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SCHC Architecture for Process Stacking and Routing in Constrained Networks
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Abstract

This document specifies architectural guidelines for dynamically stacking and routing SCHC processes in constrained networks. It details how independent SCHC modules can be composed into processing chains that adapt to PDU attributes. For instance, SCHC Compression may trigger SCHC Fragmentation when the compressed PDU exceeds the L2 MTU, or alternatively, trigger SCHC Aggregation. For traffic that is not delay tolerant, a direct routing from SCHC Compression to SCHC Reliability Fragmentation is provided. Subsequent processing by SCHC FEC Fragmentation modules ensures robust error correction. This modular approach promotes scalability and flexibility within the SCHC framework.

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1. Introduction

RFC8724 defines the SCHC framework for compressing and fragmenting IPv6/UDP packets in low-power, constrained networks. While the specification addresses individual processes, many deployment scenarios require multiple SCHC processes to be chained based on the properties of the PDU. This document presents architectural guidelines to dynamically stack and route SCHC processes, enabling optimal handling of PDUs through configurable processing chains.

2. Architectural Overview

The proposed architecture is built upon two core principles:

* Modular Composition: Each SCHC process (e.g., Compression, Fragmentation, Aggregation) is an independent module with clearly defined interfaces for exchanging metadata such as PDU size, delay sensitivity, and error correction parameters.

* Dynamic Routing: A central Process Router evaluates incoming PDUs against operational criteria (e.g., PDU size relative to the L2 MTU, aggregation requirements, delay tolerance) and directs them through the appropriate processing chain.

This design ensures that the SCHC framework can be adapted in real time to diverse network conditions and application requirements.

3. Process Stacking and Routing Recommendation

Operators may configure SCHC processes in various sequences. Typical chains include:

* Compression and Fragmentation Chain:

  1. SCHC Compression reduces header overhead.

  2. If the compressed PDU exceeds the L2 MTU, the Process Router directs it to SCHC Fragmentation.

  3. Each fragment is then passed to SCHC FEC Fragmentation for error correction.

* Compression and Aggregation Chain:

  1. SCHC Compression is applied.

  2. If multiple small PDUs can be combined, the Process Router forwards the compressed output to SCHC Aggregation.

  3. SCHC Reliability Fragmentation is invoked to ensure reliable delivery.

  4. Finally, SCHC FEC Fragmentation is applied to the resulting fragments.

* Direct Reliability Chain for Non-Delay-Tolerant Traffic:

  1. SCHC Compression is executed on the PDU.

  2. For traffic that is not delay tolerant, the Process Router bypasses intermediate processing steps and directs the compressed PDU directly to SCHC Reliability Fragmentation.

  3. SCHC FEC Fragmentation is then applied to incorporate error correction.
     This streamlined path minimizes processing delay, catering to applications where latency is a critical parameter.

4. Schemas

4.1. Process Stacking Overview

```
       +---------------------+
       | SCHC Compression    |
       +---------------------+
                 |
                 v
         +----------------+
         | Decision Node | <-- Evaluates PDU size, delay tolerance, and aggregation requi
rement
         +----------------+
             /      |       \
            /       |         \
   (PDU > MTU)  (Aggregation)  (Non-Delay Tolerant)
          /              |                     \
         v               v                      v
+----------------------+  +-------------------+   +---------------------------------+
| SCHC Fragmentation  |  | SCHC Aggregation |   | SCHC Reliability Fragmentation|
+----------------------+  +-------------------+   +---------------------------------+
         |                         |                                    |
         v                         v                                    v
+----------------------+   +-------------------------------+   +--------------------------
--+
| SCHC FEC            |   | SCHC Reliability Fragmentation|   | SCHC FEC Fragmentation
   |
| Fragmentation       |   +-------------------------------+   +--------------------------
--+
+----------------------+             |
                                     v
                          +------------------------+
                          | SCHC FEC Fragmentation|
                          +------------------------+
```

Figure 1: Overview of SCHC Process Stacking and Routing

4.2. Detailed Routing Logic Schema

5. Operational Considerations

The architecture ensures:

* Interface Consistency: Standardized metadata exchange between modules (e.g., PDU size, delay tolerance, error correction parameters) ensures seamless handovers.

* Dynamic Adaptation: The Process Router can adjust routing decisions based on real-time network conditions, including MTU constraints and delay sensitivity.

* Scalability: The modular design allows additional SCHC processes to be integrated with minimal impact on existing chains.

6. Security Considerations

The modifications introduced by dynamic process stacking do not alter the fundamental security mechanisms of SCHC as defined in RFC8724. Implementations must protect the metadata exchanged between modules and ensure that the decision logic within the Process Router is resilient against unauthorized manipulation.

7. IANA Considerations

No IANA Considerations.

8. Examples and Use Cases

8.1. Example 1: Compression and Fragmentation

A compressed PDU that exceeds the L2 MTU is routed to SCHC Fragmentation. Each fragment is then processed by SCHC FEC Fragmentation to add error correction, ensuring reliable delivery despite potential losses.

8.2. Example 2: Compression and Aggregation

For scenarios requiring the combination of multiple small PDUs, SCHC Compression is followed by SCHC Aggregation. The aggregated output is then forwarded to SCHC Reliability Fragmentation to provide recovery capabilities, with SCHC FEC Fragmentation applied subsequently.

8.3. Example 3: Direct Path for Non-Delay-Tolerant Traffic

In applications with strict delay constraints, the processing chain is streamlined. After SCHC Compression, the Process Router directs non-delay-tolerant PDUs directly to SCHC Reliability Fragmentation, bypassing the aggregation and conventional fragmentation steps. SCHC FEC Fragmentation is then applied to incorporate error correction with minimal latency overhead.

```
+---------------------+
| SCHC Compression    |
+---------------------+
           |
           v
+-------------------------------+
| SCHC Reliability Fragmentation |
+-------------------------------+
           |
           v
+----------------------------+
| SCHC FEC Fragmentation      |
+----------------------------+
```

Figure 2: Direct Routing for Non-Delay-Tolerant Traffic

9. Normative References

[RFC8724] Minaburo, A., Toutain, L., Gomez, C., Barthel, D., and JC. Zuniga, "SCHC: Generic Framework for Static Context Header Compression and Fragmentation", RFC 8724, DOI 10.17487/RFC8724, April 2020, <https://www.rfc-editor.org/info/rfc8724>.

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