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Peer-to-Peer Signalling

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S-38.115 Signalling Protocols

Agenda

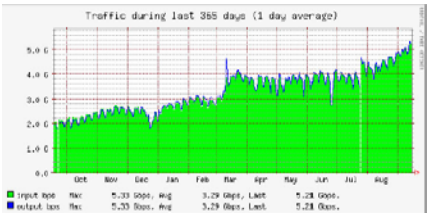
- Introduction
- P2P architectures
- Skype
- Mobile P2P
- Summary

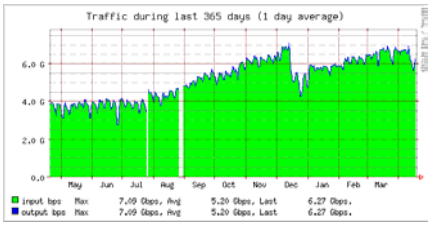
Introduction

- Peer-to-Peer (P2P) is a communications model in which
  - each communication node (peer) has both server and client capabilities
  - either party can initiate a communication session
  - applications connect with each other directly
- Various definitions exist

Peer-to-Peer popularity

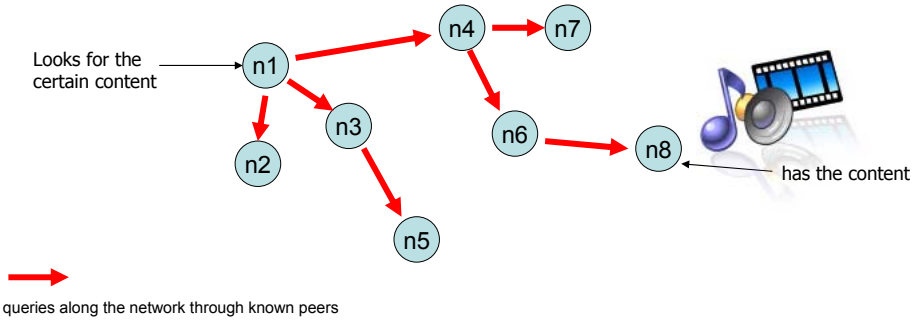
- The most popular P2P application is content sharing e.g. Napster, Kazaa, Direct Connect
- P2P accounts for the lion's share of rising bandwidth consumption
- Other applications are also gaining popularity e.g. Skype - Voice over P2P, Mobile P2P





P2P basics

- How to find specific peer that hosts desired data within decentralized network?



queries along the network through known peers

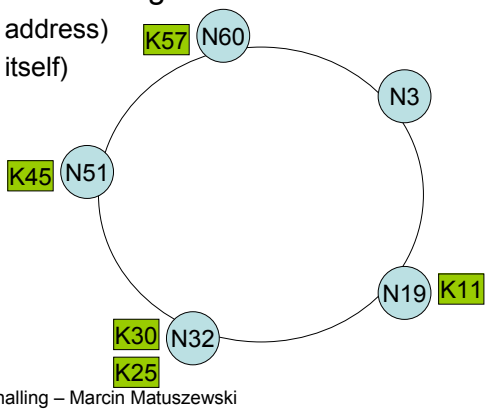
Pure P2P architecture

- Control and data are completely distributed
- No centralized server
- Example: Gnutella
- Advantage
  - Resilience to node failures
- Disadvantage
  - Inter-peer connections tend to form a power-law graph (a small number of highly connected peers)
  - Simple broadcast search is not efficient (delay, bandwidth)
  - TTL is used to limit flooding

  => many improvements have been proposed (next slides)

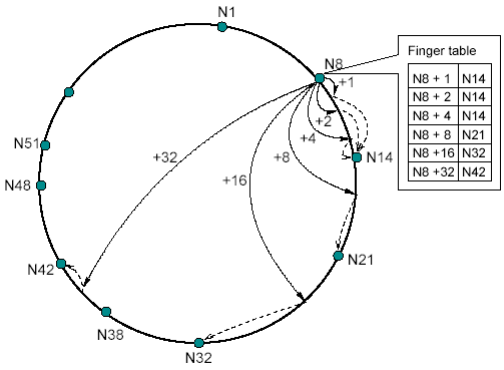
Pure P2P architecture - Chord

- Chord provides improvements to the searching process
- Nodes in a network are organized in a circle
- Each node and each key have assigned identifiers
  - Node identifiers: SHA1(IP address)
  - Key Identifiers: SHA1(key itself)
- Each key is assigned to its successor

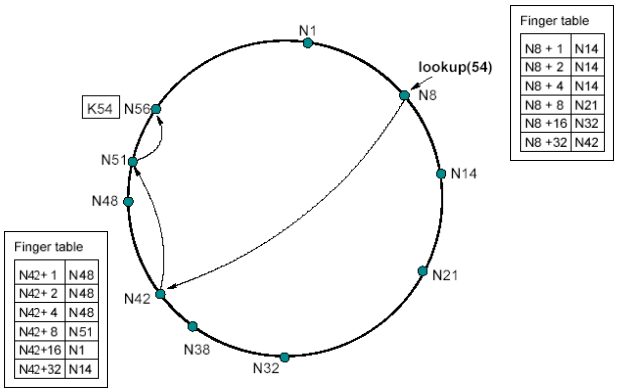


Chord - Finger Table

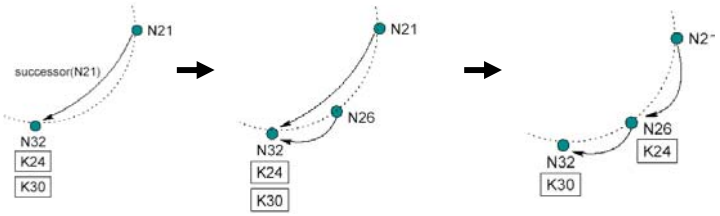
- The information stored in the Finger Table is used for scalable node localisation



Chord - key localisation process



Chord – joining node



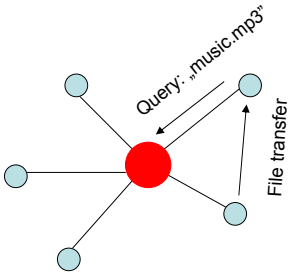
- Node 21 asks its successor the following question: “Am I your predecessor?”
- If node 26 joins the network an answer to this question is: “NO, node 26 is my predecessor”

Properties of Chord

- Availability
  - Protocol functions very well even if the system is in a continuous state of change
- Scalability
  - Lookup grows only logarithmically with the number of nodes
- Load balancing
  - Keys are spread evenly over the nodes
- Flexible naming
  - No constraints on a key structure
- Not suitable for search engines
  - Chord supports “exact match“, cannot handle queries similar to one or more keys

Centralized P2P architecture

- Centralized server provides meta-data (e.g. list of files shared by each peer)
- Communication is directly between peers
- Example: Napster
- Advantages
  - Searches can be quick and need very little bandwidth
- Disadvantages
  - Server represents a single point of failure for entire system
  - Can be easily attacked
  - Have limited resources => scalability issue

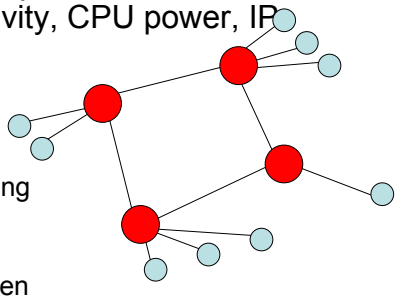


Semi-centralized P2P architecture

- There are two types of peers in a network:
- Gateways (Super-peers)
  - more powerful peers become gateways to a network
  - form a pure P2P network between themselves
  - handle search requests on behalf of clients
- Clients (Ordinary-peers)
  - less powerful peers act as clients to the gateway peers
  - upload metadata information about shared files to gateways

Semi-centralized P2P - KaZaA

- KaZaA is an example of semi-centralized P2P network
- Super-Peers (SPs) are normal peers that have been automatically elected as the super-peers based on their up time, bandwidth, connectivity, CPU power, IP address (public vs private)
- Super-peers maintain a database with:
  - file identifiers, their children are sharing
  - metadata (file name, file size, contentHash, file descriptors)
  - corresponding IP addresses of children
- SP maintain long-lived TCP connections with other SPs



KaZaA cont.

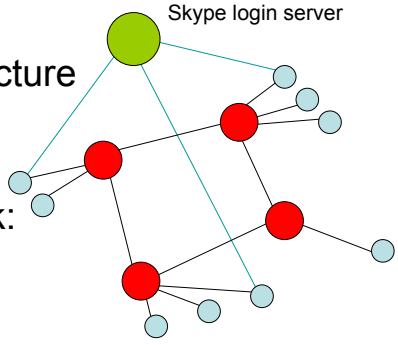
- KaZaA peers frequently exchange list of super-peers
  - Ordinary-Peer (OP) maintains list of 200 super-peers
  - Super-Peer (SP) appears to maintain list of thousands of SPs
- All of the signaling traffic between peers is encrypted
  - Handshaking traffic for connection establishment
  - List of super-peers exchange
  - Metadata upload
  - Queries and replies
- File transfer between nodes is not encrypted
- TCP is used for both file transfer and signaling traffic

KaZaA cont.

- Files searching
  - OP sends a query with a keyword to its SP
  - SP returns IP addresses and related metadata that correspond to the match from its database
  - SP may forward query to one or more SPs to which it is connected
  - Query visits only a small subset of SPs so the result represent only a small subset of all files stored in KaZaA network
- SPs frequently change their SP-SP connections on a time scale of tens of minutes => Larger part of network can be explored

- Skype is another application of peer-to-peer concept
- It provides very successful internet telephony, instant messaging and file transfer services
- Skype is a proprietary protocol in contrast to SIP and H.323
- Researchers are trying to apply P2P principle to SIP-based systems

Skype architecture



- Skype has a similar architecture as its predecessor KaZaA
- There are three types of nodes in the Skype network:
  - Ordinary-peers
  - Super-peers
  - Central login server
- The login server stores all of user names and passwords and ensures that names are unique across the Skype name space

Skype – some facts

- It uses TCP for signaling and both UDP and TCP for transporting media traffic
- It uses iLBC, iSAC or a third party unknown codec probably developed by GlobalIPSound
- All of the user communication is encrypted using AES 256-bit (Advanced Encryption Standard)
- It uses a variation of STUN and TURN for NAT and firewall traversal
- Buddy list is signed digitally, encrypted and is local to the machine (not stored on the central server like in case of MSN Messenger)

Skype - login

- After installation a client connects to some bootstrap super-peers, since its Super-Peer list is empty, and acquires the address of the Login Server
- Normal login:
  - Skype client (OP) connects to a Super-Peer
  - OP authenticates the user name and password with the Login Server

Skype - user search

- Client sends an user name to SP and as an answer receives four IP addresses and port numbers
- Subsequently the client contacts these four nodes
- If it cannot find the user it sends request to its SP once again and as a result receives eight IP addresses and port numbers
- The process continues until the user is found
- If the user is behind a NAT and an UDP-restricted firewall, SP searches user on behalf of the client
- Search results are cashed in the intermediate nodes

Skype - call establishment

- If both a caller and a callee have public IP addresses, a caller sends signaling information over TCP to a callee
- If a callee is behind a port-restricted NAT, caller sends signaling information over TCP to an online Skype node that forwards it to a callee
- If both a callee and a caller are behind a port-restricted NAT and an UDP-restricted firewall both exchange the information with an online Skype node

Mobile P2P

- Faster residential Internet connection, more powerful desktops, and cheaper storage were the main drivers stimulating P2P growth.
- We can observe a similar technological change in mobile networks
- Research on mobile P2P file sharing is ongoing in the Networking Laboratory!

Mobile P2P challenges

- Shortage of resources:
  - Battery, CPU, Memory, Network connection
  - Widely used P2P applications/protocols have to be redesigned
- Business issues
  - Understand and analyze the impact of peer-to-peer services on the mobile market and its value chain
  - Identify some key application scenarios that are likely to be attractive to users

Summary

- P2P architecture offers scalability, robustness and fault tolerance
- Content sharing is a dominant P2P application however other applications are emerging
- SIP over P2P concept aims to improve scalability and usability of standardized SIP applications
- In the near future we will see P2P services provided by mobile service operators

Thank you!

References

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