Speckled Computing
(www.specknet.org)

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Outline

• What are Specks, Specknets and Speckled Computing?
• Features of selected applications in Homeland Security
• Research Issues for solutions using specknets
“To realise programmable semiconductor specks which can sense, compute, and network wirelessly.”

- Specks communicate **wirelessly** over a few cms
- Size of a matchstick head (5X5X5mm) with **limited power**
- Specks bought by the weight: yellow specks - temperature sensor, black specks - pressure sensor
- Specks are assumed to be **non-static and unreliable**
Specknets and Speckled Computing

- Thousands of specks collaborate as dense programmable network – Specknet
- Sensory data processed collaboratively, and information extracted *in situ* – fine-grained distributed computation
- Encapsulation of sensing, processing and wireless networking in a single chip

Enabler technology for truly ubiquitous computing

Speckled Computing looks beyond sensor networks
Status

- Funded by SHEFC/EPSRC (equivalent of the NSF in the US) – US$ 9.22 Million 2003-09 for “blue skies” research
- 25 researchers (rising to 40 in 2006) – Computer scientists, electronic engineers, electrochemists, and physicists from 5 universities
- Target applications in security, health, tangible interfaces
- Industrial affiliate programme and research partnership schemes
Multidisciplinary consortium

Programmable Networks

Radio

Photonics

Solar Cells

Batteries

Digital Signal Processing

Demonstrators

Distributed Computing

Processor
Categories of selected applications in security

- Control intrusion in area with sensor nodes
  - Co-operative targets tagged with smart tags for building, airport security
  - Non co-operative targets: CBRE sensors – chemical, biological, radiological and explosive

- Disaster prevention and management
  - Forest fire detection
  - Monitor dissipation of chemical clouds
  - Communication infrastructure in disaster zone
  - Sensor network assisted Medical Triage after a disaster
Common features of security applications

• Mobile, ad-hoc wireless networks
• Limited communication range (tens of cm to a few meters)
• Heterogeneous nodes with different sensors with should interoperate
• Adaptive network – nodes may be lost due to attrition in a hostile environment, or nodes may be added to maintain a given QoS
• Scalability – 100s, if not 1000s of nodes
• Autonomous nodes are resource constrained in terms of energy, memory and processing speed.
• Location awareness using non-GPS solutions
Specknets - Looking Beyond Traditional Sensor Networks

- Program-centric (specknets) v/s data-centric (sensor networks)
- Sparse (sensor networks) v/s Dense networks (specknets) – short range comms
- Mobility model – nodes in sensor networks are static. In contrast, specks are mobile
- Data transfer model – Source nodes transfer to sink nodes (sensor networks) v/s peer-to-peer model in specknets
- Control model - Decentralised, leaderless
The SpeckSim Simulator

Speckled Computing
ProSpeckz II and III

Rapid development platforms for research in networking and programming environments, and development of applications in Speckled Computing
5CubeOTS

- Radio and MCU dies wirebonded with discrete components on a thin PCB.
- Batteries and external aerial shown
**PerSpeckz64**

- An 8X8 array of Prospeckz 2 devices

- Platform to test and evaluate MAC layer, networking protocols and programming environments, especially scalability issues
- Validate the simulation results
Conclusions

• A unique, multidisciplinary consortium of computer scientists, electronic engineers, electro-chemists and physicists to provide an integrated technology push

• Guaranteed funding until 2010 – stable collaboration partner

• A long-term vision and a roadmap to reach the goals

• Partners in Homeland Security applications

Contact dka@inf.ed.ac.uk for more information
Research Focus

- Architectures and realisation of 5Cube specks which are constrained by size, memory, speed and power
- Networking protocols for hubless, transient network of specks
- Programming environments for specknets
- Novel thin film battery technology
- Radio and antenna designs
- Decentralised leaderless distributed algorithms for clustering and location determination