
RM-E - Practical Radio Telemetry Systems for Industry



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Short Description

This manual covers topics such as antennas and fixed systems. Other essentials of data communications (and Ethernet) are also reviewed as they apply to radio telemetry systems. A selection of case studies is used to illustrate the key concepts with examples of real-world radio telemetry systems in the water, electrical and processing industries.

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1 Introduction

1.1 Overview

Communication networks evolved due to the need to exchange and share information to a group of machines. During the last century many kinds of communication networks have been developed. These include telephone networks, computer networks and cable TV networks.

With the need for data exchange superseding voice and picture transmission, computer networks have become the most prevalent of all communication networks. Depending on the distances between the computers, networks can be further differentiated into:

- LANs (Local Area Networks)—Networks connecting computers located a small distance apart, for instance computers in an office
- MANs (Metropolitan Area Networks)—Networks connecting computers located at medium distances from each other, for instance around the perimeter of a large city
- WANs (Wide Area Networks)—Networks connecting computers located at large distances from each other, for instance in different cities or countries

Traditionally, all types of networks have been wire-based networks, as they use extensive cabling to enable data, voice, and picture transmission. The use of wire limits the ability of computer networks to provide network services in absence of LAN/telephone connection.

Since around 1990, with the release of the IEEE 802.11 standard, vendors have been developing protocols and systems that provide connectivity without wires, for LANs, MANs, and WANs. The result has been the emergence of wireless networks.

1.1.1 How did it begin?

The first form of wireless communication came into existence when Native Americans used to send their messages to each other using smoke signals. The sender would wave a deer skin over the fire to convey messages. However, modern wireless communication was established with Marconi's radio transmission in 1895. In 1946, with the introduction of the Public Mobile Telephone Service in the USA, wireless communication seemed attainable. Finally, in 1971, the packet-switched wireless network, ALOHANET, developed at the University of Hawaii, realized the much-awaited dream of true wireless communication.

At present, the following wireless networking technologies are in demand:

- Wireless LANS (e.g. IEEE 802.11)
- Point-to-Point Wireless Ethernet
- Wireless Mesh Networks (typically IEEE 802.11 or IEEE 802.15.4-based)
- Fixed broadband wireless multi-service WANs (e.g. WiMax)
- Small dish satellite (e.g. VSat)
- Mobile (cellular) wireless (e.g. 3G/4G)
- Wireless Personal Area Networks (e.g. ZigBee)

1.2 Advantages of using wireless technology

There are numerous benefits in using wireless technologies, irrespective of the communication solution to be implemented. They are:

Mobility

Mobility implies the constant and random physical movement of the person and the network appliance. A wired network solution requires fixed, predetermined positions of user workstations and network resources. These factors make roaming impossible. Wireless networking technologies provide the freedom to move workstations and mobile devices.

High degree of accessibility

Wireless technologies can help you reach anywhere, anytime. You can connect to places that do not have wired installations. For instance, a head office may establish connection with branch offices located across rivers and mountains. A wired installation will be difficult in such areas.

Reduced installation time

Installation of cabling is a time consuming process. For instance, in LANs you need to pull twisted pair wires above the ceiling and drop cables through walls to network outlets/sockets. Moreover, this type of installation can take days, weeks and even months.

High reliability of network

Wired networks can experience a long period of downtime in cases where there

are wire and cabling faults. Such problems take considerable time to track and resolve. This problem does not exist with wireless networks.

Cost savings

Company reorganization and relocation are common these days. In such cases, the wired network infrastructure needs to be set up again, resulting in high expenses on labor and material. Establishing wireless network solution across organizations can minimize these costs. Other than the initial outlay on setting up the cell sites, the cost of running and maintaining a radio based communications solution is minimal.

1.3 Some acronyms and definitions

802.11

IEEE standard for wireless Local Area Networks.

Access point (AP)

The interface between wireless and wired network.

AMPS (Advanced Mobile Phone System)

The original standard specification for analog systems. It is used primarily in North America, Latin America, Australia and parts of Russia and Asia.

ATM (Asynchronous Transfer Mode)

A cell-based connection oriented high-speed data service.

Bluetooth

A computing and telecommunications industry specification that describes the way mobile phones, computers, and personal digital assistants can easily interconnect with each other using a short-range wireless connection.

Bandwidth

Amount of frequency spectrum available for data transfer.

Baseband signal

A signal that has not undergone any shift in frequency.

Base station

A networking installation that houses the equipment needed to set up and complete calls on wireless phones, i.e. transmitter and receiver equipment, antennas, and computers. The base station works along with the subscriber's handset and the mobile switching center (MSC) to complete call and/or data transmission.

BTS (Base Transceiver Station)

A networking component of a base station system that consists of all radio transmission and reception equipment. This provides coverage to a geographic area, and is controlled by a base station controller.

CDMA (Code Division Multiple Access)

A multiplexing standard supporting multiple callers along the same carrier. In CDMA, transmission signals are broken up into coded packets so information that hops along the four clearest, available frequencies in the 1.25 kilohertz range are reassembled at the receiving end.

Cell

The coverage area (usually an outdoor coverage area) that defines the complete range of one or more radio transmitters/receivers acting as a single communications link for a user.

Circuit-switched

A network in which a physical path is obtained for and dedicated to a single connection between two end-points in the network for the duration of the connection. The old electro-mechanical telephone exchanges employed circuit switching.

Directional antenna

An antenna that sends out a signal only in a specific direction (as opposed to an omni-directional antenna).

Demodulation

The reverse process of modulation. Please see 'modulation'.

FDMA (Frequency Division Multiple Access)

A technique used in cellular communications in which channels are assigned specific frequencies.

Frequency

The number of repetitions per second of energy in the form of waves.

GPRS (General Packet Radio Services)

A packet-based wireless communication service that features data rates from 56 to 114 kbps. It also ensures continuous connection to the Internet for mobile phone and computer users.

GPS (Global Positioning System)

A one-way satellite technology that enables persons to determine their exact position within Meters.

GSM (Global System for Mobile communications)

European standard for digital cellular service using slow frequency hopping and Time Division Multiple Access.

HDLC (High Level Data Link Control)

An ISO bit-oriented protocol for link synchronization and error control.

HDR (High Data Rate)

A spectrum-efficient CDMA-based data-only 3G network technology.

Modulation

The process of translating baseband signals to analog.

Packet-switched

The type of network in which relatively small units of data called packets are routed through a network based on the destination address contained within each packet. Breaking communication down into packets allows the same data path to be shared among many users in the network (as opposed to circuit switching).

PCM (Pulse Code Modulation)

A digital scheme for transmitting analog data. Using PCM, it is possible to digitize all forms of analog data, including full-motion video, voices, music, telemetry, and virtual reality.

Radio spectrum

The radio spectrum consists of radio waves of different frequencies (for example, 900 MHz). All radio spectra are regulated, with some licensed and others unlicensed.

RF (Radio Frequency)

Radio frequency is the range of electromagnetic frequencies above sound and below visible light, generally in the 30 KHz to 300 GHz range, used for all broadcast transmission including AM and FM radio, television, short-wave, microwave, and satellite transmissions.

Spectrum

The electromagnetic spectrum includes all frequencies that travel in waves from 10 hertz, just below human audible range, to 10^{25} hertz, cosmic ray range. The radio spectrum includes frequencies between 3 kilohertz and 300 Gigahertz.

Spread Spectrum

This technique sends a message as a series of computer codes. However, since the signal is stretched out over a broad frequency band, the receiver only needs to receive a part of the transmitted signal to reconstruct the original message.

TCP (Transmission Control Protocol)

A very reliable connection-oriented Transport layer protocol designed as part of the Internet.

TDMA (Time Division Multiple Access)

A digital cellular multiplexing standard that divides each carrier frequency into a number of time slots, each constituting an independent telephone circuit.

TDM (Time Division Multiplexing)

A scheme in which numerous signals are combined for transmission on a single communications line or channel. Each signal is broken up into many segments, each having very short duration.

WCDMA (Wideband Code-Division Multiple Access)

An ITU standard derived from CDMA that is officially known as IMT-2000 Direct Spread. WCDMA is a 3G mobile wireless technology.

UMTS (Universal Mobile Telecommunications System)

Universal Mobile Telecommunications System is a 3G broadband packet-based transmission of text, digitized voice, video, and multimedia at data rates up to and possibly higher than 2 Megabits per second (Mbps).