



# iMinds

- Middle Boxes for IoE
- Intent-based Computing
- Energy-Efficient Internet

Stefan Van Baelen Research Coordinator  
Berlin, 25/06/2014

# iMinds: Strong in Cooperative Research

demand-driven



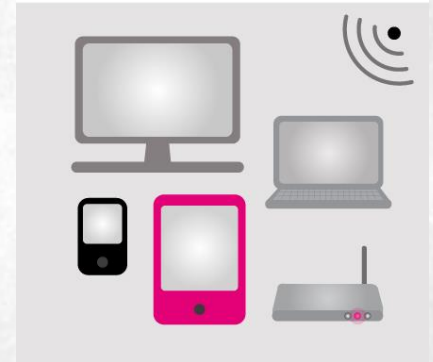
cooperative



interdisciplinary



research in ICT



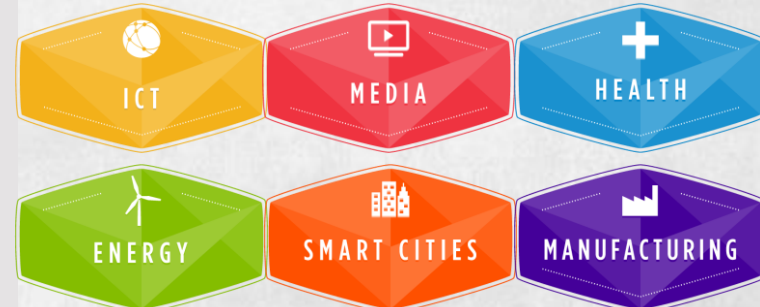
5 university partners



5 departments

Digital Society  
Future Health  
Future Internet  
Future Media & Imaging  
Security

5 vertical markets + ICT



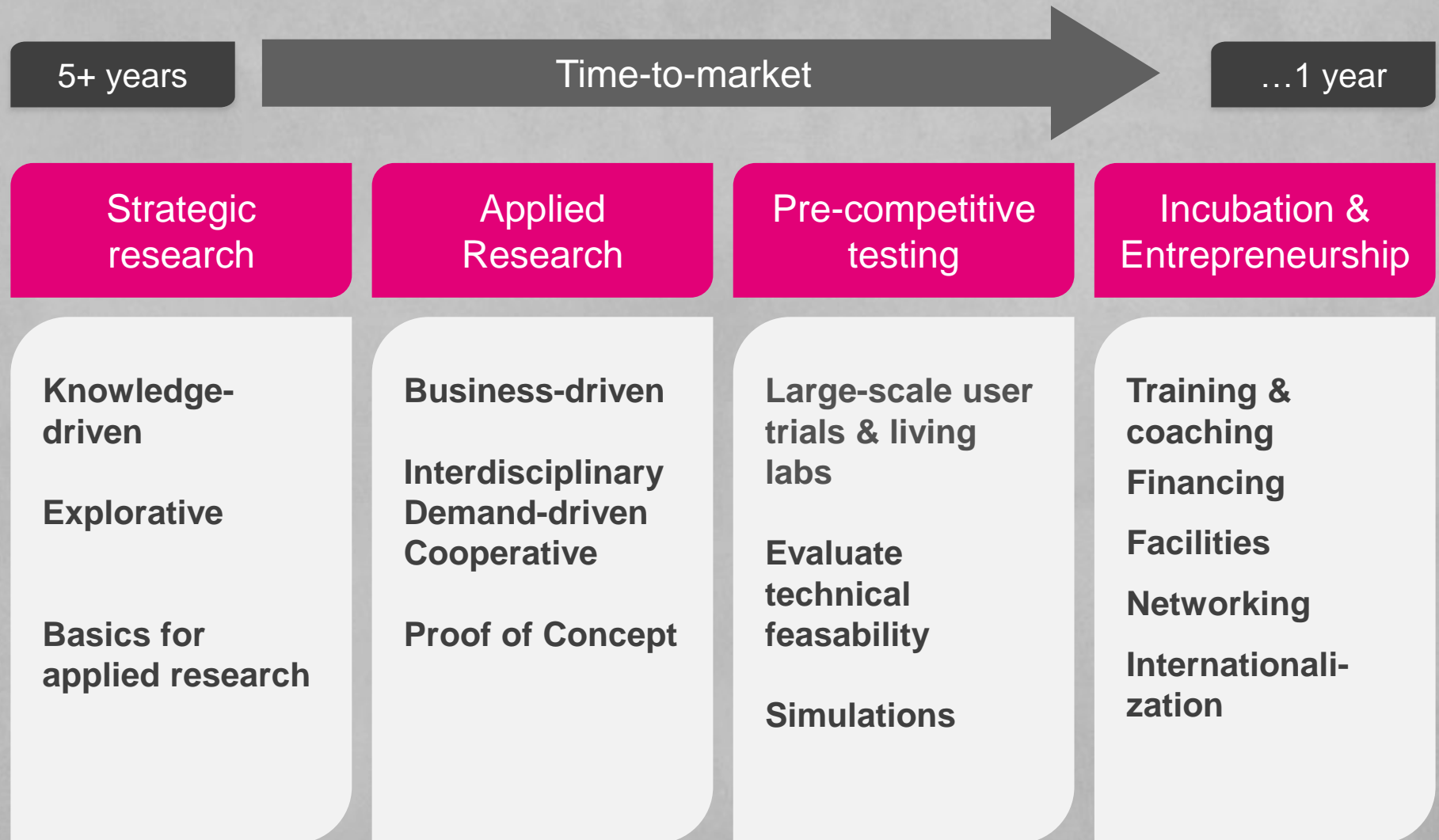
**400+ PROJECTS** with industry  
(FP7 incl. FIRE & FI-PPP, EUREKA, JTIs, EIT)



**1000+ PARTNERS** in the iMinds ecosystem  
(Large Industry, SMEs, Public Sector)

**800+ RESEARCHERS** located at 5 universities

# From idea to business: our innovation toolbox



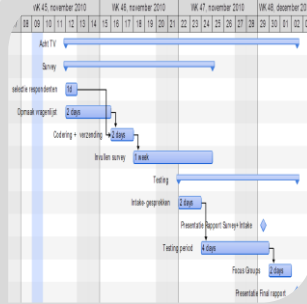
# The iLab.o toolbox: 5 unique assets

European  
Network of  
Living Labs



## Panel Management

We'll find and motivate your test-users



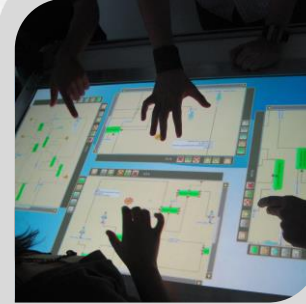
## Living Lab Methodology

We'll show you how to set up a living lab project – e.g. with LL Analyser and Data Aggregator



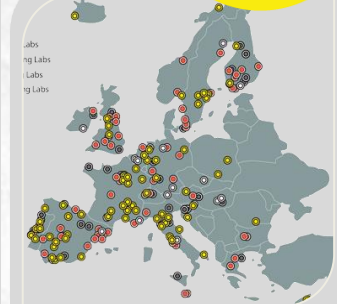
## Prototyping & testing

We'll model a rough idea into a usable app for daily life and test it through



## Simulate Your Business

Co-design of cooperative business model on the fly

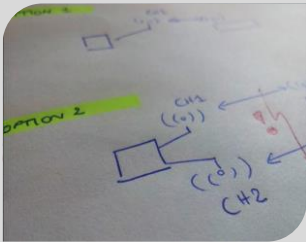


## European Network of Living Labs

Gateway to 300+ Living Labs

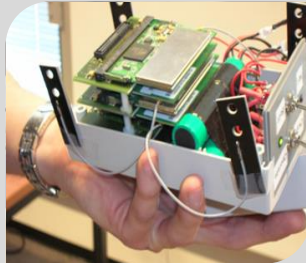
**Importance of validated toolbox!**

# iMinds Research Infrastructures: iLab.t



## Strategic Advice

Solving technical issues, develop measurement strategies, High-level solution architecture, techno-economics



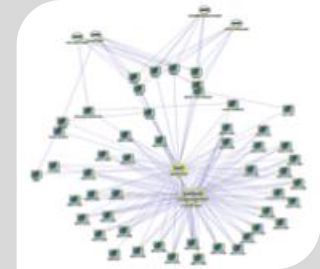
## Discovery & feasibility

Technology discovery & feasibility analysis



## Prototyping & testing

Rapid prototyping in state-of-the-art technical facilities, specialized measurement equipment

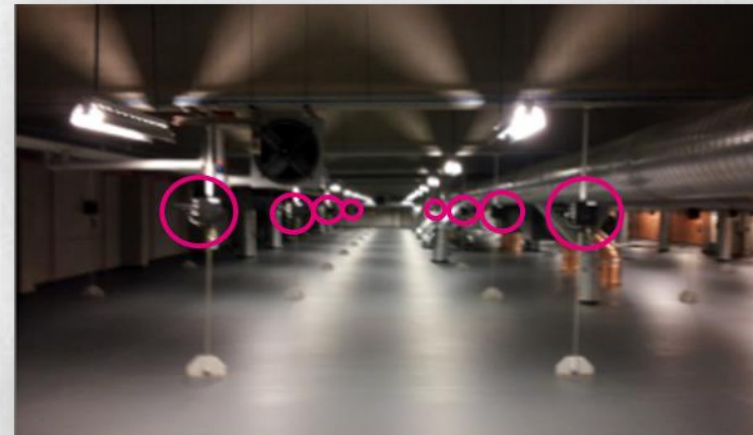
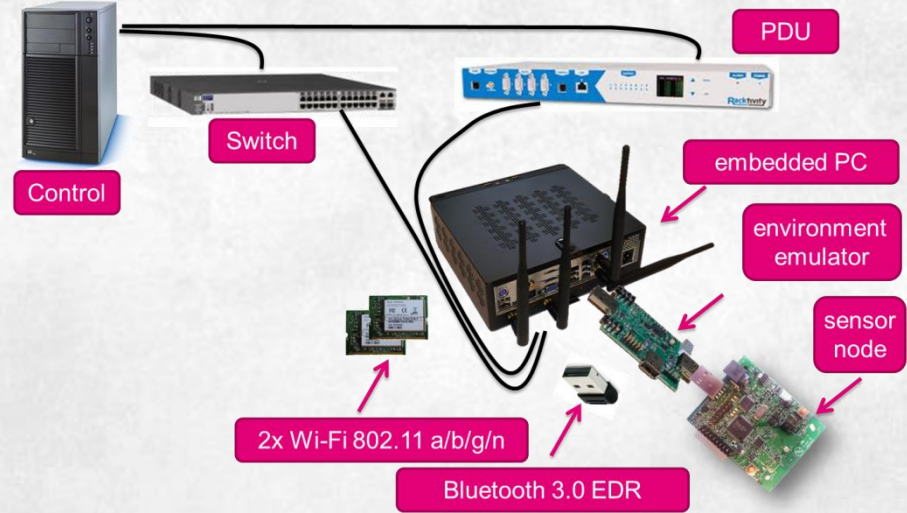


## Analyze

Performance and scalability analysis

**Supported by multidisciplinary technical and practical expertise**

# iLab.t technical facilities

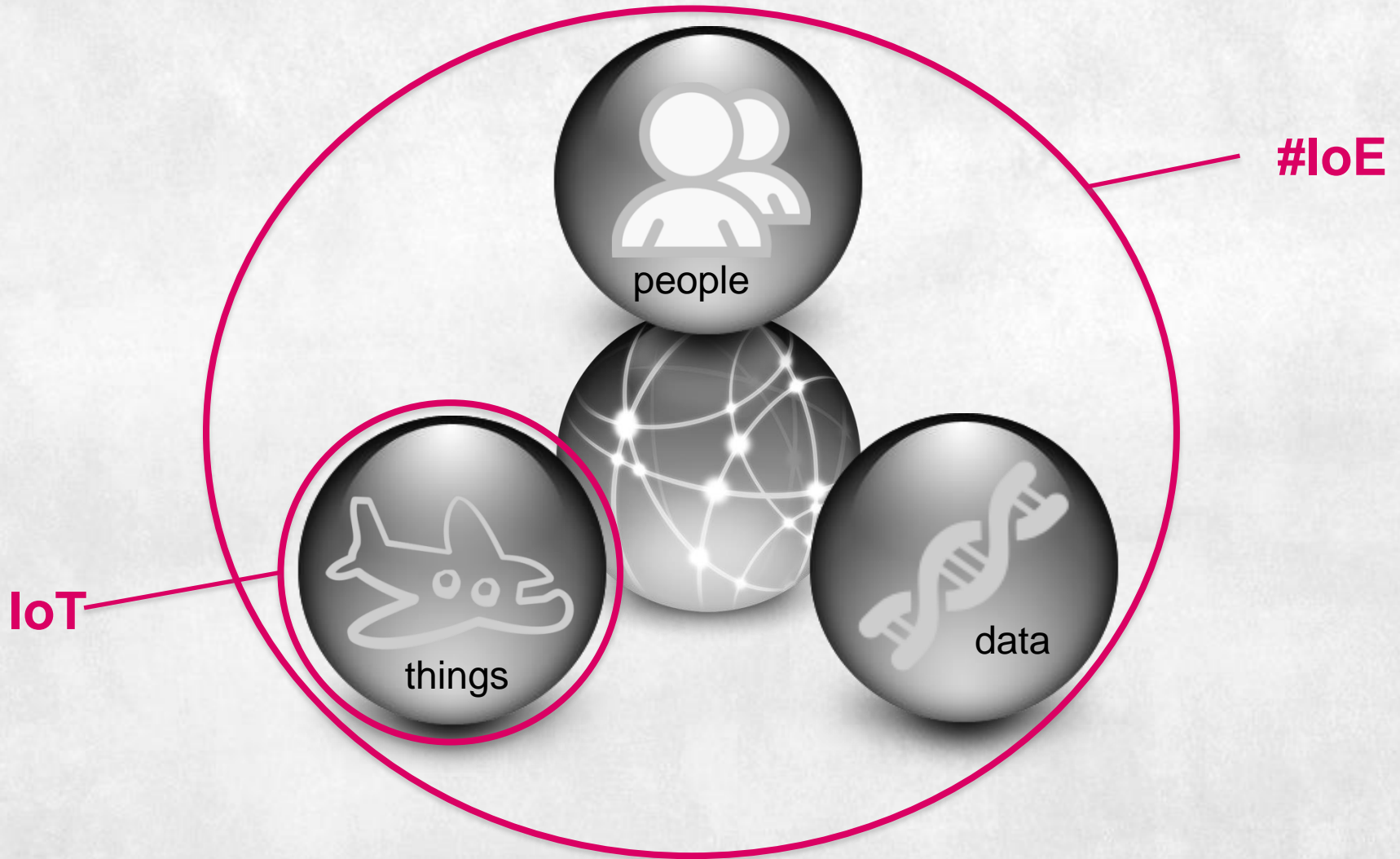




# Middle boxes for the Internet of Everything

Jeroen Hoebeke  
Ingrid Moerman  
(iMinds-IBCEN-UGent)  
Stefan Van Baelen  
(iMinds)

# Towards the Internet of EVERYTHING







## People

Connecting people in more relevant, valuable ways



## Process

Delivering the right information to the right person (or machine) at the right time



## Data

Leveraging data into more useful information for decision making

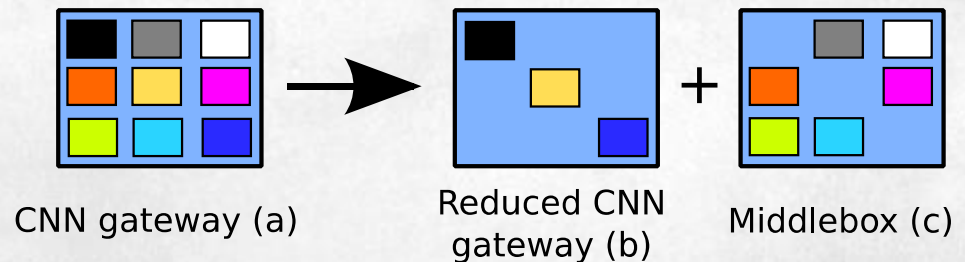


## Things

Physical devices and objects connected to the Internet and each other for intelligent decision making

# Project idea: Middle boxes

- **Middle boxes** offer additional control and signaling logic on behalf of Constrained Node Networks (CNN), while maintaining communications transparency in order to avoid breaking the end-to-end principle of the Internet.

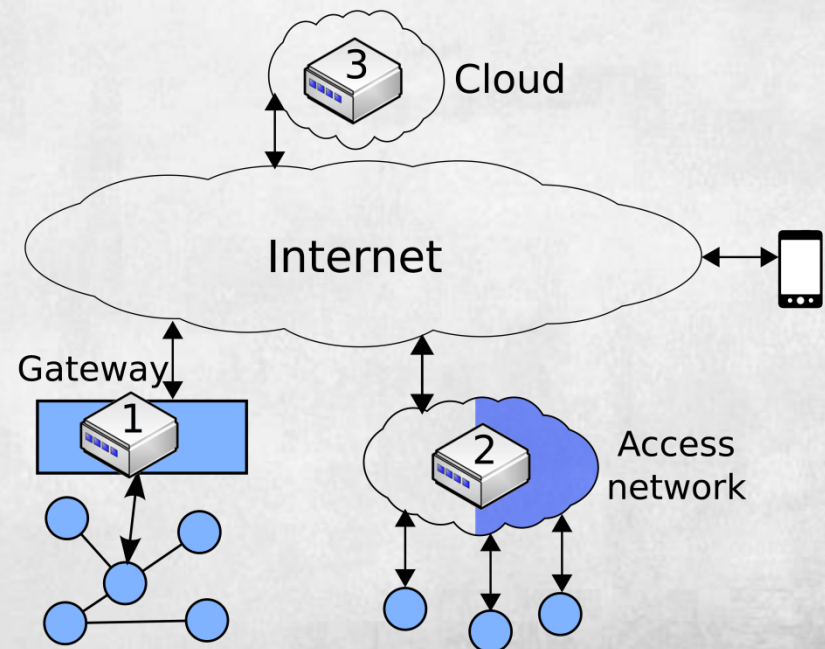


- **Research goals**

- Distributed
- Transparency
- Scalability
- Heterogeneity & flexibility

- **Possible deployment**

1. the edge of network.
2. the cloud
3. the access network



# iMinds Expertise

- Application domains
  - Home
  - Healthcare
  - Manufacturing
  - Smart metering
  - Transportation & logistics
- Technologies & standards
  - IEEE 802.15.4
  - IETF 6LoWPAN: IPv6 over Low power WPAN
  - IETF ROLL: Routing over Low power and Lossy networks (LLNs)
  - IETF CoRE: Constrained RESTful environments (active contributions to drafts)

# Intent-based Computing using Edge Clouds



Pieter Simoens  
Bart Dhoedt  
(iMinds-IBCN-UGent)  
Stefan Van Baelen  
(iMinds)

# A view on the future: Intent-based computing



**deviceless  
cyber-physical interfaces**



**context**



**personalized blending  
of multimedia**

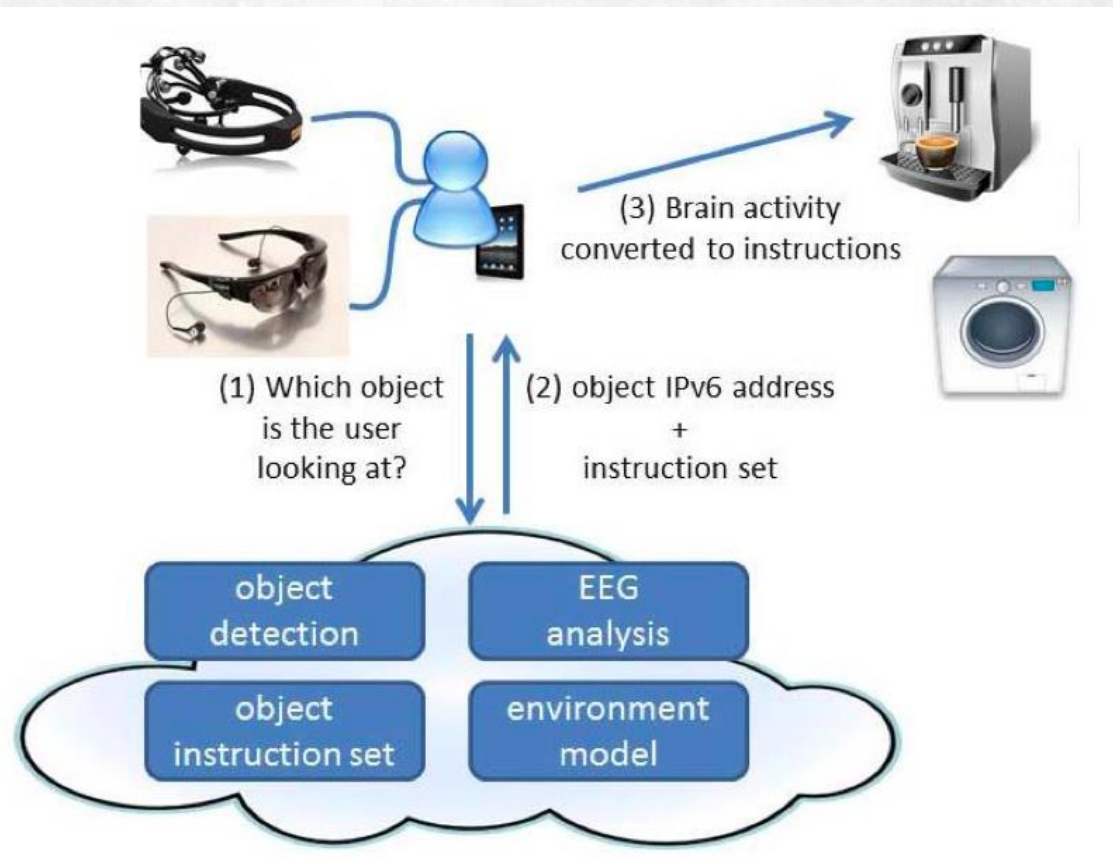


**Intent-based computing**

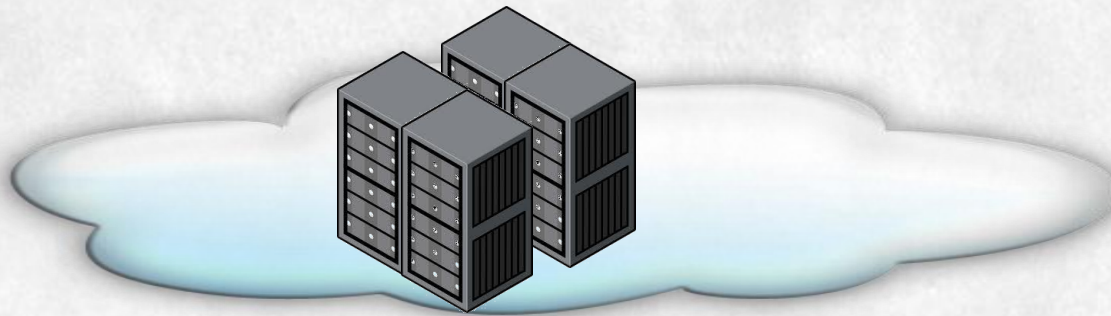
# Mobile and wearable devices interacting with the cloud

## 4 TYPICAL STEPS IN INTENT-BASED COMPUTING

- derive intent from user viewpoint
- map to model of indoor environment
- dynamic instruction loading
- network routing

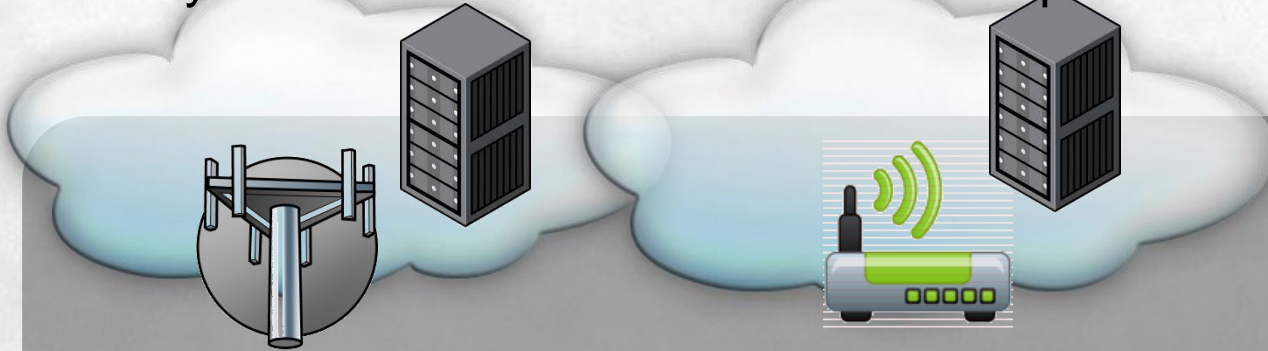


# The architecture behind: Clouds, edge clouds and cloudlets



**cloud**

latency bandwidth localized data personalization



**edge  
cloud**



**Intrinsic limitations**



size



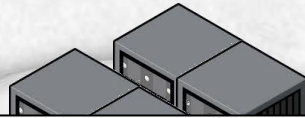
weight



battery

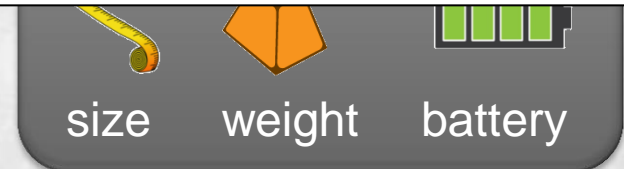
**iMinds Cloudlets on wearable devices**

# The architecture behind: Clouds, edge clouds and cloudlets



## Key challenges:

- **Infrastructure management of edge cloud**
  - **Offloading computational tasks in WAN and LAN**
  - **Latency, energy consumption, processing**
  - **Facilitate peer-to-peer connections**
- **Intelligent data upload strategies**
- **Collaborative modeling of real world models**
- **Software distribution**



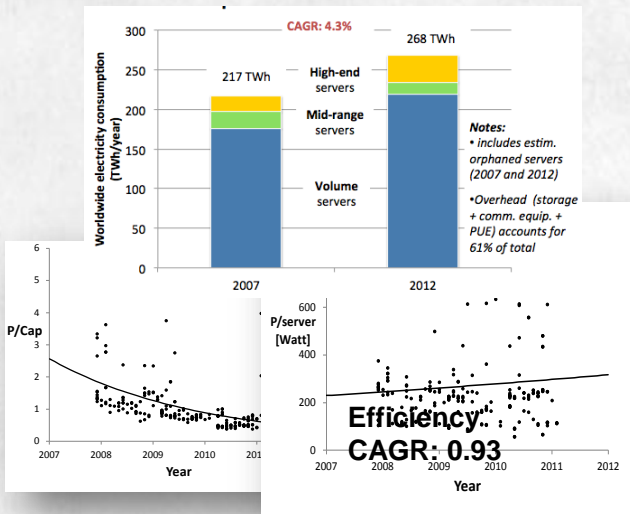


# Energy-efficient and environment friendly internet



Wouter Haerick  
Piet Demeester  
(iMinds-IBCN-UGent)  
Stefan Van Baelen  
(iMinds)

# Context



**Increasing power consumption  
Energy hotspot in cities**

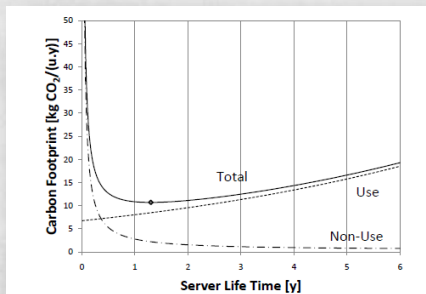
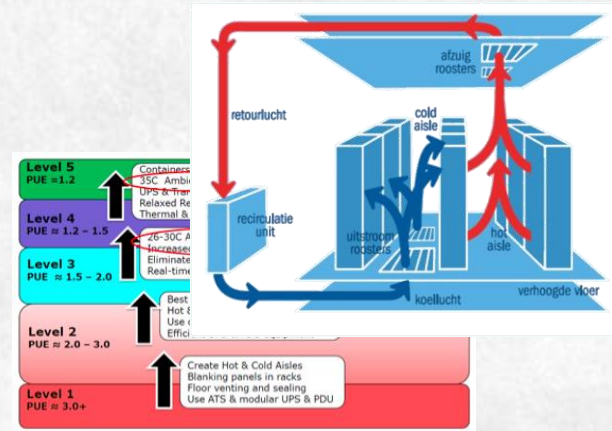


Figure 7. Server Carbon Per User Footprint in function of Server Life Time (Optimal Server Usage)

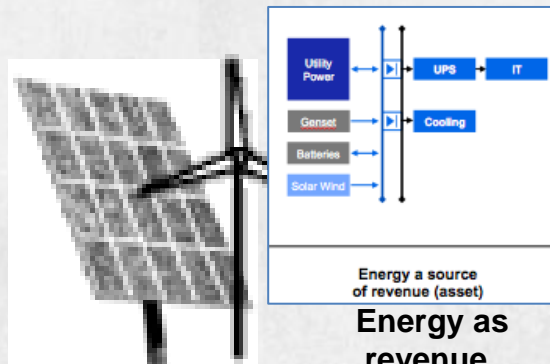
**Server Lifetime & Carbon footprint**



**Green DC  
Datacenters with  
integrated EMS**



**PUE reduction techniques  
→ Thermal maturity model**

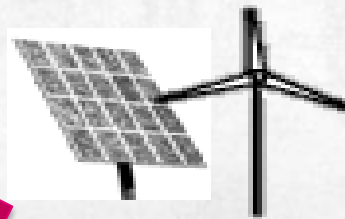


**City context:  
Underexploited interaction  
to absorb green city energy**



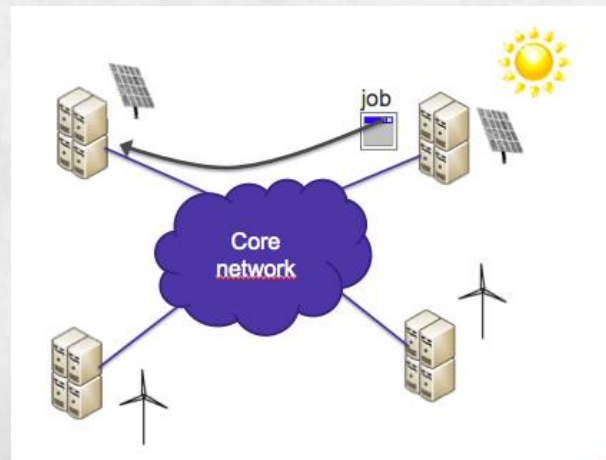
**Underexploited energy  
tuning of ICT equipment**

# Realizing an energy-efficient internet



CITY ENERGY CONSUMPTION  
AND GENERATION

Connect datacenters with  
cities energy consumers/produces



Spread load across  
datacenters  
to optimize usage of  
green energy

# iMinds Expertise

Modeling energy consumption of (global) ICT energy equipment

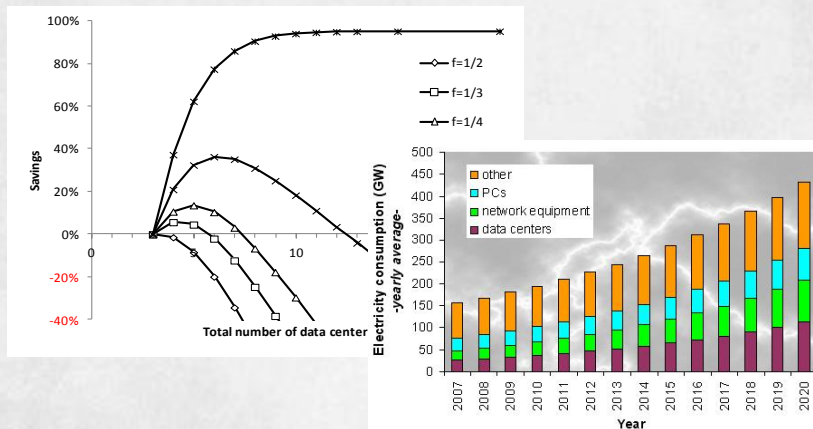
Modeling carbon footprint

Modeling, prototyping and evaluation of carbon-driven load balancing

Design of energy-efficient (optical) core and access networks

Software defined networking

Experimental validation (Testbeds, FIRE, OpenFlow)

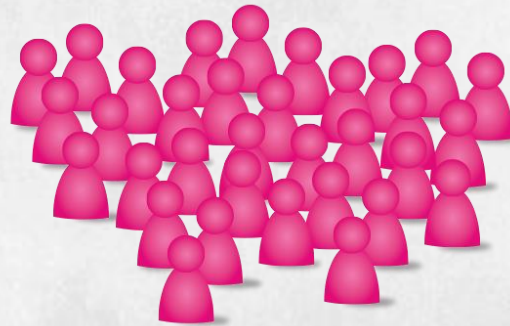


Currently involved in >25 EU projects in the domain of Future Internet

Collaborations with main telecom & equipment providers

Regional ecosystem with local SMEs

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Join us  
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