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SDCP: Streaming Distributed Control Protocol
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Abstract

This memorandum describes SDCP, a protocol to control multimedia streaming in cases where streaming generation should be distributed to improve performance. This is especially useful for Human-Things streams. Usually, real-time applications such as virtual reality generate a user-controlled multimedia streaming. This is a time-continuous data flux that could be divided spatially or temporally to distribute processing, memory or network resources. This protocol does not describe streaming communication, but the control of each single streaming generation in a best-effort by many nodes or things.

Status of This Memo

Copyright Notice

Table of Contents

1. Introduction

The amount of information transmitted from human-to-computer (H2C) is usually very small. This is the case of information generated by input devices, for example, keyboards, mouses or touch screens. Conversely, the amount of information transmitted from computer-to-human (C2H) is huge which is increasing over time. This is the case of information generated for output devices, such as computer monitors, mobile phone screens or virtual reality headsets. Furthermore, the hardware resources such as data processing, network bandwidth or storage are also considerable. H2C control data is required to generate C2H data, such as virtual reality and other applications. In this way, H2C control data may be sent to many nodes in multicast method by best-effort delivery and processing. The protocol has been implemented by [Perez-Monte14] [Perez-Monte16b] with good results and its has been descripted in detail by [Perez-Monte16].

Streaming Distributed Control Protocol (SDCP) is an application-level protocol for control of streaming distributed generation. SDCP is built over the User Datagram Protocol (UDP) [RFC0768] or the Lightweight User Datagram Protocol (UDP-Lite) [RFC3828], which provides a connection less deterministic transport mechanism. SDCP provides the complete information for suitable streaming distributed generation. Other mechanism have been specified to transmit multimedia streaming, including the Real Time Streaming Protocol (RTSP) [RFC2326]. The SDCP is not meant to displace this mechanism but rather complement it.

1.1. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

1.2. Terminology

Some clarifications and additional definitions follow:

- o Multimedia Streaming: It is a group of successive multimedia real-time data blocks over time. A real-time data block can be an audio level for multimedia audio streaming or a frame for multimedia video streaming. Successive blocks of multimedia streaming must be ordered in time.

- o Data Block (DB): Data portion of stream with the same shared time slot.

- o Spatial Data Segment (SDS): Spatial Data segment is subdivision or partition of each Data block to distributed generation. These fragments could be a piece of a render image.

- o Processor nodes: These nodes generate the multimedia streaming under a distributed scheme.

- o Administrator Node: This node controls multimedia streaming generation by periodically sending streaming control to the processor nodes.

- o Integrator node: This node receives multimedia streaming from Processor nodes to display this to a human receptor.

Integrator and Administrator nodes are the human-side and Processor nodes are the things-side of the communication system.

2. Distributed Scheme

Figure 1 shows scheme of a distributed stream generation system. Each processor node has processing, bandwidth or storing resources for partial stream generation.

```
+------------------------------------------------------------------+
|Remote Administrator Node                                          |
+------------------------------------------------------------------+
                               | Multicast SDCP data communication
                               V
+---------------++---------------++---------------++---------------+
|Local Proc Node||Local Proc Node||Local Proc Node||Local Proc Node|
+---------------++---------------++---------------++---------------+
                               ||Uncompressed stream communication
                               \/
+--------------------------------++--------------------------------+
| Local Integrator Node          || Local Integrator Node          |
+--------------------------------++--------------------------------+
                               ||Compressed stream communication
                               \/
+------------------------------------------------------------------+
| Remote Human Receptors                                           |
+------------------------------------------------------------------+
```

Distributed Scheme.

Figure 1

Administrator Node sends periodically SDCP multicast control datagrams to Processor Nodes. The use of multicast is mandatory to select processor group ID. The amount of SDCP datagrams should be sufficient to compensate losses and to allow real-time operation. These losses may occur by delivery problems or it could be ignored datagrams by processor nodes. Administrator Node MAY assign different Processor Node for processing each SDS.

Each unoccupied Processor Node receives SDCP datagrams. Occupied Processor Node SHOULD ignore SDCP datagrams. Each Processor Node generates stream portion through the use of more current SDCP control data. This generated stream is sent to an appropriate Integrator Node.

Integrator Node receives stream portion unicast communication. All the stream portion received are integrated in a single stream that is sent to remote human receptors or locally visualized.

Administrator Node MAY assign different destination Integrator Node for each SDS. Each Integrator node MAY receive multiple streams, a same DB or multiple/single SDS of multiple Processor Node. However, each SDS is assigned to only one Integrator node. While that different SDS of the same stream MAY be assigned to send these to different integrator nodes, each SDS of the same stream MUST NOT be sent to more than only one Integrator node.

3. SDCP Constant

TO DO

3.1. Multicast Addressing

TO DO

3.2. UDP Ports

TO DO

4. SDCP Format

Main SDCP format is shown in figure 2.

```
+-------------------+---------------------+--------+
| General DB Header | Specific SDS Header | Payload|
+-------------------+---------------------+--------+
```

SDCP Format.

Figure 2

- o General DB Header: 256-bits length field. This header is required and identifies fields from all the DB.
- o Specific SDS Header: Multiple of 128-bits, variable-length field. This header is optional and identifies fields from specific SDS. If this header is not present, all SDS of same DB SHOULD be treated equally.
- o Payload: Variable-length field. Stream Control Data.

4.1. General DB Header

DB Header is required.

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|control data type|M| RD  |    Stream Generation Source ID      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
|                        Timestamp (64 bits)                    |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           SDCP Counter                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           Var DB Counter                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             DB size                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             SDS size                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|               DB Type           |       Next Header Counter   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

DB Header Format.

Figure 3

Processor Node or Processor Node Group 64 bit ID is determined by multicast destination address of IP stack.

Control data type: 8-bit selector. Type of control streaming generation data. Types are defined in accordance with specific requirement of application. E.g. virtual reality, game or video streaming, drone controller application, etc.

Control data mode: 1-bit selector. Instant or Historical Mode.

0 - Instant Mode: The payload has the last control data configuration for the Processor Nodes, which means that the Administrator Node sends control data in a deterministic way with the last setup.

1 - Historical Mode: Administrator Node sends previous and actual control data to the processor nodes, in order to help them to generate the next streaming sequence.

RD: 3-bit selector. Reserved for future use.

Streaming Generation Source ID: 20-bit unsigned integer. Multimedia generation data source identification. It identifies the data source generating multimedia stream.

Timestamp: 64-bits unsigned fixed-point. It includes a 32-bit unsigned seconds field spanning 136 years and a 32-bit fraction field resolving 232 picoseconds such as RFC 5905 [RFC5905]. This 64-bit timestamp format is used in General DB header and payload.

SDCP Counter: 32-bit unsigned integer. Total number of SDCP datagrams sent.

Var DB Counter: 32-bit unsigned integer. Total number of SDCP datagrams sent with control data changes.

DB type: 16-bit unsigned integer.

DB size: 32-bit unsigned integer.

SDS size: 32-bit unsigned integer.

Next Header Counter: 16-bit unsigned integer. Number of Optional SDS Headers. Length of optional headers in 16-octet units.

4.2. Specific SDS Header

SDS header is optional. This header specifies SDS allocation to nodes. Two functions are defined. On the one hand, this header MAY determine which SDS data are assigned to generate by processor node. On the other hand, this header MAY determine which SDS data are assigned to send from processor node to integrator node. Each unique 64 bit id can identify a node, node group and node role or SDS data task or SDS data task group. The node roles are processor, integrator and administrator but others roles can be defined.

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
|                       SDS task ID (64 bits)                   |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
|                       Resource ID (64 bits)                   |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

SDS Header Format.

Figure 4

SDS task ID: 64-bit selector. It identifies individual SDS task or SDS group tasks for allocation to nodes. The tasks already assigned to a node can also assigned to other node by setting SDS task ID with its node ID.

Resource ID: 64-bit selector, identifies integrator or processor node from its interface identifier from IPv6 unicast destination address or identifies processor node group from its low-order 64 bits of an IPv6 multicast destination address such as IP Version 6 Addressing Architecture [RFC2373]. Allocated Processor Node MUST process all SDS assigned in SDS group ID and MUST NOT process SDS not assigned. Non-allocated Processor Node MAY process all SDS. SDS not assigned to any Integrator Node MUST be sent to Default Integrator Node. Similarly, SDS assigned more than one Integrator Node MUST be sent only to Default Integrator Node.

4.3. Payload

Payload data format is specified in control data type field of general header. This field determines in virtual reality applications variables such as camera positions, light positions, etc.

Two modes are supported.

Instant Mode: Last change control data is only sent.

Historical Mode: All changes control data are sent.

Types of control data: TO DO.

5. Identificators Format

TO DO

5.1. SDS index

TO DO

5.2. Node index

TO DO

6. Payload types

TO DO

7. Streaming considerations

TO DO

7.1. Streaming protocols

TO DO

8. Acknowledgements

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9. IANA Considerations

This memo includes no request to IANA.

10. Security Considerations

TO DO

11. References

11.1. Normative References

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