White paper: the right way to bring MCx-over-LTE to control rooms

Choosing a server-to-server architecture will preserve vital control room functionality without impeding standardisation

As countries migrate to LTE-based critical communications, there is a risk that the specialised requirements of mission-critical control rooms—for example, affiliation and parallel group calls to support free seating and complex role management—will be overlooked by network providers. This will potentially jeopardise the operational flexibility that first-responder organisations need for life-saving activities. While the 3GPP standard for Mission Critical Services (including MCPTT) purports to support control room requirements, there is no definition of any specific control room interface. If providers of control room solutions are required to re-use standard User Equipment (UE) mobile client interfaces to mission-critical LTE networks, this will place unhelpful restrictions on functionality, performance and scalability.

Rather than creating a proprietary solution to overcome the deficiencies in the current approach, network providers should offer an application server interface—and this is already specified in the standard—alongside UE interfaces. Provided it offers a server-to-server rather than a server-to-client reference point, a standard interface is perfectly capable of meeting requirements in mission-critical control rooms.

Connecting control room solutions through an application server interface will enable a standards-first approach while preserving the unique functionality on which emergency operators depend. This is also necessary to ensure interworking between new technology (LTE) and legacy radio systems.

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Crucial functions for control rooms

The emergency services and services responsible for maintaining critical infrastructure are vital in any modern nation. To respond to incidents rapidly, effectively and efficiently, these services depend on flexible mission-critical communications to, from and within control room infrastructures. Since a typical incident will demand multiple actions from different responders, operators rarely work in isolation. Rather, they must be able to coordinate activities across dynamic virtual teams, taking advantage of features such as group-combine, multiselect, private call, priority override, affiliation, dynamic group patching, parallel group calls on multiple talk groups, and PTT request queuing. Features like these support free seating within the control room, as well as the sophisticated role management required to support flexible virtual teams.

As the UK, US and other countries push ahead with plans for migrating from trunked radio to LTE (or even 5G), network providers are naturally keen to sell them on the benefits of sophisticated new capabilities. However, in a world that is increasingly geared to the multimedia needs of consumer mobile subscribers, there is a clear risk that network providers will overlook the specific operational requirements of the much smaller population of control room operators. Specifically, the 3GPP standard for Mission Critical Services (MCx), which includes Mission Critical Push to Talk (MCPTT), Mission Critical Data (MCData) and Mission Critical Video (MCVideo), has not defined a specific interface for control rooms. The assumption seems to be that control room clients will be treated as standard mobile devices, putting some existing functionality at risk.

Before even considering future functionality such as video calls and advanced messaging, national bodies must ensure that the adoption path to LTE guarantees at least like-for-like replacement of existing audio and data functions used in mission-critical control rooms. For audio, the basic functions include group communication (both parallel and serial), private calls, emergency calls, patching and ambient listening, while those for data include text messages, DGNA, location information, user tracking and affiliation.

Learning from history

The standardisation of mission-critical communication on LTE networks will bring a number of important benefits to control rooms, including greater interoperability, increased functionality, access to new multimedia communication, and lower operational costs. However, the current lack of a control-room-specific interface means that some crucial existing functionality will not be available as standard. This could require some costly and inefficient workarounds using mixed legacy-LTE operations and dual-mode mobiles.

Historically, some network and middleware providers have taken the view that a control room console is a standard UE entity with the same functionality requirements as a radio mobile. This assumption is in fact highly limiting and costly, as seen during 18 years of Airwave (a UK-specific version of Motorola DIMETRA 5 and 6) deployment for emergency services in the UK. Specifically, treating control room consoles as standard UEs limits the number of groups that can be managed for events or that users can access and transmit on, creates unnecessary network traffic and does not allow

enterprise-level affiliation and throughput. It also limits the number of different user roles that can be selected, and the flexibility with which emergency activations can be handled across multiple positions. Over the years, control room suppliers and agencies have developed technical or operational work-arounds—for example "talk group pooling"—but these introduce additional complexity and cost.

We contend that emergency control rooms are much more than simply a collection of individual consoles, and that treating them as a loose grouping of mobiles will fail to deliver efficient implementations, let alone improve on the functionality of existing trunked radio solutions. Such an approach will also make control room implementations difficult, complex and costly.

The current definition of the MCx UE interface introduces limits on how many talk groups or combine groups can be transmitted on at the same time (one Tx stream per UE). By contrast, the use of a standardised server reference point would permit multiple media stream up- and down-links. And although PTT solutions may offer standards-based interfaces and implement standards-based capabilities, past experience suggests that there will be limitations and supplier-specific implementation nuances.

Control room requirements

Control room solutions are expected to handle much more than simply mission-critical "radio" communication between groups and individuals. They also provide functionality across incident management, CRM, call taking, mapping, recording and teamwork, and they are usually composed of elements from multiple solution providers. Control room solutions integrate multiple communication systems—ISDN or SIP/RTP based telephony, intra- and inter-site multi-channel communication (a.k.a. "Intercom"), web chat, trunked radio (P25, TETRA, Airwave) and more—and bring them to each user's working position. They also typically process audio and video at the backend, and perform patching between voice calls, talk group/individual calls and other services. In the near future, they will handle next-generation 999/112/911 calls—for example, video calls routed to a group video broadcast, conference calls with multiple parties including talk groups, and so on.

In addition, most control room solutions on the market include extensive role- and user-management functionality to reflect operational procedures: which users or roles are permitted to take certain actions, which users or roles have access to which talk groups, which users or roles have telephony and video call access rights, and so on. Especially valuable for large organisations, this functionality enables multi-site hot-desking at a national level.

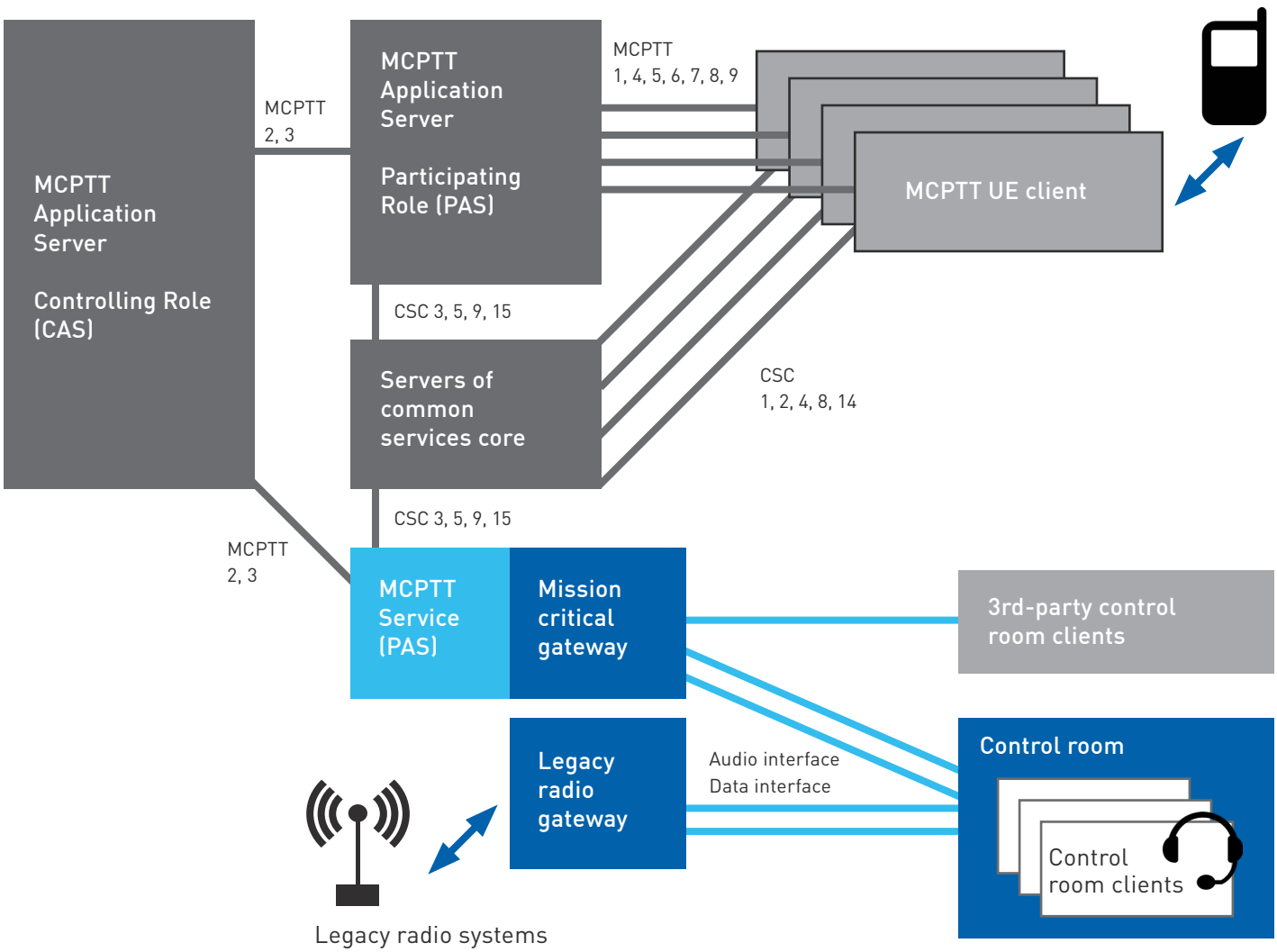
If vendors of control room solutions are required to use a limited UE-based interface for the coming LTE rollout, the result will be more complex—and therefore more costly—implementations that will restrict operational functionality and efficiency for agencies both now and in the future. To preserve existing functionality, some organisations are proposing to continue running legacy radio for MCPTT while switching to LTE for MCData—a potentially inefficient approach that will also require a very good architecture. Equally, vendors will need to implement vendor-specific interfaces which will not be usable for other MCx solutions, increasing development costs and potentially decreasing competition and choice in the market.

Proposed interfaces

Moving to LTE or 5G represents a major change that will require a good deal of thinking—particularly during the transition phase itself. Rather than investing in costly mobile devices that can work on both legacy and new networks but will then only use 50 percent of their functionality for the rest of their working life, organisations can choose a smarter approach. Using server-to-server reference points or gateways (one for legacy; one for the new mission-critical LTE traffic) will provide complete transparency to the control room without any loss of functionality. A solution with this server-to-server architecture will be able to support normal operations during the transition to LTE and beyond. Equally, organisations will be able to replace their mobiles step-by-step without any concerns about interoperability between different generations of mobiles, since it will be possible to patch them together regardless of their system of origin.

To address the transition challenge, some network providers are proposing solutions with mixed patching of LTE and trunked radio in the network. However, these solutions are essentially static: setting up patches is a non-real-time process, which can take weeks or even months to complete. This will force first-responder organisations to order potentially hundreds of unnecessary patches in advance just to be on the safe side. The demand on talk group resources and the complexity of the network will rocket as a result, potentially creating an unmanageable environment.

Figure 1: Proposed architecture for application plane of MCPTT service



Based on the current MCPTT-3 Application Server (AS) standards-based interface, it will be possible to implement all the required features for a control room interface. We contend that vendors of control room solutions should be permitted to connect directly to an application server in a controlling role, henceforth called a controlling application server (CAS). The control room solution would act like a standard Application Server in participating role (PAS) from the perspective of the CAS, but rather than connecting to standard UEs it would serve control room devices. As seen in the most recent ETSI Plugtests, the MCPTT-3 AS interface already provides the required affiliation functionality for control room applications.

It also makes sense on a technical level to use the AS-based (server-to-server) rather than the UE-based (server-to-client) approach—the former requires just two points of integration while the latter requires seven. By acting as a layer of abstraction between the CAS and the control room application, the proposed use of the CAS-PAS interface provides an efficient way to respect the 3GPP MCPTT-over-LTE standard without compromising existing functionality around affiliation and role-management. Vendors will naturally respect authentication and security standards when linking control room devices to the CAS, and control room solutions will sync with user credentials managed in the mission-critical network.

Table 1: Comparison of AS- and UE-based audio interfaces in 3GPP MCPTT-over-LTE

Function	Server-based	Client-based
Enables transmission on multiple talk groups from control room position?	Yes	No
Offers affiliation?	Yes	No
Number of MCPTT interfaces	Low	High
Complexity	Low	High
Cost of implementing cross-position control room functionality	Low	High
Network load on connection to MCx services	Low	High

Benefits of a server-based approach

By allowing vendors of control room solutions to use server interfaces rather than UE interfaces, network providers will preserve vital functionality for control room operators. This approach will also eliminate the challenge of ongoing adaptations and workarounds aimed at returning missing functionality to those specialist users, enabling the network providers to concentrate on their core market of consumer mobile users.
If network providers enforce the use of UE-based interfaces, the result will be a service to control rooms that is not fit for purpose, imposing limitations on operations that will ultimately put the safety of first responders at risk.

On the technical front, enabling MCPTT-3 connections directly to the CAS will also reduce network load by an estimated 80 percent in the mission-critical infrastructure. This is because control room solutions will require only one connection per resource or group and will themselves handle the distribution of that connection in a redundant and load-balanced manner. Analysis performed for a large organisation has revealed that a UE-based approach would result in approximately 250 concurrent UE instances and up to 1,000 talk group subscriptions (including numerous duplicates). By contrast, the proposed AS-based approach would require a maximum of 180 talk group subscriptions in the same scenario. The AS-based approach would also enable horizontal scaling within the control room solution without linearly increasing the load on interfaces to the mission-critical infrastructure.

Even disregarding the functional needs of control room operators, network providers will need to create and manage AS-based interfaces for their own scaling requirements. We believe that a monolithic server architecture that allows for just one CAS/PAS pair will simply not scale to the performance needs of a nationwide network. This means that network providers will in any case need to create server-to-server interfaces for their own use, and it is just a small step from there to open those already-standardised interfaces for third-party connections to control rooms.

Conclusion

For mission-critical communication over LTE, the industry is at a critical crossroads. Remaining on the current path of providing only a sub-optimal UE-based interface will leave control room users in the hands of non-specialists that do not appreciate their highly specific requirements. The consumer mobile market dwarfs the control room market, making it extremely unlikely for network providers to invest the appropriate resources in building and maintaining functionality such as enterprise affiliation for control rooms.

This paper is not arguing that network providers should be required to create an additional, control-room-specific interface. Not only do the network providers lack the knowledge and experience of serving this group of users, they also lack economic incentive to invest heavily in maintaining such a niche interface. Rather, we propose that vendors of control room solutions be permitted to act as a PAS, collecting traffic from the control room and passing it to the CAS. Vendors would then be free to implement their own functionality on the control room side, fostering healthy competition to the benefit of end users.

By opening up standardised server reference points to third-party control room gateways in this manner, network providers can ensure an optimal solution for emergency services and good user acceptance for LTE adoption.

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