Protocol for Carrying Authentication for Network Access (PANA)

(draft-ietf-pana-pana-00.txt)

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Contents

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- PAA Discovery
- Carrying EAP AVPs
- Creating a PANA SA
- ….

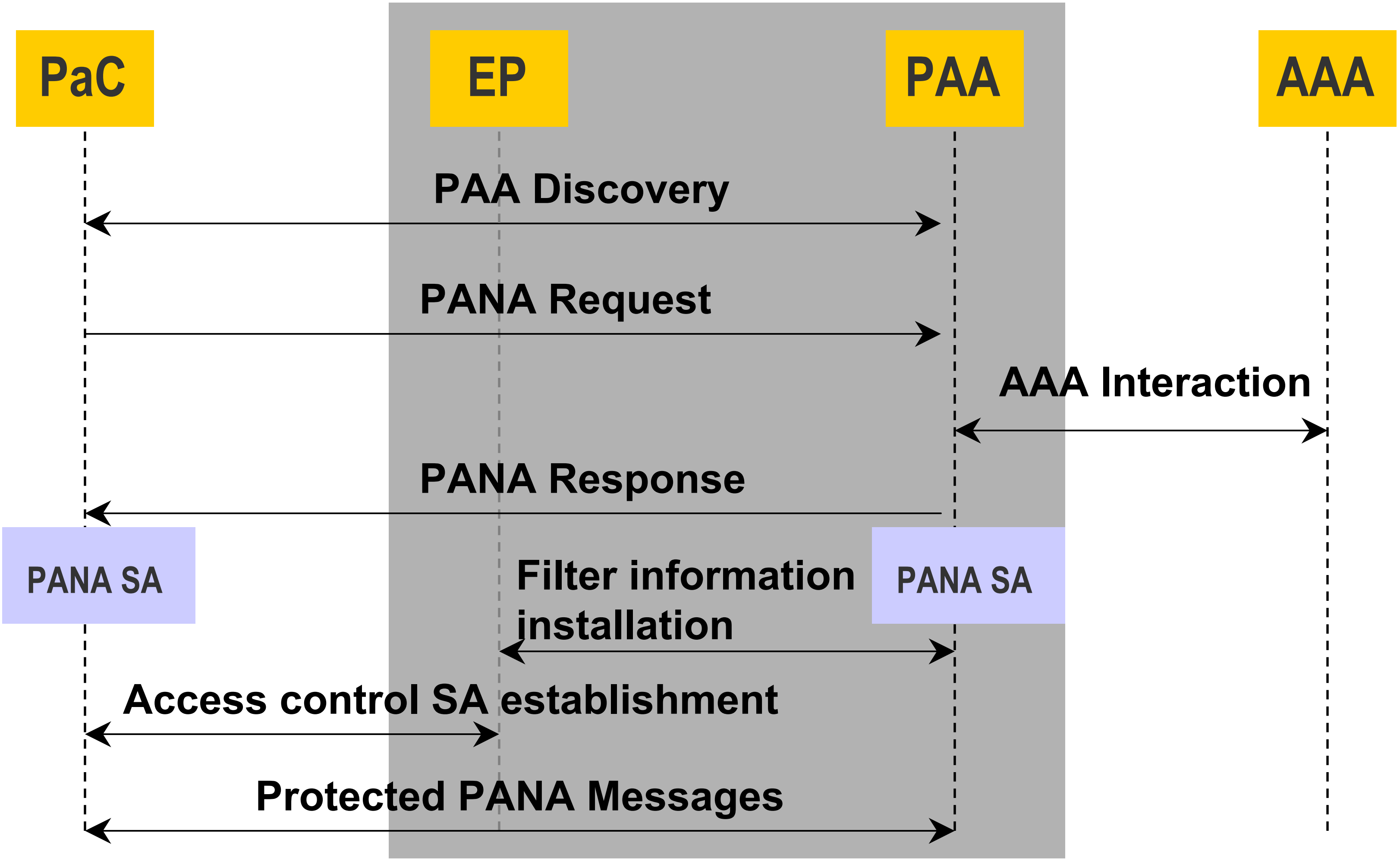
Producing the First Draft

- Design Team was established to work on initial proposal
- Work in progress:
  - Further discussions will be carried on the PANA ML

- Scope of the solution is bounded by:
  - `draft-ietf-pana-usage-scenarios-04.txt`
  - `draft-ietf-pana-threats-eval-02.txt`
  - `draft-ietf-pana-requirements-04.txt`

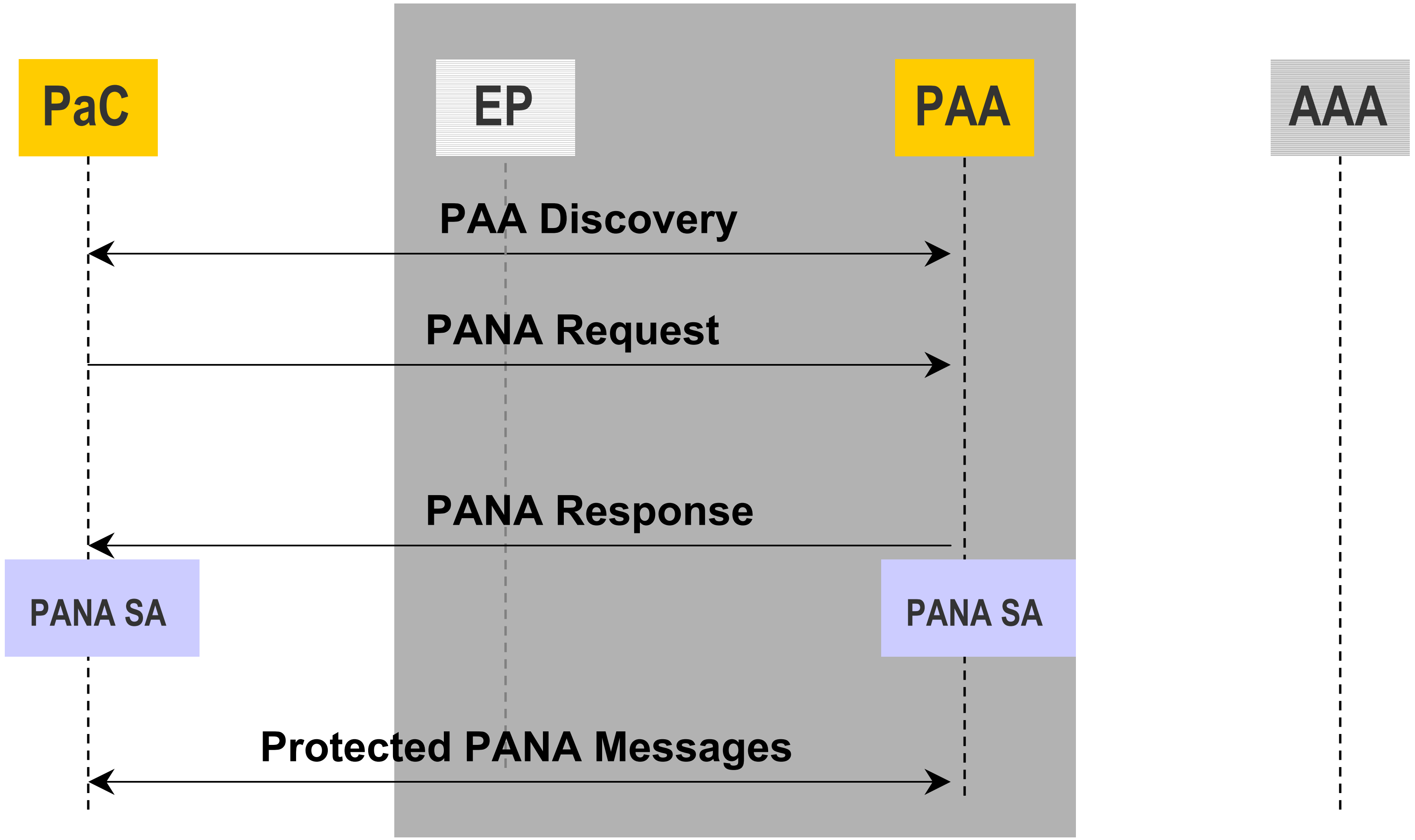
- Design team discussion archive available at:
  - **http://danforsberg.info/pipermail/pana-dt**
- Objective:
  - Satisfy the above requirements and scenarios by a simple protocol design
  - Various optimizations and enhancements left out for future consideration

Introduction: PANA Framework



Note: Some protocol interactions are optional.

Introduction: PANA Protocol



Interaction of PANA with the other protocols needs to be analyzed.

What was learned from the Usage Scenarios?

- PANA can be used in

  1. Environments with physical layer security
  2. Environments with link layer security
  3. Environments where no lower security is available

- Scenario (3) is the most difficult one for PANA deployment and adding the most requirements

- It is difficult to support all scenarios with a single protocol. Hence some protocol steps have to be optional.

- Multiple Authentication and Key Exchange methods should be supported $\Rightarrow$ EAP

Assumptions

- **Topology Knowledge**

  Device Identifier information can be installed at the correct devices

- **Device Identifier Installation**

  Security provided by DI installation is sufficient for some environments. Otherwise, DI is accompanied by cryptographic keys.

- **Disconnect Indication**

  Link layer disconnect indication cannot be assumed

- **Session Key Establishment**

  Session key needs to be available for PANA SA

Note: Some assumptions will be explained in more details in subsequent slides.

PAA Discovery (1/2)

- **Why?**
  - To discover the PAA's address dynamically .
- **How?**
  - 1a) (Link local) multicast UDP packet from PaC.
  - 1b) PaC sends data packets.
    - EP sends a **`PANA_discover`** message to PAA, which contains PaC's unicast address.
  - PAA sends **`PANA_start`** to PaC.

PAA Discovery (2/2)

- **Threats?**
  - Man-in-the-Middle between PaC and PAA.
  - DoS against PAA, DoS against PaC.
- **Countermeasures?**
  - Difficult since message exchange between neighboring nodes.
    - hop limit check
  - Goal:
    - Prevent off-path attacks (Cookie, Sequence numbers)
    - Prevent memory allocation with single message (Cookie)

Initial Sequence Number and Cookie

- Initial Sequence Number (ISN) mechanism is used to prevent blind DoS and off-path attacks.
- Cookie mechanism is used to prevent non-blind DoS attack.
  - Cookie is sent from PAA in **`PANA_start`** message, but does not create any state in PAA that would enable DoS attack.
  - Cookie is implementation specific
- Message Flow

```
   PaC         PAA        Message(tseq,rseq)[AVPs]
   ----------------------------------------------------
1)  ------------>         PANA_discover(0,0)
2)  <------------         PANA_start(x,0)[Cookie]
3)  ------------>         PANA_start(y,x)[Cookie]
                          (continued to authentication phase)
```

Carrying EAP over PANA

- **Why?**
  - Authentication and authorization required for network access procedures
- **How?**
  - EAP is payload of PANA (carried in **EAP AVP**)
- **Threats?**
  - MITM (injecting, modifying etc.); DoS; Eavesdropping
- **Countermeasures?**
  - Use an appropriate EAP method depending on the security requirements
  - Difficult to prevent all attacks until PANA SA is established

Carrying EAP over PANA
Transport Protocol Properties

- EAP requires ordered message delivery
  - EAP provides its own reliability and does not require the transport to be reliable

- EAP recommends EAP methods to provide message fragmentation
  - EAP TLS and PEAP support fragmentation, for example

- EAP supports retransmission for EAP Requests
  - Retransmission timeout calculation based on RFC2988 takes congestion control into account

Carrying EAP over PANA
Approach chosen by PANA

- PANA does not provide fragmentation.
  - Use EAP method fragmentation for EAP messages
  - Use IP fragmentation for other messages
- PANA provides:
  - Ordered delivery of EAP messages on top of UDP
  - Protection of PANA PDU after PANA SA is established

Carrying EAP over PANA
Sequence number handling(1/3)

- Why sequence number?
  - To provide ordered delivery of messages
  - Robustness against blind DoS attack is needed
- Considered approaches:
  - Single sequence number with PANA-layer retransmission
  - Dual sequence number with orderly-delivery
  - Dual sequence number with reliable-delivery
- Selected approach: **Dual sequence number with orderly-delivery**
  - Reason:
    - The 1st approach assumes 'lock step' messaging for all messages (EAP Success/Failure is not lock-step safe)
    - The 3rd approach is not simpler than the 2nd one
- Appendix in the draft provides detailed explanation

Carrying EAP over PANA
Sequence number handling(2/3)

- Following sequence numbers are included in PANA header
  - Transmitted sequence number (**tseq**)
  - Received sequence number (**rseq**)
- **tseq** starts from initial sequence number and is incremented by 1 when sending a message (even it is retransmitted)
- **rseq** is copied from the **tseq** field of the last accepted message
- When a message is received, it is valid (in terms of sequence #) if
  - Its tseq > tseq of the last accepted message, AND
  - Its rseq falls in the range

    [tseq of the last ack'ed msg+1,tseq of the last transmitted msg]

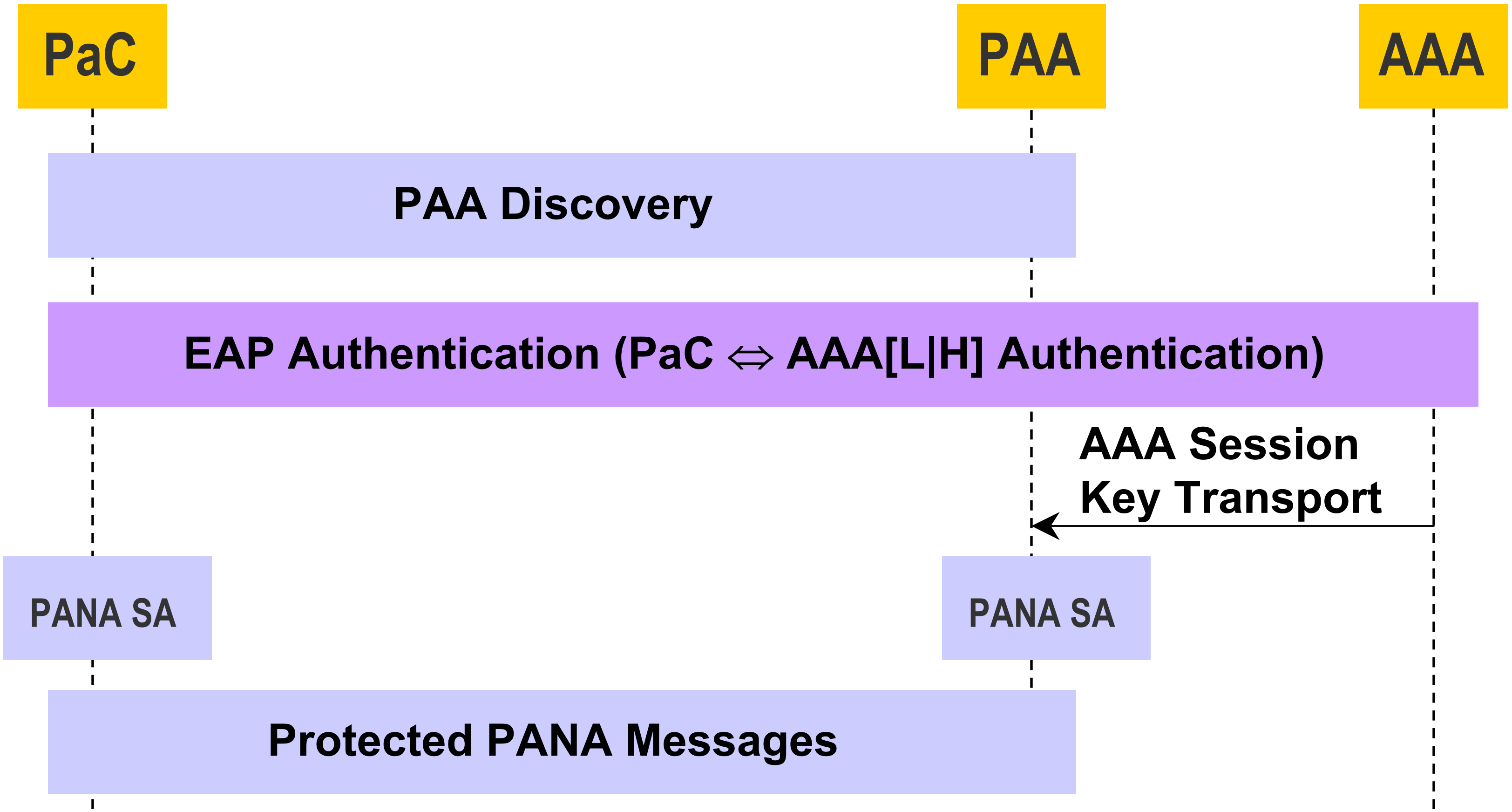
Carrying EAP over PANA
Sequence number handling (3/3)

```
   PaC       PAA  Message(tseq,rseq)[AVPs]
-----------------------------------------------
                  (continued from discovery and initial handshake phase)
     <-----       PANA_auth(x+1,y)[EAP{Request}]
     ----->       PANA_auth(y+1,x+1)[EAP{Response}]
       .
       .
     <-----       PANA_auth(x+2,y+1)[EAP{Request}]
     ----->       PANA_auth(y+2,x+2)[EAP{Response}]
     <-----       PANA_success(x+3,y+2)                // F-flag set
                    [EAP{Success}, Device-Id, Data-Protection, MAC]
     ----->       PANA_success_ack(y+3,x+3)
                    [Device-Id, MAC]                  // F-flag set
```

PANA SA Establishment

- **Why?**
  - Protect subsequently exchanged PANA messages
    - E.g.: re-auth, disconnect
  - Bootstrap L2 or L3 access control, when needed
- **How?**
  - Key derived from EAP method; No algorithm negotiation
- **Threats?**
  - MITM - weak EAP methods
- **Countermeasures?**
  - Mutual authentication within EAP method
  - Weak EAP methods $\Rightarrow$ see next slides

PANA SA Establishment



PANA relies on EAP methods to produce keying material for PANA SA.

PANA SA Establishment

- EAP method must provide session key for PANA SA
- There is no secure tunnel established between the PaC and the PAA (e.g. via ISAKMP or TLS) outside EAP!

EAP Method Choice

- PANA can carry any EAP authentication method
- It is the responsibility of the user and the network operator to pick the right method, depending on the environment
  - key derivation
  - mutual authentication
  - DoS resiliency
- PANA does not enable weak methods in insecure environments (a non-goal!)
  - PANA does not create a secure channel for them
  - PANA can carry EAP-tunneling methods (PEAP, EAP-TTLS)
    - Risk: MitM, needs to be fixed (not in PANA WG!)

Device ID Choice

- PaC will configure an IP address before PANA if it can
  - Network policy: EP might detect PaC's attempts and trigger PANA first
- DI is either a link-layer address, or IP address
  - IP address: when PaC can configure one prior to PANA and IPsec is used for access control.
  - Link-layer address: otherwise.

Filter Rule Installation

- PANA protocol helps identifying who should gain access
- PAA helps EP build filters based on PANA results
- When PAA and EP are separated, a protocol is needed
  - This is not “PANA protocol”
  - PANA WG will “identify” at least one such protocol
  - MIDCOM WG’s output might be useful

Device Identifier Exchange

- **How?**
  - Key derived from EAP method; No algorithm negotiation
- **Why?**
  - By installing this device identifier unauthorized nodes are not able to inject packets.
- **Threats?**
  - MITM (injecting, modifying, etc.); DoS
  - IP spoofing; DI reuse (e.g. after roaming)
- **Countermeasures?**
  - Exchange data origin authenticated, replay and integrity protected with PANA SA
  - IP Spoofing and DI => see next slides

Triggering a data protection protocol

- **Why?**
  - Spoofing attacks on shared links cannot be prevented by device ID based packet filters. Cryptographic protection needed.

- **How?**
  - PAA can signal if L2 or L3 ciphering should be initiated after PANA.
  - EAP established session key is indirectly used as an input to enforce link or network layer protection.
  - PANA can help bootstrap link-layer/network-layer ciphering

Re-authentication (1/3)

- **Why?**
  - Lower-layer disconnect indication is not always available
  - Garbage collection and stop of accounting required
  - Prevent DI spoofing and resulting service theft after disconnect (e.g. due to roaming)

- **How?**
  - Soft-state principle
  - Two types of re-authentication supported by PANA
    - Re-authentication based on **EAP**
    - Re-authentication based on **PANA_reauth/PANA_reauth_ack** exchange
  - Both PaC and PAA can initiate re-authentication

Re-authentication (2/3)

- **Threats?**
  - Spoofing re-authentication messages
- **Countermeasures?**
  - Protection by PANA SA
  - Limit re-authentication rate in implementation

Re-authentication (3/3)
Message Flow

```
PaC      PAA     Message(tseq,rseq)[AVPs]
  ------------------------------------------------------
     ----->          PANA_reauth(q,p)[MAC]
     <-----          PANA_reauth_ack(p+1,q)[MAC]
```

Example Sequence for PaC-initiated Quick Re-authentication

```
PaC      PAA     Message(tseq,rseq)[AVPs]
------------------------------------------------------
   <-----          PANA_reauth(p,q)[MAC]
   ----->          PANA_reauth_ack(q+1,p)[MAC]
```

Example Sequence for PAA-initiated Quick Re-authentication

PANA session termination (1/2)

- **Why?**
  - PaC $\Rightarrow$ PAA: Stop of accounting or finish network access
  - PAA $\Rightarrow$ PaC: Many reasons (e.g. insufficient funds)
- **How?**
  - PANA message sent by PaC (disconnect indication)
  - PANA message sent by PAA (session revocation)
    - Revocation reason is included in **Revocation-Status AVP**
- **Threats?**
  - Adversary injecting a termination message (DoS)
- **Countermeasures?**
  - Protection by PANA SA

PANA session termination (2/2) Message Flow

```
PaC       PAA     Message(tseq,rseq)[AVPs]
  ------------------------------------------------------
     ----->          PANA_disconnect(q,p)[MAC]
     <-----          PANA_disconnect_ack(p+1,q)[MAC]
```

Example Sequence for <u>Disconnect Indication</u>

```
  PaC       PAA     Message(tseq,rseq)[AVPs]
  ------------------------------------------------------
     <-----          PANA_revocation(p,q)[Revocation-Status,MAC]
     ----->          PANA_revocation_ack(q+1,p)[MAC]
```

Example Sequence for <u>Session Revocation</u>

Open Issues and Next Steps

- **Discuss some open issues**
  - Flexibility of Device Identifier
  - Updating a device identifier
  - Session Identifier
  - Key derivation
  - Sequencing EAP methods
  - Integrity protection offered by PANA SA sufficient?
  - Re-authentication lifetime negotiation
  - Flow/Congestion Control
- **Next steps**
  - Improve draft
  - Define message formats

Backup Slides

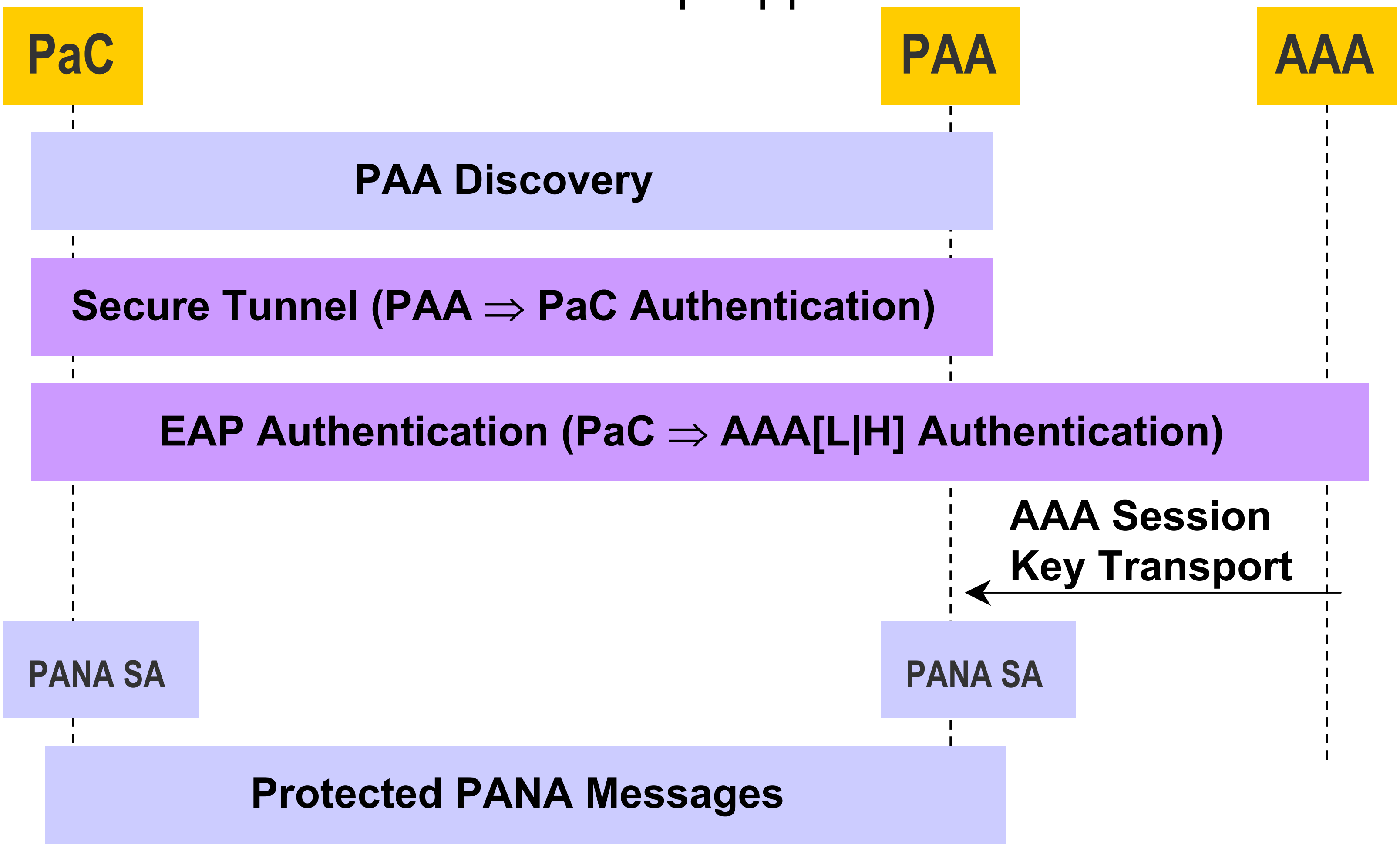
Sequencing of EAP methods

- **Why?**
  - Some scenarios require more sequencing of EAP methods
- **How?**
  - Multiple EAPs performed in a single PANA session
    - Each EAP is delimited with **PANA_success/failure**
    - **PANA_success/failure** has **F-flag** to indicate final exchange.

Sequencing of EAP methods Message Flow

```
   PaC      PAA  Message[AVPs]
-------------------------------------------------
                 (continued from discovery and initial handshake phase)
// First EAP run for NAP authentication
      <-----     PANA_auth[EAP{Request}]
      ----->     PANA_auth[EAP{Response}]
        .
      <-----     PANA_success[EAP{Success},MAC]       // F-flag not set
      ----->     PANA_success_ack[Device-ID, MAC]     // F-flag not set
// Second EAP run for ISP authentication
      <-----     PANA_auth[EAP{Request},MAC]
      ----->     PANA_auth[EAP{Response},MAC]
        .
      <-----     PANA_success[EAP{Success}, MAC]      // F-flag set
      ----->     PANA_success_ack[MAC]                // F-flag set
```

Two-Step Approach



Session key for PANA SA is a combination of two AKA steps.