Grand Challenges: Time to Act

Bits & Chips Hardware Conference 2010

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Humanity’s top 10 problems for next 50 years (*)

1. **Energy**
2. **Water**
3. **Food**
4. Environment
5. Poverty
6. Terrorism & war
7. Disease
8. Education
9. Democracy
10. Population

(*) Prof. Richard E. Smalley 1943-2005, Nobel price winner Chemistry 1996

Grand Challenges

- What are they (*)
  - Major societal challenges
  - Calling for urgent solutions
  - Cannot be solved in a reasonable time and/or with acceptable social conditions without a strong and coordinated input requiring technological and non-technological innovation, and (though not necessarily always) advances in scientific understanding
- They include: climate change, energy shortages, sustainable development, affordable high-quality healthcare and many others

(*) from “The role of community research policy in the knowledge-based economy”, European Research Area Export Group

Grand Challenges: time to act

- We are obliged to address the grand challenges
- They require a multi disciplinary approach with many stakeholders
- They offer interesting business opportunities
- Europe has the capabilities to act

European Research Area milestones by 2030

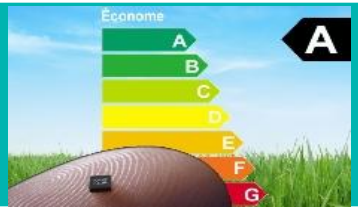
- A third of public, non military research is geared to grand societal challenges, with a multi disciplinary approach
- 30% of all scientists, including humanities and social sciences, are trained in research fields relevant to the Grand Challenges

High Tech Industry has a role to play

- Many grand challenges are very technology intensive
- Electronics is one of the necessary fundamental capabilities
- The combination of application know-how and electronics is essential
- Knowledge institutes and companies should team up
- In The Netherlands, Knowledge Workers Projects and High Tech Top projects address Grand Challenges

Grand challenges and electronics

Energy



- Efficient power conversion & management
- CFL and LED lighting and back-lighting solutions
- Energy conservation: e-metering, smart appliances

Health

- Smart and small hearing aids and headsets
- Personal health devices and portable medical imaging
- Biosensors

Mobility

- Intelligent traffic management
- Car safety, security and remote diagnostics features
- Green cars: electrical vehicles, car networks

Security

- Secure mobile transactions and secure identity
- Goods tagging, authentication and tracking
- Security and privacy protection

Strategic Platform for Intelligent Traffic Systems

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What is the issue ([1]) ?

- **Safety in Europe**
  - 38000 deaths on the road (EU-2008)
  - 1.7 M persons injured (EU27-2007)
  - Human error involved in 93% of all accidents
- **Congestion**
  - in Europe 10% of road network daily congested,
  - representing a loss of 1% of GDP annually
- **Energy Efficiency and emissions**
  - Green house gasses (CO_2)
  - Depending on fossil fuels
  - Slow take-up of renewable fuels

([1]) presentation at 2nd ETSI TC ITS workshop Feb 2010, Sophia Antipolis, Juhani Jääskeläinen, Head of unit ICT for Transport at the EC

One of the Dutch answers: a Strategic Platform for Intelligent Traffic Systems, SPITS

- Dutch consortium of 13 companies and universities
  - Funded by the Dutch Ministry of Economic Affairs
  - Duration: July 2009 - June 2011
  - High Tech Top Project

TOMTOM NXP logica be brilliant together TLO

CATENA GreenCat PEEK traffic solutions Fourtress TASK24 making technology matter

TU/e Technische Universiteit Eindhoven University of Technology TU Delft UNIVERSITEIT TWENTE. Universiteit Leiden

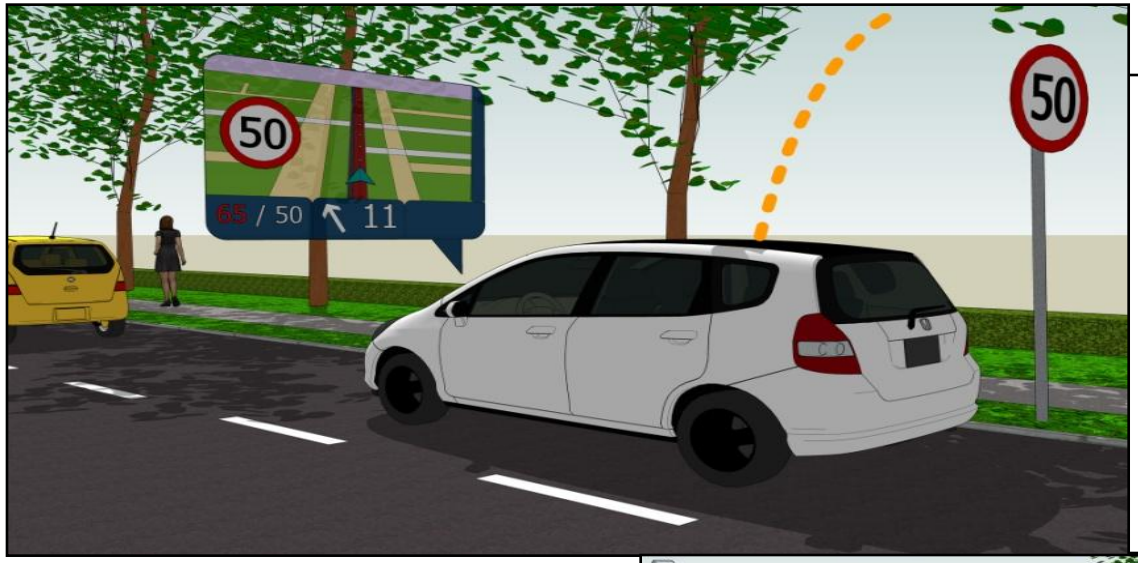
Agentschap NL
Ministerie van Economische Zaken

www.spits-project.com

Why SPITS?

- Mobility, safety and environmental challenges
  - Society needs
    - Higher throughput, better air quality, and safer traffic
  - Businesses and consumers needs
    - Efficiency, driver assistance, and infotainment
- Large potential for in-vehicle intelligence
  - Platform and applications need to be:
    - Available and affordable
    - Standard and open
    - Easy to connect and upgradeable

Use cases



Vehicle to remote server

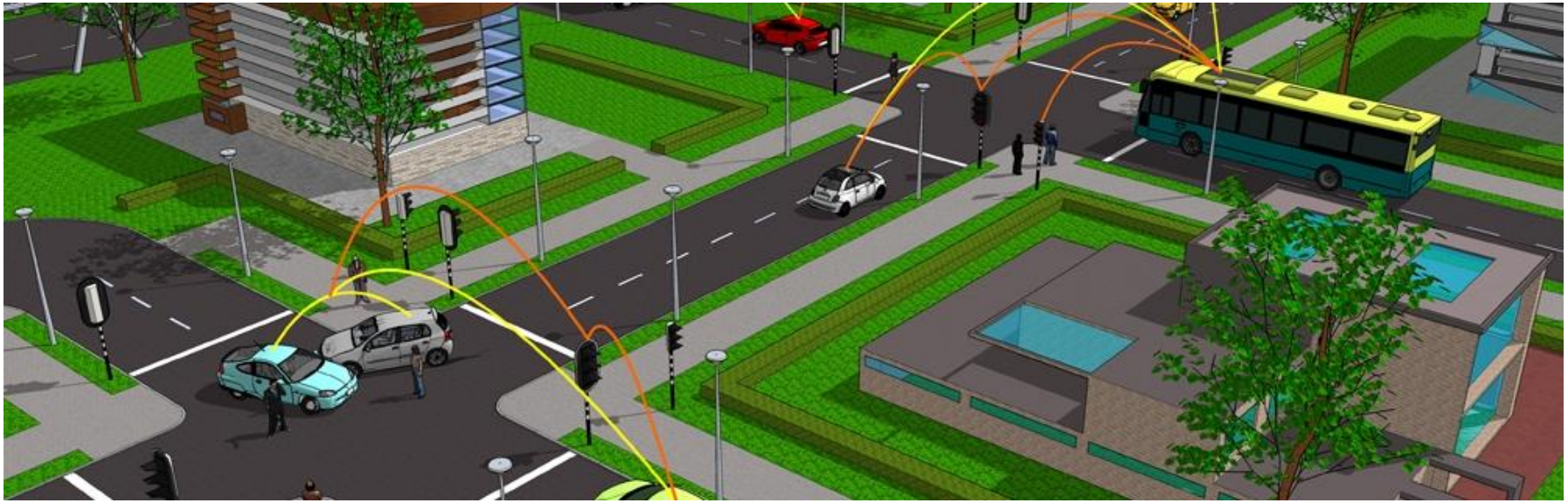
- Eco-routing
- Insure-How-You-Drive
- Logistical management
- Driving Time Assistant
- B-Call / E-Call
- Remote Diagnostics

Vehicle to Vehicle

- Cooperative-Adaptive Cruise Control
- Accident Warnings
- Shockwave dampening (V2V)
- Road trains / Platooning

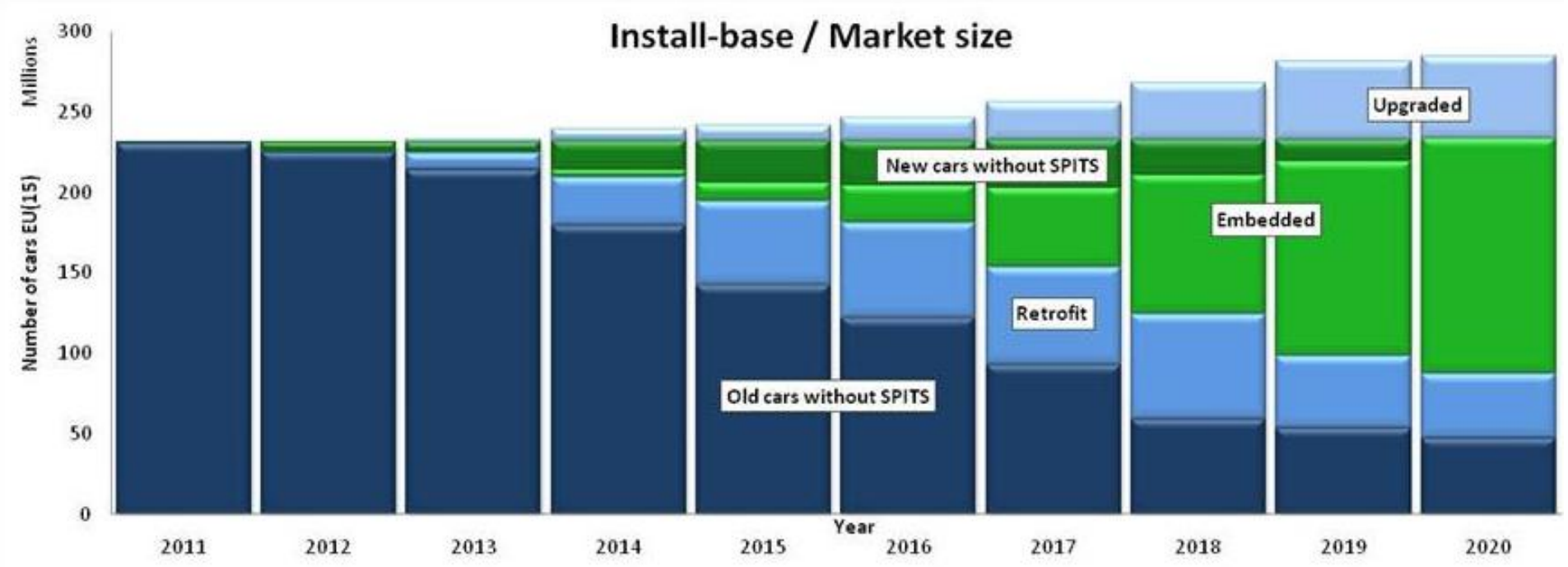
Evolving towards connected traffic

Individual routing replaced by cooperative routing schemes
Dynamic load balancing of network



Connected Vehicles	**Safety & cooperative driving**	**Telematics**	**Open telematics**
Open, affordable platform	**Traffic Management**	**Eco-Drive**	**Sustainable mobility**

Economic ambitions of SPITS



Societal impact ambitions of SPITS

- Potential of ITS applications enabled by SPITS
  - In 10-15 years reduction of: 50% congestion, 25% fatalities, 10% CO_2 and 20% urban air pollution
  - Increased employment in automotive and services industry

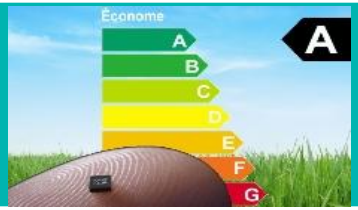
	Throughput Increase	Safety Impact	Environmental Impact
Speed Alerts	1-7%	12-24%	-
Lane Keeping Schemes	11%	Car: 25-37% Truck: 9%	-
Cooperative Cruise Control	30% at 10% Installed Base (IB) 50% at 60% IB	8%	10%
Local Warnings	-	5%	-
E-Call	-	4-5%	-

SPITS characteristics

- A multi disciplinary project
- Exploiting collective know-how of knowledge institutes and high tech companies in automotive domain
- A unique consortium enabled by Dutch government
- The overall project duration too short
- Project should be continued

Building Brains

Energy



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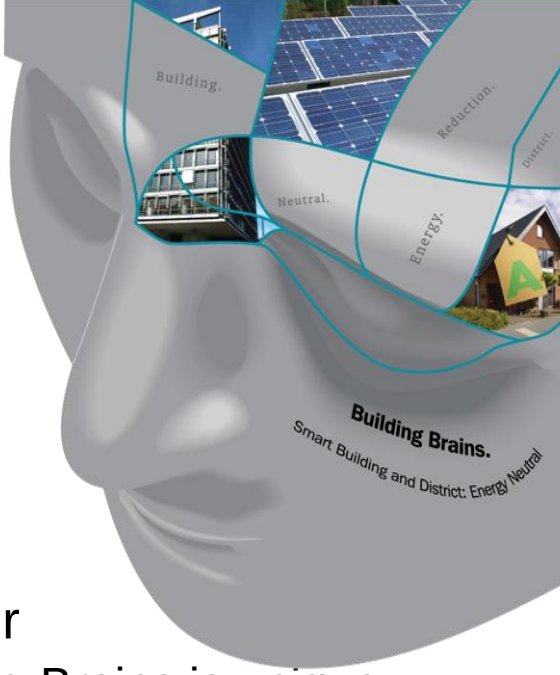
What is the issue



- Extremely relevant for energy use and sustainability
  - 40% of energy and material use is in buildings (*)
  - 80% of people's time is spend indoors (**)
  - 35% of all waste is from building industry (**)
- Traditionally very conservative and fragmented sector
  - Participation through the complete chain like in Building Brains is unique
- Buildings stand for some 100 years → long time to renew the total "installed base" (unlike e.g. cars)
- Construction is an important economic and social sector (***)
  - Approx 10% of GDP is construction related
  - Biggest sector in terms of employment (with lots of SMEs and "ZZP-ers")

(*) Publication EC (**) Various references on WEB (***) European Construction Industry Federation

One of our answers: Building Brains

- Develop significant innovations for energy saving and sustainability in the built environment
- Contribute to the 20/20/20[1)] vision and the 80% CO_2 reduction by 2050 goals
- Improve the competitive position of the Dutch Building sector
- Co-operation between 27 partners and 170 knowledge workers

Energy-neutral, or even -positive, buildings and districts

1) EU target for 2020 to (a) reduce emission of greenhouse gasses with 20% compared to 1990, (b) increase green energy fraction to 20% of the total production, and (c) achieve 20% overall efficiency gain

The Work Packages

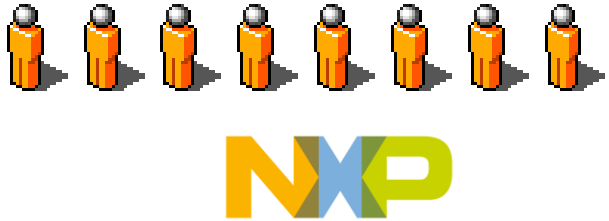
- **WP1 Smart Evaluation and Innovation**
  - Analyze existing buildings for achieved results
  - Define metrics for efficiency
  - Propose new norms / building codes

- **WP 2 Smart Building – BIM**
  - Deploy and extend the Building Information Model (BIM)
  - Identify and resolve bottlenecks in the deployment & tooling around BIM
  - Extend BIM with design support for energy efficiency of buildings

- **WP3 Smart Energy Systems**
  - Balance the energy supply and demand using contextual information
  - Maximize use of green & locally generated (c.q. stored) energy
  - Preserve user comfort

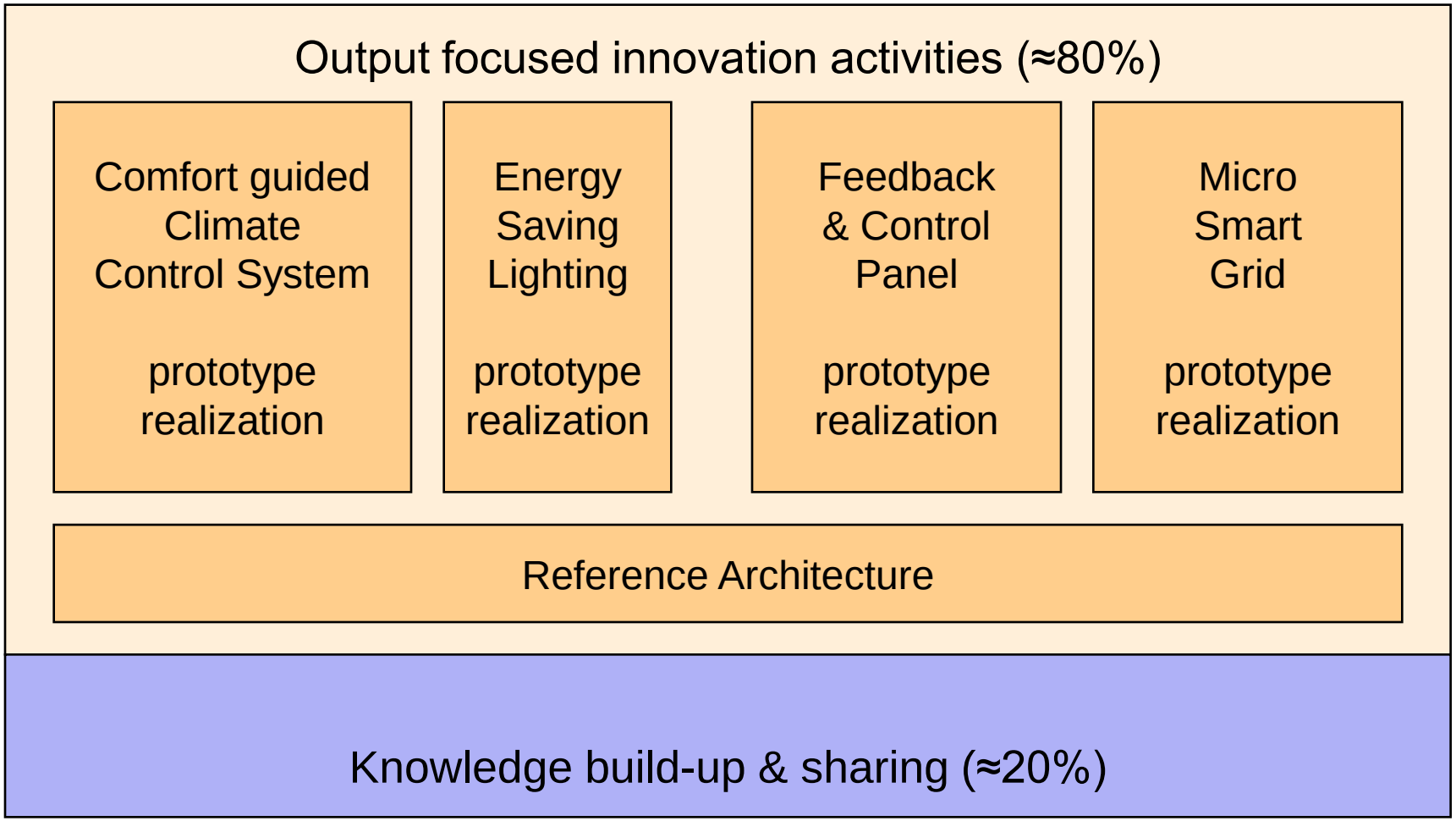
- **WP4 Smart District Urban Strategy**
  - Develop the Smart District concept
  - Optimal Layout using modeling
  - Inclusion of (green) energy sources

The WP 3 Partners in Building Brains



Founter = VolkerWessels

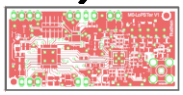
WP3 Activities 2010



Use case demonstrator: electricity

- Energy awareness:
  - Total energy use (electricity, gas, water, heat, …)
  - Electricity use per appliance/lamp
- Demand management
  - Need 2-way comms. in Plug Meters (i.e. “Smart Plug”)
  - Need smart grid enabled appliances
  - Need to deploy microgrid

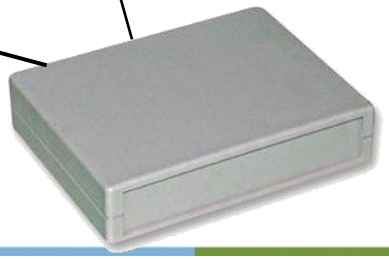
Automatic reflective blind system

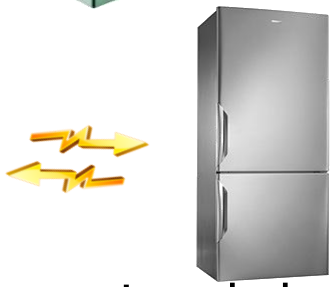


Smart Meter NTA8130

AMI/ micr ogrid

DC/AC converter





Load shedding

Submetering (gas, water, heat)

AMI: advanced metering infrastructure

Electronics Innovations to drive Building Smartness

- Multi-model, cost effective, ultra-low power CMOS sensors
- Long range, reliable, low power RF connectivity (868 MHz)
- Low power, cost effective microcontrollers (e.g. Cortex M0, M3)
- Efficient, dimmable CFL & LED drivers
- Low standby power for tethered nodes (e.g. RF-controlled lamps)
- Power conversion for indoor (scavenged sensors) and outdoor PV
- Solutions for easy setup
- Solutions for security & privacy

Building Brains characteristics

- A unique consortium of architects, construction companies, installation companies, software companies, knowledge institutes, electronic companies with a common goal
- Very multi disciplinary consortium enabled by Dutch government
- Many opportunities that should be very explored beyond the scope of the current Building Brains project

Grand challenges and electronics

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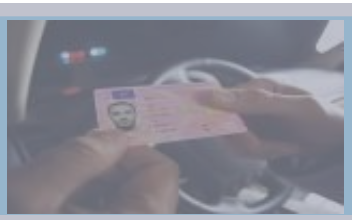

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Opportunity

Changing society

Aging population

Less blockbusters drugs

More chronic diseases

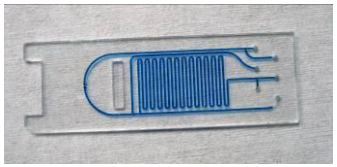
Pressure on healthcare budgets

Changing In Vitro Diagnostic market

Personalized medicine

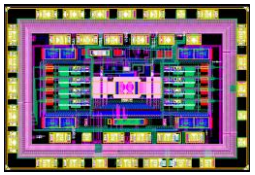
Increased prevention

On-the-spot diagnostics



Need for new technologies

Semiconductor biochips, label-free, miniaturisation, wireless, portable, ease of use, ….



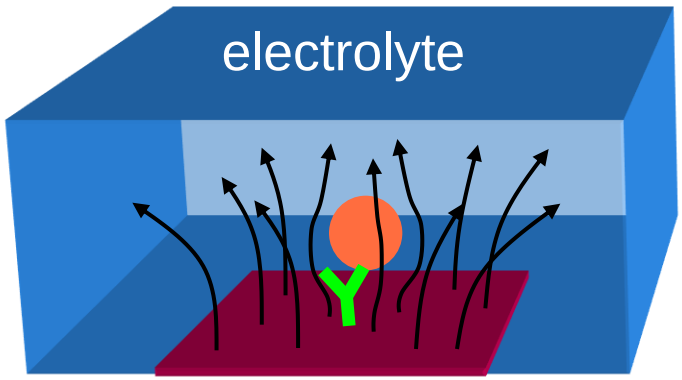
CMOS based biosensors Platform

The opportunity !

Changing IVD market needs semiconductors competences & techologies

- Biosensing technology ☑
- Fast on-chip processing ☑
- Data security/encryption ☑
- Wireless communication ☑
- Ultra low power processing ☑
- Miniaturization ☑
- Biological content ☒ → Partners
- Approval & sales channels ☒ → Partners

Basic Principle: Capacitive detection



- **Target bio-molecule** specifically captured by an **immobilized probe molecule**
- Causes a **change in the capacitance of the nano-electrode**

$$C = \varepsilon_{eff} A / d$$

- **Capacitive change** is proportional to **volume (~mass) of the captured bio-molecule**
- **ΔC ~ 0.2 - 2 aF for typical biomarkers**

Capacitive detection

Conventional approach: large electrodes

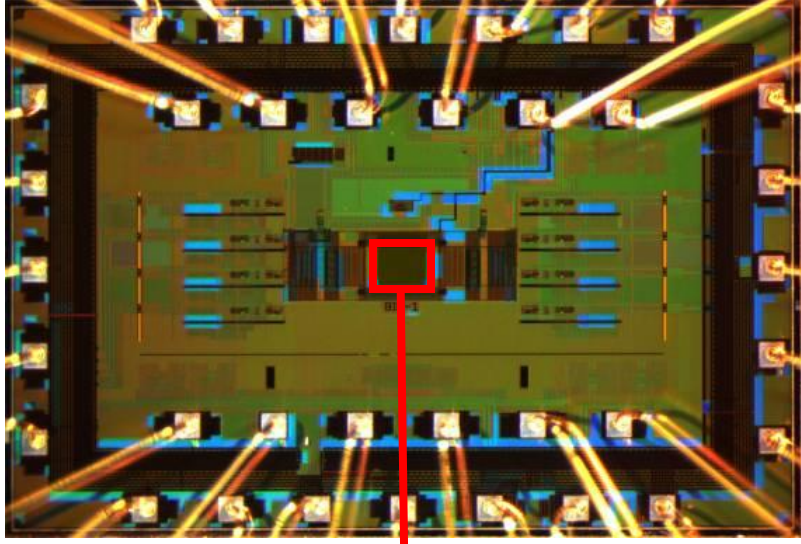
- Only measurement of ensemble average properties
- Collective effects of many bio-molecules **and** defects

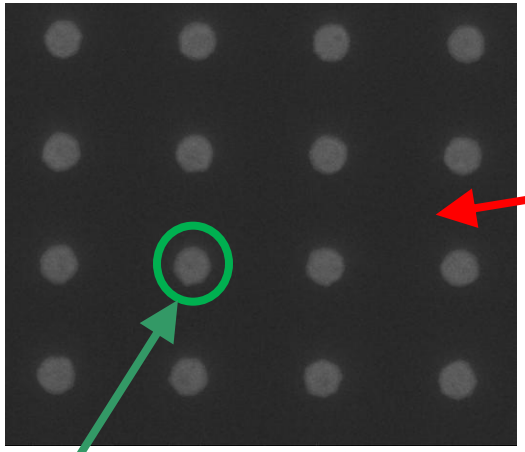
Disruptive approach: large array of nano-electrodes

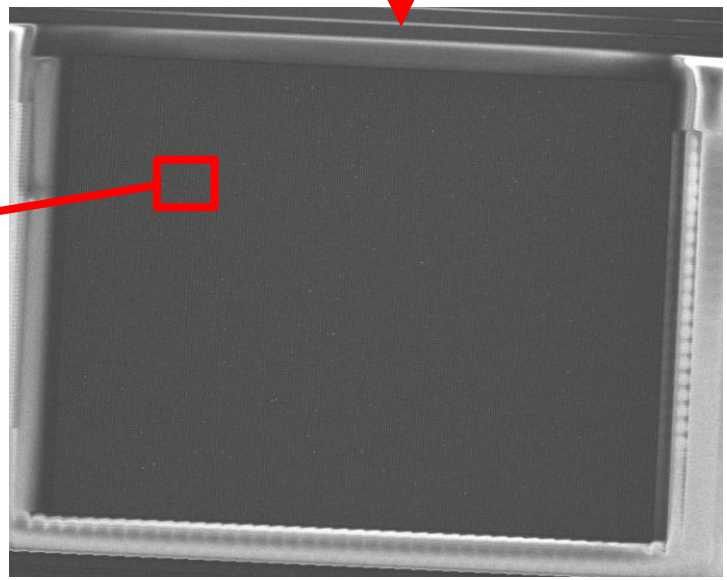
- Ensemble of single-molecule signals: maximum information
- Effects of individual bio-molecules **or** defects
- Counting of captured molecules

Biosensor prototype chip

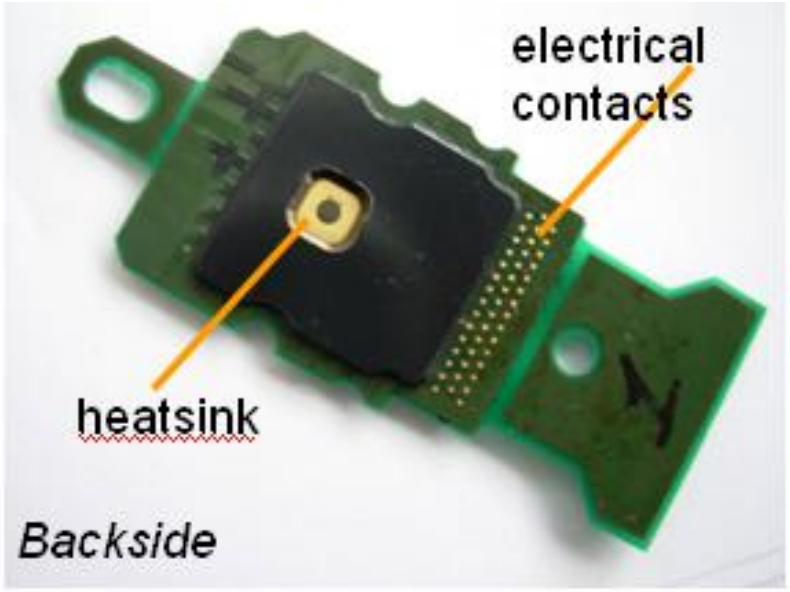
- On-chip signal processing
- Large statistics from 65,536 electrodes
- Real-time sensitive analysis on each electrode

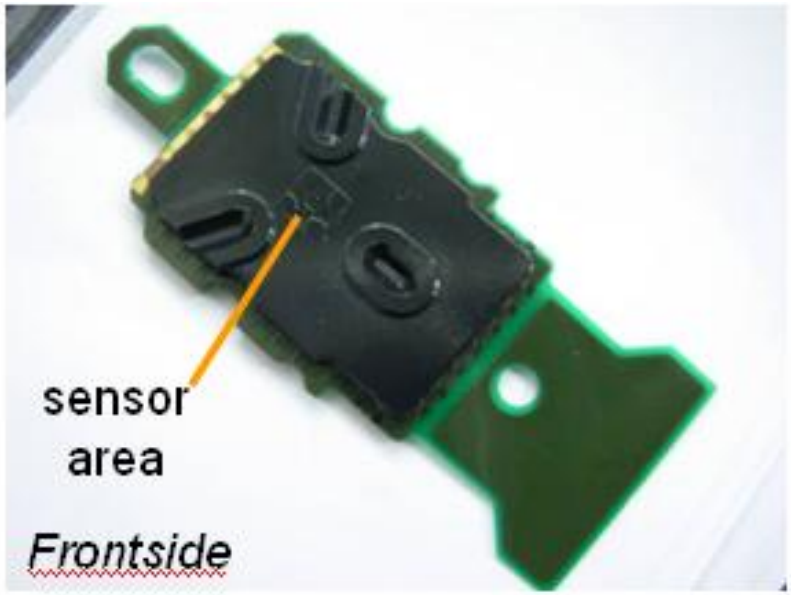


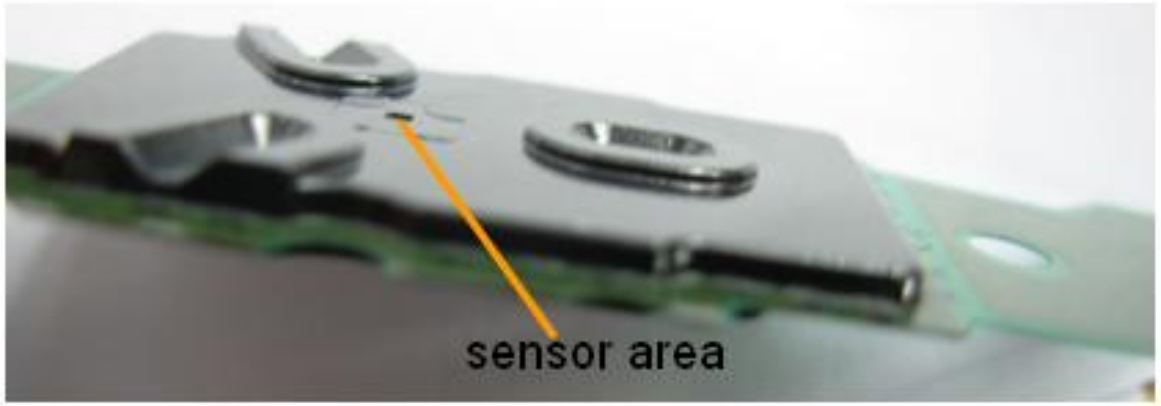




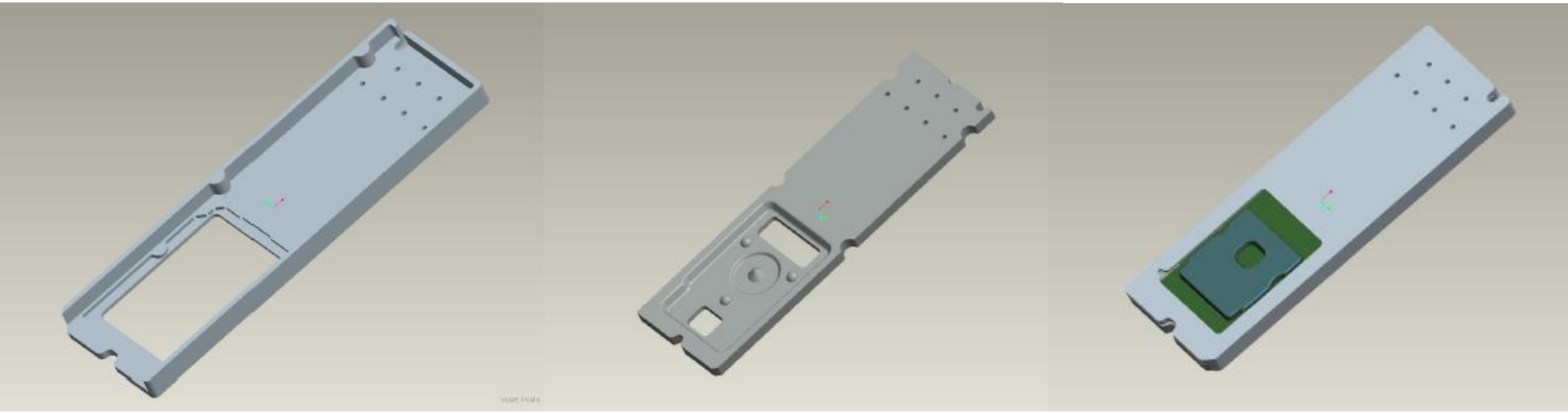
Packaged sensor chip

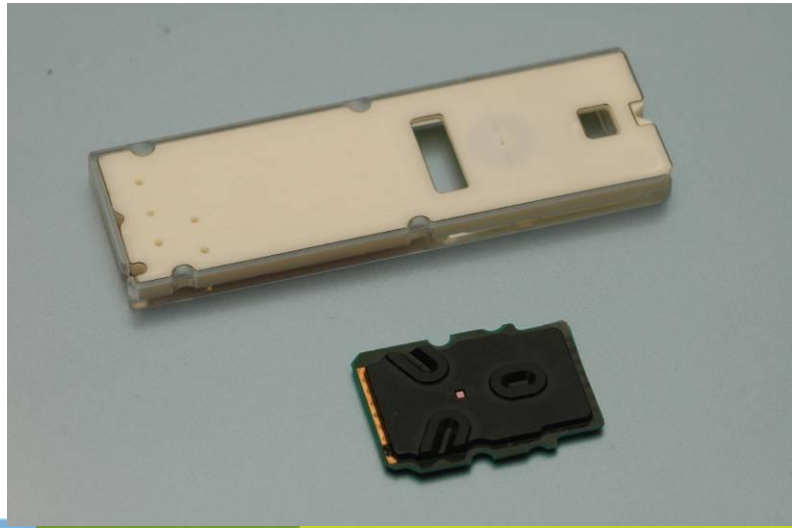






Micro-fluidic cartridge





(With miniFab)

A multi disciplinary approach enabled by governmental support

- Knowledge workers project with Radboud University Nijmegen: Detection of viral RNA of human Respiratory Syncytial Virus (RSV)
- MicroNed program with University of Wageningen and Royal Tropical Institute in Amsterdam: diagnosis of resistant variants of Tuberculose
- IMEC Leuven: surface modifications
- KU Leuven: materials science for surface modification and statistical data analysis

Conclusions and next steps

Grand Challenges:

- Will create a framework for the European Research programs
- Will bring new business opportunities
- Require a multi disciplinary approach
- Require a concerted action between knowledge institutes and industry

Next steps

- Grand challenges will be one of the drivers of research programs
- The co-operation between the industry and knowledge institutes should be further facilitated to jointly address the challenges
- Industry should continue to develop innovative solutions addressing the grand challenges
- In The Netherlands, government has a role to stimulate R&D
  - In the context of Point-One and HTAS
  - Continuation of the Knowledge Workers program
  - Pre-commercial procurement
- Grand challenges: time to act