Co-operative proxy caching algorithms for time-shifted IPTV services

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Outline

- Introduction
  - advanced access network services
  - IPTV
  - access network transformation
- Time-shifted television
  - concept
  - caching algorithms
  - simulation results
- Proxy implementation
  - RTP / RTCP / RTSP
- Conclusions

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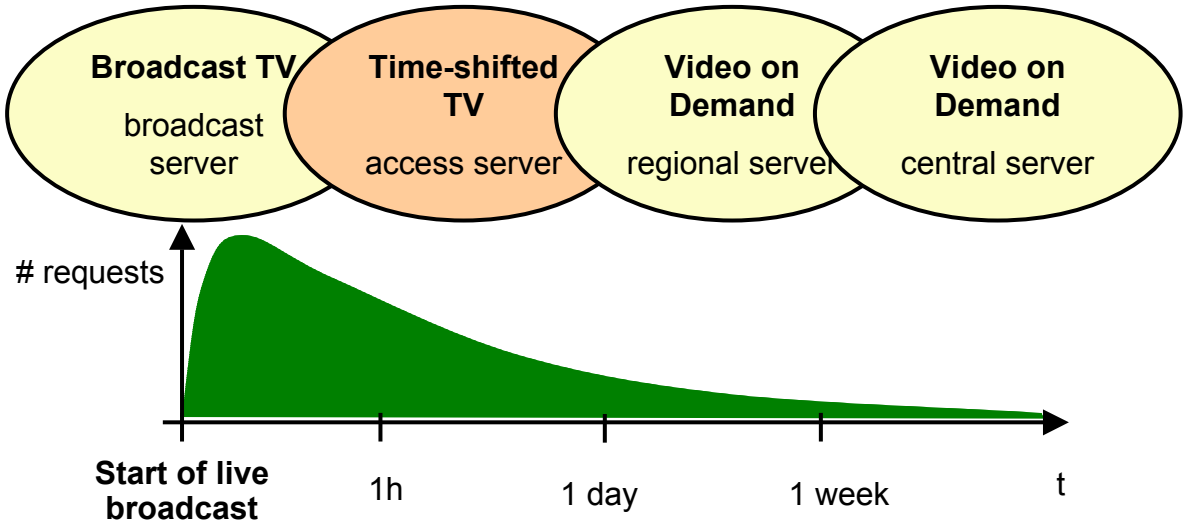
Introduction

- Network requirements for next-generation services
  - content delivery (IPTV, VoD)
    - high bandwidth, low jitter
  - multiplayer games (server based, P2P)
    - low delay
  - distributed storage
    - low delay, high availability
  - conferencing (IP telephony, video conferencing)
    - low delay and jitter
  - home management (automation, security)
    - high availability

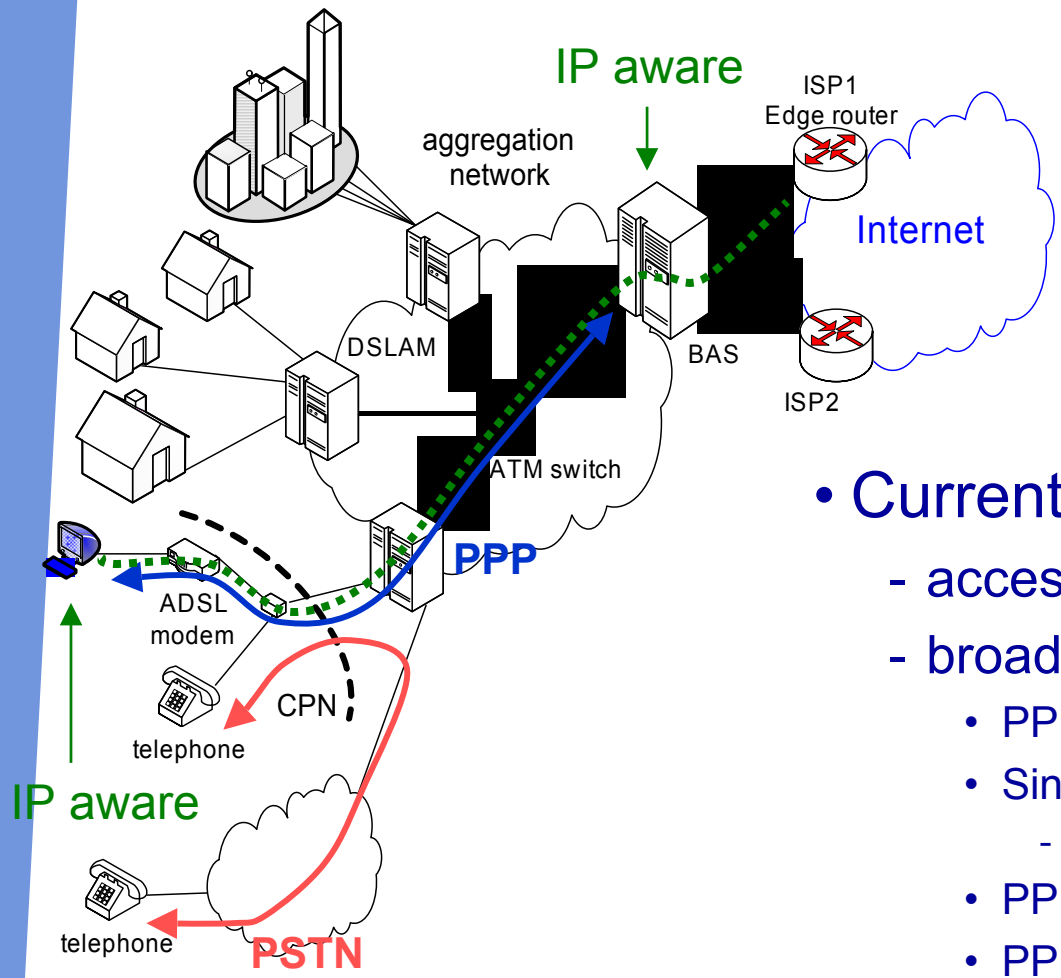
=> increasing bandwidth and QoS

Introduction

- High priority: IPTV services
  - today: broadcast TV (live) or VoD (older content)
    - highly loaded VoD servers at the network edge
    - complete files are stored
  - solution: time-shifted TV for (very) recent content
    - distributed servers in the access network, storing fragments

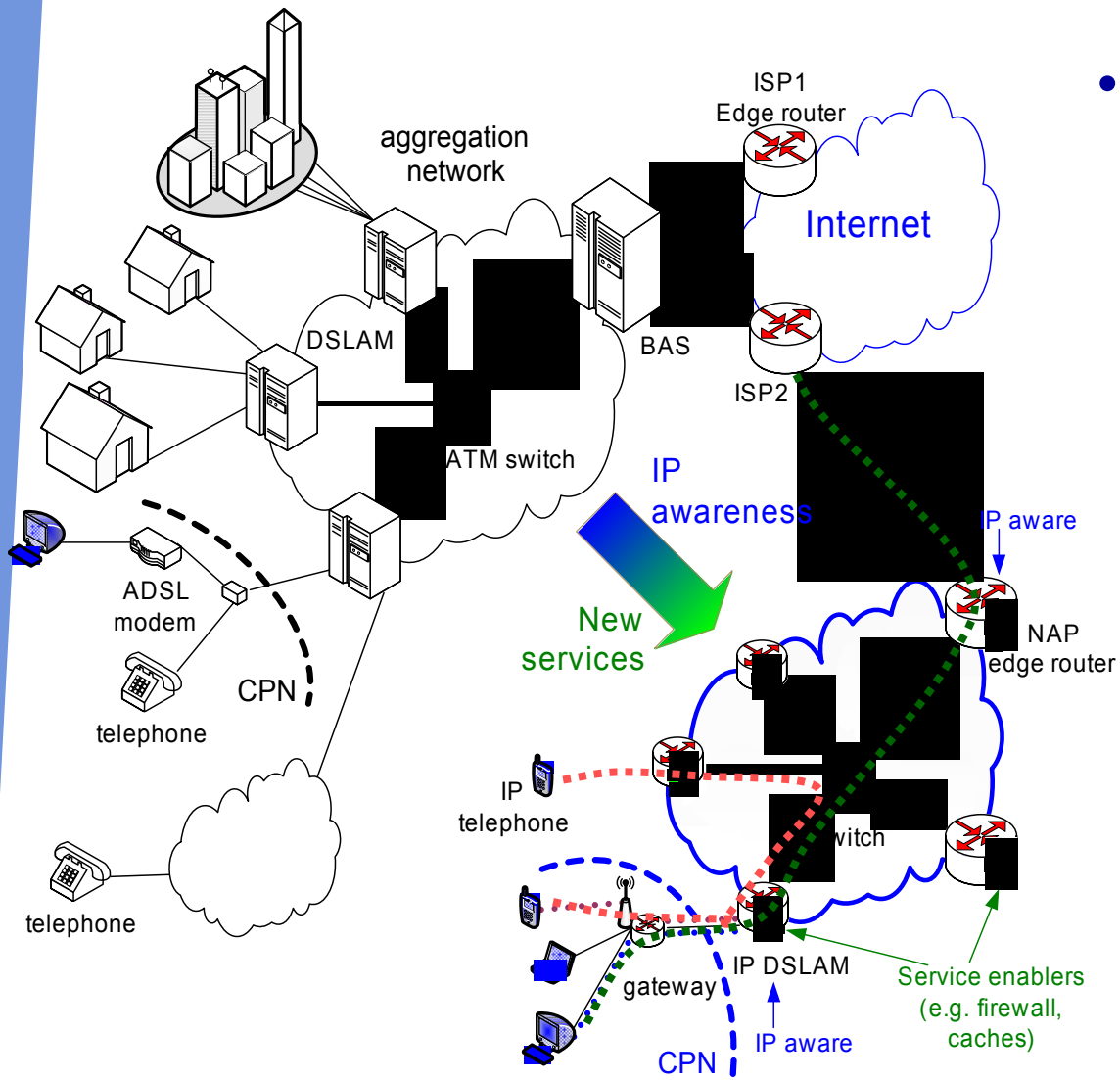


Access network



- Current architecture
  - access network per service
  - broadband Internet (DSL / ATM based)
    - PPP terminated in single device (BAS)
    - Single device per subscriber
      - NAT breaks E2E connectivity
    - PPP setup hampers autoconfiguration
    - PPP conflicts with application-based QoS and multicast support

Access network



- Next-generation architecture
  - Converged access
  - IP awareness
    - Multicast support
    - Local P2P traffic
  - Multi-edge
    - Scalability
    - High availability
  - New services (triple play)
  - Application based QoS

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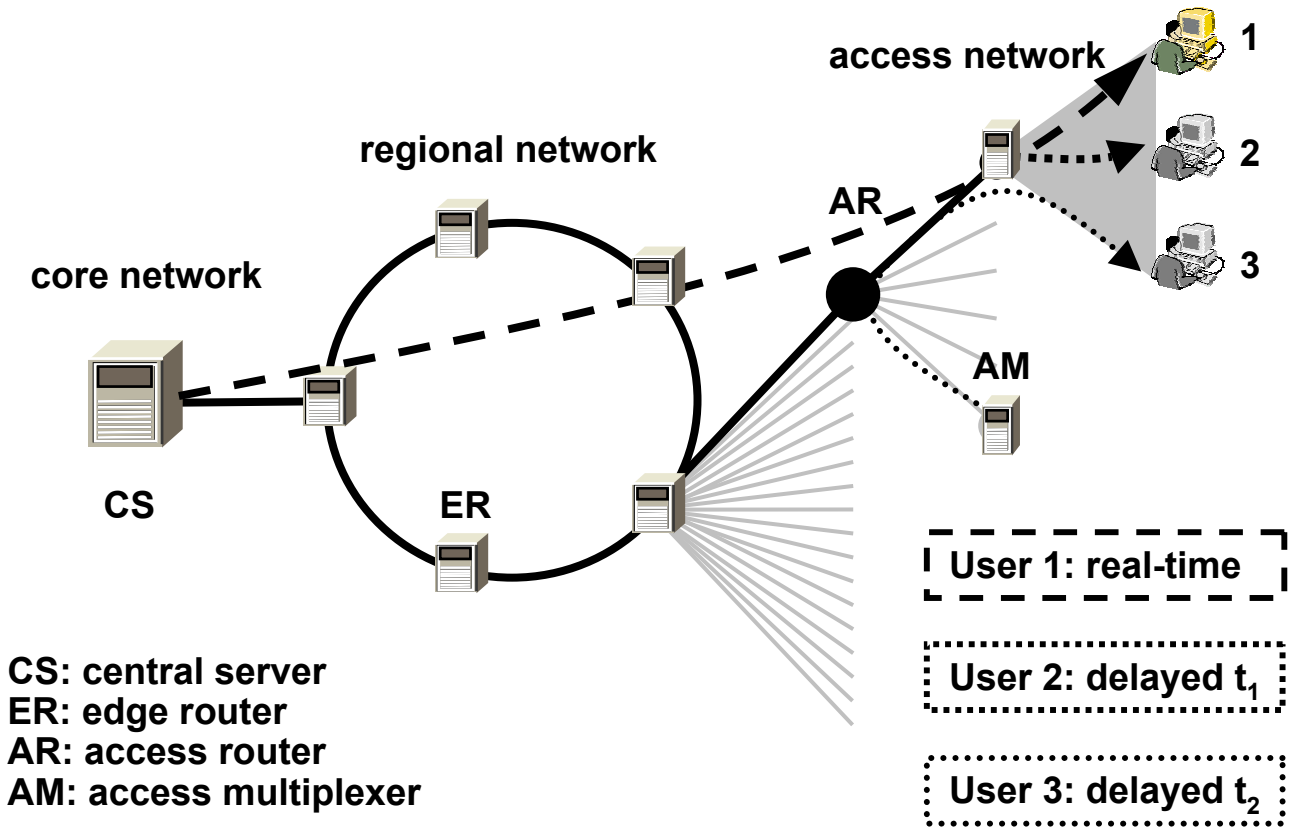
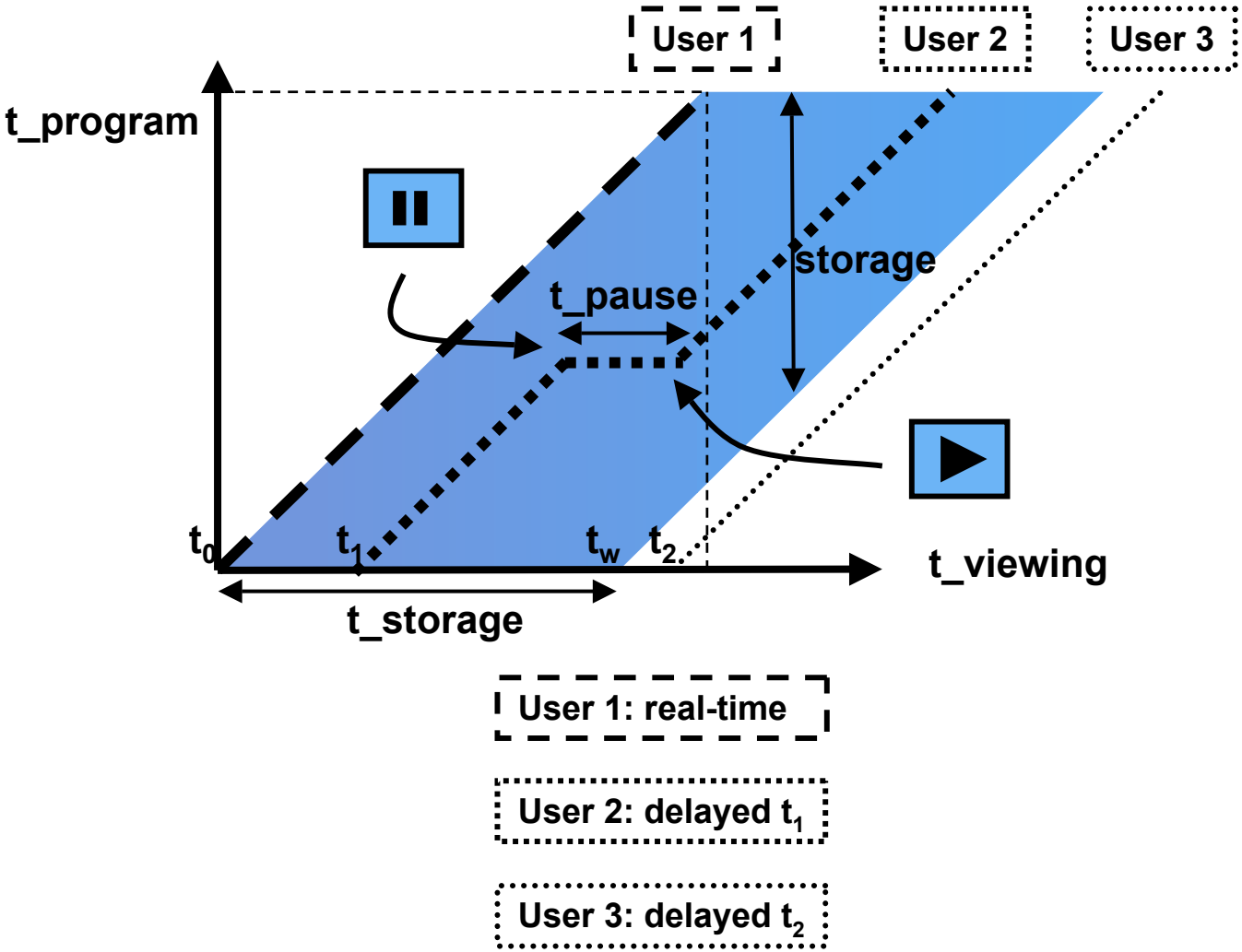
Time-shifted TV

- Network view
  - caching of fragments
  - p2p techniques at cache level



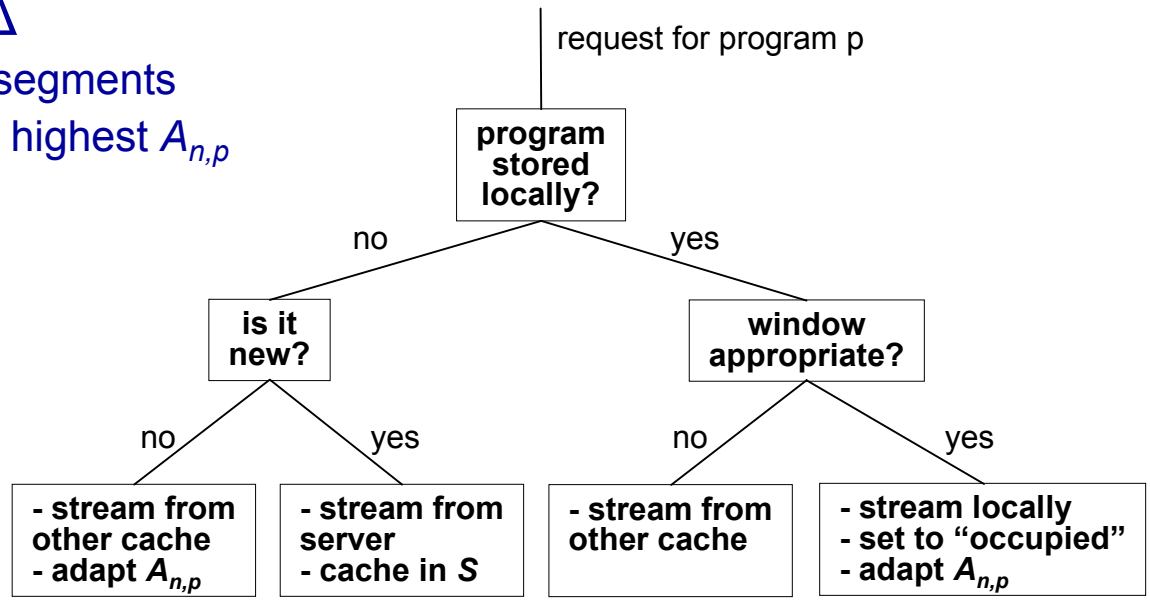
Time-shifted TV

- Streaming diagram



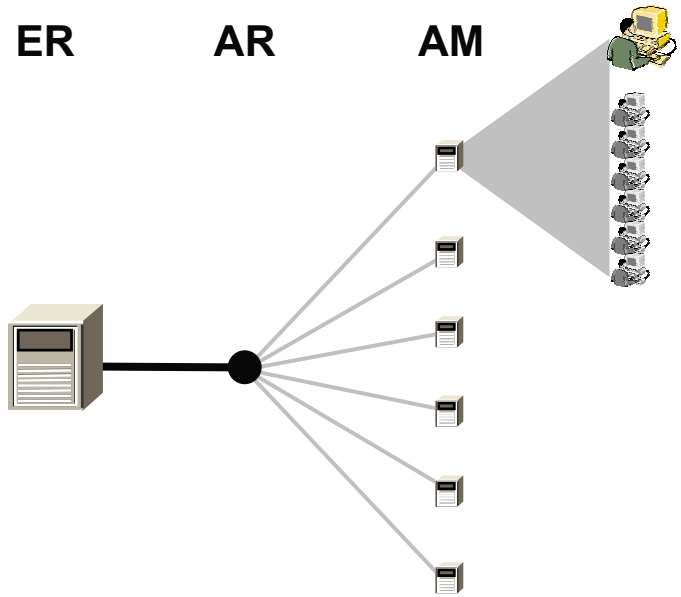
Time-shifted TV

- Caching algorithm
  - storage
    - small part *S* (< 1 GB) for learning
    - large part *L* for storage of popular / distant segments
  - during each interval Δ (e.g. 5 minutes)
    - parameter $A_{n,p}$ is increased every time a request for program *p* passes by cache *n*
    - increase $A_{n,p}$ by 1 (pure popularity) or by the hopcount between cache *n* and the serving node (popularity & distance)
  - after each interval Δ
    - store all “occupied” segments
    - store segments with highest $A_{n,p}$



Time-shifted TV

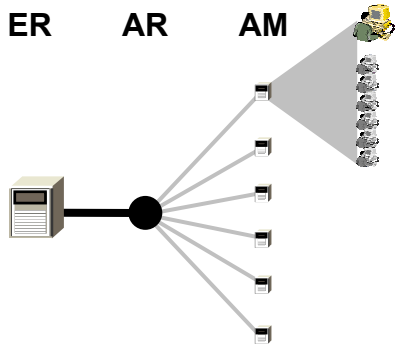
- Input parameters
  - 5 tsTV channels
  - 6 programs per channel
  - 45 minutes per program
  - 2.5 Mbps streams
    (≈ 1 GB per hour)
  - popularity halved after each interval Δ (= 5 minutes)



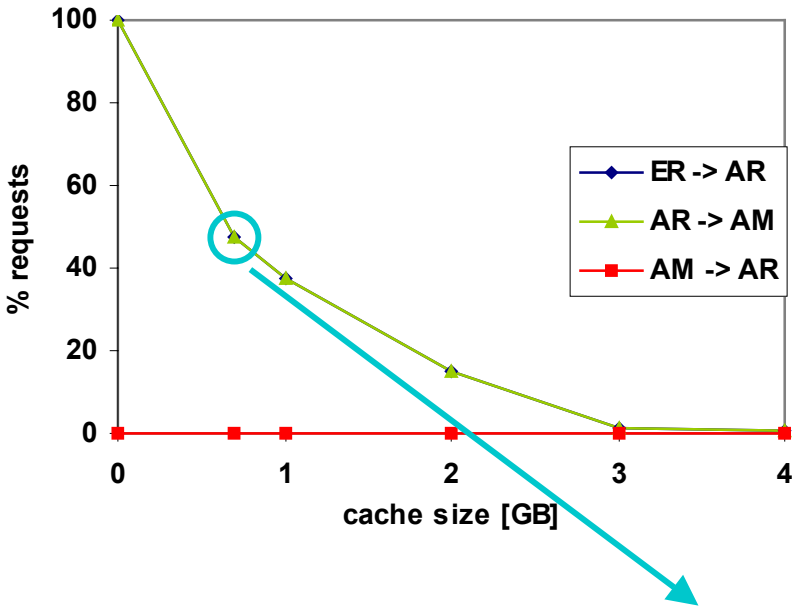
- Deployment options
  - hierarchical caching
    - caches at AR and AM level
  - co-operative caching
    - co-operating caches at AM level

Time-shifted TV

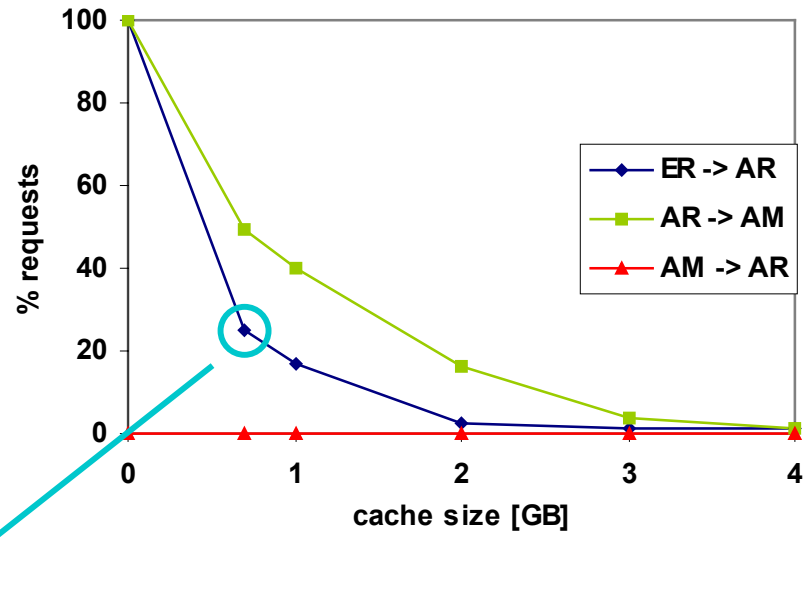
- Hierarchical caching



AM caches only



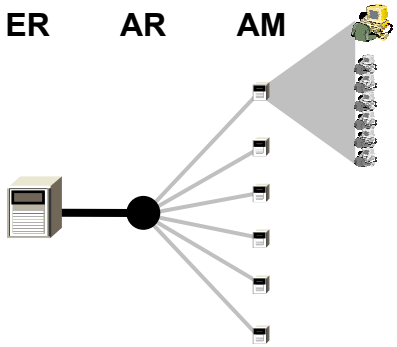
AR and AM caches

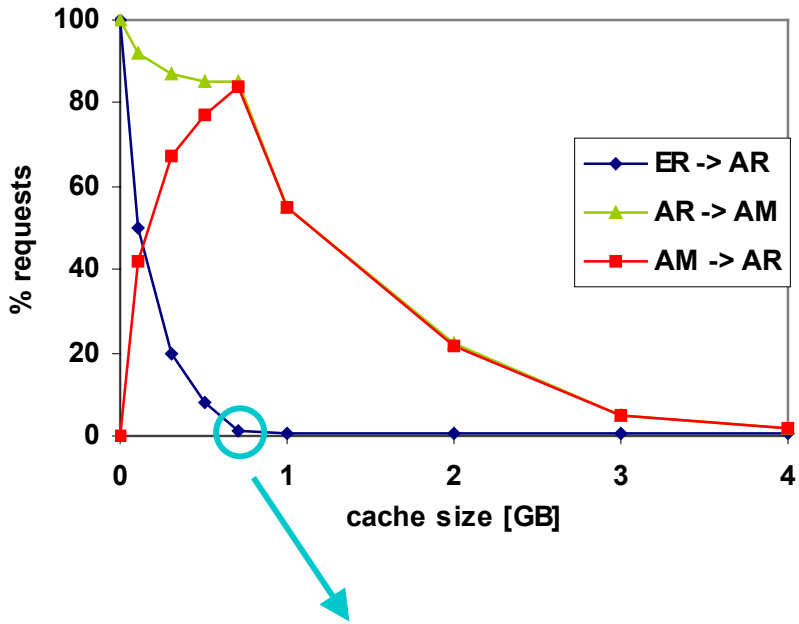


Server load reduced by 50% to 70% with 0.5GB caches

Time-shifted TV

- Co-operative caching





AM caches only

Server load reduced by 95% with 6 co-operating 0.5GB caches

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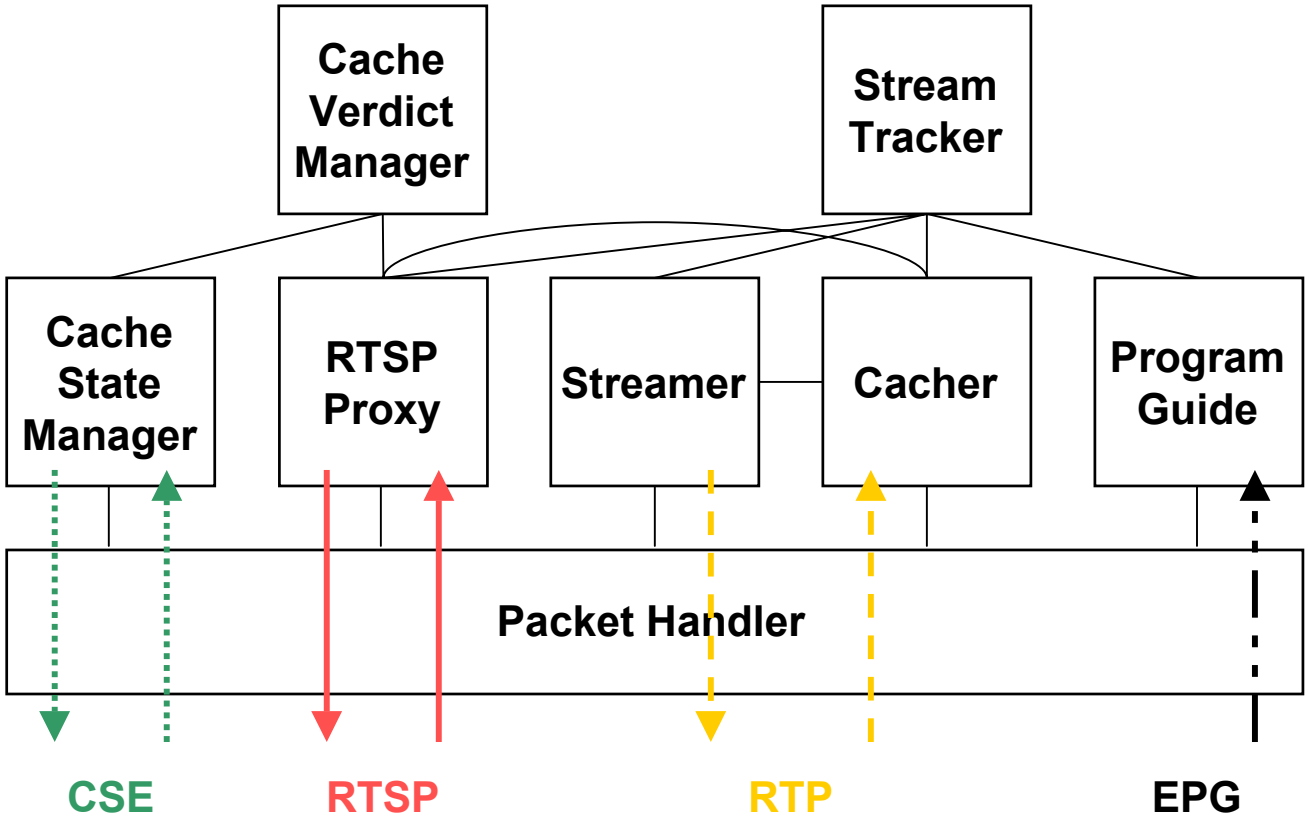
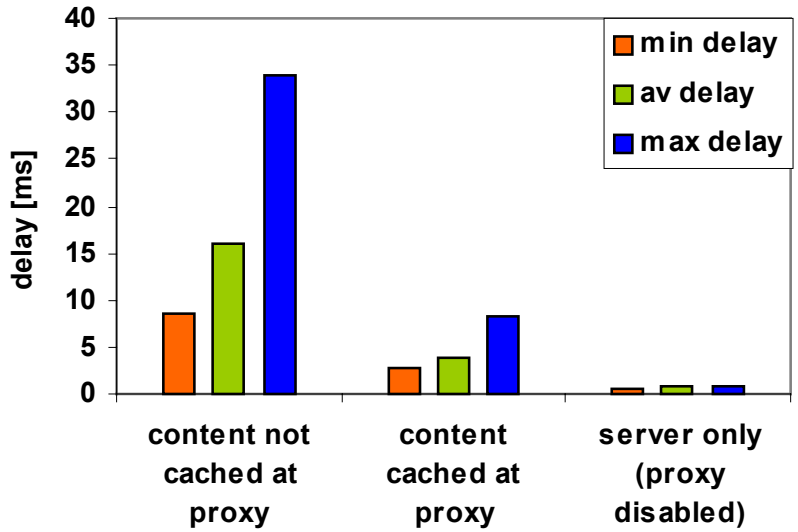
Proxy implementation

- RTSP proxy
  - implementation using RTP / RTCP / RTSP



Proxy implementation

- RTSP proxy
  - measurements
    - AMD Athlon™ 64 (512MB RAM)
    - delay between PLAY request and first RTP packet in a server - proxy - client configuration



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Conclusions

- Access network transformation
  - from ATM based broadband aggregation to multi-service IP-aware access networks
  - necessary to meet QoS requirements

- IPTV
  - identified as highest-priority, bandwidth-intensive residential telecom service
  - server load and access network load reduced effectively through time-shifted TV using distributed proxy streamers
  - implementation using RTSP proxy streamers