8.4.3. ACK-on-Error Mode

The ACK-on-Error mode supports L2 technologies that have variable MTU

and out-of-order delivery. It requires an L2 that provides a

feedback path from the reassembler to the fragmenter. See Appendix F

for a discussion on using ACK-on-Error mode on quasi-bidirectional

links.

In ACK-on-Error mode, windows are used.

All tiles except the last one and the penultimate one MUST be of

equal size, hereafter called "regular". The size of the last tile

MUST be smaller than or equal to the regular tile size. Regarding

the penultimate tile, a Profile MUST pick one of the following two

options:

\* The penultimate tile size MUST be the regular tile size, or

\* the penultimate tile size MUST be either the regular tile size or

the regular tile size minus one L2 Word.

A SCHC Fragment message carries one or several contiguous tiles,

which may span multiple windows. **A SCHC ACK reports on the reception**

**of exactly one window of tiles. A SCHC Compound ACK reports on the reception of several windows of tiles, each one identified by its window number.**

See Figure 23 for an example.

+---------------------------------------------...-----------+

| SCHC Packet |

+---------------------------------------------...-----------+

Tile# | 4 | 3 | 2 | 1 | 0 | 4 | 3 | 2 | 1 | 0 | 4 | | 0 | 4 |3|

Window# |-------- 0 --------|-------- 1 --------|- 2 ... 27 -|- 28-|

SCHC Fragment msg |-----------|

Figure 23: SCHC Packet Fragmented in Tiles, ACK-on-Error Mode

The W field is wide enough that it unambiguously represents an

absolute window number. The fragment receiver sends **SCHC ACKs** **SCHC Compound ACKs** to the

fragment sender about windows for which tiles are missing. No **SCHC**

**ACK** **SCHC Compound ACK** is sent by the fragment receiver for windows that it knows have

been fully received.

The fragment sender retransmits SCHC Fragments for tiles that are

reported missing. It can advance to next windows even before it has

ascertained that all tiles belonging to previous windows have been

correctly received, and it can still later retransmit SCHC Fragments

with tiles belonging to previous windows. Therefore, the sender and

the receiver may operate in a decoupled fashion. The fragmented SCHC

Packet transmission concludes when:

\* integrity checking shows that the fragmented SCHC Packet has been

correctly reassembled at the receive end, and this information has

been conveyed back to the sender, or

\* too many retransmission attempts were made, or

\* the receiver determines that the transmission of this fragmented

SCHC Packet has been inactive for too long.

Each Profile MUST specify which RuleID value(s) corresponds to SCHC

F/R messages operating in this mode.

The W field MUST be present in the SCHC F/R messages.

Each Profile, for each RuleID value, MUST define:

\* the tile size (a tile does not need to be multiple of an L2 Word,

but it MUST be at least the size of an L2 Word),

\* the value of M,

\* the value of N,

\* the value of WINDOW\_SIZE, which MUST be strictly less than 2^N,

\* the size and algorithm for the RCS field,

\* the value of T,

\* the value of MAX\_ACK\_REQUESTS,

\* the expiration time of the Retransmission Timer,

\* the expiration time of the Inactivity Timer,

\* if the last tile is carried in a Regular SCHC Fragment or an All-1

SCHC Fragment (see Section 8.4.3.1), and

\* if the penultimate tile MAY be one L2 Word smaller than the

regular tile size. In this case, the regular tile size MUST be at

least twice the L2 Word size.

**\* if the SCHC Compound ACK is used.**

For each active pair of RuleID and DTag values, the sender MUST

maintain:

\* one Attempts counter, and

\* one Retransmission Timer.

For each active pair of RuleID and DTag values, the receiver MUST

maintain:

\* one Inactivity Timer, and

\* one Attempts counter.

8.4.3.1. Sender Behavior

At the beginning of the fragmentation of a new SCHC Packet:

\* the fragment sender MUST select a RuleID and DTag value pair for

this SCHC Packet. A Rule MUST NOT be selected if the values of M

and WINDOW\_SIZE for that Rule are such that the SCHC Packet cannot

be fragmented in (2^M) \* WINDOW\_SIZE tiles or less.

\* the fragment sender MUST initialize the Attempts counter to 0 for

that RuleID and DTag value pair.

A Regular SCHC Fragment message carries in its payload one or more

tiles. If more than one tile is carried in one Regular SCHC

Fragment:

\* the selected tiles MUST be contiguous in the original SCHC Packet,

and

\* they MUST be placed in the SCHC Fragment Payload adjacent to one

another, in the order they appear in the SCHC Packet, from the

start of the SCHC Packet toward its end.

Tiles that are not the last one MUST be sent in Regular SCHC

Fragments specified in Section 8.3.1.1. The FCN field MUST contain

the tile index of the first tile sent in that SCHC Fragment.

In a Regular SCHC Fragment message, the sender MUST fill the W field

with the window number of the first tile sent in that SCHC Fragment.

A Profile MUST define if the last tile of a SCHC Packet is sent:

\* in a Regular SCHC Fragment, alone or as part of a multi-tiles

Payload,

\* alone in an All-1 SCHC Fragment, or

\* with any of the above two methods.

In an All-1 SCHC Fragment message, the sender MUST fill the W field

with the window number of the last tile of the SCHC Packet.

The fragment sender MUST send SCHC Fragments such that, all together,

they contain all the tiles of the fragmented SCHC Packet.

The fragment sender MUST send at least one All-1 SCHC Fragment.

In doing the two items above, the sender MUST ascertain that the

receiver will not receive the last tile through both a Regular SCHC

Fragment and an All-1 SCHC Fragment.

The fragment sender MUST listen for **SCHC ACK** **SCHC Compound ACK** messages after having

sent:

\* an All-1 SCHC Fragment, or

\* a SCHC ACK REQ.

A Profile MAY specify other times at which the fragment sender MUST

listen for **SCHC ACK** **SCHC Compound ACK** messages. For example, this could be after

sending a complete window of tiles.

Each time a fragment sender sends an All-1 SCHC Fragment or a SCHC

ACK REQ:

\* it MUST increment the Attempts counter, and

\* it MUST reset the Retransmission Timer.

On Retransmission Timer expiration:

\* if the Attempts counter is strictly less than MAX\_ACK\_REQUESTS,

the fragment sender MUST send either the All-1 SCHC Fragment or a

SCHC ACK REQ with the W field corresponding to the last window,

\* otherwise, the fragment sender MUST send a SCHC Sender-Abort, and

it MAY exit with an error condition.

All message receptions being discussed in the rest of this section

are to be understood as "matching the RuleID and DTag pair being

processed", even if not spelled out, for brevity.

On receiving a **SCHC ACK** **SCHC Compound ACK**:

\* if **one of** the W fields in the **SCHC ACK** **SCHC Compound ACK Header** corresponds to the last window of

the SCHC Packet:

- if the C bit is set, the sender MAY exit successfully.

- otherwise:

o if the Profile mandates that the last tile be sent in an

All-1 SCHC Fragment:

+ if the **SCHC ACK** **SCHC Compound ACK** shows no missing tile at the receiver,

the sender:

\* MUST send a SCHC Sender-Abort, and

\* MAY exit with an error condition.

+ otherwise:

\* **the fragment sender MUST send SCHC Fragment messages**

**containing all the tiles that are reported missing in**

**the SCHC ACK.**

\* **the fragment sender MUST send SCHC Fragment messages**

**containing all the tiles of all the windows that are**

**reported missing in the SCHC Compound ACK.**

**\* if the last of these SCHC Fragment messages is not an**

**All-1 SCHC Fragment, then the fragment sender MUST in**

**addition send after it a SCHC ACK REQ with the W field**

**corresponding to the last window.**

**\* if the last of these SCHC Fragment messages**

**is not an All-1 SCHC Fragment, then the fragment**

**sender MAY either send in addition a SCHC ACK REQ with**

**the W field corresponding to the last window, continue**

**the transmission of the remaining SCHC Fragments to be**

**transmitted, or repeat the All-1 SCHC Fragment to confirm that**

**all tiles have been correctly received.**

\* in doing the two items above, the sender MUST

ascertain that the receiver will not receive the last

tile through both a Regular SCHC Fragment and an All-1

SCHC Fragment.

o otherwise:

+ if the **SCHC ACK** **SCHC Compound ACK** shows no missing tile at the receiver,

the sender MUST send the All-1 SCHC Fragment

+ otherwise:

\* the fragment sender MUST send SCHC Fragment messages

containing all the tiles that are reported missing in

the **SCHC ACK** **SCHC Compound ACK**.

\* the fragment sender MUST then send either the All-1

SCHC Fragment or a SCHC ACK REQ with the W field

corresponding to the last window.

\* otherwise, the fragment sender:

- MUST send SCHC Fragment messages containing the tiles that are

reported missing in the **SCHC ACK** **SCHC Compound ACK**.

- then, it MAY send a SCHC ACK REQ with the W field corresponding

to the last window.

See Figure 43 for one among several possible examples of a Finite

State Machine implementing a sender behavior obeying this

specification.

8.4.3.2. Receiver Behavior

On receiving a SCHC Fragment with a RuleID and DTag pair not being

processed at that time:

\* the receiver SHOULD check if the DTag value has not recently been

used for that RuleID value, thereby ensuring that the received

SCHC Fragment is not a remnant of a prior fragmented SCHC Packet

transmission. The initial value of the Inactivity Timer is the

RECOMMENDED lifetime for the DTag value at the receiver. If the

SCHC Fragment is determined to be such a remnant, the receiver MAY

silently ignore it and discard it.

\* the receiver MUST start a process to assemble a new SCHC Packet

with that RuleID and DTag value pair. The receiver MUST start an

Inactivity Timer for that RuleID and DTag value pair. It MUST

initialize an Attempts counter to 0 for that RuleID and DTag value

pair. If the receiver is under-resourced to do this, it MUST

respond to the sender with a SCHC Receiver-Abort.

On reception of any SCHC F/R message for the RuleID and DTag pair

being processed, the receiver MUST reset the Inactivity Timer

pertaining to that RuleID and DTag pair.

All message receptions being discussed in the rest of this section

are to be understood as "matching the RuleID and DTag pair being

processed", even if not spelled out, for brevity.

On receiving a SCHC Fragment message, the receiver determines what

tiles were received, based on the payload length and on the W and FCN

fields of the SCHC Fragment.

\* if the FCN is All-1, if a Payload is present, the full SCHC

Fragment Payload MUST be assembled including the padding bits.

This is because the size of the last tile is not known by the

receiver; therefore, padding bits are indistinguishable from the

tile data bits, at this stage. They will be removed by the SCHC

C/D sublayer. If the size of the SCHC Fragment Payload exceeds or

equals the size of one regular tile plus the size of an L2 Word,

this SHOULD raise an error flag.

\* otherwise, tiles MUST be assembled based on the a priori known

tile size.

- If allowed by the Profile, the end of the payload MAY contain

the last tile, which may be shorter. Padding bits are

indistinguishable from the tile data bits, at this stage.

- The payload may contain the penultimate tile that, if allowed

by the Profile, MAY be exactly one L2 Word shorter than the

regular tile size.

- Otherwise, padding bits MUST be discarded. This is possible

because:

o the size of the tiles is known a priori,

o tiles are larger than an L2 Word, and

o padding bits are always strictly less than an L2 Word.

**On receiving an All-0 SCHC Fragment:**

**\* if the receiver knows of any windows with missing tiles for the**

**packet being reassembled (and if network conditions are known to be**

**conducive), it MAY return a SCHC Compound ACK for the missing**

**tiles, starting from the lowest-numbered window.**

On receiving a SCHC ACK REQ or an All-1 SCHC Fragment:

\* **if the receiver knows of any windows with missing tiles for the**

**packet being reassembled, it MUST return a SCHC ACK with the lowest-numbered such window:**

\* **if the receiver knows of any windows with missing tiles for the packet being reassembled, it MUST return a SCHC Compound ACK for the missing tiles, starting from the lowest-numbered window.**

\* otherwise:

- if it has received at least one tile, it MUST return a **SCHC ACK** **SCHC Compound ACK**

for the highest-numbered window it currently has tiles for,

- otherwise, it MUST return a **SCHC ACK** **SCHC Compound ACK** for window numbered 0.

A Profile MAY specify other times and circumstances at which a

receiver sends a **SCHC ACK** **SCHC Compound ACK**, and which window the **SCHC ACK** **SCHC Compound ACK** reports

about in these circumstances.

Upon sending a **SCHC ACK** **SCHC Compound ACK**, the receiver MUST increase the Attempts counter.

After receiving an All-1 SCHC Fragment, a receiver MUST check the

integrity of the reassembled SCHC Packet at least every time it

prepares for sending a **SCHC ACK** **SCHC Compound ACK** for the last window.

Upon receiving a SCHC Sender-Abort, the receiver MAY exit with an

error condition.

Upon expiration of the Inactivity Timer, the receiver MUST send a

SCHC Receiver-Abort, and it MAY exit with an error condition.

On the Attempts counter exceeding MAX\_ACK\_REQUESTS, the receiver MUST

send a SCHC Receiver-Abort, and it MAY exit with an error condition.

Reassembly of the SCHC Packet concludes when:

\* a Sender-Abort has been received, or

\* the Inactivity Timer has expired, or

\* the Attempts counter has exceeded MAX\_ACK\_REQUESTS, or

\* at least an All-1 SCHC Fragment has been received and integrity

checking of the reassembled SCHC Packet is successful.

See Figure 44 for one among several possible examples of a Finite

State Machine implementing a receiver behavior obeying this

specification. The example provided is meant to match the sender

Finite State Machine of Figure 43.