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R. Valmikam
Unaffiliated
R. Koodli
Intel

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Extensible Authentication Protocol (EAP) Attributes for Wi-Fi Integration with the Evolved Packet Core

Abstract

With Wi-Fi emerging as a crucial access network for mobile service providers, it has become important to provide functions commonly available in 3G and 4G networks in Wi-Fi access networks as well. Such functions include Access Point Name (APN) Selection, multiple Packet Data Network (PDN) connections, and seamless mobility between Wi-Fi and 3G/4G networks.

The EAP Authentication and Key Agreement (EAP-AKA), and EAP-AKA', protocol is required for mobile devices to access the mobile Evolved Packet Core (EPC) via Wi-Fi networks. This document defines a few new EAP attributes to enable the above-mentioned functions in such networks. The attributes are exchanged between a client (such as a Mobile Node (MN)) and its network counterpart (such as an Authentication, Authorization, and Accounting (AAA) server) in the service provider's infrastructure.

Status of This Memo

This document is not an Internet Standards Track specification; it is published for informational purposes.

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Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at http://www.rfc-editor.org/info/rfc7458.

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1. Introduction

Wi-Fi has emerged as a "trusted" access technology for mobile service providers; see [EPC2] for reference to the 3rd Generation Partnership Project (3GPP) description of "trusted" access. Advances in IEEE 802.11u [IEEE802.11u] and "HotSpot 2.0" [hs20] have enabled seamless roaming, in which a Mobile Node can select and connect to a Wi-Fi access network just as it would roam into a cellular network. It has thus become important to provide certain functions in Wi-Fi that are commonly supported in licensed-spectrum networks such as 3G and 4G networks. This document specifies a few new EAP attributes for an MN to interact with the network to support some of these functions (see below). These new attributes serve as a trigger for Proxy Mobile IPv6 network nodes to undertake the relevant mobility operations. For instance, when the MN requests a new IP session (i.e., a new APN in 3GPP) and the network agrees, the corresponding attribute (defined below) acts as a trigger for the Mobile Anchor Gateway (MAG) to initiate a new mobility session with the Local Mobility Anchor (LMA). This document refers to [RFC6459] for the basic definitions of mobile network terminology (such as APN) used here.

The 3GPP networks support many functions that are not commonly implemented in a Wi-Fi network. This document defines EAP attributes that enable the following functions in Wi-Fi access networks using EAP-AKA [RFC4187] and EAP-AKA' [RFC5448]:

- APN Selection
- Multiple APN Connectivity
- Wi-Fi to 3G/4G (Universal Terrestrial Radio Access Network (UTRAN) / Evolved UTRAN (E-UTRAN)) mobility

The attributes defined here are exchanged between the MN and the EAP server, typically realized as part of the AAA server infrastructure in a service provider's infrastructure. In particular, the Wi-Fi access network simply conveys the attributes to the service provider's core network where the EAP processing takes place [EPC]. Since these attributes share the same IANA registry, the methods are applicable to EAP-AKA, EAP-AKA', EAP Subscriber Identity Modules (EAP-SIM) [RFC4186], and with appropriate extensions, are possibly applicable for other EAP methods as well. In addition to the trusted Wi-Fi access networks, the attributes are applicable to any trusted "non-3GPP" access network that uses the EAP methods and provides connectivity to the mobile EPC, which provides connectivity for 3G, 4G, and other non-3GPP access networks [EPC2].

1.1. APN Selection

The 3GPP networks support the concept of an APN. This is defined in [GPRS]. Each APN is an independent IP network with its own set of IP services. When the MN attaches to the network, it may select a specific APN to receive desired services. For example, to receive generic Internet services, a user device may select APN "Internet"; and to receive IP Multimedia Subsystems (IMS) voice services, it may select APN "IMSvoice".

In a Wi-Fi access scenario, an MN needs a way of sending the desired APN name to the network. This document specifies a new attribute to propagate the APN information via EAP. The agreed APN is necessary for the Proxy Mobile IPv6 MAG to initiate a new session with the LMA.

1.2. Multiple APN Connectivity

As an extension of APN Selection, an MN may choose to connect to multiple IP networks simultaneously. 3GPP provides this feature via additional Packet Data Protocol (PDP) contexts or additional Packet Data Network (PDN) connections and defines the corresponding set of signaling procedures. In a trusted Wi-Fi network, an MN connects to the first APN via DHCPv4 or IPv6 Router Solicitation. This document specifies an attribute that indicates the MN’s capability to support multiple APN connectivity. The specific connectivity types are also necessary for the Proxy Mobile IPv6 signaling.

1.3. Wi-Fi to E-UTRAN Mobility

When operating in a multiaccess network, an MN may want to gracefully handover its IP attachment from one access network to another. For instance, an MN connected to a 3GPP E-UTRAN network may choose to move its connectivity to a trusted Wi-Fi network. Alternatively, the MN may choose to connect using both access technologies simultaneously and maintain two independent IP attachments. To implement these scenarios, the MN needs a way to correlate the UTRAN/E-UTRAN session with the new Wi-Fi session. This document specifies an attribute to propagate E-UTRAN session identification to the network via EAP. This helps the network to correlate the sessions between the two Radio Access Network (RAN) technologies and thus helps the overall handover process.

2. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

3. Protocol Overview

3.1. Brief Introduction to EAP

EAP is defined as a generic protocol in [RFC3748]. EAP, combined with one of the payload protocols such as EAP-AKA' [RFC5448] can accomplish several things in a network:

- Establish the identity of the user (MN) to the network.
- Authenticate the user during the first attach with the help of an authentication center that securely maintains the user credentials. This process is called "EAP Authentication".
- Re-authenticate the user periodically, but without the overhead of a round-trip to the authentication center. This process is called "EAP Fast Re-Authentication".

This document makes use of the EAP Authentication procedure. The use of the EAP Fast Re-Authentication procedure is for further study. Both the EAP Authentication and EAP Fast Re-Authentication procedures are specified for trusted access network use in 3GPP[TS-33.402].

3.2. IEEE 802.11 Authentication Using EAP over 802.1X

In a Wi-Fi network, EAP is carried over the IEEE 802.1X Authentication protocol. The IEEE 802.1X Authentication is a transparent, payload-unaware mechanism to carry the authentication messages between the MN and the Wi-Fi network elements.

EAP, on the other hand, has multiple purposes. Apart from its core functions of communicating an MN's credentials to the network and proving the MN's identity, it also allows the MN to send arbitrary information elements to help establish the MN's IP session in the network. Figure 1 shows an example of end-to-end EAP flow in the context of an IEEE 802.11 Wi-Fi network. We first define the terminology:

- MN: Mobile Node
- WAN: Wi-Fi Access Node, typically consisting of Wi-Fi Access Point and Wi-Fi Controller. The CAPWAP [RFC5415] protocol allows these functions to be realized in separate physical nodes or in a single node. In a Proxy Mobile IPv6 (PMIPv6) [RFC5213] network, the MAG functionality is located in the WAN, either in the Wi-Fi Access Point or in the Wi-Fi Controller.

- AAA: The infrastructure node supporting the AAA server with the EAP methods (AKA, AKA', EAP-SIM). The endpoints of the EAP method are the MN and the AAA server.

- IPCN: IP Core Network. This includes the PMIPv6 LMA function.

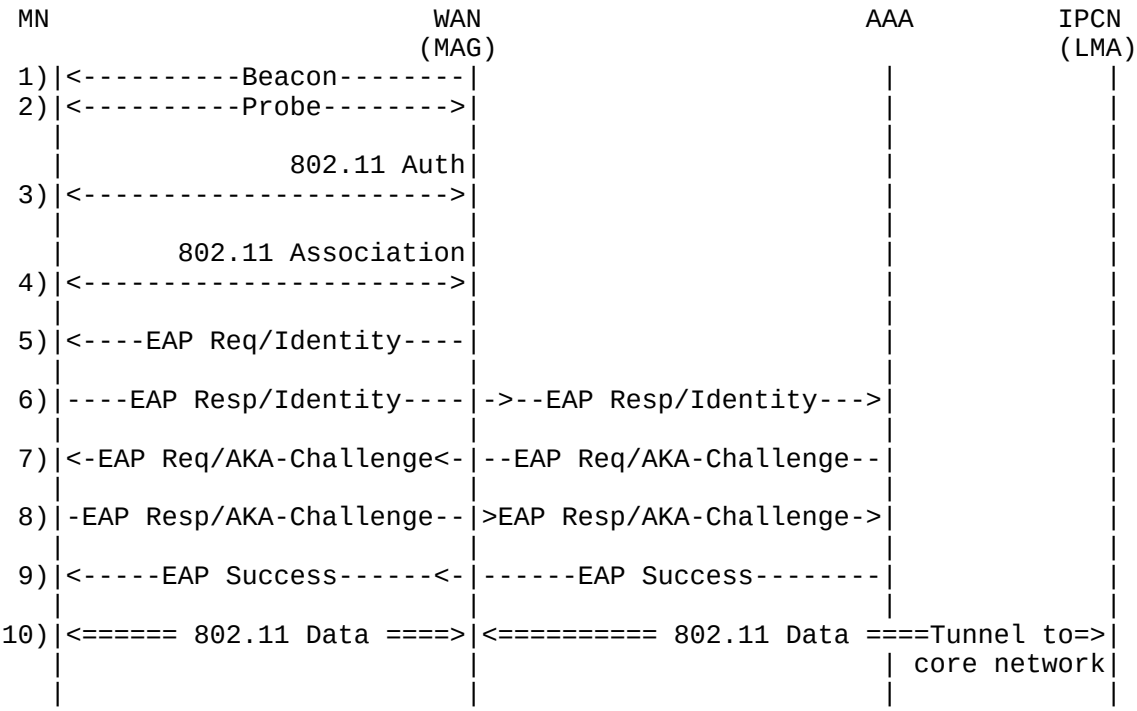

Figure 1: Example EAP Deployment

1. An MN detects a beacon from a WAP in the vicinity.

2. The MN probes the WAP to determine suitability to attach (Verify Service Set Identifier (SSID) list, authentication type, and so on).

3. The MN initiates the IEEE 802.11 Authentication with the Wi-Fi network. In Wi-Fi Protected Access (WPA) / WPA2 mode, this is an open authentication without any security credential verification.

4. The MN initiates 802.11 Association with the Wi-Fi network.

5. The Wi-Fi network initiates 802.1X/EAP Authentication procedures by sending EAP Request/Identity.

6. The MN responds with its permanent or temporary identity.

7. The Wi-Fi network challenges the MN to prove its identity by sending EAP Request/AKA-Challenge.

8. The MN calculates the security digest and responds with EAP Response/AKA-Challenge.

9. If the authentication is successful, the Wi-Fi network responds to the MN with EAP Success.

10. An end-to-end data path is available for the MN to start IP layer communication (DHCPv4, IPv6 Router Solicitation, and so on).

4. New EAP Attributes

The following subsections define the new EAP attributes and their usage.

4.1. APN Selection

In a Wi-Fi network, an MN includes the AT_VIRTUAL_NETWORK_ID attribute in the EAP-Response/AKA-Challenge to indicate the desired APN identity for the first PDN connection.

If the MN does not include the AT_VIRTUAL_NETWORK_ID attribute in the EAP-Response/AKA-Challenge, the network may select an APN by other means. This selection mechanism is outside the scope of this document.

An MN includes the AT_VIRTUAL_NETWORK_REQ attribute to indicate single or multiple PDN capability. In addition, a Sub type in the attribute indicates IPv4, IPv6, or dual IPv4v6 PDN connectivity.

4.2. Connectivity Type

An MN indicates its preference for connectivity using the AT_CONNECTIVITY_TYPE attribute in the EAP-Response/AKA-Challenge message. The preference indicates whether the MN wishes connectivity to the Evolved Packet Core (the so-called "EPC PDN connectivity") or Internet Offload (termed as "Non-Seamless Wireless Offload").

The network makes its decision and replies with the same attribute in the EAP Success message.

4.3. Wi-Fi to UTRAN/E-UTRAN Mobility

When a multiaccess MN enters a Wi-Fi network, the following parameters are applicable in the EAP-Response/AKA-Challenge for IP session continuity from UTRAN/E-UTRAN.

- AT_HANDOVER_INDICATION: This attribute indicates to the network that the MN intends to continue the IP session from UTRAN/E-UTRAN. If a previous session can be located, the network will honor this request by connecting the Wi-Fi access to the existing IP session.

- AT_HANDOVER_SESSION_ID: An MN MAY use this attribute to identify the session on UTRAN/E-UTRAN. If used, this attribute contains Packet Temporary Mobile Subscriber Identity (P-TMSI) if the previous session was on UTRAN; if the previous session was on E-UTRAN, it contains Mobile Temporary Mobile Subscriber Identity (M-TMSI). This attribute helps the network correlate the Wi-Fi session to an existing UTRAN/E-UTRAN session.

4.4. MN Serial ID

The MN_SERIAL_ID attribute defines an MN’s serial number, including International Mobile Equipment Identity (IMEI) and International Mobile Equipment Identity Software Version (IMEISV). The IMEI (or IMEISV) is used for ensuring a legitimate (and not a stolen) device is in use. As with the others, this attribute is exchanged with the service provider’s AAA server. The MN_SERIAL_ID MUST NOT be propagated further by the AAA server to any other node.

5. Attribute Extensions

The format for the new attributes follows that in [RFC4187]. Note that the Length field value is inclusive of the first two bytes.

5.1. AT_VIRTUAL_NETWORK_ID

The AT_VIRTUAL_NETWORK_ID attribute identifies the virtual IP network to which the MN intends to attach. The implementation of the virtual network on the core network side is technology specific. For instance, in a 3GPP network, the virtual network is implemented based on the 3GPP APN primitive.

This attribute SHOULD be included in the EAP-Response/AKA-Challenge message.

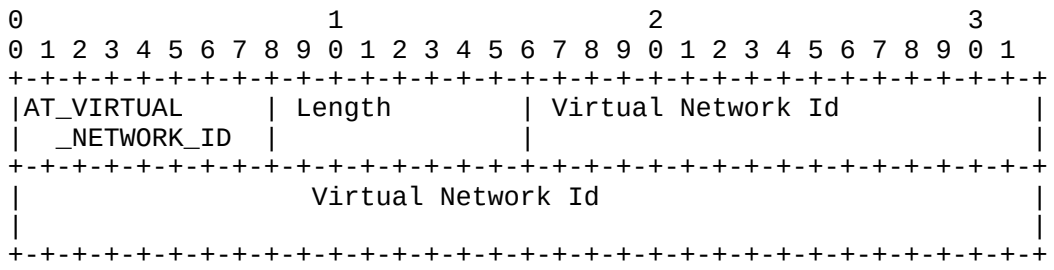

Figure 2: AT_VIRTUAL_NETWORK_ID EAP Attribute

Virtual Network Id:

An arbitrary octet string that identifies a virtual network in the access technology to which the MN is attaching. For instance, in 3GPP E-UTRAN, this could be an APN. See [TS-23.003] for encoding of the field.

5.2. AT_VIRTUAL_NETWORK_REQ

When an MN intends to connect an APN, it SHOULD use this attribute to indicate different capabilities to the network. In turn, the network provides what is supported.

From the MN, this attribute can be included only in EAP-Response/ Identity. From the network, it SHOULD be included in the EAP Request/AKA-Challenge message. In the MN-to-network direction, the Type field (below) indicates the MN’s request. In the network-to-MN direction, the Type field indicates the network’s willingness to support the request; a present Type field value indicates the network support for that Type.

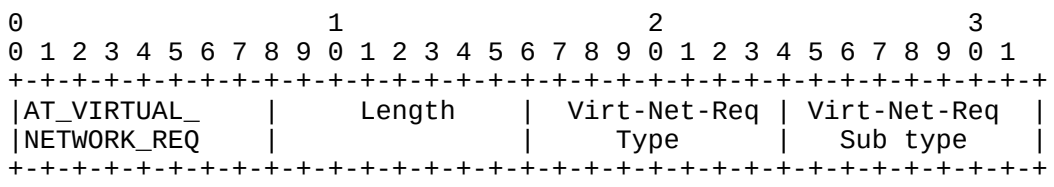

Figure 3: AT_VIRTUAL_NETWORK_REQ EAP Attribute

Virt-Net-Req Type:

Type can have one of the following values:

o 0: Reserved

- 1: Single PDN connection
- 2: Multiple PDN connection. Can request Non-Seamless Wi-Fi Offload or EPC connectivity (see the Connectivity Type attribute below)

Virt-Net-Req Sub type:

Sub type can have one of the following values:

- 0: Reserved
- 1: PDN Type: IPv4
- 2: PDN Type: IPv6
- 3: PDN Type: IPv4v6

5.3. AT_CONNECTIVITY_TYPE

An MN uses this attribute to indicate whether it wishes the connectivity type to be Non-Seamless WLAN Offload or EPC. This attribute is applicable for multiple PDN connections only.

From the MN, this attribute can be included only in EAP-Response/Identity. From the network, it SHOULD be included in the EAP Request/AKA-Challenge message.

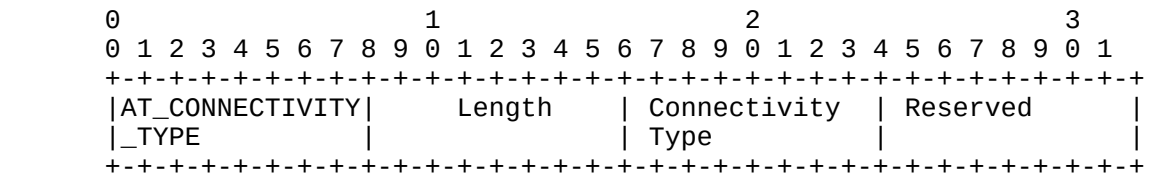

Figure 4: AT_CONNECTIVITY_TYPE EAP Attribute

Connectivity Type:

Connectivity Type can have one of the following values:

- 0: Reserved
- 1: Non-Seamless WLAN Offload (NSWO)
- 2: EPC PDN connectivity

5.4. AT_HANDOVER_INDICATION

This attribute indicates an MN's handover intention of an existing IP attachment.

This attribute SHOULD be included in the EAP-Response/AKA-Challenge message.

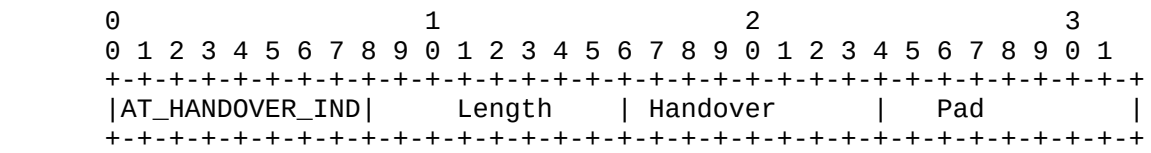

Figure 5: AT_HANDOVER_INDICATION EAP Attribute

Handover Type:

- 0 - The MN has no intention of handing over an existing IP session, i.e., the MN is requesting an independent IP session with the Wi-Fi network without disrupting the IP session with the UTRAN/E-UTRAN. In this case, no Session Id (Section 5.5) is included.

- 1 - The MN intends to handover an existing IP session. In this case, MN MAY include a Session Id (Section 5.5) to correlate this Wi-Fi session with a UTRAN/E-UTRAN session.

5.5. AT_HANDOVER_SESSION_ID

When an MN intends to handover an earlier IP session to the current access network, it may propagate a session identity that can help identify the previous session from UTRAN/E-UTRAN that the MN intends to handover. This attribute is defined as a generic octet string. The MN MAY include an E-UTRAN Globally Unique Temporary User Equipment Identity (GUTI) if the previous session was an E-UTRAN session. If the previous session was a UTRAN session, the MN MAY include a UTRAN Global Radio Network Controller (RNC) ID (Mobile Country Code (MCC), Mobile Network Code (MNC), RNC ID) and P-TMSI concatenated as an octet string.

This attribute SHOULD be included in the EAP-Response/AKA-Challenge message.

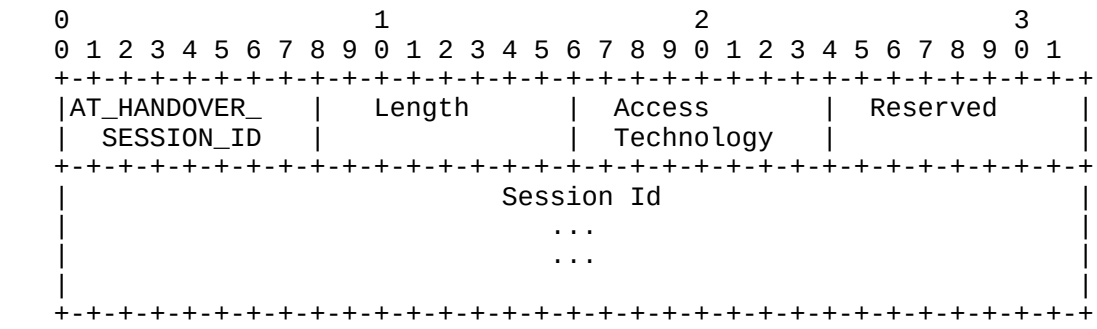

Figure 6: AT_HANDOVER_SESSION_ID EAP Attribute

Access Technology:

This field represents the RAN technology from which the MN is undergoing a handover.

- 0: Reserved
- 1: UTRAN
- 2: E-UTRAN

Session Id:

An octet string of variable length that identifies the session in the source access technology. As defined at the beginning of this section, the actual value is RAN technology dependent. For E-UTRAN, the value is GUTI. For UTRAN, the value is Global RNC ID (6 bytes) followed by P-TMSI (4 bytes). See [TS-23.003] for encoding of the field.

5.6. AT_MN_SERIAL_ID

This attribute defines the MN's machine serial number. Examples are IMEI and IMEISV.

A network that requires the machine serial number for authorization purposes MUST send a request for the attribute in an EAP-Request/AKA-Challenge message. If the attribute is present, the MN SHOULD include the attribute in the EAP-Response/AKA-Challenge message. If the MN sends the attribute, it MUST be contained within an AT_ENCR_DATA attribute. An MN MUST NOT provide the attribute unless it receives the request from a network authenticated via EAP/AKA.

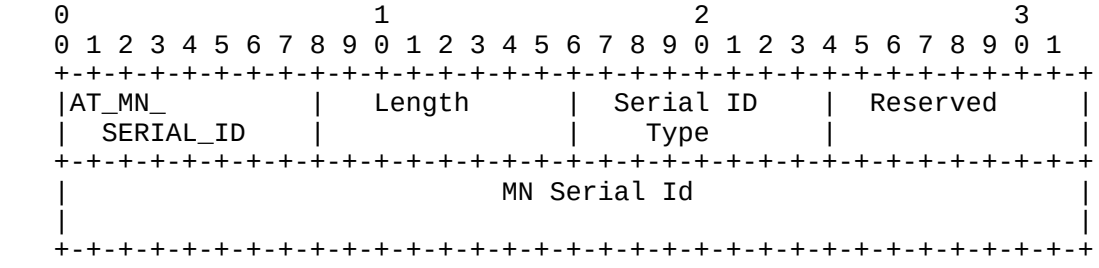

Figure 7: AT_MN_SERIAL_ID EAP Attribute

Serial ID Type:

This field identifies the type of the MN Identifier.

- 0: Reserved
- 1: IMEI
- 2: IMEISV

MN Serial Id:

An arbitrary octet string that identifies the MN's machine serial number. The actual value is device specific. See [TS-23.003] for encoding of the field. When sent by the network in the EAP-Request/ AKA-Challenge message, this field is not present, which serves as an indication for the MN to provide the attribute in the EAP-Response/ AKA-Challenge message.

An AT_MN_SERIAL_ID attribute MUST only be used with methods that can provide mutual (network and device) authentication, such as AKA, AKA', and EAP-SIM.

6. Security Considerations

This document defines new EAP attributes to extend the capability of the EAP-AKA protocol as specified in Section 8.2 of [RFC4187]. The attributes are passed between an MN and a AAA server in provider-controlled, trusted Wi-Fi networks, where the Wi-Fi access network is a relay between the MN and the AAA server. The document does not specify any new messages or options to the EAP-AKA protocol.

The attributes defined here are fields that are used in existing 3G and 4G networks, where they are exchanged (in protocols specific to 3G and 4G networks) subsequent to the mobile network authentication (e.g., using the UMTS-AKA mechanism). For the operator-controlled

Wi-Fi access that is connected to the same core infrastructure as the 3G and 4G access, a similar model is followed here with the EAP-AKA (or EAP-AKA', EAP-SIM) authentication. In doing so, processing these attributes, security-wise, is no worse than that in existing 3G and 4G mobile networks.

The attributes inherit the security protection (integrity, replay, and confidentiality) provided by the parameters in the AKA(') or SIM methods; see Section 12.6 in [RFC4187]. Furthermore, RFC 4187 requires attributes exchanged in EAP-Request/AKA-Identity or EAP-Response/AKA-Identity to be integrity-protected with AT_CHECKCODE; see Section 8.2 in [RFC4187]. This requirement applies to the AT_CONNECTIVITY_TYPE and AT_VIRTUAL_NETWORK_REQ attributes defined in this document.

The AT_MN_SERIAL_ID attribute MUST have confidentiality protection provided by the AKA(') or EAP-SIM methods beyond the secure transport (such as private leased lines, VPN, etc.) deployed by the provider of the trusted Wi-Fi service.

Use of identifiers such as IMEI could have privacy implications, wherein devices can be profiled and tracked. With additional information, this could also lead to profiling of user's network access patterns. Implementers should consult [hotos-2011], and the references therein, for a broader discussion and possible mitigation methods on the subject.

7. IANA Considerations

This document defines the following new skippable EAP-AKA attributes. These attributes have been assigned from the "EAP-AKA and EAP-SIM Parameters" registry at <https://www.iana.org/assignments/eapsimaka-numbers>.

- AT_VIRTUAL_NETWORK_ID (Section 5.1): 145
- AT_VIRTUAL_NETWORK_REQ (Section 5.2): 146
- AT_CONNECTIVITY_TYPE (Section 5.3): 147
- AT_HANDOVER_INDICATION (Section 5.4): 148
- AT_HANDOVER_SESSION_ID (Section 5.5): 149
- AT_MN_SERIAL_ID (Section 5.6): 150

A new IANA registry titled "Trusted Non-3GPP Access EAP Parameters" has been created. The range for both Types and Sub types in the registry is 0 - 127, with 0 (zero) being a reserved value. IANA has made assignments in a monotonically increasing order in increments of 1, starting from 1. New assignments in this registry are made with the Specification Required policy [RFC5226].

The IANA Designated Expert should review the requirements for new assignments based on factors including, but not limited to, the source of request (e.g., standards bodies), deployment needs (e.g., industry consortium, operator community), and experimental needs (e.g., academia, industrial labs). A document outlining the purpose of new assignments should accompany the request. Such a document could be a standards document or a research project description. The Designated Expert should consider that there is sufficient evidence of potential usage both on the endpoints (e.g., Mobile Devices, etc.) and the infrastructure (e.g., AAA servers, gateways, etc.)

The following fields have been assigned:

- Virt-Net-Req Type (Section 5.2): 1
- Virt-Net-Req Sub type (Section 5.2): 2
- Connectivity Type (Section 5.3): 3
- Access Technology (Section 5.5): 4
- Serial ID Type (Section 5.6): 5

8. References

8.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997, <http://www.rfc-editor.org/info/rfc2119>.

[RFC4187] Arkko, J. and H. Haverinen, "Extensible Authentication Protocol Method for 3rd Generation Authentication and Key Agreement (EAP-AKA)", RFC4187, January 2006, <http://www.rfc-editor.org/info/rfc4187>.

[RFC5226] Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", BCP 26, RFC 5226, May 2008, <http://www.rfc-editor.org/info/rfc5226>.

[RFC6459] Korhonen, J., Ed., Soininen, J., Patil, B., Savolainen, T., Bajko, G., and K. Iisakkila, "IPv6 in 3rd Generation Partnership Project (3GPP) Evolved Packet System (EPS)", RFC 6459, January 2012, <http://www.rfc-editor.org/info/rfc6459>.

8.2. Informative References

[EPC] 3GPP, "General Packet Radio Service (GPRS); enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access", TS 23.401 8.8.0, December 2009, <http://www.3gpp.org/ftp/Specs/html-info/23401.htm>.

[EPC2] 3GPP, "Architecture enhancements for non-3GPP accesses", TS 23.402 8.8.0, December 2009, <http://www.3gpp.org/ftp/Specs/html-info/23402.htm>.

[GPRS] 3GPP, "General Packet Radio Service (GPRS); Service description, Stage 2", TS 23.060, December 2006, <http://www.3gpp.org/ftp/Specs/html-info/23060.htm>.

[IEEE802.11u] IEEE, "IEEE Standard for Information Technology-Telecommunications and information exchange between systems-Local and Metropolitan networks-specific requirements-Part II: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: Amendment 9: Interworking with External Networks", IEEE Std 802.11u-2011, February 2011, <http://standards.ieee.org/findstds/standard/802.11u-2011.html>.

[RFC3748] Aboba, B., Blunk, L., Vollbrecht, J., Carlson, J., and H. Levkowetz, Ed., "Extensible Authentication Protocol (EAP)", RFC3748, June 2004, <http://www.rfc-editor.org/info/rfc3748.txt>.

[RFC4186] Haverinen, H., Ed. and J. Salowey, Ed., "Extensible Authentication Protocol Method for Global System for Mobile Communications (GSM) Subscriber Identity Modules (EAP-SIM)", RFC 4186, January 2006, <http://www.rfc-editor.org/info/rfc4186>.

[RFC5213] Gundavelli, S., Ed., Leung, K., Devarapalli, V., Chowdhury, K., and B. Patil, "Proxy Mobile IPv6", RFC 5213, August 2008, <http://www.rfc-editor.org/info/rfc5213>.

[RFC5415] Calhoun, P., Montemurro, M., and D. Stanley, "Control And Provisioning of Wireless Access Points (CAPWAP) Protocol Specification", RFC5415, January 2009, <http://www.rfc-editor.org/info/rfc5415.txt>.

[RFC5448] Arkko, J., Lehtovirta, V., and P. Eronen, "Improved Extensible Authentication Protocol Method for 3rd Generation Authentication and Key Agreement (EAP-AKA')", RFC 5448, May 2009, <http://www.rfc-editor.org/info/rfc5448>.

[TS-23.003] 3GPP, "Numbering, addressing and identification", TS 23.003 12.2.0, March 2014, <http://www.3gpp.org/ftp/Specs/html-info/23003.htm>.

[TS-33.402] 3GPP, "3GPP System Architecture Evolution (SAE); Security aspects of non-3GPP accesses", TS 33.402 8.6.0, December 2009, <http://www.3gpp.org/ftp/Specs/html-info/33402.htm>.

[hotos-2011] Wetherall, et al., D., "Privacy Revelations for Web and Mobile Apps", Proceedings of the Hot Topics in Operating Systems (HotOS), May 2011, <https://www.usenix.org/legacy/events/hotos11/tech/>.

[hs20] "Hotspot 2.0 (Release 2) Technical Specification Package v1.0.0", <https://www.wi-fi.org/hotspot-20-release-2-technical-specification-package-v100>.

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Authors' Addresses

Ravi Valmikam
Unaffiliated
United States

EMail: valmikam@gmail.com

Rajeev Koodli
Intel
United States

EMail: rajeev.koodli@intel.com