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Mobitrack - Holistic Measurement of Mobile User Behavior

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MOBITRACK - HOLISTIC MEASUREMENT OF MOBILE USER BEHAVIOR

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Abstract

Amidst the rapid transformation of the wireless industry, the factors driving user behavior and satisfaction are changing. This paper presents MobiTrack, a framework to measure user experience at the point of convergence – devices. The paper compares the MobiTrack framework to alternative methods to measure user experience, and shows the unique advantages of on-device measurements in building a comprehensive view on user experience. Along with data collection, the paper addresses the approaches for analytics, in showing how the presented framework provides value to device vendors and carriers through holistic user research, utilizing adoption models, and stickiness analysis, to complement the data collected from the introduced mobile audience measurement platform.

Introduction

The mobile industry is amidst a transformation, as new players like Apple and Google are expanding to the wireless space, with old giants like Nokia and RIM fiercely defending themselves through new releases of devices, platforms and services, and a number of other players, including carriers, advertisers, application developers and content providers, are assessing their future role in the wireless industry. The competition is shifting towards applications, services, and usability, instead of mere hardware (networks and devices), and the players successful in these dimensions are likely to be strong in the battle for user attention and face time. Smartphone sales are ramping up quickly, with estimated 300 million smartphones device to be sold annually by 2013 [1]. Smartphones not only enable new applications and services, but they are also in the heart of customers' digital lives, being ubiquitous, personal mini computers.

In this transformation, the key players of the industry are likely put more focus on user data and insights. Who are likely to adopt my application? How do user interfaces and keypad affect stickiness to value-added applications? When and where should location-based advertisements be delivered, and to whom? How are the investments in networks actually correlating with perceived use, and satisfaction, among users? Are users satisfied with my services, and if not, why? Who are customers likely to change for a competing device or subscription in the short-term future, and how to prevent this from happening? How is pricing affecting the use of the mobile Internet? Who are the people interested in using, and willing to pay for my new application offering? How to increase adoption of services through the elimination of bottlenecks? These are some exemplary questions that are of importance to mobile businesses across the globe today. One thing is for sure, new kinds of data on user behavior is needed in solving these problems.

The research on the use of mobile services and applications has been a growing business since the 90s. The typical ways to understand customer behavior include different kinds of interviews and surveys, laboratory tests, and analysis of operator CRM databases or charging records (CDRs). Different kinds of traffic measurements [9] and header data analyses represent as more technical measurements of specifically mobile Internet usage [6]. However, these methods and data points do not provide a complete, real view on the details of customer behavior, and are not typically collected from real environments, with also context being tracked. Neither do these research methods always include both subjective (questionnaire) and objective (behavioral) data collected simultaneously. The research problem of this paper is: **"How to collect comprehensive data on the usage of mobile devices and applications, and use advanced analytics in measuring user experience and extracting actionable insights for the purposes of carrier and device vendor revenue improvement?"**

The paper introduces and evaluates MobiTrack, a new framework to conduct user experience research in the wireless industry. This approach, and related technologies, is developed by MobiTrack Innovations Ltd., which is working closely with leading carriers and device vendors in modeling user behavior in real-life environments. The MobiTrack approach is based on the utilization of different types of data collected from real lives of people, using on-device meters in customer

panels, and deploying advanced analytics in converting data into actionable insights. There is some earlier research on the use of device-based behavioral data in the mobile industry, in academia [12] [13] [14] [15] [5], but no complete end-to-end approaches, including data collection, mining and reporting, have been introduced so far commercially. Terminals have been used earlier in collecting behavioral data, for example, on TV or Internet usage. The research is typically conducted with specialized technologies or software applications that are embedded into terminals. For example Nielsen and ComScore have been monitoring TV [10] and web [17] usage for years in coordinated panel studies. This paper evaluates the power of on-device meters in helping the mobile industry to better understand its massive audience, reaching to billions of potential users globally in the future.

In the empirical part of the paper, exemplary ways to use customized analytics in converting the collected MobiTrack data into actionable and valuable insights for the key players of the wireless industry are introduced. The dataset is collected during 2009 in MobiTrack Global Smartphone Study, involving users of Windows Mobile, Android, Symbian S60, Blackberry devices all around the world.

Background

Traditional research methods

Questionnaire surveys are one of the most widely used ways of studying service usage. Different kinds of questionnaires are applied, from single answer to multiple answer ones, and from fixed answer to open-ended answer ones. In the past, questionnaires were printed on paper and distributed via mail or presented on special occasions (such as in events where many members of the target group were present at the same time, for example academic conferences or class-room events). Nowadays electronic means of deploying questionnaire studies are increasingly used. Particularly Internet technologies provide new ways of implementing questionnaire studies. Web-based questionnaires provide a possibility to quickly reach a wide selection of end-users, and through electronic means the analysis of questionnaire results is quick. Questionnaires are a flexible method to end-users, who fill in the questionnaire when they have the best occasion to do so. Questionnaires can include many kinds of questions. Open-ended questions allow respondents to express their real opinions on the topic. Fixed pre-specified answers on the other hand are quicker to fill in. The cost per respondent is low in questionnaires. On the other hand, questionnaires are highly subjective. End-users do not always know the answer, and they might give false answers either intentionally or unintentionally. The interpretations of both questions and answers pose challenges, too [8]. Questionnaire structures are typically fixed beforehand, providing less flexibility in study deployment. On the other hand, questionnaires are cheap to deploy.

Interviews are an interactive method of end-user research, where an interviewer asks questions directly from respondents. The interviewers can guide the discussion based on their own research interests. This is both a challenge and an advantage. The discussion should not be guided too much, because that would spoil true interactivity. On the other hand, if the discussion goes off in a wrong direction, the time is running out or if the answers are incomplete (more details are needed to interpret them correctly), then the interviewer has a possibility to control the discussion and get it back on track. By using communication skills in capturing emotional hints, interviewees can also capture spontaneous feedback, as experimented in the interviews of this study. Interviews are in several cases valuable because of the interaction involved. Complicated research problems can be solved by asking both structured and unstructured questions from end-users. The setback of interviews is the expense in carrying them out. Doing interviews is slow, and the interviewer has to invest time in both preparing and executing the interviews. No economies of scale exist and extensive interview studies are either expensive or logistically impossible to carry out. Interviews, just as questionnaires, also face the problem of subjectivity (after all, the collected data represent people's perceptions, it is not hard data). Traditional interviews are at their best in studies which require detailed and open-ended answers to a specific set of questions.

Laboratory and ***road tests*** refer to pre-planned tests taking place in a fixed context (such as in a laboratory). Road tests are different from laboratory tests in that they take place in more natural contexts, in places where also actual use cases happen. Both laboratory and road tests follow the same principles. Services are provided to end-users in controlled environments, and during the experiment observations are made regarding end-user Behaviour. In some tests questions are also asked from end-users to complement usage-level observations. Laboratory and road tests

require effort in setting up the test environment. A context for testing has to be arranged, services and devices have to be prepared for testing, observation processes have to be planned and end-users have to be recruited. Laboratory tests best suit for specific research needs in which both actual usage-level observations and end-user opinions are needed. Usability designers typically use laboratory tests.

Traffic measurements take place at network gateways. Examples from the academic community include among others [9], [16] and [4]. Typically packet data traces are collected at network gateways. A point of convergence should be found, because at these points a maximum coverage (e.g. maximum number of data flows) can be metered. In traffic trace measurements individual packets (their header information) are studied and classification schemes are used in modeling data flows (e.g. distinguishing between different protocols, source devices or operating systems). Sometimes the analysis is easy (e.g. based on TCP port numbers), but in many cases different kinds of "TCP finger printing" methods are used in categorizing the traffic by operating systems [4]. Traffic trace measurements provide a scalable and computerized method for studying packet data service usage. This restricts the method only to packet data studies (mobile Internet), but, on the other hand, the amount of data to be studied is often extensive. At best traffic trace measurements provide an extensive amount of data on many interesting factors, and particularly the scalability and potential for automation is high.

By doing ***measurements at servers***, specific data points can be collected that reflect the server's functionality in the network. For example, from web-servers the specific types of documents and sub-sites that users retrieve can be observed. As with traffic measurements, server-side measurement processes can be computerized, and given that a server is heavily loaded, lots of accurate data can be captured. The setback is that an access to the server should be first achieved, and additionally potential legal problems (with regards to user privacy, for example) should be solved in advance. At best server-side measurements provide complete data on specific applications. Examples of what server-side measurements include can be found in [2] and [3].

Charging records (CDRs), to the extent collected by carriers, provide a centralized database on user behavior. Services that utilize the operator's infrastructure can be charged for by the operator. These services include such things as voice calls, SMS messaging, packet data traffic, MMS messages, downloadable ring tones and wallpapers. If charging records are available for research purposes, they can be utilized in analyzing service usage in several dimensions. Also the analysis of charging records can be computerized (see e.g. [11]).

MobiTrack Innovations

The research methods presented above have their own strengths, but also weaknesses. Some of the methods are based on subjective data, like interviews and surveys, and they provide little details on actual usage. On the other hand, most computerized methods rely on CDRs or Internet traffic measurements, which provide a restricted view (only at a certain gateway point, and with limited details e.g. on protocols and applications) on mobile consumption at best, given that the measurements can be done at all due to technical challenges. The ultimate way to measure actual user behavior on a very detailed level, and in collecting contextual feedback from real lives of people, is to use device-based tools in audience measurements.

Devices have been used also earlier in collecting behavioral data, for example, on TV consumption. The research is typically conducted with specialized technologies or software applications that are embedded into terminals. For example Nielsen and ComScore have been monitoring TV [10] and web [17] usage for years in coordinated panel studies. According to [7], panel studies of this kind, also called audience measurements, have certain challenges, mainly attrition bias (loss of panel participants over time), panel selection bias (people in the panel are different from the population to be studied), and conditioning effects (the implementation of the panel affects the behavior of panel participants). Audience measurements in TV, web and radio domains provide insights about real-life consumption, and these panel studies can be of either dynamic (new panelists replace old ones gradually) or static (the panelists stay the same) nature. Audience measurements in mobile phones are still an unexplored territory in the research world, and the research process defined below proposes an approach to do audience measurements with smartphones.

MobiTrack Innovations Ltd. has been developing technologies and analytics approaches since 2002 in the field of mobile audience measurements. The group has submitted several patent applications regarding the optimal way of collecting data from

smartphone devices, and applying customized analytics in processing the collected data. MobiTrack Innovations Ltd. is working closely with global leaders of the telecom industry throughout the world, including device vendors, carriers, service and content providers, Internet companies, and advertisers, in modeling user experience with panels involving on-device meters. The company also runs its own global smartphone study, some of the results of which are published in this paper.

MobiTrack framework

Figure 1 illustrates the MobiTrack approach. The framework is structured around three kinds of data:

1. ***Behavioral measurements***, consisting of on-device measurements on communication (voice, SMS, MMS, email, instant messaging), application (personal information management, productivity, maps and navigation, games etc.), mobile Internet (web browsing, streaming, downloads), device feature (camera, calendar, USB, Bluetooth, WiFi), and multimedia usage (music, imaging, video), complemented with technical measurements such as location and time of usage, battery status, and network parameters, among others.
2. ***Contextual surveys***, involving on-device questionnaires on user perceptions and satisfaction, that can be triggered by location, time, activities (e.g. application usage) or transactions (e.g. an incoming SMS)
3. ***Web surveys***, that are deployed online, and used typically to collect comprehensive subjective data on user needs, demographics, and other relevant background factors

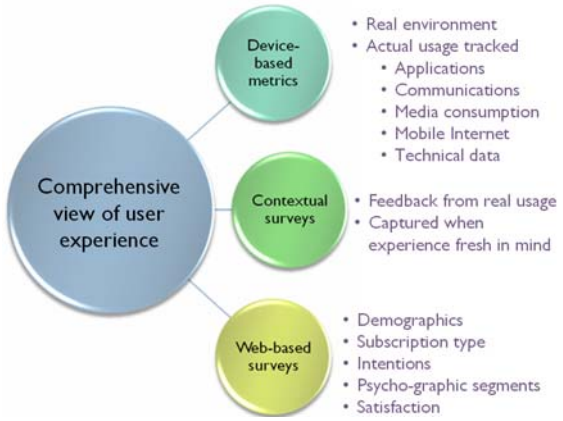

Figure 1 – MobiTrack approach

The research is typically conducted in the form of audience measurement panels (see Figure 2 for an exemplary study timeline), meaning that people from the target population are invited to the study, with incentives like an annual compensation plan (cash), free vouchers, or participation in a lottery of smartphones, attracting people to sign up. People register for the study on a web site, on which the generic guidelines of the study are presented, including statements on the motivation and objectives for the whole study, lists of collected data points, and terms for the collection and handling of data. When people sign up for the study, they agree on the terms, and opt in. After filling in their demographics and other important information, panelists download and install the MobiTrack research application into their smartphones.

The on-device meters are included in a MobiTrack research application that can be installed to all of the leading smartphone platforms of today. The application, after being installed to the device, works automatically on the background of the phone. It does not significantly affect battery lifetime, neither does it affect other use of the smartphone (it does not slow down the device, or intervene with the use of other applications). The meters are collecting all kinds of relevant information on device and service usage, together with contextual data and technical measurements. Some of the data points collected include:

- Communication usage (voice, SMS, MMS, instant messaging, email, VoIP)
- Multimedia consumption (camera, music, gallery, video, mobile TV, streaming)
- App store and add-on application usage (installations and use)
- Mobile Internet traffic (web browsing usage, data service usage)
- Mobile advertising and use of carrier-specific services
- Device features (downloads, file storage, calendar, phonebook, profiles)
- Maps and navigation (applications, GPS)
- Location and time of activities
- Network parameters (used protocols, signal strengths, throughput rates etc.)
- Network access methods (including e.g. WiFi, 3G, GRPS)

The collected data is first locally stored into the devices, and periodically synchronized to servers. When terminating a panel study, participants are simply asked to remove the research application. All the collected data is anonymous, and survey

and behavioral data are only linked together for the purposes of correlations and cross-tabulations. During the panel studies, several on-device contextual or online questionnaires can be implemented, in dynamically obtaining more information from users. For example, based on behavioral measurements it can be identified that there is a group of people who have indicated they are interested in mobile email, but in practice they however do not use mobile email at all. A customized survey can be sent to these people's mobile phones about possible reasons of not using mobile email.

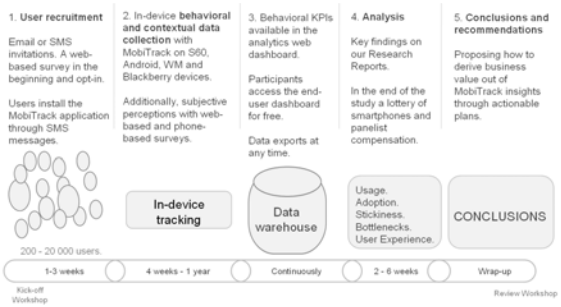

Figure 2 – Mobile audience measurement panel

After data collection, it is being processed and analyzed. Due to the special nature of collected data points, customized approaches to pre-process them are needed. The analysis itself consists of various processes, and there are various approaches to visualize and correlate the data, effectively combining both behavioral (on-device meters) and subjective (surveys) data. Some exemplary analysis approaches are presented below. Typically the key findings of the study are published as research reports, with benchmarking to reference datasets being combined to put the obtained results into a perspective. There is also a web-based dashboard tool available to access and plot the key data points, to conduct correlations, and to export the data into spreadsheets or PowerPoint figures (see Figure 3) through a SaaS (software-as-a-service) concept.

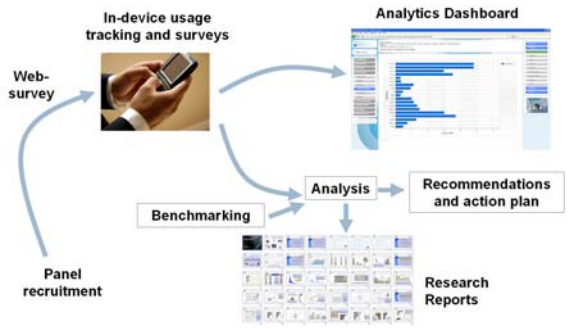

Figure 3 – MobiTrack process

MobiTrack analytics

In addition to data collection, the analysis of the collected data is one of the key parts of the solution provided by MobiTrack Innovations. The analytics approaches answer specific problems posed by industry players, each approach deep-diving into a certain dimension. In holistic views of device usage, for example, universal activity metrics on application usage are cross-tabulated over device types or subscriber segments, to gain insights on the actual use of devices. On the other hand, for example adoption models deep-dive into the balance between potential and actual usage, comparing user needs with actual usage as measured with on-device meters. The purpose of analytics is to transform the collected raw data into information (concrete KPIs), and further into insights (that have relevance to industry players) and advice (actionable recommendations that suggest how to improve revenues based on the insights).

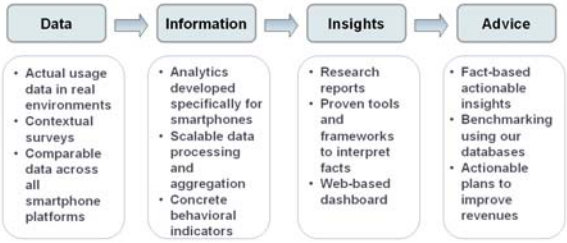

Figure 4 – From raw data to insights

This section provides some examples of the different analytics as provided in the MobiTrack framework.

Research context

The data for this paper is collected from MobiTrack's Global Smartphone Study during 2008-2009. This study is an initiative to collect important benchmarking data, and to analyze emerging trends in mobile consumption. The panel is being operated and maintained by MobiTrack Innovations Ltd., and reaches across the globe including panelists from North-America, Europe, and selected markets of Asia (China, Japan, Hong Kong, Singapore).

The panelists are using all kinds of smartphones, including Symbian S60, Windows Mobile, Google Android and Blackberry devices. The panelists are compensated with free participation in lotteries (e.g. vouchers and smartphones), panelists additionally gain a restricted access to their own usage data, an online, rich phone bill. 67% of participants are

male, and 33% female, with 56% of participants being younger than 30 years. 86% of participants pay their phone bills themselves, being therefore consumer subscribers. This dataset is not completely representative in the sense of demographic distributions or level of advancement in smartphone usage, mainly due to the used recruitment methods and incentives. Nevertheless, the results showcase the unique value of the approach.

For this study, selected panelists from this panel population are included in the analysis, demonstrating the capabilities of the approach.

Analysis

Holistic view on smartphone usage

MobiTrack provides a holistic view on usage, facilitating several usage activity measures that can be calculated for particular features or applications, and averaged for any user, or groups of users:

- Average number of usage sessions per unit of time (e.g. sessions/week)
- Average number of transactions per unit of time (e.g. messages/month)
- Average number of face time minutes per unit of time (e.g. minutes/day)
- Average frequency of usage (e.g. distinct usage days per month)

In understanding the overall usage of today's smartphones, average application specific face time measures for each users are aggregated together in Figure 5, giving a high-level view on the ways people spend time with devices. In general, messaging (21% of all direct face time spent with smartphones) and voice (34%), only represent together a total of 55% of all smartphone usage. Internet browsing (14%) and multimedia (15%) are clearly emerging as competing categories of applications to voice and messaging, both communication functions. In categorizing browsers, the de-facto device browsers (S60 browser, Blackberry browser, Internet Explorer, Android browser) represent 75% of browsing face time, the rest divided between Opera (12%) and Opera Mini (13%). This can be partially explained by the fact that certain Windows Mobile and S60 devices include Opera browsers preinstalled. In messaging, SMS (*short messaging service*) and email represent a total of 96% of messaging usage, MMS (*multimedia messaging services*) and IM (*instant messaging*) being used very little. Music, camera and gallery (viewing of photos) are the key multimedia functions.

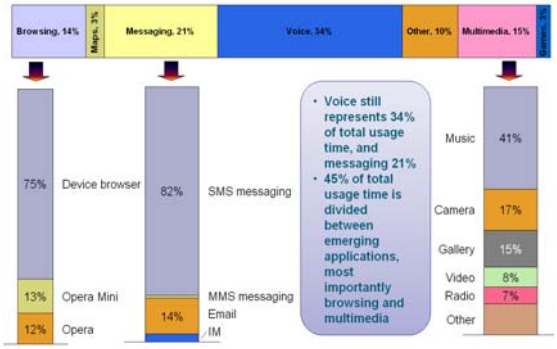

Figure 5 – Aggregate face time over smartphone applications

In Figure 6 the most important application categories are plotted over the number of weekly users (x-axis) and average usage frequency (average distinct usage days per month, y-axis). No surprise, voice and SMS are used by almost everybody, and average usage frequency is very high – these services are in daily use. Also Internet browsing and calendar are in fairly frequent usage among those who use them. However, Internet browsing attracts about 30% more users than calendar. Multimedia functions and map applications face rather low usage frequencies; they are not used on a daily basis. App stores are on average not accessed very frequently, but music stores and email services on average are used every second day, though their penetration is lower than 35%.

Application stores are interesting, as most global players have taken steps to launch their own stores during 2009. At the time of this research, only RIM, Google and Nokia had their app store up and running, and 22%, 72%, 35% of users, respectively, accessed them on a weekly basis. The top installed applications through app stores are:

1. Adobe Reader
2. Navicore
3. Anti-Virus
4. Quickoffice
5. Opera Mini
6. Opera
7. Google Mail
8. Google Maps
9. Google Latitude
10. Nokia WidSets

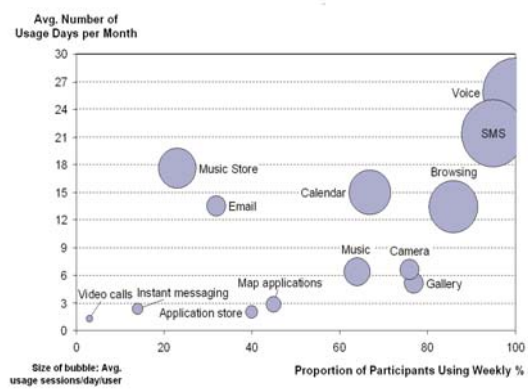

Figure 6 – Ranking of device functionalities

In Figure 7, adoption of key smartphone functions are compared across device platforms. All in all, 65% of Nokia S60 users used Internet browsers on a weekly basis, whereas only 55% of Windows Mobile users, and 34% of Blackberry users did the same. The same patterns (S60 devices being used more actively than Windows Mobile and Blackberry) hold for music and video playback, MMS, and map applications, too. Interestingly, in instant messaging and MMS the differences are not that significant, and expectedly in email usage Blackberry tops the rankings with 56% of Blackberry users using mobile email on a weekly basis. In general, Nokia S60 devices still outperform in the use of many advanced functions, when comparing the older, established device platforms.

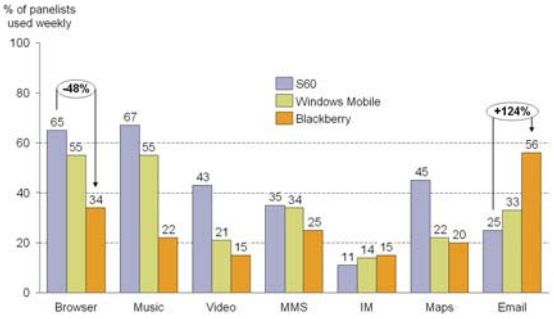

Figure 7 – Comparison of device platforms vs. application adoption

In Figure 8, all the device platforms are compared against each other in overall face time distribution. It is evident that while Symbian S60 is strong in multimedia, Google Android is pushing the usage of the mobile Internet (23% of Google Android face time goes on mobile browsing), and Blackberry users spend more time on messaging (SMS, email) than on voice calls. These statistics not only reflect the characteristics of different devices, but they also tell about the users of devices to some extent. For example, many Blackberry users are still from the domain of corporate users.

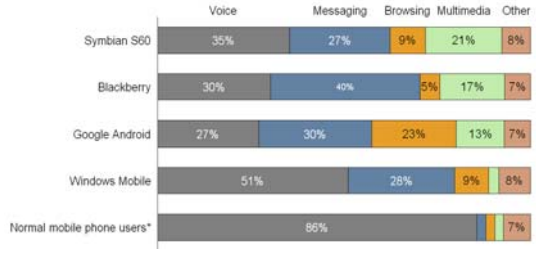

Figure 8 – Distribution of face time across device platforms

Based on the holistic analysis of smartphone usage, many kinds of topics can be assessed, including ranking of device functions and applications in usage activity (e.g. face time) or reach (e.g. penetration), contextual analysis of usage (see Appendix A), correlation between different services, high vs. low vs. non-user analysis, data service analysis (studying the average amount of data generated), trend analysis, user segmentation etc. Because of the vast amount of data that can be collected from the point of convergence, the possible dimensions for analytics are numerous, and the view on user behavior is complete, instead of partial.

Adoption analysis

In addition to providing high-level views on device usage, the MobiTrack research methodology allows for all kinds of deeper, more specific analysis angles. In this paper, three more specific types of analytics approaches are demonstrated. In particular, adoption, stickiness and satisfaction measurements are discussed.

First, **adoption analysis** dives deeper into the differences between potential usage (intentions and interest to use applications) and actual usage (as measured with on-device meters). High-level analyses, as presented above, certainly give insights on the overall user base of different applications and device functions, but a more actionable metric are adoption rates, that effectively compare the real user base to the potential one (that could be achieved).

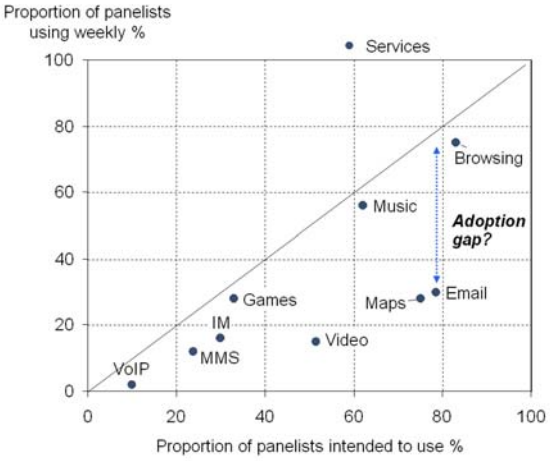

Figure 9 – Adoption matrix

In Figure 9 the key findings of the adoption analysis are presented. The x-axis reflects the level of interest, in other words the proportion of panelists who indicated (in surveys) that they are interested in using the specific applications. The y-axis reflects the proportion of panelists who actually used the applications on a weekly (recurring) basis. By reading the matrix over the x-axis, out of the included newer mobile services, Internet browsing, email, map applications, music and video, have reasonable interest from the user base. In contrast, few users are interested in gaming, instant messaging, MMS or Internet calls at this point of time.

The value of the adoption analysis is in correlating interest with actual usage. By including the y-axis in the analysis, the adoption barriers are easy to identify. In the figure above, for example, it is easy to see that email and Internet browsing have almost an equal base of participants interested in using, and therefore a valid hypothesis could be that they have an approximately same number of users. However, based on this analysis it is evident that only 31% use mobile email actively, whereas 77% are using Internet browsing on a weekly basis. Therefore mobile email significantly fails in terms of relative adoption, when comparing to Internet browsing. From the matrix it can also be identified that video playback and map applications have relatively low adoption rates.

Adoption analysis gives insights on the biggest opportunities to improve usage activity and revenues, by identifying application categories with high interest from users, but low current usage. MobiTrack tools, including a set of contextual questionnaires (in mobile phones) or web surveys, also help in finding out the key bottlenecks that are the cause of adoption problems.

Stickiness analysis

Whereas adoption analysis compares actual usage with potential usage, **stickiness analysis** gives insights on the gaps between trial and active usage. That is, even though many people might give a try to different applications, the stickiness analysis measures on a relative basis how many of these users continue using the application in a sustainable manner, in a recurring fashion.

Figure 10 below plots different applications and device functions in user rate (proportion of panelists who used the application; x-axis) and stickiness rate (y-axis). The stickiness rate measures the relative difference between trial and active user domains. If the stickiness rate is high, it means that most people, who try out the application, also keep on using it actively. If the stickiness is low, it means that a relatively low number of people who have tried the application, continue using it.

In the exemplary analysis below it is evident that map applications, calculator, MMS, music, gallery and camera have very low stickiness, whereas voice and SMS, web browsing, calendar, phonebook and call register have high stickiness. The matrix also visualizes that MMS, music, camera and gallery are anyways tried by a relatively high number of people, meaning that the low stickiness of these applications is a bigger value destroyer in absolute terms than that of less widely used applications. Certain applications, like Poker, VoIP and friend finder applications (picked here for exemplary purposes), can have a relatively small user domain, but still high stickiness (indicating that people who install these applications, typically use them very actively).

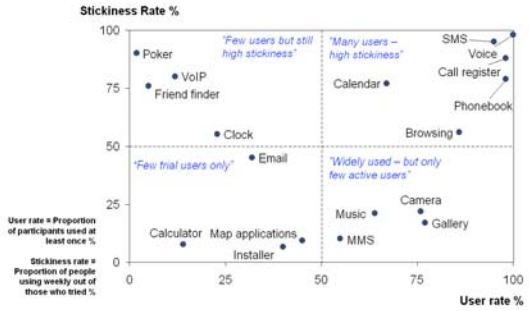

Figure 10 – Penetration vs. stickiness rates

1.1.1. User satisfaction

As a final demonstrating on the MobiTrack analytics, some insights from **user satisfaction** research are provided here. Instead of doing traditional paper or online surveys, not to talk about

interviews, in the MobiTrack framework user perceptions and satisfaction are measured with on-device, contextual questionnaires. This means that when actual users of individual applications terminate the session, or have completed a task (e.g. reading or writing SMS messages), there is a pop-up questionnaire, right after the experience, asking feedback regarding the completed task, application session, or other transaction.

In Figure 11 the results of contextual questionnaires (user satisfaction as measured in a real environment, x-axis) and average monthly face time (in number of minutes, y-axis) are plotted, revealing that most basic services receive high satisfaction and usage activity, with the exception of email. Email users spend an average of 410 minutes per month with mobile email (almost as much as people spend talking on the phone), but still the average user satisfaction is very low. Based on another contextual survey, the main causes of dissatisfaction for email are poor keypads (most of the devices in the study did not include QWERTY keypads), small screens, and lack of push functionality. Continuing the analysis, it is also evident that web browsing, MMS and map applications receive relatively high satisfaction rates, though actual usage is not that high. As found also earlier, games, video, instant messaging and VoIP are applications that receive low usage activity, the measured user satisfaction being also low.

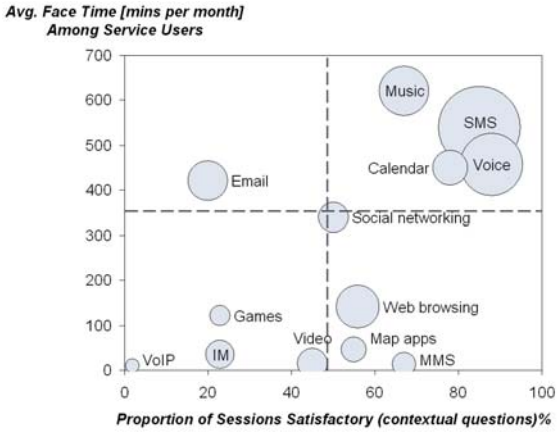

Figure 11 – Correlation of user satisfaction and usage activity

In Figure 12, average satisfaction rates across a set of exemplary services are plotted against stickiness, showing that on average perceived satisfaction has very high correlation with measures stickiness rates (see the previous section).

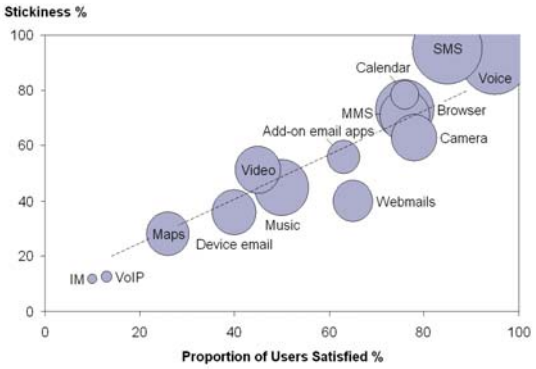

Figure 12 – Correlation of user satisfaction and stickiness

Conclusion and discussion

This paper has presented MobiTrack, which answers to the demand for more reliable and precise user experience research in the world of rapidly changing wireless business. The key advantages of MobiTrack are the capabilities to collect a comprehensive set of data from real environments of users, measuring at the point of convergence not only behavioral, but also technical and subjective dimensions of user experience, and providing of actionable insights through advanced analytics approaches. MobiTrack brings the advantages of audience measurement panels, earlier used only in measuring TV, radio and Internet usage, to smartphones. The shortcomings of the method include a certain degree of effort needed in launching bigger panel studies, challenges in motivating people to join the panel (incentives), and the selection bias due to the fact that only smartphone users can be studied.

In general, the amount of data collected is vast, and possible degrees of freedom in analytics approaches are numerous. Carriers and device vendors, in particular the ones who build and deploy own services and can affect usability-related factors, are the key customers of the presented tools. In the future, also service providers, application developers, content houses and advertisers alike are increasingly interested in understanding the mobile medium, making them potential customers. In addition to valuable descriptive statistics of user behavior and satisfaction, the following two important research problems can be assessed in providing actionable insights: 1. What are the user needs? How to improve adoption of mobile applications? 2. How to improve usage activity and user satisfaction, and contribute to revenue growth?

Exemplary topics of MobiTrack research include:

- Mobile Internet (social networking, web)
- Use of applications and device features
- Adoption and stickiness bottlenecks
- Service and device testing, lead-user studies
- Usability evaluations
- App stores and add-on application usage
- Benchmarking against references
- Trend analysis
- Customer segmentation
- Churn and up-selling modeling
- Perceived quality of user experience
- Correlation of technical drivers (e.g. network quality) and user behavior
- Contextual analysis (roaming, home vs. office)

MobiTrack provides an innovative approach of research for both commercial players and academics, in going closer to users' real life experiences than any other research method.

Appendix A – Additional visualizations

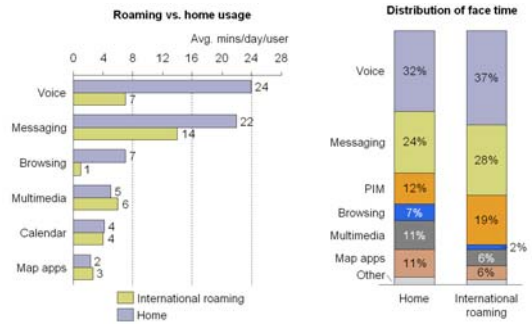

Figure 13 – Roaming vs. home usage

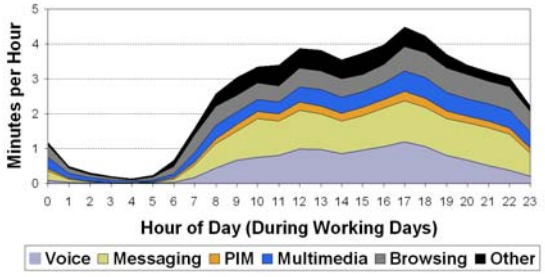

Figure 14 – Distribution of face time over the hours of working days

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