Wireless Networking Technology

Fall 2013

Chapter 3 无线网络物理结构

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有线网络拓扑结构

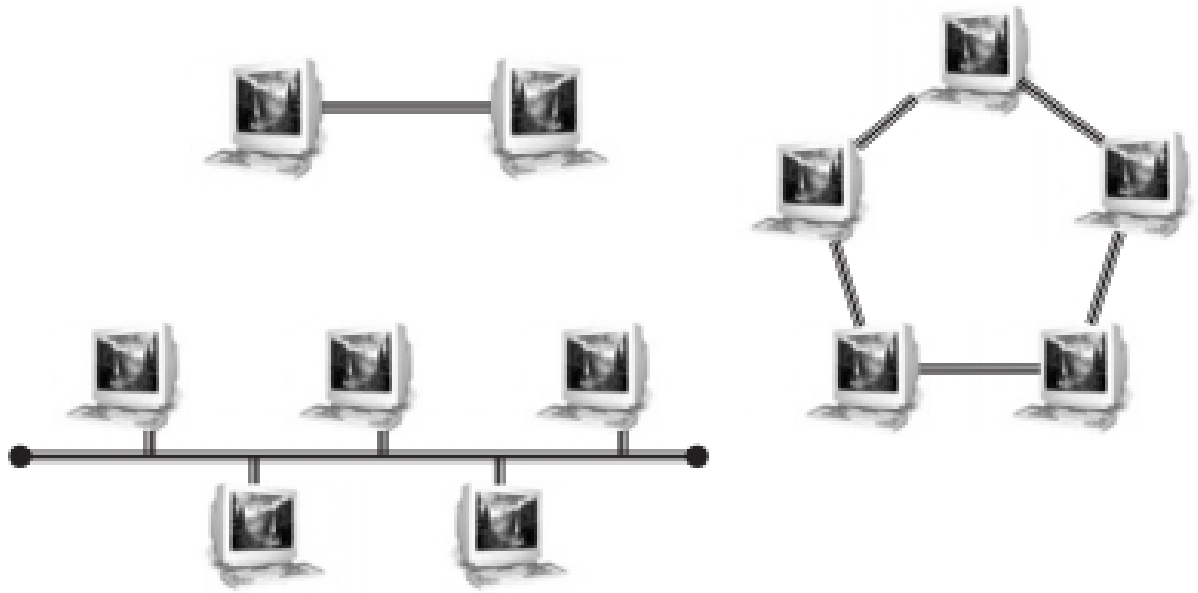


Figure 3-1: Point-to-point, Bus and Ring Topologies

避免链路单点故障

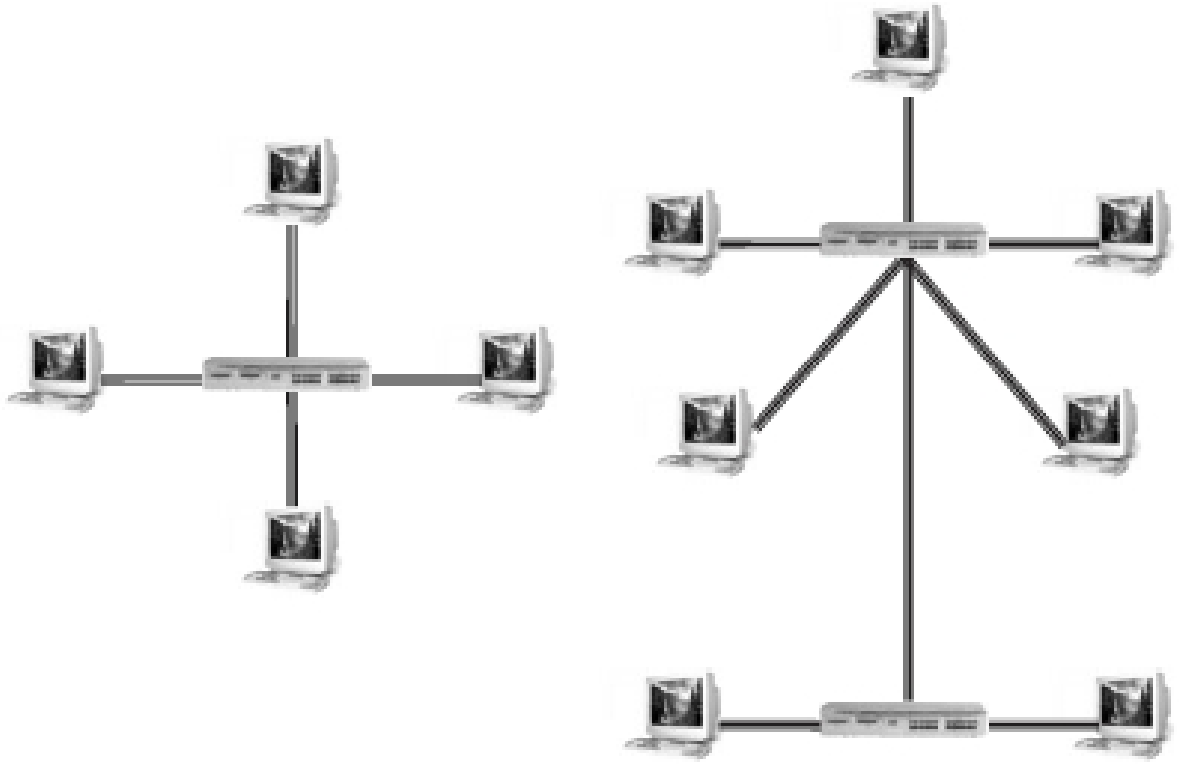
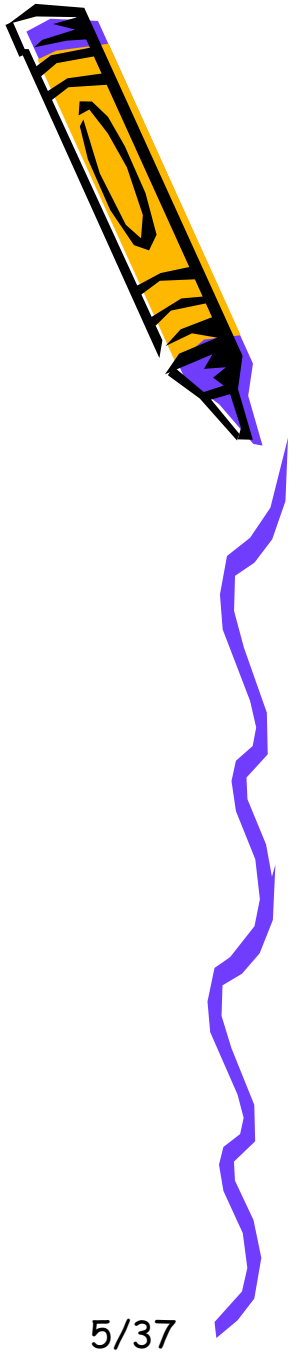


Figure 3-2: Star and Tree Topologies

无线网络星型拓扑结构



- 可考虑题目1:
- 无线路由器接入压力测试
  - 场景设计
  - 数据生成设计
  - 测试方案设计
  - 结果及分析

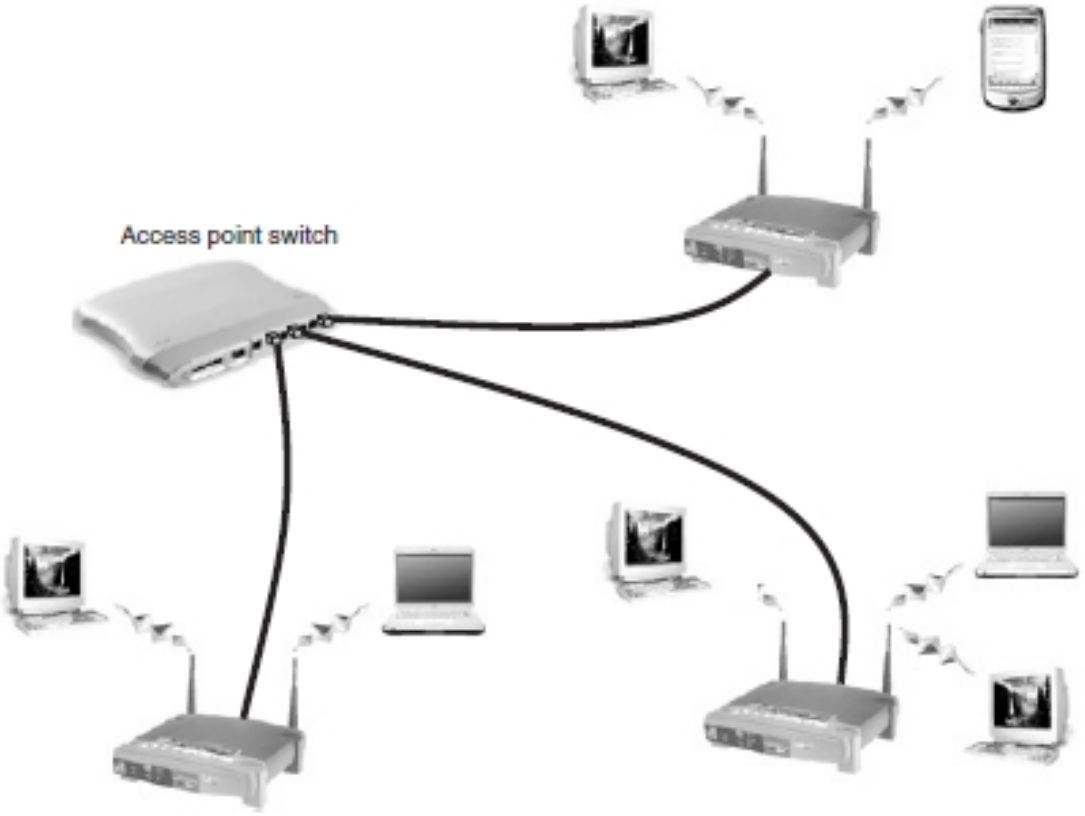


Figure 3-6: A Tree Topology Using a Wireless Access Point Switch

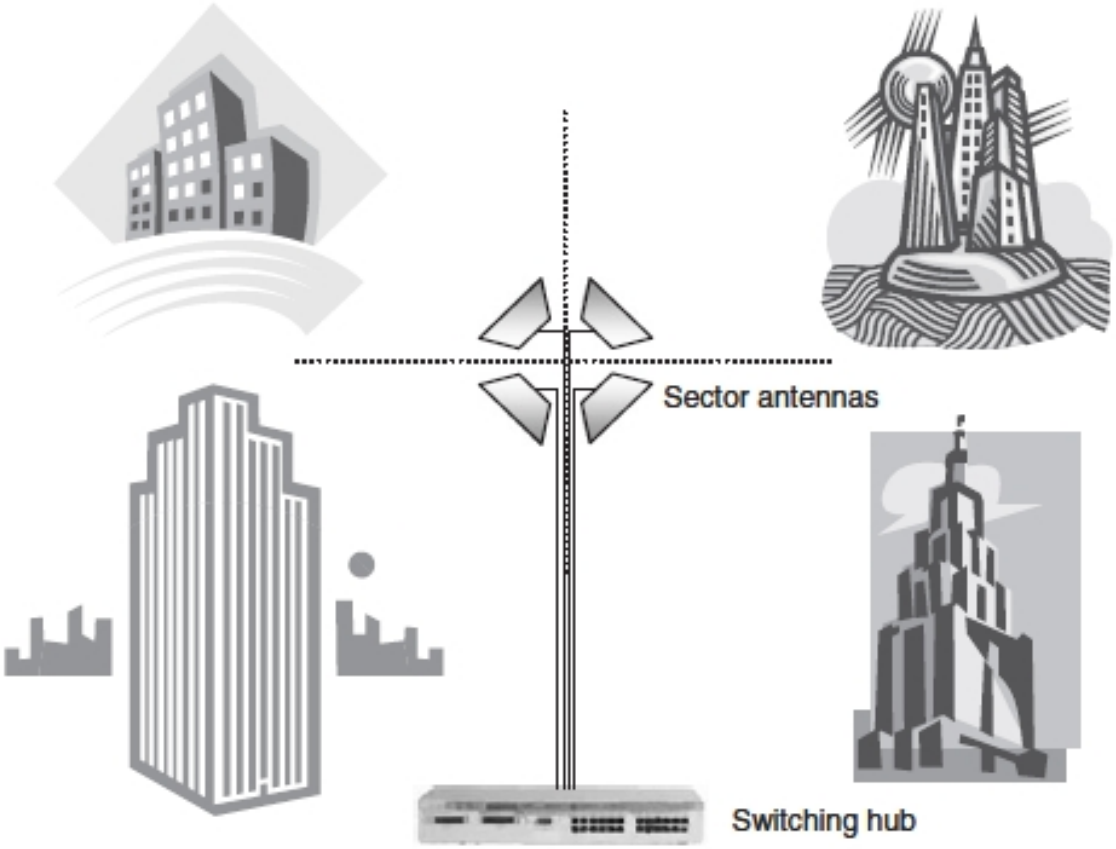


Figure 3-7: Switched Star Wireless MAN Topology

as mobile ad hoc networks (MANETs)?

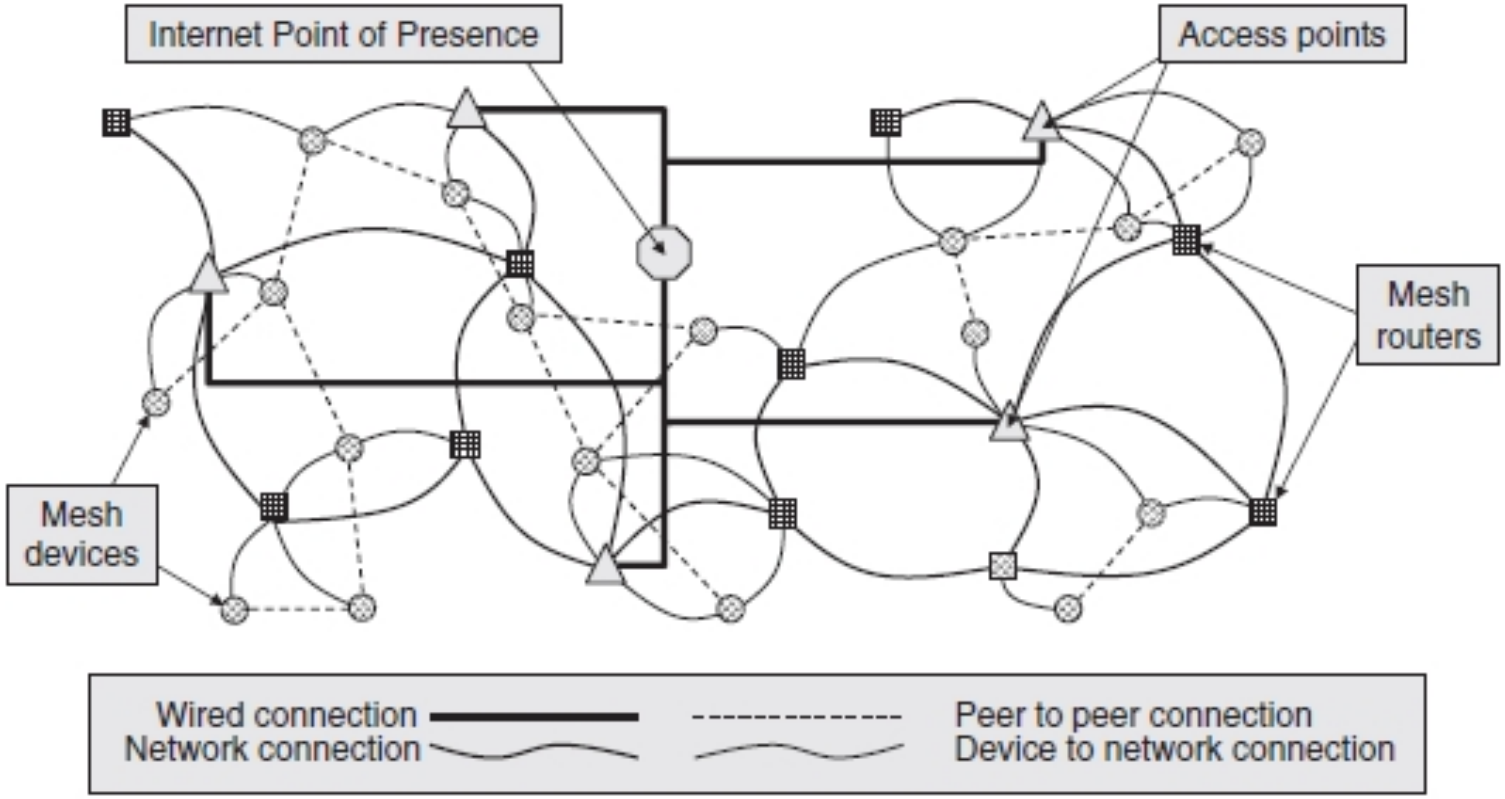


Figure 3-8: Mesh Network Topology

mesh networks face several additional technical challenges

- Wireless link reliability — a packet error rate that may be tolerable over a single hop in an hub and spokes configuration will quickly compound over multiple hops, limiting the size to which a mesh can grow and remain effective.
- Seamless roaming — seamless connection and reconnection of moving nodes has not been a requirement in most wireless network standards, although 802.11 Task Groups TGr and TGs are addressing this.
- Security — how to authenticate users in a network with no stable infrastructure?

Wireless LAN Devices

Figure 3-9: A Variety of Wireless NIC Forms (courtesy of Belkin Corporation, D-Link (Europe) Ltd. and Linksys (a division of Cisco Systems Inc.))

The access point (AP)

- 第一代
  - "fat" access points

- security features, such as authentication and encryption support
- access control based on lists or filters
- SNMP configuration capabilities

Table 3-1: Optional Access Point Functionality

Feature	*Description*
Internet gateway	Supporting a range of functions such as: routing, Network Address Translation, DHCP server providing dynamic IP addresses to client stations, and Virtual Private Network (VPN) passthrough.
Switching hub	Several wired Ethernet ports may be included that provide switching hub capabilities for a number of Ethernet devices.
Wireless bridge or repeater	Access point that can function as a relay station, to extend the operating range of another access point, or as a point-to-point wireless bridge between two networks.
Network storage server	Internal hard drives or ports to connect external storage, providing centralised file storage and back-up for wireless stations.

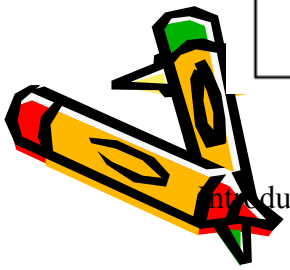


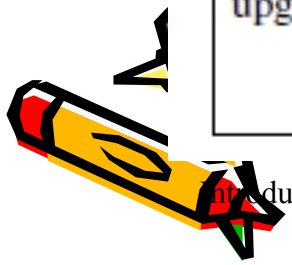
Figure 3-10: First Generation Wireless Access Points (courtesy of Belkin Corporation, D-Link (Europe) Ltd. and Linksys (a division of Cisco Systems Inc.))

- In contrast to the first generation "fat" access point described above,
- slimmed-down "thin" access points are also available that limit access point capabilities to the essential RF communication functions and rely on the centralisation of control functions in a wireless LAN switch.

With a centralised security architecture provided by a wireless switch,these management tasks only need to be completed once.

Table 3-2: "Thin" Access Point Advantages

Advantage	*Description*
Lower cost	A "thin" access point is optimised to cost effectively implement wireless communication functions only, reducing initial hardware cost as well as future maintenance and upgrade costs.
Simplified access point management	Access point configuration, including security functions, is centralised in order to simplify the network management task.
Improved roaming performance	Roaming handoffs are much faster than with conventional access points, which improves the performance of voice services.
Simplified network upgrades	The centralised command and control capability makes it easier to upgrade the network in response to evolving WLAN standards, since upgrades only have to be applied at the switch level, and not to individual access points.



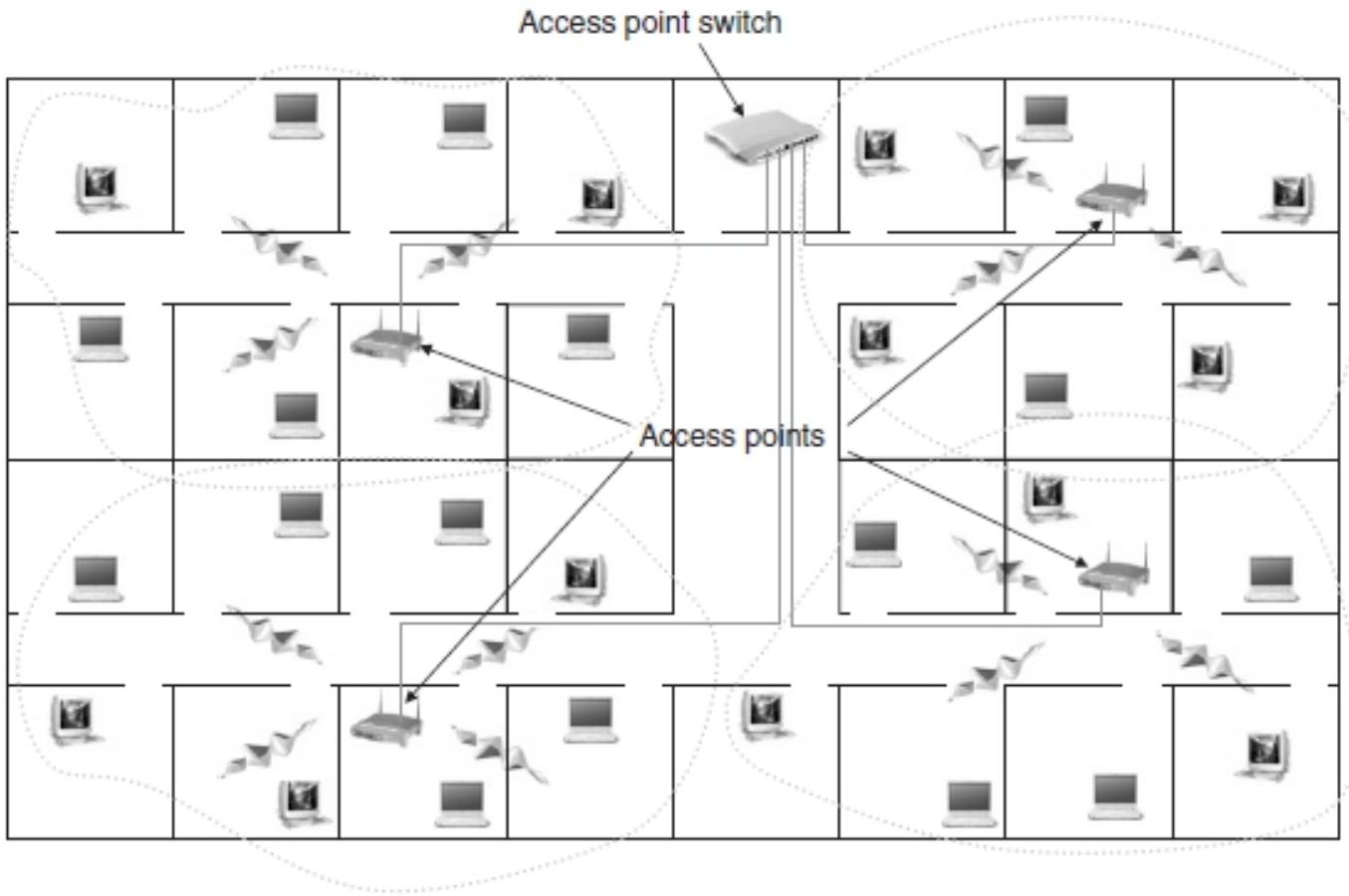


Figure 3-11: Wireless LAN Topology Using a Wireless Switch

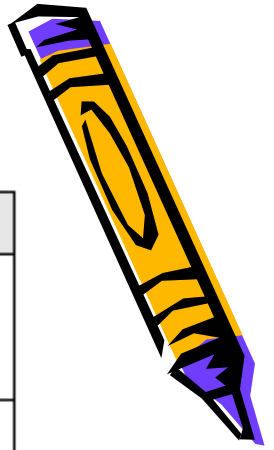
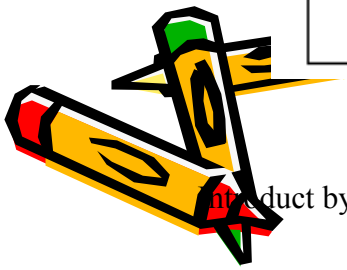
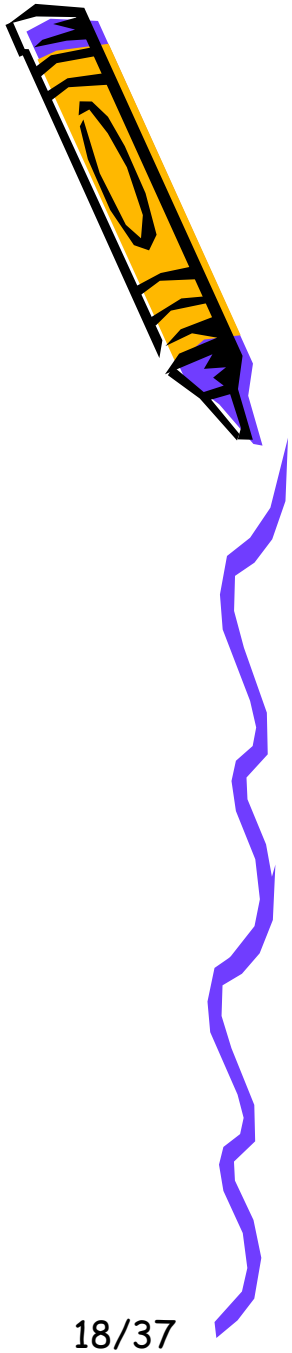


Table 3-3: Wireless LAN Switch Features

Feature	*Description*
Layout planning	Automated site survey tools that allow import of building blueprints and construction specifications and determine optimal access point locations.
RF management	Analysis of management frames received from all access points enables RF signal related problems to be diagnosed and automatically corrected, by adjusting transmit power level or channel setting of one or more access points.
Automatic configuration	Wireless switches can provide automatic configuration by determining the best RF channel and transmit power settings for individual access points.
Load balancing	Maximising network capacity by automatic load balancing of users across multiple access points.
Policy-based access control	Access policies can be based on access point groupings and client lists that specify which access points or groups specific client stations are permitted to connect to.
Intrusion detection	Rogue access points and unauthorised users or ad hoc networks can be detected and located, either by continuous scanning or by scheduled site surveys.





- 可考虑题目2：
- 胖瘦AP的可扩展性测试
  - 场景设计
  - 数据生成设计
  - 测试方案设计
  - 结果及分析

Lightweight Access Point Protocol（终止）

Table 3-4: LWAPP Functions

LWAPP function	*Description*
Access point device discovery and information exchange	An access point sends a Discovery Request frame and any receiving access router responds with a Discovery Reply frame. The access point selects a responding access router and associates by exchanging Join Request and Join Reply frames.
Access point certification, configuration, provisioning and software control	After association, the access router will provision the access point, providing a Service Set Identifier (SSID), security parameters, operating channel and data rates to be advertised. The access router can also configure MAC operating parameters (e.g. number of transmission attempts for a frame), transmit power, DSSS or OFDM parameters and antenna configuration in the access point. After provisioning and configuration, the access point is enabled for operation.
Data and management frame encapsulation, fragmentation and formatting	LWAPP encapsulates data and management frames for transport between the access point and access router. Fragmentation of frames and re-assembly of fragment will be handled if the encapsulated data or management frames exceed the Maximum Transmission Unit (MTU) supported between the access point and access router.
Communication control and management between access points and associated devices	LWAPP enables the access router to request statistical reports from its access points, including data about the communication between the access point and its associated devices (e.g. retry counts, RTS/ACK failure counts).

作业

- Although the initial draft specification for LWAPP expired in March 2004, a new IETF working group called Control and Provisioning of Wireless Access Points (CAPWAP) was formed, with most working group members continuing to recommend LWAPP over alternatives such as Secure Light Access Point Protocol (SLAPP), Wireless LAN Control Protocol (WICOP) and CAPWAP Tunnelling Protocol (CTP).
- It seems likely that LWAPP will be the basis of an eventual CAPWAP protocol.
- LWAPP现在的情况、标准及特性总结（新标准中的特性总结）

Wireless LAN Arrays

- "3rd generation" architecture for WLAN deployment

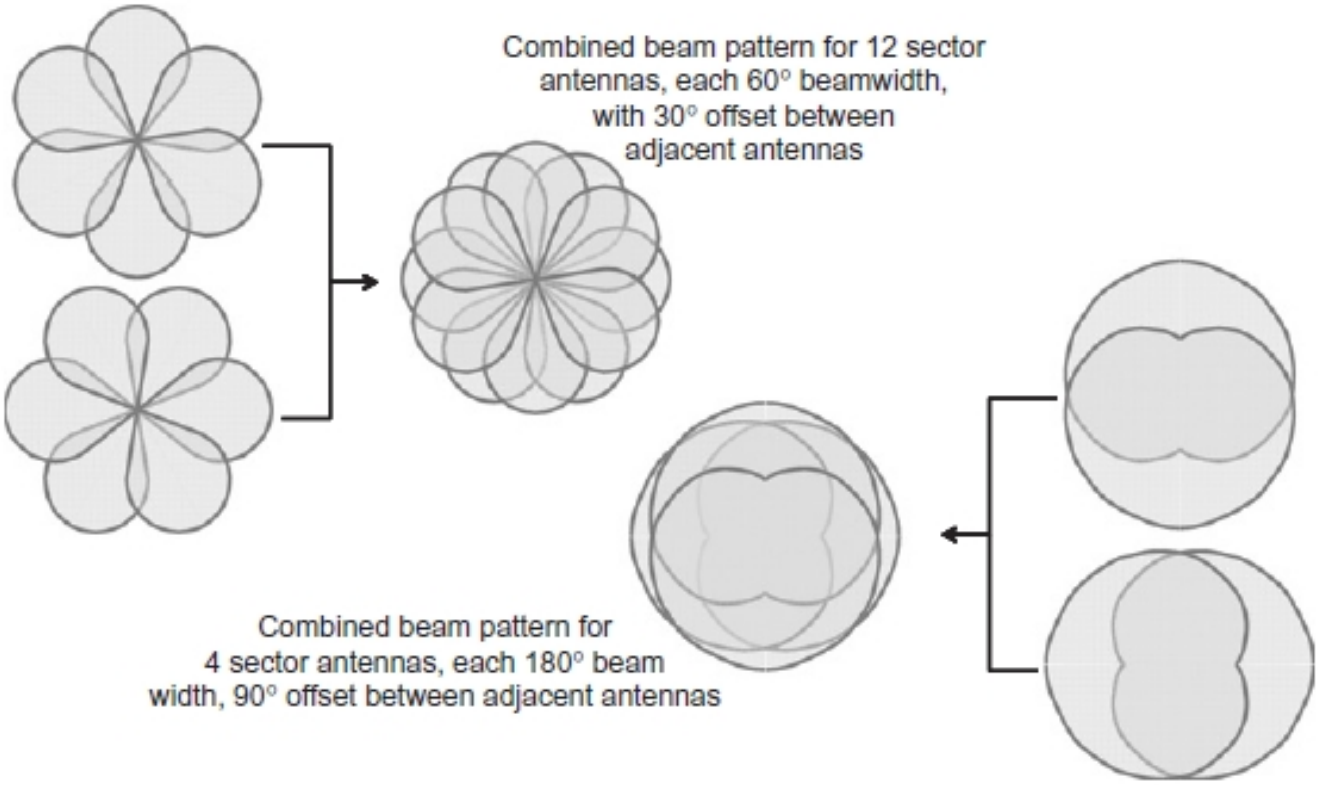


Figure 3-12: Antenna Configuration in a 16-sector Access Point Array

with multi giga-bit total WLAN capacity.

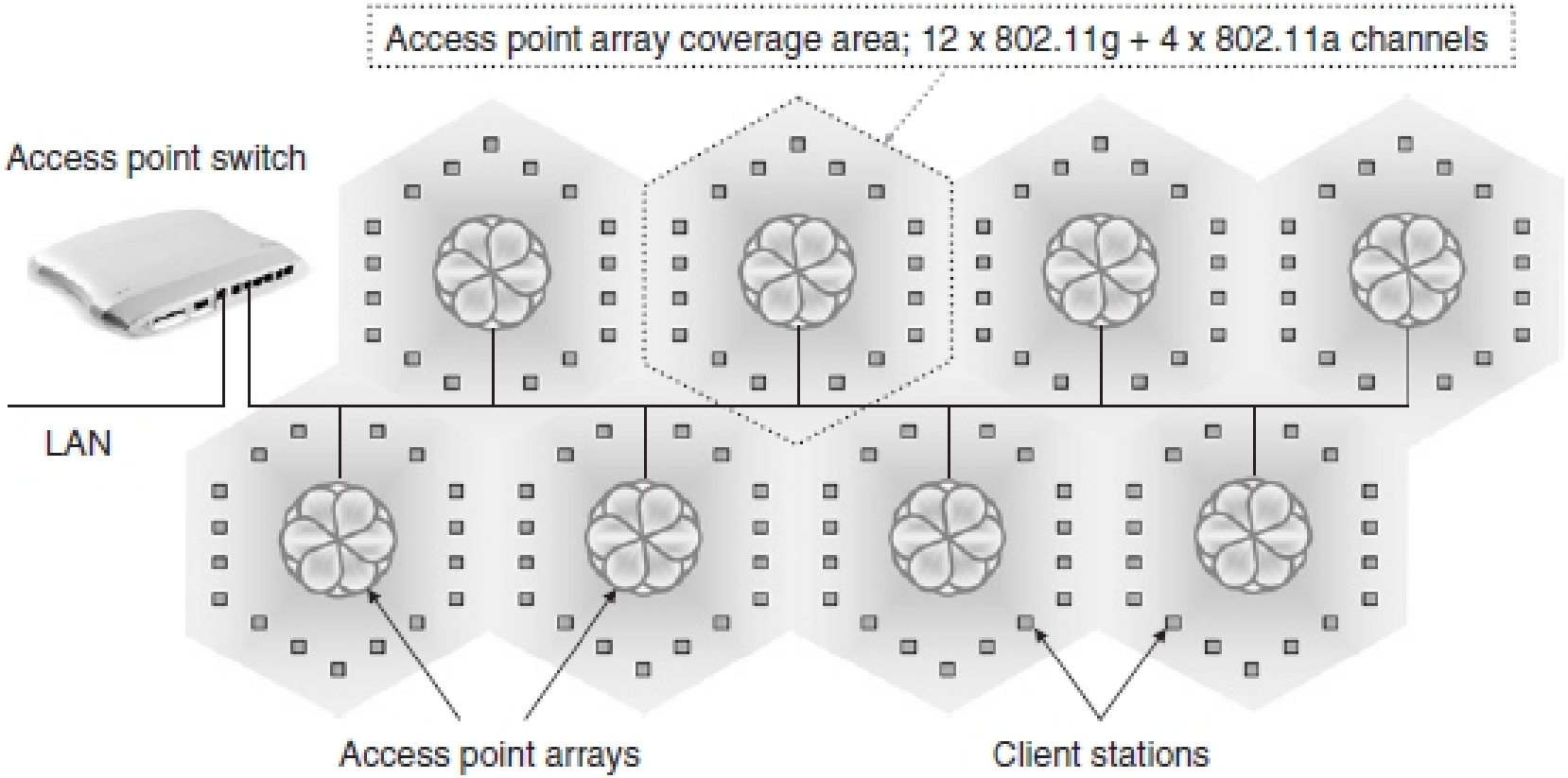


Figure 3-13: WLAN Tree Topology Employing Access Point Arrays

Wireless Network Bridging

Figure 3-14: Outdoor Wireless Bridges (courtesy of D-Link (Europe) Ltd. and Linksys (a division of Cisco Systems Inc.))

Wireless Printer Servers

Figure 3-15: Wireless Printer Servers (courtesy of Belkin Corporation, D-Link (Europe) Ltd. and Linksys (a division of Cisco Systems Inc.))

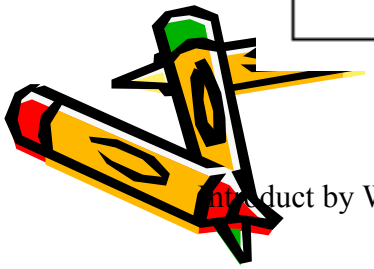
Wireless LAN Antennas

Figure 3-16: Wireless LAN Antenna Types (courtesy of D-Link (Europe) Ltd.)

通信原理？

Table 3-5: Typical Wireless LAN Antenna Parameters for 2.4 GHz Operation

Antenna type	*Sub-type*	*Beamwidth (Degrees)*	*Gain (dBi)*
Omnidirectional		360	0–15
Patch / Panel		15–75	8–20
Sector		180	8–15
		120	9–20
		90	9–20
		60	10–17
Directional	Yagi	10–30	8–20
	Parabolic reflector	5–25	14–30



Smart Antennas

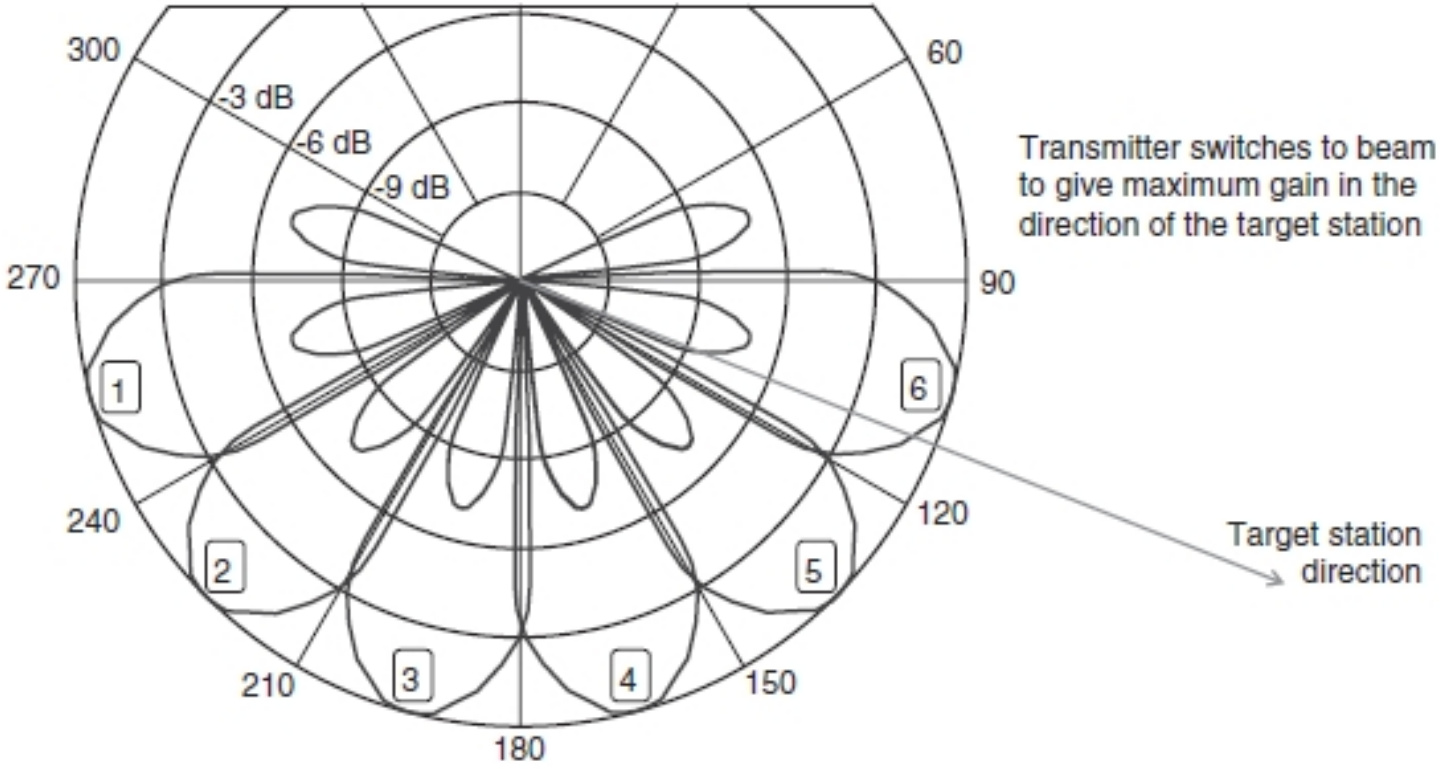


Figure 3-17: Beam Pattern of a Six Element Switched Beam Array

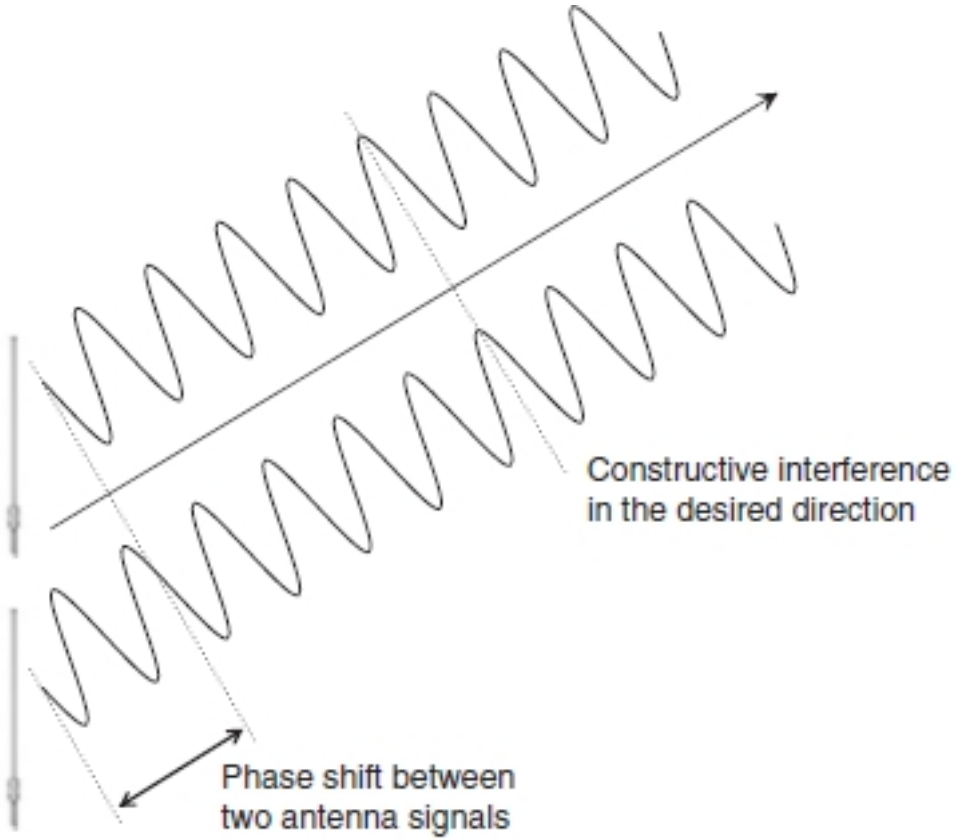


Figure 3-18: Phase Shift Between Two Antennas Resulting in a Directed Beam

MIMO （later）

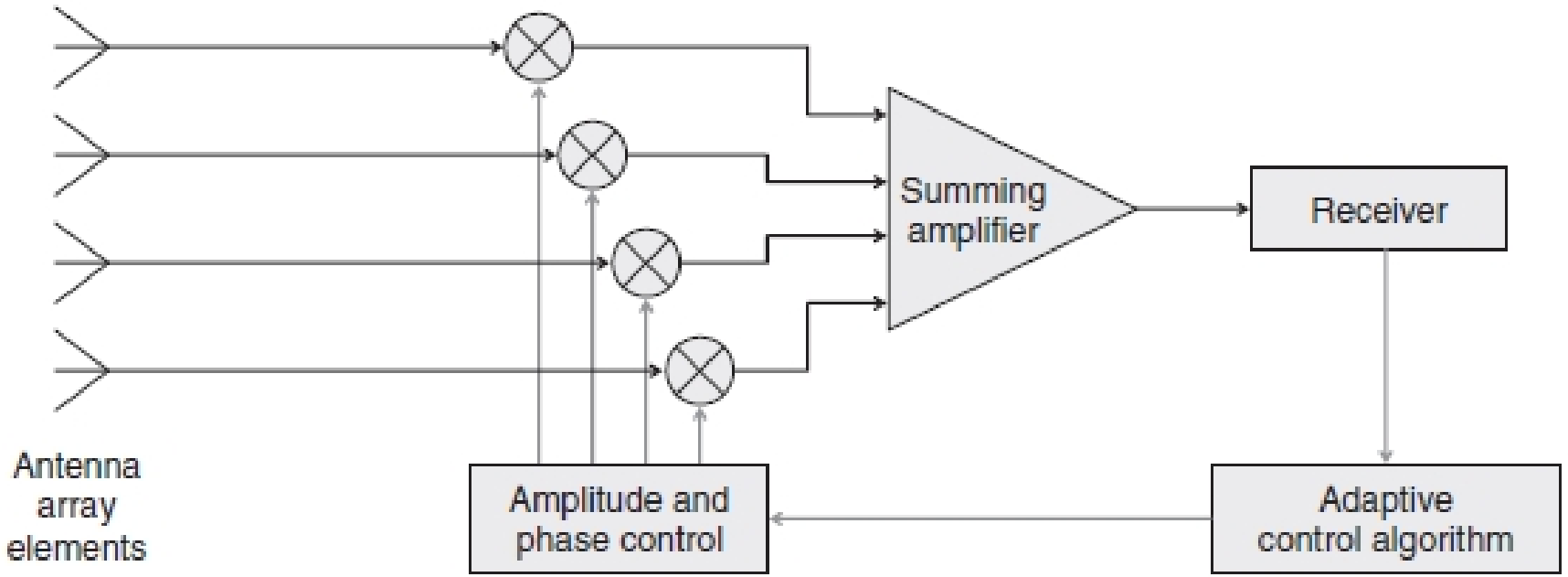
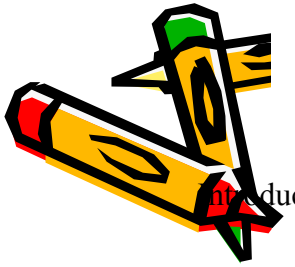


Figure 3-19: Adaptive Beam Antenna

Table 3-6: Adaptive Beam Arrays and MIMO Radio Compared

	Adaptive beam array	*MIMO radio*
Objective	Focus the propagation pattern along a single desired spatial direction, to allow multiple access, reduce interference or increase range.	Exploit multi-path propagation to increase data capacity by multiplexing data streams over several spatial channels.
Antenna configuration	2 or more antenna elements at Tx and/or Rx. Tx and Rx configurations are independent.	Typically 2 × 2 or 4 × 4 (Tx × Rx). Tx and Rx are linked by the digital signal processing algorithm.
Spatial diversity	Single spatial channel focussed between transmitter and receiver.	Multiple spatial channels, exploiting multi-path propagation.
Data multiplexing	Single bit stream encoded to all transmit antennas.	Data stream multiplexed over spatial channels.
Signal processing	Simple phase and gain modification for each antenna.	Complex processing algorithm to decode signals over multiple spatial channels.
Application example	3rd generation WLAN access points — Section "Wireless LAN Arrays, p. 52".	PHY layer for the 802.11n standard — Section "MIMO and data rates to 600 Mbps (802.11n), p. 165".



Bluetooth Devices

Figure 3-20: A Variety of Bluetooth Devices (courtesy of Belkin Corporation, D-Link (Europe) Ltd., Linksys (a division of Cisco Systems Inc.) and Zoom Technologies, Inc.)

ZigBee Devices

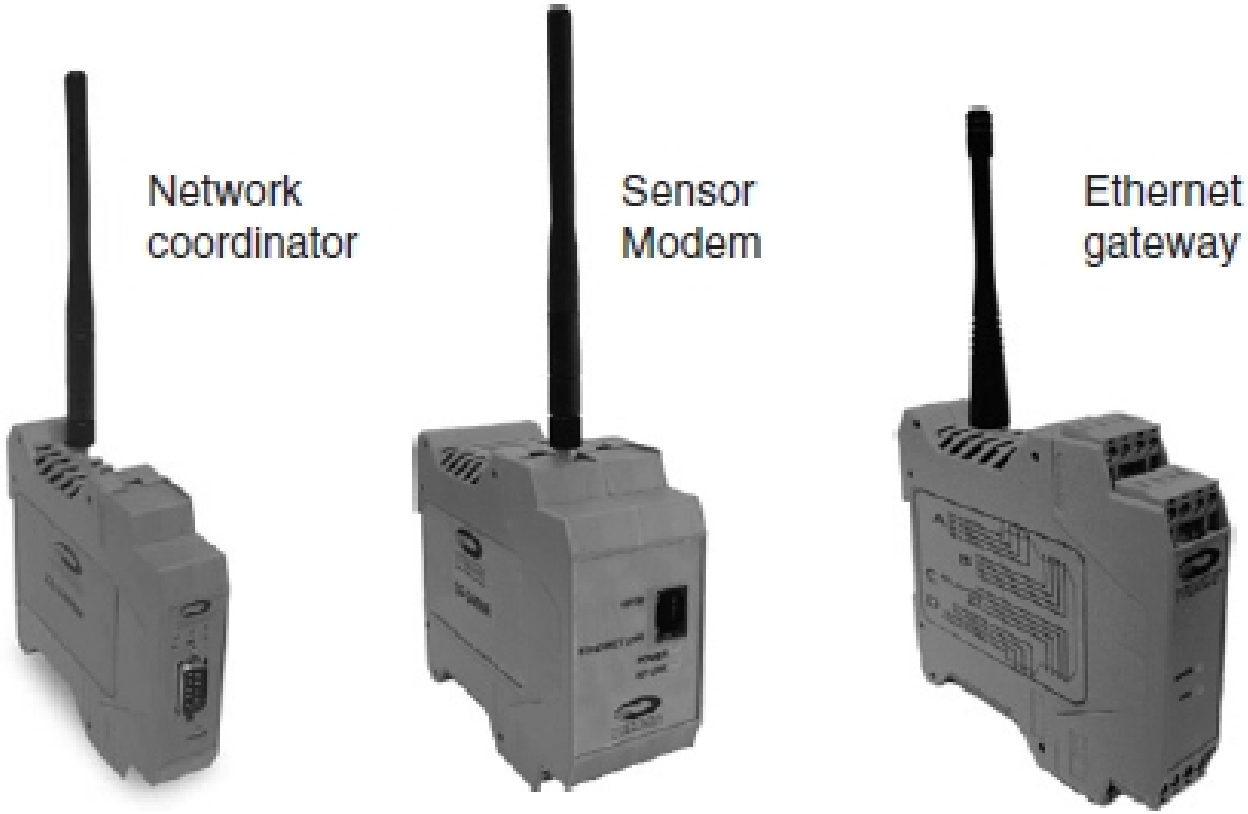


Figure 3-21: A Variety of ZigBee Devices (courtesy of Cirronet Inc.)

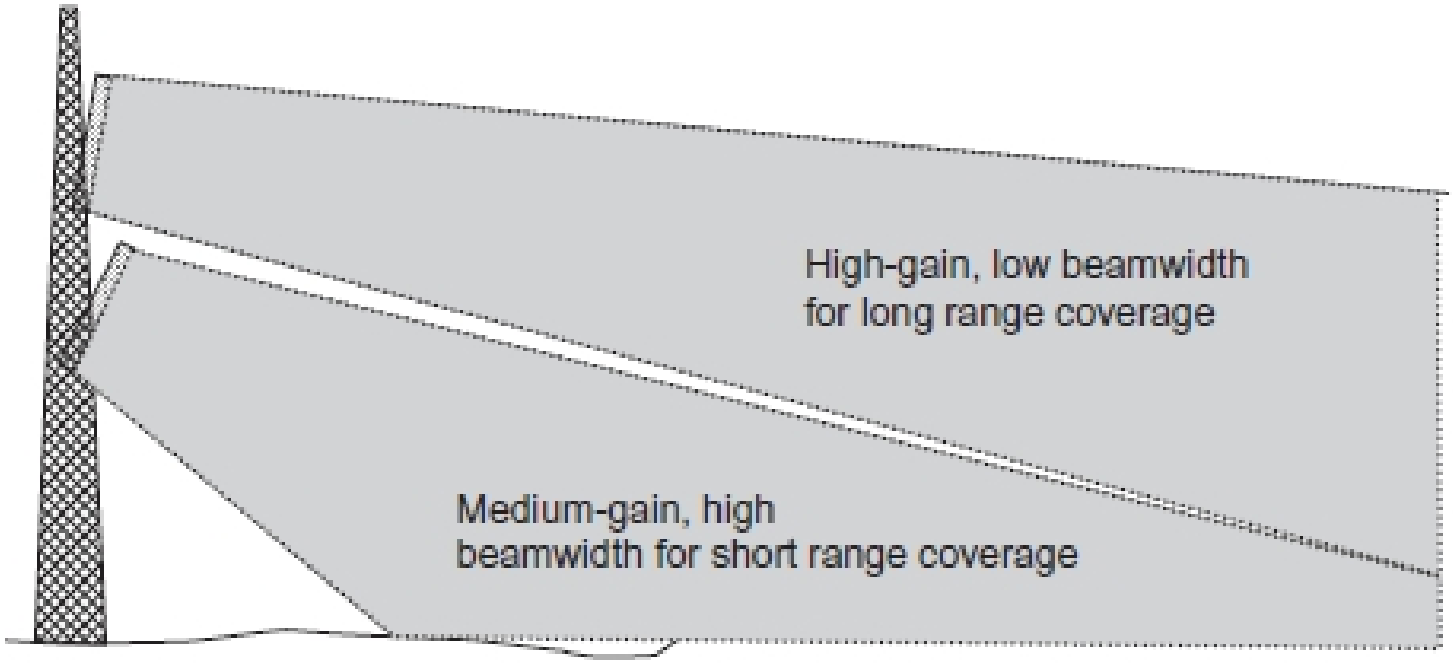
Wireless MAN Devices

Figure 3-22: Micro and Macro WMAN Base Station Equipment (courtesy of Aperto Networks Inc.)

Table 3-9: Wireless MAN Devices and Features

WMAN device	*Typical features*
Basic self installed indoor CPE	Basic WMAN connectivity to a customer PC or network. Multiple diversity or adaptive array antennas to improve non line-of-sight reception.
Outdoor CPE	External antenna and radio. Provides higher antenna gain and longer range.
Base station equipment	Modular and scalable construction. Macro and micro configurations for dense metropolitan or sparse rural installations. Flexible RF channel usage, from one channel over multiple antenna sectors to multiple channels per antenna sector.
Integrated network gateway	MAN interface with network gateway functions (Routing, NAT and firewall capabilities). Optionally with integrated wireless LAN access point. Integrated CPU to support additional WISP services such as VoIP telephony.

Figure 3-23: Fixed Wireless MAN CPE Equipment (courtesy of Aperto Networks Inc.)



igure 3-24: WMAN Base Station Sector Antenna Configuration

WiBro (Wireless Broadband)

Figure 3-25: Wireless MAN Enabled Phones (courtesy of Samsung Electronics)