KENWOOD

NEXEDGE®
KENWOOD DIGITAL SYSTEMS

Case Study

Tokyo Broadcasting System Television, Inc.

TBS

Interviewees:

Katsuyuki Katoh
Information System Technology Division
Tokyo Broadcasting System Television, Inc

Hajime Shishido
General Coordinator
Division of TV Technology
Tokyo Broadcasting System Television, Inc.

One of Japan's five major TV broadcasters, TBS (JORX-DTV) – officially known as Tokyo Broadcasting System Television Inc. – is designated as a key terrestrial broadcaster serving the greater Kanto region. On April 1, 1955, it became the second commercial TV station in Japan to start operations, affiliated with the Japan News Network (JNN). Today's TBS is one of the three consolidated companies established when Tokyo Broadcasting System Inc. was split up in March 2000. April 2015 marked the 60th anniversary of the start of TBS TV.

Tokyo Broadcasting System Television Inc.

5-3-6 Akasaka, Minato-ku, Tokyo 107-8006

URL: www.tbs.co.jp/eng/
www.tbs.co.jp/eng/corporatedata/index.html/ (Corporate Data)

While looking for the optimum system for digitizing TBS's VHF wireless communications, the broadcaster came across NEXEDGE and 4-level frequency-shift keying (FSK). Before long this led to collaboration between TBS and JVCKENWOOD, a company which has extensive experience of 4-level FSK modulation. They even lobbied the government to act and set up new ARIB standards. And then, marking a first for Japan, TBS launched a new VHF wireless communications system compliant with the ARIB STD-B54 standard. And playing a key role at the heart of this system are JVCKENWOOD products.

With the upcoming transition to VHF frequencies for wireless communications and the shift to narrowband operations, all Japan's broadcasters were considering the adoption of a new analog-based scheme. However, while undergoing the transition a number of issues arose. So to clear these issues, the search began for an alternative system...

TV broadcasters make use of wireless and wired links to deliver programming to the public; less known is the fact that they employ professional VHF/UHF radios to provide a communications network linking studios and teams working in the field. You might think that, with today's widespread use of cell phones, smartphones, etc., these mobile devices would be fine for keeping staff in contact, and indeed that did seem to be the trend at one point. However, cell phones do not provide coverage everywhere on land – or in the air either, as their use is banned when flying in a helicopter. So in practice there are many places where cell phones can neither make nor receive calls. Moreover, in emergencies such as natural disasters, professional radios can continue to function using their own communications links, while cell phone networks may well be out of action. And when a crew is filming in a potentially dangerous situation, these radios enable important instructions to be received by several people simultaneously and promptly. In short, radios offer several advantages not available from cell phones. As a result they represent one type of equipment that TV stations find indispensable for their field operations.

This case study focuses on how a broadcaster looking to adopt digital VHF wireless communications for its staff went ahead and created digital VHF radio standards for TV stations that have been adopted by the Association of Radio Industries and Businesses (ARIB) and the radio communications industry. TBS went on to digitize its own communications network, paving the way for other broadcasters to follow. It is a long story, stretching over 8 years, during which time both software and systems were developed, based on NEXEDGE hardware and a system controller supplied by Zetron, a member of the JVCKENWOOD Group.

The story begins back in 1998. Japanese TV stations had for a long time been using FM analog (both VHF and UHF bands) wireless for staff communications. But then in 1998 came a directive from Japan's MIC* to the effect that, in order to make more efficient use of frequencies, these companies should shift from 150MHz to 160MHz and also to narrowband operations. The deadline was initially 2014, which was later extended to 2016. And so it was that, at the turn of the century, Japan's broadcasters began reviewing suitable modulation schemes.

*Ministry of Internal Affairs and Communications

How 4-level FSK came to be used for ENG communications

In 2001 a revision was made to the screening criteria related to Japan's Radio Law. It was decided that a new analog-based scheme that excels in terms of low latency and high audio quality would be adopted for VHF wireless communications used by TV station staff; this transition was to be completed by May 31, 2014. Furthermore, in 2004 the ARIB TR-B21 standard, based on the new scheme, was published, and started on actually developing and testing transceivers with the new scheme in 2008. But it soon emerged that there were problems posed by this system, including interference, unstable connections, and poor security (the threat of others overhearing a conservation). Looking back, Katsuyuki Katoh emphasizes how serious these issues were: "From our perspective as broadcasters, these radios are integral to everyday operations – making programs, filming events, etc. But we also think of them as a lifeline, a way of contacting staff in a potentially dangerous situation. If we can't be sure of getting that all-important message to them – Danger! Get out! – then we can't entrust people's lives to such an unreliable system. Also, if the new analog-based scheme had been adopted, the coverage we could have expected may well have been smaller than that provided by our FM analog radios. But above all, one can't compromise when it comes to equipment on which our own lives will depend. So we dropped the original analog-based idea, and we all put our heads together to come up with an alternative solution. And one candidate that came to our attention was a new digital scheme, 4FSK*."

Test station

JVCKENWOOD was picked as it was already selling 4-level FSK radios under the NEXEDGE brand. In 2008 a 4-level FSK test station was set up jointly by several Japanese broadcasters, including TBS, and testing began using JVCKENWOOD equipment. At that time there were 3 criteria for an in-house VHF wireless system: (1) Over-the-air confidentiality and (2) minimal latency for voice; plus (3) music transmission. What happened was that 4-level FSK NEXEDGE products being sold by JVCKENWOOD in Europe and the US were brought to Japan, where engineers adapted them for testing purposes as well as modifying them so as to meet the above criteria for use by Japan's TV stations. In the end they proved capable of satisfying all but the third criterion (music). Finally, in 2010 the decision was made to use 4-level FSK modulation. In that same year, another revision was made to the Radio Law screening criteria and 4-level FSK was added as one of the standards.

ARIB STD-T102 & ARIB STD-B54

For use by broadcasters in Japan, products specified for overseas markets had to be thoroughly customized. In March 2011 the broadcasters and JVCKENWOOD published ARIB STD-T102: "Narrowband digital communications scheme (SCPC/4-level FSK)"; then in September of the same year, ARIB STD-B54 was published, which defined additional features such as user ID, GPS and SMS.

Advantages & disadvantages of 4-level FSK

Since 4-level FSK has both strengths and weaknesses, we asked Katsuyuki Katoh and Hajime Shishido for their opinions.

"This scheme uses an encoder that is dedicated for voice applications; it processes only human voices," explained Katoh. "Now, there's this thing called speaker recognition. Some voices are easy to demodulate and others not so. And it's a fact that with 4FSK speaker recognition is problematic. But when you have the sort of deafening noise made by a helicopter from which ENG staff are transmitting, conventional FM analog radios make everything sound garbled. It was no easy matter to make out what someone was saying at such times. But with 4FSK the noise vanishes like magic because only human voices are demodulated. No longer do we have to shout into the microphone or turn up the volume on the receiver. As far as being able to clearly understand what is being said, these radios are very easy to use."

"Since it's a vocoder," added Shishido, "it's a little tricky to listen to at first. You can't recognize who is speaking, which is a drawback. But once you get used it, it's okay. Also, it's quite unlike FM analog radios where poor S/N can make it difficult to hear the other party, or everything is swamped by noise. There's none of that. It's great to be able to hear someone's voice coming across loud and clear. As for drawbacks, well it's fine for person-to-person communications but since it can't handle music that is somewhat of a disadvantage. So now, when we need to transmit music, we use UHF FM analog radios."

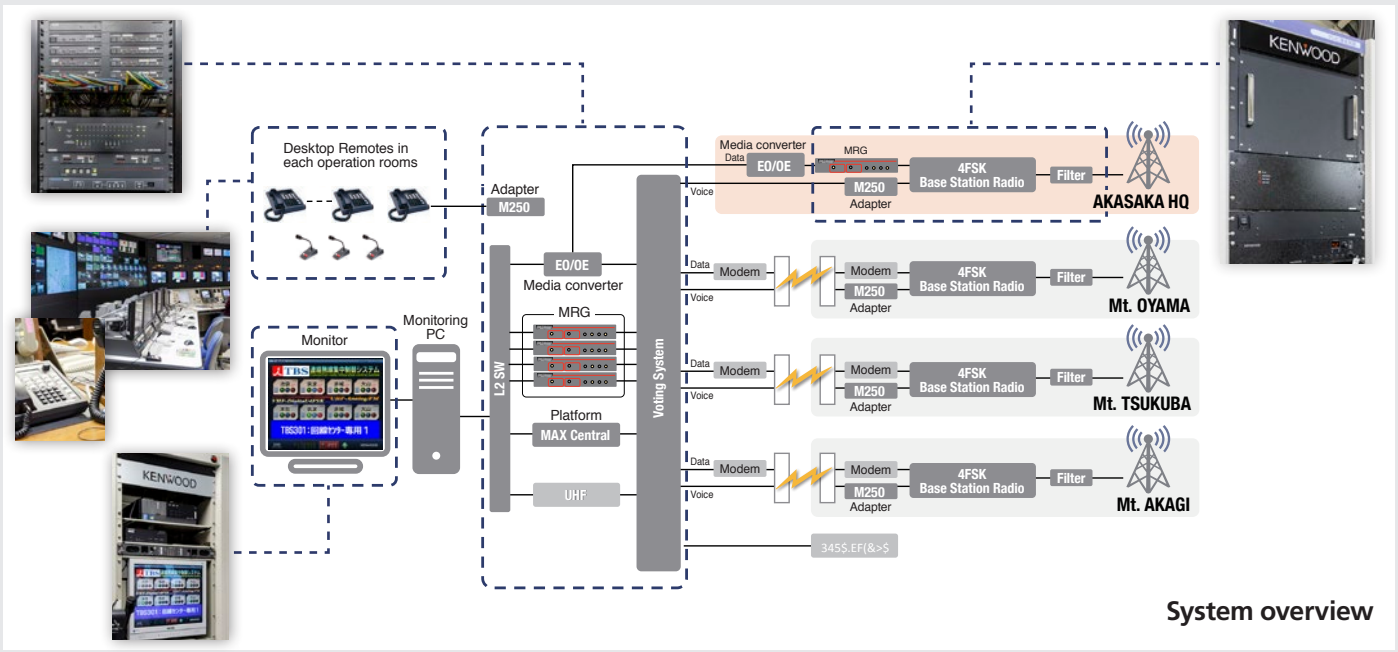
Although there had been initial concerns about the latency of these digital radios, following repeated adjustments this was brought down to about 0.1sec. Other enhancements resulted in reduced susceptibility to interference and a coverage area almost identical to that of analog radios, ensuring that 4-level FSK could offer the performance needed for vital staff communications. In March 2013 ARIB STD-B54 was updated to version 2.0, including many additional features.

Building TBS's own system & developing new features

In 2011, TBS decided to adopt 4-level FSK as the next-generation VHF standard scheme for staff communications for JNN affiliate stations. And, paving the way for its competitors, TBS became the first station in Japan to introduce a VHF digital wireless system compliant with ARIB STD-B54, starting operations with a slew of new features.

Let's now have a look at Japan's first VHF digital wireless system for field communications.

*The official name is 4-level FSK, but broadcasters refer to it as 4FSK.



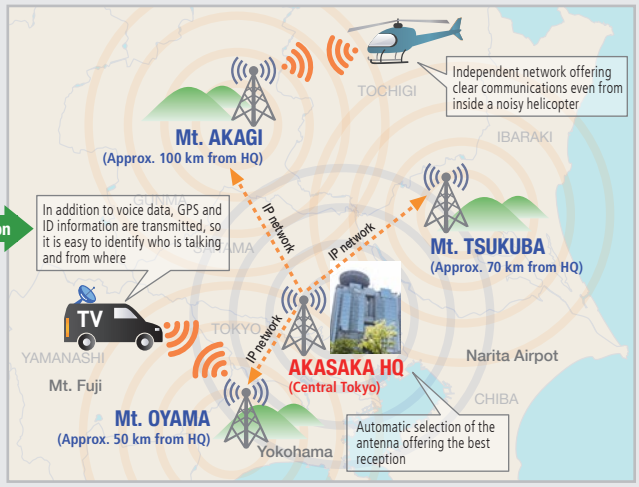
System overview

TBS operates VHF base stations at four locations: in addition to the one at the Head Office in Akasaka (Tokyo), there are three sited on mountains in the Kanto region – Mt. Oyama, Mt. Tsukuba, and Mt. Akagi. Atop the Biz Tower and the Akasaka HQ are four tall masts in total; mounted on three of these are microwave parabola antennas pointed at Mt. Oyama, Mt. Tsukuba, and Mt. Akagi, respectively. The remaining mast supports the antenna for the Akasaka base station. The overall arrangement is as shown in the diagram. The line center and studios are equipped with the remote consoles and desktop remotes made by Zetron. It is from this command center that instructions are issued to helicopters, ENG vehicles and location crews. Once a call starts a remote tone signal is sent to the voting system located in the line center, and the data is transferred via IP link to the base station automatically selected by the KTI-5BC line-switcher (introduced on the next page) on the basis of offering the best connection for the current conditions. The data received by the base station is demodulated from the IP line and sent to a 4-level FSK transceiver connected to the on-site crew – in an ENG vehicle, helicopter, etc. As regards the antenna for the Akasaka HQ base station, because of the proximity of other buildings on the site, instead of IP links fiber-optic connections are used.

One of the advantages of digital communications is that data can be transmitted simultaneously with voice, so the system provides such features as the transmitter's ID, GPS data, and short messages. Not only does this enable one to check such vital information as who is where and who is speaking, but by making use of short messages it is possible to send script updates to a reporter in a helicopter or a phone number to a location crew – in other words, information that has to be conveyed with 100% accuracy. These features are just a few of those offered by NEXEDGE and which have also been included in the ARIB STD-B54 standard.

Distances:

Tokyo — Mt. Akagi (in Gumma Pref.):	**Approx. 100 km**
Tokyo — Mt. Tsukuba (in Ibaraki Pref.):	**Approx. 70 km**
Tokyo — Mt. Oyama (in Kanagawa Pref.):	**Approx. 50 km**



Kanto region coverage with links to Akagi, Tsukuba and Oyama mountains

Two of the 4 roof-mounted antenna masts

ENG vehicle equipped with 4-level FSK digital transceiver

KTI-5BC Base station line-switcher

This KTI-5BC base station line-switcher was installed to ensure efficient use of limited frequency bands and at the same time realize stable communications over a wide area. Linking controlling and controlled devices, it instantly decides which base station offers the best reception conditions. But there is more: because it automatically selects lines, even if signal conditions deteriorate to interrupt voice communications, the interruptions are timed so that the line with the best connection can be chosen. In addition, making use of a variety of information – such as user ID, GPS positional data and messages – it is possible to obtain the most suitable lines.

MAX Dispatch central control system for wireless communications

The line-switching control software is installed on this server, which plays the role of communications portal for each base station and is operated via a monitoring & control PC (main PC). A display is connected to the system, as illustrated here, and this enables the operator to monitor its status. When communicating with a mobile station, the station's name is displayed (in blue).

Transmitting station's ID displayed on screen

Network gateway

This gateway device serves to connect radios over LAN, converting audio data and control data to IP packets. It comes between the central network control system and the line-switcher, enabling and managing two-way data transfers between radios. Here Zetron's Max Radio Gateway has been adopted.

Network gateway bristling with LAN cables (VHF on left, UHF on right)

The screen of the central network control system together with a control monitor installed in the line center

TCN-371 Multifunctional control unit

As well as displaying the transmitter's ID, this unit performs radio handset operations for voice communications. Displayed are the call sign and user information details, so it is clear at a glance who the other party is in a conversation.

The TCN-371 that is set with a mic shows at-a-glance display of the other party's terminal and user name.

T4FSK-100 Interface box

The interface box (seen at the bottom in this photograph) is essential for carrying out the sort of processing that cannot be performed by software alone.

Rack featuring a Prosper interface box and base station line-switching device

Web-based viewer for VHF ancillary information

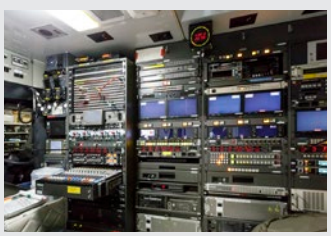
Employing the standard browsers used on PCs and mobile devices running Android™, iOS™, etc., together with Google Maps™, this system enables one to check in real time the information associated with a VHF connection – for example, transmitter's ID/info and GPS positional data. For a selected area on the map, one can perform a search based on past activity records. And since it is Web-based, it can be used from any location as long one has a computer or mobile device with a connection to the Internet. When GPS positional data is available, one can see the point on the map it refers to; a search using that data will result in the actual address being displayed at the bottom of the map.

Red and blue flags indicate ancillary information, while the result of a search for the location's address is displayed at the bottom of the screen

FPU Antenna auto-rotating system

In order to automatically and accurately rotate a receiving antenna in the direction of the transmitter, the necessary GPS data is sent to the Akasaka HQ from the TX head by VHF wireless link. This enables the existing FPU antenna auto-rotating system to track an ENG vehicle on the move.

Display of the automatic antenna-rotating system using GPS data



Interior of an ENG vehicle equipped with 4-level FSK transceiver

Comprehensive control system with unique features

"One reason why we adopted JVCKENWOOD's system was their solid track record with 4-level FSK overseas. But in addition to that, we were drawn by the original features offered by NEXEDGE products," explained Katoh.
In addition to the superiority of 4-level FSK as a modulation scheme, the unique features of NEXEDGE products were a perfect for TV station requirements, offering performance that is very difficult to duplicate with conventional analog technology. And providing comprehensive management of these functions is this control system. It handles four important tasks: (1) transmitting short messages; (2) retrieving and displaying GPS data from mobile stations; (3) listing the status of communications links between base stations and mobile stations; and (4) sending remote stun/revive/kill signals to designated radios.

(1) Transmitting short messages: As explained above, it is not only voice data that can be sent to a designated mobile radio; text messages of up to 100 characters (or 50 double-byte characters) can also be transmitted. And the person on the receiving end can easily respond with one tap on a preset message.

(2) Retrieving and displaying GPS data from mobile stations: There are basically two modes. With "Regular positioning mode", when GPS data is received from a mobile radio, that location is indicated on a map. It is also possible to display the location's address and the transmitter's ID. This mode is also used for the Web-based viewer for VHF ancillary information. With "Radio search & display mode", a command is sent to the mobile station to trigger the automatic transmission of GPS data. Thus one can check whether a specific radio is stationary or in transit. There are three available patterns for this trigger signal: single, multiple and continuous. In the third case, the mobile station continuously transmits its position until a stop command is received from the base station.

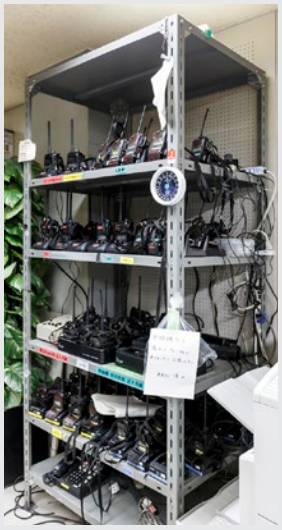
(3) Listing the status of communications links between base stations and mobile stations: This examines whether communications are possible between designated base and mobile stations, listing the color-coded results on the monitor alongside the respective call signs: green for OK, red for NG, and orange for pending (as each link is examined in turn).

(4) Inhibiting the operation of mobile radios: If a mobile radio should be lost, stolen, or subject to malicious jamming, etc., it can be remotely inhibited (stunned) and later revived. In an extreme case, a radio can be "killed," or made permanently inoperable; it would need to be returned to the factory for repairs to be ever used again. Security is paramount and to ensure that only those in positions of responsibility have access to these functions, 3 different passwords are required for stunning, reviving and killing radios. The kill function in particular needs to be entrusted to only a small number of people because of the serious consequences.

"There is no doubt that these security features provide a sense of reassurance for those managing the system," added Katoh, who went on to stress a user-friendly aspect of the system. "Nationwide JNN has more than twenty stations, and they are not each allotted different frequencies. In fact there are only four. This means that to provide nationwide coverage in Japan JNN has to be very careful with how it uses those four frequencies. To avoid interference each station is assigned a frequency/code combination, and all that's required for setup is selection of a zone number, which refers to the area of Japan where the radios are to be used. It's so simple that anybody can do it. ENG staff on location can start using their radios immediately. So I can safely say that we have arrived at a system that is extremely easy to use."

JVCKENWOOD models also used for analog UHF

The network gateway in this system actually includes UHF wireless communication system. Regarding how VHF and UHF are used, it was explained that at present UHF is mainly employed for local applications, such as communications between members of the same ENG team on location, while VHF is reserved for other applications. In other words, VHF and UHF are integrated into the same dispatch system and they both have a role to play. For risk management purposes, the UHF base station is situated on an upper floor of a high-rise building in Ikebukuro, 7 kilometers away from Akasaka. The station is equipped with NEXEDGE NXR-810 repeaters.



A rack where VHF and UHF as well as FM analog radios are stored.

Future outlook

In addition to Katsuyuki Katoh and Hajime Shishido who were interviewed for this article, many other people have been involved in the lengthy development of this 4-level FSK system. They explained that the first phase of this long-term project is now almost complete: the new system has succeeded in becoming invaluable to location staff involved in ENG production for TBS. It was clear from what they said that it is already playing a key role as a communications network for daily operations, capable of serving as a lifeline in emergencies. However, as regards the full potential of digital radios like NEXEDGE, it may be said that we have only just scratched the surface. We feel sure such technology will prove itself to be a much more valuable asset as a result of further development on the leading edge of ENG.

KENWOOD

JVCKENWOOD Corporation

1-16-2 Hakusan, Midori-ku,
Yokohama-shi, Kanagawa,
226-8525, Japan

T: +81-45-939-7362
F: +81-45-939-7364