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References: Lecture notes

J. A. Gutiérrez, E. H. Callaway and R. L. Barrett, *Low-Rate Wireless Personal Area Networks*, IEEE Press, 2003.

4.1 STRUCTURE OF STANDARD IEEE 802, THE RELATIONSHIP BETWEEN ZigBee AND IEEE STANDARD 802.15.4

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4.1.1 Acronyms and Abbreviations: A – E

ACK	acknowledgment
ACL	access control list
BPSK	binary phase shift keying
BSP	beacon synchronization parameter
CAP	contention access period
CCA	clear channel assessment
CFP	contention-free period
CSMA-CA	carrier-sense multiple access with collision avoidance
DS-SS	direct sequence spread spectrum
ED	energy detection
ETSI	European Telecommunications Standards Institute

Acronyms and Abbreviations: F – L

FCC	Federal Communications Commission, USA
FCS	frame check sequence
FFD	full function device
FH-SS	frequency hopping spread spectrum
GSM	global system for mobile
GTS	guaranteed time slot
ISM	industrial, scientific, and medical
ITU-T	International Telecommunication Union – Telecommunication Services
LAN	local area network
LLC	logical link control
LQI	link quality indication
LR-WPAN	low-rate wireless personal area network

Acronyms and Abbreviations: M – O

MAC	medium access control
MAN	metropolitan area network
MBWA	mobile broadband wireless access
MCPS-SAP	MAC common part sublayer service access point
MIC	message integrity code
MLME-SAP	MAC sublayer management entity service access point
MSB	most significant bit
MPDU	MAC protocol data unit
MSDU	MAC service data unit
MSK	minimum shift keying
OEM	original equipment manufacturer
O-QPSK	offset quadrature phase shift keying
OSI	open systems interconnection

Acronyms and Abbreviations: P

PAN	personal area network
PD-SAP	PHY layer data service access point
PHY	physical layer
PHR	PHY header
PIB	PAN information base
PLME	PHY layer management entity
PLME-SAP	PHY layer management entity service access point
PN	pseudo-noise
POS	personal operating space
PPDU	PHY protocol data unit
PSDU	PHY service data unit
ppm	parts per million (10^{-6})

Acronyms and Abbreviations: Q – S

QoS	quality of service
RF	radio frequency
RFD	reduced function device
RFID	radio frequency identification
RSSI	received signal strength indication
Rx	receiver or receiver
SAP	service access point
SAW	surface acoustic wave
SHR	synchronization header
SNR	signal-to-noise ratio
SoC	system-on-a-chip
SSCS	service specific convergence sublayer

Acronyms and Abbreviations: T – W

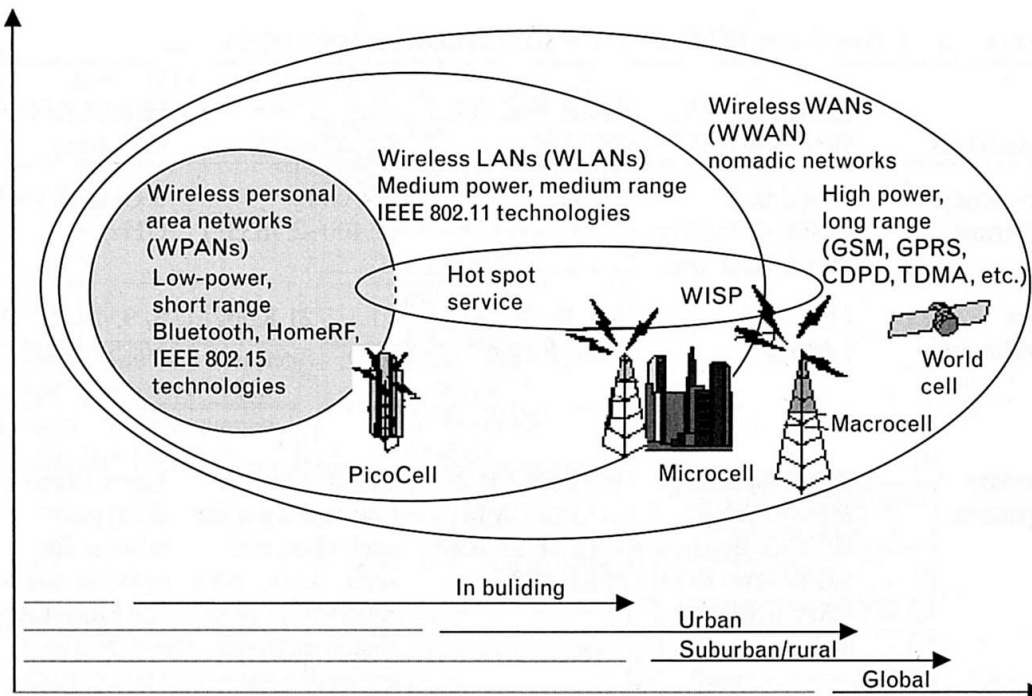
TDMA	time division multiple access
Tx	transmit or transmitter
VCO	voltage controlled oscillator
WLAN	wireless local area network
WMAN	wireless metropolitan area network
WPAN	wireless personal area network
WSN	wireless sensor network

4.1.2 Structure and operation principle of IEEE 802 LAN/MAN Standards Committee

- The IEEE 802 LAN/MAN Standard Committee develops Local Area Network (LAN) standards and Metropolitan Area Network (MAN) standards
- IEEE 802 standards are restricted to networks carrying variable-size packets
- Typical examples: Ethernet family, Token Ring WLAN, WPAN, etc
- An individual *Working Group* (WG) is organized for each application area. If an application area becomes obsolete and useless then the WG responsible for that area is *disbanded*
- Each WG has *Task Groups* (TGs) that is responsible for a special application. For example: Task Groups of IEEE 802.15 WG are: 802.15.1 ~ Bluetooth, 802.15.4 ~ ZigBee, 802.15.4a ~ Ultra-Wideband (UWB) radio, etc.
- Any company may join a TG and submit a proposal, the decision is done based on *merging* and *majority vote*
- For more details visit: <http://ieee802.org/>

4.1.3 Positioning Low-Rate Wireless Personal Area Network

Positioning by cell size



CDPD: Cellular Digital Packet Data

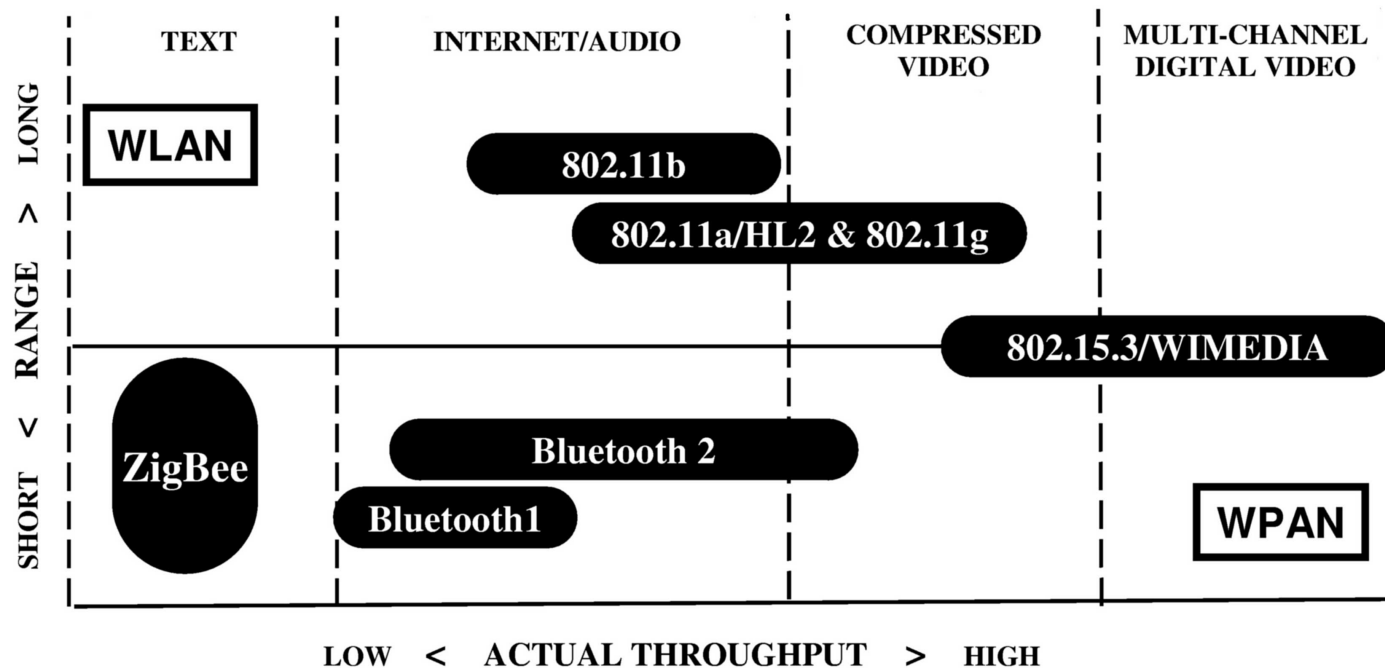
GPRS: General Packet Radio Service

GSM: Global System for Mobile Communication

WISP: Wireless Internet Service Provider

WWAN: Wireless Wide Area Network

Positioning by data rate and area covered



IEEE 802.15 Working Group:

- IEEE Std 802.15.3: Suitable for multimedia applications that require very high QoS
- IEEE Std 802.15.1: Consumer electronics, PDAs with QoS suitable for voice transmission
- IEEE Std 802.15.4: Low data rate and low power consumption with relaxed QoS

4.1.4 Comparison of LR-WPAN and WLAN technologies

	WLAN	WPAN		
	Wi-Fi 802.11b	Bluetooth 802.15.1	ZigBee ^{1,2} 802.15.4	UWB radio ^{1,2} 802.15.4a
Range	~100 m	10–100 m	15–30 m	typical 30 m, up to 100 m
Data rate	2–11 Mb/s	1 Mb/s	≤250 kb/s	1, 10 kb/s max. 1 Mb/s
Power consumption	Medium	Low	Very low	Ultra low
Size	Large	Small	Very small	Very small
Cost/complexity	High	Medium	Low	Very Low
Location awareness (Ranging capability)	No	No	No	Yes

¹ A special communication protocol has been chosen to get ultra low power consumption

² ZigBee and UWB differ in the physical and upper layers (PHY)

4.1.5 Relationship between ZigBee Alliance and IEEE Std. 802.15.4

- ZigBee is the name of a specification of high level communication protocol using the Physical Layer (PHY) defined by the IEEE Standard 802.15.4
- Entry level membership in ZigBee Alliance costs US\$3,500
- ZigBee protocols are intended for use in embedded applications requiring *low data rate, low power consumption, self-organizing and self-healing, ad-hoc networks*

4.1.6 Relationship between the OSI BR model and the model defined by IEEE 802 Standards

Recall: Open Systems Interconnection (OSI) Basic Reference (BR) Model

- In OSI model each logical functionality is associated with a layer
- OSI model makes the different systems compatible
- A framework elaborated in *computer science*

IEEE 802 model

- Layered model where each layer is associated with a functionality
- It provides standards and parameters required by the system and circuit designers
- A framework elaborated in *electrical engineering*

Comparison of OSI and IEEE 802 layers

Seven-layer ISO-OSI model	Simplified five-layer ISO-OSI model	IEEE 802 model
7 Application	5 User application	Upper layers specified by industrial alliances
6 Presentation	4 Application profile	
5 Session		
4 Transport		
3 Network	3 Network	
2 Data link	2 Data link	Logical link control (LLC)
		Medium access control (MAC)
1 Physical	1 Physical	Physical (signaling) layer (PHY)