**Characterizing the Effects of Low-Rate DoS Attacks on Streaming Media Traffic**

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**Abstract**

Much research has been done to evaluate the effects of low-rate DoS attacks on TCP traffic in the Internet. However, very few studies have evaluated the effects of low-rate DoS attacks on UDP traffic in the Internet, such as streaming media traffic. Advances in compression technology and the completion of the last-mile broadband networks have made video streaming a staple application in the Internet. For this reason, it is important to investigate the effects of the low-rate DoS attack on the quality of received video. We used the video evaluation toolset EvaVid with the network simulator ns-2 for the extraction of video performance metrics such as PSNR, loss, and delay rates. EvaVid generates trace files which are put through an ns-2 simulation. This creates send and receive trace files which EvaVid then uses to make calculations and produce a potentially corrupted video. These results allow us not only to evaluate network statistics such as loss rates, but also allow for evaluation of the user-perceived video quality through PSNR and MOS data. Our work can be beneficial to network defense engineers in building robust defense systems against these new breed of DoS attacks and will also greatly improve our understanding of these attacks.

**Introduction**

Low-Rate DoS Attacks

- Low-rate DoS attacks target routers by sending high volumes of packets in quick bursts, creating a square wave traffic pattern
- The attack rate should be at least equal to bottleneck capacity
- Low sending rate can easily evade congestion control algorithms at the router making it difficult to detect attack

Streaming Media

- There are two frame types in MPEG-4's Simple Profile: I frames (intra-coded frames or key frames) are coded in reference to themselves  
  - P frames (predictive frames) are coded in reference to the previous I frame
- These frames are organized into GoPs (Groups of Pictures), each group is made of one I frame and all the P frames between it and the next I frame

EvaVid

EvaVid is a video evaluation toolset which contains programs to create trace files, reconstruct erroneous video, and compute various performance metrics

**Methodology**

Network Topology

- Implemented a dumbbell topology for network simulation  
  - Allows us to send traffic across a bottleneck link  
  - Bottleneck link speed: 10 Mbps
- Allows us to set delay boxes on either side of the bottleneck link
- Background traffic is important in creating a realistic simulation
- HTTP flows generated by PackMime
- Without attack traffic, this model is intended to provide good Quality-of-Service

Attack Design

- We chose to explore a scenario of 30 fps with a GoP size of 30
  - This translates to one I frame per second
- Since I frames are used to decode P frames, the loss of an I frame is much more damaging than the loss of a P frame
- An attack seeking to induce I frame loss would be more lethal
- We set the period of attack at 1.33 seconds so that in 3 seconds the attack would have nearly 100% probability of occurring during I frame transmission because it cycles through the beginning, middle, and ending thirds of a second.

Simulation and Evaluation

- Primary Procedure (shown in blue)
  - Encode raw video with MPEG-4
  - Put in mp4 container and hint for transmission
  - Generate video trace
  - Put trace through ns-2 simulation
- Secondary Procedures (shown in gray)
  - Create reference video
  - Use ns send and receive trace files to reconstruct the erroneous video and calculate loss, rate, and delay metrics
  - Use yuv files to calculate Peak Signal-to-Noise Ration (PSNR) and a reference PSNR
  - Calculate Mean Opinion Score (MOS) from PSNR values

**Metrics**

- In the case of streaming media, it is very important to evaluate user-perceived quality as well as network statistics such as loss and delay because it is the final quality which is what determines whether or not a user continues to watch streaming media.
- PSNR is one of the most common methods of video evaluation. It has been found that there is a direct correlation with PSNR and video quality.
- PSNR can be used to calculate the MOS, which is a 1-5 scale that ranks video according to user perception.

**Sources**