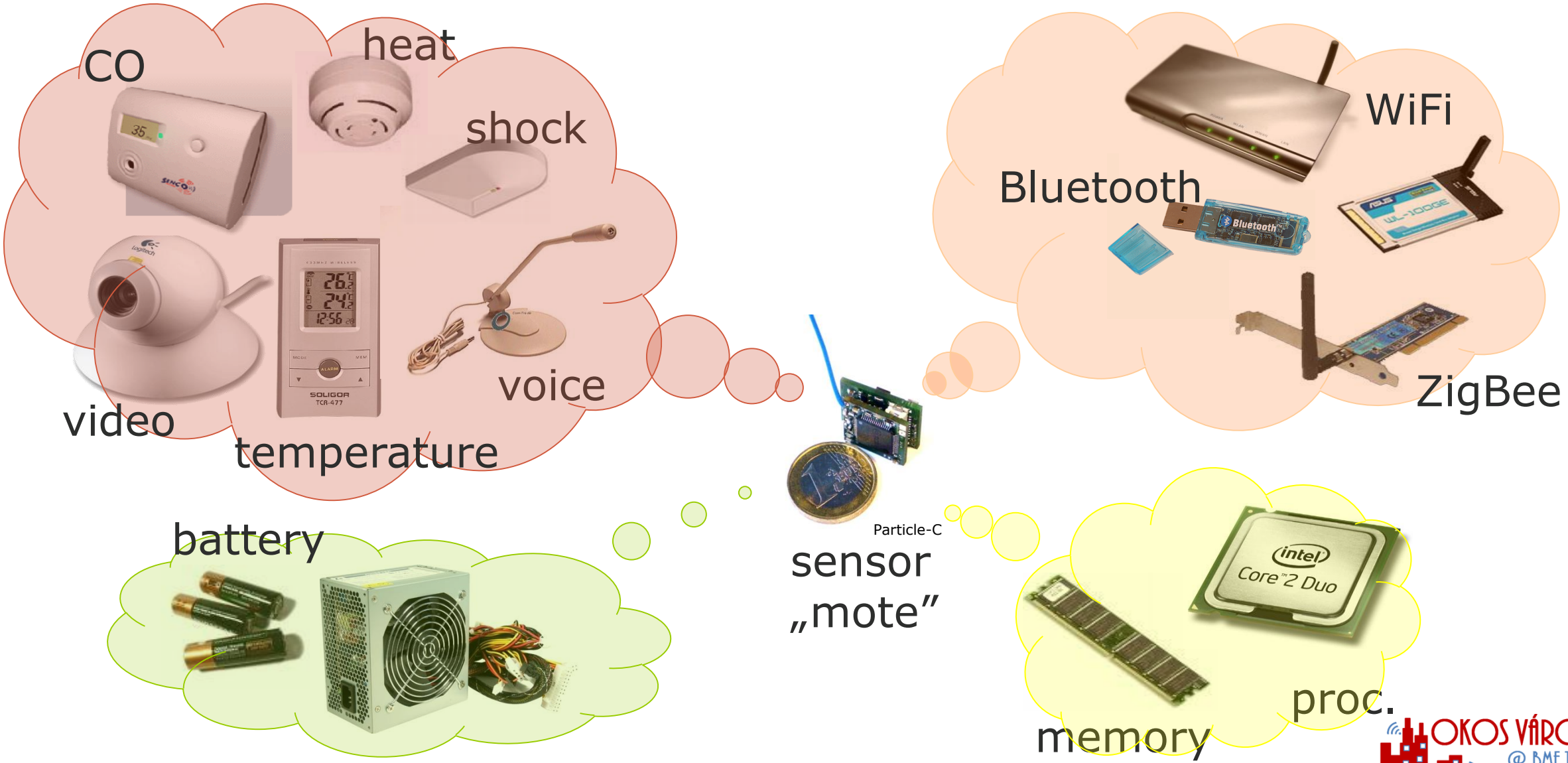

# Sensor networks and applications

Introduction

# Sensors + intelligence + network...



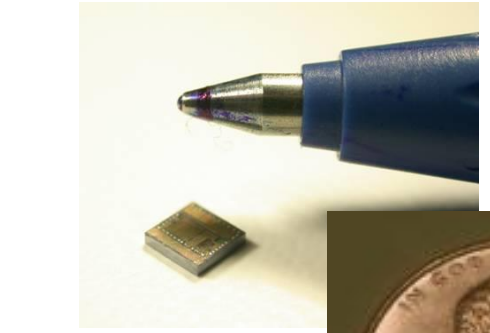
# Be small, cheap and many...

Requirements for sensors:

- small size + **cheap +** low energy consumption

Corollary:

- limited computational power
- limited energy
- limited radio range
- „**simple**” solutions

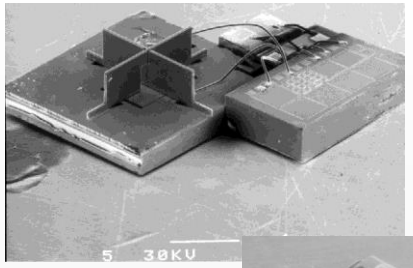


Hitachi

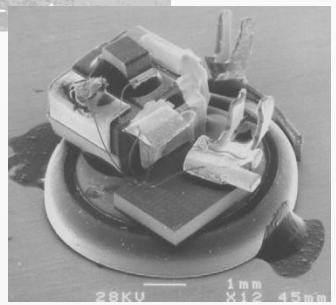

Uni California, Berkeley

Requirements for sensor networks:

- typically **many** nodes
- long lifetime
- robust
- self-organizing, unsupervised
- fault tolerant, self-healing




MEMS



# WSN areas of applications – examples

- **Helalthcare** (hospital management; disaster recovery; support of elderly or disabled, home medication)
- **Manufacturing, storage** (Production line monitoring; inventory)
- **Environment** (habitat monitoring; disaster forecast)
- **Agriculture** („precision” farming)
- **Engineering applications** (static monitoring of buildings; traffic monitoring)
- **Intelligent buildings** (intelligent home; intelligent office)
- **Defence** (monitoring, tracking, detection; sniper localization)
- **Space research**

source: Gy. Simon

> **Search for a rabbit!**
> searching... found
>
> **Where is the rabbit?**
> www.aniel-wallpapers.hu/ALLATOK/aa14.jpg
>
> **Show the rabbit!**

# „The rabbit...” – on the Internet

> **Search for a rabbit!**
> searching... found
>
> **Where is the rabbit?**
> 47°31’07.46’’ N 19°04’39.22’’ E elev 109 m
>
> **Show the rabbit!**
>
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# „The rabbit...” – in real world

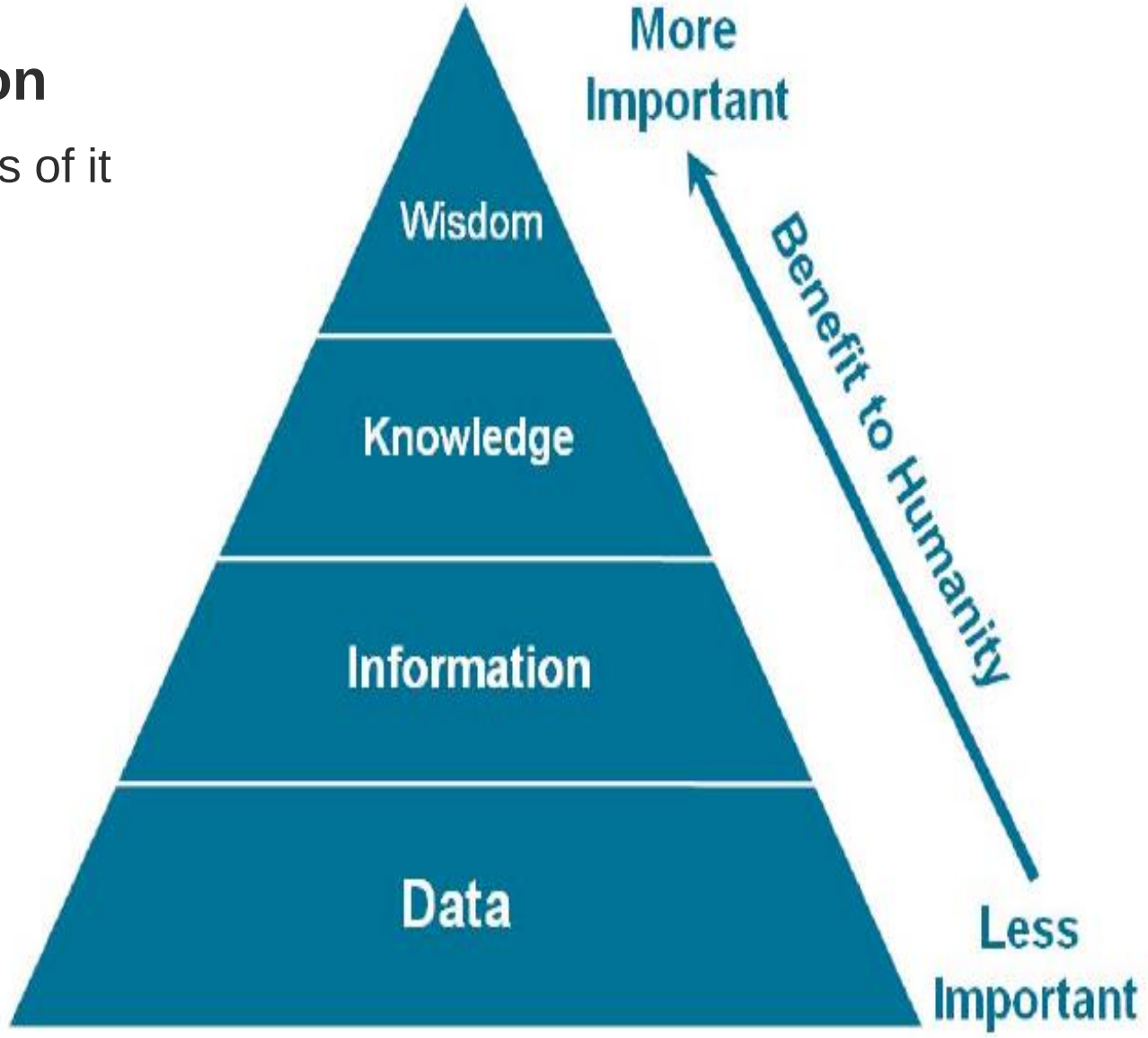
# Convergence...

- What is really challenging is to connect the real world with the virtual dataspace!
- It’s already ongoing:
  - GoogleEarth
  - surveillance cameras
  - weather forecat sites
  - remote monitoring and alarm systems
  - navigation
  - (videoconference)
  - ...


CHARLES' GEORGE ORWELL LINKS

# From data to human wisdom [4]

- **Raw data** is processed into **information**
  - individual data is not very useful, but volumes of it can identify trends and patterns
- **Information** come together to form **knowledge**
  - knowledge is information of which someone is aware
- **Wisdom** is born from **knowledge** plus **experience**
  - knowledge changes but wisdom is timeless
- **...and it all begins with the acquisition of data!**




Source: Cisco IBSG, April 2011

# From data to human evolution (cont'd)

- Humans evolve because they communicate
  - Once fire was discovered and shared, it didn't need to be rediscovered, only **communicated**

- The more data is created, the more knowledge and wisdom people can obtain!

- **WSN**s dramatically increase the amount of data available for us.
- With the **Internet**'s ability to communicate will enable people to advance further.


Photo Gallery by Field & Stream Online Editors.


# WSN and Smart City

When do we call a city smart? Data.

# When do we call a city smart?

- **First step: I know what's happening in the city**
  - Where is the bus? How many people traveling on it?
  - Is the parking place free? Is the garbage can full? Is the soild moist enough in the park?
  - What's the temperature on the street? Is it windy? Is it well lit? What's the air quality? Is anyone there at the moment? How many car passed in the street in the last 10 minutes?

# When do we call a city smart?

- **First step: I know what's happening in the city**

**Solution: sensing, data gathering – with or without human interaction**

- "When you can measure what you are speaking about, and express it in numbers, you know something about it" – Lord Kelvin


Library of Congress

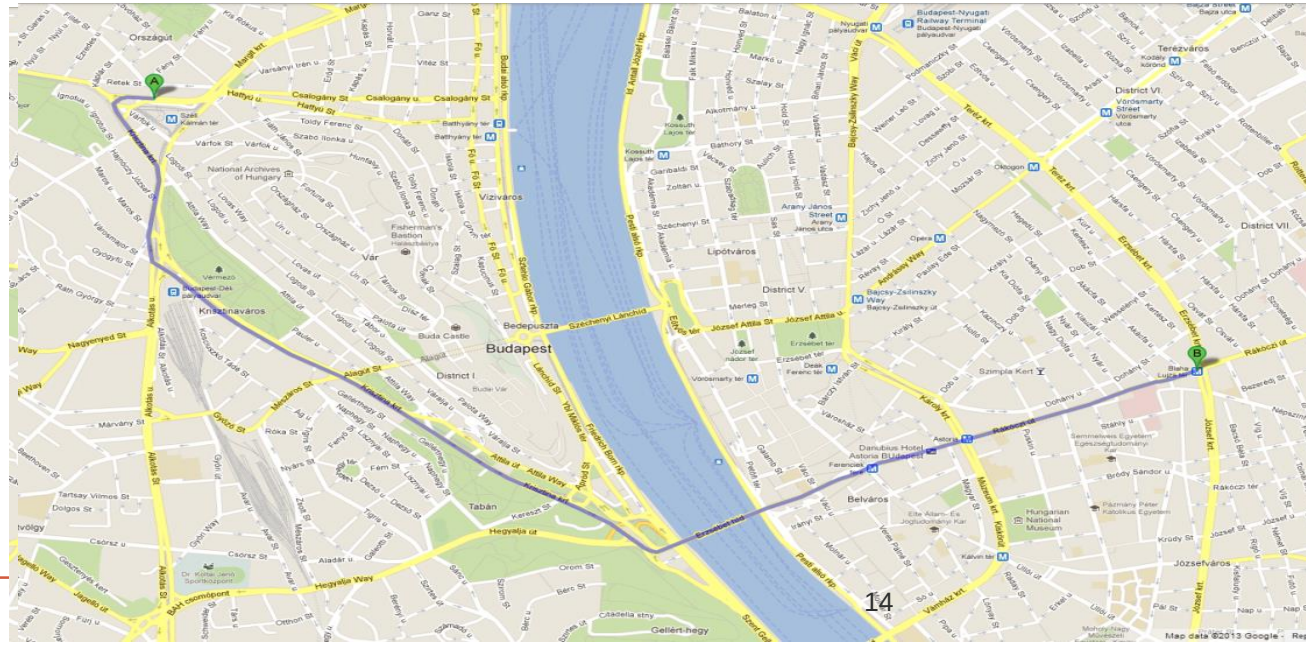
- Intelligent devices with unique ID
  - sensors, smartphones, vehicles, etc.
  - *Measure and communicate*

# When do we call a city smart?

- **Second step: Customized, context-aware „smart” services based on data**
  - **It’s not the pure data that is valuable, but processing the data**
  - Data gathering into the „cloud” – networking solutions
    - Sensor networks, vehicular networks, mobile networks
  - Analytics, filtering, aggregation, data mining
  - Generating value-added services
    - *Personalized: user profile, history*
    - *Context-aware: where am I, what am I doing, what devices do I have, who’s nerby, etc.*

# Example: (The truly) smart navigation

- Which route shall I choose from Blaha Lujza square to Széll Kálmán square?
  - It’s not always the shortest path that is the best
  - **It depends on the context**
    - By night, walking – safety first: where are the most people on the streets, better lighting, lowest criminal statistics, etc.
    - At daylight, with a bicycle – bicycle lanes
    - At peek hour, by car – lightest traffic
    - At peek hour, walking – best air quality
    - In winter when it’s cold, walking – less windy
    - …
- What’s needed … data, data, data!



# When do we call a city smart?

- **Citizens active support**
  - **Citizens as innovative developers and testers**
    - Services tailored to everydays' needs
    - City of „smart" (educated, innovative, open, jómódú) people
  - **Open Data** – access to deployed sensors' data
    - Using data in own applications

# When do we call a city smart?

- **Citizens active support (cont'd)**
  - **Crowdsensing**
    - Users' measurements (e.g., with smartphones)
    - Replacing or complementing the network
  - **Trust, data sharing**
    - Basically, we don't like being watched
    - but we can accept, if we get access to useful services

# Open Data vs. Closed Data

## Why Open Data is needed?

- Data and knowledge belong to humanity as a whole – medical science, environmental protection, genetics,etc.
- All data is public that was financed by taxpayers money
- Data can not be copyrighted
- If everyone can access the data, new services can be freely created

# Open Data vs. Closed Data

## Why Open Data is NOT needed?

- If some companies profit from the data, then they should pay the price as well
- Money collected from data usage can be used for desired purposes
- Data privacy could easily result in closed data
- Data collection, cleaning, processing can be a hard work, so it is reasonable to ask for its price