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Technology trends in large-scale high-efficiency network computing

Key words: Supercomputing; Cloud computing; Network technology; Development trends

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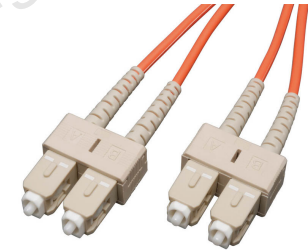
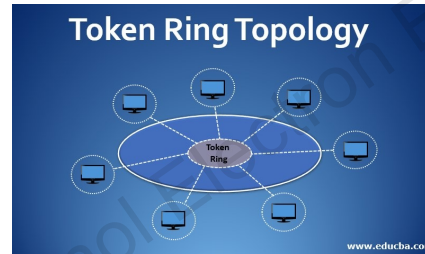


Background

- Networking technology has three important characteristics:
 - Networking technologies are changing rapidly.

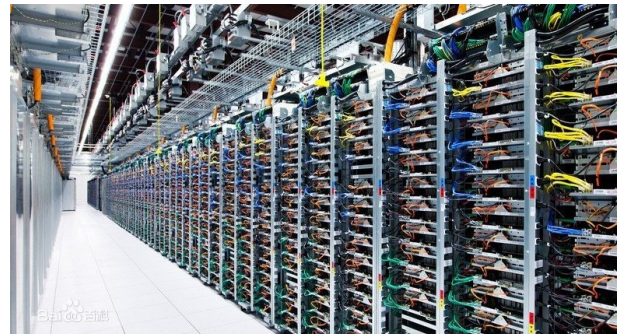


Ethernet has developed into a rich family



Some technologies (e.g., Token Ring, FDDI) disappear

- There is a rapid development of data centers.
- The computing power is developing at an unimaginable speed.



Background

- It is necessary to explore new models and new paths for the development of network technologies.

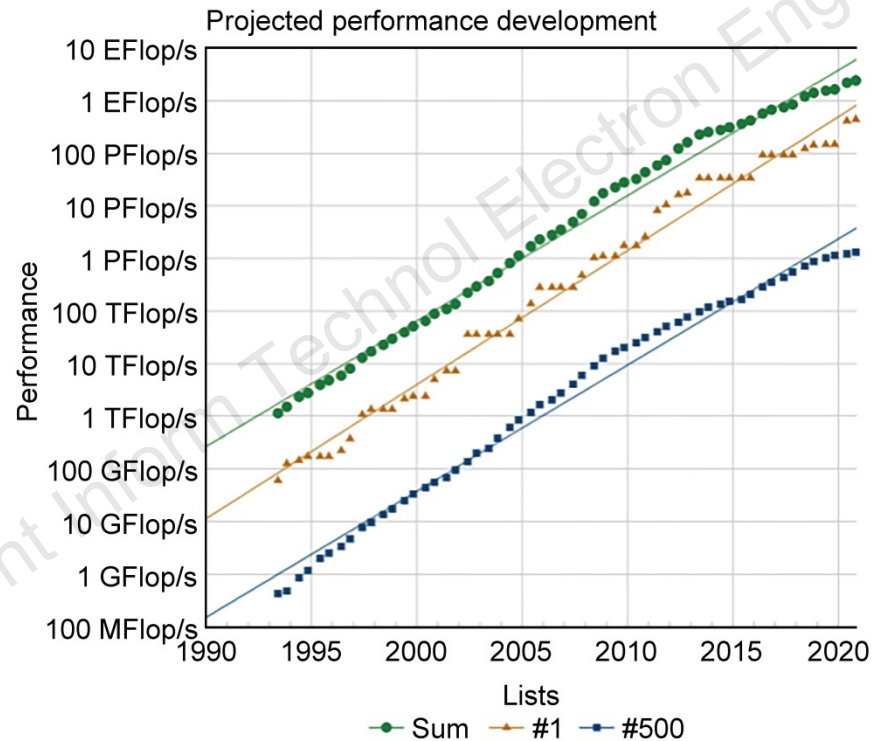


Fig. 1 Diagram of supercomputing TOP500 performance from 1993 to 2021

The graph is generated from the www.top500.org website. References to color refer to the online version of this figure

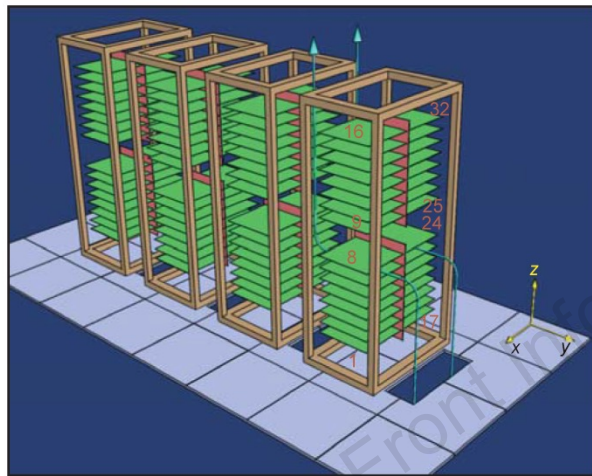
Three trends

- ❑ Integration: The performance demands are similar under different scenarios.
- High throughput and low latency are the main goals for both the data center and supercomputing.
- ❑ Differentiation: Many new technologies have evolved according to the goals pursued by different applications.
- ❑ Optimization: To satisfy the high performance requirements, optimization is a permanent topic.

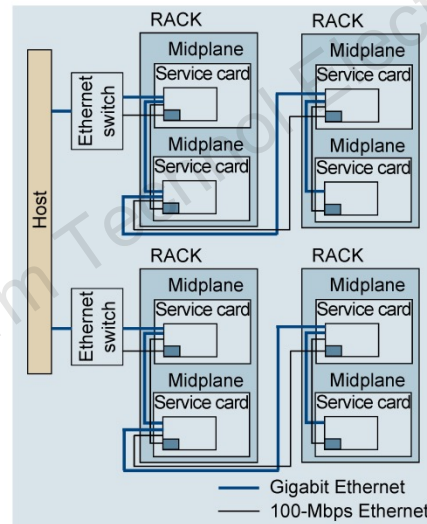
1) Integration

□ Heterogeneous network complementarity

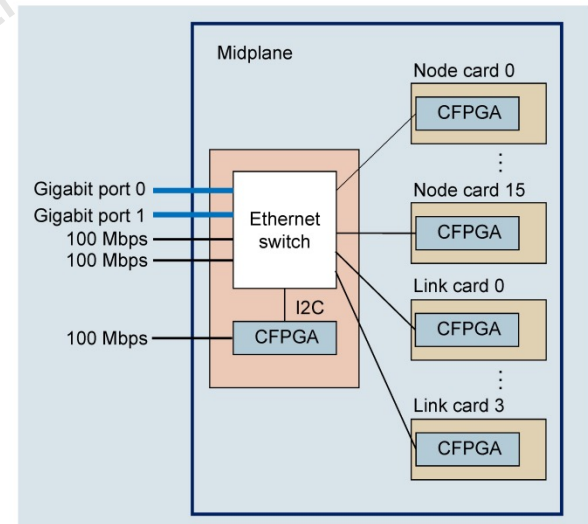
- The inherent networking requirements are multifaceted, and heterogeneous network integration is a trend.



(a)



(b)



(c)

Fig. 2 Diagram of IBM Blue Gene Q series heterogeneous networks: (a) diagram of four RACKs; (b) top-level view of the Blue Gene L control network; (c) configuration diagram of half RACK (Coteus et al., 2005)

1) Integration

- Generalization of link technology
 - Improve the link speed
 - Shorten the point-to-point delay
- Link transmission unification
 - SerDes technology is widely used.

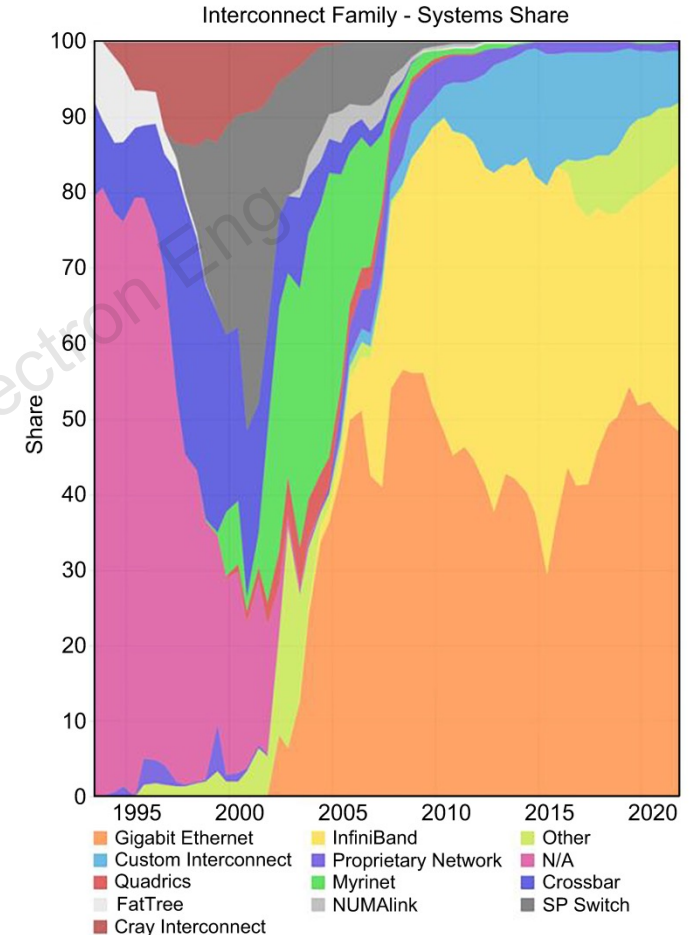


Fig. 3 Diagram of the network technology trend in TOP500 supercomputing

The graph is generated from the www.top500.org website. References to color refer to the online version of this figure

2) Differentiation

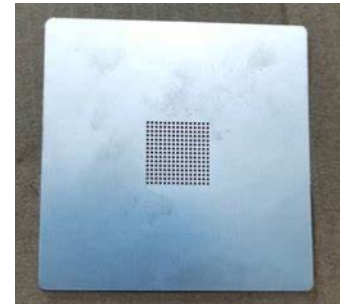
□ High-end system customization

- Advanced enabling technologies are widely adopted in high-end systems and customized interconnection networks.



□ Integration design for the network and interface

- Data center networks generally use a single network technology.



□ Transmission protocol customization

- In the long term, QUIC instead of TCP may be the mainstream.



3) Optimization

□ In-network computing in data centers

- The innovation of software and hardware has promoted the rapid development of in-network computing.



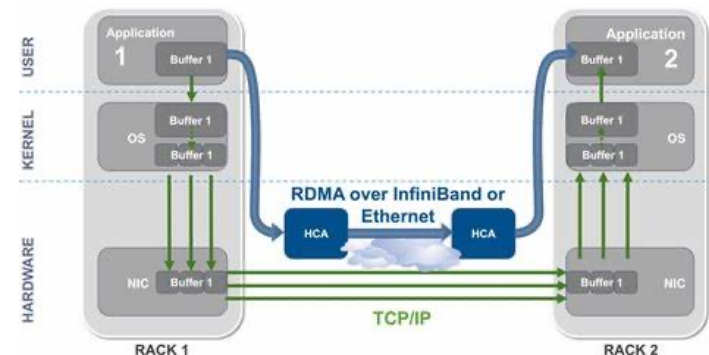
□ Collective computing for supercomputing

- Collective computing makes the CPU-centric processing mode evolve into a data-centric processing mode.

□ Protocol offloading

- Protocol offloading achieves acceleration using relatively complex protocols as individual components.

□ Cross-layer optimization



Summary

- ❑ Driven by the development of the Internet, supercomputing, cloud computing, big data, artificial intelligence, and AR/VR of the Metaverse, increasing demands on network technology have been proposed.
- ❑ From the perspective of the overall development of network technology, this paper summarizes three development trends of network technology, i.e., integration, differentiation, and optimization.
- ❑ It aims to provide useful guidance for system designers and key technical points for researchers.

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