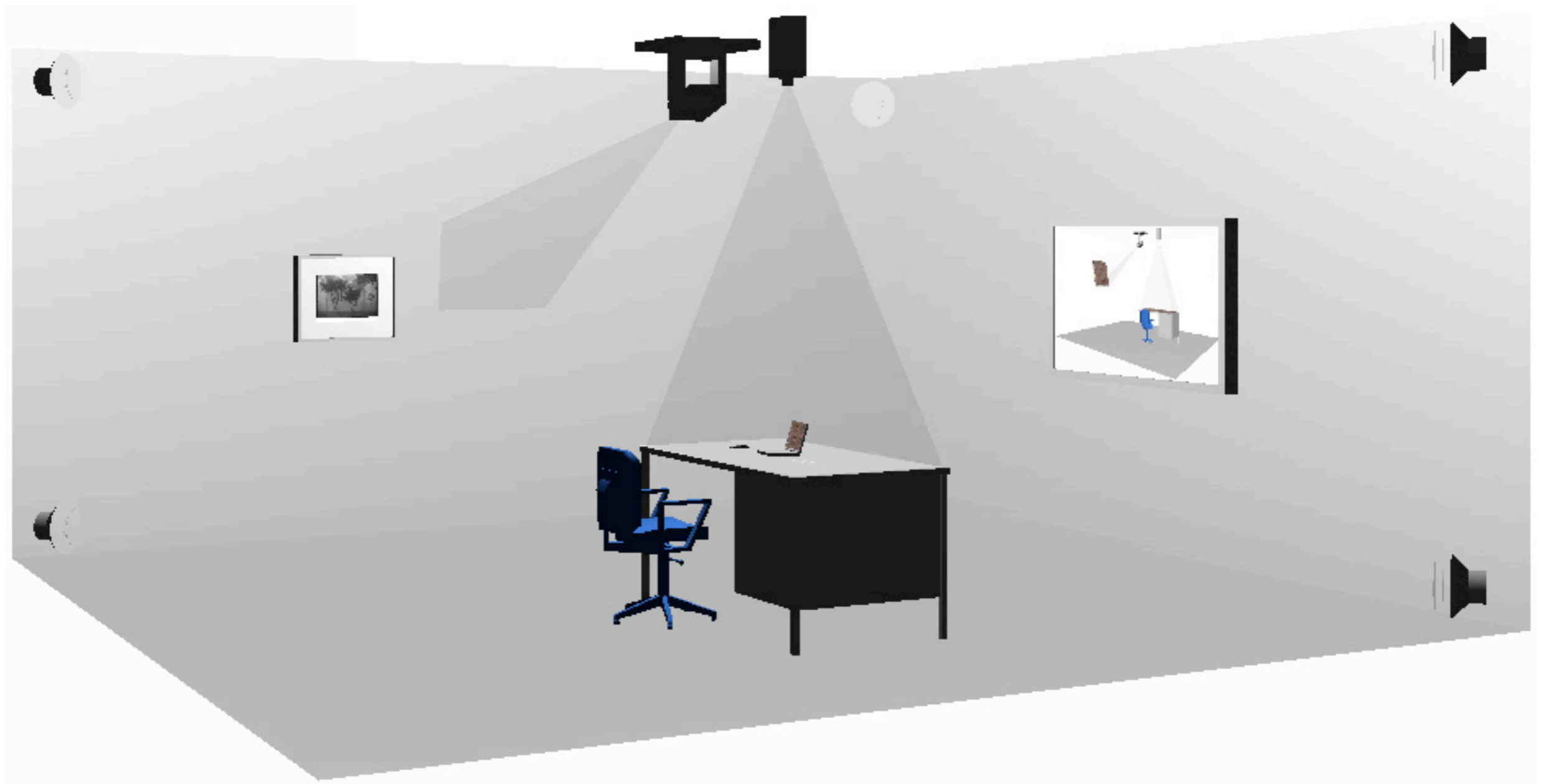


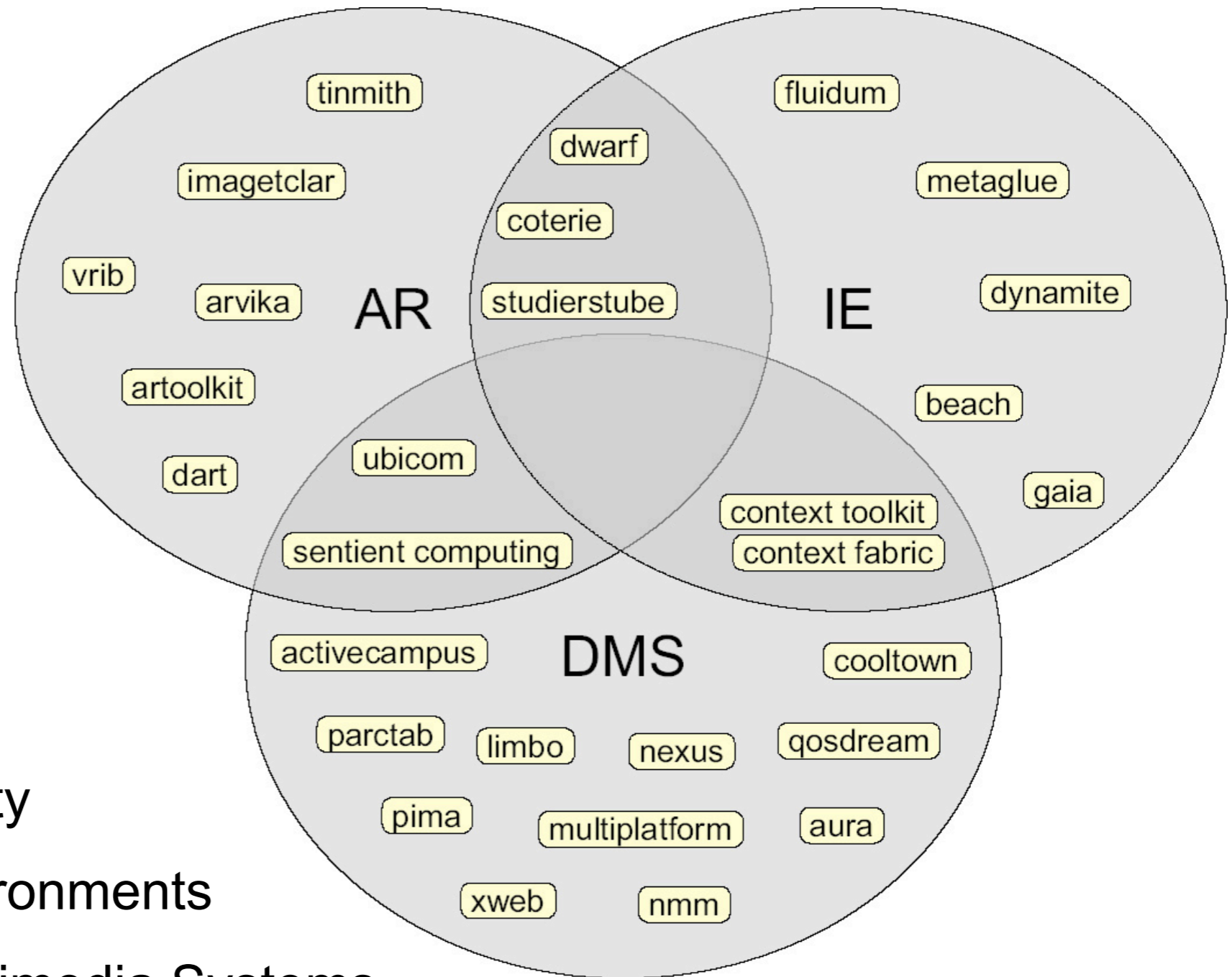
Instrumented Environments

Andreas Butz, butz@ifi.lmu.de, www.mimuc.de



SW Toolkits

Thematic map of SW infrastructures



AR = Augmented Reality

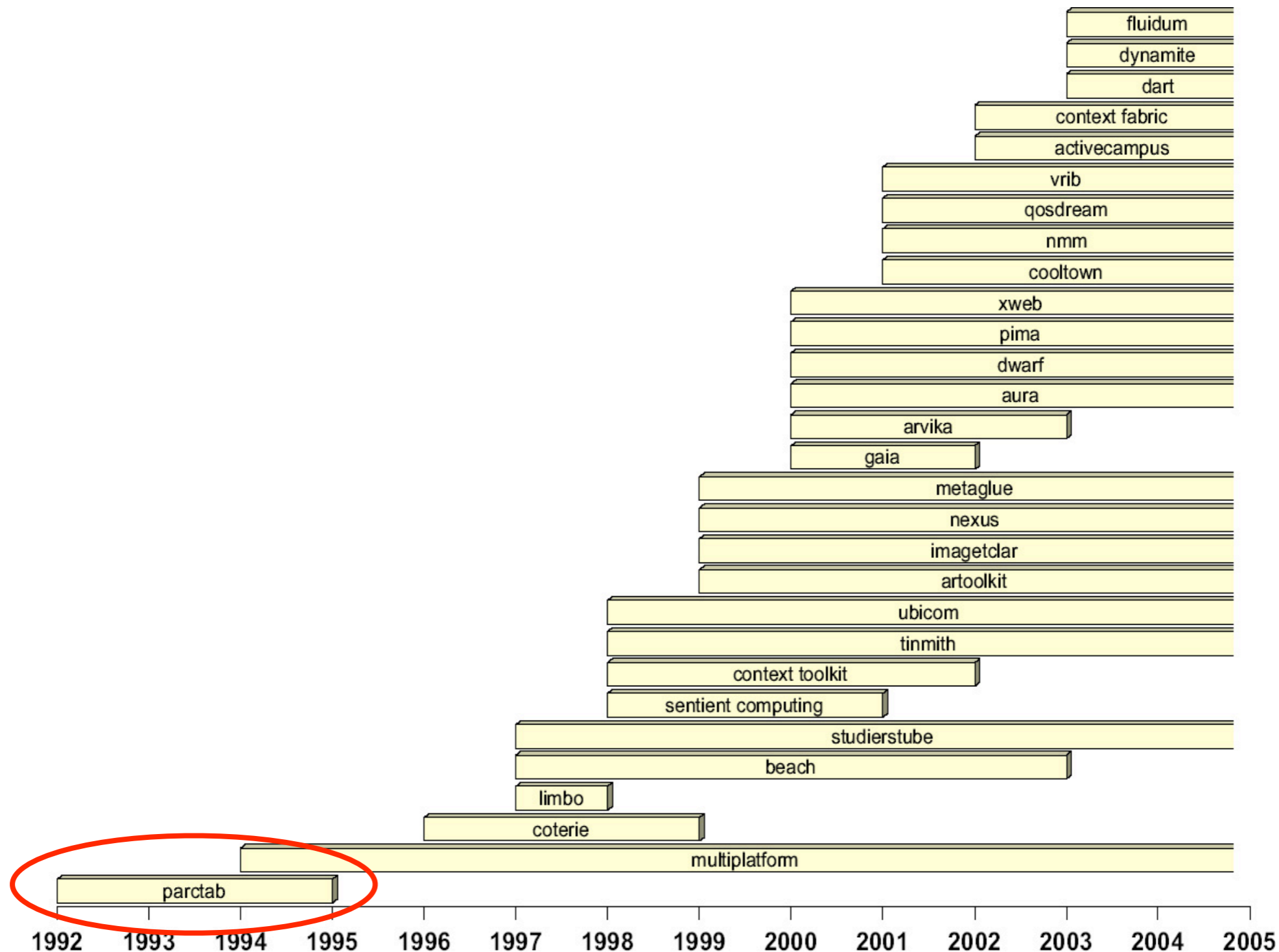
IE = Instrumented Environments

DMS = Distributed Multimedia Systems

World map of SW infrastructures



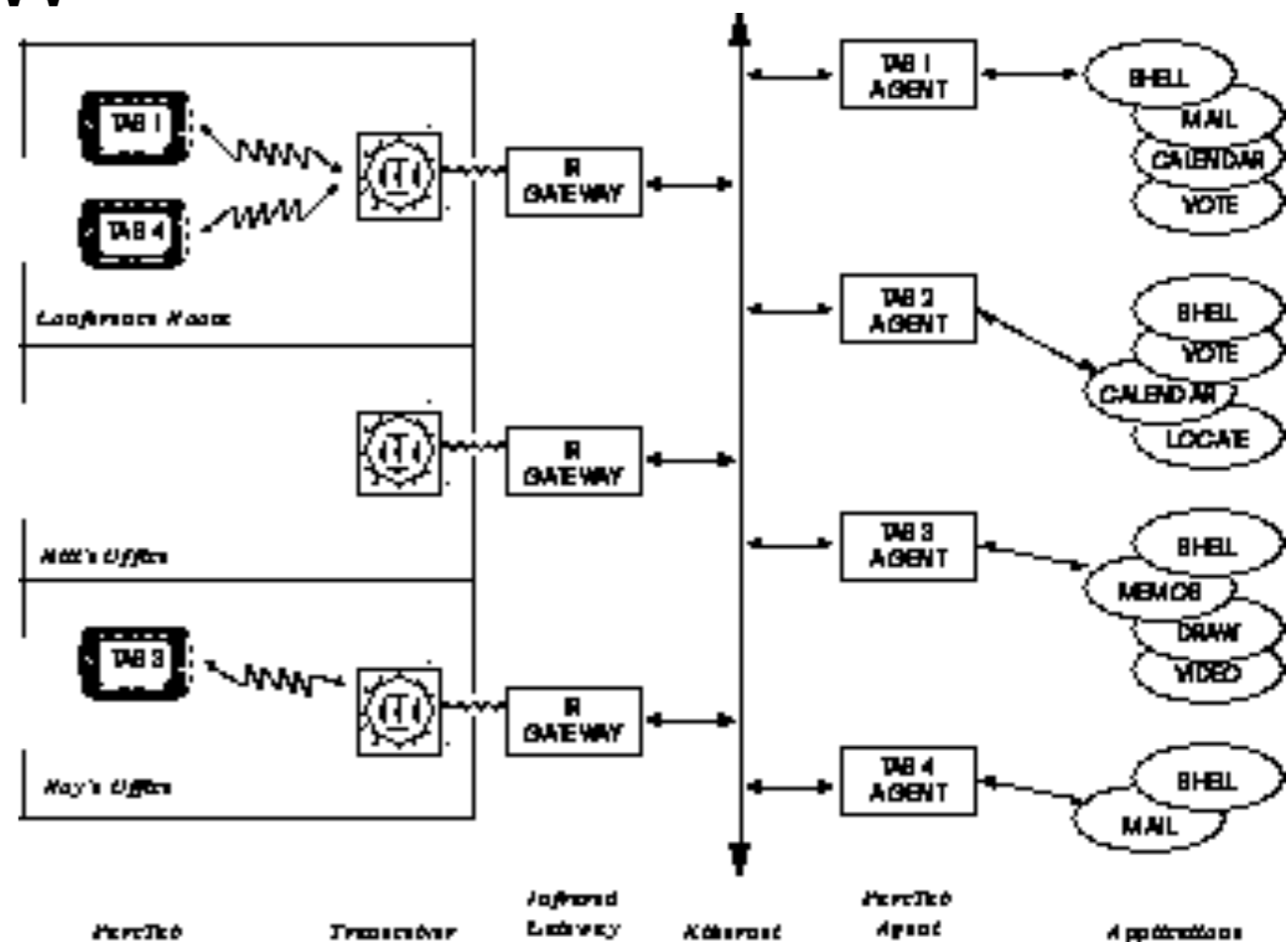
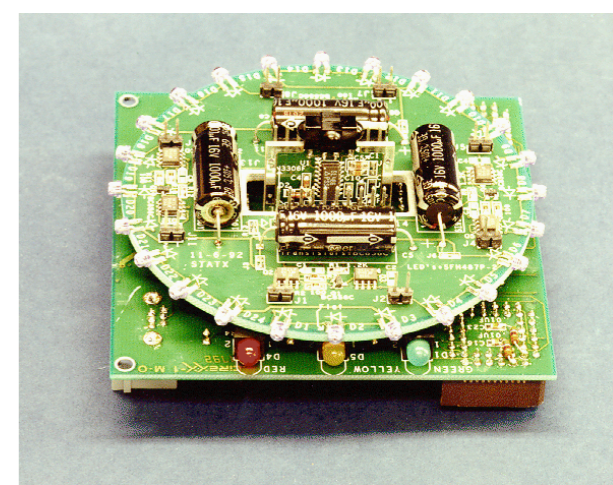
Timeline of SW infrastructures



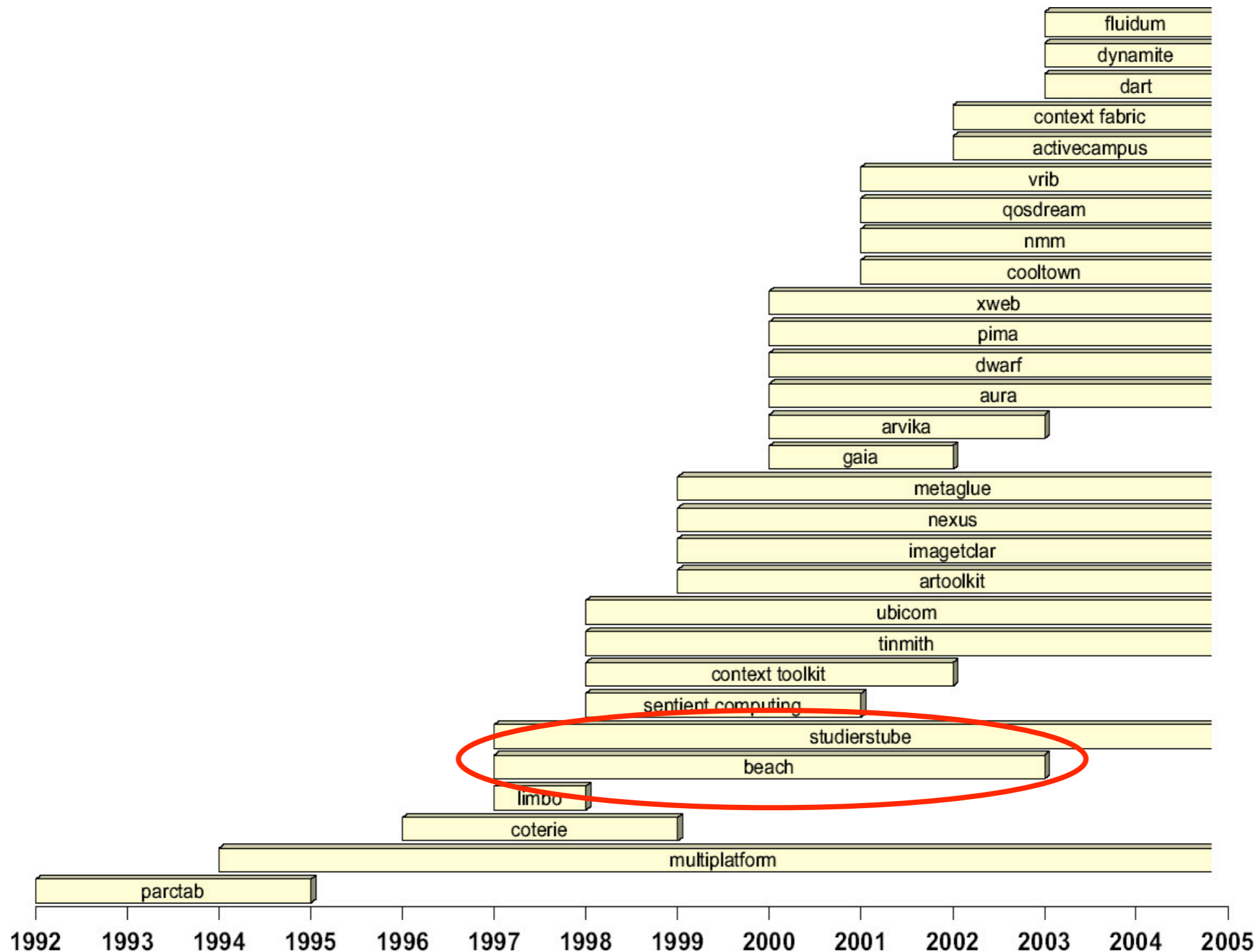
Xerox ParcTab

<http://sandbox.parc.xerox.com/parctab/>

- Infrared network
 - Base stations in the ceiling
- Each base station was controlled by a IR gateway
- Each tab represented by a SW agent (tab agent)
- Applications written in
 - modula-3
 - Tcl/Tk
 - Using MacTabit (~VNC)

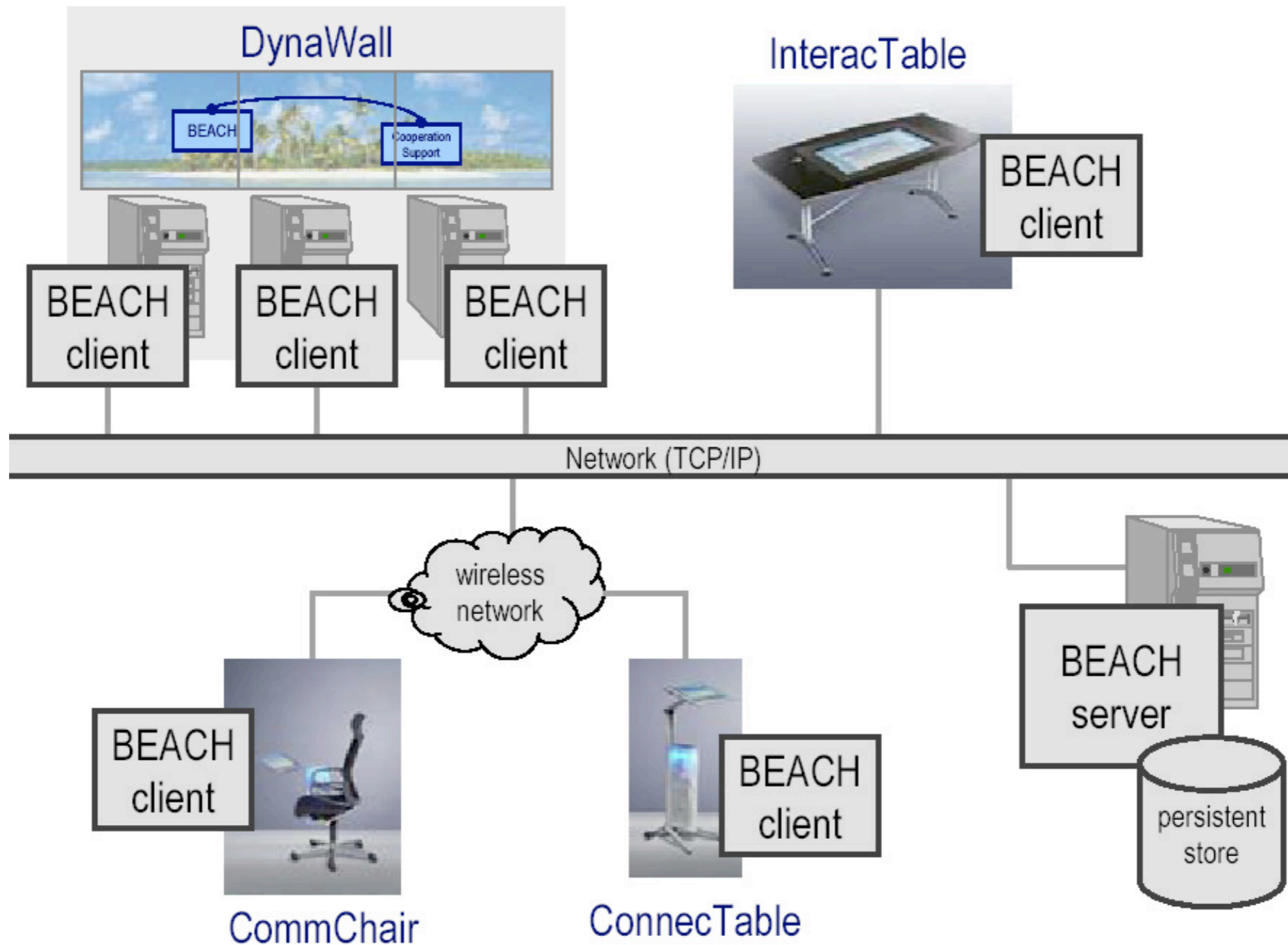


Timeline of SW infrastructures

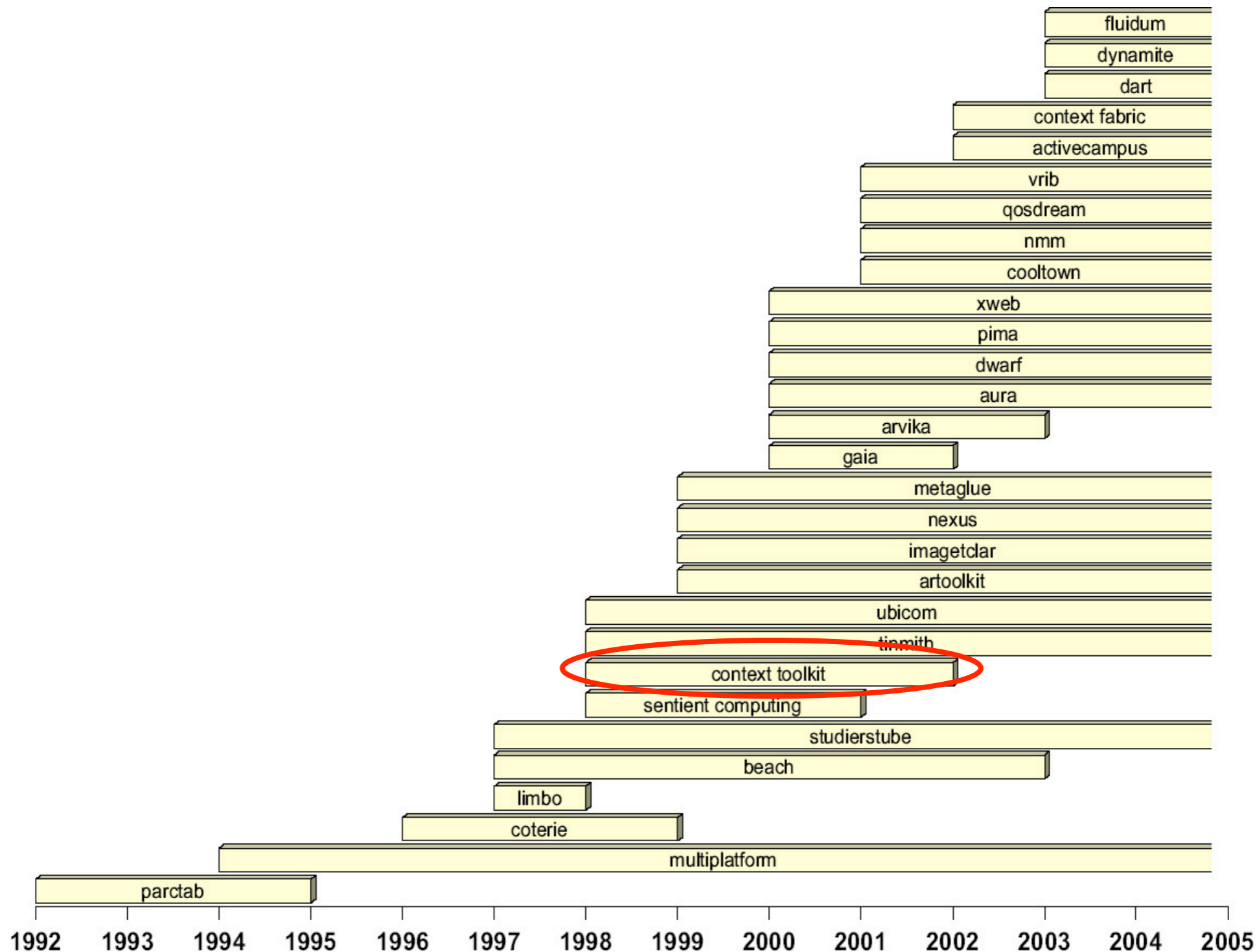


BEACH (FhG IPSI Ambiente)

<http://www.ipsi.fraunhofer.de/ambiente/>

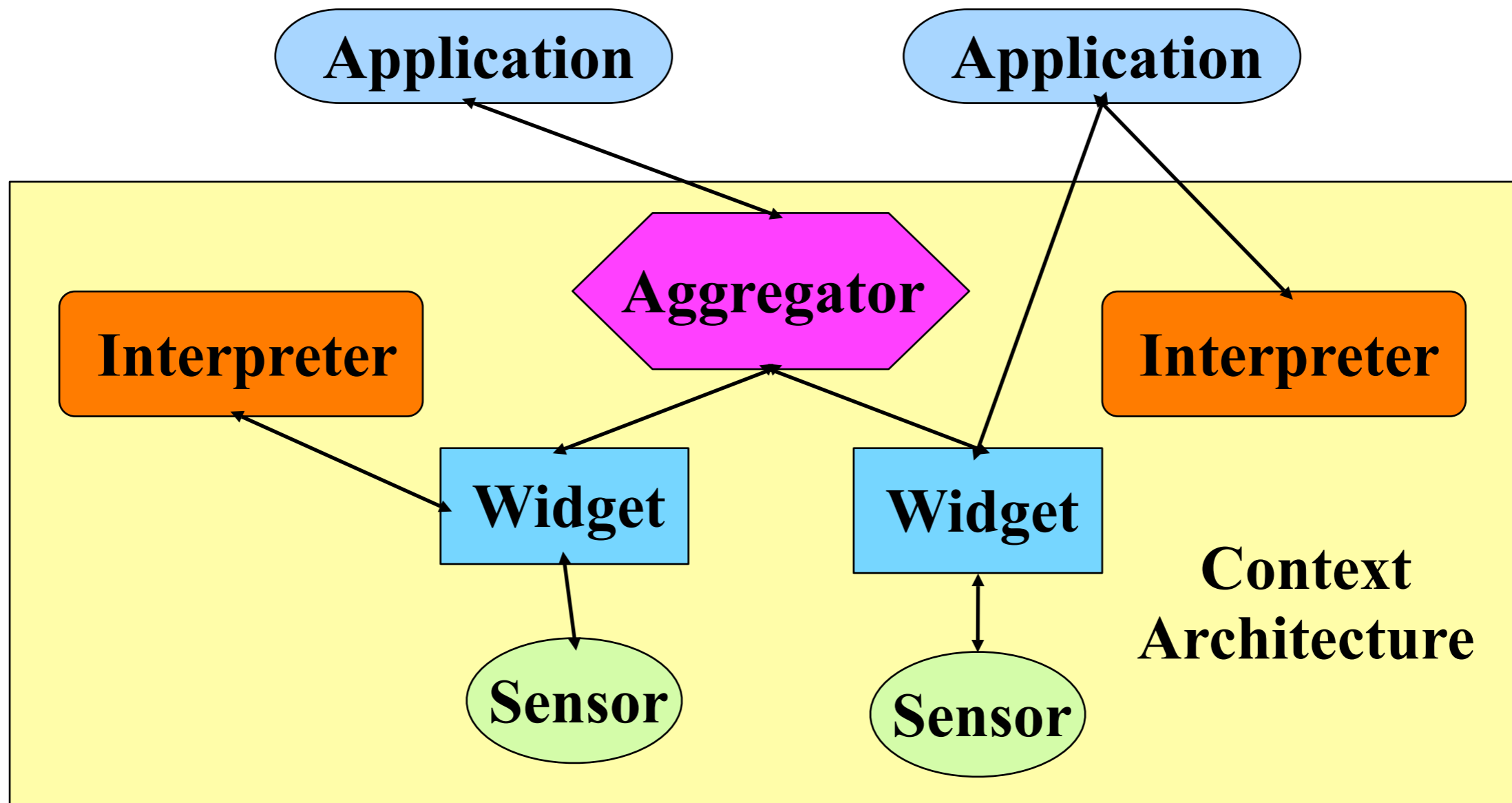


Timeline of SW infrastructures

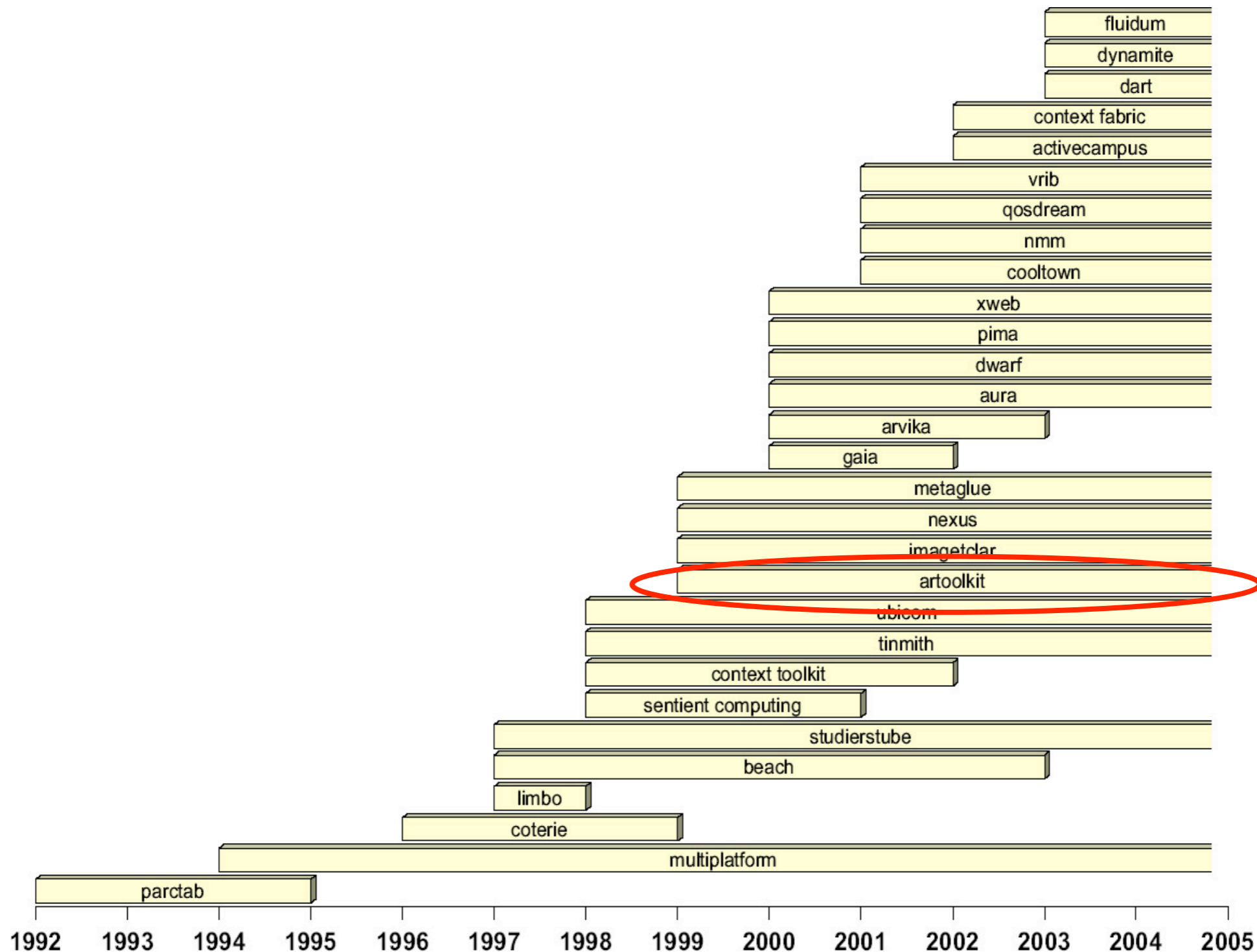


Context Toolkit Framework

- Supports real-world model/methodology and provides library (distributed: XML/HTTP, input-focused)
- Component model: facilitates building of applications in Java

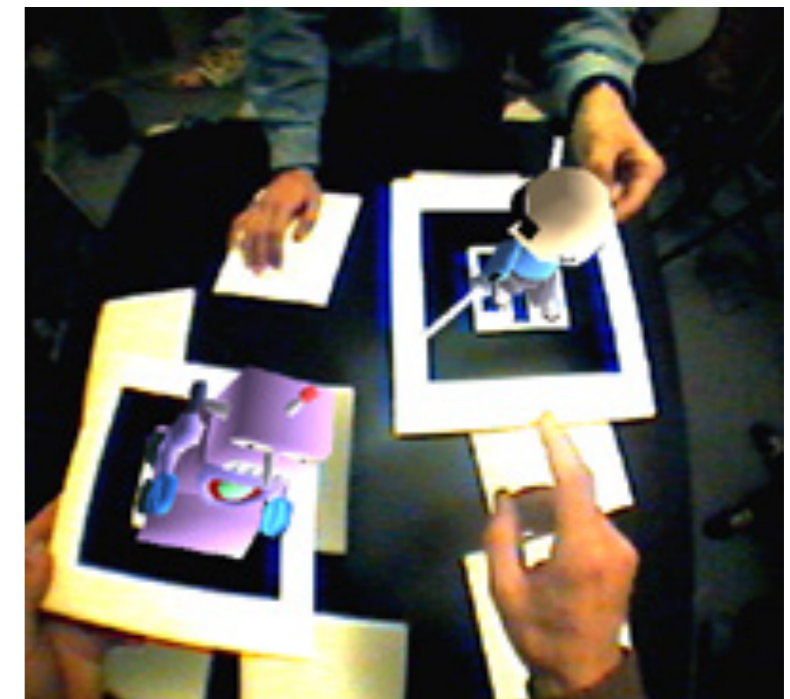
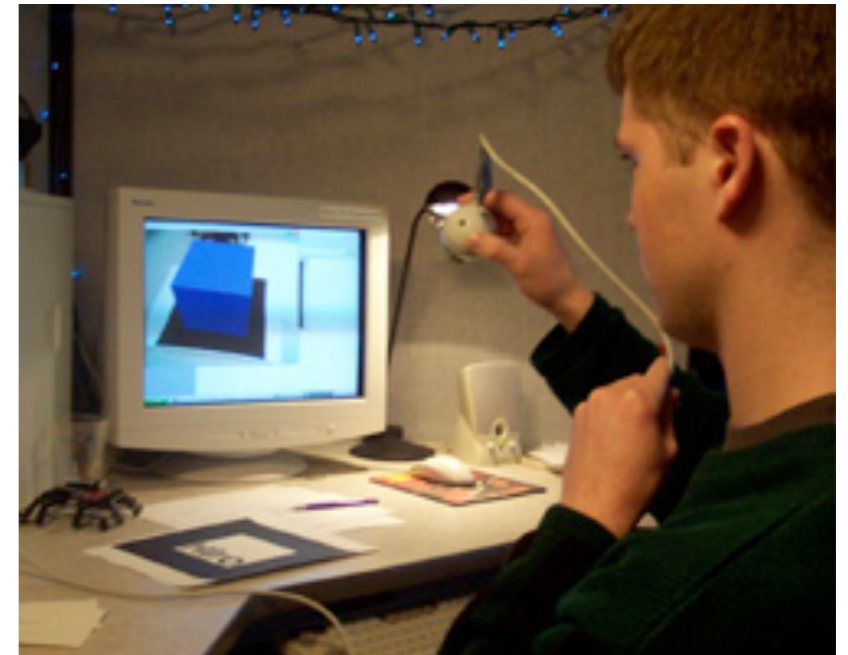


Timeline of SW infrastructures

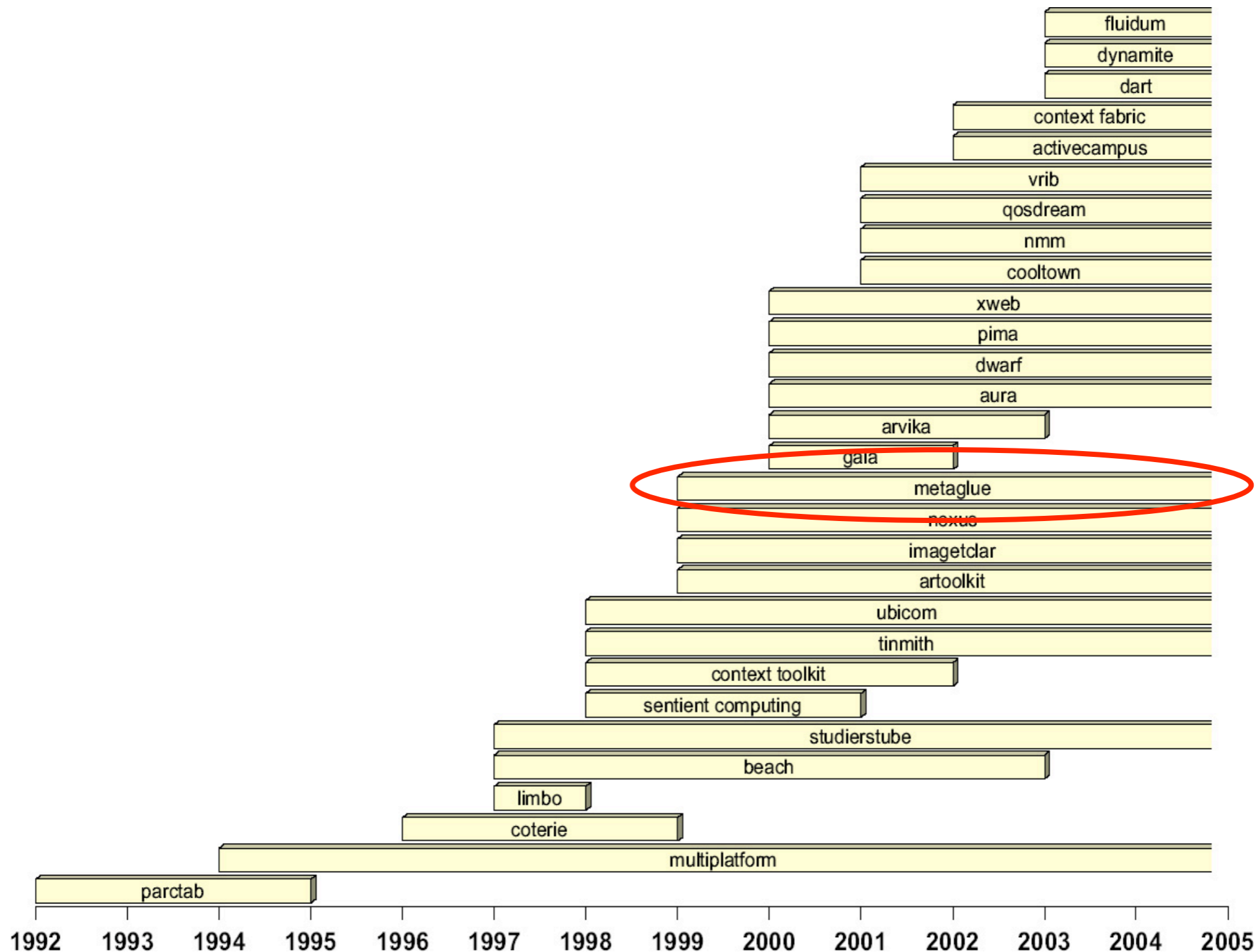


AR Toolkit

- Library for Marker recognition
- Can be used for camera-based tracking
 - With head-mounted displays
 - With other screens
- C library
- Java wrapper available
- Works on
 - Windows
 - Linux
 - PDAs (WinCE)

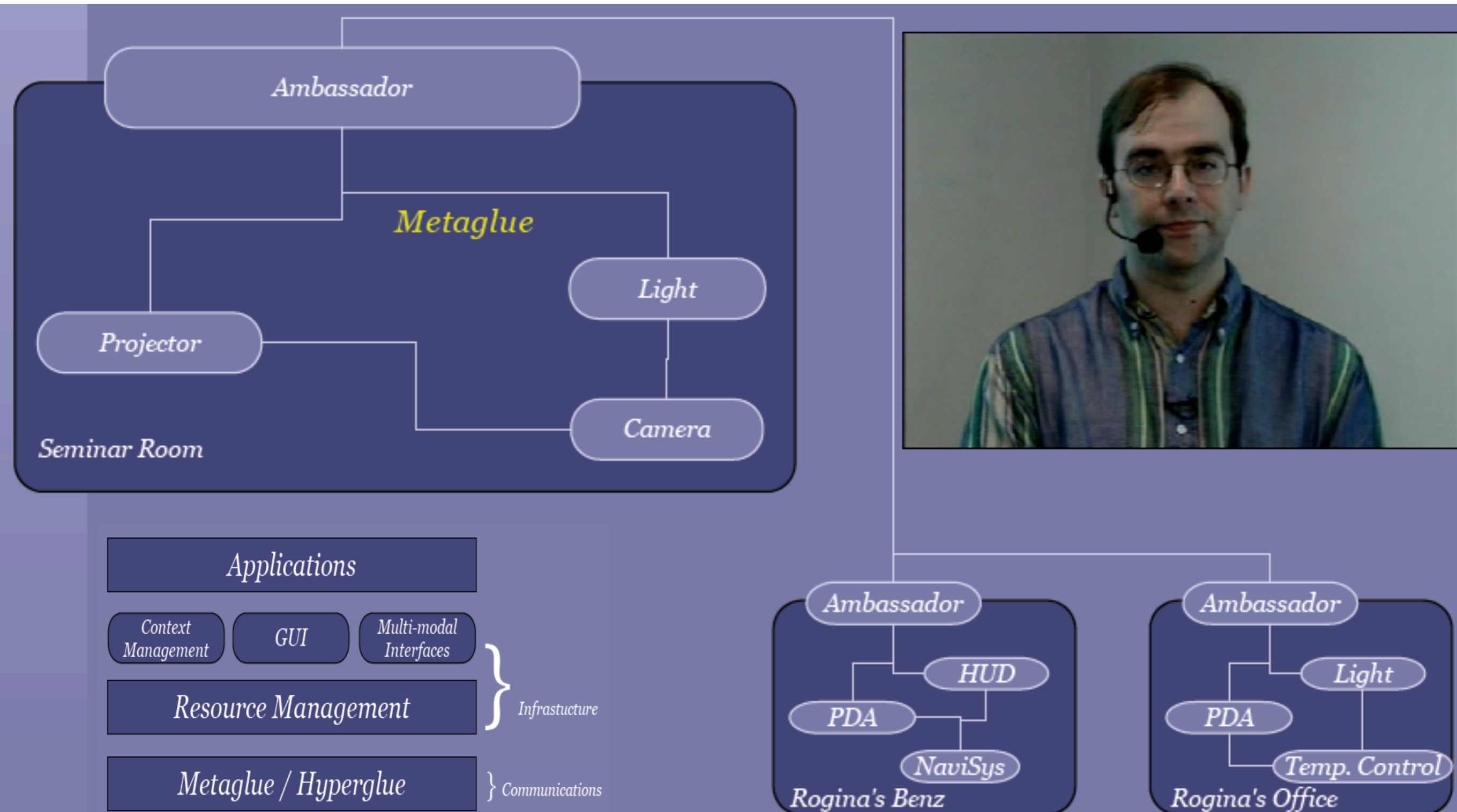


Timeline of SW infrastructures



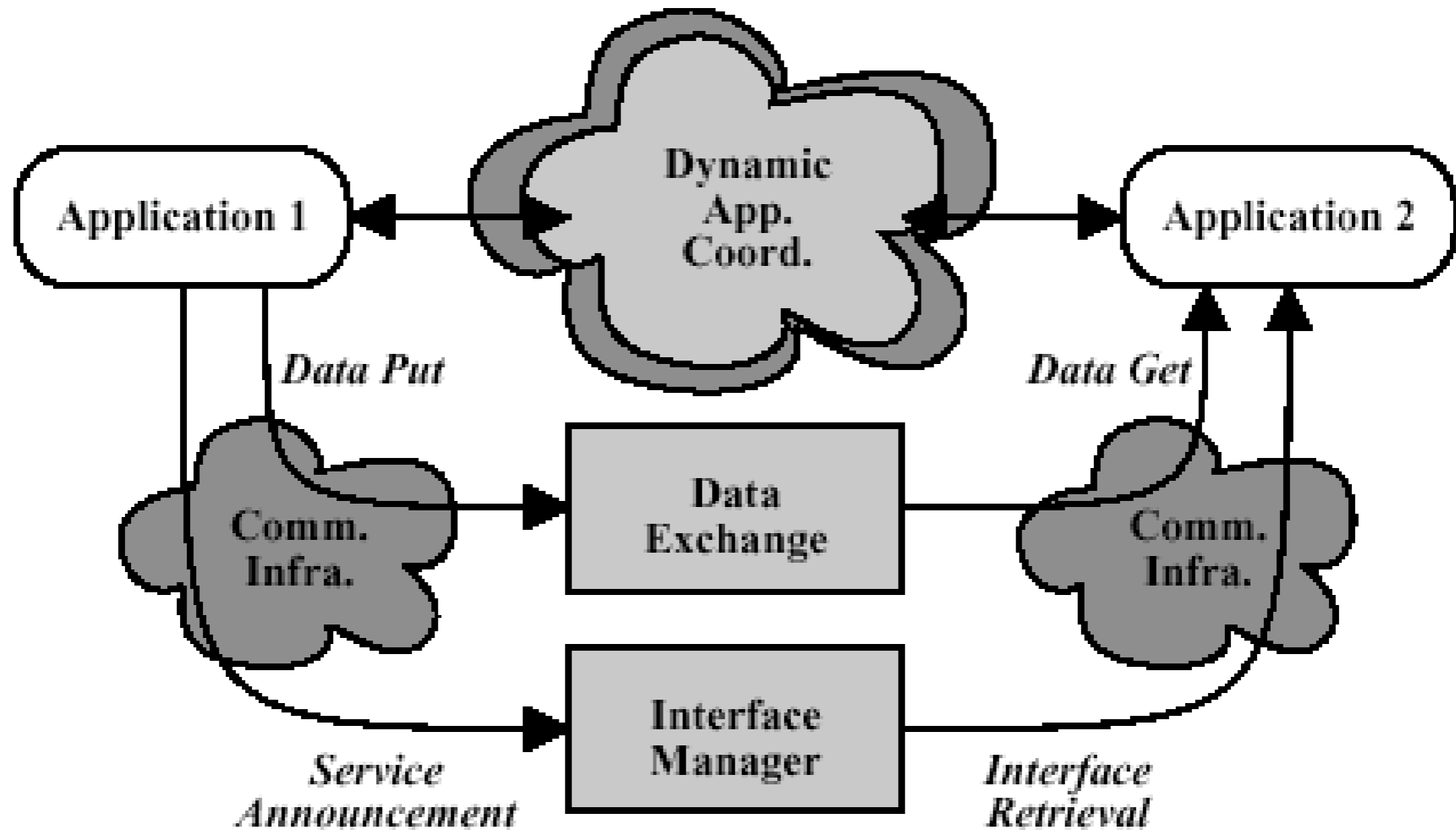
MIT aire + MetaGlue

<http://aire.csail.mit.edu/> see video

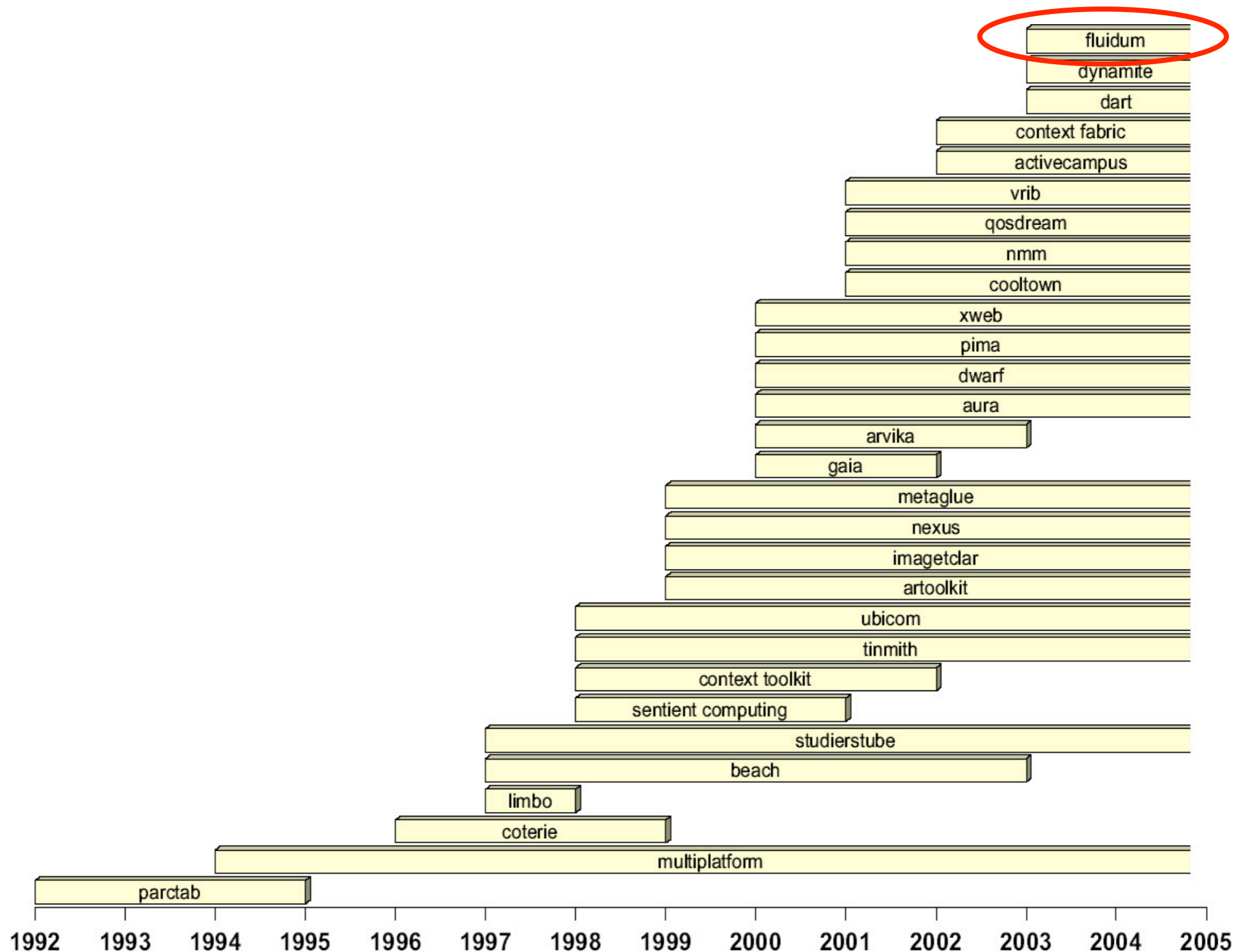


Stanford Interactive Workspaces

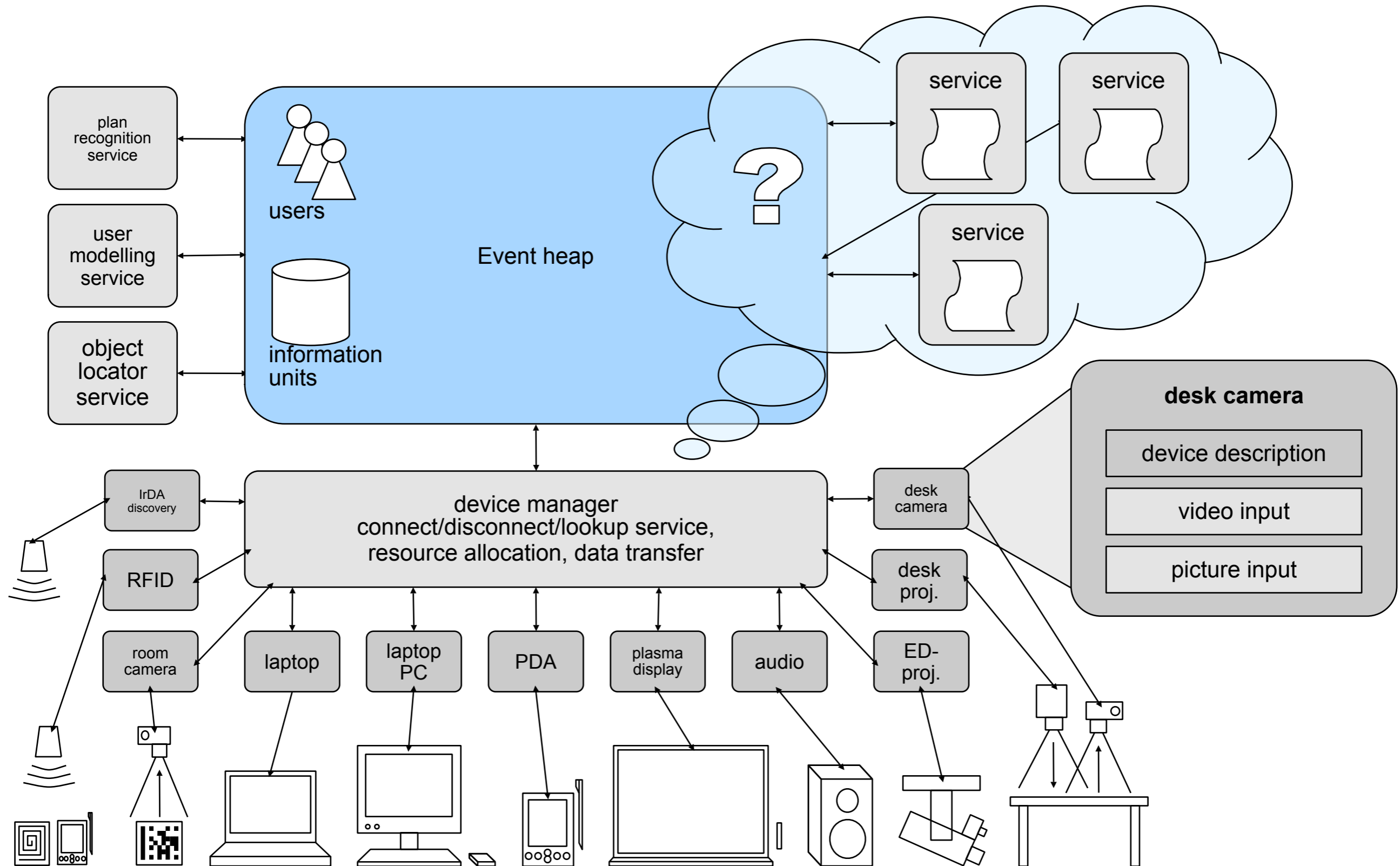
<http://iwork.stanford.edu/>



Timeline of SW infrastructures



Fluidum SW infrastructure



Device Modeling

Universal Plug and Play (UPnP)

<http://www.upnp.org/>

Just send data over the network

- (No executables)
- Minimize version issues
- Minimize security issues

Keep implementation private

- Be agnostic re: programming language, OS
- Update implementation w/o affecting interop
 - Improve performance
 - Reduce footprint
 - Improve capabilities

Agree on meaning / format of data

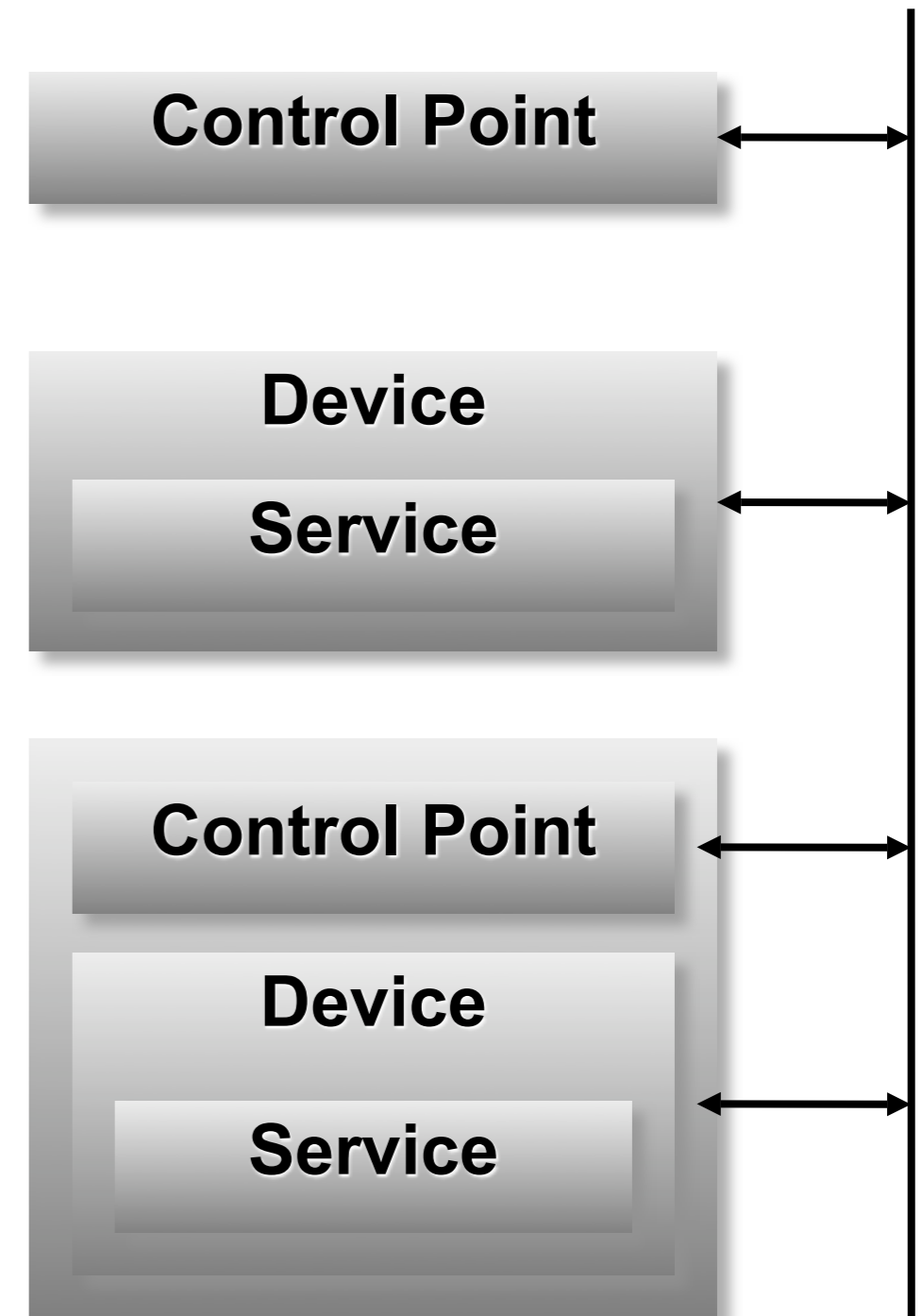
- Choose substrate of proven protocols
- Define device (service) specific protocols in a Forum

UPnP Tactics

- Start simple
 - Build in only universal things that everybody needs (and can live with)
 - Add as needed
- Minimize requirements
 - Basic IP network connectivity
 - Common HTTP protocol stack
- Leverage existing standards
 - HTTP, XML

Goals

- Describe the protocols for communication between
 - Control points
 - Controller, usually client
 - Device
 - Controlled, usually server
 - *An actual device might contain both functions*



Steps to UPnP Networking



- 0 Control point and device get addresses
- 1 Control point finds interesting device
- 2 Control point learns about device capabilities
- 3 Control point invokes actions on device
- 4 Control point listens to state changes of device
- 5 Control point controls device and/or views device status using HTML UI

UPnP protocol stack

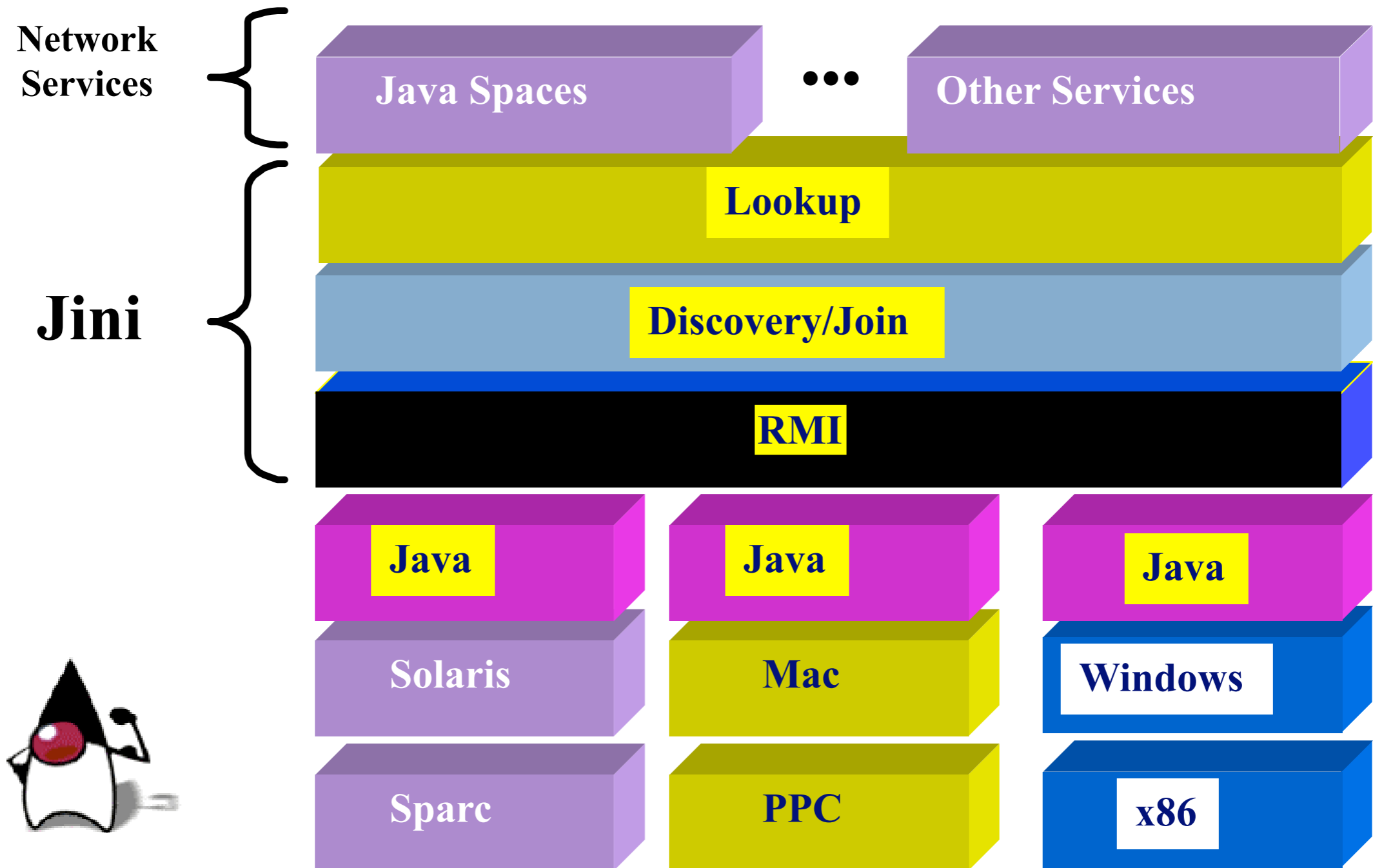
Protocol stack

<i>UPnP vendor [purple-italic]</i>			
<i>UPnP Forum [red-italic]</i>			
<u>UPnP Device Architecture [green-bold]</u>			
<u>SSDP [blue]</u>	Multicast events [navy-bold]	<u>SOAP [blue]</u>	GENA [navy-bold]
		HTTP [black]	HTTP [black]
UDP [black]		TCP [black]	
IP [black]			

- <http://www.upnp.org/specs/arch/UPnP-arch-DeviceArchitecture.pdf>

Jini

<http://www.jini.org/>



Jini, Java, RMI

- Jini is 100% Pure Java
 - Write once, run anywhere
 - Designed for building robust network apps
 - built on the Java standard RMI
- Jini uses RMI for object-object communication
 - Full object module support
 - Pass any Java object and its code
 - Works in any compliant JVM
 - Easy to implement (i.e. automatic serialization)
 - Provides foundation for addition of
 - multicast, replication and basic security

“Jini.. a networked federation of Java virtual machines”

Jini Architecture

	Infrastructure	Programming Model	Services
Jini	Discovery Lookup Extended Security	Lease Event Transaction	JavaSpaces TX Manager
Java	Java VM RMI Security	Java API's Beans ...	Enterprise Beans JNDI JTS ...

“Jini can be seen as an extension of the infrastructure, programming model, and services of Java”

Discovery

- Allows Jini services (both HW and SW) to:
 - Find and join a group of Jini devices
 - Advertise its capabilities
 - Provide any required SW and attributes
 - Works with JVM-enabled or non-JVM devices
 - Send out a multicast packet with reference to yourself
 - Receive a RMI reference to the Lookup service

“Discovery solves the problem of finding the place to start in an unknown network”

Discovery in Brief

1. The device advertises and looks for a service



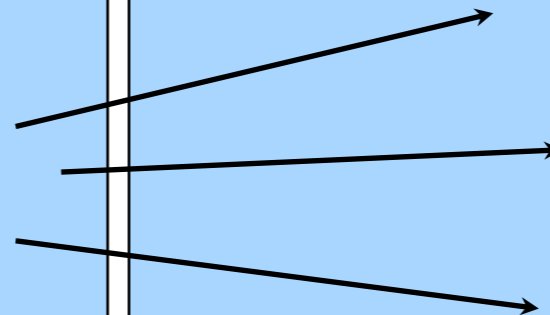
Discovering Entity

2. Lookup Servers run instances of the discovery service which listen for multicast requests from discovering entities

Lookup Server



3. The discovering entity performs a multicast that requests references to the lookup service.



4. The lookup server calls a remote method on the discovering entity's exported object instance passing a remote reference to its lookup service as the parameter



Lookup

- Repository of available services
- Stores service as an extensible set of Java objects
 - ID, interface, GUI's, attributes, drivers ...
- Service objects downloaded to user as required
- May be federated with other Lookup services
- Lookup service interface:
 - Registration, Access, Search, Removal

“The lookup service binds the federation together”

User Modeling

A very brief intro to user modeling

- A user model is:
 - Any kind of information about the user
 - Stored in one or several systems (→distr. UM)
 - Used for adapting system output and/or behavior
- Example:
 - Recommendations by Amazon

A practical example for UM

The screenshot shows the top of the Amazon.de website. At the top left is the Amazon.de logo. To the right are links for 'WUNSCHZETTEL', 'MEIN KONTO', 'HILFE', and 'IMPRESSUM'. Below the logo is a promotional banner for 'Harry Potter 6' with a 'Jetzt vorbestellen' button. A navigation bar contains categories: 'HOME', 'ANDREAS' SHOP', 'BÜCHER', 'ENGLISH BOOKS', 'ELEKTRONIK & FOTO', 'MUSIK', 'DVD', 'VHS', 'SOFTWARE', 'PC- & VIDEO-SPIELE', 'KÜCHE, HAUS & GARTEN', and 'SPELWAREN & KINDERWELT'. A secondary navigation bar has buttons for 'INTERNATIONAL', 'FREUNDE WERBEN', 'TOPSELLER', 'PREIS-HITS', 'GUTSCHEINE', and 'JETZT VERKAUFEN'. Below this is a search bar with 'SCHNELLSUCHE', a search input field, a dropdown menu set to 'Alle Produkte', and a 'LOS' button. A yellow banner below the search bar reads 'Weihnachtsgeschenke zu Bargeld machen. Jetzt verkaufen!'.

ANGEBOT DER WOCHE

Wetten, dass..?



Die Stars der Wetten, dass..?-Show vom 22. Januar aus Hannover.

UNSERE SHOPS

Buch, Musik & DVD

- [Bücher](#)
- [English Books](#)
- [Zeitschriften](#)
- [Musik](#)
- [DVD](#)
- [Video](#)

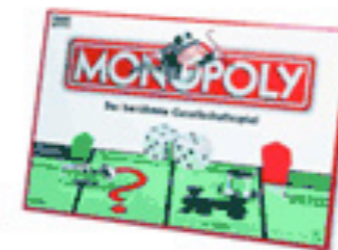
Elektronik & PC

- [Elektronik](#)

Hallo, Dr. Andreas Butz! Hier sind [Ihre persönlichen Empfehlungen](#).

(Wenn Sie nicht Dr. Andreas Butz sind, [klicken Sie bitte hier](#).)

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[Hier klicken](#)

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Notting Hill,

Tatsächlich...Liebe und viele weitere
Top-Angebote: [700 CDs ab 7 EUR!](#)

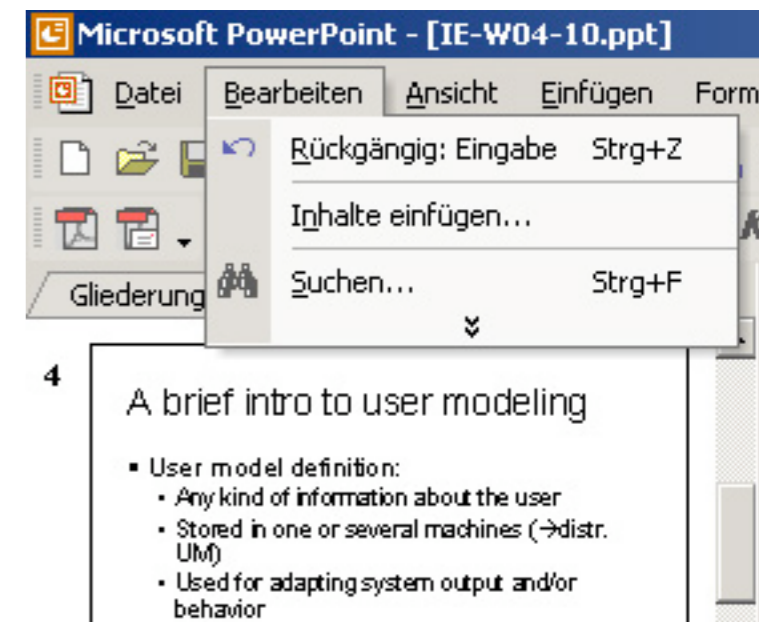
Acquisition of data for a UM

■ Explicit

- Type in your name, age, address, credit card
- Adjust your preferences, skills, interests

■ Implicit

- Items purchased in the past
- Money spent
- Pages visited / items looked at ?
- Navigation speed ??
 - Automatic detection of web bots ;-)



Construction of a UM from data

- According to data collected, systems can
 - Store an individual profile of the user
 - Assign the user to a predefined stereotype
 - Find new stereotypes by clustering users
 - Make default assumptions for missing info
 - From global defaults
 - From stereotype

Adapting system behavior from UM

- Greeting customers by name
- Offer customers to sell their used stuff
- Filling in the correct credit card number
 - → security issues, cookies,
 - Try signing on to amazon.co.uk with your account (email address & PW) from amazon.de
 - What parts of the UM do they have?
- Recommendations from domain models
 - Buyers of a DVD Player need DVDs
- Recommendations from „collaborative filtering“
 - Customers who bought X, also bought Y in the past

Ideas for UM in IEs

■ Individual UM

- Identity: detected for example from BT phone
- Person's name for communication
- Person's preferences for the room setup
- Personal working environment
- Messages for this person
- User's current plan/task/goal
- Privacy settings

■ Stereotype UM

- Age group
- Novice/expert
- Technical/
untechnical
- Slow/fast typer
- Tall/short person
- ...???

Context Modeling

Context Toolkit

(with slides courtesy of Anind Dey)

- Anind K. Dey (prev. Intel, UCB, now CMU)
- <http://www.cs.cmu.edu/~anind/>
- Toolkit to support Context-Aware applications
- Strong formalization of “context”
- Implementation in Java.
- Can be distributed on several machines in the environment



Context and Context-Awareness

- Focused on input
- Context: *any information relevant to an interaction that can be used to characterize the situation of an entity*
- Context-Awareness
 - General model of interactive computing
 - Addresses subset of ubicomp problems: input

Value of Context

- Potential for improved usability
 - Very important for mobile users with poor input devices
- “Smarter” applications
- Increased communications bandwidth

Design Space for Context-Aware Applications

- Toolkit allows exploration of design space
- Basic types of context:
 - Location, identity, time, activity
 - Simple/singular → complex/multiple
 - Combinations
- Uses of context:
 - **Present** to user
 - Automatically perform set of **services**
 - **Tag** captured information to ease retrieval

Example

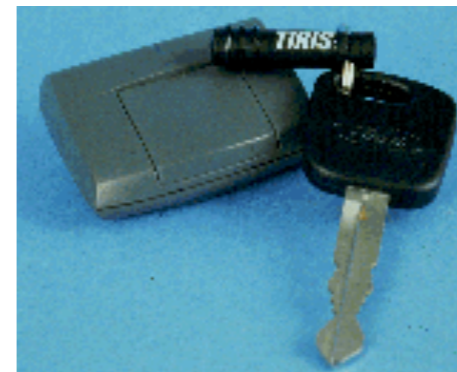
- Tour guides, travel assistants, personalization software
- Reminder to buy milk
 - When to deliver: not time/location specific
 - How to deliver: appropriate modality

Building Applications

- M. Weiser: The whole point of ubiquitous computing, of course, is the applications.
- But ... what if the applications are hard to build? And, what if this inhibits our ability to build compelling applications?

Why Context is Hard to Use

- Acquired from sensors
 - Not just keyboards and mice – lots of heterogeneous devices
- Need to abstract data
- Distributed
- Dynamic



Results of Difficulties

- *Ad hoc* application building
 - Difficult to build, reuse and evolve
- Small variety of sensors
- Small variety of context: mostly *location*
- Few applications, mostly simple: mostly *presenting context*

- Practical: difficult to prototype, test and evaluate

Context Toolkit: Research Contributions

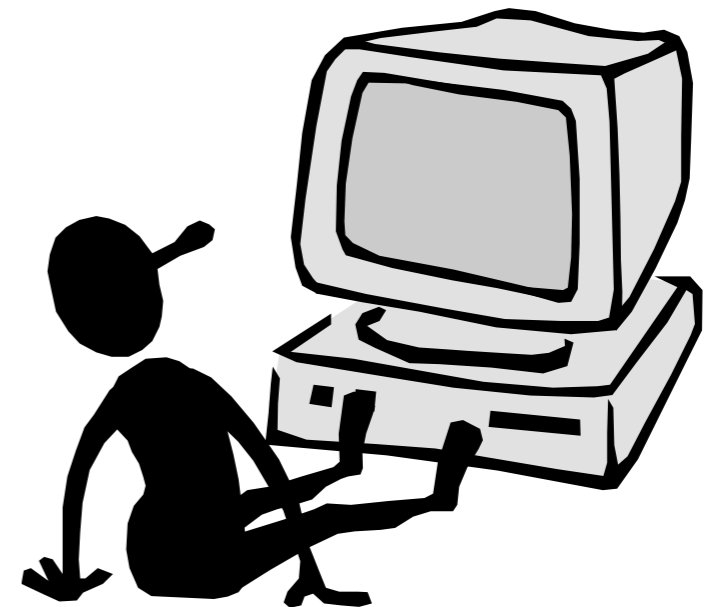
- **Conceptual framework requirements**
 - Provide framework for designing apps more easily
 - Lower threshold to enable more designers
- **Context Toolkit itself**
 - Implementation and exploration of design space
- **Support investigation of complex problems and more realistic apps**
 - Raise ceiling
 - Privacy, uncertainty, security, end-user programming

Toolkit Requirements

- Context specification
- Discovery
- Separation of concerns
- Storage
- Constant availability
- Transparent communications
- Interpretation

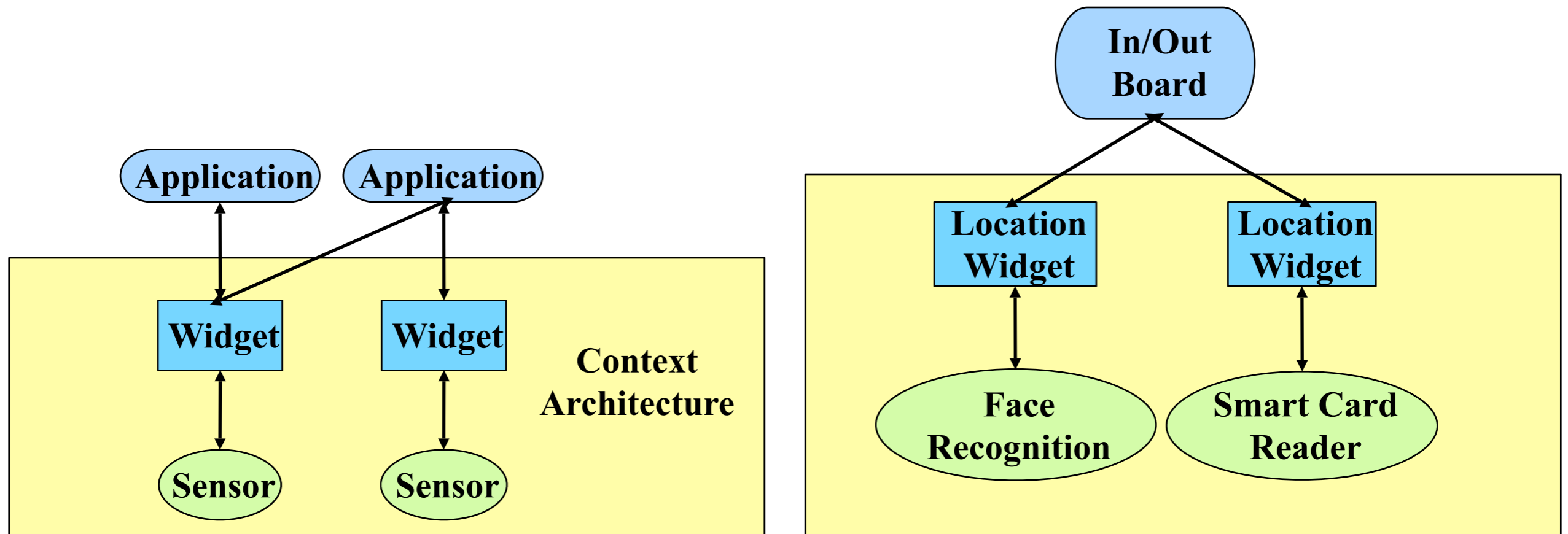
Look to input handling

- Graphical User Interface (GUI) widgets
 - separation of concerns
 - callbacks and attributes
 - query/subscribe
 - common interface
- e.g. button



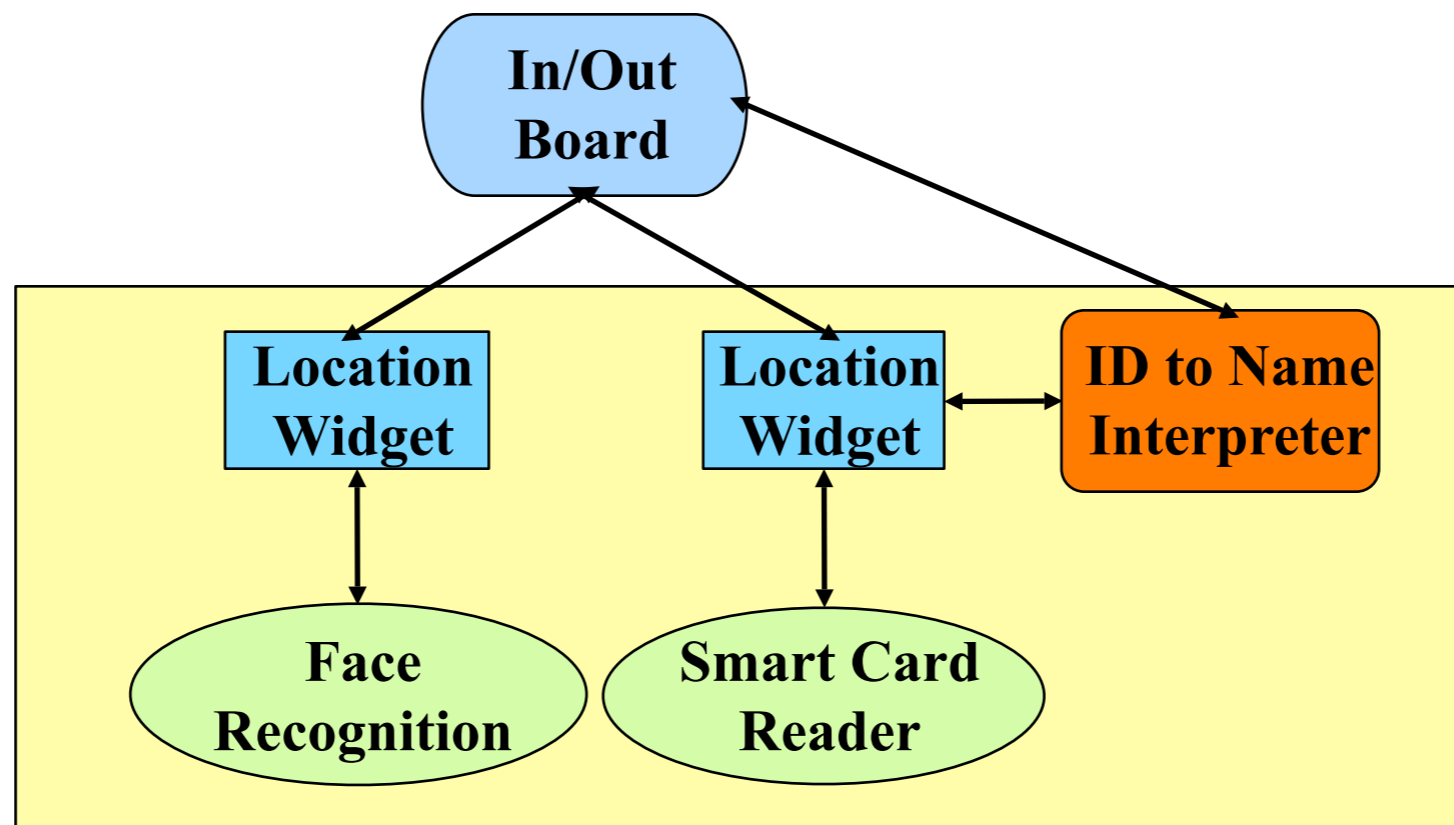
Context Widgets

- Responsible for acquiring and abstracting data from particular sensor, separation of concerns, storage



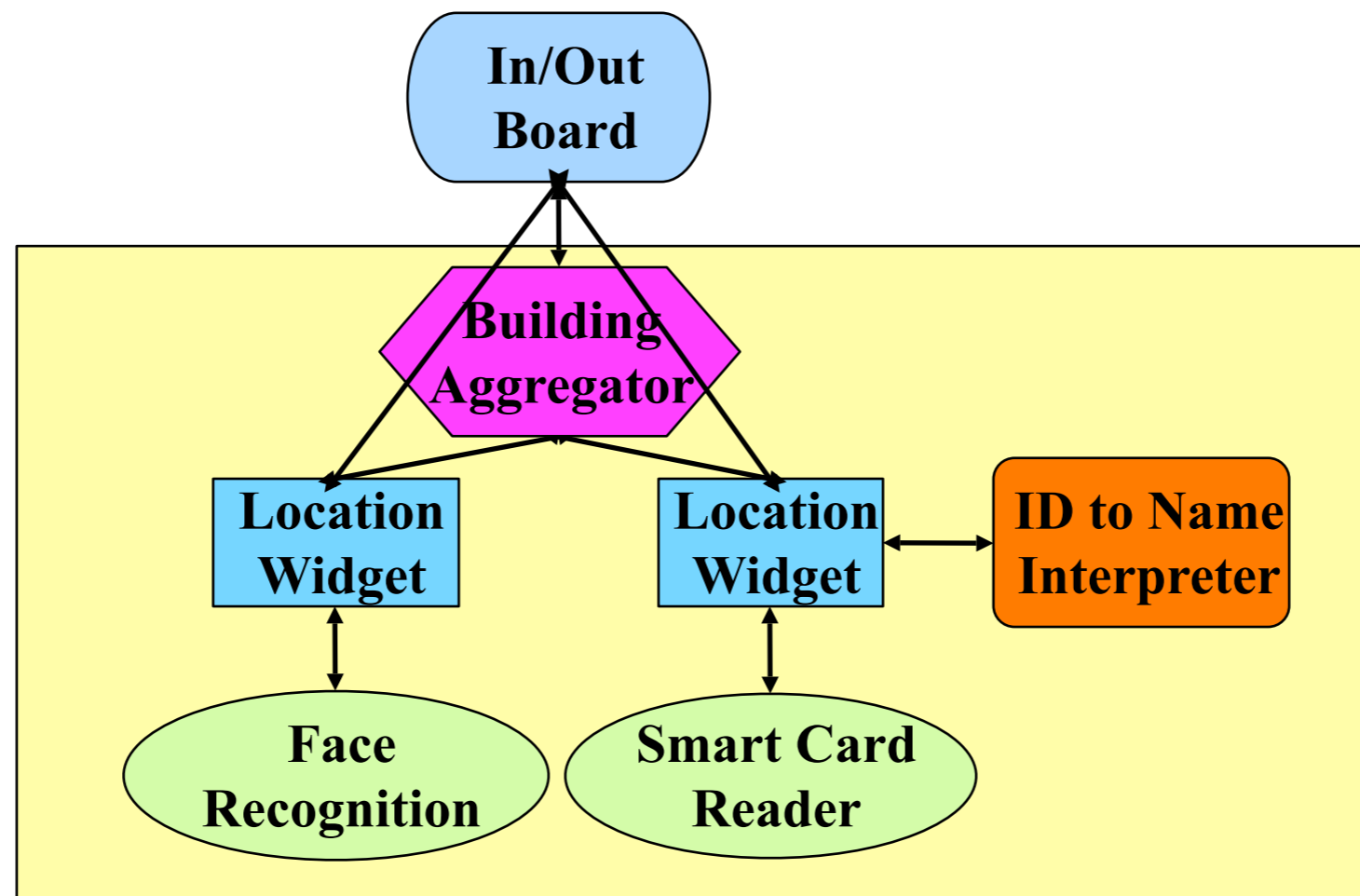
Context Interpreters

- Convert or interpret context to higher level information
- Context not available at appropriate level



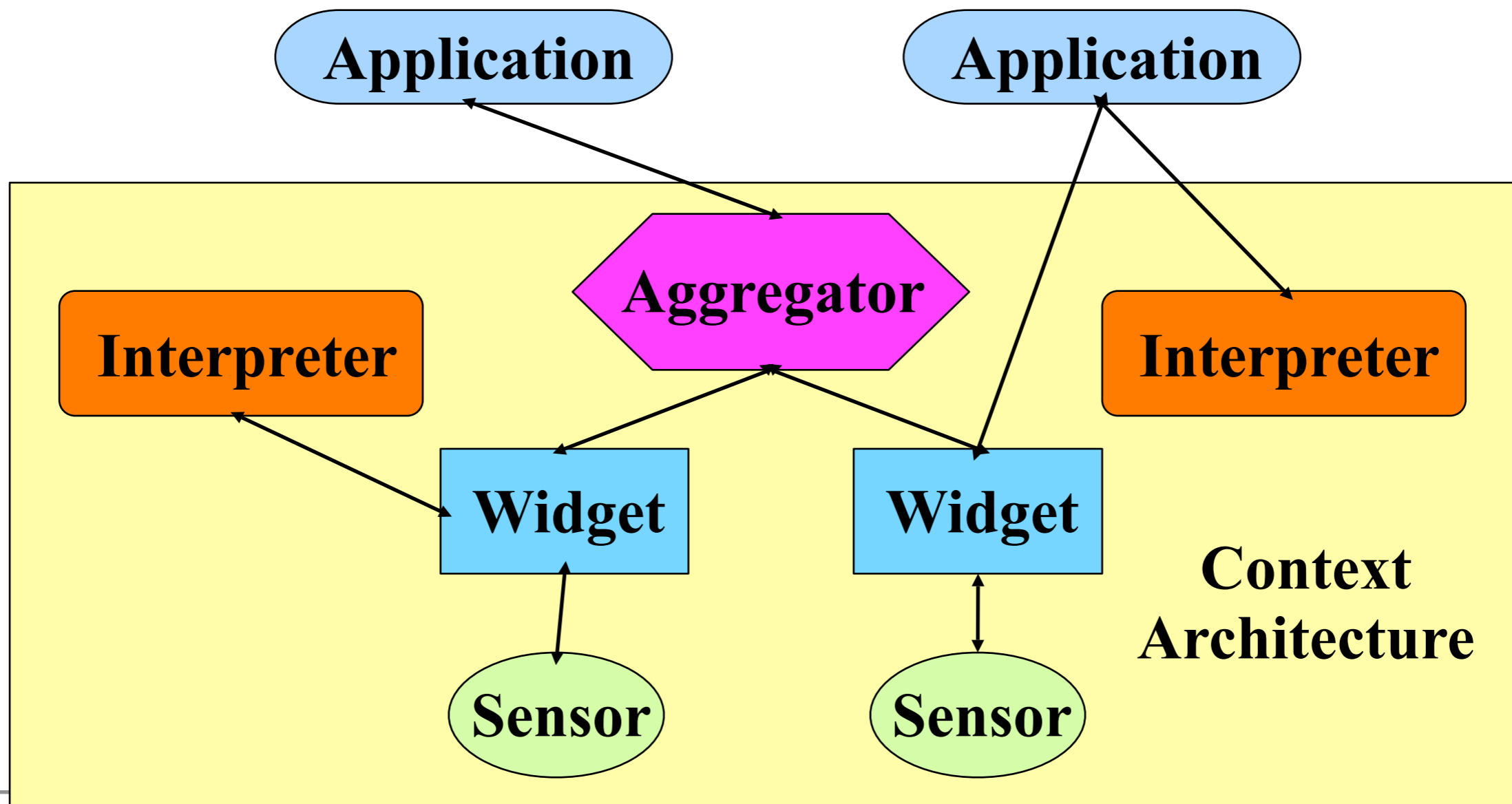
Context Aggregators

- Collect context relevant to particular entities (recall definition)
- Further separation, simplifies design



Context Toolkit Framework

- Supports real-world model/methodology and provides library (distributed: XML/HTTP, input-focused)
- Component model: facilitates building of applications



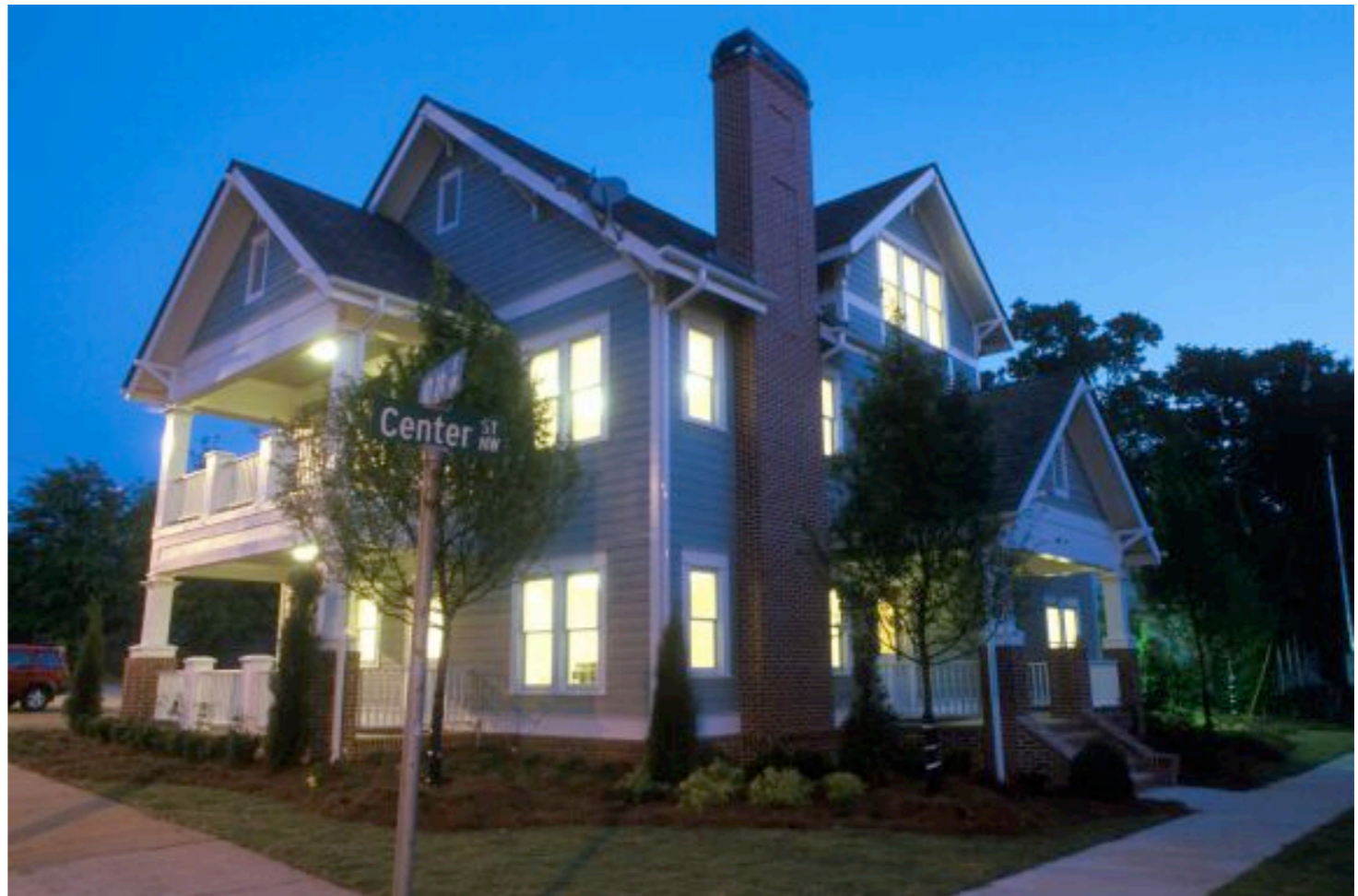
Experiences: Benefits

- Provides separation of concerns
- Lightweight integration and re-use of components
- Easy to create and evolve apps, allowing exploration of the design space
 - Add context to context-less apps
 - Add more context to context-aware apps



Aware Home (MANSE '99)

- Great testbed for context-aware computing
- 3 goals: elderly, infants, everyone
- Context Toolkit is the s/w infrastructure in the Aware Home



Applications Built

- Simple use of location:
 - Turn lights on and off (perform service)
- Location and id (perform service)
 - Information Guide: present info about user's group (CHI '99)
 - Context-Aware Mailing List

In/Out Board – 3 versions (CHI '99)

- Context used: location, identity, time
- How used: present context

A screenshot of the 'FCL In/Out Board' interface. It displays a grid of employee status information. Each entry consists of a name, a colored circle (red for 'out', green for 'in'), and a time. The grid is divided into two columns by a vertical cyan line.

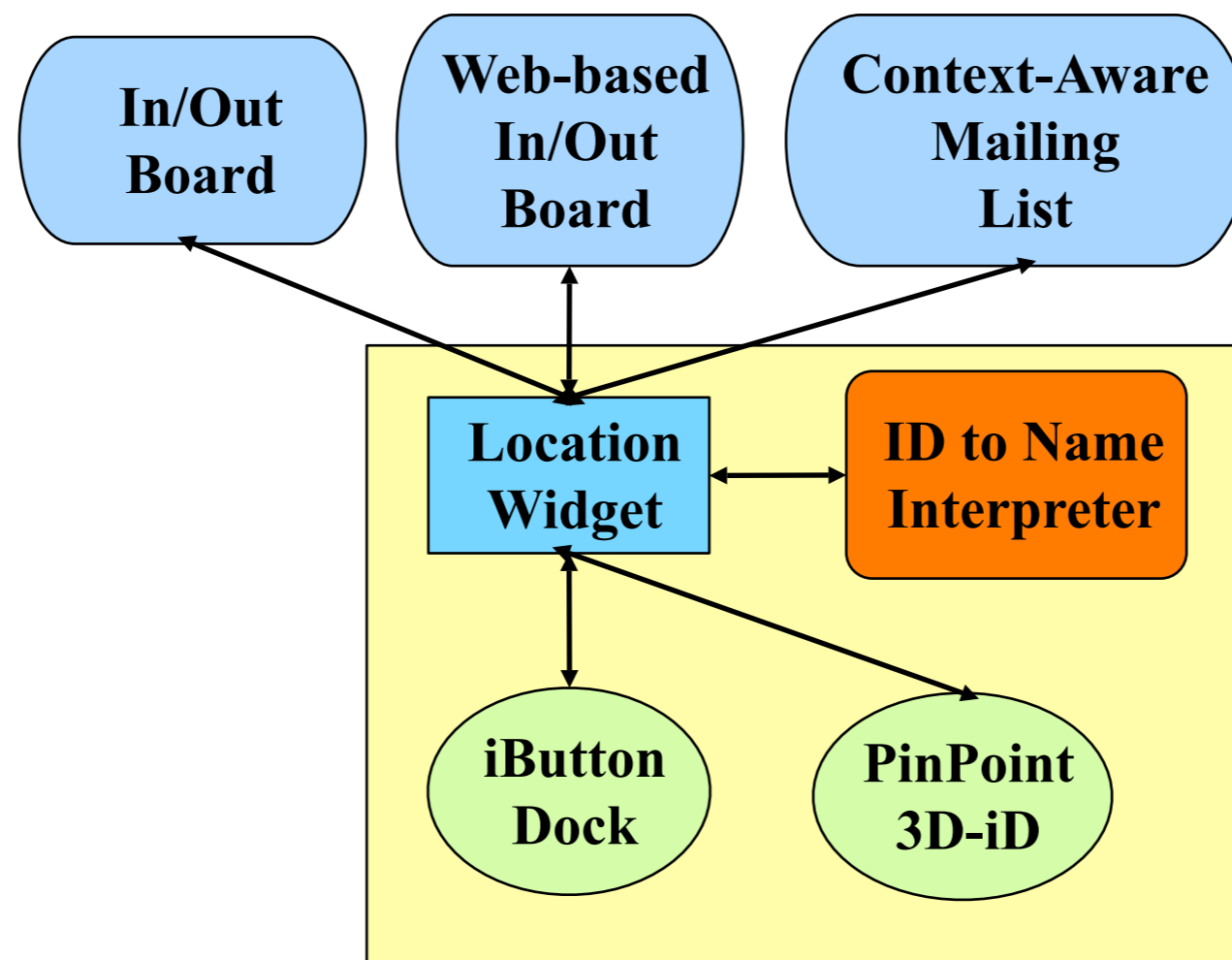
Name	Status	Time
Gregory Abowd	Out	10:50am
Jen Mankoff	In	12:08pm
Jason Brotherton	In	9:28am
David Nguyen	In	11:09am
Anind Dey	In	12:08pm
Rob Orr	Out	1:25pm
M. Futakawa	In	12:00pm
Maria Pimentel	Out	5:54pm
Y. Ishiguro	Out	10:52am
Daniel Salber	In	10:14am
Rob Kooper	Out	5:26pm
Brad Singletary	Out	2:59pm
Kent Lyons	Out	12:27pm
Khai Truong	Out	1:25pm

A screenshot of the 'FCL In/Out Board' interface displayed in a Netscape browser window. The interface shows a vertical list of employee status information. Each entry consists of a name and a status (in/out). The list is scrollable.

Gregory Abowd	in
Jason Brotherton	out
Anind Dey	in
Tanisha Hall	out
Cory Kidd	out
Kent Lyons	in
Jen Mankoff	in
Todd Miller	out
Kris Nagel	in
David Nguyen	out
Rob Orr	in
Daniel Salber	out
Chris Shaw	out
Brad Singletary	in
Khai Truong	out

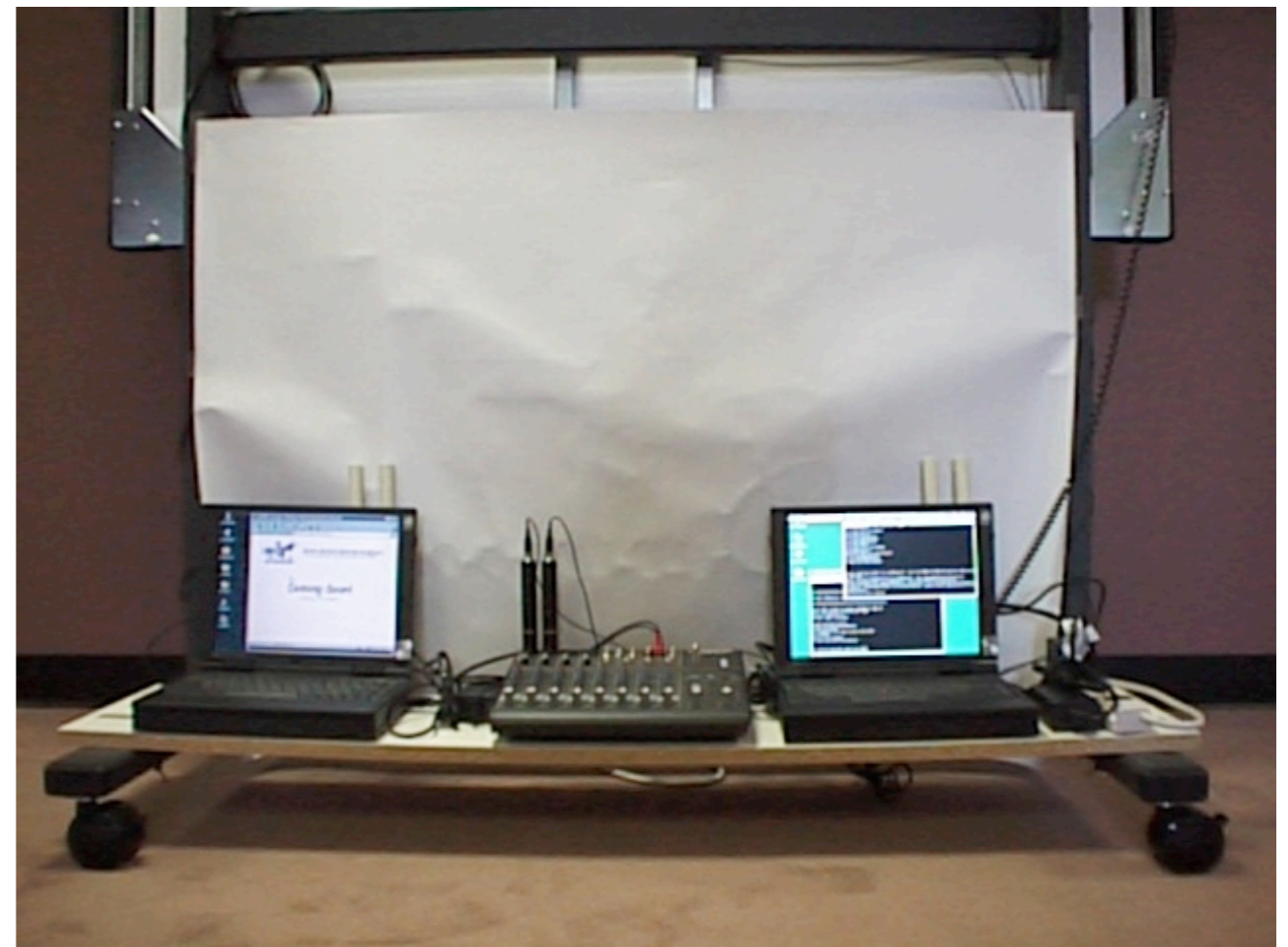
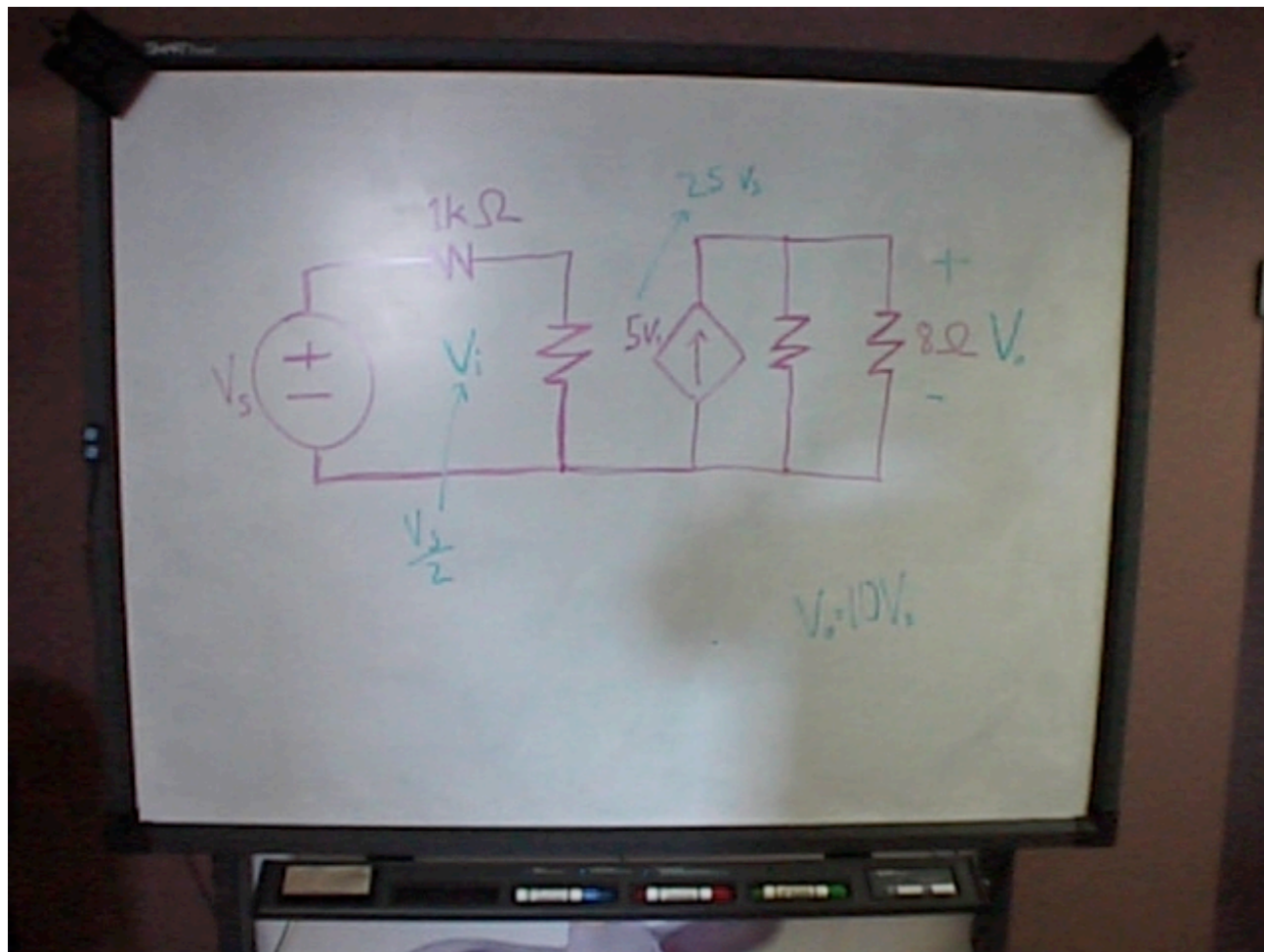
In/Out Board Architecture

- Simple app demonstrates support for **reusability** (don't have to re-build infrastructure on per-application basis) and **evolving** applications



Serendipitous Meetings

- Context used: location, id, time, activity
- How used: present, perform service, tag
- record and tag drawings and audio for later retrieval



The screenshot shows a window titled "DumbaAccess" containing a whiteboard with handwritten notes and diagrams. The notes include "CW", "attainment in 1?", "Gather Ac", "Sensor" pointing to a box labeled "W", "GUI", "location", "size", "Speech Audio", "CA", "entity", "People plus Things Separation", and "location = Person widget (f.-)". A diagram shows a box labeled "MT" connected to a circle "S" and another box. The bottom of the window features a playback control interface with "Play" and "Stop" buttons, a progress bar, and a calendar grid. The calendar shows the month of August 1998, with the 4th, 25th, 26th, 27th, and 28th highlighted in yellow. Below the calendar are filter fields for "When: Aug 1998", "Who: Jason Brotherton", and "Where: Mobile SMART Board #1".

Ink written *before* current time is in original color

Ink written *after* current time is in lighter color

Playback controls

Current time within session

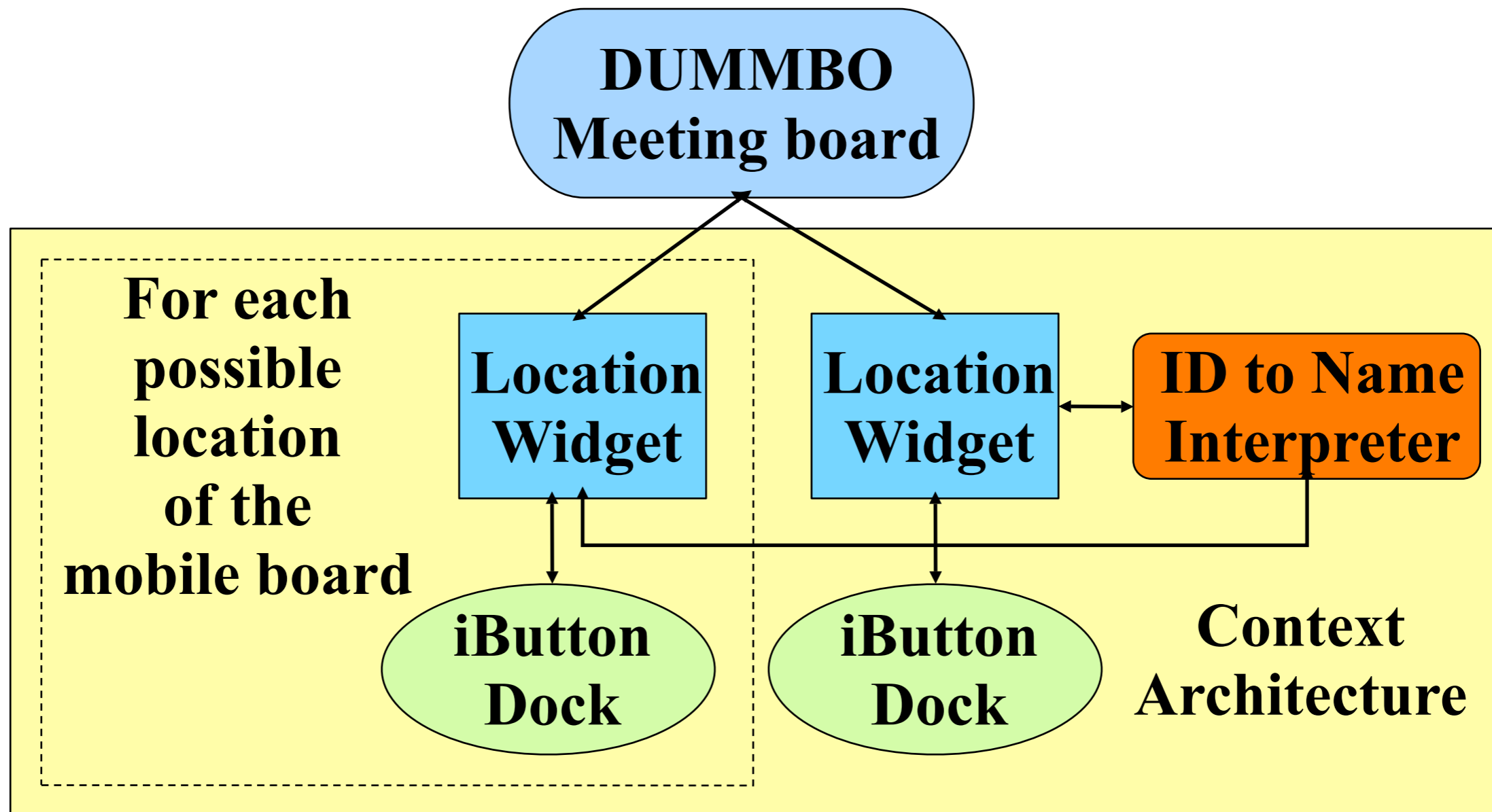
Selected session

Selected day

Day containing whiteboard activity

Filters

Meeting Architecture



Conference Retrieval

Time	Event	Time	Event	Time	Event
9:00	A Daniel Salber-Context Toolkit	9:00	Bill Ribarsky-VR Workbench	9:00	Don Allison-VR Gorilla
9:15		9:15		9:15	
9:30		9:30		9:30	
9:45		9:45		9:45	
10:00	Chris Atkeson-Machine Learning	10:00	A Maria Pimentel-C2000	10:00	Ashwin Ram-Pepe
10:15		10:15		10:15	
10:30		10:30		10:30	
10:45		10:45		10:45	
11:00	Jessica Hodgins-Human Motion	11:00	Ashwin Ram-Personal Pet	11:00	A Anind Dey-Ubicomp Apps

Personal Events: Person: Keyword:

Anind Dey -- Ubicomp Apps

Schedule

Retrieved slide

Slide text

Query Interface

User notes

slide #2

Slide text

User Memo

Identity, Location, Activity of People, Places, Things

context widgets

Back Forward

The slide content is as follows:

- What Is Context?**
- The missing piece
- Information sensed
- Identity, Location, Activity of People, Places, Things
- Who? Where? When? What? Why?

Conference Assistant Arch.

