Accelerating Peer-to-Peer Networks for Video Streaming Using Multipoint-to-Point Communication

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Outline

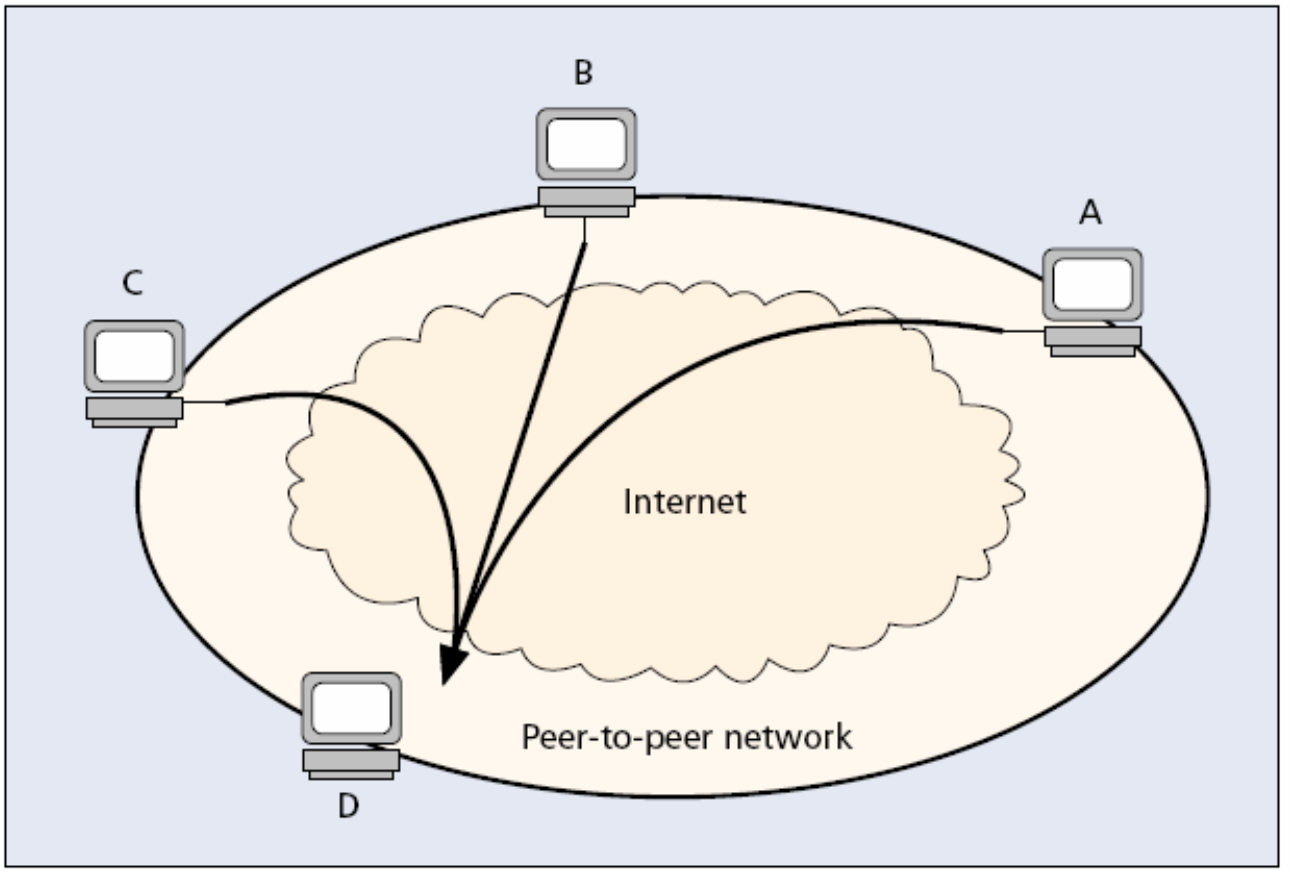
- Introduction
- Related work
- R^2CP protocol
- Evaluation
- Conclusion

Introduction

- Multipoint-to-point communication.
  - A single client can use multiple “servers” to access the desired content.
- The availability of the content increases as its popularity increases.
- Bottleneck:
  - Upload bandwidth.
  - Download bandwidth.
  - The bottleneck lies at peer server end.

Introduction

- Multipoint-to-point communication:



Introduction

- Video streaming :
  - To fetch different piece of accessed content independently.
  - Perform offline re-sequencing on the disk.
  - When a finite re-sequencing buffer is used
    → global sequence number is required.

- Peer-to-peer networks:
  - Heterogeneous capacity.
  - Transient availability.
  - Optimal server placement or content distribution is not applicable.

Introduction

- Radial Reception Control Protocol(R^2CP)
  - Enables effective multipoint-to-point video streaming.
  - Receiver driven protocol.
  - Delivers the aggregate of bandwidths available on individual paths.
  - Achieve real-time video streaming.

Related Work

- Kazza
  - Use multiple sources to speed up downloads.
  - Not applicable to real-time video streaming.

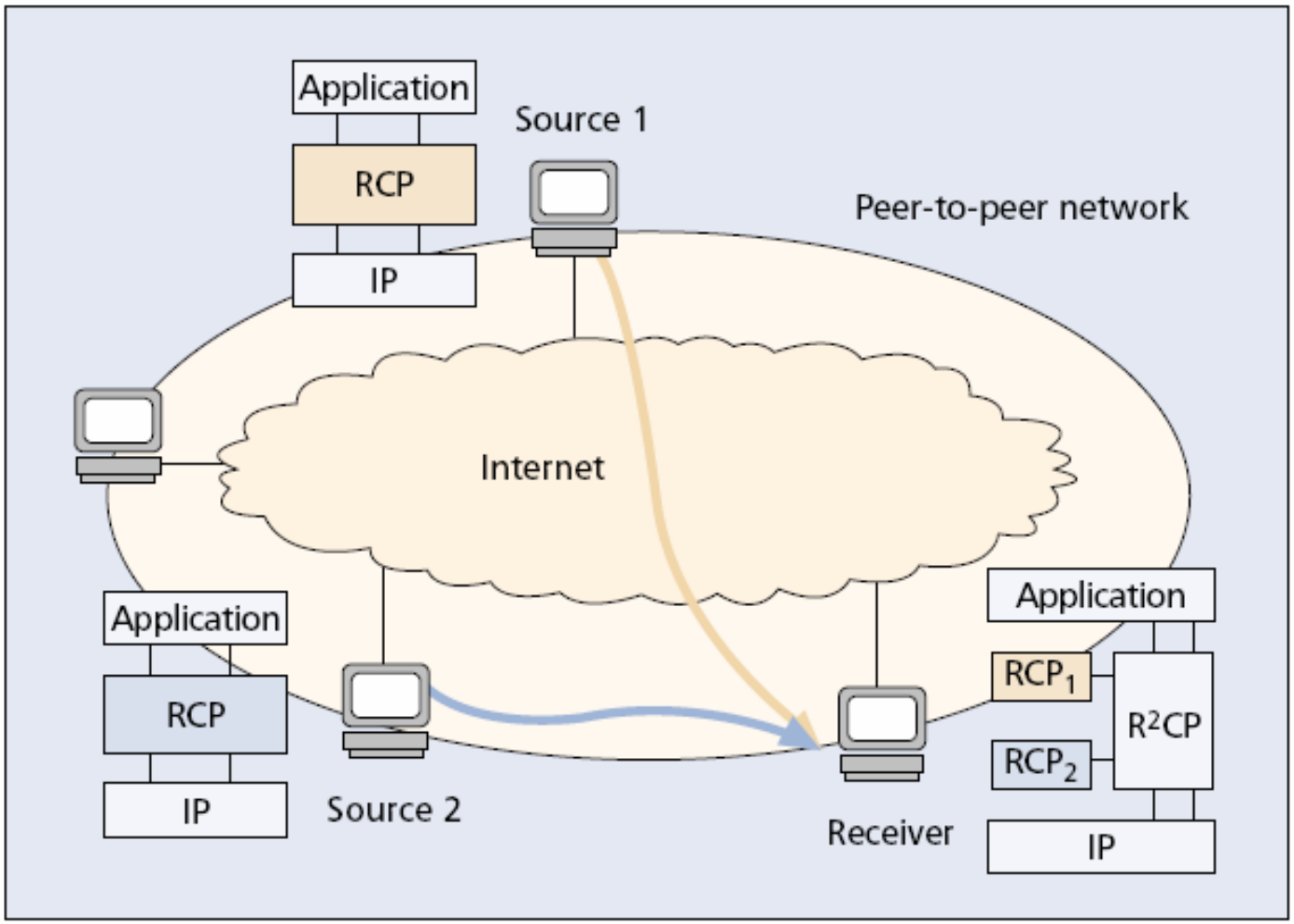
- MDC (Multiple Description Coding)
  - Multiple descriptions for a video streaming are created and distributed across the edge servers.
  - Server coding, server placement, and server selection.

- Multiple resource
  - Focus on the problem of data assignment when the bandwidth available at each source is predetermined.

The R^2CP Protocol

- Architecture.
- Dynamic binding.
- Packet Scheduling.
- Protocol Operation.

Architecture of R²CP



Architecture of R^2CP

- The R^2CP engine resides only at receiver.
- RCP sender merely response to the requests sent by receiver.
- Receiver is in charge of the connection progression along each pipe, including congestion control and, loss recovery, and facilitates the coordination task performed by R^2CP.
- The receiver in an R^2CP connection is the primary seat of intelligence for most protocol functionalities, including congestion control, loss recovery, packet scheduling.

Architecture of R^2CP

- R^2CP decouples the protocol functionalities associated with individual paths.
- The per-connection and per-pipe functionalities are handled by the R^2CP and RCP.
- Packet scheduling pertains to the aggregation.
- Individual RCPs track the characteristics of the underlying paths and control how much data request from each source.
- R^2CP engine tracks the progression of the connection and controls which data to request from each source.

Dynamic Binding

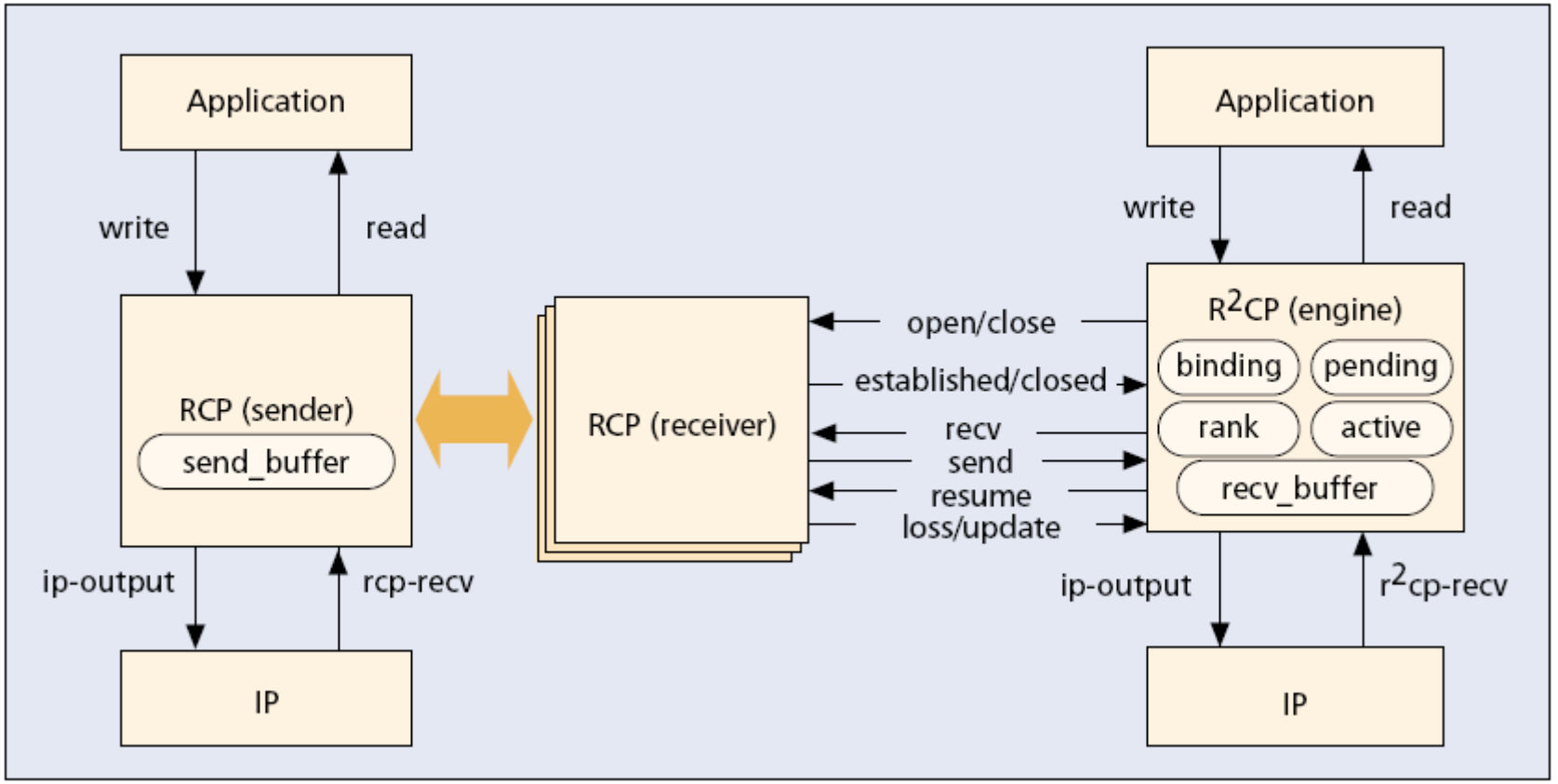
- R^2CP engine maintains the global sequence number.
- Individual RCPs maintain local sequence number for their protocol operations.
- Congestion control mechanism used in RCP is designed for in-sequence delivery.

  → The R^2CP engine may retrieve non-contiguous data from each source (out-of order arrival).
- Any local sequence number used by RCP will be converted to the global sequence number by R^2CP.

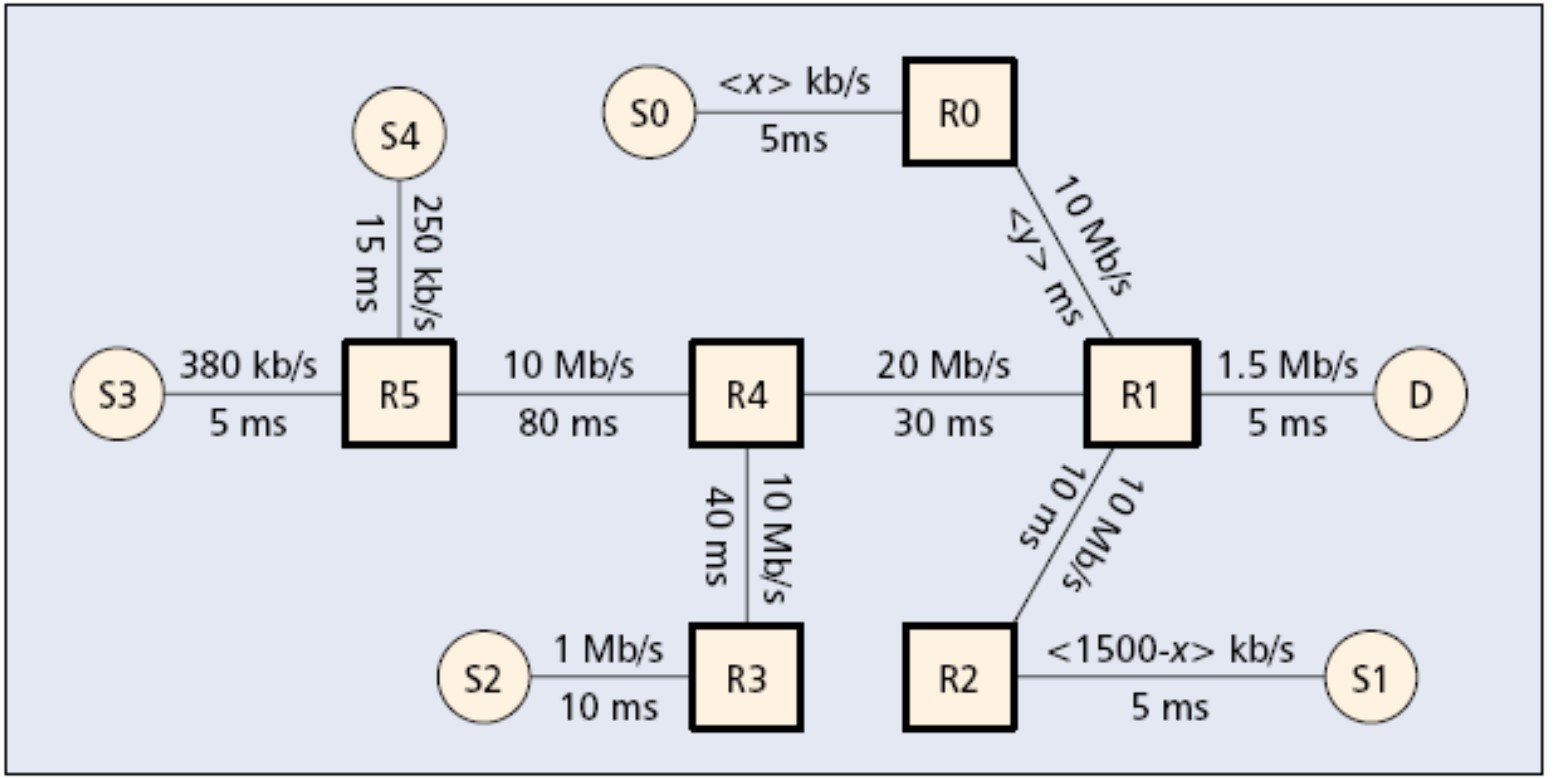
Packet Scheduling

- RCP pipes provide transmission slots for data request from the sources.
- R^2CP decides which data to request for each transmission slot.
- Optimal schedule: ensures in-sequence arrival of packets at the receiver.
- In-sequence delivery minimizes the changes of buffer overflow at the receiver.
- In order to minimize out-of-order arrivals, the R^2CP engine needs information regarding the bandwidth and latencies of individual paths.

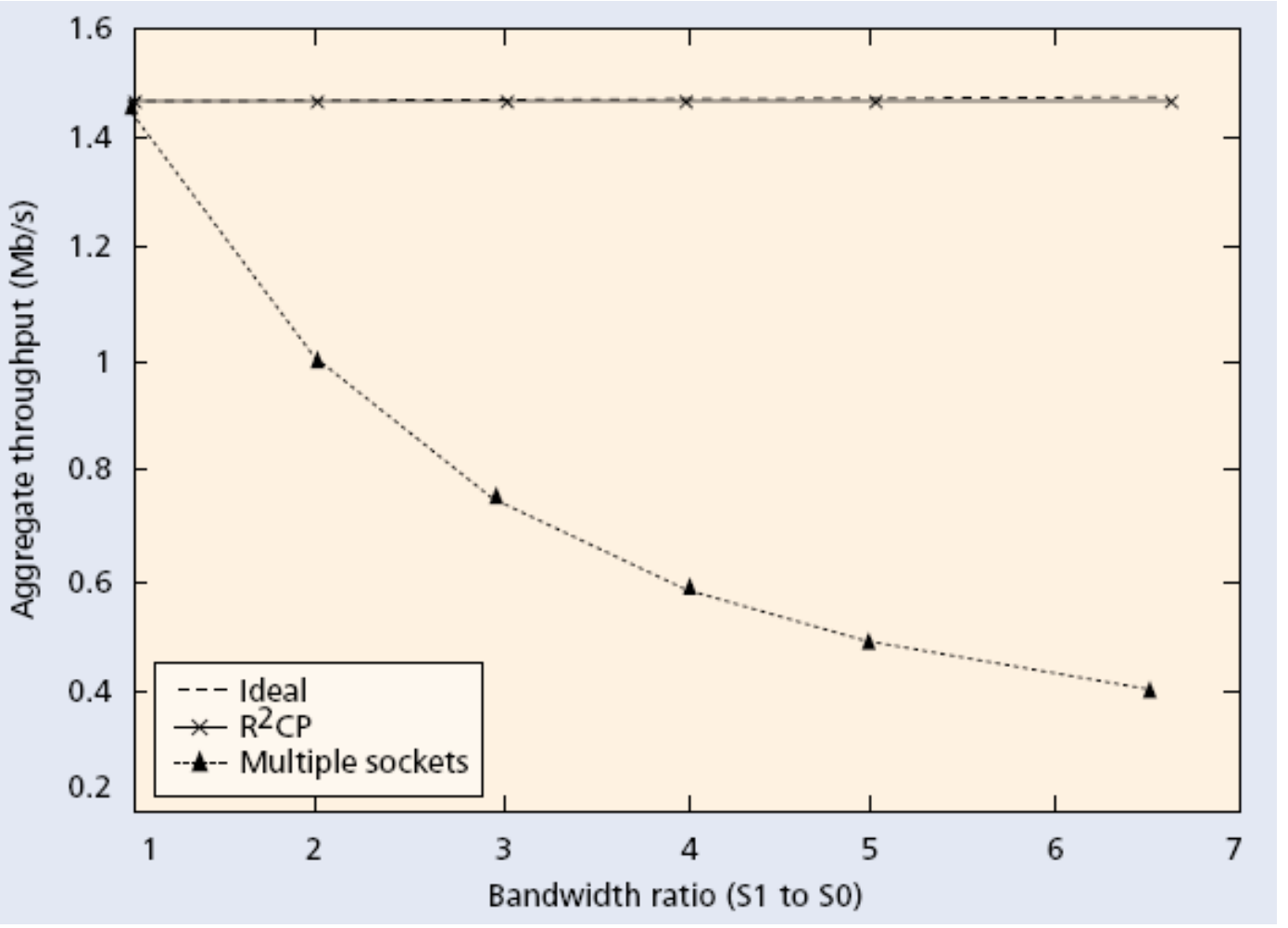
R²CP Architecture and Operation



Simulation Model



Simulation Results



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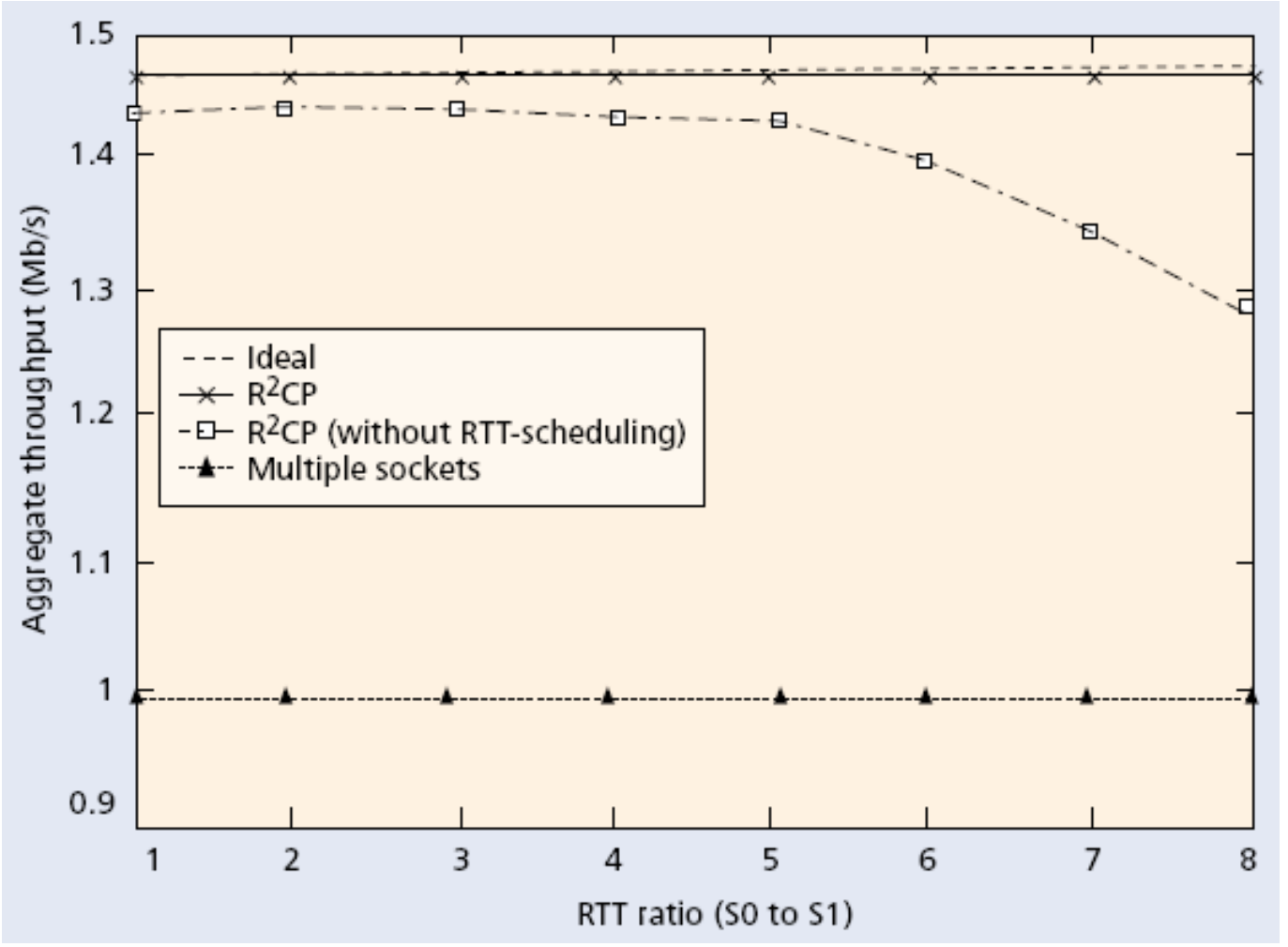

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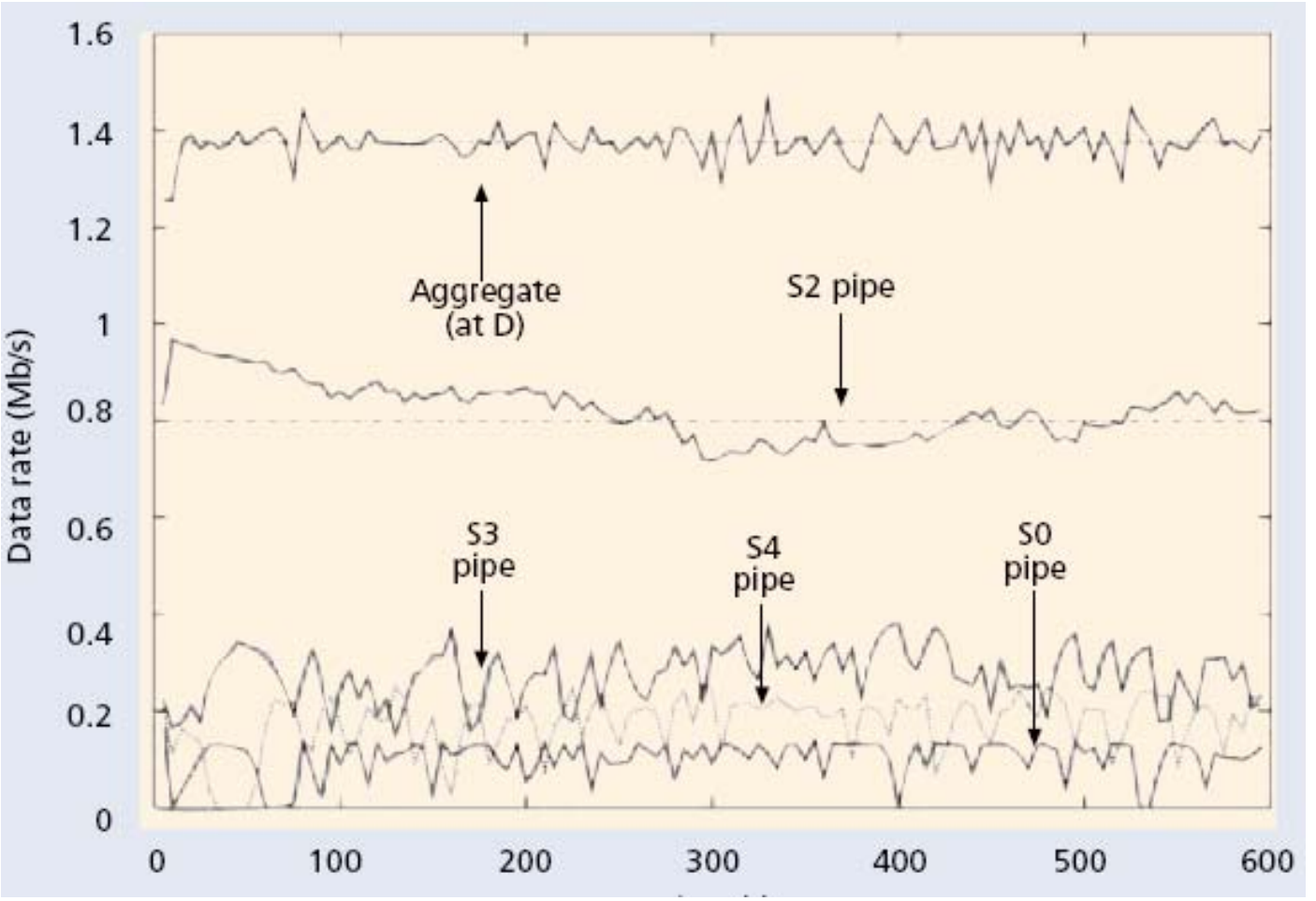

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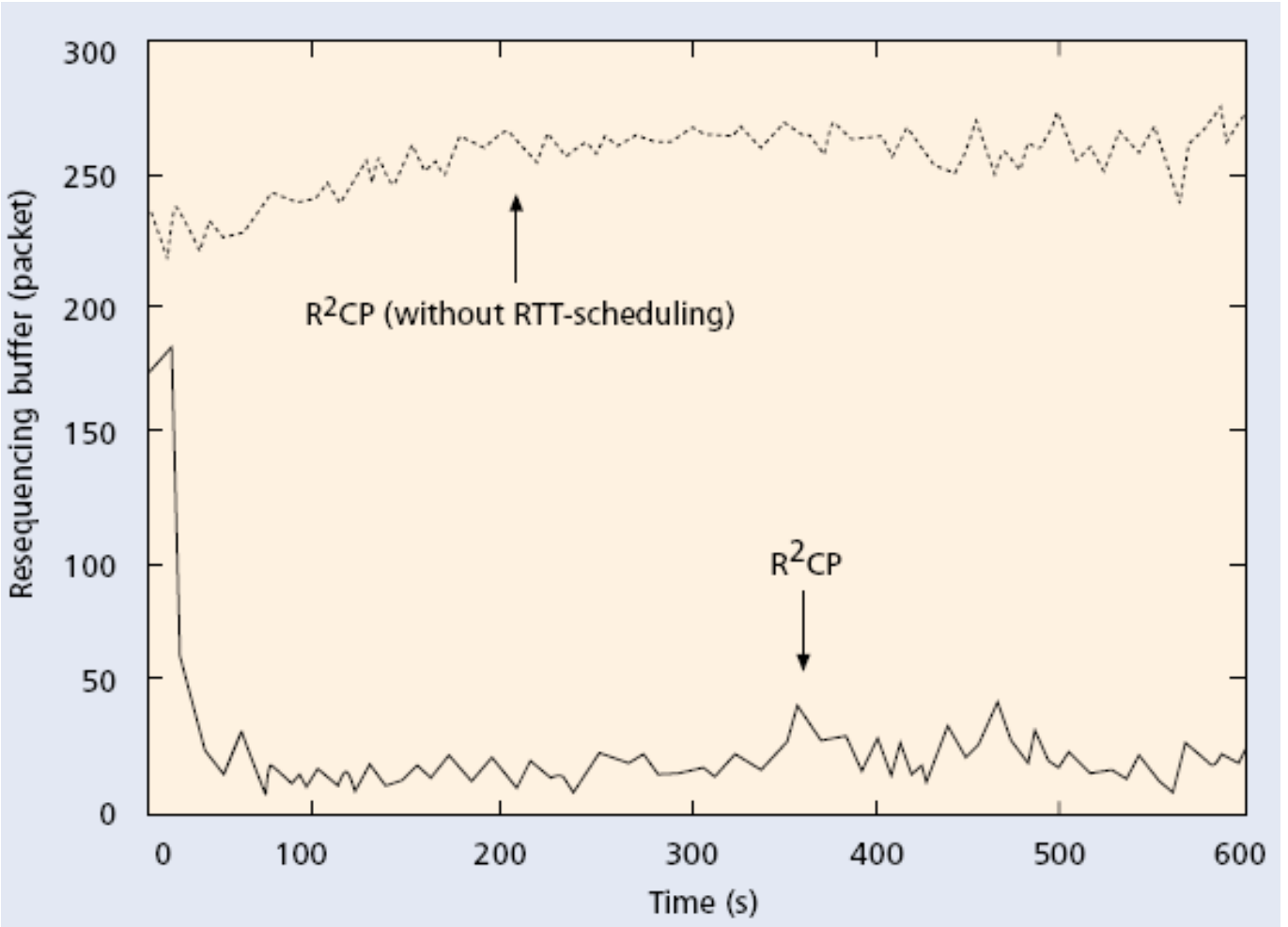

Conclusion

- R^2CP is a receiver-driven engine.
- Enables real-time multipoint-to-point video streaming from heterogeneous peers.
- Uses TCP-friendly congestion control.
- Uses packet scheduling.
- Effectively achieve multipoint-to-point streaming over p2p network.