Standards for Wireless Home Network

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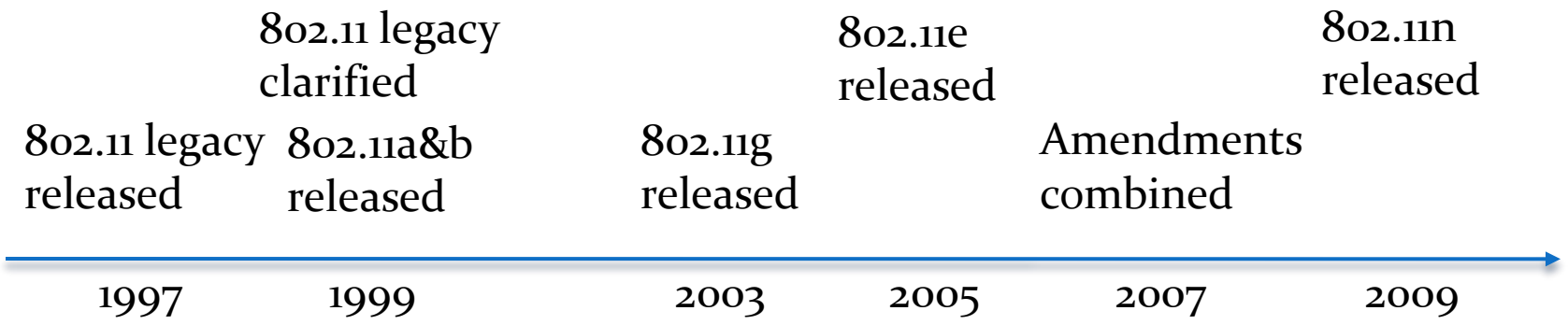
IEEE 802.x Standards

- 802.11 for Wireless Local Area Network

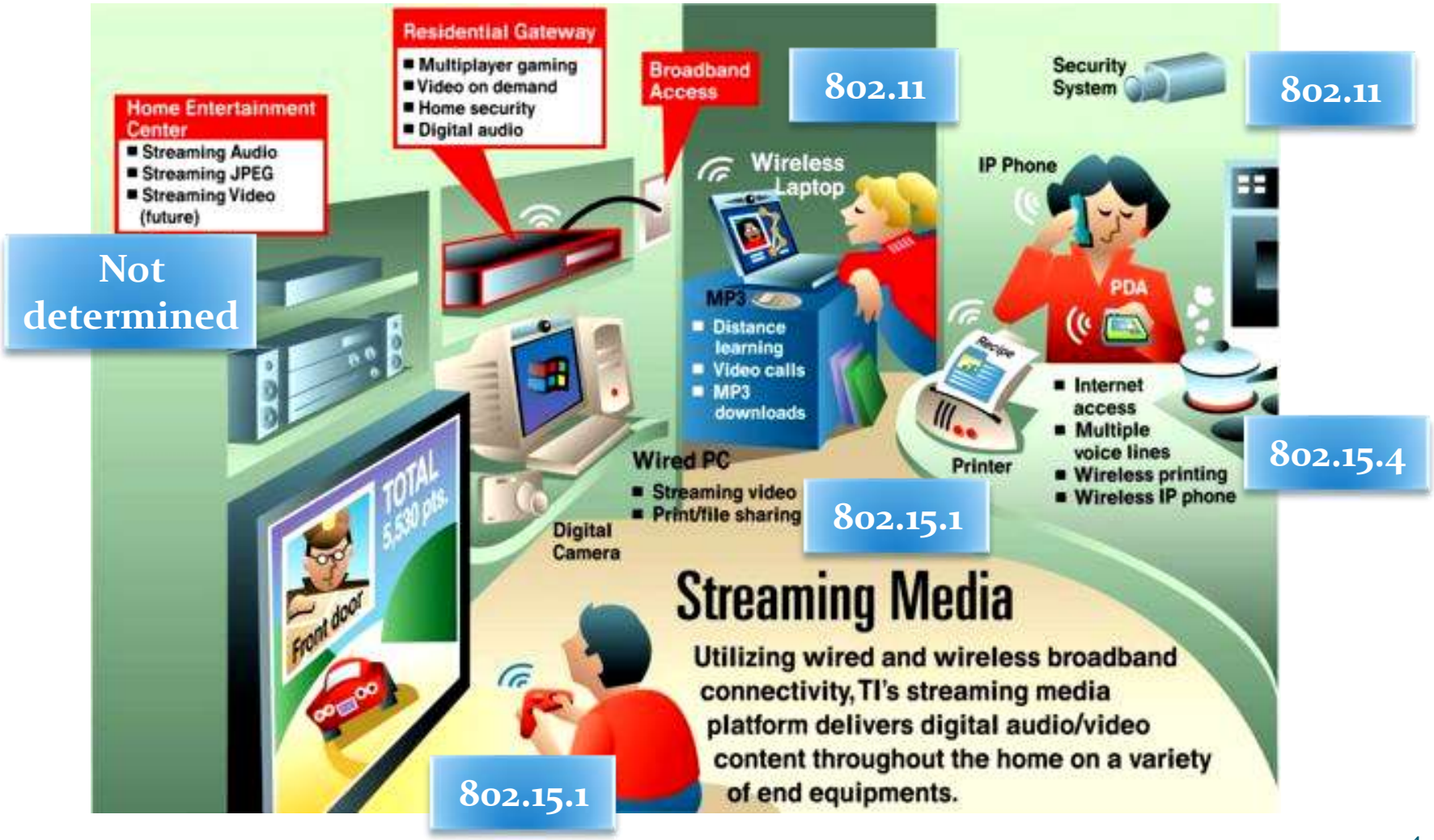


- 802.15 for Wireless Personal Area Network
- 802.16 for Broadband Wireless Metropolitan Area Network

IEEE 802.x Standards

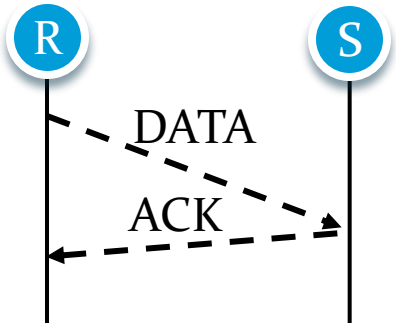
- 802.11 for Wireless Local Area Network
- 802.15 for Wireless Personal Area Network
  - Task Group (TG) 1 (WPAN / Bluetooth)
    - Released in 2002 Revised in 2005 / max. 1Mbps / 2.4GHz / freq. hopping (Bluetooth 2.0+EDR supports 3Mbps)
  - TG 2 (Coexistence)
  - TG 3 (high rate WPAN)
    - Released in 2003 / max. 55Mbps / 2.4GHz / no spreading code
  - TG 4 (low rate WPAN / ZigBee)
    - Released in 2003 / max. 250kbps / 2.4GHz / DSSS

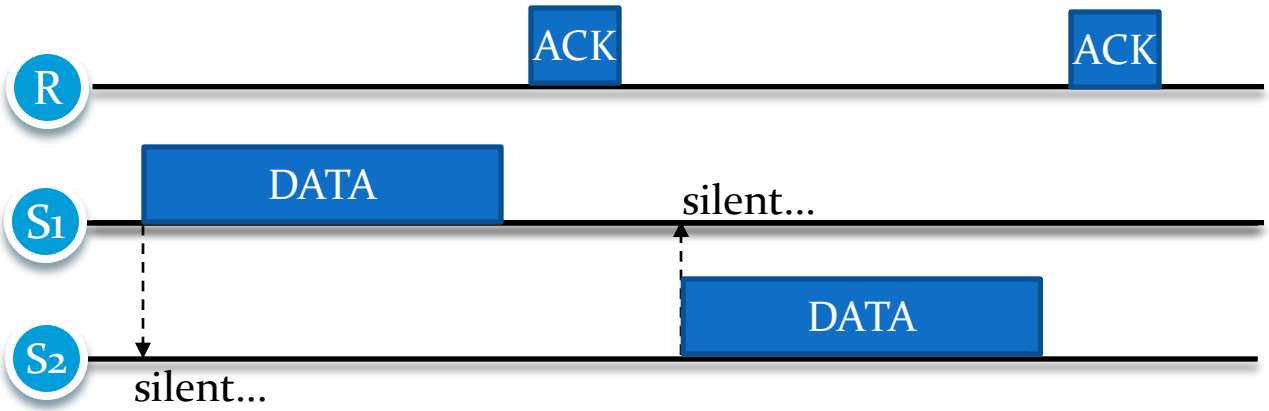
Home Network with IEEE Standards



CSMA-CA

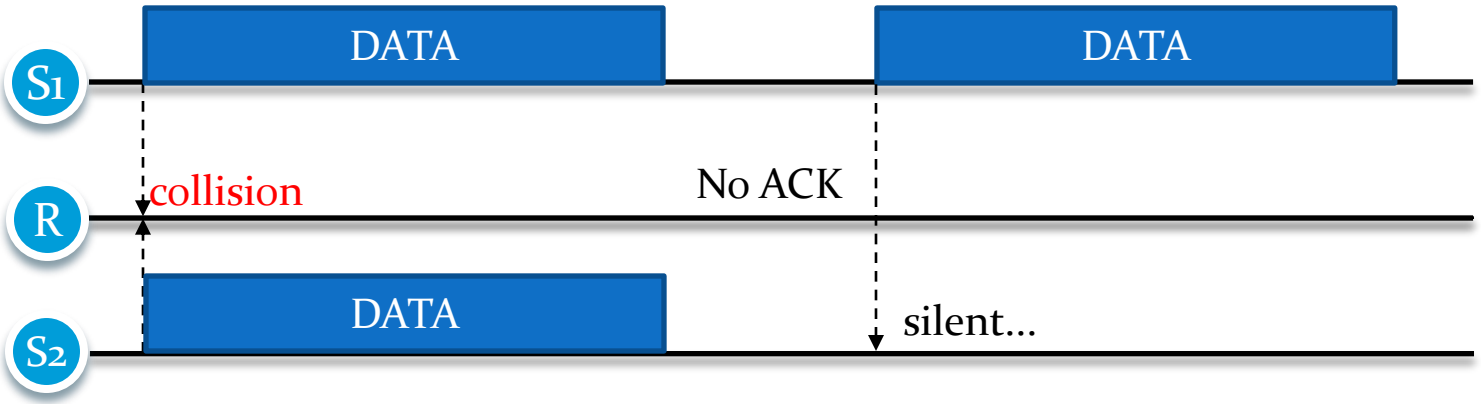
- Carrier Sense Multiple Access – Collision Avoidance

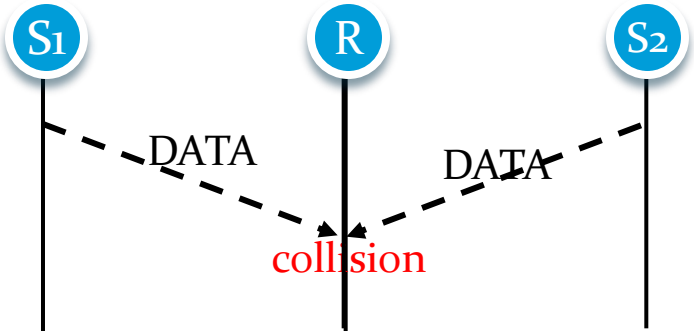




CSMA-CA (Cont.)

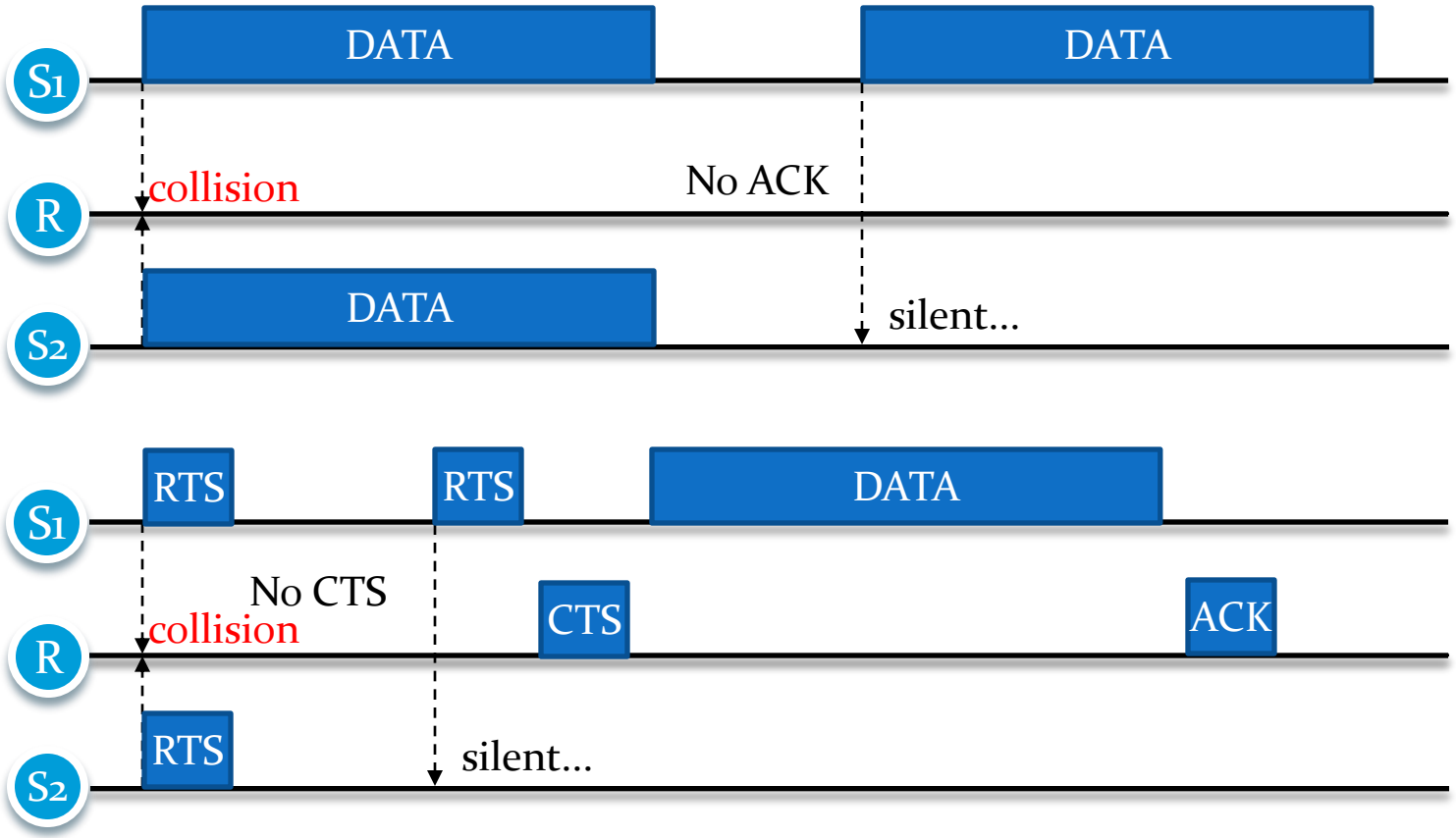
- Collision Avoidance





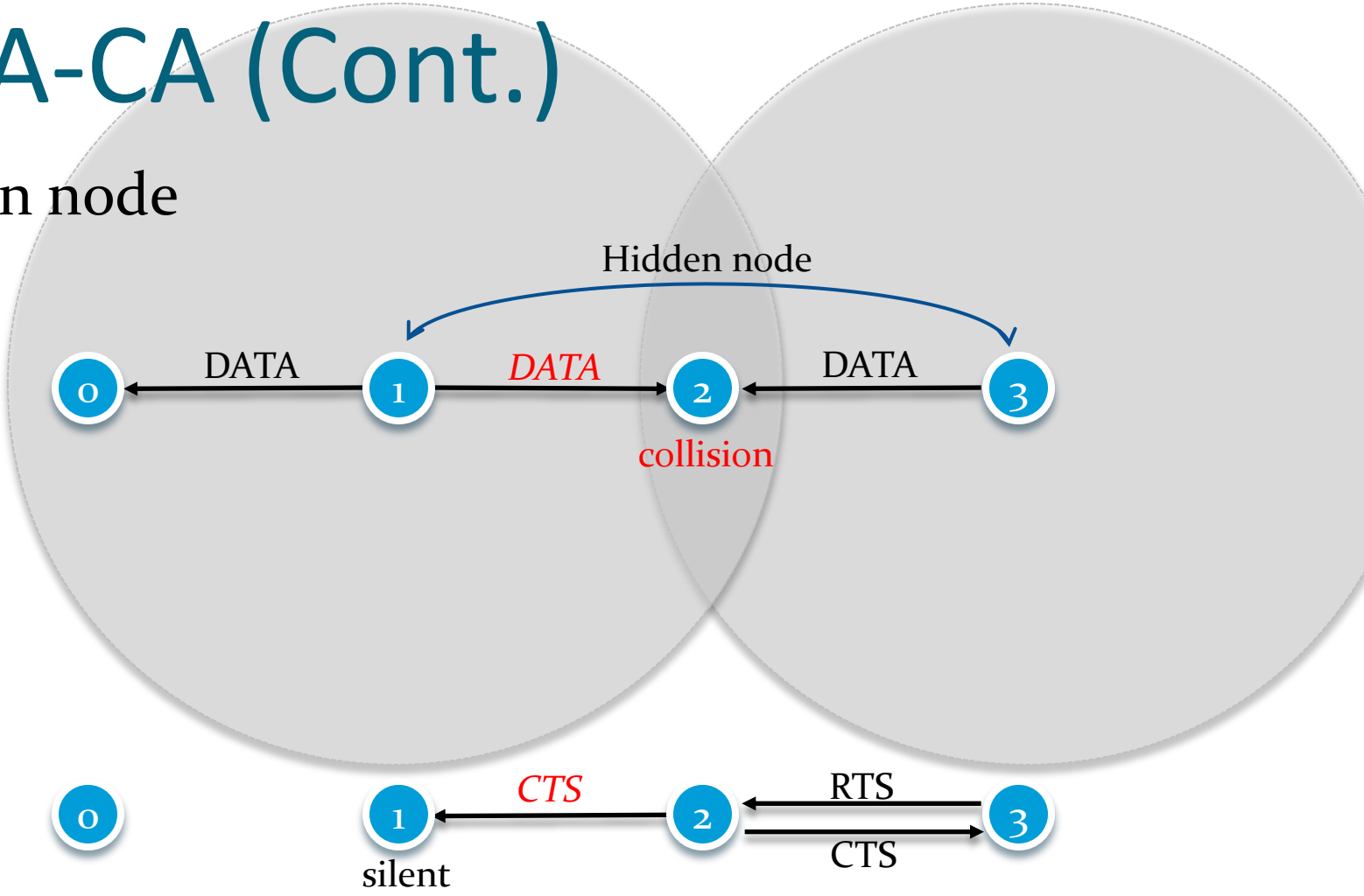
CSMA-CA (Cont.)

- RTS-CTS handshaking



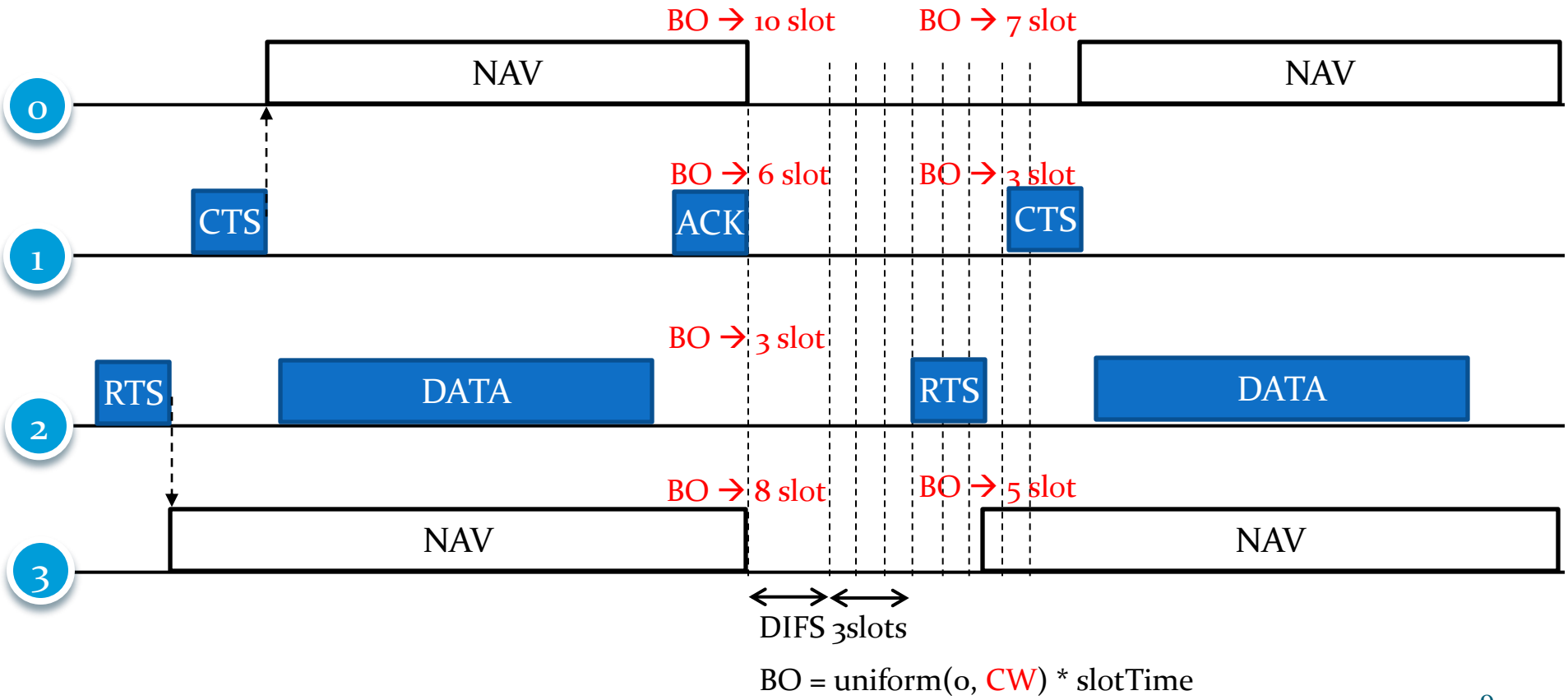
CSMA-CA (Cont.)

- Hidden node



CSMA-CA (Cont.)

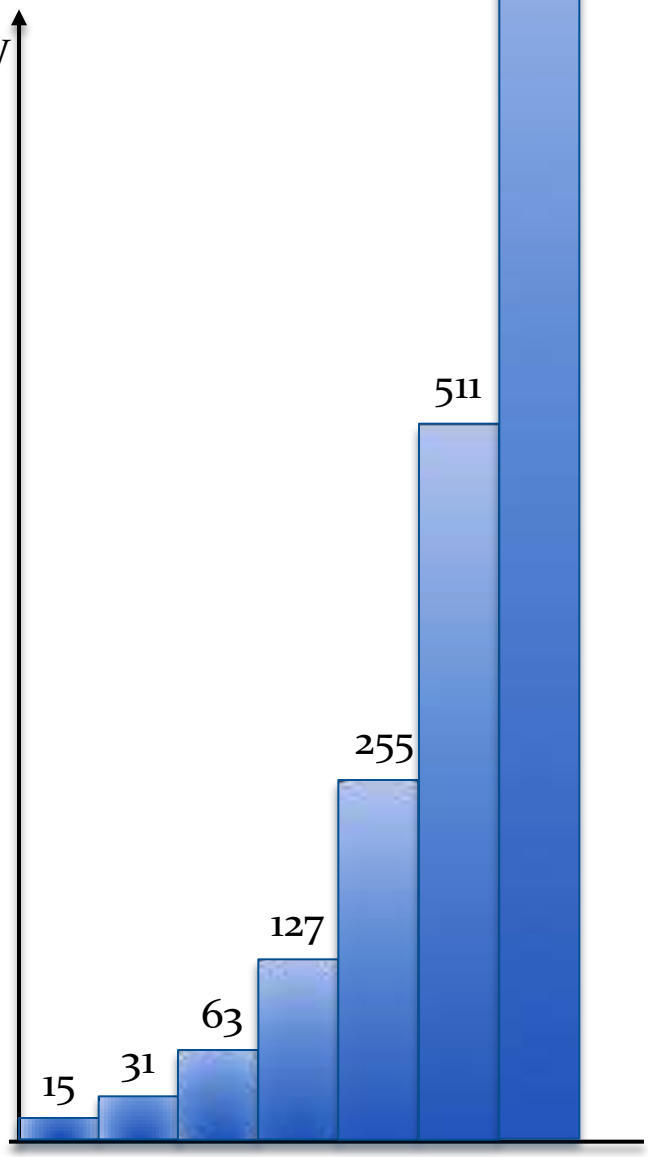
- Random back-off (BO)



BO = uniform(0, CW) * slotTime

CSMA-CA (Cont.)

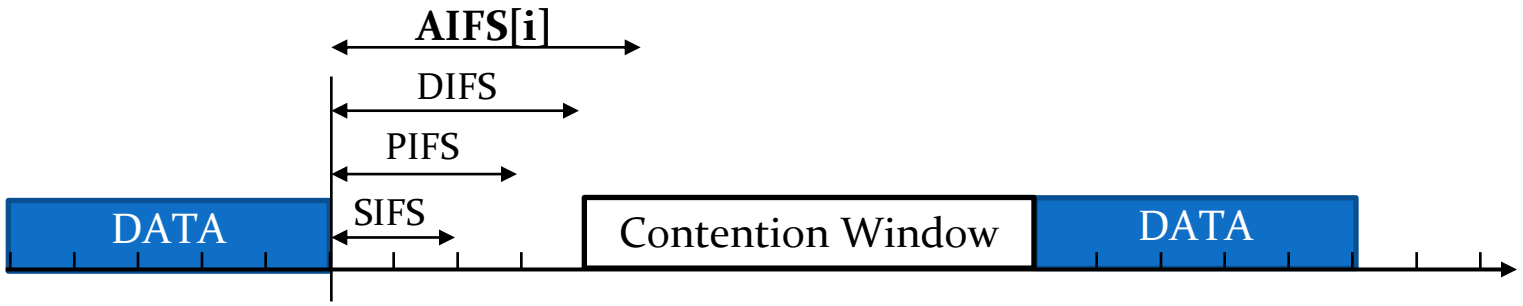
- Contention Window (CW)



*Window: An interval of time during which an activity can or must take place

802.11e

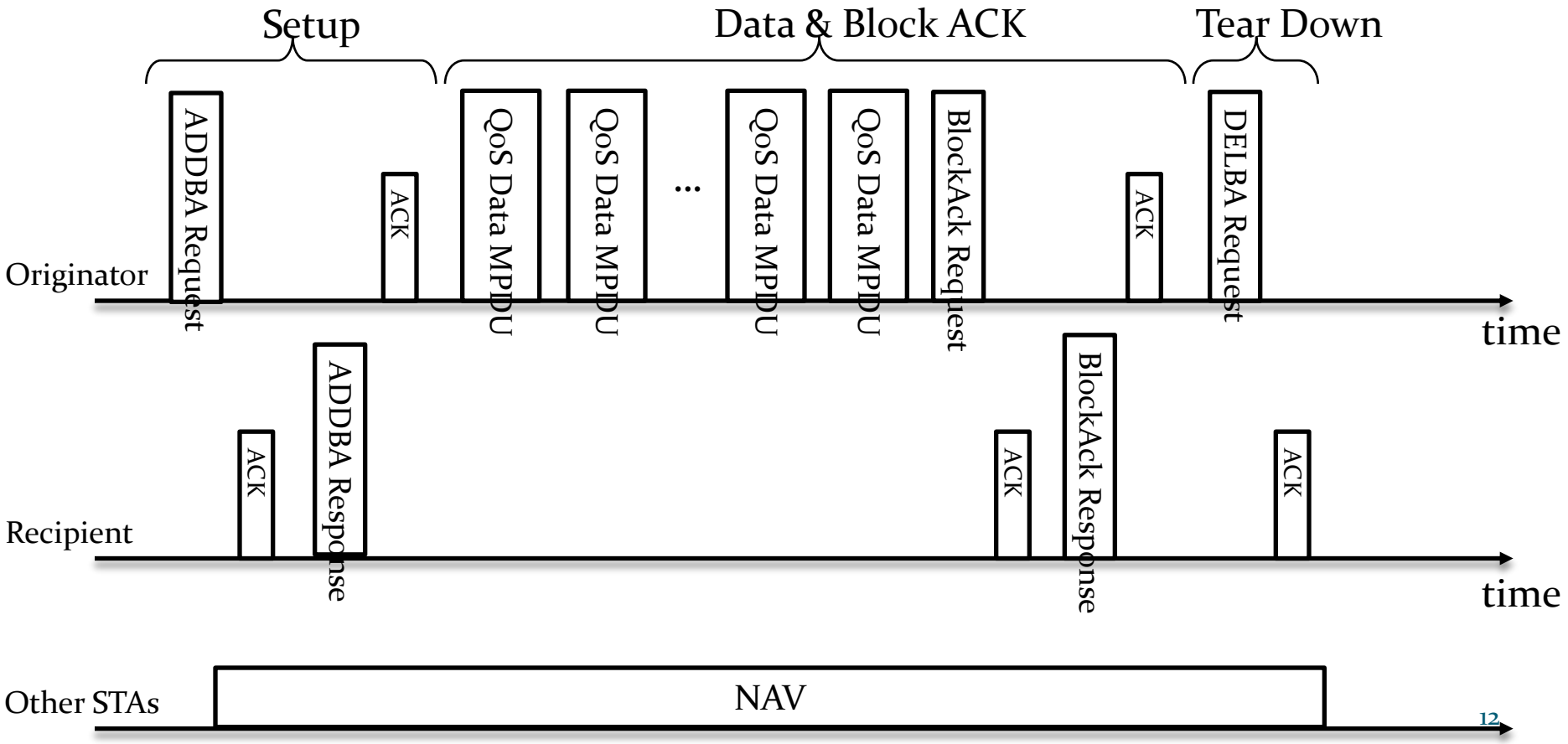
- enhanced distributed channel access (EDCA)
  - Enhancement of distributed contention function (DCF) in 802.11 legacy



Access Class	CWmin	CWmax	AIFSN	TXOP limit
BACKGROUND	aCWmin (=15)	aCWmax (=1023)	7	0
BEST EFFORT	aCWmin	aCWmax	3	0
VIDEO	(aCWmin+1)/2-1	aCWmin	2	3.008ms
VOICE	(aCWmin+1)/4-1	(aCWmin+1)/2-1	2	1.504ms

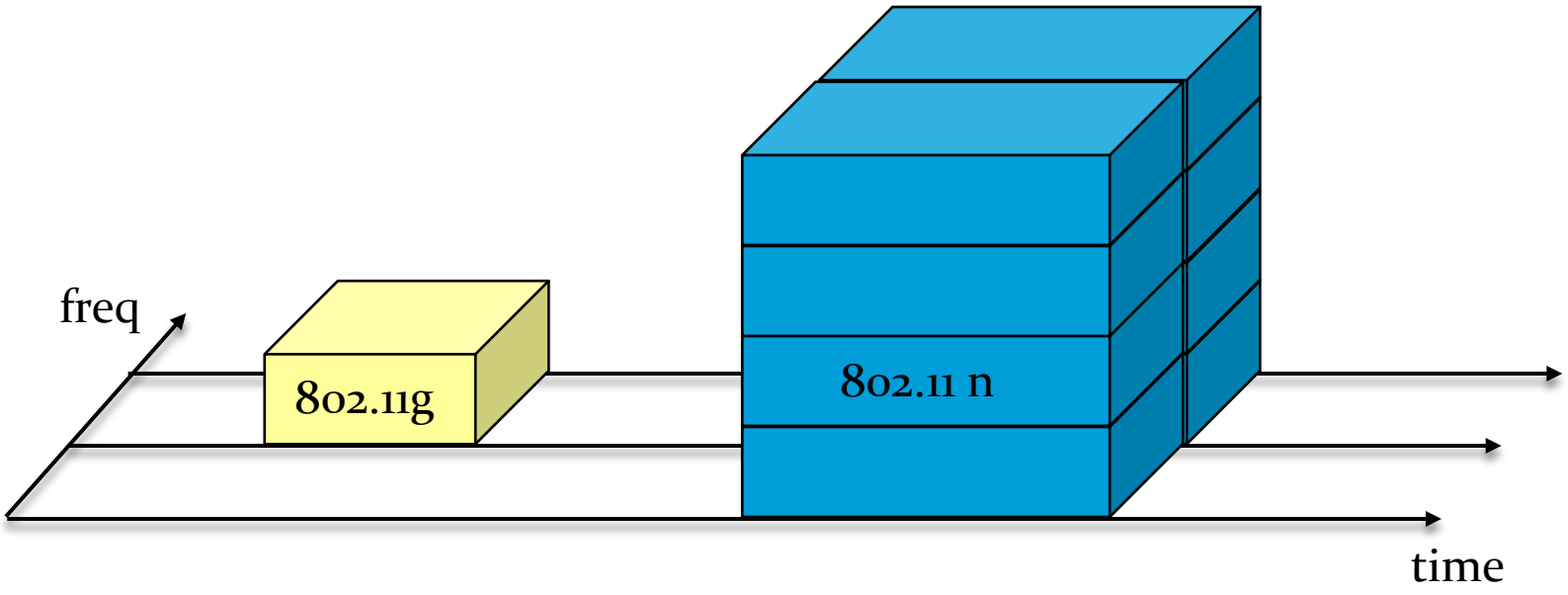
802.11e (Cont.)

- Block ACK



802.11n

- Data rate is up to 600Mbps
  - 802.11g's max. data rate is 54Mbps

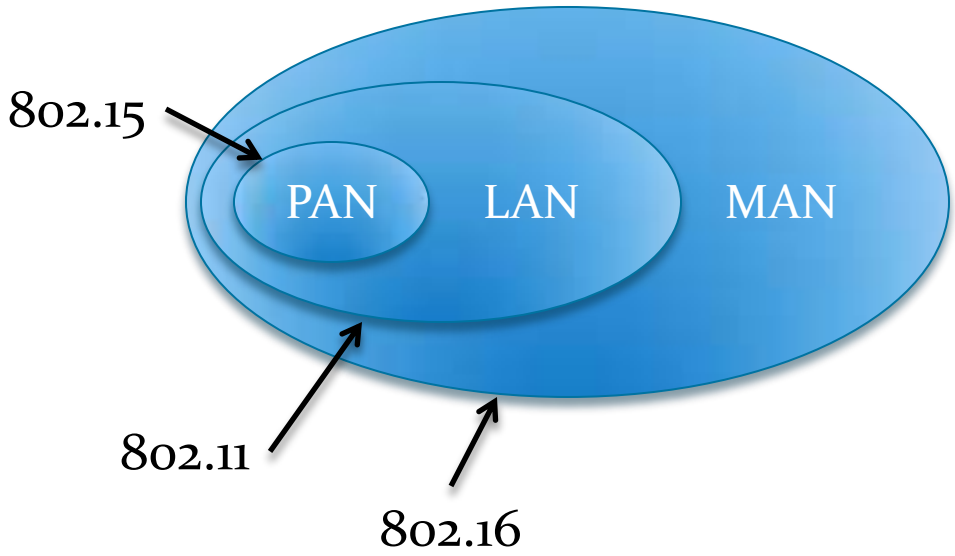


802.11g vs. 802.11n

- 802.11g
  - 64QAM: 6bits (=$\log_2 64$) per one symbol
  - OFDM: 48 sub-carriers * 6 = 288bits
  - 3/4FEC: 288 * 3/4 = 216bits
  - 4us symbol duration: 216/4 = *54Mbps*
- 802.11n
  - 64QAM: 6bits
  - OFDM: 108 sub-carriers * 6 = 648bits
  - 5/6FEC: 648 * 5/6 = 540bits
  - 4 sets of TX/RX antennas: 540 * 4 = 2160bits
  - 3.6us symbol duration: 2160/3.6 = *600Mbps*

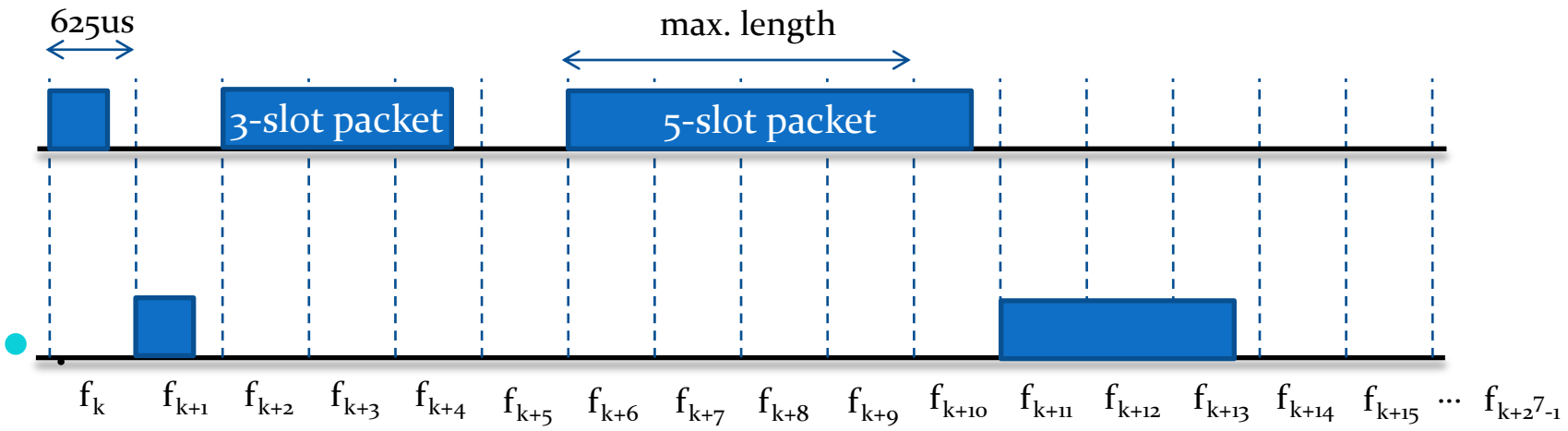
Do not Confuse

- Wireless Sensor Network (WSN) is neither Bluetooth, ZigBee, WiFi, or any IEEE Standard.



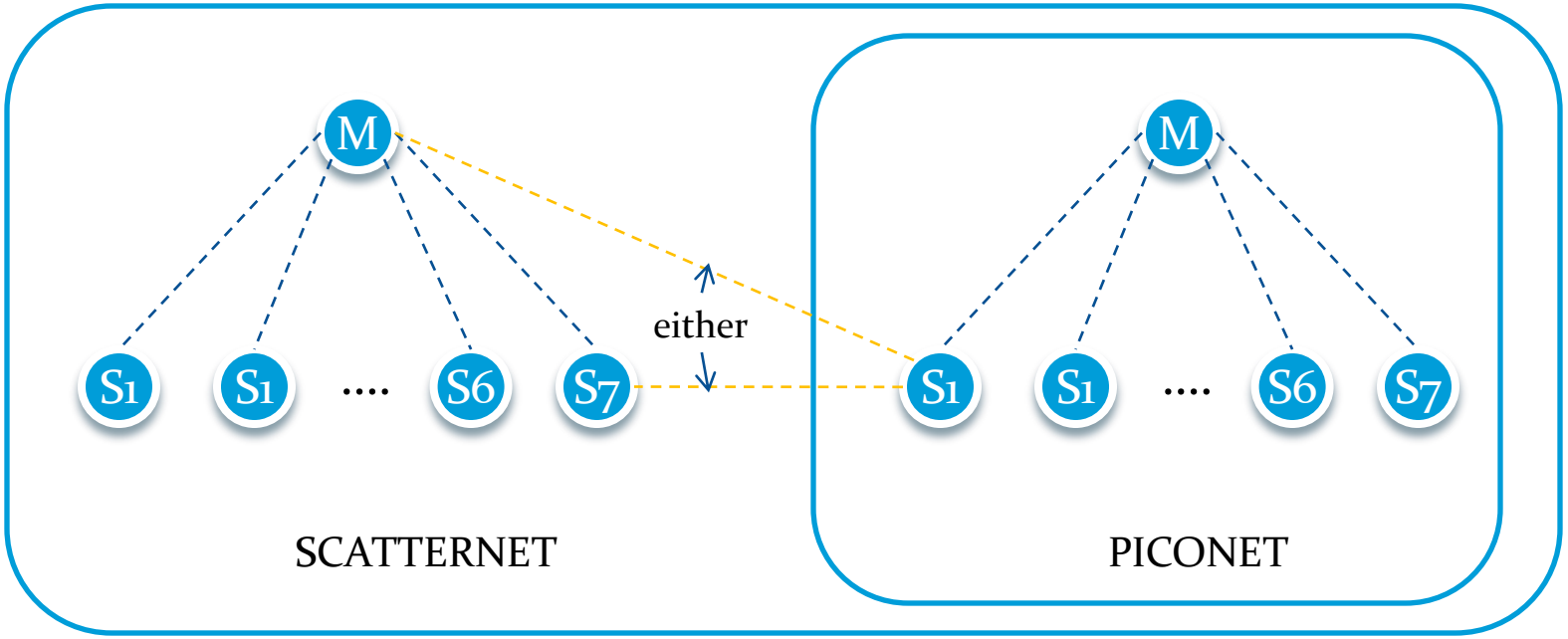
802.15.1

- IEEE Standard for Wireless Personal Area Network (WPAN)
  - For wireless connectivity with fixed, portable, and moving devices within a personal operating space.
  - 1600 hops/sec across 79 frequencies
    - Class 1: +20 dBm (100 mW), 50-100 meters
    - Class 2: +4 dBm (2.5 mW), 20 meters
    - Class 3: 0 dBm (1 mW), 10 meters



802.15.1 (Cont.)

- Master establishes a piconet with up-to 7 slaves
  - Master determines piconet's frequency hopping pattern

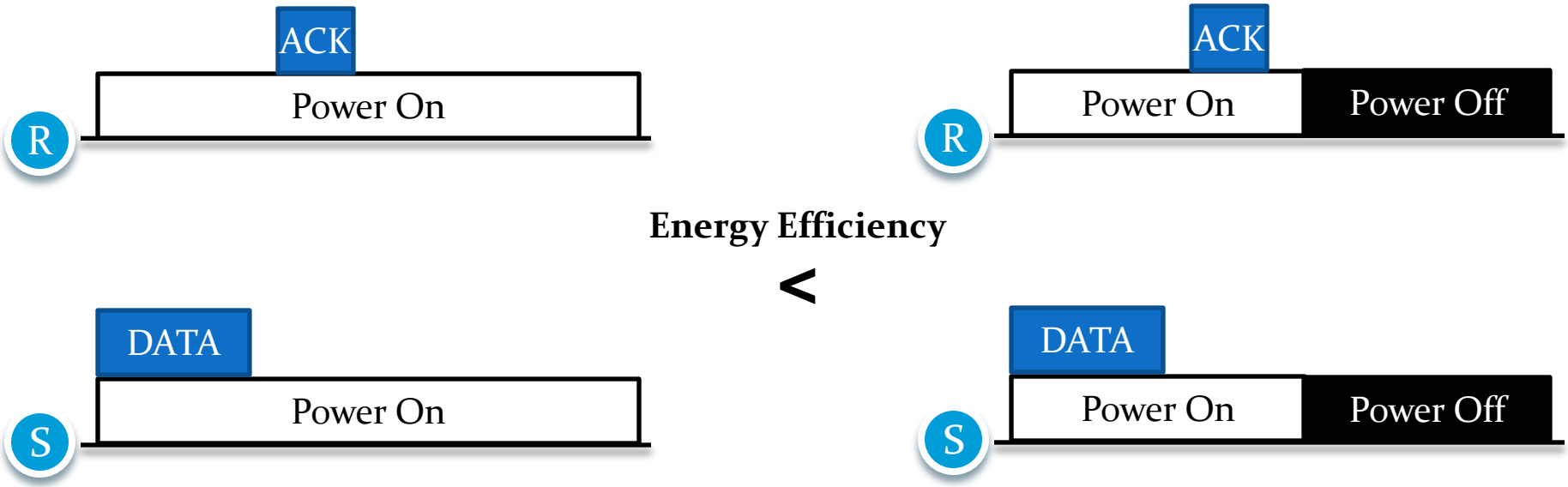


802.15.4

- IEEE Standard for *Low-Rate* Wireless Personal Area Network (LR-WPAN)
  - For communication devices using
    - low data rate
    - low power
    - low complicate
    - short range radio
- Do not Confuse
  - 802.15.4 is not ZigBee
  - ZigBee is not WSN

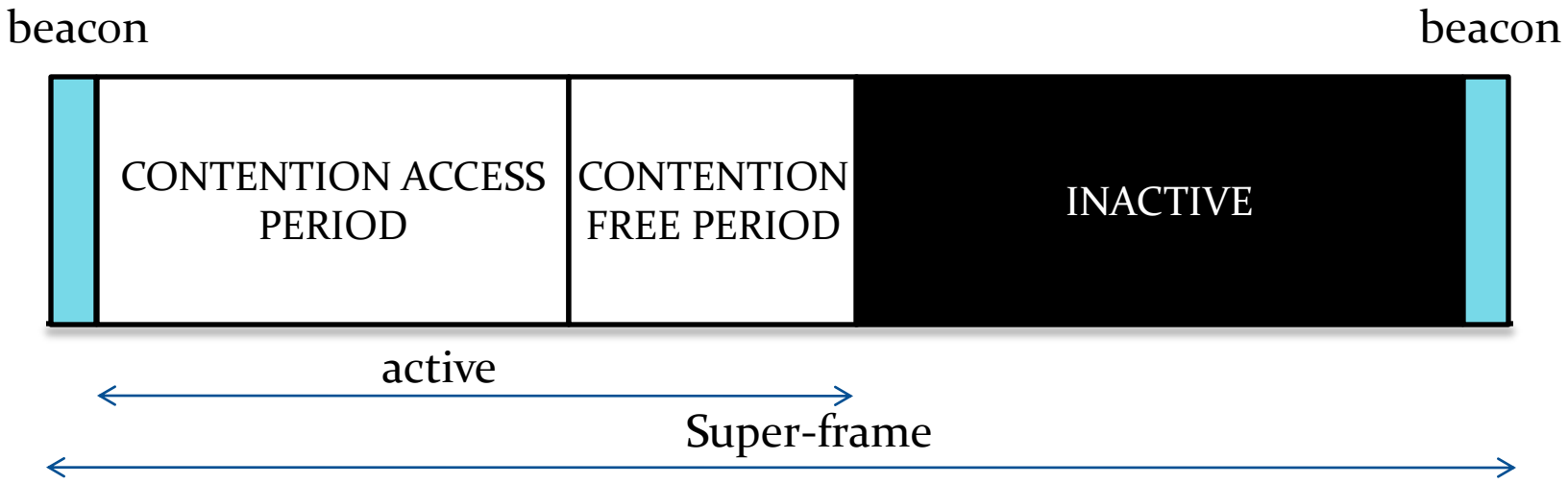
802.15.4 - Low Power

- Most LR-WPAN devices operates with small batteries
  - Turn off the radio periodically to save the energy



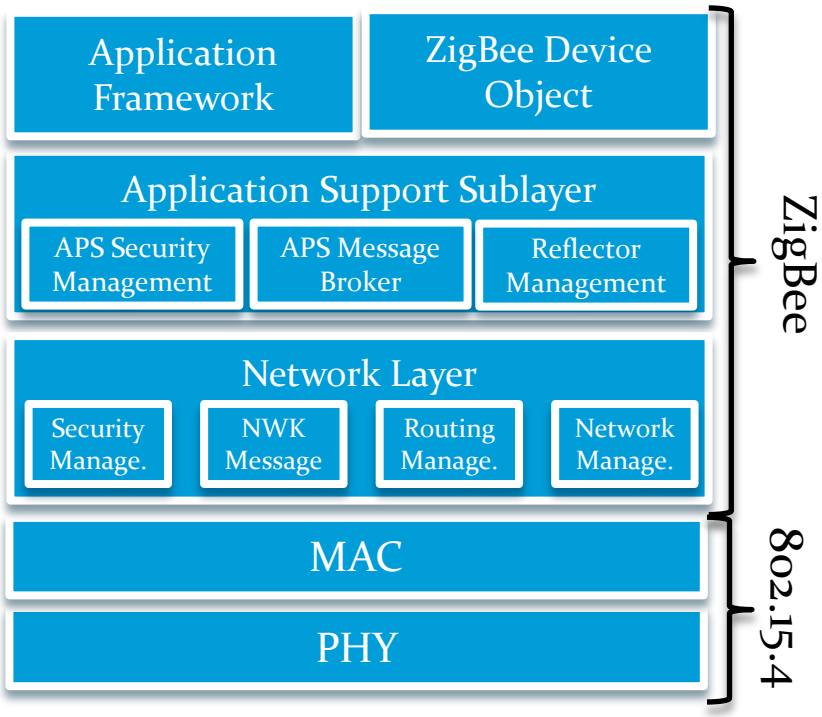
802.15.4 – Super-frame Structure

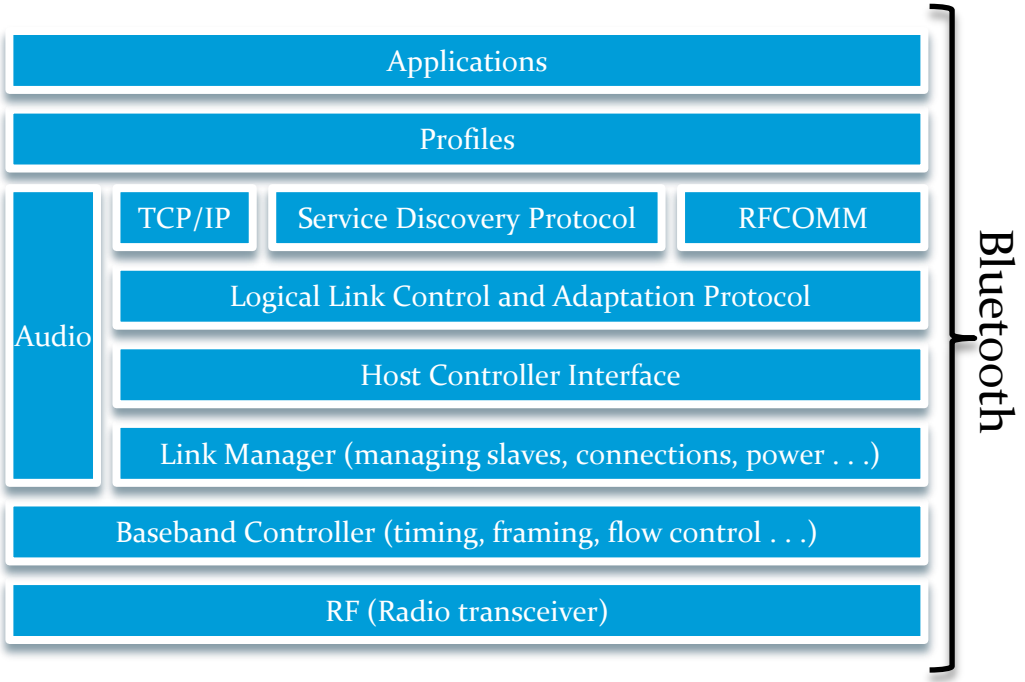
- Most LR-WPAN devices operates with small batteries



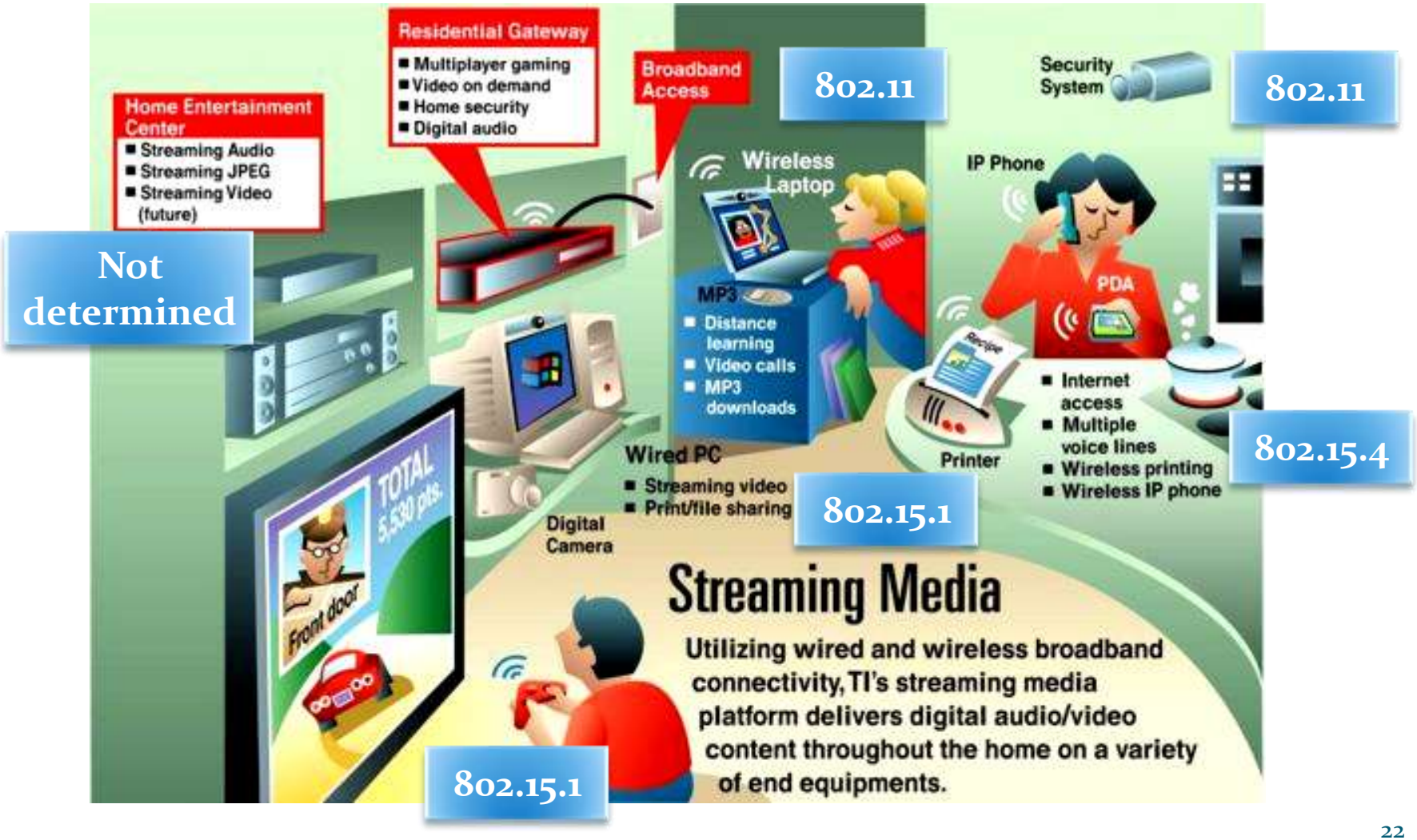
802.15.4 – ZigBee vs. Bluetooth

- ZigBee defines network, security, application layers



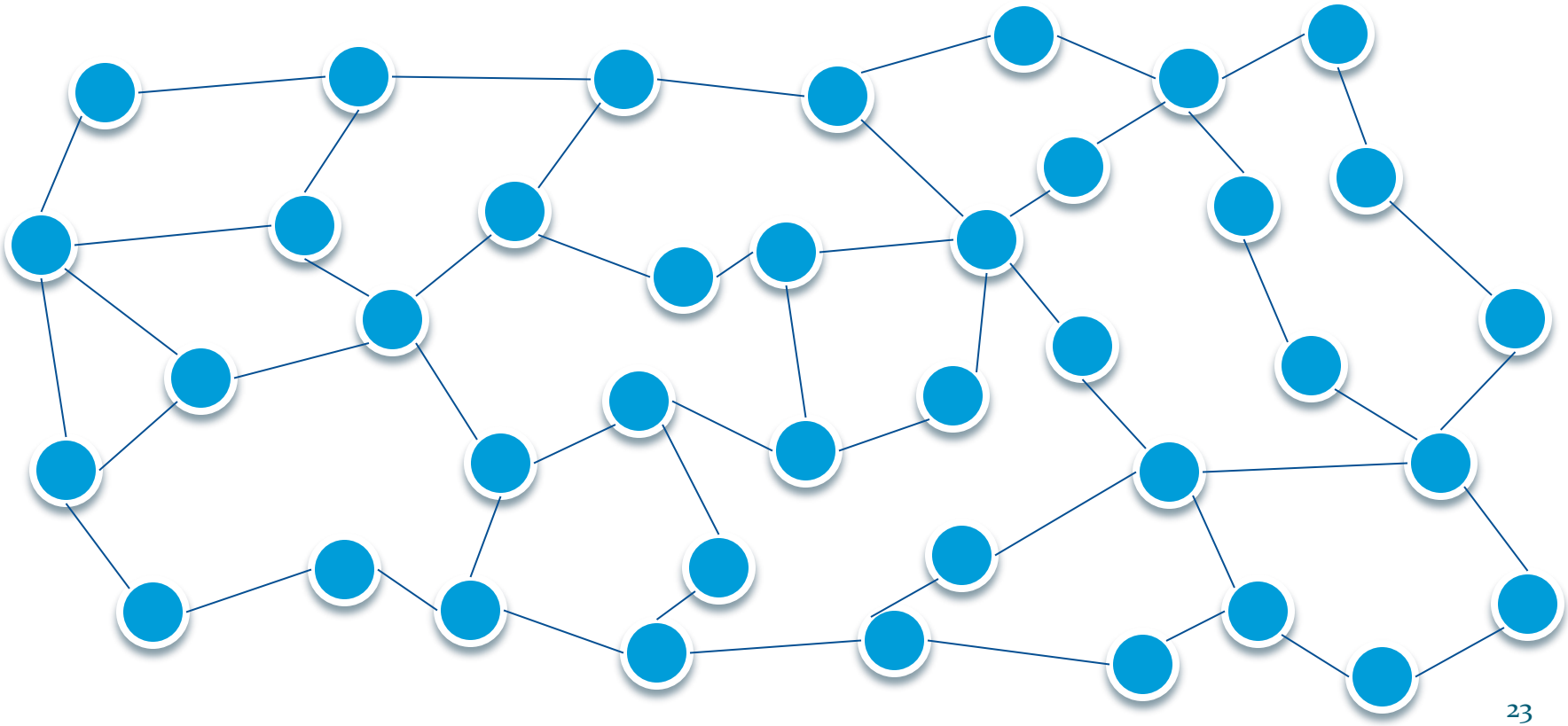


Home Network with IEEE Standards



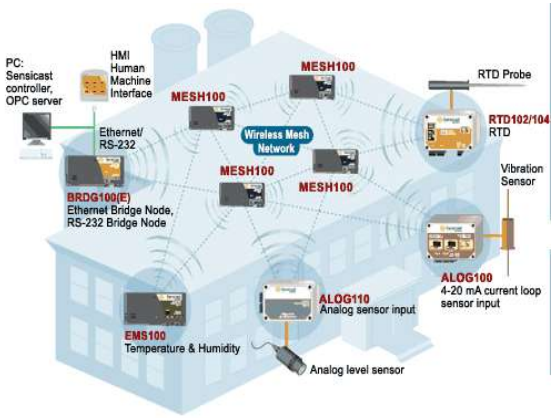
Wireless Sensor Network (WSN)

- Large Ad-hoc Network consists of numerous sensors (which have RF transmitter)



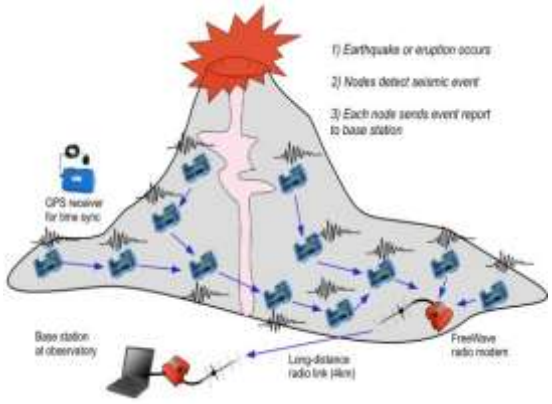
WSN applications

- But, very few commercial success. Why?
  - In addition, research interests on WSN decline.

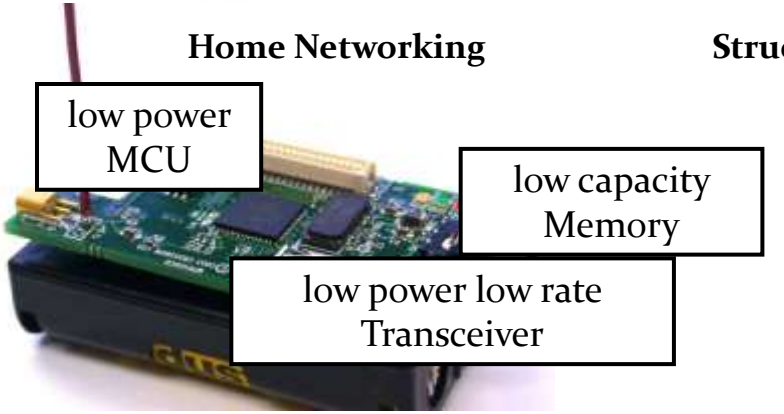


Home Networking

Structure Health Monitoring



Disaster Monitoring



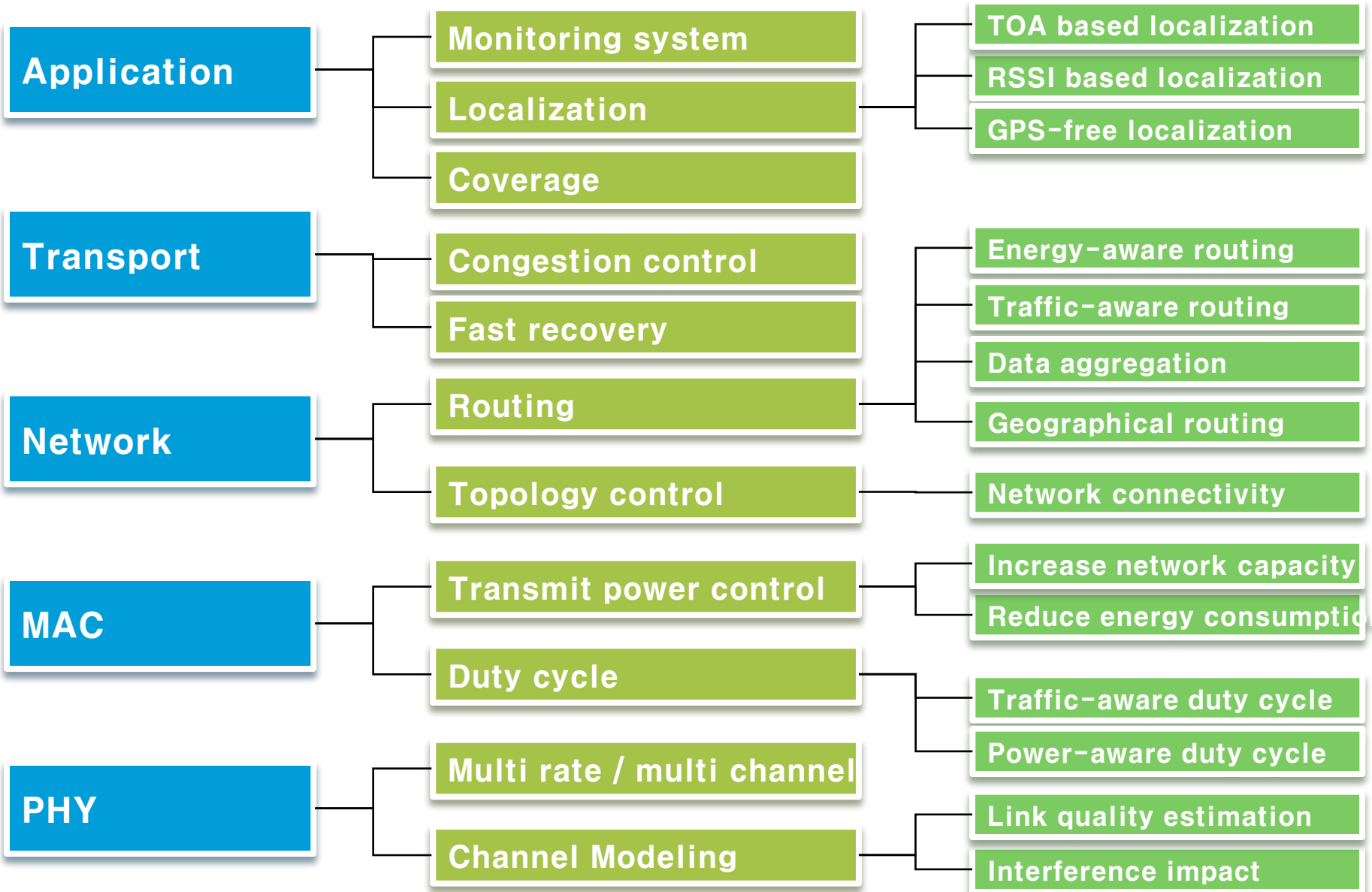
Maybe. It's Future direction

- A few leading research centers started these kinds of projects

Future WSN device?

Pedestrian navigation
Location-based services
Intelligent Transportation Systems
Smart shopping assistant
Entertainment integration
Environment Monitoring in City by iPhones

Research topics on WPAN and WSN



Q and A