Concept of a Universal Mobile Application Accessing Environmental Information Systems

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Abstract
Considering the development of mobile applications, it can be noted that implemented processes often are very similar. The concept presented here describes a declarative approach to generating an entire family of mobile applications. These applications are based on descriptions of their functionality and appearance. Standard data formats are used for information interchange. Appropriate tools enable a cross-platform development and minimize the effort required for this.

1. Mobile Devices Are Emerging
When news on the Consumer Electronics Show (CES) and on CeBIT 2011 report a "spirit of optimism", this is mainly due to innovations in mobile devices and applications (N24 2011, Hannoverimpuls 2011).

Within a few years, entirely new classes of high-performance mobile end devices have emerged. Developments in this area still seem to be accelerating. Mobile phones, smart phones, PDAs, tablet-PCs, netbooks, E-book readers, and laptops sometimes are difficult to distinguish from each other. Transitions between these classes are fluent. Hybrid devices like the "Dell Inspiron Duo" even combine the properties of several classes.

Availability of many components, such as cameras, microphones, loudspeakers, GPS receivers, position sensors or compasses, Bluetooth, WiFi, and mobile radio communication technologies allow for a variety of functions. This significantly pushed the creativity of developers all around the globe (Appcelerator 2011).

The success of mobile end devices is mainly due to the wide availability of rapid network connections, whether over wireless local area networks or powerful cellular networks (UMTS, LTE). These enable users to communicate virtually anytime and anywhere and to access current data. Data are not needed to be stored on the device itself. Server infrastructures and cloud services provide for a synchronization of e-mail accounts, calendars, address books, task lists, document repositories, etc. Thus, transparent access to the same data by both the workstation and mobile devices (e.g. netbook or smartphone) is possible.

Another important factor is new use concepts based on high-resolution, touch-sensitive screens, which enable the user to operate programs through simple contact with one or more fingers. Text is input via software keyboards or voice recognition.

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Recent developments use mobile devices as a means of payment (Heise 2011), for control of home automation (Home Theatre Network 2011), but also as a platform for professional applications, e.g. for use by field staff, on construction sites, in factories, for civil protection (Wilbios et al. 2010), etc. – the possibilities of mobile devices seem almost inexhaustible.

2. Gathering Context Information

For a variety of services the context of a request represents important additional information. Mobile devices may supply valuable context information to the applications. Modern smart phones, for instance, have several sensors, by means of which the position, the location, and the direction can be determined. These data may then be combined with information of other sensors, e.g. of the camera. In this way, applications for tourists can identify buildings of a city or summits of a mountain range and provide the user with the corresponding information.

The location of a user represents valuable context information when searching for environmental data. An application to display current air measurement values may use these location data to identify the closest measurement station. If this is done on the server side, technical criteria extending far beyond the Euclidian distance may be used for the selection of the measurement station without the mobile application having to know or contain the logics behind. A request like “Give me the current ozone data to my location at 49° 0’ N, 8° 24’ E!” is quite sufficient.

This request already implicitly and explicitly contains context information on time (current=today, now) and place (site identified: city of Karlsruhe). It has been shown that requests for environmental information often consist of three components (or a subset thereof) (Schlachter et al. 2011b):

- Subject
- Spatial reference (e.g. coordinate, administrative unit, professional object)
- Temporal reference (e.g. point or period of time)

Spatial reference, if not explicitly given by the user, may be generated using the context information given by the mobile device.

3. Creating Universal Applications

Many suppliers of websites have noticed a shift from classical users applying PCs and web browsers for access to users with mobile end devices. Mobile applications (“apps”) compete with classical websites. However, the data and services of websites often can also be used for access from apps. If a service-oriented infrastructure already offers services to process queries relating to a certain topic (with a certain spatial or temporal reference) and answers are supplied in a machine-readable format, these services can also be used from mobile end devices, of course.

Corresponding apps offering a rich, graphical research interface, using user input and context information for the data requests, and finally displaying results in an appropriate form can be implemented relatively easily. Usually, a corresponding new app is developed for new services. The large number of very similar apps available in several marketplaces clearly illustrates this problem: considerable effort is spent to implement and distribute new apps, though many of them do not differ in their basic behavior and operations, but are provided with a different design only. On the free market, this would certainly stimulate the business of the provider. Public providers, by contrast, need to focus in particular on the effort they put into the development and maintenance of these apps.
The following section presents an architecture that is designed to counteract the multiple developments within a certain scope.

3.1 Using Simple Standard Data Formats
The data used by apps frequently exist in standard formats. For instance, many news apps use RSS feeds that are made available as a standard by many news portals. The situation is similar in the environmental sector: Data sources with geo-referenced objects frequently offer lightweight formats like GML, KML, GPX, GeoJSON, or GeoRSS. All these formats are structured rather simply and contain data on a high abstraction level, e.g. the title and a short description. This means that conversion of special data objects into these formats is relatively easy (but lossy). On the other hand, these formats can be used universally by standard components of mobile devices. A GeoRSS feed with certain objects (e.g. air measurement stations), for example, is suited for representation as a list, but also as a layer over a background map. In both cases, the user can access more detailed information (e.g. represented in a browser component) by selecting a certain object via a link.

Both access to data and their representation (and, hence, their semantics) can be described formally. The project “Landesumweltportale mobil” (LUPO mobil, mobile state environmental portals) is aimed at using these descriptions for the construction of a universal mobile environmental application. The term "universal" should not be interpreted too widely, but considered in the context of the project described here. It is not referred to the development of a completely generic architecture, but to a pragmatic representation of the reality of environmental information systems (in the state of Baden-Wuerttemberg).

3.2 Representing Data
As flexible as the abstractness of GeoRSS is on the one hand, as difficult it is to adequately reflect the semantics of an object on the other hand. The following two GeoRSS entries do not differ in structure but in semantics, which is expressed only by contents.

```
<entry>
  <title>Rhine in Maxau</title>
  <link href="http://www.hvzbw.de/dat?id=9016"/>
  <updated>2011-07-22T15:00:00Z</updated>
  <summary>556.0</summary>
  <georss:point>49.013 8.298</georss:point>
</entry>

<entry>
  <title>NSG Weingartener Moor-Bruchwald Grötzingen</title>
  <link href="http://www.ripsbw.de/nsg?id=91900100009"/>
  <updated>1984-07-27T00:00:00Z</updated>
  <summary>Remains of a fen in the former Kinzig-Murg channel</summary>
  <georss:point>49.0395 8.5135</georss:point>
</entry>
```

The first entry describes the level measurement of the river Rhine at the point of time given in the "updated" field. The "title" field contains the name of the river and the gauging station, "summary" contains the corresponding measured value (in cm).
The second entry represents a nature reserve (NSG) with its name given in the "title" field. The time given in "updated" represents the date of the related ordinance. "Summary" here actually contains a brief description of the protected area.

Both entries can be presented in the same technical ways, e.g. in a list, table or map. In order to account for the semantic differences, it is desirable to get at least a suitable labeling of the table (such as column headings) and to control the output of the data (e.g. by adding the unit "cm" to the water level). On a map, the user may want the objects to be represented by different icons.

The following section shows how both the access to data and their representation (and thus in some ways, their semantics) can be described. The aim is to use these descriptions to construct a universal mobile environmental application.

4. Description of Target Systems

The OpenSearch description format allows for the description of simple URL patterns for dynamic access to web systems (OpenSearch 2011). Originally, it was designed for access to web interfaces of search machines and mainly supplies a syntactic description for queries. The semantics of potential parameters is rigid. However, OpenSearch descriptions can be extended in principle, like all XML formats. To use them for a universal mobile environmental application, the following features have to be added:

- Freely definable URL parameters.
- A “typification” of these free parameters, i.e. a rudimentary description of their semantics, for instance, the geographical position of a place in a certain format.
- A description of the sources of these parameters, e.g. automatically determined from a GPS component or by the selection from a given list of values.
- Structural presentation of the results, e.g. mapping of attributes to certain table columns.

OpenSearch descriptions extended by these features supply the information necessary for the registration of an information source in an application, for the generation of a user interface for queries, and for the visualization of the information from the answers. These “service descriptions” can be used by the mobile environmental app.

5. Tier Architecture

Once registered (and activated), the services are administrated by the registration service and made available to all other components. The necessary (use) data are collected by the data service. It transfers the data to the application logics that is equipped with an interface for the generation of the graphical user interface.
Both the location service and the abstract user interface (abstract UI) offer a system-independent view on system-dependent components. System-specific implementations of these services are hidden in a system-depending layer below. Consequently, the architecture is divided into a system-dependent and system-independent part that can be used in various systems in principle. Hence, the system-dependent part has to be implemented (or generated) for new systems only.

5.1 Cross-platform Development

Development platforms, such as Appcelerator Titanium, RhoMobile, MoSync, or ELIPS Studio, allow for the development of general applications for mobile devices and the subsequent generation of packages for several systems like Android, iOS, and Windows mobile/phone (Mashable 2011). The development of such platforms is progressing rapidly. However, market consolidation has not yet taken place. For this reason, the platform-overlapping development in the first phase of the LUPO mobil project was deferred and the Android 2.x operating system was defined as target platform.
6. Demonstrator

The first project phase (until November 2011) focuses on the development of a demonstrator. It is concentrated on confirming the concept of using service descriptions. The target systems and data sources are services developed within the framework of the state environmental portals project (LUPO), e.g. for water level and air quality data (Schlachter et al. 2010, 2011a).

This is already achieved based on the principles described above: use of existing environmental data services, use of various standard data formats, use of contextual information (location) at the request of the systems, and the service-specific presentation of environmental data. If Android-specific components are used, e.g. for map display based on Google Maps, this always happens in the light of a subsequent cross-system development.

![Figure 2](image)

First demonstrator of a mobile environmental app.
Left: Fetching actual water levels. Middle: Setting up an alarm. Right: Overview map.

7. Conclusion and Outlook

As an economically efficient use of funds is recommended by authorities when developing and maintaining applications, the approach presented here promises to be of very high potential. Multiple use of existing services and interfaces (also for the mobile area) will produce synergy effects. Generation of descriptions of these services promises to reduce the expenditure compared to the development of always new mobile applications for special purposes.
One planned extension of the architecture provides for the reversal of data flow. The mobile application will then be used to collect environmental data. In addition to location data, also simple factual data (by choice or input by the user) and multi-media data (photo, video, audio) will be recorded and transmitted to a central server.

If a platform-overlapping development will be achieved in a next project phase, LUPO mobil will certainly be a “universal mobile environmental application”.

**Bibliography**


