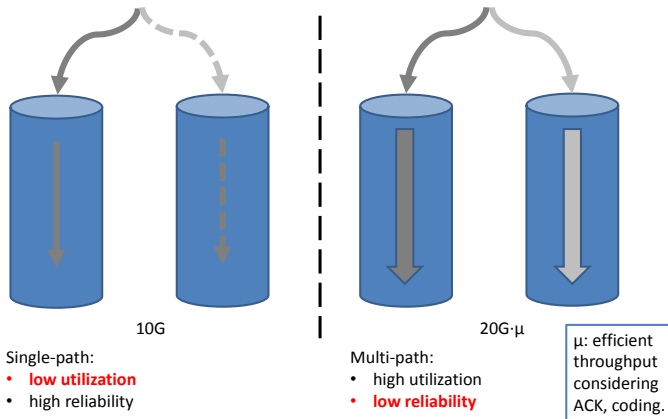


# Multi-path TCP in Data Centers

Trade-off between reliability and utilization

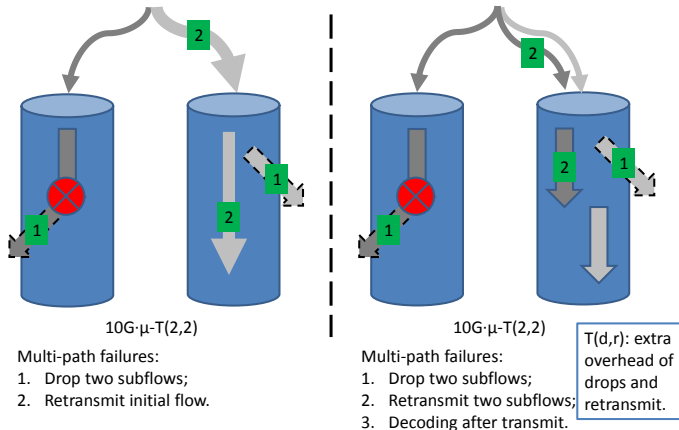
## Static Data Centers



# Multi-path TCP in Data Centers

Low reliability due to drops and retransmission

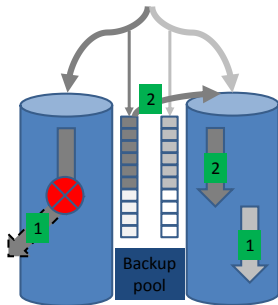
## Static Data Centers



# Failures Handling in Data Centers

High reliability through flows backup

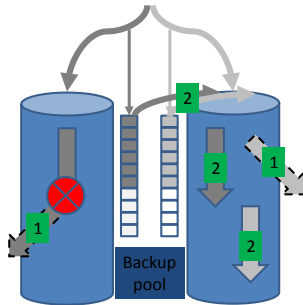
## Static Data Centers



$10G-\mu-T(1,1)$

Multi-path failures by backup:

1. Drop one subflow;
2. Retransmit one subflow;
3. Decoding after transmit.



$10G-\mu-T(2,2)$

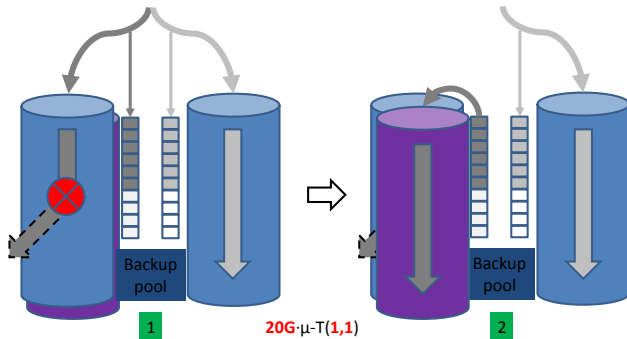
Multi-path failures by backup:

1. Drop two subflows;
2. Retransmit two subflows;
3. Decoding **as transmitting**.

# Failures Handling in Data Centers

High efficiency through flexible switching

## Flexible Data Centers



Multi-path failures by backup:

1. Drop **one subflow**;
2. Retransmit **one subflow**;
3. Decoding **as transmitting**.

# Multi-path TCP and Failures handling

## Basic Procedures

### Topology & Congestion Control, Packet Scheduling & Decoding

- 1 Split flow(s) into subflows and push into backup pool
  - 2 Congestion control by length of **flow backup** or **block ACK**
  - 3 Topology control and scheduling by **flexible switching**
  - 4 Add premix to subflows, make backup and transmit subflows
  - 5 Decoding according to premix or flow backup
- Flow backup: copy the transmitting subflows and premix
  - Block ACK: several backup subflows use one combined ACK
  - Flexible switching: on-demand response by block ACK and backup

# Multi-path TCP and Failures handling

Adopted Technologies

## Failures handling technologies

- **Flow backup** reduces the overhead of drops and retransmission:  $T(2,2) \rightarrow T(1,1)$ .
- **Flexible switching** improves the capacity and reduces the delay:  $10G \rightarrow 20G$ .

The above failures handling methods improve the decoding efficiency: after transmit  $\rightarrow$  as transmitting.

## Multi-path TCP technologies

- **Block ACK** reduces extra overhead: ACK/subflow  $\rightarrow$  ACK/block

These are much work on multi-path TCP including protocol design and congestion control. But the multi-path routing and scheduling (topology control) in flexible data centers has not been explored, especially on failures handling (including congestion control) and flexible switching.