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A Model for Error Avoidance and Error Correction in Peer-to-Peer Networks

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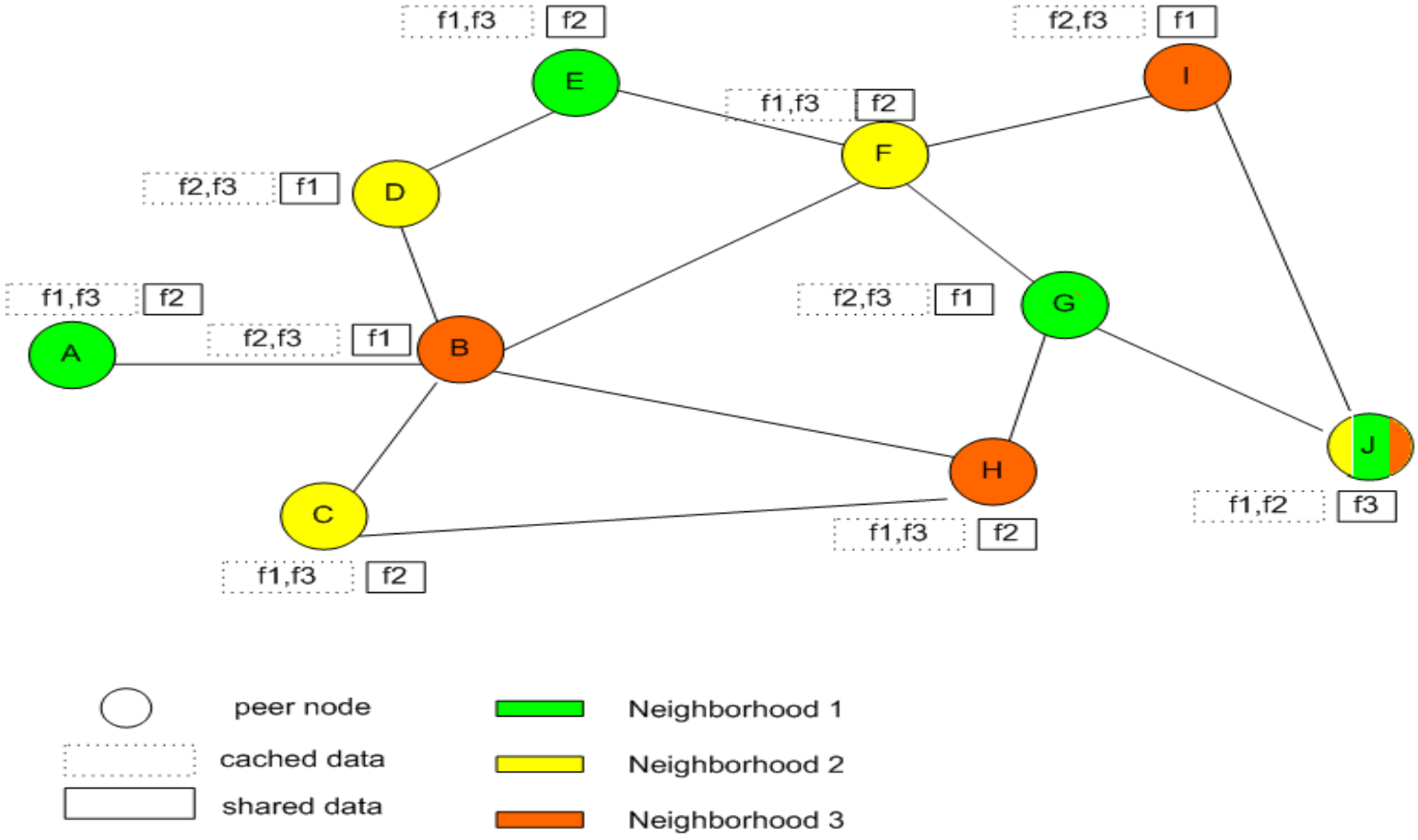
Motivation

- **Goal:**
  - Enable lossless video streaming over best effort networks
- **Why streaming?**
  - Low startup delay (quasi immediately) vs. complete download
  - Negative example: Download 2h movie, 900MB --- NW: 2Mb/s => needs 1h download before playback can start
- **Challenge of video streaming:**
  - Video has to be delivered as a continuous stream
  - Video Frames must arrive in time – otherwise useless (soft realtime)
- **Problem:**
  - Best effort network provides no QoS guarantees

The Peer-to-Peer Overlay with Indexing-Cache and Virtual Neighborhoods

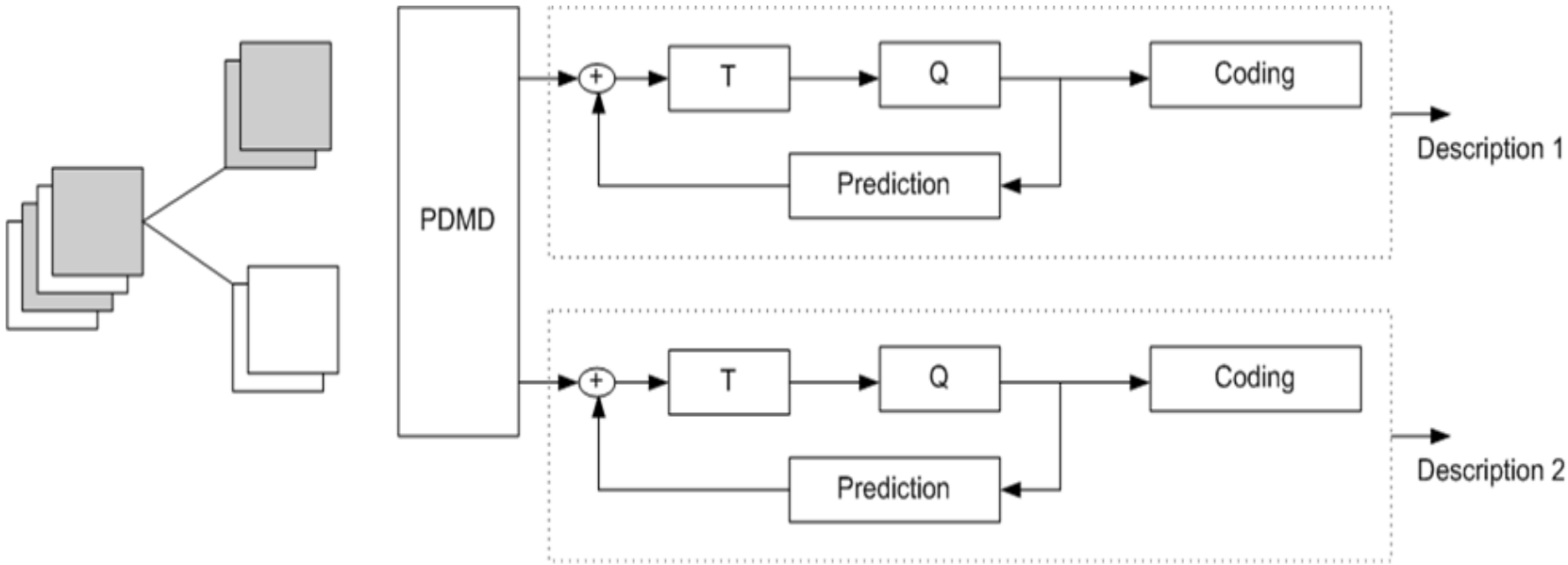


Error Avoidance / Error Correction

- **Main Aspect:**
  - For QoS aware delivery over best effort networks, find tradeoff between:
    - Error Avoidance
    - Error Correction
    - Combination of Error Avoidance + Error Correction
- **Error Avoidance:**
  - Streaming from multiple sources (based on Multiple Description Coding)
  - Transparent merging by using an RTP-Mixer (close to the client host)
- **Error Correction:**
  - Transmission of redundant (XOR) packets

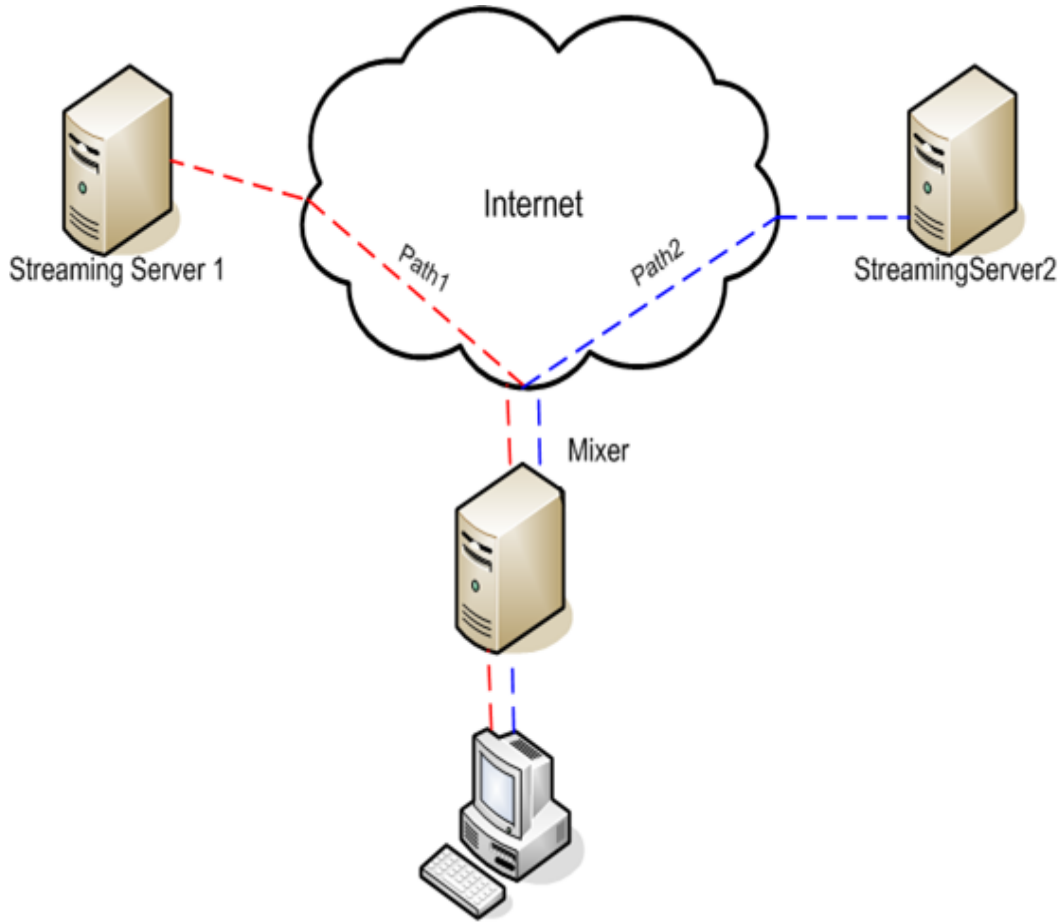
Error Avoidance – MDC temporal

- **Multiple Description Coding in the temporal domain**
  - Example: Polyphase Multiple Description Coding
  - Separate prediction loop for each description



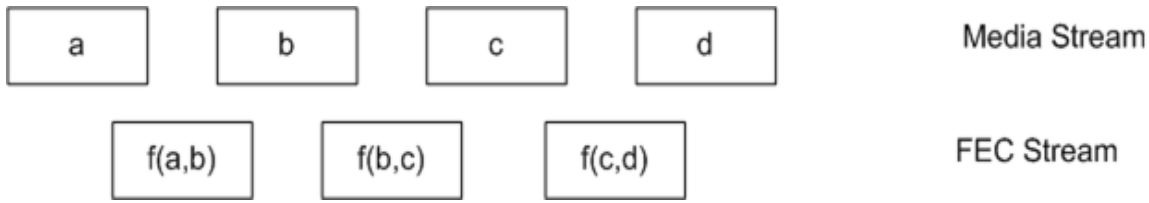
Error Avoidance – Stream Delivery

- **Main Aspect**
  - Streams are delivered over separate paths
- **Advantages**
  - Lower network load
  - Lower loss probability
- **Disadvantage**
  - Content Replication is required

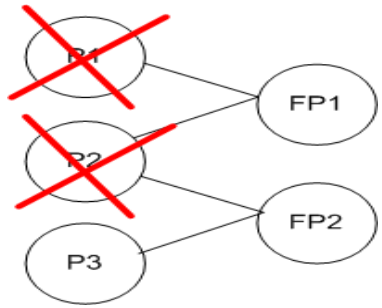


Error Correction

- **Main Aspect**
  - Forward Error Correction Packets are created at stream delivery (XOR-ed)
  - Number of packets can be set dynamically



- **Example Loss Scenario:**



Error Handling Model

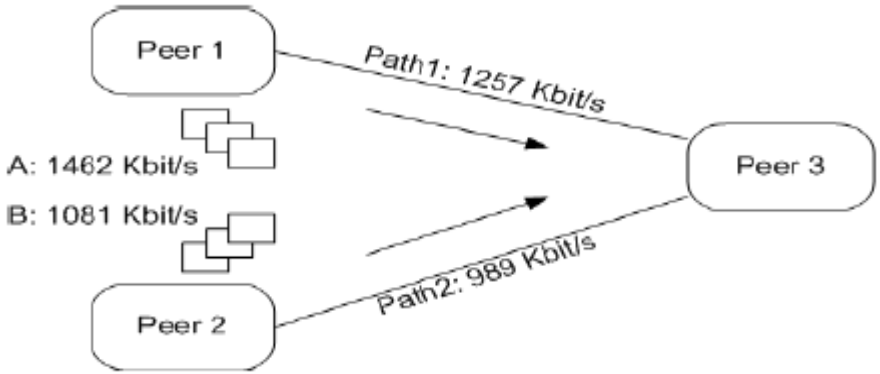
$$SuccessProbability = QualityProbability * \prod_{i=1}^{M} NetworkProbability_i$$

$$QualityProbability = ap_I * ap_P^{C_P} * ap_B^{C_B}$$

$$NetworkProbability = min(1, \frac{AvailableBandwidth}{RequiredBandwidth})$$

Streaming Example (Evaluation)

$$SuccessProbability = QualityProbability * \prod_{i=1}^{M} NetworkProbability_i$$



Stream	Stream Affinity
A	0.66
B	0.5

$$NetworkCloseness = min(1, \frac{AvailableBandwidth}{Bitrate})$$

Alternative	Bitrate	Avail.-BW	Netw.-Probability
A	1462	1257	0.86
B	1081	989	0.90

Decision	Mean Opinion Score
Server A	4,02
Server B	3,50

Work presented

- **A low cost Peer-to-Peer overlay which uses content indexing to balance the cost for locating popular and unpopular videos**
- **An overview about Error Avoidance and Error Correction**
- **A model for finding a tradeoff between Error Avoidance and Error Correction**
- **Streaming example applying the model**