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RaptorQ Forward Error Correction Scheme for Object Delivery

draft-ietf-rmt-bb-fec-raptorq-02

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RaptorQ code properties

- Systematic code
- Source symbols per source block – supports up to 56,403
- Repair symbols per source block – supports up to 16+ million
 - Fountain code – same code used for any needed code rate
- Symbol size – supports up to 65,536 bytes
- Linear time encoding and decoding
 - Comparable to Raptor specified in RFC 5053
 - Smooth CPU over entire range of number of source symbols

RaptorQ recovery properties

- If the number of source symbols is K then...
 - **99%** decode success from K symbols
 - **99.99%** decode success from $K+1$ symbols
 - **99.9999%** decode success from $K+2$ symbols
- True for all source block sizes
 - Examples: $K = 20$, $K = 20,000$
- True for all loss models
 - Examples: loss of 5%, loss of 97%
- Strongly systematic
 - Recovery independent of mix of received source and repair

RaptorQ for object delivery

- Same parameters as RFC 5053
 - FEC Payload ID: SBN is 8 bits, ESI is 24 bits
 - FEC OTI parameters: F, AI, T, Z, N
- Similar derivation of FEC OTI as RFC 5053
 - Simpler – recommends one symbol per packet
 - More flexible – larger source blocks possible
 - Improved sub-blocking parameter derivation
 - Example of sub-blocking
 - 2 MB of working memory available to decode at receiver
 - Set sub-block maximum size to 1 MB
 - Set minimum sub-symbol size to 32 bytes
 - Packet payload size is 1280 bytes
 - **Can encode a file up to 40 MB as one source block**

Raptor RFC 5053 vs. RaptorQ

Property	Raptor RFC 5053	RaptorQ
# source symbols	8,192	56,403
# encoded symbols	65,536	16,777,216
Max. sym. size	65,536	65,536
# source blocks	65,536	256
Recovery properties	Good	Exceptional
# symbols/packet	Often multiple	1
Sub-block support	Good	Improved

Changes

- From: draft-luby-rmt-bb-fec-raptorg-object-01
- To: draft-ietf-rmt-bb-fec-raptorq-02
 - Small errors/typos fixed
 - Small improvements to the explanations
 - Updates to tables
 - Simplified a bit
 - Name changed from RaptorG to RaptorQ
- To: next draft
 - Fill in additional supported K' values (Table 2)
 - Gaps between K' values reduced from 10% to 1%
 - Further smoothing of CPU

Implementation status

- Two “independent” DF/QC implementations
 - Both implemented according to spec (by different groups)
 - Encoders/decoders have been cross-verified
- Third party implementation in progress
 - Access only to spec
 - Helped to make clarifications to the spec
 - Will cross-verify third party implementation with DF/QC implementations

Other information

- Being adopted into additional standards
 - For file delivery and streaming
- Being proposed to FECFRAME
 - For streaming

Other information

- DF/QC IPR statements have been updated
 - **Not yet posted by the IETF – within 7 days**
 - For RMT and FECFRAME documents
 - For documents that DF/QC has made an IPR statement

Other information

- If the technology in the draft "RaptorQ Forward Error Correction Scheme for Object Delivery" draft-ietf-rmt-bb-fec-raptorq-02 is included in a standards track or experimental document adopted by the IETF, and any claim of any patent issued from the above mentioned patents, patent applications or corresponding patents and patent applications is required for the implementation of any broadcast/multicast object delivery product that (a) fully implements such adopted standards track or experimental document; and (b) implements a wireless wide-area standard (for example, a UMTS-compatible handset or Infrastructure equipment), Qualcomm will offer licenses to such claim as part of its established licensing terms and conditions for such products, without charging any additional incremental royalty rate above Qualcomm's standard royalty rate for use of its patents in such products implementing such wireless wide-area standard.
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Next steps

- It is believed that the current draft is
 - Stable
 - Accurate
 - Complete
- One more technical update planned
 - As described before – fill in additional K' values
- Ready for WGLC
 - Immediately after next technical update and cross-verification of DF/QC implementations with third party implementation