Networking Issues and Solutions in Online Games Part II

Claudio E. Palazzi

Credits to Nadjib Achir, Khaled Boussetta, Arnaud Kaiser, Jose Saldana, Mirko Suznjevic

Internet legacy

- The Internet was designed for elastic flows, not for real time ones
  - E.g., data transfer
- Best effort service
  - No maximum delay guaranteed
- The current size of the Internet does not allow to deploy quick global modification
  - E.g., IPV6 is from 1998
- Changes must be accepted and prograssively introduced
  - And must be backward compatible

Internet legacy

- The last big change: January 1st, 1983
  - NCP was replaced by TCP/IP
  - 400 nodes

Real-time service revolution

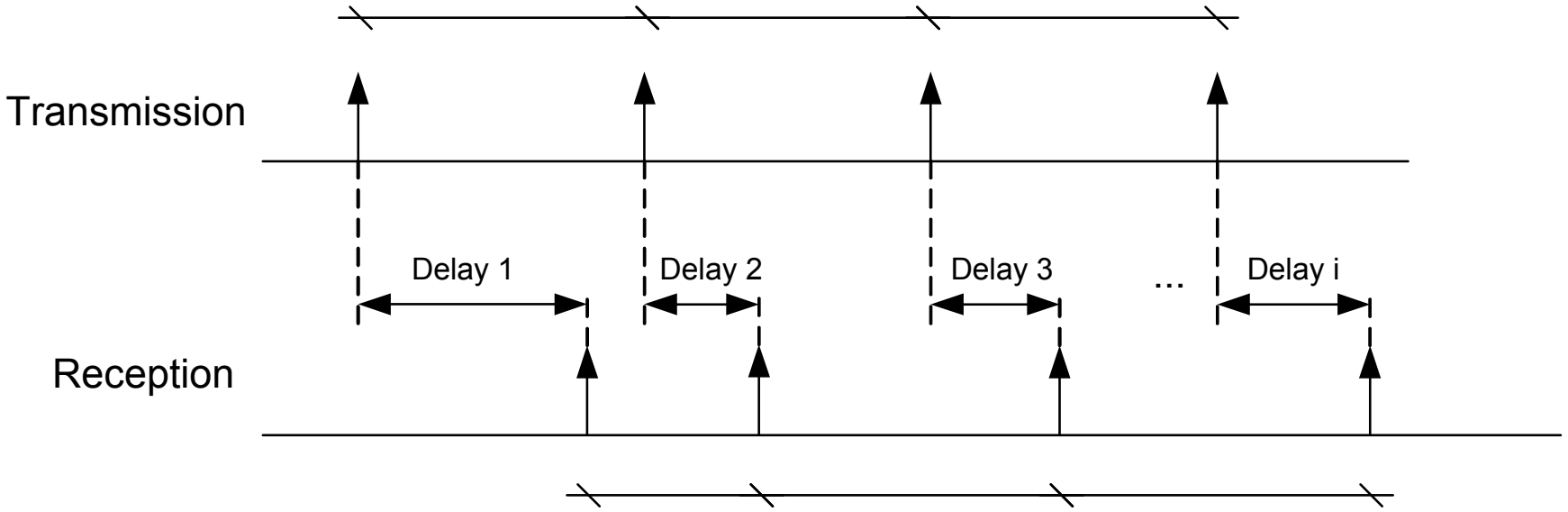
- Real time services are nowadays widely used
  - VoIP, video conference, online gaming
- Quality problem
  - Using a best effort network for real-time services

Networking issues: Delay

- Interactivity requires small delays
  - VoIP and FPS: less than 150ms of delivery delay
- Causes
  - Network equipment
  - Applications
  - Speed of light
  - Network congestion
  - Computational load

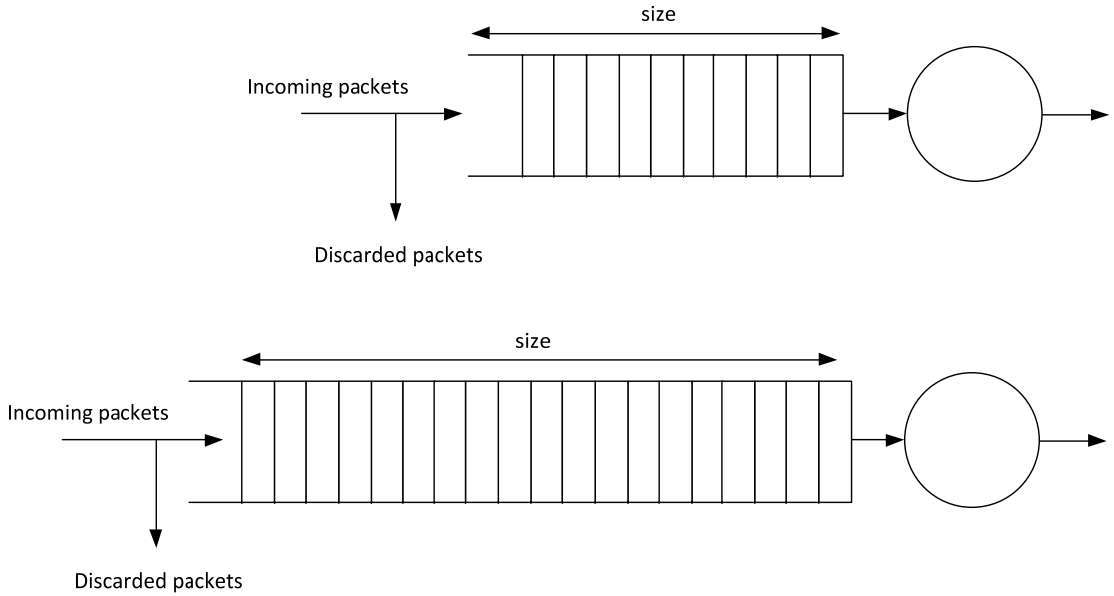
Networking issues: Jitter

- **Jitter**: different network delivery delays for different packets
  - Caused by bursty traffic (e.g., web browsing)



Networking issues: Packet loss

- There are networks bottlenecks
  - So buffers are used
  - Buffers have limited capacity
  - Sometimes packets are dropped

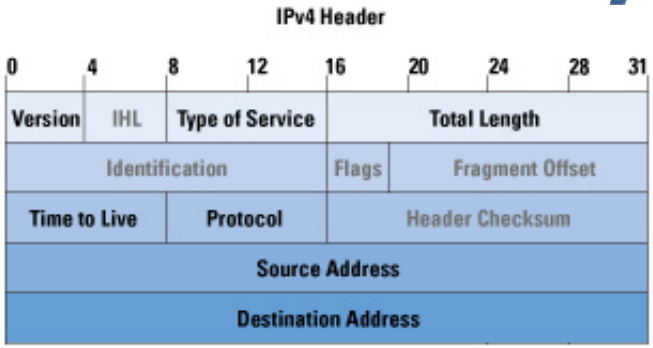


Networking issues: Efficiency

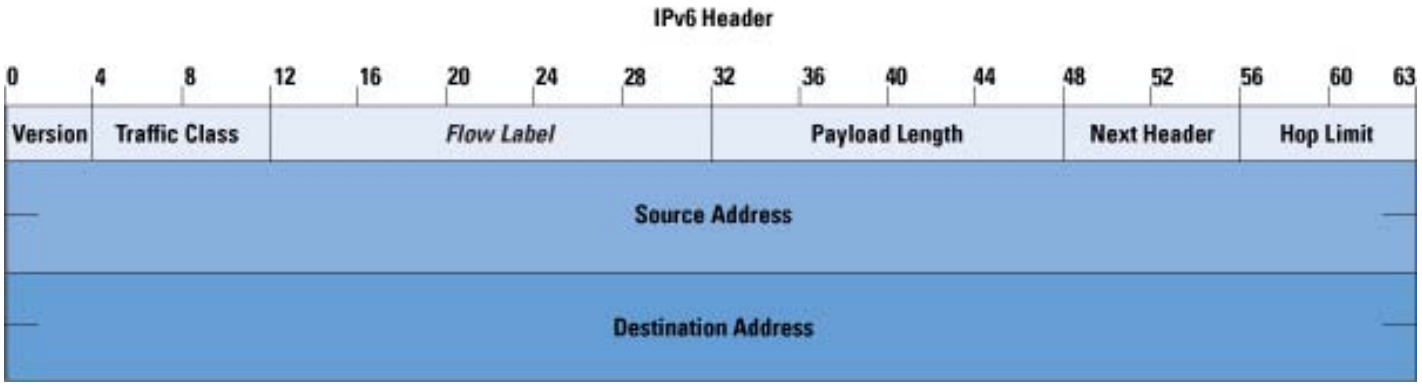
- Every packet needs a header
  - Origin, destination, sequence number, type, ecc.
- It is not the data we are transmitting
  - **Overhead**
- Maximum packet size: 1500B

Networking issues: Efficiency

- **The IPv4 header: 20 bytes**

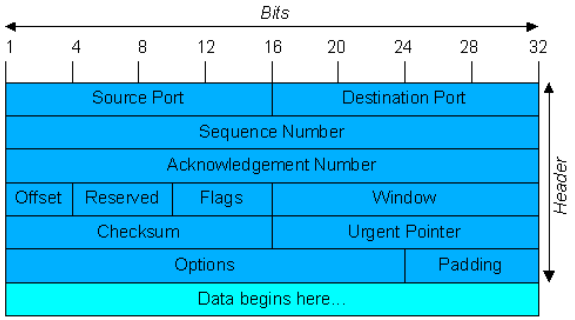


- **The IPv6 header: 40 bytes**

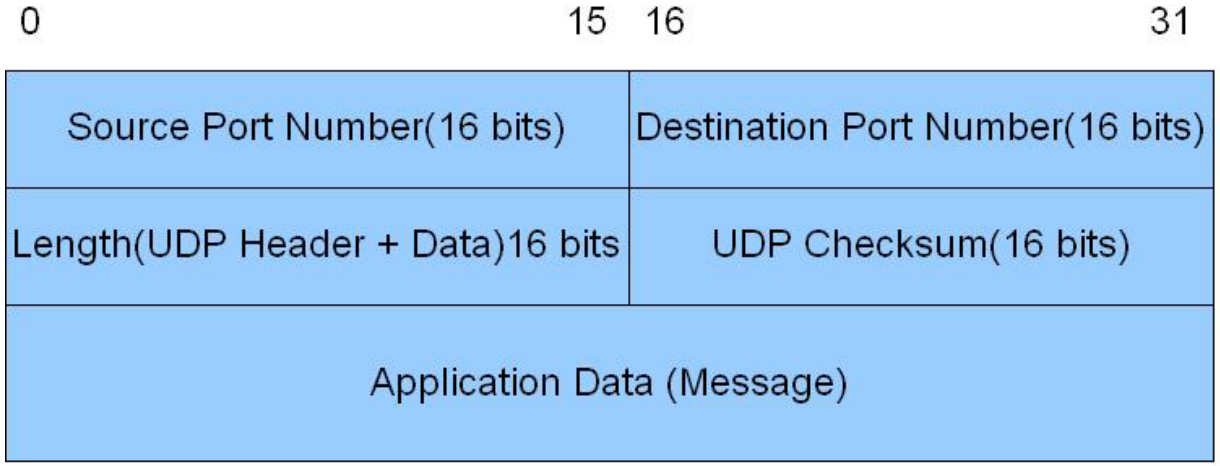


Networking issues: Efficiency

- **The TCP header: 20 bytes**



- **The UDP header: 8 bytes**



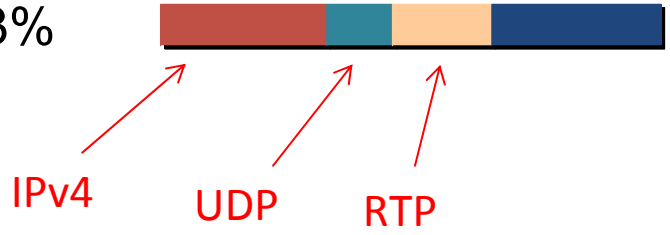
Networking issues: Efficiency

- If I have to send a big file and I divide it into chunks of 1500B then I have an efficiency of 97% for IPv4 an 96% for IPv6

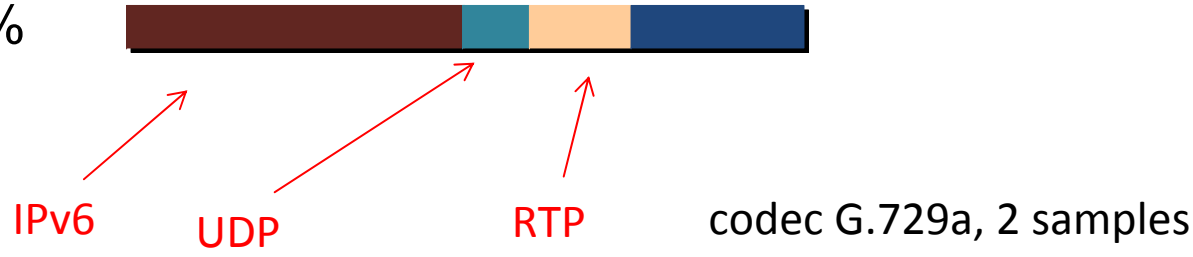
Networking issues: Efficiency

- With real-time services small packets have to be immediately sent (no time for aggregation) thus resulting in poor efficiency

One IPv4/UDP/RTP VoIP packet with two samples of 10 bytes
η=20/60=33%

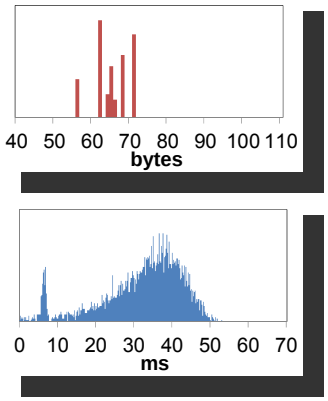


One IPv6/UDP/RTP packet of VoIP with two samples of 10 bytes
η=20/80=25%

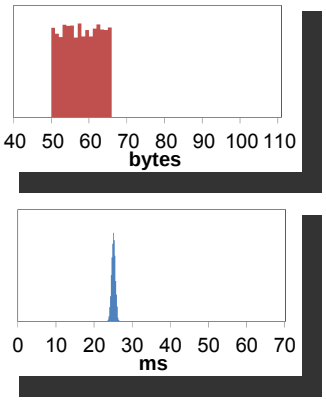


Online games traffic

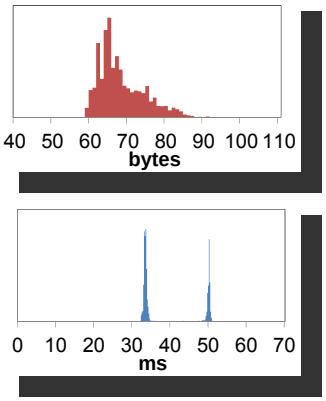
- Online games generate small packets every few tens of ms
  - Poor efficiency



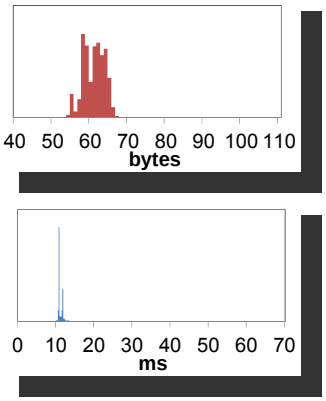
Quake II



Unreal Tournament



Counter Strike I



Quake III

Online games: some genres

Real-time strategy

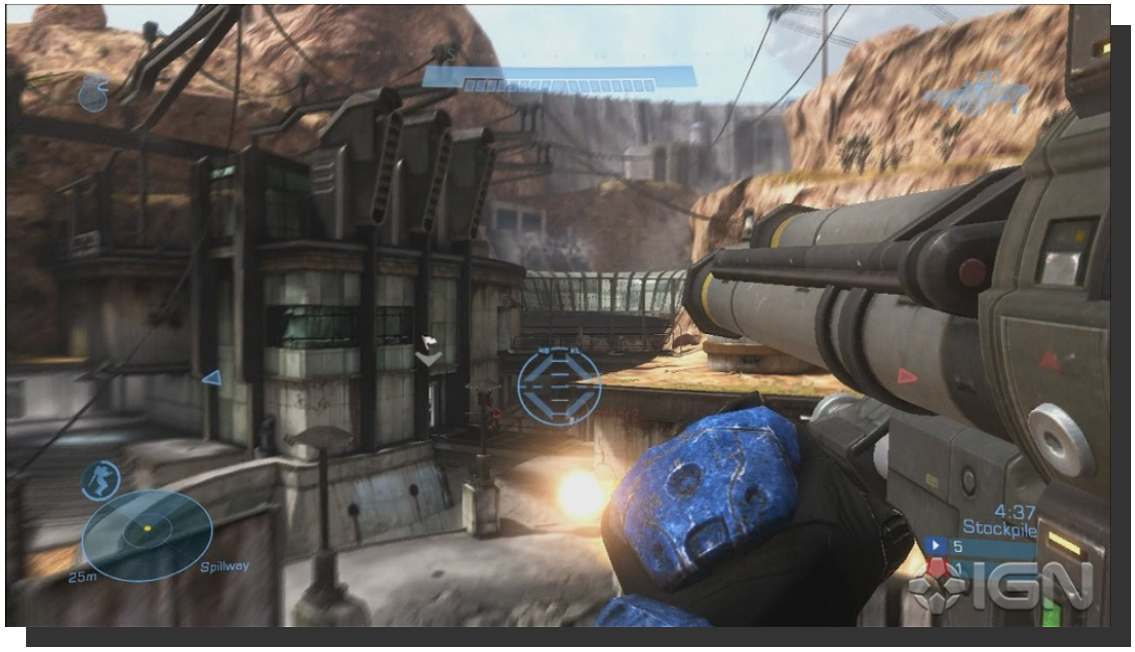
Sports

MMORPG

FPS

FPS online games

- FPS games are those with the tightest real-time requirements
  - Possibly, packets with game events should be delivered in less than 100ms since their generation
  - Less than 50ms for professional players



FPS online games

The CLQ - The #1 in global gaming statistics - GAMES - Windows Internet Explorer

TheCLQ.COM

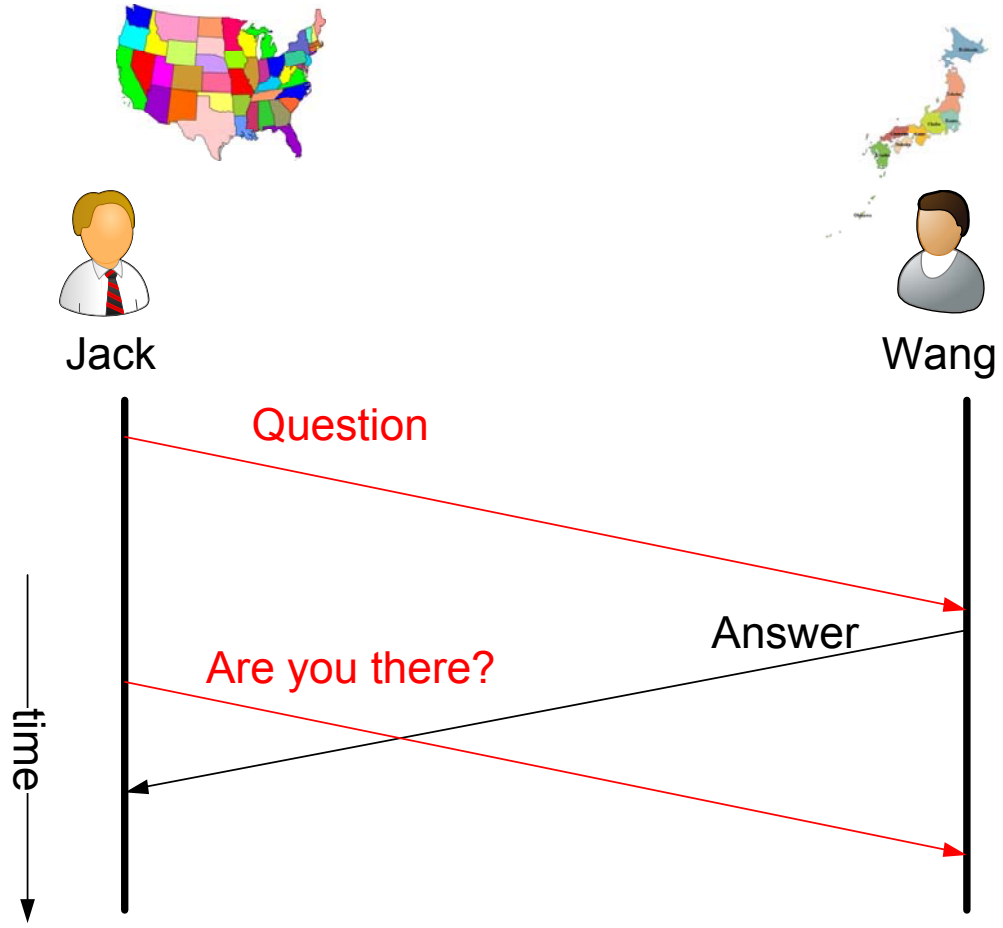
Home | Games | Servers | Players | Player | Register | Login | FAQ / ABOUT

Ads by Google | Online Games Play | Xbox Video Games | Play Video Games | For Play Games

Last updated	4 hours ago
Total players	50,381,205
Online human players	271,869
Online players (humans + bots)	430,427
Total servers	1,335,608
Online servers	87,350

Game	Online human players	Online players (humans + bots)	Online servers	Total Servers
America's Army	26	26	55	5,555
BattleField 1942	528	596	255	
BattleField 2	4,248	5,308	957	2
BattleField 2142	427	541	137	
Battlefield Bad Company 2	804	804	59	
Call of Duty	592	614	144	
Call of Duty 2	3,088	3,384	1,897	2
Call of Duty 4	11,581	13,365	6,806	9
Call of Duty: United Offense	615	804	511	
Call of Duty: World at War	469	597	217	
Counter-Strike	167,304	284,468	27,854	59
Counter-Strike: Source	47,082	70,029	28,190	32
Crysis	113	114	20	
Day of Defeat	1,096	1,608	108	
Day of Defeat: Source	1,906	5,744	1,418	1
Doom 3	1	1	32	
Enemy Territory: Quake Wars	220	391	91	
F.E.A.R.	41	43	101	
Fortress Forever	2	2	9	
Half-Life	879	1,003	248	
Half-Life 2	20	624	690	
Halo	429	429	318	
Left 4 Dead 1	499	510	1,129	2

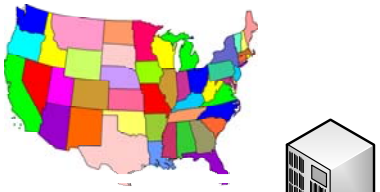
Network delay scheme

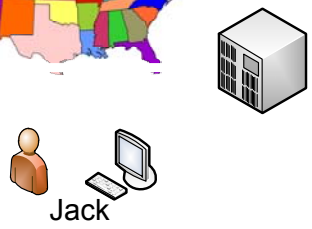


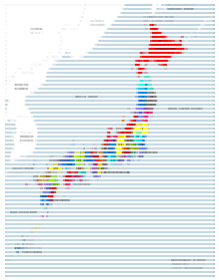
Network delay scheme

FPS online games

"Shooting around the corner"

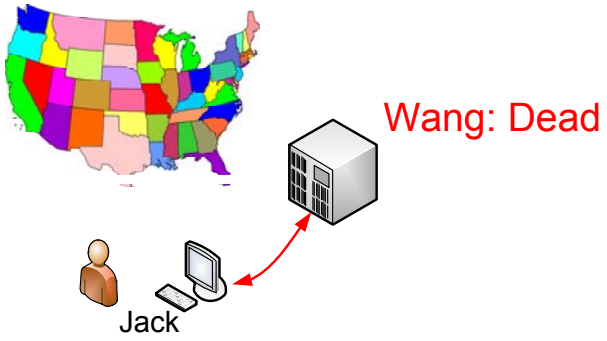


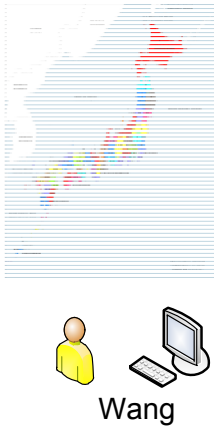




FPS online games

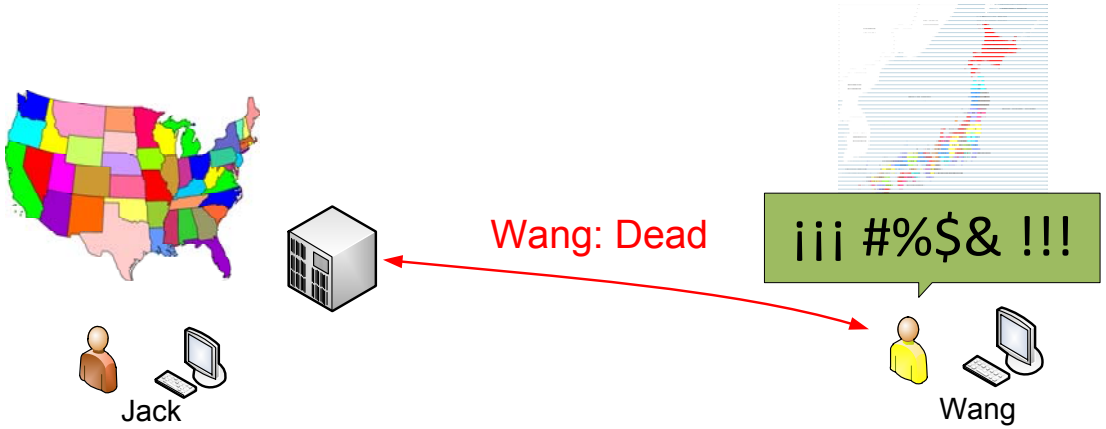
"Shooting around the corner"





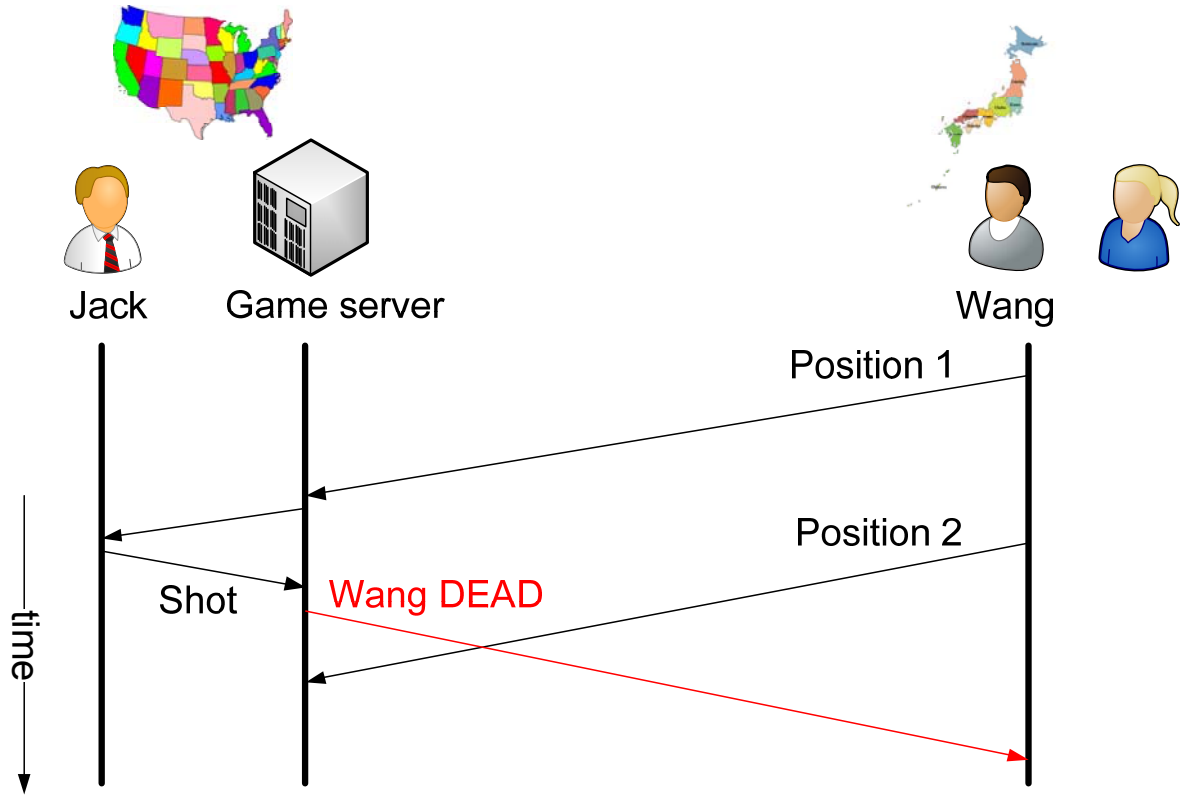
FPS online games

"Shooting around the corner"



FPS online games

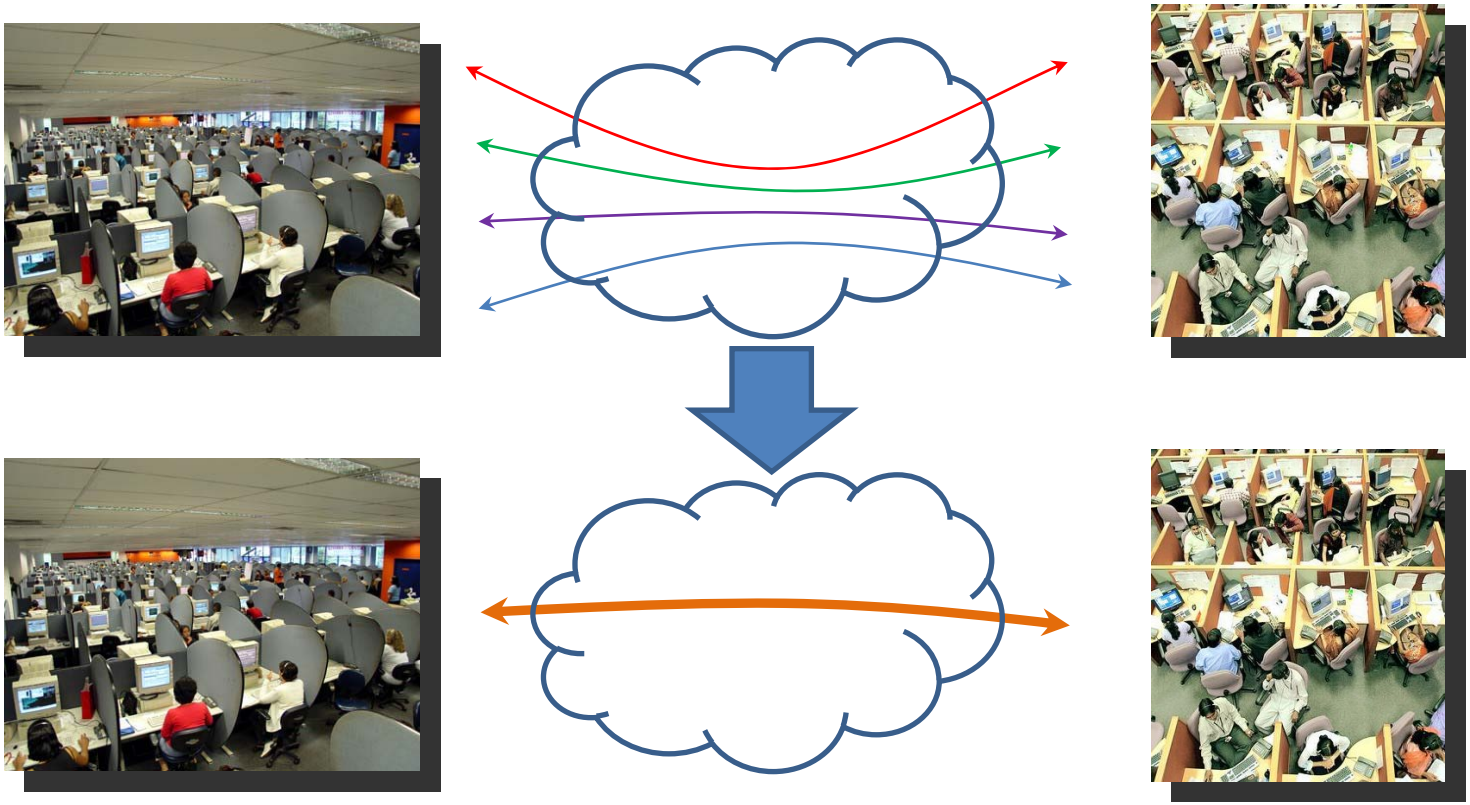
"Shooting around the corner"



Network delay scheme

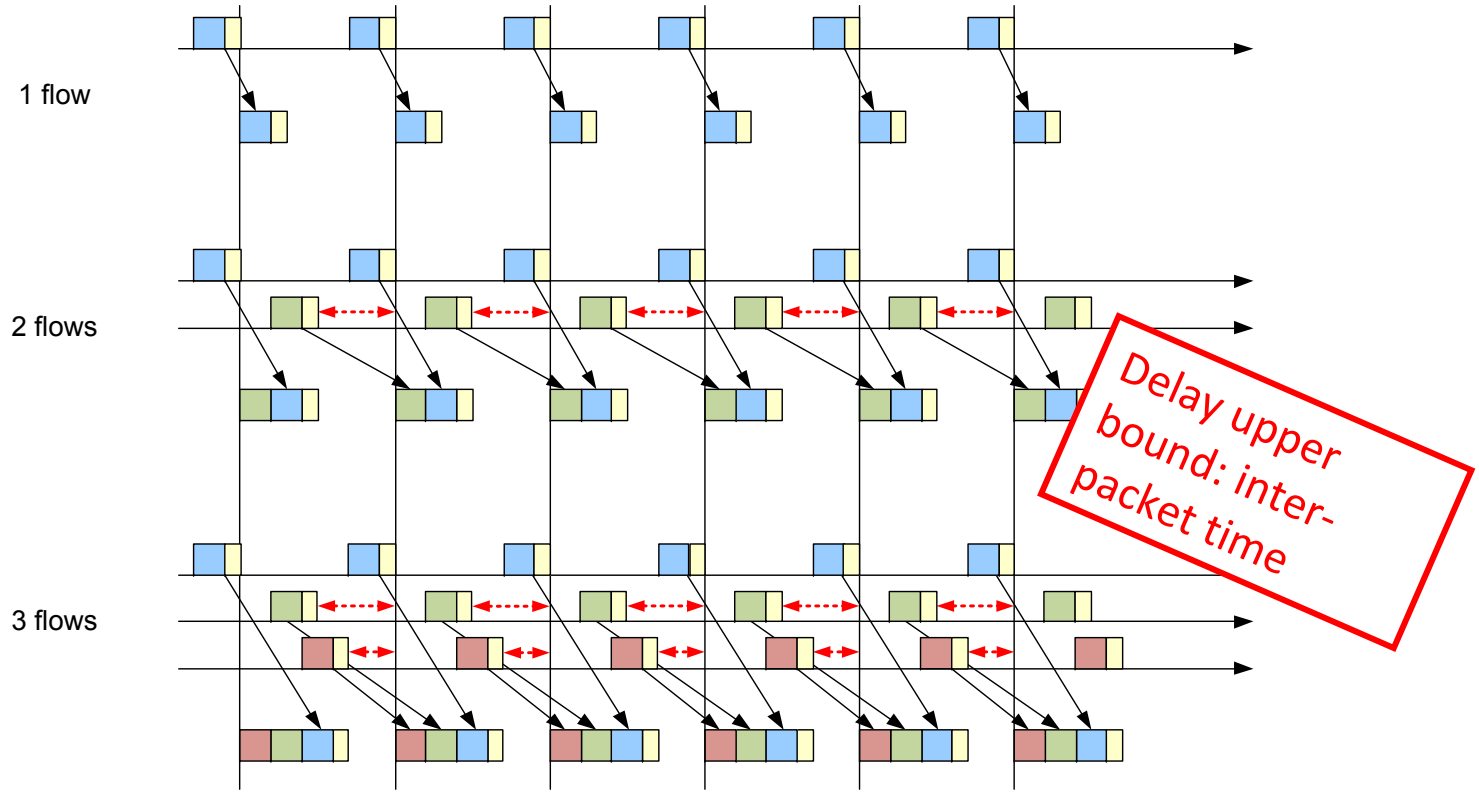
Multiplexing

- Voice trunking between offices



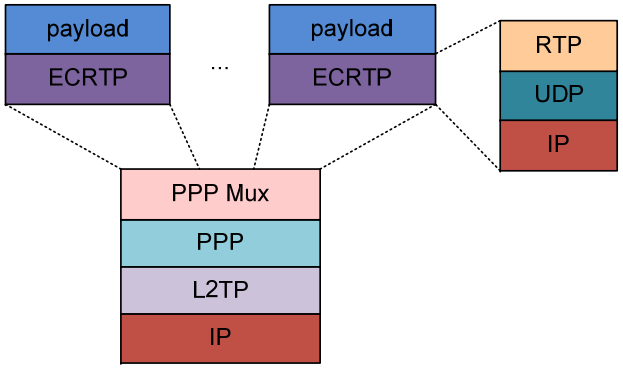
Multiplexing

- Merge the packets and make them share their headers

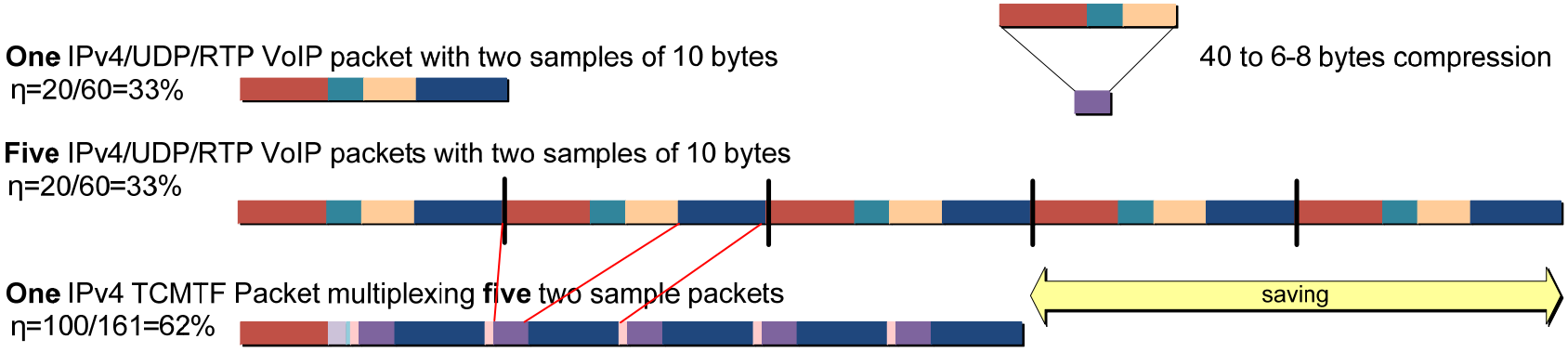


Multiplexing

- **RFC 4170 (2005) deploys this, and also compresses the header**

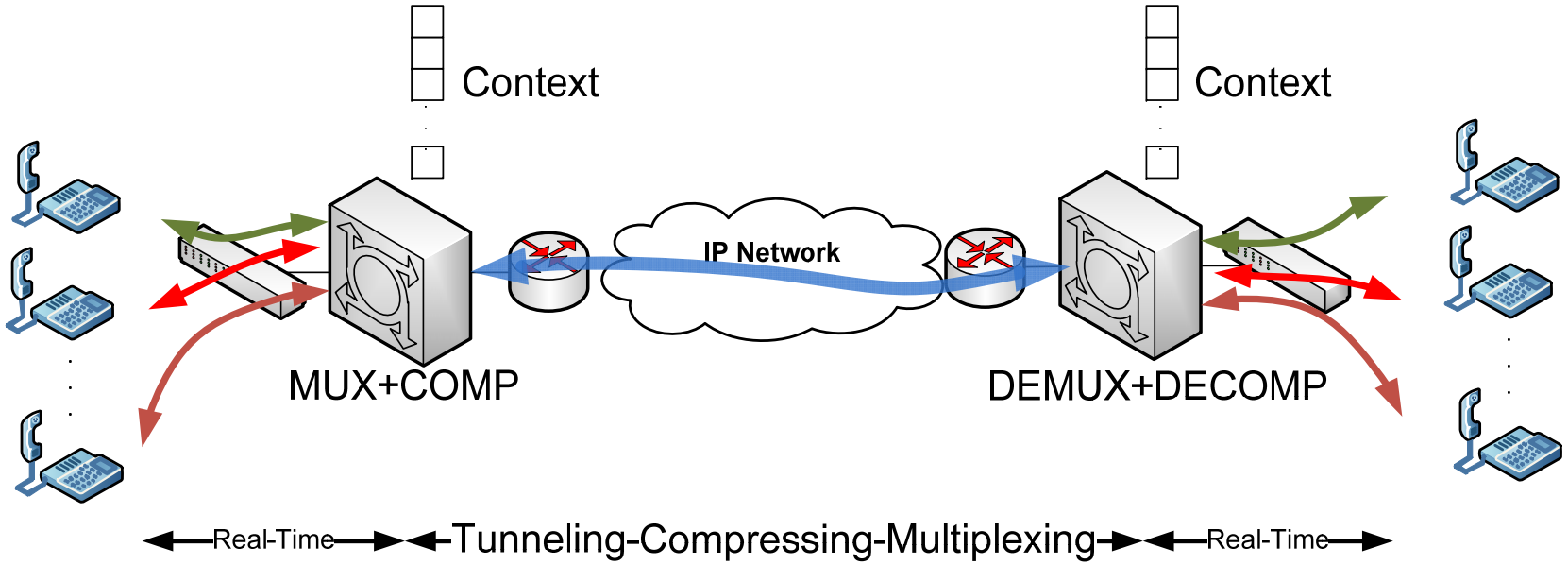


VoIP



Multiplexing

- **RFC 4170 (2005) deploys this, and also compresses the header**



Multiplexing

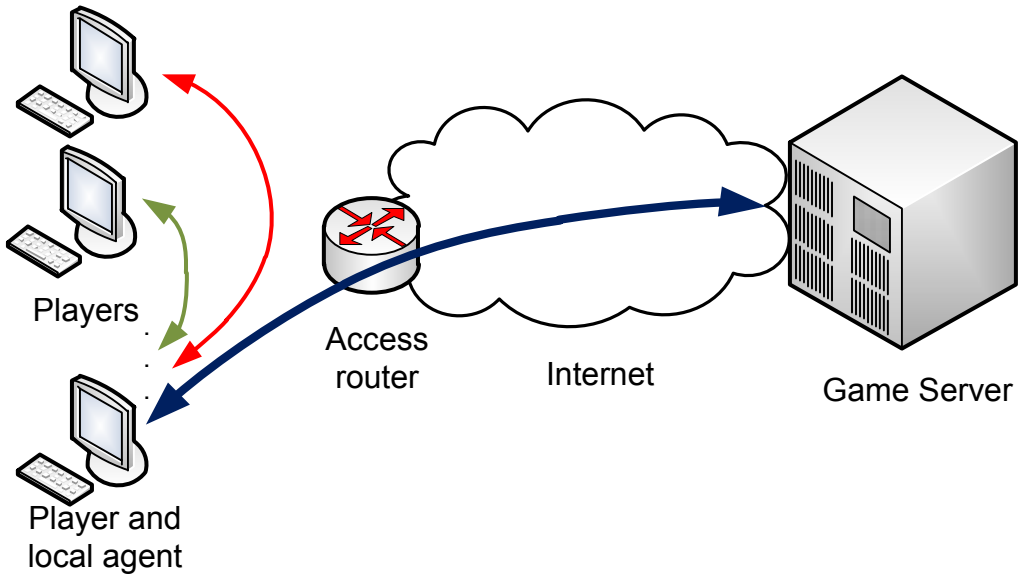
- Tradeoff in aggregating and compressing flows:
  - requires time
  - Improves the efficiency of bandwidth usage
- May work in scenarios where several game flows share the same path

Multiplexing applicability

Internet café

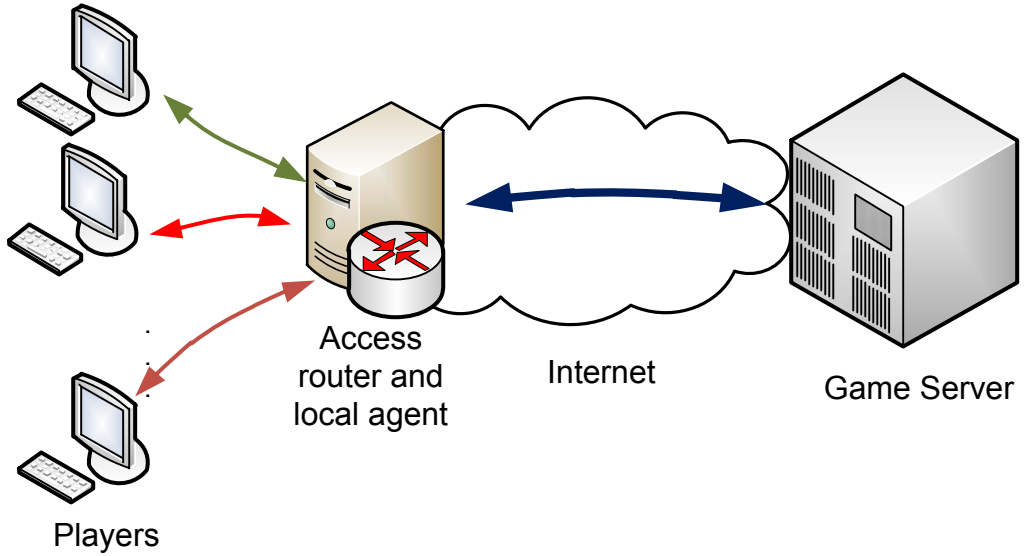
Multiplexing for gaming: Where?

- **Local agent in the computer of a player**



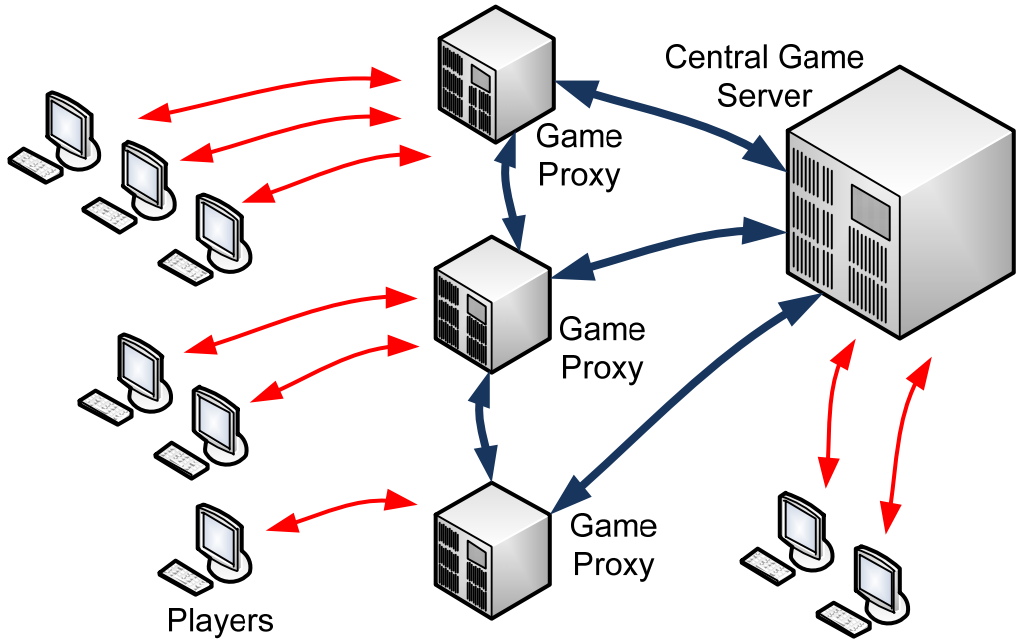
Multiplexing for gaming: Where?

- **Local agent embedded in the router**



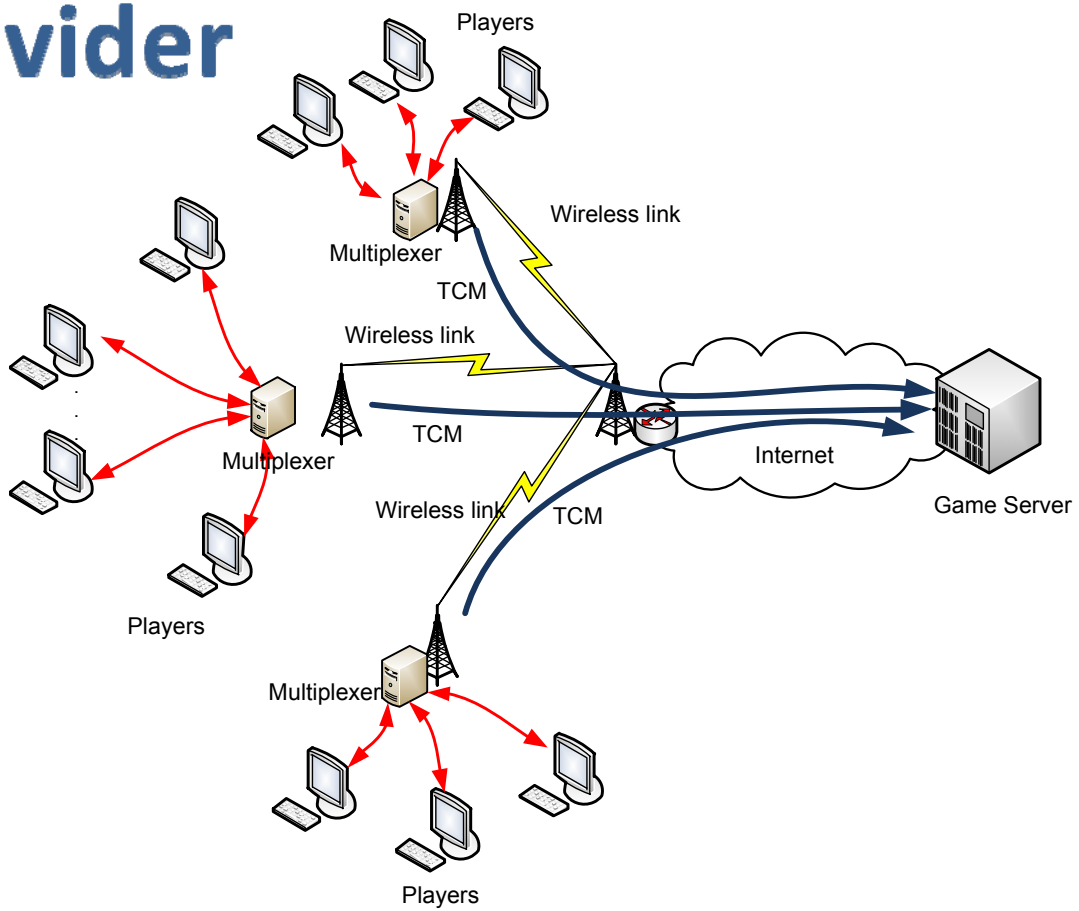
Multiplexing for gaming: Where?

- **Proxies managed by the game provider**



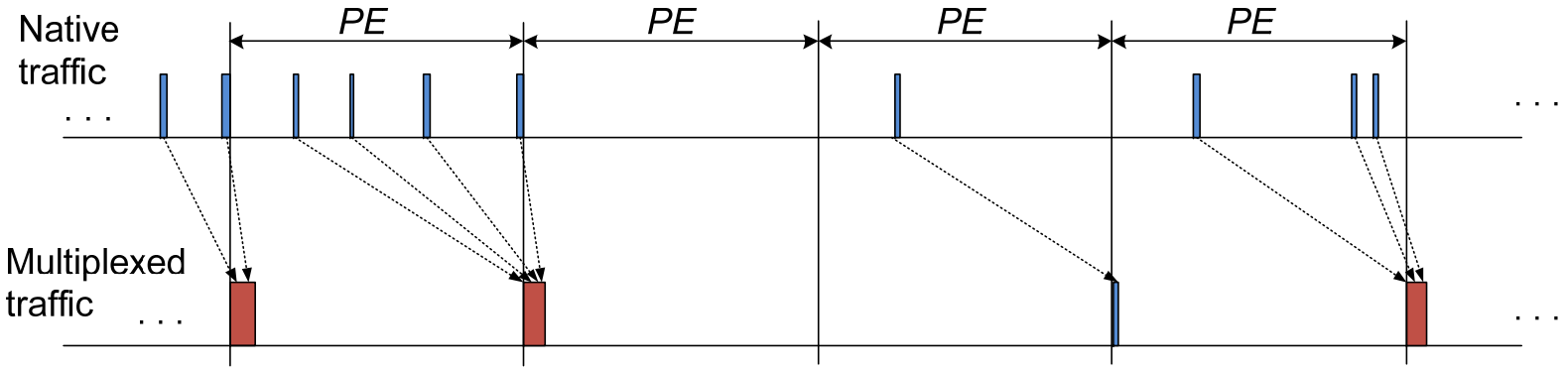
Multiplexing for gaming: Where?

- **Proxies managed by the game provider**



Multiplexing for gaming: How?

A period is defined, and all the packets arrived are compressed and multiplexed



Multiplexing

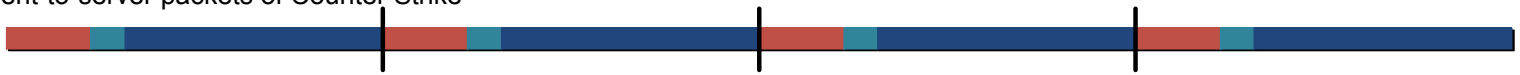
Efficiency improvement IPv4

One IPv4/TCP packet 1500 bytes
η=1460/1500=97%

One IPv4/UDP/RTP packet of VoIP with two samples of 10 bytes
η=20/60=33%

One IPv4/UDP server-to-client packet of Counter Strike with 9 players
η=160/188=85%

Four IPv4/UDP client-to-server packets of Counter Strike
η=61/89=68%



One IPv4/TCM packet multiplexing **four** client-to-server Counter Strike packets
η=244/293=83%

Multiplexing

Efficiency improvement IPv6

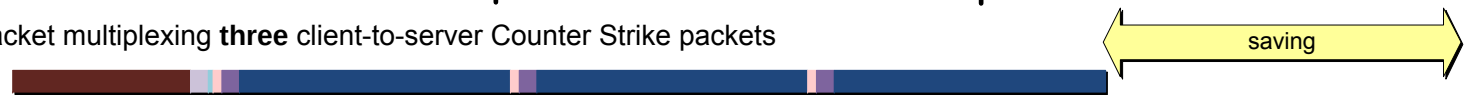
One IPv6/TCP packet 1500 bytes
η=1440/1500=96%

One IPv6/UDP/RTP packet of VoIP with two samples of 10 bytes
η=20/80=25%

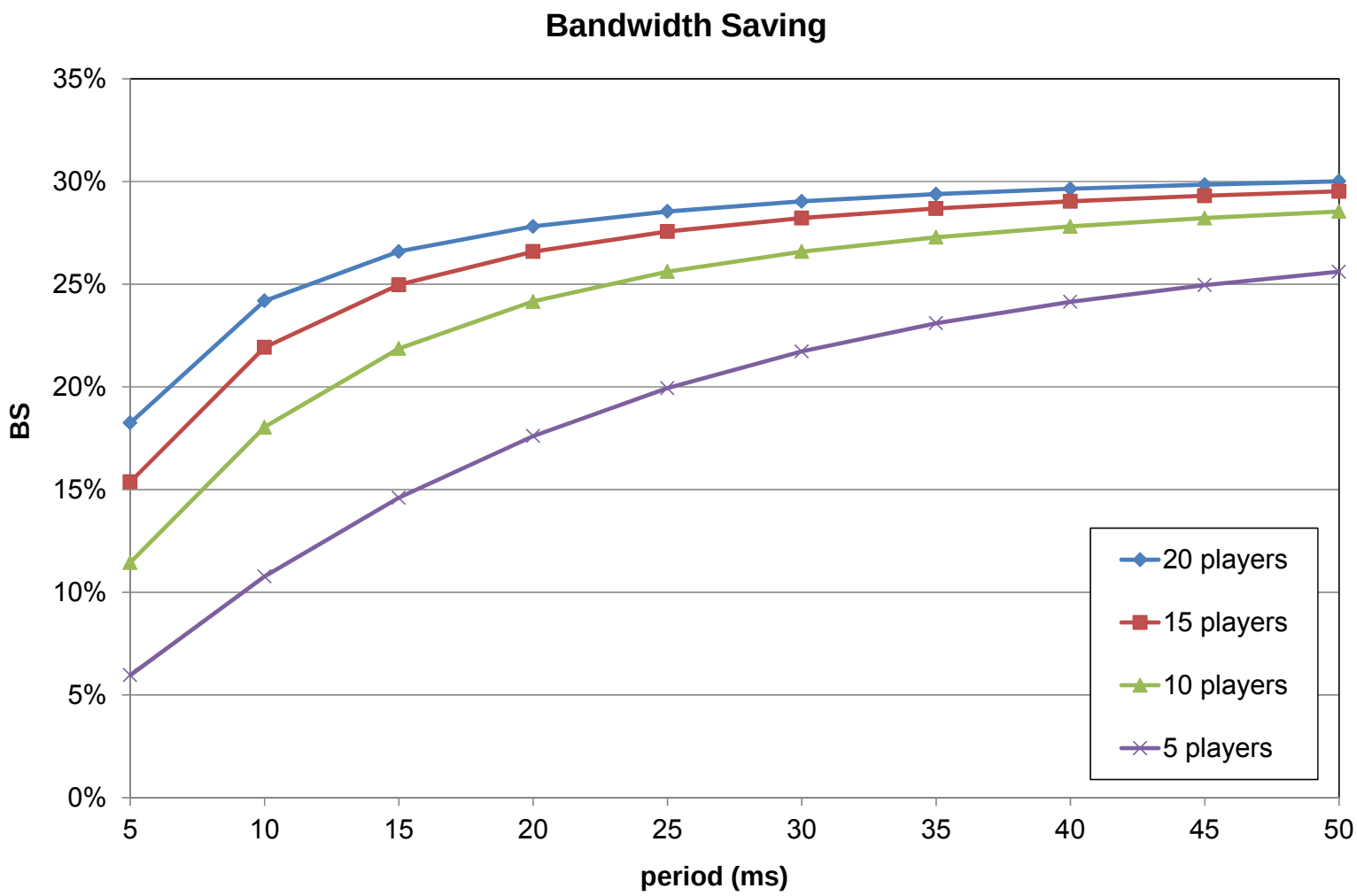
One IPv6/UDP server-to-client packet of Counter Strike with 9 players
η=160/208=77%

Three IPv6/UDP client-to-server packets of Counter Strike
η=61/109=56%

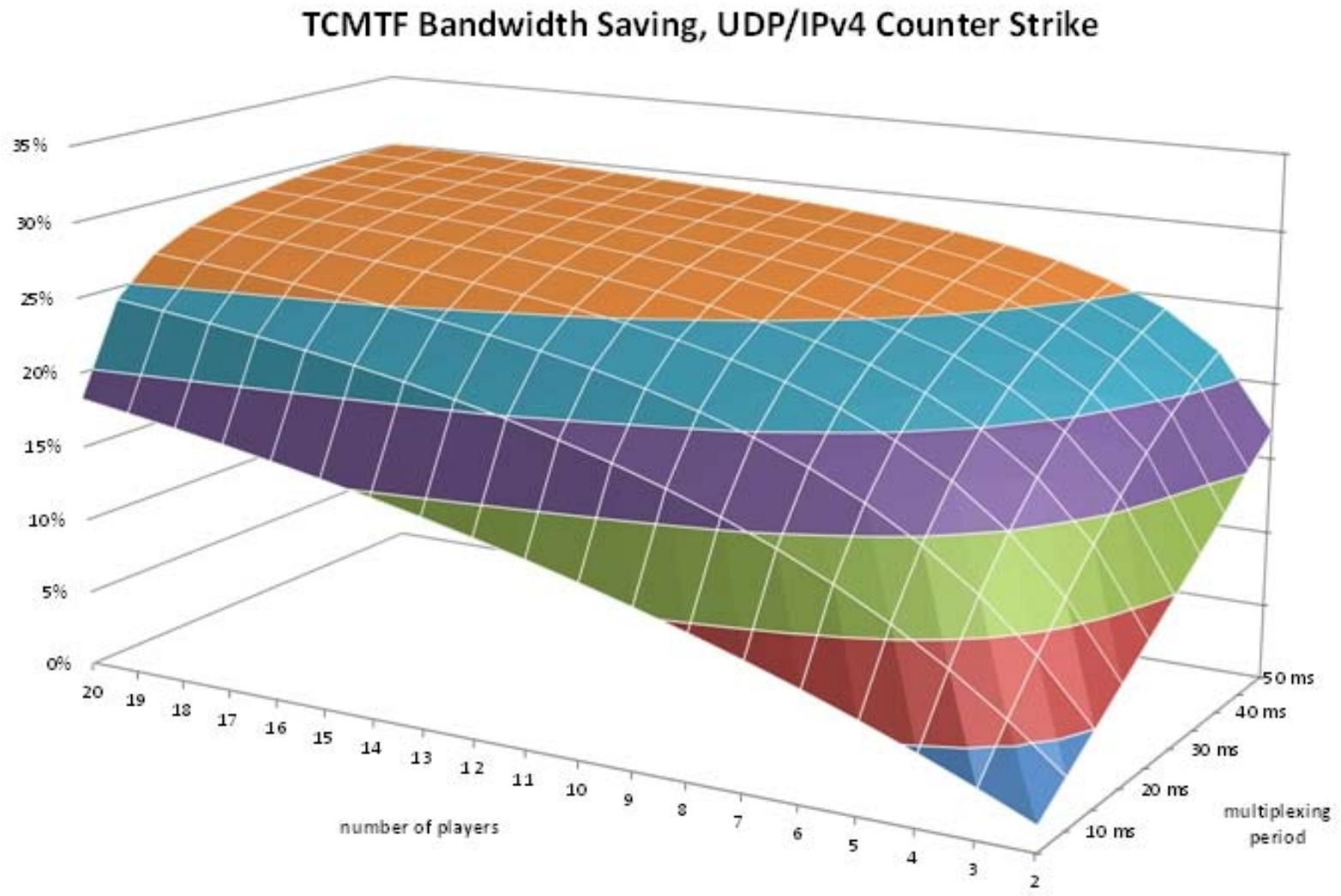
One IPv6/TCM packet multiplexing **three** client-to-server Counter Strike packets
η=183/246=74%



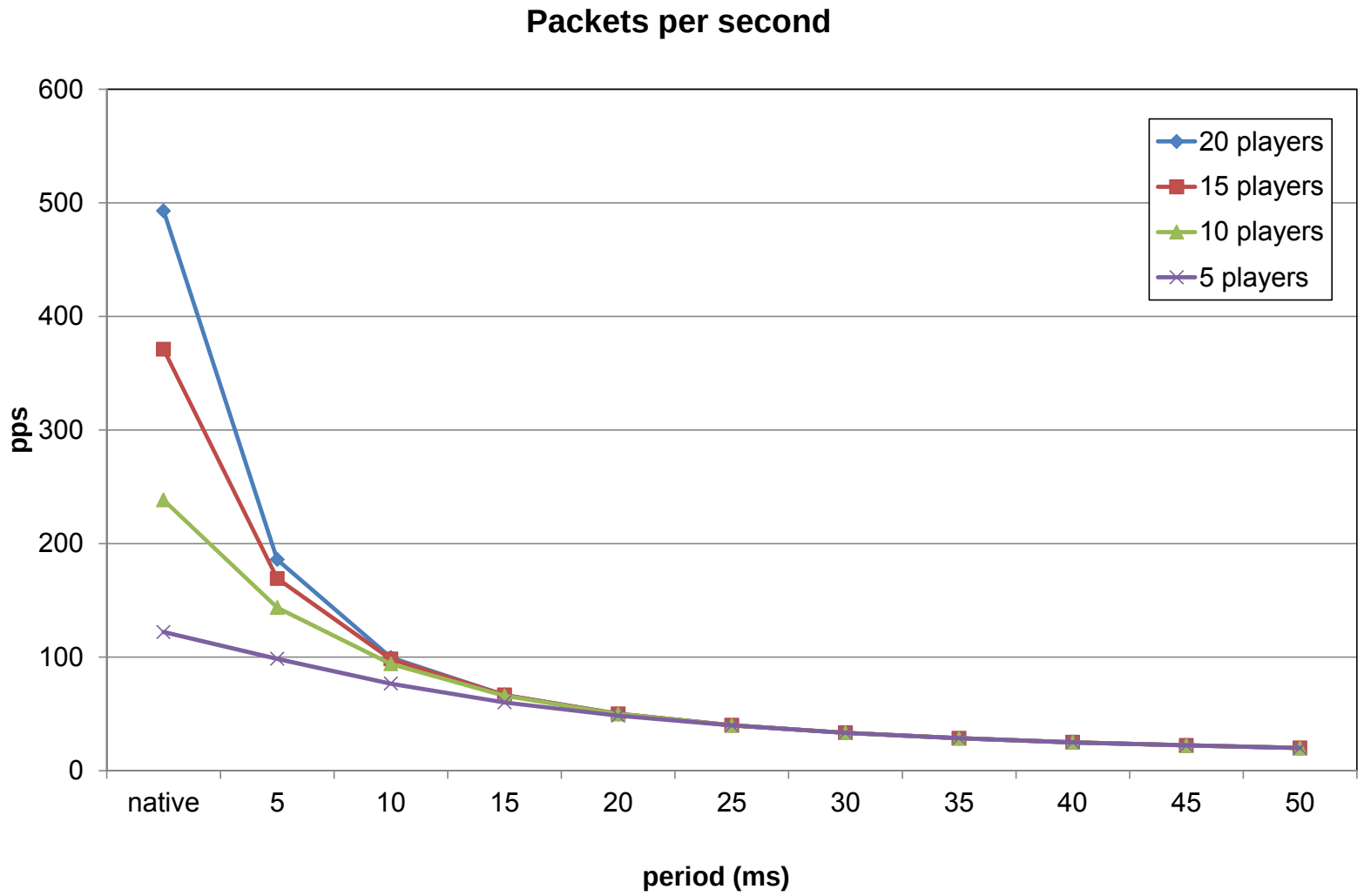
Multiplexing: Counter Strike



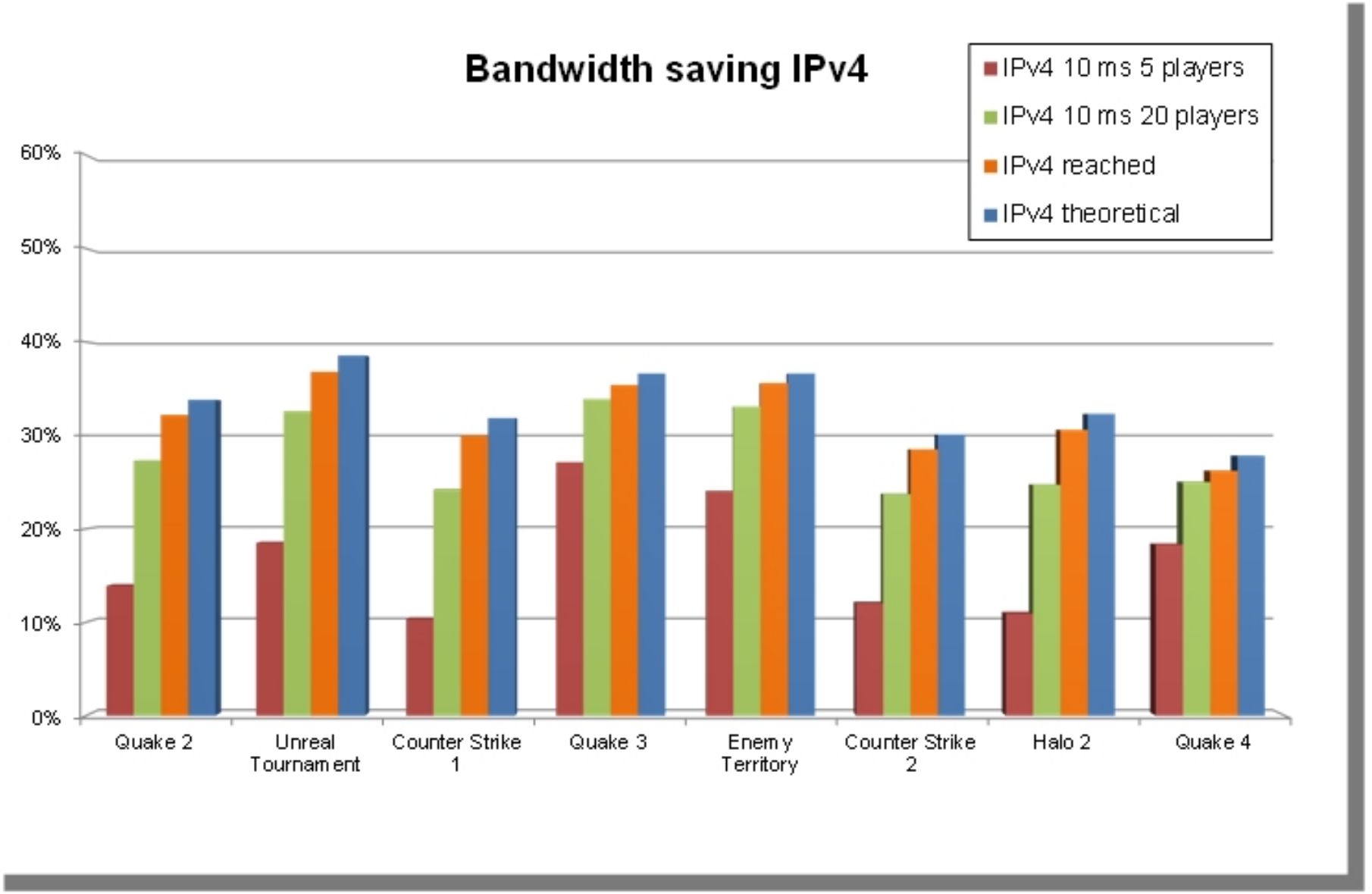
Multiplexing: Counter Strike



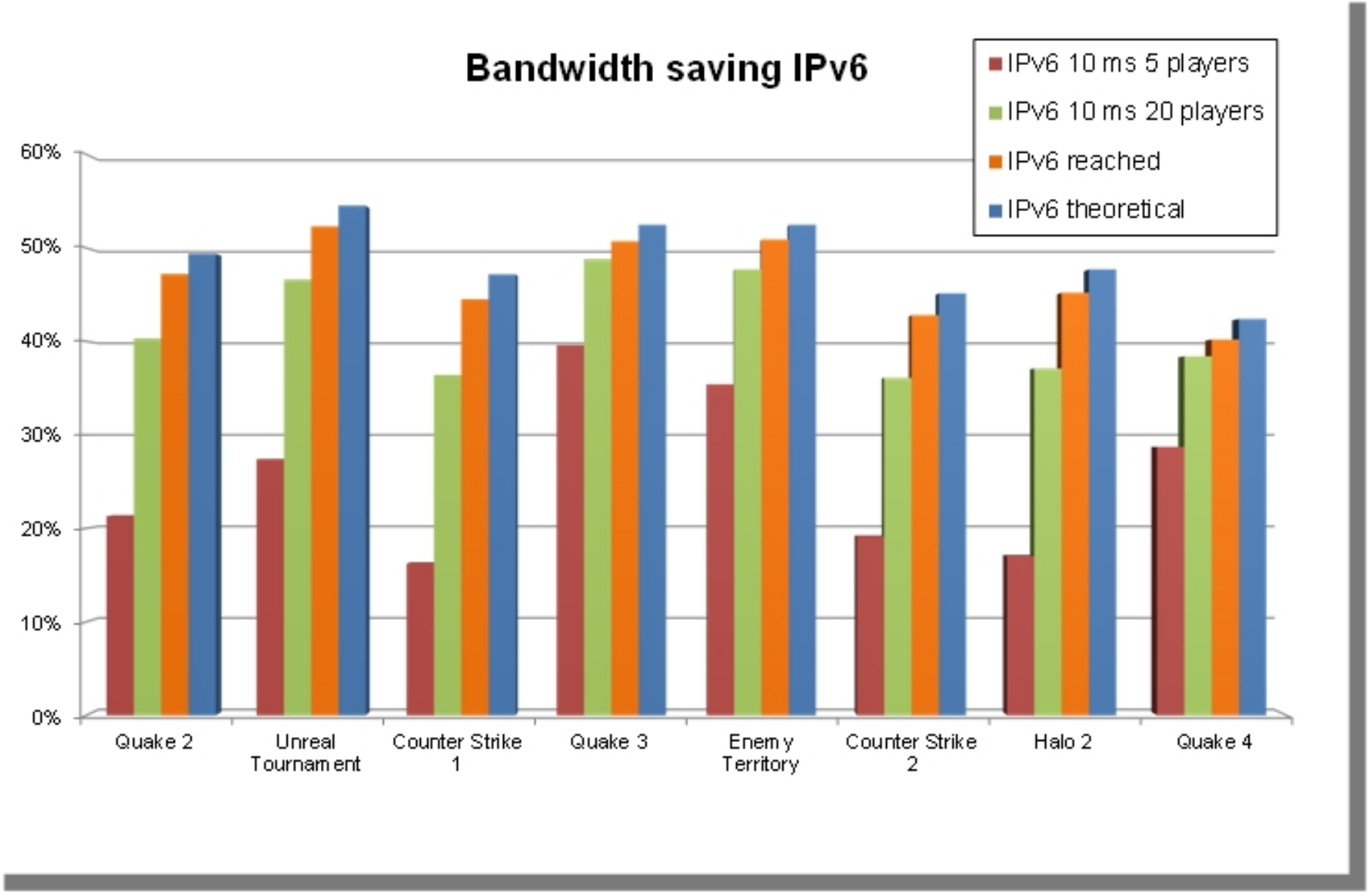
Multiplexing: Counter Strike



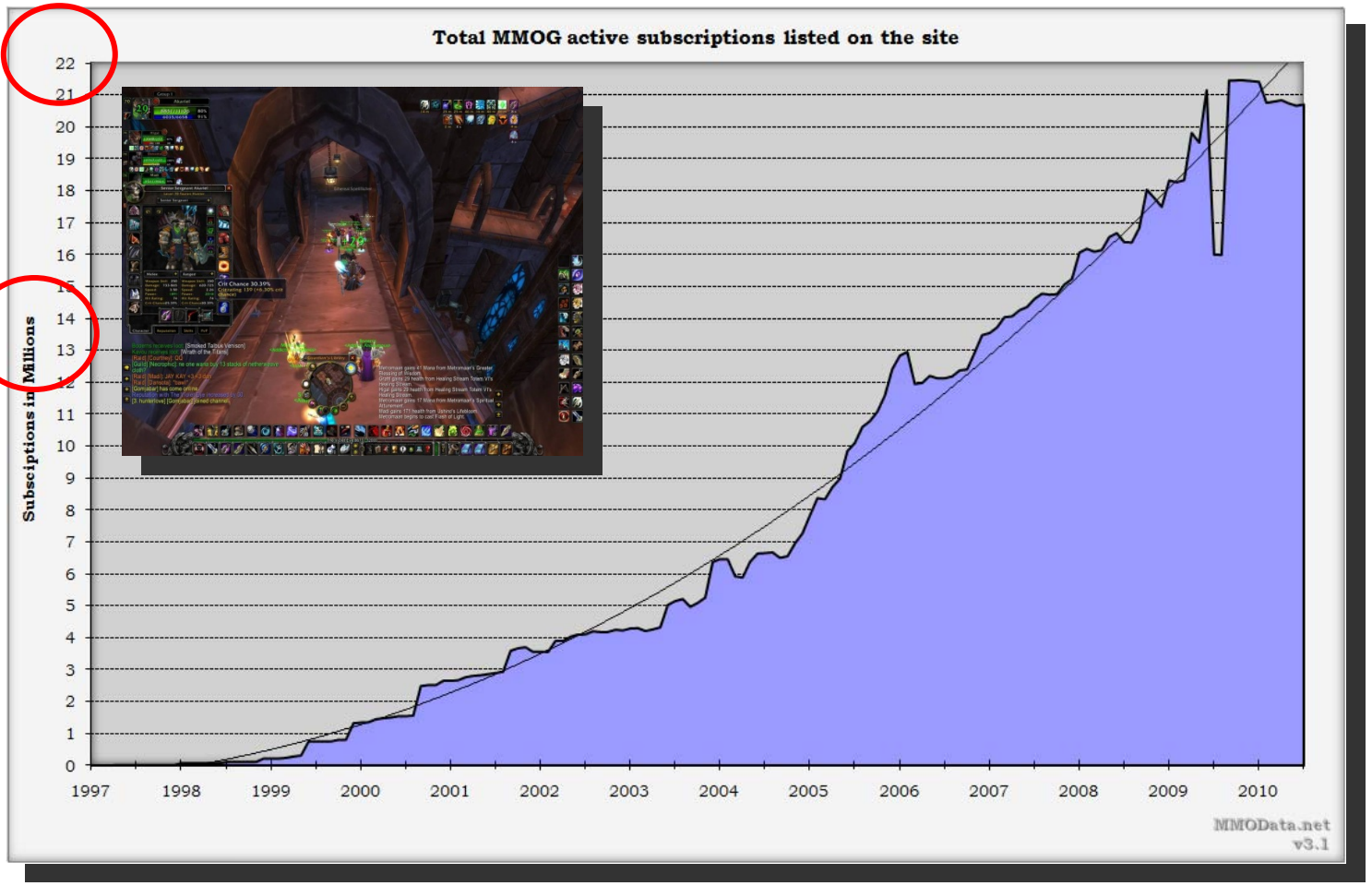
Multiplexing



Multiplexing



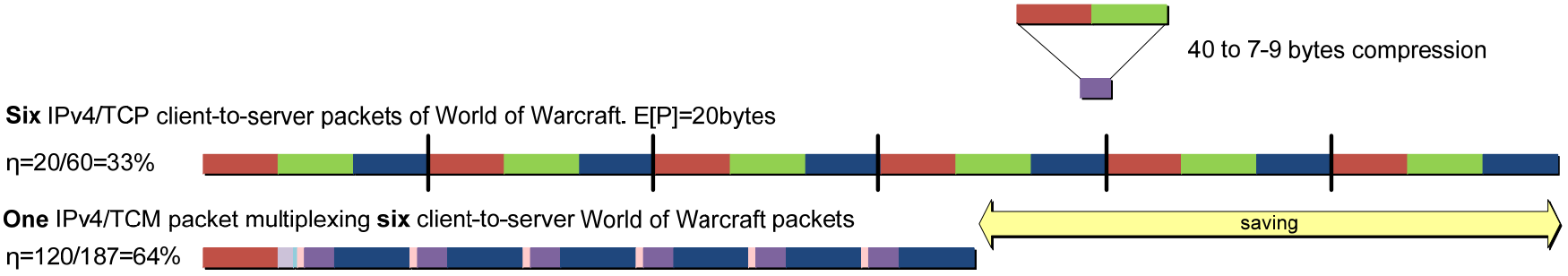
How about MMORPG?



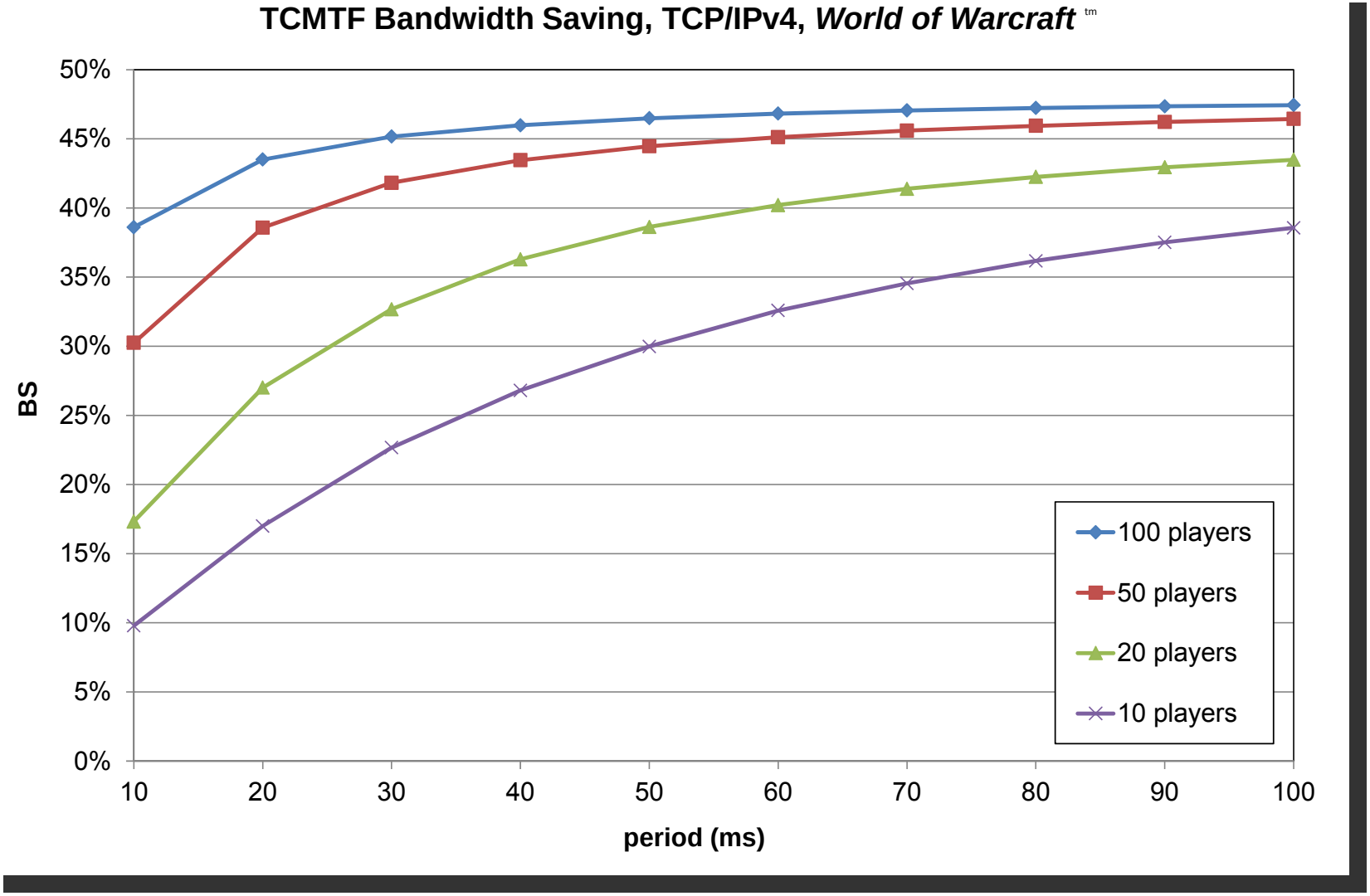
http://designcult.org/designcult/2010/08/mmo-subscription-charts.html

Multiplexing with MMORPG

Massively Multiplayer Online Role Playing Game (TCP)



Multiplexing with MMORPG



"*Widening the Scope of a Standard: Real Time Flows Tunneling, Compressing and Multiplexing*," IEEE ICC 2012, Workshop on Telecommunications: from Research to Standards, June 10-11, 2012, Ottawa, Canada. In press