Open innovation
in
Embedded Systems Design

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DSP Valley
Why Innovation?
Innovation in Automotive

More than 60 microprocessors in a modern car, enabling new functionalities:

- improved safety: ABS, ESP, airbag, …
- more efficient power consumption: engine control, emission,…
- luxurious comfort: A/C, Radio-CD, Video,…
Innovation in Health Care

- Echography
- Heart defibrillator
- Electro stimulation
- Hearing devices
- ...

- New services
- New products
- Better health care
Innovative (IC) Technology for Added Value

- Innovative technology brings new added value to products
- In commercialisation process, new added value is crucial to maintain competitive position

Diagram:
- Navigation & Communication Technology
- Sensor-controlled Systems
- Digital Image Processing
- Digital Sound Processing
- Machine Construction
- Multimedia Infrastructure
- Consumer Electronics
- Wireless Communication
- Space
- Medical Applications
- Automotive Electronics
- Networks

6 October 2009
Differentiation needed for Competition

- Price differentiation
  - However: some competitive price disadvantages for European companies...
  - Cost reduction by using new technologies

- Product differentiation
  - New functionalities
  - New features

- Service differentiation
However...

Ever increasing complexity 😞
Trend: HW Architectural Complexity

- From 4bit to 32bit µP to 64bit µP
  - 8bit (PIC, AVR, H8, 8051,…):
    - Programming in assembler, C
    - Simple control functions,
    - CAN, LIN
    - Distributed intelligence, Industrial Networks, Toys
  - 16bit / 32 bit
    (ARM, MIPS, PowerPC,…):
    - Programming in C(++), Java

- From single processor to multiprocessor
  - TI OMAP™ and OMAP™ 2 architectures (ARM processor + TI DSP)
  - ARM MPCore multiprocessor based on ARM11™ core (up to 4 processors!)
  - FPGA + µP (Xilinx Virtex 4-FX: PowerPC)

Bron: LinuxDevices.com
Trend: Moore’s Law for Hardware

"# transistors on a chip: x2 every 18 month"
Trend: Software law...

1965

1979

1 kB

2000

Moore's law

1990

2 MB

64 kB
From stand-alone to connected systems

- Example: remote management of vending machines, printers, copying machines, industrial machines...
  - Tracking of consumables
  - Localisation
  - Remote diagnostics

Send: 'Almost out of Coke'
Action: 'Send truck'
Action: 'Refill at ...'

GPRS network

Internet
Trend: Connectivity becomes Wireless

<table>
<thead>
<tr>
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<th>70's</th>
<th>80's</th>
<th>90's</th>
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<td>voice</td>
<td>wired telephony</td>
<td>analog wireless phones</td>
<td>GSM</td>
<td>DECT</td>
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<td>data</td>
<td>proprietary wired networks</td>
<td>Ethernet (wired)</td>
<td>GPRS</td>
<td>WIFI</td>
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<tr>
<td>video/multimedia</td>
<td>analog TV (cable or wireless broadcast)</td>
<td>Digital TV</td>
<td>UMTS</td>
<td>WIFI (new versions)</td>
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<tr>
<td>industrial</td>
<td>limited automation</td>
<td>local PLC</td>
<td>Fieldbus</td>
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<td>control</td>
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<td>automation</td>
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new WIRELESS opportunities

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THE EMBEDDED TECHNOLOGY NETWORK
What is different for Embedded Technology?

- Why no embedded PC with Windows or Linux?

- This would be an ideal solution for all application, except that it would be:
  - Too big
  - Too expensive
  - Too slow
  - Too energy consuming
  - Too unreliable…

- Would you by a “Wintel” platform pacemaker???
- Would you like a car with a CTRL-ALT-DEL reboot function???
Innovation by Cooperation?
What is this?

→ **YES:**
→ a mobile phone

→ **NO:**
→ NOT ONLY a mobile phone
  - a digital camera
  - a MP3-player
  - an address book
  - an e-mail device…

But: telephone developer / manufacturer is not necessarily a specialist in all the required technologies…
Many possibilities of complementarity

- Technological complementarity
  - Mobile phone
  - + digital camera
  - + MP3 player
  - + address book
  - + FM radio
  - + e-mail device
  - + mobile TV
  - + games
  - + ...
  - + ...
  - + ... (imagination is the limit?)
Many possibilities of complementarity

Complementarity in the value chain

- Fabless design house
- Waferfab
- Packaging
- System integration
- Product integration
Many possibilities of complementarity

- Logistic complementarity
  - Product vendor
  - Distributor
  - Retail

- Business model complementarity
  - Universities and technical university colleges
  - Non-profit research centers
  - Businesses

Need for clustering: Different players can help each other!
5 commandments of (open) innovation...

1. Don’t be afraid to start
2. Know what you want
3. Know when you want it
4. Know what you know

5. Know where to find help
   (know the knowledgeable people)

Network organization stimulates and manages brokerage and matchmaking and partnering and cooperation
How DSP Valley promotes Open Innovation
DSP Valley’s Networking Mission

- **Primary Mission**
  - To stimulate new innovative partnerships, by offering a platform where potential partners can meet
  - To create a (technology) community, with mutual trust, where people are prepared to exchange ideas and to help each other, by exploiting technological complementarities

- **Secondary Mission**
  - To create an exposure as a region of excellence in our technology domain
  - To grow the community and the number of interactions between potential partners, by attracting new players to the region (in cooperation with the responsible regional government services), and thus increasing the number of potential interactions and partnerships

- **You can never know enough about your potential partners**
- **You can never work together with somebody you don’t know!**
Focus: Design of DSP system

Design:
1st creative engineering phase in value adding chain
Focus: Design of (D)SP system

(D)SP System = (HW + eSW) + SoC + critical (D)SP function

- Memory Blocks
  - ROM: Read-Only Memory
  - RAM: Random Access Memory

- General Purpose Microprocessor
  - Control and synchronization
  - MMI (mouse, keyboard…)

- Interface with analog environment
  - Imaging sensor
  - Microphone
  - Antenna + R/F

- Analog-digital conversion

- Digital Signal Processor
  - Image processing
  - Sound Processing
  - Communication functions

- Reconfigurable Logic

Communication bus
## Technology domains

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<tr>
<th>Communication &amp; Navigation Technologies</th>
<th>Sensor-controlled Systems &amp; Machine Control</th>
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<tbody>
<tr>
<td>Fleet Tracking</td>
<td>CMOS imaging sensors</td>
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<td>GPS / Galileo / Egnos</td>
<td>AD/DA convertors</td>
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<td>3G (UMTS)</td>
<td>Data acquisition</td>
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<td>xDSL</td>
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<td>Zigbee</td>
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<td>Precise Timing</td>
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<td>802.11 a/b/g</td>
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<td>Still image compression</td>
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<td>Voice control</td>
<td>3D image synthesis</td>
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<td>Hearing implants</td>
<td>Set-top boxes</td>
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<td>Hearing instruments</td>
<td>Medical Atlas</td>
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<td>Noise reduction</td>
<td>Medical Imaging</td>
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<td>Transformations</td>
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<td>MP3</td>
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<td>Filters</td>
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<tr>
<td>Digital Audio &amp; Sound Processing</td>
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<td>Digital Image Processing (Still Images &amp; Video)</td>
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DSP Valley = Cluster of technology providers
- Cooperation based on co-development of basic technology building blocks

Bridging to application domains
Does it work?
Successes?
Success Story: Ultra Low Power Design

Development tools

TARGET
THE ASIP COMPANY

Cochlear

NXP
founded by Philips

CoolFluxDSP

Swans-project: DSP-improvements

imec
Cooperation example: Cochlear

eSW development

Algorithm development: noise suppression & multimicrophone sound acquisition

Algorithm development

Hardware implementation

μsystems & packaging IC prototyping & small volume production

Clinical software

Hardware architecture
IMEC industrial cooperation

Hyper APS
IC prototyping & small volume production + layout services

Layout services

IC prototyping & small volume production

MEMS
Reconfigurable systems
Packaging

µsystems & packaging
IC prototyping & small volume production

Design technology

Hybrid APS
IC prototyping & small volume production + layout services

Ultra-low-power wireless communication

Design Reconfigurable SoC

Multimedia Community
Inkjet printing
Imager tiling

GPS GLONASS
IC prototyping & small volume production

Wireless Communication

Ultra-low-power wireless
Low power design methodology
Multimedia Community

Layout services

6 October 2009
KHLim and DSP Valley

- DSP Valley is member of IWT research projects

- DSP Valley and KHLim were member of Interreg project “Proeftuinen voor ESS” (end in 2008) together with Kdg, Avans en HS Zuyd.

- KHLim is member of DSP Valley since 2007
Conclusion
Open Innovation = Co-operation

- Innovation is required to maintain competitive advantages, through introduction of new functionalities and features.
- However, increasing complexity of technology requires specialisation.
- Innovation combined with increasing complexity and short time-to-market leads to open innovation.
- Open innovation = all about co-operation with external partners.
- Networking helps to find knowledgeable external partners: be prepared!

Luck is where preparation meets opportunity.
Thank you