# 802.3 to 802.15.4 Bridging Proposal

Issues to be addressed bridging proposal are:

By using layer 3 routing between 802.15.4 network and 802.3 network a large percentage of capacity is wasted by layer 3headers on small 802.15.4 frame size especially with IPv6 addressing

An 802.15.4 device cannot subscribe to 802.1 TSN talker for control information or any other TSN features as it communication are done at layer 3 and since 802.15.4 is used extensively in industrial automation this could be a significant problem.

Proposed solution is to use bridging between two types of network. Main challenges are that 802.15.4 uses 64 bit MAC addresses and 802.3 uses 48 bit MACs and that the frames size on 802.15.4 is substantially smaller than 802.3

Proposed fixes are documented below with potential issues and workarounds listed after.

## 1 Addressing issue

There is new 802.1c standard under development for dynamic address allocation. When the 802.15.4 controller detects the existence of an 802.15.4 end point it can use this standard to dynamically obtain a 48 bit address for the 64 bit end point and holds the translation in a table. When it receives a frame from the 802.3 side with dynamic MAC address it forwards the message to the 64 bit address associated with the 802.3 MAC address. When it receives a message from an 802.15.4 end point the controller looks up its translation table and forwards the message with the source MAC updated as the dynamic MAC address associated with the 802.15.4 end point.

## 2 Frame size issue

The simplest way to deal with the difference in frame sizes between the two systems is to support fragmentation on the 802.15.4 side of the bridge since its frame is smaller than the 802.3 side and as noted before complete upper-layer packets in a single 802.15.4 frame burn a lot of overhead.

The proposed solution to this is to reserve the top 2 bits of the 802.15.4 sequence number for fragmentation indication. The top bit indicates that the 802.15.4 frame is part of a fragmented packet and the second top bit indicates that the packet is the last packet in the fragmented packet. If the last packet is dropped there would be a sequence error indicating a fault in the packet so there is no danger of dropping the end of fragment packet and merging two consecutive fragmented packets together.

Potentially changing the top two bits of the sequence number might cause backward compatibility issues, another alternative would be to add an extra two bits to the header but again this could potentially cause backward compatibility issues.

## 3 Potential issues

When the frame is reconstructed by the method above an Ethernet frame will be passed to the application instead of an 802.15.4 frame but this is just something the application would need to deal with. When using layer 3 the endpoint would need to support full TCP stack but then if it was using layer 3 routing it would also have to support full TCP stack.

When sending a message from the 802.15.4 endpoint the end point does not have to include the dynamic 48 bit MAC address in its packet it could just send a blank source MAC and the controller would overwrite this with the dynamic MAC address. Also the endpoint does not have to calculate the for the Ethernet frame as this can be added by the forwarding controller. Since 802.15.4 has its own check sums and sequence numbers it is known that the full and correct packet has been received for forwarding.

The proposed solution effectively turns the 802.15.4 network into an 802.3 link so all 802.1tsn standards should be capable of working over the link with the possible exception of 802.1Qbv on the transmit side from the 802.15.4 network as the time is not as predictable as required but it is probable that the vast majority of 802.15.4 devices will be listeners rather than talkers and this should work just fine with this proposal.

The packet drop rate will not change on the 802.15.4 as it would by significantly increasing the frame size. Any dropped fragment will be retransmitted by the sequence number protection system as any 802.15.4 frame would be.

If there is a requirement to have the endpoint MAC address in an external message beyond just the source address then when the controller detects an endpoint and allocates a MAC address for it it could send an initialization message to the endpoint telling it the dynamically allocated address.