OKOS VÁROS
@ BME TMIT

Sensor networks and applications

Introduction

Sensors + intelligence + network...

CO

heat

shock

WiFi

Bluetooth

voice

ZigBee

video

temperature

Particle-C

sensor „mote"

battery

memory

proc.

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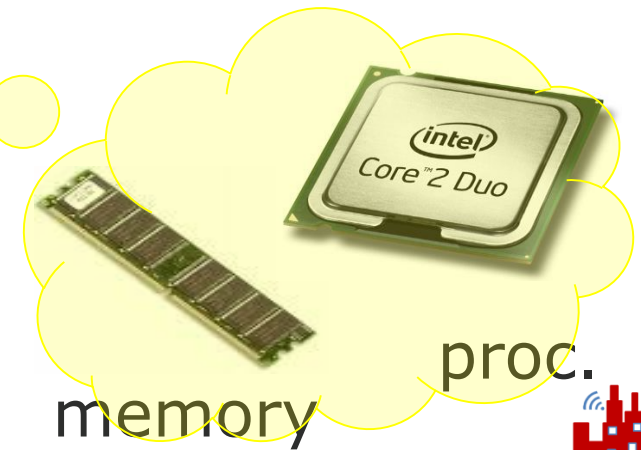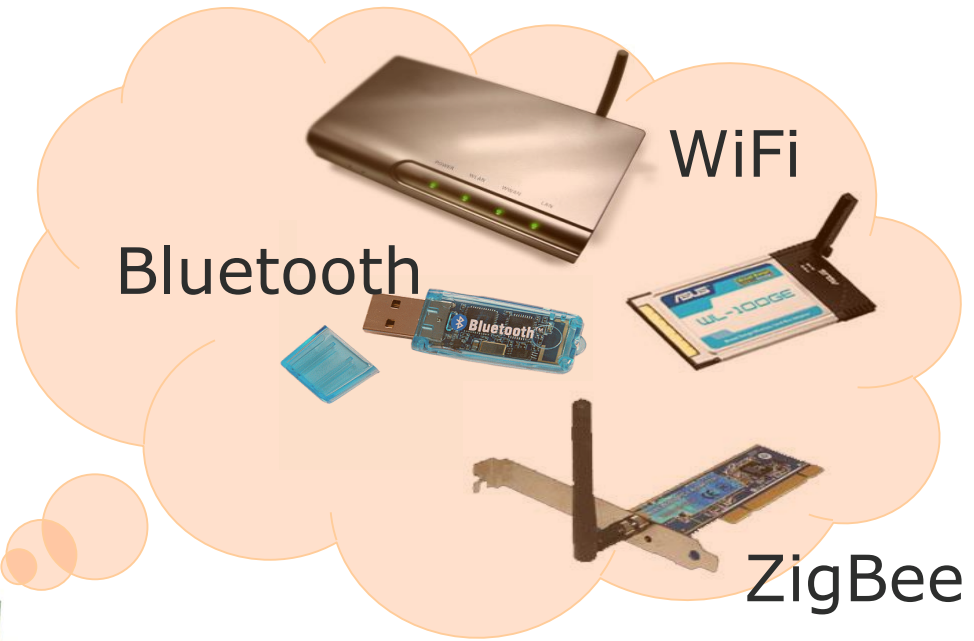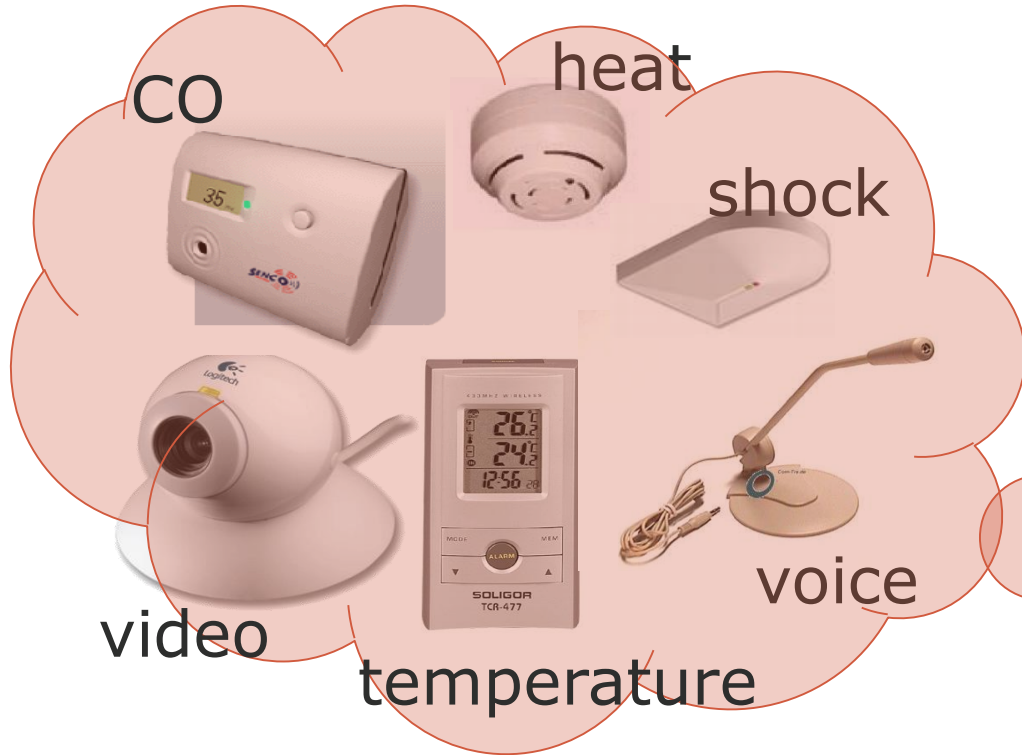
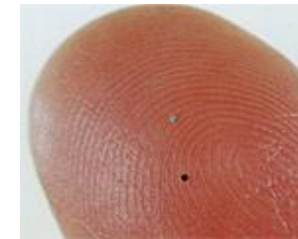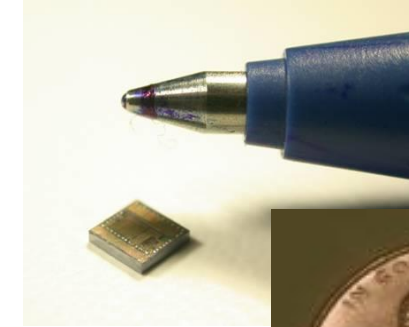# Be small, cheap and many...

Requirements for sensors:
- small size + **cheap** + low energy consumption

Corollary:
- limited computational power
- limited energy
- limited radio range
- „**simple**" solutions

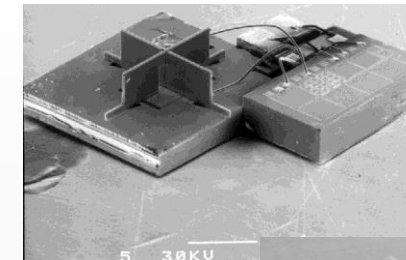Requirements for sensor networks:
- typically **many** nodes
- long lifetime
- robust
- self-organizing, unsupervised
- fault tolerant, self-healing

Hitachi

Uni California, Berkeley

MEMS
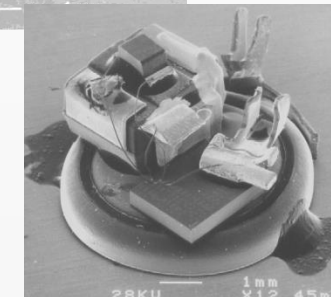
WSN areas of applications – examples

- **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!**
>
>
>
>
>
>
>
>

„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!**
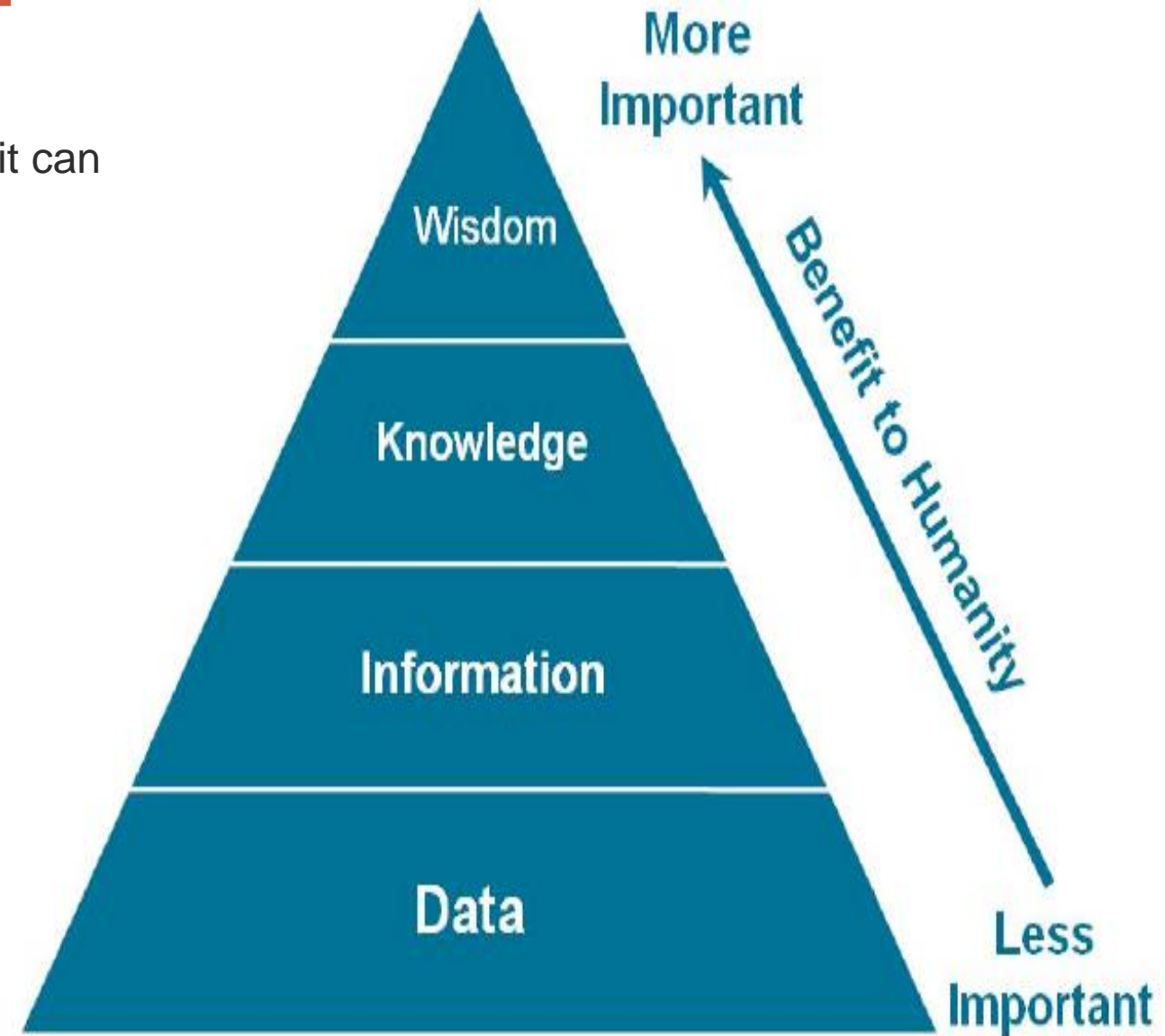
Source: Cisco IBSG, April 2011

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.

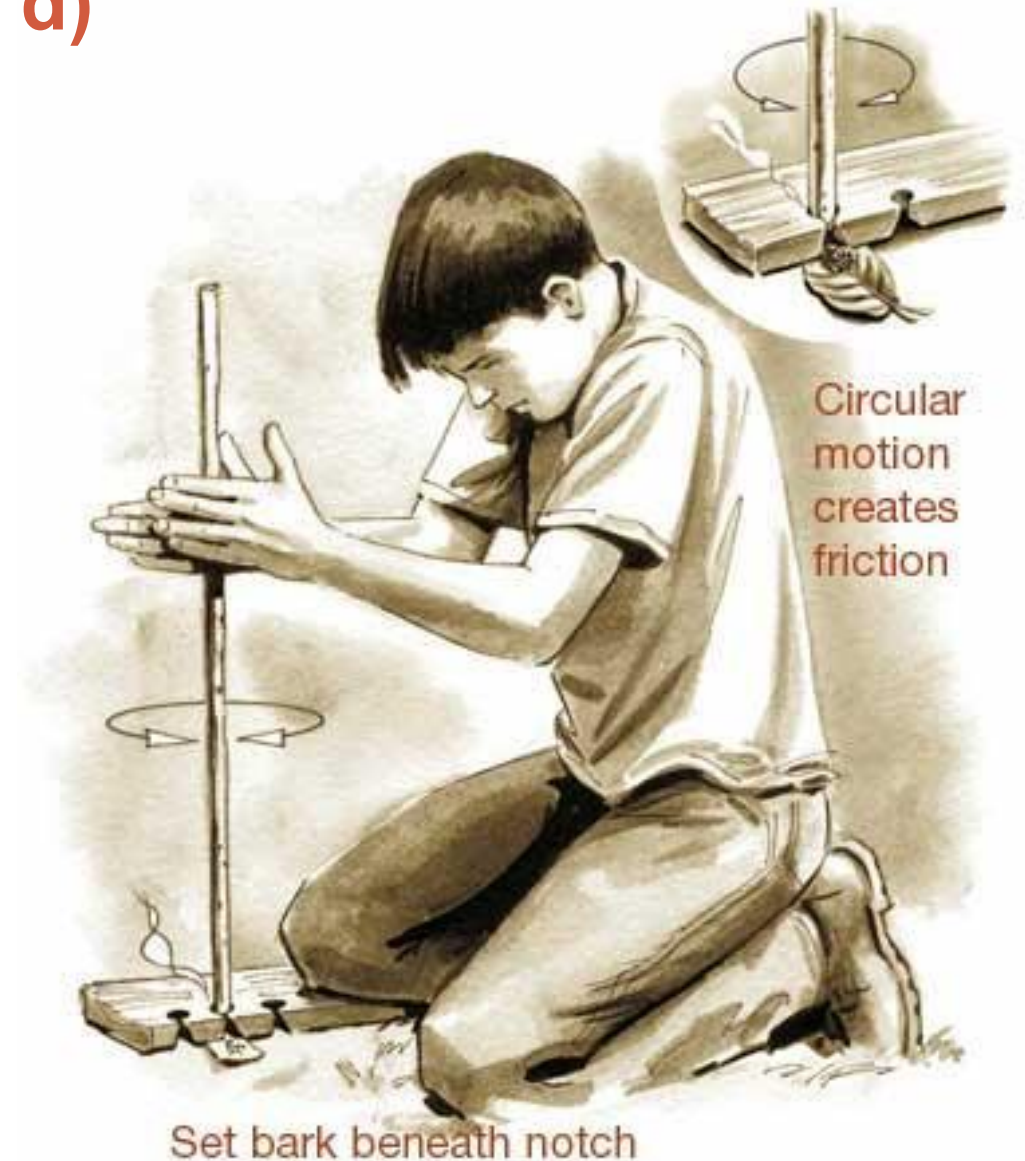- With the **Internet**'s ability to communicate will enable people to advance further.

Circular motion creates friction

Set bark beneath notch

Photo Gallery by Field & Stream Online Editors.

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WSN vs. Internet - hardware

- **Powerfull**

- Internet end hosts are full blown computers (laptops, smart phones, etc.)

- Require regular access to the power grid

- Humans interact with them

- **Invisible**

  - Things are very small, even invisible, low-end computers

    - With low energy consumption

    - Limited functionality, including sensing

  - Commuicating a limited amount of information

    - Cannot directly interact with humans

(Fleisch, 2010)

WSN vs. Internet – last mile

- **Broadband**

- The last mile in the Internet has been increasing tremendously (cable based at least 1 Mbps, optical based up to 50-100 Mbps and beyond...)

- **Bottleneck**

- The speed towards a low energy comsuming radio (of sensor motes) is around 100 kbps.

WSN vs. Internet – addressing

- **Global identification**

- IP – as simple as that

- **Babylon**

  - IP-based identification and addressing schemes require too much capacity to become part of low-end smart things

  - New solutions such as IPv6 and 6LoWPAN are required

WSN vs. Internet – focus

- **Communication**

- Economic success story of the Internet: **WWW** – reaching out to a global customer base at *very* low cost!
(e.g., advertising – Google, shopping – eBay, Amazon, ...)

- The ability to deal with user-generated content: **Web 2.0**
(Wikipedia, Facebook, YouTube, ...)

- **Sensing**

- It allows the *physical world*, things and places, to generate data automatically.

- IoT is about **sensing the physical world**

WSN – communication and cooperation

- Sensors have the ability to network...
  - with each other, and
  - with Internet resources

- Technologies:
  - Wireless technologies (e.g., IEEE 802.15.4 and ZigBee, UMTS, WiFi, ...)
    - E.g., range of 10 to 100 m for 1 mW transmission power, with transmission rate of 250 kbps
  - wireless networking standards (related to WPANs) are of primary relevance here
  - 6LoWPAN – IPv6 over Low Power Wireless Area Networks IETF Working Group: IPv6 using 802.15.4
    - E.g., TCP/IPv6 stack with 4 kB RAM and 24 kB flash memory