Chameleon
reconfigurable computing in handheld multimedia systems

Gerard Smit
University of Twente
department of Computer Science
the Netherlands
e-mail: smit@cs.utwente.nl
WEB:
www.cs.utwente.nl/~havinga/chameleon.html
or chameleon.ctit.utwente.nl
Program of today

- 13.45 Who-is-who of Chameleon
- 13.50 Short overview of Chameleon (Gerard Smit)
- 14.15 Energy efficiency through adaptation to the environment (Lodewijk Smit)
- 14.45 FPFA (Paul Heysters)
- 15.15 SMART (Paul Havinga)
- 15.45 Evaluation and date next usergroup meeting
Chameleon who-is-who

- UT-EL staff
  - Prof. C. Slump
  - ir. J. Smit
- UT-INF staff
  - Prof. dr. P. Hartel
  - Prof. Th. Krol
  - dr. ir. G.J.M. Smit
  - dr. P.J.M. Havinga
  - ir. E. Molenkamp
- STW (MOZ)
  - ir. L. Smit
  - ir. P. Heysters
  - Vacancy

- Philips Research
  - ir. J. Huisken
  - AIO vacancy
- Usergroup
  - ir. J. Huisken (Philips Research)
  - ir. H. Kip (Nedap N.V.)
  - dr. ir. G. Heijenk (Ericsson EMN)
  - ir. J. Kruys (Lucent WCND)
Why energy-efficient reconfigurable Systems?
Sample scenario: visiting Las Vegas

- What could a future hand-held device do for you?
  - Purchase tickets (E-commerce)
  - Guides you through the city (GPS, ....)
  - Gives additional local information on a point of interest (Bluetooth, WirelessLAN)
    - sound fragment / video clip / animation
    - user determines the amount of detail using his preferences
  - Receive e-mail, phone calls (?), voice-mail (GSM / UMTS)
  - Make reservations for your diner (WAP)
  - Take pictures/ video clips (Microdrive)
  - Listening to music of Händel (MP3)
  - store your power-point presentation (files)
Typical luggage of today's traveler
or “a Swiss army knife of computing”...
In Chameleon we concentrate on three issues

- Future handhelds have multimedia functionality
  - small user interface: pen, voice, gesture, ..
  - many standards (no space for a chip for every standard)
  - real-time processing
  - long execution time (listening to music, ..)
- They work in a dynamic environment
  - Environment and (downloadable) applications are dynamic
  - quality changes from place to place, high error rate, ...
  - hybrid networking: DECT, GSM, UMTS, Wireless LAN, Bluetooth, ....
- They have to be energy-efficient
  - do the utmost with the battery energy
Challenge

Design a battery powered personal mobile computing device that has multimedia functionality and can operate in a dynamic environment.
Focus

- To focus the research we have decided to use examples of base band processing for 3G wireless networking

- Why?
  - Lot of processing power needed
  - Energy is an important issue there
  - Adaptivity is needed to tackle the dynamics of wireless environment
  - Lots of open research problems
  - UMTS is (too?) hot

- What have we done / are we working on
  - Turbo decoding / RAKE receiver
  - QoS modeling
  - Energy efficient TCP
  - FPFA architecture definition
Digital Baseband algorithm complexity

384 kbps UMTS receiver

- Digital Filters (RRC, Channelization, ..) \( \sim 3600 \) MIPS
- Searcher (frame, slot, delay path, ..) \( \sim 1500 \)
- RAKE receiver \( \sim 650 \)
- Maximal Ratio Combining (MRC) \( \sim 24 \)
- Channel Estimation \( \sim 12 \)
- Turbo decoding \( \sim 52 \)

Total \( \sim 5838 \) MIPS

Source: Jan Rabaey Berkeley 1999
Paul Heysters

vacancy

Lodewijk Smit

C++

DFG

FPFA

compute intensive kernels

Graph mapping

Processor control

Runtime decision

Processor

FPFA configurations

vacancy

Processor
Prototyping hardware

- Photos
- Block diagrams
Testbed

- Together with Nallatech we designed a Dime module (creditcard sized testbed) with:
  - StrongARM 1110
  - Xilinx Virtex 1000 FPGA
  - Flash memory for booting
  - 2 times 16Mx32 SDRAM
- 4 Dime modules on one PCI board
- We will port Linux to this platform
- We will port FPFA prototype on this platform
- Testbed can be used for all kind of embedded systems experiments
Nallatech

PCI bus

DI ME modules

Ballynuey 2
Ballynuey 2

Xilinx Virtex

2 x 2 Mb of ZBT SSRAM
BallyARM

Gen. Purpose I/O

IDE

32 Mb Flash

128 Mb SDRAM

Xilinx Virtex-E

LED

Serial I/O

StrongARM

DI ME conn.
BallyARM
Ballynuey 2 - overview

- JTAG configuration
- 3 user-programmable clocks

Diagram showing DIME, ZBT SSRAM, Virtex 800, PCI interface, and PCI conn. connections.
BallyARM – overview

Serial header
- RS-232
- Serial port
- USB
- Serial port

SDRAM

SDRAM

Flash

Virtex 1000E

Transceiver

StrongARM

IDE header

GPIO header

(2x) 32
(2x) 32
20
4x
2x
10
6

Serial port

USB
Heterogeneous computing

BallyARM

StrongARM

Virtex 1000E

Some FPGA

Ballynuey 2

CPU on host PC

Linux

Thread

Thread

Thread

Thread

Thread

Thread

Thread

Thread
Results


Results (cont.)

Questions?

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