The Consultative Committee for Space Data Systems

Draft Recommendation for
Space Data System Standards

TC SPACE DATA LINK PROTOCOL

PROPOSED DRAFT RECOMMENDED STANDARD

CCSDS 232.0-P-3.0

PROPOSED PINK SHEETS

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2.1.2 PROTOCOL FEATURES

2.1.2.1 Efficient Data Transfer

The TC Space Data Link Protocol provides the users with several services to transfer service data units over a space link. The major functions performed by this protocol are (1) segmentation and blocking of service data units and (2) transmission control of service data units.

Because the underlying space link inherently includes a noisy signal path, there is a finite probability that it will introduce an error. It is desirable to break large service data units into relatively small pieces so that each piece has a lower probability of being invalidated by transmission error than if the entire service data unit were sent contiguously. System throughput efficiency is improved because only small pieces have to be retransmitted when errors are detected. However, there may also be situations in which the service data units are very small. For efficient transfer of service data units, it is desirable to group these small units into larger pieces. The TC Space Data Link Protocol provides the capability to break large service data units into relatively small pieces (segmentation) and to group small service data units into larger pieces (blocking).

The TC Space Data Link Protocol controls the transmission of service data units through the space link performing retransmissions needed to ensure delivery of service data units in sequence and without gaps or duplication. This function is provided by an automatic retransmission control mechanism called the Communications Operation Procedure (COP). The specification of the COP is given in reference [4]. In addition, ~~a~~the systematic retransmission mechanism decribed in 2.4.2 for use on deep space links can optionally be provided by the Synchronization and Channel Coding Sublayer as specified in reference [3].

2.1.2.2 Sharing the Physical Channel

The protocol data units employed by this protocol are the TC Transfer Frame (unless otherwise stated, the terms ‘Transfer Frame’ and ‘Frame’ in this document refer to the TC Transfer Frame) and the Communications Link Control Word (CLCW). Each Transfer Frame contains a header, which provides protocol control information, and a variable-length data field, within which higher-layer service data units are carried. Transfer Frames are sent in the direction of the flow of service data units. Each CLCW contains a report that describes the status of acceptance of Transfer Frames. CLCWs are sent from the receiver to the sender of Transfer Frames.

A key feature of the TC Space Data Link Protocol is the concept of ‘Virtual Channels’. The Virtual Channel facility allows one Physical Channel to be shared among multiple higher-layer data streams, each of which may have different service requirements. A single Physical Channel may therefore be divided into several separate logical data channels, each known as a ‘Virtual Channel’ (VC). Each Transfer Frame transferred over a Physical Channel belongs to one of the Virtual Channels of the Physical Channel.

2.2 OVERVIEW OF SERVICES

2.2.1 COMMON FEATURES OF SERVICES

The TC Space Data Link Protocol provides users with data transfer services. The point at which a service is provided by a protocol entity to a user is called a Service Access Point (SAP) (see reference [1]). Each service user is identified by a SAP address. ~~At a SAP, two ports may be provided, each of which is for one of the service types described in 2.2.2.~~

Service data units of the same type submitted to a SAP ~~(or a port if implemented)~~ are processed in the order of submission. No processing order is maintained for service data units submitted to different SAPs ~~(or ports)~~.

NOTE – Implementations may be required to perform flow control at a SAP ~~(or a port if present)~~ between the service user and the service provider. However, CCSDS does not make any recommendations for a scheme for flow control between the user and the provider.

The followings features are common to all the services defined by this Recommended Standard:

a) Unidirectional (one way) services: one end of a connection can send, but not receive, data through the space link, while the other end can receive, but not send.

b) Asynchronous services: there are no predefined timing rules for the transfer of service data units supplied by the service user or for the transmission of Transfer Frames generated by the service provider. The user may request data transfer at any time, but there may be restrictions imposed by the service provider on the data generation rate. The timing of data transfer is determined by the provider in accordance with mission-specific rules and may depend on the traffic at the time of transfer.

c) Sequence preserving services: the sequence of service data units supplied by the sending user is preserved through the transfer over the space link, although for the Expedited Service, described below, there may be gaps in the sequence of service data units delivered to the receiving user.

NOTE – This Recommended Standard assumes that these services are provided at the end points of a space link. However, this Recommended Standard makes no assumptions concerning how these end points are composed or configured either on-board a spacecraft or in a ground system. In a ground system, the services defined by this Recommended Standard may be extended or enhanced with Space Link Extension Services (reference [B5]).

2.2.2 SERVICE TYPES

2.2.2.1 Overview

The TC Space Data Link Protocol provides two service types (Sequence-Controlled and Expedited) that determine how reliably service data units supplied by the sending user are delivered to the receiving user.

Both of these two service types are provided at any Service Access Point except for the Virtual Channel Frame, Master Channel Frame, and COP Management Services. The user requests with a parameter of the service request primitive whether the Sequence-Controlled or Expedited Service Type should be applied to each service data unit. ~~Alternatively, the service provider may provide two separate ports (one for the Sequence-Controlled Service Type and the other for the Expedited Service Type) within a Service Access Point.~~

For the Virtual Channel Frame and Master Channel Frame Services, the service provider does not make any distinction between Sequence-Controlled and Expedited service types applicable to service data units supplied by the user. The user should perform necessary procedures to provide Sequence-Controlled and Expedited Service Types for its service data units.

2.2.2.2 Sequence-Controlled Service (Type-A Service)

The Sequence-Controlled Service (Type-A Service) utilizes an Automatic Repeat Request (ARQ) procedure of the 'go-back-*n*' type with sequence-control mechanisms at both sending and receiving ends and a standard report returned from the receiving end to the sending end.

For Type-A Service, service data units supplied by a sending user at a SAP are inserted into Transfer Frames (after MAP multiplexing when applicable) and transmitted on a Virtual Channel in the order in which they are presented at the SAP. The retransmission mechanism ensures with a high probability of success that:

a) no service data unit is lost;

b) no service data unit is duplicated;

c) no service data unit is delivered out of sequence.

The Type-A Service guarantees, with a high probability, complete in-sequence delivery of service data units supplied by a user on a single MAP or Virtual Channel. Because retransmission is performed independently on each Virtual Channel, there is no guarantee that Type-A service data units transmitted on separate Virtual Channels will be delivered to the receiving users in the order initially presented. Further, because MAP multiplexing is performed before the sequence-control mechanisms are applied, there is no guarantee that Type-A service data units transmitted on separate MAP Channels will be delivered to the receiving users in the order initially presented.

NOTE – Some implementations of this protocol may not distinguish service data units transferred with Type-A Service from service data units transferred with Type-B Service at the receiving end. In this case, if both Type-A Service and Type-B Service are used simultaneously on one MAP Channel, the receiving end may not be able to reconstruct service data units transferred with Type-A Service even though the ARQ procedure has been applied to them (because, for example, the Type-A Transfer Frames derived from a single service data unit may be interlaced, at the receiving end, with Type-B Transfer Frames derived from a different service data unit). For this implementation, the sending end should terminate any ongoing Type-A Service before starting a Type-B Service on the same Virtual Channel.

2.2.2.3 Expedited Service (Type-B Service)

The Expedited Service (Type-B Service) is normally used either in exceptional operational circumstances, typically during spacecraft recovery operations, or when a higher layer protocol provides a retransmission capability.

For Type-B Service, service data units supplied by the sending user are transmitted only once (i.e., no retransmission). There is no guarantee that all Type-B service data units are delivered to the receiving user.

NOTES

1 Although Type-B Service carries the name ‘Expedited’, it is neither a required method nor a faster method for sending urgent data to the receiving end. If the service provider is supporting a reliable Type-A Service, then Type-A Service should be used exclusively.

2 For frames carrying service data units on the Type-B Service (i.e., type BD frames), the TC Space Data Link Protocol does not use the systematic retransmission mechanism that is optionally provided by the Synchronization and Channel Coding Sublayer (see 2.4.2).

2.2.3 SUMMARY OF SERVICES

2.2.3.1 Overview

~~Seven~~Six data transfer services are provided by the TC Space Data Link Protocol. Two of them (MAP Packet and MAP Access) are provided for a MAP Channel. ~~Four~~Three of them (VC Packet, Virtual Channel Access, and Virtual Channel Frame~~, and COP Management~~) are provided for a Virtual Channel. One of them (Master Channel Frame) is provided for a Master Channel. In addition, the protocol provides a management service, the COP Management Service, which is used at the sending end to control the COP automatic retransmission procedure of a Virtual Channel.

Table 2-1 summarizes these services and shows their characteristics, the Service Data Units (SDUs) that they transfer, and the availability of SDLS security features. The optional SDLS protocol can provide security features for the SDUs transferred by some of the services:

– encryption, to provide confidentiality by hiding data content;

– authentication, to confirm the source and integrity of the data.

Table 2-1: Summary of Services Provided by TC Space Data Link Protocol

Service	Service Type	Service Data Unit	SAP Address	SDLS Security Features
MAP Packet (MAPP)	Type-A and Type-B	Packet	GMAP ID + Packet Version Number	All
Virtual Channel Packet (VCP)	Type-A and Type-B	Packet	GVCID + Packet Version Number	All
MAP Access (MAPA)	Type-A and Type-B	MAP_SDU	GMAP ID	All
Virtual Channel Access (VCA)	Type-A and Type-B	VCA_SDU	GVCID	All
Virtual Channel Frame (VCF)	N/A	Transfer Frame	GVCID	None
Master Channel Frame (MCF)	N/A	Transfer Frame	MCID	None
COP Management	N/A	N/A	GVCID	N/A

2.2.3.2 MAP Packet (MAPP) Service

The MAP Packet (MAPP) Service transfers a sequence of variable-length, delimited, octet-aligned service data units known as Packets across a space link on a specified MAP Channel. The Packets transferred by this service must have a Packet Version Number (PVN) authorized by CCSDS. PVNs presently authorized by CCSDS are defined in reference [5].

The service is unidirectional and asynchronous. Both Sequence-Controlled (Type-A) and Expedited (Type-B) service types are provided for the MAPP Service. The user requests with a parameter of the service request primitive whether Type-A or Type-B should be applied for each Packet~~ or uses one port for Type-A Packets and another port for Type-B Packets~~.

In the context of a given GMAP ID (i.e., a GVCID and a MAP ID), a user of this service is a protocol entity that sends or receives Packets with a single PVN. A user is identified with a PVN and a GMAP ID. Different users (i.e., Packets with different versions) can share a single MAP Channel, and if there are multiple users on a MAP Channel, the service provider multiplexes Packets of different versions to form a single stream of Packets to be transferred on that MAP Channel.

2.2.3.3 Virtual Channel Packet (VCP) Service

The Virtual Channel Packet (VCP) Service transfers a sequence of variable-length, delimited, octet-aligned service data units known as Packets across a space link on a specified Virtual Channel. The Packets transferred by this service must have a PVN authorized by CCSDS. PVNs presently authorized by CCSDS are defined in reference [5].

The service is unidirectional and asynchronous. Both Sequence-Controlled (Type-A) and Expedited (Type-B) service types are provided for the VCP Service. The user requests with a parameter of the service request primitive whether Type-A or Type-B should be applied for each Packet~~, or uses one port for Type-A Packets and another port for Type-B Packets~~.

Within the context of a given GVCID, a user of this service is a protocol entity that sends or receives Packets with a single PVN. A user is identified with a PVN and a GVCID. Different users (i.e., Packets with different versions) can share a single Virtual Channel, and if there are multiple users on a Virtual Channel, the service provider multiplexes Packets of different versions to form a single stream of Packets to be transferred on that Virtual Channel.

2.2.3.4 MAP Access (MAPA) Service

The MAP Access (MAPA) Service provides transfer of a sequence of privately formatted service data units of variable length across a space link. The length of the service data units transferred by this service is not constrained by the length of the Data Field of the Transfer Frame.

The service is unidirectional and asynchronous. Both Sequence-Controlled (Type-A) and Expedited (Type-B) service types are provided for the MAPA Service. The user requests

with a parameter of the service request primitive whether Type-A or Type-B should be applied for each service data unit~~, or uses one port for Type-A service data units and another port for Type-B service data units~~.

For a given service instance, only one user, identified with the GMAP ID (i.e., GVCID and MAP ID) of the MAP Channel, can use this service on a MAP Channel. Service data units from different users are not multiplexed together within one MAP Channel.

2.2.3.5 Virtual Channel Access (VCA) Service

The Virtual Channel Access (VCA) Service provides transfer of a sequence of privately formatted service data units of variable length across a space link. The length of the service data units transferred by this service can not exceed the maximum length of the Data Field of the Transfer Frame.

The service is unidirectional and asynchronous. Both Sequence-Controlled (Type-A) and Expedited (Type-B) service types are provided for the VCA Service. The user requests with a parameter of the service request primitive whether Type-A or Type-B should be applied for each service data unit~~, or uses one port for Type-A service data units and another port for Type-B service data units~~.

For a given service instance, only one user, identified with the GVCID of the Virtual Channel, can use this service on a Virtual Channel. Service data units from different users are not multiplexed together within one Virtual Channel.

2.2.3.6 Virtual Channel Frame (VCF) Service

The Virtual Channel Frame (VCF) Service provides transfer of a sequence of TC Transfer Frames, created by an independent protocol entity, on a Virtual Channel across a space link. The service does not guarantee completeness nor does it make any distinction between Sequence-Controlled and Expedited service types applicable to service data units supplied by the user. The user should perform necessary procedures to provide Sequence-Controlled and Expedited service types.

For a given service instance, only one user, identified with the GVCID of the Virtual Channel, can use this service on a Virtual Channel, and each VCF Service instance on a physical channel must utilize a unique GVCID value. Service data units from different users are not multiplexed together within one Virtual Channel.

The Virtual Channel Frame Service transfers the independently created TC Transfer Frames through a space link, possibly together with TC Transfer Frames identified by other GVCID values created by the service provider itself. This service is made available to trusted users who are certified during the design process to ensure that the independently created protocol data units do not violate the operational integrity of the space link. Moreover, transfer frames provided by the VCF service User are partially formatted TC Transfer Frames as defined in 3.2.5.

2.2.3.7 Master Channel Frame (MCF) Service

The Master Channel Frame (MCF) Service provides transfer of a sequence of TC Transfer Frames of a Master Channel, created by an independent protocol entity, across a space link. The service does not guarantee completeness nor does it make any distinction between Sequence-Controlled and Expedited service types applicable to service data units supplied by the user. The user should perform necessary procedures to provide Sequence-Controlled and Expedited service types.

For a given service instance, only one user, identified with the MCID of the Master Channel, can use this service on a Master Channel, and each MCF Service instance on a Physical Channel must utilize a unique MCID value. Service data units from different users are not multiplexed together within one Master Channel.

The Master Channel Frame Service transfers the independently created TC Transfer Frames through the space link, possibly together with TC Transfer Frames identified by other MCID values created by the service provider itself. This service is made available to trusted users who are certified during the design process to ensure that the independently created protocol data units do not violate the operational integrity of the space link. Moreover, transfer frames provided by the MCF service User are partially formatted TC Transfer Frames as defined in 3.2.5.

2.2.3.8 COP Management Service

The COP Management Service is used by a user at the sending end for managing the operations of the COP for a particular Virtual Channel. The user manages the operations of the COP by invoking Directives defined in reference [4]. The user is notified by the service provider of events associated with Directives and events that occur asynchronously with Directives.

A user of this service must be authorized to manage the COP for a particular Virtual Channel. For a given service instance, only one user, identified with the GVCID of the Virtual Channel, is allowed to use this service on a Virtual Channel.

2.2.4 RESTRICTIONS ON SERVICES

There are some restrictions on the services provided on a Physical Channel.

a) If the Master Channel Frame Service exists on a Master Channel, other data transfer services shall not exist simultaneously on that Master Channel.

b) If the Virtual Channel Frame Service exists on a Virtual Channel, other data transfer services shall not exist simultaneously on that Virtual Channel.

c) If the Virtual Channel Access Service exists on a Virtual Channel, other data transfer services shall not exist simultaneously on that Virtual Channel.

d) If the Virtual Channel Packet Service exists on a Virtual Channel, other data transfer services shall not exist simultaneously on that Virtual Channel.

e) On one MAP Channel, the MAP Access Service shall not exist simultaneously with the MAP Packet Service.

f) On one Virtual Channel, the COP Management Service shall not exist simultaneously with the Virtual Channel Frame Service.

g) The COP Management Service shall not exist simultaneously with the Master Channel Frame Service.

2.3 OVERVIEW OF FUNCTIONS

2.3.1 GENERAL FUNCTIONS

Using services of lower layers, the TC Space Data Link Protocol transfers various service data units, supplied by sending users, encapsulated in a sequence of protocol data units. The protocol data units, known as TC Transfer Frames, have variable lengths and are transferred over a Physical Channel asynchronously.

The protocol entity performs the following protocol functions:

a) generation and processing of protocol control information (i.e., headers and trailers) to perform data identification, loss detection, and error detection;

b) segmenting and blocking of service data units to transfer service data units of various sizes in protocol data units suitable for efficient transfer;

c) multiplexing/demultiplexing in order for various service users to share a single Physical Channel;

d) retransmission of missing protocol data units, rejection of out-of-sequence and duplicated protocol data units, and control of sequence-control mechanisms at sending and receiving ends to guarantee complete and in-order delivery (for Type-A Service only);

e) flow control (for Type-A Service only).

If the protocol entity supports the optional SDLS protocol, then it uses the functions of SDLS to apply the configured security features.

The protocol entity does not perform the following protocol functions:

a) connection establishment and release;

b) management or configuration of the SDLS protocol.

such errors or discontinuities introduced by the space link, the correctness, completeness, and sequentiality of the delivered service data units.

Correctness of the delivered service data units is guaranteed (within known error probabilities) by the error-protection encoding applied by the Channel Coding Sublayer, and by the Frame Validation Checks performed in this protocol. However, validation of the completeness, sequentiality, and non-duplication of the delivered service data units on a particular Virtual Channel requires that an accounting (i.e., numbering) scheme for Transfer Frames be implemented by the COP.

The COP controls transfer of Type-A Transfer Frames so that service data units within Type-A Transfer Frames are delivered to the receiving end of the layer above, correct and without omission or duplication, and in the same sequential order in which they were received from the layer above at the sending end.

~~Type-B Transfer Frames are processed by the COP only to the extent of causing~~The receipt of a Type-B Transfer Frame causes the FARM to increment a counter for Type-B Transfer Frames in the CLCW. Type-B Transfer Frames are also used to send Control Commands from the FOP to the FARM.

Only one COP, which is called COP-1, is defined in this Recommended Standard. The detailed specification of the COP-1 is given in reference [4].

CAUTION – The controlling specifications for the logical operations which must be executed to perform the COP-1 are contained in a more detailed CCSDS Recommended Standard (reference [4]). In the event of any conflict between the descriptive text contained in this Recommended Standard and the text of reference [4], the more detailed specifications contained in reference [4] are normative.

2.4 SERVICES ASSUMED FROM LOWER LAYERS

2.4.1 SERVICES ASSUMED FROM THE CHANNEL CODING SUBLAYER

As described in 2.1.1, the TC Synchronization and Channel Coding Recommended Standard (reference [3]) must be used with the TC Space Data Link Protocol as the Synchronization and Channel Coding Sublayer specification. The functions provided by the TC Synchronization and Channel Coding Recommended Standard are as follows:

a) error control encoding and decoding functions;

b) bit transition generation and removal functions (optional);

c) delimiting and synchronizing functions.

The Synchronization and Channel Coding Sublayer, then, transfers variable-length, delimited protocol data units as an intermittent stream of bits over a space link using the services of the underlying Physical Layer.

2.4.2 SYSTEMATIC RETRANSMISSIONS

In addition, the TC Space Data Link Protocol can request the Synchronization and Channel Coding Sublayer to perform systematic retransmissions of the data units submitted to it. The retransmissions can improve the efficiency of the protocol for deep space missions on links with long light time delays.

The definition of the service interface to the Synchronization and Channel Coding Sublayer specified in reference [3] includes the ChannelAccess.request service primitive, which has an optional Repetitions parameter. The sublayer transfers the data unit the number of times specified by Repetitions. If the value of Repetitions is one, or if the sublayer does not support the Repetitions parameter, then no systematic retransmissions are performed, and the data unit is transferred once.

The TC Space Data Link Protocol requests the systematic retransmissions in accordance with parameters set by management. For each Virtual Channel, management sets the value to be used for the Repetitions parameter when requesting the transfer of frames carrying service data units on the Type-A Service. For each Virtual Channel, management sets a similar parameter for frames carrying COP control commands (i.e., type BC frames). For a Physical Channel, management sets an upper limit for the value of the Repetitions parameter specified in reference [3].

When requesting the transfer of frames carrying service data units on the Type-B Service (i.e., type BD frames), the TC Space Data Link Protocol always sets the value of the Repetitions parameter to one (i.e., no systematic retransmissions).

2.4.3 PERFORMANCE REQUIREMENTS TO LOWER LAYERS

The coding options of the TC Synchronization and Channel Coding Recommended Standard and the performance of the RF link provided by the Physical Layer shall be chosen according to the following criteria:

a) the probability of misidentifying the MCID, VCID and MAP ID shall be less than a mission-specified value;

b) the probability of rejection of Transfer Frames by the Channel Coding Sublayer due to channel errors shall be less than a mission-specified value.

In order to assure correct decoding at the receiving end, the same coding options must be applied to all Transfer Frames of a Physical Channel.

3.2.2.3 If blocking of Packets is performed by the service provider, the position and length of the Packet Length Field of the Packets must be known to the service provider in order to extract Packets from Transfer Frames at the receiving end.

3.2.3 MAP CHANNEL ACCESS SERVICE DATA UNIT (MAP_SDU)

3.2.3.1 MAP Channel Access Service Data Units (MAP_SDUs) shall be transferred over a space link via the MAP Channel Access Service.

3.2.3.2 A single MAP_SDU may be transmitted in the Data Field of one or multiple Transfer Frame(s), and therefore the length of MAP_SDUs is not constrained by the length of the Data Field of the Transfer Frames.

NOTE – MAP_SDUs are variable-length, octet-aligned data units, the format of which is unknown to the service provider.

3.2.4 VIRTUAL CHANNEL ACCESS SERVICE DATA UNIT (VCA_SDU)

3.2.4.1 Virtual Channel Access Service Data Units (VCA_SDUs) shall be transferred over a space link via the Virtual Channel Access Service.

3.2.4.2 A single VCA_SDU shall be transmitted in the Data Field of a single Transfer Frame, and therefore the length of VCA_SDUs shall not exceed the maximum length of the Transfer Frame Data Field.

NOTE – VCA_SDUs are variable-length, delimited, octet-aligned data units, the format of which is unknown to the service provider.

3.2.5 TC TRANSFER FRAME

~~If it is present on the Physical Channel, the Frame Error Control Field of Transfer Frames submitted to the Virtual Channel Frame and Master Channel Frame Services shall be included and shall be set to 'all zeroes'.~~

3.2.5.1 TC Transfer Frames transferred by the Virtual Channel Frame and Master Channel Frame Services shall be partially formatted TC Transfer Frames

3.2.5.2 The Frame Error Control Field of the TC Transfer Frames submitted to the Master or Virtual Channel Frame Service shall be empty, if it is present on the Physical Channel.

NOTE – The TC Transfer Frame is the variable-length protocol data unit of the TC Space Data Link Protocol, but it can also be used as the service data unit of the Virtual Channel Frame and Master Channel Frame Services. Its format is defined in 4.1 and 6.3 of this Recommended Standard. ~~Transfer Frames submitted to the Virtual Channel Frame and Master Channel Frame Services are actually partially formatted TC Transfer Frames having 'empty' Frame Error Control Fields.~~

3.3 MAP PACKET SERVICE

3.3.1 OVERVIEW

The MAP Packet (MAPP) Service transfers a sequence of variable-length, delimited, octet-aligned service data units known as Packets across a space link on a specified MAP Channel. The Packets transferred by this service must be assigned a Packet Version Number (PVN) by CCSDS. Packet Version Numbers presently authorized by CCSDS are defined in reference [5].

The service is unidirectional and asynchronous. Both Sequence-Controlled (Type-A) and Expedited (Type-B) service types are provided for the MAPP Service. The user requests with a parameter of the service request primitive whether Type-A or Type-B should be applied for each Packet~~, or uses one port for Type-A Packets and another port for Type-B Packets~~.

A user of this service is a protocol entity identified with the PVN and a GMAP ID (i.e., a GVCID and a MAP ID) that sends or receives Packets with a single PVN. Different users (i.e., Packets with different versions) can share a single MAP Channel, and if there are multiple users on a MAP Channel, the service provider multiplexes Packets of different versions to form a single stream of Packets to be transferred on that MAP Channel.

3.3.2 MAPP SERVICE PARAMETERS

3.3.2.1 General

The parameters used by the MAPP Service primitives shall conform to the specifications of the following subsections.

3.3.2.2 Packet

The Packet parameter shall contain a Packet for transfer by the MAPP Service.

NOTE – The Packet parameter is the service data unit transferred by the MAPP Service. Restrictions on the Packets transferred by the MAPP Service are stated in 3.2.2.

3.3.2.3 GVCID

The GVCID parameter shall contain a GVCID that indicates the Virtual Channel through which the Packet is to be transferred.

NOTE – The GVCID consists of an MCID and a VCID and is part of the SAP address of the MAPP Service.

3.3.2.4 MAP ID

The MAP ID parameter shall contain a MAP ID that indicates the MAP Channel (within the Virtual Channel specified by the GVCID) through which the Packet is to be transferred.

NOTE – The MAP ID is part of the SAP address of the MAPP Service.

3.3.2.5 Packet Version Number

The Packet Version Number parameter shall contain the PVN of the Packet to be transferred.

NOTE – The PVN is part of the SAP address of the MAPP Service and identifies the upper-layer protocol entity that uses the MAPP Service.

3.3.2.6 SDU ID

The SDU ID parameter shall contain a user-supplied sequence number to be used to identify the associated Packet in subsequent MAPP_Notify.indication primitives.

3.3.2.7 Service Type

3.3.2.7.1 The Service Type parameter shall indicate whether the Packet should be transferred with the Sequence-Controlled Service type (Type-A) or the Expedited Service type (Type-B).

~~**3.3.2.7.2** When separate ports are provided for Type-A and Type-B Services (see 2.2.2), the Service Type parameter is not used.~~

3.3.2.7.2 At the receiving end, the Service Type parameter is not used.

3.3.2.8 Notification Type

In notifications to the user, the Notification Type parameter shall contain information about an event associated with the transfer of a Packet. The values taken by this parameter are defined in reference [4].

3.3.2.9 Packet Quality Indicator

The Packet Quality Indicator is an optional parameter that may be used to notify the user at the receiving end of the Packet Service whether the Packet delivered by the primitive is complete or partial. This parameter shall be used when the service provider is required to deliver incomplete Packets to the user at the receiving end.

3.3.3.2 MAPP.request

3.3.3.2.1 Function

At the sending end, the MAPP Service user shall pass a MAPP.request primitive to the service provider to request that a Packet be transferred to the user at the receiving end through the specified MAP Channel.

3.3.3.2.2 Semantics

The MAPP.request primitive shall provide parameters as follows:

MAPP.request	(Packet, GVCID, MAP ID, Packet Version Number, SDU ID, Service Type)

~~NOTE — When separate ports are provided for Type-A and Type-B Services, the Service Type parameter is not used in this primitive.~~

3.3.3.2.3 When Generated

The sending-end user shall generate a MAPP.request primitive when a Packet is ready to be transferred.

3.3.3.2.4 Effect On Receipt

Receipt of the MAPP.request primitive shall cause the service provider to transfer the Packet.

3.3.3.3 MAPP_Notify.indication

3.3.3.3.1 Function

At the sending end, the service provider shall pass a MAPP_Notify.indication primitive to the MAPP Service user to notify the user of an event associated with the transfer of a Packet.

3.3.3.3.2 Semantics

The MAPP_Notify.indication primitive shall provide parameters as follows:

MAPP_Notify.indication	(GVCID, MAP ID, Packet Version Number, SDU ID, Service Type, Notification Type)

~~NOTE — When separate ports are provided for Type-A and Type-B Services, the Service Type parameter is not used in this primitive.~~

3.3.3.3.3 When Generated

The sending-end service provider shall generate a MAPP_Notify.indication primitive in response to an event associated with the transfer of a Packet.

3.3.3.3.4 Effect On Receipt

The effect of receipt of the MAPP_Notify.indication primitive by the MAPP Service user is undefined.

3.4 VIRTUAL CHANNEL PACKET SERVICE

3.4.1 OVERVIEW

The Virtual Channel Packet (VCP) Service transfers a sequence of variable-length, delimited, octet-aligned service data units known as Packets across a space link on a specified Virtual Channel. The Packets transferred by this service must be assigned a Packet Version Number (PVN) by CCSDS. Packet Version Numbers presently authorized by CCSDS are defined in reference [5].

The service is unidirectional and asynchronous. Both Sequence-Controlled (Type-A) and Expedited (Type-B) service types are provided for the VCP Service. The user requests with a parameter of the service request primitive whether Type-A or Type-B should be applied for each Packet~~, or uses one port for Type-A Packets and another port for Type-B Packets~~.

A user of this service is a protocol entity identified with the PVN and a GVCID that sends or receives Packets with a single PVN. Different users (i.e., Packets with different versions) can share a single Virtual Channel, and if there are multiple users on a Virtual Channel, the service provider multiplexes Packets of different versions to form a single stream of Packets to be transferred on that Virtual Channel.

3.4.2 VCP SERVICE PARAMETERS

3.4.2.1 General

The parameters used by the VCP Service primitives shall conform to the specifications of the following subsections.

3.4.2.2 Packet

The Packet parameter shall contain a Packet for transfer on the Virtual Channel identified by GVCID.

NOTE – The Packet is the service data unit of the VCP Service. Restrictions on the Packets transferred by the VCP Service are stated in 3.2.2.

3.4.2.3 GVCID

The GVCID parameter shall contain a GVCID that indicates the Virtual Channel through which the Packet is to be transferred.

NOTE – The GVCID consists of an MCID and a VCID and is part of the SAP address of the VCP Service.

3.4.2.4 Packet Version Number

The Packet Version Number parameter shall contain the PVN of the Packet to be transferred.

NOTE – The PVN is part of the SAP address of the VCP Service and identifies the upper-layer protocol entity that uses the VCP Service.

3.4.2.5 SDU ID

The SDU ID parameter shall contain a user-supplied sequence number to be used to identify the associated Packet in subsequent VCP_Notify.indication primitives.

3.4.2.6 Service Type

3.4.2.6.1 The Service Type parameter shall indicate whether the Packet should be transferred with the Sequence-Controlled Service type (Type-A) or the Expedited Service type (Type-B).

~~**3.4.2.6.2** When separate ports are provided for Type-A and Type-B Services (see 2.2.2), the Service Type parameter is not used.~~

3.4.2.6.2 At the receiving end, the Service Type parameter is not used.

3.4.2.7 Notification Type

In notifications to the user, the Notification Type parameter shall contain information about an event associated with the transfer of a Packet. The values taken by this parameter are defined in reference [4].

3.4.2.8 Packet Quality Indicator

3.4.2.8.1 The Packet Quality Indicator shall indicate whether the Packet delivered by the service provider to the service user at the receiving end is complete or not.

3.4.2.8.2 This parameter shall be used only when the service provider is required to deliver incomplete Packets to the service user at the receiving end.

3.4.3.2 VCP.request

3.4.3.2.1 Function

At the sending end, the VCP Service user shall pass a VCP.request primitive to the service provider to request that a Packet be transferred to the user at the receiving end through the specified Virtual Channel.

3.4.3.2.2 Semantics

The VCP.request primitive shall provide parameters as follows:

VCP.request	(Packet, GVCID, Packet Version Number, SDU ID, Service Type)

~~NOTE — When separate ports are provided for Type-A and Type-B Services, the Service Type parameter is not used in this primitive.~~

3.4.3.2.3 When Generated

The sending-end user shall generate a VCP.request primitive when a Packet is ready to be transferred.

3.4.3.2.4 Effect On Receipt

Receipt of the VCP.request primitive shall cause the service provider to transfer the Packet.

3.4.3.3 VCP_Notify.indication

3.4.3.3.1 Function

At the sending end, the service provider shall pass a VCP_Notify.indication primitive to the VCP Service user to notify the user of an event associated with the transfer of a Packet.

3.4.3.3.2 Semantics

The VCP_Notify.indication primitive shall provide parameters as follows:

VCP_Notify.indication	(GVCID, Packet Version Number, SDU ID, Service Type, Notification Type)

~~NOTE — When separate ports are provided for Type-A and Type-B Services, the Service Type parameter is not used in this primitive.~~

3.4.3.3.3 When Generated

The sending-end service provider shall generate a VCP_Notify.indication primitive in response to an event associated with the transfer of a Packet.

3.4.3.3.4 Effect On Receipt

The effect of receipt of the VCP_Notify.indication primitive by the VCP Service user is undefined.

3.5 MAP ACCESS SERVICE

3.5.1 OVERVIEW

The MAP Access (MAPA) Service provides transfer of a sequence of privately formatted service data units of variable length across a space link. The length of the service data units transferred by this service is not constrained by the length of the Data Field of the Transfer Frame.

The service is unidirectional and asynchronous. Both Sequence-Controlled (Type-A) and Expedited (Type-B) service types are provided for the MAPA Service. The user requests with a parameter of the service request primitive whether Type-A or Type-B should be applied for each service data unit~~, or uses one port for Type-A service data units and another port for Type-B service data units~~.

Only one user, identified with the GMAP ID (i.e., GVCID and MAP ID) of the MAP Channel, can use this service on a MAP Channel. Service data units from different users are not multiplexed together within one MAP Channel.

3.5.2 MAPA SERVICE PARAMETERS

3.5.2.1 General

The parameters used by the MAPA Service primitives shall conform to the specifications of the following subsections.

3.5.2.2 MAP_SDU

The MAP_SDU parameter shall contain a MAP_SDU to be transferred over the MAP channel identified by MAP ID.

NOTE – The MAP_SDU is the service data unit transferred by the MAPA Service. Restrictions on the MAP_SDUs transferred by the MAPA Service are stated in 3.2.3.

3.5.2.3 GVCID

The GVCID parameter shall contain the GVCID of the Virtual Channel through which the MAP_SDU is to be transferred.

NOTE – The GVCID consists of an MCID and a VCID and is part of the SAP address of the MAPA Service.

3.5.2.4 MAP ID

The MAP ID parameter shall contain the MAP ID of the MAP Channel (within the Virtual Channel specified by GVCID) through which the MAP_SDU is to be transferred.

NOTE – The MAP ID is part of the SAP address of the MAPA Service.

3.5.2.5 SDU ID

The SDU ID parameter shall contain a user-supplied sequence number to be used to identify the associated MAP_SDU in subsequent MAPA_Notify.indication primitive.

3.5.2.6 Service Type

3.5.2.6.1 The Service Type parameter shall indicate whether the MAP_SDU should be transferred with the Sequence-Controlled Service type (Type-A) or the Expedited Service type (Type-B).

~~**3.5.2.6.2** When separate ports are provided for Type-A and Type-B Services (see 2.2.2), the Service Type parameter is not used.~~

3.5.2.6.2 At the receiving end, the Service Type parameter is not used.

3.5.2.7 Notification Type

In notifications to the user, the Notification Type parameter shall contain information about an event associated with the transfer of a MAP_SDU. The values taken by this parameter are defined in reference [4].

3.5.2.8 Verification Status Code

3.5.2.8.1 The Verification Status Code is an optional parameter that may be used if the service provider supports the optional SDLS protocol.

3.5.2.8.2 The Verification Status Code parameter shall be used to notify the user at the receiving end of the MAPA Service of a verification failure in a transfer frame addressed to the MAP.

3.5.2.8.3 A non-zero value shall indicate that the SDLS protocol has detected an error: the values taken by this parameter are defined in reference [7].

NOTE – A non-zero value of the Verification Status Code does not indicate an error in the delivered MAP_SDU. Processing of frames failing verification is implementation specific and depends also on the processing capabilities of the service user for eventual forensic investigation.

3.5.3 MAPA SERVICE PRIMITIVES

3.5.3.1 General

The service primitives associated with this service are:

a) MAPA.request;

b) MAPA_Notify.indication;

c) MAPA.indication.

3.5.3.2 MAPA.request

3.5.3.2.1 Function

At the sending end, the MAPA Service user shall pass a MAPA.request primitive to the service provider to request that a MAP_SDU be transferred to the user at the receiving end through the specified MAP Channel.

NOTE – The MAPA.request primitive is the service request primitive for the MAPA Service.

3.5.3.2.2 Semantics

The MAPA.request primitive shall provide parameters as follows:

MAPA.request	(MAP_SDU, GVCID, MAP ID, SDU ID, Service Type)

~~NOTE – When separate ports are provided for Type-A and Type-B Services, the Service Type parameter is not used in this primitive.~~

3.5.3.2.3 When Generated

The sending-end service user shall generate a MAPA.request primitive when a MAP_SDU is ready to be transferred.

3.5.3.2.4 Effect On Receipt

Receipt of the MAPA.request primitive shall cause the service provider to transfer the MAP_SDU.

3.5.3.3 MAPA_Notify.indication

3.5.3.3.1 Function

At the sending end, the service provider shall pass a MAPA_Notify.indication primitive to the MAPA Service user to notify the user of an event associated with the transfer of a MAP_SDU.

3.5.3.3.2 Semantics

The MAPA.indication primitive shall provide parameters as follows:

MAPA_Notify.indication	(GVCID, MAP ID, SDU ID, Service Type, Notification Type)

~~NOTE — When separate ports are provided for Type-A and Type-B Services, the Service Type parameter is not used in this primitive.~~

3.5.3.3.3 When Generated

The sending-end service provider shall generate a MAPA_Notify.indication primitive in response to an event associated with the transfer of a MAP_SDU.

3.5.3.3.4 Effect On Receipt

The effect of receipt of the MAPA_Notify.indication primitive by the MAPA Service user is undefined.

3.6 VIRTUAL CHANNEL ACCESS SERVICE

3.6.1 OVERVIEW

The Virtual Channel Access (VCA) Service provides transfer of a sequence of privately formatted service data units of variable length across a space link. The length of the service data units transferred by this service should not exceed the maximum length of the Data Field of the Transfer Frame.

The service is unidirectional and asynchronous. Both Sequence-Controlled (Type-A) and Expedited (Type-B) service types are provided for the VCA Service. The user requests with a parameter of the service request primitive whether Type-A or Type-B should be applied for each service data unit~~, or uses one port for Type-A service data units and another port for Type-B service data units~~.

Only one user, identified with the GVCID of the Virtual Channel, can use this service on a Virtual Channel. Service data units from different users are not multiplexed together within one Virtual Channel.

3.6.2 VCA SERVICE PARAMETERS

3.6.2.1 General

The parameters used by the VCA Service primitives shall conform to the specifications of the following subsections.

3.6.2.2 VCA_SDU

The VCA_SDU parameter shall contain a VCA_SDU to be transferred on the Virtual Channel identified by GVCID.

NOTE – The VCA_SDU is the service data unit transferred by the VCA Service. Restrictions on the VCA_SDUs transferred by the VCA Service are stated in 3.2.4.

3.6.2.3 GVCID

The GVCID parameter shall contain the GVCID of the Virtual Channel through which the VCA_SDU is to be transferred.

NOTE – The GVCID consists of an MCID and a VCID and is the SAP address of the VCA Service.

3.6.2.4 SDU ID

The SDU ID parameter shall contain a user-supplied sequence number to be used to identify the associated VCA_SDU in subsequent VCA_Notify.indication primitives.

3.6.2.5 Service Type

3.6.2.5.1 The Service Type parameter shall be used to indicate whether the VCA_SDU should be transferred with the Sequence-Controlled Service type (Type-A) or the Expedited Service type (Type-B).

~~**3.6.2.5.2** When separate ports are provided for Type-A and Type-B Services (see 2.2.2), the Service Type parameter is not used.~~

3.6.2.5.2 At the receiving end, the Service Type parameter is not used.

3.6.2.6 Notification Type

In notifications to the user, the Notification Type parameter shall contain information about an event associated with the transfer of a VCA_SDU. The values taken by this parameter are defined in reference [4].

3.6.2.7 Verification Status Code

3.6.2.7.1 The Verification Status Code is an optional parameter that may be used if the service provider supports the optional SDLS protocol.

3.6.2.7.2 The Verification Status Code parameter shall be used to notify the user at the receiving end of the VCA Service of a verification failure in a transfer frame addressed to the Virtual Channel.

3.6.2.7.3 A non-zero value shall indicate that the SDLS protocol has detected an error: the values taken by this parameter are defined in reference [7].

NOTE - A non-zero value of the Verification Status Code does not indicate an error in the delivered VCA_SDU. Processing of frames failing verification is implementation specific and depends also on the processing capabilities of the service user for eventual forensic investigation.

3.6.3 VCA SERVICE PRIMITIVES

3.6.3.1 General

The service primitives associated with this service are:

a) VCA.request;

b) VCA_Notify.indication;

c) VCA.indication.

3.6.3.2 VCA.request

3.6.3.2.1 Function

At the sending end, the VCA Service user shall pass a VCA.request primitive to the service provider to request that a VCA_SDU be transferred to the user at the receiving end through the specified Virtual Channel.

NOTE – The VCA.request primitive is the service request primitive for the VCA Service.

3.6.3.2.2 Semantics

The VCA.request primitive shall provide parameters as follows:

VCA.request	(VCA_SDU, GVCID, SDU ID, Service Type)

~~NOTE — When separate ports are provided for Type-A and Type-B Services, the Service Type parameter is not used in this primitive.~~

3.6.3.2.3 When Generated

The VCA service user shall generate a VCA.request primitive when a VCA_SDU is ready for transfer.

3.6.3.2.4 Effect On Receipt

Receipt of the VCA.request primitive shall cause the service provider to transfer the VCA_SDU.

3.6.3.3 VCA_Notify.indication

3.6.3.3.1 Function

At the sending end, the service provider shall pass a VCA_Notify.indication primitive to the VCA Service user to notify the user of an event associated with the transfer of a VCA_SDU.

3.6.3.3.2 Semantics

The VCA.indication primitive shall provide parameters as follows:

VCA_Notify.indication	(GVCID, SDU ID, Service Type, Notification Type)

~~NOTE — When separate ports are provided for Type-A and Type-B Services, the Service Type parameter is not used in this primitive.~~

3.6.3.3.3 When Generated

The service provider shall generate a VCA_Notify.indication primitive in response to an event associated with the transfer of a VCA_SDU.

3.6.3.3.4 Effect On Receipt

The effect of receipt of the VCA_Notify.indication primitive by the VCA Service user is undefined.

3.9 COP MANAGEMENT SERVICE

3.9.1 OVERVIEW

The COP Management Service is used by a user at the sending end for managing the operations of COP for a particular Virtual Channel. The user manages the operations of COP by invoking Directives defined in reference [4]. The user is notified by the service provider of events associated with Directives and events that occur asynchronously with Directives.

A user of this service must be authorized to manage COP for a particular Virtual Channel. Only one user, identified with the GVCID of the Virtual Channel, is allowed to use this service on a Virtual Channel.

3.9.2 COP MANAGEMENT SERVICE PARAMETERS

3.9.2.1 General

The parameters used by the COP Management Service primitives shall conform to the specifications of the following subsections.

3.9.2.2 GVCID

The GVCID parameter shall contain the GVCID of the Virtual Channel for which the COP is managed.

NOTE – The GVCID consists of an MCID and a VCID and is the SAP address of the COP Management Service.

3.9.2.3 Directive ID

The Directive ID parameter shall contain a user-supplied sequence number to be used to identify the associated Directive.request primitive in subsequent Directive_Notify.indication primitives.

3.9.2.4 Directive Type

The Directive Type parameter shall contain the type of Directive. The values taken by this parameter are defined in table 4-1 of reference [4].

3.9.2.5 Directive Qualifier

The Directive Qualifier parameter shall contain a qualifier of the Directive if one is required. The values taken by this parameter are defined in table 4-1 of reference [4].

3.9.3.2 Directive.request

3.9.3.2.1 Function

At the sending end, the authorized user shall pass a Directive.request primitive to the service provider to invoke a Directive defined in reference [4].

3.9.3.2.2 Semantics

The Directive.request primitive shall provide parameters as follows:

Directive.request	(GVCID, Directive ID, Directive Type, Directive Qualifier)

3.9.3.2.3 When Generated

The authorized user shall generate a Directive.request primitive when execution of a Directive is required.

3.9.3.2.4 Effect On Receipt

Receipt of the Directive.request primitive shall cause the service provider to execute the Directive.

NOTE – Most of the directives only cause internal processing in the FOP, while two of them cause the generation of Type-BC Transfer Frames, carrying Control Commands for configuring COP-1 (‘Unlock’ and ‘Set V(R)’) (see 4.1.3.3).

4.2 PROTOCOL DATA UNIT (CLCW)

4.2.1 COMMUNICATIONS LINK CONTROL WORD

4.2.1.1 General

4.2.1.1.1 The Communications Link Control Word (CLCW), which is the protocol data unit transmitted from the receiving end to the sending end, shall provide the mechanism by which the FARM at the receiving end reports the status of frame acceptance to the Frame Operation Procedure (FOP) at the sending end.

NOTES

1 The controlling specification for how the CLCW is used within the COP is contained in reference [4].

2 CLCWs are usually carried in the Operational Control Field of TM or AOS Transfer Frames (references [B6] and [B7]) using the MC_OCF or VC_OCF Service. This Recommended Standard does not specify the interfaces and methods by which CLCWs are delivered to the FOP by those services.

3 The CLCW is the only reporting mechanism for this protocol. Although it is not necessary that the CLCW reporting rate (from the receiving end to the sending end) match the Transfer Frame transfer rate (from the sending end to the receiving end), some minimum CLCW sampling rate is necessary for the proper operation of the COP.

4.2.1.1.2 The CLCW shall consist of ten fields, positioned contiguously, in the following sequence:

a) Control Word Type (1 bit, mandatory);

b) CLCW Version Number (2 bits, mandatory);

c) Status Field (3 bits, mandatory);

d) COP in Effect (2 bits, mandatory);

e) Virtual Channel Identification (6 bits, mandatory);

f) Reserved Spare (2 bits, mandatory);

g) Flags (5 bits, mandatory);

h) FARM-B Counter (2 bits, mandatory);

i) Reserved Spare (1 bit, mandatory);

j) Report Value (8 bits, mandatory).

NOTE – The structural components of the CLCW are shown in figure 4-6.

4.3.5 VIRTUAL CHANNEL GENERATION FUNCTION

NOTE – The Virtual Channel Generation Function is the 'heart' of this protocol. It builds Transfer Frames and performs most of the operations required to move service data units reliably from the sending end to the receiving end of the protocol. There is an instance of the Virtual Channel Generation Function for each Virtual Channel.

4.3.5.1 The Virtual Channel Generation Function shall perform the following two procedures in the following order:

a) the Frame Operation Procedure (FOP), which is a sub-procedure of the Communications Operation Procedure (COP); and

b) the Frame Generation Procedure ~~in this order~~.

4.3.5.2 The FOP shall accept Frame Data Units (FDUs) from the MAP Multiplexing Function, the VC Packet Processing Function, or a VCA Service User (one VCA_SDU is treated as one FDU) and shall control transmission and retransmission of FDUs by examining the report contained in the CLCWs and generating Control Commands.

4.3.5.3 The FOP shall also accept Directives from a COP Management Service User.

NOTE – The detailed specification of the FOP is given in reference [4].

4.3.5.4 The Frame Generation Procedure shall generate Transfer Frames by attaching a Transfer Frame Primary Header to each Frame Data Unit or Control Command delivered by the FOP.

NOTES

1 The Frame Generation Procedure generates the Transfer Frame Primary Header using also parameters (values) supplied by the FOP: Bypass Flag, Control Command Flag, and Frame Sequence Number.

2 An abstract model of the Virtual Channel Generation Function is illustrated in figure 4-15.

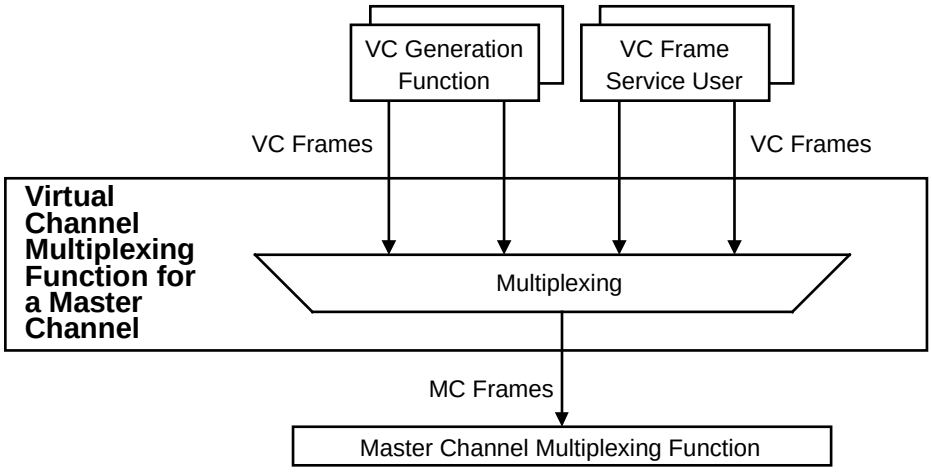

Figure 4-16: Abstract Model of Virtual Channel Multiplexing Function

4.3.7 MASTER CHANNEL MULTIPLEXING FUNCTION

4.3.7.1 The Master Channel Multiplexing Function shall be used to multiplex Transfer Frames from different Master Channels on a Physical Channel.

NOTE – There is an instance of the Master Channel Multiplexing Function for each Physical Channel that has multiple Master Channels.

4.3.7.2 The Master Channel Multiplexing Function shall multiplex Transfer Frames received from the instances of the ~~Master Channel Generation~~Virtual Channel Multiplexing Function and, if present, the Master Channel Frame Service users, and shall put them into a queue of Transfer Frames in an appropriate order set by management.

4.3.7.3 The algorithm to be used to order the Transfer Frames is not specified by CCSDS, but shall be defined by project organizations considering factors such as priority, release rate, isochronous timing requirements, etc.

NOTE – An abstract model of the Master Channel Multiplexing Function is illustrated in figure 4-17.

~~**4.4.5.2** The FARM shall examine the Primary Header of the incoming Transfer Frames, perform Frame Acceptance Checks against Type-A Transfer Frames, execute Control Commands, and generate some parameters to be transferred back to the sending end with CLCWs.~~

4.4.5.2 The FARM shall examine the Primary Header of the incoming Transfer Frames in order to

a) perform Frame Acceptance Checks against Type-AD Transfer Frames;

b) execute Control Commands whenType-BC Transfer Frames are received; and

c) generate some parameters to be transferred back to the sending end with CLCWs.

4.4.5.3 Frame Data Units extracted from Type-AD Transfer Frames shall be delivered to their users (or Functions) only if they have passed the Frame Acceptance Checks.

4.4.5.4 Frame Data Units extracted from Type-BD Transfer Frames shall be delivered to their users (or Functions) immediately.

NOTES

1 The detailed specification of the FARM is given in reference [4].

2 An abstract model of the Virtual Channel Reception Function is illustrated in figure 4-24.

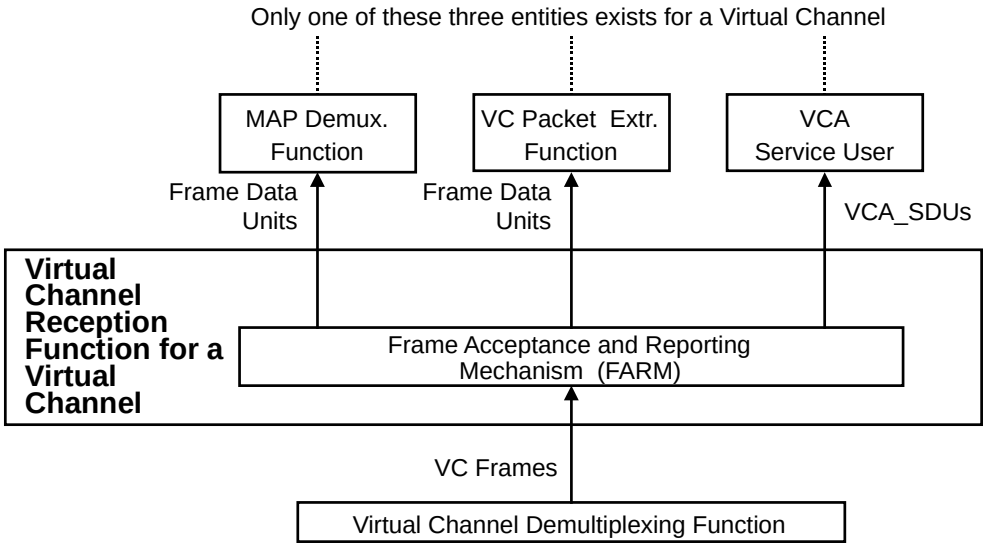

Figure 4-24: Abstract Model of Virtual Channel Reception Function