

WLAN/WPAN/MANET

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Contents

- Evolution of Wireless Communication Systems
 - Ubiquitous Networking
 - MANET, WPAN/WLAN
 - Mobile Handheld Devices
 - New Services
- New Media Environment

21st Century Computing

☐ Ubiquitous Computing

■ Ubiquitous, Pervasive

- ☐ They weave themselves into the fabric of everyday life until they are indistinguishable from it
[Mark Weiser, 1988]

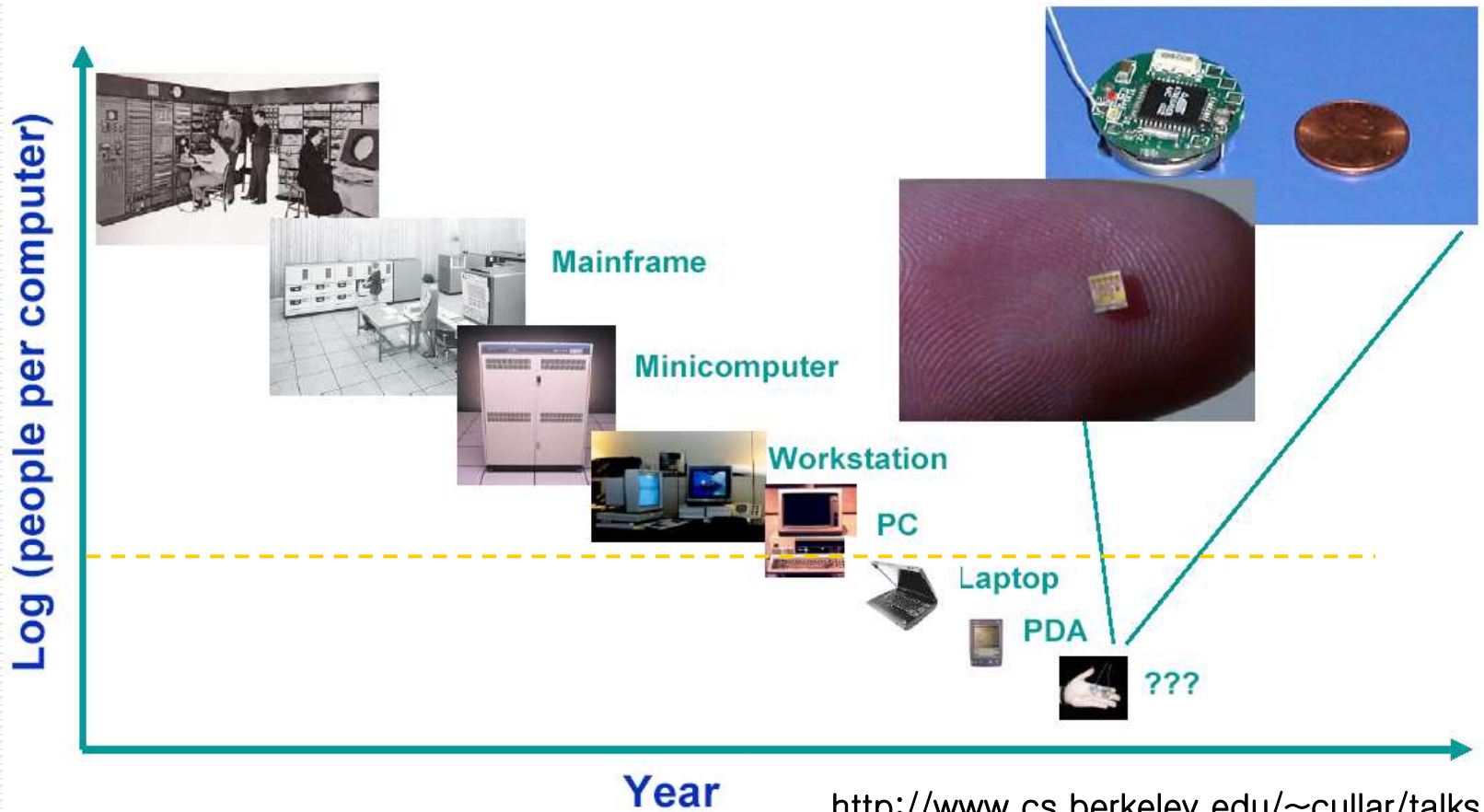


- ☐ Embedding computers everywhere and having them “disappear in the background”

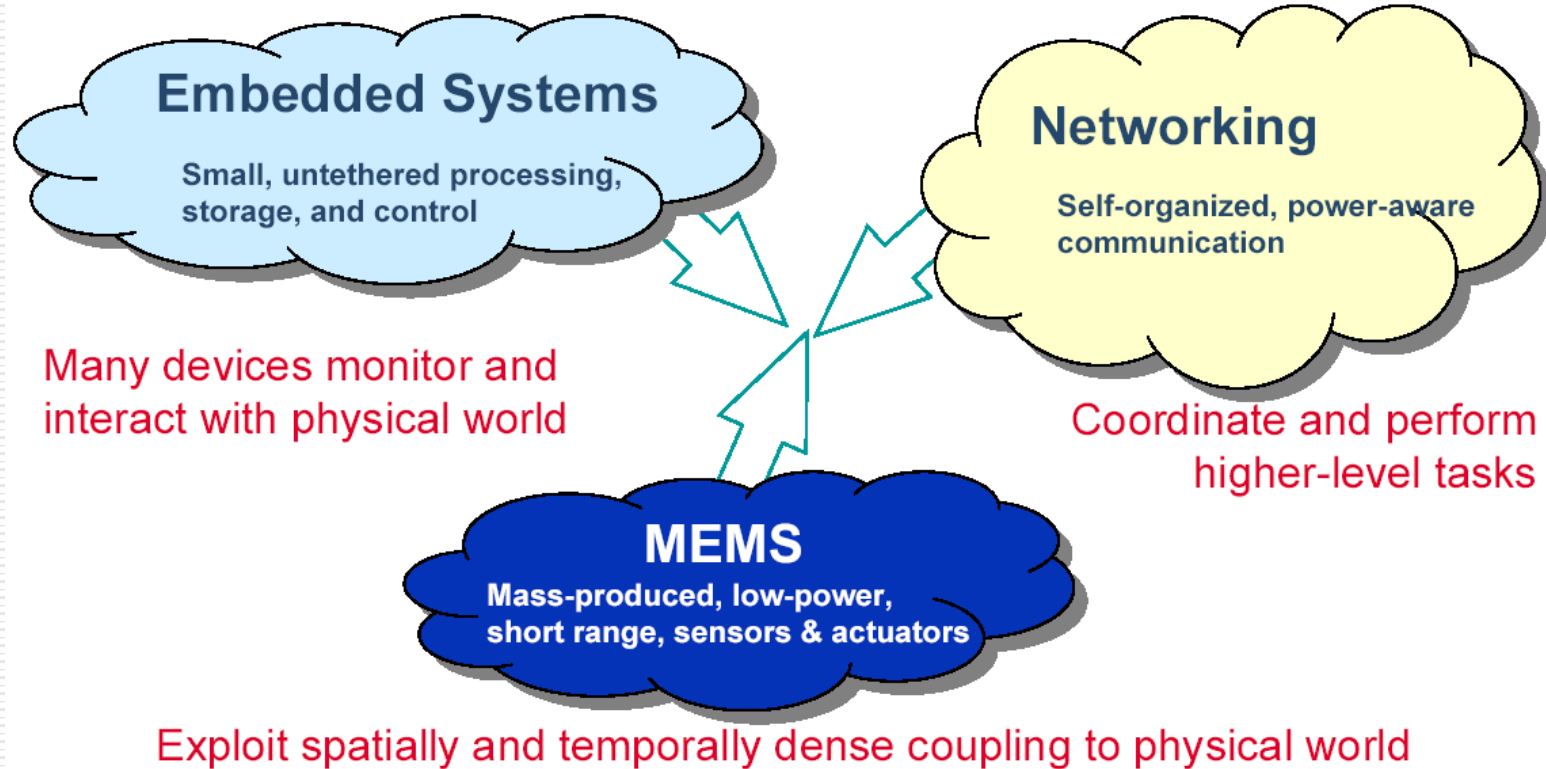
■ Ubiquitous Networking

- ☐ [Murakami Deruyas, 1999]
- ☐ Whenever, Wherever

Computing Evolution (size and number)

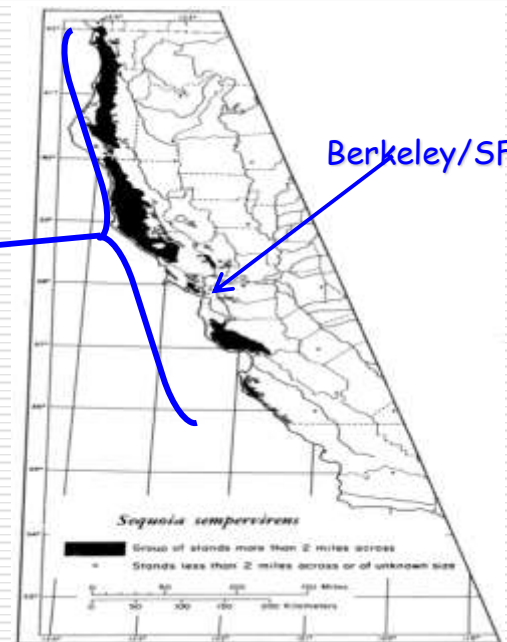


Confluence of Technologies

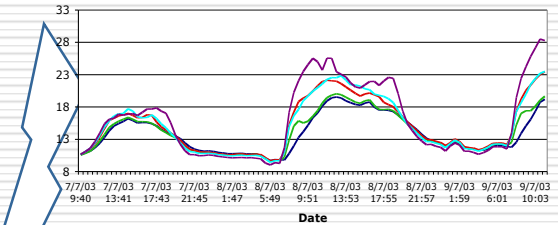
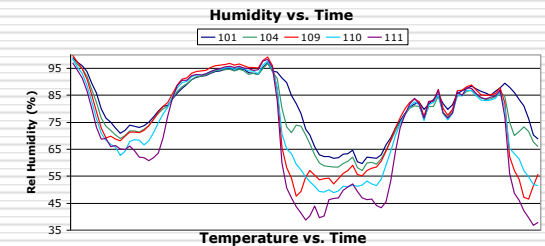
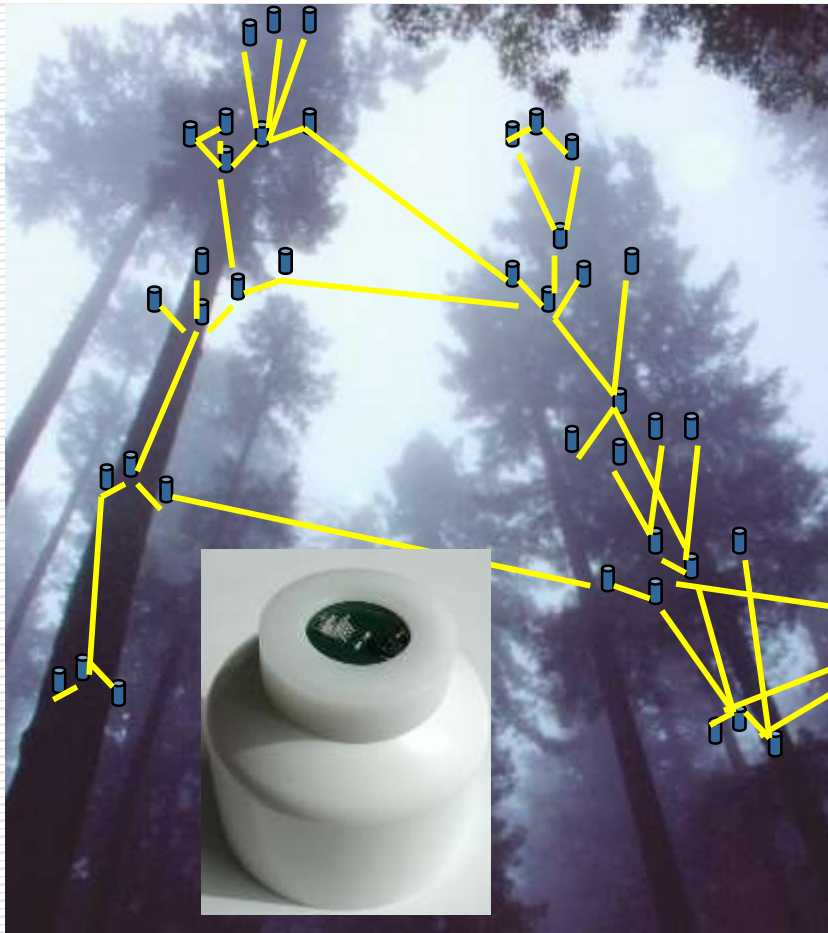


Example: Redwood

- 70% of H_2O cycle is through trees, not ground
- Can only observe top surface of the forest
- Need to understand what happens within the trees



Dense Self-Organized Multihop Net.



Example 802.15.4 Platforms

- Standards Based
 - IEEE 802.15.4, USB
- IEEE 802.15.4
 - CC2420 radio
 - 250kbps
 - 2.4GHz ISM band
- TinyOS support
 - New suite of radio stacks
 - Pushing hardware abstraction
 - Must conform to std link
- Ease of development and Test
 - Program over USB
 - Std connector header
- Interoperability
 - Telos / MicaZ / ChipCon dev



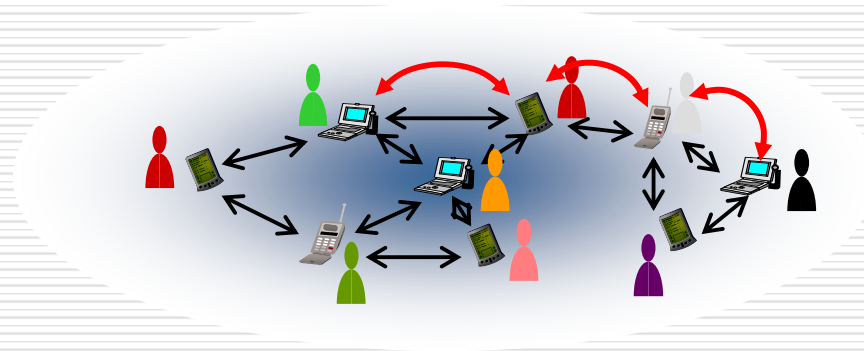
Xbow MicaZ



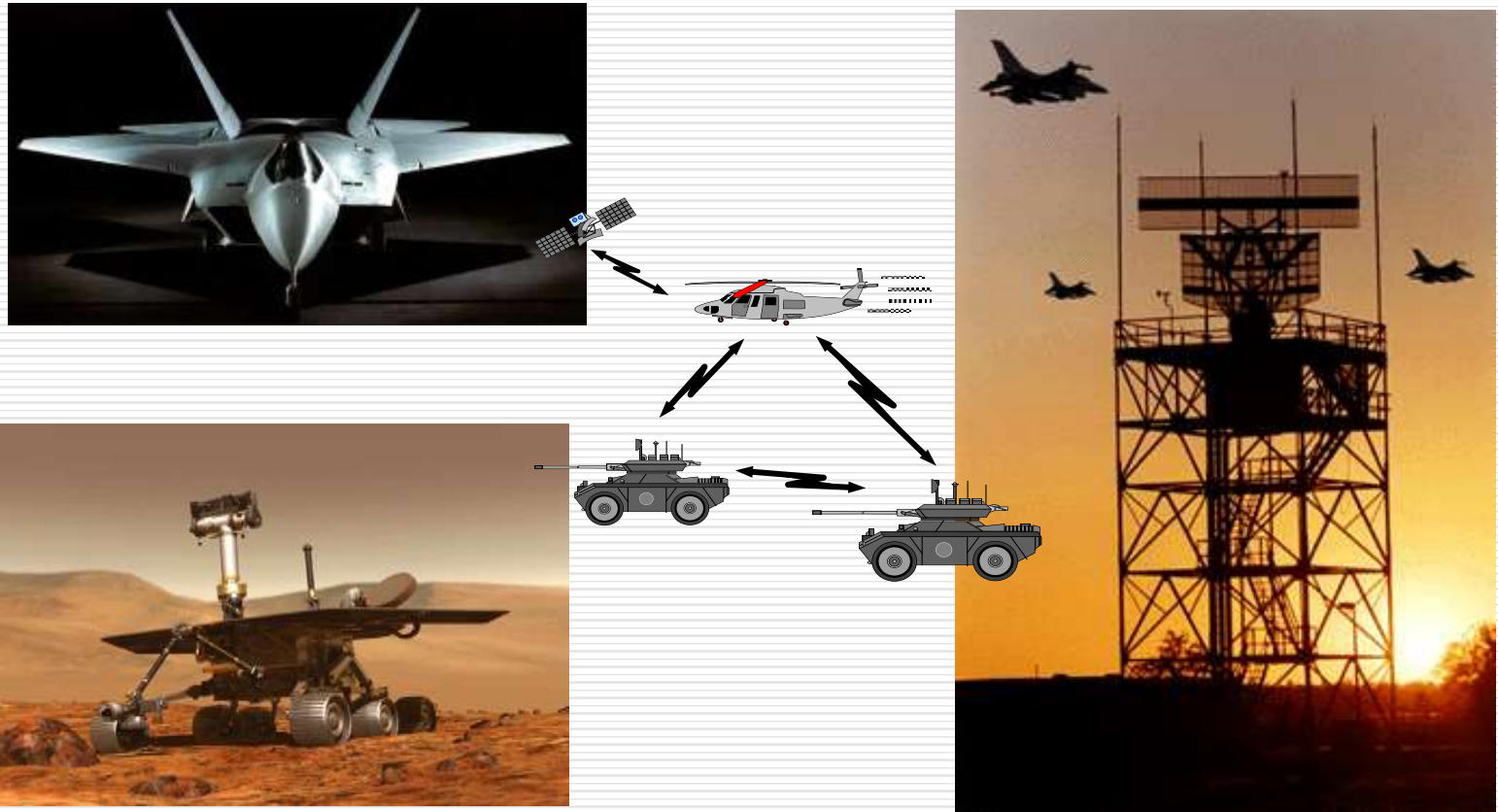
Mobile Ad-Hoc Networks

□ What is MANET ?

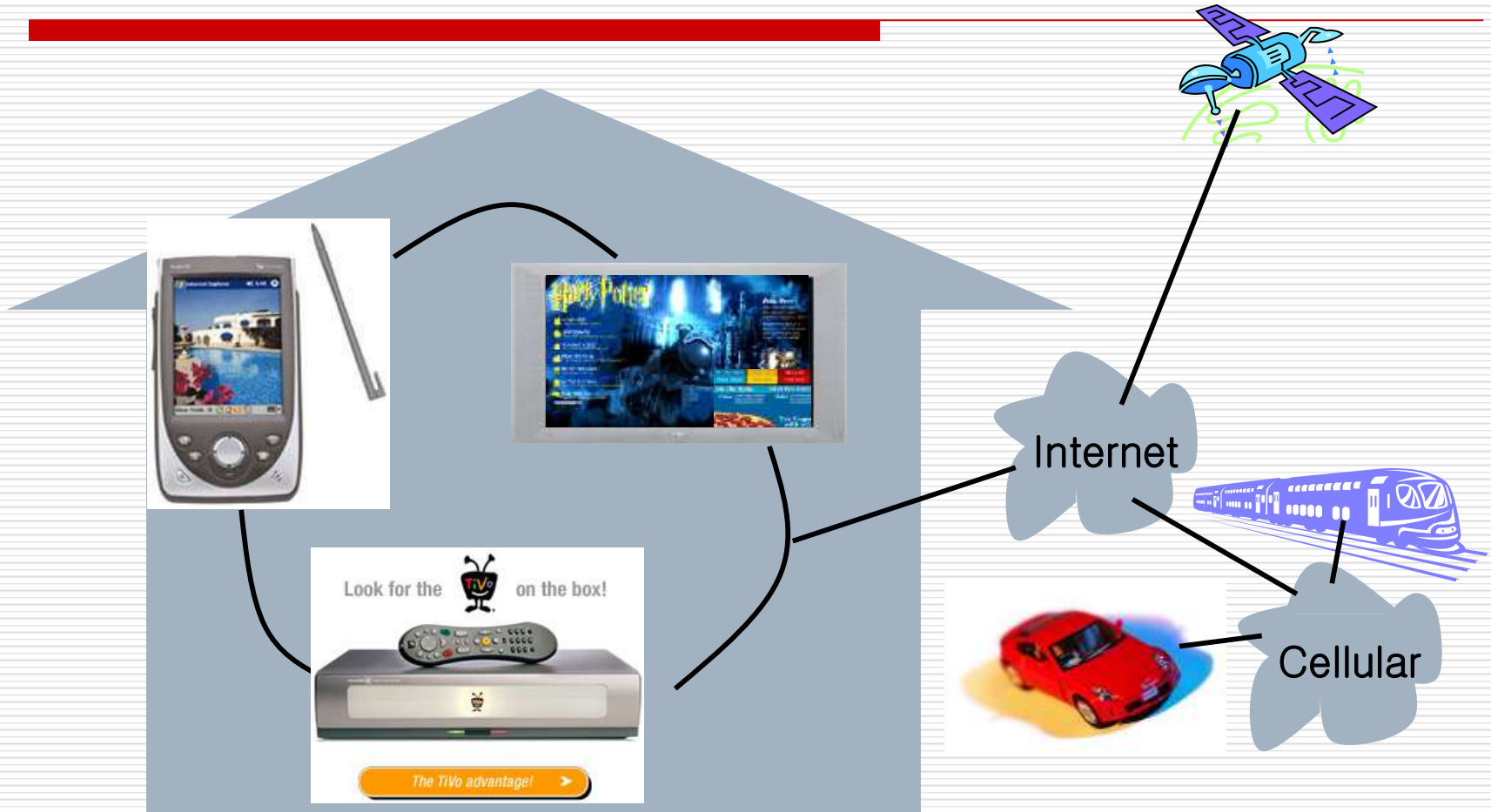
- Self-organized local or personal area networks consisting of a collection of mobile nodes
- MANETs *do not use any form of fixed infrastructure* or centralized administration
 - not available, impractical, expensive
 - Multi-hop delivery: Star → Mesh



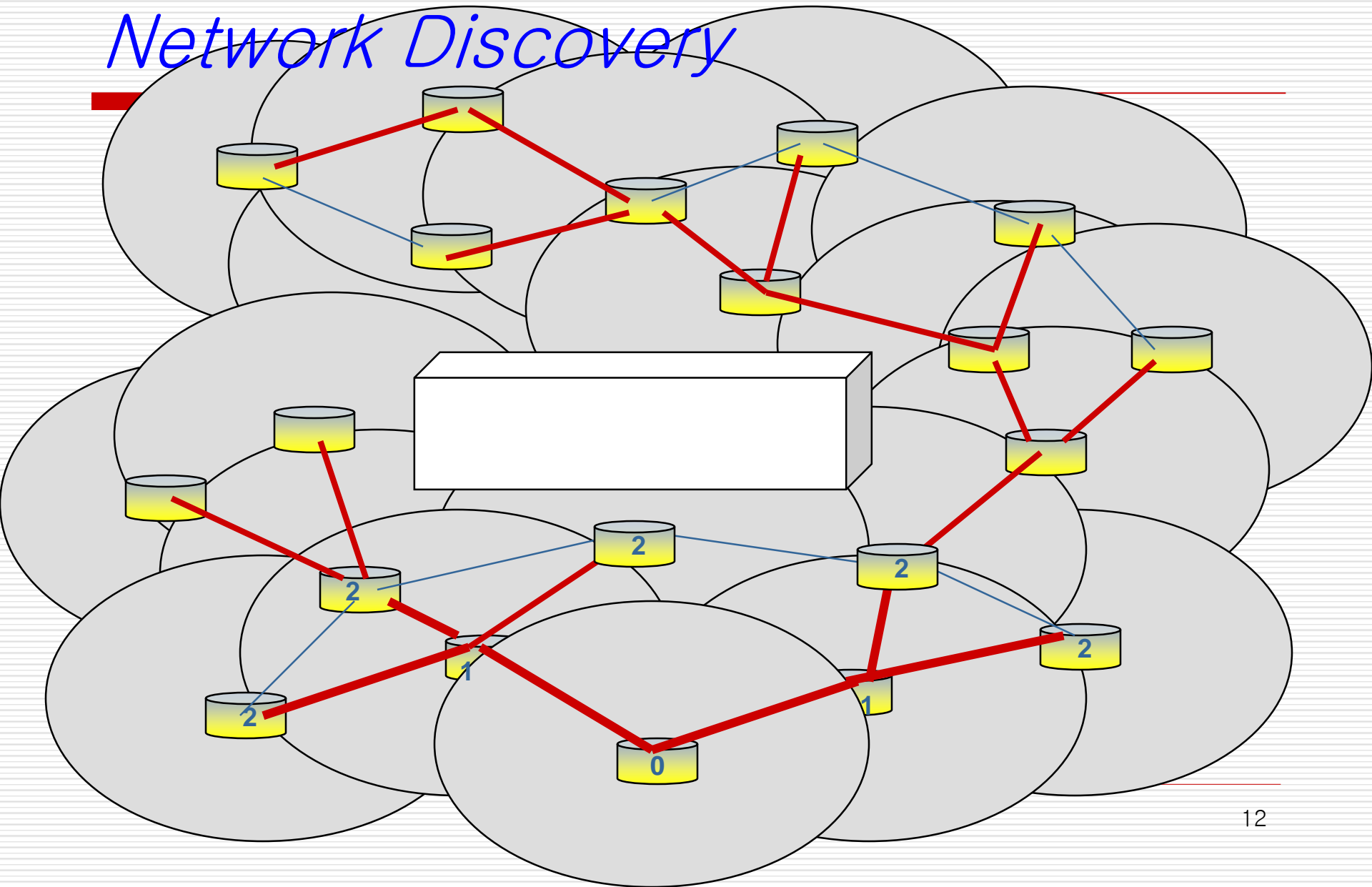
MANET – Military Environments



MANET – Civil Applications

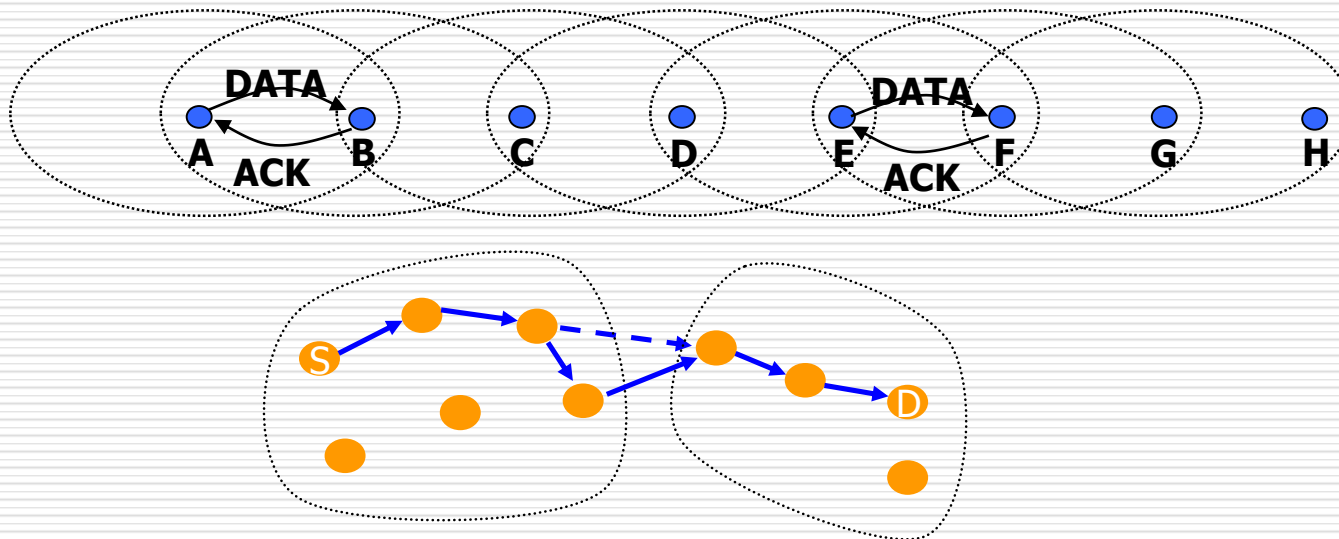


Network Discovery

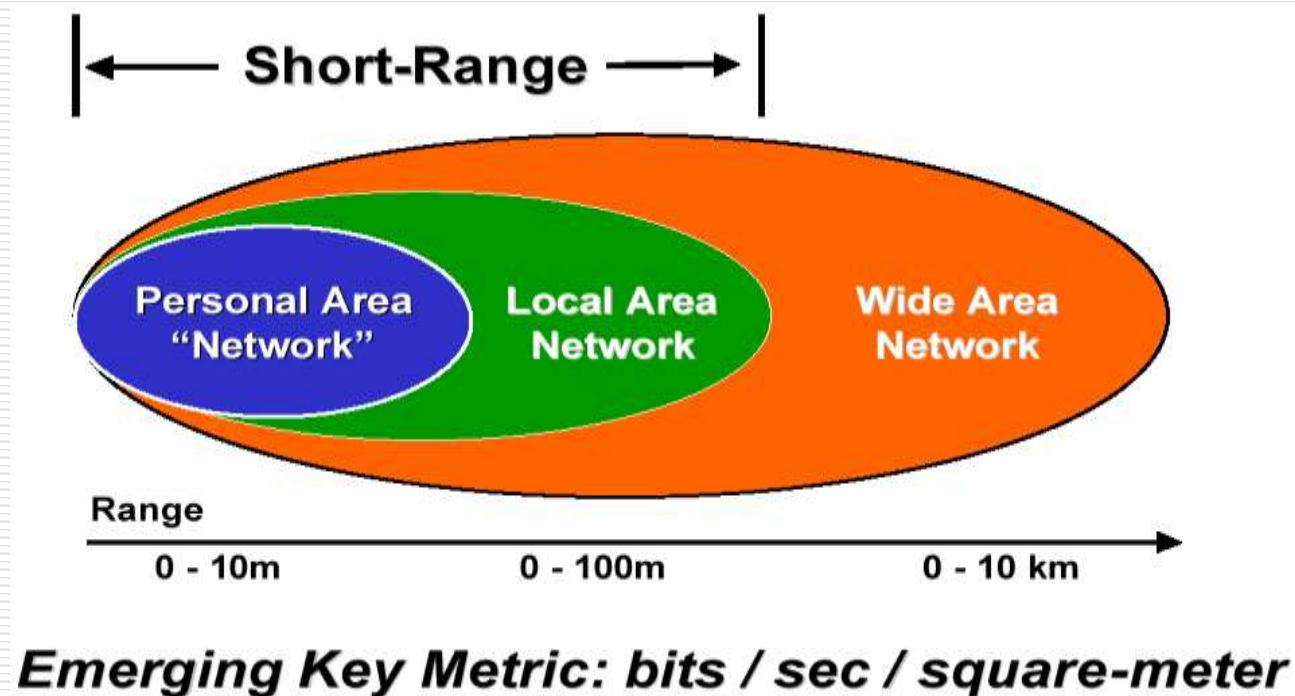


MANET Characteristics

- ❑ Limited bandwidth and radio ranges
- ❑ Limited energy: Energy consumption \propto distanceⁿ
- ❑ Dynamic topology changes
- ❑ Easy snooping



Networks by Range



Frequency Domain

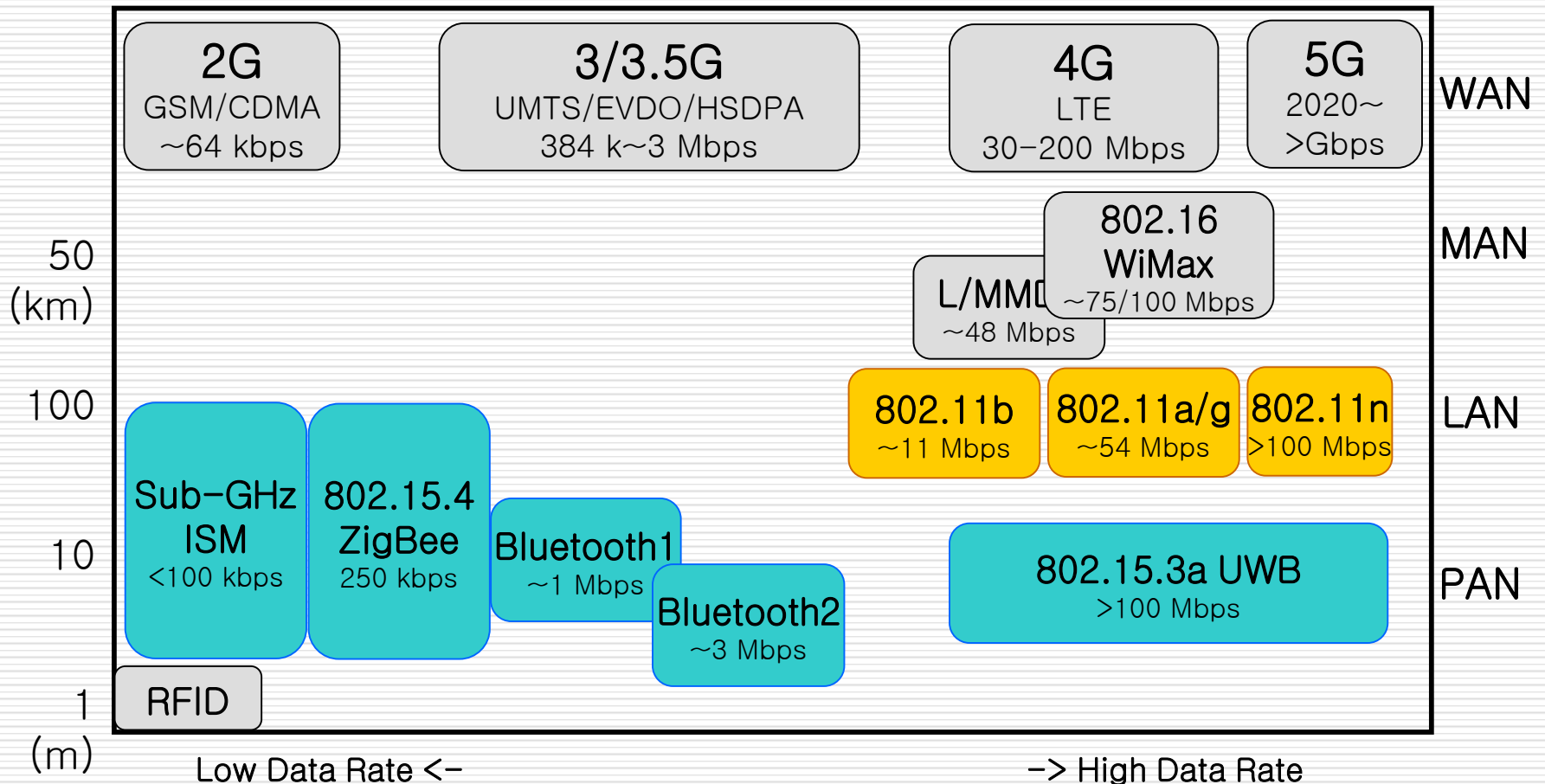
☐ Licensed Band

- Cellular: 800MHz
- PCS: 1.7~1.8GHz
- IMT2000: 1.92~1.98GHz up, 2.11~2.17GHz down

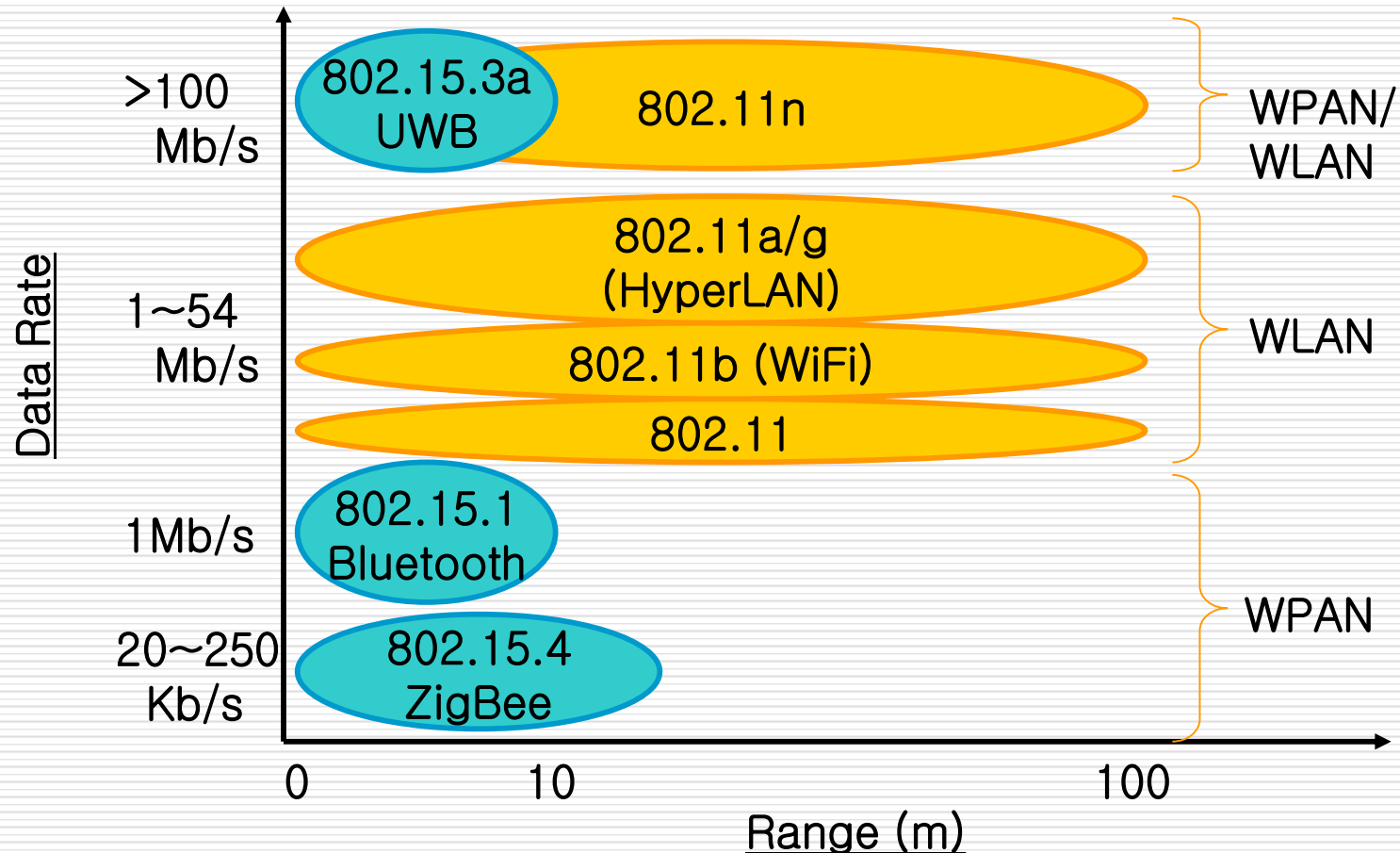
☐ ISM band (Unlicensed)

- Industrial, Science, and Medical
- No need FCC license, but controlled power
- 902~928MHz, 2.4~2.4835GHz, 5.725~5.85GHz
- 27MHz, 46/49MHz, 400MHz

Wireless Environment



Wireless Environment for MANET



Wireless LAN (802.11)

	802.11b	802.11a	802.11g	802.11n
Standard	1999. 9	1999. 9	2003. 6	2007.
Band	2.4~2.48GHz	5.15~5.35, 5.72~5.8GHz	2.4~2.48GHz	2.4GHz 5GHz
Rate	1~11Mbps	6~54Mbps	1~54Mbps	100~600Mbps
Distance	100m	50m	100m	100m
Org.	WiFi Alliance			EWC (Enhanced Wireless Con.)

Wireless PAN (802.15)

IEEE 802 Standards Working Group

Task Group 1
WPAN
Bluetooth

Task Group 2
Coexistence

Task Group 3
WPAN High Rate

Task Group 3a
WPAN Alt.
Higher
Rate/UWB

Task Group 4
WPAN Low Rate
ZigBee

Task Group 4a
UWB+ZigBee

IEEE 802.11
WLAN Working Group

IEEE 802.16
WMAN Working Group

IEEE 802.18
Radio Regulatory TAG

IEEE 802.19
Coexistence TAG

IEEE 802.20
Mobile BWA Working Group

IEEE 1451.5
Working Group
for Wireless Sensors

What is Bluetooth?

□ Harald “Bluetooth” II – Viking

- King of Denmark 940–981
- Who liked blueberry, but didn’t have a toothbrush
- Unification of Scandinavia

□ Bluetooth SIG

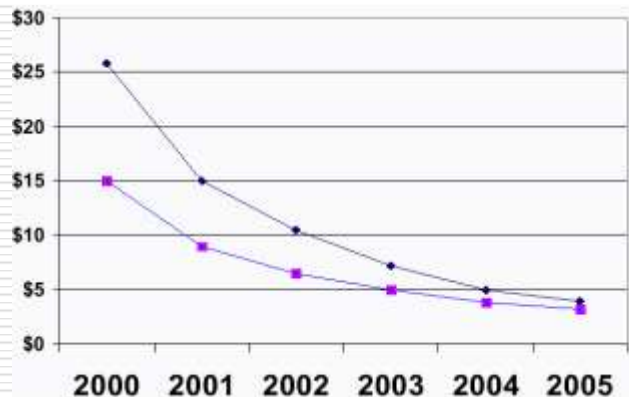
- Ericsson + IBM, Intel, Nokia, Toshiba, MS, Motorola
- 1998.2



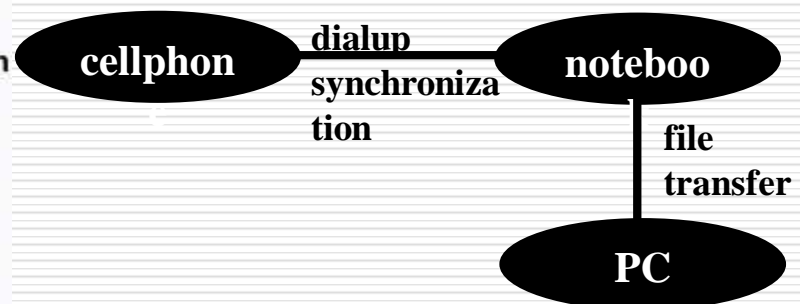
www.bluetooth.com

Bluetooth in 2000

- “Cost of Bluetooth will drop below \$10. Most cell phones and notebooks will have Bluetooth in 2002.”



Source: TDK, Nick Hunn, 1999.12.9



□ CeBIT2001

- Failure demo for compatibility
- Lost MS support for Windows XP

Bluetooth in 2005

□ Applications

- Mouse, keyboard, Headset, PDA, MP3, Game
- 5M products per week



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Bluetooth

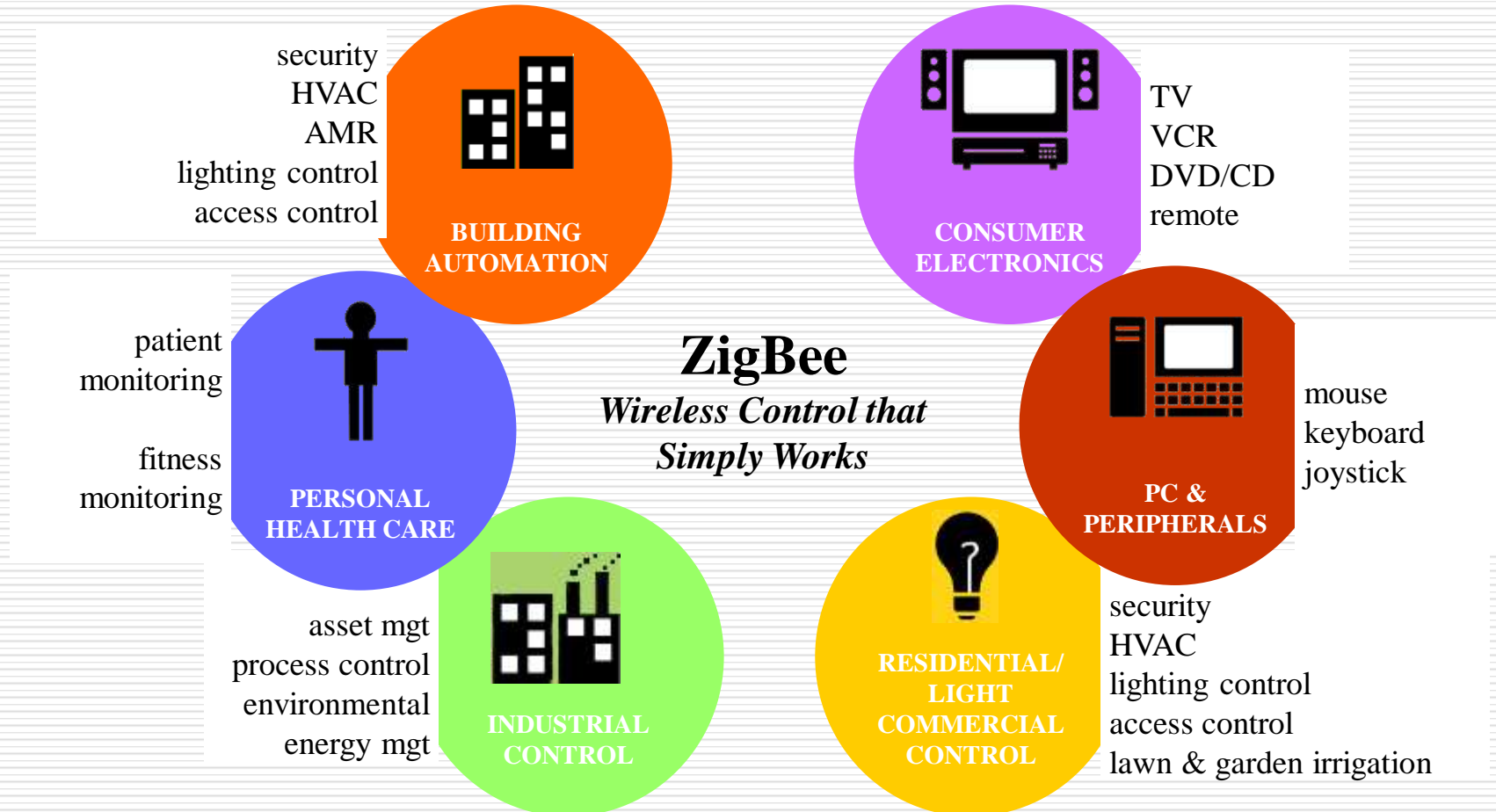
□ Technical Summary

- Short Range: ~10m
- Low cost: \$5/chip
- Low power: 1mW (optional 100mW)
- Band: 2.4~2.4835GHz
- Rate: 1Mbps
- Piconet: 8 devices
- Applications: Cellphone, PC, Notebook, Peripheral devices, Home automation

ZigBee

- Etymology
 - ZigZag + Bee
- Concept
 - Wireless network standard for home and office
 - **Low power, Low cost, Low rate**
 - 2.4GHz ISM band
 - 20~250 Kbps
 - 255 devices per network
 - Distance about 30m
 - Standardization: ZigBee Alliance

ZigBee Applications



Bluetooth and ZigBee

	Bluetooth (802.15.1)	ZigBee (802.15.4)
PROTOCOL STACK	250kb	28kb
BATTERY	rechargeable	non-rechargeable
DEVICE/NETWORK	8	255~65535
LINK RATE	1->3 Mbps	20~250 kbps
RANGE	10 meters	30->70 meters

UWB (IEEE 802.15.3a)

□ Majority of Application Requirements

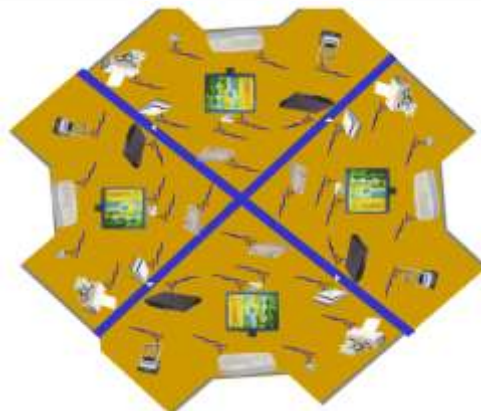
- High bit rate >100 Mb/s
- Range < 10 meters (WPAN)
- Low cost Comparable to Bluetooth
- Co-location > 4 piconets
- Power Low consumption (100mW)
- Band 3.1~10.6 GHz
- Coexistence With 802.11a/b/g & 802.15
- Standardization MBOA, DS-UWB

UWB Applications

- ❑ Originally: Radar, Sensing (military)
- ❑ Cable replacement (e.g. USB, 1394)
- ❑ Real-time wireless video transmission (Home theater)
- ❑ Wireless projector, Wearable computing
- ❑ Localization, Alarm



Home Networking

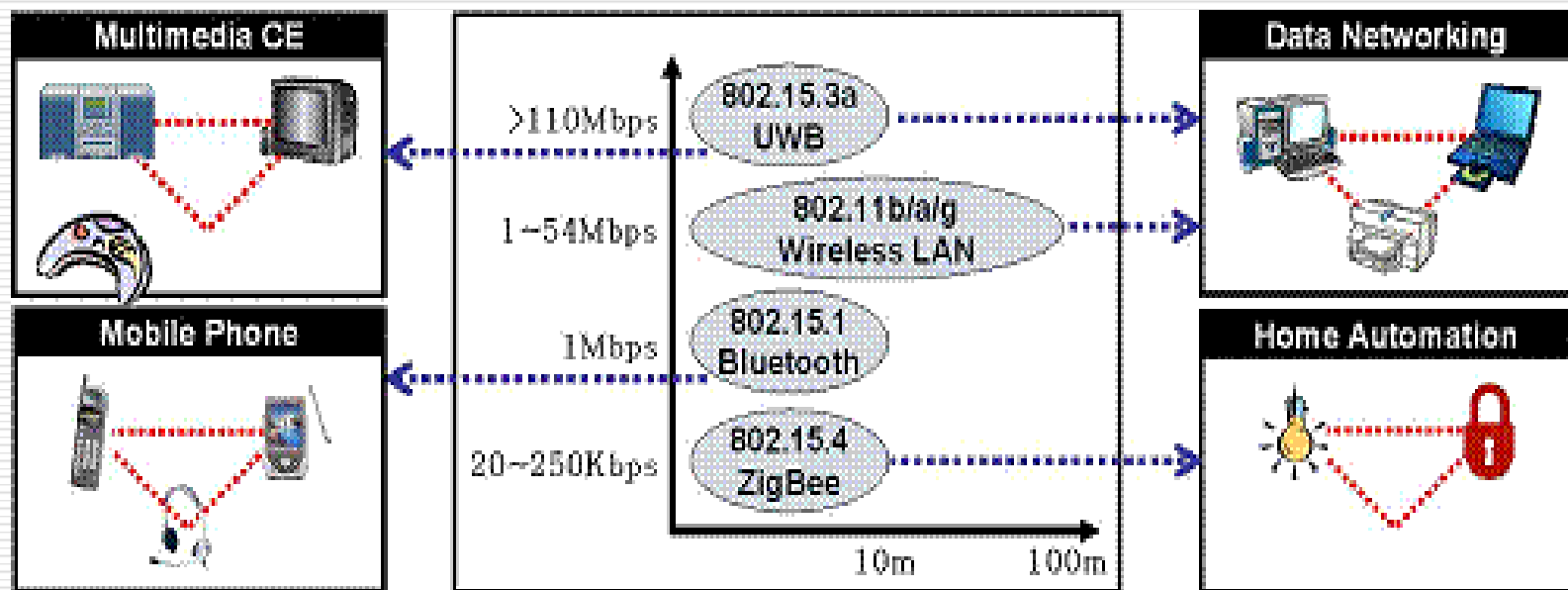


Wireless Desktop



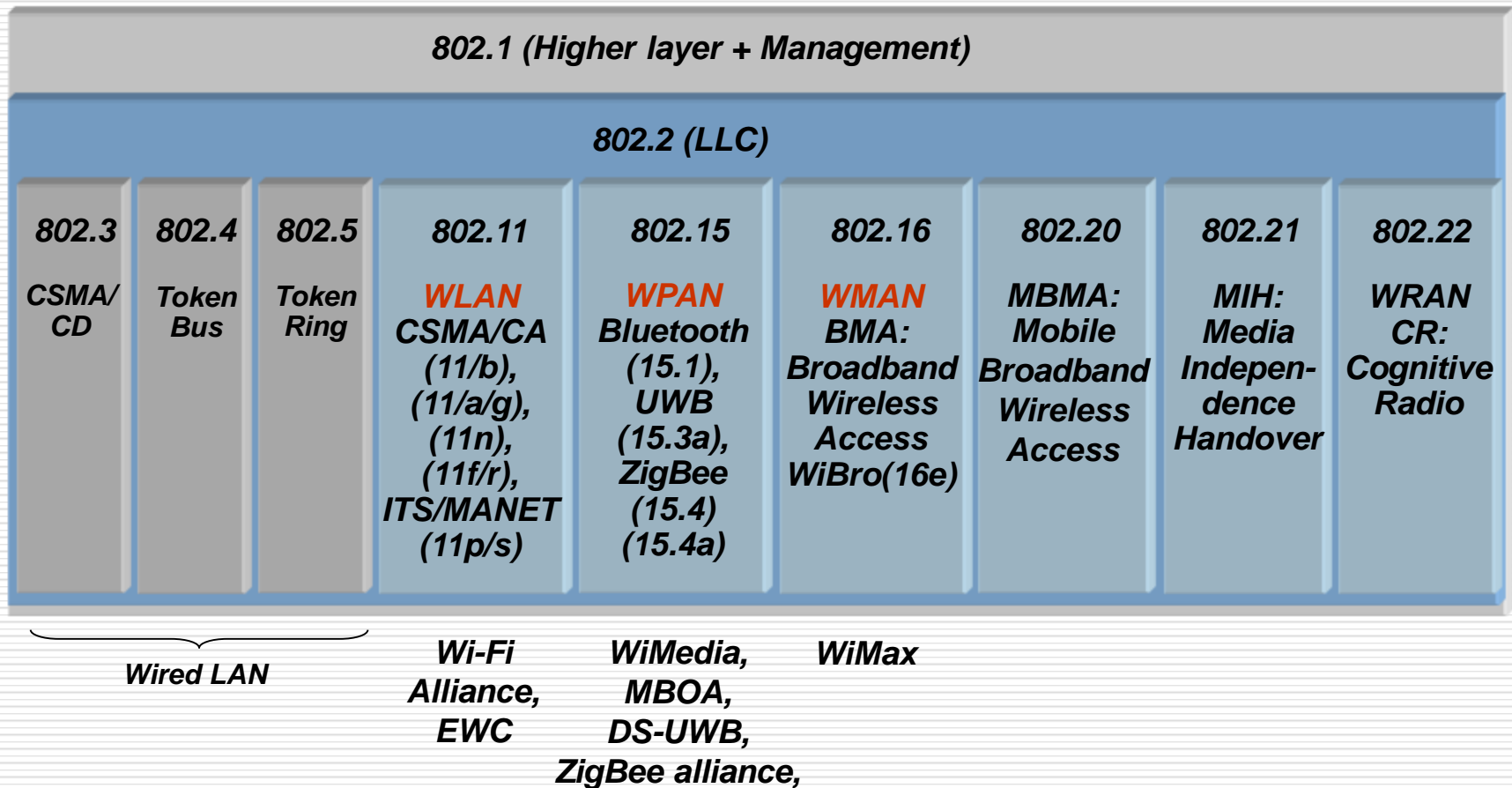
Wearable Computing

Wireless Home Network



<자료> ITA 정보조사분석팀, 2004.

IEEE 802 Summary



Issues and Challenges

☐ MAC

- Limited bandwidth, radio range
- Broadcast nature

☐ Routing

- Frequent topology change or partitioning due to node mobility and node failure

☐ Low power

- Limited battery
- Energy consumption \propto distanceⁿ

☐ Security

☐ QoS

MAC

☐ Based on CSMA/CA

- 802.11 DCF, PCF

☐ MACA solutions using RTS, CTS

- Hidden terminal/Exposed terminal problem

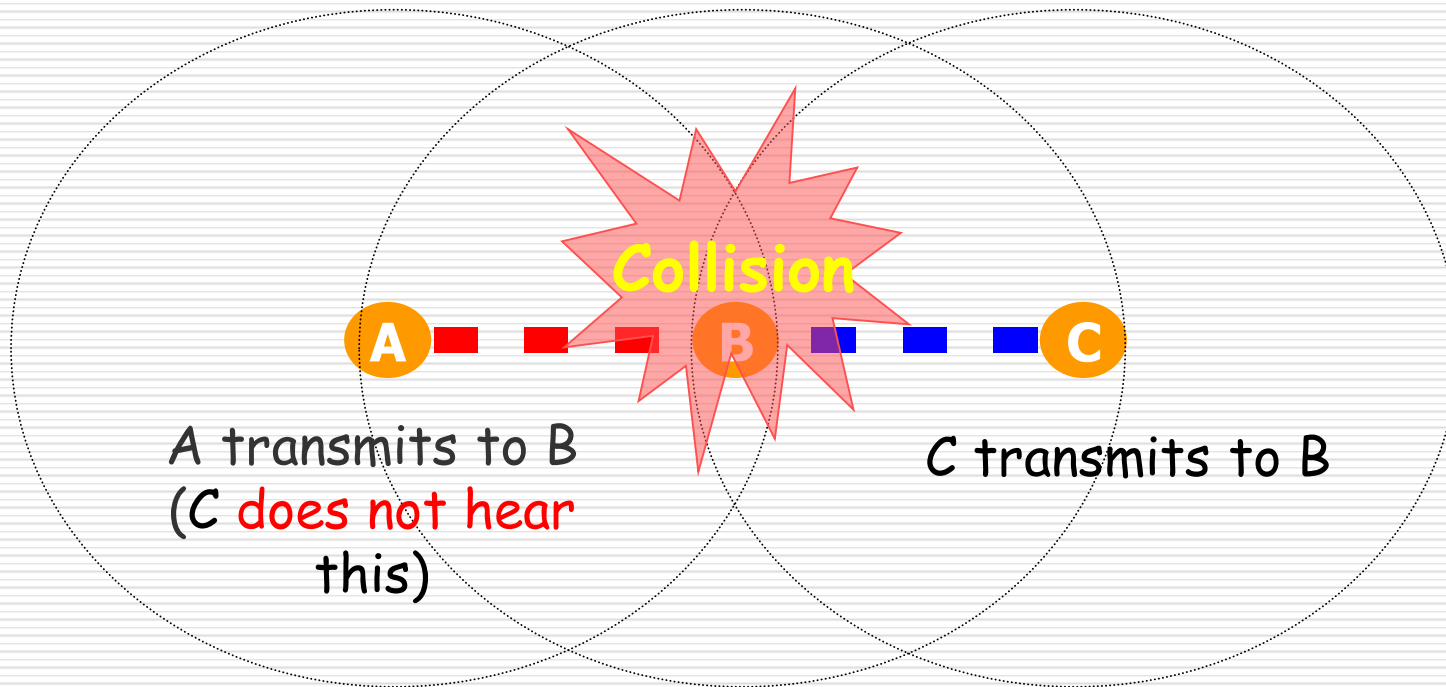
☐ Power saving protocol

- Transmission Power Adjustments
- Sleep mode operation
- Reducing control message overhead

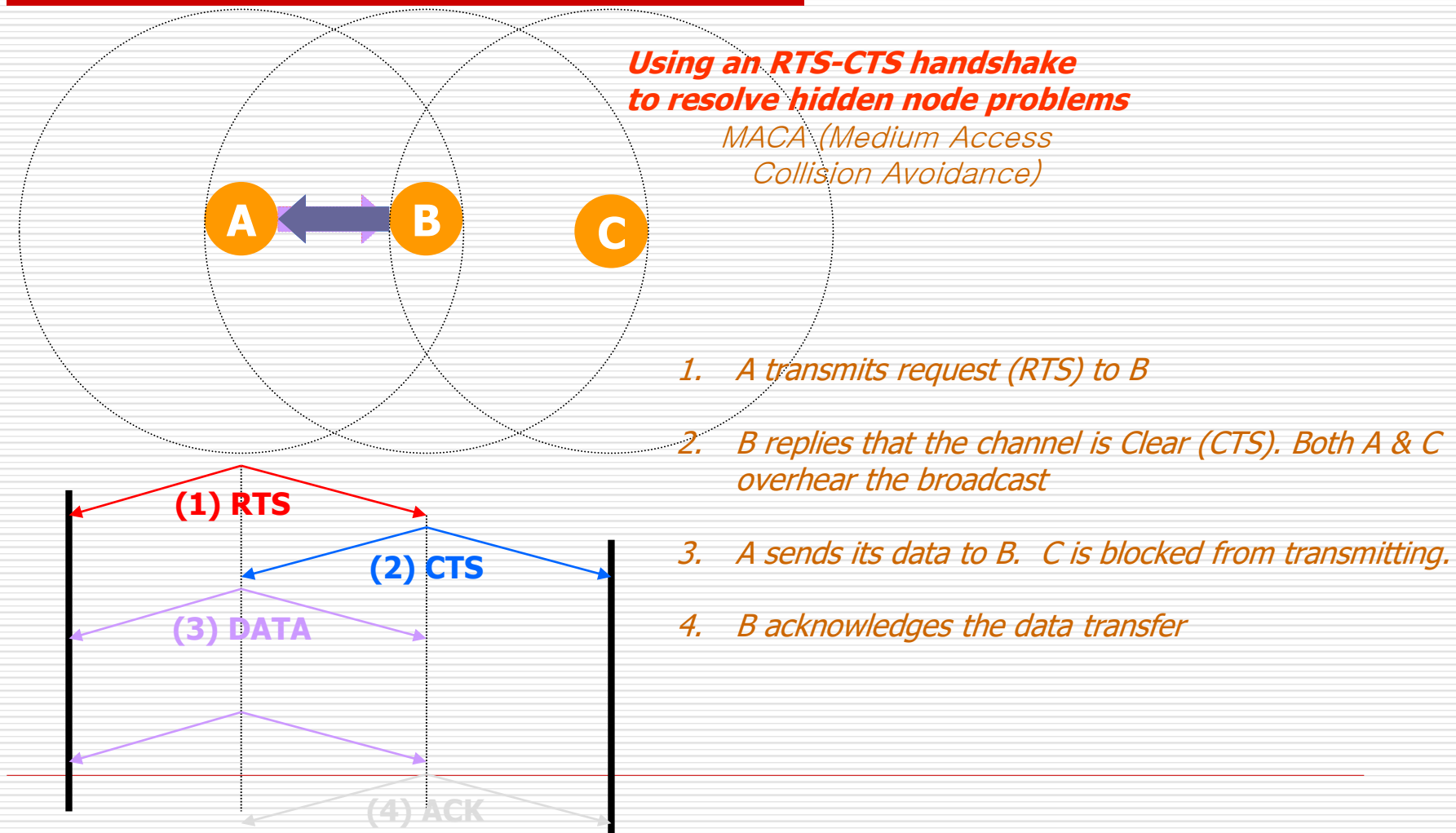
☐ Capacity increase

- Directional Antenna
-

Hidden Node Problems



Hidden Node Problems



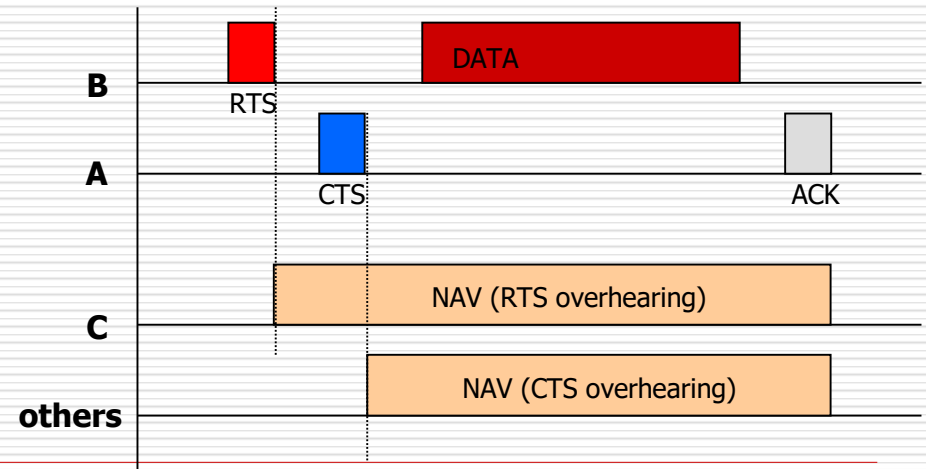
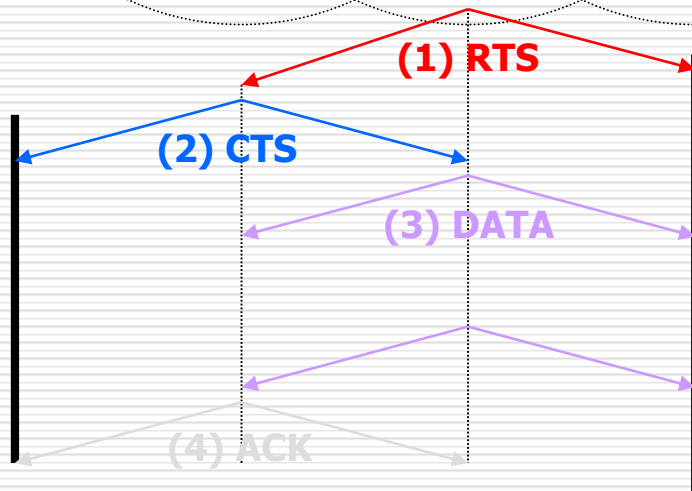
Exposed Node Problems



1. B is transmitting to A

2. C overhears this, and is blocked

3. C wants to transmit to D, but is being blocked by B

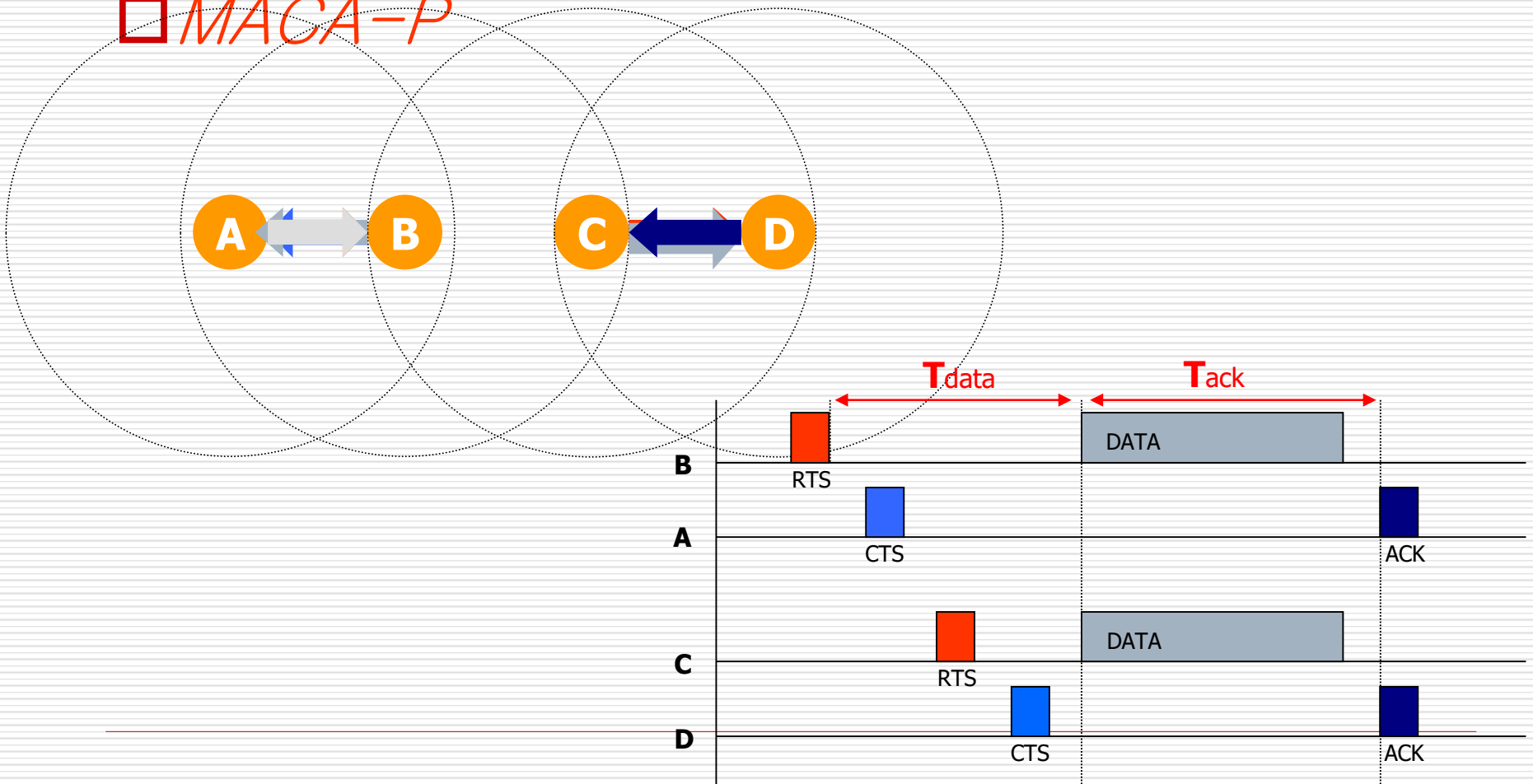


CTS_overhear

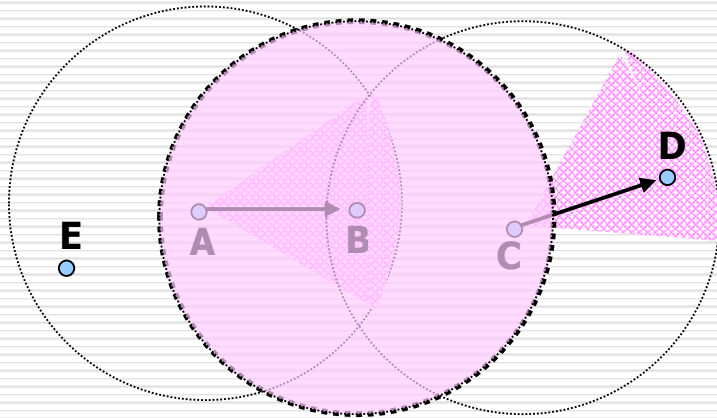
RTS_overhear

Exposed Node Problems

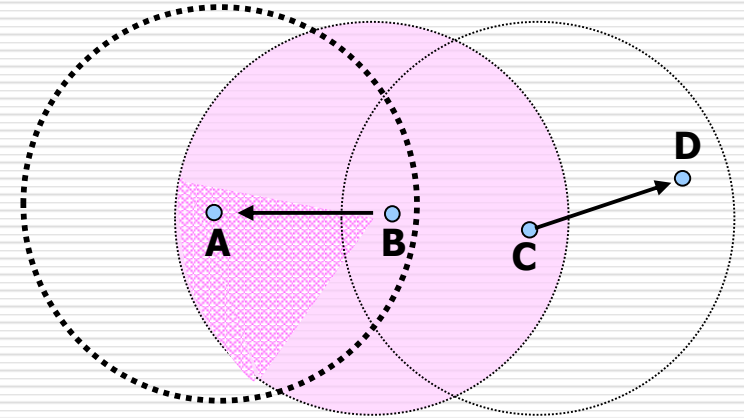
□ MACA-P



Directional Antenna



***Expand channel capacity and
Prevent hidden node problem***



A void exposed node problem

Routing Protocol

□ Proactive Protocols (Table-driven)

- *Lower latency and higher overhead*
- Distance vector/link state protocols send periodic or frequent routing advertisement
- Optimized Link State Protocol (OLSR) [RFC 3626]
- Topology Broadcast Based on Reverse-Path Forwarding (TBRPF) [RFC 3684]

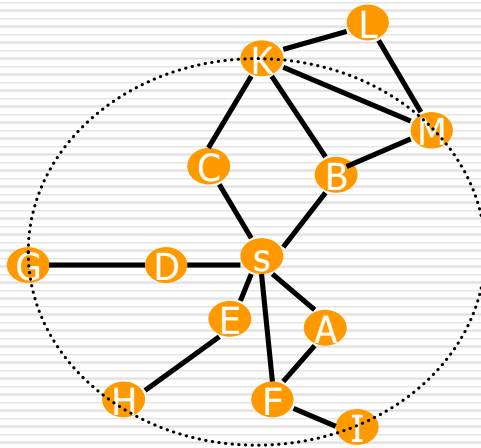
□ Reactive protocols (On-demand)

- *Higher latency and lower overhead*
 - Eliminate periodic updates – saves power and bandwidth
 - Ad-hoc On Demand Distance Vector (AODV)[RFC 3561]
 - Dynamic Source Routing (DSR)
-

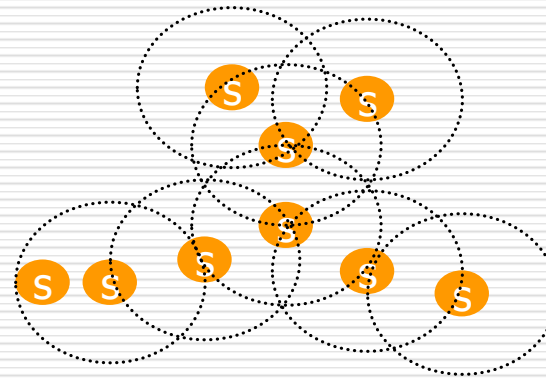
Routing

□ Hybrid protocols

- Application oriented routing
- Zone Routing Protocols (ZRP)
 - *Intra Zone : Proactive*
 - *Inter Zone : Reactive*



Intra Zone



Inter Zone

Routing

☐ Location based routing

- Using GPS location info. and timer sync.
- LAR, DREAM, Geocast

☐ Energy-aware routing

- Not just shortest path
- Traffic balancing in MANET

☐ Hierarchical routing

- Cluster-based routing
 - Cluster head, VBS
-

Routing

☐ Rerouting in MANET

- No fixed infrastructure
 - Limited spare bandwidth and resources
 - Heterogeneous environments
 - Frequent topology changes
 - Lack of existing works and statistic data
-

Etc.

- ☐ Low power
 - ☐ Security
 - ☐ QoS
 - ☐ Application
 - *What is the killer application in the next decade?*
-