Software Architecture of the Infopad System

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Outline

- Infopad System Overview

- Infonet Software Requirements and Architecture

- Scenarios

- Performance

- Summary / Future Work

Infopad System

- Goals:

  Wireless computing environment

  Support access to large number of users

  Provide mobile access to multimedia network services

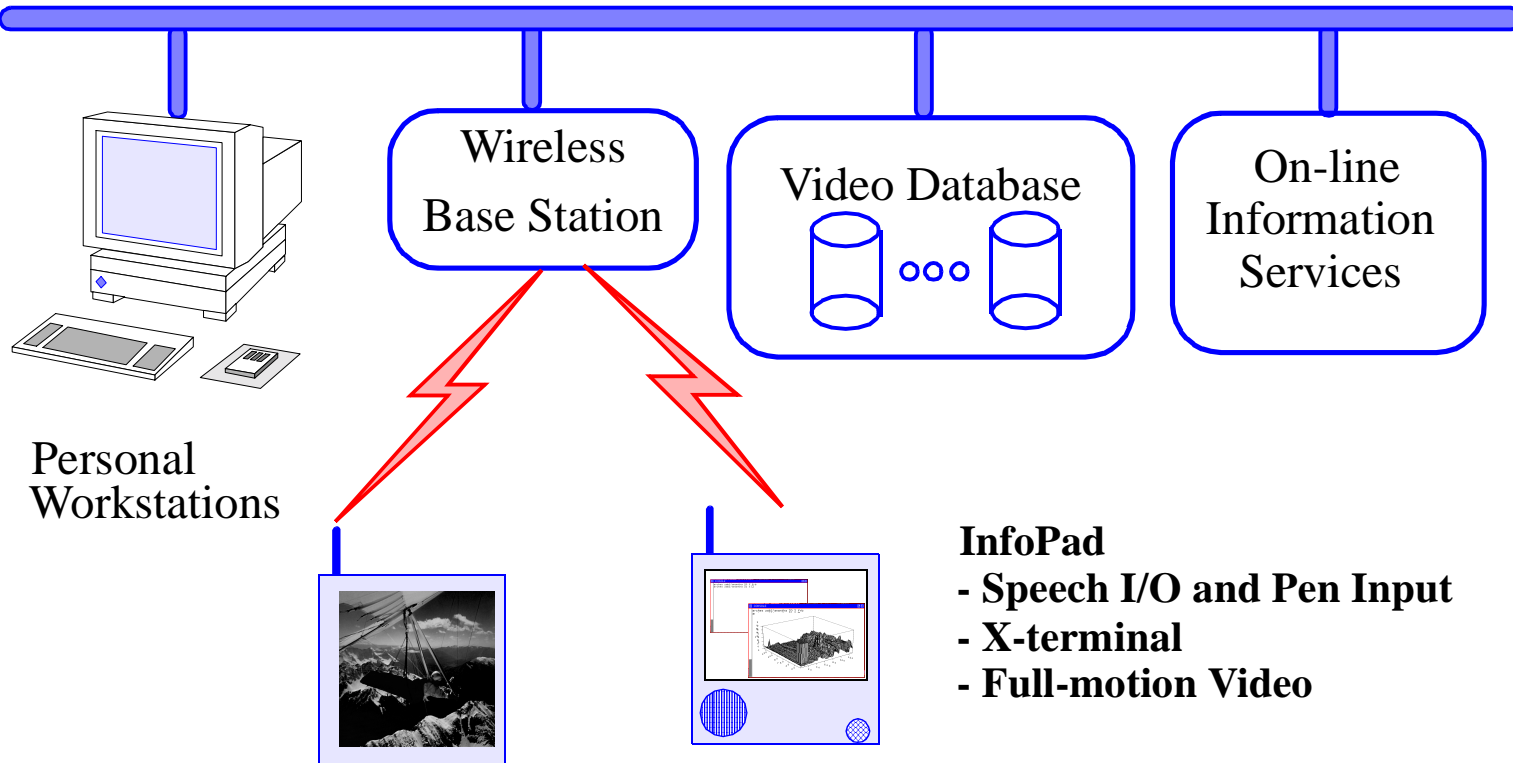 Compatibility with workstation applications

- Underlying Concepts:

  Ubiquitous access to network using wireless technology

  Remote computation & storage

Creates many challenges in network software infrastructure

Infopad System Environment

Fiber Optic Backbone Internetwork 100 Mbps - 1 Gbps

Wireless Base Station

Video Database

On-line Information Services

Personal Workstations

InfoPad
- **Speech I/O and Pen Input**
- **X-terminal**
- **Full-motion Video**

- Compatibility with workstation applications

- Support for real-time multimedia

Wireless Network
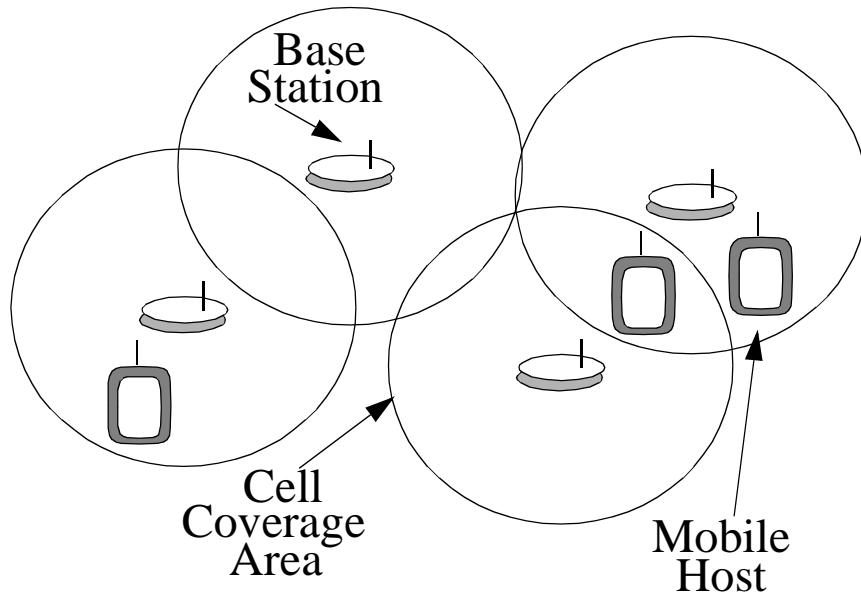
- 5 meter cell radius
- up to 60 users/cell
- 1 Mbps/user
- CDMA
- Overlapping cells
- Pilot tone
- Mobile host measures signal strength of nearby base stations

Diagram labels: Base Station, Cell Coverage Area, Mobile Host

- Mobility --> cellular handoff
- Manage CDMA code reuse
- Quality of Service (QOS) --> power & bandwidth management
- Compensate for high error rate

The Pad: A Multimedia Terminal

Support

- Graphics
- VQ-compressed motion video
- High quality audio
- Pen input
- Cellular radio network

- Low Power - 100 mW budget for electronics

- Intelligent multimedia display

- Remote computation needed

- Move computation/storage to backbone network

- Error resistant

Infopad Software Infrastructure Challenges

- Communication based / distributed computing

    Low latency communication between remote computation and Pad

- Mobility

    Cellular handoff must be done efficiently

    Location of Pads must be kept track of

- Compatibility

    Remote computing and mobility must be made transparent to user/application

- Heterogeneous network environment

    Support characteristics of wired and wireless networks

- QOS requirements

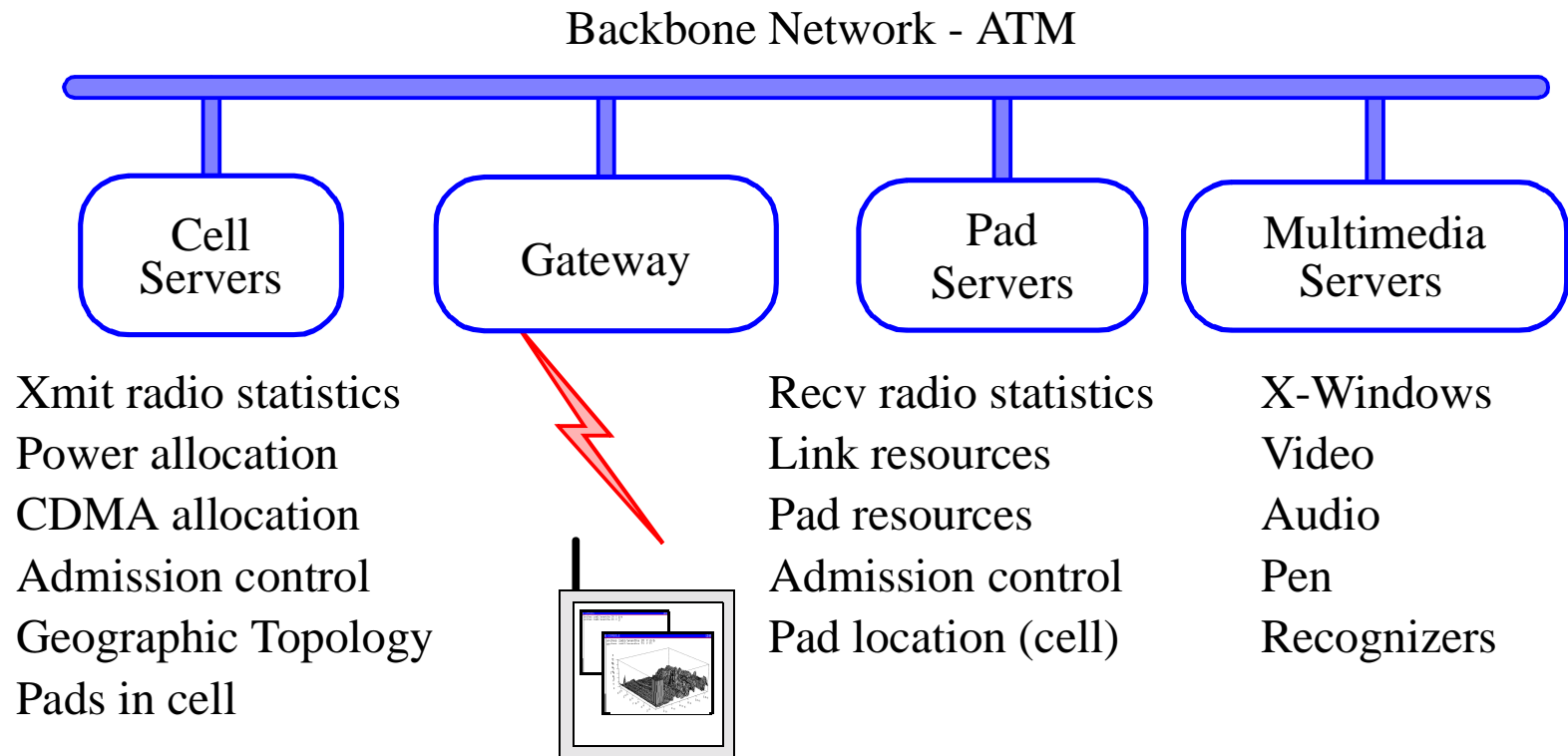   Support widely varying QOS requirements across wired & wireless links.

Division of State/Responsibility

- Pad Server - control for each Pad

- Cell Server - control for each cell

- Gateway - data path for each cell

- Network Controller - control for backbone network
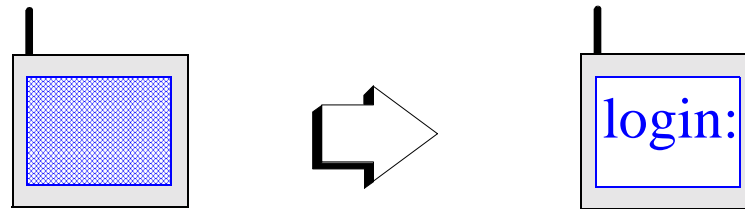
InfoNet Architecture

Backbone Network - ATM

| Cell Servers | Gateway | Pad Servers | Multimedia Servers |

Xmit radio statistics   Recv radio statistics   X-Windows
Power allocation   Link resources   Video
CDMA allocation   Pad resources   Audio
Admission control   Admission control   Pen
Geographic Topology   Pad location (cell)   Recognizers
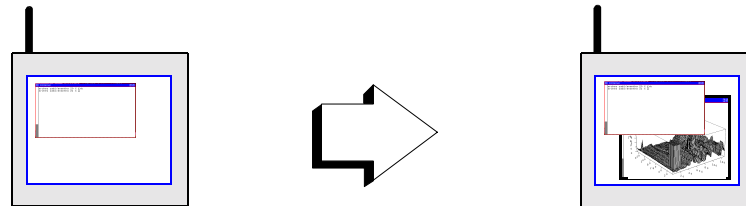Pads in cell

- **Network Controller**

    Create, route, manage connections & resources in the wired
        network

Scenarios

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- Activation

login:
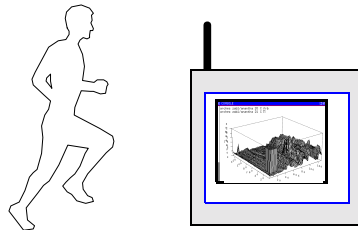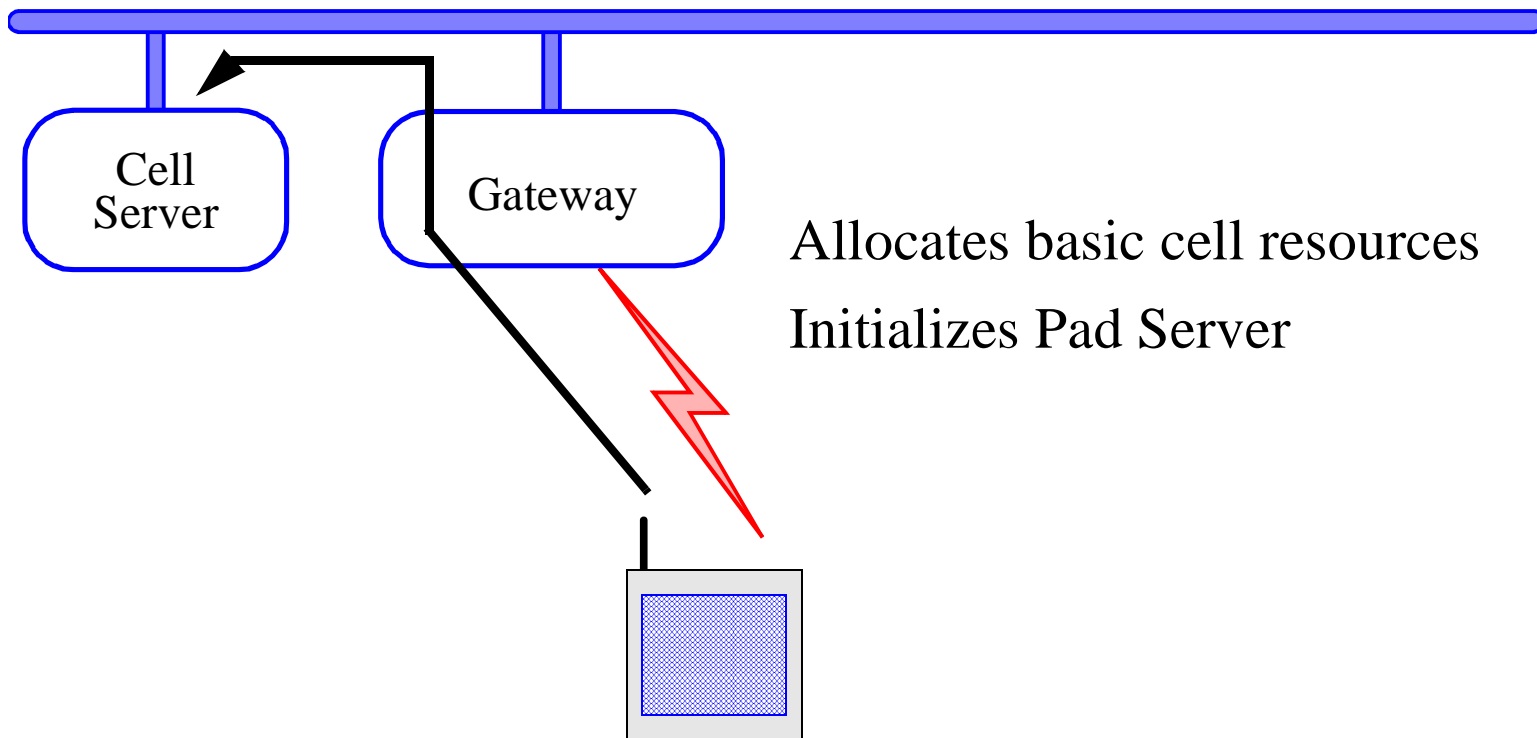
- Application initialization

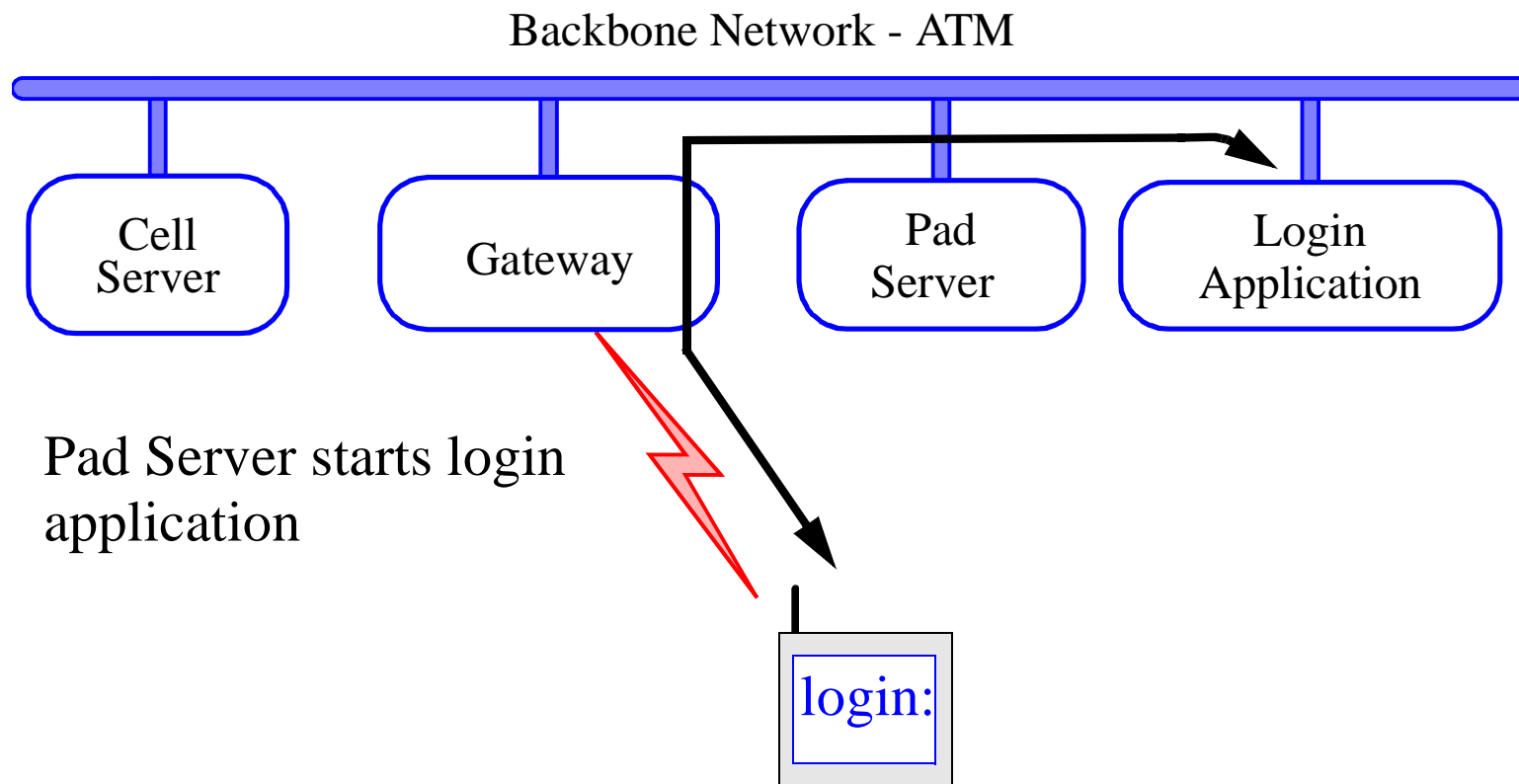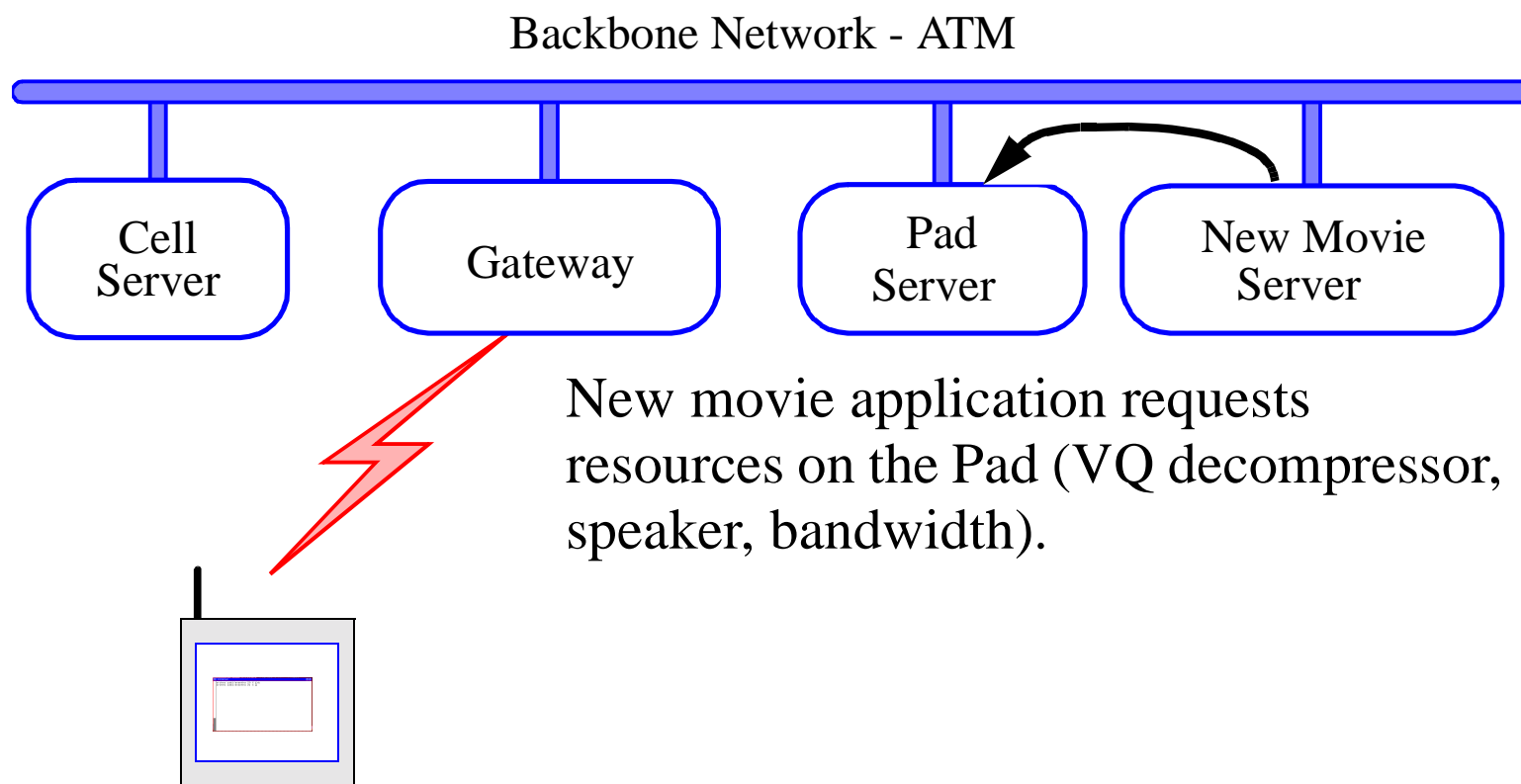- Mobility

Activation 1

Backbone Network - ATM

Cell Server

Gateway

Allocates basic cell resources

Initializes Pad Server

Activation 2

Backbone Network - ATM

Cell Server Gateway Pad Server Login Application

Pad Server starts login application

login:

Application Initialization 1

Backbone Network - ATM

| Cell Server | Gateway | Pad Server | New Movie Server |

New movie application requests resources on the Pad (VQ decompressor, speaker, bandwidth).

Application Initialization 2

Backbone Network - ATM

| Cell Server | Gateway | Pad Server | New Movie Server |

Pad Server may handshake with the Cell Server

Pad Server allocates resources

Movie server begins sending data

Mobility (Handoff)
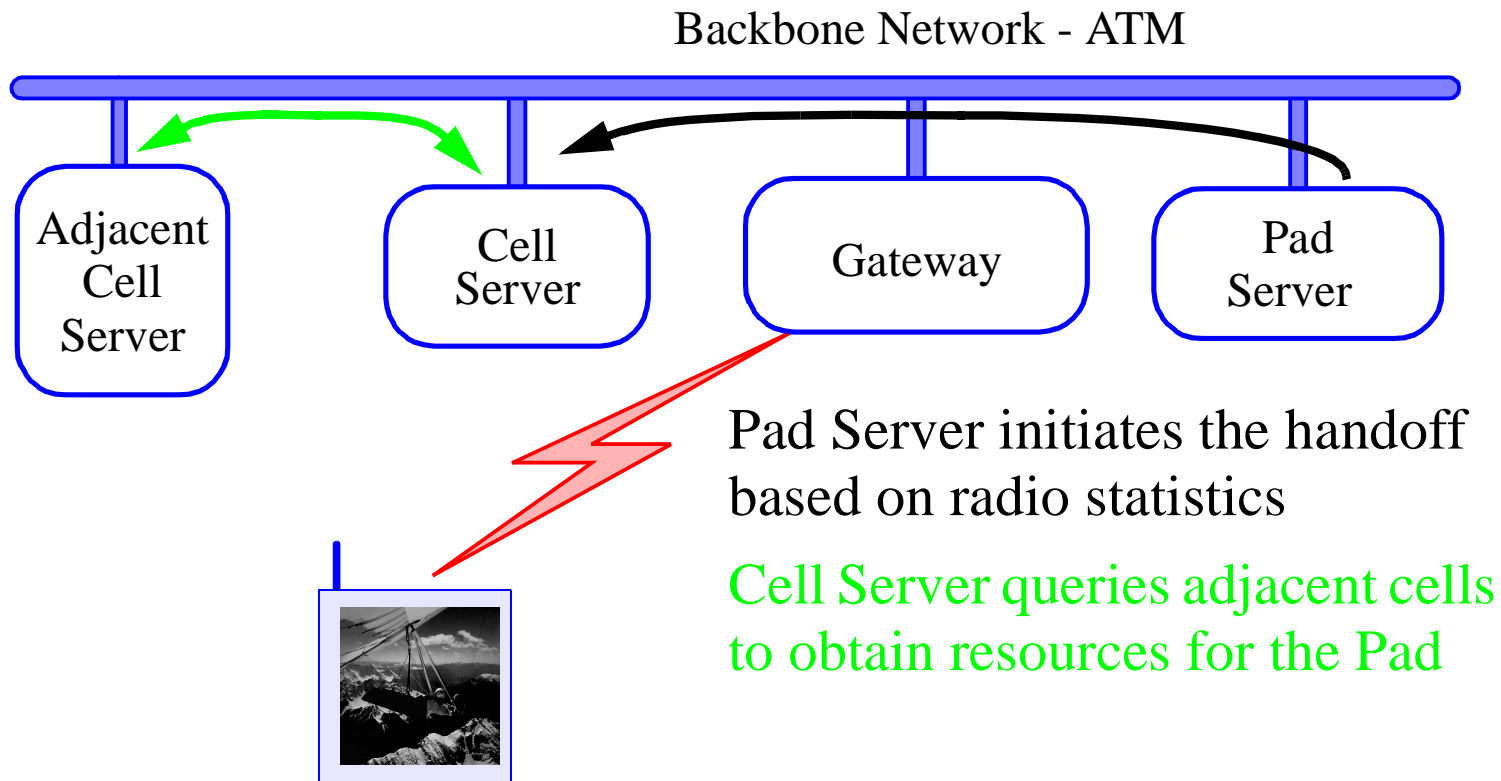
- User travels between cells of wireless network

   Requested handoff (common case)

   Lost contact/unexpected arrival

Requested Handoff 1

Backbone Network - ATM

Adjacent Cell Server

Cell Server

Gateway

Pad Server

Pad Server initiates the handoff based on radio statistics

Cell Server queries adjacent cells to obtain resources for the Pad

Requested Handoff 2

Backbone Network - ATM

Adjacent Cell Server

Cell Server

Gateway

Pad Server

Pad Server and Pad are notified of negotiation result

Radio and communication reconfigured to complete the handoff

Prototype

- Objective: "quick and dirty" implementation to test feasibility
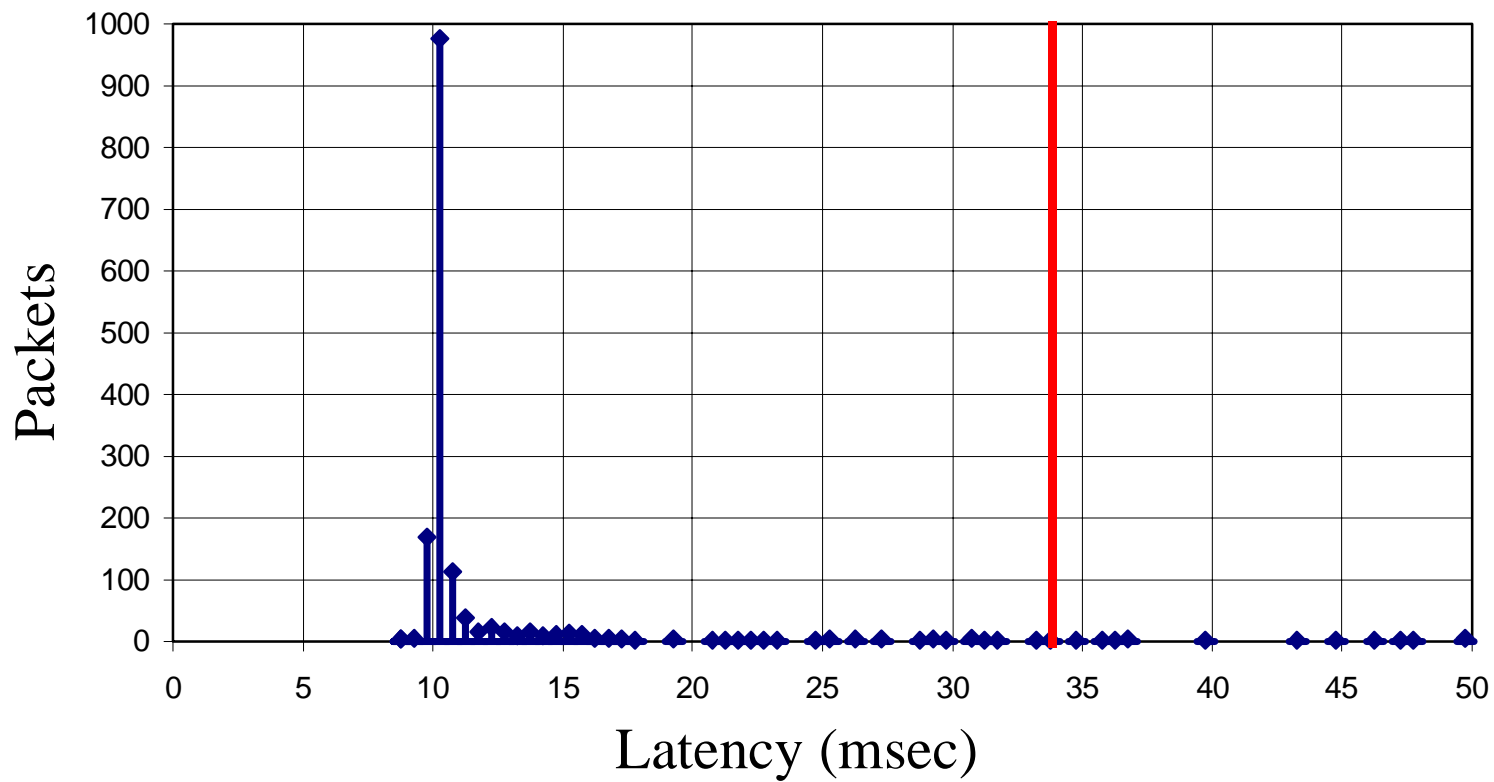
- Pad

  640x480 B&W, small separate color video, pen, audio

- Link

  Wired full duplex 1Mbps link

- Infonet Software

  Only Gateway & Pad Server

  UNIX user processes

  TCP/IP sockets across Ethernet

  Data copied through Pad Server

- Applications

  X11R5 server, pen application, pen server, simplified video
    server

Performance

- Latency from pen action to inking

Summary / Future Work

- Current implementation shows acceptable performance

- Status:

    Performance limited by network bandwidth, system call overhead in Gateway

    Initial implementation of handoff completed

- Future Work

    Switch to ATM

    Hardware Gateway

    Integration of radio characteristics into QOS & Mobility support