

Cyber-Physical System Network Protocol (CPSNP) Specification

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The CPSNP is built on top of the UDP network protocol. CPSNP uses datagram multicasting to send packets across a network to reach an unknown amount of listener. A broadcaster has an idea of the size of the CPS network from most recent network update but because UDP is a connectionless protocol, a system can never know for certain how many other systems are listening on the network. An acknowledgement packet implementation can let the broadcaster know another system received the packet and move on.

Within this specification, a system that is broadcasting a packet across the network is A and a system(s) that are listening on the network are $\{B \mid C \mid D\}$.

Behavior Packet:

A behavior packet is used when A wants to broadcast a behavior request with n -parameters across the network on a specific channel. Within the behavior packet, A 's MAC address is included to identify which system is broadcasting the packet since MAC addresses are unique.

opcode / packet ID	channel	src mac addr	behavior code	param 1	0	param N	0
2 bytes	2 bytes	6 bytes	2 bytes	N bytes	1 byte	N bytes	1 byte

Acknowledgement (ACK) Packet:

An acknowledgement packet is used when A broadcasts a behavior request with n -parameters across the network on a specific channel and B receives the packet, properly parses the packet, and acts on the behavior code. B can send an acknowledgement packet back to let A know the packet was received. B needs to include its own MAC address in "src mac addr" to let A know where the acknowledgement is coming from, and B needs to also include A 's MAC address (which can be obtained from A 's behavior packet) in "dest mac addr" to let A know the acknowledgement packet is for them.

opcode / packet ID	channel	src mac addr	dest mac addr	behavior code
2 bytes	2 bytes	6 bytes	6 bytes	2 bytes

Channel Request (CRQ) Packet:

A scenario where a channel request packet will be used is when A , B , C , and D are all on the same CPS network. A wants to send a behavior packet to just B but wants to stay on the same CPS network. A sends B a channel request packet which includes A 's mac address to indicate where the request is coming from and B 's mac address to indicate who is receiving the channel request. All systems on the CPS network can receive the channel request packet but the packet is only meant for the system with the same MAC address as the one specified in "dest mac addr." If the channel request is accepted by B , then A can send a behavior packet across the network with the channel parameter changed to the same channel in the channel request packet. All systems on the network can receive the behavior packet but if the system does not have the channel internally mapped to another system, then the behavior packet will be dropped.

Channel request packets can be sent to a subset of systems in the network as well. If A wants to communicate to just B and C , then A sends a channel request packet with the same channel to both B , and C . Channel request packets is useful if a system wants to communicate a behavior to nearby systems (i.e. systems on the same track piece) but wants to stay on the same network as the entire track.

opcode / packet ID	channel	src mac addr	dest mac addr	channel request
2 bytes	2 bytes	6 bytes	6 bytes	2 bytes

Channel Acknowledgement (CAACK) Packet:

A channel acknowledgement packet is used when A sends a channel request packet across the network to communicate on a specific channel and B receives the packet, properly parses the packet, and internally maps the channel to the sender of the channel request packet. B can send a channel acknowledgement packet back to let A know the packet was received. B needs to include its own MAC address in “src mac addr” to let A know where the channel acknowledgement is coming from, and B needs to also include A ’s MAC address (which can be obtained from A ’s channel request packet) in “dest mac addr” to let A know the channel acknowledgement packet is from them.

opcode / packet ID	channel	src mac addr	dest mac addr	channel request
2 bytes	2 bytes	6 bytes	6 bytes	2 bytes

Error Packet:

An error packet is used when a system receives a packet from another system but cannot act on the behavior. An error packet is useful to let the sender of the behavior packet to stop (and possible try again with new parameters) sending packets to not clog the CPS network. The origin of the error is specified within the error code.

opcode / packet ID	channel	src mac addr	dest mac addr	behavior code	error code
2 bytes	2 bytes	6 bytes	6 bytes	2 bytes	2 bytes