

# Digital City Kyoto

THE CONCEPT OF DIGITAL cities is to build an arena in which people in regional communities can interact and share knowledge, experiences, and mutual interests. Digital cities integrate urban information (both achievable and real time) and create public spaces in the Internet for people living/visiting the cities.

Digital cities are being developed all over the world [7]. Why do regional information spaces attract people given this era of globalization? The Internet has triggered global businesses, but at the same time enables us to create rich information spaces for everyday life. While the Internet makes research and businesses global, life is inherently local. Business requires homogeneity to allow global competition, while life is heterogeneous reflecting the different cultural backgrounds. Business applications require standard protocols to overcome differences, but we do not need any standard for our life. If there are differences, we need to support cross-cultural communications.

The rapid advance of Internet technologies makes any prediction rather suspect. Digital cities will change together with the computer and communication technologies. No digital city can remain at its current status. Given this qualification, we visit several digital cities around the world and then review their goals, architecture, and technologies for a better

understanding of their current status and future.

We first turn to digital cities in the U.S. When we perform a "digital city" search, we find many instances created by America Online. AOL provides locally focused online network services for several hundred cities and the number is growing. Each AOL digital city delivers locally relevant news, community resources, entertainment, and commerce. Unlike general search engines aimed at retrieving information around the world, digital cities focus on local information. Besides those information services, AOL provides local advertising opportunities for vertical markets including auto, real estate, employment, and health. AOL digital cities are very homogeneous as a result of pursuing economic efficiency.

In Europe, however, more than 100 local authorities started different digital cities in the last eight years. The topics include telematic applications, car-free cities, and so on. The European Digital Cities Conference started in 1994 to discuss a wide variety of topics [9].

Digital City Amsterdam, for example, was built eight years ago [12] as a platform for various community networks and thus focuses particularly on social interaction among citizens. This digital city was first created for communication between the municipal council and citizens. All communication was presented via text and modems. Terminals were placed at public spaces such as libraries and transportation centers. The success of this experiment increased citizens' interest in the Net. The system continued to grow; in 1998 80,000 users were registered with Digital City Amsterdam, which is operated by a nonprofit organization called De Digitale Stad (DDS).

The Helsinki Arena 2000 Project began in 1996 under the initiative of the Helsinki telephone company (now Elisa Communications) [8]. The goal of the project was building the next-generation metropolitan network. This network enables citizens to communicate with each other using live video in both directions; members of a classic car community can cooperate on repairs by using live video transfer. In parallel to the development of high-speed networks,

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an attempt to build the entire 3D city of Helsinki is under way ([www.hel.fi/infocities](http://www.hel.fi/infocities)). As the 3D models become more accurate, more computational power and communication bandwidth will be required to view the digital cities at home. Thus, the virtual city can be a face of the project, and will provide a human interface for new broadband services.

Digital cities commonly provide both profit and nonprofit services and try to strike a balance between the two. Without profit services, digital cities are seldom attractive and fail to become a portal to the city. Without nonprofit services, the city may become too homogeneous as a result of pursuing economic effi-

*Digital cities can provide the social information infrastructure for everyday life. The Digital City Kyoto project incorporates a three-layer architecture based on the newest technologies for a real-time, real-life feel to the city.*





**Figure 1. Digital cities in Europe:**  
 (a) Virtual Helsinki;  
 (b) Digital City Amsterdam.

ciency. In any case, digital cities are forced to face competition with private companies, which provide only profit services. Can digital cities compete with those companies? Technology may also move the border between profit and nonprofit services. For example, digital cities often provide free email and free disk space services in an attempt to guarantee an equal opportunity to anyone who wants to access the Internet. Since free email services can become commercial, however, it is no longer clear whether this service is profit or nonprofit.

### Digital City Kyoto

Kyoto was the capital of Japan for more than a thousand years, and has been a cultural center of Japan for even longer. To begin a digital city project for Kyoto, we started with its design policies. The first policy for designing Digital City Kyoto is to make it *real* by establishing a strong connection to physical Kyoto. Unlike Digital City Amsterdam, Digital City Kyoto is not an imaginary city existing only in cyberspace. Instead, this digital city complements the corresponding physical city, and provides an information center for daily life for actual urban

communities. Digital activities will become an essential part of the real city in the near future. We think digital and physical make things real, and thus are working on a digital part of the real city. The second design policy is to make the digital city live by dynamically integrating Web archives and real-time sensory information created in the city. We will not produce contents nor select them. We will provide a tool for viewing and reorganizing digital activities created by people in the city.

We propose the three-layer model as a system architecture suitable for digital cities (see Figure 2) [5]. The first layer is the information layer where Web archives and real-time sensory data are integrated and reorganized using the city metaphor. The geographical database is

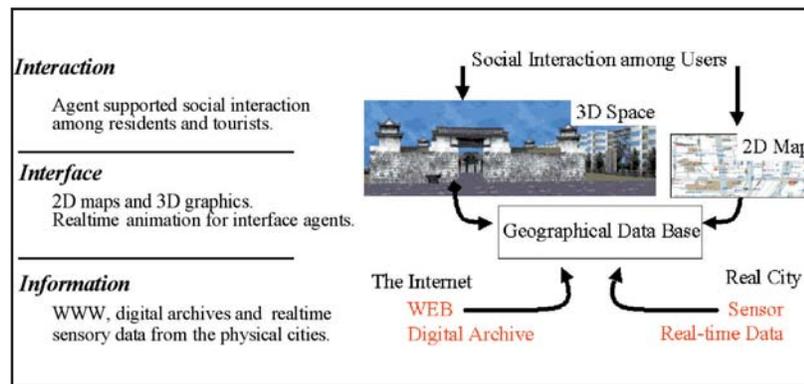
used for the integration of different types of information. The second layer is the interface layer where 2D maps and 3D virtual spaces provide an intuitive view of digital cities. The animation of moving objects such as avatars, cars, buses, trains, and helicopters demonstrate some of the dynamic activities in the cities. If an animation reflects a real activity, the moving object can become a tool for social interaction: users may want to click the object to communicate with it. The third layer is the interaction layer where residents and tourists interact with each other. Community computing experiments [4] will be applied to encourage interactions in digital cities.

**Information layer.** Operations on current Web sites are mainly by text—users search information by keywords and software robots retrieve information. This search-and-retrieve metaphor works well, especially if the needed information is distributed worldwide. If the Internet is to be used for everyday life, however, the geographical interface will become more important. As shown in Figure 2, geographical information systems (GIS) is the core of our digital city. The geographical database connects 2D/3D interfaces to Web/sensory information. From the viewpoint of system architecture, introducing the geographic database allows us to test various interface/information technologies independently.

After digital cities become popular, people will register their pages directly with the geographical data-

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**Figure 2. The three-layer architecture for Digital City Kyoto.**



bases. Until then, we need some technology to automatically determine

As the real-time sensory information, we are considering bus schedules, traffic status, weather condition, and live video from the fire department. In Kyoto City, more than 300 sensors have already been installed and they are gathering the traffic data of more than 600 city buses. Each bus sends its location and route data every few minutes. Such dynamic information makes our digital city live. The first trial collects real-time bus data and displays it on the digital city. Real-time city information is more important for people who are doing something in the physical city than for those who are sitting in front

of desktop computers. For example, people would like to know when the next bus is coming, where the nearest vacant parking lot is, whether they can reserve a table at a restaurant, and what is on sale at the department store just in front of them. We are now implementing a prototype application that provides live information to mobile users through wireless phones.



(a)



(b)

**Figure 3. Digital City Kyoto:**  
(a) GeoLink (by Kaoru Hiramatsu)  
(b) 3D Kyoto (by Stefan Lisowski).

the XY coordinates of each Web page. However, since Kyoto is 1,200 years

old, there are various ways to express the same address, and this makes the process very complicated. So far, we have processed 4,800 pages that refer to public spaces including restaurants, shopping centers, hospitals, temples, schools, and bus stops. Figure 3(a) shows the results of locating the pages on the map. We can see how Web pages (restaurants, schools, temples, shopping centers, and so on) are distributed in the city. Various data retrieval methods involving this map are under development [2].

3D graphic technology becomes a key component of the interface layer when used in parallel with the 2D maps. The 3D aspect to a digital city allows nonresidents to get a good feel for what the city looks like, and to plan actual tours. Residents of the city can use the 3D interface to pinpoint places or stores they would like to visit, and to test walking routes.

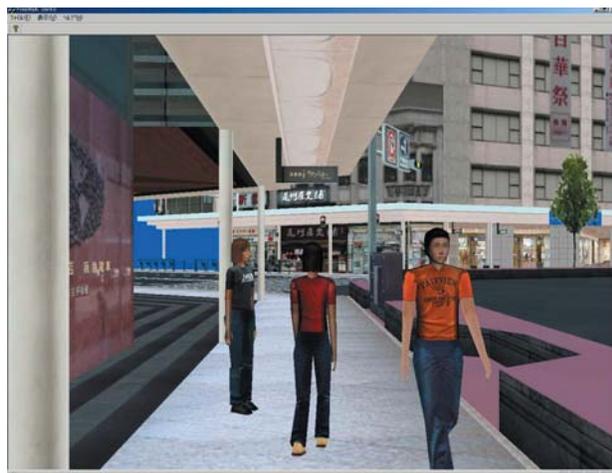
Figure 3(b) shows the 3D implementation of Shijo Shopping Street (Kyoto's most popular shopping area). We use 3DML, which is not well suited to reproducing gardens and grounds, but has no problem with modern rectilinear buildings. Since 3DML is easy to use, college and high school students in Kyoto have joined us in building the 3D Kyoto. This

follows the bazaar approach to software development. We hope contributors from all over Kyoto will keep the project from being a small handful of stagnant areas, and make this a vast and dynamic city.

At the same time, we are discussing various problems with the shopping street community—since we are using photos, information in the photos becomes old; the advertisements in the photos quickly become out-of-date; and some photos include registered trademarks. It is important for engineers, researchers, and shop owners to consider these issues. One solution is a Web interface to allow individual shopkeepers to update the advertisement photos on their 3D buildings by themselves.

**Interaction layer.** Social interaction is an important goal in digital cities. Even if we build a beautiful 3D space, if no one lives in the city, the city cannot be very attractive. We plan to use cutting-edge technologies to encourage social interaction in Digital City Kyoto. One idea we must encourage for cross-cultural interaction in the digital city is to implement a digital bus tour for foreign visitors to the site. The tour will be a point of entry for foreigners to the digital city, as well as to Kyoto itself. The tour has been implemented within the Web environment, using I-Chat and Microsoft's agent technology (see Figure 4).

**Figure 5. Walking in 3D Kyoto** (by Hideyuki Nakanishi).



**Figure 4. Digital bus tour with agent guide** (by Katherine Isbister).

The tour guide agent will lead visitors through the Nijo Castle in Kyoto simulated with 3DML. To create the tour guide agent, we participated in several guided tours of Kyoto. We noticed the tour guides often told stories to supplement the rich visual environment of Kyoto and provided explanations of what Japanese people—both past and present—

did in each place.

Another trial for developing social interaction in digital cities uses avatars in the 3D space to bridge residents and visitors. Figure 5 shows the animation of avatars walking in 3D Kyoto. The technology allows a number of avatars to walk around the city in real time. By making links between the avatars and the people walking in the corresponding physical city, we can realize communication between digital tourists and physical residents. As the walking motion can be generated by the user's machine via a Web browser plug-in, only the walking position/velocity and direction need to be downloaded. Thus, a large number of avatars can be created rapidly in real time. Aside from the known avatars, adding a virtual population will activate the digital city and make it more attractive. We have also begun work on disaster management simulations in digital cities.

## Technologies for Digital Cities

The following technologies are unique to digital cities.

*Technology for information integration.* is essential to accumulate and reorganize urban information in a comprehensive manner. Digital cities typically handle Web pages and real-time sensory data from physical cities. Voluminous high-quality digital archives can also be accessed from digital cities. The idea of using a map is commonly observed in digital cities. Amsterdam uses an abstract information map, while Kyoto uses a physical map. In the latter case, technologies are needed to integrate different kinds of urban information via GIS. Indeed, GIS becomes a key technology for this.

*Technology for public participation.* To allow various

individuals and organizations to participate in building digital cities, the entire system should be flexible and adaptive. For designing a human interface that supports both content creation and social interaction, a new technology is required that encourages people with different backgrounds to join in. In Amsterdam, a city metaphor is used to create a new interface for public participation. In designing Kyoto, we recognized the importance of participation when building a virtual shopping street.

*Technology for social agents* is being tested [3]. So far, most digital cities adopt the direct manipulation approach to realize friendly human interfaces. The direct manipulation approach allows users to explicitly operate information objects. Since social agents (human-like, dog-like, bird-like, and so on) should have the ability to communicate with a group of users in natural languages, users can enjoy interacting with the agents and access information without explicit operation. This allows a digital city to keep its human interface simple and independent of the volume of stored information [11]. Social agents can also easily connect mobile users to the digital city.

*Technology for information security* becomes more important as more people connect to the digital city. For example, it is not always appropriate to make links from digital cities to individual home pages. We found that most kindergartens declined our request to link them to the digital city. Just as we have social laws in physical cities such as peeping-tom laws, digital cities should introduce social technologies to secure the information spaces. These issues are being discussed, but no implementation has been announced yet.

## Conclusion

Each digital city has its own goal. AOL's digital cities aim at growing their business in so-called vertical markets. Digital City Amsterdam was intended to provide a public communication space to people living in the city. Helsinki is planning the next generation metropolitan network. In Kyoto, a social information infrastructure for urban life is being tested. Urban planning is another motivation behind digital cities—allow community members to participate directly in the urban planning process [10].

The digital city project in Kyoto was initiated by researchers in NTT and Kyoto University in October 1998. The Digital City Kyoto Experiment Forum was launched in 1999, 10 months after work on the Digital City Kyoto commenced. The forum includes several universities, local authorities, leading computer companies, as well as local companies, temples, photographers, volunteers, and so on. Researchers and designers from overseas have joined the project.

Besides technological problems, we have encountered numerous nontechnical research issues such as security, privacy, and intellectual property rights. In July 2001, we started a JST project on the “Universal Design of Digital Cities” for exploring basic research issues.

During this project, we found the digital cities have many directions: tourism, commerce, transportation, urban planning, social welfare, health control, education, disaster protection, and politics. Digital cities attract people because different experts contribute to building a new city, and provide an opportunity to create for people a new information space for their everyday life. **C**

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Visit Digital City Kyoto at [www.digitalcity.gr.jp](http://www.digitalcity.gr.jp) and [www.digitalcity.jst.go.jp](http://www.digitalcity.jst.go.jp).

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