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dCS Approach to High End Sound From PC/Mac Based Music

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1. Background

The explosion of portable music players and the increasing popularity of downloading music and ripping entire CD collections to a single box has influenced many consumers to start using dedicated media servers and/or PC/Mac computers as their high end source. This paper describes some of the limitations of current designs in both media serves and home-grown setups using a PC or Mac and discusses the dCS approach to getting no compromise high end sound from PC or Mac based music.

Once installed, ease of use and increasingly powerful user interfaces are just one of the many undisputed benefits to using a dedicated media server as a high end source. However, there are also challenges that the audiophile must address before investing the time and effort in buying a media server and then moving their entire music library to this single source.

Our analysis has shown that the majority of media servers available display one or more of the following design limitations:

- No industry standard specifications exist for media servers
- Extremely difficult to switch from one media server to another
- Complex installation and set-up often requires specialist assistance
- Proprietary user interface and accessories
- Support for limited number of file types (e.g. FLAC, WAV)
- Fixed storage capacity (Example: 1 x SACD requires 9Gb)
- Only able to play back music stored on the hard drive
- Internal PC (running TCP/IP, UI etc) damaging to D/A process due to noise and jitter
- No additional digital inputs or outputs
- Inadequate backup and failover features
- No more functionality than an average PC and Sound Card
- Exciting new software to support Playback, Remote Control, Ripping etc. is written for Windows™ and Apple™ **not** the high end media server manufacturers

Many consumers have recognised these limitations and instead of buying a dedicated high end media server they have built their own using a PC/Mac, Network and a network storage device or external hard drive. This alternative to a dedicated media server has the obvious benefit that the hardware and software is much lower cost as well as multi functional. This means consumers can still play discs as well as take advantage of cutting edge security and failover software, new playback and ripping software as well as use the disc storage to manage not just their music but video, photo and documents.

2. Using a PC/Mac as a Source

So… music is served! And for those who are on the way to storing all of their music collection on some form of hard disk drive the next step is how to get the best possible performance from this system. Consumers using a PC/Mac as the source have a few options open to them:

1. Upgrade the PC/Mac Sound Card
2. USB to SPDIF Converter
3. USB Digital to Analogue Converter

PC Sound Cards

There are many sound cards available to PC and Mac users and on average this is the cheapest of the 3 options but also the poorest in terms of performance.

USB to SPDIF Converters

In order to get these PC/Mac based music collections into their high end system, often the consumer will use a USB to SPDIF adaptor so that they can feed their existing Digital to Analogue Converter or Pre-Amplifier directly from the adaptor.

We have researched and tested a number of these converters and identified a number of problems with their current design:

- None use an asynchronous mode of data transfer meaning the PC/Mac source is using its own internal clock which is typically far less stable than a hi-fi component.
- None provide word clock outputs for lower jitter slaving of the DAC, making the converters vulnerable to data induced jitter.
- None use a high grade oscillator such as a VCXO or provide an input for a word clock, so even if they were to use asynchronous mode, jitter and absolute frequency would be worse.

USB DAC

An alternative solution to the USB to SPDIF problem is to add a separate USB DAC to the chain that will interface directly with the PC/Mac source and output to the amplification components. There are currently a growing number of DAC products on the market that feature a USB capability.

Our analysis has shown the following problems with existing USB DAC products:

- Having USB natively inside a DAC unit means another clock inside the DAC that is not correlated with audio clocks. This can cause clock contamination.
- USB is also capable of carrying EMI from the PC inside the DAC, causing noise in delicate analogue electronics.
- A stand alone DAC has no capability of slaving to another clock source, which the consumer might own and prefer for its improved sonic performance.
- A stand alone USB DAC does not exploit the investment and quality of a stand alone DAC unit which the consumer might already own.

3. Connectivity Challenges

All of the above mentioned PC/Mac based systems and dedicated media servers use a combination of 3 connection options: TCP/IP (Ethernet), Wireless (Wi-Fi) and USB.

An inherent problem in all sources that use Wi-Fi and Ethernet is that the source (Server or PC/Mac) requires software to be installed in order to operate. This can be extremely problematic when a consumer decides to upgrade their PC/Mac, as they often have to reinstall a number of drivers and software.

In high end audio the goal is to get as close to the original analogue signal as possible and a major weakness of both wifi and Ethernet is that **neither can guarantee bandwidth, or quality of service between the components**.

This means that a user sitting down during a listening session can have dropouts caused by microwave ovens being turned on, sudden bandwidth spikes caused by, for example, other people on the network suddenly deciding they must download huge amounts of video. Large amounts of buffering will improve the situation, but we believe this is a compromise in sound quality.

USB solves this problem because it is isochronous. This means that the host and client device both know how much bandwidth is available at the outset, and the host can guarantee that bandwidth will be available all the time.

Presently there are numerous modes for synchronizing the audio between the PC/Mac (the host), and an audio device. The most popular of these, Adaptive, is where the audio device synchronizes itself to the USB “frame” provided by the PC.

The ‘Adaptive’ method which is used by most USB audio devices tends to be **relatively poor in terms of both absolute frequency and jitter and as a result is not suitable for high performance.**

4. The dCS Solution

In developing our solution to the above challenges we were guided by a set of design principles:

- Musical performance cannot be compromised by the choice of source (PC vs. Compact Disc)
- Consumers cannot lose existing investments in separate components (e.g. PC, DAC, Amplifier)
- Consumer is given the freedom to choose which file types, software and hardware to use in their system (e.g. Ripping, Playback, File management, Backup and Failover)

Our solution is the patent pending (GB0817141.5) Scarlatti Upsampler and Puccini U-Clock.

Scarlatti Upsampler is a digital-to-digital converter (DDC) that converts digital audio data at one sample rate to a higher sample rate, providing listeners with higher levels of performance from any industry standard digital source, including PC/Mac and Media Servers. This is done at the same time as preventing the PC/Mac from injecting jitter into the sensitive analogue stage of the DAC process.

The Puccini U-Clock is a separate system clock that also allows users to connect their PC/Mac/Media Server computer to the Puccini Player using a USB input on the U-Clock. The U-Clock will convert the USB to SPDIF and present this to the digital inputs on the Puccini Player.

We considered carefully the optimum connection methods for bringing a PC/Mac source into a high end installation as well as the limitations of USB DACs and USB to SPDIF converters and we believe **that both the U-Clock and Upsampler allow users to play sound files from a PC or Mac using the USB to SPDIF conversion mechanism without the inherent weaknesses common in USB DACs and the USB to SPDIF process**.

The method of synchronizing the audio between the PC/Mac (the host), and an audio device used by the Scarlatti Upsampler and Puccini U-Clock is called **"Asynchronous USB"** (NOT to be confused with asynchronous rate conversion). In this scenario, the audio device synchronizes the audio by providing a feedback pipe to the PC/Mac. **The PC/Mac then is effectively locked to the audio device, which can have a much more accurate clock and much lower jitter.**

This approach allows consumers to use any software and hardware they choose, to rip, store and play back music without sacrificing the quality of separate high-end DACs and amplifiers. The dCS approach also allows the consumer to benefit from adding a clock to the PC/Mac source which can mean **excellent absolute frequency as well**.

We believe that the majority of consumers buy high end audio equipment for a no compromise listening experience, and we go a long way to achieving that by having the source connected by wire to a dCS Upsampler. It is increasingly possible to buy quiet PCs/laptops/Macs, and as devices such as the iPod touch have proved, the remote interface can be in your hands at the listening position.

See www.dcsltd.co.uk for more information on our range of USB equipped products.

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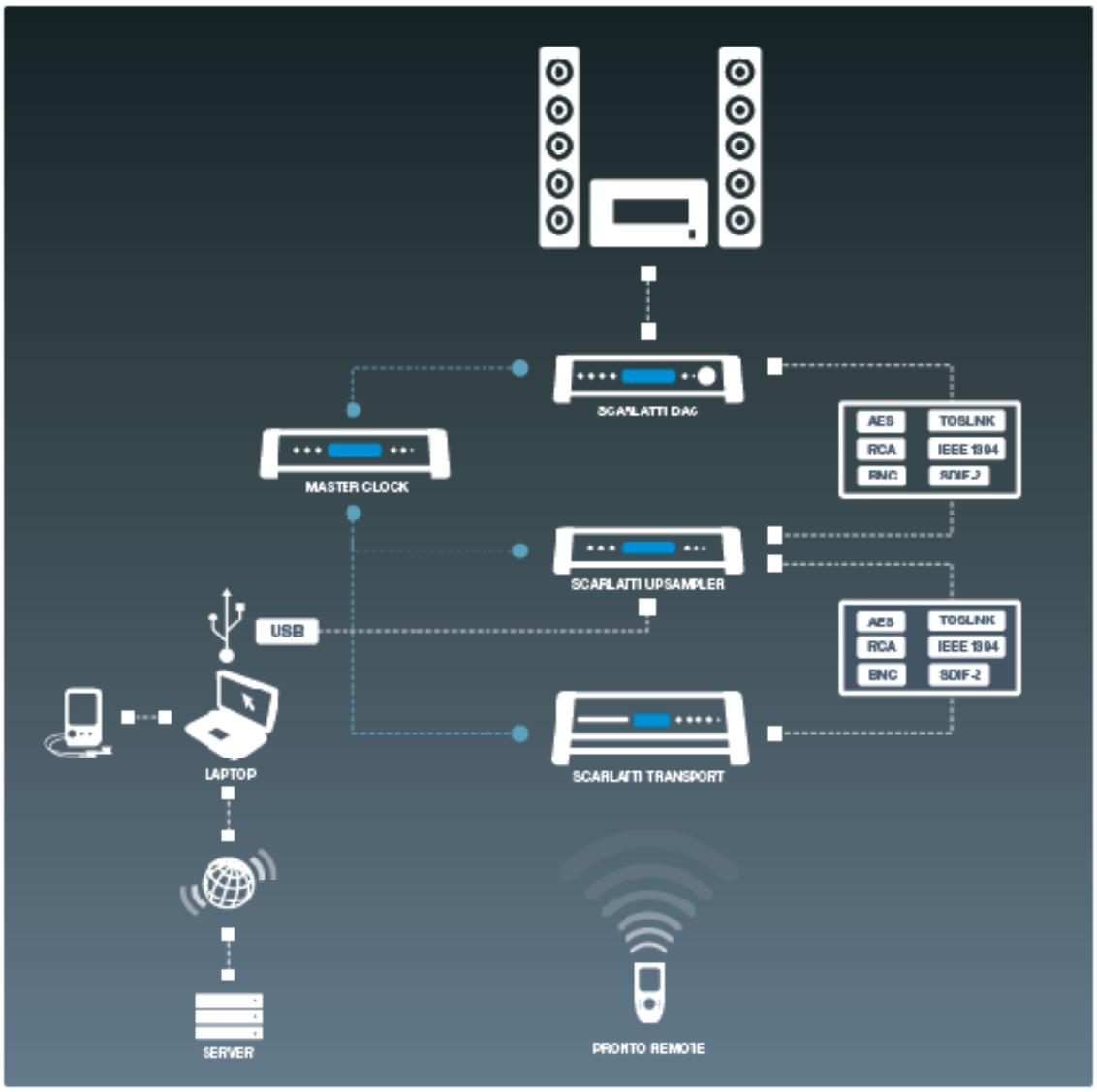
Scarlatti Upsampler
Laptop Configuration



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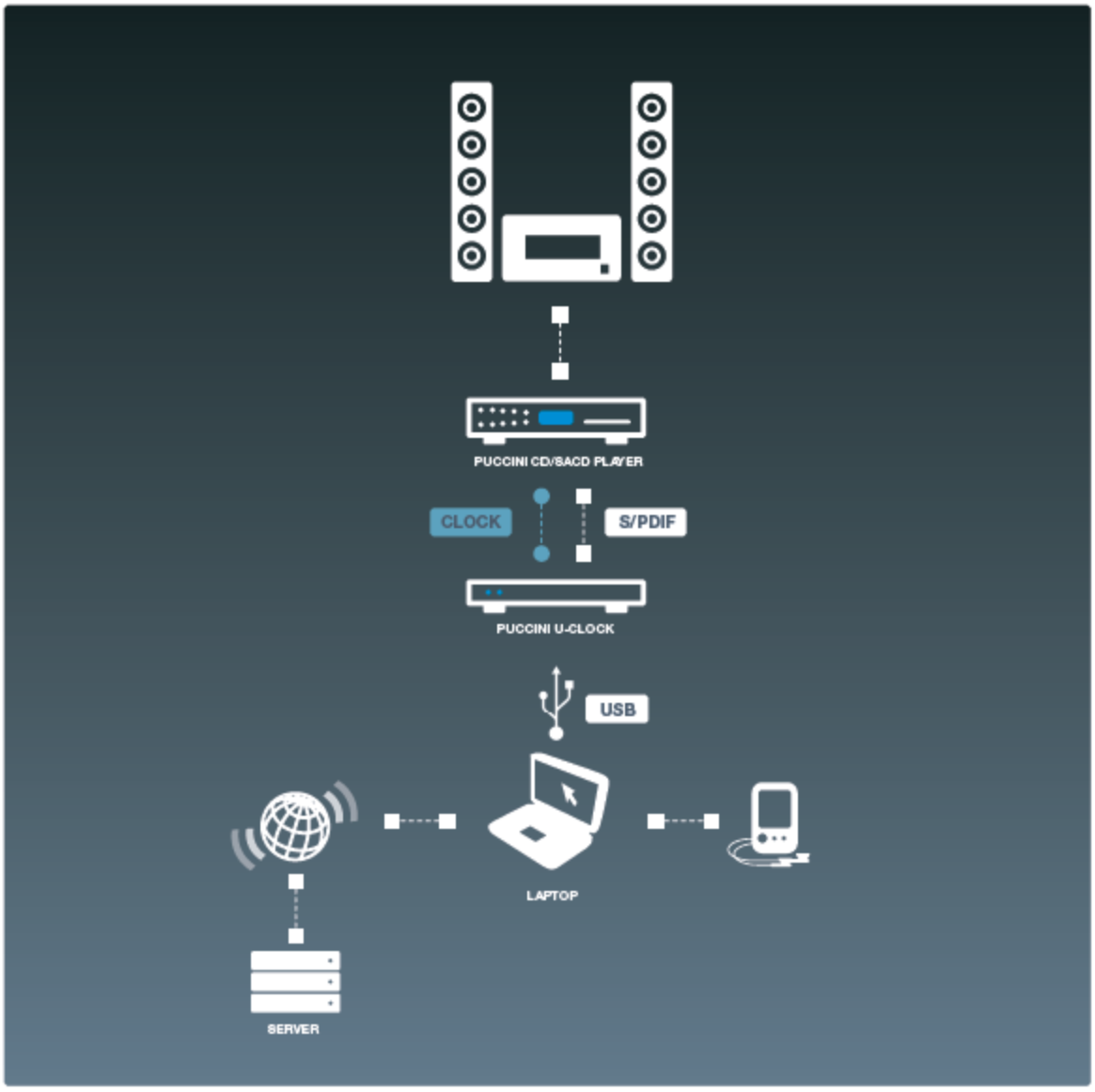
Puccini U-Clock
Laptop Configuration



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Frequently Asked Questions

Why USB instead of Ethernet?

- USB is isochronous. This means that the host & client both know how much bandwidth is available at the outset, and the host can guarantee that bandwidth will be available all the time. Ethernet/Wi-Fi cannot guarantee bandwidth – there is a concept of "Quality of Service", but this is not set in stone - especially with Wi-Fi.

Why USB and not Firewire?

- USB was chosen because it natively supports a mechanism by which the rate of data delivery from the host device (PC) can be controlled by the receiver. This allows the receiving device to feature a high quality clock and/or slave to an external clock source and be immune from the jitter and other inaccuracies of the host PC's clock. Firewire does not provide for this type of feedback, so is less suitable for this type of application. Additionally, USB is more widely available, especially on older PCs, making our solution accessible to a greater quantity of potential users.

Can I stream music from remote or online sources and play through Scarlatti Upsampler?

- Yes. The device connected to the upsampler doesn't have to contain all the audio. It makes perfect sense to have something small and silent connected by a cable to the Upsampler or U-Clock (e.g. Laptop), but then have a large HDD somewhere else connected wirelessly. In this scenario when the user selects the audio for playback, the Mac/PC streams all of it in one go from the Network Assigned Storage (NAS), then outputs that down the USB.

File formats supported by dCS

- The audio flowing between the PC and the Upsampler or U-Clock is packetised PCM at 32, 44.1, 48, 88.2 or 96k. It is the job of the PC, and in particular codec's installed on that PC, to decode file formats and present them to the Upsampler in one of these formats. In general, if the PC can play the file (using Media Player, iTunes etc), it will work.

Operating System Support

- The Upsampler and U-Clock use the "Audio Class" in USB. This means no special drivers are required, and any playback software can access the upsampler and U-Clock as an audio device. Tested on Windows XP, Windows Vista and Mac OS X.

How is the dCS approach to Digital to Analogue conversion different?

- The design philosophy behind current DAC chips is an acceptable performance level for a certain price point, but this means everyone who uses them is faced with the same limitations and offers a similar sound quality. Our patented dCS Ring DAC is a discrete balanced design, using around 40 chips, NONE of which are DAC chips. All data presented to the Ring DAC is oversampled to Ring DAC format - 5 bits at about 3MS/s. The 5-bit data is decoded to drive 32 balanced current sources, each of which makes the same contribution to the output. This means accurate ratio-matching of current sources in a binary sequence (which ruins low-level linearity) is not needed. The drive to the current sources is rotated randomly, so that any mismatch appears as a small amount of extra noise, rather than distortion. We have progressively developed this design over the last 21 years; it is one of the key concepts that has allowed dCS to drive the high-sample-rate revolution.