# YAMAHA System Solutions *white paper*

## Networked audio system design with CobraNet™

*This white paper's subject is Networked audio system design with CobraNet™.*

*The design concept in this paper supports systems varying from small touring event setups to very large scale networked audio installations. That does not mean that the design concept is the best solution to all system specifications, other network topologies and audio protocols should always be considered in the initial phase of the design project. The advantage of this Yamaha System Solutions design concept is that it is based on Ethernet / CobraNet™, both open protocols that use computer networking components widely available on the market. Other compatible brands of both network and audio equipment can be included in the design concept, assuring maximum flexibility and project efficiency for system integrators. It is also good to know that the design concept is not just a theoretical exercise; we have built, tested and installed systems based on this design concept so you can be confident that the concept will work in real life.*

*We assume the reader is a system integrator with detailed knowledge of analogue and digital audio, and basic knowledge of networking technologies as covered in the 'Yamaha System Solutions - an introduction to networked audio' white paper.*

*The Yamaha Commercial Audio team.*

The complete package

CobraNet™ networked audio systems

# 1. System design

## Customer's requirements

The first step in any design is to chart the customer's requirements. Sometimes the requirements can be found in a formal tender if a consultant has already been involved in the customer's system specification process. In many cases the consultant or system integrator has to discuss the customer's requirements in depth to find the most appropriate system specifications, and perhaps suggest additional system possibilities made possible by new technologies on the market.

## System specifications

The second step is to draw up a system specification based on the customer's requirements. A system specification document contains the requirements for a system to fulfill as operational parameters. The system specifications should not include any direction to actual solutions as that would narrow the scope of possibilities in the design stage. Only by keeping the system specifications and the design solution options strictly separated can the broad scope of choices be truly considered by the designer, allowing for maximum flexibility, quality and creativity in the design stage.

## Design options

Based on the system specifications document, basic design options can be conceived. The main decision to make is the selection of the technology to be used: analogue or digital, point to point or networked, closed (proprietary) or open (manufacturer-independent) platforms etc. These decisions are fundamental as they determine the degree of freedom allowed in further design stages.

## Selection of network and audio devices

After the technology platforms have been selected the system's actual network and audio devices must be selected. Input parameters for selection include feature set, audio quality, technical reliability, supplier reliability, complexity and of course cost level. There are no products with an 'A-score' on all of these parameters; quality comes with higher costs, more functionality comes with a more complex user interface, etc. The designer must study each system component's feature set in depth to assess if it meets the system specifications or not, and conceive creative solutions in case no matching products are available.

## Design tools

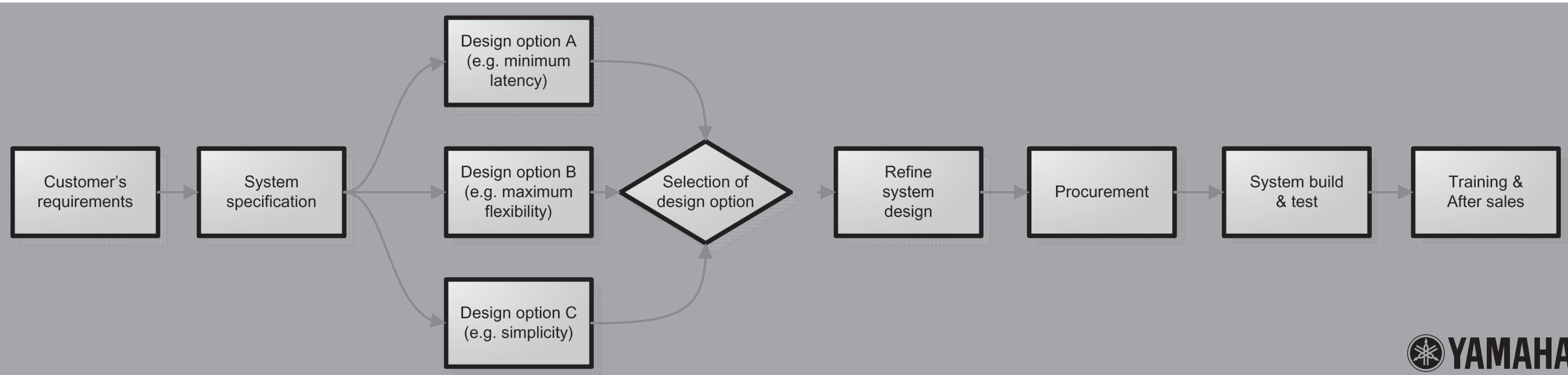
The more complex a system the more important design tools become. A small system can be described in words or an excel sheet, but larger or more complex systems have to be described in drawings to be able to communicate them to all stakeholders in a project. In these cases software programs are used to construct system designs, such as AutoCAD in the contracting business, StarDraw in the audio markets and CobraCAD for CobraNet™ system designs.

## System test

A very important part of the network design process is to conduct (sub) system tests. Especially network systems using managed switches offer an extremely high functionality level that require system tests to verify that all parameters have been programmed correctly.

## Training & after sales

A networked audio system offers different functionality compared to analogue systems. Therefore the design of appropriate after sales and training activities for future users of the system is an important part of the design stage.



# 2. Specification list for Yamaha System Solutions CobraNet™ designs

Based on the customer's requirements a system specification must be drawn up. For this white paper a 'one size fits all' system specification is listed intended to cover most of 'every day' applications from small touring sound reinforcement sets to large scale distributed i/o installations. Although this system specification list will most probably produce a system design that meets the average customer's requirements, it might cover more than required. To achieve efficient system designs it is recommended to carefully go through the first step of the system design process of charting the customer's requirements before drawing up the system specification list.

## True Network

The design concept should cover virtually all application sizes; from simple P2P connections to large scale installations with many locations. To allow this level of scalability, and to keep systems manageable, a true network protocol should be used. Functional connections must be separate from the physical cabling in the network assuming the network offers sufficient bandwidth for the application.

## Open system

Both the network protocol and the audio network protocol should be open market standards. This way the new developments in the IT industry over the past decades can be utilized, and connectivity is not limited to Yamaha components alone. The use of established standardised technology allows high quality and cost-effective designs.

## Cabling

The design concept should cover long distance cabling of up to 500 meters. The network design should support up to five long distance locations. The long distance locations should offer connectivity to Local network structures.

## Touring

For live touring applications, touring grade cabling should be used. Cables should include road proof connectivity systems.

## Topology

For all designs, the network topology should offer easy connectivity - supporting the use of cost effective computer networking hardware.

## Redundancy

All designs should feature full redundancy for all network components. A system should recover automatically from any network component failure.

## Bandwidth

The network should have a bandwidth supporting at least 500 audio channels. All individual audio devices should support up to 64 channel bi-directional links.

## Audio quality

The system should support at least 24-bit 48 kHz audio signals.

## Latency

The network should support a fixed latency of 1.3 ms for mid size systems. For larger systems higher fixed latency modes are allowed.

## Acoustic noise

Apart from the star location the network devices in the system should not make any significant audible noise.

## Status monitoring and control

The design concept should include a computer to control and monitor the system's audio and network devices.

## Serial connectivity

Connectivity of serial standards such as RS232C and RS422 should be possible using inexpensive hardware.

## Ethernet connectivity

The system should offer a 100Mb Ethernet network for connections to Ethernet compatible devices. This network should be separate from the audio network.

## Costs

The system should be cost effective.

## Options

The system should support optional video connections using IP cameras, Uninterrupted Power Supplies and wireless access points etc.

# 3. Network & Redundancy concept

Based on the system specification list in the previous chapter the following Yamaha System Solutions design concept is proposed.

## Network

The Yamaha System Solutions design concept uses CobraNet™ audio devices. All devices are connected to a Gigabit Ethernet network using a star topology. The network uses managed switches supporting VLAN and Rapid Spanning Tree Protocols.

## VLAN

The network is divided in two VLANs: one for CobraNet™ and one for control. If a system requires the use of many multicast bundles, additional VLANs can be included.

## Switches

A high capacity and a low capacity switch supporting Gigabit connectivity are used to build the network.

Both switches support IEEE802.1q VLAN, IEEE802.1w rapid spanning tree, IEEE802.3ad link aggregation and QoS functionality.

## Star locations

A high capacity switch including at least four GBIC ports for Gigabit fiber connectivity is used for the star location. Such a high capacity switch is typically not available without cooling fans, so this location should be planned in a place where acoustic noise is not a problem such as the amplifier rack.

## End locations

A low capacity switch including at least eight 100Mb RJ45 ports, one Gigabit RJ45 port and one GBIC port for Gigabit fiber connectivity is used for all other locations at the ends of the star network. The eight 100Mb ports are divided in six ports carrying the CobraNet™ VLAN, and two ports carrying the control VLAN.  The switch should not have cooling fans so it can be used in noise-free conditions on stage or at the FOH position in the audience.

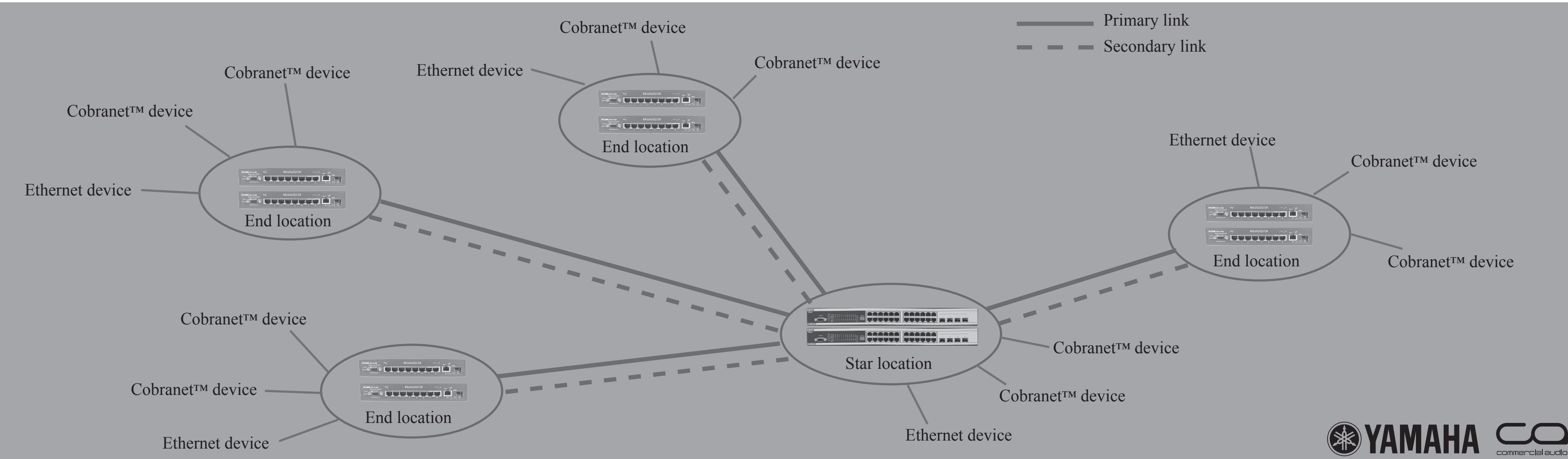
## Cabling

All long distance cabling from the star to the four locations carrying Gigabit network information is specified with 50 µm multimode fiber, connected to the switches using appropriate GBIC fiber modules. For distances under 50 meters CAT5E cabling can be used instead.

All further connections in the system use CAT5 cabling carrying 100Mb network information.

## Redundancy

All locations use double switches, labelled primary and secondary,  with a Gigabit link between them. The two switches are connected to the star location by two cables, preferably laid out over different physical paths through the venue. All CobraNet™ devices' primary links are connected to the primary switch, and the secondary links to the secondary switch. In the star location's secondary switch the Rapid Spanning Tree Protocol is active.



# 4. Control network

## VLAN

To ensure that CobraNet™ data traffic and other Ethernet traffic flowing through the network can not interfere with each other, a separate 'control' VLAN is used for all non-CobraNet™ devices. At each switch location two ports are configured to carry the control VLAN signals.

## M7CL Studio Manager

The control VLAN can be used to connect M7CL Studio Manager to all M7CL consoles in the system. This way the system engineer can plug in the Ethernet port of a laptop anywhere in the system and have control over any console. The Studio Manager software and the consoles are linked together by their IP addresses.

## DME Designer

The control VLAN also connects to the Ethernet port on all Digital Mixing Engines. GPI and parameter control signals in systems using multiple DME units can be linked together through the control VLAN. Any DME unit can be monitored, controlled and programmed on a computer using DME designer software from anywhere in the system. Individual DME's can be selected by their IP address.

## Serial servers

A pair of serial servers can be used to connect serial signals such as the RS422 head amp control on digital mixers. Functional connection is done by matching the serial server's IP addresses, allowing multiple serial connections to be used.

## IP cameras

Inexpensive internet video surveillance cameras can be used to make multiple low quality video monitor connections to be picked up anywhere in the network. An internet browser such as Microsoft® Internet Explorer can be used to display the video signals on a computer screen.

## DMX

Using RS485 to Ethernet devices, the connection of lighting consoles and dimmer packs using the DMX control standard can be run on the network.

## Wi-Fi

A wireless access point can be added to the control VLAN to allow wireless access to all of the audio system's networked control functionality.

## IT network

Both the complete Yamaha System Solutions network or just its control VLAN can be connected to an existing IT network, allowing a venue's Ethernet devices such as printers, servers and internet modems to be used. For these applications, it is essential to involve suitably experienced network professionals, such as the IT network administrator.


Serial server (B&B ESP901)


IP camera ( Dlink DCS6620)


Wireless access point (Dlink DWL7200)

Lighting console (WholeHog® III)

# 5. Locations & connections

## Locations

All locations in the system feature two Gigabit managed switches. CobraNet™ and Ethernet devices are connected to specific connectors of the switches.

## Installations

For installations, the network connections of the switches can be used. No front panel connectors are required.

## Touring

In case of a 19” rack, the two top units carry the two switches. The back side allows access to the switch ports, the front side includes touring connectivity using EtherCon® connectors for CAT5E cabling and Fiberfox® EBC52 connectors for fiber cabling.

In case of a mixing console, the switches, EtherCon® and Fiberfox® connectors can be built into the mixer’s flightcase, e.g. in the dog box at the rear of the console.

## Star location

A high capacity switch, such as the Dlink DGS3324SR, featuring 24 Gigabit ports with four GBIC SFP slots for fiber connectivity, is used for the star location. Ports 1 to 8 are allocated to VLAN1: default (the control VLAN). Ports 9 to 16 are allocated to VLAN2: CobraNet™. For redundancy one CAT5E patch cable connects to port 17 of both switches. Ports 21 to 24 double with the GBIC slots for connection to the end locations.

For touring applications, each location to be connected to the star requires two connectors on the front panel of the location’s case: two EtherCon® connectors for redundant CAT5E cabling or two Fiberfox® EBC52 connectors for redundant fiber cabling.

## End locations

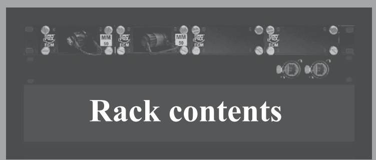
A low capacity switch, such as the Dlink DES-3010GA, featuring eight 100Mb ports, one Gigabit port and one GBIC SFP slot for fiber connectivity, is used for all end locations. This switch does not have a fan so it is silent; it can be used in critical acoustic environments.

Ports 1 and 2 are allocated to VLAN1: default (the control VLAN). Ports 3 to 8 are allocated to VLAN2: CobraNet. For locations with Fiber connectivity, one CAT5E patch cable connects the TX Gigabit ports of both switches to support the RSTP redundancy, while the GBIC slot is used for connection with the star location. For locations with CAT5E connectivity the GBIC slot is used for the RSTP redundancy link, and the TX Gigabit port for the connection with the star location.

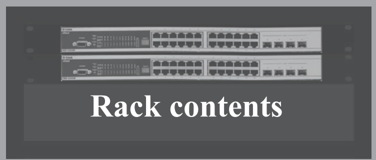
For touring applications, two connectors are available on the front panels: two EtherCon® connectors for redundant CAT5E cabling or two Fiberfox® EBC52 connectors for redundant fiber cabling. An end location can connect to further CobraNet™ devices, other than those built in the stage rack, using two EtherCon® connectors per device.

## Redundancy

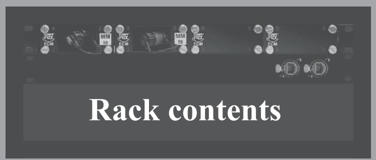
All connections come in pairs for redundancy. Connections should be rolled out physically separated from each other as much as possible to offer maximum protection from cabling accidents e.g. involving rodents or heavy military equipment.



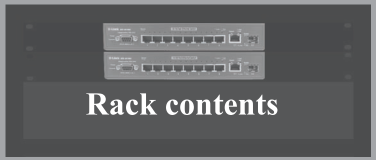
Star location rack front view



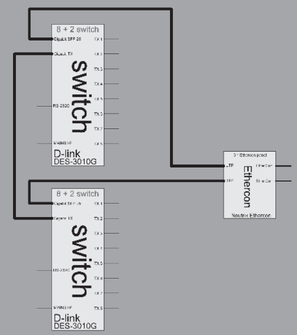
Star location rack rear view



End location rack front view



End location rack rear view



Location functional diagram

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# 6. Programming the network

## Network settings

Network settings have to be programmed using the software provided by the switch manufacturer. Switches can be programmed with a computer connected to one of its network ports using a web browser such as Microsoft® Internet Explorer in a user-friendly way. Old style ‘command line’ programming is possible using a serial RS232C connection using the Windows® Hyperterminal software; the Command Line Interface (CLI) that has to be used will be described in the switch’s users manual.

Port-based VLAN’s have to be programmed one by one on all switches. On the secondary star switch RSTP should be enabled on the ports connected to the other switches in the system. RSTP should be disabled on all other ports and all other switches in the system. Connect the secondary star switch to the network only after RSTP has been enabled.

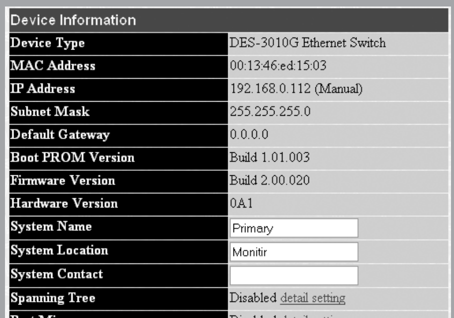
## Switch IP address

The switch’s web based user interface can be accessed using Microsoft® Internet Explorer. Out of the box, every switch in this example will have the same default IP address, so the first thing to do is to connect each switch one by one as a single device to a computer using an Ethernet crossover cable. Then log in using the default IP address specified in the switch’s users manual, leaving the user name and password empty. To be able to access the switches after they are connected in the network, it’s best to change the IP addresses of all switches to a logical order range on the control network that you will use for IP services in the system, and document the addresses in the system project document. After setting the new IP address and subnet mask store the settings and then log into the web based user interface again using the new IP address. Connect to the switch using a port planned to be in the Default VLAN.

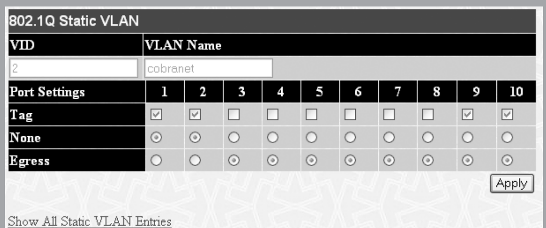
## VLAN and STP settings

For Dlink switches the VLAN settings are available under the ‘L2 features’ tab in the folder hierarchy on the left side of the web display. Clicking the ‘Static VLAN entry’ tab produces a list of programmed VLANs. Use the ‘modify’ or ‘add’ buttons to set up the VLANs. To set the spanning tree parameters access ‘Spanning Tree’ under the ‘L2 features’ tab. Don’t forget to store all settings after every change !

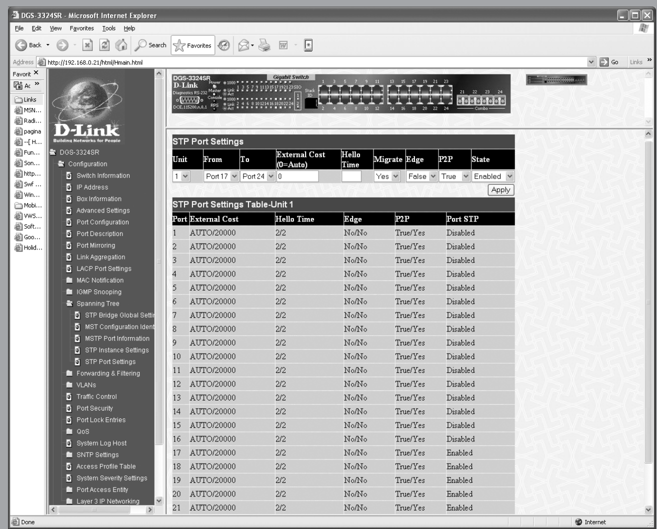
In the end locations the switches’ default VLAN should include ports 1 and 2, an additional CobraNet™ VLAN should include ports 3 to 8. Both VLANs should be tagged and assigned to ports 9 and 10. On the secondary star switch RSTP should be enabled on the long distance link ports only. Then test the system and fine-tune STP settings.

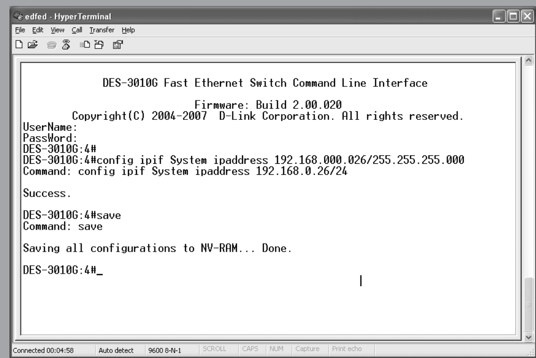


DES3010G web interface - IP settings



DES3010G web interface - VLAN settings


DGS3324SR web interface - STP settings



DES3010 CLI interface - IP settings

# 7. Programming the IP over Ethernet devices

## Serial server

To connect RS232C, RS422 and RS485 control signals over the network a serial server must be used. Serial servers are available from Moxa, B&B Electronics, Axis etc. Using, for example, the B&B ESP901 serial server a web interface is available to program the settings. First login using the default IP address of each device in the system and change the IP addresses one by one to a logical order range so they can be accessed later on when the system has been assembled. The serial server allows for its serial port to be connected to another server by selecting the matching IP address and setting the correct serial port parameters. For AD8HR head amp control select RS422 at 38,400 baud, 8 data bits, one stop bit, no parity. A special cable is required to connect the serial server's port to the AD8HR.

## IP Cameras

IP cameras are available from Dlink, Level1, Sony, Sweex etc.
Cameras can be used for visual communication links, monitoring of amplifier racks, etc.
Using, for example, the Level1 FCS-1030, login to each camera in the system using the default IP address and change the IP addresses one by one to a logical order range so they can be accessed later on when the system has been assembled. That's it ! The video signal can be monitored using a web browser, typing in the IP address in the web browser's URL area. The typical video quality of a budget IP camera is MPEG4 VGA with a latency of roughly one second. For better quality video and lower latency, higher quality cameras or video servers can be specified.

## DME Designer software

To connect a PC to Yamaha devices in a network the Yamaha DME network driver needs to be installed first. For DME designer the network driver's settings must include the master DME's IP address and MAC address to allow DME designer to access the network.

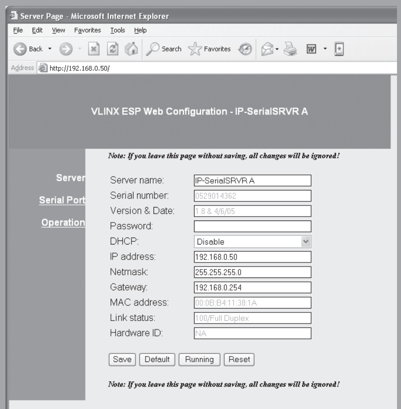
In the DME designer MIDI Setup menu the network can be selected as the software's communication port. Now the software's synchronisation menu will display all DMEs and ICPs in the network.

## GPI using DME

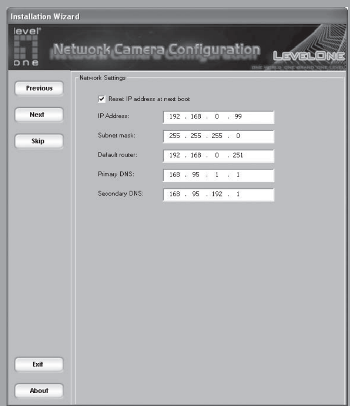
At the moment there is no separate GPI network connection function available in DME designer, so GPI connections can be made using dummy parameters in each DME unit; connecting them using the global parameter link function.

## M7CL

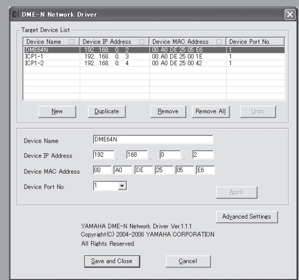
To connect the M7CL editor to an M7CL mixing console in the network the DME network driver must be used. Set matching IP and MAC addresses in the network driver and the M7CL's network settings.

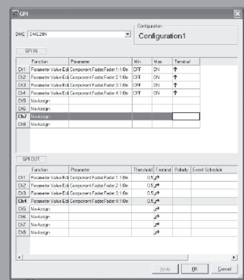


ESP901 web interface



IP camera web interface


DME network driver settings


DME GPI settings

DME network settings


M7CL network settings

# 8. Yamaha CobraNet™ devices

## NHB32-C

The NHB32-C is a 32 channel AES/EBU network hub and interface to CobraNet™. The back panel offers four 25-pin Dsub connectors for 8 channels / 4 pairs AES/EBU inputs and outputs each. In 5.3 ms and 2.6 ms latency mode the NHB32-C supports 4 CobraNet™ bundles in and out, with a programmable matrix router between the AES/EBU i/o and CobraNet™ bundles. In 1.3 ms latency mode there is a restriction of using four bundles in total for inputs and outputs.

## ACU16-C

The ACU16-C offers sixteen analogue 24-bit 48 kHz outputs on Euroblock connectors to drive power amps. An RS485 data connector is included to connect to a series of PC01N power amplifiers, bridging the connection to other ACU16-C units in the network. This functionality allows control, logging and monitoring of all PC01N amplifiers with a PC connected to the USB port of any ACU16-C or NHB32-C in the CobraNet™ network.

## DME Satellite

The DME Satellite series are compact 1U units with 8 channels of analogue i/o, 8 GPI inputs and 4 GPI outputs. The DME satellite is available in three analogue i/o configurations: 4 in 4 out, 8 in or 8 out. All analogue inputs offer a remote controllable head amp for easy connectivity of microphone level signals. A serial port is available for remote control of AD8HR units or RS232C control by AMX™ or Crestron® systems (for example).

## MY16-C

The MY16-C offers 2 bundle i.e. 16ch in & 16ch out CobraNet™ connectivity to compatible MY16 devices such as the M7CL, DME24N, DME64N, PM5D. Due to power supply limitations, the use of the MY16-C in the DM2000 is limited to one card only, and the MY16-C can not be used in other MY16 compatible products such as the DM1000, 02R96, 01V96.

## MY16-CII

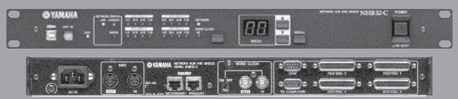
The MY16-CII is the successor of the MY16-C with connectivity to all MY16 compatible products. The power supply limitation is solved so the card can be used in any MY16 compatible digital mixing console. The setting of bundle numbers with rotary switches has been replaced by software control using the supplied CobraNet Manager Lite software package.

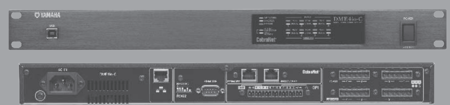
## DME24N, DME64N

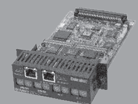
Both DME24N and DME64N can connect to a CobraNet™ network using MY16-C or MY16-CII cards.

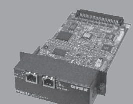
## Digital mixing consoles

Any Yamaha MY16 compatible digital mixing console can connect to a CobraNet™ network using the MY16-CII card. The PM5D and M7CL also accept MY16-C cards.


NHB32-C

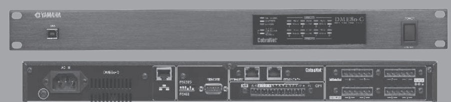

DME4io-C

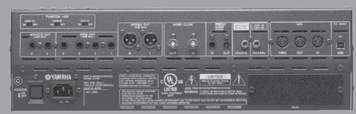

MY16-C

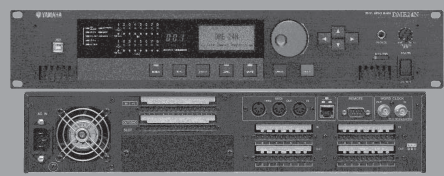

MY16-CII


DME8i-C


ACU16-C


DME8o-C


Digital mixer with Mini-YGDAI slot


DME24N/DME64N with M-YGDAI slot

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# 9. Programming the CobraNet™ devices

## Setting up NHB32-C and ACU16-C

To program NHB32-C and ACU16-C devices a Windows® XP computer is required. First install the Yamaha MIDI USB driver and NetworkAmp Manager software available on www.yamahaproaudio.com/downloads. Activate the MIDI ports in the MIDI USB driver in the computer's control panel and launch the AmpManager.exe software.

Then set the rotary ID switches on the front all NHB32-C and ACU16-C devices in the network to a logical order from zero upwards. Connect the computer to any of the NHB32-C or ACU16-C units in the network using the USB connector on the front side of the unit. With this connection all units in the system can be programmed using the CobraNet™ network.

The software allows settings of the latency mode, unicast enable, sample size and incoming and outgoing bundle numbers.

In 1.33 ms latency mode the NHB32-C can only handle a total of 4 bundles, in all other modes the full 4 in 4 out can be used. In 5.3 ms latency mode the 24-bit setting reduces the channel count to seven channels per bundle, the lower latency modes do not have this restriction.

## Setting up MY16-C

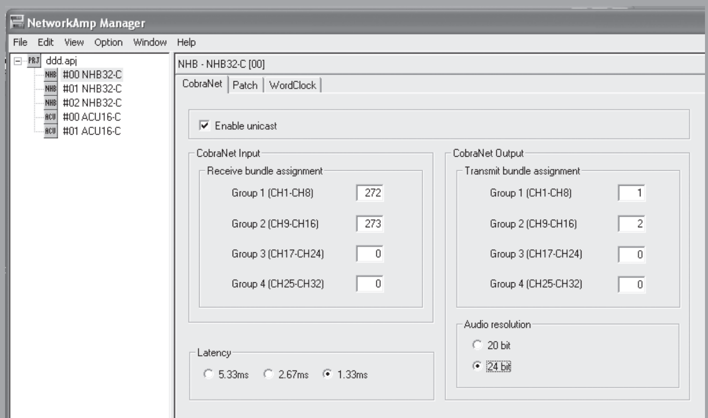
The old version MY16-C cards offers two input bundles and two output bundles for a total of 16 channels in and out. There are two rotary switches on the back of the card for each bundle which can be set from 0 to 15. If both rotary switches are set to 0, the bundle is inactive. If the MSB rotary switch is set to 0, the LSB rotary switch defines the bundle number to be multicast ranging from 1 to 15. If the MSB is set from 1 to 15, the LSB sets unicast bundles starting from 272. A list of bundle settings is included in the users manual.

Settings for wordclock (sample rate), sample size and latency mode are also available as dip switches on the card's PCB.

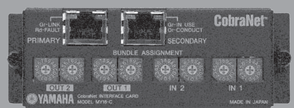
## Setting up MY16-CII

The MY16-CII uses a software program to set the bundle numbers, sample size, wordclock and latency mode. First install Cobranet Manager Lite on the PC, then connect it to the CobraNet™ network. After starting the software, all CobraNet™ devices will be recognized by the program and a selection display will ask for four devices to be selected for editing. All CobraNet™ devices in the network will be displayed on the CobraNetManager's screen in a matrix view, with the four selected devices activated for editing . To be able to edit all devices at the same time an upgrade to the full version of CobraNet™ manager is required, available by request from www.cobranetmanager.com

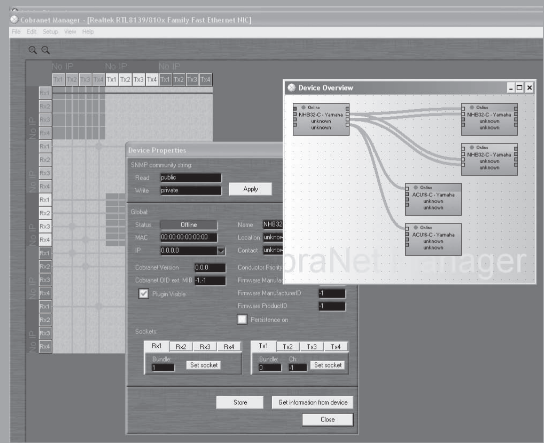
Click on an active MY16-CII and select 'Yamaha settings' to access the device settings menu to set wordclock, sample size and latency mode.



Yamaha NetworkAmp Manager (NHB32-C, ACU16-C)



Rotary switches bundle selection (MY16-C)



CobraNetManager lite (MY16-CII, DME Satellite)

# 10. Testing & troubleshooting

## Checklist

After assembling a networked audio system it is good practice to conduct a systematic series of checks to make sure everything is OK. These checks should include network functionality, audio functionality and sabotage behavior.

## Check 1: Double check network settings

Connect a PC to the default VLAN and confirm that all switches are on-line, for example Dlink's D-View monitoring software. Double check the VLAN settings and STP settings in every individual switch by browsing them one by one.

## Check 2: Check the CobraNet™ network

Connect a PC to the CobraNet™ VLAN and launch CobraNet™ Manager. Confirm that all CobraNet™ devices are shown in the overview.

## Check 3: Double check audio settings

Using the appropriate software, double check the audio settings in all individual CobraNet™ devices: bundle numbers, wordclock settings, sample size and latency mode. Confirm that the conductor is assigned to the appropriate device.

## Check 4: Listen

Connect some small speakers to the most important system outputs and then connect an audio source to every input one-by-one and check if a connection to the outputs is available with good sound quality.

## Check 5: Disco

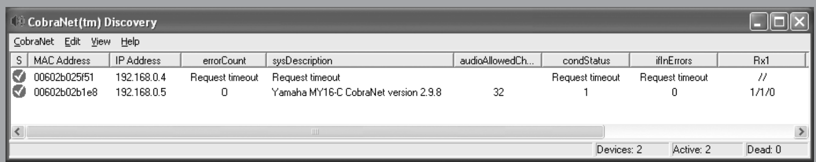
Connect a PC to the CobraNet™ network and launch Discovery to confirm that all audio connections are really error-free. Check for errors at all bundles.

## Check 6: Sabotage

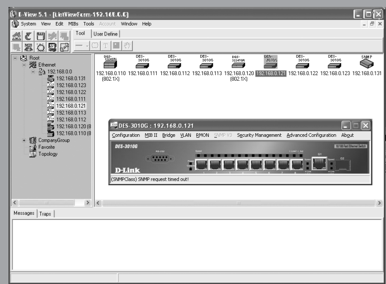
Sabotage all network components in the system one by one: remove cables or power down switches, confirm system recovery, re-connect or power-up, confirm that the system switches back to a redundant state. Note the recovery timing at each stage to include in the project documentation.

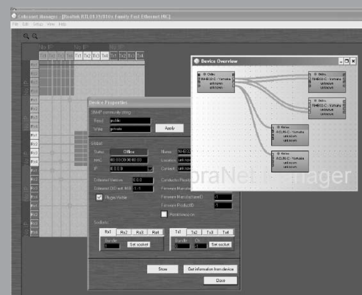
## Troubleshooting

If an emergency occurs in a system the most important thing to do is to wait until the recovery is completed. Interfering with the system before recovery takes place might disable the recovery! After the system has recovered steps 1, 2 and 5 of the checklist can be performed to assess the situation. If the problem can be located wait for a break in the performance to solve it as the audio will probably be affected when the system switches back to a redundant state.



CobraNet™ Discovery


D-View 5.1


CobraNet™ Manager

# 11. System examples

## M7CL FOH & monitor locations, stage amplifier rack, two 24ch input racks

### System

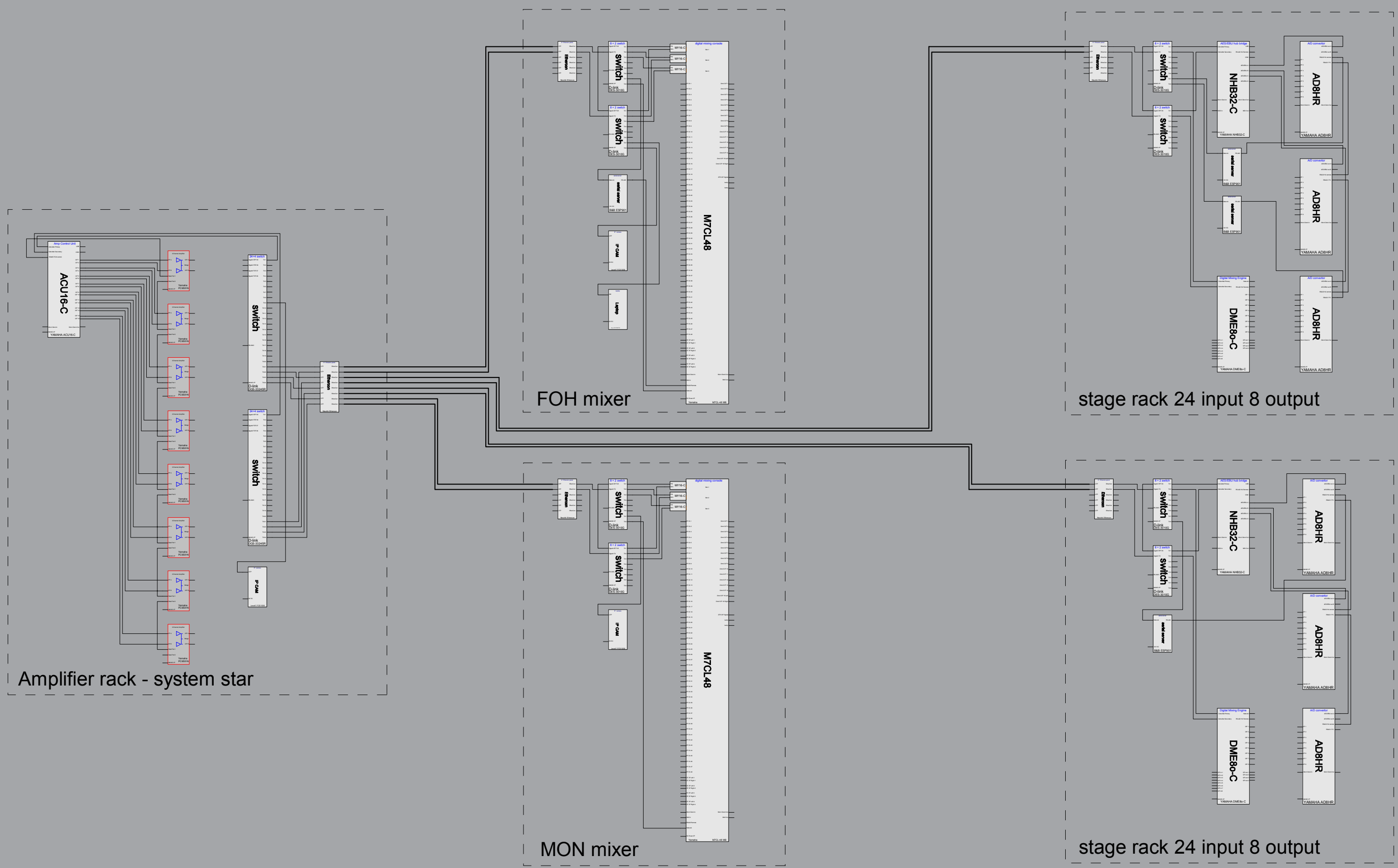
As the system star location includes high capacity switches with fans it is located in the amp rack - set up in a place where the amp's fan noise is not a problem. One mixing console is located on the FOH position, one on the Monitor position side stage. Two 24 channel input racks are set on stage, with 8 returns each for local monitoring. Double (redundant) EtherCon® cabling is used for the long distance links.

### CobraNet™

Each stage rack transmits three multicast bundles to be picked up anywhere on the network. From FOH and MON mixers unicast bundles are sent to the amplifier rack and the two stagerack return outputs. A third mixer, recording rack or a clean feed to an OB van can be added to the system at any time at any location.

### IP over Ethernet

The control network is used to connect the RS422 head amp control signals from the FOH M7CL mixer to the first stage rack, and from the first stagerack to the second using serial servers. A laptop is connected to the FOH location (or any other location), allowing access to both FOH and monitor mixers, the DME output devices in both stageracks and the IP cameras in the amplifier rack, FOH mixer and Monitor mixer locations.



## 4-location boardroom with analogue I/O and control

### System

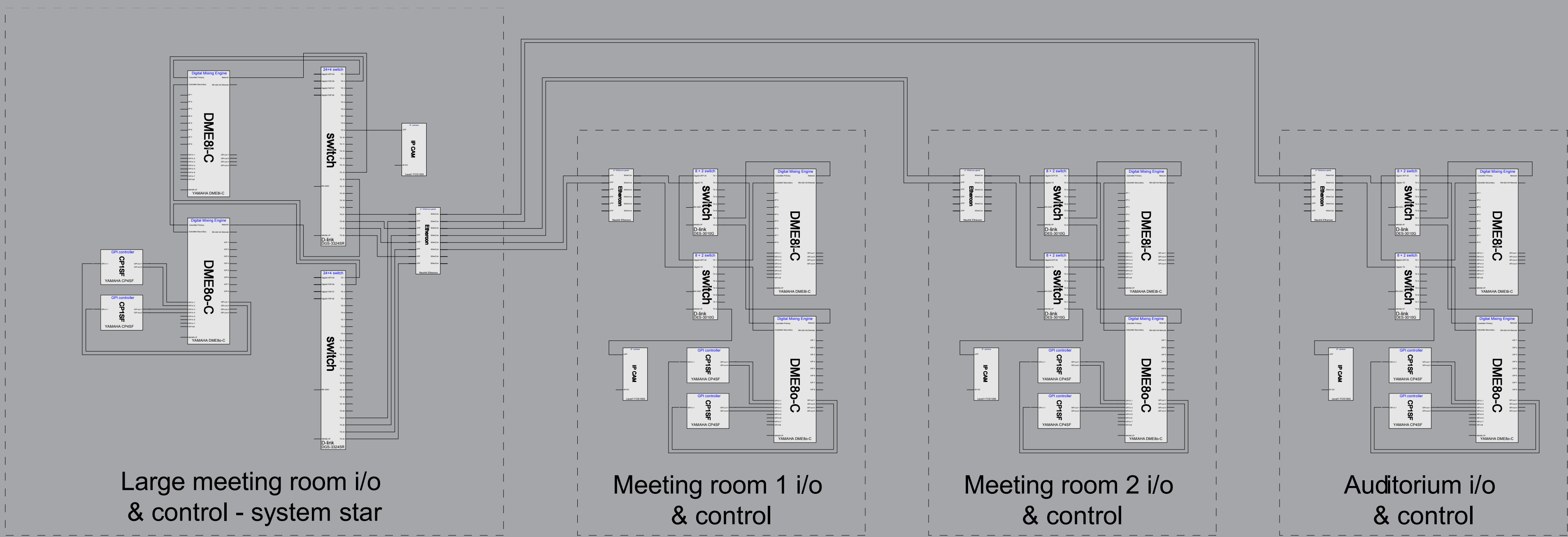
All four rooms offer connectivity to four analogue stereo player/recorder devices such as compact cassette, CD, DVD, Minidisk etc. Two faders and on/off switches with tally LED are provided in all four rooms for simple control of the audio level. Further GPI inputs and outputs are available to control external equipment. More detailed control of the audio functionality can be realized using a computer with DME designer user control displays on a computer display. Crestron® or AMX™ Control systems can also be used, integrating other multimedia devices in the system such as video recorders, projectors etc.

### CobraNet™

Each room features one DME8i-C and one DME8o-C device offering 8 inputs and 8 outputs in all rooms. Each DME8i-C unit transmits one multicast bundle so all inputs of all rooms are available in any location. For ad-hoc expansion a mixing console or extra i/o devices can be connected to any switch in the system, e.g. when two or more rooms are combined for a company presentation an 01V96 mixing console can be used to mix the event.

### IP over Ethernet

A computer can be used to control the DME units in the system with user friendly control menus on the computer's display. GPI functionality of each DME device in the system can be linked to all other DME devices for detailed control of the complete system functionality. Each room is fitted with an IP camera offering simple and cost effective video links between rooms using computers connected to the control network. As the DME designer software offers easy interfacing functions for Crestron® and AMX™ systems, the audio system can be integrated in total multimedia systems based on these platforms.




YAMAHA commercial audio

# Notes

# Notes


The complete package

**The complete package**

Yamaha's expanded Commercial Audio portfolio facilitates a single manufacturer solution to the most complex of audio installation and touring challenges. We offer digital mixing and processing as well as multi-channel, networking amplification and a wide range of advanced output devices.

**Yamaha System solutions**

Although we are proud of our line up of excellent quality products, we understand that a system solution includes more than just products: cabling, network technology, design tools, quality management tools etc. This document aims to support networked audio system design including examples of 3rd party components.

**White paper 'networked audio system design with CobraNet™'**

Yamaha Commercial Audio, 2006 - Ron Bakker, Hiroshi Hamamatsu, Tim Harrison, Kei Nakayama, Taku Nishikori, Tree Tordoff