Draft1：Digital Twin Network Flow Simulation

draft-yz-nmrg-dtn-flow-simulation-00

Draft2：One-way delay measurement method based on Digital Twin Network

draft-yc-nmrg-dtn-owd-measurement-00

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Digital Twin Network Flow Simulation

draft-yz-nmrg-dtn-flow-simulation-00

Backgound

- Twin flow in a digital twin network requires accurate simulation of physical flow in a physical network
  - such as network new technology experiment, network configuration verification, network performance optimization, etc.

•The twin flow of the twin network layer and the physical flow of the physical network need to satisfy the following three characteristics at the same time.

① Forwarding paths are consistent

② Network performances are consistent

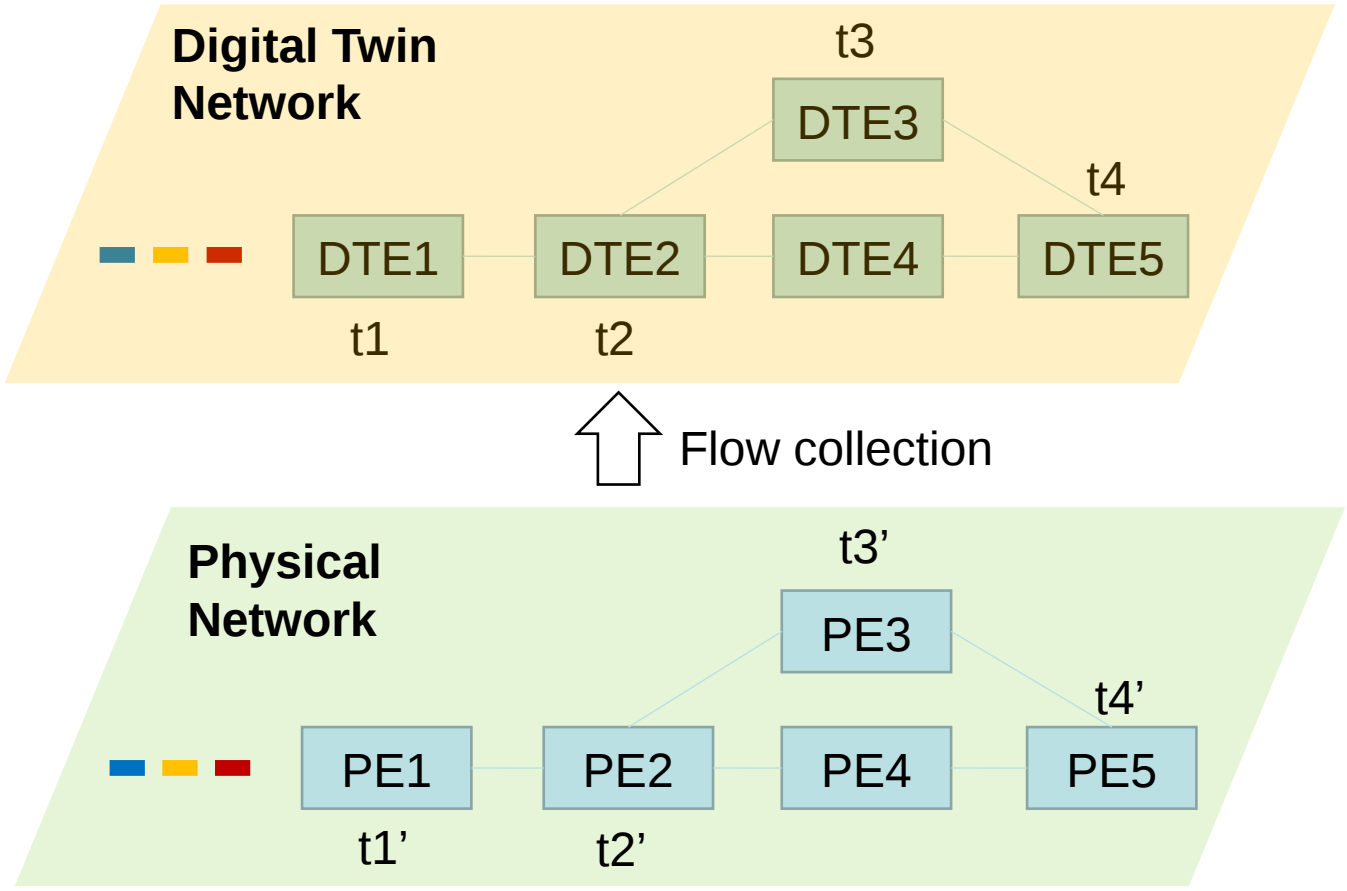
③ Data characteristics are consistent

The most perfect twin flow

TheTwin Flow **VS** The Physical Flow

- Exactly the same data forwarding path and time
- Exactly the same flow data

But this is impossible, because data collection takes time, and the packet by packet collection of flow is too high.



tn’ = tn

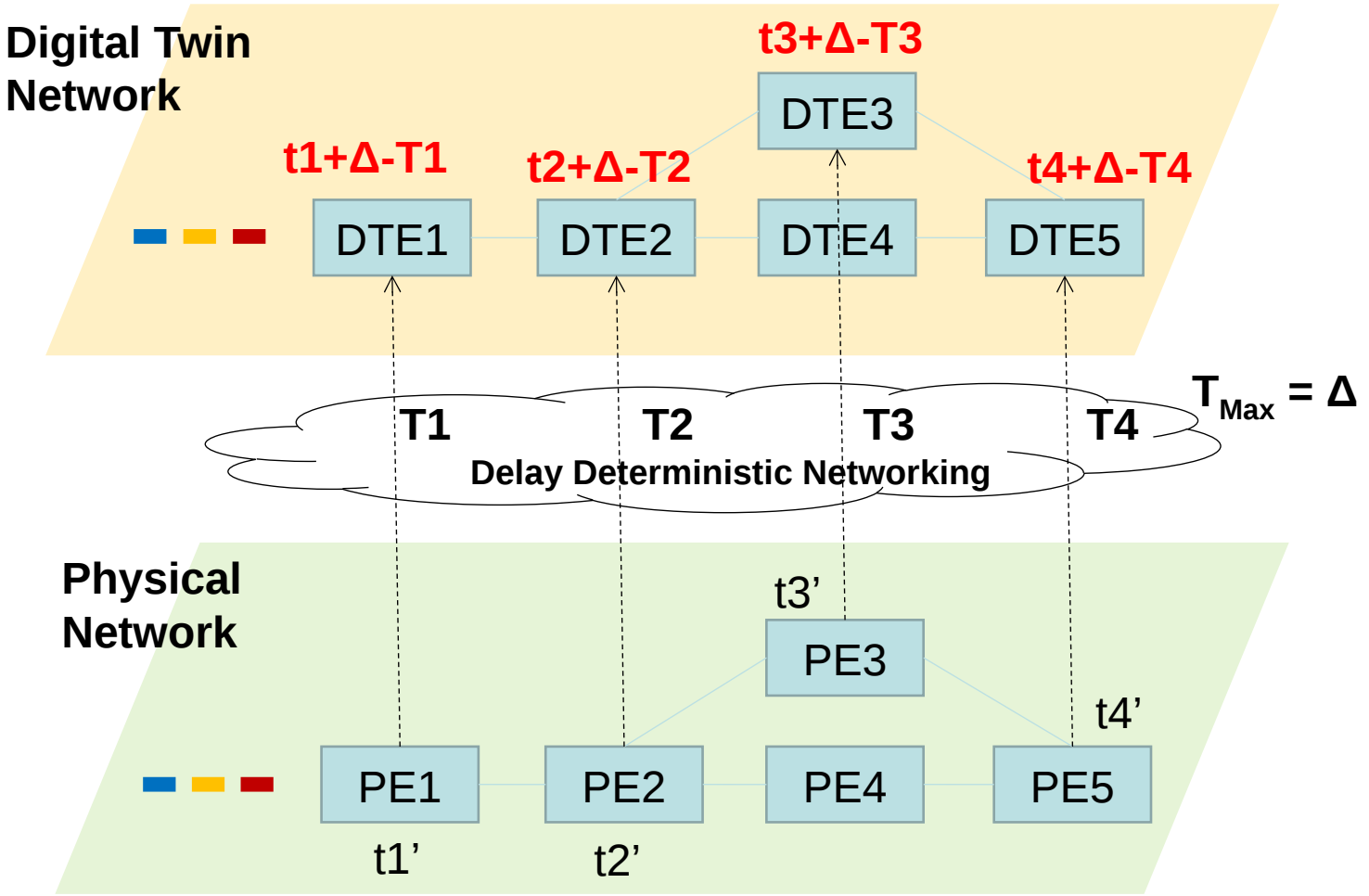
The implementation method of twin flow

Three key technologies:

① The physical network element and the twin network element have **unique identifiers** in the entire network.

② The data transmission network between the physical network and Digital Twin Network used **DetNet network.**

③ Only **the key information** of physical flow is collected, some payload information does not need to be collected.



The twin flow delays the physical flow by a **fixed time Δ**

Advantages

- The forwarding path, forwarding time, and key flow information are consistent between twin flow and physical flow;
- Can meet the needs of various scenarios
- Easy to implement

One-way delay measurement method based on Digital Twin Network

draft-yc-nmrg-dtn-owd-measurement-00

Backgound

•Traditional network delay measurement methods include active measurement, passive measurement, hybrid measurement, etc., but they all have some disadvantages

- Special test packets are required.
- Cannot test all network protocols, For example, it is difficult to measure the one-way delay for UDP packets.
- Time synchronization is required.
- Need to change the format of service packets.

Paper introduces a new network delay measurement method,That

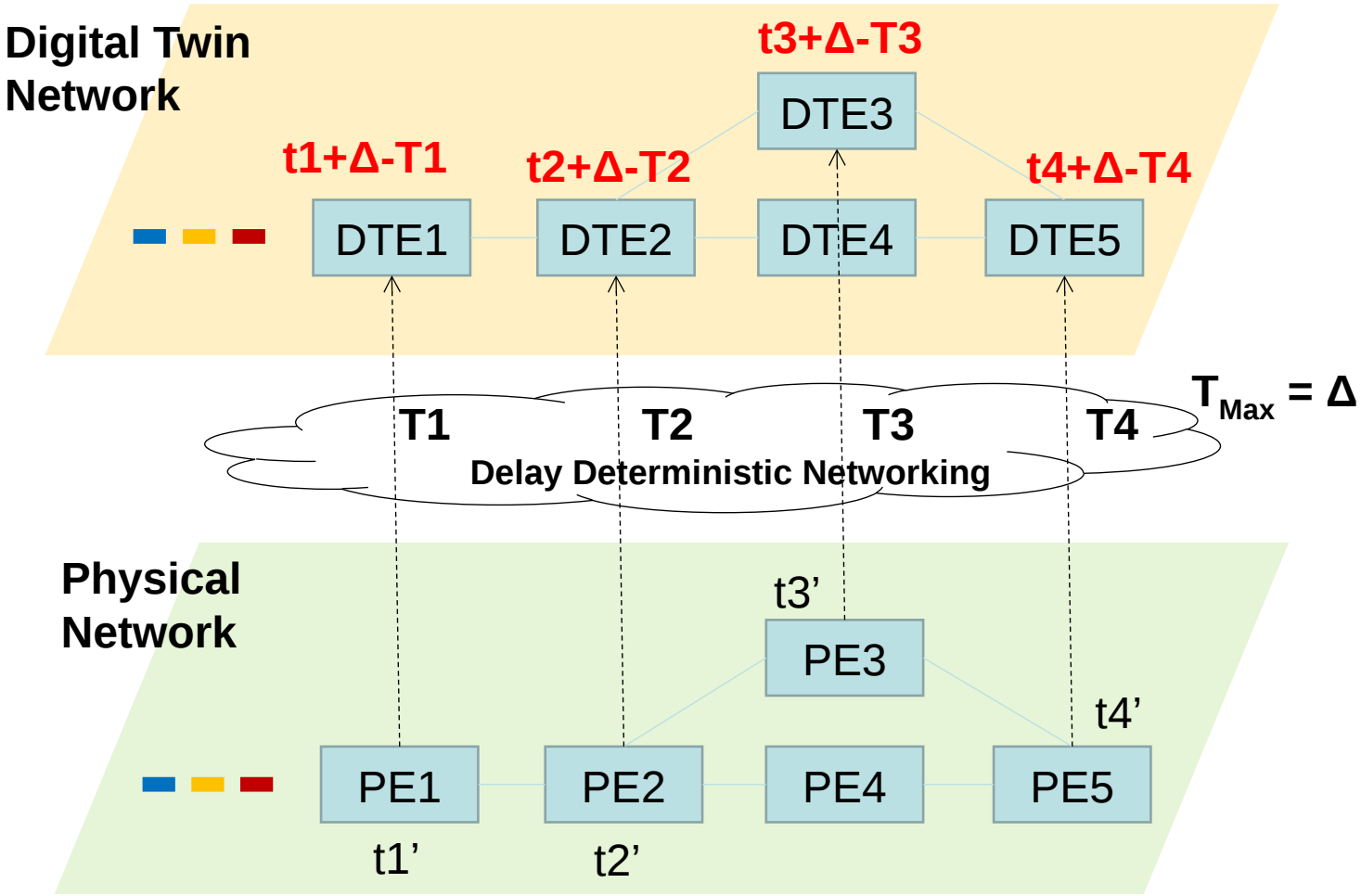
- **No need** to send measurement packets,
- **No need** to change the physical network configuration,
- **No need** to change the format of service packets
- **No require** physical network elements to support the time synchronization protocol.

Time delay measurement of physical flow based on twin flow

Time synchronization is maintained between each twin network element in the digital twin layer.

a) If multiple twin NEs are in the same physical entity, such as the NFV-based modeling method, where multiple twin NEs are deployed in one server and share the same local clock, the twin NEs themselves is time-synchronized;

b) If multiple twin NEs are deployed in different physical entities, use PTP (Precise Time Protocol) or NTP (Network Time Protocol) to achieve time synchronization between physical entities to ensure time synchronization of all twin NEs;



Time delay measurement of physical flow based on twin flow

For example, if a UDP data packet is transmitted from physical network element 1 to physical network element 3, the one-way transmission delay is:

(t3+Δ-T3)-(t1+Δ-T1) = t3-t1-T3+T1

Under the premise of time synchronization between twin NEs, the transmission delay of packets of any protocol type in any two physical NEs is equal to some formulas：

one-way delay = tn-tm-Tn+Tm

Conclusion :

- Time synchronization between physical network elements is not required during the measurement process.
- The accuracy of delay measurement depends on the time synchronization accuracy of the twin network elements and the time synchronization accuracy of the delay deterministic network. If both use the PTP synchronization protocol, the delay measurement accuracy can reach the nanosecond level.

Next Steps

- Strengthen the realization of system solutions
- Verify program performance
- We also welcome proposals to enhance the document.

- **Your comments are always welcome!**