Athens University of Economics and Business
Master in Computer Science

Master Thesis

Evaluation of video streaming extensions to BitTorrent

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June 2011

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Introduction

- BitTorrent is a peer-to-peer file sharing protocol used for distributing large amounts of data.
- BitTorrent is one of the most common protocols for transferring large files
  - responsible for more than 45-78% of all P2P traffic.
  - accounts for roughly 27-55% of all Internet traffic as of February 2009.
- Resist free-riding
  - Tit-for-Tat policy

Video Streaming

- Video streaming has become increasingly popular in the last few years
  - bandwidth availability
  - lower cost
- Media content proliferation in many different application areas
  - education, entertainment, medical treatment

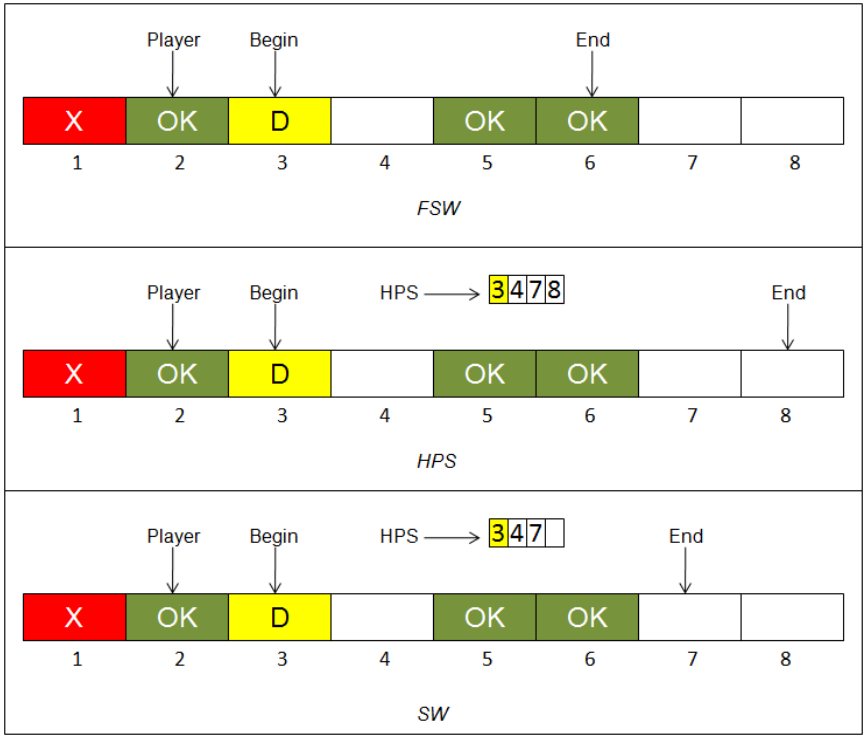
Using BitTorrent for video streaming

- BitTorrent with minimal changes can support streaming.
- BitTorrent vs Centralized solutions
  - we can achieve bandwidth scalability (overcome the bandwidth limitations of keeping the file in a server)
- Streaming-enhanced vs Standard BitTorrent
  - the peer may have the ability of watching the video before the complete download of the file.
  - the peer can evaluate the quality of the video content early and decide if this particular video worth spending time and resources.

Related Work

- P2P Multimedia Streaming using BitTorrent (P. Shah et al., 2007)
  - Sliding window (fixed size)
  - Not requesting pieces outside the window
- BiToS: Enhancing BitTorrent for supporting Streaming Application (A. Vlavianos et al., 2006)
  - High Priority Set
  - Requests pieces from the H.P.S with probability **p** (p=0.8 recommended)
- Windowing BitTorrent for VoD – Not all is lost with Tit-for-Tat (P. Savolainen et al., 2008)
  - Stretching window (adaptive size)
  - Not requesting pieces outside the window

Algorithm	Maximum Window Size	Probability of Requesting from within the Window
Fixed-size Window	w pieces	1
BiToS	w non-arrived pieces	p (typically 0.8)
Stretching Window	w non-arrived pieces or b pieces	1

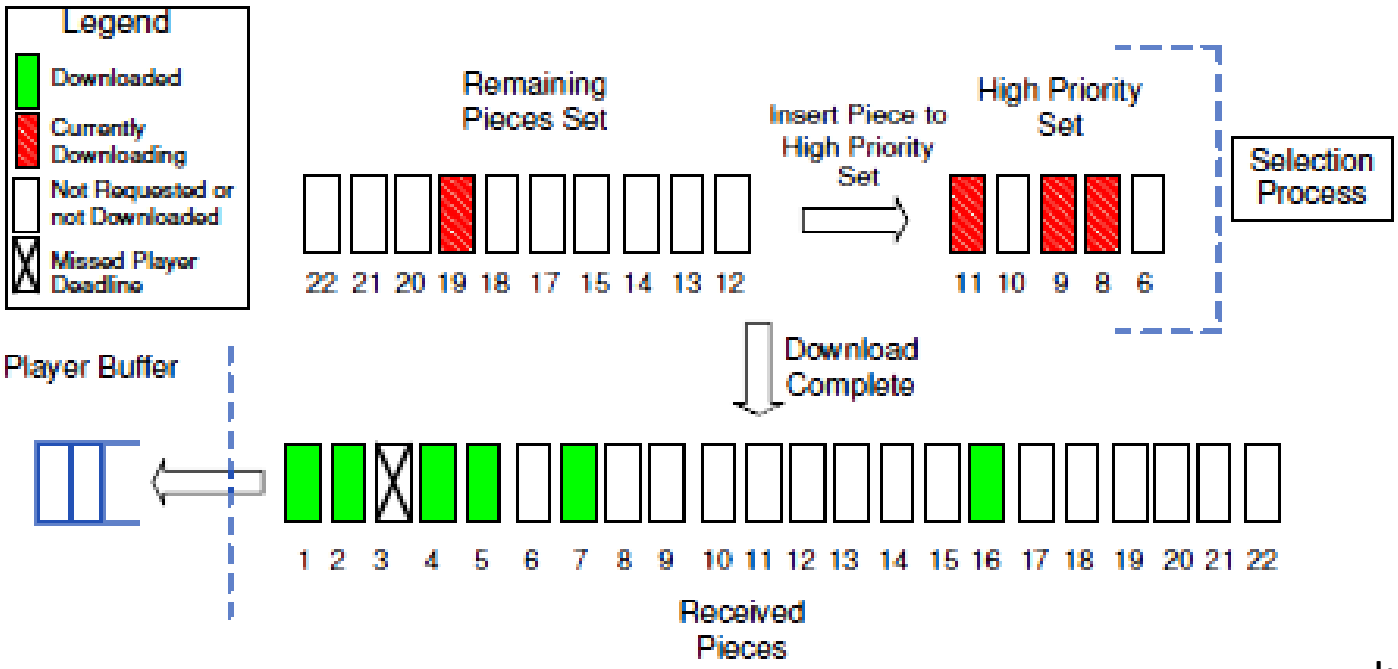


Thesis contribution

- Extended BiToS
  - Probability in each piece inside window
  - Probability in group of pieces inside window
- Evaluate Bitos, Bitos extensions and compare with FSW and SW through two techniques
  - Stall player
  - Player (missed blocks)
- Video Streaming implementation and simulation scenarios were made on a full featured and extensible implementation of BitTorrent for the OMNeT++ simulation environment.

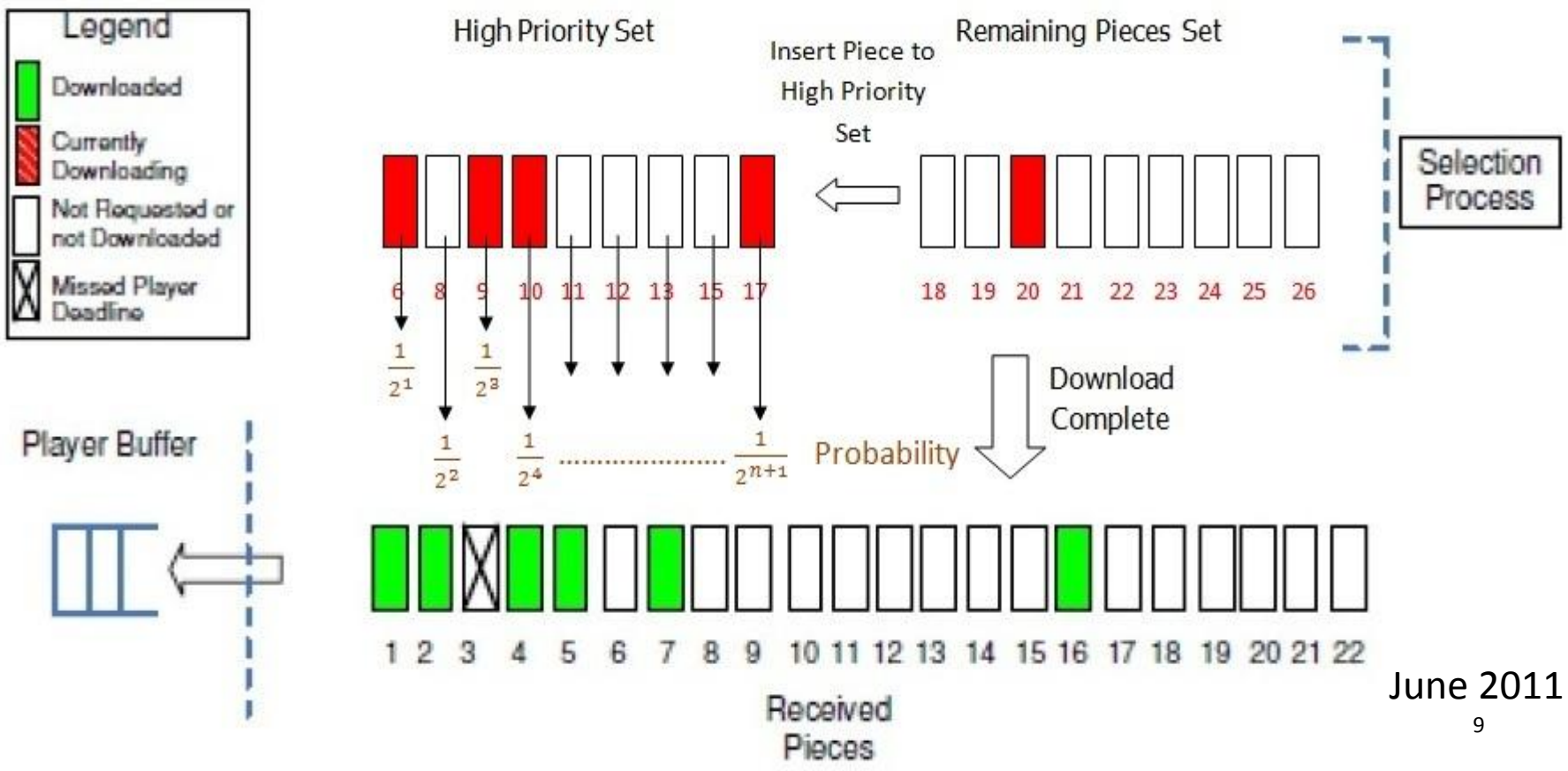
BiToS analysis

- Piece Selection Strategy for Video Streaming
  - Higher download priority to pieces which are close to deadline
  - Rarest first selection, among these *high priority* pieces



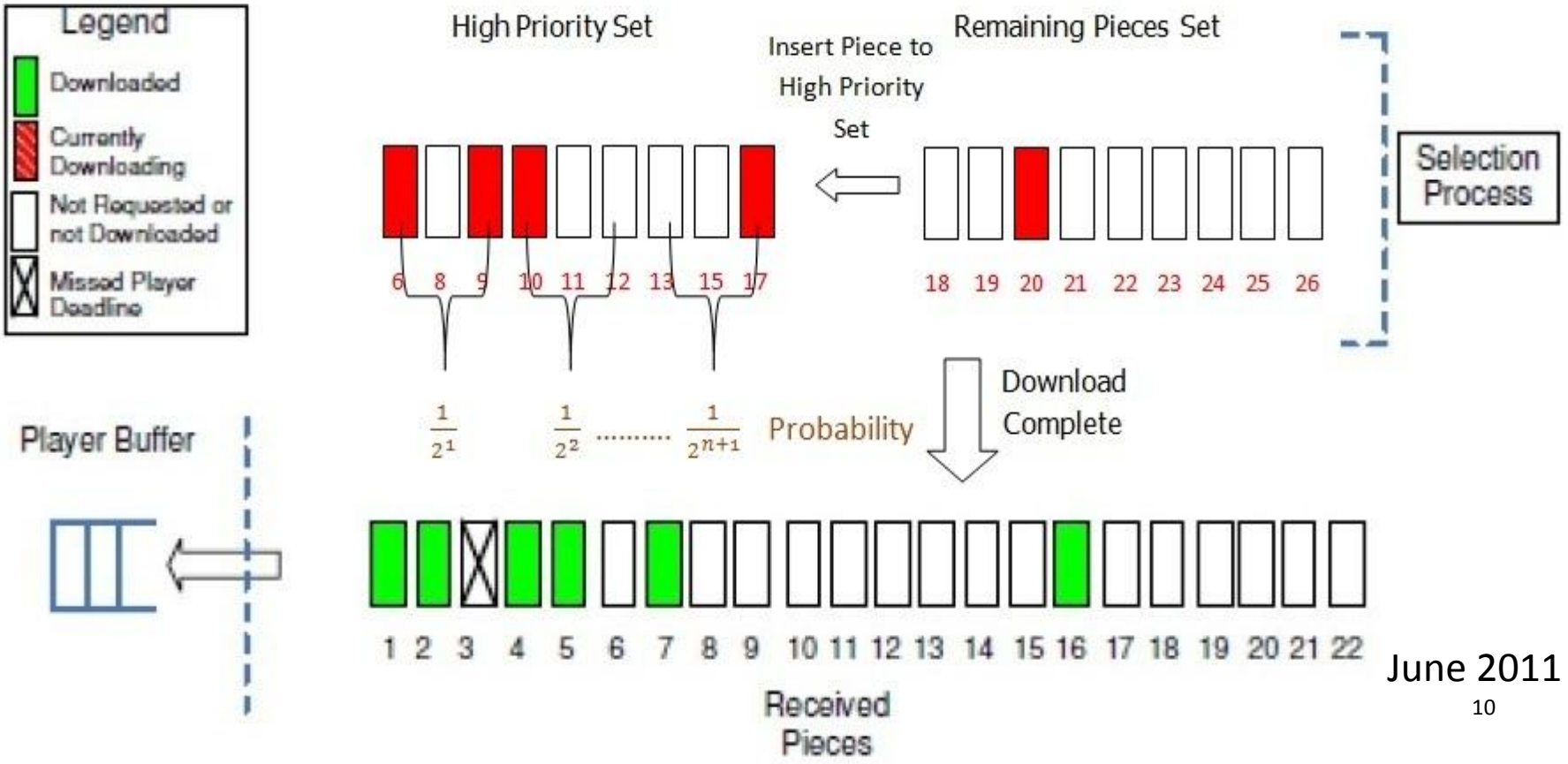
BiToS extension (1/2)

- BiToS with probability in each piece inside the High Priority Set.



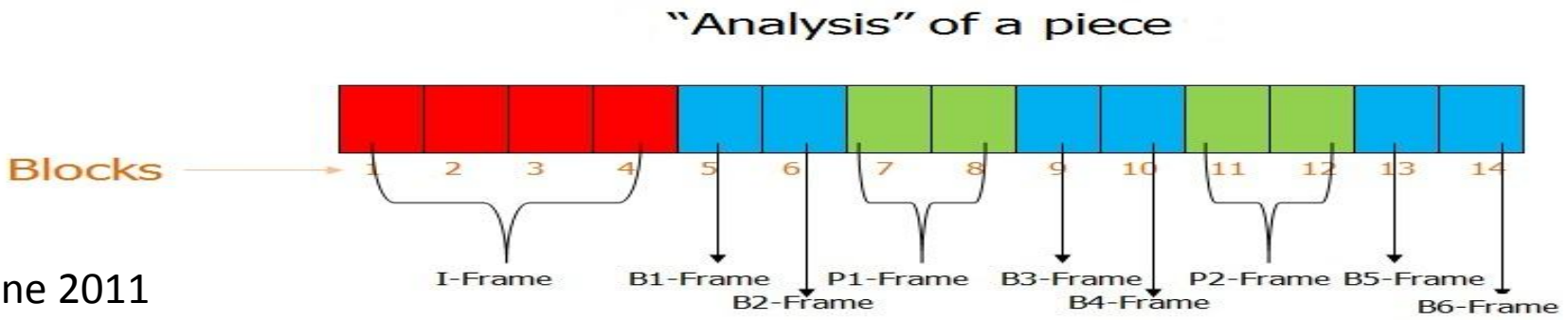
BiToS extension (2/2)

- BiToS with probability in a group of pieces inside the High Priority Set



Playback

- Player
  - Plays the available pieces in sequential order
    - Checks if the next piece in order is available
      - ➢ If not, we work through two techniques
        - 1st technique
          - Player waits until the piece is downloaded
        - 2st technique
          - Player now checks and plays if exists each block of the piece that missed and if it found a missed block it places it in the Missed Block Set
          - Each piece is divided in frames as it appears below



Simulation Parameters (1/2)

- Swarm size
    - Increasing the swarm size may increase the degree of parallelization. This may have positive effects (a peer may download a block faster) or negative effects (there may be more duplicates-redundant data).
- Window size
    - Larger Window size
        - Peers download pieces based on their rareness without considering their deadline
        - The more time it will take on average before the first piece in the window has arrived and the window can move forward
    - Small Window size
        - Peers do not increase the diversity of the pieces (Choked, suffer of overall system efficiency)
    - Tradeoff
        - Window-file size dependent
- Piece size
    - Smaller piece size
        + Shorter initial buffering time
        + Smaller (in KB) and more flexible window size
        - Overhead increase
        - Larger .torrent file

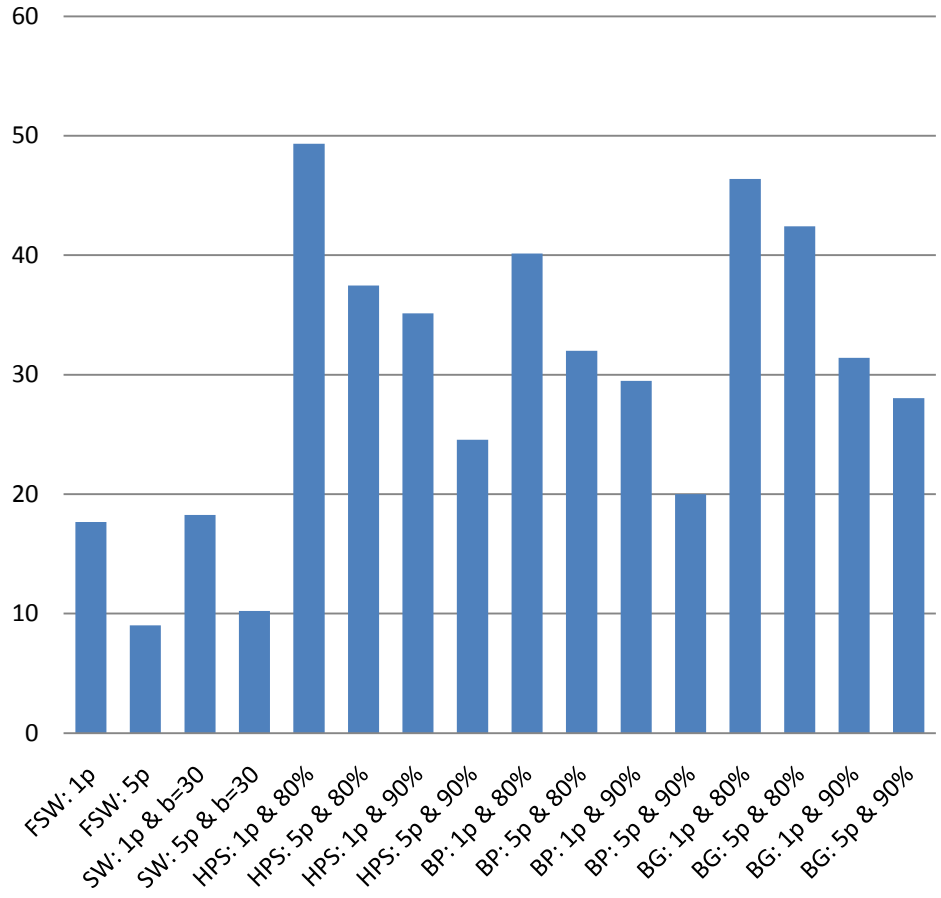
Simulation Parameters (2/2)

- HPS Probability p
  - Large values of p
    - \+ Pieces close to reproduction will be requested earlier than the rest
    - – Peers not choosing rare pieces → choked
- Video Bit Rate
  - Video Quality vs. Piece Loss
  - Player
    - 128KB piece played in 7sec (about 150Kbps)

Parameter	***Value***
Video size (in MB)	200
Video Bit rate (in Kbps)	128
Piece size (in KB)	224
Block size (in KB)	16
Num of pieces for prefetch buffering	1 or 5
Window size (% of total num of pieces)	2% or 8%
Probability p (only for HPS)	80% or 90%
Bound (only for SW)	30 or 100
Player Mode	1,2 or 3
Num of Pieces in group (only for HPS)	25%

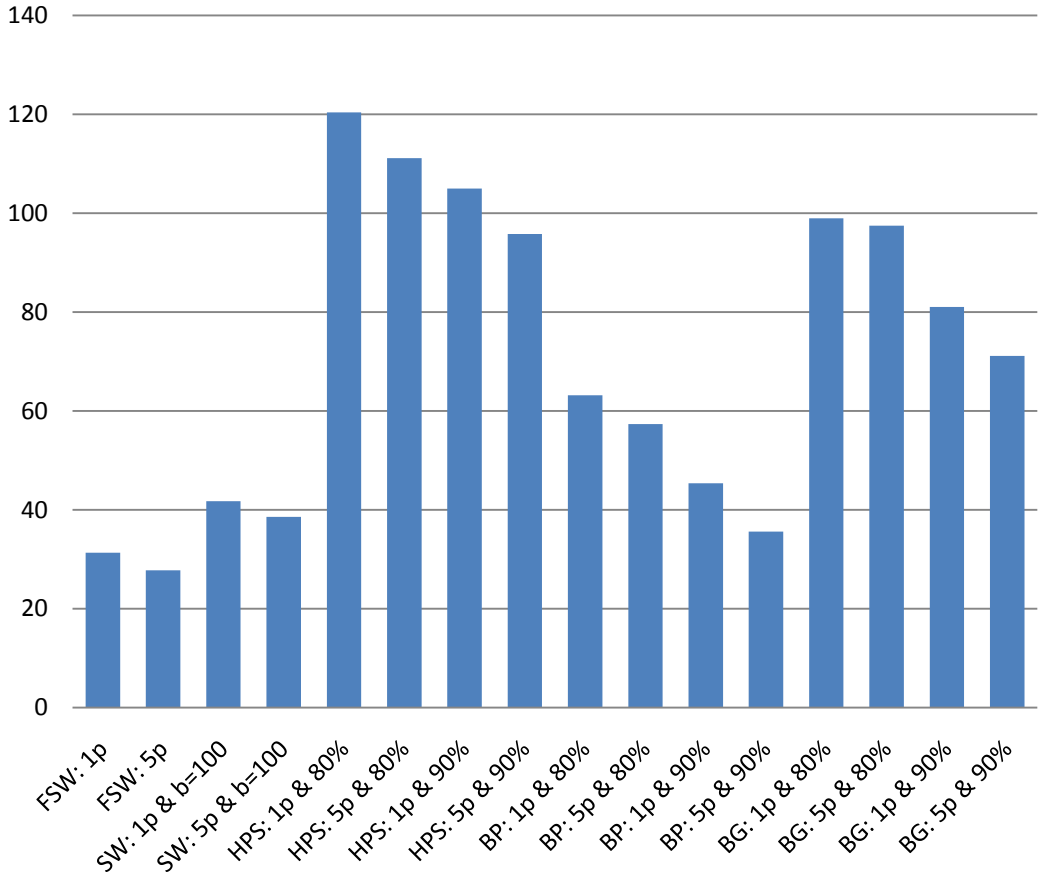
Experimental Results (1/8)

- Wait time for 2% window size (Player mode 1)



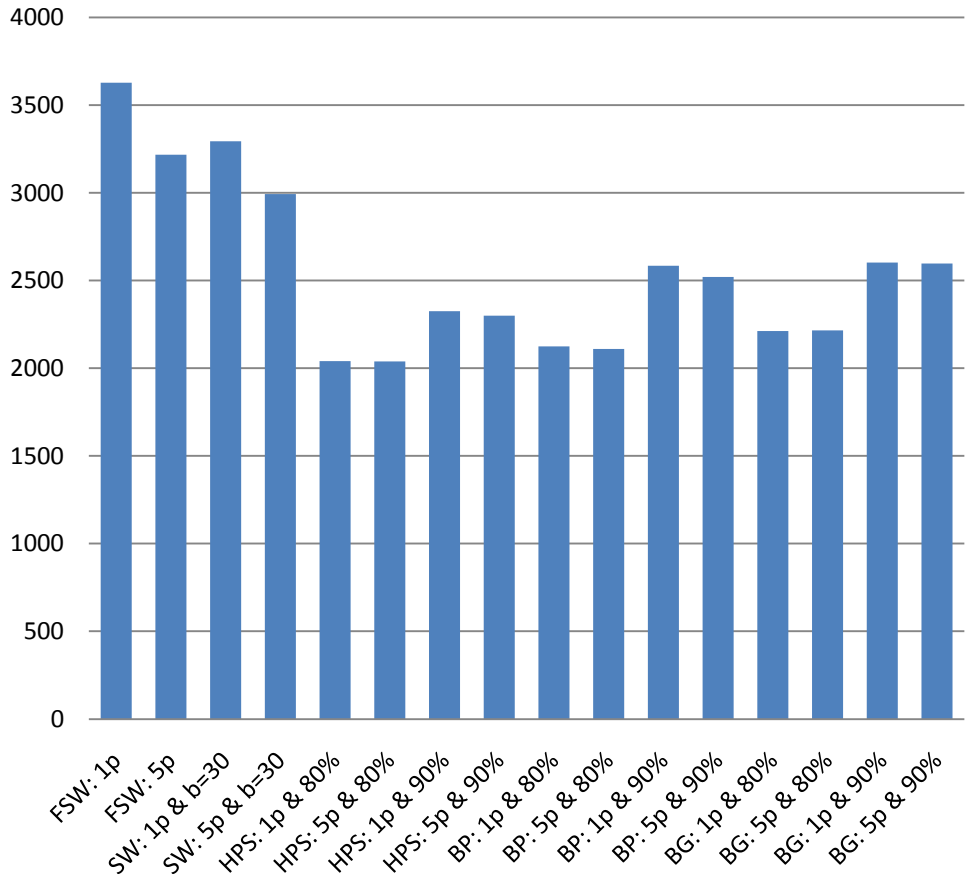
Experimental Results (2/8)

- Wait time for 8% window size (Player mode 1)



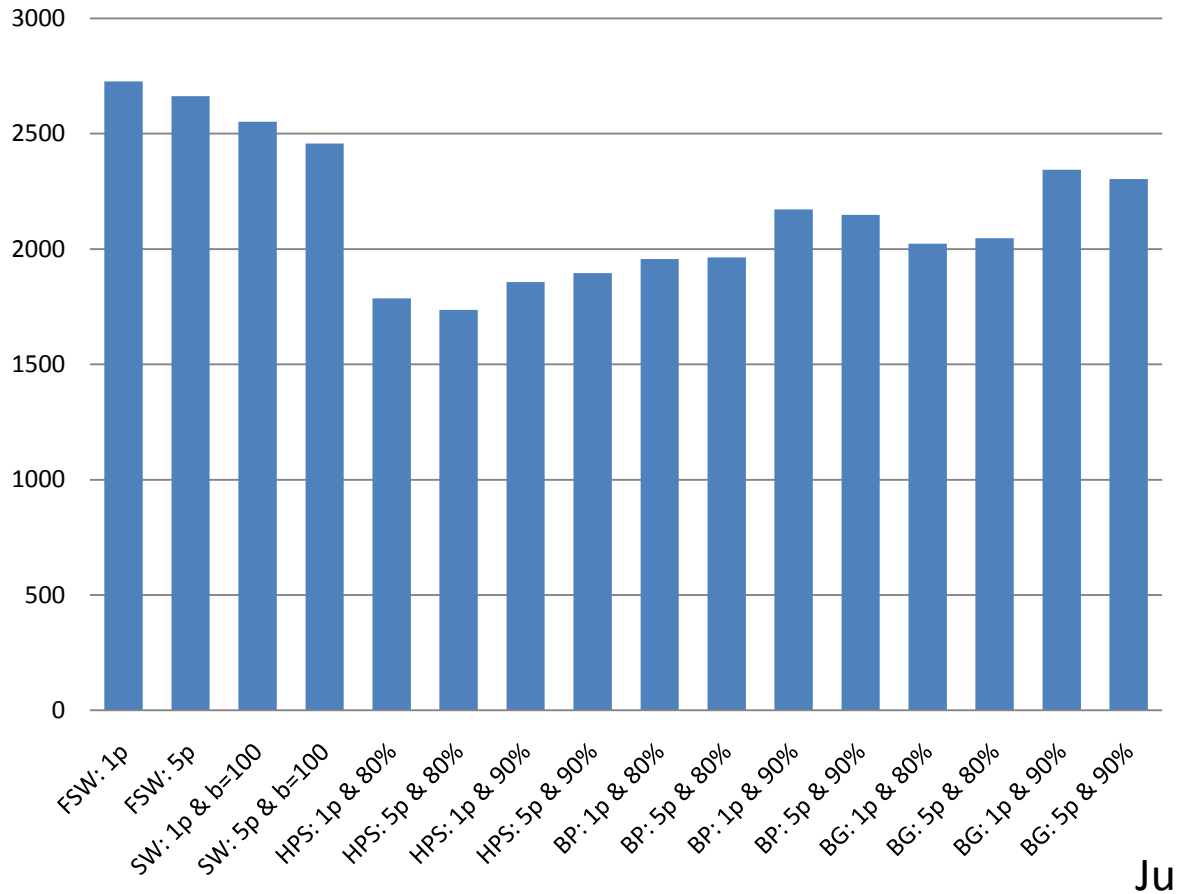
Experimental Results (3/8)

- Download time for 2% window size (Player mode 1)



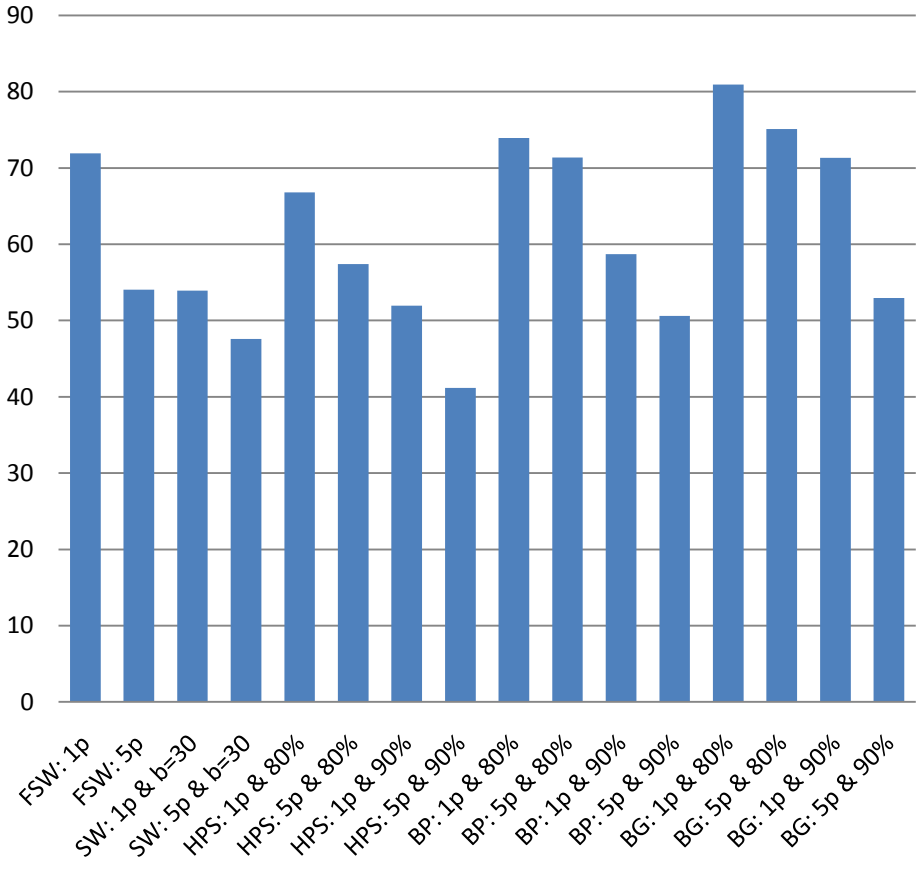
Experimental Results (4/8)

- Download time for 8% window size (Player mode 1)



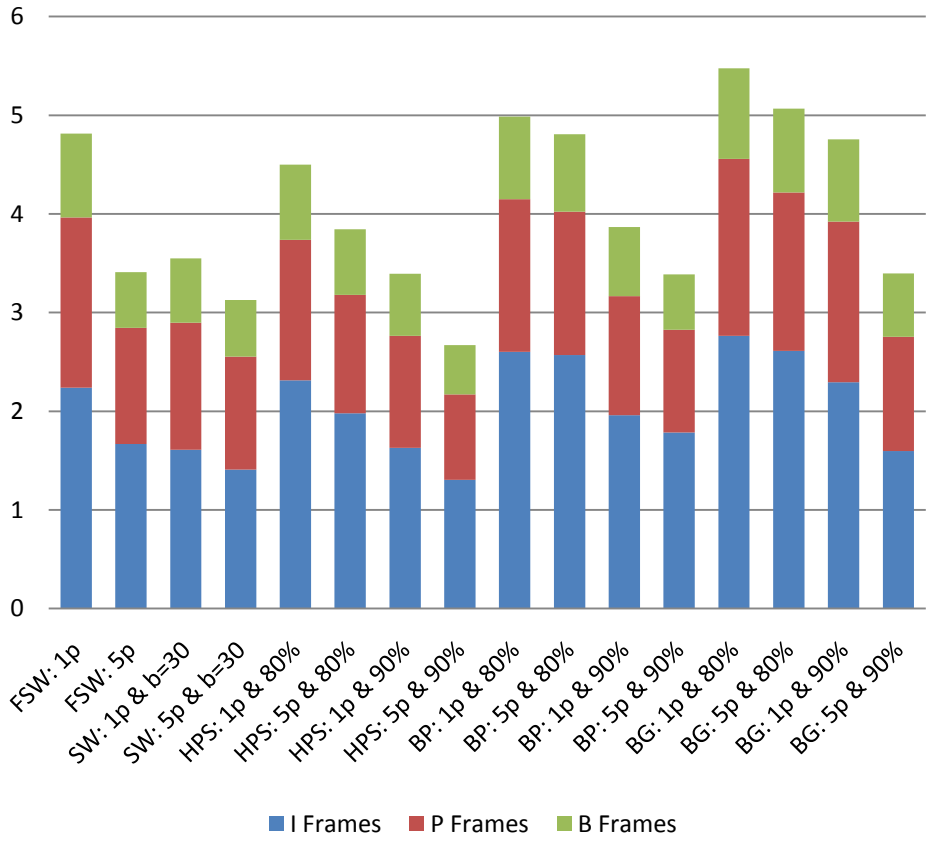
Experimental Results (5/8)

- Block loss for 2% window size (Player mode 2)



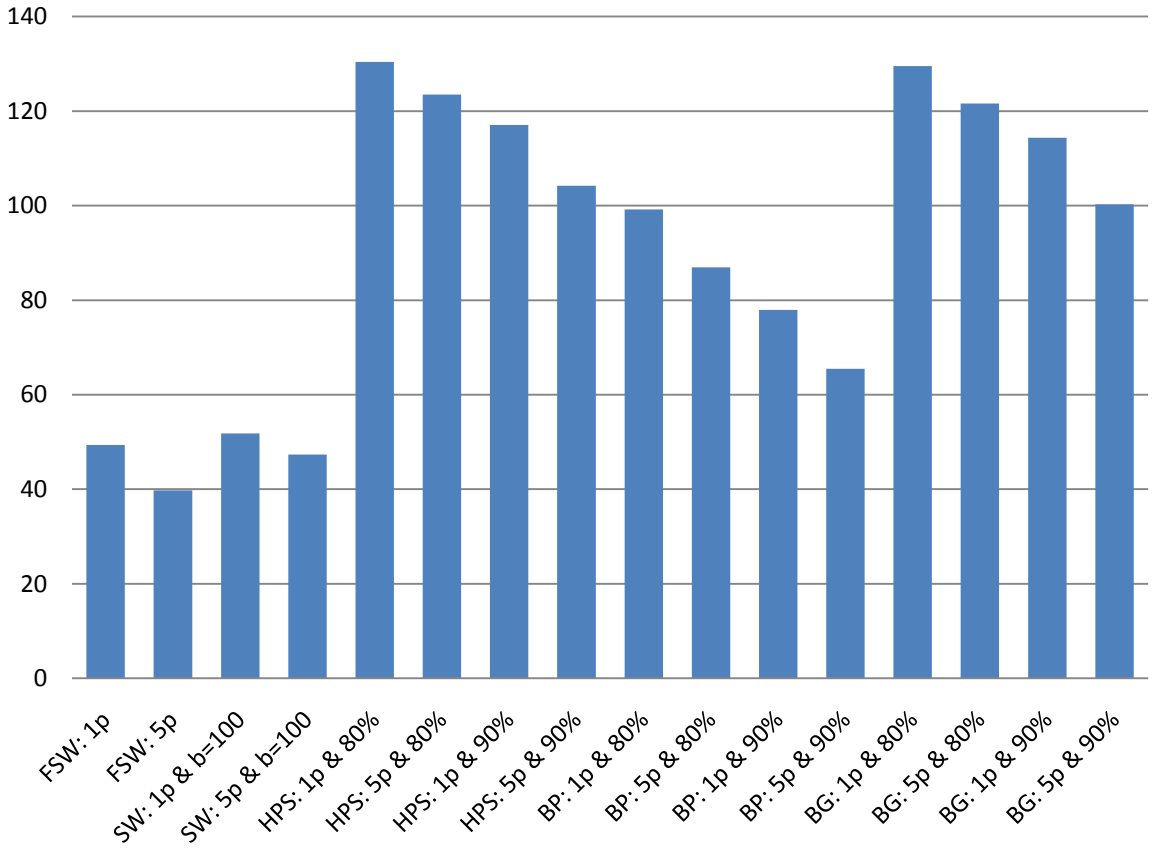
Experimental Results (6/8)

- Frame loss for 2% window size (Player mode 2)



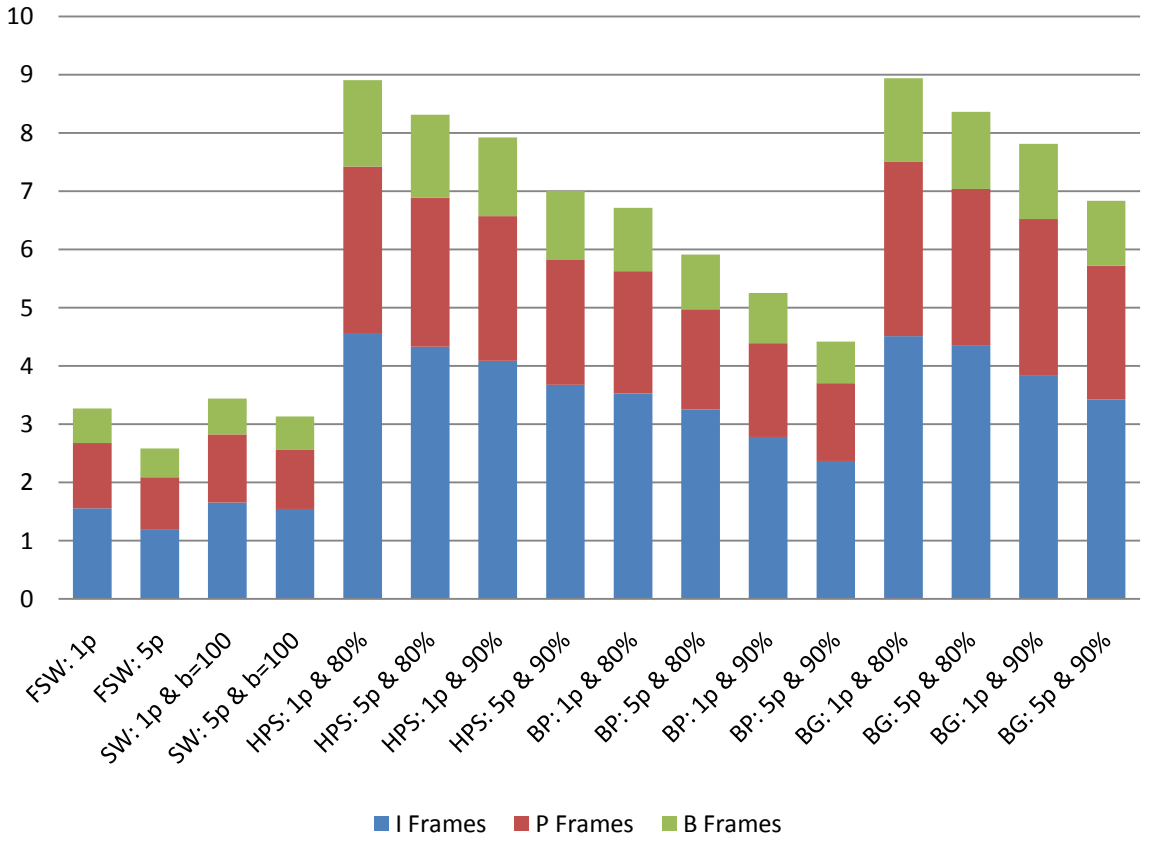
Experimental Results (7/8)

- Block loss for 8% window size (Player mode 2)



Experimental Results (8/8)

- Frame loss for 2% window size (Player mode 2)



Overall Evaluation

→ FSW exhibits lower wait time than SW, HPS and his modifications, both with a 2%, as well as an 8% window size

- FSW and SW perform nearly identically, therefore the extra complexity of SW does not seem to be worthwhile

→ FSW exhibits lower block loss rates than SW, HPS and his modifications for larger windows, but with smaller windows HPS works better

- Prefetching does lower the block loss rates and the wait time slightly, but at the cost of adding nearly 10 extra seconds of startup delay until the pieces are downloaded

→ Regarding download times, HPS is clearly the winner, but since all protocols complete the download well before the end of playback, this is not as important as a reduced loss rate or wait time.

Future Work

- Adaption of HPS probability p
  - Can be triggered by events like missing a deadline
    - Increase probability p in order to give high priority to pieces with shorter deadlines
    - Decrease p when missing many deadlines while not having any received pieces
      - Indicates that the peer is choked by most of its peers, because it doesn't have pieces to exchange
- In case of player mode two
    - try to download the missed blocks and seeding to other peers until the player move to the end of playback

References

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- András Varga OMNeT++ network simulator homepage http://www.omnetpp.org

Thank you

Q & A