



**Integrated Project on Interaction and Presence
in Urban Environments**

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**Initial Demonstrator of City Tales II application
“Second City”**

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Abstract

This document describes the third year of research within the WP9 CityTales subproject of IPCity. CityTales concentrates on providing mixed reality with an emphasis on a user generated content creation interface to a wide range of user groups in an urban context. The aim of the project is to create a homogeneous, self-governing mixed reality platform accessible to all city inhabitants as well as to visitors.

The specific objectives for CityTales are:

- To develop and evaluate concepts and tools for:
 - Transforming mixed reality applications into a mass market tool by familiarizing mass media users with mixed reality applications
 - Development of intuitive and easy to use user interfaces for Mixed Reality applications.
- Further advancing research into the subject of presence in mixed realities in an edutainment context by:
 - Understanding how users experience stories across the boundaries of virtuality and physicality and how different combinations of virtuality and physicality influence the perception of a story

Examining engagement and augmentation issues that are designed to support a sense of presence.

Intended Audience

This document is intended to all partners of the project, the EC and to the reviewers of the third project phase.

1 Workpackage Objectives

<p>Objectives Phase III</p>	<p>Objectives of Phase III of WP 9 were:</p> <ul style="list-style-type: none"> • research of story-telling in urban environments • development of client prototypes on mobile devices • development of story-telling database infrastructure
<p>Results Phase III</p>	<p>Starting Phase III the work package 9 was refocused to concentrate on story-telling in mixed reality environments.</p> <p>The new focus yielded a number of new investigations and developments. A number of research prototypes for mobile mixed reality clients and user interfaces have been developed or customized, based on work in the research work packages.</p>
<p>Evaluation Results Phase III</p>	<p>We gathered experience with mobile content retrieval in urban environments, investigated mobile content creation user interfaces.</p> <p>Our results suggest that users get an altered impression about the urban environments with an additional information layer. Even more they would like to become participating in the creation of the content and modify what's there.</p> <p>The Second City server architecture is a crucial element of the City Tales system as it provides the coverage and continuity of the mixed reality layer over the urban tissue. The persistence of information is a crucial element to suspend disbelief in the artificial content elements.</p>
<p>Objectives Phase IV</p>	<p>Create and evaluate the combination of the diverse, singular prototype applications.</p> <p>Test the performance of the system on a large user base to receive measurable test results.</p> <p>Create story creation toolsets that allow to use singular content elements to combine them to a mixed reality story-telling environment.</p>

2 Introduction

Mixed Reality (MR) refers to imaging technologies that seamlessly integrate the real and virtual worlds in real time. IPCity develops MR technology for practical outdoor use in urban environments, moving the technology out from the labs. Research work packages create basic technology modules and prototype applications to test certain infrastructure elements. Application work packages drive the development of the infrastructure with specific research questions needed to be answered using prototype applications that are tested with a number of users to receive feedback for analysis.

The City Tales work package (WP9) is working towards establishing a digital layer over the urban tissue of a city that contains a story telling environment based on participant's input. The power of a community driven content creation approach has been shown in many Web 2.0 applications, such as encyclopedia¹, social networking portals² and geo-information³. Our aim is to focus this power to the creation of content into the digital layer of an urban environment, supported with easy to use yet powerful tools for mixed reality content creation.

As part of our work we developed a set of applications to play back mixed reality content on commercially available mobile devices (e.g. smart-phones) to support a large user basis, to perceive location based content on-site when strolling through a city (Walking Explorer) and to get first experience on mobile content creation (Wall Blogging).

2.1 Related Work



Figure 1: Related projects

Several projects (Figure 1) investigate the possibility contained in the possibility of nowadays emerging technology to interlink locations with information. Global Positioning System (GPS) provides for most approaches the basis to locate the user's "playback device" on global scale and to provide information from a database related to this location. Games, experiences, narratives are provided and many of the existing systems also try to involve the community to introduce the content themselves. Lack of standards, diverse "playback technologies", technical pitfalls, non oriented user base however let's most of the existing systems stay in a beta-phase. Also none of the investigated systems is using the power of 3D display to create a compelling mixed reality experience.

¹ Wikipedia – The Free Encyclopaedia [www.wikipedia.org] – accessed last 19.12.2008

² e.g. Facebook [www.facebook.com] – not freely accessible; MySpace [www.myspace.com] – accessed last 19.12.2008

³ Google Earth Community [http://mw2.google.com/mw-earth-vector/db/gallery_layers/network_links/google_earth_community/google_earth_community_en.kml] – accessed last 19.12.2008

Urban Tapestries⁴ investigated the social and cultural uses and behaviors to annotate a city; Hewlett Packard runs the project mscape⁵ as a continuation of Mobile Bristol dating back to 2002 to allow participants to create games, guides, stories triggered by GPS location – currently containing about 300 “mediascapes”. MIT’s M-Views⁶ is a context sensitive mobile cinematic narrative system that enhances real world with video clips based on WiFi triggering. MIT’s Museum Without Walls Project⁷ puts history and science in the user’s hand and turns the world into a museum by adding location based information and stories to historic relevant places. The project is currently on hold due to funding issues.

A relatively new system is bliin YourLIVE!⁸ which is dedicated to creating a fluid social network for sharing personal experiences - photos, videos, sound & text - in real-time, located on a world map and focuses since 2007 directly as a Web 2.0 application on a young community with currently about 23.000 “shares”. GPS Mission⁹ is a GPS game for mobile phones where the community can create missions and riddles to other members. The last two systems are purely commercial, however all services are free so the business model behind is not obviously visible currently.

A special class of more content focused applications can be defined, such as Sonic City¹⁰ which generates a personal soundscape co-produced by physical movement, local activity, and urban ambiance. Sony’s Street Beat followed a similar approach to enhance the audio environment in a city. Landvermesser.tv¹¹ – a new Berlin art project creates fiction literature stories on real places in the city, written by 10 participating professional writers. The stories can be perceived as a combination of audio stories and video clips played on city embedded displays or on-line.

Combining existing resources and location based information in a mixed reality environment is demoed by the WikiTude¹² project that allows users of the new Android G1 phone to overlay the camera image of the user’s environment with Wikipedia entries related to the actual location of the user with a definable range. Available geo-located Wikipedia entries (around 350.000 worldwide) are represented with balloons of information over the real buildings or points of interest. Selection enables to read the attached Wikipedia entry on-line.

An interesting approach is to omit the necessity of a continuous tracking throughout the story telling domain by not relying in GPS or similar approaches, but by using discrete points of identification or tracking, e.g. 2D-markers. The method of “mobile tagging” becomes widely popular as the link between the real world and the digital content is achieved with a simple to create 2D barcode marker that is placed at an exactly defined location. As one example of the many-many we point to the Active Print¹³ project which is exploring how printed materials and digital displays can be linked to online content, services and applications in all kinds of urban/suburban/rural situations.

⁴ <http://research.urbantapestries.net/> – accessed last 19.12.2008

⁵ <http://www.mscape.com/> – accessed last 19.12.2008

⁶ Crow, D., Pan, P., Kam, L., Davenport, G., M-views: A system for location based storytelling, Proceedings of Ubiquitous Computing (Ubicomp), Seattle, Washington, October 12-15, 2003, pp 31-34.; more information available at <http://ic.media.mit.edu/projects/M-Views/>

⁷ <http://museum.mit.edu/mwow> – accessed last 19.12.2008

⁸ <http://www.bliin.com/> – accessed last 19.12.2008

⁹ <http://gpsmission.com/> – accessed last 19.12.2008

¹⁰ <http://www.tii.se/reform/projects/pps/soniccity/index.html> – accessed last 19.12.2008

¹¹ <http://landvermesser.tv/> – accessed last 19.12.2008

¹² <http://www.wikitude.org/> and <http://www.youtube.com/watch?v=8EA8xlicmT8> – accessed last 19.12.2008

¹³ <http://www.activeprint.org/> – accessed last 19.12.2008

3 City Tales Concept Map Context

Results and prototypes created in City Tales are to be evaluated using the framework of the presence concept map created in WP3. The mutual contribution of having on one hand a tool to measure presence in a powerful framework, and on the other to provide these comparable results to the general presence research for further refinement of the concept map is an ideal collaboration basis.

Based on the IPCity presence concept map we identified the core areas in which WP9 is exploring the temporal, social and ambient aspects of mixed reality enhanced urban environments (Figure 2). CityTales specifically explores temporal aspects (such as creating memories, traces of the past), transformation of a physical location over time (following a path) and ambience (sense of place). These characteristics of the urban environment are connected to other elements such as awareness cues, and the multimodality of the user experience.

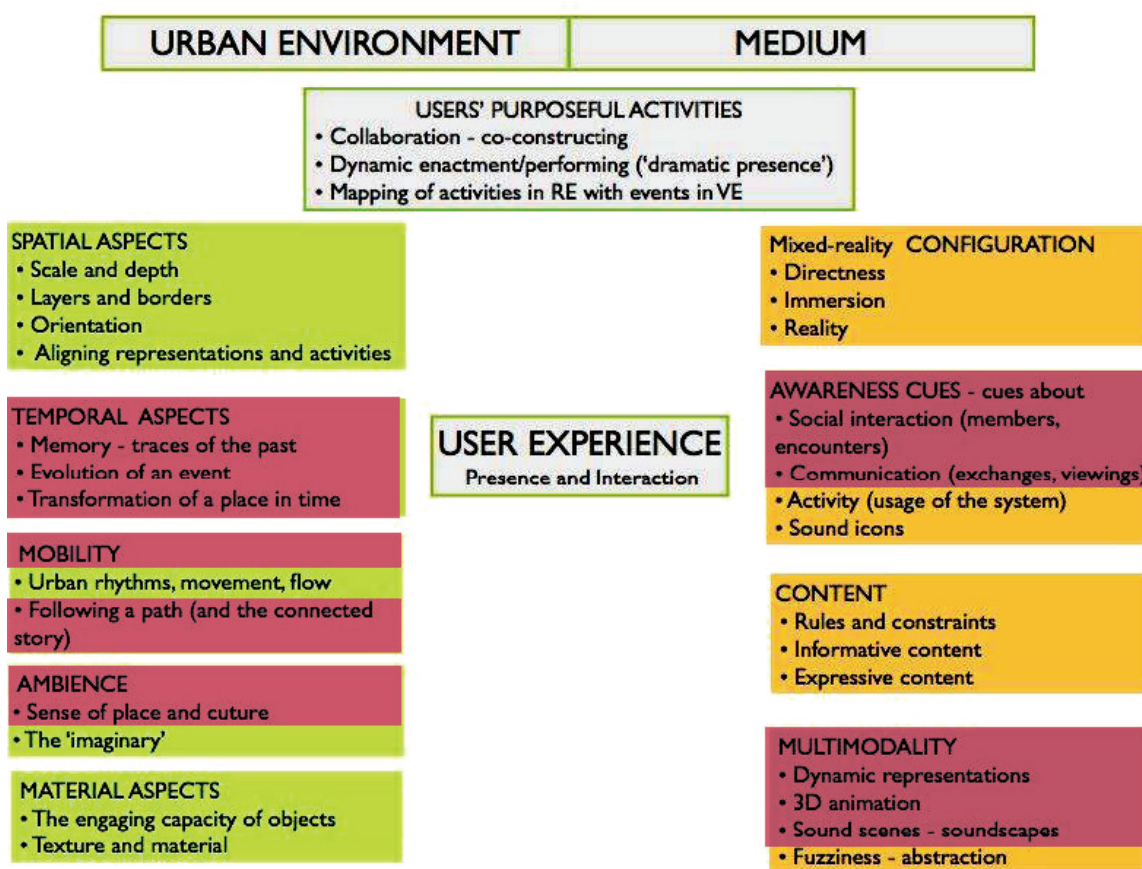


Figure 2: Concept map formulated in WP3 with WP9’s focus areas highlighted

3.1 Investigation dimensions

Formulating questions to investigate the different aspects of the concept map we could identify the most probing ones to be the basis for the evaluation process:

3.1.1 Cross-reality story experiences

Perceiving stories while on the go creates a rather new context for story-telling. The closest to this situation would be listening to a podcast or an audio-book while on the move. As we know from previous studies that a drivers attention is largely captured by various sources of distraction (e.g. mobile phone calls, audio sources, eating, small-talk) we assume that perceiving a mixed-reality story in urban environments also creates a similar distraction.

- *How are stories perceived on-site?*

If and how is the urban tissue having an influence on the story that the user perceives during the physical presence on the given spot? A basic question to all further investigations is also if the locality is altered by the additional information provided within the digital experience. Studies on user behaviour have been conducted throughout IPCity project as well as other, locations based systems.

Evaluation of the prototypes will add the experiences gained in CityTales to the common pool of knowledge how to design outdoor mixed reality experiences.

- *Do stories enrich the experience?*

An important question to the overall value of the mixed reality layer is if it can act as enrichment to the real world? As WP3 investigated the issue in detail, we will check during the evaluation if the purposeful action of users is a must in order to create an enrichment of the urban environment. We think that information in general can be valued by users of the system, should it be punctual or interwoven as part of a story line, or even just a “virtual post-it” left by another user. The fact that the user interface as gateway to the digital layer acts as a looking glass to a parallel world will raise the curiosity of the users to look for and investigate content stored in the system.

- *Which impact have diverse mixtures of real vs. virtual?*

The level of plausibility of a mixed reality setting largely relies on the level of immersion the experience can provide. In a movie the combination of visual and audio cues and the actual intensity of the story stress level have a great impact on how much a viewer is involved into the film. In location based story telling the impact is always a combination of the local surroundings, the actual situation at the time of perception of the story and the digital cues of the storyline. To reach an acceptable level of immersion and credibility of the story we assume that the digital cues must go much behind the normal level that would be necessary in a closed setting. The content of the story is competing heavily with the much stronger cues of the surroundings, so exaggeration of the story elements is a way to get attention. This induces also the question of how digital narratives can be embedded to create convincing mixed reality applications?

3.1.2 Fusion of the physical environment and digital narratives

Overlaying the real world with digital information creates additional layers to the perceived reality. As the real environment acts always as a background to all digital information in a mixed reality setting we must investigate how content can be anchored in the real world.

- *How is content attached to the real environment?*

When strolling through the environment the user must easily find, identify, be able to perceive, and interact with the digital environment. This raises the question on how the digital content is anchored in the real world. On the first level the location based aspect of the narrative elements and the story is the governing aspect of the localization. As focussing on the urban context in IPCity this geolocation is potentially a wide area that can currently be only covered with GPS measurement that provides geocoordinates of the location (more exactly WGS 84¹⁴ coordinates of the actual

¹⁴ See "National Imagery and Mapping Agency Technical Report 8350.2", Third Edition [<http://earth-info.nga.mil/GandG/publications/tr8350.2/wgs84fin.pdf>] for detailed description of the WGS 84 coordinate system or http://en.wikipedia.org/wiki/World_Geodetic_System for an introductory overview.

location). To organize content CityTales choose the 3D geocoordinates of a location (latitude, longitude and altitude) to enhance the real world with additional content. The assumption that we make during the development of the CityTales demonstrators is that we can convert any additional tracking input to the same coordinate reference system. Sensor fusion on this level allows to abstract the coordinate input of the client device on a general level, all hybrid sensor inputs deliver the same coordinate reference with different levels of reliability and precision.

Any content that is brought in by the users on first level will be geolocated should it happen either on site or using a remote authoring method with the help of a digital map of the actual location.

- *Is 'shared blogging' a feasible method to relate content to other's input?*

Another interesting method to anchor content inside the digital part of the mixed reality experience is to relate – i.e. attach – the new input to someone else's contribution. This method is somewhat similar to the technology of hyperlinks in a document; the difference is that the content attached with this method will inherit the first contributions geolocation coordinates. This method assures that the chain of interlinked inputs will still relate to the original location. Cross references to other locations or locationless content can be still achieved using hyperlinking methods. Whether and how to present these links in the mobile application; this can be a further field of investigation.

- *Is geolocation only a feasible approach to store content?*

When researching the above methods of interlinking and attaching of content elements by these simple methods the issue of creating information clutter becomes quickly immanent. Co-location of information can create difficulties on the perception of the information. Either runtime methods will be needed in the content representation or other methods of filtering multiple information layers. Our approach to overcome this future problem is to tag content elements with meta-information that will help the users to filter out relevant information not only based on the geolocation.

- *What are temporal aspects in the City Tales system?*

Information has multiple layers of relation to time. Information is created at a certain time, the topic covered by this information can be attached to a certain point or period in time, and the content representing this information is perceived at a different time.

This fact raises the question how to handle the temporal issue in a shared mixed-reality content creation environment such as City Tales? To be able to access this issue our database design – see chapter 6.2 – is considering the time of creation and an additional, user definable time of content contributed.

For the user the perception of the story and the immersion to the digital narrative time plays an important role. On the client side we aim for an easy to understand interface to manipulate the time period to filter available information. This allows the user control of the experience to put herself or himself into a different period of time (i.e. perceive content elements of the same location at a different time of day or year).

Rich content environments with multiple layers of time are required to investigate this aspect of the system during the runtime of the IPCity project in detail, however we see the practical problems involved in the creation of all this multi-layer content. Thus if the user created content allows we will focus on evaluating if and how the time represented by the content is influencing the user experience.

3.1.3 Awareness of users in a shared system

Multi-user systems per default create situations where users can simultaneously participate in the functionality of the system. Methods and case-by-case handling of situations is necessary in order to prepare the most apparent cases. Other situations must be learned in the evaluation phase as we cannot predict all possible situations in this highly complex system of interactions.

An important issue is that participants of City Tales remain during the participation of the mixed reality experience still part of the real urban environment as pedestrians. This assures that social communication channels are still open and allow to interact with other participating and non-participating persons. City Tales thus will only focus on user representations and communication issues where participating persons are not in reach due to distance in space or time.

- *Being aware of other users, how?*

Collaboration with other users in a location based system like City Tales requires knowing whether they are on-line participating and what is their current location. These two – temporal and spatial – coincidences allow interacting with others in the real environment, to share information, or simply to meet for a chat.

How can other users be represented in the system, and how is this feedback to all participating users. The City Tales database system is aware of each participant currently connected to the system – see chapter 6.2. Depending on the implementation of their client, users position updates can be transmitted to the server on regular intervals to keep an up-to-date information or based on the requests they send to the server. This is a more sparse update of their position, but allows for a more efficient communication between client and server. The location updates are shared amongst all other users in form of a representation on the surrounding map.

- *How can users exchange information?*

Seeing others representations raises naturally the question for communication between users. Participating users of the system can of course walk up to each other in order to meet and talk directly to each other. But remote communication and communication with others at different times participating will require mechanisms to share information. Leaving messages in form of content is always a form of communication over time. This is one of the basic tasks of City Tales, so we will not further investigate this, as this mechanism will work naturally by perceiving other user's inputs and reacting on it.

Sending messages to other users participating at the same time was however an issue to consider. We found a very simple mechanism which is inherent to the City Tales system: When contributing content to the system the contributing author can decide at which geolocation to position the content. This is very similar to the method of entering the relevant time period to which the submitted content is related to. Submitting content to another participating user's location will allow building up content chains between them.

- *Is personalization an issue in City Tales?*

Much like other shared systems City Tales has to cope with the issue of personal vs. public information, anonymous vs. personalized representation of the user's contribution and the representation of the person at runtime.

Being a research system at the moment all users are "friendly" users. To bring the system to real world applications however we think this issue can be crucial. We will pay special attention to this problem during our evaluation and testing with the "friendly" users in order to gain experience with privacy issues in this environment as there is little or no previous experience in this field around.

3.1.4 Alternative city spaces

Participants in a community created environment benefit from the stored content in an equal way as in most on-line communities content can be equally accessed by every user. But how is the distribution of “contributing creators” vs. “perceiving only users”? How to measure this in order to get real results? Recent examples have shown that the conclusions drawn based on statistical analysis of the access data to such systems highly depend on the methods of measurement method and the interpretation of the data. In the case of Wikipedia one internal study yielded the result that 2% of the users contribute more than 75% of the article edits and basically ~1.400 persons are creating most of what is known as Wikipedia English version (2006). A new study¹⁵ taking into account the amount of information entered by the contributors came to a completely contrary result by showing that most articles are created by not even registered editors, who never or seldom update their contribution. The inner core of the Wikipedia community takes then care about the form, layout, etc. of the sole contributor’s input, ensuring by this the continuous quality fitting the accepted Wikipedia guidelines.

- *Which user group will be more perceiving and more creating?*

Without large scale studies and a large user group we cannot tell. The natural assumption is that the relation contributors vs. preceptors will not be equal, that more users will be passive participating in the system, while a small group of users will create more elements. Looking at the above mentioned result however it is hard to predict if this situation does not overturn into more creators. We plan to investigate also to learn if there is a characteristic pattern in the type of users who extensively contribute or not. If yes, how can we transfer these users’s ability or strive to other participants of the mixed reality experience?

¹⁵ <http://www.aaronsw.com/weblog/whowriteswikipedia> – accessed last 19.12.2008

4 City Tales Usability and Technical Issues

4.1.1 Cross-reality content conversion

When rolling out a wide-area community system – as we envision City Tales could become – one has to investigate the aspect of diverse platforms the client must run on. Not only differ platforms in technical terms of operating systems (e.g. different versions of Symbian, Windows Mobile, iPhone, Android on mobile phones, and flavors of Windows and Linux on UMPCs - to name a few) but also the capabilities involved within these mobile units are different. Cameras have a poor quality providing insufficient resolution and/or update rate; the built-in processor of the mobile platforms is getting faster with each generation, however lags still behind the most simple desktop computing power; and user interfaces (buttons, touch- and multi-touch screens, pen-based input) diversifies the range of possibilities further. This is one of the main reasons why no current mobile application can be acknowledged as major breakthrough – simply because the user base cannot reach a significant level beyond a well defined (mostly geek) community.

- *How can content be delivered to different devices & UIs?*

IPCity as a research project cannot and will not solve this problem in general, however we can deliver experiences gained during our experiments back to the project partners and the community who develops mobile applications in general. With our background in mobile application development are conducting development under Windows and Windows Mobile, porting APIs, applications also to Symbian and recently iPhone.

As the different platforms define their own guidelines how application developers must create interface elements, the best rule of thumb is to follow these on the different platforms. This naturally creates an overhead, but largely influences the usability on the given platform, as users will face familiar interface metaphors and user interface elements (such as soft buttons, icons, in/output-fields). This creates different flavours of the application, however the basic principle of a mixed-reality setting remains equal.

The actual user interface of the City Tales client is currently highly dynamic and is modified up to the diverse functionalities supported. Also as described later in this document different implementations exist currently for different sub-tasks. Unification of these and the accompanying fusion of the user interface is a task for the next phase of the City Tales work package.

One method to ease the content delivery problem was to break down all content communicated to one common standard protocol. See chapter 6.2 on this in more detail.

Further challenges in this context are questions: What are general UI design guidelines for MR interfaces? To which extent can users be involved into UI creation? Which processes or metaphors are suitable? Answers to these questions are investigated in the technology work packages WP4 and WP5. WP9 will contribute to this research by providing its own findings on these questions.

- *Which content media formats should be supported?*

Content delivery in terms of protocols and file formats can be largely unified as most modern accepted and de-facto standards are supported by the mobile devices for text, rich text (HTML), image, and audio transfer. Problems arise when one is incorporating more complex multimedia content such as video or Adobe flash, due to differences in the support for diverse codes, versions, and feature sub-sets. When taking into account 3D and dynamic 3D content the standards are even weaker, here we follow the rule to use standards accepted within the IPCity framework, such as Morgan and Studierstube SceneGraph.

Following media types are currently supported by the different demonstrators:

- text – user entered text
- image – JPG and PNG pictures (e.g. taken with the built-in camera)
- audio – MP3 audio files
- video – 3GP compression
- 3D content – Studierstube Scenegraph (StbSG)

As the framework of the server architecture permits the storage, organisation and distribution of arbitrary content element types we also foresee in future to add support for Morgan, which includes Morgan Behaviour Script File and X3D 3D content.

4.1.2 Quality of content

An important question already touched previously is the quality and quantity of the content contributed by the community. Following issues we considered to investigate during WP9 activities:

- *How will the MR environment evolve with user generated content (Wikipedia effect)?*

The possibility of entering arbitrary content to a shared open community system is opening the gates to meaningful content to be shared within the community but also to vandalism and abuse of the systems capabilities. Normally such systems are regulated by social conventions, hierarchical peer reviewing communities, moderation or simple censorship in accordance to the terms of use of such platforms.

One can hardly predict the evolution of the community behaviour as different examples in the past exist to create and preserve a quality level in open contribution environments. So this question will remain an open that we can report on when a significant number of users entered content into the system.

- *How can quality of content be measured?*

Decision on what is to be considered as valuable or garbage is very hard, especially in a social networking community. As the value of information can be very subjective based on the purpose of the storage, we cannot decide and govern in the prototyping phase on the quality of content. Measures can only be defined in relation to the purposeful activities of the participants to the system. So we must decide on a case-by-case basis to introduce a content quality measure and can evaluate this against our previously laid out assumptions.

- *Is manual or automated revision and organization of content needed?*

This question tightly relates to the above described hard to predict situation, manual revision can be one method to handle abuses of the system.

4.1.3 Cross-reality authoring tools for narratives

From a technical point of view, enabling presence and experience in mixed reality environments requires a multi-layer approach. Firstly, providing the general infrastructure (hardware and software) and services to realize MR systems is a basic requirement. Secondly, the provision of higher-level tools for authoring MR environments and supporting the realization of MR user interfaces. As third step the development of the actual MR application including application-specific features and tools must be considered. Figure 3 further clarifies the concept between the various building blocks of MR technology and gives an overview of interconnections between the developed tools and senses and sensations of presence.

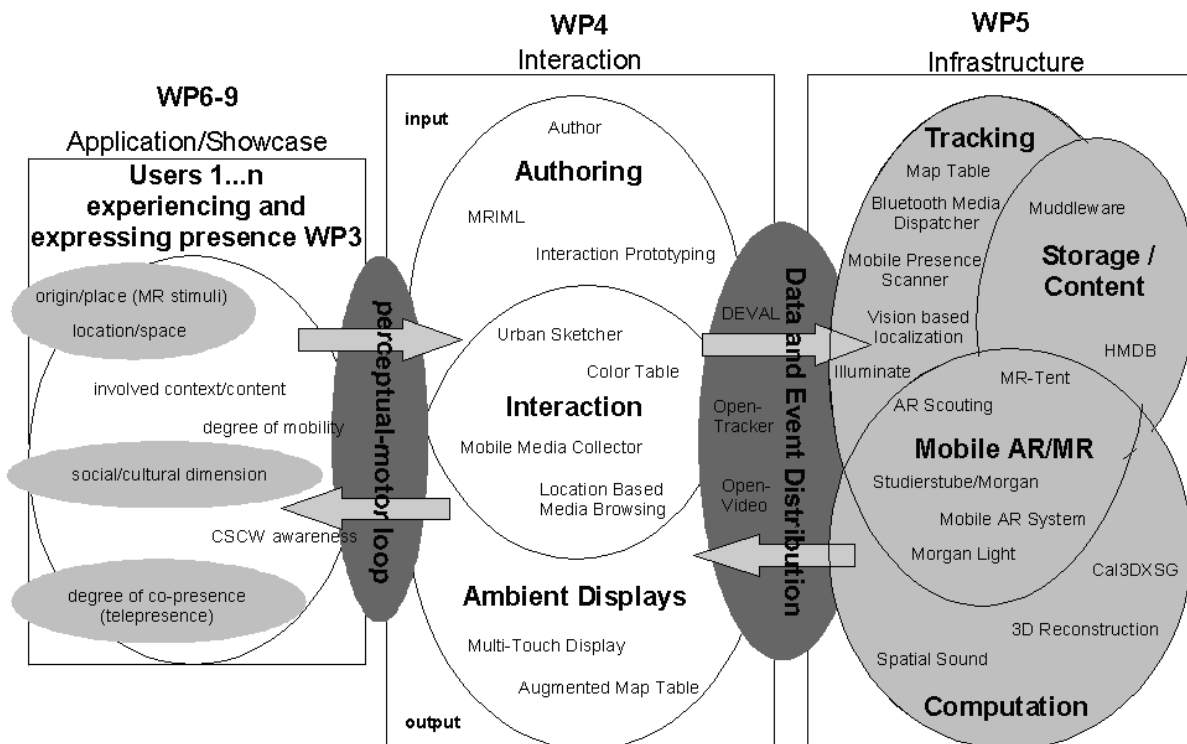


Figure 3: Flow of information in the application of IPCity. A conventional human-computer interaction loop demonstrates that users, interaction tools and infrastructure each have very complex aspects that need to be orchestrated in order to support Mixed Reality co-presence

- *Which tools help non-experts to tell multi-sensory, location based stories?*

Within the above framework authoring of digital narratives beyond the authoring of singular content elements is not covered in detail. Our approach of letting users create punctual content elements on the go and provide a higher level interface as remote authoring capability is a complex – yet to be tested method. Currently the diverse prototypes provide exploration and content contribution; the higher level content authoring methods are to be implemented in the next phase.

5 Target Investigation Area Selection

To set-up the prototype installation of Second City with a good combination of content and a potentially mixed user-base we were looking for a test region that allows us to investigate different aspects of the system, yet which allows to draw general conclusions valid beyond this area.

5.1 Considerations

Aspects that played a role in territory identification:

- *Rich content already available*: if we can build the system based on existing stories in the beginning this will help to create a basic layer of information and stories. We looked for a place with current, historical, and eventually so called “local stories” – stories that are known city-wide involving local urban people.
- *Living place all year*: a place that is filled at all times during the year allows to follow our research interests throughout the year and is a guarantee for many potential users. Especially if attractions exist in the target region one can rely on the availability of public.
- *Crossroad of many interests*: urban places integrating multiple functions in a city provide a mixed urban public. This can be a key issue for the diversification of participants.
- *Dynamic urban area & long-term historic context*: as the previous two points suggest such a place would be a dynamic urban area in the sense of presence of people. We also look for a place that has a dynamics in time – it has a historic context that is also changing rapidly so we have an interesting temporal dimension of the place.
- *Role in city history/context*: a place that is far-off the pulsating heart of a city might be not as important to the general city context compared to a place that is central. Such an integration with the neighboring regions and the city as a whole is an important measure to evaluate a place’s significance to the urban context. We are tendentiously looking for a well networked place in order to see the flow of information in and out to the target region.
- *Open space*: from a technical point-of-view a more open space is a better starting prerequisite to use urban position tracking methods. Both GPS and other positioning methods can provide higher accuracy results in more open spaces than cluttered, high-rise areas with reflection and shadowing problems of the used tracking signals.
- *Easy to reach*: A practical approach is to use an area that is close to us and allows for frequent on site-tests easily.

After considering the above selection preferences we identified the area called Naschmarkt as the ideal test region. The map depicted in Figure 4 shows the approximately marked target area that extends beyond the actual market area, which is denoted Naschmarkt. Red stars mark the offices of Imagination (upper left) and the Technical University of Vienna (middle right). Also UniAK is approximately apart the same distance to the east from the Nashmarkt as Imagination is.



Figure 4: The target area of Naschmarkt marked yellow on the partial satellite map of Vienna city centre

5.2 Naschmarkt



Figure 5: Naschmarkt view

The Naschmarkt (Figure 5) is Vienna's most popular market. Located at the Wienzeile over the Wien River it is about 1,5 kilometers long.

The Naschmarkt has existed since the 16th century when mainly milk bottles were sold (As Milk Bottles were made out of Ash (Wood from an Ash-Tree), "Asch" (English for "Ash") led to the name "Aschenmarkt"). From 1793 onwards, all fruits and vegetables brought to Vienna with carts had to be sold here, while goods arriving on the Danube were sold elsewhere.

Nowadays, you can buy fresh fruit and vegetables from around the world, exotic herbs, cheese, baked goods such as bread, Kaiser rolls, and torte, meats, and seafood. There are also a lot of small restaurants which offer e.g. sushi, kebab, fish, seafood, traditional Viennese food such as Kaiserschmarrn or Palatschinken and stalls which offer clothes and accessories. Since 1977, the market extends further along the Wienzeile to an adjacent area every Saturday, when a flea market takes place there.

The unique atmosphere of the Naschmarkt is famous far beyond the borders of Vienna, and large numbers of tourists visit the market every year.

5.3 Urban Strategies Workshop on Naschmarkt

In order to investigate Second City on a conceptual level and its potential within urban strategies we decided to work on questions concerning the collection and distribution of information about the city with UniAk's and its postgraduate students from Urban Strategies. For our collaboration in WP9 we decided to focus on the following key questions:

- What kind of information can be collected and what is the respective media to store and visualize it?
- How does objective information of the city (map space) relate to individual perceptions and experiences (perceptual space)?
- What kind of inscribed rules within the cities fabric and mechanism has effect on how people perceive, use and navigate the city?

After a presentation of the concept and future technologies of Second City at UniAk the postgraduate students investigated the Naschmarkt and its surrounding. For various kinds of information we defined six main topics on which the students should focus.

- Urban zoning and building code: the statutory regulations of the Naschmarkt territory
- History, typology and morphology: the physical appearance of the market and its surrounding
- Infrastructure and locomotion: the connectivity of the market territory to the city
- Users behaviour: different behaviours of various user groups
- Uses of stalls: the actual function, supply and demand
- Temporary uses: emerging phenomena of other functions

In groups of two, students mapped the particular information by using different kinds of methods to collect information. Beside spending several hours on different days of the week on Naschmarkt students and documenting their observations with photographs, films and notes (written and sketched) they also researched the internet and libraries. This step also generated a huge set of initial data for the Second City database that is built up continuously. Some of them also tried to ground their findings with interviews. After two internal reviews with UniAk the mapping projects were presented and discussed with Imagination. Apart from the density of information the students gathered within the short time it was interesting to see how the findings were visualized on the plots. We particularly discussed the re-arrangement and connection of information of space and time and how to navigate the two dimensional *paper-scape*.

The topic of urban zoning and building code was investigated at different levels. Whereas the stalls underlie building codes and preservation, occupation of territories relate to temporary spatial extension for display of commodities and rent for stalls and stands. For this topic it seemed to be challenging to find adequate ways of representation, since most of the information strongly relate to abstract numbers at first hand which are then reflected in space in variety of ways. The mixture of map, diagrams, photographs and texts blocks the students chose, turned out to be partially confusing (Figure 6).

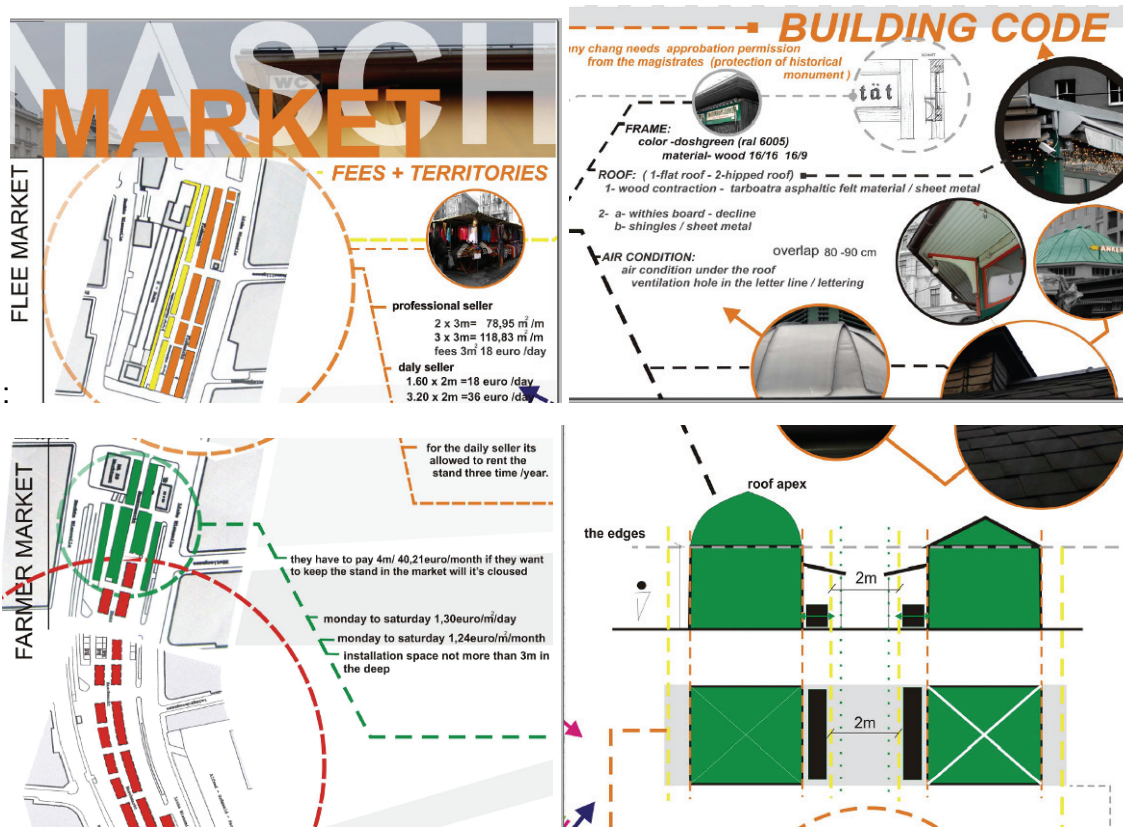


Figure 6: urban zoning and building codes

A combination of photographs, architectural drawings and diagrams related to the physical appearance and typology of stalls was more successful, since the student decided to analyse a specific street view of the Naschmarkt according to the daily and weekly cycle (Figure 7).

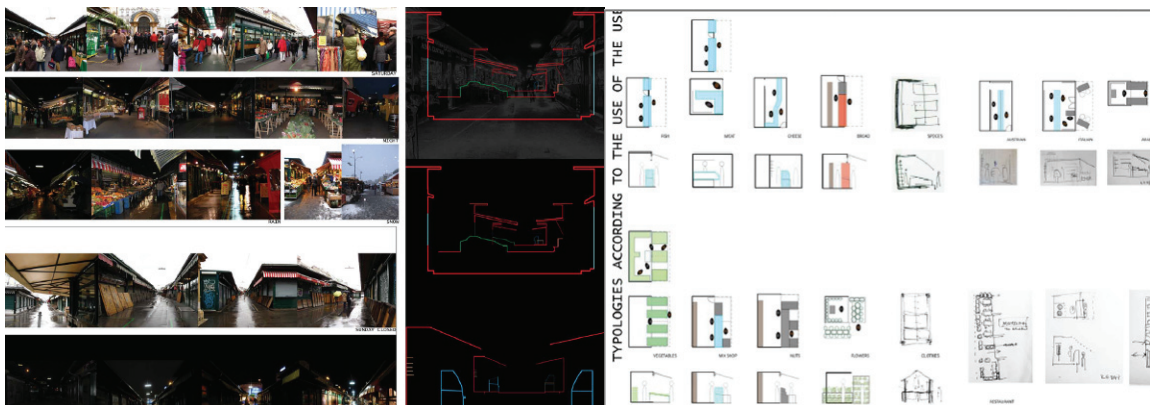


Figure 7: physical appearances of the stalls during different times of the week, typology of stalls

Students that investigate infrastructure and locomotion found out, that transversal crossing of the Naschmarkt territory is strongly affected by the two adjacent arterial roads, and the way how alleys through the Naschmarkt are programmed during different daytimes. As a notation method the Students invented a speed-analysis and measured the time that is needed to cross the Naschmarkt and reach the other side of the road. For analysis of the broader connectivity the students literally walked around the area of Naschmarkt and documented obstacles (Figure 8).

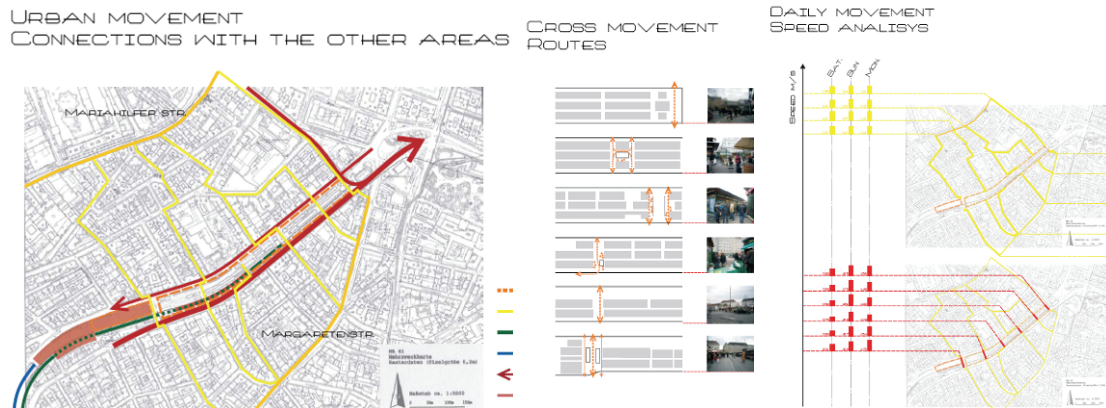


Figure 8: traffic flow and transversal crossing of the territory at different times

User's behaviours were measured in a similar way. In order to map the different behaviours of various user groups the students followed single persons during their way through Naschmarkt and documented paths and activities on a map. In this way they already simulated working with a tracking device (Figure 9).

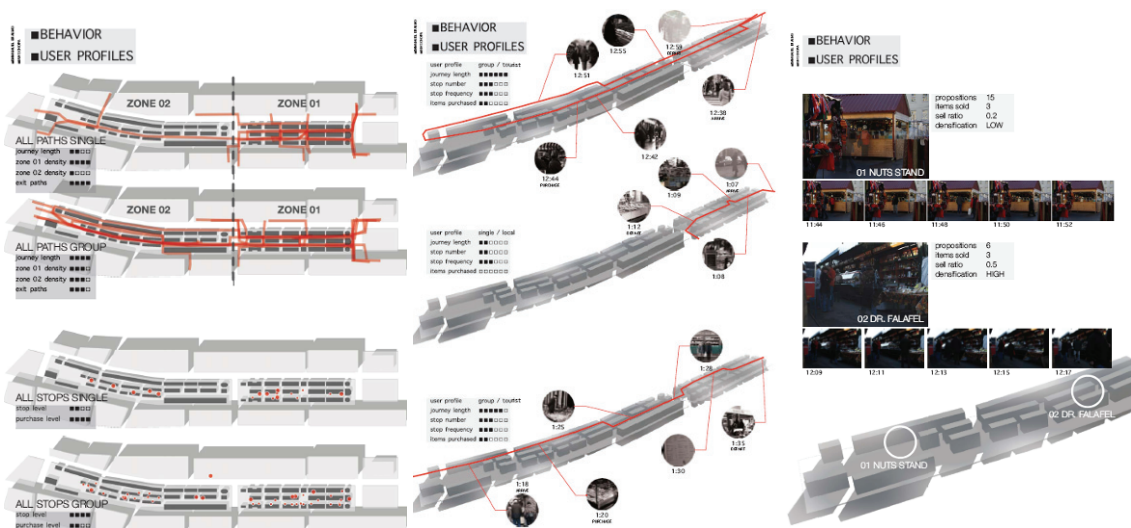


Figure 9: user behavior: paths of users, destinations and activities

Documenting the uses of Naschmarkt resulted in an abstract layout with a colour-code to describe the distribution of functions. The sequence of diagrams shows the mixing of programs from 1912 up to now. Whereas the diagram of the earlier days show a large part of the market being occupied by butchers (orange) the Naschmarkt now shows a varicoloured pattern of different uses which is difficult to read (Figure 10).



Figure 10 : changes of distribution of uses since 1912 and actual interrelations of owners

The investigation in temporary occupancy turned out to be an interesting topic to interlink programmatic, spatial and infrastructural aspects with user behaviour. The students defined different types of temporary uses, such as the occupation of vertical surfaces with posters and graffiti, furniture and mobile garbage bins and `invisible territories` that are caused by light or mountebanks (Figure 11).

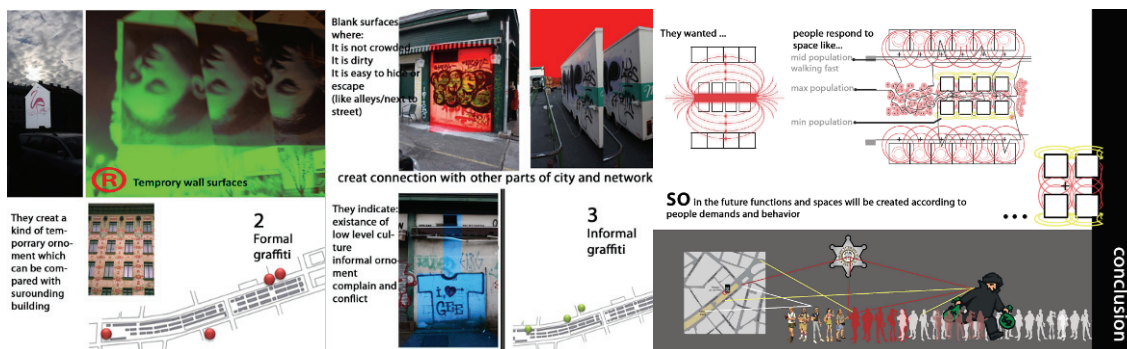


Figure 11: occupation of surfaces within the Naschmarkt and how it affects the uses of spaces

These issues raised a vivid discussion among all students about their individual experiences during their Naschmarkt strolls. Together they defined hot spots like general meeting points or a famous Kebab Stand.

For future work we plan to integrate the mobile devices into the students mapping strategies and to further investigate the notion of strolling in the city. Based on the results of these studies we assume to have a better understanding and analysis to user's behaviour using the Second City system as we created a comparison base for the non-digital city.

6 Year 3 Demonstrators

6.1 Overview

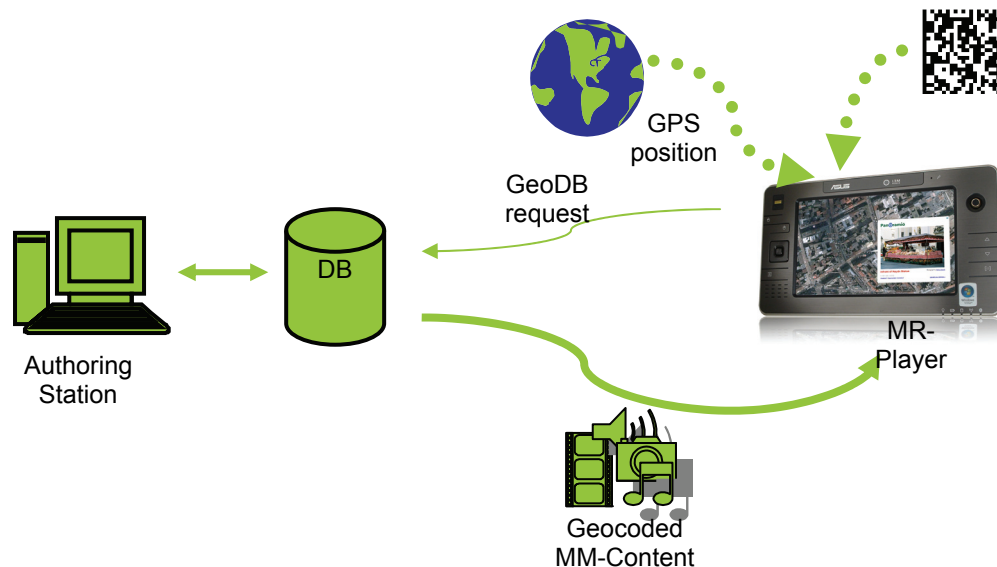


Figure 12: Simplified system overview diagram of the Second City distributed system

The application Work Package 9 of IPCity integrates components of the research work packages to deliver a high quality user experience. To provide a continuously available and right to the needs shaped test bed to the presence related user tests we built a system framework (Figure 12) consisting of a database server containing geo-coded multi-media data and client applications built from modules of the research work packages.

6.2 Second City Database

Initially we investigated HMDB to store media elements for our City Tales approach. The hierarchical structure of the HMDB puts the hierarchy of the media elements into the foreground and by meta-information added we would have had the possibility to add certain functionality to it.

But on progress in the design we also noticed that we need user management, geolocation and time based queries, etc. The largest step towards a new database was however our internal decision to use KML as the major communication protocol to both export AND import data into the database. One simple reason for that was to be compatible with "clients" like GoogleEarth that allows both retrieving, browsing of all data now contained in the DB but also provides a (simple) content creation tool in the same moment.

6.2.1 Description

The decision was to develop and setup a new database to be provided also as service to all IPCity partners. We installed a dedicated server that can hold all types of (mime-typed) data files that are stored in geocoded indices. The server does validation of uploaded (KML or any type of XML) files against freely definable schemas. Upload and download is running using standard HTTP protocol to ease integration and provide access with a wide number of clients.

Automatic features provide package upload/download mechanism (ZIP compacted archives, like KMZ) in order to keep track also of the media files referenced inside a KML document. The server is built in order to allow also extensions to KML (which we need in IPCity, such as sound). We have a user management in the system that allows multi-user content creation and manipulation.

The dedicated server will be put to a public reachable IP in the internet, so any IPCity partner is invited to use the service then. We see also a chance that content of other IPCity prototype applications and demonstrators is stored in our database compared to the current situation of storing them in several dislocated and separated databases. Our idea was to demonstrate the possibility of combing different work packages also on the content level in order to provide a common view on data.

6.2.2 Technical Specification

Hardware and OS	<ul style="list-style-type: none"> ▪ Intel Based PC Platform ▪ SUSE Linux 11
Software	<ul style="list-style-type: none"> ▪ MySQL DataBase Server ▪ Apache TomCat 5.5
Core Features	<ul style="list-style-type: none"> ▪ Multimedia content database ▪ Geolocated indexing of content ▪ User Management ▪ KML import/export ▪ XML schema checking
Status	Stable prototype
Intended users	> 10, content providers, story authors
Test users	~ 10
Research Workpackages	
Relevance Beyond Project	Stable community server for geo-located content. Flexible and extendible and support further functions and request types.

6.2.3 Testing / Evaluation

The database is currently filled up with the target region specific data. Date interfaces and user interfaces are under development to ease the work with the database. Currently externally authored KML elements and KMZ archives (combination of KML description and media files) can be uploaded using a web-based HTML interface that is generated using Java in TomCat.

The download of data is achieved using HTTP requests with encoded database lookup parameters. Clients have to build the request string that is sent over HTTP protocol by themselves. The database supports connections directly from GoogleEarth¹⁶ client using Network Connection nodes. This provides real-time database updates and allows fast access to the data, which is crucial during the remote authoring process of stories.

¹⁶ Google Earth is a 3D Map and Satellite Data Viewer integrating multimedia information and 3D content integrated with the visualization of the Earth's surface. More at <http://earth.google.com/> – accessed last 19.12.2008.

6.3 MR Player

The MR-Player client application builds the bridge between the tracking technologies, establishes the basic communication with the Second City database, and performs display of content. It supports the dynamic retrieval, download and playback of multimedia content associated with geo-coordinates and/or fiducial markers (2D barcodes) on various mobile devices such as cell phones, PDAs and UMPCs. The MR Player client is a cross-platform application targeted at mobile platforms, which is capable of recognizing 2D barcode markers in various visual forms such as 2D barcodes, iconic symbols by employing advanced computer vision techniques.

6.3.1 Description

The core module is using Studierstube Tracker to decode the camera image and register the marker and Studierstube ES framework to render 3D content. Identification data read from the marker is used to generate the HTTP request to the database. Data is requested from the database as a description XML document and associated media files, such as images, sound-files, videos, and 3d geometry objects. For the download available network connections such as WiFi, GPRS or HSDPA can be used, depending on the capabilities of the hardware. Figure 13 and Figure 14 show the application during set-up and use.

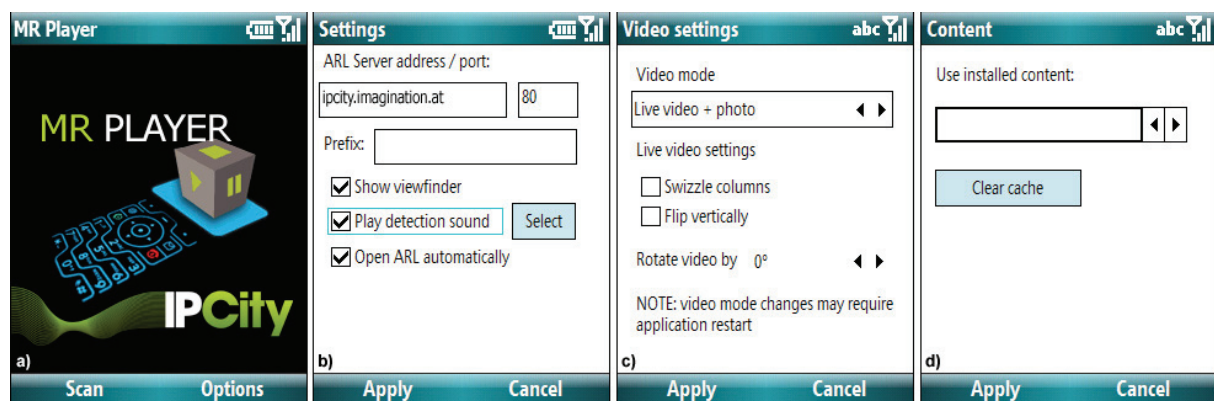


Figure 13: Setup screens of the MR-Player application in Windows Mobile 6 environment



Figure 14: Screenshots of the MR-Player application in use:
 a) User points the camera at a visual marker. b) Content is downloaded from the server.
 c) Video playback. d) 3D geometry presented overlaid onto the marker.

6.3.2 Technical Specification

Hardware and OS	<ul style="list-style-type: none"> ▪ Windows Mobile 6 mobile phones ▪ UMPC / WinXP compilation TBD
Software	<ul style="list-style-type: none"> ▪ Studierstube Tracker ▪ Studierstube ES ▪ MR-Player Application
Core Features	<ul style="list-style-type: none"> ▪ 2D Marker recognition and decoding ▪ Content retrieval over network
Status	stable prototype
Intended users	Intermediate prototype to be integrated with walking explorer
Test users	3
Research Workpackages	WP5
Relevance Beyond Project	MR Player can be an isolated application to retrieve content from the Second City database, based on IDs or so called ARL (Augmented Reality URLs).

6.3.3 Testing / Evaluation

MR-Player implementation has been integrated and tested with various Windows Mobile phones. The current implementation only employs the built-in camera of the mobile phone for the identification and tracking of the visual marker. The application has been tested with colleagues in order to test the ease of use. As the interaction only requires basic operation of the phone itself and additionally uses only one metaphor – namely to hold the red targeting frame against the visual markers – operation of the application has been turned out to be straight forward.

In the current implementation the marker encodes a direct index in the database. This is somewhat cumbersome during the set-up as the indices have to be manually paired with the content elements during the database authoring step. We think that this method is not feasible for a content creation process to be achieved by non-professional users. An automatic marker generation and printout interface is required to ease this step.

6.3.4 Future steps

The implementation of the MR-Player application was necessary to test-run the server based content retrieval based on HTTP request sent from mobile devices over wireless networks. This basic functionality allows providing extendible content of theoretically arbitrary amount that is expected to be injected by the users. Also the MR-Player is a testing interface to the Second City Database architecture.

In accordance with the work in the basic research work packages we are looking for an abstraction of the tracking problem, to overcome limitations and performance issues of one method with the help of other tracking methodologies. This sensor fusion helps to provide a robust and continuous tracking throughout the whole experience area.

As next steps we are integrating the capabilities of MR-Player with the below described Walking Explorer. This combination of the GPS based localization and information delivery based on position with the marker based localization and id based content placement can deliver a higher level and more exact experience to urban environments as one system only.

6.4 Walking Explorer

On the search of the optimal “Walking Explorer” implementation platform we were investigating a number of commercially available UMPC, PDA and mobile phone platforms (Figure 15). As our requirements involve a large number of participating/testing users on one hand we needed a platform that can be affordable also in quantities in order to reach a significant number of participants, on the other hand looking at future devices we needed a list of functionality that is not easily available on current mobile computing hardware. These included:

- GPS receiver for localization, if possible with AGPS extension
- WiFi connection for localization and wireless network connection
- GPRS or HSDPA network connection for wide-area network connection (flatrate!)
- Built-in high quality camera
- Sun-readable display
- Speaker to play-back sound
- Built-in microphone to record voice notes or urban noise
- Bluetooth wireless connection to connect auxiliary hardware such as a headset
- Powerful processor for computer vision algorithms and graphics rendering
- Good battery lifetime for an extended mobile use in urban environments
- Keyboard for text input – to be evaluated if desired by users in mobile setting
- additional sensors (i.e. acceleration, compass, etc.) to test improvement possibilities of tracking fusion

Current mobile phones facilitate above requirements only partially, a few come up with the complete list. On the other hand most UMPCs are cumbersome or require additional cabling for some of the above listed peripheral.



Figure 15: Some contenders during the search for the optimal mobile companion

Finally we settled with two platforms that are used in most cases as prototype platforms to run our tests and studies with: the ASUS-R2E UMPC platform and ETEN glofiish M800 Windows Mobile phone depicted in Figure 16. See the comparison of features of these devices in the table below:

Device	ASUS-R2E	ETEN Glofiish M800
GPS receiver	Yes with integrated and optional external antenna	SIRF Star III Instant fix
WiFi	IEEE 802.11 b/g	IEEE 802.11 b/g
Mobile networking	None (in some regions 3G network interface built-in)	HSDPA/UMTS, QuadBand GSM, GPRS class 10
Built-in camera	Only LQ user facing webcam, additional USB-camera used for tests	2.0 Mpixel CMOS
Sun-readable display	7" 800x480 active matrix LCD	2,8" 640x480 TFT-LCD
Speaker	Yes	Yes
Built-in microphone	Yes	Yes
Bluetooth	BT v2.0	BT v2.0 class 2 + EDR
Powerful processor	Intel A110 (stealey) – 800MHz	Samsung S3C2442 – 500 MHz
Battery	3000mAh, longtime battery 6860mAh	LiPolymer 1530 mAh
Keyboard	none (external foldable USB keyboard option)	Sliding backlit
Additional sensors	fingerprint scanner	none
Weight	830g [960g with longtime battery]	178g



Figure 16: ASUS-R2E UMPC and ETEN glofiish M800 mobile phone (left to right)

6.4.1 Description

As first implementation of the “Walking Explorer” set-up – that allows users to stroll through the city and perceive location based information additionally to the real world environment – we created an implementation with the ASUS R2E. In this configuration we combined the GPS reading of built-in GPS device and the Google Earth v4.x client to create automatic updates of the surroundings with satellite map data fetched through an open network connection and additional layers of information stored both in the Google Earth database and Second City database. This additional layer of information includes multimedia information (pictures, text, video clips) localized on the map and marked with placemarks. Due to the automatic following of the map to the users’s current position the user doesn’t have to care about the device more than select the represented placemarks to reveal the information contained in the database to this spot. As our model of ASUS R2E does not have built-in wireless network other than WiFi, an external phone was used to establish network connection.

6.4.2 Technical Specification

Hardware and OS	<ul style="list-style-type: none"> ▪ ASUS R2E [details see above] ▪ Windows Vista Professional
Software	<ul style="list-style-type: none"> ▪ Google Earth v4.x ▪ Franson GPS ▪ Configuration scripts
Core Features	<ul style="list-style-type: none"> ▪ Automated following of user and retrieval of location specific satellite map data with additional information layers
Status	Beta prototype
Intended users	City Tales test subjects
Test users	~3
Research Workpackages	
Relevance Beyond Project	Easy to use content browsing application with map support for birds-eye-view representation of surroundings.

6.4.3 Testing / Evaluation

Initial results show that the additional information layer is an enrichment of the experience when on-site. The accessibility of “background” information about the location of walk is an experience that suggest users the existence of a digital information layer “above” the city. The amount of information and the level of how much this information is interwoven with the urban environment creates the level of acceptance. More detailed user testing with a larger number of test users, supported with a questionnaire is planned to provide more detailed information on the level of acceptance of the digital layer.

The “Walking Explorer” implementation is one basis of the next level of the Second City client application that will combine multiple tracker input and more diverse mixed reality content.

6.5 Mobile Content Creator – “Wall Blogging”

As a first step towards the mobile creation of mixed reality content we created the first prototype of a content creation tool that allows users to create and place content into the 3D environment using a mobile phone. The preliminary tool will be tested with a small user group to gain first impressions and comments on interface design and user feedback with this type of tools.

6.5.1 Description

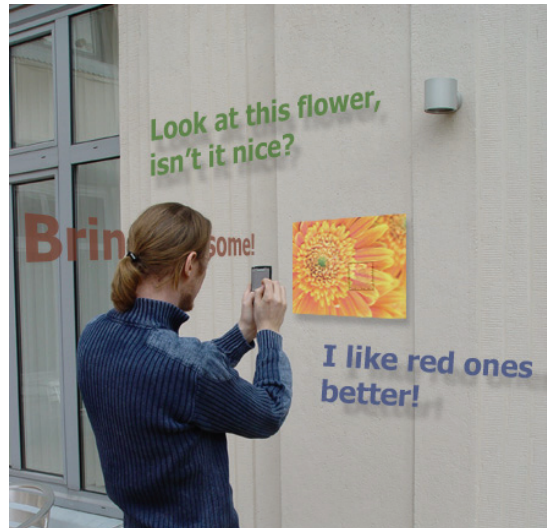


Figure 17: Wall Blogging application to retrieve and place content elements in a mixed reality environment [above picture is a visualization of the mixed reality environment perceived using the mobile phone]

We implemented a “Wall Blogging” application shown in Figure 17 in a visualization and in Figure 18 in use, running on Windows Mobile 6 and based on the Studierstube ES SDK. The application allows the user to hold the phone camera against a 2D marker (mounted on a wall) and see a 3D mixed reality world on the phone display consisting of the video background coming from the camera overlaid with photos and text placed by other users at an earlier stage. Furthermore the user is able to

- select a photo already on the blogging wall
- place a photo from the camera memory (i.e. previously created with the phone built-in camera)
- re-place the photo by moving and rotating it freely in relation to the marker
- writing short text messages using the keyboard of the phone
- placing and rotating the text freely in relation to the marker

All these virtual objects (photos, text) are stored automatically. This means, the user will find and see the same situation when returning next time to the blogging wall.

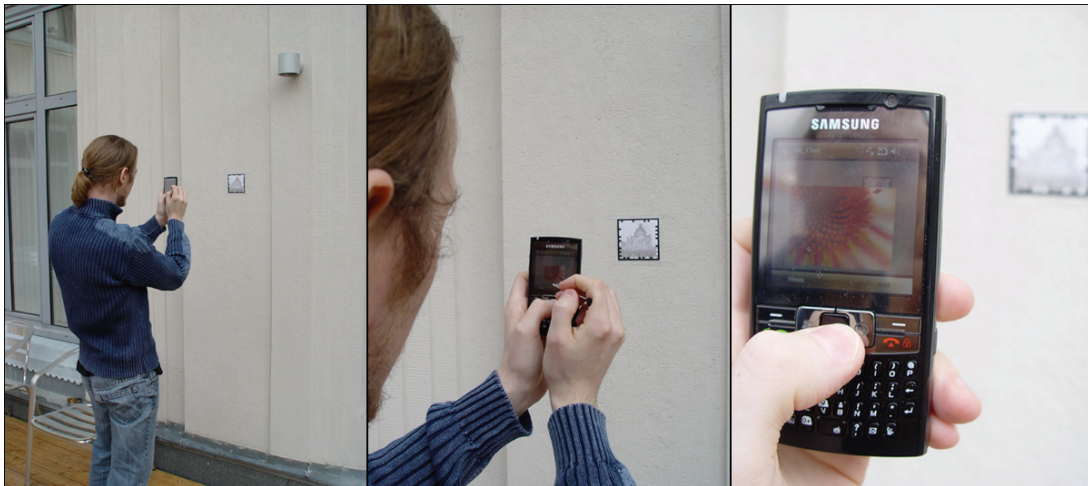


Figure 18: Wall Blogging application in use

The software works with more than one marker; each holds a set of photos and texts together with position and orientation information for each marker.

6.5.2 Technical Specification

Hardware and OS	tested on Samsung SGH-i780 Windows Mobile 6
Software	Studierstube ES SDK Wall Blogging application
Core Features	Creation and modification of pictures and text elements in a 3D mixed reality environment tied to a 2D-marker coordinate system
Status	Preliminary prototype
Intended users	Preliminary user group to test user interface and provide feedback on user experience
Test users	3-5 test persons
Research Workpackages	WP5
Relevance Beyond Project	Testing prototype, functionality will be integrated with Walking Explorer and MR Player.

6.5.3 Testing / Evaluation

The preliminary prototype will be used to collect preliminary user feedback on the user interface of a mobile content creation tool. Functionality is planned to be integrated with Walking Explorer and the MR Player.

The photos and the text messages in the Wall Blogging application are internally fully featured 3D objects (textured polygon geometry). This means that the application can easily be extended to place and modify arbitrary (animated) 3D objects into the 3D world. At the first stage we did not want to overwhelm with the obviously more complicated task to interact with dynamic 3D objects, thus we reduced the functionality to the mentioned 2D photograph and (3D) text. We plan to introduce template and library based content creation of 3D objects in a latter step.

7 Summary

The initial prototypes deepened the experience with mobile content retrieval and content creation in urban environments. Content creation user interfaces on mobile devices that allow users to input and modify location based content are rare and need experience both on the application developer as well as on the user's side.

Our informal results with first test users indicate that users get an altered impression about the urban environments with an additional information layer. Perceiving location based information on the spot the interaction of the urban surroundings with the digital information creates a mixed reality experience that needs more in-depth investigation and documented user studies and evaluation of these.

The Second City server architecture is a crucial element of the City Tales system as it provides the coverage and continuity of the mixed reality layer over the urban tissue. The persistence of information is a crucial element to suspend disbelief in the artificial content elements.

Out of our first user tests we plan to deepen understanding of the problems of on-site content creation:

- What are general UI design for MR interfaces?
- To which extent can users be involved into UI creation?
- Which processes or metaphors are suitable?

For this reason we plan to create and evaluate the combination of the diverse, singular prototype applications, and test the performance of the system on a large user base to receive measurable test results.

Story creation toolsets are of highest importance in the next phase that allow users to use singular content elements to combine them to a mixed reality story. This type of interlinked stories will be evaluated to understand the influence of story lines compared to singular elements on presence issues.

On the technical side we will work further on the unification of different independent tracking technologies to create a continuous story experience for the participating user. We discovered that a complete and continuous hybrid tracking space is evidently not essential to perceive a continuous mixed reality experience. The content, the story setting, and the involved urban environment largely influence the necessity of tracking coverage, which is not uniform. Thus for a working Second City community a well balanced mixture of tracking technologies are a key issue, this we plan to investigate further.

8 Dissemination

As the WP9 was re-started with the participation of Imagination the workshops and other dissemination events were too early for a presentation of preliminary results. However Imagination was trying to do it's best to present the ideas and plans of the IPCity project as a whole at different audiences.

Imagination participated at the "5th Symposium on LBS & Telecartography" at the end of November 2008 in Salzburg to collect up-to-date information on the LBS communities work. We presented IPCity project in small groups that created large interest and led to an invitation to an Innovation Workshop on LBS technology in January 2009.

WP9 will participate the "Science beyond Fiction" - The European Future Technologies Conference in April 2009 in Prague and represent IPCity activities to the audience.

Acknowledgements and Further Information

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*For further information regarding the IPCity project please visit the project web site at:
ipcity.eu*