

Next Generation Mobile Networks Architecture

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Abstract— In this paper we define device-based functional architecture for next generation mobile networks. The proposed architecture is based on user-centric mobile concept in a heterogeneous wireless environment. The implementation of the proposed architecture is performed regarding the Next Generation Networks approach in the service stratum, while the radio access technologies belong to the transport stratum. In the proposed architecture we define a possibility to change the Radio Access Technology - RAT by mobile terminal using certain user-side criteria. For the purpose of transparent change of the RATs by the mobile terminal, we introduce so-called Policy-Router as a new node in the core network, with main propose to establish IP tunnels to the mobile terminal via different available RATs.

Index terms—5G architecture, Heterogeneous networks, Radio Access Technology, Next Generation Networks.

1. INTRODUCTION

Today we have different wireless and mobile technologies, which are mass deployed, such as 3G mobile networks (UMTS, cdma2000), LTE (Long Term Evolution), WiFi (IEEE 802.11 wireless networks), WiMAX (IEEE 802.16 wireless and mobile networks), as well as accompanying networks, such as sensor networks, or personal area networks (e.g., Bluetooth, ZigBee). Mobile terminals include variety of interfaces, including the GSM ones, which are based on old-fashioned circuit switching, the technology that is going into its last decade of existence. All wireless and mobile networks today are going towards all-IP principle, meaning all data and signaling will be transferred via IP (Internet Protocol) on network layer [1]. So, we may have different Radio Access Technologies (RATs) today and new RATs in the future (e.g., LTE-Advanced), but the common “thing” for all of them is IP, which is unifying technology. The 4G term is related to available bit-rates in the access link, i.e. more than 1 Gbps is set as condition by ITU for a technology to be marked as 4G. Also, all-IP is the characteristic of 4G in the access and in the core network part, there will be no

circuit-switching as it existed in 3G systems, such as UMTS. On the other side there a lot of efforts done for separation of transport stratum and service stratum in the concepts of Next Generation Networks (NGN), [2], [3]. Next generation of mobile and wireless networks will certainly need to fit within the NGN, because it is based on wireless and wired access possibilities, including all services and using all-IP concept. However, the main principle for NGN is complete separation in parallel between the transport part in the access and in the core networks from the service provisioning, i.e., from the service stratum. Since, the 4G is already at the “front door” of communication world, the next generation of mobile and wireless networks will be labeled 5G, if we continue the same pattern from the past two decades. We believe that the 5G approach will be user-centric approach [4], since the mobile terminals are becoming highly computationally capable devices which can support more complex functionalities for performing calculations, as well as bigger memory space and longer battery life in years will provide enough storage capability for control information. Then, in IP world, the main principle from the beginning was keeping simple network nodes and having smart end devices (e.g., computers), an approach completely different from the Public Old Telephone Systems (POTS). However, we need smart nodes on the networks side in all-IP concept as well, which should be used for negotiation with the user equipment premises (mobile terminals in the case of mobile networks) for providing necessary Quality of Service, as well as authentication, authorization, accounting and security functionalities.

2. INTEROPERABILITY IN HETEROGENEOUS WIRELESS ENVIROMENT

The challenge in the design of the terminals is connected to the management of trade between the flexibility of how to use the spectrum and needed space and power to given platform. New methods for partial reconfigurable offer design dimensions that allow the system to adapt to the opportunities and requirements of the terminals in a manner that shall maximize the spectral efficiency and also maximize the battery power [4], [5]. As a result of growing level of acceptance of the wireless technologies in different fields, challenges

and types of wireless systems associated with them are changing.

To meet the relevant requirements of the user applications we consider two possible models for interoperability between different radio access technologies. First one refers to a centralized operator access, while the second one defines the Internet model of interoperability. The first model involves introducing a certain level of integration between the radio access technologies for realization of the vertical handovers, [5], [6]. The introduction of this model requires definition of RATs interoperability protocols. The second model is called the Internet model, which represents a focus for further development in this paper and refers to providing continuity of customer service in case of independent radio access technologies available to the mobile terminal by connecting on the network level, [7]. In this case, interoperability between network technologies is done on the upper (network) protocol levels, i.e. at a level that is common to all access technologies for communication between user applications with the appropriate application servers. The second method is more general and relates to network interoperability regardless of the access network providers, [8], [9].

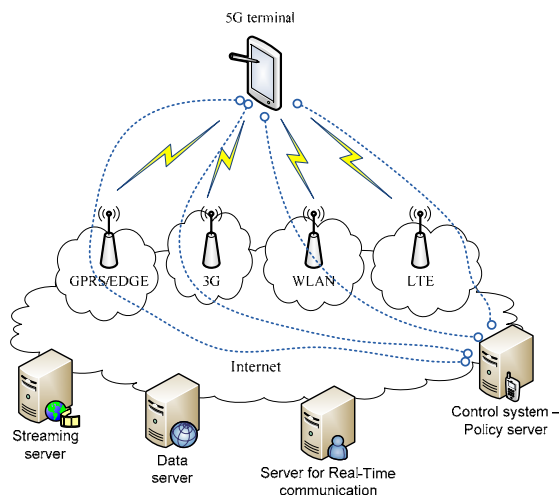


Figure 1. Functional architecture for 5G mobile networks

3. DESIGN OF 5G NETWORK ARCHITECTURE

Figure 1 shows the proposed design of network architecture for 5G mobile systems, which is all-IP based model. The system consists of a user terminal (which has a crucial role in the new architecture) and a number of independent, autonomous radio access technologies. Within each of the terminals, each of the radio access technologies is seen as the IP link to the outside Internet world. However, there should be different radio interface for each Radio Access Technology (RAT) in the mobile terminal. For an example, if we want to have access to four different RATs, we need to have four different access-specific interfaces in the mobile terminal, and to have all of them

active at the same time, with aim to have this architecture to be functional.

In order to solve this deficiency we propose a new level that will take care of the abstraction levels of network access technologies to higher layers of the protocol stack. This layer is crucial in the new architecture. Protocol setup of the new levels within the existing protocol stack, which form the proposed architecture, is presented in Figure 2.

The network abstraction level would be provided by creating IP tunnels over IP interfaces obtained by connection to the terminal via the access technologies available to the terminal (i.e., mobile user). In fact, the tunnels would be established between the user terminal and control system named here as Policy Router, which performs routing based on given policies.

4. PERFORMANCE MEASUREMENT FOR NEXT GENERATION WIRELESS NETWORKS

Next Generation Networks (NGN) consists of support functionalities for data transport, and control transport, as well as functionalities for support of services and applications. The measurement of traffic is a basic control activity in order to provide Quality of Service, [10]. So, performance measurement is an intrinsic component in NGN, and it is usually performed at edge (border) network nodes, in access, core and transit networks. Also, it can be performed by the mobile terminals in the wireless environment, and here this is very important to create mobile user assisted probing of the RAT performances, [11].

Figure 3 presents also detailed view of the general architecture for Performance Measurements (MPM) in NGN, with added functionalities on the side of the mobile terminal (CPE – Customer Premises Equipment).

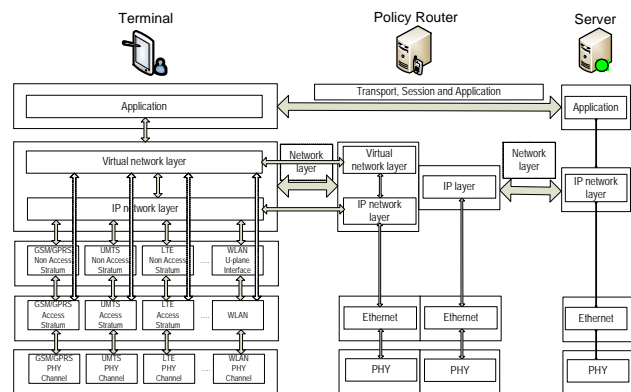


Figure 2. Protocol layout for the elements of the proposed architecture

The network architecture consists of the following entities:

- Performance Measurement Execution Functional Entity (PME-FE) is an entity to perform performance measurements;
- Performance Measurement Processing Functional Entity (PMP-FE) is an entity for processing the measurements. PMP-FE is responsible for two

groups of functions: processing of measurements and configuration of measurement tests across the network architecture; and

- Performance Measurement Reporting Functional Entity (PMR-FE) is an entity reporting the performed performance measurements.

Figure 3 shows the possible configuration for performance measurements using RTP / RTCP. On this Figure is presented Mu interface to Resource and Admission Control Function (RACF), which is an essential part of the process of decision-making performance in the allocation of resources. In the proposed architecture in this paper the interface for measurement data is between the QoS / QoE CM software module and software module for control of handovers between wireless technologies (ITHC).

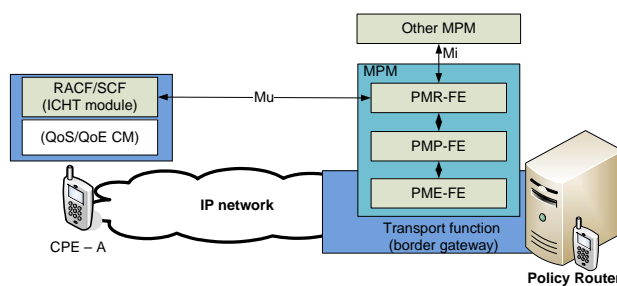


Figure 3. Network performance measurements using RTP / RTCP and RTCP extension.

The procedure for notifications based on qualitative performance measurements obtained by RTP / RTCP-based scheme is shown in Figure 4. The necessity of setting a new protocol for the exchange of network parameters between the two sides of the network architecture (policy client and router) is perceived by the parameters and scope of information to be exchanged.

The idea of QoSPRO (Quality of Service Policy based Routing) is to define all necessary parameters between the control and measurement entities, in particular between MQPBR and CQPBR software modules in the proposed architecture, would enable the mutual synchronization in order to achieve proper operation. Protocol procedures by QoSPRO protocol are shown in Figure 5. Decisions for change of the radio access technology are executed on the mobile terminal (client) side, using the developed M-RATS algorithm [9], which uses key performance indicators as input parameters for proper decision for RAT choice.

5. CONCLUSION

In this paper we have defined novel network architecture for such 5G mobile networks. The architecture includes introduction of software agents in the mobile terminal, which will be used for

communication with newly defined nodes called Policy Routers, which shall be placed in the core network. The Policy Router creates IP tunnels with the mobile terminal via each of the interfaces to different RATs available to the terminal. Based on the given policies, the change of the RAT, i.e., vertical handover, is executed via tunnel change by the Policy Router, and such change is based on the given policies regarding the Quality of Service and user preferences, as well as performance measurement obtained by the user equipment via new defined procedure for that purpose in this paper, called Quality of Service Policy based Routing (QoSPRO).

The proposed architecture for future 5G mobile networks can be implemented using components of the shelf (existing and standardized Internet technologies) and its implementation is transparent to the radio access technologies, which makes it very likeable solution for the next generation mobile and wireless networks.

6. REFERENCES

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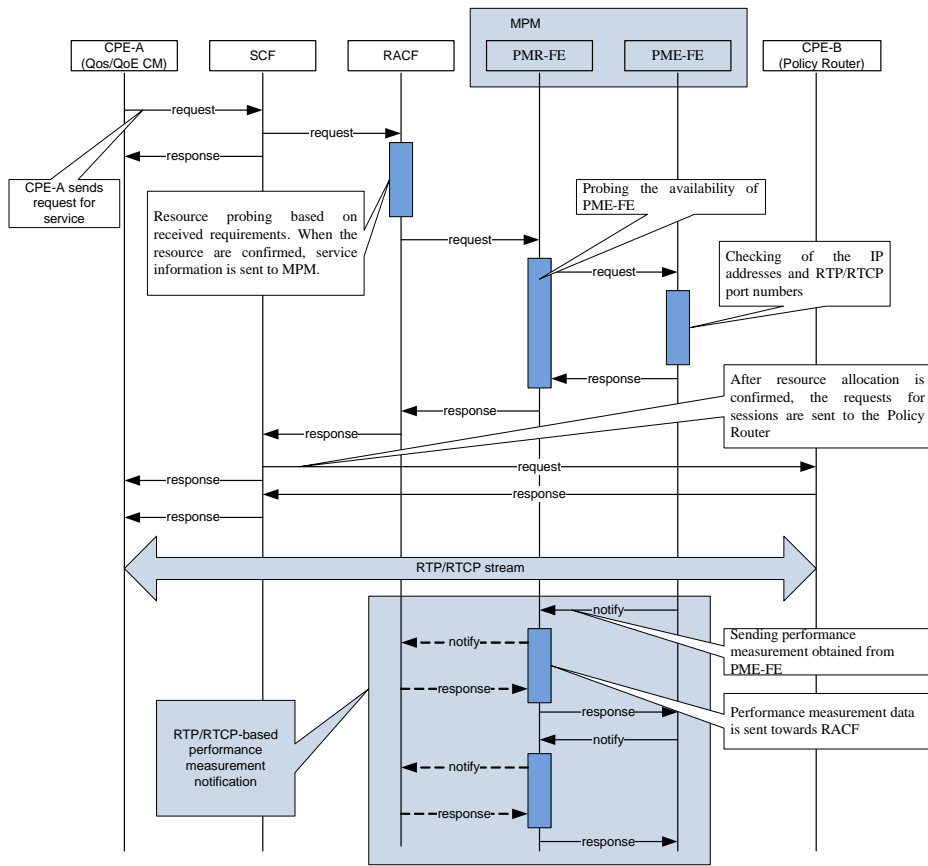


Figure 4. RTP / RTCP-based diagram for performance measurements

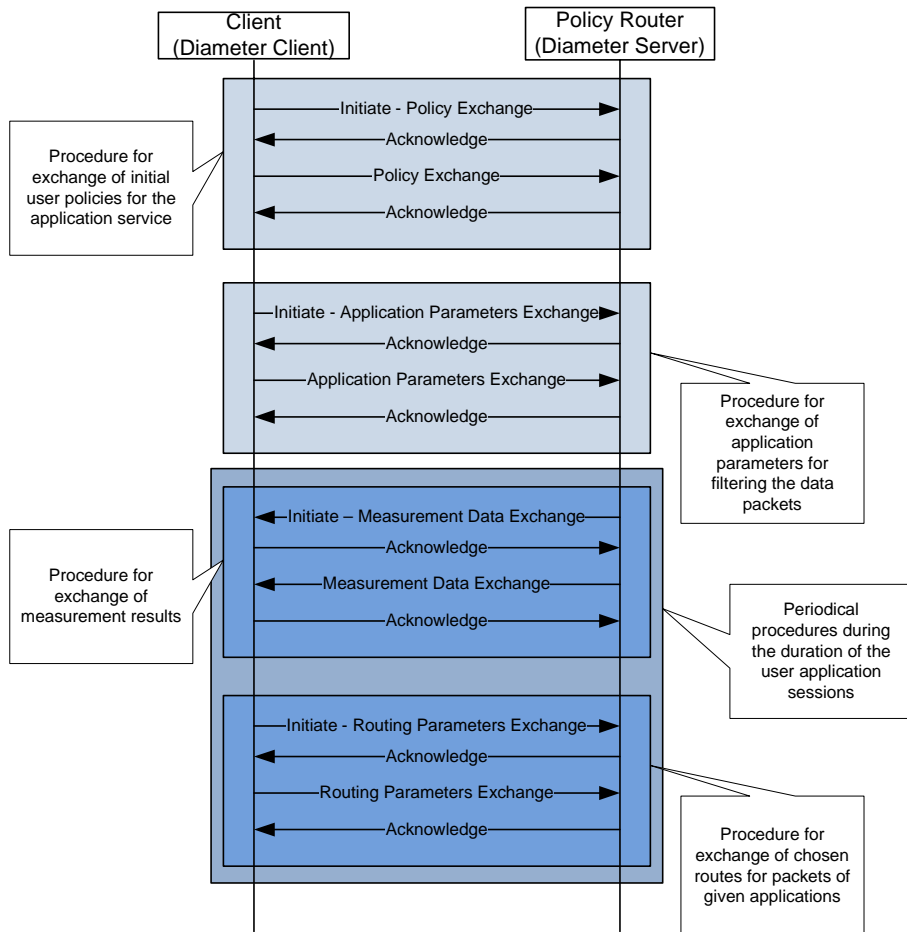


Figure 5. QoSPRO – novel procedure for the exchange between network entities in the proposed architecture