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### IMPACT ASSESSMENT OF KPIS AND KQIS ON COMMUNICATION SERVICES PROVIDERS AND CUSTOMER SATISFACTION

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#### ABSTRACT

There lies a significant gap between a Communication Service Provider's (CSP) presumption of delivered customer services (experience) and the actual experience of the end customers. To ensure that customer expectations are met, it is essential to carry out network parameters optimization. The same is achieved using Key Performance Parameters (KPIs) and Key Quality Parameters (KQIs). Quality of Service (QoS) which are the parameters that give the holistic network functioning report depend on both KQIs and KPIs. Many different kind of analysis are performed using these indices to improve cellular network services. The study comprises of KPI/KQI verification and analysis of different test case scenarios. Real time data of cellular network is fetched and fed into the Hadoop database to form the test data. The java scripts are developed to derive the KPI/KQI values. The KPI/KQI values calculated are verified against the values reported on CEMoD product to check the integrity of the product. Analysis of these KPI/KQIs for their relevance in the telecom industry and impact on CSPs has been studied. The details are presented in the paper. The study is carried out at Nokia Networks (NN). It is based on the cellular network data and the method of KPI/KQI analysis adopted by the Nokia Networks

**KEYWORDS:** customer satisfaction; impact; KPI; KQI; telecommunication

#### INTRODUCTIO

Telecommunication continues to be a powerhouse industry. The present statistics regarding the mobile subscriber base suggest that there are over 4 billion mobile phones in use world over, out of which 1.08 billion are smart phones. However, the industry is facing cut throat competition due to technological revamps and ever rising demands of media-savvy customers. It requires adaptation of latest technological advancements, maintenance of customer satisfaction and innovative marketing strategies for the telecommunication mammoths to maintain their foothold in the growing telecommunication market. Today, the focus of CSPs is on being customer-centric than being only technology-centric. There lies a significant gap between a CSP's presumptions of delivered customer services (experience) and the actual experience of the end customers. The perception gap is substantiated by the fact that, while 80% of the CSPs are convinced of delivering a superior customer experience, only 8% of their customers believes they received it. Therefore, CSPs want to reduce the 'churn' by increasing the customer satisfaction.

To ensure that customer expectations are met, it is essential to carry out network parameters optimisation followed by detailed, repetitive, and reliable cellular performance testing at multiple layers of the network. To process this humungous cellular network data efficiently and accurately, Nokia has come out with a product CEMoD (Customer Experience Management on Demand) which is used by leading telecommunication operators. It analyzes the data in terms of the various KPIs and KQIs.

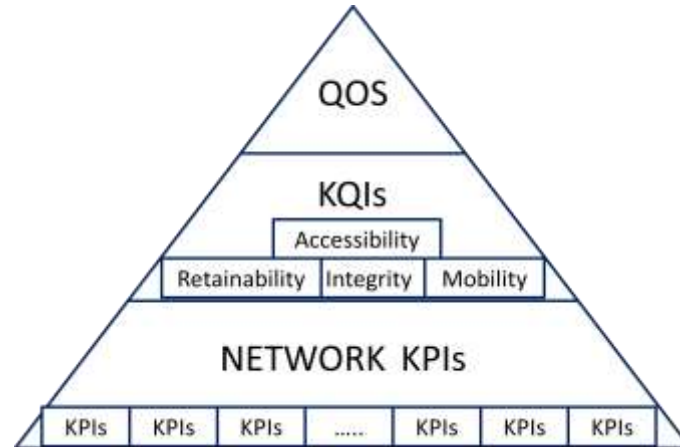
The present study is carried out as a part of M.tech final year project work at Nokia Networks (NN). The study is carried out based on CEMoD operations using cellular network data and analysis facilities available at NN.

#### KPIs and KQIs

KPIs are variables that evaluate the fulfilment of a cellular system's goals, in terms of its performance. They are considered primary metrics of performance and are internal indices that depend on network entities and vendors. While KQIs are variables that measure network performance in customer's perspective. They are external indices which are network and operator independent. KPIs and KQIs are measured in percentage, time interval, Erlang or Kbps. These are represented as an average, ratio or cumulative quantity. The product KQIs are

represented in terms of services KQIs which in turn are specified in terms of core network and Radio access network (RAN) KPIs. We require performance monitoring, measurement and reporting systems to determine the KPIs and KQIs from the cellular system data. These are illustrated in **Fig. 1**.

Quality of Service (QoS), the parameters that give the holistic network functioning report, depend on both KQIs and KPIs. There are four major QoS classes of cellular network categorised based on delay sensitivity and throughput of the applications they gauge. Interactive class and the Background are less delay sensitive compared to the conversational and streaming classes. Both these classes provide better error rate by means of channel coding techniques and retransmissions.



*Fig. 1: Dependencies of KPIs and KQIs*

## IMPACT OF KPIS AND KQIS ON CUSTOMERS AND SERVICE PROVIDERS

Many different kind of analyses are performed using KPIs and KQIs to improve cellular network services, these include:

- i) Analysis of usage pattern.
- ii) Analysis of failures in service provisioning.
- iii) Analysis of services based on telecom standards.
- iv) Analysis of tariff plans.
- v) Analysis of location of bottlenecks.

The impact of the same on customer satisfaction and Customer Service Providers (CSP) are discussed below.

### Analysis of the usage pattern

The pattern of SMS, Voice or Data service varies with time. Studies suggest that peak traffic is not uniform over the day. Peak network service usage hours experience network congestion which may cause service inaccessibility (e.g. web page waiting for connection to server) or service failure (viz call drops, interrupted video streaming etc.) leading to customer dissatisfaction.

By the study of KPIs and KQIs that analyse the usage, CSPs can determine the Usage vs. Time trend. Since the service usage drives the revenues, it's important to retain customer satisfaction in context of service usage by preventing network congestion. The study on weekly basis suggests peak traffic hours during evenings and study on weekly basis suggests high traffic on weekends. There lies a significant difference in the traffics at peak and non-peak hours. To curb the traffic explosion at peak hours for voice applications appropriate billing plans can be made. For instance, low call rates at morning or free calls at night encourage uniform distribution of service requests over the entire day. Similarly, high internet browsing application at evening hours can be restricted by intentional bandwidth throttling or increasing network capacity.

KPIs such as number of HTTP requests per user, Minutes Of Use (MOU) per user, average call duration, uplink/downlink browsing volume, static/live webpage session duration, number of attach/detach requests etc are used to analyse subscribe usage of services.

### Analysis of failures in service provisioning

Proliferation of large screen smartphones with higher resolutions in the market has resulted in escalation in the telecom subscriber base. Applications like web surfing, social networking, email transfer and instant messaging require downlink throughput of 100 Kbps. While multimedia applications such as audio and video streaming

require about 1Mbps. Over The Top (OTT) services of HD video streaming and real-time video conferencing applications require data rates as high as 10Mbps. Availability of 3G/4G enabled handsets at low cost which support these applications puts a huge pressure on network capacity in terms of throughput and lag-free transmission. Failure in provisioning of uninterrupted gaming, browsing or video streaming leaves customers unsatisfied with the service. Moreover, inadequate infrastructure for 3G/4G services in certain areas especially rural areas results in poor coverage.

By the study of KPIs and KQIs that analyse the service failure causes, CSPs can determine the failure scenarios based on the type of handsets (smartphones or non-smartphones) or the technology subscribed (2G/3G/4G). For instance, in time sensitive interactive online applications where increasing page loading delay increases the probability that the user will give up waiting, mechanisms like local caching and local buffering can assist in providing uninterrupted services. Based on failure cause analysis the telecom operators may also take other steps to increase coverage, increase throughput, reduce latency and adapt new technologies to improve service integrity. The CSPs can also identify the regions where the customers who have subscribed for 4G/3G technology but are getting access only 3G/2G due to unavailability of necessary infrastructure and implement cell restructuring, hardware/software installations at network entities, etc to resolve this problem.

KPIs like DNS resolution time, successful download attempts (RAB / TBF successful establishments), minimum download speed, uninterrupted video playout percentage, uninterrupted voice session percentage, average throughput per packet data, latency, PDP Context Activation success rate, IP service access duration, etc are used to determine the failure in service provisioned.

#### **Analysis of services based on telecom standards**

For instance, let us consider the analysis between CDMA and GSM standards of 2G. Limited range of CDMA enabled handset options in the market, higher price of the handsets and lower battery life (due to continuous transmissions) compared to GSM counterparts causes dissatisfaction in CDMA costumers.

In terms of services, the following factors are some of the reasons the customers prefer GSM:

- CDMA doesn't support large SMSs having more than 160 characters and delivery of SMS is time consuming.
- CDMA doesn't offer video call services.
- Global roaming is easier in GPRS/EDGE phones compared to CDMA.
- Low range of data packs to choose for mobile broadband in CDMA.

CDMA is losing the battle against GSM. With Mobile Number Portability (MNP) and Lucrative offers in GSM CSPs can soon expect greater churn towards GSM.

By the study of KPIs and KQIs that analyse the volume of GSM/CDMA users and their mobility, enables the CSPs to make vital decisions to either gravitate towards providing the other benefitting technology or make better marketing strategies to promote their standard. Some CDMA providers are now phasing out while some have started providing both GSM and CDMA services.

KPIs like total number of GSM and CDMA users, number of HTTP requests per user per standard, Minutes Of Use (MOU) per user per standard, average call duration per standard, as penetration per household, Mobile market share index (MMSI), etc are used to analyse subscribe usage of services.

#### **Analysis of tariff plans**

The general tariff plans primarily focus on draw customers to their subscriptions and maintain their loyalty with the operators. Promotional offers regarding lucrative post-paid connections and easy switch between post-paid and prepaid plans are one method of achieving this goal. Low number of tariff plans to choose from (e.g. mobile data plans in CDMA) or poor quality of voice/audio/data service offered at high tariffs cause customer dissatisfaction.

By the study of KPIs and KQIs that analyse the Tariff plans vs. Usage trends in the network, CSPs determine the roll out next tariff plans and their marketing strategies to further expand their subscriber base. Mobile data pricing of both voice and mobile broadband services have deep impact on the revenues of the operator. CSPs offer a range of options of tariff plans with low call rates to lure customers. Call rates have already hit the rock bottom as cheapest possible across India and hence operators are relying only on data usage for revenues. Different pricing for different internet content is being proposed by the operators, however telecom governing bodies are advocating net neutrality i.e. equi-treatment of all internet traffic in terms of its content or user.

KPIs such competition intensity index, data penetration, Pricing ratios, Average Revenue Per User (ARPU/ASPU), prepaid/post-paid service success rate, Average Revenue Per Minute (ARPM), Marginal Revenue Per Minute are used to analyse the effect of tariff plans on the customer base.

#### **Analysis of location of bottlenecks**

Increase in 4G customer base has directly impacted the increase in the number of applications resulting in large traffic and signalling data burden on the cellular network. Out of the several applications that run on the smartphones, non-interactive background applications are key drivers of signalling load.

By the study of KPIs and KQIs that help in identification of hotspots and bottlenecks in the network enables CSPs to carry out regional optimization at potential traffic hotspots and resolution of network issues causing traffic overload and increased signalling load such as hardware faults, radio link failures, radio bearers' unavailability etc.

The CSPs may also take measures to increase the app coverage i.e. perimeter within which an application runs with acceptable quality limit which depends on the number of active users in the cell, the number of demands made for a given app at a time and the backhaul capacity from the radio base stations as well as the packet core and content delivery networks. The flow of steps in the methodology is shown in **Fig. 2**.

KPIs such as video playout waiting time, call setup time, percentage of successful downloads per user, IP service access time, video buffering time, average mean user data rate, call setup success rate (CSSR), SDCCH congestion, radio network utilization, handover success rate, average Erlang per subscriber are used for analysing the network congestion scenarios.

#### **METHODOLOGY**

The study is based on the cellular network data and the method of KPI/KQI analysis adopted by the Nokia Networks. The KPI/KQI analysis is carried out to determine the level of customer satisfaction, which is further used to increase the quality of services provided by the telecom operators across the world and to reduce the churn (switching of users from one service provider to other). The proprietary algorithms developed for calculation of KPI/KQIs by the NN have been used in the analysis. The various steps in the methodology are listed below.

Step 1: Load the Cellular network data derived from several network entities (GGSN, Iub, NodeB, SGSN etc) into the database in appropriate format and table structures.

Step 2: Calculate the KPI/KQI values by querying the database of cellular network data. The queries are based on the formulae enlisted in the KPI/KQI sheet.

Step 3: Develop java scripts to test the KPI/KQI values calculated by the CEMoD product developers against the values calculated by querying.

Step 4: Automate the entire process of verification (including querying and comparison) using Selenium tool.

Step 5: Report the discrepancies in the values verified and review the code written by the developers to debug the errors thus found.

Step 6: Assure that the product to be released is completely validated and all the values computed are displayed accurately.

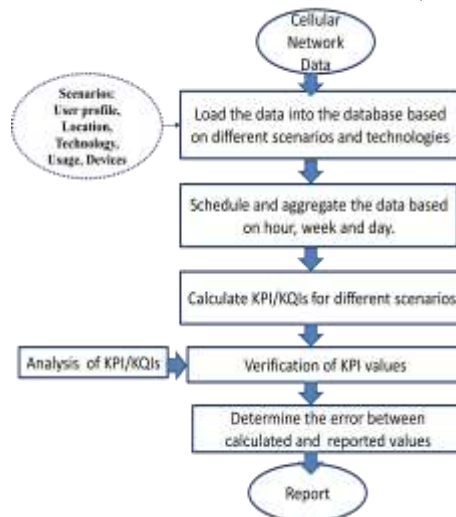


Fig. 2: Flowchart of methodology

## WORK DONE

The study comprises of literature survey, KPI/KQI verification and analysis of different test case scenarios. The literature regarding the 2G, 3G and 4G KPIs available from online resources, Nokia documents available at NN and the books available in the library have been studied. The literature survey was conducted to understand the role of KPIs and their applicability for assessment of customer satisfaction, analysis of the causes of network failures, the call/SMS and data browsing volumes, APN failures etc that affect the quality of mobile phone services across the world.

Real time data of cellular network was fetched and fed into the database to form test data. The java scripts were developed to derive the KPI/KQI values from test data. The KPI/KQI values calculated are verified against the values displayed on CEMoD product to check the integrity of the product. Analysis of these KPI/KQIs for their relevance in the telecom industry and impact on CSPs is carried out. The product is validated for its release after complete verification of its accuracy.

## RESULTS/CONCLUSIONS AND SUGGESTIONS

The study carried out indicate the following:

- Real time monitoring and calculation of KPI/KQIs is found to be highly effective in assessment of the customer satisfaction compared to conventional time consuming and tedious method of conducting customer feedback surveys on telecom services.
- CEMoD provides long-term storage of traffic and ancillary data useful in comparative analysis of real-time KPI/KQIs.
- Analysis of failure events (occurring in the cellular network services) in terms of KPI/KQIs is found to be most crucial for CSPs to enhance level of customer satisfaction.
- Failure analysis in terms of nature of faults, its criticality, location and time indicate the probable steps that CSPs should take to prevent the failures.
- Service usage trend analysis with respect to tariff plans, time, location, technology and standards enable CSPs to make revenue centric decisions on providing customer friendly services.

There is a scope of extending the KPI/KQI analysis to the areas of net neutrality and network virtualisation functions.

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