DIY sensor networks

Community-driven environmental monitoring

Martin Dittus, 2014-02-21
@dekstop

About Me

Martin Dittus

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Formerly:
Grad student at Centre for Advanced Spatial Analysis (CASA), UCL
Data team member, project manager at Last.fm
Occupy London tech team member
Organiser at EMFCamp, Hack the Barbican, others

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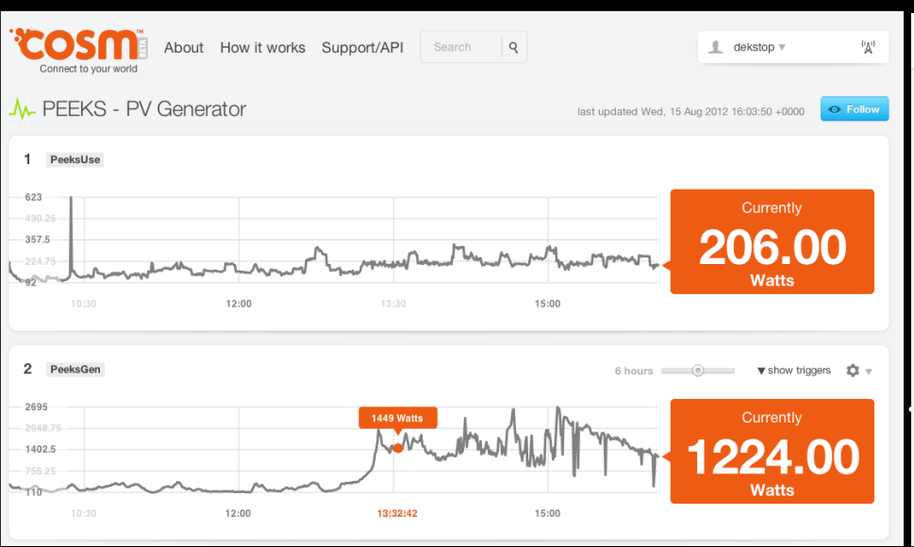
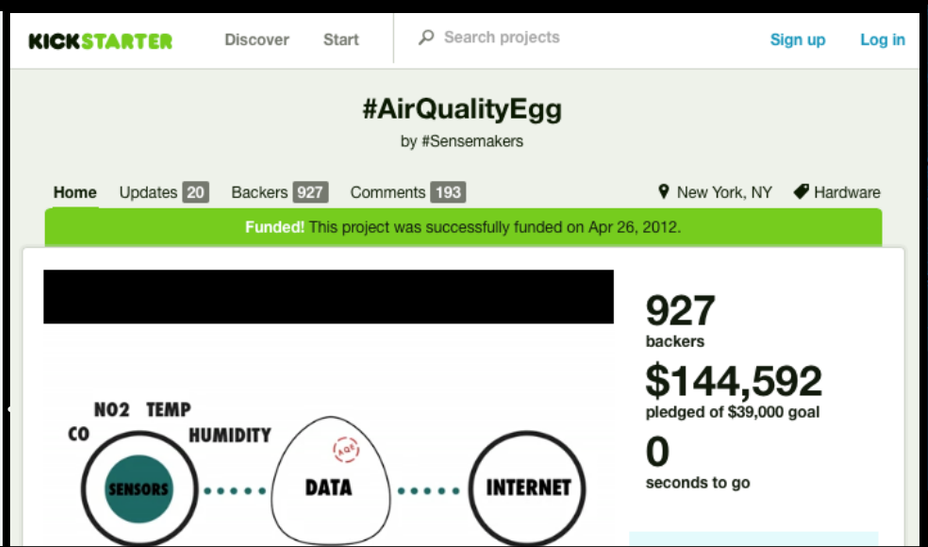
I will talk about **three DIY sensor networks**, one of which is brand new.

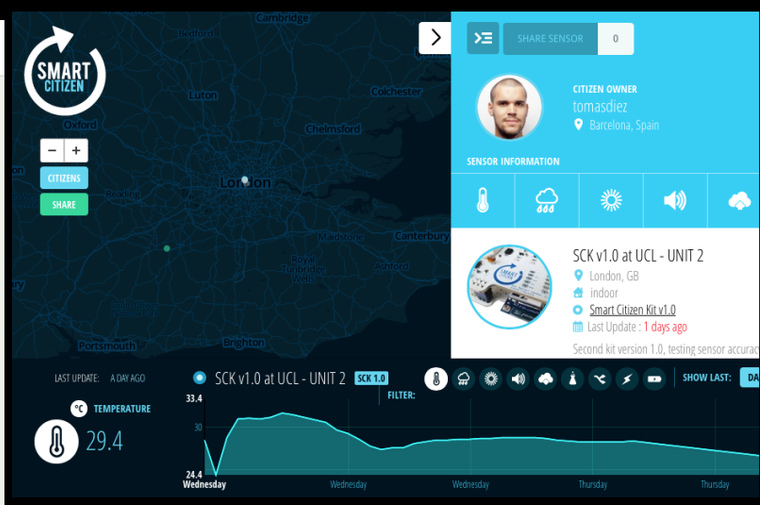
Cosm: a "sensor commons", with a strong focus on personal interests and personal purpose.

Air Quality Egg (based on Cosm): a centrally managed effort, but built on community contributions; still requires some technical knowledge to contribute.

Smart Citizen: a centrally managed effort, but driven by community interests; with a strong focus on ease of use, and well-integrated technology.







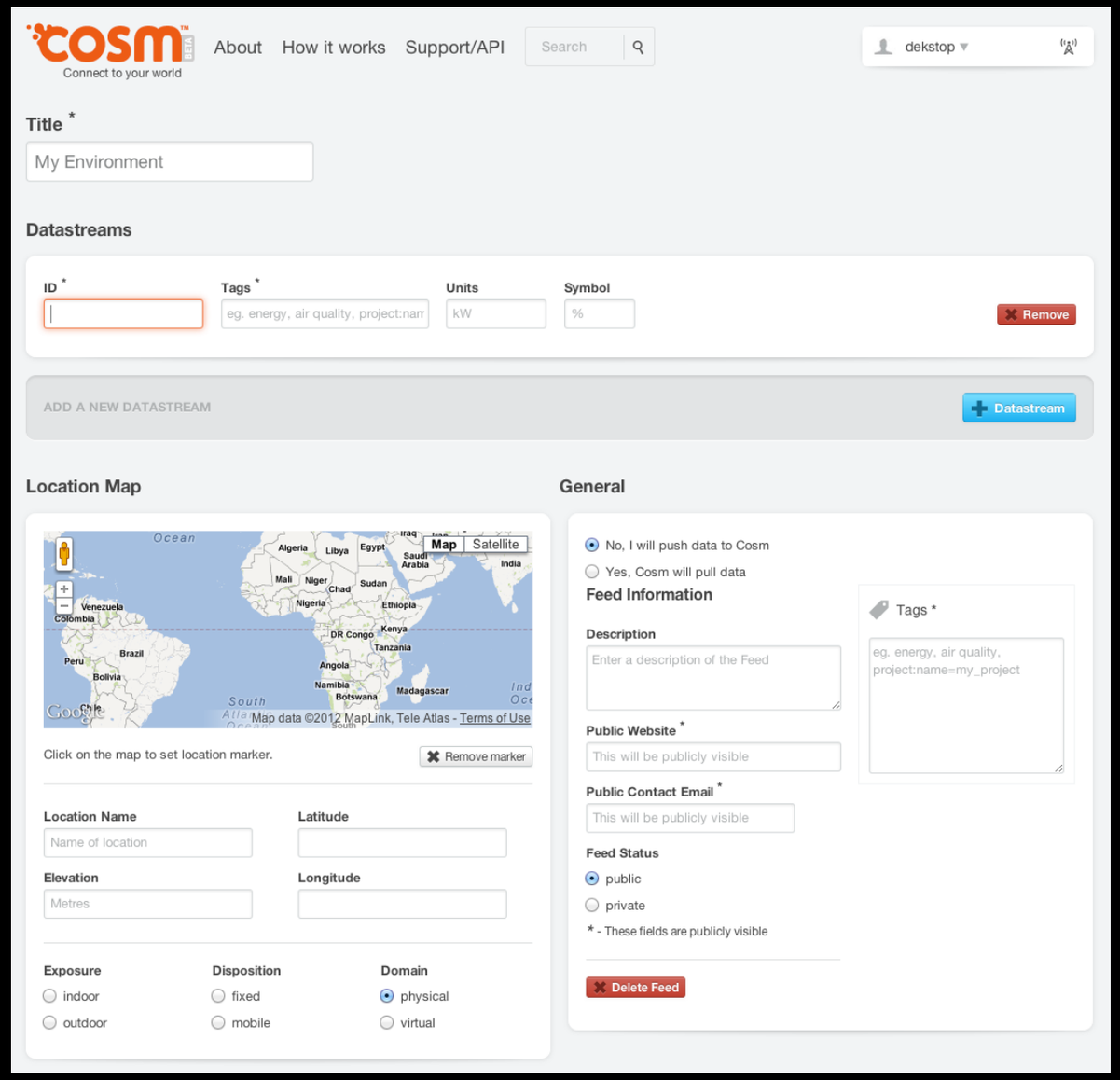
Cosm (now Xively, né Pachube)

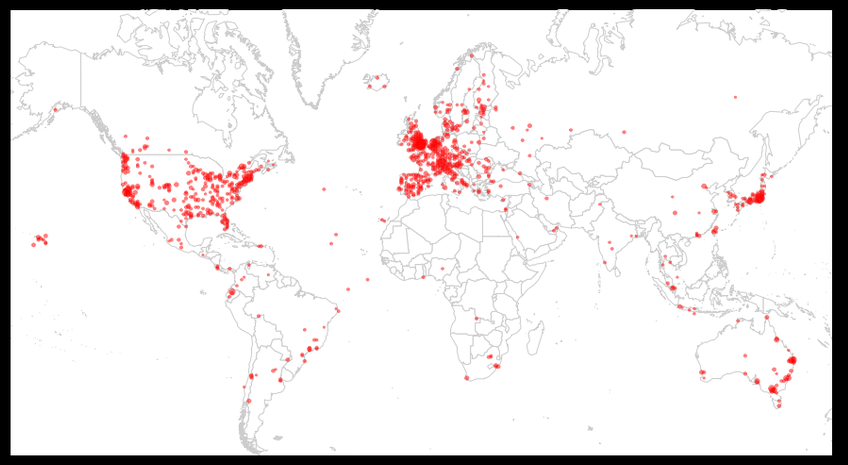
A general-purpose data platform for DIY sensor data enthusiasts.

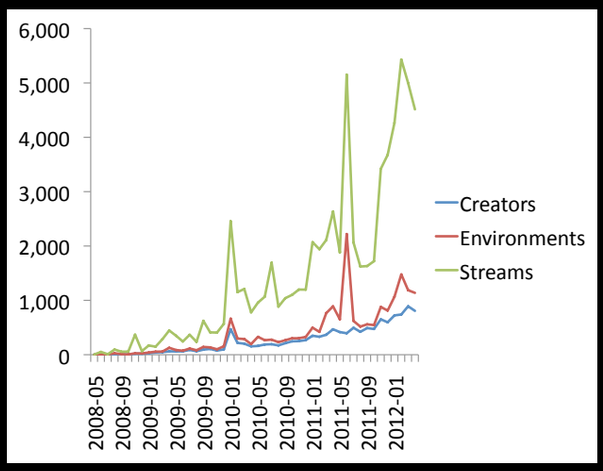
Users publish sensor measurements. These are shown on their profile page as **public data streams with metadata**: name, geo coordinates, tags, units of measurement.

Any kind of time series data can be published: existing products such as energy monitors, DIY sensing hardware, software-only time series data, …

In January 2012:
~1,000 global contributors
~5,000 active data streams







Dittus (2012), “The Cosm Sensor Data Set”

In principle Cosm allows for groups of interest to form: data is public by default. It quickly became a meeting ground for enthusiasts. However:

Data on Cosm is primarily published out of self-interest.There is **no intrinsic motivation to annotate** anything.
Result: Annotations are highly heterogenous, and often sparse!

Do people annotate their data streams well enough to identify implicit activity groups?

Can we build large-scale spatio-temporal models from these seemingly disconnected activities?

We attempted to discover implicit groups of interest to test this.

Dittus (2012), “The Cosm Sensor Data Set”

Japan	United Kingdom
1 時間移動平均	watts
10 分間移動平均	power
cpm	electricity
1 時間移動平均	temperature
sensor:type=radiation	Temperature
Temperature	Humidity
10 分移動平均	Pressure
humidity	humidity
CPM	light
radiation	Power
Humidity	Outside Temp
sensor:model=lnd-712	latitude
temperature	longitude
sensor:model=SBM-20	Wind Speed
µSv/h	elevation

The most frequently used tags for datastreams active in March 2012 within the geographic regions of the United Kingdom and Japan.

Cosm term similarity networks

Synonym detection for tags and units of measurement.

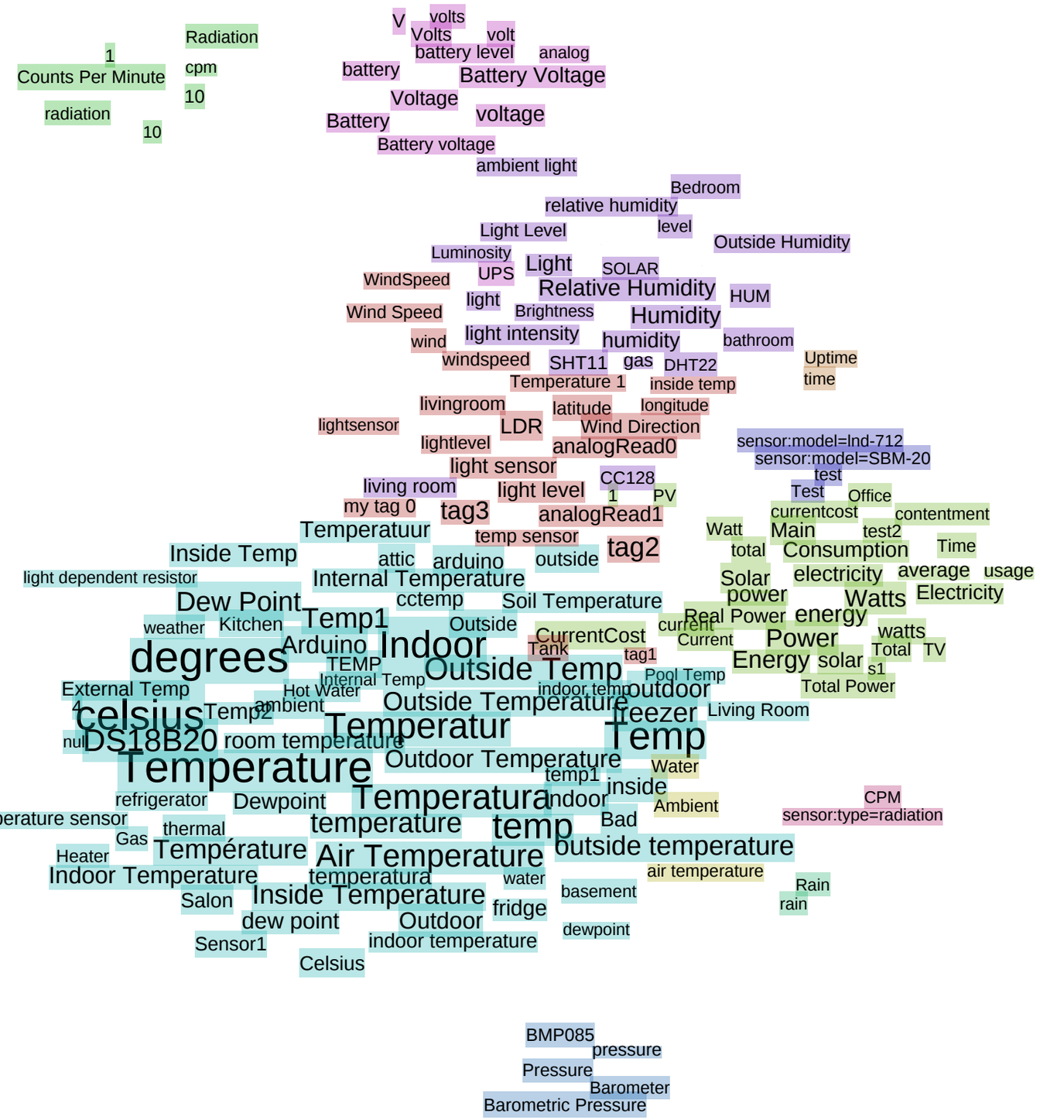
“Similar” tags have low user correlation, high item correlation. (Clements et al. 2008)

Some identifiable groups, but also **very inconsistent annotations**.

Multiple languages, alternative notations, abbreviations, spelling errors, capitalisation, …

75% of all unique tag terms have only been used once!

Dittus (2012), “The Cosm Sensor Data Set”



Key thematic groups (in 2012)

Community detection from term similarity graph: Blondel and Guillaume (2008).

Energy usage and power, e.g. CurrentCost, battery chargers, …
Radiation, particularly in Japan, but also Germany and elsewhere.
Humidity, air pressure.

Temperature was the most popular sensing theme.

We wanted to compare with ground truth, but **failed to build a temperature model for the UK**:

- Only a very small number of sensors was sufficiently well annotated
- This subset had negative spatial autocorrelation… likely very different kinds of “temperature” measurement (outdoor, indoor, …)

Dittus (2012), “The Cosm Sensor Data Set”

Some missed opportunities

It may not be that hard to bridge this gap between disconnected contributors.

No guidance: Cosm provided no assistance for tag usage: neither UX (auto-complete), nor advice (documentation).

Bad defaults: some widely-used devices had built-in Cosm integration, however little attention was paid to annotations. E.g. some energy monitors changed annotation practices multiple times across revisions.

We could consider these “opportunistic” means of ensuring homogeneity.

Little facilitation: no channels for more explicit collaboration, no spaces for shared projects.

No QA: no means of assessing and asserting data quality.

Dittus (2012), “The Cosm Sensor Data Set”

Air Quality Egg

A Cosm initiative to create a community around DIY air quality sensors.

Very successful on Kickstarter.

Facilitators and paid specialists worked with community groups to design and build the device.

Workshops with schools, local communities, at conferences, hackerspaces, …

But: community activity has stopped “at the last mile” after Cosm ended their support.

http://airqualityegg.com

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http://www.flickr.com/photos/nathanchantrell/8459182757

http://www.flickr.com/photos/medialab-prado/7186404129

Smart Citizen

An integrated urban sensing platform with custom DIY-friendly hardware.

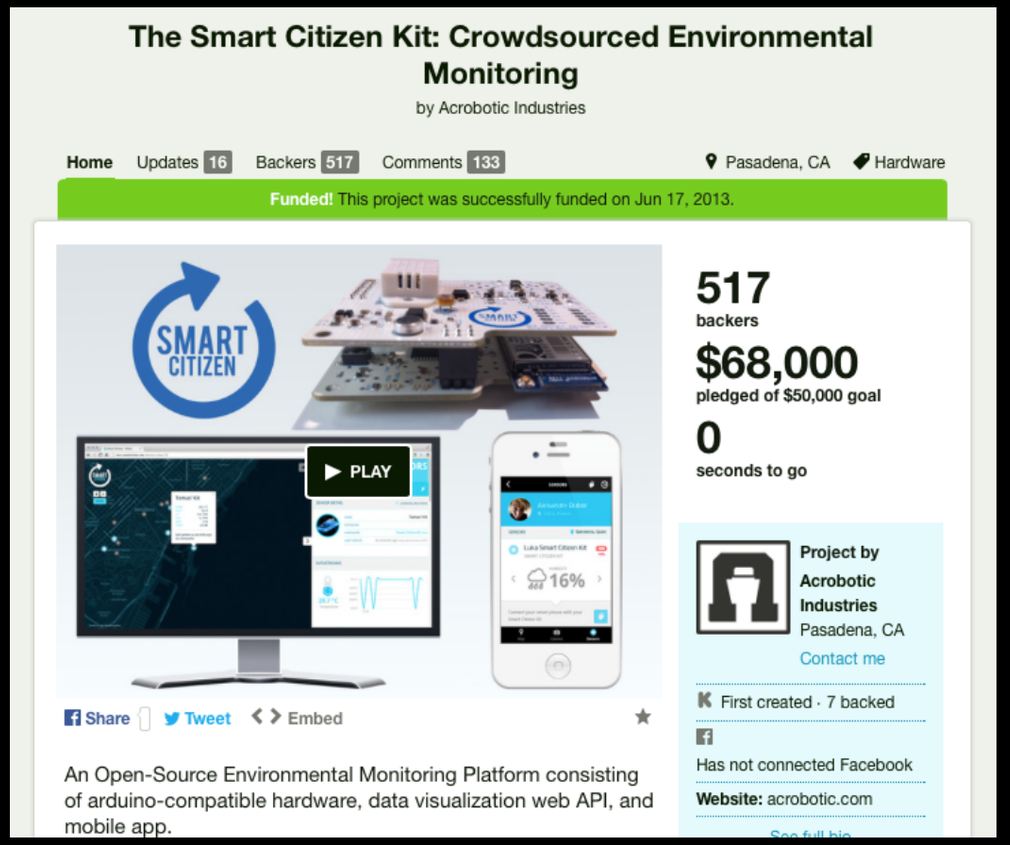
Very successful on Goteo, Kickstarter.

Common sensing hardware, sensor metadata is consistent and generally quite complete.

Coming out of a DIY scene (Fablab Barcelona), but with professional ambitions, and very well-designed.

This just launched, the first devices are now shipping.

http://smartcitizen.me/



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SMART CITIZEN

CITIZENS

SHARE

SHARE SENSOR 0

SENSORS

CITIZEN OWNER

tomasdiez

Barcelona, Spain

SENSOR INFORMATION

UCL - Research Office - Sensor 2 - V1.0

SHOW IN MAP

London, GB

indoor

Smart Citizen Kit v1.0

Last Update : 5 days ago

Smart Citizen V1.0 set at ICRI-Cities research office. Comparing data with kit version 1.1

LAST UPDATE: 5 DAYS AGO

°C TEMPERATURE

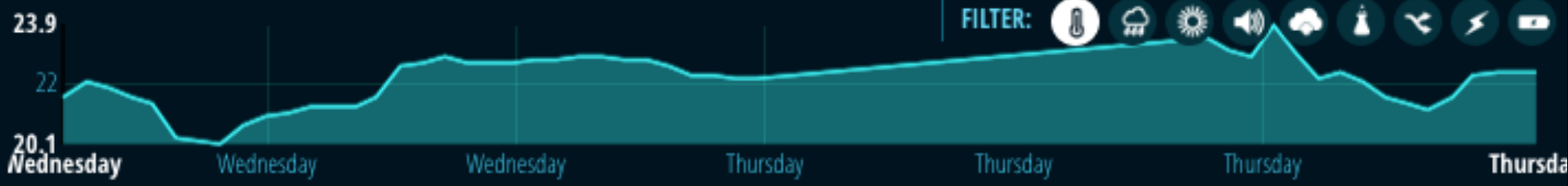
22.4

UCL - Research Office - Sensor 2 - V1.0 SCK 1.0

SHOW LAST: DAY

6.5 %

FILTER:



Smart Citizen

A growing number of collaborations with other organisations:

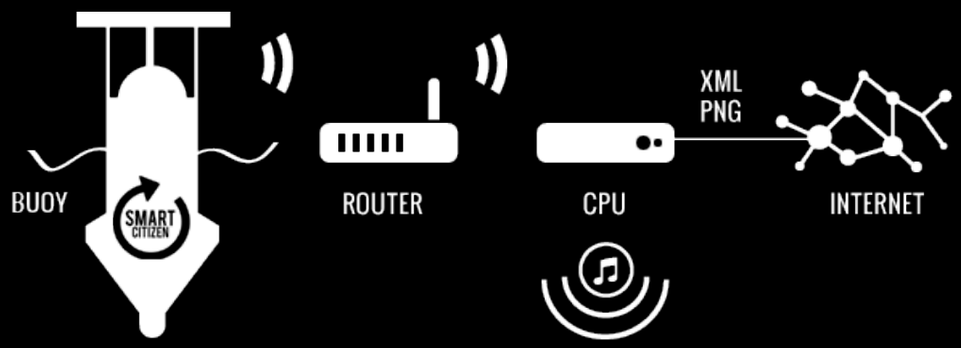
Waag Society, deployment of 100 sensors in Amsterdam. http://waag.org/en/project/smart-citizen-kit

Refarm the City, urban agriculture monitoring. http://www.refarmthecity.org

Open Source Beehives, to monitor and track the health and behaviour of a colony as it develops. http://www.opensourcebeehives.net

Whale, a generative music and art project about the sea. http://www.espigoplatja.com/whale/en/

Researchers at ~10 universities worldwide are now testing the Smart Citizen sensors.



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These are **powerful approaches to explicit collaboration**.

They offer a **shared mission as driver for participation**: to engage in public discourse about environmental concerns.

They **increase homogeneity of contributions**: they rely on known sensing hardware, and ensure metadata consistency.

They are **coordinated by specialists**, but open to the public.

This is the near future. What will the far future look like? In addition to these I think there's also an **opportunity to experiment with more fluid forms of governance** for DIY sensing platforms.

Where participants choose their own purpose.
Where a strong focus is placed on **facilitation and community discourse.**
Where activities are **supported by software**, e.g. to reveal and amplify emergent annotation practices.

Not "**crowdsourcing**",
instead a "**sensor commons**".

(OpenStreetMap is really good at that, and can serve as a source of inspiration. Most of its facilitation is provided by volunteer members.)

Thank You.

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