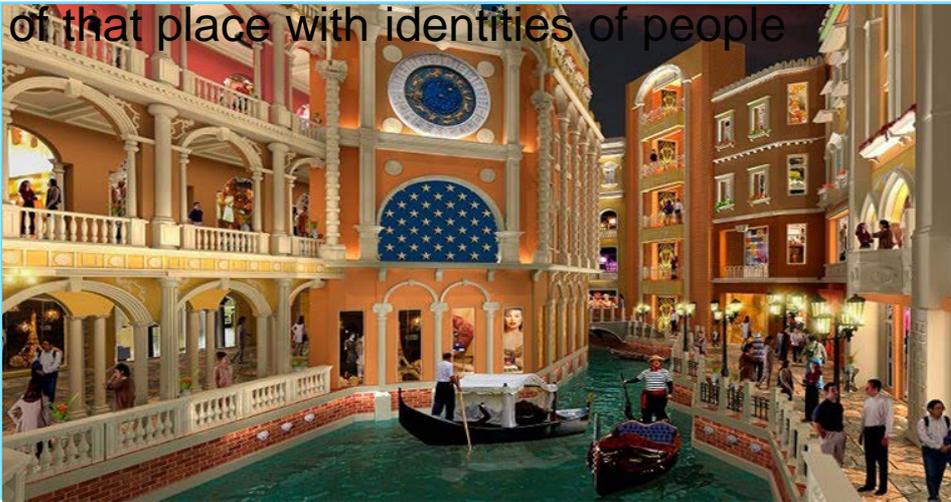
# All very focused on a small part of the City



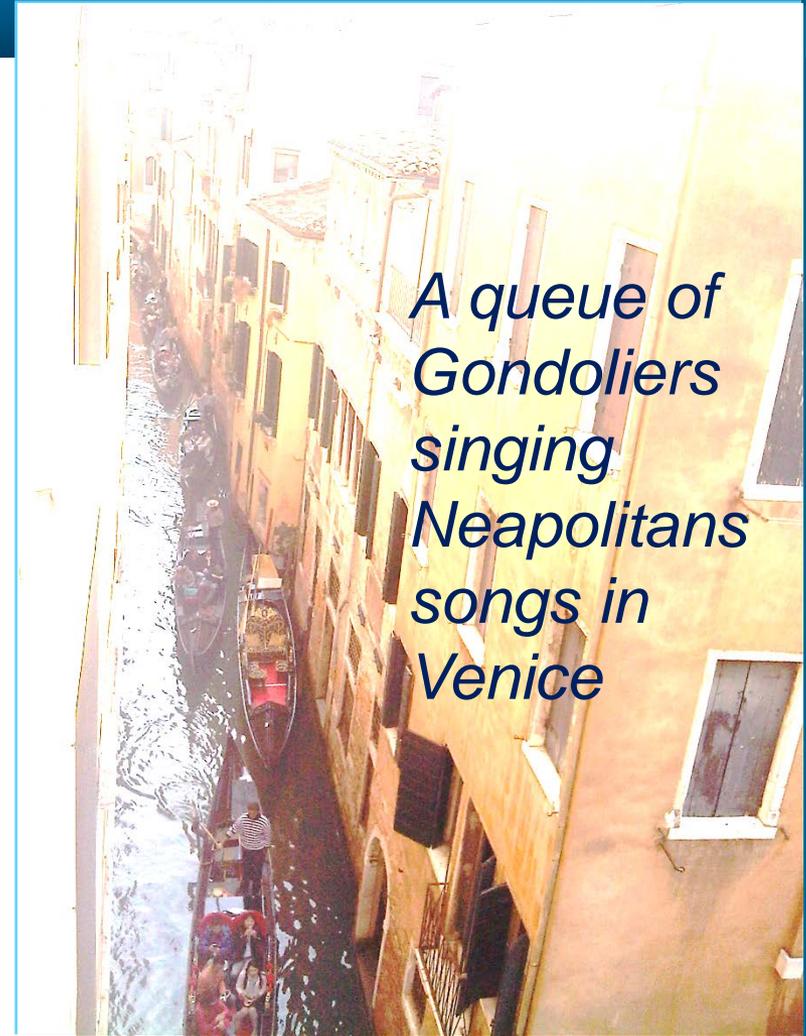
# The Identity of a «Place»

All Places look alike !! They are «no places» actually  
All places have a standard pattern for visiting

We need to support a rediscovery of Place Identities and we need to relate the identity of that place with identities of people



*Venice or Las Vegas ?  
And Las Vegas is cleaner ...*



*A queue of  
Gondoliers  
singing  
Neapolitans  
songs in  
Venice*

# Here we are again ....



[http://it.123rf.com/archivio-fotografico/ostia\\_antica.html?media\\_popup=61625210](http://it.123rf.com/archivio-fotografico/ostia_antica.html?media_popup=61625210)

Ostia – the ancient  
Rome Harbour

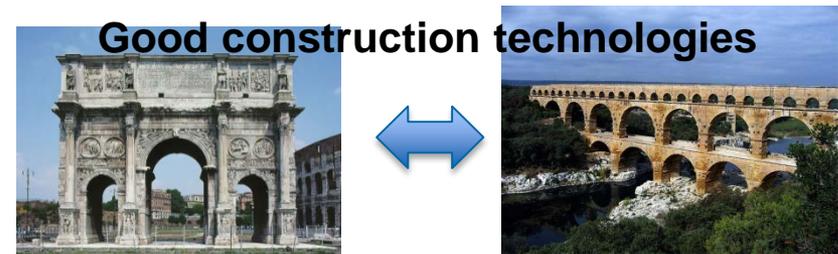
Venice – the external  
walls of the Arsenal



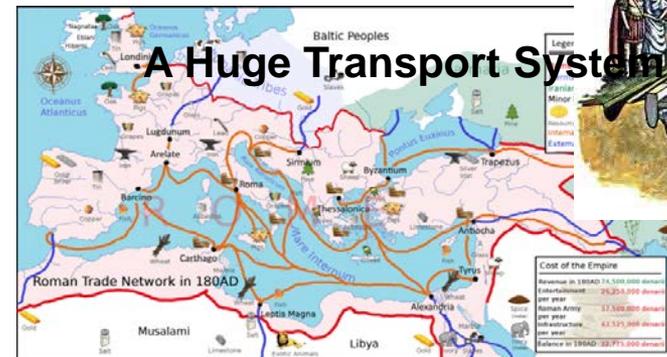
<http://www.panoramio.com/photo/72521167>

# The City and Its Ecosystem – Ancient Rome

- Rome was by far the largest City of the Empire (and in the world)
- All the economy was built around it → the first SMART City?
- It was a kind of magnet, attracting business from every part of the empire and beyond
- The city developed huge logistics, transportation and water systems to support itself
- The Ostia Harbor was a central knot of this system



The Roman Road



# Ostia Harbour ... and more



- Ships arriving in Ostia were unloaded and goods sent to Rome either by road (via Ostiense) or by the river
- Monte Testaccio (also known as Monte dei cocci) is an artificial mound in Rome composed almost entirely of testae (Italian: cocci), fragments of broken amphorae dating from the time of the Roman Empire. It was close to the fluvial harbour and the oil warehouses

L'autrice dell'opera di ricostruzione del porto antico è Viviana Meucci (Viviana Meucci: [www.focemicina.it](http://www.focemicina.it))

For long stops in Fiumicino, Alitalia was offering a free visit to the old harbour. Did you take your chance ?



# The Arsenal (Did you visit it?)

- The term Arsenal derives from the Arab word *daras-sina'a*h, i.e., home of industry
- The Arsenal was occupying up to 16000 workers (a large % of the entire population)
- It was the precursor of the factory concept, actually in the XVI century it was the biggest factory in the world
- They changed the way Ships were built using extensively the «frame first» technology reducing the time to build
- Galileo was a «consultant»
- Here they invented the Bombard
- It was instrumental for the success of Venice as a commercial and military Mediterranean power
- It had a very strategic role (in fact Napoleon greatly reduced it and



Painting of Canaletto



Squero delle Gagiandre

# Cultural Heritage and Data



[http://cdn2.hubspot.net/hub/188705/file-399394244-jpg/images/history\\_of\\_data\\_room\\_pricing.jpg](http://cdn2.hubspot.net/hub/188705/file-399394244-jpg/images/history_of_data_room_pricing.jpg)

# Cultural Heritage and the Quest for Data

- ▶ We need to capture data that span over time and tell a compelling story ...
  - Understanding the past and
  - Framing (history and data) in the current world
- ▶ See for instance Venice Time Machine from EPFL
  - Collection of all historical data and then creation of linkage between this huge archive of histories
  - <https://www.youtube.com/watch?v=QTBkuyFbIz0>
- ▶ Useful for historians but useful to Citizens and Visitors
- ▶ Extracting data not only from documents but also from other «information»
  - A similar approach applicable to buildings, artifacts, oral tradition, music
  - ...
- ▶ This means ...

# A different approach to data

- From Wikipedia: Spime is a neologism for a futuristic object, characteristic to the Internet of Things, that can be tracked through space and time throughout its lifetime. They are essentially virtual master objects that can, at various times, have physical incarnations of themselves. An object can be considered a spime when all of its essential information is stored in the cloud. Bruce Sterling sees spimes as coming through the convergence of six emerging technologies, related to both the manufacturing process for consumer goods, and through identification and location technologies. Depending on context, the term "spime" can refer to both—the archetype, as designed by the developer, or a user-specific instance of it.
- Data representing an historical object is then **a set of triplets**
  - **(value + location + time)**
- Plenty of (virtual reality) applications become immediately possible
- By the way I think IEEE should be in the forefront of this «for the benefit of Humanity» !!!

# A few Experiences (1)

- ▶ Fulvio Dominici started [www.ultramundum.org](http://www.ultramundum.org) with the goal of providing new solutions for the immersive presence
- ▶ It is based on an intuition: adding the TIME dimension to the 3D Virtual World
  - Possibility to surf and experience environments as they are now or back in time
  - Creation of personalized Worlds
- ▶ Users will spend more time in virtual worlds than in real worlds
- ▶ Practical Applications:
  - Cartography for Turin Olympic games



# A few Experiences (2)



<http://hyperrhiz.io/hyperrhiz12/augmented-maps/2-forster-metzger.html>

Time Window Weimar': Students Map their Town's History through Augmented Reality

# A few Experiences (3)

## App Mobile



### **Augmented Reality**

Virtual reconstruction of the main places in the most important moments of their history (paintings, photos, movies)



### **Audio**

Voiceover describing the places visited and pulling out the sensations, reading passages from authors of the past and present



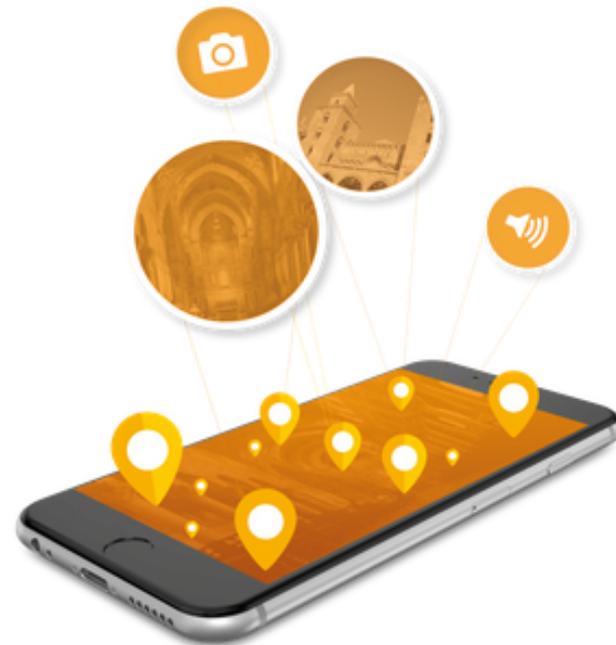
### **Google Maps**

A map identifying the route and its points of interest (monuments and historical events)



### **Camera Device**

The user shall interact with the system and the Facebook community through the camera device



<http://www.smartheritageproject.com/?lang=en#app>

# Build your own APP with NEARBY function of Wikipedia



- Pagina principale
- Ultime modifiche
- Una voce a caso
- Vetrina
- Aiuto
- Comunità
  - Portale Comunità
  - Bar
  - Il Wikipediano
  - Fai una donazione
  - Contatti
- Strumenti
  - Puntano qui
  - Modifiche corrette
  - Carica su Commons

Accesso non effettuato | discussioni | contributi | Registrati | Entra

Voce | Discussione | Leggi | Modifica | Modifica wikitesto | Cronologia | Ricerca

Wiki Loves Monuments: fotografa un monumento, aiuta Wikipedia e vinci!

## Monte Testaccio

Da Wikipedia, l'enciclopedia libera.

Il **monte Testaccio**, in latino *Mons Testaceus*, popolarmente noto come **monte dei Cocci**, è una collina artificiale a Roma di circa 36 m di altezza, vera e propria *discarica* specializzata di epoca romana. È infatti costituita da strati ordinatamente disposti di cocci provenienti da più di 53 milioni di anfore per la maggior parte olearie. I contenitori di terracotta, scaricati dal vicino porto fluviale sul Tevere, una volta svuotati dal contenuto, venduto sul mercato capitolino, venivano lì gettati. Il nome deriva dal termine latino *testae*, ossia "cocci". Il colle si trova tra le mura aureliane e la sponda sinistra del Tevere, nell'omonimo XX rione di Roma, Testaccio.

Coordinate: 41.875952°N 12.475694°E (Mappa)

Una sezione riordinata degli strati di cocci

Indice [nascondi]

- 1 Storia
- 2 Descrizione
- 3 Note

Many objects in Wikipedia have spatial coordinates

There is a Nearby search function

<https://en.m.wikipedia.org/wiki/Special:Nearby>

And an API definition:  
<http://blog.wikimedia.org/2013/01/31/geodata-a-new-age-of-geotagging-on-wikipedia/>

Browser address bar: <https://en.m.wikipedia.org/wiki/Special:Nearby#/search>

Search bar: Search Wikipedia

### Nearby

- Palazzo delle Albere, Trento**  
330 m
- Stadio Briamasco**  
390 m
- Trento**  
Italian city in the North-East of the country  
620 m
- Roman Catholic Archdiocese of Trento**  
archdiocese  
620 m
- Trento Cathedral**  
cathedral  
970 m

# ICT and Cultural Heritage



Smart **Heritage**

<http://www.smartheritageproject.com/demo/wp-content/uploads/2013/06/logo22.png>

# Why working on the Cultural Heritage

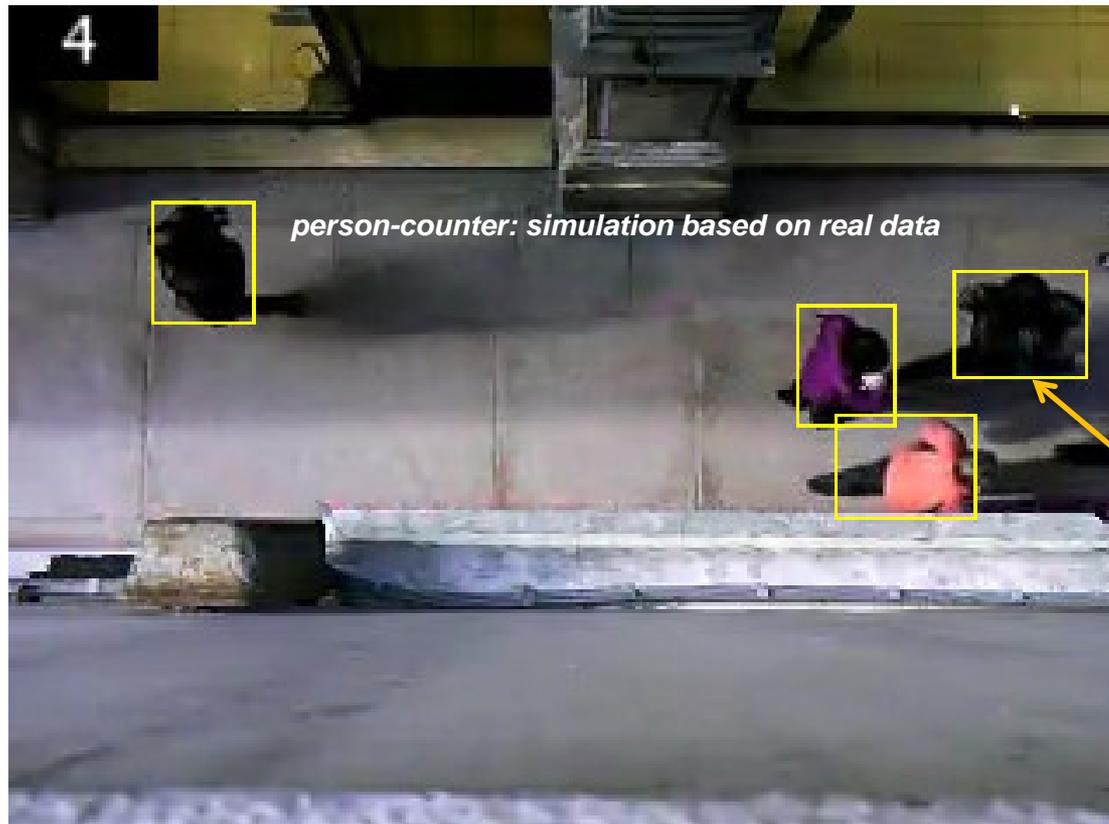
- ▶ An important area for the development of ICT solutions
- ▶ An important contribution to the development of Italy and other Countries
- ▶ Opportunity to experiment new approaches integrating Big Data, IoT and History
  - What if each object in the world could tell his story...
- ▶ Possibility to create a vast ecosystems and nurture a business around it

# How contribute to the Leverage of Cultural Heritage

- ▶ Two major lines of work
- ▶ **Digital Humanities**, i.e., studies and initiatives to collect, preserve and make available the rich Cultural Heritage of Italy (and Venice in particular)
  - Big Data for Cultural Heritage
- ▶ **Smart Cities**, i.e., the availability of data describing the city
  - First a Measurable City
  - Then usage the data in order to control the city and make it smart
  - Finally Virtual Continuum

# Measurable City: Counting people without infringing Privacy

*The Future Centre in Venice is working at the monitoring in quasi real-time on the pedestrian flows in the city center. The goal is to measure the pedestrian traffic and keeping the anonymity and privacy of users. The project has been using low-cost sensors and devices (50-100 euros) with a small size (two cigarette packs) in order to acquire video flows of passing by people and to process it locally without any leak or privacy violation. These devices will provide their Id, the time and the number of people that have been detected. Ideally these objects could be scattered in many places of the city and freely transit their data (e.g., through twitter). In such a way, interested developers could crate new applications based on these data..*



Is it a person or a shadow ?

# Actually a (Smart) City is a Complex System [interacting with other Complex Systems → a Network of Complex Ssystems]

- Michael Batty in “Cities as Complex Systems: Scaling, Interactions, Networks, Dynamics and Urban Morphologies” available at <http://discovery.ucl.ac.uk/15183/1/15183.pdf>
- Luis Bettencourt: Cities as Complex Systems available at <https://www.youtube.com/watch?v=JTZ6onbPjWk>
  - Heterogeneity: diversity of people and Organizations
  - Interconnectivity: Everything is connected in Networks
  - Scaling: Cities of different sizes have different problems
  - Circular - Causality: Cause and Effect are mixed
  - Development: Cities change in open-ended ways
- We don't know exactly what happens when we introduce new technologies in a City

# The impact of technologies on the City: The Freedom Bridge example

Ponte della Libertà, i.e., the Freedom Bridge



Every day in Venice almost 200 K people are in the city , even if only less than 60K of Venice live in here

It is more than 140K transits: it is not only tourists, it is commuters: students and workers.

A lot of people have left the city for the mainland. And the city has lost not only citizens, but also a part of its identity.

How this happened ? Because of a Bridge!!!

The Liberty Bridge has introduced a «Semiotic breakdown»: instead of bringing in modernization, it has brought the «symbolization» of Venice. A different proposal: to close the cars and trains (and its asphalt) and to make it a cycle track forcing people to live in Venice

<http://www.linkiesta.it/blogs/cultura-rete-il-blog-di-venezia-2019-salone-europeo-della-cultura/l-alba-di-una-nuova-venezia->

Wikipedia: **Ponte della Libertà** is a road bridge connecting the historical center of the city of Venice to the mainland.

Designed in 1932 by engineer Eugenio Miozzi, and opened by Benito Mussolini in 1933 as **Ponte Littorio**, the bridge is the only access for road vehicles to the historical center. It is built alongside the Venice Railroad Bridge, which was constructed in 1846 by Austrian, with two tracks each way, and is still in use.

# Models to measure a City

## ► Gravity Model

$$\langle T_{ij} \rangle = k P_i P_j / (c_{ij})^2$$

See <http://www.spatialcomplexity.info/files/2011/10/Spatial-Complexity-Lecture-6.pdf>

## ► Radiation Model

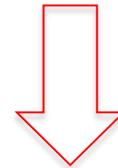
$$\langle T_{ij} \rangle = T_i \frac{m_i n_j}{(m_i + s_{ij})(m_i + n_j + s_{ij})},$$

universal model  
for mobility and migration patterns. Nature, 484(7392), 96-100. Available at  
<https://arxiv.org/ftp/arxiv/papers/1111/1111.0586.pdf>

# How do we get the data then?

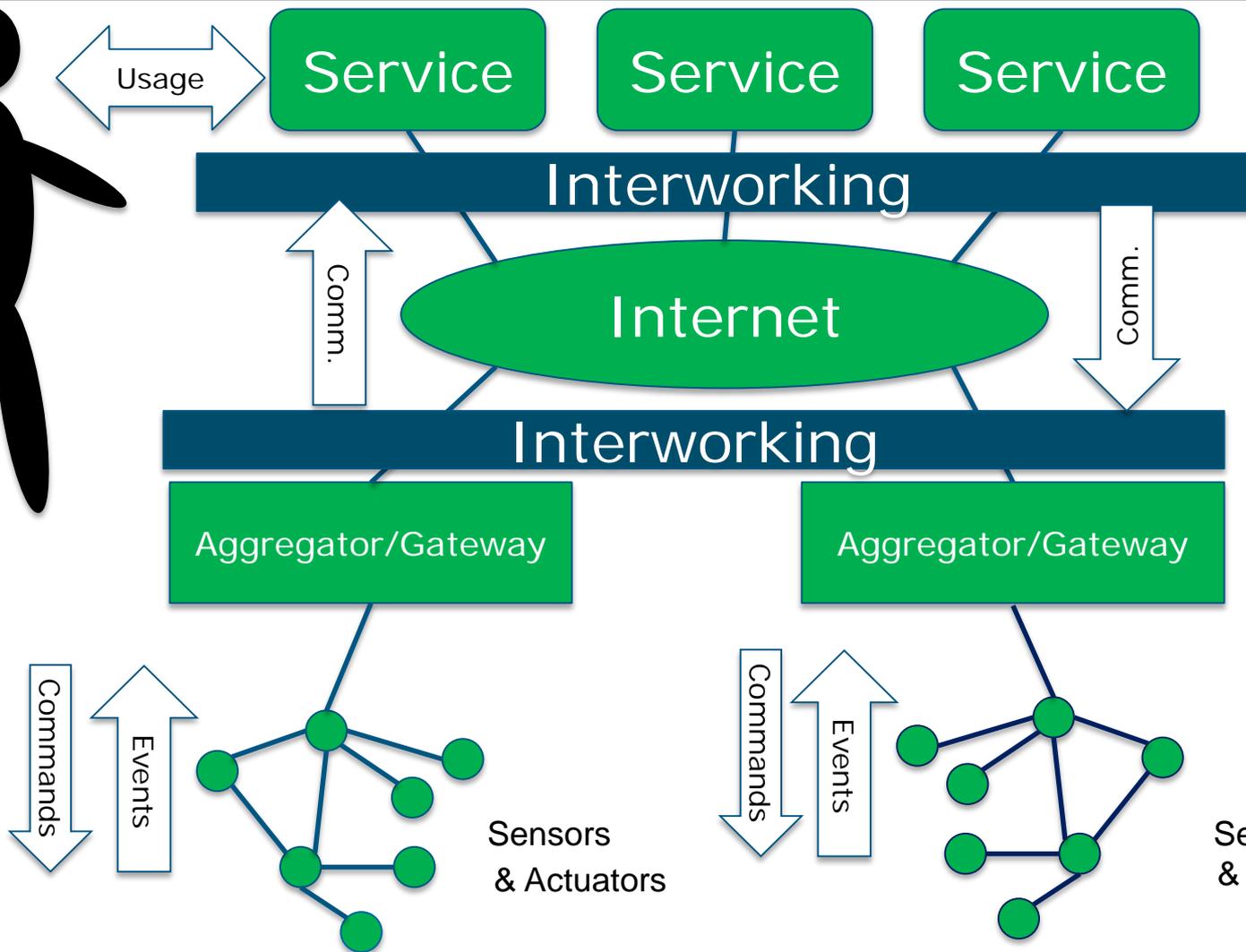
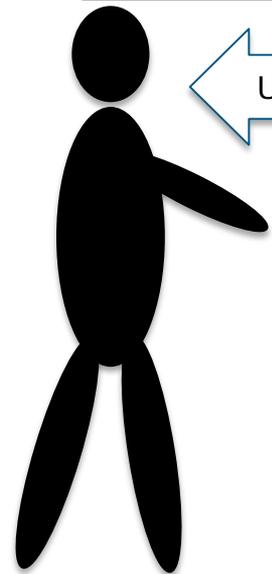
- ▶ Open Data is ok ... but
- ▶ A Measurable City is made out of thousands of information coming from Databases, or generated in Real-Time typically by **Sensors** that provide millions of data per second
- ▶ Data may be:
  - Events
  - Continuous flows of simple data
  - Update to existing data bases
  - Inferred data
  - ...

Sensors



Internet of Things + BigData

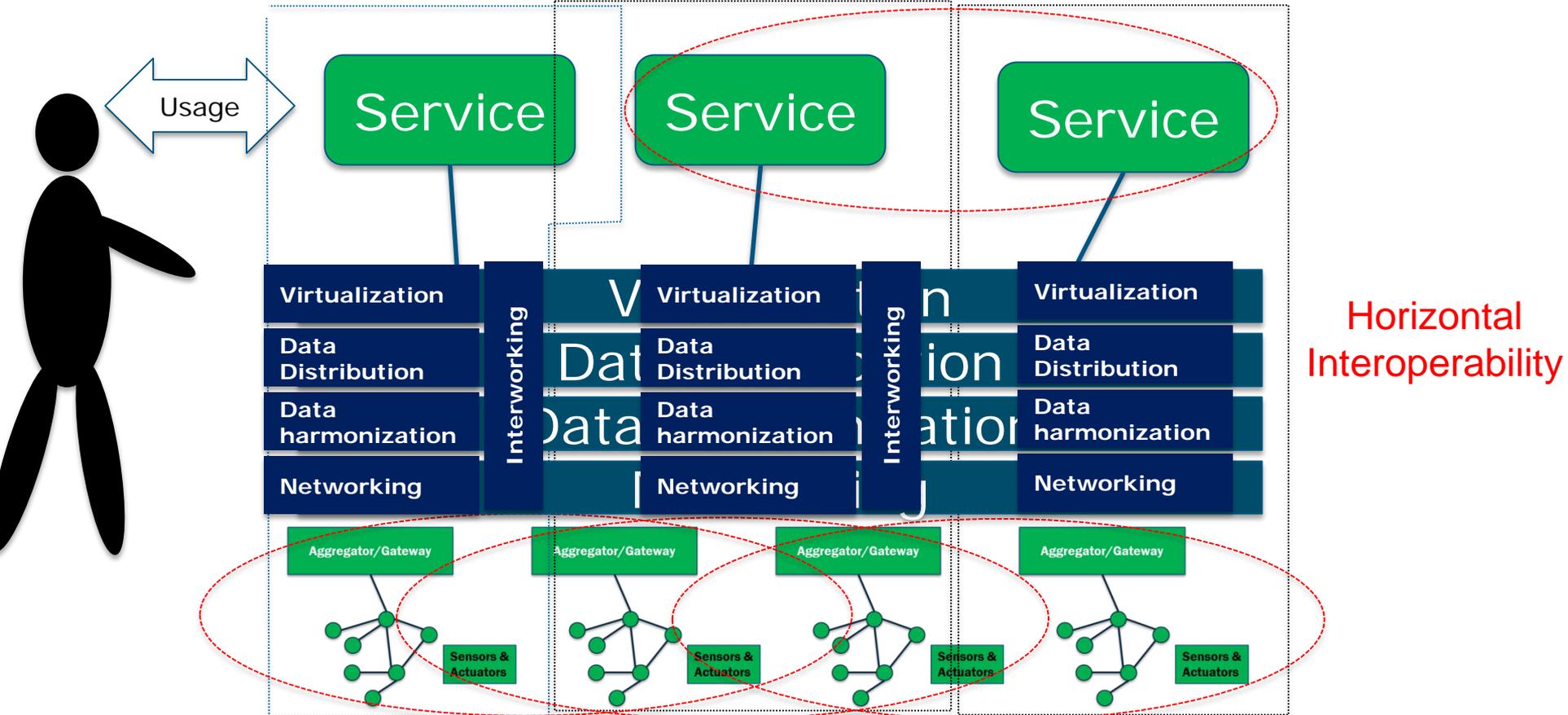
# What Internet of Things is (a simple view)



Vertical Interoperability

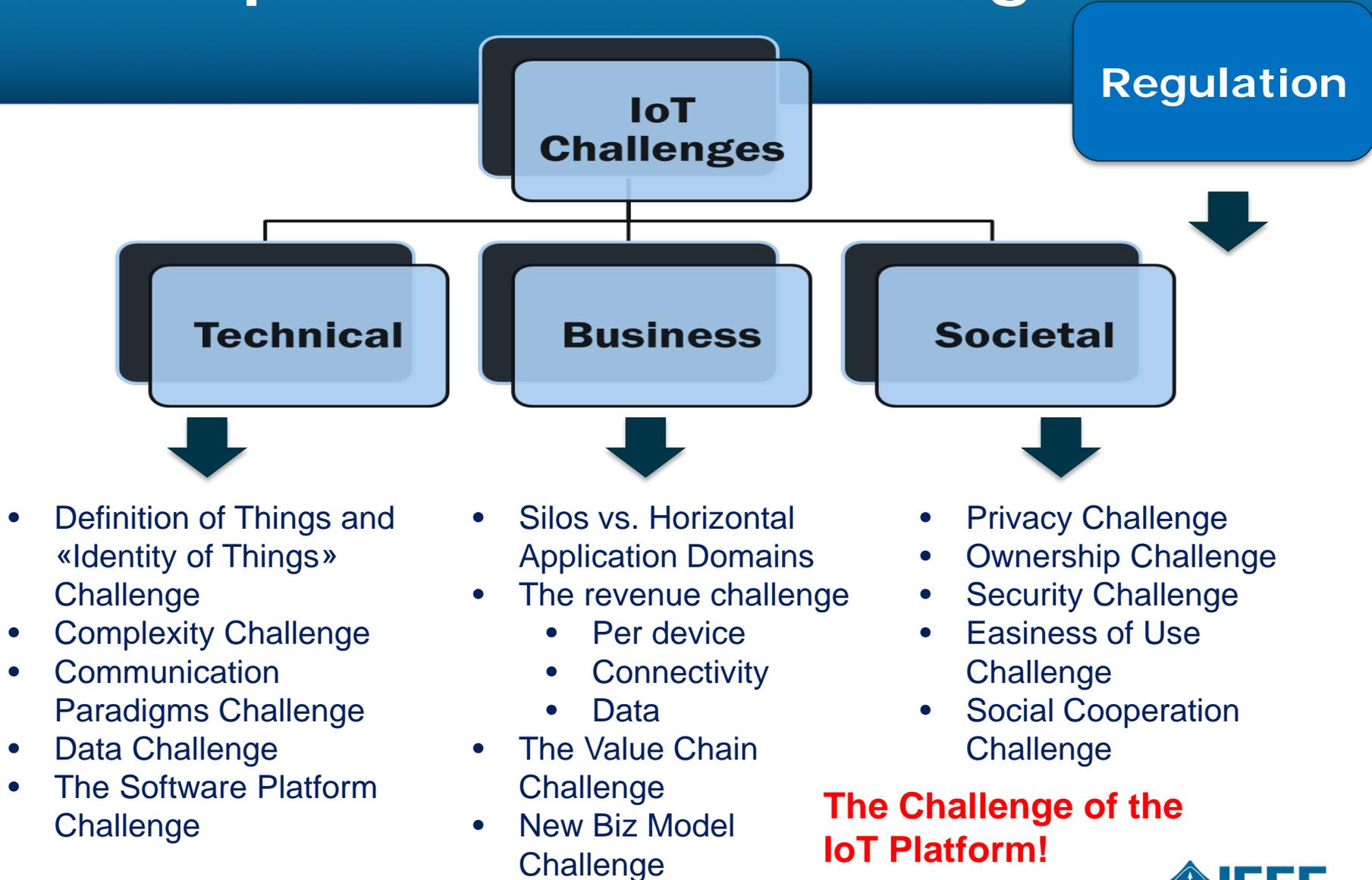
# What Internet of Things actually is

(an this is a simplistic view as well 😊)



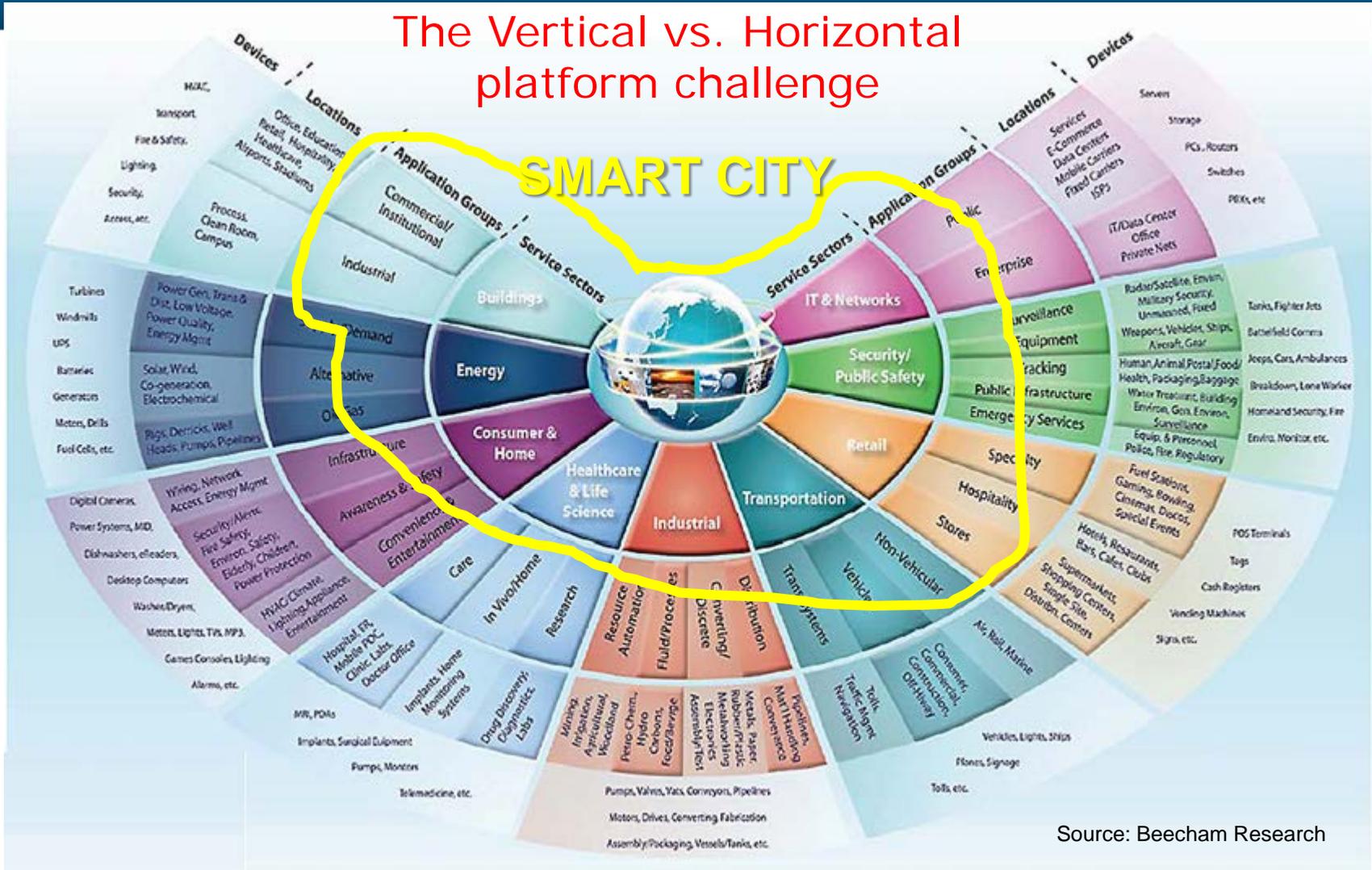
Different Administrative Domains

# IoT implies a lot of Challenges



# The Challenge of the IoT Platform!

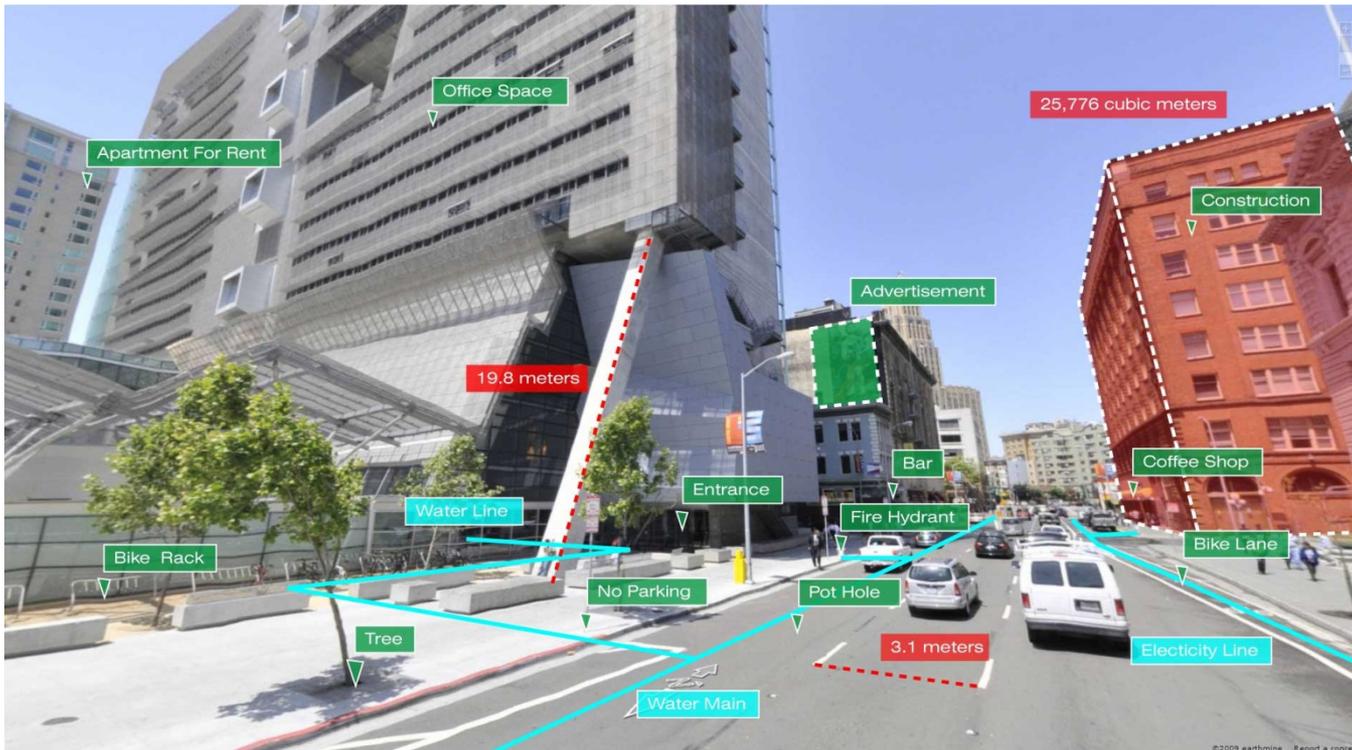
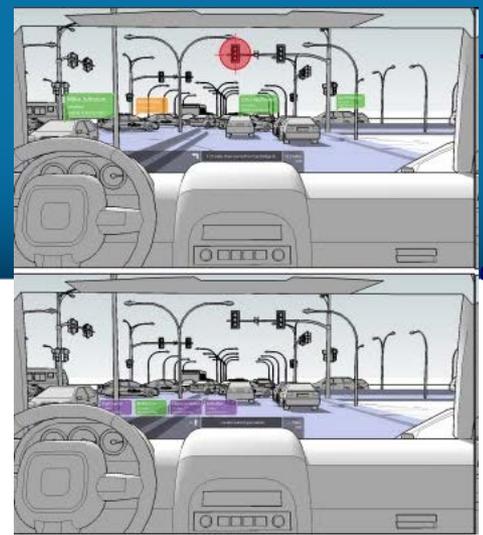
The Vertical vs. Horizontal platform challenge



Source: Beecham Research

# Example of Social Issues

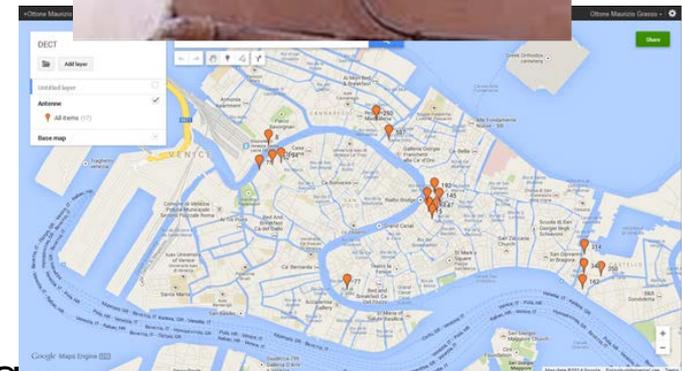
How much **PERSONAL** information could a **CITY** need/generate/provide/manipulate ?



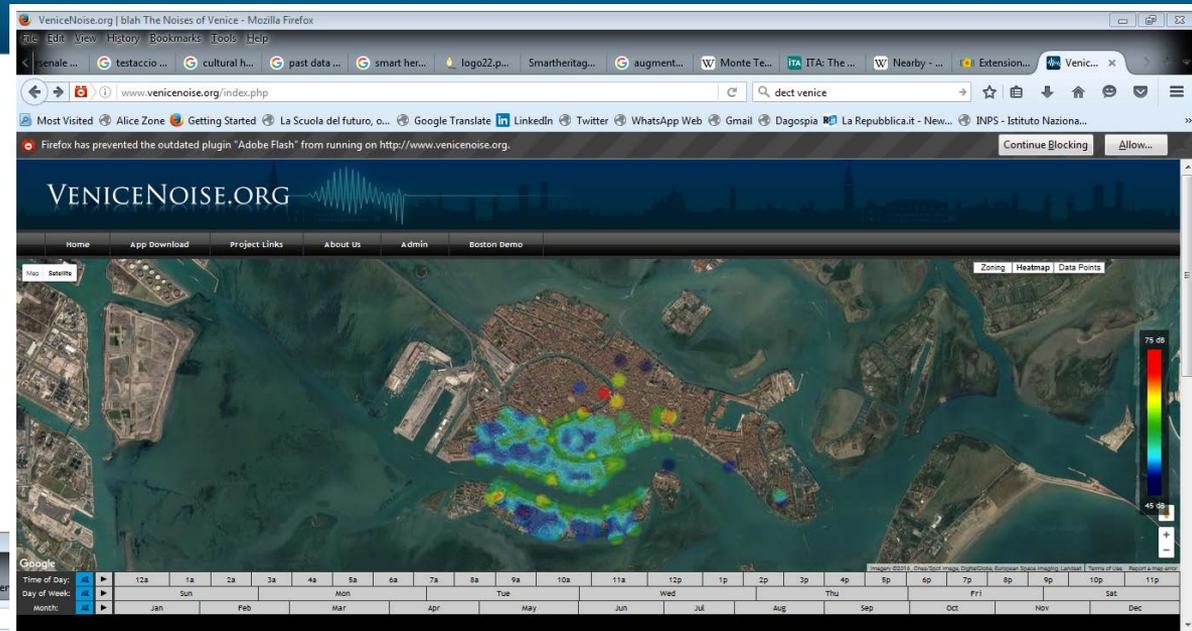
What is the **PERSONAL** contribution that a single citizen could give without been tracked ?

# Why crowdsourcing ? Deploy IoT on a large scale is difficult!!!

- ▶ Deploying and maintain sensor networks is costly!! Finding a sustainable Business Model is difficult
  - Specific applications can be viable but ...
    - They are Vertical and Closed applications
    - Sharing of data is not an option for owners
- ▶ Reuse of Existing Infrastructure
  - Many «Operators» have infrastructure that could be instrumented with sensors and other equipments in order to measure the City
  - We considered to launch a Challenge to Universities for reusing existing capillary infrastructure
- ▶ Crowdsensing is exploiting the user's Terminal power and it is easier to manage. It gives results if there are many engaged terminals ...



# Crowdsourcing in Venice



The screenshot shows the VeniceNoise.org website in a Mozilla Firefox browser, specifically the 'App Download' section. The page features a navigation menu with links for Home, App Download, Project Links, About Us, Admin, and Boston Demo. The main content area is titled 'App Download' and contains the following text:

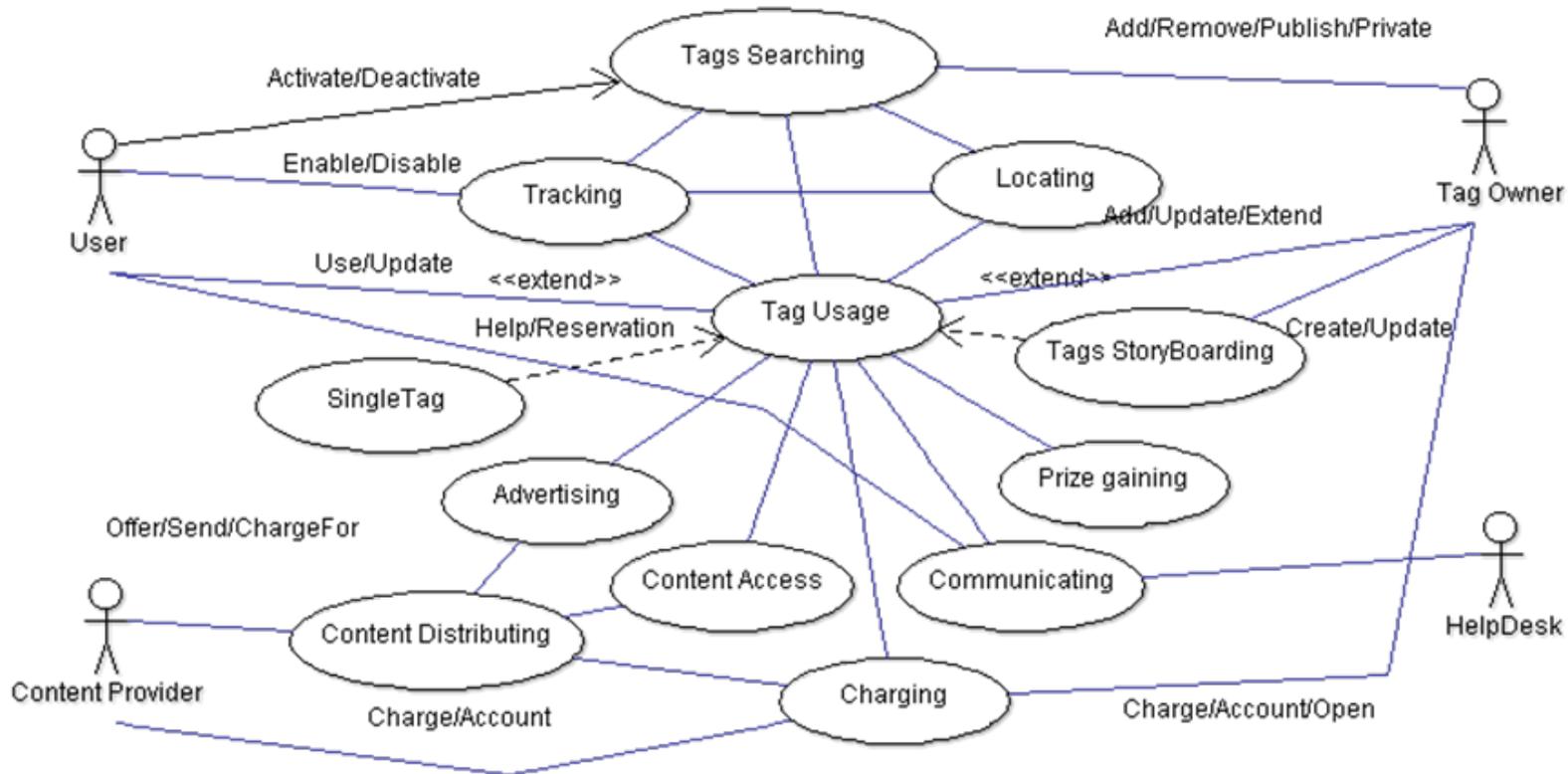
The Venice Noise App allows anyone with a smartphone to become a citizen scientist and record noise data in Venice. Along with a photograph and description of the noise, you can submit these data points to VeniceNoise.org and contribute to a growing database and heatmap. You can [download it here](#) or use the QR code below:



This is an open source project hosted on Google Code. [Click here](#) to view the repository.

Copyright © 2014, VeniceNoise.org. All rights reserved.  
Website designed by [nail.pomerleau](#).

# An Example of Crowdsourcing: Tag the City



# An ICT Architecture for Cultural Heritage

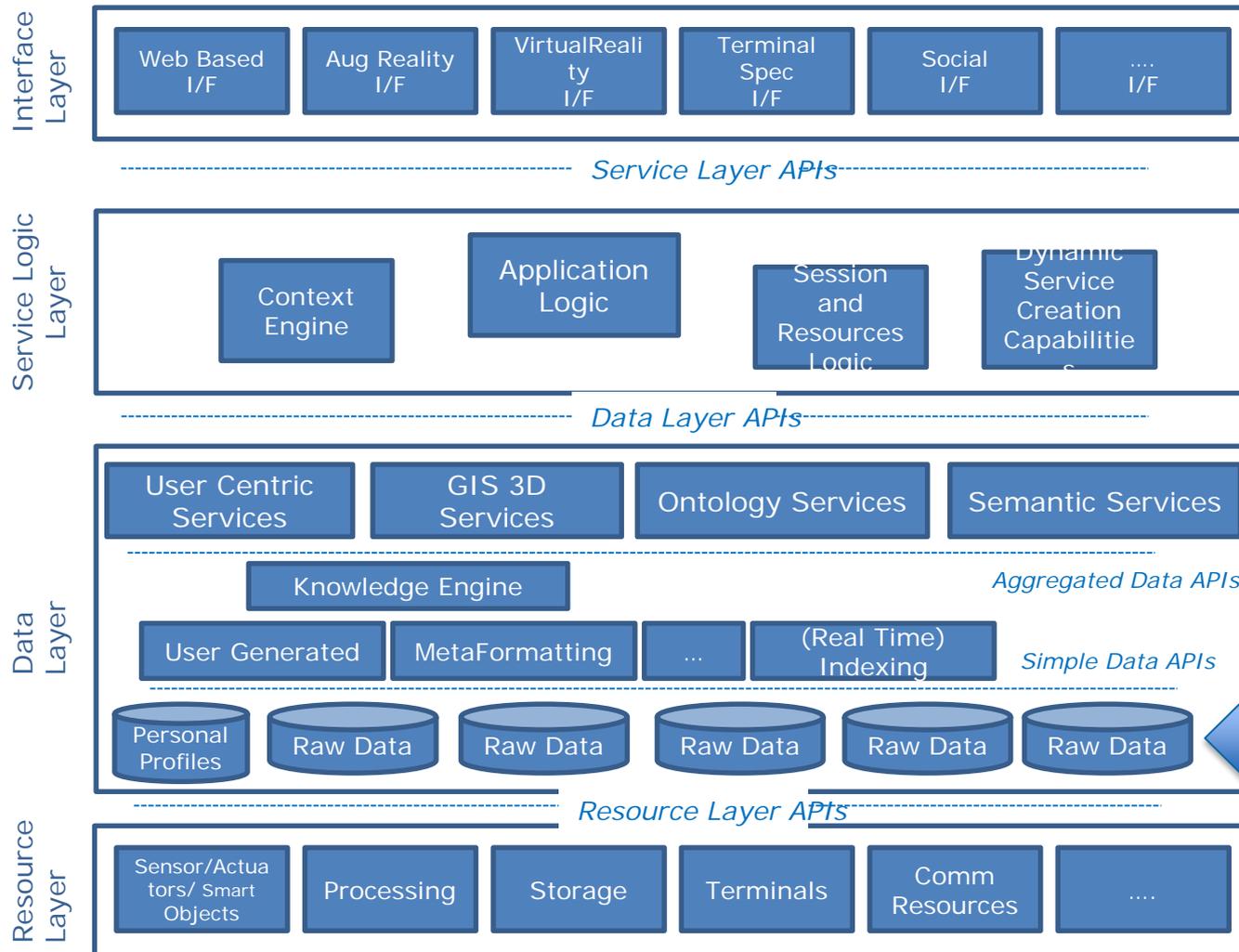


# Five dimensions of Cultural Heritage

- **First Dimension: Identification and preparation of the Cultural Heritage Content**
  - These activities are cross-disciplinary: they aim at identify the Cultural Content. The existing sources for data identified (e.g., Museums, Historical Archives , ...) in addition hypothesis for relating the different sources should be put forward. In addition the means to be used to create new data or collect new information should be stated and elaborated (e.g., how to collect the oral tradition)
- **Second Dimension: digitalization of the Cultural Heritage Content**
  - The identified sources should be progressively digitalized (it can take a long time) without impacting too much on the original material (e.g., old books) and a «big data» like infrastructure put in place. At this stage also discovery of new relationships and «automatic reasoning» on available data should be elaborated and performed
- **Third Dimension: easing the access to the (digitalized) Cultural Content**
  - At this stage, mechanisms for easing the access to available (original or inferred) information should be studied and made available to user. Extensive research on user interaction, recommendation engines and new forms of data representation should be conducted.
- **Fourth Dimension: the Ecosystem View on the Cultural Heritage**
  - Integration of Measurable City data with Cultural Heritage ones. This wealth of data should be made available to enterprises, users and organization in order to promote the city or the territory and to create a strong link between the cultural heritage and the enterprises operating in the tourism or cultural industries
- **Fifth Dimension: the creation of new Cultural Content**
  - New Digital technologies can be made available to artists, designers and also users in order to create new (digital) content. Examples could be the Art Lab (as an implementation of the FabLabs for art), new forms of TV, etc..

# An Architecture for Digital Humanities

(a part of)



**Feeds from the Measurable City**

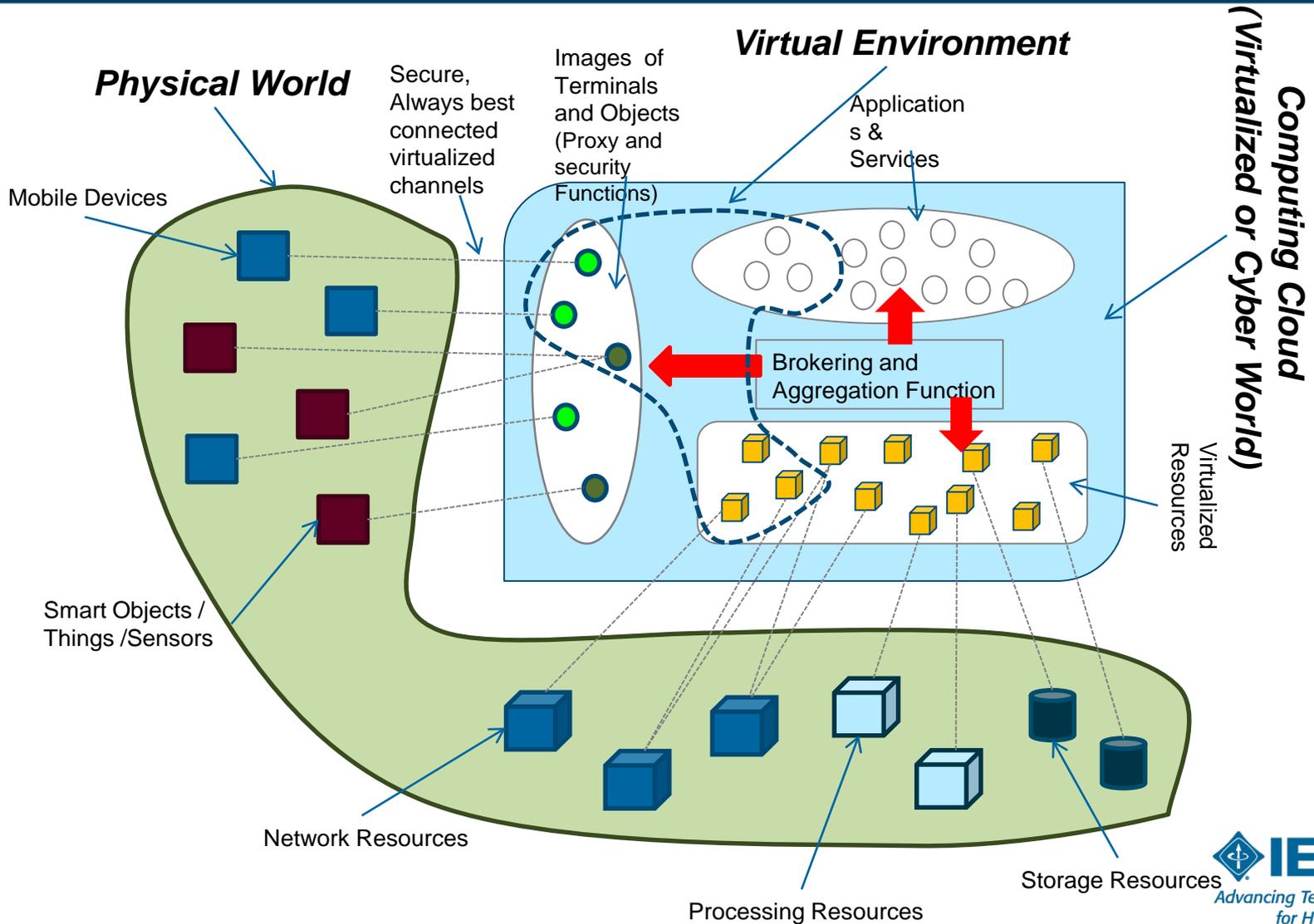
# Towards the Virtual Continuum

A virtual environment is a software feature that allows customers to use an entire (virtualized) computational and communication environment tailored to their specific needs.

The Virtual Continuum is the constant entanglement between real objects and their representations in the network. Events, actions, data on a physical object will be represented in the virtual world and vice versa. The Virtual Continuum makes possible the close relation between atoms and bit

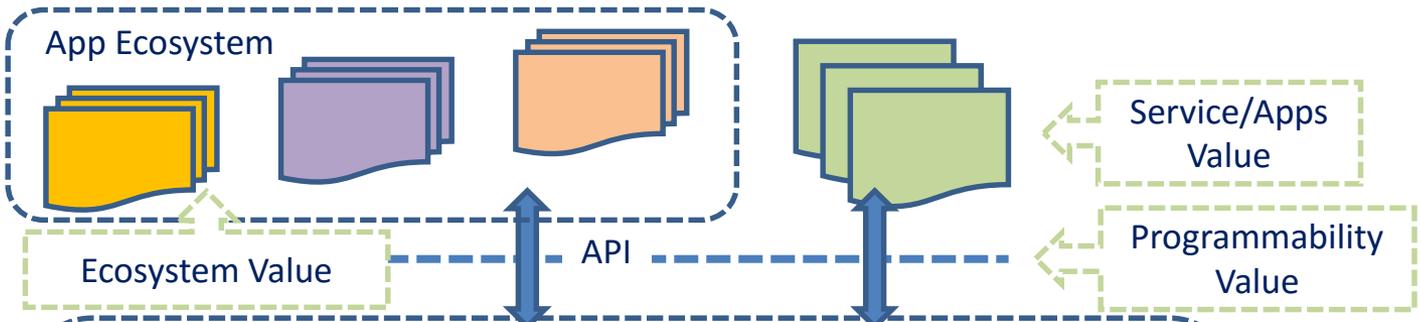
In a context of Future City, the virtual continuum offers **the opportunity to measure the relevant events occurring in a city** by means of **physical objects** (e.g., sensors, smart objects) and consequently **to plan policies** for adapting the usage to the resources of the city and to the context of users

# The Context for Virtual Continuum

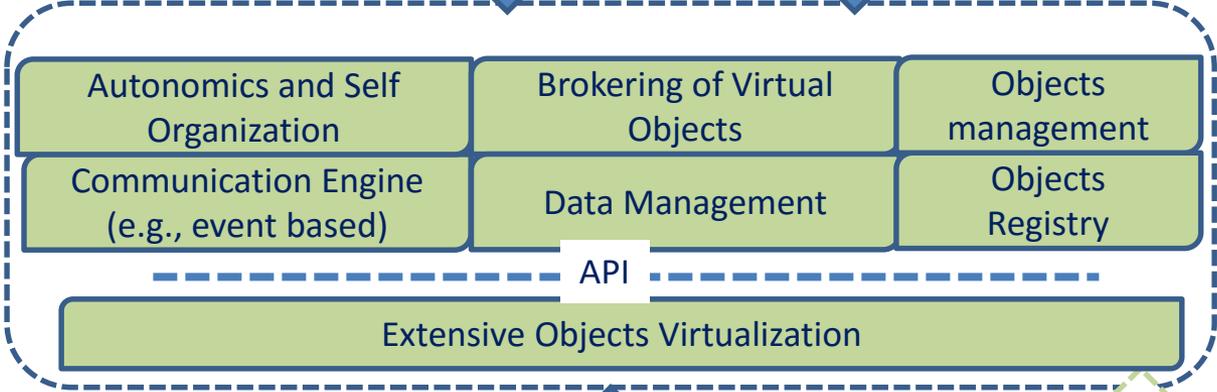
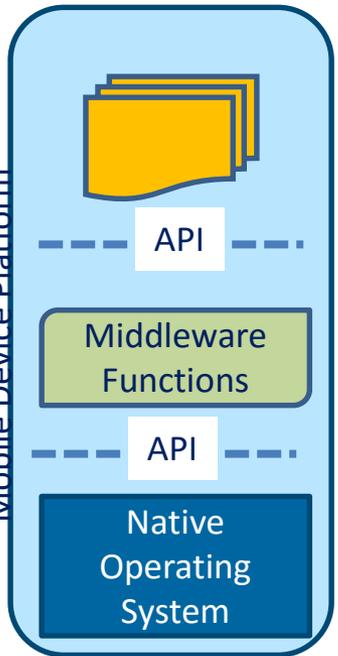


# Framework for Virtual Continuum Platform

Terminal to Cloud Relationship



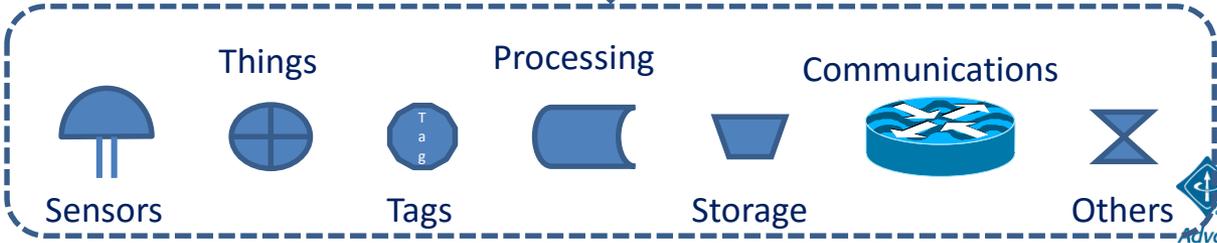
Mobile Device Platform



Telco Building Blocks



Terminal to Capillary Relationship



Thank you!

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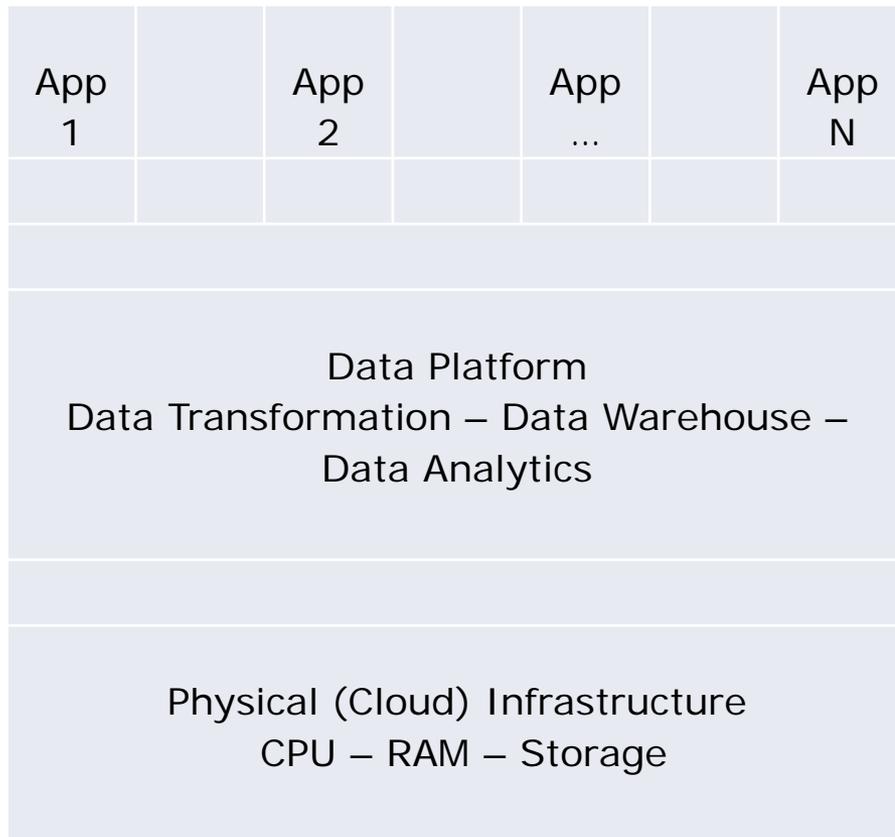
## Scala Contarini del Bovolo

<http://www.euro-poi.com/venice-bovolo-house-italy-383.html>

# Stuff

# Big Data For Cultural Heritage

Data management for Cultural Heritage falls in what classical data warehousing literature terms as an ETL (Extract, Transform, Load) process.



In order to allow such an architecture to scale and to be agile and manageable by all the parties involved, it has to sit on a cloud infrastructure:

Data store implementation will make use of Big Data technologies (like MapReduce approaches, NoSQL and NewSQL data stores, CEP analysis) to allow the scalability and response time needed to act effectively on homogeneous sets of data.

