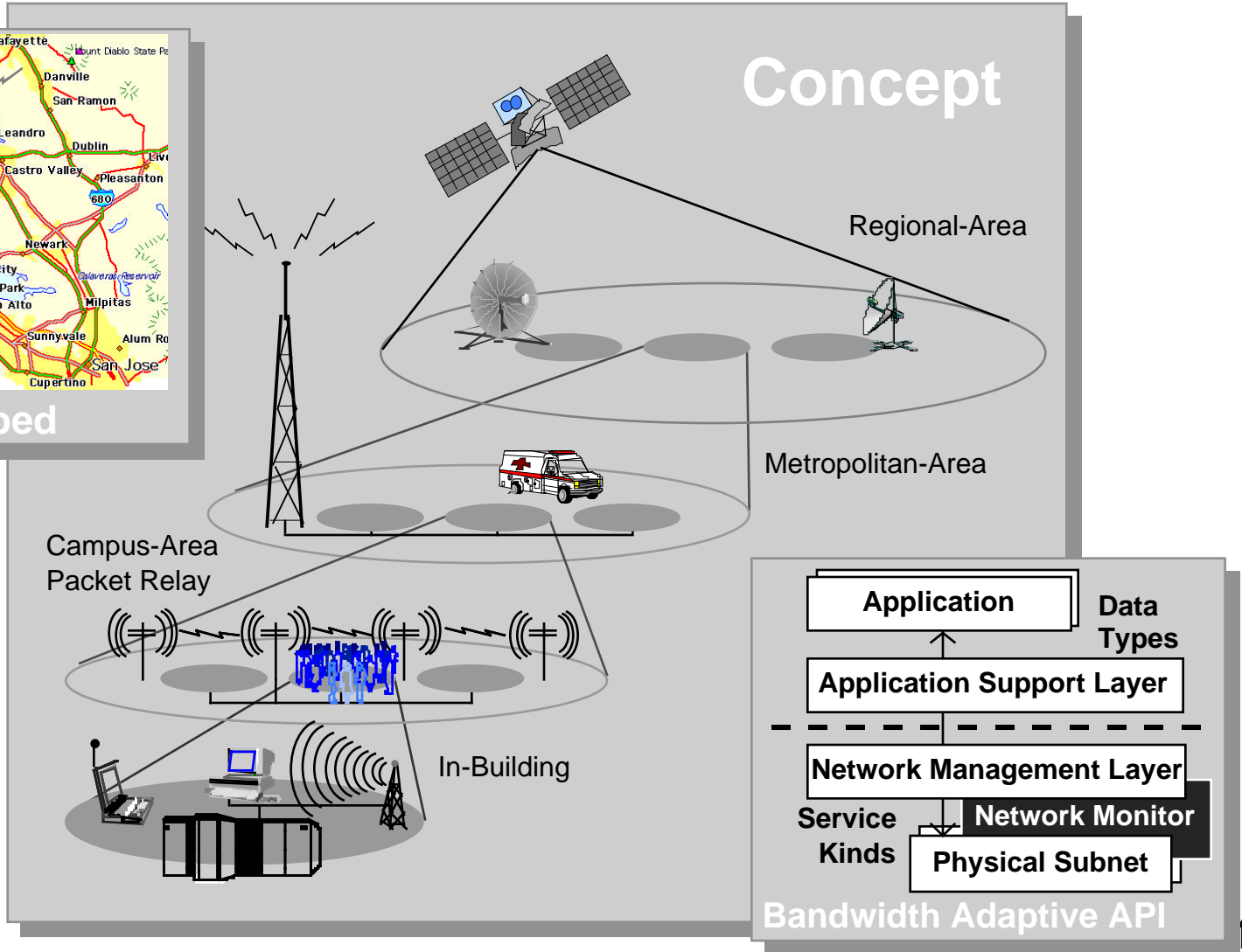
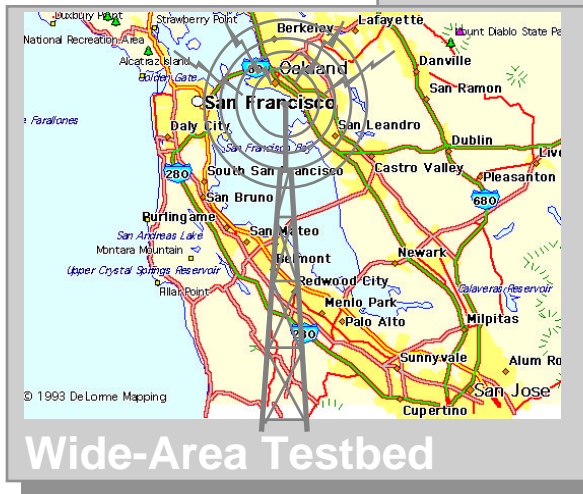


Bay Area Research Wireless Access Network: Towards a Wireless Overlay Internetworking Architecture

Randy H. Katz, Eric A. Brewer, UC Berkeley



Subcontractor:
Hughes Malibu
Research Labs

Project Vision

“Access is the Killer App”

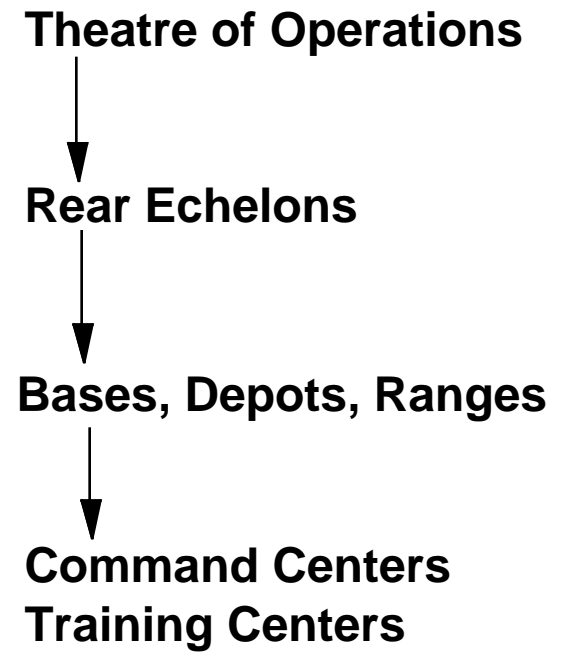
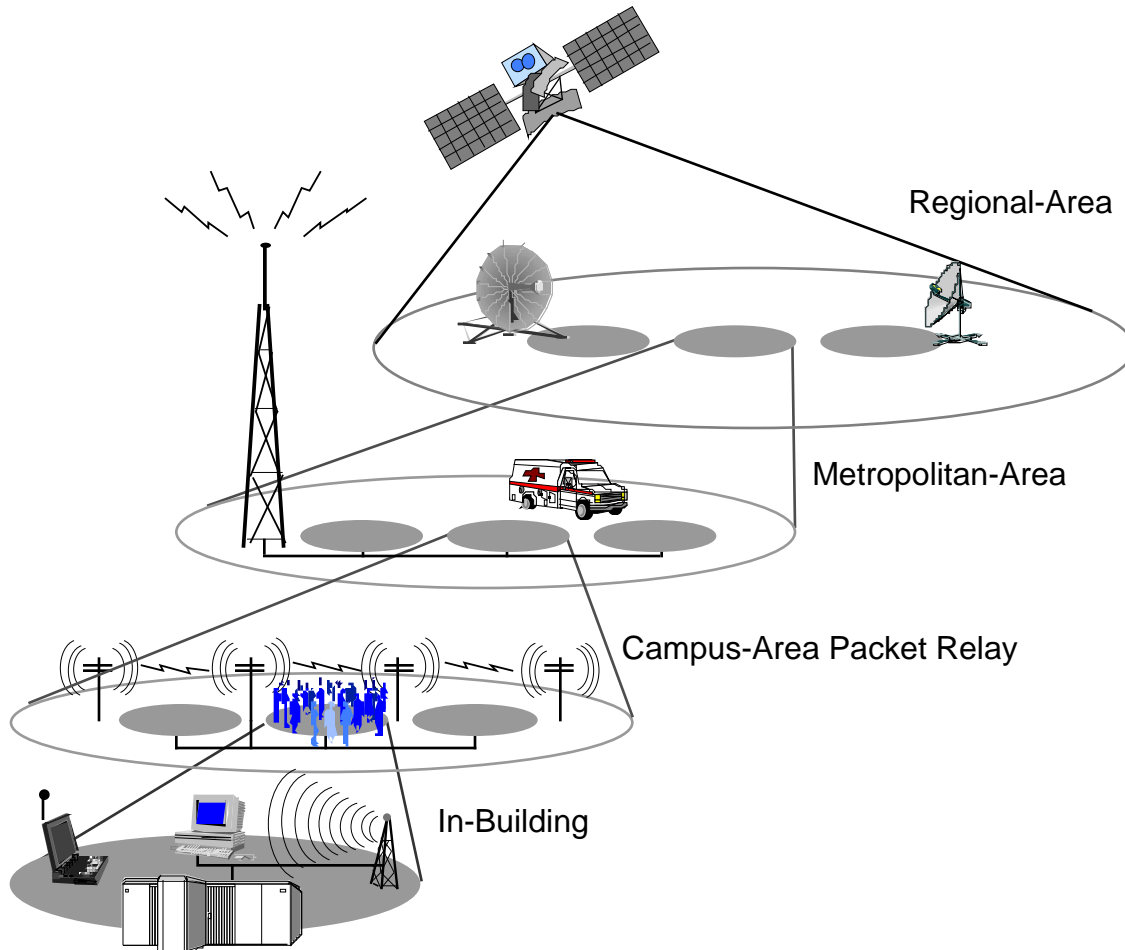
- **Goals**

- Be connected anywhere, anytime via the “best” available (wireless/wireline) network
- Adapt the application to the available bandwidth and latency

- **Strategies**

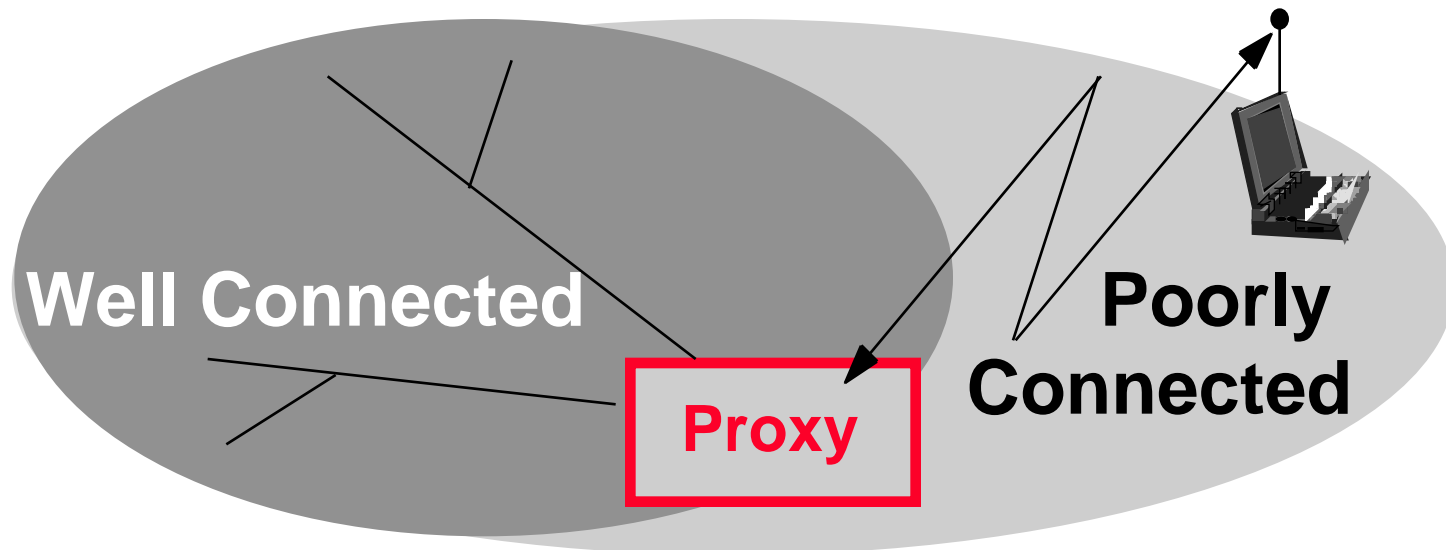
- Wireless Overlay Internetworking Architecture
- Network- and Type-Aware Applications Building Blocks

Wireless Overlay Concept



Proxy Architecture

- **Proxy**
 - Mediates between wireless and wireline environment
 - Ideally executes at “well-connected” boundary of internetwork
 - Changes data representations on-the-fly
 - Trade-off in transcoding time and communications time

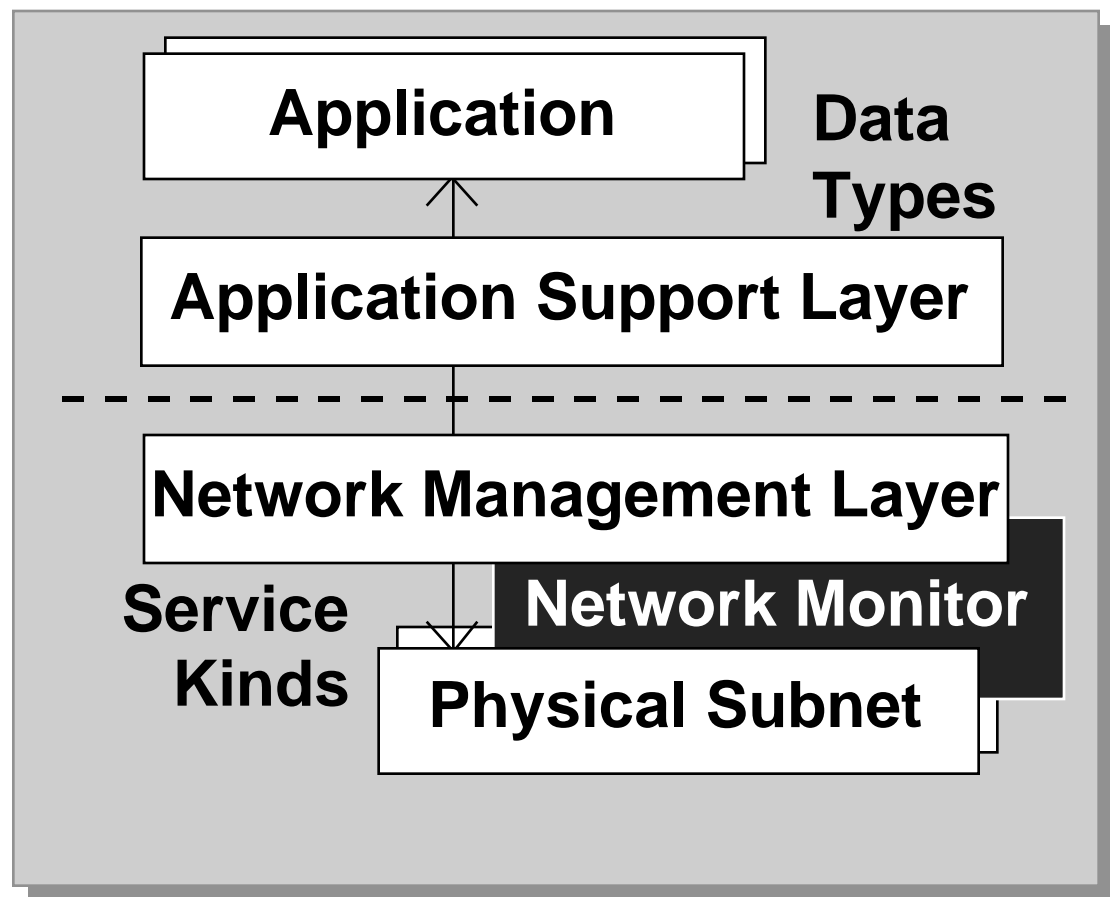


Bandwidth Adaptive Application Interfaces

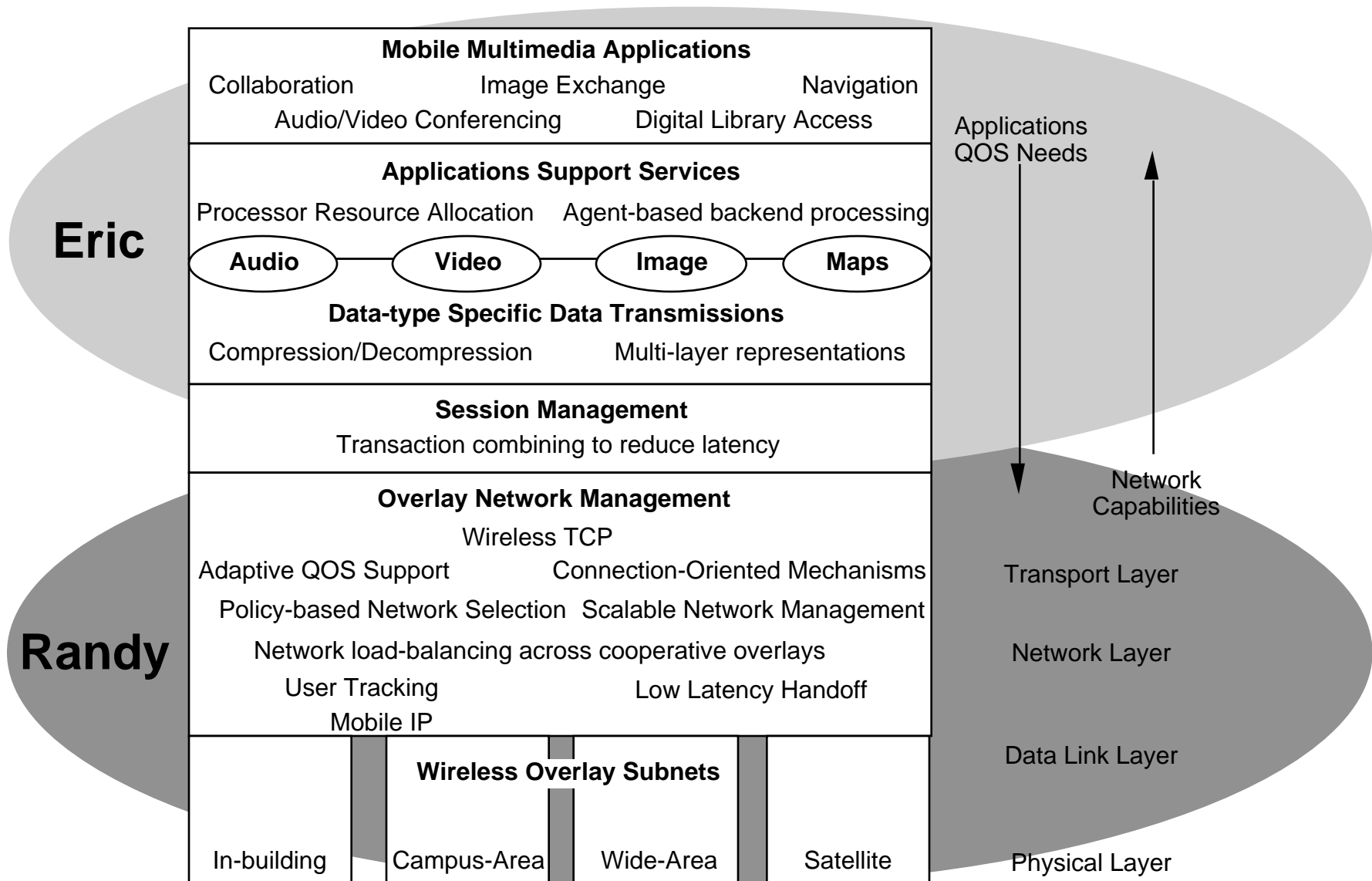
When to switch from one overlay network to another?

Strategy:

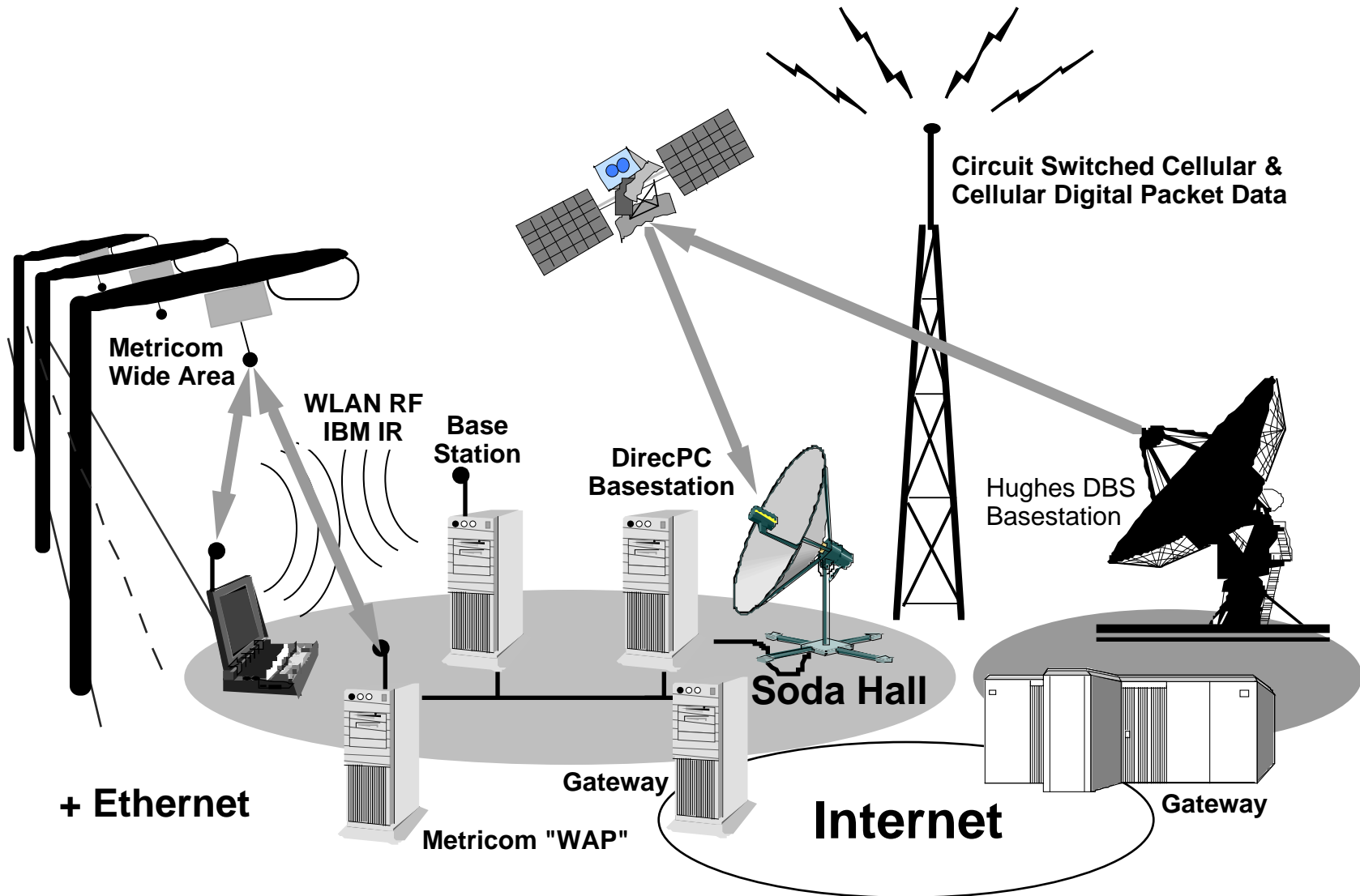
- Monitor network state
- Detect edge of coverage
- Initiate vertical h/o



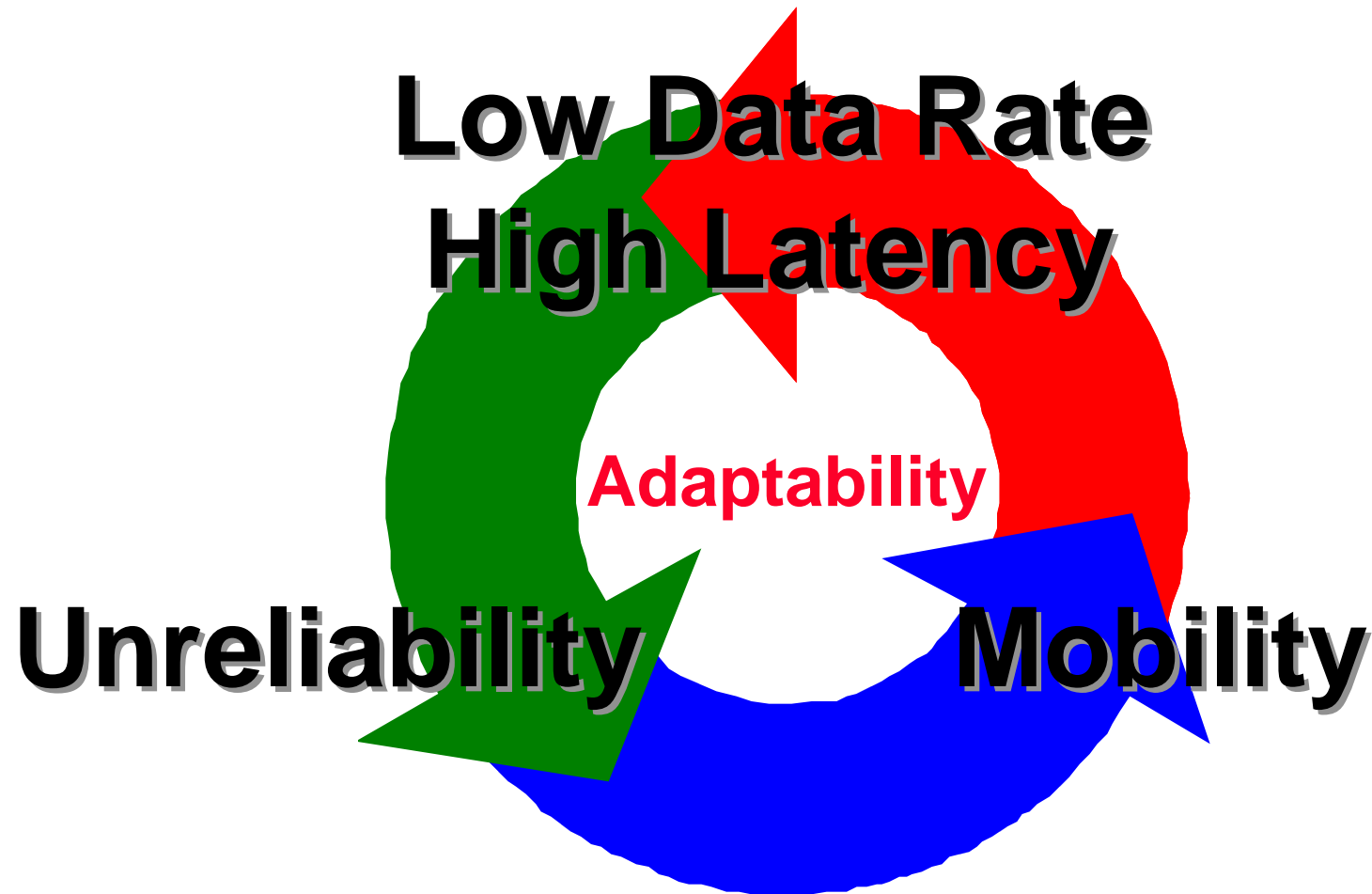
Layered Architecture



Bay Area Research Wireless Access Network Testbed



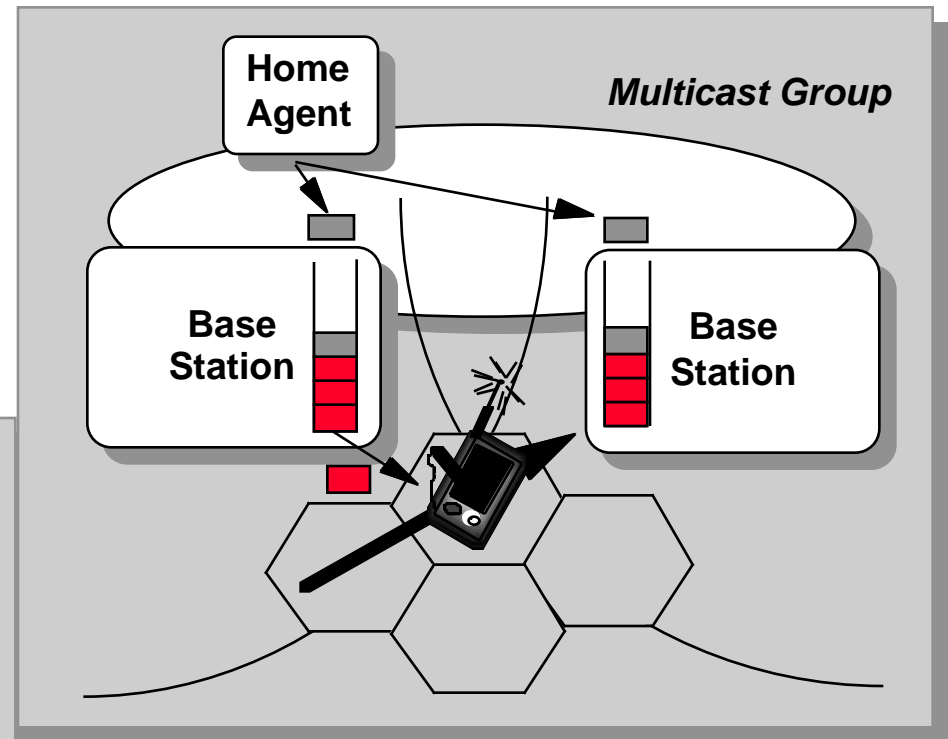
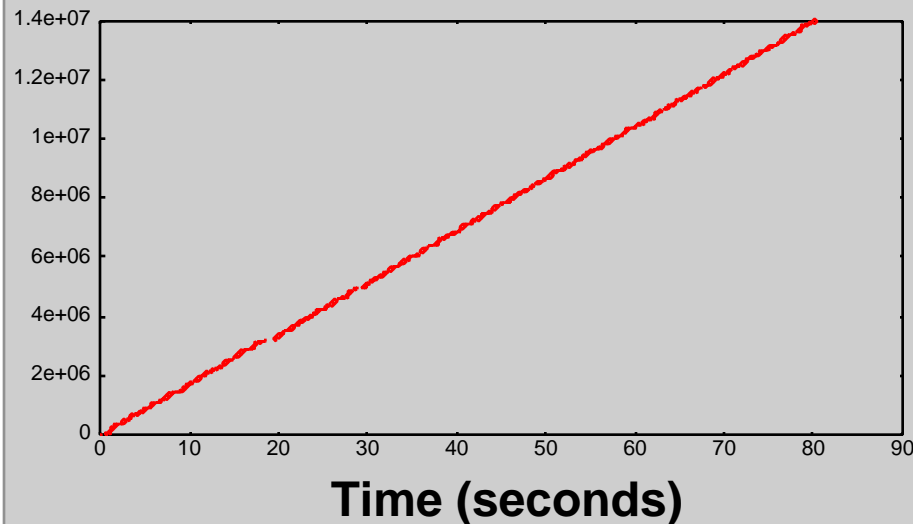
Wireless Networking Challenges



Mobility Meets Multimedia: Low Latency Handoff

- Use hints about terminal trajectory to assist in handoffs
- Multicast packets to adjacent base stations to smooth handoffs

Packet Sequence Numbers



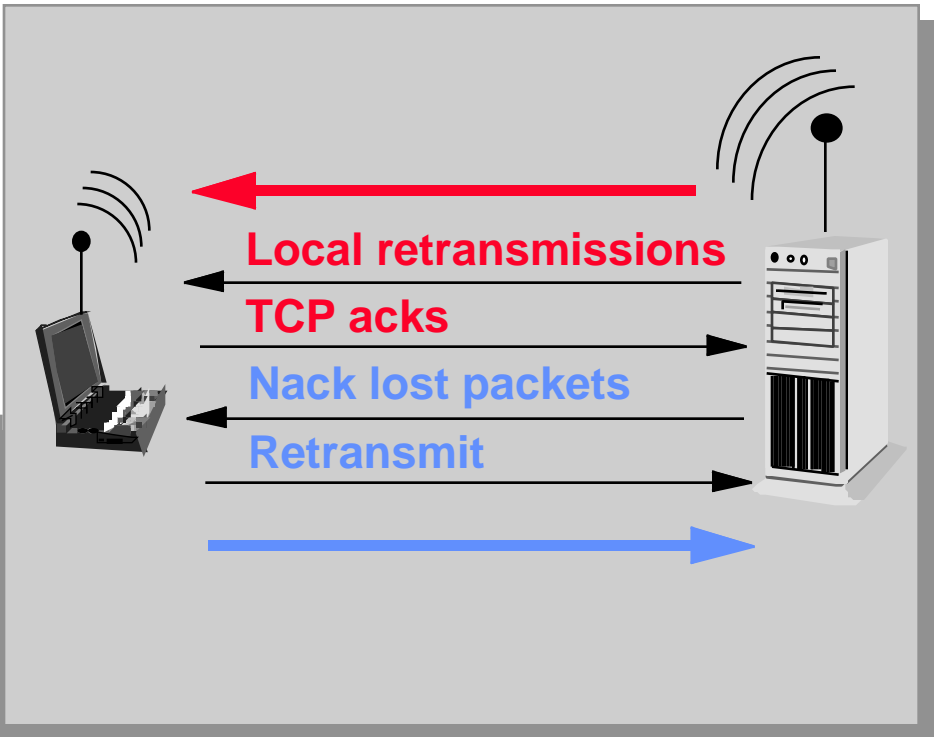
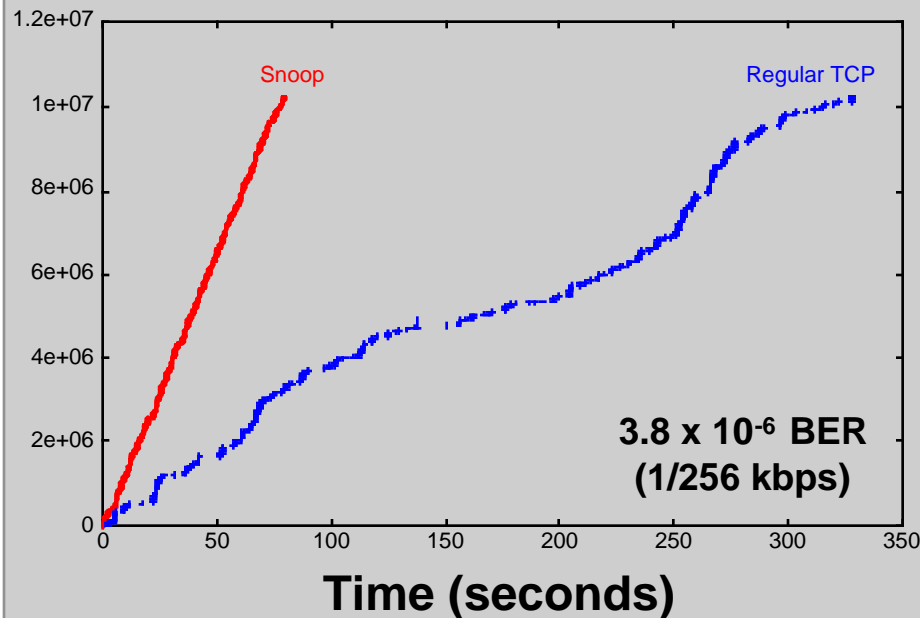
Handoffs every 10 seconds

Code release 1st Quarter 1996

Web Browsing on the Move: Reliable Wireless Transport

- Cache unacknowledged TCP data;
Snoop on TCP acks, do local retransmit
- BS explicitly NACKs MH's lost pkts
- Maintain end-to-end TCP semantics

Packet Sequence Numbers



20X speed-up in presence of bit errors

Aggregate b/w 1 Mbps vs. 0.25 Mbps

Code release integrated with handoff

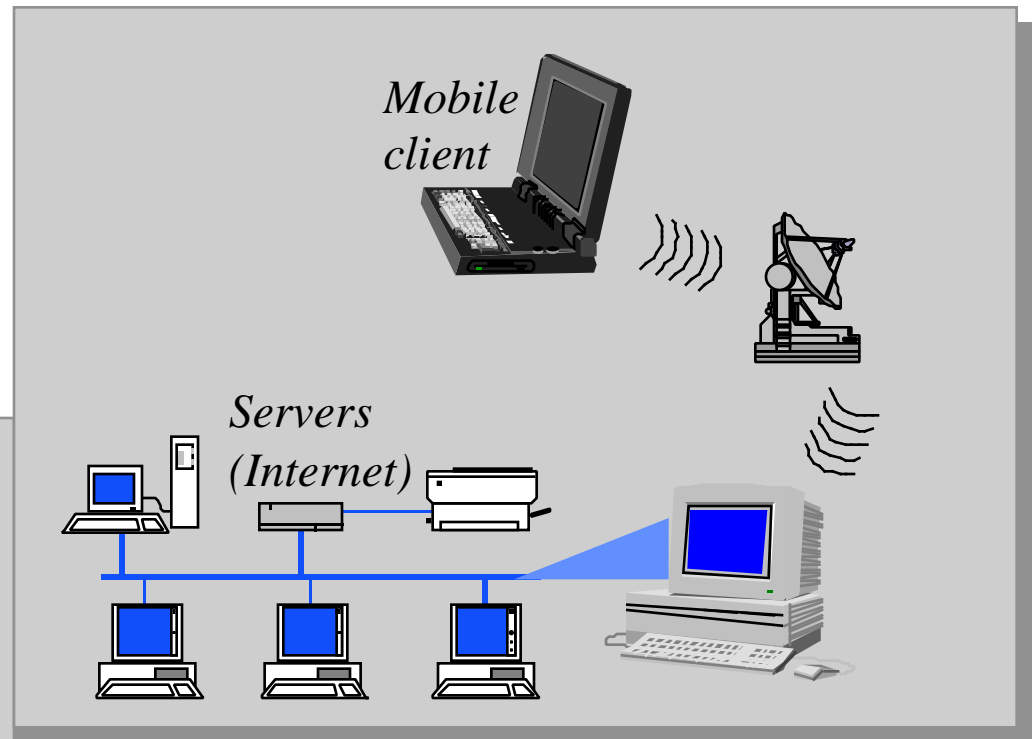
Proxy Architecture: Image Proxy

- **Distillation**: lossy compression that preserves semantic content
- Works in R/T on desktop PC
- Client can request **refinement** of distilled image

78 colors,
49K bytes

~2 sec.

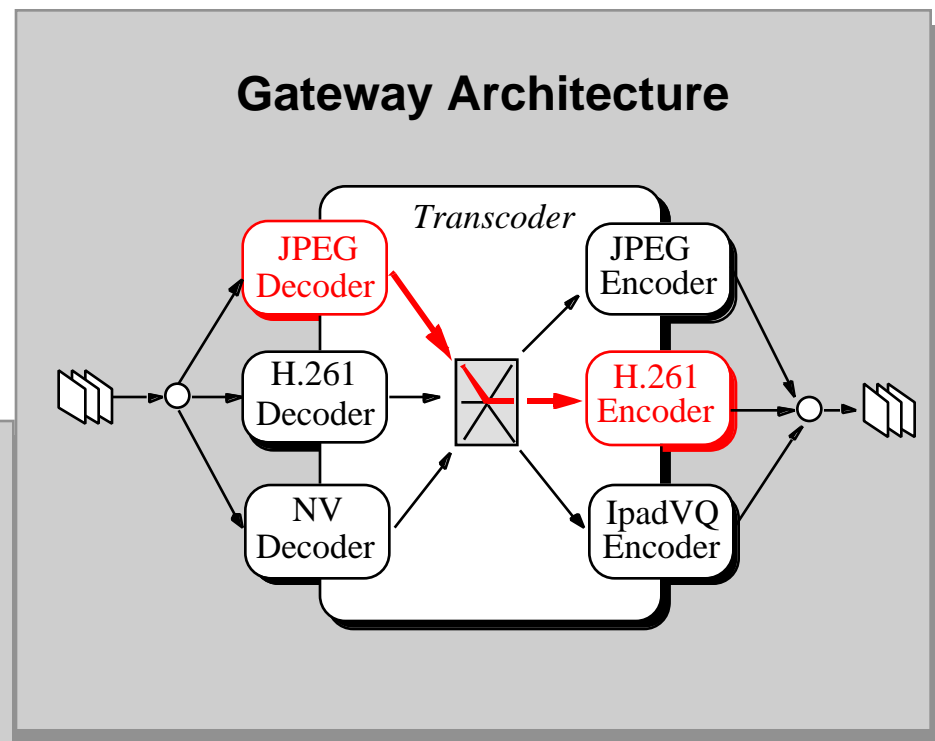
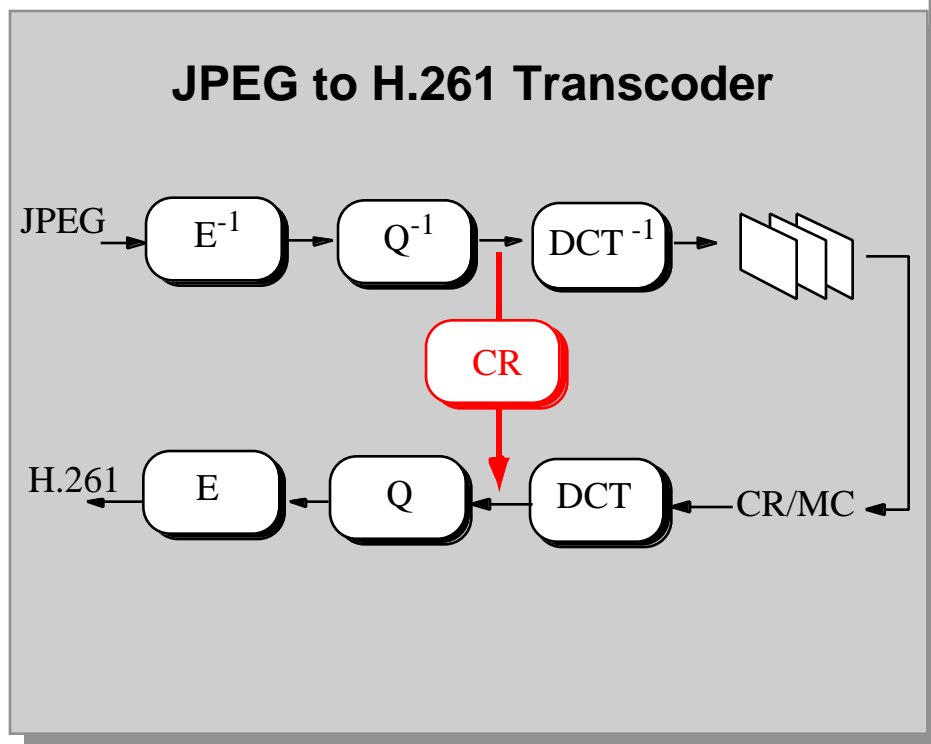
4 grays,
530 bytes



Orig. size (bytes)	New size	New size as % of original	Pixel dimensions	Scaled by	Time (sec.)
34K	2022	0.058	320x200	2	1
848K	5938	0.007	1280x1024	4	13
848K	1676	0.002	1280x1024	8	10
361K	24311	0.066	1022x703	2	8
361K	6240	0.017	1022x703	4	7
173K	4974	0.028	640x480	2	4
173K	1644	0.009	640x480	4	3

Proxy Architecture: Video Gateway

- Another early instance of a proxy
- R/T transcode from high b/w video to low bandwidth video formats
- Integrated with existing Internet MM infrastructure via RTP



Motion Full Dec/Enc DCT Dec/Enc

Low	26 fps	30 fps
High	15 fps	27 fps

1/4 NTSC JPEG to CIF H.261 on SparcStation 20

Research Plan as Proposed

	Year 1	Year 2	Year 3
T1: Overlay Internetwork Management Services	Measure & Eval Ovly Nets Design for In-Building Ovly	Design for Wide-Area Ovly Demo In-Building Ovly Net	Demo Wide-Area Ovly Demo Scaled Net Perform
T2: Mobile Application Support Services	Design API & Appl Toolkit	Demo API for In-Building Develop Simple Collab Apps	Integrate with NOW Servers Demo Scaled Apps Perf
O1: Wide-Area Deployment and Demonstration	Accelerate Design for Wide-Area Ovly Integration	Demo Wide-Area Overlay Design for Multiple Ovlys	Demo Extension to Multiple Wide-Area Overlays
O2: Pilot Application Demonstrations	Deploy In-Build Net@UCSF Eval Med Image Apps Reqs	Design Libr Nav & Med Image Distr Apps using API	Large Scale Demo of Nav & Med Image Distr Apps
	9/95 - 8/96	9/96 - 8/97	9/97 - 8/98

Fit with GloMo Program Goals

ARPA GloMo	Daedalus/BARWAN Program
FY 96 Adaptive Mobile Internet Services Location Transparent Computing	Measure/eval overlay networking tech Design overlay network architecture Design proxy architecture, API, toolkit Prototype proxies for image, video, maps
FY 97 Demo B/W Adaptive MM Node Demo Advanced Mobile Networking	Demo first impl of proxy API & toolkit Prototype apps for A/V conferencing Demo in-building coop vertical handoff Extend design for metro/wide-area ovlys
FY 98 Demo Multimedia Conferencing Demo Continuous Mobility	Demo scalable processing for proxies Demo seamless roaming over in-building, wide-area wireless overlays