802.1 AVB Support for Coordinated Shared Network

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Coordinated Shared Network

• Time domain multiple access (TDMA) network
• Coordinated contention free media access controlled by a single elected or designated network controller (NC)
• Interface for priority (& parameterized) QoS

• CSN is the trend of the more recent (OFDM based) home networks:
  – Moca (coax)
  – Homeplug (powerline)
  – UWB, 802.15 (wireless)
  – HCCA 802.11
IEEE 802.1as includes the current 802.11 AP/STA topology

"similar *" to the shared network topology if a single node only is connected to a bridge...

[*] SN supports node-to-node connections while 802.1 does not support STA-STA connections (if Direct Link Protocol is not supported)
Shared Network Backbone Support in IEEE 802.1 AVB

- Current draft model does not support SN backbone connecting multiple bridges
  - No support in the current IEEE 802.1 AVB standard for AVB to AVB SN link
  - However, an 801.11 STA / Bridge discussion has been initiated in the joint AVB and Video Transport TG.
AVB Support for Coordinated Shared Network

- **Proposal:** AVB Standard layer interface for any **Coordinated Shared Network (CSN)**
  - MoCA
  - HomePlug
  - Future 802.11 with STA-Bridge support
  - ...

[Diagram of AVB and Coordinated Shared Network]

NC = Network Controller
MoCA Network Characteristics

• 802.3 Link emulation over coax
  – Bridge 802.3 packets over coax medium

• Synchronized access network
  – Network access is controlled by a single (self-selected or preferred) Network Coordinator (NC)

• Clock Services
  – NC periodically broadcasts clock references to all the nodes
  – Nodes maintain a local timer, resynchronized by the NC clock references
  – Max permissible jitter defined by the specs
Topography Option #1

- CSN Adapter (CSNA) is a 802.3 / CSN bridge

**PRO**
- Natural decomposition – Cascaded bridges
- Bridge 2 Bridge interface is well defined

**CONS**
- Implementing a full bridge HW/SW functionality might be too expensive for low end adapters
Topology Option #2

- CSN Adapter emulates links (CSNA is seen as a PHY)

**PRO**
- Cheaper implementation
- Transparent to AVB

**CONS**
- Transparent to AVB (LLDP & RSP messages should be spoofed & modified)
- SNA inner queue latencies
- SN link latencies might change over time
- No Bridge interface to export / import CSN characteristics / policies for 802.1Qav
• IBQ-EBQ latencies and policies are covered by IEEE 802.1Qav
• CSNA’s S&F inner queues cannot be transparent to AVB:
  – IAQ-EAQ max latencies should be queried and accounted for by the AVB
  – IAQ-EAQ policies should be exported by the AVB
• Could be done thru a AVB standardized sub-layer interface
### AVB Messages CSN Handling

<table>
<thead>
<tr>
<th>Messages</th>
<th>CSN Handling</th>
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</thead>
<tbody>
<tr>
<td>802.1 ab Link Layer Discovery Protocol Msgs</td>
<td>• LLDP queries messages broadcasted to every CSNAs</td>
</tr>
<tr>
<td></td>
<td>• LLDP responses forwarded over the CSN</td>
</tr>
<tr>
<td>802.1 at Stream Reservation Protocol Msgs</td>
<td>• Similar to non AVB intermediate bridge...</td>
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<tr>
<td></td>
<td>– Request are transparently forwarded from SN edge to edge</td>
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<tr>
<td></td>
<td>– Responses are intercepted and eventually modified (if i.e. the SN capabilities are lower than the 802.3 capability for this link)</td>
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<tr>
<td>802.1 as Clock Synchronization Msgs</td>
<td>• SN Native Sync handling</td>
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<td>Spoofed and broadcasted by CSN</td>
</tr>
<tr>
<td></td>
<td>Spoofed &amp; intercepted by CSN</td>
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</tbody>
</table>
AVB LLDP Messages Broadcasting

- LLDP request messages are encapsulated in CSN containers and broadcasted over the CSN network
  - AVB support to on to many links (multiple discovery responses to the same discovery request)?
• Available bandwidth of the SN link might be lower than the bandwidth reservation acknowledged by AVB2
  — AVB reservation responses should be demoted by the SN
  — *do we need feedback msg to AVB2 to update AVB2 ?*
SN 802.1as Clock Model

Model #1
- AVB
- TC
- CSNA
- CSN

Model #2
- AVB
- S-BC
- CSNA
- CSN

OC = Ordinary Clock
S-BC = Simple Boundary Clock
TC = Transparent Clock
SN AVB Timing Services

• AVB Timing Services
  – If the CSN clock is accurate enough, the 802.1as CSN media dependant part could be provided by the CSN time services:
    • NC’s master clock periodically broadcasted to all CSNAs
    • CSNAs local timer synchronized on NC’s master clock references
    • Time-stamped Txm frames

• AVB CSN Timing SAP:
  – Sync, Follow_Up,
  – Pdelay_Req, Pdelay_Resp, Pdelay_Resp_Follow_Up
Link Delay SAP

\[ \text{LinkDelay}^* = \frac{(T_2 - T_1) - (t_2 - t_1)}{2} \]

* In most cases, CSNA will be co-located on the AVB board and LinkDelay should be neglectable
CSN Propagation Delay Measurement between 2 CSNAs

CSNA_a  CSN  CSNA_b

\[ t_{a1} \]  \[ CSN \text{ Pd}\_\text{Request}(\cdot) \, [t_{a1}] \]

\[ t_{b1} \]

\[ t_{b2} \]

\[ t_{a2} \]  \[ CSN \text{ Pd}\_\text{Resp}(\cdot) \, [t_{b2}] \]

w/i Txm packet timestamps

CSNA_a  CSN  CSNA_b

\[ t_{a1} \]  \[ CSN \text{ Pd}\_\text{Request}(\cdot) \]

\[ t_{b1} \]

\[ t_{b2} \]

\[ t_{a2} \]  \[ CSN \text{ Pd}\_\text{Resp}(\cdot) \]

\[ CSN \text{ Pd}\_\text{Resp\_FU}(\cdot) \]

w/o Txm packet timestamps

\[
\text{CSN\_PropagationDelay} = \frac{(t_{a2}-t_{a1}) - (t_{b2}-t_{b1})}{2}
\]

[\text{t}] \, \text{Tx Packet Header 's Timestamp}

(\text{t}) \, \text{API Parameters}
Transparent Clock Sync SAP

AVB_a → CSNA_a → CSN → CSNA_b → AVB_b

GT = AVB Grand Time  FRC = free running clock
Id = AVB - SNA link delay  tx_i = free running clock time
pd = SN propagation delay

GT_{ta1} = T_1 + Id_a
GT_{ta2} = GT_{ta1} + \Delta T(ta_2-ta_1)
GT_{tb1} = GT_{ta2} + pd_{a-b}
GT_{tb2} = GT_{tb1} + \Delta T(tb_2-tb_1)

Sync ()
Sync FU (T_1)
Sync FU (GT_{ta2})
Sync FU (GT_{tb2})
GT = AVB Grand Time  
CSN-LC = CSN Local Clock  
Id = AVB - CSNA link delay  
tx = CSN Local Clock time  
pd = CSN propagation delay
Thank you