GSA GAT PROTOCOL V4.2 DRAFT 2
Game Authentication Terminal

Gaming Standards Association

GAT Technical Committee

Released: TBD

GSA GAT Protocol V4.2 DRAFT 2

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I About This Document

The GSA GAT Protocol is a communication standard used by regulators and operators to identify and authenticate gaming software and firmware in the field.

I.I Acknowledgements

The Gaming Standards Association expresses its appreciation to all members of the GAT committee (past and present) as well as gaming regulators and others, for their significant contribution and dedication to the creation of this standard.

I.II Related Documents

SVC Serial Protocol v1.0

http://www.gamingstandards.com/pdfs/standards/SVC_r1.pdf

Game Authentication Terminal Program (GAT3) Requirements Document

http://www.gamingstandards.com/pdfs/standards/GSA_GAT3_r1.pdf

EIA/TIA-232 (RS-232)

http://www.tiaonline.org/standards/

I.III Document Conventions

I.III.I Indicating Requirements, Recommendations, and Options

Terms and phrases in this document that indicate requirements, recommendations, and options are used as defined in the IETF RFC 2119.

In summary:

Requirements:
To indicate requirements, this document uses "MUST", "MUST NOT", "REQUIRED".

Recommendations:

To indicate recommendations, this document uses "SHOULD", "SHOULD NOT", "RECOMMENDED".

Options:

To indicate **options**, this document uses "MAY" or "OPTIONAL".

I.III.II Changes, Corrections, and Clarifications

A pale **yellow** banner identifies content that has been changed, corrected, or clarified since the last released version, along with text that identifies in what version the changes were made. The following example shows how this convention is used, and indicates that corrections were made in v3.50.1 to content.

Note that correction banners and the associated inserted and deleted text is highlighted only in the mark-up PDF of released versions, and are provided only for changes made between the last released version and the current released version. Correction indicators are not carried forward from version to version.

Change in v3.50.1

Lorem ipsum dolor sit amet, consectetur ~~consectetur~~ adipiscing elit. Aliquam consectetur justo vel odio consequat rutrum. Morbi magna neque, blandit a dictum nec, vestibulum ac velit. Donec ultrices imperdiet mi, eget pharetra enim porttitor quis. Nam vestibulum massa eget augue consectetur condimentum tempus enim pellentesque.

I.III.III Other Formatting Conventions

- Blue text indicates an internal link or external hyperlink to a URL.
- **Bold** (other than in headings) or underlined text is used for emphasis, unless specifically indicated otherwise.
- *Italicized* text (other than in headings) is used for terms being introduced and/or being defined.
- `Courier New` font is used to indicate code or pseudo code.

I.IV Categorization of Standards

Correction in v4.2

To help provide guidance to implementers regarding the maturity and stability of its standards, GSA categorizes its standards as Candidate Standards, Proposed Standards, or Recommended Standards. The categorizations can be found on the GSA website.

- Standards identified as Candidate Standards are the least mature; changes to these standards should be expected in future releases.
- Standards identified as Proposed Standards have been reduced to practice and deployed; very few changes to these standards should be expected.
- Standards identified as Recommended are the most mature and have been widely deployed; no changes to these standards should be expected.

Further details about the categorization of standards and extensions can be found in the GSA Policy Handbook.

Chapter 1

Introduction

1.1 Overview

GAT defines a communications protocol used, between a master and an EGM, to authenticate software and firmware components within the EGM. Typically, a portable PC or a laptop is used for the role of the master. EGMs and other devices can be used for the role of the EGM.

The GAT communication protocol is simple in order to reduce complexity of design, implementation, testing and usage. Due to the simplicity of this protocol, a standard layered approach is not necessary. Only the physical layer and the application layer command set are specified.

The GAT protocol and associated calculations are to be run on a properly functioning EGM. Any attempt to use GAT while an EGM is in an error state, tilted, or otherwise malfunctioning is beyond the scope of this standard.

The GAT protocol and associated calculations are designed for the purposes of verifying software content on an EGM. Any attempt to use GAT for any other purpose, such as verifying jackpots, game history recall, and so forth, is beyond the scope of this standard.

Chapter 2

Physical Layer

2.1 Physical Layer Between EGM and Master

The physical layer between the EGM and the master is:

- point-to-point
- full duplex
- no handshaking
- 3-wire (Tx/Rx/Gnd) RS232C

The default communication:

- 9600 baud with eight data bits
- no parity
- one stop bit

The master is typically a laptop PC and is generally assumed to provide a standard DE9 (commonly known as a DB9) male connector (DE9M) configured as a DTE interface, as shown in Table 2.1.

Table 2.1 Pinout for DE9M Connector Configured as DTE

Pin	Function
Pin 2	RX. Receives data.
Pin 3	TX. Transmits data.
Pin 5	GND. Signal ground.

The EGM MUST provide a connector suitable for connection to this typical master DE9M. There are three options by which this may be accomplished:

1. The EGM MAY provide a standard DE9 female connector (DE9F) configured as a DCE, as shown in Table 2.2. The master may connect to the EGM using a standard RS-232 "straight-through" cable.

Table 2.2 Pinout for DE9F Connector Configured as DCE

Pin	Function
Pin 2	TX. Transmits data.
Pin 3	RX. Receives data.
Pin 5	GND. Signal ground.

2. The EGM MAY provide a standard DE9 male connector (DE9M) configured as a DTE, as shown in Table 2.1. The master may connect to the EGM using a standard RS-232 "null modem" cable.
3. The EGM MAY provide a non-standard connector. If a non-standard connector is provided, the EGM manufacturer MUST clearly document the pinout for this connector, and MUST make available a cable or adapter that mates to the EGM's GAT connector on one end and has a standard DE9 female connector (DE9F) configured as a DCE, as shown in Table 2.2, on the other end. This cable MUST NOT exceed 10 feet in length.

The EGM GAT connector MUST be located within a secure area of the EGM. It is recommended that the GAT connector be located in an easily accessible location within the interior of the EGM cabinet and labeled for easy identification.

NOTE:
This standard does not specify whether a dedicated physical port is (or is not) required for the EGM GAT connector. This leaves the option open to the manufacturer as to whether port sharing is an acceptable solution within the particular jurisdiction where it will be used. It is up to the manufacturer to determine whether the jurisdiction will allow port sharing.

Chapter 3

Application Command Layer

3.1 Overview

At the application layer, the master sends a *query* to the EGM and waits for the *response* before sending another command. The EGM always responds to a query with a response. As a consequence no more than one query / response may be pending at the master / EGM side at any given time.

The EGM MUST validate the length and CRC, and then it MUST validate the command byte. The EGM SHOULD NOT respond to messages with invalid length, CRC, or command bytes.

The Master MUST validate the length and CRC, and then it MUST validate the command byte. The master SHOULD ignore messages with invalid length, CRC, or command bytes.

The following time-outs will be in effect:

1. The EGM MUST respond within 200ms of receiving a complete message from the master.
2. If the master does not receive a response to a request, the master SHOULD wait at least 225ms before sending another request.
3. The recommended inter-byte timeout value is 5ms.
4. If the EGM has determined that the previously received byte was the last byte of a valid message, or 200ms have elapsed since the previously received byte, the EGM SHOULD treat the next byte received as belonging to a new message.
5. The master MUST wait at least 10ms upon receipt of a response before transmitting again.

3.2 Application Layer Format

3.2.1 Byte Order

The GAT protocol uses Big Endian (most significant byte first) byte ordering for all cases where multi-byte, numeric information is conveyed by the GAT protocol unless another format is specifically stated (typically through the use of the Data Format byte).

3.2.2 Bit Order

For bit-field parameters, bit **0** always refers to the least significant bit. Bit **7** always refers to the most significant bit. The following table may be used to determine bit positions:

Table 3.1 Bit Positions (Sheet 1 of 2)

Bit	Bit Mask	Description
0	0x01	Least significant bit.
1	0x02	2nd bit position.
2	0x04	3rd bit position.
3	0x08	4th bit position.
4	0x10	5th bit position.
5	0x20	6th bit position.

Table 3.1 Bit Positions (Sheet 2 of 2)

Bit	Bit Mask	Description
6	0x40	7^{th} bit position.
7	0x80	Most significant bit.

3.2.3 Transmission Order

The bytes of a message are transmitted from left to right—that is, command byte first and CRC bytes last. The order of the bits within a byte follows the RS-232 specification of LSB (bit **0**) first and MSB last. All bits of a byte are transmitted before the next byte is started.

3.2.4 Data Formats

The following data formats are supported by the GAT protocol:

Binary: Each byte represents a binary value between `0x00` through `0xFF` inclusive.

Packed BCD: Each byte represents a decimal value between 00 and 99 inclusive, represented as binary `0x00` through `0x99`.

HEX-ASCII: A hexadecimal string representation of a binary value. Binary values are converted to uppercase ASCII hexadecimal strings that represent the binary values. An even number of nibbles (hexadecimal digits) MUST be included. Only ASCII characters 0-9 (0x30 through 0x39) and A-F (0x41 through 0x46) MUST be used. For example: the binary value 0x0123456789abcdef (or 0x0123456789ABCDEF) is represented as the string 0123456789ABCDEF and is transmitted as the bytes 0x30, 0x31, 0x32, 0x33, 0x34, 0x35, 0x36, 0x37, 0x38, 0x39, 0x41, 0x42, 0x43, 0x44, 0x45, 0x46. See Section 5.4, Example SHA-1 HMAC Authentication, which documents a transmission that includes a 20-byte binary key value.

ASCII: An ASCII data string. May include control characters such as CR (`0x0D`) and LF (`0x0A`).

XML: A well-formed XML document conforming to XML version 1.0.

XML version 1.0 requires that XML processors MUST support UTF-8 and UTF-16 encodings of an XML document. Thus, implementations of the GAT protocol MUST support UTF-8 and UTF-16 encodings for the XML data type. However, since UTF-8 tends to create smaller document sizes than UTF-16, implementations of this protocol SHOULD use UTF-8 encodings for XML documents. The GAT protocol does not provide a mechanism for selecting the encoding of an XML document. The default encoding is UTF-8.

3.2.5 Application Layer Frame

Table 3.2 Frame Structure

Command	Length	Message Data	CRC
1 byte binary	1 byte binary	0 to 251 bytes (varies)	2 bytes binary

This frame consists of the following fields:

Table 3.3 Frame Field Descriptions

Field	Description
Command	This is a command byte that indicates the message format and its purpose. Transmitted first.
Length	The total number of bytes in frame (including Command, Length, Message Data, and CRC bytes). Note: The maximum message length is restricted to 255 bytes.
Message Data	This field contains any data relevant to the command. The data format depends on the specific command.
CRC	A CRC-16 checksum of the Command, Length, and Message Data fields. Each frame is protected with a 16-bit Cyclic Redundant Check sequence. The CRC uses the industry standard CRC-16 polynomial generator of x^16 + x^15 + x^2 + 1 starting with a seed of 0xFFFF. See Appendix A for further details on correct implementation of this CRC. Transmitted last.

3.3 Commands - Query / Response Pairs

Each query has one corresponding response. The appropriate matched response should be returned by the EGM when a query is received and processed. The command byte for a response is the same as that of the query, except the high bit is set (i.e. `0x02-0x82`).

3.3.1 Status Query (0x01 SQ)

[Master ⇨ EGM] Request the current status information from the EGM.

Table 3.4 0x01 SQ Structure

Cmd = 0x01 SQ	Length = 0x04	CRC
1 byte binary	1 byte binary	2 bytes binary

3.3.2 Status Response (0x81 SR)

[EGM ⇨ Master] Return the current status information.

Table 3.5 0x81 SR Structure

Cmd = 0x81 SR	Length = 0x08	Version ID	Status Data1	Data Format	CRC
1 byte binary	1 byte binary	2 bytes packed BCD	1 byte binary	1 byte binary	2 bytes binary

Table 3.6 0x81 SR Fields

Field	Description
Version ID	Indicates the version of the GAT protocol supported by the EGM. The version is a 4-digit number, where the first byte is 2-digit major revision number and the second byte is 2-digit minor revision number. The errata revision number is not included. For example, `0x03 0x50` indicates GAT version 3.50.0, 3.50.1, 3.50.2, and so on; `0x03 0x51` indicates GAT version 3.51.0, 3.51.1, 3.51.2, and so on; and, `0x04 0x01` indicates GAT version 4.1.0, 4.1.1, 4.1.2, etc.
Status Data1	General Status: Bit **0**: Calculation Status. `0` = Idle. `1` = Calculating. Bit **1**: Last Authentication Results. `0` = Not Available. `1` = Available. Bit **2** & **3**: See Table 3.7 for Current Calculation. Bit **4** to **7**: Reserved. Always set to `0`.
Data Format	Data formats supported: `0x00` = Reserved, do not use. `0x01` = Plain text format. `0x02` – XML format. `0x03` to `0xFF` – Reserved for future use.

Table 3.7 0x81 Status Data1 Field: Bit 2 & 3, Current Calculation

Bit 3 Value	Bit 2 Value	Description
0	0	Requested.
1	0	Calculating.
0	1	Finished.
1	1	Error, cannot complete or failed.

3.3.3 Last Authentication Status Query (0x02 LASQ)

[Master ⇨ EGM] Request the status of the last authentication performed by the EGM. Only the status of the last completed authentication is returned.

Table 3.8 0x02 LASQ Structure

Cmd = 0x02 LASQ	Length = 0x04	CRC
1 byte binary	1 byte binary	2 bytes binary

3.3.4 Last Authentication Status Response (0x82 LASR)

[EGM ⇨ Master] Return the status of the last authentication result calculated by the EGM.

Table 3.9 0x82 LASR Structure

Cmd = 0x82 LASR	Length = 0x09	Authentication Level	Time	CRC
1 byte binary	1 byte binary	1 byte binary	4 bytes binary	2 bytes binary

Table 3.10 0x82 LASR Fields

Field	Description
Authentication Level	Indicates the level or type of authentication that was calculated. A value of `0x01` refers to Level 1 Authentication, `0x02` refers to Level 2 Authentication, and so on. A value of `0x00` indicates no authentication results are available. For this version of the GAT protocol, an EGM MUST support levels 0xBA and 0x00. Other levels MAY be defined in other versions of the GAT protocol and MAY be supported by the EGM.
Time	Time (in seconds) since last results were calculated. If no authentication results are available, then a value of `0x00000000` is returned.

3.3.5 Last Authentication Results Query (0x03 LARQ)

[Master ⇨ EGM] Request the previous/currently available Authentication results.

Table 3.11 0x03 LARQ Structure

Cmd = 0x03 LARQ	Length = 0x07	Data Format	Frame Number	CRC
1 byte binary	1 byte binary	1 byte binary	2 bytes binary	2 bytes binary

Table 3.12 0x03 LARQ Fields

Field	Description
Data Format	The format of the data: `0x00` = Reserved, do not use. `0x01` = Plain text format. `0x02` = XML format. `0x03` to `0xFF` = Reserved for future use.
Frame Number	This number, with the most significant byte first, is used to indicate the Data Frame that should be returned as data in the Last Authentication Results Response (0x83 LARR). The frame number data is indexed from `1`, so a value of `0` is illegal. The range is large enough to handle a file containing up to 65535 frames.

NOTES:

1. It is important to note that this mechanism of accessing the authentication results is linear, not random access. The rule exists in order to reduce any possible load or restrictions on the implementation within the EGM. The implications of this are that for each result, the first frame requested can only be frame 1. After that the master can only request either the *first* frame, frame *n*, or frame *n+1*, where *n* was the previous frame requested. This results in a linear request process, with the ability to reset back to the first frame, or request a retransmit of the current frame, or request that the next frame be transmitted.
2. Prior to reaching the last frame, the master MAY issue another command, such as an SQ or LASQ command. Unless the command nullifies the authentication results, the master MAY resume the LARQ series following the command. The master does not have to restart at frame 1 unless the authentication results have been nullified.

   For example, if the authentication results require 10 frames and the master issues an SQ command after receiving frame 5, the master may resume gathering the authentication results at frame 6. However, if the master issues an IACQ after receiving frame 5, nullifying the previous authentication results, the master must restart at frame 1 once the new authentication results are available.

3.3.6 Last Authentication Results Response (0x83 LARR)

[EGM ⇨ Master] Return a data frame of the previous or currently available Authentication results.

Table 3.13 0x83 LARR Structure

Cmd = 0x83 LARR	Length = 0x07 to 0xFF	Status Data	Frame Number	Data	CRC
1 byte binary	1 byte binary	1 byte binary	2 bytes binary	0 to 248 bytes (varies)	2 bytes binary

Table 3.14 0x83 LARR Fields

Field	Description
Status Data	General Status: Bit **0**:Error Status. `0` = No error. `1` = Error. (Note: Error would usually indicate either no data available, or an invalid frame.) Bit **1**: Frame Status. `0` = Not Last Frame. `1` = Last Frame.
Frame Number	Used to indicate the frame, with the most significant byte first, that is being returned in the Data field. MAY be set to frame 0 (`0x00 0x00`) when an error is being reported (Bit **0** of the Status Data set to `1`).
Data	Contains requested Authentication information (formatted as requested). This response is the mechanism used by the EGM to communicate the result of any special function. See Chapter 4 and Chapter 5 for further discussion of the format for authentication and special function responses.

NOTE:
Authentication Results are not available while an Authentication Calculation is in progress. If a 0x03 LARQ request is received while an Authentication Calculation is in progress, the EGM MUST return an error to the master in the 0x83 LARR response, setting Bit **0** and Bit **1** of the Status Data to `1`.

3.3.7 Initiate Authentication Calculation Query (0x04 IACQ)

[Master ⇨ EGM] Request that the EGM start authentication calculation.

Table 3.15 0x04 IACQ Structure

Cmd = 0x04 IACQ	Length = 0x05 to 0xFF	Authentication Level	Authentication Parameter	CRC
1 byte binary	1 byte binary	1 byte binary	0 to 250 bytes HEX-ASCII	2 bytes binary

Table 3.16 0x04 IACQ Fields

Field	Description
Authentication Level	Indicates the level or type of authentication calculation that should be returned. A value of `0x01` refers to Level 1 Authentication, `0x02` refers to Level 2 Authentication, and so on. A value of `0x00` is illegal. For this version of the GAT protocol, an EGM MUST support level 0xBA. The EGM MUST return error code 0x04 if level 0x00 is requested. Other levels MAY be defined in other versions of the GAT protocol and MAY be supported by the EGM. The special authentication level `0xBA` is used by the master to signal that the Authentication Parameter field contains a special function command. In this case, the Authentication Parameter field MUST have the first byte set to `0x00`. See Chapter 4 and Chapter 5 for further discussion of special functions.
Authentication Parameter	The Authentication Parameter value is used for some Authentication Levels. The same value is used for all modules verified by an Authentication Level. If the value is longer than required by an Authentication Level, it is truncated, the high order bytes discarded. The Authentication Parameter is represented in HEX-ASCII format. If the Authentication Level is set to the special value `0xBA`, the first byte of the Authentication Parameter field MUST be set to `0x00` while the remainder of the field contains the special function. See Chapter 4 for details. The data format is specified with each command.

NOTE:
If an Authentication Calculation is in progress when this command is received by the EGM, the EGM MUST abort the calculation and start the new Authentication Calculation. Issuing a new Authentication Calculation while the EGM is calculating is not recommended. The master can determine the state of the EGM using the 0x01 SQ command.

3.3.8 Initiate Authentication Calculation Response (0x84 IACR)

[EGM ⇨ Master] Indicate that the EGM has received a 0x04 IACQ command. The EGM SHOULD maintain the last 0x04 IACQ result for the master to retrieve for as long as that result is valid, even while the master is disconnected. Whenever a new 0x04 IACQ request is received by the EGM, the EGM MUST overwrite any previous results with the new authentication results. If an error occurred such that the IACQ request did not result in new authentication results, the 0x84 IACR response MUST report the error and the EGM MAY overwrite or otherwise discard the previous authentication results. In addition, the EGM SHOULD discard the last 0x04 IACQ result whenever the EGM is reset or the set of supported calculations changes—for example, due to a change to the set of components on the EGM. If the operator has placed the EGM in a special GAT authentication mode in order to calculate authentication results, the EGM MAY also discard the last result when the operator causes the EGM to exit its GAT authentication mode.

Table 3.17 0x84 IACR Structure

Cmd = 0x84 IACR	Length = 0x05	Status	CRC
1 byte binary	1 byte binary	1 byte binary	2 bytes binary

Table 3.18 0x84 IACR Fields

Field	Description
Status	Bit **0**: ACK/NACK. `0` = Cannot Acknowledge. `1` = Acknowledged. Bit **1**: Calculation Started. `0` = Not started. `1` = Started. Bit **2**: Level Compliance Error. `0` = Valid Level. `1` = Invalid Level requested.

Chapter 4

Special Functions

4.1 Overview

The master may request the EGM to execute a number of special functions. This is accomplished by setting the Authentication Level to `0xBA` and providing the appropriately formatted command in the Authentication Parameter field of an Initiate Authentication Calculation Query (0x04 IACQ). Results from the execution of a special function are sent to the master from the EGM in the Last Authentication Results Response (0x83 LARR).

When formatting special function commands, the following rules MUST be observed:

1. Individual data elements within the command MUST be separated by the tab character (`0x09`). A tab character MUST NOT precede the first data element. A tab character MUST NOT follow the last data element.
2. The name of the special function MUST be the first data element in the command. The name of the special function is contained in the `Feature` element of the response to the "Get Special Functions" command.
3. Unless specified otherwise in the description of the special function, parameters of the special function, if any, MUST follow the first data element in the same order as they are reported in the response to the "Get Special Functions" command.
4. When a parameter of the special function specifies a wildcard, the master may replace the wildcard with an appropriate corresponding value—for example, the matching value contained in the SEEDS.INI configuration file used by the GAT3.exe program.
5. Wildcards MUST be constructed from a leading `%%` sentinel (two percent signs), a wildcard name, and a trailing `%%` sentinel (two percent signs)—for example, `%%SHA1_HMAC%%`. The wildcard name MUST be constructed using one or more valid ASCII characters in the range `0x20` to `0x7E`, excluding `0x25` (the percent sign).
6. The master MUST provide an actual value for the wildcard. If there is no corresponding value for the wildcard, the wildcard MUST be replaced by "(none)" (0x28 0x6E 0x6F 0x6E 0x65 0x29). If the wildcard represents a seed, hash, offset, or HMAC key, the text string "(none)" MUST be interpreted to mean "no seed, hash, offset, or key provided" and MUST NOT be used as a seed, hash, offset, or key.
7. Special Functions that call for an offset parameter, a salt parameter, a key parameter, or an authentication hash parameter MUST provide those values in a HEX-ASCII data format (see Section 3.2.4, Data Formats, for more details). If the values are not in HEX-ASCII data format, the EGM SHOULD respond to a 0x04 IACQ command containing such values with a 0x84 IACR command containing status 0x00 and not execute the special function.

When the master issues the 0x04 IACQ command, the EGM responds with the Initiate Authentication Calculation Response (0x84 IACR) command. The EGM MUST use the Status field of the 0x84 IACR to indicate the state of the request. One of the following states in Table 4.1 MUST be reported by the EGM.

Table 4.1 0x84 IACR States (Sheet 1 of 2)

0x84 Response Status Field	State
`0x00`	Request not acknowledged—invalid Authentication Parameters detected. Special function will not be executed.
`0x01`	Request acknowledged and special function will be executed.
`0x03`	Request acknowledged and special function started.

Table 4.1 0x84 IACR States (Sheet 2 of 2)

0x84 Response Status Field	State
0x04	Request not acknowledged—invalid Authentication Level detected. Special function will not be executed.

The master MUST be prepared to receive other states from the EGM. Any such states simply indicate that the request could not be acknowledged (Bit **0** set to 0 or Bit **2** set to 1). The master MUST interpret other states as if state 0x04 was reported (when Bit **2** is set to 1) or as if state 0x00 was reported (when Bit **2** is set to 0).

After the master issues an 0x04 IACQ containing a special function request, the master may use the Status Query (0x01 SQ) command to determine if the results of the special function are ready. The EGM should use the Status field of the Status Response (0x81 SR) to determine the state of the request. One of the following states MUST be reported by the EGM:

Table 4.2 0x81 SR States

0x81 Response Status Data1 Field	States	Description
0x00	Idle, Not Available, and Requested	The special function request has been received but has not yet been executed.
0x04	Idle, Not Available, and Finished	No special function results are available from the EGM. This is the initial state of the EGM before any special function requests have been executed.
0x06	Idle, Available, and Finished	The special function has been completed and the results are available.
0x09	Calculating, Not Available, and Calculating	The special function is executing.
0x0C	Idle, Not Available, and Error	The special function failed in some way. No further information is available.
0x0E	Idle, Available, and Error	The special function failed in some way. Information regarding the error is available.

The master MUST be prepared to receive other states from the EGM. Any such states are contradictory and/or ambiguous. The master MUST interpret other states as if state 0x0C (Idle, Not Available, and Error) was reported.

Once the EGM has indicated results are ready, the results may be obtained by the master through the use of the Last Authentication Results Query (0x03 LARQ). The EGM should then respond with the 0x83 LARR command and set the Data field to appropriate value.

The Data Format for the special function responses that are defined in this section is always XML. Thus, after a special function that is defined in this section has been successfully executed by the EGM, the Data Format of the 0x81 SR from the EGM MUST specify XML format (0x02). Likewise, when the master requests the results of a special function that is defined in this section, the Data Format of the 0x03 LARQ from the master MUST specify XML format (0x02). Other formats may be used for other types of functions and for reporting errors.

As described in Section 3.3.8, Initiate Authentication Calculation Response (0x84 IACR), the EGM SHOULD maintain the last 0x04 IACQ result for the master to retrieve for as long as that result is valid, even while the master is disconnected. Requesting a new special function MUST overwrite the previous results with the new authentication results. If an error occurred such that the IACQ request did not result in new authentication results, an error MUST be reported in the 0x84 IACR response and the EGM MAY overwrite or otherwise discard the previous authentication results. The EGM SHOULD discard the last 0x04 IACQ result whenever the EGM is reset or the set of supported special functions changes.

In the following sections, "<00>" is used to indicate an ASCII null character (byte value of `0x00`) and "<09>" is used to indicate an ASCII tab character (byte value of `0x09`).

4.2 Defined Special Functions

The GAT process is primarily intended to facilitate compliance with jurisdictional requirements. For example, Nevada requires an EGM to provide a method to authenticate all EGM control programs and data on demand via an approved communication port and protocol. It is up to each manufacturer to determine which components are included in these requirements. It is also up to each manufacturer to determine to what granularity components may be authenticated. It is strongly recommended that the master be able to authenticate components to the same level of granularity that they are submitted to the jurisdiction for approval.

4.2.1 Special Function: Get Special Functions

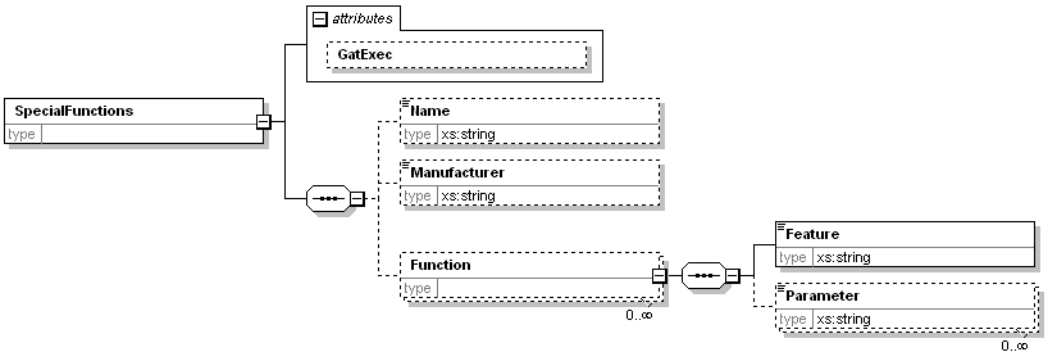
All EGMs MUST support the "Get Special Functions" special function. To discover which special functions an EGM supports, the master may send the following 0x04 IACQ:

Table 4.3 0x04 IACQ Structure for Get Special Functions

Cmd	Length	Authentication Level	Authentication Parameter (Data)	CRC
0x04	0x1B	0xBA	<00>Get Special Functions	0x2B54

Upon receipt of this special function, the EGM MUST acknowledge it with a correctly formatted 0x84 IACR. Once the EGM indicates it is finished by returning a Status of `0x06` in a 0x81 SR, the master may then retrieve the listing by sending a 0x03 LARQ command. The EGM should respond with a 0x83 LARR command containing the supported special functions.

The response MUST be XML formatted and conform to the following definition (See Appendix B for more details):



The `GatExec` attribute MUST be set to `default` for compatibility with this version of the GAT protocol. The original GAT3 protocol intended that this attribute could be set to the path of an executable program on the master; and, the master would save the response in a file by the filename specified in the first parameter, and then execute the program specified by `GatExec`. This capability is NOT supported by this version of the GAT protocol.

The `Name` and `Manufacturer` elements SHOULD be included in the `SpecialFunctions` response. When included, the `Name` element MUST contain the product name used by the manufacturer when the EGM was submitted for regulatory approval. Similarly, when included, the `Manufacturer` element MUST contain the name of the manufacturer that submitted the EGM for approval. The intent is for the master to be able to use the contents of the `Name` and `Manufacturer` elements to find the components that were previously approved. For example, once the master has received a `SpecialFunctions` response, the master should be able to look up the components that were previously approved, and then compare those components to the components contained in the `SpecialFunctions` response to verify that only approved components are present on the EGM.

The EGM MUST return a list of all special functions that it supports, other than the "Get Special Functions" special function. The "Get Special Functions" special function MUST NOT be included in the response. Each special function MUST have a feature name and MAY have zero or more parameters as appropriate to each special function.

4.2.2 Special Function: Get File filename.xml

The "Get File" is a generic special function which allows the master to obtain an XML response as identified by the included filename.

The first parameter (for example, `filename.xml`) MUST be included, and identifies the nature of the data that will be returned by the EGM when the master sends this special function.

Optional parameters may be included as appropriate to the special function.

Upon receipt of this special function, the EGM MUST acknowledge it with a correctly formatted 0x84 IACR. Once the EGM is finished, the master may then retrieve the listing by sending a 0x03 LARQ command. The EGM should respond with a 0x83 LARR command containing the requested data.

4.2.2.1 Get File AuthenticationResponse.xml %%SHA1_HMAC%%

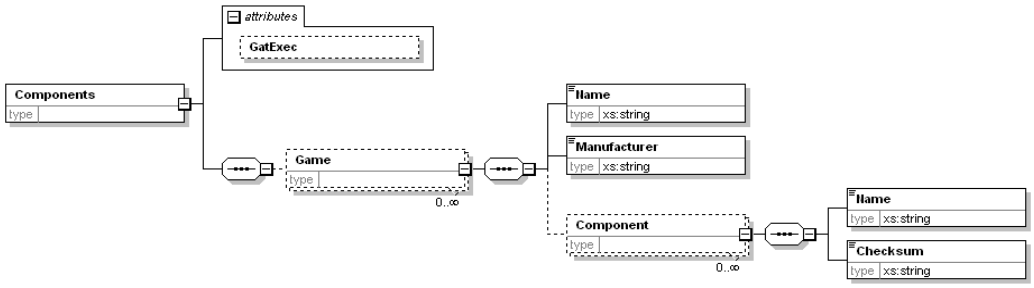
All EGMs MUST include the "Get File" feature with the parameters `AuthenticationResponse.xml` and `%%SHA1_HMAC%%` in the response to the Get Special Functions command. This specific form of the "Get File" special function is used by the master to obtain the authentication results for all EGM components using a

single request. Only components that can be authenticated using the SHA-1 and SHA-1 HMAC algorithms may be included in the response.

The specific wildcard parameter `%%SHA1_HMAC%%` MUST be included so the master may optionally provide a SHA-1 HMAC key. If the master does not provide a key (i.e wildcard replaced with "(none)"), the EGM MUST authenticate each component using the SHA-1 algorithm, not SHA-1 HMAC with a NULL or zero key. If the master does provide a key, the EGM MUST authenticate each component using the SHA-1 HMAC algorithm.

Once the EGM indicates that the results are available, the master may then retrieve the listing by sending a 0x03 LARQ command. The EGM's response MUST be XML formatted and conform to the following definition (See Appendix B for more details):

Figure 4.1 Components Definition Diagram



The EGM's response is a list of all components that were authenticated, along with the SHA-1 or SHA-1 HMAC authentication result for each component. This list MUST include, at a minimum, all EGM control programs and data as required by the jurisdiction. The EGM MAY include additional components, but all returned components MUST be authenticated using the SHA-1 or SHA-1 HMAC algorithm.

Authentication MUST be performed at the component level, not as a single result for all control programs and data, unless all control programs and data on an EGM are approved by the jurisdiction as a single unit, in which case, all control programs and data MAY be identified as a single component of the EGM.

The `GatExec` attribute MUST be set to `default` for compatibility with this version of the GAT protocol.

The `Name` element for each component SHOULD be consistent with the naming convention used when submitting the component to a regulator or testing agency for approval.

4.2.3 Special Function: Component name %%SHA1_HMAC%%

The "Component" special function identifies an individual component on an EGM that may be authenticated using the SHA-1 and SHA-1 HMAC algorithms.

The "name" parameter MUST be included, and is used to identify the specific component that will be authenticated by the EGM when the master sends this special function. The "name" MUST be consistent with the naming convention used when submitting this component to a regulator or testing agency for approval.

The specific wildcard parameter "`%%SHA1_HMAC%%`" MUST be included so the master may optionally provide a SHA-1 HMAC key. If the master does not provide a key (i.e wildcard replaced with "(none)"), the EGM MUST use the SHA-1 algorithm, not SHA-1 HMAC with a NULL or zero key. If the master does provide a key, the EGM MUST use the SHA-1 HMAC algorithm.

Once the EGM indicates that the results are available, the master may then retrieve the listing by sending a 0x03 LARQ command. The EGM's response MUST be XML formatted and conform to the Components definition specified in Section 4.2.2.1. It MUST include only one `Component` element, providing the SHA-1 or SHA-1 HMAC authentication result as appropriate for the component named in the command.

The EGM MUST support a "Component" special function for each individual component that can be authenticated using the "Get File AuthenticationResponse.xml" special function. The EGM MAY include additional "Component" special functions, for example to authenticate sub-components or special groups of components. Only components capable of being authenticated using the SHA-1 and SHA-1 HMAC algorithms may be exposed using the "Component" special function.

4.2.4 Special Function: doVerification name algorithm parameters

The "doVerification" special function identifies an individual component on an EGM that may be verified using a specified authentication algorithm. Additional parameters beyond the name of the component and the algorithm may be used when salts, seeds, offsets, etc. are supported for an algorithm.

4.2.4.1 Component Name

The component "name" MUST be included in the "doVerification" command. The "name" identifies a specific component that can be verified by the EGM. The "name" MUST be consistent with the naming conventions used when submitting components to regulators or testing agencies for approval. The intent is for the master to be able to use the "name" to identify a specific component of the EGM that was previously approved for the manufacturer and EGM.

To help facilitate the identification of components, each "name" SHOULD be unique to the manufacturer and product identified in the `SpecialFunctions` response. The version number and release number of the component SHOULD be included in the component "name"—for example, "XYZ_OS_v1.2_r12". See Section 4.2.1 for more details about the `SpecialFunctions` response.

When reporting components that represent the software for peripherals of an EGM—that is, note acceptors, printers, etc.—the EGM SHOULD report the component "name" provided by the peripheral, not a component "name" constructed by the EGM. The intent is for the master to be able to identify peripheral components by "name" across all EGM manufacturers and products. For this reason, peripheral manufacturers SHOULD adopt naming conventions that keep component "names" globally unique. For example, peripheral manufacturers can use 3-character GSA-assigned manufacturer prefixes when constructing component "names" to maintain uniqueness.

NOTE:
The maximum length of an authentication request in a 0x04 IACQ command is 250 bytes. Thus, the practical limit for the length of a component "name" is significantly less than 250 bytes. The space needed for the special function name, "algorithm", and additional "parameters" SHOULD be taken into consideration by manufacturers when constructing component "names".

4.2.4.2 Algorithms & Parameters

An "algorithm" MUST always be included in the "doVerification" command. The "algorithm" identifies that authentication algorithm that should be used to verify the component—for example, CRC32, SHA1, etc.

Additional "parameters" MAY be included in the "doVerification" command. The additional "parameters" identify optional features of the "algorithm"—for example, seeds, salts, offsets, etc. Additional "parameters" are always expressed as wildcards. See Section 4.1, Overview, for more information regarding wildcards.

The following table identifies the "algorithms" that MAY be supported by an EGM. The table also identifies the additional "parameters" for those "algorithms" that MAY be supported by an EGM.

- When "doVerification" special functions are reported by an EGM, the EGM MUST only include "algorithms" and "parameters" listed in this table.

- When a particular "algorithm" is reported by an EGM, the EGM MUST only include "parameters" listed in this table for that "algorithm".
- Other "algorithms" and "parameters" MUST NOT be reported by the EGM as part of "doVerification" special functions.

Table 4.4 Algorithms and Additional Parameters EGM MAY Support

Algorithm	Additional Parameters	Description
CRC16	%%CRC16_seed%%	Seed value.
	%%CRC16_start%%	Starting offset.
	%%CRC16_end%%	Ending offset.
CRC32	%%CRC32_seed%%	Seed value.
	%%CRC32_start%%	Starting offset.
	%%CRC32_end%%	Ending offset.
SHA1_HMAC	%%SHA1_HMAC%%	Key value; MUST be included.

An EGM MAY choose which "algorithms" to support. An EGM MAY also choose which additional "parameters" for those "algorithms" to support. Unless specified otherwise, an EGM MAY choose to not support any of the additional "parameters" for an "algorithm".

- When an EGM does support a particular "parameter" for a "doVerification" special function, the EGM MUST include that "parameter" when it reports the special function to the master.
- When an EGM does not support a particular "parameter" for a "doVerification" special function, the EGM MUST NOT include that "parameter" when it reports the special function to the master.

4.2.4.3 Constructing Requests

Even though an EGM may support a particular "parameter", the master does not have to use it. Unless specified otherwise, the master MAY choose to not use a particular "parameter"; the master MAY replace any additional "parameter" that it chooses not to use with "(none)". The value "(none)" indicates that no seed, salt, key, or offset is provided. See Section 4.1, Overview, for more details on constructing special function requests.

4.2.4.4 doVerification Examples

The following examples demonstrate how "doVerification" special functions should be reported by an EGM and how the EGM should indicate which additional "parameters" are supported for a particular special function.

```
<SpecialFunctions GatExec="default">
    <Name>SuperSpinner</Name>
    <Manufacturer>XYZ Manufacturing Company</Manufacturer>
    <Function>
        <Feature>doVerification</Feature>
        <Parameter>ABC_idReader_v14_r5</Parameter>
        <Parameter>CRC32</Parameter>
        <Parameter>%%CRC32_seed%%</Parameter>
        <Parameter>%%CRC32_start%%</Parameter>
```

```
        <Parameter>%%CRC32_end%%</Parameter>
    </Function>
    <Function>
        <Feature>doVerification</Feature>
        <Parameter>ABC_noteAcceptor_v1.2.34</Parameter>
        <Parameter>CRC32</Parameter>
        <Parameter>%%CRC32_seed%%</Parameter>
    </Function>
    <Function>
        <Feature>doVerification</Feature>
        <Parameter>ABC_printer_v21_r3</Parameter>
        <Parameter>CRC32</Parameter>
    </Function>
</SpecialFunctions>
```

For the first special function, all of the additional "parameters" for the CRC32 algorithm are supported by the EGM. When using this special function, the master must include all of the additional "parameters" when constructing a "doVerification" request—for example, "doVerification ABC_idReader_v14_r5 CRC32 123456 (none) (none)".

For the second special function, only a seed value is supported by the EGM. When using this special function, the master must only include the seed value when constructing a "doVerification" request—for example, "doVerification ABC_noteAcceptor_v1.2.34 CRC32 123456".

And, for the last special function, no additional "parameters" at all are supported by the EGM. When using this special function, the master must not include any additional "parameters" when constructing a "doVerification" request—for example, "doVerification ABC_printer_v21_r3 CRC32".

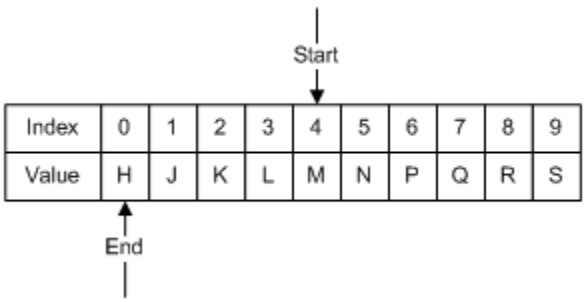
4.2.4.5 Using Offsets

When supported by an algorithm, offsets may be used to refine the portion of the component that should be verified. Offsets can be used to identify a subset of the component that should be verified, as well as a starting position from which the verification algorithm should wrap around.

When zero-based buffer indexing is used by an implementation, the starting offset identifies the first byte to be included in the calculation. The ending offset identifies the byte at which the calculation stops; that byte is not included in the calculation. If the ending offset is less than or equal to the starting offset, the algorithm wraps around.

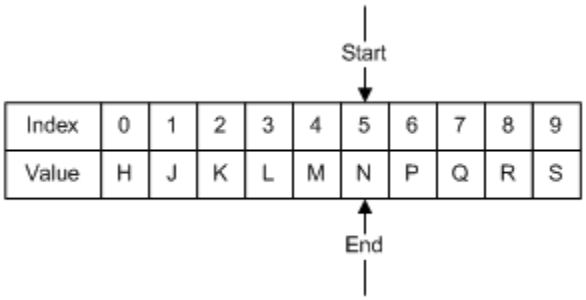
For example, to verify the final 6 bytes of the 10-byte buffer containing the ASCII string "HJKLMNPQRS", the starting offset should be set to 4 and the ending offset should be set to 0 (or 10). The buffer to hash would be "MNPQRS".

Figure 4.2 Verifying Final 6 Bytes of Buffer Containing "HJKLMNPQRS"



To verify the entire 10-byte buffer containing the ASCII string "HJKLMNPQRS" starting in the middle, the starting offset and the ending offset should both be set to 5. The buffer to hash would be "NPQRSHJKLM".

Figure 4.3 Verifying Full 10-byte Buffer Containing "HJKLMNPQRS"



Certain algorithms may support a salt value. When supported by an algorithm, the salt value MUST be prepended to the component buffer. The salt value MUST NOT be padded or otherwise adjusted before it is prepended to the component buffer unless required by the algorithm.

For example, for the 10-byte buffer containing the ASCII string "HJKLMNPQRS", if the client system specifies a 3-byte salt value that is equivalent to the ASCII string "TVW" (no padding or other adjustments required) with a starting offset and an ending offset 4, then the entire 13-byte buffer to hash would be "TVWMNPQRSHJKL".

4.2.4.6 Using the SHA1_HMAC Algorithm

When the SHA1_HMAC algorithm is specified, if the master does not provide a key—that is, the %%SHA1_HMAC%% wildcard is replaced with "(none)"—the EGM MUST use the SHA-1 algorithm, not the SHA-1 HMAC algorithm with a NULL or zero key. If the master does provide a key, the EGM MUST use the SHA-1 HMAC algorithm.

4.2.4.7 Reporting Results

Once the EGM indicates that the results of a "doVerification" request are available, the master may retrieve the results by sending a 0x03 LARQ command. The EGM's response MUST be XML formatted and MUST conform to the Components XML schema definition specified in Section 4.2.2.1. The response MUST include only one "Component" sub-element. That sub-element MUST provide the verification result for the component named in the "doVerification" command.

Chapter 5

Operational Scenarios

5.1 Sample Get Special Functions request

Here is a sample communication session where the master makes a request of the supported special functions:

Table 5.1 0x04 – IACQ

Field	Hex Value	Description
Command	04	Initiate Authentication Calculation Query.
Length	1B	27 bytes.
Authentication Level	BA	Special function designator.
Authentication Parameter	00	Special function designator.
	47 65 74 20 53 70 65 63 69 61 6C 20 46 75 6E 63 74 69 6F 6E 73	"Get Special Functions" special function.
CRC	2B 54	16-bit CRC.

Table 5.2 0x84 – IACR

Field	Hex Value	Description
Command	84	Initiate Authentication Calculation Response.
Length	05	5 bytes.
Status	03	Request acknowledged and special function started.
CRC	B8 72	16-bit CRC.

Here is a sample communication session where an EGM reports its list of supported special functions:

Table 5.3 0x03 – LARQ

Field	Hex Value	Description
Command	03	Last Authentication Results Query.
Length	07	7 bytes.
Data Format	02	XML format requested.
Frame Number	00 01	Request the 1st frame of data.
CRC	74 01	16-bit CRC.

Table 5.4 0x83 LARR

Field	Hex Value	Description
Command	83	Last Authentication Results Response.
Length	Up to FF	Total length of command.
Status Data	00	No error, this is not the last frame.
Frame Number	00 01	Frame number 1.
Data		First frame of XML special functions list (up to 248 bytes). See Section 5.1.1, Example Get Special Functions Response.
CRC	00 00 – FF FF	16-bit CRC.

5.1.1 Example Get Special Functions Response

```
<?xml version="1.0"?>
<SpecialFunctions GatExec="default">
    <Function>
        <Feature>Get File</Feature>
        <Parameter>AuthenticationResponse.xml</Parameter>
        <Parameter>%%SHA1_HMAC%%</Parameter>
    </Function>
    <Function>
           <Feature>Component</Feature>
           <Parameter>ABC_boot_123</Parameter>
           <Parameter>%%SHA1_HMAC%%</Parameter>
    </Function>
    <Function>
           <Feature>Component</Feature>
           <Parameter>ABC_os_345.pkg</Parameter>
           <Parameter>%%SHA1_HMAC%%</Parameter>
    </Function>
    <Function>
           <Feature>Component</Feature>
           <Parameter>ABC_game_789_012.pkg</Parameter>
           <Parameter>%%SHA1_HMAC%%</Parameter>
    </Function>
</SpecialFunctions>
```

5.2 Example All Components Authentication Request

Here is a sample communication session where the master makes a request for the EGM to authenticate all components:

Table 5.5 0x04 IACQ

Field	Hex Value	Description
Command	04	Initiate Authentication Calculation Query.
Length	32	50 bytes.
Authentication Level	BA	Special function designator.
Authentication Parameter	00	Special function designator.
	47 65 74 20 46 69 6C 65 09 41 75 74 68 65 6E 74 69 63 61 74 69 6F 6E 52 65 73 70 6F 6E 73 65 2E 78 6D 6C 09 31 32 33 34 41 42 43 44	"Get File<09>AuthenticationResponse.xml<09>1234ABCD" special function.
CRC	F3 4B	16-bit CRC.

Table 5.6 0x84 IACR

Field	Hex Value	Description
Command	84	Initiate Authentication Calculation Response
Length	05	5 bytes
Status	03	Request acknowledged and special function started.
CRC	B8 72	16-bit CRC

Here is a sample communication session where an EGM reports the authentication results for all components:

Table 5.7 0x03 LARQ

Field	Hex Value	Description
Command	03	Last Authentication Results Query.
Length	07	7 bytes.
Data Format	02	XML format requested.
Frame Number	00 01	Request the 1st frame of data.
CRC	74 01	16-bit CRC.

Table 5.8 0x83 LARR

Field	Hex Value	Description
Command	83	Last Authentication Results Response.
Length	Up to FF	Total length of command.
Status Data	00	No error, this is not the last frame.
Frame Number	00 01	Frame number 1.
Data		First frame of XML authentication results (up to 248 bytes). See Section 5.2.1, Example All Components Authentication Response.
CRC	00 00 - FF FF	16-bit CRC.

5.2.1 Example All Components Authentication Response

```
<?xml version="1.0"?>
<Components GatExec="default">
    <Game>
        <Name>ABC</Name>
        <Manufacturer>A Better Company</Manufacturer>
        <Component>
            <Name>ABC_boot_123</Name>
            <Checksum>0833B58888612D2A37829F44B58A63FF32933FFF</Checksum>
        </Component>
        <Component>
            <Name>ABC_os_345.pkg</Name>
            <Checksum>AEC231D3EDF4D338F1F81DBAA98742A4D6278ECB</Checksum>
        </Component>
        <Component>
            <Name>ABC_game456_789_012.pkg</Name>
            <Checksum>377938A82F5DEA976D86119C1CD5B65EE9CE2413</Checksum>
        </Component>
    </Game>
</Components>
```

5.3 Example SHA-1 Authentication

Here is a sample communication session where the master makes a request for the EGM to perform a SHA-1 authentication for a "SHA1-Example" component:

The authentication calculation is based on a NIST example, where the "SHA1-Example" component consists of the 3 ASCII bytes:

"abc" or

616263

CSRC Home > Groups > ST > Cryptographic Toolkit

EXAMPLE ALGORITHMS

http://csrc.nist.gov/groups/ST/toolkit/examples.html

http://csrc.nist.gov/groups/ST/toolkit/documents/Examples/SHA1.pdf

Table 5.9 0x04 – IACQ

Field	Hex Value	Description
Command	04	Initiate Authentication Calculation Query.
Length	23	35 bytes.
Authentication Level	BA	Special function designator.
Authentication Parameter	00	Special function designator.
	43 6F 6D 70 6F 6E 65 6E 74 09 53 48 41 31 2D 45 78 61 6D 70 6C 65 09 28 6E 6F 6E 65 29	"Component<09>SHA1-Example<09>(none)" special function.
CRC	B8 BC	16-bit CRC.

Table 5.10 0x84 IACR

Field	Hex Value	Description
Command	84	Initiate Authentication Calculation Response.
Length	05	5 bytes.
Status	03	Request acknowledged and special function started.
CRC	B8 72	16-bit CRC.

Here is a sample communication session where an EGM reports the authentication result for the component:

Table 5.11 0x03 LARQ

Field	Hex Value	Description
Command	03	Last Authentication Results Query.
Length	07	7 bytes.
Data Format	02	XML format requested.
Frame Number	00 01	Request the 1st frame of data.
CRC	74 01	16-bit CRC.

Table 5.12 0x83 LARR

Field	Hex Value	Description
Command	83	Last Authentication Results Response.
Length	Up to FF	Total length of command.
Status Data	00	No error, this is not the last frame.
Frame Number	00 01	Frame number 1.
Data		First frame of XML authentication results (up to 248 bytes). See Section 5.3.1, Example SHA-1 Response.
CRC	0000 – FFFF	16-bit CRC.

5.3.1 Example SHA-1 Response

```
<?xml version="1.0"?>
<Components GatExec="default">
    <Game>
        <Name>ABC</Name>
        <Manufacturer>A Better Company</Manufacturer>
        <Component>
            <Name>SHA1-Example</Name>
            <Checksum>A9993E364706816ABA3E25717850C26C9CD0D89D</Checksum>
        </Component>
    </Game>
</Components>
```

5.4 Example SHA-1 HMAC Authentication

Here is a sample communication session where the master makes a request for the EGM to perform a SHA-1 HMAC authentication for a "SHA1-HMAC-Example" component:

The authentication calculation is based on a NIST example, where the "SHA1-HMAC-Example" component consists of the 34 ASCII bytes:

"Sample message for keylen<blocklen" or

5361 6D706C65 206D6573

73616765 20666F72 206B6579 6C656E3C 626C6F63 6B6C656E

And where the following 20-byte key is used:

00010203 04050607 08090A0B 0C0D0E0F 10111213

CSRC Home > Groups > ST > Cryptographic Toolkit

EXAMPLE ALGORITHMS

http://csrc.nist.gov/groups/ST/toolkit/examples.html

http://csrc.nist.gov/groups/ST/toolkit/documents/Examples/HMAC_SHA1.pdf

Table 5.13 0x04 – IACQ

Field	Hex Value	Description
Command	04	Initiate Authentication Calculation Query.
Length	4A	74 bytes.
Authentication Level	BA	Special function designator.
Authentication Parameter	00	Special function designator.
	43 6F 6D 70 6F 6E 65 6E 74 09 53 48 41 31 2D 48 4D 41 43 2D 45 78 61 6D 70 6C 65 09 30 30 30 31 30 32 30 33 30 34 30 35 30 36 30 37 30 38 30 39 30 41 30 42 30 43 30 44 30 45 30 46 31 30 31 31 31 32 31 33	"Component<09>SHA1-HMAC-Example<09>000102030405060708090A0B0C0D0E0F10111213" special function.
CRC	6A B2	16-bit CRC.

Table 5.14 0x84 IACR

Field	Hex Value	Description
Command	84	Initiate Authentication Calculation Response.
Length	05	5 bytes.
Status	03	Request acknowledged and special function started.
CRC	B8 72	16-bit CRC.

Here is a sample communication session where an EGM reports the authentication result for the component:

Table 5.15 0x03 LARQ

Field	Hex Value	Description
Command	03	Last Authentication Results Query.
Length	07	7 bytes.
Data Format	02	XML format requested.
Frame Number	00 01	Request the 1st frame of data.
CRC	74 01	16-bit CRC.

Table 5.16 0x83 LARR

Field	Hex Value	Description
Command	83	Last Authentication Results Response.
Length	Up to FF	Total length of command.
Status Data	00	No error, this is not the last frame.
Frame Number	00 01	Frame number 1.
Data		First frame of XML authentication results (up to 248 bytes). See Section 5.4.1, Example SHA-1 HMAC Response.
CRC	0000 – FFFF	16-bit CRC.

5.4.1 Example SHA-1 HMAC Response

```
<?xml version="1.0"?>
<Components GatExec="default">
    <Game>
        <Name>ABC</Name>
        <Manufacturer>A Better Company</Manufacturer>
        <Component>
            <Name>SHA1-HMAC-Example</Name>
            <Checksum>4C99FF0CB1B31BD33F8431DBAF4D17FCD356A807</Checksum>
        </Component>
    </Game>
</Components>
```

Appendix A

CRC Calculation

A.1 CRC Calculation in Java

Here is an implementation of the CRC calculation in Java:

```
/**********************************************************************
*
* Uses irreducible polynomial:  1 + x^2 + x^15 + x^16
*
**********************************************************************/



public class crc
{
    private static int[] table =
    {
        0x0000, 0xC0C1, 0xC181, 0x0140, 0xC301, 0x03C0, 0x0280, 0xC241,
        0xC601, 0x06C0, 0x0780, 0xC741, 0x0500, 0xC5C1, 0xC481, 0x0440,
        0xCC01, 0x0CC0, 0x0D80, 0xCD41, 0x0F00, 0xCFC1, 0xCE81, 0x0E40,
        0x0A00, 0xCAC1, 0xCB81, 0x0B40, 0xC901, 0x09C0, 0x0880, 0xC841,
        0xD801, 0x18C0, 0x1980, 0xD941, 0x1B00, 0xDBC1, 0xDA81, 0x1A40,
        0x1E00, 0xDEC1, 0xDF81, 0x1F40, 0xDD01, 0x1DC0, 0x1C80, 0xDC41,
        0x1400, 0xD4C1, 0xD581, 0x1540, 0xD701, 0x17C0, 0x1680, 0xD641,
        0xD201, 0x12C0, 0x1380, 0xD341, 0x1100, 0xD1C1, 0xD081, 0x1040,
        0xF001, 0x30C0, 0x3180, 0xF141, 0x3300, 0xF3C1, 0xF281, 0x3240,
        0x3600, 0xF6C1, 0xF781, 0x3740, 0xF501, 0x35C0, 0x3480, 0xF441,
        0x3C00, 0xFCC1, 0xFD81, 0x3D40, 0xFF01, 0x3FC0, 0x3E80, 0xFE41,
        0xFA01, 0x3AC0, 0x3B80, 0xFB41, 0x3900, 0xF9C1, 0xF881, 0x3840,
        0x2800, 0xE8C1, 0xE981, 0x2940, 0xEB01, 0x2BC0, 0x2A80, 0xEA41,
        0xEE01, 0x2EC0, 0x2F80, 0xEF41, 0x2D00, 0xEDC1, 0xEC81, 0x2C40,
        0xE401, 0x24C0, 0x2580, 0xE541, 0x2700, 0xE7C1, 0xE681, 0x2640,
        0x2200, 0xE2C1, 0xE381, 0x2340, 0xE101, 0x21C0, 0x2080, 0xE041,
        0xA001, 0x60C0, 0x6180, 0xA141, 0x6300, 0xA3C1, 0xA281, 0x6240,
        0x6600, 0xA6C1, 0xA781, 0x6740, 0xA501, 0x65C0, 0x6480, 0xA441,
        0x6C00, 0xACC1, 0xAD81, 0x6D40, 0xAF01, 0x6FC0, 0x6E80, 0xAE41,
        0xAA01, 0x6AC0, 0x6B80, 0xAB41, 0x6900, 0xA9C1, 0xA881, 0x6840,
        0x7800, 0xB8C1, 0xB981, 0x7940, 0xBB01, 0x7BC0, 0x7A80, 0xBA41,
        0xBE01, 0x7EC0, 0x7F80, 0xBF41, 0x7D00, 0xBDC1, 0xBC81, 0x7C40,
        0xB401, 0x74C0, 0x7580, 0xB541, 0x7700, 0xB7C1, 0xB681, 0x7640,
        0x7200, 0xB2C1, 0xB381, 0x7340, 0xB101, 0x71C0, 0x7080, 0xB041,
        0x5000, 0x90C1, 0x9181, 0x5140, 0x9301, 0x53C0, 0x5280, 0x9241,
        0x9601, 0x56C0, 0x5780, 0x9741, 0x5500, 0x95C1, 0x9481, 0x5440,
        0x9C01, 0x5CC0, 0x5D80, 0x9D41, 0x5F00, 0x9FC1, 0x9E81, 0x5E40,
        0x5A00, 0x9AC1, 0x9B81, 0x5B40, 0x9901, 0x59C0, 0x5880, 0x9841,
        0x8801, 0x48C0, 0x4980, 0x8941, 0x4B00, 0x8BC1, 0x8A81, 0x4A40,
        0x4E00, 0x8EC1, 0x8F81, 0x4F40, 0x8D01, 0x4DC0, 0x4C80, 0x8C41,
        0x4400, 0x84C1, 0x8581, 0x4540, 0x8701, 0x47C0, 0x4680, 0x8641,
        0x8201, 0x42C0, 0x4380, 0x8341, 0x4100, 0x81C1, 0x8081, 0x4040,
    };

    public static int hash(int[] bytes)
    {
        int crc = 0xFFFF;
        for (int b : bytes)
        {
            crc = (crc >>> 8) ^ table[(crc ^ b) & 0xff];
        }
        return crc;
    };

    public static void main(String args[])
    {

        int[] bytes = {      0x04,
                             0x4A,
                             0xBA,
                             0x00,
                             0x43, 0x6F, 0x6D, 0x70, 0x6F,
```

```
                              0x6E, 0x65, 0x6E, 0x74, 0x09,
                              0x53, 0x48, 0x41, 0x31, 0x2D,
                              0x48, 0x4D, 0x41, 0x43, 0x2D,
                              0x45, 0x78, 0x61, 0x6D, 0x70,
                              0x6C, 0x65, 0x09, 0x30, 0x30,
                              0x30, 0x31, 0x30, 0x32, 0x30,
                              0x33, 0x30, 0x34, 0x30, 0x35,
                              0x30, 0x36, 0x30, 0x37, 0x30,
                              0x38, 0x30, 0x39, 0x30, 0x41,
                              0x30, 0x42, 0x30, 0x43, 0x30,
                              0x44, 0x30, 0x45, 0x30, 0x46,
                              0x31, 0x30, 0x31, 0x31, 0x31,
                              0x32, 0x31, 0x33 }; // Table 5.13 0x04 - IACQ
        System.out.println(Integer.toHexString(hash(bytes)));
    }

}

Generated output:
6ab2
```

Appendix B

XSD for SpecialFunctions and Components

B.1 XSD

The following XML Schema Definition (XSD) identifies the proper syntax for the SpecialFunctions and Components XML data structures.

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
    attributeFormDefault="unqualified">
    <!--GAT3 XML Structures.-->
    <xs:element name="SpecialFunctions">
        <xs:annotation>
            <xs:documentation>List of special functions.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
            <xs:sequence>
                <xs:element name="Name" type="xs:string" minOccurs="0"/>
                <xs:element name="Manufacturer" type="xs:string" minOccurs="0"/>
                <xs:element name="Function" minOccurs="0" maxOccurs="unbounded">
                    <xs:complexType>
                        <xs:sequence>
                            <xs:element name="Feature" type="xs:string"/>
                            <xs:element name="Parameter" type="xs:string" minOccurs="0"
                                maxOccurs="unbounded"/>
                        </xs:sequence>
                    </xs:complexType>
                </xs:element>
            </xs:sequence>
            <xs:attribute name="GatExec" type="xs:string" use="optional" default="default"/>
        </xs:complexType>
    </xs:element>
    <xs:element name="Components">
        <xs:annotation>
            <xs:documentation>List of components and signatures.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
            <xs:sequence>
                <xs:element name="Game" minOccurs="0" maxOccurs="unbounded">
                    <xs:complexType>
                        <xs:sequence>
                            <xs:element name="Name" type="xs:string"/>
                            <xs:element name="Manufacturer" type="xs:string"/>
                            <xs:element name="Component" minOccurs="0" maxOccurs="unbounded">
                                <xs:complexType>
                                    <xs:sequence>
                                        <xs:element name="Name" type="xs:string"/>
                                        <xs:element name="Checksum" type="xs:string"/>
                                    </xs:sequence>
                                </xs:complexType>
                            </xs:element>
                        </xs:sequence>
                    </xs:complexType>
                </xs:element>
            </xs:sequence>
            <xs:attribute name="GatExec" type="xs:string" use="optional" default="default"/>
        </xs:complexType>
    </xs:element>
    <!--End of Schema.-->
</xs:schema>
```

New Appendix

Appendix C

Directory Signature

Calculations

Correction in v4.2

New Appendix

C.1 Introduction

This chapter defines a standard method for generating signatures of files that are contained in a Windows directory structure. First the signature for each file and sub-directory within a directory is calculated using the designated algorithm. Next the signatures are sorted in alphanumeric order. Finally, the signature for the entire directory is calculated across the sorted signatures of the individual files and sub-directories. The process is repeated recursively starting with the lowest level directories.

C.1.1 File Sorting

The sorting of the files within a directory MUST be done at the end of the calculation process. The sorting MUST be based on the resulting hashes of the file contents for the designated algorithm. The format of the hashes MUST match the format dictated in Section 1.4 and MUST be sorted in alphabetical order.

C.1.2 File Reading

This section outlines the reading and hashing process for the various types of files that are encountered on Windows FAT and NTFS file systems.

- Regular Files: Normal files MUST be hashed using the designated algorithm by reading the contents from the beginning to the end. Seeds, salts, and offsets MUST not be utilized in the hashing of the individual files.
- Shortcuts: Windows shortcuts are files that point to another file on the computer. Shortcuts MUST be hashed using the designated algorithm by reading the internal binary contents from the beginning to the end. Seeds, salts, and offsets MUST not be utilized in the hashing of the individual files.
- System Files: Some files are not accessible when Windows mounts a file system. When these files are encountered, the file name MUST be hashed instead of the contents.
- Reparse Points: A reparse point is an NTFS file system object that contains a reparse tag and data that is interpreted by a file system filter identified by the tag. Reparse points MUST be ignored.
- Symbolic Links: A symbolic link is like a shortcut but instead of being saved as a file it is registered to the hard drive partition. Symbolic Links MUST be hashed using the designated algorithm by reading the contents of the file or directory to which the symbolic link points from the beginning to the end. Seeds, salts, and offsets MUST not be utilized in the hashing of symbolic links.
- Hard Links: A hard link points to and duplicates a file or directory as a mirrored copy but the copy does not use any additional space on the hard drive partition. Hard Links MUST be hashed using the designated algorithm by reading the contents of the file or directory to which the hard link points from the beginning to the end. Seeds, salts, and offsets MUST not be utilized in the hashing of the hard links.
- Windows File Junctions: A **Windows File Junction** behaves like a hard link for directories but unlike file hard links you can create junctions that span multiple partitions. Windows File Junctions MUST be hashed using the designated algorithm by reading the contents of the file or directory to which the windows file junction link points from the beginning to the end. Seeds, salts, and offsets MUST not be utilized in the hashing of the windows file junctions.
- Alternate Data Streams: An **alternate data stream** (ADS) is a feature of Windows New Technology File System (NTFS) that allows multiple sets of data to be stored with a file. Alternate data streams MUST be hashed using the designated algorithm by reading the contents of the alternate data stream as if it were a unique file from the beginning to the end. If multiple alternate data streams exist they

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should each be treated as individual files. Seeds, salts, and offsets MUST not be utilized in the hashing of the alternate data stream.

C.1.3 Directory Hashing

For the purpose of calculating the directory signature, the hashing results for all individual files and sub-directories MUST be converted to their uppercase hexadecimal ASCII equivalent characters. All white space, symbols and special characters MUST be removed from the hashing results prior to calculating the directory signature. The signatures of sub-directories MUST be calculated before the signature of the directory is calculated.

The signature of a directory is a mathematically calculated value consisting of a variable number of hexadecimal digits depending on the designated algorithm. The directory signature MUST be calculated over a single binary buffer where the contents consist of a concatenated list of the individual file hashing results and formatted as defined above and sorted as defined in Section 1.2.

New Appendix

END OF DOCUMENT

Released: TBD