Protocol Assisted Protocol (PAP)

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Motivation

- Protocol troubleshooting methods
  - Centralized data collection + SDN server analysis: SNMP, Netconf, BMP
    - Advantage:
      - Network-wide data view
      - facilitating automatic troubleshooting
    - Disadvantage:
      - Relying on the existence of a centralized SDN server
      - gh network resource consumption: bandwidth + CPU cost
      - Lack cross-domain information (out of management domain)
  - Distributed troubleshooting: Manual per-device login + CLI checking statistics/logs/alarms
    - Advantage:
      - Low network resource consumption
    - Disadvantage:
      - Lack network-wide view
      - Low efficiency for locating the issue
      - Requiring high NOC experience
  - Semi-centralized semi-distributive approach: convey diagnosing data using existing routing protocols
    - Advantage
      - Not relying on the existence of a centralized SDN server
    - Disadvantage
      - Requires persistent augmentation work to all routing protocols
      - Possible interop issues with legacy devices, affecting existing routing system

PAP (Protocol assisted Protocol)

- A new semi-distributive semi-centralized approach
  - A generic "tunnel" for exchanging troubleshooting data of various protocols
- PAP (Protocol assisted Protocol)
  - designed for devices to exchange protocol related information between each other
  - Separates routing and non-routing data
- Merits
  - Adds more network-wide data for individual device
  - Not relying on a centralized server
  - No data collection boundary in cross-domain environment
  - Relieves bandwidth/CPU pressure of centralized data collection/analysis
  - Facilitates automatic troubleshooting
  - No impact on existing routing system

Troubleshooting Use Cases

- BGP route oscillation
  - A PAP Request Message sent: "Are you the oscillation source?"
  - A PAP Reply Message sent: "I'm the oscillation source!"
  - or A PAP Reply Message sent: "I'm not the oscillation source!", with a further PAP Request Message sent: "Are you the oscillation source?"
  - …
  - Until someone replies with "I'm the oscillation source!"

- RSVP-TE set up failure
  - A PAP Notification Message "A link failure happens here!" sent from the failure device to the Ingress device.

PAP Messages

- PAP uses UDP as its transport protocol
  - UDP vs TCP: PAP designed for on-demand communications
  - Requires the assignment of a User Port registry for the UDP Destination Port
- PAP Message format
  - PAP common Header
  - Negotiation Message
  - Request Message
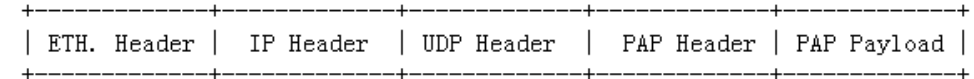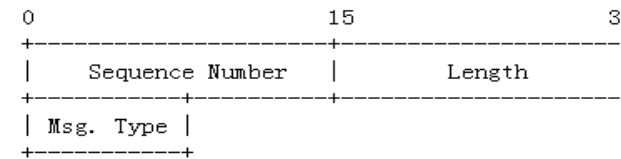 - Reply Message
  - Notification Message
  - ACK Message

```
+--------------+-------------+-------------+-------------+-------------+
| ETH. Header  |  IP Header  | UDP Header  | PAP Header  | PAP Payload |
+--------------+-------------+-------------+-------------+-------------+
```

Figure 1. Encapsulation in UDP

```
0                      15                      31
+-----------------------+-----------------------+
|   Sequence Number     |        Length         |
+-----------------------+-----------------------+
| Msg. Type |
+-----------+
```

Figure 2. PAP Common Header

```
0                      15                      31
+-----------------------+-----------------------+
|      Version      |A|C|      Reserved         |
+-----------------------+-----------------------+
|          Protocol Capability                  |
+-----------------------------------------------+
|          Optional Capability                  |
+-----------------------------------------------+
```
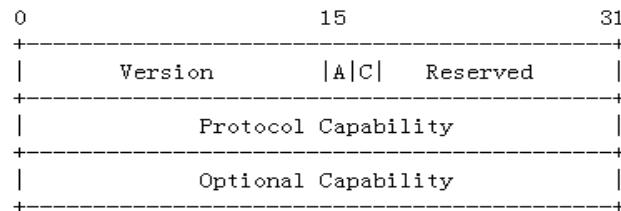
Figure 3. PAP Negotiation Message

```
0                      15                      31
+-----------------------+-----------------------+
|A|     Reserved        |
+-----------------------+
|             Capability                        |
+-----------------------------------------------+
|             Data Request                      |
+-----------------------------------------------+
```
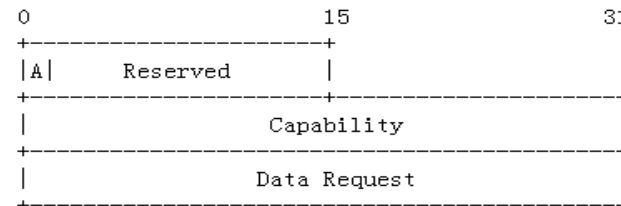
Figure 4. PAP Request Message

```
0                      15                      31
+-----------------------+
|A|     Reserved        |
+-----------------------+-----------------------+
|             Capability                        |
+-----------------------------------------------+
|             Data Reply                        |
+-----------------------------------------------+
```
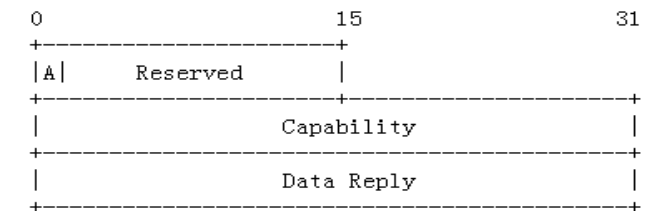
Figure 5. PAP Request Message

```
0                      15                      31
+-----------------------+
|A|     Reserved        |
+-----------------------+-----------------------+
|             Capability                        |
+-----------------------------------------------+
|             Data Nitification                 |
+-----------------------------------------------+
```

Figure 6. PAP Notification Message

```
0                      15                      31
+-----------------------------------------------+
|             ACK Sequence Number               |
+-----------------------------------------------+
```
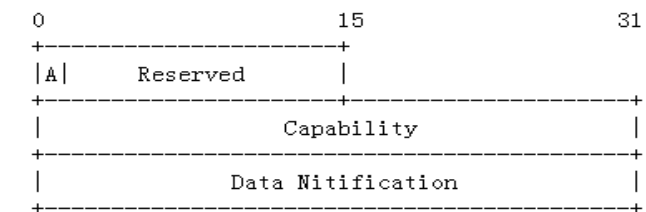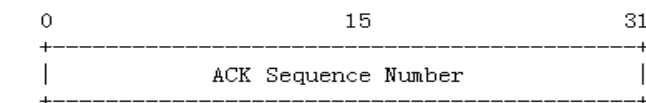
Figure 7. PAP ACK Message

PAP Operations

- Capability Negotiation Process
  - Exchange protocol capabilities between PAP speakers
  - Inform the remote PAP speakers of enabling/disabling local protocol capabilities

- Data Request and Reply Process
  - Request specific data from remote PAP speakers
  - Reply with requested data to requested PAP speakers

- Data Notification Process
  - Actively send notification information to remote PAP speakers

Questions and Comments?