

SUBJECT

WIRELESS NETWORKS

Session 4 Physical Layer
Fundamentals"LAN - Local
Area Network

SESSION 4

One way to categorize the different types of computer network designs is by their scope or scale. For historical reasons, the networking industry refers to nearly every type of design as some kind of *area network*. Common examples of area network types are:

- LAN - Local Area Network
- WLAN - Wireless Local Area Network
- WAN - Wide Area Network
- MAN - Metropolitan Area Network
- SAN - Storage Area Network, System Area Network, Server Area Network, or sometimes Small Area Network
- CAN - Campus Area Network, Controller Area Network, or sometimes Cluster Area Network
- PAN - Personal Area Network
- DAN - Desk Area Network
- [Network Topology](#)
- [Network Management](#)
- [Network Diagram](#)
- [Home Computer Network](#)
- [Network Load Balancer](#)

LAN and WAN were the original categories of area networks, while the others have gradually emerged over many years of technology evolution.

Note that these network types are a separate concept from network topologies such as bus, ring and star.

See also - [Introduction to Network Topologies](#)

LAN - Local Area Network

A [LAN](#) connects network devices over a relatively short distance. A networked office building, school, or home usually contains a single LAN, though sometimes one building will contain a few small LANs (perhaps one per room), and occasionally a LAN will span a group of nearby buildings. In [TCP/IP](#) networking, a LAN is often but not always implemented as a single IP [subnet](#) .

In addition to operating in a limited space, LANs are also typically owned, controlled, and managed by a single person or organization. They also tend to use certain connectivity technologies, primarily Ethernet and Token Ring.

WAN - Wide Area Network

As the term implies, a WAN spans a large physical distance. The Internet is the largest WAN, spanning the Earth.

Ads

A WAN is a geographically-dispersed collection of LANs. A network device called a router connects LANs to a WAN. In IP networking, the router maintains both a LAN address and a WAN address.

A WAN differs from a LAN in several important ways. Most WANs (like the Internet) are not owned by any one organization but rather exist under collective or distributed ownership and management. WANs tend to use technology like ATM, Frame Relay and X.25 for connectivity over the longer distances.

LAN, WAN and Home Networking

Residences typically employ one LAN and connect to the Internet WAN via an Internet Service Provider (ISP) using a broadband modem . The ISP provides a WAN IP address to the modem, and all of the computers on the home network use LAN (so-called *private*) IP addresses. All computers on the home LAN can communicate directly with each other but must go through a central gateway, typically a broadband router , to reach the ISP.

Other Types of Area Networks

While LAN and WAN are by far the most popular network types mentioned, you may also commonly see references to these others:

- **Wireless Local Area Network** - a LAN based on WiFi wireless network technology
- **Metropolitan Area Network** - a network spanning a physical area larger than a LAN but smaller than a WAN, such as a city. A MAN is typically owned and operated by a single entity such as a government body or large corporation.

- **Campus Area Network** - a network spanning multiple LANs but smaller than a MAN, such as on a university or local business campus.
- **Storage Area Network** - connects servers to data storage devices through a technology like Fibre Channel.
- **System Area Network** - links high-performance computers with high-speed connections in a cluster configuration. Also known as Cluster Area Network.

A **home network** or **home area network (HAN)** is a type of local area network that develops from the need to facilitate communication and interoperability among digital devices present inside or within the close vicinity of a home. Devices capable of participating in this network—smart devices such as network printers and handheld mobile computers—often gain enhanced emergent capabilities through their ability to interact. These additional capabilities can then be used to increase the quality of life inside the home in a variety of ways, such as automation of repetitious tasks, increased personal productivity, enhanced home security, and easier access to entertainment.

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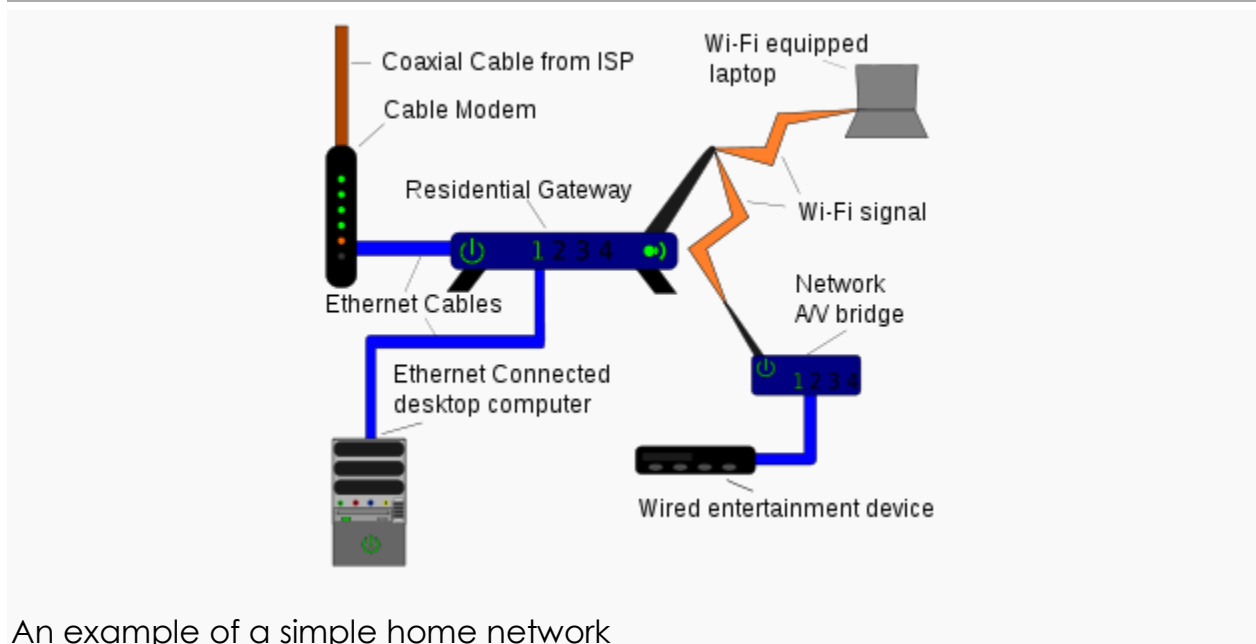
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Causes[

One of the primary drivers behind the establishment of this kind of network is the need to distribute residential Internet access to all internet capable devices in the home. Due to the effect of IPv4 address exhaustion, most Internet Service Providers provide only one WAN-facing IP address for each residential subscription. Therefore most homes require a device capable of network address translation (NAT) that can route packets between the public address visible to the WAN and private addresses of individual devices that share that public address. This router defines the boundary at which the service provider's network stops and the home's network begins. While it is possible for home networks to exist without connectivity to the outside world via a router, such topologies would have limited utility considering the bulk of current home network usage comes from home devices communicating with the WAN rather than with other home devices.

Infrastructure[



An example of a simple home network

A home network usually relies on one of the following equipment to establish physical layer, data link layer, and network layer connectivity both internally amongst devices and externally with outside networks:

- A modem is usually provided by an ISP to expose an Ethernet interface to the WAN via their telecommunications infrastructure. In homes these usually come in the form of a DSL modem or cable modem.
- A router manages network layer connectivity between a WAN and the HAN. Most home networks feature a particular class of small, passively-cooled, table-top device with an integrated wireless access point and 4 port Ethernet switch. These devices aim to make the installation, configuration, and management of a home network as automated, user friendly, and "plug-and-play" as possible.
- A network switch is used to allow devices on the home network to talk to one another via Ethernet. While the needs of most home networks are satisfied with Wi-Fi or the built-in switching capacity of their router, certain situations require the introduction of a distinct switch. For example:
 - When the router's switching capacity is exceeded. Most home routers expose only 4 to 6 Ethernet ports.
 - When Power over Ethernet is required by devices such as IP cameras and IP phones
 - When distant rooms have a large amount of wired devices in close proximity
- A wireless access point is required for connecting wireless devices to a network. Most home networks rely on one "Wireless Router" combination device to fill this role.
- A network bridge connecting two network interfaces to each other, often in order to grant a wired-only device, e.g. Xbox, access to a wireless network medium.

Transmission Media[

Home networks can use either wired or wireless technologies to achieve full connectivity. Home networking may use

- Ethernet Category 5 cable, Category 6 cable - for speeds of 10 Mbit/s, 100 Mbit/s, 1 Gbit/s, or 10Gbit/s.
- Wi-Fi Wireless LAN connections - for speeds up to 450 Mbit/s, dependent on signal strength and wireless standard.

- Coaxial cables (TV antennas) - for speeds of 270 Mbit/s (see [Multimedia over Coax Alliance](#) or 320 Mbit/s see [HomePNA](#))
- Electrical wiring - for speeds of 14 Mbit/s to 200 Mbit/s (see [Power line communication](#))
- Phone wiring - for speeds of 160 Mbit/s (see [HomePNA](#))
- Fiber optics - although rare, new homes are beginning to include fiber optics for future use. Optical networks generally use Ethernet.
- All home wiring (coax, powerline and phone wires) - future standard for speeds up to 1 Gbit/s being developed by the [ITU-T](#) (see [G.hn](#)). ^[1]

Wireless

IEEE 802.11 (WLAN)[

Further information: [IEEE 802.11](#)

One of the most common ways of creating a home network is by using [wireless](#) radio signal technology; the 802.11 network as certified by the [IEEE](#). Most products that are wireless-capable operate at a frequency of 2.4 [GHz](#) under 802.11b and 802.11g or 5 [GHz](#) under 802.11a. Some home networking devices operate in both radio-band signals and fall within the standard 802.11n. [Wi-Fi](#) is a marketing and compliance certification for IEEE 802.11 technologies.^[2] The [WiFi Alliance](#) has tested compliant products certifies them for interoperability.

IEEE 802.15 (WPAN)[

Further information: [IEEE 802.15](#)

Low power, close range communication based on IEEE 802.15 standards has a strong presence in homes. [Bluetooth](#) continues to be the technology of choice for most wireless accessories such as keyboards, mice, headsets, and game controllers. These connections are often established in a transient, ad-hoc manner and is not often seen as an act of expanding a home network.

IEEE 802.15.4 (LR-WPAN)[

Further information: [IEEE 802.15.4](#)

A "low-rate" version of the original WPAN protocol was used as the basis of [ZigBee](#). Despite originally being conceived as a standard for low power machine-to-machine communication in industrial environments, the technology has been found to be well suited for integration into embedded "Smart Home" offerings that are expected to run on battery for extended periods of time. ZigBee utilizes [mesh networking](#) to overcome the distance limitations associated

with traditional WPAN in order to establish a single network of addressable devices spread across the entire building. Z-Wave is a newer standard also built on 802.15.4, that was developed specifically with the needs of home automation device makers in mind.

Structured cabling

Main article: Structured cabling

Twisted pair cables

Further information: Twisted Pair and Ethernet

Most wired network infrastructures found in homes currently utilize some form of category 5 or category 6 twisted pair cabling with RJ45 compatible terminations. This type of medium provides physical connectivity between the Ethernet interfaces present on a large number of residential IP-aware devices.

Fiber Optics

Main article: Fiber to the home

Existing Home Wiring

Further information: Home wiring

As an alternative to wireless networking or additional network cable installation, the existing home wiring (coax in North America, telephone wiring in multi dwelling units (MDU) and power-line in Europe and USA) can be used as a network medium. Using these wiring systems requires installation of a home networking device before the network can be accessed by the end user device.

Power lines

Main article: Power line communication

The ITU-T G.hn and IEEE Powerline standard, which provide high-speed (up to 1 Gbit/s) local area networking over existing home wiring, are examples of home networking technology designed specifically for IPTV delivery.^[3] Recently, the IEEE passed proposal P1901 which grounded a standard within the Market for wireline products produced and sold by companies that are part of the HomePlug Alliance.^[4] The IEEE is continuously working to push for P1901 to be completely recognized worldwide as the sole standard for all future products that are produced for Home Networking.

- [HomePlug](#)
- [Universal Powerline Association](#)
- [HomePNA](#)
- [HomeGrid Forum](#)

Telephone wires[

- [HomePNA](#)
- [VDSL](#)
- [VDSL2](#)

Coaxial cables[

The following standards allow devices to communicate over coaxial cables, which are frequently installed to support multiple television sets throughout homes.

- [DOCSIS](#)
- [Multimedia over Coax Alliance \(MoCA\)](#)
- [CWave](#)

Endpoint devices and services[[edit](#)]

General Purpose

- [Personal computers](#) such as [desktops](#), [laptops](#), [netbooks](#), and [tablets](#)
- A [network attached storage](#) (NAS) device can be easily accessed via the [CIFS](#) or [NFS](#) protocols for general storage or for backup purposes.
- A [print server](#) can be used to share any directly connected printers with other computers on the network.
- [IP Phones](#) or [Smartphones](#) (when connected via [Wi-Fi](#)) utilizing [VoIP](#) technologies

Entertainment

- Television: Some new [TVs](#) and [DVRs](#) include integrated WiFi connectivity which allows the user to access services such as [Netflix](#) and [YouTube](#)
- Home audio: [Digital audio players](#), and [stereo systems](#) with network connectivity can allow a user to easily access their music library, often using [Bonjour](#) to discover and interface with an instance of [iTunes](#) running on a remote PC.

- Gaming: video game consoles rely on connectivity to the home network to enable a significant portion of their overall features, such as the multiplayer in games, social network integration, ability to purchase or demo new games, and receive software updates. Recent consoles have begun more aggressively pursuing the role of the sole entertainment and media hub of the home.
- DLNA is a common protocol used for interoperability between networked media-centric devices in the home

Some older devices may not feature the appropriate network interfaces required for home network connectivity. In some situations, USB dongles and PCI Network Interface Cards are available as accessories that enable this functionality.

Home Automation

Main article: Home Automation

Due to the lowering cost of computing and the ubiquity of smartphone usage, many traditionally non-networked home equipment categories have begun seeing new variants capable of control or remote monitoring through an app on a smartphone. Newer startups and established home equipment manufacturers alike have begun to offer these products as part of a "Smart" or "Intelligent" or "Connected Home" portfolio. The control and/or monitoring interfaces for these products can be accessed through proprietary smartphone applications specific to that product line.

- HVAC: Nest Thermostat
- Smoke/CO detectors: Nest Protect
- Garage door and gate openers: Liftmaster MyQ, GoGogate
- Lighting: Phillips Hue, Samsung Smart Bulb
- Wireless on/off switches

Instead of selling individual products, some service providers have begun offering complete and externally managed home automation and home security solutions that lease networked systems of devices in a subscription model together with externally managed services.

- Time Warner Cable IntelligentHome
- AT&T DigitalLife
- Comcast Xfinity Home

- ADT

Network Management[

Embedded Devices

Most small embedded home network devices require remote configuration from a PC on the same network. For example, broadband modems are often configured through a web browser running on a PC in the same network. These devices usually use a minimal Linux distribution with a lightweight HTTP server running in the background to allow the user to conveniently modify system variables from a GUI rendered in their browser. These pages use HTML forms extensively and make attempts to offer styled, visually appealing views that are also descriptive and easy to use.

Windows PCs[

For HAN users, Microsoft offers simple access control features built into their Windows Operating System. **Homegroup** is a feature that allows shared disk access, shared printer access and shared scanner access among all computers and users (typically family members) in a home, in a similar fashion as in a small office workgroup, e.g., by means of distributed peer-to-peer networking (without a central server). Additionally, a home server may be added for increased functionality.

A *Windows HomeGroup* is a new feature in Microsoft Windows 7 that simplifies file sharing. All users (typically all family members), except guest accounts, may access any shared library on any computer that is connected to the home group. Passwords are not required from the family members during logon. Instead, secure file sharing is possible by means of a temporary password that is used when adding a computer to the HomeGroup.^[5]

Common Infrastructure Issues

Wireless signal loss

The wireless signal strength of the standard residential wireless router may not be powerful enough to cover the entire house or may not be able to get through to all floors of multiple floor residences. In such situations, the installation of one or more Wireless Repeaters may be necessary

"Leaky" Wi-Fi

WiFi often extends beyond the boundaries of a home and can create coverage where it is least wanted, offering a channel through which non-residents could

compromise a system and retrieve personal data. To prevent this it is usually sufficient to enforce the use of authentication, encryption, or VPN that requires a password for network connectivity.

However new Wi-Fi standards working at 60 GHz, such as 802.11ad, enable confidence that the LAN will not trespass physical barriers, as at such frequencies a simple wall would attenuate the signal considerably.

Electrical grid noise[

For home networks relying on powerline communication technology, how to deal with electrical noise injected into the system from standard household appliances remains the largest challenge. Whenever any appliance is turned on or turned off it creates noise that could possibly disrupt data transfer through the wiring. IEEE products that are certified to be HomePlug 1.0 compliant have been engineered to no longer interfere with, or receive interference from other devices plugged into the same home's electrical grid.^[7]

Future[

- Cloud computing has successfully abstracted away even the most simple of network infrastructure concepts from the average home user. Home-dwellers without interest or experience in IT often find it more convenient to migrate assets to an externally managed infrastructure.
- There is an increasing trend of home-dwellers opting for Service Providers' "triple play" solutions which are usually bundled with Gateway/Router/WiFi combination devices that require nothing but the setting of a password to complete configuration. In such situations the home-dweller no longer requires the purchase of an additional routing device to distribute internet access throughout the home—It also obviates the need for the home-dweller having even the most basic understanding of networking technology.
- The recent intense competition brewing between the major Service Providers over the "Connected Home" market of the Internet of Things suggests the possibility that the concept of a "Home Network"—a network distinct from the outside world and managed by the home-dweller—might dissolve over time as complete "Smart Home" solution offerings become more and more appealing to the average consumer who does not always have the time,

patience, knowledge, or interest in the extra IT activities required to make the various devices in the home talk to one another