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PERSONALIZED SERVICES FOR COMMERCIAL ESTABLISHMENTS USING PLASERES

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This paper presents the application of adaptation aspects defined in *IAM* (acronym in English of Integrated Adaptation Model) on the platform "***PlaSerEs***". The main goal of this platform is to provide personalized information about the products and/or services provided by commercial establishments to their clients. This platform is structured in four layers: *i)* the adaptation layer, composed of four modules: context, access device, user and wireless connection. *ii)* The general services layer, *iii)* the personalized services layer and, *iv)* the application layer. In order to validate and to evaluate how "***PlaSerEs***" works, we developed a functional prototype for a restaurant. This prototype works on Mobiles Devices (*MD*).

Key words: ***PlaSerEs***, *IAM*, Adaptation, Personalization, Commercial Establishments, Services.

1 Introduction

Currently, some establishments have carried out efforts in pleasing their clients by offering "custom-made" products and services. According to Jeff Bezos, founder and chief executive of Amazon.com, such establishments want to offer virtual business the personal touch that business without technology have. This way, a completely different and personalized page is presented. This page considers as much preferences and previous purchases, as data provided by the client at the moment of registering to the system. Bezos affirms: "*If we want to have 20 million customers, then we want to have 20 million' stores*'".

When a nomadic user wants to request the different services and/or products provided by commercial establishments, these establishments promote these services through generalized portfolios and catalogues intended for any type of public. The resulting answers for customer inquiries are provided without considering the particular needs of each individual client. Also, publicity is carried out through massive means of communication, aiming to keep their clients or to attract new clients only with good prices and good products without offering additional services that fit the user's characteristics [7].

When a nomadic user accesses different Information Sources (*IS*) of commercial establishments through his/her Mobile Device (*MD*), the displayed information does not take into consideration his/her needs, characteristics, preferences or the characteristics of the context of use [14][18].

Traditionally, the obtained results correspond to generalized information. Any user, without considering who or where he/she is, upon executing a query, he/she will obtain the same results. Guaranteeing a nomadic user access to several *IS* through *MD* [22], and adapting information as much to the user's profile as to his/her context of use [23][13] are two problems which currently are the reason of research [20]. Nomadic users who access several *IS* can obtain as answers to their different queries a great volume of information that is not always relevant and, sometimes, is not supported by his/her *MD*.

Considering the situation that has been described, a very valuable opportunity was found in offering certain services to commercial establishments that allow these to provide their clients adapted information according their preferences, their *MD* and their context. The interest of this paper focuses on helping commercial establishments to provide fast and better attention to their clients. In order to carry out tests in a nomadic environment, clients must comply with a certain number of requisites from which the most important are: *i)* clients equipped with *MD*; these *MD* must be equipped with a wireless connection. *ii)* The user's expectations concerning quality of service must be high.

In order to provide personalized services to clients of commercial establishment, we propose a platform named ***PlaSerEs*** [15]. This platform is structured in four layers: *i)* the adaptation layer, composed of four modules: context, access device, user and wireless connection. *ii)* The general services layer, *iii)* the personalized services layer and, *iv)* the application layer. In this paper we briefly describe each layer. We also describe a way to improve the adaptation layer presented in [15] by including adaptation features of an adaptation model named ***IAM*** (acronym of Integrated Adaptation Model) which allows for the representation of user characteristics, those of his/her access device and those of the context where the interaction of the user with the system develops. The model has four components: *i)* the presentation module which establishes what the user wants and can see displayed on her/his access device, *ii)* the contextual module which represents the characteristics related to the interaction of the user with the system, *iii)* the wireless connection module which establishes the characteristics of hardware and software of the most appropriate connection technology used by the user in order to access through her/his device and finally *iv)* ***IAM*** has the content module which allows to establish user individual characteristics and those of a community in order to model a user or a group.

This paper is organized as follows: section 2 presents "***PlaSerEs***", a platform which provides personalized services to clients of commercial establishments. Section 3 presents ***IAM***, an integrated adaptation model which represents different approaches for adapting information: display, content, context and wireless connection characteristics. Section 4 shows a functional prototype which uses "***PlaSerEs***" for a restaurant. In section 5, we explain how to integrate the ***IAM*** adaptation aspects into ***PlaSerEs***. Section 6 presents tests and results generated from the ***PlaSerEs*** prototype and the analysis of some related works. In section 7, we conclude and present some perspectives for this work.

2 *PlaSerEs*

PlaSerEs [15] (acronym in Spanish of *Plataforma de Servicios personalizados para Establecimientos Comerciales*, *Platform of Personalized Services for Commercial Establishments*, see Figure 1) considers different aspects of the user: the access device and his/her context in order to display adapted information when the user requests certain services to commercial establishments. This section describes in detail each component of this platform.

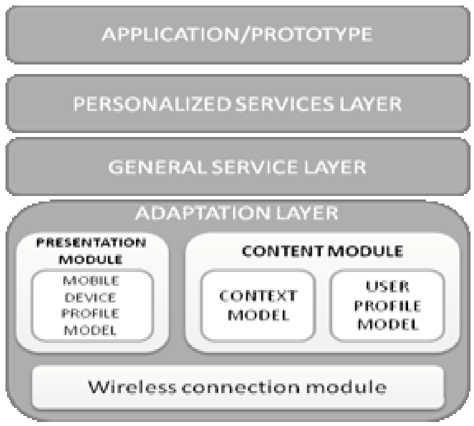

Figure 1 Architecture of the platform “PlaSerEs”.

From the need of adaptation, the concept of a model which has diverse aspects arises, specially, for adaptation oriented to the content, to the display and to the connection. This adaptation model considers: *i)* the content of information, based on a user profile and a context profile, *ii)* the display of information using a *MD* profile and *iii)* the connection of both, the establishment and the *MD*.

In ***PlaSerEs***, the content module is composed of the user profile model and the context model. The user profile model adapted from work of Carrillo *et al.* [6] describes user preferences with regard to four main aspects: *i)* activity preferences which correspond to the user characteristics with regard to activities executed by a user in the system and the way in which he/she executes them. These activities are registered in a historical file which is used in order to determine possible user behaviours. Additionally, user preferences are considered. These preferences are related to the specific application, for example, culinary preferences if the application is for a restaurant. Finally, it is necessary to specify the user’s job in order to determine which information can be relevant. *ii)* Basic user data such as his/her name, gender, age, birth place and place of residence are used to personalize the content of information that will be offered as result for each query. Depending for example on the gender, different products or services are offered. *iii)* Result preferences and display preferences which correspond to the display of the information on his/her *MD*, specially, the format and the multimedia data which prefers (*e.g.*, images, videos). The remainder of information about the *MD* information is contained in the *MD* profile and finally, *iv)* we have environmental and socio-cultural constraints which constrain the behaviour of the user to certain conditions of the context. For example, if he/she is in the cinema, his/her behaviours (and preferences) are different than those he/she would have if he/she were in a soccer stadium with his/her friends. This information is obtained from the context profile that will be later explained. In Figure 2, components of the user profile and its relations to other components of the adaptation model are presented.

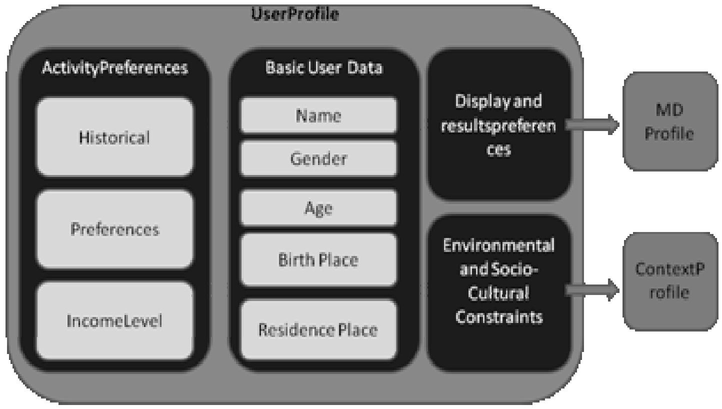

Figure 2 User profile model.

The context model proposed by Kirsch-Pinheiro *et al* [12] describes five dimensions: *i)* What?: are the services which can be presented in this place and at this moment. This dimension depends on the information provided by the *IS* to which the user is connected. *ii)* When?: establishes the temporal constraints that the application has. A user can determine in which moment to execute certain activities. *iii)* Who?: determines to whom belongs the profile relating it to the user profile and in this way, determine the characteristics which can influence in the adaptation of the information. Other data from this profile is used to describe the system's context at the moment of the query. What day is it today? What time is it? What is the weather like? What season are we in right now? and What is the kind of establishment where the user is located? Figure 3 shows the components of the context model and its relations to other components of the adaptation model of the superior layers of ***PlaSerEs***.

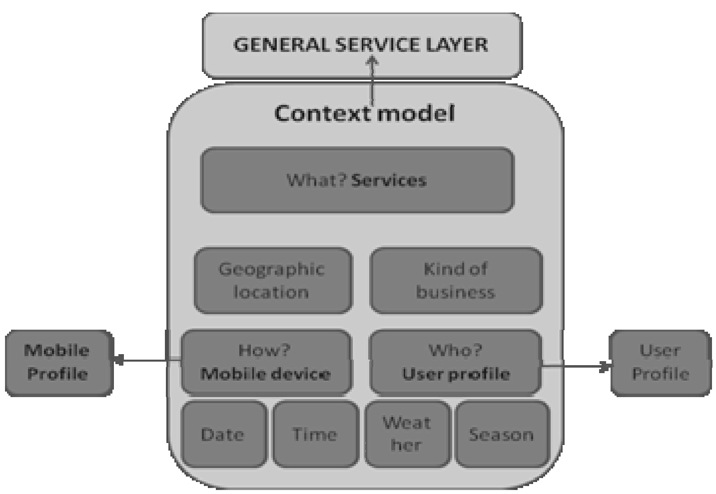

Figure 3 Context profile model.

The presentation module has as an objective to consider the features to take into account, in order to display information on the *MD*; it is composed of the *MD* profile model and it is defined using the extensions of *CC/PP* (acronym of Composite Capabilities/Preferences Profile) presented by Indulska [11]. The great advantage provided by this module is the possibility of knowing when to limit or to expand, according to its case, the quantity of information and the way in which it is given, taking full advantage of the *MD*'s capabilities without overloading it. Such overload can occur, for example, when users receive very large sized messages. The first that is considered is the information which the CC/PP standard provides, divided in three main groups: *a)* the hardware platform which contains information about processing speed, memory, autonomy with regard to the battery duration and to the screen resolution (width and height), *b)* the software platform has information about the versions of the operating system and the supported formats. And finally, *c)* the individual applications show information about the applications like browsers with their different versions and manufacturers.

After these layers, we can find user data related to his/her *MD* (see Figure 4).

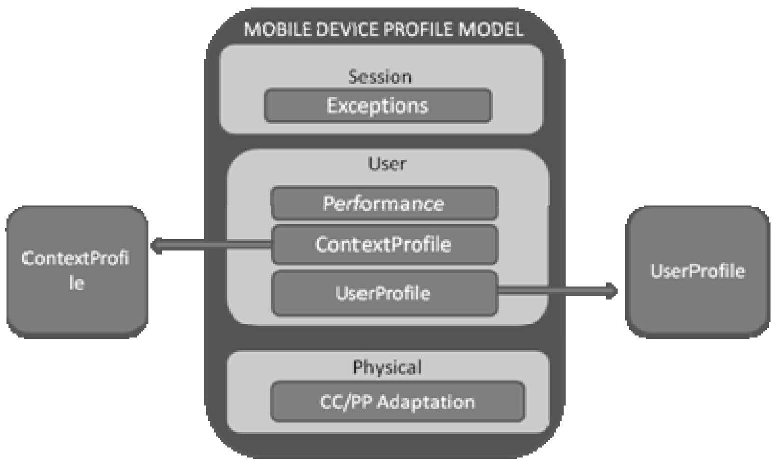

Figure 4.*MD* profile model.

That is, the user preferences with regard to: *i)* the specific metrics defined by the user that the *MD* will try to fulfill for example, not to wait more than X seconds in order to display a video. *ii)* The spatio-temporal context, when and where the user wants to see information displayed. The *MD* can determine, according to the user preferences, if certain information can be displayed. For example, if the user does not want to be interrupted while he/she sleeps, if the *MD* is on and on silence mode, in this period, any event will be reported as a sound. On the user layer, we can find the session preferences which are a particularization of any preferences we have just mentioned but are only valid for a particular session. These are used in order to consider exceptions which are not in contradiction with the profile, having for example, a behaviour which is not permanent. For example, a person can have as a permanent preference that all requested information does not have a delay superior to five seconds for loading. If on Sunday, user wants to watch all the news in video (thus, loading delays more than five seconds), it is possible to display this information on his/her *MD* and the latter must put this preference as a “temporal” one in order to establish his/her preference for the video format. Figure 4 presents the *MD* profile module.

The connection wireless model [16] (see Figure 5) has four main modules which collect information that can be considered in order to connect the *MD* in the best possible way at a certain moment: *i)* the hardware module considers the communication interfaces of the device with which the user wants to access the information, and the communication infrastructure of the *IS*. The communication interfaces correspond to those adapters installed into the *MD* which allow for the connection (*e.g.*, Bluetooth, IrDa, Wi-Fi). The concept of infrastructure corresponds to the set of devices which are present in the environment and which allow the reception of connection and communication requests from the *MD* (*e.g.*, access points). *ii)* The software module considers the communication protocols and the respective operating systems supported as much by the *IS* as by the *MD* in order to validate the interoperability between the different hardware devices (defined in the hardware module). *iii)* The logical module has a decision tree that allows the selection of the most adequate technology considering as reference characteristics of the application, the users and the data which will be managed in the system. This decision tree does not consider characteristics of the network or those of the *MD* because this information is managed by the hardware and software modules. *iv)* The taxonomic classifier module extracts characteristics from the hardware, software and logical modules, such as: *a)* of the network to which *MD* is connected, *b)* of the *MD*, *c)* of the application, *d)* of the users and *e)* of the data, in order to select the best configuration to be used by the application. This classifier notifies which is the best configuration, for example, Bluetooth, Wi-Fi, 3.5G.

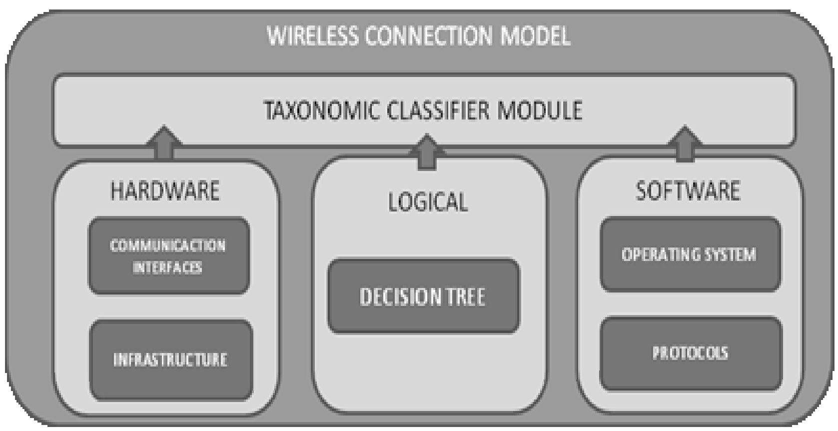

Figure 5 Connection Wireless Module

On the adaptation layer, we find the general services layer which consists of services such as: *i)* Reservation of a turn at the arrival to the establishment, notifying the client at the moment in which he/she can be served in order to use the different products/services of the establishment. *ii)* Query the products/services catalogue through the user's *MD* and in this way the client could have the needed information displayed without executing an exhaustive information search. *iii)* Order according to the catalogue. *iv)* Shipment of promotions and messages with general information to each user according to his/her profile and his/her interests.

Above the general services layer, we can find the personalized services layer. The objective of this layer is to particularize the general services to a specific commercial establishment, adapting them to the establishment needs. For example, the general service "*Show catalogue*" for the specific case of a restaurant, corresponds to "*Show menu*" in the personalized services layer. In addition, it is necessary to consider the adaptation layer in order to personalize the information to be displayed on the *MD*.

Above the adaptation, general and personalized services layers, we find the layer in which the application or the specific prototype of the commercial establishment executes. In this layer, graphic interfaces are built and mechanisms for collecting user information which will be processed by the other layers of the platform. This interface does not carry out the adaptation process. It is only the input/output interface which provides needed information to the lower layers in order to process the queries. For the study case of this paper, we developed a prototype and its respective tests, oriented to a restaurant (see Section 5).

3. IAM

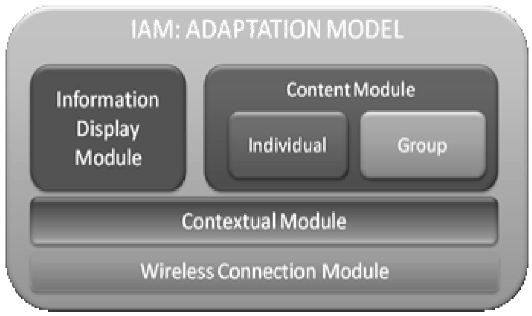

Figure 6 IAM: Integrated Adaptation Model

The Integrated Adaptation Model (***IAM***) was developed by a group of students at the Pontificia Universidad Javeriana (Bogota, Colombia). *IAM* can represent adaptation information, integrating several dimensions such as: context, user profile, access device and wireless connection. Such dimensions can provide users information, according to their needs and characteristics. Components in *IAM* (see Figure 6) will be briefly described in this section. A detailed description can be found in [7].

Based on existent wireless technology, the wireless connection module selects the best connection technology to be used according to application features and those of the access device (for example, the connection speed required for the application, the technologies supported by the access device, *etc.*). A detailed description of this module can be found in [16].

MOCA (acronym in Spanish of Módulo Contextual de Adaptación, Contextual Adaptation Module) [2] in *IAM* corresponds to the Contextual Module. Context is composed of the relevant characteristics of the interaction between users and the system. *MOCA* contemplates environmental characteristics, space, time, user activities and location characteristics. In addition, *MOCA* adapts content displayed to the user according to his/her needs at a certain moment. This module is a general representation which can be adapted considering application needs.

The *NOMAD* architecture [17] in *IAM* corresponds to the Information Display Module. This module is in charge of joining the characteristics of the mobile session (physical characteristics of the device and of the network) to the user session (user preferences and profile), to enrich presentation considering the particular display characteristics of the current session.

The Content Module in *IAM* is responsible for facilitating the access to information for *IAM* users according to their user information needs and contextual features. The Content Module has two objectives: the first one consists in facilitating the information access to the users according to their preferences; the second one focuses on obtaining information related to the communities to which they belong to. This module is composed of two profiles: an individual profile and a group profile.

On the one hand, *MAIPU* [19] (acronym in Spanish of Modelo de Adaptation de Information basado en Perfil de Usuario, Information Adaptation Model based on User Profile) in IAM corresponds to the Individual Profile Module. This module allows the user to obtain information which responds to the information needs of users when they access an application and help them to search for products/services that fit to their preferences, context and user activities.

On the other hand, *MAICO* [9] in *IAM* corresponds to the group profile module. *MAICO* represents the characteristics of a community. These characteristics establish how information will be managed in a community, identifying mainly the existent policies and preferences to differentiate and select information corresponding to the interest of the community and of its members.

4. Incorporating IAM to *PlaSerEs*

The Adaptation Layer in ***PlaSerEs*** is based on an adaptation model which was developed taking into account the information collected from several revised works. This collection process produced an architecture which considers different aspects for executing the personalization process and satisfactorily achieves with the established requirements. However, we have identified some adaptation models which can be used in ***PlaSerEs*** in order to convert it in a more complete and robust platform. These models are the main components of *IAM*. In this section, we present the main ideas about how to improve the adaptation layer of ***PlaSerEs*** by including the *IAM* Models and the benefits that these models bring to *IAM*.

The Mobile Device Profile used in ***PlaSerEs*** is located in the Display Module. In this model, the characteristics and constraints of the *MD* are taken into account. However, we consider that this profile can be improved considering the *NOMAD* features [17]. *NOMAD* also considers the mobile session characteristics and the network features. With these considerations, ***PlaSerEs*** could separate the characteristics of a mobile session and the user session. This separation could serve for personalizing information according to the user history in the system, his/her preferences (*e.g.,* performance preferences), his/her user profile and characteristics.

In order to ensure that ***PlaSerEs*** will be used in several contexts we can include *MOCA* [2] characteristics. Among the features to be included, we can mention: *i)* characteristics of the physical space (structural, environmental) and *ii)* the activity concept which defines the user activities in the system. If we model these activities, we can consider context as a physical space where actions can be executed. It is important to note that context can affect the user's activities and it can modify user information needs.

In order to apply the user profile defined in ***PlaSerEs*** in a different scenario, we can complement it by including *MAIPU* characteristics [19]. *MAIPU* differences between preferences (of activity, of results and related activities) and also separates the concepts of interest and taste.

Although ***PlaSerEs*** is focused on the users as individual persons and on satisfying his/her needs as a person in a specific context, people carry out their daily activities in group or they belong to a group while they execute them. The characteristics of a group and the relations between its members can influence their activities (in an individual or in a group way) and their preferences. In order to include the group concept into ***PlaSerEs*** we can use *MAICO* [9]. *MAICO* can model the way in which a user interacts with a specific community, using all the personalization options presented in other modules and applying them to the group to which the user belongs to. With *MAICO*, we can consider the user as a person in a context and as a member of a group whose common interests allow them to share, for example, activities or information of his/her daily life.

The Services Layer was designed for modelling all the services provided by a commercial establishment; however with the changes proposed in the adaptation layer, the services supported by ***PlaSerEs*** can augment or be improved. We have to investigate if the list of services provided is enough for all the possible clients of the platform. If it is necessary, we have to include new general services and to consider the impact in the remainder of the architecture, calculating the quantity of modules at modifying and we have to do the changes which allow maintaining the robustness of ***PlaSerEs***. For example, if we want to include the bill payment service, we have to include a security model which can connect to the bank entities in order to carry out money transactions in a successful way. Moreover, in the data model, it is necessary to include bank user information in order to pay bills in an automatic way by using the platform. So, to include a bill payment service, we do not have to modify any existent module but it would be necessary to create a security module in order to pay the bills.

The services of the Personalized Services Layer are related to the General Services of the platform. However, it is necessary to specify new general services, to specialize them with adaptation characteristics oriented to a specific commercial establishment with the purpose of obtaining personalized services. In order to identify new services, it is necessary to research the market's needs to find those that are not satisfied given current services offered by ***PlaSerEs***.

Prior to considering the core focus of this paper - the role of designs in supporting development of client understanding - we can comment briefly on the support within the empirical data for the key assumption that clients typically have a poor understanding of the ways in which the technology can be utilise to their advantage, and how this may impact on their business models. A more complete coverage of this issue, and the relevant survey and interview data, is given in [12].

5. PlaSerEs applied in a Commercial Establishment: a Restaurant

As presented in previous sections, ***PlaSerEs*** aims to help commercial establishments to provide better information services to their clients. As an example of these commercial establishments, are restaurants, which attend millions of people daily. It is established that services for restaurants are a complete case of study that can show how ***PlaSerEs*** would work in the real world. Figure 7 shows for each layer of the architecture, which content could be present and what kind of information or services each module can provide.

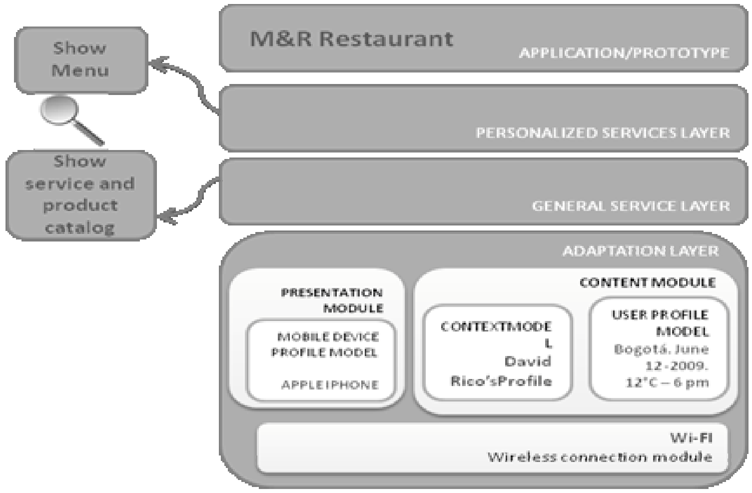

Figure 7 PlaSerEs Platform used for a restaurant.

In order to evaluate ***PlaSerEs***, a prototype for a restaurant was developed. This prototype uses the adaptation model of the platform in order to display information in the most adequate way according to the user's characteristics and context. The following test scenarios for the application are used by ***PlaSerEs*** to demonstrate the use of the adaptation models and the various elements that will be personalized. The scenarios are described below.

First Scenario: In this scenario we assume a smoker client, who visits the establishment in a warm afternoon. Then, the user can see the menu and the table reservation interface as shown in the Figures 8 and 9:

Figure 8 Menu showed to the user in the first scenario (warm afternoon).

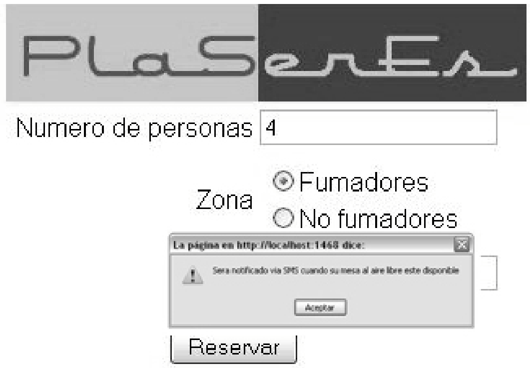

Figure 9 Reservation interface in the first scenario (smoker user).

In a different occasion, the user comes back to the restaurant in a cold and rainy night. In this case, the platform checks these conditions and removes from the available list of tables those that are located outdoors and also removes dishes that are not suitable for this kind of weather. The user can see the menu and the reservation interface as shown in the Figures 10 and 11:

Figure 10 Menu showed to the user in the first scenario (cold night).

Figure 11 Reservation interface in the first scenario (smoker user).

Second Scenario: In this scenario, the user can define the information format to be displayed. For example, a user prefers to receive the information in an "*image*" format. The user can see the menu as shown the Figure 12.

If the user changes his/her display preferences to a "text" format, the platform creates a procedure to deliver the same information in the same order but instead of images, the description of the dishes is offered in text format appears. The menu would be as shown in Figure 13.

Figure 12 Menu showed to the user in the second scenario (image format).

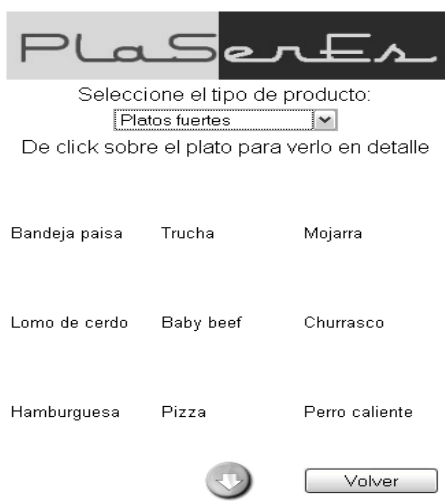

Figure 13 Menu showed to the user in the second scenario (text format).

Third Scenario: In this scenario, a user can define the maximum amount he/she is willing to spend in his/her bill. For example, the user decides that the maximum amount he is willing to pay is $13.000.The user can see the menu and the bill control as shown Figures 14 and 15:

Figure 14 Menu showed to the user in the third scenario (bill control -$13.000-)

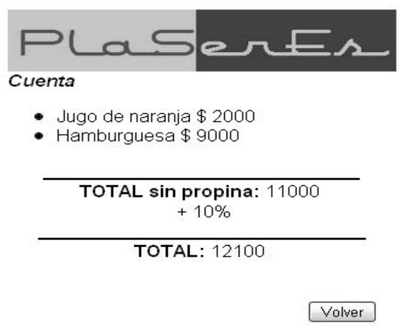

Figure 15 Bill control interface in the third scenario (bill control -$13.000-)

Now, the user decides that the maximum amount he is willing to pay increases to $20.000. ***PlaSerEs*** deletes the last maximum amount ($13.000) and generates new preferences based on the new amount. The menu and the bill control are shown in Figures16 and 17:

Figure 16 Menu showed to the user in the third scenario (bill control -$20.000-)

Figure 17 Bill control interface in the third scenario (bill control -$20.000-)

Fourth Scenario: In this scenario, the user can define the browser application for example, to access ***PlaSerEs*** by using the Firefox browser. He/she can see the promotions interface as shown Figure 18:

Figure 18 Promotions interface in the fourth scenario (Firefox browser)

The user changes browser preference to Internet Explorer, this generates a restriction: the JavaScript content has to change due to known problems with Microsoft's browser. For that reason, the acceptance message of the promotion is omitted and the platform sends a message to the waiter so that the user will confirm whether the promotion is credited to his/her bill, as shown Figure 19.

Figure 19 Promotions interface in the fourth scenario (Internet Explorer browser)

Fifth Scenario: In this scenario, the user defines his/her preferences related to products or retailers. For example, the user does not like mushrooms. This preference allows for the adaptation of the order and content of the ingredients list of the interface, as shown Figure 20:

Figure 20. Ingredients list interface in fifth scenario (without mushrooms).

The user can set a preference of mushroom for rice, meaning that, the user would like mushrooms. This change adds a new preference for the rice and removes the last one (mushrooms) as shown Figure 21.

Figure 21 Ingredients list interface in fifth scenario (without rice).

Sixth Scenario: This scenario shows how a wireless device can modify the way the information is presented.

The user attends the restaurant which presents its product catalog in different formats (video, image, text). The user's device has Wi-Fi, Bluetooth and 2.5G technologies. The application uses a medium size volume and data size according to the parameters of ***PlaSerEs***. Further, this application does not have data protection priorities because all of the data is public. It is necessary to ensure a high concurrence of users who can use the application at any time and from different tables within the restaurant.

In case that all technologies are available, due to the specific application characteristics, the platform will use Wi-Fi as the communication technology. In this case, the presentation format will be an "*image*" because the transmission speed can display the information in this format (more quality than text) but it will not show on video due to performance constraints (see Figure 22):

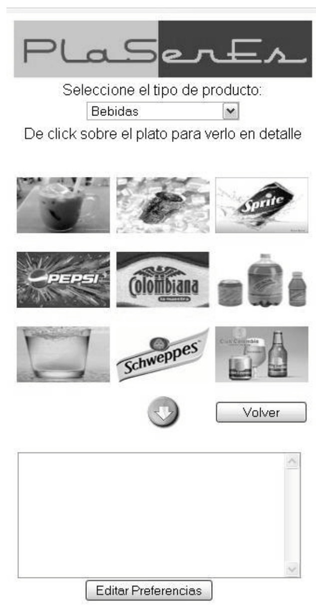

Figure 22 Drinks interface when the connection is Wi-Fi

For testing purposes with a wireless connection, the router is disabled and the device cannot connect through Wi-Fi. Consequently, the platform presents to the user the option to connect through other available technologies as shown Figure 23:

Figure 23 Connection interface where the user decides which technology uses.

If the user decides to connect via Bluetooth, the platform adds restrictions associated to distance and it will be necessary to access the platform from certain specific tables. Now, for example, the chosen technology allows the presentation format "*video*" as shown Figure 24.

In a case where the infrastructure does not allow to maintain the connection, the user will be connected through 2.5G since is the last available technology. This connection has a low speed limit, so it is necessary to change the presentation format to "text", however the user can access the platform from any table of the restaurant (see Figure 25).

Figure 24 Drinks interface when the connection is Bluetooth

Figure 25 Drinks interface when the connection is 2.5G

Seventh Scenario: Finally, this scenario shows how the presentation module modifies the presentation of information according to device capabilities.

The user enters the restaurant and his/her device can access the ***PlaSerEs*** prototype which supports "*image*" and "*text*" format. The wireless connection is high-speed, so both formats can be shown. So, the information will be presented in "*image*" format, specifically Bitmap (see Figure 26):

Figure 26 Drinks interface when the device supports image

In the case where the user accesses the platform with another device that cannot support "*image*" format, the platform establishes this as a restriction and thus the only format allowed would be "text". Therefore the information on the menu would look like the display shown in Figure 27.

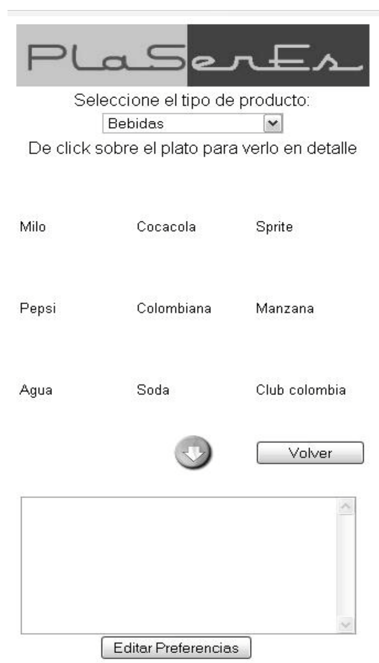

Figure 27 Drinks interface when the device supports text

6. Test and Results

The functional prototype described in section 5 showed adaptation information that considers the user, the device and the context. To offer an appropriate result, the platform follows some procedures in each mentioned scenario.

In the first scenario (the smoker user visits the establishment in a warm afternoon) the platform adapts the information to bring a personalized menu. First, the platform determines the time of the day (morning, afternoon or night), then it checks the dishes that are not available at that time to delete them from the list and finally, it checks if additional restrictions exist. The results are shown in Table 1:

Table 1 Actions and results of the platform in the first scenario

Platform action	Results
Checks the actual time to determinate the range of the day (morning, afternoon or night).	OK
Checks the dishes that are not in the range to delete them of the list	OK.
Checks if exists additional restrictions	NO.

According to the results of the Table 1, ***PlaSerEs*** will consider the changing characteristics of the environment to adapt information about the content of the products and services that are offered for the restaurant. It defines specific characteristics that limit the information displayed making it more accurate and lightweight.

In this second scenario, the platform follows the procedures showed in the Table 2 to display information according to the format preference of the user. It checks if the user has a display preference and if the device is able to display the information according to the user's preferences. Additionally, it checks if the information is available in the chosen format to evaluate if this format meets with performance restrictions related to displaying information in an "*image*" format.

Table 2 Actions and results of the platform in the second scenario.

Platform action	Results
Checks if the user has a display preference	In this case Yes: the format is "image".
Checks if the device is able to display the information according to the user's preference	Yes
Checks if information is available in the chosen format	Yes
Evaluates if the chosen format meets with performance restrictions	Yes
Shows the information in an "image" format (in this particular case)	Yes

In conclusion, the adaptation model separates display preferences from the rest of the system information. In this manner, if any change occurs, these do not affect the content of the displayed information. Thus, changes are made only to the display format, always considering the devices and network capabilities according to the user preferences.

Another test was carried out for the third scenario where the user defines the maximum amount he is willing to spend in his/her bill. The platform adapts the displayed content by checking if a maximum amount has been specified and in this way determines the dishes that exceed the given amount. Low-priority preferences will be generated for the identified dishes. Results are shown in Table 3.

Table 3 Actions and results of the platform in the third scenario

Platform action	Results
Checks if a maximum amount exists	In this case: Yes ($13.000)
Determine the dishes that exceed this amount and will generate low-priority preferences for these products.	OK
Every time the user orders a dish, the platform checks the amount to pay, if this exceeds the maximum amount, the menu of that bill must be changed	OK

As can be seen, ***PlaSerEs*** generates low-priority preferences that affect information content in a less critical compared to the case of the user generating this information manually. These preferences help to determine the presentation order of dishes on the menu and the announcements of the bill control interface. However, the platform does not remove the elements of the menu permanently.

In the fourth scenario, the user decides he/she will access ***PlaSerEs*** by using the Firefox browser. The platform creates this browser preference (see Table 4) and shows information by checking if the user has a browser preference and its restrictions.

Table 4 Actions and results of the platform in the fourth scenario

Platform action	Results
Checks if a browser preference exists	Firefox
Checks if browser restrictions exist	NO
Displays the information through the selected browser with the information adapted to it	OK

According to the Table 4, the platform checks the browser preferences of the user to determine application restrictions and to show complete information in all cases. These restrictions are default and help to adapt the presentation information.

Table 5 Actions and results of the platform in the fifth scenario

Platform action	***Results***
Checks the list of products according to user preferences	None, the preference is an ingredient.
Checks the products list that contains the preference product and deletes it from the list.	OK

The Table 5 shows that ***PlaSerEs*** considers user preferences about the products offered by the commercial establishment and also the contents of these products (for example, the ingredients).

The next test was applied for the sixth scenario (wireless module modifies the presentation of the information). The platform checks hardware and software restrictions of the device and the information source to determine which technology to use. Then, it uses the characteristics of the application to determine the appropriate technology and other features that could be used if other technologies are not available. Finally, the application organizes the priority of the technology to be used (see Table 6). It is necessary to ensure that the application can handle high amounts of concurrency so many users are able gain access to the application and use it at the same time at any time and from different tables of the restaurant.

Table 6. Actions and results of the platform in the sixth scenario.

Platform action	***Results***
Checks hardware and software restrictions of the device and the information source to determine the technologies to use.	BlueTooth, 2.5G, Wi-Fi
Uses the characteristics of the application to determine the appropriate technology to use and others that could be used to replace the first if it is not available. Organize the technology to be used.	1. Wi-Fi 2. Blue-Tooth 3. 2.5G

In conclusion, the platform adapts information through its wireless connection module using the type connection technology that the device is equipped with. This module can analyze a number of factors to determine the appropriate technology available, but if conditions change, the information can be adapted with or without user intervention.

Finally, the seventh scenario shows how the presentation module modifies the presentation of information according to device capabilities. The platform shows information given the following procedure: first, it checks presentation formats that can offer support to the device and presentation restrictions related to the wireless connection, after this, it checks and sets the presentation to the highest quality format that complies with the proposed restrictions. The results are shown in Table 7.

Table 7. Actions and results of the platform in the seventh scenario

Platform action	Results
Checks presentation formats that support the device.	JPEG, BMP, PNG and Text
Checks the presentation restrictions related with the wireless connection	No
Checks and sets the presentation to the higher quality format that complies with the proposed restrictions.	BMP

The presentation module (through the mobile device profile), as shown in Table 7, allows the platform to take into account the device characteristics. With these features, presentation and content restrictions are established with the purpose of ensuring that for any scenario, the maximum performance of the applications that are supported by ***PlaSerEs*** can be achieved.

7. Related Works

PlaSerEs is a platform which applies concepts of ubiquitous computing and adaptation in order to provide services to the clients of commercial establishments.

Another example of a similar application that merges adaptation concepts with anytime anywhere technology-enabled services is AMIGO [1]. AMIGO is a home automation system that adds different adaptation modules to a number of the services that it provides. For example, it offers its users suggestions of exercise routines depending on the day. This system can also offer suggestions about foods given a user's request. Additionally, AMIGO controls all in house systems and generates an environment for each person who lives in the household by taking into account his/her specific and unique preferences. The system can be accessed through heterogeneous devices such as a television or even a mirror. In addition, it can be controlled from anywhere within the house and the user's work place by having a system extension in that area. It is important to mention that each subsystem is connected to a specific device; thus, if the user wishes to send or receive information in different ways, the subsystem cannot adapt to a new device. This means that, for example, if a diet is controlled through a mirror, information cannot be displayed on a mobile phone.

ASAM 5 (acronym of "Adaptive Service Access Management") is a solution that allows for the interaction between devices and networks in a transparent way. To achieve such an interaction, an agent-based architecture is created that behaves using a one to one relationship between the device's agents and the agents that provide adaptation services. On the provider side the synchronization processes are held and the results are sent according to the best available technology and to the customer's requirements. The client side runs a protocol for switching and trying to continue using the system transparently. ASAM [11] takes into account the network that connects the device but not the specific characteristics of the device; for this reason, it cannot make presentation changes according to the technology in use or user preferences.

Finally, Berhe *et al.* 3 present their work which specifies issues related to adapting information generated from different information sources. In this case, the adaptation problem is studied given a simple, scalable, flexible and interoperable architecture that can extract environmental restrictions, and match these with adaptation profiles to be used in order to identify the best configuration available. However, this project does not consider the variety of devices and their profiles and thus can't differentiate them.

The adaptation objective according to Brusilovsky [10] is to guide users by adapting the presentation of information, and in this way help users accomplish their goals based on what users know and what they like. To achieve this, the designer will normally focus on: the construction of the prototype, the appearance, the location and the functionality. State diagrams are also used, among other things, to identify paths on a hyperlink and the user's characteristics.

Table 8. Related Works with ubiquitous computing and adaptation subjects

	10	1	5	3	PlaSerEs
Ubiquitous access	+	+	+	+	+
Adaptation of content	+	+	+	+	+
Adaptation of presentation	?	?	-	?	+
Adaptation to the *MD*	-	-	+	-	+
Adaptation to the context	+	+	+	+	+

In Table 8 we can find a comparison among some works which apply concepts of adaptation or personalization combined with the basic concepts of ubiquitous computing. In addition, it is important to highlight adaptation aspects which are being considered. This table uses the following notation: "+" if the work contemplates an aspect, "–" if it does not contemplate an aspect "?" if there is not enough information about an aspect. We can conclude that all of the explained works have low restrictions over accessibility and adapt information according to context. These aspects have been considered as the most important ones because it is very important that a user is able to connect to the platform and also that information is adapted according to his/her location (that is, adaptation of content). Aspects of adaptation of the presentation considering specific access devices have not been widely worked, mainly because each work is limited to a particular *MD* and these works do not allow scalability in this aspect. Nowadays, it is necessary that the applications allow this scalability, because all users do not have the same *MD*. Therefore, adaptation to the presentation, to the device and of content (considering the context), are all aspects equally important to consider for new applications.

Focusing on restaurants, most of them have the same mechanism to serve their customers. They still take the customer's order face to face with a pencil and paper. This routine causes flaws in the processes and therefore the restaurant's resources are wasted and customers usually are not satisfied. However, there are many ways to increase the efficiency of this mechanism so that both, response times and relative cost, decrease.

Prasad *et al* [21] present an approach of how to integrate different restaurant areas through a wireless network. The first restaurant that the authors mention is Little Chef. This restaurant implemented a wireless system on 2002 that allows the waiters to take the customers' orders using handheld devices that gather information through its touch screen. Those devices automatically send the information about the dishes to the kitchen to generate the customer order and at the same time, send the financial information to the register. This inclusion of this technology to the business creates an improvement on the restaurant personal, reduces costs caused by human mistakes and increases customer satisfaction. However, this model does not consider adaptation characteristics such as content preferences of customers or the way that he/she wants to view content, which would help to customize the customer's experience.

The second example that Prasad *et al* used is Kudos and Wine Bar. Those restaurants use devices to capture the customer order too. So, the verified information is sent to the kitchen or the bar to offer the customer his/her customized order. This application does not consider menu recommendations based on the user profile

Another approach is the Modelling Studio Restaurant [4]. This is a framework that seeks the satisfaction of those involved in the restaurant through the simulation of different areas in the restaurant's operation. This application takes into account, among other operational and administrative aspects of the restaurant, customer requirements and concerns to increase the speed of a service and service capacity. However, it does not consider how products and services are presented according to the user’s profile or the contextual characteristics of the restaurant, for example, the specific location. It is important to note that this framework provides some applications to improve customer service. For instance, if the customer orders a hamburger with French fries, the application detects if the processes (grill and fries) can be done sequentially or in parallel to deliver the customer his/her order faster. In this way, the customer feels satisfied with the service because of the short amount of waiting time. Although fast service is shown to clients as a customized service, this application does not take in account the user’s profile or context profile, so the customer order is not completely customizable.

A bit different from the proposals of Prasad *et al* [21] and Brann *et al* [4] is the one presented by Seneff *et al* [24] called Dinex. Dinex is an application that stores and shows information about a consulted geographic area. Specifically for restaurants, Dinex shows the name, address, phones, opening hours, types of food, parking, if it accepts credit cards and online menu of the restaurants of a certain area. This information can be consulted through the Web and it shows customers which are the restaurants near his/her position. Although the use of adaptation is seen in this type of applications, Dinex is not limited to restaurants because it also handles information about other places in the same geographic area. However, it does not consider the customer preferences to show the restaurant’s products and services.

Finally, the most user-centered adaptation framework is E-restaurant [8] that uses a wireless local area network (WLAN) to allow user recognition in the moment that he/she is inside the restaurant through a RF card. This way, the waiter can provide a personalized customer service because the restaurant counts with customer historical information, mainly considering their preferences. Additionally, the waiter can retrieve the customer’s order and information though a *PDA*. This order is sent directly to the kitchen though the WLAN for the preparation of the dishes. However, E-restaurant does not take into account the contextual characteristics of the restaurant to offer customers different options depending on the season, or to show discounts, reservations and other functionalities. Also, the *PDA* device is underused because its use is limited only for receiving and sending the orders made by the customer.

8. Conclusions and Future Work

PlaSerEs was developed in order to provide commercial establishments, the possibility of offering personalized services to their clients. To make this possible, the internal architecture of this platform takes into account user characteristics and context. The models developed with adaptation purposes are: *i)* of the user profile, *ii)* of the context of use which includes characteristics that affect the interaction between the IS and the user, depending on his/her location. For all people in the same location, this model presents information in the same way. *iii)* Of the *MD* profile which describes the device used by the user to connect to the system; this profile defines the best way to display information. *iv)* Of the wireless connection profile used for personalizing of information according to the available connections either in the establishment where the user is located or on other connections the user’s *MD* may have. These models are the main components of the adaptation layer which allows ***PlaSerEs*** to personalize the content of the information displayed and how this information is presented to the user. Personalized information is offered through the invocation of services provided by the commercial establishments. These services are described and defined in the general services layer. The particular implementations (developed for a specific commercial establishment) of these services belong to the personalized services layer. In order to validate and evaluate the accomplishment of the set goals, a prototype was developed which provides adapted services to users of a restaurant, taking into account the user profiles, their *MD*, the available wireless connections and their context of use. This prototype produced successful results in the tests cases.

After the finalization of this stage of the project, where research and software design element were combined, it is important to collect and document the experiences acquired throughout the entire process. The following subsections show the results of the work mentioned above. Additional results that were achieved during the process and that were not originally planned, as well as the problems that arose and the way they were solved is also presented. The following results were proposed for the initial stage of this project: *i)* User, context and device profile models were represented through OWL ontology. *ii)* A data collection mechanism was established. *iii)* In order to build a wireless connection model a comparison between the different wireless technologies was made and then, it was represented through an OWL ontology. *iv)* A general and personalized layer was developed for commercial establishments. Personalized services use information provided by profiles created given the proposed profile models. *v)* Generation of a functional prototype to simulate adapted services.

During the development of this project some results were achieved in accordance to the proposed objectives. Table 9 shows contributions, each one has a justification that explains why it was necessary to build.

Table 9 Contributions not originally considered

Description	Justification
Wireless module	It was necessary to create a wireless module that considers hardware and software aspects to choose the wireless technology according the context and user's device.
Research of existing Technology	The technical research about wireless technologies on the market helps to improve the lack of documentation on this subject.
Taxonomies	Finding the technologies that are likely to be used in real applications.
Architecture	Modeling of the information collected on wireless technologies into an architecture in order to incorporate the adaptation module built.
Device profile model improvements	The mobile device profile is built according to today's necessities. Thanks to the IAM project, this model is improved to include a profile that contains features such as a mobile session.
Context profile model improvements	The contextual profile is built in accordance with today's necessities. Thanks to the IAM project this model was improved to include a profile that has features such as activities and physical space.
User profile model improvements	The contextual profile is built to satisfy the necessities of today. Thanks to the IAM project a profile that has features such as the different preferences representation could be added.
How to join the group profile model	The incorporation of a group profile to the platform allows to join the community concept to the adaptation processes established.

Even though planning helped the overall development unexpected problems are unavoidable. Table 10 shows those unexpected problems and the way they were confronted.

Table 10. Problems during the results achievement

Problem	Solution
The profiles found did not consider the requirements that the project needs.	The profiles found given a literature review were insufficient. It was necessary to create new profile models by complementing the ones found.
The definition of the profiles takes time	Modeling new profiles takes time and effort. Mostly because it is necessary to research the relevant characteristics of each profile.
The learning curve was larger than expected	A large amount of time was spent in preparation and the acquisition of knowledge on the used technology. The use of tutorials, tools documentation and meetings with expert personal were necessary.
Configuration problems with Internet Information Server and SQLServer	Different tools, configuration manuals and forums helped to solve these problems.

In future works, a study needs to be carried out to verify if the list of services defined is enough for all the possible clients of the platform. It is necessary to define if new general services need to be added and to consider the impact produced by these additions to the other components of the architecture. For example, if a service designed for paying the bill is to be included, additionally a security component has to be added as well to establish secure transactions with the bank and allow customers to make payments in a successful way. In addition, the data model must include user banking information so that he/she can pay his/her bill in an automatic fashion. In conclusion, in order to include the general service of paying the bill (or any other service) to ***PlaSerEs***, it is not necessary to modify any existent modules but to add new ones. Finally, it is necessary to research market needs in order to identify general services that are not included in ***PlaSerEs***.

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