



On the convergences between “More Moore”, “More Than Moore” and “Beyond CMOS”

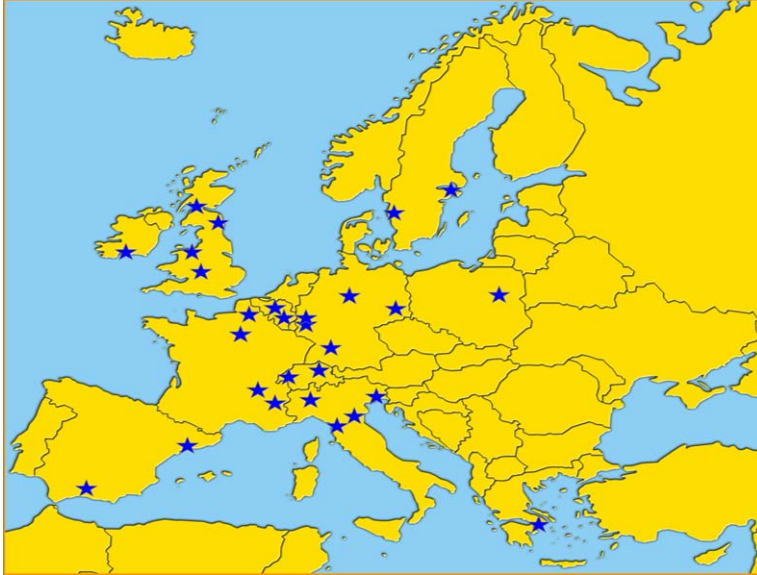
Workshop organizers :

Francis BALESTRA & Raphael CLERC
IMEP, Grenoble, FRANCE

Thank you to A. Godoy and colleagues for the help organizing it !



Network of Excellence NANOSIL :



Silicon-based nanostructures and nanodevices for long-term nanoelectronics applications

28 Partners from 11 European countries:
University Labs, Research Centers

- Strengthen interaction between the **Scientific Community** and the **European Industry**

Visionary projects:

- ⇒ *discussion Forums, brainstorming activities and Workshops* to **generate new ideas**
- ⇒ identify the **most promising topics** for future information technology



Introduction



Nanoelectronics area : "More Moore"

The 'More Moore' domain is internationally defined as an attempt to **further develop advanced CMOS technologies** and reduce the associated cost per function

Almost 70% of the total semiconductor components market is directly impacted by advanced CMOS miniaturization achieved in the More Moore domain. This 70% comprises three component groups of similar size, namely **microprocessors, mass memories, and digital logic**.





Introduction



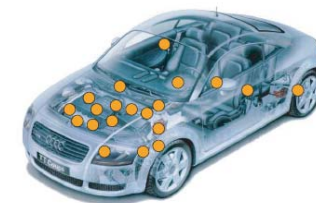
Nanoelectronics area : "More Than Moore"

'More than Moore' (MtM) refers to a set of technologies that enable **non digital micro / nanoelectronic functions**.

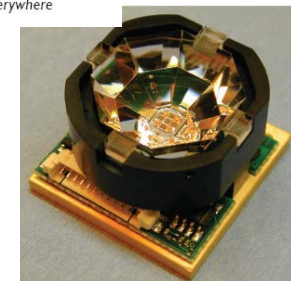
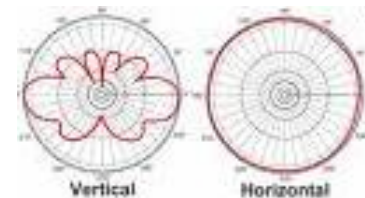
They are based on, or derived from, silicon technology but **do not necessarily scale with Moore's Law**.

MtM devices typically provide conversion of non-digital as well as non-electronic information, such as mechanical, thermal, acoustic, chemical, optical and biomedical functions, to digital data and visa versa.

- Radio frequency (RF)*
- High-voltage and power*
- Solid-state lighting (SSL)*
- Medical Ultrasound, Biochips and microfluidics*
- Energy scavenging*
- Electronic imaging*
- Sensors and actuators on CMOS platforms*



Sensors and actuators are everywhere





Introduction



Nanoelectronics area : "Beyond CMOS"

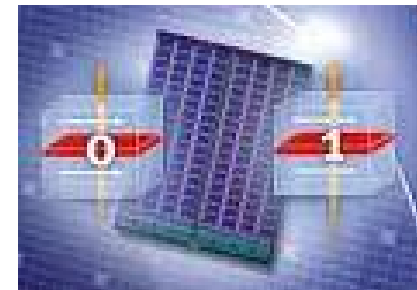
significant breakthroughs can be expected in the longterm from the progress in **nanometre-sized functions**.

It is expected that such new ideas will move to the MtM and HI domains as they mature

Dedicated European workshops may help to refine this research structuring effort



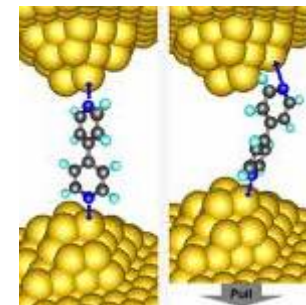
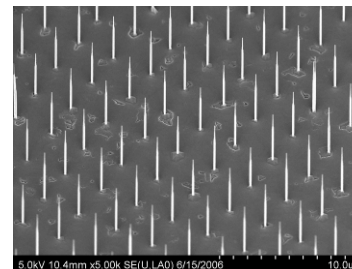
Electronics using New state variables (spin, molecular state, photons, phonons, nanostructures, mechanical state, resistance, quantum state (including phase) and magnetic flux)



Spintronics (spin-based electronics)

Molecular electronics

Heat transfer management





Introduction

ENIAC 2007 VISION :



European R&D will increasingly turn its attention to extending the 'More than Moore' domain.

No one is quite yet sure what these 'Beyond CMOS' technologies will be, but whatever they are, **they are unlikely to result in sudden transitions**. Candidate technologies will almost certainly be pre-tested in the More than Moore and Heterogeneous Integration domains - the two domains where Europe is already building world-class expertise.



Introduction

These main trends, referred as “More Moore”, “More Than Moore” and “Beyond CMOS”, are usually presented as three distinct fields.

But is it so simple ?

In Physics, Technology and Design : what are in fact the connections between these three domains?

What are the synergies needed between the various aspects of Nanoelectronics ?

Is there a convergence between future research topics and platforms in these areas ?



Our Speakers :

Experts From Industry

Thomas Skotnicki, STMicroelectronics, France
Reiner Kress, Infineon Technologies, Germany
Heike Riel, IBM Research, Switzerland
Jan Hoentschel, Global Foundries, Germany

Experts From Research Center

Sywert Brongersma, imec, Belgium
Michel Brillouet, CEA LETI, France

Experts From Academia

Enrico Sangiorgi, IU.NET, Italy
Mireille Mouis, IMEP-LAHC, France
Siegfried Mantl, Julich Univ., Germany
Jean Pierre Colinge, Tyndall, Ireland



Agenda / Morning

8.45 – 9.00 : Welcome and Opening

9.00 – 9.30 : **Thomas Skotnicki**, STMicroelectronics, France,
“III-V high mobility materials in advanced CMOS”

9.30 – 10.00 : **Sywert Brongersma**, IMEC, Belgium,
“CMOS, CMORE, and what to use it for”

10.00 – 10.30 : Coffee Break

10.30 – 11.00 : **Enrico Sangiorgi**, IU.NET, Italy,
“When More Moore meets More than Moore and Beyond CMOS”

11.00 – 11.30 : **Mireille Mouis**, IMEP-LAHC, France ,
“Nanowires in the Beyond CMOS and More than Moore perspectives :
Electromechanical properties”

11.30 – 12.00 : **Peter Baumgartner**, Infineon Technologies, Germany,
“Scaling Challenges for complex SOC products”



Agenda / Afternoon

12.00 – 13.00 : Lunch

13.00 – 13.30 : **Heike Riel**, IBM Research, Switzerland,
“Tunnel Field Effect Transistors based on grown Nanowires”

13.30 – 14.00 : **Michel Brillouet**, CEA LETI, France,
“Synergies and differences between More Moore, More than Moore and Beyond CMOS”

14.00 – 14.30 : **Siegfried Mantl**, Forschungszentrum Julich, Germany,
“Novel Materials, a source of innovation and performance gain”

14.30 – 15.00 : **Jan Hoentschel**, Global Foundries, Germany,
“Diversification of Moore's law and its advanced technologies”

15.00 – 15.30 : **Jean Pierre Colinge**, Tyndall, Ireland,
“Junctionless nanowire transistor: an example of the convergence between More Moore and Beyond CMOS”



To the audience :

After each talk, I will ask the speakers the same set of questions

I would like to have also your opinion
→ fill the survey !



Help me to make this workshop interesting / funny

→ Please also ask even more provocative
/ relevant questions than mine !



“III-V high mobility materials in advanced CMOS”

Thomas Skotnicki, STMicroelectronics, France

High Mobility like ...

in High Mobility Multipurpose Wheeled Vehicle ?





Speaker's ID : Would you define your past / present activities as :
More Moore / More Than Moore / Beyond CMOS ?

What about your future activities ?

Speaker's Vision :

In your opinion, which domain offers the most promising research perspective ?
the most promising medium term market ?

More Moore / More Than Moore / Beyond CMOS ?

Is it possible to be successful in More Than Moore or Beyond CMOS innovation
without mastering More Moore ?

Do you find this division of the nanoelectronics meaningful / relevant ?



THE NASTY QUESTION :

Could you help me answering one of my student following comment :

I can not see the fun in shrinking transistor dimension !



“CMOS, CMORE, and what to use it for”

Sywert Brongersma, IMEC, Belgium



The ad says : “ Building chips with sensational functions”

I can not wait to see what this is about !



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THE NASTY QUESTION :

If you have to bet one month of salary
about the success of an emerging technology :

What technology would it be ?



Agenda :

“When More Moore meets More than Moore and Beyond CMOS”

Enrico Sangiorgi, IU.NET, Italy



“Close Encounters of the Third Kind”



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THE NASTY QUESTION :

You spend some time in the former Bell Labs.
If the Bell Labs would still exist :

What would be their point of view / strategy about
More Moore / More Than Moore / Beyond CMOS ?





Nanowires in the Beyond CMOS and More than Moore perspectives :

Electromechanical properties

Mireille Mouis, IMEP-LAHC, France





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THE NASTY QUESTION :



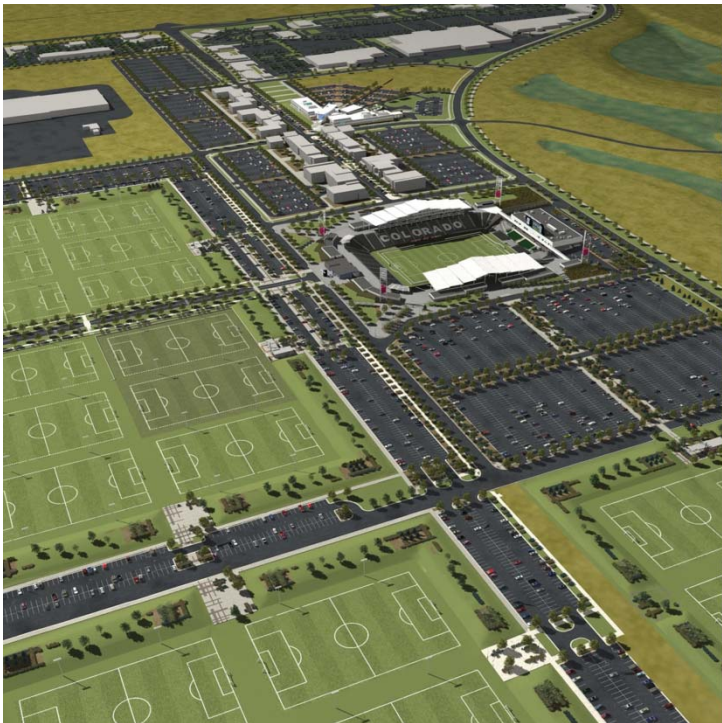
Would you classify research on nanowire transistor as :

More Moore / More Than Moore / Beyond CMOS ?



Scaling Challenges for complex SOC products

Peter Baumgartner, Infineon Technologies, Germany



Do you mean “Scaling of SOCcer complex” ?





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THE NASTY QUESTION :

Is 3D integration (TSV) a friend or an enemy of System on Chip ?



Tunnel Field Effect Transistors based on grown Nanowires

Heike Riel, IBM Research, Switzerland



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Synergies and differences
between More Moore, More
than Moore and Beyond CMOS

Michel Brillouet, CEA LETI, France



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Novel Materials,
a source of innovation and performance gain

Siegfried Mantl, Forschungszentrum Julich, Germany



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Diversification of Moore's law and its advanced technologies

Jan Hoentschel, Global Foundries, Germany



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Junctionless nanowire transistor: an example of the convergence between More Moore and Beyond CMOS

Jean Pierre Colinge, Tyndall, Ireland



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Thank you very much
for attending
this workshop !