Improving congestion latency for online games

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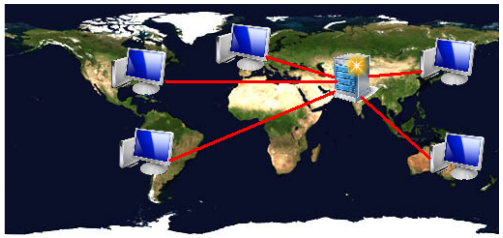
Content

- Identify the problem
  - What is lag?
  - How does my family make me lag?
  - Explain how TCP can cause large queuing delays at ISP
- Related Work – existing solutions to the problem
- Explanation of a new approach we are researching
- Questions?

Online Games



- Online games allow people to compete, co-operate and explore in virtual worlds
- Players interact with the world by exchanging frequent updates

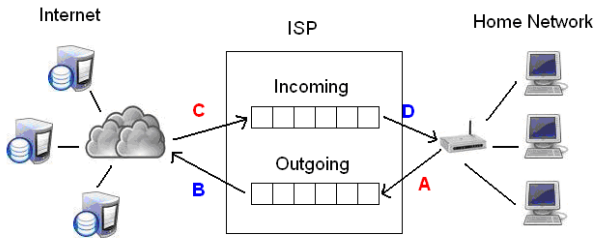
Lag Kills !

- The latency between player and host is important
- High latencies will desynchronise the player with the world (which is very frustrating!)
  - Shot through wall
  - Shots not registering
  - Opponents teleporting

Playing From Home

- The majority of people play from home
- Family members can cause the game to lag
  - Sister uploading images to facebook
  - Dad web conferencing with colleague
  - Mum streams video on the tv downstairs

What Causes The delay?



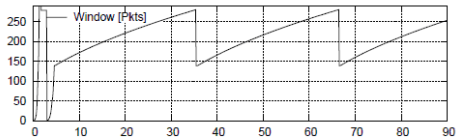
- One of main increases in round trip time is due to time spent in ISPs queue [Dischinger 2007]
- If the sending rate is greater than the capacity of the link, the queue will fill
- The incoming queue is a more challenging problem

The Incoming Queue

- What fills the incoming queue?
- We restrict our exploration to TCP and game traffic
- Reasons for restricting to TCP:
  - Latest SPRINT Internet backbone traces show 80.63% of Internet traffic is TCP [24]
  - Most bulk transfer protocols such as FTP require the reliability provided by TCP

TCP

- TCP is transport protocol that provides reliable connection-orientated communication
- TCP has a congestion control algorithm, which allows it to utilise links to full and react to congestion

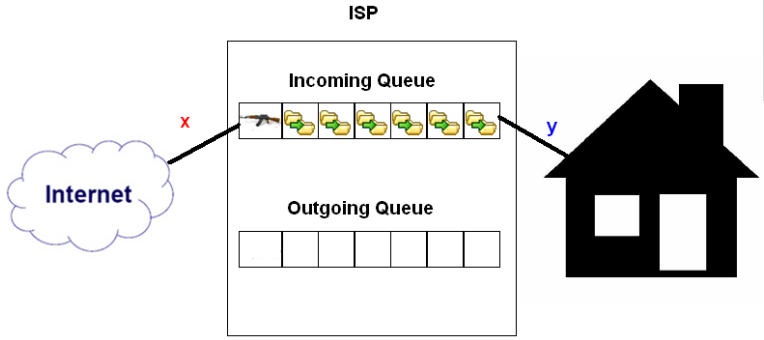


- Uses additive increase / multiplicative-decrease
  - This causes the sending rate graph to look like a saw-tooth
- All available buffers will fill as a result of this algorithm
- This aim conflicts with online games low latency requirements

Game Traffic or Thin Streams

- Game traffic consists of very small packets with large inter-arrival times
  - Packets only contain physics updates like velocity therefore they will be small
  - The inter-arrival times are large because the data is application limited not network limited
- Traffic with these properties are referred to as *thin-streams*
- On a typical British broadband connection 131 counter-strike games could run concurrently till the link becomes saturated

The Problem



- The aggregate remote host sending rate (x) is greater than the capacity from the ISP to the house (y) which causes queuing
- The queue is mostly made up of bulk TCP traffic like FTP
- The game traffic is small and the packets have relatively large inter-arrival times
- The queuing delay can make the game unplayable

Related Work

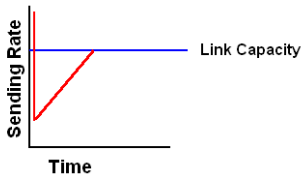
- A great deal of research has gone into congestion algorithms and therefore there are solutions to the problem
  - Differentiated Service [Xiao 1999]
  - Reduce buffer size [Appenzeller 2004]
  - Weighted Fair Queuing [Stilliadis 1998]
- However all these solutions require collaboration with the ISP

Differentiated Services

- Allows different services for different flows
  - Low-delay
  - High-throughput
  - Low-loss rate
- Based on a field in IP packet
  - Routers can remain stateless
  - Simple processing to read a field in a header
- A customer must have service level agreement with ISP
  - Specify service classes supported
  - Amount of traffic allowed in each class
- It is hard for ISPs to charge and account for service

Reduce Buffer Size

- The purpose of buffers is to support bursty traffic
- Buffers are NOT there to stop overflow but instead underflow

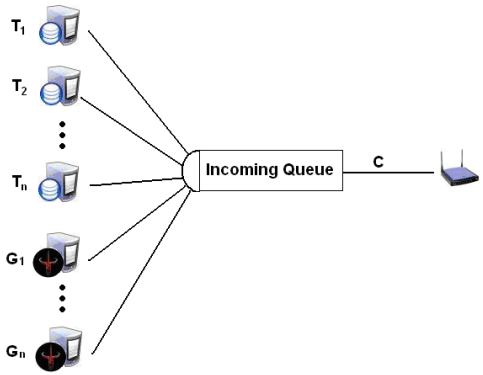


- One possible solution would be to reduce the buffer sizes therefore queuing delays would not be so large
- However this will increase packet loss and reduce throughput therefore its unlikely ISPs will adopt it

Weighted Fair Queuing

- First-come-first-serve is appealing due to its simplicity
- Different flows have different requirements
- Fair Queuing has a separate queue for each flow
  - Each flow will get fair share
  - However still suffer from queuing delays
- Weighted fair queuing (WFQ) allows flows to be scheduled based on their requirements
- Problems?
  - Hard to implement
  - Requires more processing power
  - Difficult to administrate

Novel Approach



- To stop queuing delays the aggregate sending rate of all the remote hosts must be less than the capacity of the link **c**

$$\sum_{i=0}^{n} T_i + \sum_{i=0}^{n} G_i \leq C$$

Remote Control TCP

- How can we control remote hosts?
  - Through the congestion control algorithm (CCA)
- The CCA allows a *windows (W)* worth of data to be sent without a response.

$$R = \frac{W}{RTT}$$

- The sending rate is therefore dependent on the window size.

Window Size

- The CCA continuously increases the window to probe for available bandwidth.

Slow Start

$$\frac{dW}{dt} = \frac{W}{RTT}$$

Congestion Avoidance

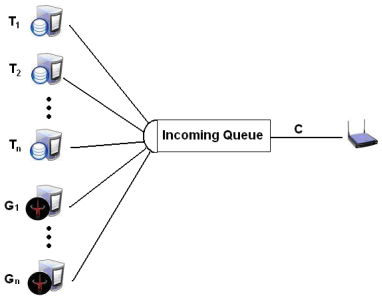
$$\frac{dW}{dt} = \frac{1}{RTT}$$

- The window growth is dependent on the round trip time.
- Finally when the CCA detects congestion via packet loss it drastically reduces the window size and therefore sending rate

Algorithm Operations

- Window growth is dependent on RTT therefore the home router can delay ACK packets to reduce window growth
- If a packet loss is detected the window size is reduce, therefore the home router can purposely drop packets.

Algorithm Aim



- Aim is to remotely control all the flows such that the aggregate sending rate is the capacity of the link
- This will allow maximum throughput and no queuing delay
- However this is difficult because:
  - Set of flows is dynamic
  - The capacity of the link is not constant
  - There are numerous TCP variants

Questions?

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