The Bit Torrent: Protocol and Incentive

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Introduction:

BitTorrent is a peer-to-peer file sharing protocol used for distributing large amounts of data. BitTorrent is one of the most common protocols for transferring large files, and it has been estimated that it accounted for roughly 27% to 55% of all Internet Traffic (depending on geographical location) as of February 2009.

Problems that BitTorrent address:

In a typical file sharing system, when a file is made available using HTTP, all upload cost is placed on the hosting machine. While, with BitTorrent, when multiple people are downloading the same time, they uplaod pieces to eachother (session-based). This redistributes the cost of upload to downloaders.

In a session-based P2P system, which peers have what parts of the file and where they should be sent is difficult to do withoutincurring a huge overhead. In addition, real deployment experiences high churn rates, with lots of users, entering and leaving the system. Finally, there is a problem of fairness. Moreover, there are users who only download, and never upload called Free-rider problem.

BitTorrent components:

There are certain terminology for users of BitTorrent as follows:

1. Seed - Peer that has the entire file
2. Leacher - Peer that has an incomplete copy of the file
3. A Torrent file
    - Passive component
    - Files are typically fragmented into 256KB pieces
    - Typically hosted on a web server
4. A Tracker
    - Active component
    - Allows peers to find each other

BitTorrent Protocol:

Publishing Content:

1. A static file, with extension .torrent is put on ordinary web-server.The torrent file contains information about the file, length, url of tracker.
2. Trackers are responsible for helping downloaders find eachother.
3. Downloaders, connect to eachother, and the one with the file, called seed, must be started.
4. The bandwidth requirements of the tracker and web server are very low, while the seed must send out at least one copy of the original file.

Piece Selection:

Selecting pieces to download in good order is important for good performance. There are following piece-selecctions strategies:

Strict-priority:

This policy is that once a sub-piece has been requested, the remaining sub-pieces from that particular piece are requested before sub-pieces from any other piece.

Rarest First:

When selecting which piece to start downloading next, peers generally download pieces which the fewest of their own peers have first, a technique we refer to as 'rarest first'. This technique does a good job of making sure that peers have pieces which all of their peers want, so uploading can be done when wanted.

Random First Piece:

Pieces to download are selected at random, until the first complete piece is selected and then strategy changes to rearest first.

End-game mode:

Sometimes a piece will be requested from a peer with very slow transfer rates. So, once all sub-pieces which a peer doesn't have are actively being requested it sends requests for all sub-pieces to all peers. Cancels are sent for sub-pieces which arrive to keep too much bandwidth from being wasted on redundant sends.

Incentive Mechanisms:

BitTorrent does no central resource allocation. Each peer is responsible for attempting to maximize its own download rate. Peers do this by downloading from whoever they can and deciding which peers to upload to via a variant of tit-for-tat and other Game-theoretic concepts.

Concept of Choking:

To cooperate, peers upload, and to not cooperate they 'choke' peers. Choking is a temporary refusal to upload; It stops uploading, but downloading can still

happen and the connection doesn't need to be renegotiated when choking stops.

BitTorrent's Choking Algorithm:

1. Each BitTorrent peer chokes a fixed number of other peers (default is four), Decisions as to which peers to unchoke are based strictly on current download rate.
2. BitTorrent peers recalculate who they want to choke once every ten seconds, and then leave the situation as is until the next ten second period is up.

Other Alternatives:

Optimised Unchoking:

Simply uploading to the peers which provide the best download rate would suffer from having no method of discovering if currently unused connections are better than the ones being used.

Solution:

BitTorrent peer has a single 'optimistic unchoke', which is unchoked regardless of the current download rate from it. Which peer is the optimistic unchoke is rotated every third rechoke period (30 seconds).

Anti-Snubbing:

Occasionally a BitTorrent peer will be choked by all peers which it was formerly downloading from.

Solution:

To mitigate this problem, when over a minute goes by without getting a single piece from a particular peer, BitTorrent assumes it is 'snubbed' by that peer and doesn't upload to it except as an optimistic unchoke.

Modelling Altruism

Apart from tit-for-tat strategy, its has been shown that high-capacity peers, provide low-capacity peers, withan unfair share of aggregate swarm of resources. Although tit-for-tat strategy achieves corelation between upload contribution and download rates, this corelation becomes unfair for high capacity nodes, resulting in altruistic modelling.

Downloading from seeds:

Uses a seeding algorithm that performs unchokes in a strict round-robin order, spreading data in a uniform manner and is therefore more robust .

Falsifying block availability:

A client would prefer to unchoke those peers that have blocks that it needs. Thus, peers can appear to be more attractive by falsifying block announcements and increase the chances of being unchoked.

Conclusion:

We have described the protocol used by Bit-torrent P2P file sharing system. We have also described certain Incentives based mechanisms like Choking that essentially builds robustness to Bittorrent systems. Although Tit-for-Tat discourages free riding, the Bulk of BitTorrent's performance has little to do with it.