# Transport Issues of Computing in the Network

https://www.ietf.org/id/draft-kunze-coinrg-transport-issues-00.txt
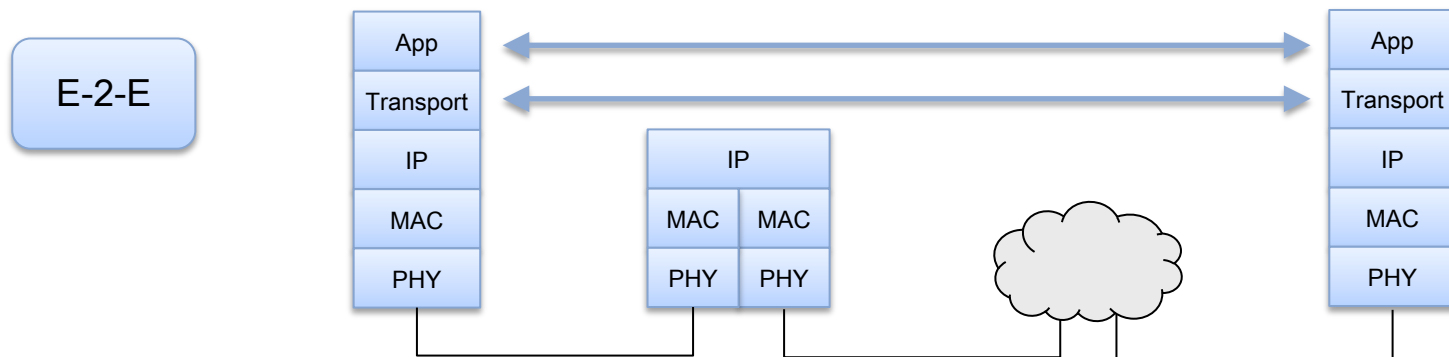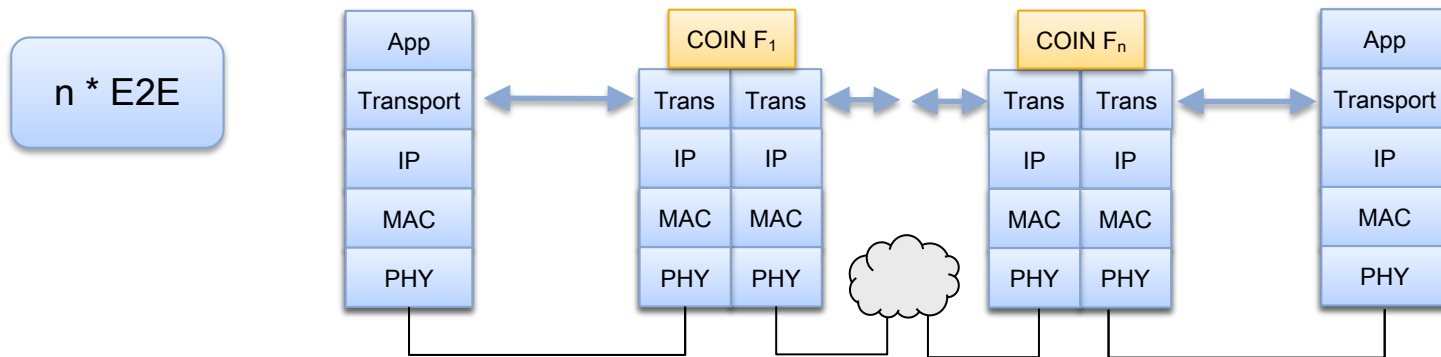
Ike Kunze, Klaus Wehrle

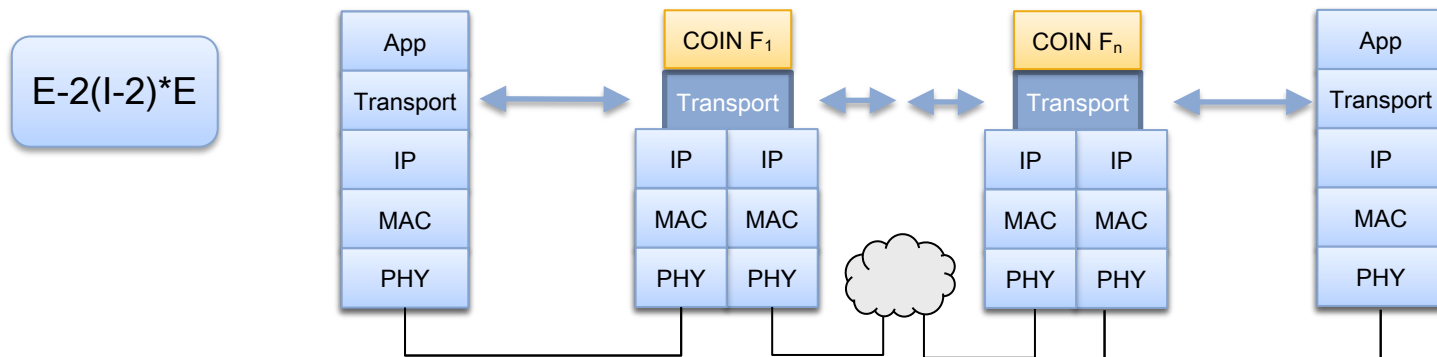# Classical End-to-end Principle



- Original design principle
  - ▶ All computing (=modifying application payload) is done at the network endpoints
  - ▶ Classic notion of an end-2-end transport session
  - ▶ Except for "some" transparent middleboxes changing headers

draft-kunze-coinrg-transport-issues-00.txt

# End-to-end Principle with Computing in the Network?

n * E2E



- COIN
  - ▶ Purposefully and explicitly process packets in the network (either Edge-clouds or on-path)
  - ▶ Breaking the end-to-end principle between source and destination
    - ■ Here: Concatenation of multiple transport sessions: E-2-E + E-2-E … + E-2-E  (basically service chaining)
    - ■ Makes transport issues easier, but looses E-2-E notion between source and destination
    - ■ Concatenation of intermediate end-points will then be an application issue

# End-to-end Principle with Computing in the Network?



$$E-2(I-2)*E$$

App | Transport | IP | MAC | PHY

COIN $F_1$ · Transport · IP IP · MAC MAC · PHY PHY

COIN $F_n$ · Transport · IP IP · MAC MAC · PHY PHY

App | Transport | IP | MAC | PHY

- **COIN**
  - ▶ Purposefully and explicitly process packets in the network (either Edge-clouds or on-path)
  - ▶ Breaking the end-to-end principle between source and destination
    - ■ Here: Keeping E-to-E notion between source and destination
    - ■ Requires new or adapted transport protocols E-$I_1$-..-$I_n$-E (End-to-Intermediate-to-Interm.-…-to-End)
    - ■ Concatenation of intermediate elements is handled on layer 3 and 4, will be configured by application via API

# Intention of draft-kunze-transport-issues

- **There is no simple solution**

- **Start a discussion about how the issues should be addressed**
  - ▶ Connecting discussions of different groups of the IETF/IRTF
  - ▶ Plus issues that are not addressed yet

- **This draft as a starting point, raising open issues**
  - ▶ Addressing
  - ▶ Flow Granularity
  - ▶ Authentication
  - ▶ Security
  - ▶ Advanced Transport Features

- **Addressing options**
  - ▶ Whom to address?
    - ■ Address based: sequence of IP + port?
    - ■ Content/function based: specify the compute function? Anycast mode?
    - ■ Or location-based?
  - ▶ How strict to address?
    - ■ Loose routing
    - ■ Strict routing
  - ▶ What kind of communication pattern among functional units?
    - ■ 1:1, 1:n, n:m

**SPRING WG:**
Segment Routing using MPLS and IPv6

- ## **What is the processing granularity?**

  - ▶ Packet-based?      → no/little state required in processing nodes
  - ▶ Message-based?     → medium/high state required …
  - ▶ Stream-based?      → state required on application (low to high state required)
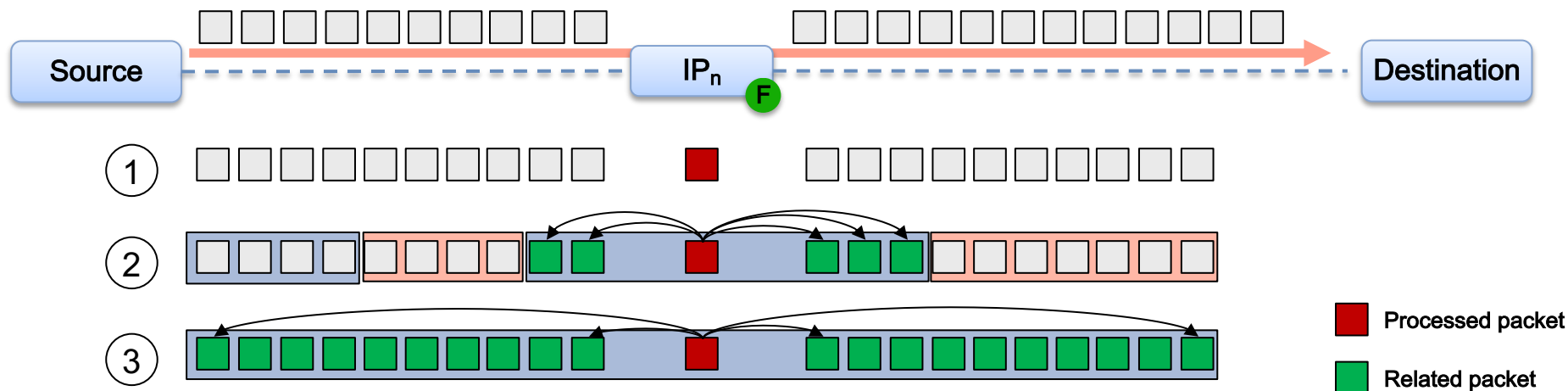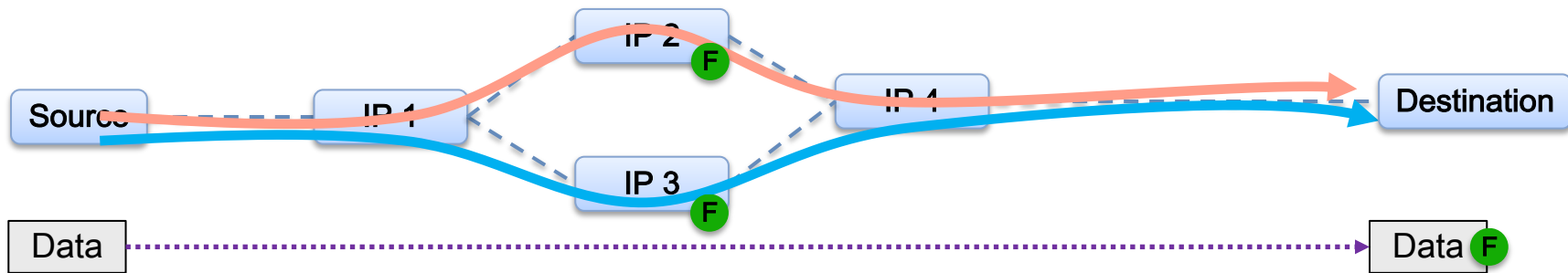
- **Which switch has done the changes?**
  - ▶ What was changed?
  - ▶ Who made the changes?
  - ▶ How synchronizing states?

- **How to authenticate packet modifications made by intermediate nodes?**

**ACE WG** (Authentication and Authorization for Constrained Environments)
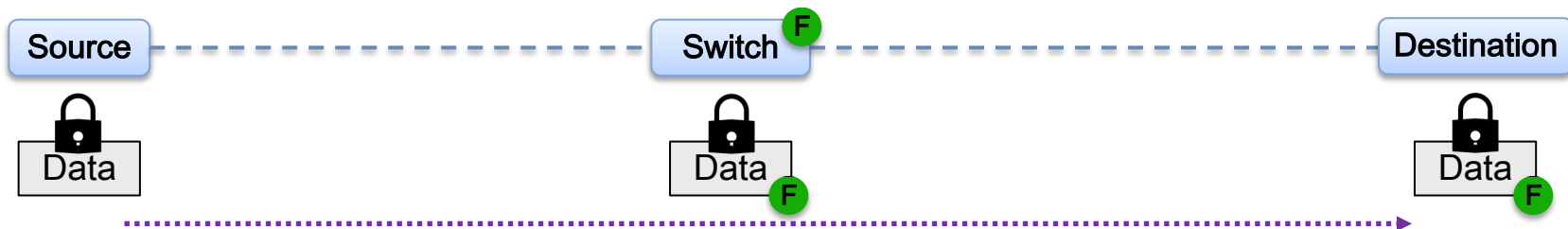
- **In-network processing currently working on plain text data**
  - ▶ Encrypted payload is an option that should not be ruled out
  - ▶ New transport protocols (eg. QUIC) encrypt headers & payload

- **How can in-network computing work on encrypted data?**
  - ▶ Decryption in intermediate nodes?
  - ▶ Option headers with payload for intermediate nodes? Possibly encrypted with session keys?
  - ▶ Homomorphic encryption?
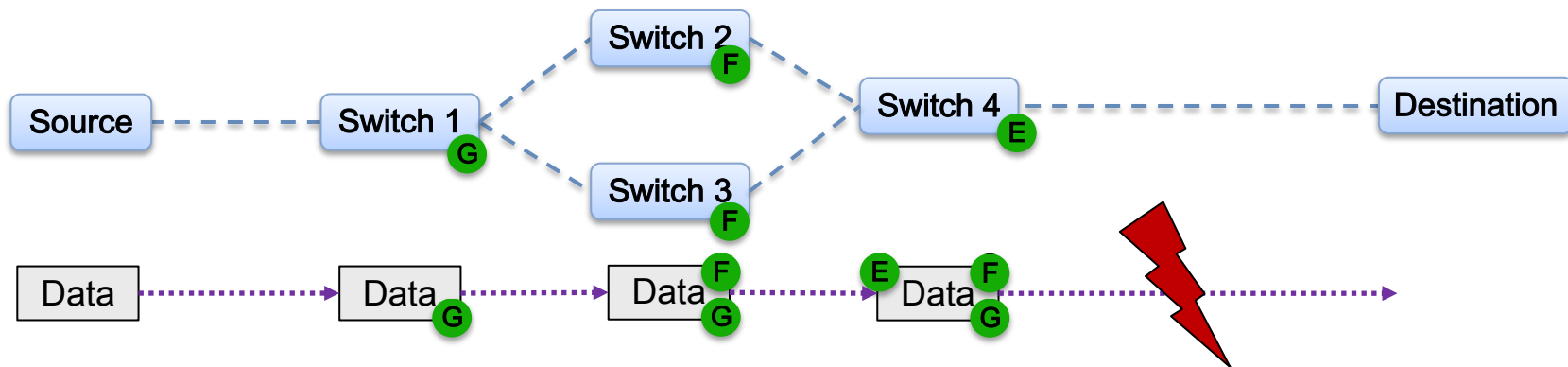
- **Who does the retransmission?**

  1. Sender
  2. Last successful position

- **How to deal with (changed) state in the intermediate nodes when packet is dropped later on the path?**

  ▶ Do we want the notion of a transaction that should be revocable?

**LOOPS BOF** (Local Optimizations on Path Segments)
- Local packet loss recovery

## Advanced Transport Features

- **Other features that cause similar questions of "who is in charge?"**
  - ▶ Congestion control
  - ▶ Flow control
  - ▶ Flow ordering/Sequence numbers

- **Different features impose different requirements**

- **Which set of transport features should be supported by COIN?**
  - ▶ Depends on application …

# Application Scenarios

- **Required transport feature set depends on application scenario**

## Datacenter

▶ Full control over network

▶ High load

▶ Reliable communication needed
  - Retransmissions
  - Congestion control

## Industrial networks

▶ Full control over network

▶ Low-latency communication

▶ Reliable communication needed
  - No retransmissions

## Internet

▶ Little to no control over the whole network

▶ Untrusted nodes involved

▶ Encrypted traffic

▶ Diverse application needs

# Conclusion

- **Solutions to the transport issues vital for the success of COIN**
  - ▶ One-fits-all solution unlikely
  - ▶ Highly application-specific requirements

- **Create awareness and consider expertise of other IETF/IRTF groups!**
  - ▶ Addressing: SPRING WG
  - ▶ Authentication: ACE WG
  - ▶ Retransmissions: LOOPS BOF
  - ▶ …

- **Goal until next meeting:**
  - ▶ Collect feedback on raised questions and suggest first transport solutions