NION*ote*: *CobraNet Network Considerations OR*
What the IT guy needs to know..

Introduction

NOTICE: CobraNet[tm] is a technology developed and owned by Cirrus Logic, which sells and/or licenses the technology to third parties. The information contained in this paper is subject to change without notice.

CobraNet is a reliable and proven technology that enables transport of high quality real-time digital audio over standard Ethernet infrastructure. CobraNet is an isochronous data delivery system at its core but Ethernet is not an isochronous data delivery system. Ethernet is a first come, first served, best effort system and will not even guarantee delivery of data. Knowing that, it is easy to see why CobraNet technology represents such an achievement and why certain constraints and operational parameters must be understood in provisioning the Ethernet that CobraNet uses. CobraNet uses Ethernet to perform tricks that Ethernet does not normally do. As with any beast that is made to do tricks, real understanding and proper care can insure a consistently good performance.

The primary differences that an IT professional should note between a CobraNet and a data network are the following:

- Data network traffic is typically 'bursty'.
- CobraNet network traffic is largely consistent.
- CobraNet networks can use far more multicast traffic then normally seen on data networks.
- CobraNet is intolerant of data errors or bandwidth over-subscription that data networks can often tolerate
- The CobraNet audio protocol itself is strictly layer 2 (Ethernet). It is not routable.
- Management functions used by CobraNet are implemented with high-level protocols (IP) such as SNMP and TFTP.

Connections

- CobraNet must operate on a full-duplex network. Repeater hubs in the network are forbidden. Collisions cannot be tolerated.
- The connection to a CobraNet device is 100 BASE TX copper.
- The switch to which it is connected can communicate with other switches by any standard full duplex Ethernet medium including copper, fiber, 100 Mbit, gigabit and 10 gigabit.
- CobraNet can be successfully bridged over other transport mediums, such as SONET. As long as the end links are IEEE 802.3 compliant and timing constraints are observed, it will work. Timing constraints are covered in a later section.
- CobraNet will work with dedicated full duplex wireless links, such as Tsunami.
- WiFi, Powerline and Homeplug are alternative Ethernet technologies that operate in half-duplex mode. CobraNet will not work properly with these technologies. However, a PC connected to the CobraNet network through one of these types of links can properly manage the CobraNet devices using SNMP.
  - **NOTE** Low bandwidth half duplex links such as these can be overloaded by the large amount of traffic that can exist on a CobraNet network. These links will support SNMP but may still not work well due to the bandwidth they are exposed to.

- The connection to a CobraNet device must be able to auto-negotiate the connection type.
  - Although CobraNet requires a 100 BASETX full duplex link, never explicitly set switch ports to operate in this mode. This will disable auto-negotiation on the port and the attached CobraNet device will not work.
  - If using an optical to copper media converter in the link attached to a CobraNet device, make sure it can bridge auto-negotiation. Not all will do this although absence of this feature is becoming less common.

Traffic

- CobraNet is an IEEE registered protocol that has a protocol number (Ethertype) of 0x8819.
- There are four types of Ethernet frames used by CobraNet that will be seen on the network.
  - **Beat packet** – only sent by a single 'Conductor' device
    - Sent 750 times per second (1 1/3 mS); the isochronous cycle.

- - The size of the beat packet depends on the number of CobraNet devices and audio bundles in use on the network.
    - It can be as small as approx 200 bytes or can be as large as a full frame
    - The beat packet is always multicast
    - Identified by 0x00 following the Ethertype field.
    - Typically, any CobraNet device on the network can become the conductor.
  - **Reservation packet** – Sent by all CobraNet devices
    - Sent every 1 ½ to 8 seconds depending on network size.
    - Usually small.
    - The Reservation packet is always multicast.
    - Identified by 0x01 following the Ethertype field.
  - **Audio Bundle Packet** – Sent by any or all CobraNet devices
    - Can be large or small depending on configuration.
    - Each device can send and receive multiple bundle packets every isochronous cycle.
    - Can be multicast or unicast depending on configuration.
    - Identified by 0x10 following the Ethertype field.
  - **Serial bridge packet** – Sent by any or all CobraNet devices
    - Use is optional; will not be seen in all cases.
    - Can be multicast or unicast; typically multicast
    - Usually smaller frames.
    - Use to bridge low data rate asynchronous (RS-232) traffic.
    - Identified by 0x20 following the Ethertype field.
- CobraNet also generates and uses other types of traffic:
  - SNMP is used to monitor and configure the device.
  - TFTP is used to update the device's firmware.
  - Packet bridge – The CobraNet device can be used as a NIC by an attached host processor.
    - Some products or implementations will use this feature, in which case any type of traffic may be seen sent or received by the CobraNet device.
    - No more than one bridge packet per device per every 2 isochronous cycles (2 2/3 mS) should be seen sent or received.

- From the above, it can be seen that a CobraNet network will usually contain a finite amount of traffic of known types.
- This traffic can vary widely in makeup between multicast and unicast
- The makeup of the traffic (multicast vs. unicast) will be consistent in an operational installation.
- Total multicast CobraNet traffic on a network can range from less than 1 Mbit/s to all of the traffic that can be supported on the net.
- In a small network, expect to see less than 1 Mbit of multicast *beat* packets.

- As a general rule, more than four 8 channel multicast bundles on a network will not work. The contractor should be aware of this constraint. If you, as an IT professional, see more than four multicast bundles on the net point this out to the audio contractor and make sure this condition is known and intended. A multicast bundle can be identified by: destination MAC address is multicast, Ethertype = 0x8819, 1st data byte = 0x10.
- In the largest network, expect to see as much as 10 Mbit of multicast *beat* packets.
- <u>Do not configure a switch to filter multicast traffic</u>. CobraNet depends on multicast traffic.
- A CobraNet device should not require more than 50 Mbits of bandwidth in each direction in most cases; half that bandwidth is typical.
- Links between switches can require far more than 50 Mbits of bandwidth. Use gigabit links between switches. The system contractor can relate what the bandwidth requirements of each link will be. Overprovision between switches to insure good performance and to accommodate future changes.

Bandwidth Allocation

- CobraNet can theoretically share a network with data traffic.
- Provided that the data traffic is predominately unicast and any links shared by CobraNet and Data are provisioned to insure that CobraNet will always have adequate bandwidth, then sharing network infrastructure can work.
- HOWEVER, It is very difficult to insure what type of data traffic will exist on a network and it is very difficult to insure enough available bandwidth on all links given the inconsistent and bursty nature of data traffic. For this reason, **segregation of data and CobraNet networks is recommended.**
- Networks can be segregated by using separate switches for each network
- Networks can be segregated by using VLANs.
- CobraNet does not support tagged VLANs. Managed switches with port based VLAN capabilities are used to implement a CobraNet VLAN.
- CobraNet VLANs should be given higher priority on shared links between switches.

Switches

- Although any 802.3 compliant switch should work with CobraNet, some less expensive switches cannot operate at wire speed or have limited queue buffer sizes and can cause problems when a large amount of traffic exists.

- Some less expensive gigabit switches will not operate at 1 Gigabit if any port is in use at 100 Mbit.
- It is best to avoid bargain switches and use good quality switches from reputable manufacturers.
- It is strongly encouraged to use managed switches in larger projects for the following reasons:
  - They can be configured to limit broadcast storms or otherwise throttle the data rate on specific ports. This can be a benefit to CobraNet. Do not limit the bandwidth to less than the CobraNet device needs to operate properly.
  - Port mirroring capability is very useful if debugging is necessary.
  - Statistics logging is very useful if debugging is necessary.
  - Use of VLANs can be very useful in large applications.
  - Link Aggregation can be very useful to increase bandwidth between switches and to provide a measure of redundancy.
  - STP, RSTP and MSTP can be used to create fault tolerant topologies. This can be a complex topic and is treated in a separate document
  - QOS can be implemented to insure that CobraNet has the highest priority.
    - CobraNet devices themselves cannot generate or process tagged QOS packets.
    - Some protocols, such as VOIP, will also attempt to secure the highest priority. Be sure to consider the types of protocols and priorities that will exist on the network in order to insure that sufficient bandwidth and priorities are in place for CobraNet.

Timing

CobraNet causes a best effort network technology to perform as an isochronous delivery system. In order to do this certain timing constraints must be met.

- Every hop a frame takes through a switch introduces forwarding delay.
- This delay is not always consistent.
- CobraNet cannot tolerate large inconsistencies in forwarding delay.
- Total variation of forwarding delay can worsen with each switch hop.
- The maximum forwarding delay that can be tolerated is no more than 3800 uS (3.8 mS) between the network diameter extremes.
- Whatever this delay is, up to the 3800 uS maximum, it must be relatively consistent between any two CobraNet devices and must not vary by more than –0/+250 uS. Occasional violations of this rule can be tolerated; chronic violations will prevent proper operation of the network.

- It has been empirically determined that the forwarding delay variability in typical 100 BASETX switches limits the number of hops to a maximum of six between any two CobraNet devices.
- Use of gigabit links between switches increases the hop limitation due to a reduction in forwarding delay between switches. However, the forwarding delay can still be variable and this variability, as opposed to the average aggregate delay, that is the important factor. Therefore, although more hops can be tolerated when they are gigabit hops, it is still wise to limit the number of hops as much as possible. A properly designed network with a balanced hierarchical layout can contain a huge number of end points while still remaining within the six hop guideline. If your network is using more than this number of hops, it would be useful to re-examine and optimize its layout.
- If the contractor chooses to use lower latency CobraNet settings, the number of hops that can be tolerated will be reduced to:
  - Two or three hops at 2 2/3 mS latency (or 10-15 with gig links) and one or two at 1 1/3 mS latency. Consult with the system contractor on this issue to determine how CobraNet will be configured.
- **The above switch hop rules are guidelines and are not concrete**. Different results can be obtained depending on the characteristics of an individual switch and the nature of the traffic on the network.

Wiring

Data networks are more tolerant of data errors than CobraNet networks. Typical layer three and above protocols will re-transmit and retry unsuccessful transmissions. CobraNet does not do this. By the time a dropped frame is detected, it is too late to re-transmit; that isochronous cycle is gone. For this reason it is important to insure the integrity of the wiring prior to commissioning. Data error rates that may go un-noticed on a typical data network cannot be tolerated on a CobraNet network.

- Make sure all cables are properly terminated.
- Do not use 'kinked' cables. If a cable is kinked during installation, do not straighten it out; use a new cable. The sensitive internal wiring twist which influences noise rejection and maximum data rate has been damaged.
- Do not run cables parallel to AC mains lines.
- Do not run cables close to noise sources such as motors, fans, compressors, dimmer circuits, AC lines, etc…
- If running longer links or in noisy environments, use optical fiber.
- Use Cat 5e or above for copper 100 BASETX links.
- Use Cat6 for copper gigabit links when copper must be used. <u>Use fiber instead of copper on gigabit links whenever possible</u>. The way in which

data is modulated on gigabit copper makes it more sensitive to outside interference. Therefore, when copper gigabit links must be used, pay particular attention to cable routing and insure that the cables are not in proximity to any potential noise or interference sources. A data integrity problem on a gigabit link may go un-noticed in a data network but will cause audio dropouts in a CobraNet network.

- If possible, perform bit error rate tests on each link and correct problems before commissioning.
- Check switch statistics for indications of errors, dropped or malformed frames. Find the root cause and correct before commissioning.
- Do not exceed the maximum recommended run length of the media in use. i.e. no more than 100 meters for copper Ethernet cables. Fiber run lengths can vary depending on cable and switch manufacturer. Typically lengths of no more than 2 km are recommended for 100 megabit multimode fiber, 600 meters for gigabit and 300 meters for 10 gigabit. Single mode fiber supports much longer runs but is also more expensive and seldom used in LAN applications. Consult the documentation for the particular equipment and wiring used in order to insure maximum lengths are not exceeded.
- A large CobraNet network can sometimes be complex to commission. Make sure the systems contractor only has to focus on his own tasks and does not have data integrity issues to debug as well. Insure that the network is operating as required before handing it over to the contractor.