



ITEC  NET - System

Technical report of Dieter Michel, PROSOUND Magazin 6/2009



## **Pole position for ITEC NET**

**Audio networking and sound engineering for the new F1 circuit in Abu Dhabi**

*Dieter Michel*

**Shortly before this edition went to press the new F1 circuit at Yas Island in Abu Dhabi was put into service with the final race of this year's F1 season on the 1st of November. The YAS Marine Circuit is a new built F1 racing track with a total length of approximately 5.5km which can be separated into two individual circuits (3.1km respectively 2.4km long), allowing simultaneous and independent use. Around 50000 visitors are able to watch the events on the circuit from the roofed grand stands or special VIP boxes. For the first time, the supplying of all stands and maintenance areas with public address systems was carried out with the brand-new "ITEC\*NET" audio network system developed by the Austrian company ITEC.**



Start / Finish straight with main grandstand (on the left) and pit buildings (on the right)

### **The circuit**

After a construction period of only 3 years the new circuit planned by the German architect Hermann Tilke was put into service on schedule with the first race. It is located on YAS Island, virtually in sight of the national airport of Abu Dhabi. Demonstrating the new classic type of F1 circuits it provides long straights and tight bends on an area of about 8 km<sup>2</sup> challenging drivers at speeds up to 320km/h.

### **Companies involved**

The main contractor for all electro-technical building facilities is a consortium of PKE Gulf W.L.I. (a subsidiary company of PKE Electronics AG) and Siemens Abu Dhabi. PKE Electronics is among other things responsible for the area "special electronics" including system components for telecommunication and

in particular audio-, video- and announcement techniques.

PKE Electronics AG, having it's headquarter in Vienna, was up to 1999 part of the division "Projects" (Philips projects), within the global operating Philips AG. This division was sold in February 2000 to the Tyco Group S.A.R.L. and was operated from that moment on under the new name Tyco Integrated Systems. In the course of a management buyout the Austrian subsidiary was transferred into today's "PKE Electronic AG" and became an independent corporation, which is 100% privately owned. From that time on the PKE Electronic AG has grown enormously also by acquisitions of other companies, e.g. in the field of traffic engineering and operates today in the realization of complex high / low voltage current projects as well as in the area of facility management.



View from the main grandstand to the pit buildings across

It installs and integrates electro-technical building facilities, management and communication systems, alarm and automatic fire detection systems, video equipment, access control systems as well as recording and evacuation equipment.

The newly built circuit in Abu Dhabi was not the first F1 project for "PKE". Already in 1996 they were involved in the instrumentation of the Österreich Ring (A1 Ring) located in Spielberg / Styria, which for example was used as venue for the Grand Prix of Austria.

In the meantime other F1 circuits like Malaysia, Le Castellet, Bahrain, Shanghai, Istanbul and now Abu Dhabi have been equipped in cooperation with "PKE". Needless to say, in such a major project you have to work together with subcontractors: Audio networks and public address systems were assigned to the Austri-

an company ITEC, which has its headquarter in Laßnitzthal near Graz. The construction of the pre-assembled equipment (e.g.: switch cabinets) was carried out by PKE / Siemens. For the company ITEC this order wasn't their F1 premiere either as they had already designed, delivered and installed public address systems for the circuits in Istanbul and Bahrain. Due to constantly increasing requirements with respect to size and quality of public address systems already in an early stage of the Abu Dhabi project the decision was made to develop with ITEC\*NET a digital audio network, which is able to fulfill monitoring and remote control tasks in addition to the distribution of audio signals.

### **General Project description**

As shown in the chart on page 24, the

the following buildings are located along the circuit: In total 4 grandstands with a total length of about 1.5km, 2 pit buildings, one of them across the main grandstand at the Start / Finish straight, a support pit building, a building for the individual teams, the VIP tower, the medical center, maintenance buildings and the main entrance building. All these locations had to be supplied with an audio network system. For this purpose ITEC\*NET, an Ethernet based multichannel audio system for public address systems, emergency, music and broadcast applications came into operation: A system that was developed by ITEC, an Austrian company, had already delivered audio equipment for the F1 circuit in Bahrain.

As special feature the F1 circuit in Abu Dhabi was equipped with a full-range public address system at the grand stands. Normally only speaker systems for normal speech are used within F1 circuits, but for the Yas Marina circuit it was the explicit request of the customer to provide a full range public system for the grandstands, suitable for high fidelity music applications and also within the VIP areas where speaker systems, mounted at the ceiling had to be used.

### **Sound Engineering for the Grandstands**

From the architectural point of view all grandstands are built up similarly: Each of them is configured as an open main stand with steel pipe based roofing, similar to that of a tent, is covered with a membrane.

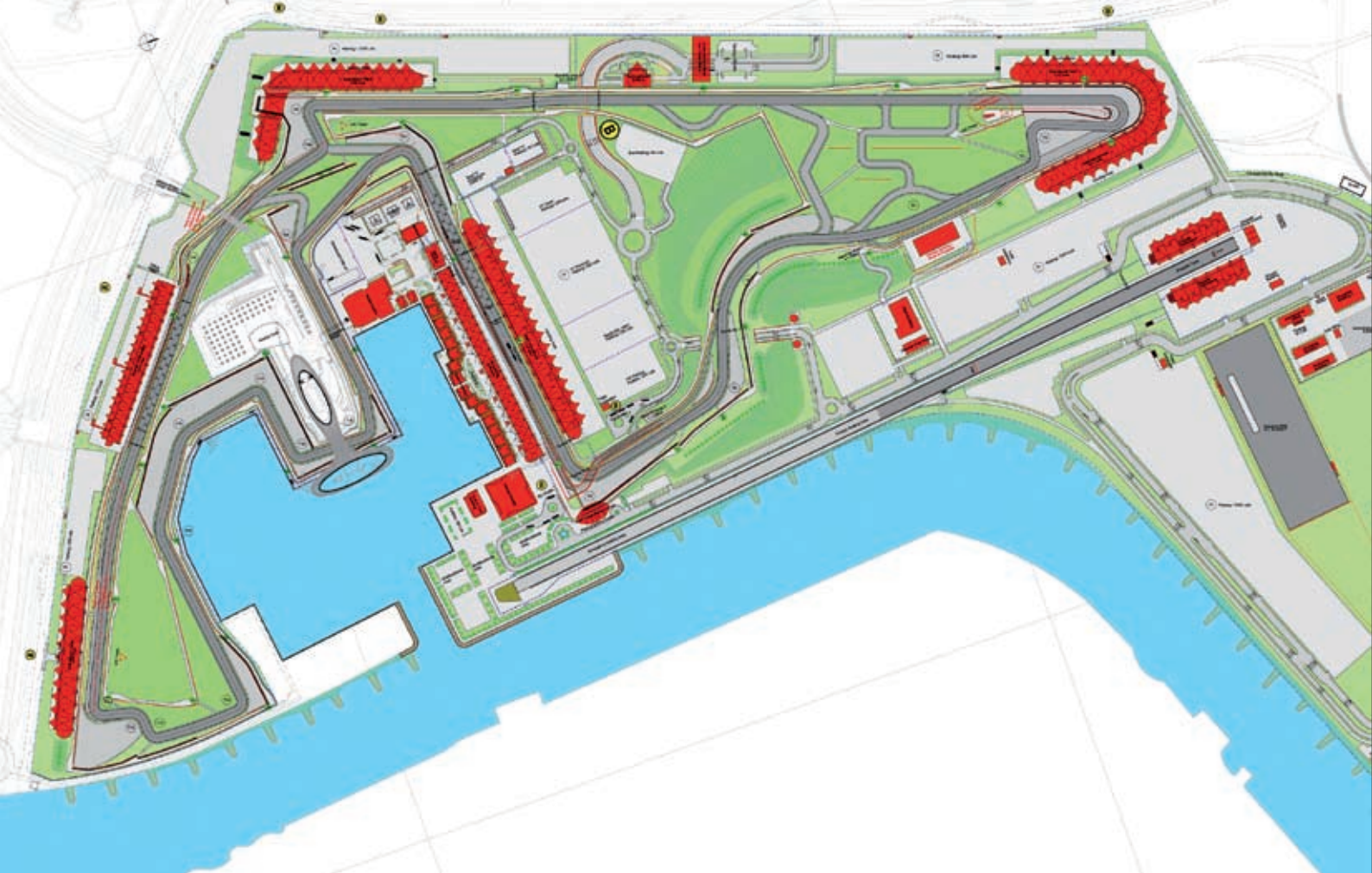
From the sound engineering perspective this type of roof construction has the advantage that the auditorium area of the stands can be equipped with a geometrically beneficial cover, with a ceiling mounted loudspeaker systems located at the front side of the roof. This concept was proven to be effective also for large outdoor stadiums, because the distance between loudspeaker systems and the audience is nearly constant, assuring a uniform sound level.

According to the specification of the customer to have a public address system in place, which is suitable for music applications as well, ITEC system designers made use of the full range speaker system "ITEC Power top 12". It offers a high duty speaker system, consisting of 2x12" Low/Mid speakers and a 1" CD horn tweeter with an average output of 104dB (@1W, 1m) and a peak level of 130dB. – The specifications of this full range system show that it is perfectly suited for performing this task.

The ITEC Power top 12 systems can either be mounted horizontal or vertical, the horn tweeter (90°x60°) itself is adjustable by 90 degrees in order to adapt it to individual assembly methods. The integrated passive frequency separating filter is equipped with a protection circuit, ensuring that no component is overloaded – highly important for speakers systems, which after installation are difficult to access. Especially important for an outdoor installation is the weather-

View from the circuit to the northern grandstand at the hairpin turn





Map of the "Yas Marina Circuit" area: The grandstands are marked red

proof. Therefore the speaker systems can be installed outdoor without any additional covering. A configuration using a 100V transmitter to integrate the "Power Top 12" in a 100V acoustic sound transmission system is optional. For the installation in Abu Dhabi the speaker systems were configured using a 4 Ohm variant, connecting 2 speaker systems in parallel. In order to make best use of the installed power amplifiers (ITEC Multipage 2x1000), these speakers were linked to one output channel. The power amplifier provides 1450W power per channel (2 Ohm), resulting in about 700W output power per speaker system. The ITEC Multipage series is designed for continuous operation and for applications within professional public address systems. For this purpose it is equipped with an integrated limiter, temperature controlled blowers and for emergency installations, particular important malfunction messaging. The power amplifiers are controllable by remote for installations where locations are distri-

buted for kilometers from each other, which is of high importance as well.

With a length of 300 meters 40 speaker systems are installed along the main grand stand at the leading roof edge of the tribune. The distance between the individual speaker systems is about 7,5 meters, the total output power of the amplifiers 29kW! With an average distance of 20 meters to the audience the Power top 12 speaker achieves an average out of 103dB and a peak level of well above 100dB (approximately 106dB), which also guarantees a sufficiently high alerting level. This is necessary, as the main PA system in Abu Dhabi is used as a security sound system as well; a configuration that is being used in F1 circuits for the first time.

During a site visit in Abu Dhabi I was able to listen to playbacks of music and spoken language via a headset. Further I could take a walk at the main grand stands at different areas (for which by the way the sound system are built up identical). The reproduction was

also very powerful for music, very direct for the spoken language, and offered very good speech reproduction.

For the area of the tribune below the outer row of seats of the VIP loges (balcony like designed), delay speaker systems of the type ITEC power line were installed in addition, in order to prevent shadowing effects of direct sound by the balcony construction. This method is essential for only the very highest row of seats located directly below the balcony, which have no direct line of sight to the main speaker systems. - The remaining rows are sufficiently supplied from the main PA system.

"Power line systems" are also used, in order to supply rows of seats in front of the VIP loges at the opposite of the main grandstand (this is the area of the pit buildings). The VIP loges are arranged in two floors here, one above the other - the rows of seats are balcony-like, but shifted, which offered the chance to install the speaker system at the leading edge of the lodge / tribune above. The "Power line system", which is used here, is operated as a 100V sound system.

### Systems Engineering

The technical environment for the ITEC\*NET audio system as well as the power amplifiers

for the various public address systems are located in 26 engineering rooms in total, which are separated along the circuit in different buildings. Thereby each grandstand is equipped with 2 engineering rooms. In total 39 racks, each with 42 units were installed. In the amplifier racks ITEC Spider 44 modules (to provide sound distribution from the ITEC\*NET) and power amplifiers (to drive low resistance speaker systems at the grandstands, high resistance 100V ceiling mounted speaker systems, speaker systems for corridors, indoor and outdoor areas and finally systems for digital delay line techniques) were placed.

For the cross linking of all buildings, which are separated up to 2kms from each other, fiber optics had been used: A star shaped topology having its centre in the race control building was put in place.

This fiber optics network is not only used for audio broadcasting but also for video transmissions. For this purpose several fiber optic lines for the various applications were installed. For ITEC\*NET a specific fiber optic line with in total 16 communication terminals (SpiderMike2 allowing areal calls) are distributed over different buildings along the circuit. 9 of them are main communication terminals, 7 local area terminals, allowing communication only within that specific area. For example a

ITEC Powertop 12 speaker system



Roof of a grandstand with multiple speaker systems mounted at the front side edge





Seat area of the VIP loges (on the left) with installed delay speaker systems below the balcony: A similar installation can be found in the pit buildings (page 9)

local area terminal at the North Grandstand allows only announcements within that specific audio area.

In general the communication terminals have different priorities, terminals with the same priority level can lock out themselves – For the other terminals this is made visible by displaying the occupied area. In the security office furthermore, the digital audio file storage for the master call station is available. A software solution for digital audio file storage module (a 2 GB Flash card) was not available at the moment of the first race exhibition. Due to this fact external Flash systems were linked to this communication terminal, allowing in emergency situations the access to pre-recorded emergency and evacuation messages at the push of a button. The according software solution for the Spider Mike2 will be finished and delivered within the next weeks.

For the power supply of all 100V systems, 100 V-amplifiers of the type ITEC 2\*300T (effective power output of 2x 300W respectively, 1\*600W in a bridged circuit mode) were put in place. Also these components offer circuit protection switches and compressor / limiter functions. This is only theoretically needed – For the installation in Abu Dhabi the public address system using ITEC\*NET ensures that

the power amplifiers are not overloaded.

The ITEC power amplifiers are equipped with malfunction messaging, which is used to monitor the actual status of each amplifier module. This is particularly important when the overall configuration is made in such a way that the power amplifiers are part of the security or emergency sound equipment. In fact for the circuit on Yas Island, originally the idea was to build the public address system as a verbal alerting system according to EN60849. Due to fact that the project costs would have significantly increased by using this work approach, only security and message redundancy features were realized. Part of these features is a self-controlling audio system that automatically reports back errors.

In the existing case ITEC\*NET knows which network components (communication terminals and Spider 44) are actually used within the overall system. In case one component does not feedback a correct operational status, an error message is passed on from one Spider 44 module via RS232 to the superior fault indication system. For safety reasons two interconnection points exist within the system to ensure a proper transmission of an error message, even when one line is broken down. A further security aspect is the surveillance



function of the power amplifiers, which due to integrated fault indication can be performed very easily: One (logic) input of the "Spider 44" can be used to monitor the power amplifiers, respectively in the existing configuration one input can be used to monitor the audio area for proper function. The actual condition of this log input can be recalled within the entire ITEC\*NET work, therefore also from the specific Spider 44, which is responsible to feed forward error messages to the superior fault indication system. When receiving an error message, the technician in charge knows immediately in which rack the faulty audio power amplifier is located.

The fault detecting relay outputs of the power amplifiers within one area are similar to an alarm system connected in series - during normal operation the contacts are closed. Is a relay due to a fault condition de-energized, the digital input of that specific "Spider 44", which is responsible for supervising this area, is set to logical 0. This status is visible within the entire ITEC\*NET, therefore only one Spider (plus one for corrective maintenance) is sufficient, to forward all error messages within the network to the superior fault indication system. Due to the fact that low resistive power amplifier outputs require complex solutions, no

One of the numerous racks with "Spider 44" systems and power amplifiers – On the right 3 "Spider 44" systems with level regulators as mentioned within the report





The circuit also leads straight through the "Yas Hotel"

automatic switch over to backup power amplifiers is used in the existing installation.

In each rack a back-up power amplifier is in place – in case of a break down this can be used to replace the faulty one just by simply unplugging one and plugging in the other. All power amplifiers are located on a guide rail system - maintenance activities or a replacement of a power amplifier can be carried out very quickly. In Abu Dhabi, beyond this, the entire ITEC\*NET system (including LWL transmitter and network switches), are permanently fed by an uninterrupted power supply. During major events such as F1 races, additional power generators are installed to secure in case of a break down of the primary power to supply uninterrupted operation. In a worst case scenario assuming a total breakdown of the power supply, only a short interrupt for the power amplifiers will occur until the power generators are activated.

As an additional redundancy measure, all grandstands are equipped with speaker systems that are quite dense. Let's assume one power amplifier channel is deactivated for test purposes: This will not result in a total loss of the speech intelligibility - only the subjective impression of directness will be decreased. Therefore the breakdown of one channel of a power amplifier does not result in the complete loss of acoustic supply of one entire tribune area.

By way using the same approach (as a sort of complementary bonus), temperature monitoring for the maintenance offices has been implemented, which works independently from

the fault indication system. For this purpose within each maintenance room a Spider is linked to a thermal switch and a certain temperature level is programmed. In case this temperature level is exceeded one digital input of the Spider is toggled and the over temperature condition is indicated. This information can be accessed independent from other monitoring systems within the entire network and transmitted to the fault indication system.

The ceiling speaker systems used within the VIP areas are also designed with the 100V-technique. In each separated VIP lodge, 8 ceiling speakers were installed, which are driven by one output channel of an ITEC Multipower 2\*300T amplifier. Per customer requirements, an additional feature was provided: The sound volume of each VIP area is independently adjustable from the responsible maintenance room. These volume adjustments only hold for the program signal and the signal of the commentator – Alerting messages certainly use the predefined sound level. In the lodges, audio signals of equipment, like flat screen TVs, are reproduced by the built in speaker system of the individual device.

During a race, only the race itself would most likely be transmitted, and in a similar way - displayed on the monitors in the grandstands, which are used to give the audience a complete picture of the race. Without these monitors they would only have a limited overview of the race as only a small part of the circuit is in the direct field of vision.

When designing the circuit and the location of the grandstands the architects already paid attention to offer all visitors a unique view: Visitors of the northern grandstand can for example experience the atmosphere of the hairpin turn; the southern grandstand offers a panoramic view of the hotel Yas and the Marina yacht club. Finally to make the range of information offerings complete, you have the possibility to distribute the mixed commentator signal to a local radio station, which is situated within the racing area as well. In this manner the visitors have the chance to listen to the commentator signal at each time via their own personal radio set – possibly also an advantage for hearing impaired people,

who may prefer to make use of earphones.

### **Commentator Room/ Commentator Console**

The commentator room is located along the Start / Finish straight right at the beginning of the pit buildings. The commentator room is equipped with a mixer like console terminal, which has beside its appearance, nothing in common with a traditional mixer. In fact, the terminal for the audio technique consists of several Spider 44, which send signals to the ITEC\*NET. Beyond this, control instructions can be sent to network components within the entire AudioNet, and for example output levels can be modified for speaker zones, which may be located some distance away. At the console this is accomplished by changing the output level on a mixer channel by turning a digital potentiometer.

The primary mixer system is located in the commentator room in the main pit buildings – further mixer systems can be found in the additional pit building, and one at the dragster circuit. The ITEC\*NET components, which are integrated into the console, are programmed in such a way that at any time only one terminal is active within the entire network.

A push button "Master to Net" at the mixer system in the main commentator building allows one to switch this console to the ITEC\*NET and to deactivate all others. An indicator light on these terminals shows that they are locked out and not able to access the network. Within the

coming months the configuration software will be updated, allowing running 2 races on the circuit from the audio perspective at the same time. The circuit itself offers this possibility as it can be split into smaller tracks by using two additional curves. This approach might be used in the near future because already now after the first F1 race the scheduling until April shows not less than 16 race events at the Yas Marina circuit.

For the commentator himself, two headsets with wireless microphones and a cable based version are available. Furthermore, two wireless hand-held transmitters, which allow him due to the usage of multi-diversity wireless microphone solution, to operate in the area of the main pits (e.g.: for carrying out interviews directly in the boxes). Beyond that he can use two local replay machines and is able to access two ITEC NET network channels, which are already pre-programmed with a broadcast tuner and a fivefold CD changer. On his transmission rack he can make use of different PFL (Pre-fader listening) functions for the individual channels (realized by a 6x ITEC multimixer). With this, he is able to create his own mixing and feed it into the audio network. He can also make use of 16 faders, allowing him the adjustment of the sound volume in 16 different speaker areas outdoor (tribunes, VIP areas). The background of using this approach is the fact that for smaller race events not encompassing the entire circuit, a sound emission is required, but only within distinct areas.

The workplace of the commentator is located right at the "Start / Finish straight" (on the left)  
Console terminal of commentator (on the right)





Spidermike 2 communication terminal



The level indicators display the actual power output levels at the whole circuit

Operating interface of the commentator's console terminal



The aforementioned PFL function is realized within four digital ITEC Multimix systems. Two of them are accessible from the user interface, allowing the commentator to adjust the gain levels for different signal sources in order to achieve approximately the same output level at identical fader positions. The possibility to adjust the output levels of different sound areas from the operator console by the commentator is a function of the ITEC audio network by default. The configuration allows for each single output like Spider 44, or Spider Mike, to determine from which entity within the network the levels for the output signals are taken. That can be on one hand a local device like the Spider itself, where the output is located, on the other hand it could also be from one of the other network participants. To realize a fader regulation, for example the analog control voltage input at each Spider can be used. When adjusting the output you can then determine either to use the input of a local voltage regulator or to take the information from a different device within the network, deriving the necessary information for the regulation from the voltage control inputs present at that device. In this way a remote adjustment of the output level is also realized: The different speaker zones along the circuit obtain their output levels from the specific Spider 44,

which is located in the commentator console (the software is programmed this way). These level adjustments from remote not only work from the control panel but basically with all other components within the ITECNET, as all network participants are equivalent. The way this function is implemented within ITECNET also means that you have the possibility to control (e.g.: with one fader), outputs of different Spiders or Spider mikes, which could be regionally separated and which have nothing further in common.

### Level Indicator

When using a mixer-like control panel, the display of levels you are going to adjust is of high importance. This holds particularly for the output levels, as the sound areas are so far from each other that the commentator virtually cannot hear the impact of the fader adjustments he has carried out. For the implementation of a level indicator, which can display in nearly real-time the output conditions of a location that is far away, status messages of the individual ITEC network components are used. The ITECNET is designed in such a way that all network clients send out status messages as broadcast signals with a time lag of 100ms. In principle, these status messages represent a table, which contains all important operating

conditions of a device including the actual status of inputs and outputs (and consequently, the actual level at each output). Therefore all important information is in principle available within the entire network with a maximum time delay of 100ms. This is used on one hand for administration functions within the ITEC-NET, in the existing case it is a quite simple method for realizing the output level indicator mentioned before. For this purpose the specific Spider 44 in the commentator room only has to pick-up status messages of network devices which are of interest and of where you would like to know the actual output level. By reading out the corresponding values you receive (with the earlier described time delay of (max.)100ms), the actual real output level. This is valid for all outputs that can be remotely controlled by the commentator with his faders.

For the visualization of the level indicators on a TFT display a small intermediate step was necessary. The Spider 44, which records the status information, converts the values of the output signals into a serial data stream which can then be sent to a PC via RS232 interface. The PC itself is responsible for a graphical display of this information, which was received from the serial interface, showing the actual output levels. For this purpose a standard Windows PC is used. For the input levels, the whole approach is much easier, as the digital ITEC Multimix is accessed directly and a graphical display of the input levels is already part of the operating software of the mixer system. A side note here is: the trickiest part when realizing the level indicators was to prevent the Windows operating system from sending out notes or error messages to the monitor display

at any inappropriate point in time.

### **Press conference Room**

The press conference room accommodates approximately 50 to 60 journalists. In front of the room you find a small pedestal, where 6 people can take a seat (typically the driver plus one person from the particular team). In the rear there is a heightened area, which offers the TV cameras to directly record all events overhead the attendees at the podium. In order to provide the live sound from the press conference to broadcasting services and TV corporations, a portable press box is used, which supplies the sum signal of the PA system to 24 line outputs.

Per output, the signal is available to XLR, and 3.5mm jack plugs, allowing the connection of most of the portable recorders as well as of audio inputs of cameras. In parallel a low signal is brought in to a speaker box located on the ground, allowing the use of voice recorders, which are equipped with a built-in microphone and having no line-in connection. For live broadcast of public-addresses, the room is equipped with 4 Powerline-2 speaker systems, which are installed at the side walls. Local broadcasting is carried out by a mobile mixer system which is linked to signal sources and signal drains in the hall, and further to the ITEC\*NET by a signal divider on the ground. The reason for using this mobile solution was that there is no control cubicle, and the room itself is not always used for one-way meetings. 6 microphones on the pedestal use the automated microphone mixer of the ITEC Multimix. This mobile feeding rack with an integrated mixer also allows operation of a press conference in manual mode.

Mobile media rack in the press conference room (on the left), View of the press conference room with installed "Powerline" speaker systems (on the right)



## **The history of development of „ITEC\*NET“**

*A visit to the F1 circuit in Abu Dhabi offered the possibility to talk with the responsible project leaders about the installation at Yas Marina Circuit, which formed the basis for the technical documentation. In a discussion with Romano Hammer, CEO of ITEC, naturally the question was raised, why a medium sized manufacturer of PA systems came up with the idea to develop it's own network compatible audio system, like ITEC\*NET. The response of Romano Hammer is summarized here:*

About 3 years ago, in November 2006, we began to put our idea into practice to develop a network based audio system, which is able to transmit digital audio data / standard data in real-time via an existing local area network (LAN). After an intensive concept phase and the evaluation of different, already existing systems in the market (CobraNet/Ethersound/MaGiC/Livewire), we made the decision to develop our own proprietary system, which combines the advantages of different solutions plus provided additional features, which allow the controlling and monitoring of each single network node via Ethernet.

In 2007 the first concept of IEEE P1722 was published by an IEEE task force, targeting transmittal of time critical data like audio or video information via bridged LANs at the layer 2 (according the ISO/OSI model). Our hope at that time was that based on the work of this task force a new standard would be developed. As a result, our ITEC\*NET transmission protocol followed this P1722 concept closely in the beginning. Due to the fact that the progress of our internal developments moved significantly faster than efforts by IEEE to develop a stan-

dard, we were forced to implement all desired features on our own in due course. Meanwhile, efforts were taken to develop a new IEEE802.1 standard which is derived from P1722; the naming convention to be used is 802.1 BA (Audio Video Bridging).

The first version (Draft 0.0) was published in September 2009, but it might take a while before this approach will lead to a worldwide established and valid standard.

Based on Switched Fast-Ethernet (100MBit/s) it is now possible to adapt within ITEC\*NET the audio quality (latency period, sampling frequency and data word length) according to customer requirements and specifications. This offers the possibility to transmit up to 90 uncompressed audio channels (latency period of 2.6ms, 16 bit resolution at a sampling rate of 48kHz), or for example, to transmit 30 audio channels (latency period of 0.6ms, 32 bit resolution at a sampling rate of 96kHz). Each of the up to 4096 network nodes can reproduce each available channel within the network, mix it if required, or modify it by using specific audio filter elements. The corresponding configuration software NETDESIGN allows carrying out all manipulations at the system in real time.

ITEC\*NET is ready to use – it is an extremely powerful and reliable audio distribution and control system, which is already used within safety related PA systems according to EN60849.

At present, all efforts are being taken to have ITEC\*NET certified according to EN54-16, in order to offer our customer certified products for the installation of safety related PA systems according to DIN 833-4 (in Austria: TRVBS 158), in near future, This is on schedule to be concluded before the end of the transition period.



View of the large process conference room within the "Media-Center" equipped with 3 large "Barco" projector systems – the sound is provided by ITEC ceiling speaker systems



Involved project partners at Abu Dhabi, holding a discussion (from left to the right): Romano Hammer (CEO "ITEC"), Günter Hiss (CEO "PKE"), Gernot Fröstl (Managing Director PKE Gulf)

## Summary

The Yas Marina Circuit – the new F1 racing circuit in Abu Dhabi is from nearly every perspective a project of superlatives: This holds for both the audio network and the public address system. Such a widely distributed audio network like the installed ITEC\*NET can only be found (heard), in amusement parks. The implementation of ITEC\*NET internal system functions to cope with requirements for a public address security system including monitor and control functions across locations are not a matter of course for an audio networks. During the installation in Abu Dhabi not only safety aspects were taken into consideration but also an exceptionally powerful public address system for a F1 circuit was realized for the grandstands, meeting music and common speech requirements. The Austrian manufacturer ITEC shows with this installation not only an impressive project on an international level and at the highest stage, but offers with ITEC\*NET a network-compatible audio system, that beyond the Abu Dhabi project will become a benchmark for existing players in the market.

## ITEC\*NET Basics

The desire to develop a reliable audio distribution system, which also incorporates safety features and which is in particular flexible to use (ruling out by default a traditional point to point wiring concept), emerged from the experiences of installations on the F1 circuits in Bahrain and Istanbul. Consequently the decision was made within ITEC, to develop a new, purely digital based, network capable audio system. The commonly used Ethernet offered an ideal basis for such a system, as high quality, inexpensive network cables and network hardware are readily available. In addition, there are many existing companies familiar with the installation of the necessary hardware.

The bandwidth of the standard 100Mbit-Fast Ethernet is sufficient to transmit about 60 audio channels in CD quality and offers sufficient reserve capacity to transmit control and status messages as well, which is required within the alerting technique. ITEC\*NET is designed as a distributed peripheral system. Therefore no central control unit exists which could break down and which could be a Single Point of Failure. A break down of one component (Spider44 or Spidermike2), by no means influences the performance of other network components. Furthermore, one network component can replace the other, and even then, when it is located areal in a very different position (in case of damage within a safety distance).

Temporary power cuts, interrupts of cables, etc., cannot cause the break-down of the overall system. The reboot time of one component after a maintenance action respectively after powering up is less than 5s.

## Ethernet as the basis

Ethernet has previously been seen as unsuitable for audio distribution, as it does not offer a deterministic transmission behavior by default. Hence, Ethernet can guarantee neither an isochromatic transmission of more channel audio data, nor a transmission which is low in latency. But with today's technology and the usage of network switches, this topic has become obsolete: A switch provides a point-to-point connection and ensures that no collision can occur. Even when using ITEC\*NET, a kind of system clock (master clock) exists, which is generated from an automatic selected network participant and which can be used for the timely organization of audio, status, control information and other network traffic, in order to maintain the network for the data transfer. Within ITEC\*NET for example, system data

are permanently exchanged, allowing the execution of measurement and control tasks as well as the monitoring and the configuration of the system via the network (for further information see example in the technical project report). The implication for the planner is, that between ITEC\*NET system components only the network connections have to be established to ensure a complete data exchange.

The channel capacity of a 100Mbit/s Fast Ethernet offers the possibility at a network utilization of less than 75% to transmit up to 64 audio channels in sound studio quality (24Bit/48kHz, higher resolutions are adjustable), at a latency period of only 1.3ms via ITEC\*NET.

ITEC\*NET is also capable of being used within major installations. Up to 4000 components (Spider 44, Spidermike2, Windows based PCs for configuration, router for remote access and maintenance) can be linked together within one system.

The main hardware components within ITEC\*NET are the universal I/O module, Spider 44, and the Spidermike2 call station device. Both are designed on the same hardware platform using a Digital Sound Processor (DSP) from the manufacturer Analog Devices.

The Spider 44 is delivered in a 19"/ 1HU construction, each equipped with 4 analog input/outputs and an Ethernet network connection providing a link to ITEC\*NET. Further capabilities of connecting additional components are: 2 serial interfaces (RS-232 and RS-485) for control tasks, 8 analogue measurement inputs, 8 digital inputs, 8 digital outputs, optional plug-in card for speaker monitoring (four way system), and optional flash memory for the digital storage of audio files. A front side monitor is used for the display of messages, program selection and volume control. A digital encoder / push button allows controlling the Spider44 in configured mode directly. On the front side in addition to that you can find an infrared receiver diode for managing the device via infrared remote control (e.g.: Program selection, volume control).

The Spidermike2 looks like a simple call station device, but is equipped with the same characteristics as the Spider44, as it has been designed using the same DSP platform. Only the interface instrumentation is slightly different: It includes a pluggable swan neck microphone, a second microphone/line input, 19 free configurable soft keys and a double spaced message monitor for the display of text and error messages. A built-in speaker system can be used for intercom functions, for example.