Bridging Frames with 64-bit addresses

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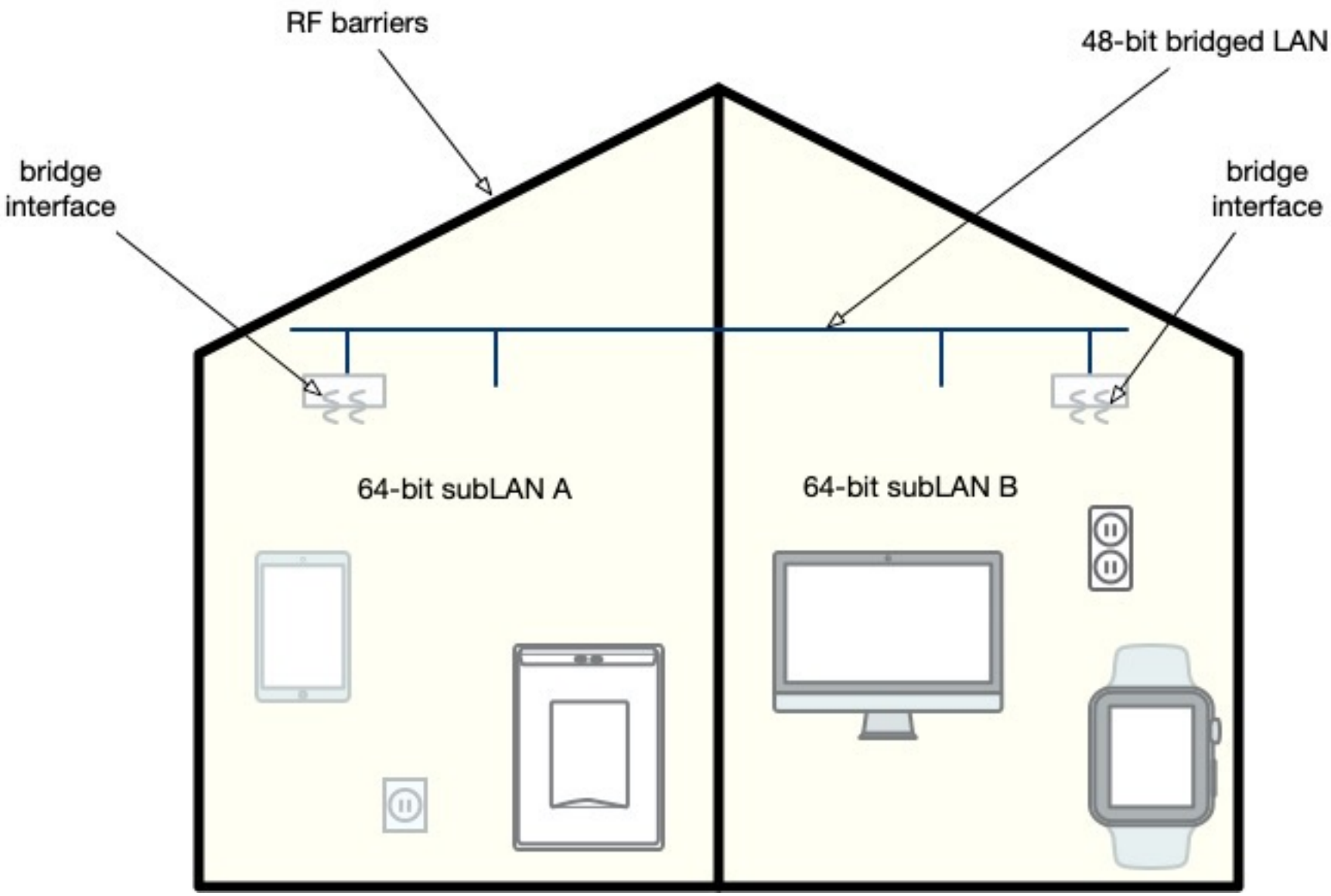
Background

- IEEE Std 802: Overview and Architecture
  - MAC address is either 48 bit and 64-bits
    - Global and local
  - *Bridging for an IEEE 802 network with 64-bit MAC addresses is currently not specified.*
  - *The reason is that the bridging function in IEEE Std 802.1D and IEEE Std 802.1Q assumes that 48-bit MAC addresses are unique among all the connected networks. Truncating an 64-bit MAC address into an 48-bit field can lead to two stations having the same 48-bit value. Instead, traffic between 64-bit and 48-bit MAC addressed networks needs to be routed at a layer above the DLL.*
- IEEE Std 802.15.4 operates with 64-bit addresses
  - and 16-bit "short addresses"
- Bridging is possible
  - not by simplistically truncating a 64-bit address to 48 bits

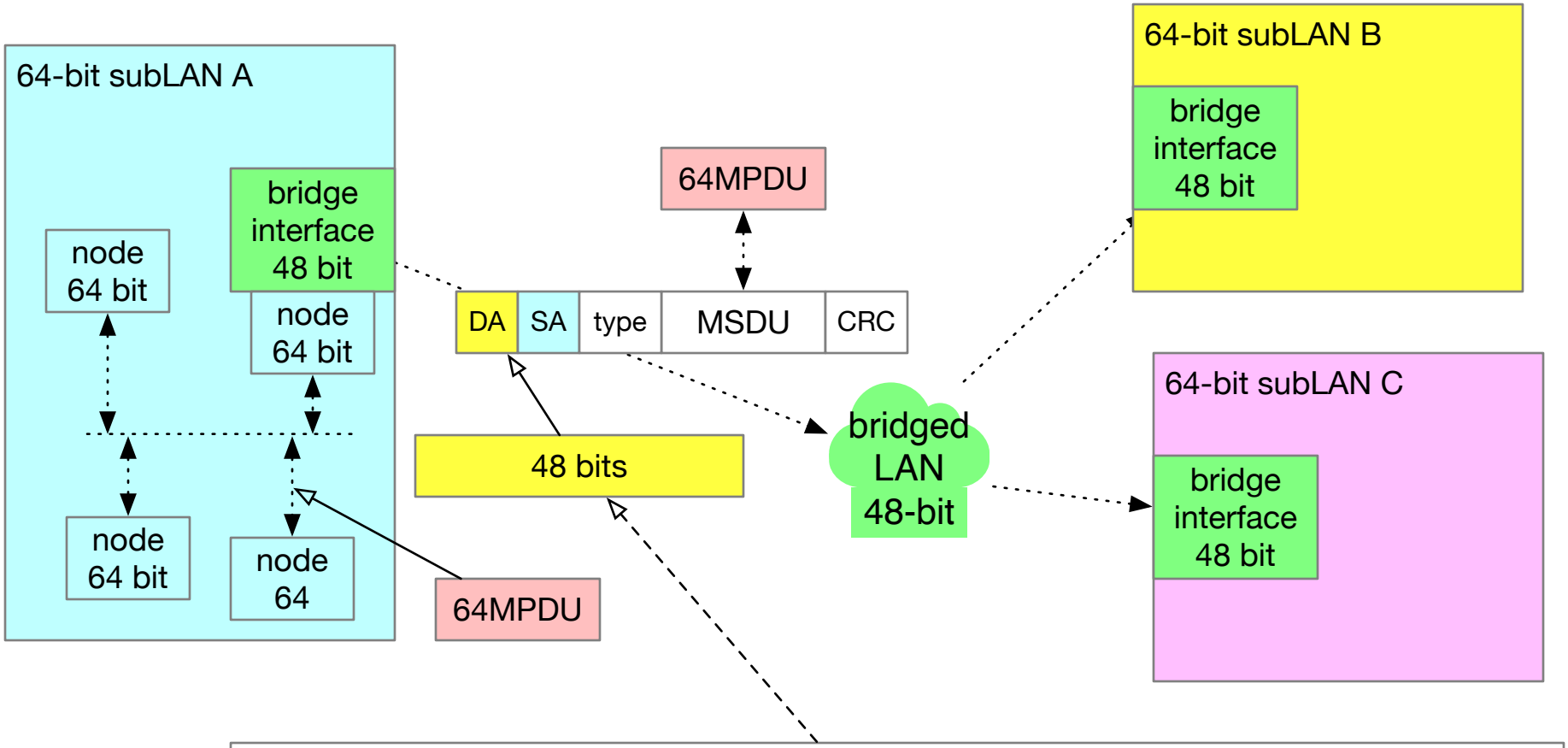
Relevant Prior Contribution

- "Adapting/Bridging 64-bit MACs with 48-bit MACs"
  - Behcet Sarikaya, Li Yizhou, Tom McBeath, Clint Powell, Max Riegel, Robert Moskowitz, Ben McCrane
  - https://www.ieee802.org/1/files/public/docs2016/new-64bitto48bitMACAdapting-sarikaya-0116-v00-xtn.pdf
- *In a Personal Area Network, there are nodes connected to two IEEE 802 technologies like 802.15.4 with 64-bit MACs and 802.3 with 48-bit MACs, PAN coordinator and intermediate bridges and routers*
- *This document presents use cases for using 802.1 bridges to adopt 64-bit MACs with 48-bit MACs*
- *Address Bridging: 64-bit to 48-bit address adaptation work is needed in 802.1*
- *Local addresses can be used by the bridge during address bridging (both for 64-bit to 48-bit and vice versa)*

A Potential Use Case: RF Barrier



48-bit Bridging of 64-bit subLANs



- 64-bit subLANs (A,B,C) convert MPDU (“64MPDU”)
- Bridged frame uses 48-bit DA and SA, carrying MSDU
- MSDU has sufficient information to reconstruct 64MPDU
- DA & SA represent either the 64-bit node, or its subLAN

Address Mapping Options

A. 1:1 address mapping
   - Each 64-bit address is mapped 1:1 to a 48-bit address; e.g.
     - by algorithm, or
     - by mapping table in each bridge interface
   - Bridge interface translates 64MPDU ⇔ MSDU
   - bridge forwards by node address
     - needs a forwarding entry for each node in the network (may timeout often)

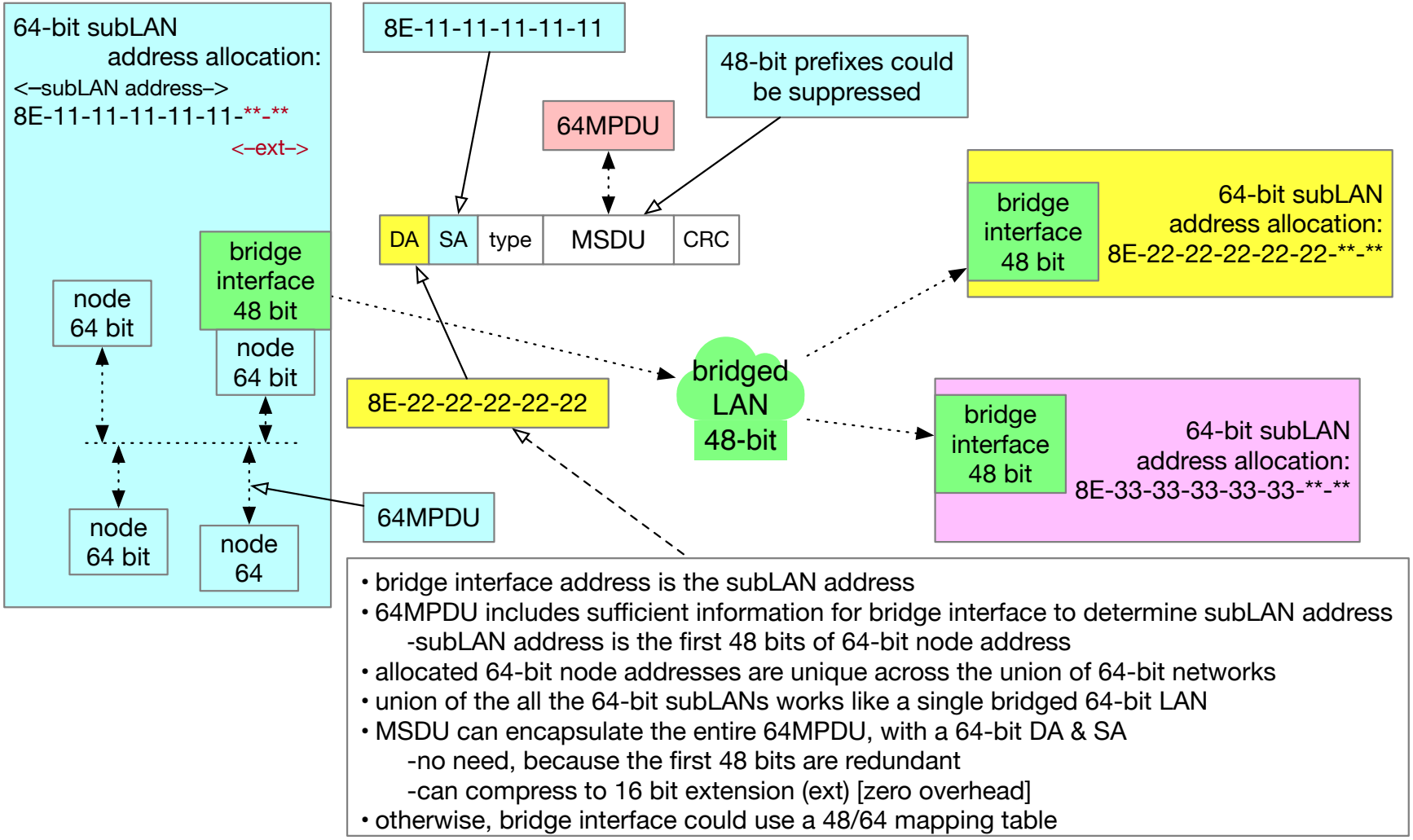
B. Encapsulation
   - bridge interface encapsulates and decapsulates 64MPDU as MSDU
   - bridge forwards by 48-bit subLAN address of bridge interface
     - needs a forwarding entry for each bridge interface
       - forwarding entry timeouts are rarer than with 1:1 address mapping
   - bridge interface knows the 48-bit subLAN address of each 64-bit DA
     - by algorithm, or by mapping table

C. Reframing (generalized encapsulation)
   - Similar to B
   - MSDU does not need to carry 64MPDU explicitly, as long as the frame includes sufficient information to reconstruct the 64MPDU

A: 1:1 Address Mapping

- 1:1 address mapping is possible
- Example: as of 2012, the IEEE SA Registration Authority's *Guidelines for 64-bit Global Identifier (EUI-64)* said:
  - ***Restricted Encapsulated Values***
  - *To support encapsulation of EUI-48 … within small subsets of the EUI-64 values, the first four digits of the manufacturer's extension identifier shall not be $FFFF_{16}$ or $FFFE_{16}$. Thus, the 64-bit values of the following form are* ***never-assigned EUI-64 values****:*
    - *ccccccFFFFeeeeee*$_{16}$ (encapsulation of EUI-48 ccccccFFFFeeeeee)
    - *ccccccFFFEeeeeee*$_{16}$ (encapsulation of EUI-48 ccccccFFFFeeeeee)
  - *…the EUI-48 value can be unambiguously encapsulated within the EUI-64*
- Currently, per the IEEE Registration Authority:
  - *Mapping an EUI-48 to an EUI-64 is deprecated. The mapping is described here for historical reasons.*
  - More importantly: the restriction on EUI-64 was dropped.
    - no longer possible to distinguish an encapsulated EUI-48 from an EUI-64
- In any case, bridging by 1:1 address mapping requires that bridge keeps a forwarding entry for each node in the network.

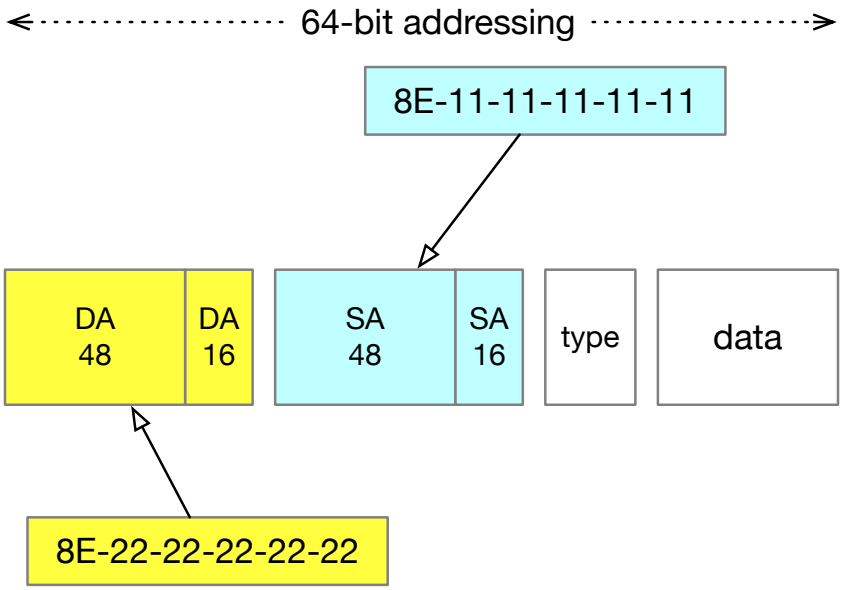
B/C: Reframing with Dynamically-Assigned Local Addresses

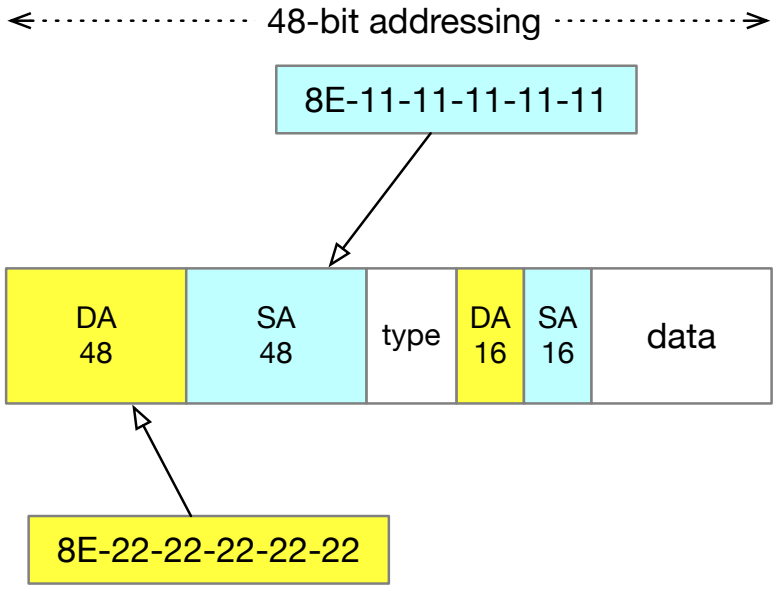


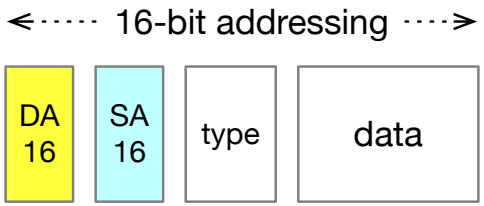
- bridge interface address is the subLAN address
- 64MPDU includes sufficient information for bridge interface to determine subLAN address
  - -subLAN address is the first 48 bits of 64-bit node address
- allocated 64-bit node addresses are unique across the union of 64-bit networks
- union of the all the 64-bit subLANs works like a single bridged 64-bit LAN
- MSDU can encapsulate the entire 64MPDU, with a 64-bit DA & SA
  - -no need, because the first 48 bits are redundant
  - -can compress to 16 bit extension (ext) [zero overhead]
- otherwise, bridge interface could use a 48/64 mapping table

- Note: This is not compatible with global addressing because the hardware address of the nodes in the subLAN will not share a common first 48 bits; a mapping table would be needed.

Reframing detail: 64-bit or 16-bit frame represented in 48-bit frame







Dynamic Local Addresses Assignment with P802.1CQ BARC

- P802.1CQ/D0.7:
  - Assigns local addresses in address blocks
  - Assignee of a 48-bit address is implicitly assigned all 64-bit extensions
    - e.g. 8E-11-11-11-11-11 is assigned to the subLAN's bridge interface
    - then all 8E-11-11-11-11-11 -**-** are simultaneously assigned to the subLAN
    - 16-bit extensions are dynamically assigned within the subLAN
  - *While BARC operates in a network based on 48-bit addresses, it provides for assignment of both 48-bit and 64-bit addresses. Assigned 48-bit addresses are usable on the bridged LAN on which BARC operates, whereas 64-bit addresses are not. A set of dual-interface devices all attached to a 48-bit bridged LAN can, using BARC, obtain 64-bit address assignments that will be unique among those devices for use on the 64-bit network.*
  - BARC functions on a standard bridged LAN. It's possible that BARC could be extended to assign extension addresses to nodes in the subLAN.
    - More information is needed about specific LANs on which such support may be required.

Call to Action

- If you are interested in this use case, see if BARC makes sense for your favorite subLAN.
- Review P802.1CQ and see if it meets your needs.
  - P802.1CQ/D0.8 is in development following comment resolution
  - Still in Task Group Ballot stage in 802.1 TSN Task Group
- Consider whether the 802.15.4 16-bit “short address” field is suitable to be concatenated to the 48-bit subLAN address to form the 64-bit 802.15.4 “extended address” in the BARC assignment.
- Consider whether a standardized address assignment protocol to hand out the node address would be helpful.
  - Should it be an extension of BARC?
  - Should it be specified in P802.1CQ, or elsewhere?

Annex: Other bridging issues

- Issues other than address size could affect bridging among 802.15 subLANs.
- Such issues are not addressed in this contribution, but…
- One point previously raised is that subLAN may have a smaller maximum frame size than Ethernet.
  - If the subLAN needed to serve as a bridge itself (for example, two Ethernet networks bridged by 802.15.4), that would be a problem.
  - In the subLAN scenario described here, frames intended for a node are generated by another node with the same requirements.
  - No problem, unless those frames exceed the bridge frame size limit.
- If subLAN frame is too long for Ethernet, fragmentation may be required.