# Searching for Invariants in Network Games Traffic

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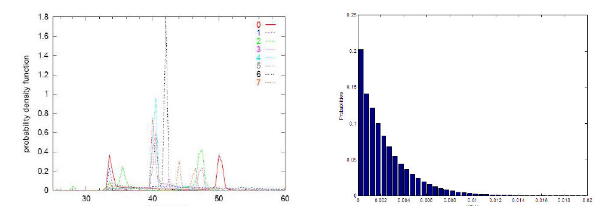
## 1- Introduction and Motivations

- An important category of emerging Internet applications
  - The percentage of Internet traffic related to network games is constantly growing [1].
  - Their traffic characteristics and QoS requirements, substantially differ from those of traditional Internet applications.
- We show an ongoing work on the search for ***invariant characteristics*** of network games traffic
  - We perform a characterization of the traffic generated by *Counter Strike*, under different network scenarios, and compare the results.
- The traffic is observed at *packet level*
  - *Payload Size (PS)* and *Inter-Packet-Time (IPT)*.

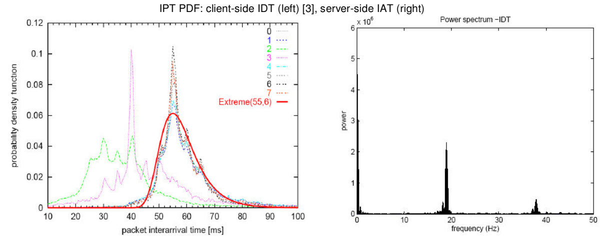
## 2- A first confirmation with available data

- Two distinct gaming sessions happened at different times and networks (WAN vs LAN), and observed respectively from the points of view of both server and clients
  - A trace from a WAN scenario, captured at a Counter-Strike server [2].
  - A characterization of a LAN party performed by J. Faerber [3].

- We compare results in [3] with our characterization of the WAN trace
  - Clients IDT mean value (41.7 ms ≡ ca. 24 pkts/s) reported in [3] is consistent with the mean of the server IAT from all the 22 clients (0.002s ≡ 528 pkts/s = 22 players × 24 pkts/s).
  - The peak at about 19 Hz (ca. each 53 ms) of server incoming packet rate freq. spectrum, is consistent with client-side IDT PDFs (mean ~55 ms) reported in [3].



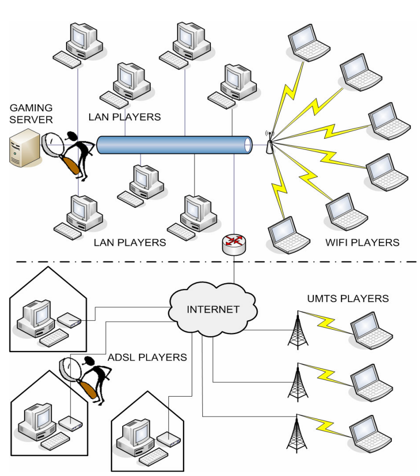

IPT PDF: client-side IDT (left) [3], server-side IAT (right)




Client-side IDT PDF (left) [3], Frequency spectrum of Server-side incoming packet rate (right)

## 3- Setting up the testbed

- To further investigate the foreseen invariants other data are needed
- To this aim a heterogeneous testbed has been set up
- We placed the game server in our LAN. Then, we made tests with clients on
  - *LAN*
  - *Wi-Fi*
  - *HOME ADSL*
  - *UMTS*
- The testbed can be used to study the traffic of other applications




## Acknowledgement

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## 4- Characterization and invariants

The results of the characterization we present are those of the LAN scenario

- All clients have the same behaviors, both in terms of IPT and PS
- Both server and clients generate small packets
  - PS clients: [25,61] bytes, mostly concentrated at 50
  - PS server: [0,460] bytes, gamma-like, higher variance
- Clients PS show some degree of correlation at least until lag 50
- Server PS correlation has an oscillating decay with period T = 4 lags
- Clients IPT are gaussian-like centered at ~42 ms (pkt rate mean ~24 pkt/s)

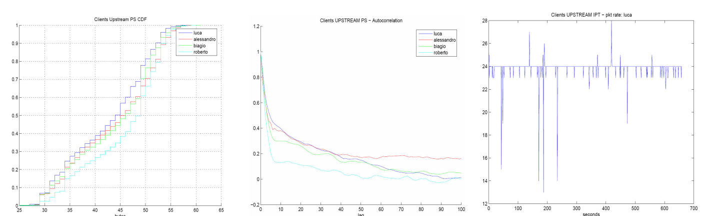
- Server IPT autocorrelation shows a strong periodicity $T = \frac{N}{K} lags$ with N = # players and K integer number. This can be due
  1) as found by Faerber [3], the server sends updates with a fixed time period (namely ***T'*** ~ 55 *ms*)
  2) packets sent to the different clients are sent either very close to each other (i.e. IPT ~ 100 *us*) or with an IPT equal to a fraction of ***T'*** (we have observed ***T'/2*** and ***T'/4***).

Lan scenario - Upstream PS statistics

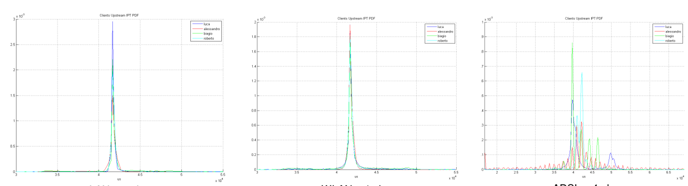
| player | mean [$Bytes$] | std [$Bytes$] | iqr [$Bytes$] | max [$Bytes$] | min [$Bytes$] | median [$Bytes$] | entropy [bit] |
|---|---|---|---|---|---|---|---|
| luca | 42.49 | 7.99 | 14.00 | 61.00 | 25.00 | 44.00 | 4.62 |
| alessandro | 43.81 | 8.41 | 15.00 | 61.00 | 25.00 | 46.00 | 4.73 |
| biagio | 43.69 | 8.11 | 14.00 | 61.00 | 25.00 | 46.00 | 4.66 |
| roberto | 45.66 | 7.58 | 12.00 | 60.00 | 25.00 | 49.00 | 4.49 |
| server | 77.48 | 32.79 | 32.00 | 461.00 | 27.00 | 72.00 | 6.67 |

Lan scenario - Upstream IPT statistics

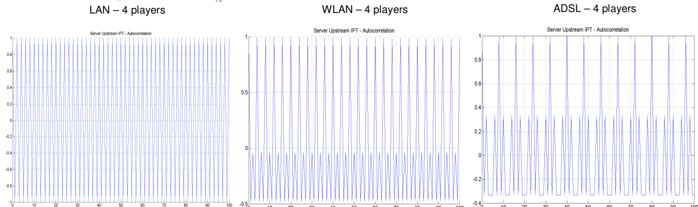
| player | mean [$\mu s$] | std [$\mu s$] | iqr [$\mu s$] | max [$\mu s$] | min [$\mu s$] | median [$\mu s$] | entropy [bit] |
|---|---|---|---|---|---|---|---|
| luca | 41910.96 | 7134.15 | 171.00 | 465432.00 | 16730.00 | 41687.00 | 2.39 |
| alessandro | 42876.46 | 16783.57 | 443.00 | 1522475.00 | 3668.00 | 41716.00 | 4.04 |
| biagio | 42175.36 | 12245.83 | 363.00 | 1528904.00 | 31225.00 | 41724.00 | 3.65 |
| roberto | 41861.18 | 1195.64 | 264.00 | 63509.00 | 32183.00 | 41728.00 | 2.78 |
| server | 13912.34 | 9975.72 | 26720.50 | 42177.00 | 3.00 | 13894.00 | 3.22 |




LAN – 4 players　LAN – 4 players　LAN – 4 players



LAN – 4 players　WLAN – 4 players　ADSL – 4 players




ADSL – 4 players　LAN – 4 players　LAN – 8 players

- PS has shown to be totally invariant with respect to the network
- Strong *invariants* for IPT
  - Clients IPT become more spread when the packets traverse a WAN
  - Looking at *seconds* time scale (pkt rate) the behavior is the same in all considered scenarios (LAN, Wi-Fi, ADSL)
  - Server IPT autocorrelation shows a periodic behavior (same behavior as in the LAN)

## 5- Conclusions and Issues for Research

- The *search for invariants* allows us to identify the behaviors related to the application by isolating them from the network environment.
- Traffic of *Counter Strike* is highly predictable. Allowing, e.g., ISPs to identify it, and to provide specific QoS and billing accordingly.
- We have identified some properties that are dependent of the numbers of players. This allows to estimate such number by looking at the traffic.
- We are also performing this analysis for other networking games.
- In general, our testbed will allow to apply our methodology to different kinds of applications.

## References

[1] S. McCreary, k. Claffy, "Trends in Wide Area IP Traffic Patterns: A View from Ames Internet Exchange," 13th ITC Specialist Seminar on Measurement and Modeling of IP Traffic, Sep 2000
[2] W. Feng, cs.mshmro.com CounterStrike Server Traffic Trace", www.ogiworks.org/files/tcpdump.11Apr0855.04, as of Apr 2002.
[3] J. Faerber, "Network game traffic modelling", ACM workshop on Network and System Support for games, Apr. 2002