Extensions to EAP Keying hierarchy for Efficient Re-authentication and Visited domain Keying

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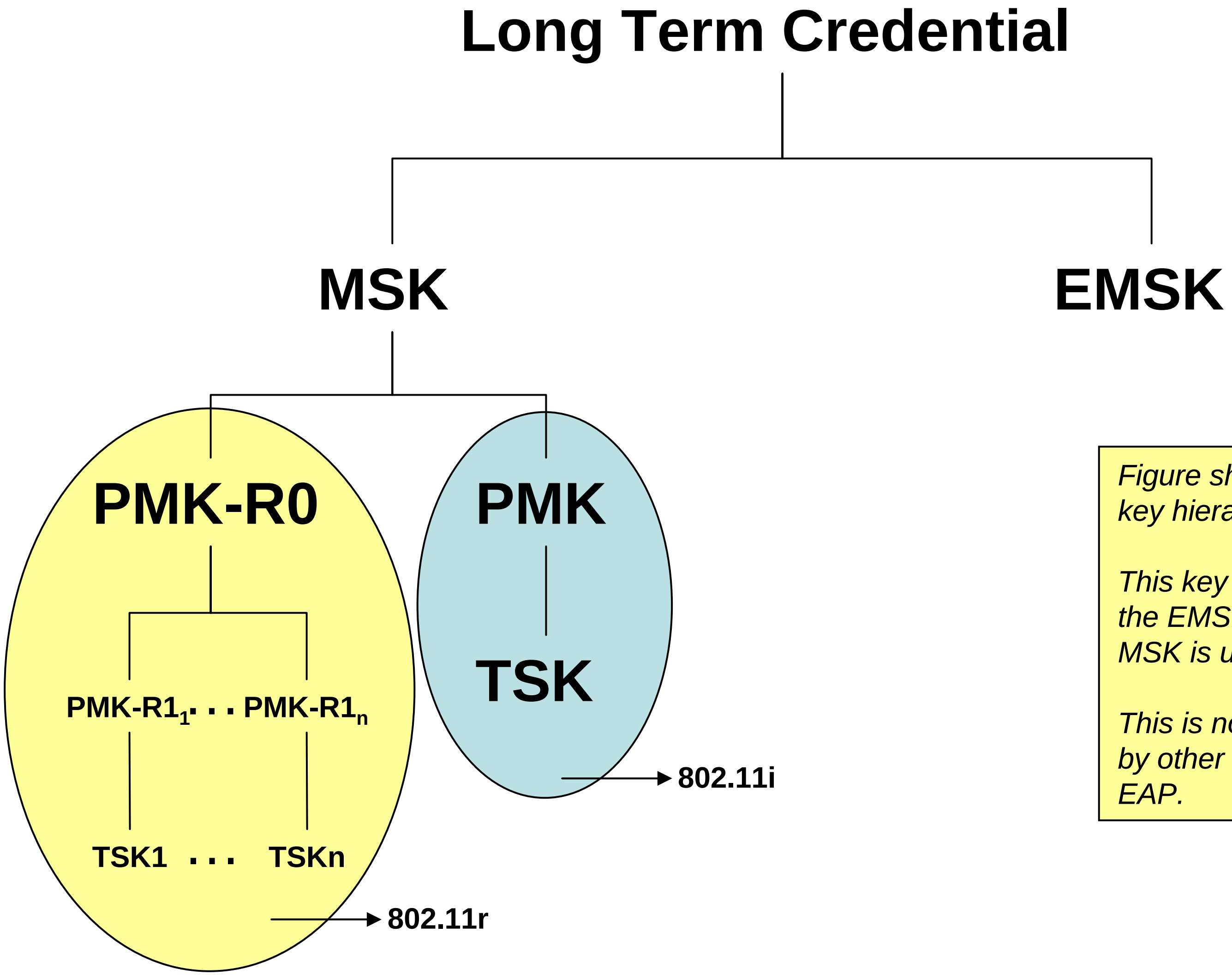
EAP keying hierarchy: 802.11i, r



Long Term Credential

MSK

EMSK

PMK-R0

PMK

TSK

PMK-R1$_1$ . . . PMK-R1$_n$

TSK1 . . . TSKn

802.11i

802.11r

Figure shows the existing 802.11r key hierarchy

This key hierarchy does not use the EMSK; the second half of the MSK is used to derive the R0-Key

This is not a universal model used by other architectures employing EAP.

Low Latency Re-authentication Requirements

- It is unacceptable to have to go back to the home domain upon every handoff in a visited domain
  - Access to AAAH may be through one or more AAA proxies

- A single roundtrip protocol that can result in fresh keying material for new points of attachment is desirable
  - The protocol must be executable with the visited domain
  - The resulting key material should be as strong as in the first full authentication case

- The protocol must be EAP method independent
  - Makes executing with the visited domain possible
    - Method specific operation limited to nodes and their home domain

- Ideally, the protocol should be executable in parallel with connection establishment
  - Security becomes undesirable when any latency or overhead is added to the critical path ☺

EAP Extensions – Constraints

- We don’t quite have a free hand in designing EAP extensions
  - To some extent, we must design around the current designs and usage models of EAP
- MSK cannot be used for new keying material
  - Usage of MSK disparate over different lower layers
- EAP authenticators and visited domain entities must not be required to support EAP methods
- The key delivery semantics from re-authentication must be similar to MSK delivery
  - Lower layers must be able to use the key for the same purpose as the MSK (e.g., for TSK derivation)

Root key selection

- MSK is delivered to the authenticator
- MSK is used differently by different lower layers and protocols
  - IKEv2 uses it for entity authentication
  - 802 lower layers use it for TSK generation
    - 802.11i uses the first 16B and 11r uses the rest
    - 802.16e uses 40B or 20B of the MSK
- Conclusion: use the EMSK hierarchy
  - For lower-layer independence
  - To avoid changing MSK delivery and usage semantics

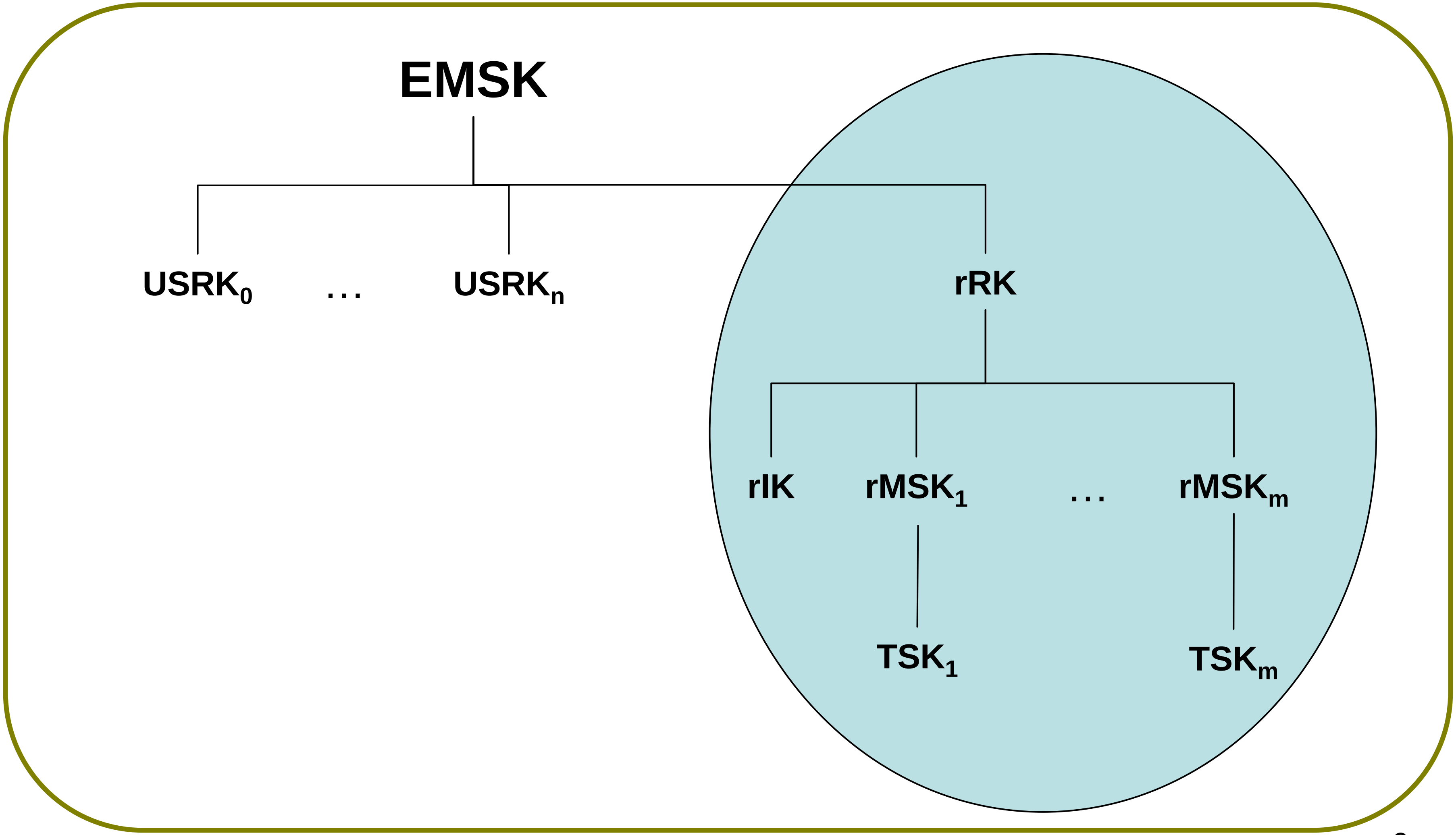
Solution requirements

- Method-independent protocol for efficient re-authentication
  - Access agnostic; can be used for inter-technology handoffs
  - Proof of possession of key material of an earlier authentication
  - Visited-domain EAP-ER capability
  - Preferably a single roundtrip re-authentication protocol
- Key Generation in EAP-ER
  - EMSK-based hierarchy defined for this purpose
    - MSK cannot be used for this in an access-agnostic manner
  - Re-authentication MSKs (rMSK)
    - Serves the same purpose as an MSK
  - Visited Domain Keying hierarchy
    - V-rMSKs derived from this hierarchy for re-authentication in a visited domain

Requirements on EAP keying hierarchy

- Need a root-key or USRK for EAP-ER
  - re-authentication Root Key (rRK, derived from EMSK)
- A key to prove being a party to the full EAP method-based authentication
  - This is used in a proof of possession exchange between the peer and the server
    - A re-authentication Integrity Key (rIK, derived from the rRK)
- A new MSK specific to each authenticator that the peer associates with
  - A re-authentication MSK (rMSK1, rMSK2, …)
  - Derived from the rRK

Re-auth key hierarchy for home domain



Key derivation

- rRK = prf+ (K, S), where,
  - K = EMSK and
  - S = rRK Label
    - (“EAP Re-authentication Root Key”)

- rRK_name = NDF-64(EAP Session-ID, rRK Label)

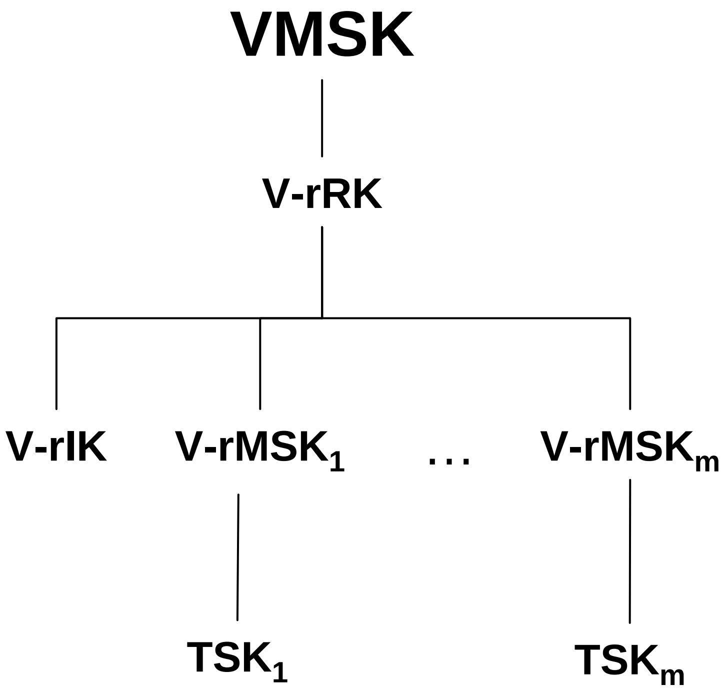
- rIK = prf+ (rRK, "Re-authentication Integrity Key")

- rIK_name = prf-64 (rRK, "rIK Name")

Visited domain requirements on the EAP keying hierarchy

- Need a USRK, visited-domain root key (VRK) for visited domain keying purposes
  - This is to be maintained at the peer and the home EAP server
- Each visited-domain needs a root key to manage domain specific keying requirements
  - A Visited-domain Master Session Key (VMSK) per domain is derived and delivered by the home EAP server
    - Each VMSK is held by the visited-domain EAP server and the peer
- The rest of the key hierarchy is similar to EMSK hierachy
  - A V-rRK maps to the rRK
  - V-rIK maps to the rIK
  - V-rMSKi maps to rMSKi

Visited Domain Re-authentication Key Hierarchy



VMSK

V-rRK

V-rIK

V-rMSK$_1$

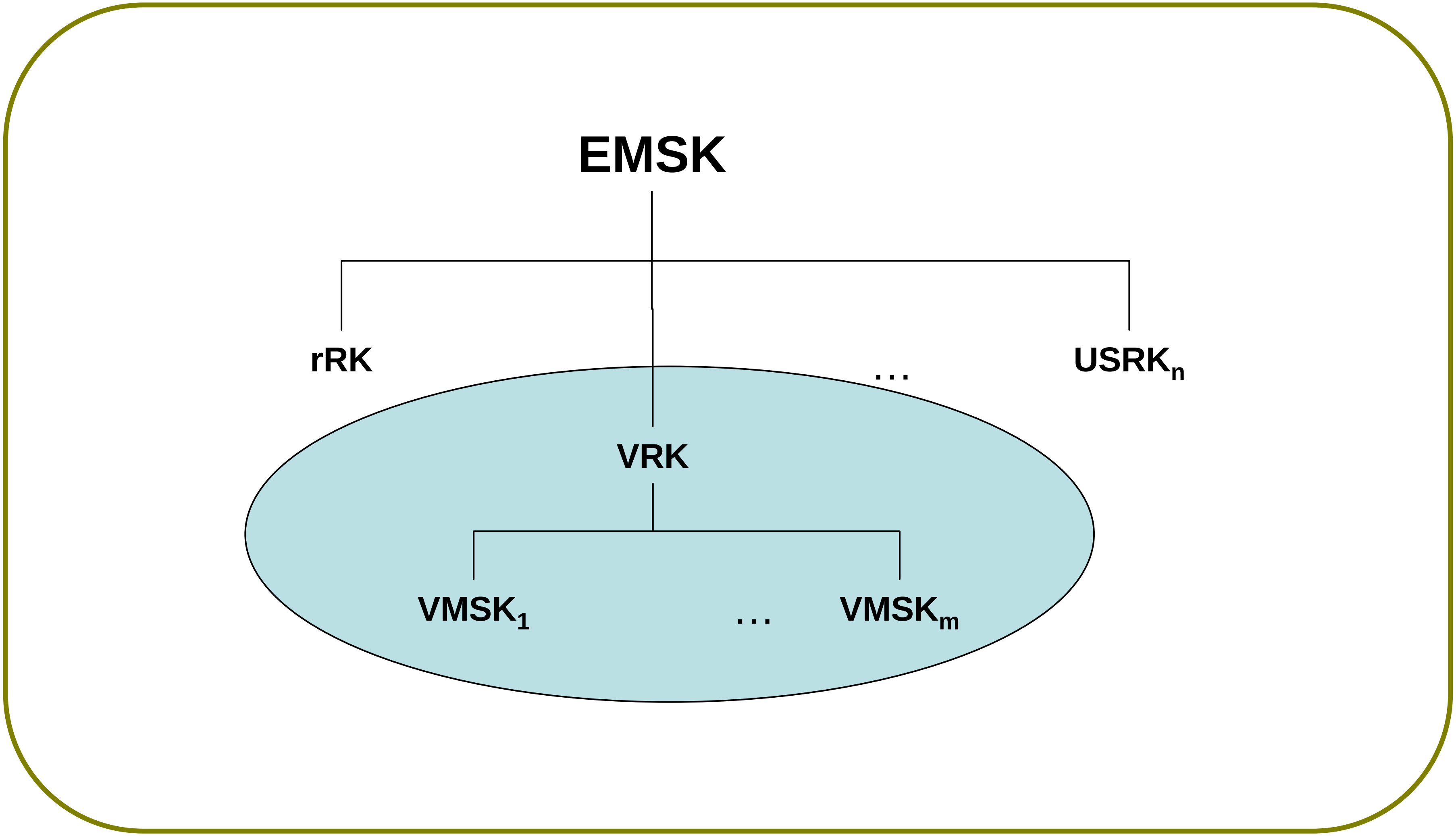
. . .

V-rMSK$_m$

TSK$_1$

TSK$_m$

Example Derivation of VMSK



VMSK Key derivation

- VRK = prf+ (K, S), where
  - K = EMSK and
  - S = “EAP Visited domain Root Key”

- VRK_name =
  NDF-64(EAP Session-ID, VRK Label)

- VMSK = prf+ (K, S), where
  - K = VRK and
  - S = Server ID || Domain Name

- VMSK_name =
  NDF-64(EAP Session-ID, Server ID || Domain Name)

Summary and Next steps

- Two extensions to the EAP keying hierarchy are proposed
  - Specified derivation of two USRKs
    - rRK for re-authentication
    - VRK for Visited-domain keying purposes
- From the rRK, a key to prove possession, one or more keys for new authenticators are derived
- From the VRK, visited domain MSKs are derived
- Specified in
  - draft-vidya-eap-er-01
  - draft-dondeti-eap-vkh-00
- The group is requested to adopt these as WG items