Multimedia Aware Adaptive Routers in Best-Effort Networks

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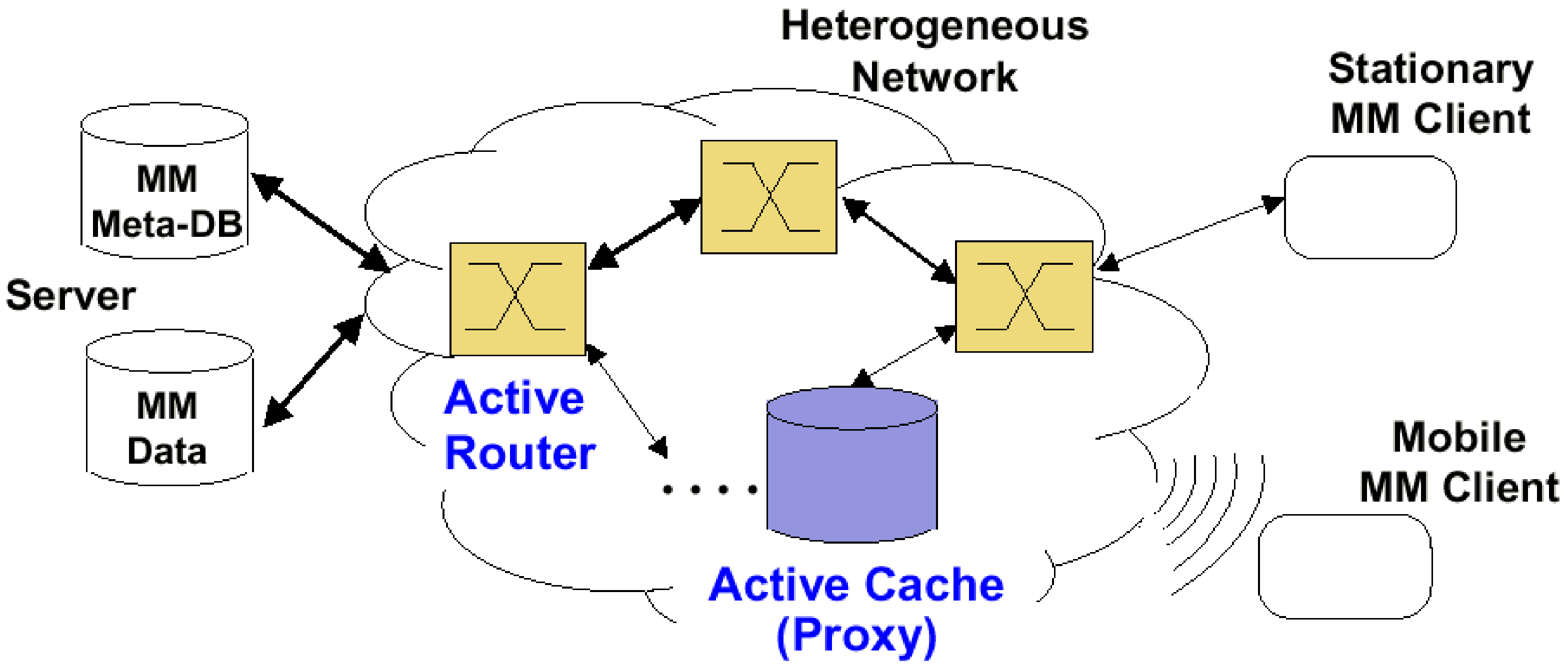
ITEC Project



Why Do We Need Adaptation? $\rightarrow$ Static Discrepancies

- hardware/software constraints
  - video resolution or color depth doesn't fit client's screen
  - client cannot cope with high frame rate (CPU constraint)
  - available bandwidth per second is too low in general
- adaptation on a meta-level
  - cut out violent scenes
  - only paid for low quality

Why Do We Need Adaptation?
$\rightarrow$ Dynamic Discrepancies

- bandwidth fluctuation cannot be compensated by buffer
- bandwidth massively changes over time
- multiple clients on the same network link
  - share same video in different qualities
  - stream other video
  - generate other traffic

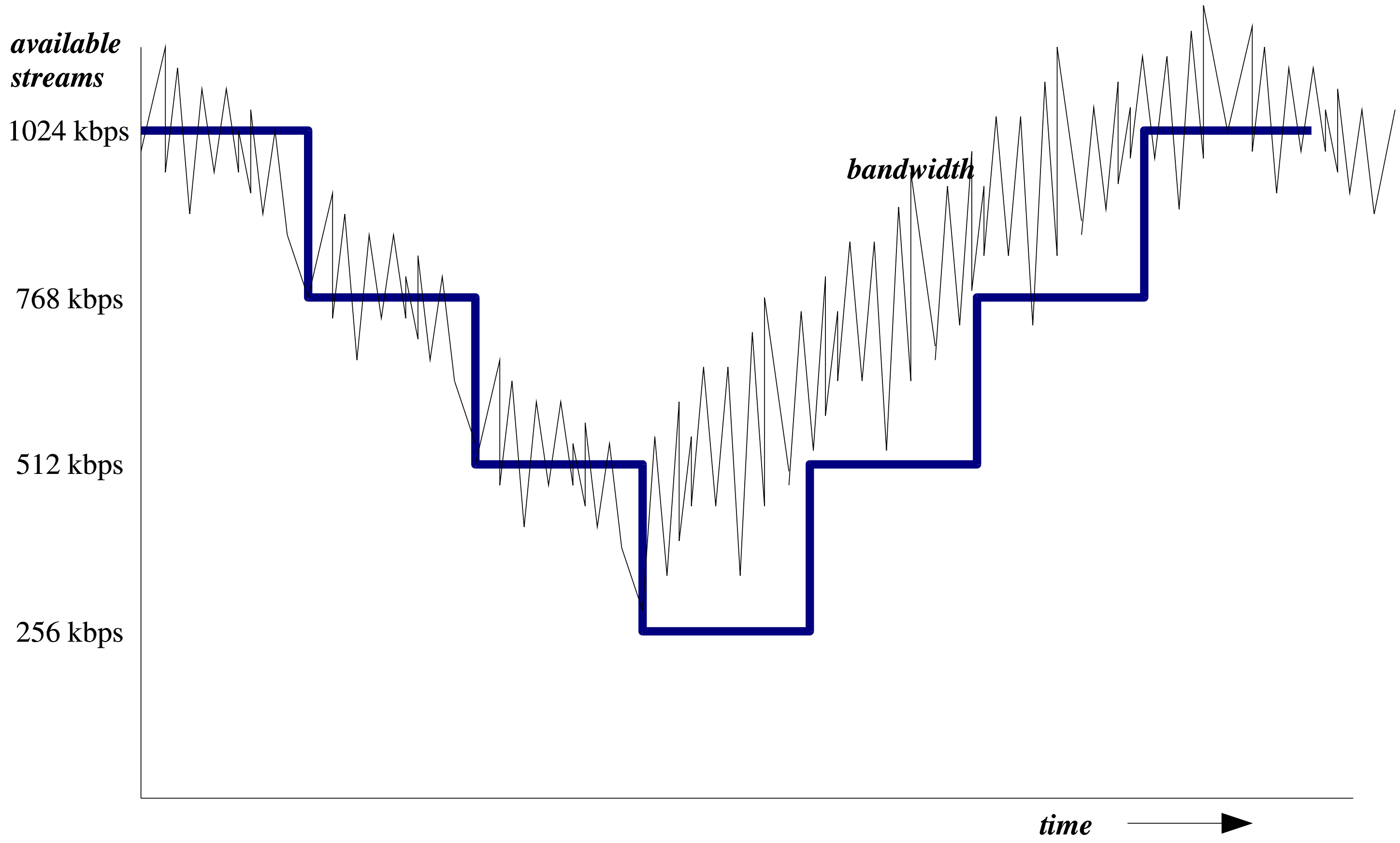
Possible Adaptation Methods

- Non Real Time Adaptation (in the Proxy)
  - Grayscaling
  - Colordepth
  - Resolution
- Real Time Adaptation (in the Router)
  - Temporal scaling
  - Spatial scaling
  - Quality scaling (SNR)
  - Fine Granular Scalability (FGS)

Switching, Simulcast and Multicast

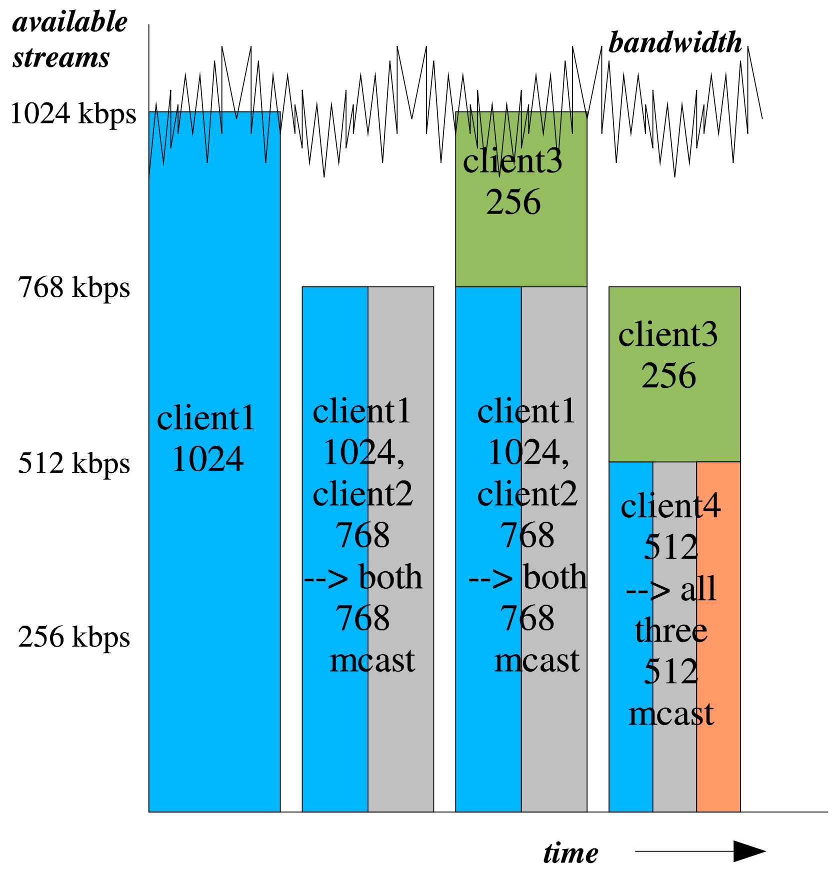
- server stores multiple bandwidth streams
- switch on massive change of link speed ($\rightarrow$ switching)
- share link bandwidth with multiple streams ($\rightarrow$ simulcast)
- share equal streams ($\rightarrow$ multicast)

Switching



available streams
1024 kbps
768 kbps
512 kbps
256 kbps
bandwidth
time

Simulcast and Multicast

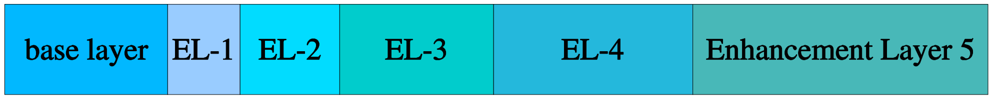


Scaling Techniques Within The MPEG-4 Scalable Profile

- stream partitioning by Temporal, Spatial, or SNR adaptation

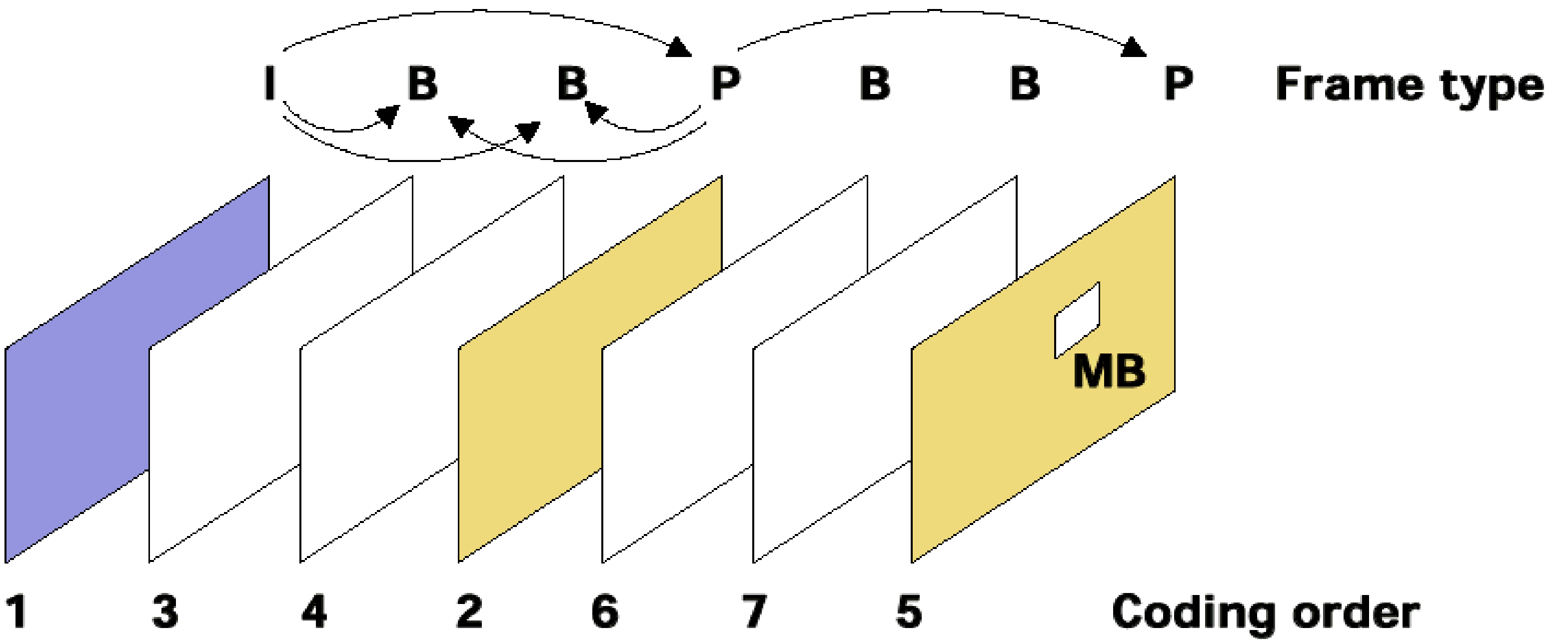
  - defer/prevent unneeded switching
  - multicast for baselayer, unicast enhancement layer

- perfect adaptability: FGS

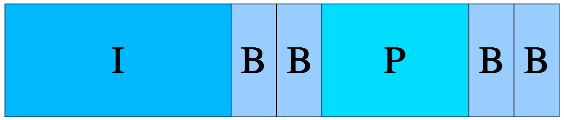


  - cut at every arbitrary byte bounding
  - coding efficiency ?

Frame Types in MPEG-4

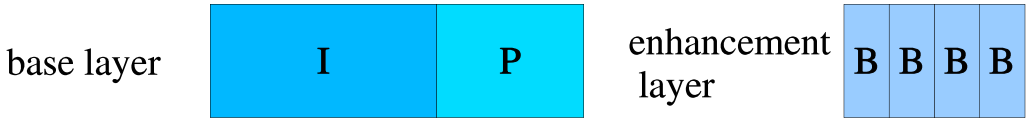


Temporal Scaling Within The MPEG-4 Simple Profile



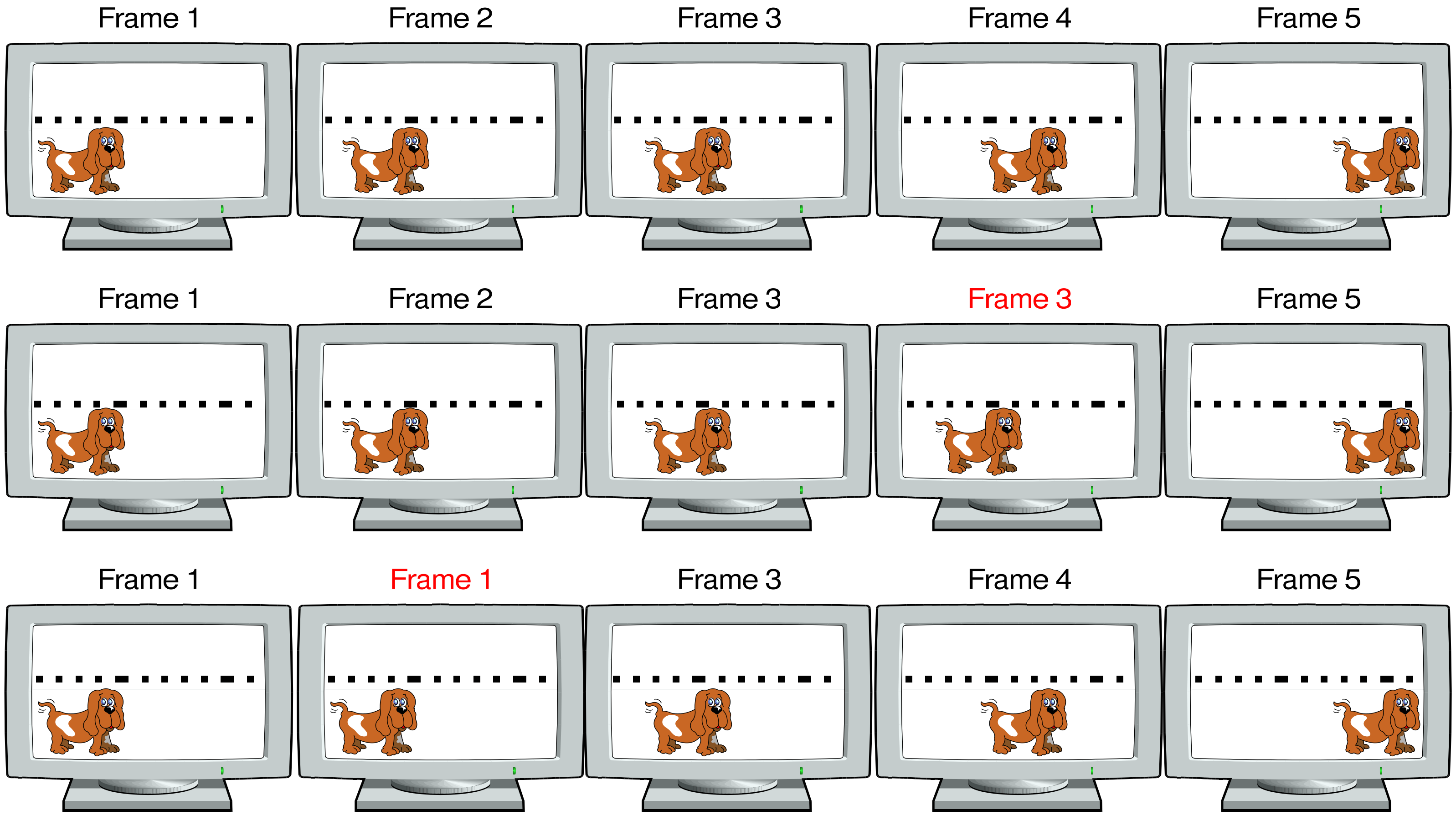
- drop any frame
- on client side, last decodable frame stays on display
- if I-VOP or P-VOP dropped, all further VOPs are useless

Advanced Temporal Scaling



- only drop B-VOPs (B-VOPs make up about 20-40% of GOP bandwidth)
- extra protection for I-VOPs and B-VOPs (aka Baselayer)
  - send them via TCP (?)
  - RTP with ARQ (Automatic Repeat reQuest)
  - RTP with Priorities (Diffserv,...)
  - RTP with Error Correction
- keep "important" B-VOPs

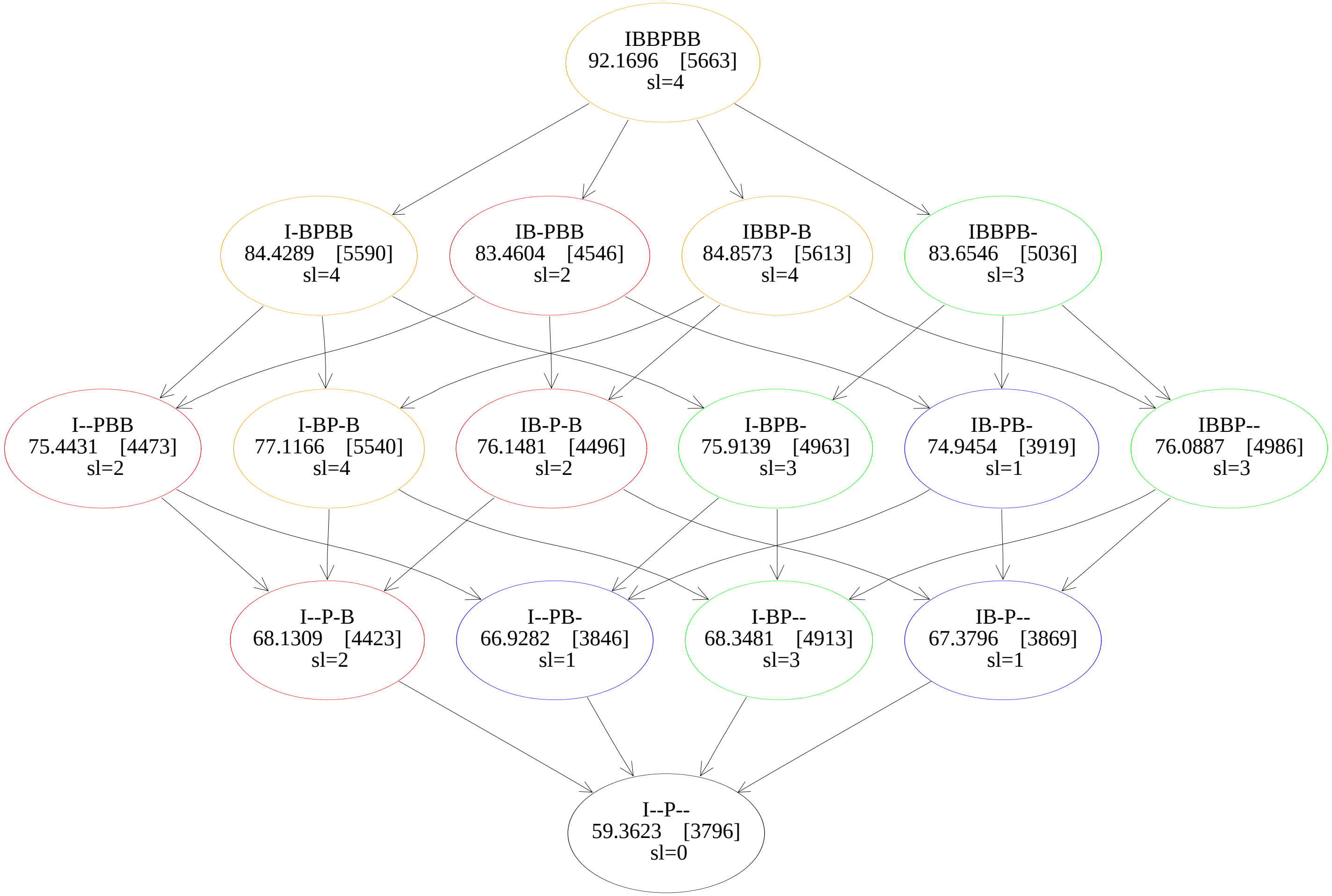
What Is An "Important" Frame?



Measurment Of Frame Importance

- subjective
  - “slightly pre-focussed” individuals
- objective
  1. Peak Signal-to-Noise Ratio (PSNR)
  2. timely distribution
  3. bandwidth

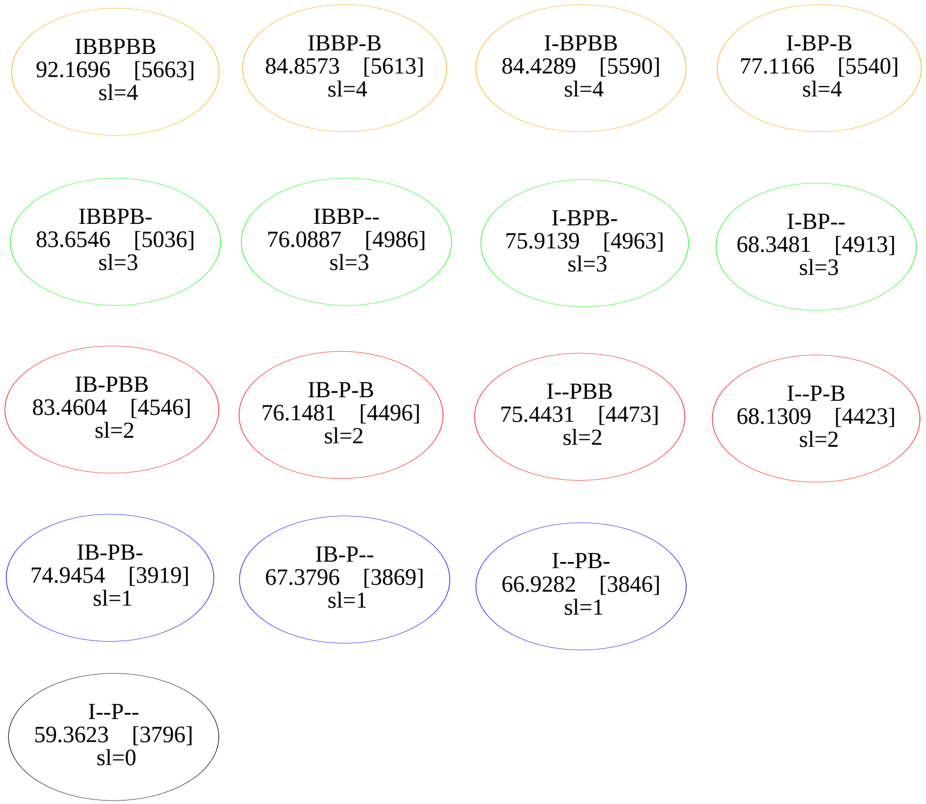
Modification Tree



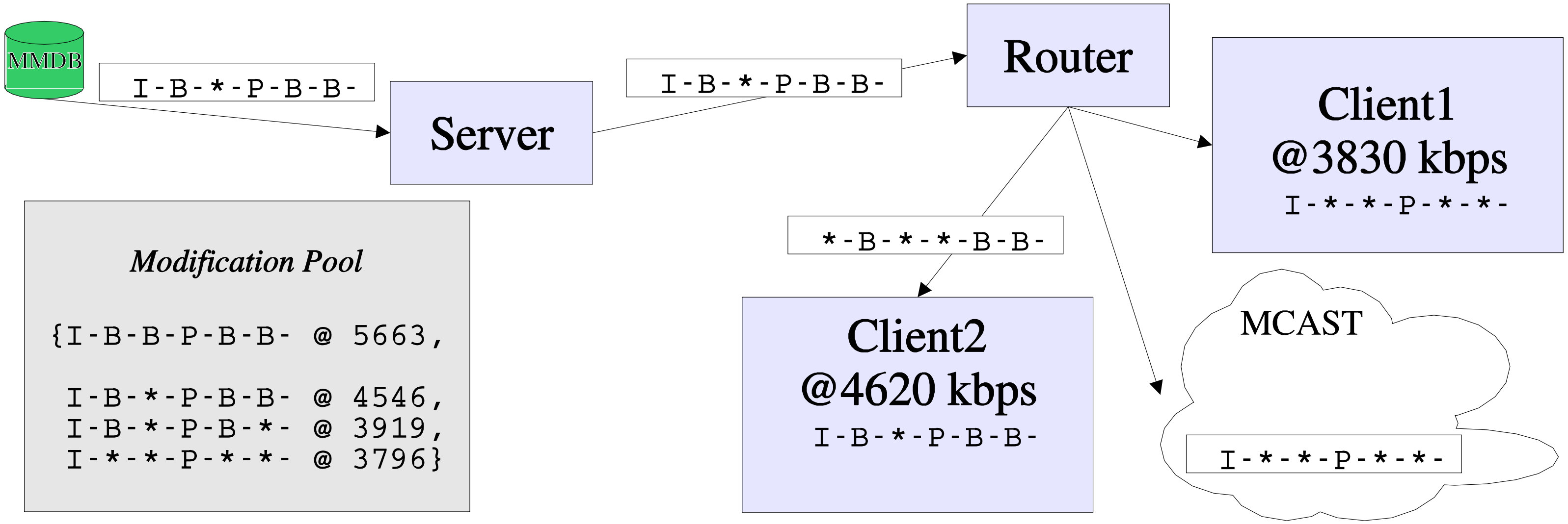
Paths and Slices

- optimizing for low bandwidth $\rightarrow$ start from bottom
  - best path
  - best possible path
- avg GOP bandwidth ($\rightarrow$ needed buffersize)
- bandwidth slices (eg. 3800 – 4300 – 4900 – 5100 – 5800)
  - best slice path
  - best possible slice path
  - $\{$best $|$ worst$\}\{$Size $|$ PSNR$\}$

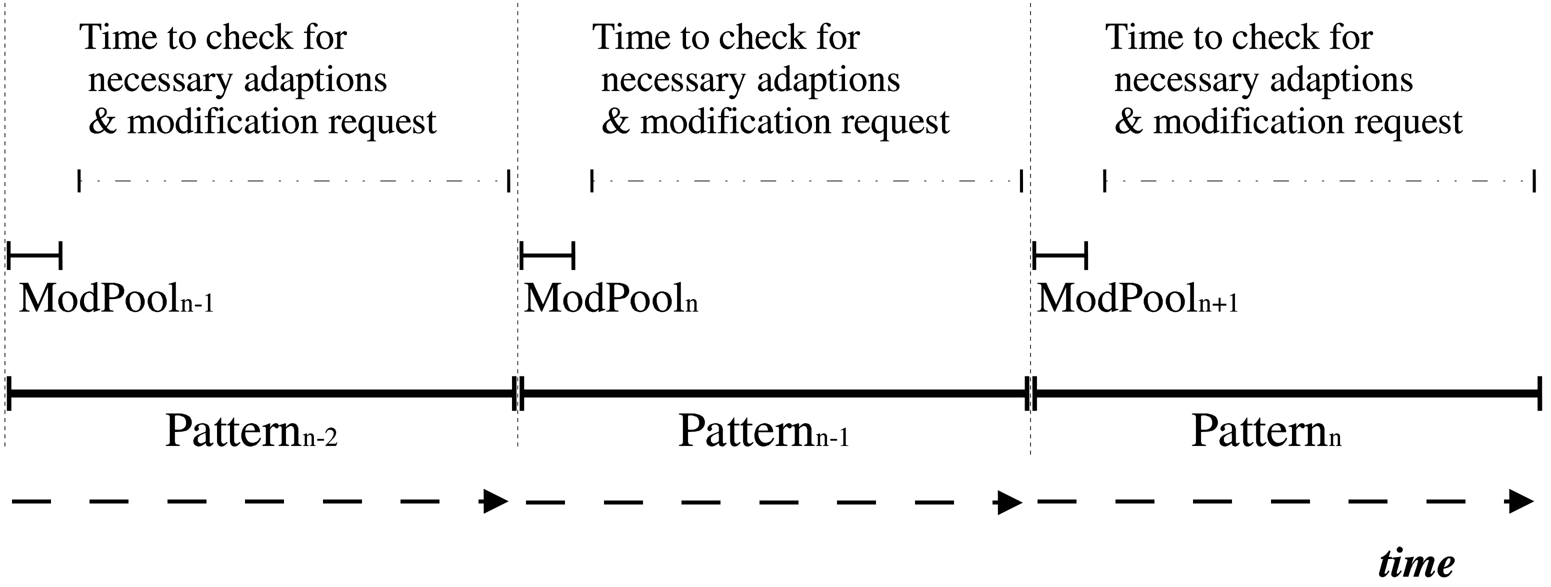
Modification Tree Sorted In Slices



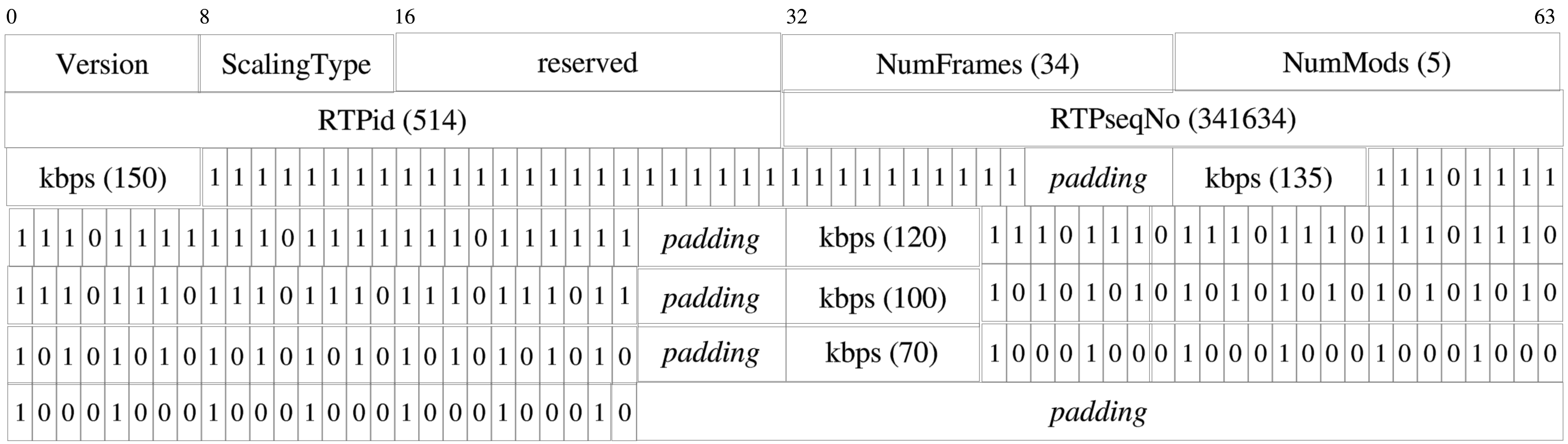
One-Router Scenario



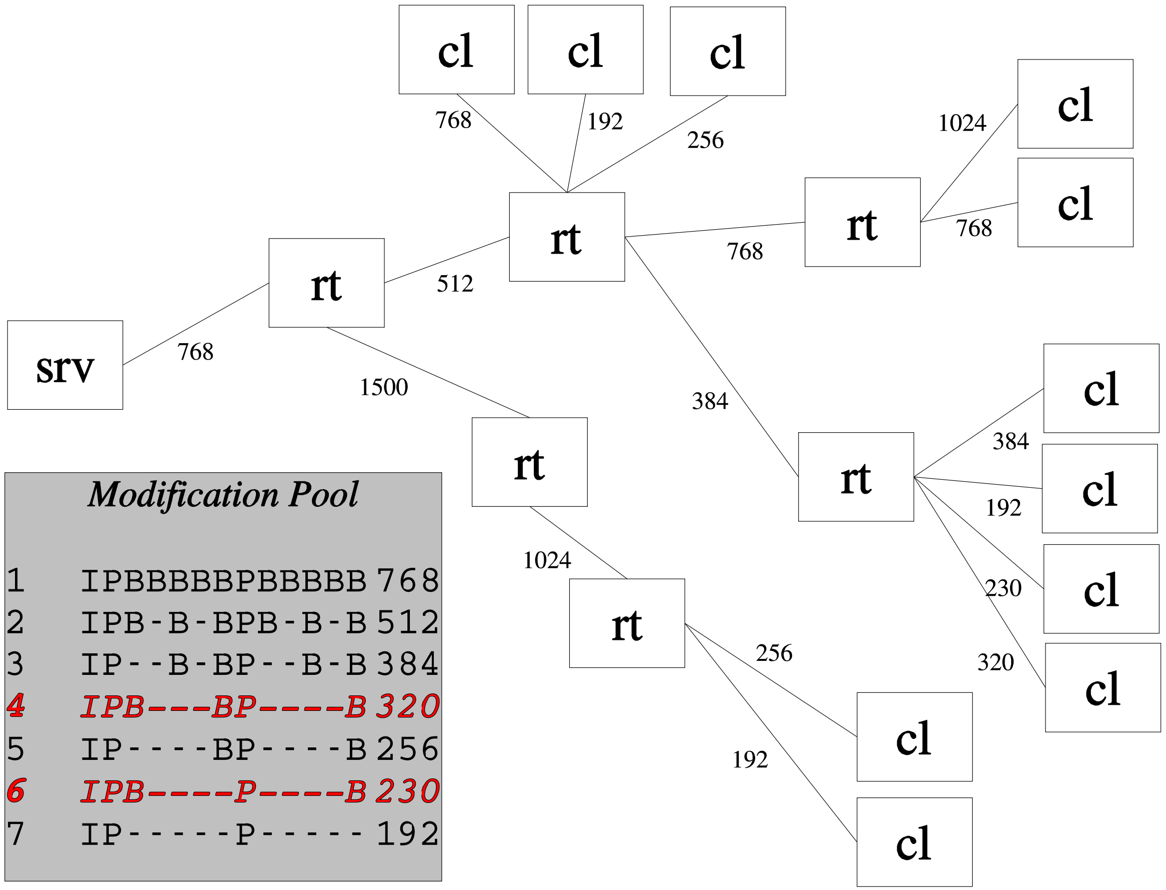
Modification List Propagation



Proposed Packet Format



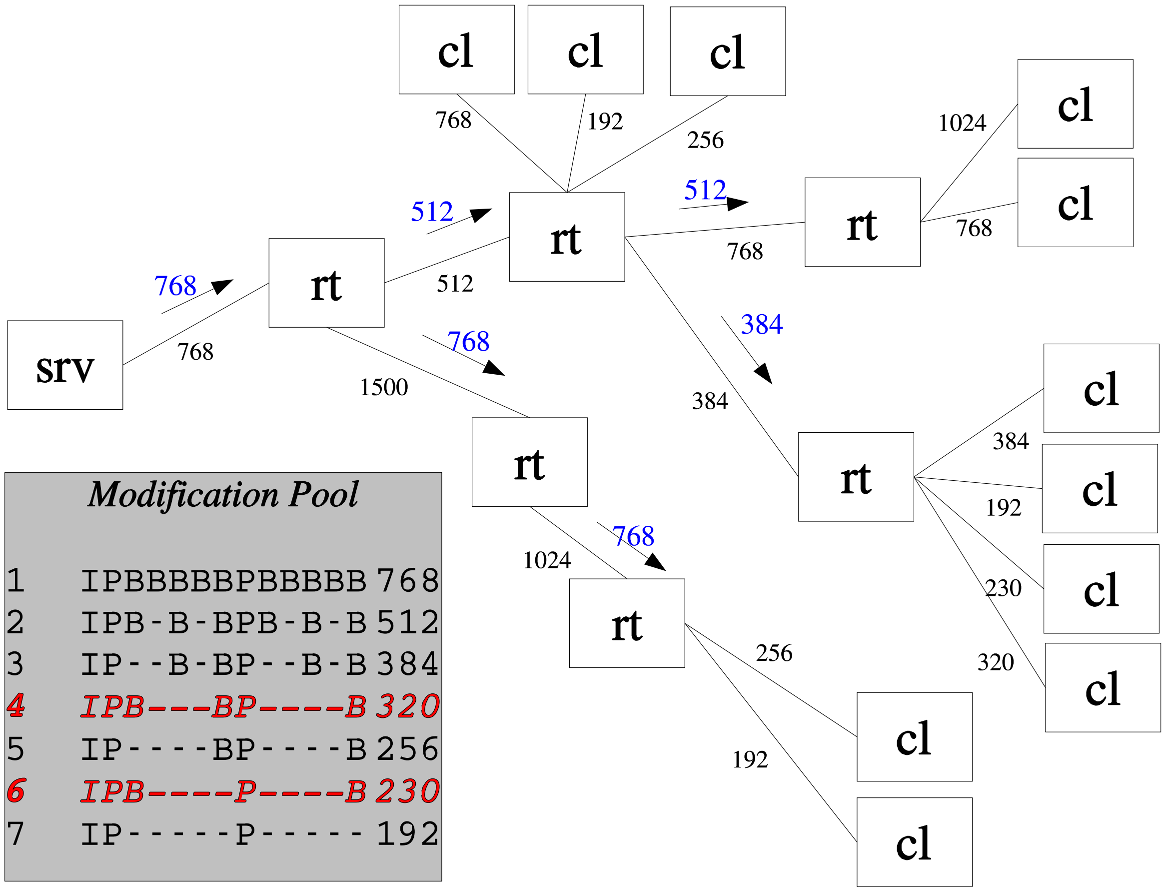
Big Network Topology 1/4



Modification Pool

1	IPBBBBBPBBBBB	768
2	IPB-B-BPB-B-B	512
3	IP--B-BP--B-B	384
4	***IPB---BP----B***	***320***
5	IP----BP----B	256
6	***IPB----P----B***	***230***
7	IP-----P-----	192

Big Network Topology 2/4



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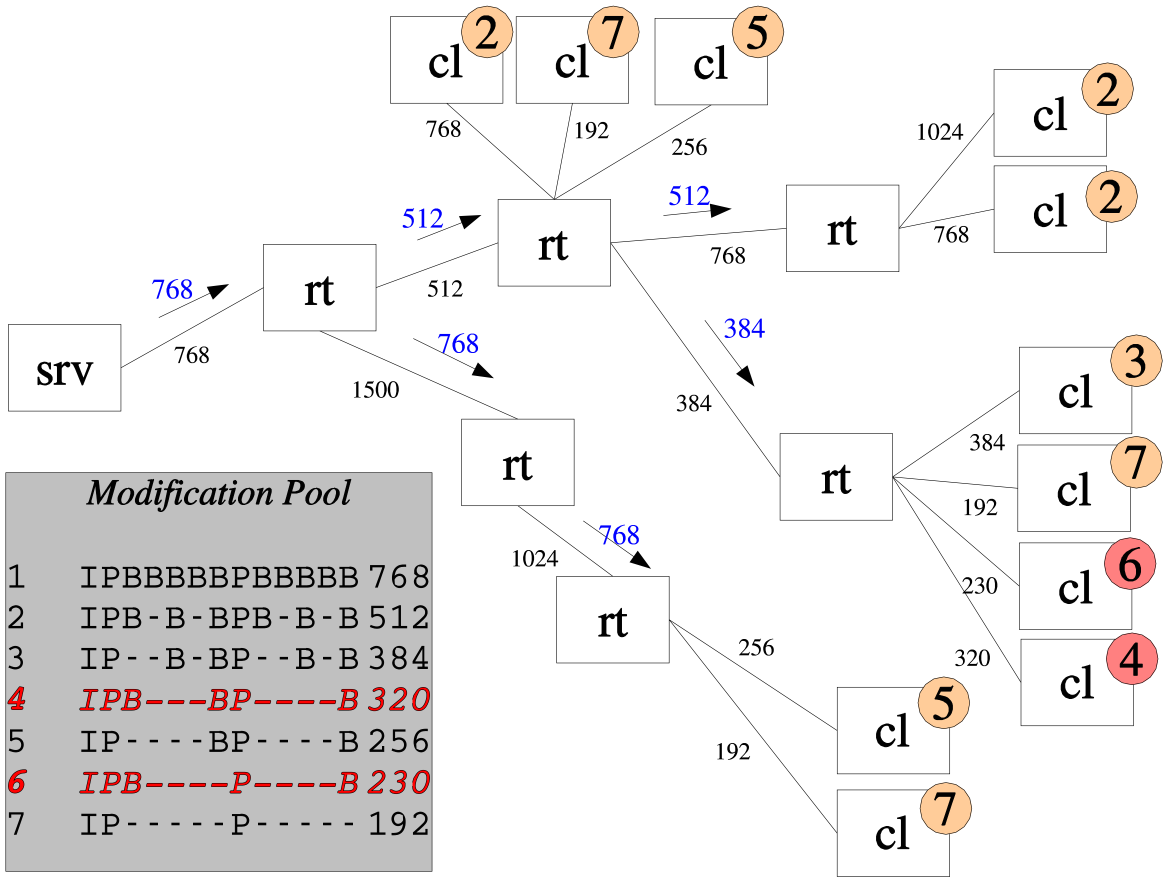
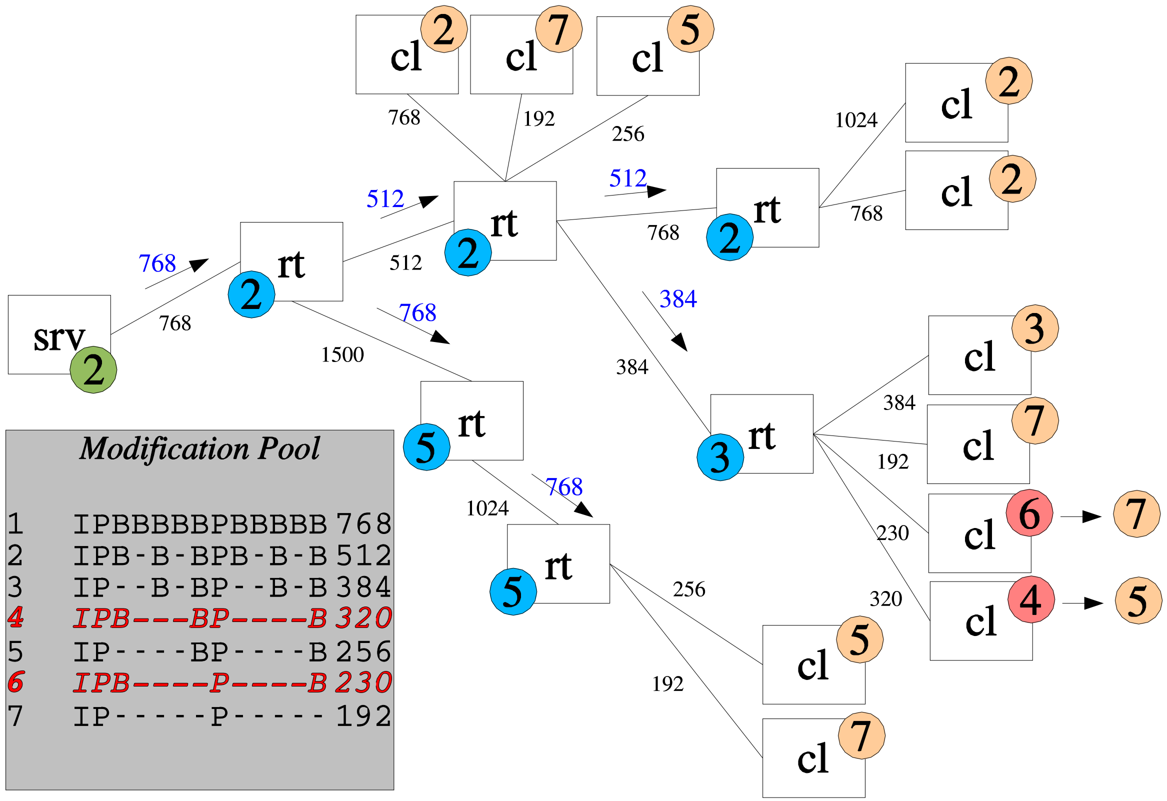
Big Network Topology 3/4



Big Network Topology 4/4



Open Questions

- safe baselayer transport
- how many frames should be dropped before switching?
- good switching algorithms
- admission control for simulcast
- TCP-friendly congestion protocols
- $\rightarrow$ functioning test setup

Running Projects

- C++ Library for MPEG-4 and YUV, Router, Proxy, Server
- 4h Praktikum Sitter + Lorber
  - Teststreams with various encoders, decoders, sizes, and patterns
- Diplomarbeit Klaus Leopold
  - Pattern Modification Simulation and Client Side Processing
- Diplomarbeit Ingo Buchbauer
  - Measurements for RTP streaming environments