Lesson 14

Mobile Multimedia Service Over Wireless Networks

- Mobility and Universal Services
- Wireless LAN (Local Area Network)
- Wireless WAN (Wide Area Network)
- 3G Wireless Networks and IMT-2000
- FOMA and DoCoMo Mobile Services
- WAP (Wireless Application Protocol)
- Techniques and Challenges in Mobile Multimedia

What is Mobility?

- Terminal mobility: A terminal that moves
 - Between different geographical locations
 - Between different networks
 - Laptop, PDA, cellular phone, etc
- User mobility: A person who moves
 - Between different geographical locations
 - Between different networks
 - Between different communication devices
 - Between different applications
- □ Service mobility
 - A communication & information system can serve mobile device/user
 - Mobile service vs fixed service
 - Fixed networks, i.e., wired Internet, provides such service for PC/WS
 - Mobile networks, i.e., wireless Internet, supports mobile device/user

Universal Service

Universal Service = Fixed Service + Mobile Service -- Enable anybody to communicate with anyone and get required information from any terminal at anywhere in anytime



Multimedia: from Desktop, to Internet, to Hand-helds, and to Wireless Terminals



Wireless Communications

General Wireless Communication Model



Multiple Access Control (MAC)

- Multiple access: to effectively utilize limited frequency resources by enabling multiple users to share radio communications channels to simultaneously conduct communications. Three types of systems
- FDMA Frequency Division Multiple Access
- TDMA Time Division Multiple Access
- CDMA Code Division Multiple Access



Wireless **LAN**



- ❑ Wireless LAN: small range (< 100m)
- □ IEEE 802.11 (similar to Ethernet)
 - Defined by IEEE (Institute for Electrical and Electronic Engineers)
 - Access control: CSMA/CD (only one can send each time similar to TDMA, listen and transmit if no other transmission, otherwise wait)
 - Speed: 2Mbps (infrared), >10Mbps (Microwave, 2.4/5.2GHz)
- HIPERLAN
 - Defined by ETSI (European Telecommunication Standard Institute)
 - Access control: dynamic TDMA
 - Speed: 25Mbps (5GHz) and 155Mbps (17GHz)
- HomeRF
 - Defined by Home Radio Frequency Working Group (Industry, 1998)
 - Access control: similar IEEE 802.11 with priority and reservation control
 - Speed: 10Mbps (2.4GHz), support both data, voice and streaming
- Bluetooth
 - Defined by Bluetooth Special Interest Group (SIG, industry)
 - Access control: TDD (Time Division Duplex) with circuit and packet switch
 - Speed: >1Mbps

WLAN Frequency & Bluetooth Applications



Wireless Access System Frequency in JAPAN

Frequency	2 4GH7	5G	Hz	22/26/38	25/27	60GH7	
band	band 2.4012 outdoor indoor		indoor	GHz	GHz	000112	
usage	Wireless LAN Wireless access	Wireless access	Wireless LAN	FWA	Wireless LAN Wireless access	Wireless LAN Wireless access	
Bandwidth (MHz)	100	160	100	2880	940	7000	
Radio Station License	free	required (base station)	free	Required	free	LAN:free	
Transmissio n speed (Mbps)	10 -> 20	5-50	20-50	156	100	Some of 100s	
Note	Ordinance for enhancemen t settled	Ordinance will be settled this summer	Products emerges since last autumn	MPHPT issues license to 15 operators MPHPT Settled Expects Products this autumn		Products emerges since last year	

Ultra-Wideband (UWB)



Figure 1. UWB spectral mask for indoor communication systems.

Unlicensed bands	Frequency of operation	Bandwidth
ISM at 2.4GHz	2,4000-2,4835	83.5MHz
U-NII at 5GHz	5.15-5.35GHz	300MHz
	5.75-5.85GHz	
UWB	3.1-10.6GHz	7,500MHz

Table 1. US spectrum allocation for unlicensed use.

Regulated in the US since February 2002

- UWB is available spectrum, not a specific technology
- 7,500MHz of unlicensed spectrum
- First regulation ever that allows spectrum sharing: low emission limit (-41.3dBm/MHz EIRP) doesn't cause harmful interference
- Transmitters need to occupy at least 500MHz all the time
- UWB devices are NOT defined as impulse radios or by any specific modulation
- Enough spectrum to reach much higher data rates than in the ISM band (83.5MHz at 2.4GHz) or the U-NII bands (300MHz at 5GHz)
- Optimized for short-distances applications

UWB Communication/Network





UWB Application Vision



Wireless **WAN**

W-WAN (Wireless Wide Area Network): city, country, continent, the globe

- □ 1G (1st generation) wireless networks (1980's)
 - Analog and FDMA, Data rate: < 2.4Kbps
- □ 2G wireless networks (1990's)
 - Digital and TDMA/CDMA
 - 2G: GSM, PDC, IS-136, IS-96/CDMAOne, <u>Data rate</u>: 10Kbps
 - **2.5G**: GPRS, EDGE, IS-95B, <u>Data</u> <u>rate</u>: 64Kbps
- □ **3G** wireless networks (2000's)
 - Digital and CDMA: WCDMA, UWC-136, CDMA2000
 - Data rate: 144Kbps (Vehicular),
 384Kbps (Pedestrian), 2Mbps (Indoor)
- □ 4G wireless networks
 - Research/service is under going



International Mobile Telecommunication



Systems beyond IMT-2000



A long-term plan required for R&D and allocating frequency

Key Elements

- 1. Very high-speed communication (50-100Mbps) equivalent to OPT fiber
- 2. All IP network (IPV6)
- 3. Integration of cellular type and wireless LAN type system.
- 4. Use of Software Defined Radio technology

(Note:3G network will not be replaced by new elements, rather co-exists with them)



Mobile Multimedia Access



Mobile Internet Access



Source: Ericsson

Mobile Multimedia Data Service



PDC-P Network and **i-mod** Server



FOMA

- Freedom of Mobile Multimedia Access
- Used in Japan for NTT DoCoMo's 3G service
- U W-CDMA
- Service starts from
 October 1, 2001



Current and Future FOMA Services

Service and applications to come



WAP (Wireless Application Protocol)

Performance of mobile terminal

	Desktop		Laptop	PDA		Cell Phone
CPU/NetB/Power	High -	>	$Middle \boldsymbol{\rightarrow} $	Low	\rightarrow	Very Low
M/Storage/Screen	Large -	>	Middle \rightarrow	Small	\rightarrow	Very Small

- □ Need special OS: PalmOS, EPOC, Windows CE, OS/9, JavaOS
- Need special data representation, delivery, browser
- WAP Forum is the industry association to develop world standard for wireless information and telephony services on digital mobile phones, pagers, PDA and other wireless terminals
- WAP is an open, global specification for mobile users with wireless devices to easily access and interact with information and services
- ❑ WAP is an analogy of Internet protocol for wireless networks WAP → Integrated OMA (Open Mobile Alliance)

WAP Protocol Stack



WML (Wireless Markup Language) and simplified XHTML
 CHTML (simplified HTML) from DoCoMo is included for i-mod
 WP-HTTP is a wireless profiled HTTP, 1.1 compatible
 WP-TLS is a wireless profiled TLS (Transport Layer Security)
 WP-TCP is a wireless profiled TCP, optimized for wireless environment

Data Transform for Optimal Wireless Delivery

- Send out content from origin Internet servers to different devices/demands
- Reduce media data via reduce quality: color, size, resolution, sample/frame rate
- Devise/Content-based transformation, transmission, presentation, etc.
 - → called transcoding, scalable coding, adaptive coding, ...





Example of a Scalable Coding



Mobile Multimedia Challenges

Adaptive Decoding - Optimizing rich digital media for mobile information devices with limited processing power, limited battery life and varying display sizes

Error Resilience - Delivering rich digital media over wireless networks that have high error rates and low and varying transmission speeds

Low Power/Energy – Multimedia computing and communication with less energy consumption, one of core issues in mobile multimedia terminals

Audio & Video Tech. and Applications

This Course → Audio and Video technologies

→ Combine AV and CG/Web Technology in Mobile Devices

セカイカメラ: 頓智ドット株式会社 が開発したiPhone向けARアプリケー ションのことで、リアルタイムに撮影している映像と重ねて、「エアタグ」と 呼ばれる半透明のアイコンをタッチすれば、そのタグに関する詳細な情報 が現れる。日本時間2009年9月24日iPhone App Storeで公開された



Beyond Audio & Video

MM → Human's Five Senses

➔ Various Sensors & Devices

➔ Ubiquitous Media and Services



Demos of MM Applications on Smart Phones