



Photo by S. Orlan Kern

## From urban data flows and civic hacking to a smart city software ecosystem

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Instituto Nacional de Ciências  
e Tecnologia para a Engenharia  
de Software



future

What is BBC Future?

Latest

Future Now

Video

OUR PICKS

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# Recife's tech hub takes on Brazil's wealthy south

Recife's tech hub tried to take on Brazil's biggest players in Sao Paulo and Rio de Janeiro. What happened next is a cautionary tale for digital start-ups thinking big.

# **A brief chronology of a mid-term/long-term strategy**

Qualification of lecturers from Centro de Informática

The creation of an IT-centered hub to fight brain-drain

A movement that reconstructed a degraded area of the city

An economical foundation to generate more work and revenue for the city

# Some “smartness” aspects of Recife

The setting: A typical brazilian metropolitan city immersed in urban problems

Some IT companies flourished on solutions being used nationwide:

Avantia, Cittati, Colab.re, Epitrack, InLoco Media, Serttel/Samba, etc

INES - An institute focused on Software Engineering for Smart Cities

INCITI - An institute focused on City Innovation

A few isolated smart initiatives from government

Still a **very** long way to go

but also,  
**strong political engagement**  
to  
**fight for the city**

Tallest buildings on today`s Estelita skyline



Proposed project  
(for the wealthy)



origin to a movement that in a  
sort of way resembled Turkey's  
**#occupygezi**





#OCUPE  
ESTELITA





**Among you, who could share with us some story  
about similar **development strategy** or any  
**fight for the city**?**

**Going straight to the smart city  
subject...**

The smart city concept is still very confusing

No consensus on a smart city definition

Several cities defining themselves smart using different perspectives

**Green City**

**Virtual City**

**Wired city**

**Sustainable City**

**Digital City**

**Intelligent City**

**smart city**

**Ubiquitous City**

**Smart Community**

**Information City**

**Knowledge City**

**Learning City**

smart cities





# Masdar City



Initial steps (2012)



Project for 2025



# New Songdo



How it was in 2013



Expected for 2020





WELCOME TO THE SMART CITY PLAZA







A talking  
post?  
Sometimes,  
legends  
are true

PA system with  
public Wi-Fi

- Full system with 100W PA and 20Mbps Wi-Fi access point
- 100W PA
- 20Mbps Wi-Fi access point
- 100W PA and 20Mbps Wi-Fi access point
- 100W PA and 20Mbps Wi-Fi access point
- 100W PA and 20Mbps Wi-Fi access point
- 100W PA and 20Mbps Wi-Fi access point
- 100W PA and 20Mbps Wi-Fi access point

SiTecno  
ENERGY - EFFICIENCY - INNOVATION

COMPLETE PLUG & PLAY SOLUTIONS  
FOR SMART CITIES

SOLAR ENERGY KIT

FOR RESIDENTIAL, COMMERCIAL AND INDUSTRIAL USE WITH LIGHTING



SOLAR ENERGY KITS 250W to 100KW  
On-grid, Off-grid & Hybrid

SOLAR STREET LIGHTING

FOR PARKS, STAIRS, STREETS AND SIDEWALKS



STREET LIGHT LED 24 W to 140 W  
3000 Lumens to 19000 Lumens

IDEAL FOR SUBURBAN, INDUSTRIAL AND AGRICULTURE WITH LIGHTING

# SMART CAFE





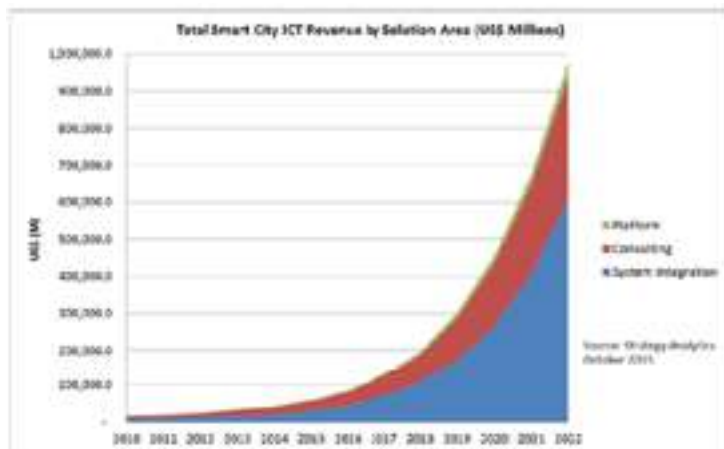
**\$mart**

**cities**



**STRATEGYANALYTICS**  
Research, Opinions, and Analytics

Strategy Analytics Smart City ICT revenues are forecast to reach \$977 Billion by 2022



**Forbes / Autos**

From Webcast: 3 Billionaire Predictions for 2016

JUN 11, 2014 9:42:07 AM 16,958 views

**Smart Cities -- A \$1.5 Trillion Market Opportunity**



Egham, UK, March 18, 2015

[View All Press Releases](#)

Gartner Says Smart Cities Will Use 1.1 Billion Connected Things in 2015

Egham, UK, December 7, 2015

[View All Press Releases](#)

Gartner Says Smart Cities Will Use 1.6 Billion Connected Things in 2016

Egham, U.K., February 7, 2017

[View All Press Releases](#)

Gartner Says 8.4 Billion Connected "Things" Will Be in Use in 2017, Up 31 Percent From 2016

# **Arguments from IT vendor based on United Nations data**



**70% of the world's urban population will be urban by 2050**





84%

urban population in **Brazil**



2010



Photo: Henrique Boney



Photo: Business Insider



Photo: UOL



CO EM VIDRO, BOX E CUBAS  
**VITRIEH**  
Caxangá - N° 2215 - Recife/PE  
Fone: (81) 3034.2901 - www.vitrieh.com.br

**SEI** GRANDE TORY  
PERIMETRAL

**039**

KCC-1420  
800 724 0034

Photo: JC Online





**SECURITY**



**EDUCATION**



**ENERGY**



**HEALTH**



**WASTE**



**WATER**



**Gather in groups of three, ideally from different  
countries (or at least different cities)**

**What are the most critical problems you can point out  
in your cities?**

**Any problem in common between your cities?**

**Are there solutions being developed/deployed?**

**Attempts to measure  
the "smartness"**

# Smart cities dimensions

**SMART ECONOMY**  
(Competitiveness)

- Innovative spirit
- Entrepreneurship
- Economic image & trademarks
- Productivity
- Flexibility of labour market
- International embeddedness
- Ability to transform

**SMART GOVERNANCE**  
(Participation)

- Participation in decision-making
- Public and social services
- Transparent governance
- Political strategies & perspectives

**SMART ENVIRONMENT**  
(Natural resources)

- Attractivity of natural conditions
- Pollution
- Environmental protection
- Sustainable resource management

**SMART PEOPLE**  
(Social and Human Capital)

- Level of qualification
- Affinity to life long learning
- Social and ethnic plurality
- Flexibility
- Creativity
- Cosmopolitanism/Open-mindedness
- Participation in public life

**SMART MOBILITY**  
(Transport and ICT)

- Local accessibility
- (Inter)national accessibility
- Availability of ICT-infrastructure
- Sustainable, innovative and safe transport systems

**SMART LIVING**  
(Quality of life)

- Cultural facilities
- Health conditions
- Individual safety
- Housing quality
- Education facilities
- Touristic attractivity
- Social cohesion

City	Smart Economy	Smart People	Smart Governance	Smart Environment	Smart Living	Index
01 LISBON	1	2	11	8	28	1
02 AARRUS	9	1	8	9	20	12
03 VIENNA	16	9	7	21	16	3
04 JAGGED	17	8	6	17	26	11
05 GOTTEN	18	8	1	1	26	17
06 NAPLES	20	7	7	17	12	8
07 OULU	20	6	2	28	19	19
08 FRANKFURT	21	13	10	7	26	18
09 LIND	21	23	11	14	24	7
10 SALZBURG	22	20	8	22	29	11
11 WROCLAW	22	21	11	24	1	24
12 BUDAPEST	23	20	9	8	40	3
13 GAZI	24	22	10	17	21	5
14 BUDAPEST	24	18	14	3	21	24
15 DORTMUND	24	19	15	20	19	13
16 GOTT	24	18	16	7	48	10
17 LUTSKA	8	11	10	21	2	20
18 PRAGUE	25	18	12	1	43	14
19 JOHANNESBURG	26	10	7	14	27	24
20 BRNO	22	22	10	18	14	2
21 BOCHUM	21	19	18	9	10	23
22 GALLI POLA	17	24	22	13	17	21
23 LINZ	19	1	10	24	14	20
24 DUISBURG	9	10	23	19	18	22
25 DUISBURG	18	29	22	24	8	25
26 BUDAPEST	21	21	22	23	10	20
27 GOTT	21	24	19	16	14	27
28 GOTTEN	21	27	20	21	8	15
29 BUDAPEST	21	21	22	20	2	22
30 COLOGNE	2	24	25	45	44	21
31 DORTMUND	20	27	21	13	21	15
32 BUDAPEST	21	20	22	11	17	23
33 BUDAPEST	21	20	22	11	17	23
34 BUDAPEST	21	20	22	11	17	23
35 BUDAPEST	21	20	22	11	17	23
36 BUDAPEST	21	20	22	11	17	23
37 BUDAPEST	21	20	22	11	17	23
38 BUDAPEST	21	20	22	11	17	23
39 BUDAPEST	21	20	22	11	17	23
40 BUDAPEST	21	20	22	11	17	23
41 BUDAPEST	21	20	22	11	17	23
42 BUDAPEST	21	20	22	11	17	23
43 BUDAPEST	21	20	22	11	17	23
44 BUDAPEST	21	20	22	11	17	23
45 BUDAPEST	21	20	22	11	17	23
46 BUDAPEST	21	20	22	11	17	23
47 BUDAPEST	21	20	22	11	17	23
48 BUDAPEST	21	20	22	11	17	23
49 BUDAPEST	21	20	22	11	17	23
50 BUDAPEST	21	20	22	11	17	23

BY BOYD COHEN



Re-designed by Mosaic

Dimension	Marking Area	Indicator	Description
Environment	Smart Buildings	Energy consumption per building	Number of buildings with energy efficiency ratings, and a percentage of buildings with energy efficiency ratings
	Smart Appliances	Energy consumption per appliance	Number of buildings with energy efficiency ratings, and a percentage of buildings with energy efficiency ratings
	Smart Transportation	Energy consumption per vehicle	Number of buildings with energy efficiency ratings, and a percentage of buildings with energy efficiency ratings
	Smart Infrastructure	Energy consumption per infrastructure	Number of buildings with energy efficiency ratings, and a percentage of buildings with energy efficiency ratings
Mobility	Smart Transportation	Number of smart transportation vehicles	Number of smart transportation vehicles, and a percentage of smart transportation vehicles
	Smart Infrastructure	Number of smart infrastructure projects	Number of smart infrastructure projects, and a percentage of smart infrastructure projects
	Smart Living	Number of smart living projects	Number of smart living projects, and a percentage of smart living projects
	Smart Governance	Number of smart governance projects	Number of smart governance projects, and a percentage of smart governance projects
Economy	Smart Business	Number of smart business projects	Number of smart business projects, and a percentage of smart business projects
	Smart Finance	Number of smart finance projects	Number of smart finance projects, and a percentage of smart finance projects
	Smart Industry	Number of smart industry projects	Number of smart industry projects, and a percentage of smart industry projects
	Smart Innovation	Number of smart innovation projects	Number of smart innovation projects, and a percentage of smart innovation projects
People	Smart Housing	Number of smart housing projects	Number of smart housing projects, and a percentage of smart housing projects
	Smart Services	Number of smart services projects	Number of smart services projects, and a percentage of smart services projects
	Smart Safety	Number of smart safety projects	Number of smart safety projects, and a percentage of smart safety projects
	Smart Education	Number of smart education projects	Number of smart education projects, and a percentage of smart education projects
Living	Smart Air Quality	Number of smart air quality projects	Number of smart air quality projects, and a percentage of smart air quality projects
	Smart Water	Number of smart water projects	Number of smart water projects, and a percentage of smart water projects
	Smart Waste	Number of smart waste projects	Number of smart waste projects, and a percentage of smart waste projects
	Smart Networks	Number of smart networks projects	Number of smart networks projects, and a percentage of smart networks projects

Cohen, Boyd. The Smart Cities Wheel

## Indicators clustered by 5 SC components:

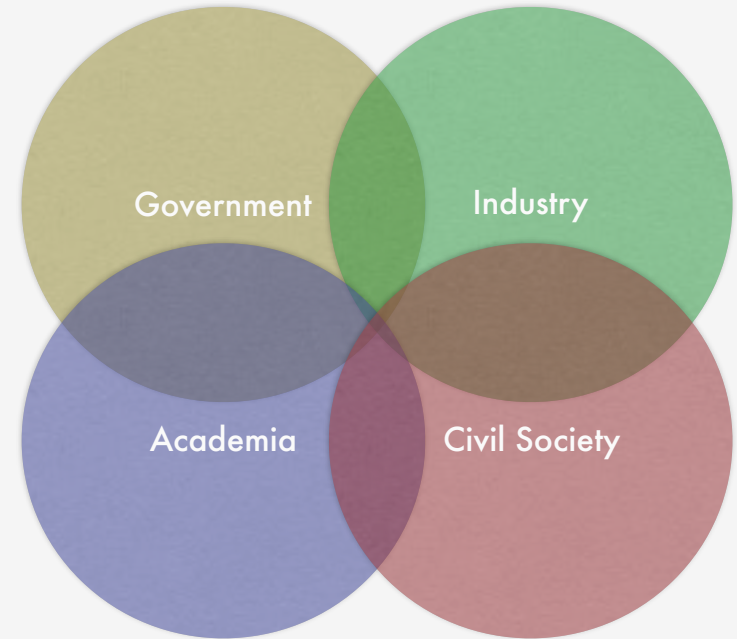
Smart Governance

Smart Economy

Smart Human Capital

Smart Living

Smart Environment



**System of systems: Having a holistic view is difficult**



**Information silos:**  
**Tool-centric**  
**Department-centric**  
**A reflex of institutional organization**





**CENTRO DE OPERAÇÕES  
PREFEITURA DO RIO**





**Vendor lock-in**  
**too many promises**

The image shows the interior of a large, circular, multi-story building under construction. The structure is composed of numerous concrete columns and beams, forming a grid of windows. A central tower is visible, and the ceiling is a large, ribbed dome. The lighting is bright, suggesting natural light from the windows. A green banner with white text is overlaid on the image.

# The Urban Panopticon

# Urban Dynamics case in Portland

**Generic system model of cities**

**3000+ equations describing the interaction of different city domains**

**The greatest revelation: Pro-bicycle policies would decline obesity**

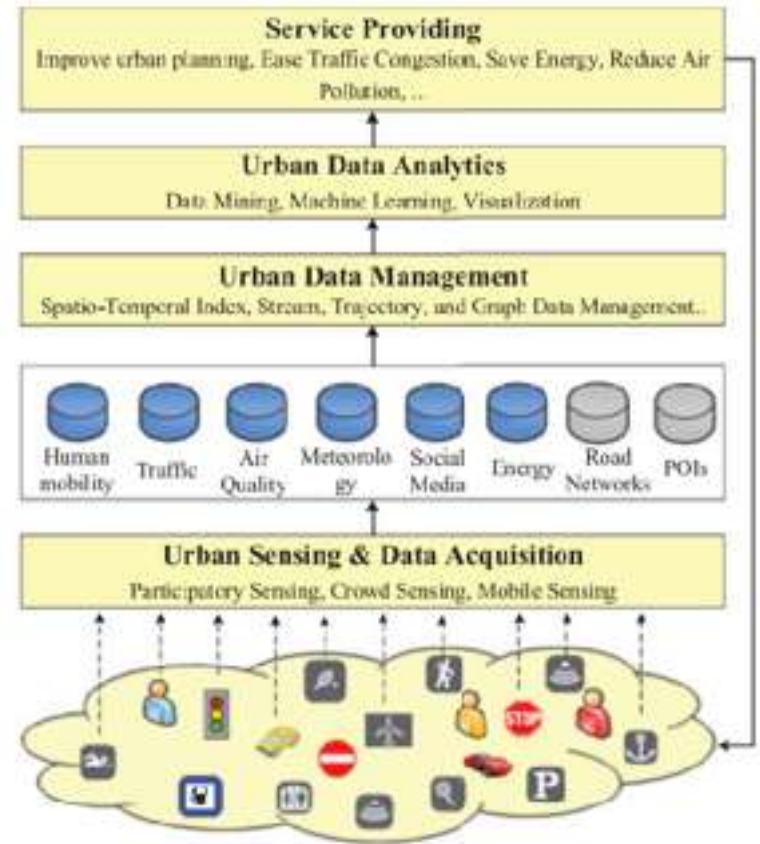
# Chaordic Cities

**chaos**  
**order**

*"...any self-organizing, adaptive, nonlinear complex system, whether physical, biological, or social, the behavior of which exhibits characteristics of both order and chaos"*

**Dee W. Hock (VISA founder)**

# Urban Computing and the promise of the magic box



# **Flows of information**



# Urban Sensing Systems

(LANE et al, 2008)

Participatory: Explicit user involvement

Opportunistic: Autonomous and Continuous

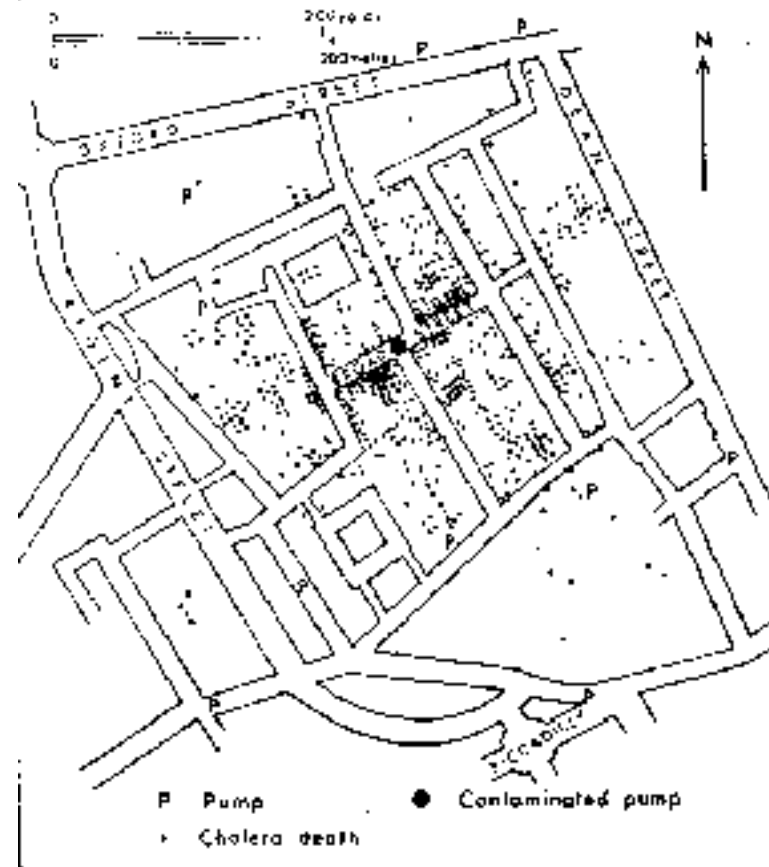
# Mobile Crowdsensing Applications (MCS)

(GANTI et al, 2011)

MCS

*community sensing*

Data of common interest, shared by smartphones

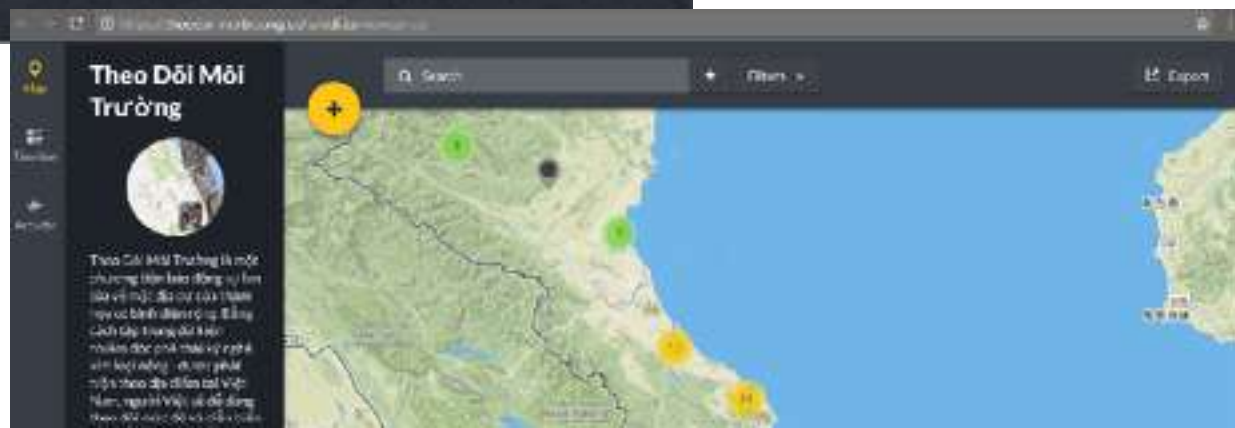


Cholera Mapping  
London, 1854



made in Recife by Epirack

# Platforms for Crowdsensing





PASADENA CITIZEN SERVICE CENTER

On this page, you can find information about how to report a problem or request a service. You can also find information about the City of Pasadena's Citizen Service Center.

Looking For Information?

Most Requested

AT&T 3G 9:09 AM 98%

Citizens Connect

Recent Reports

My Reports

Favorite Reports

Tweets

Settings

About

Citizen Service Center

Submit a Report

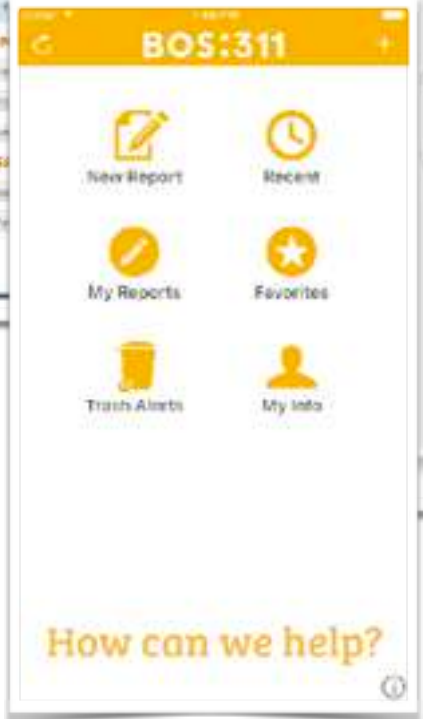
Request a Service

Sign Up

Help

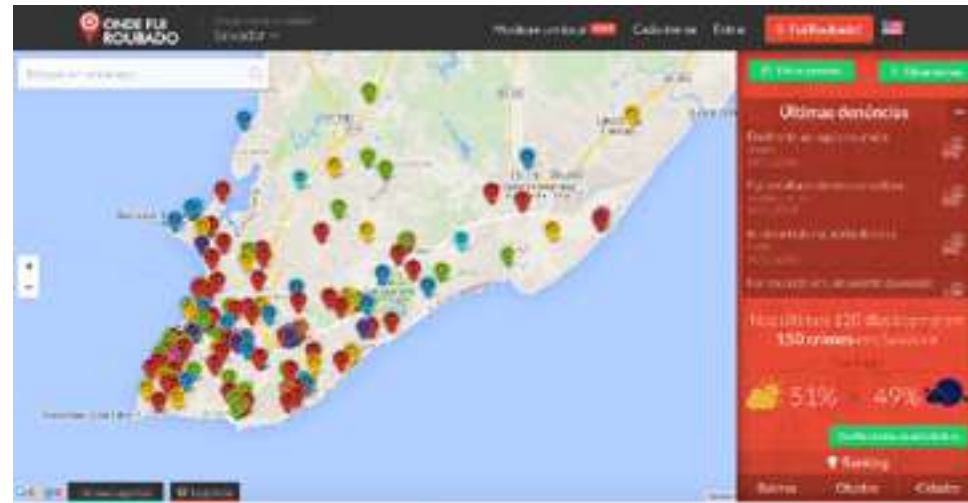
TTY 626-798-3111

TTY 626-798-3111



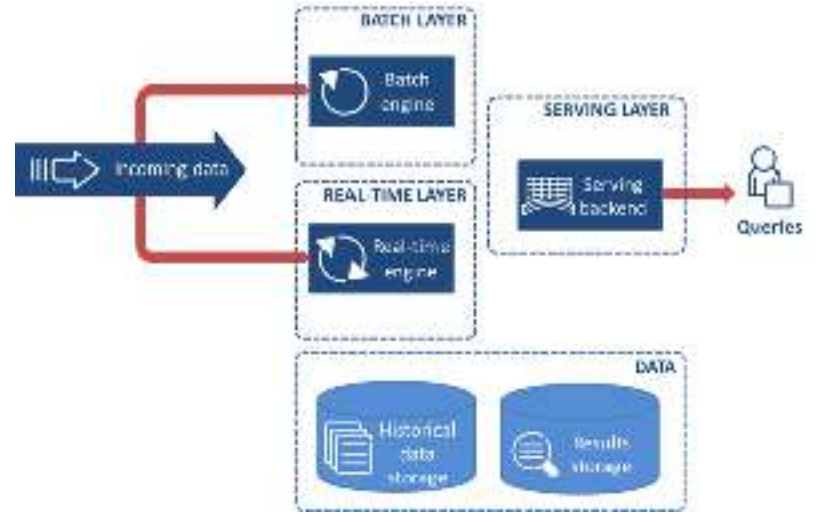
# Challenges with the quality of crowdsensed data

**Also: a limited and biased view of facts**

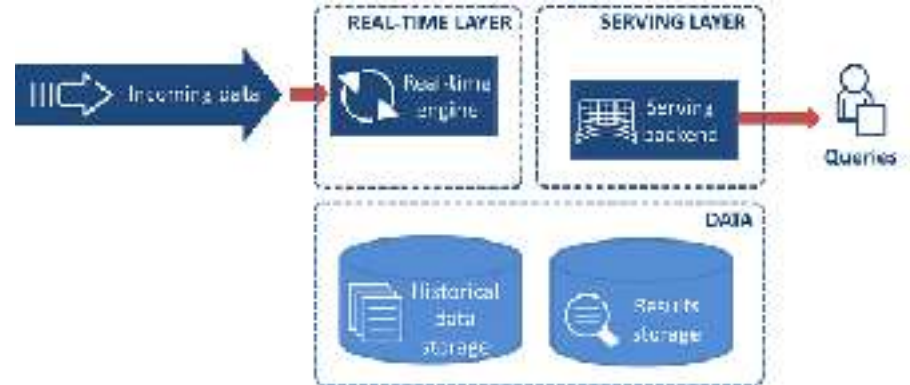


# Architectures we are experimenting

## Lambda



## Kappa



**How to make non-specialists deal with data from so many different flows?**



# Simplicity...



## Some example Recipes

if  then 

Nearly home? Direct message the person who should know

if  then 

Email your new iPhone photos to yourself

if  then 

Backup your contacts to a Google Spreadsheet

[www.ifttt.com](http://www.ifttt.com)

# Dealing with Complex Event Processing using programming styles: SQL extensions, rule-based languages and imperative languages.

## Esper's EPL

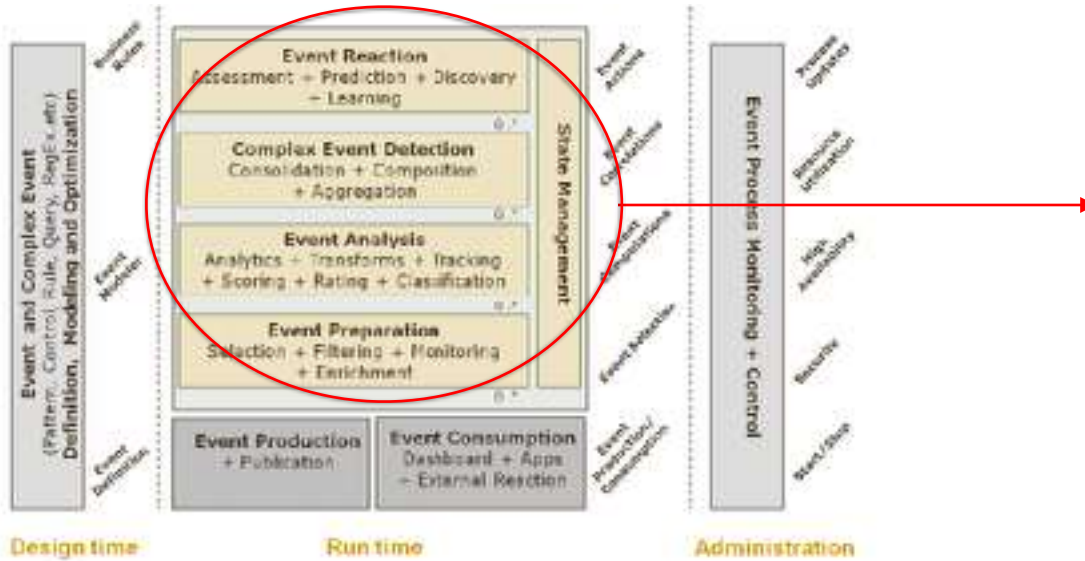
```
select * from TemperatureEvent
match_recognize (
  measures A as temp1, B as temp2
  pattern (A B)
  define
    A as A.temperature > 400,
    B as B.temperature > 400)
```

## Drools Fusion

```
rule "Sound the alarm in case temperature rises above threshold"
when
  TemperatureThreshold( $max : max )
  Number( doubleValue > $max ) from accumulate(
    SensorReading( $temp : temperature ) over window:time( 10m ),
    average( $temp ) )
then
  // sound the alarm
end
```

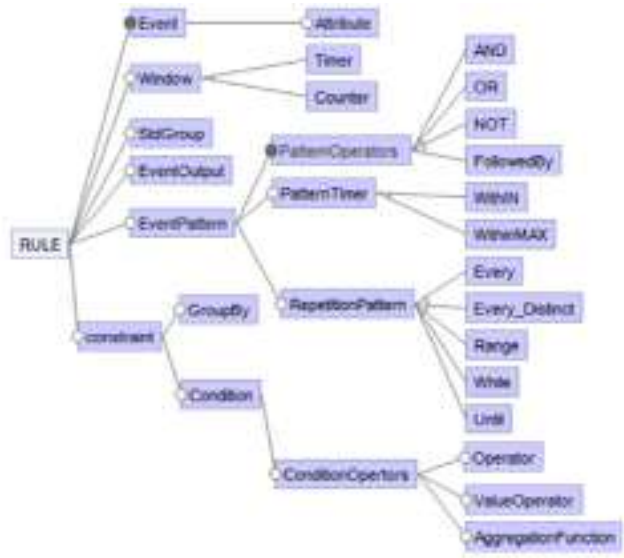
## Apache Flink

```
Pattern<MonitoringEvent, ?> warningPattern =
Pattern.<MonitoringEvent>begin("First Event")
  .subtype(TemperatureEvent.class)
  .where(evt -> evt.getTemperature() >= TEMPERATURE_THRESHOLD)
  .next("Second Event")
  .subtype(TemperatureEvent.class)
  .where(evt -> evt.getTemperature() >= TEMPERATURE_THRESHOLD)
  .within(Time.seconds(10));
```



		COMPONENTS CAPABILITY				
		Reactive	Processing	Knowledge	Act	Learning
			Block	Stream		
REQUIREMENTS	OPERATION	COMPETITIVE ADVANTAGE (E.T.)				
	OPERATIONAL EFFICIENCY	REAL TIME OPERATIONAL PERFORMANCE MONITORING				
REQUIREMENTS	OPERATIONAL EFFICIENCY	OPERATIONAL EFFICIENCY				
	OPERATIONAL EFFICIENCY	OPERATIONAL EFFICIENCY				
ANALYSIS	ANALYSIS	EVENT TRANSFORMATION				
	ANALYSIS	EVENT MONITORING				
	ANALYSIS	EVENT STORAGE			DATABASE LOOKUP (A.I.)	EVENT CONDITION ACTION (A.I.)
	ANALYSIS	EVENT RETRIEVAL			DATABASE WRITE (A.I.)	
	ANALYSIS	EVENT CLASSIFICATION				
REQUIREMENTS	REQUIREMENTS	BEST CONNECTION (A.I.)				
	REQUIREMENTS	BEST CONNECTION (A.I.)				
REQUIREMENTS	REQUIREMENTS	BEST CONNECTION (A.I.)				
	REQUIREMENTS	BEST CONNECTION (A.I.)				
REQUIREMENTS	REQUIREMENTS	BEST CONNECTION (A.I.)				
	REQUIREMENTS	BEST CONNECTION (A.I.)				

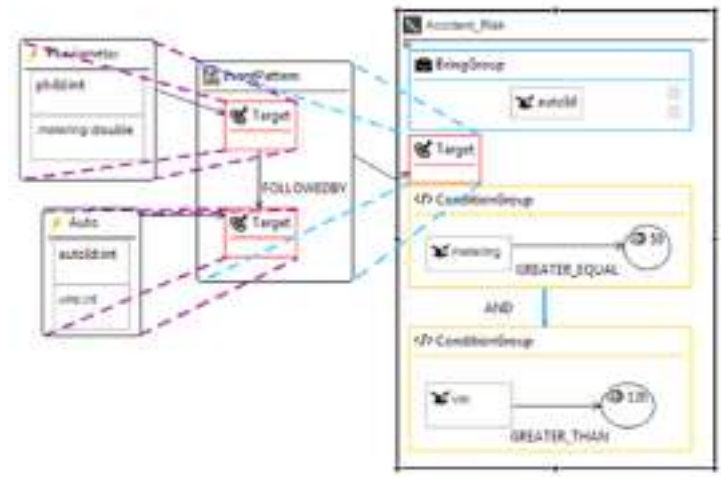
A catalog of design patterns inspired on Hohpe & Woolf's Enterprise Integration Patterns



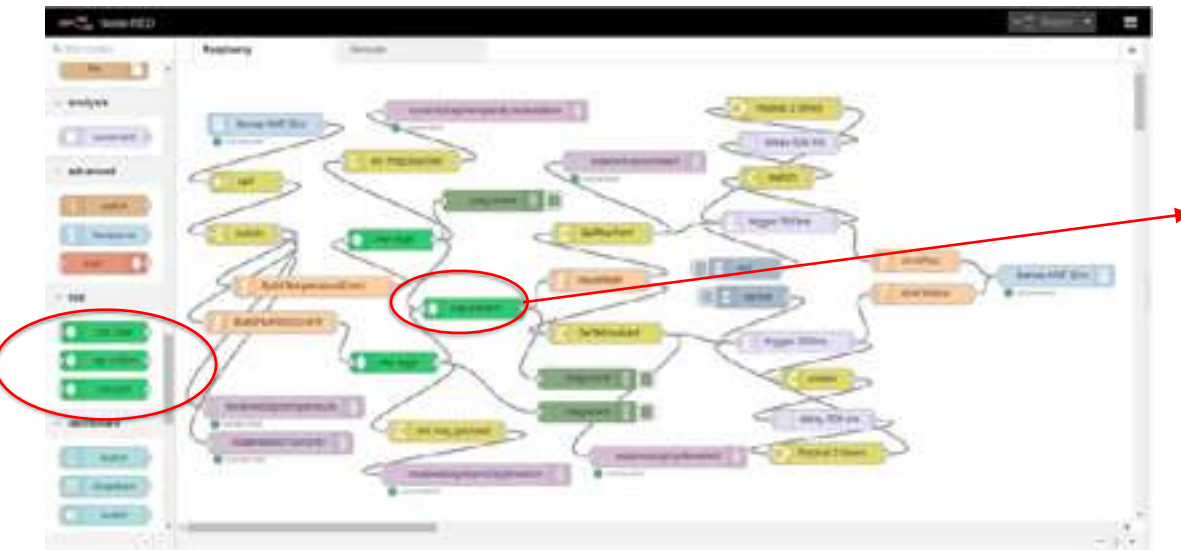
```

SELECT id, metering FROM Pluviometer WHERE metering >= 50 GROUP BY id
  
```

BringGroup
Target
ConditionGroup
GroupByCondition



Herbertt Diniz (MSc) - Domain specific language for the abstraction of complex event processing solution  
co-advisor: Robson Fidalgo



**Edit cep pattern node**

Delete

Property

Event Name #1

Event Name #2

Window

Filter

Pattern

Join Clause

Generated Event

Selected Fields

A set of Node-RED extensions for complex-event processing

<https://www.npmjs.com/package/node-red-contrib-cep>

**Integrating these flows**  
**(some of which from the silos we discussed before)**

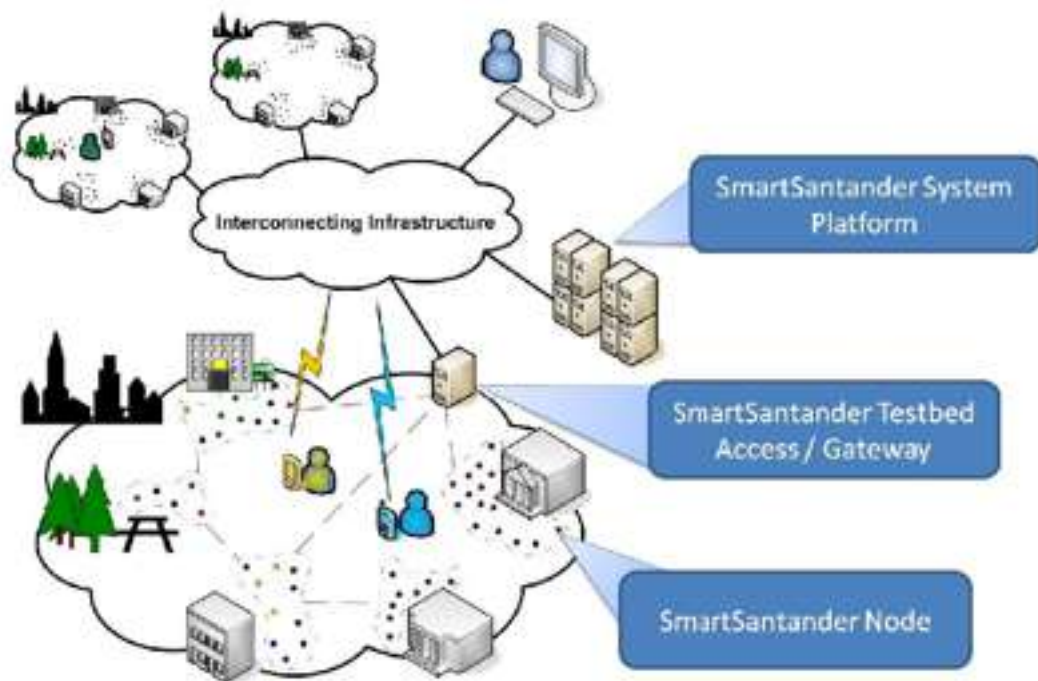
**SOA did not deliver what it  
promised**



**Instead, microservices took over**



**What if we "accessed" the City  
through an API?**



NYC OpenData

1100+



### Using OpenData to help drivers navigate NYC

Track and analyze parking tickets and camera violations using data provided by the New York City Department of Finance (DOF), now available through NYC OpenData.



Discover over 1,100 datasets on the NYC OpenData portal

Get Started With Our APIs

[Collaborate with us on Github](#)

[Got ideas for an API?](#)

[Got a concept for an APP?](#)

NYC Developer Portal Is...

**Top-down**  
**x**  
**Bottom-up**

A "frugal" Smart City empirically raises as a collection of individual initiatives (bottom-up)

It may be non-holistic and lack strategic vision, but is pragmatic and cheaper.

The "evil side" of big technology suppliers remain trying to provide a top-down perspective to sell expensive products

**smart cities**

**X**

**smart citizens**

Proxima

smart city expo  
WORLD CONGRESS  
12-17 November 2016  
12-17 Nov 2016



CITIES FOR CITIZENS

South Access



Proxima  
12-17 November 2016

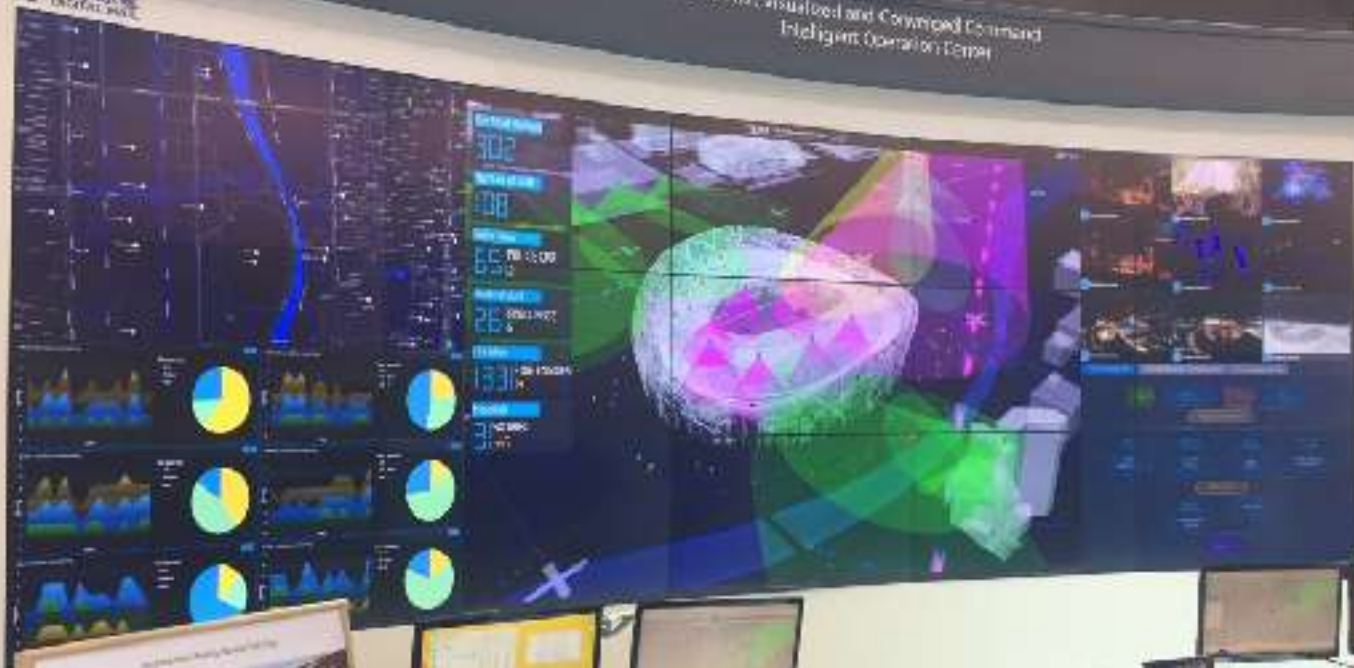


THE NEW ECONOMY



数字水控  
DIGITAL WATER

World's First Visualized and Centralized Command  
Intelligent Operation Center





Inclusion para personas con discapacidad

Smart  
MORE things

# What do you expect from a smart city?

Jorge Gomez  
2008-2010-2011  
Risco CO2 emissions

TALAN

Intelligent Community

Safe Cities  
NO TRAFFIC JAMS  
MORE FRESH AIR

More Fresh Air



Smart Water  
Smart Energy  
Smart Mobility  
Smart Living  
Smart Governance

Smart Energy  
Smart Mobility  
Smart Living  
Smart Governance



Smart Buildings with people

Be Happy  
Smart Buildings  
Smart Energy  
Smart Mobility  
Smart Living  
Smart Governance

Don't use desktop

Stop talking about it  
Start taking action!

Smart people  
To Be Done for  
People's  
Not for  
Smart

AGUSTINE LINDA  
EXPERTISE IN  
ENTREPRENEURSHIP

SAFER  
PEOPLE!



INTEGRATING  
DIGITAL TECHNOLOGIES  
+ SCIENCE



**Smart City: who is it for?**

**in a country of contrasts**



**Smart can't be 100% technological**

Many articles claim the importance of citizens being involved in smart cities solutions

We don't see that much from us (IT people) talking about technology

# **[Multi | Inter | Trans]disciplinarity**

In this path I had the opportunity to discuss and work with people from different backgrounds

Our IT knowledge and vision is not enough to tackle city problems

# living lab

Important (although vague) concept for "human" smart cities

Conceive solutions for real problems

Technology as a possible means to an end

Citizens (users) involved in the process

Interdisciplinary approach

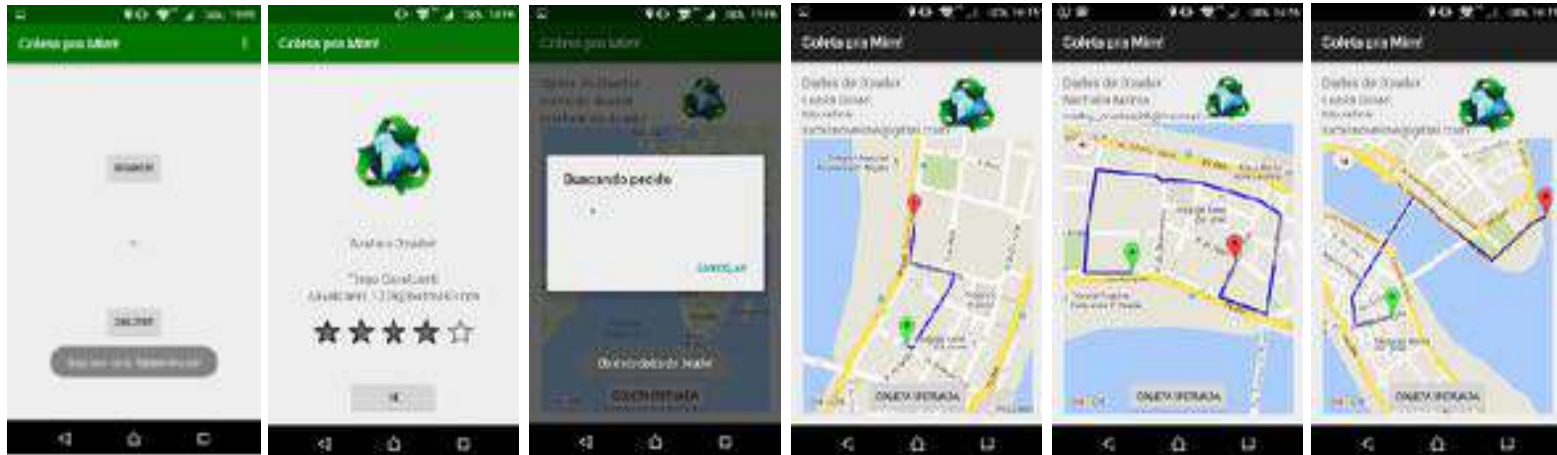
## user-centered design



# Summer school



Empowering the Cart Haulers that collect recyclables



# PlayTown: A ludic city where you can play

www.playtownrec.com.br/playtown/

playtown

Home

Playtown

Eventos

Galeria

Contato

PLAYTOWN

- Open calls for citizen participation
- Co-creation of ludic urban furniture together with citizens
- Fab-lab infrastructure being used
- Interdisciplinary approach to foster thinking “outside the box”
- A different type of hackathon
- As an immediate result, the transformation of the Recife Antigo neighbourhood
- Potential incubation of winning projects



Ministério do  
Turismo









Biblioteca de Troca



Intemporal



Urban Umbrella



Brincachão



Scaffolding Tile



Kinematicity



Peças de Conversação



SIBIPIKE



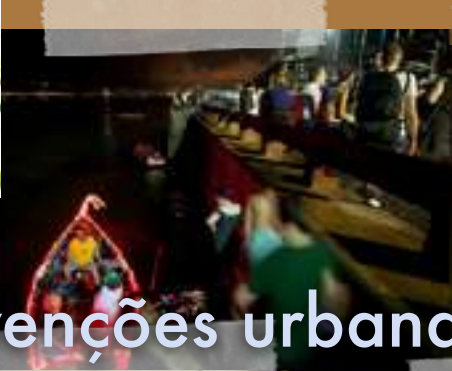
Blocomposição no Largo



Mesa Intendente

# Recife the Playable City





Intervenções urbanas



Experiência lúdica



Interdisciplinaridade



Interações pessoa-cidade



A photograph of a busy makerspace workshop. In the foreground, a man in a yellow shirt is working on a small device. To his right, a man in a green shirt is looking at a laptop. In the background, several other people are working at tables. One man in a blue shirt is leaning over a table, and another man in a red shirt is working on a project. A large screen in the background displays a website. The workshop is filled with various tools, materials, and equipment.

**makerspaces**  
are key players in this setting

# cultural obstacles



## **Assignment:**

- Thinking with a "bottom-up smart city" mindset, what problems did you see here or in your city could be overcome with the help of IT?**
- Who are the citizens that could benefit from that? What are their needs? (employ the techniques from Gemma's workshop)**
- What resources are available (data, APIs)?**
- What can be made available through a possible solution?**
- Are there similar solutions ?**
- What professionals (from which disciplines) would be required to develop a solution in that context?**
- What obstacles would you have to overcome?**