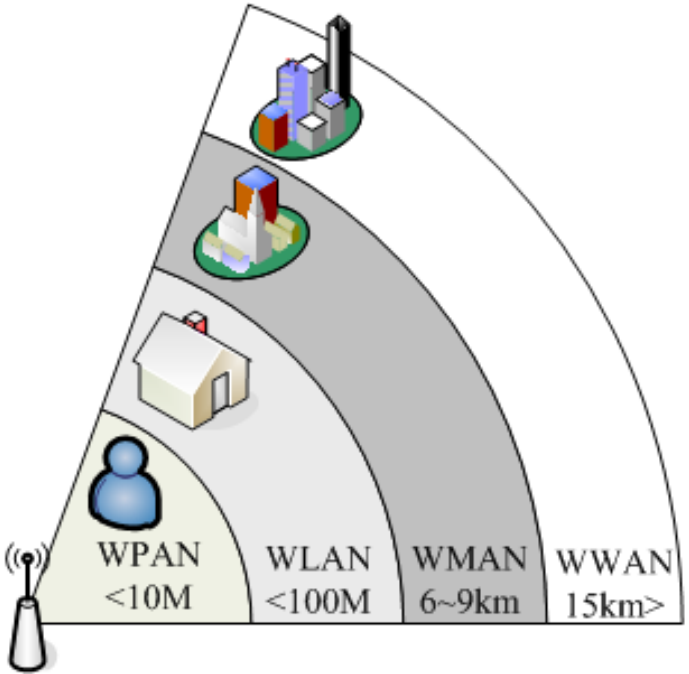
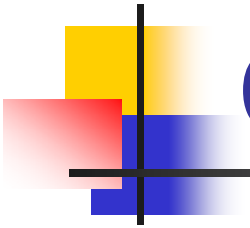
# Chapter 7. Introduction to Bluetooth

# Overview

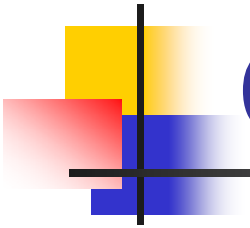
- WMAN 無線都會網路: 802.16
- WLAN 無線區域網路: 802.11
- WPAN 無線個人網路: 802.15





# Goals

- a universal short-range wireless capability on 2.4 GHz band ISM band (which is globally available for unlicensed low-power uses)
- In 10 meters, two bluetooth devices can share up to 720Kbps rate.
- Support data, audio, graphics, and even videos.



# Capability

- make calls from a wireless headset
- eliminate cables linking computers, printers, keyboards, and mouses
- hook MP3 players wirelessly
- remotely control AC, oven, home devices
- See table 15.1

**Table 15.1** Bluetooth User Scenarios [HAAR98]

**Three-in-one phone**
When you are in the office, your phone functions as an intercom (no telephony charge). At home, it functions as a cordless phone (fixed-line charge). When you are on the move, it functions as a mobile phone (cellular charge).

**Internet bridge**
Use your portable PC to surf the Internet anywhere, whether you are connected wirelessly through a mobile phone (cellular) or through a wired connection (PSTN, ISDN, LAN, xDSL).

**Interactive conference**
In meetings and at conferences, you can share information instantly with other participants. You can also operate a projector remotely without wire connectors.

**The ultimate headset**
Connect a headset to your mobile PC or to any wired connection and free your hands for more important tasks at the office or in your car.

**Portable PC speakerphone**
Connect cordless headsets to your portable PC, and use it as a speaker phone regardless of whether you are in the office, your car, or at home.

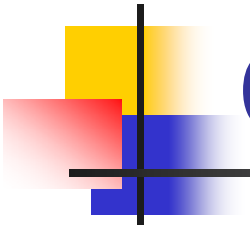
**Briefcase e-mail**
Access e-mail while your portable PC is still in the briefcase. When your PC receives an e-mail message, you are notified by your mobile phone. You can also use the phone to browse incoming e-mail and read messages.

**Delayed messages**
Compose e-mail on your PC while you are on an airplane. When you land and are allowed to switch on your mobile phone, the messages are sent immediately.

**Automatic synchronization**
Automatically synchronize your desktop computer, portable PC, notebook, and mobile phone. As soon as you enter the office, the address list and calendar in your notebook automatically updates the files on your desktop computer or vice versa.

**Instant digital postcard**
Connect a camera cordlessly to your mobile phone or to any wire-bound connection. Add comments from you mobile phone, a notebook, or portable PC and send them instantly.

**Cordless desktop**
Connect your desktop/laptop computer cordlessly to printers, scanner, keyboard, mouse, and the LAN.

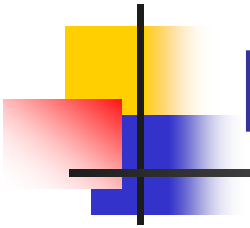


# General Application Category

- data and voice access points:
  - effortless wireless connection
- cable replacement:
  - normally 10 m (1mW), but can be extended up to 100 meters (100mW)
- ad hoc networking:
  - building a network instantly when two bluetooth devices meet

# Networking Capability Brief

- up to 8 devices can communicate in a small network called a “piconet” (微網)
- 10 piconets can coexist in the same coverage range



# Piconet

- piconet: the basic networking unit
  - one master + 1~7 active slaves
- Master:
  - determining channel and timing
    - channel: frequency-hopping sequence
    - timing: offset and when to transmit
  - the decision is based on its 48 bits bluetooth device address as a parameter

# Piconet

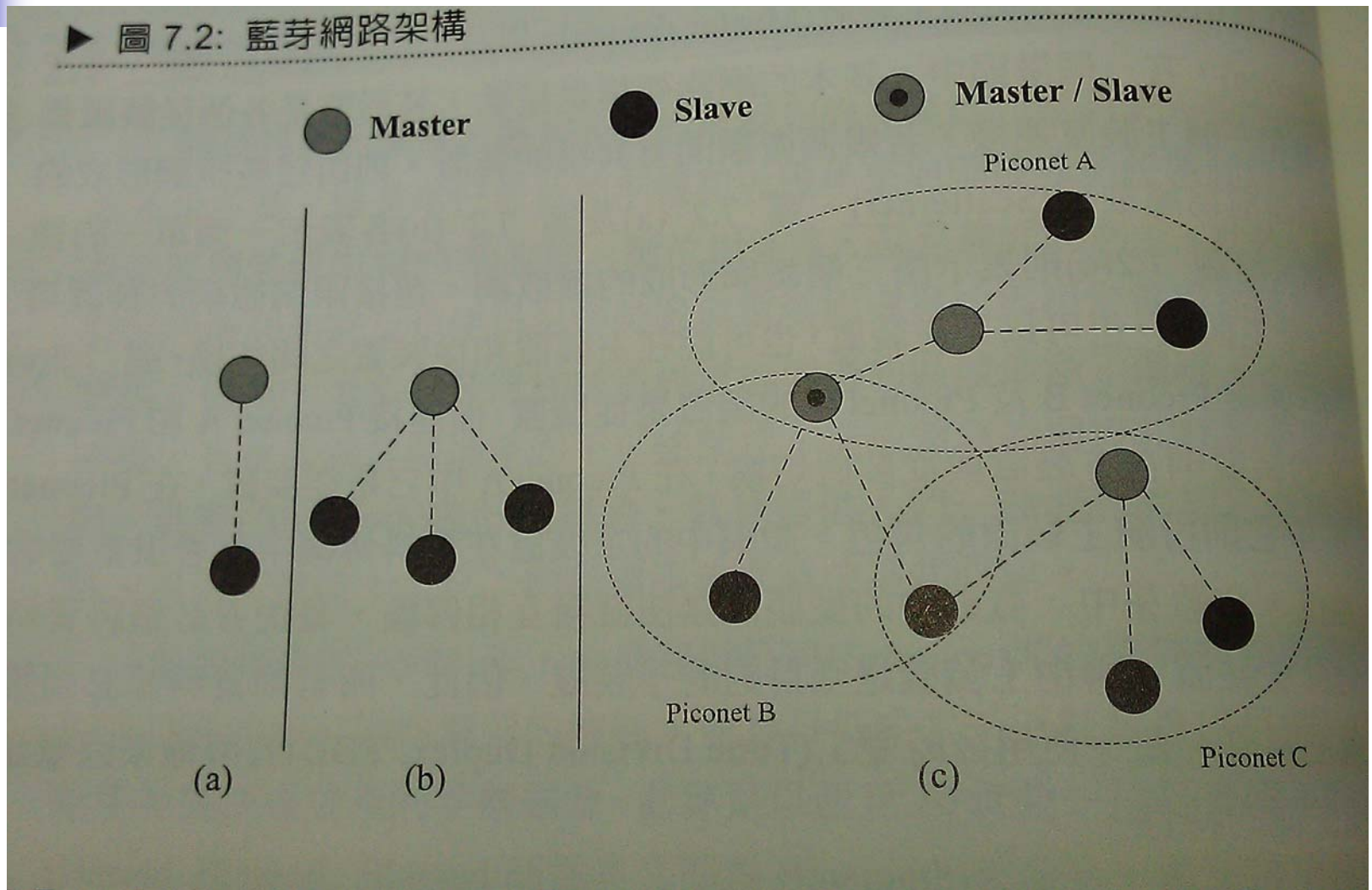


圖 7.2: 藍芽網路架構
Master
Slave
Master / Slave
Piconet A
Piconet B
Piconet C
(a)
(b)
(c)

# Frequency Hopping among Piconets

- When two piconets choose the same 1MHz-band, collision occurs.
- FH scheme uses carriers spacing of 1 MHz with up to 79 different frequencies (channels) to avoid collision.
  - hopping rate = 1600 hops/sec
  - one slot = 0.625 ms

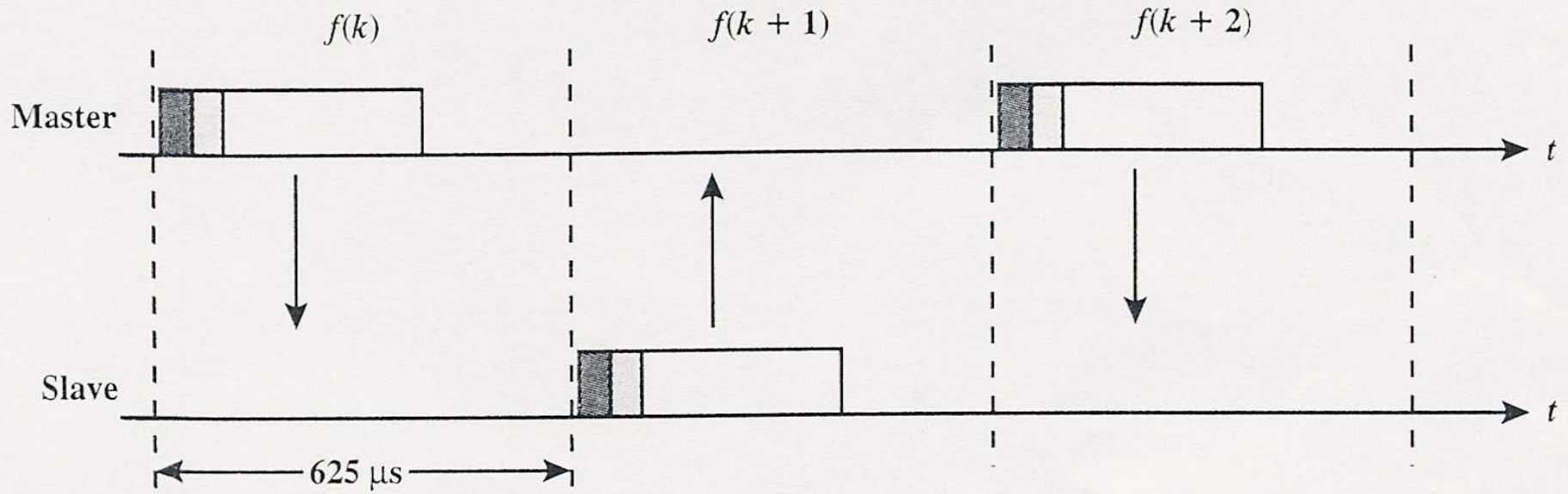



**Figure 15.6** Frequency-Hop Time Division Duplex

# Multi-slot Packets (1, 3, or 5 Slots are Allowed)

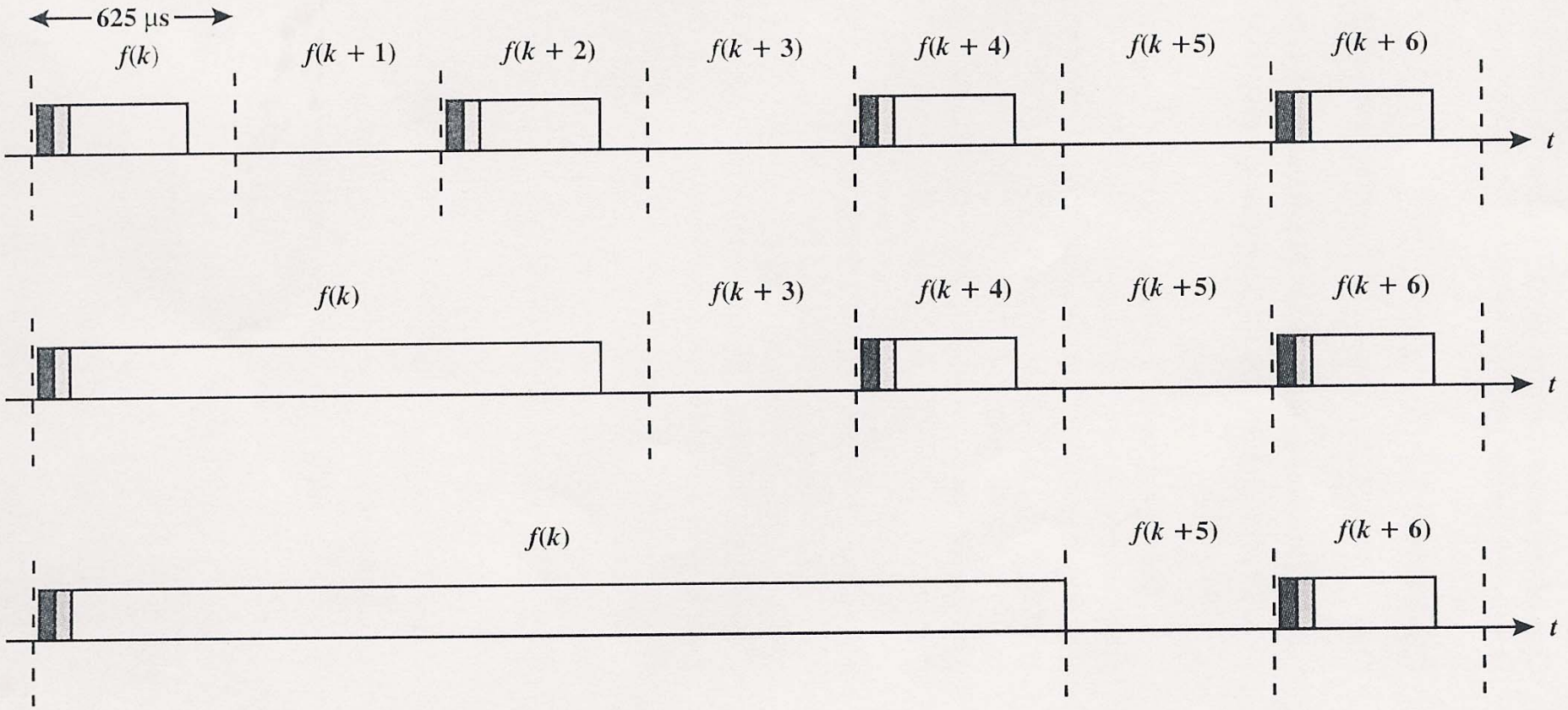



**Figure 15.7** Examples of Multislot Packets

# Key Parameters

**Table 15.2** Bluetooth Radio and Baseband Parameters

| | |
|---|---|
| Topology | Up to 7 simultaneous links in a logical star |
| Modulation | GFSK |
| Peak data rate | 1 Mbps |
| RF bandwidth | 220 kHz (−3 dB). 1 MHz (−20 dB) |
| RF band | 2.4 GHz, ISM band |
| RF carriers | 23/79 |
| Carrier spacing | 1 MHz |
| Transmit power | 0.1 W |
| Piconet access | FH-TDD-TDMA |
| Frequency hop rate | 1600 hops/s |
| Scatternet access | FH-CDMA |

# Frequency Availability

- on 2.4 GHz in ISM band
- sufficient to define 79 continuous 1-MHz physical channels

**Table 15.3** International Bluetooth Frequency Allocations

| Area | Regulatory Range | RF Channels |
|---|---|---|
| U.S., most of Europe, and most other countries | 2.4 to 2.4835 GHz | $f = 2.402 + n$ MHz, $n = 0,\ldots, 78$ |
| Japan | 2.471 to 2.497 GHz | $f = 2.473 + n$ MHz, $n = 0,\ldots, 22$ |
| Spain | 2.445 to 2.475 GHz | $f = 2.449 + n$ MHz, $n = 0,\ldots, 22$ |
| France | 2.4465 to 2.4835 GHz | $f = 2.454 + n$ MHz, $n = 0,\ldots, 22$ |

# Bluetooth Products

- bluetooth enabled products

**Headset** Logitech Mobile Bluetooth Headset

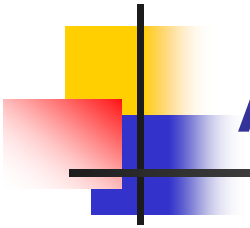
The Logitech® Headset with *Bluetooth*® wireless technology allows for up to 7 hours of talk time and a standby time of up to 1 month. The headset has a soft-touch headset for a comfortable fit and a noise-canceling microphone.

# Bluetooth Products

- bluetooth enabled products

**Mobile Phone** X70

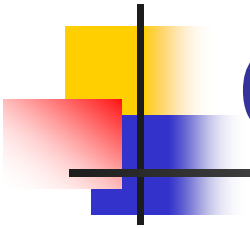
The Panasonic clamshell with *Bluetooth*® wireless technology weighs only 95 grams. The built-in camera lets you take digital photos. Don let the X70 compact size fool you, it has a memory size of 4MB and up to 5 hours of talk time.



# Adopted Protocols

- borrowed from other standard-making organizations to compatibility
  - PPP
  - TCP/UDP/IP
  - OBEX (object exchange protocol by IrDA)
  - WAE/WAP

# Piconet Formation and Connection Procedure



# Channel Control

- To form/join a piconet, a host must enter the “connection” state.
- There are two major states:
  - standby:
    - the default state
    - low-power, only native clock is running
  - connection:
    - connected to a piconet, as a master or a slave

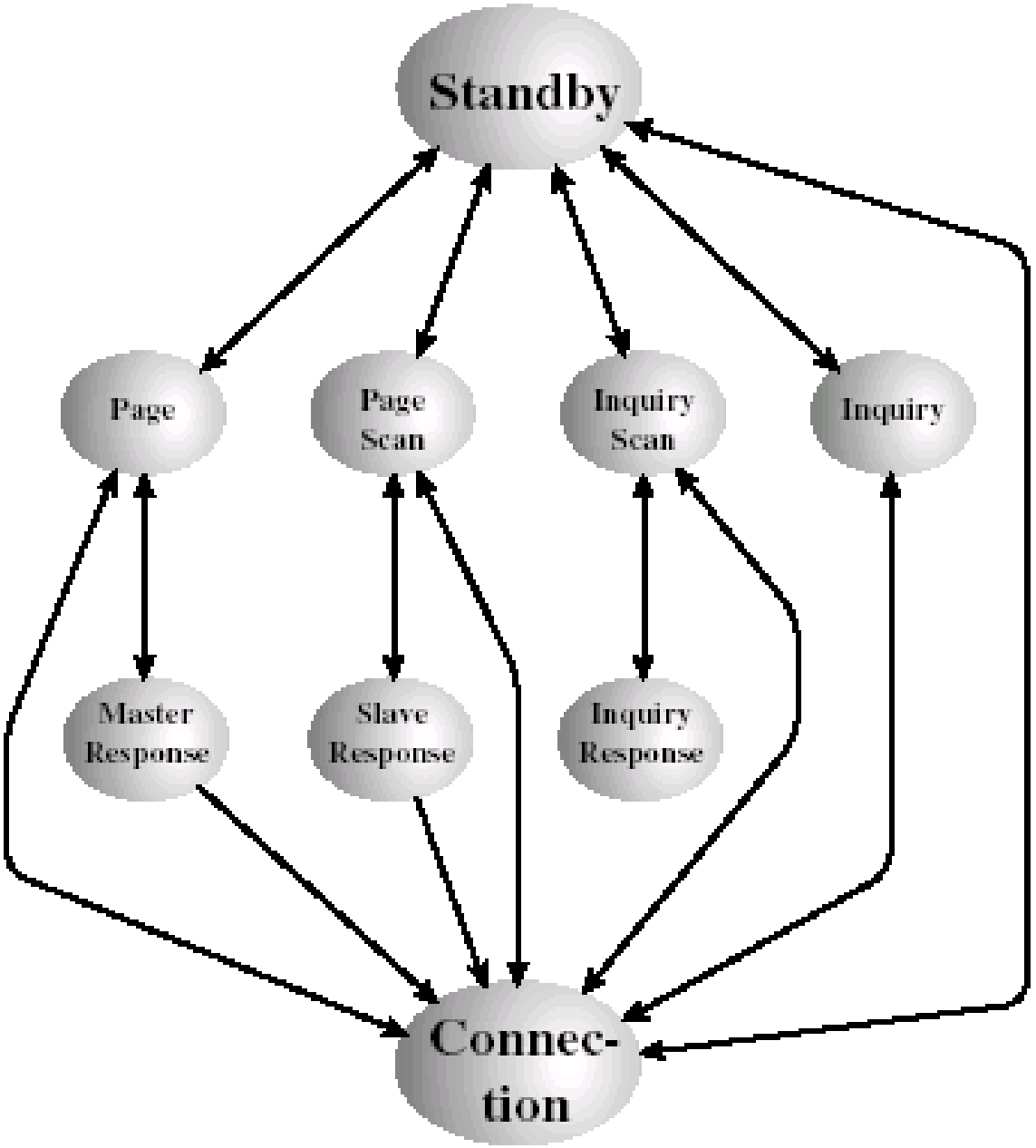
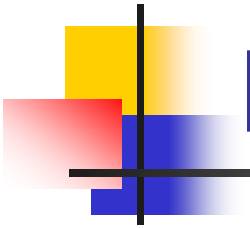



Figure 15.12 Bluetooth State Transition Diagram



# Detailed Connecting Steps

- inquiry:
  - used by master to find the identities of devices within range
- inquiry scan:
  - listening for an inquiry message
- page:
  - used by master to send PAGE message to connect to a slave by transmitting slave's device address code (DAC)
- page scan:
  - slave listening for a paging packet with its DAC

# Inquiry and Page Flowchart

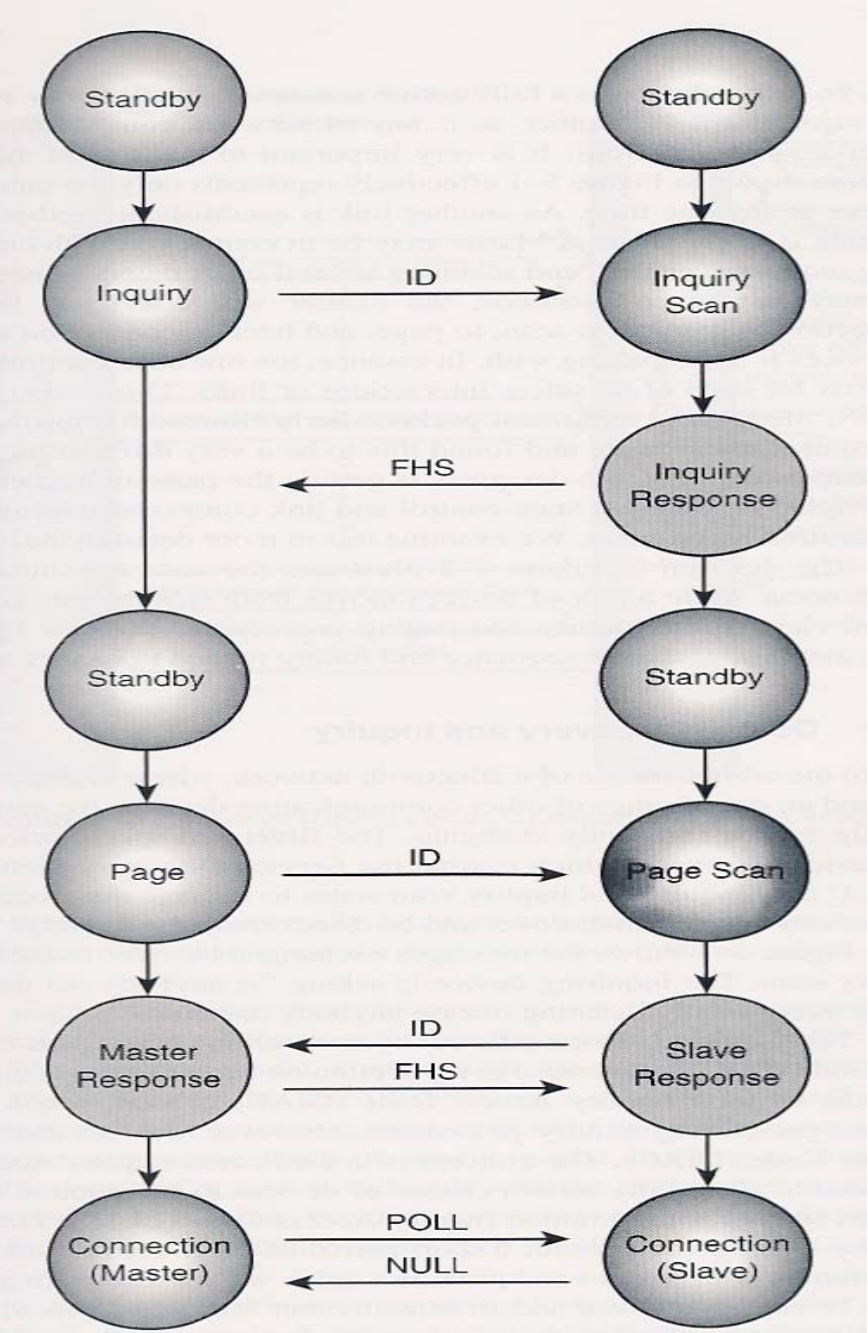



**Figure 5–2** State transition from standby into connection.