Interfacing ATM to the Pro-Bel MADI Audio Switching System

Introduction

MADI is a distributed switching system that is 100% non-blocking and destination-controlled. It is similar to a traditional cross-point matrix, but with a small central switch that can be spread over an area to provide multiple routes for redundancy, ie critical sources can be available via more than one switch. ATM offers a distributed system which can have sufficient bandwidth for non-blocking operation and is source-controlled. Control latency in ATM is largely un-defined, however MADI is specified closely, as required by television applications. MADI switches routes, but ATM cannot do this directly. A destination asks for a new route to be set up for the new source and cross-fades to it when it be comes available.

Both offer multiple channels on one cable or fibre, making for flexibility in siting and changes to a system. MADI offers 56 channels, and ATM up to approx. 80 at 155Mbits/s, although network capacity may compromise this. In fact, the capacity is largely defined by the number of signal terminations available, at a studio for example. Note that sound consoles often offer a direct MADI interface, thus avoiding a plethora of jackfield or other cabling connections. Few offer ATM interfaces, to AES47 or other ATM.

Interfacing between the two systems can always be achieved at the digital level by interconnecting signals using the AES3 interface. However, OEM cards are/will be available for the de-multiplexing of MADI data to the common level required by the ATM multiplexer and vice versa in a straightforward manner. This interface has a control function allowing it to set up individual calls for each audio channel, or for any grouping of channels.

Synchronisation

The assumption is made that broadcast quality audio is being carried on an ATM network meeting AES47 at least in broad terms and that the majority of signals will be synchronous at 48kHz. Where the ATM signal delivers other frequencies to the MADI interface sample rate converters will be required (these are optional features in some MADI interfaces). Outputs from MADI to ATM are inherently synchronous and can always be multiplexed into AES47 ATM. There may be a considerable advantage in feeding house clock to the MADI/ATM conversion units, as is standard practice with MADI/AES3 interfacing.

Signal Latency

Each MADI switch has a fixed delay of two samples, assuming the inputs are fully synchronous (ie meet the phasing requirements of AES11). Multiplexers and de-multiplexers are also fixed at about 3 samples each end, making synchronous switching between two instances of the same source seamless. (There will be some variation between switches in a very large system, but this is always known and stable, so that critical routes can be arranged to have the same delay. AES11 compliance can be expected with cable runs up to 1km (Velocity factor = 2/3, 20.8us/4 for AES11 = 5us, 300m/us x 2/3 x 5 = 1000m). ATM requires bit reversal, (to MSB first) plus cell assembly. A latency of 125us is expected to guarantee constant sampling frequency out, plus the delay in each switch (may be several times more than in MADI) which may be supplier dependent.

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Control Latency

MADI is destination-controlled and new destinations can be added or disconnected from one source without disturbance to other destinations. ATM is source controlled, with every connection made by setting up a circuit and then opening it to signals, which makes the above cross-fade necessary. The MADI control is defined to operate within one video field, but ATM control and set-up is undefined.

Other Matters

There are many details in ATM which are understood but not mentioned here, and it is assumed that the interface standards applied are for a User Network Interface (UNI) and the adaptation layer AAL5 is used. AES47 can be downloaded for a single user printout at aes.org/standards/standards-in-print. Use the link at the BOTTOM of the paragraph, otherwise you will get an ordering proforma.

The vast majority of AES3 signals in use employ 20 bits plus VUCP and channel status bits. If capacity for 24-bit audio is not required, then a significant saving is made in the number of ATM cells required per MADI stream. (3 octets per channel v. 4). Hence 16 channels can be carried per cell (ie per virtual circuit) rather than 12. (The parity bit is traded for a block start bit).

A similar saving could be achieved for 24-bit audio by abandoning channel status and validity and user bits, but these features of AES3 are in common use and their retention is advised. It may be that four octets per sample, 12 samples per virtual circuit is desirable for more universal interoperability.

If switch selection (under software control) is used to select only some, up to 12 (16) channels, from any MADI output stream, then the AES47 format defined as 'temporal' grouping can be used, which may improve interoperability. Otherwise all the 56 channels must be multiplexed into ATM, which will require the 'multi-channel' grouping.