MobiTel: A Interactive Mobile Tool for the Visualisation of Telecommunication Service Utilisation

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Abstract- Analysing information about how customers use telecommunication services can provide valuable knowledge for a telecommunication service provider. The knowledge gained can help improve the quality of the company's services. There is currently a lack of software tools that effectively support the visualisation of telecommunication service utilisation. Current systems used to visualise service utilisation also lack dynamic interaction, which is supported on mobile devices. This paper introduces MobiTel, an interactive prototype for the visualisation of service usage information on a tablet device. MobiTel combines touch interaction with two-dimensional and multi-dimensional visualisation techniques to allow dynamic exploration of service usage information. This paper discusses mobile information visualisation and identifies requirements for visualising service utilisation. The design and implementation of MobiTel is discussed together with future work to be completed.

Index Terms —Visualisation, Mobile Apps, TMN, OSS, ITSM

I. INTRODUCTION

The increasing demand for new telecommunication services is placing considerable pressure on existing telecommunication networks [1]. Managing the services that run over networks is a challenge that telecommunication service providers (TSPs) face daily. TSPs are now more focused on service management than on network management [2]. This shift towards service management is the reason why TSPs are becoming more customer focused. Information about how customers use these services can assist with improving service quality and provisioning.

TSPs need to monitor customer service usage, as this information can provide valuable insight into the quality of the services. For example, low service usage could indicate that the service is perceived as unreliable or costly to use by the customer [3]. The data stored on service usage provides information about when and how a service has been used. The service usage data can be processed for further analysis in order to support decision making, such as which service packages are better suited for a customer based on the service usage. Large volumes of data are logged on customer service usage. Storage capacity for data is increasing, but the software used for the analysis of the data is improving at a slower rate [4]. In certain situations it is necessary to process information on site [5]. Mobile devices have become an attractive option for day to day use as well as in-field analytics.

When a TSP employee consults with a customer, information about the customers and the services need to be compiled. During the consultation, this information needs to be effectively communicated to a customer. The improvement of mobile technology has led to the adoption of mobile devices as an efficient tool for enabling businesses to become agile [6]. Mobile devices allow employees to access information anywhere, which provides the advantage of being able to make decisions faster.

Mobile information visualisation (MIV) of telecommunication service utilisation (TSU) is proposed as a solution to support the analysis of service usage data. Information visualisation (IV) focuses on the representation and interaction with data to improve the understanding of the information presented [7]. MIV applies IV principles to mobile devices, addressing the mobile device's limitations such as screen size and resolution [8]. Mobile devices, such as tablet PCs, provide intuitive ways to interact with the device through the use of a multi-touch gestures. A more natural form of interaction can be achieved with touch devices, which can improve the user experience and support interaction.

The aim of this paper is to introduce MobiTel, a tool for the visualisation of service usage data on a tablet device. Section II discusses the background of the research by examining related work done on TSU and MIV. The requirements for reporting service utilisation on a mobile device are identified in Section III. Section IV proposes the design of MobiTel and Section V discusses the implementation of the prototype. Sections VI and VII present the conclusion and future work to be completed.

II. RELATED WORK

A. Telecommunication Service Utilisation

TSU is focused on investigating how customers make use of telecommunication services. Information gathered about a customer's service usage can provide a TSP with insight into the customer's behaviour, which can assist in improving the services offered to the customer [9]. Information about service utilisation can assist in a variety of ways [10]. Customer service representatives can use service usage information to identify problems and make recommendations to customers regarding upgrades or modifications to customer packages. To effectively

understand service utilisation, the data logged for service usage needs to be investigated in order to determine what type of knowledge can be extracted.

There are three basic types of usage records that exist [11]:

- *Duration*-based usage records – usage attributes are based on the time period for which the service is used;
- *Event*-based usage records – usage attributes related to the number of times the service has been used;
- *Volume*-based usage records – usage attributes store the amount of data that a service has consumed.

Several existing systems were evaluated to identify problems with current reporting approaches for service utilisation. ETM Usage Manager and Comcast are systems that report on service usage for voice and Internet traffic [12]. ETM Usage Manager assists with capacity planning and service management where the user can analyse volumes, trends and traffic patterns of call data. An example of a service usage report generated is shown in Figure 1, which is obtained by selecting a set of criteria. To obtain a different view of the information another query needs to be performed. Comcast is another example of a system that reports on service usage for Internet traffic of a customer. The information aggregates the traffic usage over a period of time and can be accessed via a customer portal.

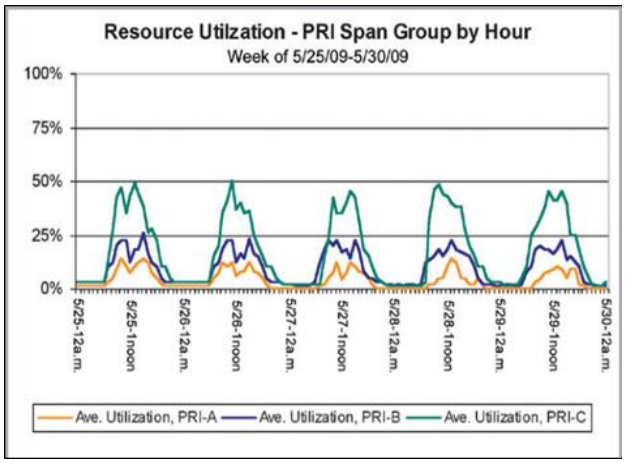

Figure 1: Example of a usage report generated by ETM Usage Manager [12]

The problems identified with the existing systems were that the different tools each focus on a specific service. Another issue identified was that the reports generated are static, lacking dynamic interaction, which encourages exploration and can lead to more insightful and meaningful information.

B. Mobile Information Visualisation

IV focuses on assisting human cognition by extracting meaningful information from large datasets through the use of an effective graphical representation of the data [7]. IV provides advantages such as reducing the time to search for information and increases the ability to detect patterns through the use of visual representations. Visualising service usage information using IV techniques can assist in more effective analysis and decision making. This can be done through the correct representation and manipulation of the information. MIV applies IV techniques to the smaller screens on mobile devices [13]. Simply mapping the IV techniques from large to small screens does not work due to the smaller screen space and the technology limits [14]. To support the use of IV on mobile devices, three well known techniques are available: Overview+Detail, Zooming+Panning and Focus+Context [8].

Overview+Detail is a visualisation technique where two views are used simultaneously and when applied, can lead to shorter completion times of the user's tasks [15]. A larger view contains detailed information on the visualization whereas a smaller view provides an overview of the entire collection. The smaller view can make use of a rectangle to highlight the detail shown in the larger view. Focus+Context is similar to Overview+Detail, but makes use of a single view instead of two views. Focus+Context zooms in on a part of the visualization and distorts the rest of the view. Zooming+panning is a simple approach used to navigate the information space. Zooming+panning is commonly used on mobile devices to allow the user to explore the information space. A combination of the three visualisation techniques mentioned above can be applied to IV techniques used on mobile devices, in order to overcome the limitations associated with smaller screens.

Another consideration when using IV techniques on mobile devices is the difference in interaction between desktop and mobile device screens. Touchscreen interaction is commonly used on mobile devices such as tablet PCs [16]. The use of finger-based interaction has become popular as an intuitive means of interaction as it mimics the idea of spatial manipulation in the physical world [17]. There are multiple touch interaction gestures, but research on using touch interaction with IV techniques is still in its infancy. MobiTel is thus proposed as a possible solution to effectively support the visualisation and manipulation of service usage information on a mobile device.

III. VISUALISATION REQUIREMENTS FOR SERVICE UTILISATION

Requirements for MIV of TSU needed to be gathered in order to effectively support the visualisation of service utilisation. A field study was conducted with solutions architects at a TSP in South Africa as well as with network engineers at the Nelson Mandela Metropolitan University (NMMU). Six participants were from the TSP and four participants from NMMU. The job roles of the participants from NMMU range from Senior Systems engineer to Network Engineers. The NMMU participants were therefore regarded as suitable subjects for gathering requirements as they also manage service utilisation at NMMU. Ethical clearance was not required for the interviews as the participants are not a vulnerable group. A semi-structured interview was conducted with each participant using a questionnaire. The interviews were recorded on a dictaphone which was transcribed for further analysis. The following information requirements were gathered from the field study:

- View information about customer usage patterns;
- View service usage measures for each service;
- View statistical usage information such as the average, rankings and outliers;
- View service usage information for different time granularities;

- View the overall customer service usage using a dashboard;
- View service usage for a particular customer site; and
- Be able to specify and view service usage thresholds.

Requirements were also obtained from a literature study where a framework for visualising subscriber usage patterns (Figure 2) was identified. The framework specifies that a visualisation tool for subscriber usage patterns should consist of display and interaction techniques [18]. The framework shown in Figure 2 was extended to include mobile touch interaction (shown as ovals) with the visualisation. The framework highlights three views to visualise usage trends; unique patterns such as outliers; as well as ranking patterns such as high and low usage. These three views can be used to meet the information requirements identified from the field study. For example, the view that includes information about usage trends meets the information requirement for showing the service usage over a period of time.

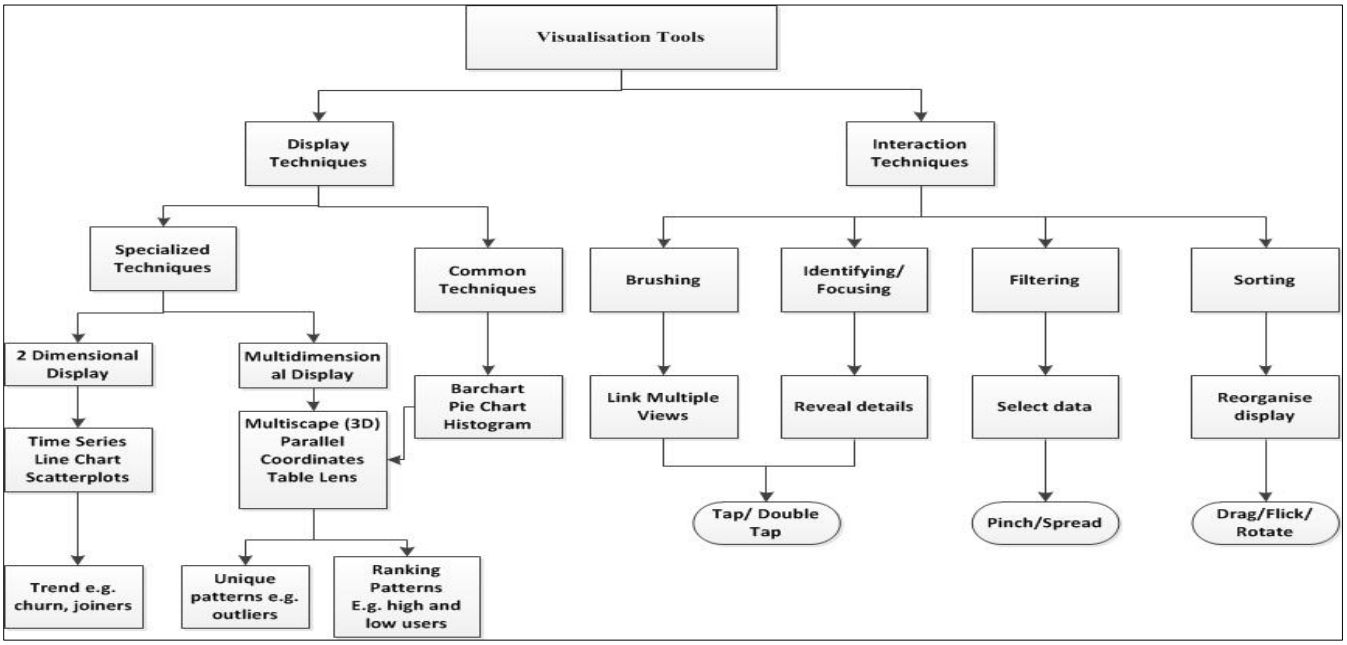

Figure 2: Updated visualisation framework for subscriber usage patterns [18]

From the field study and the visualisation framework (Figure 2), three views were identified to meet the requirements for visualising service usage information. The views that are thus required for service utilisation are:

- A *trend*-usage view to visualise the service usage over a period of time using a time series chart;
- A *network*-usage view to show the high and low usage on different customer sites;
- A *detailed*-usage view to provide in-depth information about the service usage data and to identify any abnormalities.

The user requirements were identified using the visual information seeking mantra, which follows Shneiderman's principle of "Overview first, zoom and filter, then details on demand" [19]. The following tasks therefore need to be supported by each usage view:

- **Overview:** Provide an overview of the service usage for the specific view;
- **Zoom:** Zoom in or out to achieve different levels of interest on the usage data using pinch or spread gestures;
- **Filter:** Remove unwanted information such as specifying time periods using pinch or spread gestures;
- **Details-on-demand:** Obtain details of the service utilisation by selecting on the visualisation using drag or tap gestures;
- **Relate:** View relationships between the different service utilisation datasets;
- **History:** Monitor the user's actions to support undo and redo of their actions;
- **Extract:** Allow the user to save what he/she has done, for example, queries or view manipulations.

IV. Design

MobiTel needs to be able to visualise various aspects of the service usage information that contain different dimensions, which are dependent on the question that the user wants to answer. Service usage data contains two-dimensional and multidimensional data. This section describes the data format, the user tasks and the visualisation techniques for.

A. Data

The most suitable format for storing and transferring service usage information is the Internet Protocol Detail Record (IPDR) protocol. The IPDR addresses the challenge of transferring network measurement and management information, specifically service utilisation information [20].The advantage of using the IPDR protocol is that the protocol describes the different types of usage information that can be obtained for a service. The IPDR protocol specifies that service usage information should be captured in an IPDR document, which is a XML template for storing

usage information for different IP-based services. Every time a service is used, information about "who", "when" "where" and "what" for the usage of a service is stored. The "what" property of an IPDR document contains service usage measurement information. For example a Voice-Over IP service would have duration and bytes transferred as usage measures. The IPDR document format will be used by MobiTel to store and read the service usage information.

The service usage data was simulated using a data generator and database management software. The database was created to ensure that the IPDR format is supported by creating a table that can store the service usage attributes. The database information is stored in a SQLLite database (suited for mobile devices) which is used on the mobile device to visualise the service usage information.

B. User Tasks

The user tasks were determined by examining the requirements in Section III. The user tasks are categorised in terms of the different views of the service usage information:

1. Dashboard View
   a. View an overview of the service usage
   b. Change the usage threshold
   c. Zoom in on a specific usage view

2. Trend Usage View
   a. View the overall usage over time
   b. Select a period of time
   c. View details on a point of the graph by touching on a point
   d. Specify usage thresholds

3. Network Usage View
   a. View the usage for all customer sites
   b. Zoom into usage for a selected customer site
   c. Specify a time period of service usage
   d. Specify usage thresholds

4. Detailed Usage View
   a. View service usage for all usage measures
   b. Filter values for an attribute
   c. Select a line to view detail information

C. Visualisation Techniques

Three different views were designed to visualise the different perspectives of the service usage information and are discussed in this section.

A Trend Usage View is used to view the service utilisation over a time period. A time series chart is used to show information such as the total usage count as time changes. Overview+Detail and Zooming+Panning visualisation techniques are used to support displaying time usage information. With Overview+Detail a smaller view, called a time slider, will show the usage for a specific period of time and a larger detailed view will show a portion of the time period, which is highlighted on the smaller view.

The Network Usage View was designed to make use of a radar chart to show the total service usage either per customer site or per user. The Network Usage view displays multidimensional service usage data and zooming is supported to allow the user to drill up or down from a customer site to users at a specific site.

The Detail Usage View is used to display the service usage measures and has a multidimensional structure. A parallel coordinate chart is used, which makes use of parallel vertical axes, each of which represents a service usage measure. The parallel coordinates chart was selected as it supports interactive exploration of the data. The parallel coordinates chart could possibly provide more value when used on a mobile device because incorporating this visualisation with touch interaction could improve user interaction.

V. IMPLEMENTATION

The prototype was developed on a Samsung Galaxy Tab 10.1, which uses the Android Operating System. MobiTel was implemented using Afreechart [21]. Various charting libraries were investigated but none of the visualisation toolkits could support all three of the service usage views identified in Section III. Afreechart provides support for time series and radar charts. Afreechart was selected as it is highly customisable by allowing other visualisations to be added to the library. Afreechart also provides basic support for touch interaction on the visualisations.

The implementation of each view was done based on the information visualisation reference model [7], where each of the components in the model were implemented for all of the views.

A. Implementation tools

Afreechart is an open-source charting library for Android, based on JFreechart (A Java charting library) [21]. Afreechart provides support for a variety of charts such as time series, scatterplot and radar. Afreechart supports the basic core touch gestures such as tap, pinch, spread and drag on the visualisations. These gestures are used within Afreechart to support zooming, panning and selecting of points on the visualisations. Other gestures such as rotate and flick had to be implemented and incorporated with the library. The touch gesture support provided by Afreechart is poor and slow which required that the touch gestures be re-implemented to allow faster interaction with the visualisations.

There are a variety of Javascript libraries for creating visualisations. The disadvantage of using Javascript libraries is that it requires the development of web-based applications. The disadvantage of developing web-based applications instead of native-based applications is performance issues such as slow processing speed. Native applications are superior in terms of user experience as the look and feel of the application is the same as what the Operating System provides. For these reasons, Afreechart was selected to develop the prototype.

B. Data

The first phase of the information visualisation reference model is retrieving and transforming the raw data (from the SQLLite database) into data tables for a specific visualisation technique. The time series chart makes use of a XYDataset which contains a set of x and y points to be plotted on the chart. The radar and parallel coordinates chart makes use of a CategoryDataset, which is similar to a table structure with rows and columns. This was chosen so that usage values could be mapped to a specific attribute. A *DataTransformationManager* manages the transformation of the raw data into the relevant data table for each visualisation.

C. Views

The second part of the information visualisation reference model is the creation of the Visual Abstraction. This is a data model that contains information such as the spatial layout, colour and size. A View is created by applying View Transformations, where the contents of the Visual Abstraction are drawn using rendering components. This process was implemented in the prototype in order to develop the three views.

The Trend Usage View is shown in Figure 3. This view contains two views which provide the total service usage over a period of time. The Overview+Detail technique was applied in this view in order to support the overview task. The smaller graph in Figure 3 provides an overview of the time series usage information, whereas the larger view shows more detailed usage information. The Overview+Detail technique implemented in the Trend Usage View gives the user the freedom to zoom and pan into a selected time period, while having an overview of the usage for a longer time period. The zoom and filter task is supported as the user is able to select a portion of the time period. Figure 3 also shows the tap, drag, pinch and spread gestures which are supported. The tap gesture is used to select a point on the graph in order to obtain the exact value at a point, which supports the detail-on-demand task. Drag, pinch and spread are implemented to support the Zooming+Panning technique to allow the user to navigate the information space. To switch between the different views, the flick gesture is used to allow quick navigation between the different views.

Figure 3: Trend Usage View with Touch Gestures

The Network Usage View is shown in Figure 4. This view makes use of a radar chart to show information such as the total usage per customer site. The user is able to obtain more detailed information by tapping on a site. This will provide information about the usage per user for the selected site. A time slider is shown in Figure 4, where the user can make use of the drag gesture to specify the time period to be displayed. The user can also interact with the visualisation by using the rotating the radar chart.

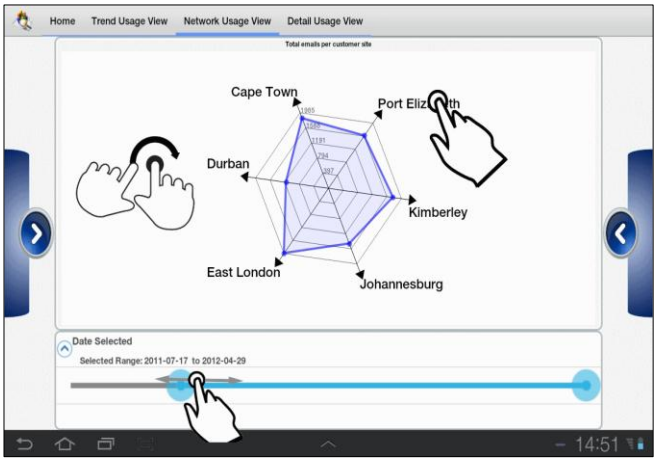

Figure 4: Network Usage View with Touch Interactions

The Detailed Usage View is shown in Figure 5, which makes use of a parallel coordinates chart. This view makes use of vertical axes to represent the different attributes of service usage information. This view supports the drag and tap gesture that allows the user to reorder the axis as well as filter the values for the different vertical axes. As the user drags on an axis, the service usage information, which satisfies the range selected, will be highlighted. Filtering can also be supported using the pinch gesture to enlarge/reduce the filter size. The user can reorder the axis by selecting an axis and moving the axis.

An iterative development process was followed for the development of MobiTel. Incremental improvements are made to MobiTel through the use of informal evaluations where the usability of the prototype was inspected to identify possible usability issues.

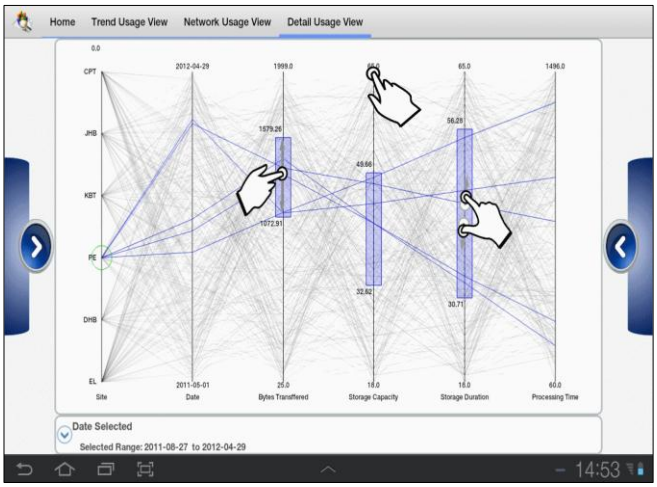

Figure 5: Detailed Usage View with Touch Gestures

VI. Conclusion

Few software tools exist to effectively visualise service utilisation. This paper has proposed using MIV for TSU to effectively support the visualisation of service utilisation. MobiTel was developed as a prototype for the interactive visualisation of service utilisation. Three views for visualising service utilisation were identified, namely the Trend, Network and Detailed Usage Views.

This research has contributed to existing work by extending a framework for visualising service utilisation to incorporate the use of mobile touch interaction on a tablet device. Future work will involve the implementation of a dashboard to allow smooth navigation between the three views. Thereafter a user evaluation will be conducted to identify any usability issues and determine whether MIV can effectively support TSU.

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