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## Contextualized Ubiquity: A new opportunity for rendering business information and services

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### Abstract

Stating that information and services are ubiquitous, means that they are available anywhere, anytime. The development of mobile-devices with wireless network-access capabilities, together with the decrease in network-traffic costs and the proliferation of free wireless hotspots, makes the use of mobile-devices, as Internet access tools, increasingly common and attractive. With novel forms of presenting information and to provide new ways to interact with consumers, new business strategies can be boosted, in Customer Relationship Management (CRM) and m-commerce. This paper describes a different approach to the relationship between customers and business-providers, based on contextualization mechanisms located in commercial products, which in turn acts as a gateway to static tag-embedded information as well as web-based information and services. A wine integrated management system, called SIGPV, is presented as a proof-of-concept, enumerating some of possible major business and CRM benefits.

**Key words:** Ubiquity, Context-aware, Mobile-devices, M-commerce, CRM

## 1 Introduction

Electronic information and services organizations are still centered on the Personal Computer (PC) as its main access vehicle. When mobility is required, several issues arise, namely: availability, suitability-of-use and connectivity. Nowadays, mobile-devices are providing companies with new ways of interacting and presenting information to customers [7]. Companies are seeking these new approaches to offer innovative CRM services to their customers.

The Ubiquitous computing model aims to break with the traditional PC-centered interaction model and to give users the opportunity to interact with the digital world through their surrounding environment elements, at any time and using any device [12], [31], [11]. To achieve real ubiquitous computing, it is necessary to address several issues and challenges, outlined by many researchers, like: privacy and trust [32]; the integration of physical and virtual spaces [16], [17]; spontaneous interoperation [16] and contextualized interactions [26], [5].

While currently common mobile-devices, with Java and web connectivity support, are progressively trying to solve the mobility and heterogeneity issues, contextualization is still in its early stage, being mainly based in Global Positioning System (GPS). However, besides this being only an outdoor solution, generally available in more expensive mobile-devices, the geographic position is just one of several attributes of context-aware, thus not allowing a full integration of physical and virtual spaces.

To overcome these limitations, one approach is to use context elements such as: barcodes, visual tags or radio-frequency tags. Although radio-frequency tags, namely Near Field Communication (NFC), are already used in closed dedicated applications, such as security, access control and commercial stock management [29], [22], they are not yet suitable as a widespread contextualization mechanism for elements in the surrounding environment, due to the need of a proper decoder, which is not yet embedded in common everyday devices (in fact, in Europe only Nokia 6212 Classic NFC has NFC support and it is only available in some countries) and also NFC tags, when compared with barcodes, are still an expensive solution.

Visual tags can be easily and inexpensively embedded in real-world objects and their decoding systems are based on image recognition algorithms. Because of their ability to handle more data per tag area, visual tags are replacing the well-known EAN13 barcodes. A common everyday device that can perform this kind of decoding is a mobile-device, like a cell-phone, with a built-in camera. Putting together barcodes with information storage capabilities and mobile-devices as decoding systems can represent a natural approach as a reliable mechanism to quickly look up information or initiate an object-specific action. In fact, visual tags and mobile-devices are already used in some activities.

A traceability system, described in [33], was developed to secure the safety of fishery products and was implemented in Japan. In this system, visual tags are used because they are the cheapest and they perform better in water environments, comparatively with other identification (ID) technologies. Also, their decoding can be made using widely available mobile-devices, which gives consumers access to the products information, therefore increasing their confidence. Site-specific access to services, such as virtual queues in restaurants, interactive advertising and vacations browsing, are introduced in [35]. This approach makes static, de-contextualized and non-adapted information or services more friendly and interactive, and is able to provide user-specific contents.

The introduction of contextualization mechanisms in education is discussed in [3], [18]. Using visual tags and mobile-devices as learning tools and class-management direct interfaces is being regarded as a way to captivate class attention and to improve success ratio, by providing students with applications which allow them to receive and access in or off class quizzes, grades, reports and activities, through their mobile-devices, in a simple and user-friendly manner. M-learning can also be regarded as a way to embed learning in daily life, by using a mobile-device as enhancer of learning experiences. So, a simple university campus tour can become a rich multimedia learning experience by using mobile-devices and contextualization mechanisms, which allow for example, the use of augmented reality contents, sound and image in well defined geographic spots, thus significantly improving the understating of a given context, situation or lesson.

Visual tags can also provide an attractive and transparent way to enable user access to product-oriented contextualized information and services, as stated in [8], which allows the creation of innovative interface between companies and customers: new CRM and Business-to-Consumer (B2C) tools.

In order to present and study the business potentialities and applicability of this approach, a prototype for wine-related electronic services, called SIGPV, has been developed. It is an integrated system that uses visual tags as contextualization mechanisms in Douro wine bottles and mobile-devices as an easy-to-use transparent access to business services and information repository. This represents the creation of a business mechanism founded over the availability of product-contextualized information and services, such as: wine characteristics, consumer feedback and easy access to m-commerce platforms, among others, namely related to tourism. SIGPV also represents an

effort to bring technology, promote innovation and business-cooperation in the oldest demarcated wine-making region of the World: the Douro Demarcated Region (DDR).

In this work we have used the Action Research method, one of the four that form the Applied Research methodology (action research, case-study research, ethnography and grounded theory, [27]), which is mainly focused on four stages: plan, action, observation, reflection and revision [14]. Applied Research is a methodology used when a given research is developed to apply the achieved results in solving an existing problem.

This work began by identifying the problem: how can companies-customers relations be improved by taking advantage of the widely present mobile-devices and using products as gateways? This question leads us to explore possible technological solutions that could enable new ways of companies-costumers interaction, promote new business mechanisms and propose a new framework. Afterwards, a proper technology state-of-the-art study has been carried out to identify and compare available technologies. A prototype has then emerged to be evaluated as a proof-of-concept. Furthermore, it should be introduced in the market, preferably with a partnership between the developers and some established wine producers and tourism services providers.

The goal of this paper is to present a framework to enable new ways of interaction between companies and consumers, through the use of contextualization mechanisms and mobile-devices, leading to better CRM and B2C tools. Section 2 presents a state of the art revision that shows the potential of applying contextualization mechanisms on real world objects, for m-commerce and CRM. Next, it is also presented a comparison of common contextualization mechanisms, such as barcodes, visual tags and radio-frequency (RF) tags, in order to evaluate which one is more suitable to use in contextualization-based m-commerce applications. This evaluation is centred mainly in three points: decoding system availability, cost-effectiveness relation and suitability-of-use. In Section 3, a context-aware ubiquitous m-commerce framework is presented and explained. A framework based prototype, SIGPV, is presented in Section 4. The use of SIGPV in products of a Douro Region consortium named Douro4U, formed by winemakers and tourism service providers' is discussed and analysed in Section 5. Some of the Douro4U major considerations are presented, as well as their feedback about the SIGPV approach and its impact on Douro4U business activities. Some conclusions are also outlined.

## 2 Using mobile-devices to decode ID-tags

Mobile-devices, mainly cell phones, are embedded in daily routines and represent the most common and widely used technology today. As such, educational level is not a serious barrier to their use. Studies have shown that in Portugal, at the end of 2009, the cell phone/person ratio is 140.6%, which is 20% above the European Union average, as presented in [1]. As a rule, "everyone carries at least one mobile-device". This wide availability makes them an ideal tool for interacting with information technology and on-demand services. This idea is reinforced by the current evolution trends in mobile-devices, which suggests an enormous potential that can be tapped to support enterprise information and services platforms, specially m-commerce, as discussed in [20], [21], making them the key technology to access data services and support ubiquitous frameworks.

### 2.1 Tag-based identification technologies

Tags, as a machine-readable representation of data [8], have been largely used to represent data and to link objects to digital information. There are several tag-based ID technologies, such as barcodes and radio-frequency identification (RFID) tags. The combination of 2D visual tags with an easy-to-use on-the-fly decoding system yields an effective, powerful and innovative way of providing real time contextualized information and on-demand services. This section briefly discusses and compares the different types of tags that can be used for this purpose.

Found almost everywhere, 1D barcodes or simply barcodes are a tag-based ID technology that have the capability to store and represent data through parallel lines of different width. They are massively used in retail commerce, linking products to databases, making automatic management and accounting systems possible.

Two-dimensional or 2D barcodes represent another early step in the tag systems technological evolution. They have emerged as the natural way to encode large quantities of alphanumeric data and to link objects to web-based information and services, through the encoding of an URL [35], [28], [23]. Recent statistics have shown that in Japan, which is nowadays the main user of 2D visual tags, 65% of the mobile phones have in-built 2D barcode reader software and 61% of the users have already scanned QR Codes [13]. Table1 shows a comparison between different types of tag-based ID technologies.

The decoding of 2D visual tags is usually performed in a cost-effective way by automatic decoding systems known as industrial visual inspection systems. But the current trends in the evolution of mobile-devices have made built-in cameras increasingly more common; as a result, it is possible to turn many currently available mobile-devices into portable decoding devices, transforming a low-cost widespread consumer electronics device into a visual inspection system.

Table 1: Comparison between common tag-based identification technologies

|            | Barcodes  | 2D Visual tags  | RF Tags  |
|------------|---|---|--|
| Strengths  | Printable;<br>Low-cost;<br>Suitable for visual decoding.      | Printable;<br>High data store capability;<br>Low-cost;<br>Suitable for visual decoding. | Automatic non-visual reading: Can be decoded while inside objects.     |
| Weaknesses | Low data store capability;<br>Decoding in dirty environments. | Decoding in dirty environments.   | Not printable;<br>Cost;<br>Reading problems;<br>RFID portable decoder. |

## 2.2 Tag-based identification decoding mechanisms

The decoding procedure of EAN13 barcodes is based on well established infrared technology. Although barcode readers are widely available and can be considered low-cost, they are not widespread among the general public, and it is unlikely that they can be brought into day-to-day operation. On the other hand, considering that RFID technology is very promising, the incorporation of RFID tags or tag readers in mobile-devices remains unlikely in the near future, as referred in [33], [35].

By contrast, the decoding of 2D visual tags can be accomplished by mobile-devices with a built-in camera and Java support, being this the consensual approach [30], [34]. Java software for coding and decoding 2D visual tags, such as QR Code and Semacode, already exists. The use of a mobile-device as a decoding platform effectively makes 2D visual tags usable worldwide and almost for any purpose.

## 3 Context-aware framework

The proposed framework intends to overcome some experienced constrains felt by users when trying to access a service-oriented platform, through mobile-devices. Our approach is based on a service-indexing element, which is part of a contextualization mechanism, used to supply static information and/or to interface with context-based dynamic information and services. In this Context-Aware Framework (CAF), depicted in Figure 1, a mobile-device is used as the decoding device and simultaneously, as the ubiquitous tool to access on-demand information and services, that are supplied by a cooperative knowledge-based system. Connectivity is ubiquitous and assured by the universal wireless networks support, such as General Packet Radio Service (GPRS), Universal Mobile Telecommunications Service (UMTS) or by using 802.11 and Bluetooth hotspots, that are progressively increasing in urban environment. The services platform is based on a web server broker, which functions as the interface between users' services requests and business providers, like e-commerce sites belonging to the cooperative associated members.

### 3.1 Using Visual Tags as a contextualization mechanism

Although other technologies may and might be used concurrently, we have chosen the QR code open standard to encode data into 2D visual tags. The bridge between a site-specific action and the information system that provides the on-demand services is accomplished by the QR Code, placed in the targeted objects. Data encoded in QR Code can be used in a static or in a dynamic approach. Helpful and static information about a given object can be directly obtained from the tag by a simple decoding procedure. Dynamic information based in context or even user profile cannot be accessed through the static data contents encoded in the tag. Instead, an element-specific parametric URL is encoded in the 2D visual tag, rendering information and/or services access automatic and element-contextualized.

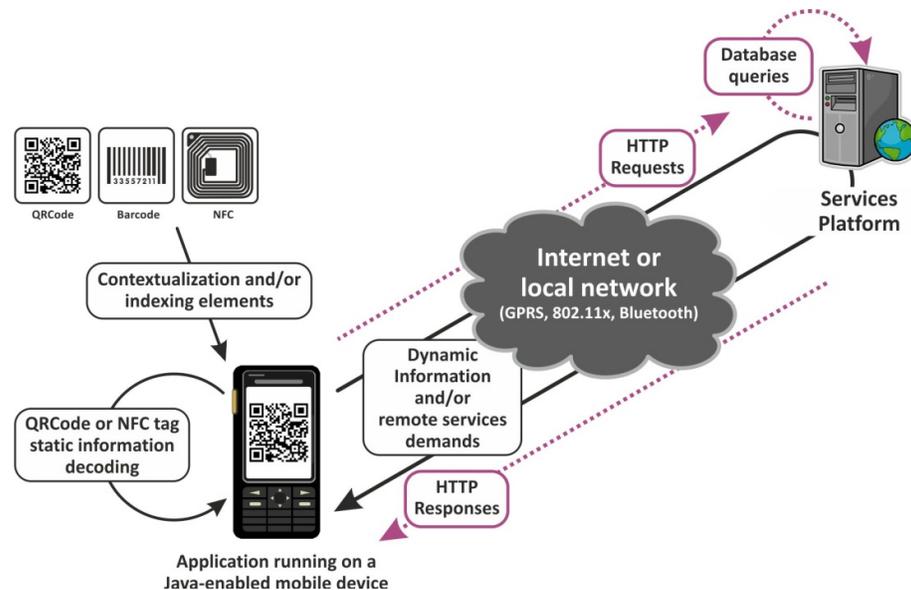


Figure 1: Context-aware framework as a service platform that is invoked dynamically by an application running on a Java-enabled mobile-device. Each service is contextualized by using distinctive tag mechanisms, covering a wide range of targeted products.

### 3.2 Mobile-device application

The CAF mobile-device application was developed to run on users' mobile-devices with an embedded camera. This client software performs three primary functions: the first function is to decode 2D visual tags, which a user can easily do simply by pointing the mobile-device camera at a visual tag and pressing a capture button; the second function is to locally decode the static content of the tag and present it, if available; finally, access a dynamic site-specific service, where the users' mobile-device must establish a connection to the CAF server, if an URL is available.

The client software was developed as a Java Micro Edition Platform (Java ME) application. Java ME Platform stands for an open solution for building mobile applications and, as a key advantage, allows portability between platforms and reuse of applications, being supported by almost every mobile-device. Mobile Media Application Programming Interface (MMAPI) or simply Java Specification Request 135 (JSR135), supports developers' access to native multimedia services. JSR135 support is available in almost all mobile-devices with a built-in camera.

Figure 2 shows the decoding procedure of the developed application. If JSR135 is not supported in a specific mobile-device model, the application can load a previously captured photo, and decode it - offline decoding. When JSR135 exists, the application will capture a photo containing the 2D visual tag and decode its content - online decoding. If the decoded content contains only static information, it will be presented on the mobile-device display. Otherwise, if the decoded content contains a URL, related element-contextualized web-based information and services are available and can be retrieved through HTTP request/response scheme and presented in the mobile-device browser.

### 3.3 Services platform

The service platform, depicted in Figure 3, has a broker interface, which enables a uniform query mechanism to access a multitude source of services provided by cooperative members and also performs response-contents adaption to mobile-devices constrains. This platform is powered by a MySQL relational database, interfaced by PHP-based web services running under an Apache server, which constitutes an open-source and platform-independent approach.

As stated earlier, the service platform operation is based on web services, which are considered as a mean to improve interoperability among heterogeneous applications, over internet protocols [4] and are also a commonly accepted and increasingly used approach to m-commerce, as stated in [4], [15], [24].

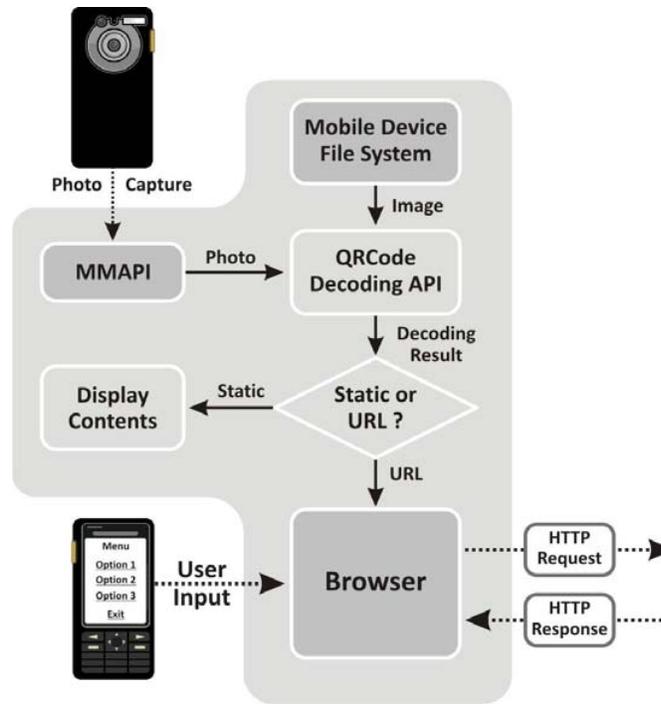


Figure 2: Mobile application data flow: decoding a 2D visual tag, accessing remote services and presenting information

The service platform is responsible for receiving client incoming HTTP requests, to process them and to generate, based on the indexing parameters, such as service ID, tag identifier and other service parameters, the consequent HTTP requests to cooperative associated members' platforms. Upon their responses, a content-adaption process, supported by data and metadata information stored in the MySQL database, is made, building proper HTTP responses to the client. New service modules can be simply added, making it a scalable platform.

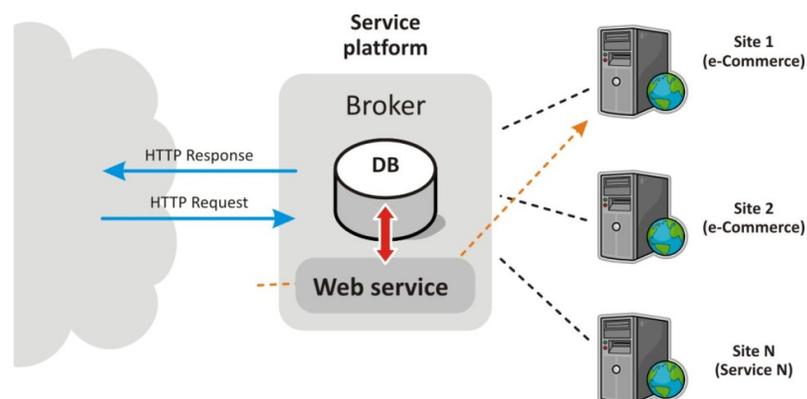


Figure 3: CAF services platform: a broker based approach

#### 4 SIGPV prototype

Wine and tourism related services are probably the most important social and economical pillars of the DDR [2], [19], [25]. So and as a proof of concept, a CAF based prototype for wine-related electronic services in DDR denoted SIGPV, was developed. SIGPV uses a globally renowned brand - Douro wine - as an interface to a service-oriented m-commerce platform, where winemakers and tourism agents promote both their products and services (interlinking tourism and wine activities can greatly benefit a region's development, according to [6], [9], [10]), Figure 4.

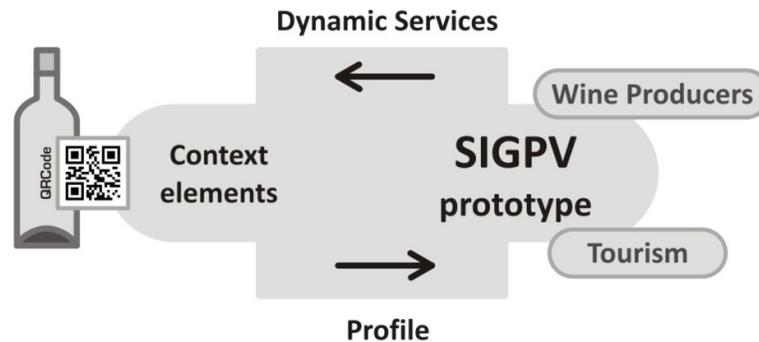


Figure 4: The SIGPV prototype overview, linking the consumer through QR codes placed in Douro wine bottles, wine producers and tourism agents.

In order to properly test and experiment the SIGPV prototype in a real environment with full access to the commercial circuit, an earlier version was presented to a consortium of wine producers and tourism agents, which operate within the DDR: the Douro4U. This consortium is formed by 5 companies based in DDR, each with their wine production, farms, renowned brands and tourism services (for more information, please consult <http://www.douro4u.com/>). After some modifications and improvements, in order to adapt the prototype to DDR market context, a new version of the SIGPV prototype was presented and made available to the consortium. Today, some of the Douro4U wine bottles have already a SIGPV QR Code in their label - as it can be seen in Figure 6 a) - and are already being sold in the commercial circuit. This is a test bed of an enormous importance to assert the prototype operations and reliability, consumers' interest and possible usability issues, before trying to introduce this first CAF framework based application in all the DDR wine bottles. Now, using a camera-equipped mobile-device together with a specific software application, which decodes QR Codes placed in wine bottles, one can easily and automatically gain access to wine and, more important, tourism related information and services, dynamically generated on-demand.

A more technical approach of the current version of the SIGPV prototype is depicted in Figure 5. After being downloaded from the SIGPV website or from any of the associated producers websites, a Java ME application is installed in the user mobile-device. The installation process is simple and straightforward, just like any kind of Java application, like games, obtained from the official mobile service operators. For this prototype testing, the full application - which has all services available - is only available to a designated few. However, anyone with a mobile-device and a proper QR Code decoding application, which are widely available in the iPhone and Android applications stores for example, can decode the existent QR Code in the wine bottles label. The application accesses the mobile-device camera through JSR-135, which is now becoming a commonly supported API by the mobile-devices manufactures, allowing the user to take a picture of the label's QR Code. Next, the decoding process is performed using open-source API, like Zxing (available in <http://code.google.com/p/zxing/>). Any static information, like the wine manufacturer, year of production, among others, if present, is immediately displayed to the user.

All of the wine and tourism related services are available using web services that are available in a central server, through the use of the SOAP protocol. Producers are responsible for updating their products and services in a Producer Information System (PIS), Wine Sellers state which of the Producers products they are selling and for how much, using the Wine Seller Information System (WSIS). Only DDR originated products are allowed (by contract) in SIGPV, thus enforcing the relation between producer products and related sellers. These interactions are all performed through the use of web services over the Internet. Finally, a series of product related information are made available to Producers, namely wine reviews, user feedbacks and also tourism related services such as inquiries about a room availability in a typical DDR farm. More services and decision support tools are now scheduled to be deployed over DDR through SIGPV platform.

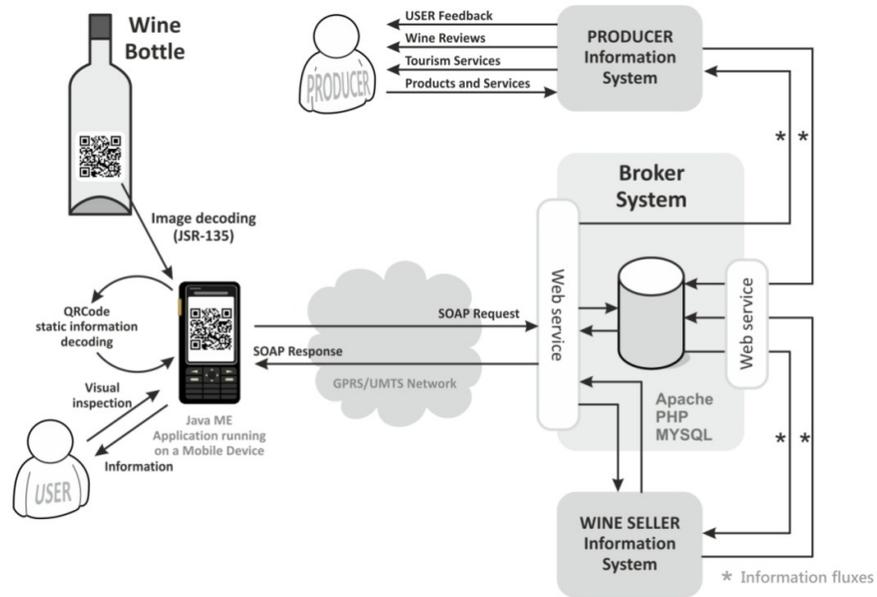


Figure 5: Technical view of the SIGPV prototype, which is currently being used in Douro4U consortium wine bottles, providing added value information and services to their products.

SIGPV has successfully implemented the following features: clients can obtain and insert wine tasting notes, Figure 6 a), access m-commerce platforms to buy the wine being consumed, Figure 6 b), obtain detailed information about the wine characteristics and manufacturing process, get touristic services which the wine producer may provide, such as a typical Douro weekend or a gastronomic route; wine producers have access to an integrated, visible and innovative publicity platform, as well as the possibility to obtain real-time feedback about their products and to offer consumption-related suggestions, namely gastronomic side-dishes and typical places where one can enjoy the wine, while relating with the DDR unique environment; DDR commerce acquires a solidly privileged contact with clients, potentiality capable of improving wine sales and furthermore, this very promising interface is likely to enhance the availability of other DDR typical products. Finally, SIGPV is a privileged vehicle to take products-related publicity and tourism activities to a vast audience, through clients' mobile-devices.



a) The SIGPV client prototype running on a mobile-device, enabling the upload of wine tasting notes.



b) SIGPV m-commerce application showing the wine buying experience.

Figure 6: Overview of the SIGPV client application running on different JAVA-enabled mobile-devices

## 5 Conclusions

Since the SIGPV prototype has been supporting the Douro4U wine and tourism related activities, it has shown great potential to support context-interaction between consumers and DDR companies. Based on the Douro4U consortium feedback, the use of visual tags on wine bottles provides consumers with an easier interaction and access to their

products, but also gave Douro4U a better understanding of consumer's opinions and needs, which is contributing to a more effective and comprehensive CRM.

The use of visual tags in the SIGPV solution for Douro4U wine bottles also proves that's the proposed CAF platform represents a feasible and cheap approach for bridging the gap between producers and consumers. CAF platform is also a suitable approach to support new ways to interact with consumers, present information, boost m-commerce and aid in new CRM strategies. Our partnership with the Douro4U will continue and we expect that by the end of 2010, a quantitative study of the SIGPV usage can be made and presented. Meanwhile, we are collecting qualitative data from producers and customers. Based on the increasing necessity of approaching companies of consumers, our approach represents a contribution that enables organizations to better use the paradigms of B2C and CRM. Wine consumers are provided with a simple and attractive way to obtain information and product-related services using their everyday mobile-devices. They can insert wine tasting notes and obtain other consumers' reviews, but also consumption tips – either gastronomic or touristic – directly from the wine producers, as well as other DDR typical products, which can be publicized using the SIGPV platform. Targeted publicity campaigns, taken directly to the consumer associating a client profile when consulting wine reviews, a region with an innovative and technological image and new tools to promote commerce and m-commerce, are some of the benefits to the DDR brought by the CAF framework.

There can be two fields where one might consider that the CAF framework can have limitations: functionalities and technologies. This paper is centered in the Douro Region and its' best and most known product: Douro wine. The goal is to improve the commercial relation between wine producers and tourism-services providers, and clients, through the contextualization mechanisms embedded in Douro wine bottles. So, more functionalities based on the CAF framework can emerge in Douro or other contexts: they only depend on imagination and market. Technology limitations cannot be considered fundamental to the development of CAF based applications. Today, Java technology is supported in most mobile-devices and is widely accepted as an excellent solution in mobile applications development. Network connection between a clients' mobile-device and the broker system can be assured by GSM, UMTS, 802.11 or other wireless technology. There are several accepted technologies to develop web services, web applications and to support the producers and sellers database. The most common contextualization mechanisms are also referred to and can be used depending on being or not supported by the mobile-devices. So, CAF framework can be considered adaptable to technology evolutions and trends, as well as to new B2C approaches.

SIGPV prototype and commercial implementation clearly demonstrates how a bottle of wine can become a gateway to a much wider range of services that directly relate to the wine. While in the DDR there is a clear symbiosis between wine and tourism, we believe that the presented CAF framework, being information and services independent, may be applied to a large number of other business areas. We also believe that the advantages and applicability of this approach are transversal and as far as consumers are concerned, they will enable a ubiquitous and contextualized access to services, allowing as well that business actors have a way to interact and develop new relations of proximity with their end-customers in an innovative way.

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