Universal Inbox: Extensible Personal Mobility and Service Mobility in an Integrated Network

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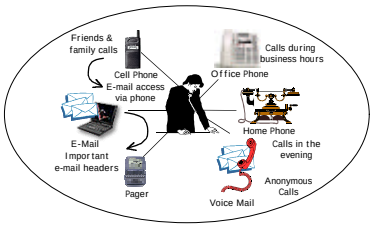
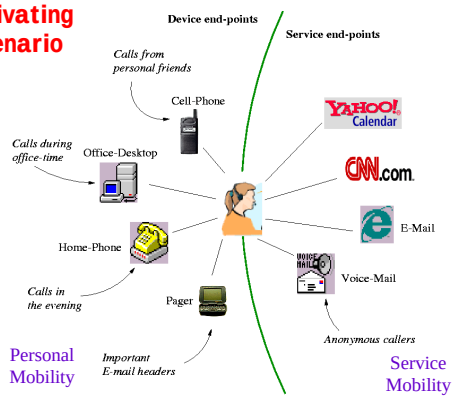


Motivating Scenario



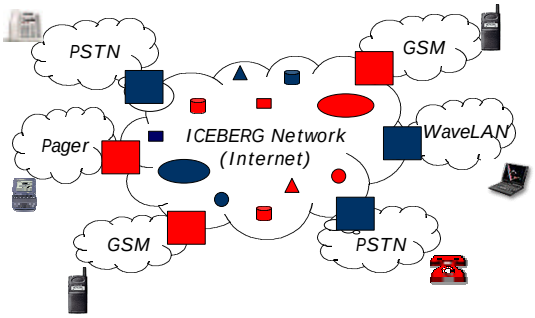
Problem Statement

Communication devices

Communication services

- Requirement
  - Service integration and personalization
- Goals
  - Any-to-any capability
  - Extensibility: ease of adding new end-points
  - Scalability: global scale operation
  - Personal mobility and Service mobility

ICEBERG: An IP-Centric Middleware Approach

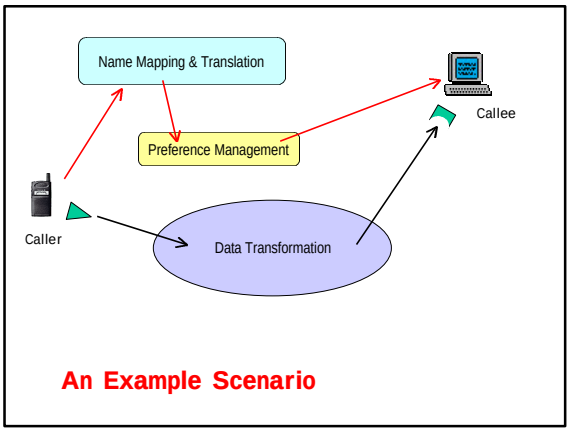


Internet-based Infrastructure

- Components in the Internet: open model
- Leverage proxy and cluster architectures
- Independent components:
  - Can be independently and incrementally deployed

Design Principles

- Separation of functionality
  - Separation → independent and reusable components
  - Reuse → easy extensibility
  - Shared network services → Economy of scale
- Network and device independence
  - Needed for extensibility to new devices
- Push control towards callee
  - In current communication networks, caller has control
  - Callee needs to have control for flexible handling of incoming communication



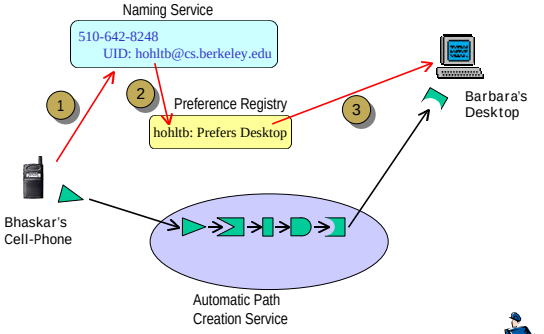
An Example Scenario

Common Functionalities

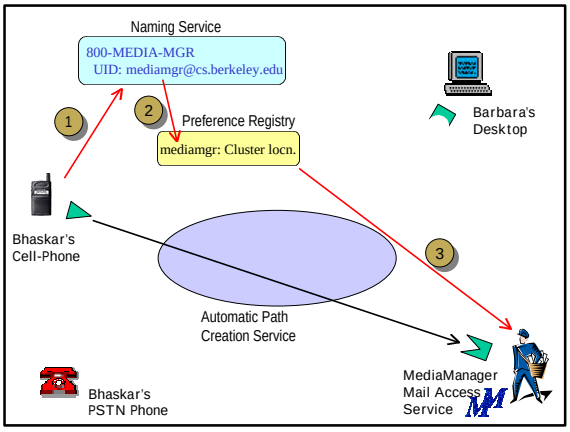
- Any-to-any data transformation
  - For communication between heterogeneous devices
  - Device data-type independence
  - Automatic Path Creation (APC) service
- User preference based ubiquitous redirection
  - For personalization of communication
  - Achieves the "control to callee" design principle
  - Preference Registry service

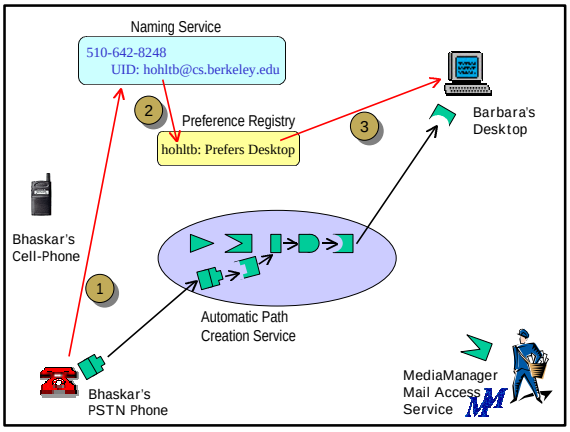
Common Functionalities

- Device name mapping and translation
  - For dealing with multiple user identities and different name spaces
  - Device name independence
  - Naming service
- Also, gateways to access networks at different locations
  - Provide network independence
  - ICEBERG Access Points



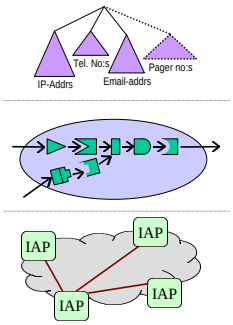
Illustrating Extensibility





Extensibility

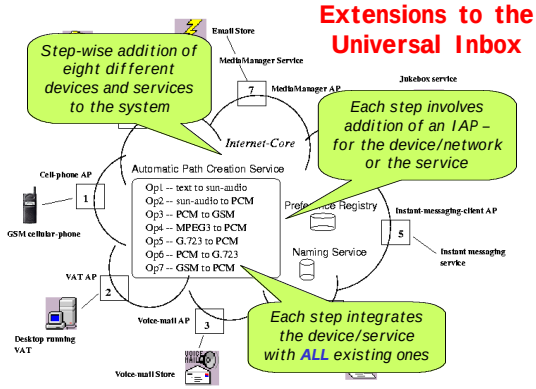
- Name-space
  - Hierarchical
  - New name-spaces added by creating a new sub-tree at root
- Automatic Path Creation service
  - Operators can be plugged in
  - Old operators are reusable
- Set of ICEBERG Access Points
  - New IAPs can be added independent of existing ones
  - All old IAPs are reachable from the new one



Implementation Experience

- Extensibility
  - Universal Inbox set of features extended to many device and service end-points
- Scalability
  - Components tested for latency and scaling bottlenecks

Extensions to the Universal Inbox



Implementation Experience with Extension

- Examples of extension:
  - IAP for MediaManager
    - Allow access to the MediaManager service
    - ~ 700 lines of Java
    - No other component had to be touched
  - Operators for G.723
    - Getting codec to work required effort
    - But, adding to APC was ~ two hours of work (➔ simple API for adding operators)

Lessons learned: What was easy?

- Extension to include a new communication service or device
  - Build an IAP
  - Add appropriate operators

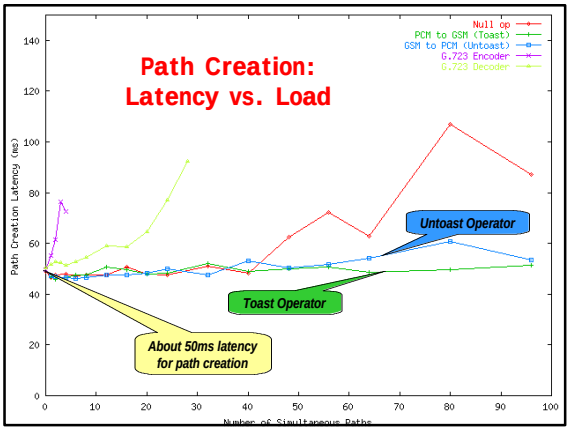
Effort involved in building a service is independent of the number of networks it is made available on

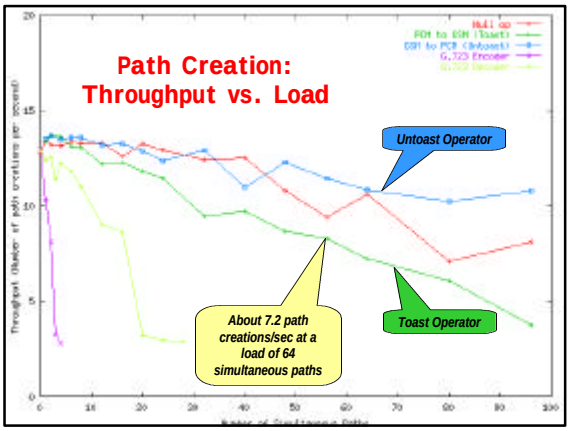
Scalability Analysis

- Shared infrastructure components
  - Scaling and provisioning concerns
- Three shared core components are:
  - APC
  - Preference Registry
  - Naming service

Scalability Analysis: APC

- Performance for the following operators
  - Null (copies input to output)
  - Toast (PCM to GSM)
  - Untoast (GSM to PCM)
- Path creation latency and throughput measured as a function of increasing load
- 500MHz Pentium-III 2-way multiprocessor running Linux-2.2 with IBM's JDK 1.1.8





Calculation of Scaling

- On average
  - 2.8 calls/hour/user
  - Average duration of calls (path) is 2.6 minutes
- Using these
  - 571 users can be supported by a two-node APC service
  - Telephone network uses expensive TRAU at the Inter-Working Function for these transformations

Related Work: State-of-the-Art

- Commercial services
  - Concentrate on functionality
  - No any-to-any capability
- Research projects
  - Mobile People Architecture: Personal Proxies
  - Telephony Over Packet networkS
  - UMTS
- Not all issues addressed
  - Infrastructure support for network integration
  - Extensibility
  - Scalability
  - Personal mobility + Service mobility

Summary

- Universal Inbox: metaphor for any-to-any communication and service access
- Internet-based infrastructure
- Personal mobility
  - redirection by preference registry
- Service mobility
  - result of the any-to-any capability
- Architecture viable for global operation
  - IAPs can be developed and deployed by independent service providers
- Extensibility
  - Made easy by the separation and reuse of functionality