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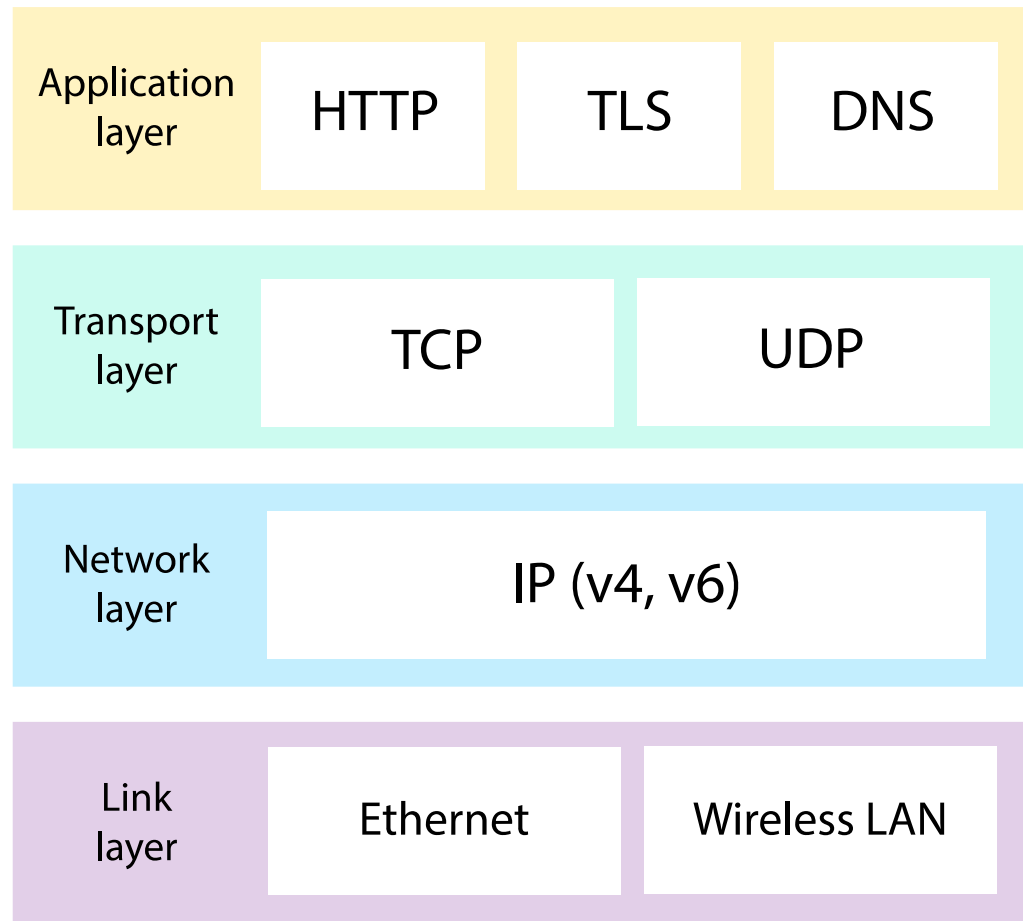
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HOMA Transport Protocol

Context: Transport Protocols

Transport protocols are protocols of the transport layer of the internet which provide applications a way of communicating with one another without resorting to lower-level tools.



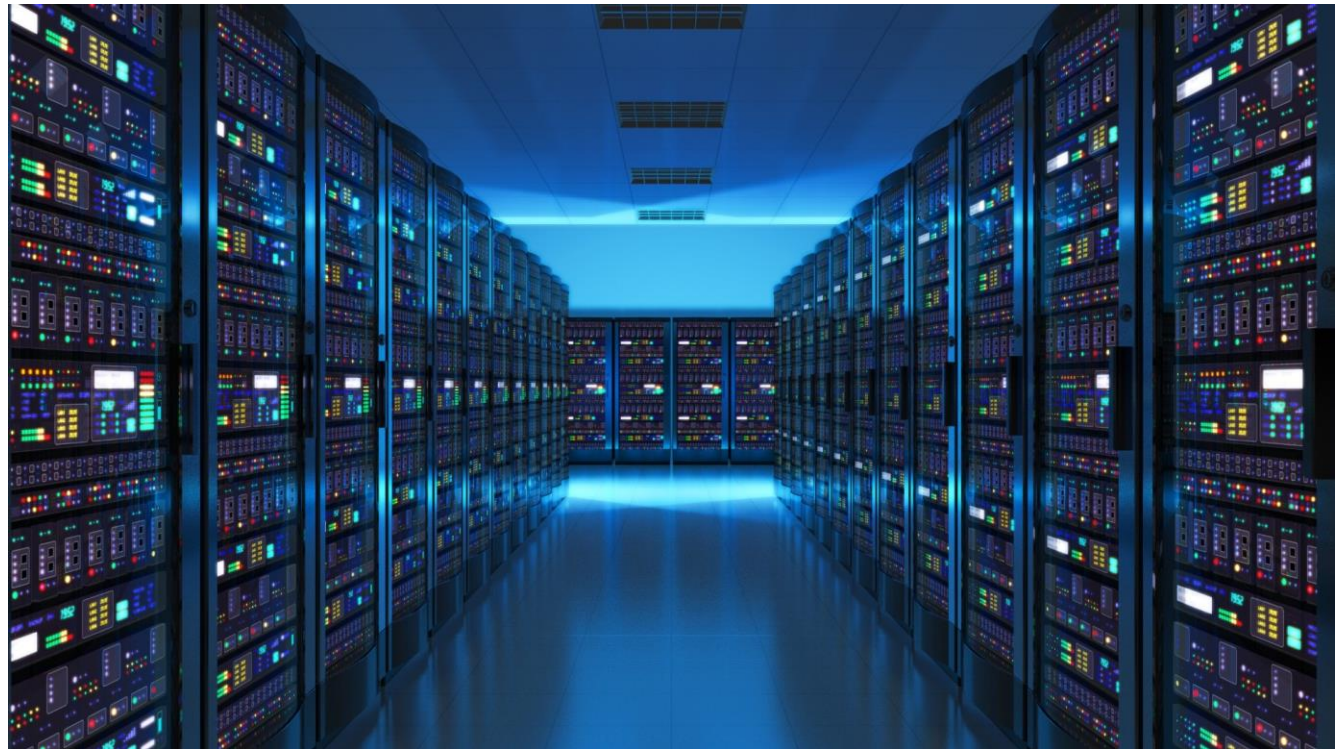
Context: Latency as a Measure of Performance

One important aspect of a system's performance is its message (or packet) latency. Latency is, essentially, a measure of network speed, it tells you the time between the moment a message is sent and when it arrives. Latency depends on a number of factors, but one important one is the transport protocol used.



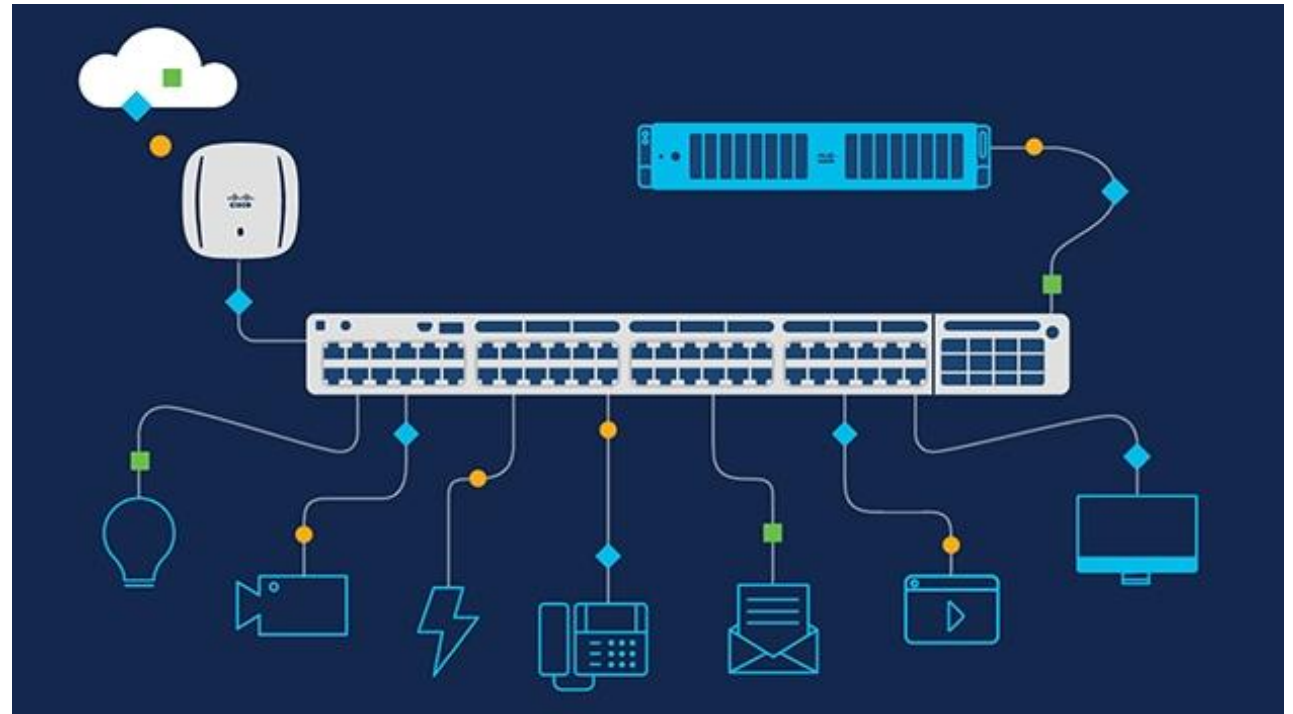
Context: Datacenter Networks

Datacenters are large networks that serve as a repository for an organization's applications or data. The importance of datacenter infrastructure on the modern world cannot be understated. In a sense, datacenters form the backbone of the internet. A significant improvement in datacenter networking technologies could potentially lead to improvements in network-based applications across the board.



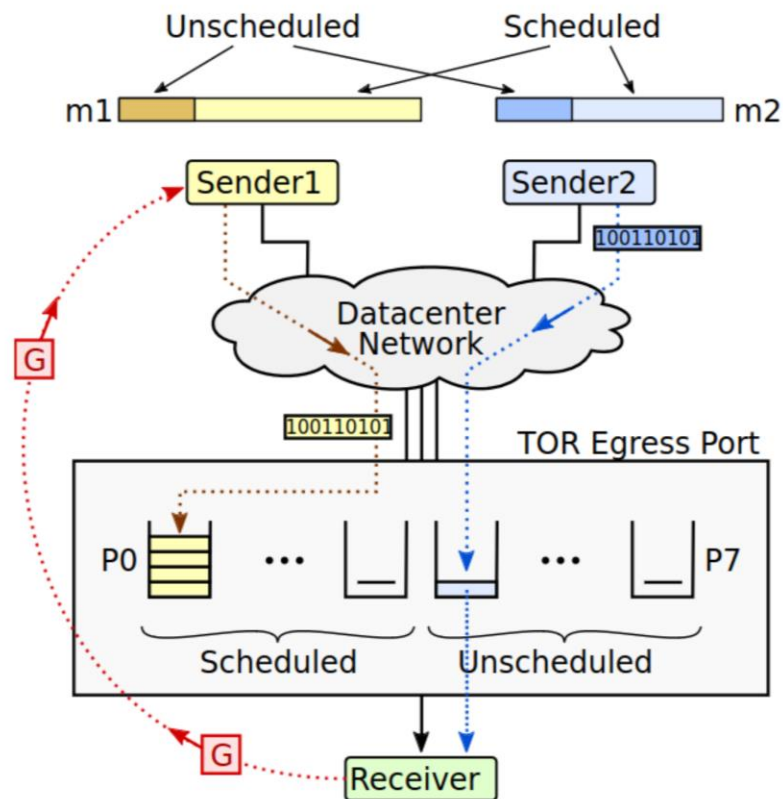
The Problem: TCP is Unsuited for Datacenter Settings

Datacenters that use TCP as their transport protocol fail to take full advantage of the advances in hardware that have occurred in recent years. TCP is currently incapable of delivering latencies within an order of magnitude of the hardware limit (milliseconds vs microseconds). Therefore, there is a large reservoir of untapped potential for improvement.



The Solution: The HOMA Protocol

HOMA is a novel transport protocol proposed recently in a paper by Montazeri, Li, Alizadeh, and Ousterhout that is specifically designed to dramatically improve the latency in networks with a high-volume of small messages. Specifically, HOMA is an attempt to catch up to hardware capabilities in modern datacenters by exploiting the fact that most messages in such networks is in the range of a few hundred bytes. By addressing this HOMA achieves a speedup of almost 100x in such situations.



HOMA with ns-3

ns-3 is a free open-source network simulator. It provides different network models and examples to work with, such as a TCP and UDP model. The Homa protocol runs with pre-designed tests and hard-coded volume of messages with set sizes to replicate the low latency feature talked about in the original document.

```
guest@Ubuntu:~/Documents/HomaCIS4911-master$ ./waf --run scratch/HomaL4Protocol-  
simple-test  
Waf: Entering directory `/home/guest/Documents/HomaCIS4911-master/build'  
Waf: Leaving directory `/home/guest/Documents/HomaCIS4911-master/build'  
Build commands will be stored in build/compile_commands.json  
'build' finished successfully (0.509s)  
Time it took: 233090 ns    Message size: 532480 b  
guest@Ubuntu:~/Documents/HomaCIS4911-master$
```

Changes:

A feature that was implemented was to be able to manipulate the size of the message being sent to be able to freely compare Homa with other data transport protocols, such as TCP and UDP. Another feature was to calculate the total time in nanoseconds it takes for the Homa protocol to send a message given its size.

HOMA or TCP?

HOMA is an attempt at replacing TCP in datacenter networks and other places where there are a very high volume of small messages.

How does HOMA stack up to TCP then?

HOMA	TCP
Connectionless: <i>HOMA reduces message latency by removing the overhead due to connection establishment.</i>	Connection-based: <i>TCP's reliability guarantees are possible due to the 3-way handshake that establishes a direct connection.</i>
Fast: <i>HOMA is designed for speed. It provides latency close to the hardware limit.</i>	Limited Speed: <i>Most applications require reliability more than speed, which is why TCP sacrifices speed for reliability guarantees.</i>
No Reliability Guarantees: <i>While HOMA takes steps to minimize packet loss, it is unable to provide the same kind of reliability guarantees as TCP due to its RPC-based architecture.</i>	Guaranteed Transmissions: <i>TCP famously guarantees that there is zero package loss in the transmission between client and server.</i>

HOMA or UDP?

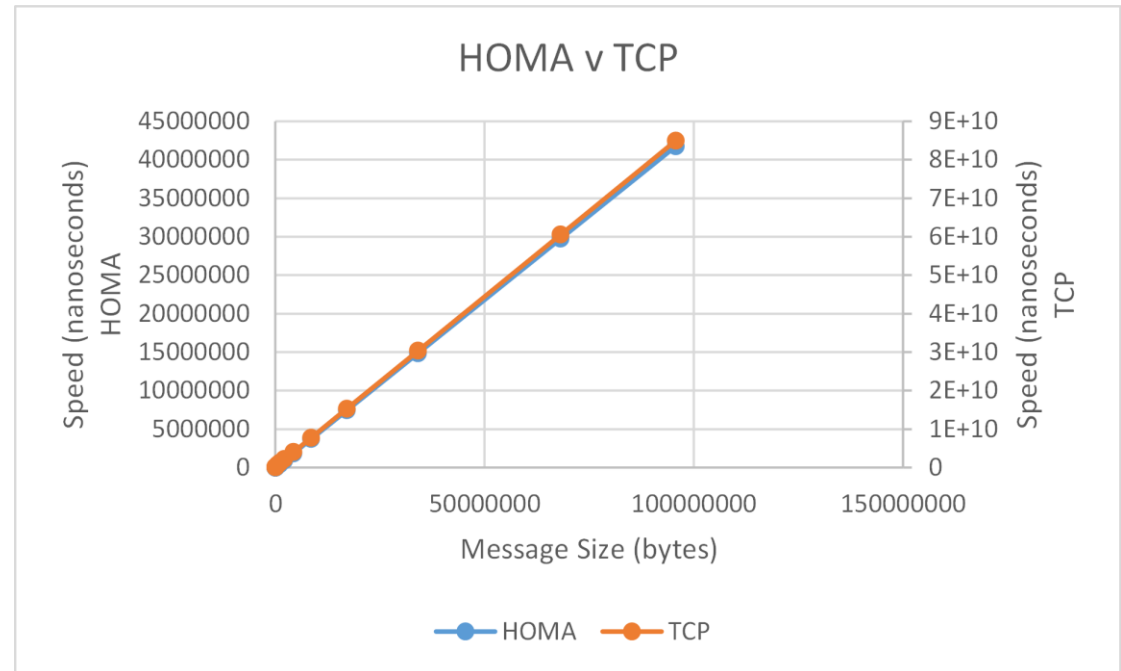
Another transport protocol that we'll compare to HOMA is UDP, which are both very similar in how they work.

Will HOMA be able to stack up against UDP?

HOMA	UDP
Steps Towards Reliability: <i>Although HOMA is a connectionless protocol, its RPC-based design allows it to take steps to lower potential packet loss.</i>	Unreliable: <i>UDP is an extremely bare-bones protocol and, as such, it takes no steps towards minimizing packet loss in any way.</i>
Designed for Datacenter Use: <i>HOMA takes enough steps towards ensuring sufficient data integrity to be useful in datacenter networks.</i>	Unsuitable for Datacenter Use: <i>UDP's unreliability makes it a bad fit for datacenter settings.</i>
Fast: <i>HOMA takes advantage of several domain-specific constraints to provide a marked speed increase.</i>	Faster: <i>Although HOMA provides low latency (comparable to the hardware limit) UDP is still slightly faster.</i>

HOMA and TCP Results

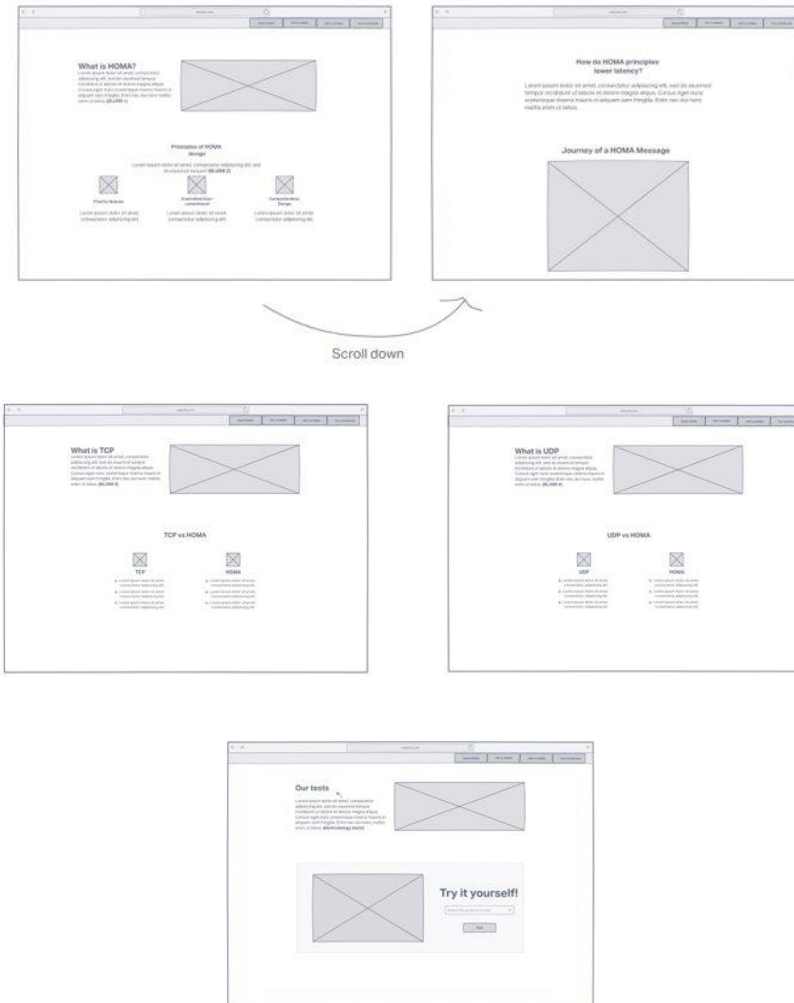
Both HOMA and TCP have the same ratio when it comes to handling increased amounts of data. But what makes HOMA better is its low latency.



The chart above shows that HOMA is around 2000 times faster than TCP which is a result of its low latency.

User Friendly Website Design

We compiled all of the testing information in a website that also includes user-friendly explanations of HOMA and the other relevant transport protocols.



Summary of Achievements

- Researched HOMA protocol and its benefits vs TCP and UDP
- Wrote testbench to confirm conclusions in original HOMA paper
 - Ran comparison of HOMA performance vs TCP using original testbench
- Designed and implemented website to present findings in user-friendly manner