Network MCS in KSM-500

TEC/NOT/068

This document describes MCS (Multi-Chassis Scheduler) over Ethernet in KSM-500 where PCM is used for real-time telemetry in an Ethernet system.

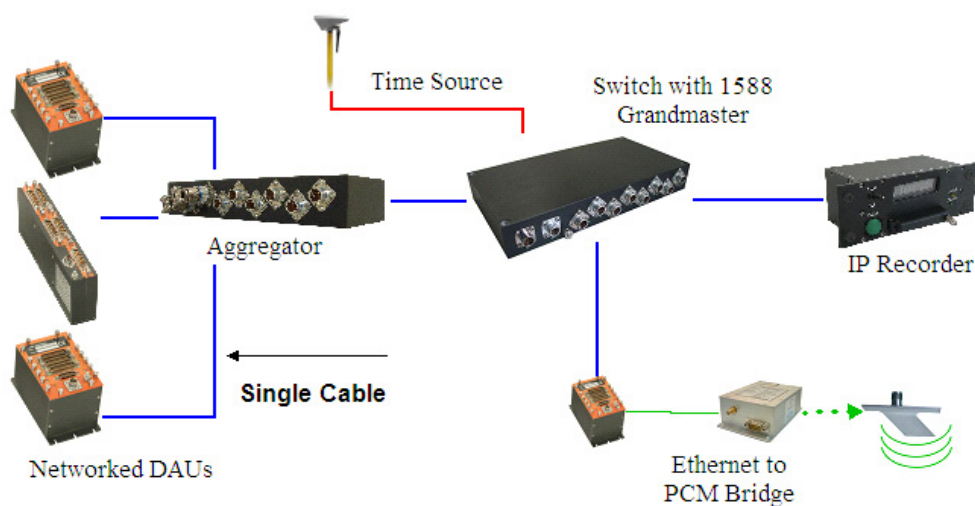This technical note discusses the following topics:

Figure 41-1: Networked FTI system

41.1 KSM-500 for network configurations

The MCS is a system scheduler that enables you to transparently create parameters to an Ethernet parsing DAU module from any available DAU in a networked system.

The following figure illustrates a kSetup example that has two Ethernet based DAUs, DAU1 and DAU2, with KAD/BCU/140s connected to a switch (not represented in the GUI) and one DAU which is used as the Ethernet to PCM bridge, ETH2PCM_BRIDGE.

The Ethernet to PCM bridge DAU must contain:

- An Ethernet bus monitor (KAD/EBM/102 in the following figure), which is used to capture packets from an aggregator port of the switch.
- A PCM encoder (KAD/ENC/106 in the following figure), which is used to create a PCM frame in which parameters from any DAU, parsed by the Ethernet bus monitor, can be transmitted.
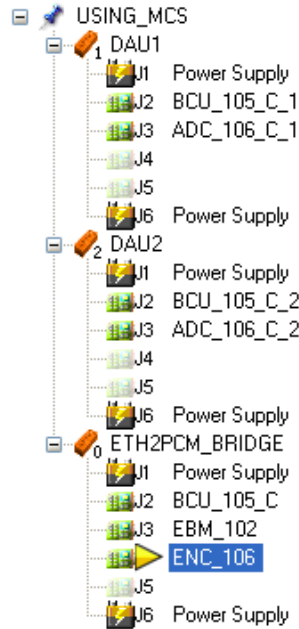
Figure 41-2: Example of a network data acquisition system in kSetup

Ethernet packets can still be created and transmitted from each stand-alone DAU but if there is no Ethernet bus monitor in that DAU then these packets can only contain parameters from the transmitting DAU, as there is no link to other DAUs. Usually these packets are sent to an IP recorder, such as a NET/REC/001, a real time monitoring PC or any device connected to the aggregator port of the switch.

The Ethernet to PCM bridge DAU allows you to transmit parameters from any existing DAU present in the network system over the PCM transmitter.

For the PCM transmission of any parameter in the network, the Frame Builder on the PCM encoder setup (KAD/ENC/106 in the previous figure) can be used. The MCS takes into account the parameters from other chassis that are available to the PCM encoder through the MCS, and allows them to be placed in the encoder's PCM frame.

Frame Builder displays all the parameters available in the system as illustrated in the following figure.

Figure 41-3: Example of Frame Builder displaying all the parameters in the different chassis

When Verify or Program are selected, the MCS transparently creates inter-chassis Ethernet packets containing the desired parameters from other DAUs. These inter-chassis packets are then parsed by the Ethernet bus monitor which renders all the parameters available for transmission over a PCM frame.

41.2 Module support

The MCS supports any Ethernet controller, such as the KAD/BCU/105 or KAD/BCU/140, and any Ethernet transmitter, such as the KAD/ETH/101. It also supports any Ethernet bus monitor, such as the KAD/EBM/101/B or KAD/EBM/102. It supports any PCM transmitter, memory module or ARINC transmitter on the receiver chassis.

41.3 How the MCS works

In Figure 41-2 on page 2, the MCS automatically creates packets to transfer parameters from DAU1 and DAU2 to the ETH2PCM_BRIDGE DAU for those placed in the PCM. It automatically sets up the Ethernet bus monitor accordingly.

41.3.1 Ethernet packets automatically built for the MCS

By default, the packets are transmitted to the Ethernet bus monitor using its unicast IP address. However, if needed, the MCS can transmit multicast packets to the Ethernet bus monitor to allow the switch, for example NET/SWI/003, to filter out the MCS packets. See "41.4.1 GUI options added to kSetup for the MCS" on page 6 for more details.

The packets are IENA packets with a unique key per packet. The key starts from FFFE in hexadecimal and then decrements, skipping any IENA keys that have already been defined in the XidML so that they are always unique.

There are one or more packets created for each parameter sampling rate group from each chassis.

For example, assuming an acquisition cycle of 1 Hz, if there is only one parameter at 50 Hz from DAU1 placed in the PCM frame then the MCS creates a packet from DAU1 containing that single parameter, that is one occurrence per packet. The packet is then sent 50 times per second to achieve the 50 Hz sampling rate needed by the PCM frame.

Another example would be if you have one hundred 5 Hz parameters from DAU2 placed in the PCM frame. In this case, the MCS creates a packet from DAU2 containing those 100 parameters. This packet is sent five times per second to achieve the 5 Hz sampling rate. Note that the number of occurrences of a parameter in a packet is one.

A single packet is created for multiple parameters that are placed in the PCM at the same rate, from the same chassis.

If the packet is too small, that is less than 64 bytes, dummy parameters (fixed data) are automatically appended.

If the packet is too long, the MCS creates multiple packets each with unique IENA keys. This occurs when there are more than 722 (by default) parameters at the same rate from the same chassis. The limit of 722 words per packet is set to avoid packet fragmentation (after 1,500 bytes), which is not recommended as it further complicates data reconstruction.

41.3.2 How to setup the Ethernet bus monitor for MCS

The MCS automatically sets up the Ethernet bus monitor according to the packets created by the MCS, as explained in "41.3.1 Ethernet packets automatically built for the MCS" on page 3.

The Ethernet bus monitor parses all the MCS packets using the IENA key and IP source classifications. It then defines the packet positions of the data words, which are the parameters going to the PCM frame.

If multiple Ethernet bus monitors are in the Ethernet to PCM bridge chassis, use kSetup to define the Ethernet bus monitor that should be used for the MCS. See "41.4.1 GUI options added to kSetup for the MCS" on page 6 for more details.

41.3.3 Example MCS packets

| MAC	IP	UDP	IENA header	Pckt1Para1	...	IENA footer

Pckt1 is transmitted 4 times per acquisition cycle

MAC	IP	UDP	IENA header	Pckt3Para1	Pckt3Para2	...	IENA footer

Pckt3 rate is transmitted once per acquisition cycle

MAC	IP	UDP	IENA header	Pckt2Para2	...	IENA footer

Pckt2 is transmitted twice per acquisition cycle

Ethernet BCU1

Ethernet BCU2

Switch

KAD/EBM/10X to KAD/ENC/106
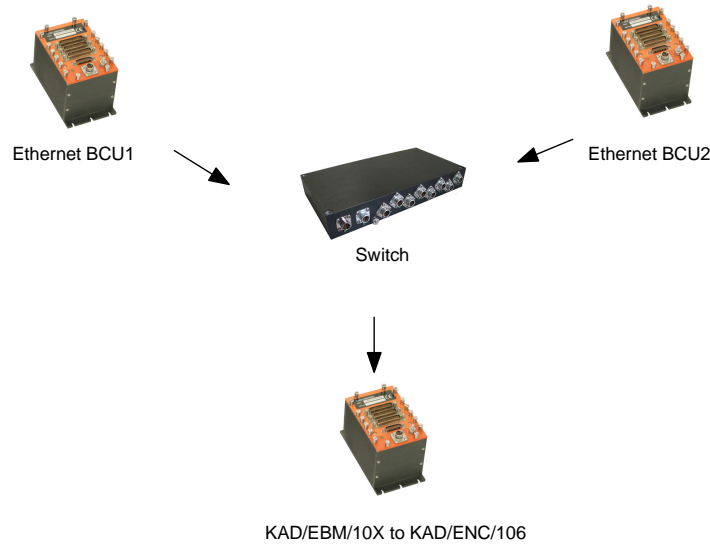
SFID	Pckt1Para1	Pckt2Para2				SYNCWORD
SFID	Pckt1Para1					SYNCWORD
SFID	Pckt1Para1	Pckt2Para2				SYNCWORD
SFID	Pckt1Para1		Pckt3Para1	Pckt3Para2		SYNCWORD

Figure 41-4: Example of a network MCS

See Pckt3 in the previous figure. This packet shows that parameters from the same chassis, at the same rate, are grouped in the same packet.

The packets created by the MCS have the same rate as the parameters transmitted in the PCM, that is occurrences of one are used for all the parameters used by the MCS.

If the packet is less than 64 bytes, dummy parameters are inserted in the packet.

41.3.4 Delays associated

This section provides simplified descriptions of underlying algorithms used in MCS within KSM-500.
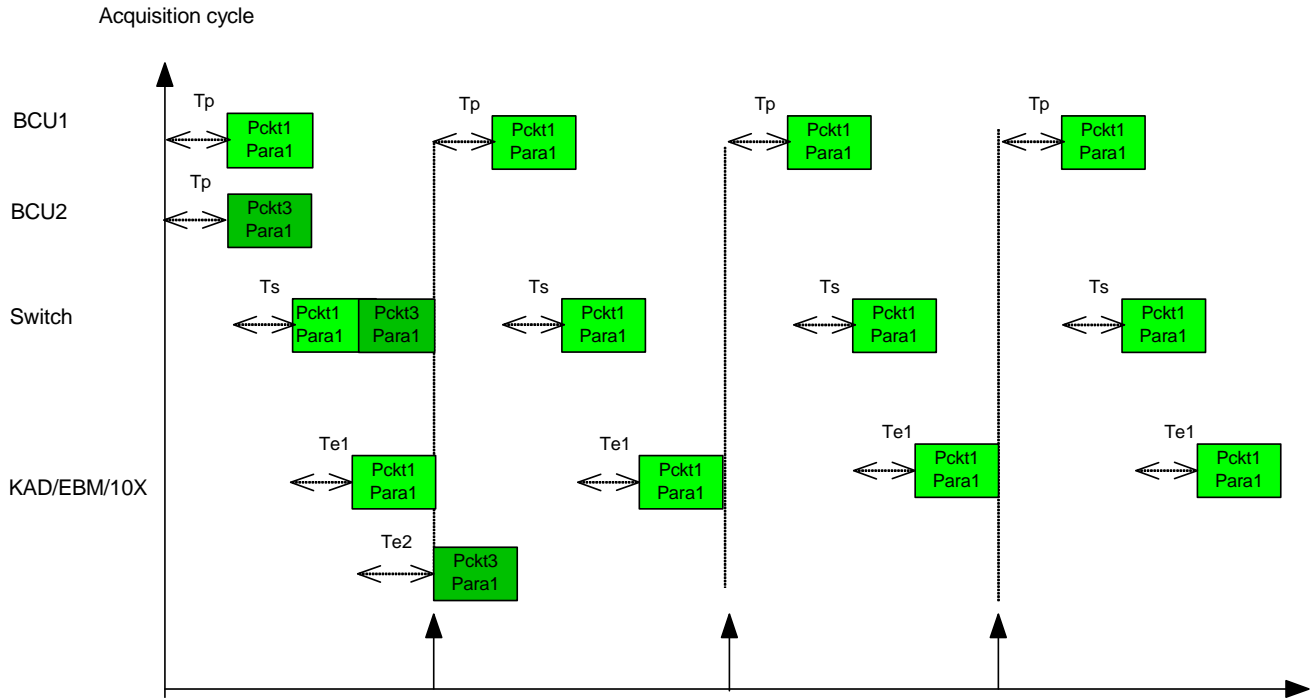
Figure 41-5: Graph representing the delay associated

Tp is controlled by the MCS, see the previous figure. The MCS can transmit packets to the Ethernet to PCM bridge at a specific time depending on the PCM deadline. Tp is in the order of microseconds.

Ts is mostly known except the jitter. It's a store and forward switch. The delay is twice the packet length at 100 Mbps. Tp is also dependent on the bandwidth of the traffic coming from the different ingress ports as this queues to the aggregator port. Ts is in the order of microseconds.

Te is known. An Ethernet bus monitor uses a triple buffered input so there may be up to two packet delays at the input.

41.3.5 Notes on network efficiency

The packets created by the MCS are not efficient for a network data acquisition system. For recorders, it's recommended to use long packets, not fragmented packets. You should optimize the packets by using parameters occurrences rather than packet rate.

However, because the PCM used by telemetry has a small bandwidth, the MCS does not have much of an effect on the overall network efficiency. For example, a PCM at 4 Mbit/s using an Ethernet to PCM bridge increases the network bandwidth by approximately 8Mbit/s.

41.3.6 Notes on PCM placement

All the parameters placed in the PCM are internally sourced by the Ethernet bus monitor when the MCS is used. The Ethernet bus monitor follows the same rules for PCM placement as other bus monitors. PCM placement rules that are specifically applicable for the MCS over IP network are:

• To not interleave parser slots from the same bus module. In Figure 41-2 on page 2, the KAD/EBM/102 in the Ethernet to PCM bridge DAU is an Ethernet bus monitor. Each parameter at the same rate from the same DAU is parsed by one parser slot from the KAD/EBM/102. Therefore you should place slave parameters from the same DAU at the same rate in a horizontal, sequential placement in the PCM frame. This limits the overhead needed when accessing these parser slots.
• To place a networked DAU parameters later in the PCM frame. There is a delay associated with transferring a parameter from a networked DAU to a PCM frame in an Ethernet to PCM bridge DAU. Therefore, parameters from the networked DAUs should be placed furthest away from the beginning of the PCM frame. This allows time for the parameter to be sampled, transmitted over Ethernet, parsed by the Ethernet bus monitor and become available to the PCM transmitter. See "Delays associated" on page 4.

Thread threshold on the Ethernet bus monitor can be used in case of a compilation issue. This advanced field allows the compiler to interleave data words from different messages on the same module. This helps compilation if the rules of PCM placement are not followed. The smaller the number used for the thread threshold the better the flexibility on the backplane, but more transfers (overhead) on the backplane are added.

41.4 Appendix

41.4.1 GUI options added to kSetup for the MCS

The MCS can be configured with different settings to make it as flexible as possible:

- The Prohibit/Allow implicit packets transmission setting determines if the module is to be used to transmit/receive MCS packets. This is useful if there are multiple Ethernet transmitters or bus monitors in the same chassis. Also, if there are Ethernet bus monitors in the task, other than the Ethernet to PCM bridge DAU, then they need to be prohibited from being used by the MCS. If they are not prohibited then a parameter could pass through the bus monitor and therefore pass through an extraneous DAU rather than go directly to the Ethernet to PCM bridge DAU.
- Multicast destination IP address can be used to filter out MCS traffic, for example, when using a NET/SWI/003 and you don't want MCS traffic going to a network recorder. If this field is left blank then the unicast IP address of the bus monitor is used as the destination for the MCS packets. If a multicast IP address is entered in the field for the Ethernet bus monitor, all MCS packets to that bus monitor use this new destination IP address. If a multicast IP address is entered in this field for a transmitter then this is used for all MCS packets going from this transmitter to the bus monitor. The setting on the transmitter takes precedence over the setting on the bus monitor.
- Max payload size is the maximum packet size used by the MCS. By default this is 722, which is the maximum size of an unfragmented IENA packet in networks with a Maximum Transmission Unit (MTU) of 1,500 bytes. The same precedence and usage rules apply as those of the multicast destination IP address. This option can be used to reduce latency. It can also make it easier to schedule the backplane transfers of a DAU that is supplying parameters for the MCS over Ethernet or an Ethernet to PCM bridge DAU, if there are problems during compilation.

The following screenshot shows how these settings appear in the Setup tab of Ethernet transmitters and bus monitors:

Figure 41-6: Setup tab of the Ethernet transmitters and bus monitors associated to the network MCS

41.4.2 Connections example

Using a NET/SWI/004 as reference, the different DAUs and recorders should be connected as in the following figure.
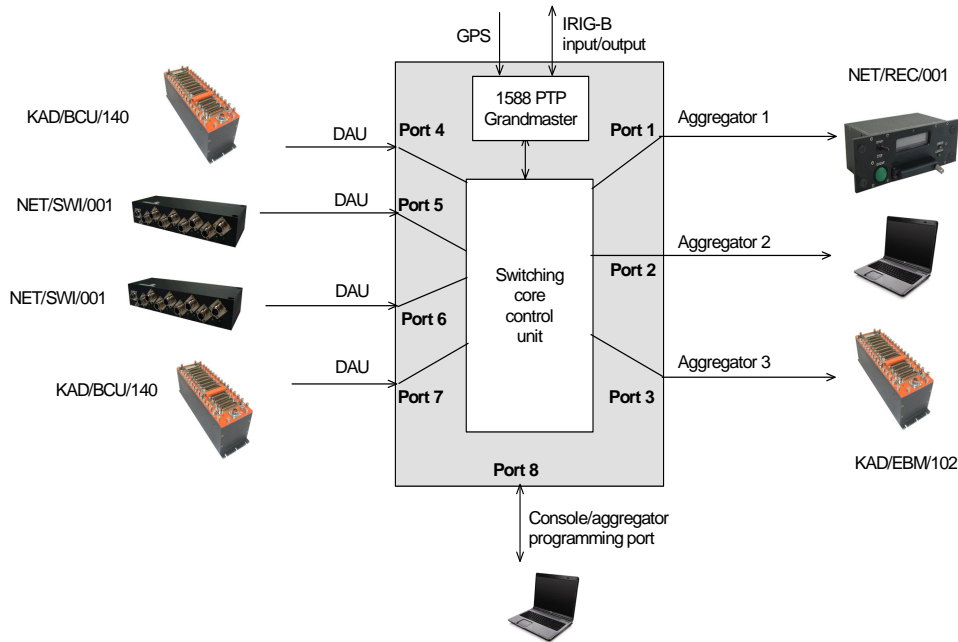

Figure 41-7: NET/SWI/004 connection example

All DAUs are connected to DAU ports. The Ethernet bus monitor is connected to an aggregator port.

NOTE: Note that the bus monitor module must be located in the same DAU as the PCM encoder. These two modules could be located in a dedicated Ethernet to PCM bridge chassis or in one of the DAUs. The network recorder and/or monitoring PC are connected to an aggregator port.

41.5 Glossary of terms

DAU: Data Acquisition Unit

IP: Internet protocol. The network layer protocol OSI stack. The IP layer provides logical IP source and destination addresses for packets that are transmitted across the network.

MCS: Multi-Chassis Scheduler. Part of the compiler that transparently looks after cross-chassis configurations.

PCM: Pulse Code Modulation. The primary way analog signals are converted into digital form by taking samples of the waveforms from 8 to 192 thousand times per second (8 to 192 kHz) and recording each sample as a digital number from 8 to 24 bits long.

This page is intentionally blank