3GPP TSG SA WG3 Security - S3#18 S3-010215
21 - 24 May, 2001
Phoenix, USA

Network Working Group J. Arkko
INTERNET-DRAFT R. Blom
Category: Informational Ericsson
<draft-arkko-map-doi-02.txt> 21 May 2001

The MAP Security Domain of Interpretation for ISAKMP

Status of this Memo

Contents

1. Abstract

In the Global Mobile System (GSM) and Universal Mobile Telecommunication System (UMTS) networks, the MAP protocol plays a central role in the signaling communications between the Network Elements (NEs). The Internet Security Association and Key Management Protocol (ISAKMP) defines a framework for security association management and cryptographic key establishment for the Internet. This framework consists of defined exchanges, payloads, and processing guidelines that occur within a given Domain of Interpretation (DOI). This document defines the MAP Security DOI (MAPSEC DOI), which instantiates ISAKMP for use with MAP when MAP uses ISAKMP to negotiate security associations.

2. Terms and Definitions

The keywords MUST, MUST NOT, REQUIRED, SHALL, SHALL NOT, SHOULD, SHOULD NOT, RECOMMENDED, MAY, and OPTIONAL, when they appear in this

document, are to be interpreted as described in [RFC 2119].

3. Introduction

3.1. MAP

In the Global Mobile System (GSM) and Universal Mobile Telecommunication System (UMTS) networks, the MAP protocol plays a central role in the signaling communications between the Network Elements (NEs). User profiles exchange, authentication, and mobility management are performed using MAP. MAP is an SS7 protocol and runs over the TCAP, SCCP, and MTP protocol layers, typically using dedicated PCM links.

The mobile networks are moving towards IP-based solutions, and completely IP based networks and new protocols such as SIP will in few years time replace MAP. However, MAP and SS7 signaling networks have to be supported during the transition time, and beyond, due to the need to retain legacy equipment in networks.

3.2. Requirements for a DOI

Within ISAKMP, a Domain of Interpretation is used to group related protocols using ISAKMP to negotiate security associations. Security protocols sharing a DOI choose security protocol and cryptographic transforms from a common namespace and share key exchange protocol identifiers. They also share a common interpretation of DOI-specific payload data content, including the Security Association and Identification payloads.

Overall, ISAKMP places the following requirements on a DOI definition:

- define the naming scheme for DOI-specific protocol identifiers
- define the interpretation for the Situation field
- define the set of applicable security policies
- define the syntax for DOI-specific SA Attributes (Phase II)
- define the syntax for DOI-specific payload contents
- define additional Key Exchange types, if needed
- define additional Notification Message types, if needed

For instance, the IP Security DOI [IPDOI] describes the use of ISAKMP in the context of IP Security AH and ESP and the IP Compression protocols. The IP Security DOI also includes the details for how phase 1 authentication and protection of ISAKMP itself is performed between two IP nodes.

This document defines the MAPSEC Domain of Interpretation. This

DOI is only relevant for Phase 2 of ISAKMP/IKE. Therefore, this documents leaves the specification of the Phase 1 details for the IP Security DOI [IPDOI]. For the sake of completeness, this document explains all issues related to the Phase 2, though in many cases it just refers to e.g. parts of the IKE RFC or the IP Security DOI.

It is envisioned that future development in algorithms, security protocols, and policy representation will be fast. Therefore, this specification defines only the framework for the MAPSEC Phase 2, and leaves the authentication algorithm, MAPSEC transform, and the definition of a policy element called the protection profile to the 3GPP Technical Specifications that are applicable at any current time. This ensures that this document does not have to modified upon the development of a new authentication algorithm, for instance.

3.3. MAP Security

Due to the role of MAP in the authentication process of GSM phones, operators are concerned about its lack of cryptographic security support. For this reason a new protocol header has been developed to protect MAP messages, much in the same way as IPsec ESP protects IP packets. Also similarly, a key management mechanism is needed for MAP. The intention of the standardization entities working on MAP is to reuse an existing key management mechanism, namely ISAKMP, and parts of IKE and the IPsec DOI. The reasons for wishing to reuse ISAKMP include the following:

- Avoiding the security and complexity pitfalls involved in new protocol design
- Benefits of using the same protocol that IP-based (especially IPv6) nodes already use for other purposes.

The remainder of this document details the instantiation of these requirements for using the GSM MAP protocol and its security to provide protection for MAP messages sent between cooperating Network Elements (NEs).

For a description of the MAP protocol, see [MAP].

3.4. Network Architecture

The MAP Security protocol and its key management part provides authentication, confidentiality, integrity, and replay protection services to the MAP messages it transports.

The purpose of the MAP Security header in the protocol is to

provide enough information to determine the MAP SA and Protection Modes used in securing the MAP operation that follows the header.

MAPSEC DOI and IKE are used to set up Security Associations for nodes implementing MAPSEC. While the MAP protocol usually runs over SS7, the MAPSEC DOI and IKE are always run over IP. It is therefore assumed that nodes or networks implementing MAPSEC always have IP connectivity in addition to the SS7 connectivity.

The network architectures where the MAPSEC DOI can be run include but are not limited to the one defined by 3GPP [NDSEC]. In the 3GPP architecture the MAPSEC is typically run between two different network operators, and the same SAs are shared by a number NEs.

It is possible that the nodes using MAPSEC DOI and IKE also have some other, IP traffic to protect. The MAPSEC DOI allows a single Phase 1 IKE to be used for the negotiation of both MAP and IP traffic protection using different Phase 2 exchanges and DOI identifiers.

As in IKE, the MAPSEC DOI allows only symmetric Security Associations to be set up. That is, a pair of SAs is always created for the incoming and outgoing directions. These SAs differ only with respect to the keys, SPIs, and peer identities but all other parameters including the algorithms will have the same values.

3.5. Reuse of IPSEC DOI and IKE

For Phase 1, all IPSEC DOI definitions [IPSDOI] and IKE procedures [ISAKMP, IKE] MUST be used unchanged in the MAPSEC DOI, including the way that peers are authenticated. However, the MAP Security DOI relaxes the full implementation requirements. The following exceptions to the full requirements are used:

- Perfect Forward Secrecy (PFS) MAY be implemented for Phase 2, but does need to be supported by all implementations. An implementation that receives a Phase 2 negotiation request with PFS on should decline the negotiation.
- Only one identity type, ID_FQDN, MUST be implemented for phase 1. Other identity types specified in [IPSDOI] SHOULD be implemented.
- Only the AES encryption and AES CBC MAC algorithms MUST be implemented as ISAKMP encryption and hash

operations. [??? - the availability of AES CBC MAC for use with IKE Phase 1 is currently being studied.]

- Only IPv6 is mandatory. [??? - this is currently being discussed by the SA2 and SA3.]

Implementor's note: IKE [IKE] specifies that all implementations MUST support authentication through pre-shared secrets and SHOULD support public key based authentication. All implementations also MUST support Main Mode. Note also IKE allows the deletion of an existing SA, which all implementations of this DOI MUST be able to handle.

Furthermore, the IKE procedures regarding phase 2 are used unchanged, with the following exceptions:

- Identity types used in phase 2 are different.
- SA payloads are different.
- There are no MAPSEC-specific phase 2 notifications.
- The procedure for creating keys for MAP Security is different than that for IPsec.

4. Definition

4.1 Naming Scheme

Within ISAKMP, all DOI's MUST be registered with the IANA in the "Assigned Numbers" RFC [STD-2]. The IANA Assigned Number for the MAP Security DOI (MAPSEC DOI) is TBD (N). Within the MAP Security DOI, all well-known identifiers MUST be registered with the IANA under the MAPSEC DOI. Unless otherwise noted, all tables within this document refer to IANA Assigned Numbers for the MAPSEC DOI. See Section 6 for further information relating to the IANA registry for the MAPSEC DOI. The MAPSEC DOI also makes a use of several numbers defined by the 3GPP Technical Specification [NDSEC].

All multi-octet binary values are stored in network byte order.

4.2 MAPSEC Situation Definition

Within ISAKMP, the Situation field provides information that can be used by the responder to make a policy determination about how to process the incoming Security Association request. For the MAPSEC DOI, the Situation field is a four (4) octet bitmask with the following value.

Situation	Value
SIT_IDENTITY_ONLY	0x01

4.2.1 SIT_IDENTITY_ONLY

The SIT_IDENTITY_ONLY type specifies that the security association will be identified by source identity information present in an associated Identification Payload. See Section 4.6.2 for a complete description of the various Identification types. All MAPSEC DOI implementations MUST support SIT_IDENTITY_ONLY by including an Identification Payload in at least one of the Phase I Oakley exchanges ([IKE], Section 5) and MUST abort any association setup that does not include an Identification Payload.

4.3 MAPSEC Policy Requirements

The policy requirements for nodes implementing the MAPSEC DOI are beyond the scope of this document. However, it is required that systems be able to specify their policies with respect to the MAP traffic in terms of so called Protection Profiles as defined in [NDSEC]. These Protection Profiles indicate the need for a particular kind of protection based on the type of the MAP message. For the purposes of this document a Protection Profile is a 16 bit number that is agreed upon during the SA negotiation.

4.4 MAPSEC Assigned Numbers

The following sections list the Assigned Numbers for the MAPSEC DOI: Protocol Identifiers, MAPSEC Transform Identifiers, Security Association Attribute Type Values, ID Payload Type Values, and Notify Message Type Values.

4.4.1 MAPSEC DOI Number

This number is TBD.

4.4.1 MAPSEC Security Protocol Identifier

The ISAKMP proposal syntax was specifically designed to allow for the simultaneous negotiation of multiple Phase II security protocol suites within a single negotiation. As a result, the protocol suites listed below form the set of protocols that can be negotiated at the same time. It is a host policy decision as to what protocol suites might be negotiated together.

The following table lists the values for the Security Protocol Identifiers referenced in an ISAKMP Proposal Payload for the MAPSEC

DOI.

Protocol ID	Value
RESERVED	0-1
PROTO_MAPSEC	TBD

4.4.1.2 PROTO_MAPSEC

The PROTO_MAPSEC type specifies the use of the MAP Security to protect MAP messages.

4.4.2 MAPSEC Transform Identifiers

The following table lists the reserved MAPSEC Transform Identifiers.

Transform ID	Value
RESERVED	0-1

Actual MAP Transform Identifiers are defined in the 3GPP Technical Specification [NDSEC], which currently specifies only one, the MAPSEC_AES transform. All implementations within the MAPSEC DOI MUST support that transform.

4.5 MAPSEC Security Association Attributes

The following SA attribute definitions are used in Phase II of an IKE negotiation. Attribute types can be either Basic (B) or Variable-Length (V). Encoding of these attributes is defined in the base ISAKMP specification.

Attributes described as basic MUST NOT be encoded as variable. Variable length attributes MAY be encoded as basic attributes if their value can fit into two octets. See [IKE] for further information on attribute encoding in the MAPSEC DOI. All restrictions listed in [IKE] also apply to the MAPSEC DOI.

Implementor’s note: The attributes describe here behave exactly as the corresponding ones in the IPSEC DOI, unless specified explicitly otherwise. For the purposes of reusing IPsec DOI code, parameters not used by MAPSEC DOI have the type reserved (values 4, 8, and 9).

Attribute Types

class	value	type

SA Life Type	1	B
SA Life Duration	2	V
Group Description	3	B
RESERVED	4	-
Authentication Algorithm	5	B
Key Length	6	B
Key Rounds	7	B
RESERVED	8	-
RESERVED	9	-
MAP Protection Profile	10	B

Class Values

SA Life Type
SA Duration

Specifies the time-to-live for the overall security association. When the SA expires, the SA MUST be renegotiated. MAPSEC messages using the expired SA MUST no longer be either sent or accepted as input. The life type values are:

RESERVED	0
seconds	1
RESERVED	2

For a given Life Type, the value of the Life Duration attribute defines the actual length of the component lifetime -- in number of seconds. If unspecified, the default value shall be assumed to be 28800 seconds (8 hours).

An SA Life Duration attribute MUST always follow an SA Life Type which describes the units of duration.

Implementor's note: The semantics and values for these attributes are exactly as they are in the IPSEC DOI, except that kilobyte lifetimes are not supported.

Group Description

Specifies the Oakley Group to be used in a PFS QM negotiation. For a list of supported values, see Appendix A of [IKE].

Implementor's note: The semantics and values for these attributes are exactly as they are in the IPSEC DOI.

Authentication Algorithm

RESERVED	0-4

This specification only lists the reserved values. Actual Authentication Algorithm values are defined in the 3GPP Technical Specification [NDSEC], which currently defines only one, the AES-CBC-MAC. That Authentication Algorithm MUST be supported by all MAPSEC and MAPSEC DOI implementations.

There is no default value for Authentication Algorithm, as it must be specified to correctly identify the applicable transform.

Implementor's note: The first five values are reserved by the IPSEC DOI.

Key Length

RESERVED 0

There is no default value for Key Length, as it must be specified for transforms using ciphers with variable key lengths. For fixed length ciphers, the Key Length attribute MUST NOT be sent. The definition of MAPSEC transforms in the 3GPP Technical Specifications such as [NDSEC] MUST specify if the use of Key Length is necessary and what the legal values are.

Implementor's note: The semantics and values for this attributes is exactly as it is in the IPSEC DOI.

Key Rounds

RESERVED 0

There is no default value for Key Rounds, as it must be specified for transforms using ciphers with varying numbers of rounds.

Implementor's note: The semantics and values for this attributes is exactly as it is in the IPSEC DOI.

MAP Protection Profile

The value of this attribute is a 16-bit entity as defined in [NDSEC].

4.5.1 Required Attribute Support

To ensure basic interoperability, all implementations MUST be prepared to negotiate all of the following attributes.

SA Life Type
SA Duration
Authentication Algorithm
Key Length
MAP Protection Profile

4.5.2 Attribute Negotiation

If an implementation receives a defined MAPSEC DOI attribute (or attribute value) which it does not support, an ATTRIBUTES-NOT-SUPPORTED SHOULD be sent and the security association setup MUST be aborted, unless the attribute value is in the reserved range.

If an implementation receives an attribute value in the reserved range, an implementation MAY chose to continue based on local policy.

Implementor's note: This is exactly as it is in the IPSEC DOI. However, there are no special lifetime attribute parsing requirements as only time-based lifetimes are supported.

4.5.3 Lifetime Matching

Offered and locally acceptable SA lifetimes must match exactly under MAPSEC in order for the responder to select an SA.

Implementor's note: This is simplified from the IPSEC DOI which required notifications. In the MAPSEC DOI lifetime notifications are not allowed.

4.6 MAP Security Payload Content

The SA Payloads that the Initiator and the Responder exchange control the Security Associations that actually get installed. The attributes discussed above are a part of the SA Payloads. For a definition of an MAPSEC SA, see [NDSEC].

The following sections describe those ISAKMP payloads whose data representations are dependent on the applicable DOI.

4.6.1 Identification Payload Content

The Identification Payload is used to identify the initiator of the Security Association. The identity of the initiator SHOULD be used by the responder to determine the correct host system security policy requirement for the association.

During Phase I negotiations, the ID port and protocol fields MUST be set to zero or to UDP port 500. If an implementation receives any other values, this MUST be treated as an error and the security

association setup MUST be aborted. This event SHOULD be auditable.

The following diagram illustrates the content of the Identification Payload.

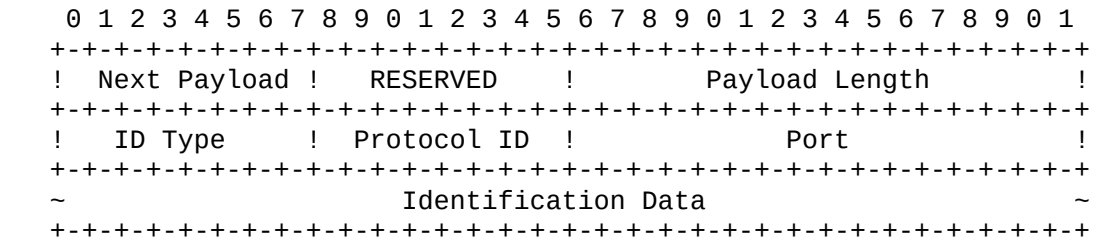

Figure 2: Identification Payload Format

The Identification Payload fields are defined as follows:

- Next Payload (1 octet) - Identifier for the payload type of the next payload in the message. If the current payload is the last in the message, this field will be zero (0).

- RESERVED (1 octet) - Unused, must be zero (0).

- Payload Length (2 octets) - Length, in octets, of the identification data, including the generic header.

- Identification Type (1 octet) - Value describing the identity information found in the Identification Data field.

- Protocol ID (1 octet) - Value specifying an associated IP protocol ID (e.g. UDP/TCP). A value of zero means that the Protocol ID field should be ignored. In the MAPSEC DOI, value of zero MUST always be used in Phase 2.

- Port (2 octets) - Value specifying an associated port. A value of zero means that the Port field should be ignored. In the MAPSEC DOI, value of zero MUST always be used in Phase 2.

- Identification Data (variable length) - Value, as indicated by the Identification Type.

The legal Identification Type field values in Phase 1 are as defined in the IPSEC DOI. However, Phase 2 identities should MUST conform to the following. The table lists the assigned values

for the Identification Type field found in the Identification Payload. (Values from 0 to 11 are reserved by the IPsec DOI for the purposes of code reuse.)

ID Type	Value
RESERVED	0-11
ID_PLMN_ID	12

In MAPSEC DOI, the ID_PLMN_ID type specifies PLMN ID of the Initiator or the Responder. The PLMN ID MUST be represented as defined in section 17.7.8 of [MAP], i.e. be a three octet data item with the Mobile Country Code (MCC) followed by the Mobile Network Code (MNC). The size of the PLMN ID MUST correspond to the size in the ID payload header.

4.6.2 Notify Message Types

There are no DOI-specific Notify Message types for the MAPSEC DOI (Phase 2).

(Note however, Phase 1 uses of course standard ISAKMP and IPSEC DOI notifications, and even Phase 2 uses standard ISAKMP notifications. The reason why MAPSEC DOI doesn't need the same Phase 2 DOI-specific notifications is the following. MAPSEC does not allow turning replay protection on or off which make the use of REPLAY-STATUS unnecessary. Responder lifetimes are required to be exactly the same as the initiator lifetimes, which makes the use of RESPONDER-LIFETIME unnecessary.)

4.7 MAPSEC Key Exchange Requirements

The MAPSEC DOI introduces no additional Key Exchange types.

5. Security Considerations

This entire memo pertains to the Internet Key Exchange protocol ([IKE]), which combines ISAKMP ([ISAKMP]) and Oakley ([OAKLEY]) to provide for the derivation of cryptographic keying material in a secure and authenticated manner. Specific discussion of the various security protocols and transforms identified in this document can be found in the associated base documents and in the cipher references.

6. IANA Considerations

This document contains many "magic" numbers to be maintained by the the standardization bodies. In the case of the MAPSEC DOI, the 3GPP handles the assignment of numbers instead of IANA. This

section explains the criteria to be used by the 3GPP to assign additional numbers in each of these lists. All values not explicitly defined in previous sections are reserved to 3GPP. (IANA will still define the DOI numbers, including the DOI number for this DOI.)

6.1 MAPSEC Situation Definition

The Situation Definition is a 32-bit bitmask which represents the environment under which the MAPSEC SA proposal and negotiation is carried out. Requests for assignments of new situations must be accompanied by a 3GPP Technical Specification which describes the interpretation for the associated bit.

The upper two bits are reserved for private use amongst cooperating systems.

6.2 MAPSEC Security Protocol Identifiers

The Security Protocol Identifier is an 8-bit value which identifies a security protocol suite being negotiated. Requests for assignments of new security protocol identifiers must be accompanied by a 3GPP Technical Specification which describes the requested security protocol.

The values 249-255 are reserved for private use amongst cooperating systems.

6.3 MAPSEC MAP Security Transform Identifiers

The MAP Security Transform Identifier is an 8-bit value which identifies a particular algorithm to be used to provide security protection for MAP messages. Requests for assignments of new transform identifiers must be accompanied by a 3GPP Technical Specification which describes how to use the algorithm within the framework.

The values 249-255 are reserved for private use amongst cooperating systems.

6.4 MAPSEC Security Association Attributes

The MAPSEC Security Association Attribute consists of a 16-bit type and its associated value. MAPSEC SA attributes are used to pass miscellaneous values between ISAKMP peers. Requests for assignments of new MAPSEC SA attributes must be accompanied by a 3GPP Technical Specification which describes the attribute encoding (Basic/Variable-Length) and its legal values. Section 4.5 of this document provides an example of such a description.

The values 32001-32767 are reserved for private use amongst cooperating systems.

Requests for new values for existing attributes must be accompanied also by a 3GPP Technical Specification. Such specifications describe the semantics of the new values.

6.5 MAPSEC Identification Type

The MAPSEC Identification Type is an 8-bit value which is used as a discriminant for interpretation of the variable-length Identification Payload. Requests for assignments of new Identification Types must be accompanied by a 3GPP Technical Specification which describes how ato use the identification type.

The values 249-255 are reserved for private use amongst cooperating systems.

7. Key Derivation for MAP Security

MAP Security requires two sets of keys, one for each direction, just as in the case of IPSEC SAs. Both need authentication and encryption keys. For one direction of an SA, these two keys are taken from the key material as follows: The authentication key is taken first and then the encryption key.

The keys are derived using exactly the same procedure as in section 5.5 of RFC 2409 [IKE].

8. Modification History

The following modifications have been made to the -01 and -02 versions of this draft:

- Section 3.5 now specify a profile for the use of IKE. Since the -02 version, Main Mode has been mandated, and SA deletion has become mandatory.
- All MAPSEC-specific phase 2 notifications have been removed for simplicity.
- AES-MAC has been specified instead of HMAC_SHA1. Note that Phase 1 has been specified to use AES and SHA1 since no RFC exists yet to define the use of AES-MAC for IKE Phase 1.
- Some formatting modifications have been made.
- Attribute parsing requirements were simplified since only a single kind of lifetimes are supported.
- MAP_BLOWFISH has been removed since 3GPP hasn’t defined it.
- MAP_NULL has been removed and protection profiles are

expected to be used instead to signify that no security is needed.
- Rules for assigning new numbers within this DOI have been clarified. Since -02, it has also been made clear which numbers are defined in this document (such as the attribute numbers) and which ones are defined in the 3GPP Technical Specifications (such as the protection

profile numbers).
- Kerberized Internet Negotiation of Keys (KINK) is no longer referenced in this document.
- Since version -02, ISAKMP protocol and transform identifiers have been removed from this document, and the introduction clarified to state that this document involves only the definition of Phase 2 elements.
- Since version -02, the MAPSEC transform, Authentication Algorithm, and Protection Profile values have been left to be defined by 3GPP Technical Specifications.
- References have been completed in version -02.
- The format of the PLMN Id has been specified in -02.
- In version -02, there are no longer private use value space for attribute values.
- In version -02, the size of the protection profile entity has been specified to be 16 bit.
- Version -02 no longer copies the key derivation text from IKE, but references it.
- Version -02 no longer describes the network architectures other than pointing to the 3GPP specifications and noting that other archictures are also possible.
- In version -02 the mandated notification message types have been clarified.
- Port and protocol fields in the Identity payload have been mandated to be always zero for MAPSEC since version -02.
- The use of several key lengths in the context of e.g. AES has been clarified in -02.
- Section 4.3 has been replaced by a brief policy comment since version -02. Possible future requirement to always implement certificate handling may have to be accompanied by clear specifications on how certificate management has to be performed by MAPSEC DOI nodes.
- References to the IPSEC DOI, ISAKMP, and IKE requirements have been clarified to be relevant for Phase 1 only in section 3.5 and 4.6.2.

9. Intellectual property rights

Ericsson has patent applications which may cover parts of this technology. Should such applications become actual patents and be determined to cover parts of this specification, Ericsson

intends to provide licensing when implementing, using or distributing the technology under openly specified, reasonable, non-discriminatory terms.

10. Acknowledgments

This document is derived from the work done by the SA3 group of 3GPP. The authors wish to thank in particular David Castellanos-

Zamora, Krister Boman, Anders Liljekvist, Eeva Munter and others at Ericsson, and Tatu Ylonen and others at SSH Communications Security Corp, Marc Blommaert, Dirk Kroeselberg, and Ulrich Wiehe at Siemens, and Olivier Paridaens at Alcatel. This document is also currently undergoing review of the SA3 group.

11. References

[AH] Kent, S., and R. Atkinson, "IP Authentication Header", RFC 2402, November 1998.

[ARCH] Kent, S., and R. Atkinson, "Security Architecture for the Internet Protocol", RFC 2401, November 1998.

[ESP] Kent, S., and R. Atkinson, "IP Encapsulating Security Payload (ESP)", RFC 2406, November 1998.

[IKE] Harkins, D., and D. Carrel, D., "The Internet Key Exchange (IKE)", RFC 2409, November 1998.

[ISAKMP] Maughan, D., Schertler, M., Schneider, M., and J. Turner, "Internet Security Association and Key Management Protocol (ISAKMP)", RFC 2408, November 1998.

[IPSDOI] D. Piper, "The Internet IP Security Domain of Interpretation for ISAKMP", RFC 2407, November 1998.

[OAKLEY] Orman, H., "The OAKLEY Key Determination Protocol", RFC 2412, November 1998.

[NDSEC] 3rd Generation Partnership Project, Technical Specification Group SA3, Security "Network Domain Security (Release 4)", 3GPP TS 33.200, (Work In Progress), January, 2001.

[MPLS] E. Rosen, Y. Rekhter, "BGP/MPLS VPNs", RFC 2547, March 1999.

[MAP] 3rd Generation Partnership Project, Technical Specification Group Core Network, "Mobile Application Part (MAP) Specification (Release 4)", 3GPP TS 29.002, September, 2000.

12. Authors' Addresses

Jari Arkko
Oy LM Ericsson Ab
02420 Jorvas
Finland

Phone: +358 40 5079256
EMail: jari.arkko@ericsson.com

Rolf Blom
Ericsson Radio Systems AB
SE-16480 Stockholm
Sweden

Phone: +46 8 58531707
EMail: rolf.blom@era.ericsson.se

Full Copyright Statement