# WIRELESS USER LOCALIZATION IN CONTROL SYSTEMS FOR PREDICTIVE DATA DATA PUSH TECHNOLOGY

**cAk**
CENTRUM APLIKOVANÉ KYBERNETIKY

## AUTHOR :

Ondřej Krejcar

**Centre for Applied Cybernetics**
Department of Measurement and Control
Faculty of Electric Engineering and Computer Science
**VSB -Technical University of Ostrava**
**Czech Republic**

# Introduction

- ☐ Mobile communication devices
  - ■ Mobile phones
  - ■ Personal digital assistants PDA, MDA
  - ■ Notebooks / Tablet PC's

- ☐ Information sources
  - ■ Internet
  - ■ e-mail
  - ■ ftp
  - ■ ICQ
  - ■ ..

- ☐ **Communication**
  - ■ GPRS (GSM)
    - ☐ SmartPhone, MDA
    - ☐ 100 kb/s
  - ■ Bluetooth
    - ☐ ~ 10m, wireless, 2.4 GHz
    - ☐ SmartPhone, PDA, MDA
    - ☐ 10 Mb/s
  - ■ WiFi (802.11b)
    - ☐ ~ 300m, wireless, 2.4GHz
    - ☐ PDA, MDA III
    - ☐ 10 Mb/s

# Mobile devices in IS

- **Software**
  - SmartPhone
    - Java (J2ME)
  - PDA, MDA
    - Java, .NET CF

- Mobile technology in information systems
  - ✓ On-line connection to information system
  - ✗ Small memory of mobile devices
  - ✗ Communication networks with small bandwidth
  - **Slow** information transfer from source to target

# WiFi quality tests

- ☐ Test between PC and PDA
- ☐ WiFi signal strength = -20 dbm (80%)

| | PDA | | | |
|---|---|---|---|---|
| | HP iPAQ H4150 | | HP iPAQ H5550 | |
| File size [kB]※ | Transfer rate [kB/s] | Transfer time [s] | Transfer rate [kB/s] | Transfer time [s] |
| 4 343 | 160 | 27 | 107 | 41 |
| 7 208 | 124 | 58 | 91 | 79 |
| 14 757 | 131 | 113 | 88 | 166 |

☐ PC => PDA USB test ~ 268 kB/s

※ SQL database, technical plan (Acad), images, video, sound
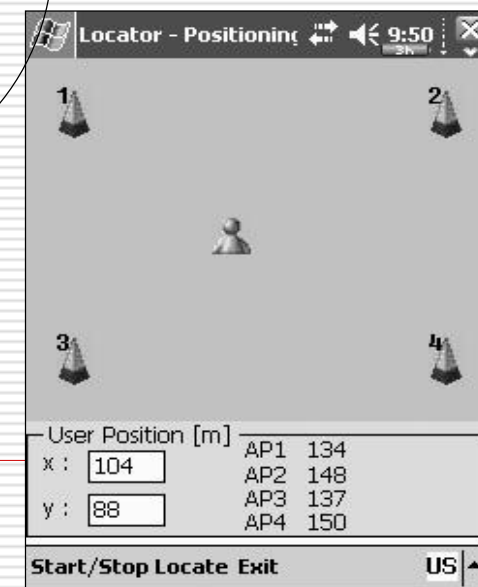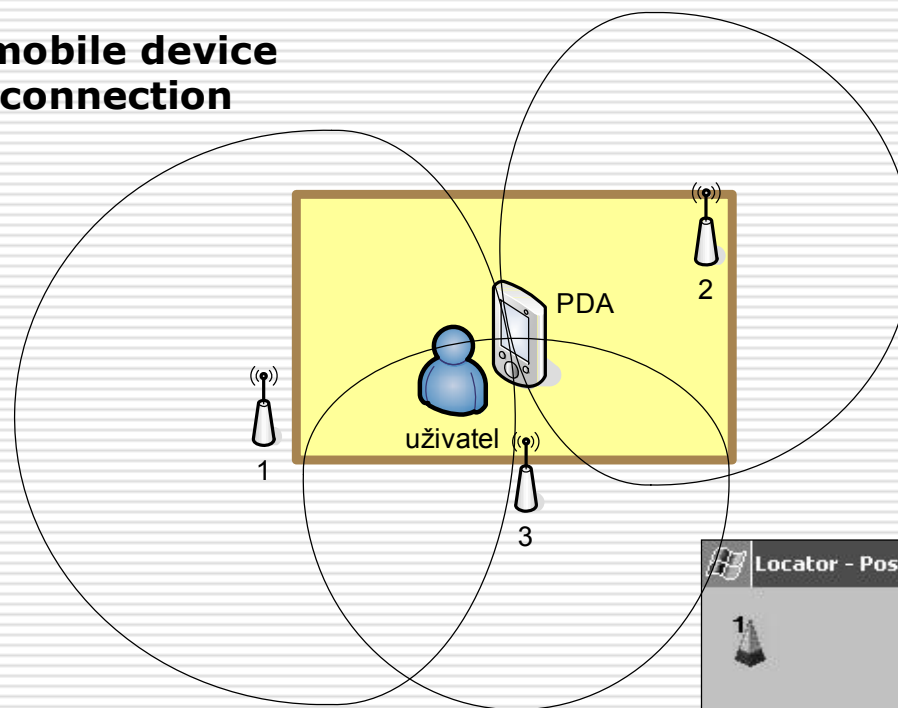
➢ **Predictive data push** can reduce transfer time

# Mobile devices programming – .NET

✖ **Slow** information transfer from source to target
  - ✖ Theoretic transfer rate = 825 kB/s
  - ✖ Real transfer rate = 160 kB/s

✓ Localization of mobile device for **predictive data push**
  - ✓ Enhancement for existing Information Systems
  - ✓ Based on .NET CF (Compact framework)
  - ✓ Special library – OpenNETCF 1.4
    - ✓ Used for manage WiFi (802.11b) hardware
  - ✓ Designed for SmartPhone & PDA (MDA)
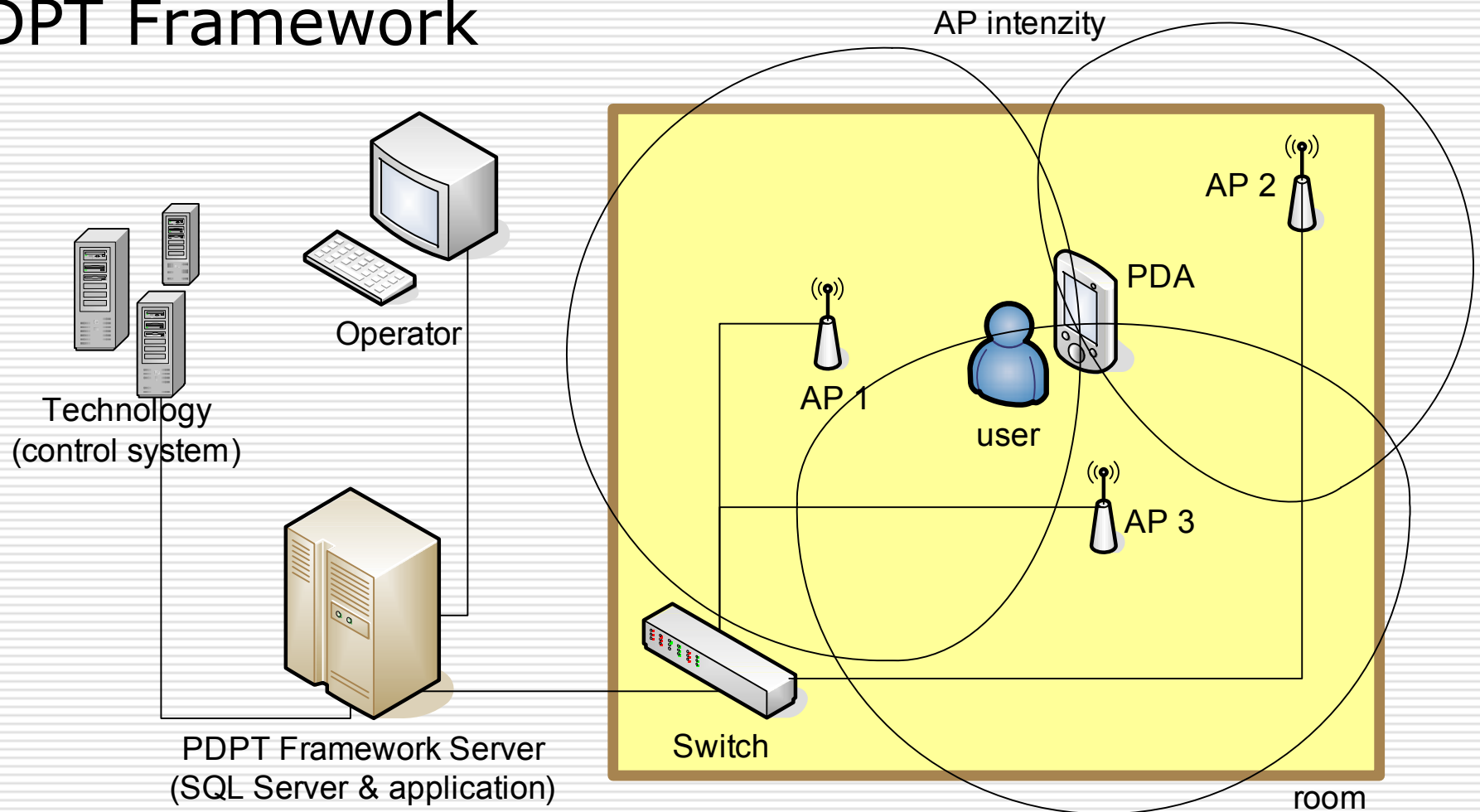    - ✓ Microsoft Windows Mobile operating system

# Localization of mobile device

- **Why we want to locate user?**
  - **Predictive push the data to his mobile device**
    - **Increase data flow on slow connection**
  - User know own position
    - Can help in emergency plan
  - IS know about user
    - Users monitoring
  - …

- IEEE 802.11 (Wi-Fi)
  - Indoor location
  - ✗ GPS, GALILEO
    - ✗ no signal in building

- WiFi user positions determination
  - min. 3 visible AP
  - AP intensity is measured and triangulated
  - accuracy 2÷3m

# Localization - Framework - Technology

☐ PDPT Framework



AP intenzity

AP 2

PDA

AP 1

user

AP 3

Operator

Technology
(control system)

Switch

PDPT Framework Server
(SQL Server & application)

room

# WiFi middleware – signal strength from AP

```
dtVisibleAP = new DataTable("Visible AP");
DataRow drDataRow;
adptrColection = Networking.GetAdapters();
foreach (Adapter adptr in adptrColection)
{
    Application.DoEvents();
    if (adptr.Type==AdapterType.Ethernet)
    {
        foreach (AccessPoint ap in
                adptr.NearbyAccessPoints)
        {
            drDataRow = dtVisibleAP.NewRow();
            drDataRow["BSSID"] =
                (ap.Name.ToString());
            drDataRow["Signal [%]"] =
                        ((ap.SignalStrength.Decibels).ToString());
            dtVisibleAP.Rows.Add(drDataRow);
        }
    }
}
```
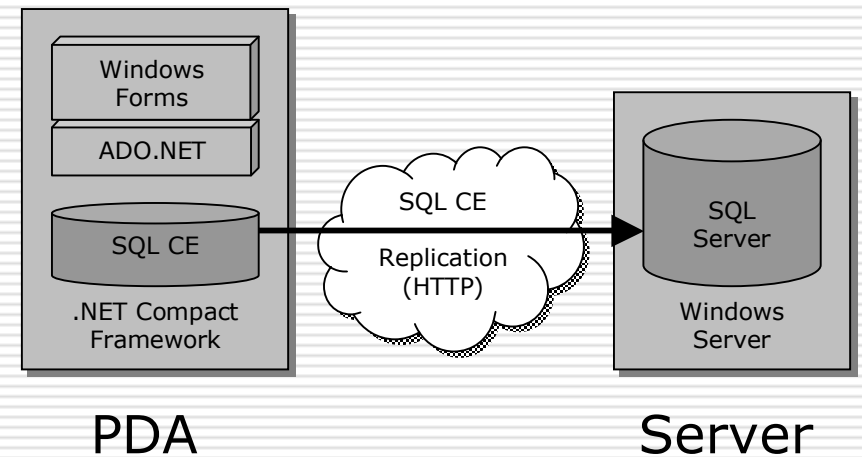
# Framework database architecture

- ☐ Wireless Location Architecture (WLA)
  - ■ define structure for data store in database
  - ■ defined as data levels in building plan for example



Building Block Level
Block Floor Level
Cell Level
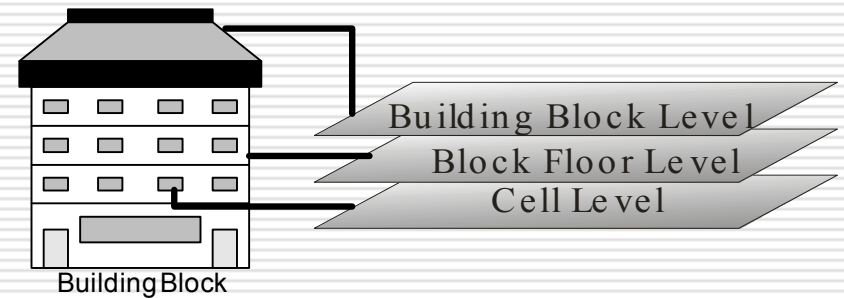
Building Block

WLA architecture

- ☐ Replication sequence
  1. the data about Building Block
  2. the Block Floor data
  3. the data about user occurred cell



Windows Forms

ADO.NET

SQL CE

.NET Compact Framework

SQL CE
Replication (HTTP)

SQL Server

Windows Server

PDA                                      Server

9

# Framework principle
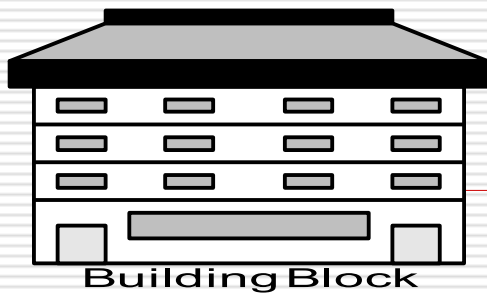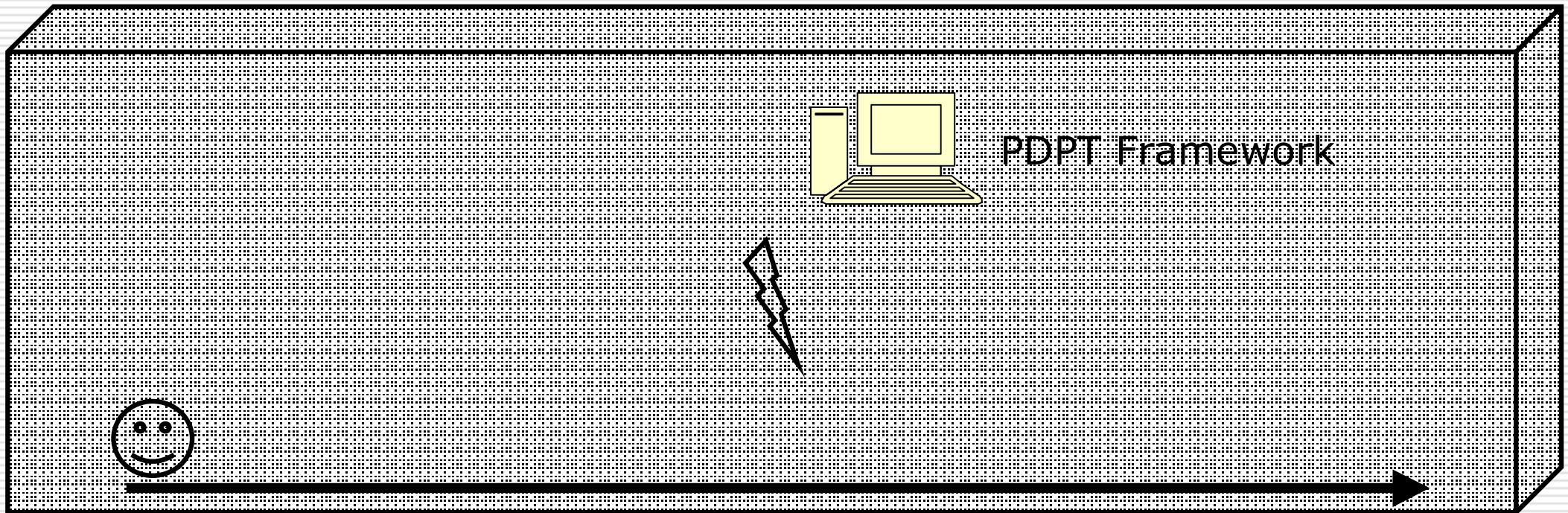
- Framework working principle
  - User is moving at some direction (from A to B)
  - Framework core is respond with command to replication of database part
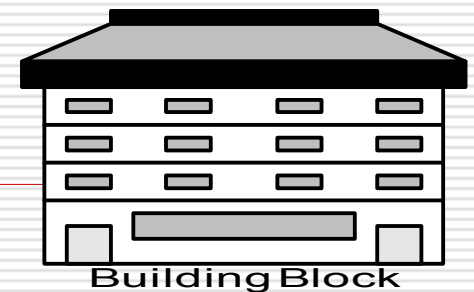  - When user occurred on predicted place, the data are ready to use in user mobile device memory

Technology service

Data Server

Switch

2

PDA

1

user

3
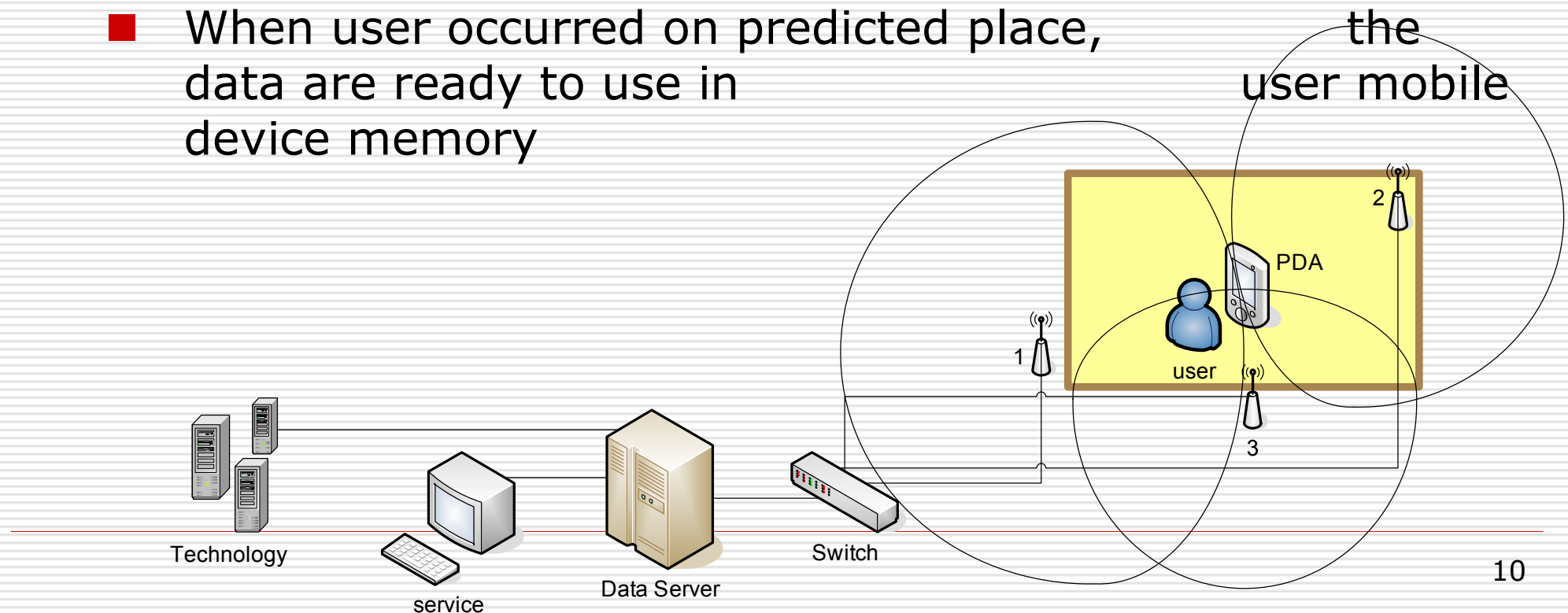
# Framework principle demonstration

Building Blocks



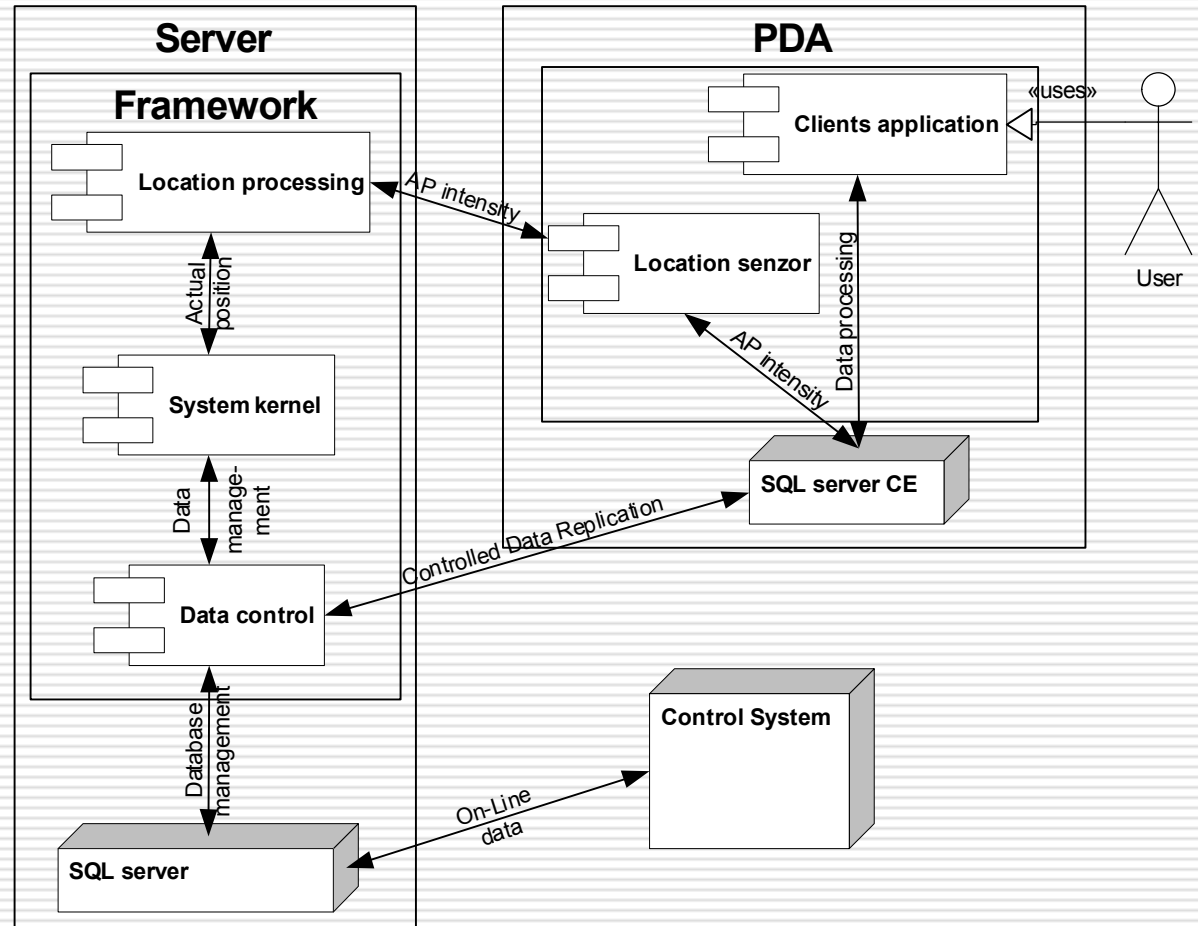PDPT Framework

Block A

Block B

Building Block

Building Block

# Framework structure

- ☐ Server
  - ■ User position determination
  - ■ Intelligent decision algorithm in Core
  - ■ SQL server has WLA architecture
- ☐ Client
  - ■ AP intensity measurement
  - ■ Manage and displays prebuffered data
  - ■ SQL server CE

# Conclusion

- The indoor location of a mobile user is obtained through an infrastructure of WiFi access points.
- User location is used in core of server application of PDPT framework to data pre-buffering and pushing information from server to user PDA.
- The experiments show
  - The location determination mechanism provides a good indication of the actual location of the user in most cases
  - The median resolution of the system ~ 5 meters (size of a typical office room)
- The experiments also show that the current state of the basic technology used for the framework (PDA HW, PDA OS, WiFi) is now at the level of a high usability of the PDPT application.

# Conferences

- ☐ ACMOS'05, Automatic Control Modeling and Simulation, Prague

- ☐ ICINCO 2005, International conference on informatics in control, automation and robotics, Barcelona, Spain
  - ■ 234 submissions accepted from 50 different countries
  - ■ accepted as short paper (108 total)
  - ■ short paper acceptance 28 %

- ☐ IEEE Workshop VRŠOV 2005

# More information…

- ☐ Localization
  - ■ Ekahau – user lokalization - http://www.ekahau.com/
  - ■ Newburynetworks – Wi-Fi net. safety - http://www.newburynetworks.com/
  - ■ WhereNet – monitoring and control of vehicle - http://www.wherenet.com/
- ☐ .NET
  - ■ Mobile Developer Center - http://msdn.microsoft.com/mobility/
  - ■ .NET Compact Framework - http://msdn.microsoft.com/smartclient/understanding/netcf/
  - ■ Smart Device Framework - http://opennetcf.org