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APISENSE®: Mobile crowd-sensing made easy!

Romain Rouvoy

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Submitted on 13 Oct 2016

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apisense

Mobile Crowd Sensing made easy!

@RomainRouvoy

SPIRALS

Inria
INVENTORS FOR THE DIGITAL WORLD

Université de Lille 1
SCIENCES ET TECHNOLOGIES

CRIStAL
Centre de Recherche en Informatique, Signal et Automatique de Lille

1h20
London
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Brighton
2h40
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Utrecht
Rotterdam
Dunkerque
Calais
Boulogne
Anvers
Gent
0h38
Brussels
Lille
Lens
Arras
Douai
Cambrai
Valenciennes
Maubeuge
Courtrai
Leuven
Charleroi
Liège
Amiens
Rouen
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Paris
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2h21
Köln
Luxembourg
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team.inria.fr

SPIRALS

Spirals

Self-adaptation for distributed services and large software systems

Home | Members | Publications | Software | Fundings | Contact | Intranet

Presentation

Spirals is conducting research activities in the domains of distributed systems and software engineering.

Spirals aims at introducing more automation in the adaptation mechanisms of software systems, in particular, transitioning from adaptive systems to **self-adaptive systems**. Spirals targets especially two properties: **self-healing** and **self-optimization**. With self-healing, Spirals aims at studying and tailoring data mining and machine learning solutions for the design and implementation of software systems. This contributes to the goal of obtaining solutions for automatic software repair. With self-optimization, Spirals aims at sharing, collecting, and analyzing distributed behaviors and data to continuously tailor, optimize, and keep under working conditions software systems. This participates to the goal of obtaining eternal distributed systems.

Spirals is a joint project-team between Inria and the University of Lille – Sciences and Technologies within UMR 9189 CRIStAL. Spirals originates from the ADAM project-team (2008-13).

Available Positions

- PhD & Internship

Privacy-aware data dissemination in mobile networks

Cartography of the Quality of Experience for Mobile Internet Access

- R&D Engineer

Développeur applications mobiles pour plate-forme de géolocalisation indoor

Research Software Engineer in Automatic Repair

Links

- Software Engineering seminar
- Somca Inria associated team
- Videos

Spirals Twitter

Tweets by @SpiralsTeam

Spirals Team Retweeted

IEEE Software
@ieeesoftware

crawdad.org

CRAWDAD

A Community Resource for Archiving Wireless Data At Dartmouth

mirrors:

- News
- Join the CRAWDAD community
- Reset your CRAWDAD account password
- Datasets and tools by name
- Datasets and tools by release date

Datasets and tools by keyword:
Select one

Datasets by measurement purpose:
Select one

- About the CRAWDAD project
- CRAWDAD references in CiteULike
- CRAWDAD contributors by country
- CRAWDAD members by country

Open "crawdad.org/index.html" in a new tab

Welcome to CRAWDAD

CRAWDAD is the Community Resource for Archiving Wireless Data At Dartmouth, a wireless network data resource for the research community. This archive has the capacity to store wireless trace data from many contributing locations, and staff to develop better tools for collecting, anonymizing, and analyzing the data. We work with community leaders to ensure that the archive meets the needs of the research community.

CRAWDAD is grateful to its current and past sponsors.

Latest News

new version of CRAWDAD dataset - factory channel gain measurements - *June 13, 2016*

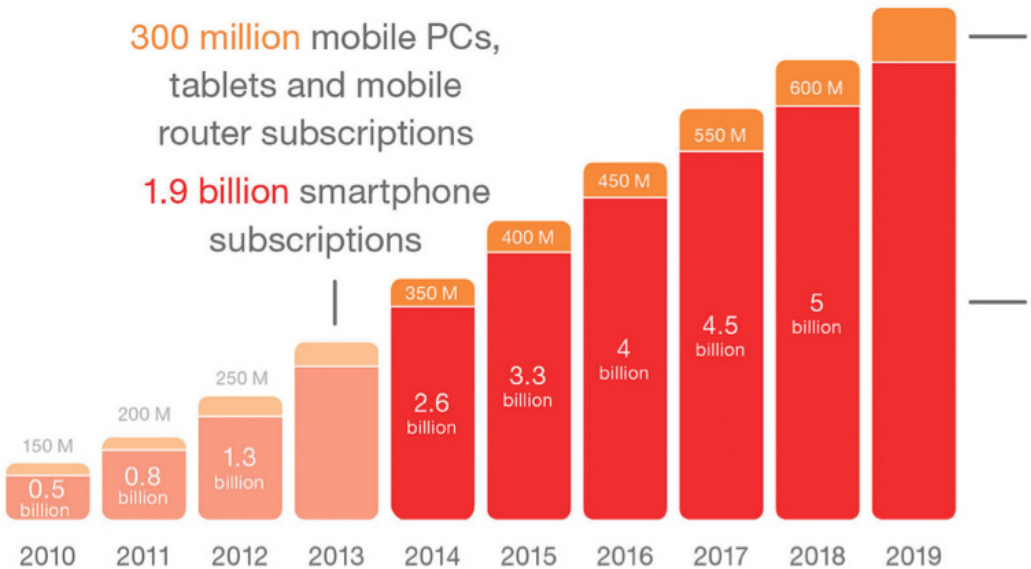
A new version of the init/factory dataset has been added to CRAWDAD.
init/factory

Contributed by Dimitri Block, Niels Hendrik Fliedner, Uwe Meier.

Measurement of the channel gain for multiple distances within a factory environment. There are two new tracesets in this version.

If you do use these data, please let us know, and you can use the DOI 10.15783/C76S3K to do so. BibTeX and RIS are provided on the website

Smartphones, mobile PCs, tablets and mobile routers with cellular connection



700 million mobile PCs, tablets and mobile router subscriptions

5.6 BILLION

smartphone subscriptions by the end of 2019

- Mobile PCs, tablets and mobile router subscriptions
- Smartphone subscriptions

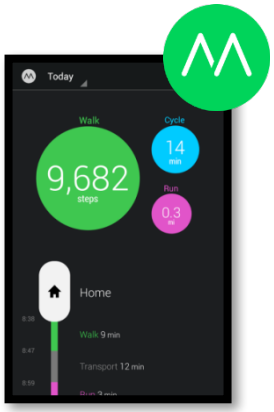
Crowd & sensing

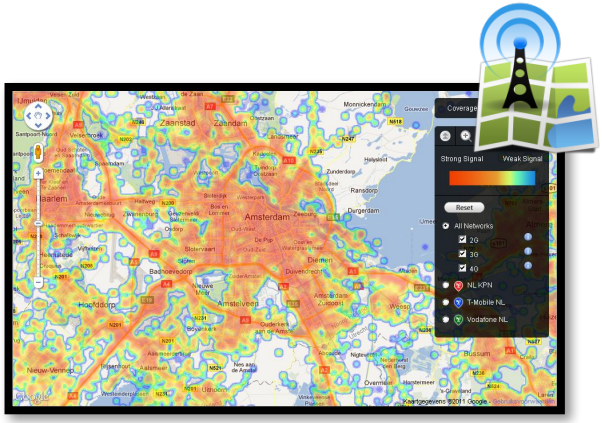
http://www.flickr.com/photos/40006794@N02/7223572802/

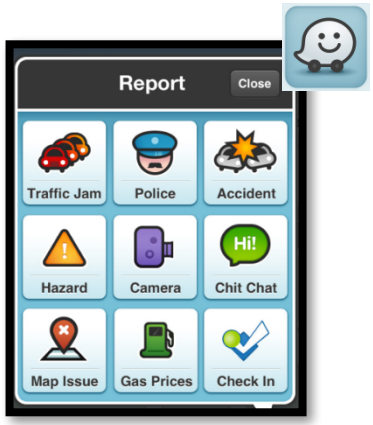
Crowd Sensing | kraʊdːsɛnsɪŋ |

*«Capability of lifting a (large) diffuse **group of participants** to delegate the task of retrieving **trustable data** from the field. This includes:*

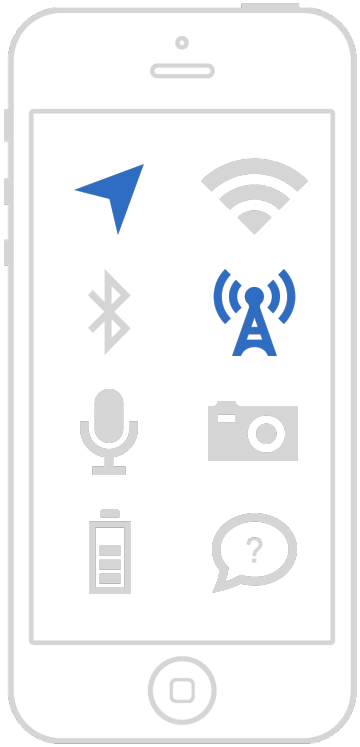
- **Participatory sensing** *involves the user in the sensing task (eg. surveys)*
- **Opportunistic sensing** *uses mobile sensors carried by the user (eg. Smartphones)»*

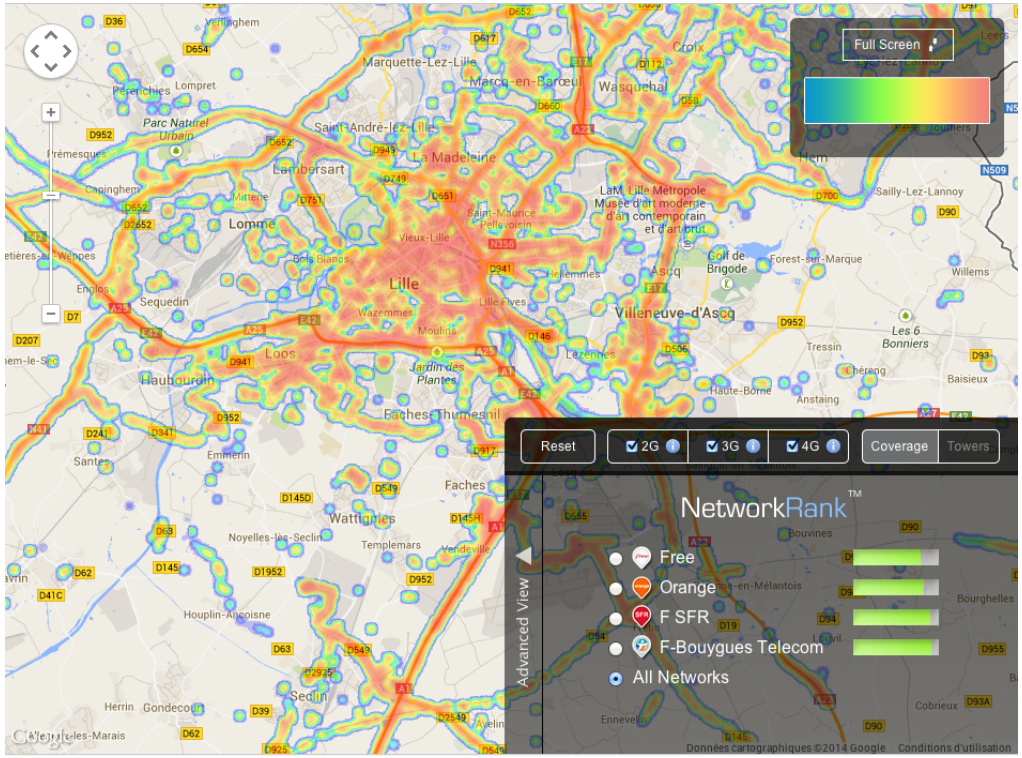






Applications to data visualisation



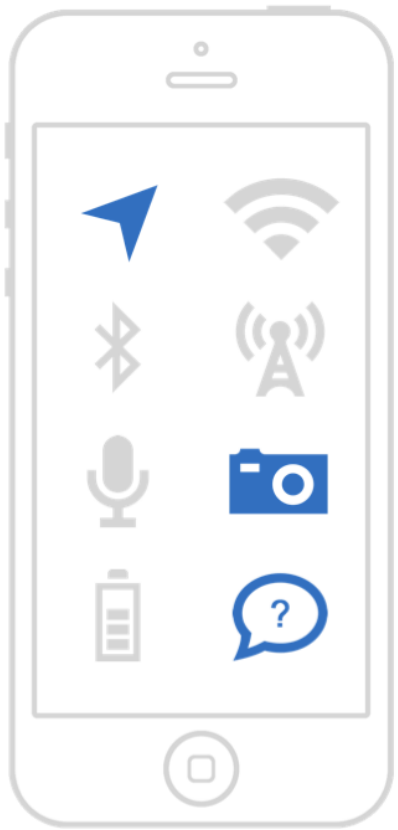


source: http://opensignal.com

Applications to IoT monitoring

source: http://goo.gl/xw8huo

Applications to crowdsourcing



source: http://fr.clicandwalk.com

apisense

Mobile Crowd Sensing made easy!

http://apisense.io

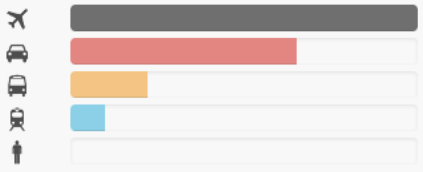
Xperium : Mobility Analysis

xperium.apisense.io

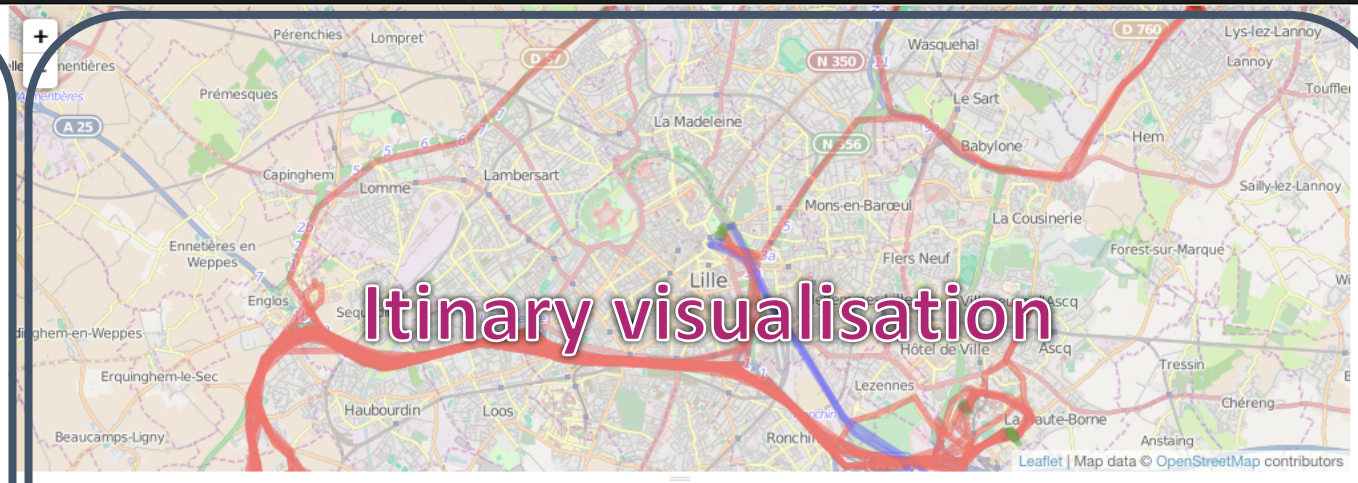
Carbon Footprint Calculator | About | Cycle paths | Clusters | 1d62ced10737cebe0b1723eddd3bb5c9

97.8 kg eq. CO_2

0.12 kg eq. CO_2 per km



Carbon footprint



Itinary visualisation

2013-12-28 — 2015-02-1

Reports

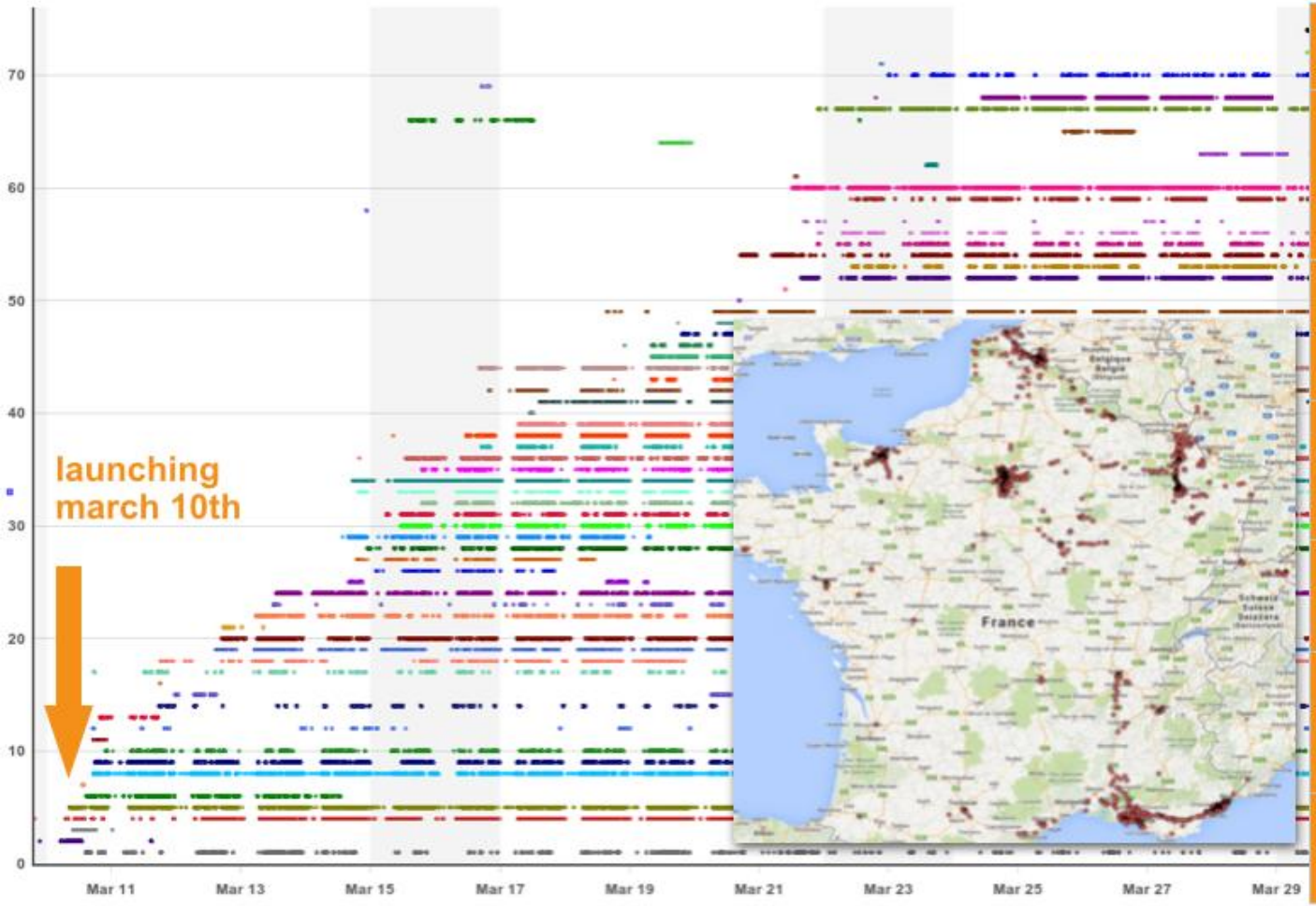
Transport	Distance (km)	Aggregated rides	Total emission (kg eq. CO_2)
walking	0.491	2	0.0
car	19.801	2	5.1
walking	0.347	2	0.0
undefined	0.201	1	0.0
car	[illegible]	[illegible]	[illegible]
walking	0.457	2	0.0
undefined	0.202	1	0.0
walking	0.596	3	0.0
car	19.263	2	4.9

Transport classification

Android app
for collecting data

PRACTIC : Human Analysis

PRACTIC jeu-concours (march 10th - april 21th 2014)

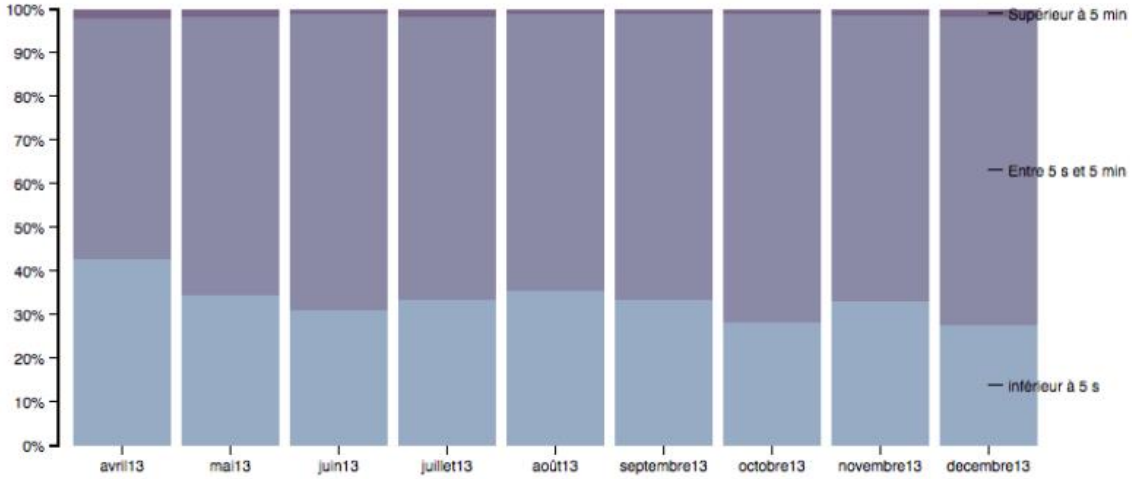


All Campaigns (except Caen)

112 371 of data	or 39 days of data per user (average)
97 volunteers	Of which : - 64 % male - 80 % age under 30 - 73 % single - 35% income < 1500€/m.
68 % of students	Of which : - 43% Computer Sc./ ingeneers - 22% Communication
14 device brands	Of which : - 41% Samsung - 24% LGE - 12%Sony
48 device models	Of which : - 12% LGE Nexus 5
13 telecom operators	Of which : - 77% Free, Orange, Bouygues and SFR; - 12% unknown
14 Androïd versions	Of which : 26% in 4.4.2

Frequency and duration of sessions on a smartphone and a tablet

(occurrences of the number of sessions according to 3 levels of duration)



Jeu de données d'un smartphone

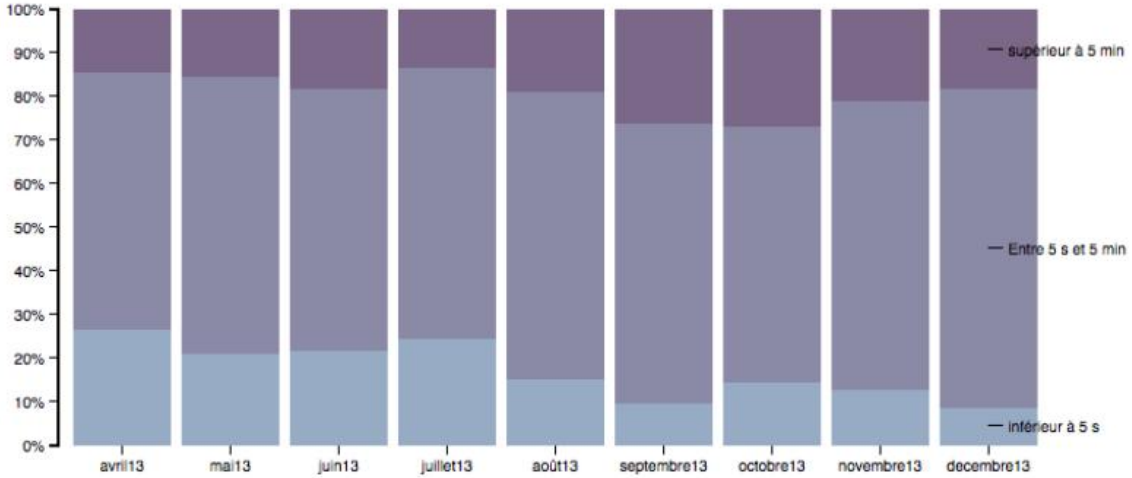
Première donnée le 19 avril 2013

- Avril : 2371 sessions sur 12 jours
- Mai : 3579 sessions sur 25 jours
- Juin : 1000 sessions sur 4 jours
- Juillet : 7090 sessions sur 31 jours
- Août : 5507 sessions sur 29 jours
- Septembre : 8304 sessions sur 30 jours
- Octobre : 8188 sessions sur 31 jours
- Novembre : 6287 sessions sur 30 jours
- Décembre : 4867 sessions sur 26 jours

Soit une présence de 218 jours sur 257 (84.82%) pour 47193 sessions

Moyenne par jour : 216.5 sessions

Ecart-type par jour : 89.03



Jeu de données d'une tablette

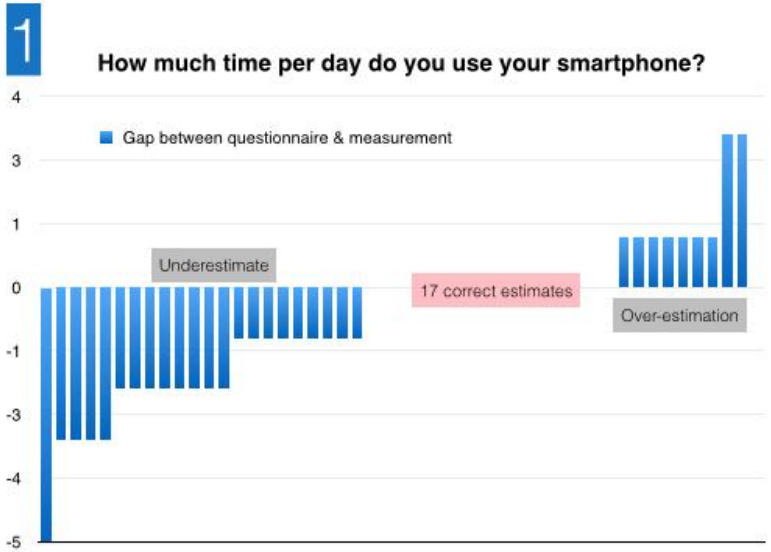
Première donnée le 11 avril 2013

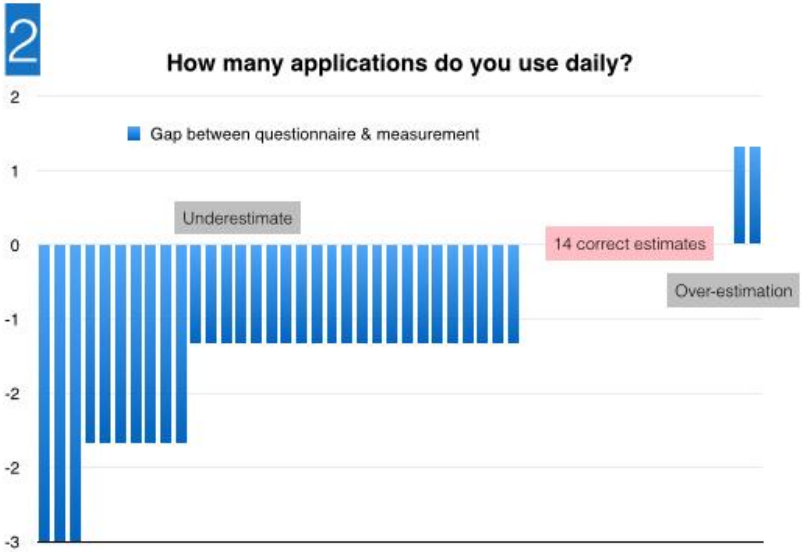
- Avril : 561 sessions sur 16 jours
- Mai : 824 sessions sur 29 jours
- Juin : 513 sessions sur 27 jours
- Juillet : 688 sessions sur 25 jours
- Août : 449 sessions sur 24 jours
- Septembre : 387 sessions sur 29 jours
- Octobre : 288 sessions sur 27 jours
- Novembre : 338 sessions sur 21 jours
- Décembre : 218 sessions sur 26 jours

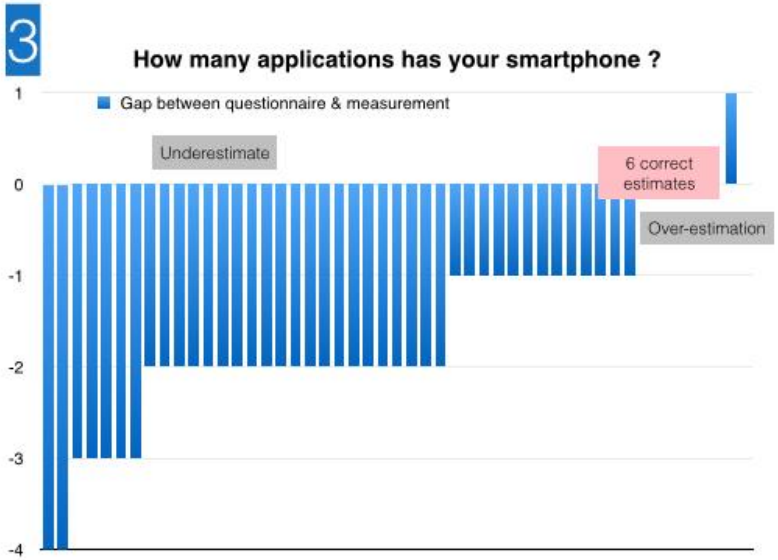
Soit une présence de 224 jours sur 265 (84.5%) pour 4266 sessions

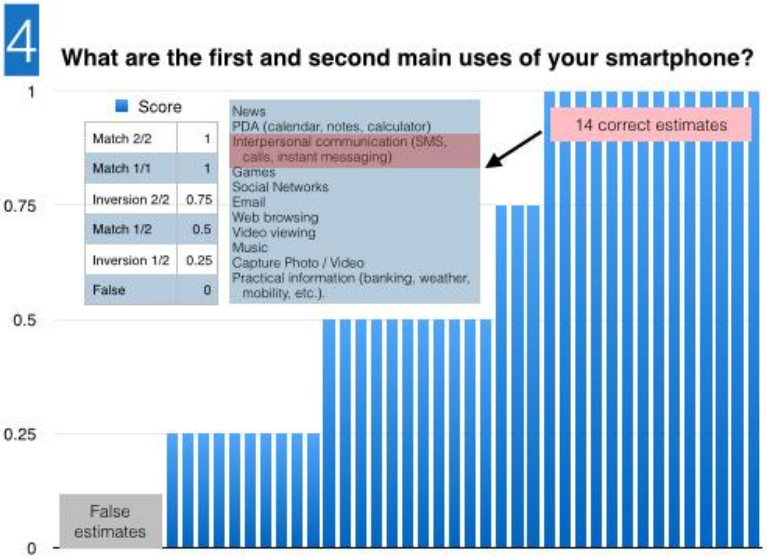
Moyenne par jour : 19 sessions

Ecart-type par jour : 17.34

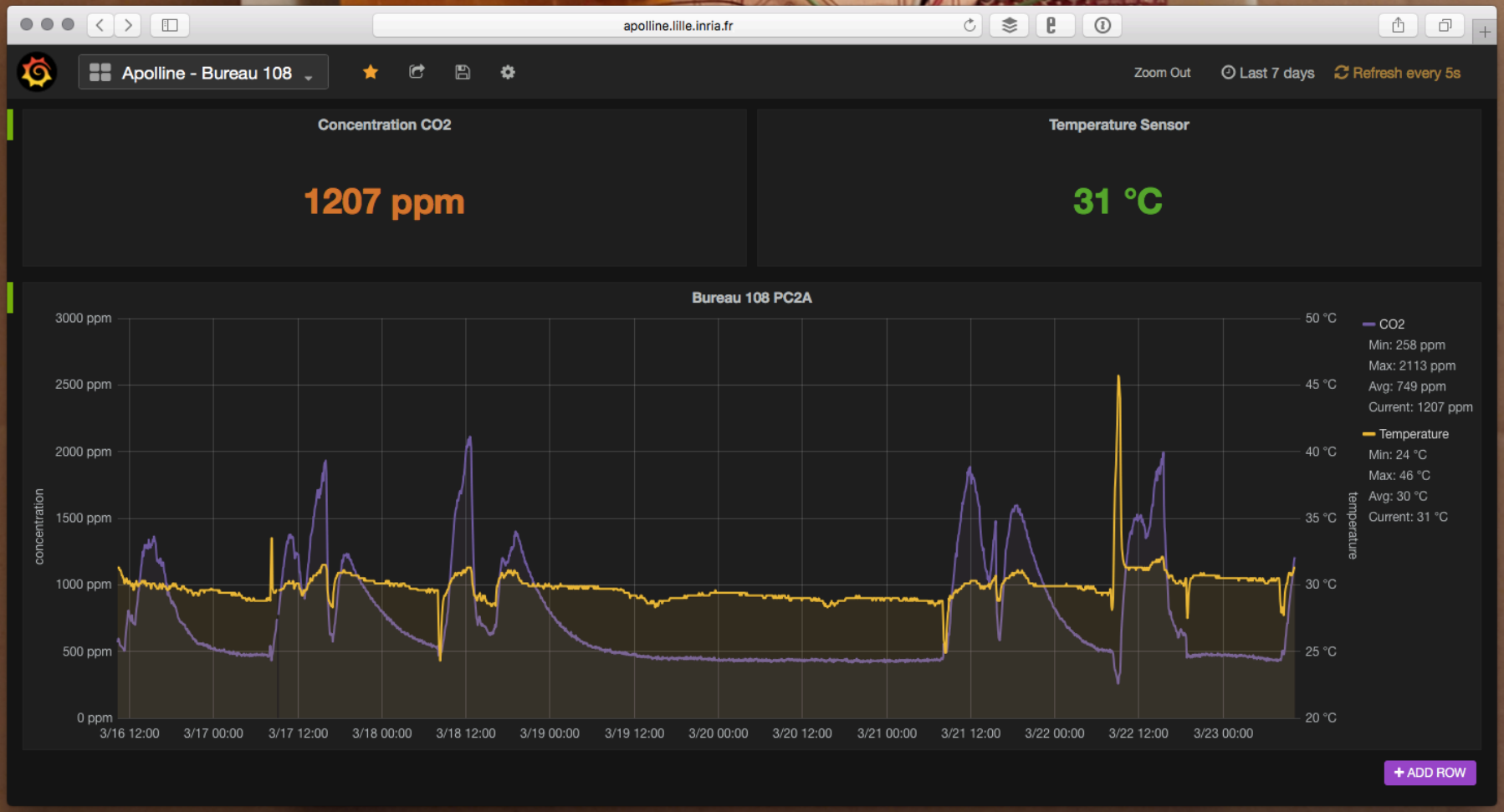

1
How much time per day do you use your smartphone?
Gap between questionnaire & measurement
4
3
1
0
-1
-3
-4
-5
Underestimate
17 correct estimates
Over-estimation

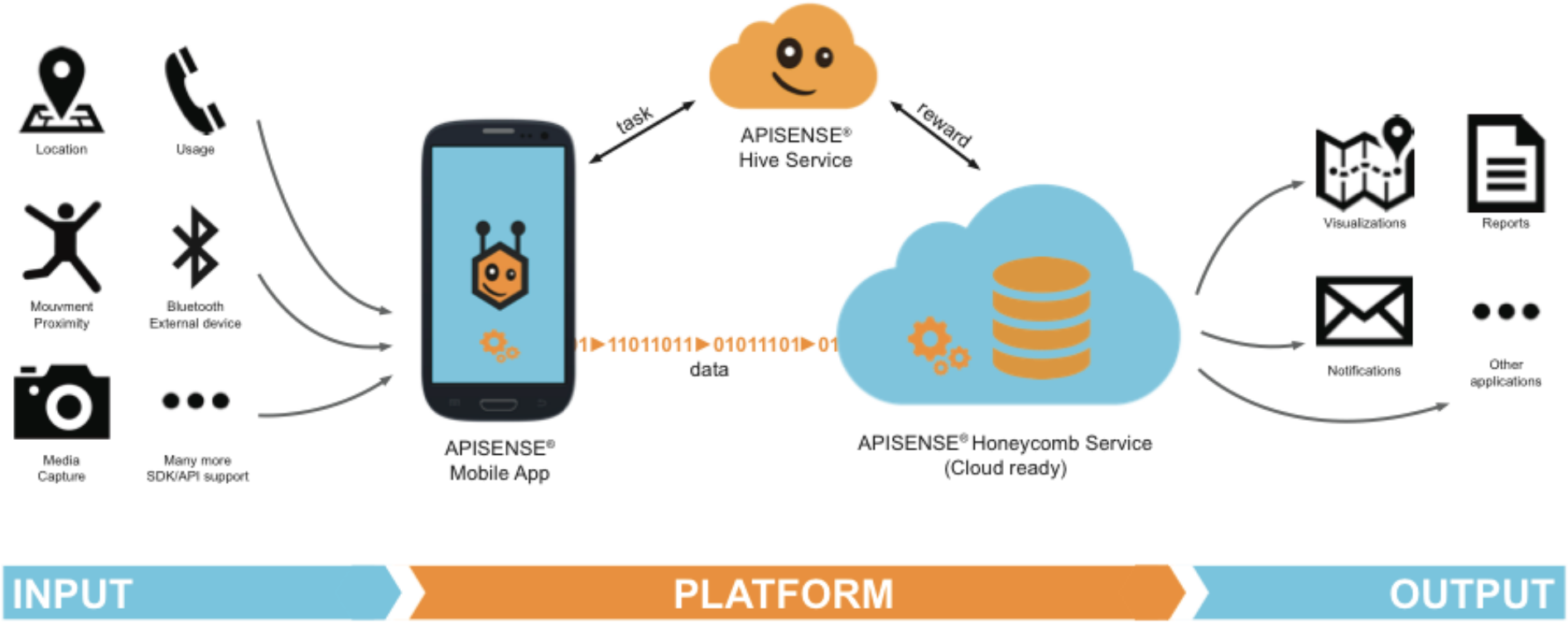

2
How many applications do you use daily?
Gap between questionnaire & measurement
2
1
0
-1
-2
-2
-3
Underestimate
14 correct estimates
Over-estimation


3
How many applications has your smartphone ?
Gap between questionnaire & measurement
1
0
-1
-2
-3
-4
Underestimate
6 correct estimates
Over-estimation


4
What are the first and second main uses of your smartphone?
Score
Match 2/2 1
Match 1/1 1
Inversion 2/2 0.75
Match 1/2 0.5
Inversion 1/2 0.25
False 0
News
PDA (calendar, notes, calculator)
Interpersonal communication (SMS, calls, instant messaging)
Games
Social Networks
Email
Web browsing
Video viewing
Music
Capture Photo / Video
Practical information (banking, weather, mobility, etc.).
14 correct estimates
1
0.75
0.5
0.25
0
False estimates

OSCAR : Air Quality Analysis




Location
Usage
Mouvment
Proximity
Bluetooth
External device
Media
Capture
Many more
SDK/API support
APISENSE®
Mobile App
task
APISENSE®
Hive Service
reward
1▶11011011▶01011101▶01
data
APISENSE® Honeycomb Service
(Cloud ready)
Visualizations
Reports
Notifications
Other
applications
INPUT
PLATFORM
OUTPUT

privacy
energy
incentives
security
smartphone
data
crowd
human
transparency
participants
feedback
SaaS
ranking
GPS
sensors
governance
visualisation
devices
deployment
recruitment
signal
sensing
cloud
iOS
STB
rewards
activity
pervasive
awareness
network
sensitization
Big Data
location
open
mobile
noise
log
prediction
physics
battery
software
phone
platform
Windows~Phone
Android
ubiquitous
scalability
transparency
energy
ranking
security
visualisation
privacy
GPS
middleware
incentives
devices
smartphone
recruitment
deployment
sensors
open
GPS
sensing
crowd
mobile
signal
governance
noise
log
battery
prediction
sensitization
software
visualisation
Android
ubiquitous
scalability
platform
pervasive
activity
cloud
location
privacy
Big Data
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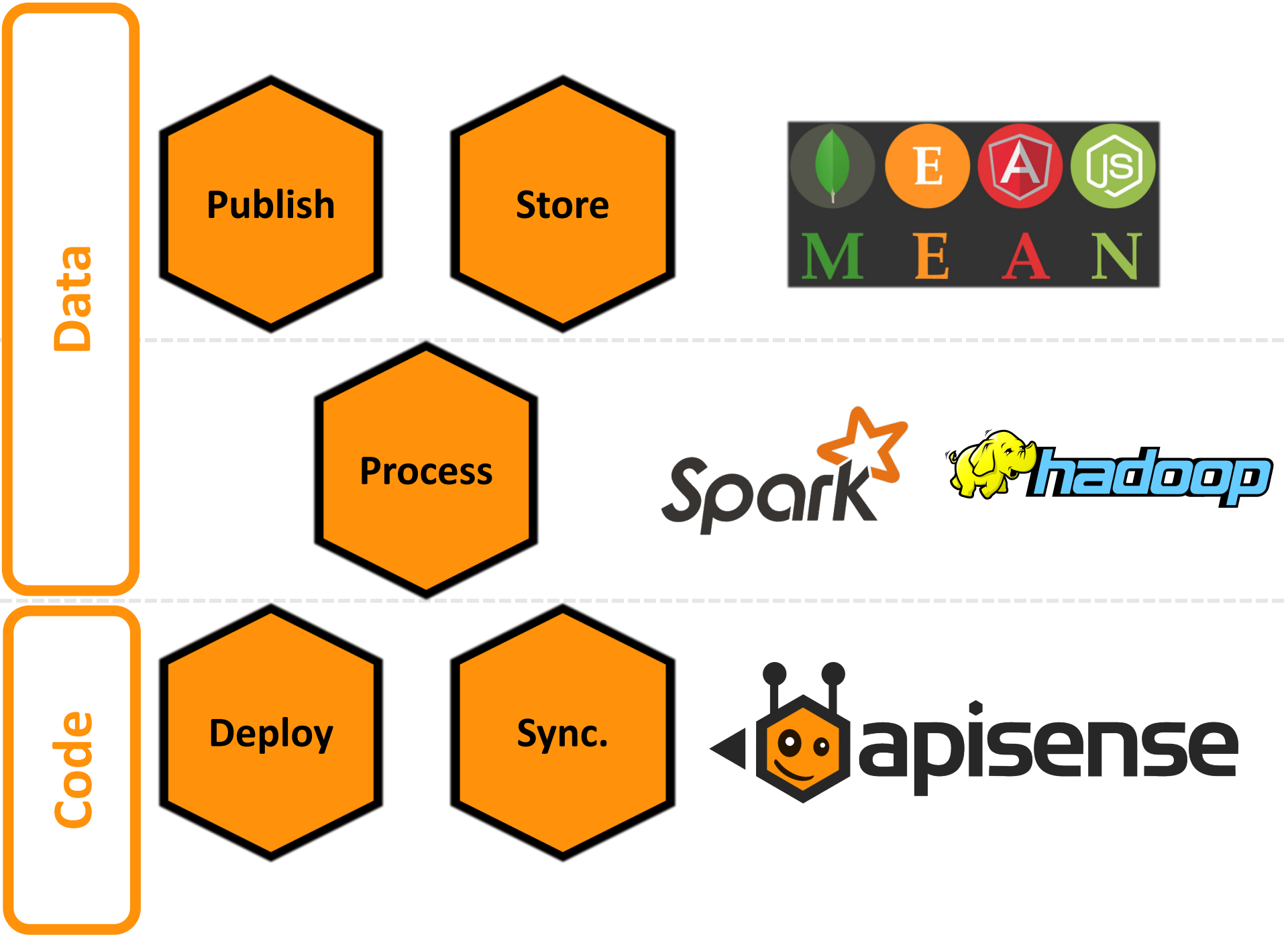
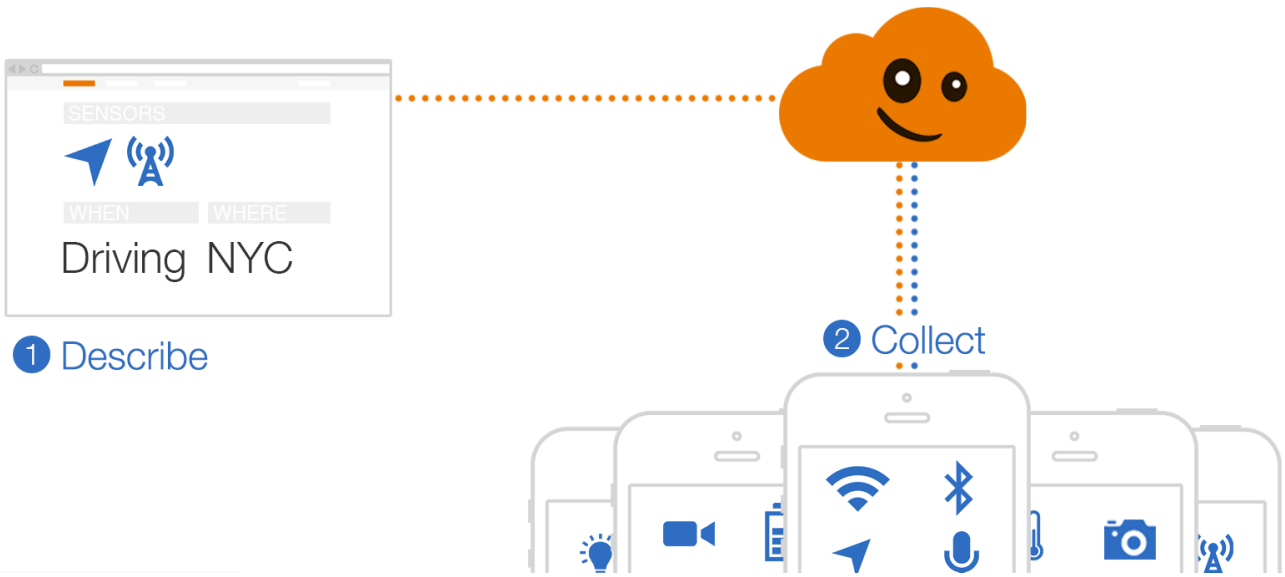
network
phone
open
STB
location
noise
physics
SaaS
human
log
prediction
physics
battery
noise


Data
Publish
Store
MEAN
Process
Spark
hadoop
Code
Deploy
Sync.
apisense

How does it work?

How does it work?



Privacy & Energy

How does it work?

Privacy & Energy

play.google.com

Applications

Catégories

Accueil

Classements

Nouveautés

Mes applications

Acheter

Jeux

Famille

Choix de l'équipe

Compte

Mon activité Play

Ma liste de souhaits

Utiliser un code

Acheter une carte cadeau

Guide à l'usage des parents

Bee

APISENSE Outils

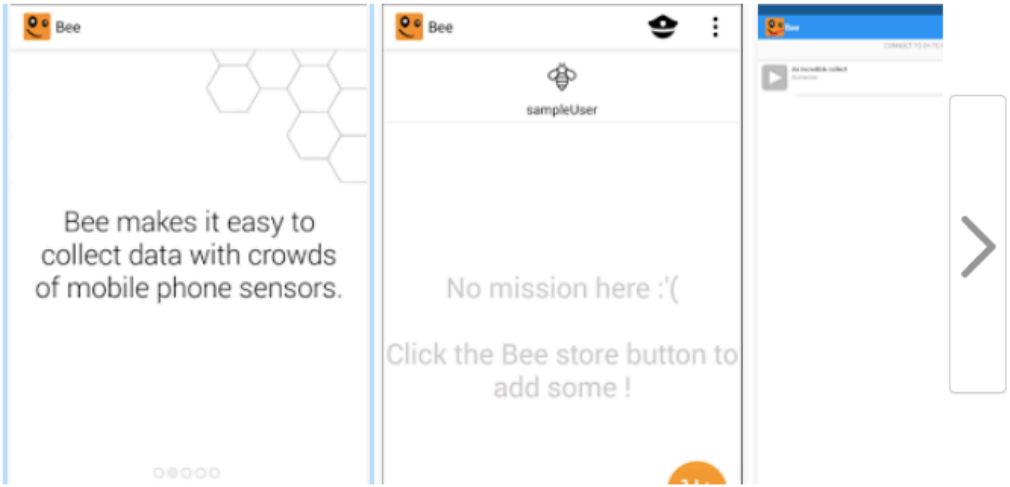
★★★★★ 3

PEGI 3

Vous ne disposez d'aucun appareil.

Ajouter à la liste de souhaits

Installer



Traduire la description en Français à l'aide de Google Traduction ?

Traduire

A crowdsensing solution.

Resources:

APISENSE Bee

Apps | My Apps | Updates | App Store

App Store > Utilities > Romain Rouvoy

APISENSE Bee 4+

Romain Rouvoy >

Details | Ratings and Reviews | Related

Get

This app is designed for both iPhone and iPad

Rating: 4+

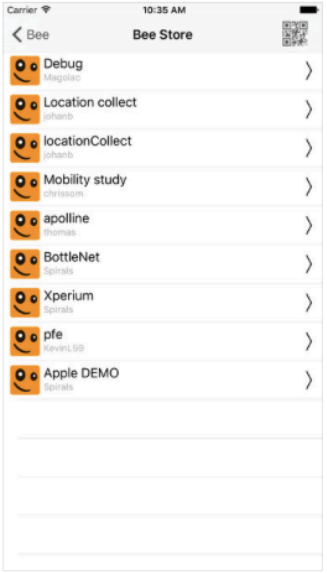
LINKS

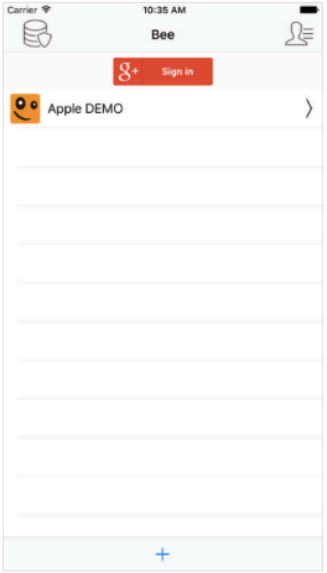
Developer Website

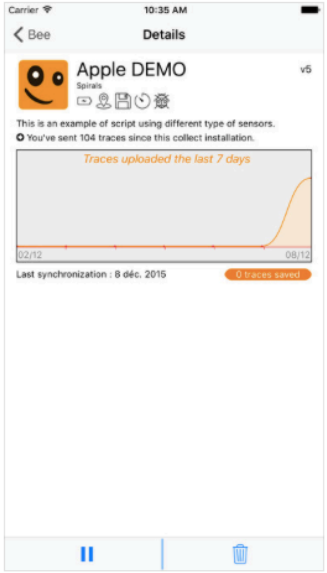
© 2013 APISENSE®

Screenshots

iPhone | iPad







apisense.io

apisense

Documentation Feedback Contact

Collect data easily with crowds of mobile phone sensors. Make sense and innovate on top of real world data feedback, in real time!

Login

Register

Spirals

••••••••••

Login

Forgot password?

Tweets by @APISENSE

APISENSE
@APISENSE
KevinL59 just published a collect called data-airflow-test2 ! Contribute with Bee at onelink.to/beeapisense
19 Apr

APISENSE
@APISENSE
KevinL59 just published a collect called data-mobility-test ! Contribute with Bee at onelink.to/beeapisense
14 Apr

APISENSE
@APISENSE

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ANDROID APP ON Google Play

Download on the App Store

apisense.io

apisense

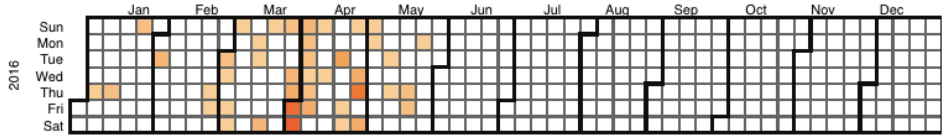
Create Spirals

Spirals INRIA

Spirals

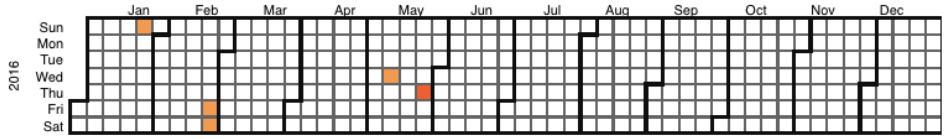
BottleNet

1 upload - 22/04/2016 | 4 ~ 217 KB | Public



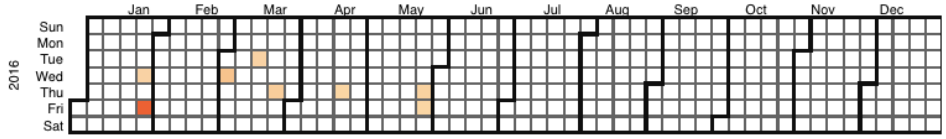
Xperium

Select a day | 6 ~ 1 MB | Public



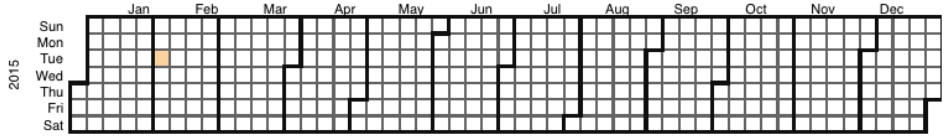
Apple DEMO

Select a day | 4 ~ 1 MB | Public



Xperium Lille - Backup from Romain

Select a day



apisense.io

apisense

Create Spirals

BottleNet | Summary | Statistics | Script | Filters | Settings

Crop panel

Test your network connection

Identifier	oPNPvJbwJ5Sv9qrBGZJ1
Visibility	Public
Version	3
Stings	
Created	17/07/2015 - 14:31
Updated	27/05/2016 - 09:01

Control panel

Stop and disable the crop on clients. They won't be able to start or subscribe anymore.

Data panel

Participants	4
Synchronizations	178
Collected data	217 KB
Last upload	26/05/2016 - 13:56

Download data

QRCode

The QRCode generated represents the crop's identifier. It can be used from the Bee application to install unlisted crops or manual installation.

Embed it on your own website:

```
<img src="apisense.io/crop/oPNPvJbwJ5Sv9qrBGZJ1/qrcode" alt="QRCode to access crop BottleNet"/>
```

Download

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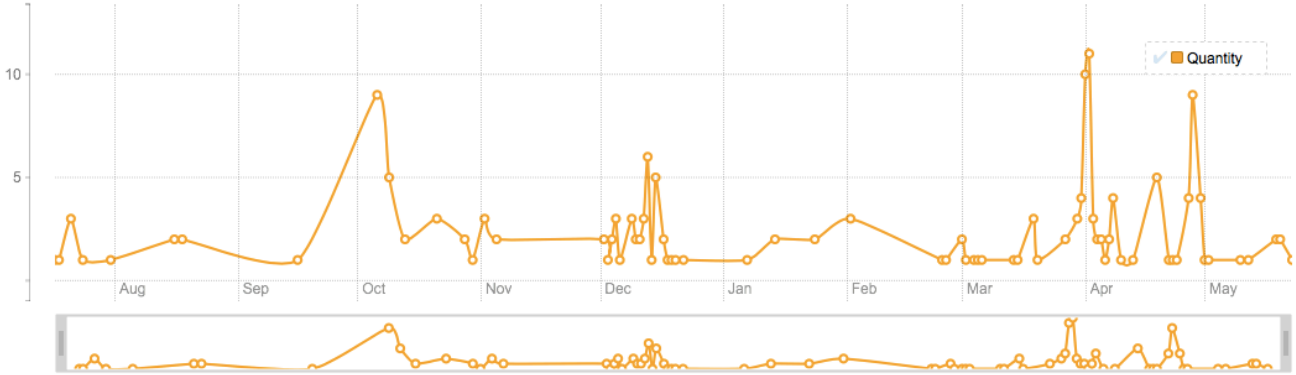
Create Spirals

BottleNet | Summary | Statistics | Script | Filters | Settings

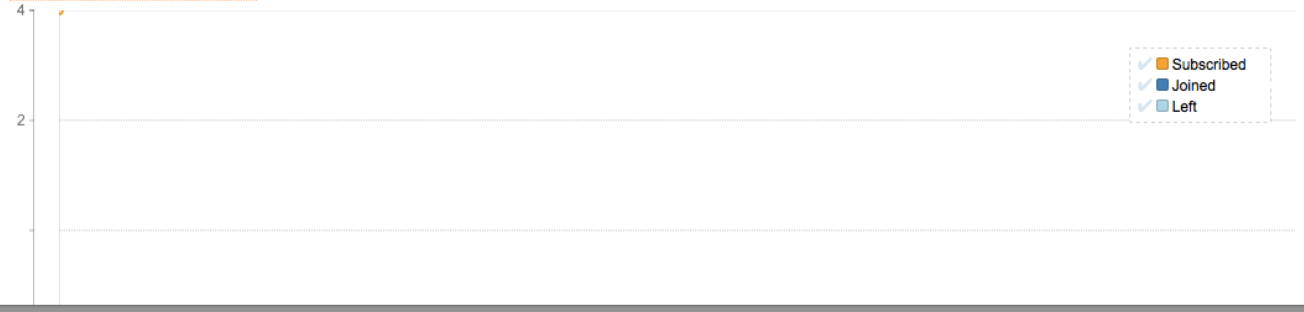
Collected data

Updated 26/05/2016 - 13:56



Subscribers evolution

Updated 26/05/2016 - 15:28



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Create Spirals

Xperium | Summary | Statistics | Script | Filters | Settings

Prod | v13 - 27/05/2016 11:01

APISENSE® API v1.6.0

```
var recorder = require("recorder");
var gps = require('location');
var battery = require('battery');

gps.onLocationChanged({mode: gps.PASSIVE, distance: 100}, funct
    recorder.save({
        'latitude': gps.latitude(),
        'longitude': gps.longitude(),
        'speed': gps.speed(),
        'accuracy': gps.accuracy()
    });
});

battery.onStateChanged(function(data) {
    recorder.sync();
});
```

Usage | Live documentation | Document

To improve your experience writing your crop, you
some of those shorcuts !

Shortcut	B
Ctrl+Shift+d	Deplo
Ctrl+s	Save
Ctrl+d	Show embed
Ctrl+Space	Call au
Ctrl+I	Dis
Alt+.	Jump
Alt+,	Ju
Ctrl+E	Find a
Ctrl+Shift+E	F

✔ Ready

8:33

Home

Classic soundtracks study
What kind of classic are you listening ?

Social interactions
This is my sweet collect

Metal soundtracks study
What kind of metal are you listening ?

apisense.io

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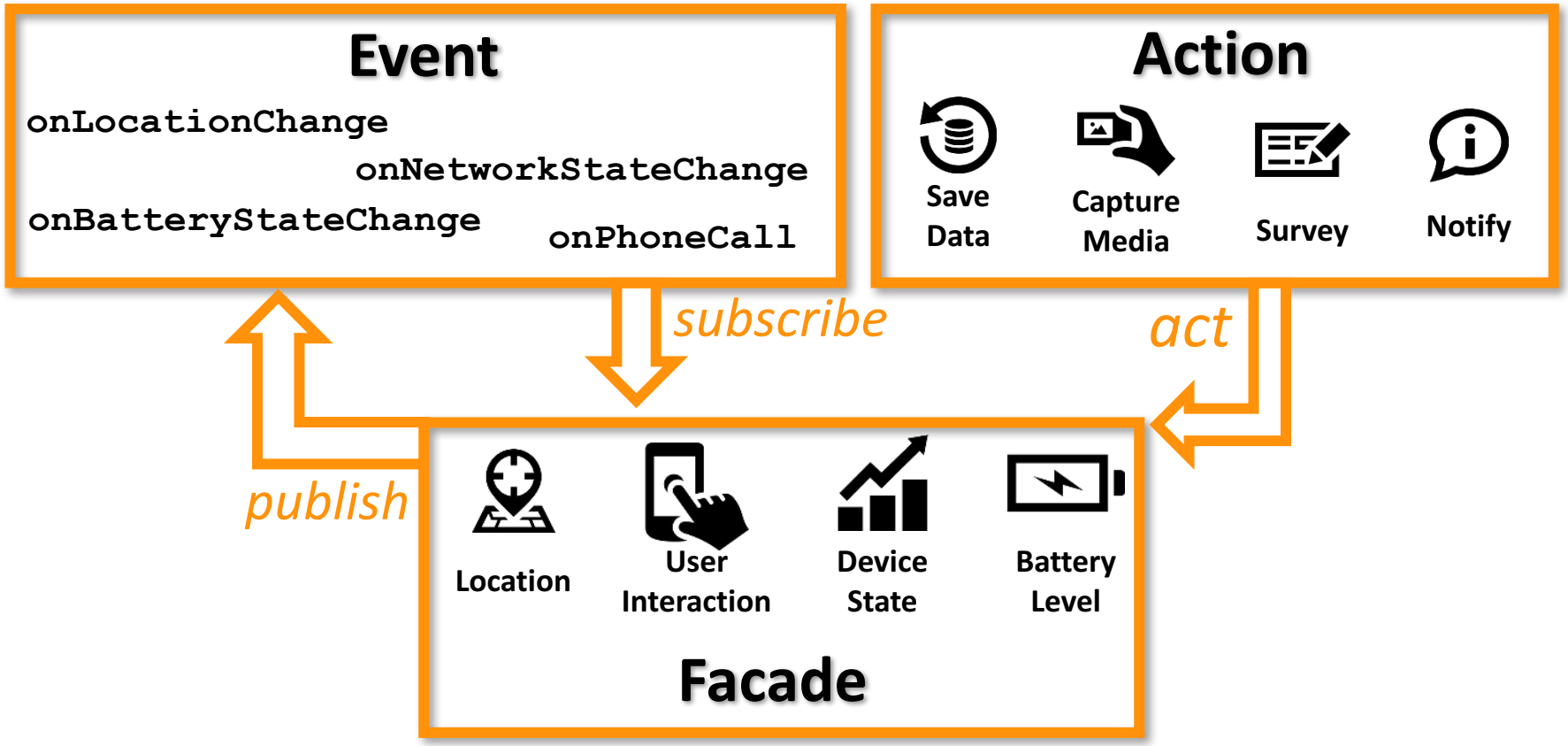
Create Spirals

Xperium | Summary | Statistics | Script | Filters | Settings

```
rest.prepareFilter("days", function(data){
  var result = [];
  var date;
  for each (var ele in data) {
    date = new Date(ele.metadata.timestamp);
    date.setHours(0);
    date.setMinutes(0);
    date.setSeconds(0);
    date.setMilliseconds(0);
    if (result.indexOf(date.toString()) == -1) {
      result.push(date.toString());
    }
  }
  return result;
});

rest.prepareFilter("byDay", function(data){
  var result = {};
  var date;
  for each (var ele in data) {
    date = new Date(ele.metadata.timestamp);
    date.setHours(0);
    date.setMinutes(0);
    date.setSeconds(0);
    date.setMilliseconds(0);
    if (result[date] === undefined) {
      result[date]= [];
    }
    result[date].push(ele.body);
  }
  return result;
});
```

✔ Ready

Device-level Sensing Task



Device-level Sensing Task

Façades

Event listener

Data upload

```
var location = requires('location');
var trace = requires('honeycomb');
var telephony = requires('gsm');

location.onLocationChange(function(event){

    trace.sync({
        lat : event.latitude,
        lng : event.longitude,
        signal : telephony.signalStrength()
    });
});
```

Crowd-scale Sensing Jobs

sense

```
sense(function( ) { … } )
```

---

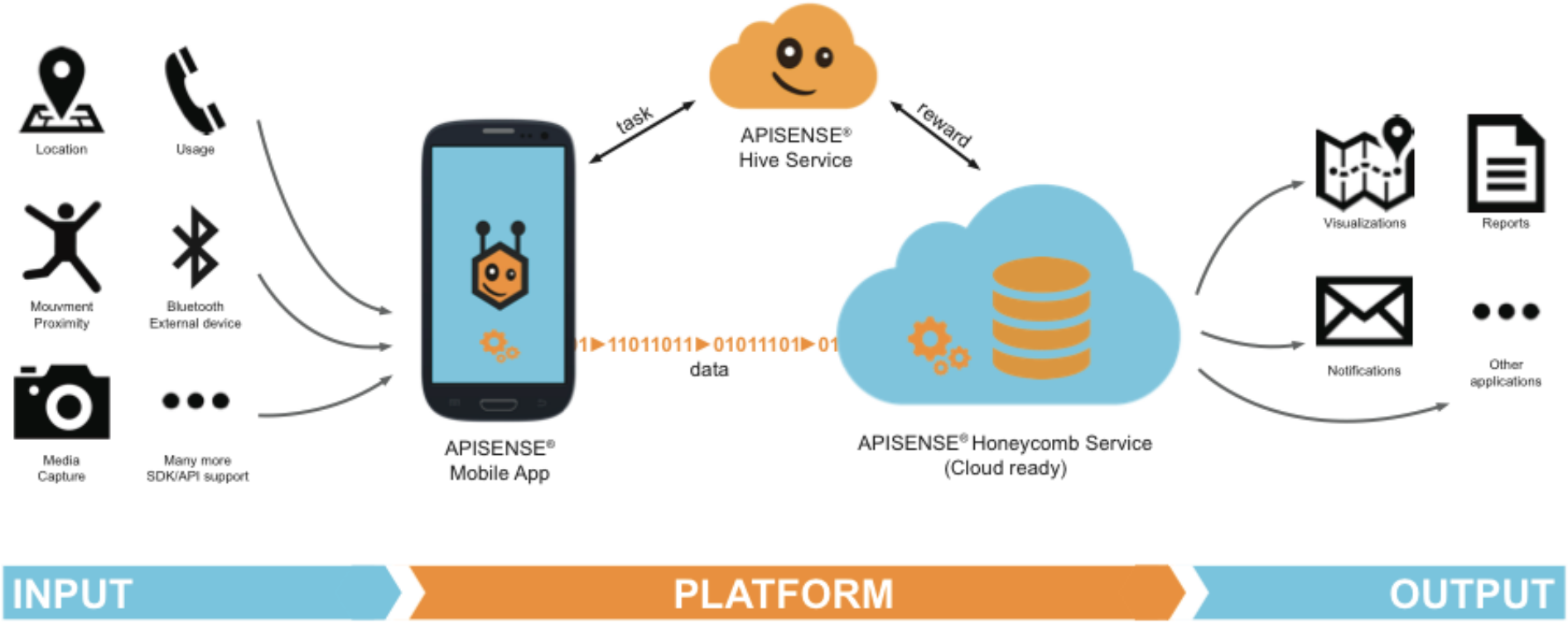
recruit

```
accept(function( ) {
   if (network.connectionType() == 'mobile')
      return {battery : battery.level()};
};

ranking(function(users){
   return users.sort('battery');
};
```

---

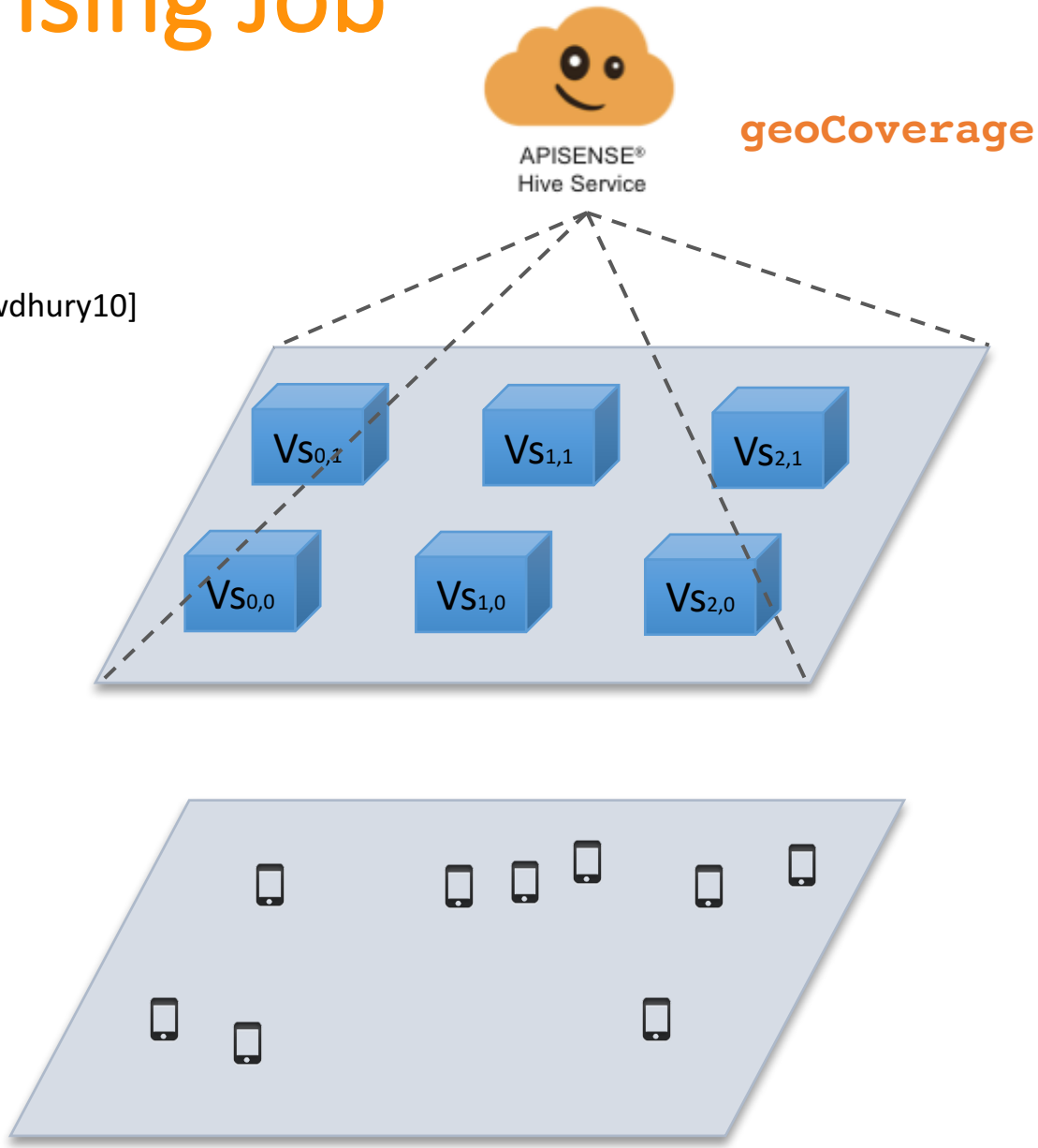
coverage

```
geoCoverage(
  [[50.614291,3.13282],[50.604159,3.15239]],
  '500 m');

timeCoverage('30 min','1 H');

duplicate(1);
```


Location
Usage
Mouvment
Proximity
Bluetooth
External device
Media
Capture
Many more
SDK/API support
APISENSE®
Mobile App
task
APISENSE®
Hive Service
reward
1▶11011011▶01011101▶01
data
APISENSE® Honeycomb Service
(Cloud ready)
Visualizations
Reports
Notifications
Other
applications
INPUT
PLATFORM
OUTPUT

Crowd-scale Sensing Job

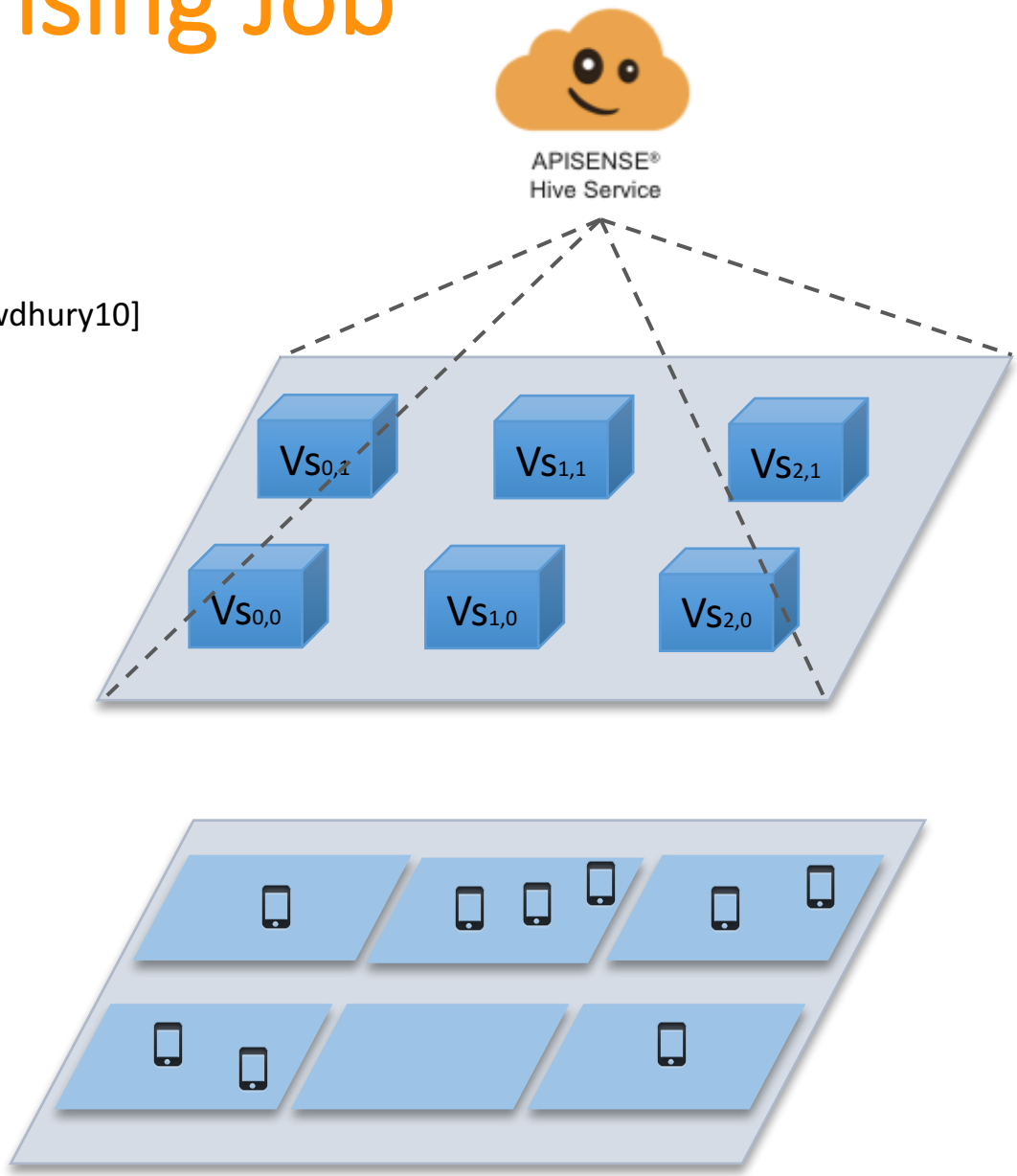
1. Virtual sensor deployment [Chowdhury10]



[Chowdhury10] **A survey of network virtualization**. *Computer Networks*. 2010

Crowd-scale Sensing Job

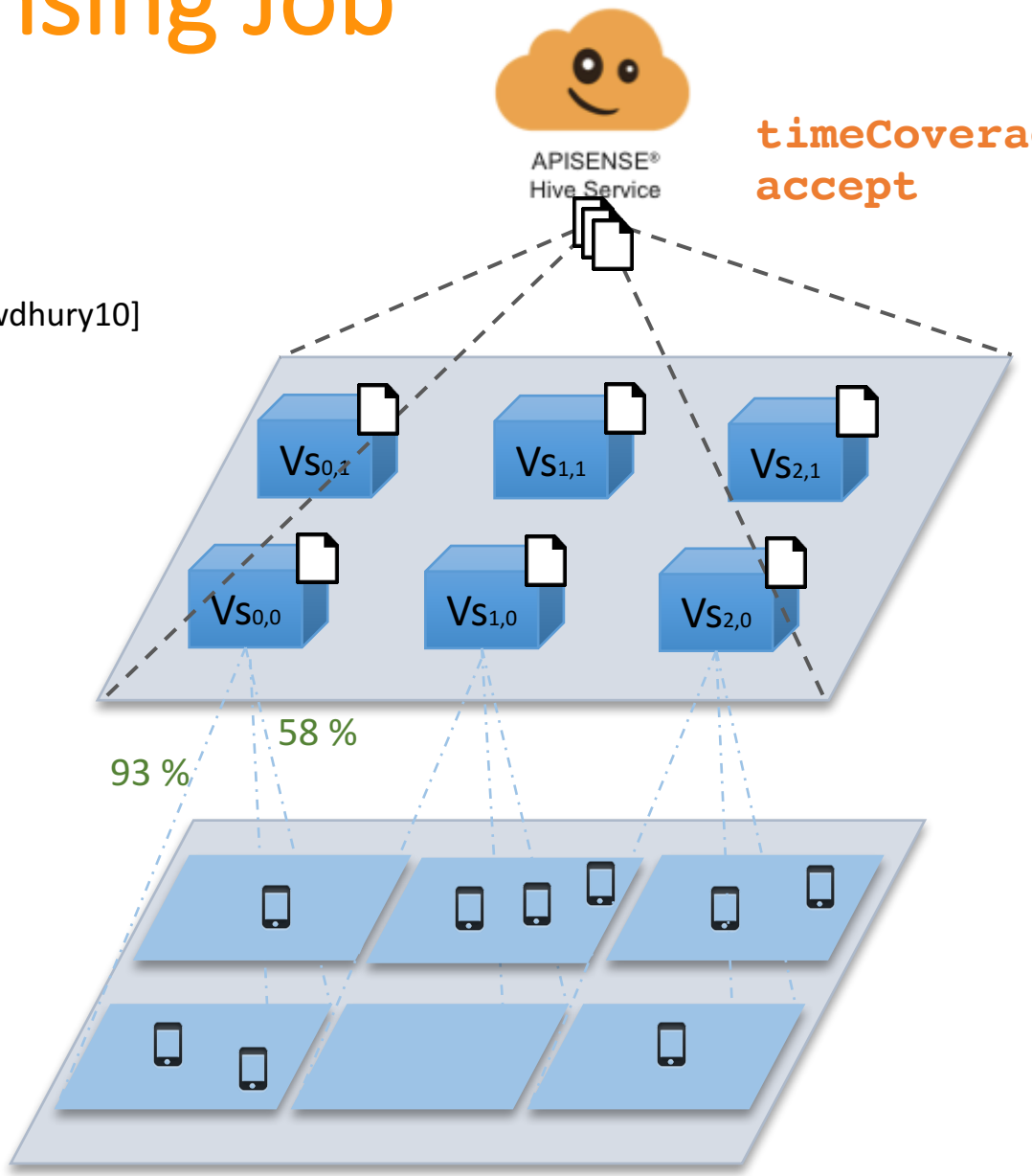
1. Virtual sensor deployment [Chowdhury10]
2. Connecting to physical devices



[Chowdhury10] **A survey of network virtualization**. *Computer Networks*. 2010

Crowd-scale Sensing Job

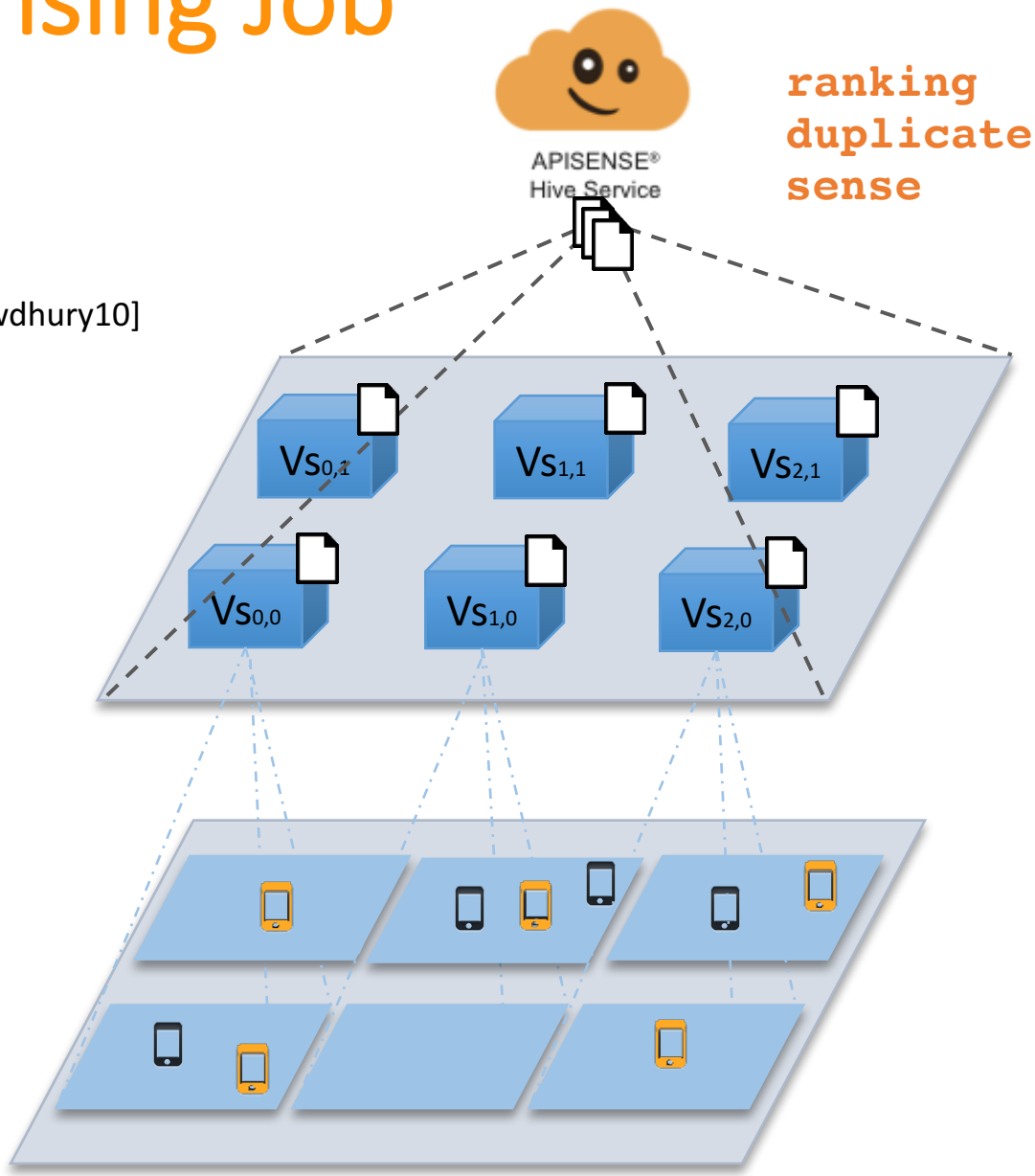
1. Virtual sensor deployment [Chowdhury10]
2. Connecting to physical devices
3. Assigning sensing tasks



[Chowdhury10] **A survey of network virtualization**. *Computer Networks*. 2010

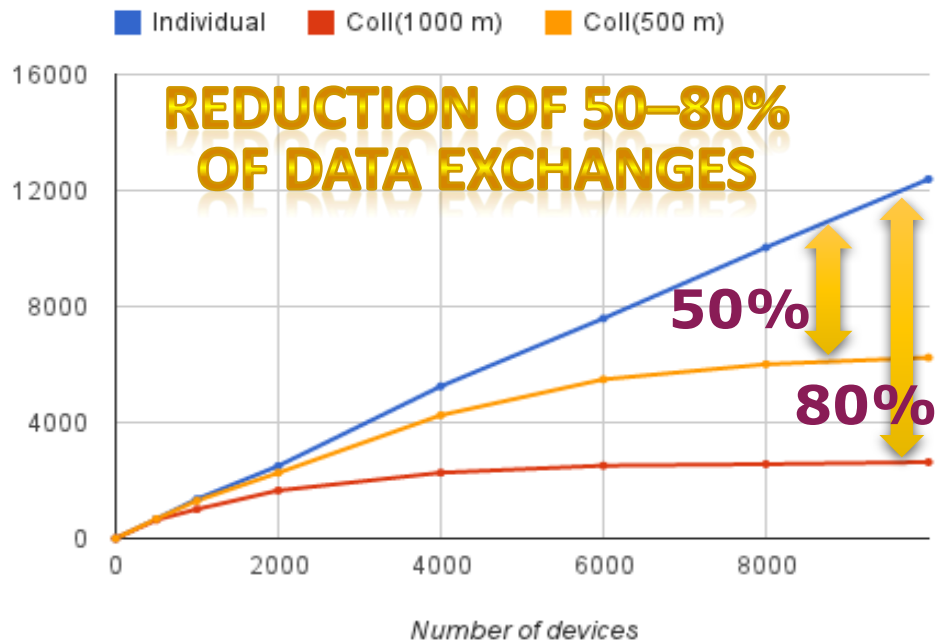
Crowd-scale Sensing Job

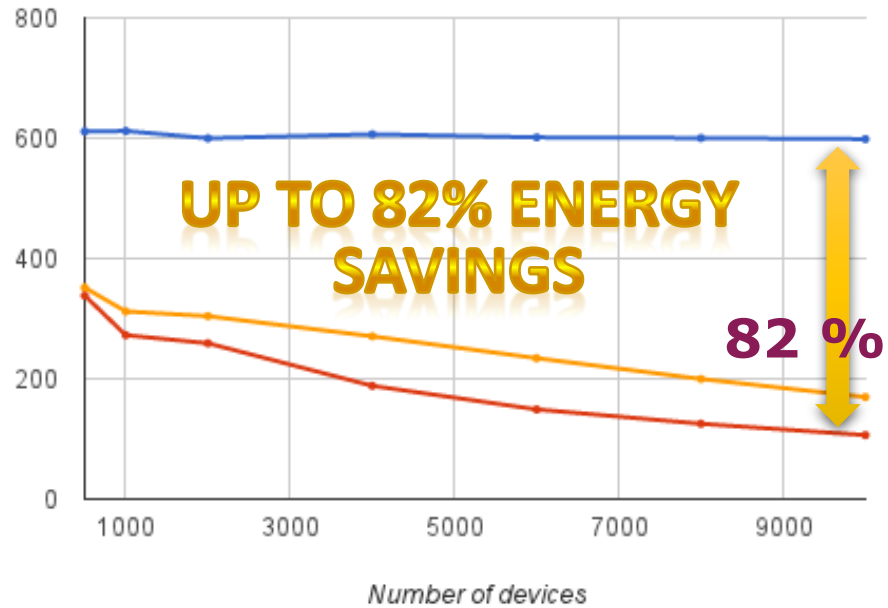
1. Virtual sensor deployment [Chowdhury10]
2. Connecting to physical devices
3. Assigning sensing tasks
4. Executing sensing tasks

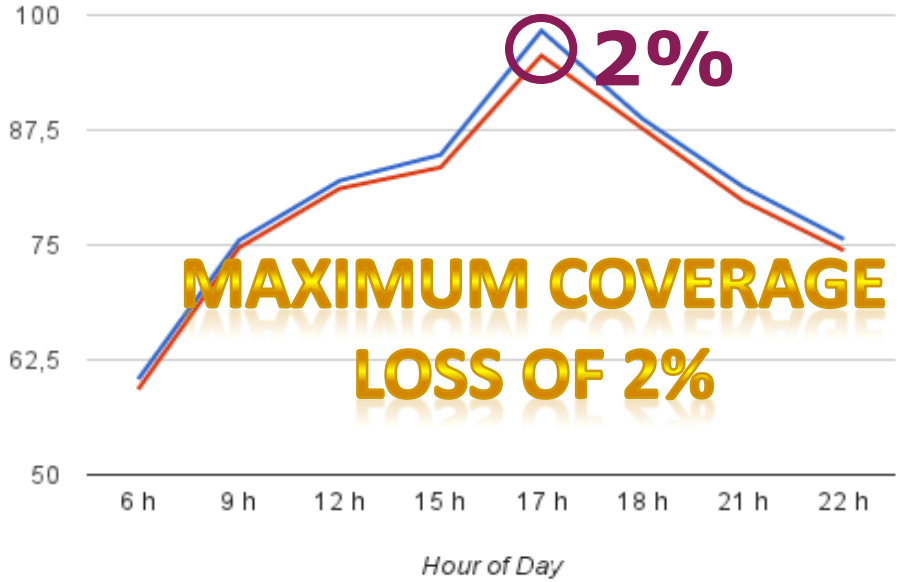


[Chowdhury10] **A survey of network virtualization**. *Computer Networks*. 2010

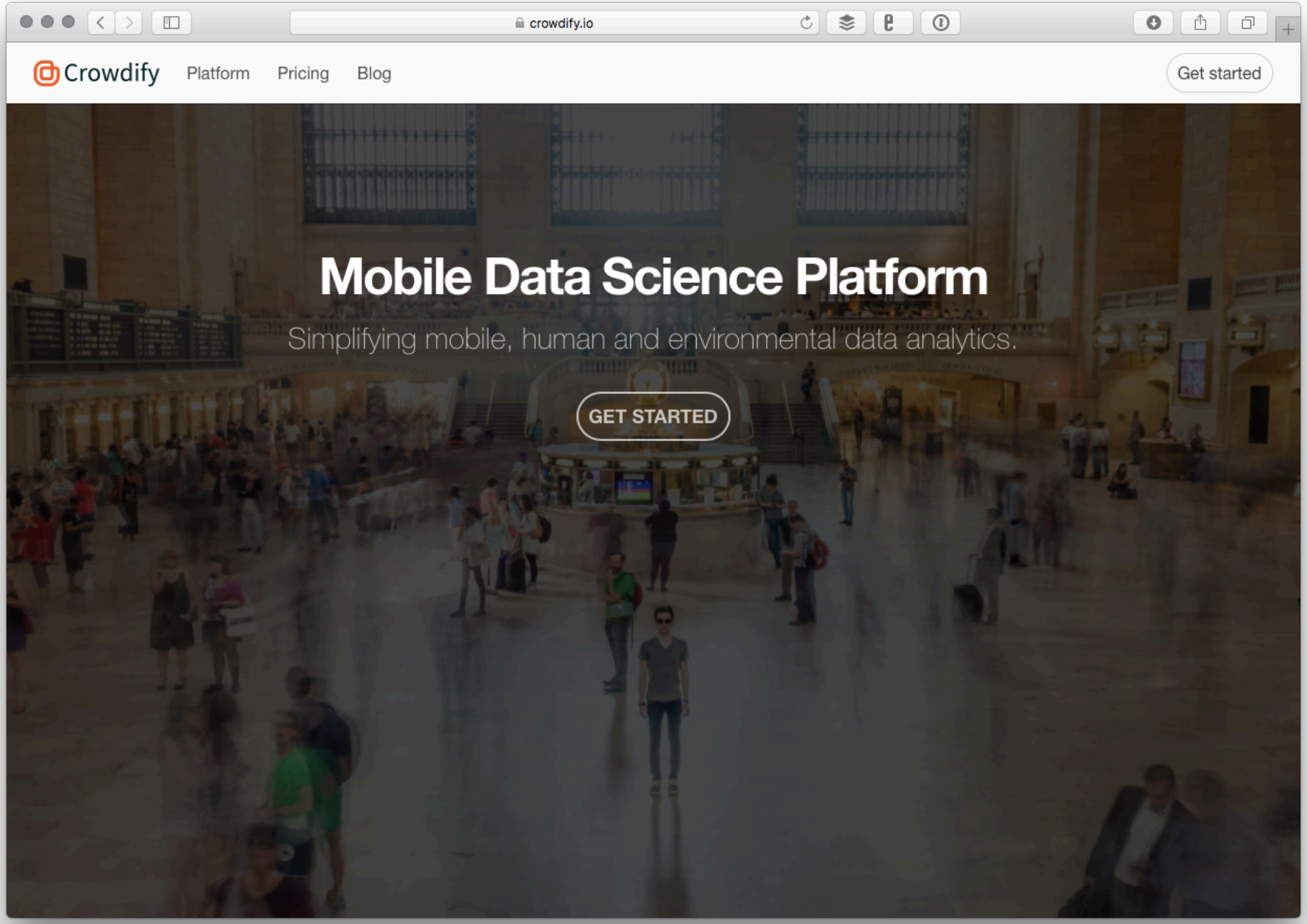
Evaluation of APISENSE®







	W/B-Scanner opportunist	Citizen journalist participative
APISENSE®	**4**	**9**
Anonysense	5	N/A
Pogo	4	N/A
MyExperience	N/A	27
Medusa	N/A	45
PRISM	??	330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Blog
Get started
Mobile Data Science Platform
Simplifying mobile, human and environmental data analytics.
GET STARTED

apisense

http://apisense.io

Book chapters

A Cloud-based Infrastructure for Crowdsourcing Data from Mobile Devices. N. Haderer, F. Paraiso, C. Ribeiro, P. Merle, R. Rouvoy, L. Seinturier. Cloud-based Software Crowdsourcing, Springer, 2014

Workshops

A preliminary investigation of user incentives to leverage crowdsensing activities. N.Haderer, R. Rouvoy and L. Seinturier. 2nd International IEEE PerCom Workshop on Hot Topics in Pervasive Computing (PerHot) (2013), pp. 199-204.

Towards Multi-Cloud Configurations Using Feature Models and Ontologies. C. Quinton, N. Haderer, R. Rouvoy and L. Duchien. 1st International Workshop on Multi-Cloud Applications and Federated Clouds (Multi-Cloud'13). April 2013, pp. 21-26.

Conferences

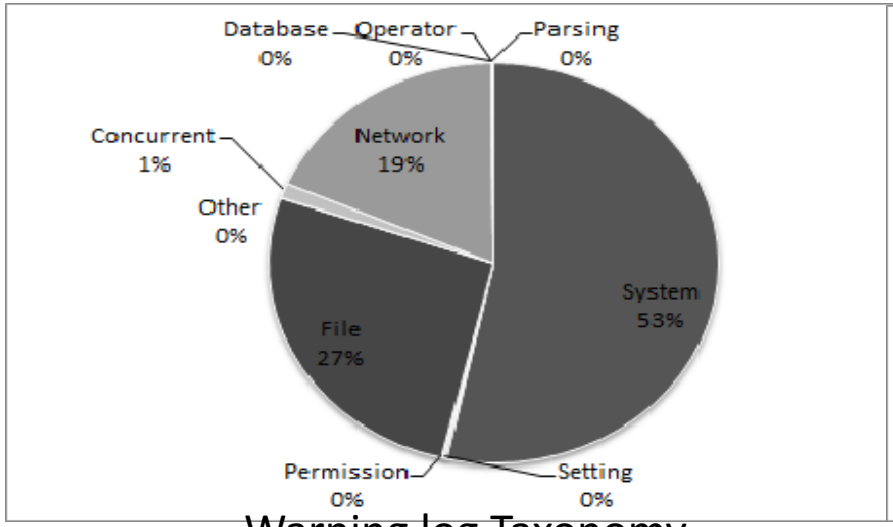
Dynamic Deployment of Sensing Experiments in the Wild Using Smartphones. N. Haderer, R. Rouvoy and L. Seinturier. 13th International IFIP 16 Conference on Distributed Applications and Interoperable Systems (DAIS), pages 43-56.

A Federated Multi-Cloud PaaS Infrastructure. Fawaz Paraiso, Nicolas Haderer, Phi- lippe Merle, Romain Rouvoy, Lionel Seinturier. In 5th IEEE International Confe- rence on Cloud Computing (2012), pages 392-399.

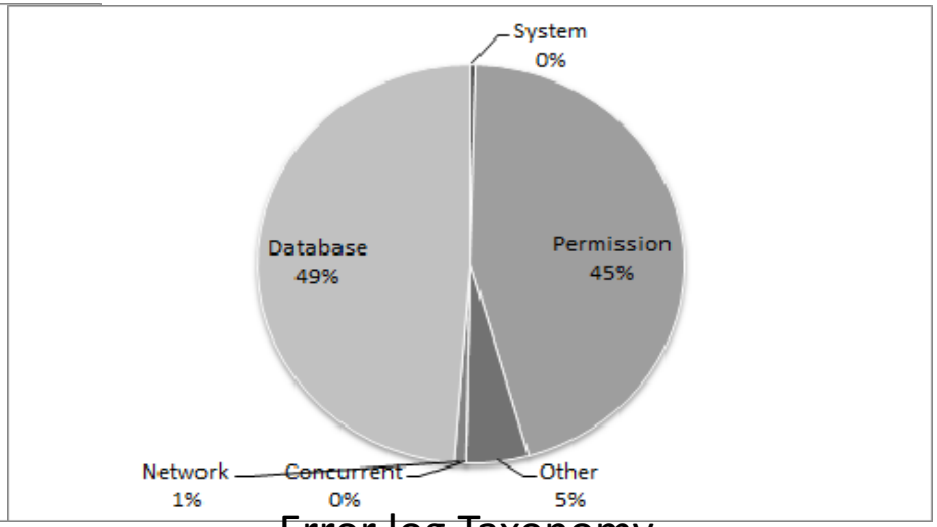
Dissemination

APISENSE : Crowd-Sensing Made Easy. Nicolas Haderer, Romain Rouvoy, Christophe Ribeiro, Lionel Seinturier. ERCIM News, ERCIM, 2013, Special theme : Mobile Computing, 93, pp. 28-29.

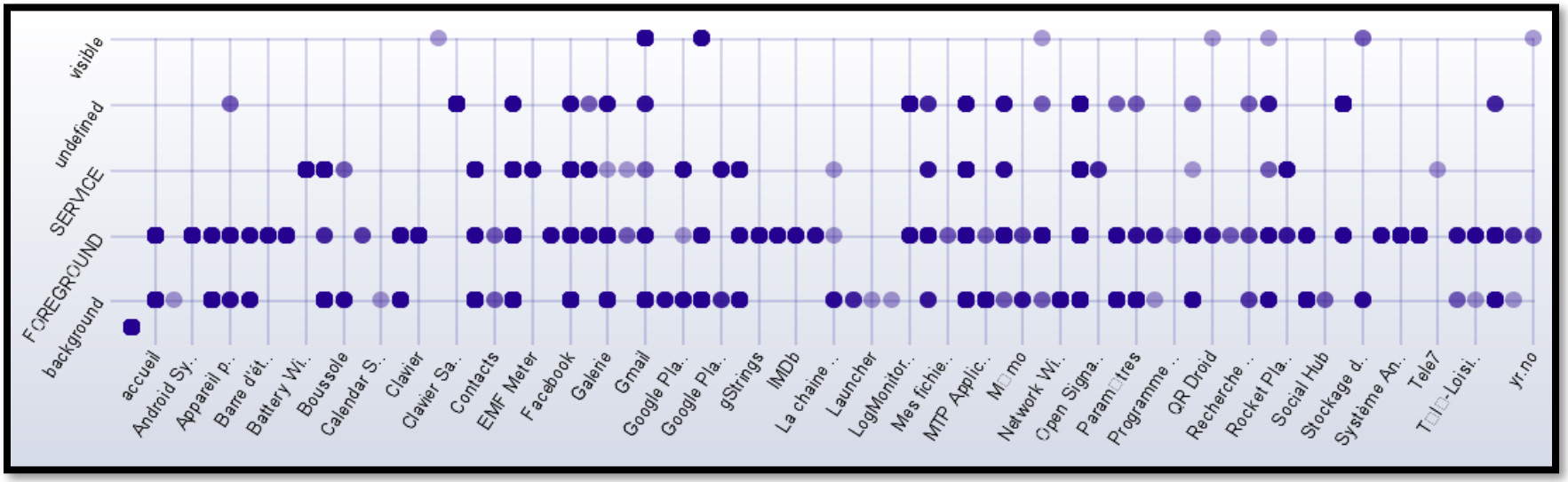
Collecting exception in the wild



Warning log Taxonomy



Error log Taxonomy



Assessing Machine Learning Models

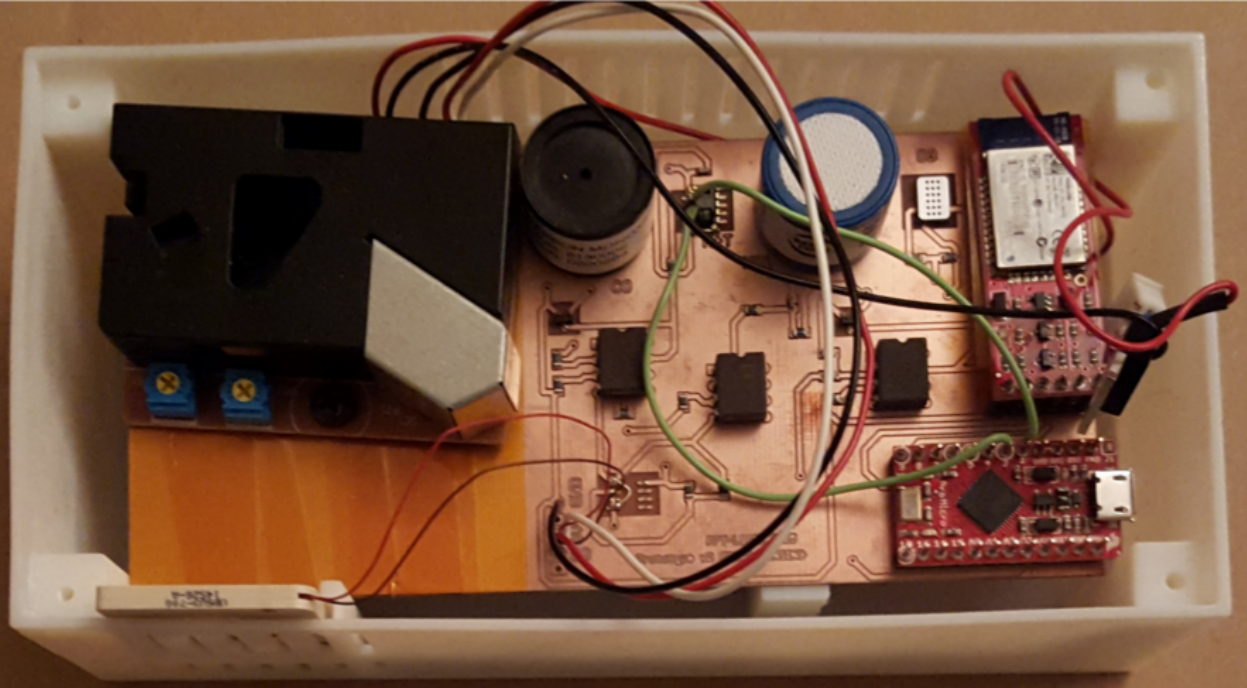
- User context recognition implementation : ~ 30 lines

```
...
accelerometer.onChange(function(acc) { buffer.push(acc) });
// Learning phase
dialog.display({ message: "Select movement", spinner: classes },function(pattern){
  accelerometer.onChange(function(acc) { buffer.push(acc) });
  sleep('5s')
  model.record(attributes(buffer), pattern);
  buffer = new Array();
  return;
});
...
// Exploitation phase
time.schedule({ period: '5s' }, function() {
  trace.add({
      position: model.evaluate(attributes(buffer)),
     stats: model.statistics() });
     buffer = new Array();
} } });
```

	Predicted class						Acc (%)
	Walk	Jog	Stand	Sit	Up	Down	
Walk	**66**	0	4	0	0	0	94,3
Jog	0	**21**	0	0	0	0	100
Stand	4	0	**40**	0	0	0	90,9
Sit	0	0	2	**83**	0	0	97,6
Up stair	0	0	0	0	**22**	0	100
Down stair	0	0	0	0	0	**11**	100

Representative Confusion Matrix

Incentive : the model of a free service between *Quantified-self* and *Mydata*



Programmer un module Arduino

```
#include "Sensor.h"
#include "Module.h"
#include "Channel.h"

Channel* mlog = new LogChannel();
Sensor* sensorTmp = new Sensor(A0, "temperature", &convertTemperature);
Sensor* sensorLum = new Sensor(A2, "Lumiere", &convertLumiere);
Module* myModule = new Module();

void setup() {
    Serial.begin(9600);
}

void loop() {
    myModule->load(sensorTmp);
    myModule->load(sensorLum);
    myModule->setChannel(mlog);
    myModule->updateM();
    delay(300000);
}
```

```
int convertTemperature(int sensorTmpVal){
  float voltage = (sensorTmpVal/1024.0) * 5.0;
  float temperature = (voltage - .5) * 100;
  return temperature;
}
```