

Distributed Systems Support for Mobile and Pervasive Computing

Nigel Davies

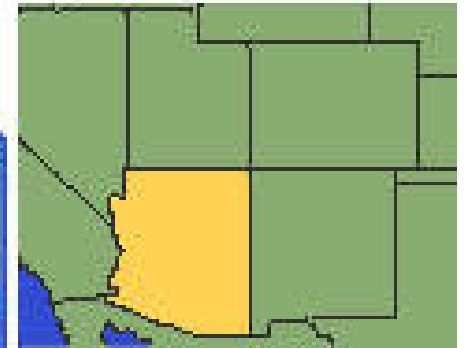
Computing Department, Lancaster University
Lancaster, England

&

Computer Science Department, University of Arizona
Tucson, AZ



Location, location, location



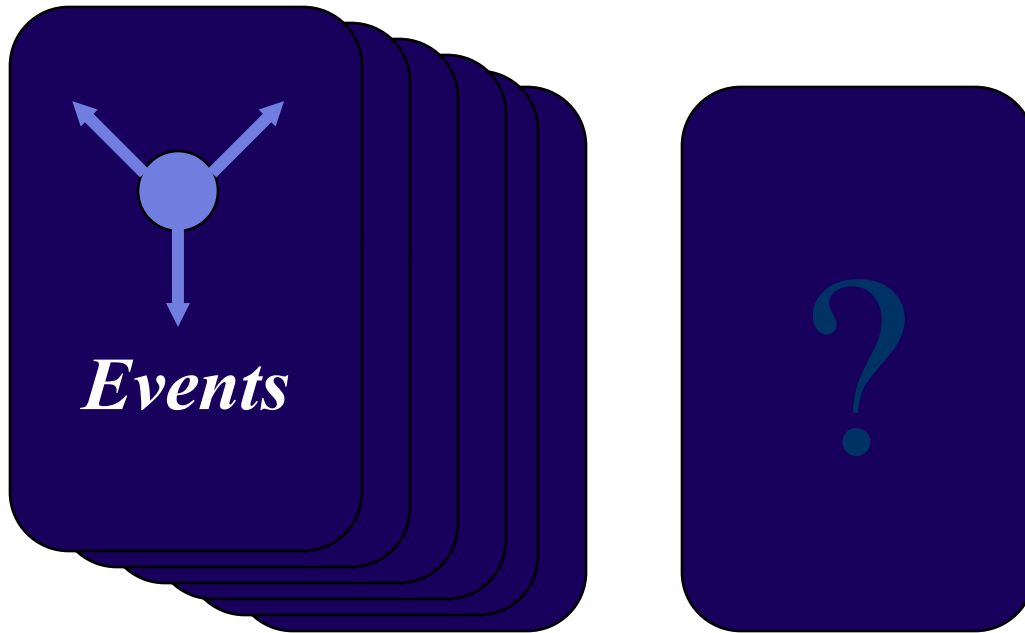
The Cast of Characters



Kindberg



The Possibilities

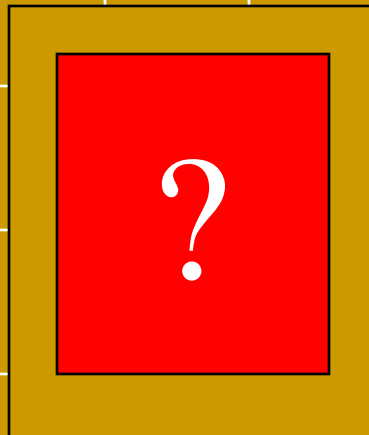


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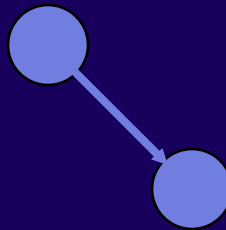
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The Early Years ... 1



Weiser



RPCs



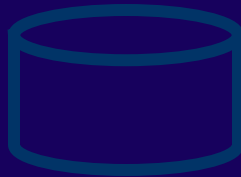
PARC



The Early Years ... 2



Satya



File Sys

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The Early Years ... 3

- ◆ The central theme was to try and hide the impact of mobility.
- ◆ Borrowed on notions of distribution transparency popular at the time (access, location, migration, replication, failure etc.)

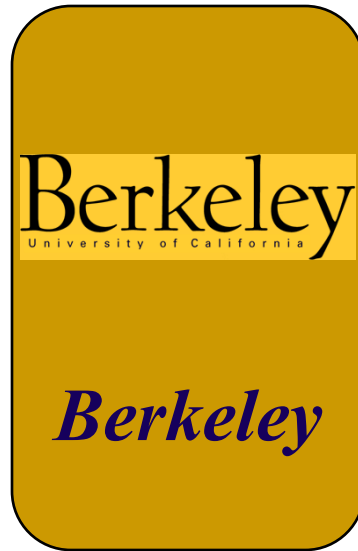
Applications

Mobility Support Layer

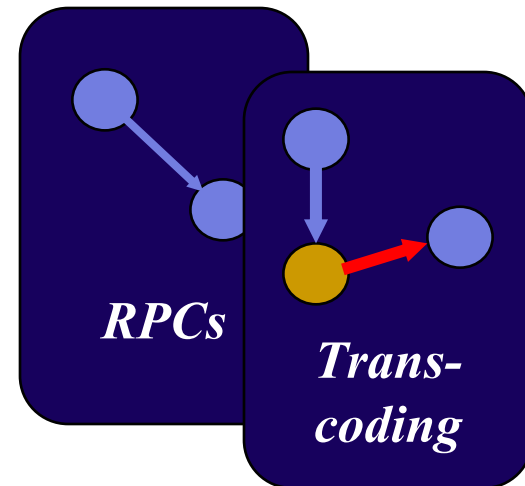
Underlying Systems



The Big Revelation



- ◆ Mobile Environments are characterized by change !



Adaptation

Freedom of Movement

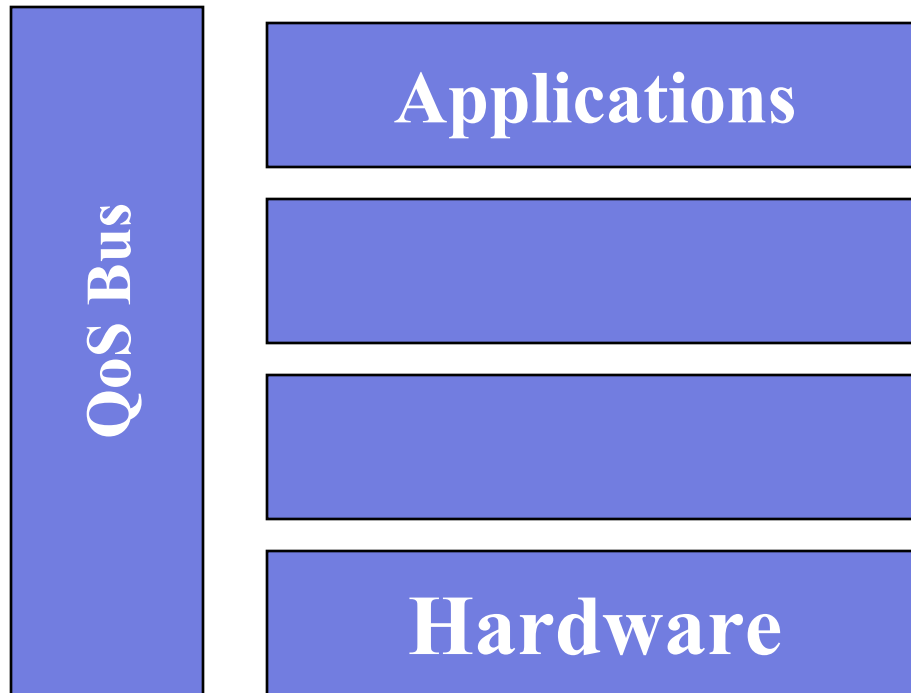


Throughput of Channel

- Disconnected
- Weakly Connected
- Fully Connected



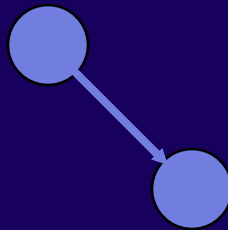
Systems Support



The Age of Adaptation ... 1



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Case Study : MOST

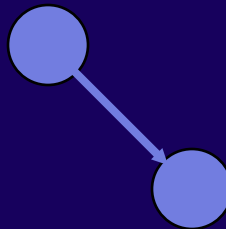
- ◆ MOST = Mobile Open Systems Technologies
- ◆ Designed to support field engineers in the power distribution industry
- ◆ Series of extensions to ANSAware – an ODP compliant (or nearly) platform developed by APM Ltd.
 - An “adaptive” RPC package with optional QoS API
 - An API that exposed communications QoS information to applications
 - Modified system services such as “traders”
- ◆ Suite of test applications



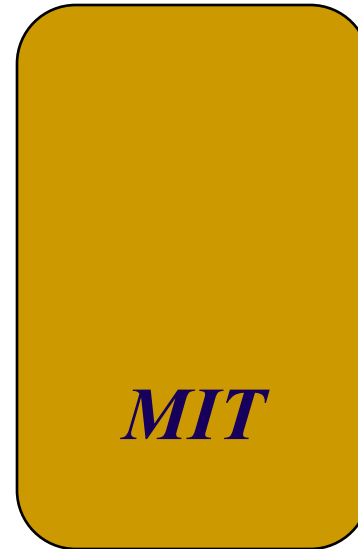
The Age of Adaptation ... 2



Joseph



RPCs



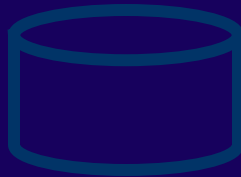
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The Age of Adaptation ... 3



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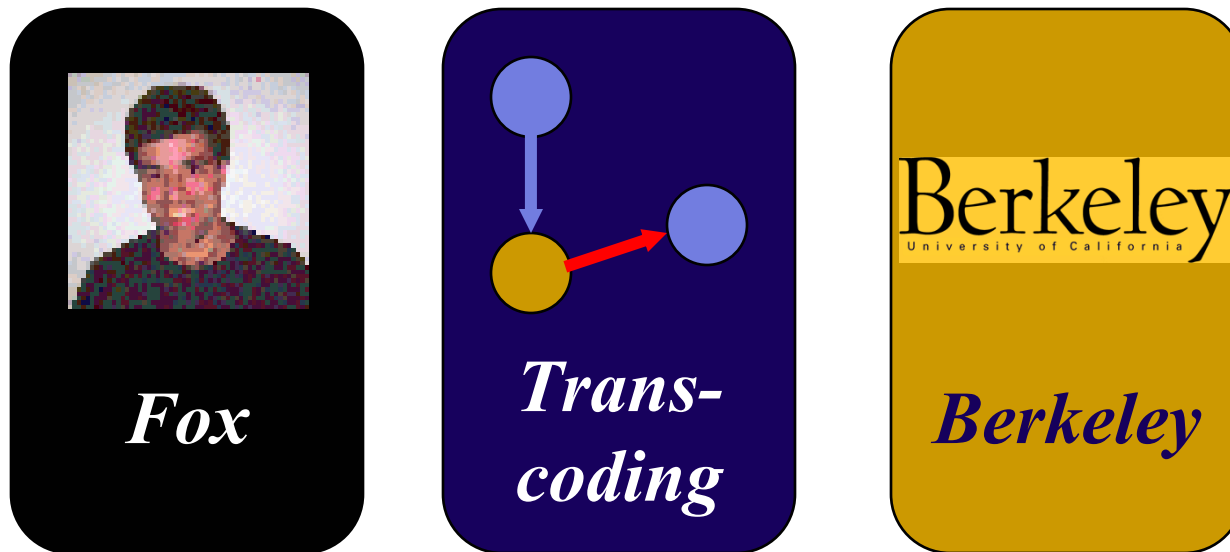
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The Web Becomes a Major Force



- ◆ TopGun project brings transcoding to the fore.

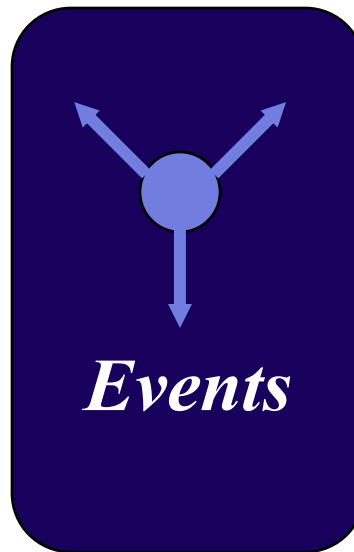
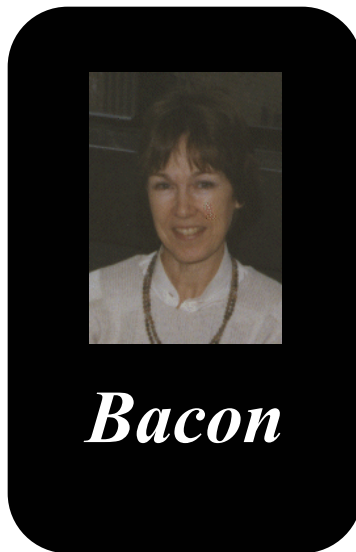


Evolution of Platforms

- ◆ Problems with RPCs:
 - Static bindings
 - Synchronous communications
 - Not well suited to multicast communications
- ◆ Solution:
 - Develop an asynch platform for mobile communications



Asynchronous Platforms for Mobile Computing



Case Study : The CEA

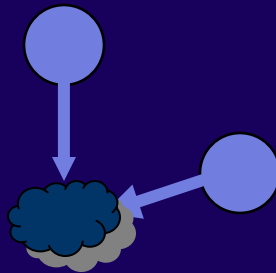
- ◆ CEA = Cambridge Event Architecture
- ◆ Designed to support a wide range of apps including “pervasive” health care scenario
- ◆ Class event architecture with publishers and subscribers
- ◆ Significant amount of work on logging and querying event databases



Asynchronous Platforms for Mobile Computing



Davies



*Tuple
Spaces*



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Case Study : Limbo

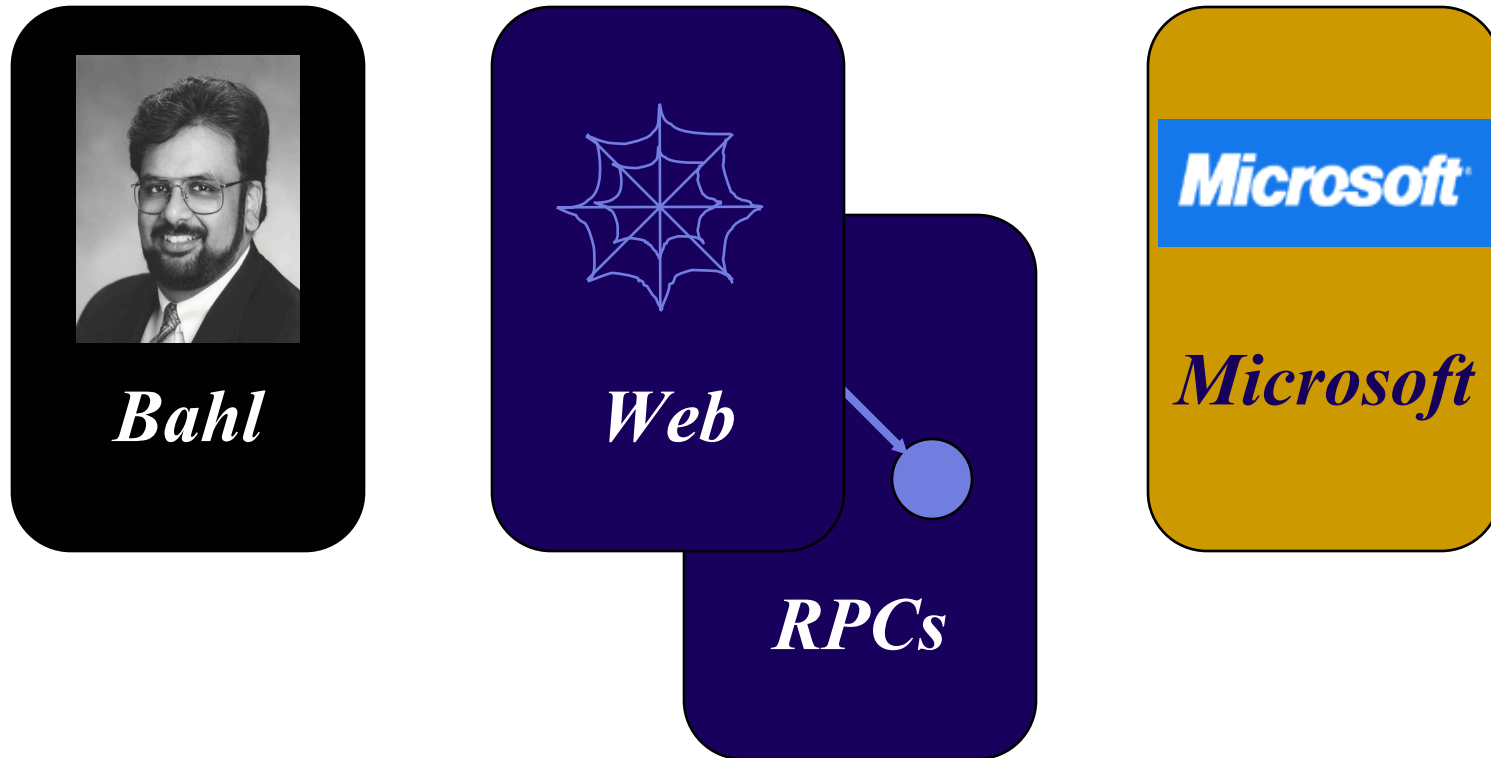
- ◆ Exploits asynchronous, anonymous communications inherent in tuple-space platforms
- ◆ Made several extensions to basic tuple-space model including multiple tuple spaces, tuple types, bridging agents between tuple spaces and basic QoS support
- ◆ Engineered using IP multicast using a fully distributed tuple space model
- ◆ Test application was video system for the emergency services over TETRA
- ◆ Currently being deployed in a Mountain Rescue scenario



What About Now ?



Platforms for Ubicomp



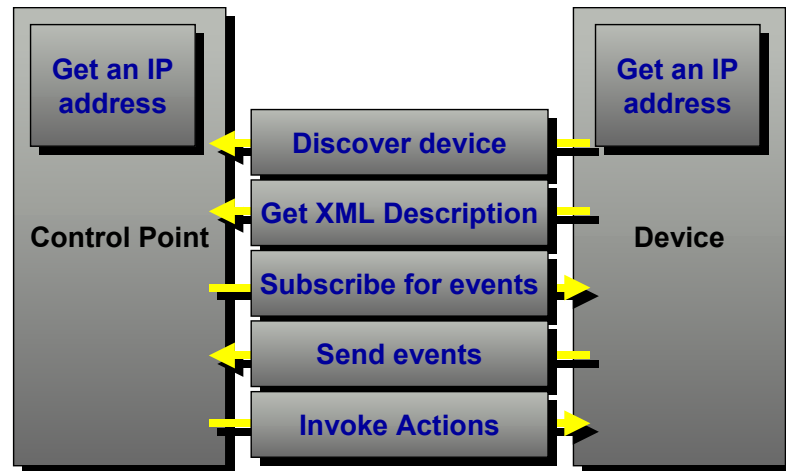
- ◆ UPnP (and maybe Jini, HAVi etc.)



Background: Universal Plug'n'Play

◆ Service discovery and interaction platform

- Developed by UPnP consortium (driven by Microsoft)
- Targets home, proximity and small business networks
- Defines ‘on-the-wire’ message format
- SSDP, SOAP and GENA



Performance and Scalability

- ◆ Poor protocol design
 - Redundancy
 - Lack of convergence algorithms
 - Use of verbose message formats
 - Use of multicast
- ◆ Query on limited service types, so clients must enumerate through available services
- ◆ Locality of reference not exploited

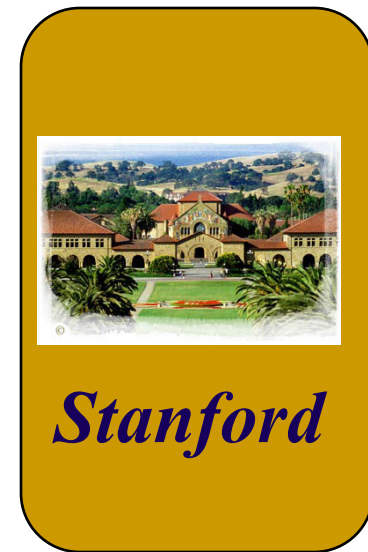
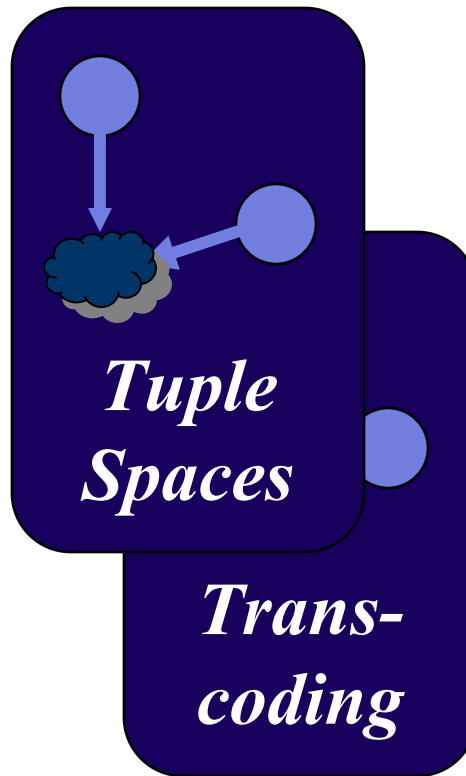


Functional Considerations

- ◆ Functionality
 - Lack of support for location-based services
 - Lack of support for temporal queries
 - Lack of support for dynamic state and state changes
 - Not all architectures support state in service descriptions
 - Directory services not linked to eventing
 - Inability to support third-party meta-data
 - Weak or non-existent security and privacy support
- ◆ We really should be able to do better !



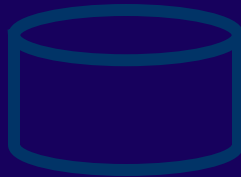
Platforms for Ubicomp



Platforms for Ubicomp



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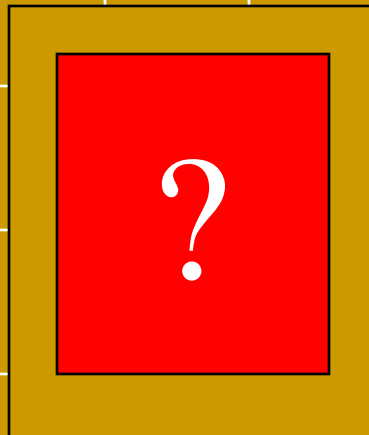
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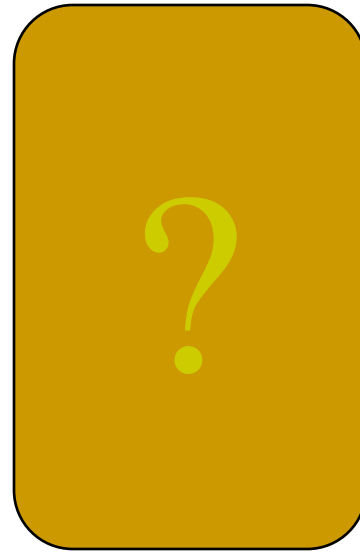
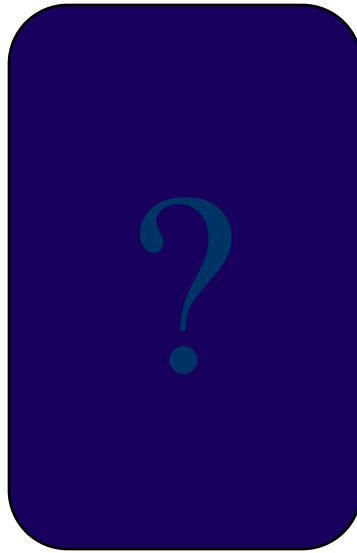
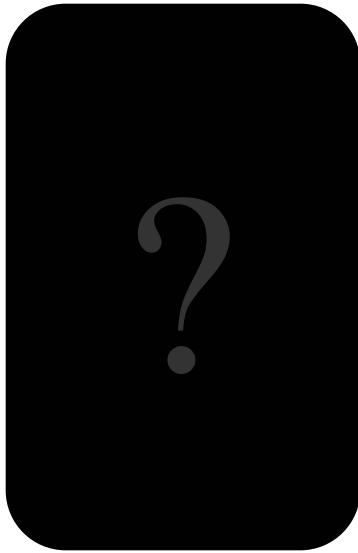
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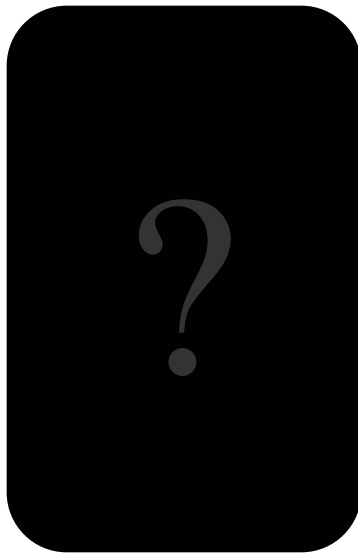
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The Future



People

- ◆ We know some people have a good track record in this area : what will Katz do with the Smart Dust work ?
- ◆ What will emerge from projects such as Oxygen, Equator and Aura ?



Concepts

- ◆ Nobody is arguing to go back to a synchronous paradigm – though many people are building these through the use of web technology.
- ◆ XML is king, so presumably all thoughts of efficiency have gone ☺
- ◆ Tuple spaces remain interesting - each generation must rediscover the same basic problems.
- ◆ More “Database” oriented ideas starting to come into play.
- ◆ Maybe the paradigm doesn’t matter – is it all going to be a mess anyway ?



Places

- ◆ The real key will be to deploy software.
- ◆ This could be done within an institution or by persuading others to use your software.





Joseph



Bahl



Katz



Bacon



Weiser



Davies

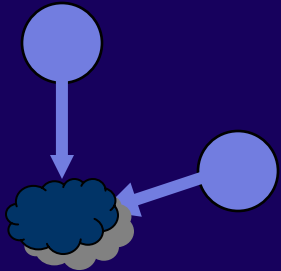


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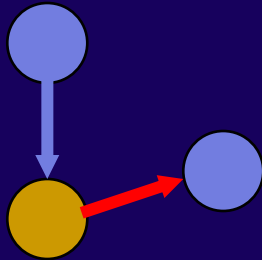


Fox

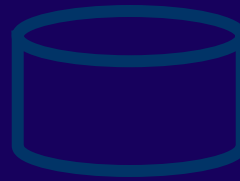




*Tuple
Spaces*



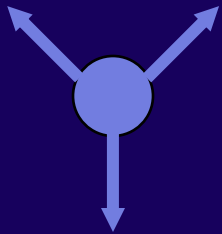
*Trans-
coding*



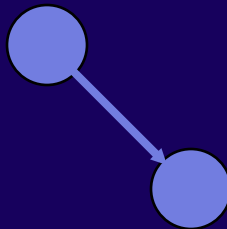
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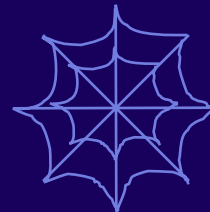
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Events



RPCs



Web



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