



Research Consortium in Speckled Computing

Speckled Computing

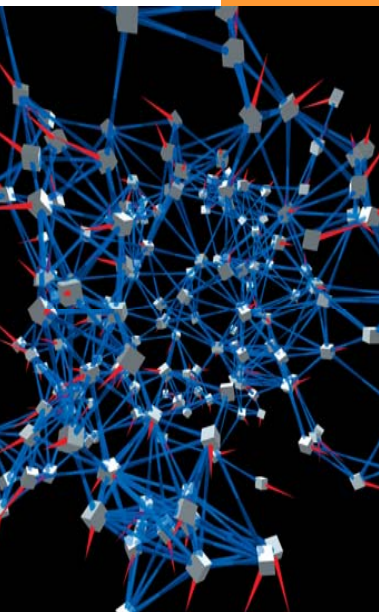
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The future Internet



- The Internet is 1 Billion strong today
- The future IPv6 will support > 35 Trillion separate subnetworks
- Each sub-network, in turn, will connect millions of devices

**We are moving towards a world of connectedness
between people and “smart” objects**

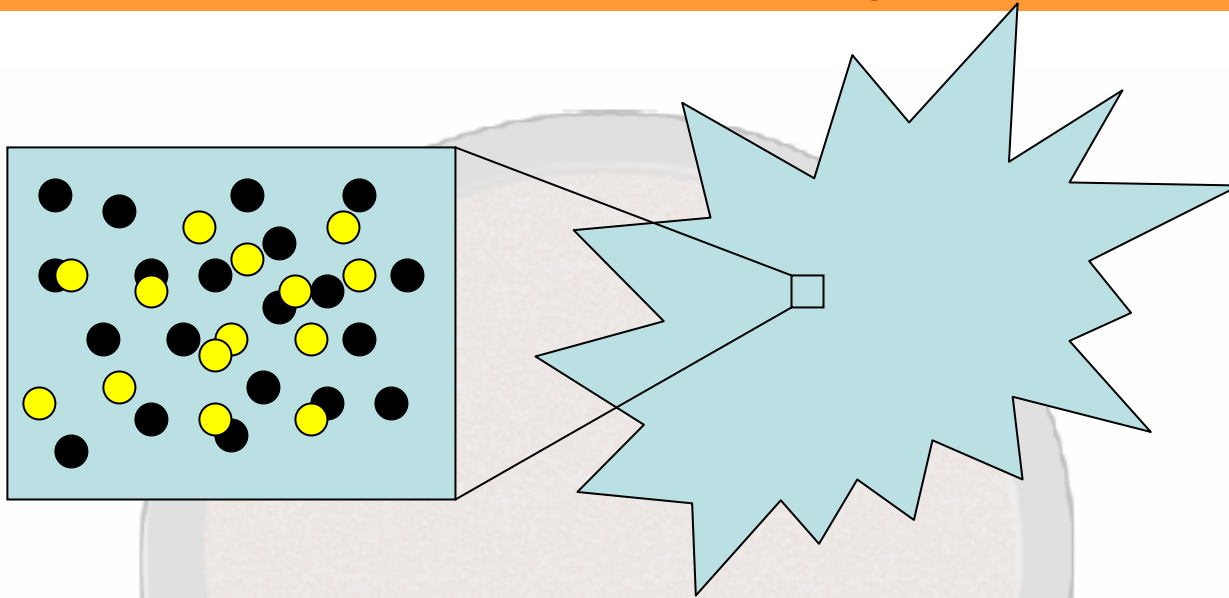
i.e. CONTEXT-SENSITIVE and LOCATION-AWARE



- Endow everyday objects with sensing, processing and wireless networking capabilities
- Link the sensory data from the physical world to the virtual world of networks of computers and the Internet

Specks bridge the physical and virtual worlds

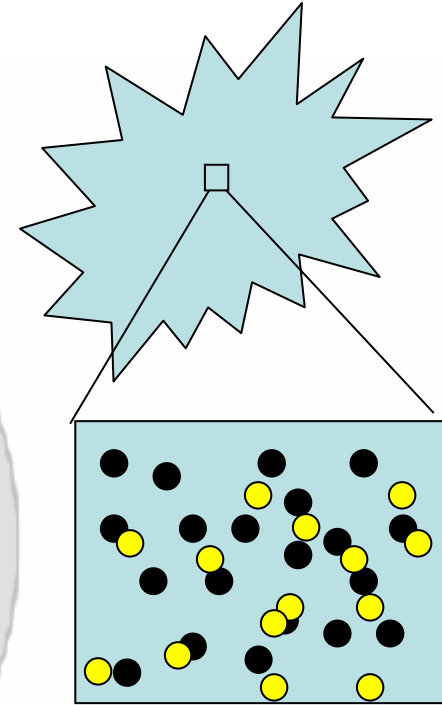
"Specks are programmable semiconductor devices which can sense, compute, and network wirelessly."



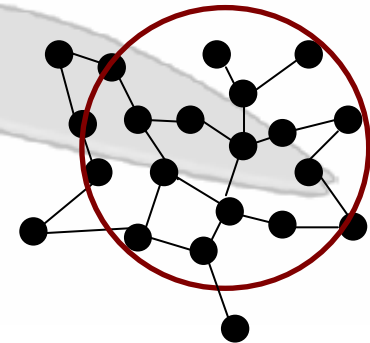
- Specks communicate **wirelessly** over a few cms
- Size of a matchstick head (5X5X5mm) with **limited power**
- Specks bought by the weight: yellow specks - temperature sensor,
black specks - pressure sensor
- Specks are assumed to be **non-static** and **unreliable**

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

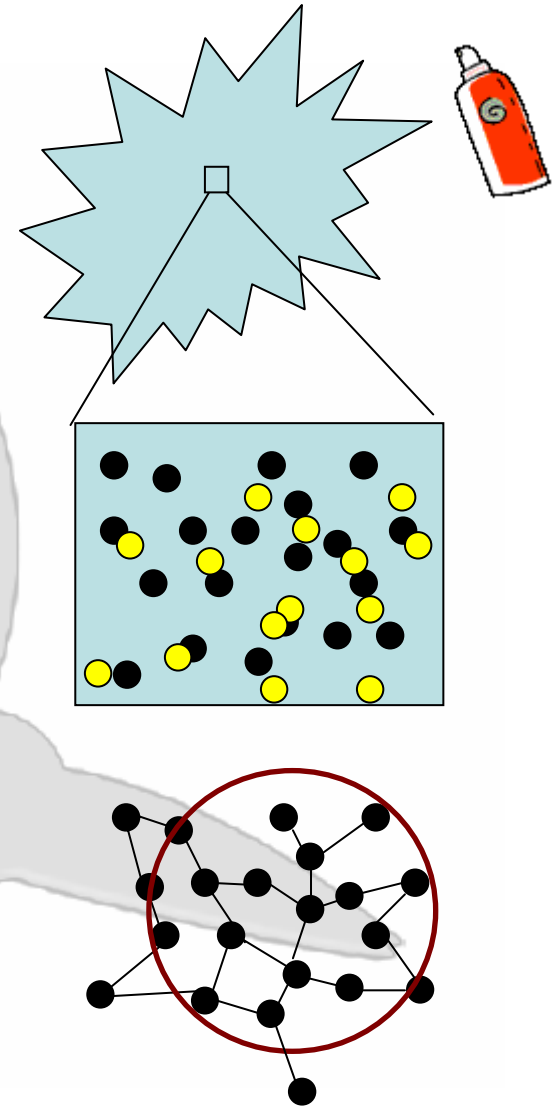


Enabler technology for ubiquitous computing

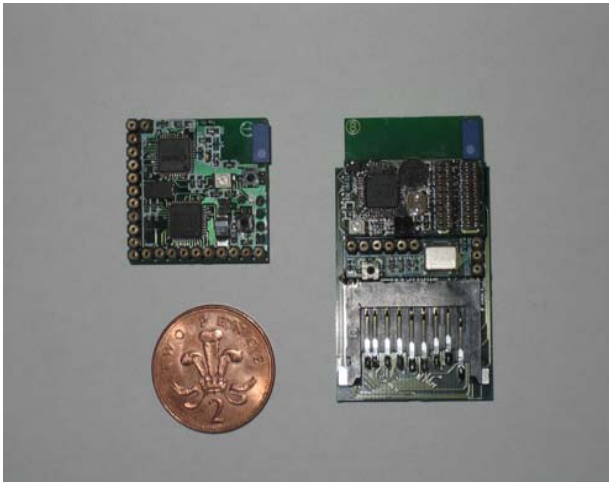


Specknets - Looking Beyond Traditional Sensor Networks

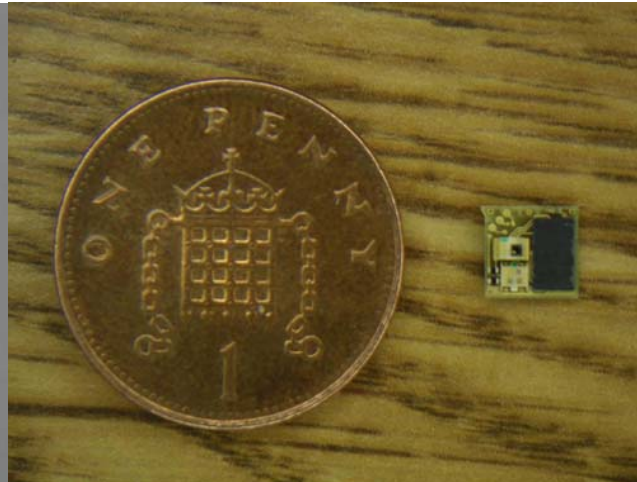
- Program-centric (specknets) v/s data-centric (sensor networks)
- Sparse (sensor networks) v/s Dense networks (specknets) – short range comms
- Mobility model – nodes in sensor networks are static. In contrast, specks are mobile
- Data transfer model – Source nodes transfer to sink nodes (sensor networks)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



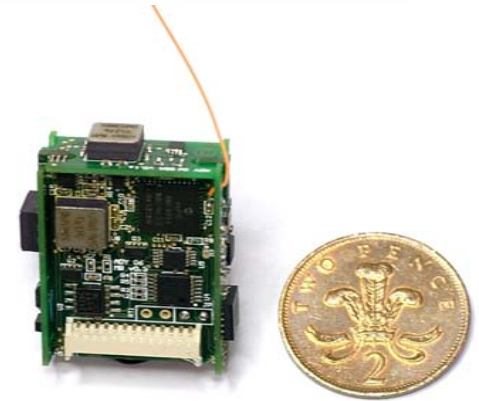
Different Classes of Specks



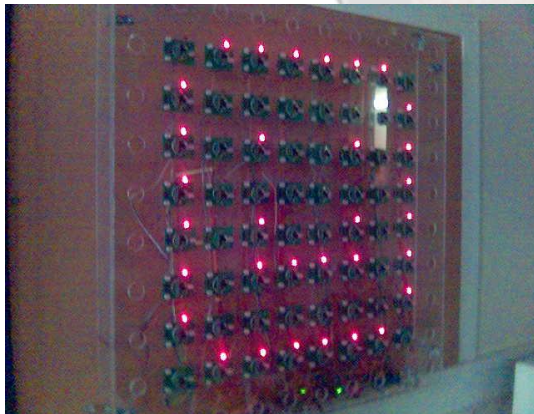
8-bit (med) client
32-bit (large) microserver



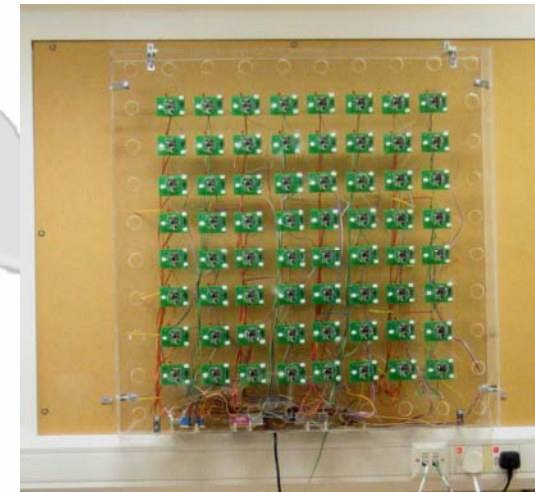
8-bit 5mm cube client



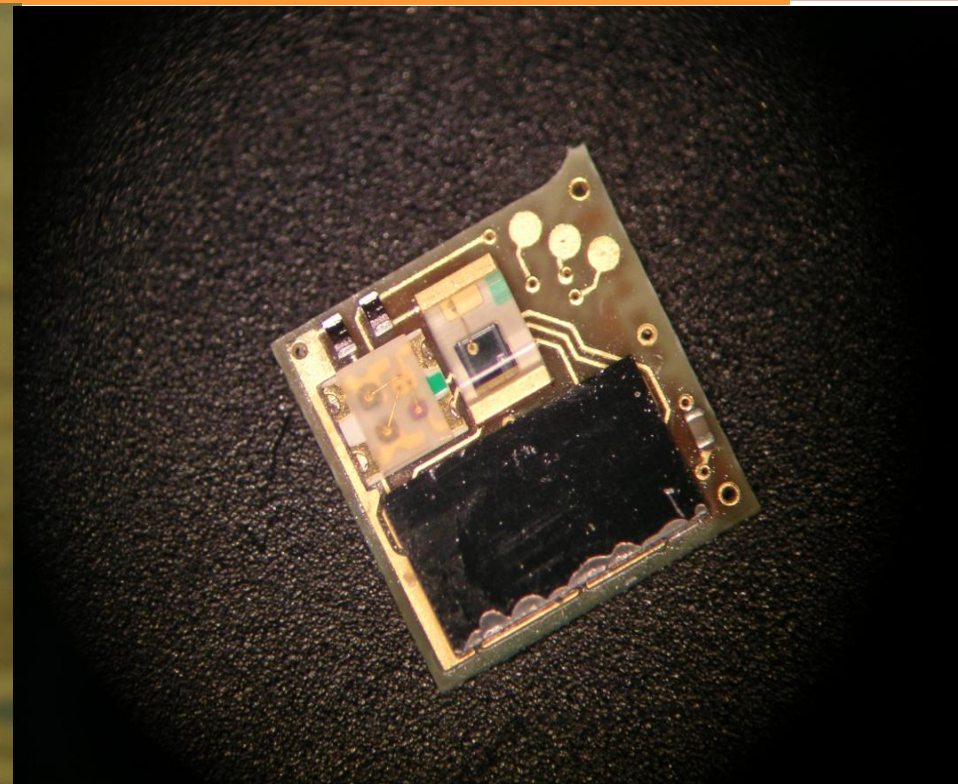
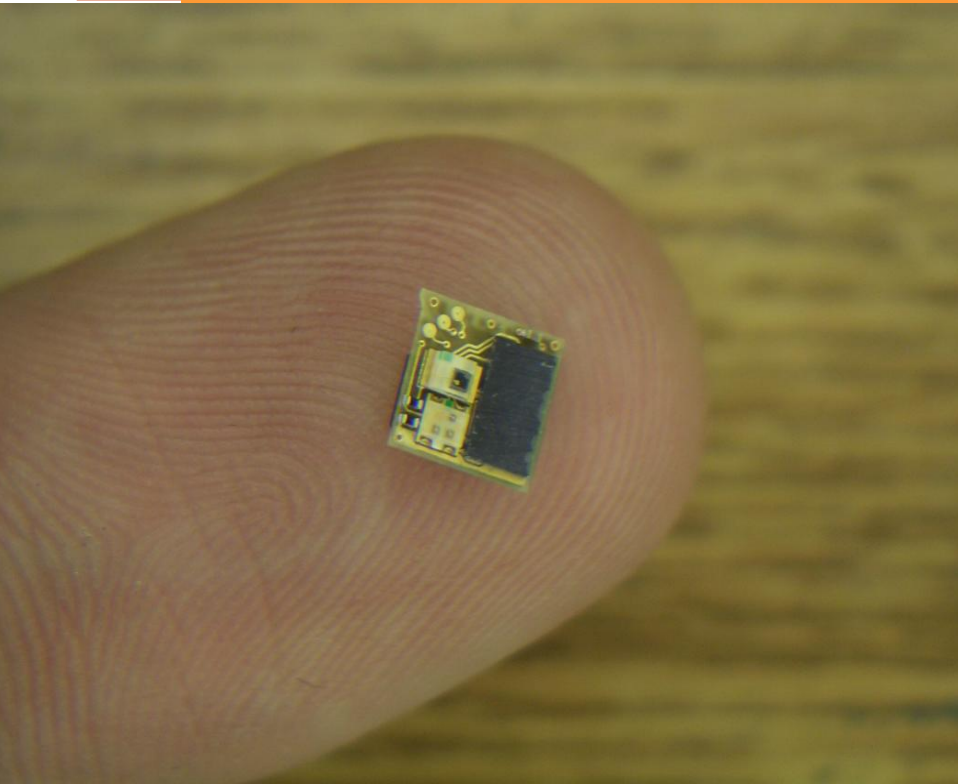
Orient2 Speck



64 node testbed accessible over the internet



5Cube0TS – When size matters



**Sensor, Processor, Wireless Networking and Battery
in 5X5X5mm**

Speckled Computing



- New models of unencumbered interaction with the digital world, in which the physical world is the primary site of interaction
- Computation and Collaboration at the edges to extract information locally and effect actuation
- Specknet on the person, say a dancer
 - Sensory data such as RPM during rotation (sensory data))
 - Track the movement of the limbs (sensing, collaboration)
 - A robot mimics the actions of the dancer (sensing, collaboration and actuation)
- This information can be accessed and manipulated remotely over the internet

Specknet – the last millimeter of the Internet

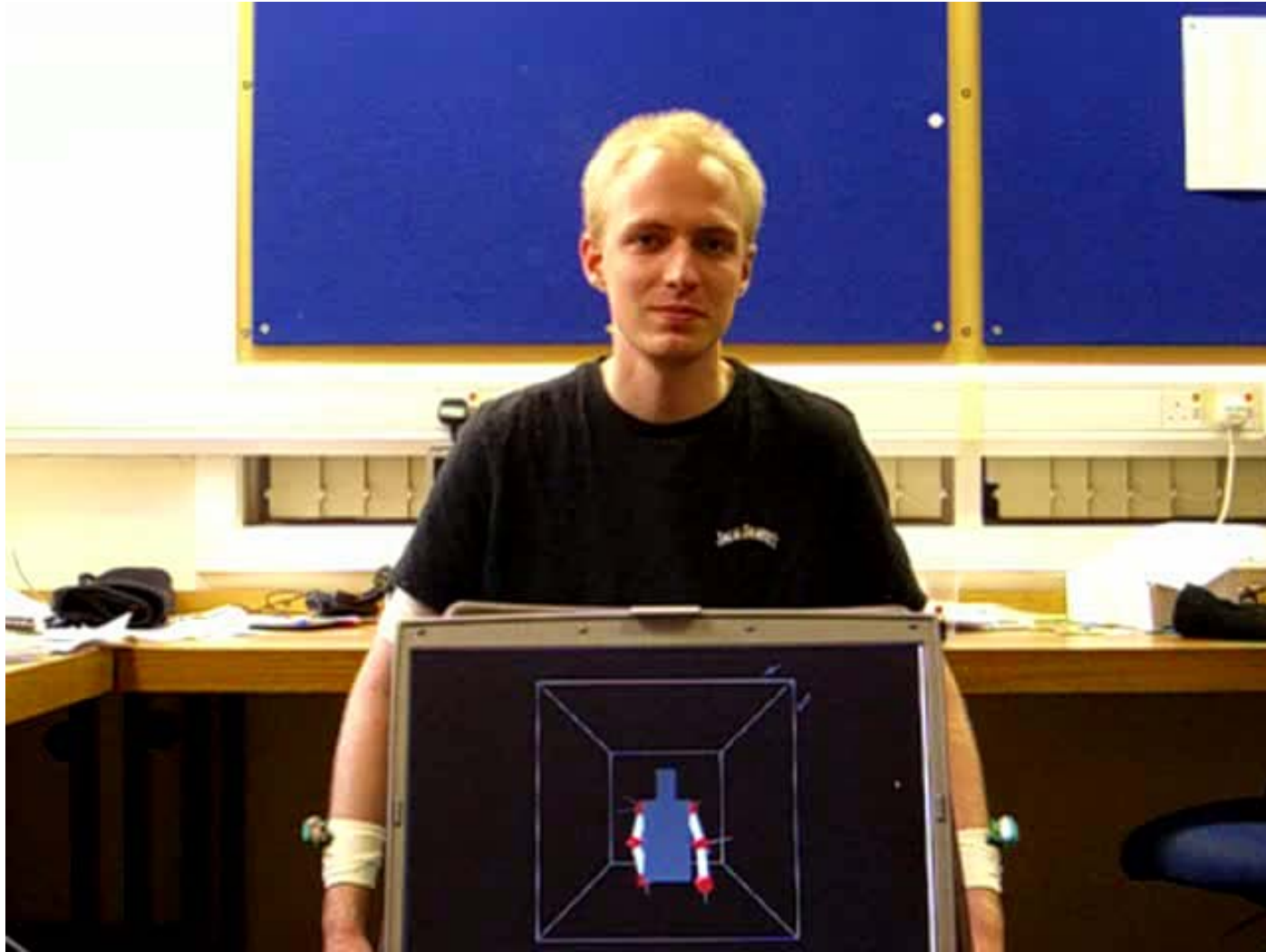
Real-time Monitoring of Breakdancers using Specks

edinburgh international
science festival 

April 2006



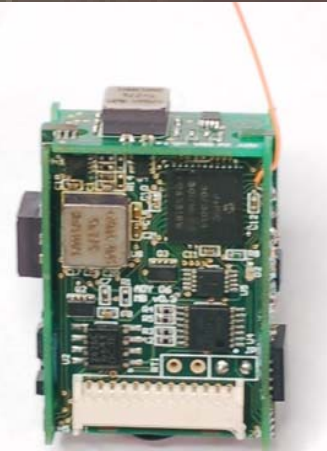
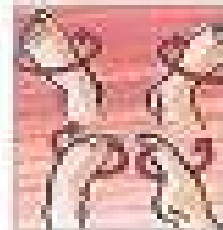
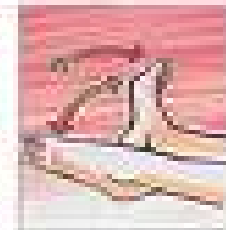
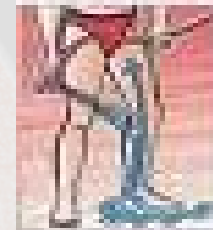
Real-time motion tracking using Specknets



Effect a robot wirelessly to mimic the movements of the human

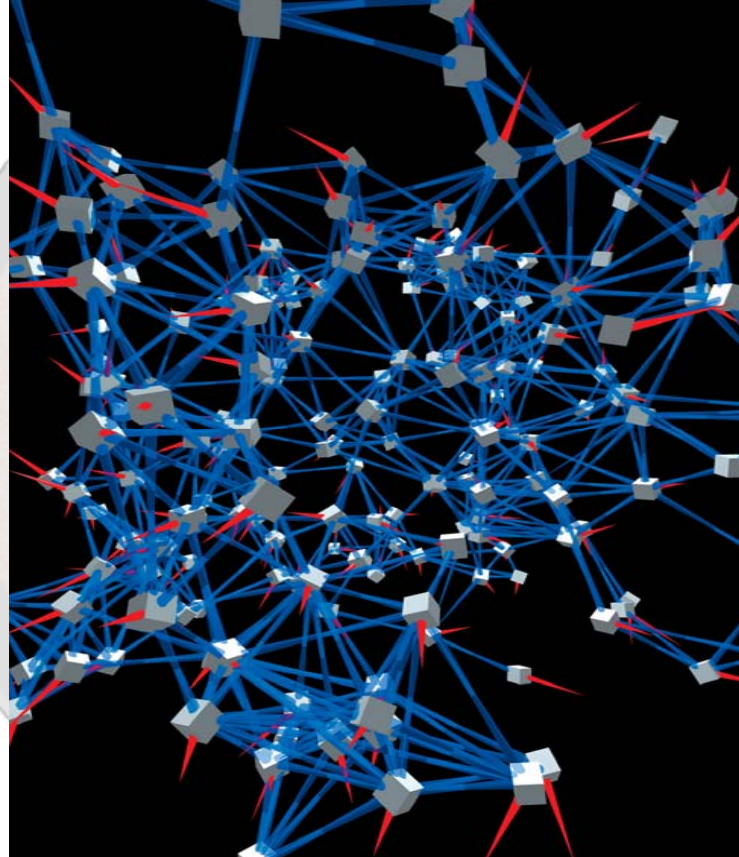


Orient2 Specknet – Application



Multidisciplinary Expertise

Programmable Networks



Radio

Photonics

Solar Cells

Batteries

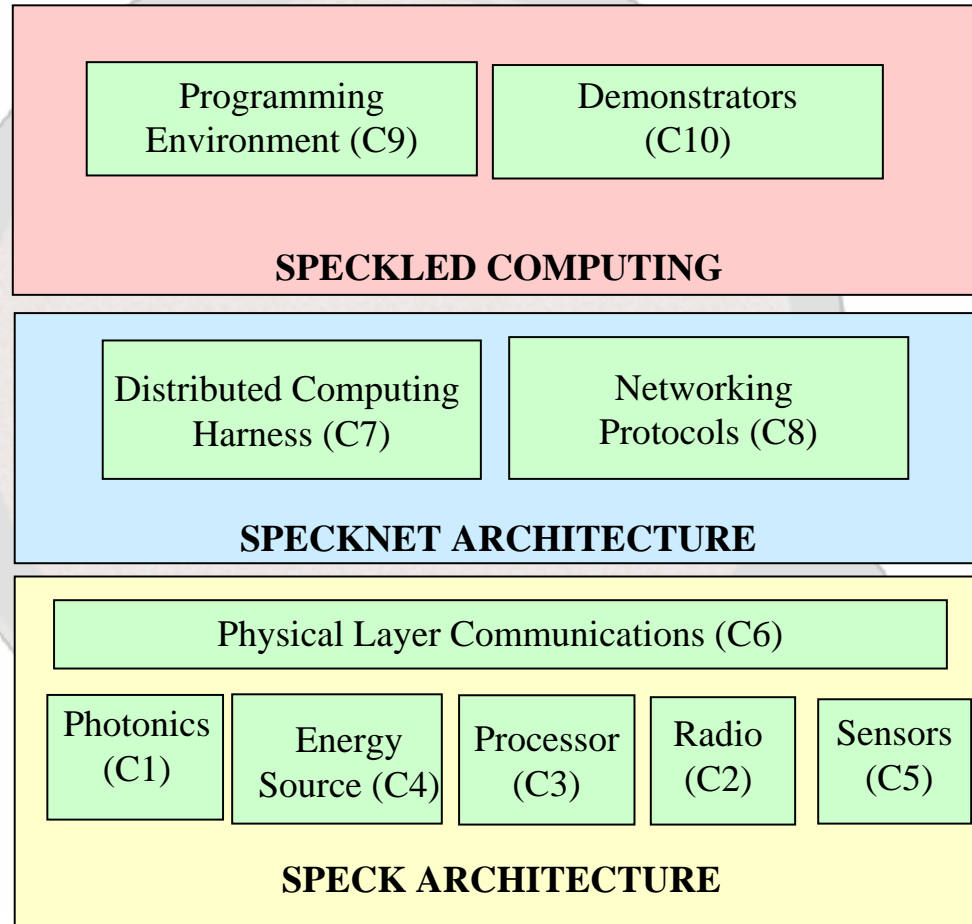
Demonstrators

**Distributed
Computing**

Processor

Digital Signal Processing

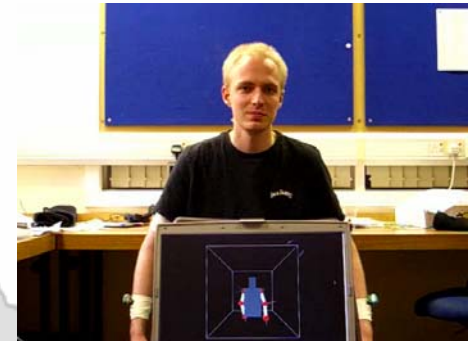
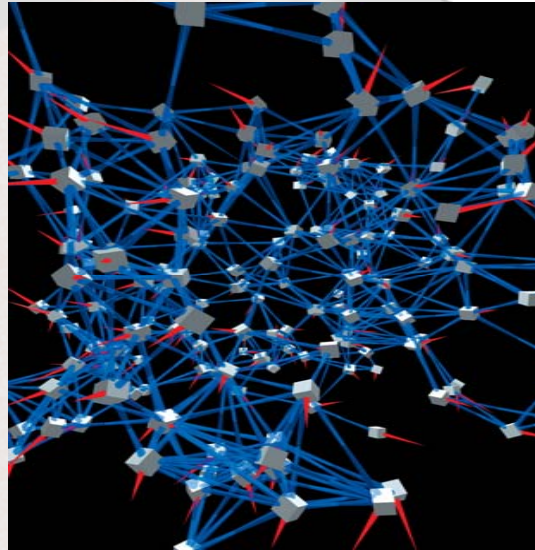
Collaborative Technology Push



Consortium Status

- SHEFC Strategic Research Development grant (2003-07)
£1.3 Million (\$ 2.34 M) - 6 RAs, 13 PhD students
- EPSRC Basic Technology grant (2005 – 10)
£3.8 M (\$ 6.84 M) - 9 RAs, 4 Phd students, 6 support staff
- Research Advisory Board
- Annual Workshop in September (6-7 Sept. 2006)

Engagement with End-users



Speckled Computing

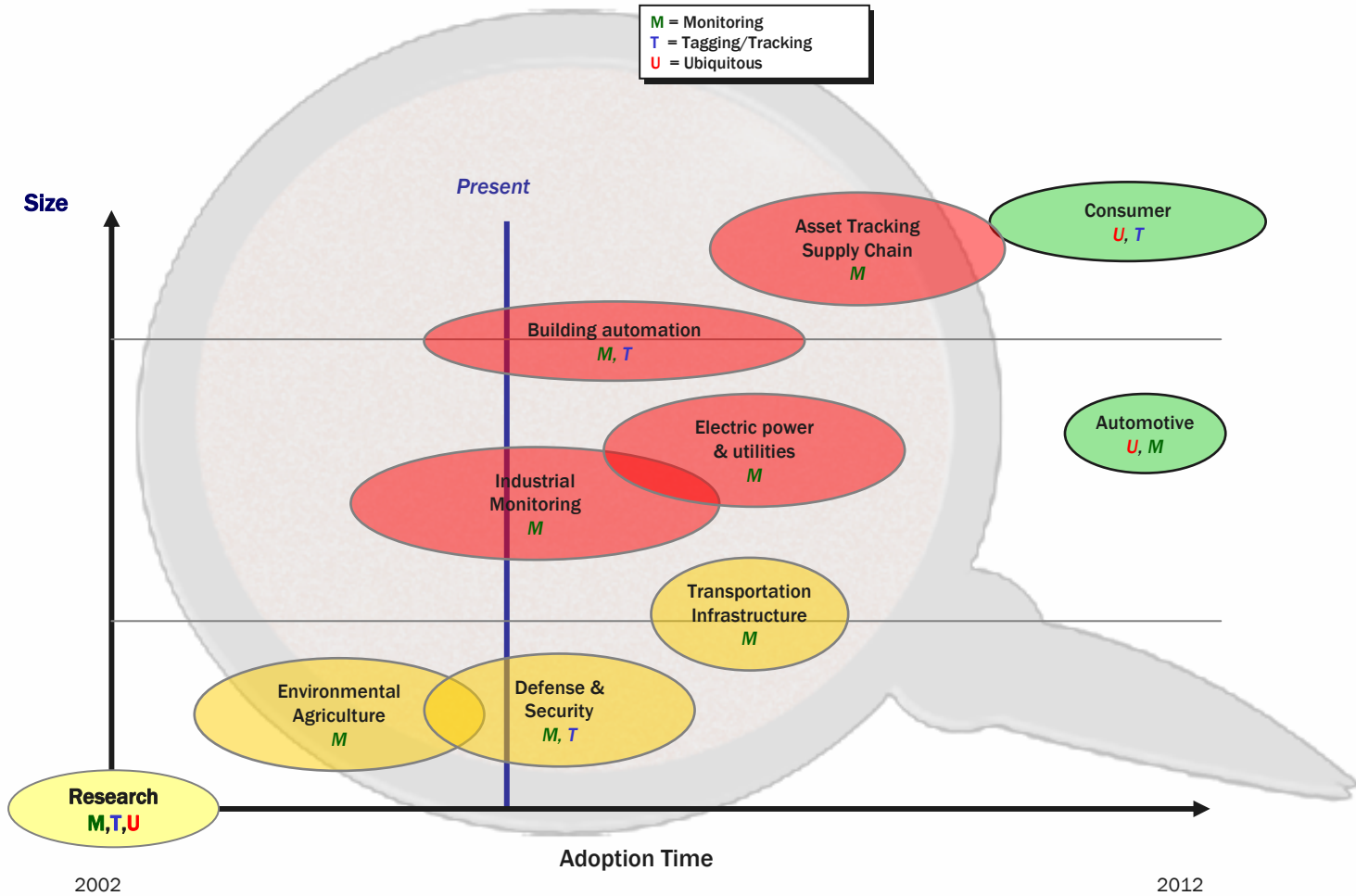
Application Areas

- Asset/People Tracking
- Environmental and Industrial Monitoring
- Health and Safety
- Security
- Games
- Tangible Interfaces

Research Topics – the bigger picture

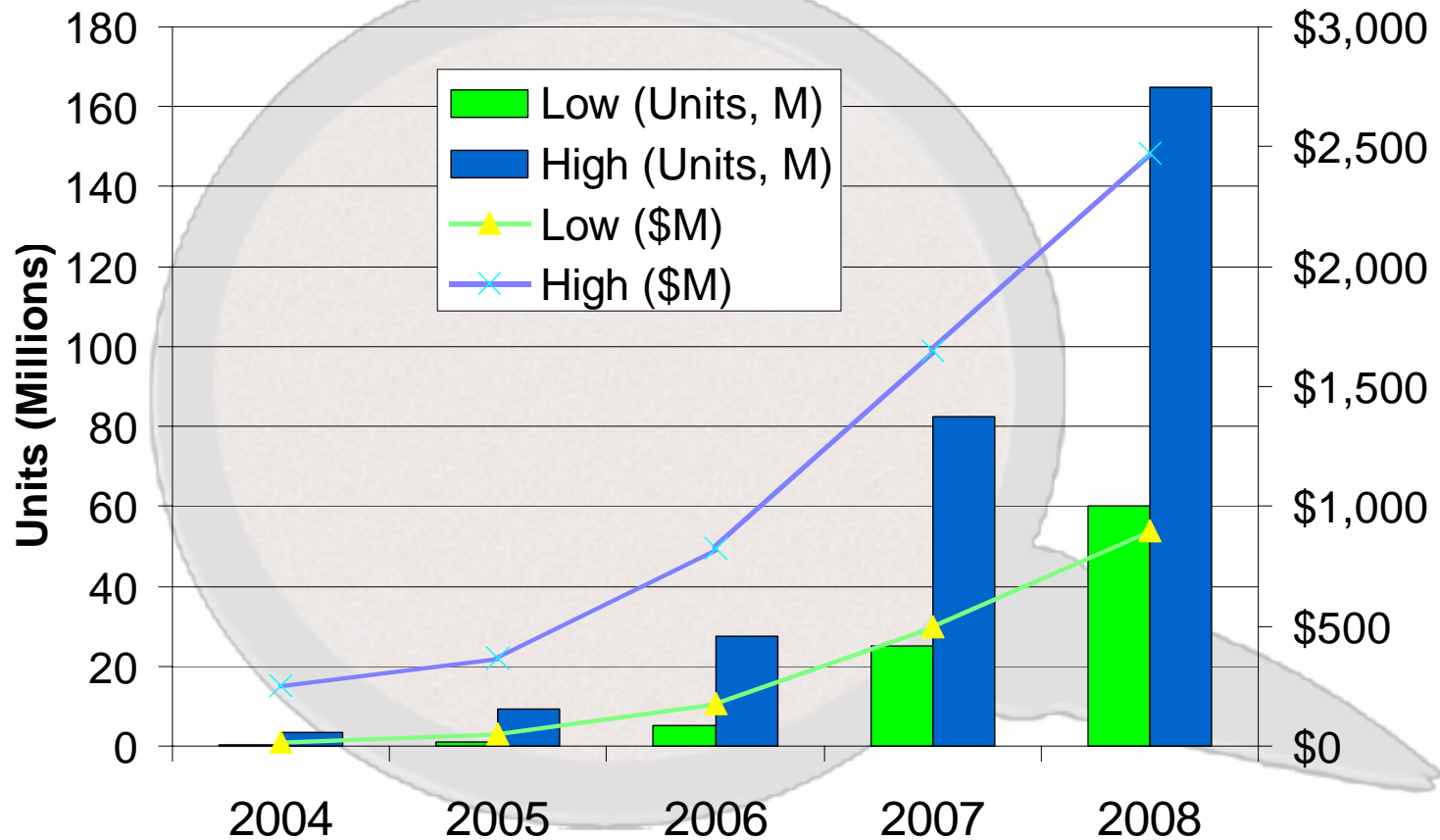
- Speck architecture and System Level Integration of miniature 5Cube specks
- Energy sources: battery, renewable sources
- Resource-constrained network services for hubless, transient network of specks
- Programming environments for specknets
- Decentralised leaderless distributed algorithms for clustering, location determination, motion tracking
- HCI Issues and Applications development

Projection of relative market sizes and adoption times



Courtesy Crossbow Technologies

Market Size in WSN



Courtesy Crossbow Technologies

Capabilities

- Power-aware Networking Protocols and Medium Access Control layer for Ad-hoc, Resource-constrained, mobile Mesh-connected networks
- Bespoke Radio and Physical layer design
- Software architectures and algorithms for distributed peer-to-peer mesh networks
- Turnkey application development

Conclusions

- A multidisciplinary consortium of computer scientists, electronic engineers, electro-chemists and physicists to provide an integrated technology push
- Guaranteed funding until 2010 – stable collaboration partner
- Invite industrial partners to collaborate on proof-of-concept projects

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

