OPTOCORE

The Pioneer and Worldwide Leader in Digital Audio Transport

Synchronous Networks for real-time Media Delivery

By Martin Barbour, Systems Support Engineer for Optocore GmbH

In September 2009, Optocore GmbH launched a new CAT5 based networking system called SANE at both the IBC and PLASA tradeshows. During preparations for the launch and impending press release events we were preparing ourselves for an onslaught of questions all revolving around the question 'Why?'

There is already a large number of networking protocols and proprietary point to point link technologies out there so we were expecting to have to justify the introduction of yet another networking system. To my surprise, after a short run through the system along with an introduction to some of the associated hardware interfaces, the question we were being asked was not 'Why?' but 'Why didn't someone already do this?'

OPTOCORE saw its initial growth in the Live Sound market where it served well as a highly resilient digital replacement for analogue multi-cores. Users soon started to realise the full potential of true synchronous digital networks so OPTOCORE became adopted as a core transport system allowing sources to be shared between multiple consoles, recorders and broadcast systems all interfaced through Open Standards protocols. Couple that with the distribution of Video for preview monitoring, Serial control as well as standard Ethernet all over the same fibre and you start to see how OPTOCORE has cemented itself as a core infrastructure system prevalent in multiple market sectors rather than just a simple digital snake.

Going back to the SANE launch and the 'Why?' question, well that's actually quite straight forward to answer. The primary goal for Optocore GmbH is to create professional network systems for delivery of the highest quality media. This goes beyond the quality of A/D/A conversions and covers aspects such as Word Clock distribution and synchronisation as well as providing an open platform network which can be interfaced with professional audio products allowing users to build the highest quality systems comprising products from multiple vendors. The issue of audio delivery is often approached with the principle of using as many standard networking components as possible to help reduce engineering time and costs as well as making the technology 'approachable' for the average user. This often leads to Ethernet being used as the transport medium with either proprietary or Standards based encapsulation methods being used to build an audio layer on top of an Ethernet transport system. Ethernet is great for many things, file transfers, accessing the internet and free phone calls across the Globe however none of these uses are particularly time dependant. Even VOIP telecommunications accept the varying time delays often experienced between participants when making just local calls across the Internet. These factors are all by-products of the asynchronous nature of Ethernet delivery where packets are sent between nodes in bursts. If a packet of data is not transmitted successfully it is often assumed that it's ok to resend that packet a little later. This means that audio networks using Ethernet as a transport medium must buffer packets at the receiver so as to allow for the potential delays and errors involved with sending data over an Ethernet network. Buffering introduces delays which can be engineered around but can never be eliminated. In addition to that, the attempt to make the technology easy to use for the average user is only partially met. Configuration of bandwidth allocation, Quality of Service as well as fault redundancy are all required

for the majority of these systems to function correctly especially when making use of a shared Ethernet system for multiple disciplines. The configuration of these network parameters becomes a specialist task as the scale of the system and complexity of the routing increases meaning it's not always for the feint hearted.

The approach taken with OPTOCORE and SANE is to build a dedicated media network through which audio, video and data including Ethernet can be tunnelled. Configuration of the network simply requires configuring the network devices with an individual device ID and a common sample rate. From that point onwards there is no further configuration required beyond the actual signal routing assignment which is both simple and dynamic, something which any user can do. The underlying protocols manage the bandwidth allocation of the different media tunnels making it impossible for one media stream to adversely affect another. This means that the audio will never be compromised by the loading on the Ethernet channel for example, something which is a common concern on Ethernet based media networks particularly in a shared network environment.

SANE stands for **S**ynchronous **A**udio **N**etwork plus **E**thernet and is the Worlds first synchronous network for audio and control delivery over standard CAT5. SANE offers 64 channels of digital audio at 24 Bit, 48kHz and will operate at sample rates up to 192kHz. Using the same principle as the company's fibre optic based system, OPTOCORE, the channel allocation relates to the number of inputs allowed on the network. This means that it is possible to build a SANE network with 64 inputs and over 1000 outputs if required. SANE is unique by virtue of the fact that in addition to the 64 digital audio channels it also offers a full 100Mbps standard Ethernet data over the same CAT5 cable making it possible to transport synchronous digital audio between devices and use the Ethernet tunnel on the same cable for remote control and monitoring of those devices or other TCP/IP compliant hardware.

SANE uses a TDM (Time Division Multiplexing) algorithm which enables real time media distribution with a network and processing latency of just 41.6µs. This TDM process involves the progressive collection of single bits from all adjacent audio and control channels across the entire network per clock cycle. The resulting stream of data is therefore a snapshot of the whole system during each clock cycle. All nodes on the network are synchronised to a single Word Clock source and receive the same data stream over their SANE CAT5 network interfaces. Due to the fact that a snapshot of every input channel is present at each network node, every device has the ability to output any channel currently active on the system. This means that signal distribution on a SANE network is Broadcast rather than multiple Point to Point links which is the practice normally employed by other media delivery systems. From the Users perspective, this removes all of the potentially complex bandwidth and routing configuration of switched networks and replaces it with the simple principle of 'once present on the network, a channel is available to all nodes all of the time' meaning the system could be considered a matrix with distributed I/O more than a typical network.

SANE borrows many of its core technologies from the company's fibre optic based system, OPTOCORE. Where the transport medium differs and the base electronics have received a revamp to bring them up to the latest standards making use of higher specification and more energy efficient components, the basic principle of how OPTOCORE works has essentially been transposed over to a new hardware platform. The benefit of using the same core technology is that it becomes very simple to switch between both OPTOCORE and SANE platforms in the same network which is demonstrated by the company's 'FX' range of devices which feature both SANE and OPTOCORE network

interfaces. This puts Optocore GmbH in the unique position of being able to offer optimised solutions for both high bandwidth Fibre Optic systems as well as lower cost, mid bandwidth CAT5 systems.

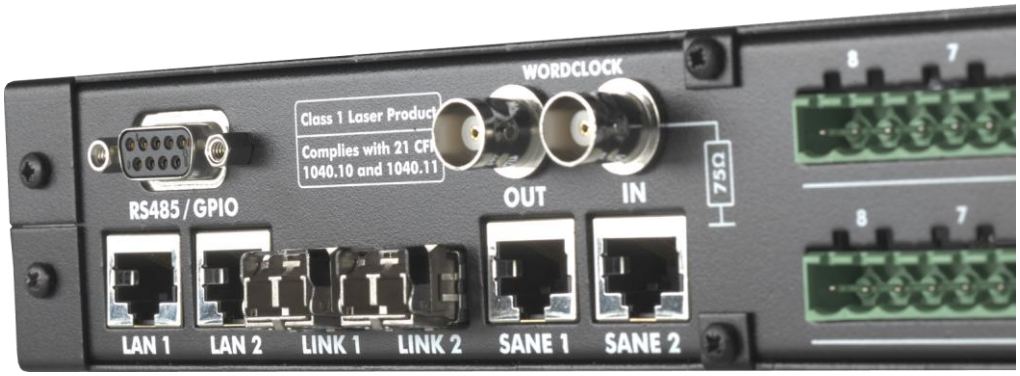

Image:- X6R-FX 'bridging' device featuring both OPTOCORE and SANE networking interfaces.

Both OPTOCORE and SANE are described as transport systems for Open Standards protocols so let's just take a quick look at what exactly that means. Optocore GmbH manufactures a number of different media interfaces which feature combinations of a multiple I/O formats. AES/EBU is implemented in its full 64 Bit frame format meaning that all of the AES/EBU data including audio, preamble, status, parity and user data bit are transported completely transparently. This makes it possible for systems using proprietary control data embedded in the AES/EBU stream to communicate across an OPTOCORE network with no extra engineering effort. The same is true of the MADI interfaces which are available in both Coaxial BNC and Fibre Optic versions where all audio and user bits are again transported completely transparently. Many digital mixing console manufacturers utilise the user bits embedded in MADI streams for the transport of control protocols to their associated stage racks, so again with very little engineering effort those products that use open standards protocols can be interfaced to an OPTOCORE or SANE network with ease.

The TDM principle used for the delivery of media between nodes means that the data on the network cables is encoded by the TDM engine but once the media stream has reached the output device it is converted back to the required format. In the case of audio, the output format does not need to match the input which means that AES/EBU inputs could be transported digitally to a MADI recording device giving the network the added benefit of functioning as a large multi format media converter.

The use of CAT5 for SANE delivery provides better initial cost efficiency when looking at system designs. CAT5 is used extensively in the communications industry so is relatively inexpensive and most electrical contractors are already proficient with the installation and termination requirements. Due to economy of scale, RJ45 CAT5 interfaces are incredibly inexpensive as are the RJ45 connectors themselves. In addition to helping to provide a lower cost entry to OPTOCORE systems, CAT5 offers just the right bandwidth and performance over distance properties to make SANE a viable solution for budget conscious system integrators and customers where medium channel counts and Ethernet connectivity are required.

Due to the synchronous nature of SANE, all nodes need to receive a Word Clock source. Every node has the ability to generate a high quality Word Clock source internally but just one device will nominate itself as the Clock Master for the network. This device will generate the clock source for the whole system and embeds the clock in to the TDM stream. All other nodes on the network then sync to the incoming clock over the CAT5 network. Where external Word Clock is provided, the device which is nominated as Clock Master receives the Word Clock via its External input. A backup device can be configured which will take over distribution responsibilities for the clock should the Master be removed from the network for any reason. In situations where you are interfacing with other equipment digitally the transfer of Word Clock between components is incredibly important or you risk free running clocks and sync problems resulting in pops, clicks and glitches in the media. For this reason SANE is used as the Word Clock distribution network for the system which when implemented correctly results in sample accurate playback across all interconnected devices and is therefore the 'glue' which links all of your digital components together.

Automatic Clock Master negotiation is just the first of a number of redundancy layers built in to the SANE system. At the network level in addition to the Clock Master negotiation described above, complete and automatic cable redundancy is also provided. Two SANE devices will work with a single piece of CAT5 cable between them giving bi-directional audio and control. By adding a second cable to create a loop between the devices, automatic cable redundancy is activated meaning any cable fault will be circumvented within a single audio sample. No configuration, no setup, just add an extra cable to complete the loop. At the hardware level, all SANE devices manufactured by Optocore GmbH feature two independent power supplies which also have an automatic switch over process in case of a fault, so high levels of resiliency are inbuilt to the system and require no user configuration.

Everyone in the digital networking business dreams of the day when we no longer have to concern ourselves with different digital formats, sample rates, firmware versions and network configuration. We've come from an analogue background where we plugged outputs in to inputs and they just worked. Optocore GmbH has been working towards addressing the issue of multiple protocols and interfacing standards on a number of levels. The Open Standards approach is the first step where manufacturers who utilise standard delivery formats such as AES3 and AES10 (MADI), RS232 or RS485, Ethernet and DMX are invited to work as development partners with Optocore GmbH thereby opening up interfacing possibilities with all other partner companies. Often, this level of integration is extremely easy because OPTOCORE or SANE already provide a solid platform for Open Standards delivery.

Another move towards the standardisation of networked media systems comes in the shape of an off shoot product realised during the development of SANE called SAPLE (Synchronous Audio Point to Point Link plus Ethernet). SAPLE provides a synchronous method for transporting MADI format audio as well as Ethernet between devices over standard CAT5. It is extremely 'light weight' from an engineering perspective which means it is easy and inexpensive to implement. As a result, it is expected that SAPLE will be submitted to the AES for standardisation in the coming months. SAPLE will be royalty free so should provide an open and very cost effective way for companies to develop medium bandwidth point to point links in an Open Standards way. It is hoped that this will provide a significant step towards the standardisation of networked media systems, something which Optocore GmbH and its development team have been working towards for the last 15 years.