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B. Moran
H. Tschofenig
Arm Limited
H. Birkholz
Fraunhofer SIT
K. Zandberg
Inria
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A Concise Binary Object Representation (CBOR)-based Serialization Format
for the Software Updates for Internet of Things (SUIT) Manifest
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Abstract

This specification describes the format of a manifest. A manifest is a bundle of metadata about code/data obtained by a recipient (chiefly the firmware for an IoT device), where to find the that code/data, the devices to which it applies, and cryptographic information protecting the manifest. Software updates and Trusted Invocation both tend to use sequences of common operations, so the manifest encodes those sequences of operations, rather than declaring the metadata.

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[1.](#) Introduction

A firmware update mechanism is an essential security feature for IoT devices to deal with vulnerabilities. While the transport of firmware images to the devices themselves is important there are already various techniques available. Equally important is the inclusion of metadata about the conveyed firmware image (in the form of a manifest) and the use of a security wrapper to provide end-to-end security protection to detect modifications and (optionally) to make reverse engineering more difficult. End-to-end security allows the author, who builds the firmware image, to be sure that no other party (including potential adversaries) can install firmware updates on IoT devices without adequate privileges. For confidentiality protected firmware images it is additionally required to encrypt the firmware image. Starting security protection at the author is a risk mitigation technique so firmware images and manifests can be stored on untrusted repositories; it also reduces the scope of a compromise of any repository or intermediate system to be no worse than a denial of service.

A manifest is a bundle of metadata describing one or more code or data payloads and how to:

- Obtain any dependencies
- Obtain the payload(s)
- Install them
- Verify them
- Load them into memory
- Invoke them

This specification defines the SUIF manifest format and it is intended to meet several goals:

- Meet the requirements defined in [[I-D.ietf-suit-information-model](#)].
- Simple to parse on a constrained node
- Simple to process on a constrained node
- Compact encoding
- Comprehensible by an intermediate system
- Expressive enough to enable advanced use cases on advanced nodes
- Extensible

The SUIT manifest can be used for a variety of purposes throughout its lifecycle, such as:

- a Firmware Author to reason about releasing a firmware.
- a Network Operator to reason about compatibility of a firmware.
- a Device Operator to reason about the impact of a firmware.
- the Device Operator to manage distribution of firmware to devices.
- a Plant Manager to reason about timing and acceptance of firmware updates.
- a device to reason about the authority & authenticity of a firmware prior to installation.
- a device to reason about the applicability of a firmware.
- a device to reason about the installation of a firmware.
- a device to reason about the authenticity & encoding of a firmware at boot.

Each of these uses happens at a different stage of the manifest lifecycle, so each has different requirements.

It is assumed that the reader is familiar with the high-level firmware update architecture [[I-D.ietf-suit-architecture](#)] and the threats, requirements, and user stories in [[I-D.ietf-suit-information-model](#)].

The design of this specification is based on an observation that the vast majority of operations that a device can perform during an update or Trusted Invocation are composed of a small group of operations:

- Copy some data from one place to another
- Transform some data
- Digest some data and compare to an expected value
- Compare some system parameters to an expected value
- Run some code

In this document, these operations are called commands. Commands are classed as either conditions or directives. Conditions have no side-effects, while directives do have side-effects. Conceptually, a sequence of commands is like a script but the used language is tailored to software updates and Trusted Invocation.

The available commands support simple steps, such as copying a firmware image from one place to another, checking that a firmware image is correct, verifying that the specified firmware is the correct firmware for the device, or unpacking a firmware. By using these steps in different orders and changing the parameters they use, a broad range of use cases can be supported. The SUIT manifest uses this observation to optimize metadata for consumption by constrained devices.

While the SUIT manifest is informed by and optimized for firmware update and Trusted Invocation use cases, there is nothing in the [\[I-D.ietf-suit-information-model\]](#) that restricts its use to only those use cases. Other use cases include the management of trusted applications (TAs) in a Trusted Execution Environment (TEE), as discussed in [\[I-D.ietf-teep-architecture\]](#).

2. Conventions and Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [BCP 14 \[RFC2119\]](#) [\[RFC8174\]](#) when, and only when, they appear in all capitals, as shown here.

Additionally, the following terminology is used throughout this document:

- SUIT: Software Update for the Internet of Things, also the IETF working group for this standard.
- Payload: A piece of information to be delivered. Typically Firmware for the purposes of SUIT.
- Resource: A piece of information that is used to construct a payload.
- Manifest: A manifest is a bundle of metadata about the firmware for an IoT device, where to find the firmware, and the devices to which it applies.
- Envelope: A container with the manifest, an authentication wrapper with cryptographic information protecting the manifest, authorization information, and severable elements (see: TBD).
- Update: One or more manifests that describe one or more payloads.
- Update Authority: The owner of a cryptographic key used to sign updates, trusted by Recipients.
- Recipient: The system, typically an IoT device, that receives and processes a manifest.
- Manifest Processor: A component of the Recipient that consumes Manifests and executes the commands in the Manifest.
- Component: An updatable logical block of the Firmware, Software, configuration, or data of the Recipient.
- Component Set: A group of interdependent Components that must be updated simultaneously.
- Command: A Condition or a Directive.
- Condition: A test for a property of the Recipient or its Components.
- Directive: An action for the Recipient to perform.
- Trusted Invocation: A process by which a system ensures that only trusted code is executed, for example secure boot or launching a Trusted Application.
- A/B images: Dividing a Recipient's storage into two or more bootable images, at different offsets, such that the active image can write to the inactive image(s).

- Record: The result of a Command and any metadata about it.
- Report: A list of Records.
- Procedure: The process of invoking one or more sequences of commands.
- Update Procedure: A procedure that updates a Recipient by fetching dependencies and images, and installing them.
- Invocation Procedure: A procedure in which a Recipient verifies dependencies and images, loading images, and invokes one or more image.
- Software: Instructions and data that allow a Recipient to perform a useful function.
- Firmware: Software that is typically changed infrequently, stored in nonvolatile memory, and small enough to apply to [[RFC7228](#)] Class 0-2 devices.
- Image: Information that a Recipient uses to perform its function, typically firmware/software, configuration, or resource data such as text or images. Also, a Payload, once installed is an Image.
- Slot: One of several possible storage locations for a given Component, typically used in A/B image systems
- Abort: An event in which the Manifest Processor immediately halts execution of the current Procedure. It creates a Record of an error condition.

3. How to use this Document

This specification covers five aspects of firmware update:

- [Section 4](#) describes the device constraints, use cases, and design principles that informed the structure of the manifest.
- [Section 5](#) gives a general overview of the metadata structure to inform the following sections
- [Section 6](#) describes what actions a Manifest processor should take.
- [Section 7](#) describes the process of creating a Manifest.
- [Section 8](#) specifies the content of the Envelope and the Manifest.

To implement an updatable device, see [Section 6](#) and [Section 8](#). To implement a tool that generates updates, see [Section 7](#) and [Section 8](#).

The IANA consideration section, see [Section 11](#), provides instructions to IANA to create several registries. This section also provides the CBOR labels for the structures defined in this document.

The complete CDDL description is provided in [Appendix A](#), examples are given in [Appendix B](#) and a design rationale is offered in [Appendix C](#). Finally, [Appendix D](#) gives a summarize of the mandatory-to-implement features of this specification.

4. Background

Distributing software updates to diverse devices with diverse trust anchors in a coordinated system presents unique challenges. Devices have a broad set of constraints, requiring different metadata to make appropriate decisions. There may be many actors in production IoT systems, each of whom has some authority. Distributing firmware in such a multi-party environment presents additional challenges. Each party requires a different subset of data. Some data may not be accessible to all parties. Multiple signatures may be required from parties with different authorities. This topic is covered in more depth in [[I-D.ietf-suit-architecture](#)]. The security aspects are described in [[I-D.ietf-suit-information-model](#)].

4.1. IoT Firmware Update Constraints

The various constraints of IoT devices and the range of use cases that need to be supported create a broad set of requirements. For example, devices with:

- limited processing power and storage may require a simple representation of metadata.
- bandwidth constraints may require firmware compression or partial update support.
- bootloader complexity constraints may require simple selection between two bootable images.
- small internal storage may require external storage support.
- multiple microcontrollers may require coordinated update of all applications.
- large storage and complex functionality may require parallel update of many software components.

- extra information may need to be conveyed in the manifest in the earlier stages of the device lifecycle before those data items are stripped when the manifest is delivered to a constrained device.

Supporting the requirements introduced by the constraints on IoT devices requires the flexibility to represent a diverse set of possible metadata, but also requires that the encoding is kept simple.

4.2. SUIT Workflow Model

There are several fundamental assumptions that inform the model of Update Procedure workflow:

- Compatibility must be checked before any other operation is performed.
- All dependency manifests should be present before any payload is fetched.
- In some applications, payloads must be fetched and validated prior to installation.

There are several fundamental assumptions that inform the model of the Invocation Procedure workflow:

- Compatibility must be checked before any other operation is performed.
- All dependencies and payloads must be validated prior to loading.
- All loaded images must be validated prior to execution.

Based on these assumptions, the manifest is structured to work with a pull parser, where each section of the manifest is used in sequence. The expected workflow for a Recipient installing an update can be broken down into five steps:

1. Verify the signature of the manifest.
2. Verify the applicability of the manifest.
3. Resolve dependencies.
4. Fetch payload(s).
5. Install payload(s).

When installation is complete, similar information can be used for validating and running images in a further three steps:

1. Verify image(s).
2. Load image(s).
3. Run image(s).

If verification and running is implemented in a bootloader, then the bootloader MUST also verify the signature of the manifest and the applicability of the manifest in order to implement secure boot workflows. The bootloader may add its own authentication, e.g. a Message Authentication Code (MAC), to the manifest in order to prevent further verifications.

When multiple manifests are used for an update, each manifest's steps occur in a lockstep fashion; all manifests have dependency resolution performed before any manifest performs a payload fetch, etc.

5. Metadata Structure Overview

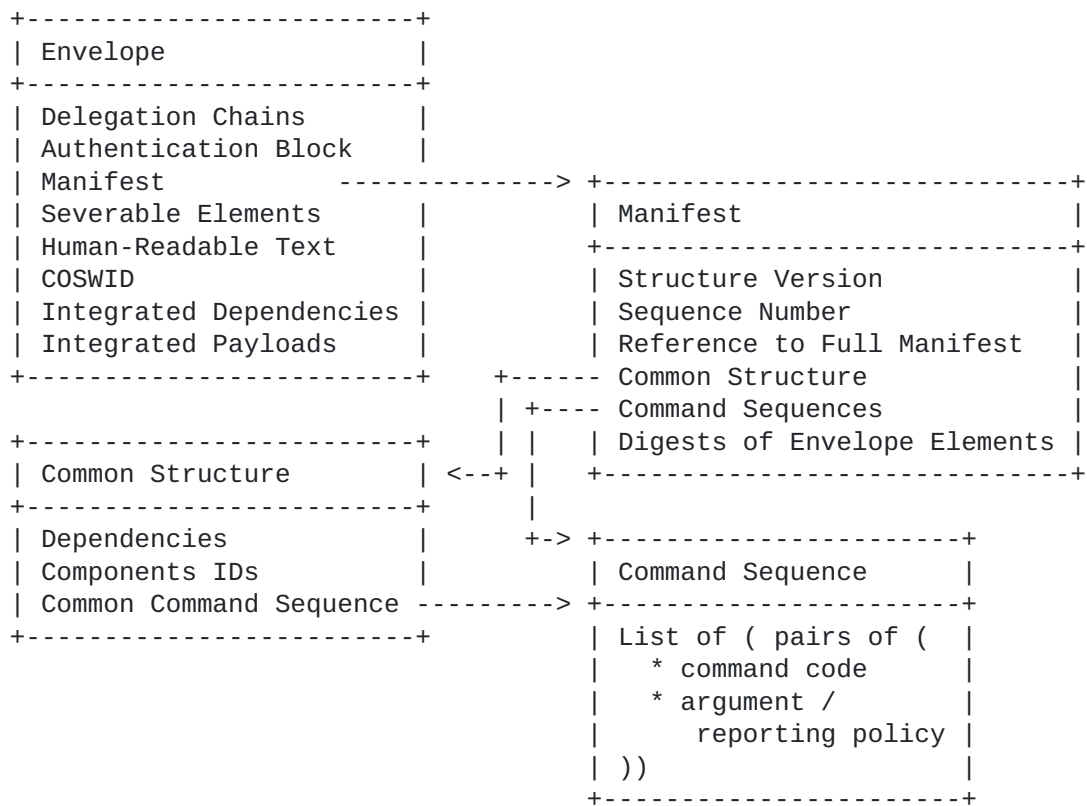
This section provides a high level overview of the manifest structure. The full description of the manifest structure is in [Section 8.6](#)

The manifest is structured from several key components:

1. The Envelope (see [Section 5.1](#)) contains Delegation Chains, the Authentication Block, the Manifest, any Severable Elements, and any Integrated Payloads or Dependencies.
2. Delegation Chains (see [Section 5.2](#)) allow a Recipient to work from one of its Trust Anchors to an authority of the Authentication Block.
3. The Authentication Block (see [Section 5.3](#)) contains a list of signatures or MACs of the manifest..
4. The Manifest (see [Section 5.4](#)) contains all critical, non-severable metadata that the Recipient requires. It is further broken down into:
 1. Critical metadata, such as sequence number.
 2. Common metadata, including lists of dependencies and affected components.

3. Command sequences, directing the Recipient how to install and use the payload(s).
4. Integrity check values for severable elements.
5. Severable elements (see [Section 5.5](#)).
6. Integrated dependencies (see [Section 5.6](#)).
7. Integrated payloads (see [Section 5.6](#)).

The diagram below illustrates the hierarchy of the Envelope.



5.1. Envelope

The SUIT Envelope is a container that encloses Delegation Chains, the Authentication Block, the Manifest, any Severable Elements, and any integrated payloads or dependencies. The Envelope is used instead of conventional cryptographic envelopes, such as COSE_Envelope because it allows modular processing, severing of elements, and integrated payloads in a way that would add substantial complexity with existing

solutions. See [Appendix C.1](#) for a description of the reasoning for this.

See [Section 8.2](#) for more detail.

[5.2.](#) Delegation Chains

Delegation Chains allow a Recipient to establish a chain of trust from a Trust Anchor to the signer of a manifest by validating delegation claims. Each delegation claim is a [\[RFC8392\]](#) CBOR Web Tokens (CWTs). The first claim in each list is signed by a Trust Anchor. Each subsequent claim in a list is signed by the public key claimed in the preceding list element. The last element in each list claims a public key that can be used to verify a signature in the Authentication Block ([Section 5.3](#)).

See [Section 8.3](#) for more detail.

[5.3.](#) Authentication Block

The Authentication Block contains a bstr-wrapped [Section 10](#) and one or more [\[RFC8152\]](#) CBOR Object Signing and Encryption (COSE) authentication blocks. These blocks are one of:

- COSE_Sign_Tagged
- COSE_Sign1_Tagged
- COSE_Mac_Tagged
- COSE_Mac0_Tagged

Each of these objects is used in detached payload mode. The payload is the bstr-wrapped SUIT_Digest.

See [Section 8.4](#) for more detail.

[5.4.](#) Manifest

The Manifest contains most metadata about one or more images. The Manifest is divided into Critical Metadata, Common Metadata, Command Sequences, and Integrity Check Values.

See [Section 8.6](#) for more detail.

5.4.1. Critical Metadata

Some metadata needs to be accessed before the manifest is processed. This metadata can be used to determine which manifest is newest and whether the structure version is supported. It also MAY provide a URI for obtaining a canonical copy of the manifest and Envelope.

See [Section 8.6.1](#), [Section 8.6.2](#), and [Section 8.6.3](#) for more detail.

5.4.2. Common

Some metadata is used repeatedly and in more than one command sequence. In order to reduce the size of the manifest, this metadata is collected into the Common section. Common is composed of three parts: a list of dependencies, a list of components referenced by the manifest, and a command sequence to execute prior to each other command sequence. The common command sequence is typically used to set commonly used values and perform compatibility checks. The common command sequence MUST NOT have any side-effects outside of setting parameter values.

See [Section 8.7.2](#), and [Section 8.7.2.1](#) for more detail.

5.4.3. Command Sequences

Command sequences provide the instructions that a Recipient requires in order to install or use an image. These sequences tell a device to set parameter values, test system parameters, copy data from one place to another, transform data, digest data, and run code.

Command sequences are broken up into three groups: Common Command Sequence (see [Section 5.4.2](#)), update commands, and secure boot commands.

Update Command Sequences are: Dependency Resolution, Payload Fetch, and Payload Installation. An Update Procedure is the complete set of each Update Command Sequence, each preceded by the Common Command Sequence.

Invocation Command Sequences are: System Validation, Image Loading, and Image Invocation. A Invocation Procedure is the complete set of each Invocation Command Sequence, each preceded by the Common Command Sequence.

Command Sequences are grouped into these sets to ensure that there is common coordination between dependencies and dependents on when to execute each command.

See [Section 8.7.3](#) for more detail.

[5.4.4.](#) Integrity Check Values

To enable [Section 5.5](#), there needs to be a mechanism to verify integrity of any metadata outside the manifest. Integrity Check Values are used to verify the integrity of metadata that is not contained in the manifest. This MAY include Severable Command Sequences, Concise Software Identifiers (CoSWID [[I-D.ietf-sacm-coswid](#)]), or Text data. Integrated Dependencies and Integrated Payloads are integrity-checked using Command Sequences, so they do not have Integrity Check Values present in the Manifest.

See [Section 8.7.8](#) for more detail.

[5.4.5.](#) Human-Readable Text

Text is typically a Severable Element ([Section 5.5](#)). It contains all the text that describes the update. Because text is explicitly for human consumption, it is all grouped together so that it can be Severed easily. The text section has space both for describing the manifest as a whole and for describing each individual component.

See [Section 8.6.4](#) for more detail.

[5.5.](#) Severable Elements

Severable Elements are elements of the Envelope ([Section 5.1](#)) that have Integrity Check Values ([Section 5.4.4](#)) in the Manifest ([Section 5.4](#)).

Because of this organisation, these elements can be discarded or "Severed" from the Envelope without changing the signature of the Manifest. This allows savings based on the size of the Envelope in several scenarios, for example:

- A management system severs the Text and CoSWID sections before sending an Envelope to a constrained Recipient, which saves Recipient bandwidth.
- A Recipient severs the Installation section after installing the Update, which saves storage space.

See [Section 8.8](#) for more detail.

5.6. Integrated Dependencies and Payloads

In some cases, it is beneficial to include a dependency or a payload in the Envelope of a manifest. For example:

- When an update is delivered via a comparatively unconstrained medium, such as a removable mass storage device, it may be beneficial to bundle updates into single files.
- When a manifest requires encryption, it must be referenced as a dependency, so a trivial manifest may be used to enclose the encrypted manifest. The encrypted manifest may be contained in the dependent manifest's envelope.
- When a manifest transports a small payload, such as an encrypted key, that payload may be placed in the manifest's envelope.

See [Section 7.9.1](#), [Section 8.5](#) for more detail.

6. Manifest Processor Behavior

This section describes the behavior of the manifest processor and focuses primarily on interpreting commands in the manifest. However, there are several other important behaviors of the manifest processor: encoding version detection, rollback protection, and authenticity verification are chief among these.

6.1. Manifest Processor Setup

Prior to executing any command sequence, the manifest processor or its host application **MUST** inspect the manifest version field and fail when it encounters an unsupported encoding version. Next, the manifest processor or its host application **MUST** extract the manifest sequence number and perform a rollback check using this sequence number. The exact logic of rollback protection may vary by application, but it has the following properties:

- Whenever the manifest processor can choose between several manifests, it **MUST** select the latest valid, authentic manifest.
- If the latest valid, authentic manifest fails, it **MAY** select the next latest valid, authentic manifest, according to application-specific policy.

Here, valid means that a manifest has a supported encoding version and it has not been excluded for other reasons. Reasons for excluding typically involve first executing the manifest and may include:

- Test failed (e.g. Vendor ID/Class ID).
- Unsupported command encountered.
- Unsupported parameter encountered.
- Unsupported Component Identifier encountered.
- Payload not available.
- Dependency not available.
- Application crashed when executed.
- Watchdog timeout occurred.
- Dependency or Payload verification failed.
- Missing component from a set.
- Required parameter not supplied.

These failure reasons MAY be combined with retry mechanisms prior to marking a manifest as invalid.

Selecting an older manifest in the event of failure of the latest valid manifest is a robustness mechanism that is necessary for supporting the requirements in [[I-D.ietf-suit-architecture](#)], [section 3.5](#). It may not be appropriate for all applications. In particular Trusted Execution Environments MAY require a failure to invoke a new installation, rather than a rollback approach. See [[I-D.ietf-suit-information-model](#)], Section 4.2.1 for more discussion on the security considerations that apply to rollback.

Following these initial tests, the manifest processor clears all parameter storage. This ensures that the manifest processor begins without any leaked data.

[6.2.](#) Required Checks

The RECOMMENDED process is to verify the signature of the manifest prior to parsing/executing any section of the manifest. This guards the parser against arbitrary input by unauthenticated third parties, but it costs extra energy when a Recipient receives an incompatible manifest.

When validating authenticity of manifests, the manifest processor MAY use an ACL (see [Section 9](#)) to determine the extent of the rights

conferred by that authenticity. Where a device supports only one level of access, it MAY choose to skip signature verification of dependencies, since they are referenced by digest. Where a device supports more than one trusted party, it MAY choose to defer the verification of signatures of dependencies until the list of affected components is known so that it can skip redundant signature verifications. For example, a dependency signed by the same author as the dependent does not require a signature verification. Similarly, if the signer of the dependent has full rights to the device, according to the ACL, then no signature verification is necessary on the dependency.

Once a valid, authentic manifest has been selected, the manifest processor MUST examine the component list and verify that its maximum number of components is not exceeded and that each listed component is supported.

For each listed component, the manifest processor MUST provide storage for the supported parameters. If the manifest processor does not have sufficient temporary storage to process the parameters for all components, it MAY process components serially for each command sequence. See [Section 6.6](#) for more details.

The manifest processor SHOULD check that the common sequence contains at least Check Vendor Identifier command and at least one Check Class Identifier command.

Because the common sequence contains Check Vendor Identifier and Check Class Identifier command(s), no custom commands are permitted in the common sequence. This ensures that any custom commands are only executed by devices that understand them.

If the manifest contains more than one component and/or dependency, each command sequence MUST begin with a Set Component Index or Set Dependency Index command.

If a dependency is specified, then the manifest processor MUST perform the following checks:

1. At the beginning of each section in the dependent: all previous sections of each dependency have been executed.
2. At the end of each section in the dependent: The corresponding section in each dependency has been executed.

If the interpreter does not support dependencies and a manifest specifies a dependency, then the interpreter MUST reject the manifest.

If a Recipient supports groups of interdependent components (a Component Set), then it SHOULD verify that all Components in the Component Set are specified by one update, where an update is composed of all the TODO: Wording

manifest and its dependencies. This manifest is called the Root Manifest.

6.2.1. Minimizing Signature Verifications

Signature verification can be energy and time expensive on a constrained device. MAC verification is typically unaffected by these concerns. A Recipient MAY choose to parse and execute only the SUIF_Common section of the manifest prior to signature verification, if all of the below apply:

- The Authentication Block contains a COSE_Sign_Tagged or COSE_Sign1_Tagged
- The Recipient receives manifests over an unauthenticated channel, exposing it to more inauthentic or incompatible manifests, and
- The Recipient has a power budget that makes signature verification undesirable

The guidelines in Creating Manifests ([Section 7](#)) require that the common section contains the applicability checks, so this section is sufficient for applicability verification. The parser MUST restrict acceptable commands to conditions and the following directives: Override Parameters, Set Parameters, Try Each, and Run Sequence ONLY. The manifest parser MUST NOT execute any command with side-effects outside the parser (for example, Run, Copy, Swap, or Fetch commands) prior to authentication and any such command MUST Abort. The Common Sequence MUST be executed again in its entirety after authenticity validation.

When executing Common prior to authenticity validation, the Manifest Processor MUST evaluate the integrity of the manifest using the SUIF_Digest present in the authentication block.

Alternatively, a Recipient MAY rely on network infrastructure to filter inapplicable manifests.

6.3. Interpreter Fundamental Properties

The interpreter has a small set of design goals:

1. Executing an update MUST either result in an error, or a verifiably correct system state.
2. Executing a Trusted Invocation MUST either result in an error, or an invoked image.
3. Executing the same manifest on multiple Recipients MUST result in the same system state.

NOTE: when using A/B images, the manifest functions as two (or more) logical manifests, each of which applies to a system in a particular starting state. With that provision, design goal 3 holds.

6.4. Abstract Machine Description

The heart of the manifest is the list of commands, which are processed by a Manifest Processor—a form of interpreter. This Manifest Processor can be modeled as a simple abstract machine. This machine consists of several data storage locations that are modified by commands.

There are two types of commands, namely those that modify state (directives) and those that perform tests (conditions). Parameters are used as the inputs to commands. Some directives offer control flow operations. Directives target a specific component or dependency. A dependency is another SUIT_Envelope that describes additional components. Dependencies are identified by digest, but referenced in commands by Dependency Index, the index into the array of Dependencies. A component is a unit of code or data that can be targeted by an update. Components are identified by Component Identifiers, but referenced in commands by Component Index; Component Identifiers are arrays of binary strings and a Component Index is an index into the array of Component Identifiers.

Conditions MUST NOT have any side-effects other than informing the interpreter of success or failure. The Interpreter does not Abort if the Soft Failure flag ([Section 8.7.5.23](#)) is set when a Condition reports failure.

Directives MAY have side-effects in the parameter table, the interpreter state, or the current component. The Interpreter MUST Abort if a Directive reports failure regardless of the Soft Failure flag.

To simplify the logic describing the command semantics, the object "current" is used. It represents the component identified by the Component Index or the dependency identified by the Dependency Index:

```
current := components\[component-index\]
  if component-index is not false
  else dependencies\[dependency-index\]
```

As a result, Set Component Index is described as `current := components[arg]`. The actual operation performed for Set Component Index is described by the following pseudocode, however, because of the definition of `current` (above), these are semantically equivalent.

```
component-index := arg
dependency-index := false
```

Similarly, Set Dependency Index is semantically equivalent to `current := dependencies[arg]`

The following table describes the behavior of each command. "params" represents the parameters for the current component or dependency. Most commands operate on either a component or a dependency. Setting the Component Index clears the Dependency Index. Setting the Dependency Index clears the Component Index.

| Command Name | Semantic of the Operation |
|-------------------------|--|
| Check Vendor Identifier | <code>assert(binary-match(current, current.params[vendor-id]))</code> |
| Check Class Identifier | <code>assert(binary-match(current, current.params[class-id]))</code> |
| Verify Image | <code>assert(binary-match(digest(current), current.params[digest]))</code> |
| Set Component Index | <code>current := components[arg]</code> |
| Override Parameters | <code>current.params[k] := v for-each k,v in arg</code> |
| Set Dependency Index | <code>current := dependencies[arg]</code> |
| Set Parameters | <code>current.params[k] := v if not k in params for-each k,v in arg</code> |
| Process Dependency | <code>exec(current[common]); exec(current[current-segment])</code> |

| | |
|-------------------------|--|
| Run | <code>run(current)</code> |
| Fetch | <code>store(current, fetch(current.params[uri]))</code> |
| Use Before | <code>assert(now() < arg)</code> |
| Check Component Offset | <code>assert(offsetof(current) == arg)</code> |
| Check Device Identifier | <code>assert(binary-match(current, current.params[device-id]))</code> |
| Check Image Not Match | <code>assert(not binary-match(digest(current), current.params[digest]))</code> |
| Check Minimum Battery | <code>assert(battery >= arg)</code> |
| Check Update Authorized | <code>assert(isAuthorized())</code> |
| Check Version | <code>assert(version_check(current, arg))</code> |
| Abort | <code>assert(0)</code> |
| Try Each | <code>try-each-done if exec(seq) is not error for-each seq in arg</code> |
| Copy | <code>store(current, current.params[src-component])</code> |
| Swap | <code>swap(current, current.params[src-component])</code> |
| Wait For Event | <code>until event(arg), wait</code> |
| Run Sequence | <code>exec(arg)</code> |
| Run with Arguments | <code>run(current, arg)</code> |

6.5. Special Cases of Component Index and Dependency Index

Component Index and Dependency Index can each take on one of three types:

1. Integer
2. Array of integers

3. True

Integers MUST always be supported by Set Component Index and Set Dependency Index. Arrays of integers MUST be supported by Set Component Index and Set Dependency Index if the Recipient supports 3 or more components or 3 or more dependencies, respectively. True MUST be supported by Set Component Index and Set Dependency Index if the Recipient supports 2 or more components or 2 or more dependencies, respectively. Each of these operates on the list of components or list of dependencies declared in the manifest.

Integer indices are the default case as described in the previous section. An array of integers represents a list of the components (Set Component Index) or a list of dependencies (Set Dependency Index) to which each subsequent command applies. The value True replaces the list of component indices or dependency indices with the full list of components or the full list of dependencies, respectively, as defined in the manifest.

When a command is executed, it either 1. operates on the component or dependency identified by the component index or dependency index if that index is an integer, or 2. it operates on each component or dependency identified by an array of indices, or 3. it operates on every component or every dependency if the index is the boolean True. This is described by the following pseudocode:

```
if component-index is true:
    current-list = components
else if component-index is array:
    current-list = [ components[idx] for idx in component-index ]
else if component-index is integer:
    current-list = [ components[component-index] ]
else if dependency-index is true:
    current-list = dependencies
else if dependency-index is array:
    current-list = [ dependencies[idx] for idx in dependency-index ]
else:
    current-list = [ dependencies[dependency-index] ]
for current in current-list:
    cmd(current)
```

Try Each and Run Sequence are affected in the same way as other commands: they are invoked once for each possible Component or Dependency. This means that the sequences that are arguments to Try Each and Run Sequence are NOT invoked with Component Index = True or Dependency Index = True, nor are they invoked with array indices. They are only invoked with integer indices. The interpreter loops

over the whole sequence, setting the Component Index or Dependency Index to each index in turn.

6.6. Serialized Processing Interpreter

In highly constrained devices, where storage for parameters is limited, the manifest processor MAY handle one component at a time, traversing the manifest tree once for each listed component. In this mode, the interpreter ignores any commands executed while the component index is not the current component. This reduces the overall volatile storage required to process the update so that the only limit on number of components is the size of the manifest. However, this approach requires additional processing power.

In order to operate in this mode, the manifest processor loops on each section for every supported component, simply ignoring commands when the current component is not selected.

When a serialized Manifest Processor encounters a component or dependency index of True, it does not ignore any commands. It applies them to the current component or dependency on each iteration.

6.7. Parallel Processing Interpreter

Advanced Recipients MAY make use of the Strict Order parameter and enable parallel processing of some Command Sequences, or it may reorder some Command Sequences. To perform parallel processing, once the Strict Order parameter is set to False, the Recipient may issue each or every command concurrently until the Strict Order parameter is returned to True or the Command Sequence ends. Then, it waits for all issued commands to complete before continuing processing of commands. To perform out-of-order processing, a similar approach is used, except the Recipient consumes all commands after the Strict Order parameter is set to False, then it sorts these commands into its preferred order, invokes them all, then continues processing.

Under each of these scenarios the parallel processing MUST halt until all issued commands have completed:

- Set Parameters.
- Override Parameters.
- Set Strict Order = True.
- Set Dependency Index.

- Set Component Index.

To perform more useful parallel operations, a manifest author may collect sequences of commands in a Run Sequence command. Then, each of these sequences MAY be run in parallel. Each sequence defaults to Strict Order = True. To isolate each sequence from each other sequence, each sequence MUST begin with a Set Component Index or Set Dependency Index directive with the following exception: when the index is either True or an array of indices, the Set Component Index or Set Dependency Index is implied. Any further Set Component Index directives MUST cause an Abort. This allows the interpreter that issues Run Sequence commands to check that the first element is correct, then issue the sequence to a parallel execution context to handle the remainder of the sequence.

6.8. Processing Dependencies

As described in [Section 6.2](#), each manifest must invoke each of its dependencies sections from the corresponding section of the dependent. Any changes made to parameters by the dependency persist in the dependent.

When a Process Dependency command is encountered, the interpreter loads the dependency identified by the Current Dependency Index. The interpreter first executes the common-sequence section of the identified dependency, then it executes the section of the dependency that corresponds to the currently executing section of the dependent.

If the specified dependency does not contain the current section, Process Dependency succeeds immediately.

The Manifest Processor MUST also support a Dependency Index of True, which applies to every dependency, as described in [Section 6.5](#)

The interpreter also performs the checks described in [Section 6.2](#) to ensure that the dependent is processing the dependency correctly.

6.9. Multiple Manifest Processors

When a system has multiple security domains, each domain might require independent verification of authenticity or security policies. Security domains might be divided by separation technology such as Arm TrustZone, Intel SGX, or another TEE technology. Security domains might also be divided into separate processors and memory spaces, with a communication interface between them.

For example, an application processor may have an attached communications module that contains a processor. The communications

module might require metadata signed by a specific Trust Authority for regulatory approval. This may be a different Trust Authority than the application processor.

When there are two or more security domains (see [\[I-D.ietf-teep-architecture\]](#)), a manifest processor might be required in each. The first manifest processor is the normal manifest processor as described for the Recipient in [Section 6.4](#). The second manifest processor only executes sections when the first manifest processor requests it. An API interface is provided from the second manifest processor to the first. This allows the first manifest processor to request a limited set of operations from the second. These operations are limited to: setting parameters, inserting an Envelope, invoking a Manifest Command Sequence. The second manifest processor declares a prefix to the first, which tells the first manifest processor when it should delegate to the second. These rules are enforced by underlying separation of privilege infrastructure, such as TEEs, or physical separation.

When the first manifest processor encounters a dependency prefix, that informs the first manifest processor that it should provide the second manifest processor with the corresponding dependency Envelope. This is done when the dependency is fetched. The second manifest processor immediately verifies any authentication information in the dependency Envelope. When a parameter is set for any component that matches the prefix, this parameter setting is passed to the second manifest processor via an API. As the first manifest processor works through the Procedure (set of command sequences) it is executing, each time it sees a Process Dependency command that is associated with the prefix declared by the second manifest processor, it uses the API to ask the second manifest processor to invoke that dependency section instead.

This mechanism ensures that the two or more manifest processors do not need to trust each other, except in a very limited case. When parameter setting across security domains is used, it must be very carefully considered. Only parameters that do not have an effect on security properties should be allowed. The dependency manifest MAY control which parameters are allowed to be set by using the Override Parameters directive. The second manifest processor MAY also control which parameters may be set by the first manifest processor by means of an ACL that lists the allowed parameters. For example, a URI may be set by a dependent without a substantial impact on the security properties of the manifest.

7. Creating Manifests

Manifests are created using tools for constructing COSE structures, calculating cryptographic values and compiling desired system state into a sequence of operations required to achieve that state. The process of constructing COSE structures and the calculation of cryptographic values is covered in [[RFC8152](#)].

Compiling desired system state into a sequence of operations can be accomplished in many ways. Several templates are provided below to cover common use-cases. These templates can be combined to produce more complex behavior.

The author **MUST** ensure that all parameters consumed by a command are set prior to invoking that command. Where Component Index = True or Dependency Index = True, this means that the parameters consumed by each command **MUST** have been set for each Component or Dependency, respectively.

This section details a set of templates for creating manifests. These templates explain which parameters, commands, and orders of commands are necessary to achieve a stated goal.

NOTE: On systems that support only a single component and no dependencies, Set Component Index has no effect and can be omitted.

NOTE: *A digest **MUST** always be set using Override Parameters, since this prevents a less-privileged dependent from replacing the digest.*

7.1. Compatibility Check Template

The goal of the compatibility check template ensure that Recipients only install compatible images.

In this template all information is contained in the common sequence and the following sequence of commands is used:

- Set Component Index directive (see [Section 8.7.7.1](#))
- Set Parameters directive (see [Section 8.7.7.5](#)) for Vendor ID and Class ID (see [Section 8.7.5](#))
- Check Vendor Identifier condition (see [Section 8.7.5.2](#))
- Check Class Identifier condition (see [Section 8.7.5.2](#))

7.2. Trusted Invocation Template

The goal of the Trusted Invocation template is to ensure that only authorized code is invoked; such as in Secure Boot or when a Trusted Application is loaded into a TEE.

The following commands are placed into the common sequence:

- Set Component Index directive (see [Section 8.7.7.1](#))
- Override Parameters directive (see [Section 8.7.7.6](#)) for Image Digest and Image Size (see [Section 8.7.5](#))

Then, the run sequence contains the following commands:

- Set Component Index directive (see [Section 8.7.7.1](#))
- Check Image Match condition (see [Section 8.7.6.2](#))
- Run directive (see [Section 8.7.7.12](#))

7.3. Component Download Template

The goal of the Component Download template is to acquire and store an image.

The following commands are placed into the common sequence:

- Set Component Index directive (see [Section 8.7.7.1](#))
- Override Parameters directive (see [Section 8.7.7.6](#)) for Image Digest and Image Size (see [Section 8.7.5](#))

Then, the install sequence contains the following commands:

- Set Component Index directive (see [Section 8.7.7.1](#))
- Set Parameters directive (see [Section 8.7.7.5](#)) for URI (see [Section 8.7.5.13](#))
- Fetch directive (see [Section 8.7.7.7](#))
- Check Image Match condition (see [Section 8.7.6.2](#))

The Fetch directive needs the URI parameter to be set to determine where the image is retrieved from. Additionally, the destination of where the component shall be stored has to be configured. The URI is

configured via the Set Parameters directive while the destination is configured via the Set Component Index directive.

Optionally, the Set Parameters directive in the install sequence MAY also contain Encryption Info (see [Section 8.7.5.10](#)), Compression Info (see [Section 8.7.5.11](#)), or Unpack Info (see [Section 8.7.5.12](#)) to perform simultaneous download and decryption, decompression, or unpacking, respectively.

7.4. Install Template

The goal of the Install template is to use an image already stored in an identified component to copy into a second component.

This template is typically used with the Component Download template, however a modification to that template is required: the Component Download operations are moved from the Payload Install sequence to the Payload Fetch sequence.

Then, the install sequence contains the following commands:

- Set Component Index directive (see [Section 8.7.7.1](#))
- Set Parameters directive (see [Section 8.7.7.5](#)) for Source Component (see [Section 8.7.5.14](#))
- Copy directive (see [Section 8.7.7.9](#))
- Check Image Match condition (see [Section 8.7.6.2](#))

7.5. Install and Transform Template

The goal of the Install and Transform template is to use an image already stored in an identified component to decompress, decrypt, or unpack at time of installation.

This template is typically used with the Component Download template, however a modification to that template is required: all Component Download operations are moved from the common sequence and the install sequence to the fetch sequence. The Component Download template targets a download component identifier, while the Install and Transform template uses an install component identifier. In-place unpacking, decompression, and decryption is complex and vulnerable to power failure. Therefore, these identifiers SHOULD be different; in-place installation SHOULD NOT be used without establishing guarantees of robustness to power failure.

The following commands are placed into the common sequence:

- Set Component Index directive for install component identifier (see [Section 8.7.7.1](#))
- Override Parameters directive (see [Section 8.7.7.6](#)) for Image Digest and Image Size (see [Section 8.7.5](#))

Then, the install sequence contains the following commands:

- Set Component Index directive for install component identifier (see [Section 8.7.7.1](#))
- Set Parameters directive (see [Section 8.7.7.5](#)) for:
 - o Source Component for download component identifier (see [Section 8.7.5.14](#))
 - o Encryption Info (see [Section 8.7.5.10](#))
 - o Compression Info (see [Section 8.7.5.11](#))
 - o Unpack Info (see [Section 8.7.5.12](#))
- Copy directive (see [Section 8.7.7.9](#))
- Check Image Match condition (see [Section 8.7.6.2](#))

7.6. Integrated Payload Template

The goal of the Integrated Payload template is to install a payload that is included in the manifest envelope. It is identical to the Component Download template ([Section 7.3](#)) except that it places an added restriction on the URI passed to the Set Parameters directive.

An implementer MAY choose to place a payload in the envelope of a manifest. The payload envelope key MAY be a positive or negative integer. The payload envelope key MUST NOT be a value between 0 and 24 and it MUST NOT be used by any other envelope element in the manifest. The payload MUST be serialized in a bstr element.

The URI for a payload enclosed in this way MUST be expressed as a fragment-only reference, as defined in [\[RFC3986\], Section 4.4](#). The fragment identifier is the stringified envelope key of the payload. For example, an envelope that contains a payload a key 42 would use a URI "#42", key -73 would use a URI "#-73".

7.7. Load from Nonvolatile Storage Template

The goal of the Load from Nonvolatile Storage template is to load an image from a non-volatile component into a volatile component, for example loading a firmware image from external Flash into RAM.

The following commands are placed into the load sequence:

- Set Component Index directive (see [Section 8.7.7.1](#))
- Set Parameters directive (see [Section 8.7.7.5](#)) for Component Index (see [Section 8.7.5](#))
- Copy directive (see [Section 8.7.7.9](#))

As outlined in [Section 6.4](#), the Copy directive needs a source and a destination to be configured. The source is configured via Component Index (with the Set Parameters directive) and the destination is configured via the Set Component Index directive.

7.8. Load & Decompress from Nonvolatile Storage Template

The goal of the Load & Decompress from Nonvolatile Storage template is to load an image from a non-volatile component into a volatile component, decompressing on-the-fly, for example loading a firmware image from external Flash into RAM.

The following commands are placed into the load sequence:

- Set Component Index directive (see [Section 8.7.7.1](#))
- Set Parameters directive (see [Section 8.7.7.5](#)) for Source Component Index and Compression Info (see [Section 8.7.5](#))
- Copy directive (see [Section 8.7.7.9](#))

This template is similar to [Section 7.7](#) but additionally performs decompression. Hence, the only difference is in setting the Compression Info parameter.

This template can be modified for decryption or unpacking by adding Decryption Info or Unpack Info to the Set Parameters directive.

7.9. Dependency Template

The goal of the Dependency template is to obtain, verify, and process a dependency manifest as appropriate.

The following commands are placed into the dependency resolution sequence:

- Set Dependency Index directive (see [Section 8.7.7.2](#))
- Set Parameters directive (see [Section 8.7.7.5](#)) for URI (see [Section 8.7.5](#))
- Fetch directive (see [Section 8.7.7.7](#))
- Check Image Match condition (see [Section 8.7.6.2](#))
- Process Dependency directive (see [Section 8.7.7.4](#))

Then, the validate sequence contains the following operations:

- Set Dependency Index directive (see [Section 8.7.7.2](#))
- Check Image Match condition (see [Section 8.7.6.2](#))
- Process Dependency directive (see [Section 8.7.7.4](#))

NOTE: Any changes made to parameters in a dependency persist in the dependent.

7.9.1. Composite Manifests

An implementer MAY choose to place a dependency's envelope in the envelope of its dependent. The dependent envelope key for the dependency envelope MUST NOT be a value between 0 and 24 and it MUST NOT be used by any other envelope element in the dependent manifest.

The URI for a dependency enclosed in this way MUST be expressed as a fragment-only reference, as defined in [\[RFC3986\], Section 4.4](#). The fragment identifier is the stringified envelope key of the dependency. For example, an envelope that contains a dependency at key 42 would use a URI "#42", key -73 would use a URI "#-73".

7.10. Encrypted Manifest Template

The goal of the Encrypted Manifest template is to fetch and decrypt a manifest so that it can be used as a dependency. To use an encrypted manifest, create a plaintext dependent, and add the encrypted manifest as a dependency. The dependent can include very little information.

The following operations are placed into the dependency resolution block:

- Set Dependency Index directive (see [Section 8.7.7.2](#))
- Set Parameters directive (see [Section 8.7.7.5](#)) for
 - o URI (see [Section 8.7.5](#))
 - o Encryption Info (see [Section 8.7.5](#))
- Fetch directive (see [Section 8.7.7.7](#))
- Check Image Match condition (see [Section 8.7.6.2](#))
- Process Dependency directive (see [Section 8.7.7.4](#))

Then, the validate block contains the following operations:

- Set Dependency Index directive (see [Section 8.7.7.2](#))
- Check Image Match condition (see [Section 8.7.6.2](#))
- Process Dependency directive (see [Section 8.7.7.4](#))

A plaintext manifest and its encrypted dependency may also form a composite manifest ([Section 7.9.1](#)).

7.11. A/B Image Template

The goal of the A/B Image Template is to acquire, validate, and invoke one of two images, based on a test.

The following commands are placed in the common block:

- Set Component Index directive (see [Section 8.7.7.1](#))
- Try Each
 - o First Sequence:
 - * Override Parameters directive (see [Section 8.7.7.6](#), [Section 8.7.5](#)) for Offset A
 - * Check Offset Condition (see [Section 8.7.6.5](#))
 - * Override Parameters directive (see [Section 8.7.7.6](#)) for Image Digest A and Image Size A (see [Section 8.7.5](#))
 - o Second Sequence:

- * Override Parameters directive (see [Section 8.7.7.6](#), [Section 8.7.5](#)) for Offset B
- * Check Offset Condition (see [Section 8.7.6.5](#))
- * Override Parameters directive (see [Section 8.7.7.6](#)) for Image Digest B and Image Size B (see [Section 8.7.5](#))

The following commands are placed in the fetch block or install block

- Set Component Index directive (see [Section 8.7.7.1](#))
- Try Each
 - o First Sequence:
 - * Override Parameters directive (see [Section 8.7.7.6](#), [Section 8.7.5](#)) for Offset A
 - * Check Offset Condition (see [Section 8.7.6.5](#))
 - * Set Parameters directive (see [Section 8.7.7.6](#)) for URI A (see [Section 8.7.5](#))
 - o Second Sequence:
 - * Override Parameters directive (see [Section 8.7.7.6](#), [Section 8.7.5](#)) for Offset B
 - * Check Offset Condition (see [Section 8.7.6.5](#))
 - * Set Parameters directive (see [Section 8.7.7.6](#)) for URI B (see [Section 8.7.5](#))
- Fetch

If Trusted Invocation ([Section 7.2](#)) is used, only the run sequence is added to this template, since the common sequence is populated by this template.

NOTE: Any test can be used to select between images, Check Offset Condition is used in this template because it is a typical test for execute-in-place devices.

8. Metadata Structure

The metadata for SUIT updates is composed of several primary constituent parts: the Envelope, Delegation Chains, Authentication Information, Manifest, and Severable Elements.

For a diagram of the metadata structure, see [Section 5](#).

8.1. Encoding Considerations

The map indices in the envelope encoding are reset to 1 for each map within the structure. This is to keep the indices as small as possible. The goal is to keep the index objects to single bytes (CBOR positive integers 1-23).

Wherever enumerations are used, they are started at 1. This allows detection of several common software errors that are caused by uninitialized variables. Positive numbers in enumerations are reserved for IANA registration. Negative numbers are used to identify application-specific values, as described in [Section 11](#).

All elements of the envelope must be wrapped in a bstr to minimize the complexity of the code that evaluates the cryptographic integrity of the element and to ensure correct serialization for integrity and authenticity checks.

8.2. Envelope

The Envelope contains each of the other primary constituent parts of the SUIT metadata. It allows for modular processing of the manifest by ordering components in the expected order of processing.

The Envelope is encoded as a CBOR Map. Each element of the Envelope is enclosed in a bstr, which allows computation of a message digest against known bounds.

8.3. Delegation Chains

The suit-delegation element MAY carry one or more CBOR Web Tokens (CWTs) [[RFC8392](#)], with [[RFC8747](#)] cnf claims. They can be used to perform enhanced authorization decisions. The CWTs are arranged into a list of lists. Each list starts with a CWT authorized by a Trust Anchor, and finishes with a key used to authenticate the Manifest (see [Section 8.4](#)). This allows an Update Authority to delegate from a long term Trust Anchor, down through intermediaries, to a delegate without any out-of-band provisioning of Trust Anchors or intermediary keys.

A Recipient MAY choose to cache intermediaries and/or delegates. If an Update Distributor knows that a targeted Recipient has cached some intermediaries or delegates, it MAY choose to strip any cached intermediaries or delegates from the Delegation Chains in order to reduce bandwidth and energy.

8.4. Authenticated Manifests

The suit-authentication-wrapper contains a list containing a [Section 10](#) and one or more cryptographic authentication wrappers for the Manifest. These are implemented as COSE_Mac_Tagged or COSE_Sign_Tagged blocks. Each of these blocks contains a SUIE_Digest of the Manifest. This enables modular processing of the manifest. The COSE_Mac_Tagged and COSE_Sign_Tagged blocks are described in [RFC 8152 \[RFC8152\]](#). The suit-authentication-wrapper MUST come before any element in the SUIE_Envelope, except for the OPTIONAL suit-delegation, regardless of canonical encoding of CBOR. All validators MUST reject any SUIE_Envelope that begins with any element other than a suit-authentication-wrapper or suit-delegation.

A SUIE_Envelope that has not had authentication information added MUST still contain the suit-authentication-wrapper element, but the content MUST be a list containing only the SUIE_Digest.

A signing application MUST verify the suit-manifest element against the SUIE_Digest prior to signing.

8.5. Encrypted Manifests

To use an encrypted manifest, it must be a dependency of a plaintext manifest. This allows fine-grained control of what information is accessible to intermediate systems for the purposes of management, while still preserving the confidentiality of the manifest contents. This also means that a Recipient can process an encrypted manifest in the same way as an encrypted payload, allowing code reuse.

A template for using an encrypted manifest is covered in Encrypted Manifest Template ([Section 7.10](#)).

8.6. Manifest

The manifest contains:

- a version number (see [Section 8.6.1](#))
- a sequence number (see [Section 8.6.2](#))
- a reference URI (see [Section 8.6.3](#))

- a common structure with information that is shared between command sequences (see [Section 8.7.2](#))
- one or more lists of commands that the Recipient should perform (see [Section 8.7.3](#))
- a reference to the full manifest (see [Section 8.6.3](#))
- human-readable text describing the manifest found in the SUIE_Envelope (see [Section 8.6.4](#))
- a Concise Software Identifier (CoSWID) found in the SUIE_Envelope (see [Section 8.7.1](#))

The CoSWID, Text section, or any Command Sequence of the Update Procedure (Dependency Resolution, Image Fetch, Image Installation) can be either a CBOR structure or a SUIE_Digest. In each of these cases, the SUIE_Digest provides for a severable element. Severable elements are RECOMMENDED to implement. In particular, the human-readable text SHOULD be severable, since most useful text elements occupy more space than a SUIE_Digest, but are not needed by the Recipient. Because SUIE_Digest is a CBOR Array and each severable element is a CBOR bstr, it is straight-forward for a Recipient to determine whether an element has been severed. The key used for a severable element is the same in the SUIE_Manifest and in the SUIE_Envelope so that a Recipient can easily identify the correct data in the envelope. See [Section 8.7.8](#) for more detail.

[8.6.1.](#) suit-manifest-version

The suit-manifest-version indicates the version of serialization used to encode the manifest. Version 1 is the version described in this document. suit-manifest-version is REQUIRED to implement.

[8.6.2.](#) suit-manifest-sequence-number

The suit-manifest-sequence-number is a monotonically increasing anti-rollback counter. It also helps Recipients to determine which in a set of manifests is the "root" manifest in a given update. Each manifest MUST have a sequence number higher than each of its dependencies. Each Recipient MUST reject any manifest that has a sequence number lower than its current sequence number. For convenience, an implementer MAY use a UTC timestamp in seconds as the sequence number. suit-manifest-sequence-number is REQUIRED to implement.

[8.6.3.](#) `suit-reference-uri`

`suit-reference-uri` is a text string that encodes a URI where a full version of this manifest can be found. This is convenient for allowing management systems to show the severed elements of a manifest when this URI is reported by a Recipient after installation.

[8.6.4.](#) `suit-text`

`suit-text` SHOULD be a severable element. `suit-text` is a map containing two different types of pair:

- integer => text
- `SUIT_Component_Identifier` => map

Each `SUIT_Component_Identifier` => map entry contains a map of integer => text values. All `SUIT_Component_Identifier`s present in `suit-text` MUST also be present in `suit-common` ([Section 8.7.2](#)) or the `suit-common` of a dependency.

`suit-text` contains all the human-readable information that describes any and all parts of the manifest, its payload(s) and its resource(s). The text section is typically severable, allowing manifests to be distributed without the text, since end-nodes do not require text. The meaning of each field is described below.

Each section MAY be present. If present, each section MUST be as described. Negative integer IDs are reserved for application-specific text values.

The following table describes the text fields available in `suit-text`:

| CDDL Structure | Description |
|--------------------------------|---|
| suit-text-manifest-description | Free text description of the manifest |
| suit-text-update-description | Free text description of the update |
| suit-text-manifest-json-source | The JSON-formatted document that was used to create the manifest |
| suit-text-manifest-yaml-source | The YAML ([YAML])-formatted document that was used to create the manifest |

The following table describes the text fields available in each map identified by a SUIT_Component_Identifier.

| CDDL Structure | Description |
|---------------------------------|---|
| suit-text-vendor-name | Free text vendor name |
| suit-text-model-name | Free text model name |
| suit-text-vendor-domain | The domain used to create the vendor-id condition |
| suit-text-model-info | The information used to create the class-id condition |
| suit-text-component-description | Free text description of each component in the manifest |
| suit-text-component-version | A free text representation of the component version |
| suit-text-version-required | A free text expression of the required version number |

suit-text is OPTIONAL to implement.

8.7. text-version-required

suit-text-version-required is used to represent a version-based dependency on suit-parameter-version as described in [Section 8.7.5.18](#) and [Section 8.7.6.8](#). To describe a version dependency, a Manifest Author SHOULD populate the suit-text map with a `SUIT_Component_Identifier` key for the dependency component, and place in the corresponding map a `suit-text-version-required` key with a free text expression that is representative of the version constraints placed on the dependency. This text SHOULD be expressive enough that a device operator can be expected to understand the dependency. This is a free text field and there are no specific formatting rules.

By way of example only, to express a dependency on a component `"['x', 'y']"`, where the version should be any `v1.x` later than `v1.2.5`, but not `v2.0` or above, the author would add the following structure to the `suit-text` element. Note that this text is in `cbor-diag` notation.

```
[h'78',h'79'] : {
  7 : ">=1.2.5,<2"
}
```

8.7.1. suit-coswid

`suit-coswid` contains a Concise Software Identifier (CoSWID) as defined in [[I-D.ietf-sacm-coswid](#)]. This element SHOULD be made severable so that it can be discarded by the Recipient or an intermediary if it is not required by the Recipient.

`suit-coswid` typically requires no processing by the Recipient. However all Recipients MUST NOT fail if a `suit-coswid` is present.

8.7.2. suit-common

`suit-common` encodes all the information that is shared between each of the command sequences, including: `suit-dependencies`, `suit-components`, and `suit-common-sequence`. `suit-common` is REQUIRED to implement.

`suit-dependencies` is a list of [Section 8.7.2.1](#) blocks that specify manifests that must be present before the current manifest can be processed. `suit-dependencies` is OPTIONAL to implement.

`suit-components` is a list of `SUIT_Component_Identifier` ([Section 8.7.2.2](#)) blocks that specify the component identifiers that will be affected by the content of the current manifest. `suit-components` is REQUIRED to implement; at least one manifest in a dependency tree MUST contain a `suit-components` block.

suit-common-sequence is a SUIF_Command_Sequence to execute prior to executing any other command sequence. Typical actions in suit-common-sequence include setting expected Recipient identity and image digests when they are conditional (see [Section 8.7.7.3](#) and [Section 7.11](#) for more information on conditional sequences). suit-common-sequence is RECOMMENDED to implement. It is REQUIRED if the optimizations described in [Section 6.2.1](#) will be used. Whenever a parameter or Try Each command is required by more than one Command Sequence, placing that parameter or command in suit-common-sequence results in a smaller encoding.

8.7.2.1. Dependencies

SUIF_Dependency specifies a manifest that describes a dependency of the current manifest. The Manifest is identified, but the Recipient should expect an Envelope when it acquires the dependency. This is because the Manifest is the one invariant element of the Envelope, where other elements may change by countersigning, adding authentication blocks, or severing elements.

The suit-dependency-digest specifies the dependency manifest uniquely by identifying a particular Manifest structure. This is identical to the digest that would be present as the payload of any suit-authentication-block in the dependency's Envelope. The digest is calculated over the Manifest structure instead of the COSE Sig_structure or Mac_structure. This is necessary to ensure that removing a signature from a manifest does not break dependencies due to missing signature elements. This is also necessary to support the trusted intermediary use case, where an intermediary re-signs the Manifest, removing the original signature, potentially with a different algorithm, or trading COSE_Sign for COSE_Mac.

The suit-dependency-prefix element contains a SUIF_Component_Identifier (see [Section 8.7.2.2](#)). This specifies the scope at which the dependency operates. This allows the dependency to be forwarded on to a component that is capable of parsing its own manifests. It also allows one manifest to be deployed to multiple dependent Recipients without those Recipients needing consistent component hierarchy. This element is OPTIONAL for Recipients to implement.

A dependency prefix can be used with a component identifier. This allows complex systems to understand where dependencies need to be applied. The dependency prefix can be used in one of two ways. The first simply prepends the prefix to all Component Identifiers in the dependency.

A dependency prefix can also be used to indicate when a dependency manifest needs to be processed by a secondary manifest processor, as described in [Section 6.9](#).

8.7.2.2. SUIF_Component_Identifier

A component is a unit of code or data that can be targeted by an update. To facilitate composite devices, components are identified by a list of CBOR byte strings, which allows construction of hierarchical component structures. A dependency MAY declare a prefix to the components defined in the dependency manifest. Components are identified by Component Identifiers, but referenced in commands by Component Index; Component Identifiers are arrays of binary strings and a Component Index is an index into the array of Component Identifiers.

A Component Identifier can be trivial, such as the simple array [h'00']. It can also represent a filesystem path by encoding each segment of the path as an element in the list. For example, the path "/usr/bin/env" would encode to ['usr','bin','env'].

This hierarchical construction allows a component identifier to identify any part of a complex, multi-component system.

8.7.3. SUIF_Command_Sequence

A SUIF_Command_Sequence defines a series of actions that the Recipient MUST take to accomplish a particular goal. These goals are defined in the manifest and include:

1. **Dependency Resolution:** suit-dependency-resolution is a SUIF_Command_Sequence to execute in order to perform dependency resolution. Typical actions include configuring URIs of dependency manifests, fetching dependency manifests, and validating dependency manifests' contents. suit-dependency-resolution is REQUIRED to implement and to use when suit-dependencies is present.
2. **Payload Fetch:** suit-payload-fetch is a SUIF_Command_Sequence to execute in order to obtain a payload. Some manifests may include these actions in the suit-install section instead if they operate in a streaming installation mode. This is particularly relevant for constrained devices without any temporary storage for staging the update. suit-payload-fetch is OPTIONAL to implement.
3. **Payload Installation:** suit-install is a SUIF_Command_Sequence to execute in order to install a payload. Typical actions include verifying a payload stored in temporary storage, copying a staged

payload from temporary storage, and unpacking a payload. `suit-install` is OPTIONAL to implement.

4. Image Validation: `suit-validate` is a `SUIT_Command_Sequence` to execute in order to validate that the result of applying the update is correct. Typical actions involve image validation and manifest validation. `suit-validate` is REQUIRED to implement. If the manifest contains dependencies, one process-dependency invocation per dependency or one process-dependency invocation targeting all dependencies SHOULD be present in `validate`.
5. Image Loading: `suit-load` is a `SUIT_Command_Sequence` to execute in order to prepare a payload for execution. Typical actions include copying an image from permanent storage into RAM, optionally including actions such as decryption or decompression. `suit-load` is OPTIONAL to implement.
6. Run or Boot: `suit-run` is a `SUIT_Command_Sequence` to execute in order to run an image. `suit-run` typically contains a single instruction: either the "run" directive for the invocable manifest or the "process dependencies" directive for any dependents of the invocable manifest. `suit-run` is OPTIONAL to implement.

Goals 1,2,3 form the Update Procedure. Goals 4,5,6 form the Invocation Procedure.

Each Command Sequence follows exactly the same structure to ensure that the parser is as simple as possible.

Lists of commands are constructed from two kinds of element:

1. Conditions that MUST be true and any failure is treated as a failure of the update/load/invocation
2. Directives that MUST be executed.

Each condition is composed of:

1. A command code identifier
2. A `SUIT_Reporting_Policy` ([Section 8.7.4](#))

Each directive is composed of:

1. A command code identifier
2. An argument block or a `SUIT_Reporting_Policy` ([Section 8.7.4](#))

Argument blocks are consumed only by flow-control directives:

- Set Component/Dependency Index
- Set/Override Parameters
- Try Each
- Run Sequence

Reporting policies provide a hint to the manifest processor of whether to add the success or failure of a command to any report that it generates.

Many conditions and directives apply to a given component, and these generally grouped together. Therefore, a special command to set the current component index is provided with a matching command to set the current dependency index. This index is a numeric index into the Component Identifier tables defined at the beginning of the manifest. For the purpose of setting the index, the two Component Identifier tables are considered to be concatenated together.

To facilitate optional conditions, a special directive, `suit-directive-try-each` ([Section 8.7.7.3](#)), is provided. It runs several new lists of conditions/directives, one after another, that are contained as an argument to the directive. By default, it assumes that a failure of a condition should not indicate a failure of the update/invocation, but a parameter is provided to override this behavior. See `suit-parameter-soft-failure` ([Section 8.7.5.23](#)).

8.7.4. Reporting Policy

To facilitate construction of Reports that describe the success, or failure of a given Procedure, each command is given a Reporting Policy. This is an integer bitfield that follows the command and indicates what the Recipient should do with the Record of executing the command. The options are summarized in the table below.

| Policy | Description |
|-----------------------------|--|
| suit-send-record-on-success | Record when the command succeeds |
| suit-send-record-on-failure | Record when the command fails |
| suit-send-sysinfo-success | Add system information when the command succeeds |
| suit-send-sysinfo-failure | Add system information when the command fails |

Any or all of these policies may be enabled at once.

At the completion of each command, a recipient MAY forward that command's reporting policy, the result of the command, the current set of parameters, and the system information consumed by the command to a TODO

several information elements are provided to an implementation defined subsystem, the Reporting Engine:

- The reporting policies
- The result of the command
- The parameters consumed by the command
- The system information consumed by the command

If the component index is set to True or an array when a command is executed with a non-zero reporting policy, then the Reporting Engine MUST receive one Record for each Component, in the order expressed in the Components list or the component index array, respectively. If the dependency index is set to True or an array when a command is executed with a non-zero reporting policy, then the Reporting Engine MUST receive one Record for each Dependency, in the order expressed in the Dependencies list or the component index array, respectively.

This specification does define a particular format of Records or Reports. This specification only defines hints to the Reporting Engine for which Records it should aggregate into the Report. The Reporting Engine MAY choose to ignore these hints and apply its own policy instead.

When used in a Invocation Process, the report MAY form the basis of an attestation report. When used in an Update Process, the report MAY form the basis for one or more log entries.

8.7.5. SUIF_Parameters

Many conditions and directives require additional information. That information is contained within parameters that can be set in a consistent way. This allows reduction of manifest size and replacement of parameters from one manifest to the next.

Most parameters are scoped to a specific component. This means that setting a parameter for one component has no effect on the parameters of any other component. The only exceptions to this are two Manifest Processor parameters: Strict Order and Soft Failure.

The defined manifest parameters are described below.

| Name | CDDL Structure | Reference |
|------------------|----------------------------------|--------------------------------------|
| Vendor ID | suit-parameter-vendor-identifier | Section 8.7.5 .3 |
| Class ID | suit-parameter-class-identifier | Section 8.7.5 .4 |
| Device ID | suit-parameter-device-identifier | Section 8.7.5 .5 |
| Image Digest | suit-parameter-image-digest | Section 8.7.5 .6 |
| Image Size | suit-parameter-image-size | Section 8.7.5 .7 |
| Use Before | suit-parameter-use-before | Section 8.7.5 .8 |
| Component Offset | suit-parameter-component-offset | Section 8.7.5 .9 |
| Encryption Info | suit-parameter-encryption-info | Section 8.7.5 .10 |
| Compression Info | suit-parameter-compression-info | Section 8.7.5 .11 |

| | | |
|------------------|---------------------------------|--------------------------------------|
| Unpack Info | suit-parameter-unpack-info | Section 8.7.5 .12 |
| URI | suit-parameter-uri | Section 8.7.5 .13 |
| Source Component | suit-parameter-source-component | Section 8.7.5 .14 |
| Run Args | suit-parameter-run-args | Section 8.7.5 .15 |
| Minimum Battery | suit-parameter-minimum-battery | Section 8.7.5 .16 |
| Update Priority | suit-parameter-update-priority | Section 8.7.5 .17 |
| Version | suit-parameter-version | Section 8.7.5 .18 |
| Wait Info | suit-parameter-wait-info | Section 8.7.5 .19 |
| URI List | suit-parameter-uri-list | Section 8.7.5 .20 |
| Fetch Arguments | suit-parameter-fetch-arguments | Section 8.7.5 .21 |
| Strict Order | suit-parameter-strict-order | Section 8.7.5 .22 |
| Soft Failure | suit-parameter-soft-failure | Section 8.7.5 .23 |
| Custom | suit-parameter-custom | Section 8.7.5 .24 |

CBOR-encoded object parameters are still wrapped in a bstr. This is because it allows a parser that is aggregating parameters to reference the object with a single pointer and traverse it without understanding the contents. This is important for modularization and division of responsibility within a pull parser. The same consideration does not apply to Directives because those elements are invoked with their arguments immediately

8.7.5.1. CBOR PEN UUID Namespace Identifier

The CBOR PEN UUID Namespace Identifier is constructed as follows:

It uses the OID Namespace as a starting point, then uses the CBOR OID encoding for the IANA PEN OID (1.3.6.1.4.1):

```
D8 DE          # tag(111)
  45          # bytes(5)
    2B 06 01 04 01 # X.690 Clause 8.19
#   1.3 6 1 4 1 show component encoding
```

Computing a type 5 UUID from these produces:

```
NAMESPACE_CBOR_PEN = UUID5(NAMESPACE_OID, h'D86F452B06010401')
NAMESPACE_CBOR_PEN = 08cfcc43-47d9-5696-85b1-9c738465760e
```

8.7.5.2. Constructing UUIDs

Several conditions use identifiers to determine whether a manifest matches a given Recipient or not. These identifiers are defined to be [RFC 4122](#) [[RFC4122](#)] UUIDs. These UUIDs are not human-readable and are therefore used for machine-based processing only.

A Recipient MAY match any number of UUIDs for vendor or class identifier. This may be relevant to physical or software modules. For example, a Recipient that has an OS and one or more applications might list one Vendor ID for the OS and one or more additional Vendor IDs for the applications. This Recipient might also have a Class ID that must be matched for the OS and one or more Class IDs for the applications.

Identifiers are used for compatibility checks. They MUST NOT be used as assertions of identity. They are evaluated by identifier conditions ([Section 8.7.6.1](#)).

A more complete example: Imagine a device has the following physical components: 1. A host MCU 2. A WiFi module

This same device has three software modules: 1. An operating system 2. A WiFi module interface driver 3. An application

Suppose that the WiFi module's firmware has a proprietary update mechanism and doesn't support manifest processing. This device can report four class IDs:

1. Hardware model/revision

2. OS
3. WiFi module model/revision
4. Application

This allows the OS, WiFi module, and application to be updated independently. To combat possible incompatibilities, the OS class ID can be changed each time the OS has a change to its API.

This approach allows a vendor to target, for example, all devices with a particular WiFi module with an update, which is a very powerful mechanism, particularly when used for security updates.

UUIDs MUST be created according to [RFC 4122](#) [RFC4122]. UUIDs SHOULD use versions 3, 4, or 5, as described in [RFC4122](#). Versions 1 and 2 do not provide a tangible benefit over version 4 for this application.

The RECOMMENDED method to create a vendor ID is:

```
Vendor ID = UUID5(DNS_PREFIX, vendor domain name)
```

If the Vendor ID is a UUID, the RECOMMENDED method to create a Class ID is:

```
Class ID = UUID5(Vendor ID, Class-Specific-Information)
```

If the Vendor ID is a CBOR PEN (see [Section 8.7.5.3](#)), the RECOMMENDED method to create a Class ID is:

```
Class ID = UUID5(  
    UUID5(NAMESPACE_CBOR_PEN, CBOR_PEN),  
    Class-Specific-Information)
```

Class-specific-information is composed of a variety of data, for example:

- Model number.
- Hardware revision.
- Bootloader version (for immutable bootloaders).

8.7.5.3. suit-parameter-vendor-identifier

suit-parameter-vendor-identifier may be presented in one of two ways:

- A Private Enterprise Number
- A byte string containing a UUID ([[RFC4122](#)])

Private Enterprise Numbers are encoded as a relative OID, according to the definition in [[I-D.ietf-cbor-tags-oid](#)]. All PENs are relative to the IANA PEN: 1.3.6.1.4.1.

8.7.5.4. suit-parameter-class-identifier

A [RFC 4122](#) UUID representing the class of the device or component. The UUID is encoded as a 16 byte bstr, containing the raw bytes of the UUID. It MUST be constructed as described in [Section 8.7.5.2](#)

8.7.5.5. suit-parameter-device-identifier

A [RFC 4122](#) UUID representing the specific device or component. The UUID is encoded as a 16 byte bstr, containing the raw bytes of the UUID. It MUST be constructed as described in [Section 8.7.5.2](#)

8.7.5.6. suit-parameter-image-digest

A fingerprint computed over the component itself, encoded in the SUIT_Digest [Section 10](#) structure. The SUIT_Digest is wrapped in a bstr, as required in [Section 8.7.5](#).

8.7.5.7. suit-parameter-image-size

The size of the firmware image in bytes. This size is encoded as a positive integer.

8.7.5.8. suit-parameter-use-before

An expiry date for the use of the manifest encoded as the positive integer number of seconds since 1970-01-01. Implementations that use this parameter MUST use a 64-bit internal representation of the integer.

8.7.5.9. suit-parameter-component-offset

This parameter sets the offset in a component. Some components support multiple possible Slots (offsets into a storage area). This parameter describes the intended Slot to use, identified by its

offset into the component's storage area. This offset MUST be encoded as a positive integer.

8.7.5.10. suit-parameter-encryption-info

Encryption Info defines the mechanism that Fetch or Copy should use to decrypt the data they transfer. `SUIT_Parameter_Encryption_Info` is encoded as a `COSE_Encrypt_Tagged` or a `COSE_Encrypt0_Tagged`, wrapped in a `bstr`.

8.7.5.11. suit-parameter-compression-info

`SUIT_Compression_Info` defines any information that is required for a Recipient to perform decompression operations. `SUIT_Compression_Info` is a map containing this data. The only element defined for the map in this specification is the `suit-compression-algorithm`. This document defines the following `suit-compression-algorithm`'s: ZLIB [[RFC1950](#)], Brotli [[RFC7932](#)], and ZSTD [[I-D.kucherawy-rfc8478bis](#)].

Additional `suit-compression-algorithm`'s can be registered through the IANA-maintained registry. If such a format requires more data than an algorithm identifier, one or more new elements MUST be introduced by specifying an element for `SUIT_Compression_Info-extensions`.

8.7.5.12. suit-parameter-unpack-info

`SUIT_Unpack_Info` defines the information required for a Recipient to interpret a packed format. This document defines the use of the following binary encodings: Intel HEX [[HEX](#)], Motorola S-record [[SREC](#)], Executable and Linkable Format (ELF) [[ELF](#)], and Common Object File Format (COFF) [[COFF](#)].

Additional packing formats can be registered through the IANA-maintained registry.

8.7.5.13. suit-parameter-uri

A URI from which to fetch a resource, encoded as a text string. CBOR Tag 32 is not used because the meaning of the text string is unambiguous in this context.

8.7.5.14. suit-parameter-source-component

This parameter sets the source component to be used with either `suit-directive-copy` ([Section 8.7.7.9](#)) or with `suit-directive-swap` ([Section 8.7.7.13](#)). The current Component, as set by `suit-directive-set-component-index` defines the destination, and `suit-parameter-source-component` defines the source.

8.7.5.15. suit-parameter-run-args

This parameter contains an encoded set of arguments for `suit-directive-run` ([Section 8.7.7.10](#)). The arguments MUST be provided as an implementation-defined bstr.

8.7.5.16. suit-parameter-minimum-battery

This parameter sets the minimum battery level in mWh. This parameter is encoded as a positive integer. Used with `suit-condition-minimum-battery` ([Section 8.7.6.6](#)).

8.7.5.17. suit-parameter-update-priority

This parameter sets the priority of the update. This parameter is encoded as an integer. It is used along with `suit-condition-update-authorized` ([Section 8.7.6.7](#)) to ask an application for permission to initiate an update. This does not constitute a privilege inversion because an explicit request for authorization has been provided by the Update Authority in the form of the `suit-condition-update-authorized` command.

Applications MAY define their own meanings for the update priority. For example, critical reliability & vulnerability fixes MAY be given negative numbers, while bug fixes MAY be given small positive numbers, and feature additions MAY be given larger positive numbers, which allows an application to make an informed decision about whether and when to allow an update to proceed.

8.7.5.18. suit-parameter-version

Indicates allowable versions for the specified component. Allowable versions can be specified, either with a list or with range matching. This parameter is compared with version asserted by the current component when `suit-condition-version` ([Section 8.7.6.8](#)) is invoked. The current component may assert the current version in many ways, including storage in a parameter storage database, in a metadata object, or in a known location within the component itself.

The component version can be compared as:

- Greater.
- Greater or Equal.
- Equal.
- Lesser or Equal.

- Lesser.

Versions are encoded as a CBOR list of integers. Comparisons are done on each integer in sequence. Comparison stops after all integers in the list defined by the manifest have been consumed OR after a non-equal match has occurred. For example, if the manifest defines a comparison, "Equal [1]", then this will match all version sequences starting with 1. If a manifest defines both "Greater or Equal [1,0]" and "Lesser [1,10]", then it will match versions 1.0.x up to, but not including 1.10.

While the exact encoding of versions is application-defined, semantic versions map conveniently. For example,

- 1.2.3 = [1,2,3].
- 1.2-rc3 = [1,2,-1,3].
- 1.2-beta = [1,2,-2].
- 1.2-alpha = [1,2,-3].
- 1.2-alpha4 = [1,2,-3,4].

suit-condition-version is OPTIONAL to implement.

Versions SHOULD be provided as follows:

1. The first integer represents the major number. This indicates breaking changes to the component.
2. The second integer represents the minor number. This is typically reserved for new features or large, non-breaking changes.
3. The third integer is the patch version. This is typically reserved for bug fixes.
4. The fourth integer is the build number.

Where Alpha (-3), Beta (-2), and Release Candidate (-1) are used, they are inserted as a negative number between Minor and Patch numbers. This allows these releases to compare correctly with final releases. For example, Version 2.0, RC1 should be lower than Version 2.0.0 and higher than any Version 1.x. By encoding RC as -1, this works correctly: [2,0,-1,1] compares as lower than [2,0,0]. Similarly, beta (-2) is lower than RC and alpha (-3) is lower than RC.

8.7.5.19. suit-parameter-wait-info

suit-directive-wait ([Section 8.7.7.11](#)) directs the manifest processor to pause until a specified event occurs. The suit-parameter-wait-info encodes the parameters needed for the directive.

The exact implementation of the pause is implementation-defined. For example, this could be done by blocking on a semaphore, registering an event handler and suspending the manifest processor, polling for a notification, or aborting the update entirely, then restarting when a notification is received.

suit-parameter-wait-info is encoded as a map of wait events. When ALL wait events are satisfied, the Manifest Processor continues. The wait events currently defined are described in the following table.

| Name | Encoding | Description |
|--------------------------------------|-----------|--|
| suit-wait-event-authorization | int | Same as suit-parameter-update-priority |
| suit-wait-event-power | int | Wait until power state |
| suit-wait-event-network | int | Wait until network state |
| suit-wait-event-other-device-version | See below | Wait for other device to match version |
| suit-wait-event-time | uint | Wait until time (seconds since 1970-01-01) |
| suit-wait-event-time-of-day | uint | Wait until seconds since 00:00:00 |
| suit-wait-event-time-of-day-utc | uint | Wait until seconds since 00:00:00 UTC |
| suit-wait-event-day-of-week | uint | Wait until days since Sunday |
| suit-wait-event-day-of-week-utc | uint | Wait until days since Sunday UTC |

suit-wait-event-other-device-version reuses the encoding of suit-parameter-version-match. It is encoded as a sequence that contains

an implementation-defined bstr identifier for the other device, and a list of one or more SUIIT_Parameter_Version_Match.

8.7.5.20. suit-parameter-uri-list

Indicates a list of URIs from which to fetch a resource. The URI list is encoded as a list of text string, in priority order. CBOR Tag 32 is not used because the meaning of the text string is unambiguous in this context. The Recipient should attempt to fetch the resource from each URI in turn, ruling out each, in order, if the resource is inaccessible or it is otherwise undesirable to fetch from that URI. `suit-parameter-uri-list` is consumed by `suit-directive-fetch-uri-list` ([Section 8.7.7.8](#)).

8.7.5.21. suit-parameter-fetch-arguments

An implementation-defined set of arguments to `suit-directive-fetch` ([Section 8.7.7.7](#)). Arguments are encoded in a bstr.

8.7.5.22. suit-parameter-strict-order

The Strict Order Parameter allows a manifest to govern when directives can be executed out-of-order. This allows for systems that have a sensitivity to order of updates to choose the order in which they are executed. It also allows for more advanced systems to parallelize their handling of updates. Strict Order defaults to True. It MAY be set to False when the order of operations does not matter. When arriving at the end of a command sequence, ALL commands MUST have completed, regardless of the state of SUIIT_Parameter_Strict_Order. SUIIT_Process_Dependency must preserve and restore the state of SUIIT_Parameter_Strict_Order. If SUIIT_Parameter_Strict_Order is returned to True, ALL preceding commands MUST complete before the next command is executed.

See [Section 6.7](#) for behavioral description of Strict Order.

8.7.5.23. suit-parameter-soft-failure

When executing a command sequence inside `suit-directive-try-each` ([Section 8.7.7.3](#)) or `suit-directive-run-sequence` ([Section 8.7.7.12](#)) and a condition failure occurs, the manifest processor aborts the sequence. For `suit-directive-try-each`, if Soft Failure is True, the next sequence in Try Each is invoked, otherwise `suit-directive-try-each` fails with the condition failure code. In `suit-directive-run-sequence`, if Soft Failure is True the `suit-directive-run-sequence` simply halts with no side-effects and the Manifest Processor continues with the following command, otherwise, the `suit-directive-run-sequence` fails with the condition failure code.

suit-parameter-soft-failure is scoped to the enclosing SUIIT_Command_Sequence. Its value is discarded when SUIIT_Command_Sequence terminates. It MUST NOT be set outside of suit-directive-try-each or suit-directive-run-sequence.

When suit-directive-try-each is invoked, Soft Failure defaults to True. An Update Author may choose to set Soft Failure to False if they require a failed condition in a sequence to force an Abort.

When suit-directive-run-sequence is invoked, Soft Failure defaults to False. An Update Author may choose to make failures soft within a suit-directive-run-sequence.

8.7.5.24. suit-parameter-custom

This parameter is an extension point for any proprietary, application specific conditions and directives. It MUST NOT be used in the common sequence. This effectively scopes each custom command to a particular Vendor Identifier/Class Identifier pair.

8.7.6. SUIIT_Condition

Conditions are used to define mandatory properties of a system in order for an update to be applied. They can be pre-conditions or post-conditions of any directive or series of directives, depending on where they are placed in the list. All Conditions specify a Reporting Policy as described [Section 8.7.4](#). Conditions include:

| Name | CDDL Structure | Reference |
|-------------------|----------------------------------|--------------------------------------|
| Vendor Identifier | suit-condition-vendor-identifier | Section 8.7.6 .1 |
| Class Identifier | suit-condition-class-identifier | Section 8.7.6 .1 |
| Device Identifier | suit-condition-device-identifier | Section 8.7.6 .1 |
| Image Match | suit-condition-image-match | Section 8.7.6 .2 |
| Image Not Match | suit-condition-image-not-match | Section 8.7.6 .3 |
| Use Before | suit-condition-use-before | Section 8.7.6 .4 |
| Component Offset | suit-condition-component-offset | Section 8.7.6 .5 |
| Minimum Battery | suit-condition-minimum-battery | Section 8.7.6 .6 |
| Update Authorized | suit-condition-update-authorized | Section 8.7.6 .7 |
| Version | suit-condition-version | Section 8.7.6 .8 |
| Abort | suit-condition-abort | Section 8.7.6 .9 |
| Custom Condition | suit-condition-custom | Section 8.7.6 .10 |

The abstract description of these conditions is defined in [Section 6.4](#).

Conditions compare parameters against properties of the system. These properties may be asserted in many different ways, including: calculation on-demand, volatile definition in memory, static definition within the manifest processor, storage in known location within an image, storage within a key storage system, storage in One-

Time-Programmable memory, inclusion in mask ROM, or inclusion as a register in hardware. Some of these assertion methods are global in scope, such as a hardware register, some are scoped to an individual component, such as storage at a known location in an image, and some assertion methods can be either global or component-scope, based on implementation.

Each condition MUST report a result code on completion. If a condition reports failure, then the current sequence of commands MUST terminate. A subsequent command or command sequence MAY continue executing if `suit-parameter-soft-failure` ([Section 8.7.5.23](#)) is set. If a condition requires additional information, this MUST be specified in one or more parameters before the condition is executed. If a Recipient attempts to process a condition that expects additional information and that information has not been set, it MUST report a failure. If a Recipient encounters an unknown condition, it MUST report a failure.

Condition labels in the positive number range are reserved for IANA registration while those in the negative range are custom conditions reserved for proprietary definition by the author of a manifest processor. See [Section 11](#) for more details.

8.7.6.1. `suit-condition-vendor-identifier`, `suit-condition-class-identifier`, and `suit-condition-device-identifier`

There are three identifier-based conditions: `suit-condition-vendor-identifier`, `suit-condition-class-identifier`, and `suit-condition-device-identifier`. Each of these conditions match a [RFC 4122](#) [RFC4122] UUID that MUST have already been set as a parameter. The installing Recipient MUST match the specified UUID in order to consider the manifest valid. These identifiers are scoped by component in the manifest. Each component MAY match more than one identifier. Care is needed to ensure that manifests correctly identify their targets using these conditions. Using only a generic class ID for a device-specific firmware could result in matching devices that are not compatible.

The Recipient uses the ID parameter that has already been set using the Set Parameters directive. If no ID has been set, this condition fails. `suit-condition-class-identifier` and `suit-condition-vendor-identifier` are REQUIRED to implement. `suit-condition-device-identifier` is OPTIONAL to implement.

Each identifier condition compares the corresponding identifier parameter to a parameter asserted to the Manifest Processor by the Recipient. Identifiers MUST be known to the Manifest Processor in order to evaluate compatibility.

8.7.6.2. suit-condition-image-match

Verify that the current component matches the suit-parameter-image-digest ([Section 8.7.5.6](#)) for the current component. The digest is verified against the digest specified in the Component's parameters list. If no digest is specified, the condition fails. suit-condition-image-match is REQUIRED to implement.

8.7.6.3. suit-condition-image-not-match

Verify that the current component does not match the suit-parameter-image-digest ([Section 8.7.5.6](#)). If no digest is specified, the condition fails. suit-condition-image-not-match is OPTIONAL to implement.

8.7.6.4. suit-condition-use-before

Verify that the current time is BEFORE the specified time. suit-condition-use-before is used to specify the last time at which an update should be installed. The recipient evaluates the current time against the suit-parameter-use-before parameter ([Section 8.7.5.8](#)), which must have already been set as a parameter, encoded as seconds after 1970-01-01 00:00:00 UTC. Timestamp conditions MUST be evaluated in 64 bits, regardless of encoded CBOR size. suit-condition-use-before is OPTIONAL to implement.

8.7.6.5. suit-condition-component-offset

Verify that the offset of the current component matches the offset set in suit-parameter-component-offset ([Section 8.7.5.9](#)). This condition allows a manifest to select between several images to match a target offset.

8.7.6.6. suit-condition-minimum-battery

suit-condition-minimum-battery provides a mechanism to test a Recipient's battery level before installing an update. This condition is primarily for use in primary-cell applications, where the battery is only ever discharged. For batteries that are charged, suit-directive-wait is more appropriate, since it defines a "wait" until the battery level is sufficient to install the update. suit-condition-minimum-battery is specified in mWh. suit-condition-minimum-battery is OPTIONAL to implement. suit-condition-minimum-battery consumes suit-parameter-minimum-battery ([Section 8.7.5.16](#)).

8.7.6.7. suit-condition-update-authorized

Request Authorization from the application and fail if not authorized. This can allow a user to decline an update. `suit-parameter-update-priority` ([Section 8.7.5.17](#)) provides an integer priority level that the application can use to determine whether or not to authorize the update. Priorities are application defined. `suit-condition-update-authorized` is OPTIONAL to implement.

8.7.6.8. suit-condition-version

`suit-condition-version` allows comparing versions of firmware. Verifying image digests is preferred to version checks because digests are more precise. `suit-condition-version` examines a component's version against the version info specified in `suit-parameter-version` ([Section 8.7.5.18](#))

8.7.6.9. suit-condition-abort

Unconditionally fail. This operation is typically used in conjunction with `suit-directive-try-each` ([Section 8.7.7.3](#)).

8.7.6.10. suit-condition-custom

`suit-condition-custom` describes any proprietary, application specific condition. This is encoded as a negative integer, chosen by the firmware developer. If additional information must be provided to the condition, it should be encoded in a custom parameter (a nint) as described in [Section 8.7.5](#). `SUIT_Condition_Custom` is OPTIONAL to implement.

8.7.7. SUIT_Directive

Directives are used to define the behavior of the recipient. Directives include:

| Name | CDDL Structure | Reference |
|----------------------|-------------------------------------|--------------------------------------|
| Set Component Index | suit-directive-set-component-index | Section 8.7 .7.1 |
| Set Dependency Index | suit-directive-set-dependency-index | Section 8.7 .7.2 |
| Try Each | suit-directive-try-each | Section 8.7 .7.3 |
| Process Dependency | suit-directive-process-dependency | Section 8.7 .7.4 |
| Set Parameters | suit-directive-set-parameters | Section 8.7 .7.5 |
| Override Parameters | suit-directive-override-parameters | Section 8.7 .7.6 |
| Fetch | suit-directive-fetch | Section 8.7 .7.7 |
| Fetch URI list | suit-directive-fetch-uri-list | Section 8.7 .7.8 |
| Copy | suit-directive-copy | Section 8.7 .7.9 |
| Run | suit-directive-run | Section 8.7 .7.10 |
| Wait For Event | suit-directive-wait | Section 8.7 .7.11 |
| Run Sequence | suit-directive-run-sequence | Section 8.7 .7.12 |
| Swap | suit-directive-swap | Section 8.7 .7.13 |

The abstract description of these commands is defined in [Section 6.4](#).

When a Recipient executes a Directive, it MUST report a result code. If the Directive reports failure, then the current Command Sequence MUST be terminated.

8.7.7.1. suit-directive-set-component-index

Set Component Index defines the component to which successive directives and conditions will apply. The supplied argument MUST be one of three types:

1. An unsigned integer (REQUIRED to implement in parser)
2. A boolean (REQUIRED to implement in parser ONLY IF 2 or more components supported)
3. An array of unsigned integers (REQUIRED to implement in parser ONLY IF 3 or more components supported)

If the following commands apply to ONE component, an unsigned integer index into the component list is used. If the following commands apply to ALL components, then the boolean value "True" is used instead of an index. If the following commands apply to more than one, but not all components, then an array of unsigned integer indices into the component list is used. TODO: Component list

If the following commands apply to NO components, then the boolean value "False" is used. When `suit-directive-set-dependency-index` is used, `suit-directive-set-component-index = False` is implied. When `suit-directive-set-component-index` is used, `suit-directive-set-dependency-index = False` is implied.

If component index is set to True when a command is invoked, then the command applies to all components, in the order they appear in `suit-common-components`. When the Manifest Processor invokes a command while the component index is set to True, it must execute the command once for each possible component index, ensuring that the command receives the parameters corresponding to that component index.

8.7.7.2. suit-directive-set-dependency-index

Set Dependency Index defines the manifest to which successive directives and conditions will apply. The supplied argument MUST be either a boolean or an unsigned integer index into the dependencies. If the following directives apply to ALL dependencies, then the boolean value "True" is used instead of an index. If the following directives apply to NO dependencies, then the boolean value "False" is used. When `suit-directive-set-component-index` is used, `suit-directive-set-dependency-index = False` is implied. When `suit-`

directive-set-dependency-index is used, suit-directive-set-component-index = False is implied. TODO: Component list|Dependency List

If dependency index is set to True when a command is invoked, then the command applies to all dependencies, in the order they appear in suit-common-components. When the Manifest Processor invokes a command while the dependency index is set to True, it must execute the command once for each possible dependency index, ensuring that the command receives the parameters corresponding to that dependency index.

Typical operations that require suit-directive-set-dependency-index include setting a source URI or Encryption Information, invoking "Fetch," or invoking "Process Dependency" for an individual dependency.

8.7.7.3. suit-directive-try-each

This command runs several SUIIT_Command_Sequence instances, one after another, in a strict order. Use this command to implement a "try/catch-try/catch" sequence. Manifest processors MAY implement this command.

suit-parameter-soft-failure ([Section 8.7.5.23](#)) is initialized to True at the beginning of each sequence. If one sequence aborts due to a condition failure, the next is started. If no sequence completes without condition failure, then suit-directive-try-each returns an error. If a particular application calls for all sequences to fail and still continue, then an empty sequence (nil) can be added to the Try Each Argument.

The argument to suit-directive-try-each is a list of SUIIT_Command_Sequence. suit-directive-try-each does not specify a reporting policy.

8.7.7.4. suit-directive-process-dependency

Execute the commands in the common section of the current dependency, followed by the commands in the equivalent section of the current dependency. For example, if the current section is "fetch payload," this will execute "common" in the current dependency, then "fetch payload" in the current dependency. Once this is complete, the command following suit-directive-process-dependency will be processed.

If the current dependency is False, this directive has no effect. If the current dependency is True, then this directive applies to all

dependencies. If the current section is "common," then the command sequence MUST be terminated with an error.

When SUIF_Process_Dependency completes, it forwards the last status code that occurred in the dependency.

8.7.7.5. suit-directive-set-parameters

suit-directive-set-parameters allows the manifest to configure behavior of future directives by changing parameters that are read by those directives. When dependencies are used, suit-directive-set-parameters also allows a manifest to modify the behavior of its dependencies.

Available parameters are defined in [Section 8.7.5](#).

If a parameter is already set, suit-directive-set-parameters will skip setting the parameter to its argument. This provides the core of the override mechanism, allowing dependent manifests to change the behavior of a manifest.

suit-directive-set-parameters does not specify a reporting policy.

8.7.7.6. suit-directive-override-parameters

suit-directive-override-parameters replaces any listed parameters that are already set with the values that are provided in its argument. This allows a manifest to prevent replacement of critical parameters.

Available parameters are defined in [Section 8.7.5](#).

suit-directive-override-parameters does not specify a reporting policy.

8.7.7.7. suit-directive-fetch

suit-directive-fetch instructs the manifest processor to obtain one or more manifests or payloads, as specified by the manifest index and component index, respectively.

suit-directive-fetch can target one or more manifests and one or more payloads. suit-directive-fetch retrieves each component and each manifest listed in component-index and dependency-index, respectively. If component-index or dependency-index is True, instead of an integer, then all current manifest components/manifests are fetched. The current manifest's dependent-components are not

automatically fetched. In order to pre-fetch these, they MUST be specified in a component-index integer.

suit-directive-fetch typically takes no arguments unless one is needed to modify fetch behavior. If an argument is needed, it must be wrapped in a bstr and set in suit-parameter-fetch-arguments.

suit-directive-fetch reads the URI parameter to find the source of the fetch it performs.

The behavior of suit-directive-fetch can be modified by setting one or more of SUIF_Parameter_Encryption_Info, SUIF_Parameter_Compression_Info, SUIF_Parameter_Unpack_Info. These three parameters each activate and configure a processing step that can be applied to the data that is transferred during suit-directive-fetch.

8.7.7.8. suit-directive-fetch-uri-list

suit-directive-fetch-uri-list uses the same semantics as suit-directive-fetch ([Section 8.7.7.7](#)), except that it iterates over the URI List ([Section 8.7.5.20](#)) to select a URI to fetch from.

8.7.7.9. suit-directive-copy

suit-directive-copy instructs the manifest processor to obtain one or more payloads, as specified by the component index. As described in [Section 6.5](#) component index may be a single integer, a list of integers, or True. suit-directive-copy retrieves each component specified by the current component-index, respectively. The current manifest's dependent-components are not automatically copied. In order to copy these, they MUST be specified in a component-index integer.

The behavior of suit-directive-copy can be modified by setting one or more of SUIF_Parameter_Encryption_Info, SUIF_Parameter_Compression_Info, SUIF_Parameter_Unpack_Info. These three parameters each activate and configure a processing step that can be applied to the data that is transferred during suit-directive-copy.

suit-directive-copy reads its source from suit-parameter-source-component ([Section 8.7.5.14](#)).

If either the source component parameter or the source component itself is absent, this command fails.

8.7.7.10. suit-directive-run

suit-directive-run directs the manifest processor to transfer execution to the current Component Index. When this is invoked, the manifest processor MAY be unloaded and execution continues in the Component Index. Arguments are provided to suit-directive-run through suit-parameter-run-arguments ([Section 8.7.5.15](#)) and are forwarded to the executable code located in Component Index in an application-specific way. For example, this could form the Linux Kernel Command Line if booting a Linux device.

If the executable code at Component Index is constructed in such a way that it does not unload the manifest processor, then the manifest processor may resume execution after the executable completes. This allows the manifest processor to invoke suitable helpers and to verify them with image conditions.

8.7.7.11. suit-directive-wait

suit-directive-wait directs the manifest processor to pause until a specified event occurs. Some possible events include:

1. Authorization
2. External Power
3. Network availability
4. Other Device Firmware Version
5. Time
6. Time of Day
7. Day of Week

8.7.7.12. suit-directive-run-sequence

To enable conditional commands, and to allow several strictly ordered sequences to be executed out-of-order, suit-directive-run-sequence allows the manifest processor to execute its argument as a SUIT_Command_Sequence. The argument must be wrapped in a bstr.

When a sequence is executed, any failure of a condition causes immediate termination of the sequence.

When suit-directive-run-sequence completes, it forwards the last status code that occurred in the sequence. If the Soft Failure

parameter is true, then `suit-directive-run-sequence` only fails when a directive in the argument sequence fails.

`suit-parameter-soft-failure` ([Section 8.7.5.23](#)) defaults to False when `suit-directive-run-sequence` begins. Its value is discarded when `suit-directive-run-sequence` terminates.

8.7.7.13. `suit-directive-swap`

`suit-directive-swap` instructs the manifest processor to move the source to the destination and the destination to the source simultaneously. Swap has nearly identical semantics to `suit-directive-copy` except that `suit-directive-swap` replaces the source with the current contents of the destination in an application-defined way. As with `suit-directive-copy`, if the source component is missing, this command fails.

If `SUIT_Parameter_Compression_Info` or `SUIT_Parameter_Encryption_Info` are present, they MUST be handled in a symmetric way, so that the source is decompressed into the destination and the destination is compressed into the source. The source is decrypted into the destination and the destination is encrypted into the source. `suit-directive-swap` is OPTIONAL to implement.

8.7.8. Integrity Check Values

When the CoSWID, Text section, or any Command Sequence of the Update Procedure is made severable, it is moved to the Envelope and replaced with a `SUIT_Digest`. The `SUIT_Digest` is computed over the entire bstr enclosing the Manifest element that has been moved to the Envelope. Each element that is made severable from the Manifest is placed in the Envelope. The keys for the envelope elements have the same values as the keys for the manifest elements.

Each Integrity Check Value covers the corresponding Envelope Element as described in [Section 8.8](#).

8.8. Severable Elements

Because the manifest can be used by different actors at different times, some parts of the manifest can be removed or "Severed" without affecting later stages of the lifecycle. Severing of information is achieved by separating that information from the signed container so that removing it does not affect the signature. This means that ensuring integrity of severable parts of the manifest is a requirement for the signed portion of the manifest. Severing some parts makes it possible to discard parts of the manifest that are no longer necessary. This is important because it allows the storage

used by the manifest to be greatly reduced. For example, no text size limits are needed if text is removed from the manifest prior to delivery to a constrained device.

Elements are made severable by removing them from the manifest, encoding them in a bstr, and placing a SUIE_Digest of the bstr in the manifest so that they can still be authenticated. The SUIE_Digest typically consumes 4 bytes more than the size of the raw digest, therefore elements smaller than $(\text{Digest Bits})/8 + 4$ SHOULD NOT be severable. Elements larger than $(\text{Digest Bits})/8 + 4$ MAY be severable, while elements that are much larger than $(\text{Digest Bits})/8 + 4$ SHOULD be severable.

Because of this, all command sequences in the manifest are encoded in a bstr so that there is a single code path needed for all command sequences.

9. Access Control Lists

To manage permissions in the manifest, there are three models that can be used.

First, the simplest model requires that all manifests are authenticated by a single trusted key. This mode has the advantage that only a root manifest needs to be authenticated, since all of its dependencies have digests included in the root manifest.

This simplest model can be extended by adding key delegation without much increase in complexity.

A second model requires an ACL to be presented to the Recipient, authenticated by a trusted party or stored on the Recipient. This ACL grants access rights for specific component IDs or Component Identifier prefixes to the listed identities or identity groups. Any identity can verify an image digest, but fetching into or fetching from a Component Identifier requires approval from the ACL.

A third model allows a Recipient to provide even more fine-grained controls: The ACL lists the Component Identifier or Component Identifier prefix that an identity can use, and also lists the commands and parameters that the identity can use in combination with that Component Identifier.

10. SUIE Digest Container

[RFC 8152](#) [[RFC8152](#)] provides containers for signature, MAC, and encryption, but no basic digest container. The container needed for a digest requires a type identifier and a container for the raw

digest data. Some forms of digest may require additional parameters. These can be added following the digest.

The SUIT digest is a CBOR List containing two elements: a `suit-digest-algorithm-id` and a `bstr` containing the bytes of the digest.

11. IANA Considerations

IANA is requested to:

- allocate CBOR tag 48 in the CBOR Tags registry for the SUIT Envelope.
- allocate CBOR tag 480 in the CBOR Tags registry for the SUIT Manifest.
- allocate media type `application/suit-envelope` in the Media Types registry.
- setup several registries as described below.

IANA is requested to setup a registry for SUIT manifests. Several registries defined in the subsections below need to be created.

For each registry, values 0-23 are Standards Action, 24-255 are IETF Review, 256-65535 are Expert Review, and 65536 or greater are First Come First Served.

Negative values -23 to 0 are Experimental Use, -24 and lower are Private Use.

11.1. SUIT Commands

| Label | Name | Reference |
|-------|-------------------|---------------------------------|
| 1 | Vendor Identifier | Section 8.7.6.1 |
| 2 | Class Identifier | Section 8.7.6.1 |
| 3 | Image Match | Section 8.7.6.2 |
| 4 | Use Before | Section 8.7.6.4 |
| 5 | Component | Section 8.7.6.5 |

| | | | |
|----|----------------------|-----------------------------------|-----------------|
| | Offset | | |
| 12 | Set Component Index | Section 8.7.7.1 | |
| 13 | Set Dependency Index | Section 8.7.7.2 | |
| 14 | Abort | | |
| 15 | Try Each | Section 8.7.7.3 | |
| 16 | Reserved | | |
| 17 | Reserved | | |
| 18 | Process Dependency | suit-directive-process-dependency | Section 8.7.7.4 |
| 19 | Set Parameters | Section 8.7.7.5 | |
| 20 | Override Parameters | Section 8.7.7.6 | |
| 21 | Fetch | Section 8.7.7.7 | |
| 22 | Copy | Section 8.7.7.9 | |
| 23 | Run | Section 8.7.7.10 | |
| 24 | Device Identifier | Section 8.7.6.1 | |
| 25 | Image Not Match | Section 8.7.6.3 | |
| 26 | Minimum Battery | Section 8.7.6.6 | |
| 27 | Update Authorized | Section 8.7.6.7 | |
| 28 | Version | Section 8.7.6.8 | |
| 29 | Wait For | Section 8.7.7.11 | |

| | | |
|------|------------------|----------------------------------|
| | Event | |
| 30 | Fetch URI List | Section 8.7.7.8 |
| 31 | Swap | Section 8.7.7.13 |
| 32 | Run Sequence | Section 8.7.7.12 |
| nint | Custom Condition | Section 8.7.6.10 |

11.2. SUIIT Parameters

| Label | Name | Reference |
|-------|------------------|----------------------------------|
| 1 | Vendor ID | Section 8.7.5.3 |
| 2 | Class ID | Section 8.7.5.4 |
| 3 | Image Digest | Section 8.7.5.6 |
| 4 | Use Before | Section 8.7.5.8 |
| 5 | Component Offset | Section 8.7.5.9 |
| 12 | Strict Order | Section 8.7.5.22 |
| 13 | Soft Failure | Section 8.7.5.23 |
| 14 | Image Size | Section 8.7.5.7 |
| 18 | Encryption Info | Section 8.7.5.10 |
| 19 | Compression Info | Section 8.7.5.11 |
| 20 | Unpack Info | Section 8.7.5.12 |
| 21 | URI | Section 8.7.5.13 |
| 22 | Source Component | Section 8.7.5.14 |
| 23 | Run Args | Section 8.7.5.15 |
| 24 | Device ID | Section 8.7.5.5 |
| 26 | Minimum Battery | Section 8.7.5.16 |
| 27 | Update Priority | Section 8.7.5.17 |
| 28 | Version | {{suit-parameter-version}} |
| 29 | Wait Info | Section 8.7.5.19 |
| 30 | URI List | Section 8.7.5.20 |
| nint | Custom | Section 8.7.5.24 |

11.3. SUIE Text Values

| Label | Name | Reference |
|-------|----------------------|-------------------------------|
| 1 | Manifest Description | Section 8.6.4 |
| 2 | Update Description | Section 8.6.4 |
| 3 | Manifest JSON Source | Section 8.6.4 |
| 4 | Manifest YAML Source | Section 8.6.4 |
| nint | Custom | Section 8.6.4 |

11.4. SUIE Component Text Values

| Label | Name | Reference |
|-------|----------------------------|-------------------------------|
| 1 | Vendor Name | Section 8.6.4 |
| 2 | Model Name | Section 8.6.4 |
| 3 | Vendor Domain | Section 8.6.4 |
| 4 | Model Info | Section 8.6.4 |
| 5 | Component Description | Section 8.6.4 |
| 6 | Component Version | Section 8.6.4 |
| 7 | Component Version Required | Section 8.6.4 |
| nint | Custom | Section 8.6.4 |

11.5. SUIE Algorithm Identifiers**11.5.1. SUIE Digest Algorithm Identifiers**

| Label | Name | |
|-------|----------|----------------------------|
| 1 | SHA224 | Section 10 |
| 2 | SHA256 | Section 10 |
| 3 | SHA384 | Section 10 |
| 4 | SHA512 | Section 10 |
| 5 | SHA3-224 | Section 10 |
| 6 | SHA3-256 | Section 10 |
| 7 | SHA3-384 | Section 10 |
| 8 | SHA3-512 | Section 10 |

11.5.2. SUIT Compression Algorithm Identifiers

| Label | Name | Reference |
|-------|--------|----------------------------------|
| 1 | zlib | Section 8.7.5.11 |
| 2 | Brotli | Section 8.7.5.11 |
| 3 | zstd | Section 8.7.5.11 |

11.5.3. Unpack Algorithms

| Label | Name | Reference |
|-------|------|----------------------------------|
| 1 | HEX | Section 8.7.5.12 |
| 2 | ELF | Section 8.7.5.12 |
| 3 | COFF | Section 8.7.5.12 |
| 4 | SREC | Section 8.7.5.12 |

12. Security Considerations

This document is about a manifest format protecting and describing how to retrieve, install, and invoke firmware images and as such it is part of a larger solution for delivering firmware updates to IoT devices. A detailed security treatment can be found in the architecture [[I-D.ietf-suit-architecture](#)] and in the information model [[I-D.ietf-suit-information-model](#)] documents.

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- David Brown
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14. References

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Appendix A. A. Full CDDL

In order to create a valid SUIT Manifest document the structure of the corresponding CBOR message MUST adhere to the following CDDL data definition.

```

SUIT_Envelope_Tagged = #6.48(SUIT_Envelope)
SUIT_Envelope = {
  ? suit-delegation => bstr .cbor SUIT_Delegation,
  suit-authentication-wrapper => bstr .cbor SUIT_Authentication,
  suit-manifest => bstr .cbor SUIT_Manifest,
  SUIT_Severable_Manifest_Members,
  * SUIT_Integrated_Payload,
  * SUIT_Integrated_Dependency,
  * $$SUIT_Envelope_Extensions,
  * (int => bstr)
}

SUIT_Delegation = [ + [ + bstr .cbor CWT ] ]

CWT = SUIT_Authentication_Block

SUIT_Authentication = [
  bstr .cbor SUIT_Digest,
  * bstr .cbor SUIT_Authentication_Block
]

SUIT_Digest = [
  suit-digest-algorithm-id : suit-digest-algorithm-ids,
  suit-digest-bytes : bstr,
  * $$SUIT_Digest-extensions
]

; Named Information Hash Algorithm Identifiers
suit-digest-algorithm-ids /= algorithm-id-sha224
suit-digest-algorithm-ids /= algorithm-id-sha256
suit-digest-algorithm-ids /= algorithm-id-sha384
suit-digest-algorithm-ids /= algorithm-id-sha512
suit-digest-algorithm-ids /= algorithm-id-sha3-224
suit-digest-algorithm-ids /= algorithm-id-sha3-256
suit-digest-algorithm-ids /= algorithm-id-sha3-384
suit-digest-algorithm-ids /= algorithm-id-sha3-512

SUIT_Authentication_Block /= COSE_Mac_Tagged
SUIT_Authentication_Block /= COSE_Sign_Tagged
SUIT_Authentication_Block /= COSE_Mac0_Tagged
SUIT_Authentication_Block /= COSE_Sign1_Tagged

```

```
COSE_Mac_Tagged = any
COSE_Sign_Tagged = any
COSE_Mac0_Tagged = any
COSE_Sign1_Tagged = any
COSE_Encrypt_Tagged = any
COSE_Encrypt0_Tagged = any

SUIT_Severable_Manifest_Members = (
  ? suit-dependency-resolution => bstr .cbor SUIT_Command_Sequence,
  ? suit-payload-fetch => bstr .cbor SUIT_Command_Sequence,
  ? suit-install => bstr .cbor SUIT_Command_Sequence,
  ? suit-text => bstr .cbor SUIT_Text_Map,
  ? suit-coswid => bstr .cbor concise-software-identity,
  * $$SUIT_severable-members-extensions,
)

SUIT_Integrated_Payload = (suit-integrated-payload-key => bstr)
SUIT_Integrated_Dependency = (
  suit-integrated-payload-key => bstr .cbor SUIT_Envelope
)
suit-integrated-payload-key = nint / uint .ge 24

SUIT_Manifest_Tagged = #6.480(SUIT_Manifest)

SUIT_Manifest = {
  suit-manifest-version          => 1,
  suit-manifest-sequence-number => uint,
  suit-common                    => bstr .cbor SUIT_Common,
  ? suit-reference-uri           => tstr,
  SUIT_Severable_Manifest_Members,
  SUIT_Severable_Members_Digests,
  SUIT_Unseverable_Members,
  * $$SUIT_Manifest_Extensions,
}

SUIT_Unseverable_Members = (
  ? suit-validate => bstr .cbor SUIT_Command_Sequence,
  ? suit-load => bstr .cbor SUIT_Command_Sequence,
  ? suit-run => bstr .cbor SUIT_Command_Sequence,
  * $$unserverble-manifest-member-extensions,
)

SUIT_Severable_Members_Digests = (
  ? suit-dependency-resolution => SUIT_Digest,
  ? suit-payload-fetch => SUIT_Digest,
  ? suit-install => SUIT_Digest,
  ? suit-text => SUIT_Digest,
  ? suit-coswid => SUIT_Digest,
```

```

    * $$severable-manifest-members-digests-extensions
  )

SUIT_Common = {
  ? suit-dependencies          => SUIT_Dependencies,
  ? suit-components            => SUIT_Components,
  ? suit-common-sequence       => bstr .cbor SUIT_Common_Sequence,
  * $$SUIT_Common-extensions,
}

SUIT_Dependencies          = [ + SUIT_Dependency ]
SUIT_Components            = [ + SUIT_Component_Identifier ]

concise-software-identity = any

SUIT_Dependency = {
  suit-dependency-digest => SUIT_Digest,
  ? suit-dependency-prefix => SUIT_Component_Identifier,
  * $$SUIT_Dependency-extensions,
}

SUIT_Component_Identifier = [* bstr]

SUIT_Common_Sequence = [
  + ( SUIT_Condition // SUIT_Common_Commands )
]

SUIT_Common_Commands // = (suit-directive-set-component-index, IndexArg)
SUIT_Common_Commands // = (suit-directive-set-dependency-index, IndexArg)
SUIT_Common_Commands // = (suit-directive-run-sequence,
  bstr .cbor SUIT_Command_Sequence)
SUIT_Common_Commands // = (suit-directive-try-each,
  SUIT_Directive_Try_Each_Argument)
SUIT_Common_Commands // = (suit-directive-set-parameters,
  {+ SUIT_Parameters})
SUIT_Common_Commands // = (suit-directive-override-parameters,
  {+ SUIT_Parameters})

IndexArg /= uint
IndexArg /= bool
IndexArg /= [+uint]

SUIT_Command_Sequence = [ + (
  SUIT_Condition // SUIT_Directive // SUIT_Command_Custom
) ]

SUIT_Command_Custom = (suit-command-custom, bstr/tstr/int/nil)
SUIT_Condition // = (suit-condition-vendor-identifier, SUIT_Rep_Policy)

```



```
SUIT_Condition // = (suit-condition-class-identifier, SUIT_Rep_Policy)
SUIT_Condition // = (suit-condition-device-identifier, SUIT_Rep_Policy)
SUIT_Condition // = (suit-condition-image-match, SUIT_Rep_Policy)
SUIT_Condition // = (suit-condition-image-not-match, SUIT_Rep_Policy)
SUIT_Condition // = (suit-condition-use-before, SUIT_Rep_Policy)
SUIT_Condition // = (suit-condition-minimum-battery, SUIT_Rep_Policy)
SUIT_Condition // = (suit-condition-update-authorized, SUIT_Rep_Policy)
SUIT_Condition // = (suit-condition-version, SUIT_Rep_Policy)
SUIT_Condition // = (suit-condition-component-offset, SUIT_Rep_Policy)
SUIT_Condition // = (suit-condition-abort, SUIT_Rep_Policy)

SUIT_Directive // = (suit-directive-set-component-index, IndexArg)
SUIT_Directive // = (suit-directive-set-dependency-index, IndexArg)
SUIT_Directive // = (suit-directive-run-sequence,
    bstr .cbor SUIT_Command_Sequence)
SUIT_Directive // = (suit-directive-try-each,
    SUIT_Directive_Try_Each_Argument)
SUIT_Directive // = (suit-directive-process-dependency, SUIT_Rep_Policy)
SUIT_Directive // = (suit-directive-set-parameters,
    {+ SUIT_Parameters})
SUIT_Directive // = (suit-directive-override-parameters,
    {+ SUIT_Parameters})
SUIT_Directive // = (suit-directive-fetch, SUIT_Rep_Policy)
SUIT_Directive // = (suit-directive-copy, SUIT_Rep_Policy)
SUIT_Directive // = (suit-directive-swap, SUIT_Rep_Policy)
SUIT_Directive // = (suit-directive-run, SUIT_Rep_Policy)
SUIT_Directive // = (suit-directive-wait, SUIT_Rep_Policy)
SUIT_Directive // = (suit-directive-fetch-uri-list, SUIT_Rep_Policy)

SUIT_Directive_Try_Each_Argument = [
    + bstr .cbor SUIT_Command_Sequence,
    nil / bstr .cbor SUIT_Command_Sequence
]

SUIT_Rep_Policy = uint .bits suit-reporting-bits

suit-reporting-bits = &(amp;
    suit-send-record-success : 0,
    suit-send-record-failure : 1,
    suit-send-sysinfo-success : 2,
    suit-send-sysinfo-failure : 3
)

SUIT_Wait_Event = { + SUIT_Wait_Events }

SUIT_Wait_Events // = (suit-wait-event-authorization => int)
SUIT_Wait_Events // = (suit-wait-event-power => int)
SUIT_Wait_Events // = (suit-wait-event-network => int)
```

```
SUIT_Wait_Events //= (suit-wait-event-other-device-version
=> SUIT_Wait_Event_Argument_Other_Device_Version)
SUIT_Wait_Events //= (suit-wait-event-time => uint); Timestamp
SUIT_Wait_Events //= (suit-wait-event-time-of-day
=> uint); Time of Day (seconds since 00:00:00)
SUIT_Wait_Events //= (suit-wait-event-day-of-week
=> uint); Days since Sunday

SUIT_Wait_Event_Argument_Other_Device_Version = [
  other-device: bstr,
  other-device-version: [ + SUIT_Parameter_Version_Match ]
]

SUIT_Parameters //= (suit-parameter-vendor-identifier =>
  (RFC4122_UUID / cbor-pen))
cbor-pen = #6.112(bstr)

SUIT_Parameters //= (suit-parameter-class-identifier => RFC4122_UUID)
SUIT_Parameters //= (suit-parameter-image-digest
=> bstr .cbor SUIT_Digest)
SUIT_Parameters //= (suit-parameter-image-size => uint)
SUIT_Parameters //= (suit-parameter-use-before => uint)
SUIT_Parameters //= (suit-parameter-component-offset => uint)

SUIT_Parameters //= (suit-parameter-encryption-info
=> bstr .cbor SUIT_Encryption_Info)
SUIT_Parameters //= (suit-parameter-compression-info
=> bstr .cbor SUIT_Compression_Info)
SUIT_Parameters //= (suit-parameter-unpack-info
=> bstr .cbor SUIT_Unpack_Info)

SUIT_Parameters //= (suit-parameter-uri => tstr)
SUIT_Parameters //= (suit-parameter-source-component => uint)
SUIT_Parameters //= (suit-parameter-run-args => bstr)

SUIT_Parameters //= (suit-parameter-device-identifier => RFC4122_UUID)
SUIT_Parameters //= (suit-parameter-minimum-battery => uint)
SUIT_Parameters //= (suit-parameter-update-priority => uint)
SUIT_Parameters //= (suit-parameter-version =>
  SUIT_Parameter_Version_Match)
SUIT_Parameters //= (suit-parameter-wait-info =>
  bstr .cbor SUIT_Wait_Event)

SUIT_Parameters //= (suit-parameter-custom => int/bool/tstr/bstr)

SUIT_Parameters //= (suit-parameter-strict-order => bool)
SUIT_Parameters //= (suit-parameter-soft-failure => bool)
```

```
SUIT_Parameters //= (suit-parameter-uri-list =>
  bstr .cbor SUIT_URI_List)

RFC4122_UUID = bstr .size 16

SUIT_Parameter_Version_Match = [
  suit-condition-version-comparison-type:
    SUIT_Condition_Version_Comparison_Types,
  suit-condition-version-comparison-value:
    SUIT_Condition_Version_Comparison_Value
]
SUIT_Condition_Version_Comparison_Types /=
  suit-condition-version-comparison-greater
SUIT_Condition_Version_Comparison_Types /=
  suit-condition-version-comparison-greater-equal
SUIT_Condition_Version_Comparison_Types /=
  suit-condition-version-comparison-equal
SUIT_Condition_Version_Comparison_Types /=
  suit-condition-version-comparison-lesser-equal
SUIT_Condition_Version_Comparison_Types /=
  suit-condition-version-comparison-lesser

suit-condition-version-comparison-greater = 1
suit-condition-version-comparison-greater-equal = 2
suit-condition-version-comparison-equal = 3
suit-condition-version-comparison-lesser-equal = 4
suit-condition-version-comparison-lesser = 5

SUIT_Condition_Version_Comparison_Value = [+int]

SUIT_Encryption_Info = COSE_Encrypt_Tagged/COSE_Encrypt0_Tagged
SUIT_Compression_Info = {
  suit-compression-algorithm => SUIT_Compression_Algorithms,
  * $$$SUIT_Compression_Info-extensions,
}

SUIT_Compression_Algorithms /= SUIT_Compression_Algorithm_zlib
SUIT_Compression_Algorithms /= SUIT_Compression_Algorithm_brotli
SUIT_Compression_Algorithms /= SUIT_Compression_Algorithm_zstd

SUIT_Compression_Algorithm_zlib = 1
SUIT_Compression_Algorithm_brotli = 2
SUIT_Compression_Algorithm_zstd = 3

SUIT_Unpack_Info = {
  suit-unpack-algorithm => SUIT_Unpack_Algorithms,
  * $$$SUIT_Unpack_Info-extensions,
```

```
}

SUIT_Unpack_Algorithms /= SUIT_Unpack_Algorithm_Hex
SUIT_Unpack_Algorithms /= SUIT_Unpack_Algorithm_Elf
SUIT_Unpack_Algorithms /= SUIT_Unpack_Algorithm_Coff
SUIT_Unpack_Algorithms /= SUIT_Unpack_Algorithm_Srec

SUIT_Unpack_Algorithm_Hex = 1
SUIT_Unpack_Algorithm_Elf = 2
SUIT_Unpack_Algorithm_Coff = 3
SUIT_Unpack_Algorithm_Srec = 4

SUIT_URI_List = [+ tstr ]

SUIT_Text_Map = {
  * SUIT_Component_Identifier => {
    SUIT_Text_Component_Keys
  },
  SUIT_Text_Keys
}

SUIT_Text_Component_Keys = (
  ? suit-text-vendor-name          => tstr,
  ? suit-text-model-name           => tstr,
  ? suit-text-vendor-domain        => tstr,
  ? suit-text-model-info           => tstr,
  ? suit-text-component-description => tstr,
  ? suit-text-component-version     => tstr,
  ? suit-text-version-required     => tstr,
  * $$suit-text-component-key-extensions
)

SUIT_Text_Keys = (
  ? suit-text-manifest-description => tstr,
  ? suit-text-update-description  => tstr,
  ? suit-text-manifest-json-source => tstr,
  ? suit-text-manifest-yaml-source => tstr,
  * $$suit-text-key-extensions
)

suit-delegation = 1
suit-authentication-wrapper = 2
suit-manifest = 3

algorithm-id-sha224 = 1
algorithm-id-sha256 = 2
algorithm-id-sha384 = 3
algorithm-id-sha512 = 4
```

```
algorithm-id-sha3-224 = 5
algorithm-id-sha3-256 = 6
algorithm-id-sha3-384 = 7
algorithm-id-sha3-512 = 8

suit-manifest-version = 1
suit-manifest-sequence-number = 2
suit-common = 3
suit-reference-uri = 4
suit-dependency-resolution = 7
suit-payload-fetch = 8
suit-install = 9
suit-validate = 10
suit-load = 11
suit-run = 12
suit-text = 13
suit-coswid = 14

suit-dependencies = 1
suit-components = 2
suit-common-sequence = 4

suit-dependency-digest = 1
suit-dependency-prefix = 2

suit-command-custom = nint

suit-condition-vendor-identifier = 1
suit-condition-class-identifier = 2
suit-condition-image-match = 3
suit-condition-use-before = 4
suit-condition-component-offset = 5

suit-condition-abort = 14
suit-condition-device-identifier = 24
suit-condition-image-not-match = 25
suit-condition-minimum-battery = 26
suit-condition-update-authorized = 27
suit-condition-version = 28

suit-directive-set-component-index = 12
suit-directive-set-dependency-index = 13
suit-directive-try-each = 15
;suit-directive-do-each = 16 ; TBD
;suit-directive-map-filter = 17 ; TBD
suit-directive-process-dependency = 18
suit-directive-set-parameters = 19
suit-directive-override-parameters = 20
```

```
suit-directive-fetch           = 21
suit-directive-copy            = 22
suit-directive-run             = 23

suit-directive-wait            = 29
suit-directive-fetch-uri-list  = 30
suit-directive-swap            = 31
suit-directive-run-sequence    = 32

suit-wait-event-authorization = 1
suit-wait-event-power         = 2
suit-wait-event-network       = 3
suit-wait-event-other-device-version = 4
suit-wait-event-time          = 5
suit-wait-event-time-of-day   = 6
suit-wait-event-day-of-week   = 7

suit-parameter-vendor-identifier = 1
suit-parameter-class-identifier = 2
suit-parameter-image-digest     = 3
suit-parameter-use-before       = 4
suit-parameter-component-offset = 5

suit-parameter-strict-order     = 12
suit-parameter-soft-failure     = 13
suit-parameter-image-size       = 14

suit-parameter-encryption-info  = 18
suit-parameter-compression-info = 19
suit-parameter-unpack-info      = 20
suit-parameter-uri              = 21
suit-parameter-source-component = 22
suit-parameter-run-args         = 23

suit-parameter-device-identifier = 24
suit-parameter-minimum-battery  = 26
suit-parameter-update-priority  = 27
suit-parameter-version          = 28
suit-parameter-wait-info        = 29
suit-parameter-uri-list         = 30

suit-parameter-custom = nint

suit-compression-algorithm = 1

suit-unpack-algorithm = 1

suit-text-manifest-description = 1
```

```
suit-text-update-description    = 2
suit-text-manifest-json-source  = 3
suit-text-manifest-yaml-source  = 4

suit-text-vendor-name          = 1
suit-text-model-name           = 2
suit-text-vendor-domain        = 3
suit-text-model-info           = 4
suit-text-component-description = 5
suit-text-component-version     = 6
suit-text-version-required     = 7
```

[Appendix B](#). B. Examples

The following examples demonstrate a small subset of the functionality of the manifest. Even a simple manifest processor can execute most of these manifests.

The examples are signed using the following ECDSA secp256r1 key:

```
-----BEGIN PRIVATE KEY-----
MIGHAgEAMBMGBYqGSM49AgEGCCqGSM49AwEHBG0wawIBAQQgApZYjZCUGLM50VBC
CjYStX+09jGmnyJPrpDLTz/hIX0hRANCAASEloEarguqq9JhVxie7NomvqqL8Rtv
P+bitWwchdvArTsfKktsCYExwKNtrNHXi90B3N+wnAUtszmR23M4tKiW
-----END PRIVATE KEY-----
```

The corresponding public key can be used to verify these examples:

```
-----BEGIN PUBLIC KEY-----
MFkwEwYHKoZIzj0CAQYIKoZIzj0DAQcDQgAEhJaBGq4LqqvSYVcYnuzaJr6qi/Eb
bz/m4rVlnIXbwK07HypLbAmBMcCjbazR14vTgdzfsJwFLbM5kdtz0LSolg==
-----END PUBLIC KEY-----
```

Each example uses SHA256 as the digest function.

Note that reporting policies are declared for each non-flow-control command in these examples. The reporting policies used in the examples are described in the following tables.

| Policy | Label |
|-----------------------------|----------|
| suit-send-record-on-success | Rec-Pass |
| suit-send-record-on-failure | Rec-Fail |
| suit-send-sysinfo-success | Sys-Pass |
| suit-send-sysinfo-failure | Sys-Fail |

| Command | Sys-Fail | Sys-Pass | Rec-Fail | Rec-Pass |
|----------------------------------|----------|----------|----------|----------|
| suit-condition-vendor-identifier | 1 | 1 | 1 | 1 |
| suit-condition-class-identifier | 1 | 1 | 1 | 1 |
| suit-condition-image-match | 1 | 1 | 1 | 1 |
| suit-condition-component-offset | 0 | 1 | 0 | 1 |
| suit-directive-fetch | 0 | 0 | 1 | 0 |
| suit-directive-copy | 0 | 0 | 1 | 0 |
| suit-directive-run | 0 | 0 | 1 | 0 |

B.1. Example 0: Secure Boot

This example covers the following templates:

- Compatibility Check ([Section 7.1](#))
- Secure Boot ([Section 7.2](#))

It also serves as the minimum example.

```
{
  / authentication-wrapper / 2:bstr .cbor ({          digest: bstr
.cbor ([
    / algorithm-id / 2 / "sha256" /,
```



```

    / digest-bytes /
h'5c097ef64bf3bb9b494e71e1f2418eef8d466cc902f639a855ec9af3e9eddb99'
  ])
    signatures: [
      bstr .cbor (18([
        / protected / bstr .cbor ({
          / alg / 1:-7 / "ES256" /,
        }),
        / unprotected / {
        },
        / payload / bstr .cbor ([
          / algorithm-id / 2 / "sha256" /,
          / digest-bytes /
h'5c097ef64bf3bb9b494e71e1f2418eef8d466cc902f639a855ec9af3e9eddb99'
          ]),
          / signature / h'60f5c3d03a3aa759bfef2ef0f5f97a93b1
5e741f7463f4385af88513a5c2957bea2d6c4cfddd03392a267aab0fc0fd515560ed5
8e33fad26ac32a024c5a7143'
        ]))
      ]
    ),
  / manifest / 3:bstr .cbor ({
    / manifest-version / 1:1,
    / manifest-sequence-number / 2:0,
    / common / 3:bstr .cbor ({
      / components / 2:[
        [h'00']
      ],
      / common-sequence / 4:bstr .cbor ([
        / directive-override-parameters / 20,{
          / vendor-id /
1:h'fa6b4a53d5ad5fdfbe9de663e4d41ffe' / fa6b4a53-d5ad-5fdf-
be9d-e663e4d41ffe /,
          / class-id / 2:h'1492af1425695e48bf429b2d51f2ab45'
/ 1492af14-2569-5e48-bf42-9b2d51f2ab45 /,
          / image-digest / 3:bstr .cbor ([
            / algorithm-id / 2 / "sha256" /,
            / digest-bytes /
h'00112233445566778899aabbccddeeff0123456789abcdeffedcba9876543210'
            ]),
            / image-size / 14:34768,
          } ,
          / condition-vendor-identifier / 1,15 ,
          / condition-class-identifier / 2,15
        ]),
      }),
    / validate / 10:bstr .cbor ([
      / condition-image-match / 3,15
    ]),
  ],

```

```

    / run / 12:bstr .cbor ([
      / directive-run / 23,2
    ]),
  }),
}

```

Total size of Envelope without COSE authentication object: 159

Envelope:

```

a2025827815824820258205c097ef64bf3bb9b494e71e1f2418eef8d466c
c902f639a855ec9af3e9eddb99035871a50101020003585fa20281814100
0458568614a40150fa6b4a53d5ad5fdfbe9de663e4d41ffe02501492af14
25695e48bf429b2d51f2ab450358248202582000112233445566778899aa
bbccddeeff0123456789abcdeffedcba98765432100e1987d0010f020f0a
4382030f0c43821702

```

Total size of Envelope with COSE authentication object: 272

Envelope with COSE authentication object:

```

a2025898825824820258205c097ef64bf3bb9b494e71e1f2418eef8d466c
c902f639a855ec9af3e9eddb99586fd28443a10126a05824820258205c09
7ef64bf3bb9b494e71e1f2418eef8d466cc902f639a855ec9af3e9eddb99
584060f5c3d03a3aa759bfef2ef0f5f97a93b1f5e741f7463f4385af8851
3a5c2957bea2d6c4cfd03392a267aab0fc0fd515560ed58e33fad26ac3
2a024c5a7143035871a50101020003585fa202818141000458568614a401
50fa6b4a53d5ad5fdfbe9de663e4d41ffe02501492af1425695e48bf429b
2d51f2ab450358248202582000112233445566778899aabbccddeeff0123
456789abcdeffedcba98765432100e1987d0010f020f0a4382030f0c4382
1702

```

B.2. Example 1: Simultaneous Download and Installation of Payload

This example covers the following templates:

- Compatibility Check ([Section 7.1](#))
- Firmware Download ([Section 7.3](#))

Simultaneous download and installation of payload. No secure boot is present in this example to demonstrate a download-only manifest.

```

{
  / authentication-wrapper / 2:bstr .cbor ({          digest: bstr
.cbor ([
    / algorithm-id / 2 / "sha256" /,
    / digest-bytes /

```

```

h'987eec85fa99fd31d332381b9810f90b05c2e0d4f284a6f4211207ed00ffff750'
  ])
    signatures: [
      bstr .cbor (18([
        / protected / bstr .cbor ({
          / alg / 1:-7 / "ES256" /,
        }),
        / unprotected / {
        },
        / payload / bstr .cbor ([
          / algorithm-id / 2 / "sha256" /,
          / digest-bytes /
h'987eec85fa99fd31d332381b9810f90b05c2e0d4f284a6f4211207ed00ffff750'
          ]),
          / signature / h'750141d65b4f20a88dc70c6785a67e0f4f
085aead83ba2289d6e37271508cc91e0a0592f5c940c2257c9c0b26403c0ba4477f2ce
37b60089fe02cde7911d1c15'
          ]))
    ]
  }),
  / manifest / 3:bstr .cbor ({
    / manifest-version / 1:1,
    / manifest-sequence-number / 2:1,
    / common / 3:bstr .cbor ({
      / components / 2:[
        [h'00']
      ],
      / common-sequence / 4:bstr .cbor ([
        / directive-override-parameters / 20,{
          / vendor-id /
1:h'fa6b4a53d5ad5fdfbe9de663e4d41ffe' / fa6b4a53-d5ad-5fdf-
be9d-e663e4d41ffe /,
          / class-id / 2:h'1492af1425695e48bf429b2d51f2ab45'
/ 1492af14-2569-5e48-bf42-9b2d51f2ab45 /,
          / image-digest / 3:bstr .cbor ([
            / algorithm-id / 2 / "sha256" /,
            / digest-bytes /
h'00112233445566778899aabbccddeeff0123456789abcdeffedcba9876543210'
            ]),
            / image-size / 14:34768,
          } ,
          / condition-vendor-identifier / 1,15 ,
          / condition-class-identifier / 2,15
        ]),
      }),
    / install / 9:bstr .cbor ([
      / directive-set-parameters / 19,{
        / uri / 21:'http://example.com/file.bin',
      } ,

```

```

        / directive-fetch / 21,2 ,
        / condition-image-match / 3,15
    ]),
    / validate / 10:bstr .cbor ([
        / condition-image-match / 3,15
    ]),
  }),
}

```

Total size of Envelope without COSE authentication object: 194

Envelope:

```

a202582781582482025820987eec85fa99fd31d332381b9810f90b05c2e0
d4f284a6f4211207ed00ffff750035894a50101020103585fa20281814100
0458568614a40150fa6b4a53d5ad5fd5fde9de663e4d41ffe02501492af14
25695e48bf429b2d51f2ab450358248202582000112233445566778899aa
bbccddeeff0123456789abcdeffedcba98765432100e1987d0010f020f09
58258613a115781b687474703a2f2f6578616d706c652e636f6d2f66696c
652e62696e1502030f0a4382030f

```

Total size of Envelope with COSE authentication object: 307

Envelope with COSE authentication object:

```

a202589882582482025820987eec85fa99fd31d332381b9810f90b05c2e0
d4f284a6f4211207ed00ffff750586fd28443a10126a0582482025820987e
ec85fa99fd31d332381b9810f90b05c2e0d4f284a6f4211207ed00ffff750
5840750141d65b4f20a88dc70c6785a67e0f4f085aead83ba2289d6e3727
1508cc91e0a0592f5c940c2257c9c0b26403c0ba4477f2ce37b60089fe02
cde7911d1c15035894a50101020103585fa202818141000458568614a401
50fa6b4a53d5ad5fd5fde9de663e4d41ffe02501492af1425695e48bf429b
2d51f2ab450358248202582000112233445566778899aabbccddeeff0123
456789abcdeffedcba98765432100e1987d0010f020f0958258613a11578
1b687474703a2f2f6578616d706c652e636f6d2f66696c652e62696e1502
030f0a4382030f

```

B.3. Example 2: Simultaneous Download, Installation, Secure Boot, Severed Fields

This example covers the following templates:

- Compatibility Check ([Section 7.1](#))
- Secure Boot ([Section 7.2](#))
- Firmware Download ([Section 7.3](#))

This example also demonstrates severable elements ([Section 5.5](#)), and text ([Section 8.6.4](#)).

```
{
  / authentication-wrapper / 2:bstr .cbor ({          digest: bstr
.cbor ([
    / algorithm-id / 2 / "sha256" /,
    / digest-bytes /
h'75685579a83babd71ec8ef22fa49ac873f78a708a43a674e782ad30b6598d17a'
    ])
    signatures: [
      bstr .cbor (18([
        / protected / bstr .cbor ({
          / alg / 1:-7 / "ES256" /,
        }),
        / unprotected / {
        },
        / payload / bstr .cbor ([
          / algorithm-id / 2 / "sha256" /,
          / digest-bytes /
h'75685579a83babd71ec8ef22fa49ac873f78a708a43a674e782ad30b6598d17a'
          ]),
          / signature / h'861b9bfb449125742baa648bc9d148cba4
5519cca8efecf705c2165ecdecaeba8b6ce2131284e66708788d741e8779d5973fa8e2
5da49eb203c81920719da949'
        ]))
      ]
    }),
  / manifest / 3:bstr .cbor ({
    / manifest-version / 1:1,
    / manifest-sequence-number / 2:2,
    / common / 3:bstr .cbor ({
      / components / 2:[
        [h'00']
      ],
      / common-sequence / 4:bstr .cbor ([
        / directive-override-parameters / 20,{
          / vendor-id /
1:h'fa6b4a53d5ad5fdfbe9de663e4d41ffe' / fa6b4a53-d5ad-5fdf-
be9d-e663e4d41ffe /,
          / class-id / 2:h'1492af1425695e48bf429b2d51f2ab45'
/ 1492af14-2569-5e48-bf42-9b2d51f2ab45 /,
          / image-digest / 3:bstr .cbor ([
            / algorithm-id / 2 / "sha256" /,
            / digest-bytes /
h'00112233445566778899aabbccddeeff0123456789abcdeffedcba9876543210'
            ]),
          / image-size / 14:34768,
        } ,
      ]
    } ,
  ]
}
```

```

        / condition-vendor-identifier / 1,15 ,
        / condition-class-identifier / 2,15
    ]),
  }),
  / install / 9:[
    / algorithm-id / 2 / "sha256" /,
    / digest-bytes /
h'3ee96dc79641970ae46b929ccf0b72ba9536dd846020dbdc9f949d84ea0e18d2'
  ],
  / validate / 10:bstr .cbor ([
    / condition-image-match / 3,15
  ]),
  / run / 12:bstr .cbor ([
    / directive-run / 23,2
  ]),
  / text / 13:[
    / algorithm-id / 2 / "sha256" /,
    / digest-bytes /
h'23f48b2e2838650f43c144234aee18401ffe3cce4733b23881c3a8ae2d2b66e8'
  ],
  }),
  / install / 9:bstr .cbor ([
    / directive-set-parameters / 19,{
    / uri /
21:'http://example.com/very/long/path/to/file/file.bin',
  } ,
  / directive-fetch / 21,2 ,
  / condition-image-match / 3,15
  ]),
  / text / 13:bstr .cbor ({
    [h'00']:{
      / vendor-domain / 3:'arm.com',
      / component-description / 5:'This component is a
demonstration. The digest is a sample pattern, not a real one.',
    }
  }
  }),
}

```

Total size of the Envelope without COSE authentication object or Severable Elements: 233

Envelope:

a20258278158248202582075685579a83babd71ec8ef22fa49ac873f78a708a43a674e782ad30b6598d17a0358bba70101020203585fa202818141000458568614a40150fa6b4a53d5ad5fd5f9de663e4d41ffe02501492af1425695e48bf429b2d51f2ab450358248202582000112233445566778899aabbccddeeff0123456789abcdeffedcba98765432100e1987d0010f020f09820258203ee96dc79641970ae46b929ccf0b72ba9536dd846020dbdc9f949d84ea0e18d20a4382030f0c438217020d8202582023f48b2e2838650f43c144234aee18401ffe3cce4733b23881c3a8ae2d2b66e8

Total size of the Envelope with COSE authentication object but without Severable Elements: 346

Envelope:

a20258988258248202582075685579a83babd71ec8ef22fa49ac873f78a708a43a674e782ad30b6598d17a586fd28443a10126a058248202582075685579a83babd71ec8ef22fa49ac873f78a708a43a674e782ad30b6598d17a5840861b9bfb449125742baa648bc9d148cba45519cca8efecf705c2165ecdecaeba8b6ce2131284e66708788d741e8779d5973fa8e25da49eb203c81920719da9490358bba70101020203585fa202818141000458568614a40150fa6b4a53d5ad5fd5f9de663e4d41ffe02501492af1425695e48bf429b2d51f2ab450358248202582000112233445566778899aabbccddeeff0123456789abcdeffedcba98765432100e1987d0010f020f09820258203ee96dc79641970ae46b929ccf0b72ba9536dd846020dbdc9f949d84ea0e18d20a4382030f0c438217020d8202582023f48b2e2838650f43c144234aee18401ffe3cce4733b23881c3a8ae2d2b66e8

Total size of Envelope with COSE authentication object: 929

Envelope with COSE authentication object:

```

a40258988258248202582075685579a83babd71ec8ef22fa49ac873f78a7
08a43a674e782ad30b6598d17a586fd28443a10126a05824820258207568
5579a83babd71ec8ef22fa49ac873f78a708a43a674e782ad30b6598d17a
5840861b9bfb449125742baa648bc9d148cba45519cca8efecf705c2165e
cdecaeba8b6ce2131284e66708788d741e8779d5973fa8e25da49eb203c8
1920719da9490358bba70101020203585fa202818141000458568614a401
50fa6b4a53d5ad5fdfbe9de663e4d41ffe02501492af1425695e48bf429b
2d51f2ab450358248202582000112233445566778899aabbccddeeff0123
456789abcdeffedcba98765432100e1987d0010f020f09820258203ee96d
c79641970ae46b929ccf0b72ba9536dd846020dbdc9f949d84ea0e18d20a
4382030f0c438217020d8202582023f48b2e2838650f43c144234aee1840
1ffe3cce4733b23881c3a8ae2d2b66e809583c8613a1157832687474703a
2f2f6578616d706c652e636f6d2f766572792f6c6f6e672f706174682f74
6f2f66696c652f66696c652e62696e1502030f0d590204a20179019d2323
204578616d706c6520323a2053696d756c74616e656f757320446f776e6c
6f61642c20496e7374616c6c6174696f6e2c2053656375726520426f6f74
2c2053657665726564204669656c64730a0a202020205468697320657861
6d706c6520636f766572732074686520666f6c6c6f77696e672074656d70
6c617465733a0a202020200a202020202a20436f6d7061746962696c6974
7920436865636b20287b7b74656d706c6174652d636f6d7061746962696c
6974792d636865636b7d7d290a202020202a2053656375726520426f6f74
20287b7b74656d706c6174652d7365637572652d626f6f747d7d290a2020
20202a204669726d7761726520446f776e6c6f616420287b7b6669726d77
6172652d646f776e6c6f61642d74656d706c6174657d7d290a202020200a
2020202054686973206578616d706c6520616c736f2064656d6f6e737472
6174657320736576657261626c6520656c656d656e747320287b7b6f7672
2d736576657261626c657d7d292c20616e64207465787420287b7b6d616e
69666573742d6469676573742d746578747d7d292e814100a2036761726d
2e636f6d0578525468697320636f6d706f6e656e7420697320612064656d
6f6e7374726174696f6e2e20546865206469676573742069732061207361
6d706c65207061747465726e2c206e6f742061207265616c206f6e652e

```

B.4. Example 3: A/B images

This example covers the following templates:

- Compatibility Check ([Section 7.1](#))
- Secure Boot ([Section 7.2](#))
- Firmware Download ([Section 7.3](#))
- A/B Image Template ([Section 7.11](#))

```

{
  / authentication-wrapper / 2:bstr .cbor ({          digest: bstr
.cbor ([
    / algorithm-id / 2 / "sha256" / ,

```



```

    / digest-bytes /
h'ae0c1ea689c9800a843550f38796b6fdbd52a0c78be5d26011d8e784da43d47c'
  ])
  signatures: [
    bstr .cbor (18([
      / protected / bstr .cbor ({
        / alg / 1:-7 / "ES256" /,
      }),
      / unprotected / {
    }],
    / payload / bstr .cbor ([
      / algorithm-id / 2 / "sha256" /,
      / digest-bytes /
h'ae0c1ea689c9800a843550f38796b6fdbd52a0c78be5d26011d8e784da43d47c'
    ]),
      / signature / h'359960bae5a7de2457c8f48d3250d96d1a
f2d36e08764b62d76f8a3f3041774b150b2c835bb1b2d7b1b2e629e1f08cc3b1b48fce
bb8fb38182c116161e02b33f'
    ]))
  ]
}),
/ manifest / 3:bstr .cbor ({
  / manifest-version / 1:1,
  / manifest-sequence-number / 2:3,
  / common / 3:bstr .cbor ({
    / components / 2:[
      [h'00']
    ],
    / common-sequence / 4:bstr .cbor ([
      / directive-override-parameters / 20,{
        / vendor-id /
1:h'fa6b4a53d5ad5fd5f9de663e4d41ffe' / fa6b4a53-d5ad-5fdf-
be9d-e663e4d41ffe /,
        / class-id / 2:h'1492af1425695e48bf429b2d51f2ab45'
/ 1492af14-2569-5e48-bf42-9b2d51f2ab45 /,
      } ,
      / directive-try-each / 15,[
        bstr .cbor ([
          / directive-override-parameters / 20,{
            / offset / 5:33792,
          } ,
          / condition-component-offset / 5,5 ,
          / directive-override-parameters / 20,{
            / image-digest / 3:bstr .cbor ([
              / algorithm-id / 2 / "sha256" /,
              / digest-bytes /
h'00112233445566778899aabbccddeeff0123456789abcdeffedcba9876543210'
            ]),
            / image-size / 14:34768,

```

```

    }
  ]),
  bstr .cbor ([
    / directive-override-parameters / 20,{
      / offset / 5:541696,
    } ,
    / condition-component-offset / 5,5 ,
    / directive-override-parameters / 20,{
      / image-digest / 3:bstr .cbor ([
        / algorithm-id / 2 / "sha256" /,
        / digest-bytes /
h'0123456789abcdeffedcba987654321000112233445566778899aabbccddeeff'
      ]),
      / image-size / 14:76834,
    }
  ]),
  / condition-vendor-identifier / 1,15 ,
  / condition-class-identifier / 2,15
]),
}),
/ install / 9:bstr .cbor ([
  / directive-try-each / 15,[
    bstr .cbor ([
      / directive-set-parameters / 19,{
        / offset / 5:33792,
      } ,
      / condition-component-offset / 5,5 ,
      / directive-set-parameters / 19,{
        / uri / 21:'http://example.com/file1.bin',
      }
    ]),
    bstr .cbor ([
      / directive-set-parameters / 19,{
        / offset / 5:541696,
      } ,
      / condition-component-offset / 5,5 ,
      / directive-set-parameters / 19,{
        / uri / 21:'http://example.com/file2.bin',
      }
    ]),
  / directive-fetch / 21,2 ,
  / condition-image-match / 3,15
]),
/ validate / 10:bstr .cbor ([
  / condition-image-match / 3,15
]),

```

```
  }),
}
```

Total size of Envelope without COSE authentication object: 330

Envelope:

```
a202582781582482025820ae0c1ea689c9800a843550f38796b6fdbd52a0
c78be5d26011d8e784da43d47c0359011ba5010102030358aaa202818141
000458a18814a20150fa6b4a53d5ad5fdbe9de663e4d41ffe02501492af
1425695e48bf429b2d51f2ab450f8258368614a105198400050514a20358
248202582000112233445566778899aabbccddeeff0123456789abcdeffe
dcba98765432100e1987d0583a8614a1051a00084400050514a203582482
0258200123456789abcdeffedcba987654321000112233445566778899aa
bbccddeeff0e1a00012c22010f020f095861860f82582a8613a105198400
050513a115781c687474703a2f2f6578616d706c652e636f6d2f66696c65
312e62696e582c8613a1051a00084400050513a115781c687474703a2f2f
6578616d706c652e636f6d2f66696c65322e62696e1502030f0a4382030f
```

Total size of Envelope with COSE authentication object: 443

Envelope with COSE authentication object:

```
a202589882582482025820ae0c1ea689c9800a843550f38796b6fdbd52a0
c78be5d26011d8e784da43d47c586fd28443a10126a0582482025820ae0c
1ea689c9800a843550f38796b6fdbd52a0c78be5d26011d8e784da43d47c
5840359960bae5a7de2457c8f48d3250d96d1af2d36e08764b62d76f8a3f
3041774b150b2c835bb1b2d7b1b2e629e1f08cc3b1b48fceb8fb38182c1
16161e02b33f0359011ba5010102030358aaa202818141000458a18814a2
0150fa6b4a53d5ad5fdbe9de663e4d41ffe02501492af1425695e48bf42
9b2d51f2ab450f8258368614a105198400050514a2035824820258200011
2233445566778899aabbccddeeff0123456789abcdeffedcba9876543210
0e1987d0583a8614a1051a00084400050514a20358248202582001234567
89abcdeffedcba987654321000112233445566778899aabbccddeeff0e1a
00012c22010f020f095861860f82582a8613a105198400050513a115781c
687474703a2f2f6578616d706c652e636f6d2f66696c65312e62696e582c
8613a1051a00084400050513a115781c687474703a2f2f6578616d706c65
2e636f6d2f66696c65322e62696e1502030f0a4382030f
```

B.5. Example 4: Load and Decompress from External Storage

This example covers the following templates:

- Compatibility Check ([Section 7.1](#))
- Secure Boot ([Section 7.2](#))
- Firmware Download ([Section 7.3](#))

- Install ([Section 7.4](#))
- Load & Decompress ([Section 7.8](#))

```

{
  / authentication-wrapper / 2:bstr .cbor ({          digest: bstr
.cbor ([
    / algorithm-id / 2 / "sha256" /,
    / digest-bytes /
h'4b4c7c8c0fda76c9c9591a9db160918e2b3c96a58b0a5e4984fd4e8f9359a928'
    ])          signatures: [
    bstr .cbor (18([
      / protected / bstr .cbor ({
        / alg / 1:-7 / "ES256" /,
      }),
      / unprotected / {
      },
      / payload / bstr .cbor ([
        / algorithm-id / 2 / "sha256" /,
        / digest-bytes /
h'4b4c7c8c0fda76c9c9591a9db160918e2b3c96a58b0a5e4984fd4e8f9359a928'
        ]),
        / signature / h'd721cb3415f27cfeb8ef066bb6312ba758
32b57410a0c700de71cf8004ea23b9dd3c912a99fab111e9b8f2cc55c7dfcc37012de
cf72e44f69b3d3db8cc98cb6'
        ]))
    ]
  }),
  / manifest / 3:bstr .cbor ({
    / manifest-version / 1:1,
    / manifest-sequence-number / 2:4,
    / common / 3:bstr .cbor ({
      / components / 2:[
        [h'00'] ,
        [h'02'] ,
        [h'01']
      ],
      / common-sequence / 4:bstr .cbor ([
        / directive-set-component-index / 12,0 ,
        / directive-override-parameters / 20,{
          / vendor-id /
1:h'fa6b4a53d5ad5fdfbe9de663e4d41ffe' / fa6b4a53-d5ad-5fdf-
be9d-e663e4d41ffe /,
          / class-id / 2:h'1492af1425695e48bf429b2d51f2ab45'
/ 1492af14-2569-5e48-bf42-9b2d51f2ab45 /,
          / image-digest / 3:bstr .cbor ([
            / algorithm-id / 2 / "sha256" /,
            / digest-bytes /

```

```

h'00112233445566778899aabbccddeeff0123456789abcdeffedcba9876543210'
    ]),
    / image-size / 14:34768,
  } ,
  / condition-vendor-identifier / 1,15 ,
  / condition-class-identifier / 2,15
]),
}),
/ payload-fetch / 8:bstr .cbor ([
  / directive-set-component-index / 12,1 ,
  / directive-set-parameters / 19,{
    / uri / 21:'http://example.com/file.bin',
  } ,
  / directive-fetch / 21,2 ,
  / condition-image-match / 3,15
]),
/ install / 9:bstr .cbor ([
  / directive-set-component-index / 12,0 ,
  / directive-set-parameters / 19,{
    / source-component / 22:1 / [h'02'] /,
  } ,
  / directive-copy / 22,2 ,
  / condition-image-match / 3,15
]),
/ validate / 10:bstr .cbor ([
  / directive-set-component-index / 12,0 ,
  / condition-image-match / 3,15
]),
/ load / 11:bstr .cbor ([
  / directive-set-component-index / 12,2 ,
  / directive-set-parameters / 19,{
    / image-digest / 3:bstr .cbor ([
      / algorithm-id / 2 / "sha256" /,
      / digest-bytes /
h'0123456789abcdeffedcba987654321000112233445566778899aabbccddeeff'
    ]),
    / image-size / 14:76834,
    / source-component / 22:0 / [h'00'] /,
    / compression-info / 19:1 / "gzip" /,
  } ,
  / directive-copy / 22,2 ,
  / condition-image-match / 3,15
]),
/ run / 12:bstr .cbor ([
  / directive-set-component-index / 12,2 ,
  / directive-run / 23,2
]),
}),
}),

```

```
}
```

Total size of Envelope without COSE authentication object: 287

Envelope:

```
a2025827815824820258204b4c7c8c0fda76c9c9591a9db160918e2b3c96
a58b0a5e4984fd4e8f9359a9280358f1a801010204035867a20283814100
814102814101045858880c0014a40150fa6b4a53d5ad5fd5f9de663e4d4
1ffe02501492af1425695e48bf429b2d51f2ab4503582482025820001122
33445566778899aabbccddeeff0123456789abcdeffedcba98765432100e
1987d0010f020f085827880c0113a115781b687474703a2f2f6578616d70
6c652e636f6d2f66696c652e62696e1502030f094b880c0013a116011602
030f0a45840c00030f0b583a880c0213a4035824820258200123456789ab
cdeffedcba987654321000112233445566778899aabbccddeeff0e1a0001
2c22130116001602030f0c45840c021702
```

Total size of Envelope with COSE authentication object: 400

Envelope with COSE authentication object:

```
a2025898825824820258204b4c7c8c0fda76c9c9591a9db160918e2b3c96
a58b0a5e4984fd4e8f9359a928586fd28443a10126a05824820258204b4c
7c8c0fda76c9c9591a9db160918e2b3c96a58b0a5e4984fd4e8f9359a928
5840d721cb3415f27cfeb8ef066bb6312ba75832b57410a0c700de71cf80
04ea23b9dd3c912a99fab111e9b8f2cc55c7dffcc37012decf72e44f69b3
d3db8cc98cb60358f1a801010204035867a2028381410081410281410104
5858880c0014a40150fa6b4a53d5ad5fd5f9de663e4d41ffe02501492af
1425695e48bf429b2d51f2ab450358248202582000112233445566778899
aabbccddeeff0123456789abcdeffedcba98765432100e1987d0010f020f
085827880c0113a115781b687474703a2f2f6578616d706c652e636f6d2f
66696c652e62696e1502030f094b880c0013a116011602030f0a45840c00
030f0b583a880c0213a4035824820258200123456789abcdeffedcba9876
54321000112233445566778899aabbccddeeff0e1a00012c221301160016
02030f0c45840c021702
```

B.6. Example 5: Two Images

This example covers the following templates:

- Compatibility Check ([Section 7.1](#))
- Secure Boot ([Section 7.2](#))
- Firmware Download ([Section 7.3](#))

Furthermore, it shows using these templates with two images.

```

{
  / authentication-wrapper / 2:bstr .cbor ({
    .cbor ([
      / algorithm-id / 2 / "sha256" /,
      / digest-bytes /
      h'de7c7927a15bd2eda59cab1512875f17c9f1e9e23885ce1ac6d671eefcefa37a'
    ])
    signatures: [
      bstr .cbor (18([
        / protected / bstr .cbor ({
          / alg / 1:-7 / "ES256" /,
        }),
        / unprotected / {
        },
        / payload / bstr .cbor ([
          / algorithm-id / 2 / "sha256" /,
          / digest-bytes /
          h'de7c7927a15bd2eda59cab1512875f17c9f1e9e23885ce1ac6d671eefcefa37a'
        ]),
        / signature / h'e71e332c985fb0479f296685669d05348b
        cdba8e186f25a5418f4682ea168df61661f54bf48f964577225ed455b22d277dd94de8
        7c57f1baceedd6719f3d56ec'
      ]))
    ]
  }),
  / manifest / 3:bstr .cbor ({
    / manifest-version / 1:1,
    / manifest-sequence-number / 2:5,
    / common / 3:bstr .cbor ({
      / components / 2:[
        [h'00'] ,
        [h'01']
      ],
      / common-sequence / 4:bstr .cbor ([
        / directive-set-component-index / 12,0 ,
        / directive-override-parameters / 20,{
          / vendor-id /
          1:h'fa6b4a53d5ad5fdfbe9de663e4d41ffe' / fa6b4a53-d5ad-5fdf-
          be9d-e663e4d41ffe /,
          / class-id / 2:h'1492af1425695e48bf429b2d51f2ab45'
          / 1492af14-2569-5e48-bf42-9b2d51f2ab45 /,
          / image-digest / 3:bstr .cbor ([
            / algorithm-id / 2 / "sha256" /,
            / digest-bytes /
            h'00112233445566778899aabbccddeeff0123456789abcdeffedcba9876543210'
          ]),
          / image-size / 14:34768,
        } ,
        / condition-vendor-identifier / 1,15 ,

```

```

    / condition-class-identifier / 2,15 ,
    / directive-set-component-index / 12,1 ,
    / directive-override-parameters / 20,{
      / image-digest / 3:bstr .cbor ([
        / algorithm-id / 2 / "sha256" /,
        / digest-bytes /
h'0123456789abcdeffedcba987654321000112233445566778899aabbccddeeff'
      ]),
      / image-size / 14:76834,
    }
  ]),
}),
/ install / 9:bstr .cbor ([
  / directive-set-component-index / 12,0 ,
  / directive-set-parameters / 19,{
    / uri / 21:'http://example.com/file1.bin',
  } ,
  / directive-fetch / 21,2 ,
  / condition-image-match / 3,15 ,
  / directive-set-component-index / 12,1 ,
  / directive-set-parameters / 19,{
    / uri / 21:'http://example.com/file2.bin',
  } ,
  / directive-fetch / 21,2 ,
  / condition-image-match / 3,15
]),
/ validate / 10:bstr .cbor ([
  / directive-set-component-index / 12,0 ,
  / condition-image-match / 3,15 ,
  / directive-set-component-index / 12,1 ,
  / condition-image-match / 3,15
]),
/ run / 12:bstr .cbor ([
  / directive-set-component-index / 12,0 ,
  / directive-run / 23,2
]),
}),
}

```

Total size of Envelope without COSE authentication object: 304

Envelope:


```
a202582781582482025820de7c7927a15bd2eda59cab1512875f17c9f1e9
e23885ce1ac6d671eefcefa37a03590101a601010205035895a202828141
008141010458898c0c0014a40150fa6b4a53d5ad5fdfe9de663e4d41ffe
02501492af1425695e48bf429b2d51f2ab45035824820258200011223344
5566778899aabbccddeeff0123456789abcdeffedcba98765432100e1987
d0010f020f0c0114a2035824820258200123456789abcdeffedcba987654
321000112233445566778899aabbccddeeff0e1a00012c2209584f900c00
13a115781c687474703a2f2f6578616d706c652e636f6d2f66696c65312e
62696e1502030f0c0113a115781c687474703a2f2f6578616d706c652e63
6f6d2f66696c65322e62696e1502030f0a49880c00030f0c01030f0c4584
0c001702
```

Total size of Envelope with COSE authentication object: 417

Envelope with COSE authentication object:

```
a202589882582482025820de7c7927a15bd2eda59cab1512875f17c9f1e9
e23885ce1ac6d671eefcefa37a586fd28443a10126a0582482025820de7c
7927a15bd2eda59cab1512875f17c9f1e9e23885ce1ac6d671eefcefa37a
5840e71e332c985fb0479f296685669d05348bcd8a8e186f25a5418f4682
ea168df61661f54bf48f964577225ed455b22d277dd94de87c57f1baced
d6719f3d56ec03590101a601010205035895a20282814100814101045889
8c0c0014a40150fa6b4a53d5ad5fdfe9de663e4d41ffe02501492af1425
695e48bf429b2d51f2ab450358248202582000112233445566778899aabb
ccddee0123456789abcdeffedcba98765432100e1987d0010f020f0c01
14a2035824820258200123456789abcdeffedcba98765432100011223344
5566778899aabbccddeeff0e1a00012c2209584f900c0013a115781c6874
74703a2f2f6578616d706c652e636f6d2f66696c65312e62696e1502030f
0c0113a115781c687474703a2f2f6578616d706c652e636f6d2f66696c65
322e62696e1502030f0a49880c00030f0c01030f0c45840c001702
```

[Appendix C](#). C. Design Rational

In order to provide flexible behavior to constrained devices, while still allowing more powerful devices to use their full capabilities, the SUIT manifest encodes the required behavior of a Recipient device. Behavior is encoded as a specialized byte code, contained in a CBOR list. This promotes a flat encoding, which simplifies the parser. The information encoded by this byte code closely matches the operations that a device will perform, which promotes ease of processing. The core operations used by most update and trusted invocation operations are represented in the byte code. The byte code can be extended by registering new operations.

The specialized byte code approach gives benefits equivalent to those provided by a scripting language or conventional byte code, with two substantial differences. First, the language is extremely high level, consisting of only the operations that a device may perform

during update and trusted invocation of a firmware image. Second, the language specifies linear behavior, without reverse branches. Conditional processing is supported, and parallel and out-of-order processing may be performed by sufficiently capable devices.

By structuring the data in this way, the manifest processor becomes a very simple engine that uses a pull parser to interpret the manifest. This pull parser invokes a series of command handlers that evaluate a Condition or execute a Directive. Most data is structured in a highly regular pattern, which simplifies the parser.

The results of this allow a Recipient to implement a very small parser for constrained applications. If needed, such a parser also allows the Recipient to perform complex updates with reduced overhead. Conditional execution of commands allows a simple device to perform important decisions at validation-time.

Dependency handling is vastly simplified as well. Dependencies function like subroutines of the language. When a manifest has a dependency, it can invoke that dependency's commands and modify their behavior by setting parameters. Because some parameters come with security implications, the dependencies also have a mechanism to reject modifications to parameters on a fine-grained level.

Developing a robust permissions system works in this model too. The Recipient can use a simple ACL that is a table of Identities and Component Identifier permissions to ensure that operations on components fail unless they are permitted by the ACL. This table can be further refined with individual parameters and commands.

Capability reporting is similarly simplified. A Recipient can report the Commands, Parameters, Algorithms, and Component Identifiers that it supports. This is sufficiently precise for a manifest author to create a manifest that the Recipient can accept.

The simplicity of design in the Recipient due to all of these benefits allows even a highly constrained platform to use advanced update capabilities.

C.1. C.1 Design Rationale: Envelope

The Envelope is used instead of a COSE structure for several reasons:

1. This enables the use of Severable Elements ([Section 8.8](#))
2. This enables modular processing of manifests, particularly with large signatures.

3. This enables multiple authentication schemes.
4. This allows integrity verification by a dependent to be unaffected by adding or removing authentication structures.

Modular processing is important because it allows a Manifest Processor to iterate forward over an Envelope, processing Delegation Chains and Authentication Blocks, retaining only intermediate values, without any need to seek forward and backwards in a stream until it gets to the Manifest itself. This allows the use of large, Post-Quantum signatures without requiring retention of the signature itself, or seeking forward and back.

Four authentication objects are supported by the Envelope:

- COSE_Sign_Tagged
- COSE_Sign1_Tagged
- COSE_Mac_Tagged
- COSE_Mac0_Tagged

The SUIT Envelope allows an Update Authority or intermediary to mix and match any number of different authentication blocks it wants without any concern for modifying the integrity of another authentication block. This also allows the addition or removal of an authentication blocks without changing the integrity check of the Manifest, which is important for dependency handling. See [Section 6.2](#)

C.2. C.2 Byte String Wrappers

Byte string wrappers are used in several places in the suit manifest. The primary reason for wrappers is to limit the parser extent when invoked at different times, with a possible loss of context.

The elements of the suit envelope are wrapped both to set the extents used by the parser and to simplify integrity checks by clearly defining the length of each element.

The common block is re-parsed in order to find components identifiers from their indices, to find dependency prefixes and digests from their identifiers, and to find the common sequence. The common sequence is wrapped so that it matches other sequences, simplifying the code path.

A severed SUIF command sequence will appear in the envelope, so it must be wrapped as with all envelope elements. For consistency, command sequences are also wrapped in the manifest. This also allows the parser to discern the difference between a command sequence and a SUIF_Digest.

Parameters that are structured types (arrays and maps) are also wrapped in a bstr. This is so that parser extents can be set correctly using only a reference to the beginning of the parameter. This enables a parser to store a simple list of references to parameters that can be retrieved when needed.

Appendix D. D. Implementation Conformance Matrix

This section summarizes the functionality a minimal implementation needs to offer to claim conformance to this specification, in the absence of an application profile standard specifying otherwise.

The subsequent table shows the conditions.

| Name | Reference | Implementation |
|-------------------|----------------------------------|----------------|
| Vendor Identifier | Section 8.7.5.2 | REQUIRED |
| Class Identifier | Section 8.7.5.2 | REQUIRED |
| Device Identifier | Section 8.7.5.2 | OPTIONAL |
| Image Match | Section 8.7.6.2 | REQUIRED |
| Image Not Match | Section 8.7.6.3 | OPTIONAL |
| Use Before | Section 8.7.6.4 | OPTIONAL |
| Component Offset | Section 8.7.6.5 | OPTIONAL |
| Abort | Section 8.7.6.9 | OPTIONAL |
| Minimum Battery | Section 8.7.6.6 | OPTIONAL |
| Update Authorized | Section 8.7.6.7 | OPTIONAL |
| Version | Section 8.7.6.8 | OPTIONAL |
| Custom Condition | Section 8.7.6.10 | OPTIONAL |

The subsequent table shows the directives.

| Name | Reference | Implementation |
|----------------------|--------------------------------------|-------------------------------------|
| Set Component Index | Section 8.7.7. 1 | REQUIRED if more than one component |
| Set Dependency Index | Section 8.7.7. 2 | REQUIRED if dependencies used |
| Try Each | Section 8.7.7. 3 | OPTIONAL |
| Process Dependency | Section 8.7.7. 4 | OPTIONAL |
| Set Parameters | Section 8.7.7. 5 | OPTIONAL |
| Override Parameters | Section 8.7.7. 6 | REQUIRED |
| Fetch | Section 8.7.7. 7 | REQUIRED for Updater |
| Copy | Section 8.7.7. 9 | OPTIONAL |
| Run | Section 8.7.7. 10 | REQUIRED for Bootloader |
| Wait For Event | Section 8.7.7. 11 | OPTIONAL |
| Run Sequence | Section 8.7.7. 12 | OPTIONAL |
| Swap | Section 8.7.7. 13 | OPTIONAL |
| Fetch URI List | Section 8.7.7. 8 | OPTIONAL |

The subsequent table shows the parameters.

| Name | Reference | Implementation |
|------------------|----------------------------------|----------------------|
| Vendor ID | Section 8.7.5.3 | REQUIRED |
| Class ID | Section 8.7.5.4 | REQUIRED |
| Image Digest | Section 8.7.5.6 | REQUIRED |
| Image Size | Section 8.7.5.7 | REQUIRED |
| Use Before | Section 8.7.5.8 | RECOMMENDED |
| Component Offset | Section 8.7.5.9 | OPTIONAL |
| Encryption Info | Section 8.7.5.10 | RECOMMENDED |
| Compression Info | Section 8.7.5.11 | RECOMMENDED |
| Unpack Info | Section 8.7.5.12 | RECOMMENDED |
| URI | Section 8.7.5.13 | REQUIRED for Updater |
| Source Component | Section 8.7.5.14 | OPTIONAL |
| Run Args | Section 8.7.5.15 | OPTIONAL |
| Device ID | Section 8.7.5.5 | OPTIONAL |
| Minimum Battery | Section 8.7.5.16 | OPTIONAL |
| Update Priority | Section 8.7.5.17 | OPTIONAL |
| Version Match | Section 8.7.5.18 | OPTIONAL |
| Wait Info | Section 8.7.5.19 | OPTIONAL |
| URI List | Section 8.7.5.20 | OPTIONAL |
| Strict Order | Section 8.7.5.22 | OPTIONAL |
| Soft Failure | Section 8.7.5.23 | OPTIONAL |
| Custom | Section 8.7.5.24 | OPTIONAL |

Authors' Addresses

Brendan Moran
Arm Limited

EMail: Brendan.Moran@arm.com

Hannes Tschofenig
Arm Limited

EMail: hannes.tschofenig@arm.com

Henk Birkholz
Fraunhofer SIT

EMail: henk.birkholz@sit.fraunhofer.de

Koen Zandberg
Inria

EMail: koen.zandberg@inria.fr