Man-in-the-middle in Tunnelled Authentication

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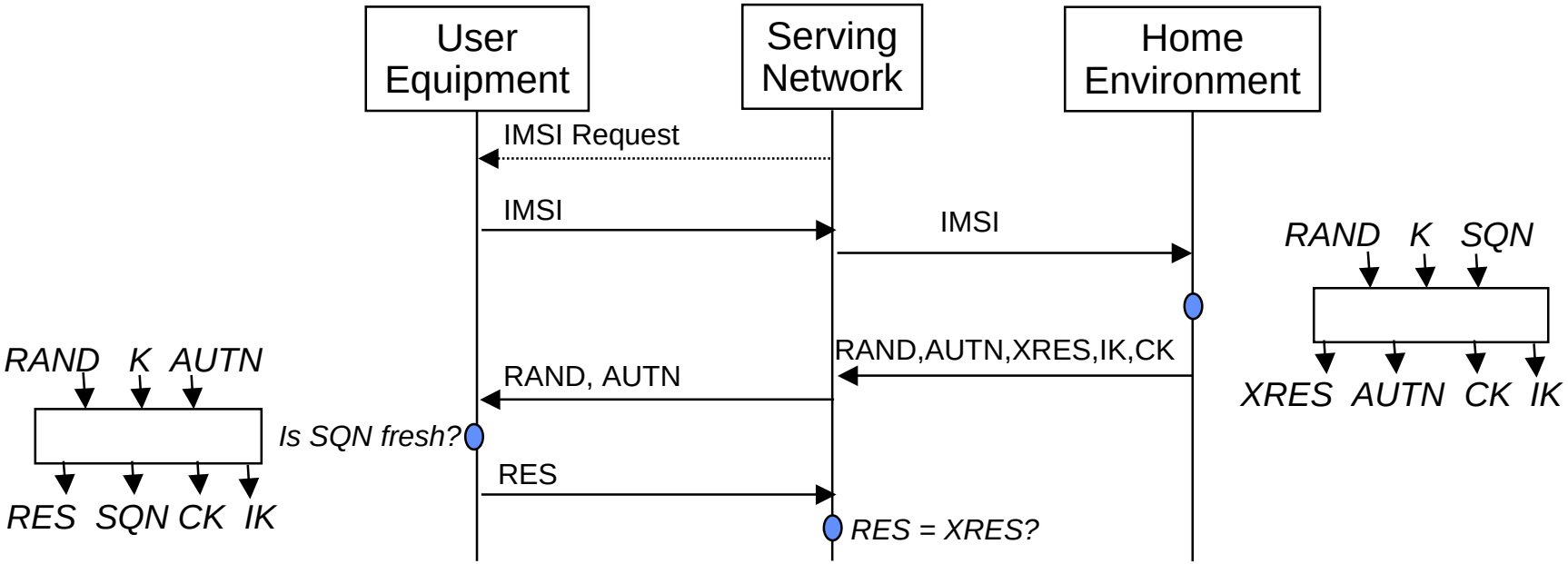
A tale of two protocols

- In the beginning..
  - an authentication method is designed and deployed for some need
  - user credentials are provisioned, at great expense
- ..then a framework protocol is developed;
  - to transparently support multiple authentication methods
  - authentication methods are plugged in to the framework
- .. new applications arise; framework doesn't quite do the job
  - missing bits: session keys, mutual authentication, identity privacy
  - designing a new protocol is not a desirable option
  - provisioning new credentials is even less desirable

➢ Use it with another protocol that provides missing features

AKA and EAP/AKA: example authentication protocol

- AKA: authentication and key agreement protocol for 3GPP
  - mutual authentication, session key derivation



- EAP: an authentication framework
  - supports multiple authentication mechanisms
- EAP/AKA: plugging AKA into EAP
  - allows WLAN access authentication using cellular credentials

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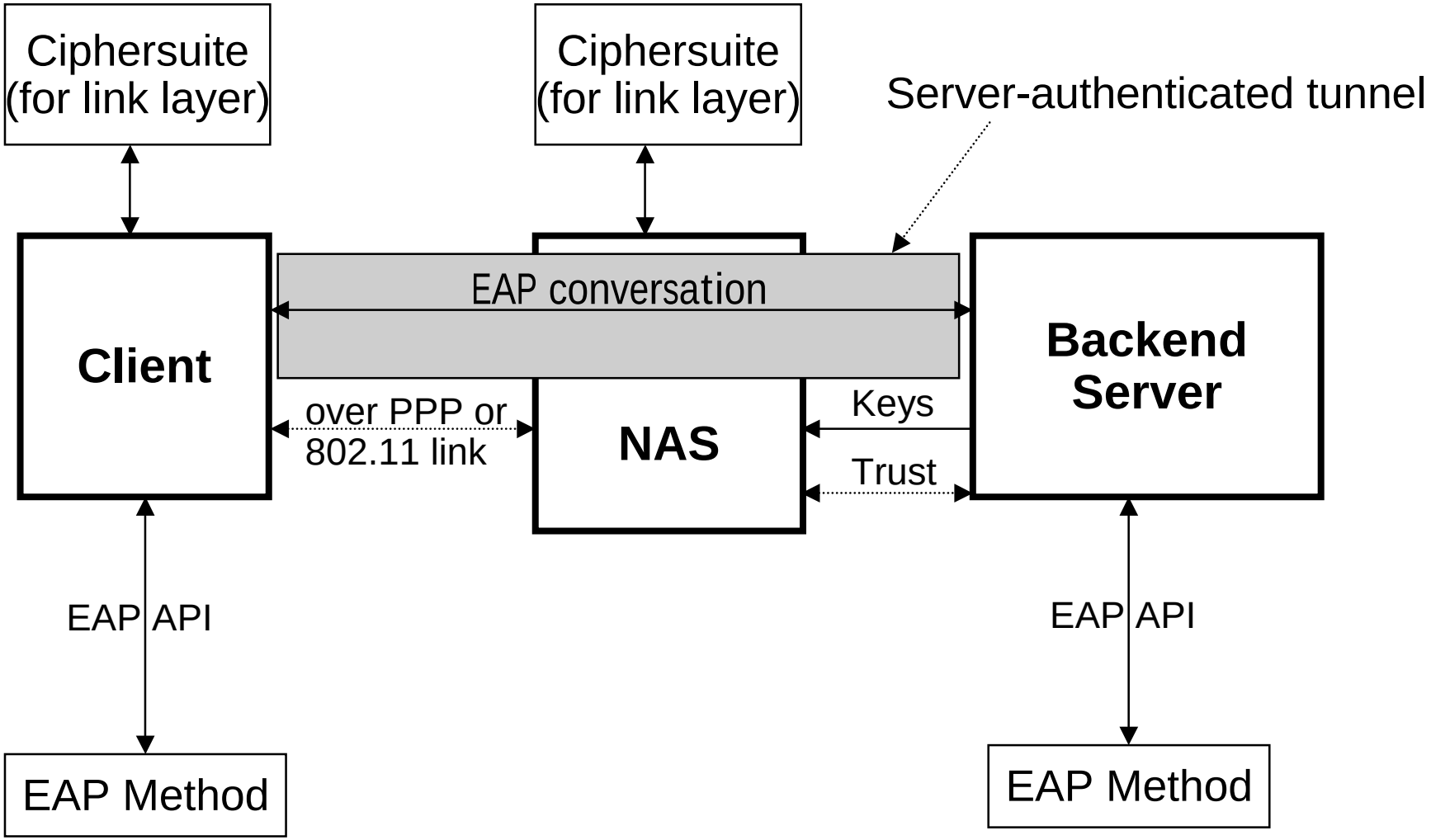
PEAP: example of tunnelled authentication



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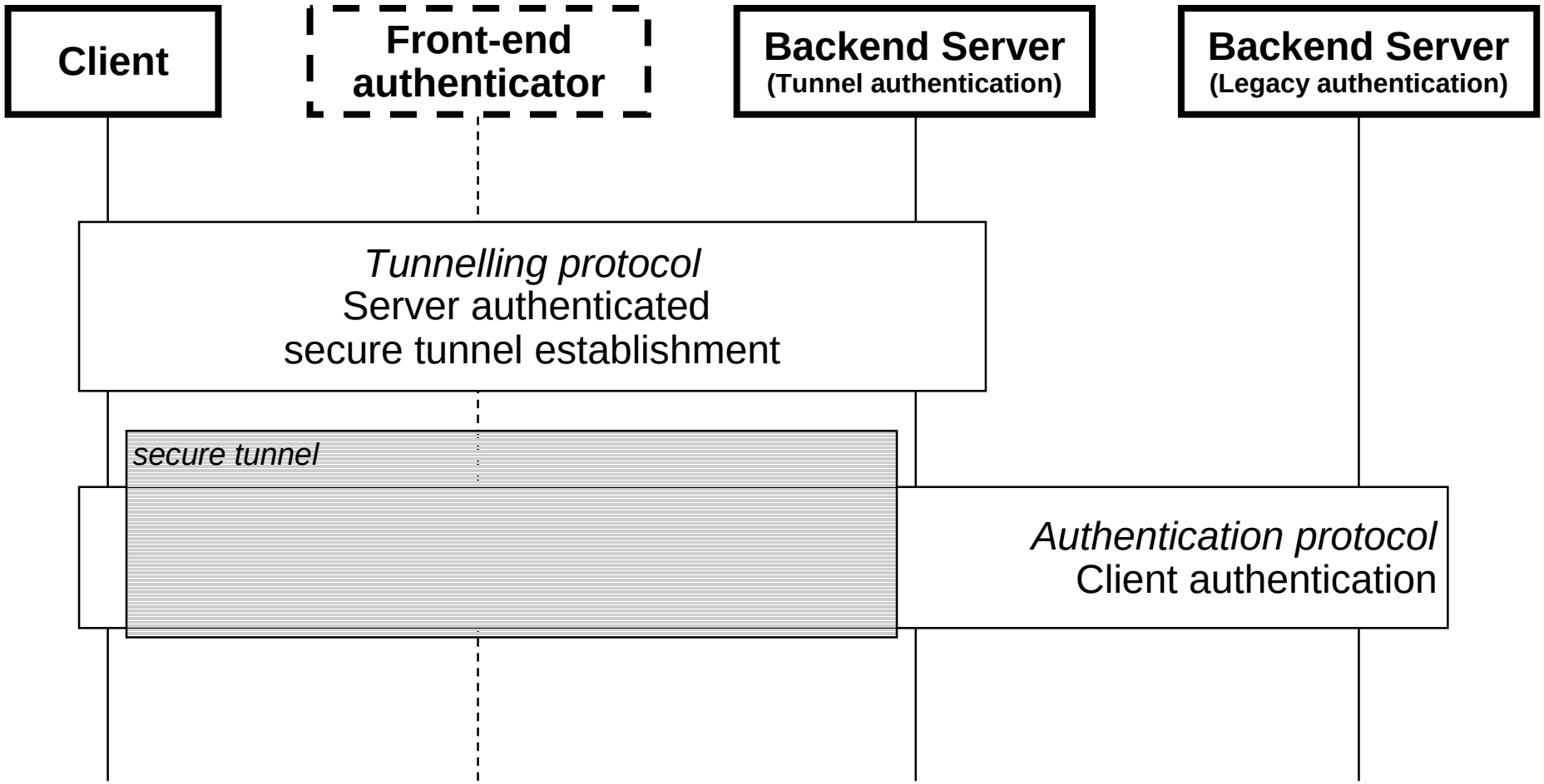
Tunnelled authentication



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The same tale in different guises

- PIC - ISAKMP and EAP: provisioning credentials based on legacy authentication
- IKEv2 Secure Legacy Authentication
- PANA over TLS: Authentication for Network Access
- HTTP Digest Authentication and TLS

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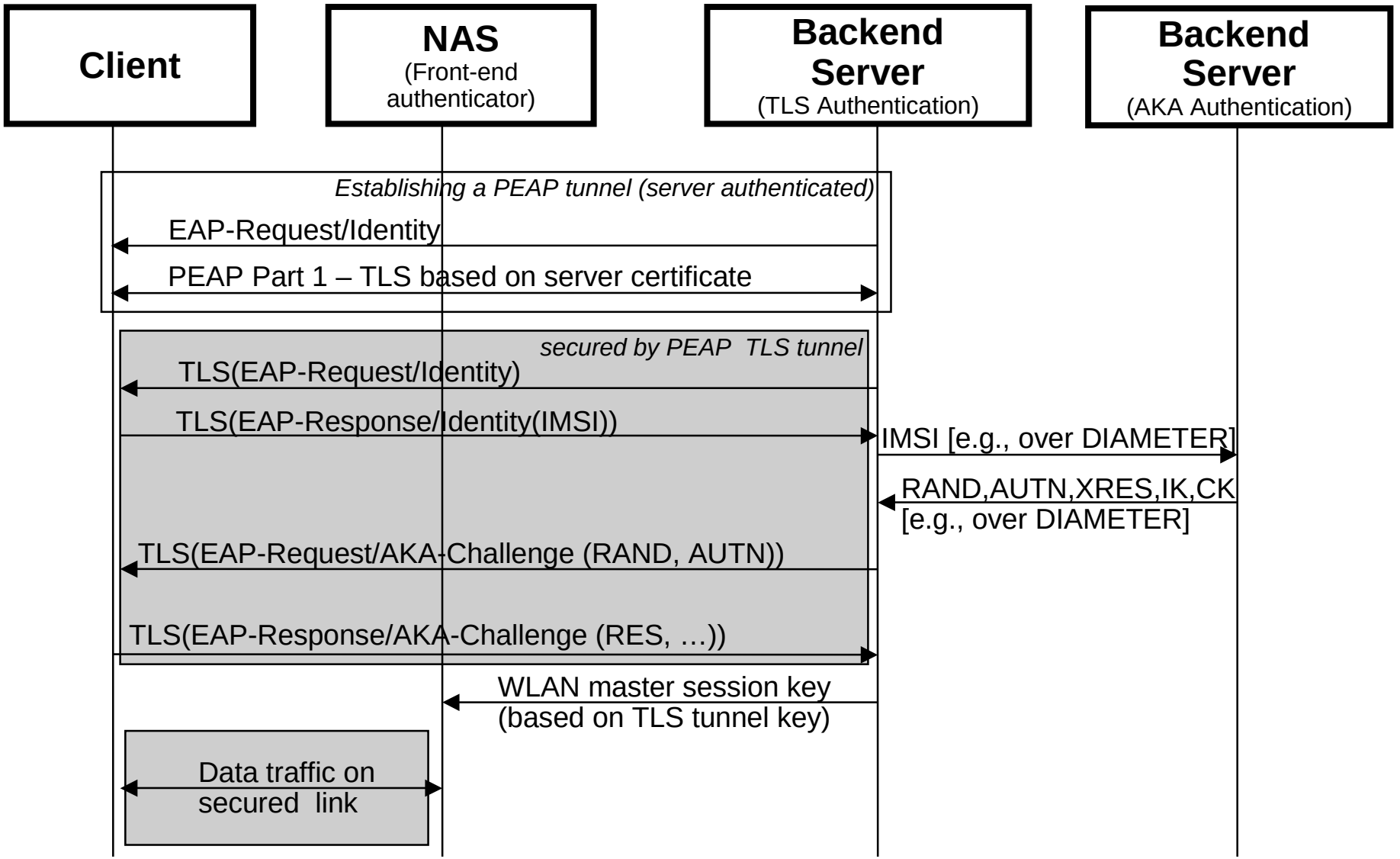
PEAP with EAP/AKA



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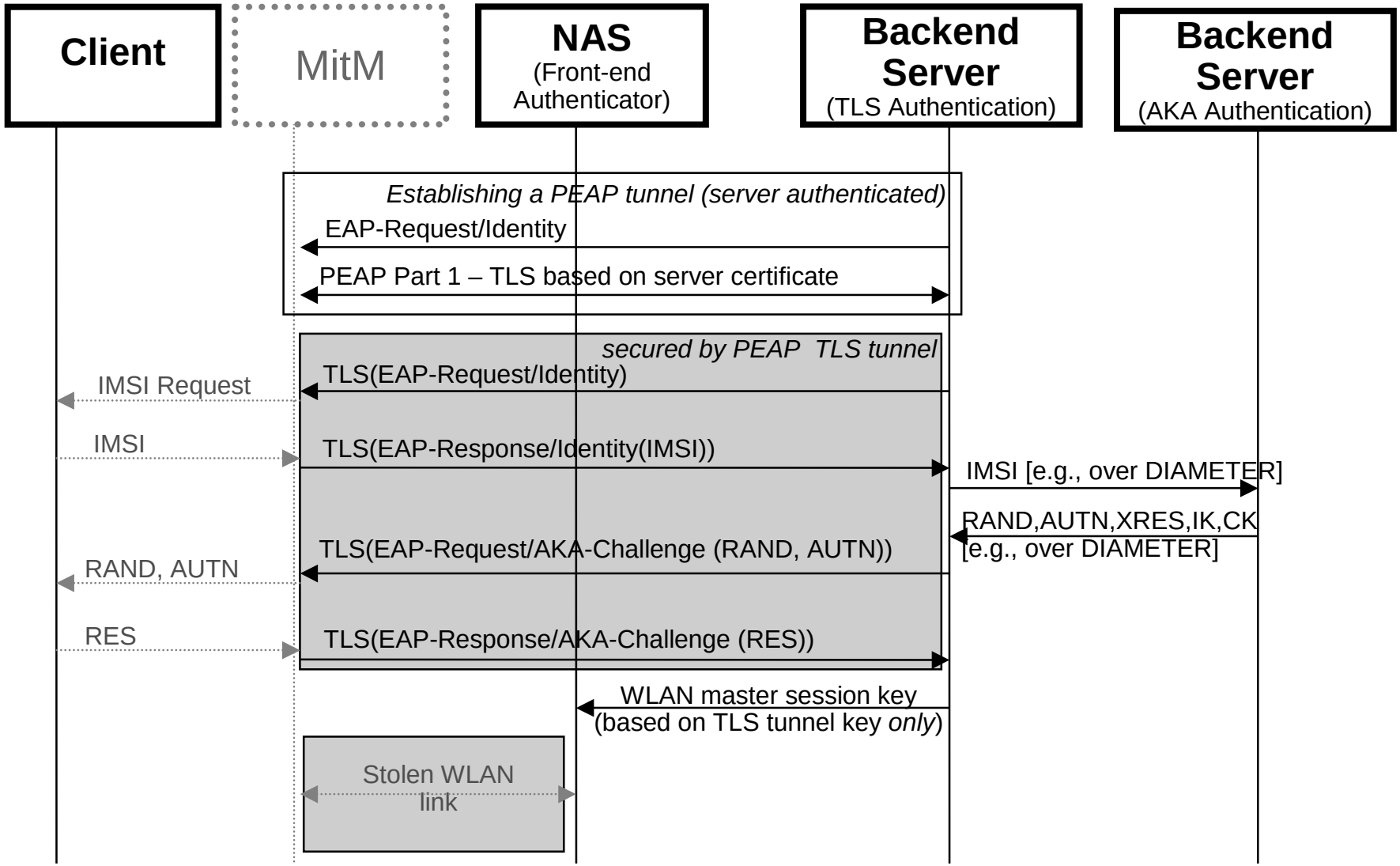
MitM against PEAP+EAP/AKA



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Conditions for failure

1. Same credential used in both tunnelled & untunnelled modes
2. Tunnelling protocol does not perform mutual authentication
3. Keys from authentication protocol not used for subsequent protection

Fixing the problem

1. Enforcing that same credential is not used in both modes
   - maybe feasible in some cases
   - not exactly “legacy authentication” anymore
   - server authentication brings in new problems
   - unnecessary restriction on strong authentication methods
2. Require mutual authentication in tunnelling protocol
   - if that is possible, no need for tunnelling in the first place
3. Cryptographically bind tunnelling and authentication protocol
   - binding can be explicit or implicit
   - requires authentication protocol to provide a key to be used in binding
   - requires changes to tunnelling protocol or framework
   - does not improve the security of weak authentication protocols

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Current status

- Some authors of tunnel proposals informed in October 2002
- General agreement that this is indeed a problem
  - opinions differ on what the solution should be
- Subsequent changes to several proposals to reduce the impact of the problem
  - EAP/AKA (v-05)
  - PEAP (v-06)
  - IKEv2 (v-05)
  - PANA over TLS (v-01) → PANA (v-00)
  - EAP SIM GMM → EAP binding
  - ...

Are there any lessons here?

- This is all obvious, at least in hindsight
- So why did it happen?
  - re-use of credentials is unavoidable in practice
  - re-use of protocols is also unavoidable in practice
  - framework equalizes all authentication methods
    - mutual authentication, key agreement etc. not visible
  - tools for/knowledge of protocol validation not accessible to designers