IEEE 802 Address Assignment with P802.1CQ

IETF 112, intarea
2021-11-09

not the formal position, explanation, or interpretation of the IEEE but rather the personal views of:

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(EthAirNet Associates)
P802.1CQ Status [1]

- IEEE SA Project Authorization (PAR) P802.1CQ
  - Initiated: 2016-02-05; Extended 2020-06-03; Expires: 2022-12-31

- Draft Standard for Local and Metropolitan Area Networks: Multicast and Local Address Assignment
  - IEEE 802 addresses (MAC addresses)

- In 802.1 Working Group, Time-Sensitive Networking (TSN) Task Group
  - https://1.ieee802.org/tsn/802-1cq/

- Current draft: P802.1CQ/D0.7
  - reviewed in Task Group Ballot
  - comment resolution completed in September

- Awaiting editor’s implementation of new draft
  - IETF/802 coordination meeting has indicated that it should be shared with intarea
P802.1CQ PAR Details

• **Scope**: This standard specifies protocols, procedures, and management objects for *locally-unique assignment* of 48-bit and 64-bit addresses in IEEE 802 networks. **Peer-to-peer address claiming and address server capabilities are specified.**

• **Need**: Currently, global addresses are assigned to most IEEE 802 end station and bridge ports. **Increasing use of virtual machines and Internet of Things (IoT) devices could exhaust the global address space.** To provide a usable alternative to global addresses for such devices, this project will define a set of protocols that will allow ports to automatically obtain a locally-unique address in a range from a portion of the local address space. **Multicast flows also need addresses to identify the flows.** They will benefit from a set of protocols to distribute multicast addresses. **Peer-to-peer address claiming and address server capabilities will be included to serve the needs of smaller (e.g. home) and larger (e.g. industrial plants and building control) networks.**
Multicast Address Assignment

- In P802.1CQ, multicast addresses are assigned to end stations.
  - In other scenarios, multicast addresses are assigned to protocols.
- In some TSN networks, streams are addressed to multicast addresses assigned by the sender (the “talker”).
- A peer-to-peer protocol (MAAP) for a talker to claim a multicast address range is specified in IEEE Std 1722 (Transport Protocol for Time-Sensitive Applications in Bridged LANs).
- P802.1CQ provides backward compatibility with MAAP.
  - new functionality:
    - address blocks
    - Registrars (address servers)
    - operation without a global address
Power of Dynamic Software-Defined Addressing

• Half of IEEE 802 addresses are global
  - unique among all devices over an intended span of 100 years
  - generally burned-in by the factory, so flat
• Half of IEEE 802 addresses are local
  - assignable dynamically
  - vast quantity available, since uniqueness restriction limited to the LAN
  - can be liberally assigned
  - can be thoughtfully assigned to have addressing power
• Block Address Registration and Claiming” (BARC) protocol
BARC assigns MAC Addresses in Blocks

- An Address Block (AB) is a set of local BARC addresses.
- An AB includes equal-sized and unicast and multicast contiguous sub-blocks.
- No BARC address falls within more than one AB.
- Registrable Address Block Identifier (RABI)
  - identifies a Registrable Address Block (RAB) holding Registrable Addresses (RAs)
  - RABIs are held in inventory of a Registrar
    - may be assigned to Claimants
- Claimable AB Address (CABA)
  - identifies Claimable Address Blocks (CABs) holding Claimable Addresses (CAs)
  - claimable by a Claimant without using a Registrar
  - CABA is a multicast MAC address, not in any AB, and used as a DA
- An Address Block Designation (ABD) is a CABA or a RABI.
- A large set of Temporary Unicast Addresses (TUAs) is specified
  - useful for initial discovery by Claimant lacking a unicast address
### BARC MAC Address Structure

<table>
<thead>
<tr>
<th>N0</th>
<th>r</th>
<th>i</th>
<th>j</th>
<th>k</th>
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<tbody>
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</tbody>
</table>

For registrable addresses, \( r=1 \); for claimable addresses, \( r=0 \)

<table>
<thead>
<tr>
<th>N1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>m</th>
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<tbody>
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</tbody>
</table>

\( m \) is the usual multicast (I/G) bit; 111 for “SAI*” (Standard Assigned Identifier)

<table>
<thead>
<tr>
<th>N2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000 for CA or TUA</td>
</tr>
</tbody>
</table>

- Address block includes subblocks of
  - \( 16^{jk} \) claimable addresses, or
  - \( 16^{jk} \) registrable addresses (or aggregated into larger blocks)
- For claimable addresses, \( i \) distinguishes
  - Claimable Addresses (CAs) from
  - CABAs
    - Identifiers that are also used as addresses
- See P802.1CQ/D0.7 for details

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<table>
<thead>
<tr>
<th></th>
<th>r</th>
<th>i</th>
<th>jk</th>
<th>m</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA</td>
<td>0</td>
<td>1</td>
<td>CAB</td>
<td>I/G</td>
</tr>
<tr>
<td>CABA</td>
<td>0</td>
<td>0</td>
<td>Size</td>
<td>1</td>
</tr>
<tr>
<td>TUA</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>RA</td>
<td>1</td>
<td>RABI</td>
<td>BABI</td>
<td>I/G</td>
</tr>
</tbody>
</table>
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12 nibbles per 48-bit address

*per IEEE Std 802 [2], “Specification of the use of the SAI quadrant for SLAP address assignments is reserved for the standard forthcoming from IEEE P802.1CQ”*
CABA and CA, CAB Size 0-3

2 contiguous subblocks per CABA (one unicast, one multicast)

- ≈6.9E10 Size 0 CABAs
- 1 CA/subblock
- ≈4.3E9 Size 1 CABAs
- 16 CAs/subblock
- ≈2.7E8 Size 2 CABAs
- 256 CA/subblock
- ≈1.7E7 Size 3 CABAs
- 4096 CAs/subblock

* indicates wildcard (any value)
Claimant of $\text{CABA}_X$ \( AB \) listens to $\text{CABA}_X$ multicast address

1. $\text{CABA}_1$ (DISCOVER state)
2. (unicast) $\text{CABA}_6$: CLAIMED state
3. Start listening to $\text{CABA}_6$

Claiming (simplified)
Registrar

• Claimant need not be aware of Registrar when initiating a claim.

• Registrar maintains an inventory of RABIs.
  – a protocol specifies how Registrars acquire RABIs.
  – set of RABs is disjoint from the set of CABs
    – AB is either claimable (CAB) or registrable (RAB); not both

• Registrar listens for all messages to a CABA.
  – r=0, i=0, m=1, i.e. DA begins 00**-1111
    • [MMRP NumberOfValues field is 13 bits]

• Registrar can respond to a DISCOVER with an offer of a RABI in its inventory.
  – The offer can also defend the DISCOVER’s CABA.
  – Registrar confirms registration of request for offered RABI.

• Pre-claim Inquiry lets Claimant reach Registrar or Advisor.
  – Client can learn of Registrars and received Claim proposals.
Operation with Registrars

Claimant

Registrar

RABI₁

(1) CABA₁: DISCOVER state

(2) (unicast) RABI₅: OFFERED state

RABI₂

(1) CABA₁: DISCOVER state

LAN

RABI₃

(2) (unicast) RABI₁: OFFERED state

(3) (unicast) RABI₁: REQUESTED state

RABI₄

(4) (unicast) RABI₁: REGISTERED state

Registrar
Semantic Address Block Assignments

<table>
<thead>
<tr>
<th>N0</th>
<th>N1</th>
<th>N2</th>
<th>N3</th>
<th>N4</th>
<th>N5</th>
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- **Semantic Prefix**: identifies format
- **Access Bridge ID**
- **Server ID**
- **Virtual Machine ID**

- Access switch ID: A
- Access switch ID: B

LAN

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<table>
<thead>
<tr>
<th>RA</th>
<th>1 0 0 0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 1 1 *</td>
</tr>
</tbody>
</table>
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<tr>
<td></td>
<td>1 1 1 *</td>
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Applications

• General address assignment
  - eliminates need for global addresses
  - reducing consumption
  - may simplify manufacturing
  - maintains uniqueness within the LAN
  - backward-compatible with IEEE 802 addressing and bridging
  - could be useful to address privacy concerns in global addressing
  - provides contiguous unicast and multicast blocks (identical except 1 bit)

• Apply address blocks to structure semantic addresses
  - addressing to reflect topology and hierarchy, as in IP
    - simplified forwarding
  - add flow identification to address
    - useful in forwarding and for other purposes
    - e.g. to multiplex within a single end station
  - combined structure and flow content
    - e.g. flow-zone switching in hyperscale Clos network [3]
  - alternative to completely random assignment; e.g. in wireless
    - dynamic assignment provides MAC address privacy
    - protocol protects against duplication
    - address blocks can code frames for location, flow, stream, etc.
  - bridging of 64-bit addressing in a 48-bit bridged LAN

• Implications to IP need exploration
References

   https://1.ieee802.org/tns/802-1cq
