

Mobile Digital Cities

Shifting to a knowledge-based economy

Mobile wireless technologies deliver a new form of tourist experience, customer service, and security at the Zollverein mine, a United Nations Educational, Scientific, and Cultural Organization (UNESCO) World Heritage site in Essen, Germany. The innovative solution concepts include technologies such as wireless fidelity (Wi-Fi), location-based services, multimedia streaming, and wireless surveillance cameras.

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Executive Summary

To become one of the leading business regions in Europe, the German North-Rhine Westphalia (NRW) government knew it had to transform its industrial-based economy into a knowledge-based economy. Building the infrastructure to stimulate growth, the government launched one of the most ambitious inter-municipal e-Government projects in Europe, the digital NRW (d-NRW) project. As part of this project, Intel® IT Innovation Centre and Intel® Solution Services collaborated with consulting firm Capgemini to design and develop a mobile solution concept for the Zollverein mine, a UNESCO World Heritage site in Essen, Germany.

Working together, we designed three solution concepts: a mobile tour guide, mobile visitor information system, and mobile security system. The solutions offer location-based services (LBS) and dynamic application provisioning using a variety of wireless technologies, including IEEE 802.11 wireless local area networks (WLANs), wireless-enabled personal digital assistants (PDAs), wireless-enabled tablet PCs, WLAN surveillance cameras, and a provisioning server.

These solutions demonstrate and deliver several key benefits of wireless technologies, including:

- Transforming business performance with increased flexibility and new usage models
- Reducing costs by eliminating wiring installation expenses
- Improving productivity
- Increasing visitor satisfaction

The solution concepts generated significant interest from business, government, and academia, and are being considered for adoption by the NRW police department and other agencies. This paper describes the three solution concepts and highlights the solution architecture for the security system.

The NRW Challenge

North-Rhine Westphalia (NRW), located in the northwest corner of Germany, is the country's most populous region, with 18 million people. Established in 1946, the region includes the cities of Bochum, Bonn, Cologne, Dortmund, Düsseldorf, Duisburg, Essen, and Gelsenkirchen. Historically, industries such as coal and steel production drove its economy.

With the decline of these industries and a loss of jobs, the local government wanted to shift to a knowledge-based economy to improve the economic potential of the region. To build an infrastructure that would stimulate growth, the government launched the digital NRW (d-NRW) project.

The d-NRW project is the largest inter-municipal e-Government project of its type in Europe. The project's goal is to transform the NRW region into one of the leading business regions in Europe through a modern, efficient e-Government platform. The project structure and organization employ an innovative public/private partnership (PPP), which drives its strategy, implementation, and operations.

As part of the d-NRW project, Intel IT Innovation Centre and Intel Solutions Services—an Intel professional services organization that helps other companies implement technology solutions based on Intel® architecture—collaborated with consulting firm Capgemini to design and develop mobile solution concepts for the Zollverein mine, a UNESCO World Heritage site in Essen, Germany.

The solution concepts deliver a new form of customer service, tourist experience, and flexible security with these key technology components:

- IEEE 802.11 wireless local area networks (WLAN)
- Wireless-enabled PDAs based on Intel XScale® technology
- Wireless-enabled tablet PCs based on Intel® Centrino™ mobile technology
- A provisioning server based on the Intel® Xeon™ processor
- WLAN surveillance cameras

Showcasing the Knowledge Economy

The rapid development of wireless technologies, mobile notebook PCs, smart phones, and PDAs is revolutionizing the way we live. As wireless devices and technologies become more affordable and widespread, their role in transforming the way we work, live, and play becomes more viable. Mobile solutions can greatly increase productivity, lower costs, bring improved performance for business and government, and deliver greater customer satisfaction.

The Zollverein mine—an old, unused coal mine converted to a museum and cultural center—was chosen as a pilot program to evaluate the benefits of mobile wireless technology. This site demonstrates the structural and economic transformation in the NRW region:

- Active coal mine from 1860 to 1986
- Designated a UNESCO World Heritage site in 2001
- Transforming into the new cultural quarter of Essen
- Tourist attraction with more than 120,000 visitors per year and ambitious plans to grow aggressively
- Broad range of local institutions and companies on site

The pilot program objective was to demonstrate the potential benefits for mobile wireless technology by using a range of applications that support the transformation and vision of the d-NRW project. The solutions include:

- Mobile tour guide for visitors
- Mobile visitor information for receptionists and visitors
- Mobile security for security guards

MOBILE TOUR GUIDE

Since its transformation into a cultural quarter, the Zollverein mine has become one of NRW's most famous tourist spots. Intel and Capgemini consultants developed a mobile, location-aware multimedia tour guide to enhance the visitor experience. This

solution achieves one of the goals of the Zollverein Foundation: to bridge the past with the future. Tourists can learn about the past through advanced technology in the palm of their hand.

The key features of the solution include:

- Mobile handheld multimedia tour guide
- Information push of rich media services
- User-controlled content display
- Enhanced physical tour through multimedia
- Location-aware, context-specific information based on the current location of the user

LOCATION-BASED SERVICES (LBS)

The LBS approach combines a variety of emerging and existing technologies, protocols, specifications, and standards. LBS presents specific content, services, and applications to a user, depending on the user's location. LBS can provide local maps, routes, street directions, restaurant information, movies, events, points of interest, general contact information, and user-specific contact information, such as friends, colleagues, and customers. Examples of LBS business applications include location-sensitive billing, traffic updates, fleet management, and asset tracking.

In this solution concept, we defined a unique location as a single IEEE 802.11 hotspot signal zone; services are offered only when the user is in the hotspot signal zone, as shown in Figure 1. This design can be enhanced with other parameters such as time, user profile, and type of device.

Zollverein mine visitors are presented with different media and additional information unique to their location. The content focuses on the history of the location, what's happening today, and the plans for tomorrow. Extended information in a multimedia format provides a richer and deeper experience for tourists, improving their understanding of the artifacts and exhibits on display. For example, the mobile tour guide can bring the past alive for the user with a video clip depicting a machine installation event that happened in 1953.

MOBILE VISITOR INFORMATION

At any large tourist site, visitors need to know the schedules, locations, and directions to current events. The event signs at the Zollverein mine are currently inadequate, and the leaflet box that contains the area map is often empty. Guests have difficulty finding the visitors' center, and they frequently ask staff who happen to be passing by for event information and directions. With so much happening at this large site, the staff may not remember all of the daily events. We developed a mobile visitor information support tool, with a tablet PC version for service staff and a PDA version for visitors.

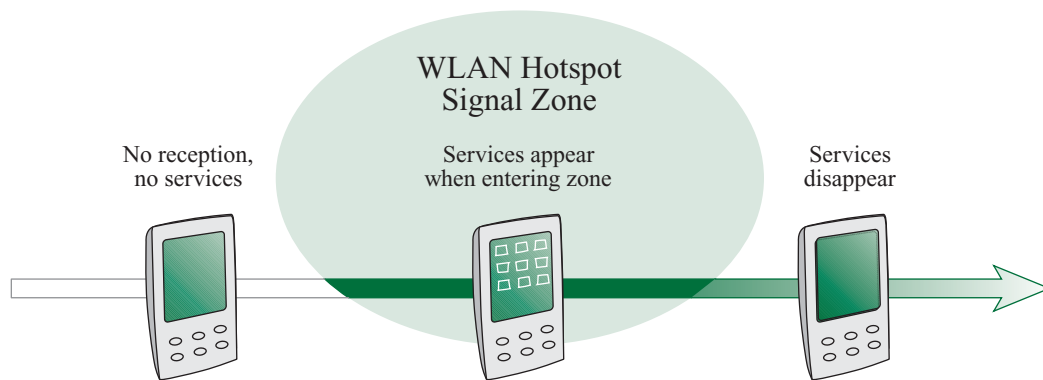


Figure 1. Services are offered when a user is present in a hotspot zone

The key features of the solution include:

- New method for providing information to tourists
- Current event calendar information available through mobile devices
- Integrated and linked navigation information system with a list of current events and an area map
- Dual-usage model developed for service staff and visitor self-service
- Architecture capable of adding a mobile ticket online reservation system

As shown in Figure 2, the mobile visitor information tool displays a list of current events and cross-references them by highlighting them on a map. By selecting an event on the map or from the list, the application displays detailed information about the event and the route to get there.

MOBILE SECURITY

The Zollverein site is large and open, similar to a small town, which makes it difficult to secure and protect. Additionally, modest budgets allow only a few security guards on duty at any time.

We designed and developed a mobile security monitoring and alert system to solve this issue. Strategically placed WLAN surveillance cameras monitor activities throughout the site. The system sends video images to a control center, where the images are monitored and recorded. Additionally, the system sends any active motion pictures to mobile devices such as tablet PCs or handheld PDAs carried by security guards. The guards can monitor activities remotely and respond quickly as an event happens, regardless of their current location. Figure 3 shows example screens of the security solution.

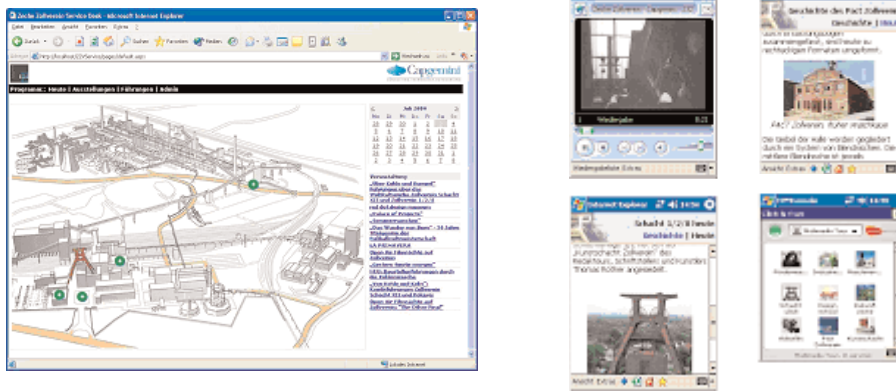


Figure 2. Mobile visitor information application and multimedia tour guide screens

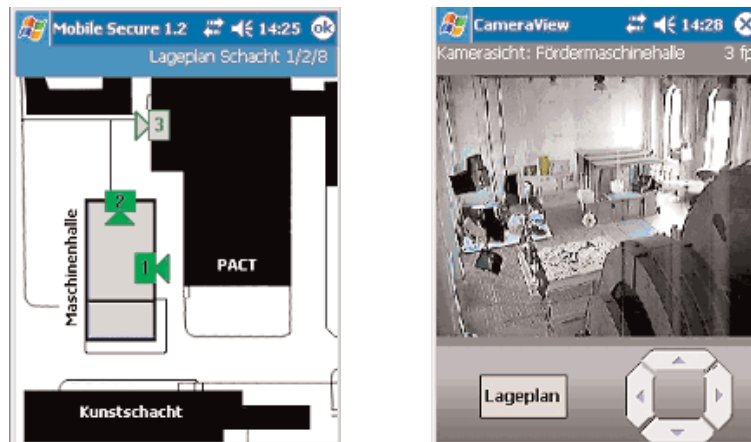


Figure 3. Sample screen of the security solution

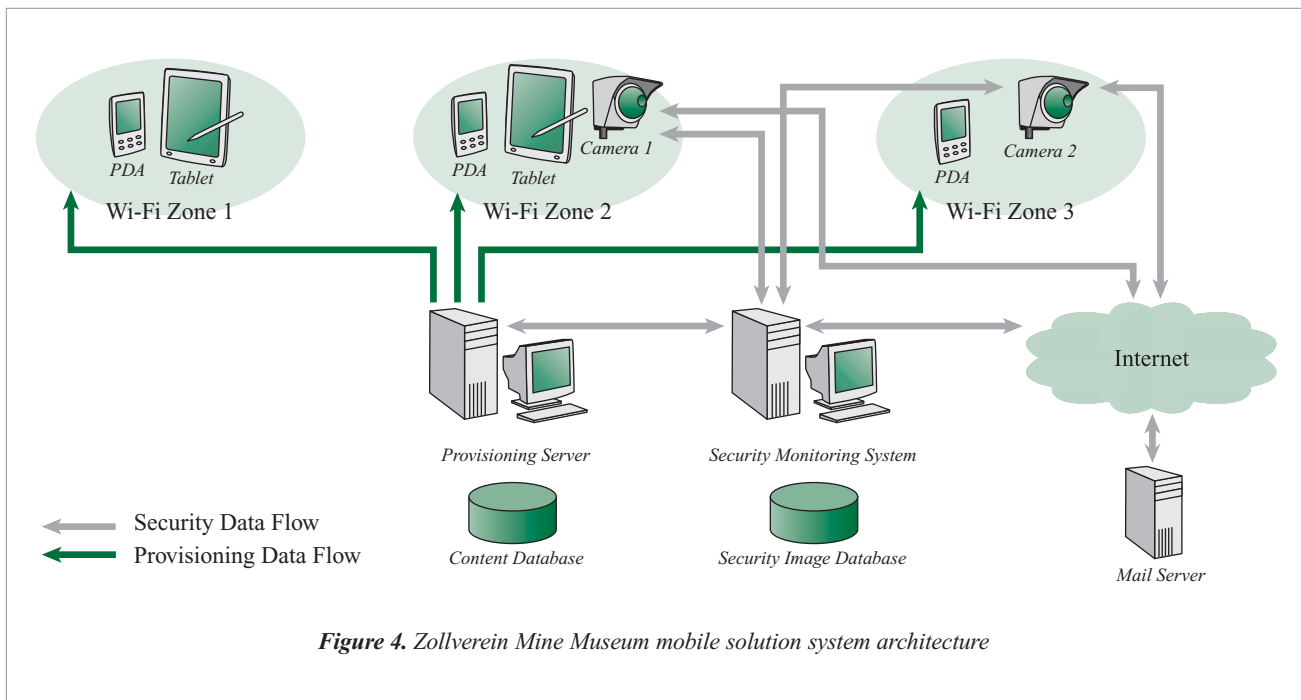


Figure 4. Zollverein Mine Museum mobile solution system architecture

Security System Solution Architecture

Consultants from Intel Solution Services held a workshop to survey the current environment and worked with the Intel IT Innovation Centre and Capgemini to design and build a prototype mobile solution. We designed a loosely coupled system architecture to handle most of the communications with HTTP, SMTP, and Web Services; we designed a WLAN to handle the mobile device communications. The following sections provide information about the 802.11 WLAN standards used in this design, the system component architecture, and the security system software architecture.

802.11 WLAN STANDARDS

We designed the WLAN based on the IEEE 802.11 standards, including:

- 802.11a – supports a maximum bandwidth of 54 Mbps in the 5 GHz band
- 802.11b – supports up to 11 Mbps in the 2.4 GHz band
- 802.11g – establishes an additional modulation technique for the 2.4 GHz band, for bandwidths up to 54 Mbps

These standards offer flexible options for WLAN implementations based on bandwidth, range, and interoperability requirements. Intel technology-based single-band (802.11b), dual-band (802.11a/b),

and tri-band (802.11 a/b/g) devices support these standards. By deploying devices that support multiple standards, organizations can upgrade existing wireless solutions, while maintaining interoperability with older devices. The IEEE 802.11 standard is often referred to as wireless fidelity (Wi-Fi), a term promoted by the Wireless Ethernet Compatibility Alliance (WECA). WECA-certified devices ensure a high level of cross-vendor interoperability.

SYSTEM COMPONENT ARCHITECTURE

Figure 4 shows the system architecture. The solution has three Wi-Fi zones, with wireless surveillance cameras mounted in zones 1 and 2. Each zone has its own content and services.

A content database holds all the content for all zones. System administrators use the content management console to add, remove, and edit content for the museum. A provisioning server grants and removes access to applications and content to mobile devices moving through the zones. The server conducts these provisioning and unprovisioning activities dynamically, using provision policies based on user location and access rights.

A security monitoring system manages the security cameras and stores video images into the security image database for later review. The security cameras send motion alerts to predefined e-mail addresses using SMTP, routing the alerts to security guards automatically.

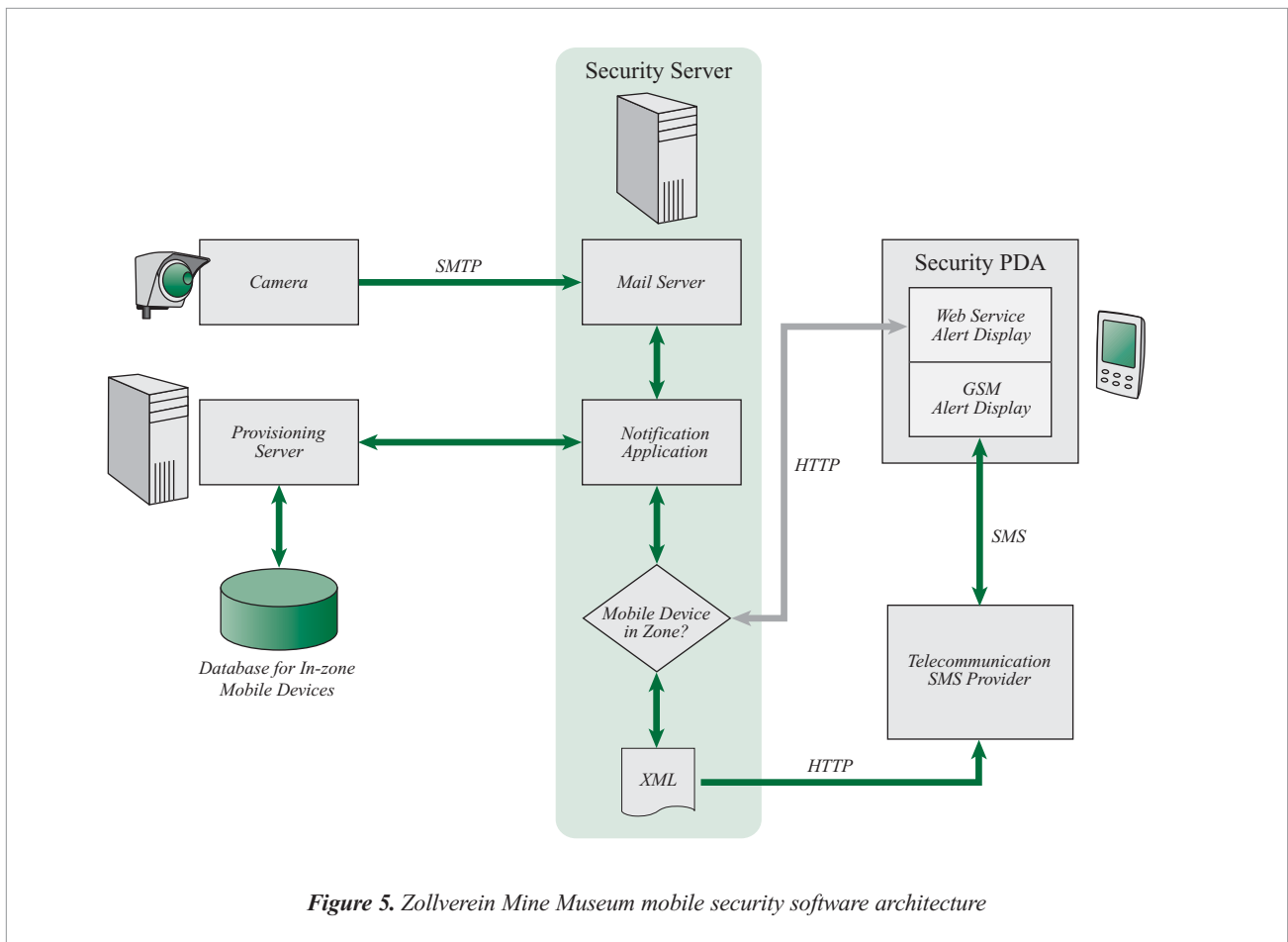


Figure 5. Zollverein Mine Museum mobile security software architecture

SECURITY SOFTWARE ARCHITECTURE

Figure 5 shows the security monitoring alert software architecture. When a security camera detects motion, it sends a security alert event to a predefined e-mail address. The alert event contains an alert description, event time, location, and the video image captured by the camera. The notification application gets the event notification from the e-mail server and determines whether a security monitoring PDA is available in a Wi-Fi zone by asking the provisioning server. If a security monitoring PDA is located in the zone, it passes the alert notification to the PDA directly. If it does not find a security monitoring PDA in the zone, the notification application sends the alert notification to a short message service (SMS) server hosted by a telecommunications service provider. The SMS server delivers the alert notification to a security monitoring mobile device through a global system for mobile communications (GSM) channel.

Results

Using the latest wireless technologies, the Intel IT Innovation Centre, Intel Solution Services, and Capgemini successfully built and developed solutions that met the goals of the pilot project. Key benefits include:

- Transformed business performance with increased flexibility and new usage models
- Reduced costs
- Improved productivity
- Increased visitor satisfaction

Deploying a WLAN instead of a wired network eliminates installation and maintenance expenses related to wiring! The mobile visitor information system gives Zollverien visitors and staff always-available access to network resources and information regardless of their location, reducing questions and staff interrupts. The mobile tour guide enhances the visitors' experience by offering location-aware information in a multimedia format, improving their understanding of the artifacts and exhibits on

display. The mobile security solution enables a few guards to successfully monitor a large, open area, which would otherwise be difficult to secure, through remote surveillance.

Capgemini consultants demonstrated the solutions at the NRW e-Government event on July 15, 2004. Attendees from government, business, and academia showed significant interest in the solutions. The concepts and the solutions are being considered for adoption by the NRW police department and other agencies.

Conclusion

With the rapid development of wireless technology, mobile applications are gaining momentum and changing our daily lives. The mobile solution concepts designed for the Zollverein mine demonstrate the significant benefits of wireless solutions, and some new and interesting usage models for this technology. By basing the design on the IEEE 802.11 standards (Wi-Fi) and deploying devices that support multiple standards, we provide a model for upgrading existing wireless solutions while maintaining interoperability with older devices.

The solution concepts described in this paper may stimulate others to develop similar usage models, architectures, and solutions. Models for similar applications may extend our wireless reach further by incorporating emerging wireless technologies, such as the metropolitan area network (MAN) technology based on IEEE 802.16—also known as worldwide interoperability for microwave access (WiMAX).

Authors

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Acronyms

d-NRW	digital North-Rhine Westphalia project
GSM	global system for mobile communications
LBS	location-based service
MAN	metropolitan area network
NRW	North Rhine-Westphalia
PDA	personal digital assistant
PPP	public/private partnership
SMS	short message service
UNESCO	United Nations Educational, Scientific, and Cultural Organization
WECA	Wireless Ethernet Compatibility Alliance
Wi-Fi	wireless fidelity
WiMAX	worldwide interoperability for microwave access
WLAN	wireless local area network

Key Benefits of Mobile Wireless Technologies at the Zollverein Mine

Transformed business performance. Increased flexibility and new usage models offer a new way of working and an enhanced visitor experience.

Reduced costs. Implementing WLANs is less expensive than wiring a large site.

Improved productivity. Security surveillance depends on the constant availability of site monitoring information. Armed with mobile devices and mobile solutions, security guards can

be anywhere onsite, and always have current site monitoring information. The guards can be mobile, rather than stationed at a monitor all day.

Increased visitor satisfaction. With mobile, solution-enabled PDAs, visitors can get the latest information about the locations and schedules of events without going to the service desk. Visitors also can get a better understanding of exhibits and artifacts on display through multimedia content.

The d-NRW Mobile Solution Project Team

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¹On another wireless city project, the City of Westminster, England, avoided 84 percent of installation costs by installing wireless security cameras instead of wired models. For more details, see "The Wireless City: Enhancing Productivity, Efficiency, and Lifestyle," Intel Corporation (December 2003) at www.intel.com/business/bss/industry/government/wireless_city.pdf.

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