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Design and Production of an EPC Core Network Sizing Tool "The Case of Orange-Guinea

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

With the arrival of 3G and 4G technologies, telecommunications networks have undergone a major expansion. These networks have enabled the integration of new services and adequate bandwidth, enabling operators to meet growing user demand. This rapid evolution has led operators to adapt their methods to new technologies, which increase network complexity. This complexity becomes even greater when these networks combine several different access technologies into a heterogeneous network, as in the case of 4G networks. In such cases, sizing involves new challenges such as: the considerable increase in service demands, compatibility with current networks, managing users' intercellular mobility and offering better quality of service.
The solution proposed to meet these new requirements is the dimensioning of the EPC core network.

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The main aim of this project is to design and produce a computerized tool for sizing the EPC. The objectives of our work are in threefold : - to provide an architecture for interconnecting the EPC core network to the existing core network ; - to provide the methodology and process for sizing the core network of an EPS network; - design and implement an EPC core network dimensioning tool. In our work, traffic models are used to calculate the traffic generated by each technology to be connected to the core network. The resulting application, developed as part of our work, calculates the traffic and estimates the capacity of EPC network's core MME.

Keywords: 4G network (EPS); 3G network (UMTS); EPC network core; architecture; sizing; sizing tool; orange guinea; technology; service.

1. INTRODUCTION

As human societies evolve, the need for telecommunications services continues to grow and diversify. From text, voice and data communications, telecoms are now moving into multimedia, which encompasses both multimedia and video. The provision of these services is made possible by scientific, technical and technological progress. Users of these services are very demanding in terms of quality, availability and so on. These demands inevitably lead operators, the providers of these services, to adapt and size their networks on a regular basis [1,2].

This is the logic behind Orange Guinea, which is constantly making improvements to its network, thereby accentuating the quality of its services for the benefit of its customers [3,4].

On the other hand, the increase in quantity of services means high bandwidths - guaranteeing quality - and exorbitant costs.

Sizing a cellular network is a network engineering operation used to determine the volume of equipment and software to be deployed to provide telecommunications services, followed by planning [5,6].

The 4G network is a backbone network, meaning that its core EPC network is capable of supporting all access technologies without interrupting traffic. This requires optimal dimensioning [7].

This project is part of the sizing of the EPC core network and modeling and realization of a sizing tool. This EPC activates data services in high-speed PS mode, ensuring high-quality services for high-end customers [8].

The EPC is mainly made up of the following entities: MME, SGW, PGW, PCRF and HSS [8,9,10]. The MME entity is responsible for exchanging signalling with the mobile and with the access network, managing mobility, attachment and detachment and updating the TAI location zone. It manages the authentication procedure and the allocation of the temporary S-TMSI identity. The SGW entity transfers incoming data to the eNode B entity and outgoing data to the PGW entity. It initiates paging to the MME entity for incoming data. It is the anchor point for intra-E-UTRAN mobility. The PGW entity connects the EPS network to the PDN data network (the Internet). It is equivalent to the GGSN entity in the UMTS network. It is responsible for assigning the IP address to the mobile. It is the anchor point for inter SGW mobility and hosts the PCEF (Policy and Charging Enforcement Function). The PCRF entity provides the PCEF function of the PGW entity with the rules to be applied for charging and quality of service when support is to be established for the mobile. The HSS database is an integration of the functions performed by the HLR (Home Location Register) and AuC (Authentication Center) databases [11-13].

Sizing equipment means determining the capacity of its links [1].

Sizing EPC core network for the 4G network involves determining not only the equipment itself, but also its capacity [14].

The main objective of this project is to size the core network and develop a sizing tool. In addition to the main objective, the specific objectives targeted in this project are : - to provide a methodology for sizing the core network of an EPS network ; - design and produce a sizing tool.

2. MATERIALS AND METHODS

2.1 Location of the Study Area

Orange Guinea is a subsidiary of the SONATEL Group, which is a subsidiary of the ORANGE Group. Orange Guinea is a mobile operator created in 2007. On December 14th, 2011, it launched 3G+. Since August 2013, Orange Guinea has been the market leader in cellular telephony in the Republic of Guinea (Source: www.guineenews.org of October 29, 2013). In 2019, it launched the 4G network. It offers cell phone and internet services. Orange Guinea has two (2) sites housing the network cores: the Sonfonia exchange and the Camayenne exchange.

2.2 Materials

To design and produce this dimensioning tool, we used the following tools: - bibliographical information; - Word and PowerPoint software; - JAVA programming software; - ORACLE database software; - The work was carried out at the LEREA laboratory (Laboratoire d'Enseignement et de Recherche en Energétique Appliquée: Applied energetic research lecturing laboratory).

2.3 Methodology

2.3.1 Method description

The study is mainly based on the EPC. In the case of Orange Guinea, we propose to size the EPC core network of the 4G network, taking into account all access technologies and services required. We will then use assumptions to model the sizing tool.

2.3.2 EPC interconnection architecture with access technologies [7]; [15]

For the purposes of this tool, the access technologies considered are : EPS, UMTS, EVDO, GSM, WIMAX MOBILE, WIMAX FIXED, ADSL and TPoIP. The services taken into account are: conversational, interactive and streaming services. The figure below shows the EPC to which the various access technologies providing the different services are attached.

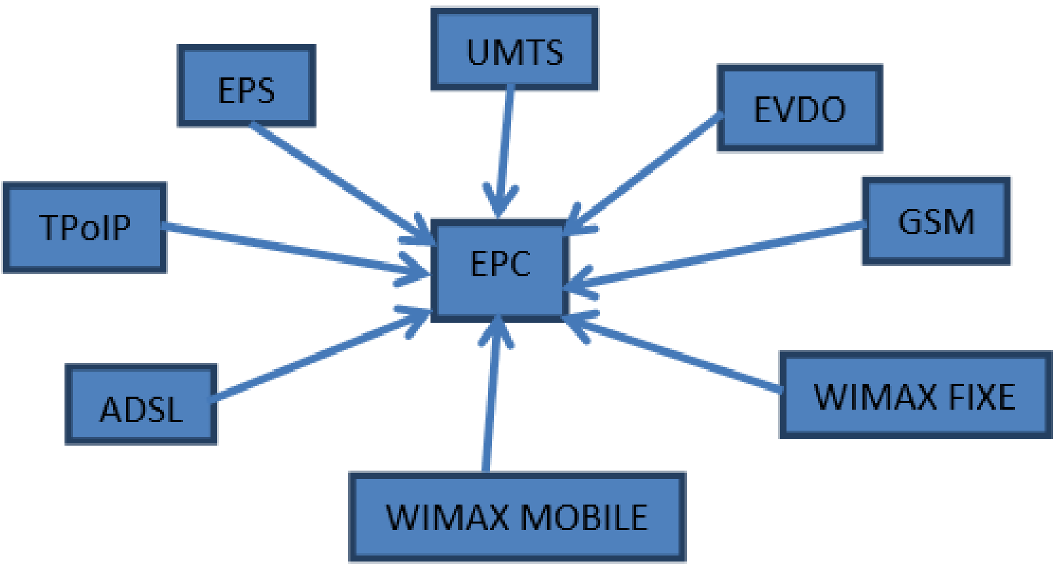


Fig. 1. Interconnection architecture from EPC to access technologies

Legend: EPC*: Evolved Packet Core;* ***EPS (LTE):*** *Evolved Packet System (Long Time Evolution);* ***UMTS:*** *Universal Mobile Telecommunications System;* ***EVDO:*** *Evolution Data Only;* ***GSM:*** *Global System for Mobile Communication;* ***WIMAX FIXE****: Worldwide Interoperability for Microwave Access Fixe;* ***WIMAX MOBILE****: Worldwide Interoperability for Microwave Access Mobile;* ***ADSL****: Asymmetric Digital Subscriber Line;* ***TPoIP:*** *Telephony over Internet Protocol*

2.3.3 Interconnection architecture for Sonfonia and Camayenne sites

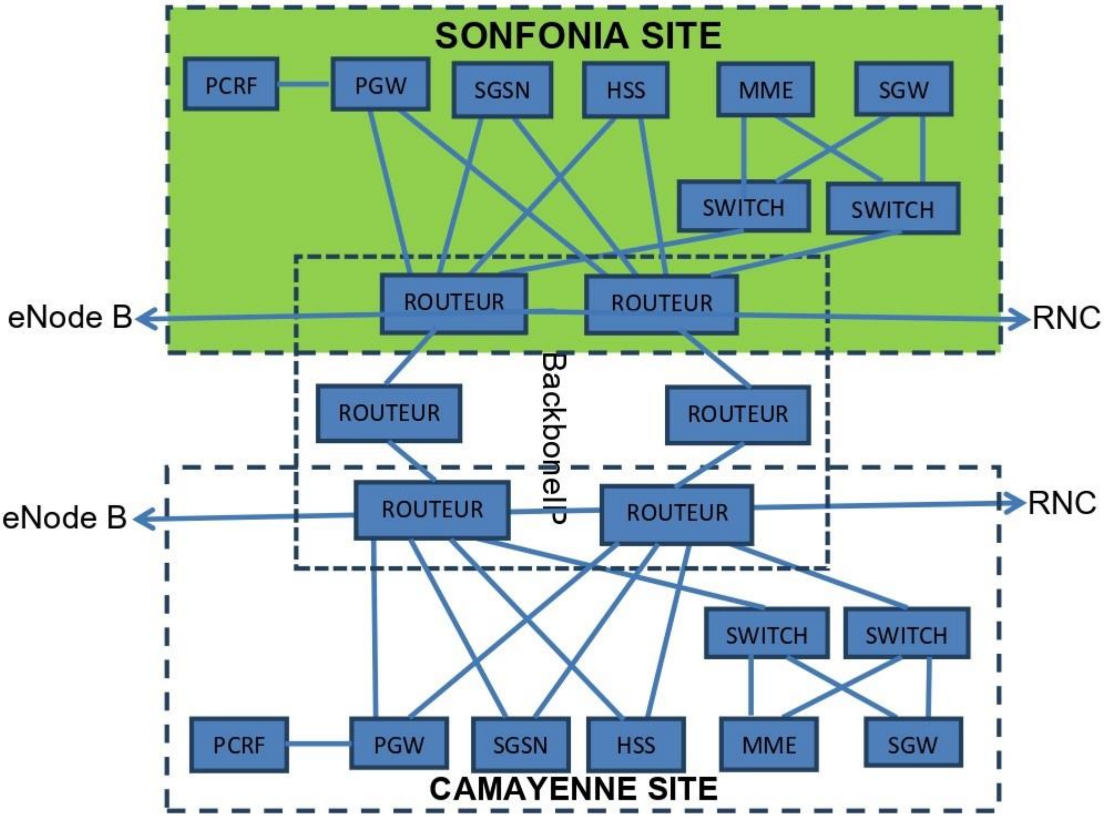


Fig. 2. Interconnection architecture for Sonfonia and Camayenne sites

Legend: PCRF: *Policy and Charging Rules Function* ***; PGW(PDN-GW) :*** *Packet Data Network Gateway* ***; SGSN:*** *Serving GPRS Support Node* ***; HSS:*** *Home Subscriber Server* ***; MME:*** *Mobility Management Entity* ***; SGW:*** *Serving Gateway*

Table 1. Subscriber parameters [16]

Parameter	Designation
Total number of subscribers	$Nb_{abonnés}$
Total mobile subscribers	$Nb_{abonnés}$ *(Mobile)*
Total number of fixed-line subscribers	$Nb_{abonnés}$ *(fixe)*
EPS subscribers as a percentage of mobile subscribers	$P_{abonnés}$ *(EPS/Mobile)*
UMTS subscribers as a percentage of mobile subscribers	$P_{abonnés}$ *(UMTS/Mobile)*
EVDO subscribers as a percentage of mobile subscribers	$P_{abonnés}$ *(EVDO/Mobile)*
WIMAX mobile subscribers as a percentage of mobile subscribers	$P_{abonnés}$ *(WIMAXm/mobile)*
GSM subscribers as a percentage of mobile subscribers	$P_{abonnés}$ *(GSM/Mobile)*
ADSL subscribers as a percentage of fixed-line subscribers	$P_{abonnés}$ *(ADSL/fixe)*
Fixed WIMAX subscribers as a percentage of fixed subscribers	$P_{abonnés}$ *(WIMAXf/fixe)*
TPoIP subscribers as a percentage of fixed-line subscribers	$P_{abonnés}$ *(TPoIP/fixe)*

$$Nb_{abonnés}(EPS) = P_{abonnés}(EPS/Mobile) * Nb_{abonnés}(Mobile) \quad (2.1)$$

$$Nb_{abonnés}(UMTS) = P_{abonnés}(UMTS/Mobile) * Nb_{abonnés}(Mobile) \quad (2.2)$$

$$Nb_{abonnés}(EVDO) = P_{abonnés}(EVDO/Mobile) * Nb_{abonnés}(Mobile) \quad (2.3)$$

$$Nb_{abonnés}(WIMAX\ M) = P_{abonnés}(WIMAXM/mobile) * Nb_{abonnés}(mobile) \quad (2.4)$$

$$Nb_{abonnés}(GSM) = P_{abonnés}(GSM/Mobile) * Nb_{abonnés}(Mobile) \quad (2.5)$$

$$Nb_{abonnés}(ADSL) = P_{abonnés}(ADSLM/fixe) * Nb_{abonnés}(fixe) \quad (2.6)$$

$$Nb_{abonnés}(WIMAX\ F) = P_{abonnés}(WIMAXF/fixe) * Nb_{abonnés}(fixe) \quad (2.7)$$

$$Nb_{abonnés}(TPoIP) = P_{abonnés}(TPoIP/fixe) * Nb_{abonnés}(fixe) \quad (2.8)$$

2.3.4 Sizing assumptions

In order to size the EPC, we will focus on peak-hour traffic. In the following, we assume that the access network traffic pattern corresponds to the busiest hour for EPC. Similarly, we assume that the distribution of conversational class traffic between packet and circuit mode is fixed, although the distribution of traffic even between the two circuit mode systems varies with time (the peak hour distribution is used as a reference). UMTS and EPS network penetration rates are fixed, independently of subscriber distribution.

Finally, we have assumed that any subscriber located under 3G+ coverage can use this technology with a maximum data rate of 2 Mbps. EPS subscribers can reach speeds of up to 75 Mbps [16]; [17].

2.3.5 Calculating traffic generated by access networks

- Subscriber distribution

First of all, we need to determine the number of subscribers for each active technology in the (central) site to be sized. To do this, we need the following data Table 1.

• Distribution of services

In the case of our study, the conversational service is offered by EPS, UMTS, GSM, ADSL and TPoIP technologies; the streaming service can be obtained with EPS, UMTS and ADSL; and the interactive service is provided by EPS, UMTS, EVDO, WIMAX MOBILE, WIMAX FIXED and ADSL networks [16].

• Determining traffic routed at access level [16], [18]**:**

Determining the traffic routed at access level is the basis for sizing the various network entities.

First, we determine the traffic generated by each service and technology, applying a traffic model appropriate to each.

For GSM, we have only the classic telephony service (in circuit mode). Its traffic, expressed in erlang, is determined by the following equation:

$$\text{Trafic}_{\text{généré}}\,(I) = \text{Nb}_{\text{abonnés}}\,(I) * \text{Trafic}_{\text{moyen/abonné}}\,(I) \quad (1)$$

Where I designates the GSM

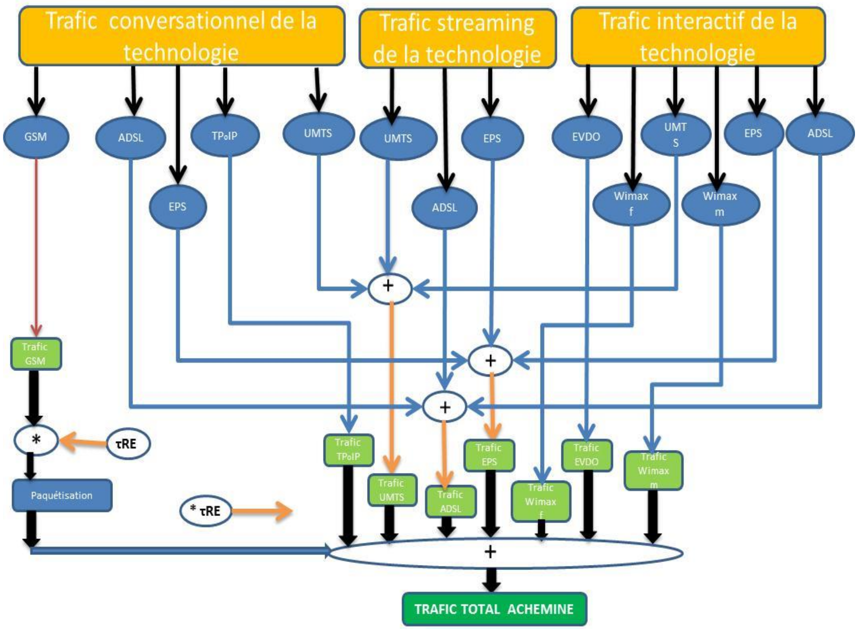


Fig. 3. Steps for calculating total traffic

***Legend: EPC**: Evolved Packet Core; **EPS (LTE):** Evolved Packet System (Long Time Evolution); **UMTS:** Universal Mobile Telecommunications System; **EVDO:** Evolution Data Only; **GSM:** Global System for Mobile Communication; **WIMAX FIXE**: Worldwide Interoperability for Microwave Access Fixe; **WIMAX MOBILE**: Worldwide Interoperability for Microwave Access Mobile; **ADSL**: Asymmetric Digital Subscriber Line; **TPoIP:** Telephony over Internet Protocol; **MME:** Mobility Management Entity**; CS:** Circuiy Switching; **PS:** Packet Switching*

Trafic ***moyen/abonné*** ***(I)*** is the average traffic per GSM subscriber.

The result obtained in erlang must be converted into Kbits so that it can be added to the conversational traffic generated by other technologies. To do this, perform the following steps :

1) Gather or be able to deduce the following operator data :

- Average call duration (DMC) in seconds
- Average number of call attempts per subscriber per busy hour (TAHC) per hour,
- The desired Grade of Service (GoS) at the Media Gateway switch interface.

The traffic generated in erlang is :

$$\alpha(\mathrm{I}) = \frac{\mathrm{Nb_{abonnés}\ (I)*TAHC(I)*DMC(I)}}{3600} \quad (2)$$

2) Calculate the number of circuits N required to carry this traffic, calculated in erlang using Rigault's formula:

N = α* k * $\sqrt{\alpha}$ (3)

with k = - 10 * log(GoS)
3) Calculate call rate

The call rate can be calculated by taking the following elements into account:

- audio codecs used at application layer level
- encapsulations used at different layers (transport, network)
- Link layer protocols.

For each site, it is assumed that there is a uniform choice between the different users of the various parameters: codec, packetization period, link-layer protocol.

The formula for calculating throughput per call is as follows :

$$\mathrm{D_{appel}} = \mathrm{Débit_{codec}} + \frac{\mathrm{Entête_{liaison} + En\ queue_{\ liaison}}}{\mathrm{Tp}} \quad (4)$$

With

- ***D appel*** : data rate per call in Kbps
- ***Débit codec*** : codec bit rate in Kbit/s
- ***T p*** : packetization period in ms
- ***Entête liaison*** : link-layer protocol header size in bits
- ***En queue liaison*** : link layer protocol tail size in Bits

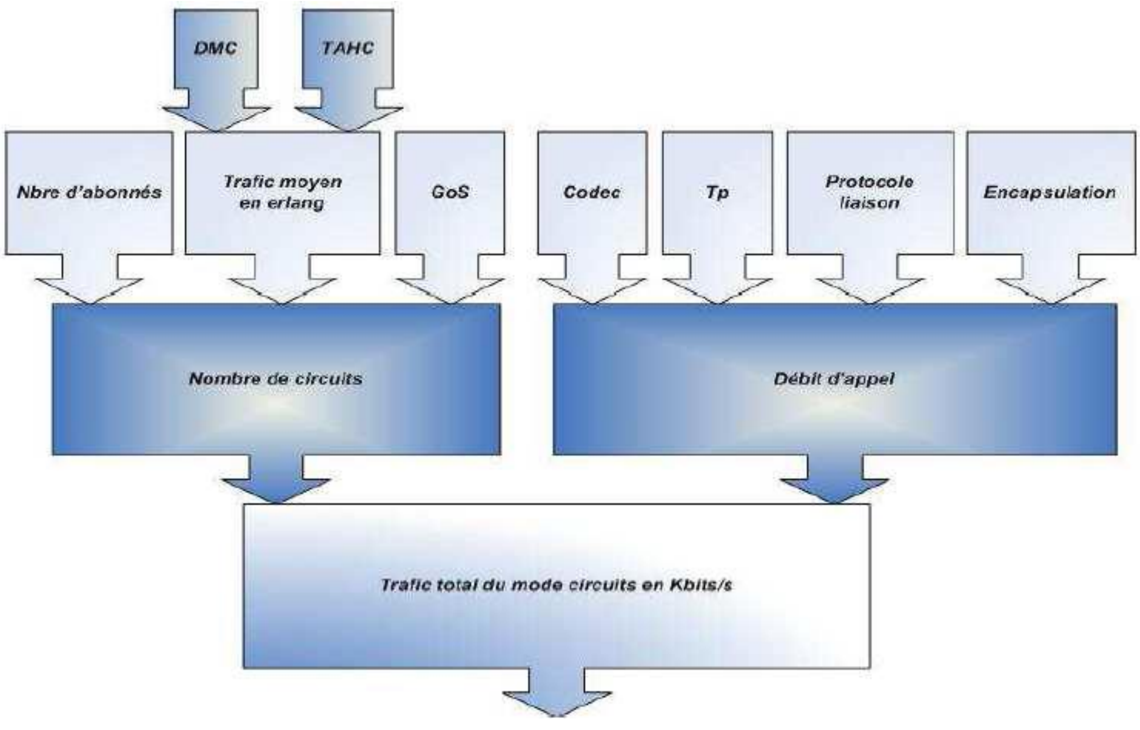


Fig. 4. Circuit mode traffic calculation steps

4) Calculate the bandwidth required to carry the generated traffic

$$\text{Trafic (Kbit/s)} = N * D_{appel} \quad (5)$$

For EPS, ADSL and UMTS technologies, we have conversational, streaming and interactive services.

First we need to determine the number of active subscribers per service and per technology. The number of active subscribers is given by equation (6) :

$$Nb_{abonnés}(I, J) = Nb_{abonnés}(I) * T_{activité}(J, I) \quad (6)$$

Where: I designates EPS, ADSL, UMTS, EVDO, WIMAX MOBILE, WIMAX FIXED or TPoIP.
J designates the Conversational, Interactive or Streaming service.

$T_{activité}$ (J, I) is the activity rate of service J of technology I.

***$Nb_{abonnés}$* (I, J)** is the number of active I subscribers to service J.

Under these conditions, the traffic generated by service J in technology I is generally modeled by the following equation :

$$Trafic_{généré}(I, J) = Nb_{abonnés}(I, J) * T_{appel}(J, I) * T_{appel}(J, I) * D_{max}(j, I) * T_{activité}(J, I) \quad (7)$$

where

$Trafic_{généré}$ (I, J) is the volume of traffic generated by service J on network I (in Kb/s) :

T_{appel} (J, I) is the call/hour/subscriber rate of service J for technology I (in calls/hour).

T_{appel} (J, I) is the call duration of service J for technology I (in s/call).

D_{max} (j, I) is the max throughput of servi J for technology I (in Kb/s).

$T_{activité}$ (J, I) is the activity rate of the service source J of technology I.

In general, the traffic generated by the service is calculated using the parameters corresponding to the technology used. We then calculate the traffic generated by each technology (EPS, UMTS, EVDO, WIMAX MOBILE, WIMAX FIXED, ADSL, TPoIP) :

$$Trafic_{généré}(I) = \Sigma_{J\in(\text{conversationnel, interactif, streaming})} Trafic_{généré}(J, I) \quad (8)$$

It is always assumed that :
$Trafic_{généré}$ (Interactif, GSM) = $Trafic_{généré}$ (Streaming, GSM) = 0

$Trafic_{généré}$ (Interactif, TPoIP) = $Trafic_{généré}$ (Streaming, TPoIP) = 0

$Trafic_{généré}$ (Streaming, WIMAX) = $Trafic_{généré}$ (Streaming, EVDO) = 0

$Trafic_{généré}$ (Conversationnel, WIMAX) = $Trafic_{généré}$ (Conversationnel, EVDO) = 0

Finally, having expressed all the traffic values generated by each technology in Kb/s, we simply add them together to determine the total load on the access network (in Kb/s).

$$Trafic_{générétotal} = \Sigma_{I\in(\text{EPS, UMTS, EVDO, WIMAXm, WIMAXf, GSM, ADSL, TPoIP})} Trafic_{généré}(I) \quad (9)$$

However, when sizing network entities, we're only interested in outgoing traffic. Not all traffic will be routed through the gateway. So, if we have external routing coefficient for each technology I: τRE (I), the traffic routed by each is determined by the following equation:

$$Trafic_{acheminé}(I) = Trafic_{généré}(I) * \tau RE(I) \quad (10)$$

Thus, the total traffic carried is the sum of the traffic carried by each technology :

$$Trafic_{acheminétotal} = \Sigma_{I\in(\text{EPS, UMTS, EVDO, WIMAXm, WIMAXf, GSM, ADSL, TPoIP})} Trafic_{acheminé}(I) \quad (11)$$

2.3.6 Sizing process [19]; [16]

a) MME sizing

The MME entity is responsible for processing and exchanging signaling with the mobile and with the access network. It manages mobile-related contexts.

The sizing of an MME consists in determining its switching capacity, which is equivalent to determining the capacity of its interfaces. Interface capacity is equal to the total traffic routed through this MME, determined by equation (2.19). All packet traffic passes directly through the MME. Remember that voice traffic must be packetized before being injected into the PS mode. Depending on the bit rate generated by the audio codec, and taking into account the different possibilities of packetization periods, we can obtain the size of the audio data. This audio data is then encapsulated at various layers, from the transport layer to the data link layer.

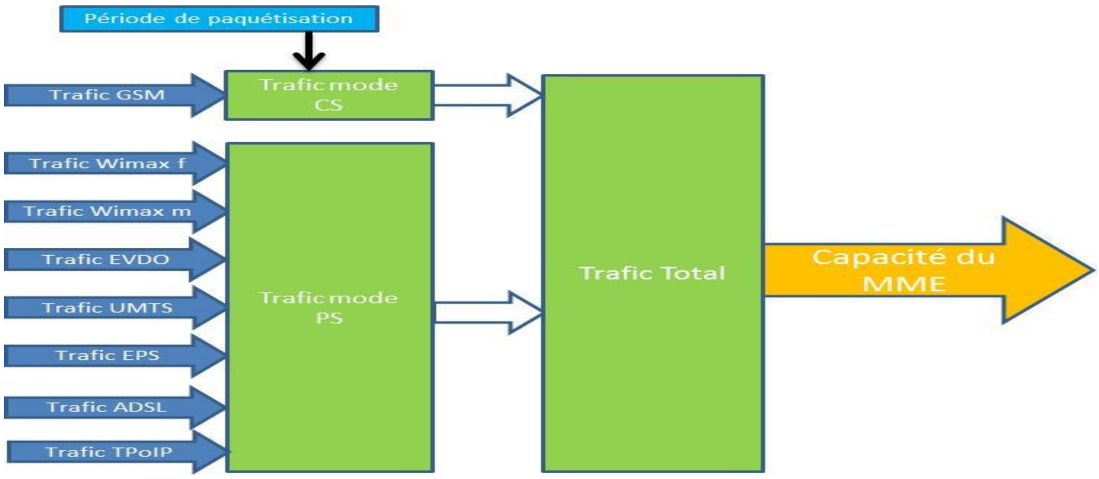


Fig. 5. Calculation of MME capacity

***Legend: EPC**: Evolved Packet Core; **EPS (LTE):** Evolved Packet System (Long Time Evolution); **UMTS:** Universal Mobile Telecommunications System; **EVDO:** Evolution Data Only; **GSM:** Global System for Mobile Communication; **WIMAX FIXE**: Worldwide Interoperability for Microwave Access Fixe; **WIMAX MOBILE**: Worldwide Interoperability for Microwave Access Mobile; **ADSL**: Asymmetric Digital Subscriber Line; **TPoIP:** Telephony over Internet Protocol; **MME:** Mobility Management Entity**; CS:** Circuiy Switching; **PS:** Packet Switching.*

The traffic generated by circuit-switched networks and calculated from formula (2.13) will be added together with all packet traffic. The capacity of an MME can also be determined in terms of the number of chassis. If the chassis capacity is available, the number of MMEs will be determined as follows:

$$N_{MME} = E\left(\frac{MME\ capacity}{\text{châssis capacity}} + 1\right) \quad (12)$$

Where E is the integer function

b) SGW sizing

The SGW is a data transfer entity.
Like the MME, it manages mobile-related contexts.
SGW sizing is therefore quantitatively analogous to MME sizing.
N.B.: The MME and SGW can be considered as a single entity for data transfer and switching.

Thus $N_{SGW} = N_{MME}$ (13)

c) PGW sizing

The PGW entity connects the EPS network to the PDN data network (the Internet). It is a gateway that assigns the IP address to the cell phone and hosts the PCEF (Policy and Charging Enforcement Function). Their dimensioning is not taken into account here.

d) PCRF dimensioning

The PCRF entity provides the PCEF function of the PGW entity with the rules to be applied for charging and quality of service when support is to be established for mobile. Their dimensioning is not taken into account here.

2.3.7 General sizing parameters [5]; [16]

For the purposes of this sizing tool, and taking into account Orange Guinea's tendency to extend its fixed and mobile networks, we have set the number of mobile subscribers at 6,000,000 and the number of fixed subscribers at 500,000. Orange Guinea has two core network exchanges: one in Sonfonia and the other in Camayenne, both in Conakry.

Subscribers will be distributed between these two central sites at a rate of 50% each, with the precaution that if one of the two should break down, the other will take over all traffic.
The routing rate between these two sites is set at 12%.

3. RESULTS AND DISCUSSION

Having detailed the sizing process for an EPC, the next step in our work is to design and produce a tool that implements the various phases of the process. Indeed, the automation of the sizing process is of great use given the complexity of this task.

We will present the simulator we have developed, describing the structure of its interface, its conceptual approach and the methodology for its use.

3.1 Tool Specifications [1]; [16]

Before the design phase, we start by specifying the functional requirements for our tool. These requirements are essential to guarantee the tool's performance.

The main functions of our tool are :

- Traffic estimation and calculation
- EPC core network dimensioning

In addition, we will apply the performance of this tool to the Orange Guinea network.

3.2 Development Environment [20]; [16]

We have opted for a SETUP interface, and the necessary calculations have been made in Java, while the database is in ORACLE SQL DEVELOPER version 4.0.3. It is quite obvious to justify our choice because :

- Our tool operates in a client-machine environment.
- Java, with its object-oriented programming features, is highly efficient for handling form data.

3.3 Specification [19]; [16]

Table 2 shows the input parameters and expected results (outputs) of the core network sizing part of our simulator.

3.4 Using the Tool [19]; [16]

On the home page of our tool, the user is offered the option of opening an old project, reading its contents or modifying it by clicking on modify, or creating a new project by clicking on new. Of course, only after entering a valid login and password.

If you choose to create a new project, by clicking on new, the following interface appears :

On this interface, you enter the project name and description. Once validated, the project is added to the list of existing projects.

After selecting the project, entering a valid login and password, and validating, the following interface appears.

● **Global Report :** displays the global results of a given project, of course after calculating the I/O parameters of both exchanges (Sonfonia and Camayenne)

● **Report by exchange :** displays overall calculation results for an exchange in the project

-I/O parameters : this sub-menu allows you to enter the input parameters of a central unit and view the output parameters by clicking on "Validate".

Users can load default values by clicking on "PMT Camayenne" or "PMT Sonfonia", or enter other specific values.

3.5 Summary of Sizing Results

This sizing tool for the EPC of the EPS produced the following results :

Table 2. Core network simulator parameters

INPUTS	OUTPUTS
General parameters	Traffic
Number of mobile and fixed subscribers	Traffic generated by each technology
Characterization of different exchange traffic models	Traffic generated by each service
Exchange parameters	Total traffic generated by each exchange
Number of mobile and fixed subscribers	Total traffic generated
Supported technologies	Equipment
Service activity rates	MME capacity
Technology parameters	Architecture
Number of subscribers	The final architecture of the EPC in the dimensioned exchange.
Services offered	

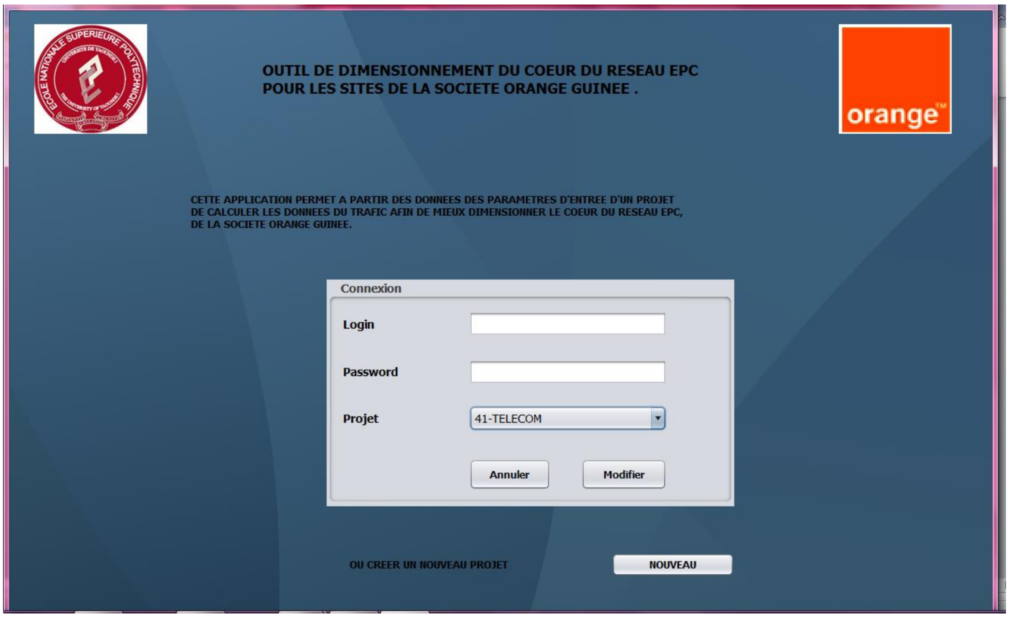


Fig. 6. Application home page

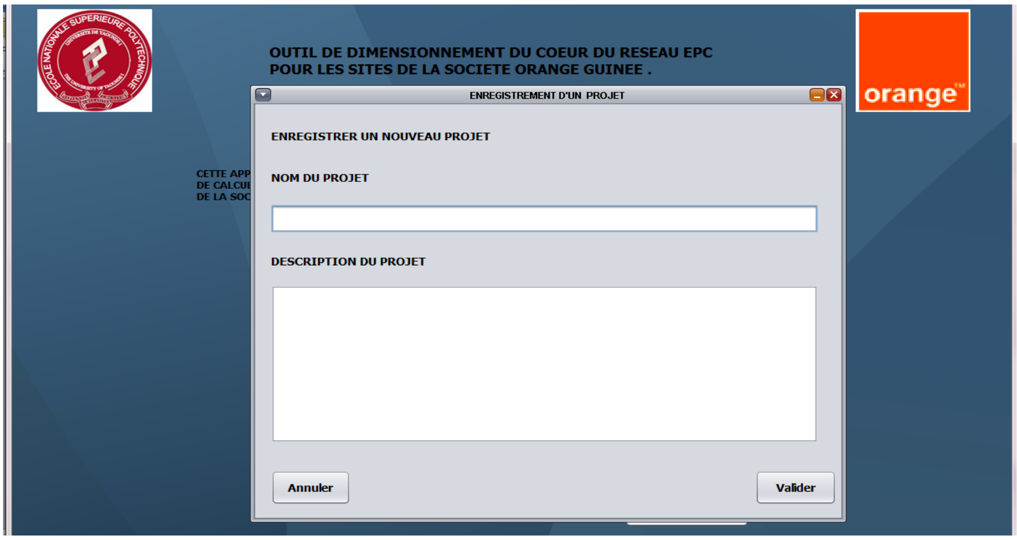


Fig. 7. New project creation interface

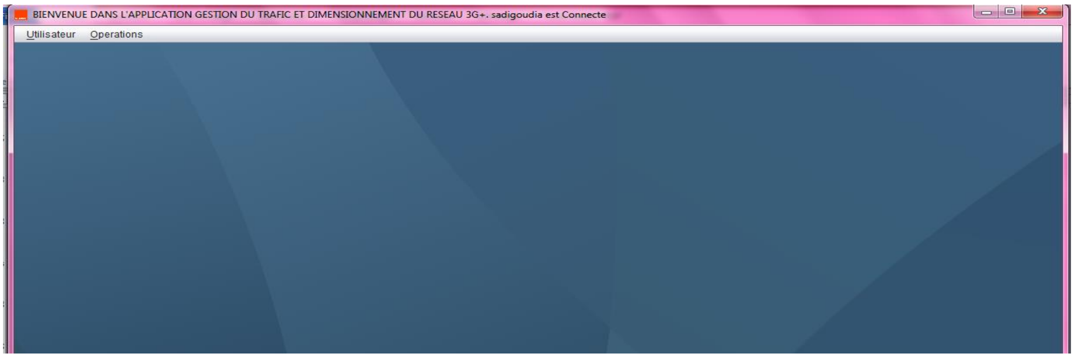
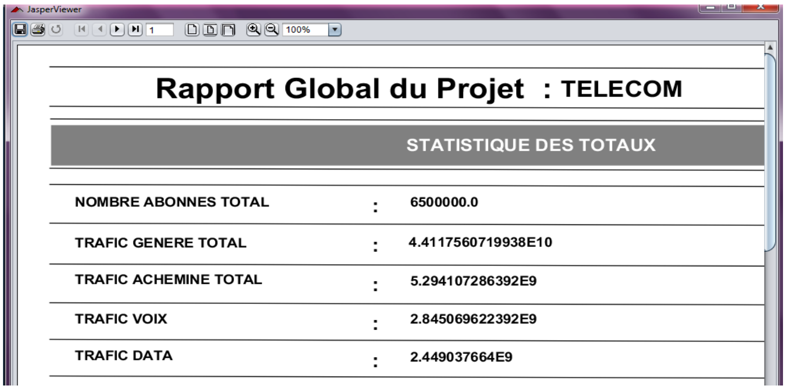


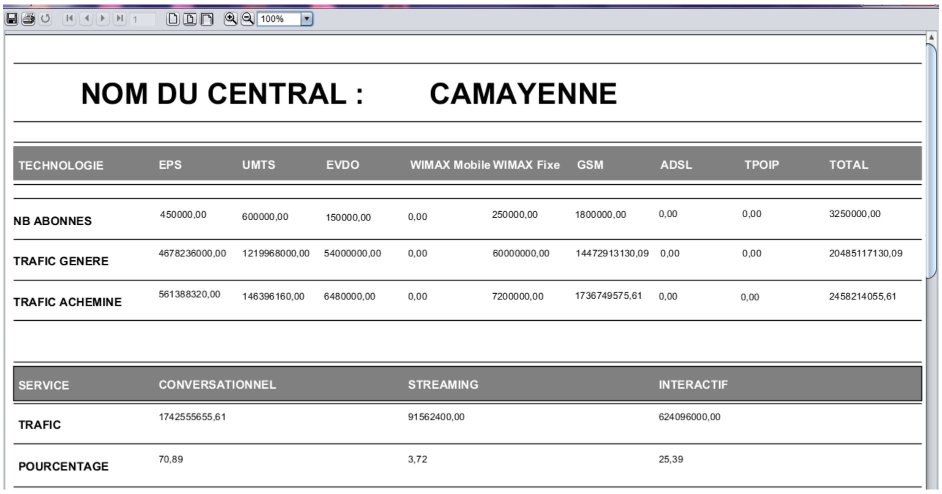
Fig. 8. Project menus



Rapport Global du Projet : TELECOM

STATISTIQUE DES TOTAUX		
NOMBRE ABONNES TOTAL	:	6500000.0
TRAFIC GENERE TOTAL	:	4.4117560719938E10
TRAFIC ACHEMINE TOTAL	:	5.294107286392E9
TRAFIC VOIX	:	2.845069622392E9
TRAFIC DATA	:	2.449037664E9

Fig. 9. Overall project results (here TELECOM)

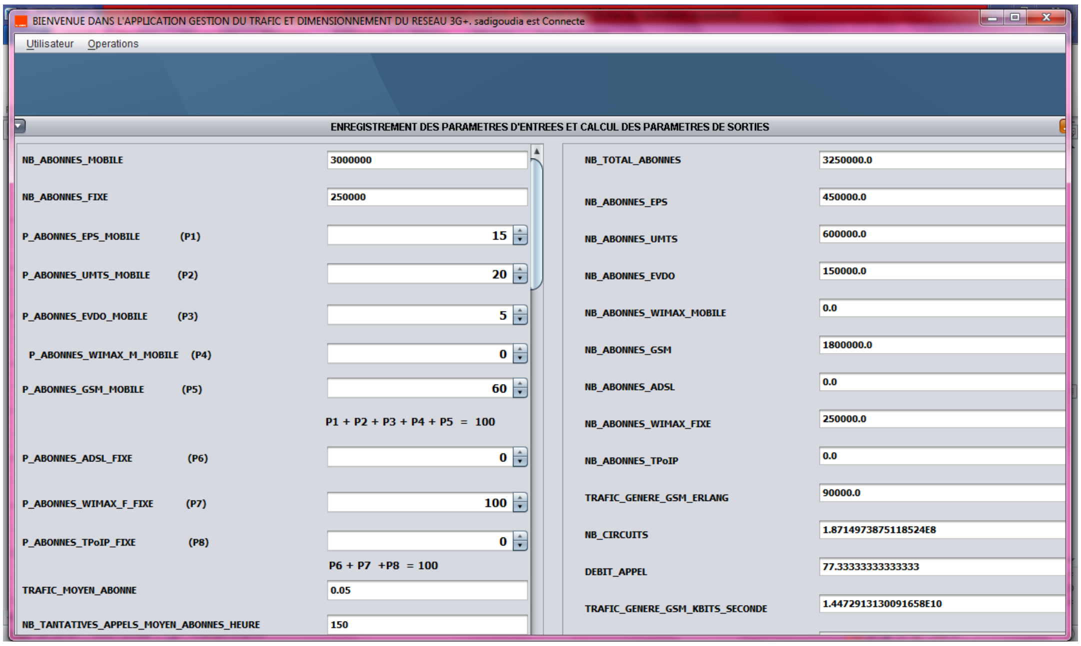


NOM DU CENTRAL : CAMAYENNE

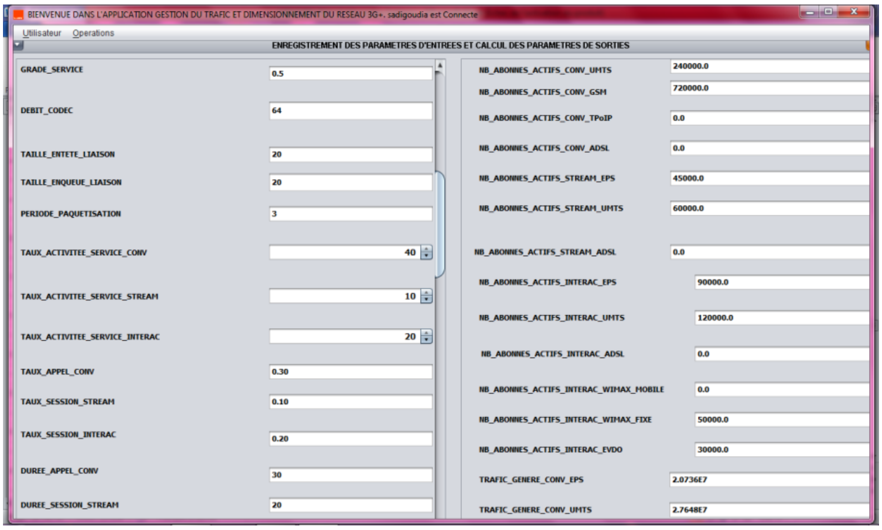
TECHNOLOGIE	EPS	UMTS	EVDO	WIMAX Mobile	WIMAX Fixe	GSM	ADSL	TPOIP	TOTAL
NB ABONNES	450000,00	600000,00	150000,00	0,00	250000,00	1800000,00	0,00	0,00	3250000,00
TRAFIC GENERE	4678236000,00	1219968000,00	54000000,00	0,00	60000000,00	14472913130,09	0,00	0,00	20485117130,09
TRAFIC ACHEMINE	561388320,00	146396160,00	6480000,00	0,00	7200000,00	1736749575,61	0,00	0,00	2458214055,61

SERVICE	CONVERSATIONNEL	STREAMING	INTERACTIF
TRAFIC	1742555655,61	91562400,00	624096000,00
POURCENTAGE	70,89	3,72	25,39

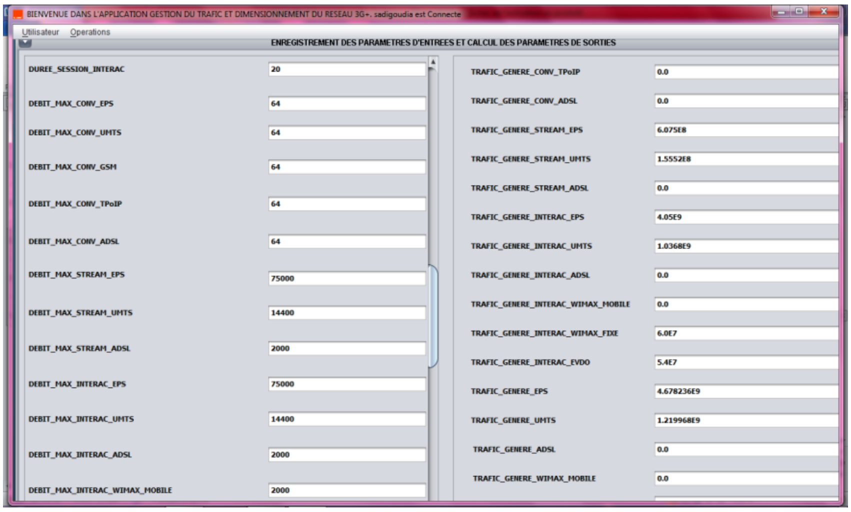
Fig. 10. Overall results for Camayenne central station



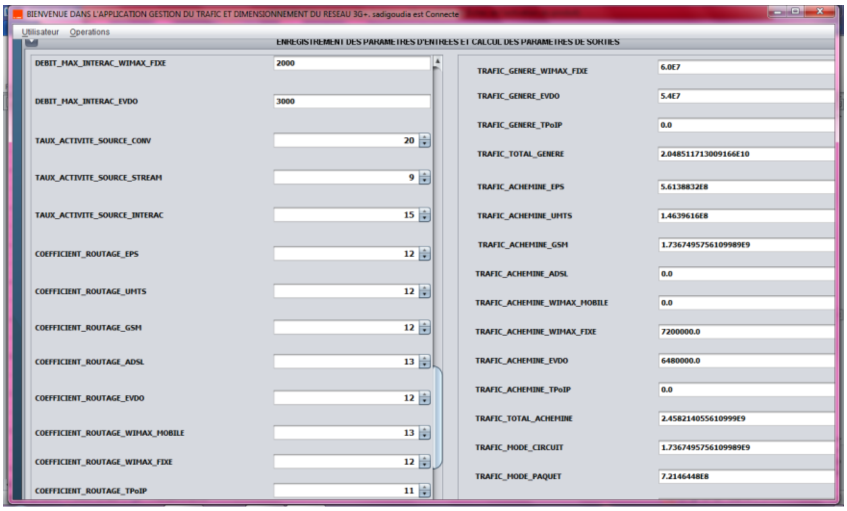
a)


BIENVENUE DANS L'APPLICATION GESTION DU TRAFIC ET DIMENSIONNEMENT DU RESEAU 3G+, sadigoudia est Connecte
Utilisateur Operations
ENREGISTREMENT DES PARAMETRES D'ENTREES ET CALCUL DES PARAMETRES DE SORTIES
GRADE_SERVICE 0.5
DEBIT_CODEC 64
TAILLE_ENTETE_LIAISON 20
TAILLE_ENQUEUE_LIAISON 20
PERIODE_PAQUETISATION 3
TAUX_ACTIVITEE_SERVICE_CONV 40
TAUX_ACTIVITEE_SERVICE_STREAM 10
TAUX_ACTIVITEE_SERVICE_INTERAC 20
TAUX_APPEL_CONV 0.30
TAUX_SESSION_STREAM 0.10
TAUX_SESSION_INTERAC 0.20
DUREE_APPEL_CONV 30
DUREE_SESSION_STREAM 20
NB_ABONNES_ACTIFS_CONV_UMTS 240000.0
NB_ABONNES_ACTIFS_CONV_GSM 720000.0
NB_ABONNES_ACTIFS_CONV_TPoIP 0.0
NB_ABONNES_ACTIFS_CONV_ADSL 0.0
NB_ABONNES_ACTIFS_STREAM_EPS 45000.0
NB_ABONNES_ACTIFS_STREAM_UMTS 60000.0
NB_ABONNES_ACTIFS_STREAM_ADSL 0.0
NB_ABONNES_ACTIFS_INTERAC_EPS 90000.0
NB_ABONNES_ACTIFS_INTERAC_UMTS 120000.0
NB_ABONNES_ACTIFS_INTERAC_ADSL 0.0
NB_ABONNES_ACTIFS_INTERAC_WIMAX_MOBILE 0.0
NB_ABONNES_ACTIFS_INTERAC_WIMAX_FIXE 50000.0
NB_ABONNES_ACTIFS_INTERAC_EVDO 30000.0
TRAFIC_GENERE_CONV_EPS 2.0736E7
TRAFIC_GENERE_CONV_UMTS 2.7648E7

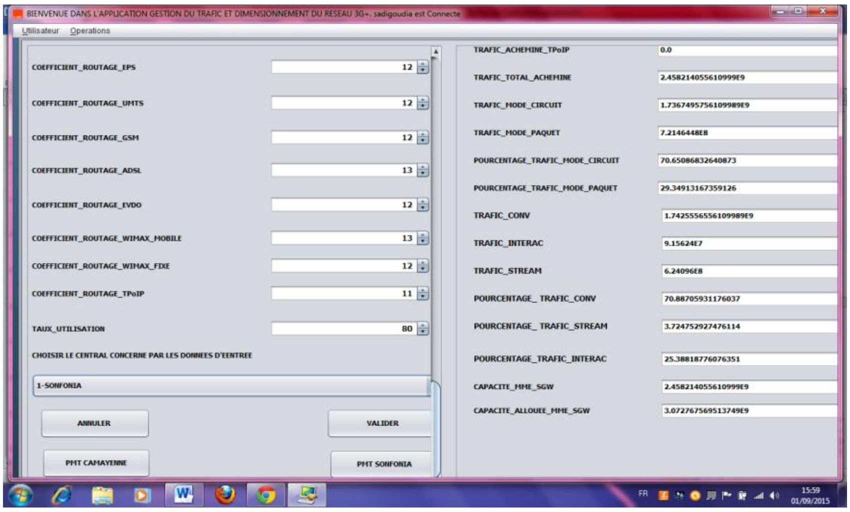
b)


BIENVENUE DANS L'APPLICATION GESTION DU TRAFIC ET DIMENSIONNEMENT DU RESEAU 3G+, sadigoudia est Connecte
Utilisateur Operations
ENREGISTREMENT DES PARAMETRES D'ENTREES ET CALCUL DES PARAMETRES DE SORTIES
DUREE_SESSION_INTERAC 20
DEBIT_MAX_CONV_EPS 64
DEBIT_MAX_CONV_UMTS 64
DEBIT_MAX_CONV_GSM 64
DEBIT_MAX_CONV_TPoIP 64
DEBIT_MAX_CONV_ADSL 64
DEBIT_MAX_STREAM_EPS 75000
DEBIT_MAX_STREAM_UMTS 14400
DEBIT_MAX_STREAM_ADSL 2000
DEBIT_MAX_INTERAC_EPS 75000
DEBIT_MAX_INTERAC_UMTS 14400
DEBIT_MAX_INTERAC_ADSL 2000
DEBIT_MAX_INTERAC_WIMAX_MOBILE 2000
TRAFIC_GENERE_CONV_TPoIP 0.0
TRAFIC_GENERE_CONV_ADSL 0.0
TRAFIC_GENERE_STREAM_EPS 6.075E8
TRAFIC_GENERE_STREAM_UMTS 1.5552E8
TRAFIC_GENERE_STREAM_ADSL 0.0
TRAFIC_GENERE_INTERAC_EPS 4.05E9
TRAFIC_GENERE_INTERAC_UMTS 1.0368E9
TRAFIC_GENERE_INTERAC_ADSL 0.0
TRAFIC_GENERE_INTERAC_WIMAX_MOBILE 0.0
TRAFIC_GENERE_INTERAC_WIMAX_FIXE 6.0E7
TRAFIC_GENERE_INTERAC_EVDO 5.4E7
TRAFIC_GENERE_EPS 4.678236E9
TRAFIC_GENERE_UMTS 1.219968E9
TRAFIC_GENERE_ADSL 0.0
TRAFIC_GENERE_WIMAX_MOBILE 0.0

c)


BIENVENUE DANS L'APPLICATION GESTION DU TRAFIC ET DIMENSIONNEMENT DU RESEAU 3G+, sadigoudia est Connecte
Utilisateur Operations
ENREGISTREMENT DES PARAMETRES D'ENTREES ET CALCUL DES PARAMETRES DE SORTIES
DEBIT_MAX_INTERAC_WIMAX_FIXE 2000
DEBIT_MAX_INTERAC_EVDO 3000
TAUX_ACTIVITE_SOURCE_CONV 20
TAUX_ACTIVITE_SOURCE_STREAM 9
TAUX_ACTIVITE_SOURCE_INTERAC 15
COEFFICIENT_ROUTAGE_EPS 12
COEFFICIENT_ROUTAGE_UMTS 12
COEFFICIENT_ROUTAGE_GSM 12
COEFFICIENT_ROUTAGE_ADSL 13
COEFFICIENT_ROUTAGE_EVDO 12
COEFFICIENT_ROUTAGE_WIMAX_MOBILE 13
COEFFICIENT_ROUTAGE_WIMAX_FIXE 12
COEFFICIENT_ROUTAGE_TPoIP 11
TRAFIC_GENERE_WIMAX_FIXE 6.0E7
TRAFIC_GENERE_EVDO 5.4E7
TRAFIC_GENERE_TPoIP 0.0
TRAFIC_TOTAL_GENERE 2.048511713009166E10
TRAFIC_ACHEMINE_EPS 5.6138832E8
TRAFIC_ACHEMINE_UMTS 1.4639616E8
TRAFIC_ACHEMINE_GSM 1.736749575610998E9
TRAFIC_ACHEMINE_ADSL 0.0
TRAFIC_ACHEMINE_WIMAX_MOBILE 0.0
TRAFIC_ACHEMINE_WIMAX_FIXE 7200000.0
TRAFIC_ACHEMINE_EVDO 6480000.0
TRAFIC_ACHEMINE_TPoIP 0.0
TRAFIC_TOTAL_ACHEMINE 2.458214055610999E9
TRAFIC_MODE_CIRCUIT 1.736749575610998E9
TRAFIC_MODE_PAQUET 7.2146448E8

d)



e)

Fig. 11. Inputs and outputs of Sonfonia exchange

Table 3. Sizing tool for the EPC of the EPS

For a central	For a project
- Total number of subscribers ;	- Total number of subscribers
- Number of subscribers by technology	- Total traffic generated
- Traffic by technology	- Total routed traffic
- Traffic by service	- Voice traffic (conversational)
- Total traffic	- Data traffic (streaming and interactive).
- Circuit mode traffic	
- Packet mode traffic	
- MME capacity.	

3.6 List of Recommendations

Taking into account the sizing results obtained, Orange Guinea, the leading operator in Guinea, will be able to size its EPC core network according to the following recommendations :

- Pay particular attention to the sizing of the EPC;
- Start by drawing up an optimal strategy and action plan for sizing the EPC, as this is not an easy task ;
- Taking into account the advantages of the EPS (data rates, user throughput 7 times higher than HSPA+, data processing speed, capacity, higher number of frequency bands, full IP, packet switching, simplicity, lower operating costs, the ability to connect to multiple sites, etc.), size the EPC core network at the Sonfonia and Camayenne sites ;
- Use the architectures shown in Figs. 1 and 2 to design and implement the tool ;
- Optimize the sizing of the EPC at these sites ;
- Equip each exchange with an MME of sufficient capacity (taking into account the result indicated by the simulator) ;
- Install application servers and HSS at each exchange ;
- Make forecasts to meet the needs of its growing number of subscribers in terms of throughput, capacity and quality of service over the medium and long term.

4. CONCLUSION

The ever-increasing need for broadband networks for the Internet on the one hand, and multimedia services on the other, is forcing operators to adapt their networks by adopting new core network architectures. The EPC core network of the 4G network can support all access technologies. That's why it's so useful to design and implement a sizing tool. This is the background to our project, in which we proposed to size the EPC of Orange Guinea's EPS (4G) network.

The EPC core network is a reliable, high-performance data switching network. It offers huge data rates (up to 100 Mbps).

We began by presenting the architecture of Orange Guinea's core network. We also studied the sizing process based on this architecture, traffic calculation and entity sizing.

We then modeled and produced a sizing tool and applied it to the case of Orange Guinea, based on the knowledge and estimation of parameters including the traffic models of Sonfonia and Camayenne exchanges.

The results enabled us to obtain the traffic and estimate the capacity of the MME.

As a general rule, equipment sizing is based on its cards.

If a card's utilization rate (capacity used/capacity allocated) reaches 60%, the card must be oversized, or replaced by a higher-capacity card.

If an equipment's utilization rate reaches 80%, it should be oversized.

If the utilization rate of a license reaches 85%, a new license is required.

At the end of this study, we proposed a list of recommendations to follow when sizing the EPC. These are essentially to optimally size the EPC in the two sites of Sonfonia and Camayenne; these two sites are located in the capital of Conakry, which is the densest region in terms of population and traffic, and most active in terms of demand for services.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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