SKA1 CSP Mid Correlator and Beamformer to Mid PSS Interface Control Document

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DOCUMENT HISTORY

Issue	Date	ECN	Change Description
A	2014-02-03		First draft
B	2014-03-31		Renamed 'Interface Control Document Mid Correlator & Central Beamformer to Mid Pulsar Search Engine'; Updated to reflect inclusion of Mid Beamformer as separate sub-element
C	2014-04-11		Changed back to 'Mid Correlator & Beamformer to Mid PSS/PST ICD' to reflect combined Mid Correlator & Beamformer sub-element. Add' Interface Requirements' section and renamed 'Interface Specifications by class' section as 'Interface Implementation'
D	2014-04-23		Split into separate ICDs for PSS and PST
E	2014-06-30		70% completion of ICD
F	2014-10-16		Addressed review comments from Rev E Compute node IP and MAC addresses configuration can be downloaded
G	2014-10-28		75% for PDR (as planned)
H	2015-06-29		CSP-PDR-OAR-133: All requirements changed to indication PSS rather than PST CSP-PDR-OAR-134: Changed length of metadata to 32 bytes CSP-PDR-OAR-136: Added statement after Figure 6.1 indicating that Mid.CBF owns cabling. CSP-PDR-OAR-137: Updated CBFPSS 6.1.1.1.5 to indicate maximum cable length is 100m. Updated Acronym List Updated Section 4, 5, 6, 7, 8.3 and Appendix A to reflect interface changes discussed with MID.PSS Team.
1	2015-12-14		Significant interface change due to Mid.CBF move to Architecture B. Added section discussing Mid.PSS redundancy.
1A	2016-11-16		Updated as per Low as discussed at SKA Engineering Meeting, Stellenbosch
2	2016-11-30		Release for TIM#5 submission
2A	2017-10-16		Update for 3 beams per node PSS

Issue	Date	ECN	Change Description
			design with no redundant nodes
2B	2017-10-27		Changes to metadata to address comments from Mid.CBF
2C	2017-11-10		Changes to metadata to address further comments from Mid.CBF
2D	2017-11-27	6.2, 7.2, 8.3	Added requirement LCBFPSS6.2.13 to explicitly define epoch for timestamp; more clearly defined what attributes are configured by LMC
3	2017-12-04		ECP-CSP-160004, ECP-CSP-170002, ECP-CSP-170004, ECP-CSP-170007: takes account of Level 2 Rev 5 CDR baseleine specifications ECP-170014: Addresses option A, reduction from 750 to 500 PSS nodes CDR Release
3A	2018-10-18	6.1, 6.1.2, 6.2, Table 7-1	Addresses CDR OARs: OAR-CSP-Se7fc-001 and OAR-CSP-SE7c-002. For consistency data rate calculations are included as per Low CBF to PSS ICD OAR OAR-CSP-SE7f-003.
4	2018-10-22		CSP Closeout Submission

DOCUMENT SOFTWARE

Application		Version	Filename
Word-processing	MS Word 2010		311-000000-009_4_MidCBFtoPSS_ICD_MacIntosh_2018-10-22.docx

ORGANISATION DETAILS

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[1] The "Responsible Organisation" is responsible for ensuring that the IP Declaration in Appendix A is accurate and completed in accordance with the SKA IP Policy.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

A	Polarization A
ANSI	American National Standards Institute
B	Polarization B
CBF	Correlator and Beamformer Element/Consortium
CRC	Cyclic Redundancy Check
CSP	Central Signal Processor
EIA	Electronic Industries Alliance
ICD	Interface Control Document
ID	Identifier
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
INSA	Infrastructure South Africa
IP	Internet Protocol
ISO	International Standards Organisation
LMC	Local Monitoring Control CSP Sub-element
LSB	Least Significant Byte
MAC	Media Access Control
MDA	MacDonald Dettwiler and Associates
MID	Middle
MSB	Most Significant Byte
NRC	National Research Council (Canada)
PPS	Pulse Per Second
PSN	Packet Sequence Number
PSS	Pulsar Search CSP Sub-element
RFC	Request For Comment
SKA	Square Kilometre Array
SKAO	SKA Organisation (or office)
STFC	Science and Technology Facilities Council
TBC	To be confirmed
TBD	To be decided
TIA	Telecommunication Industry Association
TM	Telescope Manager Element or Consortium
UDP	User Datagram Protocol
UTC	Coordinated Universal Time

1 INTRODUCTION

This document defines the interfaces between the Mid Correlator and Beamformer (Mid.CBF) and Mid Pulsar Search Engine (Mid.PSS) sub-elements of the SKA CSP Element. In general, the interfaces shall be defined in accordance with the SKA Interface Management Plan [AD1] with the exception that the concept of using another sub-element transparently is revoked. Instead the following party for the interface shall be responsible for specifying and providing any required electrical or electro-optical cabling between the leading and following sub-elements.

1.1 Scope of Document

This document only provides details of the interfaces between the specified sub-elements of the CSP Element. Interfaces to other sub-elements of the CSP or external interfaces to other SKA Elements are defined elsewhere.

1.2 Intended Audience

The intended audience of this document are the Systems Engineers and engineering teams of the leading and following parties of the interface.

1.3 Roles and responsibilities

Table 1-1 defines the roles and responsibilities for the relevant parties.

Table 1-1 Roles and responsibilities

Role	Sub-element	Point of contact	Responsibilities
Leading Party	Mid Pulsar Search Engine	Ben Stappers	Create and maintain this document
Following Party	Mid Correlator and Beamformer	Mike Pleasance	Contribute to, review and approve this document

1.4 Interface scope

Table 1-2 lists the classes of interface specification which are included in this document.

Table 1-2 Interface class specifications

Interface class	Included in document?
Mechanical	N
Fluid	N
Thermal	N
Electromagnetic	N
Optical	N
Electrical	N
Electronic	N
Electro-optical	Y
Data exchange specifications	Y
Human-Machine Interface	N

1.5 Interface topology

The Mid Correlator and Beamformer uses data from the MeerKAT and SKA1-Mid receptors to form beams for use by the Mid Pulsar Search Engine Sub-element [Figure 1-1].

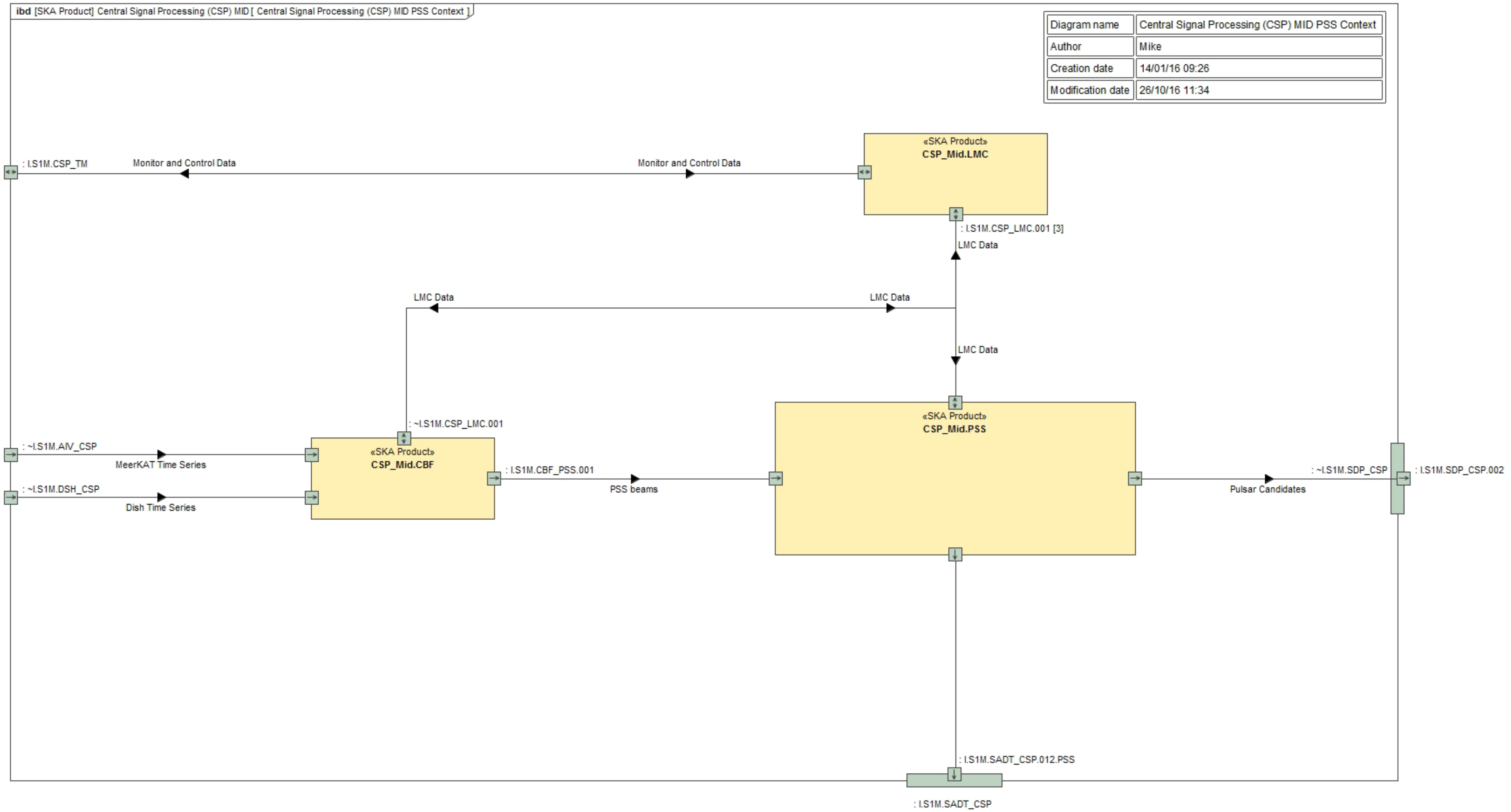


Figure 1-1 Context for the Mid.CBF to Mid.PSS interface

1.6 Summary of standards

The list of standards employed by this interface is summarized in the Table below:

Interface Standards	Rationale
Request for Comment (RFC) 971 Internet Protocol (IP) v4	Common protocol used to network computers and servers. IPv4 provides sufficient address range for the interfaces described in this document.
RFC 768 User Datagram Protocol (UDP)	Common protocol used to network with computers and servers. UDP is light weight, a small transport layer designed on top of IP. UDP is suitable for applications that need fast, efficient transmission.
IEEE 802.3by 25 Gigabit Ethernet Standard	Common physical interface used to network with computers and servers
TIA/EIA-568-C.3 and ISO/IEC 11801	Fibre optic cable standards.

2 APPLICABLE AND REFERENCE DOCUMENTS

2.1 Applicable Documents

The following documents at their indicated revision form part of this document to the extent specified herein.

Table 2-1 Applicable Documents

Ref No	Document/Drawing Number	Document Title	Issue Number
AD1	SKA-TEL-SKO-0000025	SKA1 Interface Management Plan	02

2.2 Reference Documents

The following documents provide useful reference information associated with this document. These documents are to be used for information only. Changes to the date and/or revision number do not make this document out of date.

Table 2-2 Reference Documents

Ref No	Document/Drawing Number	Document Title	Issue Number

3 SPECIFICATION CLASSES AND APPLICABLE STANDARDS

3.1 Electro-optical

[MCBFPSS 3.1.1] The physical interface shall comply with IEEE 802.3by 25G Ethernet Standard.

The baseline number of beams that can be processed per Mid.PSS Compute Node is 3.

[MCBFPSS 3.1.2] The Fibre optic cables shall comply with the TIA/EIA-568-C.3 and ISO/IEC 11801 standards.

3.2 Data exchange specifications

[MCBFPSS 3.2.1] The data exchange protocol shall comply with the RFC 768 User Datagram Protocol, IPv4.

4 TEST, DIAGNOSTIC OR MAINTENANCE FEATURES

[MCBFPSS 4.1.1] The mechanisms to detect interface failures shall include the following:

1) The Mid.PSS Compute Node has not received any data packet within 2 s of the start of the observation or within 2 ms since the previous data packet was received.
2) UDP Packet checksum is incorrect
3) CRC (Cyclic Redundancy Check) is incorrect
4) IP Header checksum is incorrect
5) Packet timestamp is incorrect
6) Packet sequence number is incorrect
7) Too many errors per second
8) The Stokes data does not conform to the mean and standard deviation requested by Telescope Manager (TM) and Local Monitoring and Controll (LMC).

[MCBFPSS 4.1.2] The interface errors detected shall be logged by the Mid.PSS Compute Nodes. The Mid.PSS Compute Nodes will limit the number of errors logged to 10 per interface per second.

[MCBFPSS 4.1.3] The errors logged shall include the following:

1) system time date and year
2) error category (major, minor, warning)
3) error type

5 SAFETY ASPECTS

ANSI Z136.2 – Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources.

6 INTERFACE REQUIREMENTS

The term ‘antenna’ refers to a SKA Mid dish or MeerKAT dish.

6.1 Electro-optical

The final configuration of the physical interface between the Mid.CBF and Mid.PSS will depend on the number of beams each Compute Node can process. The baseline configuration, based on three beams per node, is shown in Figure 6-1.

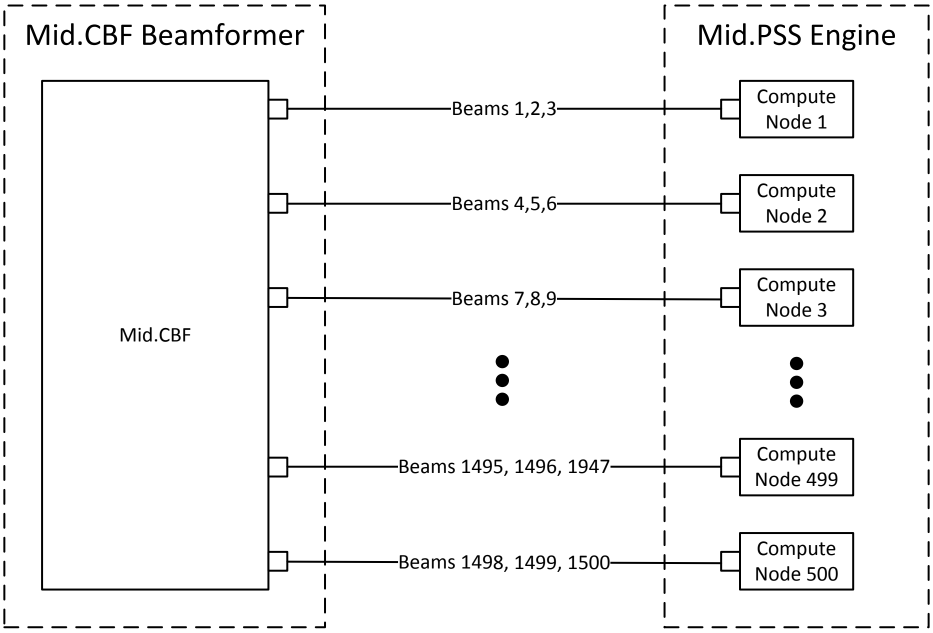


Figure 6-1 Mid.CBF to Mid.PSS Engine Physical Interface for three beams per Compute Node

[MCBFPSS 6.1.1] Each Mid.PSS Compute Node shall interface to the Mid.CBF via a 25GBASE-SR Ethernet link.

[MCBFPSS 6.1.2] Each Mid.PSS Compute Node shall be capable of receiving UDP packets at a sustained rate of 20 Gb/s of data (80% of the physical line speed).

[MCBFPSS 6.1.3] The Mid.CBF shall provide one OM4 duplex optical fibre terminated with LC connectors for each Mid.LOW.PSS Compute Node (500 in the baseline design).

[MCBFPSS 6.1.4] The Mid.PSS Compute Node shall provide SFP28 fibre optic transceiver modules with duplex LC fibre receptacles

[MCBFPSS 6.1.5] The fibre cable length between the Mid.CBF and Mid.PSS Compute Node shall be no greater than 100 meters.

If greater cable lengths are required, external signal repeaters will likely be required.

It is assumed that any excess cable between Mid.CBF and Mid.PSS will be handled by the INSA cable management system e.g. cable trays.

[MCBFPSS 6.1.6] The interface shall be at the fibre connectors on the SFP28 module in the 25G network card on each Mid.PSS Compute Node. Mid.CBF is responsible for all cabling between Mid.CBF and Mid.PSS.

6.1.2 Typical data rates

Requirement SKA1-CSP_Mid_PSS_REQ-113 specifies that PSS shall process 4096 channels. Mid.CBF provides 330 MHz of processed bandwidth to PSS. This gives a channel width of 330 Mhz / 4096 = 80.6 KHz which is equivalent to a 12.4 microsecond sample rate. A minimum of four samples are averaged per output giving 49.6 microseconds per output sample.

Data is sent from Mid.CBFto PSS in packets of 4206 bytes.The number of data packets per second is 4 every 49.6 microseconds = 80566 packets/second. This then gives a data packet rate of 80566 * 4206 bytes* 8 bits/byte = 2.71 Gb/s. In addition a data quality packet is sent after every 128 data packets at a rate of (1 / 49.65 microseconds) / 128 = 157.4 packets per second. This then gives a data quality packet rate of 157.4 * 4206 * 8 bits/byte = 5.3 Mb/s. Overall this gives a data rate per beam of 2.71 + 0.0053 = 2.71 Gb/s. If the data for 3 beams is sent over each fibre optic link, the total data rate per link is 8.1 Gb/s.

6.2 Data exchange specifications

The network protocol is based on the User Datagram Protocol (UDP) as specified in RFC 768.

Each Compute Node processes the complete bandwidth for up to 3 beams. The spectral bandwidth is subdivided into many channels. Bands 1 to 5b all have the same Search Window bandwidth.

The number of beams sent to each Compute Node iby Mid.CBF is configured by the Mid.LMC. The acceptable values for the number of beams sent to each Compute Node is 1, 2 or 3 per 25G link.

The data for all of the beams going to a single Compute Node is sent to a single Internet Protocol (IP) address. The IP address will have at least one port per Stokes parameter per beam which the data can be distributed across. The port which each type of packet is sent to is configured by the MID.LMC. The port number for each packet type for each beam can be unique or multiple packet types can be sent to the same port. 15 ports per Compute Node allow a unique port for each packet type for up to 3 beams per link.

The five packet types per beam are:

1. Stokes Parameter #1 [$\mathbf{|A|^2+|B|^2}$]
2. Stokes Parameter #2 [$\mathbf{|B|^2-|A|^2}$]
3. Stokes Parameter #3 [**2 x Re(A x B*)**]
4. Stokes Parameter #4 [**2 x Im(A x B*)**]
5. Antenna Count Summary

Each set of Stokes parameter data will have an individual offset and scale which will be set such that the data is kept within the available range as far as possible. It is expected that the offset and scale will remain constant across each scan.The packet type field will be used to identify which offset and scale is stored in the metadata for each packet.

[MCBFPSS 6.2.1] Each individual network interface on each Compute Node shall have a unique IP address that can be configured by the Mid.LMC.

[MCBFPSS 6.2.2] Each Compute Node IP address shall have up to 15 sequential port numbers above or starting from port 2000 that can be configured by the Mid.LMC.

[MCBFPSS 6.2.3] The number of beams sent to each network interface in a Compute Node shall be configurable between 1 and 3. The baseline is 3.

[MCBFPSS 6.2.4] The port number for each packet type and beam is configured by the Mid.LMC.

[LCBFPSS 6.2.5] Each UDP packet shall contain metadata and one time sample for all spectral channels, assumed to be 4096 in this document. The packet will contain one of the four stokes parameters or antenna count summary data. The packet metadata shall indicate what type of data is present.

The decision to have all channels for a single time sample in each packet reduces the amount of memory required to buffer PSS Output data in Mid.CBF.

[LCBFPSS 6.2.6] Packet metadata shall contain time, sequence number, scan identifier (ID), packet type, number of channels, Stokes parameter offset, Stokes parameter scale, first channel frequency, channel bandwidth and a valid sample count for the antenna count summary packets.

The packet type will indicate what type of data is contained in the packet:

- Stokes Parameter #1 [$|A|^2+|B|^2$]
- Stokes Parameter #2 [$|B|^2-|A|^2$]
- Stokes Parameter #3 [**2 x Re(A x B*)**]
- Stokes Parameter #4 [**2 x Im(A x B*)**]
- Antenna Count Summary

[MCBFPSS 6.2.7] The metadata length shall be 64 bytes in length.

The metadata length is chosen to be a multiple of 32 bytes in length to ensure word alignment with the Compute Node Memory Organization.

[MCBFPSS 6.2.8] The data content following the packet metadata shall be full spectra of 8-bit unsigned integers, both for the Stokes parameters and the antenna count summary. The expected mean and standard deviation of each of the Stokes parameters should be in agreement with parameters passed down by TM and LMC.

For Stokes parameters 2, 3 and 4 the values can be negative. The values will be formatted such that a value of -127 maps to 0. The offset and scale shall be set such that all data values remain in range as far as possible. This could be achieved, for example, by setting the value -127 such that it corresponds to the mean noise minus ~6 sigma

[MCBFPSS 6.2.9] The metadata, time sample channel data and weight data shall be delivered in the little Endian format.

[MCBFPSS 6.2.10] The time sample channel data within the UDP packet shall be ordered from the lowest to the highest frequency channel.

[LCBFPSS 6.2.11] One Antenna Count Summary packet shall be transmitted for every 128 sets of Stokes Parameters packets.

The timestamp in the Antenna Count Summary packet will match the timestamp of the first time sample that contributed to the averages. The Valid Sample Count in the packet metadata describes the number of time samples used to compute the average, which is always 128.

[MCBFPSS 6.2.12] Two separate sequence numbers, one for Stokes parameters packets (packet types 1 to 4) and antenna summary packets (packet type 5) shall be maintained. The packet counters shall be referred to as the 'Data packet sequence count' and 'Summary packet sequence count', respectively. The sequence numbers shall be an increasing count of the packet number that will be reset to 0 upon the commencement of an observation. The packet type field shall be used to determine which count is provided in the metadata.

[MCBFPSS 6.2.13] The epoch for the timestamp specified in the metadata shall be 00:00:00 on January 1, 1970. This allows times up to the year 2106 to be specified.

7 INTERFACE IMPLEMENTATION

7.1 Electro-optical

The optical fibre will be based on the 850 nm OM4 cable type. Duplex LC fibre receptacles will be fitted to the Mid.PSS end of the cable.

7.2 Data exchange specifications

The Compute Node IP and MAC (Media Access Control) Address will be configured by the Mid.LMC.

Each Compute Node network interface has one IP address. The port number starts from or above 2000 and data are distributed across a maximum of 15 ports per interface, as described above. The number of beams per Compute Node and the allocation of beams to ports will be configured by the Mid.LMC.

The UDP Packet format is shown in Figure 7-1.

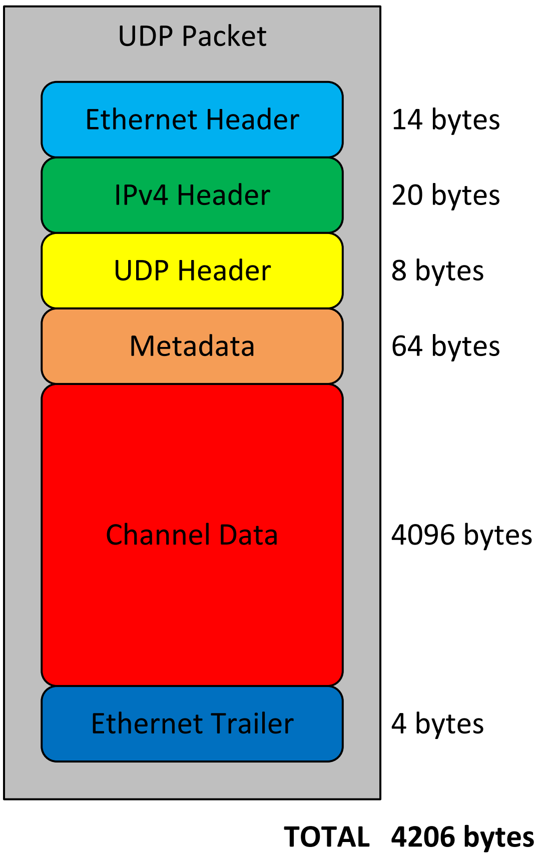


Figure 7-1 UDP Packet Format

The Ethernet Header and Trailer format is shown in Figure 7-2.

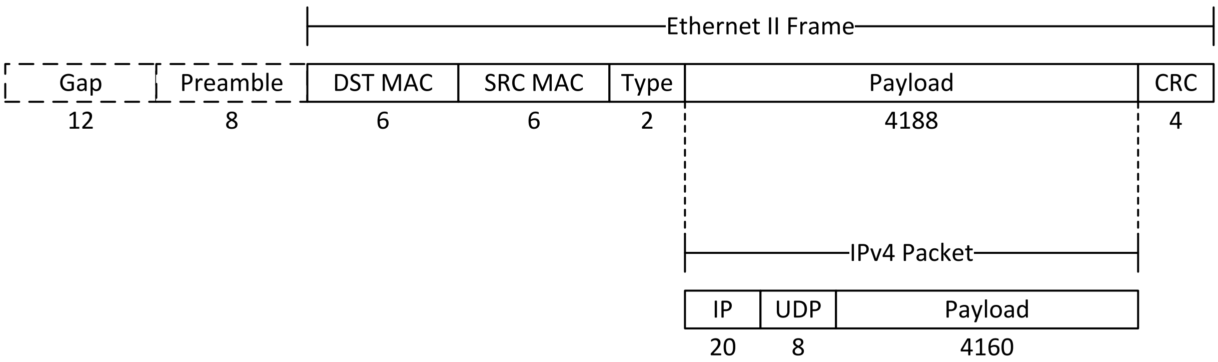
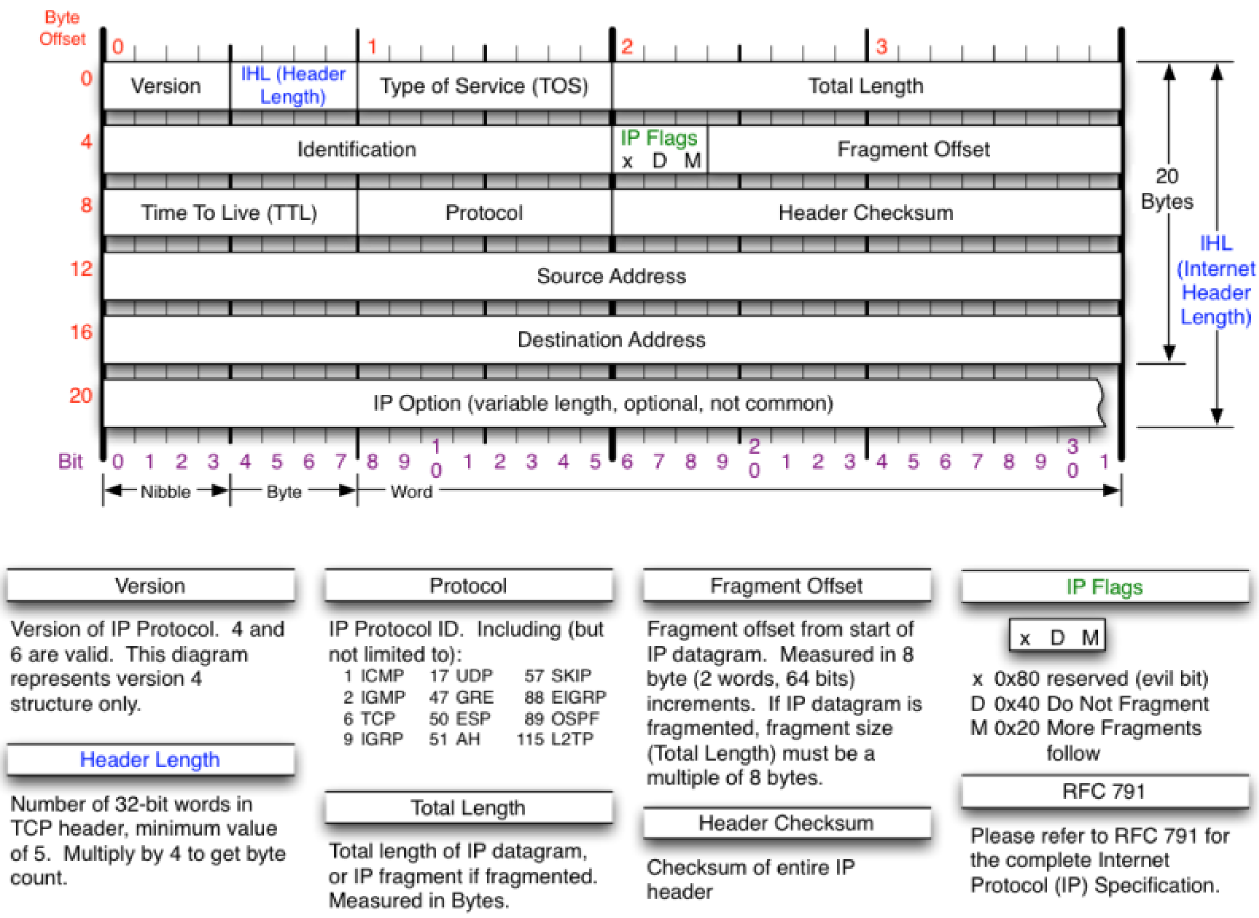


Figure 7-2 Ethernet Header and Trailer Format

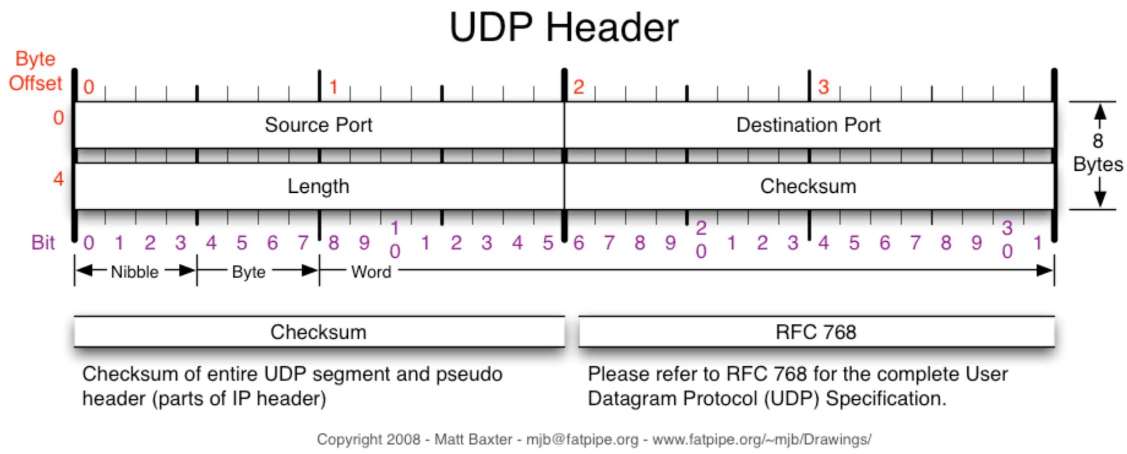
The IP Header format is shown in Figure 7-3.

Figure 7-3 IP Header Format



The UDP Header format is shown in Figure 7-4.

Figure 7-4 UDP Header Format



The payload of the UDP packet consists of metadata, sample data or weight data. Little Endian format is used to match the Compute Node memory storage organization. The metadata format is shown in Table 7-1.

As mentioned above, 64-bit unsigned integers will be used to provide a robust method to detect lost, out of order or dropped packets. The data and summary packet sequence numbers are used to provide information on both the time sequence of packets and also the location of the packet in the frequency spectrum.

The packet sequence counters will be used in association with the known start time for an observation. This start time will occur on a 1 PPS (pulse per second) boundary of UTC (Coordinated Universal) time. At the start time, the CBF will reset the packet counters to 0 for the first packet of each packet type and increment each packet type by one for each subsequent packet of that type. The PSS Compute Node will use the sequence numbers in combination with the sampling time to determine the exact position of the data in the overall data stream, it also allows the PSS Compute Node to detect any missing packets and take appropriate action.

The scan ID allows each packet to be uniquely identified with a particular scan.

The first channel and number of channels fields are added to allow some flexibility in the number of channels per packet. It is anticipated that all spectral channels of a given time sample will be present, and that packets will typically contain a single time sample.

The Timestamp field indicates the UTC time of the first time sample in the packet. The timestamp contains two parts; an unsigned integer indicating the number of seconds since the epoch of 0:00:00 on January 1, 1970 and an unsigned integer indicating the fractional part of that second in nanoseconds. This timing scheme is valid for times up to the year 2106.

The first channel frequency and channel bandwidth fields allow the frequency of each channel to be determined.

Table 7-1 Metadata Format

Byte Offset	Description	Data type
0	Packet sequence count (LSB)	64-bit unsigned

Byte Offset	Description	Data type
1	Packet sequence count	
2	Packet sequence count	
3	Packet sequence count	
4	Packet sequence count	
5	Packet sequence count	
6	Packet sequence count	
7	Packet sequence count (MSB)	
8	Scan ID (LSB)	64-bit unsigned
9	Scan ID	
10	Scan ID	
11	Scan ID	
12	Scan ID	
13	Scan ID	
14	Scan ID	
15	Scan ID (MSB)	
16	Timestamp – Seconds from Epoch (LSB)	32-bit unsigned
17	Timestamp – Seconds from Epoch	
18	Timestamp – Seconds from Epoch	
19	Timestamp – Seconds from Epoch (MSB)	
20	Timestamp – Nanoseconds(LSB)	32-bit unsigned
21	Timestamp – Nanoseconds	
22	Timestamp – Nanoseconds	
23	Timestamp – Nanoseconds (MSB)	
24	Beam Number (LSB)	16-bit unsigned
25	Beam Number (MSB)	
26	First Channel Number (LSB)	16-bit unsigned
27	First Channel Number (MSB)	

Byte Offset	Description	Data type
28	Number of Channels (LSB)	16-bit unsigned
29	Number of Channels (MSB)	
30	Beamformer Version	8-bit unsigned
31	Time Samples (LSB) for packet type 1-4, valid sample count for packet type 5	16-bit unsigned
32	Time Samples (MSB), valid sample count for packet type 5, as with 23	
33	Integration Time (In number of samples)	8-bit unsigned
34	Band Number this indicates which frequency band within the receiver bandwidth was used for this beam. 0 = Band 1 1 = Band 2 2 = Band 3 3 = Band 4 4 = Band 5a 5 = Band 5b	8-bit unsigned
35	Packet Type: 0 = Invalid Packet 1 = Stokes Parameter #1 2 = Stokes Parameter #2 3 = Stokes Parameter #3 4 = Stokes Parameter #4 5 = Antenna Count Summary	8-bit unsigned
36	First channel frequency (kHz) (LSB)	32-bit unsigned
37	First channel frequency (kHz)	
38	First channel frequency (kHz)	
39	First channel frequency (kHz) (MSB)	
40	Channel bandwidth (Hz) (LSB)	32-bit unsigned
41	Channel bandwidth (Hz)	
42	Channel bandwidth (Hz)	
43	Channel bandwidth (Hz) (MSB)	
44	Offset – Stokes parameter (LSB)	Float
45	Offset – Stokes parameter	
46	Offset – Stokes parameter	

Byte Offset	Description	Data type
47	Offset – Stokes parameter (MSB)	
48	Scale – Stokes parameter (LSB)	Float
49	Scale – Stokes parameter	
50	Scale – Stokes parameter	
51	Scale – Stokes parameter (MSB)	
52	0 - reserved	
53	0 - reserved	
54	0 - reserved	
55	0 - reserved	
56	0 - reserved	
57	0 - reserved	
58	0 - reserved	
59	0 - reserved	
60	0 - reserved	
61	0 - reserved	
62	0 - reserved	
63	0 - reserved	

The sample data format is shown in Table 7-2.

Table 7-2 Channel Data Format

Byte Offset	Description
0	Channel 0 for time sample K, content depends on packet type: **1. ($\|A\|^2+\|B\|^2$)**, 8 bit unsigned **2. ($\|B\|^2-\|A\|^2$)**, 8 bit unsigned **3. 2 x Re(A x B*),** 8 bit unsigned **4. 2 x Im(A x B*),** 8 bit unsigned **5. Antenna Count Summary,** 8 bit unsigned
1	Channel 1 for time sample K
2	Channel 2 for time sample K
3	Channel 3 for time sample K
-	
-	
4092	Channel 4092 for time sample K
4093	Channel 4093 for time sample K
4094	Channel 4094 for time sample K
4095	Channel 4095 for time sample K

7.3 Packet transmission schedule

The pseudocode below describes the packet transmit schedule for each fibre input to a PSS compute node. S is the number of samples per second per channel. K is the sample timestamp. B is the LMC configurable number of beams per fibre.

```
Wait until PPS == 1

Data Packet sequence count = 0

Summary Packet sequence count = 0

for sample in 1 to S

    K = sample timestamp

    for fibre local beam number in 1 to B

        for packet type in 1 to 4

            transmit channel data packet to compute node
```

```
            increment data packet sequence count
        end for
        if sample % M == M-1
            transmit packet type 5 to compute node
            increment summary packet sequence count
        end if
    end for
end for
```

This is shown diagrammatically in Figure 7-5.

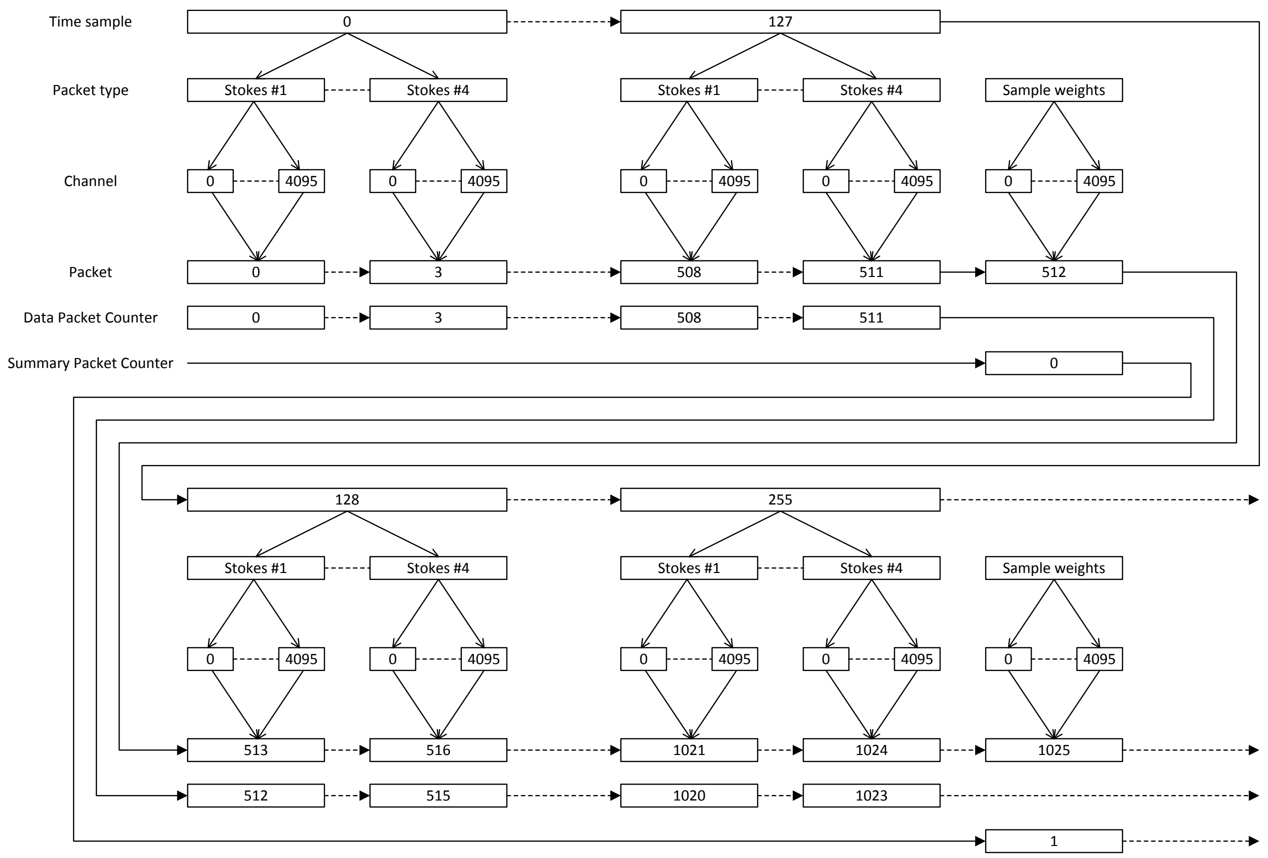


Figure 7-5 Packet transmission schedule

8 INTERFACE VERIFICATION

8.1 Verification stages

The Interface validation and verification process occurs in at least three stages:

a) **Stage 1:** Validation and verification of the interface control document through formal reviews during the design phase. This stage is the responsibility of the leading party, using models and analysis methods which themselves have been validated and verified.
b) **Stage 2**: Verification of the interface implementation by individual sub-elements during their design qualification phase by means of exercising the interface with the use of test equipment and/or simulators. During the Construction Phase, Mid CBF and Mid.PSS may provide simulators to each other if so defined in the Statement of Work. This verification is the responsibility of the individual sub-elements, under the supervision of the Element System Engineering team.
c) **Stage 3**: Verification of the interface during integration of the sub-elements, as part of system integration testing. This verification is the joint responsibility of the Element System Engineering team and the leading party. This stage has two phases – a formal Acceptance verification made at Element level and in isolation, followed by a carefully controlled sequence of making and verifying made interfaces as part of integration.

8.2 Requirement Verification Methods

Table 8-1 defines the verification methods.

Table 8-1 Verification Methods

Method	Description
Analysis	A form of verification that uses established technical or mathematical models or simulations, algorithms, charts, graphs, circuit diagrams, or other scientific principles and procedures to provide evidence that stated requirements are met.
Demonstration	A form of verification that involves the actual operation of an item to provide evidence that the required functions are accomplished under specific scenarios. The items may be instrumented and performance monitored.
Inspection	A form of verification that is generally non-destructive and typically includes the use of sight, hearing, smell, touch, and taste; simple physical manipulation; and mechanical and electrical gauging and measurement.
Test	A form of verification in which physical experimental principles and procedures are applied to determine the properties or functional capabilities of an item.

8.3 Verification Matrix

For each interface requirement, Table 8-2 lists the verification method, stage at which the verification takes place and the configuration (list of applicable items) required to carry out the verification. In all cases it is assumed that Mid.LMC or a Mid.LMC simulator is available to provide control and monitoring functionality.

Table 8-2 Verification cross reference matrix

Requirement ID	Method	Stage	Configuration
MCBFPSS 3.1.1	Demo	2	Mid CBF + Fibre cables + Mid PSS simulator
MCBFPSS 3.1.2	Inspection	2	Fibre cables
MCBFPSS 3.2.1	Demo	2	Mid CBF + Fibre cables + Mid PSS simulator
CBFPSS 4.1.1	Demo	2	Mid CBF simulator + Fibre cables + Mid PSS
		3	Mid CBF + Fibre cables + Mid PSS
CBFPSS 4.1.2	Demo	2	Mid CBF simulator + Fibre cables + Mid PSS
		3	Mid CBF + Fibre cables + Mid PSS
CBFPSS 4.1.3	Inspection	2	Mid CBF simulator + Fibre cables + Mid PSS
CBFPSS 6.1.1	Inspection	2	Fibre cables
CBFPSS 6.1.2	Demo	2	Mid CBF simulator + Fibre cables + Mid PSS
		3	Mid CBF + Fibre cables + Mid PSS
CBFPSS 6.1.3	Inspection	2	Mid.CBF + Fibre cables
		3	Mid CBF + Fibre cables + Mid PSS
CBFPSS 6.1.4	Inspection	2	Mid PSS
CBFPSS 6.1.5	Inspection	2	Fibre cables
		3	Fibre cables
CBFPSS 6.1.6	Inspection	3	Mid CBF + Fibre cables + Mid PSS
CBFPSS 6.2.1	Demo	2	Mid PSS
CBFPSS 6.2.2	Demo	2	Mid PSS
CBFPSS 6.2.3	Demo	2	Mid CBF
		3	Mid CBF + Fibre cables + Mid PSS
CBFPSS 6.2.4	Demo	2	Mid PSS
CBFPSS 6.2.5	Demo	2	Mid CBF simulator + Fibre cables + Mid PSS
		3	Mid CBF + Fibre cables + Mid PSS
CBFPSS 6.2.6	Demo	2	Mid CBF simulator + Fibre cables + Mid PSS
		3	Mid CBF + Fibre cables + Mid PSS
CBFPSS 6.2.7	Demo	2	Mid CBF + Fibre cables + Mid PSS simulator
CBFPSS 6.2.8	Demo	2	Mid CBF + Fibre cables + Mid PSS simulator
CBFPSS 6.2.9	Demo	2	Mid CBF + Fibre cables + Mid PSS simulator
CBFPSS 6.2.10	Demo	2	Mid CBF + Fibre cables + Mid PSS simulator
CBFPSS 6.2.11	Demo	2	Mid CBF + Fibre cables + Mid PSS simulator
CBFPSS 6.2.12	Demo	2	Mid CBF + Fibre cables + Mid PSS simulator
CBFPSS 6.2.13	Demo	2	Mid CBF + Fibre cables + Mid PSS simulator

A INTELLECTUAL PROPERTY DECLARATION

There is no IP to declare in this document.

B APPENDIX: LIST OF TBDS AND TBCS

Note: there are currently no TBDs or TBCs.

Table B-1 List of TBDs and TBCs

Section	Text	Disposition by


SKA1 CSP Mid Correlator and Beamformer to Mid PSS Interface Control Document

311-000000-009_4_MidCBFtoPSS_ICD_MacIntosh_2018-10-22

Adobe Sign Document History 10/23/2018

Created:	10/22/2018
By:	Donna Morgan (donna.morgan@nrc-cnrc.gc.ca)
Status:	Signed
Transaction ID:	CBJCHBCAABAA9I5Sa5Wn22r461xsb64jU9TrhFcRcdHa

"311-000000-009_4_MidCBFtoPSS_ICD_MacIntosh_2018-10-22" History

Document created by Donna Morgan (donna.morgan@nrc-cnrc.gc.ca)
10/22/2018 - 9:48:39 AM PDT- IP address: 132.246.216.37

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10/22/2018 - 9:49:58 AM PDT

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10/23/2018 - 10:10:33 AM PDT