

# Aplicações Modelo Peer-to-Peer (P2P)

**Redes e Serviços**

**Licenciatura em Tecnologias e Sistemas de Informação  
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# Terminology

- Peer-to-Peer Systems are distributed systems that operate without centralized organization or control
- Overlay Networks create a structured virtual topology above the basic transport protocol level that facilitates deterministic search and guarantees convergence



# Pure vs Hybrid P2P

- Pure P2P refers to an environment where all the participating nodes are peers
  - ◆ No central system controls, coordinates, or facilitates the exchanges among the peers
- Hybrid P2P refers to an environment where there are servers which enable peers to interact with each other
  - ◆ The degree of central system involvement varies with the application
  - ◆ No one method is better than the other: each has its advantages and its drawbacks, each is the right choice for some applications



# Unstructured vs Structured

- Unstructured overlay networks are not embedded with a logically deterministic structure for organizing and managing the peer nodes
  - ◆ No prior knowledge of the topology
  - ◆ Flooding
  - ◆ E.g. Napster/OpenNap, Gnutella, Freenet, FastTrack/KaZaA, BitTorrent, Overnet/eDonkey
- Structured overlay networks manage the peer nodes with an implicit logical and deterministic structure
  - ◆ Topology is tightly controlled
  - ◆ Use DHT (distributed hash tables)
  - ◆ E.g. Chord, CAN, Tapestry, Tornado, Kademlia



# P2P Discovery Algorithms

- Centralized Directory Model (CDM)

- The peers connect to a central directory where they publish informations about the shared content
- Upon request from a peer, the central index will find the best peer that matches the request
- Advantages: simple, high degree of control on shared contents
- Limits: not scalable, single point of failure.
- E.g.: Napster, Direct Connect, eDonkey (eMule), BitTorrent

- Flooded Requests Model (FRM)

- Pure P2P algorithm in which each request from a peer is flooded (broadcasted) to directly connected peers, which themselves flood their peers, etc.
- Advantages: efficient in limited communities (i.e. not very scalable).
- Limits: requires large bandwidth.
- E.g.: Gnutella, FastTrack

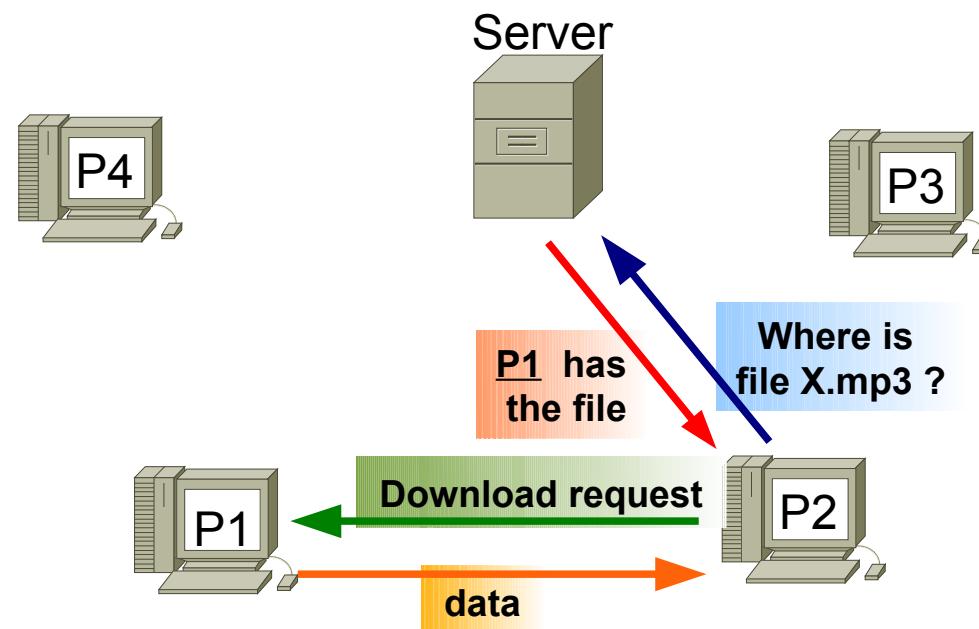
- Document Routing Model (DRM )

- This algorithm is based on Distributed Hash Tables (DHT).
- Publishing of a document: routing it to the peer whose ID is the most similar to the document ID, and repeating the process until the nearest peer ID is the current peer's ID.
- Discovery: the request goes to the peer whose ID is the most similar to the document ID, and the process is repeated until the document is found.
- Advantages: scalable.
- Limits: malicious participants can threaten the liveness of the system.
- E.g.: FreeNet, Chord, CAN, Tapestry.



# Napster/OpenNap

- Network architecture: Hybrid, Unstructured
- Algorithm: Centralized Directory Model (CDM)
- With Napster, the files stay on the client machine, never passing through the servers. The servers provide the ability to search for particular files and initiate direct transfers between clients.
- OpenNap extends the Napster protocol to allow sharing of any media type and the ability to link servers together



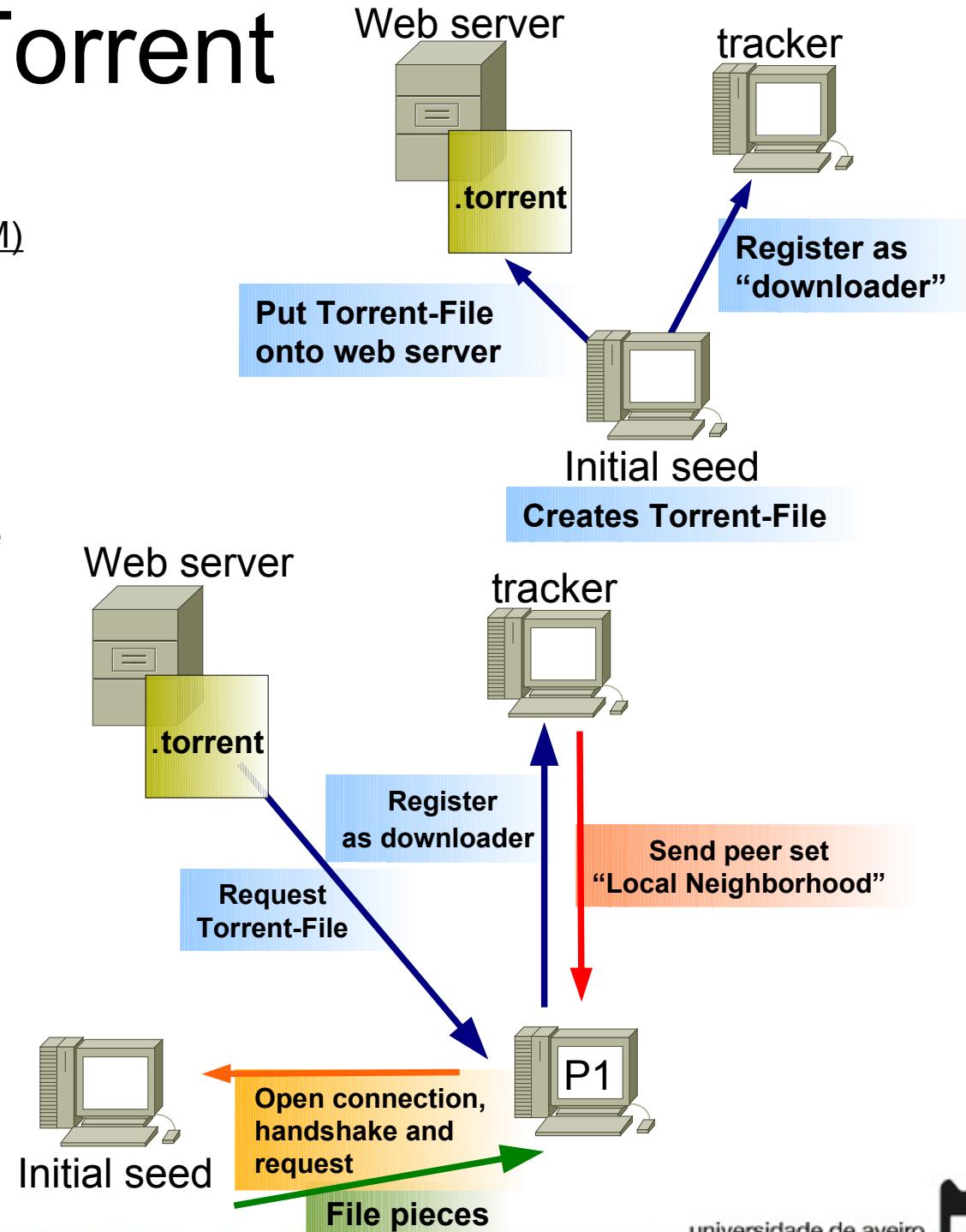
# Direct Connect

- Network architecture: Hybrid, Unstructured
- Algorithm: Centralized Directory Model (CDM)
- The DC network is composed of Hubs, Clients, and by the HubListServer
- Hubs act as naming services and communication facilitators for Clients, allowing them to exchange search commands and chat messages
- The HubListServer acts as a naming service: Clients discover Hubs asking the HLS



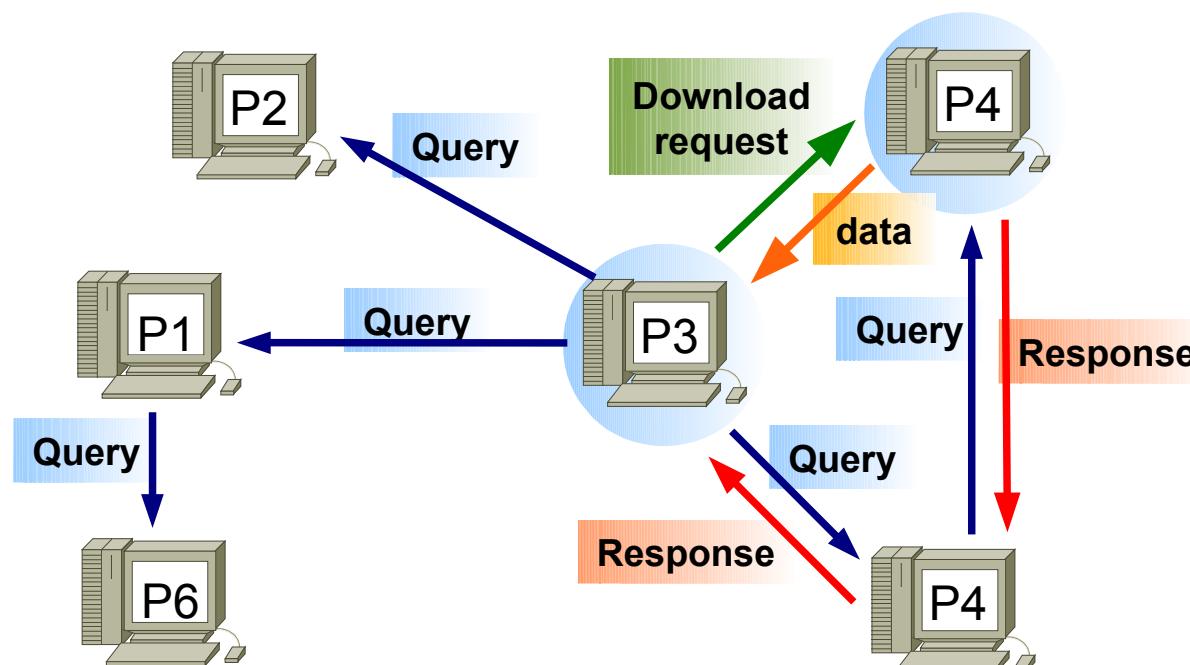
# BitTorrent

- Network architecture: Hybrid, Unstructured
- Algorithm: Centralized Directory Model (CDM)
- The (Web) servers don't have informations about content location
  - ◆ Only store metadata files describing the objects (length, name, etc.) and associating to each of them the URL of a tracker
- Trackers are responsible for helping downloaders find each other, using a simple protocol on top of HTTP.
- Moreover, a downloader sends status info to trackers, which reply with lists of contact information for peers which are downloading the same file.
- BitTorrent cuts files into pieces, which are broken into sub-pieces.



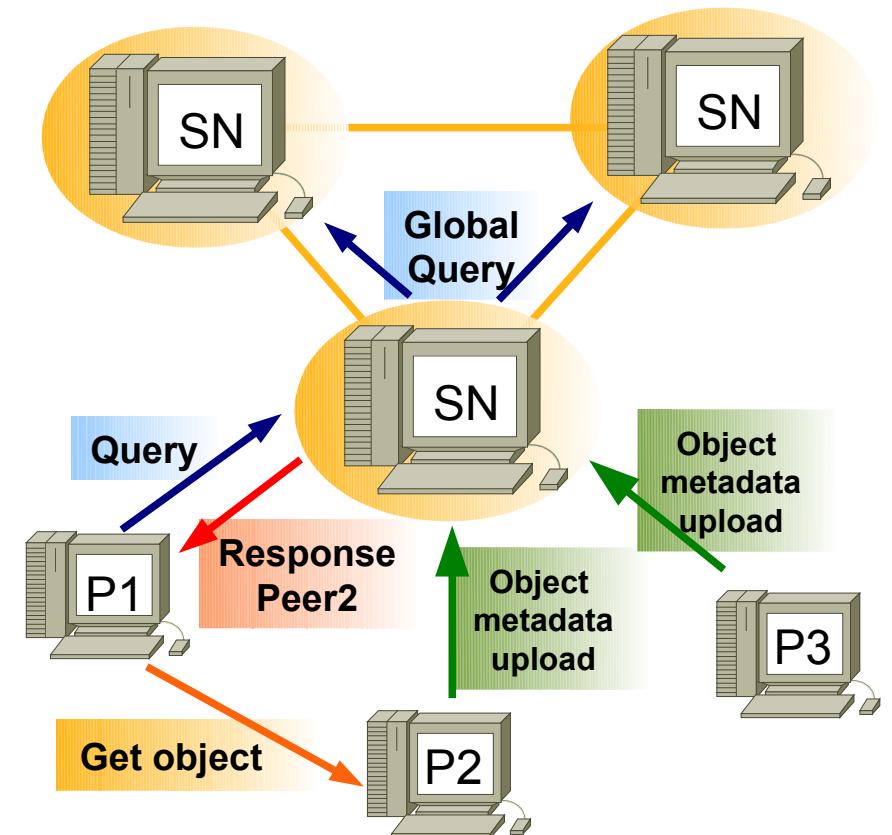
# Gnutella

- Network architecture: Pure, Unstructured
- Algorithm: Flooded Requests Model (FRM)
- A Gnutella node connects to the network by reaching one of the several known hosts which are almost always available
- The messages allowed in the Gnutella network can be grouped as follows:
  - ◆ Group Membership (PING and PONG, for peer discovery queries/replies)
  - ◆ Search (QUERY and QUERY HIT, for file discovery queries/replies)
  - ◆ File Transfer (GET and PUSH, for file exchange between peers)
- To improve scalability, Gnutella v2 adds dual layer hierarchy with the introduction of super-nodes



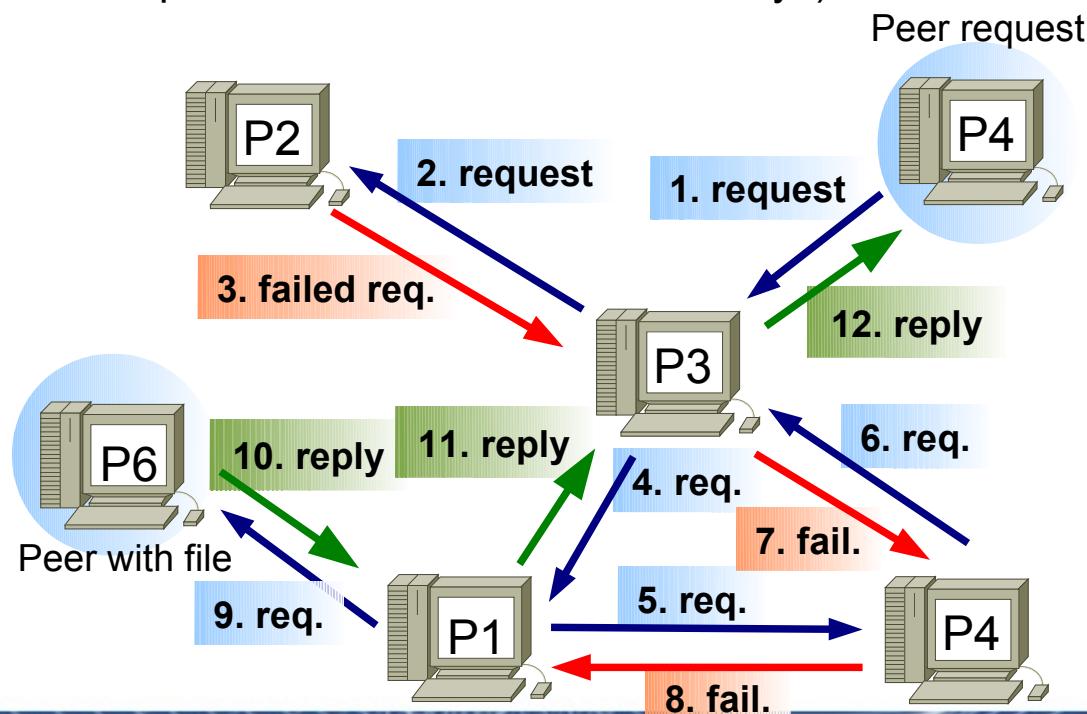
# FastTrack/KaZaA

- Network architecture: Hybrid, Unstructured
- Algorithm: Flooded Requests Model (FRM)
- Is an extension of the Gnutella protocol which adds super-nodes to improve scalability
  - ◆ A peer application hosted by a powerful machine with a fast network connection become automatically a super-node, effectively acting as a temporary indexing server for other slower peers
  - ◆ Communicate between each others in order to satisfy search requests



# FreeNet

- Network architecture: Pure, Unstructured
- Algorithm: Document Routing Model (DRM) )
- Focus on, Privacy, Resistance, High availability and reliability and Efficient, scalable and adaptive storage routing
- When a peer wants to share a file, it uses an hash function to generate a key from a text description of the file
- Every node maintains a routing table that lists the addresses of other nodes and the files they holds (with high probability)
- When a node receives a query it first check its own list and, if it finds the key, returns the file
- Otherwise, the node forwards the request to the node in its table with the closest key to the one requested (Freenet attempts to cluster files with similar keys)



# Chord

- Network architecture: Pure, Structured
- Algorithm: Document Routing Model (DRM)
- An hash function is used to assign each node and key (identifying a file) an m-bit identifier
- The key and the node identifiers are arranged on an identifier circle of size  $2^m$  called the Chord ring
- Additional routing information is stored to accelerate lookups

