Personalized Adaptive Navigation for Mobile Portals

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Abstract. The ability of users to navigate efficiently to content is a key portal usability test, one that WAP portals are currently failing. Today WAP users waste time navigating through a sea of menus to locate content. A solution to this problem, that adapts portal navigation structures for the needs of individual users, is presented. We show how this can radically improve the usability of wireless portals, resulting in significant revenue benefits for mobile operators.

1 INTRODUCTION

User time online is a mix of navigation and content time. The former is the time spent navigating to content. The latter is time spent interacting with content. This distinction is clear in the current generation of mobile (WAP) portals, which separate navigation and content access as they are typically structured as a hierarchical set of navigation (menu) pages leading to distinct content pages. This is important from a usability perspective: for the end-user navigation is a means to an end, a necessary evil in the quest for compelling content. An ideal portal should present a user with relevant content without the need for spurious navigation. Indeed personalization research seeks to develop techniques for learning and exploiting user preferences to deliver the right content to the right user at the right time (see [2], [3], [4] ,[5], [7] and [9]). This paper addresses the navigation issue in mobile portals (see [1] and [8]) and argues that excessive navigation times are partly responsible for the poor take-up of WAP portals today. We describe ClixSmart Navigator by ChangingWorlds Ltd. as a solution that automatically adapts the navigation structure of a portal, reducing the effort required for a user to locate relevant content. We show how Navigator benefits both the operator and user, citing recent results from field studies and pilot deployments on live portals.

2 PROBLEM DESCRIPTION

The wireless Internet, made possible by the arrival of WAP (Wireless Application Protocol), has failed to meet user expectations. Many factors have been responsible - unreliable early handsets, limited content, slow connections, and poor portal usability. Today, the first 3 of these issues have been largely solved (by improved handsets, better content and high-speed infrastructure) but portal usability remains a problem, limiting the ability of users to easily locate, and benefit from, wireless content.

The core usability problem is that, with WAP portals, users spend a significant time navigating to content through a series of menus. This frustrates users, and the fact that mobile operators continue to charge users for their navigation time (as well as their content time) adds insult to injury. Studies highlight the scale of this problem and the mismatch between user expectations and realities. One study claims that while the average user expects to be able to access content within 30 seconds, the reality is closer to 150 seconds ([6]). The result: WAP offers users poor value-for-money.

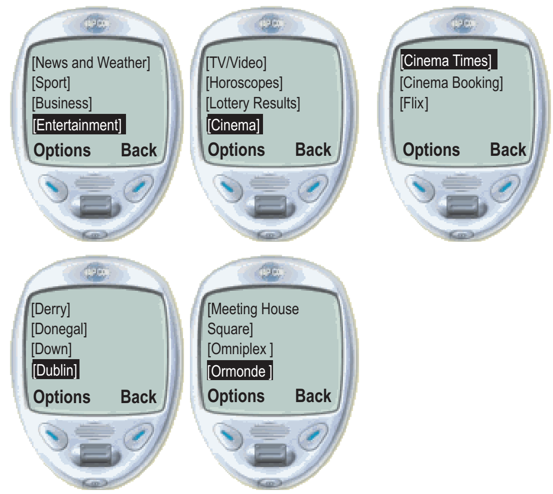

Figure 1. A click-distance of 16 for local cinema listings.

WAP navigation effort can be modeled as click-distance ([10]) - the number of menu selections and scrolls needed to locate a content item - and our studies indicate that many portals suffer from average click-distances (home page to content items) in excess of 20 (see Figure 1). We believe that personalization techniques for adapting the navigation structure of a portal can reduce click-distance and thus radically reduce navigation effort and improve portal usability.

3 APPLICATION DESCRIPTION

Figure 2 outlines the ClixSmart Navigator architecture and a typical integration scenario in which the Navigator Server sits between the content store and the gateway, intercepts user requests from the gateway and returns personalized responses. When a user requests a WAP menu, instead of returning the static menu page, a personalized version of this page is constructed based on the user's profile.

Menu Manager is a content management tool but also allows operators to control a portal's personalization properties (see Section 3.3). The tool can also be used in conjunction with existing content management systems, to automatically import and reconfigure pre-existing portals for personalization.

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Report Manager is used to generate a variety of standard and customizable usage reports so that the operator can fully exploit the business intelligence contained within user profiles.

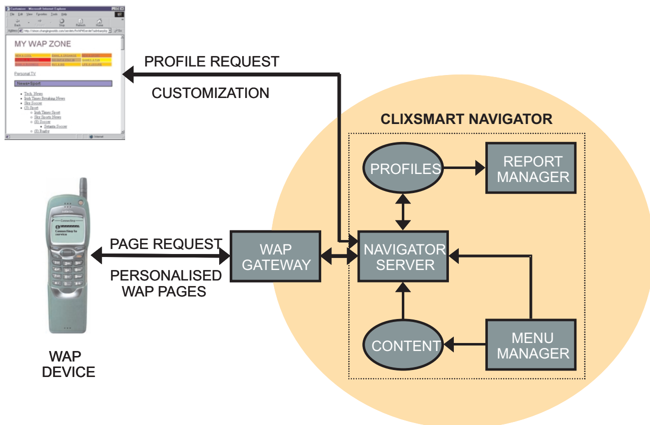

Figure 2. ClixSmart Navigator outline architecture and integration scenario.

Navigator is J2EE compliant and has been designed with performance and scalability in mind. It is capable of deploying large-scale WAP portals that attract millions of users and hundreds of millions of page impressions per month. For instance, on an entry level Sun Netra T1 Server, with 440 Mhz CPU, running Solaris V7 with 256 MB Ram, it is capable of handling $> 15k$ simultaneous user sessions with a throughput of > 200 requests per second. This hardware configuration is currently running a portal for an operator with 1.5 million subscribers ($> 100k$ unique WAP users per month) and with a CPU usage level of less than 2%.

3.1 Personalizing Navigation Structures

Navigator tracks user accesses to individual menu options using so-called hit tables; hash-tables keyed on menu ids and storing a list of accesses made by that user to options within that particular menu. For example, Figure 3(a) indicates that a user has accessed option B from menu A 10 times and option C 90 times.

In fact two types of hit table are used: a global, static hit table that is initialized with respect to the default portal structure (Figure 3(b)); and a user hit table that records each user's individual history. The static table makes it possible to deliver a default menu structure early on that will be over-ridden by the personalized menu once a user's access probabilities build. Moreover, the hit values set in the static table make it possible to control personalization latency - low values mean that personalization takes effect very quickly.

To build a personalized menu m we must identify the k most probable options for m (the k options with the highest $P(o|m)$ values) using the frequency information in the user and static hit tables. Consider the data in Figure 2 and the construction of menu A. The access probabilities can be determined as shown in Figure 4. In descending order of access probability we have C, F, B, G, D, and E. For $k = 3, C, F$, and B are selected, in order, for menu A.

This approach supports two types of menu adaptations called *vertical promotions*. A menu option may be promoted *within* its parent menu; that is, its relative position within the parent menu is adjusted. A promotion *between* menus occurs when an option is promoted into an ancestral menu. Promotions are side-effects of the probability calculations. In the above example, option F is promoted to A's menu - options can even be promoted from deeper levels if appropriate. If F is subsequently selected from A, it is added to A's hit table entry for that user, so the next time that A is created, the computation of $P(F|A)$ must account for the new data on F (see Figure 3(a) for example). Specifically, assuming a single access to F as an option in A, we get:

$$P(F|A) = 1/101 + (110/141)(10 + 80/20 + 90) = 0.647$$

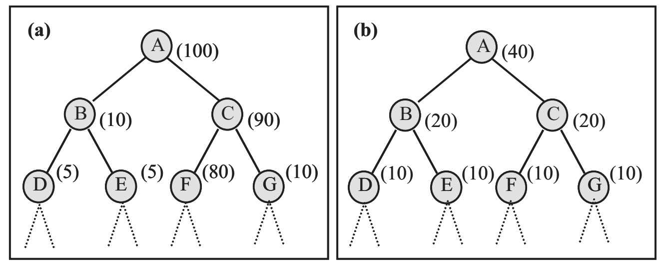

Figure 3. User (a) and static (b) hit-table representations.

P(B|A)		= (20+10)/(40+100)	.214
P(C|A)		= (20+90)/(40+100)	.786
P(D|A)	= P(B|A)•P(D|B)	= (30/140)(10+5)/(20+10)	.107
P(E|A)	= P(B|A)•P(E|B)	= (30/140)(10+5)/(20+10)	.107
P(F|A)	= P(C|A)•P(F|C)	= (110/140)(10+80/20+90)	.642
P(G|A)	= P(C|A)•P(G|C)	= (110/140)(10+10)/(20+90)	.142

Figure 4. Sample access probabilities.

3.2 Operator Controls

It is worth highlighting how Navigator provides the mobile operator with sophisticated and intuitive control over personalization to maximize the resulting benefits. The Menu Manager includes a personalization administration tool, allowing the operator to control the personalization offered on a menu-by-menu basis. This includes features such as the ability to turn personalization on or off, as well as more advanced controls over the type of personalization offered. For instance, Navigator allows operators to control how far a given option can be promoted (the number of levels from its starting point) and whether, as a result of promotion, it is removed from its original position or not (move-promote vs. copy-promote).

In addition, the operator can accelerate the promotion of a menu option by increasing its sensitivity - options with high sensitivity are promoted more rapidly than those with lower levels. This allows operators to accelerate the promotion of short-lived menu options (eg., Valentine's Day services) or revenue generating services (eg, ticket sales) to drive usage and revenue growth.

3.3 The Complete Navigator

The discussion so far has dealt with just one of Navigator's personalization methods for vertical promotions. Navigator supports a range of other techniques to implement different types of personalization. It also includes techniques for horizontal promotions in which options are inserted into a menu, m, from parts of the portal that are not descendents of m. In addition, collaborative filtering techniques are used to make targeted recommendations for options that a user has never before accessed, based on the behaviour of other similar users. Unfortunately, for space reasons it is not possible to consider these facilities further in this paper.

4 APPLICATION BENEFITS

We claim that ClixSmart Navigator significantly reduces navigation time to improve usability by minimizing click-distance. But the business-case can only be made if we can show that this enhances WAP usage in a way that drives incremental revenues for the operator. In this section we provide evidence from a recent 6-week pilot of Navigator with a major European operator on a cohort of 130 users. The trial consists of three 2-week periods. In period 1 user behaviour is profiled but no personalization takes place. This static period is a benchmark against which to judge the effects of personalization during the following 2 periods.

4.1 Click-Distance Reduction

Figure 5(a) illustrates how portal click-distance changes during the trial in terms of the average user click-distance from the home page to each user's top 3 sites. The results show that a click-distance of 13.88 for the static portal drops by over 50% to 6.84 during the first personalization period and by a further 2% for the final period. These results show two things: first that significant click-distance reductions are possible; and second, that these reductions are realized very rapidly, in this case after only two weeks of profiling, which corresponds to about 3-5 sessions per user.

4.2 Navigation Time vs. Content Time

Figure 5(b) shows how the click-distance reduction translates into a reduction in average daily navigation time. Over the 4-week personalization period (weeks 3-6) average daily navigation time reduces by 36%. During the initial static period users are spending an average of 56.42 seconds navigating to content each day, but this falls to only 35.99 seconds for the 4 weeks of personalization. Indeed if we look at the results for the final two weeks (weeks 5-6) in comparison to the first two weeks of personalization (weeks 3-4) we see that the incremental benefits of personalization more clearly, with navigation time reducing from an average of 36.55 seconds (weeks 3-4) to 35.43 seconds (weeks 5-6).

It is important to realize that the above results refer to total daily navigation time for the average user. However since the number of sites that a user accesses may change day by day, the above timings do not give an accurate picture of the average navigation time for an individual content site. Figure 5(c) presents this data by dividing the above navigation times by the average number of daily site hits for each period. They show a clearer picture of what is really happening to navigation time, which is seen to decrease by 50% as a result of personalization. During the static period the average user is taking nearly 32 seconds to navigate to an individual content site, but this falls to about 16 seconds as a result of personalization.

In contrast, when we look at the daily content time for users (Figure 5(d)) we find that there is a significant increase due to personalization. Over the 4-week personalization period (weeks 3-6) average daily content time increases by 17%. During the static period the average total daily content time per trialist is 312.46 seconds compared to 364.55 as an average of the 4-week personalization period. Moreover, if we look at the average content time for the final two trial weeks (as opposed to the final 4 weeks) we find a relative increase of more than 22% (average content time of 382.62 seconds). Thus, the relative increase in content time for the final two weeks of the trial (22.45%) has more than doubled in comparison to the first two weeks of personalization (10.89%); as personalization proceeds so too do the benefits increase.

These results also highlight an important point about the willingness of users to trade savings in navigation time for increases in content time. According to these results, for every second of navigation time saved the average user increases their content time by more than 3 seconds - by the final two weeks of personalization the average user is saving an average of 22.99 seconds in total navigation time, but increases their total content time by 70.16 seconds. There are obvious benefits here for the mobile operator from a revenue point of view, not only in terms of existing airtime-based charging models but also as operators move to content-based charging models where navigation time charges must be eliminated or minimized, and so where it is critical to look for ways to reduce the need for navigation.

4.3 User Sessions

Figure 5(e) illustrates how the average number of daily sessions (separate portal visits) per user drops slightly, from 1.54 during the static period to 1.5 during the personalization period (weeks 3 - 6), a relative decrease of just over 4%. On the face of it, these results suggest that users are engaging in fewer sessions on average during the personalization period - a potentially negative result for personalization. However, this is not the case.

To better understand these session results it is important to understand the concepts of a successful session and a failed session. A successful session is any session where the user accesses at least one content site, since users get no value from sessions that include navigation only. Our hypothesis is that many users fail to locate content within a session, during the static period, and that such sessions have a negative impact on user satisfaction.

The percentage of successful sessions during the static and personalization periods are shown in Figure 5(f) and indicate a clear improvement during the personalization period. During the static period only 58% of sessions are successful; that is, 42% of the time that users log-on they fail to access content. However, during the personalization period the percentage of successful sessions rises to nearly 79%, a relative increase of 36%. Thus, the percentage of failed sessions has fallen from 42% during the static period to 21% during the personalization period. The percentage of failed sessions has been cut in half. Navigator is eliminating the failed sessions that are due to navigation difficulties and there is a clear indication that users are more reliably able to locate content.

By combining the successful session percentages with the daily session results we can obtain a clearer picture of how the actual number of (successful) sessions changes due to personalization (Figure 5(g)). Thus during the static period the average user engages in only 0.9 successful sessions per day on average. During the personalization periods this grows by over 31%; the average number of successful sessions for the 4-week personalization period hits 1.19. Thus, although the total number of sessions does not increase, because of the significant reduction in failed (content-less) sessions, the number of successful sessions does increase. Users benefit from fewer failed sessions, improved usability and greater value-for-money, so they engage in additional sessions, which are more likely to be successful.

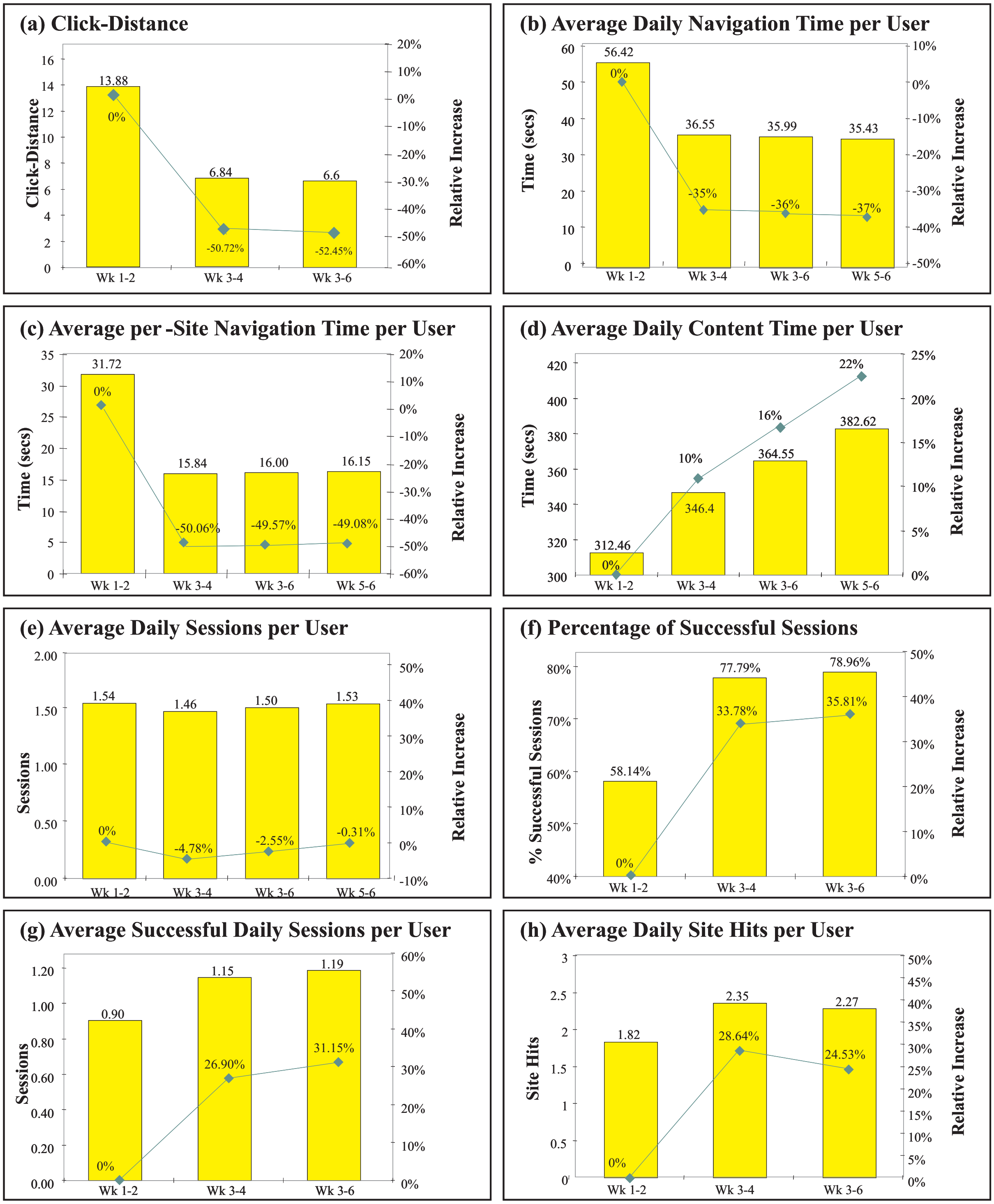

Figure 5. Usage results from live-user trials of ClixSmart Navigator on European WAP portals.

4.4 Site Hits

So far we have seen how users are engaging in additional content time and sessions as a result of personalization. How are they spending this extra time? Figure 5(h) shows that the average number of site hits (individual accesses to content sites) increases by nearly 25% when we compare the 4-week personalization period to the static period. Thus, users are spending their extra time online going to extra content sites - the newfound ease with which users can access content leads them to additional sites.

5 BUSINESS BENEFITS

Ultimately the immediate business benefit of ClixSmart Navigator's personalized navigation solution is to dramatically improve the usability of a mobile portal and so increase usage. This in turn leads to direct revenue benefits for the mobile operator alongside improved user satisfaction and loyalty. Thus Navigator clearly enhances the revenue opportunities for operators, not only for today's airtime-based charging models, but also for tomorrow's content-based models.

In addition, Navigator offers more than just a technical solution to a technical problem. It offers mobile operators new kinds of business models for third-party content and m-commerce relationships, by allowing operators to offer personalization as a premium service. For example, operators can negotiate improved revenue-share deals with third-party providers by increasing the personalization sensitivity associated with their sites - essentially a form of preferential product placement that will drive interested users towards relevant premium services.

Moreover, the user profile generated by ClixSmart Navigator can be used as a valuable source of business intelligence to assist an operator's CRM division. For example, these profiles can be used to drive targeted marketing campaigns of content-push services in the future. ClixSmart Navigator includes a range of data mining capabilities in order to assist the operator in making the most from this form of business intelligence.

It is also worth highlighting that Navigator's profiles potentially cover all of an operator's (WAP-active) subscribers, both pre-paid and contract subscribers. This is a significant step forward since in the past most operators have no way of gaining information about the habits and preferences of their pre-paid customers, which can often account for up to 70% of their subscriber-base. Indeed, personalization can be used as an incentive for contract customers that are not offered to prepaid customers as a way of attracting more contract customers (a major goal for operators).

6 CONCLUSION

In general, limited usability and poor value-for-money are major contributing factors for the low levels of interest in WAP currently shown by the general public. These problems are closely aligned with the difficulty that users have in navigating to content on WAP portals.

ClixSmart Navigator can solve the navigation problem by adapting portal structure to the needs of individual users. We have shown how Navigator reduces click-distance, navigation time, and the percentage of failed sessions by 50% to result in significant increases in online usage (airtime, sessions, page impressions, and site hits). Indeed for each second of navigation time saved, the average user is willing to invest an additional 3 seconds in content time. Moreover, although these figures are derived from a modest 6-week trial of 130 users, similar results are emerging for a much larger 200k-user deployment that has been underway for 6 months.

The significance of reduced navigation time should not be underrated. By cutting navigation time in half, bandwidth has been effectively doubled without a major infrastructural investment. Moreover, this bandwidth doubling can be achieved on top of future bandwidth increases and as operators move to faster GPRS systems, Navigator can double the effective bandwidth here too.

In conclusion, ClixSmart Navigator enables mobile operators to deliver a new type of personalized information service that is suited to the needs of mobile users and the capabilities of mobile devices. It provides operators with greater control over the targeted delivery of content to the benefit of end-users. For the operator the result is a more profitable mobile Internet service, and for the end-user, improved value-for-money.

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