Adapting/Bridging 64-bit MACs with 48-bit MACs

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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 adapting or bridging 64-bit MACs with 48-bit MACs

• We will also present technical issues in the adaptation/bridging solution
Use Case: Monitor SOHO Traffic

- 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 adapt 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
• 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 Adaptor/Bridge is the only solution to provide immediate monitoring capability

802.15.4 – 64 bit MAC
Adaptor

LAN – 48 bit MAC
Use Case: 11ah to 15.4

- Industrial Automation System involving 802.15.4 sensors and 802.11ah sensors/AP

Use Case: 11ah to 15.4

- 11ah to 15.4 bridge/adaptor helps connect 15.4 sensors (15.4e, 15.4g, etc.) to the control center
- 11ah to 15.4 bridge/adaptor has 11ah interface so it can connect to 11ah AP over long range (500m)
- 11ah AP backhauls the traffic eventually to the control center
- Need to consider only outgoing traffic from 15.4 network in the plant, i.e. data frames
Use Case: RF Barrier

Lights & Light Switch with RF Barrier

- 64 bit MAC to 48 bit MAC Adaptor/Bridge is the only solution to provide switch control to the lights in this scenario.
Use Case: RF Barrier

- In this use case, the adaptor adapts from 15.4 to 802.3 and then 802.3 to 15.4
- All traffic has to be adapted, data and control frames
- 64 bit long addresses as well as 16 bit short addresses need to be considered
Use Case: Home Gateway

- Making case for smart home/office gateway (SOHO) to do bridging not routing

- 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 Adapting/Bridging?

- Why adapting/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.
• **802.15.4 MAC Data Frame**

<table>
<thead>
<tr>
<th>Octets:2</th>
<th>1</th>
<th>4 to 20</th>
<th>variable</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame control</td>
<td>Data sequence number</td>
<td>Address information</td>
<td>Data payload</td>
<td>Frame check sequence</td>
</tr>
</tbody>
</table>

- **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**

<table>
<thead>
<tr>
<th>8</th>
<th>6</th>
<th>6</th>
<th>2</th>
<th>0 to 1500</th>
<th>0 to 46</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preamble</td>
<td>Destination address</td>
<td>Source address</td>
<td>Type</td>
<td>Data</td>
<td>Pad</td>
<td>Checksum</td>
</tr>
</tbody>
</table>
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:** Control frames need not be sent out in all cases except RF Barrier case as RF Barrier adaptor/bridge connects to the same PAN

- **So no control frame loop possibility**
• Currently there is no solution for 64-bit to 48-bit MAC address conversion
• Also no solution for 48-bit MAC addresses conversion/mapping into 64-bit addresses
• New developments in this area include 802.1 TG dealing with local addresses
• Consider support for short (16-bit) addresses
• 16-bit short address to 48-bit MAC address conversion and vice versa (RF Barrier Use Case)
802.1 Local Addressing

- Local addressing is now part of 802.1 DCB Task Group
- Currently lots of 48-bit MAC address space exist but depletion possibility from heavy use of network ports on devices should be addressed early enough
- Local address TG will recommend how to use local addresses, 7\textsuperscript{th} 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 (both for 64-bit to 48-bit and vice versa)
• 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

• 802.15.4 amendments that can support 1500 octets: 802.15.4g, 802.15.4m

• Other 802.15 technologies that have smaller MPDU sizes like 127 octets in 802.15.4e, 802.15.4k

• Ethernet can carry frame sizes 64 to 1500 octets

• MPDU bridging: Bridge/adaptor may receive frames longer than 802.15 can handle, fragmentation/reassembly is needed in 802.15
Dealing With Frame Sizes

- Segmentation and reassembly of frames
- Adaptor/Bridge does segmentation of frames
- Receiver does reassembly
• 802.15.4 MAC allows low-power/inactive mode
• Determined by superframe with inactive period
• Inactive period could be larger than 0
• Adaptor/Bridge have to stay away from transmitting the frame during inactive period
• Some 802.15.4 MAC supports sleeping mode
• Those MACs also have wakeup frames (as defined in 802.15.4e, 4k)
• Adaptor/Bridge have to wake up the node before transmitting the frame
Thank you!

Questions