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# Building Pervasive Display Landscapes with Stick-On Interfaces

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**Manfred Hechinger****Heinrich Schmitzberger****Abstract**

In today's everyday-life an increasing amount of displays of arbitrary kind are used; in particular, the amount of publicly used displays of any kind are growing. Currently these displays are often static regarding the content they are presenting and moreover often do not allow people to directly interact with them.

We propose "Stick-On Interfaces" consisting of a stick-on hardware module and corresponding operating software which are attached to any kind of display in order to provide users with direct interaction capabilities with such "enabled" displays.

As a general goal, users should be able to interact with these displays in a seamless, personalized and context-aware style.

**Keywords**

Everywhere displays, pervasive, display landscapes, stick-on interfaces, stick-on hardware

**ACM Classification Keywords**

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

## Introduction

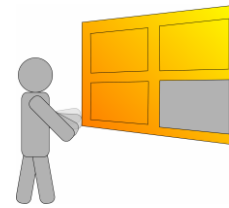
Public displays are widely spread in every day life environments. One encounters them on the way to the office, in the supermarket, at the airport, etc. Benefiting from their social acceptance and their integration into cityscapes all over the world, public displays offers an opportunity for presenting all kinds of information to a potentially anonymous audience. Additionally the usage of displays for non-traditional purposes (signs, advertisements, etc.) is constantly increasing in popularity.

Unfortunately currently offered solutions in display technologies are rather proprietary and strictly dedicated to a special aim. Personalisation and user interaction is still lacking in implementation.

Another vital issue concerning display landscapes to be considered states that "...the informative aspects of the [display] environment – in the shape of posters, screen displays or anything able to display information – do not always make best use of their display real-estate. Traditional static media such as posters quickly become outdated, their informative purpose outlived as they become commonplace" [1]. In this regard the organisational demands of display landscapes pose a challenge. There is a permanent need for keeping the information up-to-date to avoid wasting precious resources

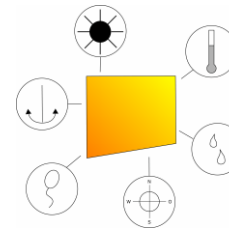
Consequently we are witnessing a paradigm shift away from separate fixed display devices towards pervasive and ubiquitous display landscapes. In order to satisfy the needs of henceforth information society such pervasive display landscapes have to support several key aspects:

## Getting in contact



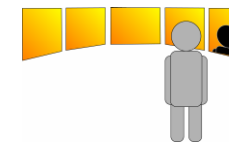
A known challenge in pervasive display development is the creation of an adaptive and flexible user interaction interface. As main requirement for adaptive interaction with the user, pervasive display landscapes have to react depending on spatial proximity. This interaction has to be processed spontaneously.

## Context awareness



Display landscapes can be found nearly everywhere and in most cases the single physical devices differ in size, resolution and supported formats not mentioning their serving different purposes. Thus there is a need for having information about the circumstances under which they operate. Furthermore a display interacting with people needs to be aware of the user it addresses as well as of its environmental parameters. To accomplish this goal, pervasive displays have to make use of modern sensor technologies such as accelerometers, brightness sensors, thermometers, etc. Combining the input of all available sensory data the device needs to extrapolate its context. Each display has to react according to this calculated context in order to enable proactive behaviour.

## Personalized displays

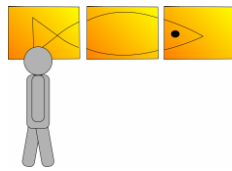


Another important challenge for ubiquitous display landscapes is reacting personally on each user according to an individual profile.

Generating such a profile could be based on a set of considerations depending on the application scenario. The age or gender of a user for example could be of interest to personalize advertisements. Another concern would be to react on social or even on cultural peculiarities.

By making use of a profile based approach, pervasive display landscapes get capable of providing personalized services for all kinds of purposes all over the world.

### Seamless in interoperability

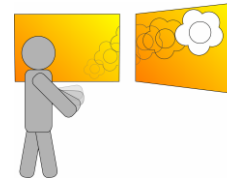


Technologies involving multiple displays have to provide means of enabling interoperability among each other to form a seamless acting display landscape. If such technologies claim public acceptance, networked pervasive display landscapes must be able to act as a single logical display while being physically dispersed.

In this manner a single picture for example has to be presented on two or more separate displays, each of different size, with the user not actually taking notice of the physical dispersion of the devices.

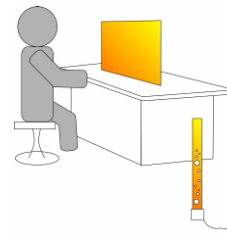
Ubiquitous display landscapes will furthermore be able to implement floating display content applications. In these applications the content presented to the user will not be bound to a particular location i.e. a fixed display. It will be able to follow the user step by step if necessary.

### Seamless in interaction



Given an at-work-situation, having two people working on a wall of displays, each on different computers, while sharing their research data. In this scenario it must now be possible that one user drags a document over the display wall to a shared space without perceiving an operational barrier. His co-worker then easily accesses or manipulates the document without taking notice of the internal processes enabling this sharing operation.

In this context an important aspect to discuss concerns privacy. It is of major importance to assure that private data keeps private even if it is displayed on non private spaces.



### Perceiving displays

Considering the wide variety of displays existing in the present, one has to differ between focused and peripheral displays. Focused or active displays such as the computer monitor have the immediate attention of their user.

On the contrary, peripheral displays are experienced unconsciously and act in a passive way.

One aim of pervasive display landscapes is to reduce the amount of attention users have to bring up towards displays while perceiving as most information as possible. In this cause peripheral displays are in advance. Though a mixed approach of focused and peripheral displays has to be aspired.

### Economical aspects



Digital ubiquitous display landscapes provide a platform for offering charged services. To make use of that an adequate framework must be applied. Such a framework needs to provide means for serving two different types of customer scenarios.

Scenario number one describes the use of pervasive display landscapes to offer services like public postings or auctions directly to the end user. The second scenario includes an explicit provider who acts as an intermediary addressing the business customer tier (advertisements, public announcements ...).

### Our approach

In order to accomplish these criteria the Institut für Pervasive Computing developed a solution which fits into the current market situation.

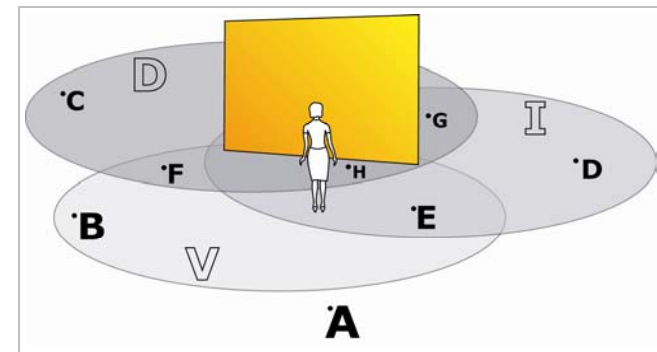
Our approach is to create a stick-on computer to apply on all types of currently existing displays so to extend them with pervasive computing functionality. This stick-on interface provides means for organizing a number of display nodes to become one logical device based on state-of-the-art (wireless) communication technologies. Therefore establishing autonomous ad-hoc networks is of major importance.

In addition a configurable and component based virtual display service framework will be implemented so as to serve current service requirements as well as future concerns. Furthermore a modular approach will be

pursued to force the extensibility of these display landscapes.

### Classification of interaction

To allow seamless interaction with display landscapes various appropriate user-input and sensor technologies will be integrated. As stated in [1] the geometric relation between a display landscape and a user can provide important information about the awareness level and interest of a user. We adapt the focus/nimbus model to take into account that users are physical objects. We classify users depending on their membership to one of three sets (cf. figure 2): Users can be in viewing range of a display landscape (thus they can see the content displayed, cf. figure 2/section V), they may be detected by the sensing system (cf. figure 2/section D), or may be close (or capable) enough so they can interact and create input to the system (cf. figure 2/section I)



- A** The user is out of reach, although known to the system. In this state no interaction or flow of information is possible.

- B** The user is able to perceive the contents of the display landscape, but is too far away for interaction (or does not have the right tools), and cannot be detected by the framework. Nevertheless, he may be attracted by content that is displayed.
- C** The user cannot observe the contents of the display landscape and cannot interact with it, but is detected by the system. For a sensing system, this is a desirable situation, but not necessarily for a display landscape.
- D** Users that cannot perceive the contents of a display landscape and are not detected by the sensors can, under circumstances, still interact with display landscapes (if they are aware of them - they are in their nimbus). We define this situation as one part of 'far interaction' (together with the next category), where users may post content to distant displays.
- E** Users are able to perceive the content of and interact with a display landscape, but are not detected. Users might be out of reach of the sensing system, so no interaction can be initiated by a service.
- F** In this category, the users are in viewing range and are detected by the display landscape, but cannot interact themselves. This enables a unidirectional flow of information from the display landscape to the user to enable notification services.
- G** A user might be detected by the system and can interact with the display landscape, but cannot see the results of his actions.
- H** Finally, the last case describes active users that can fully interact with the display landscape.

### **Interaction in service-classes**

The way how people can interact with display landscapes differs depending on the displayed content as well as the interaction-needs between users. We classify the interaction with display landscapes regarding the control-flow:

- Applications which require only "one-way" interaction capabilities, e.g. posts which are presented on a wall. Such applications only need to be able to receive content from users, for example via SMS.
- Applications which require "two-way" interaction capabilities, e.g. an auction system. This category requires that data can be sent to the display landscape from users and vice versa. However a user is not required to permanently interact with the system.
- Applications with a high degree of interaction requirements, e.g. (multi-user) games presenting their content to display landscapes. Such applications require a permanent interaction between display landscape and users in both directions.

We therefore distinguish service-classes with different interaction capabilities and modalities. Each service-class describes which interaction capabilities it has, thus how users can interact with the provided service and the display. The following list depicts several example service-classes which shall be used on spontaneously networks ubiquitous display landscapes.

## Service-class Note



This service class should display short notices as a form of broadcast 1:n communication tokens. It acts as a digital analogy of stickies or "Post-It" notes. Several properties may be changed to customize the appearance of notes to ones personal preferences. To use this kind of service-class a request containing the text is necessary. Creating a note offers all persons in spatial proximity to the display (passengers, customers, loaded guests, etc.) the possibility for ad-hoc communication with the user. These can be answers to a note, their message should then be automatically forwarded to the author. After a predefined period of time the note-instance should be removed from the display(s).

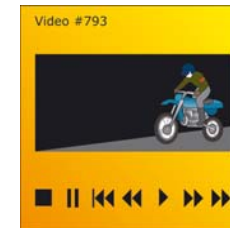
## Service-class Auction



This service class should provide the user with the possibility of offering items he wishes to sell in a public area. The user should be able to have the ability to set a description of the item, a basic price, define an expiration time (up to an administrative maximum) and provide a picture of the item. Interested users then can submit a bid which is higher than the actual price displayed on the Auction instance. It is also possible to post longer term valid offers for sale at distant places. Without disclosure of the bid

sum, the service class "Auction" can be used like a traditional advertisement solution. The service-class "auction" permits in addition to normal text (like a note) the integration of arbitrary graphics and HTML-elements. Beside that, a directly visible feedback (for instance the price) is given, to communicate the current auctions state.

## Service-class Video



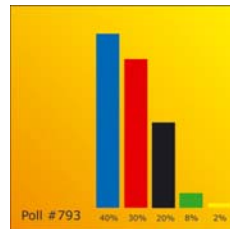
With this kind of a service class it is possible for a user to show videos on displays. Just by sending an URL or a predefined shortcut to a specific display number, this service class allows a video to be played. It is also possible to interact with a video (e.g. to restart a previously stopped video, etc.). The set of possible commands will be extended in future time depending on technical features of the used video-codecs and player-software. Depending on the type of the video-file and the server on which the file is located, a display either completely downloads and then plays the video or streaming technology is used for instant playing. A general disadvantage of this service class concerns the size of the used files, which shows up if the internet-connection-speed used either by the user device or the server storing the file is slow. Regarding this problem, a possible solution would be restricting play-time to a well considered duration or even a restriction considering the file-size in case of download.

## Service-class Gallery



This service-class should provide a user of this system with the possibility to post a slideshow of pictures on any display. Users should be able to create lists of pictures which are shown in specified orders and a user defined delay time between each picture. Implementing some commands for navigating/browsing with, for example, SMS-commands through the Gallery should also be included. This could for example be: next picture, first picture, (re)start slideshow, etc. All HTML-Browser understandable picture types should be permitted (gif, jpeg, png, etc.).

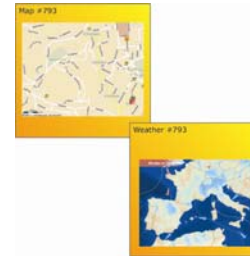
## Service-class Poll



This service-class should be used to hold polls via displays. The "question" to be investigated and the alternatives should be displayed on an instance of the service class. It should be possible, that a poll is shown on several displays at the same time. The (only way) of user-interaction with the service-class should be the sending of a user's ballot to the display. When a new ballot arrives at service-class implementation, all database entries will be updated and the new values should be displayed on the instance (which could be indicated by one or more displays).

The service-class should provide different kinds of ballots (for example basis-democratic processes, group tuning processes or opinion casting of votes to current topics) by implementing various group decision techniques (simple majority decision, borda-voting, approval-voting, etc). The counting of votes and announcement should also be settled by this class. In the case of need, it would be possible, to dispose of the user-identification for the elimination of double-votes. It is intended, that only authorized users can instantiate polls.

## Service-class Map



This service class should add geographical features to the stick-on interfaces. Especially for tourists, the service class Map could be very interesting, because it is possible to view various kinds of maps such as city-maps, weather charts, road-maps, etc. A route-planning facility and the ability of indicating the actual position of the user on a map would be two more grateful features of this service-class. To request a map of a specific location the user should send a request to a display and the corresponding map should then be displayed on the screen, showing the requested position. The user should be able to interact with the map (for example adjust the center of the map by using a zoom or move-command). Another possibility of using the service-class Map could be the showing of maps other than the user's current position. Another functionality could be a route-planning function between two locations. A <route-planning> command

followed by the identification of start- and arrival point could be send to the stick-on interface; after path-calculation the route would be presented on the display(s).

### Service-class Web



By using this service class it should be possible to browse web-pages on display(s). A user just has to send a specific URL or a shortcut to the stick-on interface, sending a command without an URL should cause a redirection to the service provider's main-page (which will also be shown on the display). Backward-browsing should also be implemented in the service-class Web to avoid the placing of backward links on every web-page. Furthermore there should be a command to browse back to the first page visited during the session. Making this features available, needs to create a history which logs all page-requests during a web-session.

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A web service-class instance should be able to display common WWW-pages (specially designed pages to be viewed by an internet-browser like Netscape, Mozilla, Internet Explorer, etc.; these pages would contain text, images, dynamic menus, active-x, javascript...) as well as predefined web-pages for being displayed on mobile devices (like WAP-pages; these would contain text, links and small images).

### Service-class Banner



This service class should be used commercially, e.g. to allow companies and interested parties the placing of ads on display landscapes. The usage should be similar to conventional banner advertisement in the internet. Banners should be administered

centralized, they should not be interactive, but however could have the possibility to change dynamically. We could imagine a billing system on basis of the time some banner is visible and the size of the banner (optionally spawned over multiple displays).

### Service-class Game



The service class Game allows users to play games on nearby display landscapes. Since mobile devices usually only provide limited means for displaying content due to their restricted size, display landscapes could be used to solve the need for larger

displays required by most games. A user device (for example a mobile phone) is used to control the game itself, the visualization of the game is presented on a nearby display landscape device (for example while waiting in train-station). We think of two types of such game service-classes, the first actually only forwards the display of the user device (the mobile phone) to a nearby display, the other actually executes the game itself on the display landscape hardware; the users device is used only for controlling the game remotely.

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