# Push To Talk over Cellular (PoC) and Professional Mobile Radio (PMR)

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# 1. Push To Talk service

Many cellular mobile equipment manufacturers and operators have recently introduced push-to-Talk voice services. The service is often quoted as Push To Talk over Cellular or PoC. For the subscribers the service when commercially available provides the possibility to create or access talkgroups and set up group calls within these talkgroups by the press a PTT key in the handset.

Technically the PoC services are implemented in the GPRS or CDMA packet core networks by using Voice over IP (VoIP) technology and typically the Session Initiation Protocol (SIP) and Real Time Protocol (RTP) of the IETF to relay voice packets from one source to multiple recipients. The current offering of proposed services is still vendor specific with varying technical solutions, however several manufacturers have disclosed plans to move towards common standardised solutions using the IP multimedia Subsystem (IMS) technology. It is understood that the Quality of Service (QoS) aspects of the current packet core networks also need careful addressing to achieve high quality high capacity PoC service offering.

The vast cellular user base of today already implies that even a very low penetration in percentage could lead to millions of PoC users. When the radio coverage is already built, the additional cost of group call servers/software would be very minor compared to the overall network investments thus giving the possibility to provide talkgroup services at affordable cost.

Building a PoC network from the start to serve only PMR users naturally would be a totally different business case and in most cases lead to far too high capital expenditure per user to be profitable.

This paper produced by the TETRA MoU Association makes a general level comparison between the technological possibilities of Push-To-Talk in the cellular network environment and the known needs of Professional Mobile Radio users - a segment whose needs are today served by Terrestrial Trunked Radio (TETRA).

It is recognised that the operators planning to offer PoC services also themselves have a clear understanding that PoC could not meet the needs of the truly mission critical PMR user segments - such as Public Safety and Security - and thus are targeting their marketing to other customer segments.

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## 2. Professional Mobile Radio user needs

The main needs of the PMR users, such as the ones representing the Public Safety and Security (PSS) forces can be briefly categorised as follows:

- Specialised functionality in group communications and dispatching, including security, dynamic management of talkgroups, emergency calls, prioritisation of communications etc

- Response times, typical requirements for voice call set-up time are in the range 0.3 to 1 second, with 0.5 s often cited as the requirement for wide area operation

- Seamless radio coverage throughout the whole served area, including guaranteed availability of coverage also under exceptional conditions

- Incident capacity; the need for radio capacity is increasing during major incidents and accidents and that capacity must be guaranteed to the rescue and law enforcement forces

- Uncompromised voice quality allowing the listener to recognise who is speaking, even under excessive background noise

These requirements – when talking about the Public Safety and Security operations and agencies – should not be taken as “needs” that can either be met fully, partly or not met at all, but rather as mandatory baseline requirements. We should remember that occupational safety of the officers as well as health and life of other citizens of the society may depend on how each of these requirements is fulfilled by the communications tools.

# 3. Radio coverage

Two traditional PMR needs are fundamental in estimating the adequacy of cellular packet voice radio service to the PMR users:

1. Full rural coverage under normal operating conditions
2. Mechanisms to guarantee coverage under exceptional conditions

In addition, there is often a need to provide dedicated frequencies for Air to Ground and Ground to Air communication e.g. for the rescue forces. Dedicated frequencies are needed for this to prevent the airborne transmitter from causing interference to ground radios even at distances of hundreds of kilometres.

## *3.1 Radio coverage during normal operation*

It is not self-evident that the next generation cellular networks (GPRS, EDGE, CDMA2000, WCDMA, …) would be constructed to provide 100 % rural radio coverage from the beginning, rather it can be assumed that rural coverage will be gradually improved as an evolutionary process based on business preferences. Eventually the coverage could reach full 100 % at least in densely populated countries. However, it must be kept in mind, that building comprehensive rural coverage with 900 or 1800 MHz etc frequencies is an expensive exercise – even compared with building a dedicated 400 MHz coverage.

## *3.2 Coverage for exceptional conditions and network outage*

PMR technologies have special arrangements to provide basic radio coverage even under network failure situations, such as Base Station Fallback and Direct Mode Operation (DMO) supported by TETRA systems. These are not provided in solutions based on cellular networks.

## *3.3 Airborne coverage and channels*

It is obvious that cellular networks cannot economically dedicate e.g. a CDMA carrier of 1.25 MHz to serve a few helicopters. Dedicating frequencies for this would also cause even international channel allocation agreements to be revisited. The Air to Ground communication would need to be provided by using separate PMR radios.

# 4. Traffic capacity and access to capacity

Current cellular radio standards do not support multicast transmission for the time being in the radio protocol, which means that a PoC talkgroup will reserve a dedicated slot or equivalent resource for each talkgroup member even when logged on the same radio site. This in turn implies that a talkgroup member can be simply left outside the group call whenever channels happen to be congested at that site.

This mode of operation also has another consequence: since the voice packets are delivered individually to each talkgroup member – over a “best effort” network, some group members can receive the voice earlier and some others possibly considerably later, depending on system load.

Since urban cellular network are capacity limited designs and use small cells this may not be an essential restriction for the typical business or free time usage patterns. For professional users and with the Public Safety services, the situation however is different.

The big benefit of dedicated PMR technologies like TETRA in this respect is the capability to use semi-duplex groups calls requiring only one channel per talkgroup per site, thus enabling very large talkgroups.

PoC channel congestion would most likely happen in rural networks that are built to support only a limited number of subscribers. This will pose a severe limitation to the feasibility of the whole service to support emergency communications during major or even moderate size incidents, effectively leaving incident communication without support.

Incident communication would not actually be much better supported in urban networks either, even though the total subscriber capacity per site is higher. Due to lack of efficient priority mechanisms it is likely that the channels resources would be loaded by ordinary subscriber traffic in the proximity of any incident – as experiences from the world clearly show - and the rescue forces could not be given the needed communications support.

It should also be noted, that even if the technology supported prioritisation of users and calls, it is unlikely that the operator would like to block the public from calling the emergency services or from calling to their families during a major incident. This should rather be seen as the legitimate right of the citizens.

# 5. Business focus/economies of scale

When working in a commercial business environment, we have to recognise that however important the mission critical PMR communication may be felt to be for the society, the Professional Mobile Radio usage represents only a fraction of the total traffic payload and revenue. This leads to rather significant implications.

The current and planned cellular standards are and will be developed to serve the bulk of the residential and business users and do not address the specific need of PMR access, and this situation is not likely to change. 3GPP standardisation does not address the mission critical communication needs either.

It can also be assumed that cellular network coverage is designed to serve the vast majority of business and residential users and mission critical usage does not generally represent significant purchasing power to direct the coverage investments.

The business drivers and motivation of the PoC deployment seems to be coming from multiple sources such as:

- to improve utilisation of the packet core network capacity
- to reduce churn from operator's network
- to offer new attractive functionality in new handset models
- to present CDMA with PoC as a "PMR" or "PAMR" service in order to obtain more favourable licensing terms to CDMA than to others

The business behaviour of the network operators will also steer the investment decisions of the equipment industry putting clear focus on the features and services that are the key contributors to implementing the operator's business plan. For this reason we cannot expect rich specialised functionality to be developed in cellular products to meet the specific needs of the PMR or mission critical users.

Also the requirements concerning the specialised functionality and construction of radio terminals differ radically between the mission critical users and mainstream cellular subscribers. The cost advantage of a mainstream cellular phone is not transferable to a specialised rugged field radio.

Furthermore, the specialised requirements for Command & Control Systems and Computer Aided Dispatching as well as being complex to implement themselves also require support from the radio network and related Application Programming Interfaces to let the dispatcher manage the fleet efficiently. This again appears to be quite far from the core focus of cellular operating business.

It seems that these issues are actually quite well understood in the business plans of operators who are planning to launch PoC services.

# 6. Response times

The Public Safety radio communication has connection set-up time requirements measured in fractions of a second for well-known reasons related to human safety and occupational health issues, and the PMR systems like TETRA can support this requirement.

Considering VoIP talkgroups, we have to remember that both ITU H.323 and IETF SIP are slow protocols when applied to radio environment due to the amount of text-encoded information they are transmitting during each signalling transaction. Hence e.g. SIP as such cannot provide a mechanism for truly fast set-up of a group call. Since the slow set-up time is a consequence of the VoIP protocols used, the same situation applies to PoC implementations over any radio access technology, even though the general perception seems to be that PoC implementations on top of CDMA would be even slower than PoC on top of GPRS.

The typical set-up times of PoC calls seem to be in the order of few seconds, even though some manufacturers have also quoted times in the order of one second. It appears to be clear that PoC solutions do not meet the often-cited Public Safety and Security set-up time requirement of 500 milliseconds or even less.

# 7. Professional Mobile Radio features

The whole concept of providing VoIP talkgroups on top of cellular infrastructure appears to suffer from quite severe limitations with regard to guaranteed radio access and incident communication capacity. This alone would lead to a situation that the specific needs of Public Safety and other mission critical users would never be properly addressed by PoC product developers.

In addition to that, the cellular air interface technologies do not have all the required signalling functionality built in, which puts technical restrictions to the feasibility of some specialised features, even though part of PSS features could be implemented in the IP servers.

The following key TETRA features would not likely be provided in PoC networks, either due to lack of technical supporting capabilities or poor match with the mainstream business objectives.

- Direct Radio-to-radio communication (TETRA Direct Mode Operation, DMO)
- Call Authorised by Dispatcher (TETRA SS CAD)
- Area Selection (TETRA SS AS)
- Access Priority (TETRA SS AP)
- Pre-emptive Priority Call (TETRA SS PPC)
- Discreet listening (TETRA SS DL)
- Ambience Listening (TETRA SS AL)

Because the talkgroup concepts seen so far are vendor specific, it is difficult to make a general statement on the suitability of these group concepts to PMR operations. Many of the demonstrated solutions in any case appear to be quite far from the speed, usability and flexibility that are wanted in mission critical use.

# 8. Conclusions

The main conclusions can be expressed as follows:

- PoC provides a new mechanism to implement talkgroup services in future cellular networks that support either GPRS, CDMA or UMTS service with sufficient capacity to deliver voice packets

- Where cellular operators decide to deploy such service, it can provide sufficient level of service to some business and residential users, free time/family activities etc

- Cellular networks can provide cost effective radio coverage for new services via economies of scale. This especially applies to densely populated areas.

- The mission critical radio users (today typically using private radio networks and PMR technologies) have specialised requirements for functionality, response times, radio coverage and quality of service particularly during major incidents - with little if any possibility to compromise in cases where safety of the society and human lives are to be protected

- Cellular networks have not been traditionally considered being properly able to serve this mission critical user community and this matter has been recently reconfirmed by several expert studies conducted for European governments

- VoIP talkgroups add group communication capability to cellular networks, when implemented, but do not appear to meet the requirements of demanding PMR usage in areas of:

    - several features for voice calling and extensive PSS specific dispatch

    - sub-second response times

    - seamless rural radio coverage

    - guaranteed urban network capacity during incidents

    - even reasonable rural network capacity during incidents

Purpose built PMR technologies like TETRA will still be needed for mission critical professional radio communications. TETRA will remain the technology for building Public Safety and Security radio networks as well as other demanding PMR applications.