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| **Contents**   * [1 Architecture of P2P systems](http://en.wikipedia.org/wiki/Peer-to-peer#Architecture_of_P2P_systems)   + [1.1 Structured systems](http://en.wikipedia.org/wiki/Peer-to-peer#Structured_systems)     - [1.1.1 Distributed hash tables](http://en.wikipedia.org/wiki/Peer-to-peer#Distributed_hash_tables)   + [1.2 Unstructured systems](http://en.wikipedia.org/wiki/Peer-to-peer#Unstructured_systems)   + [1.3 Indexing and resource discovery](http://en.wikipedia.org/wiki/Peer-to-peer#Indexing_and_resource_discovery) * [2 Peer-to-peer-like systems](http://en.wikipedia.org/wiki/Peer-to-peer#Peer-to-peer-like_systems) * [3 Advantages and weaknesses](http://en.wikipedia.org/wiki/Peer-to-peer#Advantages_and_weaknesses) * [4 Social and economic impact](http://en.wikipedia.org/wiki/Peer-to-peer#Social_and_economic_impact) * [5 Applications](http://en.wikipedia.org/wiki/Peer-to-peer#Applications)   + [5.1 Content delivery](http://en.wikipedia.org/wiki/Peer-to-peer#Content_delivery)   + [5.2 Exchange of physical goods, services, or space](http://en.wikipedia.org/wiki/Peer-to-peer#Exchange_of_physical_goods.2C_services.2C_or_space)   + [5.3 Networking](http://en.wikipedia.org/wiki/Peer-to-peer#Networking)   + [5.4 Science](http://en.wikipedia.org/wiki/Peer-to-peer#Science)   + [5.5 Search](http://en.wikipedia.org/wiki/Peer-to-peer#Search)   + [5.6 Communications networks](http://en.wikipedia.org/wiki/Peer-to-peer#Communications_networks)   + [5.7 General](http://en.wikipedia.org/wiki/Peer-to-peer#General)   + [5.8 Miscellaneous](http://en.wikipedia.org/wiki/Peer-to-peer#Miscellaneous) * [6 Historical perspective](http://en.wikipedia.org/wiki/Peer-to-peer#Historical_perspective) * [7 Network neutrality controversy](http://en.wikipedia.org/wiki/Peer-to-peer#Network_neutrality_controversy) * [8 See also](http://en.wikipedia.org/wiki/Peer-to-peer#See_also) * [9 References](http://en.wikipedia.org/wiki/Peer-to-peer#References) * [10 External links](http://en.wikipedia.org/wiki/Peer-to-peer#External_links) |

A **peer-to-peer** (abbreviated to **P2P**) computer network is one in which each computer in the network can act as a client or server for the other computers in the network, allowing shared access to various resources such as files, [peripherals](http://en.wikipedia.org/wiki/Peripheral), and sensors without the need for a central server. P2P networks can be set up within the home, a business, or over the Internet. Each network type requires all computers in the network to use the same or a compatible program to connect to each other and access files and other resources found on the other computer. P2P networks can be used for sharing content such as audio, video, data, or anything in digital format.

P2P is a distributed application architecture that partitions tasks or workloads among peers. Peers are equally privileged participants in the application. Each computer in the network is referred to as a [node](http://en.wikipedia.org/wiki/Node_(networking)). The owner of each computer on a P2P network would set aside a portion of its resources - such as processing power, disk storage, or network bandwidth - to be made directly available to other network participant, without the need for central coordination by servers or stable hosts. With this model, peers are both suppliers and consumers of resources, in contrast to the traditional [client–server](http://en.wikipedia.org/wiki/Client%E2%80%93server) model where only the server supply (send), and clients consume (receive). Emerging collaborative P2P systems are going beyond the era of peers doing similar things while sharing resources, and are looking for diverse peers that can bring in unique resources and capabilities to a virtual community thereby empowering it to engage in greater tasks beyond that can be accomplished by individual peers, yet are beneficial to all the peers.

The first P2P distributed system platform was Pipes Platform by PeerLogic.[[*citation needed*](http://en.wikipedia.org/wiki/Wikipedia:Citation_needed)] One of PeerLogic's first licensees was [Texas Instruments](http://en.wikipedia.org/wiki/Texas_Instruments) in 1993. While P2P systems were used in many application domains, the first P2P killer application was the file sharing system [Napster](http://en.wikipedia.org/wiki/Napster), originally released in 1999. The concept has inspired new structures and philosophies in many areas of human interaction. P2P networking is not restricted to technology; it also covers social processes with a P2P dynamic. In such context, [social peer-to-peer processes](http://en.wikipedia.org/wiki/Social_peer-to-peer_processes) are currently emerging throughout the [society](http://en.wikipedia.org/wiki/Society).

Architecture of P2P systems

Peer-to-peer systems often implement an abstract [overlay network](http://en.wikipedia.org/wiki/Overlay_network), built at [Application Layer](http://en.wikipedia.org/wiki/Application_Layer), on top of the native or physical network topology. Such overlays are used for indexing and peer discovery and make the P2P system independent from the physical network topology. Content is typically exchanged directly over the underlying [Internet Protocol](http://en.wikipedia.org/wiki/Internet_Protocol) (IP) network. [Anonymous peer-to-peer](http://en.wikipedia.org/wiki/Anonymous_P2P) systems are an exception, and implement extra routing layers to obscure the identity of the source or destination user/node.

A pure P2P network does not have the notion of [clients](http://en.wikipedia.org/wiki/Client_(computing)) or servers but only equal [*peer*](http://en.wikipedia.org/wiki/Peer_group_(computer_networking)) nodes that simultaneously function as both "clients" and "servers" to the other nodes on the network. This model of network arrangement differs from the [client–server](http://en.wikipedia.org/wiki/Client%E2%80%93server) model where communication is usually to and from a central server. A typical example of a file transfer that does not use the P2P model is the [File Transfer Protocol](http://en.wikipedia.org/wiki/File_Transfer_Protocol) (FTP) service in which the client and server programs are distinct: the clients initiate the transfer, and the servers satisfy these requests.

The P2P [overlay network](http://en.wikipedia.org/wiki/Overlay_network) consists of all the participating peers as network nodes. There are links between any two nodes that know each other: i.e. if a participating peer knows the location of another peer in the P2P network, then there is a directed edge from the former node to the latter in the overlay network. Based on how the nodes in the overlay network are linked to each other, we can classify the P2P networks as structured or unstructured

In *structured P2P* networks, peers are organized following specific criteria and algorithms, which lead to overlays with specific topologies and properties. They typically use[distributed hash table](http://en.wikipedia.org/wiki/Distributed_hash_table) (DHT) based indexing, such as in the [Chord](http://en.wikipedia.org/wiki/Chord_(peer-to-peer)) system ([MIT](http://en.wikipedia.org/wiki/Massachusetts_Institute_of_Technology)).[[4]](http://en.wikipedia.org/wiki/Peer-to-peer#cite_note-4) Structured P2P systems are appropriate for large-scale implementations due to high scalability and some guarantees on performance (typically approximating O(log N), where N is the number of nodes in the P2P system).

*Unstructured P2P* networks do not impose any structure on the overlay networks. Peers in these networks connect in an [ad-hoc](http://en.wikipedia.org/wiki/Ad-hoc) fashion based on some loose set of rules. Ideally, unstructured P2P systems would have absolutely no centralized elements/nodes, but in practice there are several types of unstructured systems with various degrees of centralization. Three categories can easily be seen:

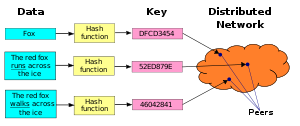
* In *pure peer-to-peer* systems the entire network consists solely of [equipotent](http://en.wiktionary.org/wiki/equipotent) peers. There is only one routing layer, as there are no preferred nodes with any special infrastructure function.
* In *centralized peer-to-peer* systems, a central server is used for indexing functions and to bootstrap the entire system. Although this has similarities with a structured architecture, the connections between peers are not determined by any algorithm.
* *Hybrid peer-to-peer* systems allow such infrastructure nodes to exist, often called *supernodes*.

The first prominent and popular [peer-to-peer file sharing](http://en.wikipedia.org/wiki/Peer-to-peer_file_sharing) system, Napster, was an example of the centralized model. [Freenet](http://en.wikipedia.org/wiki/Freenet) and early implementations of the [gnutella](http://en.wikipedia.org/wiki/Gnutella) protocol, on the other hand, are examples of the decentralized model. Modern [gnutella](http://en.wikipedia.org/wiki/Gnutella) implementations, [Gnutella2](http://en.wikipedia.org/wiki/Gnutella2), as well as the now deprecated [Kazaa](http://en.wikipedia.org/wiki/Kazaa) network are examples of the hybrid model.

**Structured systems**

Structured P2P networks employ a globally consistent protocol to ensure that any node can efficiently route a search to some peer that has the desired file/resource, even if the resource is extremely rare. Such a guarantee necessitates a more structured pattern of overlay links. The most common type of structured P2P networks implement a [distributed hash table](http://en.wikipedia.org/wiki/Distributed_hash_table) (DHT), in which a variant of [consistent hashing](http://en.wikipedia.org/wiki/Consistent_hashing) is used to assign ownership of each file to a particular peer, in a way analogous to a traditional [hash table](http://en.wikipedia.org/wiki/Hash_table)'s assignment of each key to a particular array slot. Though the term DHT is commonly used to refer to the structured overlay, in practice, DHT is a data structure implemented on top of a structured overlay.

**Distributed hash tables**

[](http://en.wikipedia.org/wiki/File:DHT_en.svg)

[http://bits.wikimedia.org/static-1.21wmf5/skins/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:DHT_en.svg)

Distributed hash tables

[Distributed hash tables](http://en.wikipedia.org/wiki/Distributed_hash_table) (DHTs) are a class of decentralized [distributed systems](http://en.wikipedia.org/wiki/Distributed_computing) that provide a lookup service similar to a[hash table](http://en.wikipedia.org/wiki/Hash_table): (*key*, *value*) pairs are stored in the DHT, and any participating [node](http://en.wikipedia.org/wiki/Node_(networking)) can efficiently retrieve the value associated with a given key. Responsibility for maintaining the mapping from keys to values is distributed among the nodes, in such a way that a change in the set of participants causes a minimal amount of disruption. This allows DHTs to [scale](http://en.wikipedia.org/wiki/Scalability) to extremely large numbers of nodes and to handle continual node arrivals, departures, and failures.

DHTs form an infrastructure that can be used to build P2P networks. Notable distributed networks that use DHTs include [BitTorrent's](http://en.wikipedia.org/wiki/BitTorrent_(protocol)" \o "BitTorrent (protocol)) distributed tracker, the [Kad network](http://en.wikipedia.org/wiki/Kad_network), the [Storm botnet](http://en.wikipedia.org/wiki/Storm_botnet), [YaCy](http://en.wikipedia.org/wiki/YaCy), and the [Coral Content Distribution Network](http://en.wikipedia.org/wiki/Coral_Content_Distribution_Network).

Some prominent research projects include the [Chord project](http://en.wikipedia.org/wiki/Chord_(peer-to-peer)), [Kademlia](http://en.wikipedia.org/wiki/Kademlia), [PAST storage utility](http://en.wikipedia.org/wiki/PAST_storage_utility), [P-Grid](http://en.wikipedia.org/wiki/P-Grid), a self-organized and emerging overlay network, and [CoopNet content distribution system](http://en.wikipedia.org/wiki/CoopNet_content_distribution_system) (see below for external links related to these projects).

DHT-based networks have been widely utilized for accomplishing efficient resource discovery for [grid computing](http://en.wikipedia.org/wiki/Grid_computing) systems, as it aids in resource management and scheduling of applications. Recent advances in the domain of decentralized resource discovery have been based on extending the existing DHTs with the capability of multi-dimensional data organization and query routing. The majority of the efforts have looked at embedding spatial database indices such as the Space Filling Curves (SFCs) including the [Hilbert curves](http://en.wikipedia.org/wiki/Hilbert_curve_scheduling), Z-curves, k-d tree, MX-CIF Quad tree and R\*-tree for managing, routing, and indexing of complex Grid resource query objects over DHT networks. Spatial indices are well suited for handling the complexity of Grid resource queries. Although some spatial indices can have issues as regards to routing load-balance in case of a skewed data set, all the spatial indices are more scalable in terms of the number of hops traversed and messages generated while searching and routing Grid resource queries]. Other design choices includes overlay rings and d-Torus. More recent evaluation of P2P resource discovery solutions under real workloads have pointed out several issues in DHT-based solutions such as high cost of advertising/discovering resources and static and dynamic load imbalance.

**Unstructured systems**

An unstructured P2P network is formed when the overlay links are established arbitrarily. Such networks can be easily constructed as a new peer that wants to join the network can copy existing links of another node and then form its own links over time. In an unstructured P2P network, if a peer wants to find a desired piece of data in the network, the query has to be flooded through the network to find as many peers as possible that share the data. The main disadvantage with such networks is that the queries may not always be resolved. Popular content is likely to be available at several peers and any peer searching for it is likely to find the same thing. But if a peer is looking for rare data shared by only a few other peers, then it is highly unlikely that search will be successful. Since there is no [correlation](http://en.wikipedia.org/wiki/Correlation) between a peer and the content managed by it, there is no guarantee that flooding will find a peer that has the desired data. Flooding also causes a high amount of signaling traffic in the network and hence such networks typically have very poor search efficiency. Many of the popular P2P networks are unstructured.

In *pure* P2P networks: Peers act as equals, merging the roles of clients and server. In such networks, there is no central server managing the network, neither is there a central router. Some examples of pure P2P [Application Layer](http://en.wikipedia.org/wiki/Application_Layer) networks designed for [peer-to-peer file sharing](http://en.wikipedia.org/wiki/Peer-to-peer_file_sharing) are [gnutella](http://en.wikipedia.org/wiki/Gnutella) (pre v0.4) and [Freenet](http://en.wikipedia.org/wiki/Freenet).

There also exist *hybrid* P2P systems, which distribute their clients into two groups: client nodes and overlay nodes. Typically, each client is able to act according to the momentary need of the network and can become part of the respective [overlay network](http://en.wikipedia.org/wiki/Overlay_network) used to coordinate the P2P structure. This division between normal and 'better' nodes is done in order to address the scaling problems on early pure P2P networks. As examples for such networks can be named modern implementations of gnutella (after v0.4) and [Gnutella2](http://en.wikipedia.org/wiki/Gnutella2).

Another type of hybrid P2P network are networks using on the one hand central server(s) or bootstrapping mechanisms, on the other hand P2P for their data transfers. These networks are in general called 'centralized networks' because of their lack of ability to work without their central server(s). An example for such a network is the [eDonkey network](http://en.wikipedia.org/wiki/EDonkey_network)(often also called *eD2k*).

**Indexing and resource discovery**

Older peer-to-peer networks duplicate resources across each node in the network configured to carry that type of information. This allows local searching, but requires much traffic.

Modern networks use central coordinating servers and directed search requests. Central servers are typically used for listing potential peers ([Tor](http://en.wikipedia.org/wiki/Tor_(anonymity_network))), coordinating their activities ([Folding@home](http://en.wikipedia.org/wiki/Folding@home)), and searching ([Napster](http://en.wikipedia.org/wiki/Napster), [eMule](http://en.wikipedia.org/wiki/EMule)). Decentralized searching was first done by flooding search requests out across peers. More efficient directed search strategies, including supernodes and distributed hash tables, are now used.

Peer-to-peer-like systems

In modern definitions of peer-to-peer technology, the term implies the general architectural concepts outlined in this article. However, the basic concept of peer-to-peer computing was envisioned in earlier software systems and networking discussions, reaching back to principles stated in the first [Request for Comments](http://en.wikipedia.org/wiki/Request_for_Comments), [RFC 1](http://tools.ietf.org/html/rfc1).

A distributed messaging system that is often likened as an early peer-to-peer architecture is the [USENET](http://en.wikipedia.org/wiki/Usenet) network news system that is in principle a client–server model from the user or client perspective, when they read or post news articles. However, [news servers](http://en.wikipedia.org/wiki/News_server) communicate with one another as peers to propagate [Usenet news](http://en.wikipedia.org/wiki/Usenet) articles over the entire group of network servers. The same consideration applies to [SMTP](http://en.wikipedia.org/wiki/Simple_Mail_Transfer_Protocol) email in the sense that the core email relaying network of [Mail transfer agents](http://en.wikipedia.org/wiki/Mail_transfer_agent) has a peer-to-peer character, while the periphery of [e-mail clients](http://en.wikipedia.org/wiki/E-mail_client) and their direct connections is strictly a client–server relationship. [Tim Berners-Lee](http://en.wikipedia.org/wiki/Tim_Berners-Lee)'s vision for the [World Wide Web](http://en.wikipedia.org/wiki/World_Wide_Web), as evidenced by his[WorldWideWeb](http://en.wikipedia.org/wiki/WorldWideWeb) editor/browser, was close to a peer-to-peer design in that it assumed each user of the web would be an active editor and contributor creating and linking content to form an interlinked *web* of links. This contrasts to the [broadcasting](http://en.wikipedia.org/wiki/Broadcasting)-like structure of the web as it has developed over the years.

Advantages and weaknesses

In P2P networks, clients provide resources, which may include [bandwidth](http://en.wikipedia.org/wiki/Bandwidth_(computing)), storage space, and computing power. This property is one of the major advantages of using P2P networks because it makes the setup and running costs very small for the original content distributor. As nodes arrive and demand on the system increases, the total capacity of the system also increases, and the likelihood of failure decreases. If one peer on the network fails to function properly, the whole network is not compromised or damaged. In contrast, in a typical client–server architecture, clients share only their demands with the system, but not their resources. In this case, as more clients join the system, fewer resources are available to serve each client, and if the central server fails, the entire network is taken down. The decentralized nature of P2P networks increases robustness because it removes the [single point of failure](http://en.wikipedia.org/wiki/Reliability_engineering) that can be inherent in a client-server based system.

Another important property of peer-to-peer systems is the lack of a system administrator. This leads to a network that is easier and faster to setup and keep running because a full staff is not required to ensure efficiency and stability. Decentralized networks introduce new security issues because they are designed so that each user is responsible for controlling their data and resources. Peer-to-peer networks, along with almost all network systems, are vulnerable to unsecure and unsigned codes that may allow remote access to files on a victim's computer or even compromise the entire network. A user may encounter harmful data by downloading a file that was originally uploaded as a virus disguised in an .exe, .mp3, .avi, or any other filetype. This type of security issue is due to the lack of an administrator that maintains the list of files being distributed.

Harmful data can also be distributed on P2P networks by modifying files that are already being distributed on the network. This type of security breach is created by the fact that users are connecting to untrusted sources, as opposed to a maintained server. In the past this has happened to the [FastTrack](http://en.wikipedia.org/wiki/FastTrack) network when the [RIAA](http://en.wikipedia.org/wiki/RIAA) managed to introduce faked chunks into downloads and downloaded files (mostly [MP3](http://en.wikipedia.org/wiki/MP3) files). Files infected with the RIAA virus were unusable afterwards or even contained malicious code. The RIAA is also known to have uploaded fake music and movies to P2P networks in order to deter illegal file sharing. Consequently, the P2P networks of today have seen an enormous increase of their security and file verification mechanisms. Modern [hashing](http://en.wikipedia.org/wiki/Hash_chain), [chunk verification](http://en.wikipedia.org/wiki/File_verification) and different encryption methods have made most networks resistant to almost any type of attack, even when major parts of the respective network have been replaced by faked or nonfunctional hosts.

There are both advantages and disadvantages in P2P networks related to the topic of data backup, recovery, and availability. In a centralized network, the system administrators are the only forces controlling the availability of files being shared. If the administrators decide to no longer distribute a file, they simply have to remove it from their servers, and it will no longer be available to users. Along with leaving the users powerless in deciding what is distributed throughout the community, this makes the entire system vulnerable to threats and requests from the government and other large forces. For example, YouTube has been pressured by the RIAA, MPAA, and entertainment industry to filter out copyrighted content. Although server-client networks are able to monitor and manage content availability, they can have more stability in the availability of the content they choose to host. A client should not have trouble accessing obscure content that is being shared on a stable centralized network. P2P networks, however, are more unreliable in sharing unpopular files because sharing files in a P2P network requires that at least one node in the network has the requested data, and that node must be able to connect to the node requesting the data. This requirement is occasionally hard to meet because users may delete or stop sharing data at any point.

In this sense, the community of users in a P2P network is completely responsible for deciding what content is available. Unpopular files will eventually disappear and become unavailable as more people stop sharing them. Popular files, however, will be highly and easily distributed. Popular files on a P2P network actually have more stability and availability than files on central networks. In a centralized network, only the loss of connection between the clients and server is simple enough to cause a failure, but in P2P networks, the connections between every node must be lost in order to fail to share data. In a centralized system, the administrators are responsible for all data recovery and backups, while in P2P systems, each node requires its own backup system. Because of the lack of central authority in P2P networks, forces such as the recording industry, RIAA, MPAA, and the government are unable to delete or stop the sharing of content on P2P systems.

Social and economic impact

The concept of P2P is increasingly evolving to an expanded usage as the relational dynamic active in distributed networks, *i.e.*, not just computer-to-computer, but human-to-human. [Yochai Benkler](http://en.wikipedia.org/wiki/Yochai_Benkler) has coined the term [commons-based peer production](http://en.wikipedia.org/wiki/Commons-based_peer_production) to denote collaborative projects such as [free and open source software](http://en.wikipedia.org/wiki/Free_and_open_source_software) and [Wikipedia](http://en.wikipedia.org/wiki/Wikipedia). Associated with peer production are the concepts of:

* peer governance (referring to the manner in which peer production projects are managed)
* peer property (referring to the new type of licenses which recognize individual authorship but not exclusive property rights, such as the [GNU General Public License](http://en.wikipedia.org/wiki/GNU_General_Public_License) and the[Creative Commons](http://en.wikipedia.org/wiki/Creative_Commons) licenses)
* peer distribution (or the manner in which products, particularly peer-produced products, are distributed)

Some researchers have explored the benefits of enabling virtual communities to self-organize and introduce incentives for resource sharing and cooperation, arguing that the social aspect missing from today's P2P systems should be seen both as a goal and a means for self-organized virtual communities to be built and fostered. Ongoing research efforts for designing effective incentive mechanisms in P2P systems, based on principles from game theory are beginning to take on a more psychological and information-processing direction.

Applications

There are numerous applications of peer-to-peer networks. The most commonly known is for content distribution

**Content delivery**

* Many file sharing networks, such as [gnutella](http://en.wikipedia.org/wiki/Gnutella), [G2](http://en.wikipedia.org/wiki/Gnutella2) and the [eDonkey network](http://en.wikipedia.org/wiki/EDonkey_network) popularized peer-to-peer technologies. From 2004 on, such networks form the largest contributor of network traffic on the Internet.
* Peer-to-peer content delivery networks ([P2P-CDN](http://en.wikipedia.org/w/index.php?title=P2P-CDN&action=edit&redlink=1)). See : [Giraffic](http://en.wikipedia.org/w/index.php?title=Giraffic&action=edit&redlink=1), [Kontiki](http://en.wikipedia.org/wiki/Kontiki), [Ignite](http://en.wikipedia.org/wiki/Ignite), [RedSwoosh](http://en.wikipedia.org/wiki/RedSwoosh).
* Peer-to-peer content services, e.g. caches for improved performance such as Correli Caches[[18]](http://en.wikipedia.org/wiki/Peer-to-peer#cite_note-18)
* Software publication and distribution (Linux, several games); via [file sharing](http://en.wikipedia.org/wiki/File_sharing) networks.
* [Streaming media](http://en.wikipedia.org/wiki/Streaming_media). [P2PTV](http://en.wikipedia.org/wiki/P2PTV) and [PDTP](http://en.wikipedia.org/wiki/Peer_Distributed_Transfer_Protocol). Applications include [TVUPlayer](http://en.wikipedia.org/wiki/TVUnetworks), [Joost](http://en.wikipedia.org/wiki/Joost), [CoolStreaming](http://en.wikipedia.org/wiki/CoolStreaming), [Cybersky-TV](http://en.wikipedia.org/wiki/Cybersky-TV), [PPLive](http://en.wikipedia.org/wiki/PPLive), [LiveStation](http://en.wikipedia.org/wiki/LiveStation), [Giraffic](http://en.wikipedia.org/w/index.php?title=Giraffic&action=edit&redlink=1) and [Didiom](http://en.wikipedia.org/wiki/Didiom).
* [Spotify](http://en.wikipedia.org/wiki/Spotify) uses a peer-to-peer network along with streaming servers to stream music to its desktop music player.
* [Peercasting](http://en.wikipedia.org/wiki/Peercasting) for multicasting streams. See [PeerCast](http://en.wikipedia.org/wiki/PeerCast), IceShare, [FreeCast](http://en.wikipedia.org/wiki/FreeCast), [Rawflow](http://en.wikipedia.org/wiki/Rawflow)
* Pennsylvania State University, MIT and Simon Fraser University are carrying on a project called [LionShare](http://en.wikipedia.org/wiki/LionShare) designed for facilitating file sharing among educational institutions globally.
* [Osiris (Serverless Portal System)](http://en.wikipedia.org/wiki/Osiris_(Serverless_Portal_System)) allows its users to create anonymous and autonomous web portals distributed via P2P network.

**Exchange of physical goods, services, or space**

* Peer-to-peer renting web platforms enable people to find and reserve goods, services, or space on the virtual platform, but carry out the actual P2P transaction in the physical world (for example: emailing a local footwear vendor to reserve for you that comfy pair of slippers which you've always had your eyes on, or contacting a neighbor who has listed their weedwacker for rent).
* [Bitcoin](http://en.wikipedia.org/wiki/Bitcoin) is a peer-to-peer based digital currency.
* [Tradepal](http://en.wikipedia.org/wiki/Tradepal) is a peer-to-peer marketplace where users list, discover, share and trade unique items with trusted peers.

**Networking**

* [Dalesa](http://en.wikipedia.org/wiki/Dalesa) a peer-to-peer web cache for LANs (based on IP multicasting).
* [Voice Peering Fabric](http://en.wikipedia.org/w/index.php?title=Voice_Peering_Fabric&action=edit&redlink=1) is a peer-to-peer interconnect system for routing [VoIP](http://en.wikipedia.org/wiki/VoIP) traffic between organizations by utilizing [BGP](http://en.wikipedia.org/wiki/BGP) and [ENUM](http://en.wikipedia.org/wiki/ENUM) technology.
* [Open Garden](http://en.wikipedia.org/wiki/Open_Garden), connection sharing application that shares Internet access with other devices using Wi-Fi or Bluetooth.

**Science**

* In bioinformatics, drug candidate identification. The first such program was begun in 2001 the Centre for Computational Drug Discovery at the [University of Oxford](http://en.wikipedia.org/wiki/University_of_Oxford) in cooperation with the National Foundation for Cancer Research. There are now several similar programs running under the [United Devices Cancer Research Project](http://en.wikipedia.org/wiki/Grid.org).
* The [sciencenet](http://en.wikipedia.org/wiki/Sciencenet) P2P search engine.

**Search**

* [Distributed search engine](http://en.wikipedia.org/wiki/Distributed_search_engine), a search engine where there is no central server
* [YaCy](http://en.wikipedia.org/wiki/YaCy), a free distributed search engine, built on principles of peer-to-peer networks.
* [FAROO](http://en.wikipedia.org/wiki/FAROO), a Peer-to-peer Web search engine

**Communications networks**

* [Skype](http://en.wikipedia.org/wiki/Skype), one of the most widely used internet phone applications is using P2P technology.
* [VoIP](http://en.wikipedia.org/wiki/Voice_over_Internet_Protocol) (using application layer protocols such as [SIP](http://en.wikipedia.org/wiki/Session_Initiation_Protocol))
* [Instant messaging](http://en.wikipedia.org/wiki/Instant_messaging) and [online chat](http://en.wikipedia.org/wiki/Online_chat)
* Completely decentralized networks of peers: [Usenet](http://en.wikipedia.org/wiki/Usenet) (1979) and [WWIVnet](http://en.wikipedia.org/wiki/WWIVnet) (1987).

**General**

* Research like the [Chord project](http://en.wikipedia.org/wiki/Chord_(peer-to-peer)), the [PAST storage utility](http://en.wikipedia.org/wiki/PAST_storage_utility), the [P-Grid](http://en.wikipedia.org/wiki/P-Grid), and the [CoopNet content distribution system](http://en.wikipedia.org/wiki/CoopNet_content_distribution_system).
* [JXTA](http://en.wikipedia.org/wiki/JXTA), for Peer applications. See [Collanos Workplace](http://en.wikipedia.org/wiki/Collanos) ([Teamwork software](http://en.wikipedia.org/wiki/Collaborative_software)), Sixearch

**Miscellaneous**

* The U.S. Department of Defense is conducting research on P2P networks as part of its modern network warfare strategy. In May, 2003, [Anthony Tether](http://en.wikipedia.org/wiki/Anthony_Tether), then director of DARPA, testified that the U.S. military uses P2P networks.
* Kato et al.'s studies indicate over 200 companies have invested approximately $400 million USD in P2P networking. Besides file sharing, companies are also interested in distributing computing and content distribution applications.
* [Wireless community network](http://en.wikipedia.org/wiki/Wireless_community_network), [Netsukuku](http://en.wikipedia.org/wiki/Netsukuku)
* An earlier generation of peer-to-peer systems were called "metacomputing" or "middleware". These include: [Legion](http://en.wikipedia.org/wiki/Legion_(software)), [Globus](http://en.wikipedia.org/wiki/Globus_Toolkit)

Historical perspective

[Tim Berners-Lee](http://en.wikipedia.org/wiki/Tim_Berners-Lee)'s vision for the [World Wide Web](http://en.wikipedia.org/wiki/World_Wide_Web) was close to a P2P network in that it assumed each user of the web would be an active editor and contributor, creating and linking content to form an interlinked "web" of links. This contrasts to the current [broadcasting](http://en.wikipedia.org/wiki/Broadcasting)-like structure of the web.

Some networks and channels such as [Napster](http://en.wikipedia.org/wiki/Napster), [OpenNAP](http://en.wikipedia.org/wiki/Opennap) and [IRC](http://en.wikipedia.org/wiki/Internet_Relay_Chat) [serving channels](http://en.wikipedia.org/wiki/Serving_channel) use a client–server structure for some tasks (e.g., searching) and a P2P structure for others. Networks such as [gnutella](http://en.wikipedia.org/wiki/Gnutella) or [Freenet](http://en.wikipedia.org/wiki/Freenet) use a P2P structure for nearly all tasks, with the exception of finding peers to connect to when first setting up.

P2P architecture embodies one of the key technical concepts of the Internet, described in the first Internet [Request for Comments](http://en.wikipedia.org/wiki/Request_for_Comments), [RFC 1](http://tools.ietf.org/html/rfc1), "Host Software" dated April 7, 1969. More recently, the concept has achieved recognition in the general public in the context of the absence of central indexing [servers](http://en.wikipedia.org/wiki/Server_(computing)) in architectures used for exchanging multimedia files.

Network neutrality controversy

Peer-to-peer applications present one of the core issues in the [network neutrality](http://en.wikipedia.org/wiki/Network_neutrality) controversy. Internet service providers ([ISPs](http://en.wikipedia.org/wiki/Internet_service_provider)) have been known to throttle P2P file-sharing traffic due to its high-bandwidth usage. Compared to Web browsing, e-mail or many other uses of the internet, where data is only transferred in short intervals and relative small quantities, P2P file-sharing often consists of relatively heavy bandwidth usage due to ongoing file transfers and swarm/network coordination packets. In October 2007, [Comcast](http://en.wikipedia.org/wiki/Comcast), one of the largest broadband Internet providers in the USA, started blocking P2P applications such as [BitTorrent](http://en.wikipedia.org/wiki/BitTorrent_(protocol)). Their rationale was that P2P is mostly used to share illegal content, and their infrastructure is not designed for continuous, high-bandwidth traffic. Critics point out that P2P networking has legitimate uses, and that this is another way that large providers are trying to control use and content on the Internet, and direct people towards a [client-server](http://en.wikipedia.org/wiki/Client-server)-based application architecture. The client-server model provides financial barriers-to-entry to small publishers and individuals, and can be less efficient for sharing large files. As a reaction to this [bandwidth throttling](http://en.wikipedia.org/wiki/Bandwidth_throttling), several P2P applications started implementing protocol obfuscation, such as the [BitTorrent protocol encryption](http://en.wikipedia.org/wiki/BitTorrent_protocol_encryption). Techniques for achieving "protocol obfuscation" involves removing otherwise easily identifiable properties of protocols, such as deterministic byte sequences and packet sizes, by making the data look as if it were random The ISP's solution to the high bandwidth is [P2P caching](http://en.wikipedia.org/wiki/P2P_caching), where a ISP stores the part of files most accessed by P2P clients in order to save access to the Internet.

References

* 1. [**^**](http://en.wikipedia.org/wiki/Peer-to-peer#cite_ref-1) Rüdiger Schollmeier, *A Definition of Peer-to-Peer Networking for the Classification of Peer-to-Peer Architectures and Applications*, Proceedings of the First International Conference on Peer-to-Peer Computing, IEEE (2002).
  2. ^ [***a***](http://en.wikipedia.org/wiki/Peer-to-peer#cite_ref-CP2P_2-0) [***b***](http://en.wikipedia.org/wiki/Peer-to-peer#cite_ref-CP2P_2-1) Bandara, H. M. N. D; A. P. Jayasumana (2012). "Collaborative Applications over Peer-to-Peer Systems – Challenges and Solutions". *Peer-to-Peer Networking and Applications*. [doi](http://en.wikipedia.org/wiki/Digital_object_identifier):[10.1007/s12083-012-0157-3](http://dx.doi.org/10.1007%2Fs12083-012-0157-3).
  3. [**^**](http://en.wikipedia.org/wiki/Peer-to-peer#cite_ref-3) D. Barkai, "Peer-to-Peer Computing," Intel Press, 2002.
  4. [**^**](http://en.wikipedia.org/wiki/Peer-to-peer#cite_ref-4) Kelaskar, M.; Matossian, V.; Mehra, P.; Paul, D.; Parashar, M. (2002), [*A Study of Discovery Mechanisms for Peer-to-Peer Application*](http://portal.acm.org/citation.cfm?id=873218)
  5. [**^**](http://en.wikipedia.org/wiki/Peer-to-peer#cite_ref-5) Shen, Xuemin; Yu, Heather; Buford, John; Akon, Mursalin (2009). *Handbook of Peer-to-Peer Networking* (1st ed.). New York: Springer. pp. 118. [ISBN](http://en.wikipedia.org/wiki/International_Standard_Book_Number) [0-387-09750-3](http://en.wikipedia.org/wiki/Special:BookSources/0-387-09750-3).
  6. [**^**](http://en.wikipedia.org/wiki/Peer-to-peer#cite_ref-6) Beverly Yang and Hector Garcia-Molina, *Designing a super-peer network*, Proceedings of the 19th International Conference on Data Engineering (2003).
  7. [**^**](http://en.wikipedia.org/wiki/Peer-to-peer#cite_ref-7) [Napster - the first prominent example of a centralized P2P system](http://www8.cs.umu.se/~bergner/thesis/html/node30.html)
  8. [**^**](http://en.wikipedia.org/wiki/Peer-to-peer#cite_ref-P2P_API_8-0) Dabek, Frank; Ben Zhao, Peter Druschel, John Kubiatowicz and Ion Stoica (2003).["Towards a Common API for Structured Peer-to-Peer Overlays"](http://dx.doi.org/10.1007/978-3-540-45172-3_3). *Peer-to-Peer Systems II*. Lecture Notes in Computer Science **2735**: 33–44. [doi](http://en.wikipedia.org/wiki/Digital_object_identifier):[10.1007/978-3-540-45172-3\_3](http://dx.doi.org/10.1007%2F978-3-540-45172-3_3).
  9. [**^**](http://en.wikipedia.org/wiki/Peer-to-peer#cite_ref-9) Ranjan, Rajiv; Harwood, Aaron; Buyya, Rajkumar (1 December 2006), [*A Study on Peer-to-Peer Based Discovery of Grid Resource Information*](http://www.cs.mu.oz.au/~rranjan/pgrid.pdf)
  10. [**^**](http://en.wikipedia.org/wiki/Peer-to-peer#cite_ref-10) Ranjan, Rajiv; Chan, Lipo; Harwood, Aaron; Karunasekera, Shanika; Buyya, Rajkumar. ["Decentralised Resource Discovery Service for Large Scale Federated Grids"](http://gridbus.org/papers/DecentralisedDiscoveryGridFed-eScience2007.pdf) (PDF).
  11. [**^**](http://en.wikipedia.org/wiki/Peer-to-peer#cite_ref-11) R. Ranjan, A. Harwood, and R. Buyya, “Peer-to-peer based resource discovery in global grids: a tutorial,” IEEE Commun. Surv., vol. 10, no. 2.
  12. [**^**](http://en.wikipedia.org/wiki/Peer-to-peer#cite_ref-12) P. Trunfio, “Peer-to-Peer resource discovery in Grids: Models and systems,” Future Generation Computer Systems archive, vol. 23, no. 7, Aug. 2007.
  13. [**^**](http://en.wikipedia.org/wiki/Peer-to-peer#cite_ref-13) Bandara, H. M. N. Dilum; Anura P. Jayasumana (January 2012). "Evaluation of P2P Resource Discovery Architectures Using Real-Life Multi-Attribute Resource and Query Characteristics". *IEEE Consumer Communications and Networking Conf. (CCNC '12)*.
  14. [**^**](http://en.wikipedia.org/wiki/Peer-to-peer#cite_ref-14) [RFC 1](http://tools.ietf.org/html/rfc1), *Host Software*, S. Crocker, IETF Working Group (April 7, 1969)
  15. [**^**](http://en.wikipedia.org/wiki/Peer-to-peer#cite_ref-15) Lua, Eng Keong; Crowcroft, Jon; Pias, Marcelo; Sharma, Ravi; Lim, Steven (2005). ["A survey and comparison of peer-to-peer overlay network schemes"](http://academic.research.microsoft.com/Publication/2633870/a-survey-and-comparison-of-peer-to-peer-overlay-network-schemes).
  16. [**^**](http://en.wikipedia.org/wiki/Peer-to-peer#cite_ref-16) Sorkin, Andrew Ross (4 May 2003). ["Software Bullet Is Sought to Kill Musical Piracy"](http://www.nytimes.com/2003/05/04/business/04MUSI.html). New York Times. Retrieved 5 November 2011.
  17. [**^**](http://en.wikipedia.org/wiki/Peer-to-peer#cite_ref-17) P. Antoniadis and B. Le Grand, "Incentives for resource sharing in self-organized communities: From economics to social psychology," Digital Information Management (ICDIM '07), 2007

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