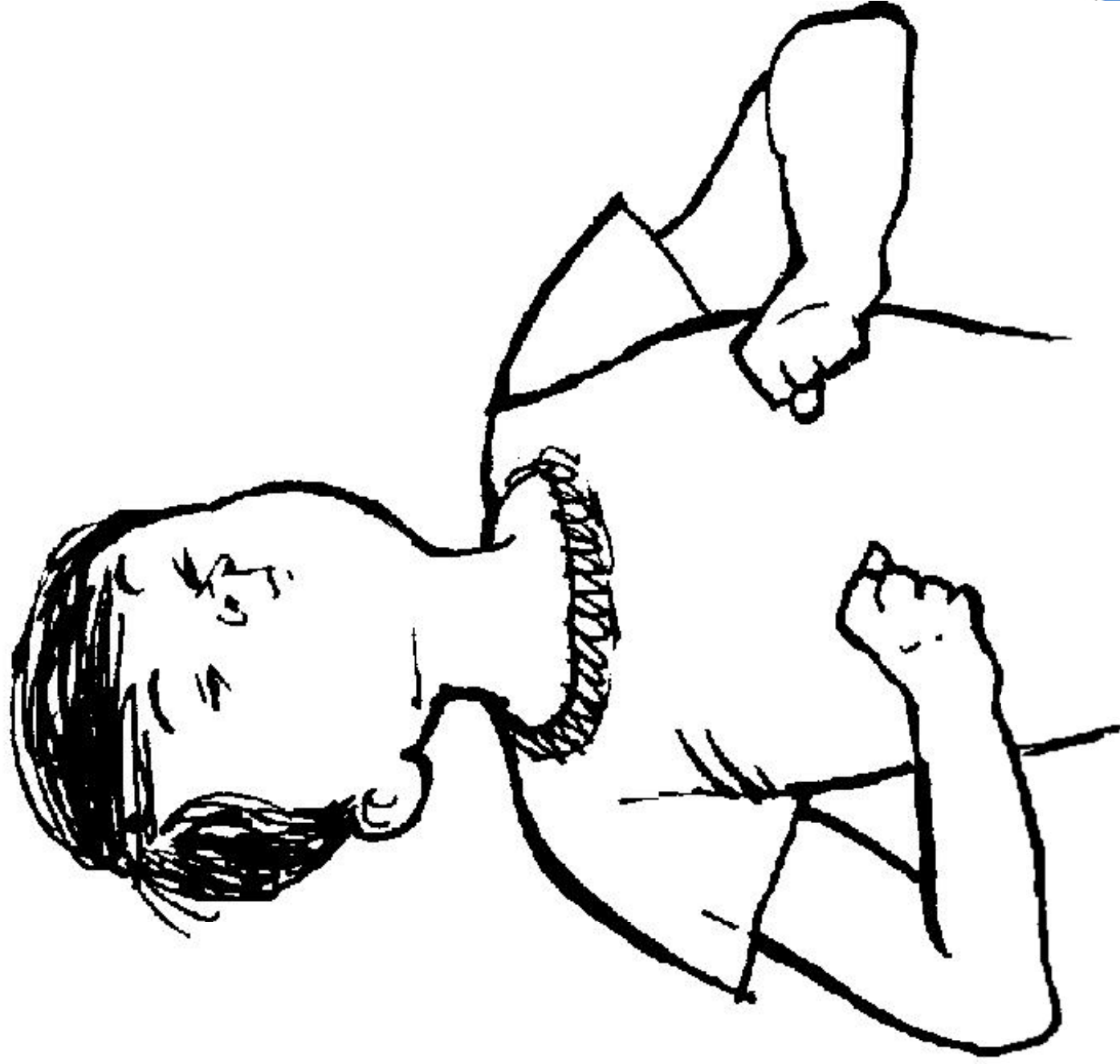


Streaming and correlating data at runtime: reasoning within models@run.time

By Yves Le Traon
Professor, Univ. of Luxembourg
yves.letraon@uni.lu



ICT Research at University of Luxembourg & IoT-related research at SnT & Streaming and correlating data at runtime: reasoning within models@run.time

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ICT Research at University of Luxembourg

What is the Computer Science and Communications Research Unit (CSC)?

What Is the SnT Research Center?

- Processing Information

- Programming
- Algorithmic
- Modeling

- Communicating information

- Networks
- Protocols

- Storing, accessing, mining information

**Make it
easy**

Smart, Secure, ... Safe



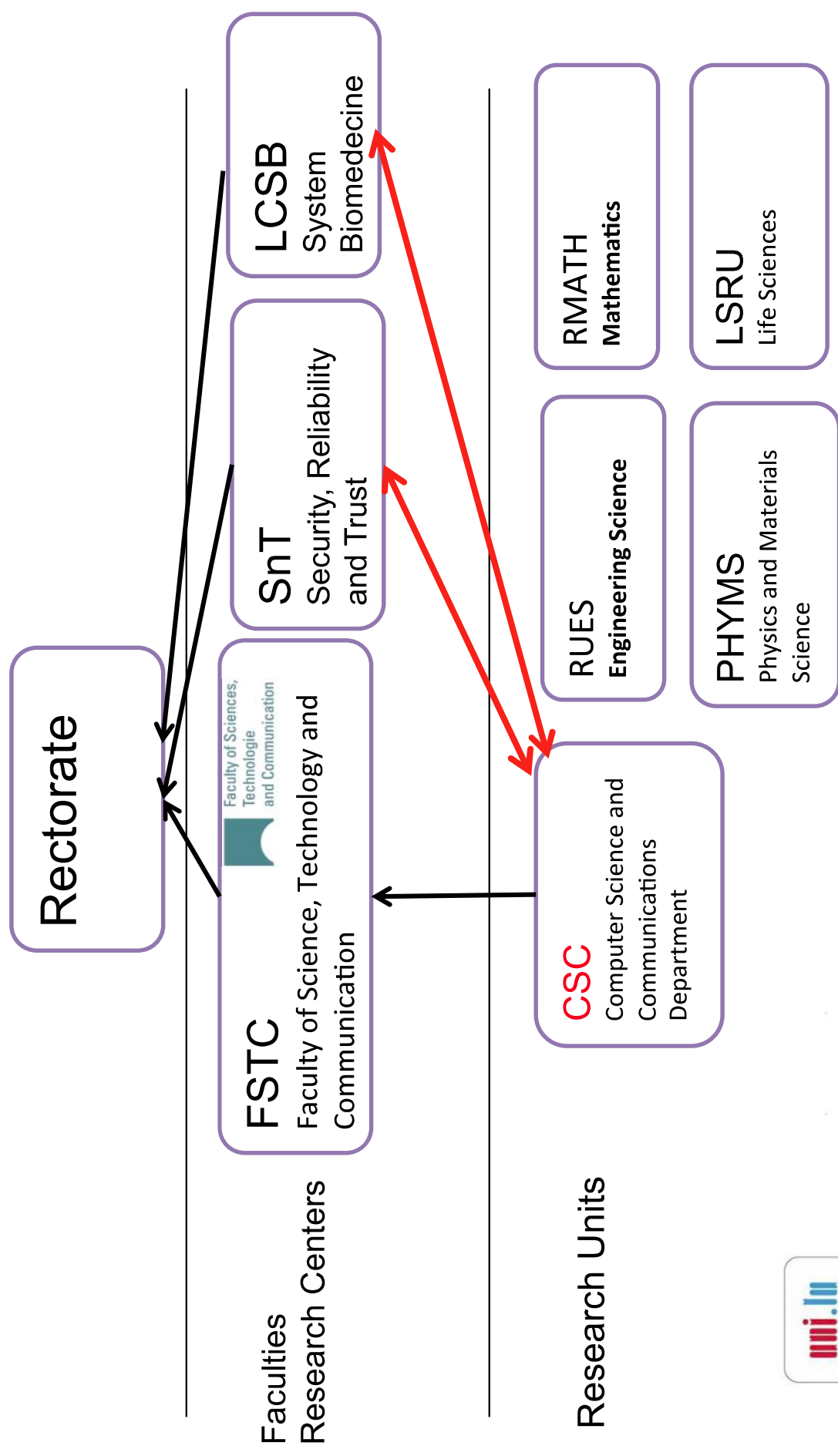
Internet



Where is Computer Science & Computer Engineering in the university?



securityandtrust.lu

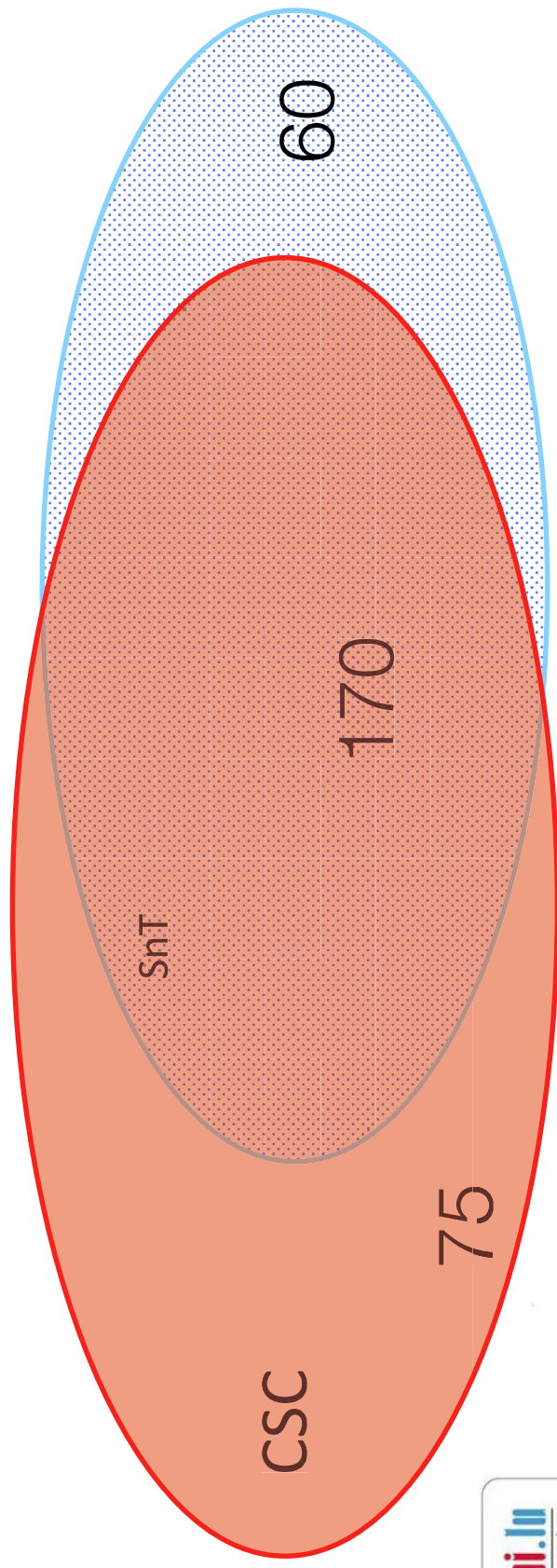


CSC Research Unit: a very productive research unit



- Head: Yves Le Traon
- 245 persons
 - 23 professors (10 nationalities)
 - 75 attached to CSC only (including structural)
 - 170 managed by CSC professors in SNT
 - support staff (scientific and admin)
- 50% PhD students from FSTC are from CSC
- 4 Research Themes
 - Communicative Systems – COMSYS - Prof. Thomas Engel
 - Intelligent & Adaptive Systems – ILIAS – Ass. Prof. Christoph Schommer
 - Systems and Software Systems – LASSY – Prof. Pierre Kelsen
 - Number theory, Cryptology, Security – LACS – Prof. Alex Biryukov
- Professors participate to different themes!

- SNT: Interdisciplinary Centre for Security, Reliability and Trust
- LCSB: Luxembourg Centre for Systems Biomedicine



Interdisciplinary Centre for Security, Reliability and Trust



- Aim: to establish Luxembourg as a European centre of excellence and innovation for secure, reliable & trustworthy ICT
- Founded 2009, current size 2014: 230+ people
- Director: Prof. Bjorn Ottersten



SnT Goals & Strategy

- Centre of excellence in research and innovations in *Security, Reliability and Trust*
- Impact well beyond the academic community
- Increase R&D investments to Luxembourg

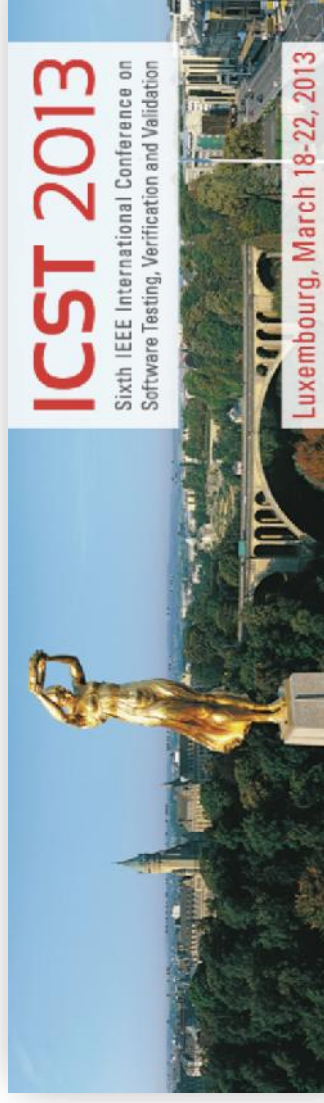


- Highest quality research in areas with a relevance to Luxembourg
- Strategic partnerships
- International cooperation and attract European research funding and ensure competitiveness
- Interdisciplinary approach with application area focus



Visibility through events organization

- 5-6 international events organized each year
 - From 40 to 300 participants
- In 2013:
 - IEEE
 - 5 days
 - 295 participants
 - 40 countries
 - 12 int. workshops associated



- In 2014
 - IEEE
 - CloudNet
 - 170 participants



ICT Research at University of Luxembourg & IoT-related research at SnT & Streaming and correlating data at runtime: reasoning within models@run.time



Serval

securityandtrust.lu

SEcurity, REasoning and VALidation

Serval

SNT

securityandtrust.lu

Yves Le Traon
Professor, Univ of Luxembourg

The topic of today

- Smart “things” and IoT

Some industrial projects- research collaborations

- CREOS – grid operator
 - Smartmeters/smart grid modelling and monitoring
 - Managing security incidents



Paul Wurth
Big Data for SmartBuilding
Itrust

- CETREL – credit card transaction authorizations
 - Decrease the cost and time-to-market
 - for testing their product-line



Security of SmartMeters

- POST (Telecom)



- IoT and SmartHome
- Big Data for Smarthome
- Model-driven and middleware

(EBRC)

Cloud infrastructure optimization
Evolutionary optimization algorithms)



Google grant

Android malware detection
Large-scale analysis of mobile apps.
Machine learning

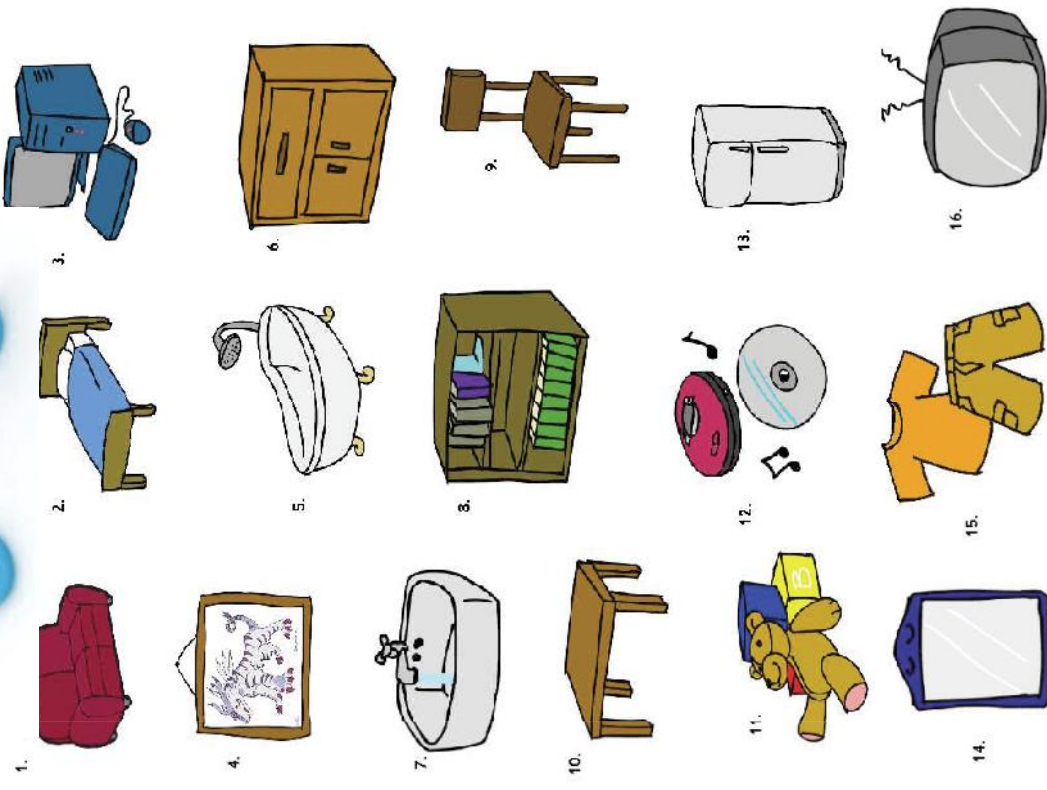


- Ville de Luxembourg

Smart Building



IoA - Internet of Anything



Internet of Things - and Smart*

A fact is that infrastructures evolve constantly:

- Homes, Building, Cities, ...
- Hardware
 - Wearable technologies, Appliances, Cars, ...
- Network
 - Wi-Fi, Bluetooth, ZigBee (IEEE standard)
 - Zwave, EnOcean, Insteon (proprietary protocol)

Cyber-physical systems (i.e. connected system with sensors and actuators).

INTERNET OF THINGS LANDSCAPE

Platforms & Enablement (Horizontal)

Connectivity

Symplio
ARRAY
electric loop
sensnode
NODE
bugswarm

ioBridge
haystack
ThingWorx

Open Source Platforms

sense
spark
nimble
ThingSpeak

Software Platforms

sense
Withings
xively
OSITO
SmartThings
NINJABLOCKS
TWINE
zonoff

Sensor Networks

MESH SYSTEMS
SAFECAST

Enabling Networks

FreedomPop
Open Garden
SocialSign.in
SIGFOX

Corporates

IBM
GE
LG
Cisco
Honeywell

Applications (Verticals)

Quantified Self

GLASS
Pebble

Fitness

amigo
Withings
fitbit
JAWBONE

Health

BASIS
LUMO
HAPIfork
wahoo
NULMETREX

Family

Lively
Good Night Lamp
Withings

Lifestyle

Leisure

Ustream
HEXBRIGHT
remee
so bi

Pets

gibi
FITBARK

Toys

sifteo
MakeLab
KAROTZ
greenacross

Gardening

plantlink
BITPONICS
Koubachi

Home Improv.

Radiator Labs
netatmo

Connected Home

Home Automation

SmartThings
NINJABLOCKS
revolv
Ubi
lapka
Wovyn

Energy Efficiency

knut
tado
ecobee
belkin
nest
LIFX
we mo
microsave

Security

Kwikset
BOSCH
CANARY
Lockitron
iSmartAlarm
ALARM.COM
HomeMonitor

New Interfaces

gestigan
sphero
EQUISO
emotivo
Interaxon
LEAP

Industries

Retail

Nomi
euclid
placemeter

Healthcare

visi
MOBILE
AdhereTech
AliveCor
intelligent

Automotive

Dashlabs
OpenXC
mojo
SYNC
entune

Smart Buildings

Johnson Controls
Schneider Electric

Industrial Internet

Robotics

KIVA Systems
Double Robotics
Airware
ROBOTEX
3D Robotics

Greentech

BigBelly
Axeda
SOLAR
enlighted
GRID MOBILITY

3D Printing

Stratasys
formlabs
shapeways
MakerBot
RepRap

Building Blocks

Connection Protocols

amazon
ZigBee
RFID
NFC
Wi-Fi
Bluetooth
M-Bus
4G

Software

amazon
Parse
iOS
Mobile

Hardware

spongegate
Arduino
Raspberry Pi
SODAK

Parts / Kits

MARKET MAKERS
real40
makey
Intimate
MOSORO

Services

DRAGON
makey
CIRCUIT LABS

Incubators

BOLT
LEARNOS
springboard

Funding

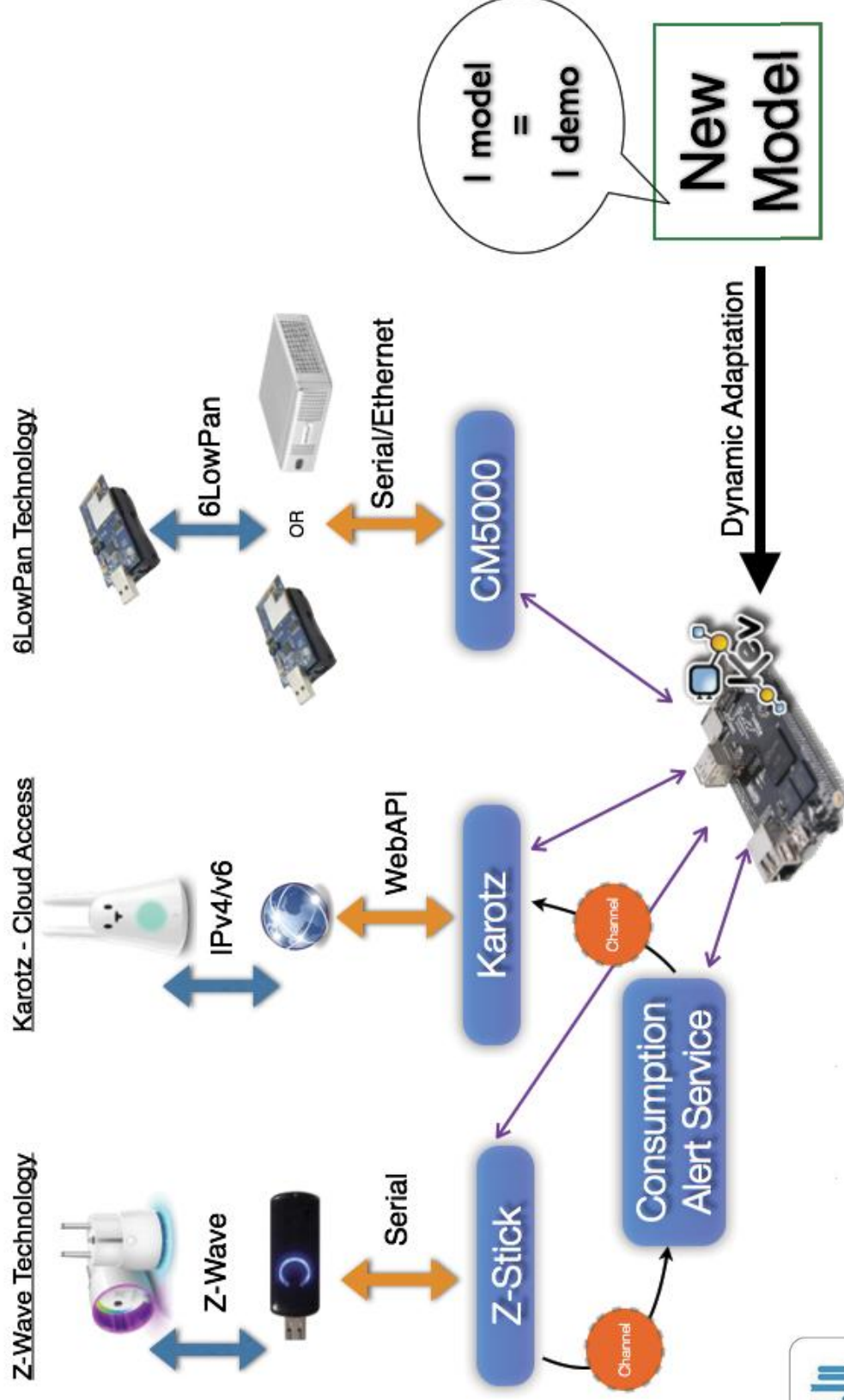
KICKSTARTER
indiegogo

Distribution

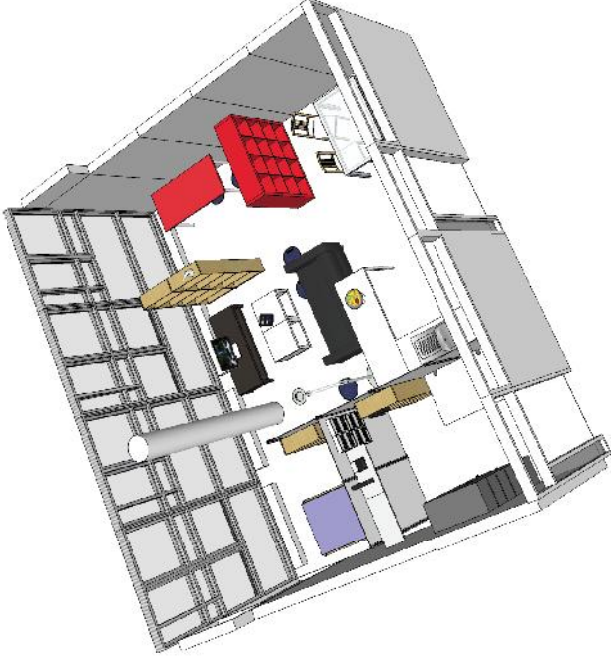
Amazon
Telit

Kevoree

Use in the IoT Lab



The Internet of Things Lab



- Internet of Things to support Smart Environments
 - Homes, Offices, Buildings, Cities
- Tests and Experimentations
 - Flexible
 - Adaptable
 - Scale 1:1
- Showroom
 - Demonstrations
 - Projects



IoA: effect on research

Software engineering:

- **Problems:**
 - software must evolve to integrate new technology, new protocol, new data type
 - Reliability and security (Stuxnet)
- **Track for solutions:**
 - Adaptive system (e.g. OSGI-like: Kevoree)
 - Independent from “Things”
 - Test and/or monitoring at runtime to point out weaknesses of a system.

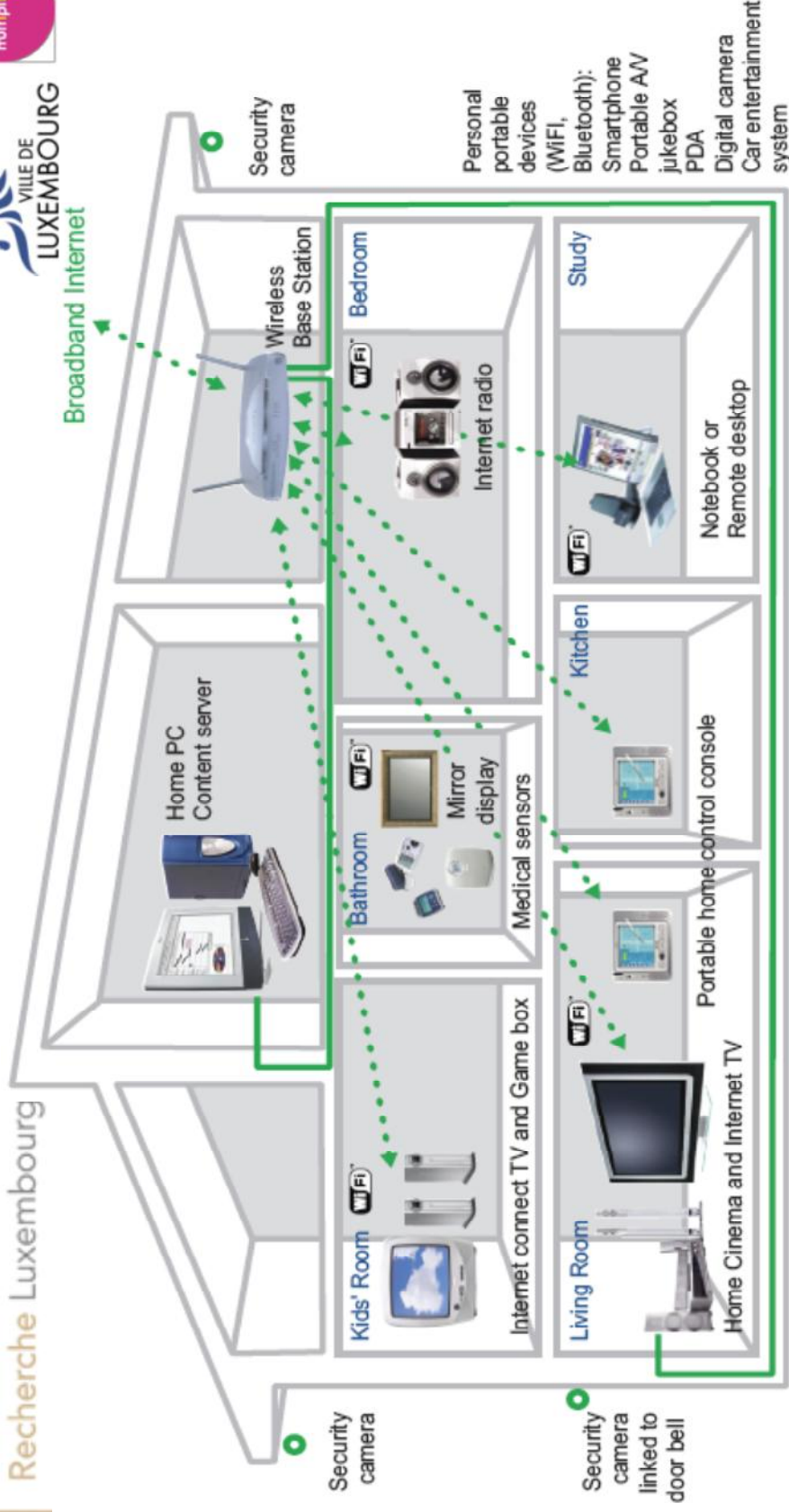
IoT: effect on research

Data management:

- **Problems:**
 - Volume, velocity in order to mine
 - Privacy (monitoring/tracking everything)
- **Track for solutions:**
 - Data stream management systems (i.e. complex event processing and event stream processing)

Leverage data to learn and adapt the system.

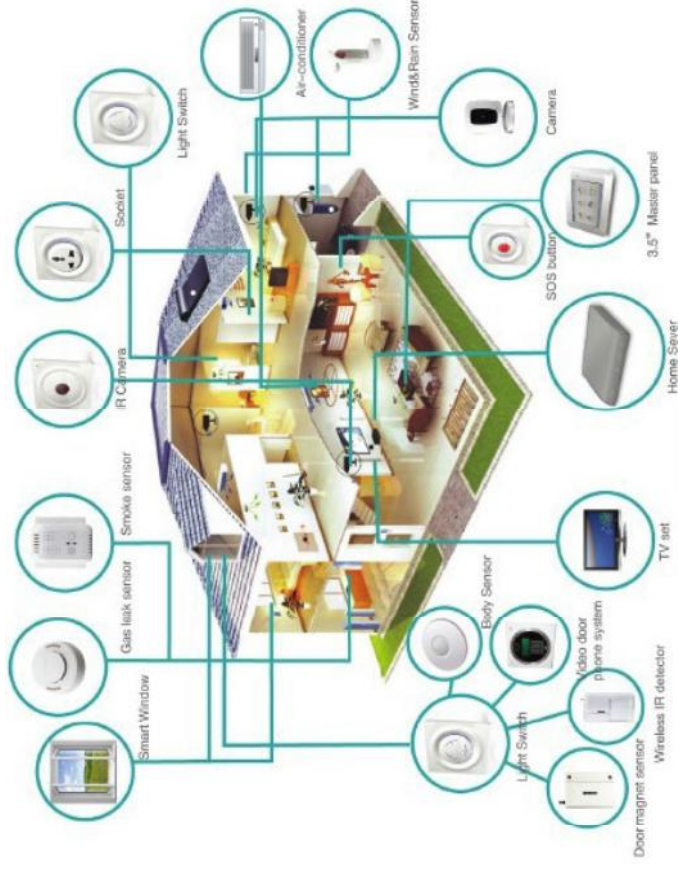
CoPAINs: Creating Privacy, Security and Conviviality for Senior Citizens in SmartHomes



- Increasing number of devices and data
- Trade-off between Conviviality and privacy requirements
- Personalization and customization of services

Human Mobility and Smart Homes

Partnership



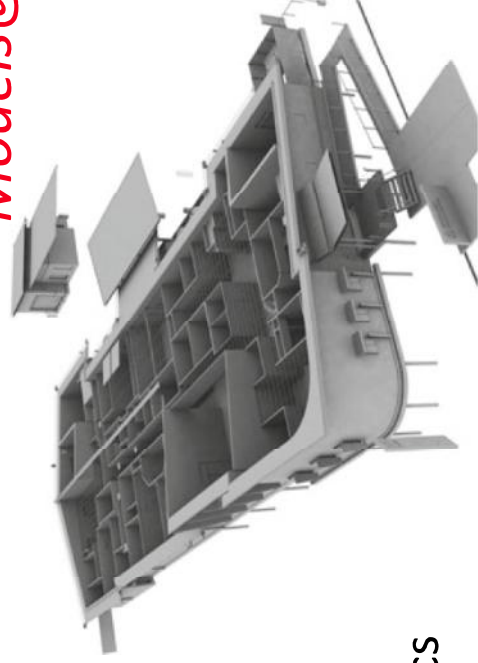
— Secure and reliable cloud based solutions for smart home

— Kevoree

Smart Buildings: make them live

Models@run.time: breathing life in buildings

BIM

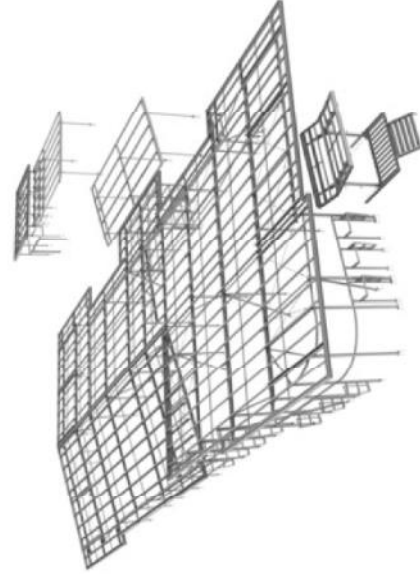


(a) Architectural

Hydraulics Model



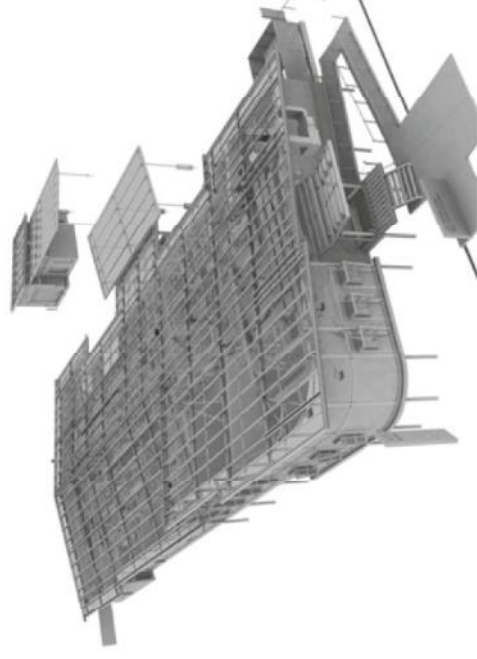
Electrical Model



(b) Structural

(c) Mechanical

Interiors Model



(d) Combined

Micro-mining – Models – Big Data

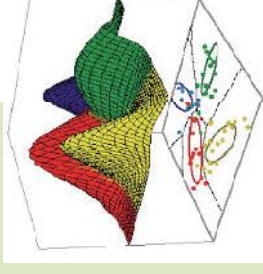


Predicting/infering

- New behaviours/ services
- Misbehaviors / Failures
- Privacy leaks
- Security attacks
- Robustness of devices

BigData@runtime

- Visiting the recent past at runtime
- Too long in advance: inefficient
- Micro-mining a sliding window
- Live streaming
- Micro-mining

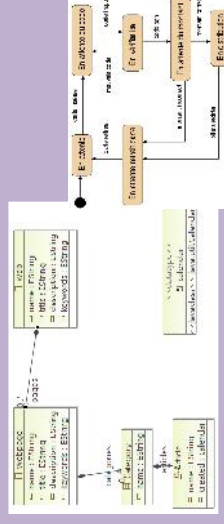


Synchronized with the connected “Things”



Observing
Setting

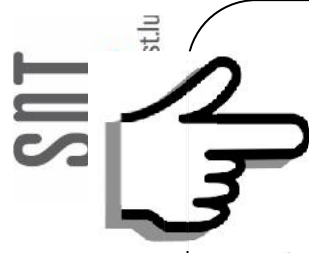
A model updated at runtime



Independent from the “Things”

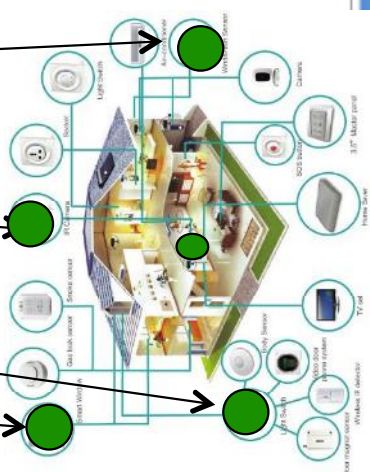
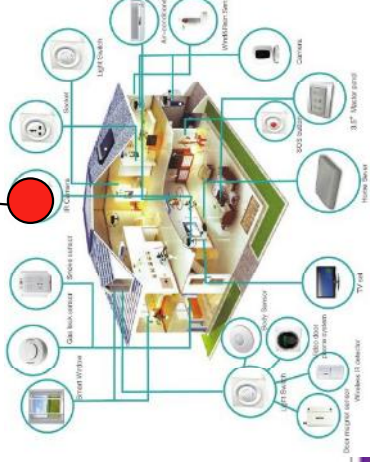
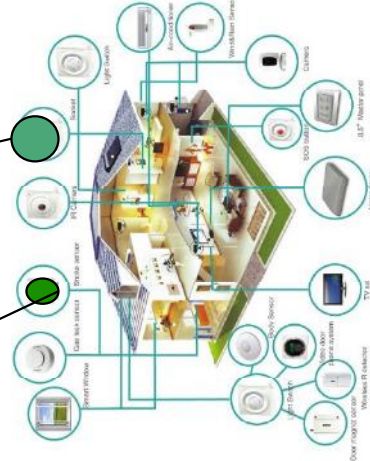
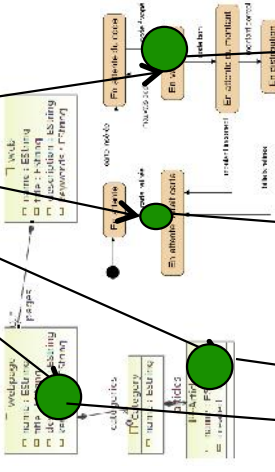
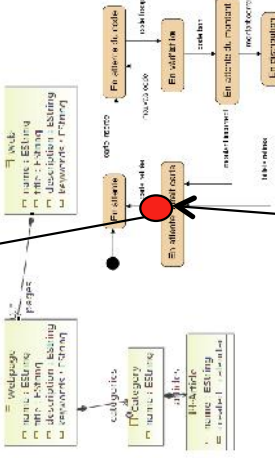
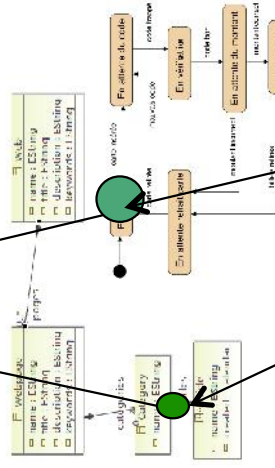
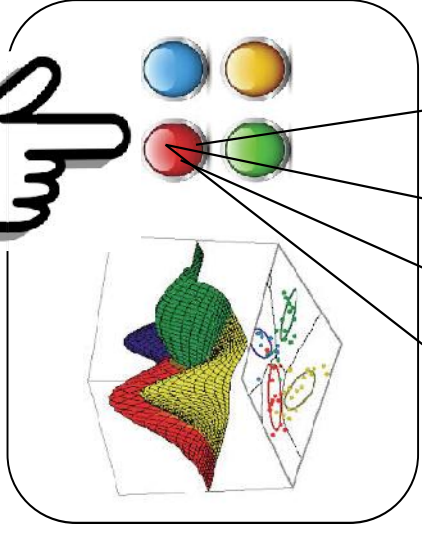
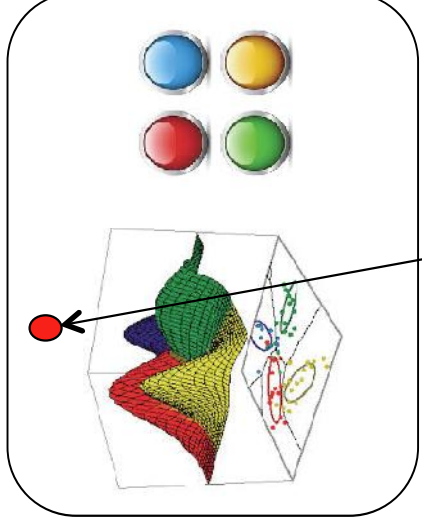
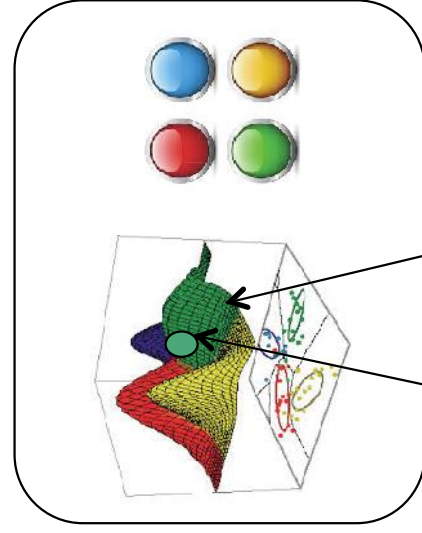


Models@run.time

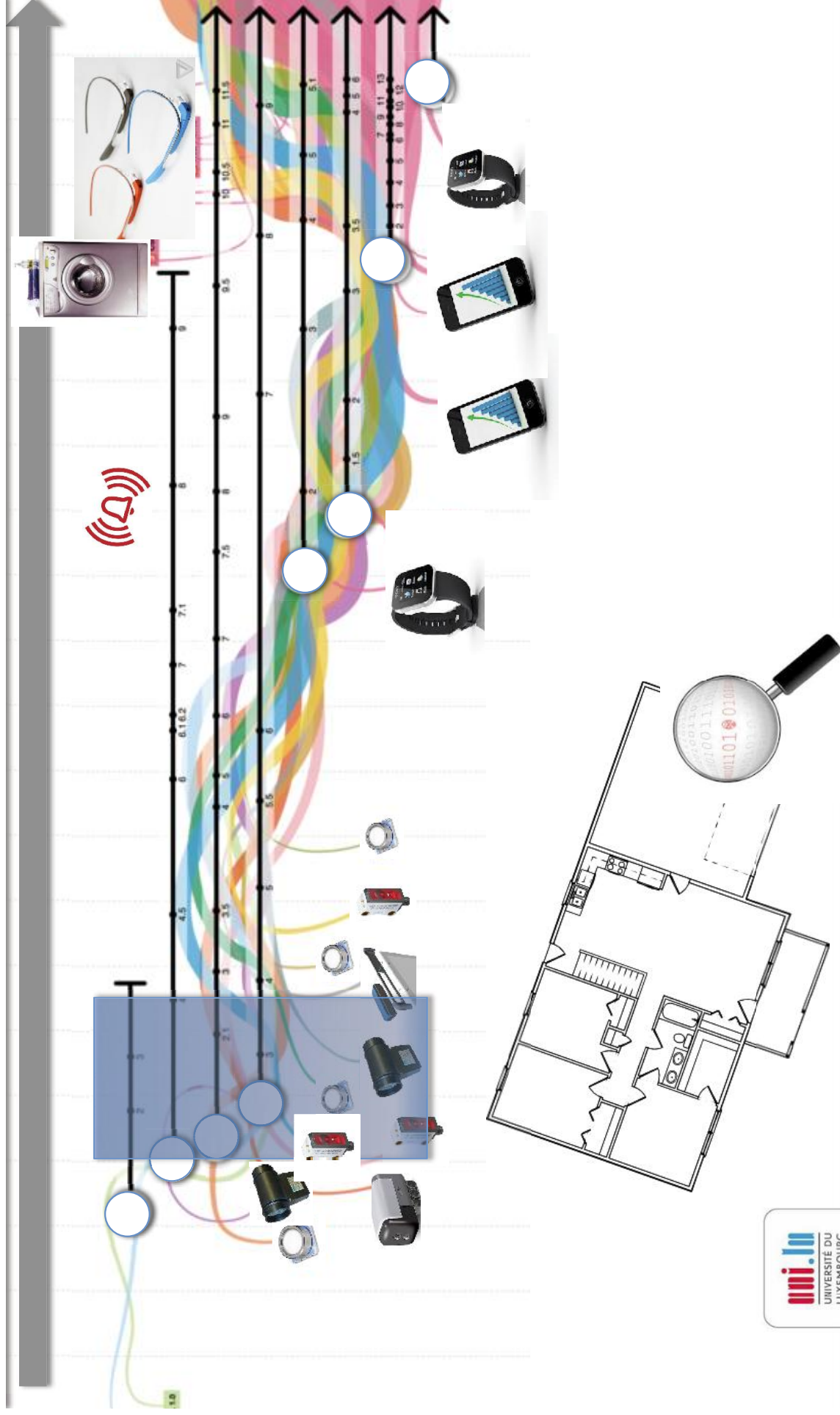


SNT

stlu



Micro-mining – Models – Big Data



« intelligently react to abnormal situations and ensure the quality of the information » (P1 conclusion)



9am	MEETINGS
10am	DEPARTMENT MEETING
11am	STUDENT MEETING
12pm	COMMITTEE MEETING
1pm	GRANT MEETING
2pm	ADMINISTRATIVE MEETING
3pm	REVIEW MEETING
4pm	MEETING TO DISCUSS FUTURE MEETINGS
5pm	MEETING RE: ANNUAL MEETING
6pm	MEETING TO ASSESS THE VALUE OF MEETINGS

