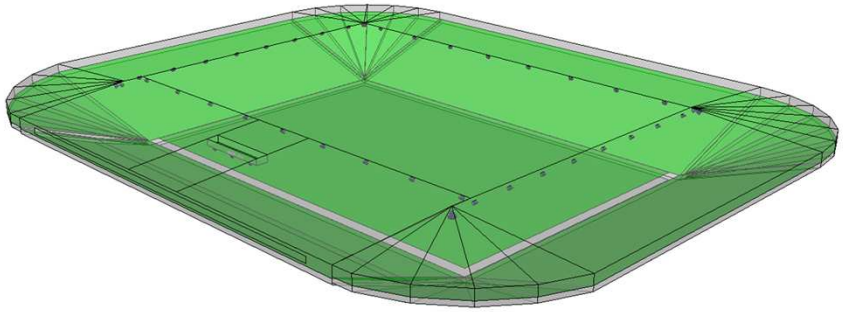
Introduction

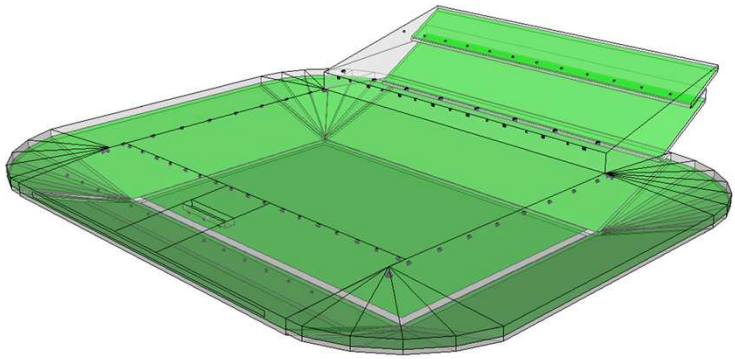
TGB SOUND

English Premier League
Football/Soccer Stadium, England

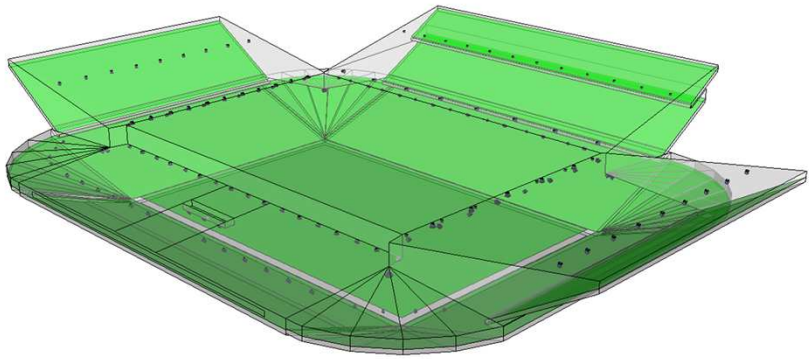
Network sound using CobraNet



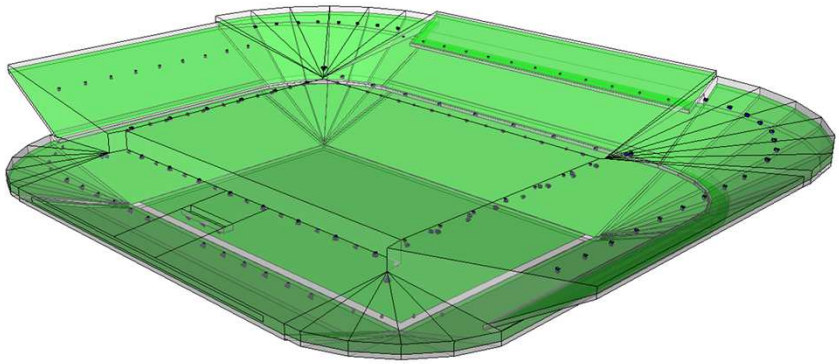
- In 1992 following Lord Justice Taylor's report into the Hillsborough tragedy the stadium was converted into an all seating venue with a capacity of 44,000
- Single tier with all of the loudspeakers mounted on the front edge of the roof
- All areas were covered by 6 - 42U racks located in the south stand



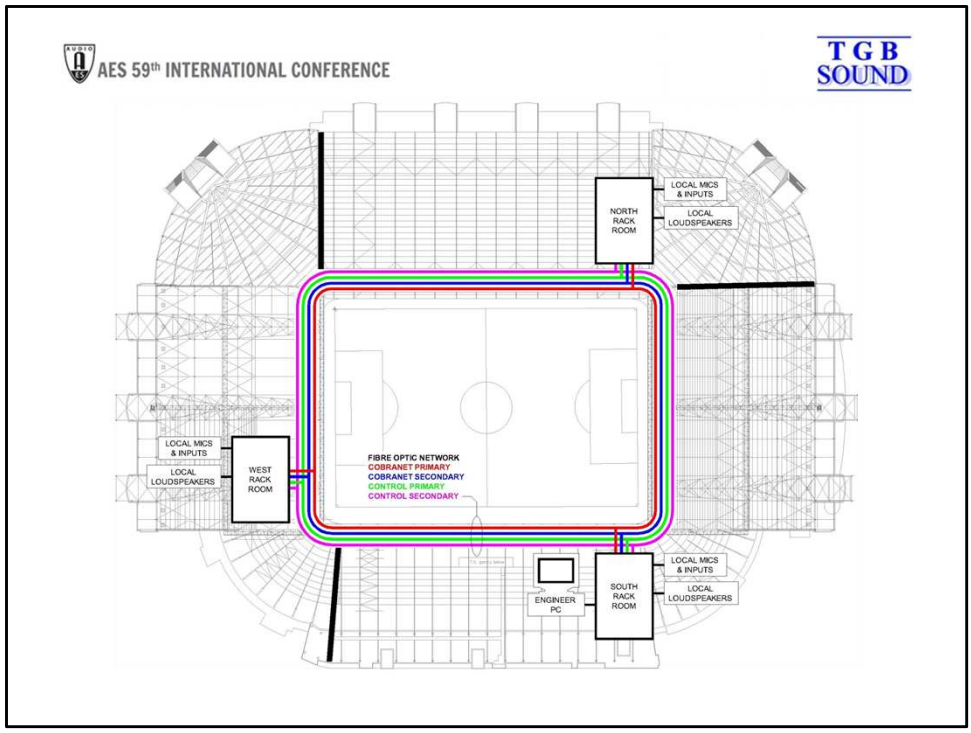
- In 1996 two tiers were added to the north stand increasing the stadium seating capacity to 56,000
- Delay loudspeakers were added to cover each tier individually as well as additional under balcony loudspeakers
- A new rack room was created in the north and analogue and control signals were cabled between the north and south stands



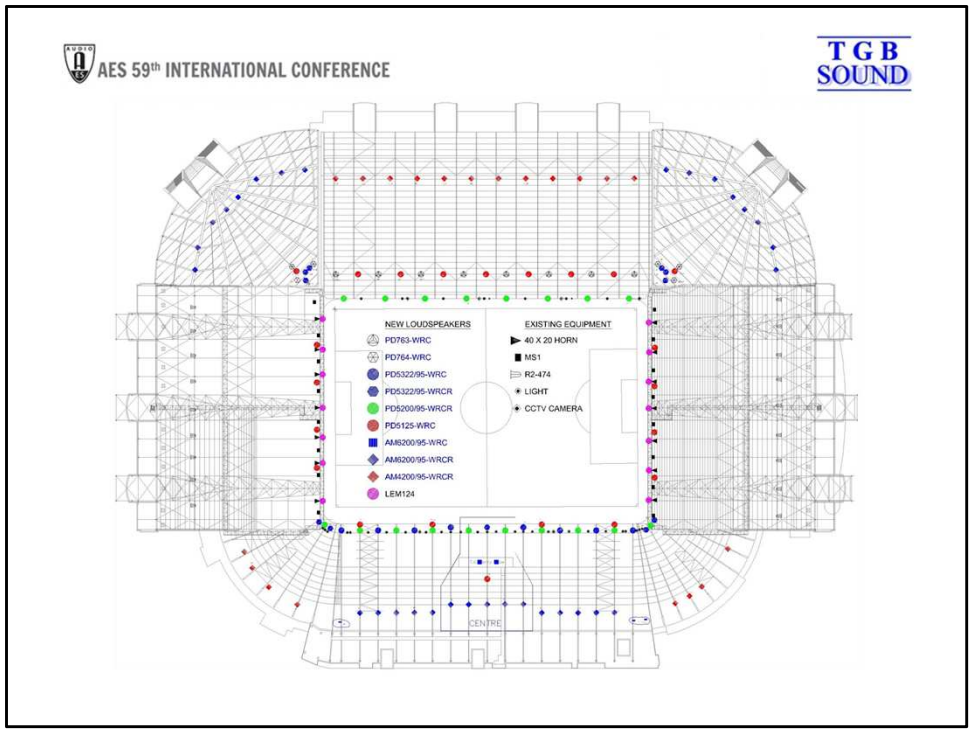
- Completed for the 2000/2001 season a second tier was added to both the east and west stands bringing the stadium seating capacity up to 67,500.
- In addition to this internal areas and function suites within the north stand continued to evolve.



- Between 2005 and 2006 additional tiers were then added to the north west quadrant and to the north east quadrant bring the stadium seating capacity up to 75,000
- Now becoming the largest stadium of it's type in the Premiership
- These quadrants also created a further 10 function rooms and expanded the private box facilities



- Due to the known expansion works in 2005 the decision was made to replace the ageing analogue system with a digital audio network
- A new rack room in the west stand was created and the amplification was spread between the three rack rooms
- The south rack room consists of 9 x 42U racks that cover the areas between the east and south stands
- The north rack room consists of 9 x 42U racks that cover the north and NEQ
- The west rack room consists of 8 x 42U racks that cover the west, SEQ and NEQ areas
- A four channel dedicated fibre optic ring was installed between each of the rack rooms and terminated into HP Procurve switches

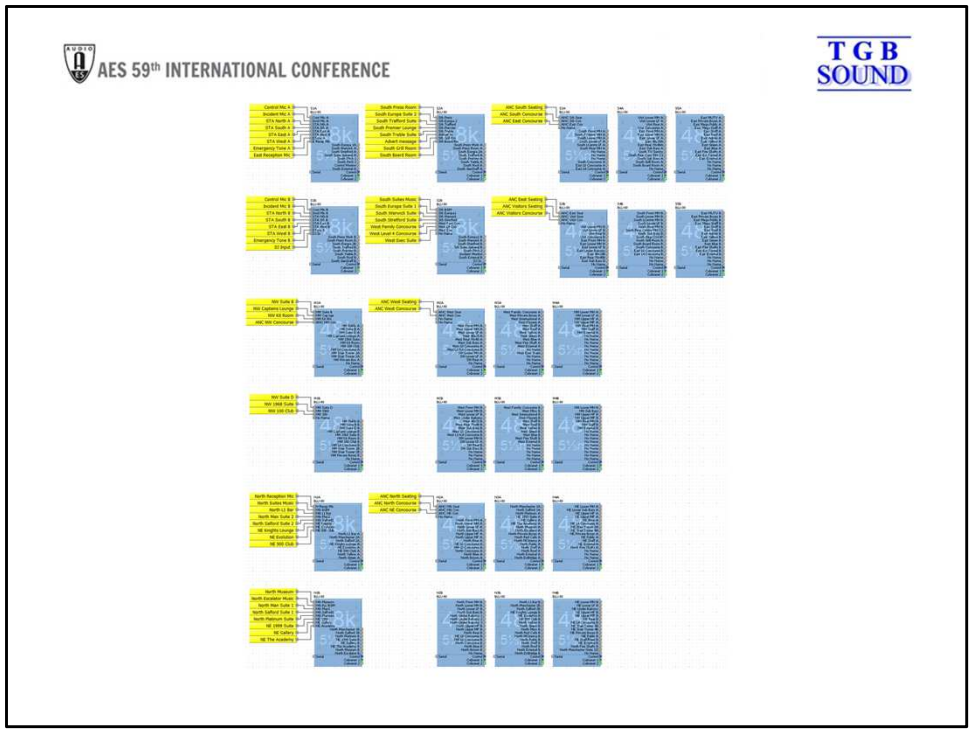


- North, South, NEQ and NWQ are covered by JBL PD7 series, PD5000 series, AM6200 and AM4200 loudspeakers; excluding the under-balcony loudspeakers there are 182 performance loudspeakers installed on the roof
- East and West stand lower tiers are covered by TOA MS1 loudspeakers and the upper tiers by Community 40x20 Long Format CD Horn and R2-474 loudspeakers
- Amplification is provided by Crown IT4000, CTs3000 and CTs2000 power amplifiers
- The DSP used is the BSS BLU80

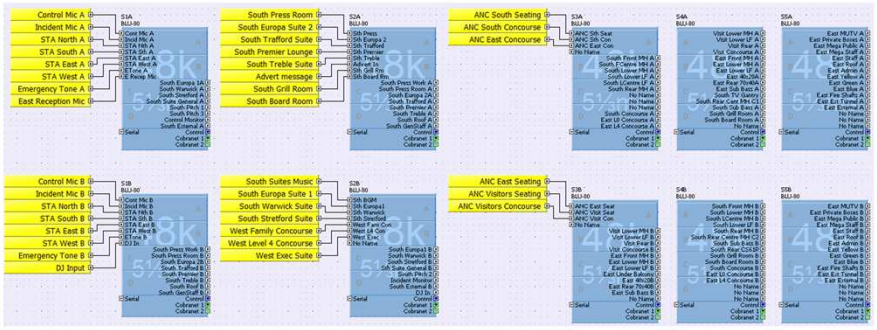
TGB SOUND

System Overview

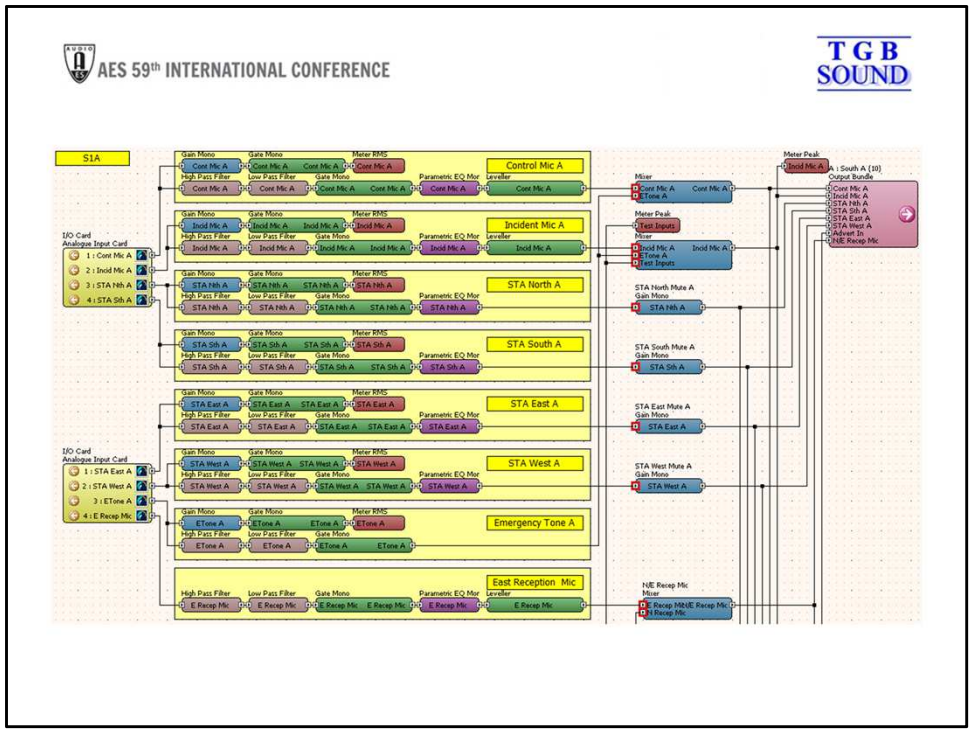
- There are 50 PAVA paging zones with 72 inputs and 334 sub zone outputs
- 2 Touch Panel Microphones (Control/Incident)
- Evacuation and Coded Messages (Auto/Manual)
- East Reception Paging Microphone
- Local portable racks with PAVA cut-off
- Local music sources



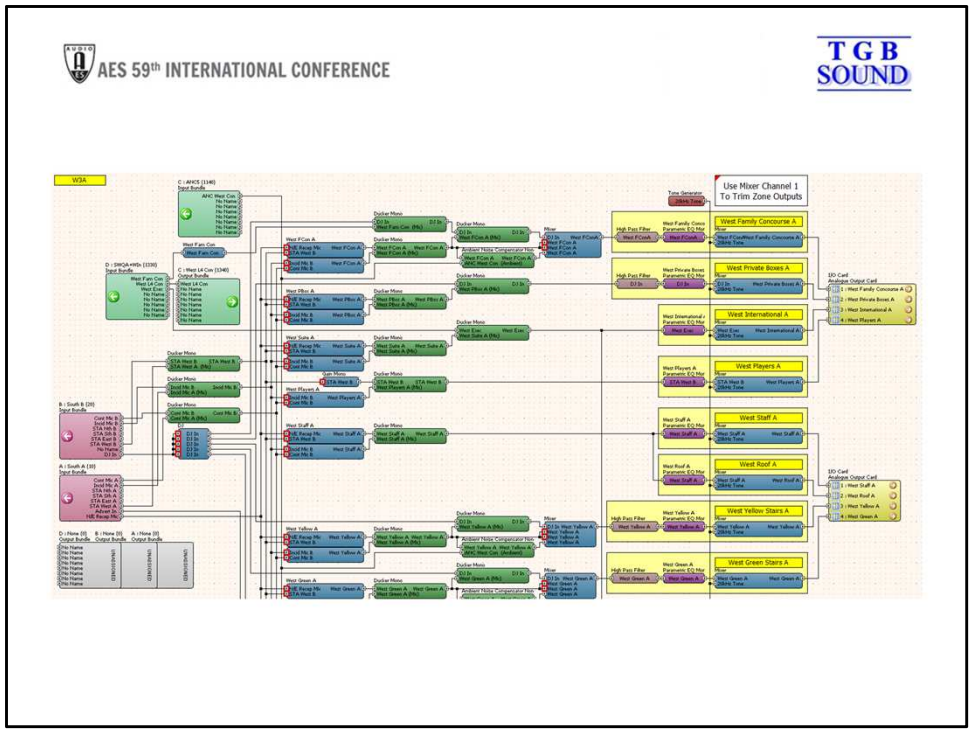
- Audio distribution is derived from 26 SoundWeb BLU80 units
- There are 10 BLU80's feeding the south and east stands, 8 BLU80's feed the west stand and NWQ and a further 8 BLU's feed the north stand and the NEQ



- Each rack location is split in to A and B networks and I/O is evenly split between the 2 networks to ensure that there is no single point of failure in any zone
- There are 2 multi-cast bundles; one in S1A and the other in S1B. All other inputs are uni-cast
- Each multicast bundle has an audio from the Control Mic, Incident Mic, NSEW Evacuate and Coded messages and the TPU Emergency Tone
- East Reception audio is received in S1A and the match day DJ is received in S1B

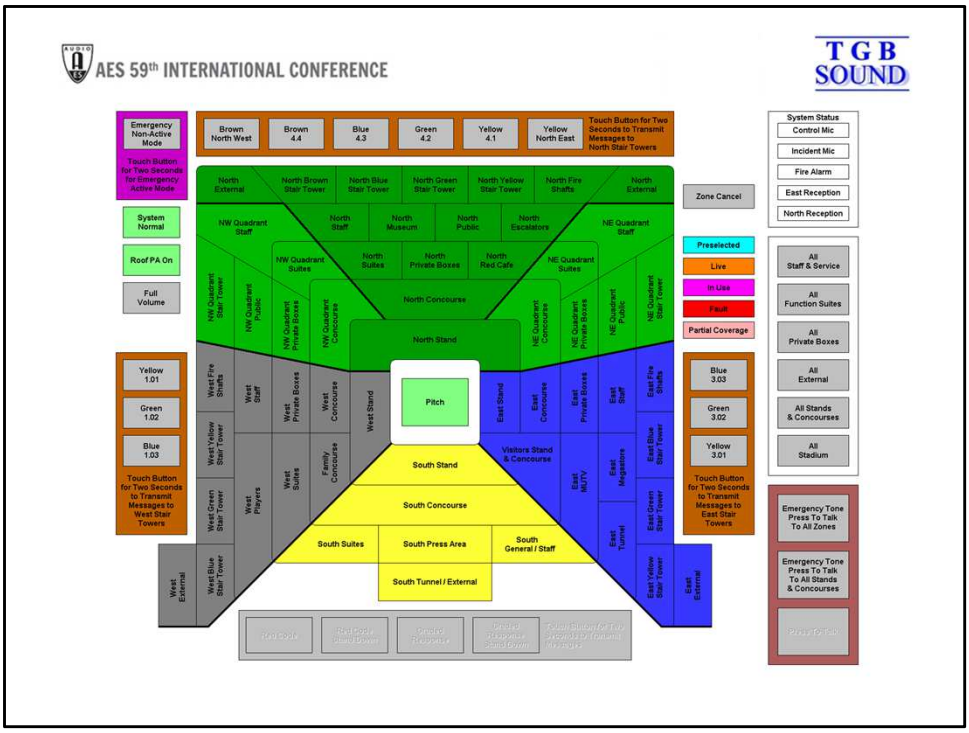


- If we take a closer look at the S1A input section we see all of the multi-cast inputs
- Each input typically has HP and LP filters, audio gate and parametric eq. The Control, Incident and East Reception mic audios also have an audio leveller
- Each of these inputs are then assigned to the multi-cast bundle



- Typical output section with the 2 multi-cast audio bundles

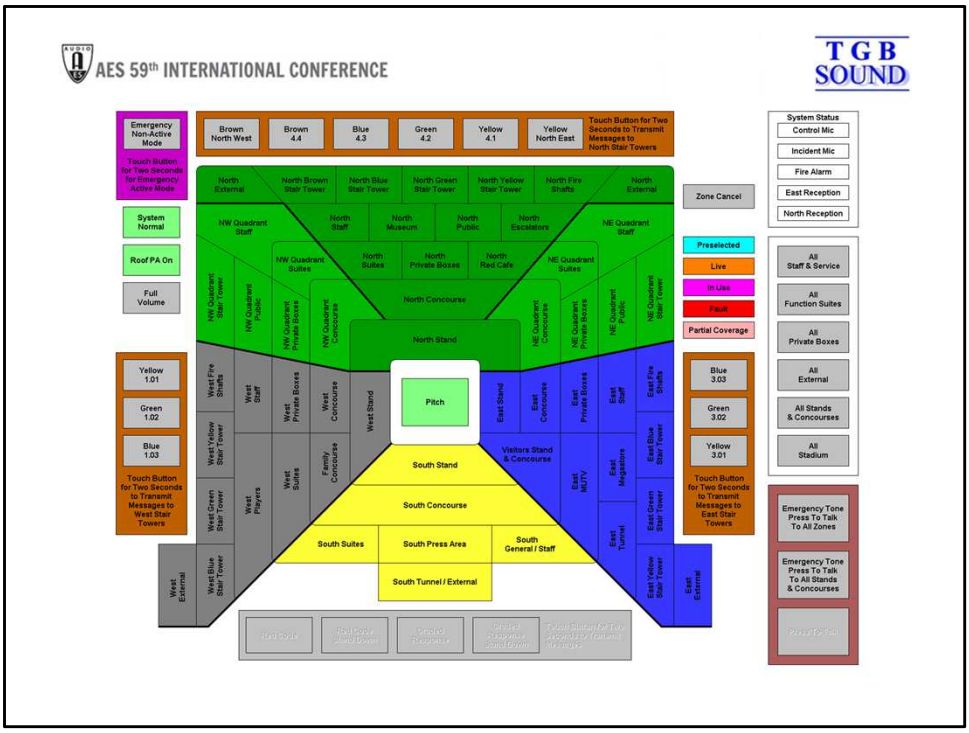
- As both multi-cast bundles appear in every DSP unit we use duckers to provide a single audio feed to the priority routing section; ANS channels have a 4 channel output mixer for ANS, Full power, Half power, Non Match day pre-sets; the output section has HP filters, parametric eq and legacy 20kHz pilot tone generator for 100V circuits.



- There are two main touch-panel microphones. Here the microphone layout is shown in non emergency mode. These microphones have identical functionality and each is the back-up for the other with both microphones connected to primary and secondary servers

- On the right hand side System Status shows which inputs are currently being used, preset controls for predesignated zone selection, Push To Talk (PTT) and emergency PTT buttons

- To the left of these there is a Zone Cancel button that removes all preselected zones, zone button table of colours and finally there are coded stair messages for stewarding to prevent over-crowding on the stairs

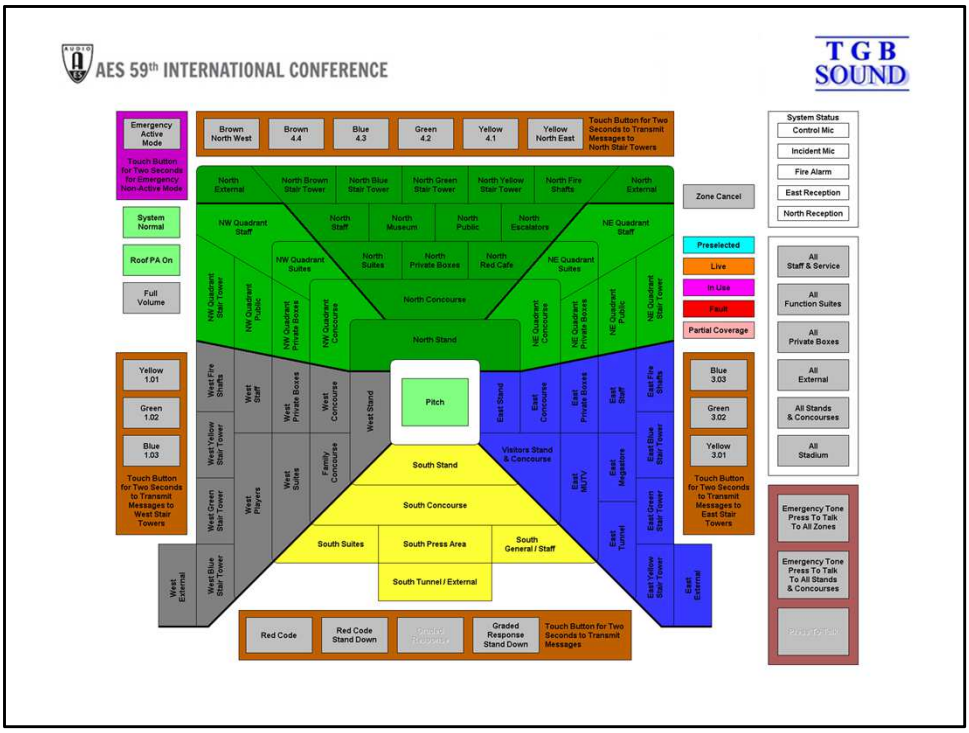


- On the left hand we have the Volume preset button that indicates the current volume level set e.g. ANS, Full Volume, Half Volume and Non Match Day, above this we have the Roof PA On indicator and System Health Status.

- The base colour on each zone button is determined by its emergency zone. Each zone button has multiple layers to indicate unselected, preselected, live, in use, partial coverage and fault conditions.

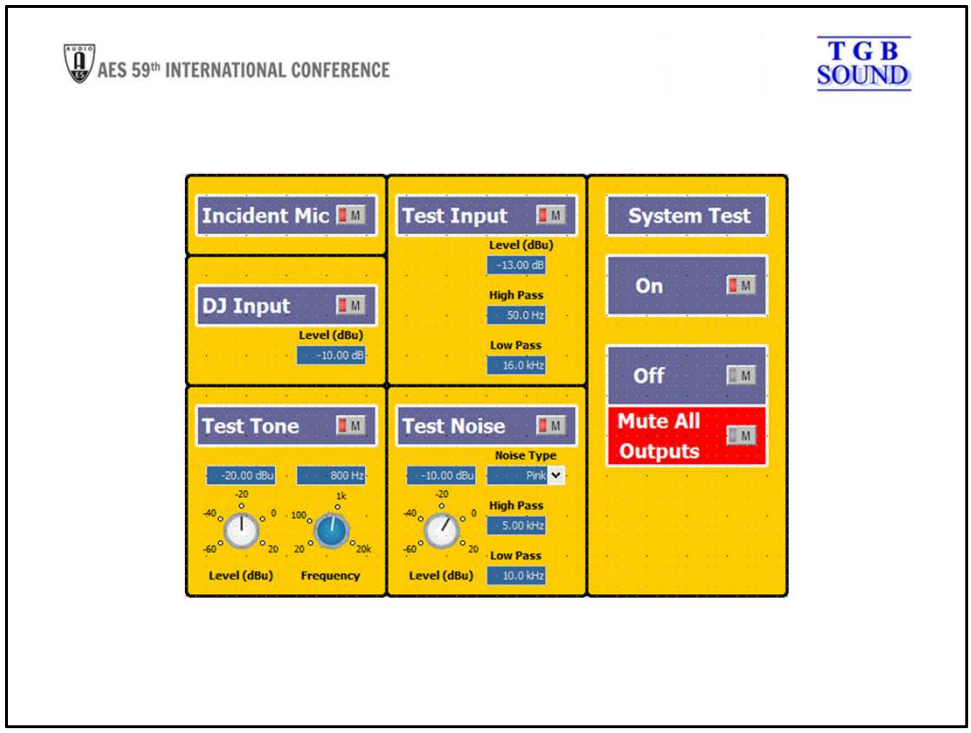
- Fault on A or B zones will indicate partial coverage. Fault on both A and B zones will indicate a major fault. Non specific zone faults are indicated by the area around the pitch changing state

- Finally in the top left hand corner if we touch and hold the Emergency Non-Active Mode button for 2 seconds we enter Emergency Active Mode



- The main difference between the two screens is that along the bottom additional coded messages are available to the user

- The Control and Incident microphones are designed to be intuitive as possible with visible instructions and pop-up splash messages when in use

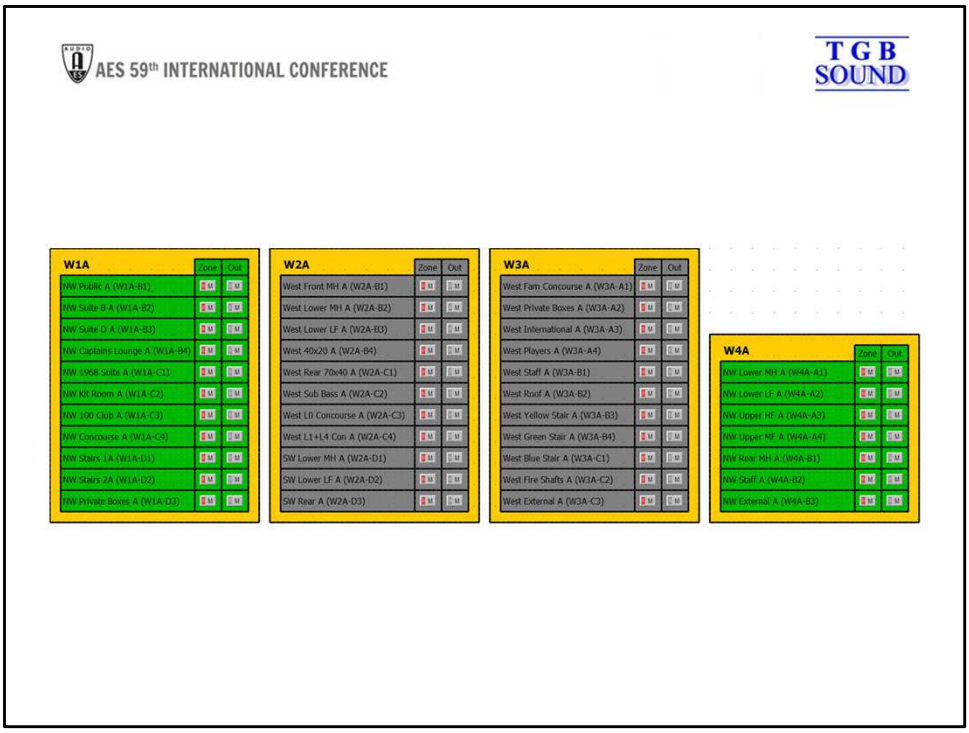


- Originally we designed the system to be operated from an engineer PC but due to the size of the stadium and the amount of concrete communication between the rack room and the testing engineer become extremely difficult

- When the stadium went digital we arranged for remote access into the sound system server. We can now control the sound system from a tablet which has enabled us to thoroughly test the system in a very short period of time without the need of radio communications

- Within the DSP we have the capability of sending up to 5 test signals into any sub zone at any one time

- For example during maintenance walk rounds we send band-limited HF and MF pink noise to verify the integrity of each of the performance loudspeakers and at the same time we can also send test messages or STI stimulus as well as test tones or pink and white noise



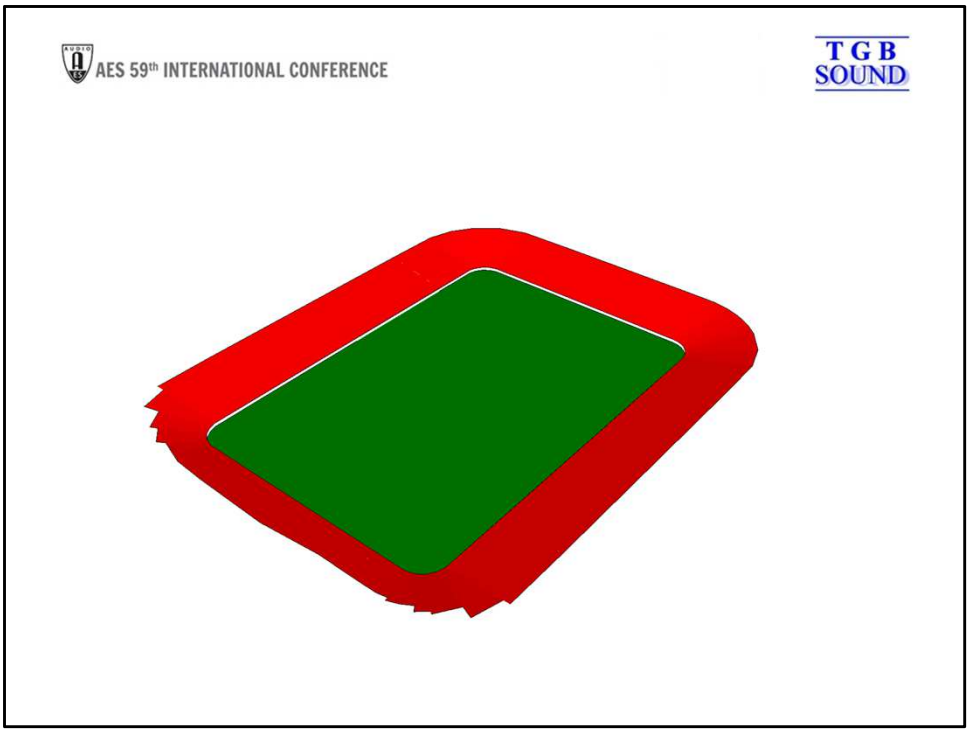
- Here is one section of the sound system sub-zones. The A side is shown here but there is also an identical B section

- Having set-up our audio test signals we use the individual zone buttons to route them. Where sub-zones are grouped we un-group them by muting the Out buttons.

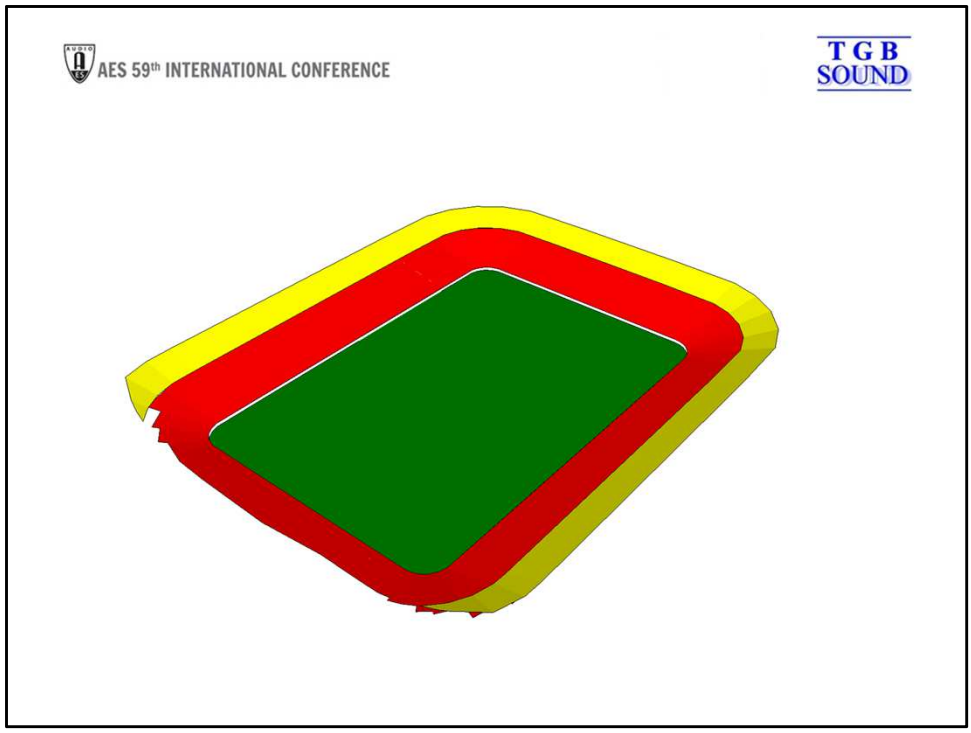
TGB SOUND

National Rugby and Football/Soccer Stadium, Ireland

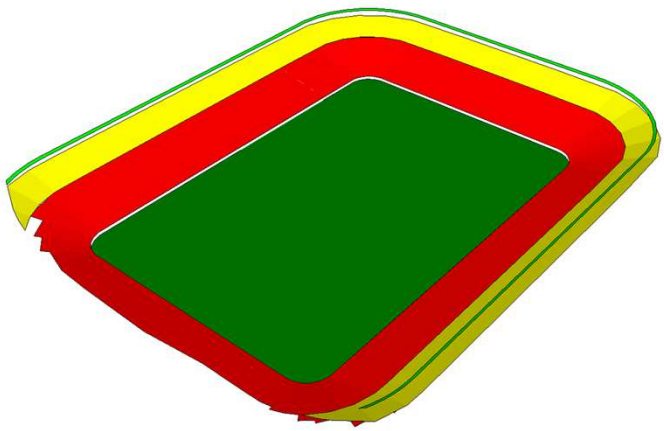
Network sound using BLU Link audio



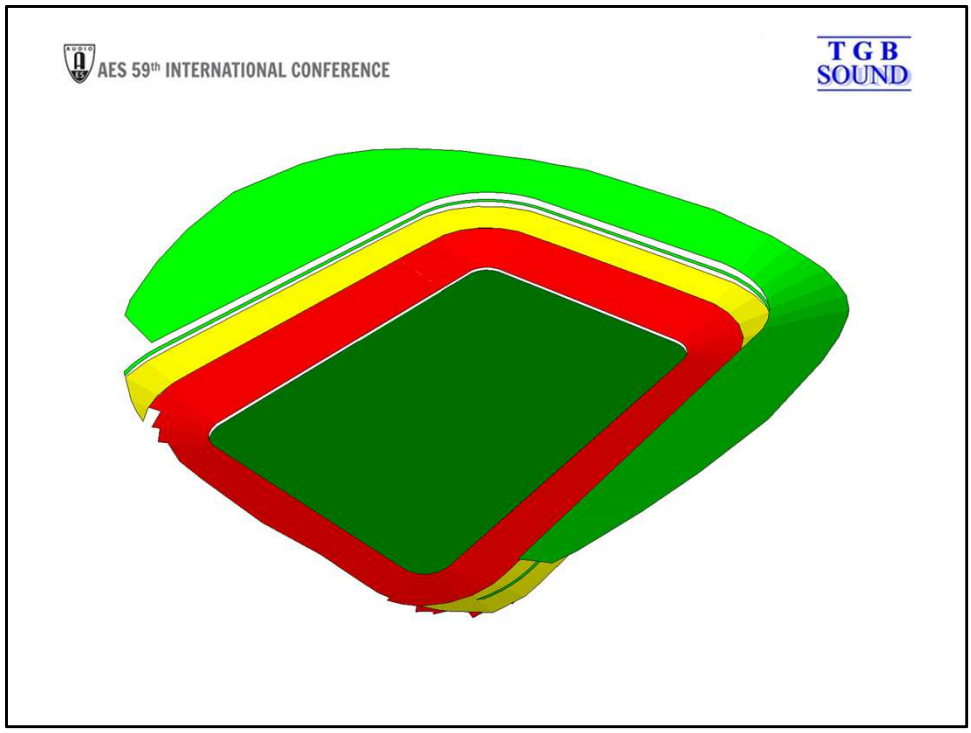
- This stadium is a very complicated shape and we will build up the view in stages
- Lower seating and grass



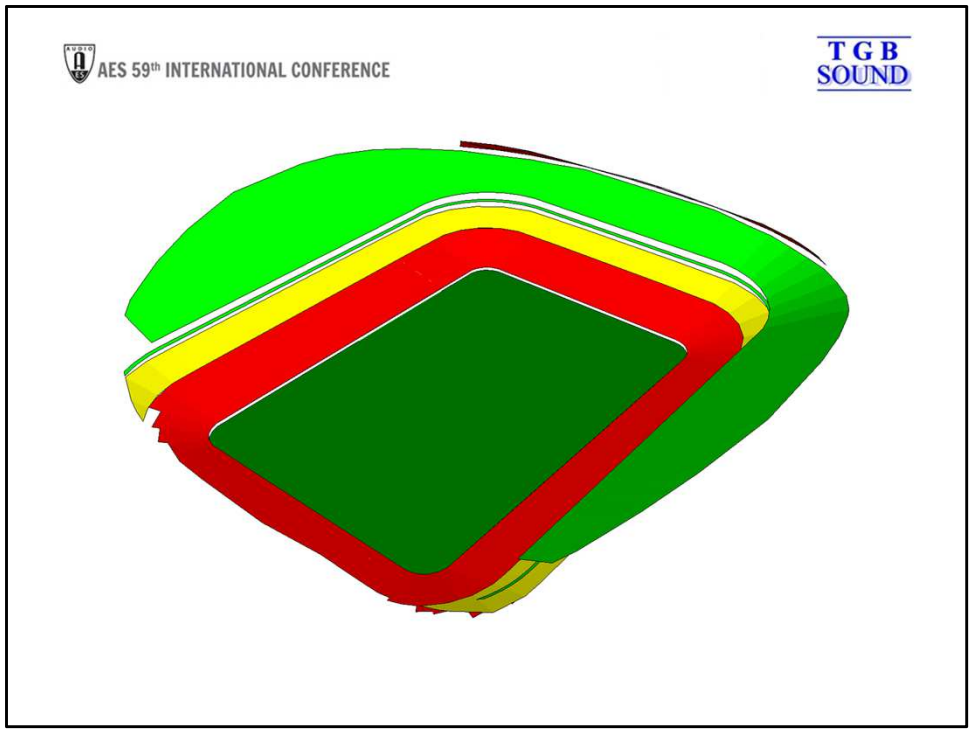
- Middle tier seating



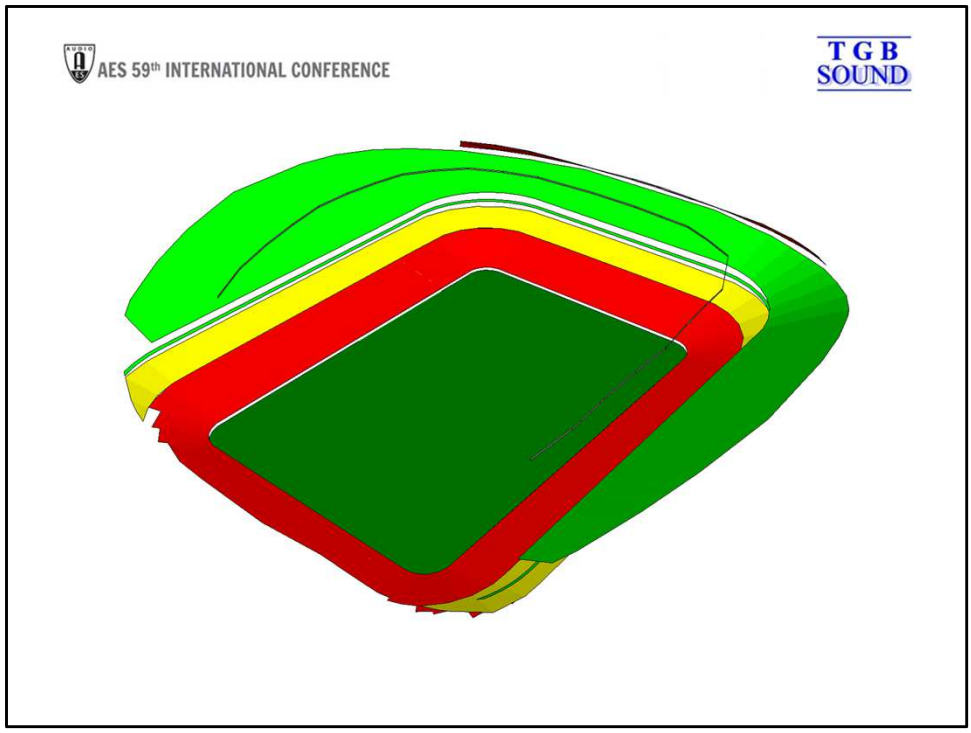
- Balcony seating in front of the private boxes



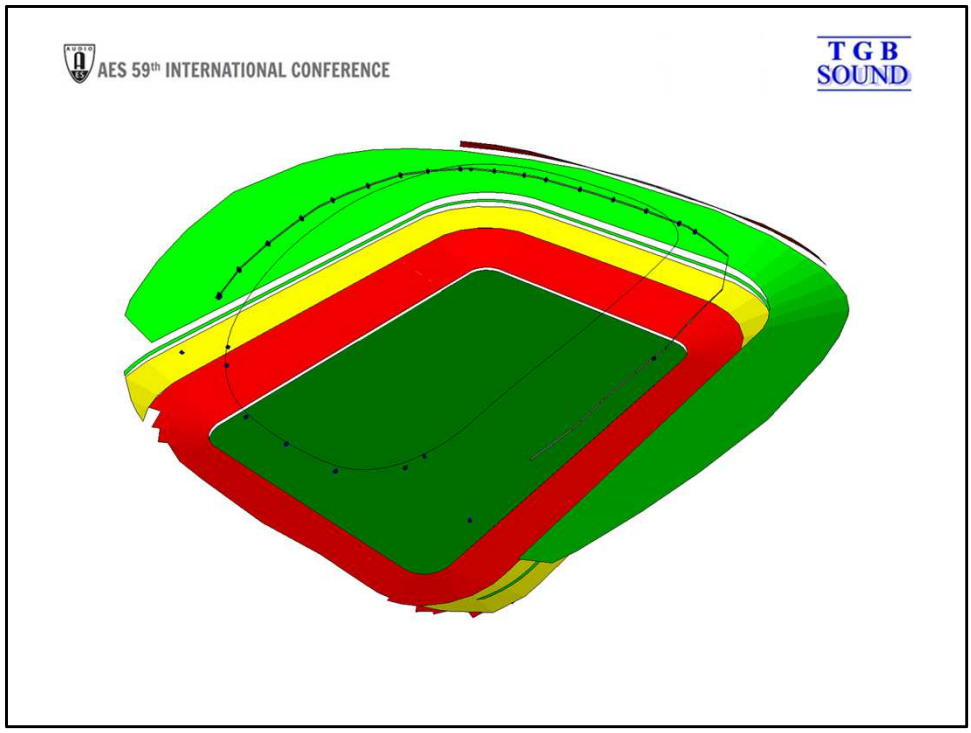
- Upper tier seating



- Acoustic panels that were incorporated into the south stand

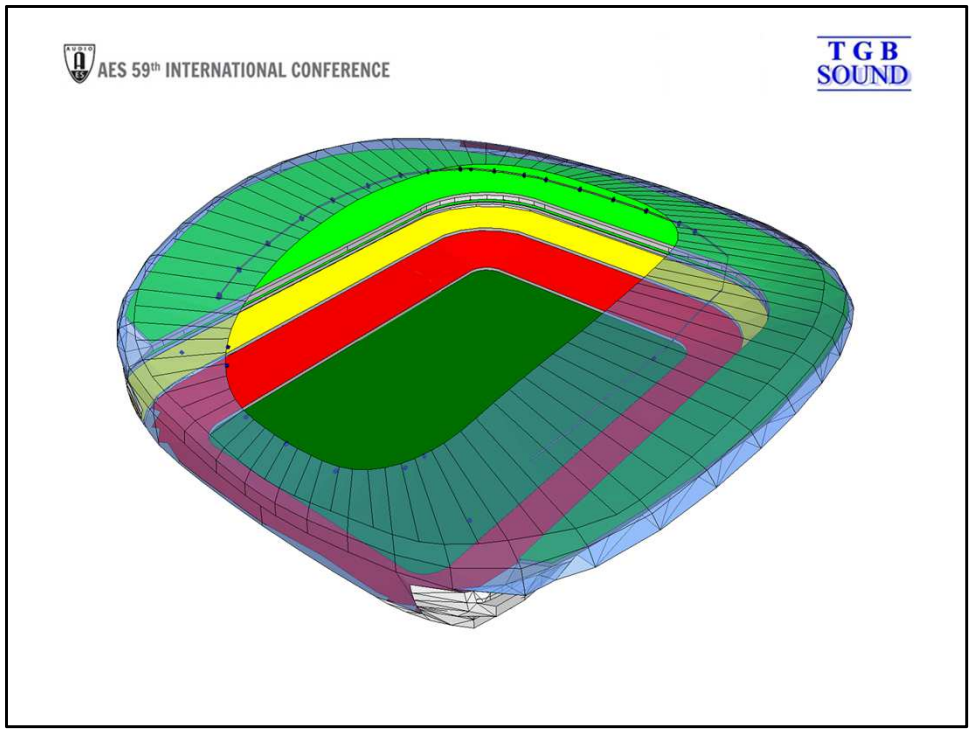


- Gantry walkway

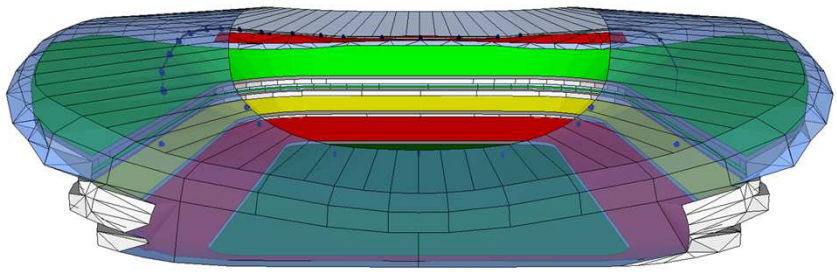


- Loudspeakers are mounted onto the gantry walkway and the roof edge in the north stand

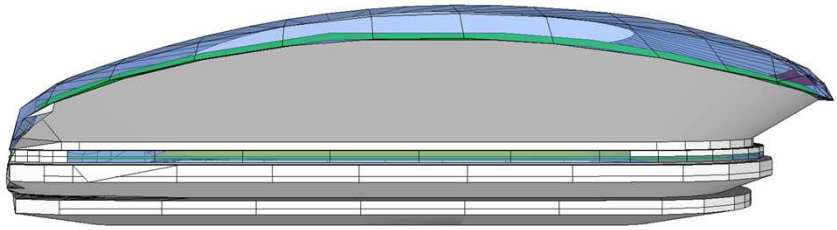
- The east and west stands are identical so we show the west stand loudspeakers and the location of the pitch cluster in the east stand



- Full 3D model of the stadium



- North to south view

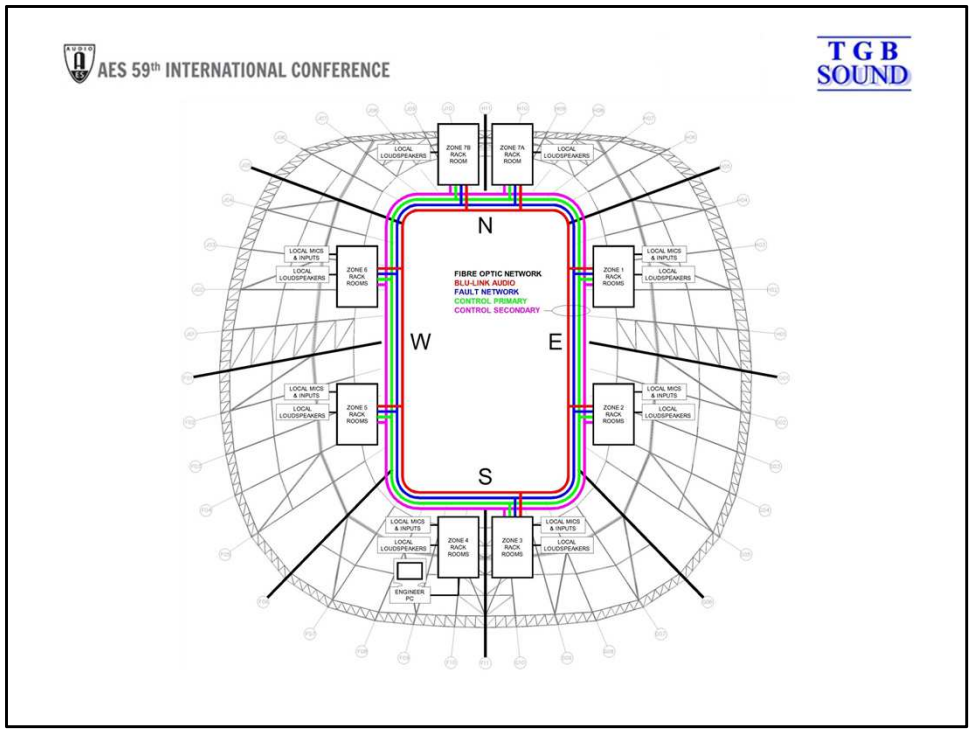


- Side view

- Aerial view during construction
- Note the self cleaning glass panels used as the outside face on all of the stands

Note the close proximity of residential housing close to the north stand hence the reason for the height of the stadium being only one tier in this section

- Photograph showing the pitch view on event day
- The stadium seating capacity is 51,700

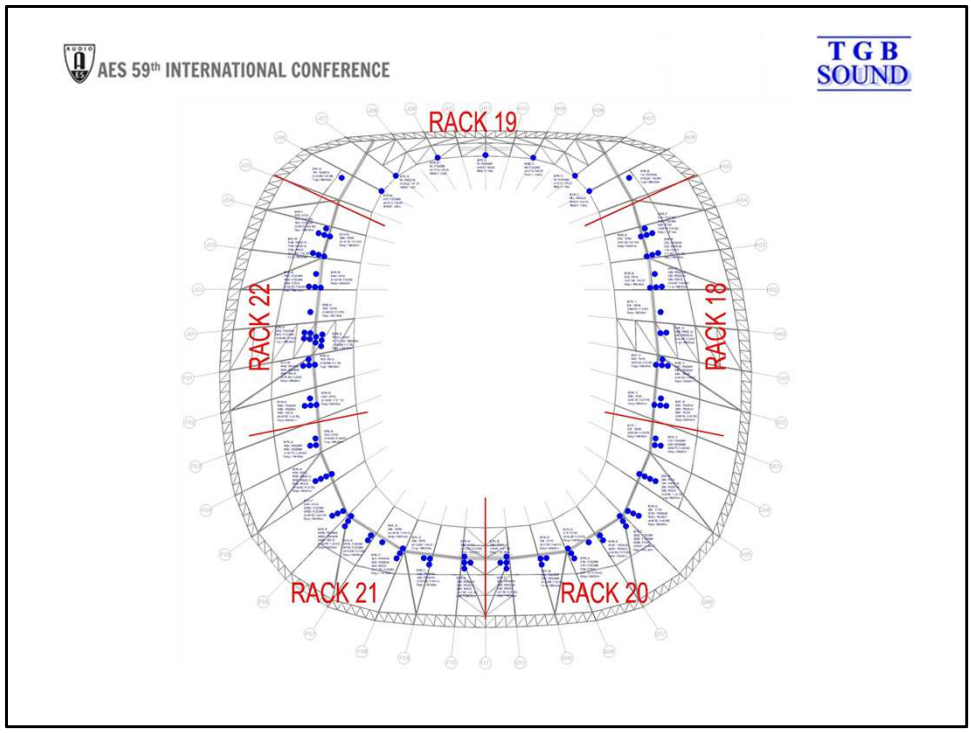


- The stadium is segmented into 7 PAVA zones and a dedicated fibre optic ring was installed between each of the rack rooms and terminated into Cisco SLM224P switches

- We extended the BLU-Link topology using Gigabit Ethernet Media Converters

- Each zone has multiple 42U racks installed

- Zone 1 has 4 racks
- Zones 2 and 3 each have 3 racks
- Zone 4 has 5 PAVA racks
- Zones 5 and 6 each have 4 racks
- Zone 7 has 2 PAVA racks

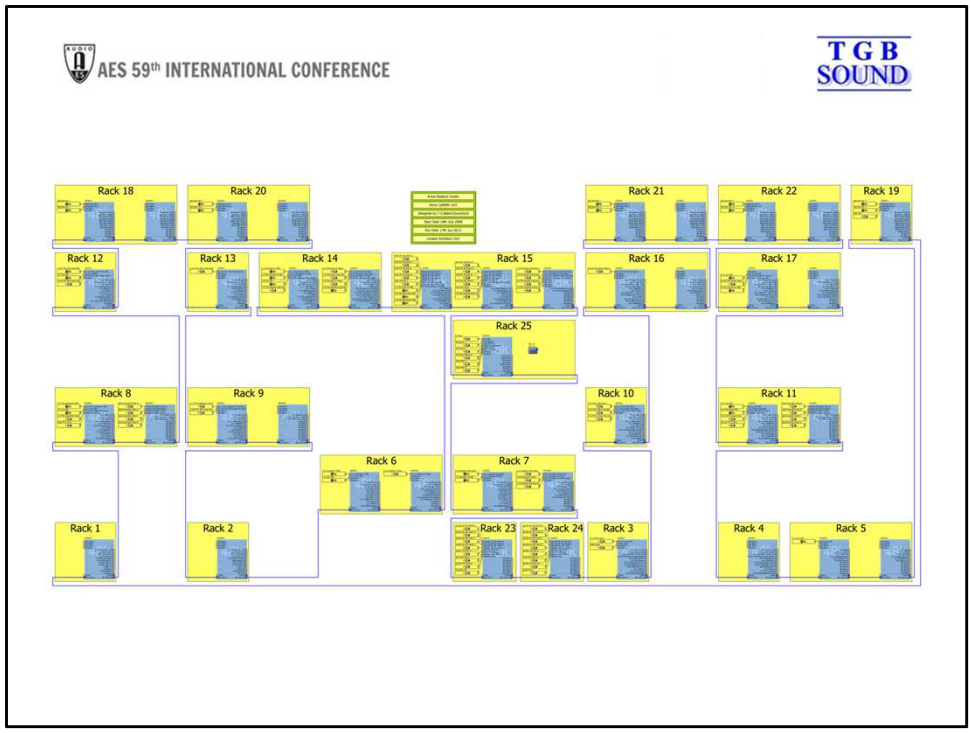


- 24 JBL PD743 cover the lower tier
- 56 JBL PD5200 cover the middle and upper tiers
- 16 JBL PD5125 additional LF bass
- North – 4 JBL PD5322 and 5 JBL PD5200
- Amplification is provided by Crown IT4000 and CTs3000 power amplifiers
- DSP is provided by BSS BLU160 units

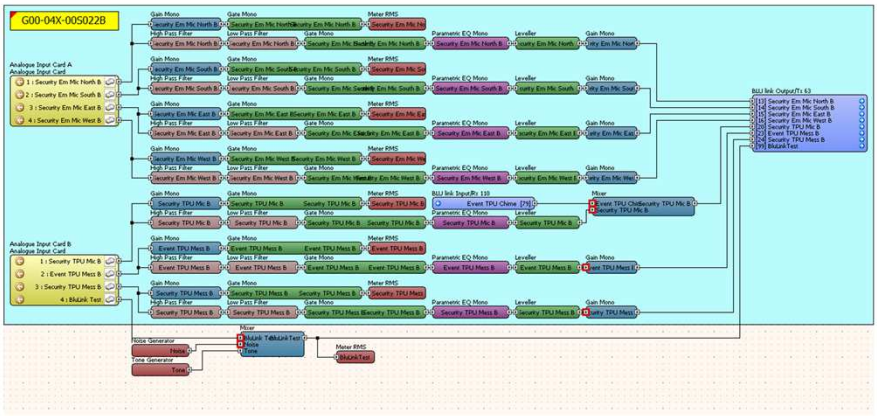
TGB SOUND

System Overview

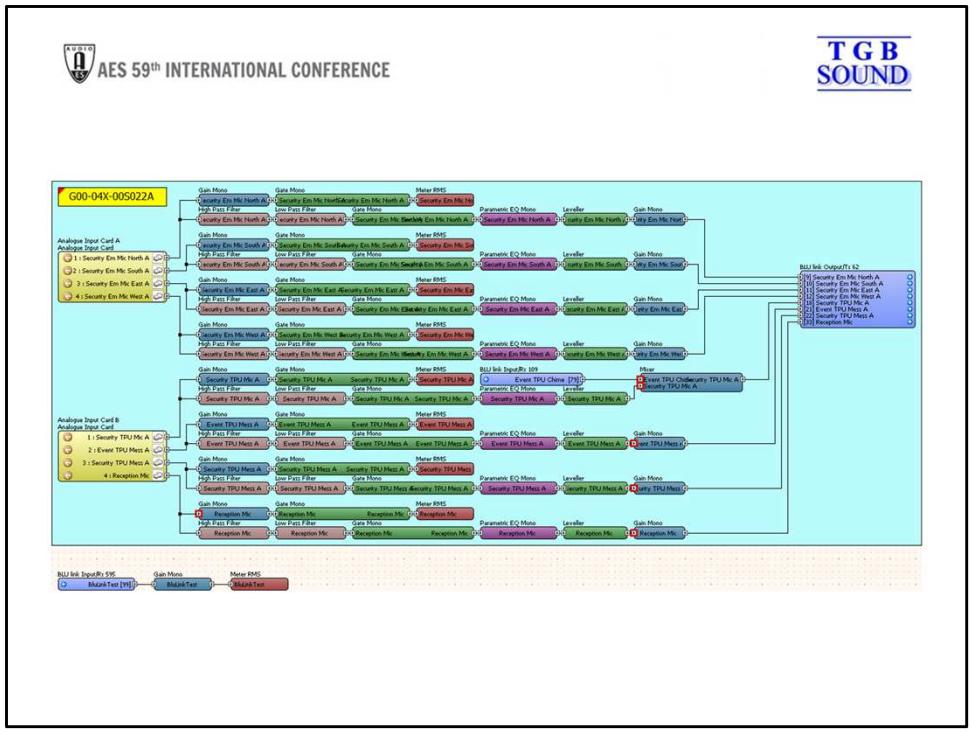
- There are 61 PAVA paging zones with 180 inputs and 444 sub zone outputs
- 2 Emergency Microphones (NSEW)
- 2 Touch Panel Microphones (Event & Security)
- Evacuation and Coded Messages (Auto & Manual)
- Reception Paging Microphones
- Local portable racks with PAVA cut-off
- Local music sources



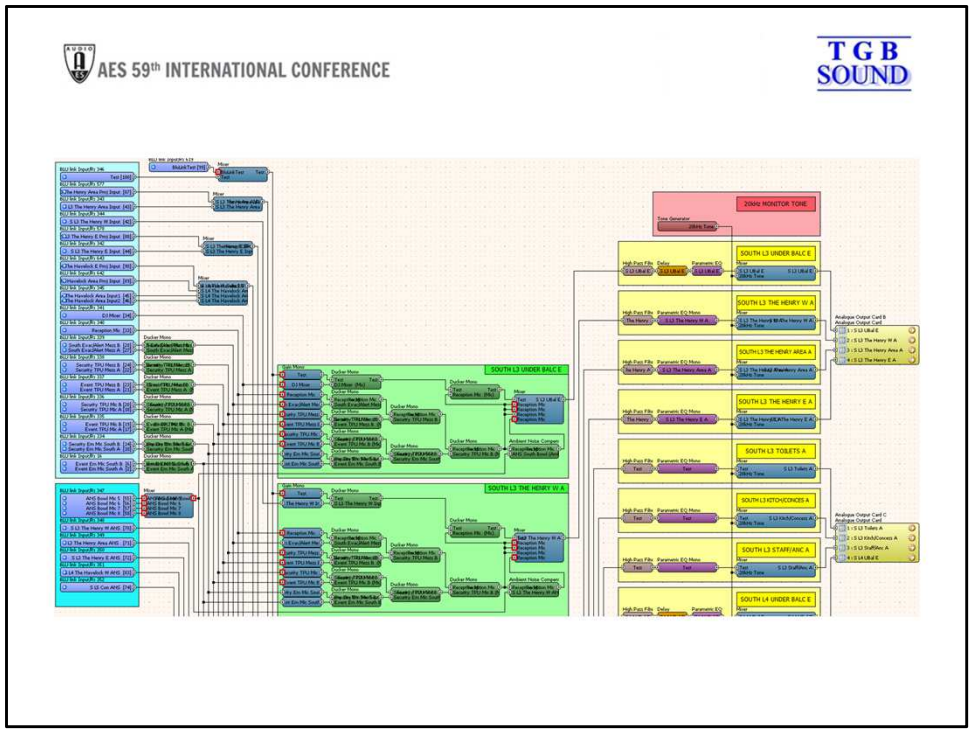
- 25 rack locations
- 40 BLU160 DSP units



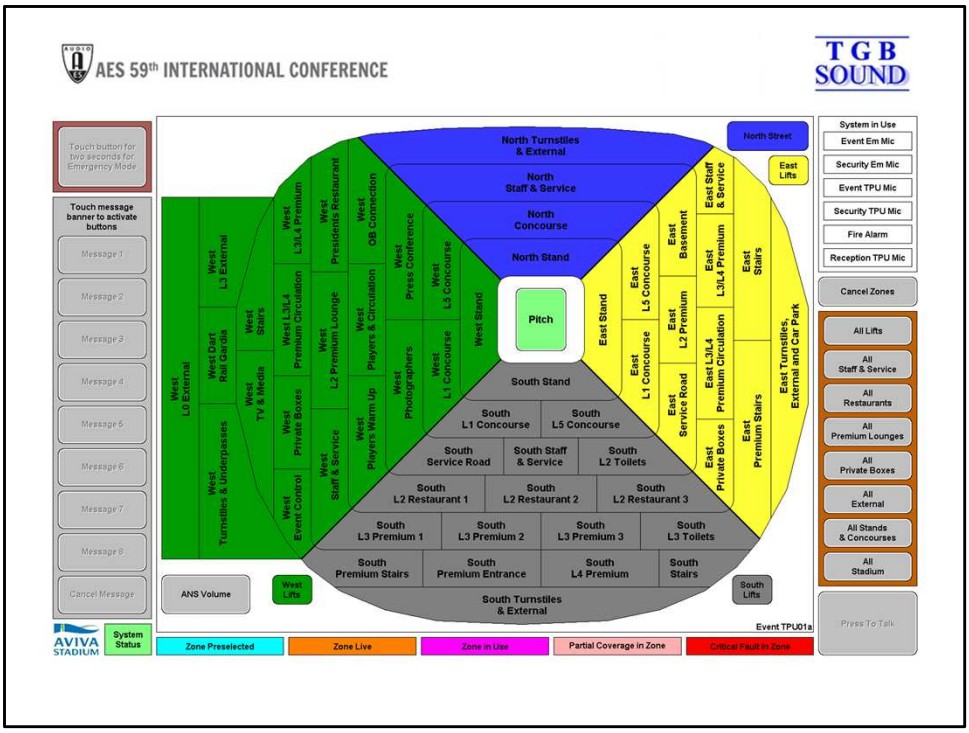
- Main input section for B side of DSP
- Each input typically has HP and LP filters, audio gate, parametric eq. and audio levellers
- This unit is the first device on the DSP loop and a test tone originates from here to monitor the integrity of BLU Link connectivity



- Main input section for A side of DSP which is virtually identical to the B side
- This is the last device on the DSP loop and here the BLU Link test tone is received and monitored for failure



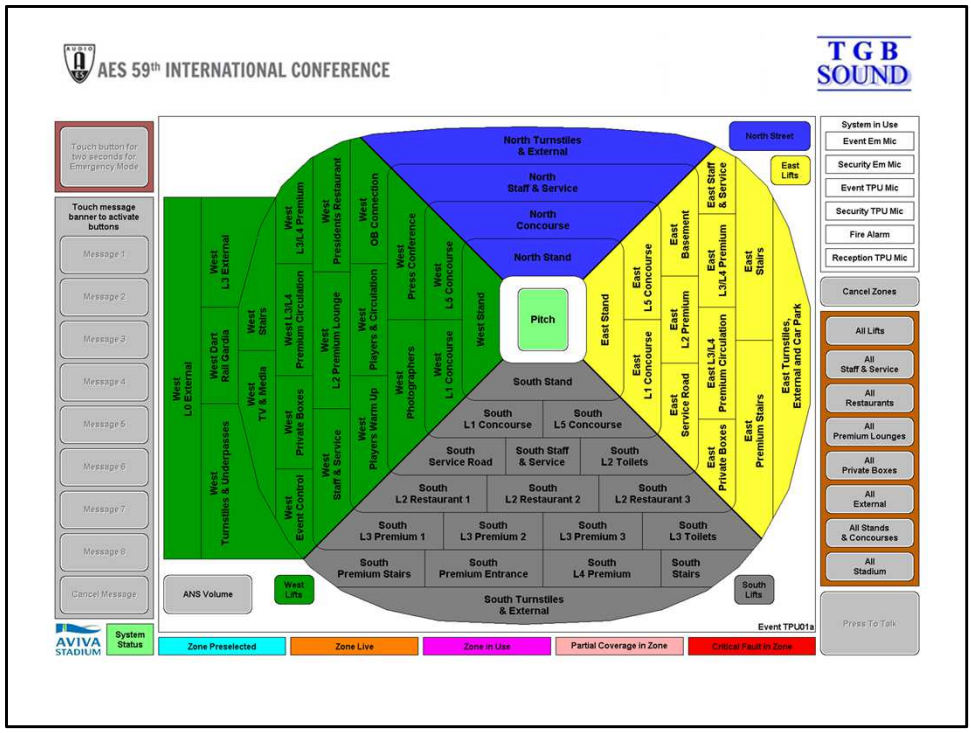
- Typical output section
- All of the 256 BLU Link audio channels are available at each BLU160. The audio channels required for the outputs are assigned and coupled via duckers into the priority routing
- Outputs with ANS assignments have ANS, Full Power, Half Power and Non Match day presets
- Output stages have filters, parametric eq and 20kHz pilot tone generator for all 100V amplifiers



- There are two main touch-panel microphones. Here the microphone layout is shown in non match day mode. These microphones have identical functionality and each is the back-up for the other with both microphones connected to primary and secondary servers

- On the right hand side the system status shows which inputs are currently being used, preset controls for predesignated zone selection and the Push To Talk button

- Along the bottom we have the zone button list of colours; in the bottom left hand corner we have the Volume preset button that indicates the current volume level set e.g. ANS, Full Volume, Half Volume and Non Match Day and the System Health Status



- The base colour on each zone button is determined by its emergency zone. Each zone button has multiple layers to indicate unselected, preselected, live, in use, partial coverage and fault conditions

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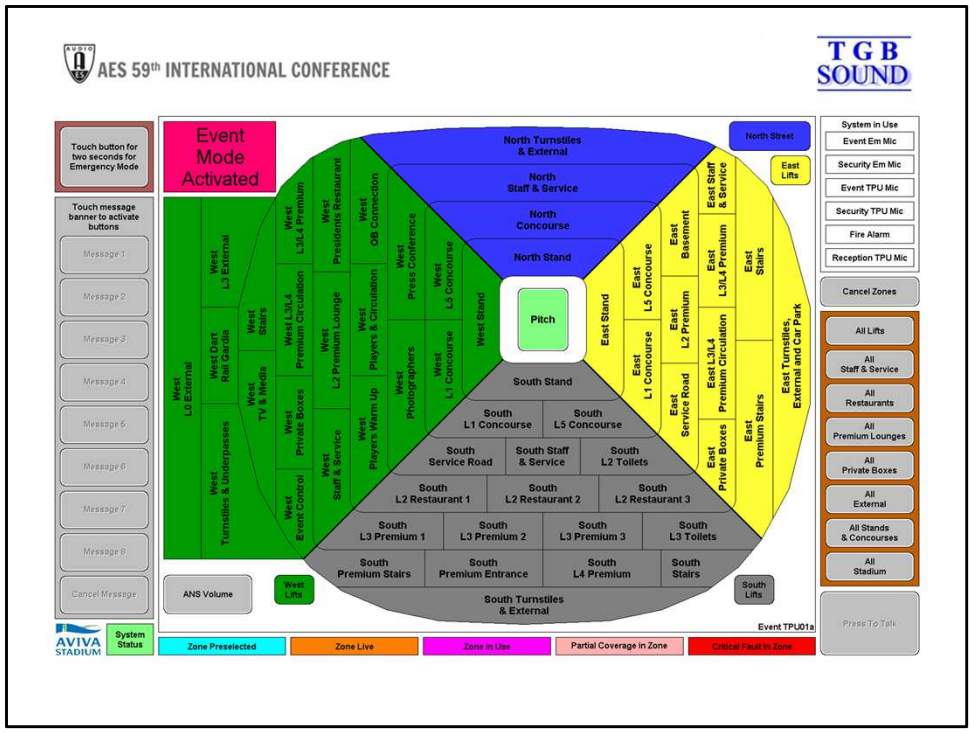
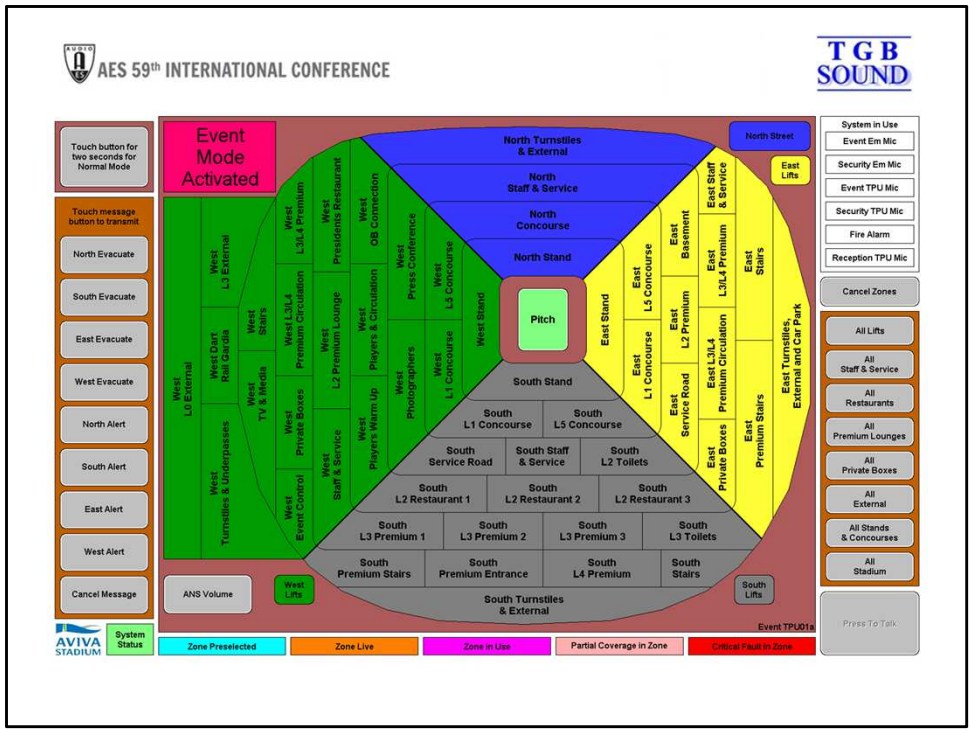
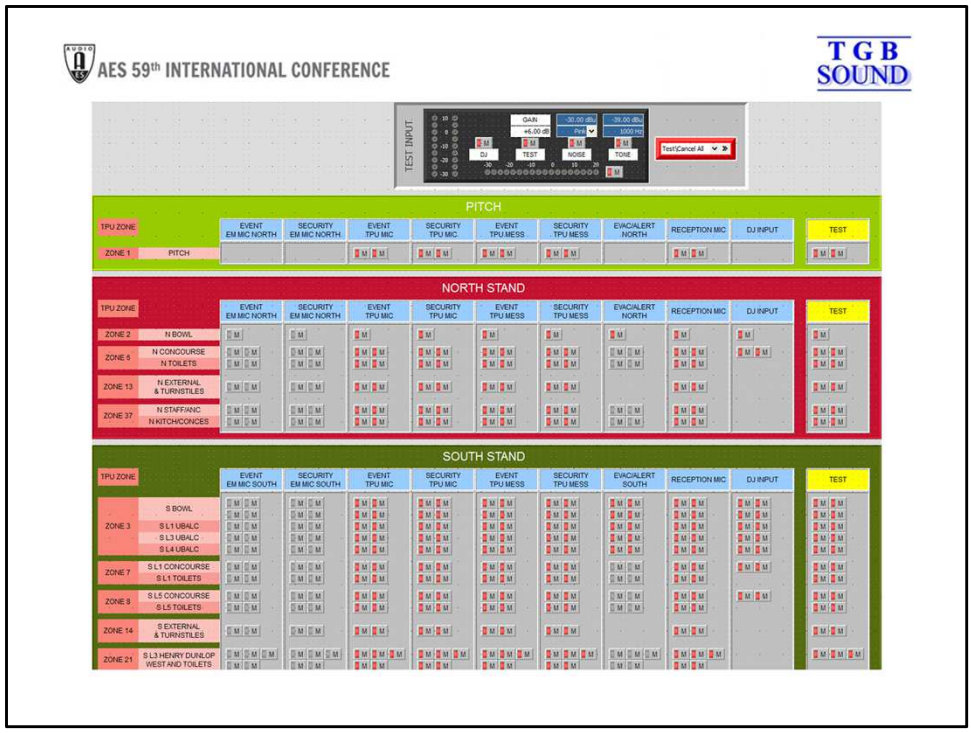


- Key operation from the fire panel on event day activates Event Mode
- In this mode microphones cannot make general announcements into the function suites
- On the left hand side the facility is available to play back pre-recorded digital messages. Currently they are not being used hence there are ‘greyed-out ‘
- Touching the button in the top left corner for 2 seconds activates Emergency Mode



- In Emergency Mode additional coded messages are available to the user and paging into the function suites is permissible

- The Event and Security microphones are designed to be intuitive as possible with visible instructions and pop-up splash messages when in use



- Here is the top of the zone control and test routing page
- From here we can initialise test routing using the right hand buttons
- We can also visualise all audio routing

- BLU Link status page
- Visual indication for BLU Link input and output status as well as unit temperature

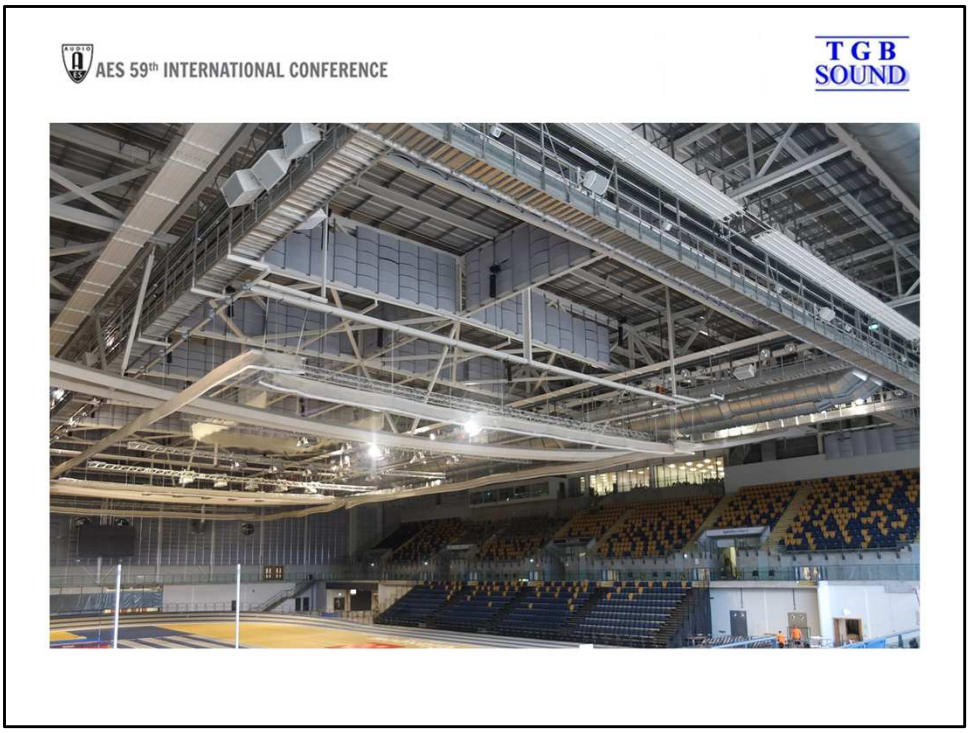
AES 59th INTERNATIONAL CONFERENCE

TGB SOUND

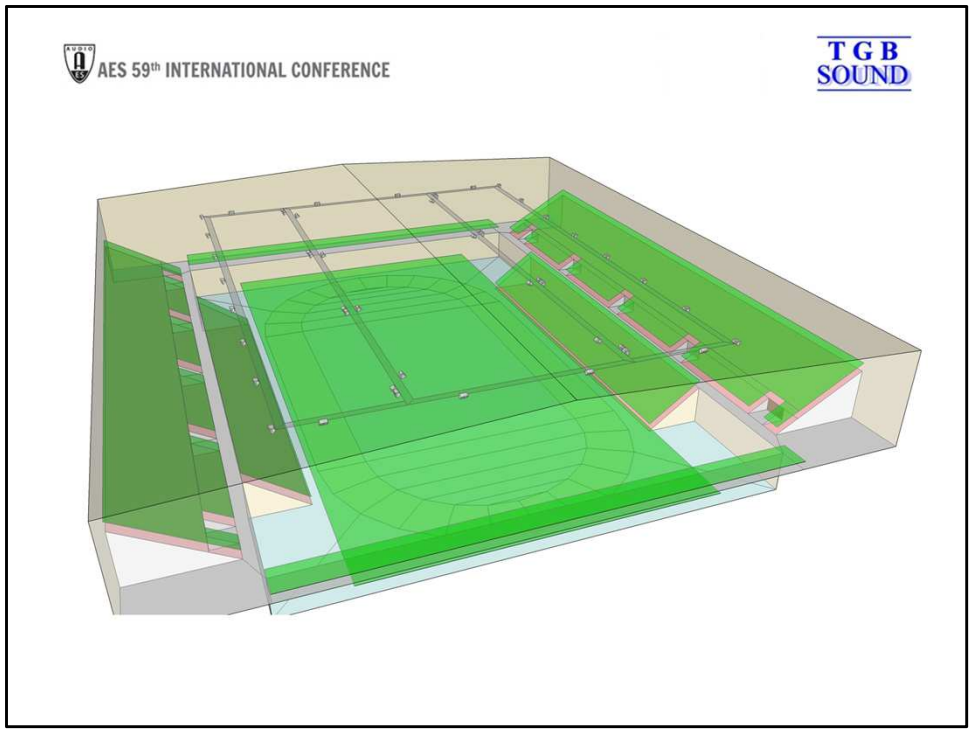
National Indoor Sports Arena and Velodrome, Scotland

Network sound using Dante

- NISA is located in the east end of Glasgow approximately 2 miles from the city centre and is owned and run by Glasgow City Council.
- The location is easily accessible on foot, car or by public transport.
- The project was completed in 2012 for the 2014 Glasgow Commonwealth Games and has state of the art facilities that anybody can use including Gym, SPA, fitness and dance studios, outside five-a-side pitches and Hospitality Suites.

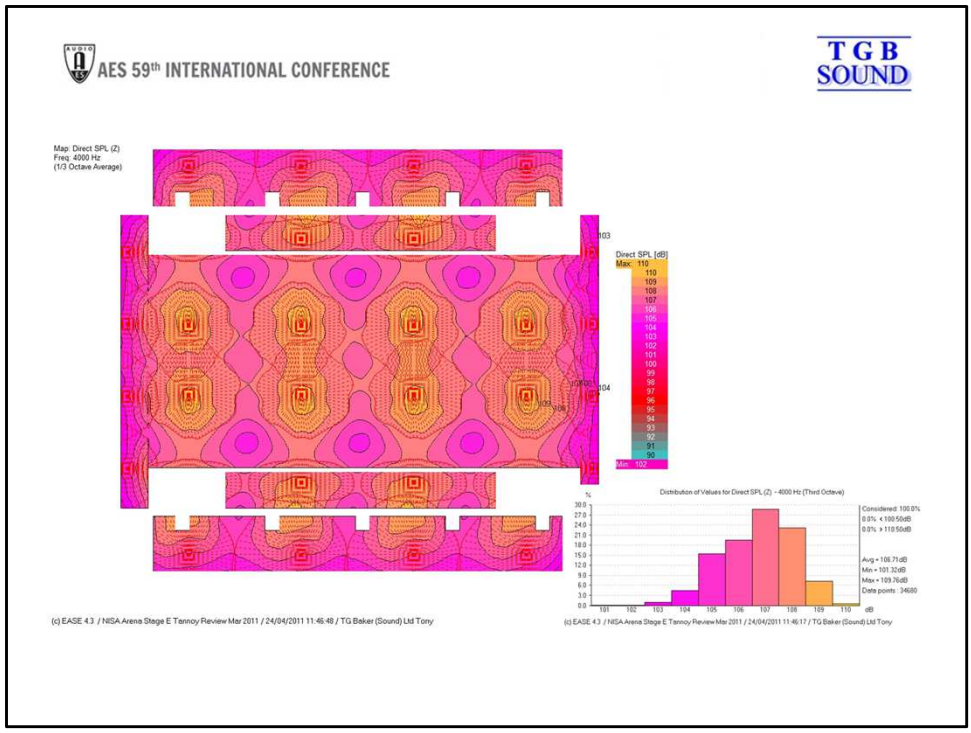


- The Arena has a seating capacity of up to 5,000 seats. There are approximately 3,500 fixed seats with further capacity for 1,500 temporary
- The venue is the new home of Scotland's only professional basketball team, the Glasgow Rocks and Scotland's leading netball side the Glasgow Wildcats
- The Arena is symmetrical with a high level gantry for the mounting of equipment. All of the gantries were made from aluminium and there were weight restrictions imposed for all of the loudspeakers
- There is also a significant amount of HVAC ducting between the gantries on both sides of the Arena
- Buro Happold designed the acoustic treatment within the space to be between 2.0 to 2.1 seconds between the frequencies 500Hz and 2kHz. Here you can see the acoustic panels on the walls and between the roof trusses

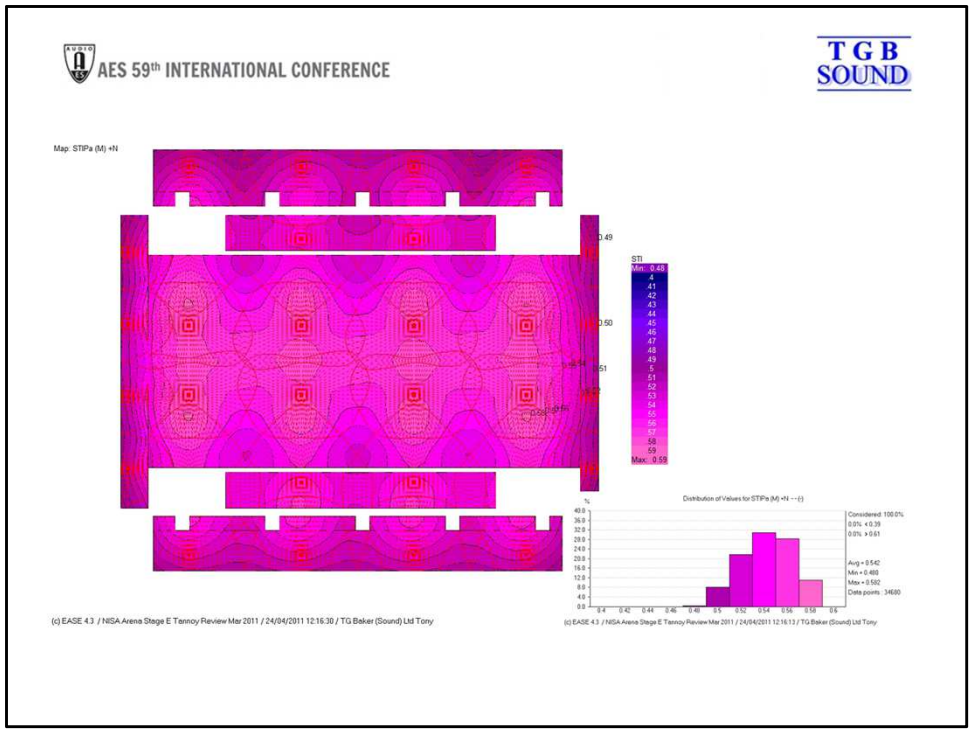


- The Arena 3D model shows the gantry and the loudspeaker locations:-

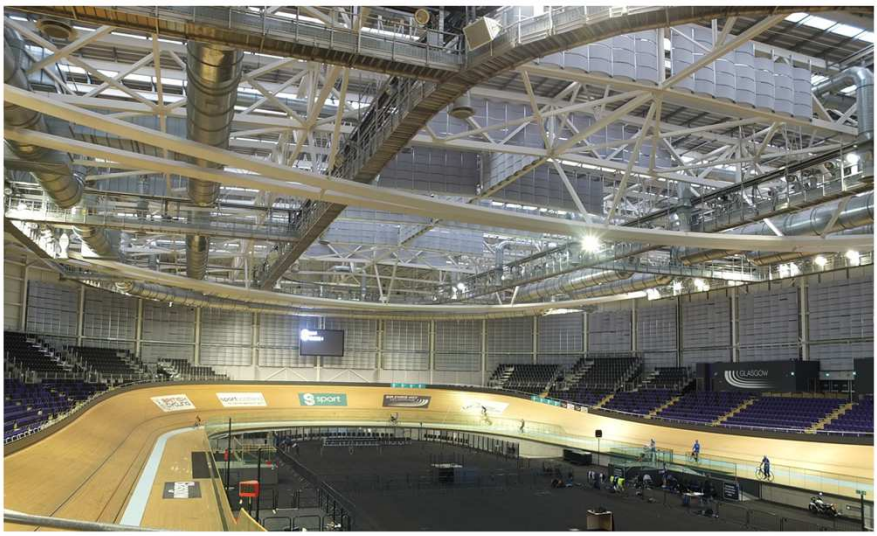
- There are 8 VQ100 loudspeakers covering the infield - 4 on each side
- There are 8 VQ95 loudspeakers covering the lower tiers - 4 on each side
- There are 8 VQ60 loudspeakers covering the upper tiers - 4 on each side
- There are 8 WA218x - 2 x 18" lightweight sub woofers - 4 on each side
- There are 8 VX15HP loudspeakers covering the end walkway - 4 on each side
- Lastly there are 16 VX15HP loudspeakers covering the last 3 rows of upper tier seating – 8 on each side



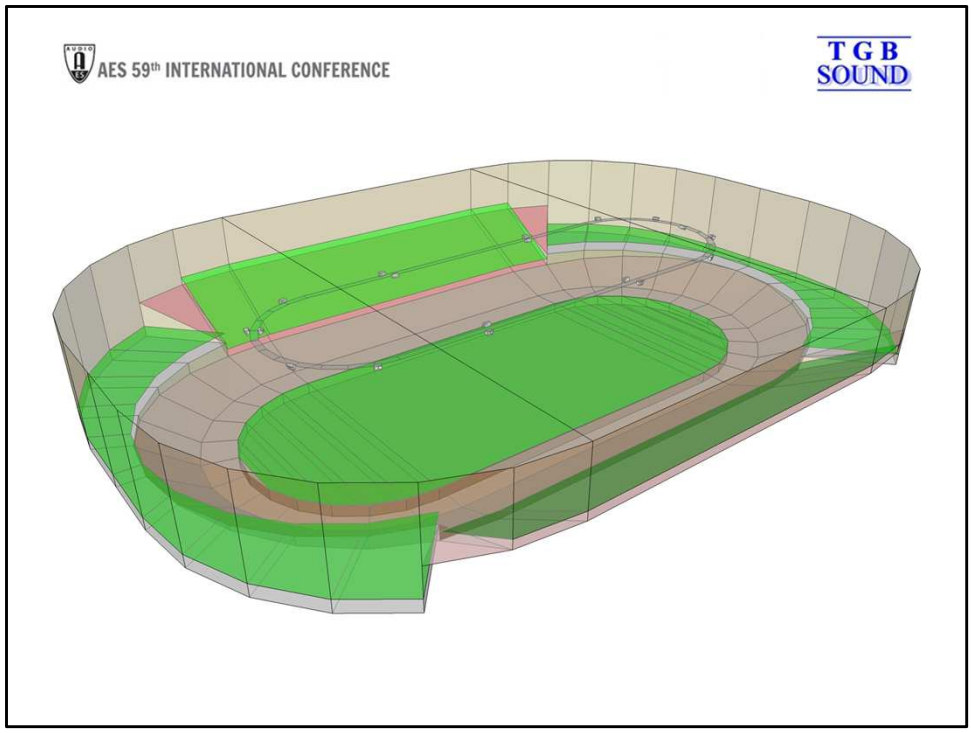
- Predicted 4kHz Direct SPL
- There is fairly even SPL coverage across all listener planes
- Measured SPL was approximately 100dB with 8 to 10dB of headroom.



- Predicted Male STIPa with simulated background noise
- Measured STI was between 0.5 and 0.6

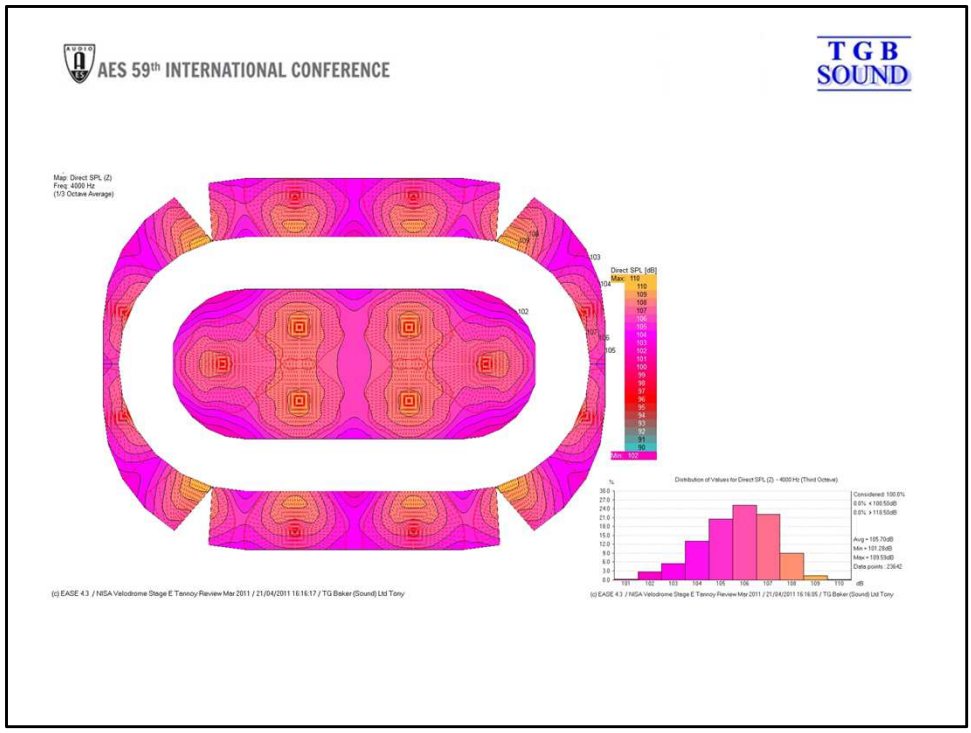


- The Velodrome has a maximum seating capacity of 4,500 seats. There are 2,500 fixed seats with a further capacity of up to 2,000 temporary seats and is the home of Scottish Cycling
- The Velodrome is symmetrical with 2 concentric high level gantries for the mounting of equipment
- All of the sound system loudspeakers are mounted on the inner gantry
- Like the Arena there is a significant amount of HVAC ducting on both sides between the gantries
- Buro Happold designed the acoustic treatment within the space to be between 1.7 to 2.0 seconds between the frequencies 500Hz and 2kHz. Here you can see the acoustic panels on the walls and between the roof trusses

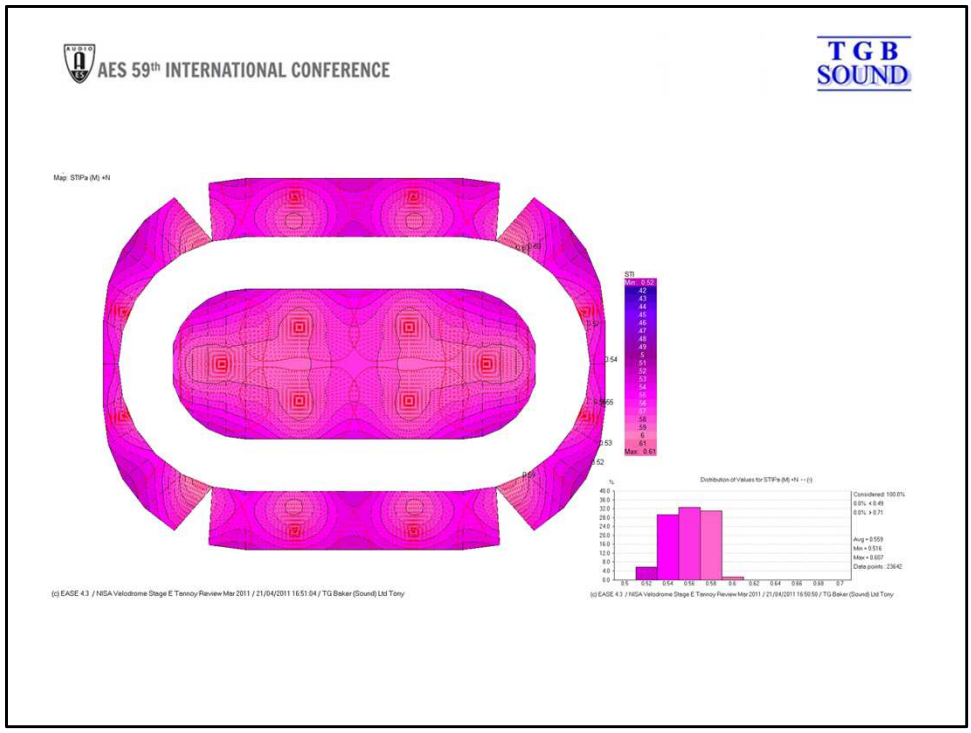


- The Velodrome 3D model shows the inner gantry and the loudspeaker locations:-

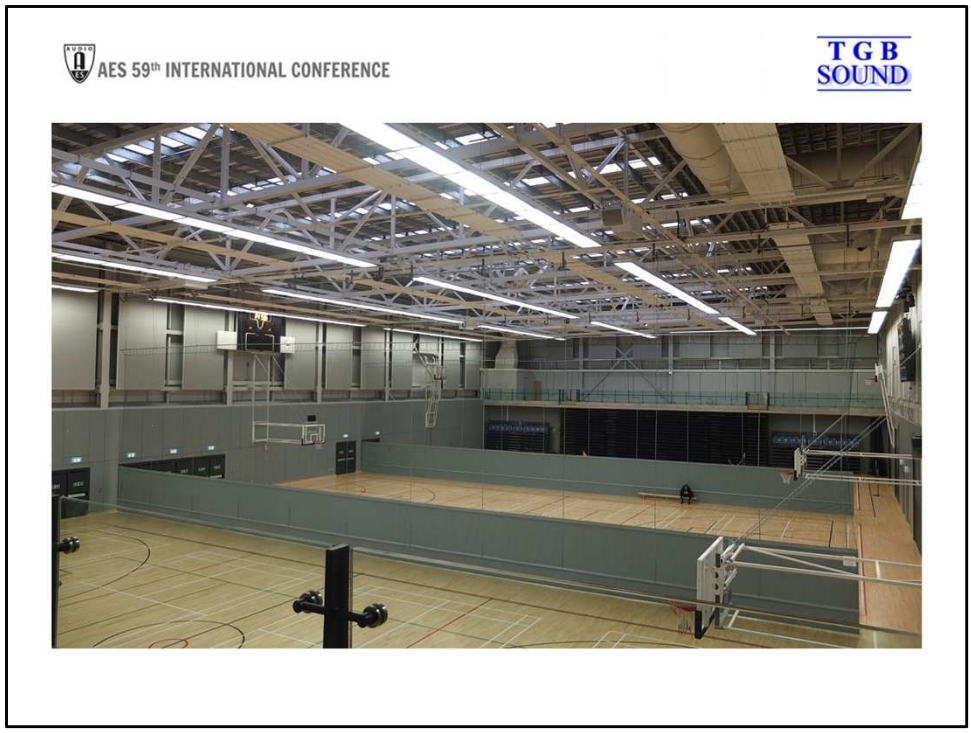
- There are 6 VQ100 loudspeakers covering inside the track.
- There are 4 VQ95 loudspeakers covering the end curves - 2 on each end.
- There are 8 VQ60 loudspeakers covering the sides - 4 evenly spaced on each side.
- There are 8 WA218x - 2 x 18" lightweight sub woofers - 4 on each side.



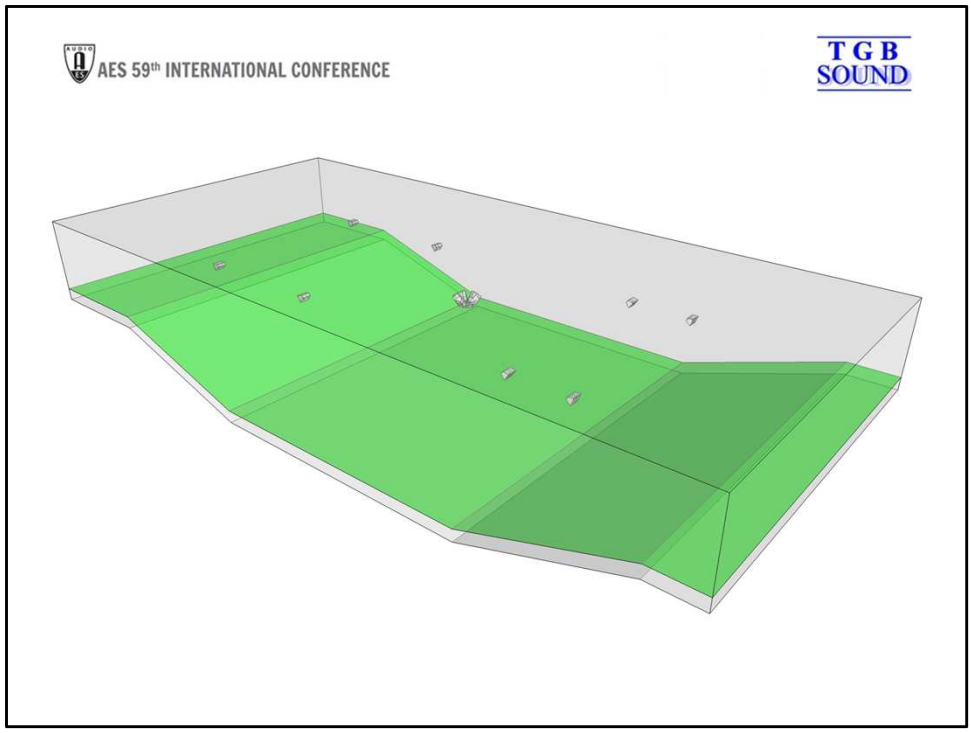
- Predicted 4kHz Direct SPL
- There is fairly even SPL coverage across all listener planes
- Measured SPL was approximately 100dB with 8 to 10dB of headroom



- Predicted Male STIPa with simulated background noise
- Measured STI was between 0.52 and 0.6

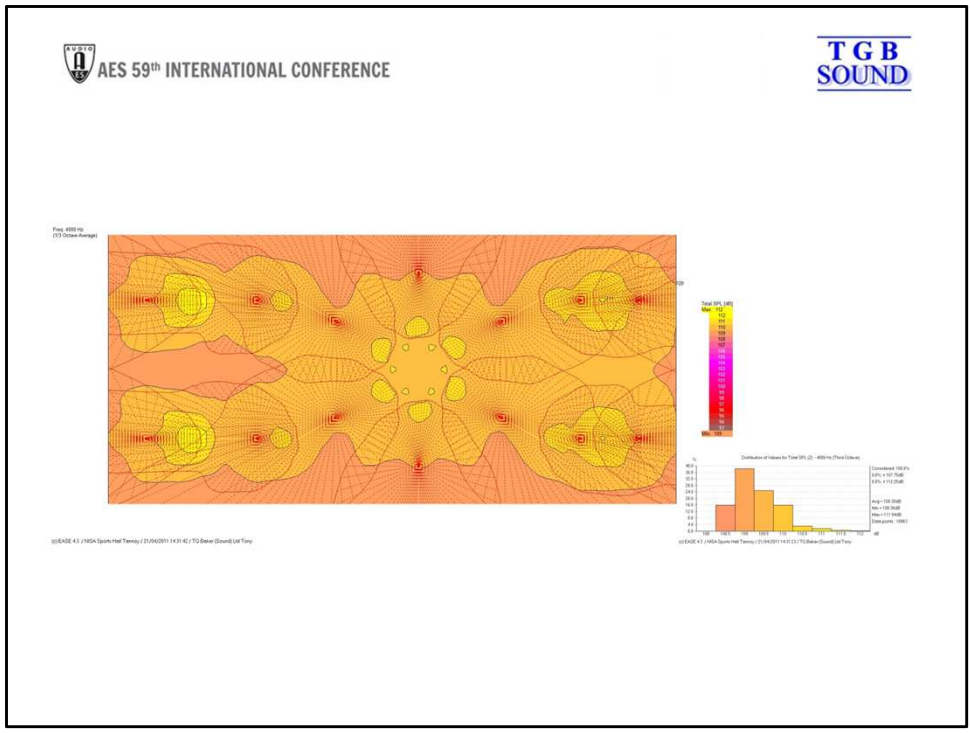


- The Sports Hall is the smallest event building and can be used for a range of indoor sports e.g. basketball, netball, football and badminton
- It's the size of 3 basketball courts or 12 badminton courts
- Some of the Arena temporary seating can be moved into the Sports Hall to provide up to 1,000 spectator seats for smaller events
- In the Sports Hall all of the loudspeakers are mounted on the roof trusses
- Buro Happold designed the acoustic treatment within the space to be between 1.9 to 2.0 seconds between the frequencies 500Hz and 2kHz. Here you can see the acoustic panels on the walls and between the roof trusses

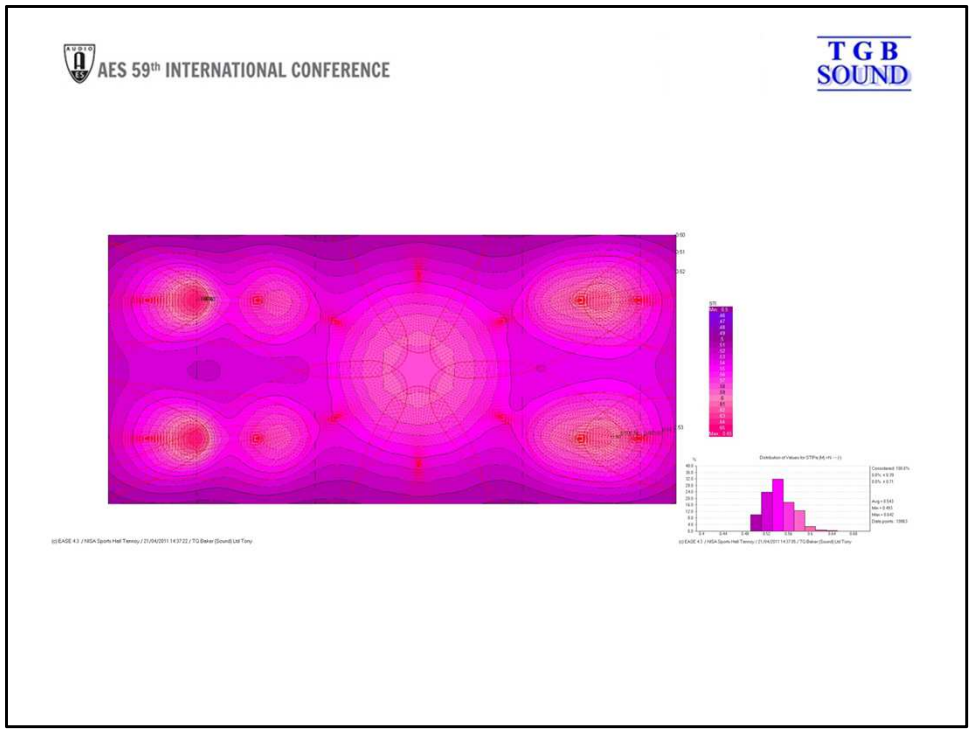


- The Sports Hall 3D model shows the loudspeaker locations:-

- There are 6 VX15HP mounted as a centre cluster covering the main basketball court and the lower section of the seating.
- There are 4 VX15HP loudspeakers covering the rest of the seating - 2 on each side.
- There are 4 VX15HP loudspeakers covering the concourses - 2 on each side.
- There are 4 WA218x - 2 x 18" lightweight sub woofers - mounted above the seating.



- Predicted 4kHz Total SPL
- There is fairly even SPL coverage across all listener planes
- Measured SPL was approximately 95dB to 98dB with 8 to 10dB of headroom



- Predicted Male STIPa with simulated background noise
- Measured STI was between 0.5 and 0.6

TGB SOUND

Installed Products

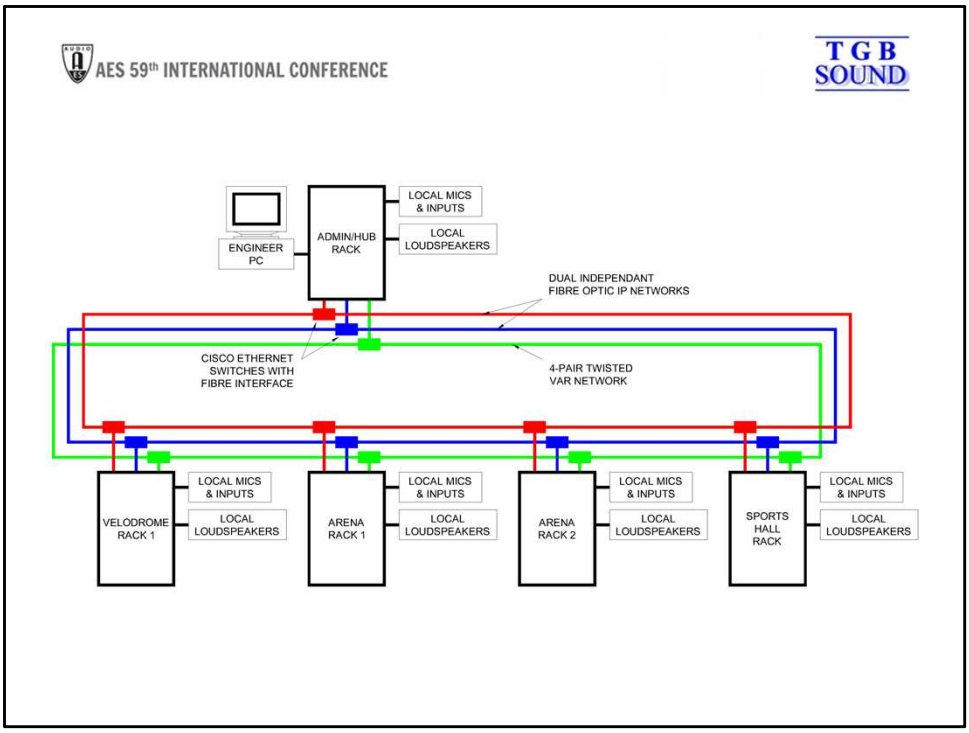
- Tannoy VQ and VX Series Loudspeakers
- Lab.gruppen PLM10000 and PLM20000 power amplifiers
- Peavey Nion nE, nt180 and Kiosk Laptop
- Application Solutions VAR Series routers and VARNIA

- Tannoy developed VQ95 and WA218x for this project
- Lab.gruppen amplifier monitoring was progressed during this project
- Peavey – Tech Spa module used to monitor Lab.gruppen amplifiers
- Dante was used between the Peavey Nions and the Lab.gruppen amplifiers
- VAR20, VAR8ACU + VARNIA

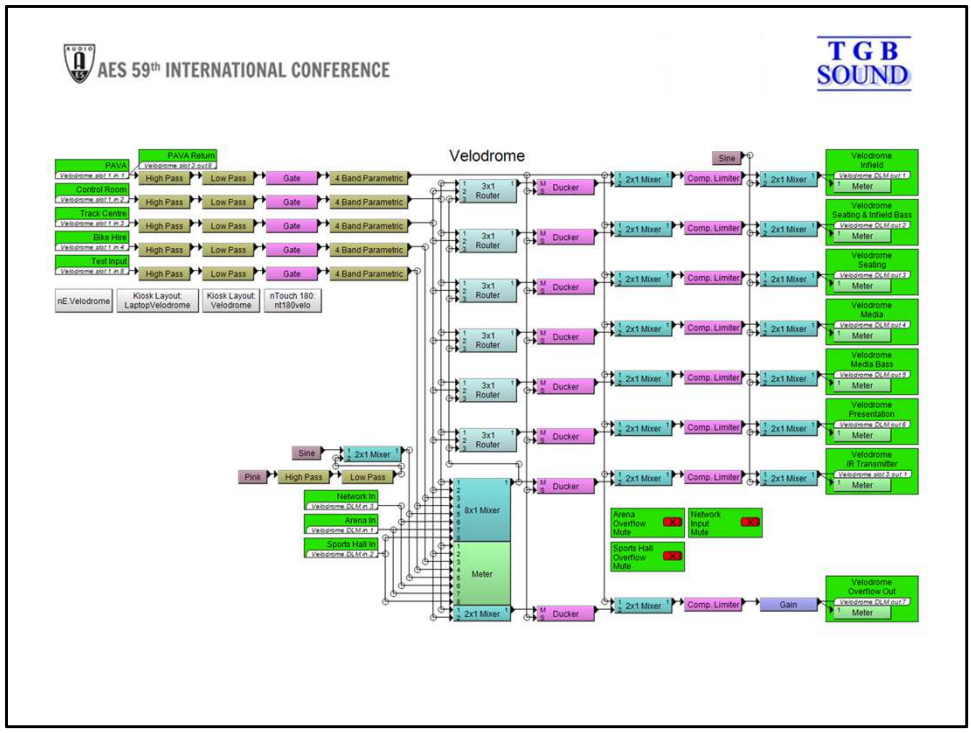
TGB SOUND

System Overview

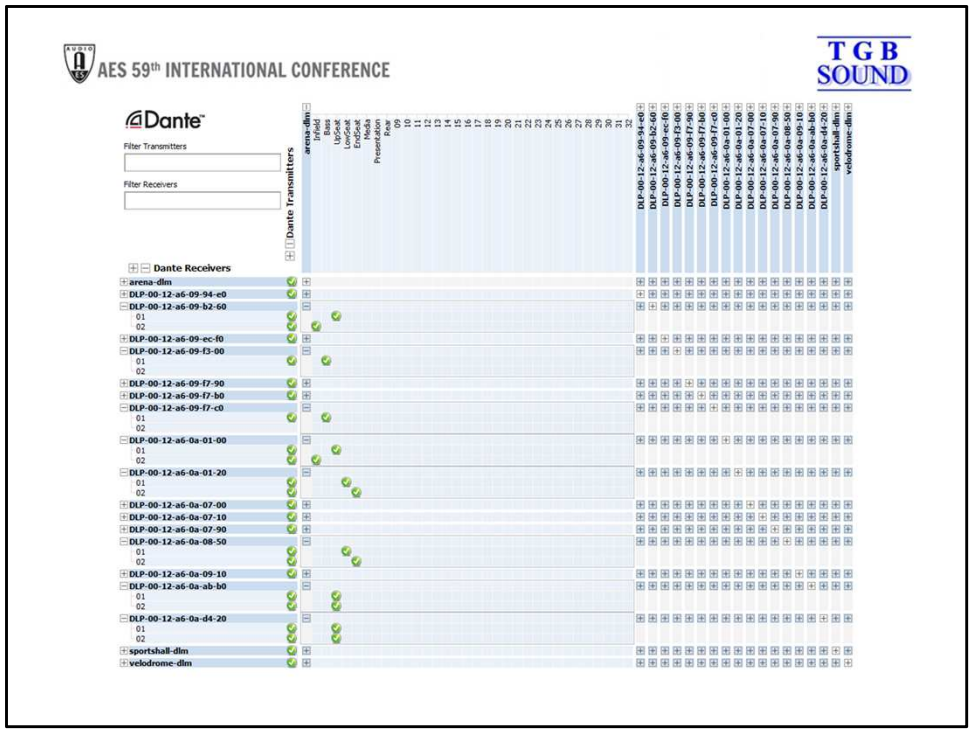
- There are 20 PAVA paging zones with up to 44 inputs and 116 outputs.
- 4 Emergency Fire Microphones
- Evacuation and Coded Messages
- Paging Microphones
- Local portable racks with PAVA cut-off.
- Local music sources.
- Attero Tech moveable network input via VPN



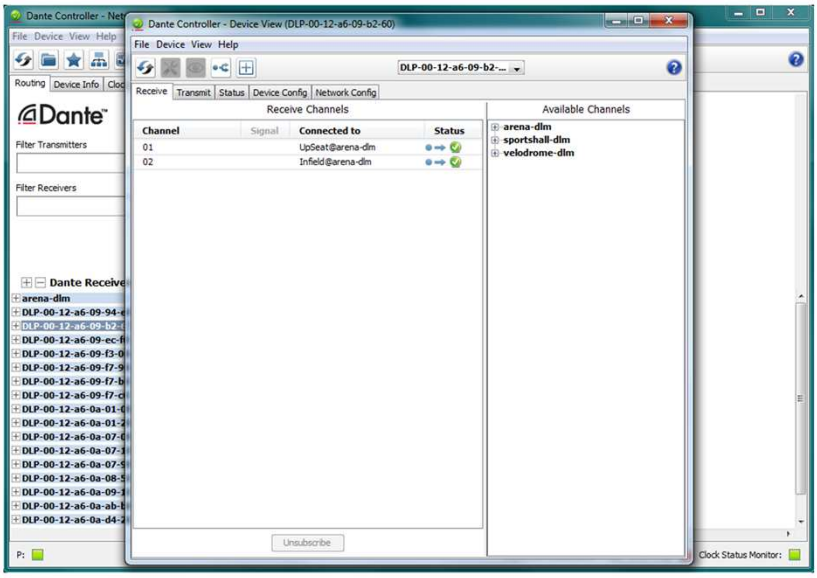
- Sound system uses a network of distributed amplifiers and equipment racks
- There are 5 nodes
- Cisco Ethernet switches with fibre interfaces are installed at all nodes
- Each node is linked by a diversely routed dual fibre optic ring for Dante and control and one 4 pair twisted cable within the structured cabling system for the VAR network
- The Dante network can also be connected to the house network via a VPN to enable remote audio to be injected easily into the sound system



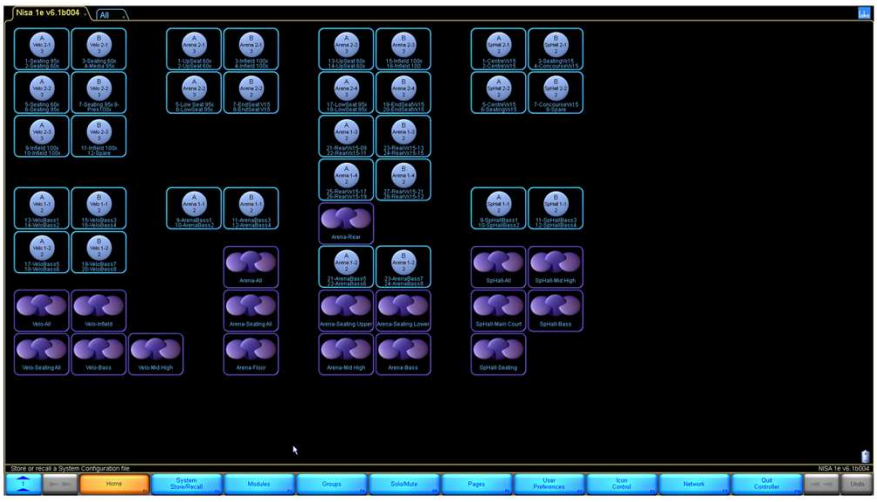
- The DSP design in all of the event buildings is similar. The velodrome is shown here
- Each input typically has HP and LP filters, audio gate and parametric eq
- Outputs are then zoned via Dante and the Lab.gruppen amplifiers to the various loudspeakers within the velodrome
- There is also an overflow output that enables the velodrome inputs to be routed into the arena and sports hall and vice versa



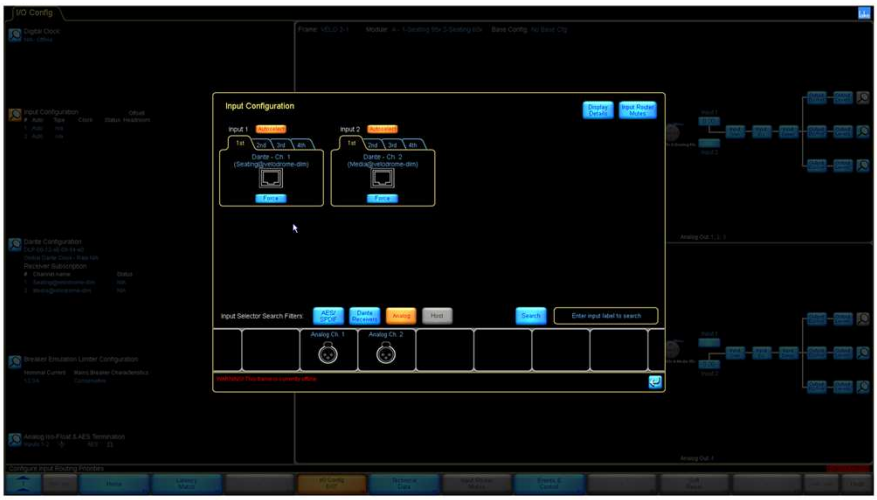
- Dante network routing for Arena
- On the top we can see the Nion Dante channels and on the left hand side we can see the Lab.gruppen amplifiers with their assignments



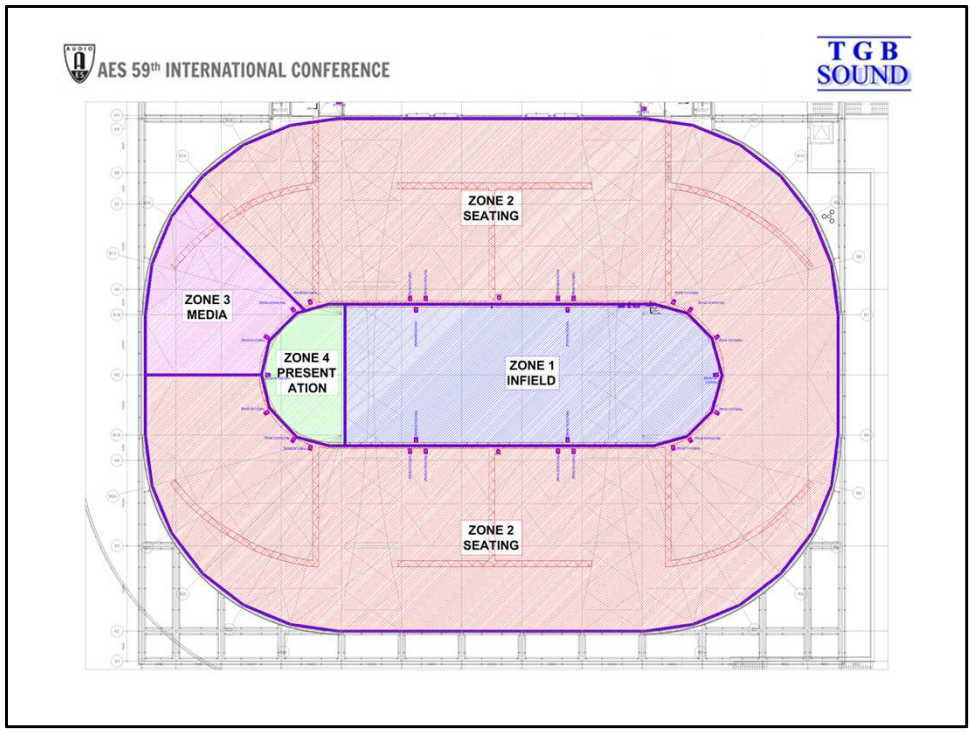
- If we open up the PLM amplifier we can see which signal and module is being used
- The Dante network is very simple to design and implement providing that you use sensible labelling



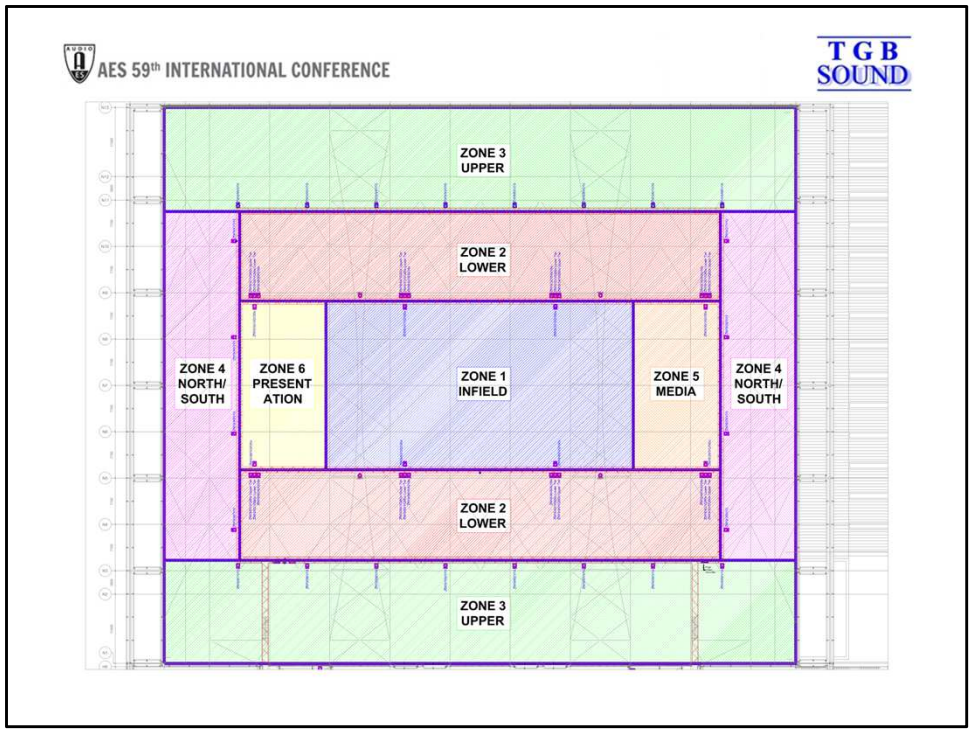
- Here is the home page from the Lake Controller software used for the PLM amplifiers. Amplifiers are arranged per node Velodrome, Arena 1, Arena 2 and Sports Hall
- Each module shows which amplifier channel is feeding the zone and loudspeaker type
- PLM10K used for the bass loudspeakers and PLM20K used for all other loudspeakers
- The loudspeaker equalisation and crossover filters are stored within the amplifiers



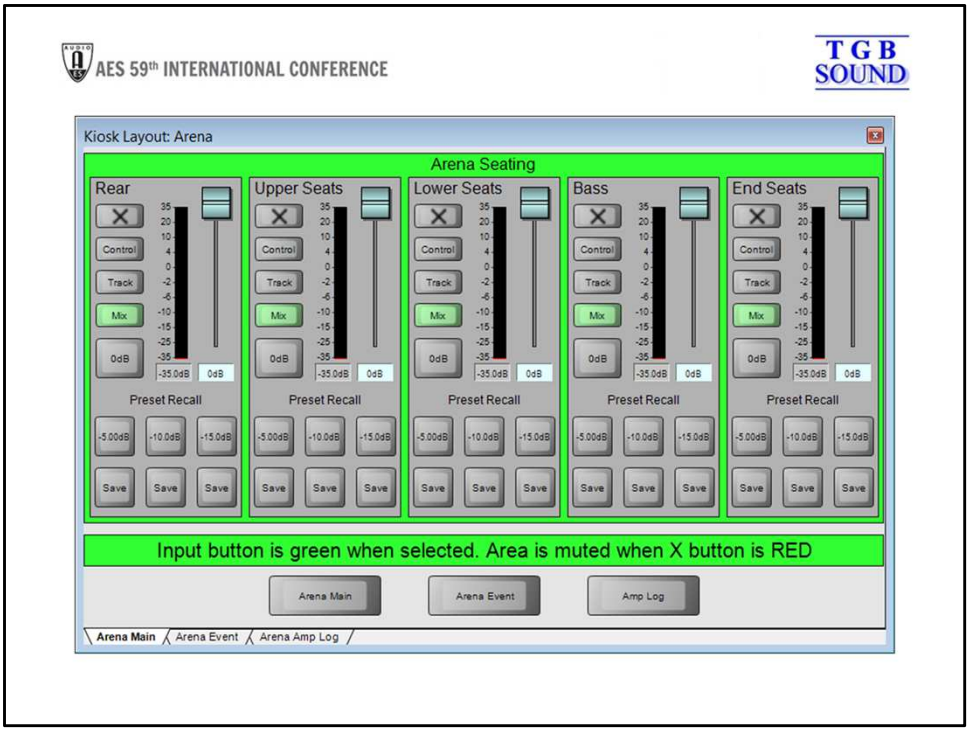
- This is one of the input configuration pages
- Highest priority audio is Dante and the lowest priority audio is the amplifier analogue input
- If anything should happen to the Dante audio or network then the amplifier would use the analogue input directly fed from the VAR network



Zone 1 - Infield
Zone 2 - Seating
Zone 3 - Media
Zone 4 - Presentation



Zone 1 - Infield
Zone 2 - Lower Tier Seating
Zone 3 - Upper Tier Seating
Zone 4 - North/south Walkways
Zone 5 - Media
Zone 6 - Presentation

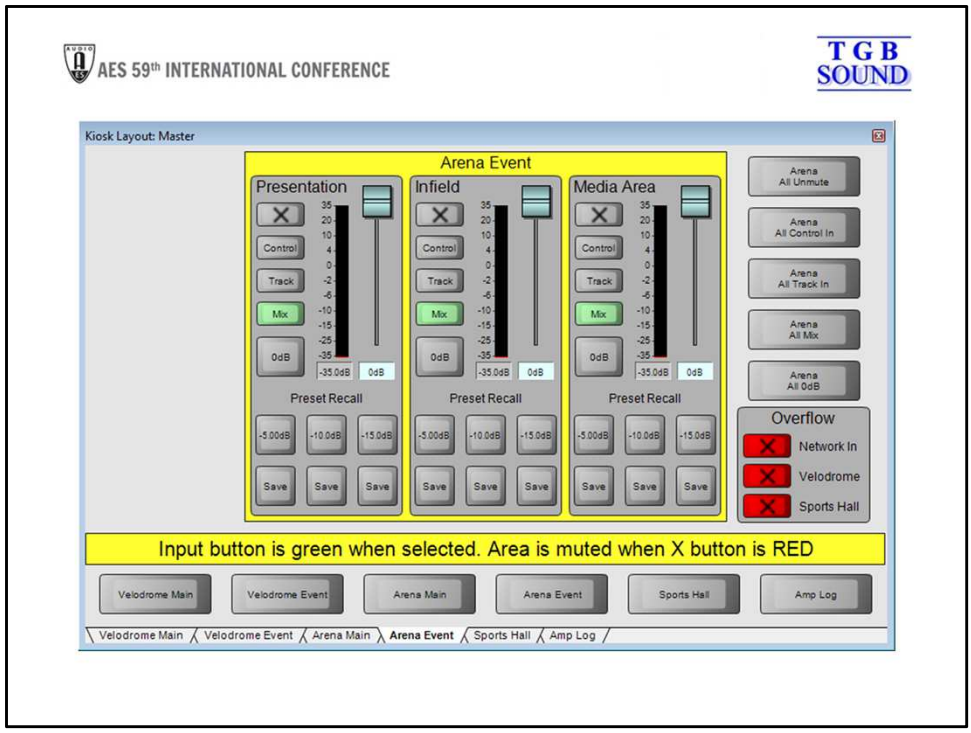


- There are 3 nt180 control panels installed one in the Arena, Velodrome and Admin/Hub rack

- Each sub zone can be controlled using either the nt180 control panels or the supplied touch-screen laptop running kiosk. It is important to note that one of these controls affects the PAVA coverage

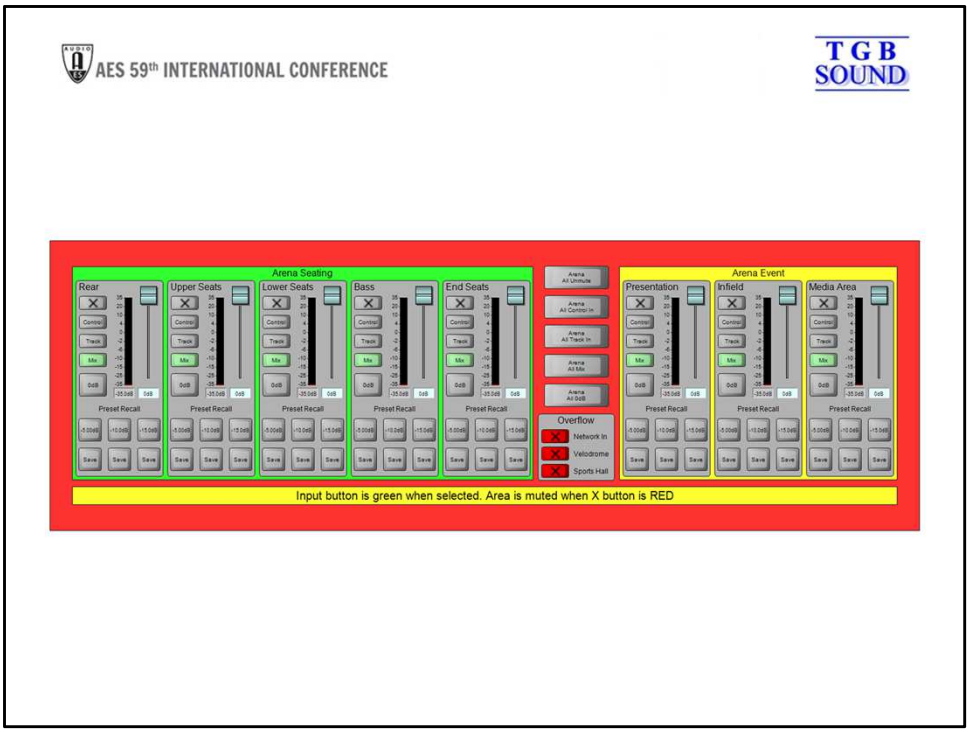
- Each zone has:-
    - An output meter, volume fader, mute, input selectors Control Room source, track side source or Mix i.e. both Control Room and Trackside sources together
    - Various preset recalls e.g. pre event levels can be set by adjusting the volume control and then the save button. The set volume is displayed on the preset button and the sound level can be recalled anytime during an event by pressing the appropriate button

- The three buttons along the button toggle between the nt180 pages.



- The event page shows the Infield, Media and Presentation zones with exactly the same sub zone control

- On the Event screen there are additional buttons to enable:-
  - All areas to be unmuted.
  - All areas to use the Control Room input.
  - All areas to use the Track side input.
  - All areas to use the Mix facility.
  - All areas to set the volume to 0dB (maximum volume).
- Overflow function:-
  - Network In
  - Velodrome
  - Sports Hall



- Control page as displayed on the touch-screen laptop running Kiosk. This can be plugged into the network using the house VPN to be in close proximity to the audio equipment

- This has exactly the same functionality as provided by the nt180 controllers but on a single screen

- Partnerships

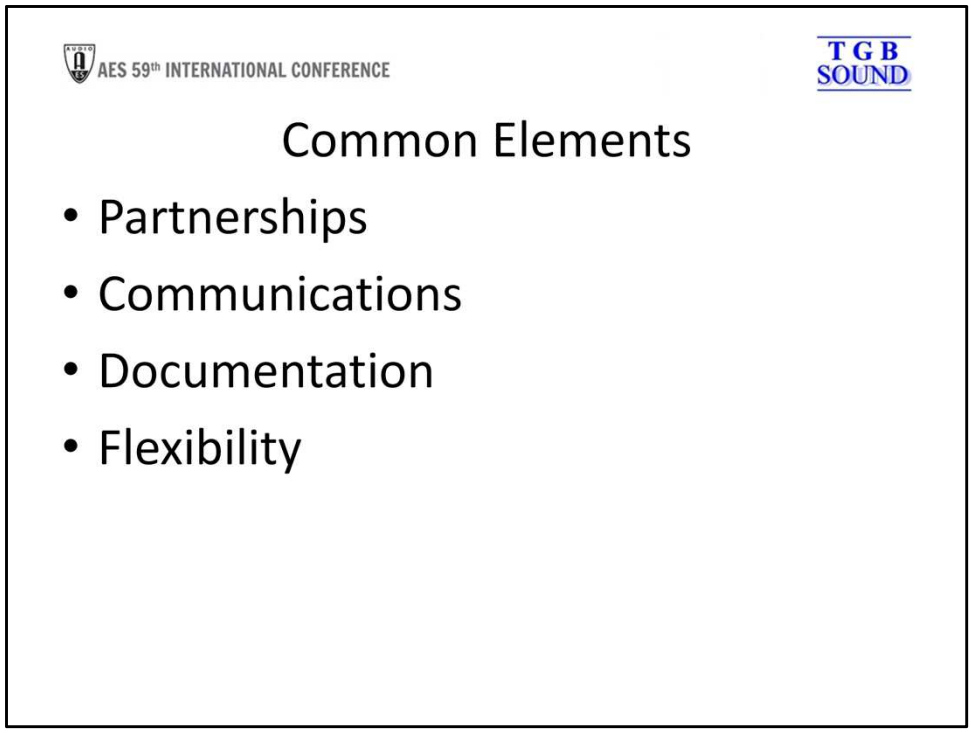
- With any project it is extremely important to partner well. When we needed over 500 presets for faster TPU operation we got a DSP software upgrade, when we needed lighter loudspeakers manufacturers have created them, when we needed amplifiers to monitor loudspeakers manufactures have supplied, when we have queried the reverberation time in rooms acoustic consultants have listened and advised. We could not have designed or installed these projects without the support of everyone involved.

- Communications

- From clients, architects, acoustic consultants, main contractors, electrical contractors, installers etc. good communications are vital to a successful project. As an audio specialist it is extremely important to engage to ensure that the audio quality meets the client expectations for example if you feel that the sound quality will be compromised due to material changes or removing acoustic treatment speak up.

- Documentation

- We cannot stress how important during construction that appropriate documentation is created, maintained up to date and handed over on completion with simple to use operating instructions. There is no point in designing the best sound system for the venue if nobody knows how to operate or maintain it.



- Flexibility

- All of these projects were so simple to implement once we had got to the price threshold where digital audio could be used. In fact due to reducing prices it is becoming easier to implement digital audio systems for even the smallest installations.

Summary

Going digital with sound systems:-

- Has enabled us to be pro-active in support and we now know the system status before we attend site.
- Remote and local access has significantly improved maintenance and service times.
- Has significantly improved the audience experience.
- The client finds the system intuitive and easy to use.
- Easier to make client changes when requested – no more filing out switches and rewiring to add new equipment.

Q&A