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Abstract

This document describes a Transport Model for the Simple Network Management Protocol (SNMP), that uses the Datagram Transport Layer Security (DTLS) protocol. The DTLS protocol provides authentication and privacy services for SNMP applications. This document describes how the DTLS Transport Model (DTLSTM) implements the needed features of a SNMP Transport Subsystem to make this protection possible in an interoperable way.

This transport model is designed to meet the security and operational needs of network administrators, operate in environments where a connectionless (UDP) transport is preferred, and integrates well into existing public keying infrastructures.

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SNMP over DTLS

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This document also defines a portion of the Management Information Base (MIB) for monitoring and managing the DTLS Transport Model for SNMP.

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## 1. Introduction

It is important to understand the SNMPv3 architecture [[RFC3411](#)], as enhanced by the Transport Subsystem [[I-D.ietf-isms-tsm](#)]. It is also important to understand the terminology of the SNMPv3 architecture in order to understand where the Transport Model described in this document fits into the architecture and how it interacts with the other architecture subsystems. For a detailed overview of the documents that describe the current Internet-Standard Management Framework, please refer to [Section 7 of \[RFC3410\]](#).

This document describes a Transport Model that makes use of the Datagram Transport Layer Security (DTLS) Protocol [[RFC4347](#)], the datagram variant of the existing and commonly deployed Transport Layer Security (TLS) protocol [[RFC4346](#)], within a transport subsystem [[I-D.ietf-isms-tsm](#)]. The Transport Model in this document is referred to as the Datagram Transport Layer Security Transport Model (DTLSTM). DTLS takes advantage of the X.509 public key infrastructure [[X509](#)]. This transport model is designed to meet the security and operational needs of network administrators, operate in environments where a connectionless (UDP) transport is preferred, and integrate well into existing public key infrastructure.

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. MIB objects are generally accessed through the Simple Network Management Protocol (SNMP). Objects in the MIB are defined using the mechanisms defined in the Structure of Management Information (SMI). This document specifies a MIB module that is compliant to the SMIV2, which is described in STD





In particular, where distinction is required the application names of "Command Generator", "Command Responder", "Notification Originator", "Notification Receiver", and "Proxy Forwarder" are used. See the "SNMP Applications" in [[RFC3413](#)] for further information.

Authentication in this document typically refers to source authentication or peer identity authentication performed in the transport subsystem.

Throughout this document, the terms "client" and "server" are used to refer to the two ends of the DTLS session. The client actively opens the DTLS session, and the server passively listens for the incoming DTLS session. Any SNMP entity may act as client or as server.

While security protocols frequently refer to a "user", the term used in [RFC3411](#) [[RFC3411](#)] and in this document is "principal". A principal is the "who" on whose behalf services are provided or processing takes place. A principal can be, among other things, an individual acting in a particular role; a set of individuals, with each acting in a particular role; an application or a set of applications, or a combination of these within an administrative domain.

Throughout this document, the term "session" is used to refer to a secure association between two DTLS Transport Models that permits the transmission of one or more SNMP messages within the lifetime of the session.

## [2.](#) The Datagram Transport Layer Security Protocol

The DTLS protocol is a datagram-compatible variant of the commonly

used Transport Layer Security (TLS) protocol. DTLS provides authentication, data message integrity, and privacy at the transport layer. (See [[RFC4347](#)])

The primary goals of the DTLS Transport Model are to provide privacy, source authentication and data integrity between two communicating SNMP entities. The DTLS protocol is composed of two layers: the DTLS Record Protocol and the DTLS Handshake Protocol. The following

sections provide an overview of these two layers. Please refer to [\[RFC4347\]](#) for a complete description of the protocol.

## [2.1.](#) The DTLS Record Protocol

At the lowest layer, layered on top of the transport protocol (UDP) is the DTLS Record Protocol.

The DTLS Record Protocol provides security that has three basic properties:

- o The session can be confidential. Symmetric cryptography is used for data encryption (e.g., AES [\[AES\]](#), DES [\[DES\]](#) etc.). The keys for this symmetric encryption are generated uniquely for each session and are based on a secret negotiated by another protocol (such as the DTLS Handshake Protocol). The Record Protocol can also be used without encryption.
- o Messages can have data integrity. Message transport includes a message integrity check using a keyed MAC. Secure hash functions (e.g., SHA, MD5, etc.) are used for MAC computations. The Record Protocol can operate without a MAC, but is generally only used in this mode while another protocol is using the Record Protocol as a transport for negotiating security parameters.
- o Messages are protected against replay. DTLS uses explicit sequence numbers, integrity checks, and a sliding window to protect against replay of messages within a session.

DTLS also provides protection against replay of entire sessions. In a properly-implemented keying material exchange, both sides will generate new random numbers for each exchange. This results in different encryption and integrity keys for every session.

## [2.2.](#) The DTLS Handshake Protocol

The DTLS Record Protocol is used for encapsulation of various higher-level protocols. One such encapsulated protocol, the DTLS Handshake Protocol, allows server and client to authenticate each other and to negotiate an encryption algorithm and cryptographic keys before the

application protocol transmits or receives its first octet of data.



Only the DTLS client can initiate the handshake protocol. The DTLS Handshake Protocol provides security that has three basic properties:

- o The peer's identity can be authenticated using asymmetric, or public key, cryptography (e.g., RSA [[RSA](#)], DSS [[DSS](#)], etc.). This authentication can be made optional, but is generally required by at least one of the peers.

DTLS supports three authentication modes: authentication of both the server and the client, server authentication with an unauthenticated client, and total anonymity. For authentication of both entities, each entity provides a valid certificate chain leading to an acceptable certificate authority. Each entity is responsible for verifying that the other's certificate is valid and has not expired or been revoked. The DTLS Transport Model SHOULD always use authentication of both the server and the client. At a minimum the DTLS Transport MUST support authentication of the Command Generator principals to guarantee the authenticity of the securityName (a parameter used to pass the authenticated identity name from the transport model to security model for even later use by the access control subsystem. See [Section 4.3.4](#)). The DTLS Transport SHOULD support the message encryption to protect sensitive data from eavesdropping attacks.

- o The negotiation of a shared secret is secure: the negotiated secret is unavailable to eavesdroppers, and for any authenticated handshake the secret cannot be obtained, even by an attacker who can place himself in the middle of the session.
- o The negotiation is not vulnerable to malicious modification: it is infeasible for an attacker to modify negotiation communication without being detected by the parties to the communication.
- o DTLS uses a stateless cookie exchange to protect against anonymous denial of service attacks and has retransmission timers, sequence numbers, and counters to handle message loss, reordering, and fragmentation.

### [3.](#) How the DTLSTM fits into the Transport Subsystem

A transport model is a component of the Transport Subsystem. The DTLS Transport Model thus fits between the underlying DTLS transport layer and the message Dispatcher [[RFC3411](#)] component of the SNMP engine and the Transport Subsystem [[I-D.ietf-isms-tsm](#)].

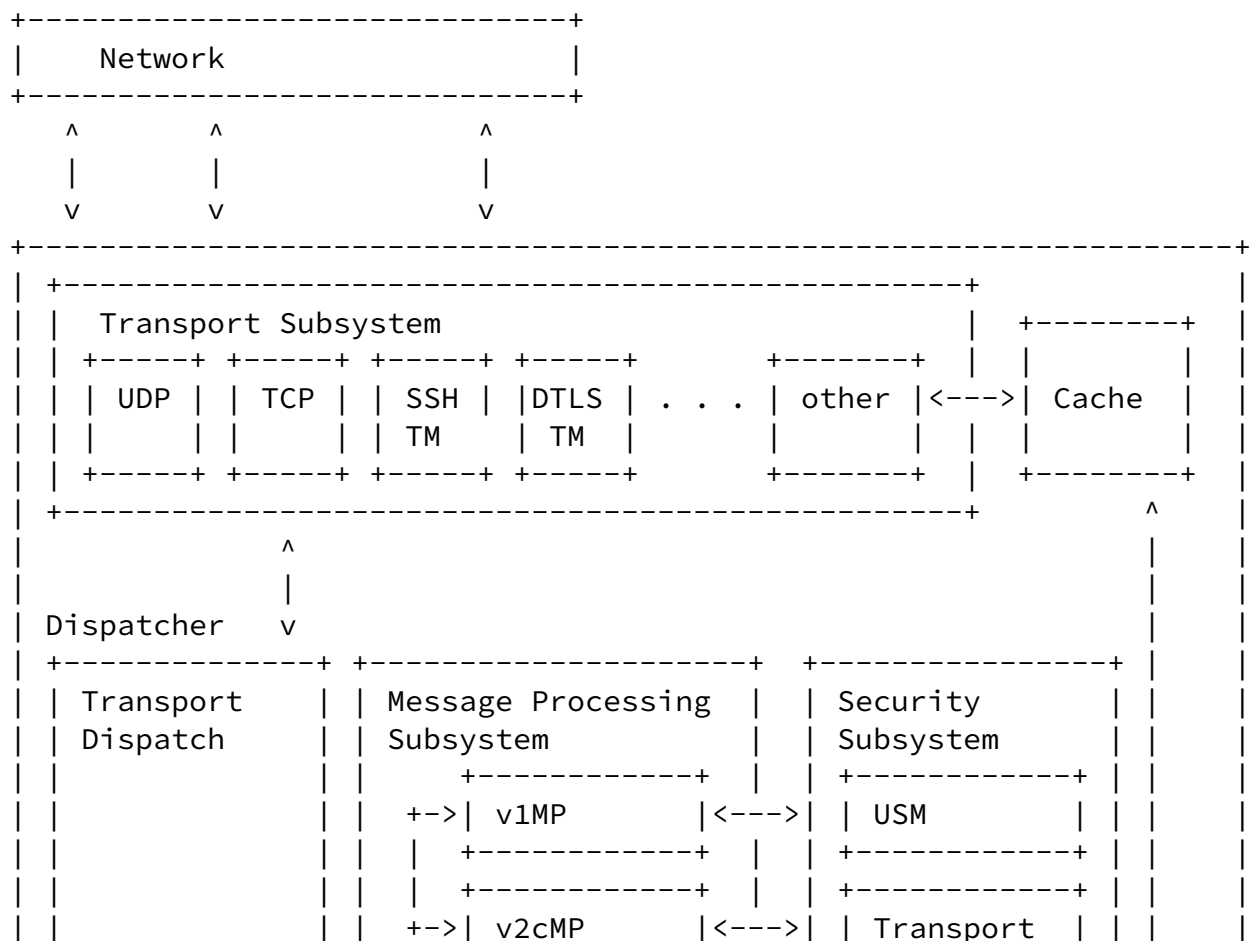
The DTLS Transport Model will establish a session between itself and

the DTLS Transport Model of another SNMP engine. The sending transport model passes unprotected messages from the dispatcher to DTLS to be protected, and the receiving transport model accepts decrypted and authenticated/integrity-checked incoming messages from DTLS and passes them to the dispatcher.

After a DTLS Transport model session is established, SNMP messages can conceptually be sent through the session from one SNMP message dispatcher to another SNMP message dispatcher. If multiple SNMP messages are needed to be passed between two SNMP applications they SHOULD be passed through the same session. A DTLSM implementation engine MAY choose to close a DTLS session to conserve resources.

The DTLS Transport Model of an SNMP engine will perform the translation between DTLS-specific security parameters and SNMP-specific, model-independent parameters.

The diagram below depicts where the DTLS Transport Model fits into the architecture described in [RFC3411](#) and the Transport Subsystem:





unauthorized manner, and data sequences have not been altered to an extent greater than can occur non-maliciously.

2. Masquerade - The masquerade threat is the danger that management operations unauthorized for a given principal may be attempted by assuming the identity of a principal with appropriate authorizations.

The DTLSTM provides for authentication of the Principal Command

Generator and Notification Generator and for authentication of the Command Responder, Notification Responder and Proxy Forwarder through the use of X.509 certificates.

The masquerade threat can be mitigated against by using an appropriate Access Control Model (ACM) such as the View-based Access Control Module (VACM) [[RFC3415](#)]. In addition, it is important to authenticate and verify both the authenticated identity of the DTLS client and the DTLS server to protect against this threat. (See Security Considerations for more detail.)

3. Message stream modification - The re-ordering, delay or replay of messages can and does occur through the natural operation of many connectionless transport services. The message stream modification threat is the danger that messages may be maliciously re-ordered, delayed or replayed to an extent which is greater than can occur through the natural operation of connectionless transport services, in order to effect unauthorized management operations.

DTLS provides replay protection with a MAC that includes a sequence number. DTLS uses a sliding window protocol with the sequence number for replay protection, see [[RFC4347](#)]. The technique used is the same as in IPsec AH/ESP [[RFC4302](#)] [[RFC4303](#)], by maintaining a bitmap window of received records. Records that are too old to fit in the window and records that have previously been received are silently discarded. The replay detection feature is optional, since packet duplication can also occur naturally due to routing errors and does not necessarily indicate an active attack. Applications may conceivably detect duplicate packets and accordingly modify their data transmission

strategy.

4. Disclosure - The disclosure threat is the danger of eavesdropping on the exchanges between SNMP engines. Protecting against this threat may be required as a matter of local policy.

Symmetric cryptography (e.g., AES [[AES](#)], DES [[DES](#)] etc.) can be used by DTLS for data privacy. The keys for this symmetric encryption are generated uniquely for each session and are based on a secret negotiated by another protocol (such as the DTLS Handshake Protocol).

5. Denial of Service - the [RFC 3411](#) architecture [[RFC3411](#)] states that denial of service (DoS) attacks need not be addressed by an SNMP security protocol. However, datagram security protocols are susceptible to a variety of denial of service attacks. Two

attacks are of particular concern:

- o An attacker can consume excessive resources on the server by transmitting a series of handshake initiation requests, causing the server to allocate state and potentially to perform expensive cryptographic operations.
- o An attacker can use the server as an amplifier by sending session initiation messages with a forged source of the victim. The server then sends its next message (in DTLS, a Certificate message, which can be quite large) to the victim machine, thus flooding it.

In order to counter both of these attacks, DTLS borrows the stateless cookie technique used by Photuris [[RFC2522](#)] and IKEv2 [[RFC4306](#)]. When the client sends its ClientHello message to the server, the server MAY respond with a HelloVerifyRequest message. This message contains a stateless cookie generated using the technique of [[RFC2522](#)]. The client MUST retransmit the ClientHello with the cookie added. The server then verifies the cookie and proceeds with the handshake only if it is valid. This mechanism forces the attacker/client to be able to receive the cookie, which makes DoS attacks with spoofed IP addresses difficult. This mechanism does not provide any defense against

denial of service attacks mounted from valid IP addresses.

Implementations are not required to perform the stateless cookie exchange for every DTLS handshakes but in environments where amplification could be an issue it is RECOMMENDED that the cookie exchange is utilized.

### 3.1.2. Security Level

The [RFC 3411](#) architecture recognizes three levels of security:

- o without authentication and without privacy (noAuthNoPriv)
- o with authentication but without privacy (authNoPriv)
- o with authentication and with privacy (authPriv)

The DTLS Transport Model determines from DTLS the identity of the authenticated principal, and the type and address associated with an incoming message, and the DTLS Transport Model provides this information to DTLS for an outgoing message.

When an application requests a session for a message, through the

cache, the application requests a security level for that session. The DTLS Transport Model MUST ensure that the DTLS session provides security at least as high as the requested level of security. How the security level is translated into the algorithms used to provide data integrity and privacy is implementation-dependent. However, the NULL integrity and encryption algorithms MUST NOT be used to fulfill security level requests for authentication or privacy. Implementations MAY choose to force DTLS to only allow cipher\_suites that provide both authentication and privacy to guarantee this assertion.

If a suitable interface between the DTLS Transport Model and the DTLS Handshake Protocol is implemented to allow the selection of security level dependent algorithms, for example a security level to cipher\_suites mapping table, then different security levels may be utilized by the application. However, different port numbers will need to be used by at least one side of the connection to differentiate between the DTLS sessions. This is the only way to

ensured proper selection of a session ID for an incoming DTLS message.

The authentication, integrity and privacy algorithms used by the DTLS Protocol [[RFC4347](#)] may vary over time as the science of cryptography continues to evolve and the development of DTLS continues over time. Implementers are encouraged to plan for changes in operator trust of particular algorithms and implementations should offer configuration settings for mapping algorithms to SNMPv3 security levels.

### [3.1.3.](#) DTLS Sessions

DTLS sessions are opened by the DTLS Transport Model during the elements of procedure for an outgoing SNMP message. Since the sender of a message initiates the creation of a DTLS session if needed, the DTLS session will already exist for an incoming message.

Implementations MAY choose to instantiate DTLS sessions in anticipation of outgoing messages. This approach might be useful to ensure that a DTLS session to a given target can be established before it becomes important to send a message over the DTLS session. Of course, there is no guarantee that a pre-established session will still be valid when needed.

DTLS sessions are uniquely identified within the DTLS Transport Model by the combination of `transportDomain`, `transportAddress`, `securityName`, and `requestedSecurityLevel` associated with each session. Each unique combination of these parameters MUST have a locally-chosen unique `dtlsSessionID` associated for active sessions. For further information see [Section 4.6](#) and [Section 5](#).

### [3.2.](#) Security Parameter Passing

For the DTLS server-side, DTLS-specific security parameters (i.e., `cipher_suites`, common name of X.509 certificate, IP address and port) are translated by the DTLS Transport Model into security parameters for the DTLS Transport Model and security model (i.e., `securityLevel`, `securityName`, `transportDomain`, `transportAddress`). The transport-related and DTLS-security-related information, including the authenticated identity, are stored in a cache referenced by `tmStateReference`.

For the DTLS client-side, the DTLS Transport Model takes input provided by the dispatcher in the `sendMessage()` Abstract Service Interface (ASI) and input from the `tmStateReference` cache. The DTLS Transport Model converts that information into suitable security parameters for DTLS and establishes sessions as needed.

The elements of procedure in [Section 5](#) discuss these concepts in much greater detail.

### [3.3](#). Notifications and Proxy

DTLS sessions may be initiated by DTLS clients on behalf of command generators or notification originators. Command generators are frequently operated by a human, but notification originators are usually unmanned automated processes. The targets to whom notifications should be sent is typically determined and configured by a network administrator.

The SNMP-TARGET-MIB module [[RFC3413](#)] contains objects for defining management targets, including `transportDomain`, `transportAddress`, `securityName`, `securityModel`, and `securityLevel` parameters, for Notification Generator, Proxy Forwarder, and SNMP-controllable Command Generator applications. Transport domain and transport address are configured in the `snmpTargetAddrTable`, and the `securityModel`, `securityName`, and `securityLevel` parameters are configured in the `snmpTargetParamsTable`. This document defines a MIB module that extends the SNMP-TARGET-MIB's `snmpTargetParamsTable` to specify a DTLS client-side certificate to use for the connection.

When configuring a DTLS target, the `snmpTargetAddrTDomain` and `snmpTargetAddrTAddress` parameters in `snmpTargetAddrTable` should be set to the `snmpDTLSDomain` object and an appropriate `snmpDTLSAddress` value respectively. The `snmpTargetParamsMPModel` column of the `snmpTargetParamsTable` should be set to the `XXX:TSM` value. The `snmpTargetParamsSecurityName` should be set to an appropriate `securityName` value and the `dtlstmParamsSubject` parameter of the `dtlstmParamsTable` should be set to the Subject of the locally held

certificate to be used. Other parameters, for example cipher suites, must come from configuration mechanisms not defined in this document. The other needed configuration may be configured using SNMP or other implementation-dependent mechanisms (such as via a CLI or a



configuration system). This securityName defined in the snmpTargetParamsSecurityName column will be used by the access control model to authorize any notifications that need to be sent.

## [4.](#) Elements of the Model

This section contains definitions required to realize the DTLS Transport Model defined by this document.

### [4.1.](#) Certificates

#### [4.1.1.](#) The Certificate Infrastructure

Users of a public key SHALL be confident that the associated private key is owned by the correct remote subject (person or system) with which an encryption or digital signature mechanism will be used. This confidence is obtained through the use of public key certificates, which are data structures that bind public key values to subjects. The binding is asserted by having a trusted CA digitally sign each certificate. The CA may base this assertion upon technical means (i.e., proof of possession through a challenge-response protocol), presentation of the private key, or on an assertion by the subject. A certificate has a limited valid lifetime which is indicated in its signed contents. Because a certificate's signature and timeliness can be independently checked by a certificate-using client, certificates can be distributed via untrusted communications and server systems, and can be cached in unsecured storage in certificate-using systems.

ITU-T X.509 (formerly CCITT X.509) or ISO/IEC/ITU 9594-8, which was first published in 1988 as part of the X.500 Directory recommendations, defines a standard certificate format [[X509](#)] which is a certificate which binds a subject (principal) to a public key value. This was later further documented in [[RFC5280](#)].

A X.509 certificate is a sequence of three required fields:

**tbsCertificate:** The field contains the names of the subject and issuer, a public key associated with the subject, a validity period, and other associated information. This field may also contain extensions.

**signatureAlgorithm:** The signatureAlgorithm field contains the identifier for the cryptographic algorithm used by the certificate authority (CA) to sign this certificate.

**signatureValue:** The signatureValue field contains a digital signature computed upon the ASN.1 DER encoded tbsCertificate field. The ASN.1 DER encoded tbsCertificate is used as the input to the signature function. This signature value is then ASN.1 encoded as a BIT STRING and included in the Certificate's signature field. By generating this signature, a CA certifies the validity of the information in the tbsCertificate field. In particular, the CA certifies the binding between the public key material and the subject of the certificate.

The basic X.509 authentication procedure is as follows: A system, which uses the X.509 key management infrastructure, is initialized with a number of root certificates which contain the public keys of a number of trusted CAs. When a system receives a X.509 certificate, signed by one of those CAs, that has to be verified, it first decrypts the signatureValue field by using the public key of the corresponding trusted CA. Then it compares the decrypted information with the tbsCertificate field. If they match, then the subject in the tbsCertificate field is authenticated.

#### [4.1.2.](#) Provisioning for the Certificate

Authentication using DTLS will require that SNMP entities are provisioned with certificates, which are signed by trusted certificate authorities. Furthermore, SNMP entities will most commonly need to be provisioned with root certificates which represent the list of trusted certificate authorities that an SNMP entity can use for certificate verification. SNMP entities MAY also be provisioned with X.509 certificate revocation mechanism which will be used to verify that a certificate has not been revoked.

The authenticated securityName of the principal is looked up using the dtlstmCertificateToSNTTable. This table maps the certificates issuer's distinguished name to a directly specified securityName or it specifies that the CommonName field of the certificate's Subject should be used as the securityName. The certificate trust anchors, being either CA certificates or public keys for use by self-signed certificates, must be installed through an out of band trusted mechanism into the server and its authenticity MUST be verified before access is granted. Implementations MAY choose to discard any connections for which no dtlstmCertificateToSNTTable mapping exists for the issuer to avoid the computational resources associated with a certificate verification check since the verified certificate would

be unusable anyway.

The typical setting will map the "CommonName" component of the Subject field in the tbsCertificate to the DTLSSM specific securityName. Thus, the authenticated identity can be verified by the DTLS Transport Model by extracting the CommonName from the Subject of the peer certificate and the receiving application will have an appropriate securityName for use by components like an access control model.

An example mapping setup can be found in [Appendix A](#)

[XXX: This securityName may be later translated from a DTLSSM specific securityName to a SNMP engine securityName by the TSM or TM component configuration. Waiting on discussion/resolution within the ISMS list about this].

#### [4.2.](#) Messages

As stated in [RFC4347](#), each DTLS message must fit within a single datagram. The DTLSTM MUST prohibit SNMP messages from being set that exceed the MTU size. The DTLSTM implementation MUST return an error when the MTU size would be exceeded and the message won't be sent.

For Ethernet the MTU size is 1500 and thus the maximum allowable SNMP message that can be sent over DTLSTM after UDP/IP/DTLS overhead is taken into account will be 1455 for IPv6 (MTU:1500 - IPv6:40 - UDP:8 - DTLS:13) and 1475 for IPv4 (MTU:1500 - IPv4:20 - UDP:8 - DTLS:13). From this integrity and encryption overhead also needs to be subtracted, which are integrity and encryption algorithm specific.

#### [4.3.](#) tmStateReference Cache

For the DTLS Transport Model, the session state is maintained using tmStateReference. Upon opening each DTLS session, the DTLS Transport Model stores model- and mechanism-specific information about the session in a cache, referenced by tmStateReference. An implementation might store the contents of the cache in a Local Configuration Datastore (LCD).

The following four parameters, referred to as tmSecurityData, are stored in the cache:

tmTransportDomain = Specified by the application

tmTransportAddress = Specified by the application

tmRequestedSecurityLevel = ["noAuthNoPriv" | "authNoPriv" | "authPriv" ] the security level requested by the application

tmSecurityLevel = ["noAuthNoPriv" | "authNoPriv" | "authPriv" ] the security level of the established DTLS session

tmSecurityName = the security name associated with a principal

The tmStateReference cache is used to pass a reference to the tmSecurityData between the DTLS Transport Model and the security model.

The DTLS Transport Model has the responsibility for releasing the complete tmStateReference and deleting the associated information when the session is destroyed.

#### [4.3.1.](#) tmTransportDomain and tmTransportAddress

The tmTransportDomain and tmTransportAddress identify the type and address of the DTLS transport endpoint. The domain for address types DTLS SHOULD be "snmpDTLSDomain" and the address should be one that conforms to the details specified in the "SnmpDTLSAddress" textual convention. These parameters are stored in a cache for active sessions and referenced by tmStateReference.

#### [4.3.2.](#) tmRequestedSecurityLevel

The tmRequestedSecurityLevel is the security level requested by the application. This parameter is set in the cache by the security model and used by DTLS Transport Model initiating a session to select the appropriate cipher\_suites and other configuration needed settings for establishing the session. The DTLS Transport Model MUST ensure that the actual security provided by the session (tmSecurityLevel) is at least as high as the requested security level (tmRequestedSecurityLevel).

#### [4.3.3.](#) tmSecurityLevel

The tmSecurityLevel is the actual security level of the established session. See [Section 3.1.2](#) for more detail about security levels. How the chosen cipher\_suites and other DTLS session parameters are translated into a security level at the DTLS Transport Model is implementation dependent and/or policy specific. Implementations MUST NOT use NULL algorithms for fulfilling authentication or encryption needs indicated by the tmSecurityLevel.

#### [4.3.4.](#) tmSecurityName

The tmSecurityName is the name of the principal on whose behalf the message is being sent. This field is set via the mapping defined in the dtlstmCertificateToSNTable when mapping incoming client

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connection certificates to a tmSecurityName. For outgoing connections, the application will specify the value that should be placed in this field possibly by extracting it from the SNMP-TARGET-MIB's snmpTargetParamsSecurityName value. The tmSecurityName is stored in a cache for active sessions and referenced by tmStateReference.

#### [4.4.](#) Transport Model LCD

Implementations may store DTLS-specific and model-specific information in a LCD. The DTLS session ID is one such parameter that could be stored in the LCD. When messages are to be routed for encapsulation or for integrity verification and decryption the message and the DTLS session ID must be passed to the DTLS transport layer for processing. Therefore, the DTLS Transport Model MUST maintain a one-to-one mapping between the DTLS session ID and the tmStateReference cache entry for that session. Implementations MAY choose to store the DTLS session ID in the tmStateReference cache to simplify the procedure.

#### [4.5.](#) SNMP Services

This section describes the services provided by the DTLS Transport Model with their inputs and outputs. The services are between the Transport Model and the Dispatcher.

The services are described as primitives of an abstract service interface (ASI) and the inputs and outputs are described as abstract data elements as they are passed in these abstract service primitives.

#### 4.5.1. SNMP Services for an Outgoing Message

The Dispatcher passes the information to the DTLS Transport Model using the ASI defined in the transport subsystem:

```
statusInformation =
sendMessage(
  IN    destTransportDomain      -- transport domain to be used
  IN    destTransportAddress     -- transport address to be used
  IN    outgoingMessage         -- the message to send
  IN    outgoingMessageLength    -- its length
  IN    tmStateReference         -- reference to transport state
)
```

The abstract data elements passed as parameters in the abstract service primitives are as follows:

**statusInformation:** An indication of whether the passing of the message was successful. If not it is an indication of the problem.

**destTransportDomain:** The transport domain for the associated destTransportAddress. The Transport Model uses this parameter to determine the transport type of the associated destTransportAddress. This parameter may also be used by the transport subsystem to route the message to the appropriate Transport Model.

**destTransportAddress:** The transport address of the destination DTLS Transport Model in a format specified by the SnmpDTLSAddress TEXTUAL-CONVENTION.

**outgoingMessage:** The outgoing message to send to DTLS for encapsulation.

**outgoingMessageLength:** The length of the outgoing message.

tmStateReference: A handle/reference to tmSecurityData to be used when securing outgoing messages.

#### [4.5.2.](#) SNMP Services for an Incoming Message

The DTLS Transport Model processes the received message from the network using the DTLS service and then passes it to the Dispatcher using the following ASI:

```
receiveMessage(  
  IN    transportDomain      -- origin transport domain  
  IN    transportAddress     -- origin transport address  
  IN    incomingMessage      -- the message received  
  IN    incomingMessageLength -- its length  
  IN    tmStateReference     -- reference to transport state  
)
```

The abstract data elements passed as parameters in the abstract service primitives are as follows:

statusInformation: An indication of whether the passing of the message was successful. If not it is an indication of the problem.

transportDomain: The transport domain for the associated transportAddress.

transportAddress: The transport address of the source of the received message in a format specified by the SnmpDTLSAddress TEXTUAL-CONVENTION.

incomingMessage: The whole SNMP message stripped of all DTLS protection data.

incomingMessageLength: The length of the SNMP message after being processed by DTLS.

tmStateReference: A handle/reference to tmSecurityData to be used by the security model.

#### [4.6.](#) DTLS Services

This section describes the services provided by the DTLS Transport Model with their inputs and outputs. These services are between the DTLS Transport Model and the DTLS transport layer. The following sections describe services for establishing and closing a session and for passing messages between the DTLS transport layer and the DTLS Transport Model.

##### [4.6.1.](#) Services for Establishing a Session

The DTLS Transport Model provides the following ASI to describe the data passed between the Transport Model and the DTLS transport layer for session establishment.

```
statusInformation =          -- errorIndication or success
openSession(
IN  destTransportDomain      -- transport domain to be used
IN  destTransportAddress     -- transport address to be used
IN  securityName             -- on behalf of this principal
IN  securityLevel            -- Level of Security requested
OUT dtlsSessionID           -- Session identifier for DTLS
)
```

The abstract data elements passed as parameters in the abstract service primitives are as follows:

statusInformation: An indication of whether the process was successful or not. If not, then the status information will include the error indication provided by DTLS.

destTransportDomain: The transport domain for the associated destTransportAddress. The DTLS Transport Model uses this parameter to determine the transport type of the associated destTransportAddress.



destTransportAddress: The transport address of the destination DTLS Transport Model in a format specified by the SnmpDTLSAddress TEXTUAL-CONVENTION.

securityName: The security name representing the principal on whose behalf the message will be sent.

securityLevel: The level of security requested by the application.

dtlsSessionID: An implementation-dependent session identifier to reference the specific DTLS session.

The procedural details for establishing a session are further described in [Section 5.3](#).

Upon completion of the process the DTLS Transport Model returns status information and, if the process was successful the dtlsSessionID and other implementation-dependent data from DTLS are also returned. The dtlsSessionID is stored in an implementation-dependent manner and tied to the tmSecurityData for future use of this session.

#### [4.6.2](#). DTLS Services for an Incoming Message

When the DTLS Transport Model invokes the DTLS record layer to verify proper security for the incoming message, it must use the following ASI:

```
statusInformation =          -- errorIndication or success
dtlsRead(
IN   dtlsSessionID          -- Session identifier for DTLS
IN   wholeDtlsMsg           -- as received on the wire
IN   wholeDtlsMsgLength     -- length as received on the wire
OUT  incomingMessage        -- the whole SNMP message from DTLS
OUT  incomingMessageLength  -- the length of the SNMP message
)
```

The abstract data elements passed as parameters in the abstract service primitives are as follows:

**statusInformation:** An indication of whether the process was successful or not. If not, then the status information will include the error indication provided by DTLS.

**dtlsSessionID:** An implementation-dependent session identifier to reference the specific DTLS session. How the DTLS session ID is obtained for each message is implementation-dependent. As an implementation hint, the DTLS Transport Model can examine incoming messages to determine the source IP address and port number and use these values to look up the local DTLS session ID in the list of active sessions.

**wholeDtlsMsg:** The whole message as received on the wire.

**wholeDtlsMsgLength:** The length of the message as it was received on the wire.

**incomingMessage:** The whole SNMP message stripped of all DTLS privacy and integrity data.

**incomingMessageLength:** The length of the SNMP message stripped of all DTLS privacy and integrity data.

#### [4.6.3.](#) DTLS Services for an Outgoing Message

When the DTLS Transport Model invokes the DTLS record layer to encapsulate and transmit a SNMP message, it must use the following ASI.

```
statusInformation =          -- errorIndication or success
dtlsWrite(
IN   dtlsSessionID          -- Session identifier for DTLS
IN   outgoingMessage        -- the message to send
IN   outgoingMessageLength  -- its length
)
```

The abstract data elements passed as parameters in the abstract service primitives are as follows:

**statusInformation:** An indication of whether the process was successful or not. If not, then the status information will include the error indication provided by DTLS.

**dtlsSessionID:** An implementation-dependent session identifier to reference the specific DTLS session that the message should be sent using.

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`outgoingMessage`: The outgoing message to send to DTLS for encapsulation.

`outgoingMessageLength`: The length of the outgoing message.

## [5.](#) Elements of Procedure

Abstract service interfaces have been defined by [RFC 3411](#) to describe the conceptual data flows between the various subsystems within an SNMP entity. The DTLSTM uses some of these conceptual data flows when communicating between subsystems. These [RFC 3411](#)-defined data flows are referred to here as public interfaces.

To simplify the elements of procedure, the release of state information is not always explicitly specified. As a general rule, if state information is available when a message gets discarded, the message-state information should also be released. If state information is available when a session is closed, the session state information should also be released. Sensitive information, like cryptographic keys, should be overwritten with zero value or random value data prior to being released.

An error indication may return an OID and value for an incremented counter if the information is available at the point where the error is detected.

### [5.1.](#) Receiving an Incoming Message

The following section describes the procedures followed by the DTLS Transport Model when it receives a DTLS protected packet. A process for multiplexing sessions must be incorporated into the procedures for an incoming message. Steps one through four of this section describe how this is done. This procedure assumes that upon session establishment, a transport mapping table is created in the Transport Model LCD. The transport mapping table associates `dtlsSessionID` with the source and destination addresses and ports used for the session. It also assumes that the LCD entry is tied to the cache entry so the `tmStateReference` can be retrieved for the `receiveMessage()` ASI.

- 1) The DTLS Transport Model examines the message, in an implementation-dependent manner, to determine the transport

parameters for the received message.

As an implementation hint, the source and destination addresses and ports of the message should uniquely assign the message to a specific session. However, another implementation-dependent method may be used if so desired.

- 2) The DTLS Transport Model queries the LCD using the transport parameters to determine if a session already exists and its `dtlsSessionID`.
- 3) If a matching entry in the LCD does not exist then the message is discarded. Increment the `dtlstmSessionNoAvailableSessions` counter and stop processing the message.

Note that an entry would already exist if the client and server's session establishment procedures had been successfully completed (as described in [Section 5.3](#)) even if no message had been sent through the newly established session. An entry may not exist, however, because of a "rogue" message being routed to the SNMP entity by mistake but it could also be the result of a "broken" session (see operational considerations).

- 4) If a matching entry is found, the `dtlsSessionID` is retrieved from the LCD.
- 5) The `dtlsWholeMsg` and `dtlsSessionID` are passed to DTLS for decryption and integrity checking using the `dtlsRead()` ASI.
- 6) If the message fails integrity checks or other DTLS security processing then the message is discarded by DTLS and an error indication may be returned by DTLS.
- 7) If the message passes all integrity checks and DTLS security processing then the message is returned to the DTLS Transport Model as a `wholeMessage`.
- 8) The DTLS Transport Model retrieves the `tmStateReference` for the message and passes the message to the dispatcher using the `receiveMessage()` ASI.

## [5.2](#). Sending an Outgoing Message

This section describes the procedure followed by the DTLS Transport Model whenever it sends an outgoing SNMP message to another SNMP engine.

- 1) Determine if there is an active session for the `tmStateReference` and determine in an implementation-dependent way if this is the first message to be passed through the session.

As an implementation hint, the DTLS Transport Model can examine its cache and the LCD to determine if there is a cache entry with an existing established session. If this is the first message then there should be a cache entry with `tmSecurityData` associated

with the `tmStateReference` but there will be no LCD entry containing the `dtlsSessionID` yet.

- 2a) If there is an active session then determine the `dtlsSessionID` and pass the `outgoingMessage` to the DTLS record layer for encapsulation and transmission. Processing for this message is complete.
- 2b) If there is no active session and this is not the first message, discard the message, increment the `dtlstmSessionNoAvailableSessions` counter, and return an error indication to the calling module. Processing for this message is complete.
- 2c) If there is no active session associated with the `tmStateReference` and this is the first message, open a session with the remote SNMP engine using the `openSession()` ASI (discussed further in [Section 4.6.1](#)). Implementations MAY wish to offer message buffering to prevent redundant `openSession()` calls for the same cache entry.
- 3a) If an error is returned from `OpenSession()`, then discard the message, increment the `dtlstmSessionOpenErrors`, and return an error indication to the calling module.
- 3b) If `openSession()` is successful, then pass the `outgoingMessage` to DTLS for encapsulation and transmission.

### [5.3.](#) Establishing a Session

The `openSession()` ASI, as mentioned in [Section 4.6.1](#), is used to establish a DTLS session.

The following sections describe the procedures followed by a DTLS Transport Model when establishing a session as a Command Generator, a Notification Originator or as part of a Proxy Forwarder.

The following describes the procedure to follow to establish a session between SNMP engines to exchange SNMP messages. This process is followed by any SNMP engine establishing a session for subsequent use.

This MAY be done automatically for SNMP messages which are not Response or Report messages.

DTLS provides no explicit manner for transmitting an identity the client wishes to connect to during or prior to key exchange to facilitate certificate selection at the server (e.g. at a

Notification Receiver). I.E., there is no available mechanism for sending notifications to a specific principal at a given UDP/port combination. Therefore, implementations MAY support responding with multiple identities using separate UDP port numbers to indicate the desired principal or some other implementation-dependent solution.

- 1) The client selects the appropriate certificate and `cipher_suites` for the key agreement based on the `tmSecurityName` and the `tmRequestedSecurityLevel` for the session. For sessions being established as a result of a SNMP-TARGET-MIB based operation, the certificate will potentially have been identified via the `dtlstmParamsTable` mapping and the `cipher_suites` will have to be taken from system-wide or implementation-specific configuration. Otherwise, the certificate and appropriate `cipher_suites` will need to be passed to the `openSession()` ASI as supplemental information or configured through an implementation-dependent mechanism. It is also implementation-dependent and possibly policy-dependent how `tmRequestedSecurityLevel` will be used to influence the security capabilities provided by the DTLS session. However this is done, the security capabilities provided by DTLS MUST be at least as high as the level of security indicated by

the `tmRequestedSecurityLevel` parameter. The actual security level of the session should be reported in the `tmStateReference` cache as `tmSecurityLevel`. For DTLS to provide strong authentication, each principal acting as a Command Generator SHOULD have its own certificate.

- 2) Using the `destTransportDomain` and `destTransportAddress` values, the client will initiate the DTLS handshake protocol to establish session keys for message integrity and encryption.

If the attempt to establish a session is unsuccessful, then `dtlstmSessionOpenErrors` is incremented, an error indication is returned, and session establishment processing stops.

- 3) Once the secure session is established and both sides have been authenticated, the DTLS server side of the connection identifies the authenticated identity from the DTLS client's principal certificate using the `dtlstmCertificateToSNTTable` mapping table and records this in the `tmStateReference` cache as `tmSecurityName`.
- 4) The DTLS client side of the connection SHOULD verify that authenticated identity of the DTLS server's certificate is the expected identity and MUST do so if the application is a Notification Generator. If strong authentication is desired then DTLS server certificate MUST always be verified and checked against the expected identity. DTLS provides assurance that the authenticated identity has been signed by a trusted configured

certificate authority.

- 5) The DTLS-specific session identifier is passed to the DTLS Transport Model and associated with the `tmStateReference` cache entry to indicate that the session has been established successfully and to point to a specific DTLS session for future use.

#### [5.4.](#) Closing a Session

The DTLS Transport Model provides the following primitive to close a session:

```
statusInformation =  
closeSession(  
IN  tmStateReference      -- transport info  
)
```

The following describes the procedure to follow to close a session between a client and server. This process is followed by any SNMP engine closing the corresponding SNMP session.

- 1) Look up the session in the cache and the LCD using the tmStateReference.
- 2) If there is no session open associated with the tmStateReference, then closeSession processing is completed.
- 3) Delete the entry from the cache and any other implementation-dependent information in the LCD.
- 4) Have DTLS close the specified session. This SHOULD include sending a close\_notify TLS Alert to inform the other side that session cleanup may be performed.

## [6.](#) MIB Module Overview

This MIB module provides management of the DTLS Transport Model. It defines needed textual conventions, statistical counters and configuration infrastructure necessary for session establishment. Example usage of the configuration tables can be found in [Appendix A](#).

### [6.1.](#) Structure of the MIB Module

Objects in this MIB module are arranged into subtrees. Each subtree is organized as a set of related objects. The overall structure and

assignment of objects to their subtrees, and the intended purpose of each subtree, is shown below.

### [6.2.](#) Textual Conventions

Generic and Common Textual Conventions used in this module can be found summarized at <http://www.ops.ietf.org/mib-common-tcs.html>



This module defines two new Textual Conventions: a new TransportDomain and TransportAddress format for describing DTLS connection addressing requirements.

### [6.3.](#) Statistical Counters

The DTLSTM-MIB defines some statical counters that can provide network managers with feedback about DTLS session usage and potential errors that a MIB-instrumented device may be experiencing.

### [6.4.](#) Configuration Tables

The DTLSTM-MIB defines configuration tables that a manager can use for help in configuring a MIB-instrumented device for sending and receiving SNMP messages over DTLS. In particular, there is a MIB table that extends the SNMP-TARGET-MIB for configuring certificates to be used and a MIB table for mapping incoming DTLS client certificates to securityNames.

### [6.5.](#) Relationship to Other MIB Modules

Some management objects defined in other MIB modules are applicable to an entity implementing the DTLS Transport Model. In particular, it is assumed that an entity implementing the DTLSTM-MIB will implement the SNMPv2-MIB [[RFC3418](#)], the SNMP-FRAMEWORK-MIB [[RFC3411](#)], the SNMP-TARGET-MIB [[RFC3413](#)], the SNMP-NOTIFICATION-MIB [[RFC3413](#)] and the SNMP-VIEW-BASED-ACM-MIB [[RFC3415](#)].

This MIB module is for managing DTLS Transport Model information.

#### [6.5.1.](#) MIB Modules Required for IMPORTS

The following MIB module imports items from SNMPV2-SMI [[RFC2578](#)], SNMPV2-TC [[RFC2579](#)], SNMP-FRAMEWORK-MIB [[RFC3411](#)], SNMP-TARGET-MIB [[RFC3413](#)] and SNMP-CONF [[RFC2580](#)].

## [7.](#) MIB Module Definition

DTLSTM-MIB DEFINITIONS ::= BEGIN

IMPORTS

MODULE-IDENTITY, OBJECT-TYPE,  
OBJECT-IDENTITY, snmpModules, snmpDomains,  
Counter32, Unsigned32  
FROM SNMPv2-SMI  
TEXTUAL-CONVENTION, TimeStamp, RowStatus, StorageType  
FROM SNMPv2-TC  
MODULE-COMPLIANCE, OBJECT-GROUP  
FROM SNMPv2-CONF  
SnmAdminString  
FROM SNMP-FRAMEWORK-MIB  
snmpTargetParamsEntry  
FROM SNMP-TARGET-MIB  
;

dtlstmMIB MODULE-IDENTITY

LAST-UPDATED "200807070000Z"  
ORGANIZATION " "  
CONTACT-INFO "WG-EMail:  
Subscribe:

Chairs:

Co-editors:

"

DESCRIPTION "The DTLS Transport Model MIB

Copyright (C) The IETF Trust (2007). This  
version of this MIB module is part of RFC XXXX;  
see the RFC itself for full legal notices.

-- NOTE to RFC editor: replace XXXX with actual RFC number  
-- for this document and remove this note  
"

REVISION "200807070000Z"

DESCRIPTION "The initial version, published in RFC XXXX.

-- NOTE to RFC editor: replace XXXX with actual RFC number  
-- for this document and remove this note  
"

::= { snmpModules xxxx }

-- RFC Ed.: replace xxxx with IANA-assigned number and  
-- remove this note

-- \*\*\*\*\*  
-- subtrees of the SNMP-DTLS-TM-MIB

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```
-- *****
```

```
dtlstmNotifications OBJECT IDENTIFIER ::= { dtlstmMIB 0 }
dtlstmObjects        OBJECT IDENTIFIER ::= { dtlstmMIB 1 }
dtlstmConformance    OBJECT IDENTIFIER ::= { dtlstmMIB 2 }
```

```
-- *****
```

```
-- Objects
```

```
-- *****
```

```
snmpDTLSDomain OBJECT-IDENTITY
```

```
    STATUS      current
```

```
    DESCRIPTION
```

```
        "The SNMP over DTLS transport domain. The corresponding
        transport address is of type SnmpDTLSAddress."
```

```
        When an SNMP entity uses the snmpDTLSDomain transport
        model, it must be capable of accepting messages up to
        the maximum MTU size for an interface it supports, minus the
        needed IP, UDP, DTLS and other protocol overheads."
```

```
 ::= { snmpDomains yy }
```

```
-- RFC Ed.: replace yy with IANA-assigned number and
--           remove this note
```

```
SnmpDTLSAddress ::= TEXTUAL-CONVENTION
```

```
    DISPLAY-HINT "1a"
```

```
    STATUS      current
```

```
    DESCRIPTION
```

```
        "Represents a UDP connection address for an IPv4 address,
        an IPv6 address or an ASCII encoded host name and port
        number."
```

```
        The hostname must be encoded in ASCII, as specified in
        RFC3490 (Internationalizing Domain Names in Applications)
        followed by a colon ':' (ASCII character 0x3A) and a
        decimal port number in ASCII. The name SHOULD be fully
        qualified whenever possible.
```

```
        An IPv4 address must be a dotted decimal format followed by
        a colon ':' (ASCII character 0x3A) and a decimal port
        number in ASCII.
```

An IPv6 address must be a colon separated format, surrounded by square brackets (ASCII characters 0x5B and 0x5D), followed by a colon ':' (ASCII character 0x3A) and a decimal port number in ASCII.

Values of this textual convention may not be directly usable as transport-layer addressing information, and may require run-time resolution. As such, applications that write them must be prepared for handling errors if such values are not supported, or cannot be resolved (if resolution occurs at the time of the management operation).

The DESCRIPTION clause of TransportAddress objects that may have snmpDTLSAddress values must fully describe how (and when) such names are to be resolved to IP addresses and vice versa.

This textual convention SHOULD NOT be used directly in object definitions since it restricts addresses to a specific format. However, if it is used, it MAY be used either on its own or in conjunction with TransportAddressType or TransportDomain as a pair.

When this textual convention is used as a syntax of an index object, there may be issues with the limit of 128 sub-identifiers specified in SMIV2, STD 58. It is RECOMMENDED that all MIB documents using this textual convention make explicit any limitations on index component lengths that management software must observe. This may be done either by including SIZE constraints on the index components or by specifying applicable constraints in the conceptual row DESCRIPTION clause or in the surrounding documentation."

SYNTAX OCTET STRING (SIZE (1..255))

-- The dtlstmSession Group

dtlstmSession OBJECT IDENTIFIER ::= { dtlstmObjects 1 }

dtlstmSessionOpens OBJECT-TYPE

```

SYNTAX      Counter32
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION "The number of times an openSession() request has been
            executed, whether it succeeded or failed."
 ::= { dtlstmSession 1 }

```

```

dtlstmSessionCloses  OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION "The number of times a closeSession() request has been

```

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```

            executed, whether it succeeded or failed."
 ::= { dtlstmSession 2 }

```

```

dtlstmSessionOpenErrors  OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION "The number of times an openSession() request
            failed to open a Session, for any reason."
 ::= { dtlstmSession 3 }

```

```

dtlstmSessionNoAvailableSessions  OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION "The number of times an outgoing message was dropped
            because the session associated with the passed
            tmStateReference was no longer (or was never)
            available."
 ::= { dtlstmSession 4 }

```

-- Configuration Objects

```

dtlstmConfig          OBJECT IDENTIFIER ::= { dtlstmObjects 2 }

```

-- Certificate mapping

```

dtlstmCertificateMapping  OBJECT IDENTIFIER ::= { dtlstmConfig 1 }

```

dtlstmCertificateToSNCount OBJECT-TYPE

SYNTAX Unsigned32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"A count of the number of entries in the  
dtlstmCertificateToSNTable"

::= { dtlstmCertificateMapping 1 }

dtlstmCertificateToSNTableLastChanged OBJECT-TYPE

SYNTAX TimeStamp

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The value of sysUpTime.0 when the dtlstmCertificateToSNTable  
was last modified through any means, or 0 if it has not been  
modified since the command responder was started."

::= { dtlstmCertificateMapping 2 }

dtlstmCertificateToSNTable OBJECT-TYPE

SYNTAX SEQUENCE OF DtlstmCertificateToSNEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"A table listing the X.509 certificates known to the entity  
and the associated method for determining the SNMPv3 security  
name from a certificate.

On an incoming DTLS/SNMP connection the client's presented  
certificate should be examined and validated based on  
an established trusted CA certificate or self-signed public  
certificate. This table does not provide  
a mechanism for uploading the certificates as that is expected  
to occur through an out-of-band transfer.

Once the authenticity of the certificate has been verified,  
this table can be consulted to determine the appropriate  
securityName to identify the remote connection. This is done  
by comparing the issuer's distinguished name against the  
dtlstmCertDN value. If a matching entry is found then the  
securityName is selected based on the dtlstmCertMapType,

dtlstmCertSubject and dtlstmCertSecurityName fields and the resulting securityName is used to identify the other side of the DTLS connection.

Users are encouraged to make use of certificates with CommonName fields that can be used as securityNames so that a single root CA certificate can allow all child certificate's CommonName to map directly to a securityName via a 1:1 transformation. However, this table is flexible enough to allow for situations where existing an existing deployed certificate infrastructures dose not provide adequate CommonName values for use as SNMPv3 securityNames."

::= { dtlstmCertificateMapping 3 }

dtlstmCertificateToSNEEntry OBJECT-TYPE

SYNTAX DtlstmCertificateToSNEEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"A row in the dtlstmCertificateToSNTTable that specifies a mapping for an incoming DTLS certificate to a securityName to use for the connection."

INDEX { dtlstmCertID }

::= { dtlstmCertificateToSNTTable 1 }

DtlstmCertificateToSNEEntry ::= SEQUENCE {

dtlstmCertID            Unsigned32,  
dtlstmCertIssuerDN    OCTET STRING,  
dtlstmCertMapType     INTEGER,  
dtlstmCertSecurityName SnmpAdminString,  
dtlstmCertStorageType StorageType,  
dtlstmCertRowStatus   RowStatus

}

dtlstmCertID OBJECT-TYPE

SYNTAX Unsigned32

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"A unique arbitrary number index for a given certificate entry."

```

 ::= { dtlstmCertificateToSNEEntry 1 }

dtlstmCertIssuerDN OBJECT-TYPE
    SYNTAX      OCTET STRING
    MAX-ACCESS  read-create
    STATUS      current
    DESCRIPTION
        "The issuer's 'distinguished name' field matching the
        certificate to be used for this mapping entry.
        "
--      XXX: allow specification via serial no too?
 ::= { dtlstmCertificateToSNEEntry 2 }

dtlstmCertMapType OBJECT-TYPE
    SYNTAX      INTEGER { specified(1), byCN(2) }
    MAX-ACCESS  read-create
    STATUS      current
    DESCRIPTION
        "The mapping type used to obtain the securityName from the
        certificate. The possible values of use and their usage
        methods are defined as follows:

        specified(1): The securityName that should be used locally to
                        identify the remote entity is directly specified
                        in the dtlstmCertSecurityName column from this
                        table.

        byCN(2):      The securityName that should be used locally to
                        identify the remote entity should be taken from
                        the CommonName portion of the Subject field from
                        the X.509 certificate."
    DEFVAL { specified }
 ::= { dtlstmCertificateToSNEEntry 3 }

```

```

dtlstmCertSecurityName OBJECT-TYPE
    SYNTAX      SmpAdminString (SIZE(0..32))
    MAX-ACCESS  read-create
    STATUS      current
    DESCRIPTION
        "The securityName that the session should use if the
        dtlstmCertMapType is set to specified(1), otherwise the value
        in this column should be ignored. If dtlstmCertMapType is set

```



to specified(1) and this column contains a zero-length string (which is not a legal securityName value) this row is effectively disabled and the match will not be considered successful."

DEFVAL { "" }

::= { dtlstmCertificateToSNEEntry 4 }

dtlstmCertStorageType OBJECT-TYPE

SYNTAX StorageType

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The storage type for this conceptual row. Conceptual rows having the value 'permanent' need not allow write-access to any columnar objects in the row."

DEFVAL { nonVolatile }

::= { dtlstmCertificateToSNEEntry 5 }

dtlstmCertRowStatus OBJECT-TYPE

SYNTAX RowStatus

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The status of this conceptual row. This object may be used to create or remove rows from this table.

The value of this object has no effect on whether other objects in this conceptual row can be modified."

::= { dtlstmCertificateToSNEEntry 6 }

-- Maps securityNames to certificates for use by the SNMP-TARGET-MIB

dtlstmParamsCount OBJECT-TYPE

SYNTAX Unsigned32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"A count of the number of entries in the dtlstmParamsTable"

::= { dtlstmCertificateMapping 4 }

dtlstmParamsTableLastChanged OBJECT-TYPE

SYNTAX TimeStamp

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The value of sysUpTime.0 when the dtlstmParamsTable was last modified through any means, or 0 if it has not been modified since the command responder was started."

::= { dtlstmCertificateMapping 5 }

dtlstmParamsTable OBJECT-TYPE

SYNTAX SEQUENCE OF DtlstmParamsEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This table augments the SNMP-TARGET-MIB's snmpTargetParamsTable with additional a DTLS client-side certificate identifier to use when establishing new DTLS connections."

::= { dtlstmCertificateMapping 6 }

dtlstmParamsEntry OBJECT-TYPE

SYNTAX DtlstmParamsEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"A conceptual row containing the certificate subject name for a given snmpTargetParamsEntry. The values in this row should be ignored if not the connection that needs to be established, as indicated by the SNMP-TARGET-MIB infrastructure, is not a DTLS based connection."

AUGMENTS { snmpTargetParamsEntry }

::= { dtlstmParamsTable 1 }

DtlstmParamsEntry ::= SEQUENCE {

dtlstmParamsSubject OCTET STRING,

dtlstmParamsStorageType StorageType,

dtlstmParamsRowStatus RowStatus

}

dtlstmParamsSubject OBJECT-TYPE

SYNTAX OCTET STRING (SIZE(1..4096))

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The subject name of the locally-held X.509 certificate that

---

```
        should be used when initiating a DTLS connection as a DTLS
        client."
 ::= { dtlstmParamsEntry 1 }

dtlstmParamsStorageType OBJECT-TYPE
    SYNTAX      StorageType
    MAX-ACCESS   read-create
    STATUS      current
    DESCRIPTION
        "The storage type for this conceptual row. Conceptual rows
        having the value 'permanent' need not allow write-access to
        any columnar objects in the row."
    DEFVAL      { nonVolatile }
 ::= { dtlstmParamsEntry 2 }

dtlstmParamsRowStatus OBJECT-TYPE
    SYNTAX      RowStatus
    MAX-ACCESS   read-create
    STATUS      current
    DESCRIPTION
        "The status of this conceptual row. This object may be used
        to create or remove rows from this table.

        The value of this object has no effect on whether
        other objects in this conceptual row can be modified."
 ::= { dtlstmParamsEntry 3 }

-- *****
-- dtlstmMIB - Conformance Information
-- *****

dtlstmCompliances OBJECT IDENTIFIER ::= { dtlstmConformance 1 }

dtlstmGroups OBJECT IDENTIFIER ::= { dtlstmConformance 2 }

-- *****
-- Compliance statements
-- *****

dtlstmCompliance MODULE-COMPLIANCE
    STATUS      current
    DESCRIPTION
        "The compliance statement for SNMP engines that support the
```

```
MANDATORY-GROUPS { dtlstmStatsGroup,
                    dtlstmIncomingGroup, dtlstmOutgoingGroup }
 ::= { dtlstmCompliances 1 }

-- *****
-- Units of conformance
-- *****
dtlstmStatsGroup OBJECT-GROUP
  OBJECTS {
    dtlstmSessionOpens,
    dtlstmSessionCloses,
    dtlstmSessionOpenErrors,
    dtlstmSessionNoAvailableSessions
  }
  STATUS      current
  DESCRIPTION "A collection of objects for maintaining
               statistical information of an SNMP engine which
               implements the SNMP DTLS Transport Model."
  ::= { dtlstmGroups 1 }

dtlstmIncomingGroup OBJECT-GROUP
  OBJECTS {
    dtlstmCertificateToSNCount,
    dtlstmCertificateToSNTableLastChanged,
    dtlstmCertIssuerDN,
    dtlstmCertMapType,
    dtlstmCertSecurityName,
    dtlstmCertStorageType,
    dtlstmCertRowStatus
  }
  STATUS      current
  DESCRIPTION "A collection of objects for maintaining
               incoming connection certificate mappings to
               securityNames of an SNMP engine which implements the
               SNMP DTLS Transport Model."
  ::= { dtlstmGroups 2 }

dtlstmOutgoingGroup OBJECT-GROUP
  OBJECTS {
```

```

        dtlstmParamsCount,
        dtlstmParamsTableLastChanged,
        dtlstmParamsSubject,
        dtlstmParamsStorageType,
        dtlstmParamsRowStatus
    }
    STATUS      current
    DESCRIPTION "A collection of objects for maintaining
                outgoing connection certificates to use when opening

```

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```

        connections as a result of SNMP-TARGET-MIB settings."
    ::= { dtlstmGroups 3 }

```

END

## [8.](#) Operational Considerations

A session is discussed throughout this document as meaning a security association between the DTLS client and the DTLS server. State information for the sessions are maintained in each DTLSTM and this information is created and destroyed as sessions are opened and closed. Because of the connectionless nature of UDP, a "broken" session, one side up one side down, could result if one side of a session is brought down abruptly (i.e., reboot, power outage, etc.). Whenever possible, implementations SHOULD provide graceful session termination through the use of disconnect messages. Implementations SHOULD also have a system in place for dealing with "broken" sessions.

To simplify session management it is RECOMMENDED that implementations utilize two separate ports, one for Notification sessions and one for Command sessions. If this implementation recommendation is followed, DTLS clients will always send REQUEST messages and DTLS servers will always send RESPONSE messages. With this assertion, implementations may be able to simplify "broken" session handling, session resumption, and other aspects of session management such as guaranteeing that Request- Response pairs use the same session.

Depending on the algorithms used for generation of the master session secret, the privacy and integrity algorithms used to protect messages, the environment of the session, the amount of data

transferred, and the sensitivity of the data, a time-to-live (TTL) value SHOULD be established for sessions. An upper limit of 24 hours is suggested for this TTL value. The TTL value could be stored in the LCD and checked before passing a message to the DTLS session.

When an SNMP engine needs to establish an outgoing session for notifications, the `snmpTargetParamsTable` includes an entry for the `snmpTargetParamsSecurityName` of the target. However, the receiving SNMP engine (Server) does not know which DTLS certificate to offer to the Client so that the `tmSecurityName` identity-authentication will be successful. The best solution would be to maintain a one-to-one mapping between certificates and incoming ports for notification receivers, although other implementation dependent mechanisms may be used instead. This can be handled at the Notification Originator by configuring the `snmpTargetAddrTable` (`snmpTargetAddrTDomain` and `snmpTargetAddrTAddress`) and then requiring the receiving SNMP engine

to monitor multiple incoming static ports based on which principals are capable of receiving notifications. Implementations MAY also choose to designate a single Notification Receiver Principal to receive all incoming TRAPS and INFORMS.

## 9. Security Considerations

This document describes a transport model that permits SNMP to utilize DTLS security services. The security threats and how the DTLS transport model mitigates these threats are covered in detail throughout this document. Security considerations for DTLS are covered in [\[RFC4347\]](#) and security considerations for TLS are described in Appendices D, E, and F of TLS 1.1 [\[RFC4346\]](#). DTLS adds to the security considerations of TLS only because it is more vulnerable to denial of service attacks. A random cookie exchange was added to the handshake to prevent anonymous denial of service attacks. [RFC 4347](#) recommends that the cookie exchange is utilized for all handshakes and therefore it is RECOMMENDED that implementers also support this cookie exchange.

### 9.1. Certificates, Authentication, and Authorization

Implementations are responsible for providing a security certificate configuration installation . Implementations SHOULD support

certificate revocation lists and expiration of certificates or other access control mechanisms.

DTLS provides for both authentication of the identity of the DTLS server and authentication of the identity of the DTLS client. Access to MIB objects for the authenticated principal MUST be enforced by an access control subsystem (e.g. the VACM).

Authentication of the Command Generator principal's identity is important for use with the SNMP access control subsystem to ensure that only authorized principals have access to potentially sensitive data. The authenticated identity of the Command Generator principal's certificate is mapped to an SNMP model-independent securityName for use with SNMP access control, as discussed in [Section 4.3.4](#), [Section 7](#) and other sections.

Furthermore, the DTLS handshake only provides assurance that the certificate of the authenticated identity has been signed by an configured accepted Certificate Authority. DTLS has no way to further authorize or reject access based on the authenticated identity. An Access Control Model (such as the VACM) provides access control and authorization of a Command Generator's requests to a Command Responder and a Notification Responder's authorization to

receive Notifications from a Notification Originator. However to avoid man-in-the-middle attacks both ends of the DTLS based connection MUST check the certificate presented by the other side against what was expected. For example, Command Generators must check that the Command Responder presented and authenticated itself with a X.509 certificate that was expected. Not doing so would allow an impostor, at a minimum, to present false data, receive sensitive information and/or provide a false-positive belief that configuration was actually received and acted upon. Authenticating and verifying the identity of the DTLS server and the DTLS client for all operations ensures the authenticity of the SNMP engine that provides MIB data.

## [9.2](#). Use with SNMPv1/SNMPv2c Messages

The SNMPv1 and SNMPv2c message processing described in [RFC3484](#) ([BCP 74](#)) [[RFC3584](#)] always selects the SNMPv1(1) Security Model for an SNMPv1 message, or the SNMPv2c(2) Security Model for an SNMPv2c

message. When running SNMPv1/SNMPv2c over a secure transport like the DTLS Transport Model, the `securityName` and `securityLevel` used for access control decisions are then derived from the community string, not the authenticated identity and `securityLevel` provided by the DTLS Transport Model.

### 9.3. MIB Module Security

The MIB objects in this document should be protected with an adequate level of at least integrity protection, especially those objects which are writable. Since knowledge of authorization and certificate usage mechanisms may be considered sensitive, protection from disclosure of the SNMP traffic via encryption is also recommended.

SNMP versions prior to SNMPv3 did not include adequate security. Even if the network itself is secure (for example by using IPsec or DTLS) there is no control as to who on the secure network is allowed to access and GET/SET (read/change/create/delete) the objects in this MIB module.

It is RECOMMENDED that implementers consider the security features as provided by the SNMPv3 framework (see [section 8 of \[RFC3410\]](#)), including full support for the USM (see [\[RFC3414\]](#)) and the DTLS Transport Model cryptographic mechanisms (for authentication and privacy).

## 10. IANA Considerations

IANA is requested to assign:

1. a UDP port number in the range 1..1023 in the <http://www.iana.org/assignments/port-numbers> registry which will be the default port for SNMP over a DTLS Transport Model as defined in this document,
2. a UDP port number in the range 1..1023 in the <http://www.iana.org/assignments/port-numbers> registry which will be the default port for SNMPTRAP over a DTLS Transport Model as defined in this document,
3. an SMI number under `snmpDomains` for the `snmpDTLSDomain` object



identifier,

4. a SMI number under snmpModules, for the MIB module in this document,

## 11. Acknowledgements

This document closely follows and copies the Secure Shell Transport Model for SNMP defined by David Harrington and Joseph Salowey in [[I-D.ietf-isms-secshell](#)].

Large portions of this document are based on work that will be acknowledge in a future version of the document once a proper attribution list has been obtained.

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## Appendix A. Target and Notificaton Configuration Example

Configuring the SNMP-TARGET-MIB and NOTIFICATION-MIB along with access control settings for the SNMP-VIEW-BASED-ACM-MIB can be a daunting task without an example to follow. The following section describes an example of what pieces must be in place to accomplish this configuration.

The `isAccessAllowed()` ASI requires configuration to exist in the following SNMP-VIEW-BASED-ACM-MIB tables:

```
vacmSecurityToGroupTable  
vacmAccessTable  
vacmViewTreeFamilyTable
```

The only table that needs to be discussed as particularly different here is the vacmSecurityToGroupTable. This table is indexed by both the SNMPv3 security model and the security name. The security model, when DTLSTM is in use, should be XXX corresponding to the TMSM [[I-D.ietf-isms-tmsm](#)]. An example vacmSecurityToGroupTable row might be filled out as follows (using a single SNMP SET request):

```
vacmSecurityModel      = XXX:TMSM
vacmSecurityName       = "blueberry"
vacmGroupName         = "administrators"
vacmSecurityToGroupStorageType = 3 (nonVolatile)
vacmSecurityToGroupStatus = 4 (createAndGo)
```

This example will assume that the "administrators" group has been given proper permissions via rows in the vacmAccessTable and vacmViewTreeFamilyTable.

Depending on whether this VACM configuration is for a Command Responder or a Command Generator the security name "blueberry" will come from a few different locations.

For Notification Generator's performing authorization checks, the server's certificate must be verified against the expected certificate before proceeding to send the notification. The securityName be set by the SNMP-TARGET-MIB's snmpTargetParamsSecurityName column or other configuration mechanism and the certificate to use would be taken from the appropriate entry in the dtlstmParamsTable. The dtlstmParamsTable augments the SNMP-TARGET-MIB's snmpTargetParamsTable with client-side certificate information.

For Command Responder applications, the vacmSecurityName "blueberry" value is a value that needs to come from an incoming DTLS session. The mapping from a received DTLS client certificate to a securityName is done with the dtlstmCertificateToSNTable. The certificates must be loaded into the device so that a dtlstmCertificateToSNEntry may refer to it. As an example, consider the following entry which will provide a mapping from a X.509 Issuer's Distinguished Name directly to the "blueberry" securityName:

```
dtlstmCertID          = 1          (arbitrarily chosen)
dtlstmCertIssuerDN    = "C=US, ST=California, ..., CN=hardaker"
dtlstmCertMapType     = specified(1)
dtlstmCertSecurityName = "blueberry"
dtlstmCertStorageType = 3 (nonVolatile)
dtlstmCertRowStatus   = 4 (createAndGo)
```

The above is an example of how to map a particular certificate to a

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particular securityName. It is recommended that users make use of direct CommonName mappings where possible since it will provide a more scalable approach to certificate management. If the following entry was created:

```
dtlstmCertID          = 1          (arbitrarily chosen)
dtlstmCertIssuerDN    = "C=US, ST=California, L=Davis, O=SuprIDs, ..."
dtlstmCertMapType     = byCN(2)
dtlstmCertStorageType = 3 (nonVolatile)
dtlstmCertRowStatus   = 4 (createAndGo)
```

The above entry indicates the CommonName field for that particular Issuer will be trusted to always produce common names that are directly 1 to 1 mappable into SNMPv3 securityNames. This type of configuration should only be used when the CA is carefully controlled.

For the example, if the incoming DTLS client provided certificate contained a Subject with a CommonName of "blueberry" and the certificate was signed by the CA matching the dtlstmCertIssuerDN value above and the CA's certificate was properly installed on the device then the CommonName of "blueberry" would be used as the securityName for the session.

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