

Outline

- *Next Century Challenges: Data-centric networking for invisible computing. The Portolano Project at the University of Washington* Mike Esler, Jeffrey Hightower, Tom Anderson and Gaetano Borriello. In Mobicom '99
- Satayanarayanan, M. Pervasive Computing: Vision and Challenges. IEEE Personal Computing. August, 2001. pp 10-17



Data-Centric Networking for Invisible Computing

- This paper presents some technical challenges for invisible computing
- Specifically:
 - User Interfaces
 - Distributed Services
 - Infrastructure



User Interface

- Multiple interface: How do we present information in multiple interfaces?
 - Do we present the same interface in all the devices (ala Windows CE approach)?
 - Do we present the interface customized for the device? (ala Palm approach)
- Invisible Interface: How do we make the interface vanish? How should the invisible interfaces work?

Distributed Services

- Agent based approach
 - Agent perform tasks on behalf of users
 - Agents exist beyond the user who initiated it
- Horizontal integration
 - Components horizontally integrated
- Service deployment
 - Service should be able to discover your resources and configure itself
 - Dynamic upgrading, hot-swapping of components
 - DVD players already do this when you play special movies. Is this good?



Infrastructure

- Resource Discovery
 - Local Service database (served based)?
 - ARP-style (broadcast) requests?
 - Data driven (the data runs code in the net to locate further resources)
 - Controlled replication
 - Reliability/fault tolerance
- Should the lookup provide name or object code (JAVA)?
 - In HW1, you provide hostname:port



Data-Centric Networking

- Data should marshal, authenticate, adapt and pay for services as it proceeds
 - E.g. I want to buy a camera
 - I send the data packet with my model preference, credit card number, shipping information etc in a data packet
 - Data packet visits internet stores, find the cheapest price for the model
 - Places an order and has it shipped to my address



Distributed Computing

- Data objects negotiate content type, move computation across the infra-structure to reach destination
- Intermittent Connectivity
 - When connectivity is lost, what happens to data packets?

Important Research Topics

- Intermitted Connectivity
 - How do we deal with network failures
- Power consumption
 - Power consumption is very important on devices that we carry all the time
- Application development and deployment
 - Development for invisible interfaces
- Service architectures and discovery
- Active networking
 - Code associated with data runs in the network



Pervasive Computing: Vision and Challenges

- No clear definition of ubiquitous computing now
- An environment saturated with **computing** and **communication** capability, gracefully **integrated with** human users.
- Pervasive Computing project:
 - Aura at CMU
 - Endeavour at UC Berkeley
 - Oxygen at MIT
 - Portalano at UW
 - AT & T Research in Cambridge, UK
 - IBM T. J. Watson Research Center

Source: Xiuzhen Cheng

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Pervasive Computing – *continued*

- Challenges or Research Thrusts:
 - Mobile Computing
 - Effective Use of Smart Spaces
 - Invisibility
 - Localized Scalability
 - Masking Uneven Conditioning
- Example Scenarios – **science fiction**
 - Jane's documents transmission
 - Fred's Presentation
- Hardware is available
 - Now but not 1991 ☺
- Software Technologies:
 - Location tracking
 - Face recognition
 - Speech recognition
 - Online calendars
- Why Science Fiction?
 - The whole is much greater than the sum of its parts

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Pervasive Computing – *continued*

- Both mobile and stationary hosts/displays
- Variety of applications – whatever you need
- Variety of media, both wired and wireless
- Lots of infrastructure – it's all around you
- Infrastructure is invisible
 - It helps us where we need help in the context in which we need help
 - We do not need to cater to it
- Coverage appropriate to the context
- Your personal information/applications go with you through the network

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Pervasive Computing – *continued*

- Augmented reality
 - Ability to query your environment
 - Ability to ask for non-intrusive guidance
- May include variety of wearable devices
- Interesting privacy and sociological questions
- Can we really build security that is equivalent but no stronger than what we are accustomed to currently?
 - This definition varies greatly across cultures/governments
- What is it really good for?
- How practical is it really?
- Is it a superset of mobile computing?

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