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MULTIPLE ACCESS COMMUNICATION PROTOCOL

(proposal of a new SnP)

SpaceWire networking Protocol Meeting 3

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MACP keywords

ECSS-E-50-12 A	MACP SnP
• Physical Network	• Virtual Network
• SpaceWire Node	• Process/Task
• Node Identifier	• Mailbox Identifier(s)
• Physical Path	• Virtual Path
• Physical Channel	• Virtual Channel

Virtual Network connects processes spread over SpW nodes

Processes point to point communicate through mailboxes

Mailboxes are terminals of virtual paths

Virtual paths time-share the physical paths of the SpW network

Virtual channels time-share the SpW ports of a SpW node

Purpose

Plan the basic inter-process communication by combining

- security in the configuration, commanding and monitoring performed by a supervisor node on all the other SpW nodes
- high data throughput in the transfer of scientific data among the SpW nodes interfacing instruments, mass memories, telemetry, ...etc
- simple re-configuration of virtual network following dynamic re-allocation of processes over the SpW nodes

Provide a means of

- writing to/reading from registers/memory inside a SpW Node (direct addressing)
- configuring/monitoring mailboxes inside a SpW Node (indirect addressing)
- writing to/reading from mailboxes inside a SpW Node (indirect addressing)

Packet types and transactions

4 types of packet

- Command packet sent by a master node to a slave node
- Reply packet answering to a command packet
- Data packet sent by a source node to a destination node
- Interrupt message packet sent by a slave node to a master node

3 types of transaction

- Bi-directional (command/reply) transactions between a master and a slave node mainly for purpose of command, configuration and monitoring (take most of the protocol complexity)
- One unidirectional transaction between a couple of nodes to exchange a sequence of data packets (allot most of the network bandwidth)
- One unidirectional transaction between a slave and a master node having purpose of interrupt notification

Bi-directional transactions in MACP protocol

- Short/long-read/write: occur as per RMAP
- Virtual channel initialisation: master node transfers to a slave node parameters needed to configure the RX/TX mailbox pair of a virtual channel, (contextually enabled to exchange data)
- Virtual channel monitoring: master node acquires from a slave node, parameters containing the status of a virtual channel
- Virtual channel/file load: master node drives the slave node to send the content of a mailbox to itself, or to another node
- Mem. to I/O (or I/O to mem.): master node drives the slave node to move data between a memory area and a specific I/O port mapped in the slave node address space. Data can be moved from the first or last row or column (“corner turning”)
- File move: master node drives the slave node to move data from an old to a new memory area mapped in the slave node address space. Since old and new memory area can overlap, data can be moved from the first or last row or column

Commands in MACP Protocol

Sorted by a 5-bit command code in the command packet

Command Type	No of cases	Indirect/ Direct Addressing	Discard Pkt with invalid Hdr Chks	Discard Pkt with invalid Data Chks
short read	1	D	Yes	Yes
short write	2	D	Yes	Yes
virtual channel initialisation	1	I	Yes	Yes
virtual channel monitoring	1	I	Yes	Yes
virtual channel/file load (*)	3	I	Yes	Yes
mem. to I/O (I/O to mem.)	4	I	Yes	Yes
file move	4	I	Yes	Yes
long read	2	D	Yes	No
long write	4	D	Yes	No

(*) embeds the exchange of a sequence of data packets in between command and (opt.) reply packet

Unidirectional transactions in MACP protocol

Initiated by a source node previously commanded either locally (e.g. master node), or remotely (e.g. slave node)

- Data transaction: a source node sends a sequence of data packets to a destination node both previously configured to exec this data exchange (e.g. a camera sends, on line basis, a video data frame to a SSMM)

- Interrupt transaction: a slave node (configured to be remotely controllable) sends an interrupt message packet to the master node, to signal both anomalous conditions and normal end of operations

MACP versus RMAP

Correspondences

- Destination Address bytes
- Destination Node Logical Address byte
- Protocol Identifier byte (and related extension bytes)
- Extra Return Address words
- Return Node Logìcal Address byte
- Transaction Identifier
- Header Checksum and Data Checksum

MACP versus RMAP (cont.)

Differences

- Virtual Channel Identifier: required to reach the destination mailbox inside the receiving node
- Password (opt.): used to prevent unauthorised or inadvertent access to the destination memory of a virtual channel
- Line Identifier: allows re-ordering of the data packets at the receiver
- Type/Command/Status/Sizes: replaces the equivalent field of RMAP specific of each packet type
- Destination Bus Address or Destination Mailbox Identifier replace Read/Write Address of RMAP
- Extn Destination Bus Address: combined with the 32-bit Destination Bus Address, allows read/write transactions with 40-bit address

MACP versus RMAP (cont.)

Other differences

- Data Length: (4 bytes instead of 3) defines the number of data samples, whose size is specified in the Type/Command/Status/Sizes field
- Reply packet: besides the Transaction Identifier, repeats all the parameters of the corresponding command packet
- Data Checksum validation: for command packets carrying configuration data (Command Code<16), shall be performed before storing data into the destination memory
- Pads: in command and reply packets to get 32-bit word alignment
- Packet format: all the command packets share a common format and have the same header size except for opt. parameters (Dest. Address, Extra Return Address and Password). The same applies to reply packets

Short Write Command

Command packet with direct addressing

First Byte Transmitted

	Destination Address	Destination Address	Destination Address
Dest. Node Logical Address	Protocol Identifier	Extn Protocol Identifier	Extn Protocol Identifier
Type/Command/Status/Sizes	Type/Command/Status/Sizes	Dest. Virtual Channel Identifier (= 0÷7)	Dest. Virtual Channel Identifier (= 0÷7)
Destination VC Password	Destination VC Password	Destination VC Password	Destination VC Password
Return Address	Return Address	Return Address	Return Address
Return Node Logical Address	Transaction Identifier	Transaction Identifier	Transaction Identifier
Return Virtual Channel Identifier (>7)	Return Virtual Channel Identifier (>7)	PAD	Extn Destination Bus Address
Destination Bus Address	Destination Bus Address	Destination Bus Address	Destination Bus Address
Data Length (N. of samples) =1	Data Length (N. of samples) =1	Data Length (N. of samples) =1	Data Length (N. of samples) =1
Header Checksum			
Destination Bus Write Data (1 sample of 1, 2, 3 .... 8 bytes)			
	Data Checksum	EOP	

Last Byte Transmitted

(1)

(1) The address bytes specify the Destination Bus Address

Short Write Reply

Reply packet with direct addressing

First Byte Transmitted

	Return Address	Return Address	Return Address
Return Node Logical Address	Protocol Identifier	Extn Protocol Identifier	Extn Protocol Identifier
Type/Command/Status/Sizes	Type/Command/Status/Sizes	Return Virtual Channel Identifier (>7)	Return Virtual Channel Identifier (>7)
Return VC Password	Return VC Password	Return VC Password	Return VC Password
Transaction Identifier	Transaction Identifier	Transaction Identifier	Extn Destination Bus Address
Destination Bus Address	Destination Bus Address	Destination Bus Address	Destination Bus Address
Data Length (N. of samples) =1	Data Length (N. of samples) =1	Data Length (N. of samples) =1	Data Length (N. of samples) =1
Reply Header Checksum			
	Destination Bus Written Data (1 sample of 1, 2, 3 .... 8 bytes)		
	Reply Data Checksum	EOP	

Last Byte Transmitted

(1)

(1) The address bytes specify the Destination Bus Address

Type/Command/Status/Sizes bytes

In a command packet

15 14	13 12 11 10 9	8	7 6 5	4	3	2	1 0
Packet Type = 00	Command Code	Password Present	Data Sample Size (N. of Octets - 1)	x	x	x	Extra Return Address Words (32 bit)

In the corresponding reply packet

15 14	13 12 11 10 9	8	7 6 5	4 3 2	1 0
Packet Type = 01	Command Code	Password Present	Data Sample Size (N. of Octets - 1)	Ack/No Ack Ack= 000 No Ack= Non Zero Error Code	Extra Return Address Words (1)

(1): relevant for the transmitter but not for the receiver of these packets.

Command Code

VALUE	COMMAND DESCRIPTION
0	read bus cycle and REPLY packet
1	write bus cycle and REPLY packet with data read back from the just written location
2	VC/file acquisition (i.e. load a file) towards the RSC without REPLY packet
3	VC/file acquisition (i.e. load a file) towards the RSC and REPLY packet towards the RSC
4	VC/file acquisition (i.e. load a file) towards a PRSD and REPLY packet towards the RSC
5	write bus cycle and REPLY packet with data copied from the COMMAND packet
6	VC initialisation, always with REPLY packet
7	VC monitoring, always with REPLY packet
8	Mem to I/O or I/O to Mem. transfer with REPLY packet (from the first row)
9	Mem to I/O or I/O to Mem. transfer with REPLY packet (from the last row)
10	Mem to I/O or I/O to Mem. transfer with REPLY packet (from the first column)
11	Mem to I/O or I/O to Mem. transfer with REPLY packet (from the last column)
12	file move up, with REPLY packet (Mem. to Mem. data transfer from the first row)
13	file move down, with REPLY packet (Mem. to Mem. data transfer from the last row)
14	file move left, with REPLY packet (Mem. to Mem. data transfer from the first column)
15	file move right, with REPLY packet (Mem. to Mem. data transfer from the last column)
16	read data block with address increment and REPLY packet
17	write data block with address increment and REPLY packet with data read back
18	write data block with address increment and REPLY packet without any data
19	read data block without address increment and REPLY packet
20	write data block without address increment and REPLY packet with data read back
21	write data block without address increment and REPLY packet without any data
22÷31	reserved

Virtual Channel Initialisation Command

Command packet with indirect addressing

First Byte Transmitted

	Destination Address	Destination Address	Destination Address
Dest. Node Logical Address	Protocol Identifier	Extn Protocol Identifier	Extn Protocol Identifier
Type/Command/Status/Sizes	Type/Command/Status/Sizes	Dest. Virtual Channel Identifier (= 0÷7)	Dest. Virtual Channel Identifier (= 0÷7)
Destination VC Password	Destination VC Password	Destination VC Password	Destination VC Password
Return Address	Return Address	Return Address	Return Address
Return Node Logical Address	Transaction Identifier	Transaction Identifier	Transaction Identifier
Return Virtual Channel Identifier (>7)	Return Virtual Channel Identifier (>7)	PAD	PAD
PAD	PAD	Destination Mailbox Identifier	Destination Mailbox Identifier
Data Length (N. of samples) <= 32x32-bit words	Data Length (N. of samples) <= 32x32-bit words	Data Length (N. of samples) <= 32x32-bit words	Data Length (N. of samples) <= 32x32-bit words
Header Checksum			
Destination Mailbox Config Data (<=32 samples of 4 bytes)			
	Data Checksum	EOP	

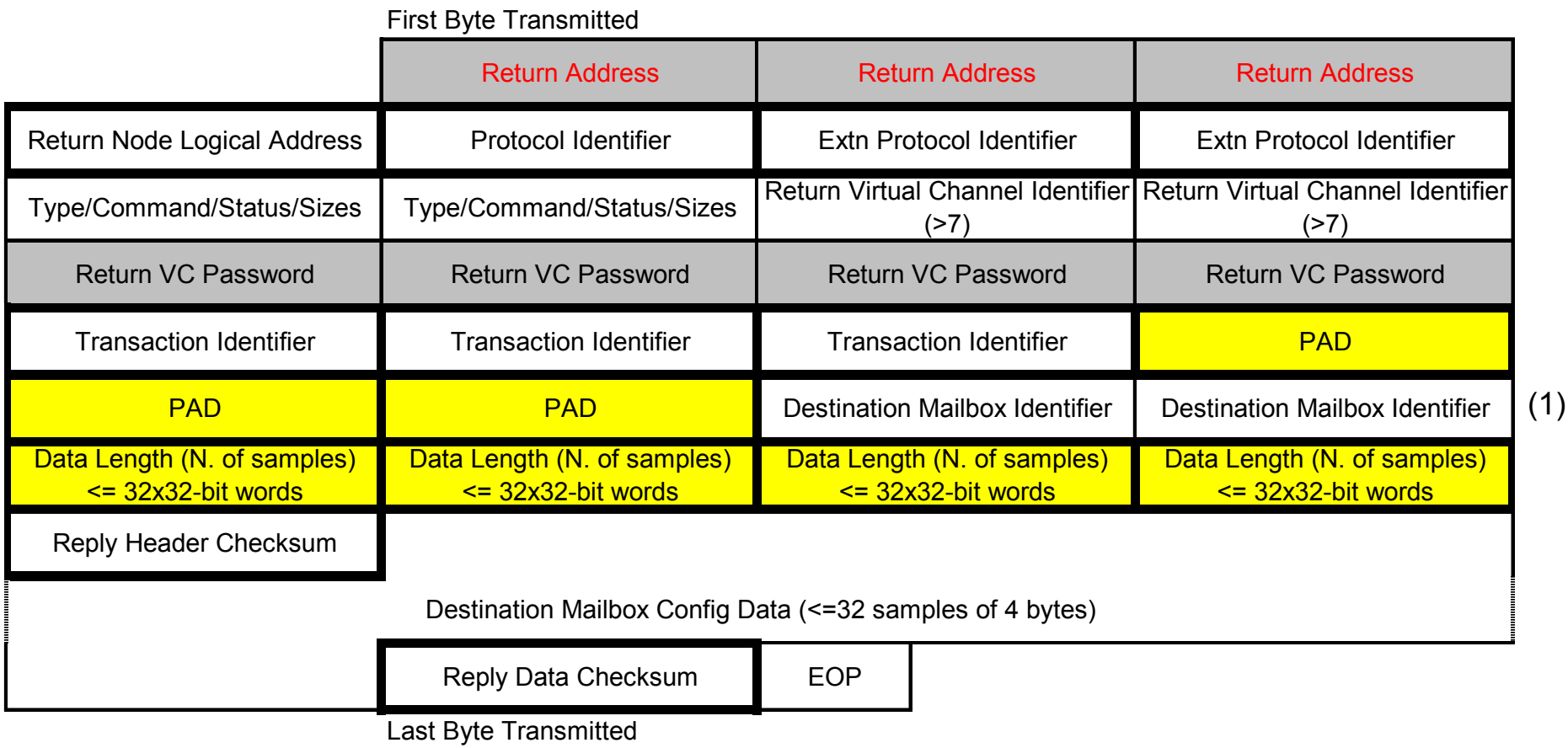
Last Byte Transmitted

(1)

(1) The address bytes specify the Destination Mailbox Identifier

Virtual Channel Initialisation Reply

Reply packet with indirect addressing



(1) The address bytes specify the Destination Mailbox Identifier

Virtual Channel/File Load Command

Command packet with indirect addressing

First Byte Transmitted

	Destination Address	Destination Address	Destination Address
Dest. Node Logical Address	Protocol Identifier	Extn Protocol Identifier	Extn Protocol Identifier
Type/Command/Status/Sizes	Type/Command/Status/Sizes	Dest. Virtual Channel Identifier (= 0÷7)	Dest. Virtual Channel Identifier (= 0÷7)
Destination VC Password	Destination VC Password	Destination VC Password	Destination VC Password
Return Address	Return Address	Return Address	Return Address
Return Node Logical Address	Transaction Identifier	Transaction Identifier	Transaction Identifier
Return Virtual Channel Identifier (>7)	Return Virtual Channel Identifier (>7)	PAD	PAD
PAD	PAD	Destination Mailbox Identifier	Destination Mailbox Identifier (1)
Data Length (N. of samples) =0	Data Length (N. of samples) =0	Data Length (N. of samples) =0	Data Length (N. of samples) =0
Command Packet Checksum	EOP		

(1) The address bytes specify the Destination Mailbox Identifier = VC/File Identifier

Virtual Channel/File Load Reply

Reply packet with indirect addressing

First Byte Transmitted

	Destination Address	Destination Address	Destination Address
Dest. Node Logical Address	Protocol Identifier	Extn Protocol Identifier	Extn Protocol Identifier
Type/Command/Status/Sizes	Type/Command/Status/Sizes	Dest. Virtual Channel Identifier (= 0÷7)	Dest. Virtual Channel Identifier (= 0÷7)
Destination VC Password	Destination VC Password	Destination VC Password	Destination VC Password
Return Address	Return Address	Return Address	Return Address
Return Node Logical Address	Transaction Identifier	Transaction Identifier	Transaction Identifier
Return Virtual Channel Identifier (>7)	Return Virtual Channel Identifier (>7)	PAD	PAD
PAD	PAD	Destination Mailbox Identifier	Destination Mailbox Identifier (1)
Data Length (N. of samples) =0	Data Length (N. of samples) =0	Data Length (N. of samples) =0	Data Length (N. of samples) =0
Command Packet Checksum	EOP		

(1) The address bytes specify the Destination Mailbox Identifier = VC/File Identifier

Data Packet

First Byte Transmitted

	Destination Address	Destination Address	Destination Address
Dest. Node Logical Address	Protocol Identifier	Extn Protocol Identifier	Extn Protocol Identifier
Type/Command/Status/Sizes	Type/Command/Status/Sizes	Dest. Virtual Channel Identifier (>7)	Dest. Virtual Channel Identifier (>7)
Destination VC Password	Destination VC Password	Destination VC Password	Destination VC Password
Line Identifier	Line Identifier	Line Identifier	Line Identifier
1st Sample = Data Length (opt.)	1st Sample = Data Length (opt.)	1st Sample = Data Length (opt.)	1st Sample = Data Length (opt.)
Header Checksum			
Destination Mailbox Current Line Data Samples (reasonably less than 2^32 Data Samples of up to 64 bits)			
	Data Checksum	EOP	

Last Byte Transmitted

(1)

(1) The Dest. VCID uniquely specifies the Destination Mailbox Identifier

Interrupt Message Packet

First Byte Transmitted

	Destination Address	Destination Address	Destination Address
Dest. Node Logical Address	Protocol Identifier	Extn Protocol Identifier	Extn Protocol Identifier
Type/Command/Status/Sizes	Type/Command/Status/Sizes	Dest. Virtual Channel Identifier (>7)	Dest. Virtual Channel Identifier (>7)
Destination VC Password	Destination VC Password	Destination VC Password	Destination VC Password
Data Length	Data Length	Data Length	Data Length
Header Checksum			
Interrupt Status Data (Source Node Logical Address, Time Tag Data, ...etc.) (up to M Data Samples of 1, 2, 3 .... 8 bytes)			
	Data Checksum	EOP	

(1)

Last Byte Transmitted

(1) The Destination VCID uniquely specifies the Destination Mailbox Identifier

Type/Command/Status/Sizes bytes

In a data packet

15 14	13	12	11	10	9	8	7 6 5 4 3 2	1 0
Packet Type = 10	x	x	x	Data Length Present	Line ID Present	Password Present	Data Sample Size (N. of bits - 1) (2)	Extra Dest. Address Words (1)

In an interrupt message packet

15 14	13 12 11 10 9	8	7 6 5	4	3	2	1 0
Packet Type = 11	Interrupt Code	Password Present	Data Sample Size (N. of Octets - 1)	x	x	x	Extra Dest. Address Words (1)

(1): relevant for the transmitter but not for the receiver of these packets
(2): optional since the value already in configuration data of destination data mailbox will prevail

Open Points

a Destination VCID (of specific value = 0÷7) in the command packet ?

b Data Length in all command packets and reply packets?

c Is the Source Node Logical Address advisable in data packets?

d Data Length Size: 2, 3 or 4 bytes?

e 4 pads in command packet with indirect addressing ?

f Frame Identifier instead of Destination VC Password in data packets ?

g Data Sample Size bit in data and interrupt message packets ?

h Copy of parameters from command packet to reply packet ?

i In a reply packet, the Reply Status could be extended from 3 to 5 bits by replacing the 5 bit Command Code.

j Are there more suitable names to indicate each transaction ?

k Are there more fitting names for the terminology used for MACP?