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Mobile Interoperability

About the need to stay in touch everywhere and anywhere, not only across our 'own' Networks, but also across 'other' Networks and system protocols, and, in particular, into areas like buildings an basements, where our prime systems do not offer coverage.

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Interoperability – what does it actually mean?

It may pay off to start this story with a brief analysis of what exactly is meant by the word 'Interoperability'. As is often the case, the same word can have quite different meanings to different people, and the word Interoperability is no exception. In fact, in geographical areas outside of the USA (like for instance, Australia) one might well get a 'Whats That???' response when the subject is raised.

We probably all agree that Interoperability (context: radio based systems) refers to the need for fleet compatibility across a range of different parameters. Whilst Interoperability is barely if at all applicable to Public Telephony systems, due to an almost prefect degree of compatibility extending into all corners of the world, the same can certainly not be said about our private radio communication systems. There is a bewildering array of variables: we operate in many different frequency bands, from the low 40 to 60 MHz range all the way up to the 800/900 MHz area. Most radio manufacturers adequately cover this wide range of spectrum but unfortunately, with a number of hardware versions (the era of one single, cost effective and practical radio covering most or all of these bands is rather utopian at this stage, and possibly, forever so). Then there are the different channel spacings that we use to cover these frequencies, extending the already large number of variations even further (most modern radios are now capable of covering various channel spacings by programming, but the fact remains that the systems they operate into are only marginally compatible at best).

Furthermore, as if this was not enough (and possibly, worst of all), we have a vast array of radio protocols and signalling systems, which in fact, make the RF diversity referred to above pale into insignificance, if the number of variations is used as a reference. We have myriads of different tone signalling systems, from humble sub audible based systems right through to complex high speed digital systems, most of which are (of course, one might cynically say…) completely incompatible.

Finally, and last but not least, we have our high level Trunking protocols, perhaps not in as many variations as our 'home grown' signalling protocols referred to above, but yet significant enough to have an enormous impact on Interoperability. Of these protocols some of the most significant ones (in terms of market penetration) are of course, Motorola's SmartZone system, the European originated MPT1327 system standard (which has started to impact also the North American market), the still going strong LTR standard, and the more recently introduced new digital TETRA system.

Now if at least, there would be some degree of standardisation in the adoption of the various standards for specific geographical areas, much would have been gained. However, a generally prevailing "Dare to be Different!" attitude has resulted in completely incompatible system standards area adopted by different government agencies, that often cover the same geographical areas.

The phenomenon of various Public Safety, Security and Emergency agencies operating in semi-isolation of each other has perhaps historically been an acceptable and workable proposition but, the 9/11 events have changed this perception forever, and Interoperability has

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become essential to any communication networks that are, or may be, deployed in any Mission Critical operations. So let us analyse the impact of this new requirement on our Private Radio Communication systems and networks a bit further.

Compatibility across the Frequency Spectrum – Mobile Solutions

Essentially, there is only one answer to solve RF spectrum incompatibility problems: use multiple radios, one for each new service or frequency band. To avoid the clumsiness of such an installation if this principle were followed to the letter, especially in vehicular applications, mobile manufacturers now offer various singular user interface options, to eliminate the otherwise daunting prospect of multiple microphones, speakers, volume controls and the like, to access the various services.

Figure 1 depicts a typical diagram of such a solution. It effectively resolves any immediate RF incompatibilities but, the option may not be cost effective, especially not if there are multiple RF variants involved. If radios operating with different signalling protocols are to be used, the solution would need to address protocol incompatibilities as well. However, in actual practice this more often than not requires different radio makes as well, which adds further to complexity and cost.

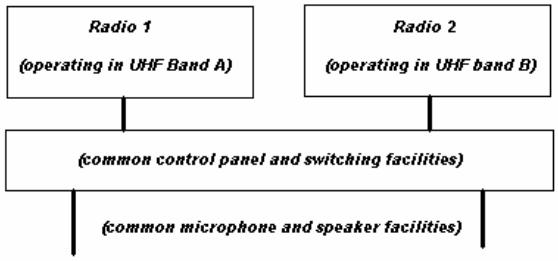

Figure 1. Block Diagram of a Dual Band mobile radio, an effective way of achieving Interoperability across the various parts of the RF spectrum. A Crossband repeater mode may be provided as well.

Compatibility across the Frequency Spectrum – Centralised Solutions

An alternative option to overcome RF incompatibilities of various mobile fleets is to install multiple radios at a centralised radio control room. This option automatically addresses protocol incompatibilities as well, as there is no need for the various radios to be functionally identical. The problem of multiple controls is less acute or even non existent, as often, a number of operators are required anyway to control the various operations. Moreover, specialist radio control console manufacturers offers a range of solutions to address this requirement.

These systems also allow for direct mobile to mobile communications, regardless of frequency bands and system protocols, as control room operators are able to patch the various circuits together in any required configuration, either in a semi-permanent mode, or on demand, in which case cross connections across different system protocols can be readily accommodated as well.

If for whatever reasons a manned control center is not practical, services may be linked (interconnected) by fixed audio bridges, that buffer, split and combine the various audio input and output sources, to not only pass through audio signals, but also, enable cross linking of the various services. Such systems are easily configured and, with 'intelligent' bridges, they may even be controlled remotely as well, using appropriate signalling systems.

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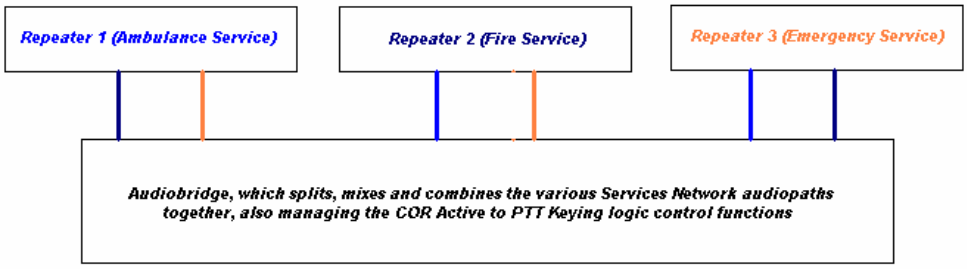

Figure 2. By using audiobridges various Services may be linked together, effectively achieving interoperability at (in this particular example) Repeater level, enabling mobile operators to access each other's Networks, without any changes to their own radios. In more sophisticated systems the switching functionality may be controlled remotely, using (for instance) DTMF signalling, so each system will return to their own, normal operation once interoperability is no longer required.

Protocol Converting Systems

When the various services to be combined and/or interconnected use different signalling protocols however, and, especially, if they use different trunking standards, the (additional) need for protocol conversion arises, particularly if the interconnect facility is unmanned. This is especially important for radio systems where users normally connect with other users by 'dialling' the required party they wish to talk to. The requirement may apply to conventional systems that use various signalling standards such as DTMF or 5-Tone Selcall to reach other users, but becomes especially essential for Message Trunked systems such as the MPT1327 system standard. In theory, services can be provided by manned control centers that manually patch calls through but this is obviously not a practical proposition in most cases.

Smartbridge® ® is the name of a family of equipment which takes full care of network interconnection, not only across frequency bands, but also, through full protocol conversion. For instance, it can interconnect an MPT1327 system to a SmartZone system, or it can link a stand alone SmartZone system to another SmartZone system, and of course, it can interconnect a Conventional radio network to Trunked networks, without requiring any central operator intervention. As such, a Smartbridge® system combines most of the capabilities of the solutions reviewed above into the one single system element.

A Smartbridge® solution typically comprises two standard radios, the two 'Network Gateway' radios. One radio links to the one network (for instance, a SmartZone system), the second radio connects the second network (for instance, a Conventional system, or a central console, or any other type of audio port that the application may present it with).

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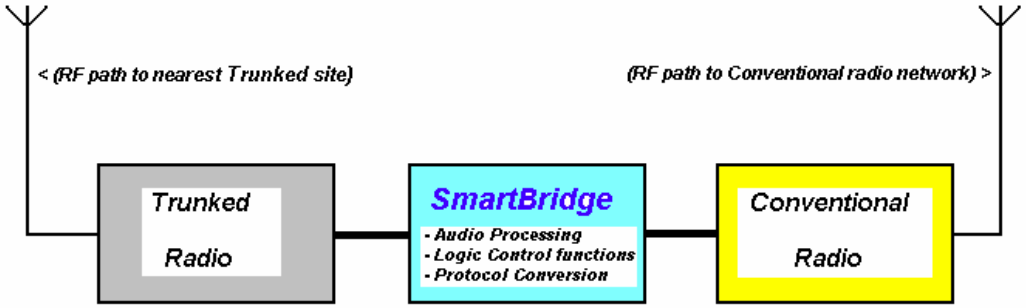

Figure 3. Simplified Block Diagram of a SmartBridge system, showing an application where a Trunked radio network is linked to a Conventional radio network. The system makes both networks fully transparent to each other, even if they use totally different signalling and call control methods

Mobile Interoperability

For very good reasons, most mission critical systems used today use some form of trunking technology. And most of these systems are Wide Area networks, covering large geographical areas, usually spread around one or more Metropolitan areas, which are normally particularly well covered, both in terms of available channel capacity, as well as in terms of RF coverage. There might perhaps be a few weak spots here and there in the Network's metro areas but, mobile coverage is normally well catered for. However, for both practical and cost reasons, the same can rarely be claimed for mobile (hand held) applications, especially in structures like tunnels, inside buildings (most modern city buildings are electrically speaking pretty perfect Faraday cages), underground car parks, and so on.

And here we touch on a vital requirement for Mission Critical operations. Whilst we have all learned to live with (and accept!), the universal problem of inadequate portable coverage in the past, this can no longer be accepted for today's safety and security operations. ***The officer on foot, which has left his vehicle to investigate a calamity, and taken his handheld radio with him, must stay in radio contact, for 2 vital reasons: his own personal safety, and the operational effectiveness of his Agency***. Mobile interoperability is rapidly becoming a vital requirement for almost any Mission Critical radio communication network.

In principle, the Smartbridge® principles referred to above can be readily extended to provide mobile interoperability but, more is needed to achieve an operationally viable outcome. To keep the system practical, the use of duplex (of TalkThrough) capable radios (complete with their antenna system complications) is generally out of the question so, radios must necessarily operate in simplex mode which in turn, leads to the need for VOX based transmitter switching control (more often than not in fact, for dual channel VOX control). This not only requires the best possible VOX technology (which would be almost certainly processor based), but also, should offer voice delay, to eliminate lost syllables (the 'I heard: 'Shoot' syndrome, whilst the message sent was actually 'Don't shoot').

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The system can be extended with operational enhancements like voice announcement and voice storage facilities, for instance, to convert specific Status messages originated by an MPT1327 based control centre into spoken commands that will reach an officer on foot far more effectively than an array of different tone coded audible messages. Enhancements such as Out of Range warning systems, Lone Worker, and Man Down facilities are often included as well, to further enhance the operational effectiveness of the system.

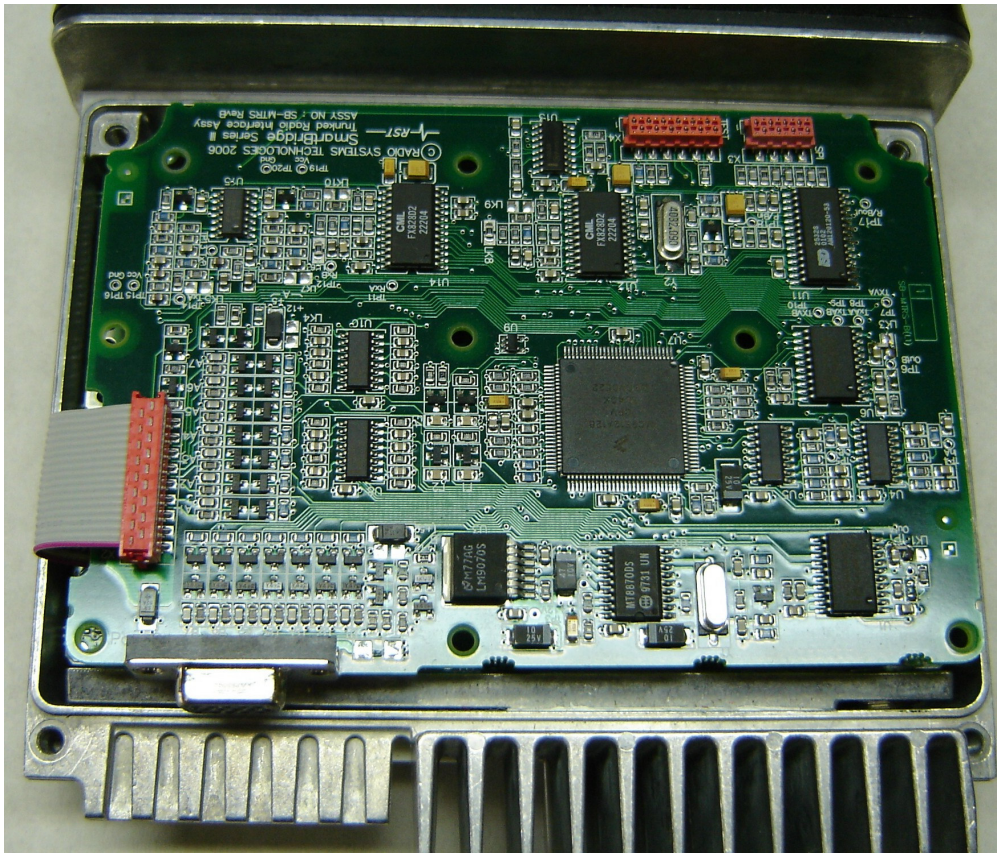

Figure 5, showing a photograph of a typical hardware implementation. The module is small enough to be fitted inside a standard radio. It has a range of on-board signalling facilities (CTCSS, DCS, DTMF, and 5-Tone) to successfully interface to the many different types of common conventional radio signalling systems. Voice storage, dual channel digital VOX operation with programmable voice delay, and 'Out of Range' warning systems are all available to maximize the prime functionality of the device: to ensure that the patrolling officer on foot stays in touch with his HQ control room, even when entering buildings and structures where his prime Network's coverage is unreliable or non existent.

Conclusion

The article has addressed only some of the aspects of Mobile Interoperability. No doubt ongoing developments will emerge that will further contribute to the operational effectiveness of Mission Critical radio communication system solutions.