METHODS OF CONTROL QUALITY OF SERVICES VoIP OVER LTE

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Abstract

Methods of control of providing users with VoIP over LTE network services are considered for the basic classes of LTE QoS in UMTS / 3GPP with the availability of the following traffic classes conversational, interactive and streaming.Shown testing, calculation, analysis and evaluation of quality parameters for VoIP over LTE network services , the behavior of VoLTE MOS vs. packet loss Ppl and Pjitter, VoLTE MOS vs. effective packet loss VoLTE.

LTE System Toolbox supports conformance testing and includes performance measures to verify compliance with standard specifications.

Natick, Mass. MathWorks introduced its new LTE System Toolbox, providing standard-compliant simulation, verification, and analysis of LTE and LTE-Advanced wireless communication systems and devices. The toolbox is an extension to MATLAB and Communications System Toolbox and intended for use by engineers who need to design or verify wireless systems conforming to the LTE standard.

As the LTE standard expands in complexity, ensuring correct design and implementation is a top challenge for developers of LTE components and end-equipment in the commercial, military, security, and public safety wireless markets. Those products must tested to ensure conformance to the standard, but developing the testing is expensive and requires specialized knowledge to understand the standard and implement validated reference models.

LTE System Toolbox supports compliance testing and includes performance metrics to verify compliance with standard specifications.

New LTE System Toolbox providing standard-compliant modeling, validation and analysis of LTE and LTE-Advanced wireless communication systems and devices. The toolbox is an extension of MATLAB and the Communications System Toolbox and is intended for use by engineers who need to design or test LTE-compliant wireless systems.

As the LTE standard becomes more complex, ensuring correct design and implementation is becoming a major challenge for LTE component and terminal equipment designers in the commercial, military, security and public wireless markets. These products must be tested against the standard, but test development is expensive and requires specialized knowledge to understand the standard and implement validated reference models.

The LTE System Toolbox provides standard LTE and LTE-Advanced reference models and test waveforms to help engineers: Risk mitigation: providing confidence that the design complies with the LTE standard; Saving time: by reducing the requirements for developing tools in-house; - Efficient use of engineering resources: allowing engineers to focus on creating unique IPs instead of creating reference models and generating test signals; - Understanding and reuse of components: make it easier to understand the standard, learn the design, and reuse as components are developed and implemented.

As the market for LTE technology grows, engineers need to make sure their design products meet or can coexist with LTE and LTE-Advanced, a signal processing strategy strategist, MathWorks. In addition, because LTE technology is extremely complex and continues to evolve, very few companies have the resources or expertise to do it in-house. The LTE System Toolbox will help teams achieve standards compliance without investing heavily in engineering.

Currently, the concept of next generation networks - NGN (Next Generation Network), implemented on the basis of various technical solutions, primarily Softswitch and IMS (IP Multimedia subsystem) . As you know, the NGN concept assumes the creation of a network connection with a guaranteed level of quality of service QoS (Quality of Service) of users, which is achieved through the creation of new QoS mechanisms. Establishment of certain relationships between telecom operators, as well as between the telecom operator and the user on the basis of contractual service level agreements - SLA (Service Level Agreement). In accordance with ITU-TY.1291 [1] to ensure the guaranteed level of quality of service in NGN networks as the main recommended algorithm for Differentiated Services (DiffServ).

With the increase in the variety and complexity of services provided in NGN networks, the operator does not just limit the ability to control traffic, but must maintain an appropriate level of transmission quality. The solution to this problem is provided by OSS systems that control the level of customer service (SLA monitoring).

The general monitoring model is shown in fig. 1. Quality of service QoS is defined as the probability of meeting a given network communication traffic agreement or, in some cases, as an informal designation of the probability of a packet being transmitted between two points in the network. QoS is a set of technologies that enable applications to request and receive a predictable level of quality of service in terms of bandwidth and overall data delivery time.

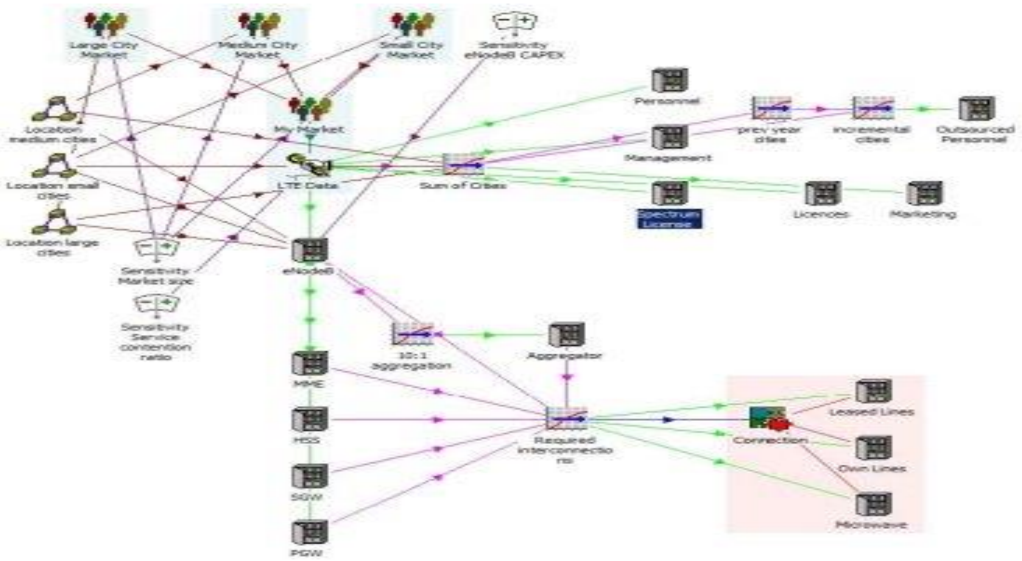

Fig. 1. Model of monitoring LTE network

Main characteristics for monitoring the operation of LTE network services: reaction time; movement speed; throughput; transmission delay and change of transmission delay.

QoS for monitoring and testing applications provides: support existing and new multimedia services and applications; transfer of management of network resources and their use to the network operator; guarantee of service and differentiation of network traffic (this is a prerequisite for combining audio / video and application traffic in one IP network); the ability of Internet providers to offer customers additional services along with the standard non-guaranteed data delivery service (in other words, to provide services in accordance with the so-called Class of Service (CoS); development of new network technologies such as virtual private networks (Virtual Private Networks - VPN).

Concerning VoLTE QoE, the most relevant KQI is the Mean Opinion Score (MOS), an dimensional subjective parameter for the evaluation of voice call quality, with values in the range between 1 and 5.

MOS can be estimated by the E-Model algorithm, whose output is the R-Factor, defined in [2].

The R-factor can expressed as follows:

$$R = R_0 - I_S - I_d - I_{e,eff} + A, \quad (1)$$

where: R_0 - the Signal to Interference Ratio; I_s - a combination of impairment factors, occurring simultaneously or not in the voice session; I_d-is an impairment factor due to talk and listener echo, and delay contributions; A - known as Expectation or Advantage Factor, with values from 0 to 20; $I_{e,eff}$ - stands for Equipment Factor, and represents the impairment caused by low bit rate CODEC, and packet loss.

In the ITU-T G.107 recommendation , this parameter has been expressed by:

$$I_{e,eff} = I_e + (95 - I_e) \frac{P_{pl}}{P_{pl}+B_{pl}}, \quad (2)$$

where I_e and B_{pl} - parameters that can assume values as indicated in the recommendation, and P_{pl} - the packet loss, in a range of values between 0 and 1, calculated as:

$$P_{pl} = 1 - m/n , \quad (3)$$

where *m* - the number of RTP packets received and *n* - is the number of RTP packets sent, with uncorrelated losses . Packet loss is an important KPI to take into account.

A mathematical relationship between QoS and QoE holding for VoIP has been introduced . This relationship known as the *IQX* Hypothesis (exponential interdependency of Quality of Experience and Quality of Service).

In such a relationship, QoE depends on only one QoS parameter, and it expressed as follows:

$$QoE = \alpha e^{-\beta QoS} + \gamma, \quad (4)$$

where α, β and γ - calculated by means of non- linear regression. An example of regression result is as follows:

$$f(p_L) = 2.861 e^{-29.816 p_L} + 1.134, \quad (5)$$

where the QoE, in MOS, is indicated with $f(p_L)$ and the QoS parameter is packet loss .

The IQX hypothesis has been drawn up for an IP context, and it is related to a particular service, the voice call, so it can represent a good starting point in establishing QoE/QoS relationship for VoLTE.

The IQX hypothesis deals with voice application and with a QoE/QoS relationship based on only one QoS parameter (either jitter or packet loss). In this paper, instead, the QoE of voice application is assessed by basing the relationship on two QoS parameters (both jitter and packet loss).

To this scope, in the model presented here, the strict packet loss expression (3) will be replaced by an expression that includes the contribution of packet loss and jitter, known as effective packet loss $P_{pl,eff}$, defined as:

$$P_{pl,eff} = 1 - (1 - P_{pl})(1 - P_{jitter}), \quad (6)$$

where P_{pl} remains the packet loss from (3), and jitter expressed as a Pareto probability by writing:

$$P_{jitter} = ½ (1 - 0.1x/\sigma)^{20} , \quad (7)$$

where *x* - the jitter buffer dimension and σ is network jitter delay, both expressed in [ms].

The $P_{pl,eff}$ in (6) can be considered as a further KPI resulting from the combination of two original KPIs, network jitter and packet loss .

By replacing (6) in the exponent of (4), the expression for MOS becomes:

$$MOS = \alpha e^{-\beta P_{pl,eff}} + \gamma. \quad (8)$$

Apart from its academic interest, the equation (8) could be useful for the network operator to predict the User. Experience starting from the variation of the combined jitter and packet-loss parameters. The next Section provides the necessary validation of (8) in the VoLTE context.

Figure 2 shows a graph of the dependence of VoLTE MOS on the probability of packet loss in BT. In other words, the IQX hypothesis can be extended to VoLTE, provided that the QoS parameter appearing in exponent (4) is network jitter, while the expansion is not performed if the exponent is the probability of packet loss Ppl.

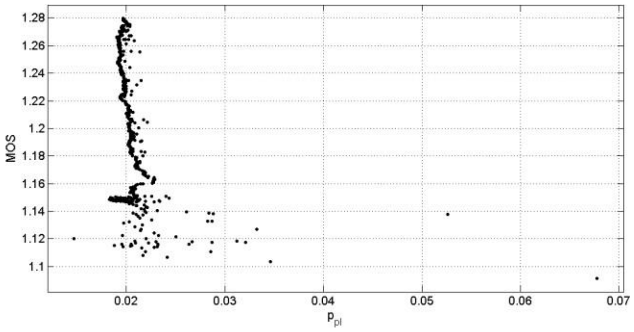

Fig. 2. Graph of dependence of the VoLTE parameter on the probability of packet loss Ppl in BH

To provide self-service in resolving customer complaints of LTE networks, obtaining information related to QoS/QoE data remotely from the end-user device is possible using a user-initiated active test. The solution is available as a standalone complaint handling application or for integration with the operator's existing applications that can be distributed to customers.

Analysis and evaluation of these QoS/QoE indicators is carried out. Problem diagnostics allows to optimize the LTE network and perform user-initiated or remotely triggered post-tests to ensure a fix with active mobile network testing. Significantly reduce customer churn and reduce customer complaints by 60%, as well as the ability to develop a strategy to improve QoS/QoE parameters.

From the user's point of view, any Android smartphone can be used as a tool for testing RF drive in LTE networks and creating detailed data using a Google map. This map displays information about 2G, 3G, 4G, 5G RF drive test parameters from the end-user perspective.

It is also possible to measure custom KPIs for LTE data, voice calls, streaming video, CSFB and VoLTE services, as well as LTE network coverage using cell base station information with precise location. It is necessary to perform post-test analysis using the interactive Google Maps web interface and optimize the LTE network by identifying areas with poor QoE parameters.

Conclusion

Considered LTE QoS parameters and attributes with planning and implementation process for UMTS/ LTE networks with radio resource concept, initial planning (i.e., system dimensioning) for providing the first and most rapid evaluation of the network element count as well as the associated capacity of those elements.

References

1. Багатоканальний електрозв'язок та телекомунікаційні технології [Електронний ресурс]: підручник 2 том. /О. В. Лемешко, В. А. Лошаков, В. В. Поповський, С. О. Сабурова та ін.// за редакцією В. В. Поповського-.Х.: ТОВ "Компанія СМІТ", 2018. Режим доступу до ресурсу: http://www.smit- book.com/books.html – с. 426-429.

2. Кадацька О.І., Сабурова С.А,Козубенко В.С., Перспективи розвитку технології , мобільного зв'язку 4G, Проблеми електромагнітної сумісності перспективних безпроводових мереж зв'язку (ЕМС-2019): Збірник наукових праць п'ятої міжнародної науково-технічної конференції, Харків 21-22 травня 2019 г. / М-во освіти і науки України, Харківський національний університет радіоелектроніки. -Харків: ХНУРЕ, 2019. - с.21-24.