Local Address Management in IoT environments

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PROBLEM STATEMENT

MAC address consumption ramps up

- **When MAC addresses were created (~1980) network ports were used only on computers and large printers in enterprises.**
- **Approaching the 2nd decade (2000), MAC address usage was still on a pace to last centuries.**
  - A typical user might have 3-5 devices with MAC addresses
- **Now, it isn't unusual to have a dozen or more addresses per person**
  - Cell phones, TVs, Blu-ray players, tablets, printers, network devices, laptops, media computer – and many of these have multiple addresses for multiple ports.
- **With IoT network ports moving into smaller and smaller things**
  - Sensors and actuators – e.g. light switches and thermostats
  - Potentially dozens of ports per home, car or machine
  - **Some may be disposable or short lived**, e.g. medical sensors

The problem statement

- **Should all these things consume global MAC address space?**
  - With cell phones and tablets, the consumption rate of MAC addresses has increased dramatically
  - The 48-bit MAC address space is supposed to last for at least 100 years
- **An explosion of IoT devices could burn through the address space long before the target 100 years.**
  - For example, Ethernet is moving into cars and by 2020 there may be 50 to 150 ports per car.
- **What about using Local Addresses?**
  - User configuration isn't reasonable – often no local interface and too large a potential for error
  - Existing automatic protocols configure addresses for virtual ports and rely existence of a physical port MAC address
- **We need to enable easy use of the Local Address Space without configuration.**

Local Address Space

- **The Local Address space is has been:**
  - A huge flat space: 2^{46} addresses
  - But lacking in organization to enable using it for anything but by a local administrator
- **It has not been widely used**
- **The first step in enabling use is providing structure.**
  - Leave a portion for local administration
  - Provide a portion with address blocks assignment to organizations
  - An organization can use such a block for an address acquisition protocol without conflicting with protocols using other blocks
  - Provide recommendations for use of the local address space
- **Define a standard generic protocol for address acquisition**
  - Some uses such as assignment of addresses to VMs are likely to use their own proprietary protocols
  - Applications such as IoT in home or Smart Grid devices would benefit from a standard for interoperable acquisition of addresses.

STRUCTURING LOCAL ADDRESS USE

Providing Structure

- **IEEE RAC has defined Company IDs (CID)**
  - 24-bit values similar to Organizationally Unique Identifiers (OUI) except that the global/local bit is set to local
  - One use of these is intended to be for local address blocks.
  - Assigned out of one quadrant of the local address space
- **IEEE 802.1 has proposed a PAR for IEEE 802c**
  - An amendment to IEEE 802 Overview and Architecture to add guidance on using the local address space.
  - Recommend using only one quadrant of the space for local administration
  - Use the CID quadrant for default address blocks for protocol
  - Forwarding the PAR will be considered at the November meeting

LOCAL ADDRESS ACQUISITION PROTOCOL

Status of work on a protocol

- **IEEE 802.1 is currently considering a project to define an address acquisition protocol**
  - Probably will decide whether to forward a PAR sometime next year.
- **The following slides are some thoughts on a protocol**

Transmitting before MAC address Acquisition

- **There is currently no way to transmit without a MAC address**
  - This is okay for obtaining an address for a virtual port because there is a physical port address that can be used.
  - That doesn’t work for an IoT device with no physical address
- **Define a Null address value to use as a source address for the address acquisition protocol**
  - This address is never allowed as a destination address
  - New bridges can ignore it for learning when seen as a source address. For existing bridges, it will move around in learning, but since it never is a destination address, it won’t matter where they think it is.
  - Could use well-known group addresses for the destination address
    - Possibly one for address servers and one for client nodes
    - Possibly existing LAN scoped addresses – e.g. nearest non-TPMR

Identifying the right response

- **With a multicast destination address, how does a client know which reply PDUs are for it?**
- **Client PDUs include a Client ID with identifier type and value; examples of identifier types:**
  - EUI-64
  - ICC ID (from SIM card)
  - A random number for those devices that have no configured unique ID
- **Response PDU includes the Client ID from the client's PDU**
  - Client processes PDUs received with its Client ID and discards ones with other Client IDs

Who’s the address server?

- **Claiming protocol without a server**
  - Client generates a proposed address and initiates a claim, waits for response and uses address if no conflict detected
  - Proposed address might have a set value for the first 24 bits and a randomly generated value for the other 24.
  - Most suited to small* networks which can operate without a server
  - Requires that all nodes receive each other’s traffic (or something in the network can proxy for nodes that don’t receive the claim).
  - Similar protocols exist for IPv6 (RFC 4862) and FCoE (FC-BB-6 VN2VN)
- **Address Server**
  - Address requests go to a server which responds with an address
  - Default address range can be defined for operation without configuration
  - Multiple servers can operate by each having an address range.

* Small could be ~ 1000 ports

Claiming, servers, bridges

- **Claiming and server protocols could coexist**
  - Claiming protocol and server protocol can operate on different address ranges
  - Server could listen for Claims and reply with an address assignment
  - Allows the network to have a server or not as dictated by its size and nature and clients to adapt to either without configuration.
- **Bridge Relay to reduce multicast**
  - Node transmits with Null Source Address
  - Bridge encapsulates in a relay PDU with the bridge's address for source address
  - Encapsulation may include a port identifier.
  - Responses go to bridge which relays to send to the well-know client multicast address
  - Bridge can use the port identifier to choose the output port for the relayed message.
  - Reduces multicast traffic for responses but requires changes to bridges

Address stability

- **Client may store the last used address**
- **On re-initializing, client may request the same address**
- **For server-less, it sends that address in the first claim**
  - If the claim fails, the client picks random address component as usual
- **For server, the address request can have a field to carry a proposed address**
  - The server assigns the proposed address if it is available and assigns another address if it isn't.

Duplicate address protection

- **Protocols should protect against duplicate addresses**
- **Servers should detect each other**
  - Might partition the address space to avoid duplication
- **On network merge there could be address duplication**
  - Protocol should provide for periodic checks that addresses are still unique

Quicker start up for specialized stable networks

- **Some applications such as automotive networks have strict requirements on latency to start the network.**
  - E.g. automotive network should work within on the order of 100 ms after power is applied
  - Changes to these networks would be rare
  - Potentially the learned address could be stored in non-volatile memory
  - If necessary, a message could be broadcast indicating that the existing addresses can still be used or a message can be sent to invalidate the existing address and restart address acquisition

Conclusion

- **IoT devices should be able to operate without a global MAC address and without configuration**
- **A protocol for this could protect the 48-bit MAC address space from exhaustion**
- **May also simplify the production of small inexpensive devices**
  - Removes need to configure with a global address at production time.
- **It is desirable to standardize two mechanisms –**
  - Address server-based
  - Server-less claiming, and
  - Provide for coexistence of the two.
- **Use of the Local Address space without configuration should be enabled by:**
  - Structuring use of the address space
  - Providing an address acquisition protocol