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# PA-TNC: A Posture Attribute Protocol (PA) Compatible with TNC

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## Status of this Memo



## Copyright Notice



## Abstract

This document specifies PA-TNC, a Posture Attribute Protocol identical to the Trusted Computing Group's IF-M 1.0 protocol. The document then evaluates PA-TNC against the requirements defined in the NEA Requirements specification.

Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [1].

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## 1. Introduction

This document specifies PA-TNC, a Posture Attribute Protocol (PA) identical to the Trusted Computing Group's IF-M 1.0 protocol [6]. The document then evaluates PA-TNC against the requirements defined in the NEA Requirements specification [7].

### 1.1. Background on Trusted Computing Group

The Trusted Computing Group (TCG) is a consortium that develops specifications for trusted (secure) computing. Since its formation in 2003, TCG has published specifications for a variety of technologies such as Trusted Platform Module (TPM),

TCG Software Stack (TSS), Mobile Trusted Module (MTM), and Trusted Network Connect (TNC).

TCG members include more than 175 organizations that design, build, sell, or use trusted computing technology. Membership is open to any organization that signs the membership agreement and pays the annual membership fee. Non-members are welcome to implement the TCG specifications. Several open source implementers have done so.

## 1.2. Background on Trusted Network Connect

Starting in 2004, the TCG has defined and published the Trusted Network Connect (TNC) architecture and standards for network access control. These standards enable multi-vendor interoperability at all points in the architecture and have been widely adopted and deployed.

## 1.3. Submission of This Document

The IETF has recently chartered the Network Endpoint Assessment (NEA) working group to develop several standards in the same area as TNC. In order to avoid the development of multiple incompatible standards, the TCG is offering several of its TNC standards to the IETF as candidates for standardization in the IETF also. This document is equivalent to TCG's IF-M 1.0.

Consistent with IETF's requirements for standards track documents, the TCG has authorized the editors of this document to offer the specification to the IETF without restriction. As with other Internet-Drafts, the IETF Trust owns the copyright to this document. The IETF may modify this document, ignore it, publish it as an RFC, or take any other action. If the IETF decides to adopt a later version of this document as an RFC, the TCG plans to publish a specification for an equivalent TNC protocol to ensure compatibility.

## 1.4. Prerequisites

This document does not define an architecture or reference model. Instead, it defines a protocol that works within the reference model described in the NEA Requirements specification. The reader is assumed to be thoroughly familiar with that document. No familiarity with TCG specifications is assumed.

### 1.5. Message Diagram Conventions

This specification defines the syntax of PA-TNC messages using diagrams. Each diagram depicts the format and size of each field in bits. Implementations MUST send the bits in each diagram as they are shown, traversing the diagram from top to bottom and then from left to right within each line (which represents a 32-bit quantity). Multi-byte fields representing numeric values must be sent in network (big endian) byte order.

Descriptions of bit field (e.g. flag) values are described referring to the position of the bit within the field. These bit positions are numbered from the most significant bit through the least significant bit so a one octet field with only bit 0 set has the value 0x80.

## 2. PA-TNC Message Protocol

This section discusses the use of the PA-TNC message and its attributes, and specifies the syntax and semantics for the PA-TNC message header. The details of each attribute included within the PA-TNC payload are specified in section 3.2.

### 2.1. PA-TNC Messaging Model

PA-TNC messages are carried by the PB-TNC protocol [5], which provides a multi-roundtrip reliable transport and end-to-end message delivery to subscribed (interested) parties using a variety of underlying network protocols. PA-TNC is unaware of these underlying PT transport protocols being used below PB-TNC. The interested parties consist of Posture Collectors on the NEA Client and Posture Validators associated with the NEA Server that have registered to receive messages about particular types of components (e.g. anti-virus) during an assessment. The PA-TNC messaging protocol operates synchronously within an assessment session, with Posture Collectors and Posture Validators taking turns sending one or more messages to each other. Each PA-TNC message may contain one or more attributes associated with the functional component defined in the PB protocol. Posture Collectors may only send PA-TNC messages to Posture Validators and vice versa. No Posture Collector to Posture Collector or Posture Validator to Posture Validator messaging is allowed to occur. Each Posture Collector or Posture Validator may send several PA-TNC messages in succession before indicating that it has completed its response to the Posture Broker Client or Posture Broker Server respectively. As necessary, the Posture Broker Client and Posture Broker Server

will batch these messages prior to sending them over the network.

PB-TNC provides a publish/subscribe model of message exchange. This means that, at any given point in time, zero or more subscribers for a particular type of message may be present on a Posture Broker Client or Posture Broker Server. This is beneficial, since it allows one Posture Collector or Posture Validator to combine multiple functions (like anti-virus and personal firewall) by subscribing to both TNC standard component types. It also allows multiple Posture Collectors or Posture Validators to support the same components, such as two anti-virus Posture Validators that are each used to manage their own respective anti-virus client software. However, this publish/subscribe model has some possible negative side effects. When a Posture Collector or Posture Validator initially sends a PA-TNC message, it does not know whether it will receive many, one, or no PA-TNC messages from the other side. For many types of assessments, this is acceptable, but in some cases a more direct channel binding between a particular Posture Collector and Posture Validator pair is necessary. For example, a Posture Validator may wish to provide remediation instructions to a particular Posture Collector that it knows is capable of remediating a non-compliant component. This can be accomplished using the PB-TNC capability to limit distribution of a message to a single Posture Collector.

## 2.2. PA-TNC Relationship to PB-TNC

This section summarizes the major elements of a PA-TNC message as they might appear inside of a PB-TNC message. The double line (===) in the diagram below indicates the separation between the PB-TNC and PA-TNC protocols. The PA-TNC portion of the message is delivered to each Posture Collector or Posture Validator registered to receive messages containing a particular message type. Note that PB-TNC is capable of carrying multiple PB-TNC and PA-TNC messages in a single PB-TNC batch. See the PB-TNC specification [5] for more information on its capabilities.

One important linkage between the PA-TNC and PB-TNC protocols is the PA message type (PA Message Vendor ID and PA subtype) that is used by the Posture Broker Client and Posture Broker Server to route messages to interested Posture Collectors and Posture Validators. The message type indicates the software component (component type) that is associated with the attributes included inside the PA-TNC message. Therefore, Posture Collectors and

Posture Validators written to support an assessment of a particular component can register to receive messages about the component and thus participate in its assessment. Each Posture Collector and Posture Validator MUST only send PA-TNC messages containing attributes that pertain to the software component defined in the message type of the message. This assures that only the appropriate Posture Collectors and Posture Validators that support a particular type of component will receive attributes related to that component. If a PA-TNC message contained a mix of attributes about different components and a message type of only one of those components, the message would only be delivered to parties interested in the component type included in the message type, so other interested recipients wouldn't see those attributes.

The message type is comprised of 2 fields: a PA Message Vendor ID and a PA Subtype. The PA Message Vendor ID identifies the vendor or other organization that defined this message type. The PA Subtype identifies the message type more particularly within the set of message types defined by that vendor. This specification defines several IETF Standard PA Subtypes to be used with a PA Message Vendor ID of zero (0). Within this specification, the PA Subtype field is used to indicate the type of component (e.g. firewall) involved with the message's attributes. Therefore for clarity the PA subtype will be referred to as the "component type" in this specification. Vendor-defined name spaces may use other semantics for the PA Subtype field as this is outside the scope of this specification.

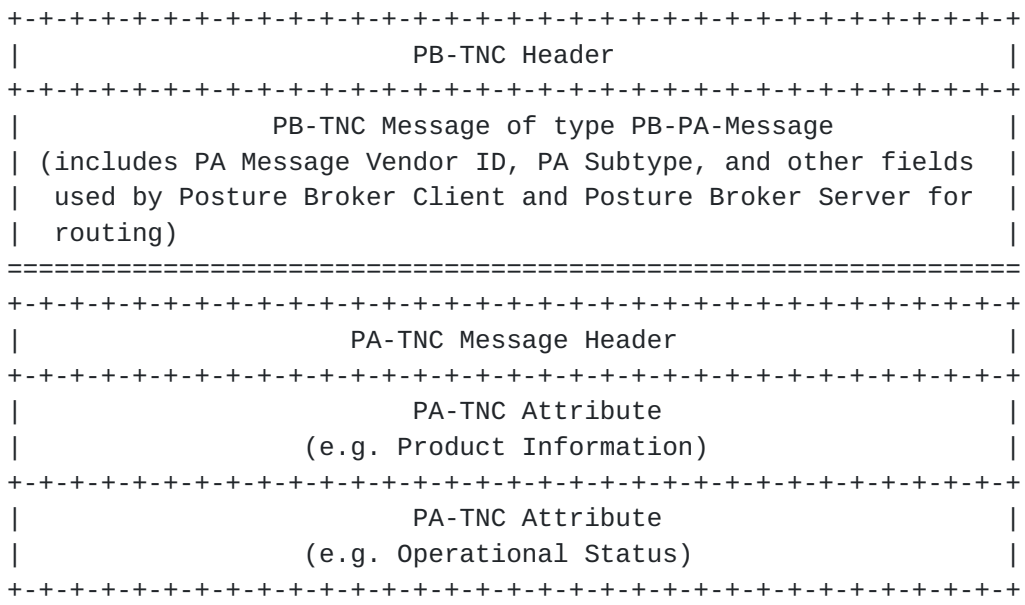



Figure 1 Overview of a PB-TNC batch that contains a PA-TNC Message

For example, if a Posture Broker Client sent a PB-TNC batch that contained a PA-TNC message with a message type indicating firewall component, this message would be routed by the Posture Broker Server to Posture Validators registered to assess firewalls. Each registered Posture Validator would receive a copy of the PA-TNC message including the PA-TNC header and set of attributes. It is important that each of the attributes included in the PA-TNC message be associated with the firewall component because only the Posture Collector and Posture

Validator interested in firewalls will receive such messages. For example, if the above message contained both firewall and operating system attributes (inside a PA-TNC message with a component type of firewall), then any Posture Collector and Posture Validator registered to receive operating system messages would not receive those attributes, as the messages would only be delivered to those registered for firewall messages.

## 2.3. PA-TNC Messages in PB-TNC

As depicted in section 2.2, a PA-TNC message consists of a PA-TNC header followed by a sequence of one or more attributes. The PA-TNC message header (described in section 2.5) and the header for each of the PA-TNC attributes (specified in section 3.1) have a fixed type-length-value (TLV) format. Each PA-TNC message MAY contain a mixture of standards-based and vendor-defined attributes identifiable using the type portion of the attribute header. All Posture Collectors and Posture Validators compliant with this specification MUST be capable of processing multiple attributes in a received PA-TNC message. A Posture Collector or Posture Validator that receives a PA-TNC message can use the attribute header's length field to skip any attributes that it does not understand, unless the attribute is marked as mandatory to process.

## 2.4. IETF Standard PA Subtypes

This section defines several IETF Standard PA Subtypes. Each PA subtype defined here identifies a specific component relevant to the endpoint's posture. This allows a small set of generic PA-TNC attributes (e.g. Product Information) to be used to describe a large number of different components (e.g. OS, anti-virus software, etc.). It also allows Posture Collectors and Posture Validators to specialize in a particular component (e.g. operating system) and only receive PA-TNC messages relevant to that component.

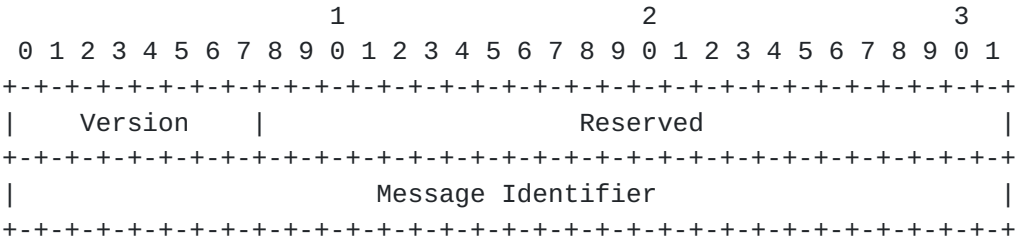
| Number | Name | Definition |
|---|---|---|
| 0 | Testing | Reserved for use in specification examples, experimentation and testing. |
| 1 | Operating System | Operating system running on the endpoint |

| | | |
|---|---|---|
| 2 | Anti-Virus | Host-based anti-virus software |
| 3 | Anti-Spyware | Host-based anti-spyware software |
| 4 | Anti-Malware | Host-based anti-malware (e.g. anti-bot) software not included within anti-virus or anti-spyware components |
| 5 | Firewall | Host-based firewall |
| 6 | IDPS | Host-based Intrusion Detection and/or Prevention Software (IDPS) |
| 7 | VPN | Host-based Virtual Private Networking (VPN) software |

These PA subtypes must be used in a PB-PA message with a PA Message Vendor ID of zero (0) (as described in the PB-TNC specification [5]). If these PA subtype values are used with a different PA Message Vendor ID, they have a completely different meaning that is not defined in this specification.

## 2.5. PA-TNC Message Header Format

This section describes the format and semantics of the PA-TNC header. Every PA-TNC message MUST start with a PA-TNC header. The PA-TNC header provides a common context applying to all of the attributes contained within the PA-TNC payload. The payload consists of a sequence of assessment attributes described in section 3.




Version

This field indicates the version of the format for the PA-TNC message. This version is intended to allow for evolution of the PA-TNC message header and payload in a manner that can easily be detected by message recipients.

PA-TNC message senders MUST set this field to 0x01 for all PA-TNC messages that comply with formats and requirements described in version 1.0 of this specification. Implementations responding to a PA-TNC message containing a supported version SHOULD use the same Version number to minimize the risk of version incompatibility.

Message senders MAY send an empty PA-TNC message with the Version value set to 0 in order to discover the PA-TNC protocol versions supported by peer recipients (see PA-TNC Error Code information in section 3.2.8). Message recipients MUST NOT support version 0 and MUST NOT interpret the contents (after the Version field) of a PA-TNC message containing a version number that the recipient does not support. Message recipients MUST respond to a PA-TNC message with an unsupported version by sending a Version Not Supported error code in a PA-TNC Error attribute.

PA-TNC message initiators supporting multiple PA-TNC protocol versions SHOULD be able to alter which version of PA-TNC message they send based on prior message exchanges with a particular peer Posture Collector or Posture Validator.

Reserved

Reserved for future use. This field MUST be set to 0 on transmission and ignored upon reception.

Message Identifier

This field contains a value that uniquely identifies this message, differentiating it from others sent by a particular PA-TNC message sender within this assessment. This value can be included in a response message to indicate which message was received and caused the response. For example, this field is included in the PA-TNC error messages so the party who receives the error message can determine which of the messages they had sent caused the error.

PA-TNC message senders MUST NOT send the same message identifier more than once during an assessment. Message identifiers may be randomly generated or sequenced as long as

values are not repeated during an assessment message exchange. PA-TNC message recipients are not required to check for duplicate message identifiers.

## 3. PA-TNC Attributes

This section defines the PA-TNC attributes that can be carried within a PA-TNC message. The initial section defines the standard attribute header that appears at the start of each attribute in a PA-TNC message. The second section defines each of the IETF Standard PA-TNC attributes and the final section discusses how vendor-defined PA-TNC attributes can be used within a PA-TNC message. Vendor-defined PA-TNC attributes use the vendor's SMI Private Enterprise Number in the Attribute Type field.

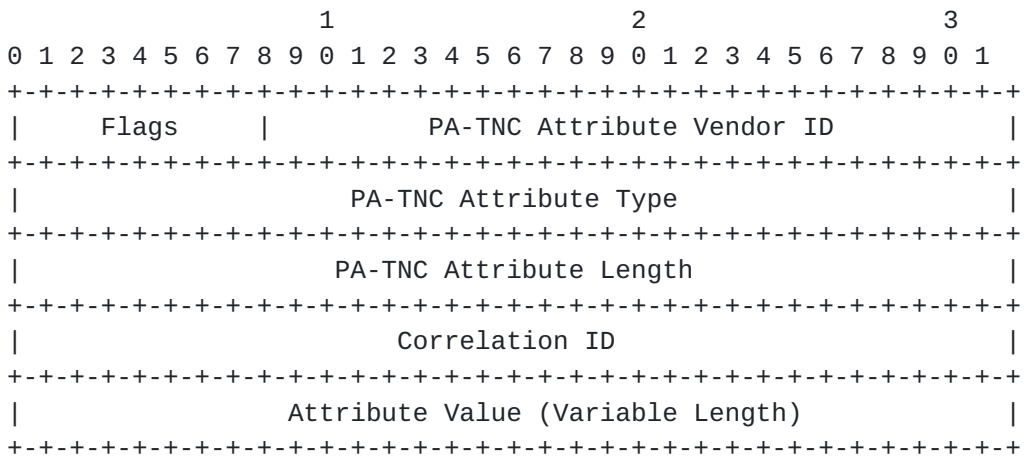
A PA-TNC message MUST contain a PA-TNC header (defined in section 2.5) followed by a sequence of zero or more PA-TNC attributes. All PA-TNC attributes MUST begin with a standard PA-TNC attribute header, as defined in section 3.1. The contents of PA-TNC attributes vary widely, depending on their attribute type. Section 3.2 defines the IETF Standard PA-TNC Attributes. Section 3.3 discusses how vendor-specific PA-TNC attributes can be defined.

### 3.1. PA-TNC Attribute Header

Following the PA-TNC message header is a sequence of zero or more attributes. All PA-TNC attributes MUST begin with the standard PA-TNC attribute header defined in this subsection. Each attribute described in this specification is represented by a TLV tuple. The TLV tuple includes an attribute identifier comprised of the Vendor ID and Attribute Type (type), the TLV tuple's overall length and finally the attribute's value. The use of TLV representation was chosen due to its flexibility and extensibility and use in other standards. Recipients of an attribute can use the attribute type fields to determine the precise syntax and semantics of the attribute value field and the length to skip over an unrecognized attribute. The length field is also beneficial when a variable length attribute value is provided.

The TLV format does not contain an explicit TLV format version number, so every attribute included in a particular PA-TNC message MUST use the same TLV format. Using the PA-TNC message version number to indicate the format of all TLV attributes within a PA-TNC message allows for future versioning of the TLV

format in a manner detectable by PA-TNC message recipients. Similarly, requiring all TLV attribute formats to be the same within a PA-TNC message also assures that recipients compliant with a particular PA-TNC message version can at least parse every attribute header and use the length to skip over unrecognized attributes. Every PA-TNC 1.0 compliant TLV attribute MUST use the following TLV format:




Flags

This field defines flags impacting the processing of the associated attribute.

Bit 0 (0x80) is the NOSKIP flag. Any Posture Collector or Posture Validator that receives an attribute with this flag set to 1 but does not support this attribute MUST NOT process any part of the PA-TNC message and SHOULD respond with an Attribute Type Not Supported error in a PA-TNC error message.

In order to avoid taking action on a subset of the attributes only to later find an unsupported attribute with the NOSKIP flag set, recipients of a multi-attribute PA-TNC message

might need to scan all of the attributes prior to acting upon any attribute.

When the NOSKIP flag is set to 0, recipients SHOULD skip any unsupported attributes and continue processing the next attribute.

Bit 1 (0x40) is the Correlation ID (COR) flag. This flag indicates whether the optional Correlation ID value is included in the header. When set to 1, a 32 bit Correlation ID field is present. Otherwise when set to 0, no Correlation ID is included.

Bit 2-7 are reserved for future use. These bits MUST be set to 0 on transmission and ignored upon reception.

PA-TNC Attribute Vendor ID

This field indicates the owner of the name space associated with the PA-TNC Attribute Type. This is accomplished by specifying the 24 bit SMI Private Enterprise Number Vendor ID of the party who owns the Attribute Type name space. IETF Standard PA-TNC Attribute Types MUST use zero (0) in this field.

The PA-TNC Attribute Vendor ID 0xffffff is reserved. Posture Collectors and Posture Verifiers MUST NOT send PA-TNC messages in which the PA-TNC Attribute Vendor ID has this reserved value (0xffffff). If a Posture Collector or Posture Verifier receives a message in which the PA-TNC Attribute Vendor ID has this reserved value (0xffffff), it SHOULD respond with an Invalid Parameter error code in a PA-TNC Error attribute.

PA-TNC Attribute Type

This field defines the type of the attribute included in the Attribute Value field. This field is qualified by the PA-TNC Attribute Vendor ID field so that a particular PA-TNC Attribute Type value (e.g. 327) has a completely different meaning depending on the value in the PA-TNC Attribute Vendor ID field.

If the PA-TNC Attribute Vendor ID field has the value zero (0) then the PA-TNC Attribute Type field contains an IETF Standard PA-TNC Attribute Type, as listed in the IANA

registry. Section 3.2 of this specification defines the initial set of IETF Standard PA-TNC Attribute Types.

The PA-TNC Attribute Type 0xffffffff is reserved. Posture Collectors and Posture Verifiers MUST NOT send PA-TNC messages in which the PA-TNC Attribute Type has this reserved value (0xffffffff). If a Posture Collector or Posture Verifier receives a message in which the PA-TNC Attribute Type has this reserved value (0xffffffff), it SHOULD respond with an Invalid Parameter error code in a PA-TNC Error attribute.

PA-TNC Attribute Length

This field contains the length in octets of the entire PA-TNC Attribute including the PA-TNC Attribute Header (the fields Flags, PA-TNC Attribute Vendor ID, PA-TNC Attribute Type, and PA-TNC Attribute Length). Therefore, this value MUST always be at least 12 (16 if the Correlation ID is present). Any Posture Collector or Posture Verifier that receives a message with a PA-TNC Attribute Length field whose value is less than 12 (16 if the Correlation ID is present) SHOULD respond with an Invalid Parameter PA-TNC error code.

Implementations that do not support the specified PA-TNC Attribute Type can use this length to skip over this attribute to the next attribute. Note that while this field is 4 octets the maximum usable attribute length is likely to be less than 2^32-1 due to limitations of the underlying protocol stack.

Correlation ID

This optional field MUST be present when the COR flag is set to 1 and MUST NOT be present when the COR flag is set to 0. Normally, this field will not be present. However, there are times when this field is necessary.

Some Posture Collectors may wish to report on several products with the same component ID on an endpoint (e.g. two anti-malware software packages). In this case, the Posture Collector and Posture Validator need a way to identify the different products. For example, if a Posture Validator requests Product Information and Numeric Version attributes for the anti-malware component, this Posture Collector would produce two Product Information and two Numeric Version attributes, each attribute having a Correlation ID specific

to the product being described. The Product Information and Numeric Version attributes describing the same product would have the same Correlation ID. This allows the Posture Validator to associate the Product Information and Numeric Version attributes that apply to a single product. Because the Product Information and Numeric Version attribute requests might be requested at different times, it is important that the Posture Collector use a consistent value for each product upon which it is able to report. A Posture Collector might create a persistent table of locally unique IDs (e.g. counters) for each product upon which it reports, for situations where a Correlation ID is necessary.

Note that many Posture Collectors will not need to worry about Correlation IDs because they will only support reporting on one product per endpoint. If an endpoint has two anti-malware Posture Collectors installed that each support only one product and those Posture Collectors are reporting on two separate anti-malware products, the Correlation ID is not required. This is because the Posture Validator can use the Posture Collector ID reported in the PB-TNC protocol to associate the attributes sent by each Posture Collector.

When a single Posture Collector needs to send several attributes in a single assessment that pertain to separate products but have the same PA Message Vendor ID and PA Subtype, the Posture Collector MUST use the Correlation ID field. The Correlation ID value MUST be constant per product for an entire PB-TNC session so that the Posture Validator can correlate attributes requested earlier about the same product. The Posture Validator MAY send attributes with a Correlation ID to identify the product to which they pertain.

Attribute Value

This field varies depending on the particular type of attribute being expressed. The contents of this field for each of the IETF Standard PA-TNC Attribute Types is defined in section 3.2.

## 3.2. IETF Standard PA-TNC Attribute Types

This section defines an initial set of IETF Standard PA-TNC Attribute Types. These Attribute Types MUST always be used with a PA-TNC Vendor ID of zero (0). If these PA-TNC Attribute Type values are used with a different PA-TNC Vendor ID, they have a

completely different meaning that is not defined in this specification.

The following table briefly describes each attribute and defines the numeric value to be used in the PA-TNC Attribute Type field of the PA-TNC Attribute Header. Later subsections provide detailed specifications for each PA-TNC Attribute Value.

| Number | Name | Description |
|---|---|---|
| 0 | Testing | Reserved for use in specification examples, experimentation and testing. |
| 1 | Attribute Request | Contains a list of attribute type values defining the attributes desired from the Posture Collectors. |
| 2 | Product Information | Manufacturer and product information for the component. |
| 3 | Numeric Version | Numeric version of the component. |
| 4 | String Version | String version of the component. |
| 5 | Operational Status | Describes whether the component is running on the endpoint. |
| 6 | Port Filter | Lists the set of ports (e.g. TCP port 80 for HTTP) that are allowed or blocked on the endpoint. |
| 7 | Installed Packages | List of software packages installed on endpoint that provide the requested component. |
| 8 | PA-TNC Error | PA-TNC message or attribute processing error. |

The following subsections discuss the usage, format and semantics of the Attribute Value field for each IETF Standard PA-TNC Attribute Type.

### 3.2.1. Attribute Request

This PA-TNC Attribute Type allows a Posture Validator to request certain attributes from the registered set of Posture Collectors.

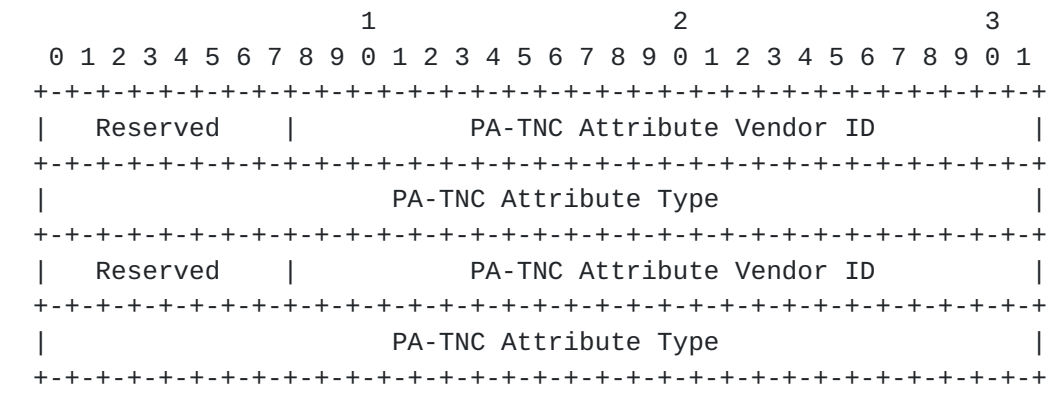
All Posture Collectors that implement any of the IETF Standard PA Subtypes defined in this specification SHOULD support receiving and processing this attribute type for at least those PA subtypes. Posture Collectors that receive and process this attribute MAY choose to send all, a subset or none of the requested attributes but MUST NOT send attributes that were not requested (except error attributes). All Posture Validators that implement any of the IETF Standard PA Subtypes defined in this specification SHOULD support sending this attribute type for at least those PA subtypes.

Posture Verifiers MUST NOT include this attribute type in an Attribute Request attribute. It does not make sense for a Posture Verifier to request that a Posture Collector send an Attribute Request attribute.

For this attribute type, the PA-TNC Attribute Vendor ID field MUST be set to zero (0) and the PA-TNC Attribute Type field MUST be set to 1.

The following diagram illustrates the format and contents of the Attribute Value field for this attribute type. The text after this diagram describes the fields shown here.

Note that this diagram shows two attribute types. The actual number of attribute types included in an Attribute Request attribute can vary from one to a large number (limited only by the maximum message and length supported by the underlying PT transport protocol). However, each Attribute Request MUST contain at least one attribute type. Because the length of a PA-TNC Attribute Vendor ID paired with a PA-TNC Attribute Type and a one octet Reserved field is always 8 octets, the number of requested attributes can be easily computed using the PA-TNC Attribute Length field by subtracting the number of octets in the PA-TNC Attribute Header and dividing by 8. If the PA-TNC Attribute Length field is invalid, Posture Collectors SHOULD respond with an Invalid Parameter PA-TNC error code.




Reserved

Reserved for future use. This field MUST be set to 0 on transmission and ignored upon reception.

PA-TNC Attribute Vendor ID

This field contains the SMI Private Enterprise Number of the organization that controls the name space for the following PA-TNC Attribute Type. This field enables IETF Standard PA-TNC Attributes and vendor-defined PA-TNC Attributes to be used without potential collisions.

Any IETF Standard PA-TNC Attribute Types defined in section 3.2 MUST use zero (0) in this field. Vendor-defined attributes MUST use the SMI Private Enterprise Number of the organization that defined the attribute.

PA-TNC Attribute Type

The PA-TNC Attribute Type field (together with the PA-TNC Vendor ID field) indicates the specific attribute requested. Some IETF Standard PA-TNC Attribute Types MUST NOT be requested using this field (e.g. requesting a PA-TNC Error attribute). This is explicitly indicated in the description

of those PA-TNC Attribute Types. Any Posture Collector or Posture Validator that receives an Attribute Request containing one of the prohibited Attribute Types SHOULD respond with an Invalid Parameter error in a PA-TNC error message.

### 3.2.2. Product Information

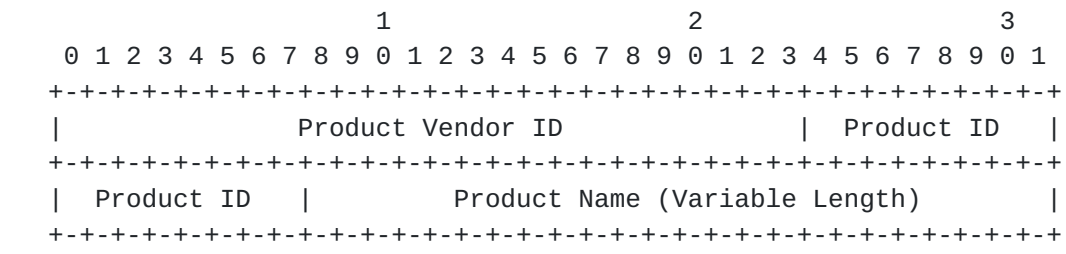
This PA-TNC Attribute Type contains identifying information about a product that implements the component specified in the PA Subtype field, as described in section 2.4. For example, if the PA Subtype is Anti-Virus, this attribute would contain information identifying an anti-virus product installed on the endpoint.

All Posture Collectors that implement any of the IETF Standard PA Subtypes defined in this specification MUST support sending this attribute type, at least for those PA subtypes. Whether a particular Posture Collector actually sends this attribute type SHOULD still be governed by local privacy and security policies. All Posture Validators that implement any of the IETF Standard PA Subtypes defined in this specification MUST support receiving this attribute type, at least for those PA subtypes. Posture Validators MUST NOT send this attribute type.

For this attribute type, the PA-TNC Attribute Vendor ID field MUST be set to zero (0) and the PA-TNC Attribute Type field MUST be set to 2. The value in the PA-TNC Attribute Length field will vary, depending on the length of the Product Name field. However, the value in the PA-TNC Attribute Length field MUST be at least 17 (21 if the Correlation ID field is present) because this is the length of the fixed size fields in the PA-TNC Attribute Header and the fixed size fields in this attribute type. If the PA-TNC Attribute Length field is less than the size of these fixed length fields, implementations SHOULD respond with an Invalid Parameter PA-TNC error code.

This attribute type includes both numeric and textual identifiers for the organization that created the product (the "product creator") and for the product itself. For automated processing, numeric identifiers are superior because they are less ambiguous and more efficient. However, numeric identifiers are only available if the product creator has assigned them. Therefore, a textual identifier is also included. This textual identifier has the additional benefit that it may be easier for humans to read (although this benefit is minimal since the primary purpose of this attribute is automated assessment).

The following diagram illustrates the format and contents of the Attribute Value field for this attribute type. The text after this diagram describes the fields shown here.




Product Vendor ID

This field contains the SMI Private Enterprise Number for the product creator. If the SMI PEN for the product creator is unknown or if the product creator does not have an SMI PEN, the Product Vendor ID field MUST be set to 0 and the identity of the product creator SHOULD be included in the Product Name along with the name of the product.

Product ID

This field identifies the product using a numeric identifier assigned by the product creator. If this Product ID value is unknown or if the product creator has not assigned such a value, this field MUST be set to 0. If the Product Vendor ID is 0, this field MUST be set to 0. In any case, the name of the product SHOULD be included in the Product Name field.

Note that a particular Product ID value (e.g. 635) will have completely different meanings depending on the Product Vendor ID. Each Product Vendor ID defines a different space of Product ID values. Product creators are encouraged to publish lists of Product ID values for their products.

Product Name

This variable length field contains a UTF-8 [2] string identifying the product (e.g. "Symantec Norton AntiVirus(TM) 2008") in enough detail to unambiguously distinguish it from

other products from the product creator. Products whose creator is known, but does not have a registered SMI Private Enterprise Number, SHOULD be represented using a combination of the creator name and full product name (e.g. "Ubuntu(R) IPtables" for the IPtables firewall in the Ubuntu distribution of Linux). If the product creator's SMI Private Enterprise Number is included in the Product Vendor ID field, the product creator's name may be omitted from this field.

The length of this field can be determined by starting with the value in the PA-TNC Attribute Length field in the PA-TNC Attribute Header and subtracting the size of the fixed length fields in that header (12 or 16, depending on whether the Correlation ID is present) and the size of the fixed length fields in this attribute (5). If the PA-TNC Attribute Length field is less than the size of these fixed length fields, implementations SHOULD respond with an Invalid Parameter PA-TNC error code.

### 3.2.3. Numeric Version

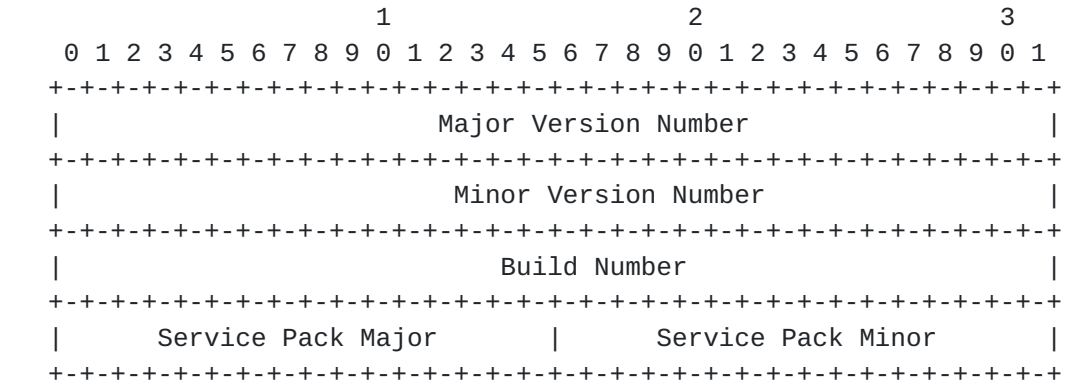
This PA-TNC Attribute Type contains numeric version information for a product on the endpoint that implements the component specified in the PA Subtype field, as described in section 2.4. For example, if the PA Subtype is Operating System, this attribute would contain numeric version information for the operating system installed on the endpoint. The version information in this attribute is associated with a particular product, so Posture Validators are expected to also possess the corresponding Product Information attribute when interpreting this attribute.

All Posture Collectors that implement the IETF Standard PA Subtype for Operating System SHOULD support sending this attribute type, at least for the Operating System PA subtype. Other Posture Collectors MAY support sending this attribute type. Whether a particular Posture Collector actually sends this attribute type SHOULD still be governed by local privacy and security policies. All Posture Validators that implement the IETF Standard PA Subtype for Operating System SHOULD support receiving this attribute type, at least for the Operating System PA subtype. Other Posture Validators MAY support receiving this attribute type. A Posture Validator that does not support receiving this attribute type SHOULD simply ignore attributes with this type. Posture Validators MUST NOT send this attribute type.

For this attribute type, the PA-TNC Attribute Vendor ID field MUST be set to zero (0) and the PA-TNC Attribute Type field MUST be set to 3. The value in the PA-TNC Attribute Length field MUST be 28 if the Correlation ID field is not present and 32 if it is present. If the PA-TNC Attribute Length field is less than the size of these fixed length fields, implementations SHOULD respond with an Invalid Parameter PA-TNC error code.

This attribute type includes numeric values for the product version information, enabling Posture Validators to do comparative operations on the version. Some Posture Collectors may not be able to determine some or all of this information for a product. However, this attribute can be especially useful for describing the version of the operating system, where numeric version numbers are generally available.

The following diagram illustrates the format and contents of the Attribute Value field for this attribute type. The text after this diagram describes the fields shown here.




Major Version Number

This field contains the major version number for the product, if applicable. If unused or unknown, this field SHOULD be set to 0.

Minor Version Number

This field contains the minor version number for the product, if applicable. If unused or unknown, this field SHOULD be set to 0.

Build Number

This field contains the build number for the product, if applicable. This may provide more granularity than the minor version number, as many builds may occur leading up to an official release, and all these builds may share a single major and minor version number. If unused or unknown, this field SHOULD be set to 0.

Service Pack Major

This field contains the major version number of the service pack for the product, if applicable. If unused or unknown, this field SHOULD be set to 0.

Service Pack Minor

This field contains the minor version number of the service pack for the product, if applicable. If unused or unknown, this field SHOULD be set to 0.

### 3.2.4. String Version

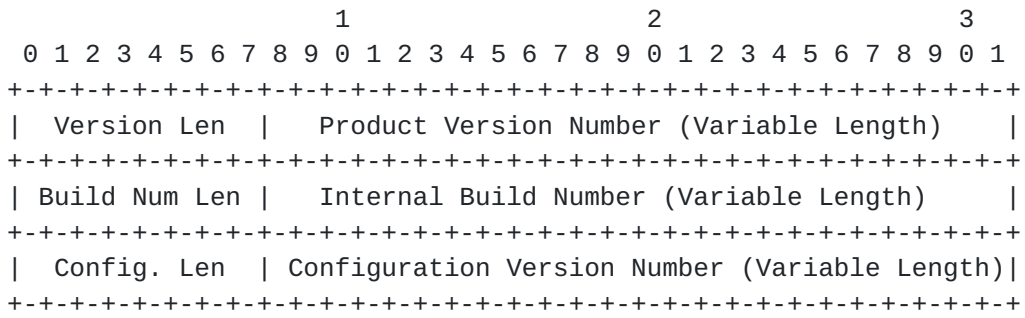
This PA-TNC Attribute Type contains string version information for a product on the endpoint that implements the component specified in the PA Subtype field, as described in section 2.4. For example, if the PA Subtype is Firewall, this attribute would contain string version information for a host-based firewall product installed on the endpoint (if any). The version information in this attribute is associated with a particular product, so Posture Validators are expected to also possess the corresponding Product Information attribute when interpreting this attribute.

All Posture Collectors that implement any of the IETF Standard PA Subtypes defined in this document MUST support sending this attribute type, at least for those PA subtypes. Other Posture Collectors MAY support sending this attribute type. Whether a particular Posture Collector actually sends this attribute type SHOULD still be governed by local privacy and security policies. All Posture Validators that implement any of the IETF Standard

PA Subtypes defined in this document MUST support receiving this attribute type, at least for those PA subtypes. Other Posture Validators MAY support receiving this attribute type. Posture Validators MUST NOT send this attribute type.

For this attribute type, the PA-TNC Attribute Vendor ID field MUST be set to zero (0) and the PA-TNC Attribute Type field MUST be set to 4. The value in the PA-TNC Attribute Length field will vary, depending on the length of the Component Version Number, Internal Build Number, and Configuration Version Number fields. However, the value in the PA-TNC Attribute Length field MUST be at least 15 (19 if the Correlation ID field is present) because this is the length of the fixed size fields in the PA-TNC Attribute Header and the fixed size fields in this attribute type. If the PA-TNC Attribute Length field is less than the size of these fixed length fields or does not match the length indicated by the sum of the fixed length and variable length fields, implementations SHOULD respond with an Invalid Parameter PA-TNC error code.

The following diagram illustrates the format and contents of the Attribute Value field for this attribute type. The text after this diagram describes the fields shown here.




Version Len

This field defines the number of octets in the Product Version Number field. If the product version number is unavailable or unknown, this field MUST be set to 0 and the

Product Version Number field will be zero length (effectively not present).

Product Version Number

This field contains a UTF-8 string identifying the version of the component (e.g. "1.12.23.114"). This field MUST be sized to fit the version string and MUST NOT include extra octets for padding or NUL character termination.

Various products use a wide range of different formats and semantics for version strings. Some use alphabetic characters, white space, and punctuation. Some consider version "1.21" to be later than version "1.3" and some earlier. Therefore, the syntax and semantics of this string are not defined.

Build Num Len

This field defines the number of octets in the Internal Build Number field. For products where the internal build number is unavailable or unknown, this field MUST be set to 0 and the Internal Build Number field will be zero length (effectively not present).

Internal Build Number

This field contains a UTF-8 string identifying the engineering build number of the product. This field MUST be sized to fit the build number string and MUST NOT include extra octets for padding or NUL character termination. The syntax and semantics of this string are not defined.

Config. Len

This field defines the number of octets in the Configuration Version Number field. If the product version number is unavailable or unknown, this field MUST be set to 0 and the Product Version Number field will be zero length (effectively not present).

Configuration Version Number

This field contains a UTF-8 string identifying the version of the configuration used by the component. This version SHOULD represent the overall configuration version even if several configuration policy files or settings are used. Posture

Collectors MAY include multiple version numbers in this single string if a single version is not practical. This field MUST be sized to fit the version string and MUST NOT include extra octets for padding or NUL character termination.

Various products use a wide range of different formats for version strings. Some use alphabetic characters, white space, and punctuation. Some consider version "1.21" to be later than version "1.3" and some earlier. In addition, some Posture Collectors may place multiple configuration version numbers in this single string. Therefore, the syntax and semantics of this string are not defined.

### 3.2.5. Operational Status

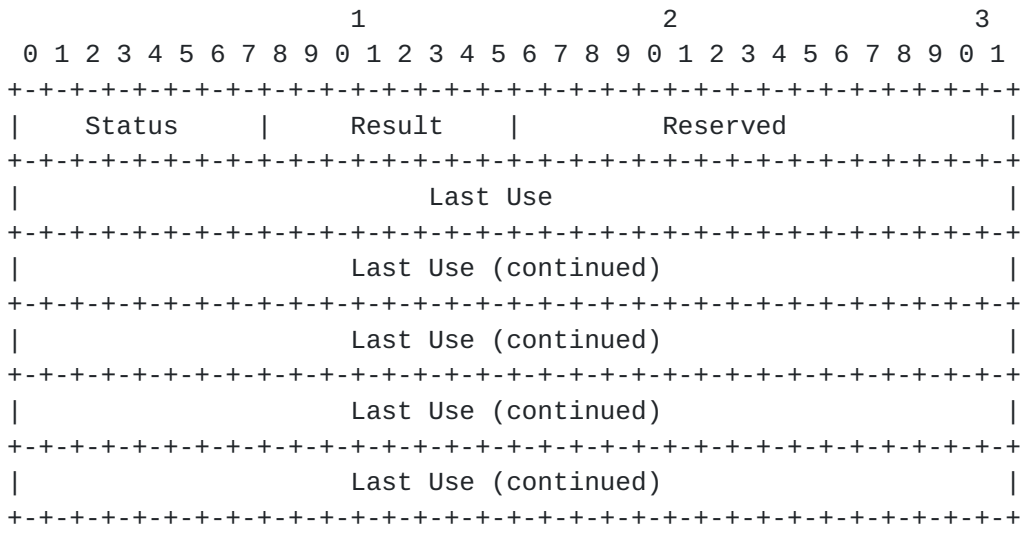
This PA-TNC Attribute Type describes the operational status of a product that can implement the component specified in the PA Subtype field, as described in section 2.4. For example, if the PA Subtype is Anti-Spyware, this attribute would contain information about the operational status of a host-based anti-spyware product that may or may not be installed on the endpoint.

Posture Collectors that implement the IETF Standard PA Subtype for Operating System or VPN MAY support sending this attribute type for those PA subtypes. Posture Collectors that implement other IETF Standard PA Subtypes defined in this specification SHOULD support sending this attribute type for those PA subtypes. Other Posture Collectors MAY support sending this attribute type. Whether a particular Posture Collector actually sends this attribute type SHOULD still be governed by local privacy and security policies. Posture Validators that implement the IETF Standard PA Subtype for Operating System or VPN MAY support receiving this attribute type, at least for those PA subtypes. Posture Validators that implement other IETF Standard PA Subtypes defined in this specification SHOULD support receiving this attribute type, at least for those PA subtypes. Other Posture Validators MAY support receiving this attribute type. A Posture Validator that does not support receiving this attribute type SHOULD simply ignore attributes with this type. Posture Validators MUST NOT send this attribute type.

For this attribute type, the PA-TNC Attribute Vendor ID field MUST be set to zero (0) and the PA-TNC Attribute Type field MUST be set to 5. The value in the PA-TNC Attribute Length field

MUST be 36 if the Correlation ID field is not present and 40 if it is present. If the PA-TNC Attribute Length field does not have this value, implementations SHOULD respond with an Invalid Parameter PA-TNC error code.

The following diagram illustrates the format and contents of the Attribute Value field for this attribute type. The text after this diagram describes the fields shown here.




Status

This field gives the operational status of the product. The following table lists the values currently defined for this field. As described in section 7, the IANA maintains a registry of valid values for this field so that new values can be defined.

| Value | Description |
|---|---|
| 0 | Unknown or other |
| 1 | Not installed |
| 2 | Installed but not operational |
| 3 | Operational |

If a Posture Validator receives a value for this field that it does not recognize, it SHOULD treat this value as equivalent to the value 0.

Result

This field contains the result of the last use of the product. The following table lists the values currently defined for this field. As described in section 7, the IANA maintains a registry of valid values for this field so that new values can be defined.

| Value | Description |
|---|---|
| 0 | Unknown or other |
| 1 | Successful use with no errors detected |
| 2 | Successful use with one or more errors detected |
| 3 | Unsuccessful use (e.g. aborted) |

Posture Collectors SHOULD set this field to 0 if the Status field contains a value of 1 (Not installed) or 2 (Installed but not operational). If a Posture Validator receives a value for this field that it does not recognize, it SHOULD treat this value as equivalent to the value 0.

Reserved

This field is reserved for future use. The field MUST be set to 0 on transmission and ignored upon reception.

Last Use

This field contains the date and time of the last use of the component. The Last Use date and time MUST be represented as an RFC 3339 [4] compliant ASCII string in Coordinated Universal Time (UTC) time with the additional restrictions that the 't' delimiter and the 'z' suffix MUST be capitalized and fractional seconds (time-secfrac) MUST NOT be included. Leap seconds are permitted and Posture Validators MUST support them. The last use string MUST NOT be NUL terminated

or padded in any way. If the last use time is not known, not applicable, or cannot be represented in this format, the Posture Collector MUST set this field to the value "0000-00-00T00:00:00Z" (allowing this field to be fixed length). Not that this particular reserved value is NOT a valid RFC 3339 date and time and MUST NOT be used for any other purpose in this field.

This encoding produces a string that is easy to read, parse, and interpret. The format (more precisely defined in RFC 3339) is YYYY-MM-DDTHH:MM:SSZ, resulting in one and only one representation for each second in UTC time from year 0000 to year 9999. For example, 9:05:00AM EST (GMT-0500) on January 19, 1995 can be represented as "1995-01-19T14:05:00Z". The length of this field is always 20 octets.

### 3.2.6. Port Filter

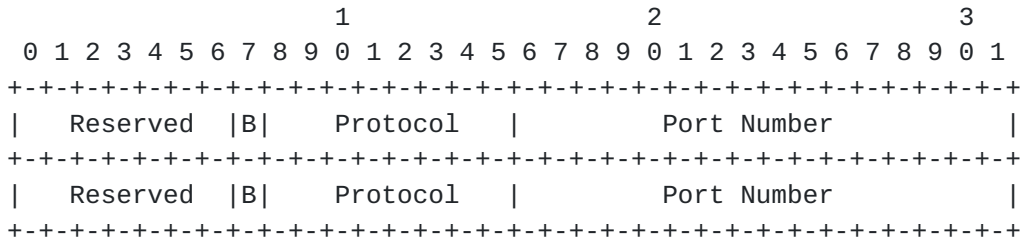
This PA-TNC Attribute Type provides the list of port numbers and associated protocols (e.g. TCP and UDP) that are currently blocked or allowed by a host-based firewall on the endpoint.

Posture Collectors that implement the IETF Standard PA Subtype for Firewall or VPN SHOULD support sending this attribute type for those PA subtypes. Posture Collectors that implement other IETF Standard PA Subtypes defined in this specification MUST NOT support sending this attribute type for those PA subtypes. Other Posture Collectors MAY support sending this attribute type, if it is appropriate to their PA subtype. Whether a particular Posture Collector actually sends this attribute type SHOULD still be governed by local privacy and security policies. Posture Validators that implement the IETF Standard PA Subtype for Firewall or VPN SHOULD support receiving this attribute type, at least for those PA subtypes. Posture Validators that implement other IETF Standard PA Subtypes defined in this specification MUST NOT support receiving this attribute type for those PA subtypes. Other Posture Validators MAY support receiving this attribute type. A Posture Validator that does not support receiving this attribute type SHOULD simply ignore attributes with this type. Posture Validators MUST NOT send this attribute type.

For this attribute type, the PA-TNC Attribute Vendor ID field MUST be set to zero (0) and the PA-TNC Attribute Type field MUST be set to 6.

The following diagram illustrates the format and contents of the Attribute Value field for this attribute type. The text after this diagram describes the fields shown here.

Note that this diagram shows two Protocol/Port Number pairs. The actual number of Protocol/Port Number pairs included in a Port Filter attribute can vary from one to a large number (limited only by the maximum message and length supported by the underlying PT transport protocol). However, each Port Filter attribute MUST contain at least one Protocol/Port Number pair. Because the length of a Protocol/Port Number pair with the Reserved field and B flag is always 4 octets, the number of Protocol/Port Number pairs can be easily computed using the PA-TNC Attribute Length field by subtracting the number of octets in the PA-TNC Attribute Header and dividing by 4. If the PA-TNC Attribute Length field is invalid, Posture Validators SHOULD respond with an Invalid Parameter PA-TNC error code.




Reserved

This field is reserved for future use. It MUST be set to 0 on transmission and ignored upon reception.

B Flag (Blocked or Allowed Port)

This single bit field indicates whether the following port is blocked or allowed. This bit MUST be set to 1 if the protocol and port combination is blocked. Otherwise this field MUST be set to 0. This field was provided to allow for more abbreviated reporting of the port filtering policy (e.g. when all ports are blocked except a few, the Posture Collector can just list the few that are allowed).

Posture Collectors MUST NOT provide a mixed list of block and non-blocked ports for a particular protocol. To be more precise, a Posture Collector MUST NOT include two Protocol/Port Number pairs in a single Port List attribute where the protocol number is the same but the B flag is different. Also, Posture Collectors MUST NOT list the same Protocol and Port Number combination twice in a Port List attribute.

Posture Collectors MAY list all blocked ports for one protocol and all allowed ports for a different protocol in a single Port List attribute, using the B flag to indicate whether each entry is blocked. For example, a Posture Collector might list all the blocked TCP ports but only list the allowed UDP ports. However it MUST NOT list some blocked TCP ports and some other allowed TCP ports.

Protocol

This field contains the protocol number being blocked or allowed. The values used in this field are the same ones used in the IPv4 Protocol and IPv6 Next Header fields. The IANA already maintains a registry of these values.

Port Number

This field contains the port number being blocked or allowed. The values used in this field are specific to the protocol identified by the Protocol field. The IANA maintains registries for TCP and UDP port numbers.

### 3.2.7. Installed Packages

This PA-TNC Attribute Type contains a list of the installed packages that comprise a product on the endpoint that implements the component specified in the PA Subtype field, as described in section 2.4. This allows a Posture Validator to check which packages are installed for a particular product and which versions of those packages are installed.

Posture Collectors that implement any of the IETF Standard PA Subtypes defined in this document SHOULD support sending this attribute type for those PA subtypes. Other Posture Collectors MAY support sending this attribute type, if it is appropriate to their PA subtype. Whether a particular Posture Collector actually sends this attribute type SHOULD still be governed by local privacy and security policies. Posture Validators that

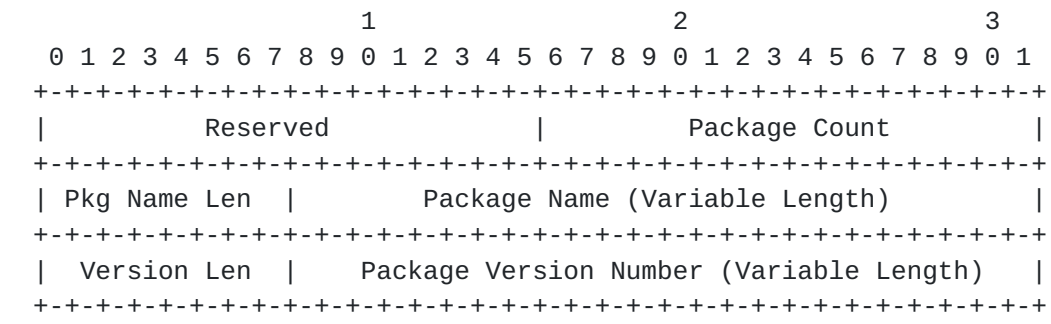
implement any of the IETF Standard PA Subtypes defined in this document SHOULD support receiving this attribute type, at least for those PA subtypes. Other Posture Validators MAY support receiving this attribute type. A Posture Validator that does not support receiving this attribute type SHOULD simply ignore attributes with this type. Posture Validators MUST NOT send this attribute type.

This attribute type can be quite long, especially for the Operating System PA subtype. This can cause problems, especially with 802.1X and other limited transport protocols. Therefore, Posture Collectors SHOULD NOT send this attribute unless specifically requested to do so using the Attribute Request attribute or otherwise configured to do so. Also, Posture Validators SHOULD NOT request this attribute unless the transport protocol in use can support the large amount of data that may be sent in response.

For this attribute type, the PA-TNC Attribute Vendor ID field MUST be set to zero (0) and the PA-TNC Attribute Type field MUST be set to 7. The value in the PA-TNC Attribute Length field will vary, depending on the number of packages and the length of the Package Name and Package Version Number fields for those packages. However, the value in the PA-TNC Attribute Length field MUST be at least 16 (20 if the Correlation ID field is present) because this is the length of the fixed size fields in the PA-TNC Attribute Header and the fixed size fields in this attribute type. If the PA-TNC Attribute Length field is less than the size of these fixed length fields or does not match the length indicated by the sum of the fixed length and variable length fields, implementations SHOULD respond with an Invalid Parameter PA-TNC error code.

The following diagram illustrates the format and contents of the Attribute Value field for this attribute type. The text after this diagram describes the fields shown here.

Note that this diagram shows an attribute containing information on one package. The actual number of package descriptions included in an Installed Packages attribute is indicated by the Package Count field. This value may vary from zero to a large number (up to 65535, if the underlying PT transport protocol can support that many). If this number is not sufficient, specialized patch management software should be employed which can simply report compliance with a pre-established patch policy.




Reserved

This field is reserved for future use. The field MUST be set to 0 on transmission and ignored upon reception.

Package Count

This field is an unsigned 16-bit integer that indicates the number of packages listed in this attribute. For each package so indicated, a Pkg Name Len, Package Name, Version Len, and Package Version Number field is included in the attribute.

Pkg Name Len

This field is an unsigned 8-bit integer that indicates the length of the Package Name field in octets. This field may be zero if a Package Name is not available.

Package Name

This field contains the name of the package associated with the product. This field is a UTF-8 encoded character string whose octet length is given by the Pkg Name Len field. This field MUST NOT include extra octets for padding or NUL character termination. The syntax and semantics of this name are not specified in this document, since they may vary across products and/or operating systems. Posture Collectors MAY list two packages with the same name in a single

Installed Packages attribute. The meaning of doing so is not defined here.

Version Len

This field is an unsigned 8-bit integer that indicates the length of the Package Version Number field in octets. This field may be zero if a Package Version Number is not available.

Package Version Number

This field contains the version string for the package named in the previous Package Name field. This field is a UTF-8 encoded character string whose octet length is given by the Version Len field. This field MUST NOT include extra octets for padding or NUL character termination. The syntax and semantics of this version string are not specified in this document, since they may vary across products and/or operating systems. Posture Collectors MAY list two packages with the same Package Version Number (and even the same Package Name and Package Version Number) in a single Installed Packages attribute. The meaning of doing so is not defined here.

### 3.2.8. PA-TNC Error

This PA-TNC Attribute Type contains an error code and supplemental information regarding an error pertaining to PA-TNC.

All Posture Collectors and Posture Validators that implement any of the IETF Standard PA Subtypes defined in this specification MUST support sending and receiving this attribute type, at least for those PA subtypes.

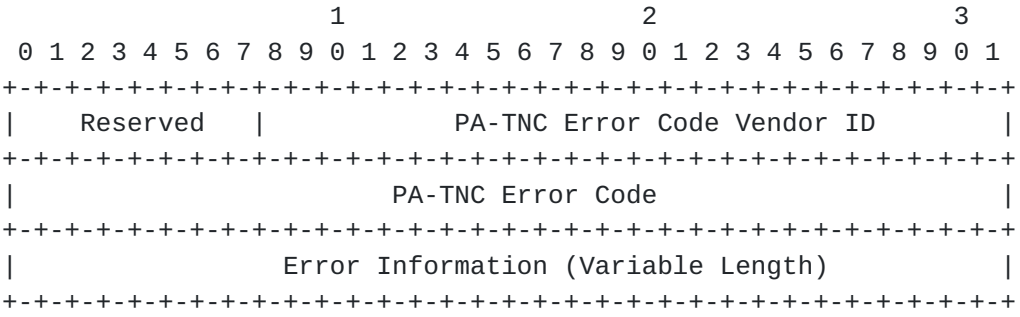
For this attribute type, the PA-TNC Attribute Vendor ID field MUST be set to zero (0) and the PA-TNC Attribute Type field MUST be set to 8. The value in the PA-TNC Attribute Length field will vary, depending on the length of the Error Information field. However, the value in the PA-TNC Attribute Length field MUST be at least 20 (24 if the Correlation ID field is present) because this is the length of the fixed size fields in the PA-TNC Attribute Header and the fixed size fields in this attribute type.

A PA-TNC error code SHOULD be sent with the same PA Message Vendor ID and PA Subtype used by the PA-TNC message that caused the error so that the error code is sent to the party who sent the offending PA-TNC message. Other measures (such as setting PB-TNC's EXCL flag and Posture Collector Identifier or Posture Validator Identifier fields) SHOULD also be taken to attempt to ensure that only the party who sent the offending message receives the error.

When a PA-TNC error code is received, the recipient MUST NOT respond with a PA-TNC error code because this could result in an infinite loop of errors. Instead, the recipient MAY log the error, modify its behavior to attempt to avoid the error (attempting to avoid loops or long strings of errors), ignore the error, terminate the assessment, or take other action as appropriate (as long as it is consistent with the requirements of this specification).

Posture Verifiers MUST NOT include this attribute type in an Attribute Request attribute. It does not make sense for a Posture Verifier to request that a Posture Collector send a PA-TNC Error attribute.

The following diagram illustrates the format and contents of the Attribute Value field for this attribute type. The text after this diagram describes the fields shown here.




Reserved

This field is reserved for future use. This field MUST be set to 0 on transmission and ignored upon reception.

PA-TNC Error Code Vendor ID

This field contains the SMI Private Enterprise Number for the organization that defined the PA-TNC Error Code that is being used in the attribute. For IETF Standard PA-TNC Error Code values this field MUST be set to zero (0).

PA-TNC Error Code

This field contains the PA-TNC Error Code being reported in this attribute. Note that a particular PA-TNC Error Code value will have completely different meanings depending on the PA-TNC Error Code Vendor ID. Each PA-TNC Error Code Vendor ID defines a different space of PA-TNC Error Code values.

When the PA-TNC Error Code Vendor ID is set to zero (0), the PA-TNC Error Code is an IETF Standard PA-TNC Error Code. The IANA maintains a registry for these values. The following table lists the IETF Standard PA-TNC Error Codes defined in this specification:

| Value | Description |
|---|---|
| 0 | Reserved |
| 1 | Invalid Parameter |
| 2 | Version Not Supported |
| 3 | Attribute Type Not Supported |

The next few subsections of this document provide detailed definitions of these error codes.

Error Information

This field provides additional context for the error. The contents of this field vary based on the PA-TNC Error Code Vendor ID and PA-TNC Error Code. Therefore, whenever a PA-TNC Error Code is defined, the format of this field for that error code must also be defined. The definitions of IETF Standard PA-TNC Error Codes on the next few pages provide good examples of such definitions.

The length of this field can be determined by the recipient using the PA-TNC Attribute Length field by subtracting the

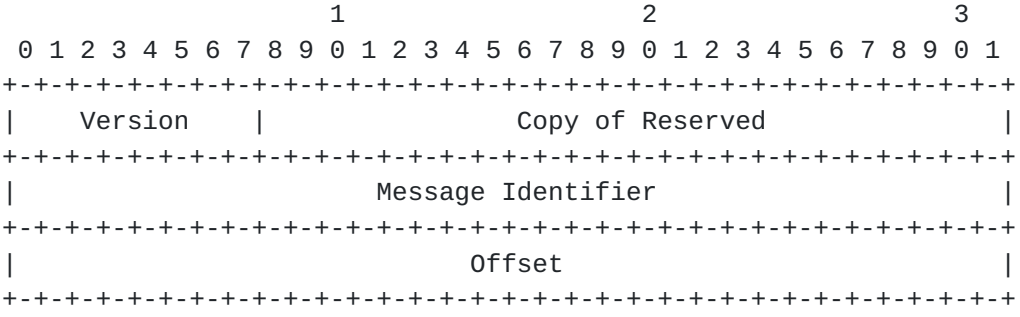
length of the fixed-length fields in the PA-TNC Attribute Header and the fixed-length fields in this attribute.

#### 3.2.8.1. Definition of Invalid Parameter Error Code

The Invalid Parameter error code is an IETF Standard PA-TNC Error Code (value 1) that indicates that the sender of this error code has detected an invalid value in a PA-TNC message sent by the recipient of this error code in the current assessment.

For this error code, the Error Information field contains the first 8 octets of the PA-TNC message that contained the invalid parameter and an offset indicating the position within that message of the invalid parameter.

The following diagram illustrates the format and contents of the Error Information field for this error code. The text after this diagram describes the fields shown here.




Version

This field MUST contain an exact copy of the Version field in the PA-TNC Message Header of the PA-TNC message that caused this error.

Copy of Reserved

This field MUST contain an exact copy of the Reserved field in the PA-TNC Message Header of the PA-TNC message that caused this error.

Message Identifier

This field MUST contain an exact copy of the Message Identifier field in the PA-TNC Message Header of the PA-TNC message that caused this error.

Offset

This field MUST contain an octet offset from the start of the PA-TNC Message Header of the PA-TNC message that caused this error to the start of the value that caused this error. For instance, if the first PA-TNC attribute in the message had an invalid PA-TNC Attribute Length (e.g. 0), this value would be 16.

#### 3.2.8.2. Definition of Version Not Supported Error Code

The Version Not Supported error code is an IETF Standard PA-TNC Error Code (value 2) that indicates that the sender of this error code does not support the PA-TNC version number included in the PA-TNC Message Header of a PA-TNC message sent by the recipient of this error code in the current assessment.

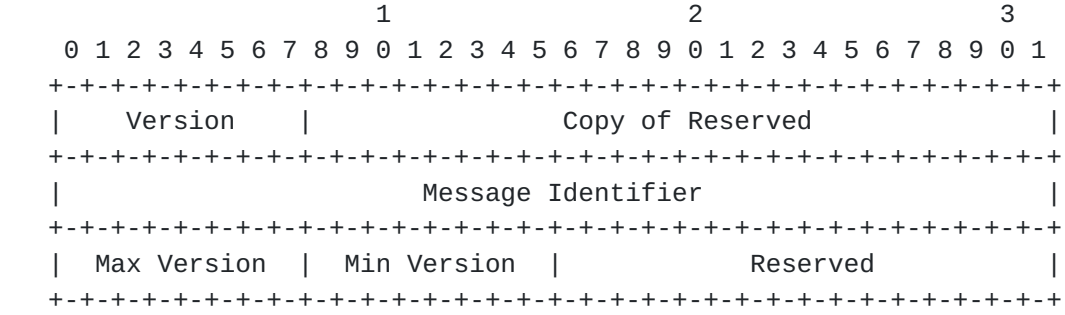
For this error code, the Error Information field contains the first 8 octets of the PA-TNC message that contained the unsupported version as well as Max Version and Min Version fields that indicate which PA-TNC version numbers are supported by the sender of the error code.

The sender MUST support all PA-TNC versions between the Min Version and the Max Version, inclusive (i.e. including the Min Version and the Max Version). When possible, recipients of this error code SHOULD send future messages to the Posture Collector or Posture Validator that originated this error message with a PA-TNC version number within the stated range.

Any party that is sending the Version Not Supported error code SHOULD include that error code as the only PA-TNC attribute in a PA-TNC message with version number 1. All parties that send PA-TNC messages SHOULD be able to properly process a message that meets this description, even if they cannot process any other aspect of PA-TNC version 1. This ensures that a PA-TNC version

exchange can proceed properly, no matter what versions of PA-TNC the parties implement.

The following diagram illustrates the format and contents of the Error Information field for this error code. The text after this diagram describes the fields shown here.




Version

This field MUST contain an exact copy of the Version field in the PA-TNC Message Header of the PA-TNC message that caused this error.

Copy of Reserved

This field MUST contain an exact copy of the Reserved field in the PA-TNC Message Header of the PA-TNC message that caused this error.

Message Identifier

This field MUST contain an exact copy of the Message Identifier field in the PA-TNC Message Header of the PA-TNC message that caused this error.

Max Version

This field MUST contain the maximum PA-TNC version supported by the sender of this error code.

Min Version

This field MUST contain the minimum PA-TNC version supported by the sender of this error code.

Reserved

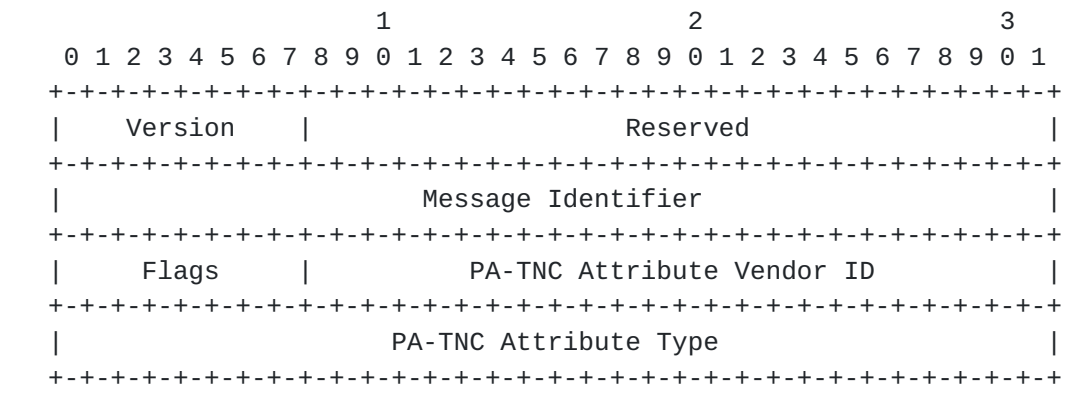
Reserved for future use. This field MUST be set to 0 on transmission and ignored upon reception.

#### 3.2.8.3. Definition of Attribute Type Not Supported Error Code

The Attribute Type Not Supported error code is an IETF Standard PA-TNC Error Code (value 3) that indicates that the sender of this error code does not support the PA-TNC Attribute Type included in the Error Information field. This PA-TNC Attribute Type was included in a PA-TNC message sent by the recipient of this error code in the current assessment.

For this error code, the Error Information field contains the first 8 octets of the PA-TNC message that contained the unsupported attribute type as well as a copy of the attribute type that caused the problem.

The following diagram illustrates the format and contents of the Error Information field for this error code. The text after this diagram describes the fields shown here.




Version

This field MUST contain an exact copy of the Version field in the PA-TNC Message Header of the PA-TNC message that caused this error.

Copy of Reserved

This field MUST contain an exact copy of the Reserved field in the PA-TNC Message Header of the PA-TNC message that caused this error.

Message Identifier

This field MUST contain an exact copy of the Message Identifier field in the PA-TNC Message Header of the PA-TNC message that caused this error.

Flags

This field MUST contain an exact copy of the Flags field in the PA-TNC Attribute Header of the PA-TNC attribute that caused this error.

PA-TNC Attribute Vendor ID

This field MUST contain an exact copy of the PA-TNC Attribute Vendor ID field in the PA-TNC Attribute Header of the PA-TNC attribute that caused this error.

PA-TNC Attribute Type

This field MUST contain an exact copy of the PA-TNC Attribute Type field in the PA-TNC Attribute Header of the PA-TNC attribute that caused this error.

## 3.3. Vendor-Defined Attributes

This section discusses the use of vendor-defined attributes within PA-TNC. The PA-TNC protocol was designed to allow for vendor-defined attributes to be used as a replacement where a standard attribute could be used. In some cases even the standard attributes allow for vendor-defined information to be included. It is envisioned that over time as particular vendor-defined attributes become popular, an equivalent standard attribute could be added allowing for broader interoperability.

This specification does not define vendor-defined attributes, but rather highlights how such attributes can be used with PA-TNC without the potential for name space collisions or misinterpretations. In order to avoid collisions, PA-TNC uses the well-established SMI Private Enterprise Numbers as Vendor IDs to define separate name spaces for important fields within a PA-TNC message. For example, to ensure the uniqueness of attribute types while providing for vendor extensions, vendor-defined attribute types include the vendor's unique Vendor ID, to indicate the intended name space for the attribute type, followed by the attribute type. IETF Standard PA-TNC Attribute Types use a Vendor ID of zero (0).

SMI Private Enterprise Numbers are used to provide a separate identifier space for each vendor. The IANA provides a registry for SMI Private Enterprise Numbers. Any organization (including non-profit organizations, governmental bodies, etc.) can obtain one of these numbers at no charge and thousands of organizations have done so. Within this document, SMI Private Enterprise Numbers are known as "vendor IDs".

# 4. Evaluation Against NEA Requirements

This section evaluates the PA-TNC protocol against the requirements defined in the NEA Requirements document. Each subsection considers a separate requirement from the NEA

Requirements document. Only common requirements (C-1 through C-10) and PA requirements (PA-1 through PA-6) are considered, since these are the only ones that apply to PA.

### 4.1. Evaluation Against Requirement C-1

Requirement C-1 says:

C-1 NEA protocols MUST support multiple round trips between the NEA Client and NEA Server in a single assessment.

PA-TNC meets this requirement. It allows an unlimited number of round trips between the NEA Client and NEA Server.

### 4.2. Evaluation Against Requirement C-2

Requirement C-2 says:

C-2 NEA protocols SHOULD provide a way for both the NEA Client and the NEA Server to initiate a posture assessment or reassessment as needed.

PA-TNC meets this requirement. PA-TNC is designed to work whether the NEA Client or the NEA Server initiates a posture assessment or reassessment.

### 4.3. Evaluation Against Requirement C-3

Requirement C-3 says:

C-3 NEA protocols including security capabilities MUST be capable of protecting against active and passive attacks by intermediaries and endpoints including prevention from replay based attacks.

Security for PA-TNC can be provided through PT security or through the use of PA-TNC security, which is defined in a separate specification: PA-TNC Security [8]. Therefore, this base specification for PA-TNC does not include any security capabilities. Since this requirement only applies to NEA protocols that include security capabilities, this base specification for PA-TNC meets this requirement.

### 4.4. Evaluation Against Requirement C-4

Requirement C-4 says:

C-4 The PA and PB protocols MUST be capable of operating over any PT protocol. For example, the PB protocol must provide a transport independent interface allowing the PA protocol to operate without change across a variety of network protocol environments (e.g. EAP/802.1X, PANA, TLS and IKE/IPsec).

PA-TNC meets this requirement. PA-TNC can operate over any PT protocol that meets the requirements for PT stated in the NEA Requirements document. PA-TNC does not have any dependencies on specific details of the underlying PT protocol.

### 4.5. Evaluation Against Requirement C-5

Requirement C-5 says:

C-5 The selection process for NEA protocols MUST evaluate and prefer the reuse of existing open standards that meet the requirements before defining new ones. The goal of NEA is not to create additional alternative protocols where acceptable solutions already exist.

Based on this requirement, PA-TNC should receive a strong preference. PA-TNC is equivalent with IF-M 1.0, an open TCG specification. Other specifications from TCG and other groups are also under development based on the IF-M 1.0 specification. Selecting PA-TNC as the basis for the PA protocol will ensure compatibility with IF-M 1.0, with these other specifications, and with their implementations.

### 4.6. Evaluation Against Requirement C-6

Requirement C-6 says:

C-6 NEA protocols MUST be highly scalable; the protocols MUST support many Posture Collectors on a large number of NEA Clients to be assessed by numerous Posture Validators residing on multiple NEA Servers.

PA-TNC meets this requirement. PA-TNC supports an unlimited number of Posture Collectors, Posture Validators, NEA Clients, and NEA Servers. It also is quite scalable in many other aspects as well. A PA-TNC message can contain up to 2^32-1 octets and about 2^28 PA-TNC attributes. Each organization with an SMI Private Enterprise Number is entitled to define up to 2^32 vendor-specific PA-TNC Attribute Types, 2^16 vendor-specific PA-TNC Product IDs, and 2^32 vendor-specific PA-TNC

Error Codes. Each attribute can contain almost 2^32 octets. It is generally not advisable or necessary to send this much data in a NEA assessment, but still PA-TNC is highly scalable and meets requirement C-6 easily.

## 4.7. Evaluation Against Requirement C-7

Requirement C-7 says:

C-7 The protocols MUST support efficient transport of a large number of attribute messages between the NEA Client and the NEA Server.

PA-TNC meets this requirement. Each PA-TNC message can contain about 2^28 PA-TNC attributes. PA-TNC supports up to 2^32 round trips in a session so the maximum number of attribute messages that can be sent in a single session is actually about 2^50. However, it is generally inadvisable and unnecessary to send a large number of messages in a NEA assessment. As for efficiency, PA-TNC adds only 12 octets of overhead per attribute and 8 octets per message (which is negligible on a per-attribute basis).

## 4.8. Evaluation Against Requirement C-8

Requirement C-8 says:

C-8 NEA protocols MUST operate efficiently over low bandwidth or high latency links.

PA-TNC meets this requirement. A typical PA-TNC exchange will involve one or two round trips with less than 500 octets of PA-TNC messages. Of course, use of PA-TNC security or vendor-specific PA-TNC attribute types could expand the assessment. However, PA-TNC itself imposes an overhead of only 8 octets per PA-TNC message and 12 octets per attribute.

## 4.9. Evaluation Against Requirement C-9

Requirement C-9 says:

C-9 For any strings intended for display to a user, the protocols MUST support adapting these strings to the user's language preferences.

PA-TNC meets this requirement. The fields defined here do not include any strings intended for display to a user. They are intended for logging and programmatic comparisons.

If any vendor-specific PA-TNC attribute types or future IETF Standard PA-TNC Attribute Types include strings that are intended for display to a user, they can be adapted to the user's language preferences using the PB-TNC protocol's ability to exchange information about those preferences in a standard manner. The Posture Broker Server will need to expose the user's preferences to the Posture Validators through whatever API or protocol is used to connect those components. However, that is all out of scope for this specification.

## 4.10. Evaluation Against Requirement C-10

Requirement C-10 says:

C-10 NEA protocols MUST support encoding of strings in UTF-8 format.

PA-TNC meets this requirement. All strings in the PA-TNC protocol are encoded in UTF-8 format. This allows the protocol to support a wide range of languages efficiently.

## 4.11. Evaluation Against Requirement PA-1

Requirement PA-1 says:

PA-1 The PA protocol MUST support communication of an extensible set of NEA standards defined attributes. These attributes will be uniquely identifiable from non-standard attributes.

PA-TNC meets this requirement. Each attribute is identified with a PA-TNC Attribute Vendor ID and a PA-TNC Attribute Type. IETF Standard PA-TNC Attribute Types use a vendor ID of zero (0), in contrast with vendor-specific PA-TNC Attribute Types, which will use the vendor's SMI Private Enterprise Number as the vendor ID. The IANA will maintain a registry of IETF Standard PA-TNC Attribute Types with new values added by IETF Consensus, as described in the IANA Considerations section of this specification. Thus, the set of standard attribute types is extensible, but all standard attribute types are uniquely identifiable.

### 4.12. Evaluation Against Requirement PA-2

Requirement PA-2 says:

PA-2 The PA protocol MUST support communication of an extensible set of vendor-specific attributes. These attributes will be segmented into uniquely identifiable vendor specific name spaces.

PA-TNC meets this requirement. Each attribute is identified with a PA-TNC Attribute Vendor ID and a PA-TNC Attribute Type. Vendor-defined PA-TNC Attribute Types use the vendor's SMI Private Enterprise Number as the PA-TNC Attribute Vendor ID. Each vendor can define up to 2^32 PA-TNC Attribute Types, using its own internal processes to manage its set of attribute types. The IANA is not involved, other than the initial assignment of the vendor's SMI Private Enterprise Number. Thus, the set of vendor-specific attributes is segmented into uniquely identifiable vendor-specific name spaces.

### 4.13. Evaluation Against Requirement PA-3

Requirement PA-3 says:

PA-3 The PA protocol MUST enable a Posture Validator to make one or more requests for attributes from a Posture Collector within a single assessment. This enables the Posture Validator to reassess the posture of a particular endpoint feature or to request additional posture including from other parts of the endpoint.

PA-TNC meets this requirement. The Attribute Request attribute type is an IETF Standard PA-TNC Attribute Type that permits a Posture Validator to send to one or more Posture Collectors a request for one or more attributes. This attribute may be sent at any point in the posture assessment process and may in fact be sent more than once if the Posture Validator needs to first determine the type of operating system and then request certain attributes specific to that operating system, for example.

### 4.14. Evaluation Against Requirement PA-4

Requirement PA-4 says:

PA-4 The PA protocol MUST be capable of returning attributes from a Posture Validator to a Posture Collector. For example, this might enable the Posture Collector to learn

the specific reason for a failed assessment and to aid in remediation and notification of the system owner.

PA-TNC meets this requirement. A Posture Validator can easily send attributes to one or more Posture Collectors.

## 4.15. Evaluation Against Requirement PA-5

Requirement PA-5 says:

PA-5 The PA protocol SHOULD provide authentication, integrity, and confidentiality of attributes communicated between a Posture Collector and Posture Validator. This enables end-to-end security across a NEA deployment that might involve traversal of several systems or trust boundaries.

PA-TNC meets this requirement when a PA-TNC Security mechanism is used, such as PA-TNC Security with CMS. The specifications for those mechanisms should be consulted for a complete analysis of their security properties.

PA-TNC Security is an optional addition to PA-TNC because different products and deployments may require different security mechanisms. For example, one product might integrate Posture Validators, the Posture Broker Server, and the Posture Transport Server into a single entity. In that case, PA-TNC security may not be needed. PT security may be enough. Another deployment may employ remote Posture Validators in the same trust domain as the Posture Broker Server. In that case, a TLS session between the Posture Broker Server and the Posture Validators may suffice. A third deployment may include a Posture Broker Server that is not trusted to see PA-TNC messages, at least for some Posture Validators. In that case, PA-TNC security may be desirable. Even there, some deployments may wish to use PKI (Public Key Infrastructure) for security, while others may wish to use Kerberos or another mechanism.

## 4.16. Evaluation Against Requirement PA-6

Requirement PA-6 says:

PA-6 The PA protocol MUST be capable of carrying attributes that contain non-binary and binary data including encrypted content.

PA-TNC meets this requirement. PA-TNC attributes can contain non-binary and binary data including encrypted content. For

examples, see the attribute type definitions contained in this specification and in the PA-TNC Security with CMS specification.

## 5. Security Considerations

This section discusses the major types of potential security threats relevant to the PA-TNC message protocol and summarizes the expected security protections that should be offered by PA-TNC security protocols. PA-TNC security protocols are described in separate specifications which layer upon the base PA-TNC protocol described in this specification. It is envisioned that additional attribute types will be defined to facilitate the exchange of security capabilities, keys, and security protected attributes. Ultimately, the NEA deployer decides which security protection is most appropriate for a particular deployment environment. The security protections discussed in this section highlight the need for PA-TNC security protocol implementations to be capable of offering the feature.

### 5.1. Trust Relationships

In order to understand where security countermeasures are necessary, this section starts with a discussion of where the TNC architecture envisions some trust relationships between the processing elements of the PA-TNC protocol. Some deployments may wish to reduce the amount of assumed trust by using a PA-TNC security protocol to protect the PA-TNC messages. The following sub-sections discuss the trust properties associated with each portion of the NEA reference model directly involved with the processing of the PA-TNC protocol.

#### 5.1.1. Posture Collector

The Posture Collectors are trusted by Posture Validators to:

- Collect valid information about the component type associated with the Posture Collector
- Report upon collected information consistent with local security and privacy policies
- Accurately report information associated with the type of component for the PA-TNC message
- Not act maliciously to the Posture Broker Server and Posture Validators, including attacks such as Denial Of Service

### 5.1.2. Posture Validator

The Posture Validators are trusted by Posture Collectors to:

- Only request information necessary to assess the security state of the endpoint
- Make assessment decisions based on deployer defined policies
- Discard collected information consistent with data retention and privacy policies
- Not act maliciously to the Posture Broker Server and Posture Collectors, including attacks such as Denial Of Service

### 5.1.3. Posture Broker Client, Posture Broker Server, and PB-TNC

The Posture Broker Client and Posture Broker Server are trusted by the Posture Collector and Posture Validator to:

- Provide a reliable transport for PA-TNC messages
- Deliver messages for a particular PA Subtype only to those Posture Collectors and Posture Validators that have registered for them
- Not disclose any provided attributes to unauthorized parties
- Not act maliciously to drop messages, duplicate messages, or flood the Posture Collectors and Posture Validators with unnecessary messages
- Not observe, fabricate, or alter the contents of a PA-TNC message (this trust can be minimized with a PA-TNC security protocol)
- Properly place Posture Collector and Posture Validator identifiers into the PB-TNC protocol, deliver those identifiers to Posture Collectors and Posture Validators as needed, and manage exclusive delivery to a particular Posture Collector or Posture Validator
- Properly expose authentication information from PT security so that Posture Collectors and Posture Validators can use this to make policy decisions

## 5.2. Security Threats

Beyond the trusted relationships assumed in section 5.1, the PA-TNC protocol faces a number of potential security attacks that could require targeted security countermeasures. PA-TNC security protocol specifications MUST state if and how the security protocol will safeguard against these types of attack.

Generally the PA-TNC protocol, without the presence of security countermeasures, relies upon the underlying PT protocol to protect the messages from attack when traveling over the network. Once the message resides on the Posture Broker Client or Posture Broker Server, it is trusted to be properly and safely delivered to the appropriate Posture Collectors and Posture Validators. However, in some deployments the PA-TNC messages need to travel over network hops that are not protected by PT or require more assurance that only the appropriate Posture Collector or Posture Validator has received the message. In these cases, end to end PA-TNC message protection might be required. The following sub-sections focus on the potential threats where end to end protection might be desired and thus when the use of the PA-TNC security protocol becomes beneficial.

### 5.2.1. Attribute Theft

When PA-TNC messages are sent over unprotected network links or spanning local software stacks that are not trusted, the contents of the PA-TNC messages may be subject to information theft by an intermediary party. This theft could result in information being recorded for future use or analysis by the adversary. Attributes observed by eavesdroppers could contain information that exposes potential weaknesses in the security of the endpoint, or system fingerprinting information easing the ability of the attacker to employ attacks more likely to be successful against the endpoint. The eavesdropper might also learn information about the endpoint or network policies that either singularly or collectively is considered sensitive information (e.g. certain endpoints are lacking patches, or particular sub-networks have more lenient policies). PA-TNC attributes are not intended to carry privacy-sensitive information, but should some exist in a message, the adversary could come into possession of the information which could be used for other financial gain.

### 5.2.2. Message Fabrication

Attackers on the network or present within the NEA system could introduce fabricated PA-TNC messages intending to trick or create a denial of service against aspects of an assessment. This could occur if an active attacker could launch a man-in-the-middle (MiTM) attack by proxying the PA-TNC messages and was able to replace undesired messages with ones easing future attack upon the endpoint. Consider a scenario where PT security protection is not used, and the Posture Broker Server proxies all assessment traffic to a remote Posture Broker Server. The proxy could eavesdrop and replace assessment results attributes, tricking the endpoint into thinking it has passed an assessment, when in fact it has not and requires remediation. Because the Posture Collector has no way to verify that attributes were actually created by an authentic Posture Validator, it is unable to detect the falsified attribute or message.

### 5.2.3. Attribute Modification

This attack could allow an active attacker capable of intercepting a message to modify a PA-TNC message attribute to a desired value to ease the compromise of an endpoint. Without the ability for message recipients to detect whether a received message contains the same content as what was originally sent, active attackers can stealthily modify the attribute exchange. For example, an attacker might wish to change the contents of the firewall component's version string attribute to disguise the fact that the firewall is running an old, vulnerable version. The attacker would change the version string sent by the firewall Posture Collector to the current version number, so the Posture Validator's assessment passes while leaving the endpoint vulnerable to attack. Similarly, an attacker could achieve widespread denial of service by altering large numbers of assessments' version string attributes to an old value so they repeatedly fail assessments even after a successful remediation. Upon receiving the lower value, the Posture Validator would continue to believe that the endpoint is running old, potentially vulnerable versions of the firewall that does not meet network compliance policy, so therefore the endpoint would not be allowed to join the network.

### 5.2.4. Attribute Replay

Another potential attack against an unprotected PA-TNC message attribute exchange is to exploit the lack of a strong binding between the attributes sent during an assessment to the specific

endpoint. Without a strong binding of the endpoint to the measurement information, an attacker could record the attributes sent during an assessment of a compliant endpoint and later replay those attributes so that a non-compliant endpoint can now gain access to the network or protected resource. This attack could be employed by a network MiTM that is able to eavesdrop and proxy message exchanges, or by using local rogue agents on the endpoints. Assessments lacking some form of freshness exchange could be subject to replay of prior assessment data, even if it no longer reflects the current state of the endpoint.

### 5.2.5. Attribute Insertion

Similar to the attribute modification attacks, an adversary wishing to include one or more attributes or PA-TNC messages inside a valid assessment may be able to insert the attributes or messages without detection is possible by the recipient. Even if authentication of the parties is present during a PA-TNC exchange, if no per-message and per-session integrity protection is present, an attacker can add information to the assessment, possibly causing incorrect assessment results. For example, an attacker could add attributes to the front of a PA-TNC message to cause an assessment to succeed even for a non-compliant endpoint, particularly if it knew that the recipient ignored repeated attributes within a message. Similarly, if a Posture Collector or Posture Validator always generated an error if it saw unexpected attributes, the attacker could cause failures and denial of service by adding attributes or messages to an exchange.

### 5.2.6. Denial of Service

A variety of types of denial of service attacks are possible against the PA-TNC message exchange if left unprotected to untrusted parties along the communication path between the Posture Collector and Posture Validator. Normally, the PT exchange is bi-directionally authenticated which helps to prevent a MiTM on the network from becoming an active proxy, but transparent message routing gateways may still exist on the communication path and can modify the integrity of the message exchange unless adequate integrity protection is provided. If the MiTM or other entities on the network can send messages to the Posture Broker Client or Posture Broker Server that appear to be part of an assessment, these messages could confuse the Posture Collector and Posture Validator or cause them to perform unnecessary work or take incorrect action. Several example denial of service situations are described in section 5.2.3 and

5.2.5. Many potential denial of service examples exist, including flooding messages to Posture Collector or Posture Validator, sending very large messages containing many attributes, and repeatedly asking for resource intensive operations.

## 6. Privacy Considerations

The PA-TNC protocol is designed to allow for controlled disclosure of security relevant information about an endpoint, specifically for the purpose of enabling an assessment of the endpoint's compliance with network policy. The purpose of this protocol is to provide visibility into the state of the protective mechanisms on the endpoint, in order for the Posture Validators and Posture Broker Server to determine whether the endpoint is up to date and thus has the best chance of being resilient in the face of malware threats. One risk associated with providing visibility into the contents of an endpoint is the increased chance for exposure of privacy sensitive information without the consent of the user.

While this protocol does provide the Posture Validator the ability to request specific information about the endpoint, the protocol is not open ended--bounding the Posture Validator to only query specific information (attributes) about specific security features (component types) of the endpoint. Each PA-TNC message is explicitly about a single component from the list of components in section 2.4. These components include a list of security-related aspects of the endpoint that affect the ability of the endpoint to resist attacks and thus are of interest during an assessment. Discretionary components used by the user to create or view content are not on the list, as they are more likely to have access to privacy sensitive information. Similarly, PA-TNC messages contain a set of attributes which describe the particular component. Each attribute contains generic information (e.g. product information or versions) about the component, so it is unlikely to include any user specific or identifying information. This combination of limited set of security related components with non-user specific attributes greatly reduces the risk of exposure of privacy sensitive information. Vendors that choose to define additional component types and/or attributes within their name space are encouraged to provide similar constraints.

Even with the bounding of standard attribute information to specific components, it is possible that individuals might wish to share less information with different networks they wish to

access. For example, a user may wish to share more information when connecting or being reassessed by the user's employer network than what would be made available to the local coffee shop wireless network. While these situations do not impact the protocol itself, they do suggest that Posture Collector implementations should consider supporting a privacy filter allowing the user and/or system owner to restrict access to certain attributes based upon the target network. The underlying PT protocol authenticates the network's Posture Broker Server at the start of an assessment, so identity can be made available to the Posture Collector and per-network privacy filtering is possible. Network owners should make available a list of the attributes they require to perform an assessment and any privacy policy they enforce when handling the data. Users wishing to use a more restricted privacy filter on the endpoint may risk not being able to pass an assessment and thus not gain access to the requested network or resource.

## 7. IANA Considerations

Two new IANA registries are defined by this specification: IETF Standard PA-TNC Attribute Types and IETF Standard PA-TNC Error Codes. This section explains how these registries work. Also, this specification defines nine new IETF Standard PA Subtypes. These assignments will be added to the registry for IETF Standard PA Subtypes when this document is approved by the IESG as an RFC.

Section 7.1 defines the new IETF Standard PA Subtypes. Sections 7.2 and 7.3 provide guidance to the IANA in creating and managing the two new IANA registries defined by this specification.

### 7.1. New IETF Standard PA Subtypes

Section 2.4 of this specification defines several new IETF Standard PA Subtypes. Here is a list of these assignments:

| Number | Name |
|---|---|
| 0 | Testing |
| 1 | Operating System |
| 2 | Anti-Virus |
| 3 | Anti-Spyware |
| 4 | Anti-Malware |
| 5 | Firewall |
| 6 | IDPS |

| | |
|---|---|
| 7 | VPN |

Once this document becomes an RFC, these IETF Standard PA Subtypes should be added to the registry for IETF Standard PA Subtypes defined in the PB-TNC specification. The RFC number assigned to this document should be associated with these assignments.

## 7.2. Registry for IETF Standard PA-TNC Attribute Types

The name for this registry is "IETF Standard PA-TNC Attribute Types". Each entry in this registry should include a human-readable name, a decimal integer value between 0 and 2^32-1, and a reference to an RFC where the contents of this attribute type are defined. This RFC must define the meaning of this PA-TNC attribute type and the format and semantics of the PA-TNC Attribute Value field for PA-TNC attributes that include the designated numeric value in the PA-TNC Attribute Type field and the value 0 in the PA-TNC Attribute Vendor ID field.

Entries to this registry may only be added by IETF Consensus, as defined in RFC 2434 [3]. That is, they can only be added in an RFC approved by the IESG.

The following entries for this registry are defined in this document. Once this document becomes an RFC, they should become the initial entries in the registry for IETF Standard PA-TNC Attribute Types.

| Integer Value | Name | Defining RFC |
|---|---|---|
| 0 | Testing | RFC # Assigned to this I-D |
| 1 | Attribute Request | RFC # Assigned to this I-D |
| 2 | Product Information | RFC # Assigned to this I-D |
| 3 | Numeric Version | RFC # Assigned to this I-D |
| 4 | String Version | RFC # Assigned to this I-D |
| 5 | Operational Status | RFC # Assigned to this I-D |
| 6 | Port Filter | RFC # Assigned to this I-D |
| 7 | Installed Packages | RFC # Assigned to this I-D |
| 8 | PA-TNC Error | RFC # Assigned to this I-D |

## 7.3. Registry for IETF Standard PA-TNC Error Codes

The name for this registry is "IETF Standard PA-TNC Error Codes". Each entry in this registry should include a human-readable name, a decimal integer value between 0 and 2^32-1, and a reference to an RFC where this error code is defined. This RFC must define the meaning of this error code and the format and semantics of the Error Information field for PA-TNC attributes that have a PA-TNC Vendor ID of 0, a PA-TNC Attribute Type of PA-TNC Error, the designated numeric value in the PA-TNC Error Code field, and the value 0 in the PA-TNC Error Code Vendor ID field.

Entries to this registry may only be added by IETF Consensus, as defined in RFC 2434. That is, they can only be added in an RFC approved by the IESG.

The following entries for this registry are defined in this document. Once this document becomes an RFC, they should become the initial entries in the registry for IETF Standard PA-TNC Error Codes.

| Integer Value | Name | Defining RFC |
|---|---|---|
| 1 | Invalid Parameter | RFC # Assigned to this I-D |
| 2 | Version Not Supported | RFC # Assigned to this I-D |
| 3 | Attribute Type Not Supported | RFC # For this I-D |

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