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LTE AS A TRUNKING-DISPATCH SYSTEM

ABSTRACT

In the paper solutions of trunking-dispatch systems based on the LTE system are presented. The solution in the form of separate LTE/TDD trunking system is discussed, and the concept of the LTE/FDD trunking system operating in the infrastructure of public, mobile networks is characterised.

Key words:
LTE, trunking, dispatch system.

INTRODUCTION

The trunking solutions based on the TETRA system (*Terrestrial Trunked Radio*) or DMR (*Digital Mobile Radio*) [1, 2] which nowadays are the most popular in Poland, have strong competition in the form of the LTE cellular system (*Long Term Evolution*). LTE may indeed be an interesting counterbalance to these systems because of its great development potential and much better technical properties. There is no doubt that the TETRA and DMR systems largely meet the expectations of customers, particularly in the dispatching function, the speech services and transmission security.

That is why they are still the main solutions applied in practice by services and institutions. However, it is impossible not to notice the very dynamic development of public cellular systems as the LTE nowadays that changed and continues to

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change the face of modern radio communications, and, consequently, also dispatching systems. The standardisation of TETRA and DMR is still dynamic, and these systems can be used as good and safety tool for services. Both two professional systems have many advantages very important from the point of view of different services, for instance: railway, border guard, police, military services, emergency services etc. However, they put in return numerous limitations. Technological development of both TETRA and DMR, especially due to narrow frequency channels, lags behind the public cellular systems that offer increasing data rates and a very wide range of services. Furthermore broadening access of TETRA and DMR requires the construction of costly technical infrastructure. Budgets of uniformed services are often not able to meet this cost. For this reason, the pace of construction of these systems and their modernization is very slow and subject to limitations, in particular, in the field of spectrum efficiency and transmission rate achievement.

Thus, despite the many advantages of TETRA and DMR, increasingly evident is their weakness of application. Therefore, in recent years, more time is spent using public cellular systems for the purpose of dispatching systems. This of course introduces the new restrictions but also opens new possibilities in the delivery of services. Public networks allow for the separation of certain system resources for the purpose of dispatching solutions, they offer a much higher frequency band, larger spectral efficiency, and achieved data rate. As well as, enable the use of ready-made infrastructure, which is their obvious advantage.

SYSTEM SOLUTIONS OF LTE IN TDD MODE

The LTE system offers dispatch solutions at present, and commercial solutions focused especially on the LTE system operating in TDD mode (*Time Division Duplex*).

This is because the frequency channels in the LTE system are much greater than the channels of TETRA or DMR. The narrowest possible channel in LTE has a bandwidth of 1.4 MHz, but most often the channel of 5 MHz is proposed to use for the trunked solutions. But, it is obvious, that it is not easy to separate channels of 5 MHz width from the available bandwidth for the needs of entities interested in the implementation of the LTE trunking system. Therefore, the dominant solution in this case will certainly become an the LTE/TDD system, which requires only single radio communication channel for both directions of transmission — from base station to mobile station and from mobile stations to the base.

Proposed LTE/TDD trunking systems are private, working independently of public mobile networks, which often is a necessary condition, and constitute a full-blown substitute for systems such as TETRA, but providing a substantially expanded range of services, especially those related to the transmission of video and data signals. At the moment, radio communications equipment manufacturers to develop and improve system solutions based on the LTE technology, dedicated for the purpose of dispatching services [3, 4], operating in the TDD mode.

The use of the TDD duplex mode also gives the freedom of shape the use of system radio resources by transmitting transmission in both directions (uplink and downlink) signals at the same, single frequency channel. This is done thanks to the possibility of independent allocation of time slots, and thus the OFDM time-frequency resources for both directions of transmission.

Example architecture of the LTE/TDD in the role of trunking-dispatch system is presented in figure 1. The main properties of this solution include the following:

- the backbone (core) network separated and independent from other radio communication (cellular) systems, largely simplified in comparison to the LTE/FDD core network;
- trunking carried on the basis on a network of dedicated base stations;
- dispatch servers and multimedia servers;
- servers for communication with external networks.

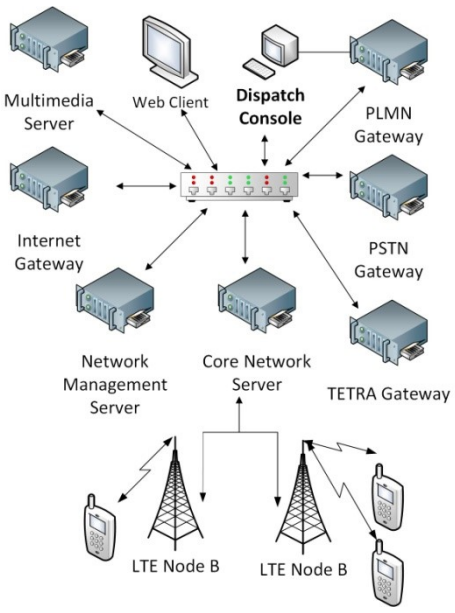

Fig. 1. Example architecture of trunking-dispatch system based on the LTE/TDD

Basic functions of communication in the core network of the LTE/TDD trunking system perform the network devices as a Core Network Server and Network Management Server. They allow communication within the separate trunked LTE network infrastructure, expansion of the network and management of physical resources, as well as exercising of overall control of the system.

Especially noteworthy are also powerful multimedia features implemented using the server marked in figure 1 as Multimedia Server. In fact, it may be an assembly comprising a dispatcher server, and data processing server, and recording and playback of multimedia data server, as well as other devices such as Web Client, Dispatch Console etc.

The LTE/TDD trunking system also consists of output gateways to external networks, and in this: PLMN Gateway (Public Land Mobile Network gateway), PSTN Gateway (Public Switched Telephone Network), TETRA Gateway, DMR Gateway, Internet Gateway, etc.

PROPOSAL OF THE USE OF PUBLIC LTE NETWORK FOR TRUNKING AND DISPATCH PURPOSE

Proposed concept is based on the separation of dedicated system infrastructure, both a hardware and software, for the dispatch purposes, which will enable expanded functionality of the LTE, which in this case operates in the frequency division duplex mode (FDD).

The new system functions can be implemented regardless of the mobile operator participation, although in this case it is not possible to create separate infrastructure of the core and radio access network. The realization of dispatching function takes place almost exclusively in the high layers of the network. This solution has a number of advantages and disadvantages with respect to the LTE/TDD. Whereas the realization of dispatch functions takes place almost exclusively in high layers of the network.

This solution has a number of advantages and disadvantages with respect to the LTE/TDD solutions. The possibility of using a ready-made LTE network infrastructure (public) reduces costs of infrastructure development, and its maintenance. So, it allows the use of dispatching services to entities that cannot afford to build and operate a separate network and does not require the purchase of rights to use the frequency channel etc. Undoubtedly, this is a great advantage for many

companies. Furthermore the use of public system also greatly expands the range of available services and radio network coverage.

In contrast, the major disadvantage of such a solution is almost impossible to exercise effective supervision over network resources and communications infrastructure, as well as difficult (and thus expensive) realization of prioritized calls. Additionally, the problem is dependence on the mobile network operator and on an external network load.

Despite this, such a system can hold its own management subsystem and a set of devices and servers supporting its dispatch function. Furthermore, by using a VPN network tunnels (Virtual Private Network) it is possible to achieve certain isolation from unauthorized user access and providing a significant level of transmission security, comparable to the banking systems. However, it will never be the same security level as in the case of systems operating separately, and the system will be more exposed to intrusions in a communications network. Note, that it is also possible to block the LTE system resources for the needs of dispatch services to increase its reliability during e.g. the crisis management. This solution is expensive, but possible for realization.

ARCHITECTURE OF LTE/FDD DISPATCH SYSTEM IN A PUBLIC NETWORK

In the proposed solution it is separated a functional area, which is called the Control Centre of the LTE Trunking System, which is the heart of the trunking system, as shown in figure 2.

As we can see, the LTE trunking system can communicate and interact with TETRA and/or DMR system in full or limited scope, which depends on the solutions dedicated to the institution, departments etc. But the basis of communication in a trunking system provides the communication through the public LTE network, that is, the communication through LTE core network called EPC (*Evolved Packet Core*).

It should be noted, that the trunking system works in packet-switched mode, like the cellular system, what gives the possibility to increase the transmission efficiency in comparison to the circuit-switched transmission. This solution allows creation of internal private VPN network to enhance the security of transmission. On the other hand the communication with the TETRA system may also take place in the circuit--switched mode. The realization of communication in this case is possible using multi-system terminals. The radio access to user terminals is made through LTE

radio access network (Enhanced-Universal Terrestrial Radio Access Network — *E-UTRAN*) using base stations of LTE (Node B).

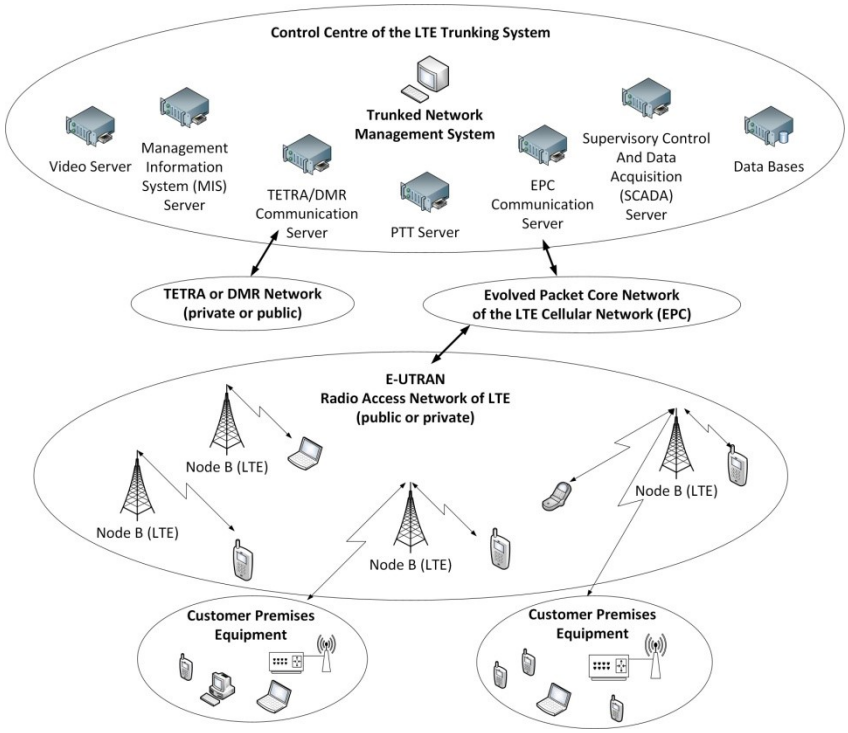

Fig. 2. Architecture of proposed solution of LTE/FDD based trunking system

An area of end-users operation includes almost any equipment belongs to the user equipment CPE (*Customer Premises Equipment*). For example, it is possible to create internal networks on the basis of additional user equipment and use a routing (e.g. WiFi). Of course, the function of user terminals can provide all types of devices, including: laptops, smartphones et al. And for CPE we can include also: telephones, routers, switches, local gateways, STB devices (called *Set-Top-Box*), peripheral devices including mobile terminal equipment, LAN network adapters, access points, etc. At the same time we can also use the terminals of increased resistance (eg. water resistant terminal, mechanical, etc.), as in conventional dispatch-trunking systems.

Control Centre of the LTE trunking system can contain different elements give network enable the implementation of different data services, voice services and others. Depending on the needs and utilized systems.

Control Centre of the LTE trunking system may include various network components enable the implementation of different data services, voice transmission services, etc., depending on the needs and systems being used. The centre may include:

- Trunked Network Management System;
- Supporting Data Bases;
- Communication Server for the cooperation with the LTE cellular network;
- Communication Server for TETRA and DMR Network,
- Management Information System Server (MIS);
- Supervisory Control and Data Acquisition Server (SCADA);
- Video Server;
- Classic server for PTT services (*Push-to-Talk*), typical for trunking systems, etc.

The above list is not closed and the actual selection of services and equipment depends on system customer's needs. As can be seen, a significant proportion of the above-mentioned devices provides services requiring a wide bandwidth and a high data rate which, at present, can be available in cellular systems only, such as LTE.

The system can allow the realization of many services that, in general, have not been previously available for dispatch systems. These services include, e.g.:

- services of industrial control and data acquisition (so-called SCADA), performing broadband transmission of video signals and high-speed data, and to enabling the acquisition of information of all kinds industrial facilities, and military bases, police, etc.;
- local and wide-area management information systems (MIS), or computer systems for businesses and other organizations, designed to record and analyze data from various organizational units and their delivery to the superior units (managers), in the form of structured, actual and properly processed, e.g.: statistics, financial reports etc.;
- video services, including wireless transmission, eg. for the transmission of multimedia signals and industrial monitoring, eg. refineries, pipelines, ports, shipyards and others, and to send films of different origin and destination.

CONCLUSIONS

There is no doubt that the dispatcher solutions based on the LTE system will be more popular. The development will cover both operating independently dispatching LTE solutions working in the TDD mode as well as separated trunking systems and other systems operating in the FDD mode using the public infrastructure of mobile networks.

It is clear that high rate data transmission in the TETRA system will never be possible with the same extent as in LTE and it never reach such a high degree of modernity, even if the TEDS subsystem is spreaded (*TETRA Enhanced Data Service*).

The pace of development of LTE is unsurpassed for TETRA because the total potential of companies engaged in the implementation of LTE is globally much greater than the potential for companies implementing TETRA. Moreover, the LTE system has already been admitted by the ITU to the group of systems meet safety requirements, recommended for services. This means that in the long term the probability of almost total displacing of TETRA by LTE is very high.

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LTE W ROLI SYSTEMU TRANKINGOWEGO-DYSPOZYTORSKIEGO

STRESZCZENIE

W artykule przedstawiono rozwiązania systemów trankingowych-dyspozytorskich opartych na systemie LTE. Omówiono rozwiązanie w postaci odrębnego systemu trankingowego LTE/TDD oraz scharakteryzowano koncepcję systemu trankingowego LTE/FDD pracującego w oparciu o infrastrukturę publicznych sieci komórkowych.

Słowa kluczowe:
LTE, tranking, system dyspozytorski.