Tech-Topic Analysis 5

W.C. Feng, F. Chang, W.C. Feng, and J. Walpole, "A Traffic Characterization of Popular On-Line Games," IEEE/ACM Transactions on Networking, vol. 13, num. 3, June 2005.

Overview

On-line multiplayer games are becoming more popular. Game consoles, such as Xbox and PlayStation, are now providing on-line gaming services. Their networks allow for thousands of users to play on-line games simultaneously. Their traffic, and traffic generated from on-line games played on a PC are starting to take up a more
significant portion of aggregate network traffic. The traffic that
is generated by these games is not the same as normal web traffic that is usually analyzed in networking research. This traffic is different because it consists of small UDP packets in frequent bursts.

The on-line multiplayer game that this research focuses on is called Counter-Strike. Counter-Strike is a first person shooter, which is a very popular category of on-line game. It is a variant of the game Half-Life and is one of the most popular first person shooters. The game is a client-server application. Counter-Strike is a team game.
There are two teams that each try to complete a mission or kill all the players on the other team. The game ends if either team accomplishes those goals or if the time runs out. After a player has been killed, that player can shadow any other player that is still alive. The game is played on different maps that typically change every 30 minutes. The typical time limit for each round is 3 minutes.
If the hardware and configuration permits, a server is able to host up to 32 players at once. The traffic from the game is generated by the real-time data sent between the clients and the server. Traffic is also generated by users who can have custom features as well as users downloading entire maps from the server (if the map is not already stored locally). This research mostly analyzes Counter-Strike traffic, but also takes traffic samples from Day of Defeat, Medal of
Honor: Allied Assault, and Unreal Tournament 2004.

In order to get a good sample of traffic, the researchers hosted a Counter-Strike server of a very popular gaming community called mshmro.com in Oregon. The server was heavily used and users connected to it from all over the world. It also allowed up to 22 simultaneous players. The traffic was recorded over a one week period (April 11-18, 2002). Over that week, the authors were able to capture a half billion packets. Even with the amount of packets captured, this sample does not necessarily generate a representative sample of all Counter-Strike traffic. More than 60gb of data was sent to the server in this week. Surprisingly, even though that their server received more packets than it sent out, the outgoing bandwidth was larger than the incoming bandwidth. The paper presents a figure that shows that the number of active players has a lot of short-term variation with predictable long-term behavior. Though the trace had several network outages, it did not have much of an affect on the traffic because it repopulated at a fast rate.

Using figures, the authors show that they their results were what they expected from their analysis. The traffic came in burst with a highly periodic pattern. The periodic pattern is caused by the server deterministically sending its clients updates every 50 ms. The lower frequency variability is caused by the map changes every 30 minutes as well as the round time limits every 3 minutes. There is a dip in network traffic every 30 minutes because a map is being loaded and the server has local tasks to perform the map change over. Most clients have the map stored locally so they do not have to download it. Another dip occurs at the beginning of each round because each user is in a frozen state for a short period of time. These dips can vary because maps beings change and round time length can be adjusted by administrators. The average bandwidth consumed by each user was 40kb/s. This makes since because Counter-Strike was designed to saturate the narrowest last-mile link.

Even though the traffic analyzed was stable and predictable, it is still made up of large, periodic bursts of small packets. Almost of all the incoming packets were smaller than 60 bytes and most of the outgoing packets were between 0 and 300 bytes. The packet size was measured purely off the application data, and did not include the headers. The incoming packets were smaller than the outgoing packets because the server aggregates all the clients data then broadcasts the aggregated data back out.

The paper follows by analyzing client behavior. The authors display a figure that shows a lot of players play only for a short time before disconnecting. It also shows that the number of players that play for longer periods of time declines sharply as time increases. The session ON times for Counter-Strike players is not heavy-tailed contrary to most other Internet traffic. Short session times could have been caused by users getting kicked from the server for friendly fire. The authors would like to do further research on session times for different games.

Because the quality of play relies on real-time interaction, it is expected that players are close to the server geographically so they avoid lag. In most cases the closer a user is to a server the less lag. However, it is possible for users who are geographically close to the server to experience network latency. The authors used an IP mapping tool in order to analyze the geographic location of the users.

The tool is not completely accurate and it was only able to generate locations for 60 percent of the IP addresses collected. The authors found that while some people were located close to the server, others connected all the way from Europe and Asia. Almost half of the people connected to the server came from across an ocean. The authors thought up some possible explanations for this. One explanation is that there is a shortage in servers overseas and that during peak times there are not enough servers to host all the users in Europe and Asia. Another explanation was that the number of players on a server determines desirability over delay. People would rather have a little lag and play with more users than no lag and only a couple users. The authors use a series of figures to show that the amount of people connecting from Europe and Asia depended on the time. For example, more Europeans connect in the mornings (Pacific Standard Time).

In order to make sure that the results seen from the Counter-Strike traffic apply to all games of this genre, the authors took traffic samples from Day of Defeat, Medal of Honor: Allied Assault, and Unreal Tournament. For Day of Defeat, the results were almost the exact same as the results seen from Counter-Strike. The Medal of Honor: Allied Assault traffic showed that it had a higher variation in the number of active players and more clients maintain a throughput that is above modem rates. However, similarly to the other two games there were bursts of small packets. Unreal Tournament 2003 had smaller packets with bursts at an interval of 100 ms and also targets the saturation of a narrower last-mile link compared to the other games.

The results collected from the games show that the routing infrastructure could use some changes to better suit gaming traffic.
The most significant pattern that the authors found is that the packets are small and come in periodic bursts. Network devices are built to a different type of network traffic (bulk transfers using TCP). In order to improve network devices, the authors suggest some things these devices should do. These suggestions are to have sufficient forwarding capacity to handle small packet sizes, employ ECN, have small buffers, and employ active queue management.

Though gaming traffic is different than the traffic network devices were built to handle, there are some positive things about gaming traffic. One positive thing is that the packets are very predictable. Given those proposed optimizations to network devices, the solution to better handle gaming traffic is an easy one.

Analysis

This paper is very well structured and easy to read. Like most good papers, at the end of the introduction the authors lay out exactly what the rest of the paper will entail. A reader with very little background knowledge can easily understand the goals of the paper and what the results of the traffic analysis mean. Also, the paper uses a lot of graphs to make it easier for the reader to understand what the traffic results mean.

The authors provide good reasoning on how their on-line multiplayer game traffic analysis is different from TCP or web based analysis.
On-line multiplayer gaming was getting more popular at the time the paper was written and its popularity has continued to grow.

There are a couple of things I did not like about the paper. The authors did not to a good job in convincing the reader that the games they selected were good ones to analyze. They said that Counter-Strike generated a large percentage of UDP traffic, but some statistics or a graph would have been nice. Also they bring up that they use games from a Quake-based engine and an Unreal Tour engine. However, they do not go into any detail about what the difference between the two engines is or why it is good that they used games from both engines.
Another critique I have about the paper is about how the IP mapping tool was only able to collect 60 percent of addresses. They mention that the tool is constantly improving, but they do not say why the tool cannot collect 40 percent of geographic locations. They also failed to talk about where those 40 percent of people might be connecting from.

I feel the papers strengths out weigh they weaknesses. The authors to a great job in their analysis of the traffic and making sure the reader understands what their analysis means. They also propose good improvements for network devices to better handle on-line multiplayer game traffic. With the constant increase in the amount of this type of traffic, network device manufacturers are going to have to take into consideration how to handle small UDP packets that come in periodic bursts.