Outline

- The issues
- The Queuing Problem
- Benefits of Priority Queuing of Game Traffic
- ANGEL
  - Requirements
  - Stakeholders
  - Basic Architecture
- Flow Classification
- Machine Learning
Issues

• Highly interactive network games have different network requirements compared to other applications

• Users ability to play successfully is highly dependent on network QoS

• With the increase in broadband popularity
  • Internet connections being shared amongst multiple users
  • Users often run network applications concurrently

• End-to-end QoS solutions are not practical
  • Requirements of application not properly understood by developers
  • Network equipment often does not implement QoS solutions
  • Configuration complex for average home users

The Queuing Problem

• Imagine a low-bandwidth consumer upstream link (128kbps) sharing:
  • TCP upload using as much bandwidth as the network will allow
  • Network game application generates small periodic UDP packets

• TCP is bursty - each burst will be queued by the gateway for transmission

• The game packet is queued behind the TCP burst

• Priority queueing of game traffic should improve performance at minimal cost to TCP throughput
**ANGEL - Requirements**

- A prototype system to identify game flows within the ISP and forward this information to CPE devices for prioritisation purposes
  - **Scalability** - Potentially support all ISP customers
  - **Access Technology Independence** - Must work at IP layer
  - **Transparency** - Transparent to end-host network applications
  - **Flexible Prioritisation** - CPE device chooses prioritisation means
  - **Heterogeneous Networks** - Not all users may be running ANGEL
  - **Minimal CPE requirements** - CPE processing capabilities
ANGEL - Potential Stakeholders

End Users

- Improved perceived performance in network gaming applications

Internet Service Providers

- Better customer service - both users and game service providers

Game Service Providers

- Improved online gaming performance will increase user base

Network Equipment Manufacturers

- Deploy ANGEL into CPE and/or ISP side network equipment
- Potential early adopter relationships between manufacturers and ISPs as preferred suppliers

ANGEL Architecture

ISP Side components

- **Flow Meter** - Monitors network traffic at a location, filters into flows, forward packet and flow information to Flow Classifier

- **Flow Classifier** - Classifies flows into gaming or non gaming classes. Change in classification of a flow is forwarded to Client Manager

- **Client Manager** - Manages database of registered users/CPE devices. Forward flows to be prioritised information to CPE and other network devices
Key ANGEL Advantages

- Flow detection moved into ISP network
- Minimal resources required in CPE equipment
- New classification models easier to propagate
- Choice of classification technique independent of ANGEL architecture

Flow Classification

- ANGEL does not specify how to classify flows
  - Architecture specifies how packets are captured and passed to the Flow Classifier
  - Classifier can use any means to perform classification
- Traditional Classification Techniques - packet inspection
  - Port numbers - new applications, dynamic allocation
  - Stateful Flow Reconstruction - not scalable, encrypted flows
- Our prototype will use Machine Learning
  - System trained using representative flow data
  - Flows classified from commonly available features (eg. packet size, inter-arrival times)
  - No payload information required - privacy issues
ML for Real-time Classification

- Problems
  - **Build accurate models** - Need to create training data that allows classifier to quickly/accurately identify flows
  - **Processing** - Need to classify potentially tens of thousands of flows, each within a short timeframe

- Two commonly used algorithms are able to quickly and accurately identify these flows

- Other work\(^1\) shows that Enemy Territory can be accurately separated from non-game traffic using a sliding window of 25 packets

\(^1\)T.T.T. Nguyen, G. Armitage, "Training on Multiple Sub-flows to Optimise the use of Machine Learning in Real-World IP Networks", IEEE Local Computer Networks Conference LCN2006 (to be presented)

**Summary**

- Networked games are typically played within a local topological region
  - Which often leads to geographical locality performance
- Majority of bottlenecks occur at the edge of the network
- Priority queuing of game traffic
  - Improves game traffic QoS - player performance
  - Minimal effect on TCP throughput
- ANGEL:
  - Does not attempt to solve end-to-end QoS issues
  - System to detect network game flows in the ISP network
  - Forward information to ANGEL-enabled CPE devices
  - CPE device prioritise these applications
  - Processing shifted to ISP
  - Uses Machine Learning techniques to classify flows in real-time