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Power-efficiency, Performance, Programmability:

Architecture and Design in Bristol

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# Bristol microelectronics industry

STMicroelectronics: consumer - DVD  
Infineon: automotive  
Broadcom: communications - DSL  
Picochip: high performance DSP - base-stations  
Elixent: configurable logic  
Quadrics: high speed interconnect  
Clearspeed: low-cost supercomputing  
Icera: low-power wireless  
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# Bristol Computer Science

Collaboration with industry

- microelectronics design companies
- computer companies including Hewlett Packard
- animation and games design companies

Our current research includes

- Architecture, Design and Verification
- Mobile and Wearable computing, Digital Media
- Machine Learning and Data Mining
- Cryptography and Security, Quantum Computing

You can find more information at [www.cs.bris.ac.uk](http://www.cs.bris.ac.uk).

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# Mobile and wearable computing

New technologies - and how they can be used

Many collaborators including universities and industry

Trials involve novel content and many mobile users

Technologies include

- Wireless communications
- Location systems - GPS, ultrasound
- Accelerometers, gyroscopes and compasses

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# Soundscapes

With headphones, location and orientation information

- we can position a sound in space

The sounds to the ears are continually adjusted

- so that the sound appears to stay in the same place

We can cover an area with a collection of sounds

- a *soundscape*.

We have developed technology to support soundscapes

- and an authoring package to create them

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# Mobile computing

We are currently planning new projects

Mobile vision - tracking and object recognition

Interaction between mobile computing and ubiquitous computing

- aim to carry as little as possible on the person
- rely on computers throughout the environment

Challenges and opportunities for electronic design

- power-efficient processing and communications
- integrated sensors

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# Computing without power

Minimising power use in ubiquitous and mobile systems

- process technology
- circuit design or logic design
- ‘low-power’ modes of operation

Our work focuses on architectural techniques

- efficiency of program and data representation,
- use of physical resources - registers, caches, execution units
- event-driven systems

Some of these systems will use multiple processors

- but they will be switched off most of the time

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# Single-chip Supercomputers

We can fit a lot of processors on the same chip!

## Picoarray

- 150 million transistors
- 460 general purpose processors with DSP instructions
- on-chip network using time-division multiplexing
- 200 billion instructions/second

## Key issues for these architectures

- maximise the power-efficiency of the processors
- minimise communication overheads between them
- event-driven processing and communications

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# Co-design

More use of FPGAs with embedded processors

But problems remain in architecture and tools

- difficult to move functions between hardware and software
- narrow interface between processor and hardware

Our work in this area addresses both aspects

- express designs in terms of concurrent programs
- provide multiple paths between processor and hardware

Recent evaluations using EEMBC benchmarks are promising

- we are now interested in industrial collaboration

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# Security and Cryptography

We also work on cryptography

- elliptic curve cryptography for mobile devices

Architecture and software work to

- find efficient low-power implementation techniques
- provide defence against side-channel attacks

Security is a major issue in mobile and ubiquitous systems

New project on secure, low power, low-speed communications

- we'd welcome collaborators

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# Verification

Early work on formal verification of microprocessor designs was done in Bristol in the 1980s

Research on verification must involve industry collaboration

- it's important to address real problems

Recent projects

- formal design techniques for processor pipelines
- automatic generation of test programs for microprocessors

Verification has become a major issue in design

- we look forward to more collaborations

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# Summary

Bristol has a concentration of expertise in microprocessor design

In the University, we aim to support microprocessor design by

- research projects
- educating students

We are interested in

- forming collaborations based on our research
- discussing potential new research areas