

# Emerging Distributed Computing and Challenges for Services Engineering

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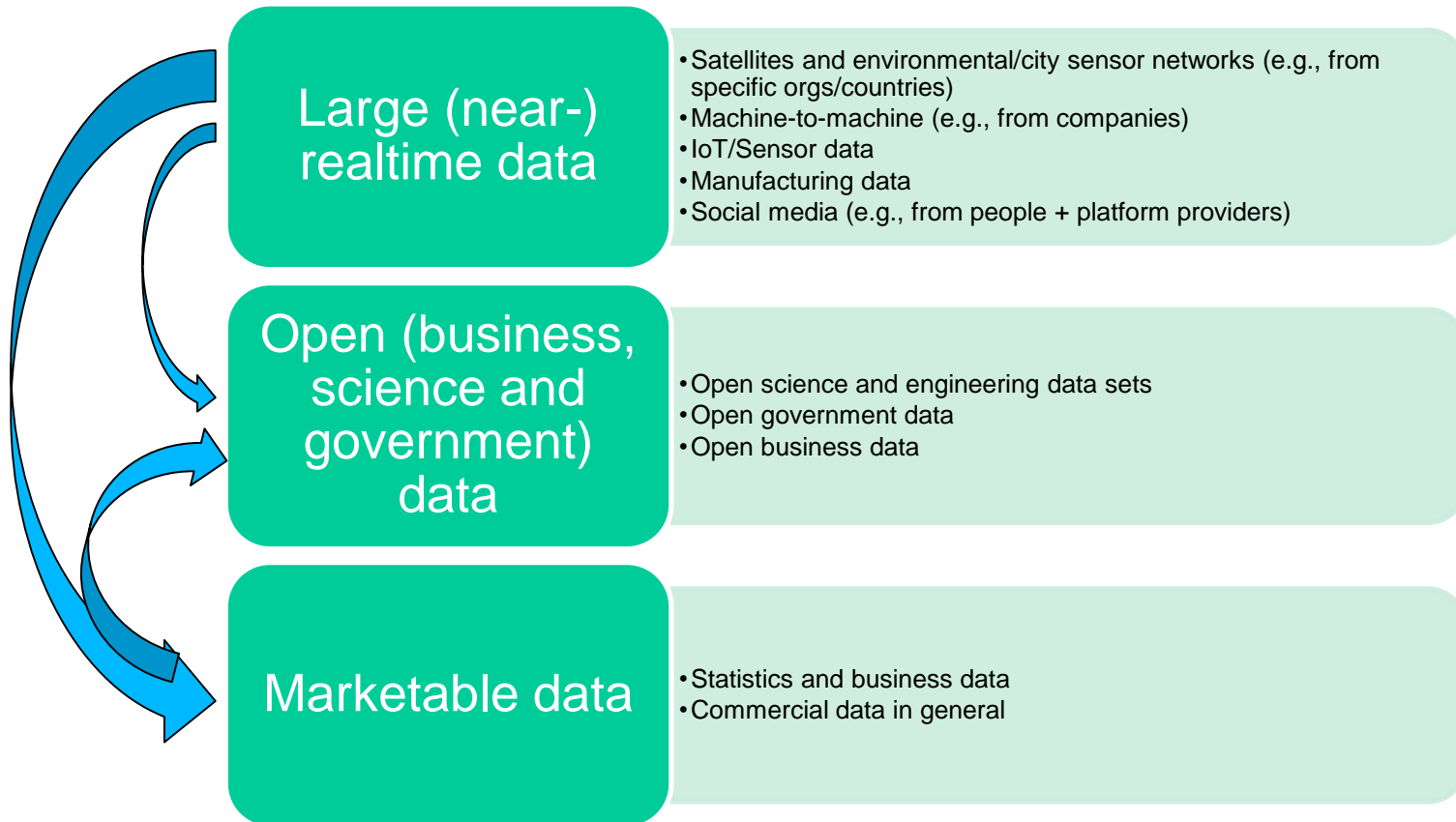
# Goals

- See emerging trends in distributed systems and computing
- Have a critical look at use cases and analyze use cases
- See the service engineering technologies needed for such use cases

- Some emerging models
  - IoT resources
  - (Big/realtime) data provisioning models
  - Computational infrastructures/frameworks provisioning
  - Human computation provisioning
  - Machine Learning as a service
  - Blockchain
- Use cases
- Advanced services engineering
  - Single service/platform engineering
  - Multi-platform services engineering

**WHICH ARE EMERGING  
FORMS OF DISTRIBUTED  
COMPUTING MODELS,  
SYSTEMS AND APPLICATIONS  
THAT YOU SEE?**

# Emerging data provisioning models



**Data are assets**



The screenshot shows the ESA Sentinel Online website. At the top, there is the ESA logo and 'Sentinel Online' text, along with icons of various satellite components and the European Commission logo. A navigation bar includes links for 'Need Help?', 'FAQ', 'Contact Us', and 'About Sentinel Online'. A search bar is present with 'Google Custom Search' and a magnifying glass icon. Below the navigation bar are several menu items: 'Missions', 'User Guides', 'Technical Guides', 'Thematic Areas', 'Data Access' (highlighted), and 'Toolboxes'. A breadcrumb trail reads 'You are here Home > Data Access'. Social media sharing icons for '+ Share', 't', 'G', 'f', and 't' are visible. The main content area features a dark blue header for 'Access to Sentinel Data' and a large banner for the 'Copernicus Europe's eyes on Earth sentinel open access hub >'. Below the banner, a paragraph states: 'The free, full and open data policy adopted for the Copernicus programme foresees access available to all users for the Sentinel data products, via a simple [self-registration](#). News and further information about the service is available [here](#).' To the right, a sidebar contains a 'Data Access' section with links for 'Data Access Home', 'Use Typologies and available Services', 'User Support and Registration', and 'Access to Sentinel Data'. Below this is a 'Latest News' section with a headline 'Data Hub services resume operations' dated '06 March 2018', followed by a summary: 'The extended planned maintenance of the Data Hub infrastructure on 5 and 6 March 2018 has been closed, and all services have been resumed as of 09:00 CET today.' and a 'Read more' link.

Source: <https://sentinel.esa.int/web/sentinel/sentinel-data-access>

# Large-scale (near-)realtime data: properties and issues

## Some properties

- Having massive data
- Requiring large-scale, big (near-) real time processing and storing capabilities
- Enabling predictive and realtime data analytics

## Some issues

- Timely analytics
  - Performance and scalability
- Quality of data control
- Handle of unknown data patterns
- Benefit/cost versus quality tradeoffs



# Example of open data



Browse Groups About



a comprehensive list of open data catalogs curated by experts from around the world.

268 registered data catalogs available.

**DATA.GOV.UK** Beta  
Opening up Government

Home Data Participate Apps Location Linked Data Library Lab About

Search | Map Search | Publishers | Tags | Public Roles & Salaries | Spend Browser | Spend Reports

**Search Datasets**  
8729 Datasets

**Tags**  
health, care, transparency, children, disclosure

**Publishers**  
View all publishers »

- Office for National Statistics (847)
- Department for Communities and Local Government (739)
- NHS Information Centre for Health and Social Care (514)
- British Geological Survey (364)
- Centre for Ecology & Hydrology (326)
- Department for Environment, Food and Rural Affairs (322)
- Welsh Government (241)
- Department of Health (239)
- Department for Children, Schools and Families (227)
- Home Office (221)

**UK Location**  
Conduct Map Based Search »

The UK Location Programme has introduced over 1000 location data records into data.gov.uk and tools to support their use. To find which of these datasets cover a particular location, you can use [Map Based Search](#).

Many of these datasets provide a Web Map Service too, and for some a preview of the data is available. Click to find out more about [Map Based Search](#) and about [Preview on Map](#).

publicdata.eu beta — Europe's Public Data

Search Groups About Apps Ideas

Login Register

europe's public data

Find datasets

- Finance and Budgeting (436)
- Environment (227)
- Education and Communication (194)
- Population (145)
- Health (63)
- Social Questions (229)
- Transportation (199)
- Agriculture, Fisheries, Forestry (181)
- Economy and Industry (118)

View larger map [+]

amazon web services

Sign Up My Account / Console English

AWS Products & Solutions Public Data Sets Developers Support

**Browse By Category**

- Astronomy
- Biology
- Chemistry
- Climate
- Economics
- Encyclopedic
- Geographic
- Mathematics

**Developer Resources**

- Amazon Machine Images (AMIs)
- Articles & Tutorials
- Customer Apps

**Public Data Sets**

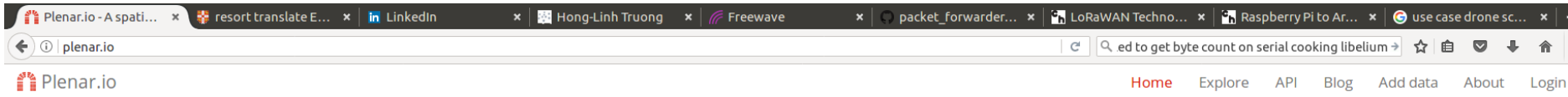

Public Data Sets on AWS provides a centralized repository of public data sets that can be seamlessly integrated into AWS cloud-based applications. AWS is hosting the public data sets at no charge for the community, and like all AWS services, users pay only for the compute and storage they use for their own applications. Learn more about [Public Data Sets on AWS](#) and visit the Public Data Sets forum.

**Featured Public Data Sets**

- 1000 Genomes Project**  
The 1000 Genomes Project, initiated in 2008, is an international public-private consortium that aims to build the most detailed map of human genetic variation available.
- Common Crawl Corpus**  
A corpus of web crawl data composed of 5 billion web pages. This data set is freely available on Amazon S3 and formatted in the ARC (.arc) file format.
- Google Books Ngrams**  
A data set containing Google Books n-gram corporuses. This data set is freely available on Amazon S3 in a Hadoop friendly file format and is licensed under a Creative Commons Attribution 3.0 Unported License. The original dataset is available from <http://books.google.com/ngrams/>.



# Static + Realtime Open Data

The next stage in open data.

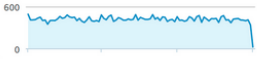


Plenario is a centralized hub for open datasets from around the world, ready to search and download.

[Explore](#) [Add data](#)

One database. One map.

All data in Plenario exists on a single map and a single timeline, making it incredibly easy to access multiple datasets at once—especially those originally housed at different data portals.

Here's an example: [A collection of data pulled from Southside Chicago during summer 2013.](#)

Source	Dataset	Count	Trend
Chicago Police Department	Crimes - 2001 to present	38,766	
City of Chicago	Business Licenses	2,492	
City of Chicago	Food Inspections	1,226	

[Try it yourself](#)

# Telecommunication

<https://dandelion.eu/datamine/open-big-data/>

## Telecommunications - SMS, Call, Internet - MI TELCO

This dataset provides information about the telecommunication activity over the city of Milano. [read more »](#)

[Download data](#)

## Telecommunications - MI to Provinces TELCO

This dataset provides information regarding the level of interaction between the areas of the city of Milan and the Italian provinces. [read more »](#)

[Download data](#)

## Telecommunications - MI to MI TELCO

This dataset provides information regarding the directional interaction strength between the city of Milan different areas based on the calls exchanged between Telecom Italia Mobile users. [read more »](#)

[Download data](#)

## Milano Weather Station Data WEATHER

The dataset describes various meteorological phenomena type and intensity of Milan city using sensors located within the city limits. [read more »](#)

[Download data](#)

## Precipitation - Milano WEATHER

The dataset describes precipitation intensity and type over the city of Milan. [read more »](#)

[Download data](#)

## Air Quality - MI ENVIRONMENT

The dataset describes the pollution type and intensity of Milan city using various types of sensors located within the city limits. [read more »](#)

[Download data](#)

## MilanoToday NEWS

This dataset contains all the articles published on the website milanotoday.it from 01/11/2013 to 31/12/2013. [read more »](#)

[Get data via API](#)

## Social Pulse - Milano SOCIAL

This dataset contains data derived from an analysis of geolocalized tweets originated from Milan during the months of November and December. [read more »](#)

[Get data via API](#)

# Open data: properties and issues

## Some properties

- Having large, multiple data sources but mainly static data
  - Real-time, open data is growing
- Having good quality control in many cases
- Usually providing the data as a whole set

## Some issues

- Fine-grained content search
- Balance between processing cost and performance
- Correlation/combination with real-time/private data

## BUY DATA

🏠 • [Data Marketplace](#) • [Buy Data](#)

View data available on BDEX with this Data Visualization Tool

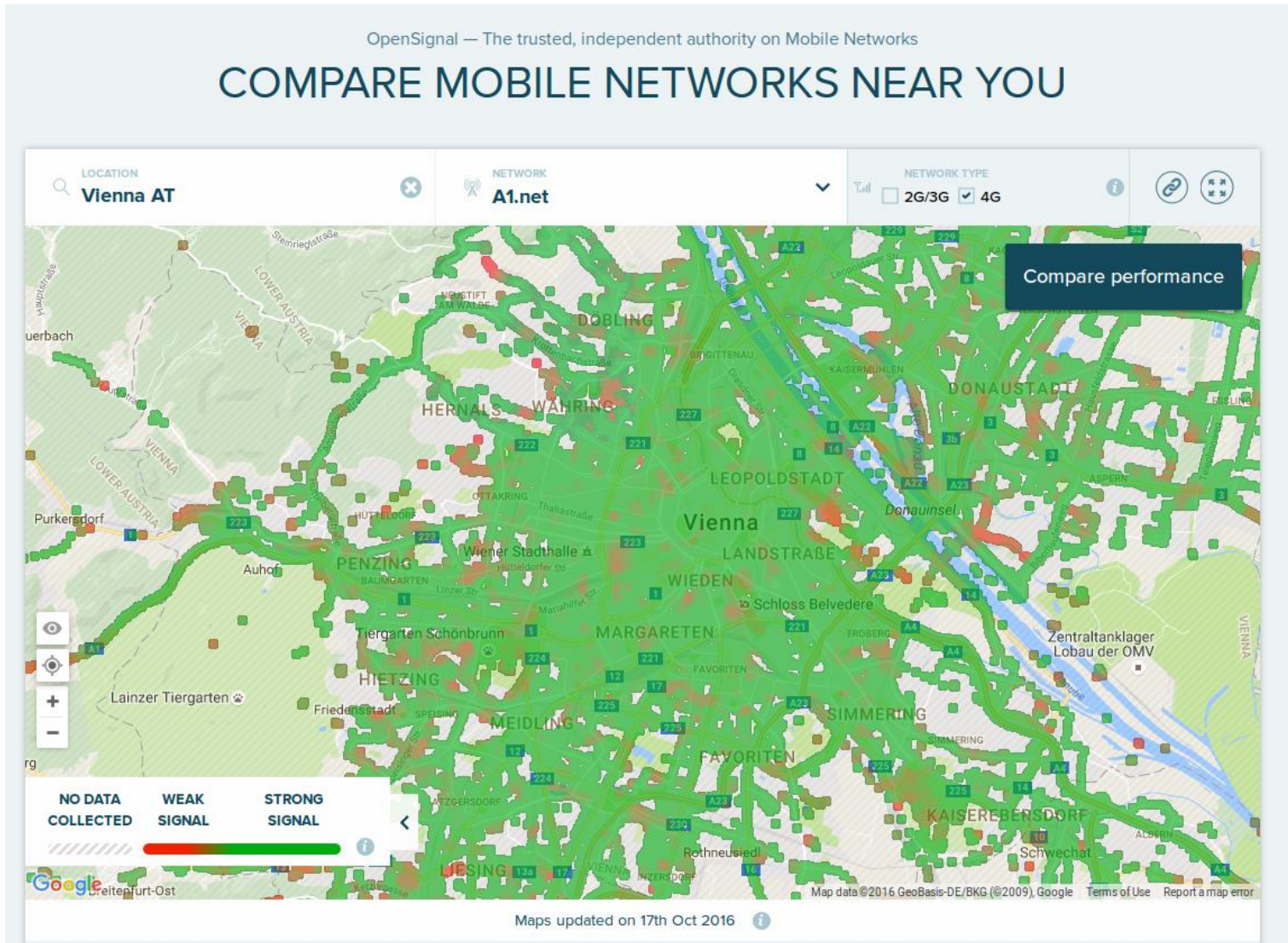
### Real-Time Targeting

Data Buying and Targeting through the BDEX suite of tools truly takes the industry to the next level. Through BDEX's unique tool set Advertisers, Publishers and Retailers alike have the ability to target with a level of granularity that was never before possible.

- Buy Data That is Only Seconds Old
- Filter Based on Data Quality (conversions)
- Create Custom Audience Groups
- Combine an Unlimited Number of Data Points
- Set Budgets by Data Point
- Manage Campaigns in Real-Time

[Buy Data](#) >[Sell Data](#) >[Advertisers / Publishers](#) >[DMP / DSP Solutions](#) >[BDEX Retail](#) >[Data Downloads](#) >[Data Scoring](#) >

# Marketable data examples



## Data Products



For Mobile Operators



For Telcoms Regulators



For Industry Analysts



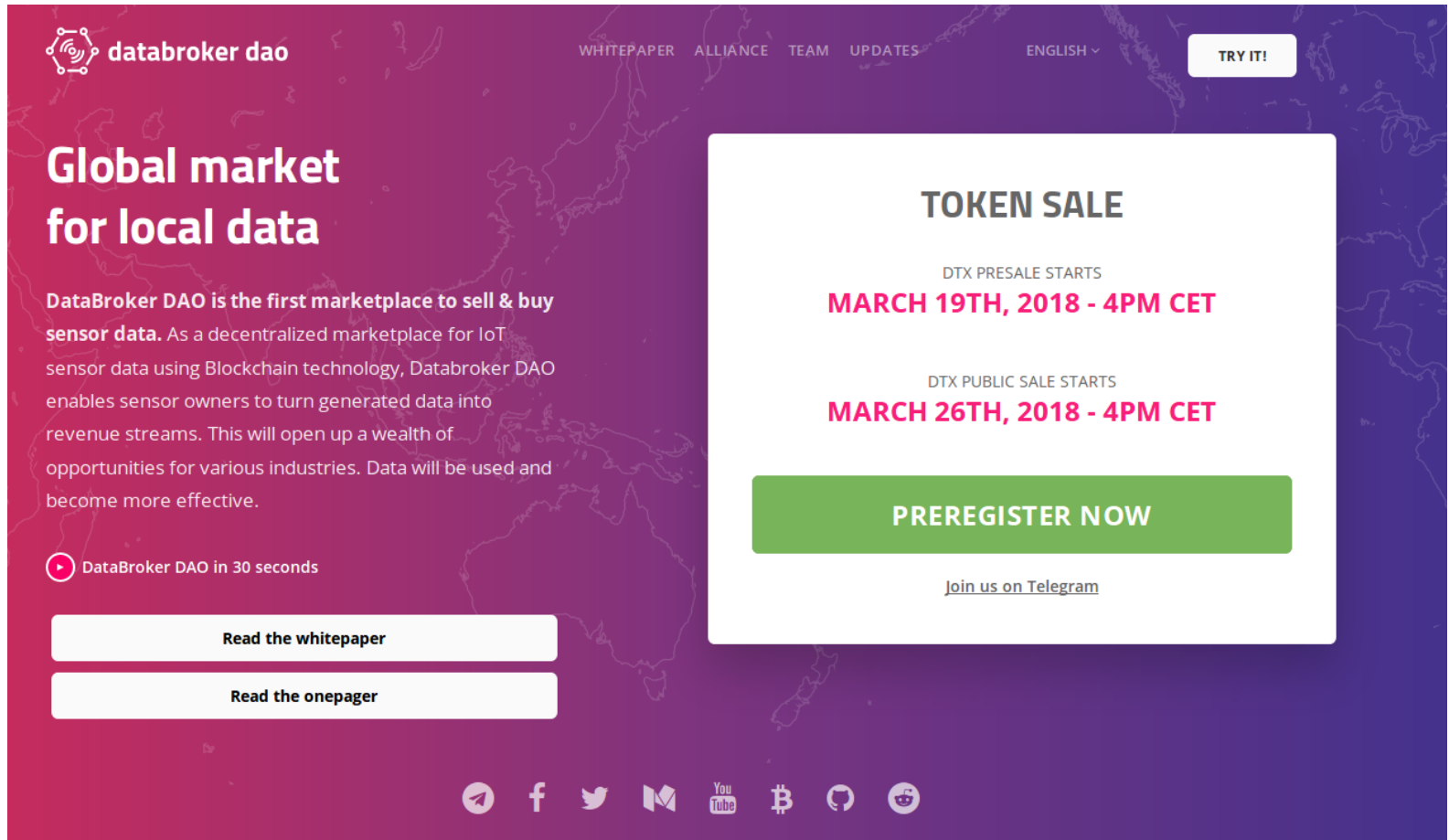
For Large Companies

### Our solutions

See how our data and analytics can help your business

[Visit the solutions site >](#)

# And trend in monetizing data



**databroker dao**

WHITEPAPER ALLIANCE TEAM UPDATES

ENGLISH ▾

**TRY IT!**

## Global market for local data

DataBroker DAO is the first marketplace to sell & buy sensor data. As a decentralized marketplace for IoT sensor data using Blockchain technology, Databroker DAO enables sensor owners to turn generated data into revenue streams. This will open up a wealth of opportunities for various industries. Data will be used and become more effective.

▶ DataBroker DAO in 30 seconds

[Read the whitepaper](#)

[Read the onepager](#)

### TOKEN SALE

DTX PRESALE STARTS  
**MARCH 19TH, 2018 - 4PM CET**

DTX PUBLIC SALE STARTS  
**MARCH 26TH, 2018 - 4PM CET**

[PREREGISTER NOW](#)

[Join us on Telegram](#)

Navigation icons: Home, Facebook, Twitter, Medium, YouTube, Bitcoin, GitHub, RSS

Source: <https://databrokerdao.com/>



# Marketable data: properties and issues

## Some properties

- Can be large, multiple data sources but mainly static data
- Having good quality control
- Have strong data contract terms
- Some do not offer the whole dataset

## Some issues

- Multiple levels of service/data contracts
- Compatible with other data sources w.r.t. contract
- Cost w.r.t. up-to-date data
- Near-realtime data marketplaces



# in EU call for proposals

## TOPIC : Supporting the emergence of data markets and the data economy

**Topic identifier:** ICT-13-2018-2019

**Publication date:** 27 October 2017

**Types of action:** IA Innovation action

**DeadlineModel:** single-stage

**Opening date:** 16 October 2018

**Deadline:** 28 March 2019 17:00:00

**Types of action:** RIA Research and Innovation action  
CSA Coordination and support action

**DeadlineModel:** single-stage

**Opening date:** 31 October 2017

**Deadline:** 17 April 2018 17:00:00

Time Zone : (Brussels time)

Source: <http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/ict-13-2018-2019.html>



# Emerging computing infrastructure and platform provisioning models

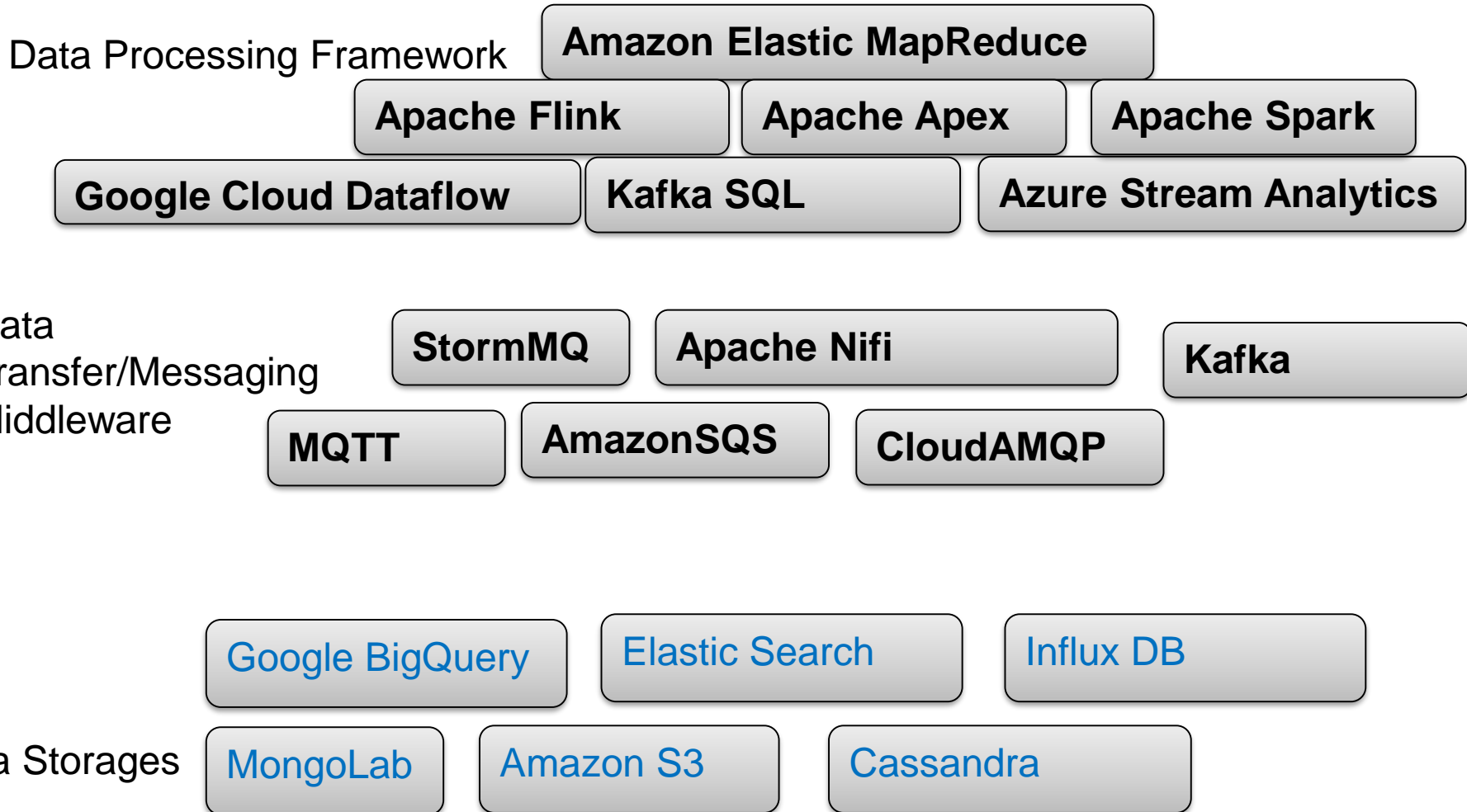
- Infrastructure-as-a-Service
  - Machine as a service
  - Storage as a Service
  - Database as a Service
  - Network as a Service (think about Network Function Virtualization with 5G)
- Edge/Fog computing
  - Distributed edge/fog systems
    - analytics at the edge
    - Network functions and other system operations at the edge/fog systems



# Emerging computing infrastructure and platform provisioning models

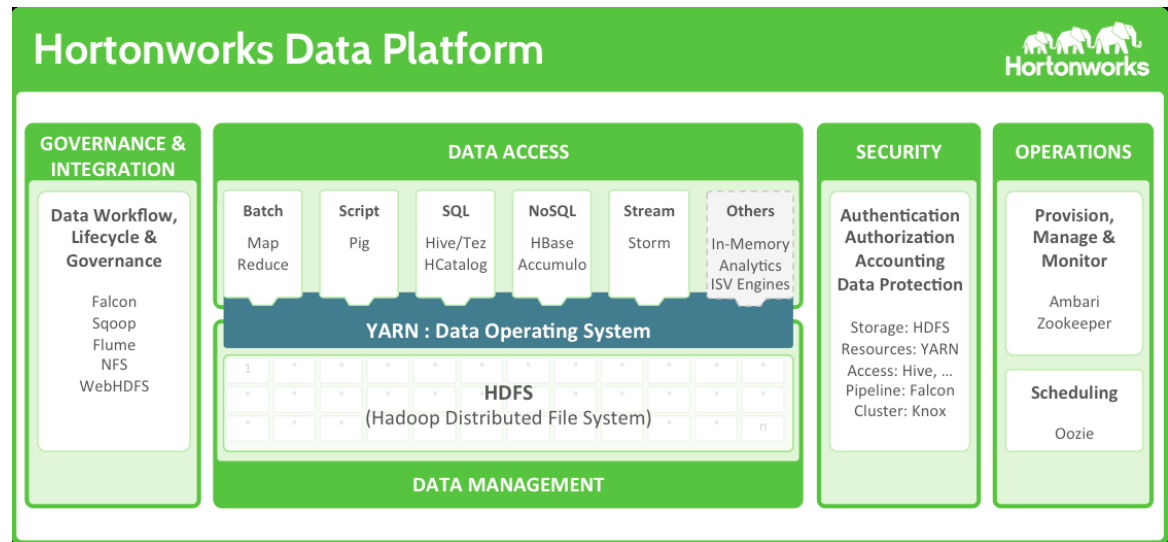
- Platform-as-a-Service
  - Application middleware
  - Computational frameworks
  - Data processing frameworks
  - Management middleware (e.g., monitoring, control, deployment)
- Technologies
  - Virtualization
  - Microservice architectures
  - Serverless computing
  - Machine learning/deep learning
  - Blockchain
  - Etc.

# Examples



# Hadoop ecosystem

- Built around Mapreduce programming models and Hadoop software ecosystems
  - <http://hadoop.apache.org/>
- From “The Forrester Wave™: Big Data Hadoop Distributions, Q1 2016”: Top Hadoop solution providers are **Cloudera, Hortonworks, IBM, MapR Technologies, and Pivotal Software**



Source: <http://hortonworks.com/blog/defining-enterprise-hadoop/>

# Spark ecosystem

Programming with Java, Scala, Python, R  
We can have a separate modules

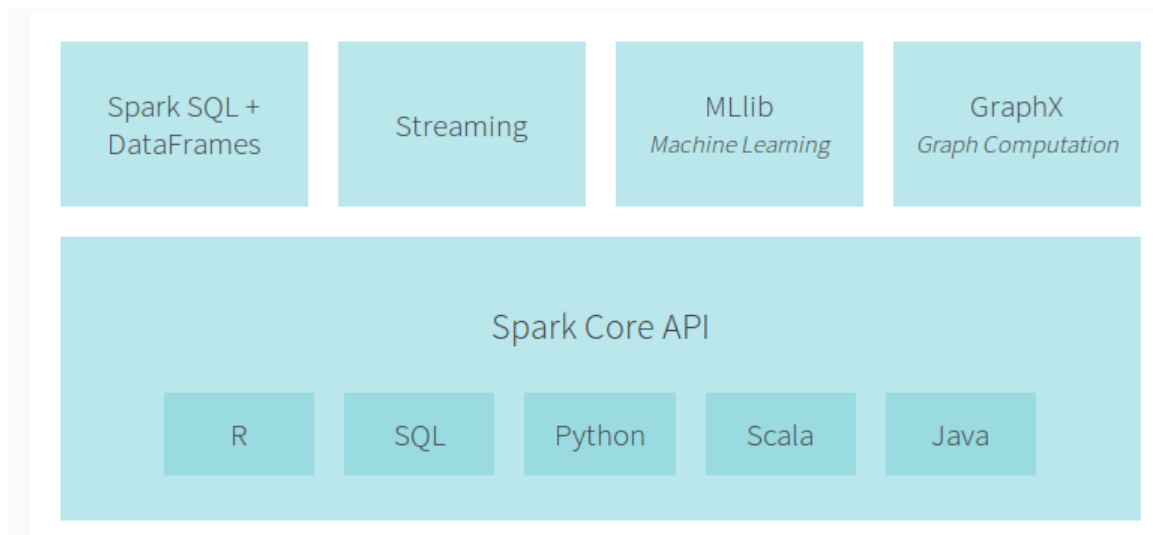
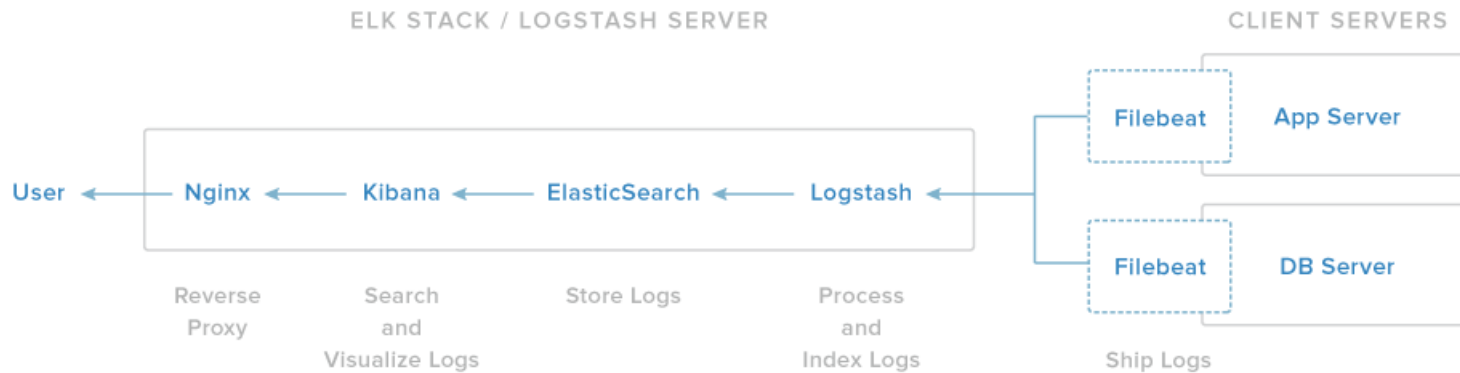


Figure source:  
<https://databricks.com/spark/about>

# ELK Stack

Building using elastic components: Elasticsearch, Elasticsearch Hadoop, Kibana, and Logstash

<https://www.elastic.co/>



Source: <https://www.digitalocean.com/community/tutorials/how-to-install-elasticsearch-logstash-and-kibana-elk-stack-on-ubuntu-14-04>

Main from services of  
Influx

<https://www.influxdata.com>

Focus on time series data

- Collect
- Storage
- Visualize
- ETL

# TICK

## Telegraf

- Time-Series Data Collector

## InfluxDB

- Time-Series Data Storage

## Chronograf

- Time-Series Data Visualization

## Kapacitor

- Time-Series Data Processing



# Machine Learning Stack

Microsoft Azure Machine Learning Studio

Hong-Linh Truong-Free-W... ?

Experiment created on 22.2.2017

Finished running ✓

Properties Project

Search experiment items

- ▶ Saved Datasets
- ▶ Data Format Conversions
- ▶ Data Input and Output
- ▶ Data Transformation
- ▶ Feature Selection
- ▶ Machine Learning
  - ▶ Evaluate
  - ▶ Initialize Model
  - ▶ Score
  - ▶ Train
- ▶ OpenCV Library Modules
- ▶ Python Language Modules
- ▶ R Language Modules
- ▶ Statistical Functions
- ▶ Text Analytics
- ▶ Time Series
- ▶ Web Service
- ▶ Deprecated

Alarm-DL-08-02-2017.csv

Summarize Data ✓

Mini Map

START TIME 2/22/201...

END TIME 2/22/201...

STATUS CODE Finished

STATUS DETAILS None

Prior Run

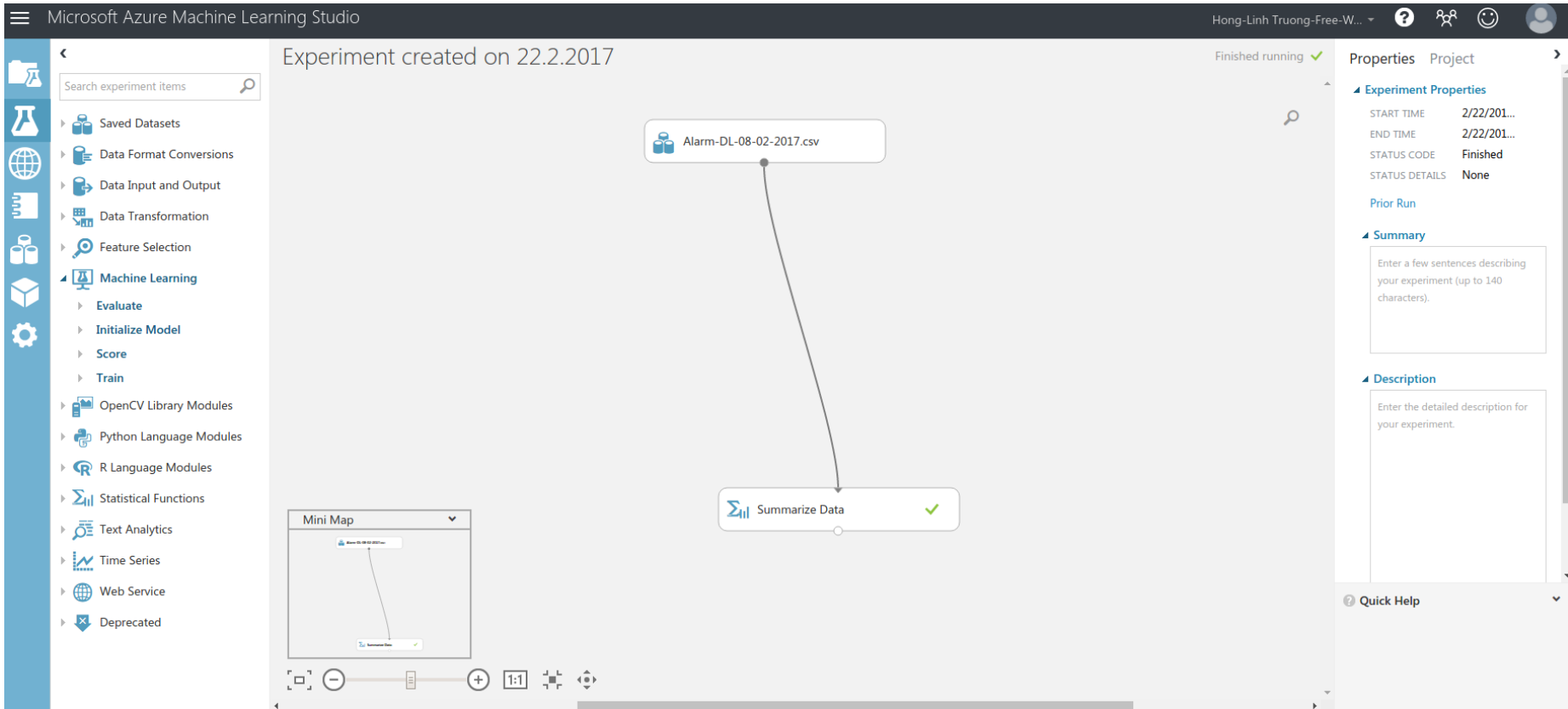
Summary

Enter a few sentences describing your experiment (up to 140 characters).

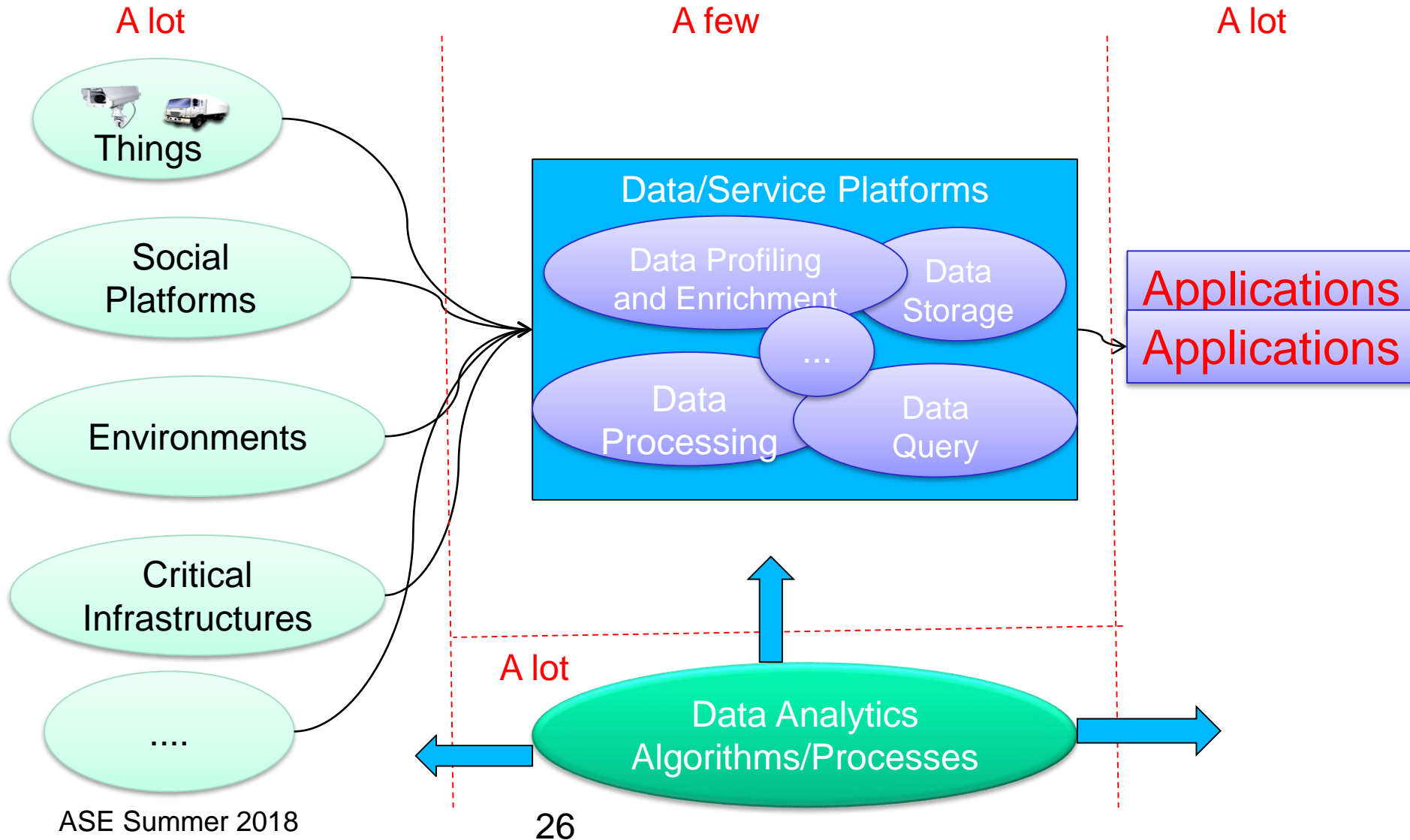
Description

Enter the detailed description for your experiment.

Quick Help



# Cloud-based Analytics



# Emerging computing infrastructure/platform provisioning models– properties and issues

## Some properties

- Rich types of services from multiple providers
  - Better choices in terms of functions and costs
- Concepts are similar but diverse APIs
- Strong dependencies/tight ecosystems

## Some issues

- On-demand information management from multiple sources
- APIs complexity and API management
- Cross-vendor integration
- Execution in Multi-cloud environments
- Data locality
- Service mess/discovery

# Emerging human computation models

- Crowdsourcing platforms
  - (Anonymous) people computing capabilities exploited via task bids
- Expert as Individual Compute Unit
  - An individual is treated like „a processor“ or “functional unit“. A service can wrap human capabilities to support the communication and coordination of tasks
- A set of individuals as *collectives*
  - A set of people and software that are initiated and provisioned as a service for solving tasks

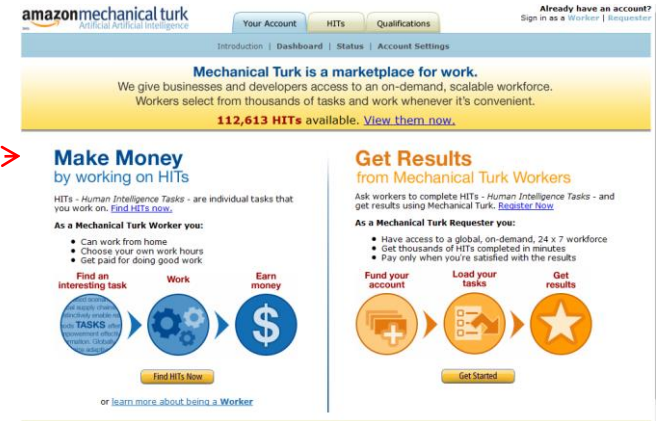
The main point: humans are a computing element

# Examples of human computation (2)

```

1  import edu.umass.cs.automan.adapters.MTurk._
2
3  object SimpleProgram extends App {
4    val a = MTurkAdapter { mt =>
5      mt.access_key_id = "XXXX"
6      mt.secret_access_key = "XXXX"
7    }
8
9    def which_one() = a.RadioButtonQuestion { q =>
10     q.budget = 8.00
11     q.text = "Which one of these does not belong?"
12     q.options = List(
13       a.Option('oscar, "Oscar the Grouch"),
14       a.Option('kermit, "Kermit the Frog"),
15       a.Option('spongebob, "Spongebob Squarepants"),
16       a.Option('cookie, "Cookie Monster"),
17       a.Option('count, "The Count")
18     )
19   }
20
21   println("The answer is " + which_one())
22 }

```



The screenshot shows the Amazon Mechanical Turk website. At the top, there are navigation links for 'Your Account', 'HITS', and 'Qualifications'. Below this, a yellow banner states 'Mechanical Turk is a marketplace for work.' and 'We give businesses and developers access to an on-demand, scalable workforce. Workers select from thousands of tasks and work whenever it's convenient.' It also mentions '112,613 HITs available. View them now.'

Below the banner, there are two main sections:

- Make Money by working on HITs:** This section is for workers. It lists benefits: 'Can work from home', 'Choose your own work hours', and 'Get paid for doing good work'. It includes a flow diagram: 'Find an interesting task' (with a 'Find HITs Now' button) -> 'Work' (with a gear icon) -> 'Earn money' (with a dollar sign icon).
- Get Results from Mechanical Turk Workers:** This section is for requesters. It lists benefits: 'Have access to a global, on-demand, 24 x 7 workforce' and 'Get thousands of HITs completed in minutes'. It includes a flow diagram: 'Fund your account' (with a plus icon) -> 'Load your tasks' (with a gear icon) -> 'Get results' (with a star icon). A 'Get Started' button is at the bottom.

Source: Daniel W. Barowy, Charlie Curtsinger, Emery D. Berger, Andrew McGregor: **AutoMan: a platform for integrating human-based and digital computation.** OOPSLA 2012: 639-654

# Human computation models – properties and issues

## Some properties

- Huge number of people
- Capabilities might not know in advance
- Unpredictable behavior
- Simple coordination models

## Some issues

- Reliability
- Quality control
- Reliability assurance
- Proactive, on-demand acquisition
- Incentive strategies
- Collectives

Discussion time:

**DO I NEED TO STUDY THEM  
ALL? WHY?**

# USE CASES/SCENARIOS



# Critical infrastructures/services for citizens and business

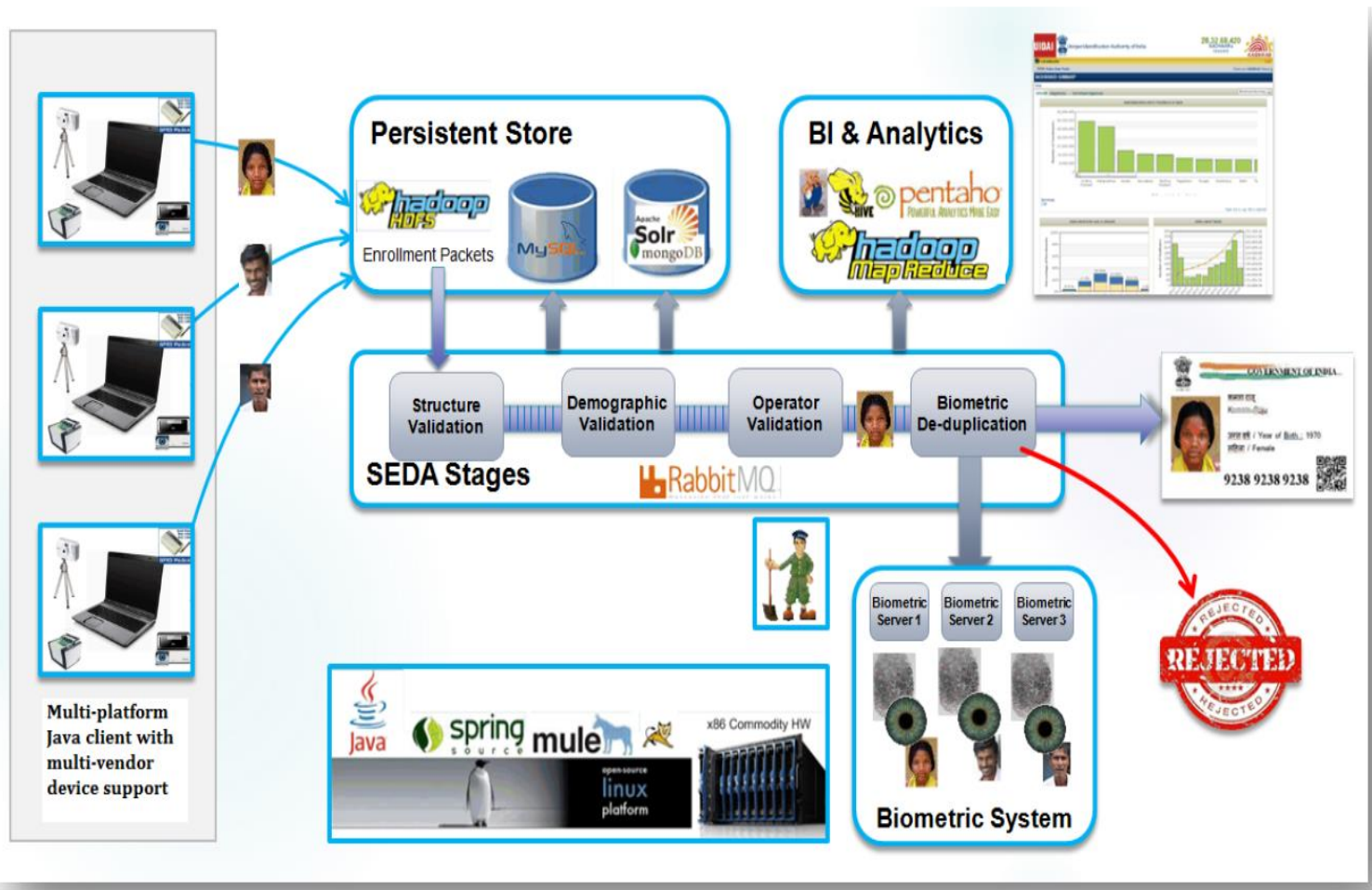
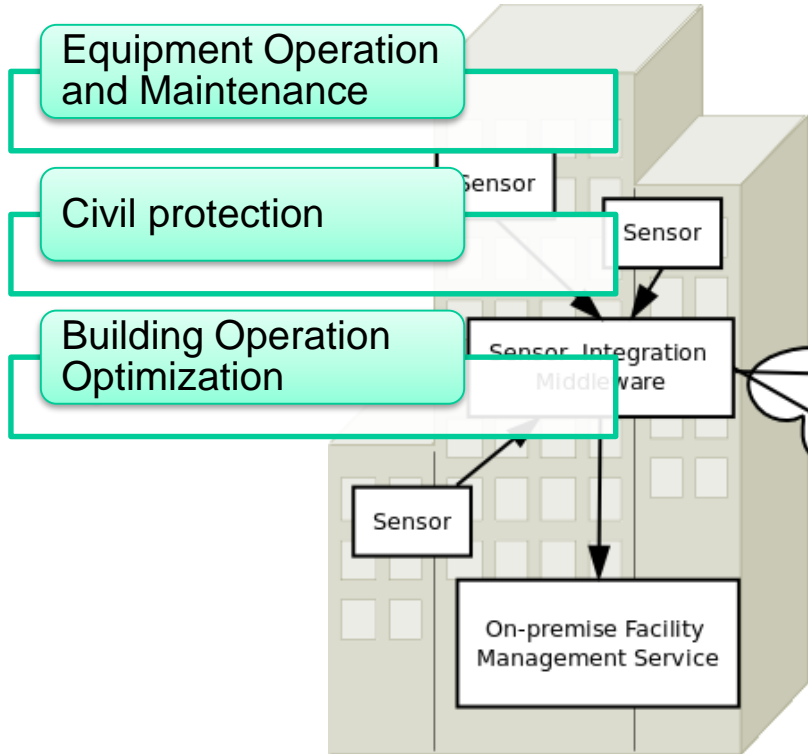


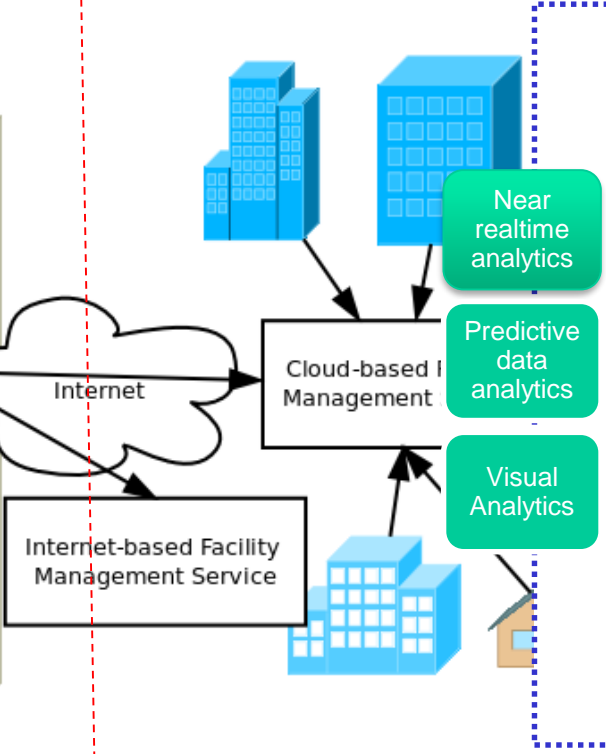
Figure source: [http://uidai.gov.in/images/AadhaarTechnologyArchitecture\\_March2014.pdf](http://uidai.gov.in/images/AadhaarTechnologyArchitecture_March2014.pdf)

# Smart building management

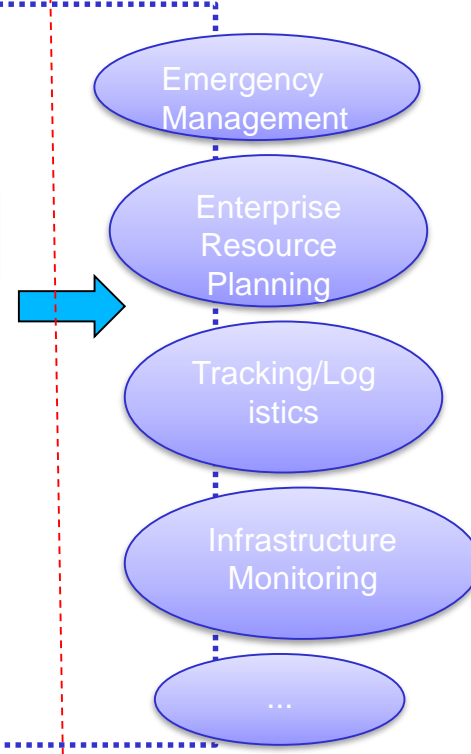
Infrastructure/Internet of Things



Internet/public cloud boundary

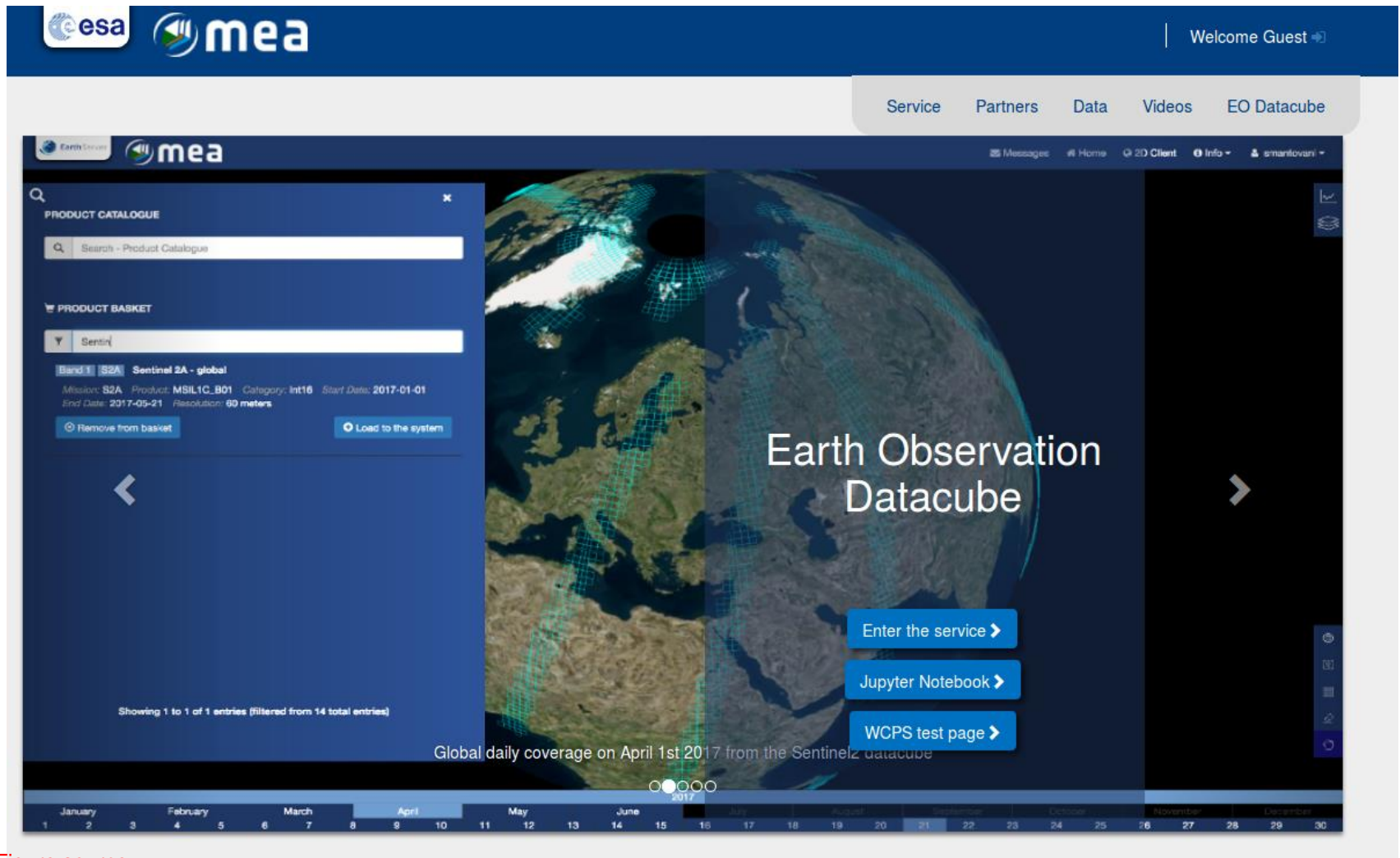


Organization-specific boundary



Cities, e.g. including:  
10000+ buildings  
1000000+ sensors

Can we combine open government data with building monitoring data?



The screenshot displays the Earth Observation Datacube web application. At the top, the ESA and MEA logos are visible, along with a 'Welcome Guest' message. A navigation menu includes 'Service', 'Partners', 'Data', 'Videos', and 'EO Datacube'. The main interface features a 'PRODUCT CATALOGUE' sidebar with a search bar and a 'PRODUCT BASKET' section. The basket contains one item: 'Sentinel 2A - global', with details for mission, product, category, start/end dates, and resolution. A central globe shows satellite coverage patterns over Europe and Africa. Overlaid on the globe is the text 'Earth Observation Datacube' and three buttons: 'Enter the service', 'Jupyter Notebook', and 'WCPS test page'. A timeline at the bottom shows the month of April 2017, with the 15th highlighted.

Figure source:  
<https://eodatacube.eu/>  
ASE Summer 2018

# Video analytics + business applications/public security

## Use Case 3: Video Analytics

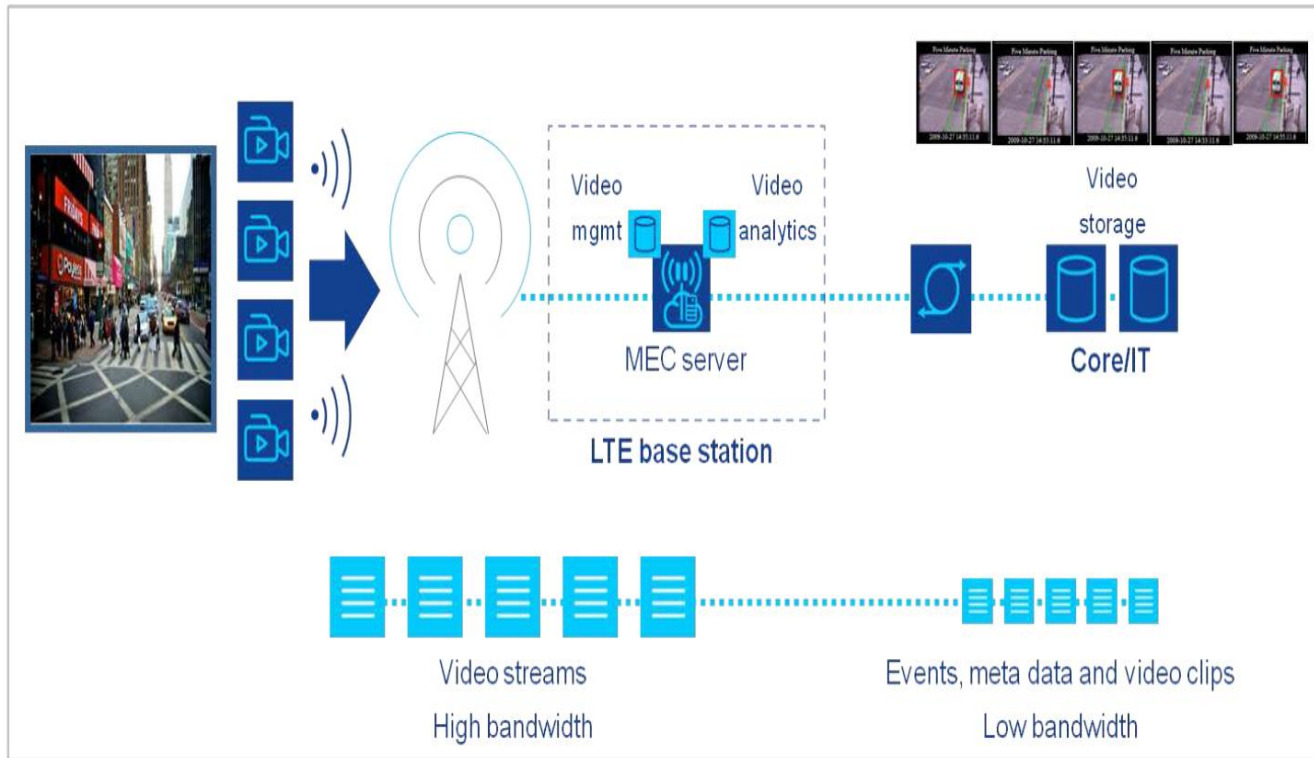


Figure 4: Example of video analytics

Figure source:

[https://portal.etsi.org/portals/0/tbpages/mec/docs/mobile-edge\\_computing\\_-\\_introductory\\_technical\\_white\\_paper\\_v1%2018-09-14.pdf](https://portal.etsi.org/portals/0/tbpages/mec/docs/mobile-edge_computing_-_introductory_technical_white_paper_v1%2018-09-14.pdf)



# Edge/Cloud ML-based Video analytics

## Chinese police are using smart glasses to identify potential suspects

Posted Feb 8, 2018 by [Jon Russell \(@jonrussell\)](#)



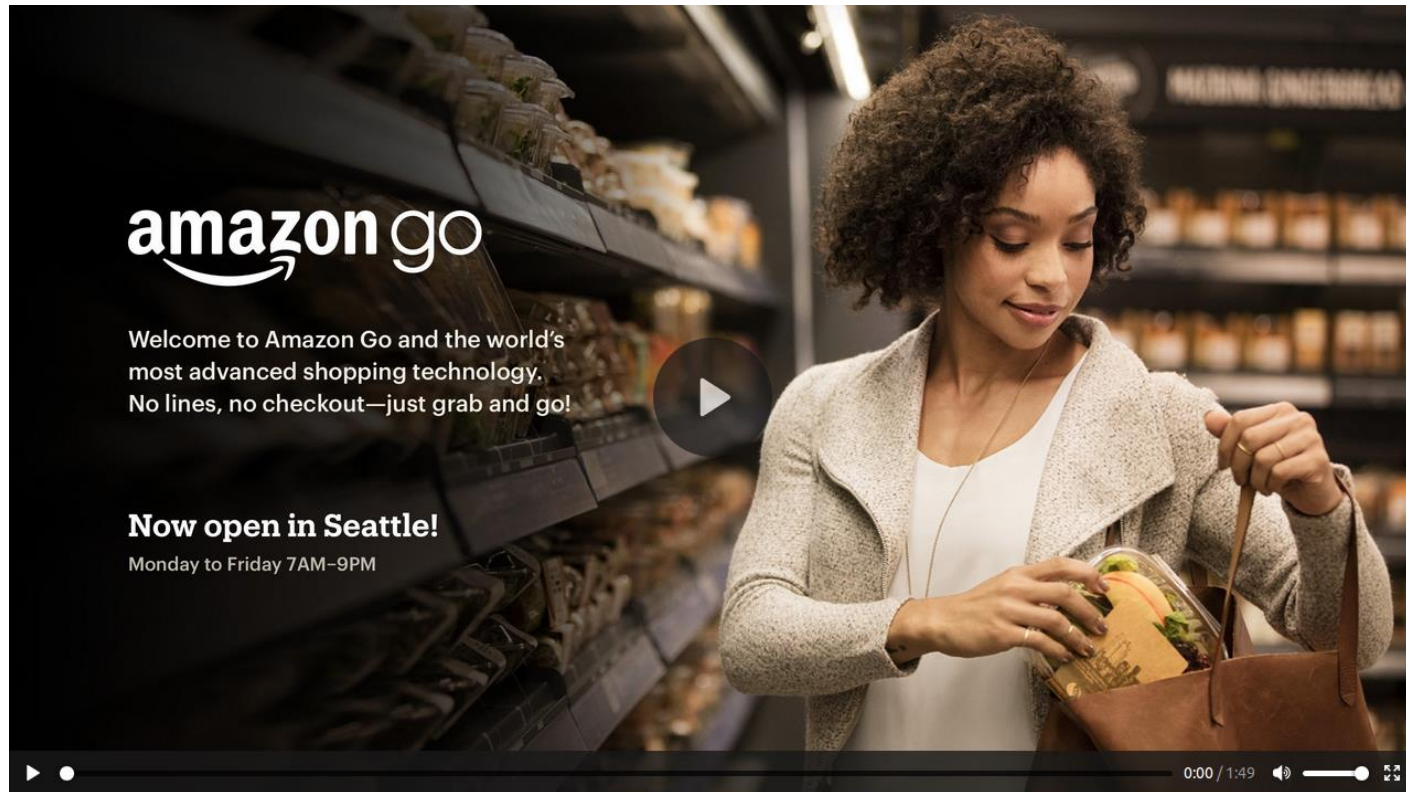
Figure source:  
<https://techcrunch.com/2018/02/08/chinese-police-are-getting-smart-glasses/>



Figure caption 2: Video data include cabin and roadway views. This view illustrates possible relationships between observed driver behavior and the roadway context outside the vehicle, which includes other vehicles, cyclists, pedestrians, and lane markings.

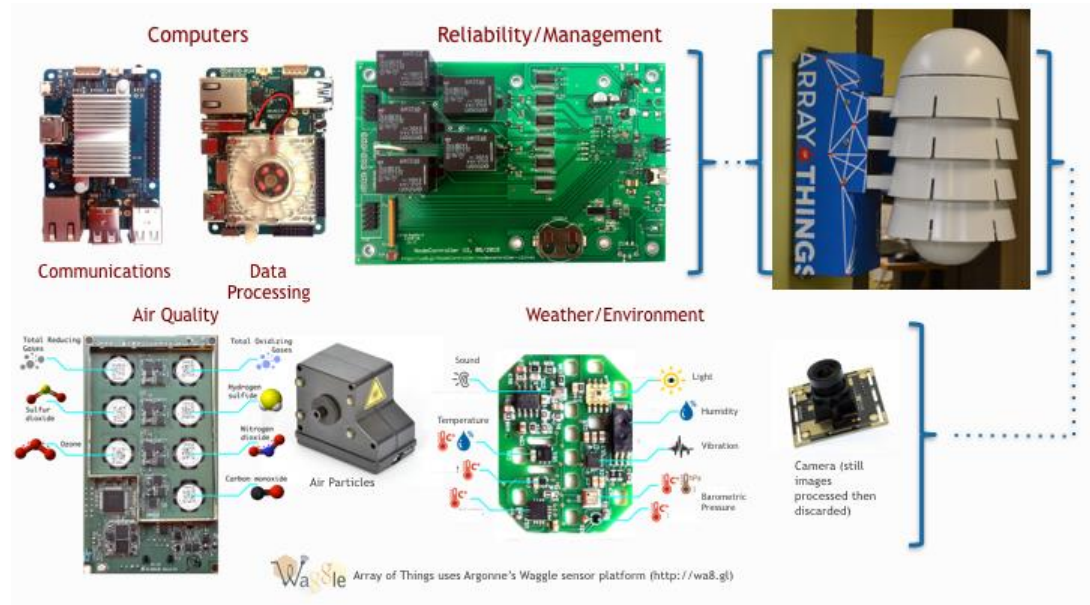
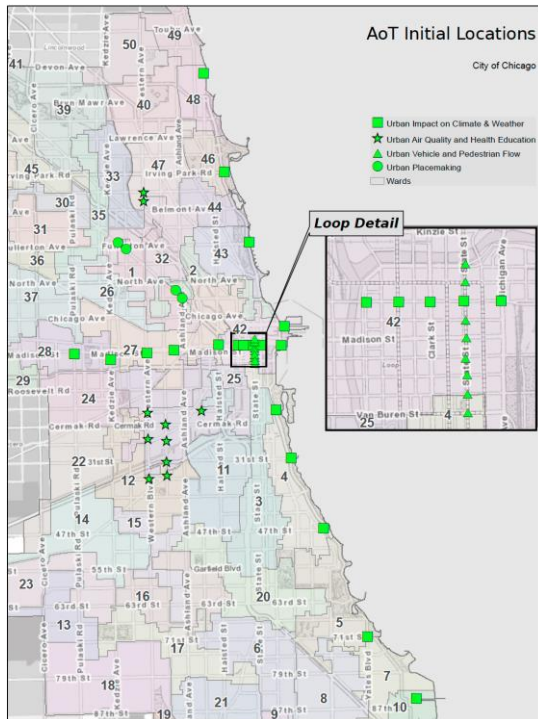
Figure source:  
[https://www.fhwa.dot.gov/research/resources/computervision\\_breakthrough.cfm](https://www.fhwa.dot.gov/research/resources/computervision_breakthrough.cfm)

# Shop scale



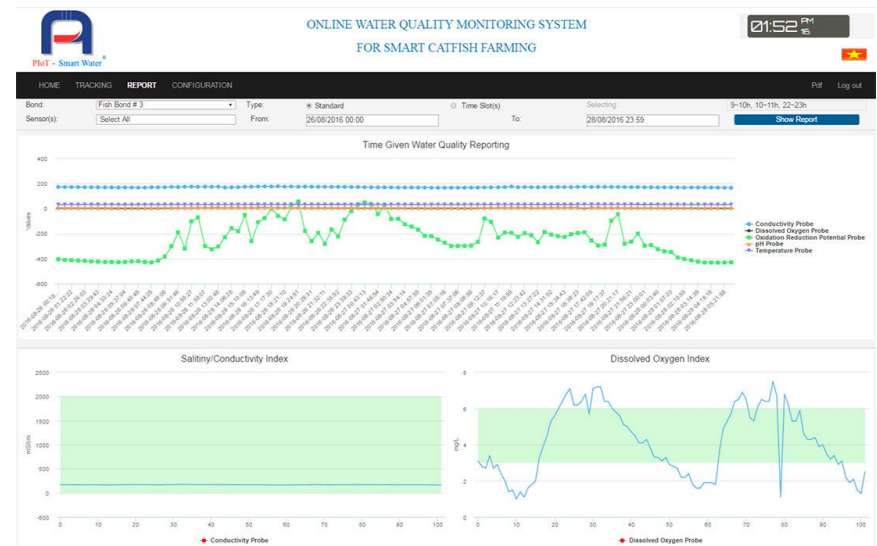
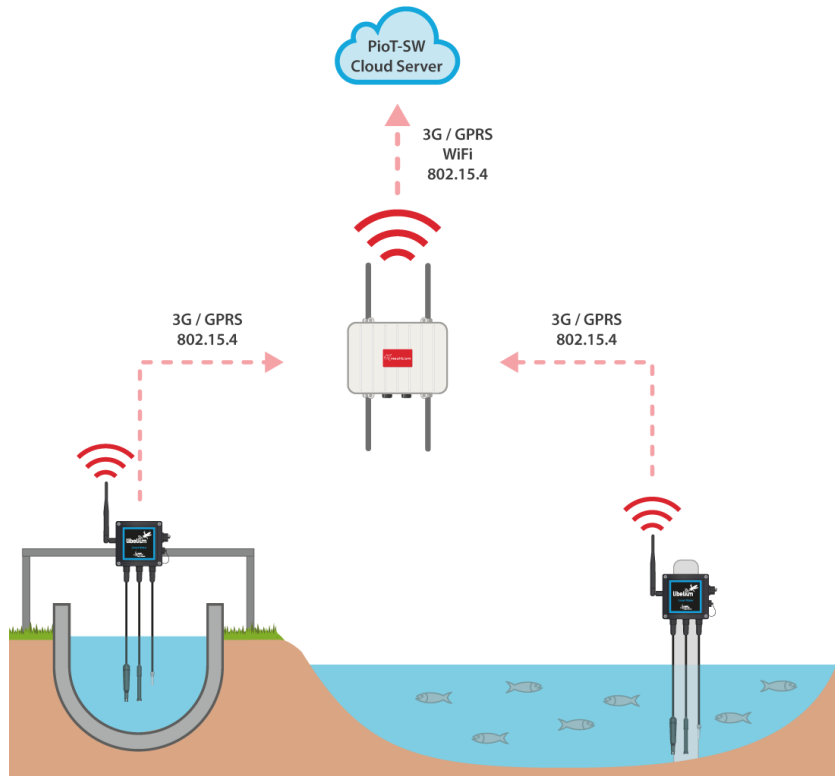
<https://www.amazon.com/b?ie=UTF8&node=16008589011>

# IoT data in City-scale



<https://arrayofthings.github.io/node.html>





Source: <http://www.libelium.com/fish-farm-monitoring-in-vietnam-by-controlling-water-quality-in-ponds-and-tanks/>





Geo Sports: Picture courtesy  
Future Position X, Sweden



# Connected Cars

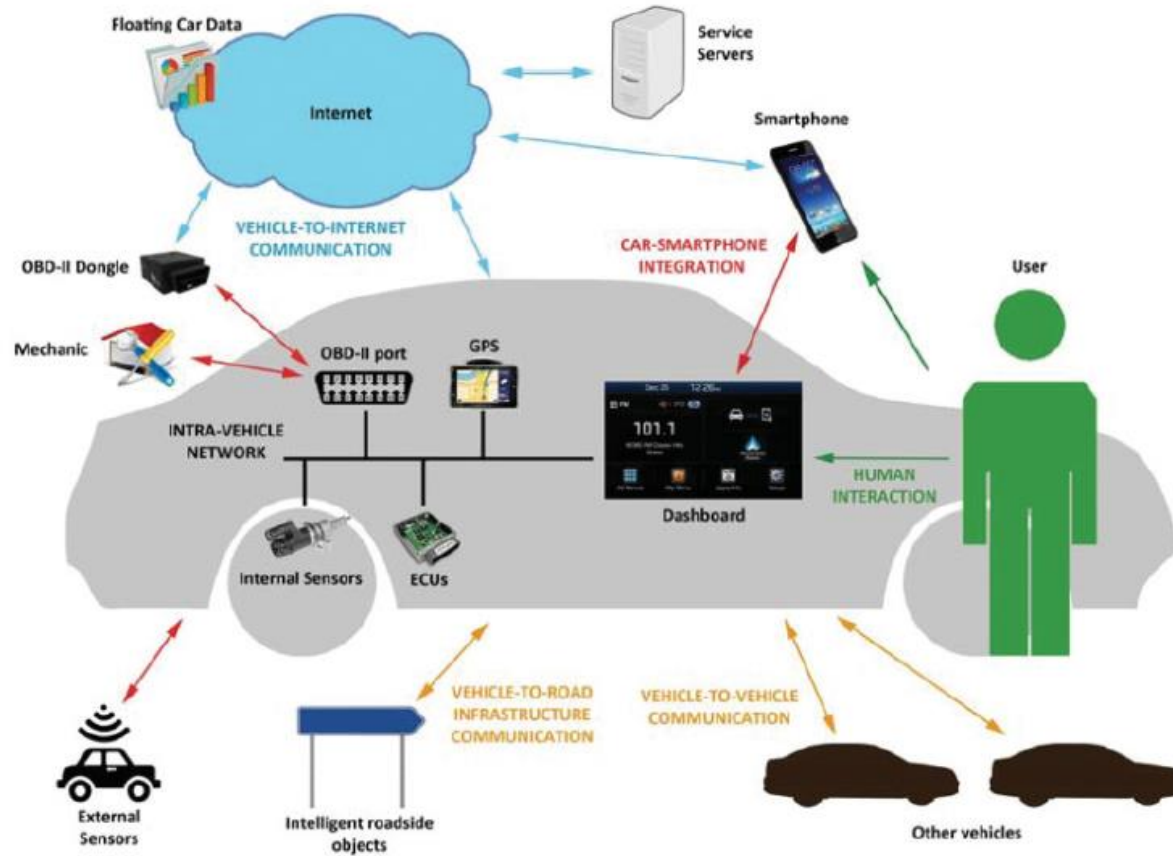


Fig. 3. Overview of the connected car system.

Source: Riccardo Coppola and Maurizio Morisio. 2016. Connected Car: Technologies, Issues, Future Trends. ACM Comput. Surv. 49, 3, Article 46 (October 2016), 36 pages. DOI: <https://doi.org/10.1145/2971482>

# Drones for logistics

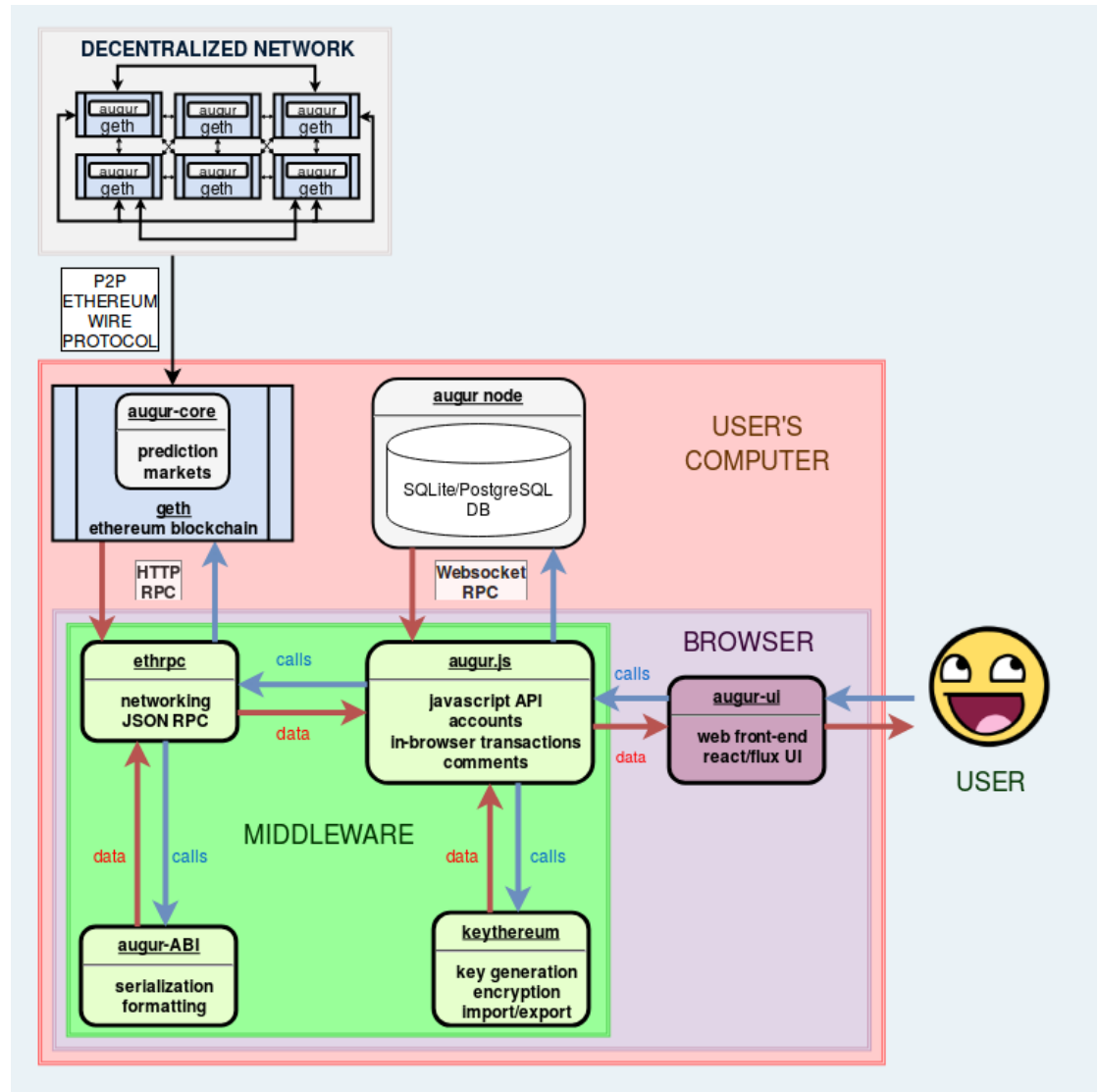


Figure 16: Urban First and Last Mile

Source: DHL Trend Report “Unmanned Aerial Vehicles”

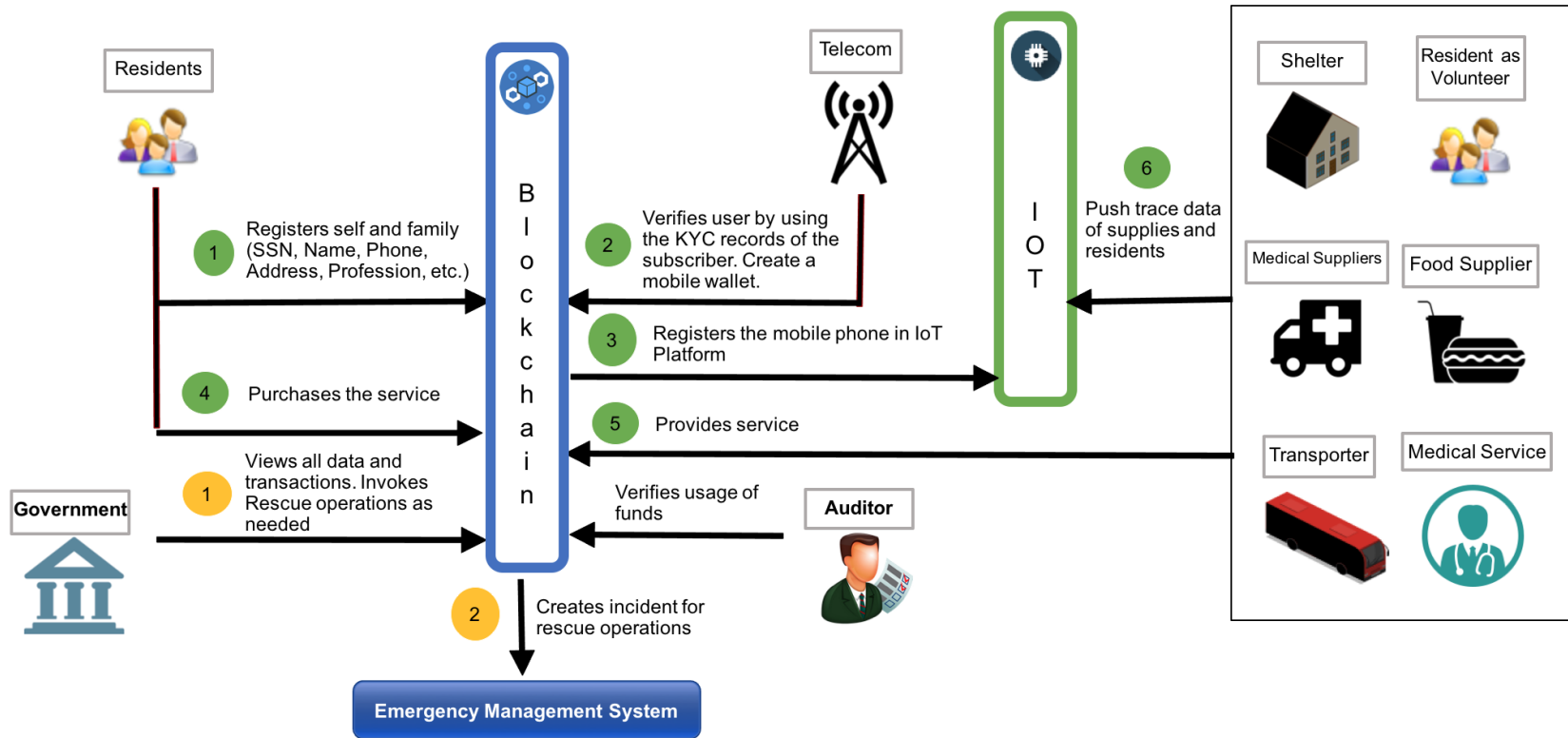
[http://www.dhl.com/content/dam/downloads/g0/about\\_us/logistics\\_insights/dhl\\_trend\\_report\\_uav.pdf](http://www.dhl.com/content/dam/downloads/g0/about_us/logistics_insights/dhl_trend_report_uav.pdf)

# Blockchain for prediction markets



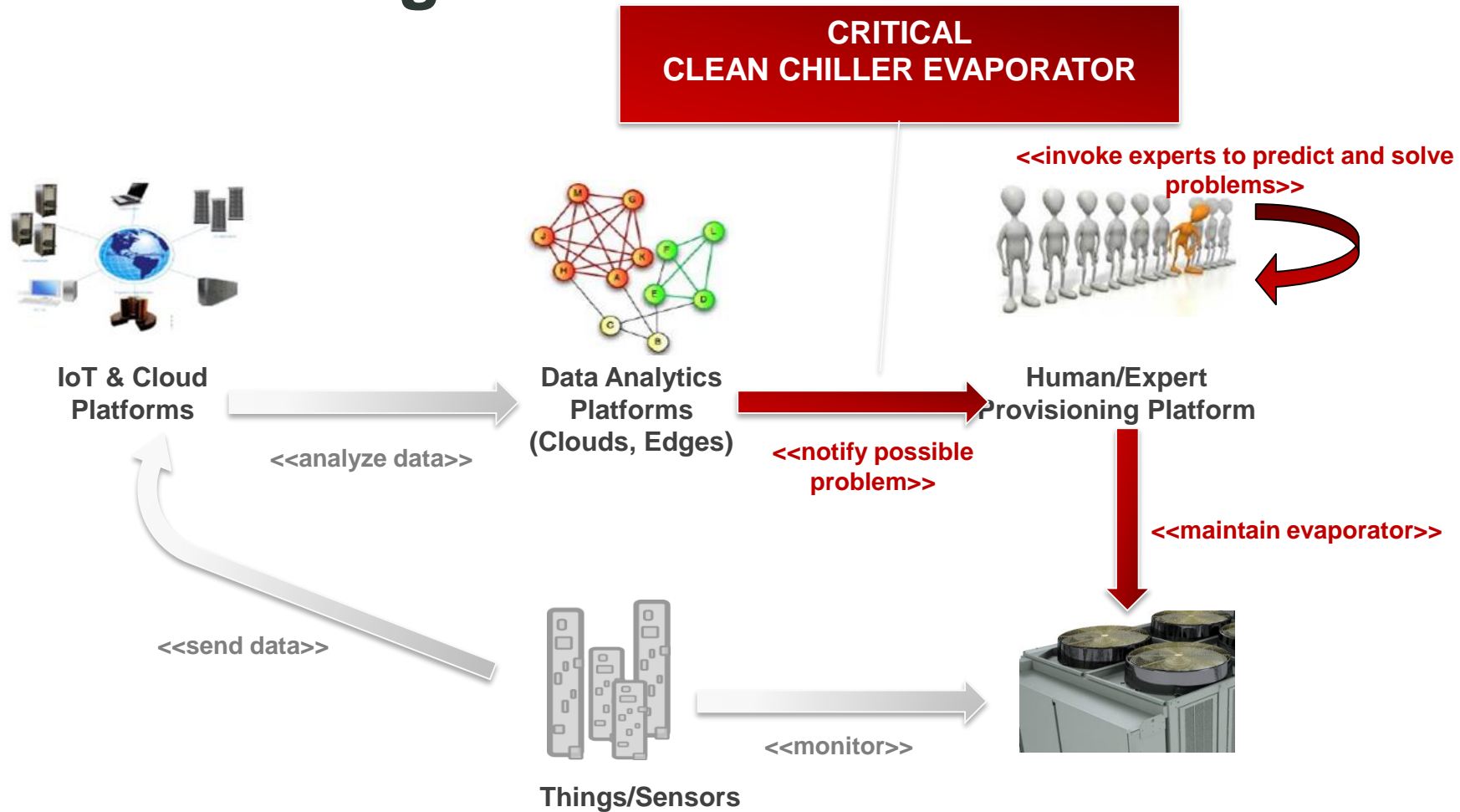
Source: <http://docs.augur.net>

# Blockchain and IoT for Disaster Management?



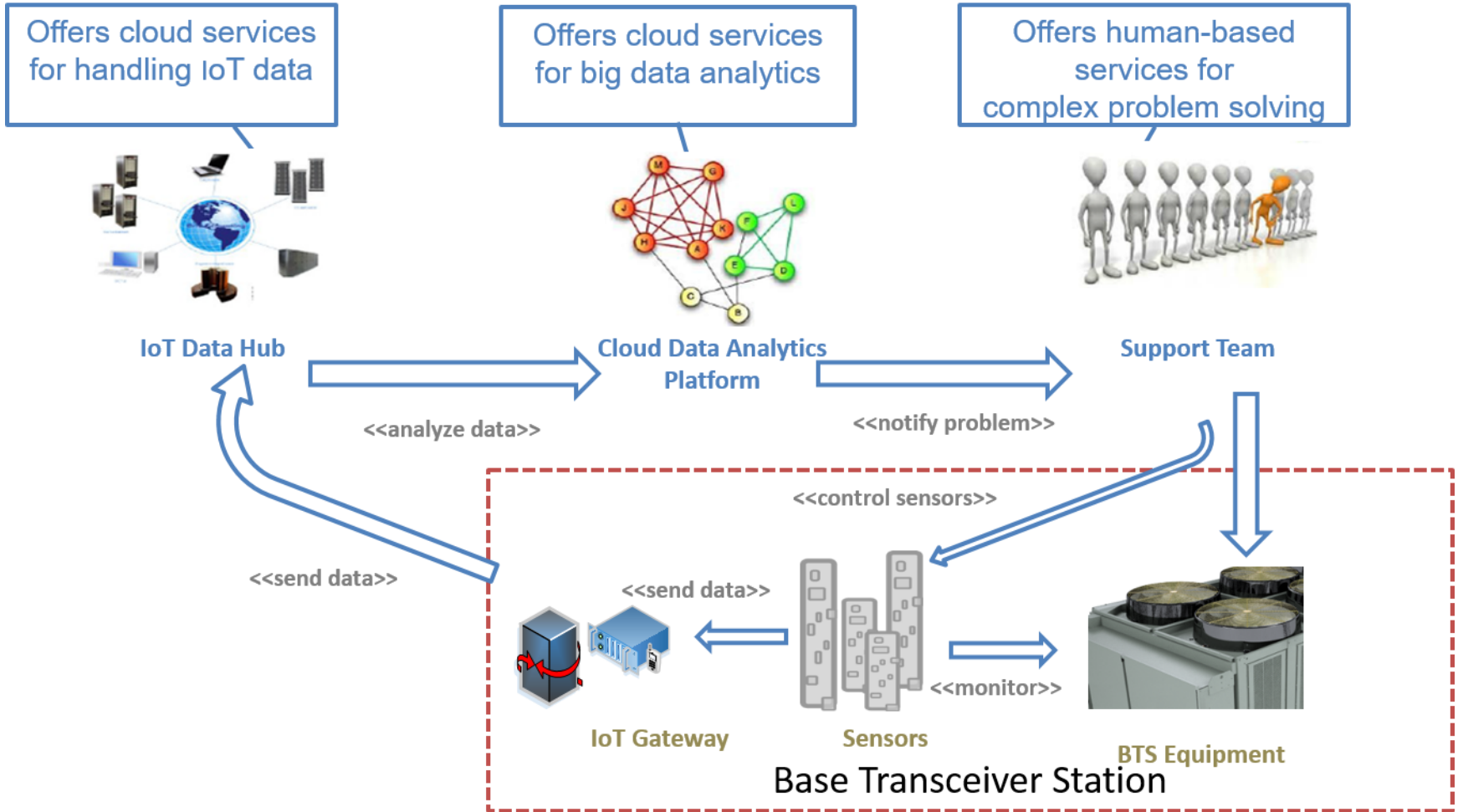
Source: <https://developer.ibm.com/blockchain/2017/12/09/disaster-management-using-blockchain-iot/>

# Predictive Maintenance in Smart Buildings





# Predictive Maintenance in Telcos

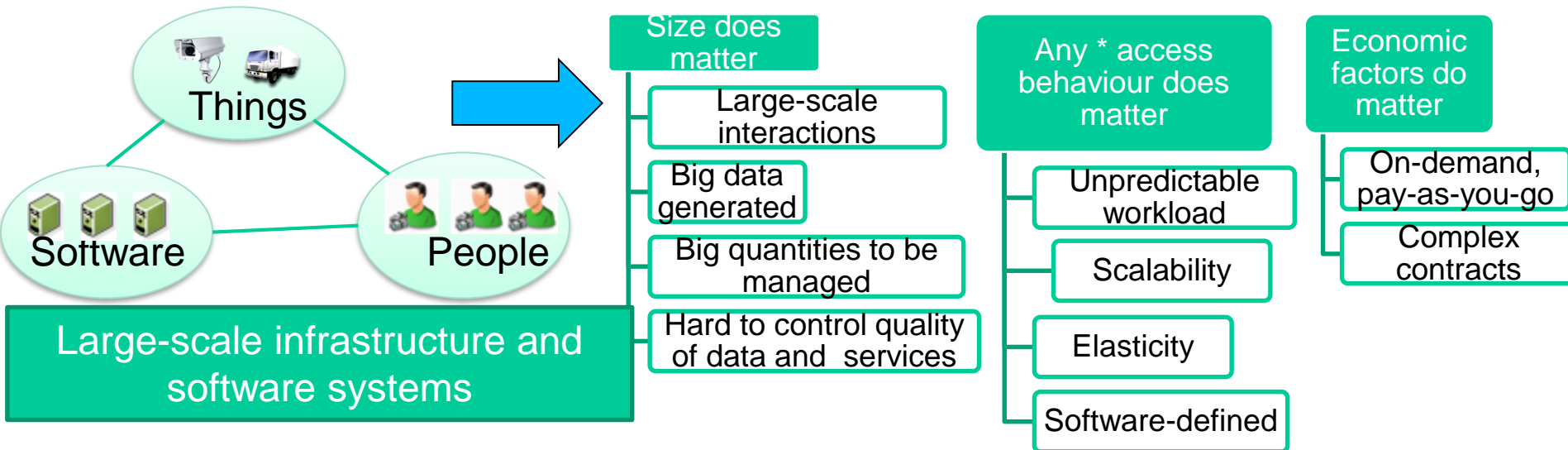


# CONVERGENCE OF MULTIPLE COMPUTING MODELS

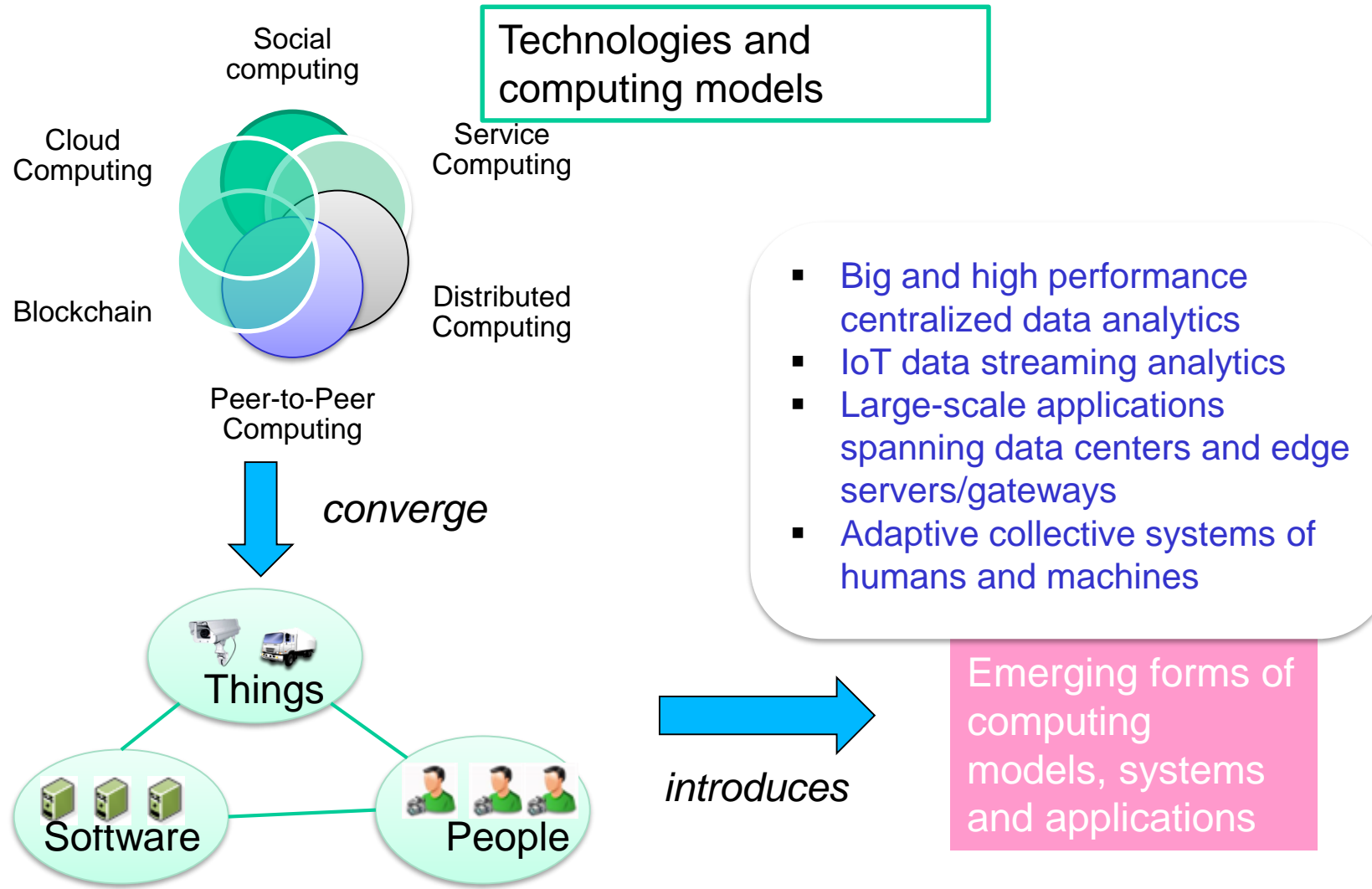


# Today's Computing Models

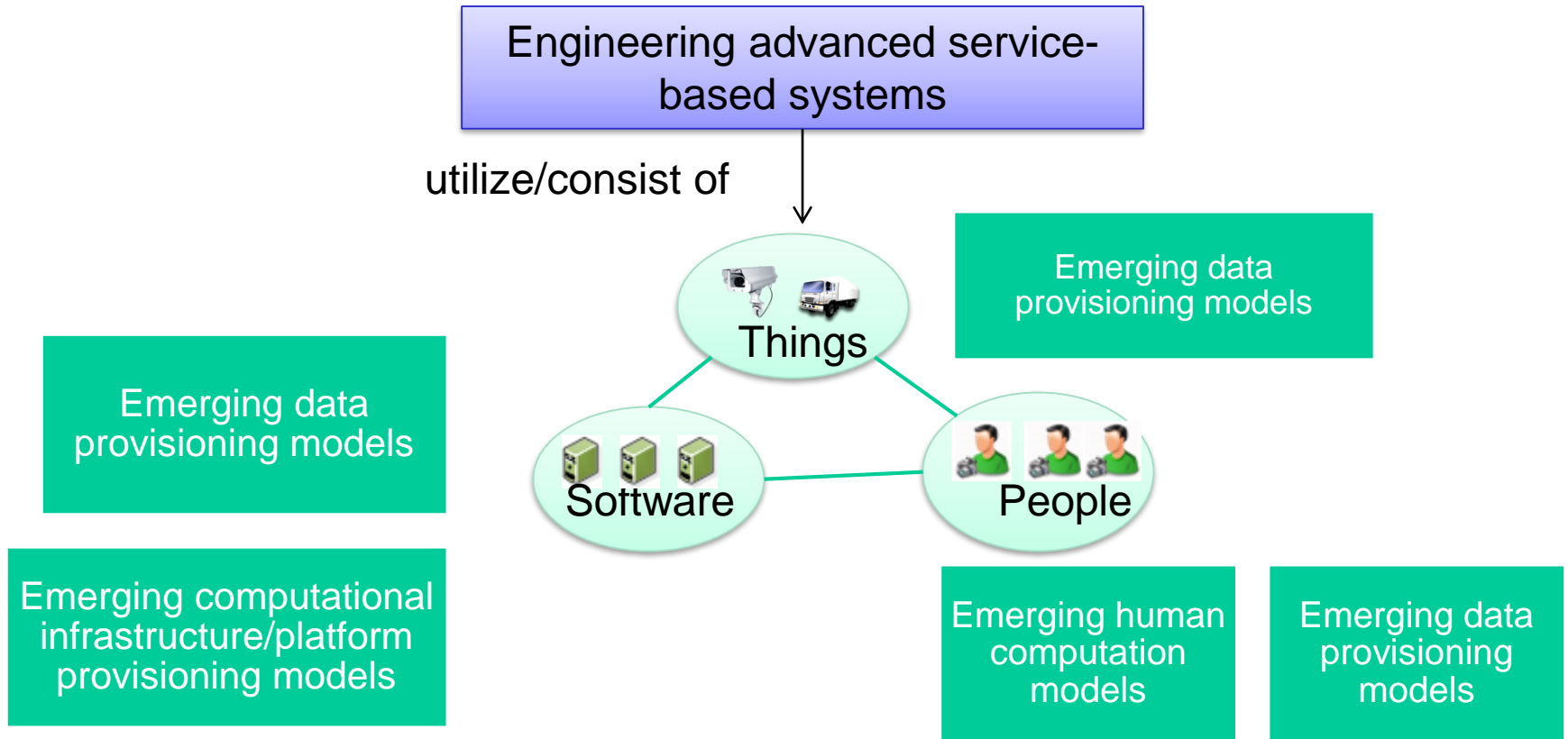
- Internet infrastructure and software connect *contents, things, and people*, each has different roles (*computation, sensing, analytics, etc.*)



# Today's Computing Models



# Summary of emerging models wrt advanced service-based systems



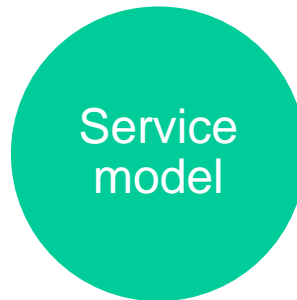
Challenges in Virtualization, Programming, Communication, and Coordination, etc.

# ADVANCED SERVICES ENGINEERING'S FOCUS

# Single service/platform engineering(1)

- The service model can be applied to things, people and software

Consumption,  
ownership,  
provisioning, price, etc.



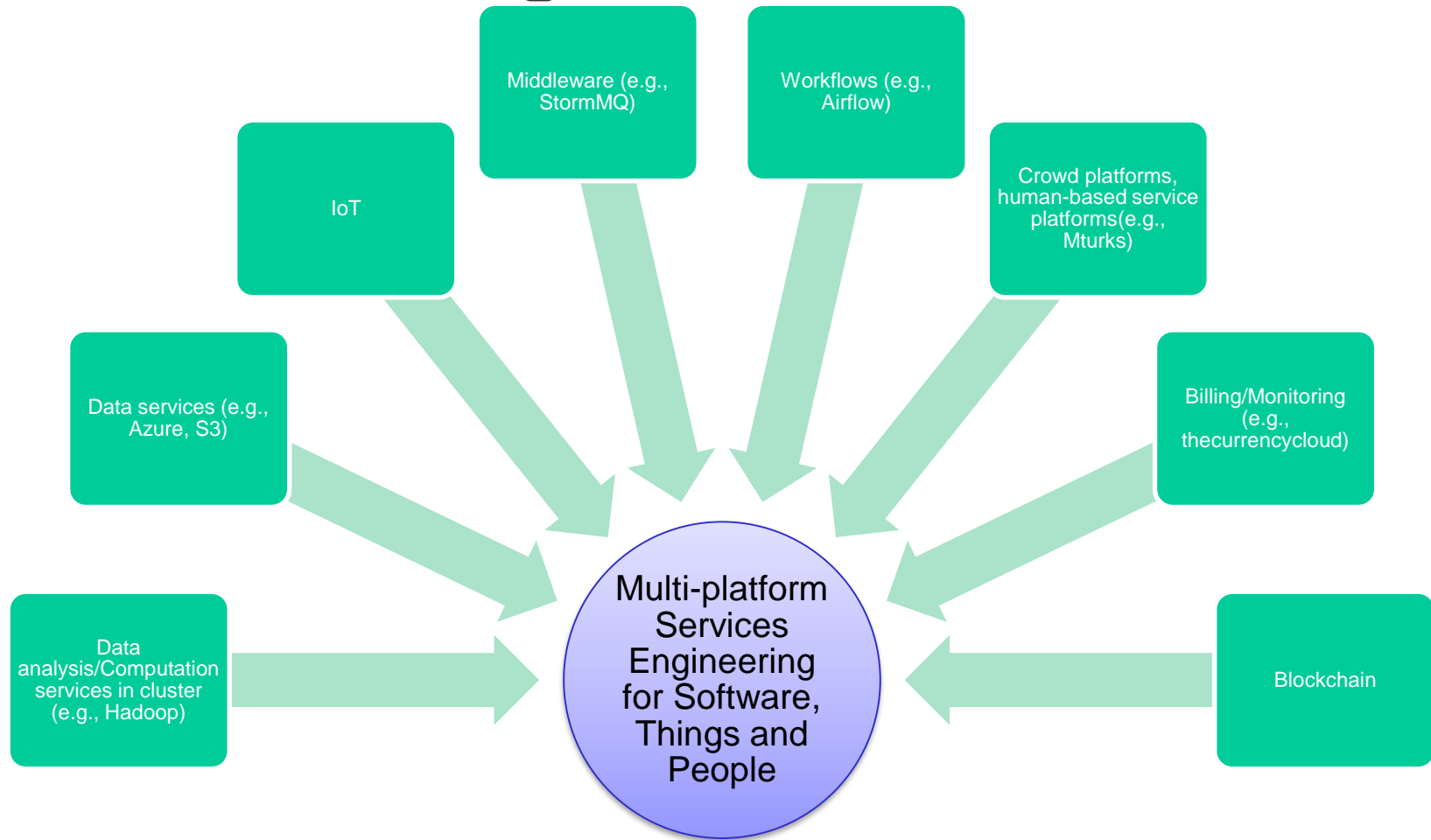
„basic  
component“/“basic  
function“ modeling  
and description  
/microservices

# Single service/platform engineering – service unit provisioning

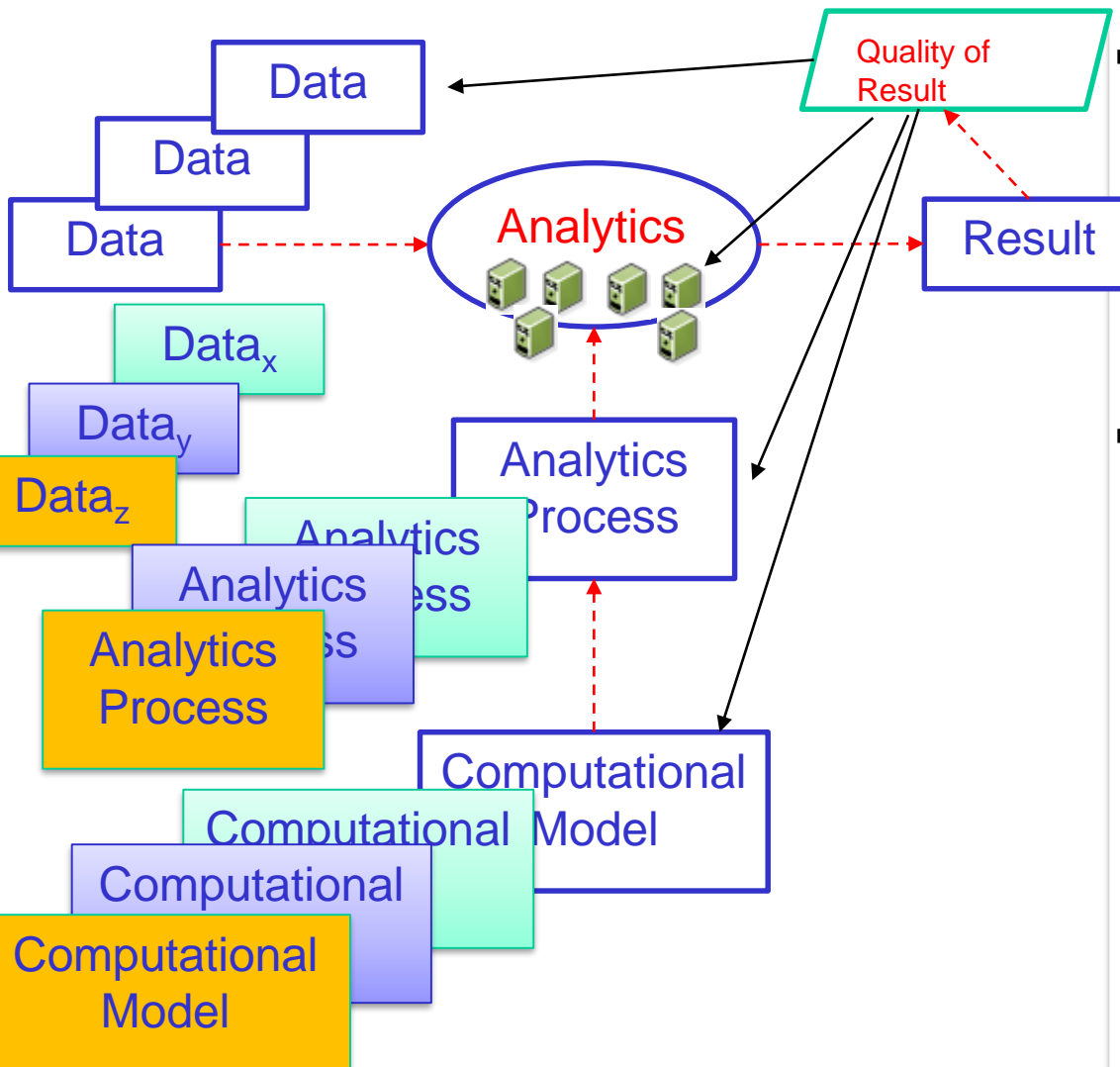
- Provisioning software, things and human capabilities under services
- E.gg., video analytics, machine learning service, Spark cluster, BigQuery, HDFS, Ethereum, etc.

1. Mark Turner, David Budgen, and Pearl Brereton. 2003. **Turning Software into a Service**. *Computer* 36, 10 (October 2003), 38-44. DOI=10.1109/MC.2003.1236470 <http://dx.doi.org/10.1109/MC.2003.1236470>
2. Luigi Atzori, Antonio Iera, and Giacomo Morabito. 2010. **The Internet of Things: A survey**. *Comput. Netw.* 54, 15 (October 2010), 2787-2805. DOI=10.1016/j.comnet.2010.05.010 <http://dx.doi.org/10.1016/j.comnet.2010.05.010>
3. Dominique Guinard, Vlad Trifa, Stamatis Karnouskos, Patrik Spiess, Dominic Savio: **Interacting with the SOA-Based Internet of Things: Discovery, Query, Selection, and On-Demand Provisioning of Web Services**. *IEEE T. Services Computing* 3(3): 223-235 (2010)

# Internet-scale multi-platform services engineering – required technologies



# Service engineering – the elasticity



- **More data** → more computational resources (e.g. more VMs)
- **More types of data** → more computational models → more analytics processes
- Change **quality of analytics**
  - Change quality of data
  - Change response time
  - Change cost
  - Change types of result (form of the data output, e.g. tree, visual, story, etc.)



# Service engineering -- big/near-real time data impact

- Which are data concerns that impact the data processing?
- How to use data concerns to optimize data analytics and service provisioning?
- How to use available data assets for advanced services in an elastic manner?
- What are the role of human-based services in dealing with complex data analytics?

# Advanced service engineering -- Steps

## Single service/platform engineering

Service units for representing fundamental things, people and software

Provisioning of fundamental service units

Engineering with single service units



## Understanding Properties/Concerns

Data /Service/Application concerns; their dependencies

Monitoring, evaluation and provisioning of concerns

Utilization of data/service concerns



## Large-scale, multi-platform services engineering

Identify platform/application problems

Identify the scale, complexity and \*city

Design units, selection of existing service units;

Development and integration, optimization

- Read papers mentioned in slides
  - Get their main ideas
- Check services mentioned in examples
  - Examine capabilities of the mentioned services
    - Including price models and underlying technologies
  - Examine their size and scale
  - Examine their ecosystems and dependencies
- Work on possible categories of single service units that are useful for your work
  - Some common service units with capabilities and providers

# Thanks for your attention

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