Interstitial Interfaces for Mobile Media

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ABSTRACT
Mobile devices make ideal *personal* ambient information systems given their ubiquitous adoption by users and their rich context knowledge of users' activity. However, we believe that unlike traditional systems, the mobile device acts more as an *interstitial* information appliance, allowing users to consume relevant information at-a-glance primarily during the interstices between other activities. In this paper, we motivate a discussion on how such usage behavior can impact the design, visualization and usage characteristics of mobile ambient information systems. We focus not just on design issues (related to information selection, rendering abstractions, impact evaluation) but also on the ecosystem concerns (provisioning costs, business models) that often prove critical to developing commercially-viable solutions.

Keywords
Ambient interfaces, information visualization, design rules, mobile media, presence, context-awareness

INTRODUCTION
Ambient information systems help users stay connected to relevant but non-critical information in a non-intrusive way. Mobile handsets make ideal personal ambient information appliances due to both their penetration among the global consumer population and their rich contextual knowledge. The always-on, always-connected nature of handsets could conceivably enable "what's happening" style interfaces [1], allowing users to remain connected and up-to-date with their community information when mobile. However, this potential is underutilized because most mobile interfaces offer a miniaturized 'browsing experience' that is at odds with users' desire for a passive 'awareness interface' – one that can expose them to a breadth of relevant information with minimal interruption. By definition, browsing requires a degree of user attentiveness (in querying, navigating and selecting content) that lends itself better to a *lean-forward,* tethered experience (PC) than to a *lean-back,* mobile one.

What then constitutes an effective ambient interface for the mobile device? In our experience, most users expect mobile phones to behave as an *interstitial* information appliance – one that allows them to grab an 'information bite' quickly and opportunistically during the interstices between other activities (e.g., while standing in the airport security line or waiting for friends at a restaurant). In this paper, we attempt to identify key design issues that need to be addressed when architecting ambient information systems for mobile, interstitial consumption of content. Relevant issues include:

- *Information Selection* – What kinds of information will be viewed as "value-add" by a mobile user *and* will lend themselves to interstitial consumption?
- *Rendering Abstractions* – What primary visualizations of ambient interfaces will enable mobile users to balance breadth of awareness with cognitive overload?
- *Evaluation Metrics* – How do we measure the impact of such systems on end users? Can we qualitatively identify factors that enhance (or disrupt) interstitial consumption?
- *Pragmatic Concerns* – What service provisioning costs and business models should we factor in, when creating 'commercial' mobile ambient information appliances?

Our insights into many of these issues – and our proposed solutions to them – are influenced heavily by our hands-on experience with the SCREEN3 product [2], a 'zero-click' ambient interface that is currently deployed on more than 2 million handsets worldwide.

RELATED WORK ON MOBILE AMBIENT DISPLAYS
Research on ambient information systems has yielded a rich and diverse variety of design approaches. These have been covered exhaustively in papers such as [3]. However, they can be coarsely segmented into two classes – *specialized ambient displays* and *information monitors.*

Specialized ambient displays are aesthetically-pleasing representations of small (often single) datasets – e.g., the Ambient Orb or the Water Lamp [4]. On the other hand, information monitors tend to unify many data sources under a single awareness interface. They can be segmented further into *distributed display architectures* and *primary display adaptors*. In the former, the primary display is augmented with a secondary display, with both displays interoperating seamlessly – e.g.,Eye-Q [5]. On the other hand, primary display adaptors 'repurpose' existing displays for enabling ambient information delivery – e.g., Sideshow[6].

Mobile phones are more likely to be information monitors. Further, while both monitor-based approaches are viable for mobiles, the distributed display solution pre-supposes the development and existence of an 'accessory' ecosystem that is however likely to happen over a longer time horizon. By contrast, primary adaptor solutions can co-exist easily with currently-supported mobile hardware.

This classification of phones as information monitors is reinforced by Schmidt [9], whose user studies show how screensaver-like visualizations of ‘communication meta-information’ (e.g., frequency of calls, initiator identifies, in-person proximity encounters) enable users to gain new perspectives on the strength (and weakness) of their social ties. The work also emphasizes how the rich capabilities of mobile phones (e.g., GPS, WiFi, accelerometer) create new contextual data for presentation via ambient displays. In essence, the mobile device acts as a sensor, inherently providing localized and *personalized* information that drives both the selection of content (for ambient display) and its subsequent visualization to the user.

Many desktop-resident ambient information systems (e.g., “What’s Happening” [1], Dashboard [7], and Konfabulator [8]) also emphasize the desirability of a passive *click-free* (lean-back) user experience. These zero-click experiences become particularly important for mobile interfaces given device input constraints – industry reports show that the proportion of engaged mobile users decreases in almost geometric progression with the effective “click-distance” of the relevant item from the main screen. As a result, we are seeing the emergence of commercial technologies such as Widsets (Java-based widgets) [10] and SCREEN3 [2] that are specifically designed to create ambient displays in the mobile device.

DESIGN PRINCIPLES

All these factors played a part in motivating our exploration of interstitial interfaces for mobile media and in guiding our thoughts on design principles for developing such systems We begin by attempting to define the dimensions of an effective mobile interstitial display. We borrow heavily from Stasko’s taxonomy of ambient information systems [3] which identifies four dimensions of design – information capacity, notification level, representational fidelity and aesthetic emphasis. In particular, we refined the definition of ‘ambient’ and its dimensions to better characterize the mobile domain and to introduce additional elements that are unique to the mobile ecosystem.

Information Capacity

This denotes the *nature* and *amount* of information that can be effectively depicted on an ambient display. The passive nature of these systems and the low interruption-tolerance of mobile users suggest that interstitial information systems are best used to convey non-critical, delay-tolerant content for casual consumption. Deployment experience and user studies indicate that environmental information (e.g., local weather), general news (e.g., sports, entertainment) and updates from the user’s primary social group (e.g., music and motion presence) are viewed as being appropriate for interstitial consumption. From the mobile perspective, the amount of information conveyed can be characterized by factors like the ***channel bandwidth*** (number of concurrent information channels supported as ambient interfaces), the ***information density*** (ratio of information value to message size) and ***hysteresis*** (rate of decay in perceived value of item over time).

Effective mobile experiences are able to support channel bandwidths of 3-5 channels, with content characterized by a high information density coupled with a low hysteresis (1-5 hours). High information density (e.g., a sports score, or a stock quote that conveys high-value information in just a few bytes) is especially important for mobile devices, given the relatively high cost of cellular bandwidth and the limited cognitive bandwidth display real-estate available to users. Emphasis on ‘hysteresis’ is also a function of the high cost of data delivery to the handset. To conserve valuable bandwidth and battery, mobile information appliances often resort to ‘cache-and-render’ models that leverage periodic bulk transfers to the mobile device (in lieu of expensive incremental or continual real-time information updates).

Notification Level

Notification levels reflect the degree of interruption that is acceptable to users. It is typically dependent on the user’s interest in his current task – which varies from inattention to divided attention to more focused attention. Accordingly, researchers [12] have identified five notification levels for peripheral displays namely *ignore*, *change blind*, *make aware*, *interrupt* and *demand attention* ordered by their increasing intrusion into user consciousness. However, Stasko observes [3] that ambience is best-served by change-blind and make-aware style notifications only.

We agree with this philosophy. In general, high levels of interruption are especially heinous in mobile environments where device constraints and the likelihood of users being otherwise engaged, combine to make such alerts annoying – leading to users questioning the utility of such interfaces, and potentially tuning out *all* notifications subsequently. However, interstitial consumption may require switching between different notification levels based on known or predicted level of user attention. By default, ‘idle screen’ behavior should be seen as user inattention – less intrusive alerts suffice. However, a user action (e.g., click through) indicative of user engagement in the content may be perceived as divided or focused attention – more intrusive alerts (e.g., to arrival of fresh content) may then be acceptable within that interstitial consumption ‘session’. Context-awareness may be key to such adaptive behaviors.

Representational Fidelity

The taxonomy for representational fidelity [3] focuses on the diversity of symbols and notation used in depicting the information on the ambient display. High bit and bandwidth costs restrict the symbolic flexibility of mobile interstitials to basic text and minimalistic symbols. However, *synthetic media* approaches (e.g., avatars) could leverage the fact that such devices are rich in graphics capability even if network bits remain expensive. Limited representational fidelity enhances *glanceability* since the user does not have to master a complicated set of notations in order to interact with the information system.

A second aspect of representational fidelity (from a mobile perspective) focuses on *nesting* – i.e., allowing the user to "snack" superficially on a number of content channels but then enabling him to drill down further to obtain additional details on items of specific interest.

Aesthetic Emphasis

Aesthetics is essentially a subjective discussion [3] where focus can vary from appreciating the innovativeness of the physical artifacts used to convey ambient data, to evaluating alternative means used for *communicating* this information effectively. From the mobile perspective, we rate aesthetics in terms of the success of the user interface in maximizing the user's "ambient bandwidth", i.e., how well does the interstitial ambient interface adapt to the user's current need for information such that the user is able to tradeoff breadth of information with depth of detail at any given time.

Given resource constraints of mobiles, any aesthetically-pleasing interface must avoid clutter and yet be relevant. We see many different 'modes' of ambience (rendering abstractions) in existence today, These translate to mobiles with varying degrees of success based on the total amount of data to be conveyed and on the total ambient bandwidth attributed to the user. Available modes include:

- *Carousel* – interface limited to a small segment of available real estate. Is ideal if *sequential* access to information can be tolerated. Is good for low item counts (allowing users to scroll through items quickly to locate specific content) but can be adapted for higher counts with intelligent design. E.g., SCREEN3 [2].
- *Widgets* – interface is ideal for scattered usage over larger display real estate. [7, 8, 10] Is ideal if *parallel* access to information sources is desirable. Is good for moderate item counts, though user action may be desired in order to "select" from large populations of available widgets for display at a given time.
- *Toasts* – interface consists of a 'pop-up' that can cover variable display real estate (part- or full- screen). Is ideal for sequential access and low item counts but differentiates itself primarily in the increased intrusion into user consciousness. They are ambient in that they can display (and retract) information without user intervention. However, toasts are usually employed in a transient manner – alerts shown once do not reappear.

Based on our experiences with SCREEN3's carousel mode, we see value to a comparative study of such 'ticker-style' interfaces that use wipe-based transitions for ambient information visualization. Different classes of tickers can be envisioned – *continuous scrolling* (steady rate), *discrete scrolling* (employing scroll➔pause➔scroll cycles) and *serial presentation* (no scrolling, just item replacement). Our initial thoughts favor the use of discrete scrolling since this allows users to consume sufficient information without additional effort on their part – also giving them sufficient time to react to information by clicking-through for details.

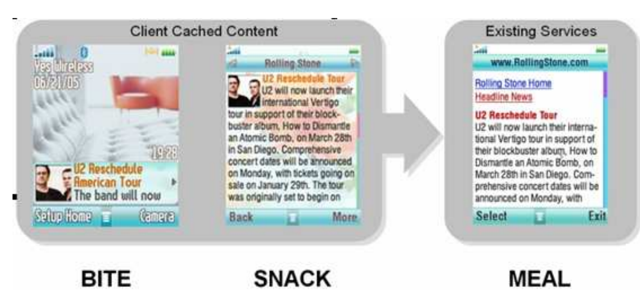
Visualization schemes are also important. While most data items are valued individually, some only translate to useful information if viewed in aggregate. For example, a user who is interested in the "Top 10 songs today" may not want to know individual items (voter identities) that contributed to this information. On the other hand, a request for "Top 10 songs played by my friends" is likely to pique the user's interest in knowing the specific identities that correspond to each item. *Cloud* abstractions [11] are ideal for this – they create 'heat maps' enabling users to absorb popular trends with a glance but subsequently drill down to see details.

Fairness

We augment Stasko's taxonomy with the dimension of *fairness*, as a way for passive interfaces to support a larger information capacity without active user navigation. It's quite common in channel-oriented mobile systems (e.g. SCREEN3 below) for the number of channels to exceed the display capacity[1] of the device, and for the number of items per channel to exceed what can be shown to the user at one time. The definition of fairness for ambient information systems parallels its usage in distributed systems – namely that every 'channelized' information item will have fair access to "face-time" with the user – even if the user does not actively navigate to it directly. The carousel model adopted by SCREEN3 is a good example of a fair ambient information system with a non-weighted, round-robin selection scheme. However, one can imagine a number of alternative ambient interfaces that support fairness. We note that fairness becomes particularly important in commercial systems where many third-party providers of such ambient content have a vested interest in having their content seen by the user at some point. This is different from the case where users elected to receive specific content of interest – i.e., the user knows the content exists and can navigate to it if desired, while in the earlier case users remained unaware of its existence unless they 'stumbled' upon it by accident.

THE SCREEN3 CONCEPT

Our exploration of mobile ambient interfaces was motivated primarily by our experiences with using the SCREEN3 technology [2] developed at Motorola for mobile handsets.



[1] Here, display capacity represents the 'viewing window' provided to the user within the available display real estate. It could equal the physical display size (for full-screen ambient interfaces) or could be some subset of it that is specifically allocated for ambient usage.

SCREEN3 targets the idle screen of mobile devices as the ideal delivery point for news, weather, sports, entertainment and other updates. The SCREEN3 client (on the handset) supports multiple channels of information (e.g., one for sports, another for community updates), and multiple items per channel. A SCREEN3 media gateway (server) manages different content feeds, allowing the client to obtain the freshest information for each feed (channel) of interest (pull-based, with the capability of WAP push).

The SCREEN3 model's emphasis has been on providing users with a zero-click, lean-back experience for lazy content consumption – with the ability to transition to a more lean-forward, interactive experience as desired.

These different degrees of user engagement are supported by a "bite–snack–meal" approach to information delivery as shown in the figure. The "bite" contains headline-quality information for content items, enabling users to consume it at a glance (passive awareness). For items of interest, users can easily transition to a lean-forward (more interactive) experience by clicking through to receive a "snack" – typically a cached extended summary for the headline article. For more information, users can then click through the snack to request a complete "meal" – typically a link to a network repository containing the complete article with richer media attachments that the user can browse online or download for consumption.

SCREEN3 currently adopts a carousel model for displaying information bites – the carousel can be navigated manually (to enable scrolling through the channels, or through items within a channel) but is typically animated, automatically scrolling through channels and items in sequence for a true zero-click consumption experience. The server caches client state in order to decide what updates need to be delivered to the mobile device. However, the content being displayed remains still fairly static in terms of both its applicability to the user (i.e., it may be a channel that the user subscribed to in the past, but hasn't v actively in recent times) and its visualization on the device.

EFFICACY MEASURES FOR INTERSTITIAL SYSTEMS

User interactions convert "ambience" into "intent". This tipping point is of value from a business perspective, as it bridges content and commerce. Where passive viewing a news item represents casual interest in something, actively interacting with it might indicate sufficient interest in the topic or item to merchandise related goods and services. Identifying user interests can also provide personalization of ambient information. This improves not only system efficiency (ability to prioritize fetching and caching of content that is likely to be of more interest to this user) but also the hit-rate (user click-through) for interstitial consumption of related content. The latter is particularly important on mobile devices. Display constraints limit the information capacity, allowing only a few items to become visible in any limited time window.

Further, interstitial consumption patterns imply that the *face-time* afforded to ambient information systems is usually limited to short 'windows of opportunity' in between other user tasks. Thus, items must now compete for the user's attention within a given opportunity. Item *selection* becomes key to either holding the users' interest (thus providing opportunities for other items to be shown) or losing it (thus ensuring that he or she remains unaware of the existence of items that *are* relevant and interesting).

So how can we measure the impact of ambient information systems? We propose various measures that reflect different degrees of user engagement and for different rendering abstractions (e.g., carousel-based, widget-based)

- *Attention Measures.* Identifies the minimal level of engagement with ambient information. E.g., time spent by user in scrolling through channels, or time for which an item was in focus with user present at device. While the notion of an attention measure could apply equally well to PCs and TVs, the fact that the phone is a personal device on which content consumption is a deliberate decision, is likely to provide "clean", high quality attention data. As shared devices, both the PC and TV suffer from the "who's watching" drawback (according to an industry statistic, over 50% of the time, the TV is on with nobody watching). Simple context enablers can disambiguate mobile-in-the-pocket and mobile-to-one's-ear situations, and allow more accurate measurements of content viewing on the handset.
- *Action Measures.* Identifies a higher level of user engagement related to a specific item or channel, particularly since the user is potentially aware of possible delays in fulfillment such as for network downloads. E.g., user click-through (bite➔snack➔meal) or hide➔reveal transitions for specific widgets [7][8][9].
- *Transaction Measures.* Identifies potentially the highest level of user engagement related to an item or channel e.g., {see concert notice (on music channel)➔buy tickets or read interesting headline (on news channel)➔blog it).

Transaction measures are more interesting from a business perspective since they translate more directly to commerce. However, they are also a more difficult measure to evaluate since the correlation between point-of-viewing (on ambient interface) may be temporally or spatially distant from the point-of-purchase (e.g., at a later time, on a potentially different application). Correlations may be simplified in cases where the transaction is driven directly off the ambient interface (e.g., via menu actions).

More complex solutions can involve correlating *short-term* activity history to *long-term* monitored user behaviors. For instance, short-term history can link an ambient display item to the user (e.g., click-through captured showing user viewed extended information about concert on the ambient display). The long-term observations (across devices and domains over a longer period of time) can be analyzed to infer that a subsequent user activity was influenced by this recently viewed item – e.g., a weather item indicating rain in the forecast was viewed some time before the purchase of an umbrella was recorded on the user's credit card. In general, we view handsets as ideal devices for gathering the raw data required for deriving such metrics. It inherently provides a source for fresh, personalized user data.

QUESTION FOR DISCUSSION

This discussion was motivated by a multi-faceted question:

> *What differentiates the design of a mobile ambient information system with an emphasis on interstitial consumption of content?*

We believe these systems are useful, are viable (given existing technologies) and are of commercial interest (both for differentiating devices with an enhanced user experience, and in creating opportunities that convert ambience to action and ultimately to commerce). However, their role as an intermittently-seen display (from the usage perspective) raises both interesting challenges and new opportunities for enhancing user awareness to information.

It also raises other secondary questions involving fairness and privacy. Given that new information is generated faster than existing information can be consumed (especially with interstitial consumption), how can we balance fairness with freshness? From a privacy perspective, where do we draw the line between utility and exposure? Because the phone is an intensely personal device, it is reflective of user interests or information that he or she may not want to reveal to others. Because we envision the ambient interface being active when the device is idle (such as when the user leaves it on his desk for a long period of time) – there is a good chance that such private information may become visible at times when the user is not present but others are.

With this paper, we hope to initiate a deeper discussion on such design and usage issues, and to identify a few key applications that can benefit from (or drive the usage of) such interfaces on the mobile phone.

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