

## What is IOT?

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### ▶ Set of visions

- ▶ Things oriented
  - ▶ The term was originally proposed in 1999 by Kevin Ashton in a P&G presentation.
  - ▶ Spime - Object that can be tracked through space and time throughout its lifetime.
- ▶ Internet oriented
  - ▶ M2M
- ▶ Information oriented
  - ▶ Web 3.0
  - ▶ Web of things
  - ▶ Linked data

## What is IOT?

- ▶ Set of revolutions
  - ▶ New technologies
  - ▶ New concepts
- ▶ Set of interests
  - ▶ It's all about the money



## What are Things?



## Market Values

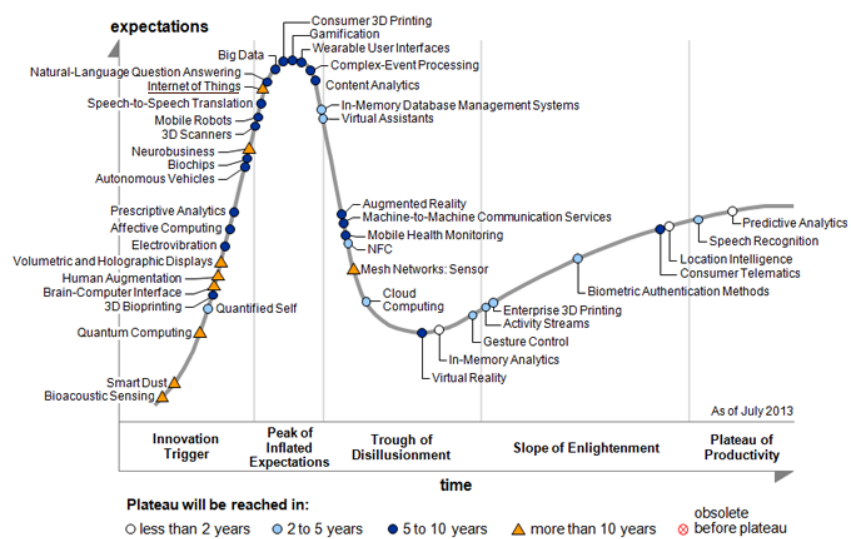
Top Ten Connected Applications in 2020	Value to the Connected Life
Connected Car	US\$600 billion
Clinical Remote Monitoring	US\$350 billion
Assisted Living	US\$270 billion
Home and Building Security	US\$250 billion
Pay-As-You-Drive Car Insurance	US\$245 billion
New Business Models for Car Usage	US\$225 billion
Smart Meters	US\$105 billion
Traffic Management	US\$100 billion
Electric Vehicle Charging	US\$75 billion
Building Automation	US\$40 billion

Resource : [gsma.com](http://gsma.com)

A May 2013 report from the McKinsey Institute suggests that connecting billions of ordinary devices to the Internet will add between \$2.7 trillion and \$6.2 trillion a year to the global economy by 2025

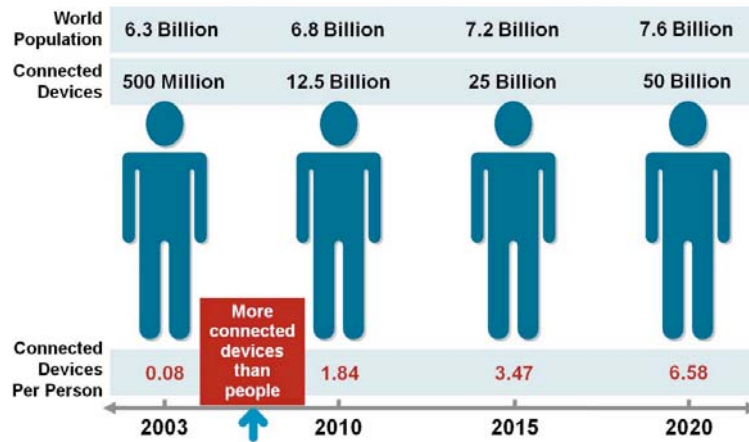


## Hype Cycle for Emerging Technologies, 2013

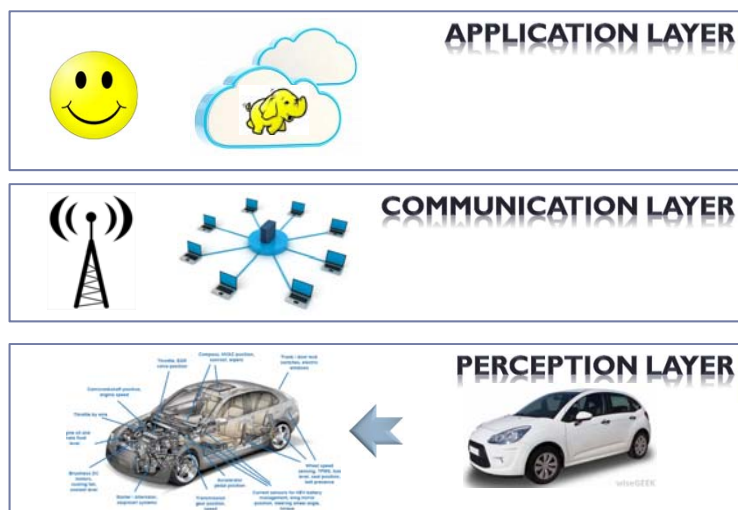


Source : [Gartner](http://Gartner)

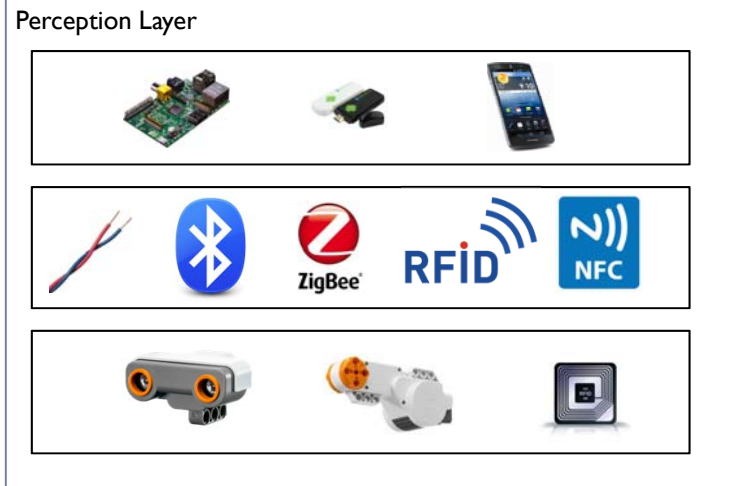
## Number of Devices



## IOT View



## Perception Layer



## Low Level Protocols

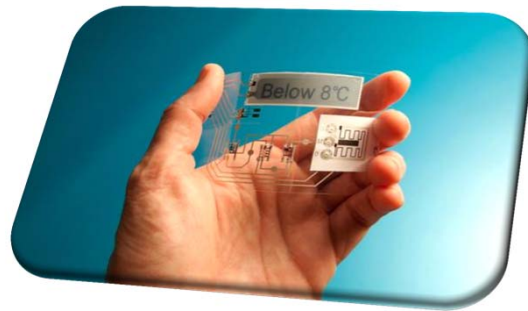
- ▶ **RFID**
  - ▶ Passive
  - ▶ Battery-assisted passive
  - ▶ Active
- ▶ **Near Field Communication**
- ▶ **Bluetooth**
  - ▶ Bluetooth LE
- ▶ **Zigbee**
- ▶ **GPS**



## Printed Electronics

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- ▶ Price : From Dollars to Cents
- ▶ Material : From rigid to flexible



## Wearable Objects

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- ▶ Functional and Health
- ▶ Quantified Self
- ▶ Electricity power
- ▶ Fashion



“Jawbone’s new activity-tracking wristband can be used to start your coffemaker when you get up”

Source: [MIT Technology Review](#)



## Mobile Devices

- ▶ First level computing
- ▶ Internet connection points
- ▶ OS Architecture
- ▶ May change their form.

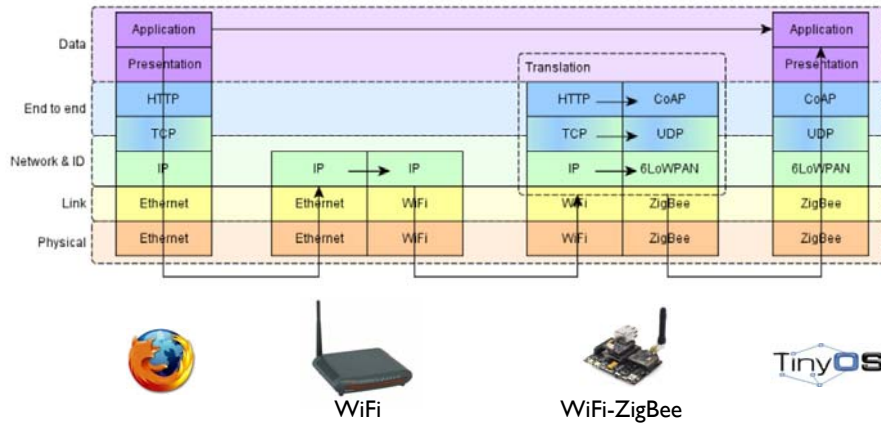


## IOT Communication

- ▶ Communication challenges
  - ▶ Low power devices
  - ▶ Synchronization between protocols
  - ▶ Packets size
  - ▶ Number of addresses
- ▶ Who's getting an IP?
- ▶ 6LoWPAN
- ▶ Constrained Application Protocol



## IOT Communication Example

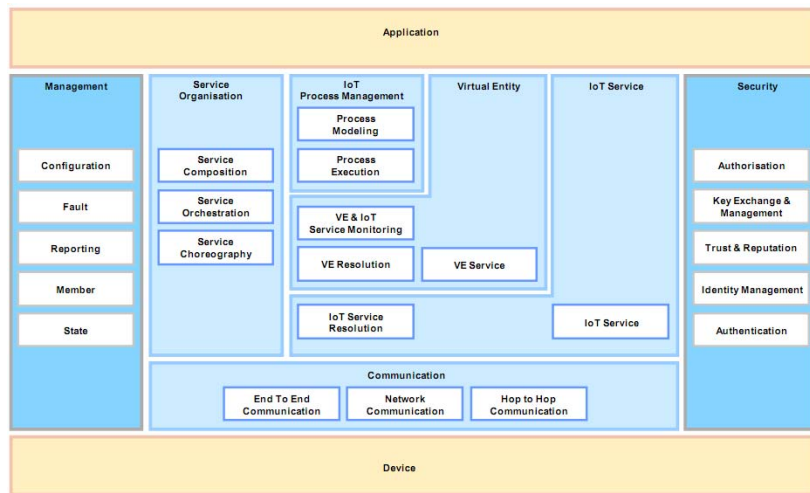


## IOT DIY Resources

- ▶ <http://postscapes.com/internet-of-things-diy>
- ▶ <http://www.libelium.com>
- ▶ <http://www.arduino.cc>
- ▶ <http://www.openpicus.com>
- ▶ <http://thingsquare.com>

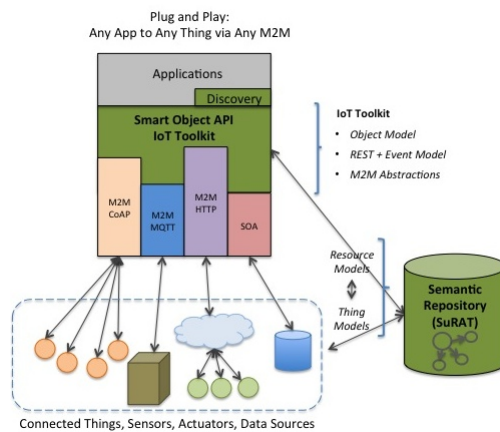


## IOT Functional Model



## IOT Bottom up Approach

### Smart Object API



## Security, Privacy and Trust

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- ▶ **IOT is complex**
  - ▶ Many systems and many protocols
  - ▶ Different sets of requirements
- ▶ **IOT control critical aspects**
  - ▶ Human health
  - ▶ Critical infrastructure
  - ▶ Lose control of your things
- ▶ **IOT has more autonomy**
  - ▶ Less human interaction
- ▶ **IOT knows more**
  - ▶ Where my privacy?
- ▶ **IOT is young**
  - ▶ Many uncovered vulnerabilities
  - ▶ Lack of regulation and standards



## Privacy in IOT

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- ▶ The big brother effect
- ▶ Very sensitive data
- ▶ Authorization and policies
- ▶ Regulations
- ▶ Change of thinking
- ▶ Privacy vs. Trust

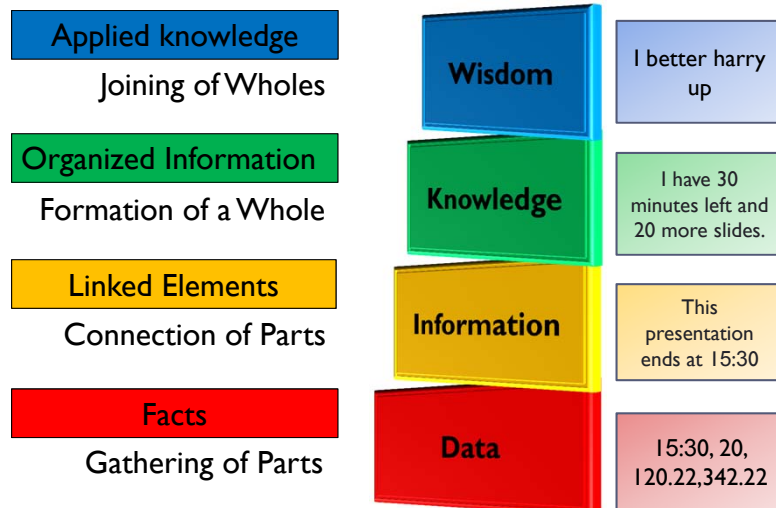


## IOT Data flow

- ▶ **Data format**
  - ▶ Standard is a good thing, that's why everybody create one of his own.
- ▶ **Data scalability**
  - ▶ Size does matter



## DIKW Pyramid



## Tim Berners-Lee 5 Start Deployment Scheme

Available on the web (whatever format) but with an open license.



Available as machine-readable structured data (e.g. excel instead of image scan of a table)



All the above plus non-proprietary format (e.g. CSV instead of excel)



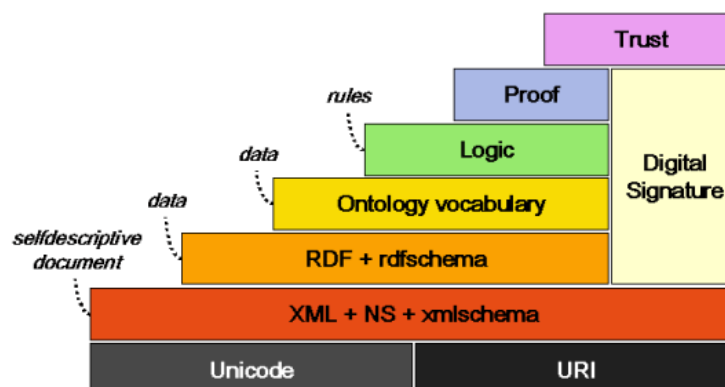
All the above plus, Use open standards from W3C (RDF and SPARQL) to identify things, so that people can point at your stuff

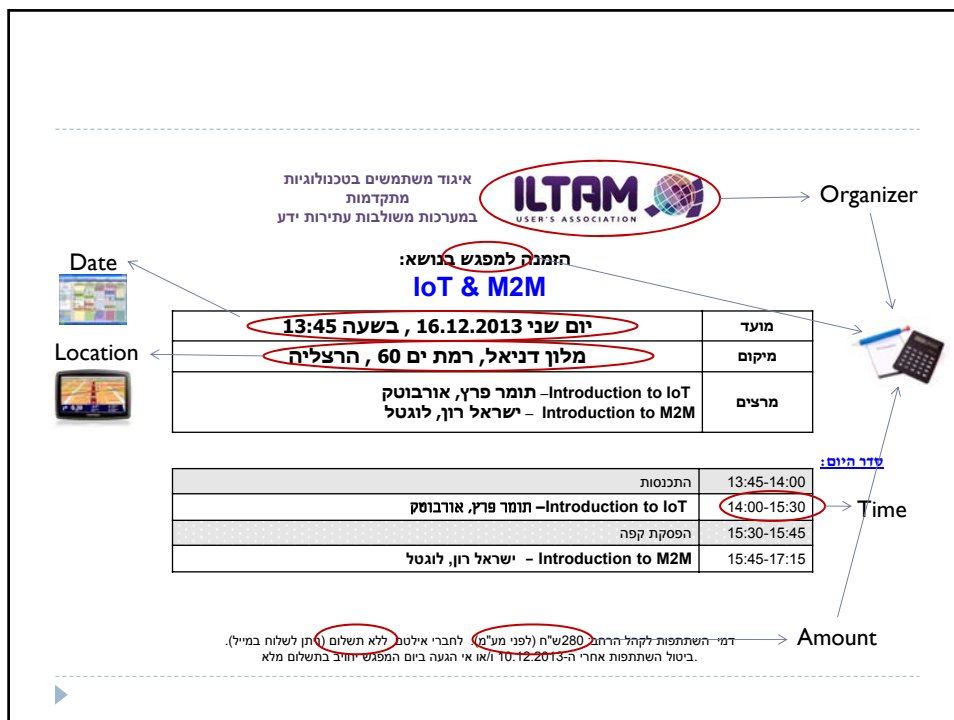


All the above, plus: Link your data to other people's data to provide context



## Semantic Web

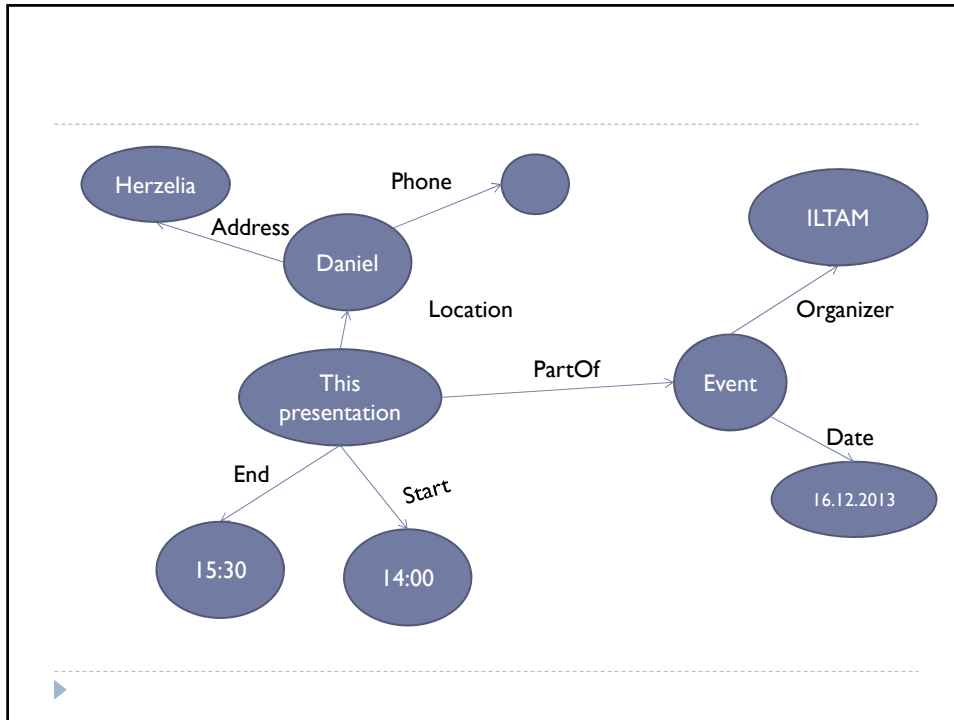




## Resource Description Framework

- ▶ RDF Triple: < Subject, Predicate, Object >
- ▶ "This presentation starts at 14:00"
- ▶ RDF Triple: < This presentation , starts , 14:00 >
  - ▶ Subject and predicate must be resource
  - ▶ Object can be resource or literal
  - ▶ RDF Triple: < URI#This presentation , URI#Start , "14:00" >

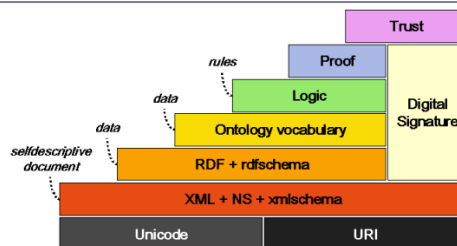
```
<rdf:Description rdf:about="URI# This presentation">
  <rdf:type rdf:resource="URI#Start"/>
  14:00
</ rdf:type>
</rdf:Description>
```



## RDF Schema (RDFS)

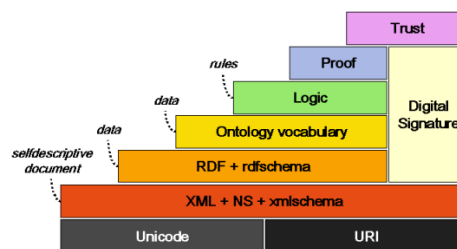
- ▶ RDF Schema (RDFS) introduces the notion of a properties and class.

URI:Event1	rdf:type	URI:Event
URI:Event2	rdf:type	URI:AfternoonEvent
URI:AfternoonEvent	rdfs:subClassOf	URI:Event



## Web Ontology Language (OWL)

- ▶ OWL adds more vocabulary for describing properties and classes.
- ▶ Adds relations between classes, cardinality, equality, enumerated classes and more.



## SPARQL

- ▶ RDF Query language

```
PREFIX ex: <http://example.com/exampleOntology#>
SELECT ?capital ?country WHERE {
    ?x ex:cityname ?capital ;
    ex:isCapitalOf ?y .
    ?y ex:countryname ?country ;
    ex:isInContinent ex:Africa .
}
```



## Web Semantic Usage - DBPedia

```
SELECT ?name ?pop ?capital ?drivesOn ?dateFormat ?callingCode ?country WHERE {
  ?country a o:Country ;
  foaf:name ?name ;
  p:capital ?capital ;
  p:dateFormat ?dateFormat ;
  p:drivesOn ?drivesOn ;
  p:callingCode ?callingCode ;
  p:populationEstimate ?pop .
  FILTER (?name = "Israel"@en) .
```

Results:

SPARQL results:

name	pop	capital	drivesOn	dateFormat	callingCode	country
"Israel"@en	7993100	"Jerusalem"@en	"right"@en	"dd/mm/yyyy"@en	Telephone_numbers_in_Israel	:Israel

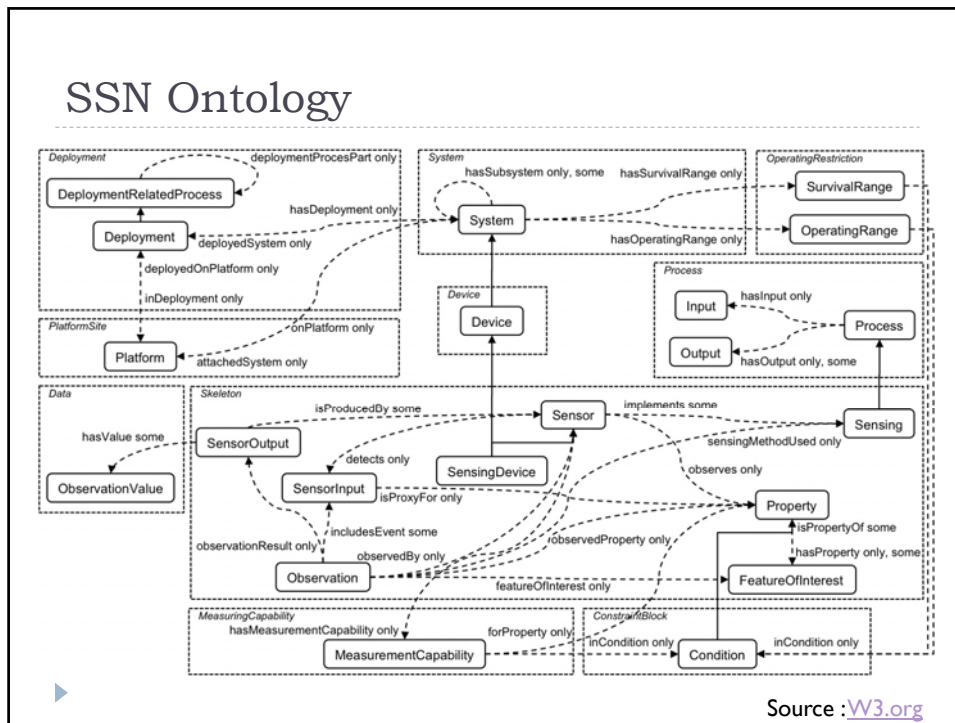
<b>Time zone</b>	Israel Standard Time (UTC+2)
- Summer (DST)	Israel Summer Time (UTC+3)
<b>Date format</b>	dd-mm-yyyy (CE)
<b>Drives on the</b>	right
<b>Calling code</b>	+972
<b>ISO 3166 code</b>	IL <a href="#">Telephone numbers in Israel</a>
<b>Internet TLD</b>	.il



## Semantic Sensor Network

- ▶ The SSN ontology can describe sensors in terms of their capabilities, measurement processes, observations and deployments
  - ▶ Data discovery and link-ing,
  - ▶ Device discovery and selection,
  - ▶ Provenance and diagnosis,
  - ▶ Device operation, tasking and programming

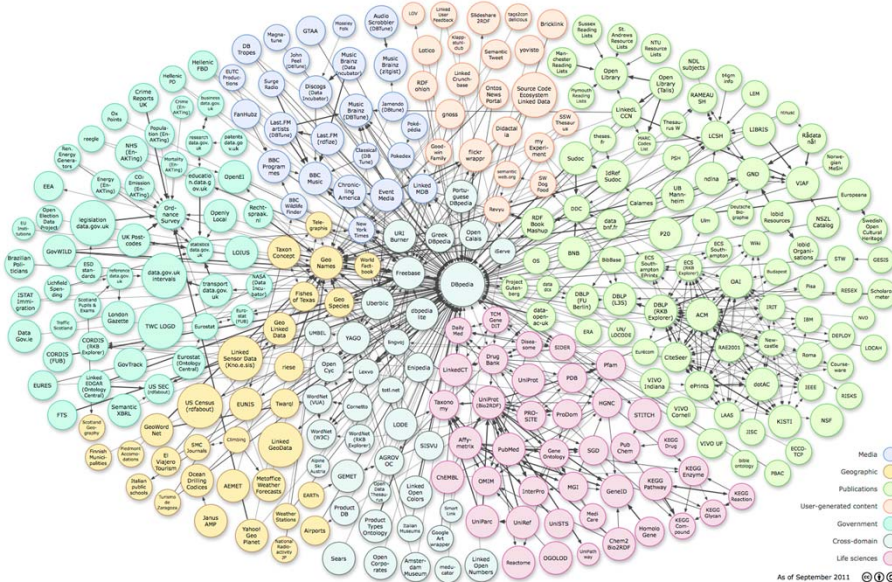




## SSN Example

A [ssn:Sensor](#) is something that has [ssn:implements](#) property who may be [ssn:Sensing](#) and is a [DUL:PhysicalObject](#) and has [ssn:detects](#) property who must be a [ssn:Stimulus](#) and has [ssn:observes](#) property who must be [ssn:Property](#) and has [ssn:hasMeasurementCapability](#) property who must be a [ssn:MeasurementCapability](#)

# Linked Data



# Search

indice THE SEMANTIC WEB INDEX

Search interface type: Simple Advanced **Guru** Query Language Documentation

keywords(s):

triple(s): "name" "dog"

filter(s):

SEARCH Group By Dataset: Sorted by: relevance

Quick filters (All options)

Time range: Any date

Format: Any format

Predicate: ?

Class: ?

Ontology: ?

Domain: ?

Sindice search: "name" "dog" found 204,728 documents (in 13.35 seconds)

[http://rdf.freebase.com/ns/en.what\\_up\\_dog](http://rdf.freebase.com/ns/en.what_up_dog) (RDF)  
 2010-08-01 - 602 triples in 77.8 kB  
<http://rdf.freebase.com/ns/guid.9202a8c04000641f8000000000ac...> (RDF)  
 2010-10-22 - 706 triples in 103.3 kB  
[http://dbpedia.org/data/The\\_Shaggy\\_Dog\\_%281959\\_film%29.rdf](http://dbpedia.org/data/The_Shaggy_Dog_%281959_film%29.rdf) (RDF)  
 2010-06-01 - 84 triples in 15.3 kB  
[http://dbpedia.org/data/The\\_Shaggy\\_Dog\\_%281959\\_film%29.rdf](http://dbpedia.org/data/The_Shaggy_Dog_%281959_film%29.rdf) (RDF)  
 2010-11-23 - 579 triples in 77.3 kB  
[http://rdf.freebase.com/ns/en.wag\\_the\\_dog](http://rdf.freebase.com/ns/en.wag_the_dog) (RDF)  
 2010-06-01 - 84 triples in 15.3 kB  
[http://dbpedia.org/data/The\\_Shaggy\\_Dog\\_%281959\\_film%29.n3](http://dbpedia.org/data/The_Shaggy_Dog_%281959_film%29.n3) (RDF)  
 2010-06-01 - 84 triples in 15.3 kB  
[http://dbpedia.org/data/The\\_Shaggy\\_Dog\\_%281959\\_film%29.n3](http://dbpedia.org/data/The_Shaggy_Dog_%281959_film%29.n3) (RDF)  
 2010-12-02 - 164 triples in 22.5 kB  
[http://rdf.freebase.com/ns/en.temple\\_of\\_the\\_dog](http://rdf.freebase.com/ns/en.temple_of_the_dog) (RDF)  
 2010-12-02 - 164 triples in 22.5 kB

Source : [sindice](http://www.indice.org/)

## Knowledge Graph

The image shows two side-by-side Google search results. The left search is for 'population of israel', showing a line graph of population growth from 1960 to 2010. The right search is for 'sites in tel aviv', showing a grid of images for various points of interest in Tel Aviv.

**Search 1: population of israel**

Results: About 125,000,000 results (0.48 seconds)

**7.908 million (2012)**  
Israel, Population

Year	Israel (million)	Jordan (million)
1960	~1.5	~0.5
1970	~2.5	~0.5
1980	~3.5	~0.5
1990	~4.5	~0.5
2000	~5.5	~0.5
2010	~7.0	~0.5
2012	7.908	6.373

Demographics of Israel - Wikipedia, the free encyclopedia  
en.wikipedia.org/wiki/Demographics\_of\_Israel

Jump to Population growth rate - Israel - 1.0% (2012). During the 1990s, the Jewish population growth rate was about 2% per year, as a result of massive ...  
Definition - Cities - Ethnic and religious groups - Languages

Israel - Wikipedia, the free encyclopedia  
en.wikipedia.org/wiki/Israel

The population of Israel, as defined by the Israel Central Bureau of Statistics, was estimated in 2013 to be 8,051,200 people, of whom 6,545,500 are Jewish.  
Jerusalem - History of Israel - Mandatory Palestine - Tel Aviv

Latest Population Statistics for Israel | Jewish Virtual Library  
www.jewishvirtuallibrary.org/jsource/entry\_7426\_-\_hebrew.html

Sep 3, 2013 - The Jewish population makes up 8,066,000 (75.1%); 1,670,000 (20.7%) are Arabs, and those identified as "others" (post-Arab Christians, ...

**Search 2: sites in tel aviv**

Results: About 125,000,000 results (0.48 seconds)

**Tel Aviv points of interest**

- Tel Aviv Museum
- Ezra Israel Museum
- Ramat Gan Safari
- Beth Hatfukh
- Yarkon Park
- Palmach Museum

Things to do in Tel Aviv - Check out 88 Tel Aviv Attractions - TripAdvisor  
www.tripadvisor.com/Attractions-g203304-Activities-Tel\_Aviv\_Tel\_Aviv.html

Things to do in Tel Aviv, Israel: See TripAdvisor's 5026 reviews and photos of 88 Tel Aviv ...  
Reset the filters to see all attractions in Tel Aviv ... Tel Aviv Museum of Art  
Hologram Center - Toytel - Palmach Museum - New Tzohar

Top 10 Attractions in Tel Aviv - Tel Aviv Guide  
www.telavivguide.net/Places/Top\_10\_attractions\_in\_Tel\_Aviv\_20051.html

Tel Aviv Guide! Our Suggestions Must See Places Top 10 Attractions in Tel Aviv ...  
Tel Aviv Museum of Art - See the best of Israeli art. 6. HaCarmel Market ...

**Tel Aviv Guide**  
www.telavivguide.net/

Tel Aviv's Beach Carefully chosen from the wide variety of activities and places the city has to offer - we are proud to present the best attractions in Tel Aviv!

**Tourist Attractions in Tel Aviv | Israel | Traveler**  
www.israeltraveltips.org/attractions/tel-aviv.html

A Variety of Interesting Sites and Places to Visit Around Israel. Historical Sites, Markets, Festivals, Religion and Heritage Sites, Streams, Waterfalls, Parks and ...

**Sights in Tel Aviv, Israel & the Palestinian Territories - Lonely Planet**  
www.lonelyplanet.com/israel-and-the-palestinian-territories/tel-aviv/sights.html

6 sights in Tel Aviv, Israel & the Palestinian Territories - including ... go to content go to search box go to global site navigation. Search Search. View Basket

**Tel Aviv**  
City in Israel

Tel Aviv is the second area in Israel, with a population of 4,000,000.

Area: 20.88 sq miles |  
Founded: April 11, 1909  
Weather: 24°C, Wind  
Local time: Wednesday  
Population: 424,031  
Colleges and Unives

## Handling Data in IOT

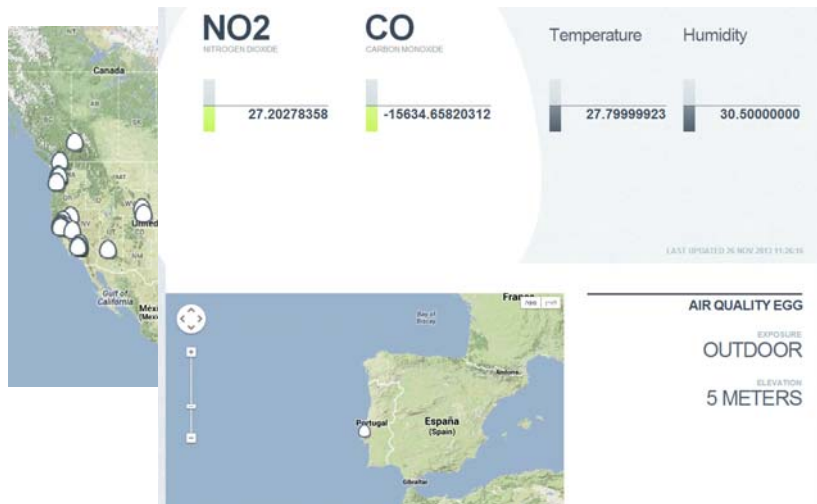
- ▶ Age of data
- ▶ Big data
  - ▶ Map reduce
- ▶ Where the data is stored

“What the use of putting so much data on the internet if you can't do anything with it”





## IOT on the Cloud Example



Source: [air quality egg](#)



## What's Next



  [tomerpz@gmail.com](mailto:tomerpz@gmail.com)



 [iot.il](#)

