Bridging 64-bit MACs with 48-bit MACs

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Current IoT Networking

- IETF is developing IPv6 solutions for addressing and routing in the PAN
- IETF is developing only IPv6 solutions on IoT in an effort to push IPv6
- Current IoT solution requires smart home/office network to terminate IP and then restart IPv6 routing downstream
- 802.3 frame from IoT server in the Internet can not be bridged at PAN coordinator

64-bit MACs vs 48-bit MACs

- 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
- We will also present technical issues in the bridge solution

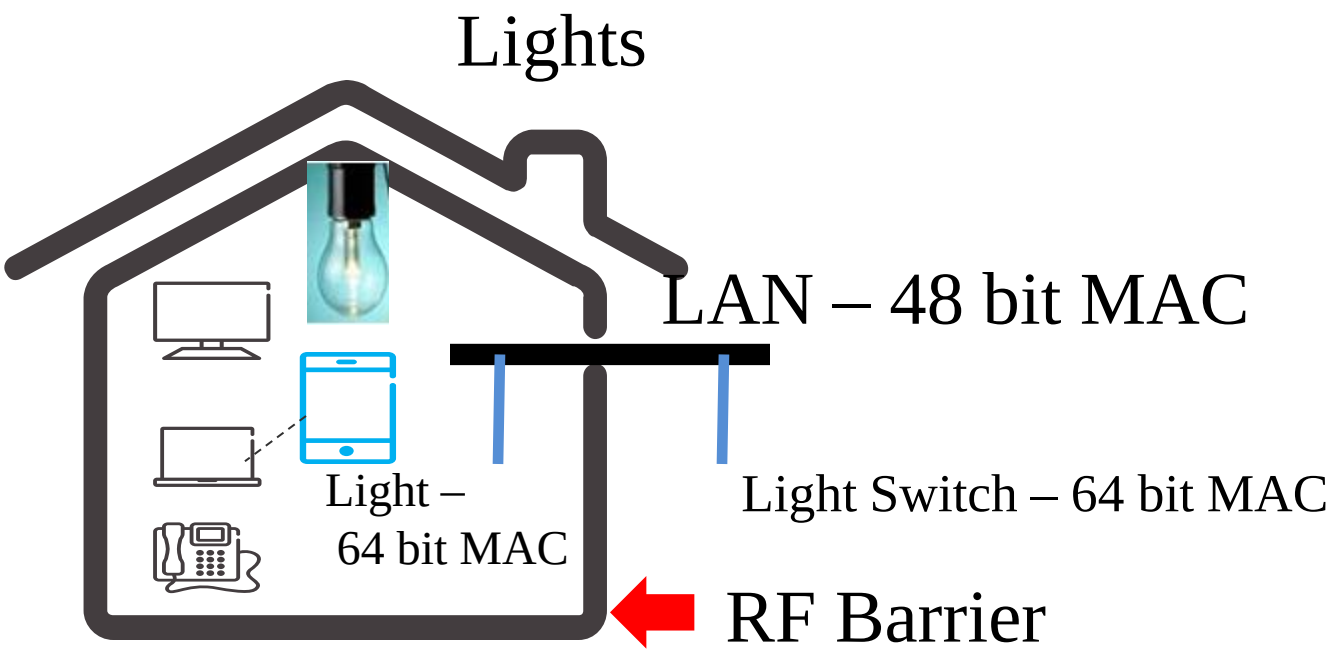
Use Cases

- Smart Home/Office
- Monitor smart home/office traffic using a laptop
- Laptop is connected to the LAN
- Laptop is connected to WPAN
- In order to adopt 64-bit MACs to 48-bit MACs, in the current solution, the laptop has to be a router, run routing software
- There is already another router in the home network complicating the routing

Use Cases

- Monitor smart home/office traffic using a laptop connected to both LAN and WPAN
- The laptop running routing software requires so much configuration, so it can not readily be used for monitoring
- 64 bit MAC to 48 bit MAC Bridge is the only solution to provide immediate monitoring capability

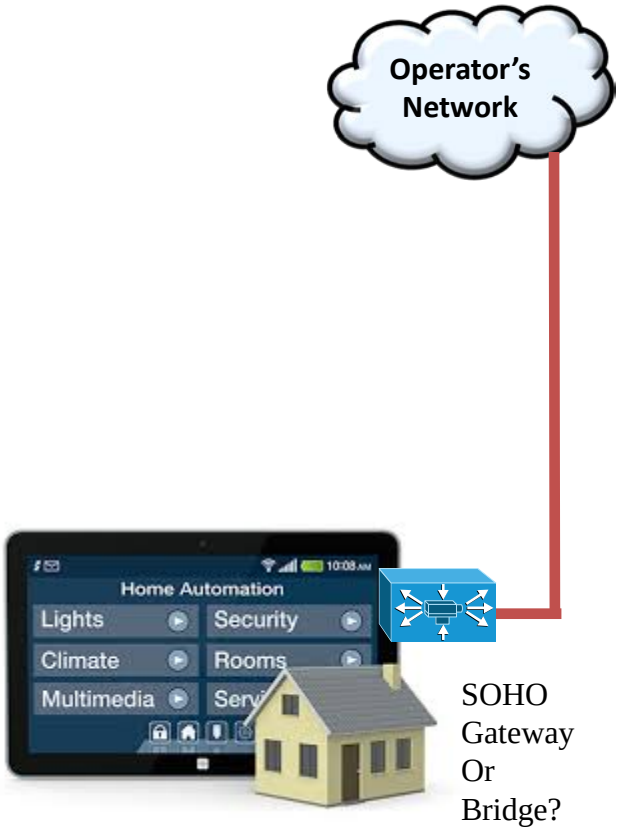
Use Cases



- 64 bit MAC to 48 bit MAC Bridge is the only solution to provide switch control to the lights in this scenario

Use Cases

- Bridge solution not IP can even apply to smart home/office gateway
- Additional overhead IP imposes on a system compared to layer 2 especially if its IPv6 could reach 50%, we'll show how:
- The packet size on 802.15.4 is about a tenth of that of non-jumbo frame Ethernet.
- IPv6 header alone is 40 bytes so if the frame size is 127 bytes the IPv6 overhead is about 30% of the frame
- Add the MAC headers and that's another 12 bytes or more
- So overhead of an 802.15.4 packet carried over Ethernet on IPv6 is close to 50% of the frame.



Why Bridging?

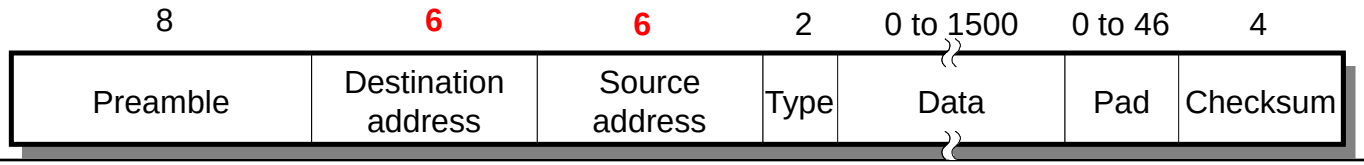
- Why bridging? if any communications equipment has a 64 bit MAC on it unless we say it can only be routed and cannot be attached to a bridged network then there is the case for bridging.
- IEEE 802 architecture (IEEE Std 802-2014) states on page 26 that bridging for an IEEE 802 network with 64-bit MAC addresses is currently not specified

Frame Formats

- 802.15.4 MAC Data Frame

Octets:2	1	4 to 20	variable	2
Frame control	Data sequence number	Address information	Data payload	Frame check sequence
MAC header			**MAC Payload**	**MAC footer**

- Only 802.15.4 MAC has 64 bit MAC addresses, others like Bluetooth or 802.15.1 are 48 bit
- 802.3 MAC Data Frame



802.15.4 to 802.3 Adaptation or Bridging

- Address bridging: 802.15.4 MAC address long format is 64 bits or 8 octets, 802.3 supports 48 bit MAC address, i.e. 6 octets
- MPDU bridging: Some 802.15.4 PHY limit MPDUs to 127 octets, 802.3 has 1500 octet MPDUs
- Avoiding control frame loops
- Timing bridging: See later

MAC address adaptation

- 48-bit MAC addresses can be converted (mapped) into 64-bit addresses as in IEEE Guidelines **standards.ieee.org/develop/regauth/tut/eui64.pdf**
- Unfortunately it was found out that IEEE Guidelines was wrong, so no solution for 48-bit MAC to 64-bit MAC exists ?
- No solution for 64-bit to 48-bit MAC address conversion
- New developments in this area include 802.1 TG dealing with local addresses and Layer 2 Routing protocol
- Consider support for short (16-bit) addresses (?)

802.1 Local Addressing

- Local addressing is now part of 802.1 DCB Task Group
- 48-bit MAC addresses are depleting like IPv4 addresses because of Data Center, IoT, etc.
- Local address TG will recommend how to use local addresses, 7th bit in Byte 1 set to 1
- Local address TG will develop protocols to acquire local addresses
- 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

- IEEE 802.15 Task Group 10 finished developing a new protocol on Layer 2 routing in Wireless Personal Area Network (WPAN)
- After the incoming frame if bridged to 802.15 network, L2R protocol can route it to the destination

MPDU Size Adaptation

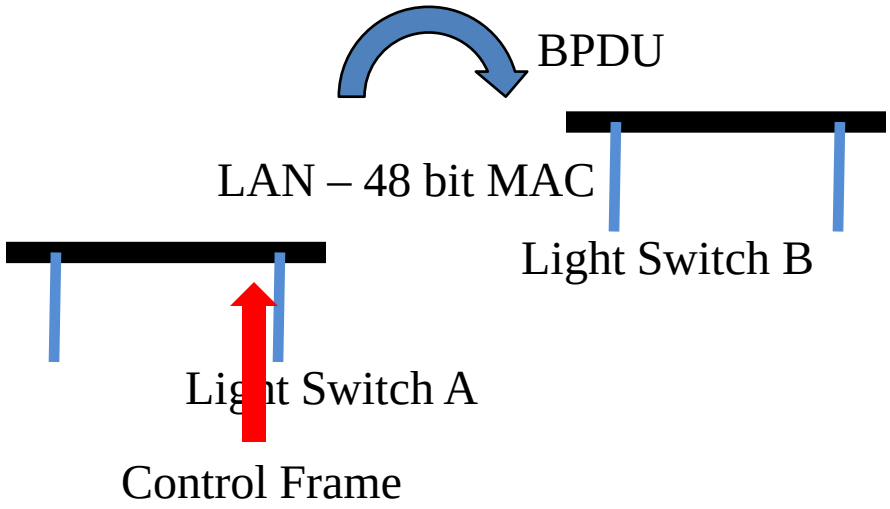
- 802.15 amendments that can support 1500 octets: 802.3d, 802.15.4g, 802.15.4m
- Other 802.15 technologies that have smaller MPDU sizes like 127 octets in 802.15.4.e
- Ethernet can carry frame sizes 64 to 1500 octets
- MPDU bridging: Bridge may receive frames longer than 802.15 can handle, fragmentation/reassembly is needed in 802.15

MPDU Size for 802.15.4

- 802.15.4 amendments that can support 1500 octets: 802.15.4g, 802.15.4m
- Others like 802.15.4k do not
- Limit the adaptation to those that can support
- Limit point to point link establishment to those that can support

Avoid Control Frame Loops

- Control frame sent by a light switch A may go to light switch B due to mobility
- A control frame from light switch A from LAN 1 and then entering to LAN 2 should not be bounced back to LAN 1 via a different port
- BPDU (STP) needs to be carried to avoid such a loop



Timing Considerations

- Bridge keeps a frame for a maximum of 1sec until it reaches the destination
- This value can be increased to 4sec maximum value
- 802.15 has sleeping nodes (4e, 4f, 4k, 15.1, 15.6)
- Timing Bridging: The work has to address this issue in 802.1
- There are wakeup frames defined in 802.15.4e, 4k
- Ways to wake up in other cases

Dealing With Frame Sizes

- Bridge protocol should try and find a way to pack multiple 802.15.4 frames into one Ethernet frame
- Even though the amount of data coming out of each PAN is low and if we have a lot of PANs the bridge may use better wireline bandwidth by packing multiple frames
- Of course the destination should be the same
- The data rate could be doubled because of the reduced overhead

Thank you!

Questions