The Swift Multiparty Transport Protocol As PPSP

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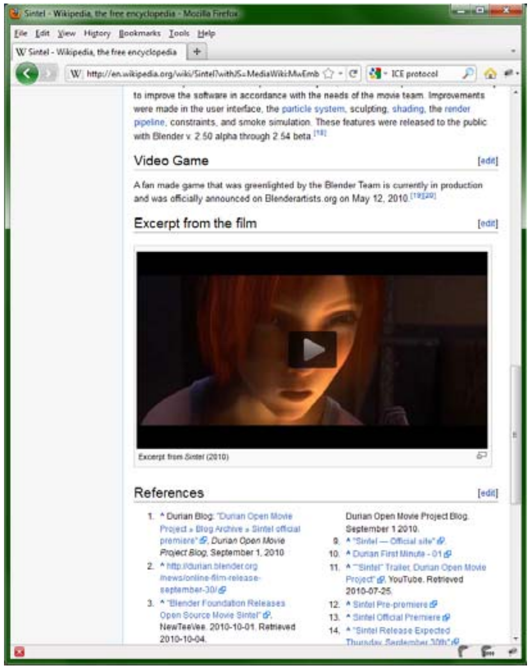
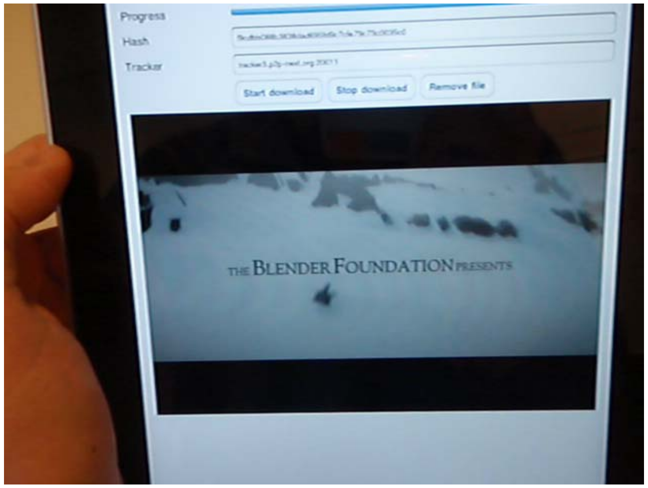
P2P-Next / Delft University of Technology

Status

- Implemented in C++
  - Video-on-demand over UDP
- Running in Firefox:
  - <video src="swift://…
  - Via 100 KB plugin
  - Hooks on en.wikipedia.org
- Running on:
  - iPad
  - Android
  - set-top box
- Works with P2P caches



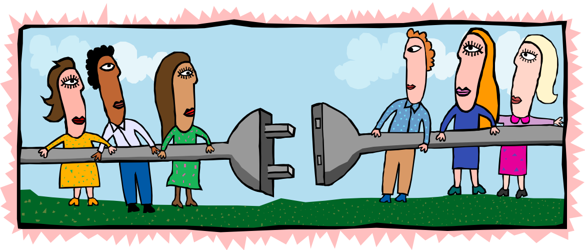


Swift design goals

1. Generic protocol that covers 3 use cases (vod, live, dl)
2. Have short prebuffering times
3. Be extensible:
   - Different congestion control algorithms (LEDBAT)
   - Different reciprocity algorithms (tit4tat, Give-to-Get)
   - Different peer-discovery schemes (tracker, DHT)
4. Can be carried over different transport protocols (UDP,TCP,RTP profile, HTTP)
5. Traverse NATs transparently
6. Low footprint

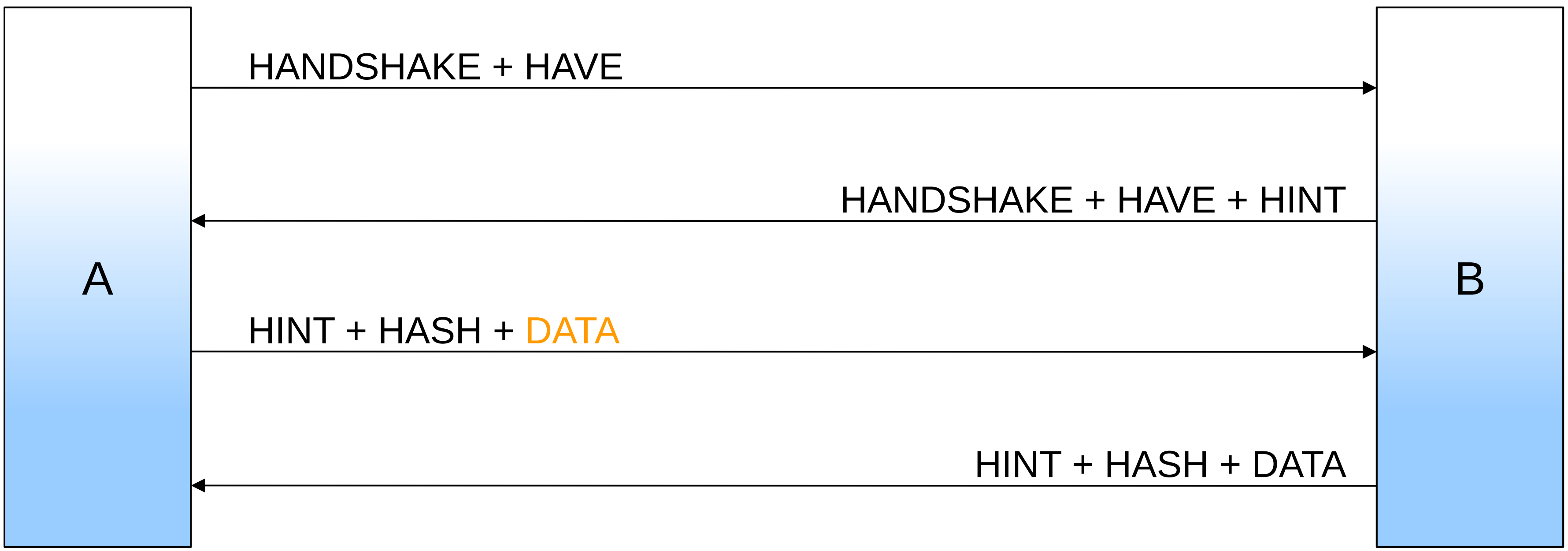
Swift messages

- Basic unit of communication: Message
  - HANDSHAKE
  - HAVE: convey chunk availability
  - HINT: request chunks
  - DATA: actual chunk
  - HASH: MDCs to enable integrity verification
  - …
- Messages are multiplexed together when sent over the wire.



Swift on the wire: Example 1

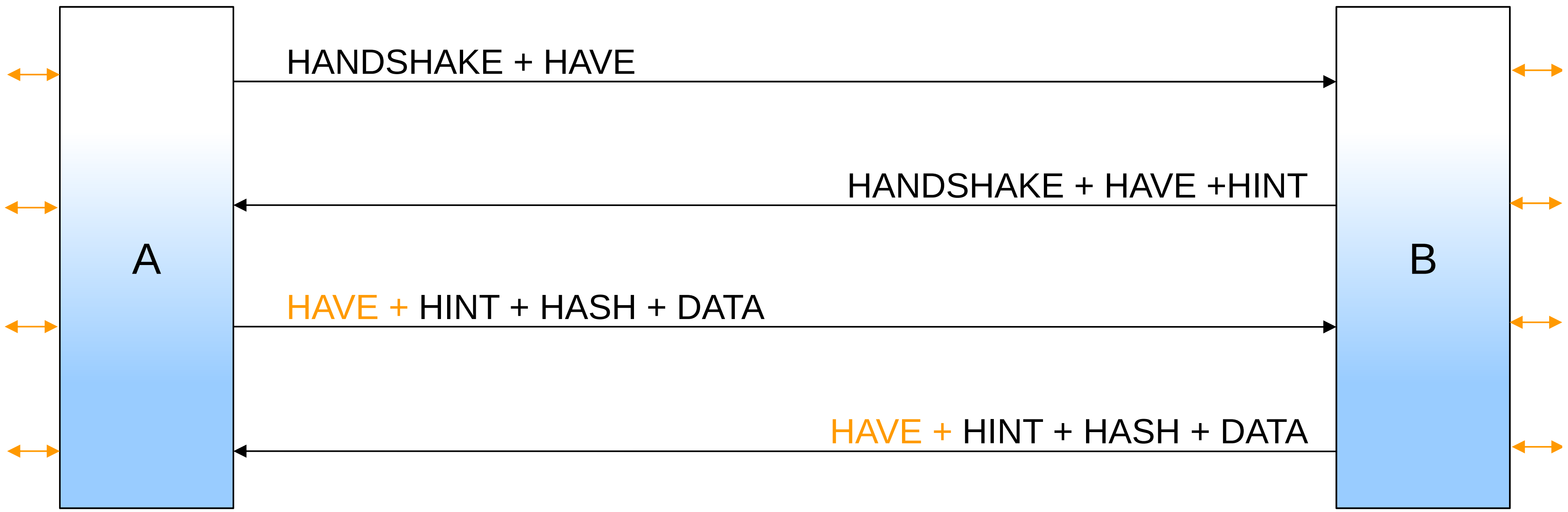
- Peer A and B both have some chunks



- Note: low latency, data transfer already in 3rd datagram.

Swift on the wire: Example 2

- Peer A and B both have some chunks
- Are receiving chunks from others in parallel

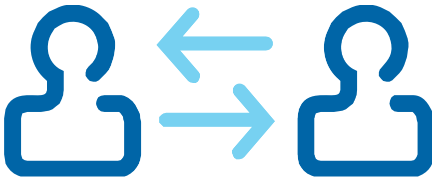


- Note: Chunk availability always up-to-date by pushing

Chunk availability and Rarest first

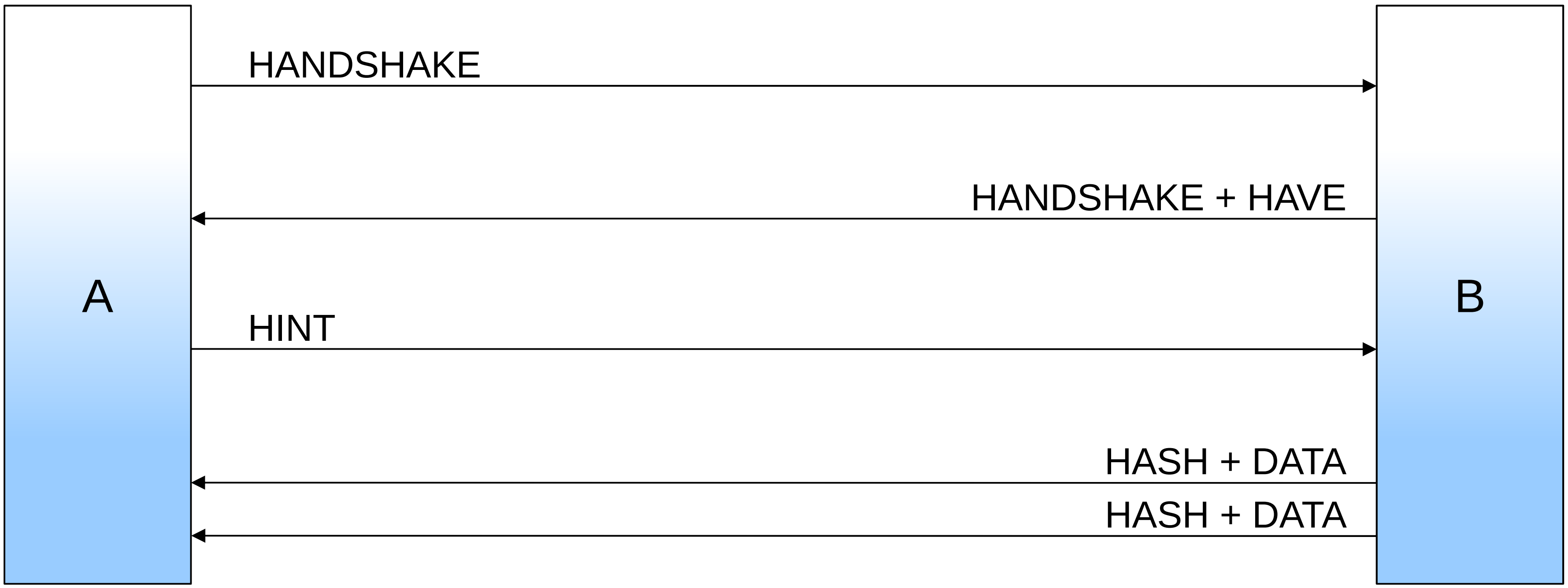
- Rarest-first is common element in chunk selection policies:
  - Peers download chunk that least peers have
    - Low supply
  - Peers can upload that to many peers
    - High demand

- Result: Upload capacity of peers exploited !
- Requires:
  - Peers have good view of neighbours' chunk availability
  - Hence: Swift pushes HAVE messages



Swift on the wire: Example 3

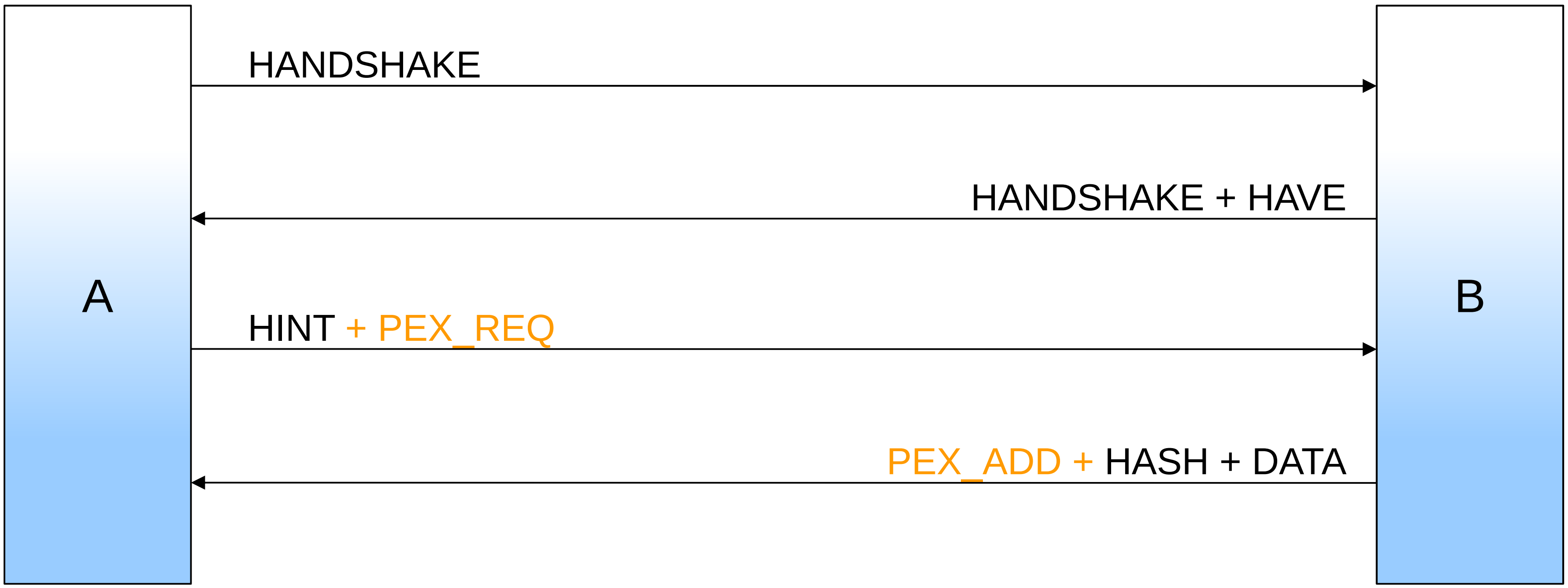
- Peer A is starting leecher, peer B is seeder



- Note: Receiver controls flow

Swift on the wire: Example 4

- Peer A is leecher, peer B is seeder,
- Peer A requests peer list

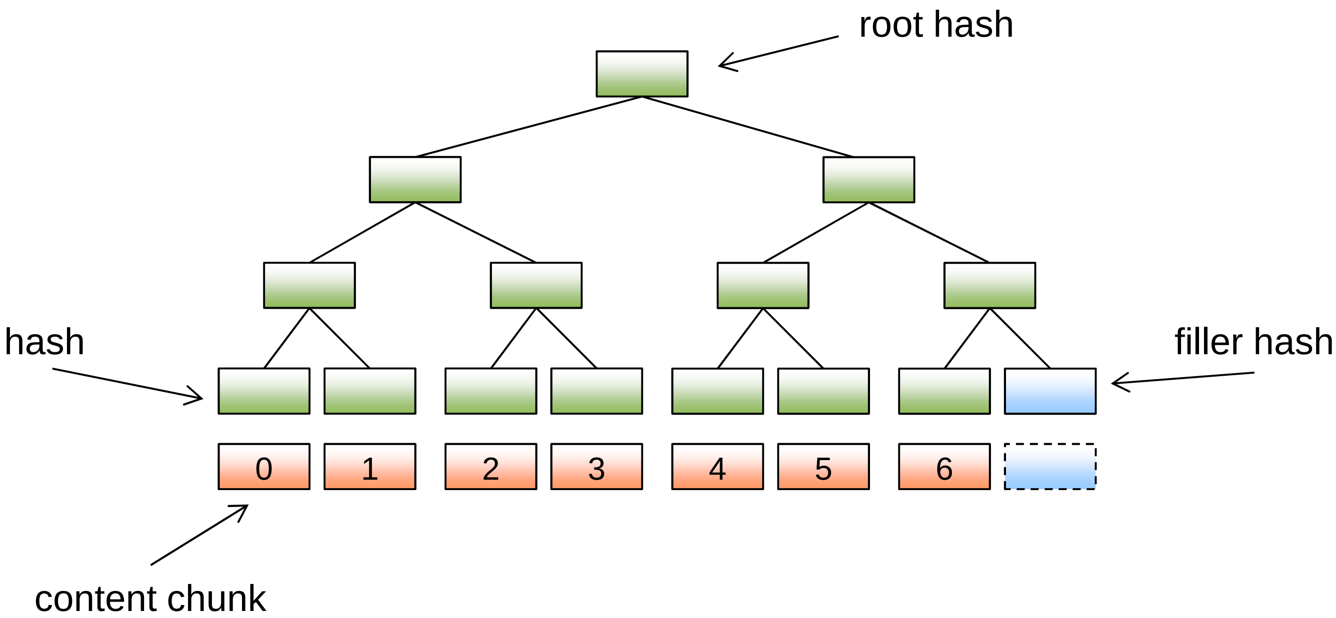


Swift in detail

- Common set of messages across transports
- Novel method of content integrity protection:
  - Merkle hash trees
- Novel method of chunk addressing:
  - Bins
  - = Address range of chunks with single integer
- Novel method of privacy protection
  - Work in progress (ask Riccardo, for SVC too)

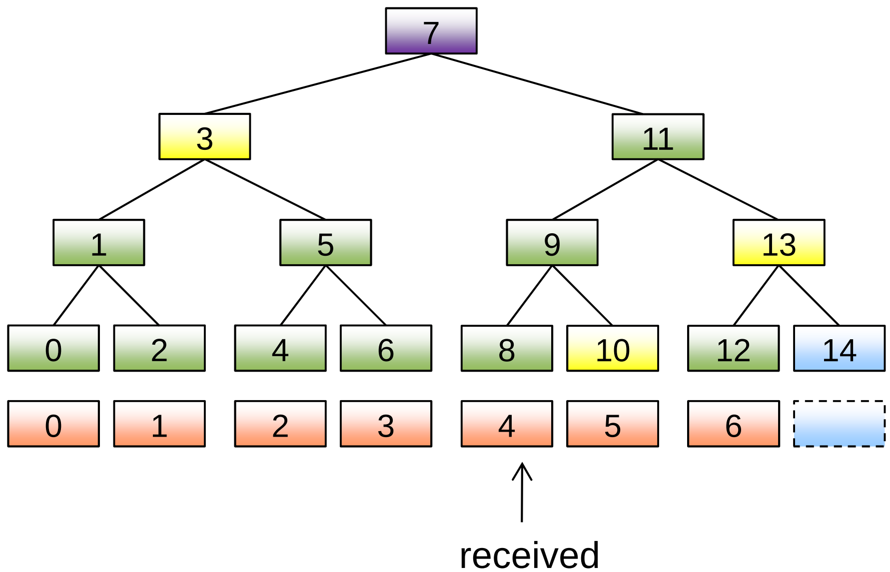
Swift integrity checking

- Content identified by single root hash
- Root hash is top hash in a Merkle hash tree



Swift integrity checking (cont'd)

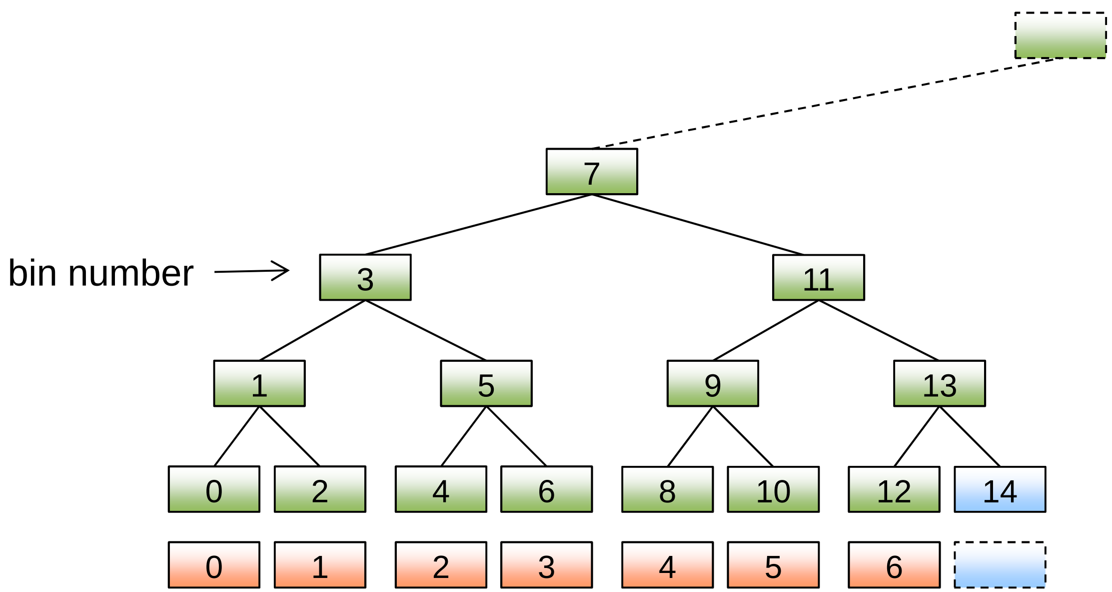
- Atomic datagram principle:
  - Transmit chunk with uncle hashes
  - Allows independent verification of each datagram



  - Root hash + some peer addresses enough to start download!

Swift chunk IDs and live trees

- Nodes in tree denote chunk ranges: bins
  - Used for scalable acknowledgements + low footprint
- Dynamically growing & pruned trees for live

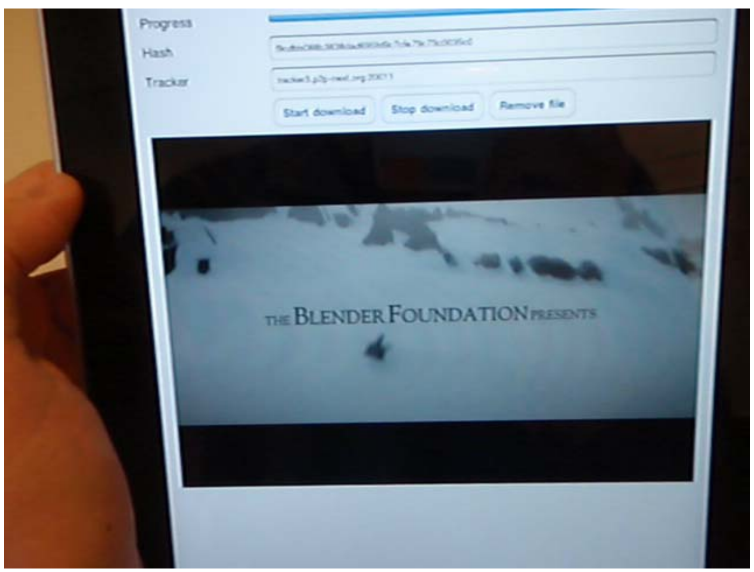


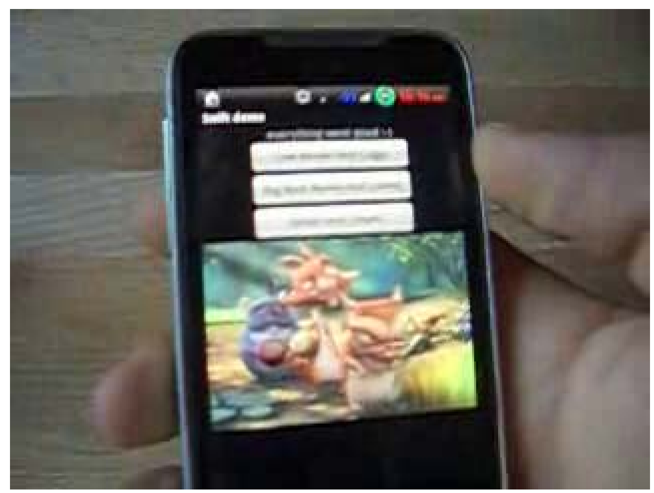
Transport protocols

- Swift over UDP
  - Implemented
- Swift as RTP profile (charter hint)
- Swift over HTTP (charter hint)

Swift over UDP

- Datagram consists of channel ID + multiple messages
  - Channels allow different swarms on single UDP port
- Message is fixed length, first byte message ID
- IETF LEDBAT congestion control
- Simple NAT traversal via protocol itself





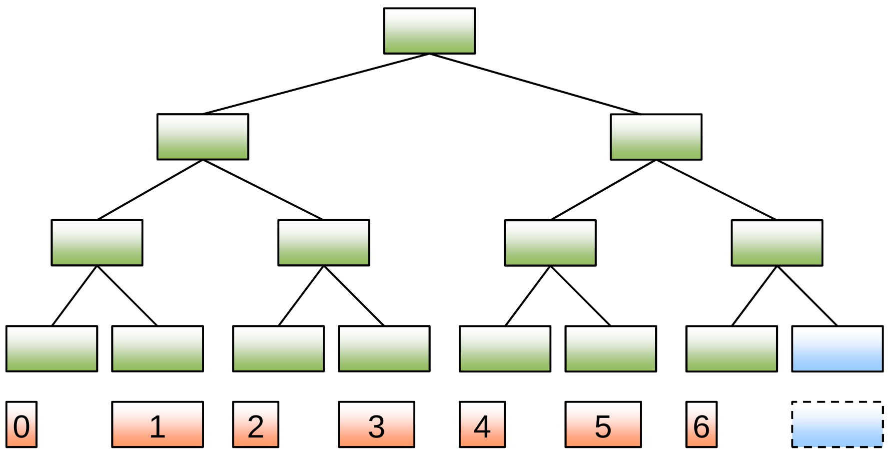
Swift as RTP profile

- cf. Secure Real-time Transport Protocol (SRTP)
  - "layer residing between RTP app and transport layer"
- Chunk = RTP packet

V P X CC M PT	Sequence Number
Timestamp	
SSRC Identifier	
Extension ID	Extension header length
Data …	
HINT+HAVE+HASH	
Length of swift messages	

Swift as RTP profile (cont'd)

- RTP header protected against malicious modification
- Merkle tree can handle variable-sized chunks (if req)
- Advantages of UDP



Swift over HTTP

GET /7c462ad1d980ba44ab4b819e29004eb0bf6e6d5f HTTP/1.1

Host: peer481.example.com

Range: bins 11 <- "I want bin 11"

Accept-Ranges: bins 3 <- "I have bin 3"

…

HTTP/1.1 206 Partial Content

Content-Range: bins 8

Content-Merkle: (10,*hash10*),(13,*hash13*) ;h=SHA1;b=1K <- hashes

Accept-Ranges: bins 7 <- "seeder"

…

Chunk 8

Summary

- More info, sources, binaries:
  - www.libswift.org
  - LGPL license
- Acknowledgements

  - European Community's Seventh Framework Programme in the P2P-Next project under grant agreement no 216217.