

Peer to Peer - Appunti

Francesco Lorenzoni

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Course info

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Chapter 1

Introduction

Opposed to Client-server architectures where there are end-hosts and dedicated-hosts (servers), in P2P Systems there only end-nodes which directly communicate with each other; they have an “on/off” behaviour, and they handle **churn**¹. However, in P2P systems servers are still needed, but only as *bootstrap servers*, typically allowing for new nodes to easily join the P2P network.

Peers’ connection in P2P is called *transient*, meaning that connections and disconnections to the network are very frequent.

Notice that since each time a peers connects to the P2P network it may have a different IP address, resources cannot be located using IP, but a different method at application layer must be used.

Definition 1.1 (P2P System) *A peer to peer system is a set of autonomous entities (peers) able to auto-organize and sharing a set of distributed resources in a computer network.*

The system exploits such resources to give a service in a complete or partial decentralized way

Definition 1.2 (P2P System - Alternative definition) *A P2P system is a distributed system defined by a set on nodes interconnected able to auto-organize and to build different topologies with the goal of sharing resources like CPU cycles, memory, bandwidth. The system is able to adapt to a continous churn of the nodes maintaining connectivity and reasonable performances without a centralized entity (like a server)*

1.1 Blockchain concepts

Definition 1.3 (Blockchain) ◇ *a write-only, decentralized, state machine that is maintained by untrusted actors, secured by economic incentive*

- ◇ *cannot delete data*
- ◇ *cannot be shut down or censored*
- ◇ *supports defined operations agreed upon by participants*
- ◇ *participants may not know each other (public)*
- ◇ *in actors best interest is to play by the rules*

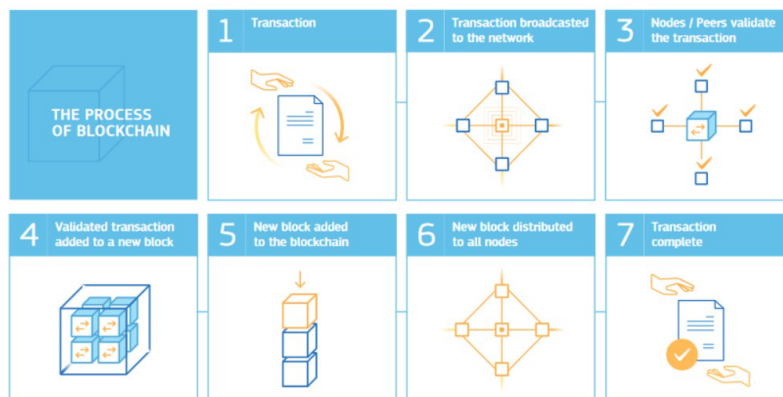


Figure 1.1: Blockchain process

¹ “churn” will be a recurring term. In italian it means “rimascolare”

Bitcoin were developed as an alternative way to exchange money which wouldn't need intermediaries such as banks. Today, *Ethereum* is becoming more and more popular. *NFT*² allow to establish the owner of a digital artwork, by generating a token using a blockchain.

1.1.1 TriLemma

The Blockchain **trilemma** states that a blockchain **cannot** simultaneously provide *Decentralization*, *Security* and *Scalability*.

1.2 P2P Systems

1.2.1 Semi-Decentralized systems

An example is **Napster**, released in 2001. Napster used servers only to allow users to locate peers which could provide the desired file, delegating the actual file exchange to peers, allowing for a very few server needed.

For the first time users are called *peers*, and the systems implemented in this way *peer-to-peer systems*

Napster had many strengths common to many P2P systems, from whose emerges the ability of peers to act both as server and a client, but also suffered from weaknesses derived from its centralization, at least for “node discovery”. Napster centralized server represents a design bottleneck, and also made it target of legal attacks.

1.2.2 Fully decentralized systems

Gnutella is similar to Napster, but here no centralized server exists. Peers establish *non-transient* direct connections to search files, not to actually transfer them.

- Cons
1. High network traffic
 2. No structured search
 3. Free-riding

1.3 P2P Overlay network

In P2P systems there is an overlay network at application level operating on top of the underlying (IP) network.

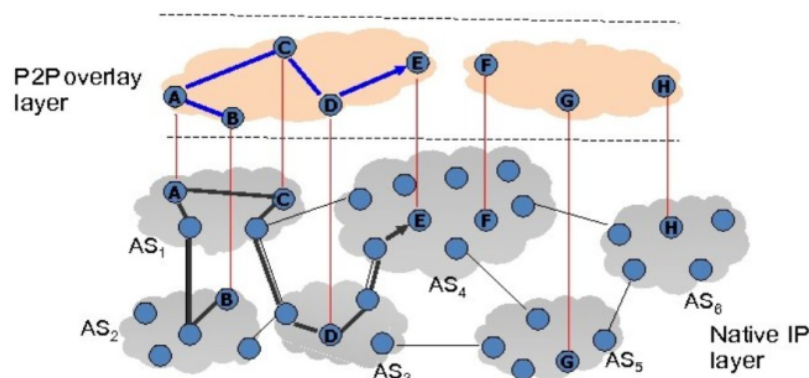


Figure 1.2: P2P Overlay networks

A P2P **protocol** —defined over the P2P overlay— defines the set of messages that the peers exchange.

1.3.1 Unstructured overlay

²Non Fungible Tokens

The two key issues here are:

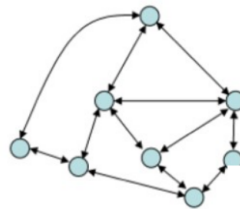
- ◇ how to **bootstrap** on the network?
- ◇ how to **find content** without a central index?

Possible lookup algorithms are the following, but they all are not very scalable, and are costly in terms of performance:

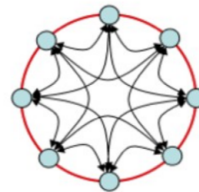
- ◇ Flooding
- ◇ Expanding ring
- ◇ Random walk

Gnutella, BitTorrent, BitCoin

- Unstructured overlays



- Structured overlays: distributed hash tables



- Hybrid overlays: SuperPeer

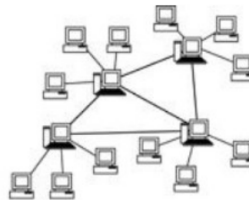


Figure 1.3: P2P Overlay Network classification