Mobile Terminal Technologies: Trends and Future Developments

KiVS Summer School on Mobile Computing, Dagstuhl 2002
Dr. Christian Prehofer
DoCoMo Eurolabs, München

Content

DoCoMo Euro-Labs

- Market and technology trends
  - Mobile market in Japan
  - 3G Systems and future directions
  - Mobile terminal technologies and trends
- System concepts and technologies
  - System architecture and programmability
  - Mobile Execution Environment (MExE) Standard
  - Java2 ME Middleware platform
  - Software defined radio
  - SIM card technologies

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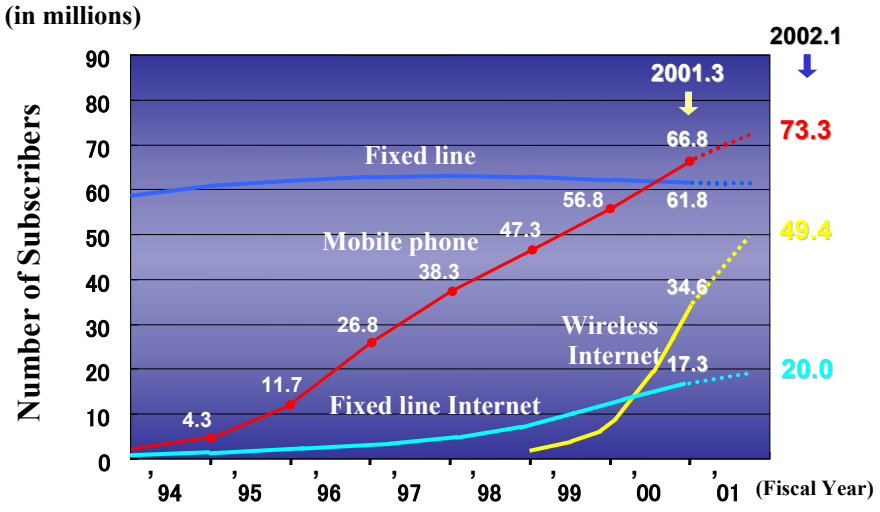
Telecom Market Trends in Japan

DoCoMo Euro-Labs



The projected values are calculated based on information and assumptions available today. However, there is no guarantee that the actual results would fall in line with the projected figures, given the inherit uncertainties in projections, as well as possible fluctuations due to future business performances and changes in internal/external circumstances, etc.

Multimedia

DoCoMo Euro-Labs

Business Use

- Video Conference
- Database / Data Center
- Electronic Commerce (Business Transactions)
- GPS Data Search

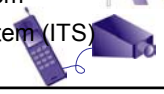
Mobile Multimedia Network

Personal Use

- Electronic Newspaper / Book
- Interactive TV
- Electronic Commerce (Shopping)
- Remote Health Care System

Public Use

- Remote Health Care System for the Elderly
- Communication System during a Disaster
- Remote Monitoring System
- Intelligent Transport System (ITS)



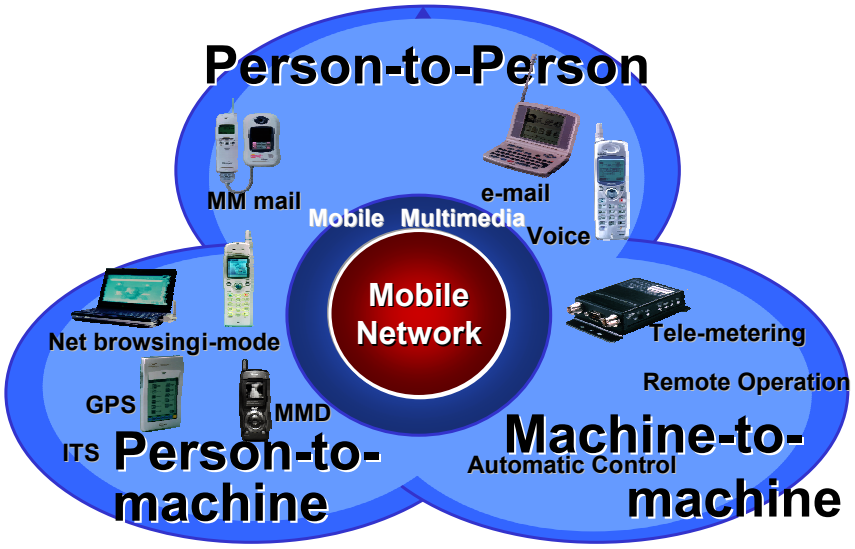
Potential Demand for Mobile Multimedia

DoCoMo Euro-Labs

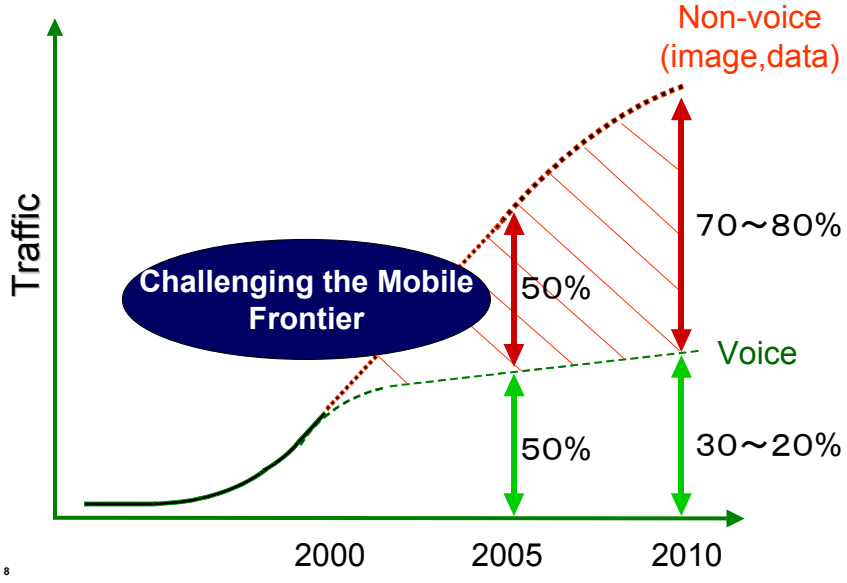
(2010)	*Number of sub./units (millions)*
People	*120*
Automobiles	*100*
Bicycles	*60*
Portable PCs	*50*
Motorcycles, boats, vending machines, etc.	*10*
Pets (dogs and cats, etc.)	*20*
TV, Set Top Box	*90*
Digital Camera, Video Camera	*50*
Refrigerator	*40*
Parcels (3 billion / 100 turn)	*30*
Total	*570*

Forecast by DoCoMo based on "Trends in Household Consumption" by Economics Planning Agency, and published material by Japan Pet Food Manufactures Association, etc.

Ubiquity



Projected Traffic Growth by Multimedia



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FOMA Handset Line-up

DoCoMo Euro-Labs

Standard type
FOMA N2002

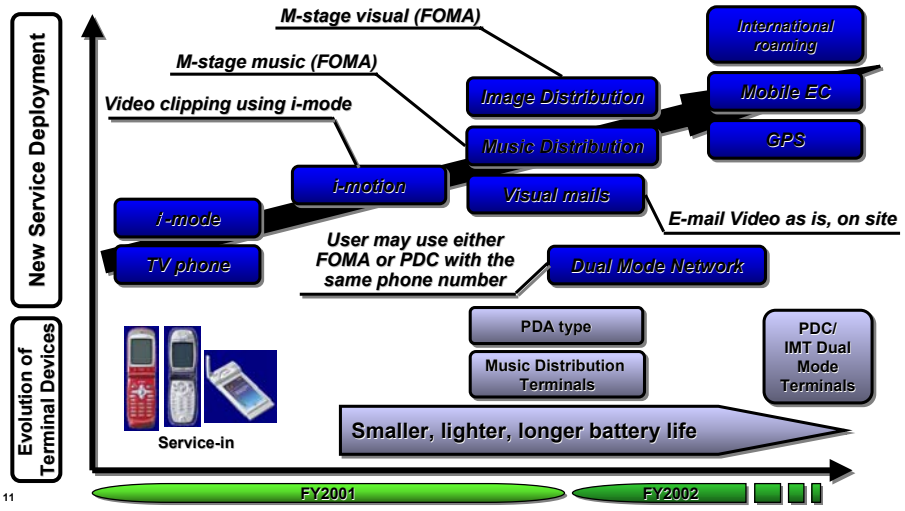
Visual type
FOMA P2101V

Data-card type
FOMA P2401

FOMA's Growing Possibilities

NTT DoCoMo Euro-Labs

FOMA continues to evolve as new functions are added



Video Clipping Service on i-mode

NTT DoCoMo Euro-Labs

Launched in November 2001

i Motion Service

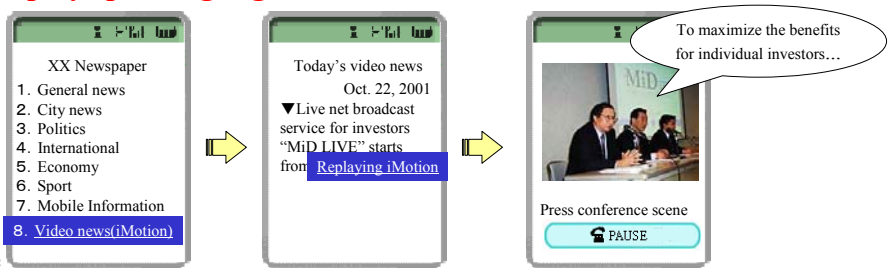
News

(News highlights or pictures of sites, etc.)

Movie/Music Promotion Videos

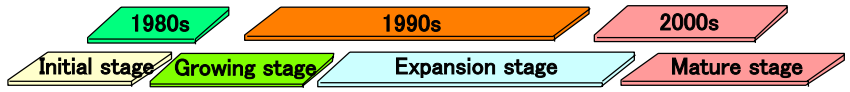
(Music video or movie trailers)

Replay sport highlights or news with video+ sound



Evolution of Network

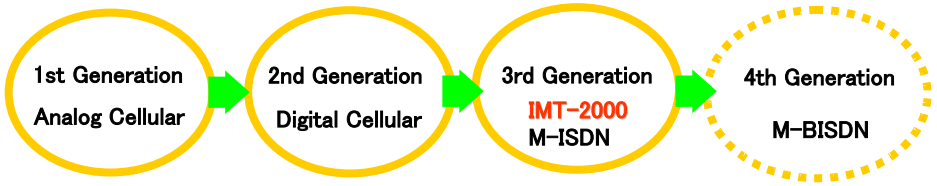
NTT DoCoMo
DoCoMo Euro-Labs



Voice

Voice, Low speed
Data Transmission
～64 kbps

High speed
Data Transmission
～384 kbps～(2M bps)



AMPS
TACS
NTT etc.

PDC
GSM
IS-95
PHS etc.

W-CDMA
CDMA2000

4G Mobile Communications Systems

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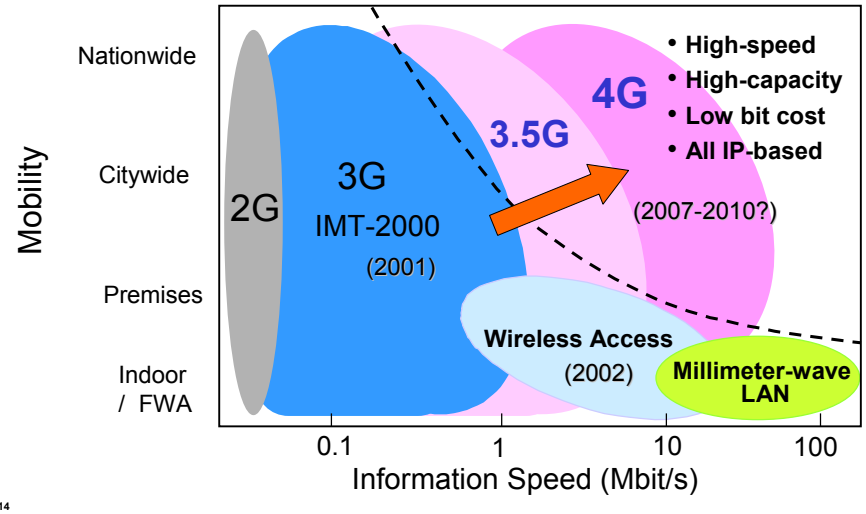

4G Requirements

- Huge Multimedia Traffic Handling
- Diversified Radio Access
  - Cellular, wLANs, ad-hoc networks, ...
- Seamless Service
  - Network seamless
  - Terminal seamless
  - Context seamless
- Advanced Mobility Management
- Application Service Support

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Terminal's CPU & Memory

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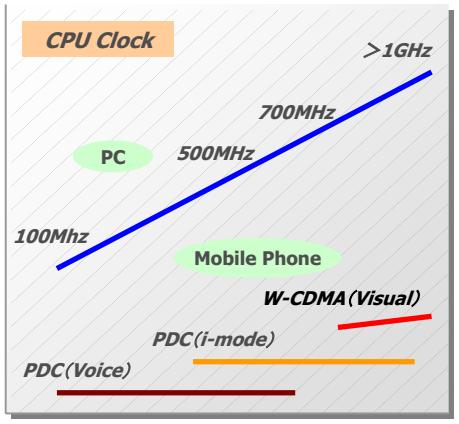

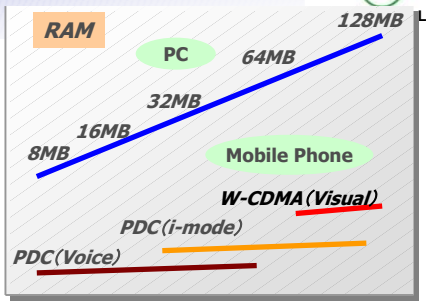

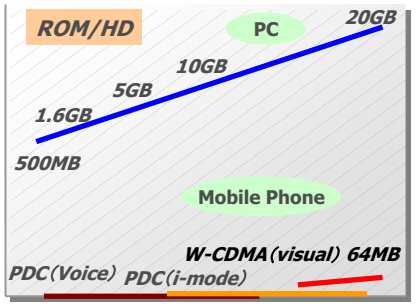

Mobile Terminal Evolution

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Nano-Technology Evolution

2001	2005	2010
3G	3.5G	4G
Data Rate 2M	30M	100M

Evolution of User Interface>>>

GUI		PUI
Graphical User Interface	Ergonomics Design ／Multimodal Interface	Perceptual User Interface

Evolution of Display>>>

Color display (65,536 color)	3D display/ holograph display

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System Concepts for Future Mobile Networks

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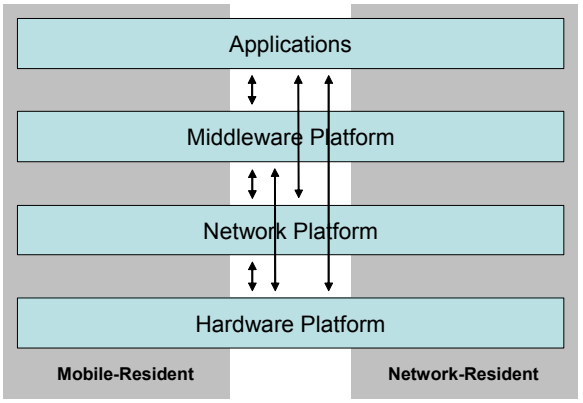
- SW platforms for fast service creation
- Separate evolution of components
  - access, core, MW, radio
- Programmable components
- Integrated networking services
  - All-IP networking as basis

➢ More flexibility and programmability is the key

Future Mobile Systems Architecture

DoCoMo Euro-Labs

Abstraction Layers & Inter-layer communication



Programmable Mobile Terminal Model

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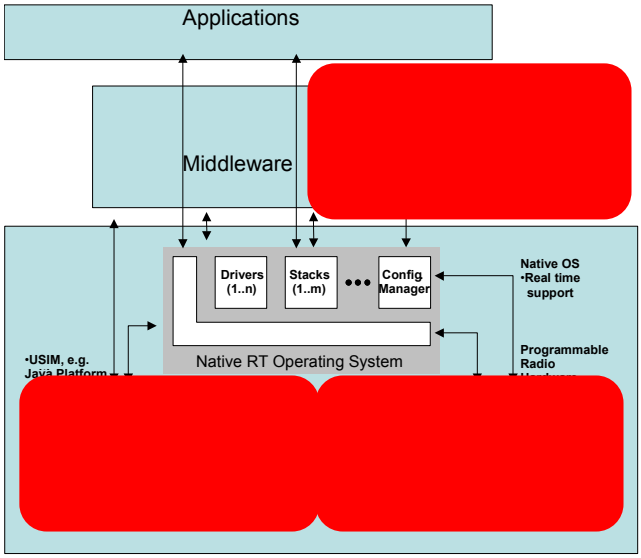

MExE Standards
e.g. Java

Programmable Network Element Model

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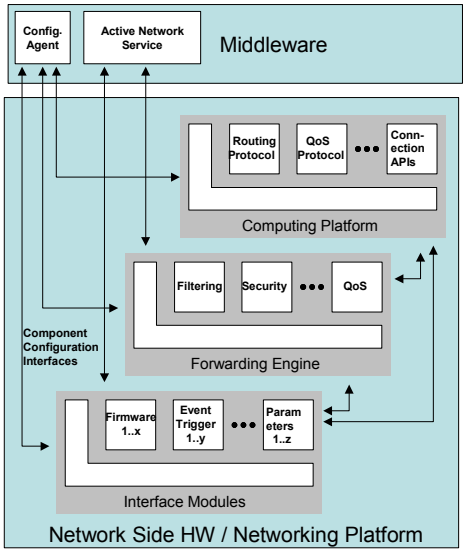

Active Network Service Components

Reliable OS Support for Active Network

Programmable L2 / L3 Switching / Routing Engine Dedicated HW OS Kernel Module

3G/2G Air If. wLAN Module Wired/Optical Network If.

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Mobile Execution Environment(s) (MExE)

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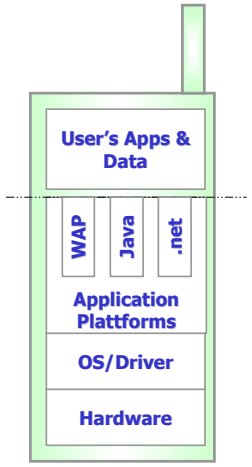

Goals of MExE Standardization (3GPP)

- Execution plattforms for mobile applications
- Security framework for SW download
  - PKI based trust model
- Security domain concept for applications
  - Operator domain
  - Manufacturer domain
  - Third party
  - Untrusted
- Trusted Apps. have access rules for APIs
  - E.g. application in operator domain can access SIM card

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What is „mobile Java"

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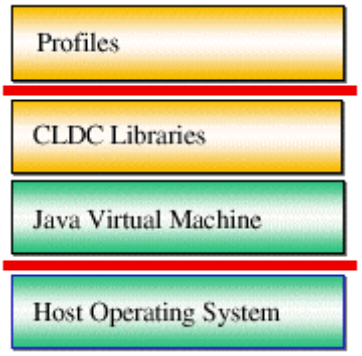
- Virtual computing plattform
- Device-independent standard
- Tailored for mobile devices
  - Limited resources
- Connected, limited Device Configuration (CLDC) Standard



Sun Java Products & Standards

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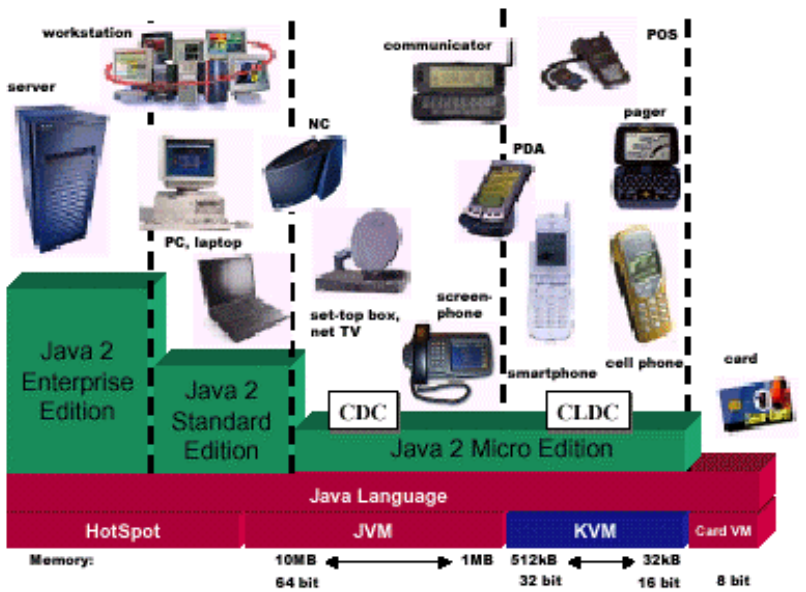

CLDC Configuration

- J2ME Connected, Limited Device Configuration
  - specification, reference implementation (KVM), Technology Compatibility Kit (TCK)
- intended for devices with following characteristics:
  - 160 kB to 512 kB total memory
  - 16 or 32 bit processor
  - limited power, often battery operation
  - intermittent connectivity to low-bandwidth network
- CDC (Connected Device Configuration)
  - intended for larger devices

Scope of CLDC

- Java language and VM features
  - subsetting J2SE
- Core Java libraries subsets
  - -java.lang
  - -java.io
  - -java.util
  - -javax.microedition.io Networking
- Security
- Internationalization
- Unsupported functions:
  - floating point, user defined classloader, thread group, weak reference

CLDC versus J2SE Java Virtual Machines

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- No floating point support
- No finalization
- Limited error handling
- No Java Native Interface (JNI)
- Pre-verifier for .class files
  - No user-defined class loaders
  - No weak references
- No support for reflection

Security Model of J2ME/CLDC

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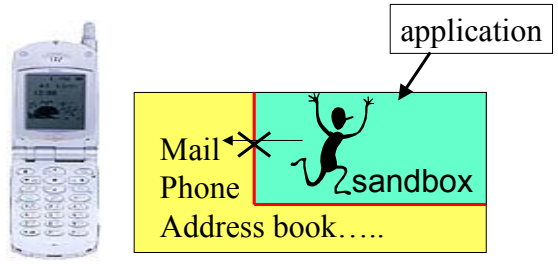
- Security model is a sandbox model in JDK1.0 and not a fine grain model in Java2.



J2ME/CLDC Security

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- Low-level virtual machine security
  - server-side pre-verifier attaches stackmaps to classfiles
  - client-side verifier checks classfiles
    - more efficient than traditional verifier
- Application-level security
  - no traditional security manager
  - no user-definable class loader
  - no user owned native functions
  - no manipulation of standard Java libraries
- End-to-End Security
  - Left to the network operators and device manufacturers

J2ME Pre-Verification for CLDC

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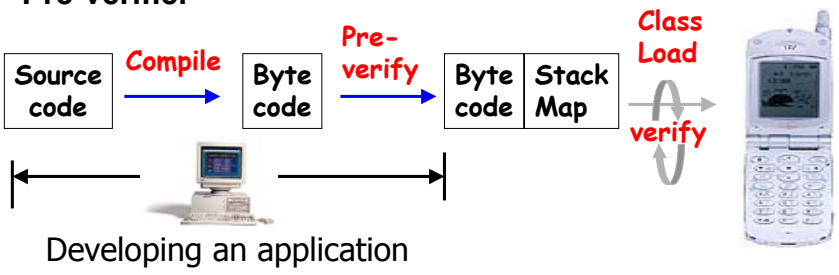
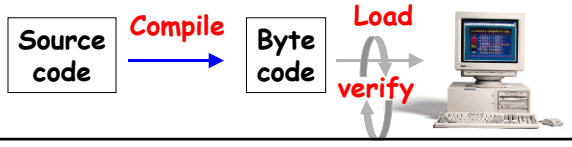
·**Pre-verifier**



Developing an application

In case of J2SE



Profiles: DoJa vs. MIDP

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- 2 Standards for Mobile Device Profiles (in 2001)
  - DoJa (NTT DoCoMo)
  - MIDP Mobile Information Device Profile (SUN etc)
- Tun on top of CLDC
- Targeted at mobile phones and pagers
- Device Profiles cover GUI and utilities
  - MIDP addresses GUI, persistency, networking, security,, timers
    - *look & feel is based on WML*
  - DoJa Look & Feel is similar to C-HTML (I-mode)
- Additional profiles in preparation
  - Games, 3D graphics, RPC, …

Current Status of DoJa

(as of 21st, May. 2002)

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Programming Mobile Devices is Different …

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- Limited memory (RAM)
- Persistent storage limited
- Large varitey of display & input techniques
- Networking is a must
- Security is essential
- How to deploy code – over the air?

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Motivation for Software Radio

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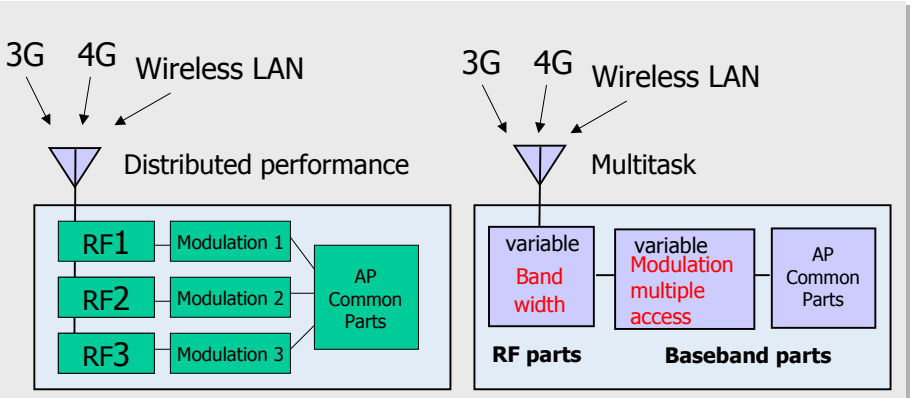
SDR(Software Defined Radio) is enabled by programmable RF and baseband hardware



Multi-mode terminal for multiple Hardware **Multi-mode terminal for SDR**

Wireless Standards Overview

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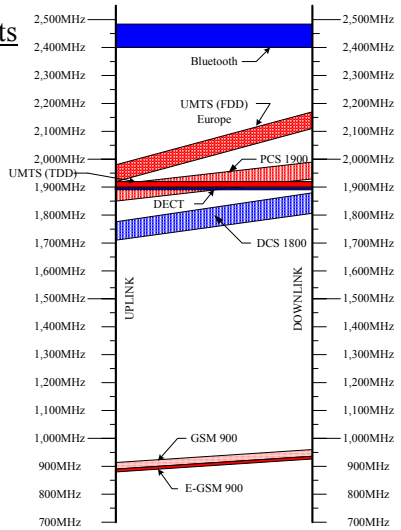
Frequency Techical Requirements

- Multi-band terminals
- Supports:
  - GSM/E-GSM
  - DCS1800
  - DECT
  - PCS1900
  - UMTS (FDD/TDD)
  - Bluetooth
  - HiperLan2 (5.150-5.350 & 5.470-5.725)



From TRUST/SCOUT IST Project
M. Dillinger/D. Bourse

What is Software Radio?

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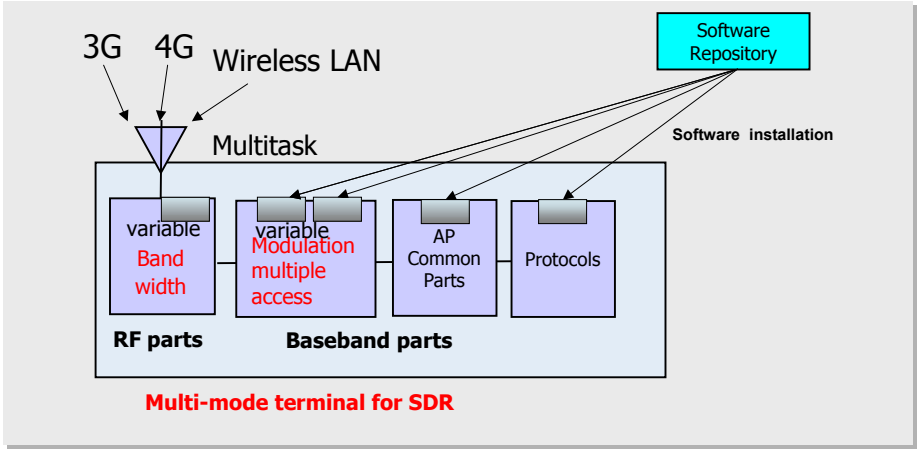
- Reconfiguration by installation of new software



Main Advantages of SDR Terminals

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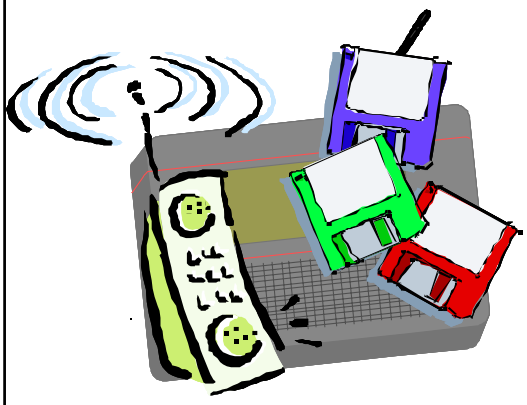

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M. Dillinger/D. Bourse

User Perspective

More Flexibility
* Uses Ad-hoc Network Flexibility
* Open System
* Real-Time Extension
* Feature Interaction
* Application Customised

Cheaper
* Cheaper Applications
* Shared SW Resources
* Cheaper Devices

Better Usability
* Easy Configuration
* Application Overhead Reduction
* Simpler Devices

Operator Perspective

Faster Application Development
Support New Billing Models
More Potential Clients

Manufacturer Perspective

Changes Development Cycle
Reduced Complexity / Component Reuse
Easier Integration of New Features

SDR is a multi-disciplinary research effort

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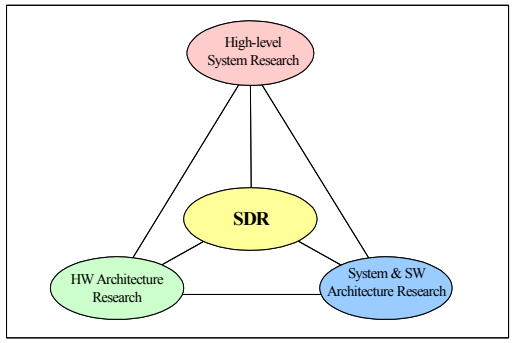
SDR Research

- Business Models
- Regulatory Issues
- User Perspectives
- RRM and Spectrum Mngt
- System Level Issues
- Enabling Technologies



SDR Research (WWRF BoV 01)

NB: SDR Research Slides are based on WWRF Book of Vision SDR Chapter

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Architecture for Network Centric Reconfiguration

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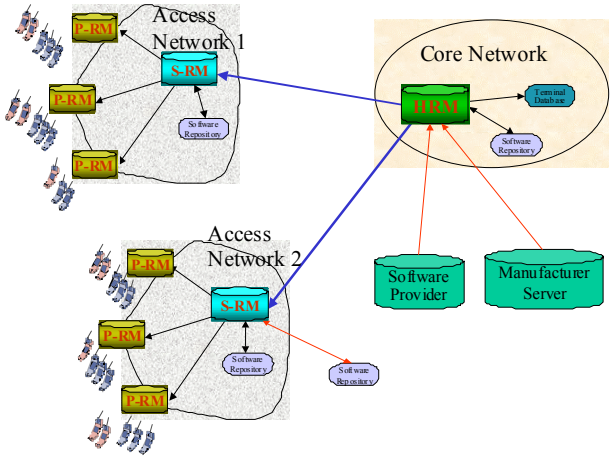
- Reconfigurations are controlled by the network



Network centric Reconfiguration

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- Advantages
  - Operator can control the terminal capabilites & services
  - Operator can install new end-to-end protocols
  - Optimal usage of network resources and radio spectrum
  - Can be triggered by network or terminal side
- The key requirements
  - Secure and reliable distribution of software
  - Integration with user profiles, applications and billing
  - Distributed execution of software updates for scalability
  - **Note**: execution of reconfiguration & fallback is local
- Alternative: Terminal controlled reconfiguration
  - User is in charge of software updates

SDR Terminal Architecture (Layers)

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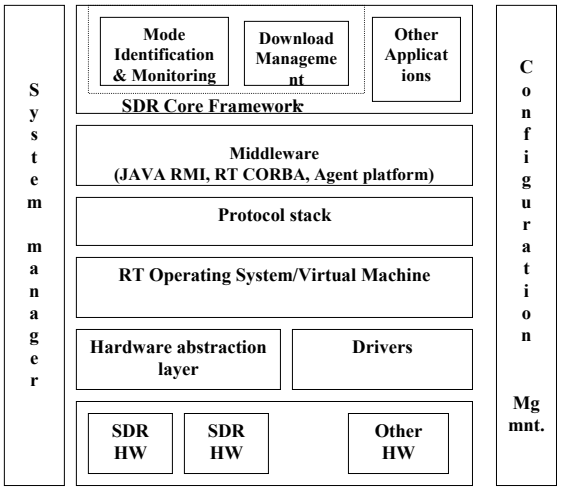

SDR Functional Architecture

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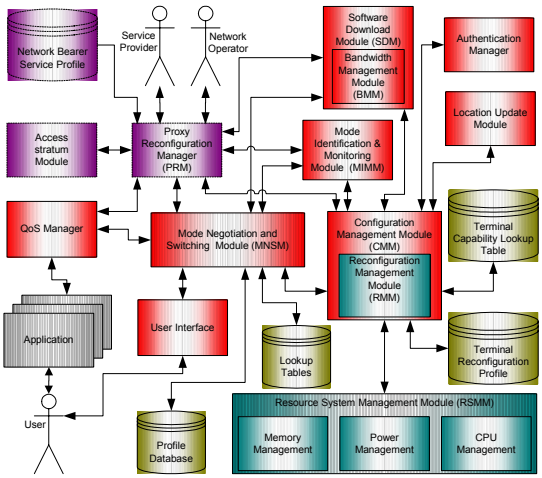

- ✓ Re-configuration Process Control and Configuration
- ✓ Re-configurable HW and Terminal Resource System
- ✓ Network Support; Download Strategies and Management
- ✓ Data storage
- ✓ Triggering Actors

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Reconfiguration Support in Networks and Terminals

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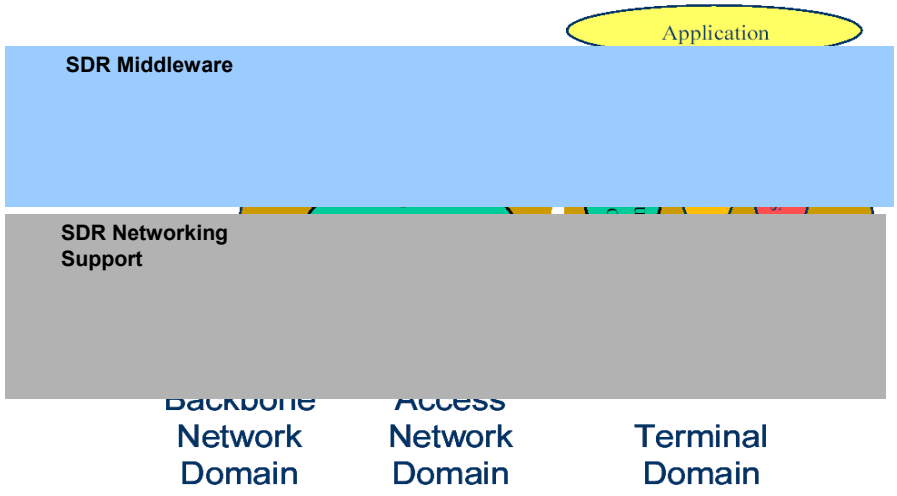

SDR Middleware for Reconfiguration

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- Design goals
  - Abstraction from network topology and terminal diversity; End-to-end model
  - Flexible and extensible wrt services, terminals and network infrastructure
  - Easy support with other system parts (applications, billing, etc)
- Responsibilities
  - Negotiation wrt terminal capabilities, network resources, user profiles
  - Resource and service control decisions
  - Mobility and location control
  - Interfaces to applications, user profiles, billing, etc

SDR Networking Support for Reconfiguration

DoCoMo Euro-Labs

- Design goals
  - Topology aware, distributed functionalities
  - Stable and robust network services; optimized for specific network technology
  - Resource and mobility aware
  - Real time support
- Responsibilities
  - Real-time software update support, including fallback
  - Distributed download infrastructure,
  - QoS and mobility management, triggers to middleware
  - Roaming support

European Project SCOUT Partners

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SIEMENS france telecom Panasonic

Telefónica TTI NTT DoCoMo DoCoMo Euro-Labs

University of Southampton

+ Cellular 3G
+ University of Portsmouth
+ German Regulator

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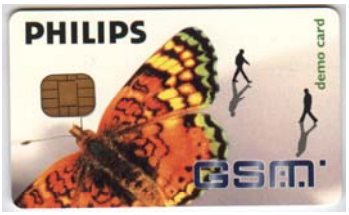
SIM Card Technology

- Computer on a chip
  - microprocessor,
  - ROM, e.g. 48 K
  - Flash EEPROM, e.g. 32 K
  - RAM, e.g. 5 K
  - NO: display, keyboard, power

- Specifications/Standards
  - ISO
  - ETSI GSM
  - 3GPP for UMTS

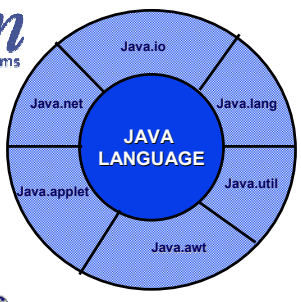
GSM®
GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS

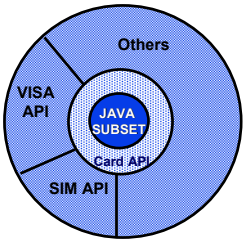


- Card represents operator
- Security critical applications
  - Authentication
  - E-commerce
  - ...
- User data (phone book etc)

Java Card

- Java Card
  - Java Card Forum
    - Major vendors / application providers
    - APIs for security, user and operator profiles
  - Different APIs
    - E-commerce
    - SIM APIs (GSM)





- Other Vendors
  - Multos (MAOSCO Cons.)
  - Windows for Smart Cards

DoCoMo Euro-Labs

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