Towards a Bay Area Research Wireless Access Network (BARWAN)

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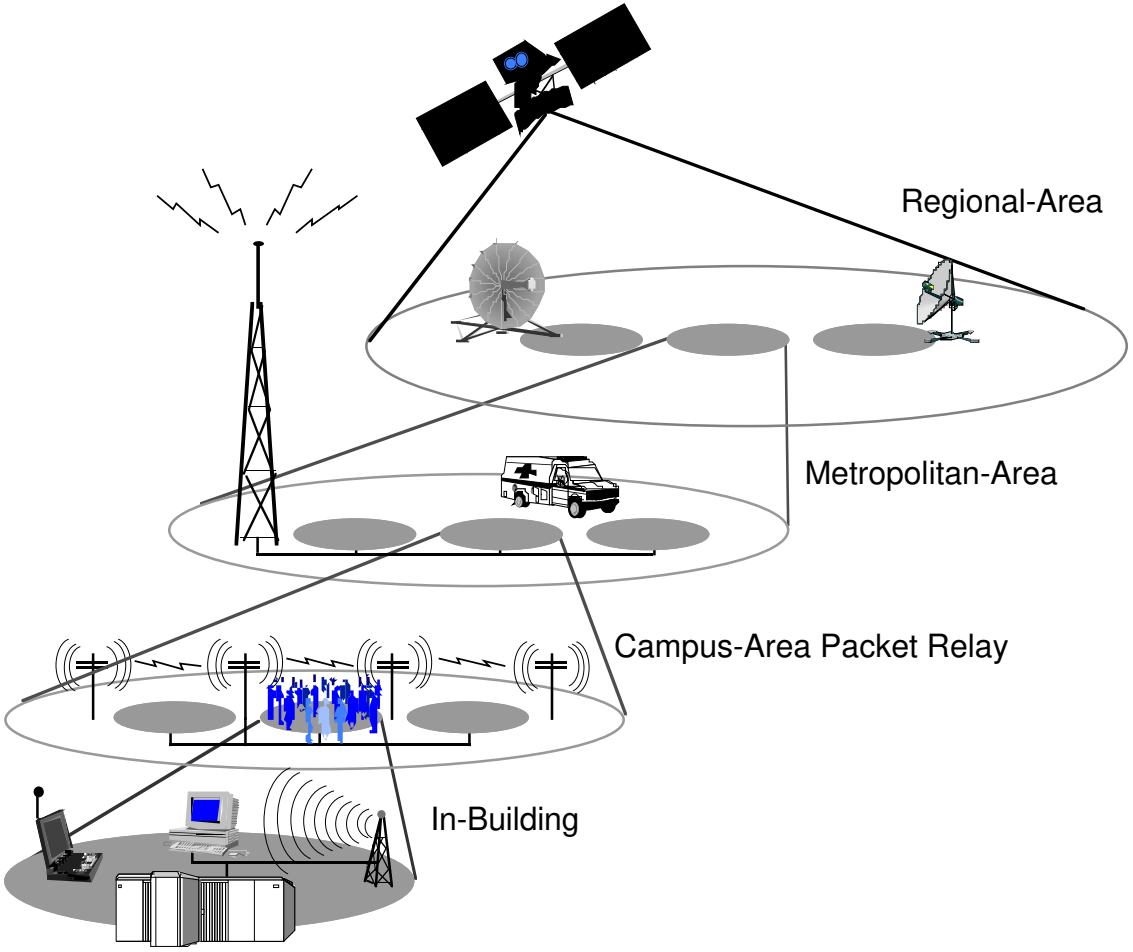
Wide-Area Wireless Testbed

Multiple Overlayed Wireless Networks

Seamless Mobility Across Overlays

Integration with wide-area high performance networks (BAGNet)
Bandwidth/latency aware APIs; Wide-area untethered applications

Wireless Overlay Concept



Remote Clinics

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Emergency Dispatch

↓

Hospital Campus

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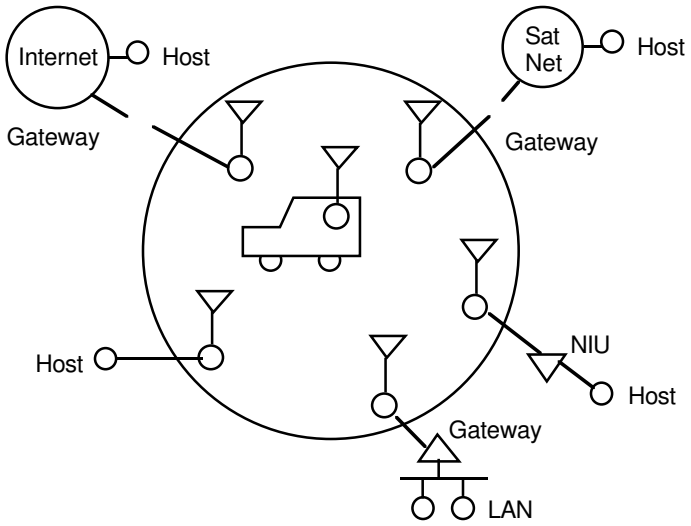
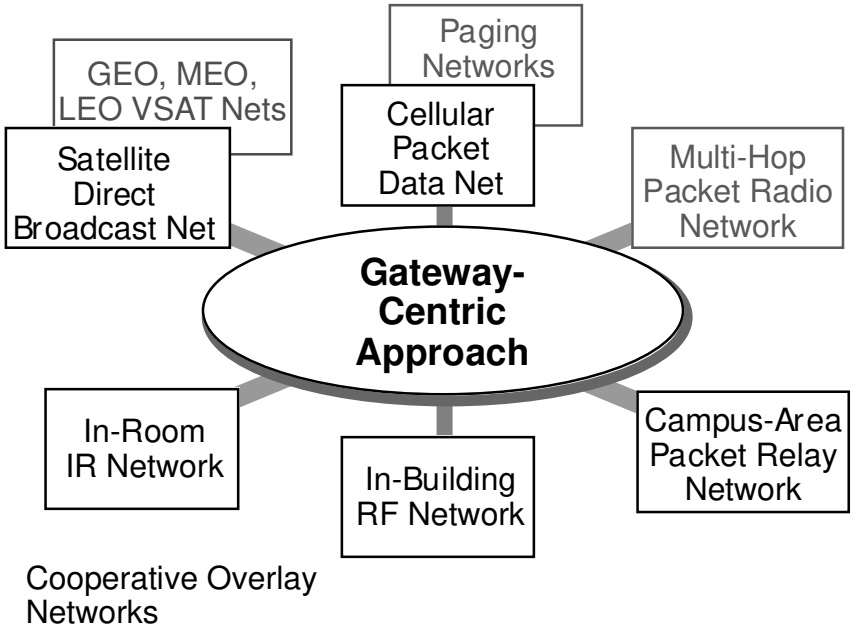
Hospital
Operating Room
Emergency Room

Overlay Internetworking





Network Centered

Within homogeneous net
No roam between nets

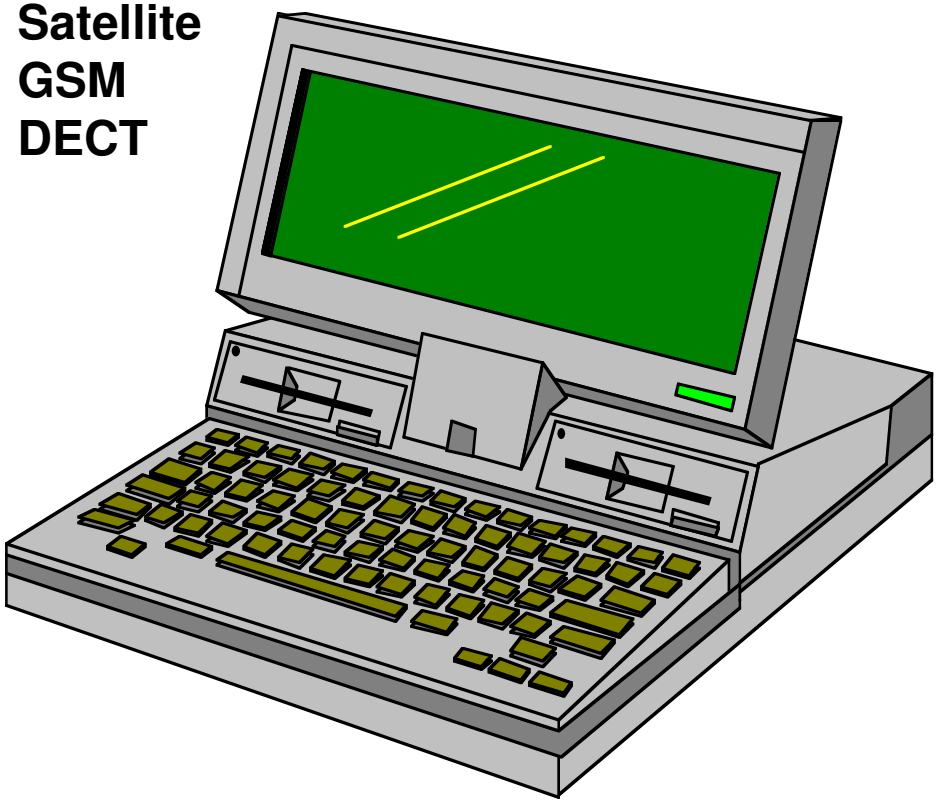
Gateway Centered

Heterogeneous nets
Roam between them

Multimode “Radios”

ITU “Future Public Land Mobile Telecommunications System” (FPLMTS)

- -- Satellite
- -- GSM
- -- DECT



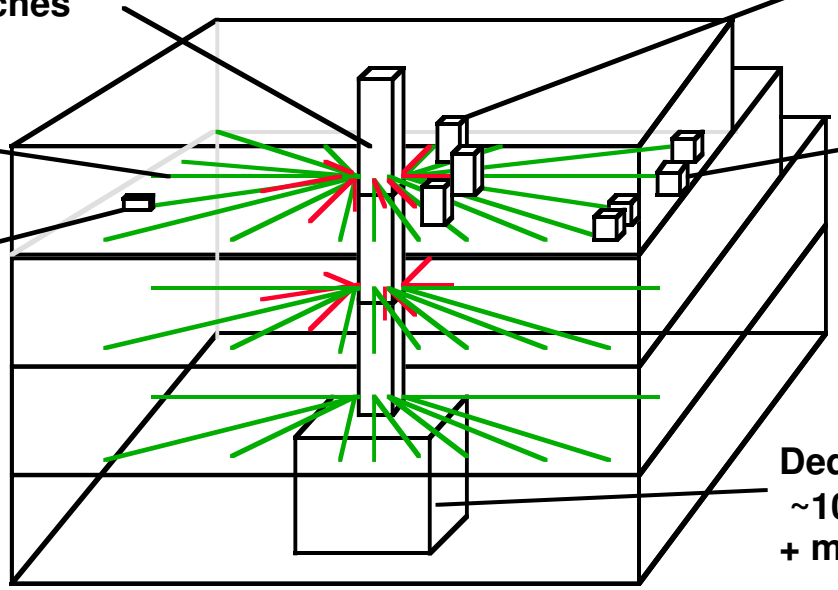
PCMCIA #1: IR modem
PCMCIA #2: RF modem
AT Slot: Hughes DirectPC
Floppy Slot: CDPD modem
Serial Port: Metricom modem

Characteristics of Alternative Overlay Technologies

Type of Network	Bandwidth	Latency	Mobility	Typ Video Performance	Typ Audio Performance
In-Building	>> 1 Mbps Comm'l RF: 2 Mbps Research IR: 50 Mbps	< 10 ms	Pedestrian	2-Way 'ractive Full Frame Rate (Comp)	High Quality 16-bit Samples 22 Khz Rate
Campus-Area Packet Relay Network	≈ 64 Kbps	≈ 100 ms	Pedestrian	Med. Quality Slow Scan	Med. Quality Reduced Rate
Wide-Area	19.2 Kbps	> 100 ms	Vehicu	ze Frame	Asynchronous "Voice Mail"
Regional-Area (LEO/DBS/VSAT)	4.8 kbps–10+ Mbps (asymmetric)	> 100 ms	Vehicular Stationary	Seconds/Frame Freeze Frame	Asynchronous "Voice Mail"

Wide diversity of network performance parameters
Mutually distrusting infrastructure providers
Pedestrian vs. vehicular mobility
APIs that are network-aware

State-of-the-Art In-building Networking Infrastructure



Cooperative In-building Wireless Overlays:

- **IR for offices, meeting spaces, classrooms**
- **RF overlay for "between" spaces, connectivity load sharing**

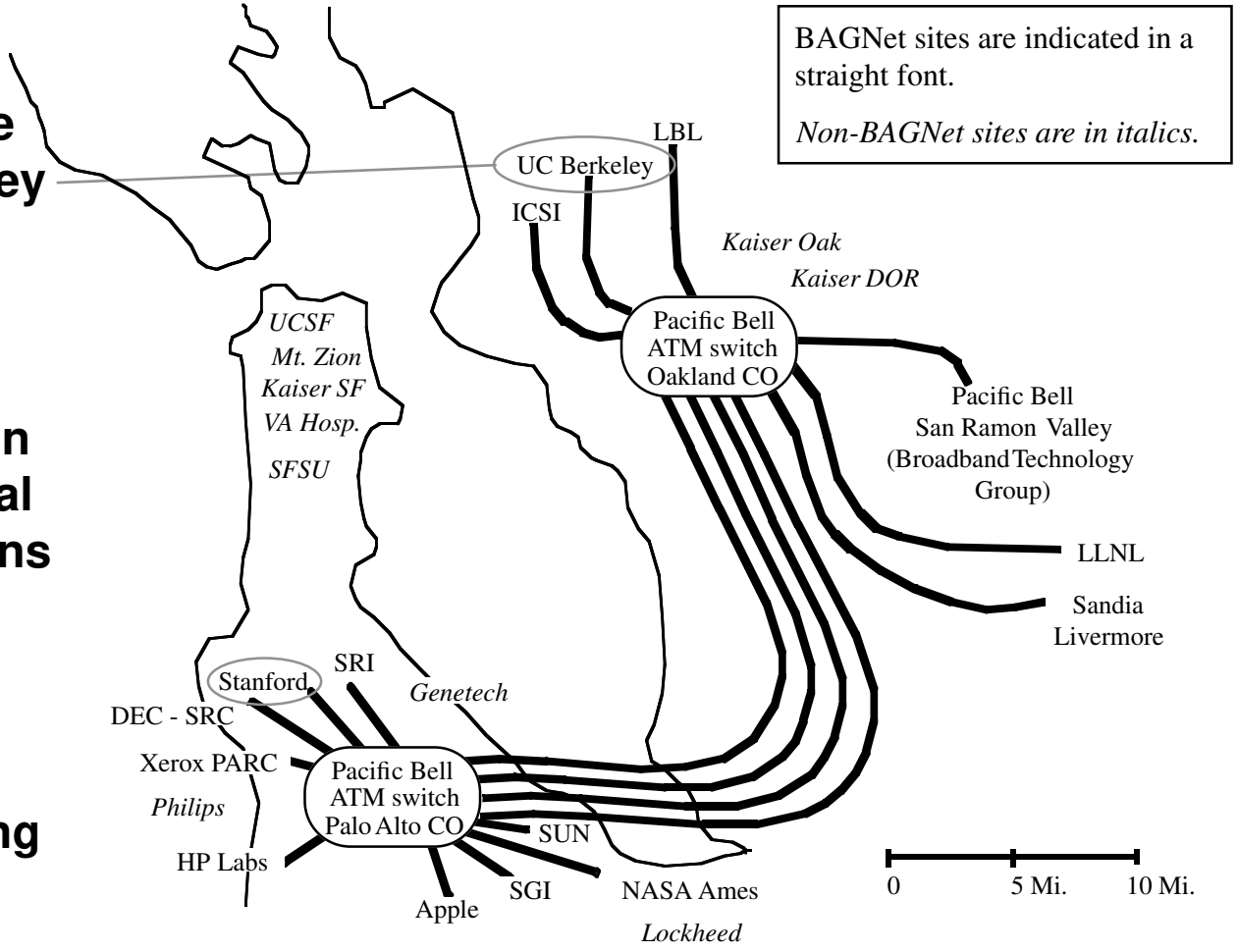
Integration with building-scale computing resources

Wide-Area Wireline Infrastructure

Wireless-to-wireline gateways in Berkeley

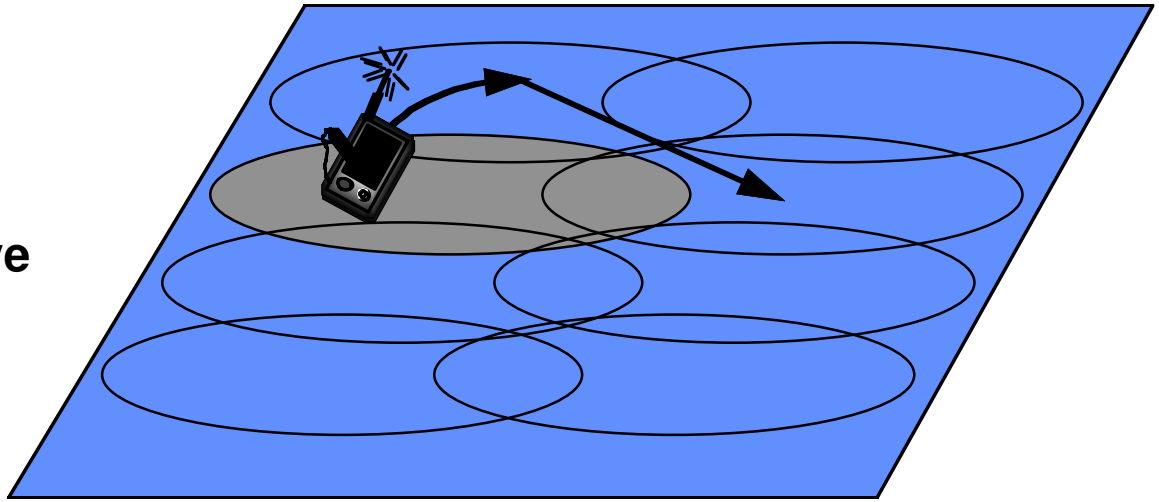
Possible exploration of wide-area medical dispatch applications

Integration with wide-area computing resources



Mobility Challenges: Horizontal Roaming

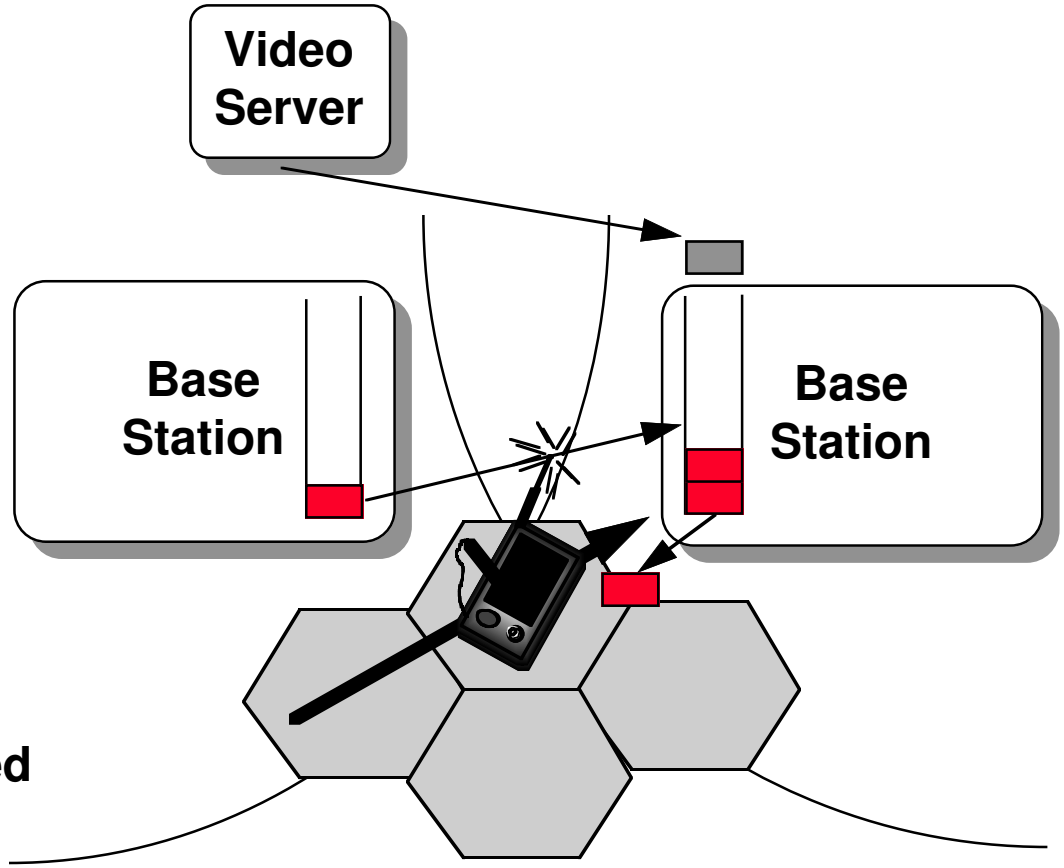
Single Administrative Domain



Roaming within an administrative domain

- -- Mobile IP provides initial solution for the routing problem
- -- Single authentication with home domain

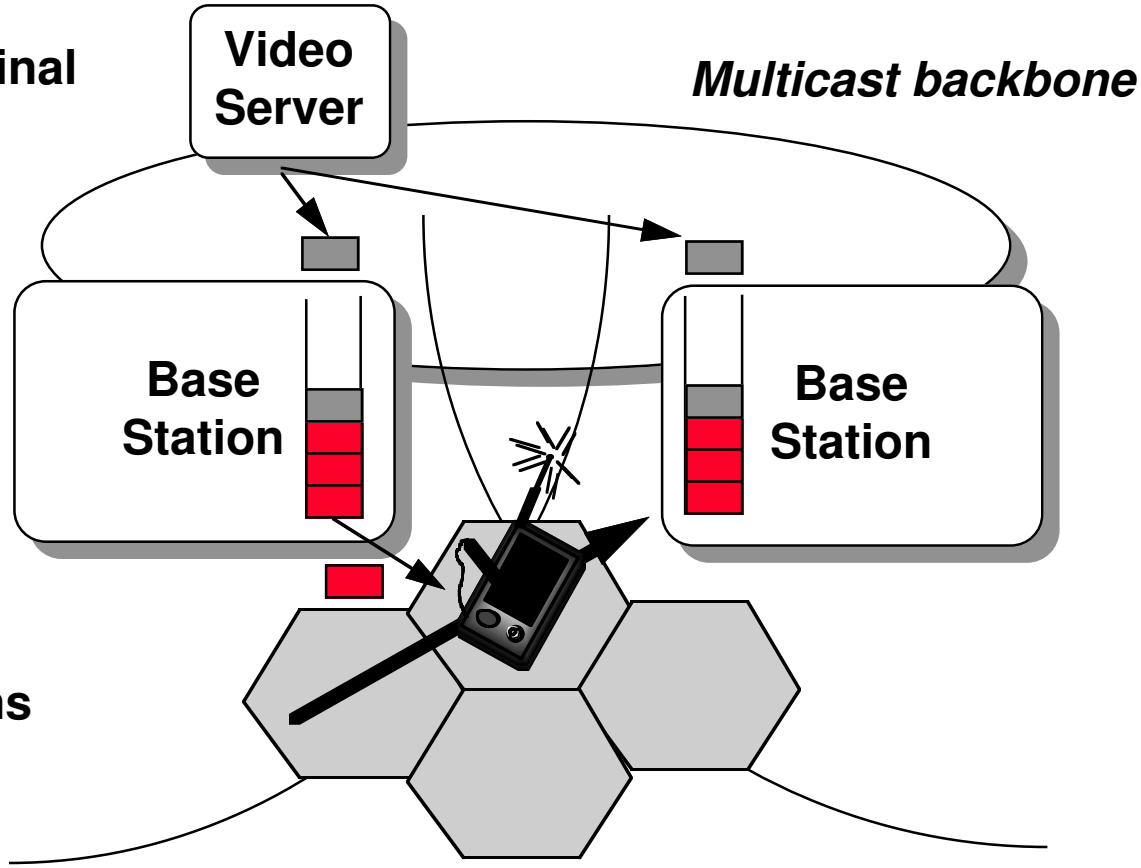
Mobile Handoff: Packet Forwarding



Forward buffered packets at old base station to new base station while rerouted connection is made

Mobile Handoff: Multicast

Use hints about terminal trajectory to assist in hand-offs to support continuous playback with real-time constraints

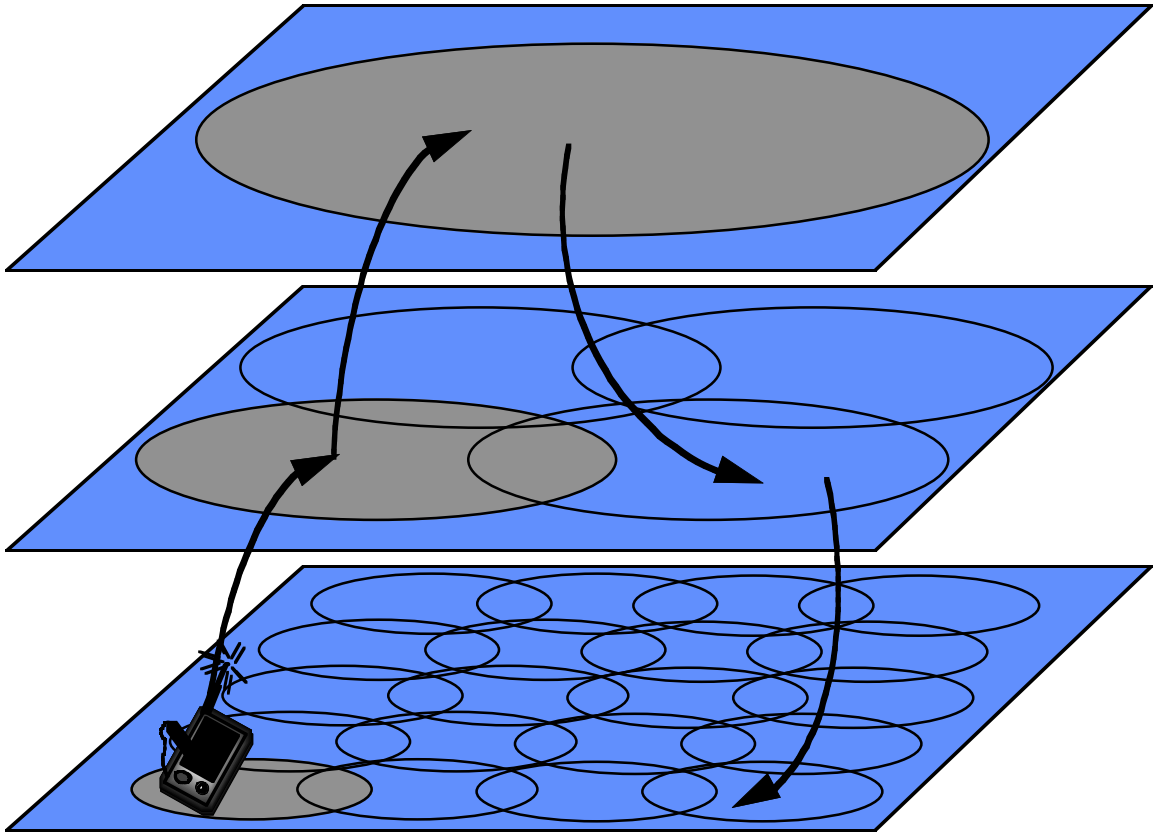


Multicast packets to adjacent base stations to smooth hand-offs

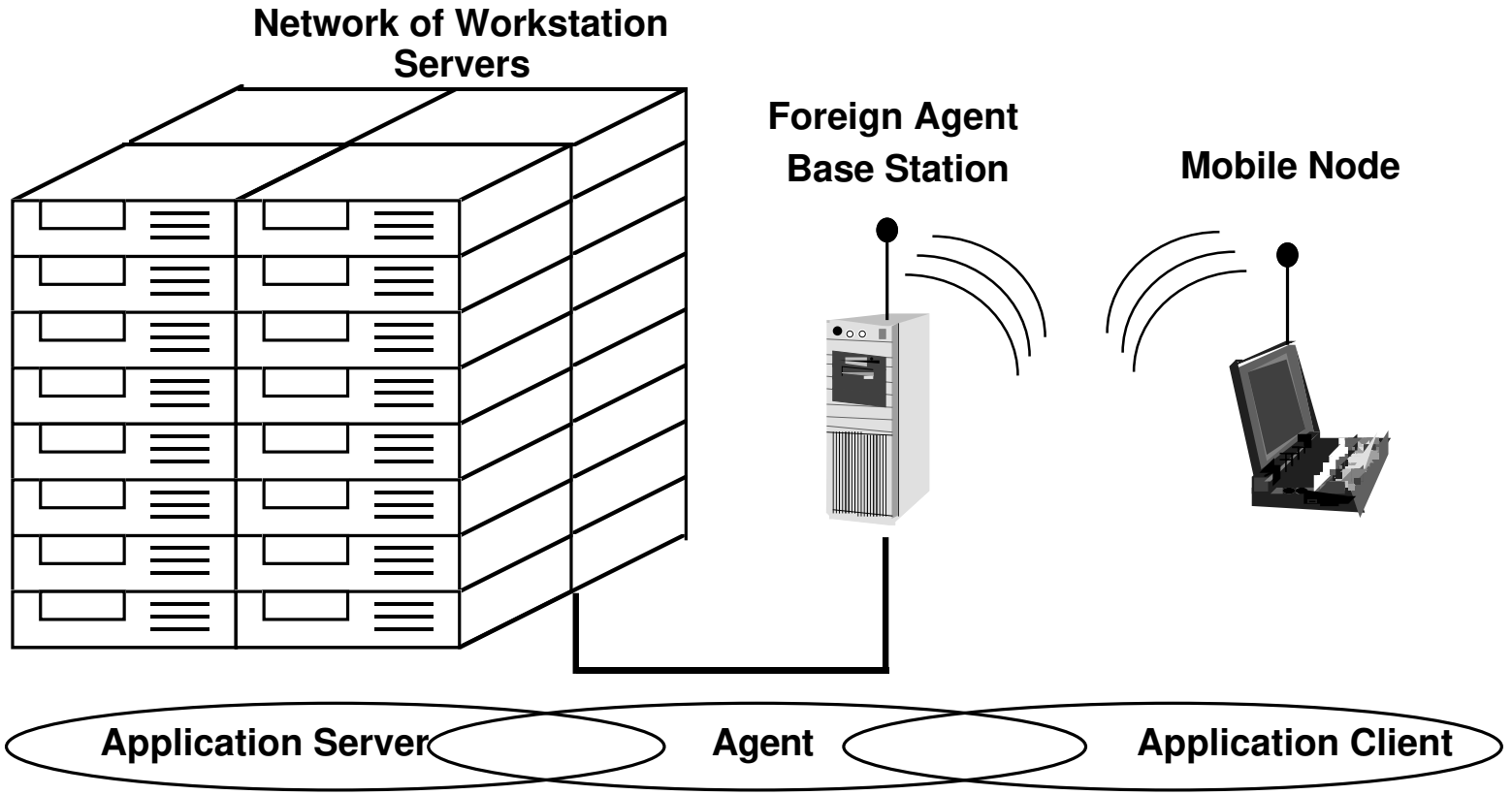
Mobility Challenges: Vertical Roaming

Multiple Administrative Domains

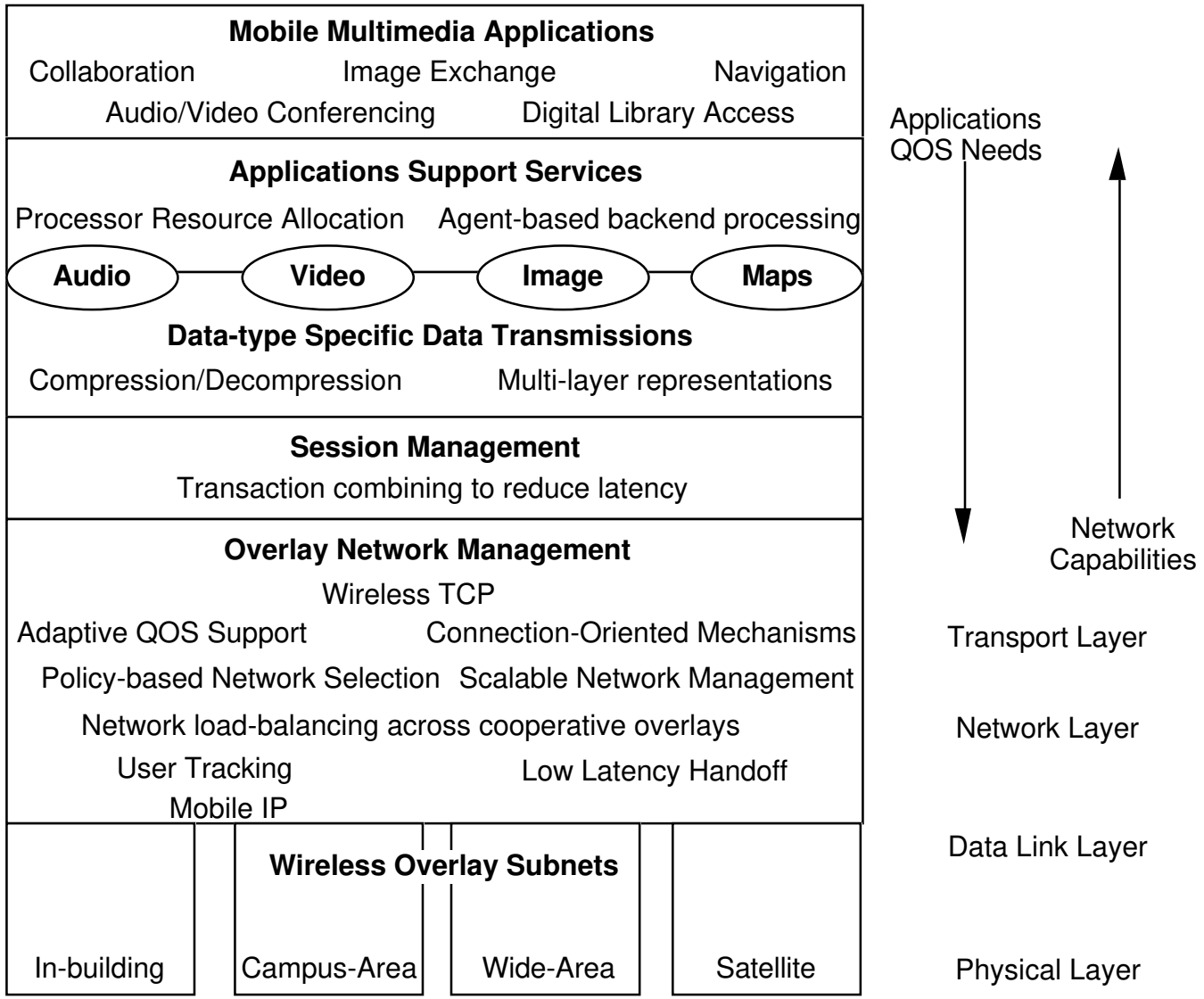
-- Handoff
-- Authentication
-- Routing
– Billing



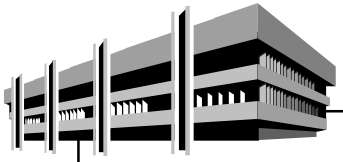
Application Support



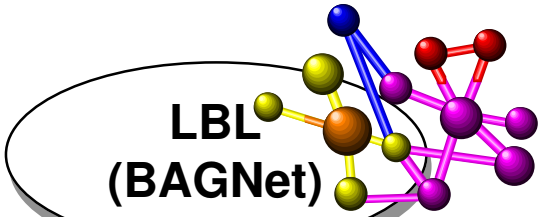
Layered Architecture



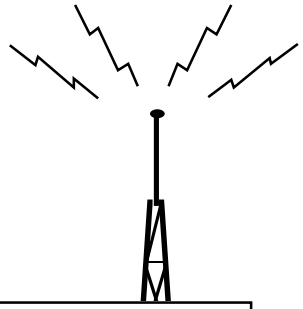
Consortium Members



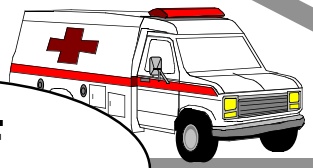
In-Building
DEC, IBM



LBL
(BAGNet)

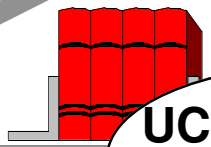


Wide-Area
Nextel, PacBell

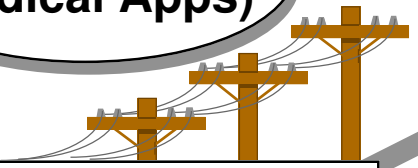


UCSF
(Medical Apps)

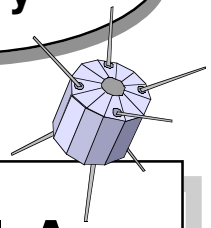
UC Berkeley



UCB University
Library



Packet-Relay
Metricom



Regional-Area
Hughes DBS

Research Issues

- **Seamless connectivity over multiple overlays**
  - Implementing low latency handoffs
  - Exploiting movement-tracking and geography
  - Performance characterization of channels
  - Authentication, security, privacy
- **Scalable mobile processing**
  - Hierarchical and distributed network management
  - Load balancing for network mgmt & application support
  - Integration with local- & wide-area networked servers
  - Application support for adaptive connections