CobraNet™ Routing Primer

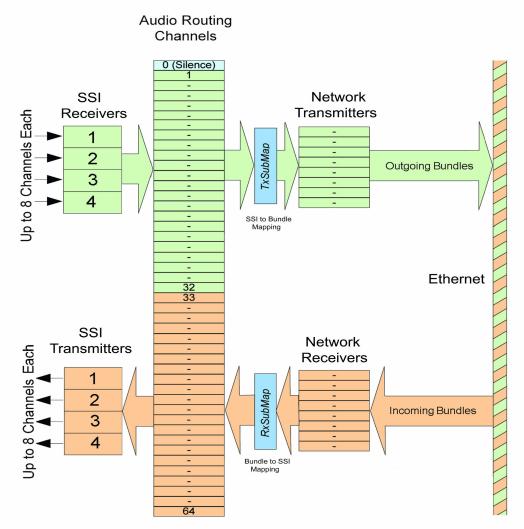*Steve Gray, Cirrus Logic, Inc.*

Configuring CobraNet™ systems to properly route audio is fairly straightforward once the underlying concepts are understood. This document explains the concepts behind end to end routing and how to configure CobraNet™ interfaces to route audio channels. Use this document as a companion to the available CobraNet™ device Data Sheets and Reference Manuals.

The variables referred to in this document are described in the CobraNet™ Programmer's Reference. They are known as Management Interface (MI) variables and can be read and written via the hardware Host Management Interface (HMI) or via SNMP over the network.

The signals referred to are described in the Datasheet or Hardware Reference Manual applicable to the particular CobraNet™ interface in use.

Referring to Figure 1 below, let's consider the components of CobraNet™ audio routing.

Fig. 1 Simplified Routing Schematic

Components of Routing

Bundles

A Bundle is the basic unit of data for transporting audio over a CobraNet™ network and can contain from zero to eight audio sub-channels. Sample size, sample rate and transmission latency all have an impact on processor bandwidth and packet sizes required to process and transmit the audio data. These factors can limit the number of audio channels that can be processed by a CobraNet™ interface. The maximum number of audio sub-channels allowable per bundle will be from 3 to 8 depending on these settings. The maximum number of bundles possible can also be affected by these settings. Maximum sub-channel count per bundle will typically be eight but may be less depending on the particular configuration.

An important attribute of the Bundle is the identifying number assigned to it (the Bundle number). The Bundle number determines both where the data is sent and, to a large extent, how it is sent. When a receiver on one interface is assigned the same bundle number as that of a transmitter on another interface, the CobraNet™ protocol will automatically establish a connection and begin transmitting audio data between the interfaces.

Bundles can be transmitted using the following modes:
- Unicast (one-to-one)
- Multiple unicast (up to four copies unicast to more than one receiver)
- Multicast (one bundle to an unlimited number of receivers)
- Private (same as unicast or multicast but requiring specification of a MAC address)

Refer to the Programmer's reference for information on valid bundle numbers and how they affect addressing modes.

Network Transmitters and Receivers

Transmitters and Receivers are logical entities within the CobraNet™ interface which are closely coupled to the concept of Bundles. Each transmitter or receiver is capable of sending or receiving one Bundle. The number of transmitters and receivers within a CobraNet™ interface is dependant on the particular implementation and is fixed by the firmware. The user can configure the number of available transmitters or receivers to be used.

Synchronous Serial Interface

Each CobraNet™ interface contains one or more Synchronous Serial Interfaces, or SSI's. SSI's carry multiplexed audio data into and out of the CobraNet™ interface in time slices and are typically connected to DACs, ADCs, DSP processors and other digital audio interfaces. See **Appendix C** for more information on the SSI.

Audio Routing Channels

Audio routing channels are used to map audio data between a multiplexed SSI time slice and a bundle sub-channel. CobraNet™ interfaces contain up to 64 audio routing channels numbered from 1 to 64. Channels 1->32 are used for transmitting and channels 33->64 are used for receiving. The actual number of routing channels available is dependant on the particular CobraNet™ implementation. Channel 0 is an additional special case which is, strictly speaking, not a routing channel. Channel 0, when assigned to a transmitter Bundle, will cause transmission of an empty channel equivalent to silence. Channel 0, when assigned to a receiver bundle sub-channel, will cause the bundle sub-channel received to be discarded.

For practical purposes, each unique audio routing channel can be thought of as having a fixed association with a unique SSI time slice. In reality, audio routing channels are assigned to SSI time slices via the *audioMap* variable array. Omission of this variable in Figure 1 is intentional. It should not be changed. See **Appendix B** for default SSI to Audio Routing channel assignments.

Bundle to Audio Routing Channel Mapping – txSubMap and rxSubMap

The *RxSubMap* and *TxSubMap* variable arrays are used to map Audio Routing Channels to and from Bundle sub-channels. As described above, an Audio Routing Channel can be thought of as assigned to a specific time slice within a Synchronous Serial Interface. Therefore, assigning an Audio Routing Channel to a bundle sub-channel is equivalent to assigning an SSI time slice to a bundle sub-channel. See **Appendix B** for default SSI to Audio Routing channel assignments.

Routing Variables

- *txBundle* [1] - Each transmitter has a *txBundle* variable associated with it which specifies the *Bundle Number* assigned to that transmitter. There is one instance of this variable for each transmitter.
- *rxBundle* [1] - Each receiver has an *rxBundle* variable associated with it which specifies the *Bundle Number* assigned to that receiver. There is one instance of this variable for each receiver.
- *txSubMap* [2] - Each transmitter has up to 8 *txSubMap* variables associated with it. [3]
- *rxSubMap* [2] - Each receiver has up to 8 *rxSubMap* variables associated with it. [3]
- *txSubFormat* [2] - Each transmitter has up to 8 *txSubFormat* variables associated with it. [3]
- *rxSubFormat* [2] - Each receiver has up to 8 *rxSubFormat* variables associated with it. [3]
- Each interface has one modeRateControl variable which specifies the latency and sample rate used for all bundles transmitted and received by the interface.

    [1] Array variables. There is one instance of this variable for each transmitter and each receiver.
    [2] Array variables that are also members of an array. There are multiple instances of this variable for each transmitter and each receiver.
    [3] 8 equals the maximum permissible number of audio sub-channels per bundle.

Putting it Together

To route audio between two CobraNet[TM] interfaces, both the transmitter and receiver must be configured to send and receive audio channels. In many cases default values can be used and only txSubMap, rxSubMap, txBundle and rxBundle variables need be set.

Transmitter Configuration

- Assign a bundle number to the transmitter using *txBundle.*
- Assign Audio Routing channels (and by extension SSI audio channels) to the transmitter (Bundle) using *txSubMap.*
- Specify the format of the channels using *txSubFormat*
- Make sure the value of *modeRateControl* agrees with the selected tx*SubFormat.*
- Make sure *txSubCount* for each transmitter is greater than or equal to the number of channels being transmitted in the bundle. If the value of *txSubCount* is larger than required, unassigned sub-channels will be sent as empty channels**.**

Receiver Configuration

- Assign a bundle number to a receiver using *rxBundle.*
- Assign Audio Routing channels (and by extension SSI audio channels) to the receiver (Bundle) using *rxSubMap*
- Make sure the value of *modeRateControl* agrees with the format of the channels to be received.

Example:

We have two standard CM-2 modules to be configured as a transmitter and a receiver. We want to send the audio data with standard latency, a 48-kHz sample rate and 20 bit sample size.

We would like to send two audio channels from the transmitter to the receiver in one unicast bundle. Bundle number 273 is a valid unicast bundle number suitable for use.

SSI interface 1 is connected to a 2 channel A to D on the transmitter and SSI interface 1 is connected to a 2 channel D to A on the receiver.

For the **transmitting interface** the following values should be set:

txBundle	273	Assign bundle number to transmitter
txSubCount	>= 2	Make sure bundle is big enough
txSubMap.1	1	Assign audio routing channel to 1st bundle channel
txSubMap.2	2	Assign audio routing channel to 2nd bundle channel
txSubFormat.1	0x54000	Set format of 1st audio channel
txSubFormat.2	0x54000	Set format of 2nd audio channel
modeRateControl	0x600	Set interface latency and sample rate

For the **receiving interface** the following values should be set:

rxBundle	273	Assign bundle number to receiver
rxSubMap.1	33	Assign 1st bundle channel to audio routing channel
rxSubMap.2	34	Assign 2nd bundle channel to audio routing channel
modeRateControl	0x600	Set interface latency and sample rate

Once the variables are properly set, the CobraNet™ protocol takes over to make sure the Bundles (audio data) go to and from the correct interfaces. The reservation and reverse reservation components of the CobraNet™ protocol, which are transparent to the user, automatically detect when a transmitter and one or more receivers on the network have the same bundle numbers assigned. It will then establish the connection between these interfaces via the permissions component of the protocol, again transparent to the user, and cause bundles to flow from the transmitting interface to one or more receiving interfaces with the same bundle number assignment(s).

Refer to the Programmer's Reference for detailed information about addressing these variables via HMI or SNMP.

Additional Information

Refer to the Cirrus Logic Application Note "Bundle Assignments In CobraNet™ Systems" for further information on the use of bundles and their implications on network design and utilization.

Appendix A - MI Variables used in routing

Refer to the CobraNet™ Programmer's Reference for more detailed information on these variables.

txBundle
rxBundle:

    Array variables which set the bundle number that a transmitter or receiver will use. There is one instance of these variables for each Receiver or Transmitter.

    Defaults: All variables = 0 for standard CobraNet™ interfaces.
                        May be initialized to other values depending on product.

txSubMap:

    An array variable which maps which Audio Routing Channel goes to which bundle sub-channel. There are multiple instances of this variable for each transmitter.

    Defaults: Transmitter 1 = 1 -> 8
                    Transmitter 2 = 9 -> 16
                    Transmitter 3 = 17 -> 24
                    Transmitter 4 = 25 -> 32

rxSubMap:

    An array variable which maps which bundle sub-channel goes to which Audio Routing Channel. There are multiple instances of this variable for each receiver.

    Defaults: Receiver 1 = 32 -> 40
                    Receiver 2 = 41 -> 48
                    Receiver 3 = 49 -> 56
                    Receiver 4 = 57 -> 64

txSubFormat:

    An array variable which sets the audio format of each bundle sub-channel. There are multiple instances of this variable for each transmitter.

    Default: 0x54000 = 5-1/3 mS latency, 48KHz sample rate, 20 bit sample size

rxSubFormat

    As above for txSubFormat except for the following:
- rxSubFormat is Read only
- The LSB will be set to 1 when the audio channel is being properly decoded. If LSB is seen set to 0, then the interface recognizes the format but cannot decode it (probably due to an incompatible modeRateControl value).

    Default: N.A.; Set based on format of received sub-channel

txSubCount:

    An array variable which sets the number of sub-channels contained in a bundle. Fewer than the maximum number of channels allowable can be specified. This value must be greater than or equal to the number of channels to be sent in a bundle. There is one instance of this variable per Transmitter.

    Default: 8

modeRateControl:

Must be set the same on both the sending and receiving interfaces. There is one *modeRateControl* variable per CobraNet™ interface and its value affects all audio channels. All channels on a particular CobraNet™ node must be set to the same latency (1 1/3, 2/23 or 5 1/3) and sample rate (48-kHz or 96-kHz). Sample sizes (16, 20 or 24 bits), as specified by *txSubFormat*, can vary by channel, and are not affected by *modeRateControl*. The sample rate and latency component of *txSubFormat* must set in agreement with the value of *modeRateControl*.

Default: 0x600 - 5 1/3 mS latency, 48kHz

Appendix B – SSI Interface Theory

There are typically four Synchronous Serial Interfaces in a CobraNet^{TM} interface. This number can differ depending on product and/or configuration. SSI interfaces are configured at the factory to carry two to eight audio channels each, in each direction. The number of audio channels multiplexed on an SSI will be reflected in the rate of the audio bit clock (SCLK). The word clock (FS1) will run at the configured sample rate of 48-kHz or 96-kHz. Each doubling of audio channels on the SSI will result in a doubling of the SCLK rate. For 2 channels per SSI, the SSI interface can be connected directly to D to A and A to D converters in most cases. For higher channel counts the SSI data and/or SLCK must be multiplexed or de-multiplexed in order to interface to the converters. The SSI interface always assumes use of a 32 bit sample size; in actual use the relevant data within each sample will be 16, 20 or 24 bits.

The SSI carries multiplexed audio data in one of three modes. The mode is fixed in firmware at the factory and is described in detail in the Hardware Reference Manual or Data Sheet applicable to the particular CobraNet^{TM} interface in use.

Example:

A CM-2 module (based on the CS18101) chip is typically configured to handle 8 audio input channels and 8 audio output channels. There are four SSI interfaces, each of which is capable of carrying 2 audio channels in each direction.

Therefore, the interface's word clock (FS1 signal) will be running at the configured sample rate of 48-kHz or 96-kHz and the bit clock (SCLK) will be running at 64 times FS1 (or at FS64). This SCLK rate allows multiplexing of two audio channels of up to 32 bits each on each SSI channel in each direction; or one channel per half cycle of FS1. SSI channels 1, 2, 3 and 4 will each contain audio channels 1 and 2 for each direction. i.e. 4 SSI channels x 2 audio channels per SSI x 2 directions = 8 channels in and 8 channels out, or 8 x 8. Refer to the Hardware Reference Manual or Data Sheet applicable to the particular CobraNet^{TM} interface in use for more detail.

Appendix C – Default SSI to Audio Routing Channel Mapping

2 x 2 Interface			
SSI Interface	**SSI Timeslice**	**Audio Routing Channel (Receive)**	**Audio Routing Channel (Transmit)**
1	1	33	1
	2	34	2

8 x 8 Interface			
SSI Interface	**SSI Timeslice**	**Audio Routing Channel (Receive)**	**Audio Routing Channel (Transmit)**
1	1	33	1
	2	34	2
2	1	35	3
	2	36	4
3	1	37	5
	2	38	6
4	1	39	7
	2	40	8

16 x 16 Interface			
SSI Interface	**SSI Timeslice**	**Audio Routing Channel (Receive)**	**Audio Routing Channel (Transmit)**
1	1	33	1
	2	34	2
	3	35	3
	4	36	4
2	1	37	5
	2	38	6
	3	39	7
	4	40	8
3	1	41	9
	2	42	10
	3	43	11
	4	44	12
4	1	45	13
	2	46	14
	3	47	15
	4	48	16

32 x 32 Interface

SSI Interface	SSI Timeslice	Audio Routing Channel (Receive)	Audio Routing Channel (Transmit)
1	1	33	1
	2	34	2
	3	35	3
	4	36	4
	5	37	5
	6	38	6
	7	39	7
	8	40	8
2	1	41	9
	2	42	10
	3	43	11
	4	44	12
	5	45	13
	6	46	14
	7	47	15
	8	48	16
3	1	49	17
	2	50	18
	3	51	19
	4	52	20
	5	53	21
	6	54	22
	7	55	23
	8	56	24
4	1	57	25
	2	58	26
	3	59	27
	4	60	28
	5	61	29
	6	62	30
	7	63	31
	8	64	32