Transport Issues of Computing in the Network

https://www.ietf.org/id/draft-kunze-coinrg-transport-issues-00.txt

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

- **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 loses 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?

- **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 $E-I_1-I_2-\ldots-I_n-E$ (End-to-Intermediate-to-Intermediate-to-Intermediate-\ldots-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

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
Flow Granularity

**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)
Authentication

- 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?
Advanced Transport Features - Retransmissions

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**

<table>
<thead>
<tr>
<th>Datacenter</th>
<th>Industrial networks</th>
<th>Internet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full control over network</td>
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<td>Little to no control over the whole network</td>
</tr>
<tr>
<td>High load</td>
<td>Low-latency communication</td>
<td>Untrusted nodes involved</td>
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<tr>
<td>Reliable communication needed</td>
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<td>Encrypted traffic</td>
</tr>
<tr>
<td>Retransmissions</td>
<td>No retransmissions</td>
<td>Diverse application needs</td>
</tr>
<tr>
<td>Congestion control</td>
<td></td>
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</tbody>
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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