Considerations on Inter-DC Network Requirements

IETF 121

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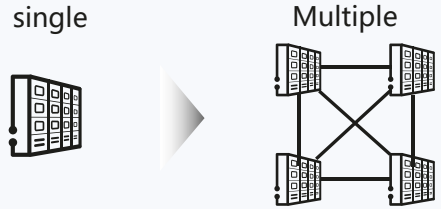
Scenario Summary

- With the development of AI large models, new intelligent computing interconnection services are emerging in an endless stream
- New intelligent computing services represented by distributed training and separation of storage and computing have put forward higher requirements for the network

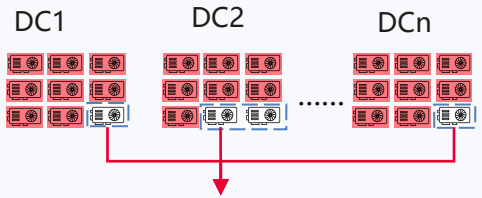
Distributed Training

Distributed deployment Break through power bottleneck



The scale of a single intelligent computing center **cannot increase without limit**

Integrate fragmented resources Avoid wasting computing power



Gathering sand into a tower, the computing power resources are fully utilized

Sample Upload

The training of large AI models generating the requirement for massive data transmission

scientific computing
FAST 15PB

autonomous driving
SAIC 38PB

Remote rendering for film and television
Hunan TV 12PB

gene sequencing
BGI 4.5PB

PB level massive data need to be transmitted to the computing power center for analysis and processing every year

Separation of Storage and Computing

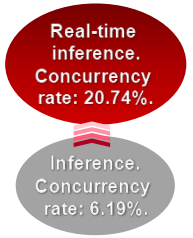
Enterprises with high data security sensitivity require that "data does not land on the disk"

The data of financial, securities and other companies are stored in private domains. When renting computing power resources, they hope to use an encrypted connection between computing and storage.

Renting computing power is more flexible and has a lower cost than investing in building an AI cluster. However, security considerations need to be met

Real - Time Inference

Large model inference requires a high bandwidth and low latency network

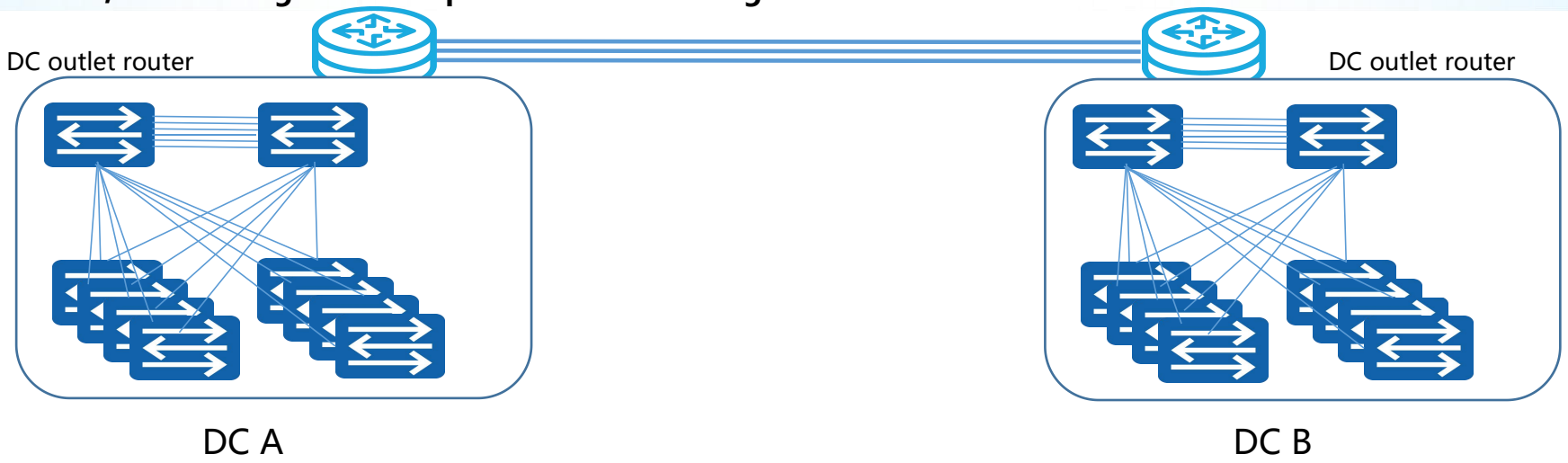


- According to the MAU model of the world's hottest Steam, the concurrency rate of popular applications can reach up to 20.74%
- Calculated based on the 230 million mobile broadband users of China Mobile in mid-2023, if the business penetration rate is 30%, the corresponding concurrent traffic needs to be 8T
- For mobile users, when the penetration rate is 50%, the business concurrent traffic needs to be 5.2T

play voice→ voice interaction	single modal → multimodal	video recording→ visual interaction
real person voice interaction latency 230ms	voice | action | emotion | virtual reality	live | education | broadcast | guide

Scenario 1: Distributed Training

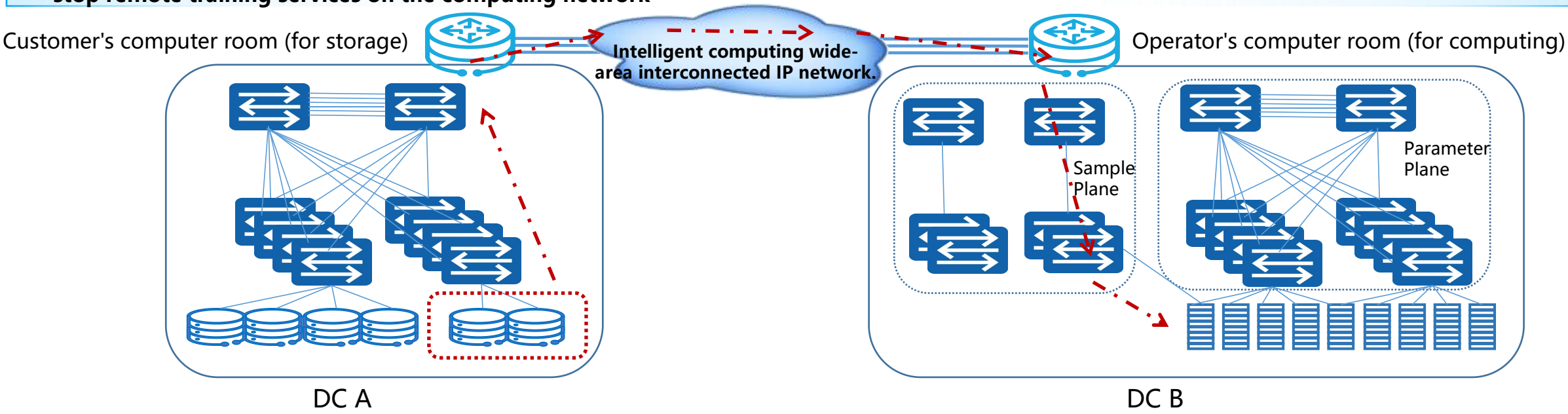
- Distributed training across intelligent computing centers breaks many hardware and networking design prerequisites of a single cluster, bringing about deterioration of network indicators such as bandwidth and latency, and significantly reducing the effective computing power of the cluster
- The scale benefits obtained from cluster interconnection are reduced, and the remote computing efficiency target cannot be lower than 90% compared to the same site, which brings ultimate performance challenges to the inter-DC network



Network challenges:	High concurrency elephant flows challenge for network bandwidth Mouse flow-->Elephant flow	High burst traffic challenge for congestion control micro burst --> high burst	Limited network resources challenge for load balancing No convergence --> convergence
Network Requirements:	Real-time transmission of T-bit-level large pipelines	"0 packet loss" in wide area data transmission	The load sharing accuracy between ports less than 5%

Scenario 2: Storage-Computing Separation

- **The cost of building a self built intelligent computing center is high, and renting computing power is a lower cost and more flexible choice for enterprises to obtain computing power**
- **Sensitive data security has become an essential requirement for enterprise intelligent computing, and there is an urgent requirement for one-stop remote training services on the computing network**



Network challenges:

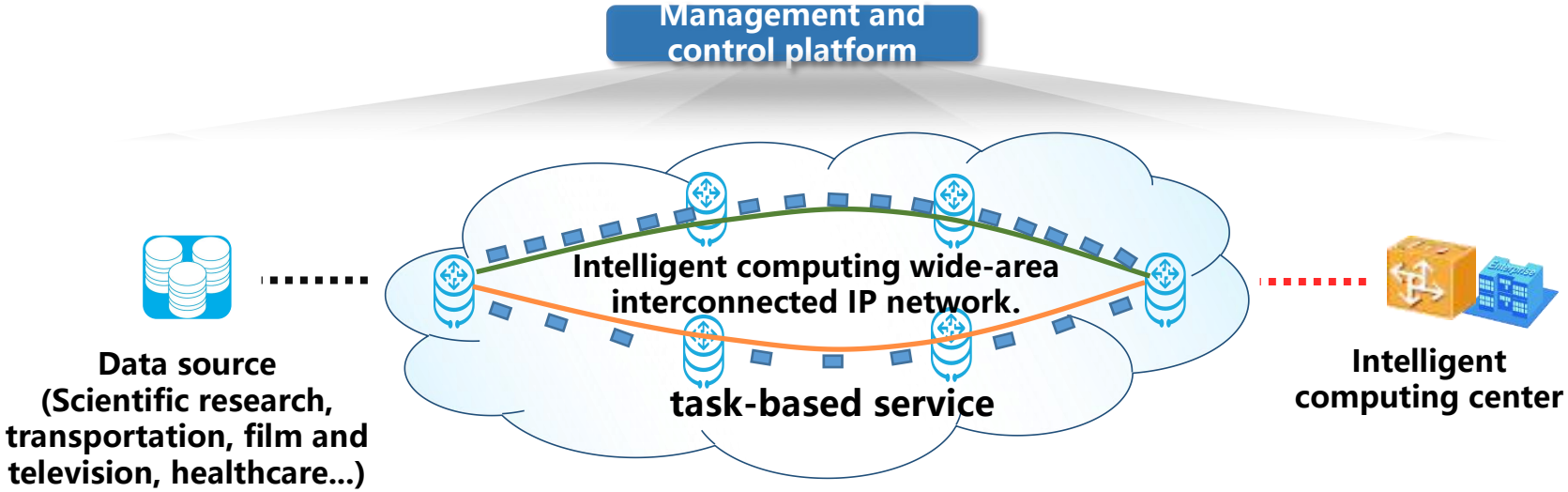
The mixed running of multiple types of traffic brings challenges to network load balancing	Data not being written to disk brings challenges to data security	The increased sensitivity to quality brings challenges to network reliability
Mouse flow-->Mouse Flow + Elephant flow	Non sensitive-->sensitive	Fault repair-->Quality degradation repair

Network Requirements:

Network throughput rate is over 90%	Low-latency encryption for wide-area data	Adaptive switching in case of quality degradation

Scenario 3: Sample Uploading

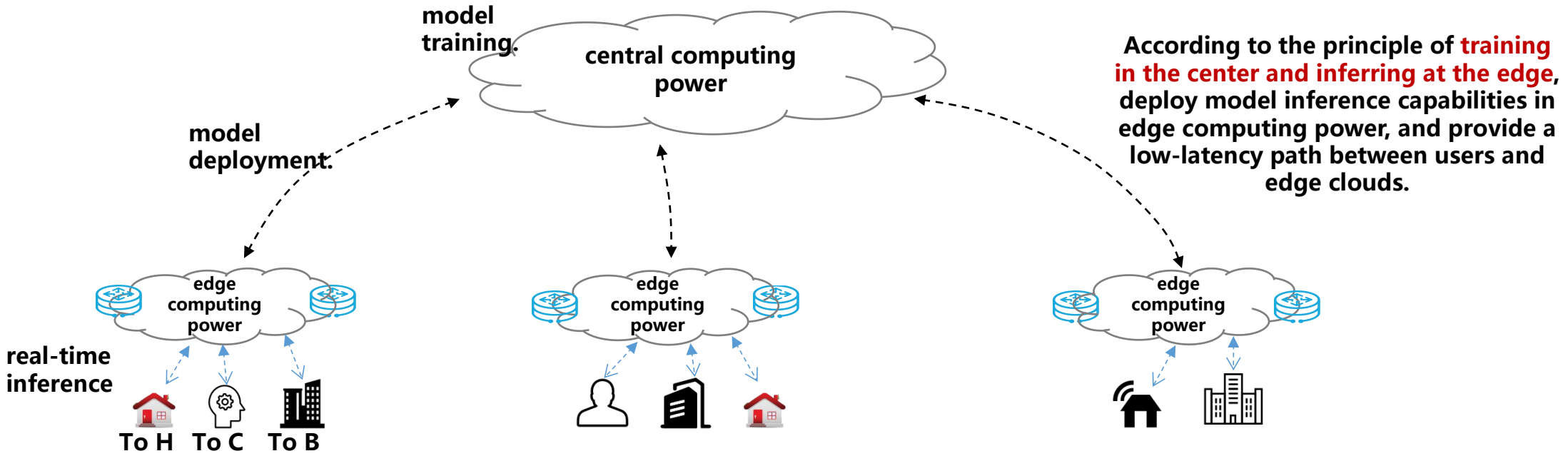
- With the continuous development of fields such as scientific research, transportation, film and television, and healthcare, there is a high requirement for computing power in AI training, leading to an increasing requirement for the transmission of massive and highly sensitive data
- The network is facing challenges such as long-distance, large bandwidth, sudden tasks, and high security



Network challenges:	The efficient transmission of massive data brings challenges to network bandwidth Gbit level --> Tbit level	User data confidentiality brings challenges to network security Non sensitive --> sensitive	Task - based services bring challenges to network flexibility Fixed services --> On-demand services
Network Requirements:	Efficient Transmission of Terabit - level Data	Wide-area data encryption	100M to 10G elastic bandwidth

Scenario 4: Real-time Inference

- AI large - models are evolving towards multimodality and real - time interaction
- Facing the interactive requirements of a vast number of users, the network is confronted with the challenges of determinism and low latency



According to the principle of training in the center and inferring at the edge, deploy model inference capabilities in edge computing power, and provide a low-latency path between users and edge clouds.

Network challenges:

Real-time inference service brings challenges to network latency

Non real time --> High real time performance

Model - pushing between computing - units brings challenges to network reliability

Fault repair-->Quality degradation repair

Network Requirements:

Low-latency routing for wide-area data

Adaptive switching for quality degradation

Technology Design Concept

Load balancing

From "Per-Flow" Load Balancing to "Micro-Flow"

- **Network-level**: Achieving Overall Network Resource Balancing through Multiple Segment Lists
- **Link-level**: The traffic is divided into packet groups and evenly sprayed onto multiple output ports of the device to achieve load balancing of the links

Congestion control

From "Port-level" Congestion Control to "Traffic-level"

Traffic-level : The existing Priority-based Flow Control (PFC) mechanism has issues such as head-of-line blocking. It is necessary to combine the flow information of Layer 3 packets with the traffic backpressure mechanism to form a traffic-level congestion control scheme

Reliability Assurance

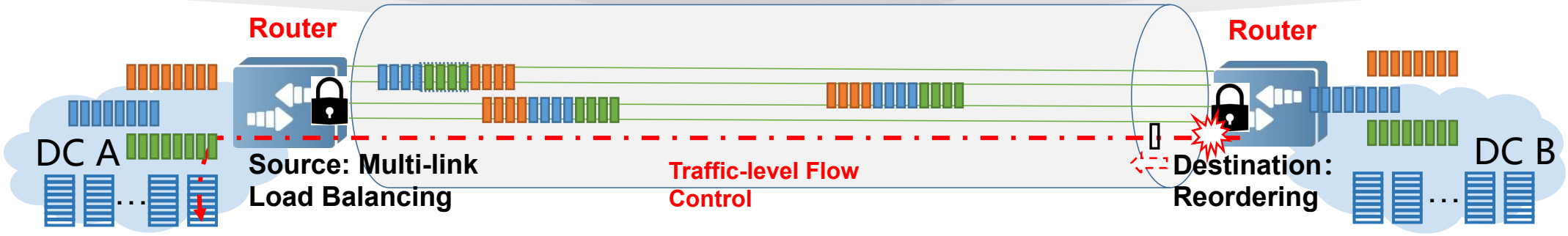
From "Fault" Repair to "Quality Degradation" Repair

Adaptive Path Switching: The head-end device responds in real-time to the degradation of network quality indicators, achieving an upgrade in network quality assurance from fault switching to degradation switching

Data Encryption

From "Packet" Encryption to "Bitstream"Encryption

PHYSec: Building Physical Layer Bit Containers and Management Channels to Achieve Nanosecond-level Low Latency, Zero Bandwidth Overhead, and Full-stack Data Encryption and Decryption



Thanks