To Support Flexible Transmission Unit in the Future Networks

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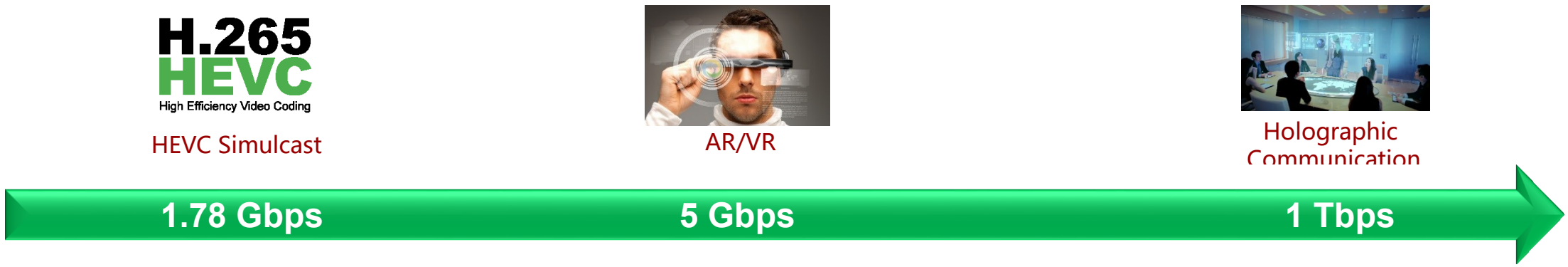
Future application requirements

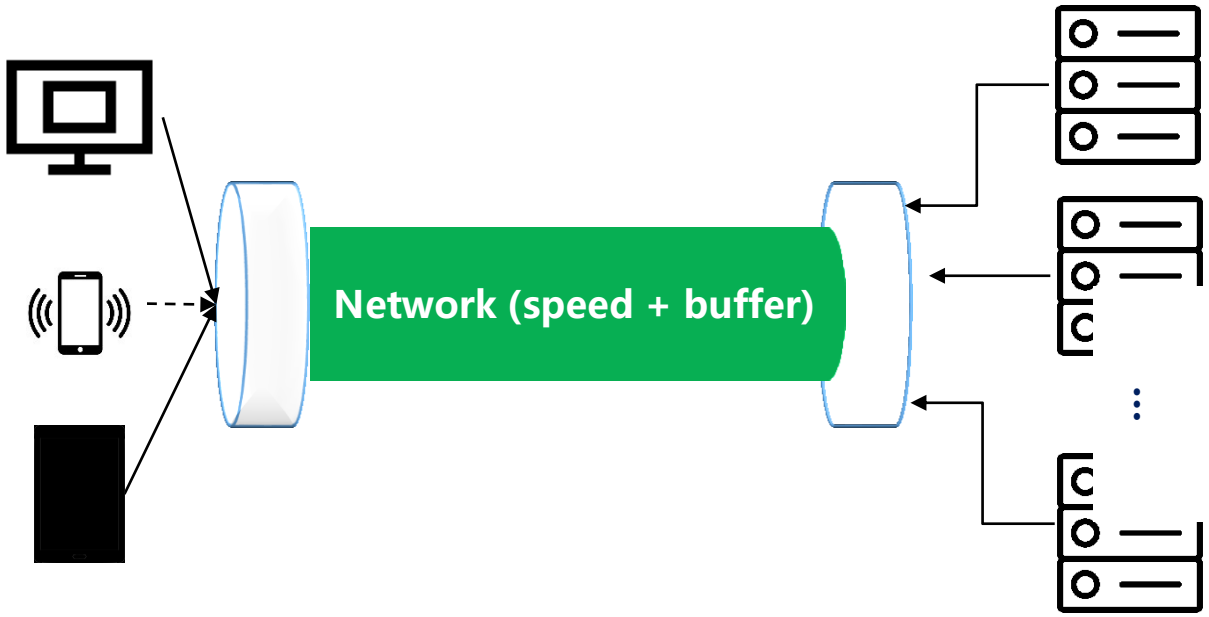


- **Network perspective**
  - Higher bandwidth
    - Electric -> Photonic
    - More powerful ship set (10T+ processing capacity per chip)
  - Scale up & Scale out

GAP?

- **Application perspective**
  - Higher throughput
    - The actual amount of data being transmitted end to end.

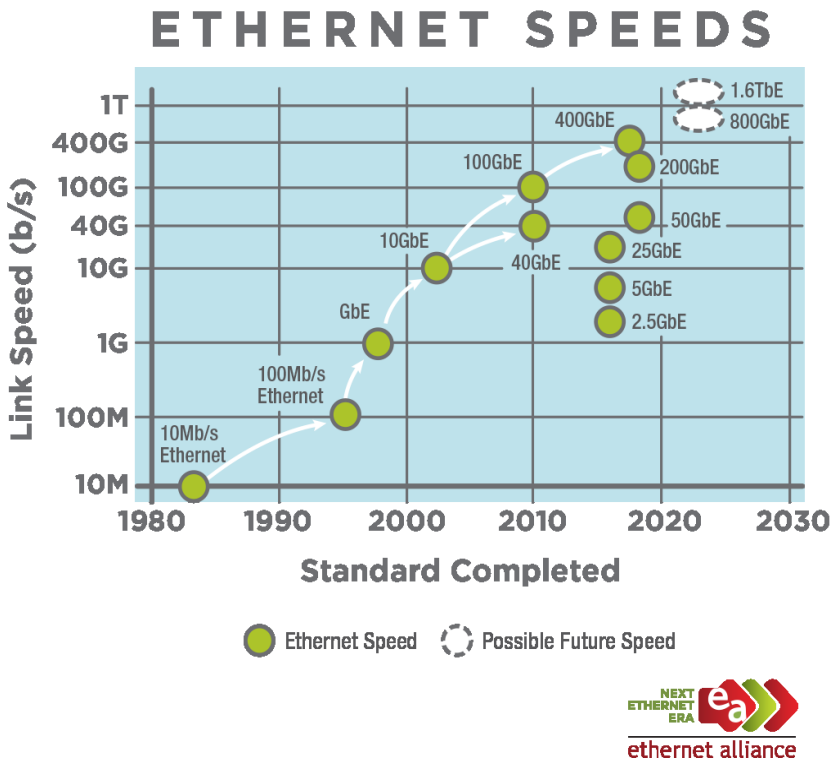
E2E performance is an interplay between networks and end system.

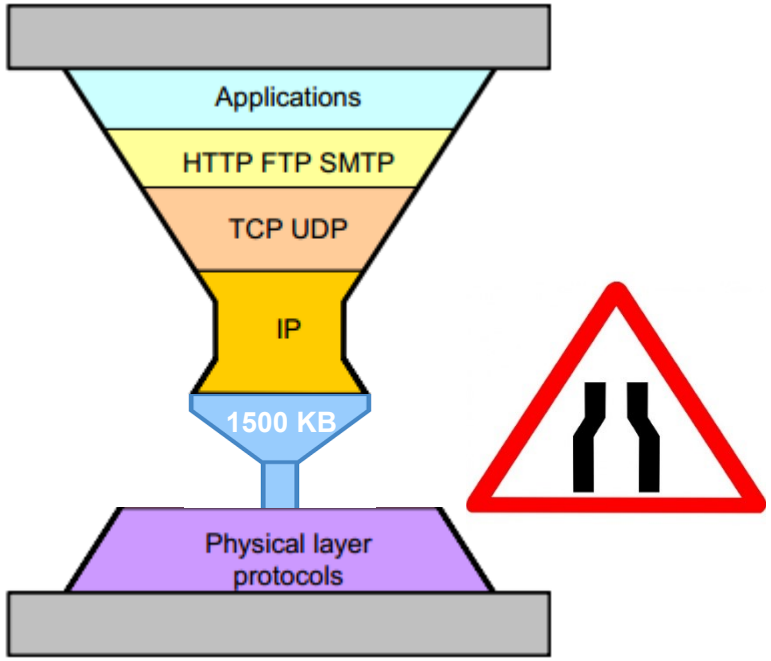


Aggr. $BW_{end\_system} > BW_{Backbone}$

- The networks establish and maintain the route between the client and server which defines the physical bandwidth (upper bound BW).
- The packet sender decides how to utilize the available bandwidth, guarantee the reliability and maintain concurrency between different flows that share the same resource, e,g., TCP congestion control algorithms, QUIC, IB flow controls and so on…
- The packet receiver process the received packet and other post-processing that is triggered by the received packet. Might drop the packet due to system overload.

Fast growing port rate vs. ever lasting frame size





1500-byte Ethernet frame size

- **Standardized in 1983, the first version of IEEE 802.3**
- **By that time, the Ethernet was developed as a shared medium or bus with 10Base5.**
- **The only mandate MTU size of today's Ethernet.**

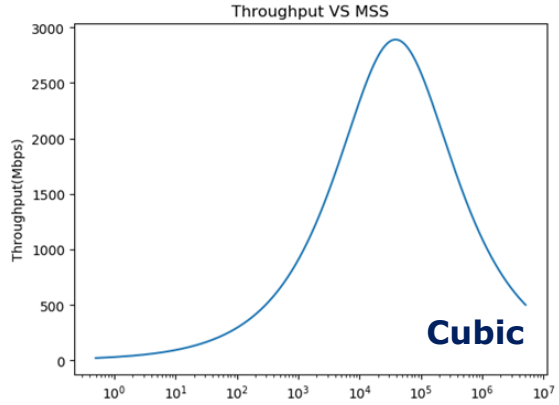
*Picture from https://ethernetalliance.org/the-2019-ethernet-roadmap/

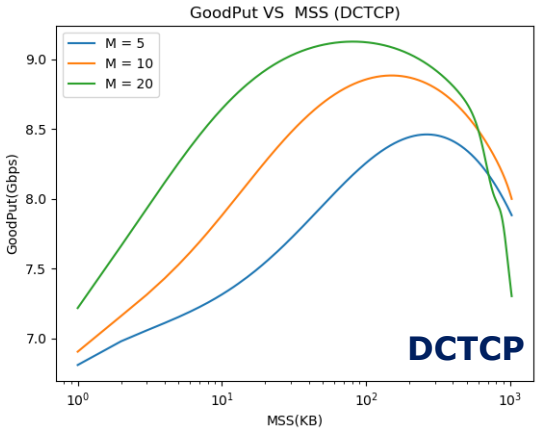
The impact of MSS size on TCP throughput (theoretical study)

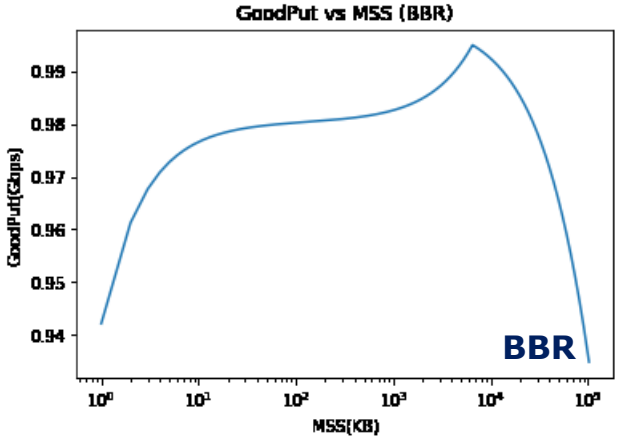
- For the algorithm that utilize packet lose as congestion indication, e.g., Reno, NewReno, Cubic, the network throughput first increase along the MSS increment, after the peak, the throughput start decrease.

- For the algorithm that utilize bandwidth and RTT detection, e.g., BBR, increasing MSS has no obvious effect on throughput increment.

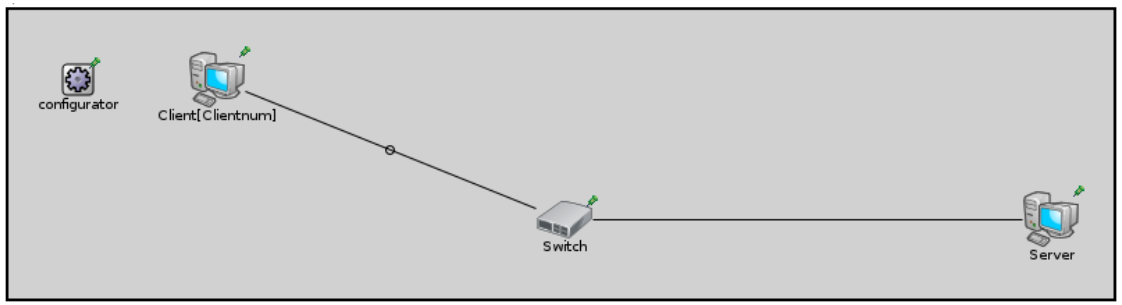
- As the number of flow increases, the optimum MSS size that produce highest throughput decreases. In a store and forward network, increasing MSS size affect the concurrency between different flows.

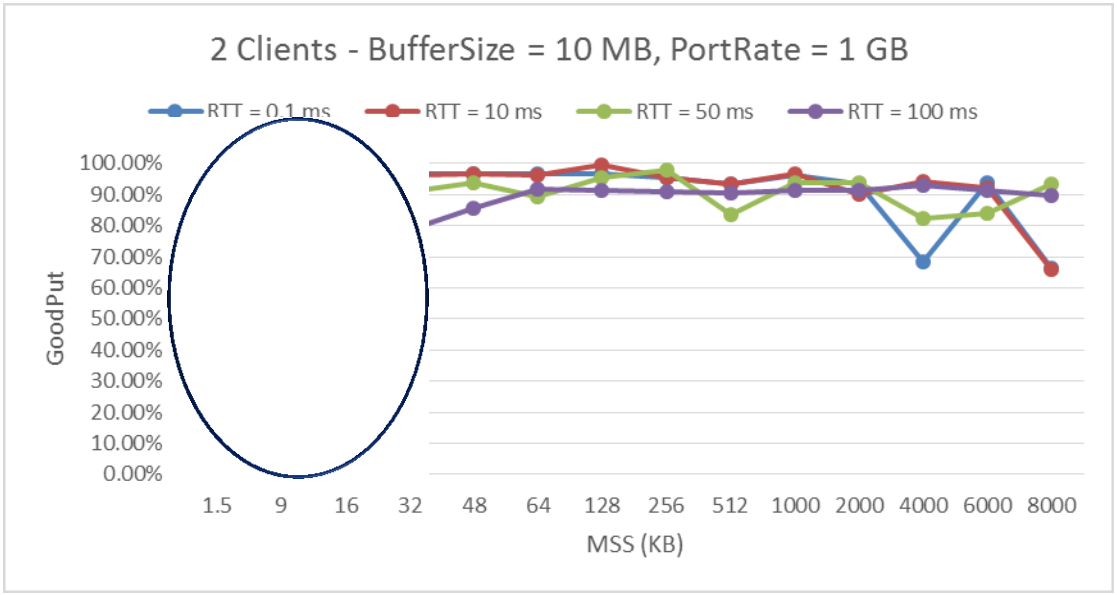




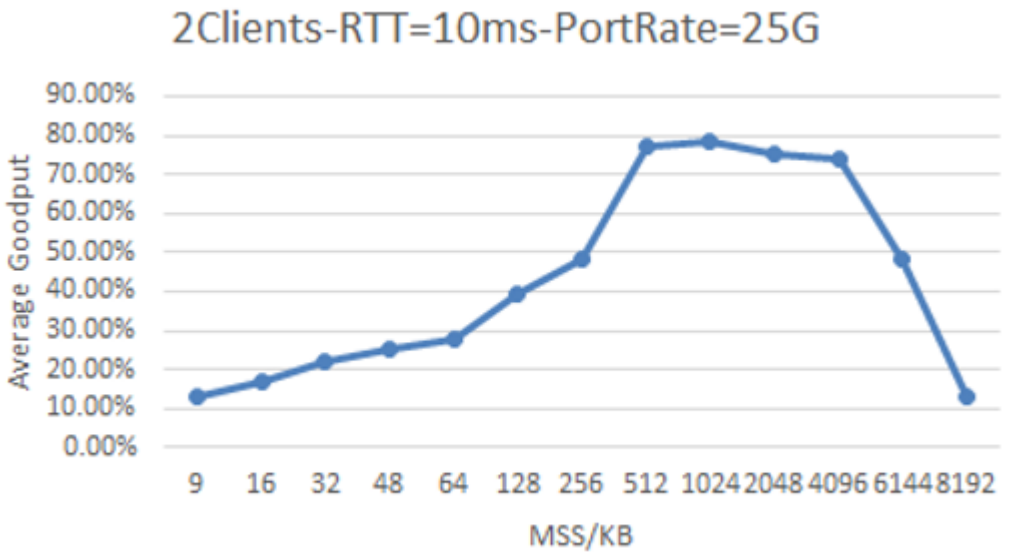


The impact of MSS size on TCP throughput (simulation)



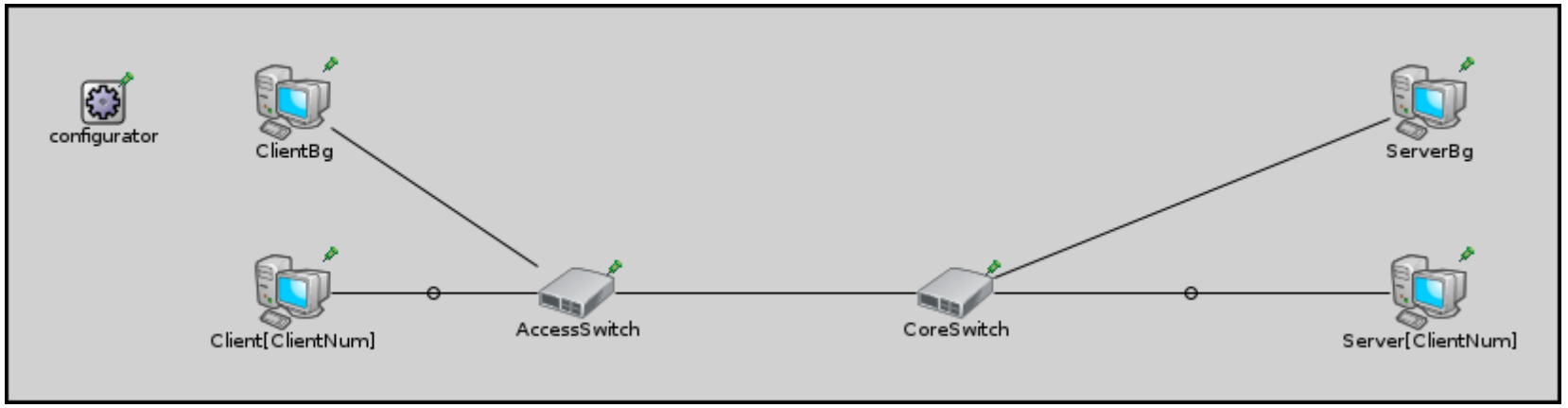


Goodput comparison of different MSS size under different RTT values



Goodput comparison of different MSS size under the same RTT interval

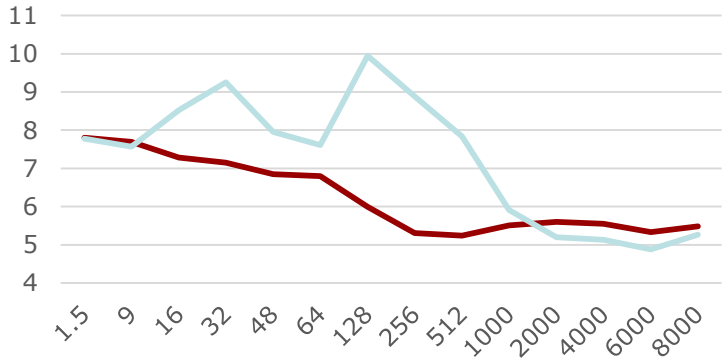
The impact of MSS size on DASH application (simulation)



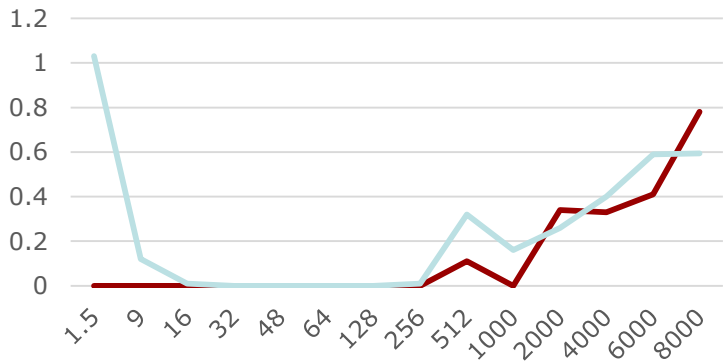
10% background traffic

40% background traffic

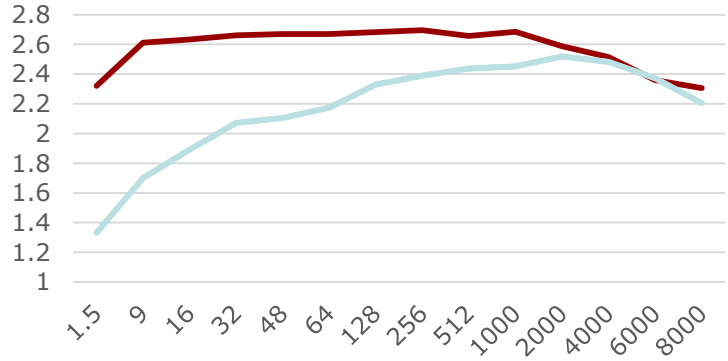
Avg Resolution Switching Number



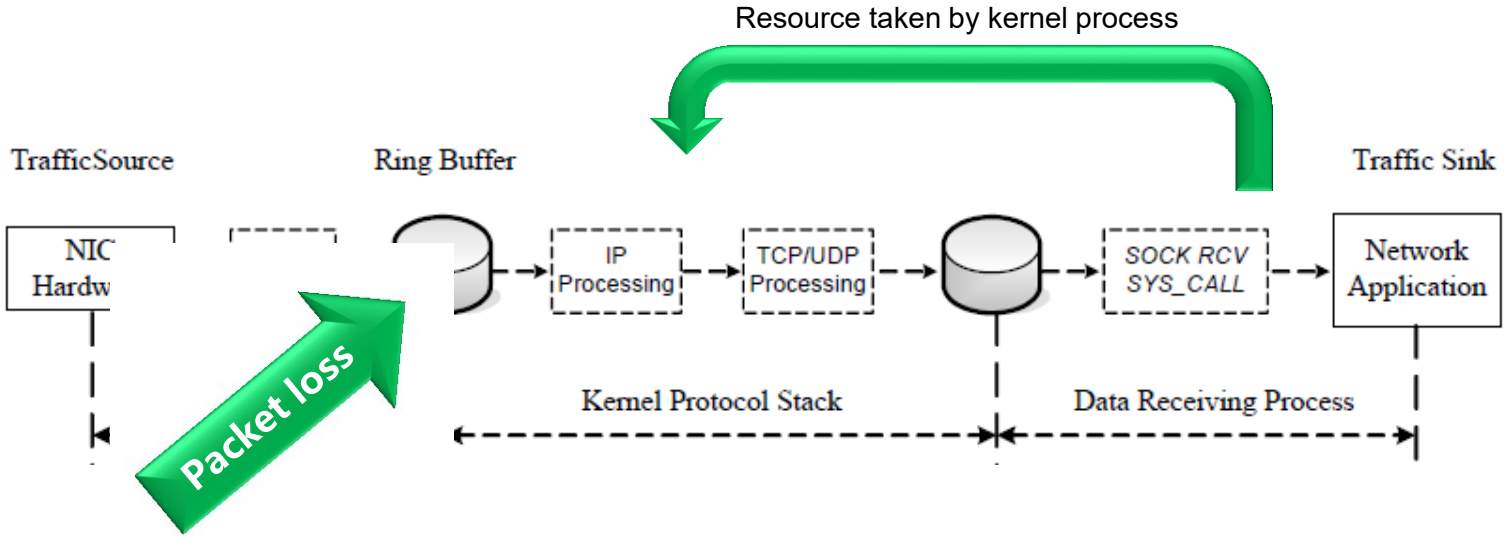
Average Re-buffering Number



Average Resolution



Operating system process the received packet



A lot of computational resource can be saved when using large frame.

Minimal Difference between processing short frame and long frame

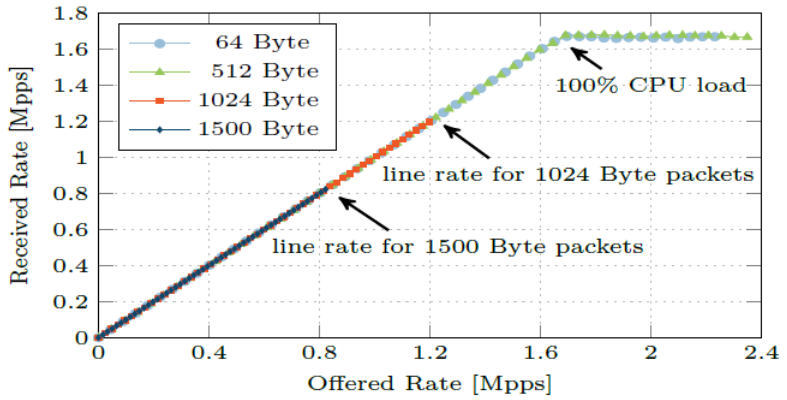


TABLE I
MAXIMUM PACKET RATE, MAXIMUM CPU LOAD AND CYCLES PER PACKET FOR DIFFERENT PACKET SIZES

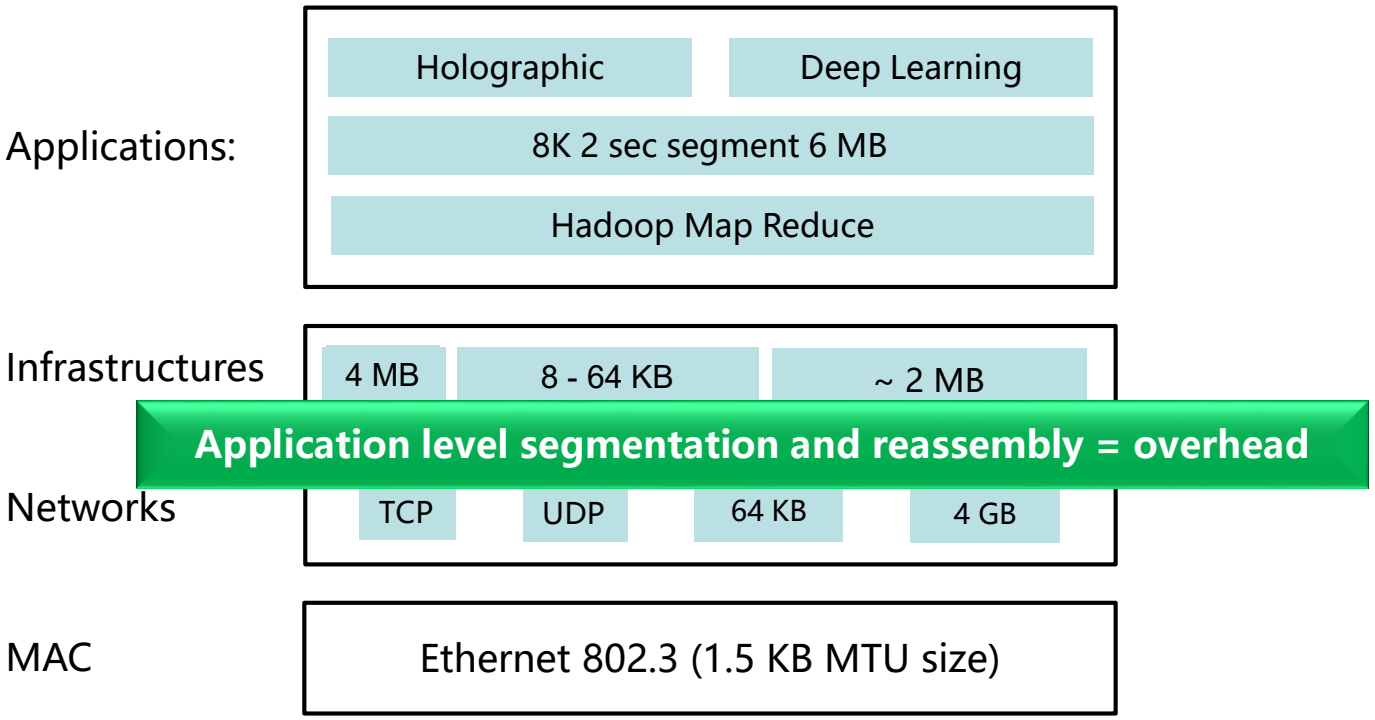
Packet Size	R_{max} [Mpps]	CPU_{load}	C_{total}
64 Byte	~ 1.67	~ 100%	1979
512 Byte	~ 1.67	~ 100%	1969
1024 Byte	~ 1.20	~ 75%	2056
1500 Byte	~ 0.82	~ 55%	2203

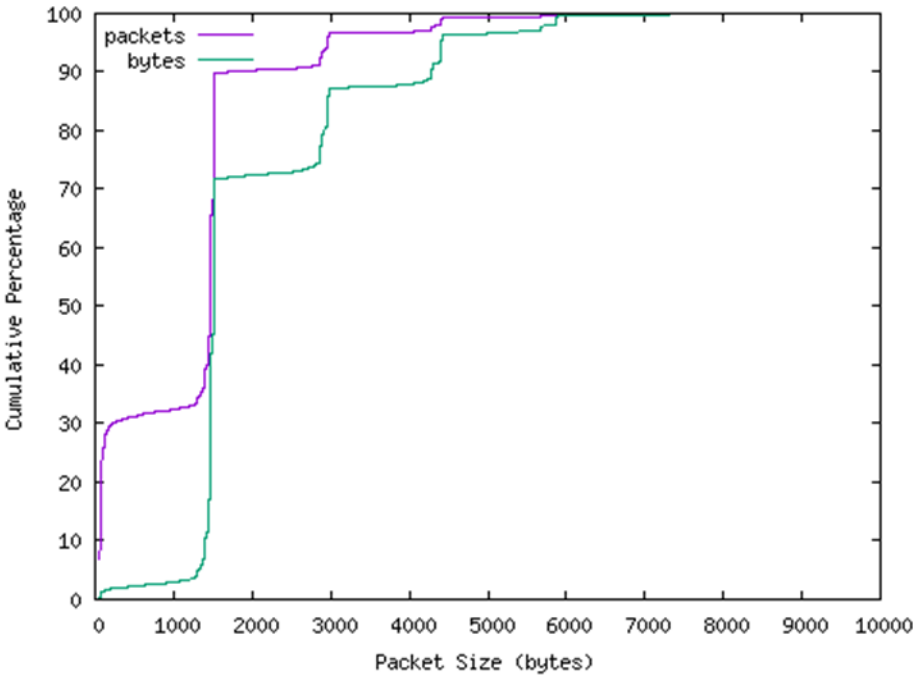
The data_len in sk_buff is at least 65 KB, can reach 4 GB.

*Figure and table is from the paper “Performance Exploration of Software-based Packet Processing Systems” by Daniel Raumer etc.

Each application has a preferred processing unit

and it is usually much larger than 1.5 KB…





By the year of 2018, around 70% packets requires the frame size to be bigger than 1.5 KB, which contributes to 95%+ of the total internet traffic.

*Picture from Caida (Center for Applied Internet Data Analysis, https://www.caida.org/data/)

Summary

- **The current 1.5 KB MTU size will not work in the future network. A much larger MTU is needed.**
- **To reach optimum E2E performance, each application has its own specific MTU size. The size can be changed over time. There is no “one size fits all "solution.**
- **The future network needs to support flexible MTU size.**

What might happen when MUT size is increased?

- **Frame-wised central traffic management, better bandwidth utilization, might obsolete TCP.**
- **Better opportunity to optimize the network monitoring and diagnose features.**

Thank you

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