Proactive Prioritized Mixing of Scalable Video Packets in Push-Based Network Coding Overlays

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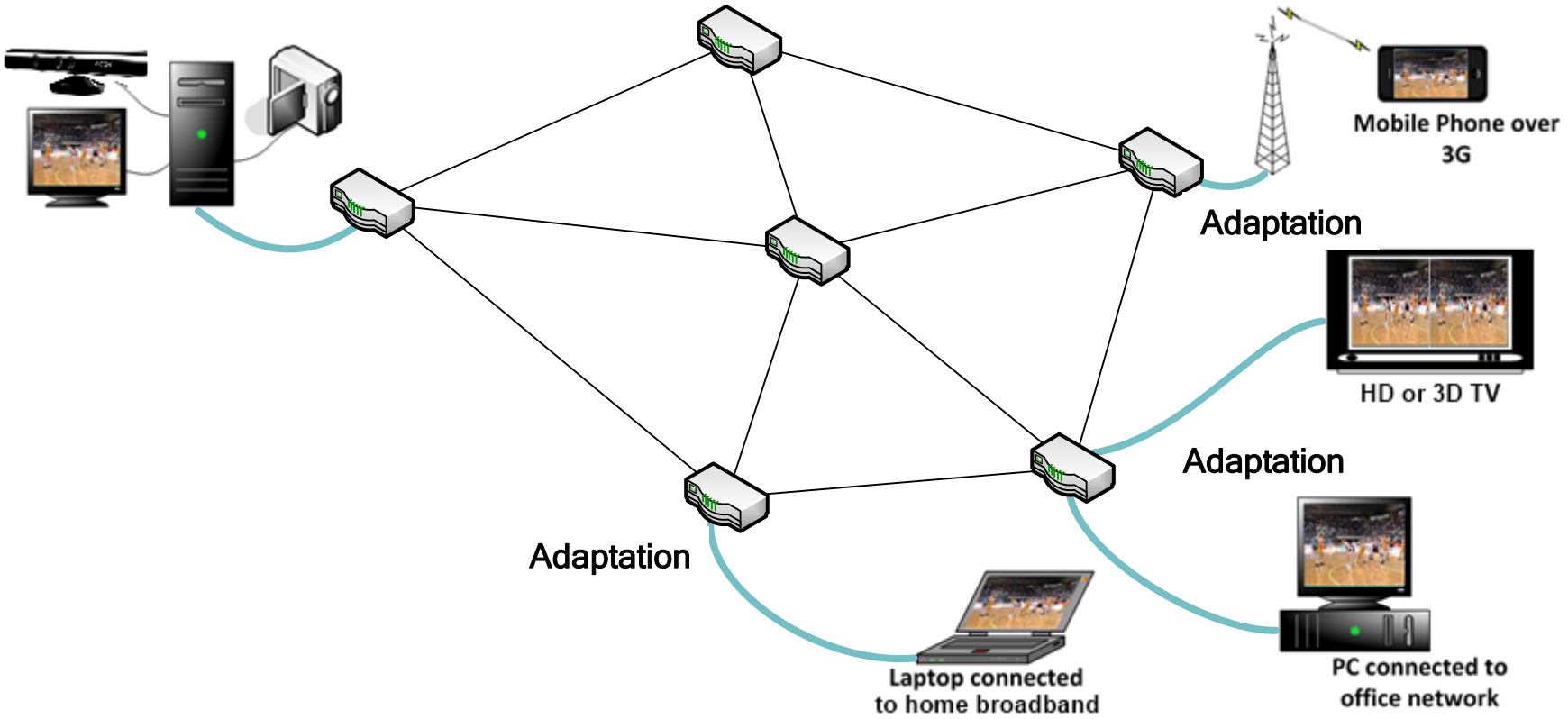
MULTIMEDIA & VISION RESEARCH GROUP

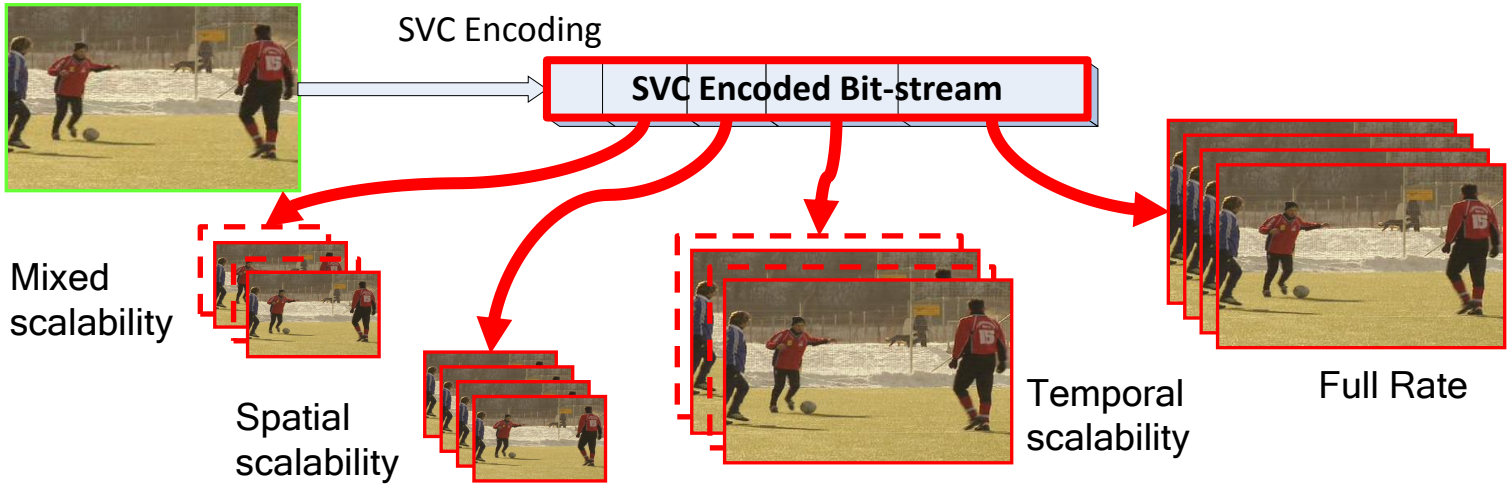
Scalable video delivery



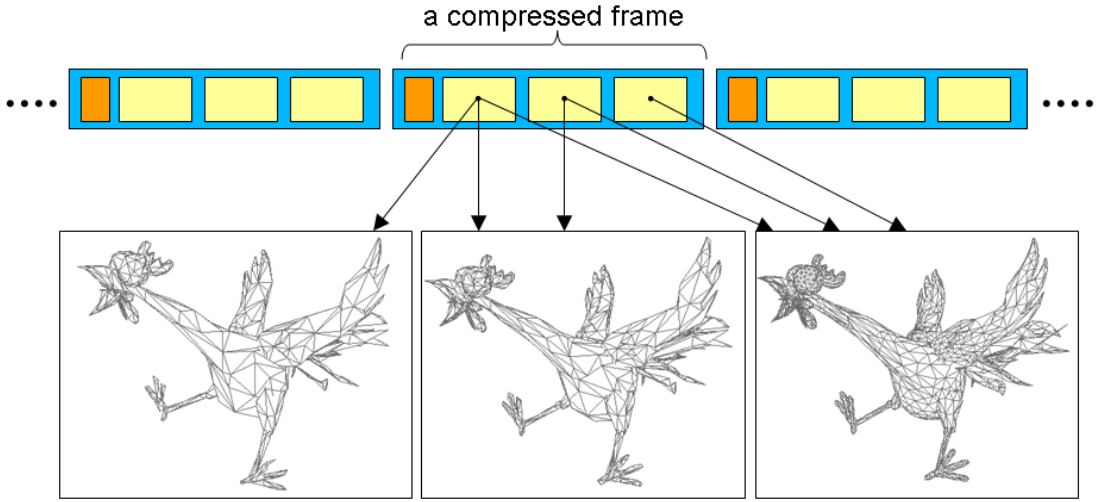
- Streaming server(s) w. Content Delivery Network (P2P)
- Different receivers demands
- Unknown up/download bandwidths

Scalable Compression

- H.264/SVC and H.265/SVC



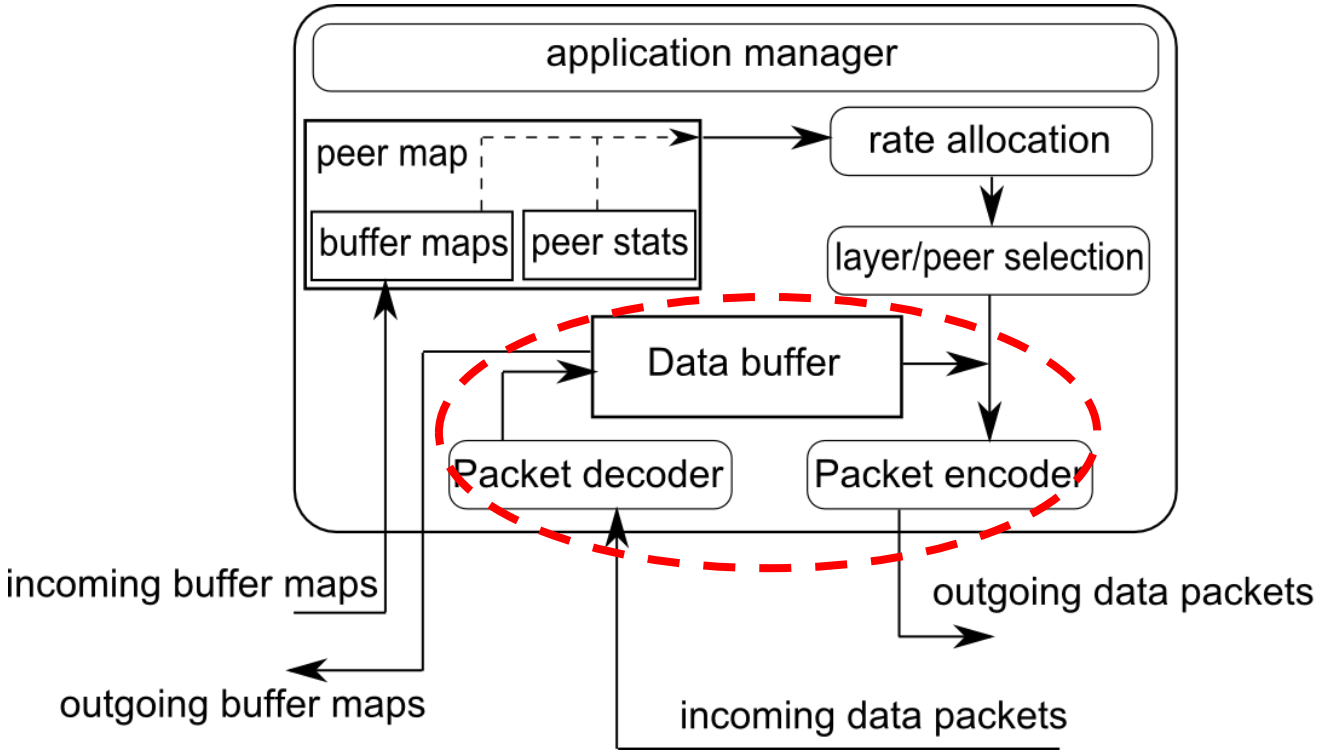
- MPEG4 Part 16 AFX: Amd2 FAMC



Stefanoski, Ostermann (2008)

Our Application

- End-system multicast node:



1. Data exchange

Our Application

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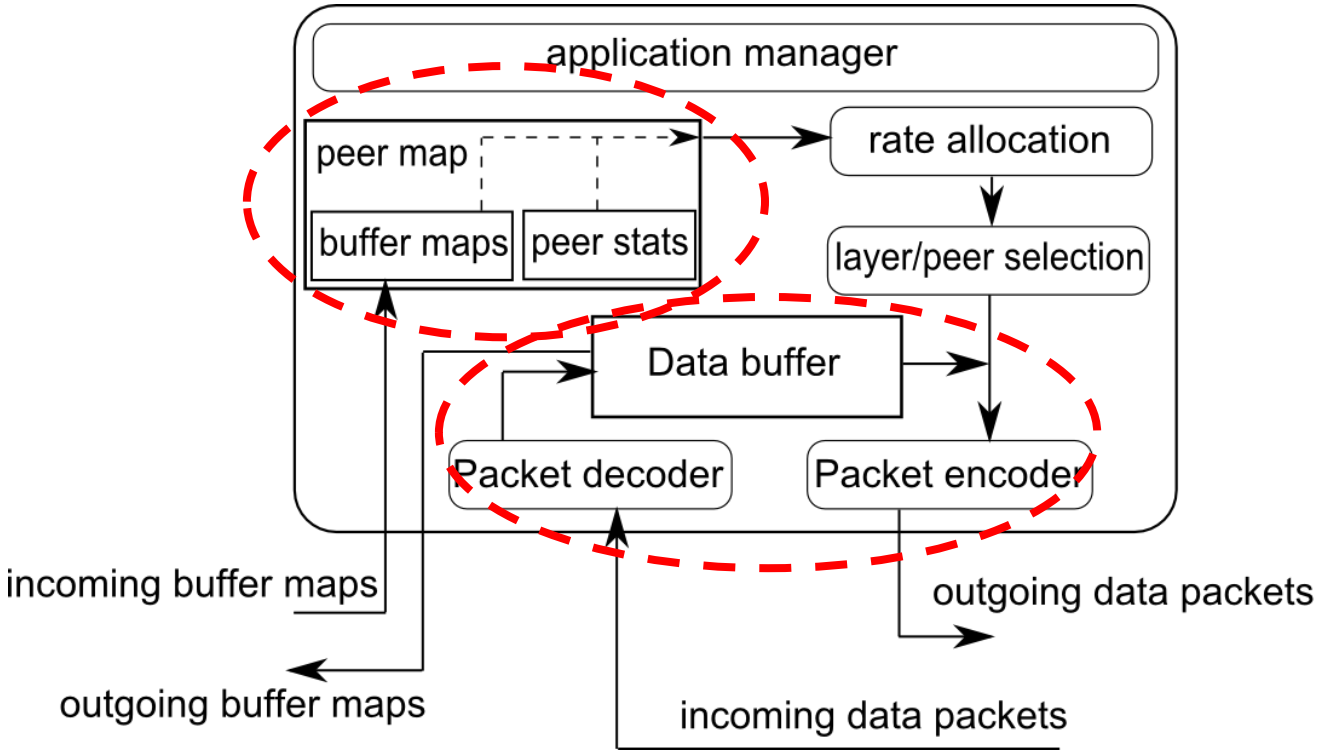
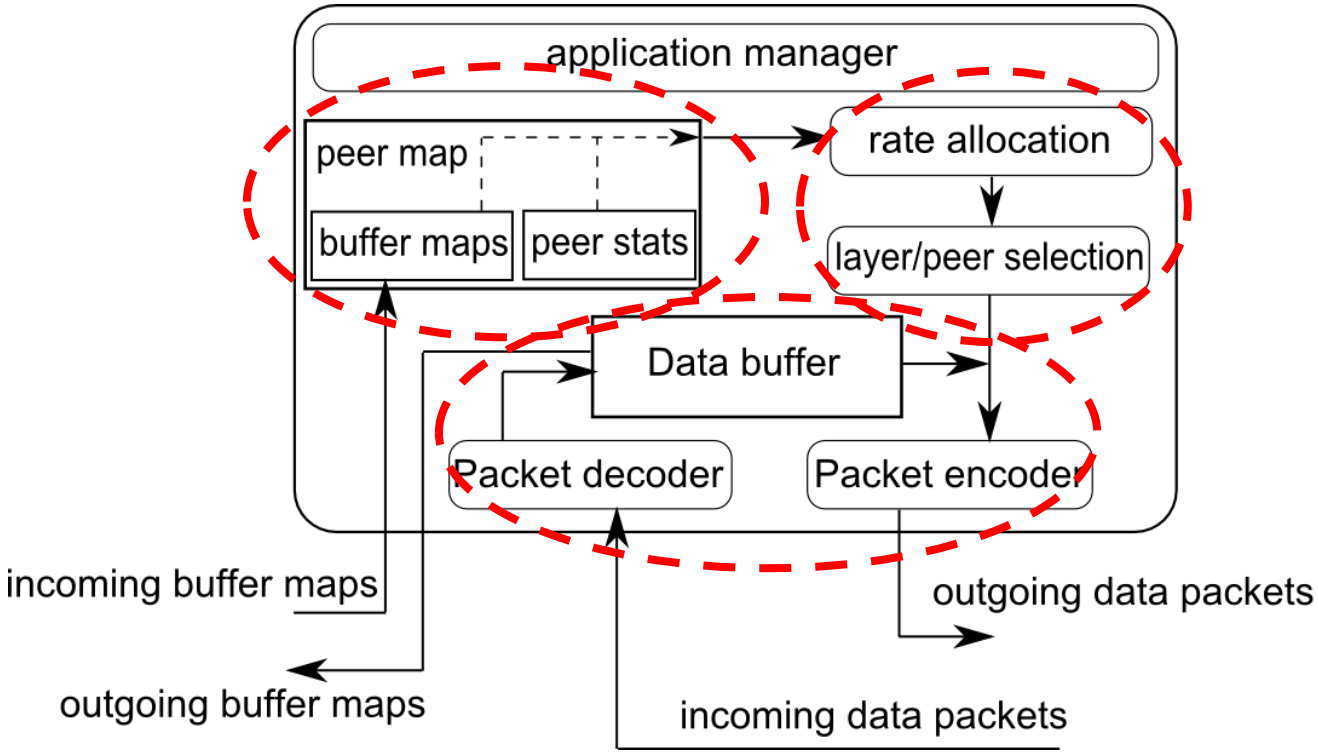


1. Data exchange
2. Node status information

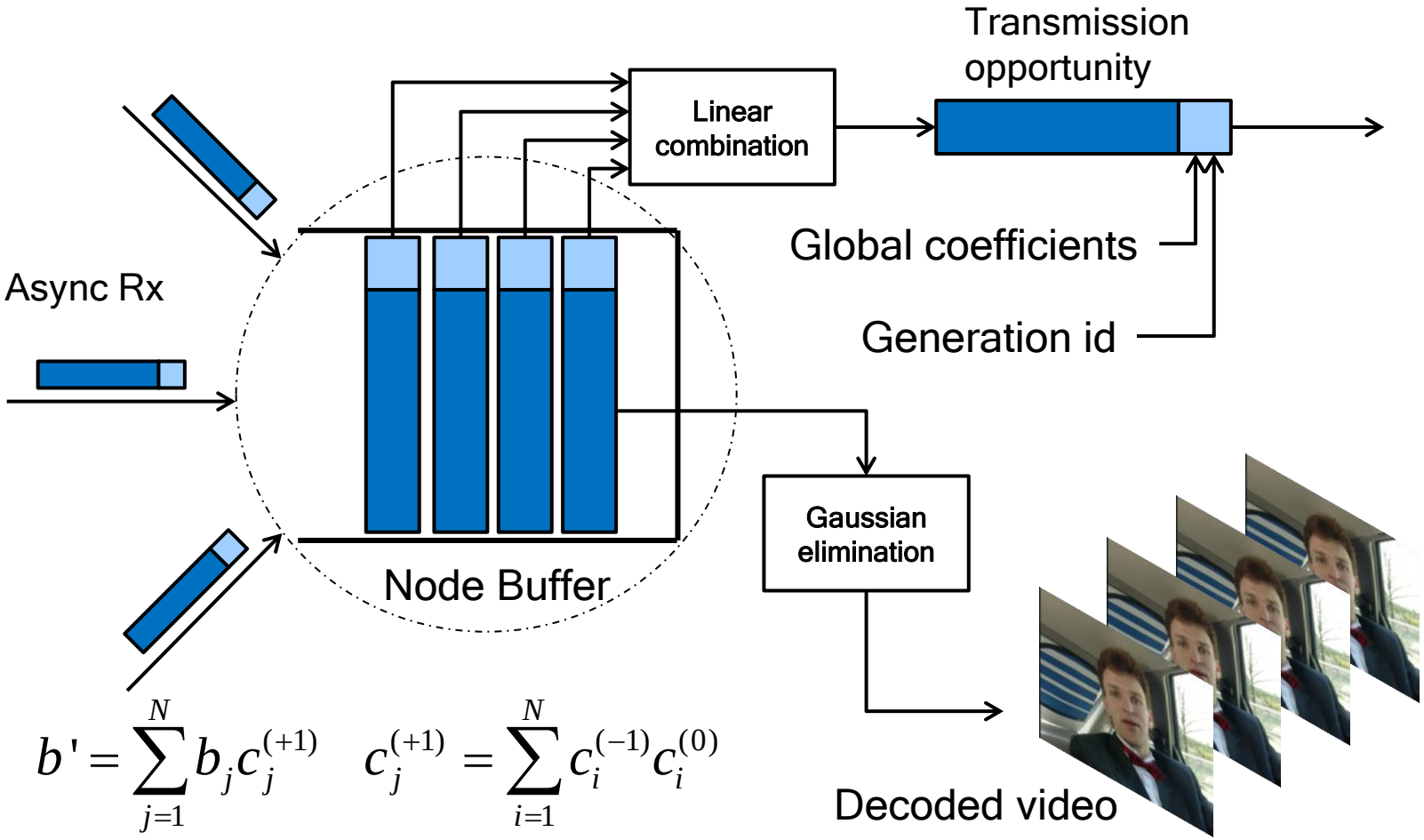
Our Application

- End-system multicast node:



1. Data exchange
2. Node status information
3. Rate allocation

Practical network coding



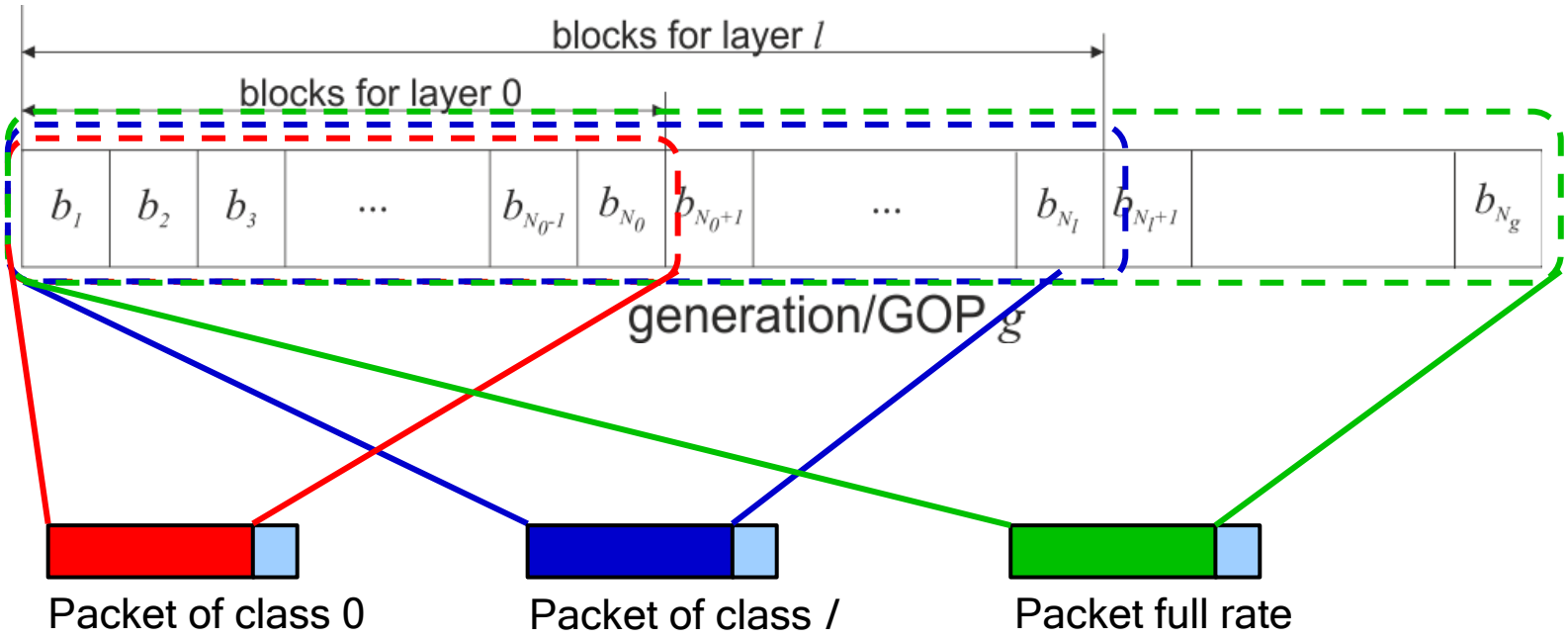
$$b' = \sum_{j=1}^{N} b_j c_j^{(+1)} \qquad c_j^{(+1)} = \sum_{i=1}^{N} c_i^{(-1)} c_i^{(0)}$$

$$b \in GF(2^{Nbit-block}) \qquad 1-1.5KBytes$$

$$c_j \in GF(2^{Nbit-symbol}) \qquad m*8bits$$

[Chou, Wu, 2003]

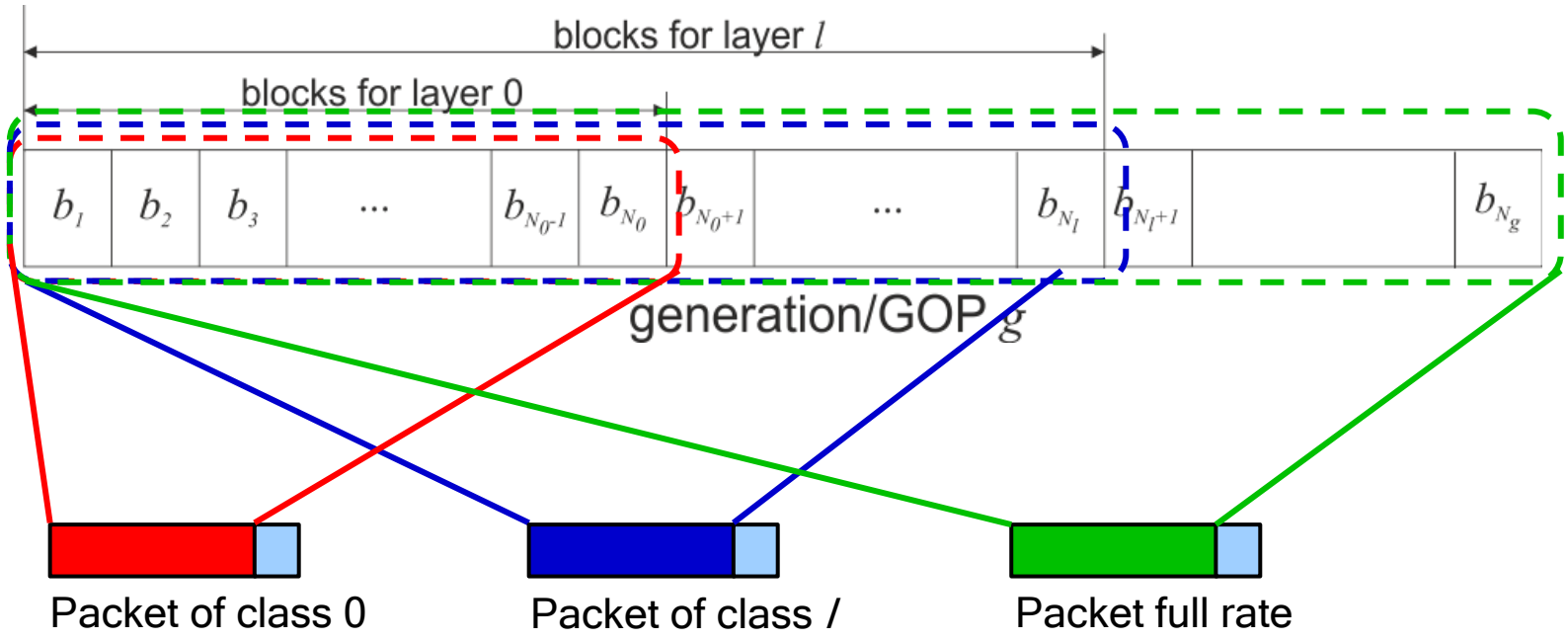
Practical network coding: scalable packet coding



Decode classes from:

N_0 pkts N_1 pkts N_2 pkts

Practical network coding: scalable packet coding



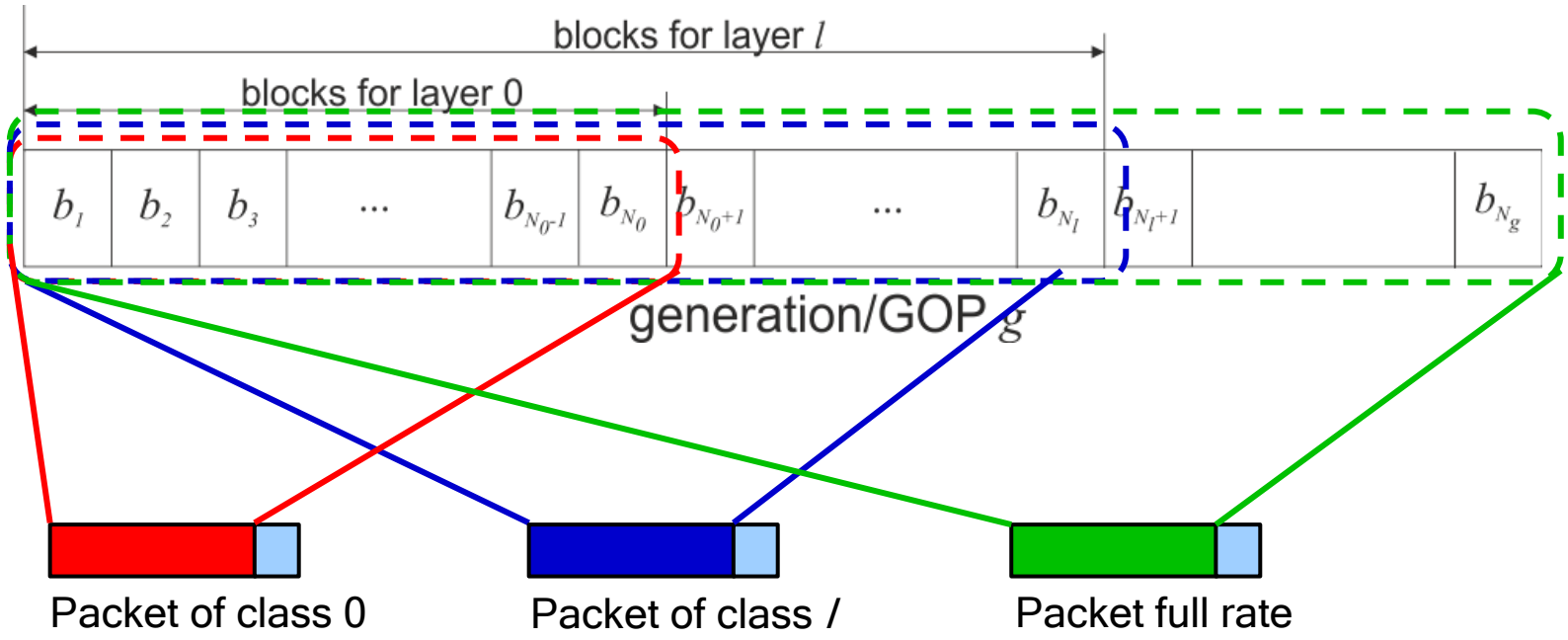
- Related work:
  - Random coding, differentiate persistence:

    Stacked/progressive network codes [Lin, Li Liang, 2007]

    Multi-Generation Mixing [Halloush, Radha 2011]

    Expanding Windows [Sejdinovic, et. al. 2010]

Practical network coding: scalable packet coding



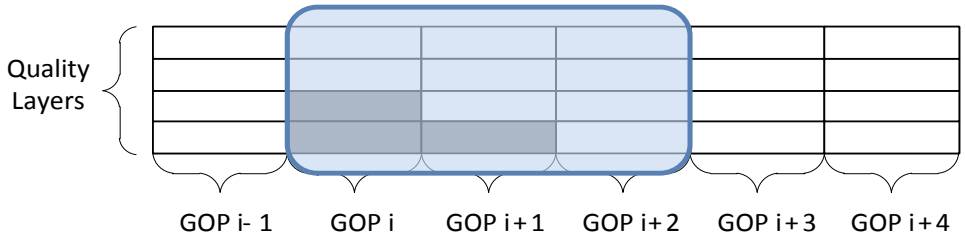
- Related work:
  - Rateless/fountain coding

    Raptor [Thomos, Frossard 2008-2010]

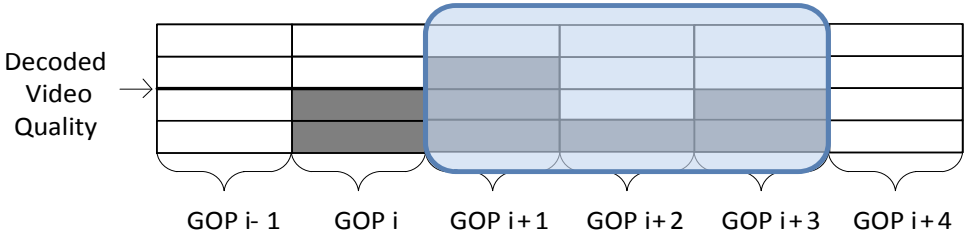
    Scalable w. Expanding windows [Vukobratovic, et. al. 2009]

Playback, Buffer Maps

- Playback buffer region



	L0	L1	L2	redundant	
i	5	4	1	3	Layer 1 received and decodable
i+1	5	2	0	2	Layer 0 received and decodable
i+2	3	0	0	1	no decodable video



	L0	L1	L2	redundant	
i	5	4	1	4	Layer 1 **decoded**
i+1	5	4	3	6	Layer 2 received and decodable
i+2	5	3	0	2	Layer 0 received and decodable
i+1	5	4	1	6	Layer 1 received and decodable

- Node/chunk selection
  - Info messages between nodes.
  - Status of GOP at receiving node: (Partially or undecoded, Decoded, or Unwanted)

- Non-scalable case: random uniform peer/GOP selection [R^2 - Wang, Li 2007]
- Scalable case: Layer selection and rate allocation

Chunk/peer selection

- A conservative case:
  - Send higher priority classes first -> uniform random choice
  - Increase to enhancement layers after ACK
  - Large braking overhead

- Rate Estimation:
  - Find layer (or range of layers) with sustainable rate for receiver *r*, GOP *g*

    -> uniform random choice

  - Estimate based on recent history

  - Assumptions: senders may depart or free-ride but:

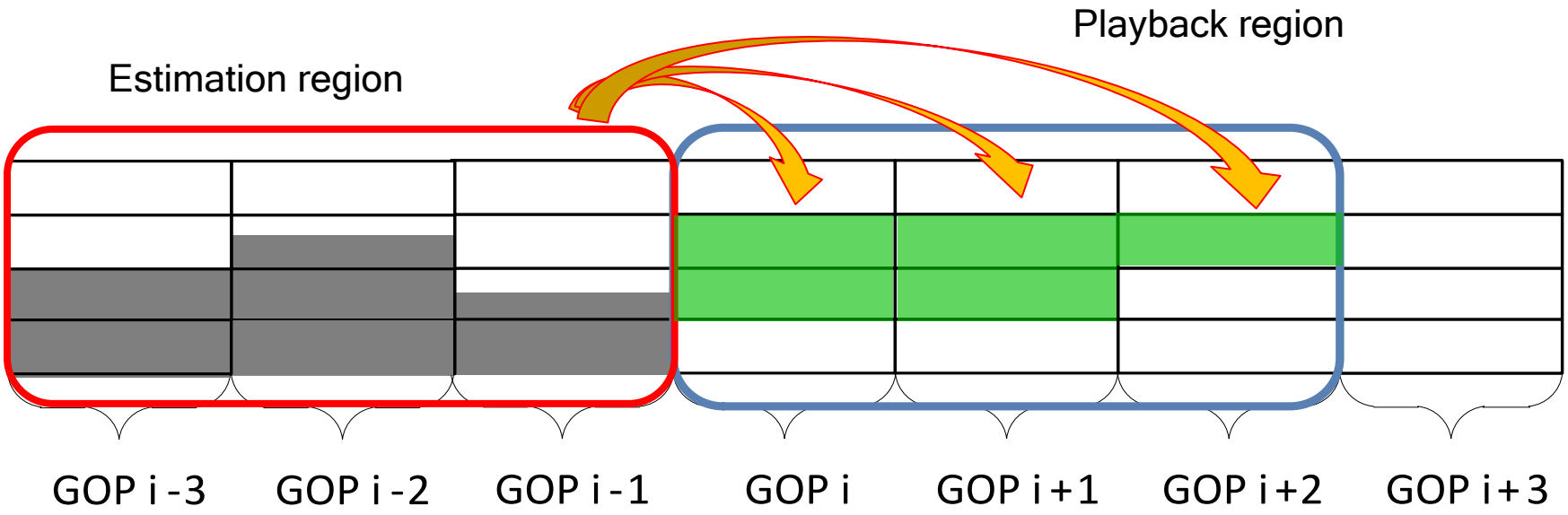
    1 - observe the same receivers status

    2 - can take the same decisions

    -> Independent Proactive Estimation

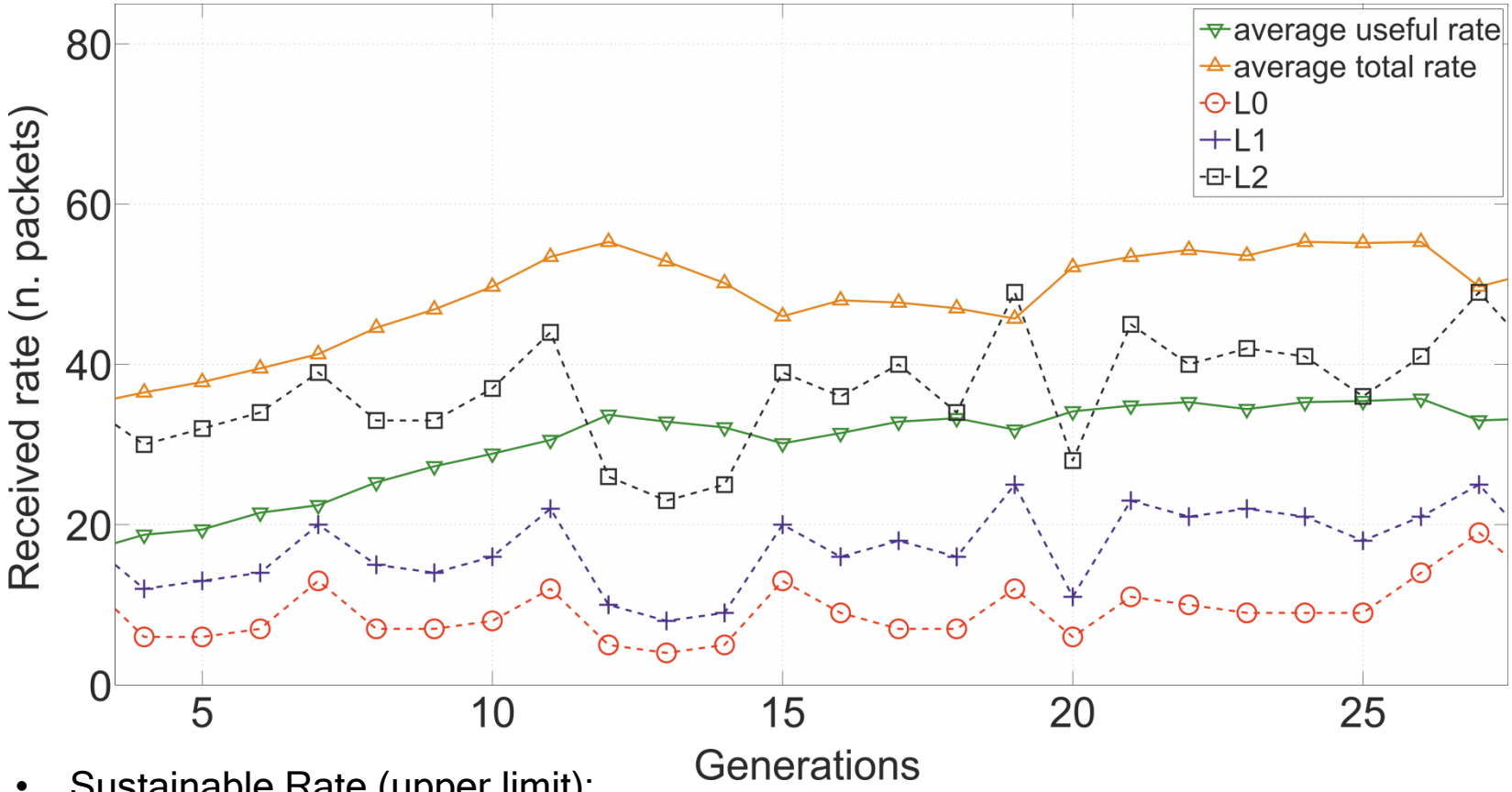
Rate allocation

- 2 rate levels considered for decision:
  1. Sustainable rate: Limitation all layers below this
  2. Preliminary target rate: Pick the first layer below this and increase when lower layers are completed



- Buffer status of potential receiver *r* considered:
  - Total Packet Rate (avg over estimation interval)
  - Innovative Packet Rate (avg over estimation interval)

Rate allocation



- Sustainable Rate (upper limit):

  $l_{max} = \max l\colon N_l <$ TPR x limitation factor

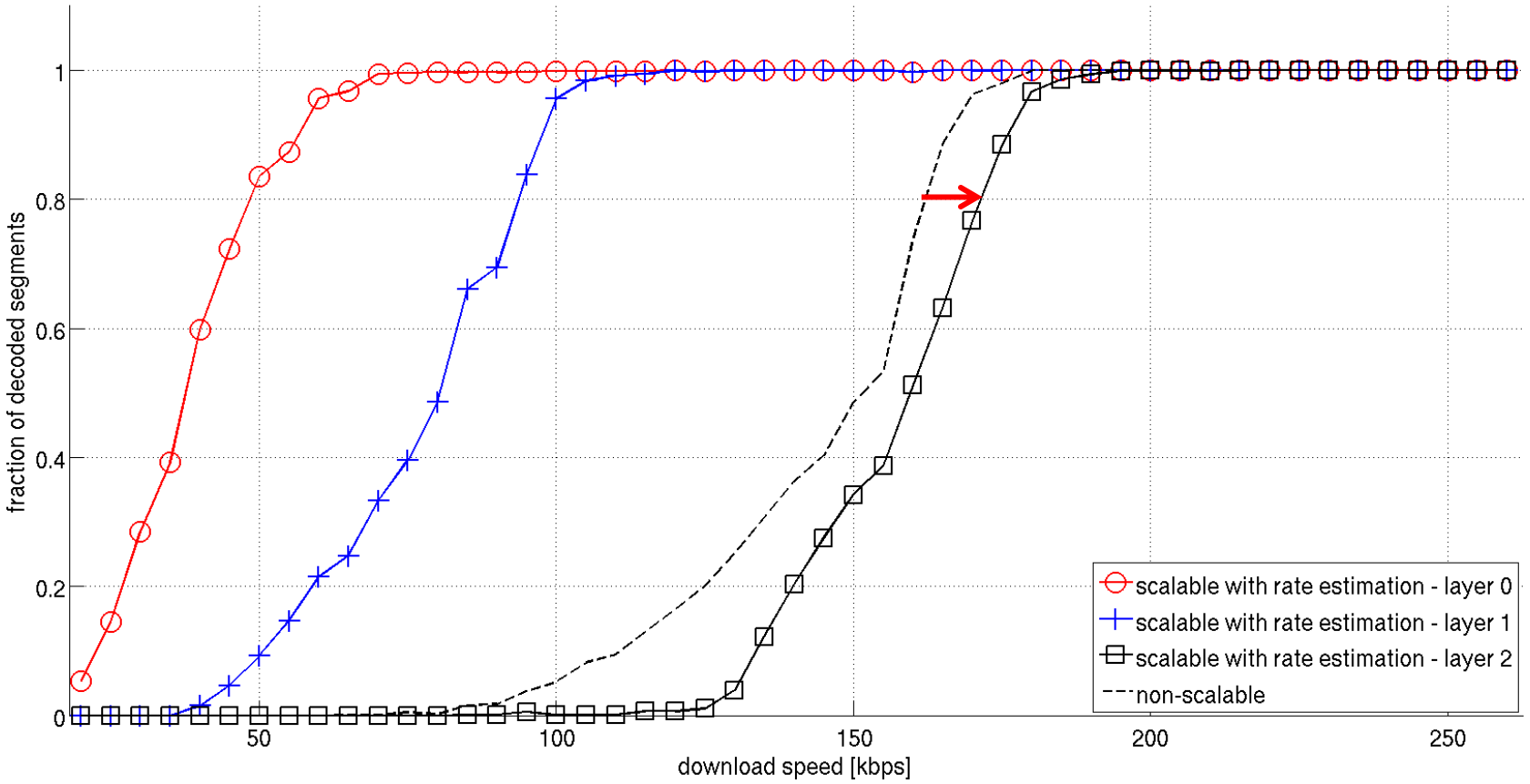
- Preliminary target rate (first pushed layer):

  $l_{min} = \max l\colon N_l <$ IPR x aggressiveness factor

Simulation Results

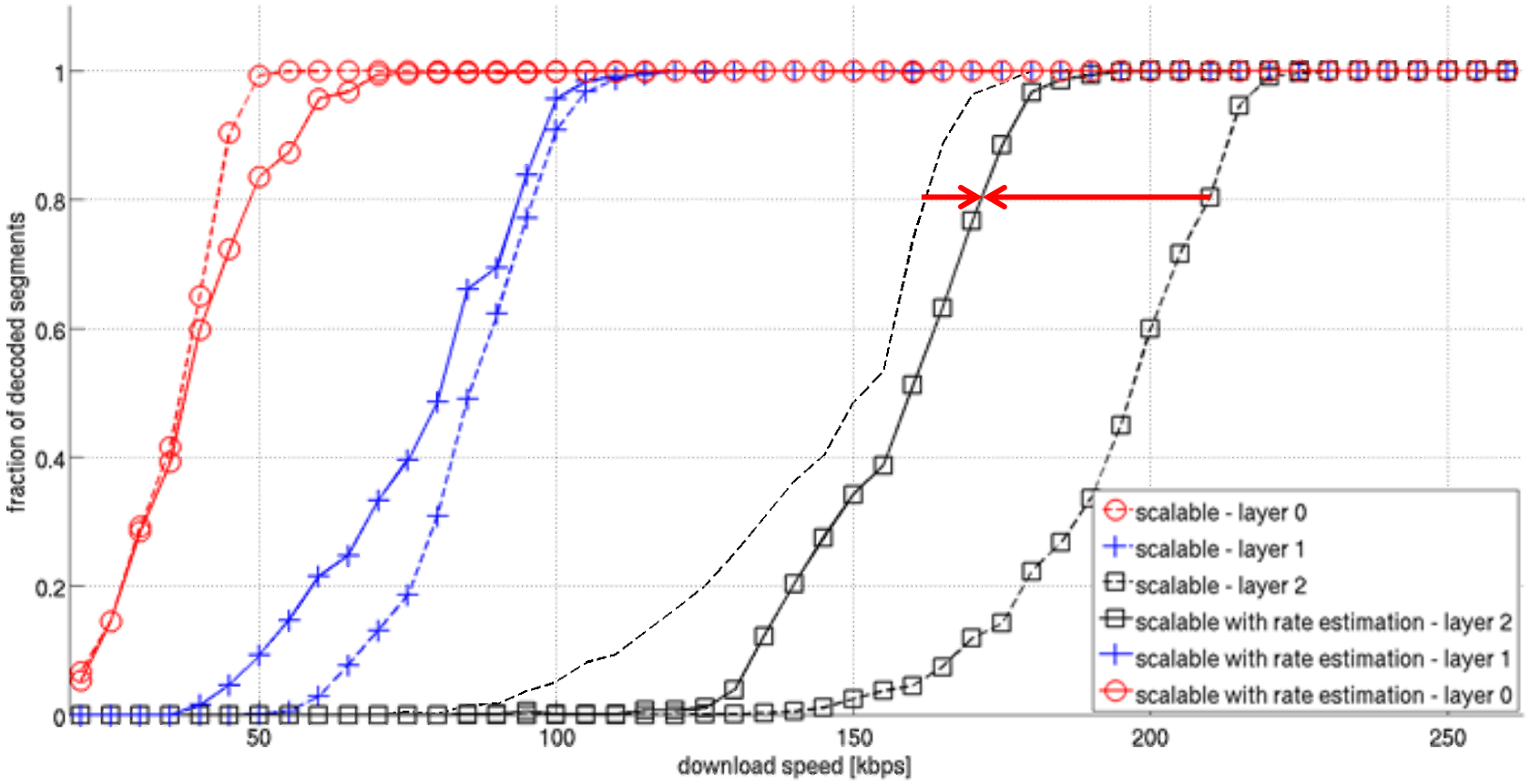
- Simulation setup:
  - Network simulator (ns2)
  - Random 20 nodes stationary network
- Parameters
  - Video: H.264/SVC mixed MGS/temporal scalability
  - Rates: 190 kbps, 340 kbps, 750 kbps
  - Playback region = estimation region ≅ 2 secs (8 GOPs)
- Performance measure
  - Variable upload rate from nodes
  - Estimation thresholds margins ≅ 30%
  - Delivery efficiency (% GOPs delivered at a specific layer)

Simulation Results



- Scalable adaptive delivery
- 5% off the non-scalable case

Simulation Results



- Scalable adaptive delivery
- 5% off the non-scalable case
- 20% better than conservative method

Concusion and future work

- Achievements:
  - Presented a novel scalable video delivery network
  - Proposed and proven validity of rate allocation algorithm

- Open issues:
  - Overhead reduction:
    - Braking
    - Dynamics of new chunks/GOPs
  - Adaptive estimation (learn from previous success)

Thank you!

Q/A?

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