Hooking Up

CABLE FOR TOMORROW NOT TODAY!

Copper or glass wrapped up in plastic – now that rivals watching drying paint for a pretty good doze inducer, yet such connections are the nervous system of any AV set-up, perhaps the most hidden yet most vital part of the installation. One duff connection worth €50 cents and (in accordance with Murphy's Law) buried in an undocumented location inaccessibly deep in the bowels of the yacht can render the most expensive, effective, state-of-the-art screen to be about as good as one of John Logie Baird's early wee-screen, mechanical 'television' machines. In this third AV primer Zeb Robin of Bond Technical Management does touch on technologies and protocols, but the main thread of this article is the 'how and why' of effective future-proofing of cabling and thus the whole system. That is as much about clever architecture and design of AV systems (and – by the way – interiors) as it is about running extra cables to second-guess future requirements. Really clever design of both could in fact mean that extra cable runs can be minimised or even avoided altogether.

It may not be a very glamorous topic, but the fact is: cables make things work. Even in the growing world of wireless technologies, you're never far from a cable. The fixed antennae your mobile devices talk to are cabled – and topping up a battery will remain impractical (at least in the near future) without old fashioned copper. In yachting, getting the right cables into your ship up front is especially important due to the high cost and complexity of adding or changing them after handover. Any seasoned yachtie knows it's more than just picking a zero-halogen cable and removing a few ceiling panels. Fire compartments, watertight penetrations, coordination space headaches and exotically beautiful interior finishes often make pulling long wires a difficult, if not outright impractical, task. If one must bite the refit bullet and pull cables, cost and time impacts mean the incentive to get it right the first time is quite high.

In our last columns (*TYR* 89 & 92) we discussed considerations for planning and selecting the best screens for your system. We even touched briefly on understanding video signals and to how important they are to image quality. Today we go further and offer some advice for cable planning that takes into account 'future proofing' concepts, streamlining construction and how vessel size can affect your choices.

Longer Yacht, Longer Cables – Know the Limits

All wired signals have length limitations that need to be respected. The permissible distance is affected by the type of signal and quality of cable. The limits can be stretched, but crossing the limit almost always results in reduced video quality, lower data speeds or in worst cases – complete and total loss of function. Provided certain installation guidelines are followed, what will happen to a signal given the length and exact type of cable is quite predictable.

Installation considerations are common sense and apply to all cable types – though each cable has different tolerances.

- *Physical:* Don't crush, exceed bend radius limits or pull too hard. Wherever possible use dedicated cable supports.
- *Electrical:* If you encounter power cables, cross perpendicularly and avoid parallel runs. Stay away from high-voltage/frequency power lines (like DE propulsion feeds or main buses).
- *Terminations:* Cheap or poorly assembled connectors are a common source of needless trouble. Ensure that quality standard compliant parts are used when cables are being terminated. You'll save money in the long run

Type	Max. Length	Usage Notes
HDMI	*~10-15 metres depending on cable quality*	***HD Video**: Be aware of HDCP copyright control – failure to plan distribution correctly may result in total failure of HD video link. For consumer HD electronics, it's becoming a de facto standard. Cable extender devices are often needed.*
Coaxial	*Highly variable based oncoaxial quality, type & signal format*	***Analog Video** (1, 3 or 5 wire): No hard limit, longer cable = poorer image.* ***Digital Video** (non-HD): Extremely long distance – no practical limit on ships.* ***Digital Video** (HDSDI): Performs well – but recommend staying under 50m.*
Cat. 6 LAN *(4 pr. STP)*	*100 metres (We do not recommend Category 5 or lower)*	***1000/100/10 Ethernet**: We recommend staying under 75 metres infrastructure'* *Low-quality, poorly installed or crushed cable performs worse – moderate care is required during installation to preserve performance.* ***AV Media Extenders**: Cat 6 is very versatile as many signal types can be transported over the copper pairs via specialty converters. While very effective, extra hardware cost is incurred. See product literature for extended length limits.*
Audio	*Highly variable based on cable type and signal format.*	***Analog Audio (unbalanced)**: As short as possible – audio quality decays fast!* ***Analog Audio (balanced)**: This is an older standard that still earns respect. Appearing on high-quality equipment, it performs dramatically better than unbalanced.* ***Digital Audio**: SPD/IF = As short as possible. AES3 = no practical limit in ships.*
Fibre	*Length limit is so high it doesn't matter in yachts.*	***Multi-mode Fibre**: Several hundred metres – cheaper than Single-mode. Lower maximum theoretical data rates than Single-mode. Fine for most needs.* ***Single-mode Fibre**: Length limits measured in kilometres or by laser strength – extremely high theoretical data limits. The ultimate in future proof – comes at a cost.*

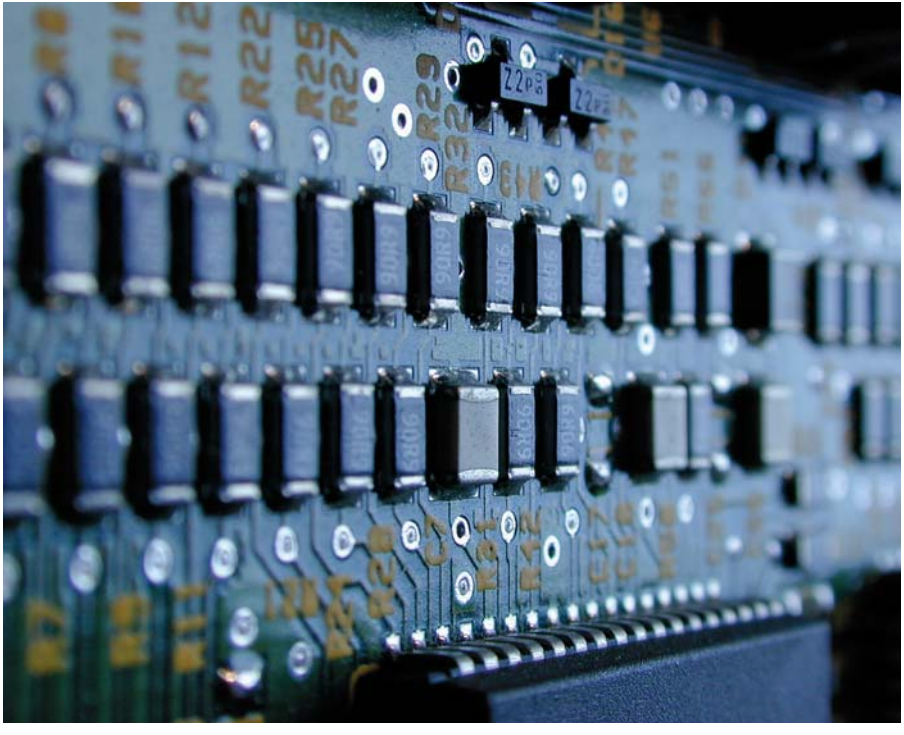
Table 1: Common cable types, length limits and notes on use – assuming quality parts are used.

and have a more reliable system. Bad connectors will sometimes worsen the length limitations for a given type of cable.

Smaller yachts often can use simpler cabling and less expensive equipment because the functionality tends to be more basic and the runs that are required are simply shorter. However, with today's modern super-sized yachts and advanced centralised AV and IT delivery systems, planning the cable distribution can present quite a design challenge. All the trade-offs of the techniques in the table on page 133 must be considered to ensure that signal quality and system performance are kept at maximum levels while still being sufficiently affordable.

Need a Media Boost?

When pushing the distance limits, the best tricks involve converting the signals to either LAN cables or to fibre. The products that do this are quite effective and usually produce good quality images and sounds; however, they aren't always cheap. They also add a possible point of failure that needs to be maintained. In most new megayachts and high-end estates, though, they are a good trade-off – especially when extending the more difficult HD signals.



Future Proofing

Increasingly, AV and IT technologies are merging. All forward trends indicate an eventual convergence of the two in one form or another. Although today's technology isn't 100% there, the process has begun and it's certainly possible to lay plans today that will serve you well tomorrow.

• Encourage shielded Category 6 type network cable usage.

Although media converters may be needed today, future generations of devices will utilise the IP data network directly.

• Note on Category 7: It would be remiss of us to not mention this buzz term. Integrators often claim they will install Category 7 cabling; however, the fact remains that there is no official standard yet. Therefore nobody can in full honesty claim that their cable and connectors are truly Cat. 7 compliant. Add to that the fact that equipment capable of utilising its potentially ultra-high speeds won't be on the market until a 2012–2016 time frame, and one must take the term with a pinch of salt. That said, it is quite likely (though not guaranteed) that high-quality shielded Category 6 cable will pass Category 7 testing standards some day when the industry eventually agrees on what exactly that standard will be.

• Avoid over-centralising. Regionalised distribution locations reduce long cable run quantities and if done well improve redundancy and automatic system failover abilities.

• Invest in quality LAN cable infrastructure. It will be the backbone of tomorrow's systems. Even wireless systems require network cables to the local access point antennae. With Power over Ethernet technology evolving rapidly, a quality LAN infrastructure has never had such a bright future. (*Power over Ethernet allows equipment which may have required a power adaptor, and thus a nearby 100/240 VAC outlet can satisfy their power needs over the network, a technically elegant and visually neat approach – Ed.)* Therefore we recommend that boat builders do not skimp on this vital copper infrastructure despite the current WiFi craze. Imagine a day when you can charge your laptop from a network cable. Promising developments on the horizon are likely to bring interesting new uses for the old tried and true LAN cables.

Keep Things Practical

As mentioned above regionalised network switches improve reliability, but they also reduce the number of gland penetrations required in the ship by converting otherwise long cable runs to short ones. Refits benefit as well because if you need a new cable somewhere – it's more likely that a local network switch will be nearby, thus making new cable pulls much shorter.

Glossary of Terms

HD – High Definition: *A general term indicating a video signal with higher image resolution than contained in a standard definition PAL or NTSC signal.*
Television standards are most often described by how many horizontal lines of resolution they contain with the letters 'p' or 'i' indicating if the image presents every line in progressive sequence or in an interlaced mesh. The main flavours of HDTV are 720p and 1080i/p in a wider (more rectangular) aspect ratio. With old-school TVs weighing in at 480i (US) and 576i (Europe) respectively – and considering that most over-the-air analog consumer televisions could only display a percentage of even that resolution – it's easy to see why digital HD is such a dramatic jump in quality.

HDMI – High-Definition Multimedia Interface: *a relatively new digital cable interface offering consumers excellent quality digital HD video and audio. A consumer standard with historic similarities to S/P-DIF in some ways, this standard has its roots in digital technologies like DVI and HD-SDI. It flexibly transports a variety of high-quality multiplexed audio/video data streams and has an included communications channel to allow source and destination devices to talk to each other for HDCP handshakes.*

HDCP – High-bandwidth Digital Content Protection: *The copy protection technique used within the HDMI standard. Designed to ensure that a player will only send its high quality HD video to a registered receive-only device such as a TV display (as opposed to your PC hard drive), HDCP uses a two-way handshake between source and destination to unlock the source media. Handshake failure will disable video transmission. It effectively hampers piracy, but poses unique problems when distributing one source to several destinations in a complex home system. New products are now starting to enter the market to alleviate this problem while staying within the law.*

HD-SDI – High-Definition Serial Digital Interface: *An HD standard that has been used for many years in television production centres to create the HD programs now available in the home. Unlike HDMI, HD-SDI uses inexpensive coaxial cable, which can be run very long distances and has no copy protection. In addition, it allows for the inclusion of many channels of AES3 digital audio to travel with the video. This performance comes at a price though as the hardware is very expensive and interfacing to HDMI sources presents challenges. It has nonetheless found its way into some of the most complex and high-end home systems in the world.*

S/P-DIF – Sony/Phillips Digital Interface Format: *The little brother of AES3, S/P-DIF is a common consumer data format for digital audio. Although the data payload is nearly identical to the more robust AES3, the similarity ends there. S/P-DIF can be found in two common cabling types: coaxial copper or optical TOSLINK. The information on both is identical. Major difference to AES3 is that S/P-DIF was intentionally down-engineered for the consumer market to cut hardware costs (and in the eyes of many, to please the copyright associations). In addition, optical TOSLINK cables should NOT be confused with real fibre optics as the quality of the optical tube and light transmitters are drastically lower (and cheaper) than real fibre optics, thus eliminating the excellent length performance of multi- or single-mode optical technology. The benefit to the consumer is that TOSLINK is harder to break, more resistant to dirt, and isn't likely to cause human blindness if mishandled. Provided length limits are observed, there is no quality difference between Copper S/P-DIF, TOSLINK S/P-DIF or AES3 (though AES3 has more technical capabilities than S/P-DIF).*

AES3 – AES3-2003: *AES standard for digital audio (named for the standards bodies that helped create it: Audio Engineering Society & European Broadcasting Union): Often called AES/EBU by seasoned broadcast guys; this is the predecessor to S/P-DIF containing all the benefits of uncompressed lossless digital audio without sacrificing cable length. It can contain many more channels of discrete audio and be transmitted very long distances over inexpensive copper cable – either coaxial 75 ohm or balanced 110 ohm. Because the electrical signals are nearly identical, one can interchangeably convert between the two cable types via inexpensive passive impedance matching transformers.*

DVB – Digital Video Broadcasting: *A widespread open standard for digital media broadcasting. Almost always employs varying degrees of compression techniques to increase the number of channels available. Conditional key encryption is also common, enabling broadcasters to control who can watch a given program.*

IPTV – Internet Protocol Television: *A generic term for video transport techniques that deliver video over packet-based computer networks. It's extremely versatile and powerful, though still very complex and often frankly troublesome. Although many years away from widespread use within the home, IPTV has the potential to make most of the above cabling standards obsolete. Standard definition 'normal video' IP systems are now on the market; however, HD is a tough sticking point for several reasons.*

Another way to streamline construction is by utilising hybridized cables – these are large cables that contain multiple smaller cables inside. The reasoning behind this is that one big 30-mm-diameter cable is often easier and cheaper to install than the six small individual cables inside would be. Fewer gland penetrations, fewer cables to comb and secure to cable trays, and a tougher overall strength to minimise possible installation damage. While hybrids are sometimes custom fabricated on spec (as we have done for some of our customers) there are also a variety of off-the-shelf hybridized products that can simplify cabling to devices like cameras, local AV systems and media sources.

The Final Test

Installing a robust cabling infrastructure is meaningless if the cables are not thoroughly tested to the highest industry standards available. Some tips to consider:

• Test the cables as early in the construction process as possible – but no earlier. Wait until the cable is fully secured and the rough walls are in place for terminations, but wait no longer than absolutely necessary. If you find a defect after the decorative walls and ceilings are finished replacement will cost dearly.

• Use modern testing systems. Ask how the cable tests will be conducted and prepared into a report. Modern equipment tests to the most rigorous standards while also having database recording capabilities that dramatically improve labour efficiency. This modern test gear therefore saves integrators' money in labour while simultaneously making fraudulent errors – either intentional or accidental – more difficult. And that's good for everyone.

• Audit the test results through an independent party. Often just knowing that you will conduct spot checks will keep things honest. We always perform our own cable audits as a service to our customers to allow us to stand by the work our integrators have done with confidence. We recommend everyone exercises this same due diligence.

In our next column we will shift gears to discuss digital broadcast technologies such as DVB and IPTV, and how these technologies are bringing new and exciting content to the modern yacht.

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