A Component Architecture for an Extensible, Highly Integrated Context-Aware Computing Infrastructure

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ActiveCampus at UCSD

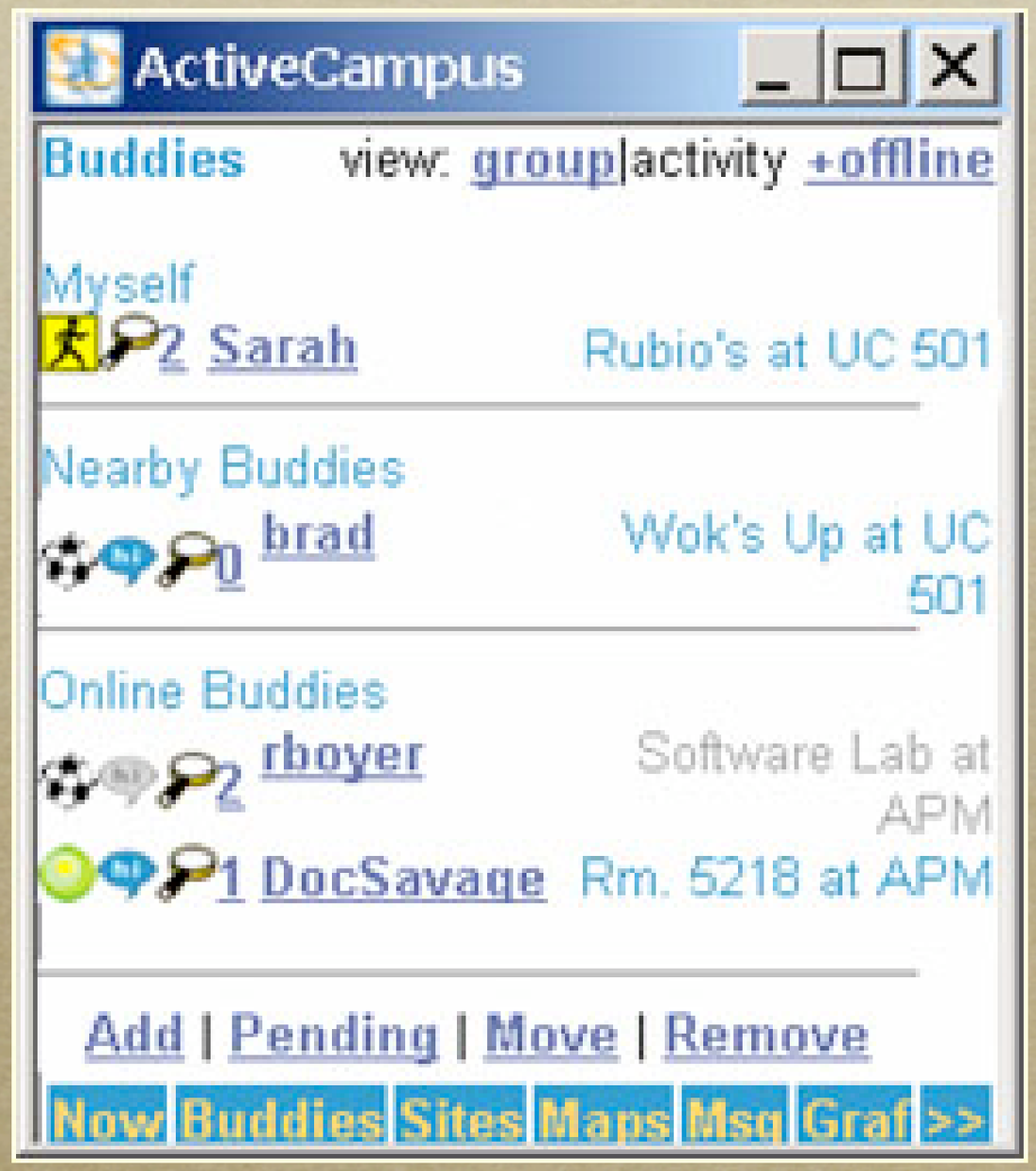
- *http://activecampus.ucsd.edu/*
- *Provide location-based applications*
  - *Also known as services*
- *Understand how such systems are used*
- *Focus on software systems*
  - *Geared for mobile devices*

Growth presents challenges

- *UCSD will add 10k students in 10 years*
- *How to facilitate a cohesive community?*
- *Students are increasingly busy*
- *Mobile technology is getting affordable*
- *Provide tools to help build communities*

ActiveCampus Buddy

- *Instant messaging client*
- *Annotated with location*
- *Display people nearby*
- *Display people online*



ActiveCampus Map

- *Shows current location*
- *Campus map overlayed*
- *Indicates building names*
- *Location of buddies*

What is context?

- *Situation is critical to context*
- *Tools can help determine context*
  - *Alidade: compass, prism, magnifier*

"Constitute the selection, superimposition, and rendering of representations of task-relevant context"

Needs for Software Architecture

- *Add services easily*
  - *Anticipate future changes*
    - *Introduce separation of concerns*
- *Desire critical constraints*
  - *Do not sacrifice integration*
  - *Performance is critical*

Goals for Extensibility

- *Add new services and functionality*
- *Introduce new sensor input*
- *Incorporate new physical entities*
- *Represent locations multiple ways*
- *Use new classes of user devices*

Building upon Context Toolkit

- *Previous work by Dey and Abowd*
- *No useful architectural style presented*
  - *Desire to have efficient communication*
    - *Context Toolkit may be too heavy*
  - *Desire to produce integrated applications*
    - *Services change over time*

ActiveCampus Architecture

- *Centralized, layered system architecture*
  - *Computation by central server*
    - *Minimizes demands on portable devices*
  - *Receive input from sensors (handhelds)*
  - *Utilize web standards for display*
    - *Handhelds or desktops*

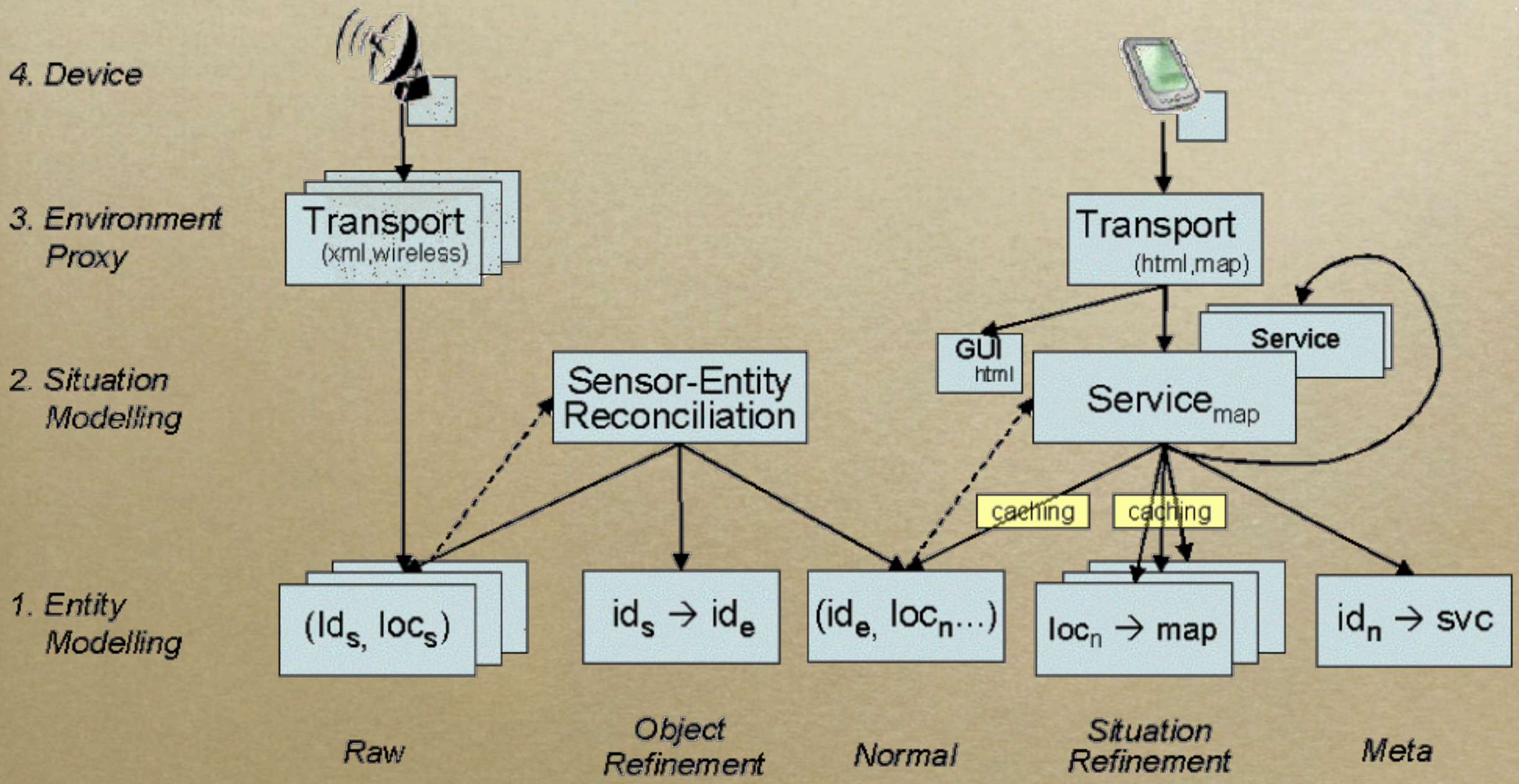
Initial Architecture Layers

- *Data Storage*
- *Data Abstraction*
- *Object Correlation*
  - *Mapping data to internal forms*
- *Environment Proxy*
  - *Transport to external devices*

Problems with Architecture

- *Entity definitions saw churn and bloat*
  - *Adding alternate representations hard*
- *Services were not decoupled properly*
  - *Interdependent chain of services*
- *Performance was becoming unacceptable*
  - *Database access became bottleneck*

Revised Architecture



Addressing Entity Bloat

- *Intrinsic blurred with presentation*
  - *People may have the same screen name*
- *Performed entity normalization*
  - *Isolates only **essential** characteristics*
- *Object Correlation is Situation Modeling*
  - *Tries to determine what is happening*

Achieving Low Coupling

- *Services available for subject about object*
  - *John's buddy service about Jane*
- *Services registered at startup*
- *Services provide standard interfaces*
  - *Defines compatibility between services*
- *Compatible services called when needed*

Optimizing Performance

- *Prior concerns may impact performance*
- *Two-level caching system deployed*
  - *Inter- and Intra-service caching used*
- *Allows for inconsistent and stale data*
  - *Location ten seconds ago is ‘fine’*
- *Allows minimization of communication*

Impact of Architecture

- *Isolate functionality in layers*
- *Add rules for combining components*
- *Present situational context to users*
- *Keys in on how services interact*
- *Support of new devices styles difficult*

Conclusions

- *Demonstration at UbiComp 2003*
  - *Opportunity to use around Seattle*
  - *Still determining what styles work best*
    - *Understand tradeoffs in UbiComp*
- *Feedback and experience only answer*