

Mobile Communications (1)

Class Overview

Jiro Katto

Dept. of Computer Science and Engineering

E-Mail: katto@waseda.jp

Wireless LAN

	802.11	802.11b	802.11a	802.11g	802.11n	802.11ac
year	1997	1999	1999	2003	2009	2014
frequency	2.4GHz	2.4GHz	5GHz	2.4GHz	2.4GHz & 5GHz	5GHz
bitrate	1 – 2 Mbps	1 – 11 Mbps	6 – 54 Mbps	1 – 54 Mbps	1 – 600 Mbps	~ 6.77 GBps
multiple access, and modulation	DSSS, FH, IrDA	DSSS, CCK	OFDM	DSSS, CCK, OFDM	OFDM, MIMO, channel bonding	OFDM, MIMO, channel bonding

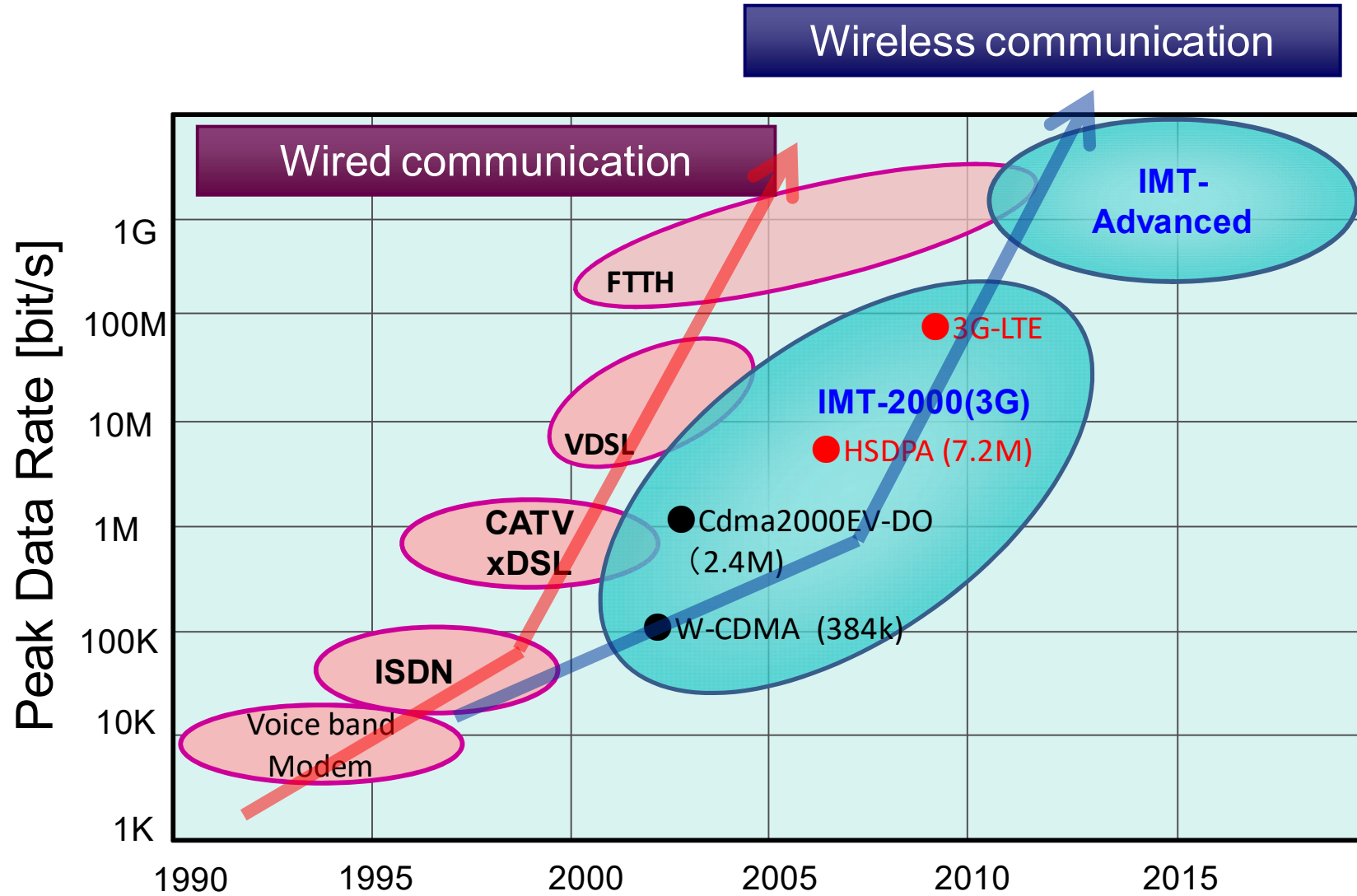
Wireless PAN/BAN

	802.15.1	802.15.3a	802.15.4a	802.15.4	802.15.6
name	Bluetooth	UWB	UWB	ZigBee	BAN
year	1999	--	2007	2003	2012?
frequency	2.4GHz	3.1 – 10.6GHz	2.4GHz	2.4GHz 868MHz 915MHz	400MHz 2.4GHz
bitrate	720kbps- 24Mbps	480Mbps	1Mbps	20-250 kbps	~10Mbps
multiple access, and modulation	FH GFSK	OFDM or DSSS	DSSS BPSK	DSSS BPSK/QPS K	?
distance	1-100m	4-10m	10m	10-75m	3m
power	1-100mW	< 100mW	1mW	< 60mW	< 1mW?

Cellular

generation	name	frequency	multiple access	modulation	bitrate (downlink)	speech codec
2G	PDC	800MHz / 1.5GHz	FDD-TDMA	$\pi/4$ -DQPSK	9.6 - 28.8 kbps	ACELP, PSI-CELP
	cdmaOne	800MHz	FDD-CDMA	$\pi/4$ -DQPSK	14.4 - 64 kbps	EVRC
	GSM	--	FDD-TDMA	GMSK	9.6 - 171.2 kbps	ACELP
	PHS	1.9GHz	TDD-TDMA	$\pi/4$ -DQPSK	32-256 kbps	ADPCM
3G (IMT-2000)	W-CDMA	800MHz / 1.7GHz / 2GHz	FDD-CDMA	$\pi/4$ -DQPSK	384kbps	AMR
	CDMA2000	800MHz / 2GHz	FDD-CDMA	$\pi/4$ -DQPSK	144kbps	EVRC
3.5G	HSPA	1.7GHz	(W-CDMA)	QPSK~16QAM	1.22 -14 Mbps	--
	EV-DO	800MHz / 2GHz	(CDMA2000)	QPSK~16QAM	2.4 -3.1 Mbps	--
3.9G (Super3G)	LTE	800MHz / 1.5GHz / 2GHz	OFDMA/SD-FDMA/MIMO	QPSK~64QAM	100 - 326.4 Mbps	--
4G (IMT-Advanced)	LTE-Advanced	3.4~3.6GHz	OFDMA/MIMO/CoMP	QPSK~64QAM	~1Gbps	--

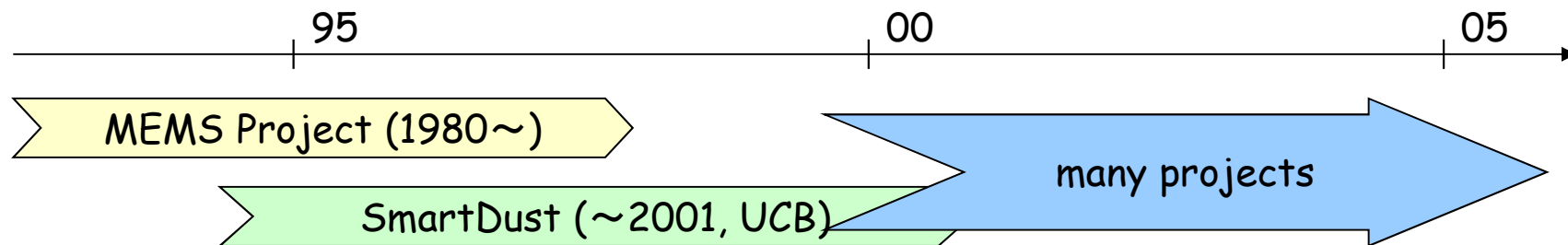
IMT-Advanced (4G)



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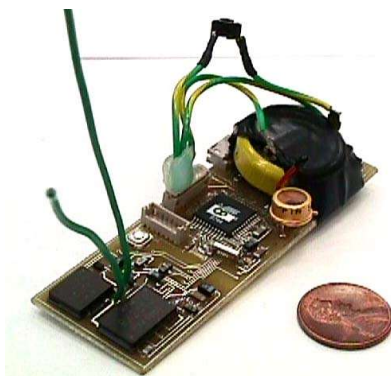
Sensor Networks

- history



Sensor(s) + MPU(s) + Networking → On-board → On-chip

RF Mote



- Prototype ▲ COTS Dust, Tiny OS
- Companies ▲ Crossbow, Dust, Ember, Senticast, ...
- Conferences ▲ IEEE Sensors, ACM SenSys, ...
- Standards ▲ IEEE 802.15.4 (ZigBee)

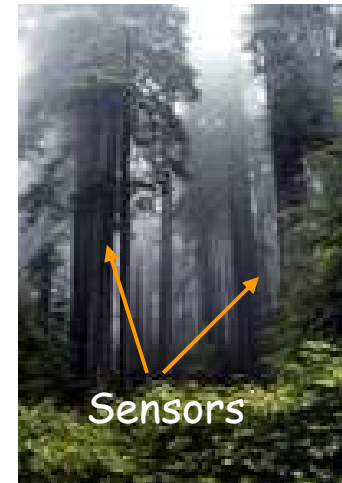
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Sensor Networks

- (1) factory
- (2) maintenance
- (3) military, national security
- (4) automation
- (5) environment monitoring
- (6) ubiquitous

(7) smart phone

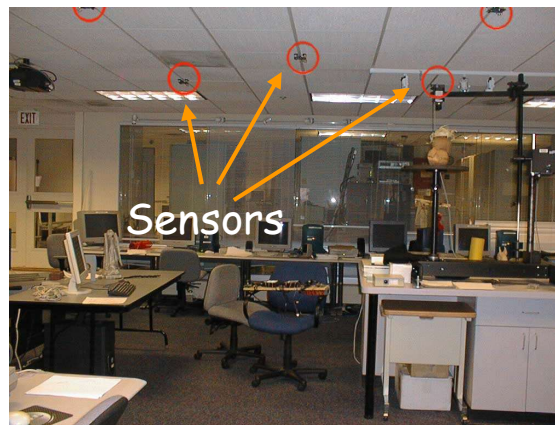
monitoring (UCB)



tracking (UCB)



smart room (MIT)



robot (USC)



Smart Phone



- Communication
 - 3G/LTE, WiFi, Bluetooth, WiMAX, ...
- Audio and Visual
 - microphone, speaker, camera, display, ...
- Sensors
 - accelerometer, gyroscope, magnetic, proximity, light, temperature, ...

smart phone is sensor network

Android APIs

android.hardware.Sensor

Summary		
Constants		
int	TYPE_ACCELEROMETER	A constant describing an accelerometer sensor type.
int	TYPE_ALL	A constant describing all sensor types.
int	TYPE_AMBIENT_TEMPERATURE	A constant describing an ambient temperature sensor type.
int	TYPE_GRAVITY	A constant describing a gravity sensor type.
int	TYPE_GYROSCOPE	A constant describing a gyroscope sensor type.
int	TYPE_LIGHT	A constant describing a light sensor type.
int	TYPE_LINEAR_ACCELERATION	A constant describing a linear acceleration sensor type.
int	TYPE_MAGNETIC_FIELD	A constant describing a magnetic field sensor type.
int	TYPE_ORIENTATION	<i>This constant was deprecated in API level 8. Use SensorManager.getOrientation() instead.</i>
int	TYPE_PRESSURE	A constant describing a pressure sensor type.
int	TYPE_PROXIMITY	A constant describing a proximity sensor type.
int	TYPE_RELATIVE_HUMIDITY	A constant describing a relative humidity sensor type.
int	TYPE_ROTATION_VECTOR	A constant describing a rotation vector sensor type.
int	TYPE_TEMPERATURE	<i>This constant was deprecated in API level 14. Use Sensor.TYPE_AMBIENT_TEMPERATURE instead.</i>

<http://developer.android.com/reference/android/hardware/package-summary.html>

This Year's Schedule

(tentative)

- 4/08 Class overview
- 4/15 Radio Communication Basics (1)
- 4/22 Radio Communication Basics (2)
- 5/06 Wireless LAN Standards (1)
- 5/13 Wireless LAN Standards (2)
- 5/20 Implementing Wireless LANs
- 5/27 (Self-study on CourseN@vi)
- 6/03 Wireless LAN Security (1)
- 6/10 Wireless LAN Security (2)
- 6/17 Wireless PAN Standards
- 6/24 Wireless MAN Standards
- 7/01 Leading Edge Wireless Networking Technologies
- 7/08 Examination (in class room)
- 7/15 (Self-study on CourseN@vi)

Self-study on CourseN@vi,
once or twice