A Performance Comparison Platform of Mobile Network Operators

Ibrahim Onuralp Yigit, Gokhan Ayhan, Engin Zeydan, Feyzullah Kalyoncu, and Cagri Ozgenc Etemoglu

Türk Telekom Labs, Istanbul, Turkey. Email: {ibrahimonuralp.yigit, engin.zeydan}@turktelekom.com.tr,

{feyzullah.kalyoncu cagri.etemoglu}@turktelekom.com.tr, {gokhanayhan38}@outlook.com

***Abstract*—Most of the Mobile Network Operators (MNOs) are investigating ways to compare their key parameter indicator (KPI) performances with respect to their competitors in their own operating country. In this demo, we demonstrate a MNO network performance comparison platform in order to analyze and visualize some of the most relevant KPIs of different MNOs. For building the proposed platform, we have utilized open-source data analytic software and have performed comparative performance analysis in terms of mean upload/download speed, latency and jitter values. Our demonstrations indicate that while some of the MNOs can perform well in general KPIs, some KPI values can be worse in comparison with other MNOs in certain geographical areas of the country.**

***Index Terms*—data analytic, MNOs, performance management, open-source.**

I. Introduction

In recent years, data has become a first-class entity for Mobile Network Operators (MNOs). The collected data from MNOs' infrastructure can either be stored in the cloud (private or public) for further analysis or analyzed in real-time to take immediate (remedial) actions such as network traffic flow data analysis for monitoring network interface [1] or streaming data analytic and visualization for predicting the potential network failures [2].

Constant monitoring of the Key Parameter Indicator (KPI) performance for MNOs in large geographical regions is significant in terms of optimizing network performance [3] and capacity planning [4] purposes. Appropriate actions taken in a timely manner can improve service quality resulting in better user satisfaction rates. Therefore, it is critical for MNOs to investigate their network KPI strength/weaknesses in whole regions of the country. Recent developments in open-source analytic toolboxes can provide various opportunities such as flexibility, and cost effectiveness for MNOs. Some of the open-source frameworks can also allow building applications that can collect, process, and analyze data with very high volume, velocity and variety [5]. For this reason, data analytic tools with visual data analysis that can provide interactive visualization of different dimensions (time, space, categorical properties), interactive maps at different resolutions and interaction with heat maps, time series, graphs to end users can provide higher intelligence as well as competitive advantages to MNOs. In this work, we demonstrate how MNO network performance analysis platform can be utilized using open-source analytic with *"Elastic Stack"* which is an integrated solution with *ElasticSearch* [6], *Kibana* [7] and *Logstash* [8] products.

Fig. 1 shows the schematic diagram of network speed test data collection process. The data is collected from user equipment (UE) applications of different MNOs by the application server and stored in the corresponding network speed test database. For this demonstration, we have utilized the data present in network speed test database for our offline data analytic. The objectives of this demonstration are to show network performance management using analytic methods that allows: (i) cleansing the network speed test data of each UE belonging to different MNOs, (ii) listening and filtering network related parameters using Logstash, (iii) performing storage and data analytic using ElasticSearch, (iv) visualizing the KPIs of each MNOs using Kibana.

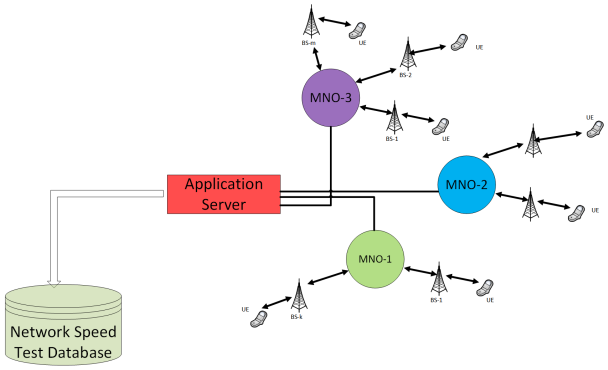

Fig. 1: An illustrative architecture for network speed test data collection.

II. Demonstration

We perform visual analysis of network speed test data which is inserted into our proposed platform in accordance with the following criteria: (i) **Exploratory Data Analysis:** Exploring the main features of the data using visual methods, (ii) **Large Data Sets:** Supporting large data sets by aggregating data at different levels. (iii) **Interactive:** Data analysis via fast response interfaces.

A. A Platform for performance comparisons

The proposed platform processes vast amounts of network speed test data that is collected a priori from multiple UEs

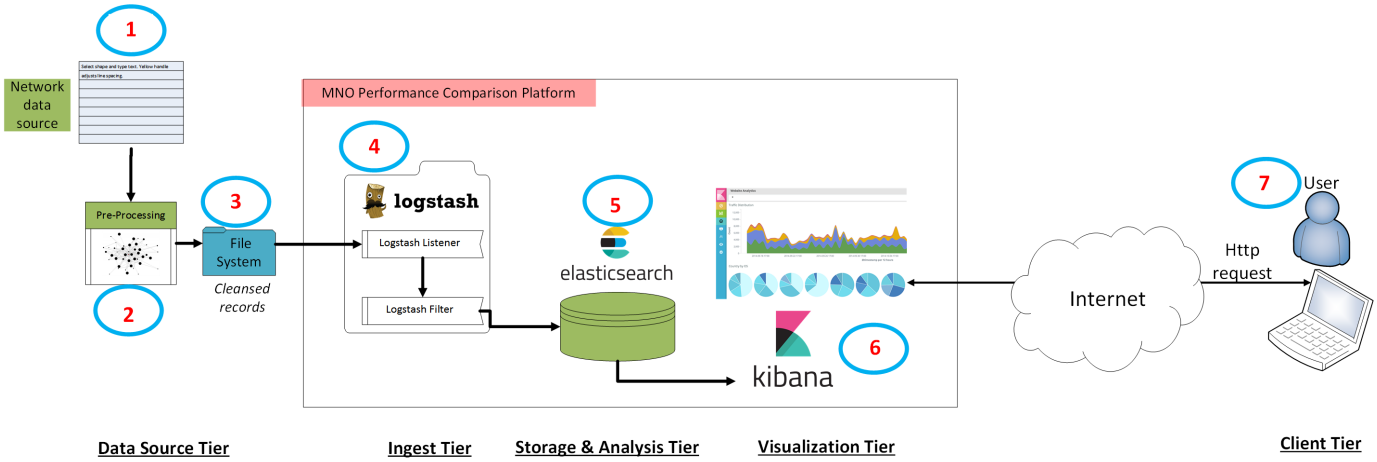

Fig. 2: Demonstration Setup

of different MNOs. It is composed of five main modules: **(a) Data Source Tier**, **(b) Ingest Tier**, **(c) Storage & Analysis Tier**, **(d) Visualization Tier**, **(e) Client Tier**. The implementation integrates the network speed test data solutions with open-source data analytics software. Fig. 2 demonstrates the general architecture of our demonstration solution.

In **Data Source Tier** marked as (1), (2) and (3) in Fig. 2, after data is collected as in step (1) from an application server similar to Fig. 1, a pre-processing stage is performed as shown in (2). In *Pre-Processing* stage, data convergence (converging all data received in various UEs (Android, IOS, etc)), filtering (separating out outliers, such as negative numeric values), data format conversion of the data collected in different formats (CSV, JSON, and so forth) (e.g., the format of data for city, district and neighborhood is in JSON and appended into the existing CSV data format after format conversion), binning (conversion of numeric data into discrete sets or bins to reduce its size, e.g. for Download (DL), Upload (UL) speeds.) and segregation of data (e.g. mobile and Wi-Fi). After pre-processing, the data is stored in a *File System* as CSV in step (3).

In **Ingest Tier**, marked as (4) in Fig. 2, there exists Logstash component with two sub-components: *Logstash Listener* and *Logstash Transformer*. Logstash is an log-parsing engine where it performs log collection, parsing and transformation operations [8]. *Logstash Listener* listens to the file system in step (3) and transfers the records in to *Logstash Transformer*. *Logstash Transformer* is used to convert CSV data format of File System into ElasticSearch data format which will later be used for storage and analysis purposes.

In **Storage & Analysis Tier**, marked as (5) in Fig. 2, we utilize ElasticSearch which is an open-source scalable full-text search and data analysis engine [6]. ElasticSearch enables query operation over stored structured and unstructured data.

In **Visualization Tier**, marked as (6) in Fig. 2 , we utilize Kibana which is an analytics and visualization platform.

In **Client Tier**, marked as (7) in Fig. 2, a user is interacting with the platform via the user interface of the platform.

B. Demonstration WorkFlow

During the experiment, we demonstrate how performance of multiple MNOs can be compared using MNO performance comparison platform using open-source analytic softwares in steps (1)–(7) given in Fig. 2. The general work-flow is as follows: First, network speed test data collected is collected from application server of the application owner as illustrated in step (1). Later, this data is pre-processed and data cleansing is performed as illustrated in step (2). In this step, all the related fields which are date, latitude, longitude, province, district, neighborhood, as well as UL, DL speeds, latency, jitter values for the considered three MNOs transformed into CSV format in step (3). Then, Logstash component listens and performs filtering/transformation in step (4). Later, the data is stored and analyzed in step (5) using ElasticSearch. Kibana in step (6) is used to visualize the data of the analyzed performance comparisons. Finally, step (7) is used to interact with the MNO performance comparison platform for the user.

C. Analysis of Demonstration Results

Fig. 3 shows the dashboard of Kibana where the statistics of the network speed data used throughout the demonstration are shown on top. The data set used for the demonstration covers time scale from January 2017 to August 2017. For visualizing this data, we have utilized the fields such as *DL (Mbps)*, *UL (Mbps)*, *latency (ms)*, *jitter*, *cities/districts/neighborhood*, *Phone OS*, *test date*, *packet loss percentage*, *MNO name* and *latitude/longitude* values as well as demonstrated top 10 city locations with higher average KPIs.

Table I shows the mean value comparisons of MNOs in terms of DL, UL, latency and jitter. Based on the value in this table, MNO-1 is outperforming the other two MNOs in DL, UL and latency figures, but has worser performance in jitter KPI compared to MNO-3.

Similarly, Fig. 4 visualizes the DL speed performance comparisons of MNOs in whole Turkey. As can be observed from this figure, MNO-1 performs the best in the country in terms servicing at higher DL speeds.

Fig. 3: Dashboard for data visualization using Kibana

TABLE I: Comparisons of mean values of observed KPIs.

	MNO-1	MNO-2	MNO-3
DL speed (Mbps)	39.68	25.92	19.38
UL speed (Mbps)	13.66	9.97	8.26
latency (ms)	35.45	45.83	42.99
jitter	18.74	18.79	16.68

(a) MNO-1

(b) MNO-2

(c) MNO-3

Fig. 4: DL speed performance comparisons of MNOs using Kibana visualization.

On the other hand, UEs of MNO-2 and MNO-3 are suffering from low DL speeds in some regions of the country.

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