ZigBee

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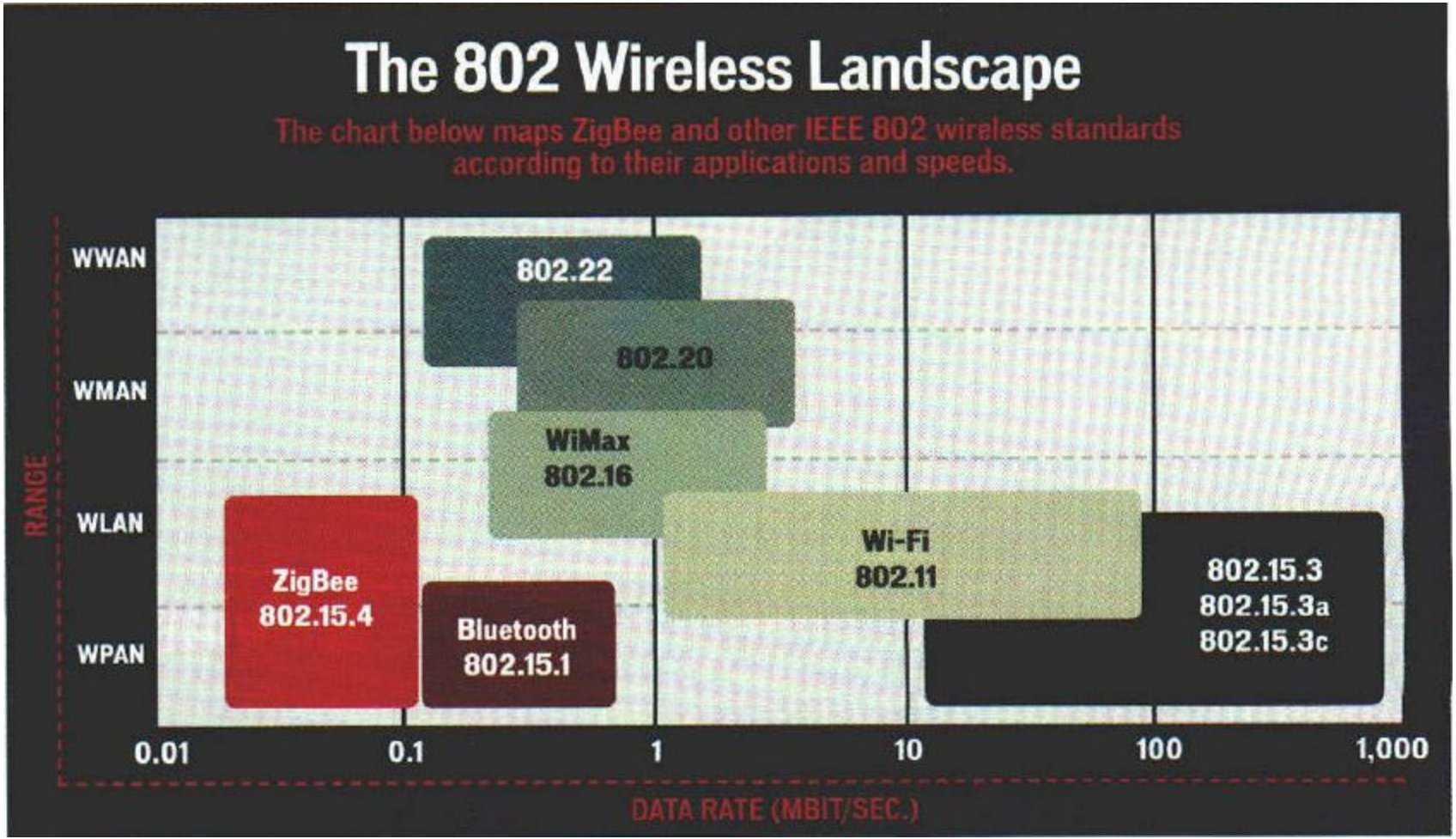
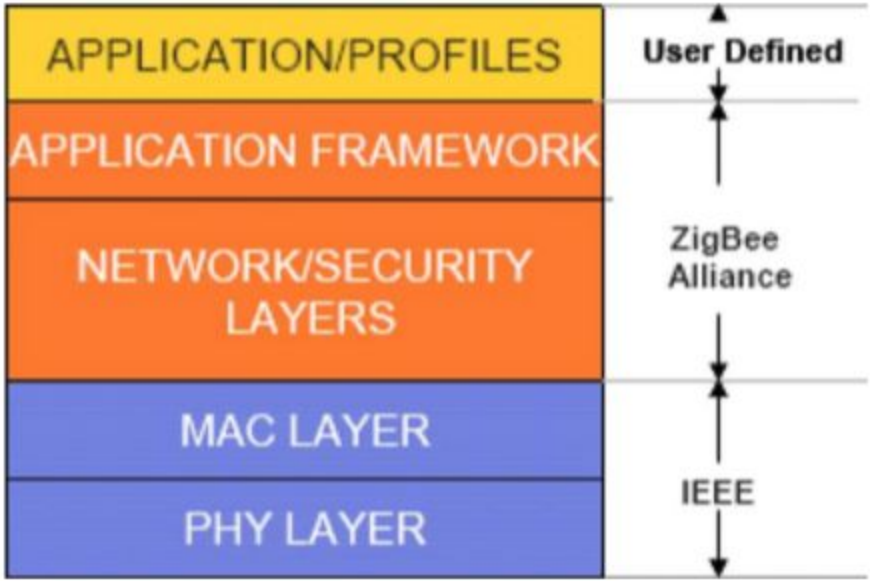
Setembro/2016

O que é o ZigBee?

- Tecnologia wireless baseado no protocolo IEEE 802.15.4 (LR-WPAN)
- Curto alcance
- Baixo custo de implementação
- Baixo consumo de energia


The 802 Wireless Landscape
The chart below maps ZigBee and other IEEE 802 wireless standards according to their applications and speeds.
WWAN
WMAN
WLAN
WPAN
RANGE
802.22
802.20
WiMax
802.16
ZigBee
802.15.4
Bluetooth
802.15.1
Wi-Fi
802.11
802.15.3
802.15.3a
802.15.3c
0.01
0.1
1
10
100
1,000
DATA RATE (MBIT/SEC.)


APPLICATION/PROFILES
APPLICATION FRAMEWORK
NETWORK/SECURITY LAYERS
MAC LAYER
PHY LAYER
User Defined
ZigBee Alliance
IEEE


Digi International
XBee

Características

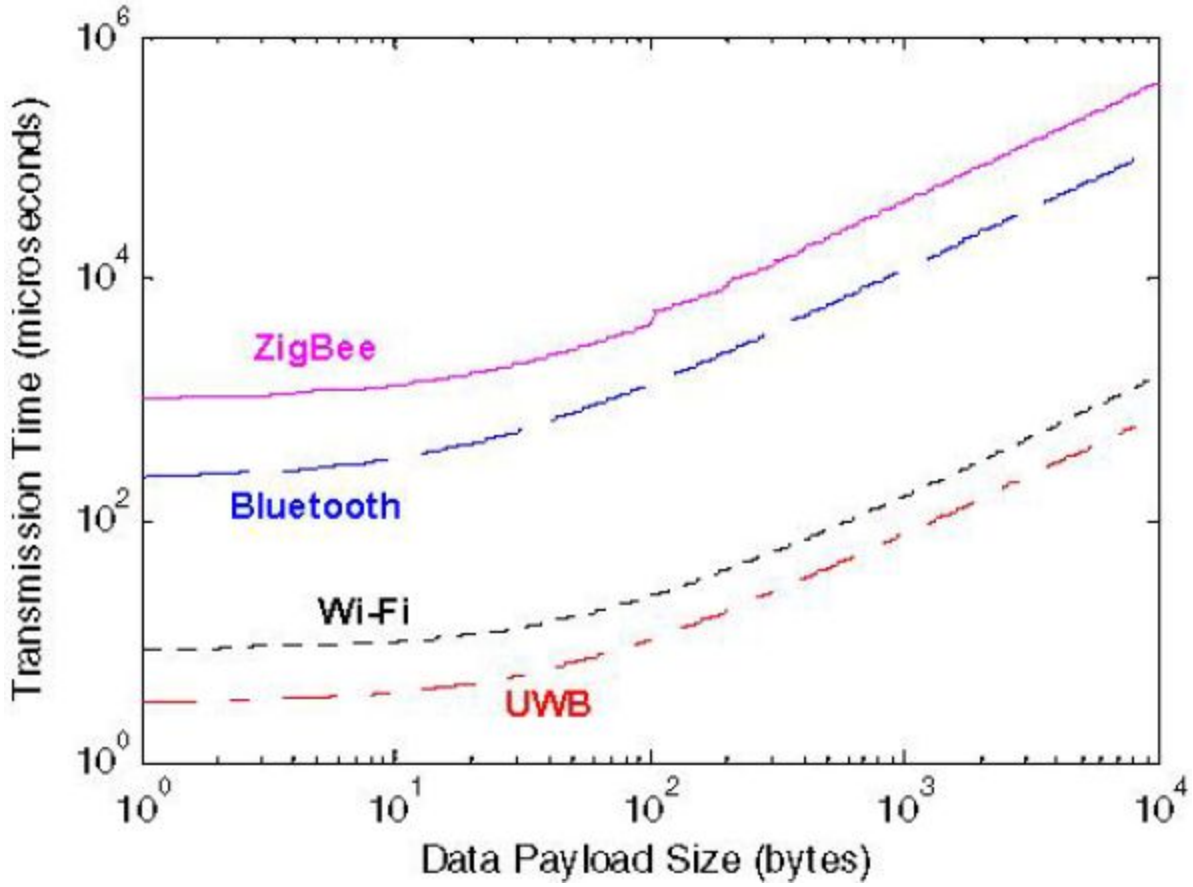
- Baixa taxa de transmissão de dados
- Dispositivos com baterias de longa durabilidade
- Rede multi-hop organizada
- Confiável
- Escalável

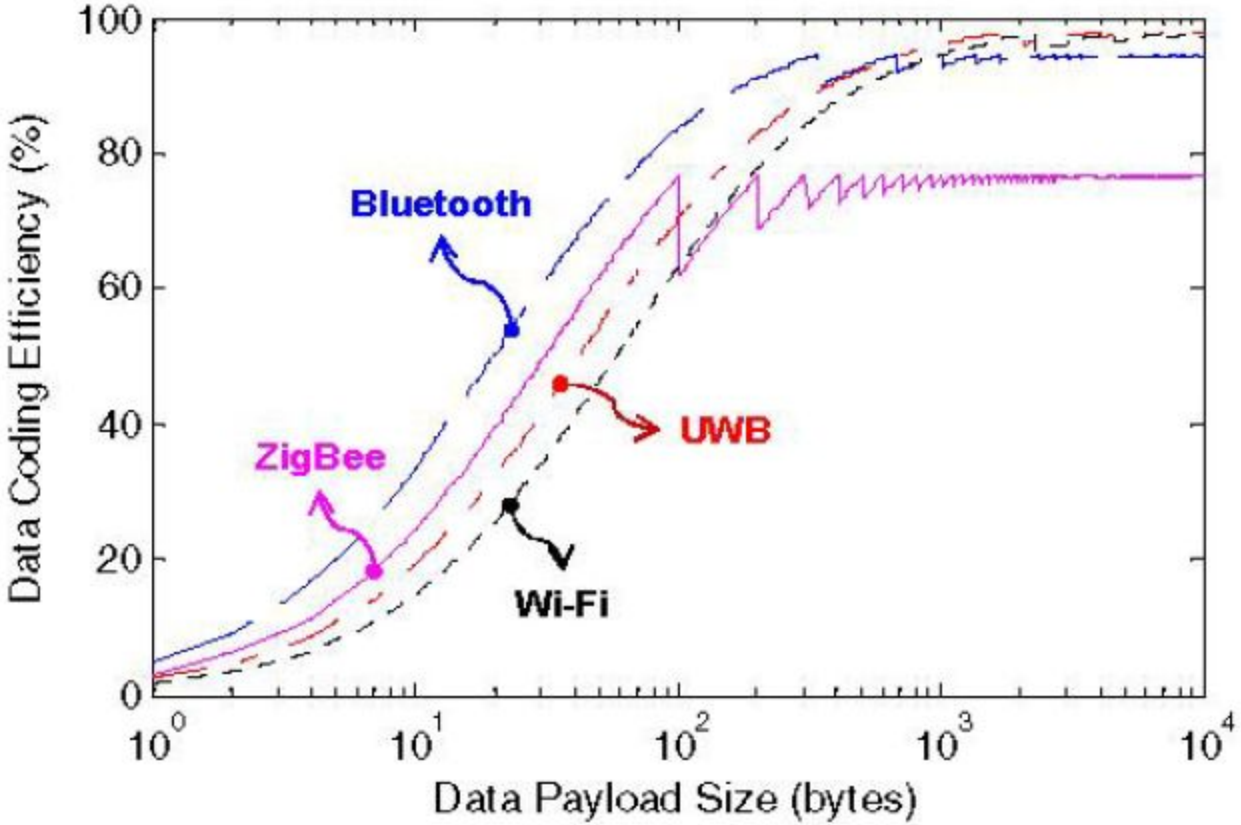
Standard	Bluetooth	UWB	ZigBee	Wi-Fi
IEEE spec.	802.15.1	802.15.3a *	802.15.4	802.11a/b/g
Frequency band	2.4 GHz	3.1-10.6 GHz	868/915 MHz; 2.4 GHz	2.4 GHz; 5 GHz
Max signal rate	1 Mb/s	110 Mb/s	250 Kb/s	54 Mb/s
Nominal range	10 m	10 m	10 - 100 m	100 m
Nominal TX power	0 - 10 dBm	-41.3 dBm/MHz	(-25) - 0 dBm	15 - 20 dBm
Number of RF channels	79	(1-15)	1/10; 16	14 (2.4 GHz)
Channel bandwidth	1 MHz	500 MHz - 7.5 GHz	0.3/0.6 MHz; 2 MHz	22 MHz
Modulation type	GFSK	BPSK, QPSK	BPSK (+ ASK), O-QPSK	BPSK, QPSK COFDM, CCK, M-QAM
Spreading	FHSS	DS-UWB, MB-OFDM	DSSS	DSSS, CCK, OFDM
Coexistence mechanism	Adaptive freq. hopping	Adaptive freq. hopping	Dynamic freq. selection	Dynamic freq. selection, transmit power control (802.11h)
Basic cell	Piconet	Piconet	Star	BSS
Extension of the basic cell	Scatternet	Peer-to-peer	Cluster tree, Mesh	ESS
Max number of cell nodes	8	8	> 65000	2007
Encryption	E0 stream cipher	AES block cipher (CTR, counter mode)	AES block cipher (CTR, counter mode)	RC4 stream cipher (WEP), AES block cipher
Authentication	Shared secret	CBC-MAC (CCM)	CBC-MAC (ext. of CCM)	WPA2 (802.11i)
Data protection	16-bit CRC	32-bit CRC	16-bit CRC	32-bit CRC

Tempo de Transmissão

TYPICAL SYSTEM PARAMETERS OF THE WIRELESS PROTOCOLS

Standard	Bluetooth	UWB	ZigBee	Wi-Fi
IEEE Spec.	802.15.1	802.15.3	802.15.4	802.11a/b/g
Max data rate (Mbit/s)	0.72	110*	0.25	54
Bit time (μ s)	1.39	0.009	4	0.0185
Max data payload (bytes)	339 (DH5)	2044	102	2312
Max overhead (bytes)	158/8	42	31	58
Coding efficiency+ (%)	94.41	97.94	76.52	97.18
* Unapproved 802.15.3a.	+ Where the data is 10K bytes.			

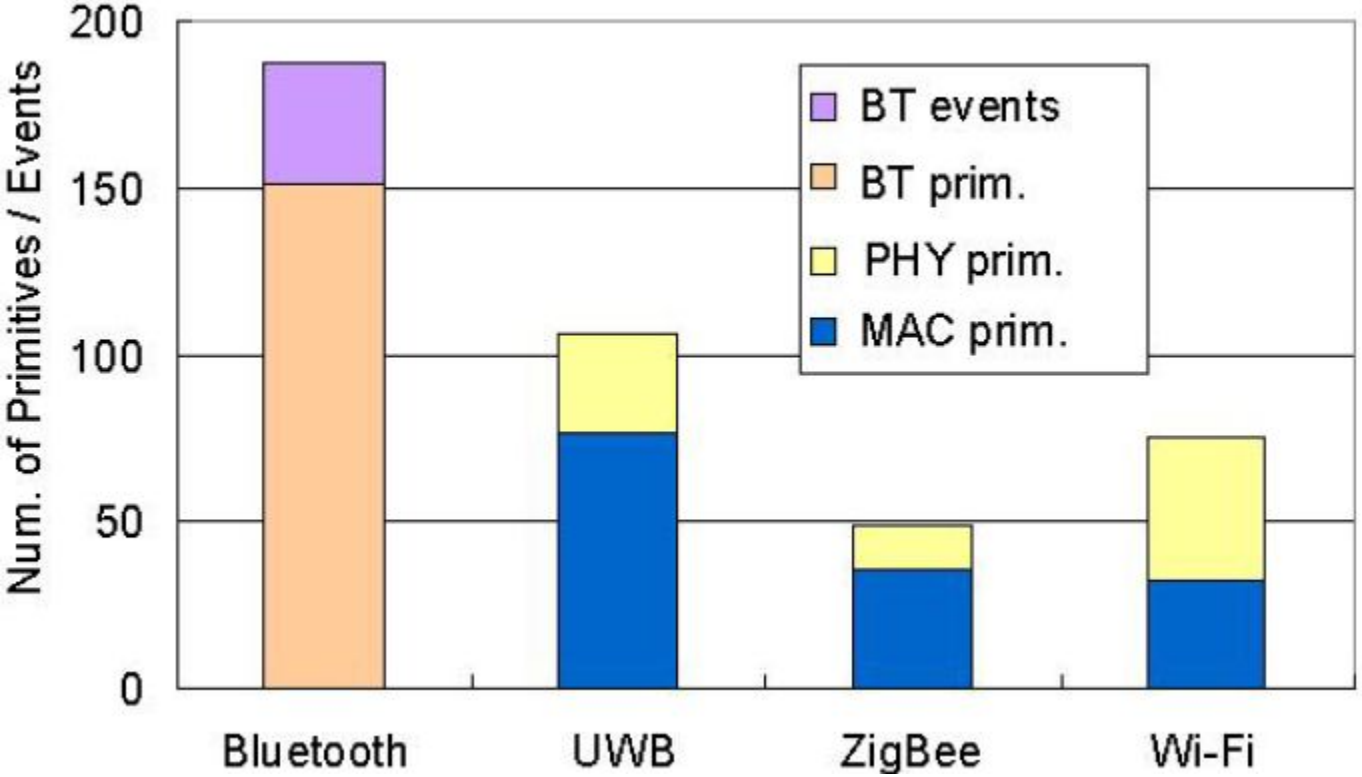

Transmission Time (microseconds)
10^6
10^4
10^2
10^0
ZigBee
Bluetooth
Wi-Fi
UWB
10^0
10^1
10^2
10^3
10^4
Data Payload Size (bytes)


Data Coding Efficiency (%)
100
80
60
40
20
0
Bluetooth
ZigBee
UWB
Wi-Fi
10^0
10^1
10^2
10^3
10^4
Data Payload Size (bytes)

Complexidade

NUMBER OF PRIMITIVES AND EVENTS FOR EACH PROTOCOL

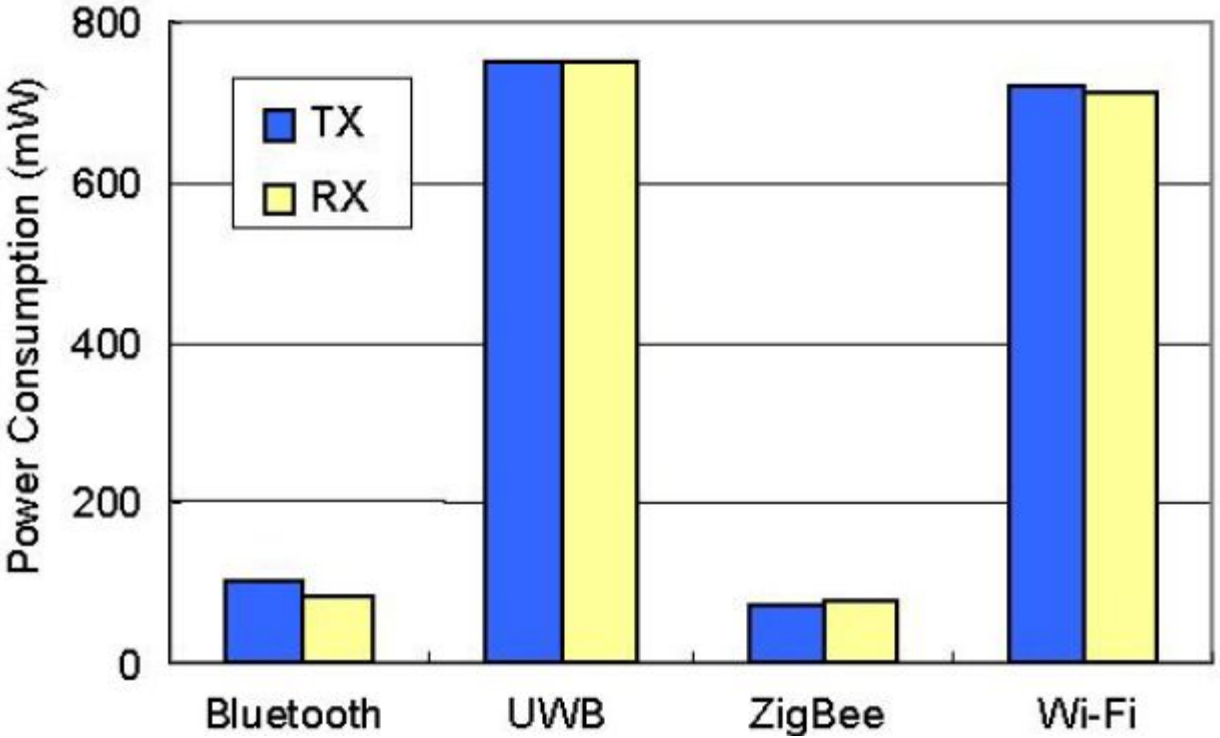
Standard	Bluetooth	UWB	ZigBee	Wi-Fi	Standard
IEEE Spec.	802.15.1	802.15.3	802.15.4	802.11a/b/g	IEEE Spec.
Primitives	151	77*	35	32	MAC primitives
HCI events	37	29	13	43	PHY primitives
					* Approved 802.15.3b.


Num. of Primitives / Events
200
150
100
50
0
BT events
BT prim.
PHY prim.
MAC prim.
Bluetooth
UWB
ZigBee
Wi-Fi

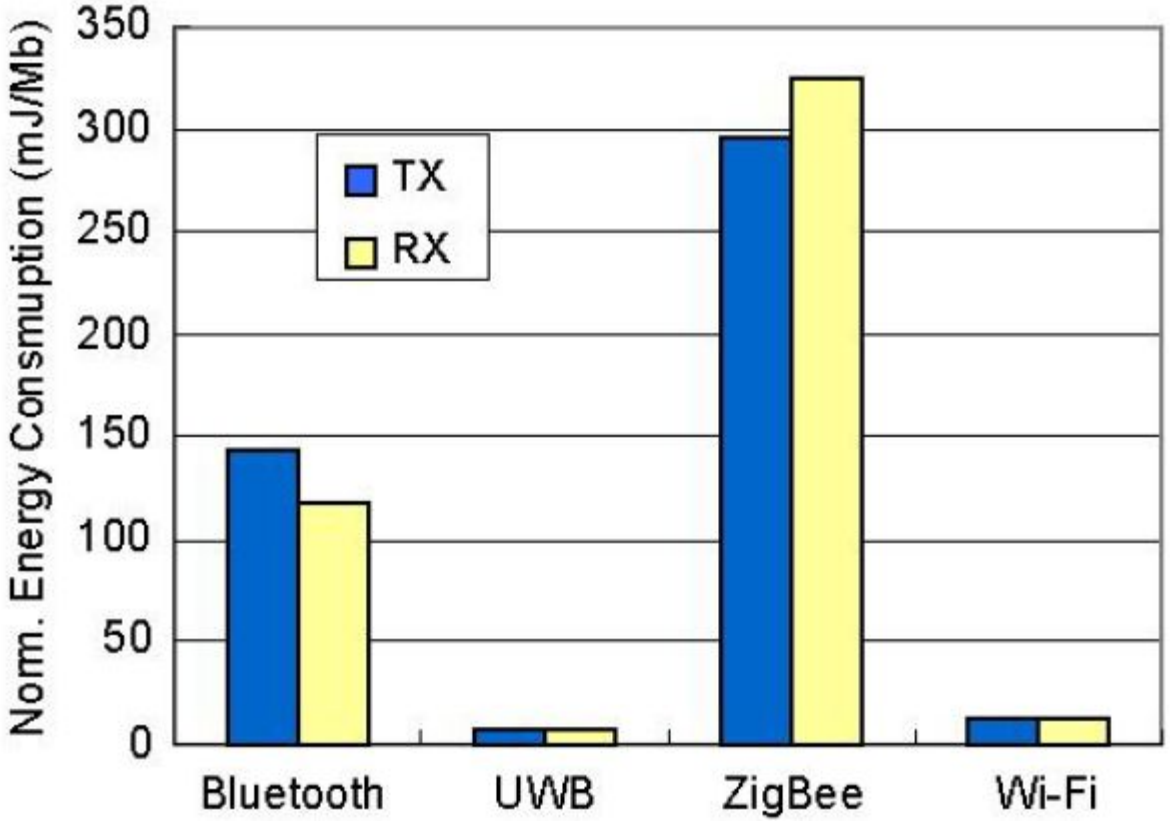
Consumo de Energia

CURRENT CONSUMPTION OF CHIPSETS FOR EACH PROTOCOL

Standard	Bluetooth	UWB	ZigBee	Wi-Fi
Chipset	BlueCore2	XS110	CC2430	CX53111
VDD (volt)	1.8	3.3	3.0	3.3
TX (mA)	57	~227.3	24.7	219
RX (mA)	47	~227.3	27	215
Bit rate (Mb/s)	0.72	114	0.25	54



TX: Transmit
RX: Receive



TX: Transmit
RX: Receive

ZigBee Devices

Reduced-Function Device (RFD)

- Desenvolvido para aplicações simples, como por exemplo, um sensor de medição de temperatura.

Full-Function Device (FFD)

- PAN Coordinator
- Coordinator (responsável pela gestão da rede)
- Device

Reduced-Function Device (RFD)

- RFD se comunica apenas com FFD
- Implementado com poucos recursos de hardware

Full-Function Device (FFD)

- FFD se comunica com outros FFD e RFD

ZigBee End Device (ZED) - RFD

- Responsável por uma função ou monitoramento

ZigBee Coordinator (ZC) - FFD

- Gerenciar a rede
- Distribuir endereços
- Manter as tabelas de roteamento

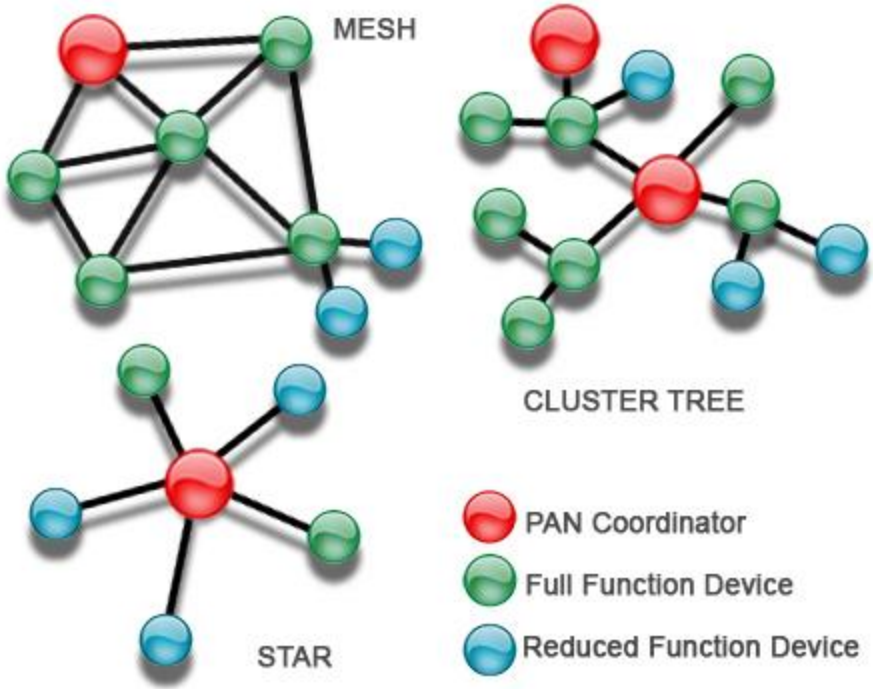
ZigBee Trust Center (ZTC) - FFD

- Gerência de segurança
- Distribuição de chaves seguras
- Autenticação dos devices

ZigBee Routers (ZR) - FFD

- Funciona como um roteador/repetidor

Topologias

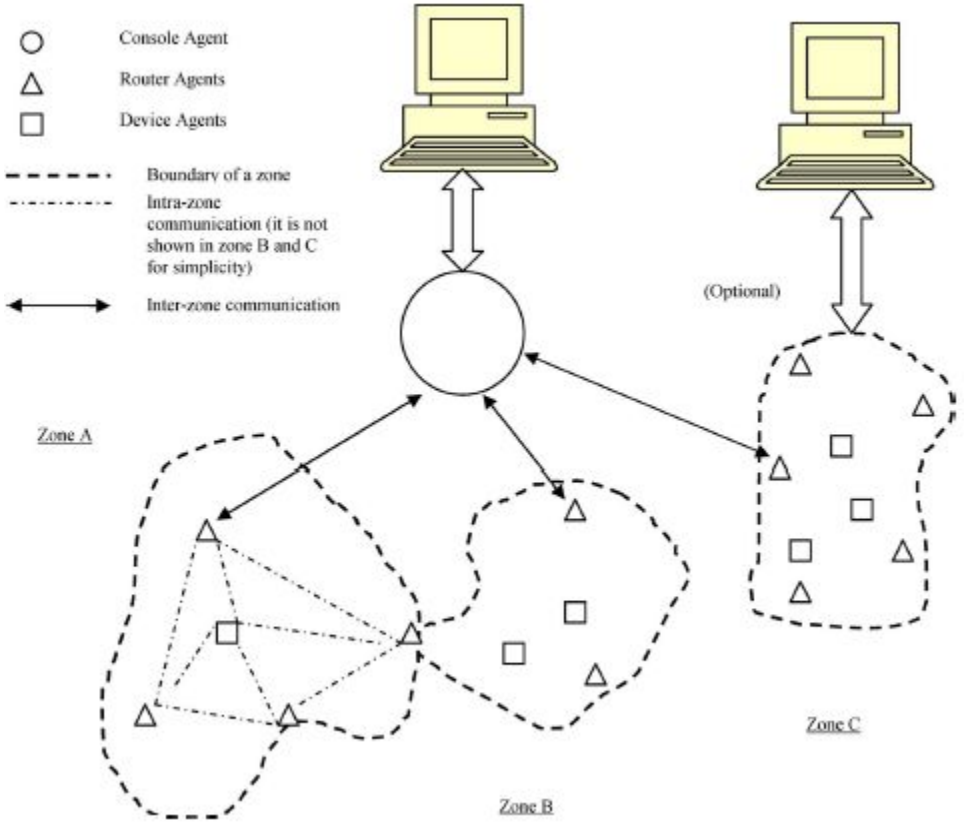

MESH
CLUSTER TREE
STAR
PAN Coordinator
Full Function Device
Reduced Function Device

Por que utilizar o ZigBee?

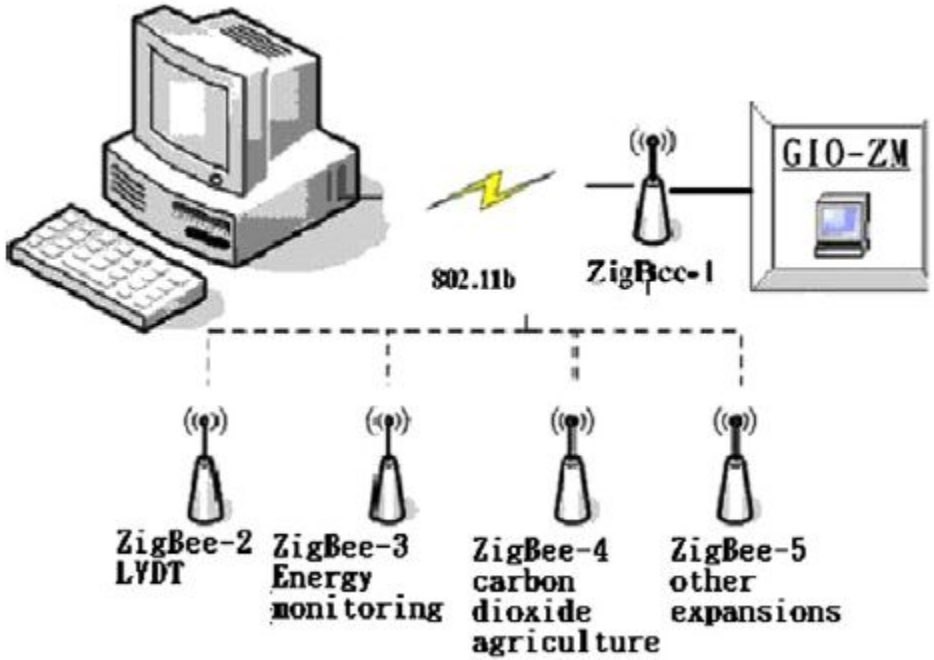
- Baixo custo com energia (Sensores)
- Curto Alcance
- Seguro
- Escalável
- Confiável

Exemplos

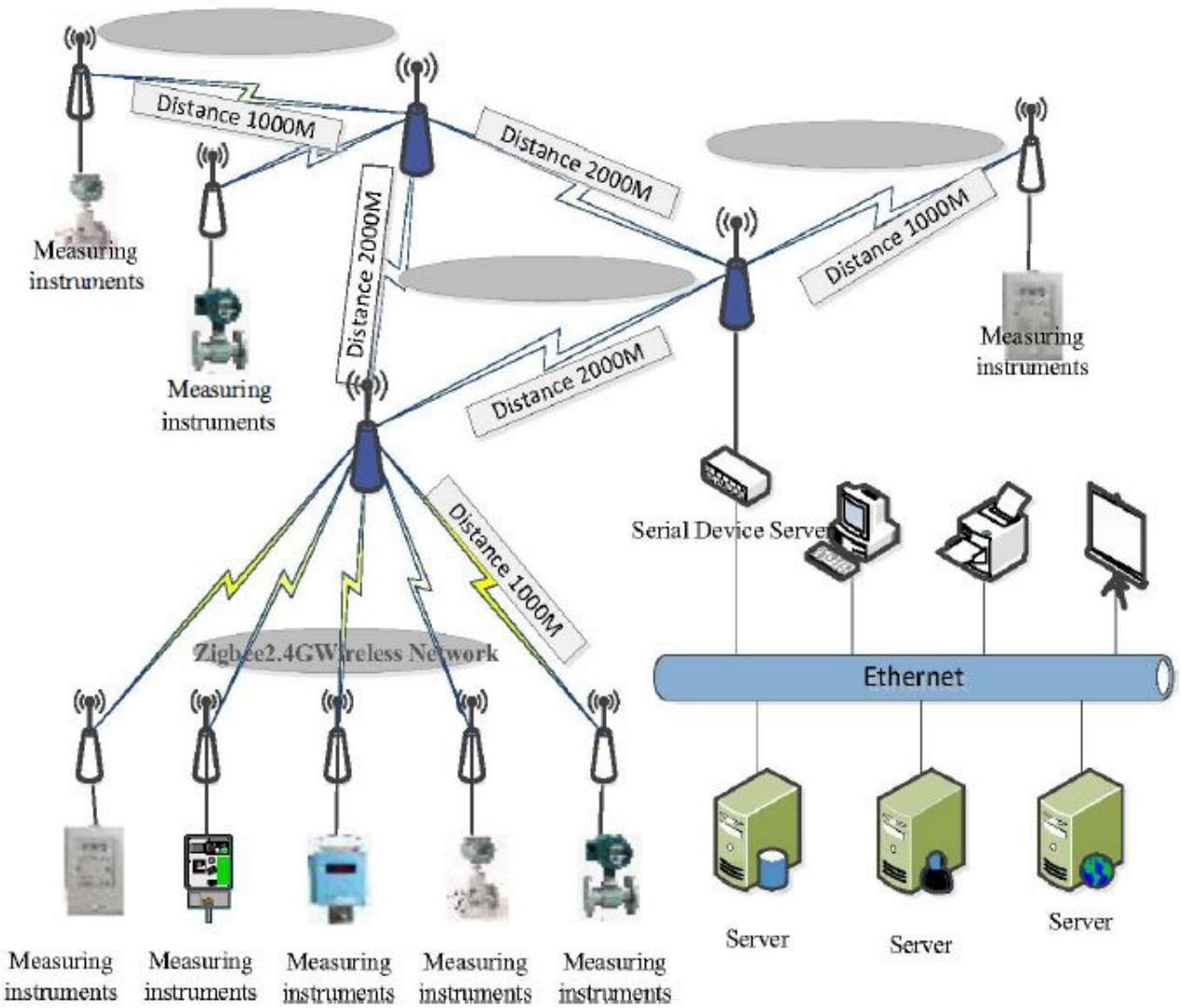
Agent-based system, with ZigBee wireless technology, for local positioning systems, which focus on factory level applications


Console Agent
Router Agents
Device Agents
Boundary of a zone
Intra-zone communication (it is not shown in zone B and C for simplicity)
Inter-zone communication
(Optional)
Zone A
Zone B
Zone C

Designing an industrial real-time measurement and monitoring system based on embedded system and ZigBee


GIO-ZM
802.11b
ZigBee-1
ZigBee-2
LVDT
ZigBee-3
Energy
monitoring
ZigBee-4
carbon
dioxide
agriculture
ZigBee-5
other
expansions

Research on Mining Energy Measurement System based on the ZigBee


Distance 1000M
Distance 2000M
Distance 2000M
Distance 1000M
Distance 2000M
Distance 1000M
Measuring instruments
Measuring instruments
Measuring instruments
Serial Device Server
Zigbee2.4GWireless Network
Ethernet
Measuring instruments
Measuring instruments
Measuring instruments
Measuring instruments
Measuring instruments
Server
Server
Server

Referências

A Comparative Study of Wireless Protocols: Bluetooth, UWB, ZigBee, and Wi-Fi

A Comparative Study of Wireless Communication Protocols: Zigbee vs Bluetooth

Real-time monitoring of GPS-tracking tractor based on ZigBee multi-hop mesh network

Designing an industrial real-time measurement and monitoring system based on embedded system and ZigBee

Agent-Based Factory Level Wireless Local Positioning System With ZigBee Technology

Introduction to the ZigBee Wireless Sensor and Control Network