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HS2020: 11072 Advanced Networking and Future Internet

Theoretical Exercises - Week 3 Solutions

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Peer-to-Peer Networks (2 points)

Q1.1 Unstructured Peer-to-Peer Networks

- Explain what mechanisms/approaches could be used to overcome the overflooding of control messages in P2P unstructured distributed networks? (2 points)
  - ***The Time To Live (TTL) is used for the propagation of messages in P2P networks and defines how long a message can be transmitted from a node to the neighboring nodes (i.e. number of hops) before it dies. To prevent messages from being broadcasted in the networks potentially leading to overflooding, we can limit the TTL of each request/message and start off with smaller values and only increase TTL if the requested information is not found within this limit. Although selecting the right TTL value that doesn't burden the network is not easy.***
  - ***Alternatively, every request could have a unique ID attached to it and the nodes in the network could keep track of every request's ID and where such requests are forwarded. This would enable a node to redirect a request with the same ID to a new (random) destination in the network.***

Mapping (2 points)

Q2 Unstructured Peer-to-Peer Networks

- What are the advantages or disadvantages of mapping in P2P networks compared to conventional DNS mapping? (2 points)
  - ***In conventional DNS, the logical host name is mapped to an IP by a DNS server. Due to the hierarchical nature of DNS, higher-level servers are more prone to overload as they have to support multiple requests from lower servers, leading to a higher chance of overload - this represents a single point of failure in the network, as requests can't be handled if a higher (e.g. root) server goes down.***
  - ***In P2P, mapping of IPs are done to file/application IDs which reside on individual hosts. There is no hierarchy between hosts, which makes it more resilient compared to conventional DNS, as there is no single point of failure. It also scales better, as there are no bottle necks due to increase in requests at nodes (no bottlenecks). However, there could be issues of resolution latency in some P2P implementations, as the geographical distance (i.e. no. of hops) between 2 peers might be large, this is (partially) resolved through local caching in DNS.***

BitTorrent (2 points)

Q3. Unstructured Peer-to-Peer Networks

- Despite the tracker being a single point of failure in BitTorrent Peer-to-Peer networks, what are it's advantages over Distributed Hash Tables? (2 points)
  - ***The efficiency of looking up for content is higher, as the tracker is aware about the location of objects in the network.***
  - ***The network traffic overhead is much lower, as there is less need to query several nodes in the network when making requests/searching for certain objects (compared to querying in DHT, where requests need to be sent to several nodes before they are resolved.)***
  - ***There is more bandwidth available due to better indexing of content sources.***
  - ***Includes a "tit-for-tat" mechanisms that rewards good behaviour and punishes bad behaviour (to encourage all peers to contribute) - ensures fairness.***

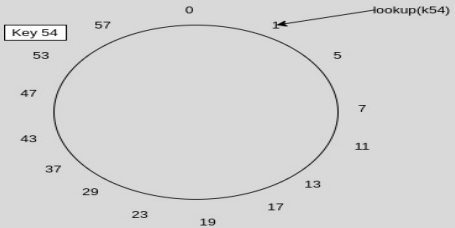
Chord (3 points)

Q4. Structured Peer-to-Peer Networks

- Consider the following Chord network with the identifiers in a circle 2^m, where m = 6, representing a total of 64 keys.
  - Construct the finger table for nodes 0 & 19 (1 point).
    - ***Finger Table [0]: 0+1->1, 0+2->5, 0+4->5, 0+8->11, 0+16->17 0+32->37***
    - ***Finger Table [19]: 19+1->23, 19+2->23, 19+4->23, 19+8->29, 19+16->37, 19+32->53***

Chord II

- Using finger tables, describe the route from node 1 to key 54 (include diagram with route) (2 points).
  - Route to key 54:
    Node 1 uses finger (1+32) to forward the query to node 37
    Node 37 uses finger (37+16) to forward the query to node 53
    Node 53 uses finger (53+1) to forward the query to node 57, which has the key.



Distributed Hash Table (1 point)

Q5. Structured Peer-to-Peer Networks

- Select a P2P network/system covered in the lecture (or one of your own) and explain how it deals with high churn rates. (1 point)
  - ***A known issue in P2P networks is the session time of peers, as this affects the network's structure & resilience. If session times are increasingly small for multiple peers, the effect caused by this independent arrival and departure of peers is called churn.***
  - ***In Kademlia each node is identified by a NodeID and must keep a list/mapping for a subset of nodes in the network in it's routing table (nodes are like leaves in a binary tree, and ordered by the length of time they have been neighbors [1]). During a query or lookup, a node sends parallel remote procedure calls (RPCs) to nodes in it's routing table that are closest to the key [2]. These parallel requests provide a low overhead and ensure that unavailable nodes do not affect the return path of the query/requests, as the network is able to route around them.***

[1] https://people.inf.ethz.ch/troscoe/pubs/usenix-cr.pdf
[2] http://www.news.cs.nyu.edu/ jinyang/pub/iptps04.pdf

Q/A

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