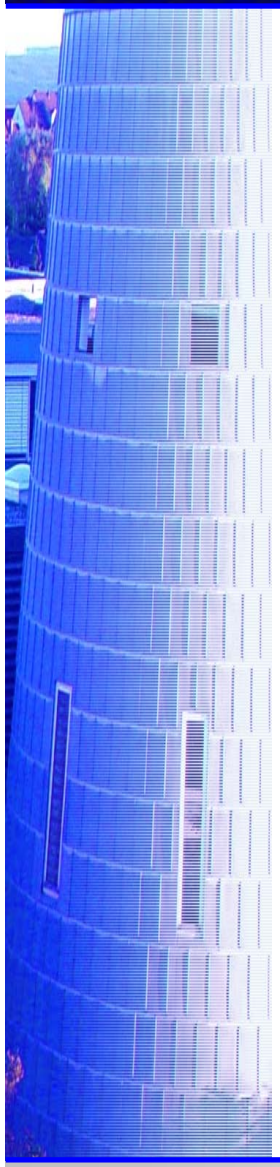


Wireless Technologies for 2015

Klaus David

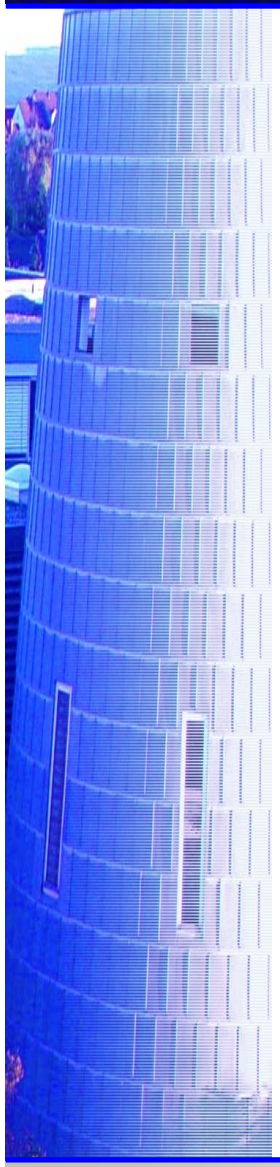
19.7.05 FDIS2005 – San Francisco

Acknowledgement

I would like to acknowledge valuable slides from:

- Dr. Frank Reichert, Ericsson, Sweden
- Dr. Seung Ku Hwang, ETRI, Korea
- Oracle
- Nokia
- WWRF
- Various people at ComTec

Overview



- **Past – Present**
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  - **Technology Trends**
  - **Application trends: Enterprise and private**
- **Wireless Technologies for the Future**
  - **What is the vision?**
  - **What are enabling key technologies?**
- **Conclusion**

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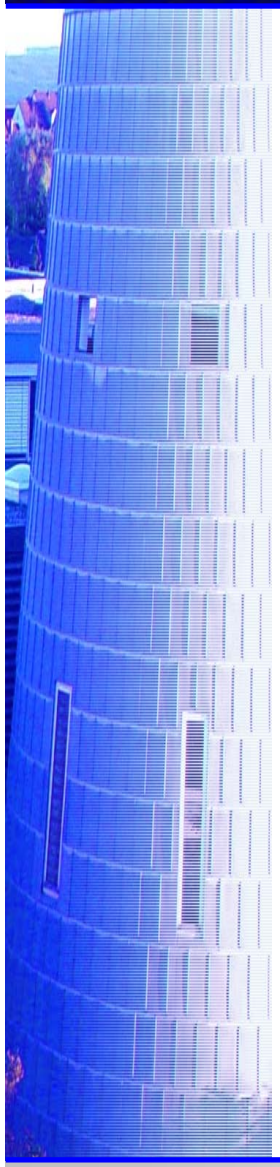
Overview



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Growth of the global digital mobile market

including comparison with Chinese GSM user base

GSM grew out of a vision that users should be able to make and receive calls on their mobiles, wherever they travelled. Among telecommunications technologies, GSM is unique in having a specific user benefit – international roaming - so central to its design, deployment and operation.

International roaming enforces compliance with open standards and promotes inter-operability between network and handset equipment from different suppliers. Together, open standards and inter-operability stimulate competition and generate economies of scale that reduce costs – to manufacturers, to operators, and most importantly, to end-users. 3GSM, based on WCDMA radio technology, was conceived and developed to carry these benefits into third generation mobile.

Not withstanding its large installed base, in 2004, GSM growth at 27.7% continued to outperform overall market growth of 23.4%. At the end of 2004, GSM was the choice of 75% of the world's digital mobile phone users. GSM added more new customers in 2004 than the end-2004 global user base of CDMA – the next most popular technology.

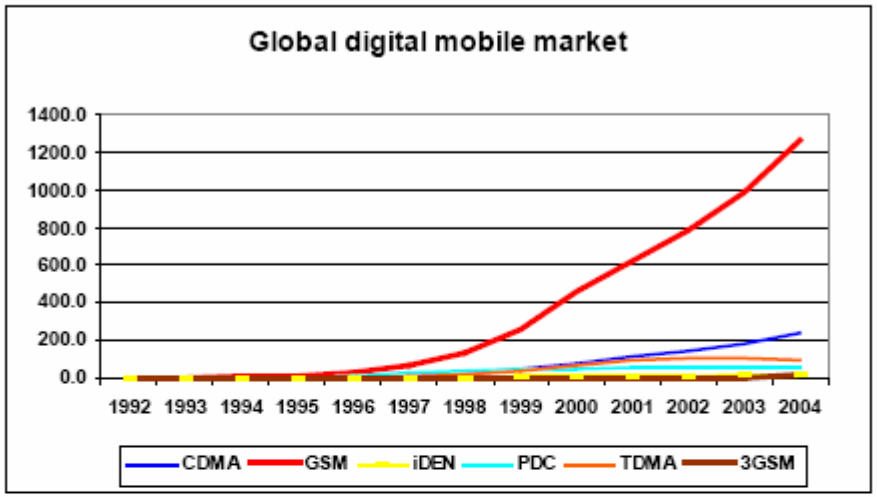
The billionth GSM user was connected in the first quarter of 2004. More than a quarter of a billion additional GSM users were connected during 2004.

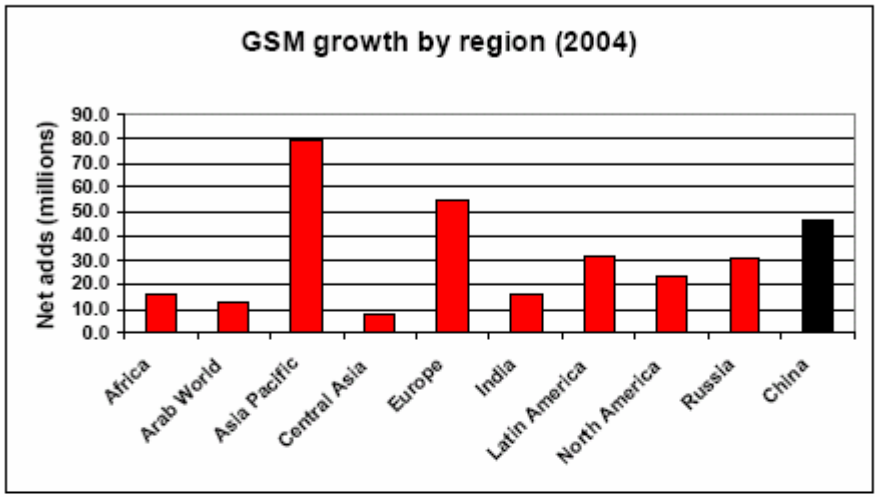
3GSM also took-off during 2004, experiencing growth of more than 500%. Of the six main digital mobile technologies, 3GSM ranked third in terms of net additions.

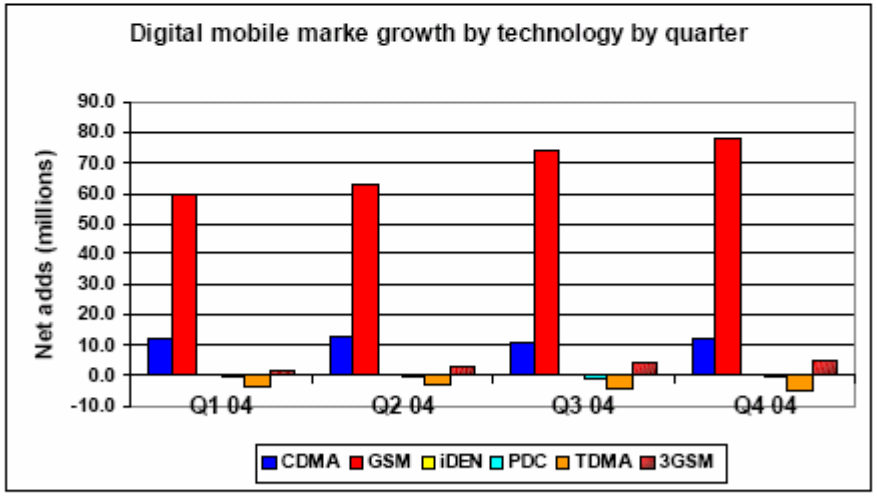
-	Dec-92	Dec-93	Dec-94	Dec-95	Dec-96	Dec-97	Dec-98	Dec-99	Dec-00	Dec-01	Dec-02	Dec-03	Dec-04	Growth 2004	% Growth in 2004	Share of 2004 growth	Share of base
CDMA	0.0	0.0	0.0	0.0	1.0	7.4	22.4	52.6	80.3	110.9	144.1	186.7	236.3	49.6	26.6%	15.4%	14.0%
GSM	0.2	1.4	5.0	13.0	32.8	71.1	138.4	258.4	456.1	626.2	790.6	991.7	1266.4	274.7	27.7%	85.2%	74.9%
IDEN	0.0	0.0	0.0	0.0	0.3	1.4	3.1	5.1	8.2	11.1	13.6	16.5	19.6	3.1	18.9%	1.0%	1.2%
PDC	0.0	0.0	0.5	3.3	13.9	26.8	38.1	44.8	50.8	56.8	60.1	61.8	58.7	-3.1	-5.0%	-1.0%	3.5%
TDMA	0.0	0.0	0.1	0.7	2.6	6.3	15.9	38.0	67.6	94.1	108.1	109.1	93.7	-15.4	-14.1%	-4.8%	5.5%
3GSM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	2.7	16.2	13.6	505.3%	4.2%	1.0%
Global Digital Base	0.2	1.4	5.6	17.0	50.8	113.0	217.9	398.8	663.1	899.2	1116.5	1368.6	1688.2	319.6	23.4%	100.0%	100.0%
China GSM	0	0	0	0.2	1.8	7.3	18.6	38.3	83.1	144.3	197.6	238.4	287.9	49.5	20.8%	15.5%	17.1%

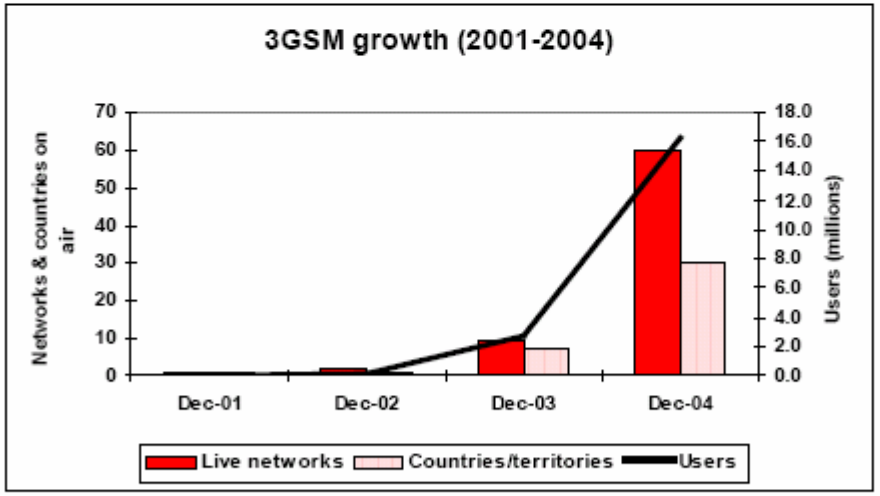
Users (millions)

Source: EMC-database.com (as at 01/02/05) GSMA analysis


Global digital mobile market
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004
CDMA GSM iDEN PDC TDMA 3GSM


GSM growth by region (2004)
Net adds (millions)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Africa
Arab World
Asia Pacific
Central Asia
Europe
India
Latin America
North America
Russia
China


Digital mobile marke growth by technology by quarter
Net adds (millions)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
-10.0
Q1 04
Q2 04
Q3 04
Q4 04
CDMA GSM iDEN PDC TDMA 3GSM


3GSM growth (2001-2004)
Networks & countries on air
70
60
50
40
30
20
10
0
Users (millions)
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Dec-01
Dec-02
Dec-03
Dec-04
Live networks
Countries/territories
Users

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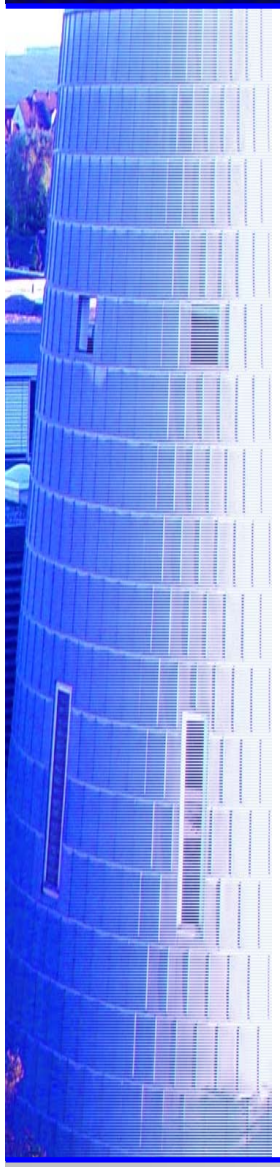
GSM Facts and Figures



- **GSM is fastest growing communications technology of all time.**
- **The billionth GSM user was connected in Q1 2004 - just a dozen years after the commercial launches of the first GSM networks.**
- **Today, GSM accounts for 75% of the world's digital mobile market and 74% of the world's wireless market.**
- **The GSM Association currently has operator members in more than 210 countries and territories.**

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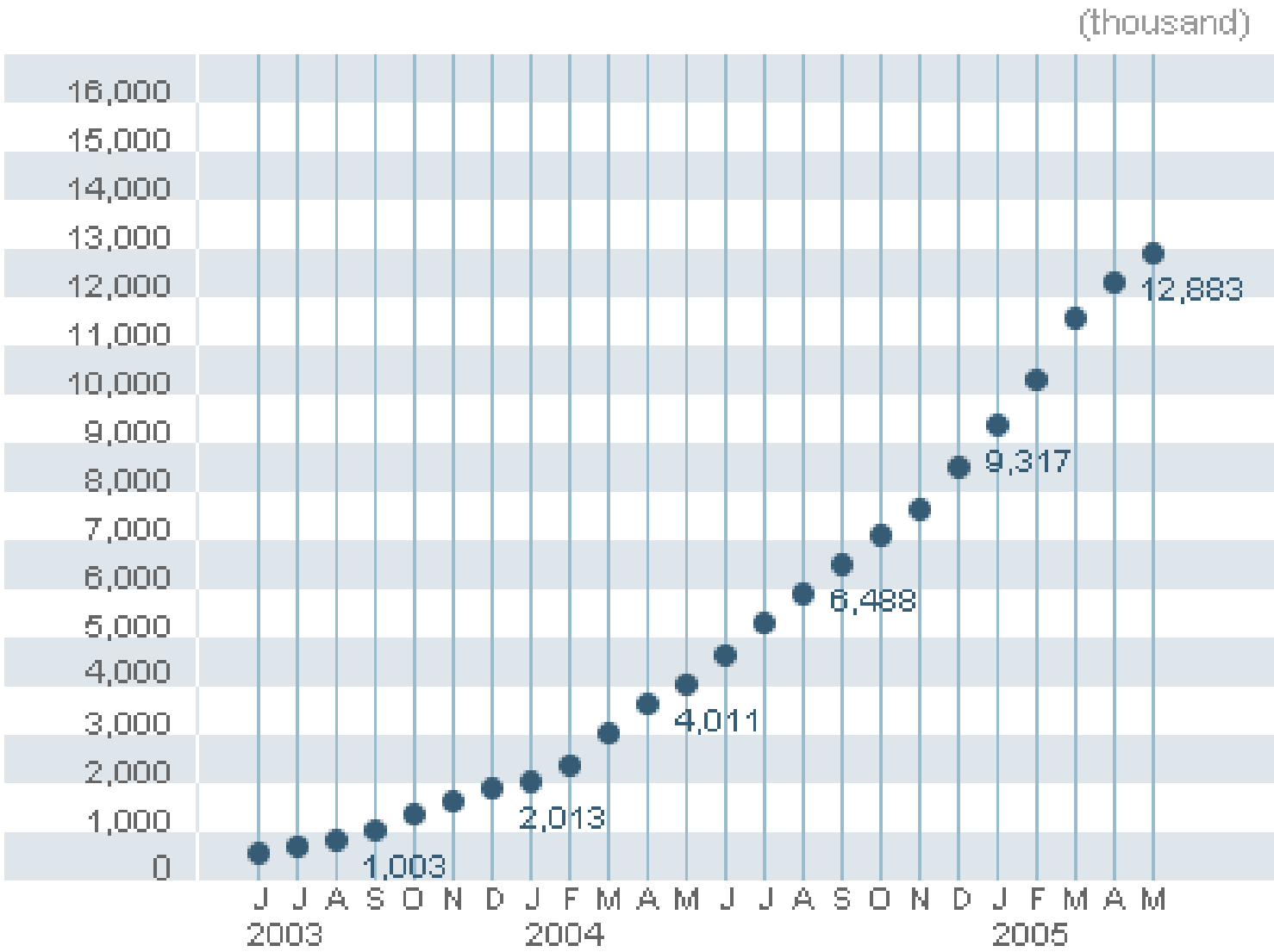
FOMA Subscriber Growth



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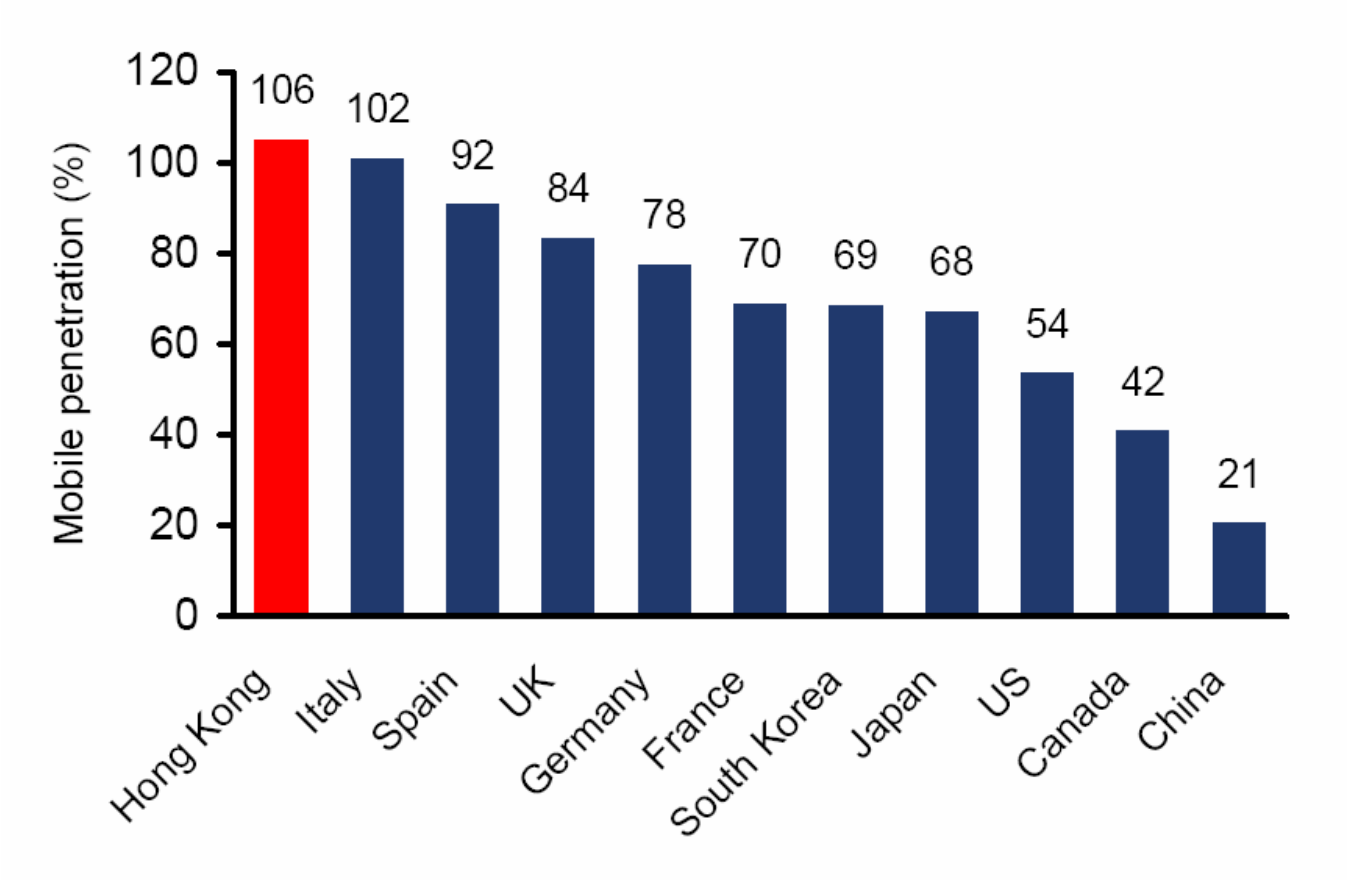
Mobile Penetration



Source: ITU, mobile penetration for 2003

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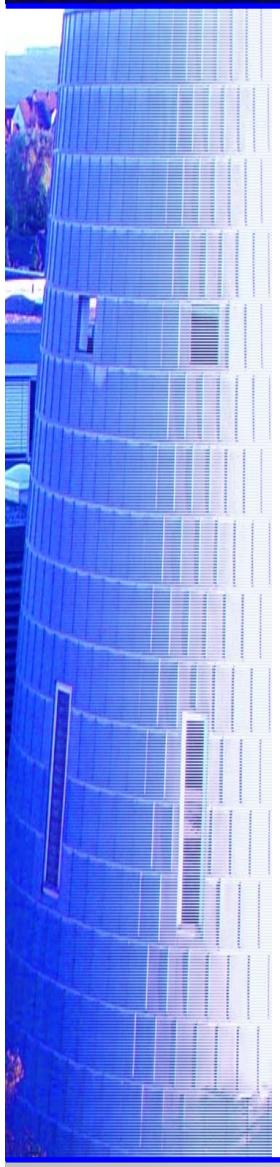
Market „Conclusions“



- **Major growths for voice (+SMS) only can be expected in e.g.**
  - **Africa**
  - **China**
  - **USA**
- **Certain markets are saturated (close to or above 100% penetration) for Voice (+SMS) like**
  - **West-Europe**
  - **Japan**

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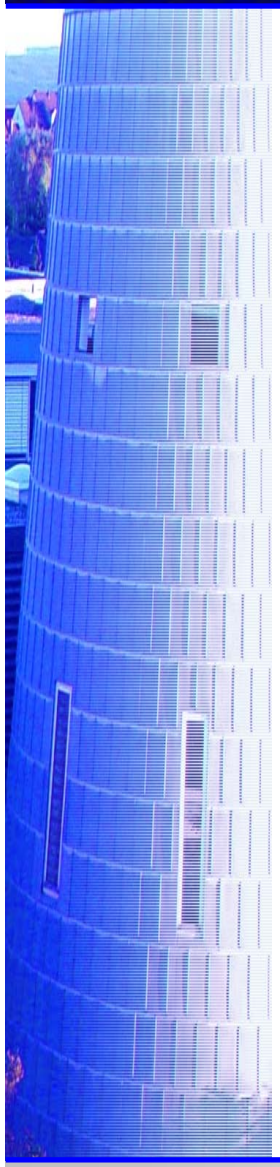
Market „Conclusions“



- **Current WLAN Pricing equal to or higher than Cellular in EU**
- **Ranking of Leading markets**
  - **ARPU**
    - **USA, Swiss ~ 50 € - Germany ~ 25 € - (Moscow ~ 2000 €)**
    - **Other figures**
  - **Penetration**
    - **Scandinavian Countries, Japan, Italy, UK, …**
  - **“value” Services**
    - **Scandinavian Countries, Japan, …**
  - **3G**
    - **Japan, ?**
  - **…**
- **Questions:**
  - **In 2003 in Germany 20 Billion SMSs**
  - **Data services?????**

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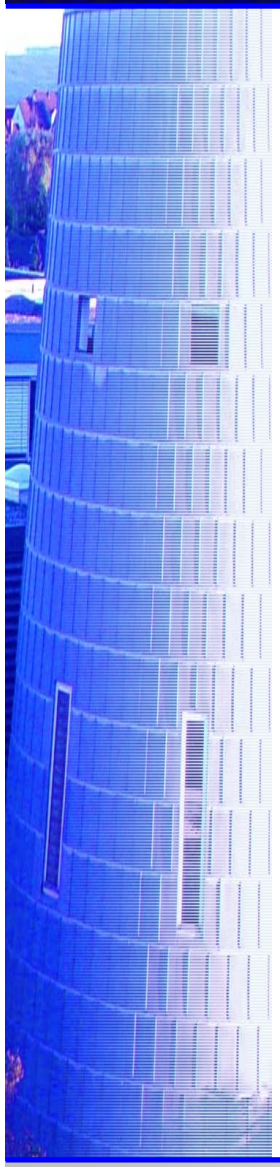
Overview



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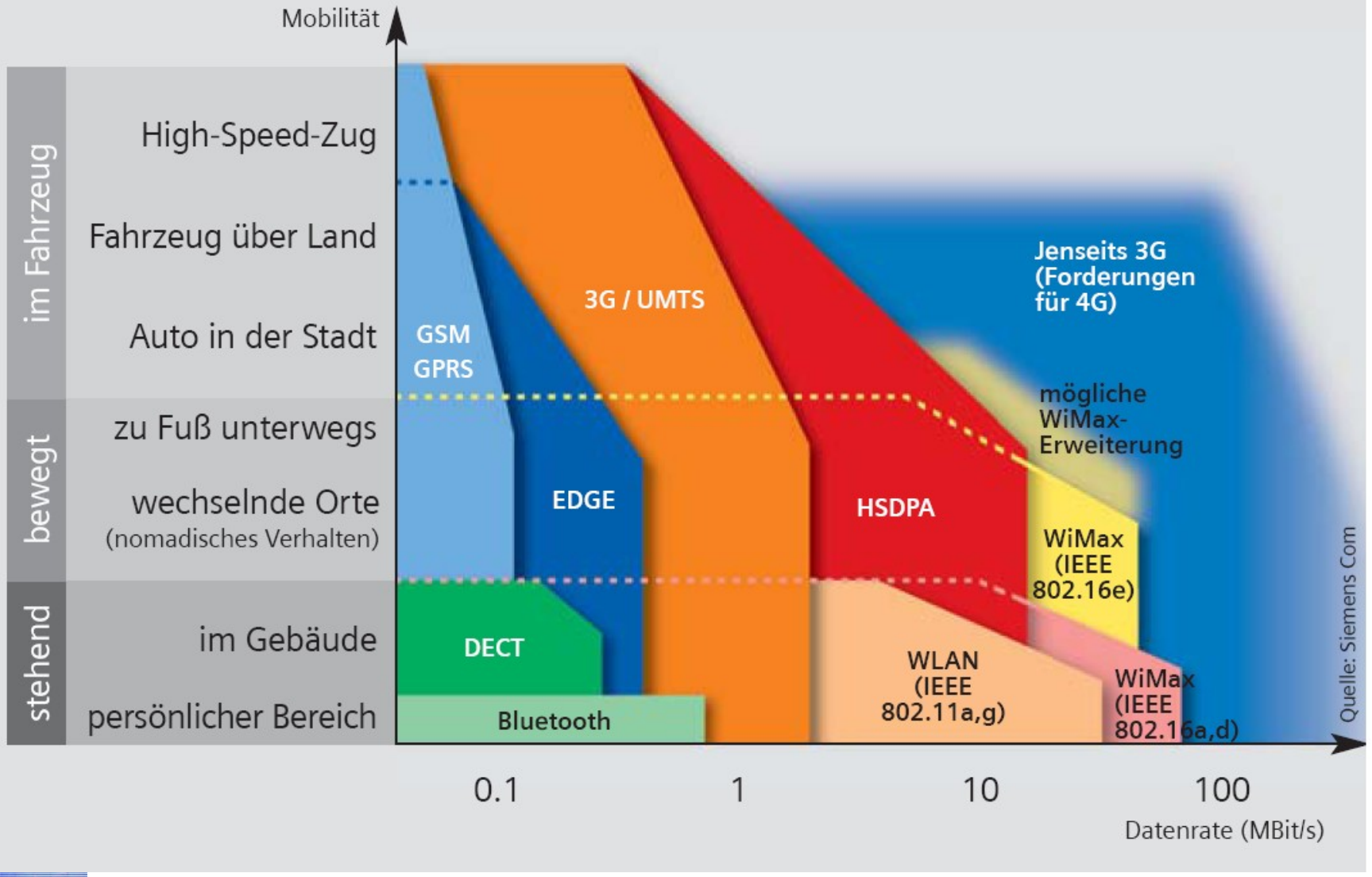
Technology Trends. Air-Interfaces



1992

≥ 2 kg, ~ 20 min. talk time

2005

~ 100 g

Several hours talk time

14 mm thin

Technology Trend: Terminals and Services

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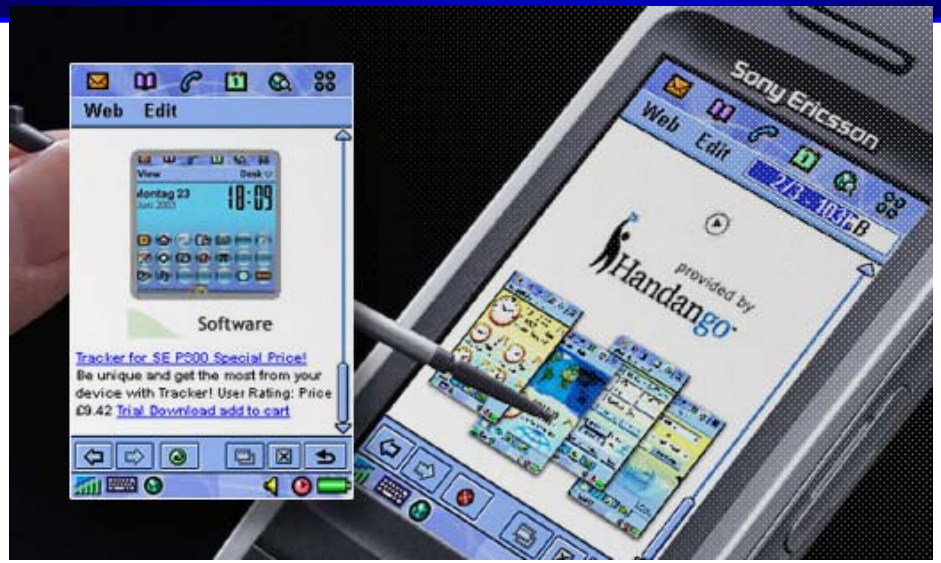
- Sony Ericsson P900
- Imaging/Messaging: 65.536 Farb LCD display, Email, MMS, EMS, VGA Kamera, Video Streaming
- Connectivity: Wireless Bluetooth Technology, Scnc ML, Memory Stick Duo,Infrared,GPRS, USB support, RS32 cable support
- Internet: WAP 1.2.1, WAP 2.0, cHTML, Modem
- Entertainment: Start up/ Shut down Shows, MP3 audio, MPEG4 Video, Java, Video Player



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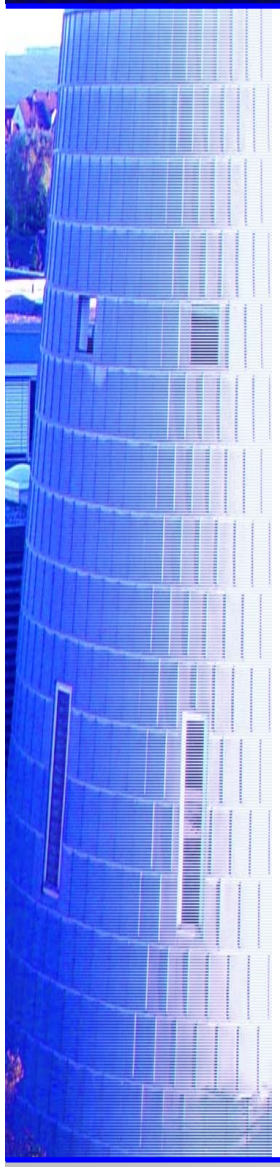
Overview



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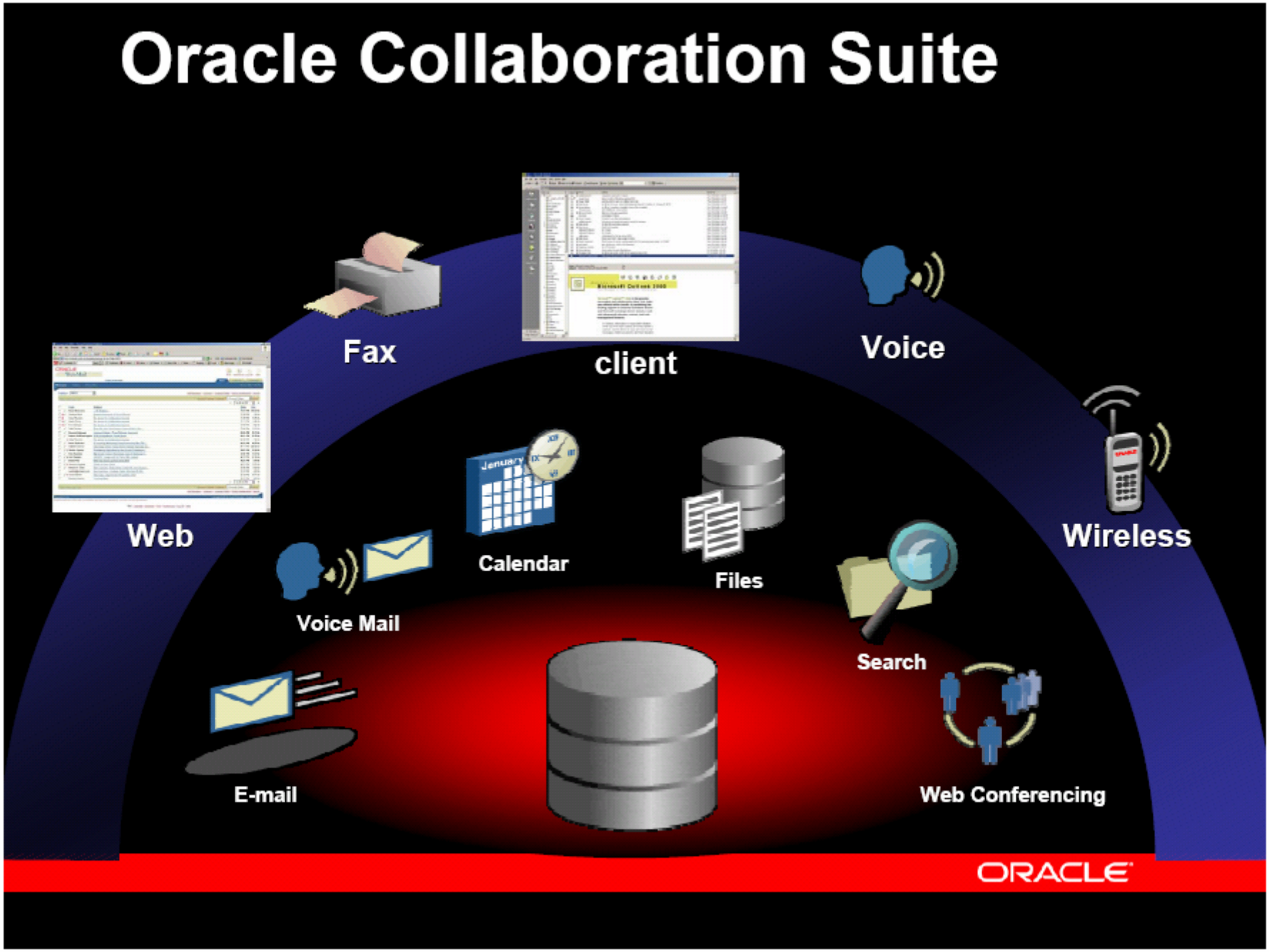
How Will it Evolve?

History tells us…


Oracle Collaboration Suite
Fax
client
Voice
Web
Wireless
Calendar
Files
Voice Mail
Search
E-mail
Web Conferencing
ORACLE

Key Mobile Applications

Notifications & Approvals

Sales

Expenses

Configurator

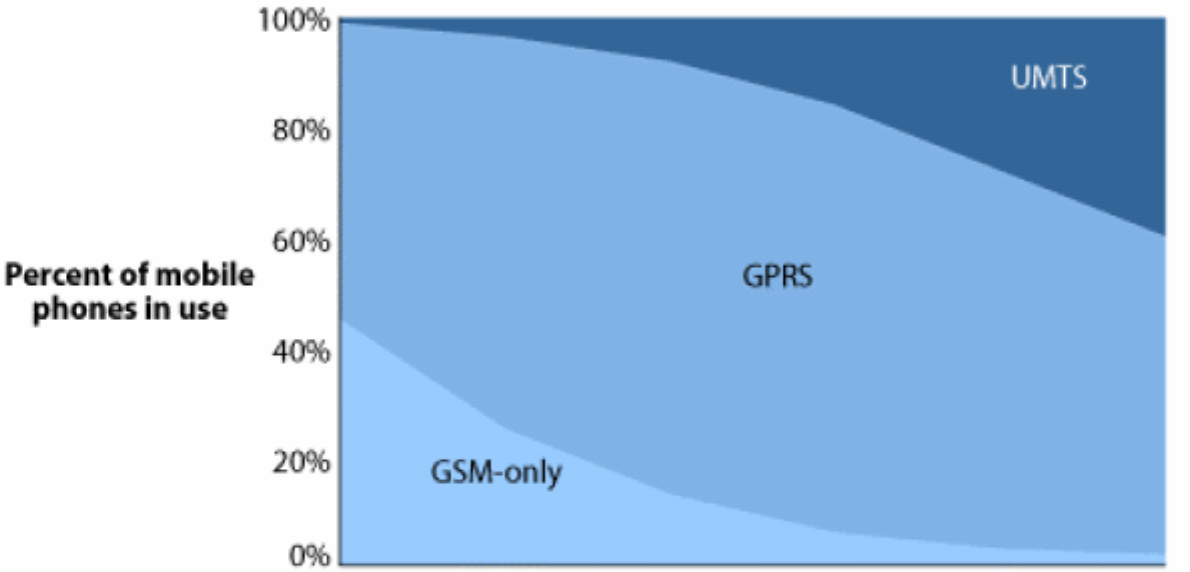
Time Reporting

Field Service

Employee Directory

Daily Business Intelligence

Identify target audience



	2004	2005	2006	2007	2008	2009
GSM-only	45%	25%	12%	6%	3%	2%
GPRS	54%	72%	79%	77%	69%	58%
UMTS	1%	4%	8%	16%	28%	40%

*All figures are at year-end.

Base: Western European mobile phones in use
(percentages have been rounded)

Source: Forrester Research, Inc.

Mobility in consumer environment

A top 10 list

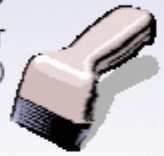
1. Many mobile banking concepts have failed in the past
2. How to improve – The difference that leads to success
3. Identify target audience
4. Communicate value
5. Make discovery easy
6. Make it easy to use
7. Create and enforce a feeling of security
8. Build a routine and ensure they return
9. Measure results for continuous improvement
10. Is it really that difficult to build a mobile bank?

Transportation Process to DaimlerChrysler **with Trendfire® RTML** (Slide 1 of 3)

Request of Component Delivery

Loading of Goods at Supplier

Barcode Scanner (or RFID Reader)



Nokia Smart-phone

Delivery information is sent to RTML Server

Truck driver uses a Symbian-based Smartphone from Nokia with a Barcode Scanner

Truck driver starts RTML client on Smartphone and downloads expected shipments

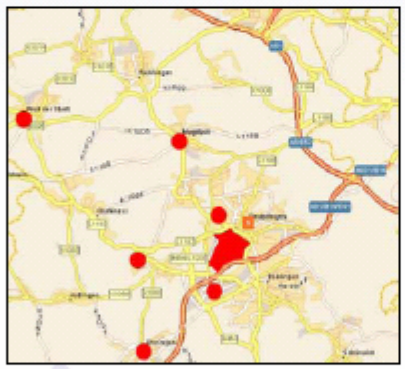
All loaded goods are scanned and compared for consistency
- Attachment of notes or pictures

Truck driver completes loading process; automated feedback is given to DaimlerChrysler

Truck driver starts trip to DaimlerChrysler and notifies RTML Server to start automated tracking

Get Connected

Transportation Process to DaimlerChrysler **with Trendfire® RTML** (Slide 2 of 3)



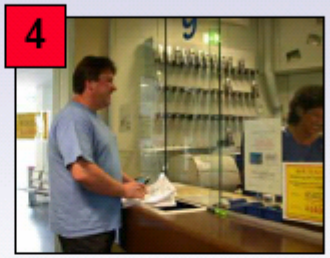
3

Transportation from Supplier to DaimlerChrysler

Continuous tracking of truck
- Tracking of truck is done with Cell-ID locations of the phone (or GPS)
- Automated calculation and correction of estimated arrival time at DaimlerChrysler

Further control instructions when approaching DaimlerChrysler at 30 and 5 km distance

4



Registration at Office for Incoming Goods

Registration process is automated

Truck permitted to enter factory by Smartphone

Get Connected

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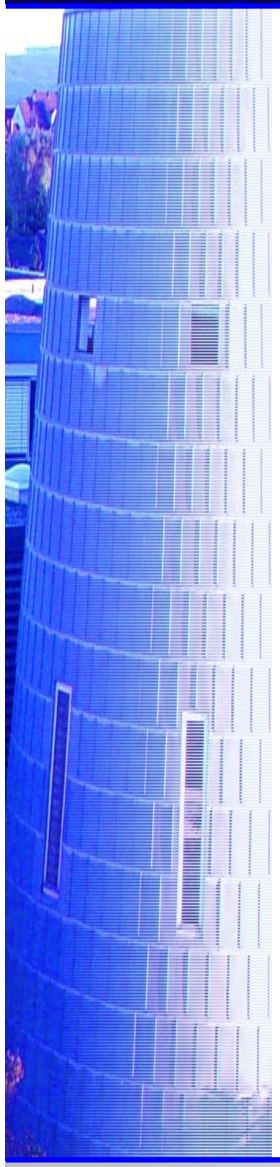
Private Applications



- **ring tones**
  - **Several hundred million EU/year in germany allone**
- **Screen safers etc.**
- **Games**
- **Camera Handies**
- **Navigation**

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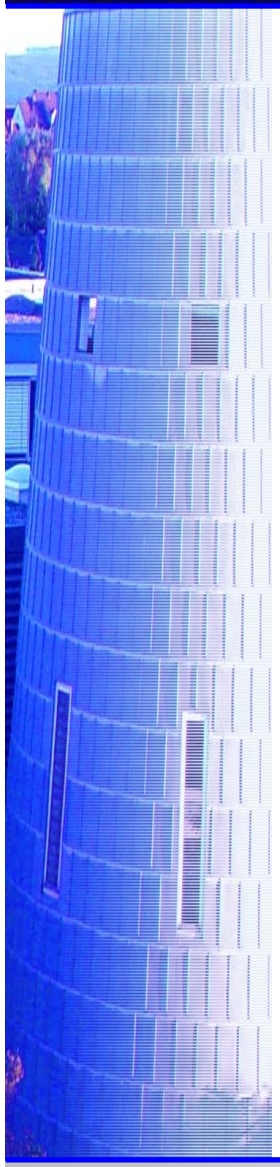
Overview



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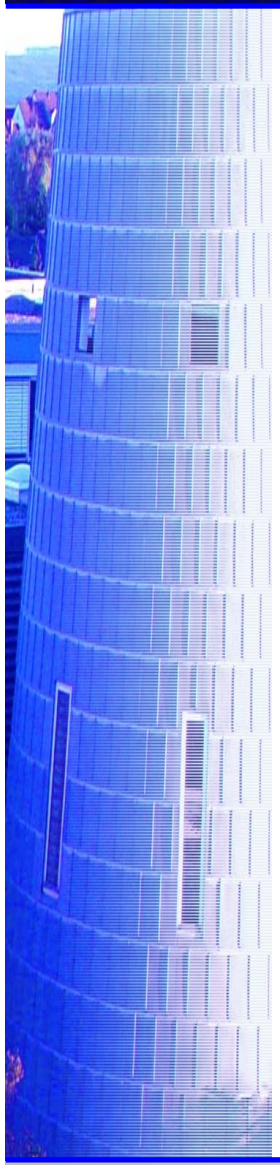
Perspectives of 3G/4G/5G:



Freedom in place and time and in Use of Features

Will allow for:

- **Enriched and cultural life**
- **More flexible and diversified life**
- **More Comfortable and Safer Life**
- **More Personal and Convenient Life**

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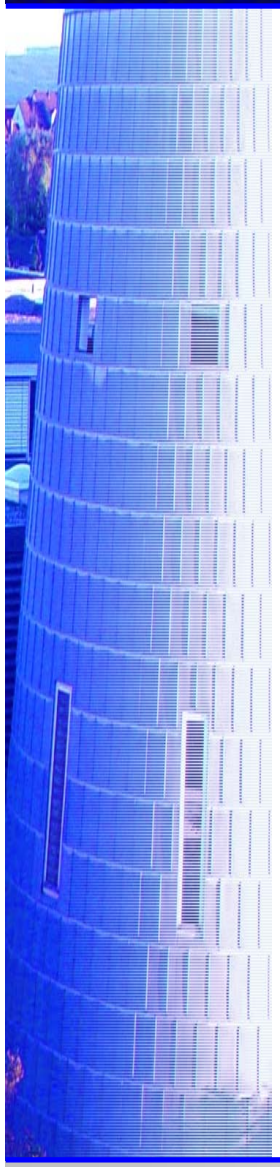
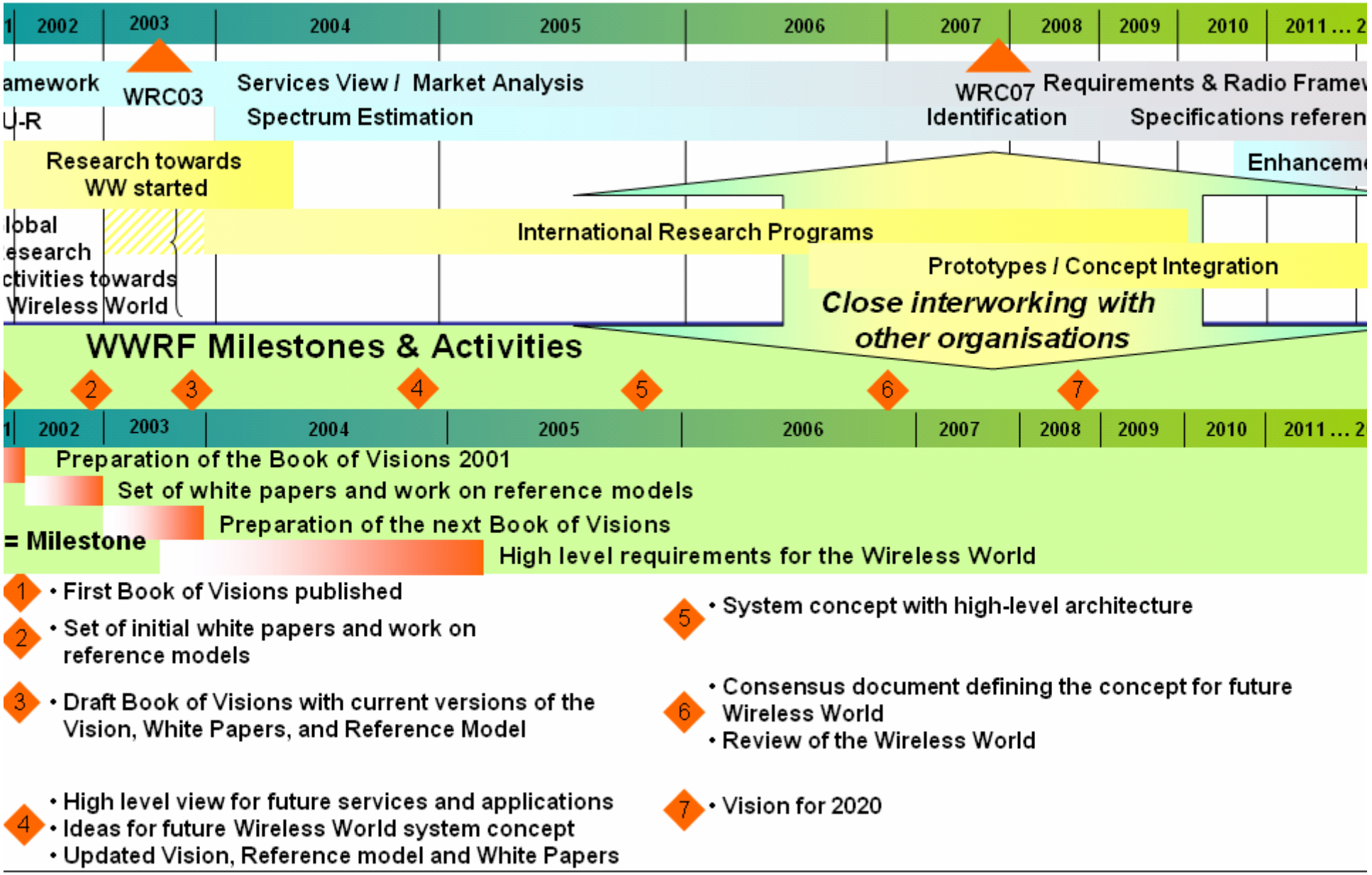
Perspectives of 3G/4G/5G:



- **An application for more real communication will likely develop into an important application. Real here means communications that can express human feelings or emotion**
- **Content is king????**
- **connectivity**
- **Meaning in communication**

Global context towards the Wireless World



1 • First Book of Visions published

2 • Set of initial white papers and work on reference models

3 • Draft Book of Visions with current versions of the Vision, White Papers, and Reference Model

4 • High level view for future services and applications
• Ideas for future Wireless World system concept
• Updated Vision, Reference model and White Papers

5 • System concept with high-level architecture

6 • Consensus document defining the concept for future Wireless World
• Review of the Wireless World

7 • Vision for 2020

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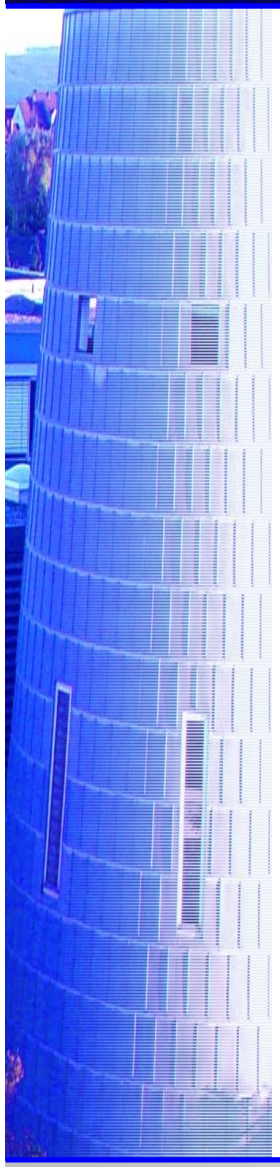
Overview



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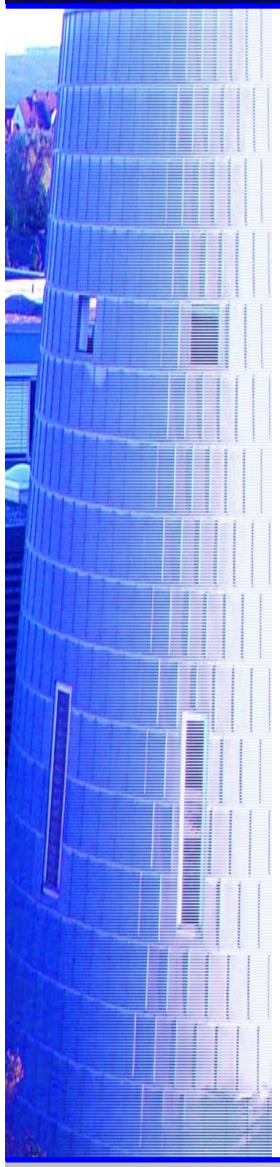
Key Technologies



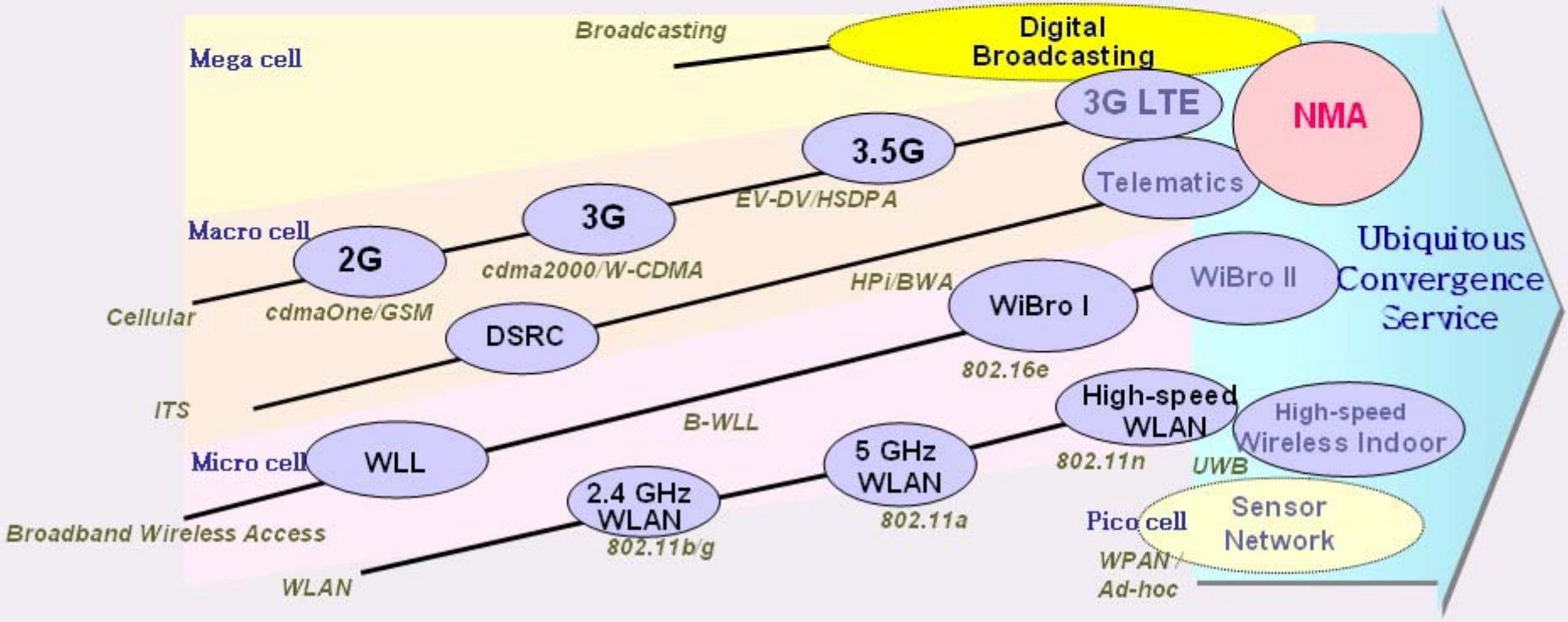
- **Korean Vision: air - interfaces**
- **Networking**
- **Terminals**
- **Middleware/ Applications**

Evolution of Wireless Communication

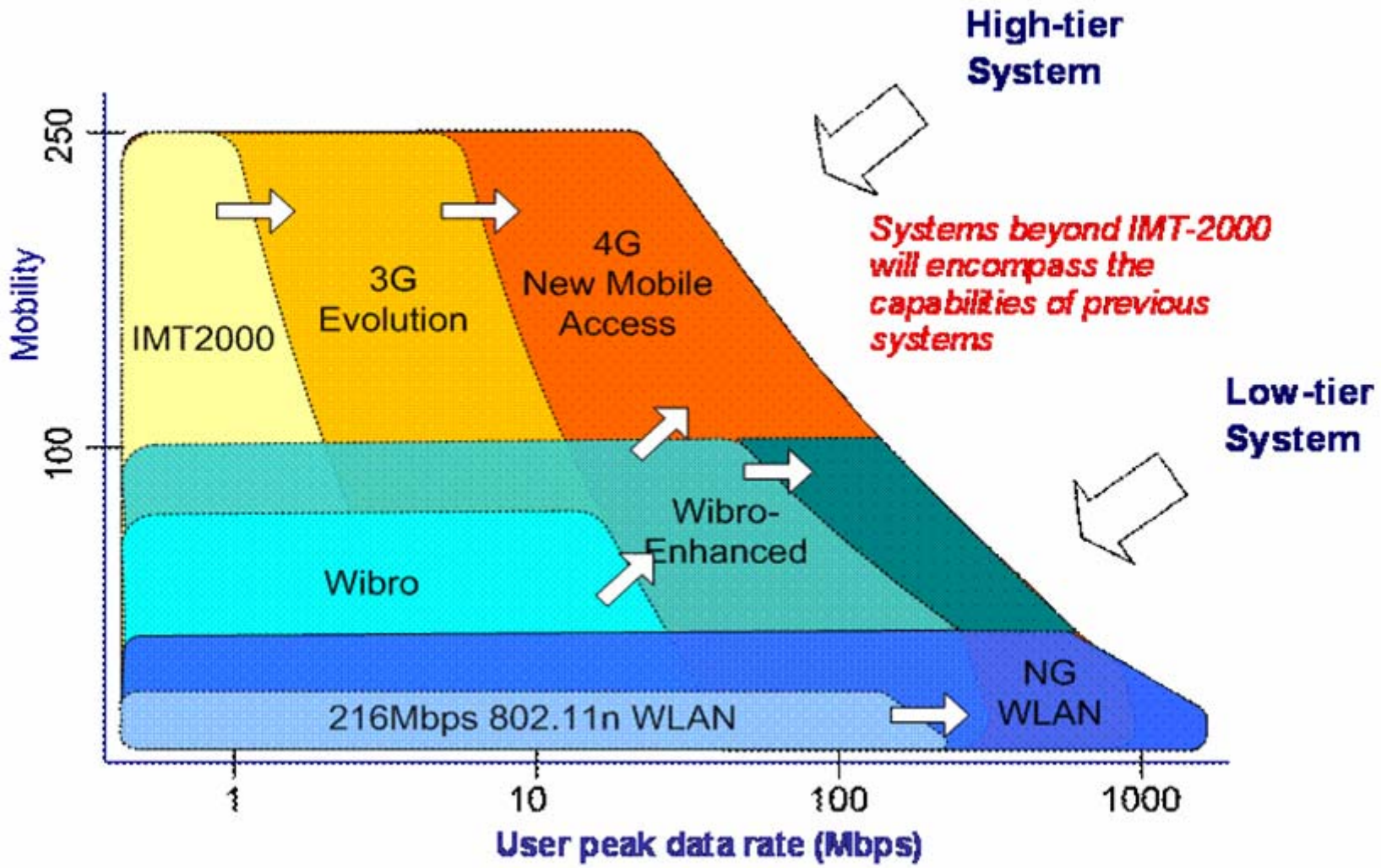
IT R&D Global Leader ETRI

Around 2012, thing-to-thing communication services, converged mobile services and custom-oriented services will be popular. There will be several different access systems, such as NMA, 3GE, WiBro, WLAN, UWB,WPAN, Sensor Networks, …, to be integrated into an unified framework to provide those services.

Systems are evolving toward an unified framework which will have an efficient architecture of providing Ubiquitous Convergence Service



R&D Direction



WiBro and IEEE 802.16

IT R&D Global Leader ETRI

- **Fixed Wireless (TGd; IEEE Std. 802.16-2004): IEEE Standard 802.16-2004 published on 1 Oct. 2004.**
  - "IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed Broadband Wireless Access System"
  - As a revision of IEEE Standard 802.16-2001 (as amended by IEEE Standard 802.16c-2002, and IEEE Standard 802.16a-2003).

- **Mobility Support Enhancement (TGe; P802.16e/D7): Under the Process of Sponsor Ballot Resolution**
  - IEEE-SA Standard Board approved a modified project authorization (PAR) for P802.16e project on 23 Sept. 2004.
    → Amendment for Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands below 6 GHz
  - Plan to complete in Sept. 2005.

- **WiBro Specification = Subset of Consolidated version of "IEEE Std. 802.16-2004 + P802.16e/D7 +P802.16-2004/Cor/D2."**

WiBro, 3G LTE, 4G Comparison

IT R&D Global Leader ETRI

	WiBro	3G LTE	4G
Spectrum	2.3GHz	2.5~2.6GHz	3GHz ~ 5GHz
Bandwidth	10MHz (20MHz)	5MHz, 10MHz, 15MHz, 20MHz	5MHz ~ 40MHz
Multiple Access	OFDMA/TDD	OFDMA/FDD OFDM-CDMA/FDD	OFDMA/FDD OFDM-CDMA/FDD
Service	Portable Internet/ High-speed Wireless Internet	High-speed Mobile Service	Ubiquitous Broadband Convergence
Peak Data Rate	I : ~ 50Mbps II : ~ x100Mbps	30~100Mbps	100Mbps ~ 1Gbps
Mobility	100km/h ~	250km/h	250km/h

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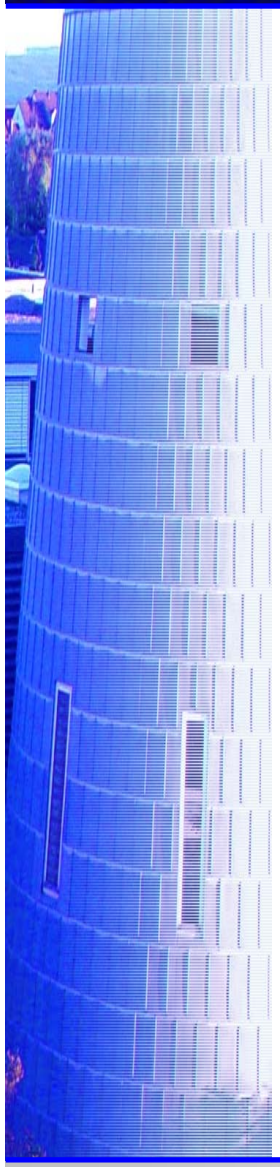
Air-Interface



- **Ultra Wideband**
- **High Speed Data Stations**
- **HAPS**

WiBro Progress & Schedule(2)

IT R&D Global Leader ETRI

- **Jan. 2005 : Selection of WiBro Operators (Decision by assessment of Business Plan proposed by candidate operators)**
  - Three operators (KT, SK Telecom, Hanaro-telecom) are selected in advance for the schedule.
- **2005. 11 : Service Demonstration at APEC PUSAN Summit 2005**
- **2005. 12 : Development of Commercial Equipments by major manufacturers**.
  - Major manufacturers (Infrastructure Systems, Radio Relays, Mobile Terminals) state that they have plans to develop commercial systems in 4Q-2005, and will start the conformance test in 1Q-2006.
- **1Q. 2006: Commencement of pre-commercialization Service**
- **2Q. 2006: Commencement of Commercialization Service in Seoul.**

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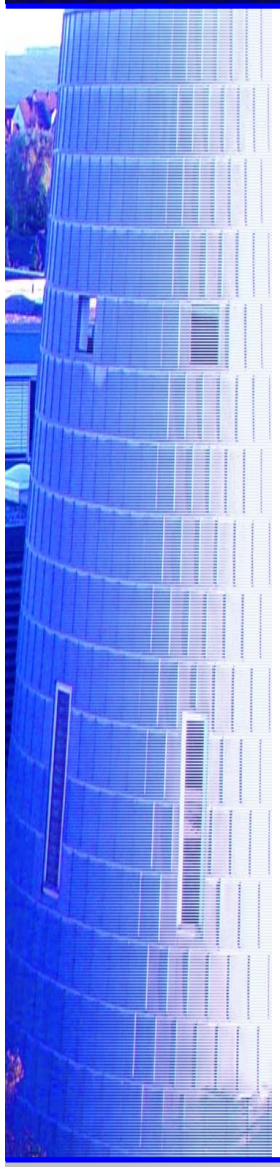
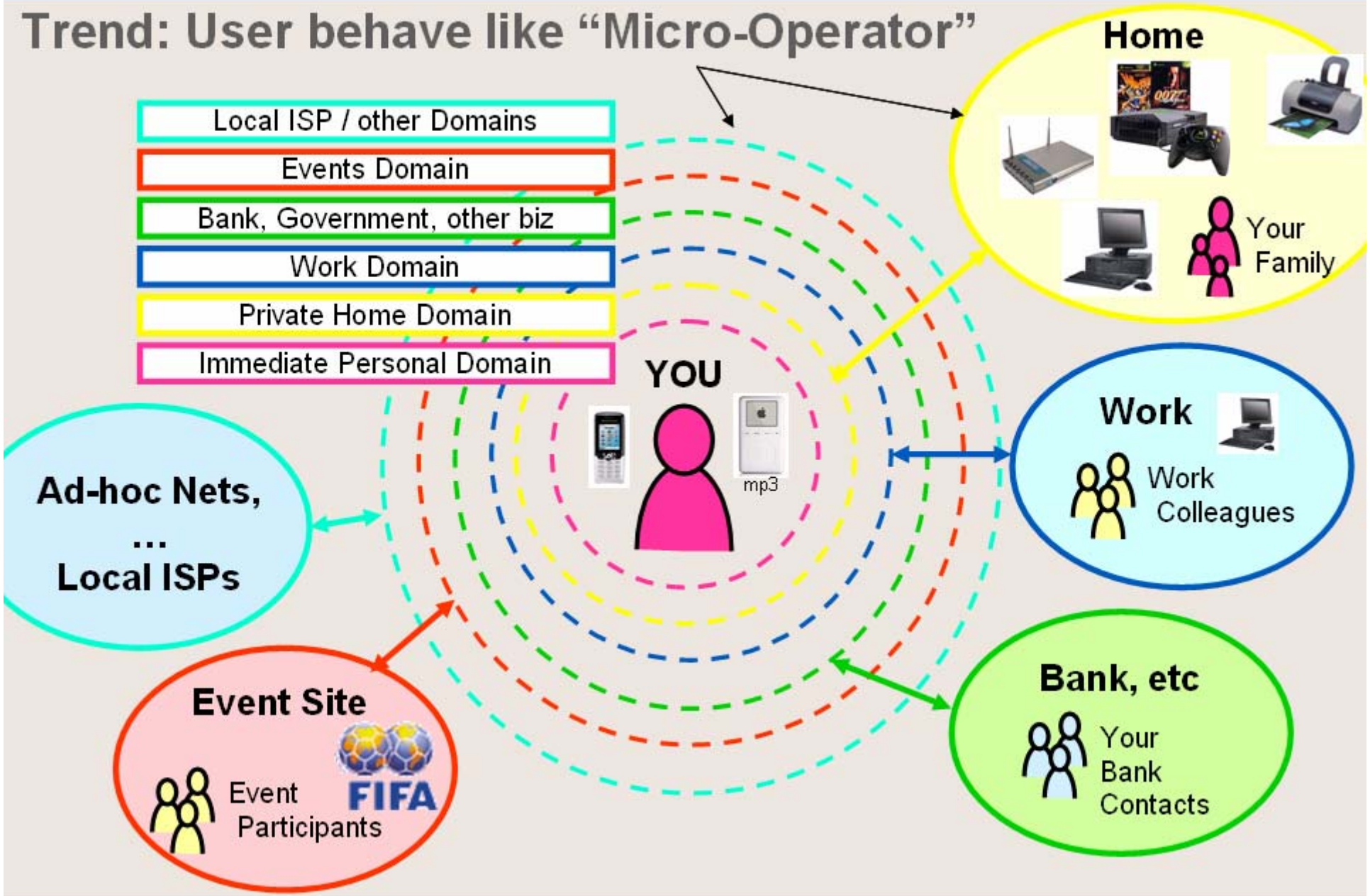
Key Technologies. Networking

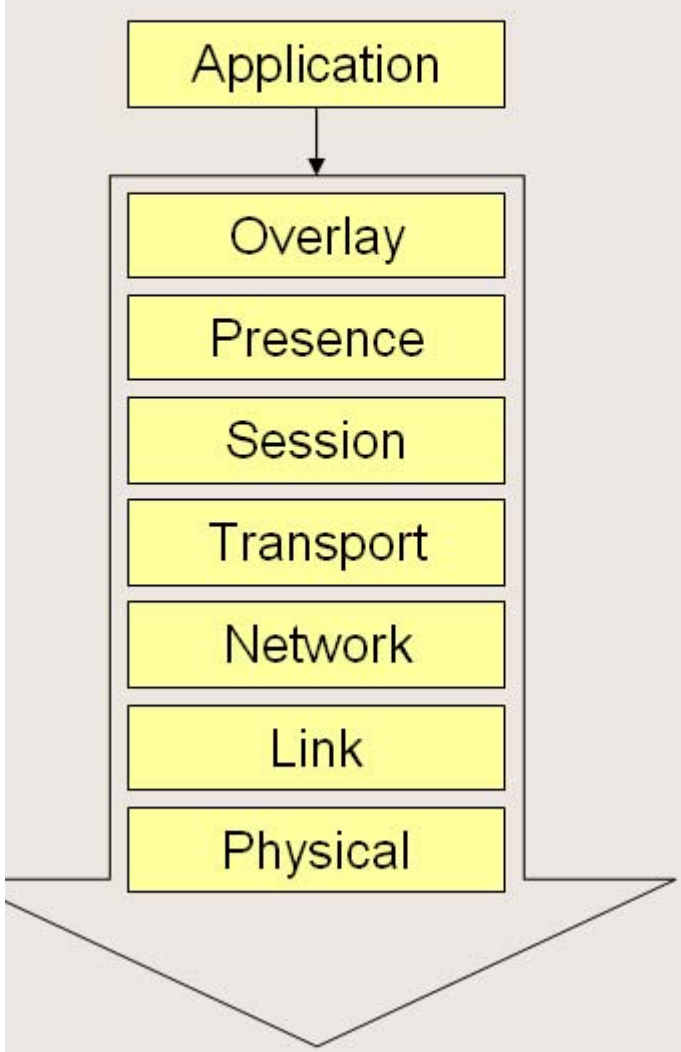


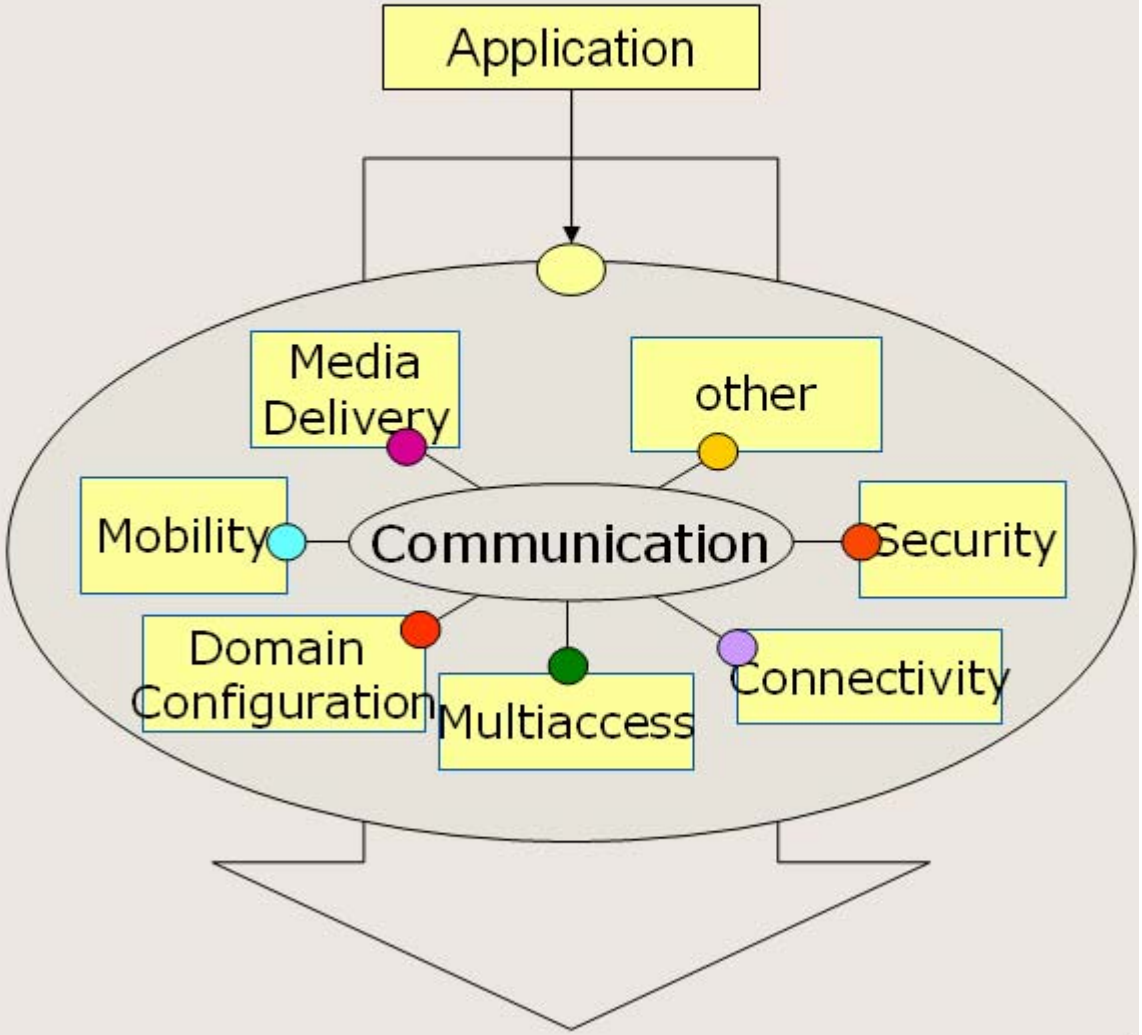
Trend: User behave like "Micro-Operator"



ERICSSON

Trend: Concurrent Entities vs. Waterfall Layers





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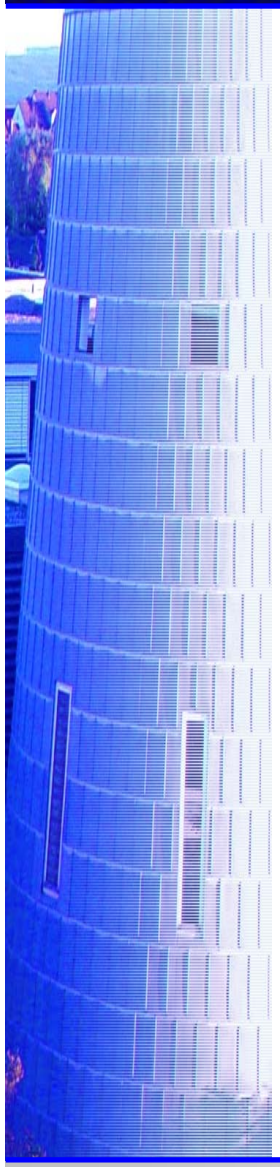
Key Technologies. Terminals



Device Trends

More Security
- DRM
- Privacy, SSO

More Openess
- Java, …
- Device management

More Storage
- Gigabytes
- memory cards
- short vs. long-term memory

More CPU Performance
- Moore's law
- 2x power / 18 months

Better Displays
- higher resolution
- more pixels
- brighter …

Enhanced Sound
- 3D, polyphonic

More Personalization
- features, color
- shape, skins, …

More Applications
- Sharing, Collaboration
- team, chat, …enterprise

More Communications
- More bandwidth
- New link types (USB, WiFi …)
- Adhoc/PAN support

Reduced Power Consumption
- New display technologies
- OS enhancements,
- MRAM technologies …

Reduced Power Consumption
- New display technologies
- OS enhancements, …

More Multimedia Support
- 3D accelaration, mpeg4, …

Improved Network Support Services
- Backup, Sync, …
- Tighter Integration with "fixed" services

Better Camera
- higher resolution
- snapshot/ video mode

More …
- advanced speech recognition
- gestures
- positioning …

Disclaimer: This is not a statement by Sony-Ericsson. Image only used for illustration purposes

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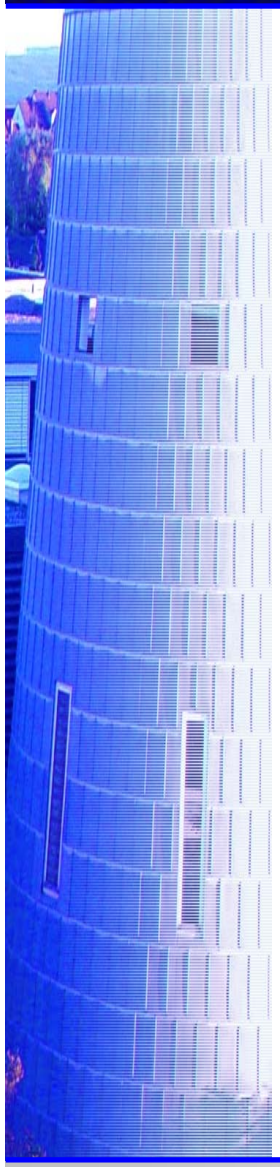
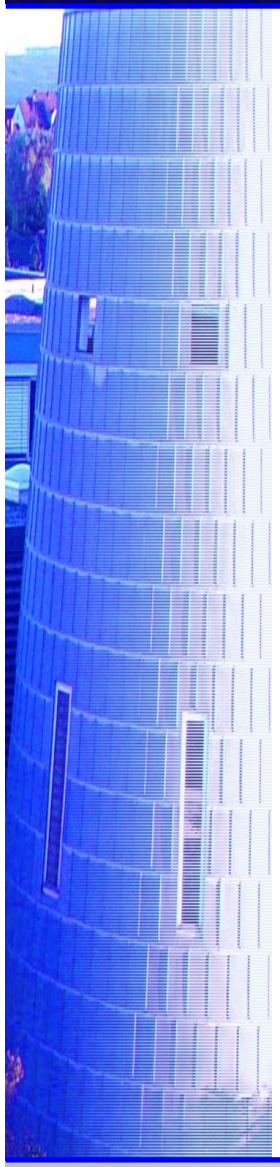
Key Technologies. Terminals



- **MMIs**
  - **Speach**
  - **Projectors – keyboards, displays**
  - **Smell**
  - **Sensors**
- **Inclusion of Broadcast Technologies**
- **Operating Systems**

Key Technologies: Middleware/ Applications - R&D at ComTec



Service Platform

Context Awareness

Personalisation

Service Creation

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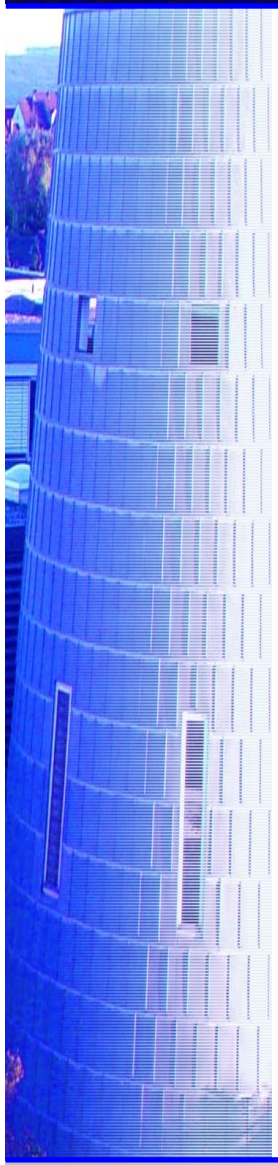
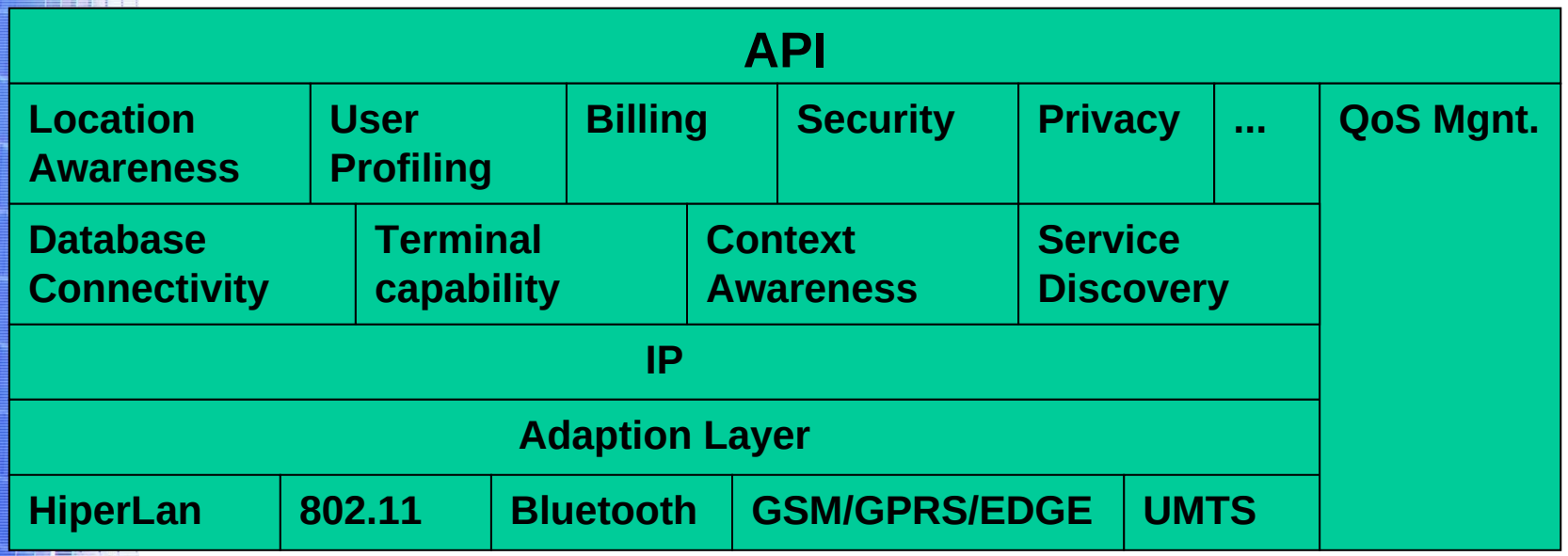
Vision: An Open Service Platform



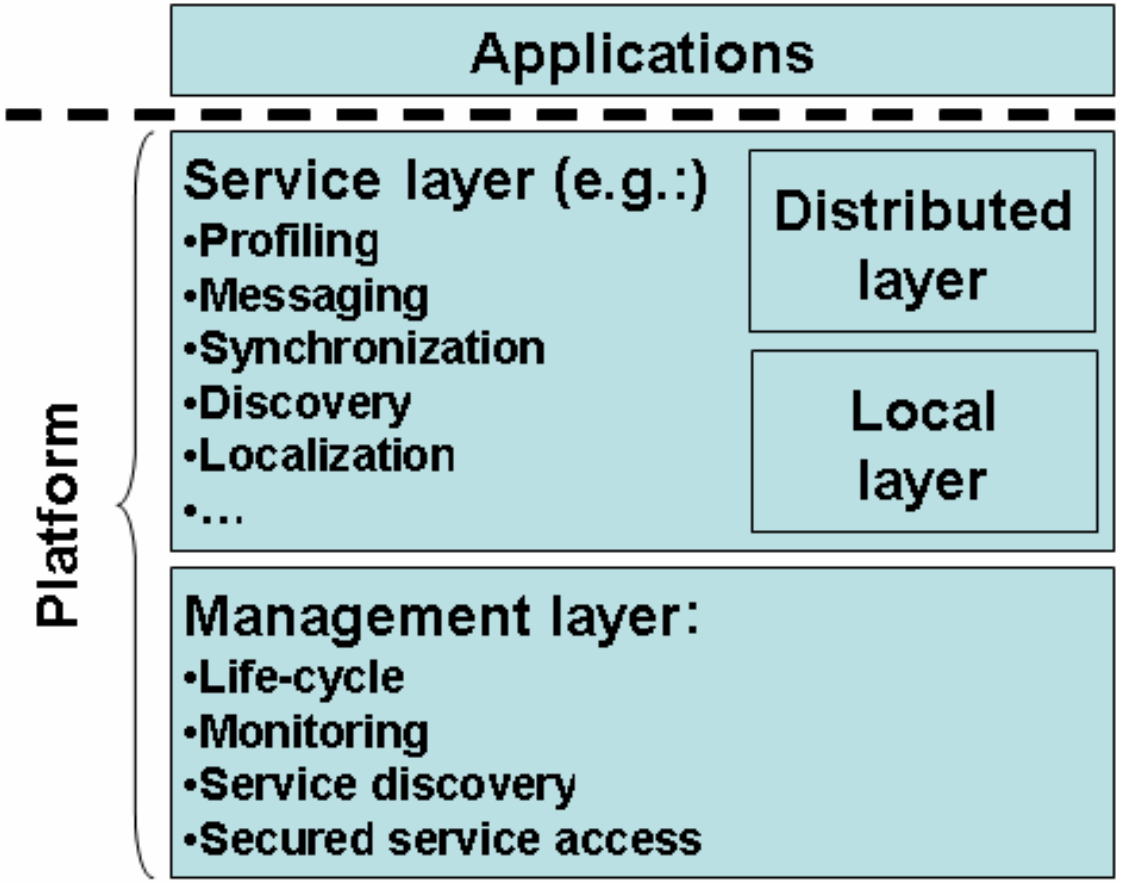
- **Principle 1: Fully distributed service environment**
- **Principle 2: Loosely coupled and composable components**
- **Principle 3: High level of cooperation at all levels (components, platforms, domains)**
- **Principle 4: Ambient intelligence**
- **Principle 5: Security and Privacy**

Different views of the same problem

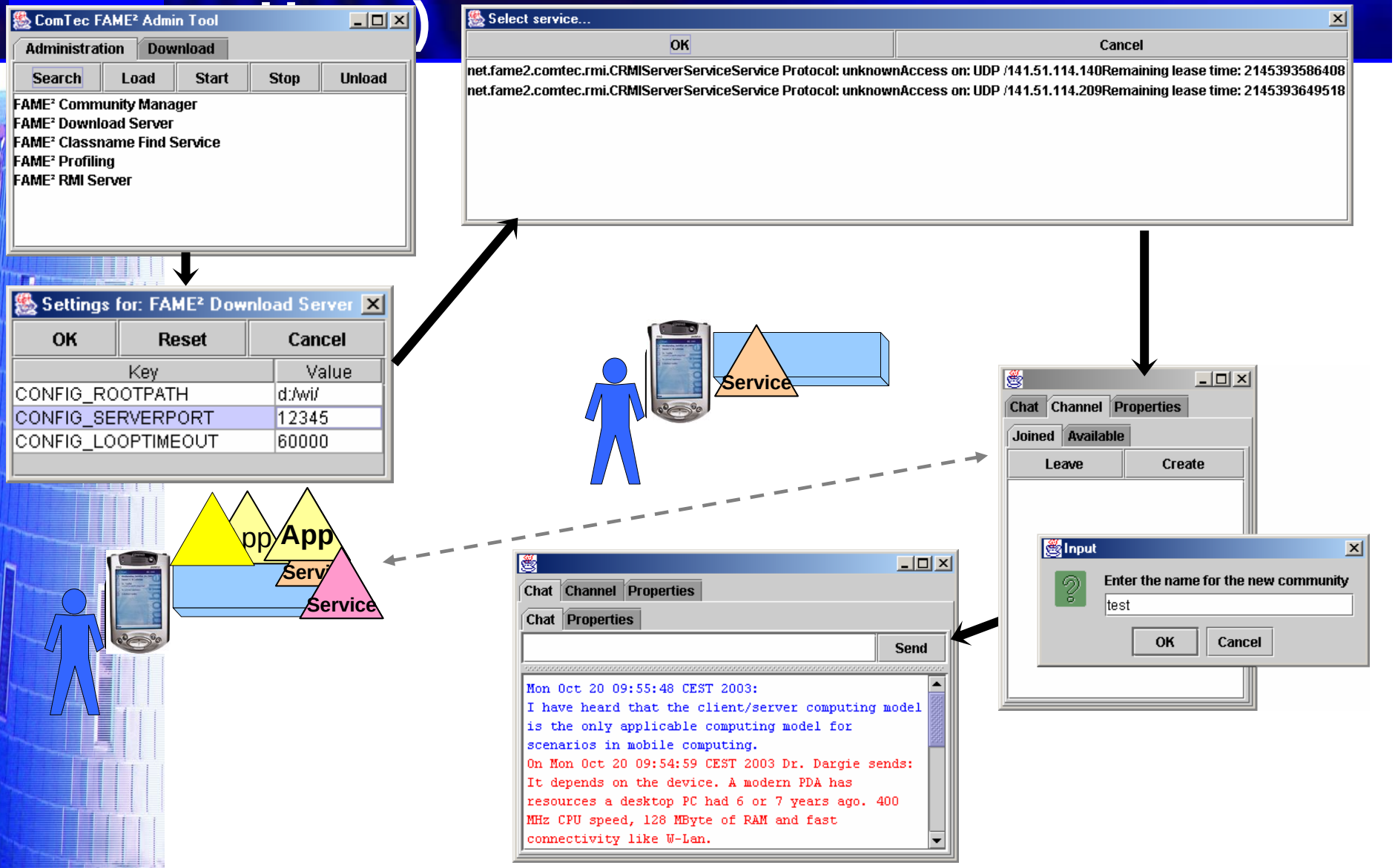
- **Middleware for “Wireless Internet Applications”**



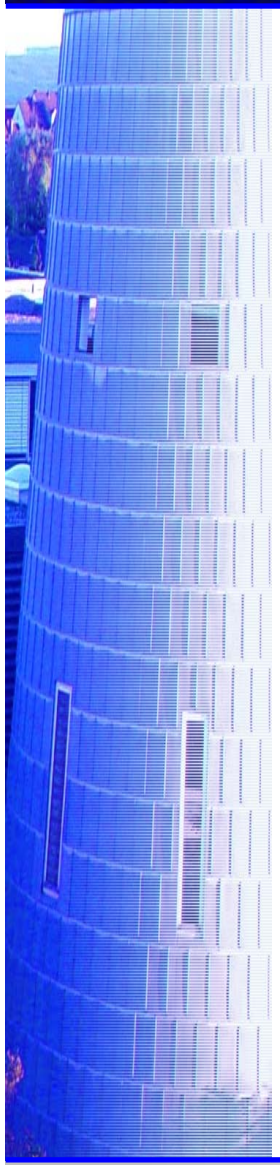
FAME² middleware concept



Peer-to-Peer: Demonstration (2 Devices /)



Definition of context awareness

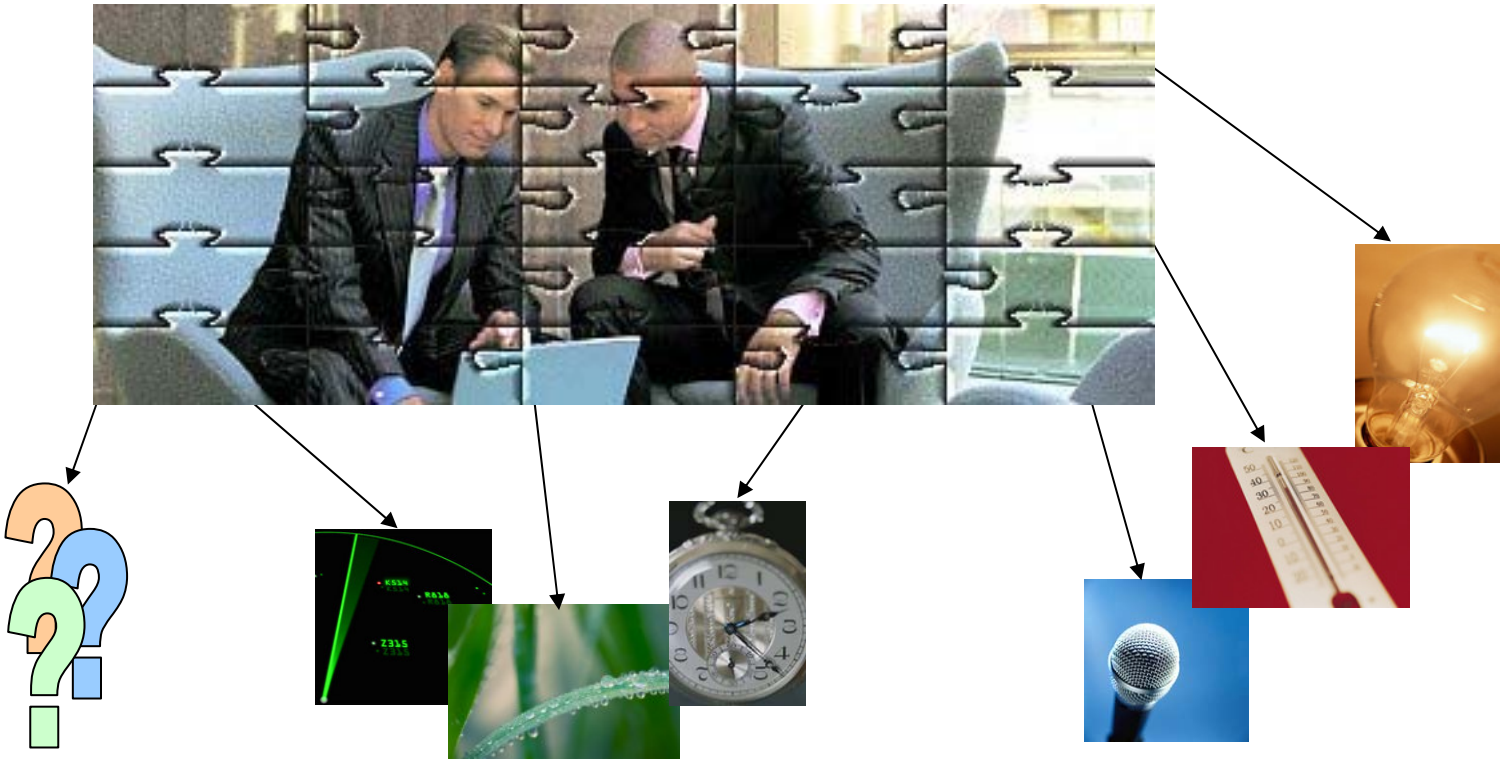


- ***Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and application themselves.***

A.K. Dey, "Providing Architectural Support for Building Context Aware Applications", PhD thesis, College of Computing, Georgia Institute of Technology, December 2000.

Situation

- **Some aspects of a situation may be measured**



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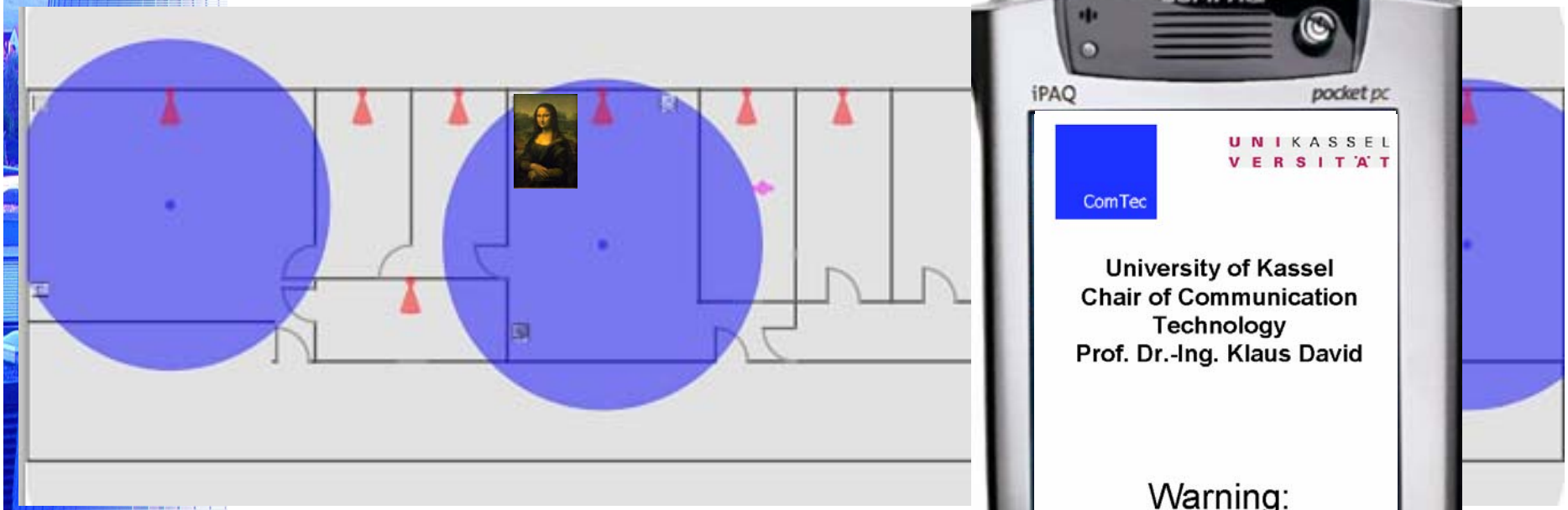
Field Trial

14. – 20. October 2004 in Saturn Shop Kassel

If (alone) - redirect



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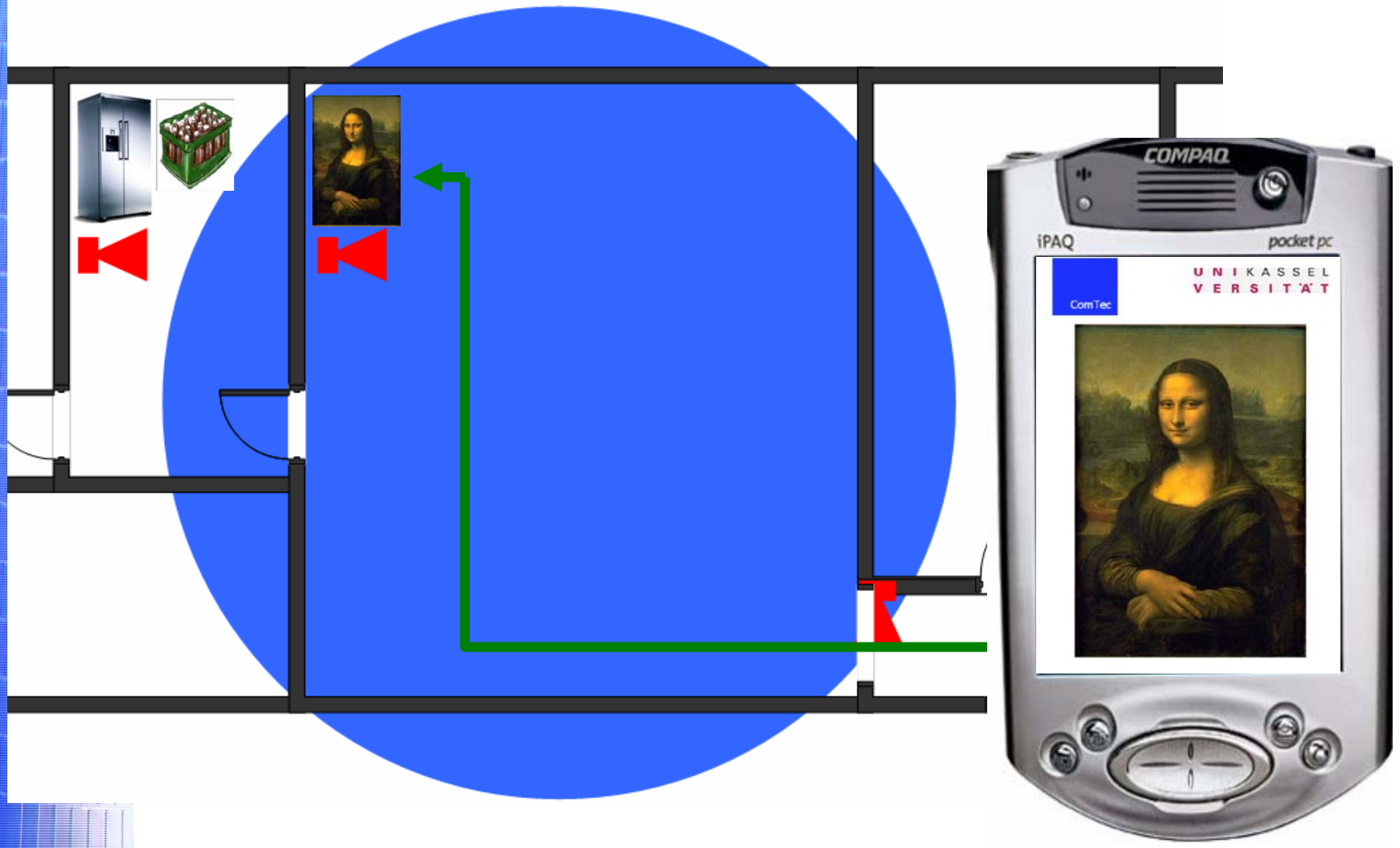
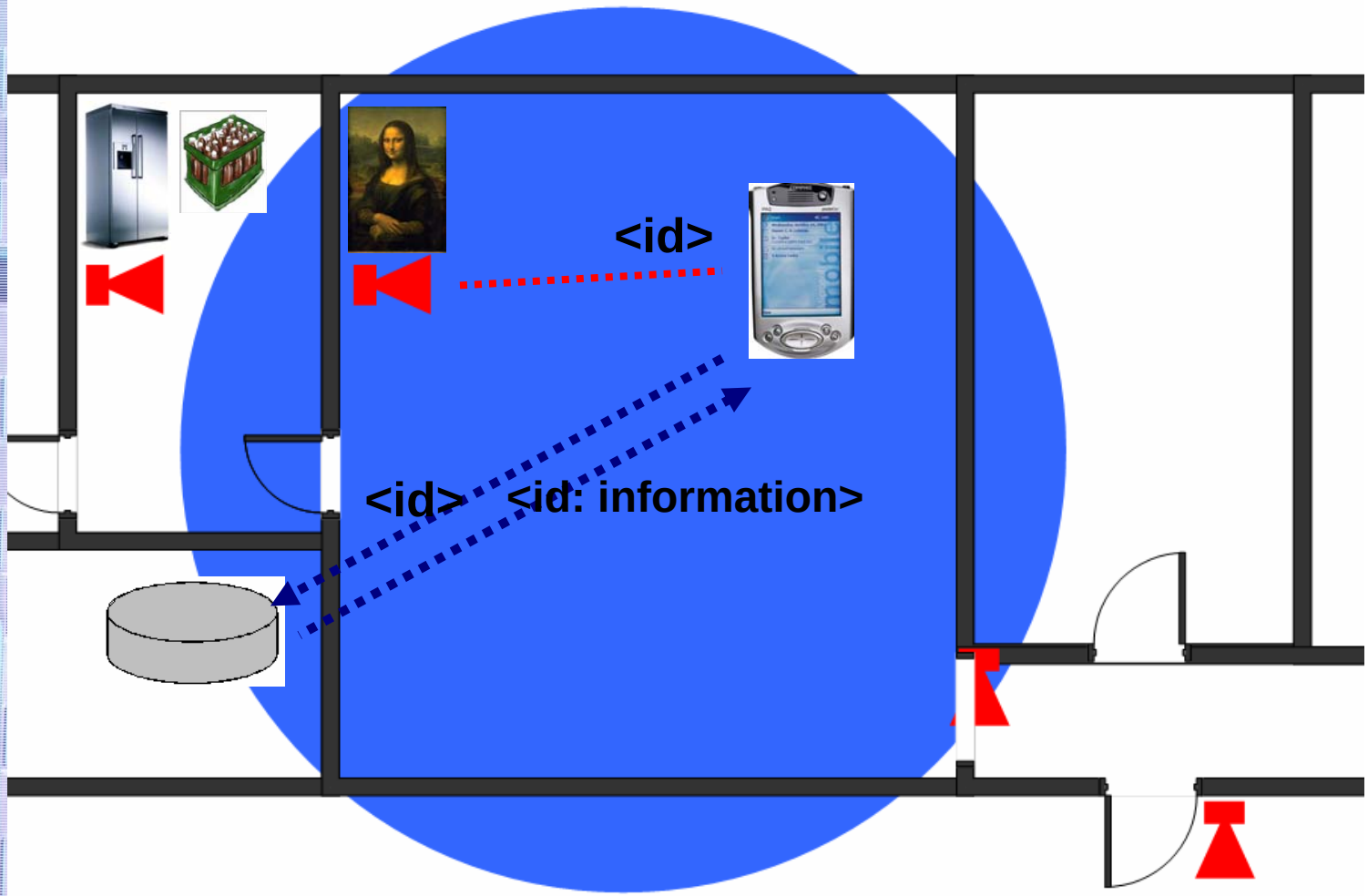
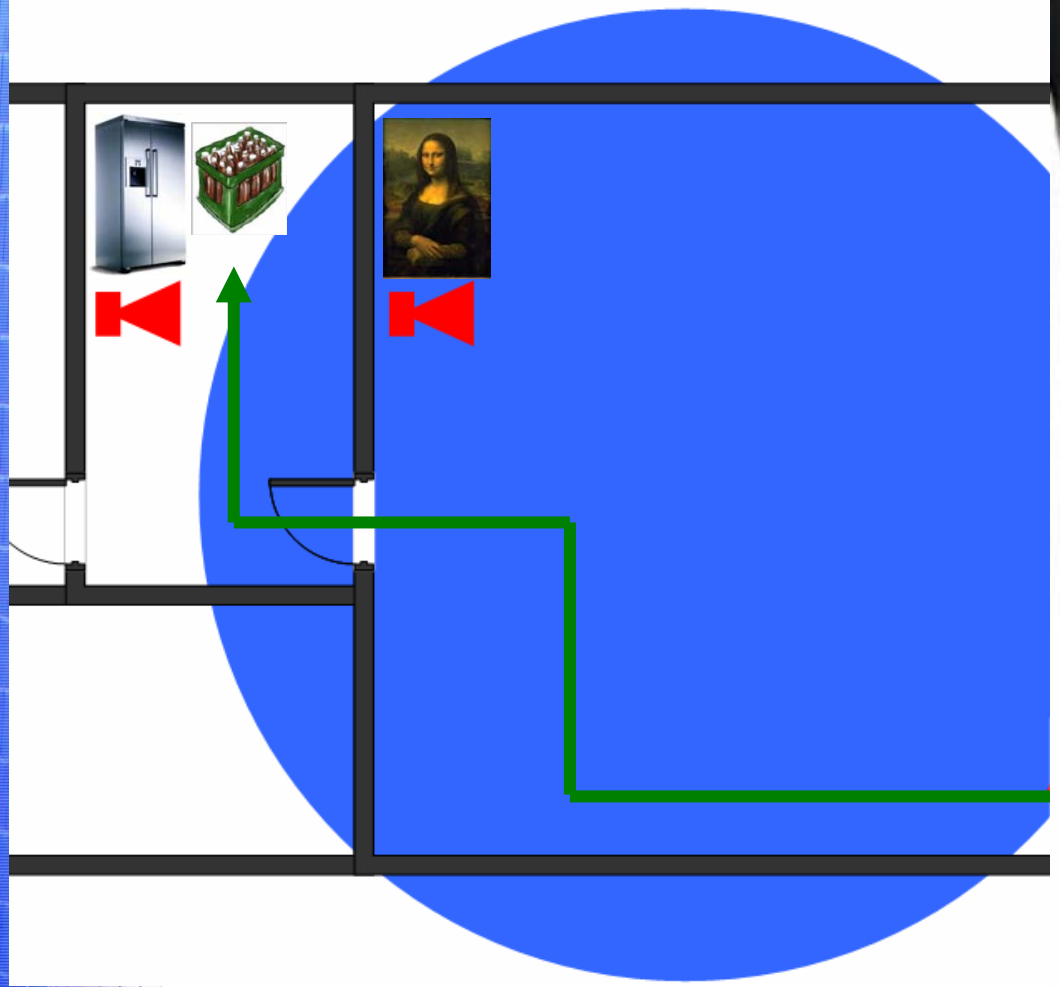
Prof. Dr.-Ing. Klaus David
Warning:
Art Object Found





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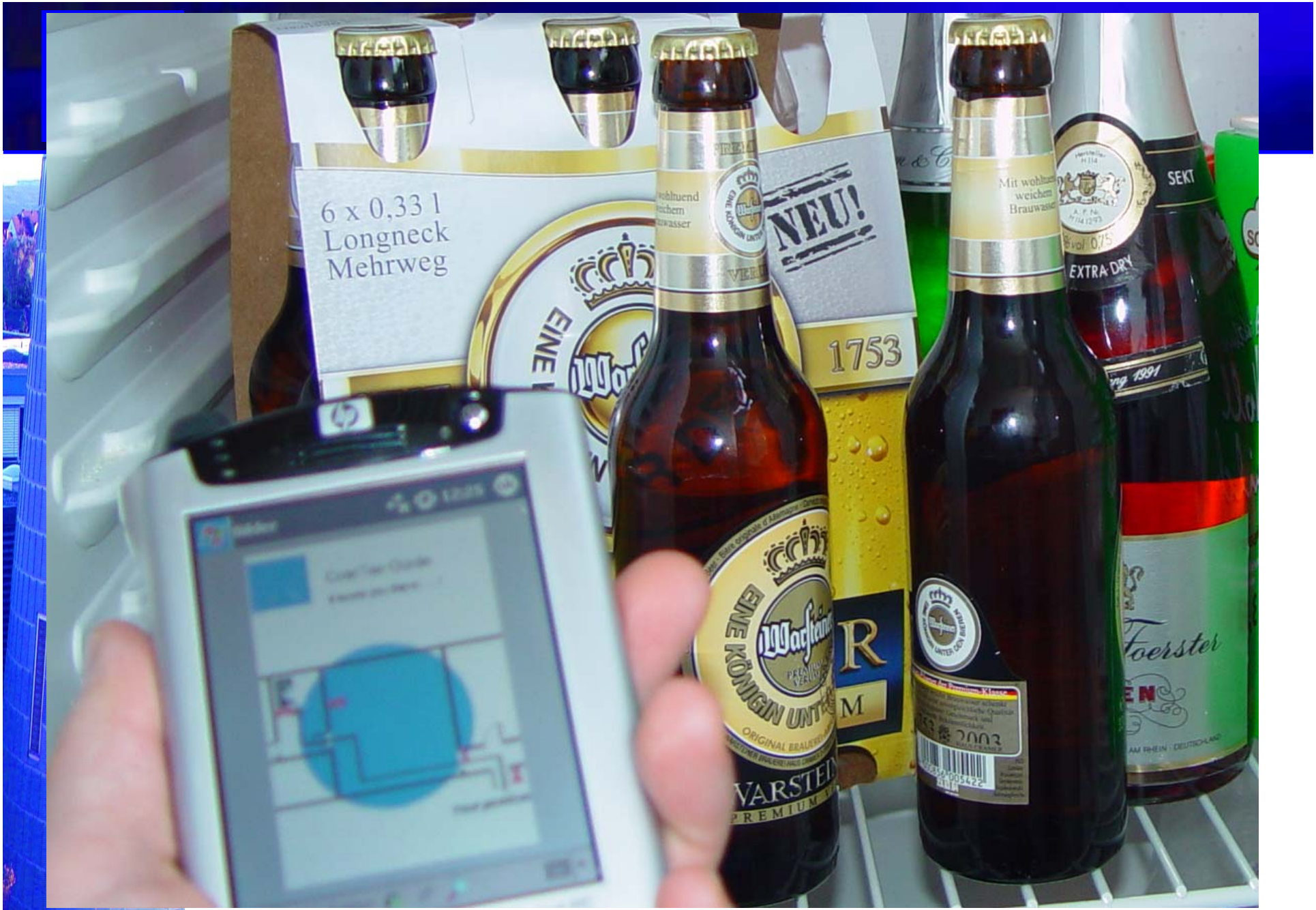
Cool Beer Found !!



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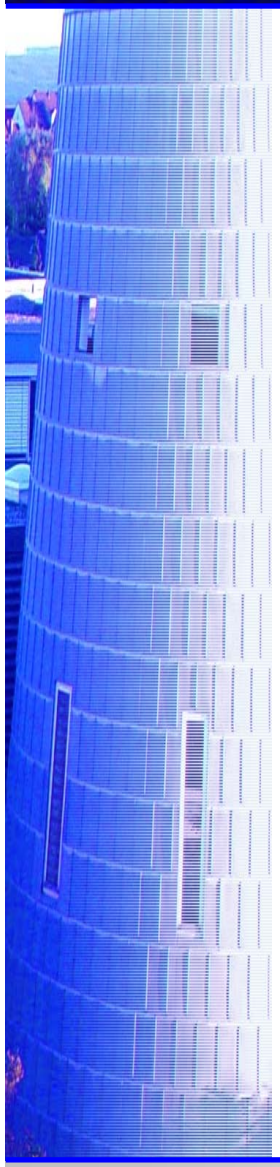
Overview



- Past – Present
  - Markets
  - Technology Trends
  - Application trends: Enterprise and private
- Wireless Technologies for the Future
  - What is the vision?
  - What are enabling key technologies?
- **Conclusion**

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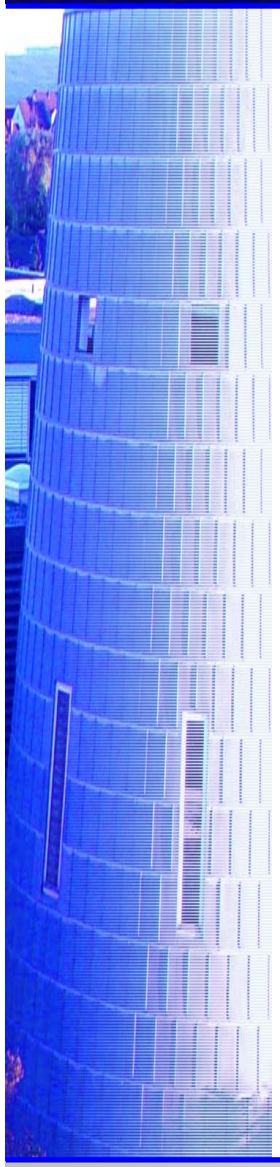
Conclusions



- **The trend and future is mobility**
- **Ever increasing performance – bandwidth etc.**
- **Real world – digital world**
- **Semantics in applications – context awareness**