Pocket Switched Networking

Challenges, Feasibility and Implementation Issues

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Overview

- Background
- Pocket Switched Networking
- Challenges in PSN
- Haggle: our implementation of PSN

Mobile wireless devices present a new environment

- Mobile device capabilities
  - Computing power: exponential growth
  - Storage: likewise
  - Programmability; general purpose apps
  - Multiple wireless network interfaces
  - Human-driven mobility

Problem Statement

- Mobility pattern influences networking
  - Constantly changing set of “local” devices
  - Occasional “global” (i.e. Internet) connectivity, depending on location and willingness to pay
  - Data can be physically carried from a to b.
- IP-centric networking has bad assumptions
  - Contemporaneous connectivity between hosts
  - Can perform address resolution before data tx
  - Role of network confined to delivery

Current result: User inconvenience when connectivity is dynamic

- Many different applications with same user-level purpose
  - Messaging: Email vs. IM vs. web chat
  - Photo sharing: Bluetooth vs. USB key vs. website upload
- Users have to understand which app to use and when
- Many applications are only useful when connected in specific ways

Pocket Switched Networking: Aims

- Replace socks/TCP/IP as the API for networking on mobile devices
- Data should be delivered using *local connectivity*, *global connectivity*, and *user mobility* transparently
- Discard end-to-end: intermediate nodes are powerful, may be interested in the data, and can help with routing

Pocket Switched Networking: Principles

- Use messages rather than packets so that intermediate nodes can participate fully
- Expose as much meta-data to the network layer as possible to allow content-based forwarding
  - E.g. send to “Jon”, or “anyone with latest football score”
- Routing decisions made locally based on knowledge of dynamic environment
- PSN is the filesystem as well as the network; all data is “public” to some extent
  - E.g. share webpages with anyone, share private files between a user’s devices

Pocket Switched Networking: Challenges

- Distributed naming/addressing
  - Cannot do many-round-trip lookups c.f. Internet
- Forwarding without flooding
  - Need to learn network state and target messages
- Security, trust, incentives/policing
  - Without access to infrastructure services
- Usability and privacy
  - How do we portray to user?
- Resource management
  - Don’t kill my battery to service stranger’s requests

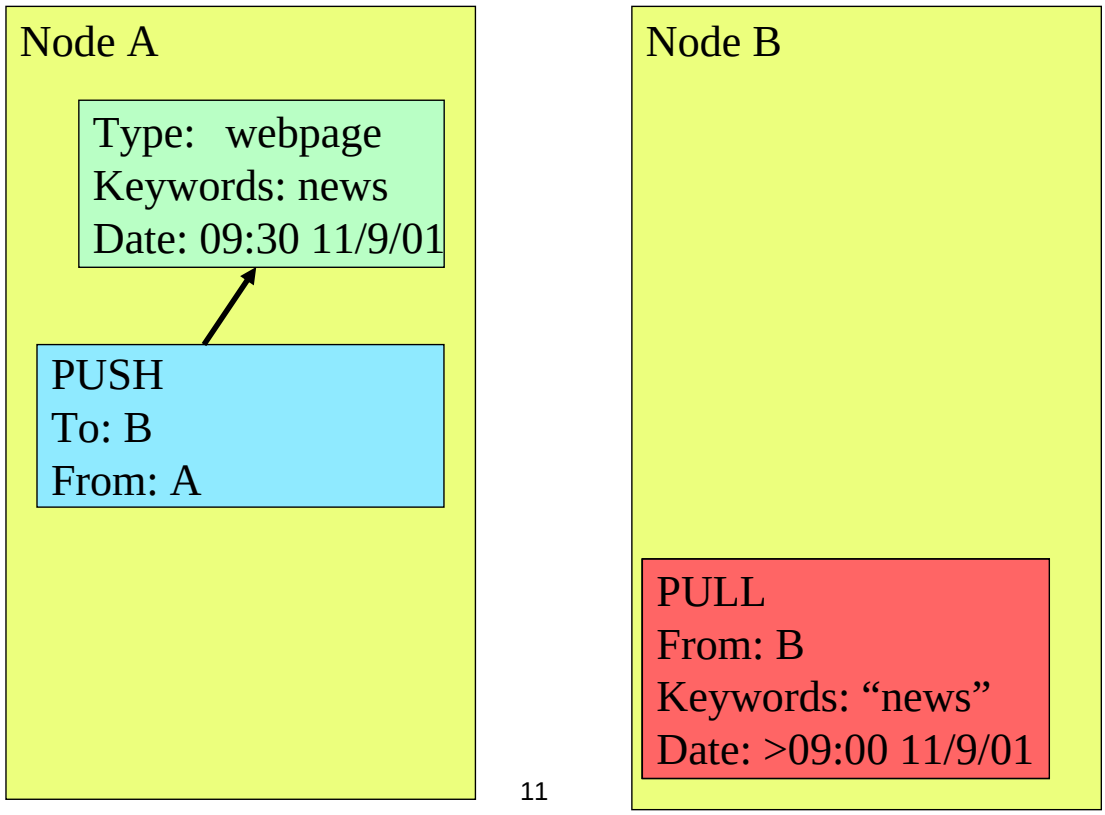
Naming/Addressing

- Use names representing user-level entities such as people, places, and info
  - “Jon”, “Intel Research Cambridge”, “current news”
- Names potentially map onto many nodes
  - E.g. My notebook *or* my mobile phone
  - E.g. Any device in Intel Research Cambridge
- Addresses annotate names with forwarding hints
  - e.g. “James” maps to: “Intel” community; seen today in Greece; email address james.w.scott@intel.com, phone number +447970123456

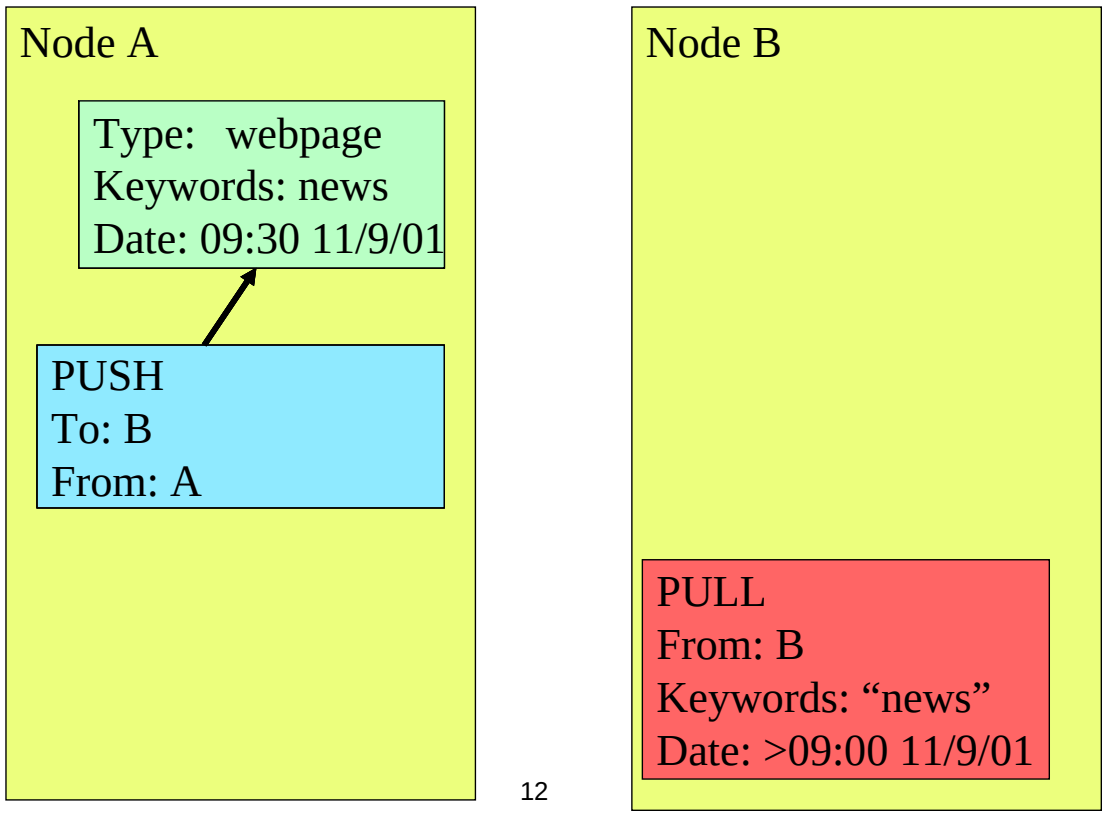
Forwarding

- Node mobility means each message may take different route
- Need to learn about and internally model the network behaviour
- Make use of addressing hints as well as dynamic state information learnt from neighbours
  - e.g. Device X saw James’s laptop 1 hour ago
- Potentially use multiple, diverse paths
- Support both push and pull…

Push and Pull Illustrated



Push and Pull Illustrated



Security, Trust and Incentives

- Need to encrypt data appropriately for the security domains encountered
  - Secrets can go from my mobile phone to my laptop via your phone, if encrypted appropriately
- Distributed trust management required
  - Prerequisite for encryption/authentication
  - Local communications means no certificate authorities
- Reputation systems may be used to provide incentives to play nice
  - “familiar strangers” [Paulos]
  - c.f. resource management later

Usability and Privacy

- Usability will require informing the user about network state issues – but how?
  - Spinning globe, signal strength bars, greyed-out names in IM
- Privacy is compromised in new ways
  - Sharing meta-data with neighbouring nodes means disclosing information
  - Must provide a way for users to mentally model and control the privacy/functionality tradeoff

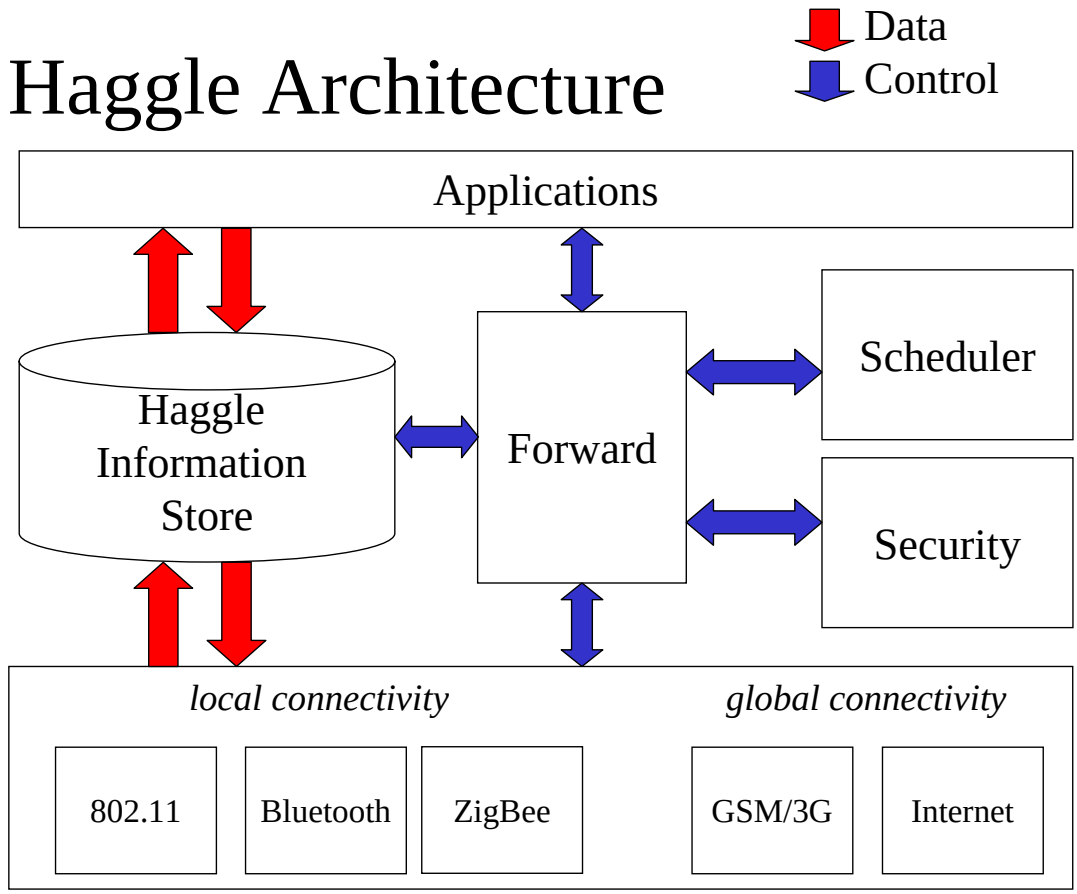
Resource Management

- Storage, CPU not a problem
  - Moore's law growth
  - Prioritisation is fairly simple
- Network and battery life more constrained
  - Use automatic policy as well as manual control
  - Nodes are often connected to power or Internet, and may also *predict* connectivity

Haggle: our PSN implementation

- Preliminary ideas – work starts Jan 2006 under EU FET Autonomic Communications project
- Build a reference PSN implementation
  - Cross platform
  - Cross network technology
  - Integration with legacy systems (e.g. email, web)
  - Modular, especially for forwarding and security

Haggle Architecture



Haggle Applications

- Asynchronous messaging
  - Subsumes email, IM, SMS
- Usenet-style newsgroups
  - Existing app which handles disconnection well
- Querying in the local environment
  - [“world news”, age < 1 hour]
  - Automatic caching
- File sharing
  - Photos/documents (e.g. this ppt file)
- Data synchronisation
  - support user’s “cloud” of devices

Questions?

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Or connect to 802.11 SSID “yaap” now!