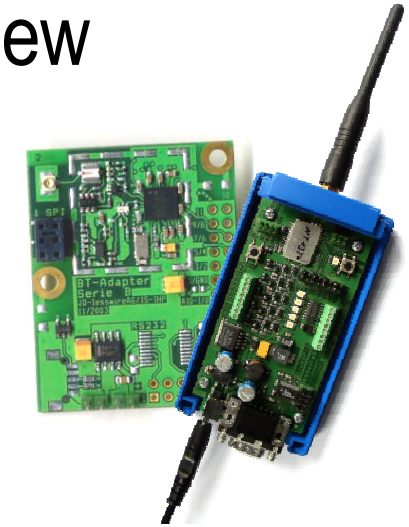
Wireless Technologies for Automation

Prof. Dr.-Ing. Jörg F. Wollert

Wireless Technologies for Automation

- Why using wireless communication?
- Pros and cons in wireless networks
- Embedded Wireless
  - Hardware
  - Software
- A short technology overview
  - WLAN
  - Bluetooth
  - ZigBee
- Conclusion



Why using wireless communication?

- Use-cases for wireless technology
  - Cable Replacement: cheap and easy interface with high data rate
  - Ad-hoc Networks: security and flexible network configuration
  - Mobile Solutions: security, low power and high reliability
  - Embedded: cheap, small, available
  - In all:
    - Standardized communication
    - precisely defined protocols
    - Scalable communication profiles for data, speach and media content
- Some demands
  - Suitable security with authentication and authorization
  - Mobile services for control, diagnostic and visualization
  - Integration of mobile Consumer devices like mobile phone, PDA or laptop

Pros and cons of wireless networks

Pros:

- Easy integration of mobile, distributed communication systems
- Independent usage of electronic devices
- No problems in cabling
- Unsusceptible against disaster and careless users
- Easy access without infrastructure

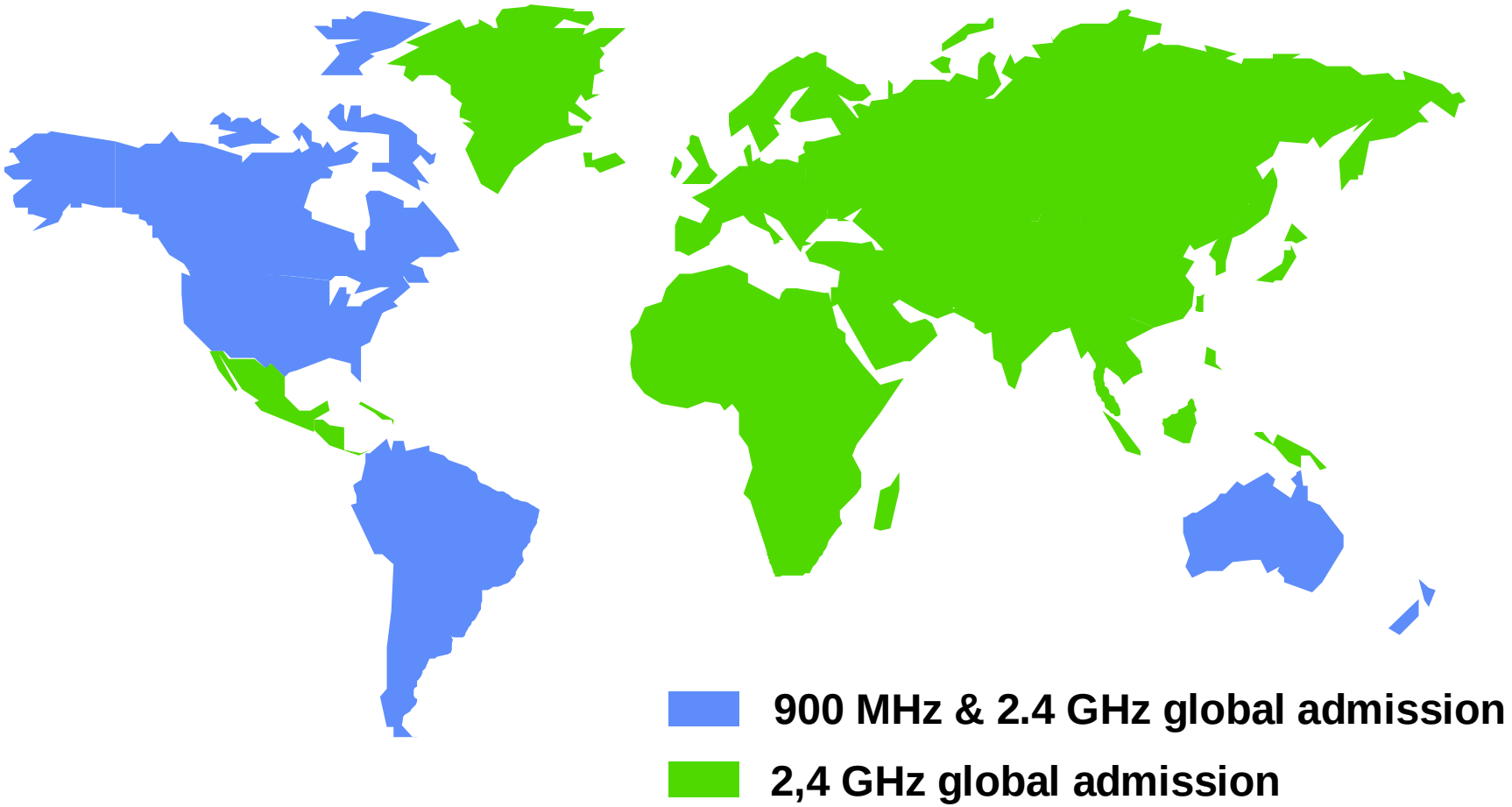
Cons:

- Less data rate in comparison with standard Ethernet cabling
- Difficult administration for a suitable security
- Great differences in standards and interoperability
- A lot of regulation constrains
- Link quality is more poor than cable technology

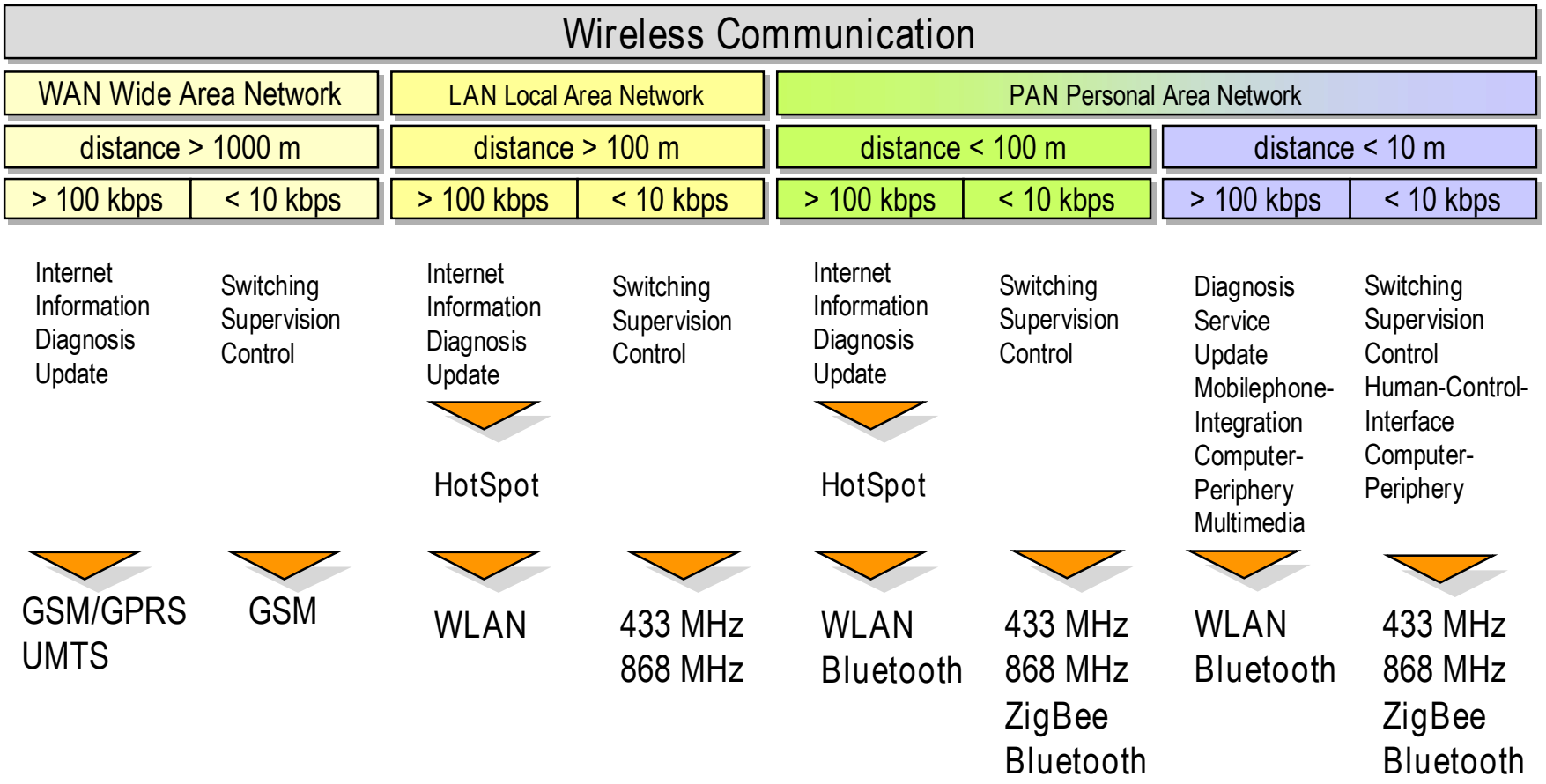
Designing wireless networks ...

- worldwide common technology
- No licenses and worldwide use without fee
- Interoperability between products of different manufacturer
- Robust and reliable transmission of data
- Easy to use and simple configuration
- Interoperability with cable based systems
- Insensitive against various security attacks (Interruption, Interception, Modification, Fabrication)
- Low power consumption
- Large communication range
- Large number of active stations
- Inexpensive

Available ISM Frequencies



Classification of wireless technology



- There are several technologies which compete for different applications!

Embedded Wireless

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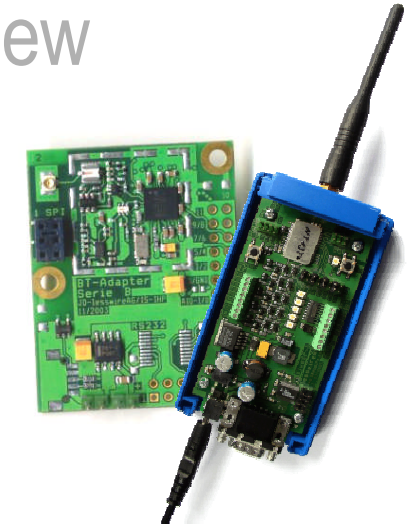
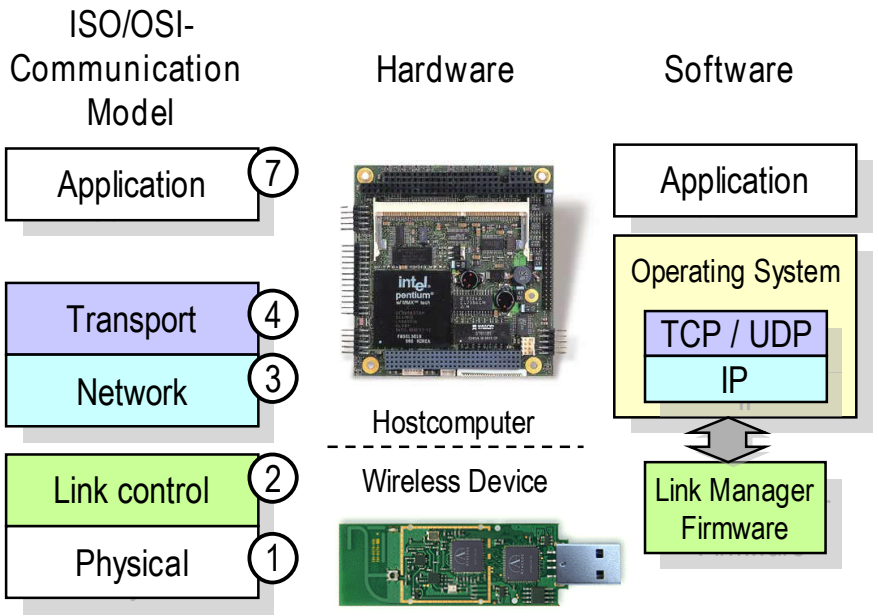


Software and hardware in embedded systems

Requirements

- Hardware
  - Standardized functionality
    - 802.11 a,b,…; Bluetooth, ZigBee
  - Standardized interfaces
    - SPI, USB, UART, PCCard
- Software
  - Operating System
    - Protocol Stacks
      - IP, TCP, UDP, OBEX, …
    - Defined functionality
      - DHCP, SMTP, ICMP, …
  - Application
    - Defined interfaces
    - Application profiles
    - Interoperability tests

- Question
  - Which functionality is done by the wireless controller?
  - How much memory is used by the necessary protocol stacks?
  - How much computing power is consumed for handling the wireless connections?



Embedded Wireless

- Why using wireless communication?
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- A short technology overview 2.4 GHz
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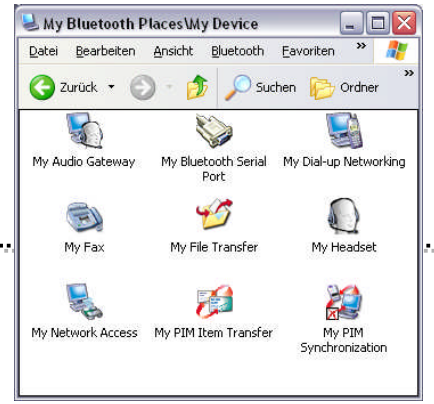
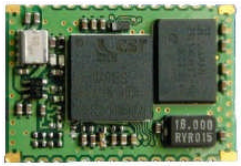
Wireless LAN 802.11

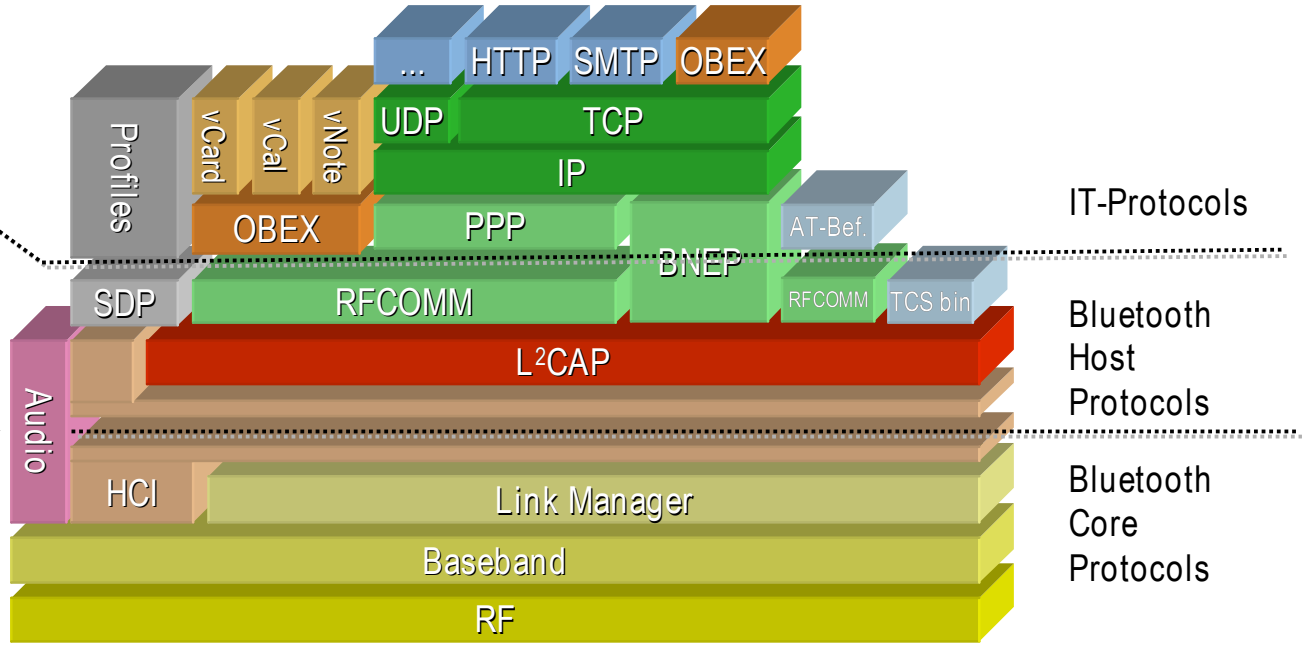
- Normally WLAN is used to replace a wired Ethernet connection.
- Beside a hardware driver for the special WLAN-hardware the additional IP, UDP and TCP-protocol stack is necessary.
- TCP/IP-Stack is expensive and needs a lot of memory and computing power
- A lot of different incompatible or additional specifications are available
- 802.11 is build for asynchronous communication with a high data rate typically 11 Mbps (802.11b), 54 Mbps (802.11g) up to 100 Mbps
- Special Profiles are not defined
- Interoperability is guaranteed by the WiFi logo

Bluetooth™

- Bluetooth features
  - 2.4 GHz ISM-Band, 79 Kanäle, 1 Mbps
  - GFSK, FHSS 1600 Hops/sec
  - Connection oriented Link (SCO) for voice-applications
  - Asynchronous connectionless link (ACL) for dataservices
  - Master-slave piconet with 7 active and up to 255 slaves in parked mode
- Completely defined, scalable software
  - 25 different communication profiles
    - Network oriented profiles
    - Telephony, ISDN, fax profiles
    - Various data-interchange profiles, based on OBEX
    - Human Interface definition profile
    - Cable replacement
  - Service Discovery Profile and Application
  - Compatible with various products







Bluetooth-Embedded

- Various Bluetooth-chips have programmable build-in µC
  - Host controller is not necessary
  - Different profiles and applications may be build in the chipset
- Embedded devices
  - Application runs on the BT-module
  - Build in security and connection manager take care of highest possible security
  - Connected serial devices doesn't need any further software implementations
  - No software protocols are necessary on the host controller

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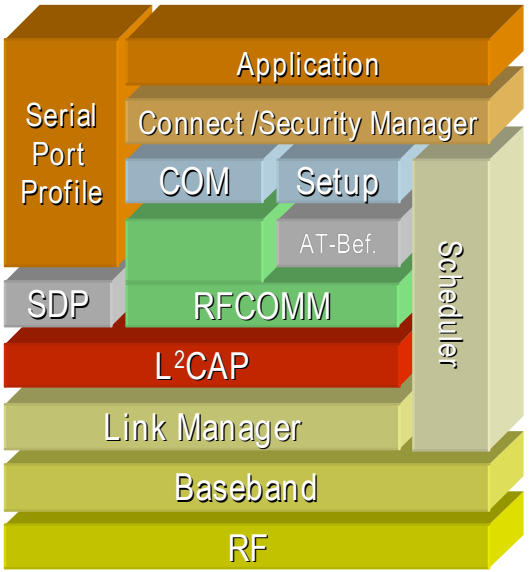
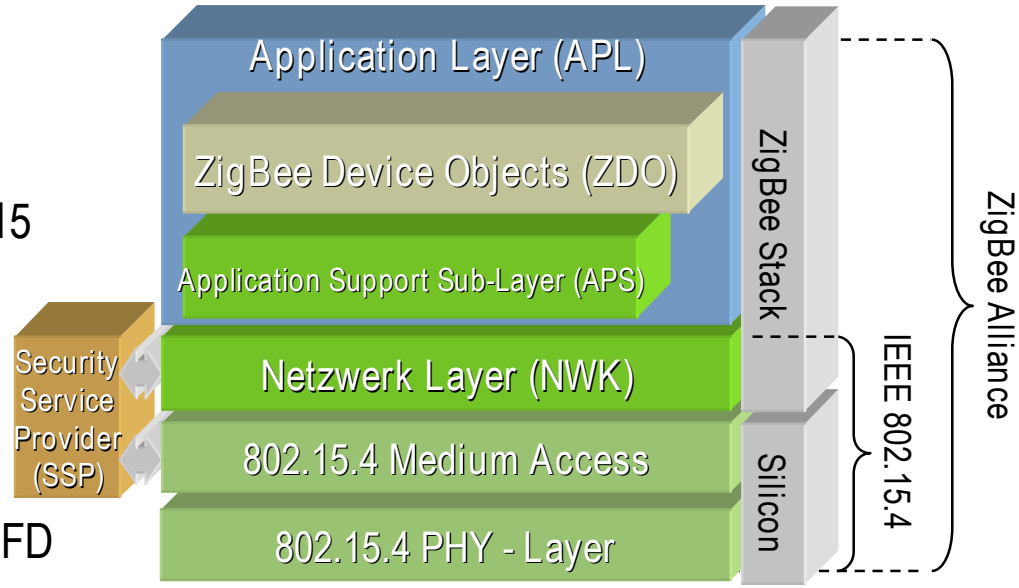
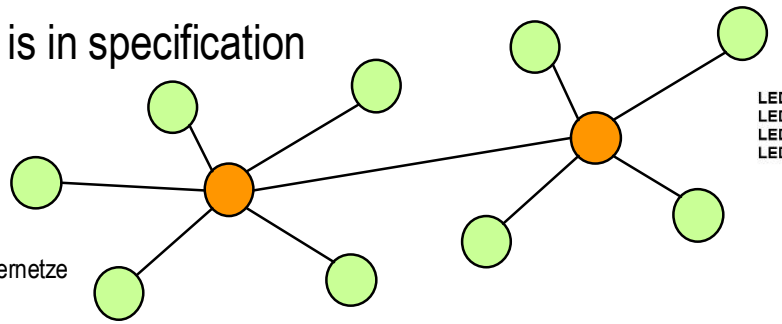


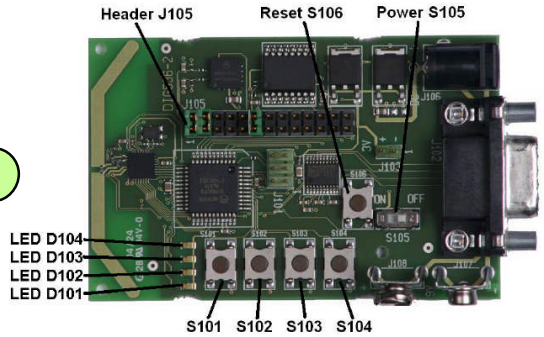
ZigBee

ZigBee Alliance

- ZigBee features
  - Data rate 20, 30 and 250 kbps
  - Low power consumption, low price
  - Scalable range and data rate in 868/915 MHz and 2.4 GHz
  - Star and mashed net topology
    - FFD network coordinator
    - RFD tiny network client
  - Up to 254 RFD are managed by one FFD
  - Routing capability between FFD
  - Small protocol stacks and few resources
  - PHY and MAC layer are defined in IEEE 802.15.4 specification
  - The ZigBee stack is in specification

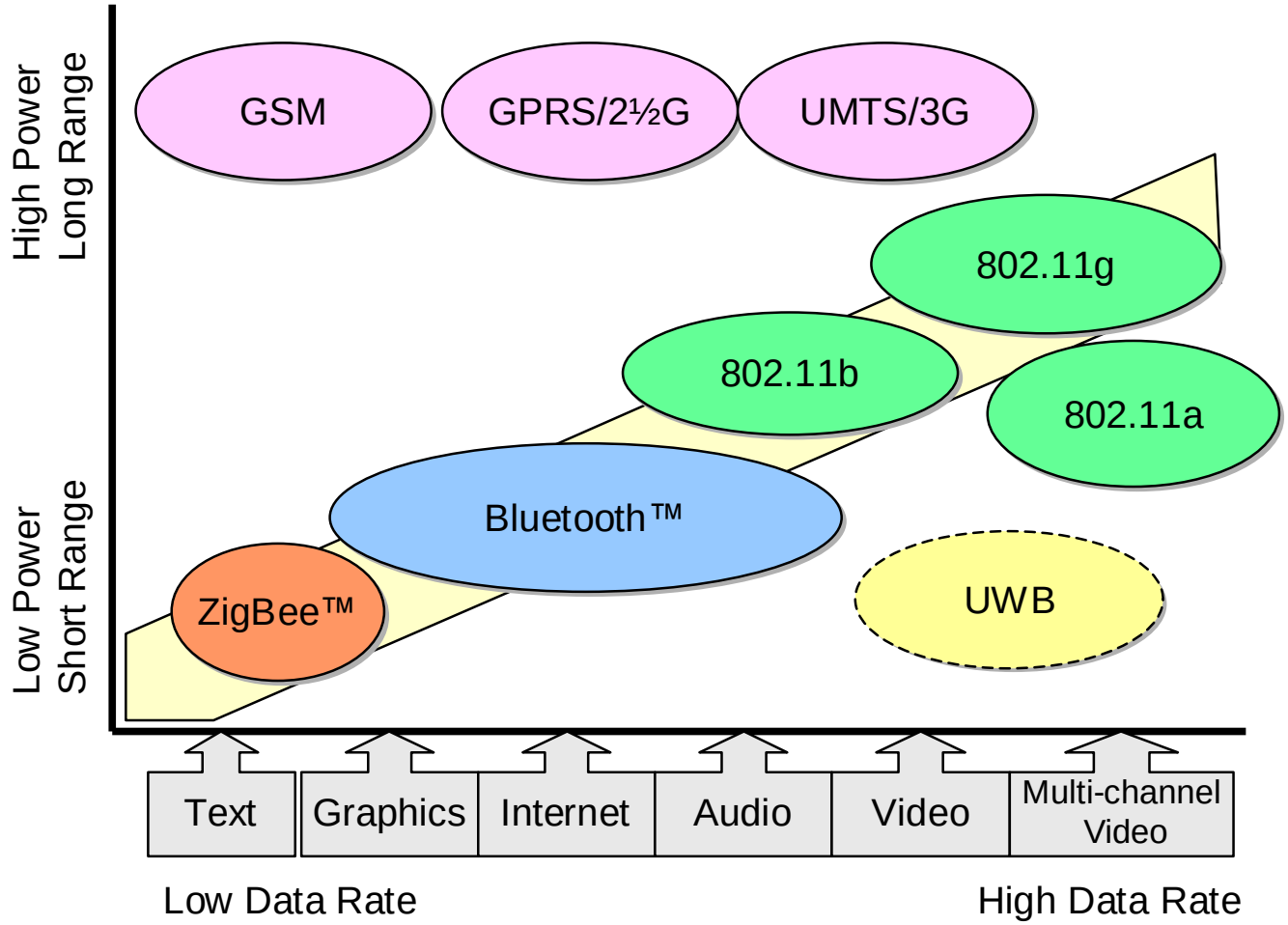






Picture: Freescale SARD-Board (AN2762)

On a glance: characteristics



On a glance: Resource consumption

Market Name Standard	GPRS/GSM 1xRTT/CDMA	Wi-Fi™ 802.11b,g	Bluetooth™ 802.15.1	ZigBee™ 802.15.4
Application Focus	Wide Area Voice & Data	Web, Email, Video	Audio, Cable Replacement	Monitoring & Control
System Resources	16MB+	1MB+	250KB+	4KB - 32KB
Battery Life (days)	1-7	.5 - 5	1 - 7	100 - 1,000+
Network Size	1	32	7 – (250)	255 / 65,000
Bandwidth (KB/s)	64 - 128+	800 .. 54.000	720	20 - 250
Transmission Range (meters)	1,000+	1 - 300	1 - 100	1 - 100+
Success Metrics	Reach, Quality	Speed, Flexibility	Cost, Convenience	Reliability, Power, Cost

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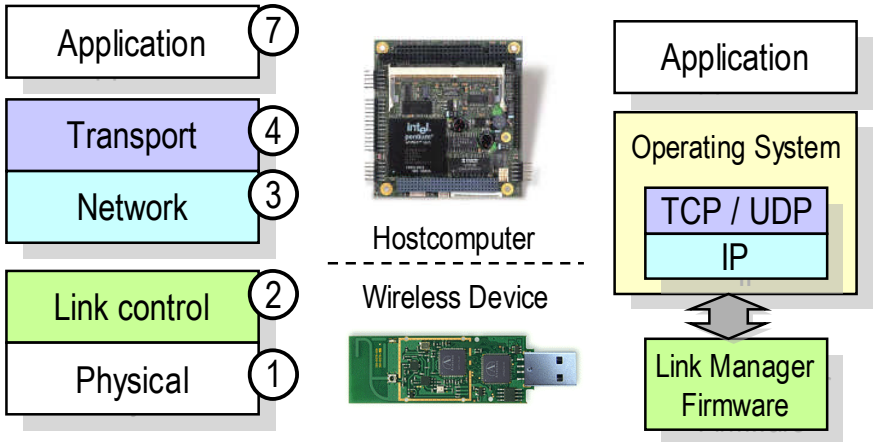
Conclusion

- Wireless products are trendy
- Different technologies are available
- The used technology depends on the specific requirements
  - Power consumption
  - Data rate and topologies
  - Interoperability to consumer or network products
  - Security and reliability
  - Easy engineering and less complexity



433 und 868 MHz, ZigBee

- Low end products with less demands on security, only small data rate, high range, few resources and specialized protocol stacks.

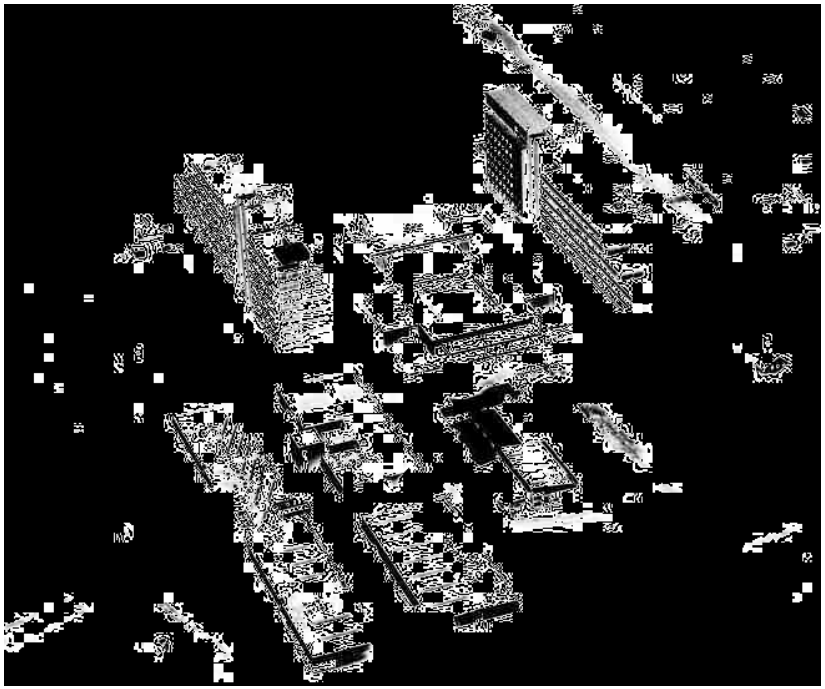
Bluetooth

- Tiny products with interoperability up to 25 different profiles
- Different channels for audio and data
- Highest embedded security on chipset level
- Easy scalable systems with build-in processors
- Exactly defined and tested interoperability
- Compatibility to consumer products

WLAN 802.11

- Compatibility to Ethernet
- Very high data rate, large range
- Large resources, host-protocol-stacks

Thanks for your attention !



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