Throughput Analysis of TCP Proxy Mechanism

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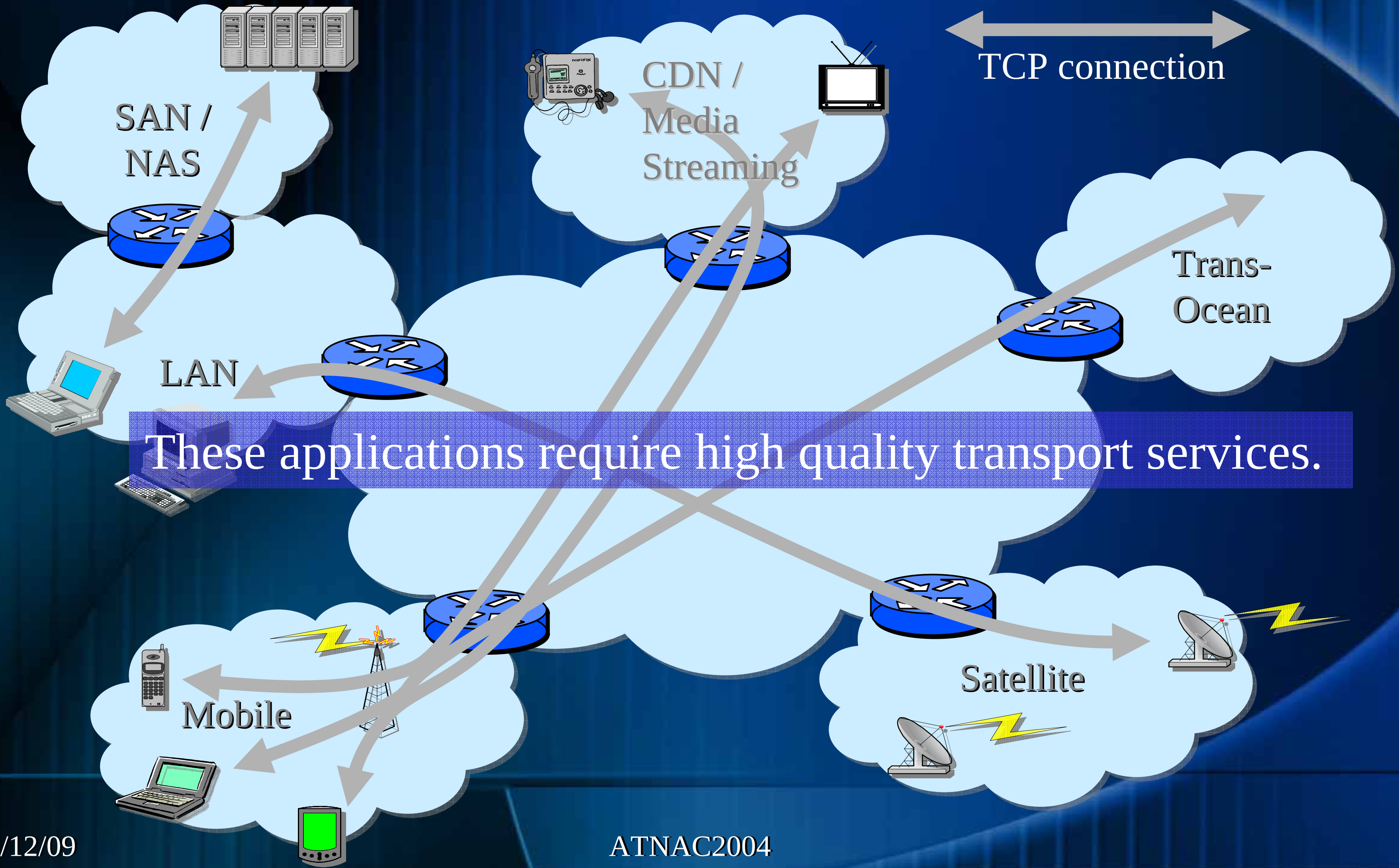
Background



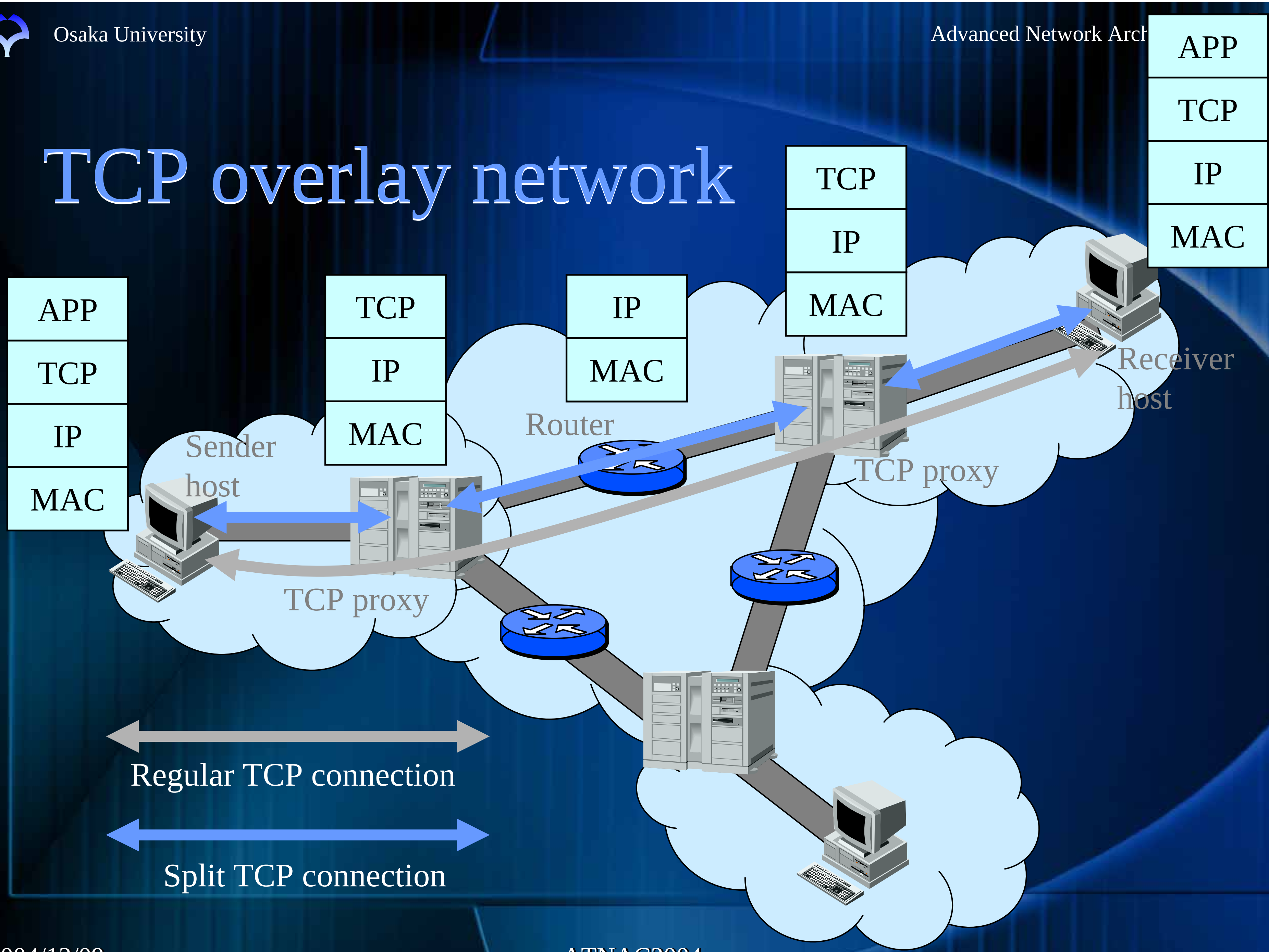
These applications require high quality transport services.

Conventional approaches for quality control

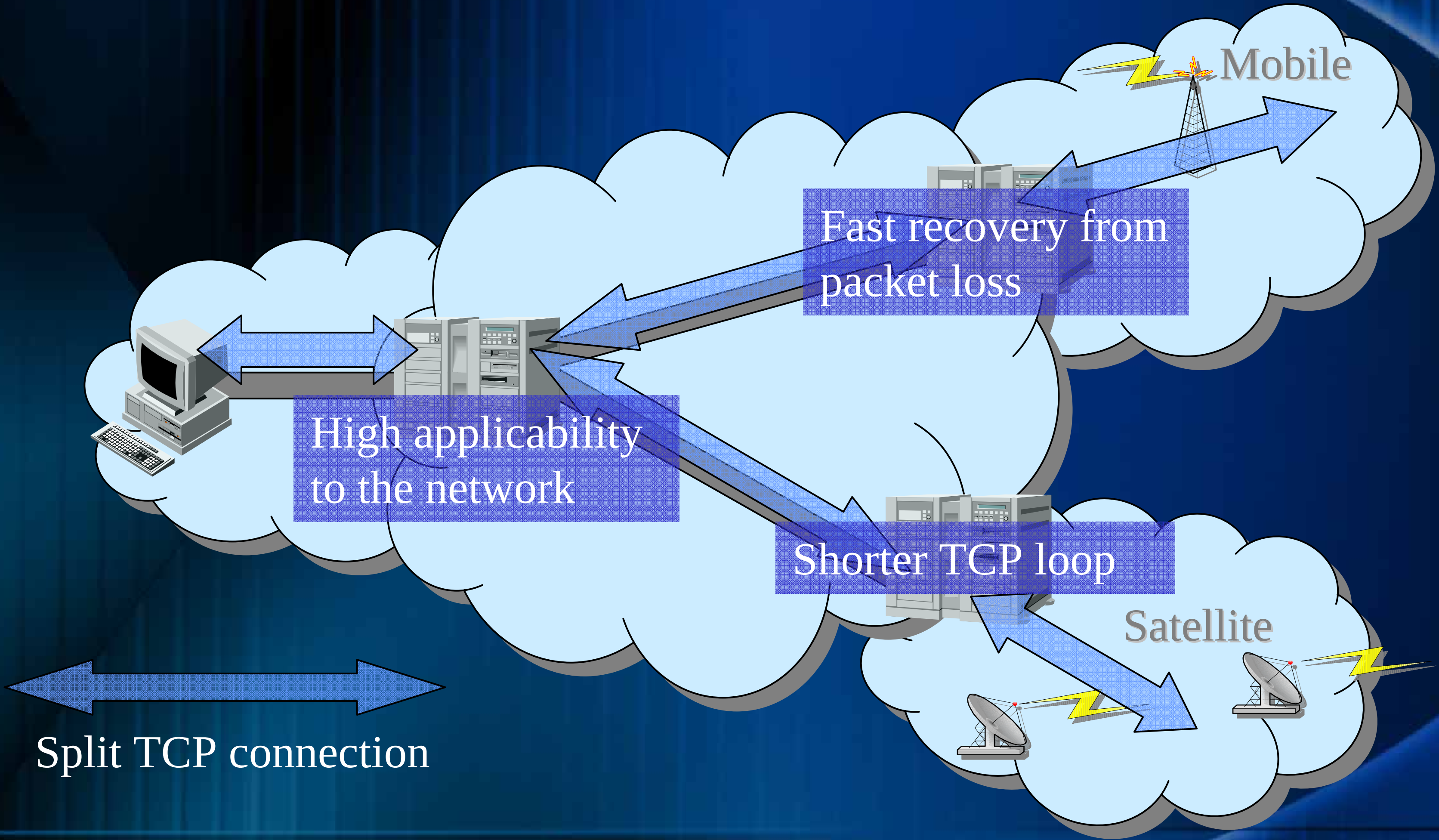
- End-to-end solution (TCP, TFRC)
  - Data transmission quality across the present Internet cannot be assured essentially because of best-effort basis.
- Network layer solution (IntServ, DiffServ)
  - They need to deploy additional mechanisms to all routers that all traffic-flows traverse.
- Underlay solution (MPLS, GMPLS)
  - They need additional mechanisms such as bandwidth broker.
- Overlay solution (RON [11], FBR [12])
  - They need additional overheads such as signaling messages and redundant traffic.

[11] D. G. Andersen, H. Balakrishnan, M. F. Kaashoek, and R. Morris, "Resilient overlay networks," in Proceedings of ACM SOSP'01, Oct. 2001.
[12] D. Zhu, M. Gritter, and D. R. Cheriton, "Feedback based routing," ACM SIGCOMM Computer Communication Review, vol. 33, pp. 71-76, Jan. 2001.

TCP overlay network



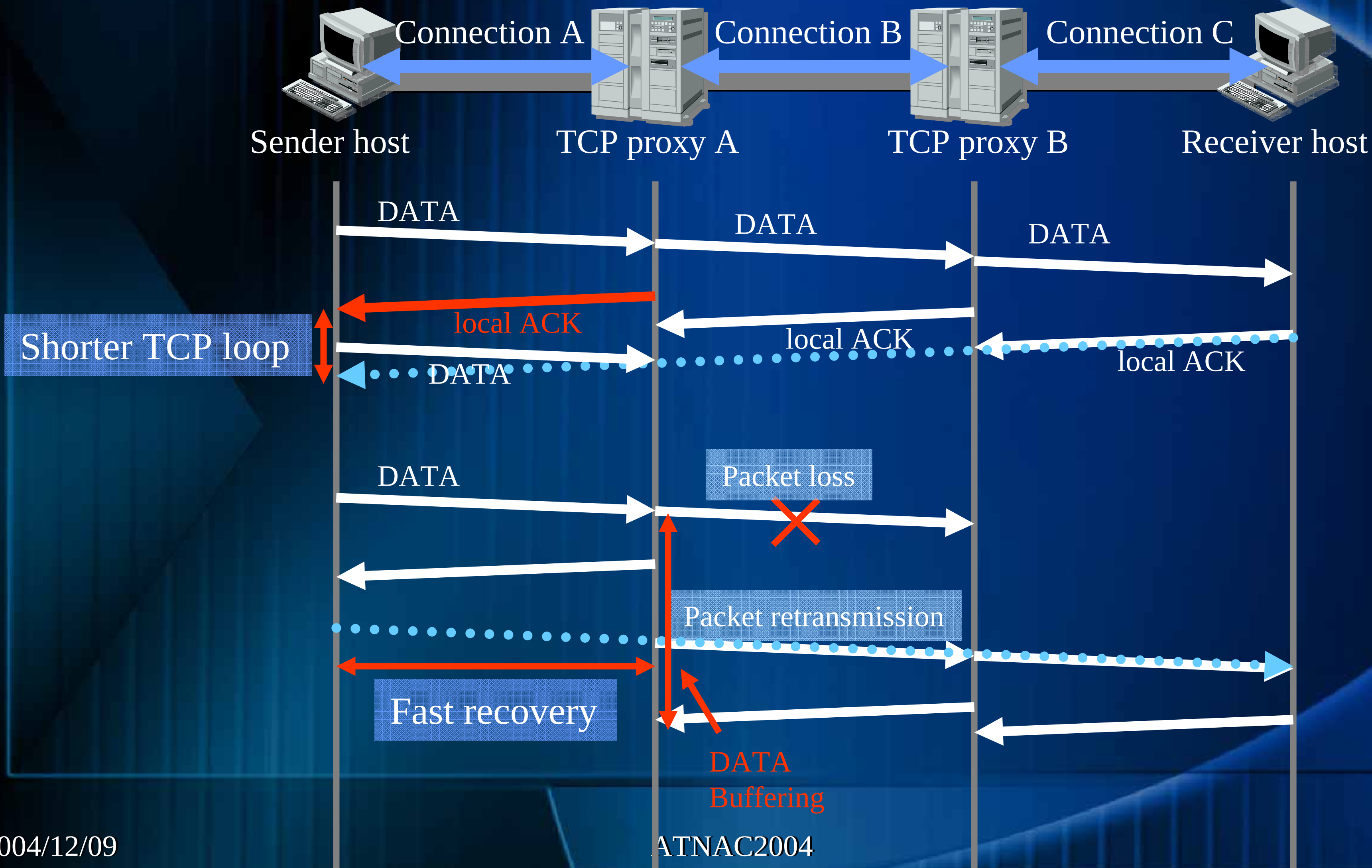
Advantages of TCP overlay network



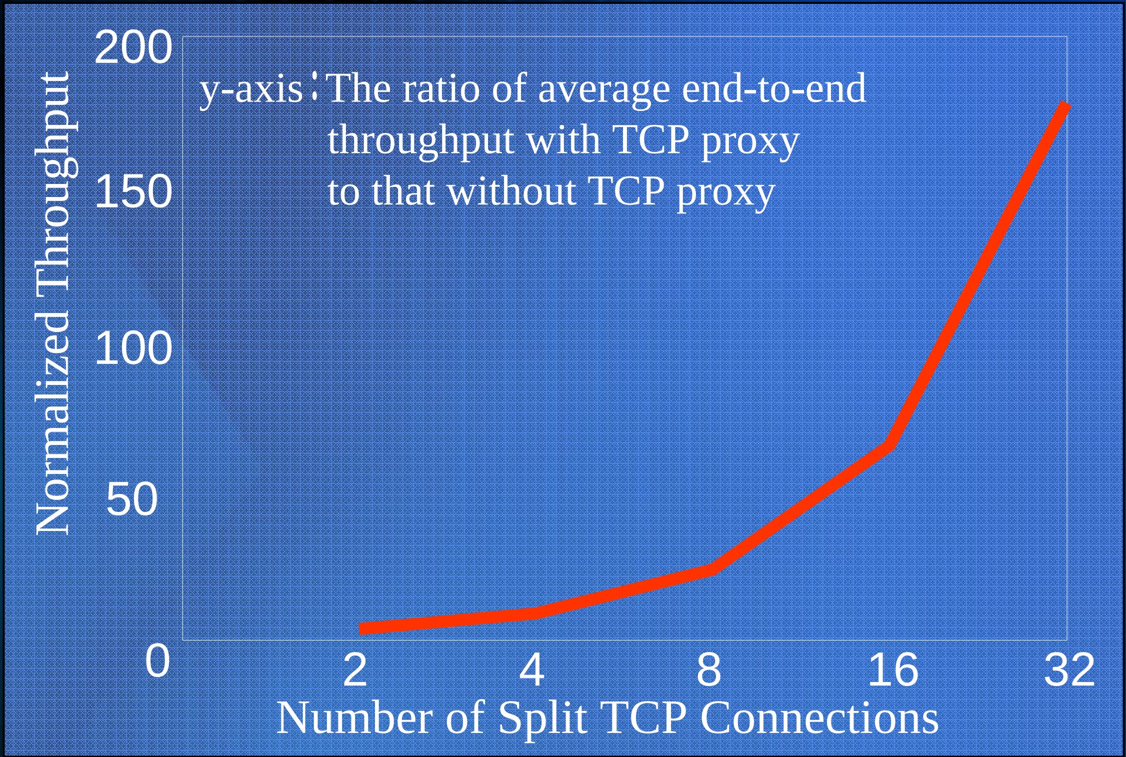
Subjects on this presentation

- Introduce an analysis approach to estimate average end-to-end throughput with a TCP proxy mechanism.
- Show the analysis results give a reasonable estimation of end-to-end throughput.
- Confirm the effectiveness of TCP proxy.

TCP proxy mechanism



Simple throughput estimation



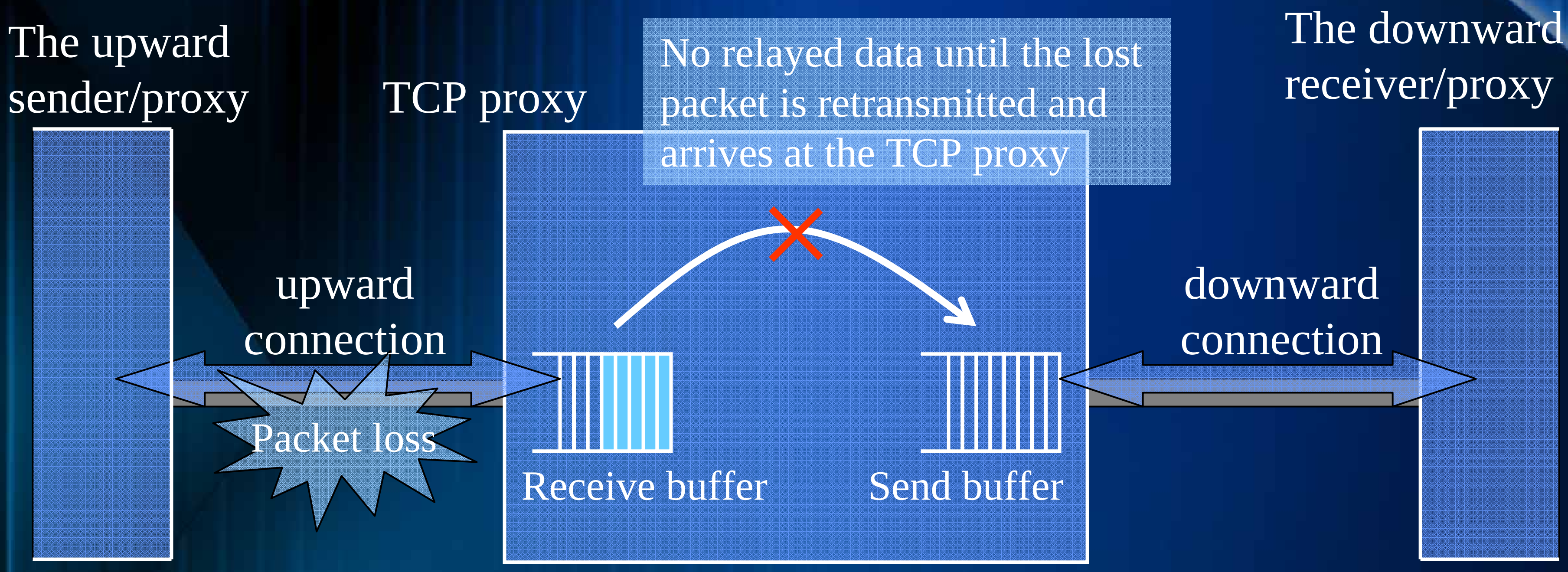
- Each split TCP connections has identical hop counts in a 32 hop network.
- Packet loss ratios and RTTs of each hop are the same.
- The expected throughput ρ can be calculated as follows.

$$\rho = \min_i \rho(i)$$

$\rho(i)$ is the throughput of each split TCP connection *i*.
It can be estimated by using Padhye's equation for the average TCP throughput.

The average end-to-end throughput is greatly improved because of the shorter RTT and lower packet loss ratio.

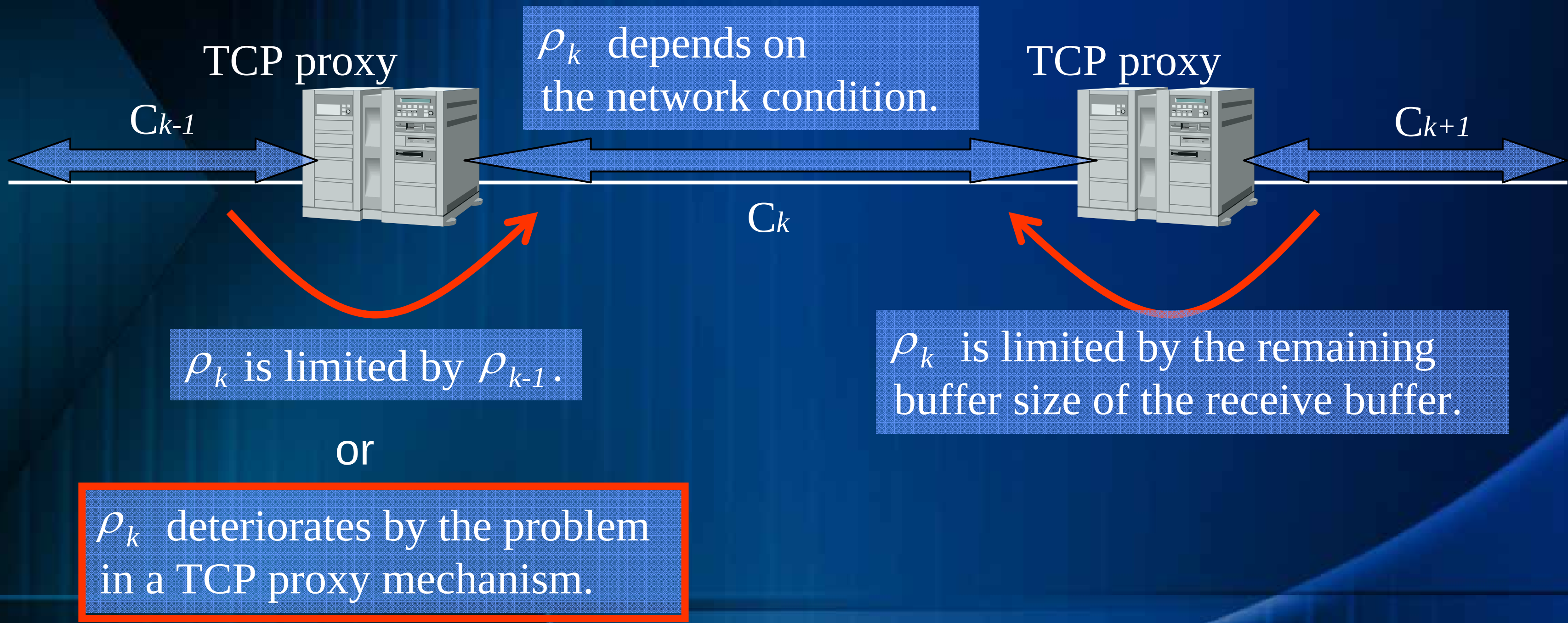
Problem in TCP proxy mechanism



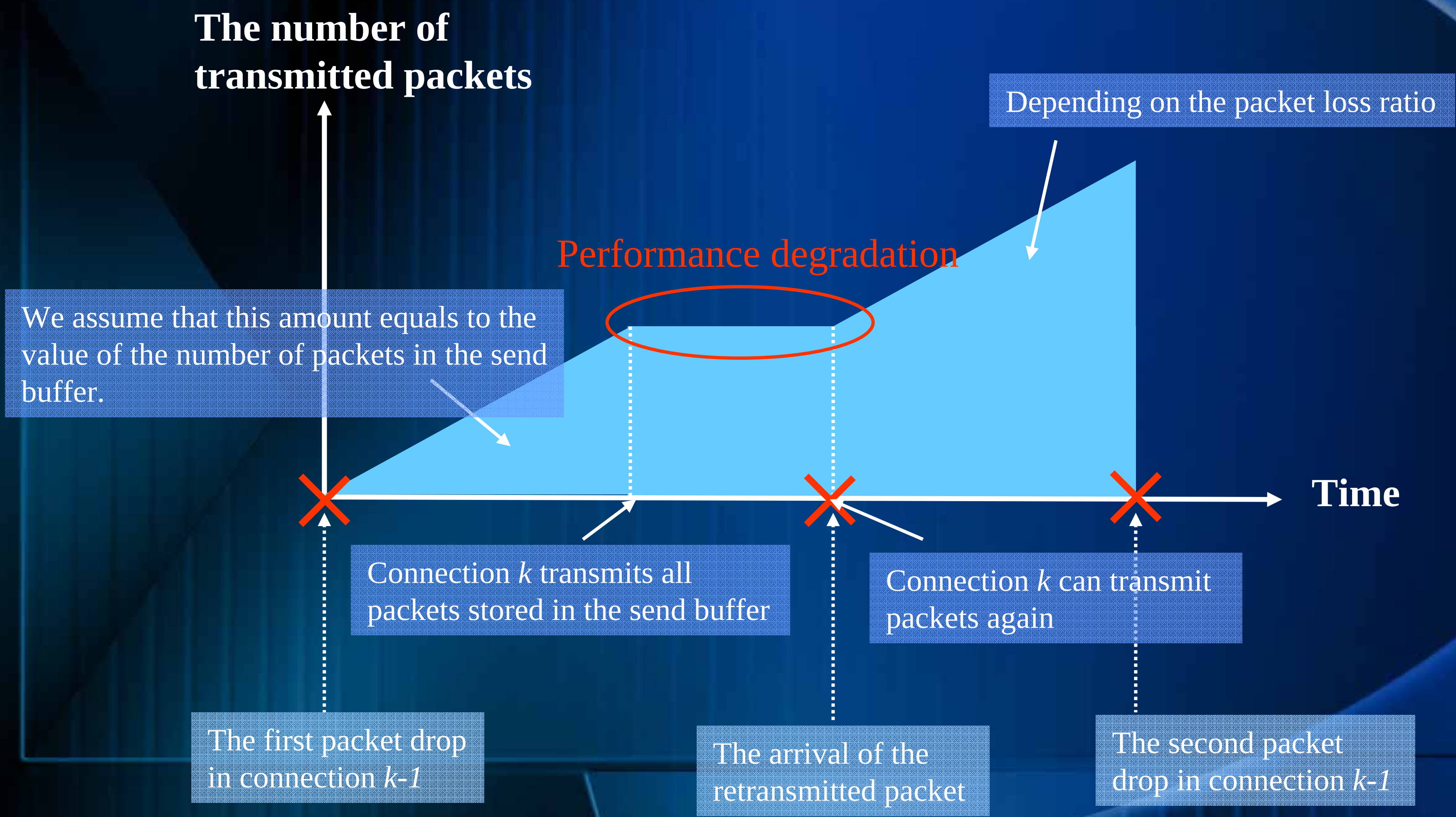
The send buffer of downward connection becomes empty and downward connection cannot send packets to the downward receiver/proxy.

Analysis outline

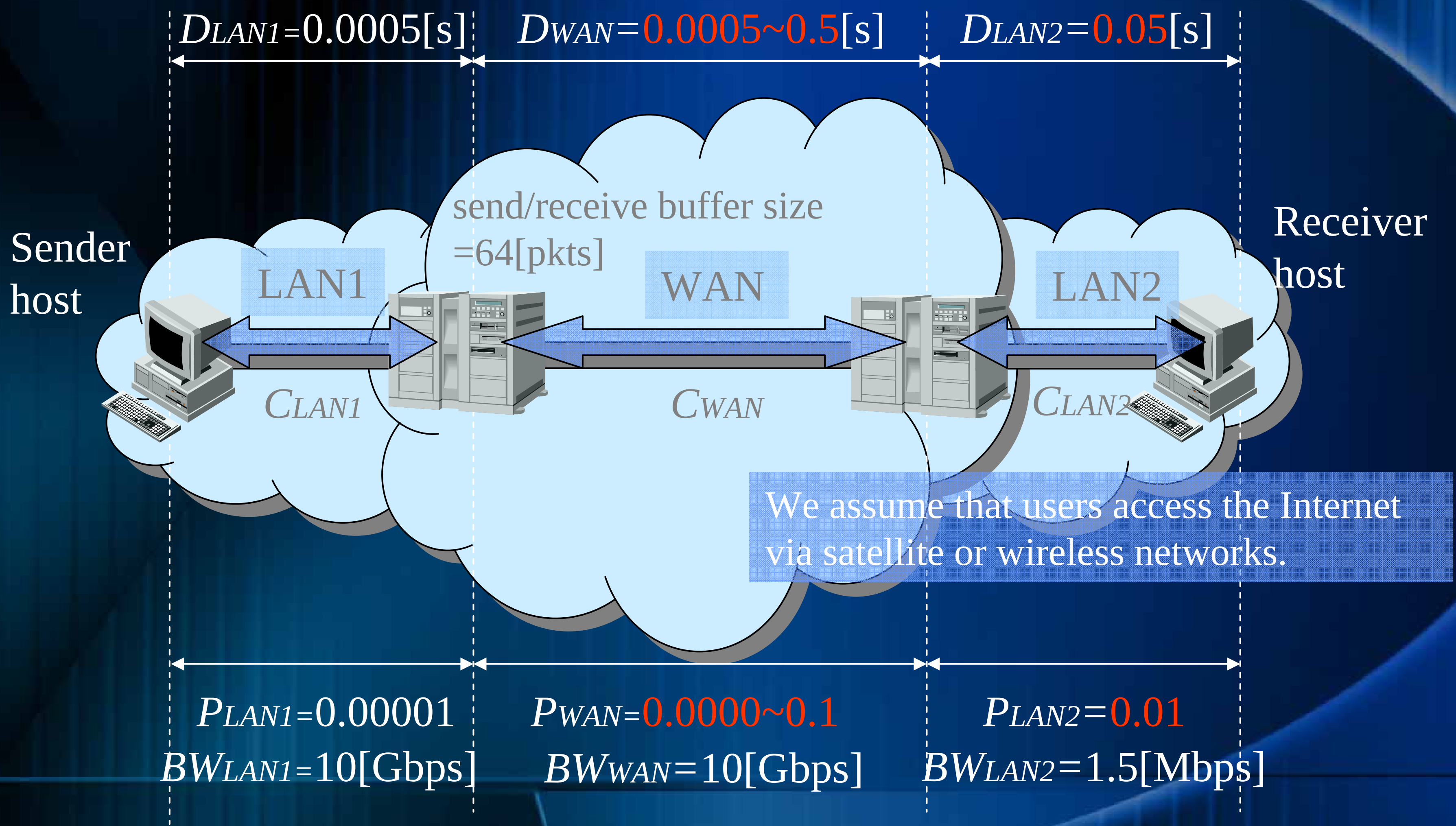
(*) We divide an end-to-end TCP connection into *m* split TCP connections.
We calculate ρ_k , the throughput of split TCP connections $C_1, C_2, \ldots, C_m$
in this order (k <= 1<= m).
Now, we consider the throughput ρ_k of connection *k* (C_k).



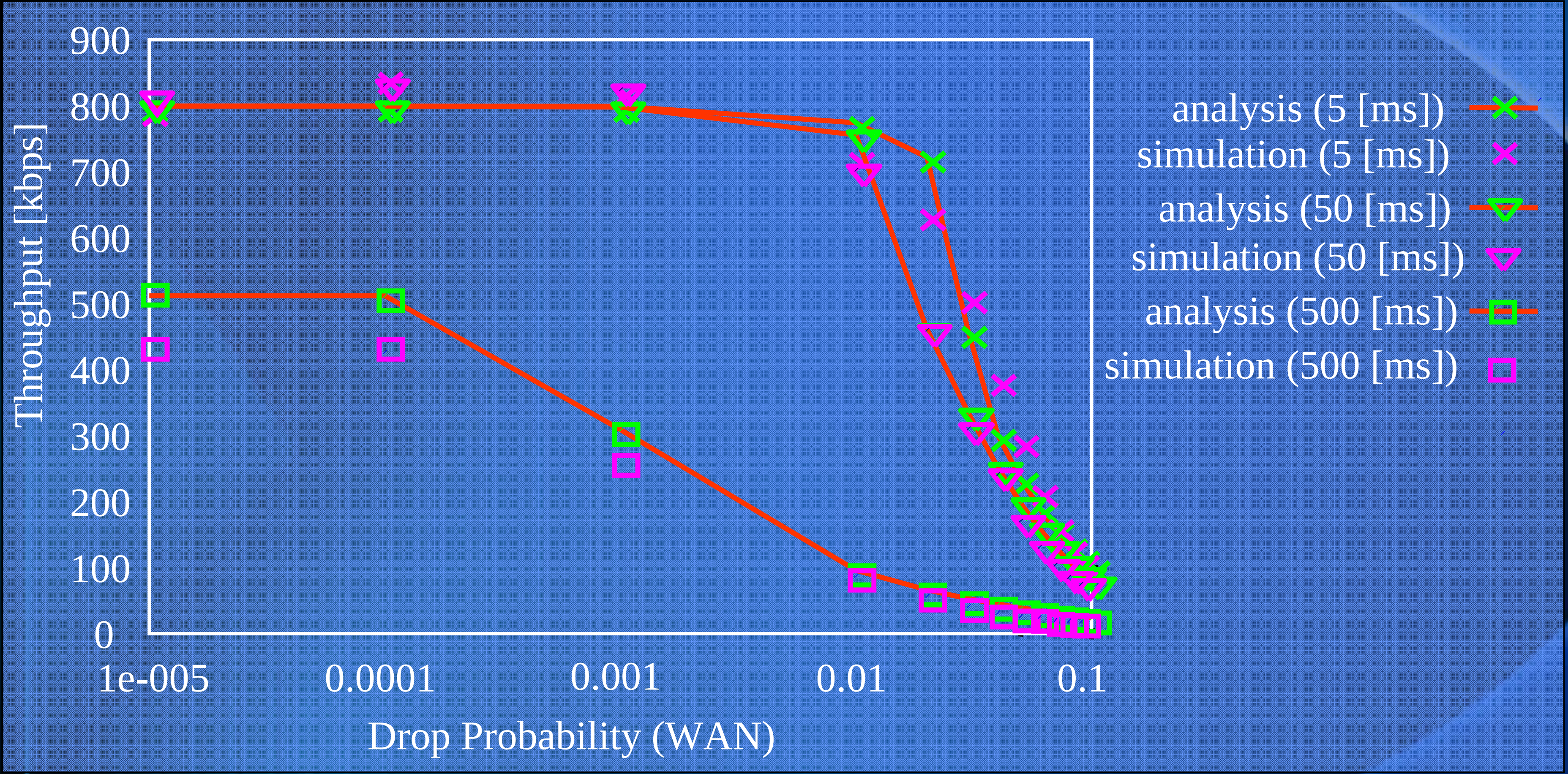
Analysis approach considering performance degradation



Evaluation model

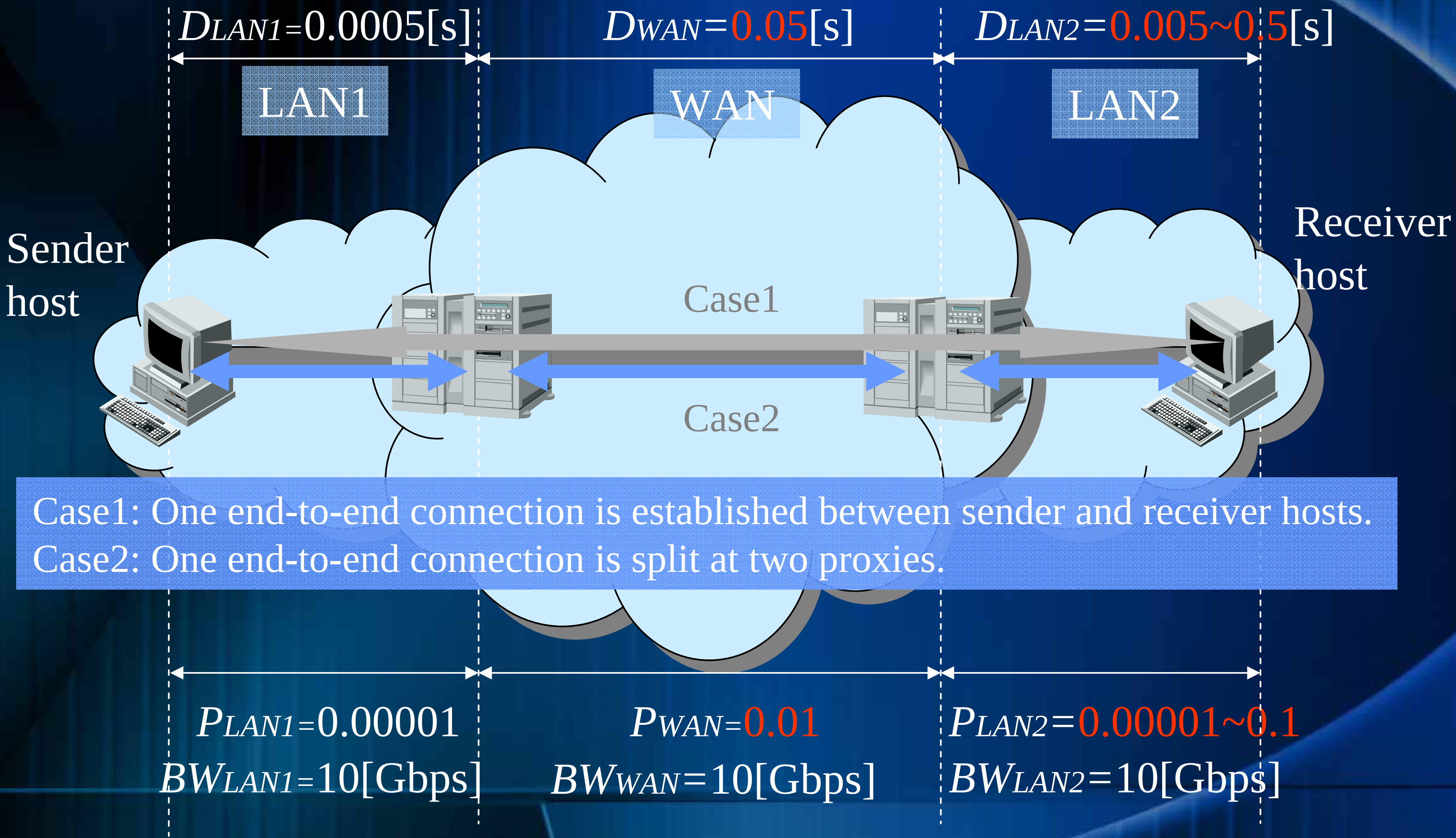


Confirmation of analysis results



The analysis results give a reasonable estimation of average end-to-end throughput.

Evaluation model

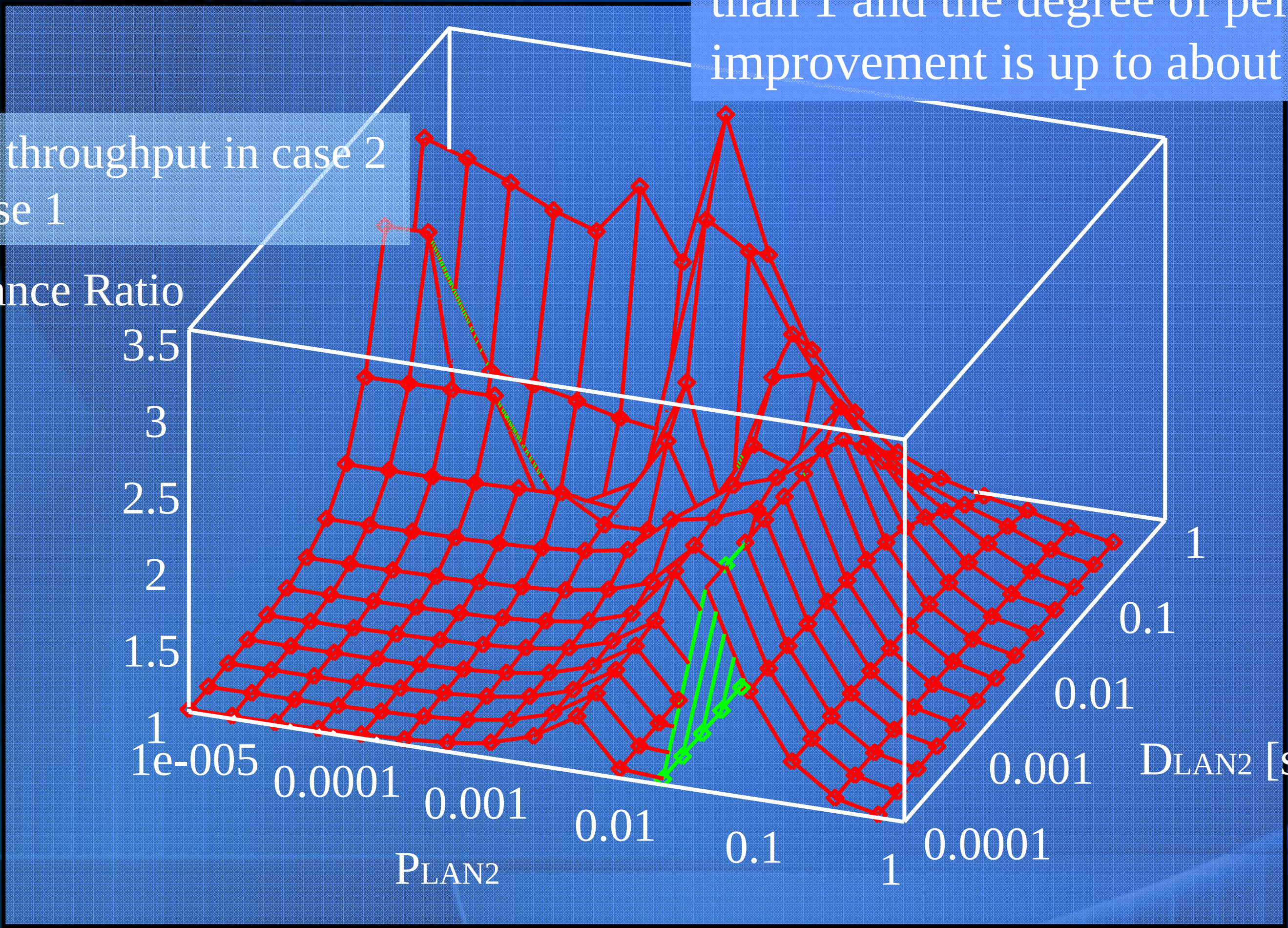


Case1: One end-to-end connection is established between sender and receiver hosts.
Case2: One end-to-end connection is split at two proxies.

Effectiveness with a TCP proxy

The performance ratio is always larger than 1 and the degree of performance improvement is up to about 3 times.

The ratio of throughput in case 2 to that in case 1



Conclusions and future works

- Conclusions
  - Introduce an effective analysis approach to estimate average end-to-end throughput considering the problems that will occur in introducing a TCP proxy mechanism.
  - Find that we cannot ignore performance degradation caused by these problems.
  - Confirm the effectiveness of the TCP proxy mechanism.
- Future works
  - Need to investigate the performance of the TCP proxy mechanism when it handles Web traffic, where its file transfer delay is severely affected by the processing delays of a TCP proxy.
  - Intend to discuss issues relating to the design of TCP overlay networks in large scaled networks.