Scenario-Oriented Parameters Optimization and Configuration Methods and Processes in TD-LTE

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***Abstract*—TD-LTE technology put up some new challenge to network optimization and configuration. In this paper, we grouped the parameters and KPIs(Key Performance Index) into 9 kind of dimensions according to scenarios in TD-LTE, they are basic information of RAN, basic physical/logical resources allocated to network elements, time interval/event scenarios, geographical scenarios, users' mobility, service models, RF propagation models, relevant parameters KPIS individually. We designed a match algorithm to manage the parameters and KPIs. Classification of the parameters and KPIS can facilitated the work of optimization of the TD-LTE, and match function can efficiently accelerate the planning process of new TD-LTE network or new basestations. At last, we developed a platform to implement the algorithm and other functions.**

Keyword*—*TD-LTE, optimazation , parameter configuration, scenario-oriented, RAN.

I. Introduction

As TD-LTE (Time Division Long Term Evolution) has reached its commercial deployment phase, it is high time to do much more research to facilitate the planning and optimization of the TD-LTE network. One of the prominent characterizations of TD-LTE is 'simple architecture'[1]. The architecture of LTE is flat, and E-NodeBs of LTE replace RNC-NodeB structure in UMTS, shown in figure 1. All the information is transmitted by IP among all network nodes, the CS service in UTRAN can be carried by PS in LTE. Such changes and the characteristic of high frequency effectiveness and high user density affect the planning and optimization of network.

Good dimensioning and deployment are the fundamental of a good operational network, and parameters and their configurations in running network play key roles to the quality of a mobile network, so configuration and optimization of wireless parameters are essential processes to the construction an effective and efficient wireless mobile network.

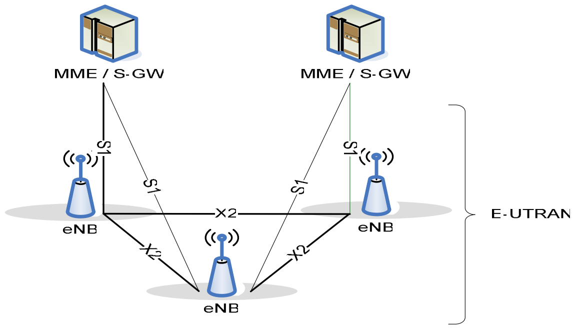

Figure 1 structure of the LTE [1]

Key Performance Indicators (KPIs) like coverage rates and successful handover rates are the objective indicators to measure the quality of wireless mobile network. There are many system and running parameters which can affect KPIs in a running wireless mobile network. Generally, these parameters can be divided into two classes: one is about the physical resources and environment, such as radio frequency (RF), number of carrier frequencies or channels, antenna types etc, the other is involved with the users' behaviours, which include users' mobility and the characteristic of services used. The users' mobility behaviour refers to how fast the users move when they use the wireless mobile services, and the characteristic of services used include service penetration, frequencies of some kind of service used, and the number of users of some kind of service, etc. Many works have been done to improve the effectiveness and reliability of algorithms to network planning and optimization[2-6]. In this paper, we will go through the engineering details about how to organize and arrange all parameters and KPIs to simplify the configuration of parameters and to accelerate the efficiency of and productivity of planning and optimization engineers.

A cost efficient and well-running wireless network requires good planning and reasonable system parameters configuration. To plan and configure a TD-LTE network effectively, we should take all the system parameters and the running conditions into consideration. There are hundreds of parameters and KPIs needed to be taken account of to maintain an operational wireless mobile network in good condition. These parameters distribute among the whole network without explicit regular patterns, maintenance staff who want to check or configure these parameters need to have the detailed knowledge of the location and the organizational structure of the involved parameters. Though such process is very complicated, it's OK to senior maintenance personnel. However, there are many junior maintenance workers who are just to change or modify some parameters according to the corresponding instructions, these workers don't or can't have a thorough understanding of the network. To facilitate the management and configuration work of such junior maintenance workers, we designed and implemented a system help their work.

The rest of paper is organized as follows. Section 2 discusses the classification of parameters and KPIs. Section 3 introduces match algorithm. Section 4 puts up system discussion. Section 5 concludes the paper and presents ideas for future research work.

II. SYSTEM DESIGN

In any well-running mobile systems, there are crucial relationship between parameters and KPIs. In TD-LTE, the following parameters can affect the KPIs are considered, including basic physical/logical resources allocated to network elements, users' mobility pattern, system parameters configuration, geography scenarios, time interval/event scenarios.

Generally, the physical/logical resources and geography conditions can be seen as fixed in a short period. Users' mobility pattern is dynamic and uncontrollable but predictable. The variation of users' behaviour results in the change of load of the network and the consumption of system resources, which in turn will impact the KPIs. In this paper, we try to build some model to show the relationship between parameters and KPIs, so we can dynamically adjust the parameters to maintain the quality of network at a high level. If there does not exist TD-LTE network, the model can be used during simulating phrase to give some sound parameter configuration reference to sustain a group of acceptable KPIs.

A. Dimension partition

First in all, we grouped the parameters and KPIs of TD-LTE into 9 dimensions as follows in order to setup the parameter-KPI model:

Basic information of RAN: Basic information of RAN includes bases of TD-LTE planning and optimizing. Such information can be described as identifications and names of E-NodeB, types of base-stations, types of terrains, longitude and latitude of E-NodeB etc. This information lays the system foundation and it affects the RF propagation model.

Basic physical/logical resources allocated to network elements: Physical wireless resources are consisted of many parameters. They can be carrier frequency, time slot, code, transmitting power and number of antenna related etc in the light of context. The number of frequency, time slot and code are very important parameters to the capacity of wireless network. However, antenna parameters are directly related to the coverage of a wireless system. These parameters are azimuth, downtilt, polarization of antenna, half Power angle， VSWR (Voltage Standing Wave Ratio) etc.

According to the different types of multiplexing and modulation, physical wireless resources include carrier frequency, time slot, code and transmitting power etc. The information related to these physical resources forms the adaptable parameters to optimize the performance of network to meet the users' need.

Time interval/event scenarios: The number of users per square meter varies dramatically from time to time, future more, the number of users per square meter changes with the different event. Therefore, time interval/event scenario is another important basic information needed to be considered. In this design, time interval/event scenarios are divided into national festivals and holidays, weekends and weekdays, important/great event period such as rallies, games and other important activities, and normal days. There is different number of users in same cell or E-NodeB depending on different time interval, and the number of users affects the performance of network networks, so we need to put some efforts to research the users' distribution according to time interval/event scenario.

Geographic scenarios: The open air interface in wireless mobile system determines the system performance on the basis of the environmental settings. In light of propagation characteristic and applications of TD-LTE, there are several geographical scenarios partitioning ways. Generally, it can be divided into two general classes, indoor and outdoor. Indoor environment can be subdivided into subclasses according to the utility of the building or other special regulation. Outdoor environment can be subdivided into subclasses as hotspots, dense urban areas, sparse urban areas, countryside etc.

Users' mobility pattern: To maintain users' live service linkage, the mobile system has to know the users' location exactly at any moment. Therefore, the mobile system has to trace a user's speed and moving trajectory to maintain a traceable context. The mobile users' speed can be high speed, medium speed and pedestrian speed and relative static. The users' mobility pattern impacts the location registration and handover process, and in turn, it impacts the handover related KPIs.

Service models: In TD-LTE, the mobile network will support almost all existing services, including voice, text, image, audio, video and their various combinations. Different service has distinctly different property which has different QoS requirement and requires different system resources. Mobile IP introduces much more services into the public land mobile network. These services and their models impact the system parameters configuration and sresources allocation.

RF propagation models: The wireless channel illustrates different propagation characteristic according to different geomorphic features. RF propagation models are determined by such parameters like the antenna directivity diagram, polarization of an antenna, isolation between antennae, shadow fading biases, shadow fading updating cycle, fast fading updating cycle etc. The path loss is calculated from RF propagation models, so is the coverage.

Relevant parameters: Except the parameters mentioned above, there are other several classes of parameters in TD-LTE needed to be taken into account to maintain an acceptable network. These relevant parameters are access configuration parameters, handoff configuration parameters, power control configurations parameters, and resource scheduling configuration parameters etc. These parameters support other parameters and algorithms to facilitate the network running in a good state.

KPIs: KPIs are results to illustrate the running state of mobile network. There are diverse KPIs responding to diverse aim. The KPIs can be divided into several classes, such as indicators about coverage, indicators involved in call setup, indicators about call holding, indicators involved in mobility management, indicators of delay, and indicators involved with system resources.

B. Similarity matching algorithm

After designing the above mentioned parameters, we try to design a matching algorithm to accelerate and simplify the configuration work of the new-built E-NodeB. In this system, we borrowed the search tree algorithms to design our matching algorithm. Each scenario acts as a node of the similar tree, the scenario is gradually specific from top to bottom, shown as figure 2. During the process of matching, the new scenario is compared to the existed one from the bottom to top until find the similar scenario. If a new E-NodeB has built, we need to configure it with appropriate parameters to meet the basic KPI requirements. At the beginning, we retrieved the scenario database, if there is a model existed matching to the specific scenes, we used the parameters of the model to configure the new-built E-NodeB. If there is no model matching the designated scenes, the system will turn to the configuration process of building a new E-NodeB. The algorithm was described in pseudo code in figure 3:

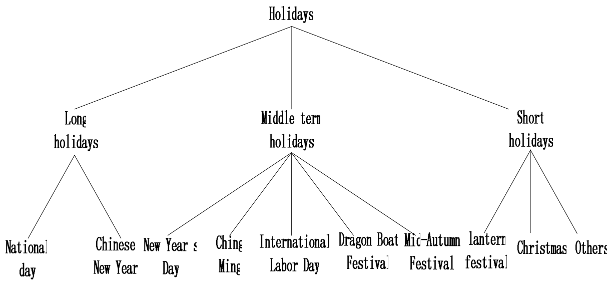

Figure 2 time interval similar tree

```
If(cell in the specific scenario model exsisted)
{ return model1;}
else
 { if(cell in the similar timescenario model existed)
    {return model2;}
    if(similar cell in the timescenario model existed)
    {return model3;}
    if(same timescenario and different cell and
geoscenenario model existed)
    {return model4;}
    if(similar geoscenario and timescenario model
existed)
    {return model5;}
    else
    default;
}
If(model1||model2||model3||model4||model5)
{Choose model from model1, model2, model3,
model4, model5;}
Else
Return new enodeB //{There is no model existed;}
```

Figure 3 similarity matching algorithm

III. RESULTS

The platform was developed using C# and SQL, figure 4 and figure 5 are two screenshots of the organized parameters of system.

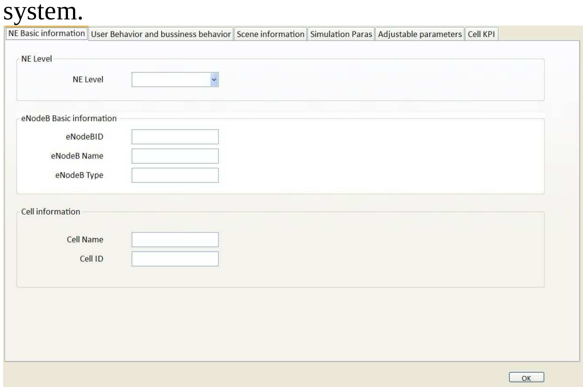

Figure 4 Network elements' screenshot

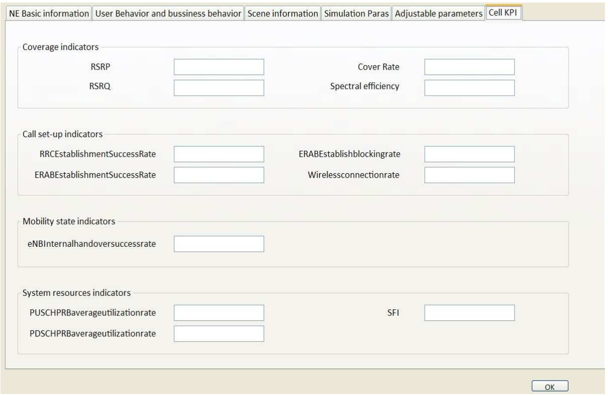

Figure 5 KPIs' screenshot

IV. CONCLUSION

In this paper, we investigated the factors related to mobile wireless network dimensioning, planning and optimization. We grouped the factors into several classes: basic information of network elements, basic physical/logical resources allocated to network elements, time interval/event scenarios, geographical scenarios, users' mobility pattern, service models, RF propagation models, relevant parameters, KPIs. Every class reflects one aspect of the radio access network. With the help of the system, we setup some bases on some specific scenarios in related dimensions. Next time when a new E-NodeB is to be built, we can retrieve the databases to choose a similar scenario template to accelerate the dimensioning process of new E-NodeBs using similarity matching rule.

By this platform, the system parameters and KPIs are organized in convenient sequence to maintenance staff. Any person can use this system to optimize or to plan a new E-NodeB by inputting some simple conditions. Therefore, the platform can increase the optimization efficiency and efficiently save the workforce and cost. Otherwise, the TD-LTE is under evolving, there are more new characteristics needed to be considered, we will put more effort to improve the algorithms involved in the platform to meet the development of the wireless part of TD-LTE.

V. FUTURE WORK

In this paper, we only set up a platform to organize and manage the parameters and indicators of TD-LTE. As to the interaction between parameters and indicators, i.e. how the variation of any parameter impact the indicator is our next work.

We are trying to induce some functional relations between parameters and indicators, $f(p_1, p_2 \cdots) \leftrightarrow KPI_k$. With these functions, we can obtain the relationship between parameters and KPIs, i.e., how the parameters impact the KPIs, or which parameters' variation can result in the change of some KPIs. When KPIs observed don't meet the operators' requirement or users' expectation, we can find out the real reasons behind many of false phenomena. Because the mobile wireless system is a very complex, high dynamic system, many inner and outer parameters can affect a KPI. As to now, we can't summarize a series of explicit functions to facility our optimization. In this paper, we built an expert system to simplify the practical network optimization. In the future, more effort will be put to discover the relationship between system parameters and KPIs.

ACKNOWLEDGMENT

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