Future Mobile Technology and Terminal

LG Electronics Inc.

Jin-Sung Choi

Ph.D

jinsungc@lge.com

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Revolution of Ubiquitous
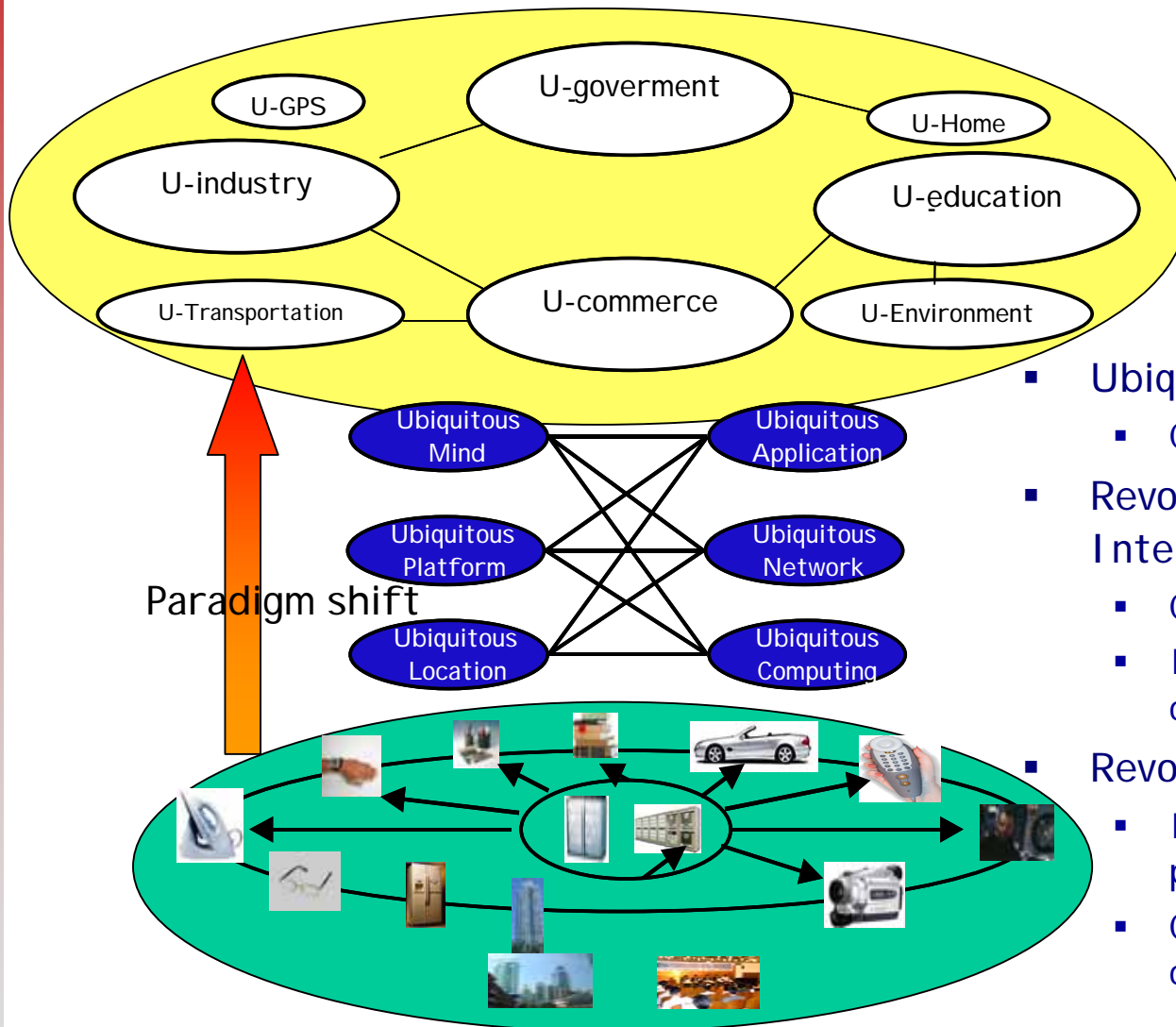
- **Ubiquitous computing**
  - Computing in everywhere
- **Revolution of Information of by Internet**
  - Cyber space
  - Inserting Physical space into computer
- **Revolution of Ubiquitous**
  - Inserting computer into physical space
  - Computing Plus Mobile communication

Paradigm shift

U-GPS
U-goverment
U-Home
U-industry
U-education
U-Transportation
U-commerce
U-Environment

Ubiquitous Mind
Ubiquitous Application
Ubiquitous Platform
Ubiquitous Network
Ubiquitous Location
Ubiquitous Computing

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Evolution of Mobile Communication

Digital
- Quality
- Security
- Reliability
- Capacity
- Roaming

Services
- Mixed services
- Capacity
- Flexible billing
- Personalisation

Integrated WW
- Mixed networks (IP based)
- Ambient awareness
- Ubiquity/flexibility
- 'Always connected'

1 G
- Analogue
- Circuit switched
- Basic voice telephony
- Low capacity
- Limited local and regional coverage

2 G
- Digital
- Circuit switched
- Voice plus basic data applications
- Low data speed
- Enhancements towards
  - packet switching
  - higher data rates
- International roaming

3G
- Digital
- Packet and circuit switched
- Data and multimedia applications
- Medium data rates
- Global coverage
- Global roaming

Beyond 3G
- Digital
- Packet-switched
- All IP based (IPv6)
- Mobile multimedia applications as commodity
- User in control
- Flexible platform of complementary access systems
- High bandwidth and capacity
- Improved QoS
- Global coverage
- Global roaming

Voice[A]

Voice[D]

Multimedia

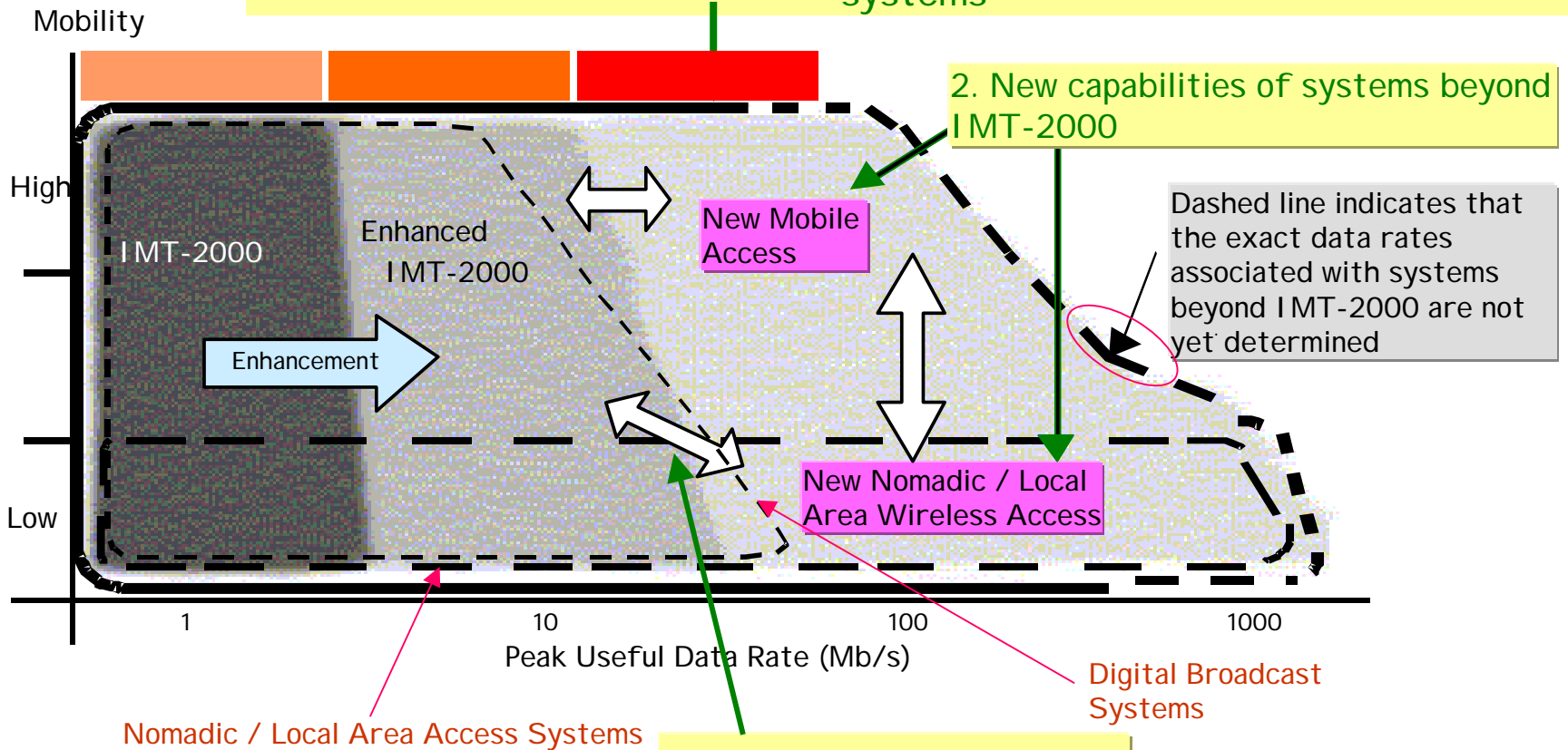**Wireless World**

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Framework of Future Communication
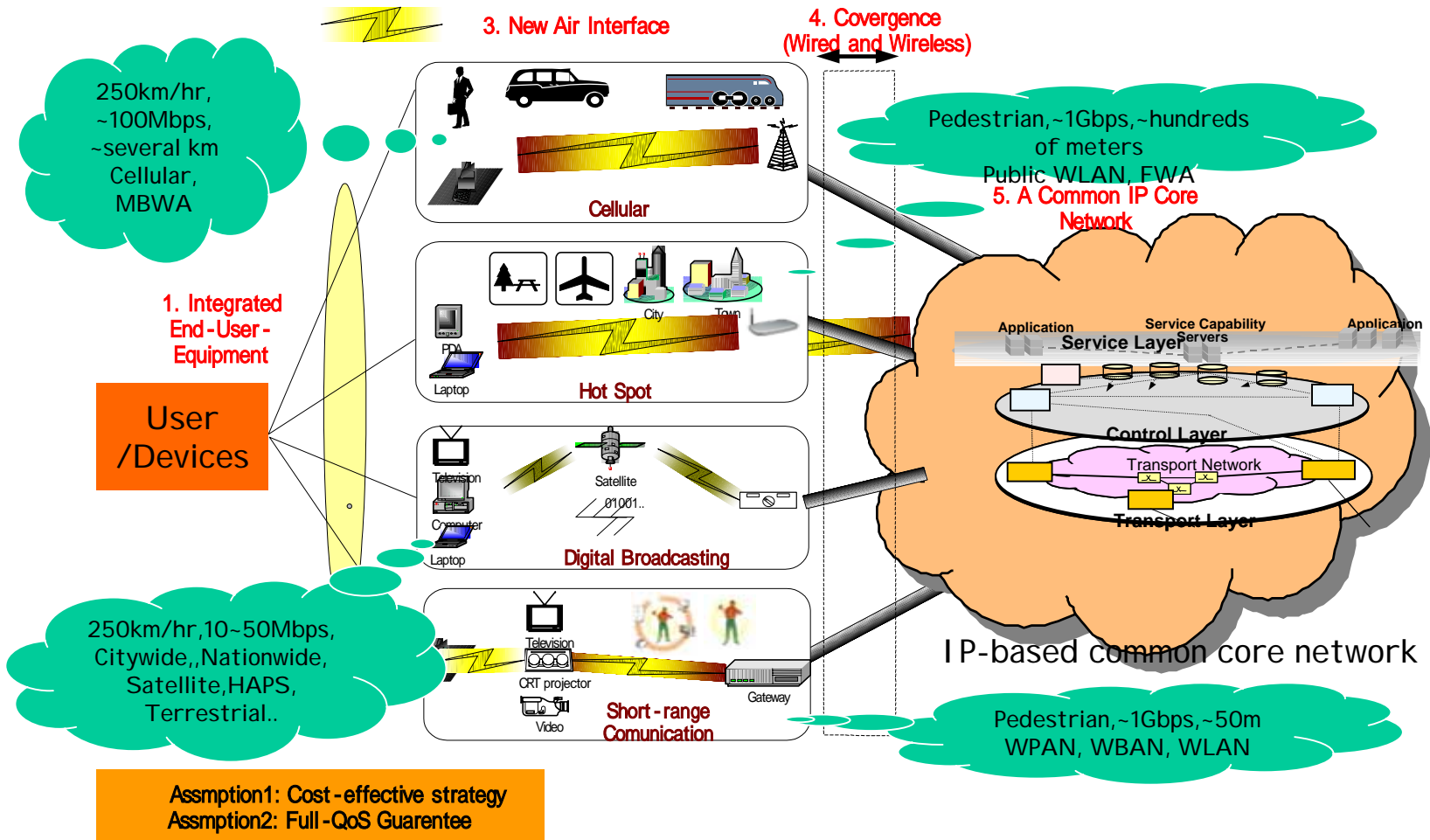
Vision in ITU-R

1. Systems beyond IMT-2000 will encompass the capabilities of previous systems

2. New capabilities of systems beyond IMT-2000

Dashed line indicates that the exact data rates associated with systems beyond IMT-2000 are not yet determined

Mobility

High

Low

IMT-2000

Enhanced IMT-2000

Enhancement

New Mobile Access

New Nomadic / Local Area Wireless Access

Peak Useful Data Rate (Mb/s)

1   10   100   1000

Nomadic / Local Area Access Systems

Digital Broadcast Systems

3. Seamless inter-working

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Contents

❑ **Perspective of Future Communication**

❑ **Requirement of Future Mobile Terminal**
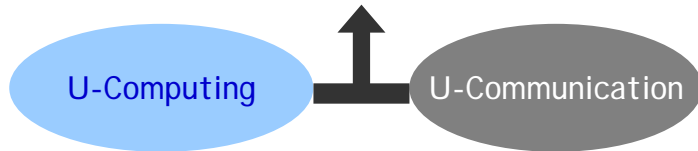
- Service aspect

- Technical aspect

❑ **Solutions**

- Radio interface

- Inter-Networking

- Multi-functional devices

- Reconfigurablity

❑ **Conclusion**

- Issue

- Expectation of the feasibility

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Concept of Future Communication

Ubiquitous & Seamless

U-Computing ← → U-Communication
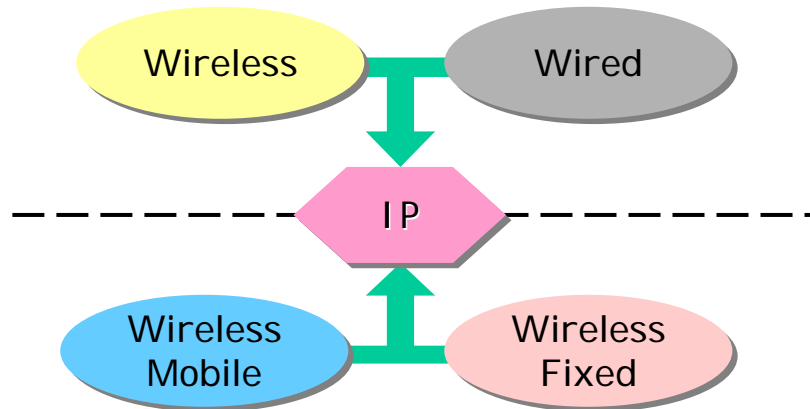
High efficiency

- Low spectrum requirement
- Low Infrastructure cost
- High capacity

Target Cost/bit: Below 1/10 of C/b of 2000

Convergence

Network:
IP-based common transport, resource management and OAM

Wireless   Wired

IP

Wireless Mobile   Wireless Fixed

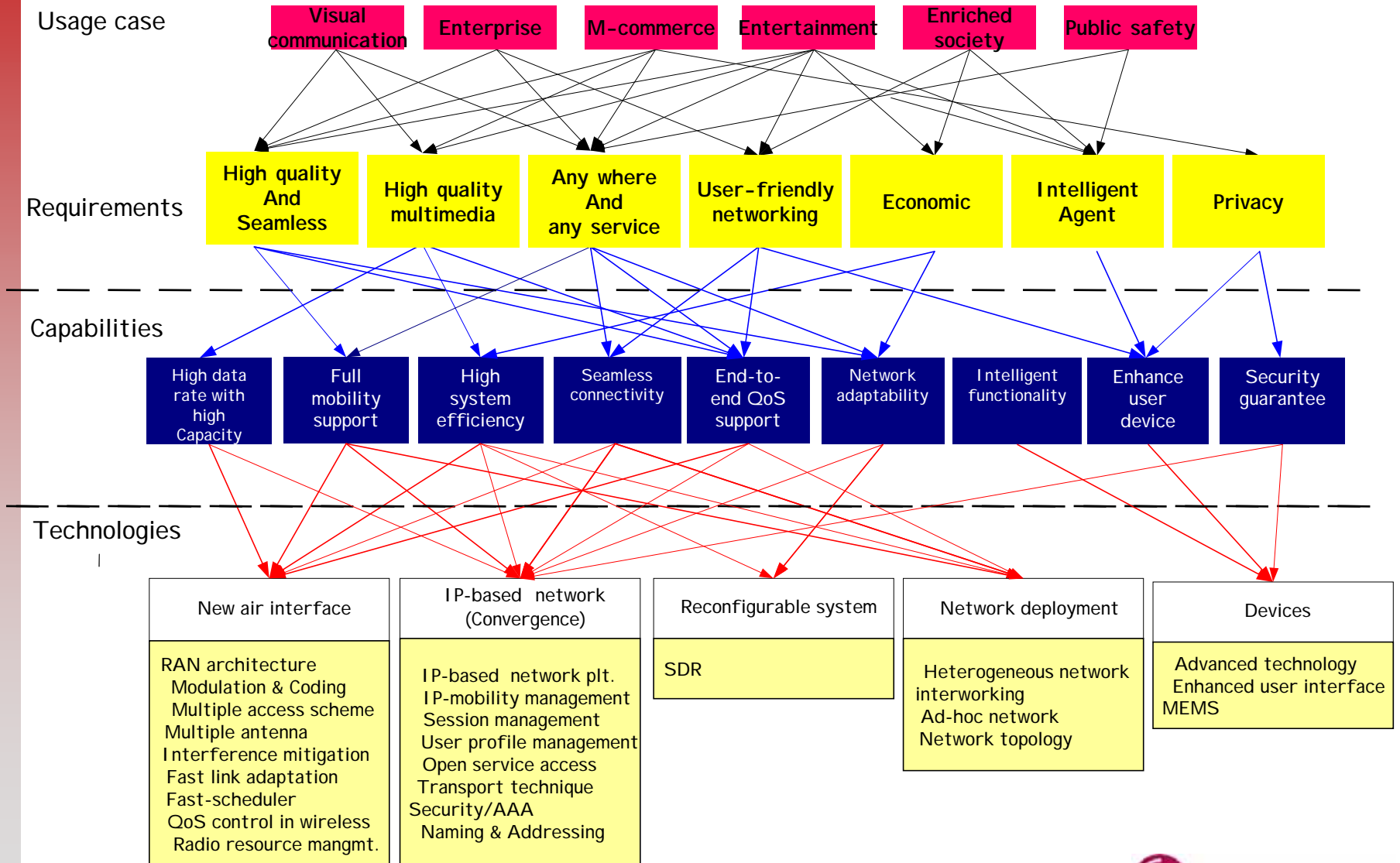Wireless Access: IP-based access router

Openness

- Separation of service and infrastructure
- Different access and Common transport
- Reconfigurable BTS, Terminal

Broadband wireless

- New air interface
- Wired and wireless E2E QoS guarantee

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Requirements in Service and Technology

Usage case

Visual communication	Enterprise	M-commerce	Entertainment	Enriched society	Public safety

Requirements

High quality And Seamless	High quality multimedia	Any where And any service	User-friendly networking	Economic	Intelligent Agent	Privacy

Capabilities

High data rate with high Capacity	Full mobility support	High system efficiency	Seamless connectivity	End-to-end QoS support	Network adaptability	Intelligent functionality	Enhance user device	Security guarantee

Technologies

New air interface

RAN architecture
Modulation & Coding
Multiple access scheme
Multiple antenna
Interference mitigation
Fast link adaptation
Fast-scheduler
QoS control in wireless
Radio resource mangmt.

IP-based network (Convergence)

IP-based network plt.
IP-mobility management
Session management
User profile management
Open service access
Transport technique
Security/AAA
Naming & Addressing

Reconfigurable system

SDR

Network deployment

Heterogeneous network interworking
Ad-hoc network
Network topology

Devices

Advanced technology
Enhanced user interface
MEMS

Contents

❑ **Perspective of Mobile Communication**

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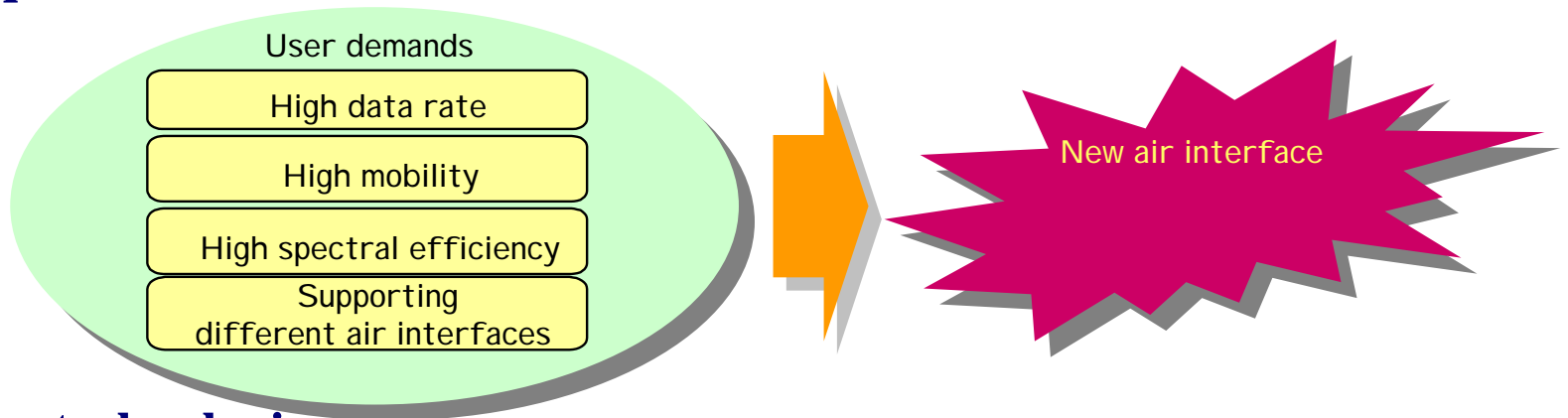
- Service aspect
- Technical aspect

❑ **Solutions**

- Radio interface
- Inter-Networking
- Multi-functional devices
- Reconfigurablity

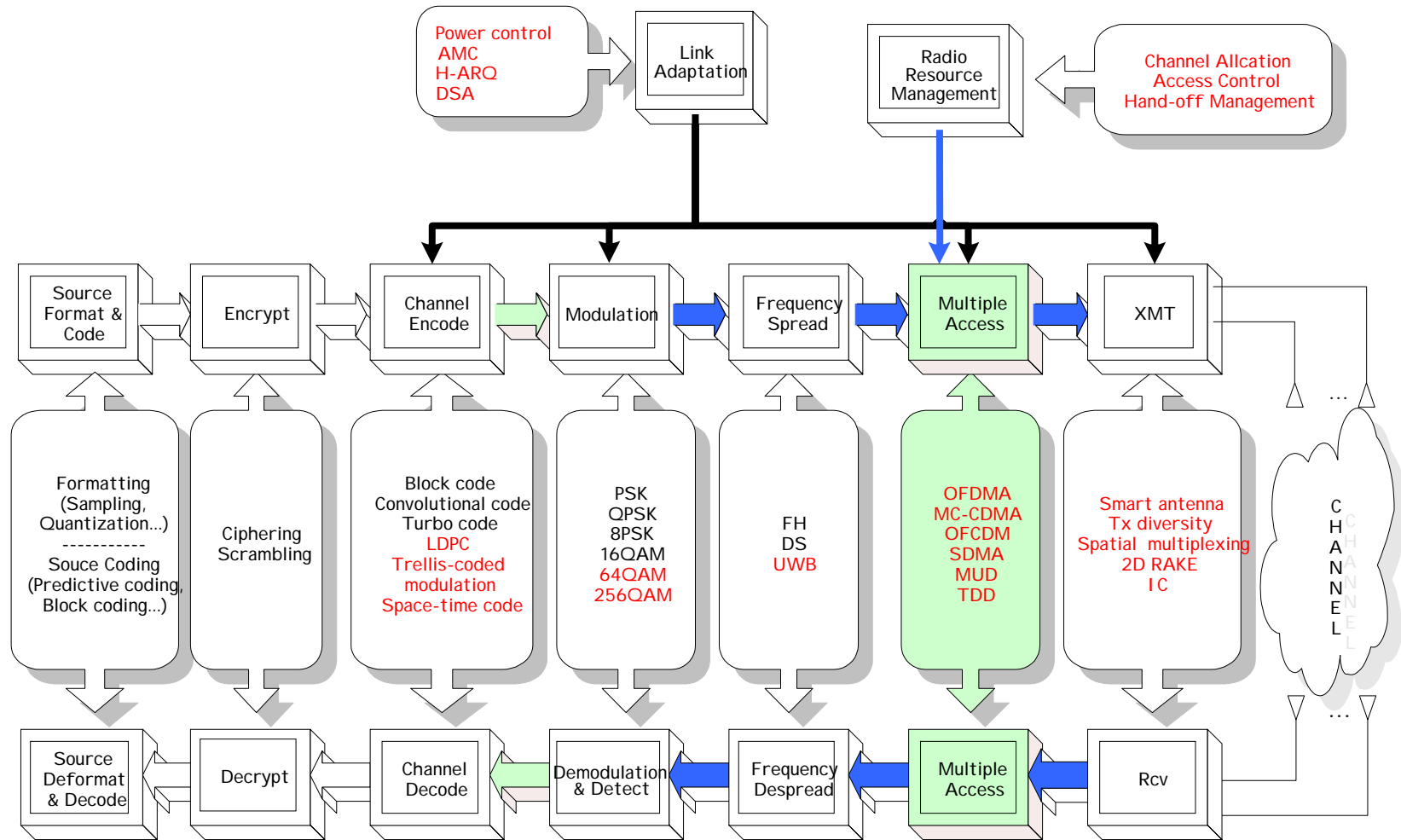❑ **Conclusion**

- Issue
- Expectation of the feasibility

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New Air Interface

❑ **Requirements**

User demands
- High data rate
- High mobility
- High spectral efficiency
- Supporting different air interfaces

→ New air interface

❑ **Core technologies**

- Multiple Access and Transmission Schemes
- Multiple antennas:Smart antenna, MIMO
- Modulation & coding: Higher order Modulation, LDPC, Graph-based Decoding
- Ultra Wide Band (UWB)
- Link adaptation: AMC, Fast HARQ,Power control
- Dynamic Resource Allocation
- QoS Guarantee for IP-based RAN

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New Air Interface; Overall Structure

Power control
AMC
H-ARQ
DSA

Link Adaptation

Radio Resource Management

Channel Allcation
Access Control
Hand-off Management

Source Format & Code	Encrypt	Channel Encode	Modulation	Frequency Spread	Multiple Access	XMT

Formatting (Sampling, Quantization...)

Souce Coding (Predictive coding, Block coding...)

Ciphering Scrambling

Block code
Convolutional code
Turbo code
LDPC
Trellis-coded modulation
Space-time code

PSK
QPSK
8PSK
16QAM
64QAM
256QAM

FH
DS
UWB

OFDMA
MC-CDMA
OFCDM
SDMA
MUD
TDD

Smart antenna
Tx diversity
Spatial multiplexing
2D RAKE
IC

CHANNEL

Source Deformat & Decode	Decrypt	Channel Decode	Demodulation & Detect	Frequency Despread	Multiple Access	Rcv

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New Air Interface

Multiple Access

OFDM
- PAPR Reduction
- CP-free technique
- Channel Estimation
- Synchronization
- Multiple Access

TDD
- Symbol Timing Synchronization
- Dynamic UL/DL Allocation

OFDMA
- DSA/ DPA
- Scheduling
- Fast/Soft Hand-off

MC-CDMA/OFCDM
- MAI/MPI Cancellation
- Scheduling

Link Adaptation/ RRM

Link Adaptation
- Combined with OFDM/MIMO
- Pre-filtering/pre-rake
- DSA
- H-ARQ with LDPC
- OFDMA power Control

Mobility-based RRM
- Traffic/Mobility Prediction-based RCA
- Mobility-based Power Control
- Location/Mobility-based Resource Reservation

Modulation & Coding

Higher-order Modulation
- Multi-path Immunity
- Symbol Detection

LDPC/ Graph-based Decoding
- Irregular LDPC Parity Check Matrix
- Combined with Modulation/MIMO
- Non-binary Code

Multiple Antenna

Smart Antenna
- DOA, Channel Estimation
- Location Detection
- High Mobility Support
- Complexity Reduction
- Cost Effective Device
- Wideband Signal Processing

MIMO
- Feedback Channel
- Hybrid open/closed-loop system/ Doppler Estimation
- Frequency Selective Fading
- Per Antenna AMC
- Antenna Selection Technique

UWB
- New Mod/Coding
- UWB-MIMO/Beamforming
- Optimizing Spectrum
- ISI reduction/Narrow-band Interference Rejection
- Multi-channel, Multi-access

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Inter-Networking (IP-based network)

❑ **Requirements**

User demands
- Seam less connectivity
- E2E QoS
- High system efficiency
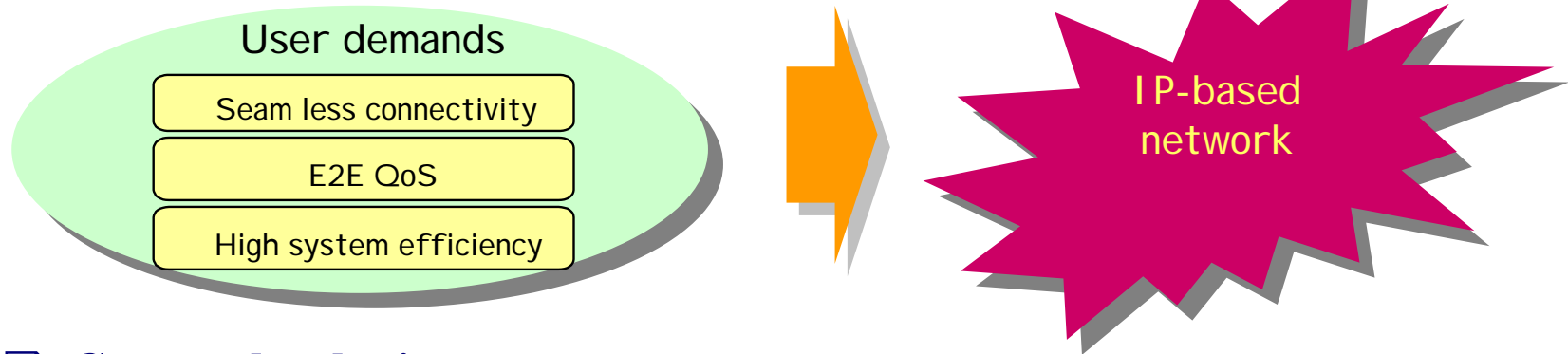
IP-based network

❑ **Core technologies**

- Overall IP-based network architecture
- IP mobility management
- Session management
- User profile management
- Open service access
- Efficient Transport
- Security/AAA
- Naming/Addressing

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Network Evolution; Evolution to All IP Network)

❑ **Why Network Evolution?**

- Legacy Network/Device Support

- Low CAPEX and Low OPEX

❑ **Why IP?**

- Seamless service provision

- Open service architecture with low cost

- Real-time multimedia service (e.g., voice, streaming video, and data)

- Reuse existing IP infrastructure

❑ **Why IP based B3G Network?**

- Meeting B3G requirements

- High data rate

- Seamless service

- Cost-effective

Network Evolution; 4 Phase to Common IP Core

Wired
WLAN
WLAN
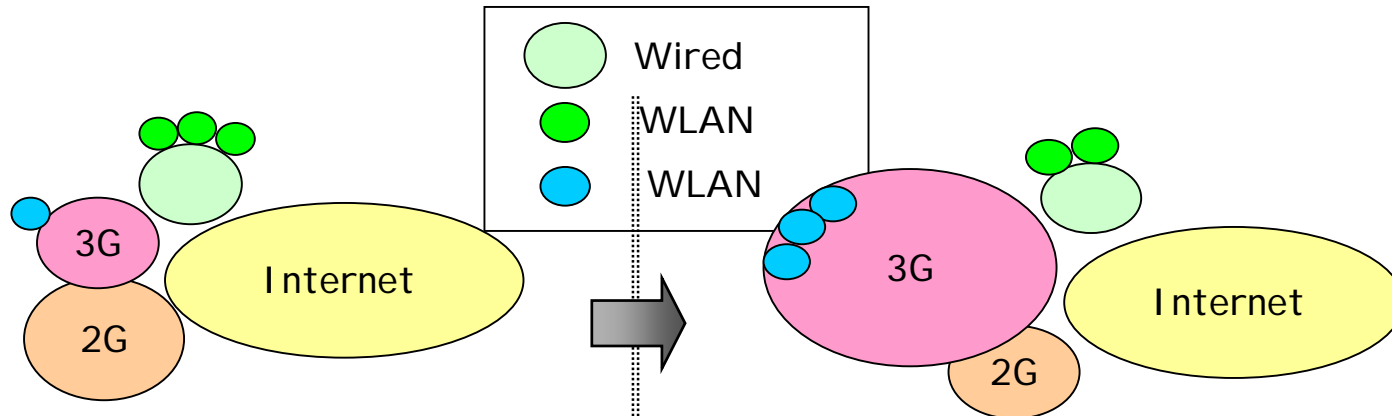
Phase 1: Interworking(3GPP Rel6)
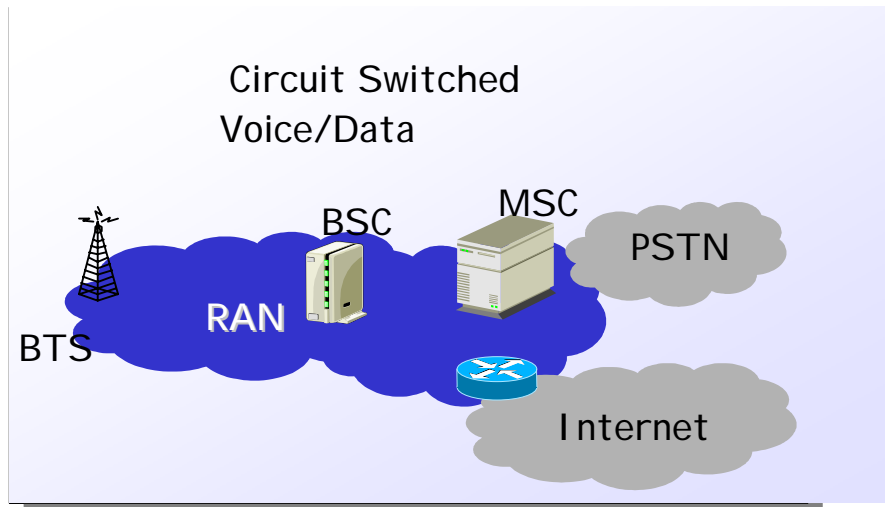
Phase 1: Integration(post 3GPP Rel 6)
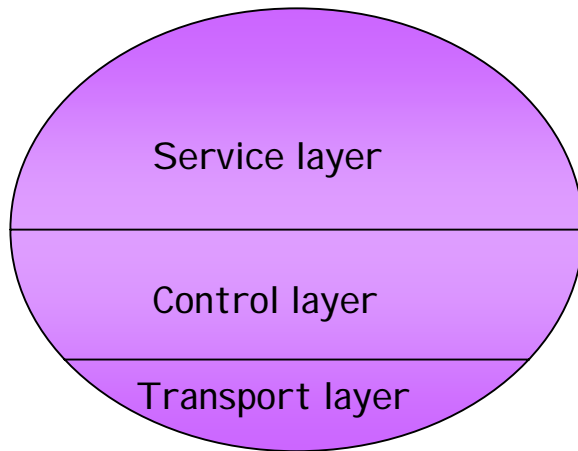
Phase 4: Full-convergence[2010~]
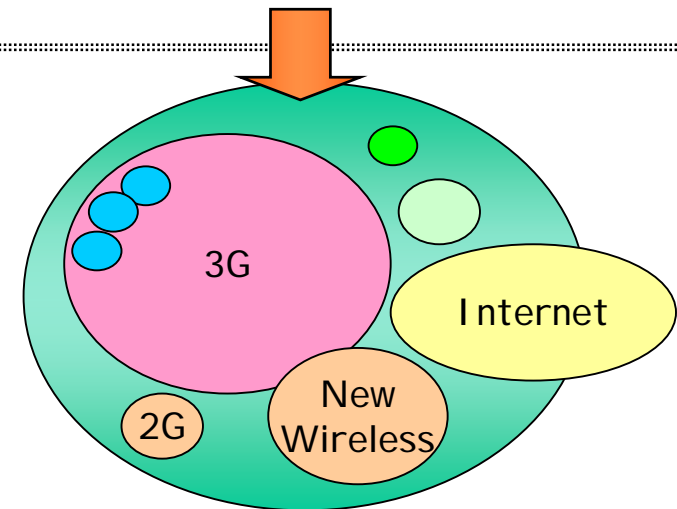
Phase 3: IP-based Harmonization [~ 2010]

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Network Evolution; IP RAN Evolution

Circuit Switched Voice/Data

BTS
RAN
BSC
MSC
PSTN
Internet

Packet Data

BTS
RAN
BSC
MSC
PSTN
GGSN PDSN
IP
Firewall
Internet

All-IP

RAN
Core Router
VoIP
Media Gateway
MSC
PSTN
IP
Firewall
Internet

Packet Voice/Data

BTS
RAN
ATM or IP
MSC
PSTN
IP
Firewall
Internet

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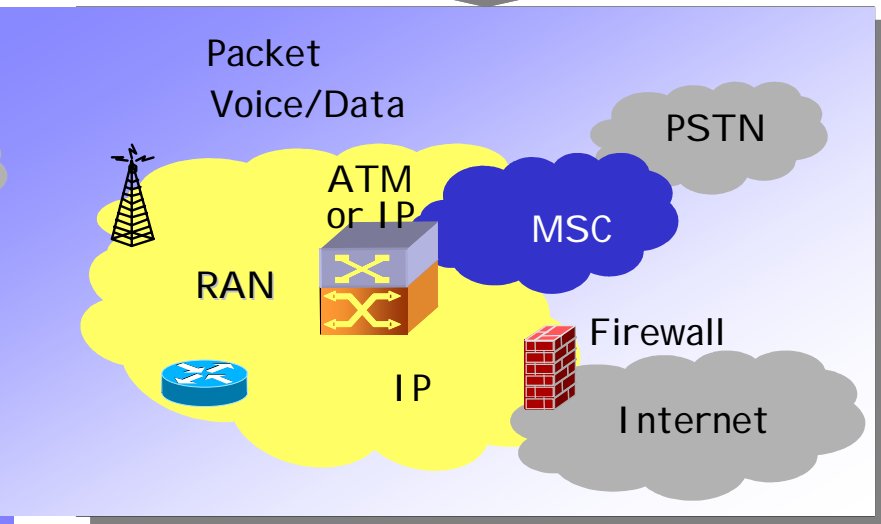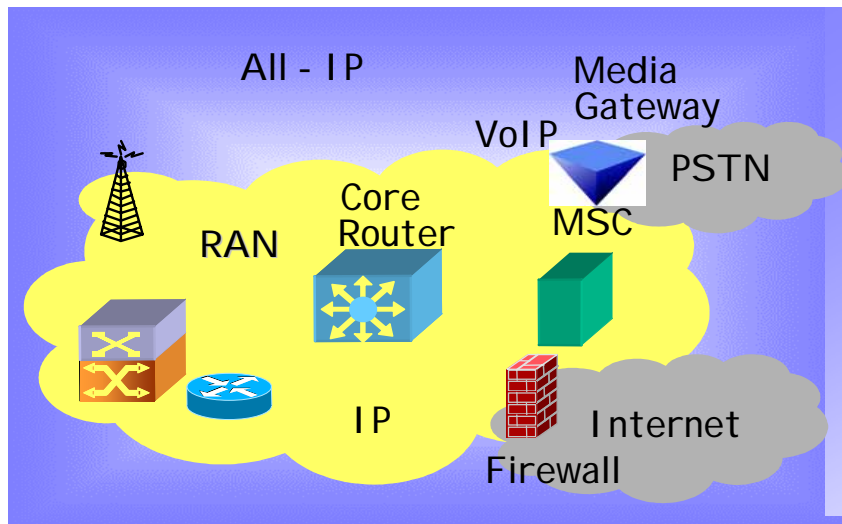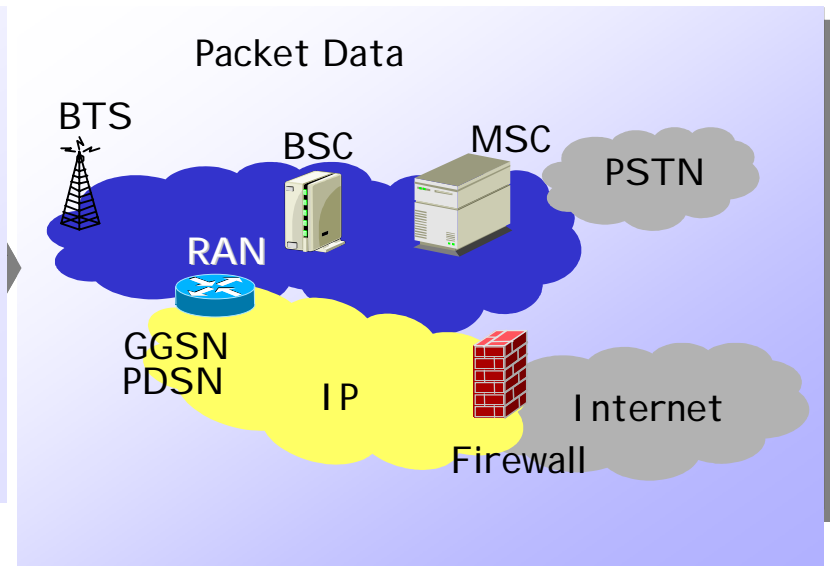
Network Evolution; B3G Functional IP Architecture)

Access Domain
- Cellular
- Hot-Spot
- Digital Broadcasting
- Short-range Communication

Other Network
- Public Internet
- PSTN/ISDN

Transport Layer
- Access G/W
- Cross Router
- Core Router
- Firewall(Router)
- Signaling G/W
- Media G/W

IP-based Common Network

Control Layer
- Micro-MM
- NMS
- Macro-MM
- Session Manager
- MRF
- AAA Server
- Geographic Manager
- Micro-MM
- Service Discovery Manager
- OSA G/W
- MGC

Service Layer
- Session-related Application
- Global Name Server
- User profile/policy Server
- Location Server
- 3rd Party Application

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Inter-Networking; Mobility Management

❑ **Terminal Mobility**

- One terminal, multiple IP addresses

❑ **Session Mobility**

- One user, multiple terminals in sequence or in parallel
- Services move with user

❑ **Personal Mobility**

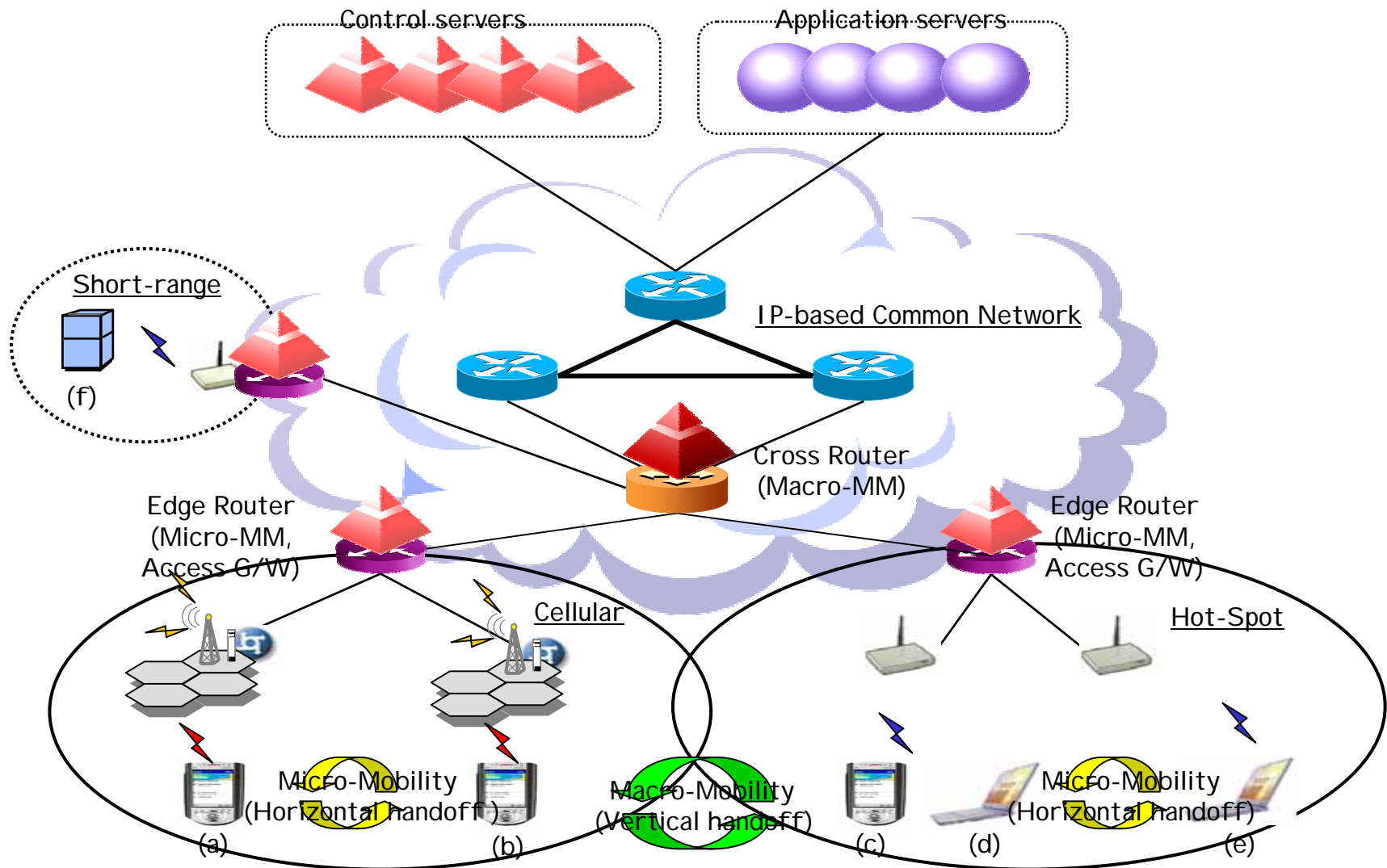- One person, multiple terminals (e.g, SIM card)

❑ **Network Mobility**

- Group mobility
  - ▸ Airplane, ship, and train..etc.

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Inter-Networking Mobility Management(2)-Terminal Mobility

Control servers

Application servers

IP-based Common Network

Short-range

(f)

Cross Router
(Macro-MM)

Edge Router
(Micro-MM,
Access G/W)

Edge Router
(Micro-MM,
Access G/W)

Cellular

Hot-Spot

Micro-Mobility
(Horizontal handoff)

Macro-Mobility
(Vertical handoff)

Micro-Mobility
(Horizontal handoff)

(a)

(b)

(c)

(d)

(e)

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Mobility Management; Terminal Mobility

Control servers

Application servers

Short-range

(f)

IP-based Common Network

Cross Router
(Macro-MM)

Edge Router
(Micro-MM,
Access G/W)

Cellular

Hot-Spot

Edge Router
(Micro-MM,
Access G/W)

Micro-Mobility
(Horizontal handoff)

Macro-Mobility
(Vertical handoff)

Micro-Mobility
(Horizontal handoff)

(a)   (b)   (c)   (d)   (e)

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Mobility Management; Personal Mobility

❑ SIP-based Personal Mobility

Location Database

User B Home

INVITE sip:userB@ domainname .com

SIP Server
Registration + Proxy

User A
INVITE sip:userB@ domainname .com

INVITE sip:userB@ domainname .com

User B Office

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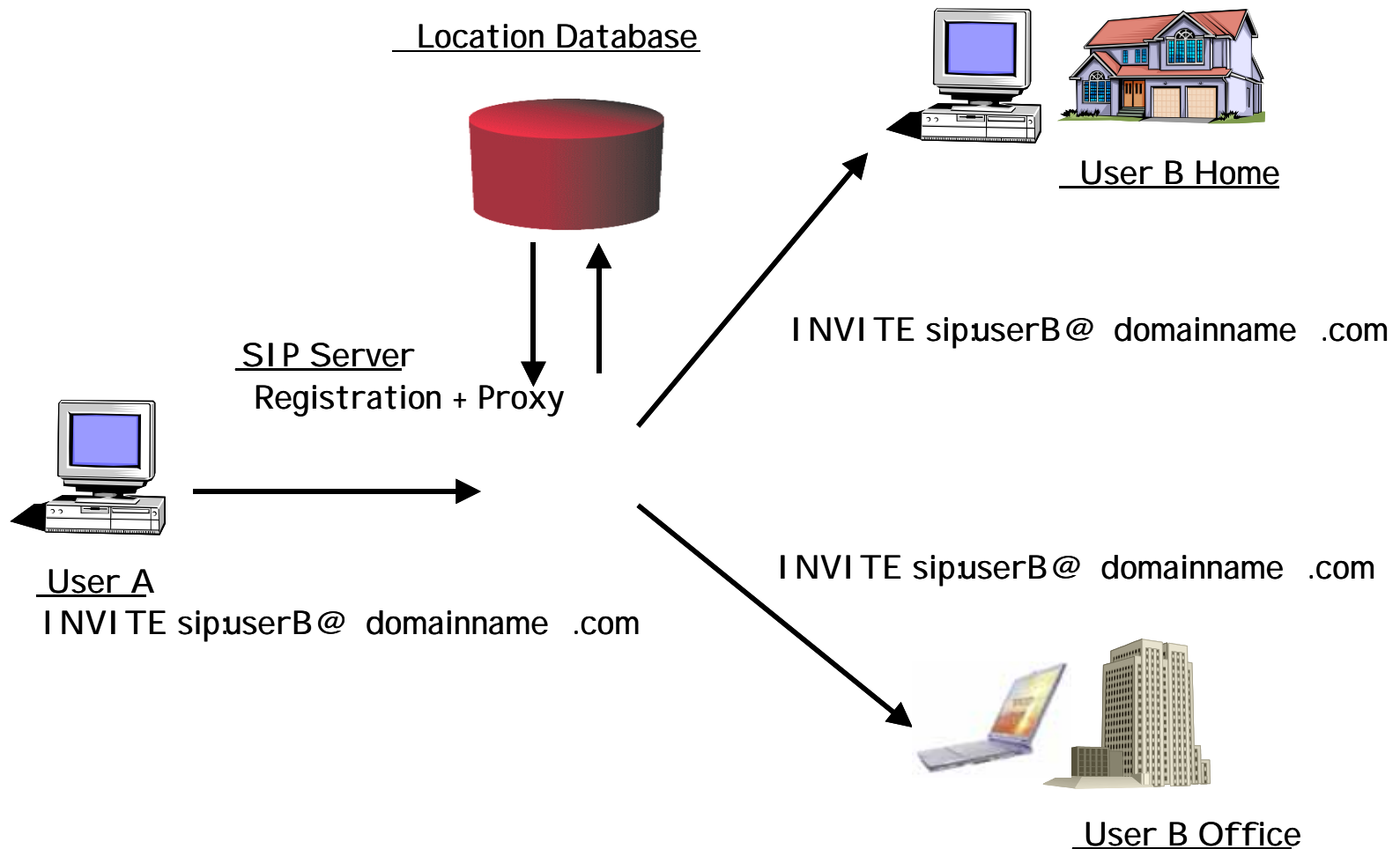
Inter-Networking (IP based Core Network)

Service Layer

Open Service Access
- OSA platform implementation for 3G/B3G
- Develop new platform

Security
- PKI in wired and wireless
- Reduce complexity of Decryption/ Deciphering
- Billing in wired, wireless and ad-hoc networks

User Profile Management
- User Profile structure
- User Profile storing

Control Layer

Mobility Management
- V/H Handoff: Mobility prediction-based HO
- Network Mobility
  - Service/Location Transparency
  - Secure Signaling
- Terminal Mobility
  - Macro Mobility (Mobile IP)
  - Micro Mobility

Session Management
- SIP

QoS
- QoS Architecture
  - DiffServ
  - IntServ
- Adaptive layer for end-to-end QoS support
- Seamless QoS support with mobility

Transport Layer

IPv6
- IPv4/IPv6 Conversion

GMPLS
- IP-compatible GMPLS

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Multi-functional devices (1)

❑ Functional integrated devices

- ● Terminal-based integration of media, IT, and communication

INTERACTIVE TELEVISION
video games
video on demand

TELECOM

COMMUNICATION
voice
non-voice

INTERNET ACCESS
e-commerce

MOBILE

INFORMATION
news
sports
special
interest

MEDIA

ENTERTAINMENT
games
music
multi-media

INFORMATION TECHNOLOGY

INTRANET ACCESS
corporate data
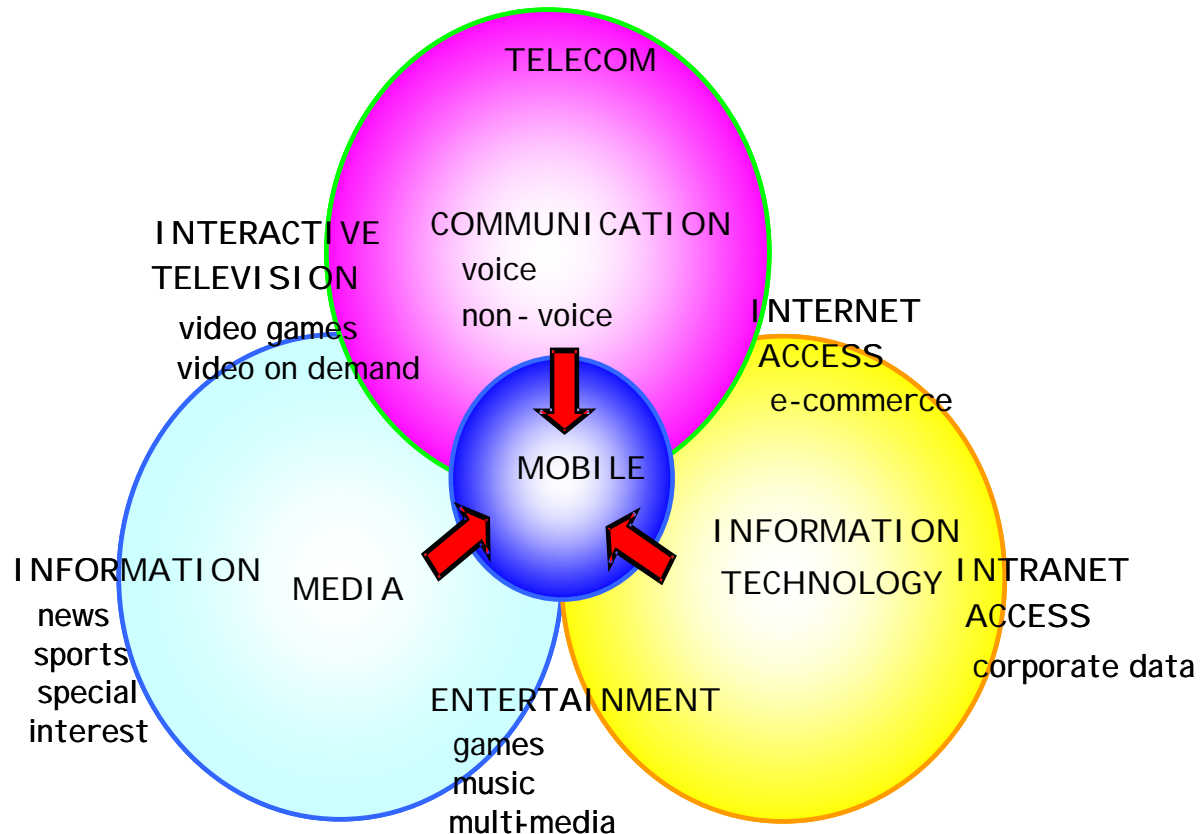
*Source : Aug. 2002, ARC Group

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Multi-functional devices (2)

❑ **Example of multi-functional devices**

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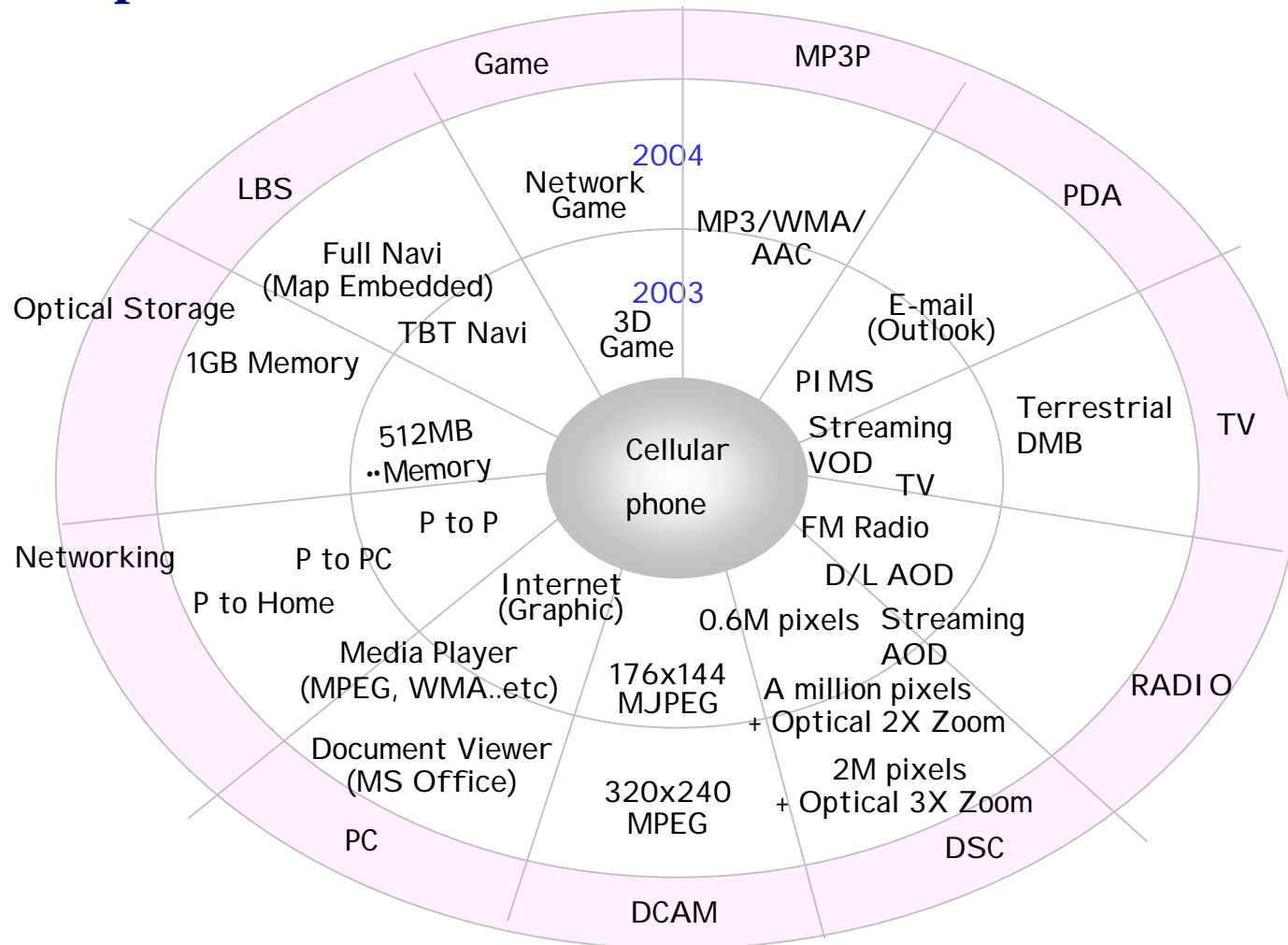
Reconfigurability

❑ Requirement for Network Deployment

User demands

- Network adaptability
- Low cost
- User-friendly interworking

SDR
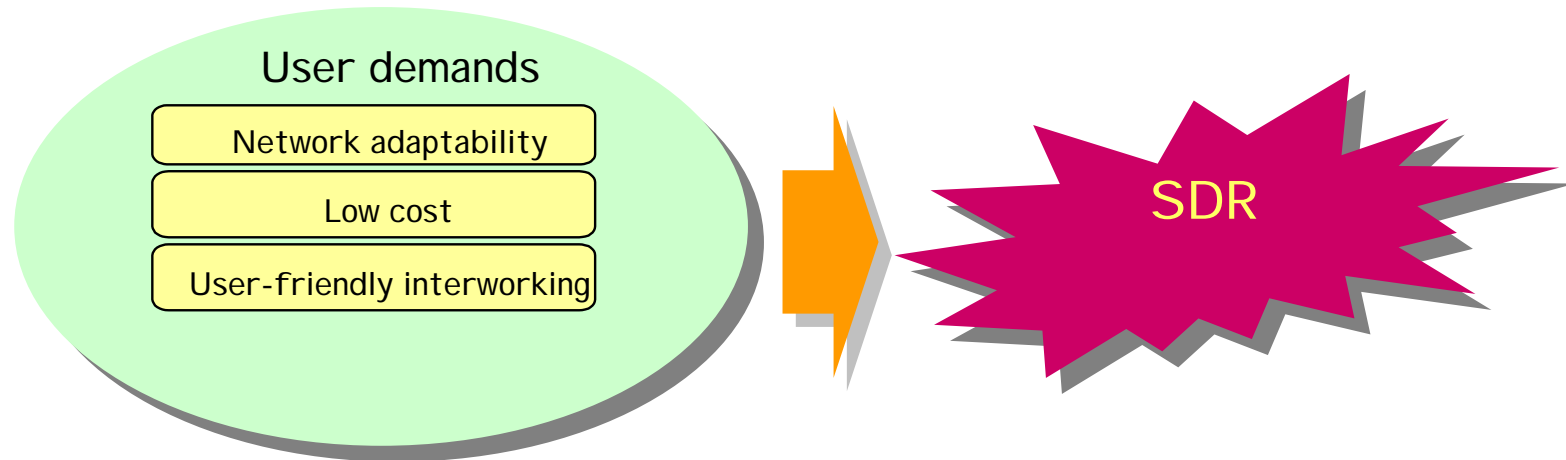
❑ Technical Issues

- ● S/W platform
- ● H/W platform

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Device

❑ Requirement for New Devices

User demands
- Intelligent functionality
- Enhanced user device

➡ New device
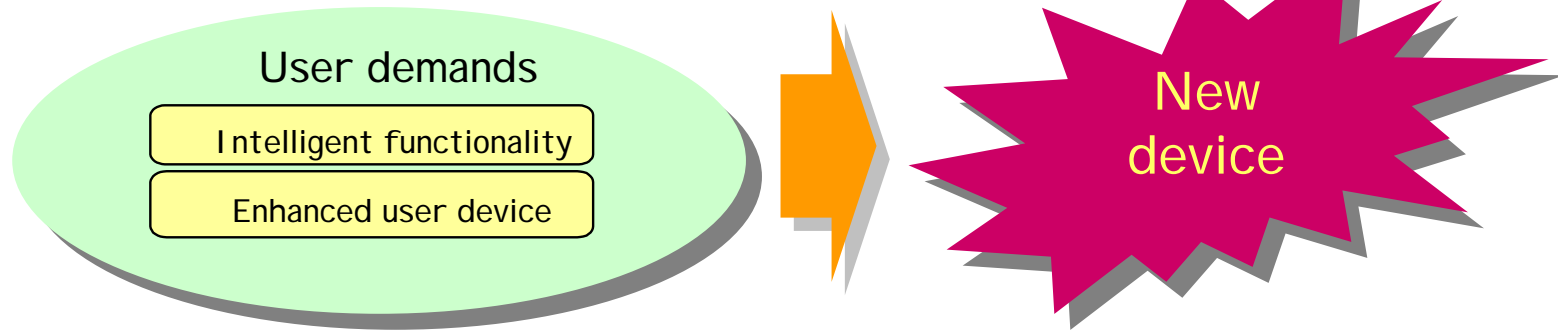
❑ Technical Issues

- Enhanced user interface
- Advanced peripheral device
- MEMS

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Devices; User Interface

❑ Paradigm Shift
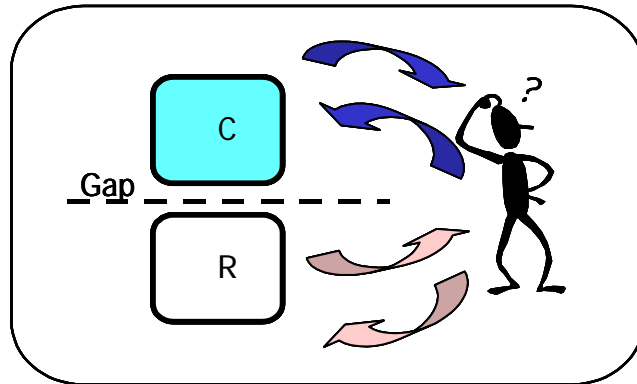
(a) GUI
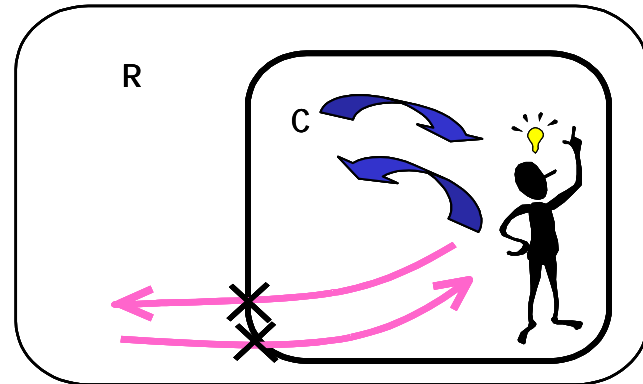
(b) Virtual Reality
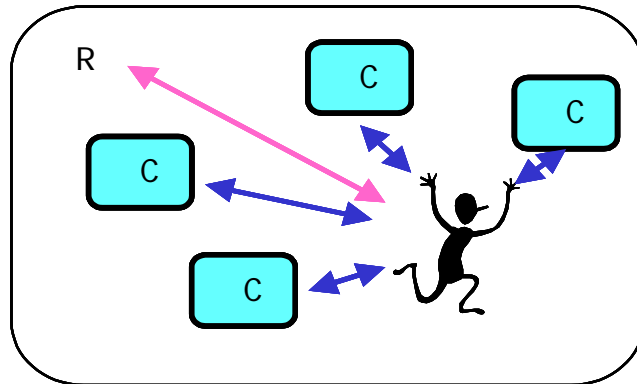
(c) Ubiquitous Computers
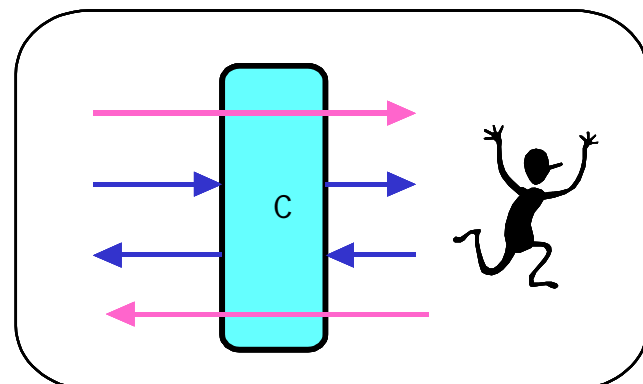
(d) Augmented Interaction

Source : Brave New Unwired World by Alex Lightman with Williams Rojas

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Devices; Processing power

❑ **New air interface and End-service**

❑ **Reconfigurable RF platform**

Present and future trends

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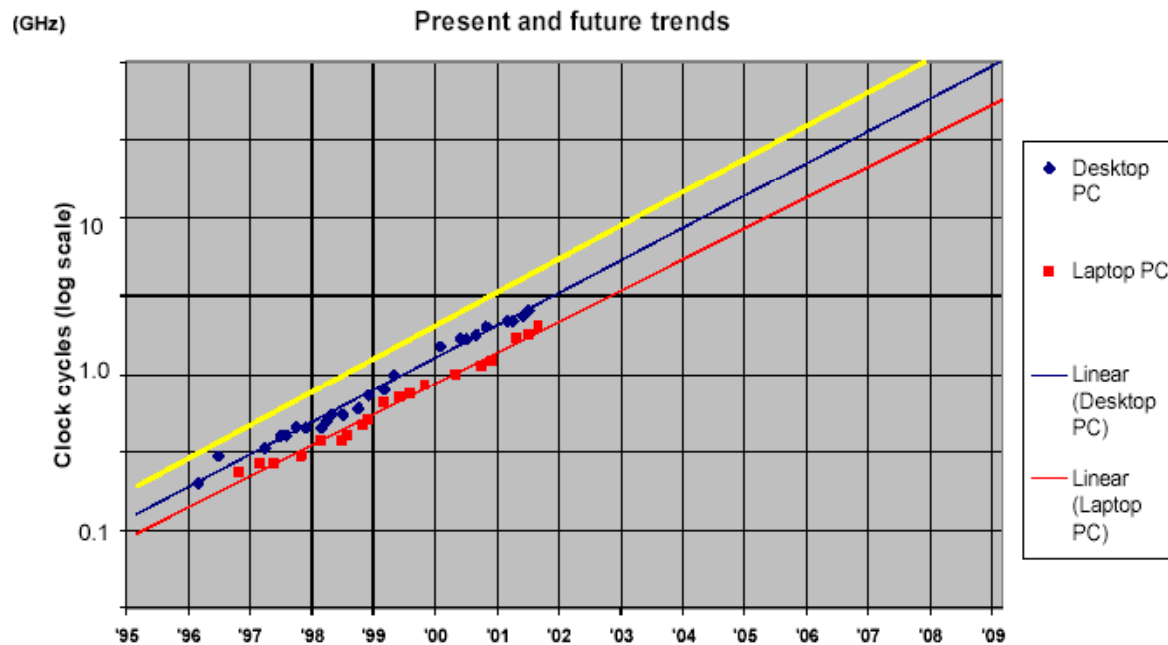
Devices; Battery

❑ Long Life-time, Portability

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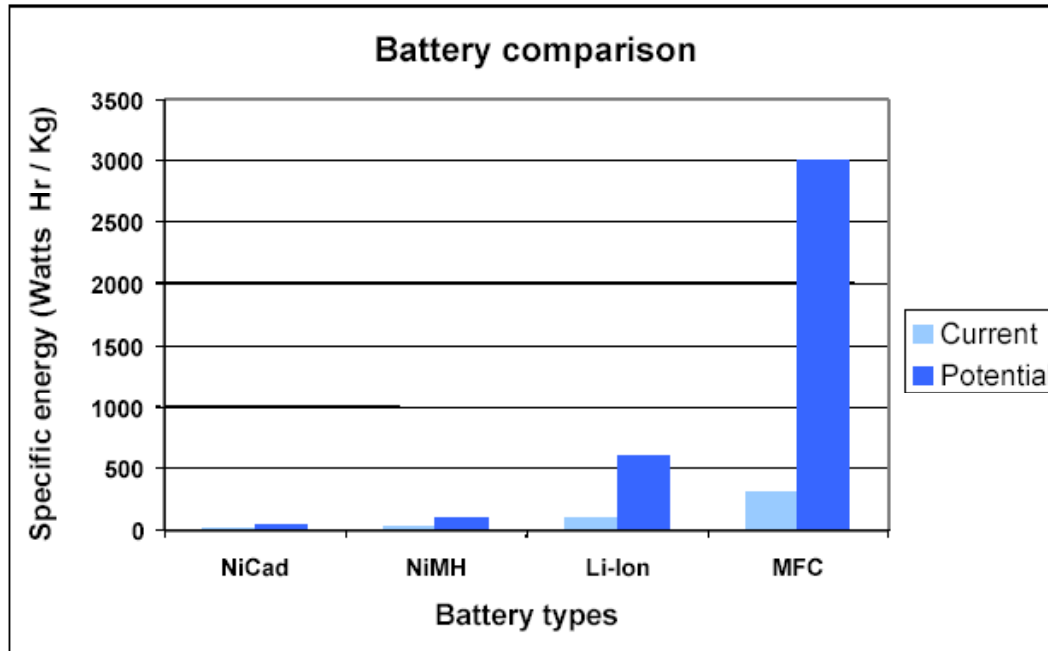
Mobile Device

Devices

Interface	Processor	Memory	Power Supply
• Intelligent, adaptive Interface • Interface for Portable/Wearable Device • User Cognition-based Interface	• Reconfigurability • Processor for Radio Device	• 70Gb/in^2 Memory	• Long Battery life • Fault-protection

Mobile Handset Software

Open OS Platform	Application Enabler	Application
• Multimedia Manager • Peer-to-peer Protocol • Security Management (DRM, Payment) • Location Engine • Personalization Agent • Connectivity to Different Networks	• Platform standard • Module-based • Multi-purpose Application support	• LBS • Multimedia Player • MMS client

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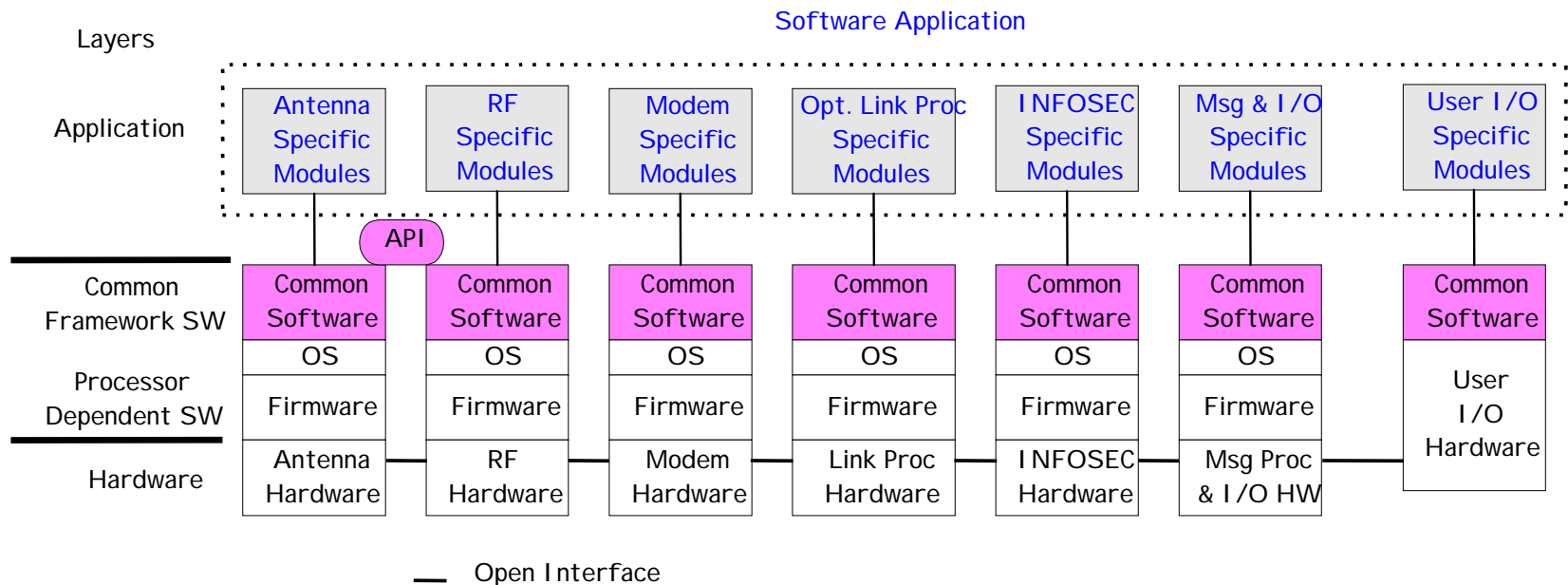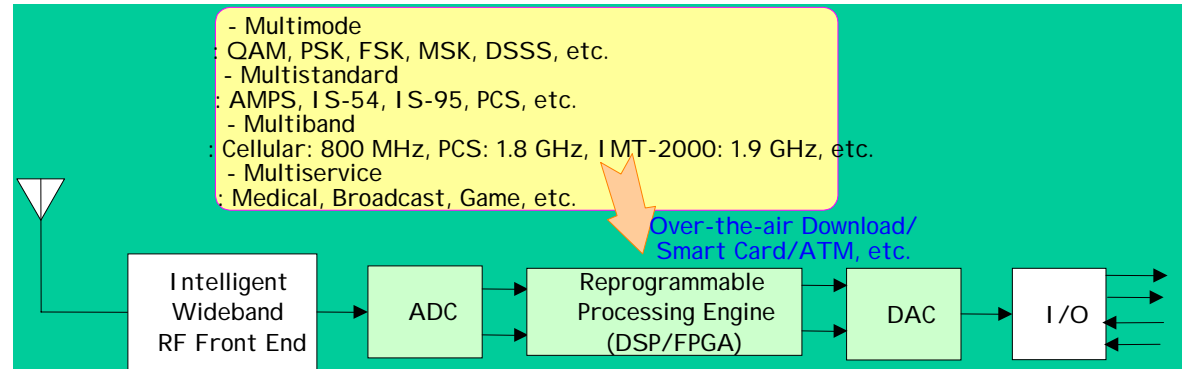# Reconfigurablity; SDR Structure

❑ SDR Structure

- ● Software
  - ▶ API
  - ▶ Download
- ● Hardware

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Reconfigurablity; Software Defined Radio

S/W Platform

H/W Platform

API

•Inter-module information/interface
•Object-oriented middleware

RF Technology

• RF-to-base Conversion
• PA, LNA
• ADC/DAC

S/W Download

•Charging for real-time downloading
• H/W Compatibility

Baseband Processing

• DSP
 - Flexibility
 - High DSP (GIPS)
 - Programmable
• FPGA
 - Flexibility
 - High Speed/ Low Power Consumption ASIC

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- Service aspect
- Technical aspect

❑ **Solutions**

- Radio interface
- Inter-Networking
- Multi-functional devices
- Reconfigurablity

❑ **Conclusion**

- Issue
- Expectation of the feasibility

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Summary

❑ **Key Features of Future Terminal will be**

- Controller connecting ubiquitous computing and communication
- Intelligent Platform always guaranteeing user-oriented service in a various of mixed networks
- Life-navigator with multi-functional device making all kind of user's daily behaviors much richer
- A Plug-in-Communication device always connected to available information
- Interpreter between user and outside through friendly-user interface

❑ **Feasible time is getting closer than we expected due to**

- Development of Devices according to Moore's Law
- Rapid growth of Wireless data rate
- Reconfigurability in device and network

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