Connection Rerouting Strategies for Mobile Networks

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Synopsis

Motivation

The Problem

Connection Rerouting Strategies

Conclusions

Future Work

The Infopad

Motivation

Mobile Computing Devices

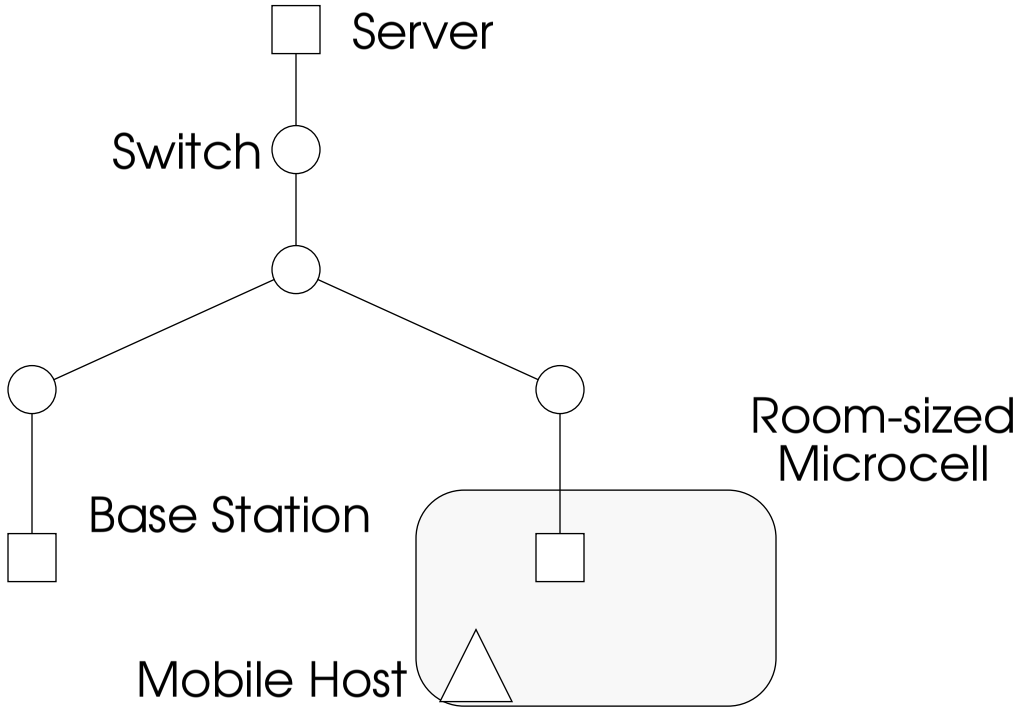
$\Rightarrow$ Mobile Networks

Multimedia Applications

$\Rightarrow$ Real-Time Network Services

Tenet Real-Time Scheme/Protocol Suite

Mobile Networks



Mobile Hosts with wireless network interfaces

Base Stations: Gateways between wireless and wired networks

Backbone network: Conventional wired network or internetwork

The Tenet Real-Time Scheme

Multimedia applications need hard real-time guarantees on network parameters, for example...

- Delay
- Delay jitter
- Bandwidth
- Buffer allocation

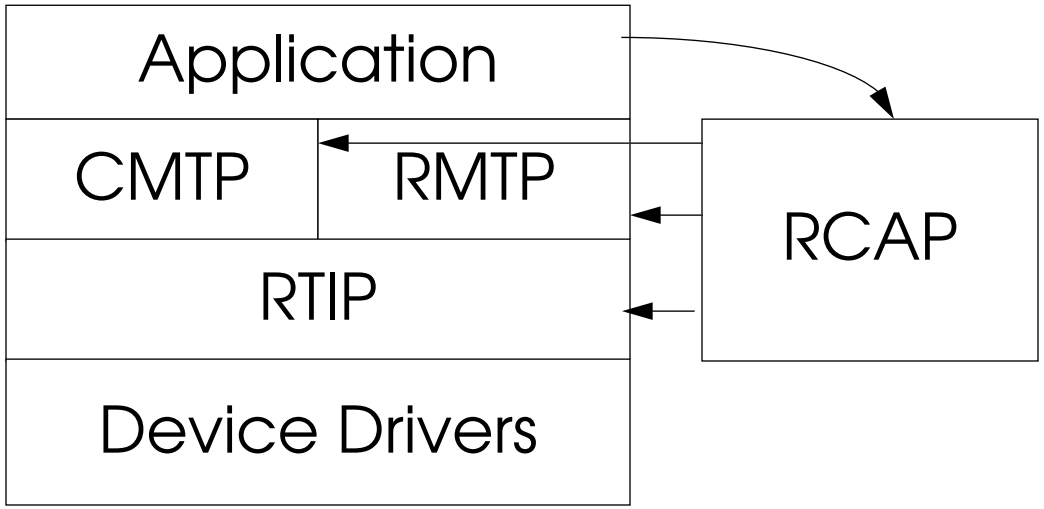
Guarantee performance using...

- Admission control
- Network resource allocation
- Work on level of individual network conversations

Requires a connection-oriented network layer

The Tenet Real-Time Protocol Suite

Performance-Guaranteed Network Communication



Continuous Media Transport Protocol (CMTP)

Real-Time Message Transport Protocol (RMTP)

Real-Time Internet Protocol (RTIP)

Real-Time Channel Administration Protocol (RCAP)

The Tenet Real-Time Protocol Suite

Tenet Suite I

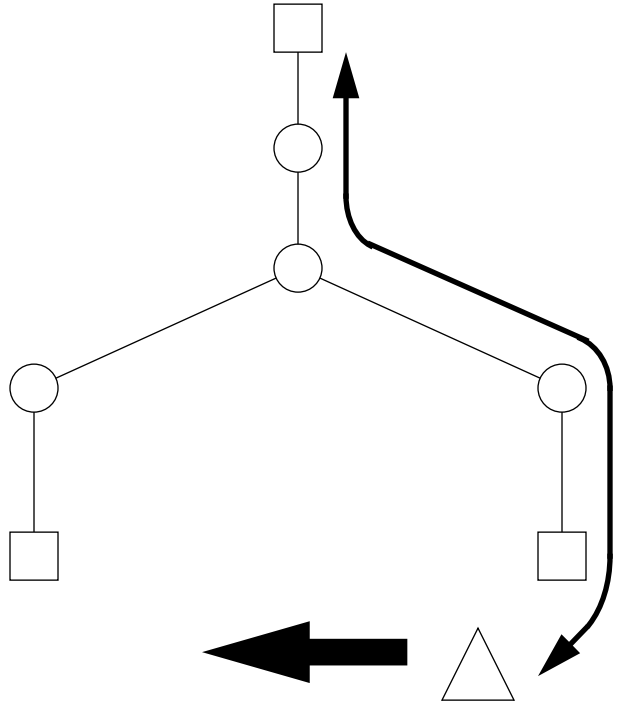
Performance-guaranteed, unreliable, connection-oriented, unicast real-time channels

Tenet Suite II: The Sequel

Performance-guaranteed, unreliable, connection-oriented, *multicast* real-time channels

The Problem

How to re-route network connections when a host moves between cells?

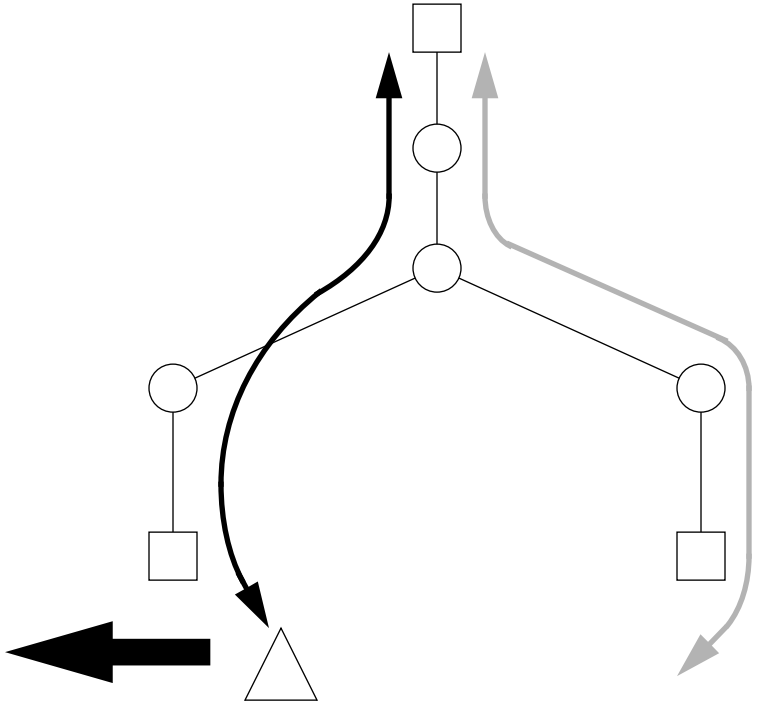


More of the Problem

- What to do
  - Determine crossover point
  - Forward data (optionally)
  - Reroute connection
- Information on impending handoffs
  - Use as hints...don't always have them
  - Radio networks may have "dead spots"
  - Infrared networks may have line-of-sight problems

Full Re-Establishment

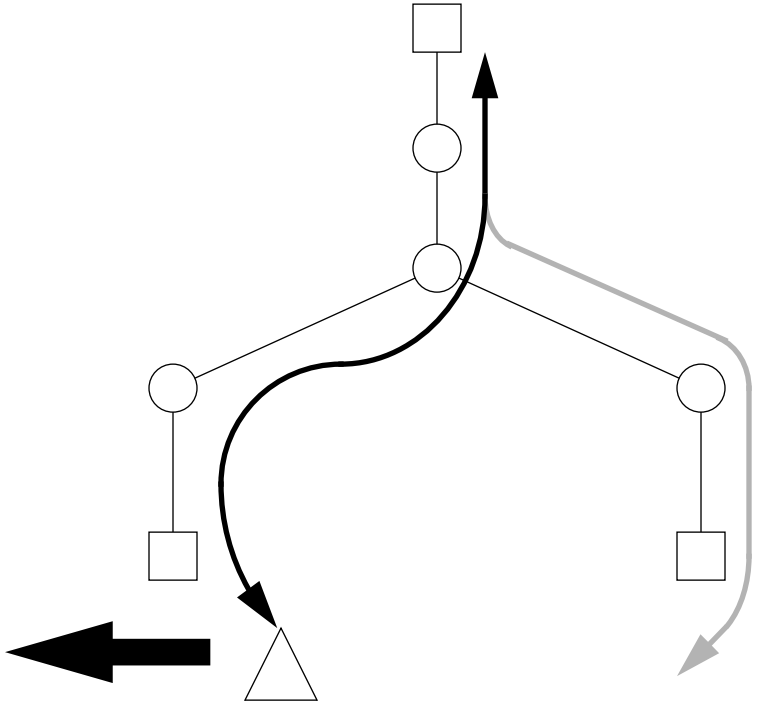
Establish new connection for every existing network connection.



Problem: Long paths mean long handoff latencies.

Incremental Re-Establishment

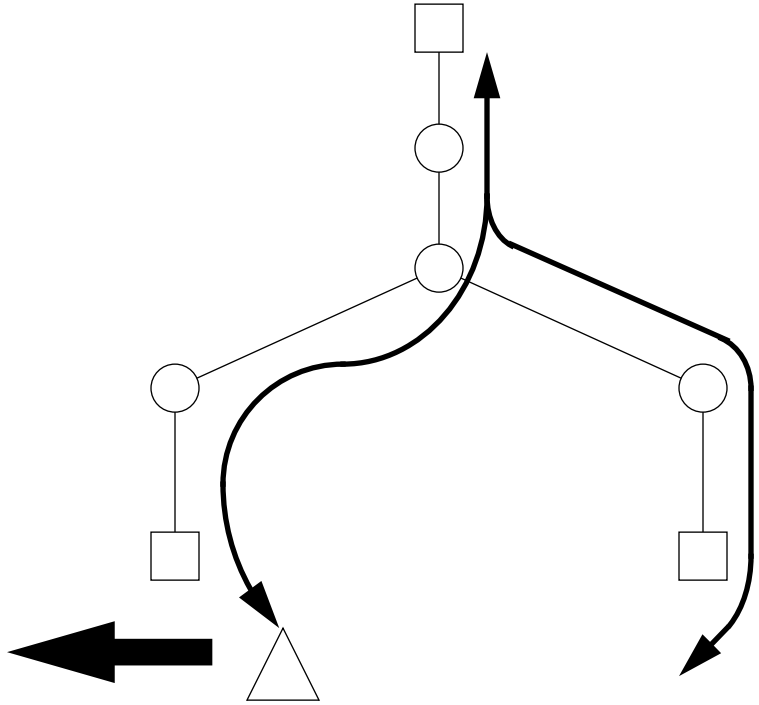
Only create the disjoint part of the connection to the new base station.



Key: Find the crossover point!

Multicast-Based Re-Establishment

Use multicast facilities of the network to support handoff



Use lots of network bandwidth to reduce handoff latency

Easy to build

Preliminary Analysis

Compute values of metrics...

- Service disruption time (mobile host cannot receive downlink data)
- Buffer usage
- Excess bandwidth utilization in the network

For different connection types...

- Distance to crossover point
- Distance between (physically) adjacent base stations

For a given technology point...

- Latency, bandwidth of wireless and wired links
- Protocol processing time
- Control and data packet sizes
- Acquisition time during host migration
- Speed of cell transition

Results of Preliminary Analysis

Service disruption time and downlink buffering in the base station vary linearly with forwarding path length (except for Multicast-Based re-establishment with hints).

Uplink buffering on the mobile hosts is identical for all algorithms.

Using hints trades excess allocation of resources in channels against needing to forward data.

Multicast-Based re-establishment uses fewer network resources than Incremental Re-Establishment or Full Re-Establishment.

For long base station-to-crossover point paths, all algorithms are about the same.

Total path length only affects Full Re-Establishment.

Conclusions

Hints are good

We should investigate other multicast-based schemes, they look promising

Considerations of network topology are important (want crossover point as close to the handoff site as possible)

Future Work

- Simulation using Ptolemy
  - Capture dynamics of the network
  - Attempt to measure network capacity
- Verification of handoff protocols
  - Hint-based protocols
  - Unreliable message delivery
- Implementation
  - Infopad
- Implications of mobility on semantics of real-time guarantees?

The Infopad

A Portable Multimedia Terminal

University of California at Berkeley Faculty

- Bob Brodersen (electronics)
- Dave Messerschmitt (display server, video coding)
- Domenico Ferrari (backbone network and network protocols)
- Randy Katz (storage servers)
- Jean-Paul Linnartz (radio links)

Key Features of the Infopad

Portable Terminals

- Lightweight: Size dictated by display
- Low power: battery operated

Multimedia I/O

- Speech (input/output)
- Full Motion Video (output)
- Graphics/Text (output)
- Pen (input)

Micro-Cellular Network

- 1-3 GHz band
- Cell size of ~30 feet in diameter
- Low power transmission(1-10 mW)
- “High” bit rate (1-2 MBps)

Applications

Video on demand: Movies, news, programming

Print media databases: Books, newspapers

Supercomputer simulation and display

Driver information and safety systems

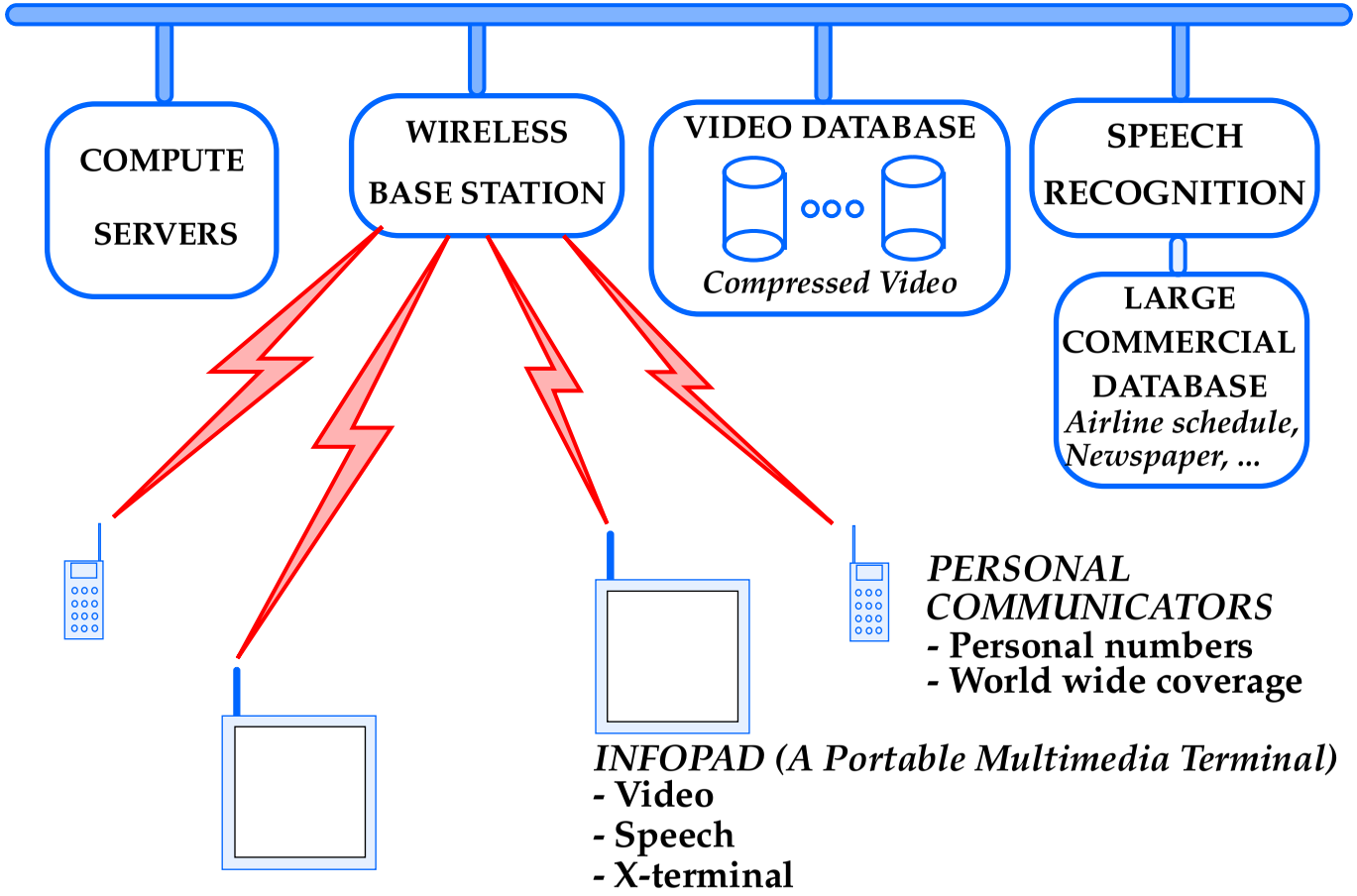
Videophone

Home and office information services

Remote sensing and actuation

Emergency services

The Infopad Environment



What's Special About Infopad?

- Power consumption is key
  - No processor on Infopad: Too much power
  - Connection endpoints may be on base stations
  - Applications run on compute servers in the backbone network
  - Process migration of display server during handoff?!?
- X as a display server
  - Is this a Good Thing™?
- Asymmetric uplink/downlink channels

Plans for the Infopad

Implement real-time protocols on Infopad backbone network

Implement mobility on Infopad when prototype hardware is available

- Experiment on a virtual mobile network first?