LAN/MAN Architectures and Video Distribution – Wireless Challenges Jun 12, 2007

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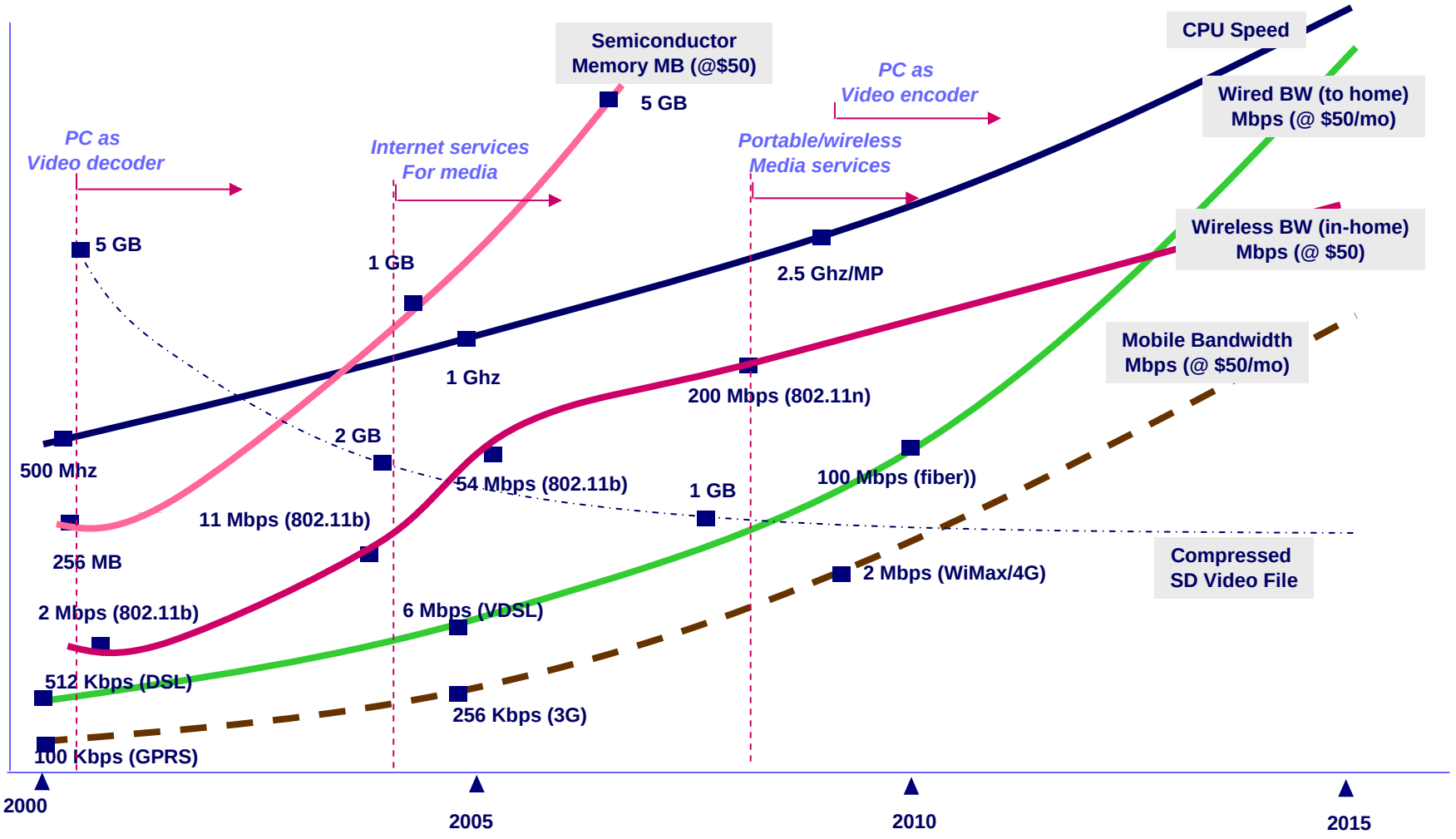
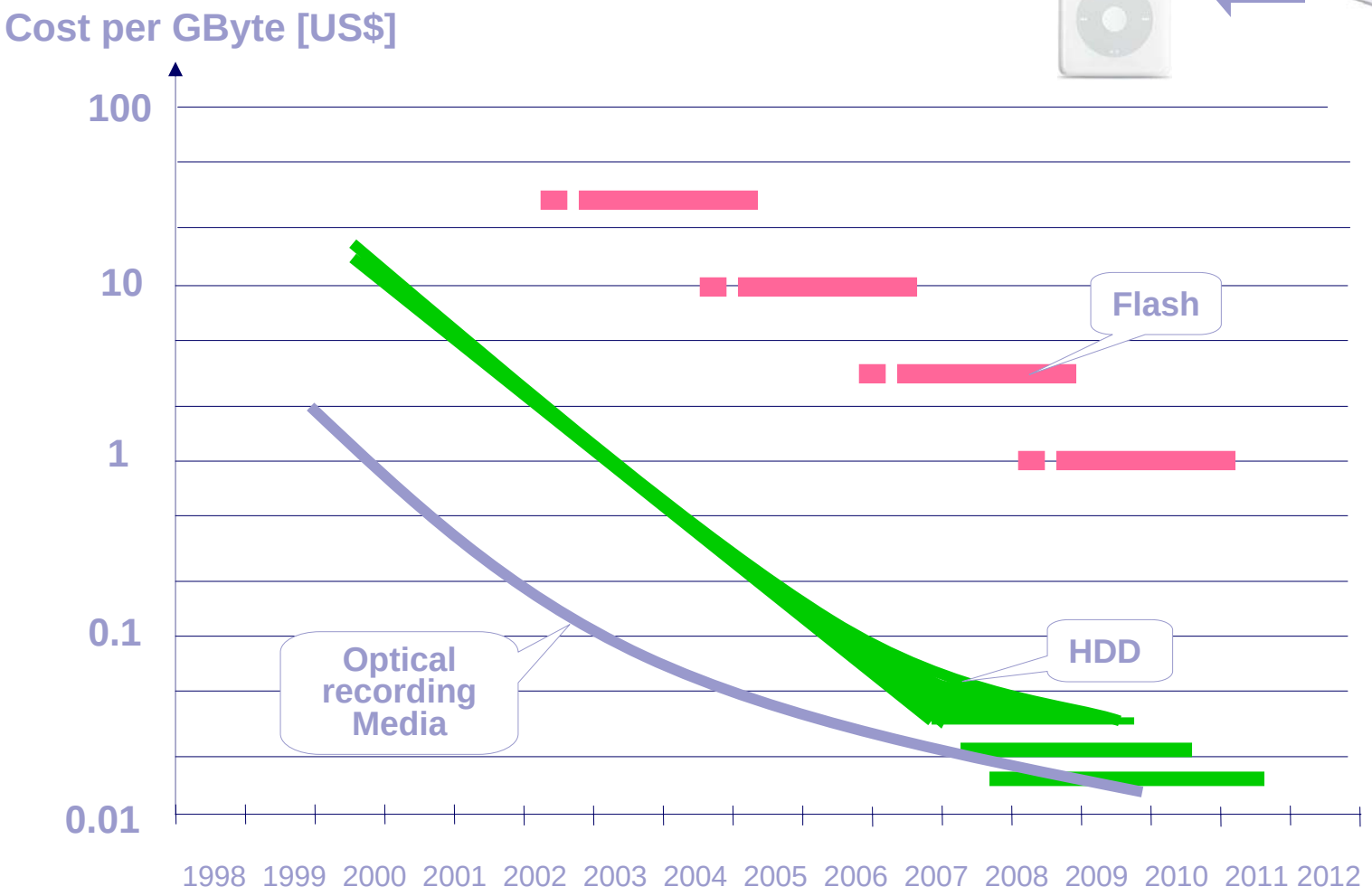
Technology Enablers: Moore's Law for Wireless Video Components



Technology Enablers: Cheap Storage

~10GB in 2007

Enables caching at wireless/mobile terminals



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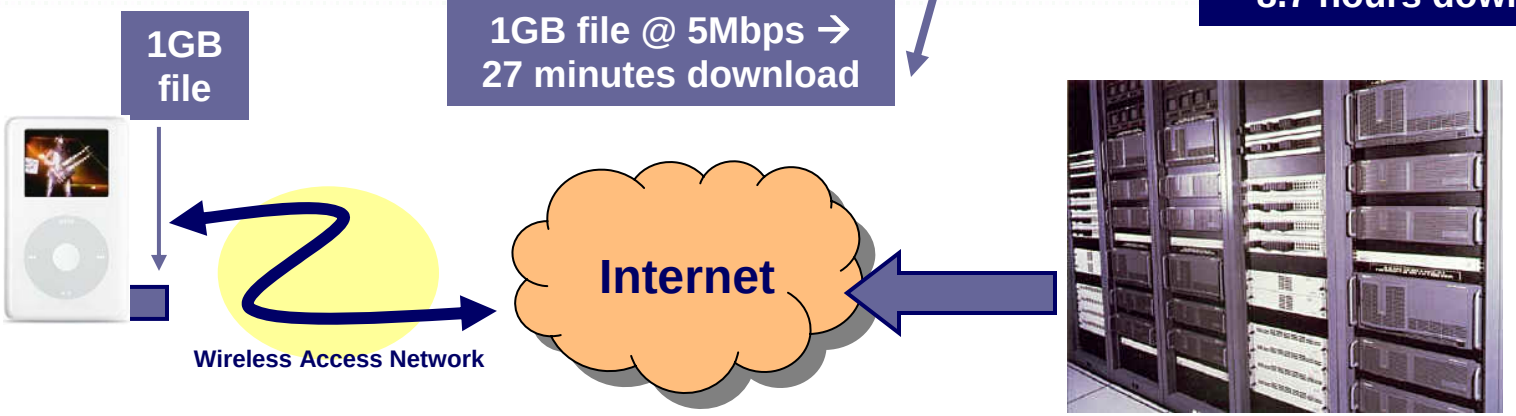
Technology Enablers: Faster Access Networks

Download Speed in Megabits/second	0.5	1.0	3.0	5.0	10.0	20.0	100.0
Small Size movie file in Gigabytes	0.4	0.6	0.8	1.0	1.2	1.5	1.8
download time in minutes	104	80	36	27	16	10	2
download time in hours	1.7	1.3	0.6	0.4	0.3	0.2	0.040
Medium Size movie file in Gigabytes	2	2.5	3	3.5	4	4.5	5
download time in minutes	521	333	133	93	53	30	7
download time in hours	8.7	5.6	2.2	1.6	0.9	0.5	0.111
HDTV Large movie file in Gigabytes	5.0	5.5	6.0	7.0	8.0	9.0	10.0
download time in minutes	1,302	733	267	187	107	60	13
download time in hours	21.7	12.2	4.4	3.1			

Source: In-Stat, 10/05

2GB file @ 500kbps → 8.7 hours download

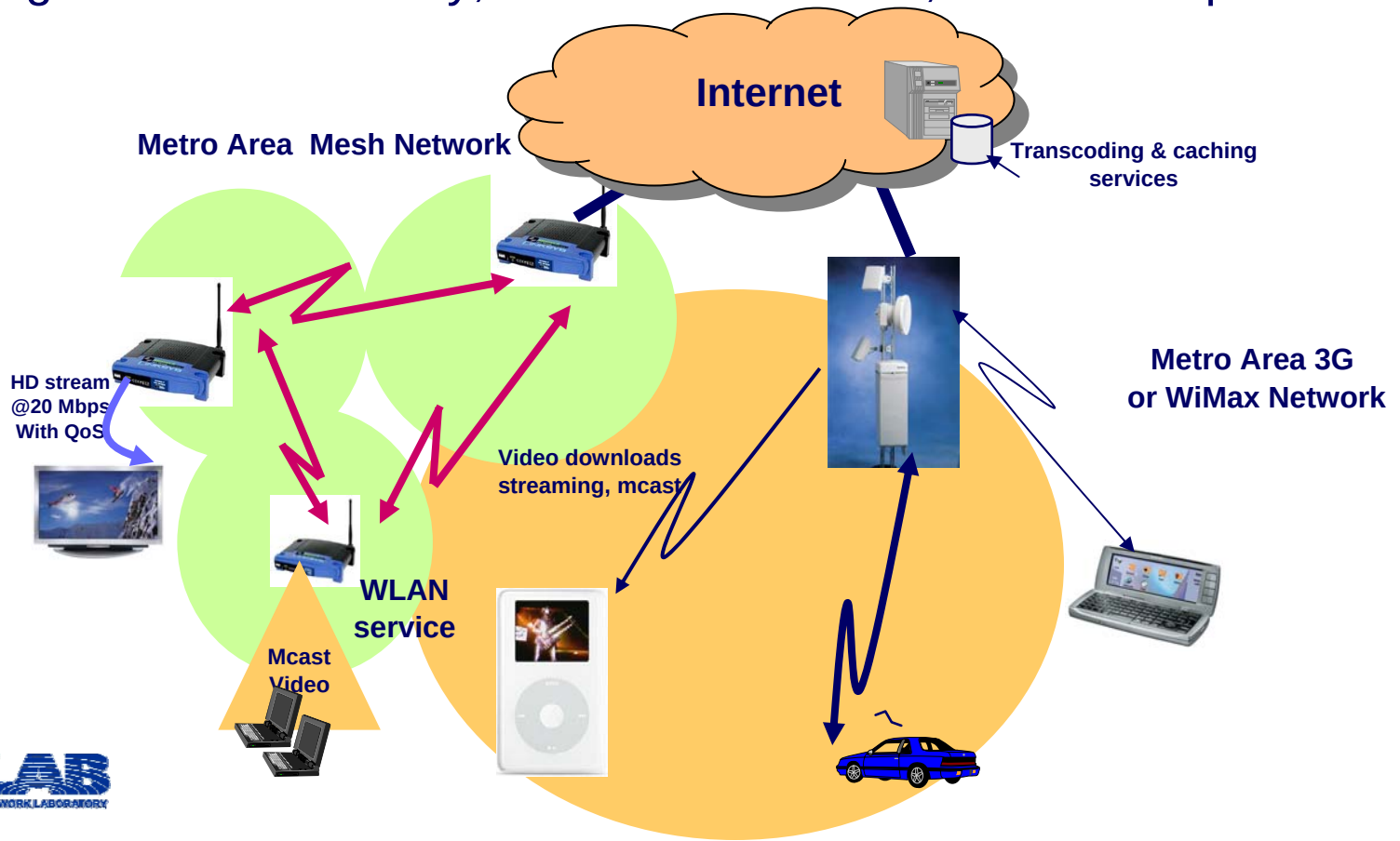
1GB file @ 5Mbps → 27 minutes download



Faster networks motivate on-demand and cached video services

Technology Enablers: Emerging Wireless Access Network Scenario

- Increasing variety of wireless access technologies → lower cost, new services, but involves network and device heterogeneity
- Implications for both wireless LAN/MAN and Internet architecture (e.g. seamless mobility, in-network services, end-to-end protocols)

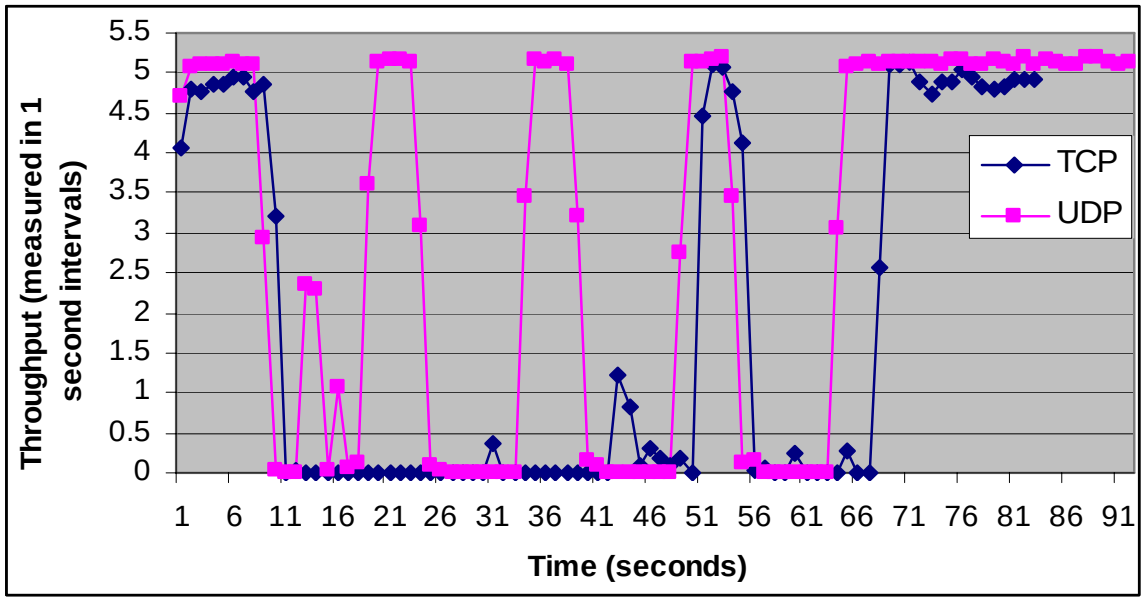


Wireless Challenges for LAN/MAN

- Dealing with time-varying link rates and quality
- Poor TCP and UD performance in terms of file download time and video quality respectively
- Enabling efficient multicast services
- Taking advantage of fast, short-range radios for wide-area services (hot-spots, Infostations)
- Overcoming intrinsic mesh network problems – MAC/routing contention and self-interference
- Supporting QoS for WLAN and mesh access
- …..

Wireless Challenges: Time-Varying Channel

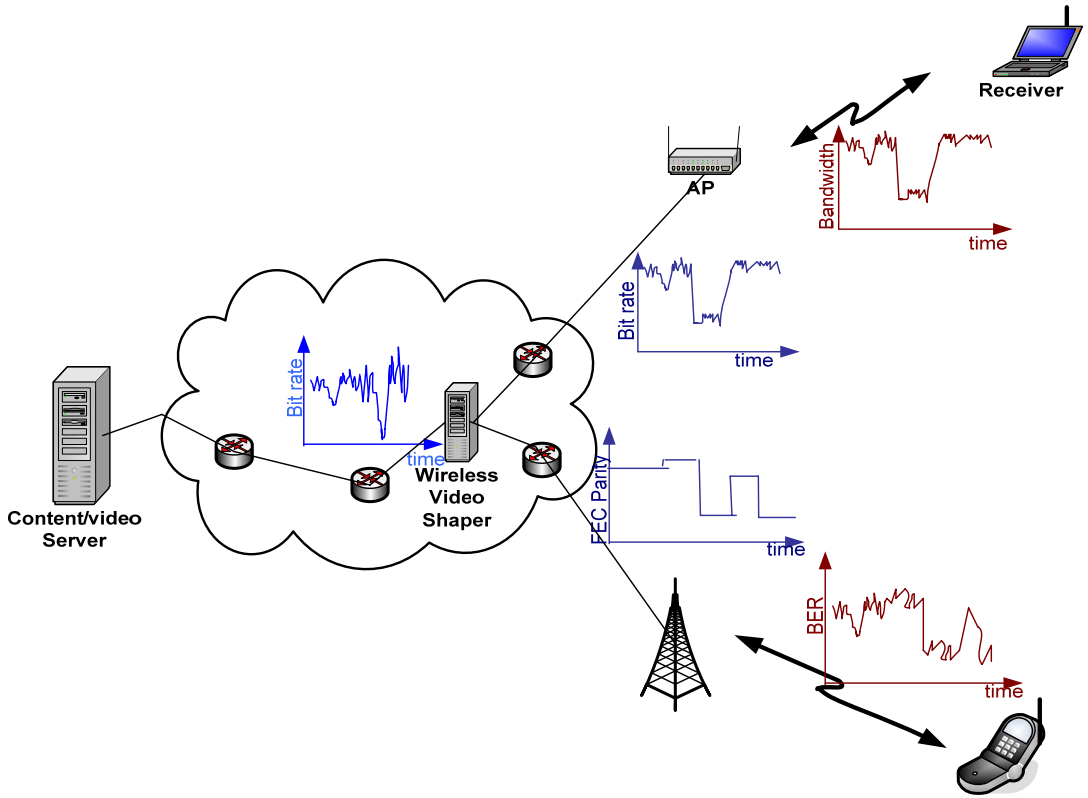
- End-to-end transport protocols severely affected by bit-rate and quality fluctuations on wireless channel
- Note that for WLAN, **MAC layer contention** can cause rate variations even when SNR is high ….



Example measurement on ORBIT Radio Grid testbed using time-varying noise source

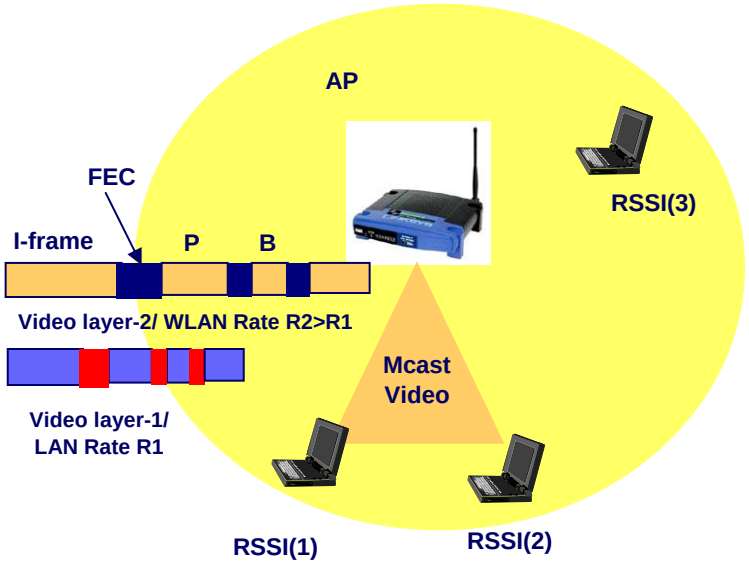
Wireless Challenges - Time-Varying Channel: Video Transcoding & Transport Gateway

- Video transport gateway for adaptive transcoding, shaping and FEC to match current radio channel and user device characteristics
- Significant improvements over end-to-end UDP or TCP



Wireless Challenges: Efficient Multicasting in 802.11 WLAN

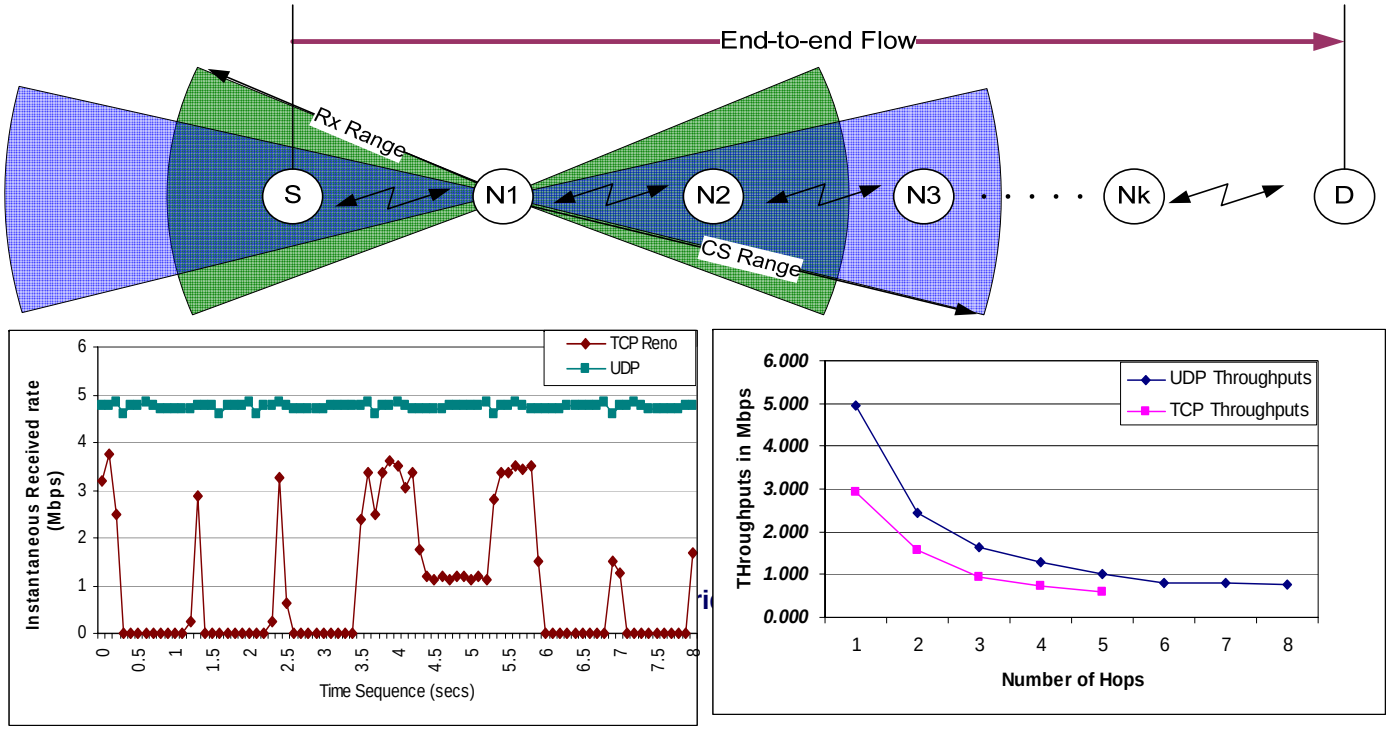
- FEC and layered video can significantly extend the range and reliability for multicast services over WLAN
- QoS support in 802.11e
- Implications for improved rate control, scheduling and FEC support in future WLAN standards



Courtesy: S. Makharia & H. Liu, Thomson Inc.

Wireless Challenges: Self-Interference

- Self-interference from successive packets in a TCP or UDP flow can significantly degrade performance
- Arises in both single-hop WLAN and multi-hop mesh scenarios

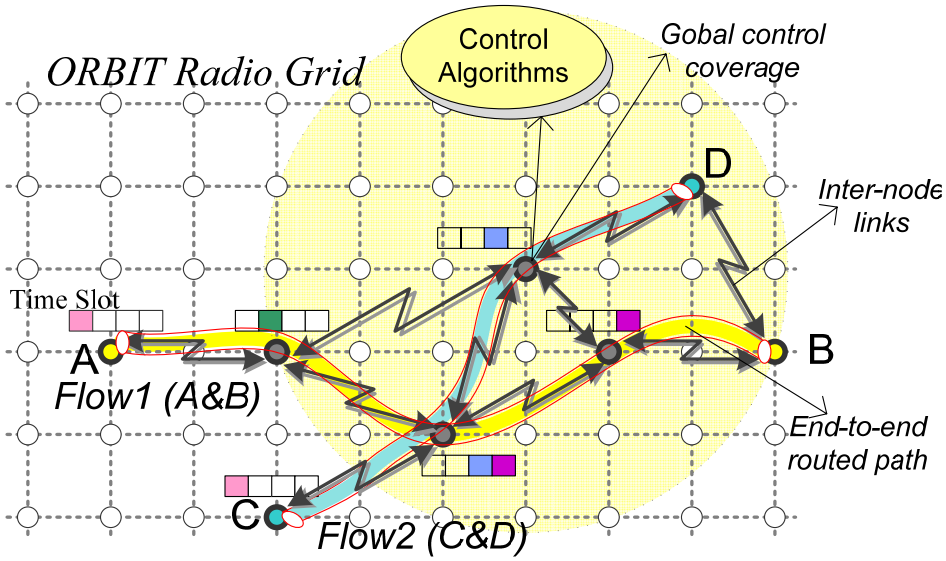


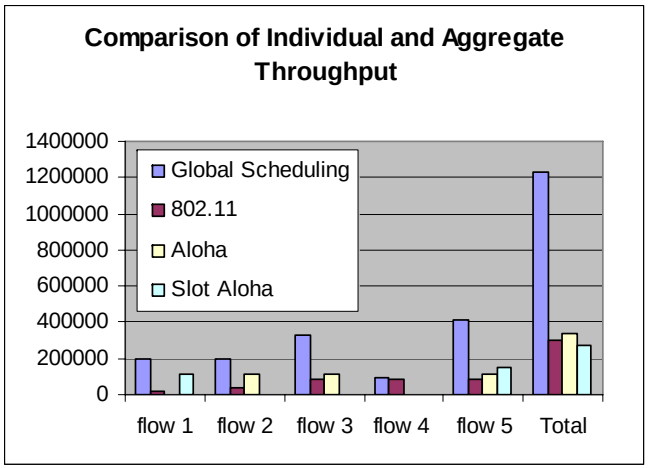
One-hop – no MAC retries

Multi-hop with MAC retries

Wireless Challenges: Self Interference - Integrated Routing & MAC

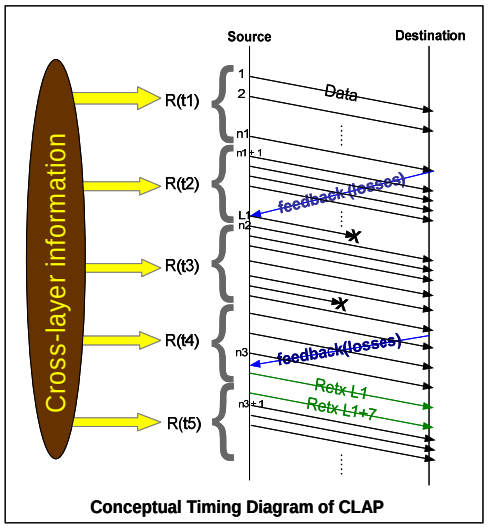
- Video transport in multi-hop mesh networks requires fundamental re-examination of MAC and routing
- Current 802.11 MAC + AODV etc unworkable for video streams
- Integrated routing and MAC (IRMA) with global allocation algorithm proposed as a solution
- Large capacity gains achieved in initial results [Wu, 2005, 2007]



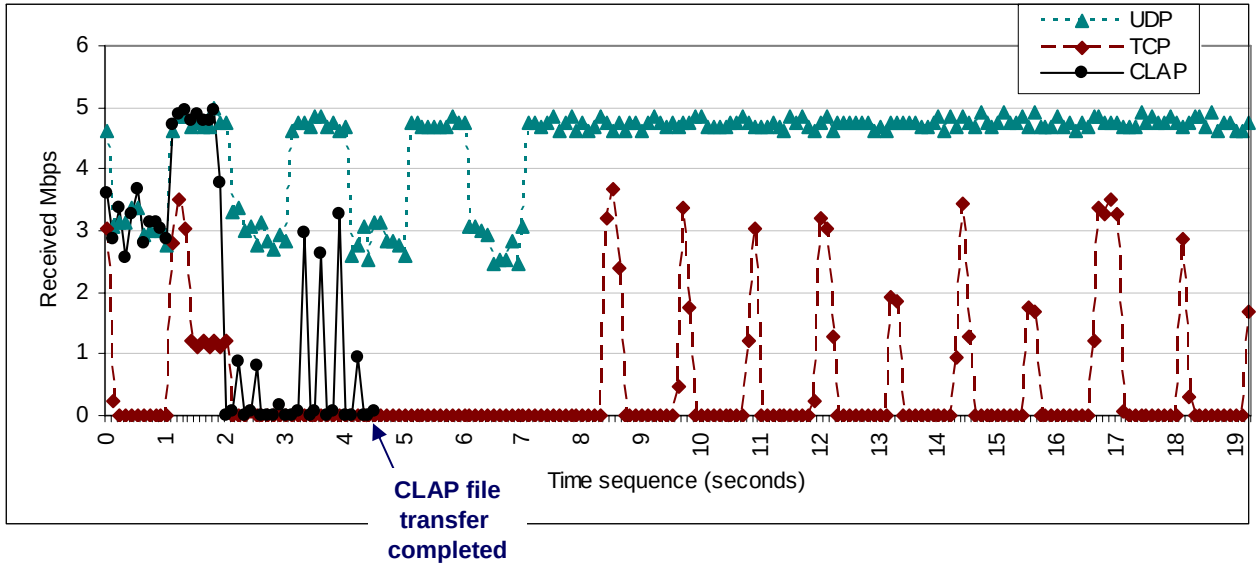


Wireless Challenges – Poor TCP Performance:
Cross-Layer Transport

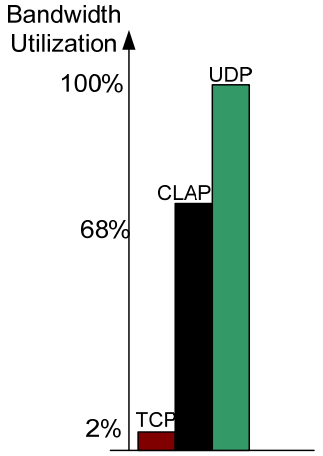
- Cross-layer aware transport protocols achieve major performance gains for wireless video
- For example, CLAP [Gopal, 2007] provides for significantly faster video on-demand downloads



Conceptual Timing Diagram of CLAP



Instantaneous received rate of TCP, CLAP, UDP (noisy WLAN example)



Wireless Challenges - Integrating Short-Range Radio: In-network storage and caching

- "Infostation" concept proposed by WINLAB ~1997
  - Takes advantage of fast short-range radio technology to opportunistically download video/audio files to mobiles
  - Content caching based on user profiles, location
  - Implications for network architecture → in-network storage, hop-by-hop transport ("CNF" future Internet project [Paul, 2007]

WINLAB's i-media Prototype (2002)

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