ABSTRACT
In this paper a framework for a novel kind of applications called Augmented-Mobile-Tagging (AMT) applications is presented. AMT applications augment classic Mobile Tagging applications with information from existing Location Based Services (LBS) in a seamless way. This leads to very powerful mobile applications without loosing the efficiency, intuitiveness and robustness of the visual tagging application. We have implemented two AMT applications based on this concept and are currently running two field trials, one a campus information system on the university campus and another, called LocalTagging, running in the town and surroundings of Winterthur.

Categories and Subject Descriptors
H.4.3 [Information Systems Application]: Communications Applications – information browsers

General Terms
Algorithms, Management, Experimentation, Human Factors.

Keywords
Mobile Computing, Visual Tag, Mobile Tagging, 2D Barcode, Augmented Mobile Tagging, Location Based Services.

1. INTRODUCTION
Mobile Tagging is a convenient way to connect objects in the real world with information in the internet by means of information tags (e.g. visual tags, RFID-tags, IR-beacons) involving different physical selection paradigms [1]. Visual tags have been used for quite some time in various experimental systems (e.g. [4][5]) and the recent availability of commercial tag readers on ordinary mobile phones have paved the way for deploying commercial applications.

Yet, Mobile Tagging has not been very successful outside Japan up to now. One reason we see for this is that each mobile tag is tied only to one particular application or service. The benefit of a single application is often too low for real users in order to install a tag reader on his phone just to scan a single mobile tag. Furthermore, it is difficult to get a big enough coverage of tags in a city or even country for just one application.

Location Based Services (LBS) on the other hand are very popular, especially map-services. They rely on the global position only. This position is determined by user input, by the device itself with e.g. GPS, or by the communication infrastructure (e.g. WLAN) with various technologies. There are a lot of valuable LBS offered on the internet. However, access to these LBS via mobile devices faces a couple of problems:

1. As the LBS in the first place only knows the position of the user as contextual information, direct access to the desired LBS is often not possible. Instead, the user has to select the right service from the list of services offered. In the worst case, the service he is looking for is not even available, but he is only getting aware of this after having started the portal service of the LBS and having scanned through the list. This can be quite frustrating.

2. The localisation of the user may not be possible (e.g. indoor, underground, or in narrow pathways) or may be too inaccurate for the given application. Or, to put it differently, an expensive infrastructure has to be set up and maintained in order to get a high enough high location accuracy for the intended mobile application.

3. The localisation itself of the user may take too long for certain mobile applications.

Augmented-Mobile-Tagging (AMT) applications that we propose allow to combine the benefits of Mobile Tagging applications with those of LBS.

The rest of the paper will go into the details of the AMT Framework and show two AMT applications we have developed.
2. THE TAGGING SYSTEM
The AMT Framework is based on a mobile tagging system that does not store the URL directly on the tag but only a tag ID which is later on mapped to an URL on a dedicated server. For our experiments we used the BeeTagg system [2] as visual tagging system which is based on the so-called BeeTags. These visual tags are specifically optimized for the use with normal mobile phone cameras. The BeeTagg-reader is available for all major mobile platforms (Java, Windows Mobile, Symbian, Palm OS) and for several hundreds of different mobile devices. On Smartphones the BeeTagg-reader scans the tags (see Figure 1) in realtime. Furthermore, it is possible to specify the mobile service offered with an icon or logo within the tag itself, which is one of the important guidelines for Mobile Tagging applications as Toye pointed out in [6].

For the use with AMT applications the BeeTags have to be geopositioned when they are being attached to a physical location. This information is then stored in the Metadata Server of the AMT Framework for each tag. The positioning information can be as accurate as needed by the AMT application and can also contain altitude information.

3. THE AMT FRAMEWORK
The AMT Framework is depicted in Figure 2. It comprises the BeeTagg Server, Application Server, and the Metadata Server. The BeeTagg Server is mainly concerned with the mapping of tag IDs to the corresponding URLs. The Application Server is responsible for the interaction with the mobile phone and offers one or more AMT services to the user. In addition, it manages all data that is specific to the AMT application (e.g. application specific POIs, proprietary maps).

The Metadata Server\(^1\) is the heart of the AMT Framework. It communicates with the AMT Application Server on one side and with all 3rd-party LBS servers on the other side. It manages all tag-specific metadata, e.g. the geo-position, orientation, application context of each tag as well as all meta-information from the LBSs, e.g. POIs, maps, or other items of interest that the Metadata Server needs to search for.

The Metadata Server updates its metadata in regular intervals from the corresponding 3rd-party LBS. If the metadata from one LBS, e.g. for a POI, is incomplete, the Metadata Server tries to initiate other LBS in order to complete the data. If more than one LBS supplies information for the same POI, the Metadata Server tries to merge this information and to solve possible conflicts based on a predefined strategy.

The Metadata Server offers several services to the AMT applications: The POI-service provides information about POIs within a specified area that match some given category. The information provided may be the meta-information about the POI stored in the Metadata Server or more detailed information from 3rd-party LBSs. Additionally, a map is provided showing the POIs found. The mapping service allows plotting POIs onto a map. The POIs and/or the map may be provided by the AMT application or may come from the Metadata Server itself. Finally, with the search service POIs can be searched for given a set of keywords.

When the user scans one of the BeeTags with his BeeTagg reader on his phone, he is directly connected to the BeeTagg Server which maps the tag ID to the corresponding URL and redirects the mobile phone to the desired AMT application. As in

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\(1\) Patent pending.
normal Mobile Tagging applications the tag hereby defines the entry-point to the application, i.e. one of the AMT services.

When the AMT application needs additional location based information it sends a request to the Metadata Server together with the tag ID and an optional user ID. The Metadata Server retrieves the context information for the corresponding tag location and user, searches for the corresponding information in its local metadata, and returns it to the AMT application. If needed the Metadata Server sends a request to one or more 3rd-party LBS. It collects the information provided by the different LBS, aggregates it and forwards it to the AMT application.

4. SAMPLE AMT APPLICATION
As the first sample AMT application the “ZHAW Campus Info” was developed. It provides students and visitors of the campus of the School of Engineering (SoE), which is part of the Zurich University of Applied Sciences (ZHAW), with information about the campus and the town of Winterthur. The AMT application consists of three services: Campus-Information, Where-Am-I, and Town Information Service. We put about 80 BeeTaggs (see Figure 1) at strategic points on the SoE-campus and geo-positioned them.

4.1 Campus Information Service
The Campus Information Service (CIS) is the actual Mobile Tagging application in this AMT application. It provides information about the buildings in the campus of the SoE on proprietary maps. The geo-position of the BeeTagg however is stored in the Metadata Server and has to be dynamically plotted onto the proprietary map by the mapping service.

Figure 3. Overview on the campus of the SoE
The information provided by the CIS of course depends on the actual mobile tag that has been scanned:

If a mobile tag outside a building has been scanned the user first gets a schematic overview of the campus together with his own position (see Figure 3). If he has “photographed” a tag within a building, he first gets an overview of the actual floor of the building together with his position (see Figure 4). The CIS also shows the different offices on the current floor together with information about the people working in the offices shown, like their phone number or e-mail address. Also more dynamic information like presence of people or room occupation could be shown on these maps, once the corresponding information is available via web-services.

4.2 Location Based Services
The other two services of the ZHAW-Campus-Info application mainly rely on 3rd-party LBS. The Where-Am-I-Service when addressed outside the campus shows a map of the town of Winterthur together with the users actual position. This map is fetched from map24 [3] through a web-service.

The Town Information Service allows the user to look for restaurants, hotels, museums and other Points Of Interest (POIs) in his neighborhood (see Figure 5). The corresponding map with the POIs is also compiled with the use of web-services from map24.

Figure 4. Map of 2nd floor in building E
If the user wants information about another floor or building, he can easily navigate to there within the AMT application.

5. LOCALTAGGING
We are currently developing another AMT application at a much larger scale for the town and region of Winterthur, the second
largest city of the canton Zurich. The service is called LocalTagging and provides tourists and visitors with detailed local maps as well as a wide variety of POIs for sight seeing, shopping, restaurants, hotel, banks and ATMs, post and municipal offices, public transport as well as guidance information. The metainformation on the general POIs and the maps (from [7]) are collected from different 3rd-party LBS. This information is merged with the POIs from the local administrative bodies.

For the current field test we applied about 200 LocalTags, mainly at bus stations and in the center of the town and villages of the region. Some of the tags come with a short instruction how to use them.

When the user scans a LocalTag with the BeeTagg Reader he first gets a map showing his location (blue banner) and the available POIs in the vicinity (see Figure 6).

Once the user has selected the POI he is looking for, another map appears showing the selected POI and the users current location. Beneath the map detailed information on the POI is presented together with the estimated distance to the POI.

LocalTagging is meant to be a basic community service on which specific AMT applications for shops (shopping guides), companies (campus information) and the communities themselves (touristic, historical, botanical etc. city guides) can easily be built.

6. CONCLUSIONS

The experiences with the two AMT applications ZHAW Campus Info and LocalTagging are promising so far. People like the fast and easy access to context-specific online information with their normal mobile phone and the intuitive interaction. The detection and decoding of the BeeTags is also fast and very robust. Even people who have never used the browser on their mobile before found it easy and intuitive to use the AMT applications. The field test with these AMT applications has also shown that user acceptance is not only a question of technology and usability but at least as much a matter of enough, reliable and actual information content. This is very difficult to achieve for a single service provider. By means of the proposed Metadata Server, this task can be tackled by various information providers in a collaborative way and is therefore much easier to achieve.

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8. REFERENCES