Ubiquitous Computing... infrastructure....
.. last time I go anywhere without a laptop ....and a gigabyte of powerpoint...
Ubiquitous middleware

What's the research problem

- Scale
- Reliability
- Heterogeneity
- Power
- Availability
- Robustness
- Mobility

- Disconnection
- Security and privacy
- Device or software
- Sensors
- Interfaces and interactions
Three Challenges of Ubiquitous Middleware

- Developing middleware in ubiquitous computing environments
- How the infrastructure presents itself to those who inhabit ubiquitous computing environments
- How the infrastructure is used and adapted and supports the evolution of those environments
Developing Ubiquitous Middleware

- The key issue is that ubiquitous computing needs to exist in the everyday world
- It is situated in this world by the people who inhabit the world
- It needs to be understood, manipulated and altered by members of the real world
  - How do we make the infrastructure visible to allow it to be understood
  - How do we provide facilities to allow it to be changed.
Ubicomp and middleware

The difficulty for ubicomp is that the infrastructure research needs to take place within the context of use.

How do we focus on issues arising when infrastructures need to find a place within the real world alongside competing paradigms and approaches?
in the wild...

advanced laboratory prototypes

mature deployed technologies

experiences

EQUATOR
The infrastructure dilemma

The need for **real world use** to inform future infrastructure presents a dilemma – we need to outline infrastructural requirements *before* such a platform is available for use.

One way to do this is to deploy advanced research infrastructure before users in the form of **installations**.
Can You See Me Now?

- Online players chased across a virtual city by 3 runners on the actual city streets
- Staged in Sheffield, Rotterdam and Oldenburg
Seeing the infrastructure

• For ubiquitous computing the underlying infrastructure becomes something that is reasoned about

• Can you see me now
  – the runners interacted with the infrastructure.
    • They exploited wavelan shadows
    • They exploited good areas of GPS coverage
  – The had to deal with the uncertainty of position
    • The made judgement based on approximates

• But the infrastructure does not show these things to let them do this
Present the infrastructure

- In addition to handling the host of other systems issues ..
- ..... how is the infrastructure made available to users
- Need to move beyond the traditional design approach of strict transparency
  - What are the mechanisms for revealing the workings of the infrastructure ..
Revealing the underlying seams

- So they are understood by the inhabitants
- In order that the effects on their interaction can be reasoned about

An overlaid map of 802.11
Our world is open to continual change

Our world is always changing and a large number of different people are involved with Inhabitants having a central role.

However, the presumption is that for distributed infrastructures systems engineers undertake
Need to reduce the cost of change ...

Shift in focus on target users
from developer
through experience builder
towards inhabitant
Step 1.. from programming to content creation....

- Most Infrastructure work is aimed at ease of programming
- Content creation involves considerable shared effort between designers and programmers
- Need to empower designers to build their own distributed mixed reality experiences
  - c.f. Distributed Phidgets (Greenberg, 2001)/ EZIO

- Enable content creator and designers (and others) who have limited programming skills to build experiences
Approach

Use off the shelf components to build a prototype in the language of the content creators

- Uses *Director* as a design-interface
  - Unprincipled, but well accepted by designers
- Uses *Lightweight* sensors as inputs
  - At present Cyberjacket and Smart-Its
- Uses *Elvin* to route messages between components
Extending Director

• Sensors appear as cast members through ‘Xtra’
  – Bindery displays new sensor (uses XML database to find icon, default name, behaviour)
  – Designer can give the sensor a useful name
  – This name can be used in Director’s Lingo script
    on location x, y
    ...
    end
  – Binding is saved and remembered with the Director movie
Programming by Example

- Can be tiresome to work with locations or other sensors as numbers \(\text{if } x<10 \text{ and } y<10 \text{ then}\)
- Train the system \textit{by example}
- Paintings of Picasso, Rembrandt, van Gogh
- System asks you to go to each location (training)
- Optionally,
  - Can introduce empty space between classified areas
  - Or hysteresis to stabilise classifications
- Names can again be used in Director:
  on Picasso
  ...

\[\text{EQUATOR} \neq\]
Moving towards the inhabitant

• People do not describe themselves in terms of lingo
• What are the appropriate ways to represent the infrastructure and allow people to amend this
• Need to find a set of principles to allow people to change and describe their environment
• Need to find a way of reasoning about these changes to prevent catastrophe
research challenges

The biggest issue for me is that ubiquitous computing moves the middleware much closer to the users.

- Developing middleware “in the wild” that can be deployed and understood in practice
- Reaching into the infrastructure and deciding how it presents itself to support practical reasoning
- Supporting evolution and repurposing by significantly reducing the cost of creating ubiquitous environments
.. and open questions

- We all live in an incomplete and messy world.. because we can reason about it and modify it
- Our existing design principles are failing ubicomp .. because they embody a separation between those who build and those who inhabit
- How will we represent ubiquitous systems infrastructure and reason about them
  - For the systems developer
  - For the content creator
  - For those who will live in these ubiquitous computing environments.
- But how do wee prevent chaos..
  - What will be the systems theories of the future
  - How close will these be to the activities of users