
**Information technology — Dynamic
adaptive streaming over HTTP
(DASH) —**

**Part 5:
Server and network assisted DASH
(SAND)**

*Technologies de l'information — Diffusion en flux adaptatif
dynamique sur HTTP (DASH) —*

Partie 5: DASH assisté par serveur et réseau (SAND)

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

A list of all parts in the ISO/IEC 23009 series can be found on the ISO website.

Introduction

In order to enhance the delivery of DASH content, this document introduces messages between DASH clients and network elements or between various network elements for the purpose of improving the efficiency of streaming sessions by providing information about real-time operational characteristics of networks, servers, proxies, caches, CDNs, as well as DASH client's performance and status.

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Information technology — Dynamic adaptive streaming over HTTP (DASH) —

Part 5: Server and network assisted DASH (SAND)

1 Scope

This document defines the following:

- the functional SAND architecture which identifies the SAND network elements and the nature of SAND messages exchanged among them;
- the semantics of SAND messages exchanged between the network elements present in the SAND architecture;
- an encoding scheme for the SAND messages;
- the SAND message delivery protocol.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 8601, *Data elements and interchange formats — Information interchange — Representation of dates and times*

ISO/IEC 23009-1:2014, *Information technology — Dynamic adaptive streaming over HTTP (DASH) — Part 1: Media presentation description and segment formats*

IETF RFC 3986, *Uniform Resource Identifier (URI): Generic Syntax*

IETF RFC 6455, *The WebSocket Protocol*

IETF RFC 7233:2014, *Hypertext Transfer Protocol (HTTP/1.1): Range Requests*

3 Terms, definitions, abbreviated terms and conventions

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 23009-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1.1

DASH Aware Network Element

DANE

network element which has at least minimum intelligence about DASH; for instance, it may be aware that the delivered objects are DASH-formatted objects such as the MPD or DASH segments, and may prioritize, parse or even modify such objects

3.1.2

SAND messages

messages exchanged between DASH clients, DASH aware Network Elements or Metrics Server in order to either enhance reception (PER) or delivery (PED) of DASH service, or to report status or metrics from the DASH client to DASH aware Network Elements or Metrics Server

3.2 Abbreviated terms

DANE	DASH aware network element
DASH	Dynamic Adaptive Streaming over HTTP
DM	DASH Metrics
HTTP	Hypertext Transfer Protocol
MPD	Media Presentation Description
PED	parameters enhancing delivery
PER	parameters enhancing reception
RNE	regular network element
SAND	server and network assisted DASH
TLS	transport layer security
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
URN	Uniform Resource Name
UTC	Coordinated Universal Time
UTF	unicode transformation format
UUID	universally unique identifier
XML	Extensible Mark-Up Language

3.3 Conventions

The following naming conventions apply in this document.

- Elements in an XML document are identified by an upper-case first letter and in bold face as **Element**. To express that an element **Element1** is contained in another element **Element2**, we may write **Element2.Element1**. If an element's name consists of two or more combined words, camel-casing is typically used, e.g. **ImportantElement**. Elements may be present either exactly once, or the minimum and maximum occurrence is defined by <minOccurs> ... <maxOccurs>.
- Attributes in an XML document are identified by a lower-case first letter, as well as they are preceded by a '@'-sign, e.g. @attribute. To point to a specific attribute @attribute contained

in an element **Element**, one may write **Element@attribute**. If an attribute's name consists of two or more combined words, camel-casing is typically used after the first word, e.g. `@veryImportantAttribute`. Attributes may have assigned a status in the XML as mandatory (M), optional (O), optional with default value (OD) and conditionally mandatory (CM).

- Namespace qualification of elements and attributes is used as per XML standards, in the form of **namespace:Element** or `@namespace:attribute`. The fully qualified namespace will be provided in the schema fragment associated with the declaration. External specifications extending the namespace of DASH are expected to document the element name in the semantic table with an extension namespace prefix.
- Variables defined in the context of this document are specifically highlighted with *italics*, e.g. *InternalVariable*.
- Structures that are defined as part of the hierarchical data model are identified by an upper-case first letter, e.g. Period, Adaptation Set, Representation, Segment, etc.
- The term “this clause” refers to the entire clause included within the same first heading number. The term “this subclause” refers to all text contained in the subclause with the lowest hierarchy heading.

4 Overview

In recent years, the Internet has become an important channel for the delivery of multimedia using HTTP as its primary protocol. In 2014, ISO/IEC published the second edition of MPEG Dynamic Adaptive Streaming over HTTP (DASH) as an International Standard that specified formats for the media presentation description (MPD), as well as ISO-BMFF and MPEG-2 TS based segments. DASH does not define a system or protocol, but is considered as an enabler for efficient and high-quality delivery of multimedia content over the Internet.

In order to enhance the delivery of DASH content, this document introduces messages between DASH clients and network elements or between various network elements for the purpose of improving efficiency of streaming sessions by providing information about real-time operational characteristics of networks, servers, proxies, caches, CDNs as well as DASH client's performance and status.

The Server and network assisted DASH (SAND) addresses the following:

- unidirectional/bidirectional, point-to-point/multipoint communication with and without session (management) between servers/CDNs and DASH clients;
- mechanisms for providing content-awareness and service-awareness towards the underlying protocol stack including server and/or network assistance;
- various impacts on elements of the existing Internet infrastructure such as servers, proxies, caches and CDNs;
- QoS and QoE support for DASH-based services;
- scalability in general and specifically for logging interfaces;
- analytics and monitoring of DASH-based services.

5 SAND reference architecture and interfaces

The SAND reference architecture is based on the following four broad categories of elements.

- a) DASH clients.

- b) Regular network elements (RNE), which are DASH unaware and treat DASH delivery objects as any other object, but are present on the path between origin server and DASH clients, e.g. transparent caches. Note that such regular network elements are not in the scope of this document.
- c) DASH aware network elements (DANE), which have at least minimum intelligence about DASH; for instance, they may be aware that the delivered objects are DASH-formatted objects such as the MPD or DASH segments, and may prioritize, parse or even modify such objects. More details on typical DANE functionalities are provided.
- d) Metrics server, which are DASH aware and are in charge of gathering metrics from DASH clients.

Based on these elements, the SAND reference architecture is defined as shown in [Figure 2](#). Within this architecture, the following four categories of messages, called SAND messages as shown in [Figure 1](#), are exchanged:

- Parameters Enhancing Delivery (PED) messages that are exchanged between DANEs;
- Parameters Enhancing Reception (PER) messages that are sent from DANEs to DASH clients;
- status messages that are sent from DASH clients to DANEs;
- metrics messages that are sent from DASH clients to Metrics servers.

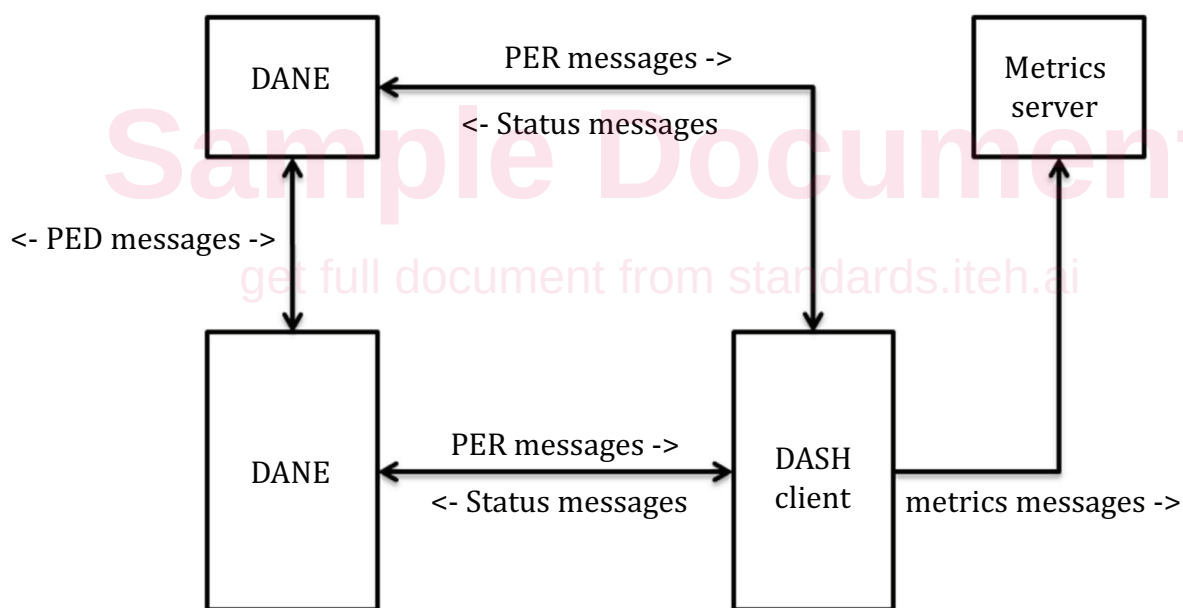


Figure 1 — SAND messages

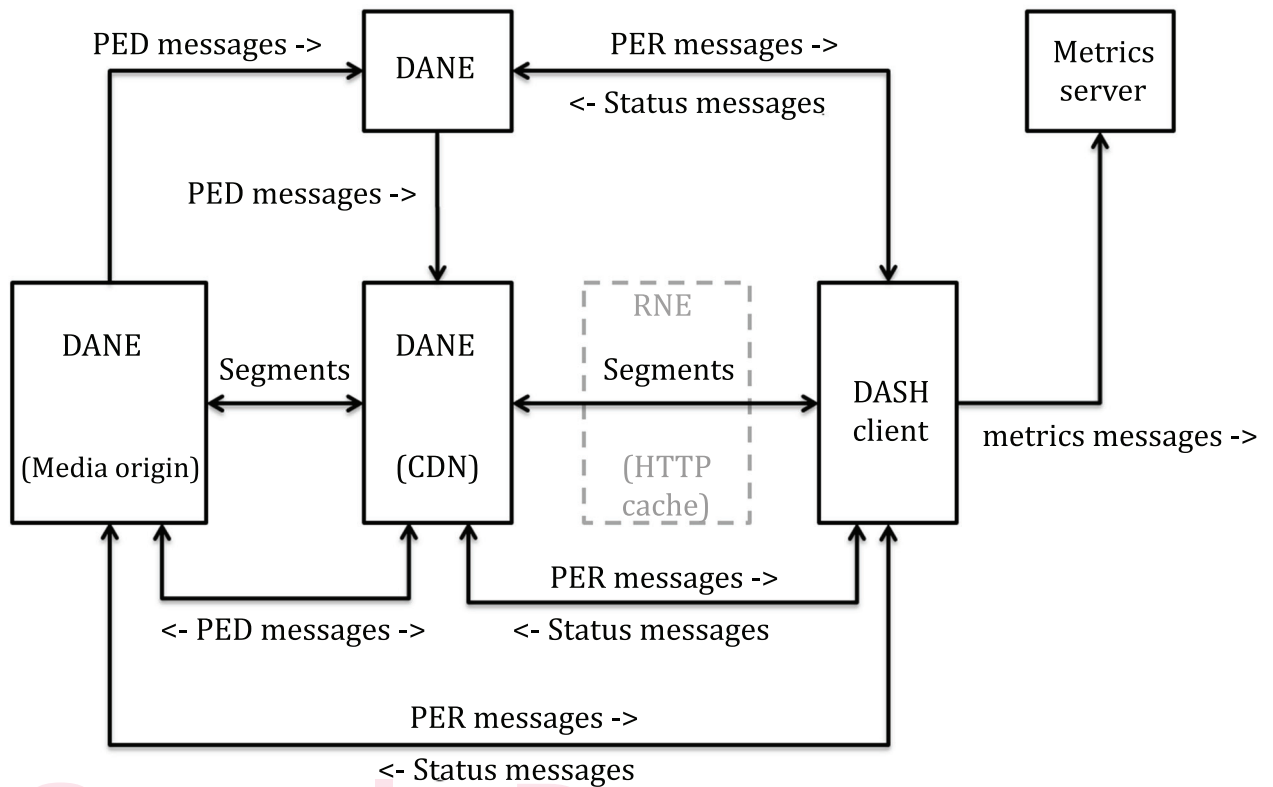


Figure 2 — SAND reference architecture

In this context, a media origin that serves DASH content may also receive status messages from the clients, send PED parameters to other DANEs, and is therefore also considered as a DANE element.

Similarly, a third-party server that may receive SAND status messages from DASH clients or send SAND PER messages to the clients is considered as a DANE element. Note that the third-party server may not necessarily be on the media delivery path and it may not see the DASH segments. However, as it may understand the SAND status messages or produce SAND PER messages to DASH clients, e.g to improve delivery efficiency, it is nevertheless considered as a DANE element.

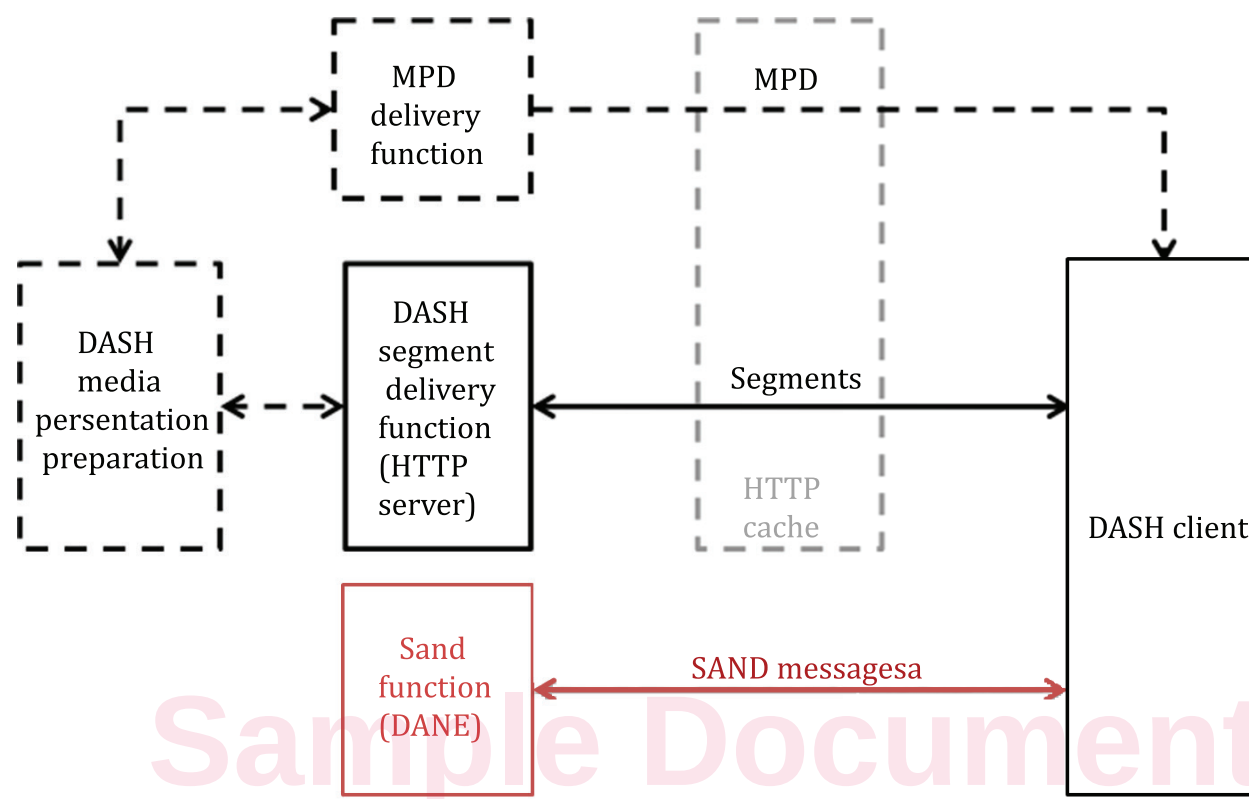
A DASH client may send two types of messages: metric messages carrying metric information and status messages carrying operational information. The metrics and status messages have a similar structure; however, it is important to distinguish them since these messages carry information of different nature. Whereas status message provide real-time feedback from the client to DANEs in order to support real-time operations, Metrics are provided as a summary of the session or at least longer time intervals of the session and are not considered provided in real-time.

Based on this terminology, the following interfaces are considered:

- Client-to-Metrics-server Interface: Carries metrics messages;
- Client-to-DANE Interface: Carries status messages;
- DANE-to-DANE Interface: Carries PED messages;
- DANE-to-Client Interface: Carries PER messages.

The implementation of the SAND architecture is neither mandatory nor necessary for successful DASH-based streaming operation. One may choose to implement a subset of the interfaces and messages defined in the SAND reference architecture.

ISO/IEC 23009-1 gives also an overview of a possible deployment architecture for DASH. In light of the SAND reference architecture above, [Figure 3](#) suggests a possible extension to it for a SAND-augmented DASH architecture.



Key

^a PER, metrics and status messages.

Figure 3 — SAND-augmented DASH architecture

In ISO/IEC 23009-1, the DASH client model consists of the DASH access engine, the Media engine and the Application. The DASH access engine operates at the interface with the network when it comes to receiving the MPD and the segments, even though the delivery of the MPD is out-of-scope of MPEG DASH as stated in ISO/IEC 23009-1:2014, 5.2.1. To support the interfaces in the SAND reference architecture, the DASH access engine becomes also responsible for the communication with the DANEs since the DANEs are network elements providing DASH-related information. [Figure 4](#) extends the original DASH Client model from ISO/IEC 23009-1 with the addition of a SAND channel to communicate with DANEs.

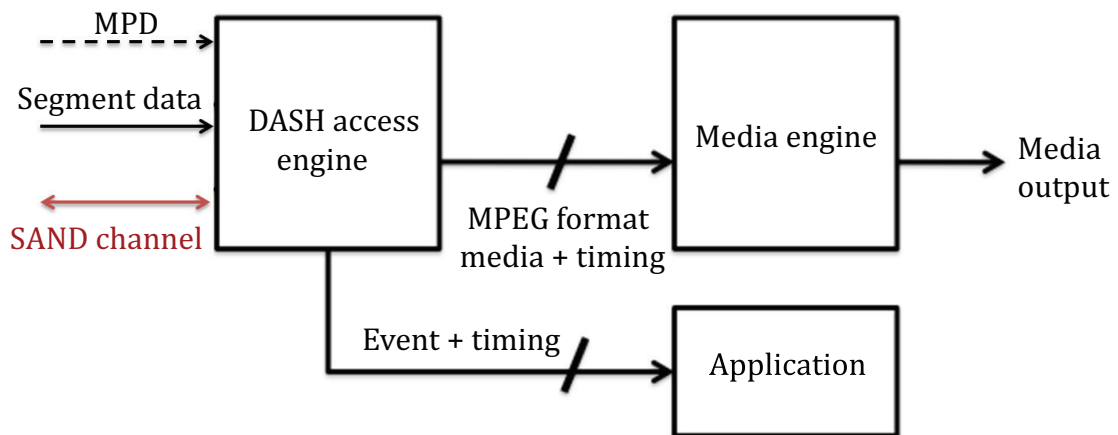


Figure 4 — SAND-augmented DASH Client model

6 SAND messages

6.1 General

This clause defines the SAND messages and their attributes. The format representation of SAND messages is XML and is defined in [Clause 7](#). SAND messages are XML documents for which the MIME type is defined in [Annex C](#).

SAND implementations may choose to support all or only a subset of the SAND messages defined here. Additionally, implementations may create their own messages by using their own XML namespace.

SAND elements (DANes and DASH clients) are expected to not send SAND messages when there is no entity in the network for using them.

6.2 Common Envelope for SAND messages

All SAND messages shall use the common envelope of [Table 1](#).

For better efficiency, the common envelope for SAND messages allows SAND messages aggregation within the same envelope. The envelope is the unit of data that is provided to the transport layer for sending SAND message.

All SAND messages have many parameters in common. Parameters which convey the same value for all messages included in a same envelope are attached to this common envelope for SAND messages. All messages also share common parameters that need to be assigned different values for each individual message in an envelope. [Table 1](#) defines these parameters and is implicitly included in all of the following message definitions.

Within this document, the date-time type indicated in the tables shall be represented as specified by ISO 8601.

Table 1 — SAND message common envelope

Parameter	Type	Cardinality	Description
CommonEnvelope		1	
senderId	token	0..1	If present, this is a unique identifier of the message sender. It is up to the sender to provide such a unique identifier.
generationTime	date-time	0..1	If present, this indicates the UTC time (format as specified by ISO 8601) at which the message was generated.

Table 1 (continued)

Parameter		Type	Cardinality	Description
SandMessage			1..N	
	messageId	int	0..1	This field allows receivers of SAND messages to discriminate between several messages sent from the same sender. Identification of the sender may be done thanks to the senderId information or other transport layer information if senderId is not present. Among messages with same sender and same messageType, message with highest messageId value shall take precedence over the others in case of any conflict between the information they convey. The maximum value for messageId is decided by senders and shall be high enough for receivers to easily identify which message shall take precedence even when messageId values have looped back to 0.
	validityTime	date-time	0..1	If present, this indicates the UTC time after which the validity of the message is not guaranteed anymore. If not present, validity of messages lasts until next message carrying conflicting information with same sender, same messageType and higher messageId is received.

Table 2 — messageType values

messageType	Message description
0	reserved
1	TCPConnections (6.3.2)
2	HTTPRequestResponseTransactions (6.3.3)
3	RepresentationSwitchEvents (6.3.4)
4	BufferLevel (6.3.5)
5	PlayList (6.3.6)
6	AnticipatedRequests (6.4.1)
7	SharedResourceAllocation (6.4.2)
8	AcceptedAlternatives (6.4.3)
9	AbsoluteDeadline (6.4.4)
10	MaxRTT (6.4.5)
11	NextAlternatives (6.4.6)
12	ClientCapabilities (6.4.7)
13	ResourceStatus (6.5.1)
14	DaneResourceStatus (6.5.2)
15	SharedResourceAssignment (0)
16	MPDValidityEndTime (6.5.4)
17	Throughput (6.5.5)
18	AvailabilityTimeOffset (6.5.6)
19	QoSInformation (6.5.7)
20	DeliveredAlternative (6.5.8)
21	DaneCapabilities (6.5.9)
22..127	reserved for future ISO use
128..255	reserved for private use

The type of SAND messages is uniquely identified thanks to a messageType value. Allowed values for this field are described in [Table 2](#). When using XML representation format, this field shall be represented by

the tag name of the message element. When using the HTTP header transport of [8.2.3](#), this field shall be represented as the header name.

6.3 Metrics messages

6.3.1 General

This subclause defines the XML format of the DASH metrics defined in ISO/IEC 23009-1:2014, Annex D. This enables the reporting of the DASH metrics over the SAND framework.

6.3.2 TCPConnections

6.3.2.1 Motivation

This metric collects information at the TCP level about HTTP request/response transactions.

6.3.2.2 Source and destination

```
Type      : Metrics
Sender    : DASH client
Receiver  : DANE
```

6.3.2.3 Data representation

See TCP connections in ISO/IEC 23009-1:2014, D.4.2 for the semantics.

6.3.3 HTTPRequestResponseTransactions

6.3.3.1 Motivation

This metric collects information about HTTP request/response transactions.

6.3.3.2 Source and destination

```
Type : Metrics
Sender : DASH client
Receiver : DANE
```

6.3.3.3 Data representation

See HTTP request/response transactions in ISO/IEC 23009-1:2014, D.4.3 for the semantics.

6.3.4 RepresentationSwitchEvents

6.3.4.1 Motivation

This metric collects information describing Representation switch events.