

Use Cases for High-performance WAN

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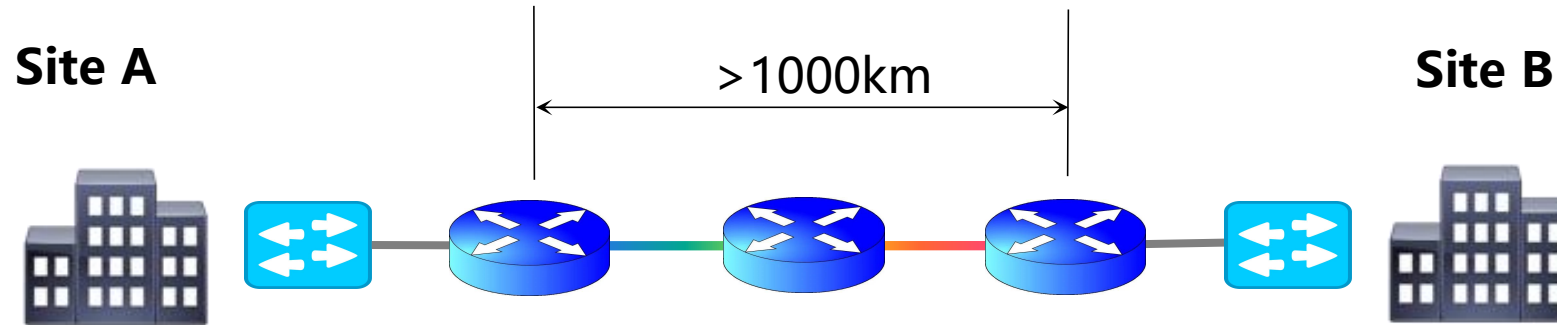
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Motivation and Problem Statement

- With the rapid development of big data and intelligent computing, there are many applications **requiring massive data transmission through long-distance connection**, such as cloud storage and backup of industrial internet data, digital twin modeling, Artificial Intelligence Generated Content (AIGC), multimedia content production, distributed training, High Performance Computing (HPC) for scientific research and so on.
- The industries need to solve the problems such as **long distance, slow feedback, course-grained load balance, low throughput** and so on.
- It is required for **High-performance WANs (HP-WAN) to achieve effective high-throughput transmission** which demands higher performance such as ultra-high bandwidth utilization, ultra-low packet loss ratio and low latency and jitter in WANs.

Scenario 1: Long-distance Transmission between Two Sites



- Typical Use Cases :

- *HPC for Scientific Research*

- generates 60~100 GB of data every five minutes, requiring data transmission from one laboratory to another for analysis.

- *Distributed Storage*

- move data from one storage system to another and needs to maintain data consistency across the distributed storage systems.

- *Data Express Service*

- requires task-based data transmission, point-to-point model, high resilience and throughput, with single data ranging from TB to 100TB.

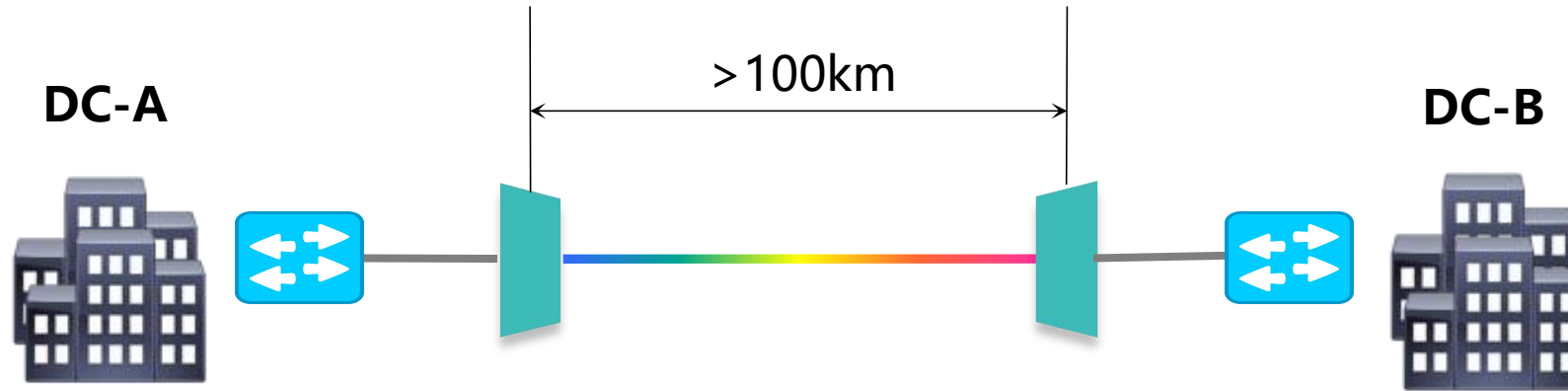
- *Multimedia Content Production*

- the raw material data of a large-scale variety show or film with a single transmission of data in the range of 10TB to 100TB and needs to be transmitted between data centers or different storage sites.

- *Data backup and Disaster Recovery*

- the working and backup data centers are built in different locations and requires long distance and massive data transmission for disaster recovery.

Scenario 2: DCs Interconnection



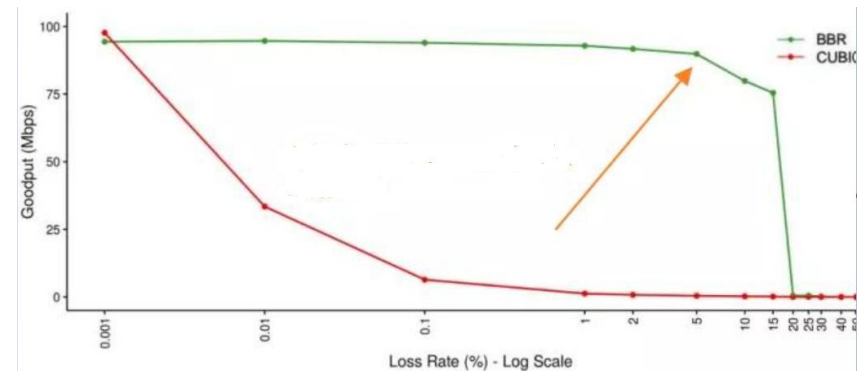
- Typical Use Cases:
 - *Collaborative Training across Multiple DCs*
 - provide on-demand task allocation to different clusters, sufficient bandwidth, low latency, high throughput, and extremely high network availability and reliability for data centers communications.
 - parameters exchange significantly increases the amount of data transmission across DCs, typically from tens to hundreds of TBPS

Objectives

- What are the objectives and goals for HP-WAN?
 - The primary goal is the **effective high-throughput transmission** which demands higher performance
 - *ultra-high bandwidth utilization*
 - efficient use of available network capacity to maximize data transfer rates
 - *ultra-low packet loss ratio*
 - the packet loss negatively correlates with throughput
 - *low latency and jitter*
 - the RTT negatively correlates with throughput

- The computing method of throughput for TCP is as following shown.

$$\text{Throughput}_{TCP} = \min \left\{ BW, \frac{\text{WindowSize}}{RTT}, \frac{MSS}{RTT} \times \frac{C}{\sqrt{p}} \right\}$$



- According to the experimental data, for TCP, the throughput dramatically decreases up to 89.9% when the packet loss ratio is 5%.

Gaps for Existing Technologies

- What are the characteristics for HP-WAN?
 - Massive elephant flows data with large burst, multiple concurrent services co-existed with dynamic flows (*e.g. 10G~400Gbit/s*)
 - Long distances, multiple hops, paths and domains between DCs (*e.g. >100km, >1000km*)
- What are the gaps for existing technologies?
 - Optic Fiber direct connection (*e.g. OTN*),
 - *limited scale and deployment and high cost, requires using IP network resources*
 - DC Technologies (*e.g. PFC*)
 - *slow feedback and high Round-Trip Time (RTT) latency and jitter, requires improving flow control precision*
 - L3 Routing Technologies (*e.g. ECN/ECMP*)
 - *network is passive and unaware of the status, requires coordination with the end systems*
 - *network resources utilization rate is low, requires fine-grained traffic scheduling*
 - *long-distance transmission requires ultra-low packet loss, long-distance latency and jitter guarantees*

IETF120 Side meeting for High-performance WAN

- HP-WAN Side Meeting Planning
 - Start a discussion about use cases, problems, motivations and requirements of High-Performance Wide Area Networks to achieve high-throughput transmission.
 - **Time: Tuesday 23 July-15: 30~17:30 (Vancouver)**
 - **Location: Prince of Wales/Oxford**
- Open Issues
 - *Is the HP-WAN topic and problem space people want to work on?*
 - *What could the IETF do to help with these problems?*
 - *Which IETF technology is most impacted?*
 - *What are the next steps for HP-WAN discussions?*

Next Steps

- Ask for WG review and feedback.
- Comments and suggestions are welcome!

Thank you!