Optimized Live Streaming on P2P Network with Network Coding

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1. Introduction

- We proposed an optimized **packet scheduling algorithm** for live streaming over P2P network.
- **Network coding(NC)** technique is extended to improve the efficiency in bandwidth utilization
- A new **Network communication model** are redesigned to achieve better bandwidth utilization
- A optimized **centralized packet scheduling algorithm (CPS)** and a real-time **distributed packet scheduling algorithm(DPS)** are proposed and compared for live streaming.

2. Network and network encoded media streaming model

a) Multimedia Network

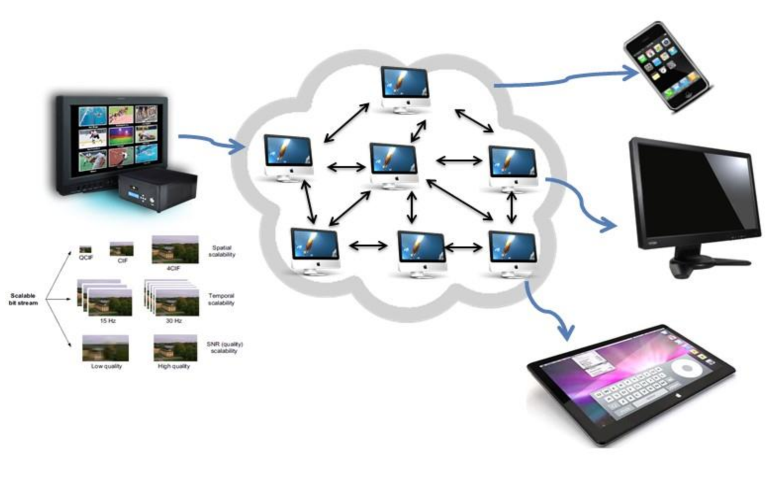


Fig.1. Illustration of the peer-to-peer network for live media streaming

b) Functional Module Diagram

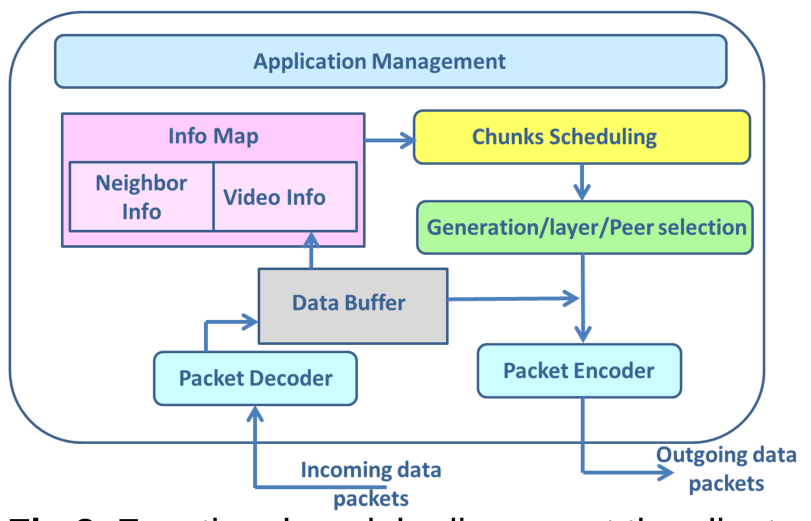
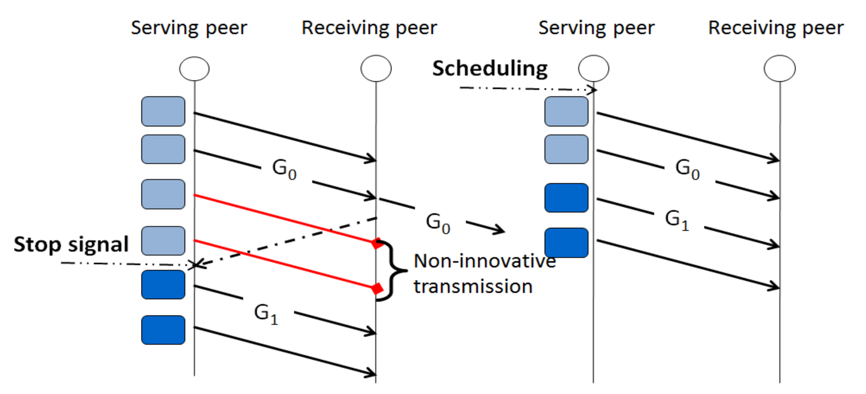


Fig.2. Functional module diagram at the client node for streaming with network coding(NC)

- Our work focuses on providing an effective P2P streaming network for low-delay and loss-resistant live media streaming
- We make use of the basic media information, and the information of neighbor nodes to perform smart optimized chunks scheduling so that the bandwidth utilization can be improved.

c) Chunks Scheduling Module



Random push with random network coding

Packet scheduling with random network coding

Fig.3. Comparison of non-innovative transmission between random scheme and the proposed packet scheduling scheme in swarm-push network

d) Data Buffer Module

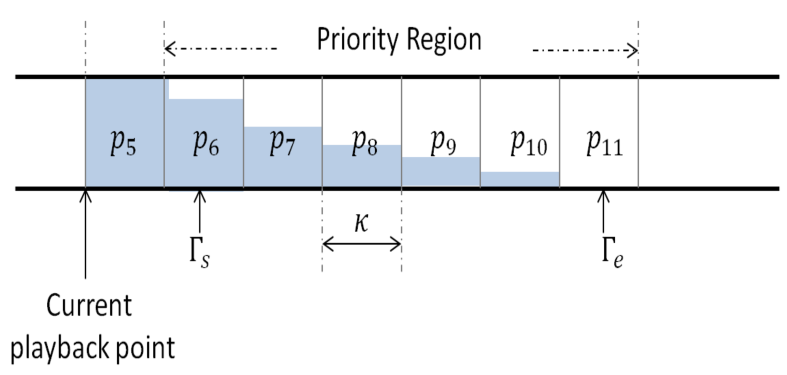


Fig.4. Sample buffer status of node N_j. The current playback point is g=5, the priority region Γ = [Γ_s, Γ_s+1, ….Γ_e].

Random NC $\quad y = \sum_{i=1}^{m} b_i c_i \quad$ (1) [1]

- Fig.3 demonstrates the difference between our proposed packet scheduling algorithm with previous random push algorithm.
- Fig.4 demonstrates the data buffer at the client nodes, the chunks scheduling module perform scheduling in the priority region.

3. The proposed CPS and DPS algorithm

- CPS aims at reducing the bandwidth cost of the whole lossy network under the bandwidth constraint in the low-delay streaming network

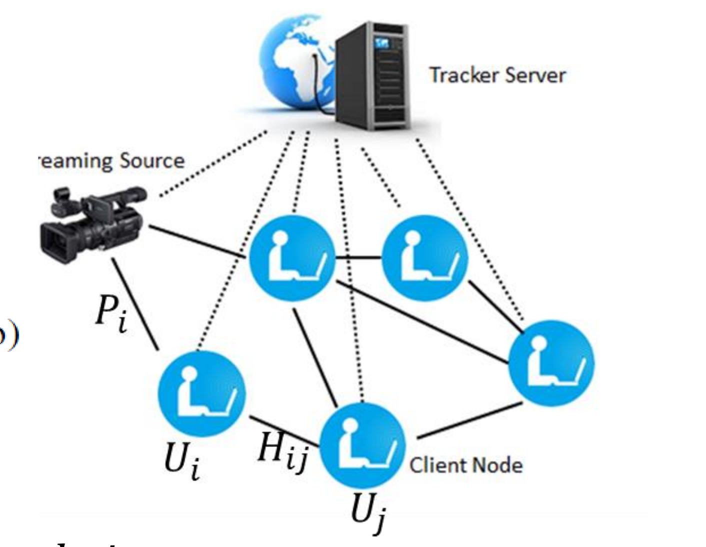
$$\boldsymbol{H} = \arg\min_{H_{ij}} \sum_{i=0}^{N-2} \sum_{j=0}^{N-2} H_{ij}$$

$$\text{subject to} \quad \sum_{j=0}^{N-2} H_{ij} \le U_i \quad \text{for} \quad \forall i \ \text{(a)}$$

$$\sum_{i=0}^{N-2} H_{ij} \ge \lceil \gamma (p_g - p_{jg}^s) \rceil \ \text{for} \ \forall j \quad \text{(b)}$$

$$H_{ij} \le p_{ig}^s \ \text{for} \ \forall i \ \text{and} \ \forall j \quad \text{(c)}$$

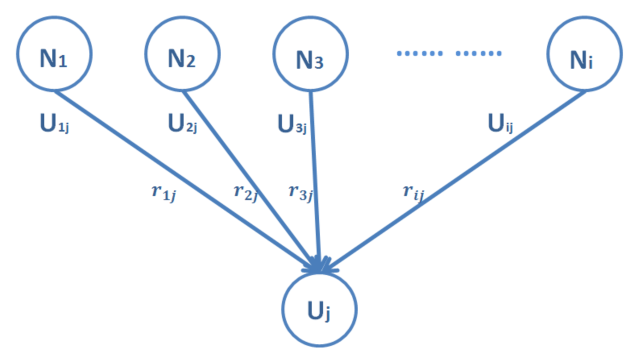
$$H_{ii} = 0 \ \text{for} \ \forall i \qquad \text{(d)}$$



P_{ig}: *Scheduling packets from source to node i*
p_g: *Number of packets in a generation*
U_i: *Upload Bandwidth of node i*
H_{ij}: *Scheduling packets from i to j*

- DPS aims at achieving the optimized blocks scheduling in a distributed way by a hand-shake procedure.

-Hand-shake procedure



$$U_{ij} = \frac{U_i}{\sum_{N_i \subset A_j} U_i} * \mathrm{R}$$

-Block Scheduling Algorithm based on order of senders

$$r_{ij} = roud\left(\frac{U_{ij}}{\sum_{k=i}^{k=|A_i|} U_{ij}} p_r\right) \quad (a)$$

$$p_r = p_g - \sum_{k=0}^{k=i-1} r_{ij} \qquad (b)$$

Where R is the expected streaming rate after considering the loss rate.
r_{ij} *is the scheduled number of packets from node* N_i *to* N_j.

4. Experimental Results

- Experimental settings
  - The experiment is conducted in a 100 nodes network over the NS2 platform to delivery the Paris Sequence(AVC).
  - The proposed CPS and DPS are compared with the R2 algorithm with different buffer update period 50ms and 200ms separately. [2]

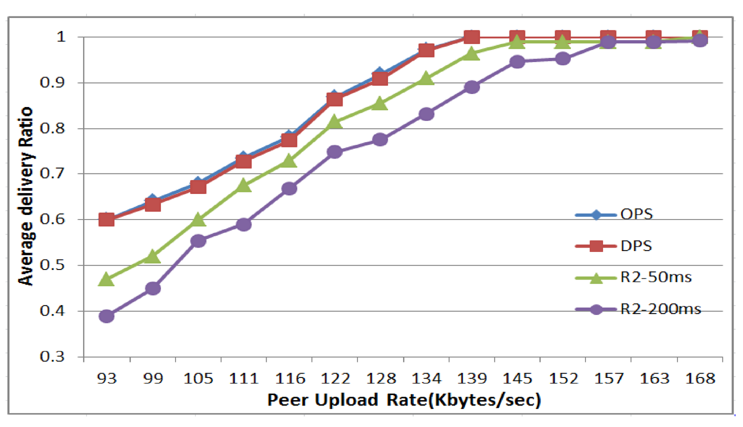


Fig. 5. Performance comparison of the average video quality among these four schemes

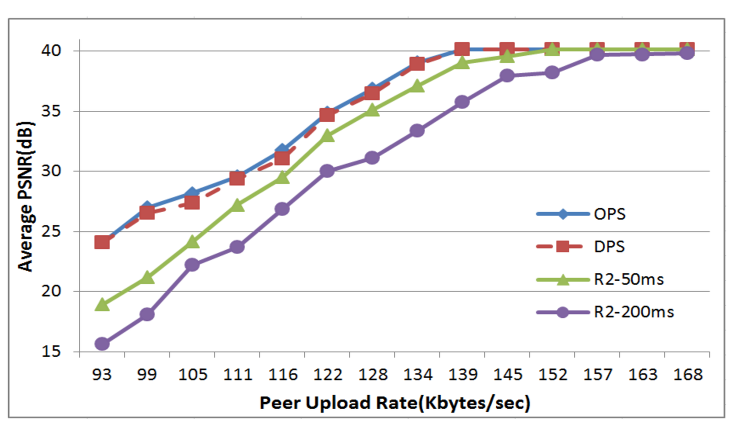


Fig.6 Performance comparison of the average delivery ratio among these four schemes

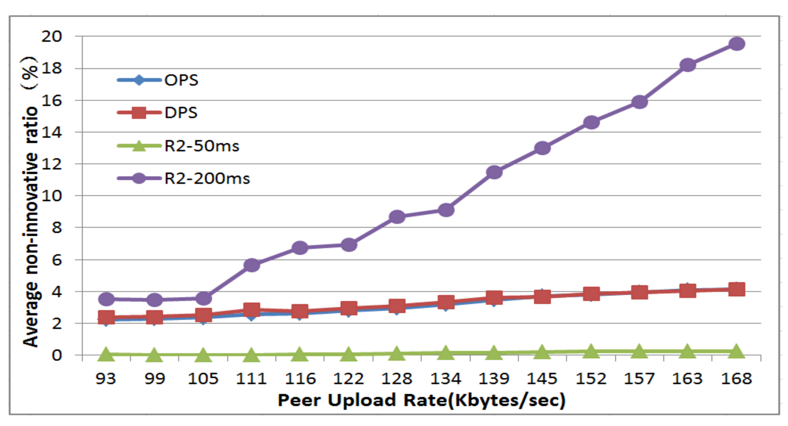


Fig. 7. Performance comparison of the average non-innovative packet ratio among these four schemes

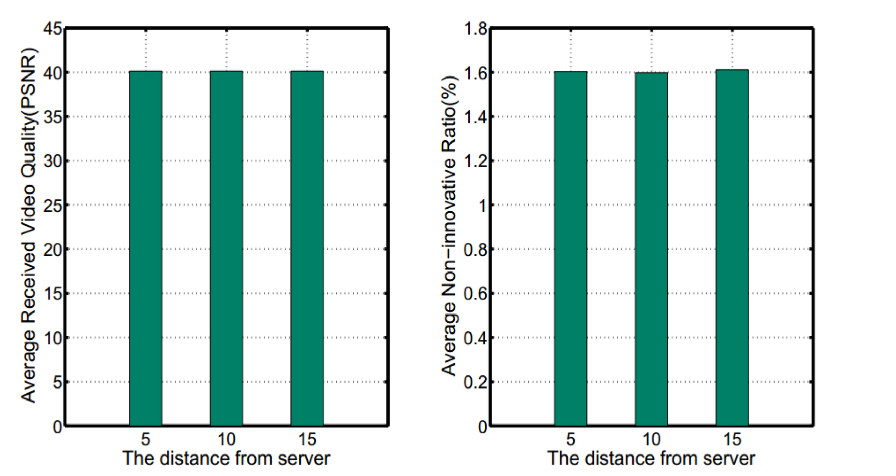


Fig.8. The impact of distance from server to the average received video quality in PSNR and the average non-innovative packet rate

5. References

[1] Chou, Philip A., Yunnan Wu, and Kamal Jain. "Practical network coding." ,2003.
[2] Wang, Mea, and Baochun Li. "R2: Random push with random network coding in live peer-to-peer streaming." *Selected Areas in Communications, IEEE Journal on* 25.9 , 2007

Acknowledgement

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