

Image based Sensor

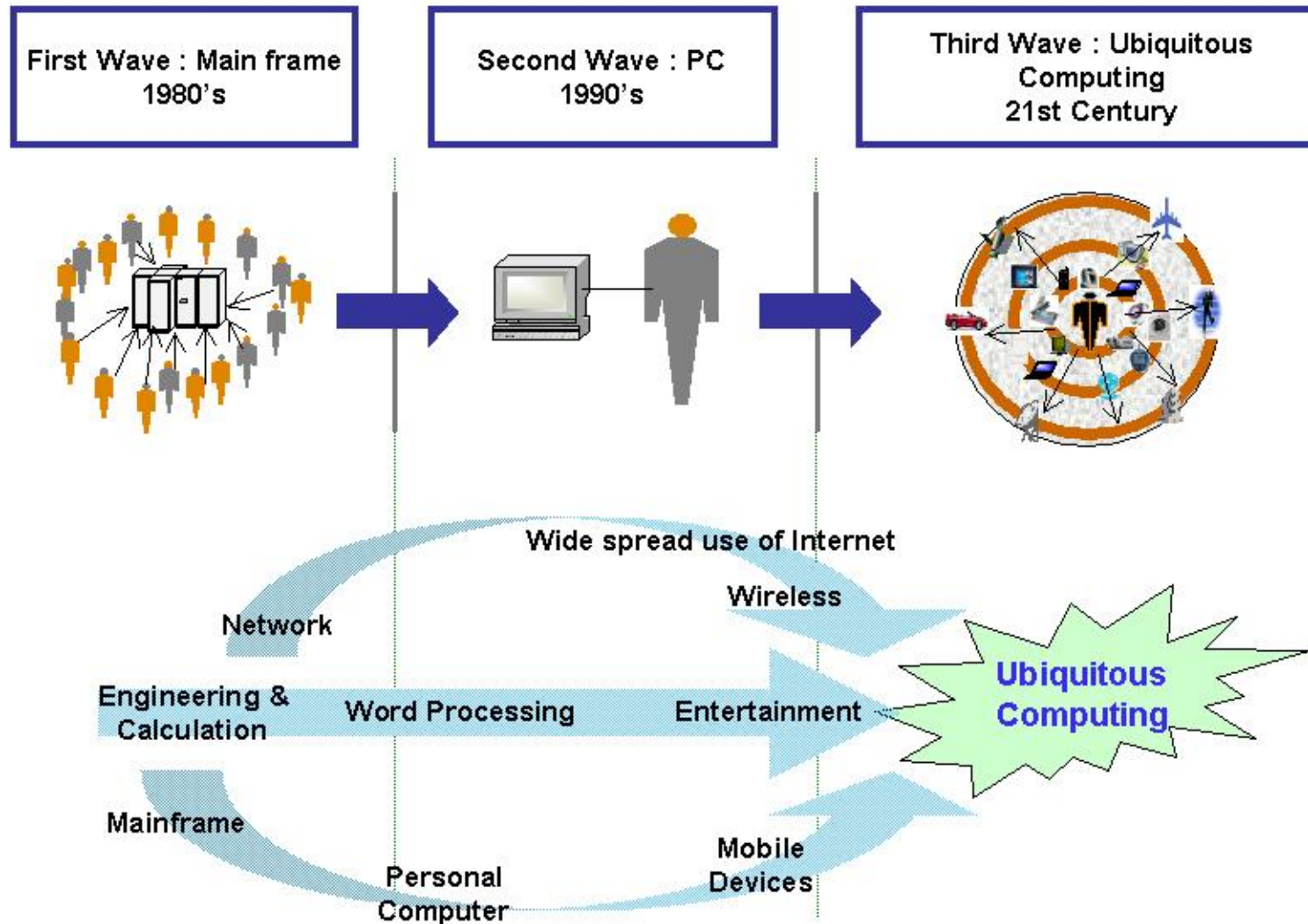
November 2005

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- **Introduction**
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Introduction: Paradigm Shift



[Xerox PARC, Mark Weiser, 1991]

Formal factors

- **Location** : head, wrist, belt, arms, legs, back, finger, ears,...
- **Materials** : plastic, textile, leather, stone, jewel, metal, glass, etc

Functional factors

- Input, output, memories, processing, networking, sensor devices

Media factors

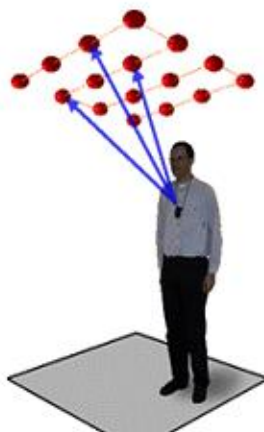
- Multimedia / Text
- Tactile, taste, smell
- Augmented media : MR, AR, VR

Interactivity factors

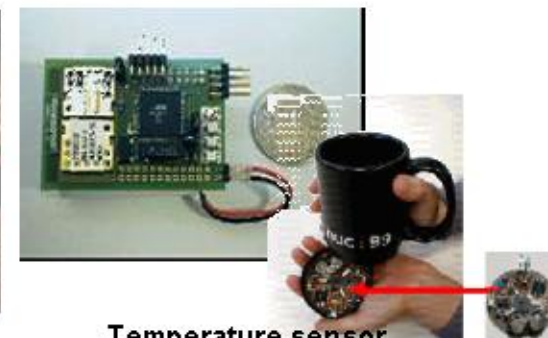
- **Context factors**
 - **human-to-environment**
 - ✓ location, in/out-door, ...
 - **machine-to-environment**
 - ✓ temperature, weather, light, ...
 - **human-to-human**
 - ✓ communication, collaborated work, ...
 - **human-to-machine**
 - ✓ user interface, bio monitoring, bio recognition, fingerprint recognition,...
 - **machine-to-machine**
 - ✓ image based sensing, RFID, middleware,...
- **Sensors**
 - GPS, gyro sensor, Gyro compass, ...
 - Camera, RFID, IR, pressure, light, time,...

Context awareness & Sensors

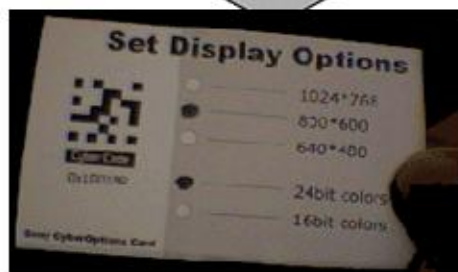
- Image based tag : ColorCode, Barcode, 2D codes
- Wireless tag : RFID, IR
- Movement : Gyro sensor
- Location : GPS
- Direction : Gyro compass
- Health : Blood, blood beat, syncope
- Pressure, temperature, light, sound sensors, ...



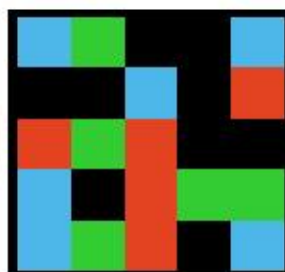
Scanner



Temperature sensor



SONY Cybercode



ColorCode™

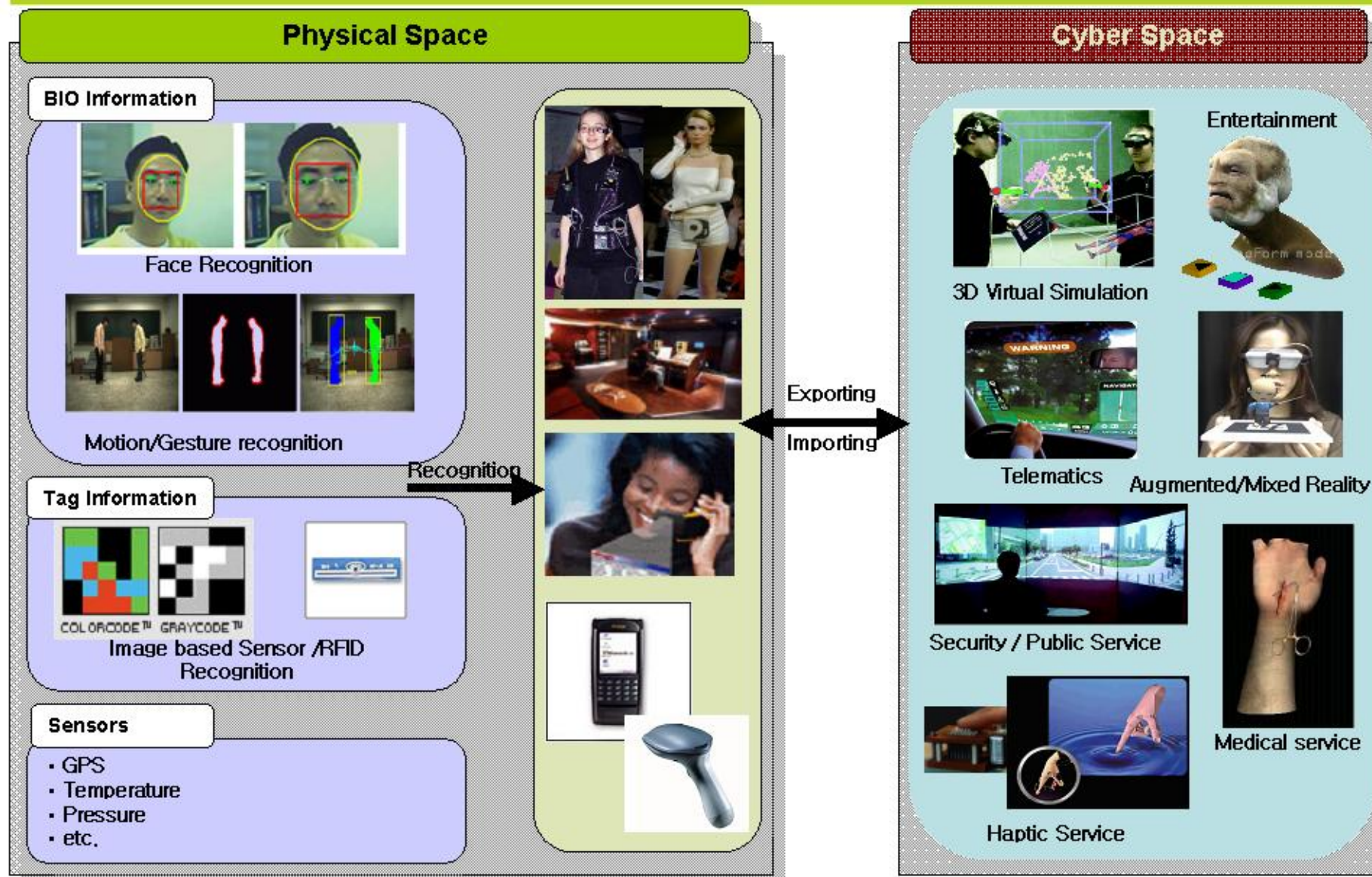


Gyro sensor



RFID

Sensing Interface for Ubiquitous Computing

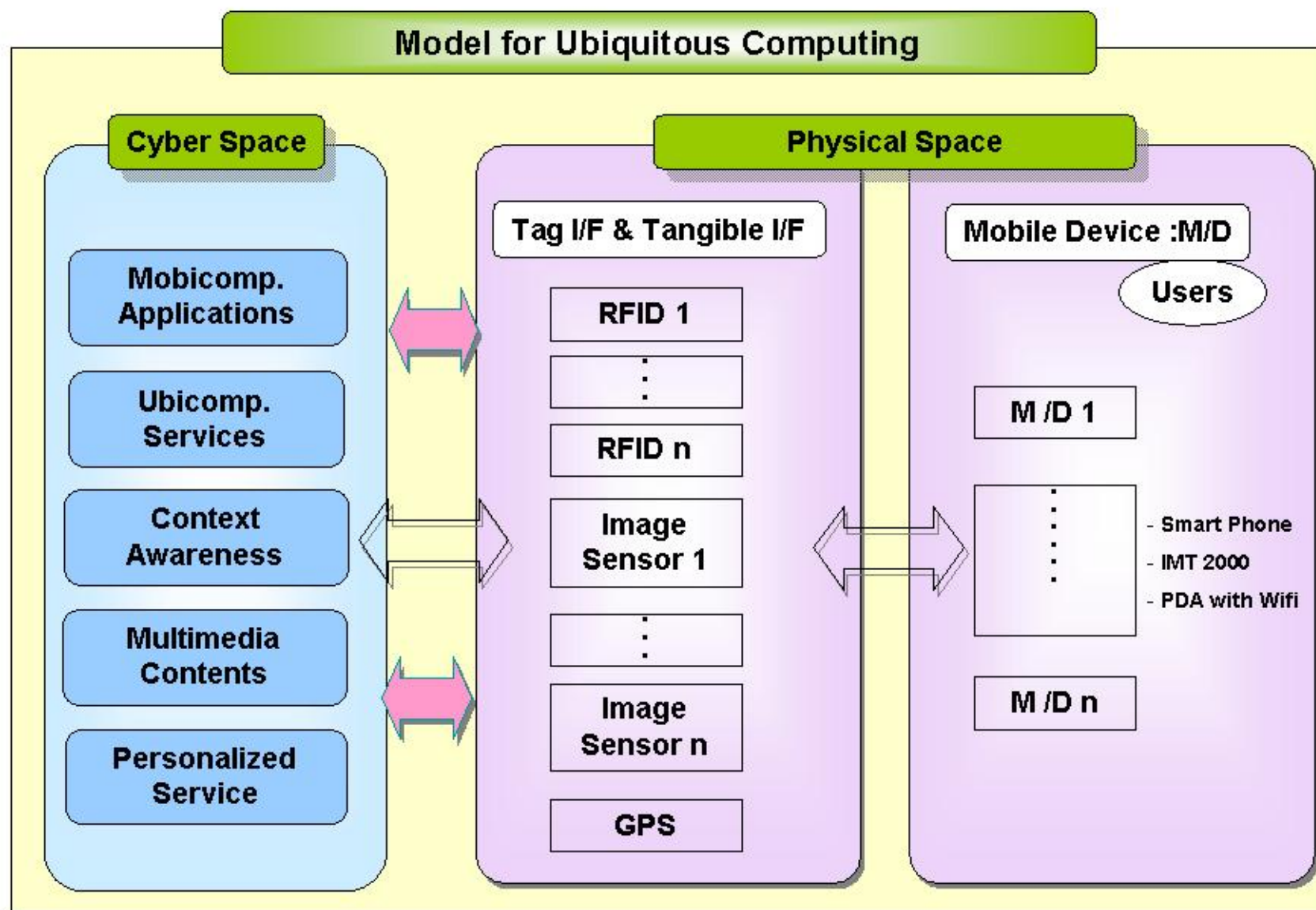


Physical Media/Sensors

Computing Devices/
Reader

Services/Application

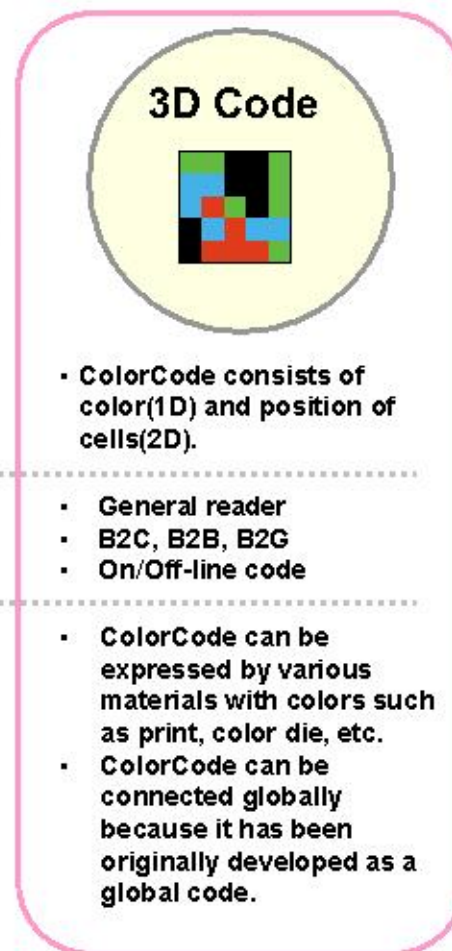
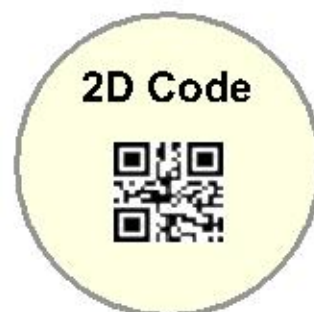
Tag Interface for Ubiquitous Computing



Concept of Tag interface

- **Tag interface**
 - Bridge between physical world and cyber world
 - Fast input, easiness
 - **Types**
 - Image based code: Barcode, 2D code
 - Industrial area: logistics, POS
 - Research area : Augmented reality, Mixed reality (WA, MIT, etc.)
 - Wireless tag: RFID, IR
 - Industrial area : EPC Global ONS, U-ID
 - Research area : Tangible interface, Smart It
- **Issues**
 - **Image based codes**
 - Off-line based black & white code
 - High cost special device: Reader, scanner
 - 1D barcode: Cultural taboo
 - **RFID**
 - Privacy problem
 - High cost special device
 - Cost per chip

Image based Sensor



Basic Structure

- 1D code consist of number, length and thickness of bar

- 2D code consists of position of cells(2D).

- ColorCode consists of color(1D) and position of cells(2D).

Feature

- Dedicated reader
- For logistics
- Off-line code

- Dedicated reader
- For logistics
- Off-line code

- General reader
- B2C, B2B, B2G
- On/Off-line code

Comparison to ColorCode

- 1D code can not be connected to internet because 1D code is a local code.
- 1D code need high pixels for recognition in case of use of camera for reader.
- 1D code need macro zoom lens.

- 2D code can not be connected to internet because some of 2D code is a local code.
- 2D code need high pixels for recognition in case of use of camera for reader.
- 2D code need macro zoom lens.

- ColorCode can be expressed by various materials with colors such as print, color die, etc.
- ColorCode can be connected globally because it has been originally developed as a global code.

- ColorCode is a revolutionary solution to connect codes to information by reading the index code with camera.
- ColorCode is a next generation code that shows data using 4 colors (Red, Green, Blue, Black).
- ColorCode Includes the path of multimedia information.

Image based Codes

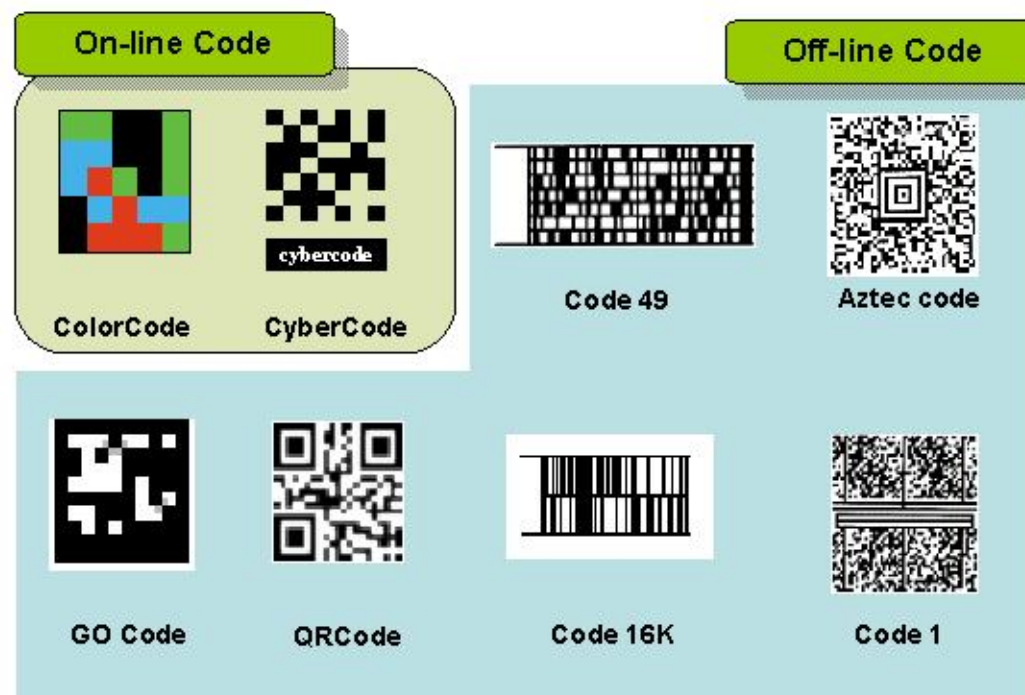
- **Shapes**
 - 1D bar type: UPC, EAN, etc.
 - Matrix type : Code 1, Datacode, Sofrstrip, Vericode, etc.
 - Multi-layer type : combining several 1D code - Code 49, Code 16K, PDF 417, Codablock
- **Colors**
 - Black & White Codes
 - ColorCode
- **Encoded data**
 - Index type : On-line
 - Full-text type : Off-line



Four score and seven years ago our fathers brought forth in this continent a new nation, conceived in Liberty and dedicated to the proposition that all men are created equal. Now we are engaged in a great civil war, testing whether that nation or any nation so conceived and so dedicated can long endure. We have come to dedicate a portion of that field as a final resting place for those who here gave their lives that that nation might live; it is altogether fitting and proper that we should do this. But, in a larger sense, we cannot dedicate we cannot consecrate we cannot hallow this ground. The brave men, living and dead, who struggled here have consecrated it far above our poor power to add or detract. The world will little note nor long remember what we say here, but it can never forget what they did here. It is for us, the living, rather, to be dedicated here to the unfinished work which they who fought here have thus far so nobly advanced. It is rather for us to be here dedicated to the great task remaining before us that from these honored dead we take increased devotion to that cause for which they gave the last full measure of devotion; that we here highly resolve that these dead shall not have died in vain; that this nation, under God, shall have a new birth of freedom; and that the government of the people, by the people, for the people shall not perish from the earth.

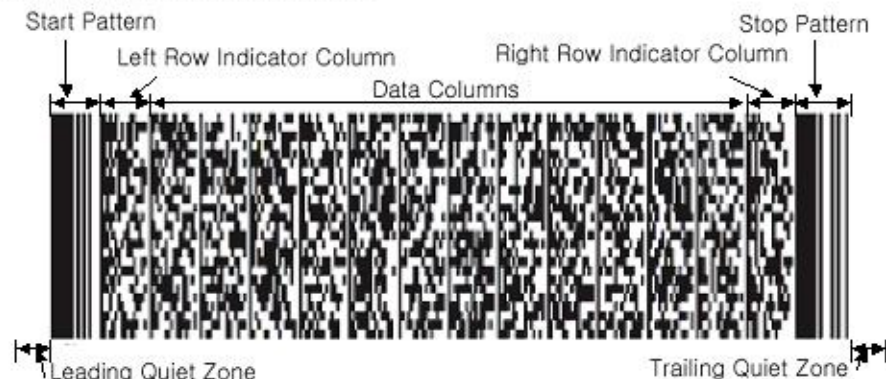
그림 2-4-11) PDF-417 샘플

PDF-417(Layer type)



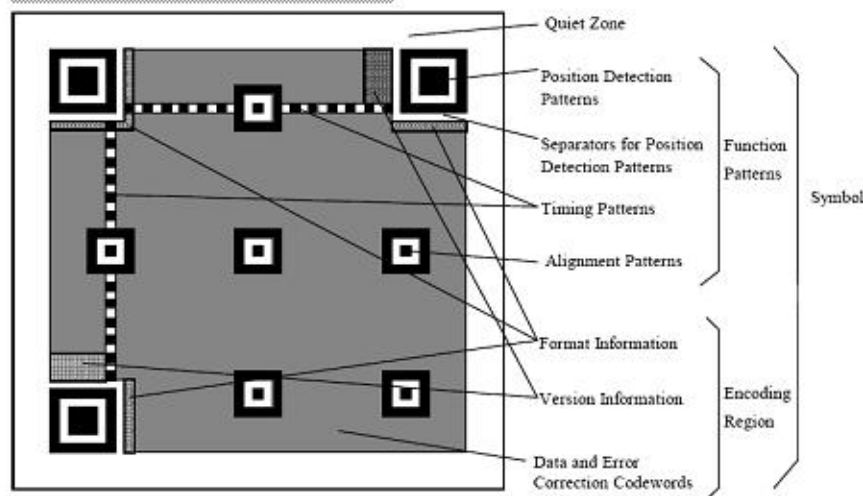
Off-Line Code: Structure of 2D Image Codes

PDF-417



- **Code Alignment Patterns**
 - Start Pattern/Stop Pattern
 - Left Row Indicator Column
 - Right Row Indicator Column
- **Data Area**
 - Stack / Layer type
 - 1 symbol
 - 4 bars + 4 spaces
 - 17 modules
- **Data Encoding**
 - Compression
 - Additive Error Correction codes
 - 9 levels
 - Reed-Solomon Code

QR

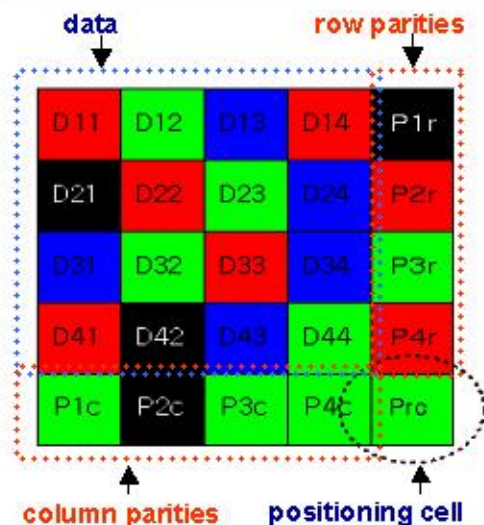


- **Code Alignment Patterns**
 - 3 Finder Patterns (Position Detection Patterns)
 - Timing Patterns
 - Alignment Patterns
- **Function Patterns**
 - Format pattern
 - Mask Pattern
 - Error Correction Level
 - Version Pattern
- **Data Area**
 - Matrix type
 - 1 symbol: 8 modules
- **Data Encoding**
 - Additive Error Correction codes
 - 4 levels R-S Code
 - Reed-Solomon Code for Data
 - BCH Code for Format & Version Information



On-Line Code: ColorCode

Structure



•Error detection

(3 typed parity)

- row parities,
- column parities,
- positioning cell

•Rotation correction

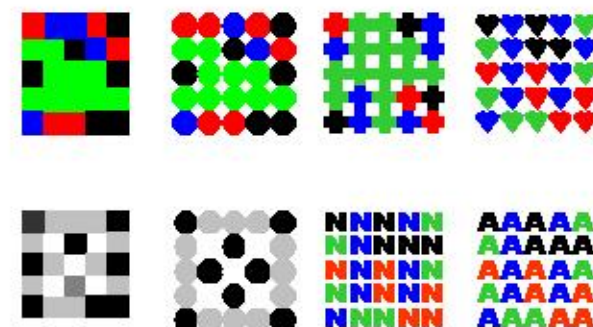
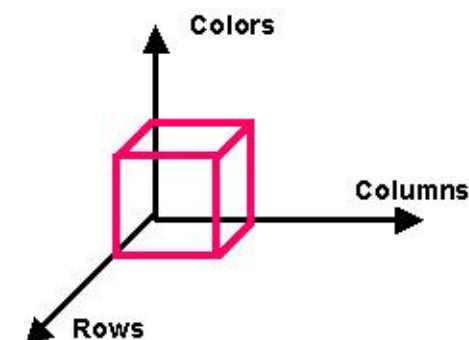
- Position detection only one positioning cell by inverse parity

Types

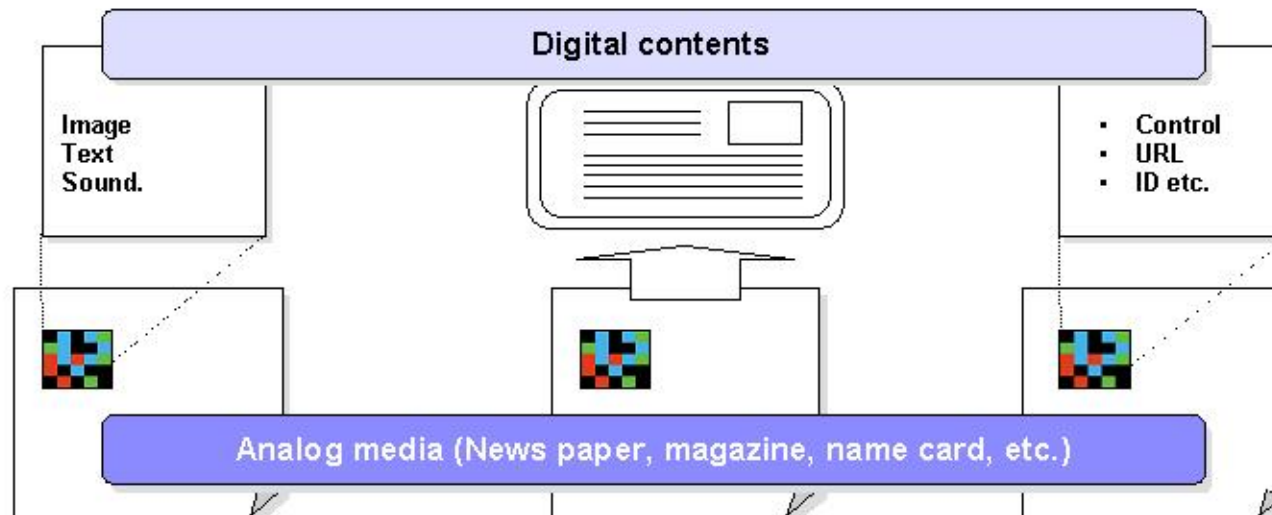
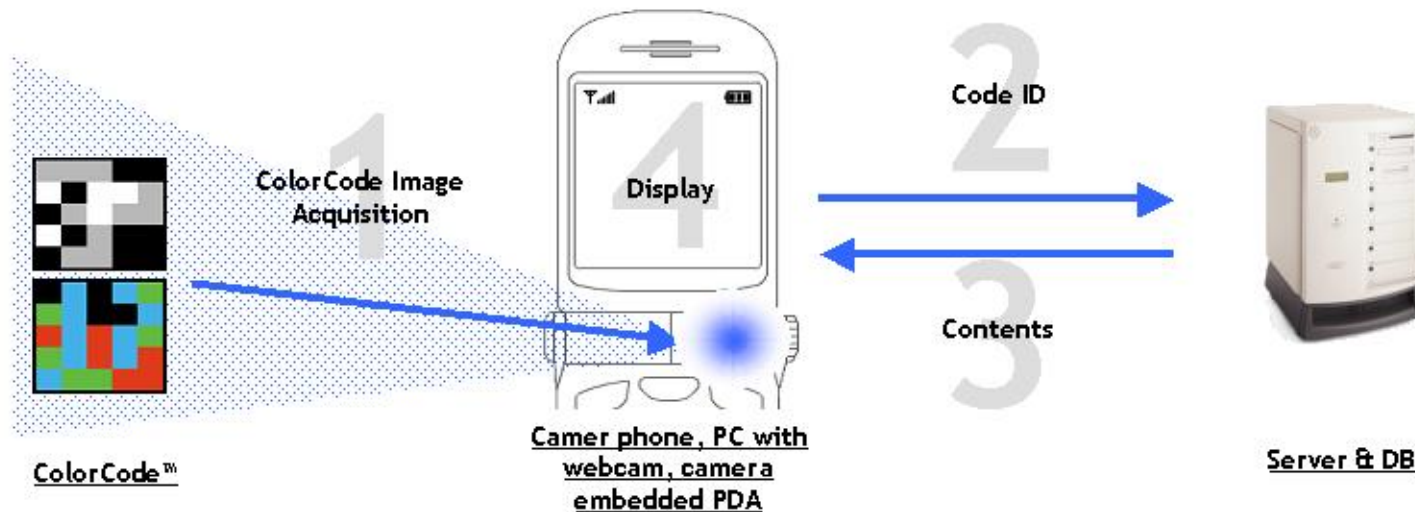
Type	Symbol	Application	Size	# of patterns
5x5 GrayCode™		Human centered Interface	5x5mm	8,600
5x5 ColorCode™		Human centered Interface	5x5mm	17.2x10 ⁹
5x8 GrayCode™		Industrial Product	5x8mm	23x10 ¹²
5x8 ColorCode™		Human centered Interface	5x8mm	72x10 ¹⁶
9x9 ColorCode™		IPv6 (Future)	9x9mm	3.4x10 ²³

of ColorCode

Color# $\wedge$ [Row# X Column# - Parity & Error Check Cell # + Extension Pattern #]



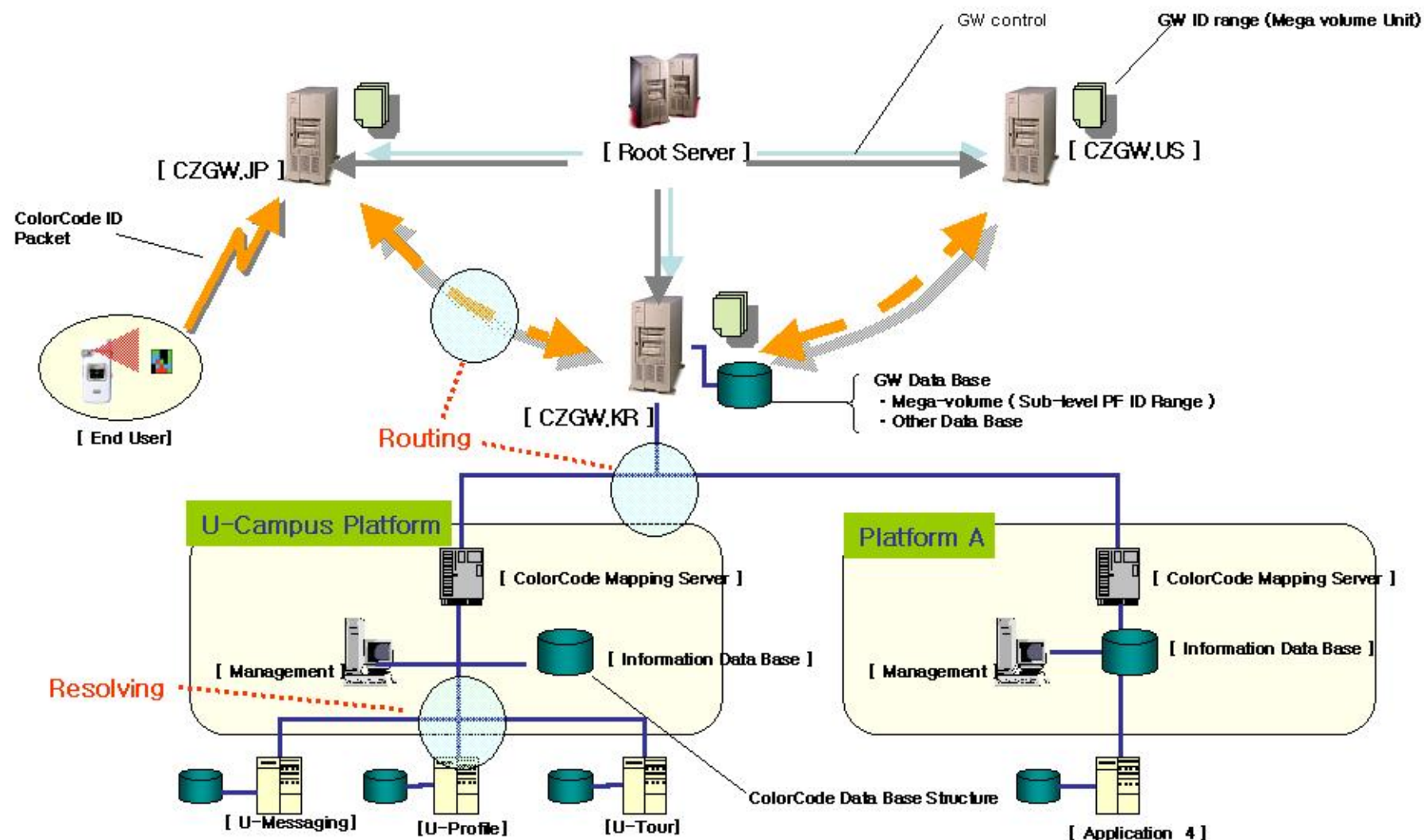
On-Line Code: ColorCode Services



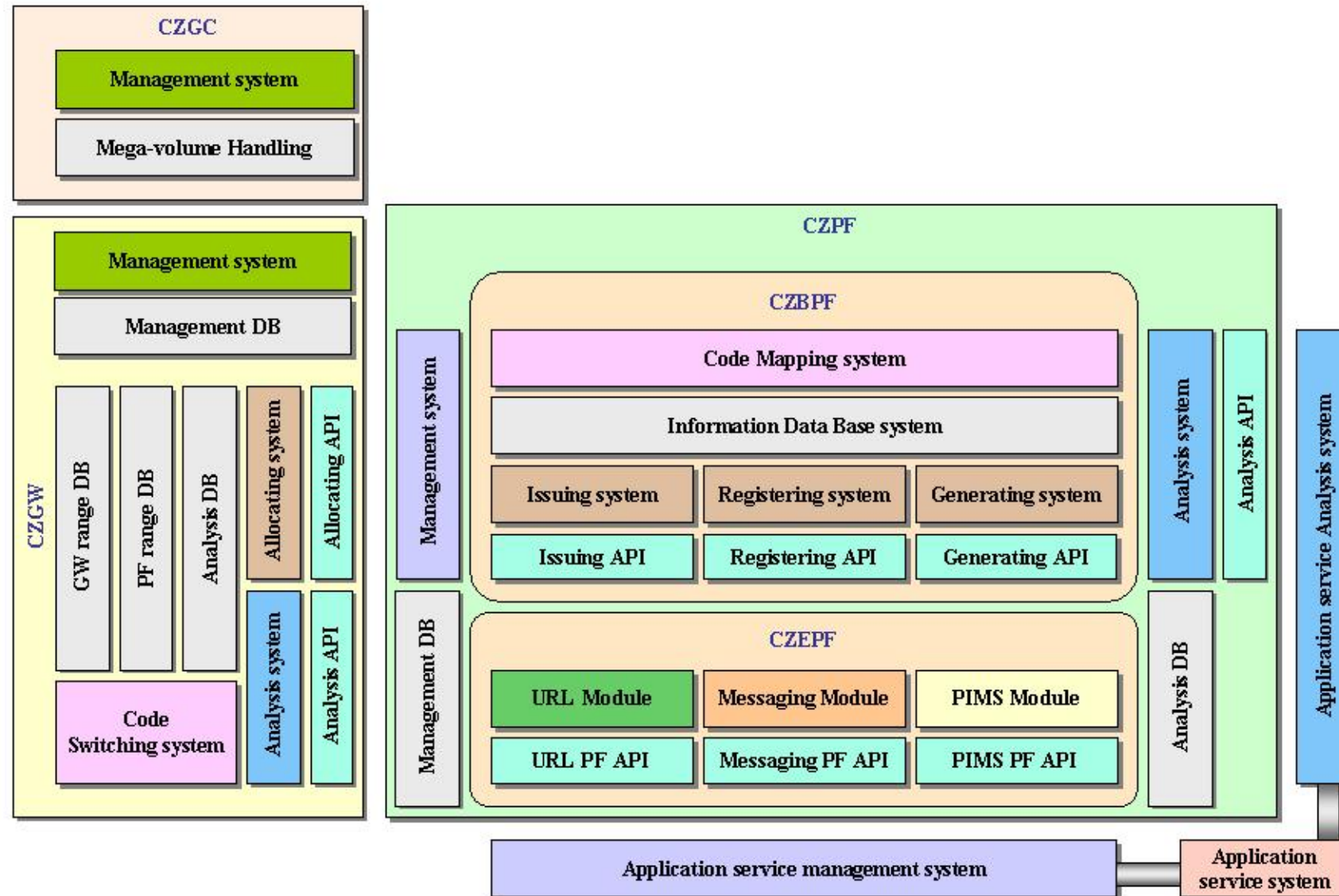
(by Nomura Research Institute, November 2001)

- **Paper**
 - Magazine
 - News paper
 - Post
 - Books
 - Catalogue / Pamphlet
 - Advertisement in trains
- **Display**
 - TV
 - Monitor
 - Color LCD display at mobile devices
- **POP/Signboard**
- **Packing**
 - Label
 - Title back on CD/DVD
 - Books

Application based Service Architecture of On-line tags

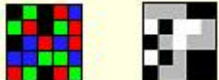


Application based Server System Architecture



General Code Comparison

ColorCode has unmatched excellence over other 2D codes in use and design with low investment.

	ColorZip Media (Korea)	DENSO (Japan)	Symbol Technology (USA)	Sony (Japan)
Code	Color / Grey Code 	QR Code 	PDF-417 	CyberCode 
Code Type	On-line Code	Off-line Code	On-line Code	On-line Code
Device	- PC Camera - PDA - Camera Mobile Phone - General Reader	- Special Scanner - Camera Decoder	Special Scanner	PC Camera
Strategic Partners	- SKT Nate Code - KT IMT 2000 - LG Telecom - Maeil Business Newspaper - Samsung Elec. - AniArt Edu.com - Toyota Group	- Toyota Tsusho - Toyota Motor	Symbol Tech.	Only Sony "Vaio" Note PC
	- Good Design - Extendibility - Low cost for device design - Small decoding module - Flexible Platform	- Direct Data Storage - Error Correction - High speed recognition	- Direct Data Storage - Error Correction - High speed recognition	High speed recognition

General Code Comparison

	ColorCode	BarCode	RF Tag
Convenient recognition	Easily recognized with CCD camera of 100,000 picture elements or more	Dedicated reader is required	Dedicated reader is required, reading distance is important
Type of reading terminal	Easily Anything possible of it satisfies CCD camera + network connection	Dedicated reader is required	Dedicated reader is required
Terminal load	Low load	High load	High load
Communication environment	Necessary / Unnecessary (depending on usage)	Unnecessary	Necessary
Issuance cost	Low	Low	High
Volume of information	Since centers have it, there is no limit	Practically, about 100 bit	128 bit
Number of patterns	17 billion (but, extendable)	Varies depending on size	10^{38}
Type of media	Anything possible if there is over certain number of colors	Anything possible if there is over a certain number of dots	-
Convenient distribution	Distributable through prints	Distributable through prints	Since it's physical media, it is confined to tags
Existence of centers	Necessary / Unnecessary (depending on usage)	Unnecessary	Necessary

Case Studies:

UTOPIA Project in Korea

International Project in Japan

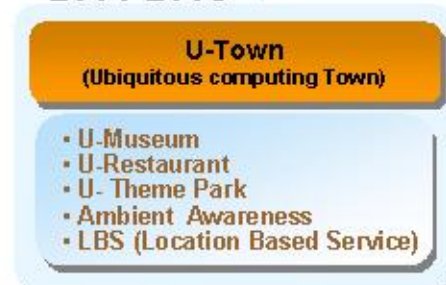
Ubiquitous TOWN Project : Intelligent context Awareness

- Providing human-centered interaction in ubiquitous computing environment
- Making new interface & service concepts for efficient interaction
- UTOPIA Team in Yonsei University

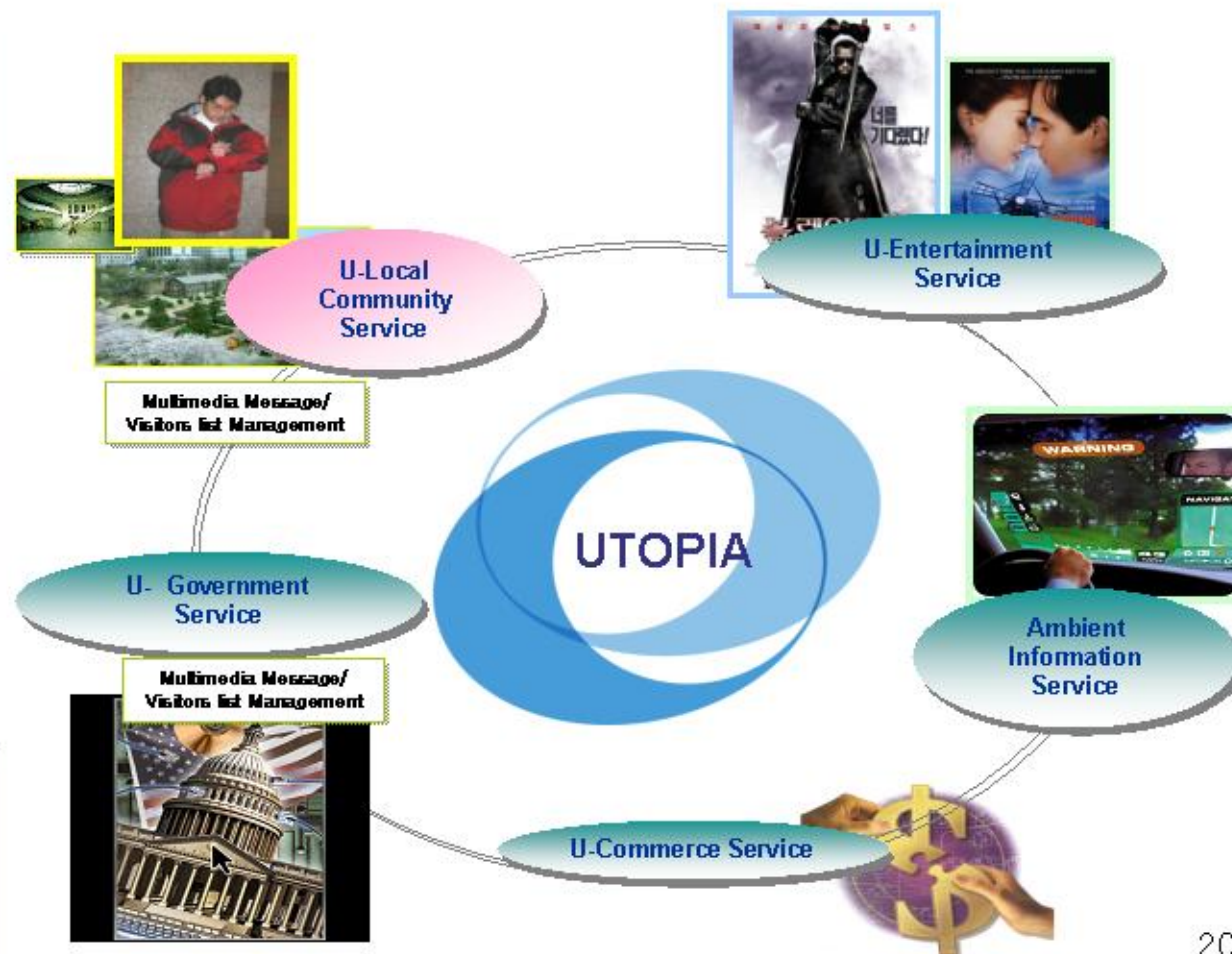
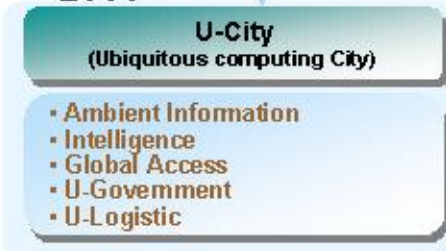
2003-2004



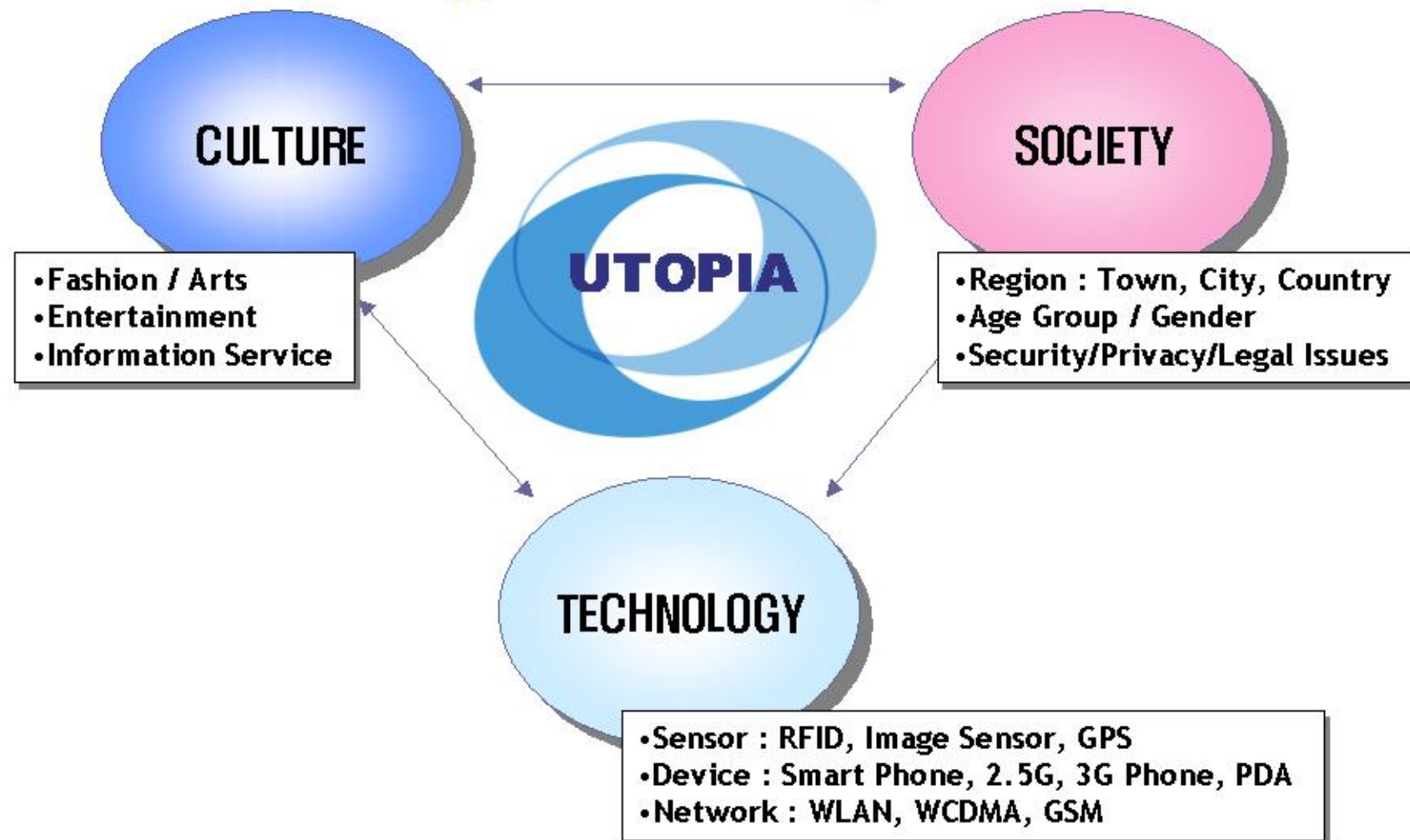
2004-2005



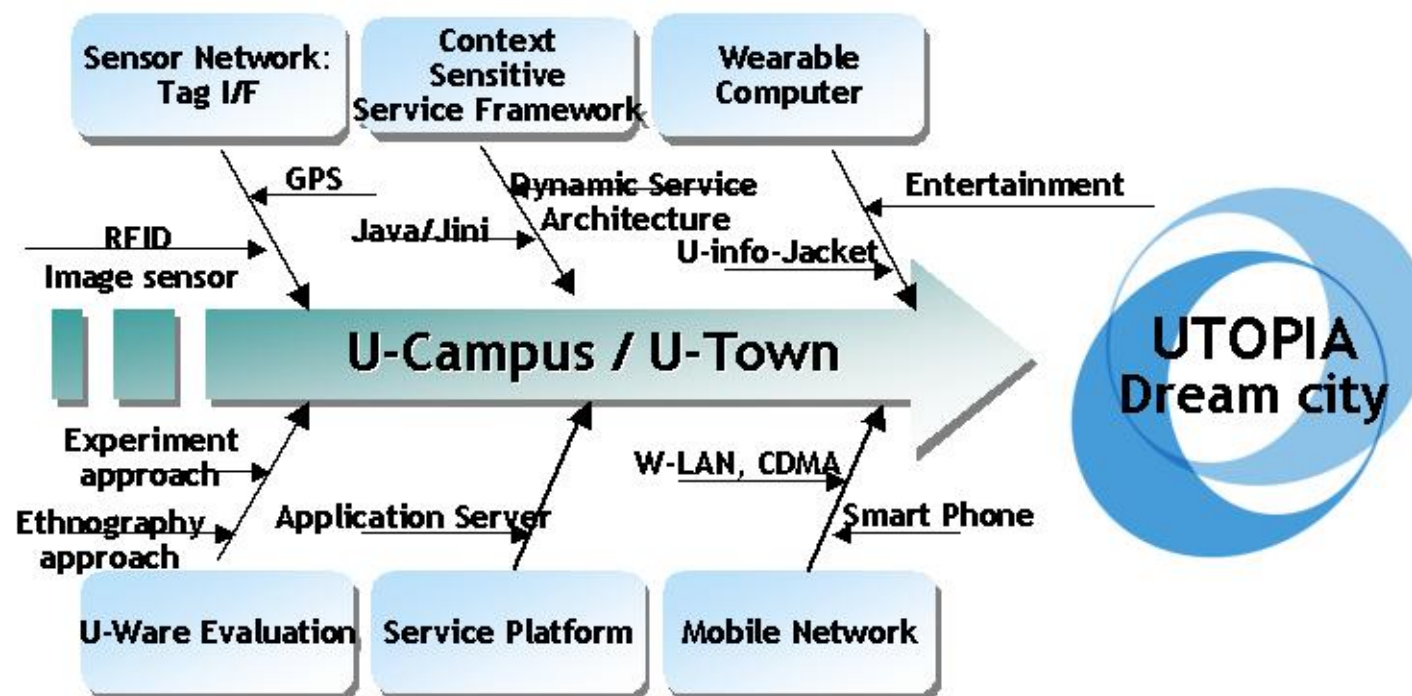
2006



Culture-driven UTOPIA technologies support Dream Society



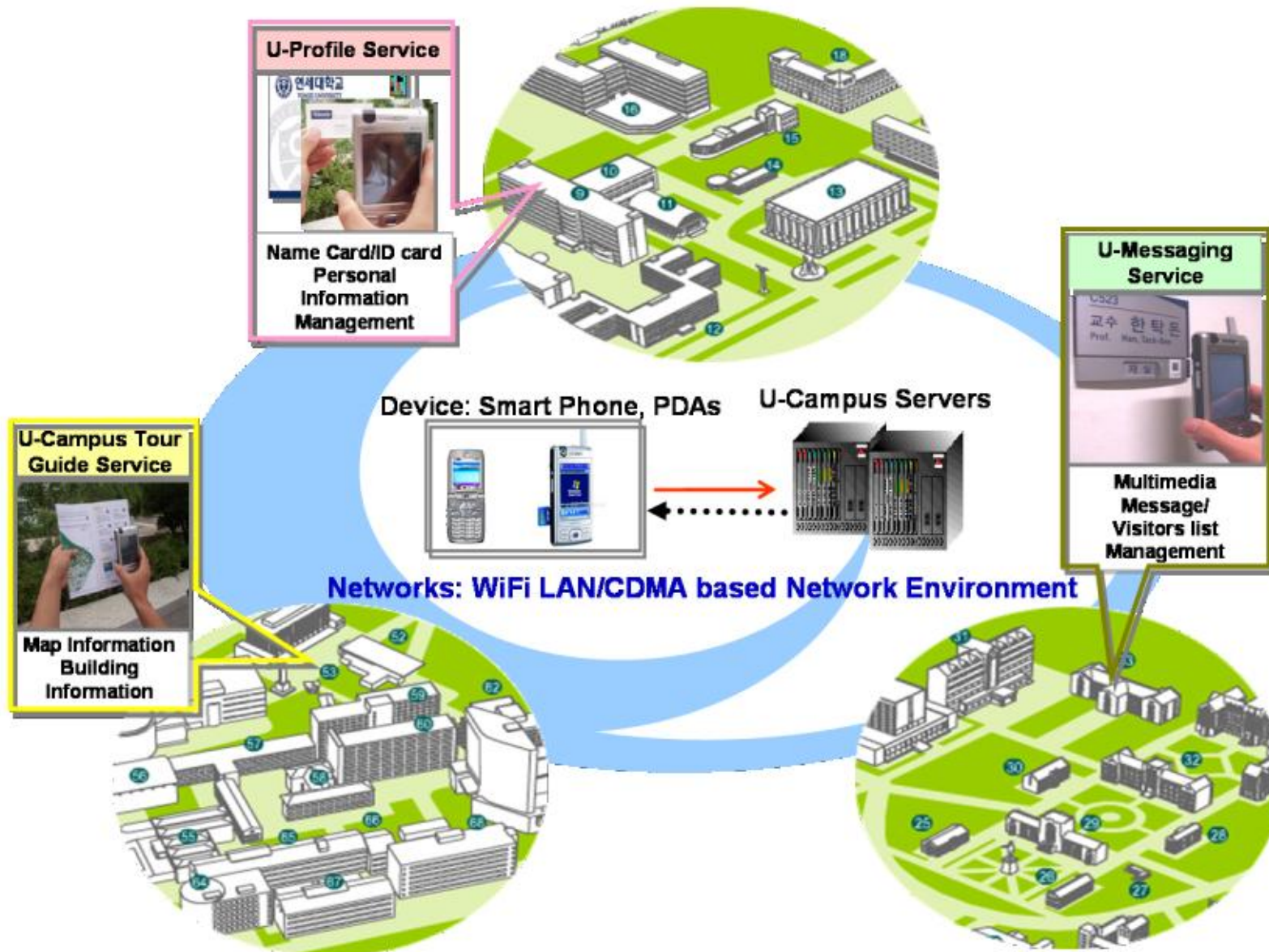
Supporting Technologies for UTOPIA



● Why U-Campus?

- Area within limits : observable, testable space
- User's characteristics : homogeneous(professors, students, and staffs of campus)
- Easy to specify services : simple, extendable and expansible but various applications
- Infrastructure : IT environment, technical supporting, collaborative working
- Liberal and judicial mind in new applications, experiments and evaluations

UTOPIA Phase I: U-Campus Project Overview (2003-2004)



VIDEO

U-campus.mpg

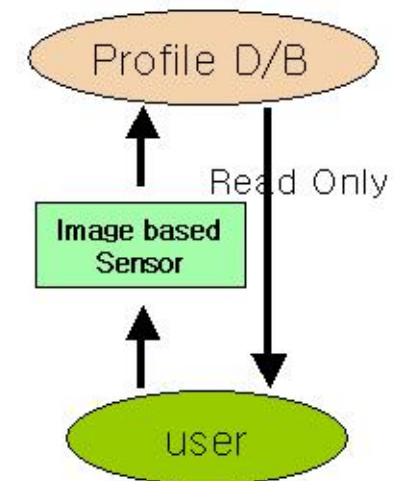
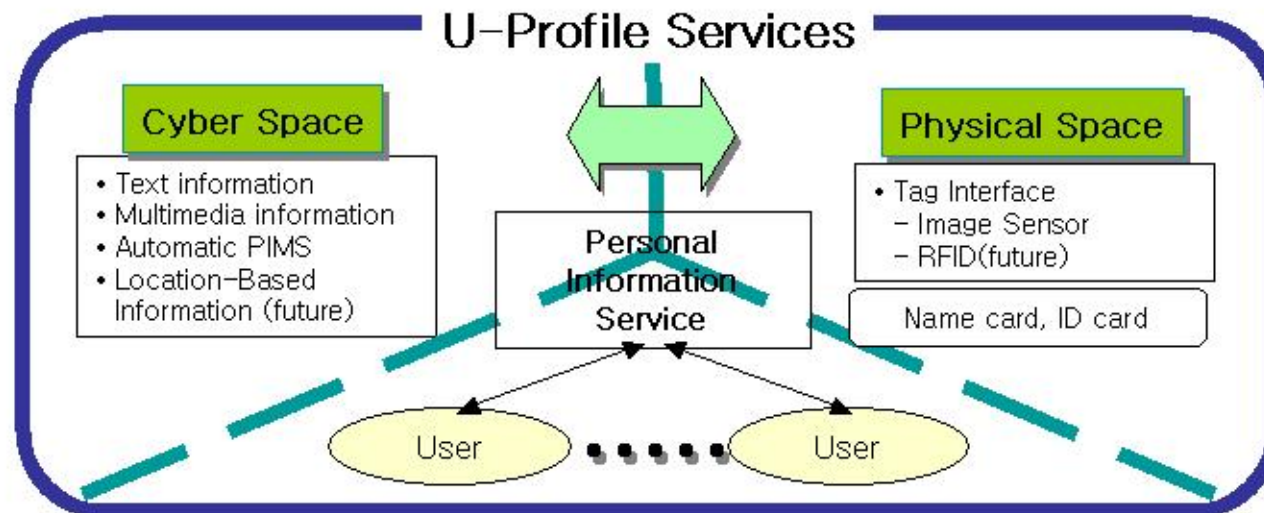
U-Profile Service

● U-Profile

- Image sensor(Color Code) based PIMS
- Device : PDA with a built-in camera and CDMA module
- Physical media : Name card, ID card

● Applications

- Automatic recognition and saving personal information
- Data are exchangeable with any PDAs and PCs using MS Windows compatible
- Text information : Name, Address,...
- Sending E-mail / Phone service / Webpage access / Individual video streaming



U-Profile Service : Scenario



Scan ColorCode
in a name card



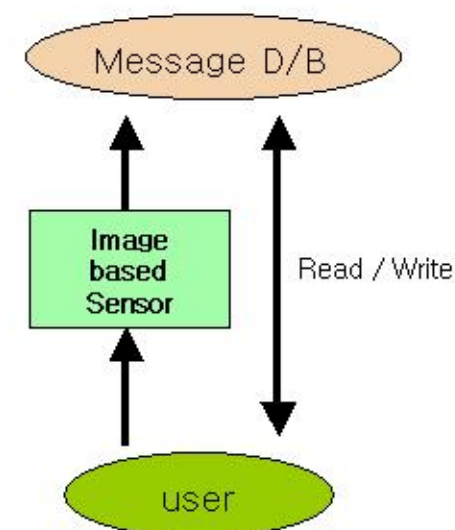
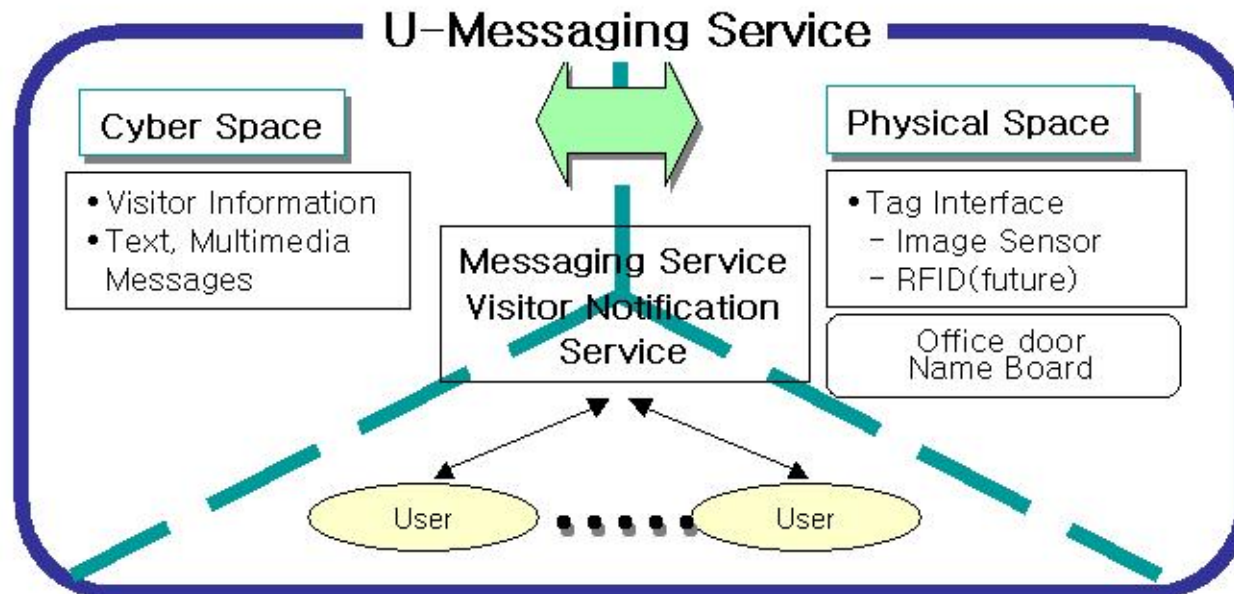
U-Messaging Service

● U-Messaging

- Messaging within image sensor(Color Code)
- Device : PDA with a built-in camera, CDMA module and voice recorder
- Physical media : Name plate, Office door

● Application

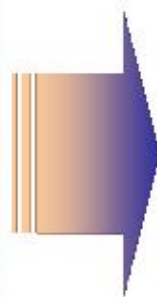
- Visitor : Sending text message / multimedia message
- Officer : Visitor information management



U-Messaging Service : Scenario



Scanning on name plate using ColorCode



Sending text / voice message



Retrieving voice and text information through email.

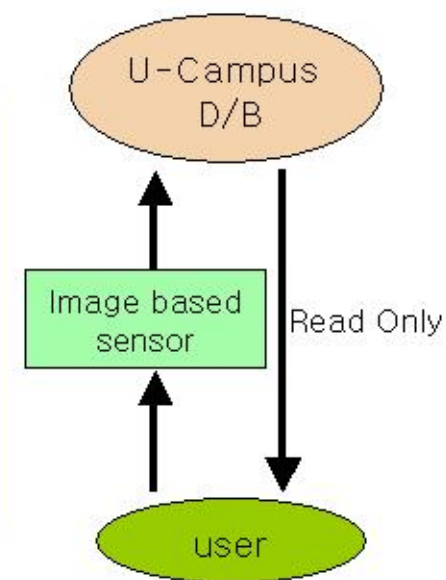
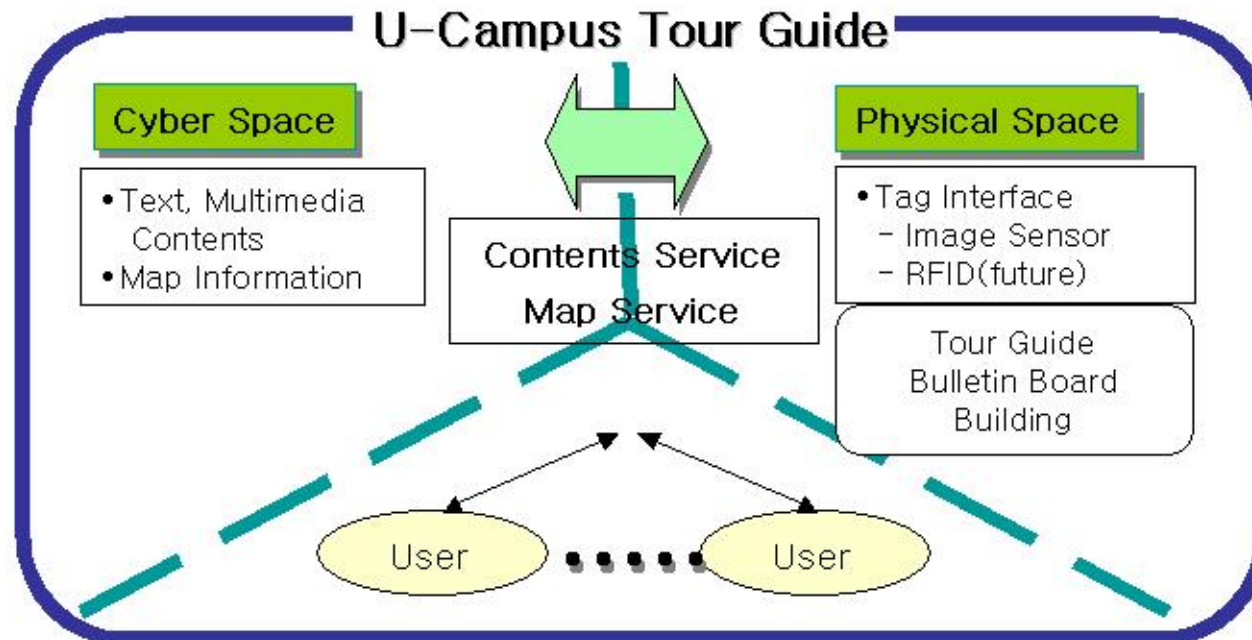
U-Campus Tour Guide Service

● U-Campus Tour Guide

- Campus guide within image sensor(Color Code)
- Device : PDA with built-in a camera, CDMA module and browser
- Physical media : Pamphlet, Tour Guide map, Building, Bulletin board,...

● Application

- Tour Guide / Location map
- Multimedia information for the building and campus
- HTML



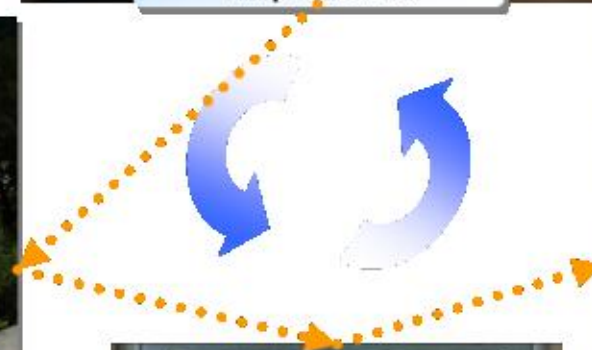
U-Campus Tour Guide Service : Scenario



Map & PDA



Scanning code on the map



Scanning & Information



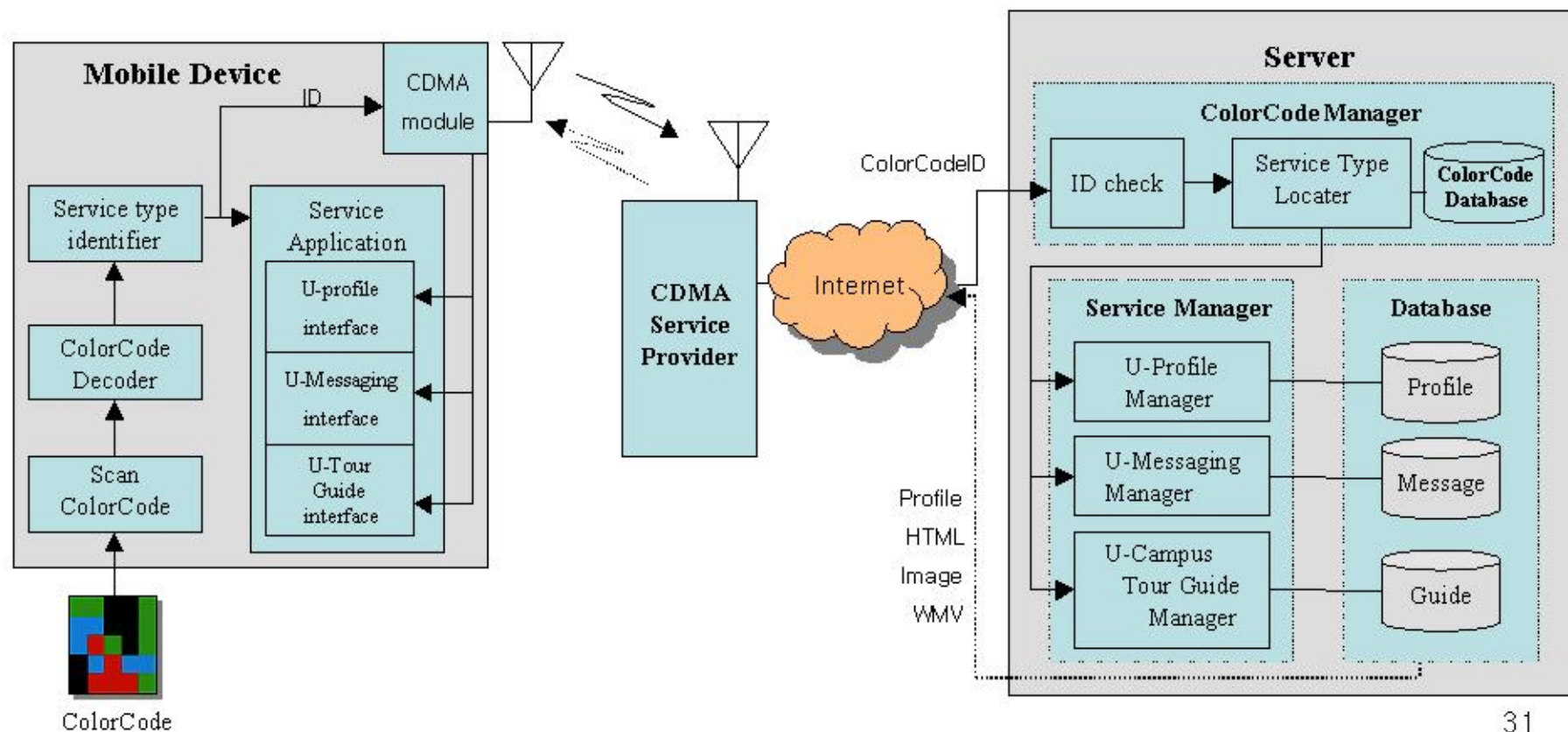
Digital Map & Text

- **Mobile device**

- Camera, CDMA module, Voice recorder, Text input device, Image sensor recognition S/W

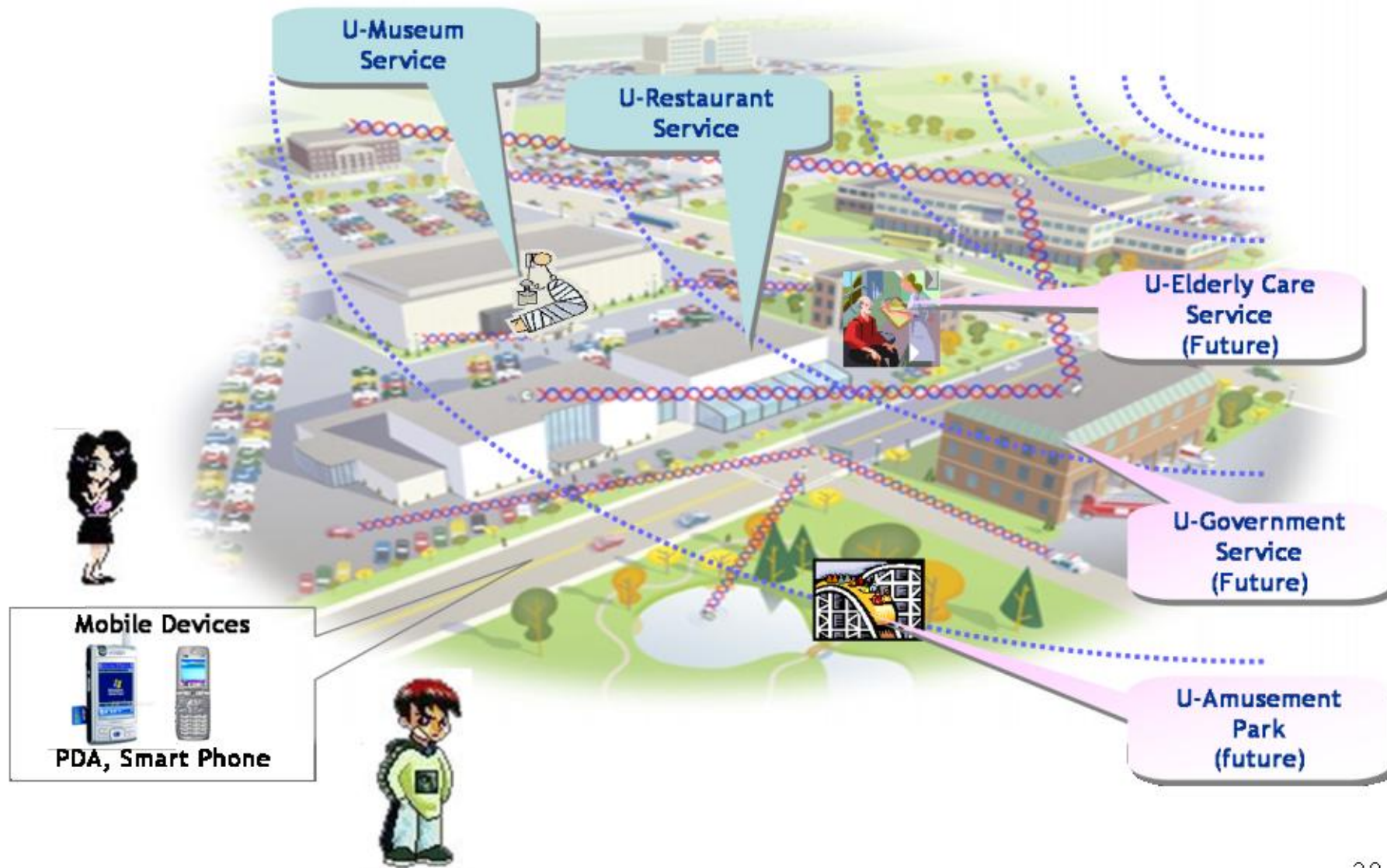
- **Server**

- ColorCode Manager
- Service Manager
- Database : contents database & ColorCode database



Phase II: U-Town Project (2004 – Current)

Ubiquitous Computing Environmental Town

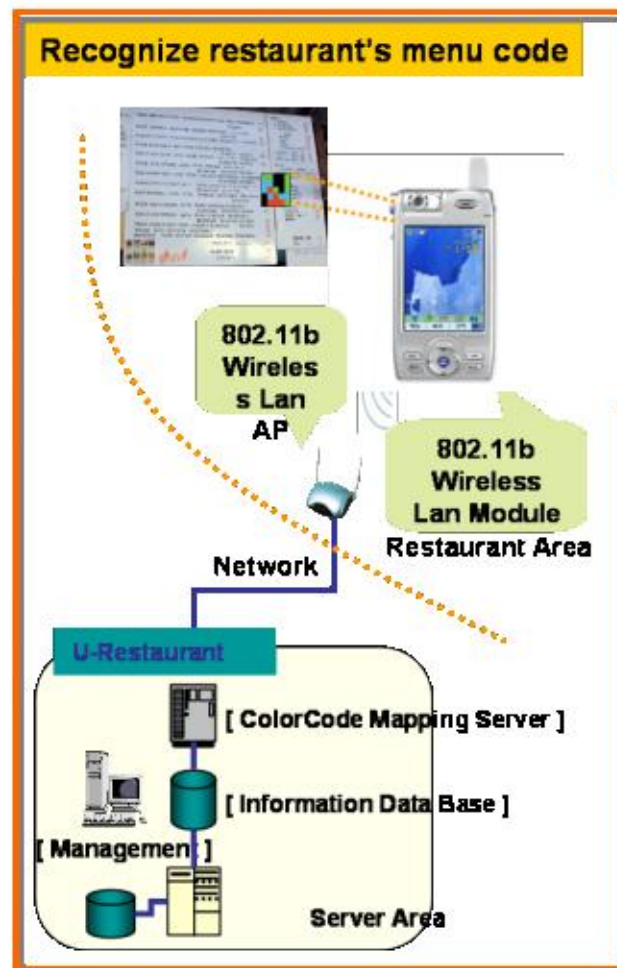


U-Restaurant Service

Restaurant Menu Service

- Application :

Showing the various menu information for foreigner, vegetarian in the Restaurant



1. Reading the restaurant's menu code



2. Showing the selected food information



3. Information for Vegetarian, foreigner



U-Restaurant Service

Integrated Menu Information

[고객 PDA]

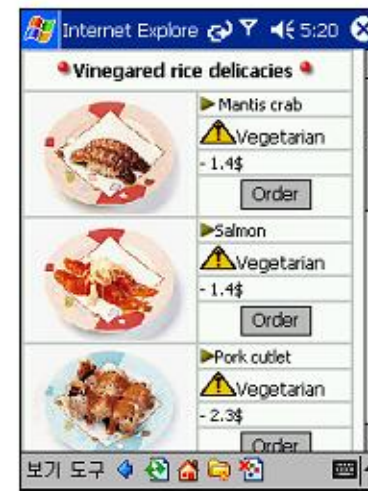
Individual Menu Information

U-Restaurant Service

Multi-Language Menu



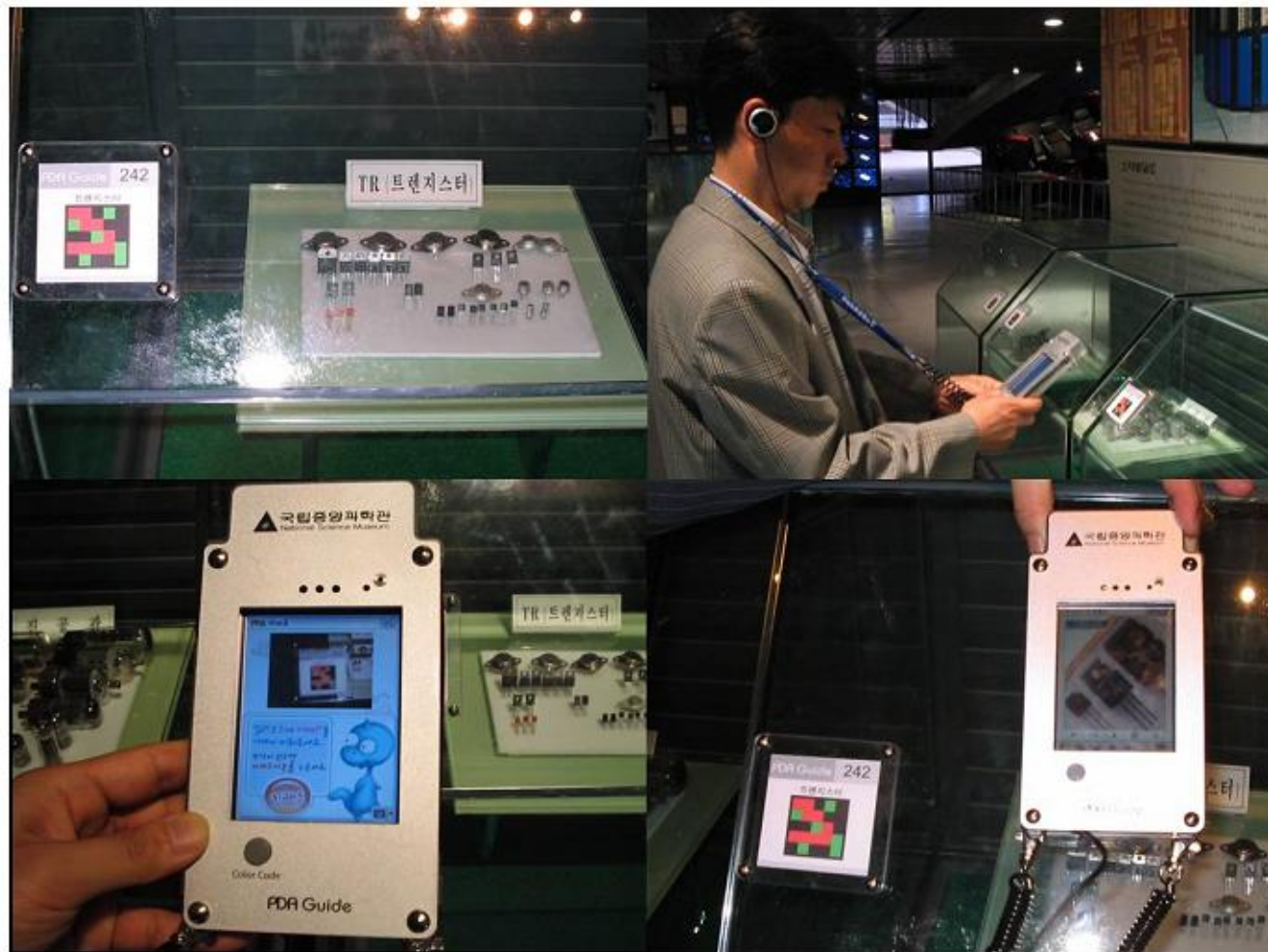
Vegetarian, Religious Belief



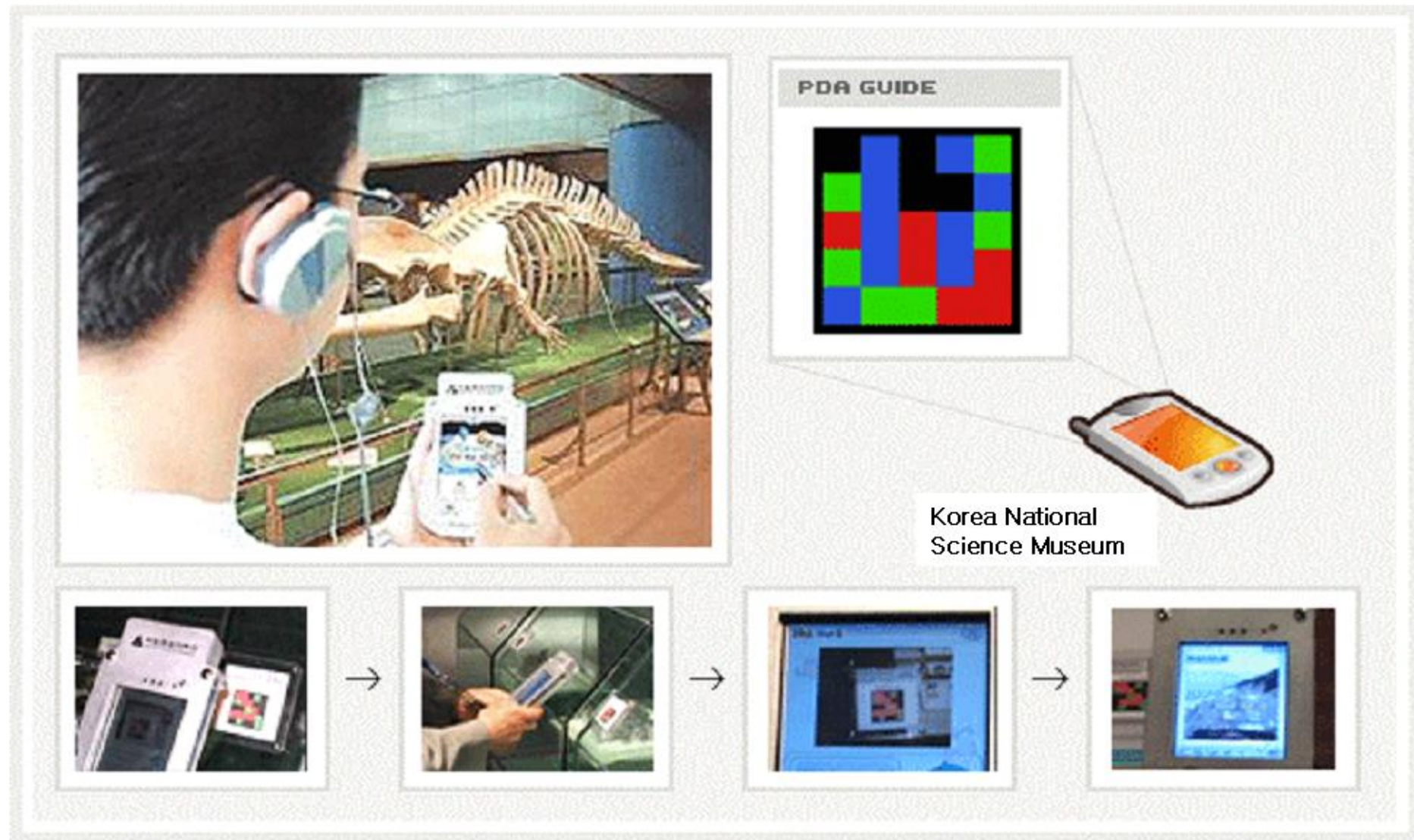
U-Museum Guide Service

U-Museum Service

- Korea National Science Museum
Providing multimedia information of the memorials



U-Museum Guide Service: Scenario

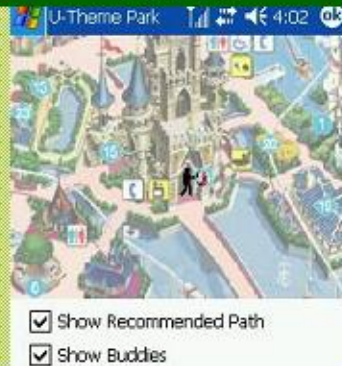


VIDEO

Museum.mpg

U-Theme Park Service(2005 ~)

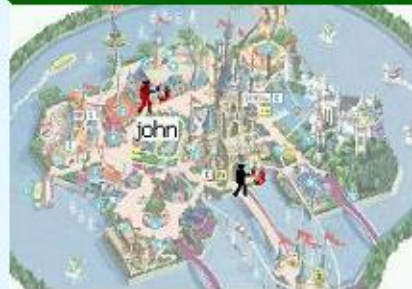
Location Information Service



tracing current location of the user using GPS



Buddy Finder Service



tracing location of family members or friends

Attraction Information Service



retrieving information of various rides and events

Tour Path Recommendation Service

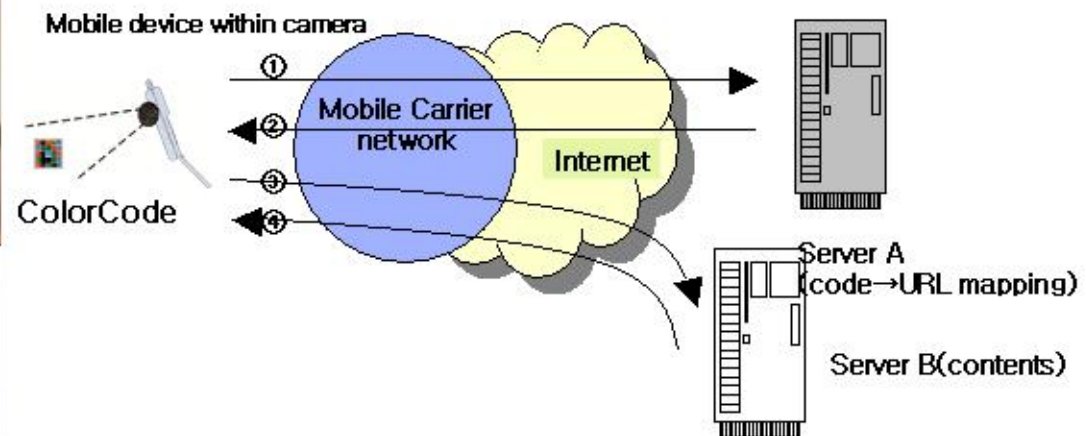


recommending a optimized tour path according to user's preference

Japan: Harajuku Project [2002]

ColorCode Field Test in JAPAN

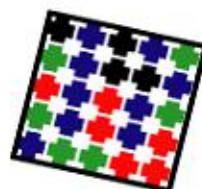
- Harajuku, Japan
- ColorCode field Test(2002.12)
 - Experiment for Image based ColorCode recognition with Mobile phone
- International Cooperative works
 - Media system Lab., Dept. of Computer Science at Yonsei Univ. in Korea
 - ColorZip Media Inc. in Korea
 - Toyota Motor / Toyota Tsusho / TWN / CASIO / KDDI/au



Support	ColorCode	Mobile Device	Server A	Server B
Company	Media Lab. ColorZip Media Inc. TOYOTA	TOYOTA	TOYOTA	TWN

ColorZip Japan

- International Collaborative Works
 - Image based Codes
 - Media System Lab., Dept. of Computer Science at Yonsei Univ.
 - ColorZip Media Inc, ColorZip Technology Inc. in Korea
 - ColorZip Japan
- Colorzip Japan to develop TV applications with Fuji TV and TBS



VIDEO

Japan.mpg

Conclusions & Future Works

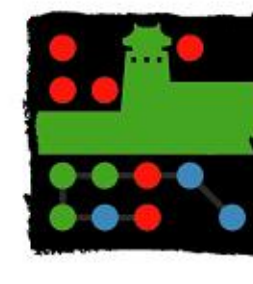
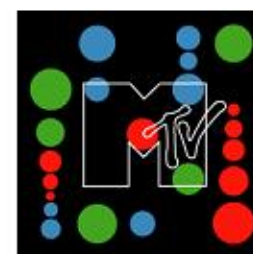
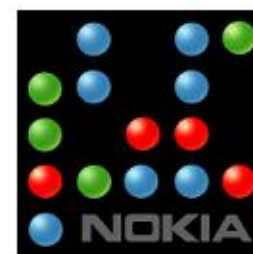
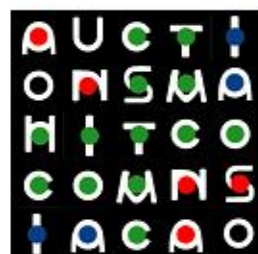
Off-line code vs. On-line Code

Participants	Needs	Off-line code	On-line code
User	① Easy to use ② Designable/Pretty ③ Recognition ④ Ubiquitous device ⑤ Low price ⑥ Many/new application	Δ X Δ Δ O Δ	O O O O Δ O
Code Company	⑦ CRM database ⑧ Easy to build new business model ⑨ Ownership/Barrier to competitor	X Δ X	O O O
Offline media	② Designable/Pretty ⑩ Easy to apply/manage ⑪ No special printing device/paper ⑫ Low cost/Low price	X Δ O O	O O O Δ
Device Manufacturer	① Easy to use ③ Recognition ④ Ubiquitous code ⑤ Low cost/price ⑥ Low resource/additional hardware	Δ Δ O X X	O O X O O
Carrier	④ Data traffic ⑦ CRM Database ⑩ New application driven ⑫ Low cost/price	X X X O	O O O Δ
Contents Provider	④ Ubiquitous device ⑤ User trends ⑦ CRM database ⑫ Low cost/price	Δ X O O	O X O Δ

Category	Characteristics	IBC(Image based Code)		RFID
		2D B/W Code	ColorCode™	
Technical Aspects	Distance for recognition	Proximity	Proximity	LF 134.2 kHz : 1,5m / HF 13,56 MHz : 1,0m UHV 868 MHz (EU) : 0,6m /UHV 915 MHz (US) : 3m MW 2,45 GHz (EU) : 0,5 m/MW 2,45 GHz (US) : 2,0 m
	On Paper	Easy	Easy	Label typed on a thick paper ($\geq 80 \mu\text{m}$)
	Colors	Black / White	Colors / Grays	–
	Data capacity	30~9Kbytes (depend on code size)	Above 4^{16} cases (above 4bytes)	12bytes ~ 10Kbytes
	Distribution (copy)	Easy	Easy	Difficult
	Durability (Temperature, Impact, humidity)	Depend on media	Depend on media	Robust
	Life-time	Depend on media	Depend on media	Semi-permanent
	Readers	Special Reader	Public camera on PDA, Phone and PC	Special Reader
Design	Aesthetics	Bad	Good	Invisible
Recognition	Speed	Slow	Slow	Very fast
	Penetration	Transparent media	Transparent media	No metals
	Interference (Light, Radio wave)	Infected by light	Infected by light	Infected by radio wave
	Inference (tag, reader)	No	No	Multiple tags
Characteristics	Price	Low	Middle	High
	Reading	Manual/Auto	Manual/Auto	Auto
	Automatic tag Discovery	No	No	Yes
	Delivery with electronic media	Fax, E-mail	Fax, E-mail	Only physical
	Reusing (changing contents)	Impossible	Changing on D/B	RFID Writer / Rewritable RFID

Future Codes I : Design-friendly Image based Code

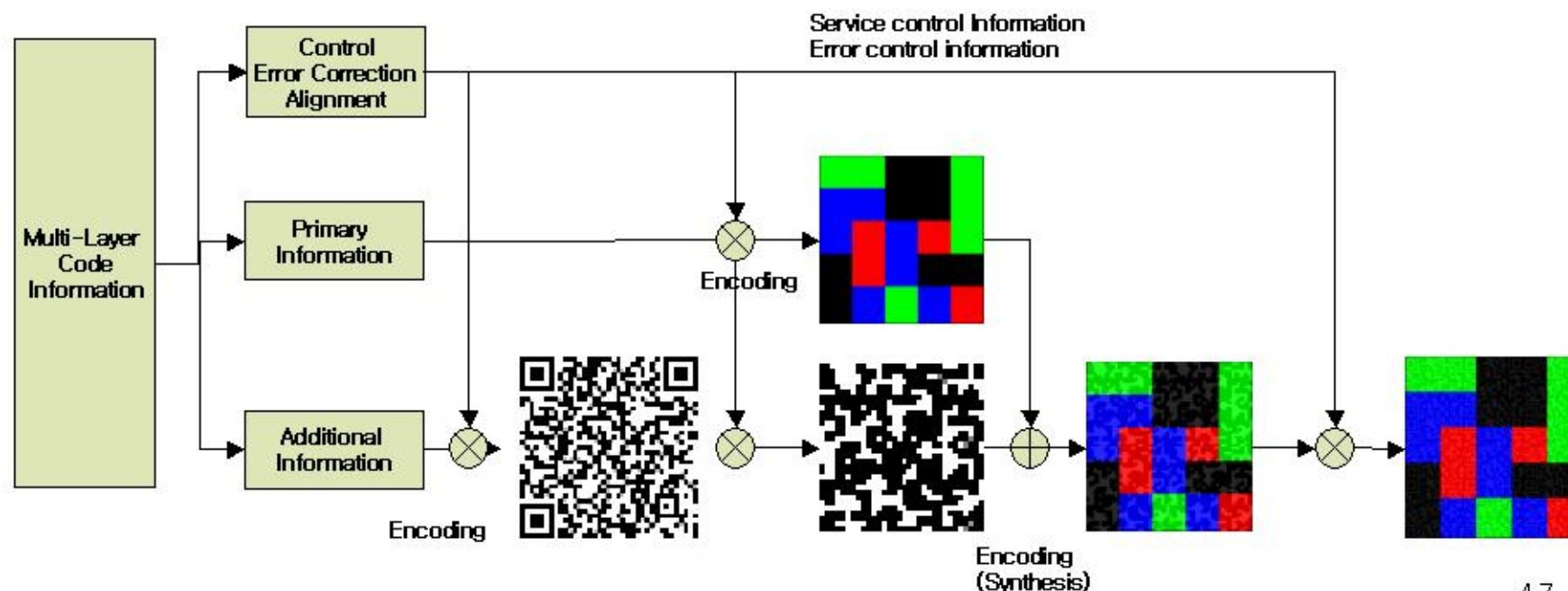
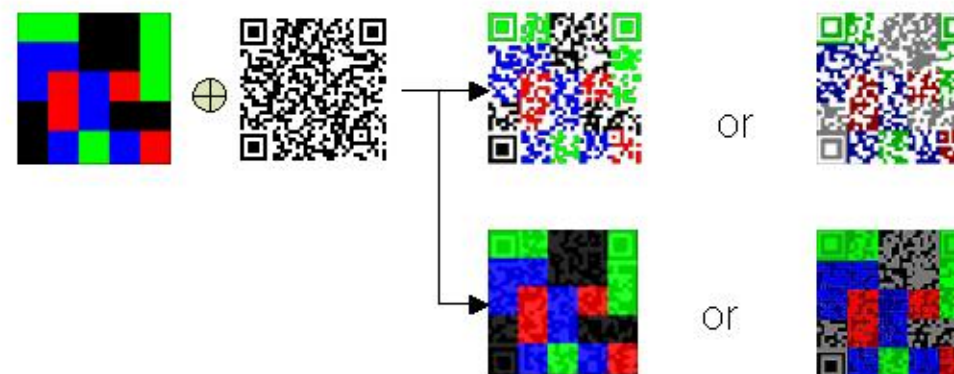
- Flexibility in design
- Media friendly codes for everything in daily life
- Adaptable extra visual information
 - Character/Image/Photos
- Information-density: # of colors, grays, patterns and/or symbols



Future Codes II : Multi-Layer code

• Multi-Layer Code

- Integration several codes
- Multiple data types
 - Index data + Direct typed data
 - Index data + Index data
 - Direct typed data + Direct typed data
- Various typed services
 - On-line + Off-line
 - Security



Thank You!