Enriching Shopping Experiences with Pervasive Displays and Smart Things

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Abstract
Brick and Mortar stores have been facing unrelenting competition from online retailers. An enhanced shopping experience is often perceived as a decisive factor in regaining market share, aiming at novel multi-channel online and offline sales strategies. Technologies aimed at this goal, promote interaction, personalization and reaction measurement based on Internet of Things and networked display technologies. There exist, however, a plethora of standards and application platforms which constitute a considerable barrier for integrators both in terms of time and man power. This paper proposes an integrated approach for cost-effective development of innovative in-shop-experience applications leveraging the Internet of Things, HTML5 and Pervasive Display Networks.

Author Keywords
Internet-of-Things; Pervasive Display Networks; Online-2-Offline; Pervasive Retail

ACM Classification Keywords
H.5.1 Information Interfaces and Presentation: Multimedia Information System

The Internet-of-Thing Concept in Retail

The *Internet of Things* approach transforms the physical objects and surfaces in a store into an interactive, activity-aware environment by leveraging sensors and actuators. These entities, their meta-information and their sensory and actuation capabilities are exposed on the Internet as "virtual entities" through service interfaces, using constructs such as REST to maintain flexibility and scalability. Such virtual objects essentially represent a programmatically accessible representation of the real world constituting the basis for numerous sensors ranging from simple direct mappings of sensor values to properties and notifications, all the way to arbitrarily complex services that take in statistically significant amounts data [2] to infer customer behavior patterns, useful in areas like personalization or proof-of-purchase advertisement.

Introduction

Due to the strong competition from online retailers, traditional retail organizations are starting to strengthen activities enabling multi-channel sales strategies. Commonly referred as Online2Offline (O2O),they involve seamless transition from online customers to offline customers and back [5]. O2O activities include targeted advertisement (e.g. through geofence-based advertisement system, loyalty card, mobile coupons), activities improving the in-shop experience, as well as providing additional after-sales support utilizing again online means.

Improving the in-shop experience is utilizing pervasive technologies and is increasingly based on the Internet-of-Things (IoT) concept. In this paper we propose the combination of pervasive IoT technologies with advanced media and Web technologies. We examine the usage of Pervasive Display Networks (PDN) which are a special instance of an IoT deployment. PDNs will be combined with mobile computing devices (such as tablets and mobile phones) and IoT devices such as NFC readers [4], embedded sensors, as well as user interface devices. When building support systems for the retail business, the local systems are required to interwork with the backend system provided by the Enterprise to which the (often franchised) stores belong. Increasingly, the backend systems are operated as Private Clouds and are offering services to retail shops. This poses several questions on how Cloud-based services can utilize the pervasive technologies deployed in the shop, how Cloud services can utilize a multitude of display devices used by the multitude of staff members and how easy services for these highly distributed environments can be created.

In the following we analyze first the evolution of retails, after we describe a retail scenario and point out the difficulties in utilizing today's technology. We then present an advanced IoT system together with social media interaction tools, to show how such a system can solve the issues mentioned. At the end, we give an outlook on outstanding issues.

The Evolution of Retail

In the retail store, the physical and social realities change quickly. Deloitte Research shows that 36% of consumers would like to access to product information by scanning a barcode with their smartphone and 14% would like to use the smartphone for payment [3]. Today retailers are interested in using such pervasive technology in the stores. The challenge is to support customers without distracting them by a highly dynamic physical environment. The user experience must benefit the customer and bring them back into the shops, ideally combining the best of offline experience (direct feel of the product, interaction with sales support, and direct comparison between similar products) with the increasingly valued online experiences like product reviews, rating, and recommendations. Highly targeted and relevant information of the customer's general interest and current situational context is a key assess. Many mobile applications for supporting customers inside the shops are based on barcode readers [5]. In the last years with the growth of NFC supported devices and IoT technologies [6], the customers experience inside the shops has changed. By combining product information, user profile information, and information about their physical activities, a pervasive IoT System can help in analyzing the data and decides which information to present to the user at which occasion. Ideally, this information can also be used to optimize the retail experience, as well as to improve business processes in the shop. Stan K. and Karthik H. proposed a context-aware mobile marketing application for wireless devices delivering narrowly targeted promotional information to their customers [9]. In our approach we tried to combine IoT technologies and Pervasive Displays for improve the users' experience inside the shops and this is shown in the scenario presented in the next section.

A Guiding Example
Consider a scenario where the retail shops are NFC-equipped and a customer is interested in buying a television set. As a first step, the user establishes a link with the shop, which can be used to interact with it or for exchanging information (e.g. preferences). This can be done in numerous ways, such as through an NFC-equipped mobile device (touching the shop's NFC reader) or a QR-Code scanned at the door. While shopping, and based on the user input such as gestures or NFC touches with his smartphones, the applications can identify the selected products and push information related to the products to displays in close vicinity. Furthermore, the products and display showcases are entities themselves, equipped with sensors that provide interaction and personalization (e.g. gender targeted content for a product when the gender is detected with software like Field Analyst, or pick-up detection using dedicated triggers or light sensors). Each product can additionally be tagged with NFC, so after examining the products, the customer can add the chosen models to his personal profile. As the related virtual entities for products and users are managed in the cyber-system of the shop, Cloud services are able to detect the new virtual entities and their relationships (e.g. from profile provide to the products of interest) and use these information for presenting targeted advertisements or special presentation on large public display. Special customer touchscreens can be used via NFC touches to find all technical information related to the chosen models and also make a technical comparison between them. When the customer has decided which product to buy he can add the selected item to his virtual wallet and go to the sales staff for purchase. The sales person can access the customer's items and also show additional information like additional services, contract terms as well as customization option shared displays. The customer, using his mobile device, can join the presentation session fill in and sign the contract. In the last step, payment, the customer can use his mobile payment system via NFC-equipped device.

Pervasive IoT Technologies for Retail
IoT integration technologies, such as NEC's leafengine, enable transparent application access to IoT data without the application having to concern itself with the underlying protocols and sensor data formats of the used devices. Such an M2M Abstraction Layer reduces the development time for the system integrators and enable very flexible configuration of system ("No store is exactly the same as another one").

In the digital signage field we can distinguish two main use cases related to the previous scenario:

(A) Real time, direct interaction: customers can interact with the installation to get product details, customize the model he is holding in his hand (e.g. colors and accessories), or even simply linking to the product using NFC tags, and interact with the product later through its virtual profile.

Industry-Grade IoT Integration technologies – leafengine

NEC Europe Labs and NEC Display Solutions have developed an IoT solution, initially aimed at Digital Signage systems. It enables integrators to build cost effective interactive, personalized installations, and further enable owners to understand their audiences and tailor their experience.

A typical leafengine installation runs within (or close to) a Digital Signage media player, that is, at the leaf of the tree which is the overall system's architecture. It virtualizes the surroundings of the installation by wrapping sensors and actuators under a common abstraction. The goal is to enable quick and flexible development of applications that both react in real time and store statistical information.

(B) Indirect interaction: customers effect a change in the environment. Such changes are detected by sensor and raise events as well as changes in the related virtual entities. As a result targeted advertisement based on customer's preferences and previous behaviors can be shown.

The aim of the leafengine is to facilitate the development of such interactive scenarios by providing easy access to a wide range of sensors, including gender and age detection, NFC, noise level, pick-up of products, light sensors and light barriers, proximity sensors, gaze detection, people counting and queue estimation among many others. The list is meant to grow further over time based on prioritization by customer feedback.

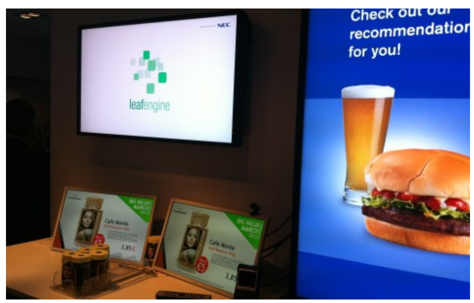

Figure 1 - leafengine integration showing an interactive supermarket shelf and a gender based advertisement

In terms of scope, leafengine supports a global view mode where multiple instances in a store share the information they sense, meaning an application needs only address any one of them to get a holistic view of the whole installation if required. By using leafengine, integrators get access to an ever growing list of retail relevant sensors (30 and growing) and can quickly choose which one is most relevant from installation to installation as it matures and its customers change.

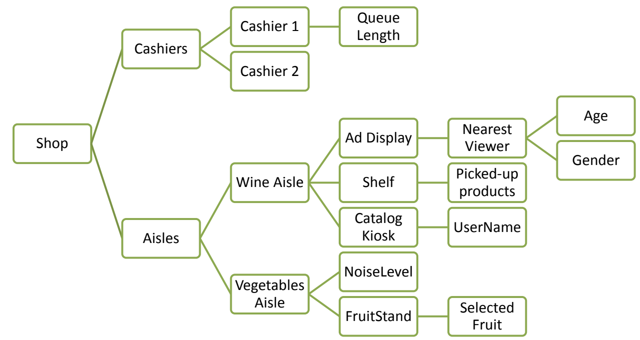

Figure 2 - A leafengine data tree for a supermarket installation

The leafengine data model consists of a data tree where each node can contain a value, a subnode, or both. Furthermore, a mapping module enables users to map existing tree nodes to new, artificial nodes. This allows integrators to encapsulate the information coming from multiple sensors into a single logical object, providing the IoT virtual entity abstraction, where the subject is an otherwise "non-electronic" item (e.g. "shelf.top") and its properties are populated from actual sensors (e.g. "shelf.top.remaining_items" from a POSTuning ePusher sensor, or "shelf.top.price_tag" from an electronic price badge").

Data access is done over a REST interface that supports both instant queries and subscriptions on events (e.g. a change in the "remaining_items" attribute on the shelf). These can be further filtered at the frontend

Cobrowsing for Sales

Cobrowsing is offering a collaborative web browsing session, in which different participants have the same synchronized view on the web content displayed (e.g. they should see each other's mouse pointers and the current web page) [1]. For example, the sales person can show some related product features from the CRM system on a big display to discuss it with the customer. If the sales person highlights some features described on the web page using his tablet then they are highlighted at the same time on the big display. Furthermore, he may navigate on his tablet to different pages or products and this is also shown on the big display.

We provide a screenshot of our solution demonstrating cobrowsing of the NEC SaaS market place in Figure 4. There the sales agent highlights the feature of one product, which the customer can see as well in the browser shown on the big display.

using information from other sensors (e.g. notify of rooms with temperature over 20C *where the air conditioning is on*). Finally, all data retrieval operations and all configuration and management interfaces are available over an HTTP interface using both POST callbacks and WebSockets as notification mechanisms.

Multiscreen Support using Cobrowsing

With the emergence of the smartphone and tablets, the number of application platforms for them has dramatically increased. Although we find several main players, such as Google Android, Apple iOS, Mircosoft Windows 8 and the amount of different mobile platforms are creating several problems for developers. We observe the tendency to develop HTML5 applications and use platform-specific wrappers to render them. This means HTML5 is an important standard for mobile development. Also in the area of Digital Signage installations, integrators are trying to move away from proprietary media player to HTML5-based solutions. However, HTML5 does not support explicitly multiscreen/multiuser applications or applications interacting on multiple screens as required in our scenario. In order to support our scenario with many PDN displays as well as many mobile devices, we suggest using cobrowsing technologies for enabling transparent interworking between different screens [1]. Cobrowsing does not require any plugins or extensions to the browser. As a side-effect, authoring content for multi-screen scenarios is reduced to standard HTML5 element annotations.

Privacy-aware Cobrowsing Technology

In many cobrowsing implementations, a dedicated proxy server is utilized to distribute the Web page content between the Session Creator and the Session Participants [10]. This is a suitable architecture for our retail scenario, especially as the proxy server can be allocated in the Cloud close to the application server. However, most cobrowsing solutions do not deal properly with encrypted HTTPS connections which are the preferred options for many retail applications. They are subject to man in the middle attacks. Furthermore, they require storing all private information occurring in a cobrowsing session, such as customer details, on the cobrowsing server, which is not desired.

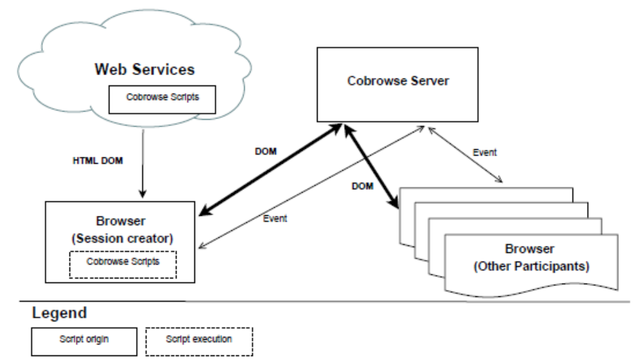

Figure 3 – Privacy Preserving Cobrowsing sessions with mediating server

To cope with these insufficiencies, we have developed a new architecture and method called "*Privacy Preserving Cobrowsing*" (see Figure 3) [10]. In this architecture, there is no proxy between the Web service and the Session Creator (e.g. the sales agent in our scenario). Instead, the Web page content is directly exchanged between Session Creator and Session Participants. Currently, we still need a Cobrowsing Server which helps to establish the sessions between the browsers. With the uptake of WebRTC [9], we expect to move to a full P2P architecture among browsers. Nevertheless, the advantage of our current solution is still that private data from the shop's application, such as the CRM system used by the sales agent, does not need to be stored on the cobrowse server and it can be obfuscated or hidden towards the other session participants.

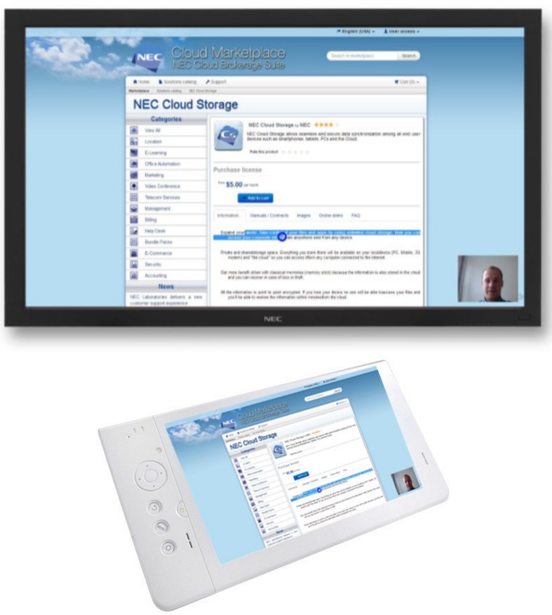

Figure 4 – Cobrowsing NEC SaaS marketplace (top: big display, bottom: sales agent tablet)

Privacy preserving cobrowsing does not require any extensions or plugins of the user's browser and it works in modern browsers. The integration into a HTML5 application is straight forward. The application pages do not need to be modified, but a simple HTML5 page including the cobrowse JavaScript libraries can be used to enable cobrowsing for all other HTML5 pages of the application. There is no need to modify the web service software. The cobrowse server leverages the Cross-Resource-Origin-Sharing (CORS) protocol to enable our privacy preserving architecture [7]. This standard is supported by all major browsers.

Our current cobrowsing engine provides functions for establishing cobrowsing sessions, for reducing the number of exchanged event, for showing the mouse pointers of the involved partners, for using WebRTC for video and audio communication, as well as for filtering and masking content for security and privacy reasons. Especially the privacy enhancements features are highly needed in the retail scenario.

Linking Pervasive displays using Cobrowsing

In the presented scenario, we want to establish shared sessions between multitudes of large public displays installed in the shops, mobile devices as carried by shop assistants as well as customers and IoT devices installed into the shop. Media devices and mobile devices can be paired by using gesture commands, NFC communication, visual markers (QR Code), or traditionally menu/map-based interactive selections. The pairing mechanism will be controlled on the mobile device and will provide a URL for the Display or IoT device to be shown in a browser. The system will establish a cobrowsing session between the involved media and mobile devices, and will create an – potential bidirectional - information flow between the cobrowsing session and the included IoT devices. Within the cobrowsing session, the shop assistant can provide product information, video tutorials, as well as purchase contract documents for display on the tablets or displays included into the cobrowsing session. This service and content can be provided from the private cloud of the shop by using standard HTML content which is augmented with rules which content shall be displayed on which kind of device.

Enabling Customer-Sales Person Interaction and Sales Process Innovation

The customer may join the cobrowsing session with his own device using one of the described pairing mechanisms, e.g. NFC touch. This direct his browser to the Cobrowsing server to join a currently ongoing session, as part of the session, the customer can input needed data, can download documents and media object, as well as interact with the shop assistants. He can highlight certain product features in question or provide information, such his/her address or credit card data to buy a selected product. Obviously, we need to build multiuser and privacy aspects into our system as required in this scenario. For instance, the customer may enter some credit card information and this should obviously not be displayed on the big display visible to other customers in the shop.

It should also be recorded who did what during the sales talk, because only the customer should click the "Buy it" button and not the sales agent. This means masking of private data and proper support for secured connections. Both are supported in our solution through privacy and recording rules embedded into the HTML content. Such features are currently not well-supported by existing cobrowsing solutions [1]. Additionally, cobrowsing sessions can be recorded and replayed at a later stage, which is useful for legal reasons (e.g. customer meetings in the banking sector as proof of advice). It can also be used for sales process improvement, such as debriefing or training purposes.

Linking the IoT system with the Multi-Screen Cobrowsing session

As several steps of our scenarios, we had identified how IoT technologies can help in establishing a user profile; simplify the interactions between users and devices, as well as helping in the service execution. Using traditional approaches, this IoT information would be transferred to related Cloud services. There is need to transfer the right content to the right Multi-Screen session by using aforementioned technologies. Especially for large retail chains with many shops and many simultaneous ongoing sessions, this introduced a sizeable complexity on the Cloud side in addition to the network load generated by the IoT devices.

As an alternative leafengine can move part of the processing from the Cloud to the local application. By using the Cross-Origin Resource Sharing (CORS) protocol, HTML5 applications issued by the Retail Cloud services, should be able to access the IoT devices in the shop. For that, the Retail Cloud service has to configure the URL of a leafengine instance running in the target shop. Then scripts in the Web page can issue a request to the leafengine to obtain IoT information or invoke IoT services. The normal REST API of the leafengine is wrapped into a CORS module checking the origin of the cross-domain request and enabling access to IoT information. JavaScript code executed in the Web page can then be used to adapt content to the context information delivered by the leafengine.

In several parts of our scenario, a device or application is waiting for an NFC touch in order to pair, e.g. a Smart Device to a Public Display. In our system, such an application can now be authored with a JavaScript code fragment that waits for respective NFC events from the leafengine. Then the code can establish, e.g. the cobrowsing session with the Public Display. These are a few lines of code which can be easily embedded into existing web pages of HTML5 applications.

In such a way, authoring context-aware services utilizing an IoT infrastructure and utilizing a multi-screen deployment is done using standard HTML5 pages with JavaScript and security annotations.

Conclusions

We have demonstrated in this paper how an industry-grade IoT middleware can be used together with an innovative HTML5 cobrowsing service for cost-effective in-shop-experience applications. Mobile HTML5 applications can access sensors data from IoT integration technologies, such as leafengine, by using REST interfaces. Cobrowsing technology can be used then to display these applications across different pervasive displays. With respect to the questions raised in the introduction, we have shown how these kinds of multi-device services can be provided from Cloud-based applications through extending normal Web pages with cobrowsing and IoT features (RQ1). We showed how this can be used to utilize a multitude of devices and provide immersive multimedia user experiences by shop assistants and end-users (RQ2). Finally, we explained the system mechanisms needed to include multiple media and IoT devices into the exposed services. We plan to investigate in future work how different actuators in a shop can be abstracted and uniformly addressed, so that conflict-free actuation is possible by our integrated approach.

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