Dante Advanced Configuration
Dante: Advanced

- Contents:
  - Clock
  - Latency
  - Bit Depth
  - Sample Rate
  - Flows
  - QoS
  - IGMP Snooping
  - VLANS, LAGs & STP
  - Switches & Cables
Dante: Clock

- Does not use TDM
- Time Division Multiplexing
  - Used by traditional digital audio transports
    - Such as AES/EBU, MADI, EtherSound
  - Each audio channel sends data during a set time interval
  - Clock signal is derived from the timing of the audio data

- But these are systems with a fixed-capacity...
Dante: Clock

- Dante Clock Is Packet Based

- Using PTP: Precision Time Protocol
  - IEEE1588
  - Sub-microsecond accuracy
  - PTP is used in extremely time critical applications
    - Factory Automation
    - Wall street trading
Dante: Clock - PTP

- It is a Master / Slave concept
  - With strictly one Master only
- The Master is automatically selected based on:
  1. Is it labelled as “Preferred”?
  2. Is it slaved to “External Clock”?
  3. Does the Dante module have a high quality clock?
  4. Is its MAC address lower than other devices?
Dante: Clock - PTP

- After a Master device is selected, it will start to multicast transmit a discipline signal to each slave, to keep them in sync.
Dante: Clock - PTP

- Each slave will determine its time offset caused by transmission delay.
  - The slave sends a “Delay Request” to its Master
  - The Master replies with a time-stamped “Delay Response” message
Dante: Clock - PTP

- The Slave will perfectly time-align itself to the Master
  - And all Slaves will be perfectly in sync
  - The sync is checked several times every second
Dante: Clock - PTP

- If the Master clock gets disconnected...
  - All slaves will continue to run from their own clocks
  - A new Master is elected quickly and automatically
  - Everything syncs again, with no silence and no glitch!
Dante: Clock - Network Clock Comparison

- How good are conventional networks at synchronising Clocks?
  - Add an extra switch: what happens to the sync?
Dante: Clock - Delay in a Network

- The “Control” of the experiment: Both mixers clock to Ext. Gen.

- In sync and in phase
Dante: Clock - Delay in a Network

- The Master Mixer clocks internally, Slave Mixer clocks via AES/EBU.
  - In sync, but not in-phase
  - (Slave = blue)
Dante: Clock - Delay in a Network

- Slave Mixer clocks via CobraNet.
- In sync but not in phase
- (Slave = blue)
Dante: Clock - Delay in a Network

- Slave Mixer clocks via CobraNet.
  - Add another switch to the network
- Clock phase shifts due to extra signal delay
- (Slave = blue)
Dante: Clock - Delay in a Network

- Slave Mixer clocks via Dante.
- See the clocks slowly converge
- Time-aligned within about 0.1μs
- (Slave = blue)
Dante: Clock - Delay in a Network

- Slave Mixer clocks via Dante.
  - Add another switch to the network

- If clock drifted away, it will drift back into phase again within a few seconds.
- Because Dante clock is time-stamped.
Dante: Clock - PTP

- The sync tolerance of Dante devices is guaranteed to be +/-1μs (microsecond)
  - In practice we find it to be more like +/-0.2μs
  - One clock cycle at 48kHz is 20.8μs
  - So we have a realistic sync within 1/100th of a sample!
  - All outputs from the network will be w/c aligned!
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Dante: Latency

- Data takes more time to travel through a switch than through a wire
  - The switch analyses, copies, filters, splits, forwards the data...
- So more switches in a network means more latency
Dante: Latency

- Some Dante devices have switches built in to allow for simple “daisy-chain” connections
- Most Dante devices have a fixed number of latency options, to keep it simple.
- Latency general rule; 100 microseconds per switch
Dante: Latency

- Star, 4 Dante devices
- Audio travels through 3 switches
- Use 0.25ms setting (or higher)
Dante: Latency

- Star, 5 Dante devices + 2 switches
- Audio travels through 4 switches
- Use 0.5ms setting (or higher)
Dante: Latency

- Or, to keep in-ear monitoring latency low, set Monitor console and Rios on stage at 0.25ms
- Set FOH console at 0.5ms
- Different latencies can co-exist!
Dante: Latency

- Latency comparison:
  - Yellow = mic->omni in->omni out (no Dante)
  - Blue = mic->Rio->CL@Mons->Rio (0.25ms latency)
  - Pink = mic->Rio->CL@FOH->Rio (0.5ms latency)

- Yellow = 2.0ms
- Blue = 2.5ms
- Pink = 3.0ms
Dante: Latency - Guidelines

- If the transmitting device and the receiving device have different latency settings, the higher setting will be used.
- Multicast transmission will ALWAYS have a latency of 1ms, regardless of the setting.
  - Switches often take more time to analyse and forward multicast data, so Dante needs to compensate.
- 1ms setting can cover a network 10 switches wide.
- 5.0ms setting is just for troubleshooting and should never be necessary.
Dante: Latency

▪ What happens if you set the latency too low?
  ▪ Don’t worry, if you follow the above guidelines, you will be safe: there is plenty of “safety margin”.
  ▪ In lab conditions, 10 switch hops can work with 0.25ms latency (very well tuned network)!

▪ Using QoS helps to achieve low latency
  ▪ (More info later)
  ▪ If latency really is set too low, there will be silence...
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Dante: Bit Depth

- Dante devices can work at 16-bit, 24-bit or 32-bit.
- Others can only work at 24-bit.
Dante: Bit Depth

- These different bit depths can co-exist on the network.
Dante: Bit Depth

- If a 24-bit device transmits to a 32-bit device, 8 “zero bits” are added to each word.
- If a 32-bit device transmits to a 24-bit device, the last 8 bits are simply removed.
Dante: Advanced

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Dante: Sample Rate

- Different sample rates can co-exist on the same Dante network.
- Even 44.1kHz and 48kHz can share the network.
Dante: Sample Rate

- But devices working at different sample rates cannot share audio!
  - Dante Controller doesn’t let you make the patch if the sample rates do not match.
Dante: Advanced

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Dante: Flows

- For efficiency, Dante organises audio channels into groups, or “flows” whenever possible.
- Up to 4 channels are grouped in each “Flow” when they are transmitted and received by the same devices (unicast traffic).
  - It means they share the same Ethernet data packets.
  - This is efficient for bandwidth.

32 Channels = 8 Flows
Dante: Flows

- Dante Controller shows the number of Flows
  - Device View->Transmit

32 Channels = 8 Flows
Dante: Flows

- Note the maximum number of Flows:
  - 32 Flows for all Brooklyn II based devices
Dante: Flows

- With 32 Flows, you can:
  - Transmit up to 4 channels to 32 different devices
  - Transmit up to 8 channels to 16 different devices
  - Transmit up to 16 channels to 8 different devices
  - Transmit up to 32 channels to 4 different devices
Dante: Flows

- So a Brooklyn II device can do a “digital split” to 4 consoles / multi-track recorders

32 Channels x4

= 32 Flows
Dante: Flows (Unicast / Multicast)

- Need to “digital split” to more devices?
- Use “Multicast”!
- By default, all Dante Flows are “Unicast”
  - This preserves network switch bandwidth.
  - Unicast only goes to the designated devices
  - Multicast transmits to all Dante devices in the network!
Dante: Flows - Multicast

- When do you need to use “Multicast”?
- When transmitting 2 channels to many amps
Dante: Flows - Multicast

- Use “Multicast”;
  - When transmitting 32 channels from Rio3224-D to 5 devices (3 consoles + 2 PCs for example)
Dante: Flows - Multicast

- Use “Multicast”
  - When playing from Dante Virtual Soundcard to 2 or more consoles.
  - DVS only has 16 Flows (16x4 = 64 Channels)
  - So to transmit 64 channels to 2 consoles, Multicast is required.
Dante: Flows - Multicast Vs. Unicast

- Multi- Unicast is more work for the transmitting device: it sends several copies of the same data.
- Multicast is more work for the switches: it copies & sends the data to all Dante devices in the network!
Dante Controller & Multicast

- Dante Controller gives **tips** for when Multicast could be necessary.
  - Look in the “Events” page after routing one Transmitter to 3 or more Receivers:

![Dante Controller - Network View](image)
Dante Controller & Multicast

- Dante Controller is needed to create “Multicast” Flows
  - Multicast Flows can hold up to 8 channels each.
  - Click on the Golden “Split” icon in Device View-＞Transmit tab.
Dante Controller & Multicast

- Don’t create Multicast Flows that are not needed.
  - Preserve the network bandwidth.
  - Remember Multicast is transmitted to ALL networked devices...
    - Unless IGMP Snooping, or multicast filtering is turned on
Dante: Advanced

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Dante: QoS

- QoS = Quality of Service
  - It is traffic management
    - Fast lanes, cycle lanes, bus lanes, emergency vehicle lanes...
    - Different types of traffic have different priorities.
  - There are several different methods for optimizing traffic flow

- Dante uses DiffServ
  - Differentiated Services Code Point
  - Also known as DSCP
Dante: QoS

- DSCP has 64 different types of data to prioritize
  - Dante uses just 4 of them
    - #56 is given to the PTP data (word clock timing)
      - Needs Highest priority
    - #46 is given to audio data
      - Needs High priority
    - #8 is given to other Dante data, such as control & monitoring
      - Needs Medium priority
    - All other values have low priority.
Dante: QoS - when to use

- QoS is only needed when networks get congested
  - For example, with a lot of multicast traffic
  - Or when mixing Dante with a lot of other data
  - Or when 100MB equipment is used
- It is not needed on small system for example.
- As your network grows, it is best to be prepared in advance:
  - The consequences could be audio dropouts!
This is how a typical switch setup looks for QoS:

<table>
<thead>
<tr>
<th>DSCP to Queue Table</th>
<th>Control</th>
<th>Audio</th>
<th>Clock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingress DSCP</td>
<td>Output Queue</td>
<td>Ingress DSCP</td>
<td>Output Queue</td>
</tr>
<tr>
<td>0 (BE)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>18 (AF21)</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>19</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>20 (AF22)</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>21</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>22 (AF23)</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>23</td>
<td>1</td>
</tr>
<tr>
<td>8 (CS1)</td>
<td>2</td>
<td>24 (CS3)</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>25</td>
<td>1</td>
</tr>
<tr>
<td>10 (AF11)</td>
<td>1</td>
<td>26 (AF31)</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>27</td>
<td>1</td>
</tr>
<tr>
<td>12 (AF12)</td>
<td>1</td>
<td>28 (AF32)</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>29</td>
<td>1</td>
</tr>
<tr>
<td>14 (AF13)</td>
<td>1</td>
<td>30 (AF33)</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>31</td>
<td>1</td>
</tr>
<tr>
<td>46 (EF)</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>56 (CS7)</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Legend:
- **Control**
- **Audio**
- **Clock**
This is how a bad switch setup looks for QoS:

![Switch Setup Example]

- **Control**
- **Audio**
- **Clock**
Dante: Advanced

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Dante: IGMP Snooping

- What is IGMP Snooping?
  - Internet Group Membership Protocol
  - It is multicast data management
  - It can restrict the propagation of multicast traffic.

- When is IGMP Snooping needed?
  - When lots of Dante Multicast flows are used
  - When Dante is mixed with other types of Multicast traffic.
Dante: IGMP Snooping

- How does it work?
  - Each flow of multicast data is assigned an IP address
  - The switch will take a note of all the multicast IP addresses
  - If a device needs to receive the multicast data, it will ask the switch to forward it.
  - The switch will only forward the multicast data to the devices that request it.

- So it can greatly reduce the amount of multicast traffic in a network!
Dante: IGMP Snooping

- An example, when doing a Virtual Sound check:
  - To playback from Dante Virtual Soundcard to 2 consoles, Multicast is needed.
  - Normally, this traffic will spread all over the Dante network.
    - The stageboxes don’t need it, but they will still receive it!
Dante: IGMP Snooping

- An example, when doing a Virtual Soundcheck:
  - With IGMP Snooping enabled, the switches will check the Multicast data.
  - So it only reaches the Mixers.
    - The Dante audio data will only transmit to the devices that are set to receive in the Dante patch/routing grid.
Dante: IGMP Snooping

- The effect on bandwidth
  - With Snooping disabled, stagebox receives 181Mbps
  - With Snooping enabled, stagebox receives 68Mbps
    - This is just the 24 outputs from the Console.
Dante: IGMP Snooping

- This is vital when:
  - Using Multicast Dante in 100M networks
    - Bandwidth can quickly be filled
  - Using critical control devices on the same network as Multicast Dante traffic
    - Where control and audio use the same network port on the device
  - Using Wi-Fi on the same network as Dante
    - Otherwise Dante multicast data will flood the wi-fi bandwidth.
Dante: IGMP Snooping

- How to set it up
  - Using Cisco SG300-20
  - This switch has IGMP Snooping
    - V3 is the latest version, which is ideal for use with Dante
  - This feature is rare to find on such low cost switches!
Dante: IGMP Snooping

- How to set it up
  - Open the Multicast menu
  - Enable Multicast Filtering
  - For each VLAN, select “IP Group Address” as the Forwarding Method.
Dante: IGMP Snooping

- How to set it up
  - Open the IGMP Snooping menu
  - Enable Snooping
  - Edit each VLAN setting...
Dante: IGMP Snooping

**How to set it up**

- Enable Snooping Status & Querier Status
- Set Query Interval to minimum value: 30
- Check IGMPV3

<table>
<thead>
<tr>
<th>IGMP Snooping Status:</th>
<th>Operational IGMP Snooping Status:</th>
<th>Enabled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MRouter Ports Auto Learn:</th>
<th>Operational MRouter Ports Auto Learn:</th>
<th>Enabled</th>
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</thead>
<tbody>
<tr>
<td>Enable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Query Interval:</th>
<th>Operational Query Interval:</th>
<th>(sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>30</td>
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</table>

<table>
<thead>
<tr>
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<th>Operational Query Max Response Interval:</th>
<th>(sec)</th>
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<tbody>
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<td>10</td>
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<table>
<thead>
<tr>
<th>Last Member Query Counter:</th>
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<tbody>
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<td>User Defined</td>
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</table>

<table>
<thead>
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<th>Operational Last Member Query Interval:</th>
<th>(mS)</th>
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</thead>
<tbody>
<tr>
<td>1000</td>
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<table>
<thead>
<tr>
<th>Immediate Leave:</th>
<th>Operational Immediate Leave:</th>
<th>Disable</th>
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<tbody>
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<td></td>
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</table>

<table>
<thead>
<tr>
<th>IGMP Querier Status:</th>
<th>Operational IGMP Querier Status:</th>
<th>Enabled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IGMP Querier Source IP Address:</th>
<th>Operational IGMP Querier Source IP Address:</th>
<th>192.168.0.212</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Defined</td>
<td></td>
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</tr>
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</table>

<table>
<thead>
<tr>
<th>IGMP Querier Version:</th>
<th>Operational IGMP Querier Version:</th>
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<tbody>
<tr>
<td>IGMPV3</td>
<td></td>
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</tbody>
</table>
Dante: IGMP Snooping

- Be aware that some other types of switch do not have the correct “Query” functions to work alone in a Dante network.
- The SG300 has all necessary functions.
- Here is a switch that has found and filtered several multicast flows.
DVS with IGMP Snooping

- There is one potential problem when using DVS & IGMP Snooping
  - Some computers don’t handle it so well
  - This will result in silence from DVS!

- In that case, use the “Forward All” setting for ports used with DVS.
  - Use this with care, and only when it is essential
  - It allows all Multicast data through the port!
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Dante: VLANs

- VLAN:
  - Virtual Local Area Network
- Sometimes, VLANs can be used to separate a network into segments
- Each segment would carry data for different purposes.
  - Such as audio / lighting / control / internet access, etc.
Dante: VLANs

- Sometimes, VLANs can be used to separate an audio system into segments.
- Each segment would have a different person managing it.
- This might be needed in large touring systems.
Dante: VLANs

- For example:
  - 1 VLAN for the support band’s stage boxes & consoles
  - 1 VLAN for the main band’s stage boxes & consoles
  - 1 VLAN for the speaker processing & amp distribution.

- Use a device like DME, or Auvitran’s Audio Toolbox to bridge between the VLANs.
Example

VLAN-1 for Main Band system

VLAN-2 for Support Band system

VLAN-3 for Processor s & Amps

ALL VLANs share the long “Multicore” cable.

AES/EBU link with SRC on
Dante: LAGs

- LAG = Link Aggregation Group
  - Sometimes called “Trunk”
  - When 2 or more cables are used to carry the data between 2 switches.
  - This can increase available bandwidth to 2GB
  - Or it can be used as a form of cable redundancy.
Dante: LAGs

- When one cable breaks, there can be a short silence
  - Less than 0.5sec
- But it is a low cost and simple way to get “Multicore” cable redundancy
Dante: STP

- STP = Spanning Tree Protocol
  - It is a form of network redundancy
  - It allows loops to be formed in networks
Dante & STP

- When one cable breaks, there can be silence up to 2 seconds.
- When the cable is repaired again, there can be longer silences of up to 20 seconds!
Dante: STP

- STP and Dante are compatible, but STP is not as quick as Dante’s own Primary/Secondary dual network redundancy.
  - Glitch-free Redundancy!
- So, only use STP when it is necessary to protect other data sharing the network.
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Dante: Cables

- Dante is 1Gb, while CobraNet, EtherSound, and many other formats are 100Mb
- Use shielded cable when RF interference is possible
  - Also better protection against EMI interference
  - Un-shielded will work in most cases
    - Un-shielded is easier to install & terminate!
Dante: Cables - CAT5/6/7

What’s the difference between CAT5, 6 & 7?

- CAT5 is the original standard, for 10Mb & 100Mb networks
- CAT5e is an enhanced standard, suitable for 1Gb
- CAT6 has more twists per metre, and a separator between each pair, designed for 1Gb networks
- CAT7 has an individual shield for each pair, designed for 10Gb networks
Dante: Cables - CAT5/6/7

- Which one to use?
  - Don’t use the old standard of CAT5
    - (rare to find new)
  - Use CAT5e or CAT6, solid core, shielded
  - CAT7 can be used for all devices, but is less easy to work with: termination takes more time, it is stiffer, and more expensive
Dante: Cables - max length

- Never use a copper cable longer than 100m
  - Use cable with solid copper cores whenever possible
  - Stranded copper cores are more flexible, but not so good at long distance transmission
    - Keep 60m maximum with stranded cable
    - A lot of rugged “stage-cable” is stranded, so take care.
Dante: Cables - Fibre-Optic

- There are 2 main types:
  - Multi-Mode, up to about 500m
  - Single-Mode, good for several Km!

- Either can be used, with the correct interface
  - Multi-mode is lower cost
  - Single-mode can go longer distance and have more joins (like for patch panels)
Dante: Cable - Fibre-Optic Converters

- A converter is needed to change from CAT5e or CAT6 to fibre
  - Use a switch that has fibre modules included
  - They can be easier to trouble-shoot than stand-alone converters
  - Use the same type of fibre module at each end
  - Use a patch panel to hold rugged fibre connections.
Dante: Ethernet Switches

- There are so many types
- What are the necessary features?
  - 1GB (or more) for every port
  - Switching capacity equal to 2 x number of ports (eg, 20Gbps for a 10 port switch)
    - This can be tough to determine accurately
  - If it has EEE (Energy Efficient Ethernet), then it should be disabled
    - If the switch has this feature and is un-managed, then it can’t be disabled: avoid it!
Dante: Ethernet Switches

“Nice to have” features:

- Internal power supply
- Silent (or no) cooling fan
- Rack-mount kit
- Fibre option modules
- Easy to use web interface for programming
- Error reporting & trouble-shooting tools.
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Questions?
Thank You