Installable Unit Package Format Specification

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2 Introduction

2.1 Objective

An installable unit is a logical component that can be selected for installation. An installable unit package (or packaged installable unit) contains files to be installed, files that implement change management operations, and a set of manifest files which include a deployment descriptor that describes the install characteristics of the installable unit, and a media descriptor that describes the binding (or physical locations) of the files. This document describes installable unit package format.

The main objective of this document is to define a common installable unit package format consistent with the solution installation architecture. Packages in this format need to be installed in local or distributed environments. Different package types are defined for a single Zip file, fixed-sized removable media, and network location. Other formats may be accommodated in the future. Installable unit packages can be used with packages in existing (de facto or de jure) packaging standards.

2.2 Audience

This document is intended as a technical specification for people who require an in-depth understanding of the common installable unit package format. This will include developers of application or solution installable unit packages, developers of applications for deploying solution packages, and tooling for constructing install packages.

2.3 Scope

This document specifies the common installable unit package format and related design. In particular, the following areas will be covered in this document.

1. Package structure
2. Physical packages
3. Security model
4. Relationship with existing install technologies and package standards
5. Tooling

Relevant designs not covered in this document can be found in other ACAB documents.

2.4 Notational Convention

The key words “MUST,” “MUST NOT,” “REQUIRED,” “SHALL,” “SHALL NOT,” “SHOULD,” “SHOULD NOT,” “RECOMMENDED,” “MAY,” and “OPTIONAL” are to be interpreted as described in [RFC2119].

2.5 Background

Figure 1 depicts an important concept in the solution installation architecture. The install package for an installable unit (IU) consists of two major parts: a deployment descriptor (DD) that describes the contents, and one or more artifacts that can be installed. An IU – or specifically the artifact in the IU – will be installed on a hosting environment. Examples of hosting environments include hardware, operating systems, J2EE application servers, etc.

This document describes a common installable unit package format used in the solution installation architecture. This package format is compatible with existing standard or de facto standard formats. As shown in Figure 1, the design pattern allows the solution installation architecture to encapsulate and use the existing install technologies for the various hosting environments. In particular, the artifacts can be standard or de facto standard packages on the target hosting environments. The actual install behavior is delegated to the install technologies for the hosting environments. The differences in various hosting environments (package format, install capabilities, etc.) are encapsulated in the deployment descriptor which provides a common and consistent view of the installable units and the install capabilities. This design allows deploying legacy products or products not created specifically for the solution installation architecture.

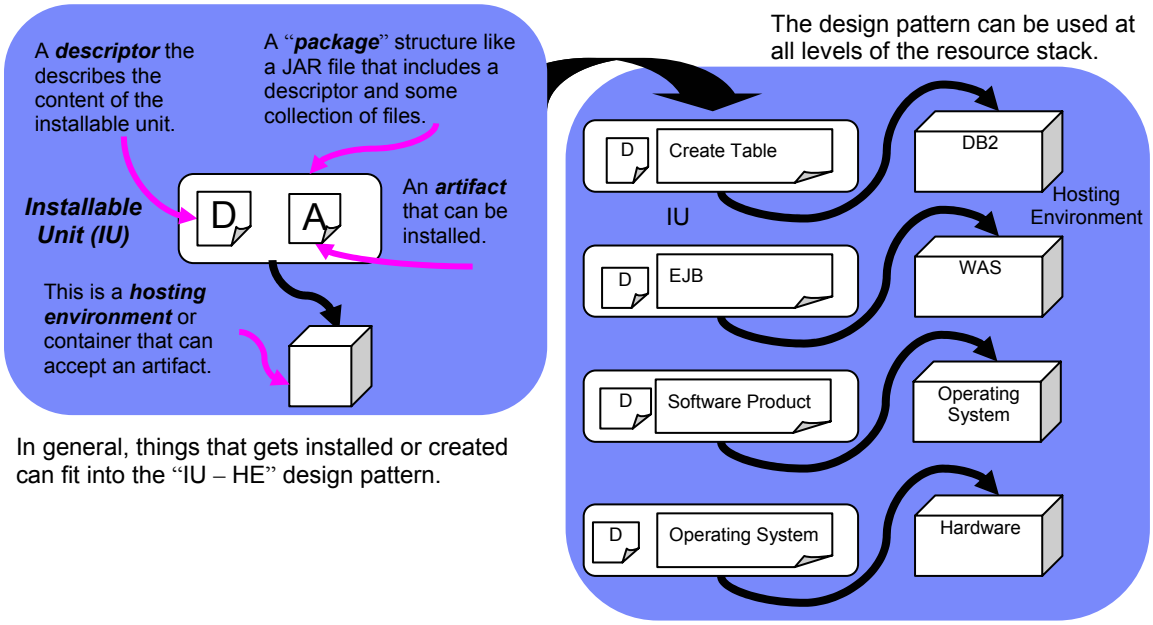


Figure 1 Installable Unit and Hosting Environment Design Pattern

The following sections describe the format of the installable unit packages to be deployed, the package contents, the relationship with the hosting environment package formats, and related tooling.

3 Installable Unit Package

An IU package can be in one of many physical formats. Although those formats are different, they are all based on a common logical layout. In this section, the IU package logical layout is described. Different types of files in an IU package and their relationships will be identified. The physical package format will be described in Section 5, “Package Types.”

3.1 Logical Layout

Figure 2 illustrates the logical view of an IU package. There are three groups of files in an IU package: the manifest files, required files, and optional files. The purposes and relationship of those files will be described in this section. Detailed description of those files, in particular the manifest files, will be provided in the following sections and other specifications.

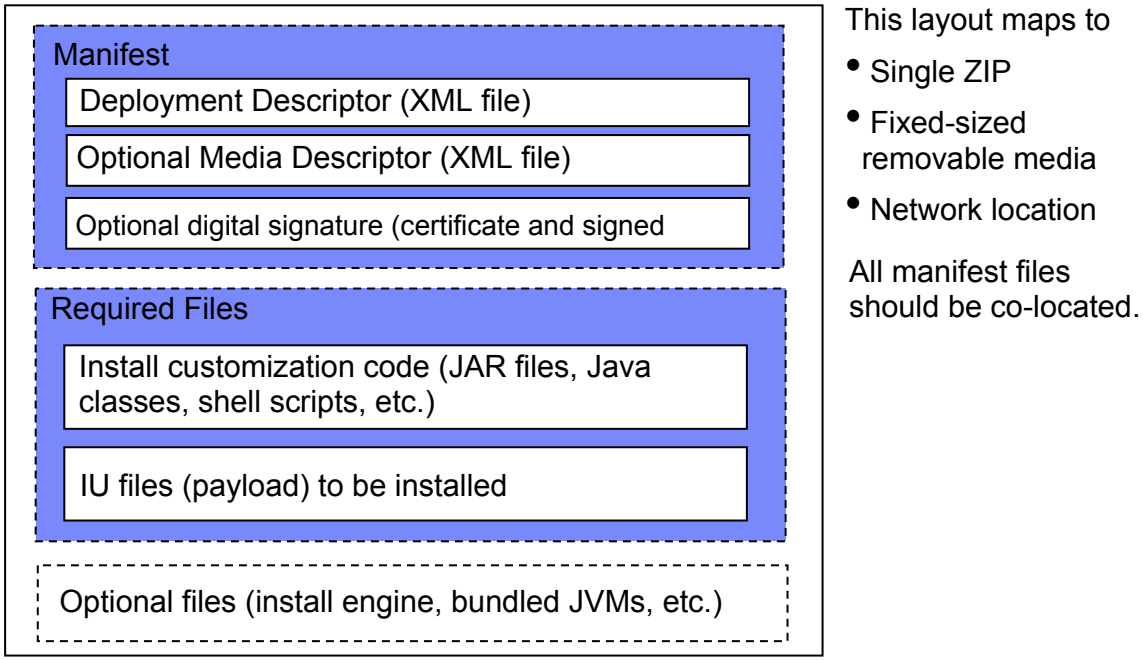


Figure 2 IU Package Layout Logical View

3.1.1 Manifest Files

The manifest files provide standard ways for providing the IU package information. Standard manifest files enable the IU packages to be processed without human intervention (or, *silently*). This is in particular important to enable IU packages for autonomic or on-demand environments. Without the standard manifest files, each IU

package has unique install information that requires human examination and sometimes modification before the IU package can be processed silently. This manual step may be unnecessary if standard manifest files are used to describe the IU packages.

The following three types of manifest files are included in an IU package:

1. **Deployment descriptor**: This is an XML document (in the IUDD [ACAB.SD0402] schema) that describes the install characteristics of the IU packages. This descriptor might reference other deployment descriptors ([ACAB.SD0402]) which could also be located in the same IU package.

   The name of the deployment descriptor file must be "`packagedIU.xml`." Please refer to ACAB specification ([ACAB.SD0402]) for details of the XML schemas.

2. **Media descriptor**: A deployment descriptor specifies *what* files are in the IU package, but not *where* they are. File paths are relative to *logical sources.* A media descriptor is an XML document that describes, among other things, the physical locations for logical sources of the files defined in the associated deployment descriptor. So an IU can be packaged in different physical formats with the same deployment descriptor, and may have unique media descriptors for each physical format.

   A media descriptor is needed when file binding information is complicated. For example, if an IU package spans multiple fixed-sized removable media (such as CD-ROM), a media descriptor is needed to describe the physical file locations that involve the media identification and path within the media.

   A media descriptor is optional. If it is not present, a single logical source is assumed for every file in the IU package, and a default physical location is used unless it is overridden by the installer.

   The name of the media descriptor file must be "`IUMedia.xml`." Section 4, "Media Descriptor", has more details about the media descriptor and the related schema.

3. **Digital signature**: This is a binary file that identifies the IU package and the vendor who created it. Digital signature files are used to verify that the IU package has not been tampered with since it was created, and the signer (vendor) is really who it says it is. A digital signature is optional. If present, a digital signature should be co-located with the associated media descriptor.

   Section 6, "Security", has more details about the IU package security architecture.

The current design does not define a "main" manifest file that contains path information for all the other manifest files such as deployment descriptor and media descriptor. Thus, the manifest files for the IU are co-located and have fixed file names. This design allows

references for one manifest file to lead to other manifest files and thus the complete package. A main manifest file might be introduced in future versions so the co-location restriction can be removed.

3.1.2 Files Defined in the Deployment Descriptor

Most files in the IU packages are defined in the deployment descriptor (`packagedIU.xml`) using the `<file>` elements. The following information, among others, is defined for each file in the deployment descriptor (see [ACAB.SD0402] for more details), and will be referenced in this specification.

- Identifier (the "`id`" attribute): This is the key used to reference the associated file from the media descriptor (see Section 4, "Media Descriptor") or elsewhere in the deployment descriptor via the `<fileIdRef>` attribute or element (see [ACAB.SD0402]).

- File pathname (the "`pathname`" child element): This is the file pathname in the IU package, and may be overwritten in the media descriptor (see Section 4.3, "File Binding Information"). The physical location of the file depends on the physical package format (see Section 5, "Package Types"), and is defined based on the file binding rules (see Section 4.4, "File Binding Rules").

- File size (the "`length`" child element): This is the file size that may be used to verify the physical file (see Section 6, "Security").

- File digital signature (the "`checksum`" child element): This is the file signature based on one of several message digest algorithms (CRC32, MD2, MD5, and SHA). This information may be used to verify the physical file (see Section 6, "Security").

3.1.3 Required Files

There are two types of non-manifest files that will be required during the installation process. These files must be specified in the deployment descriptor, and are mapped to physical locations via the media descriptor.

1. **Install customization code**: Those are the files used to implement custom install logic. They are specified in artifact descriptors (see [ACAB.SD0402]). Such custom code can be in external files (such as native OS commands) or packaged as part of the IU packages. In the latter case, the custom code is packaged just like other files and the binding information is specified in the media descriptor.

   In the case of the multiple fixed-sized removable media packages (such as CD-ROMs), the custom code of the IUs (including the aggregated ones) should be put on the first media so it does not require access to other media to execute the custom code. Unnecessary media swapping should be avoided. In the IUDD spec

[ACAB.SD0402], files containing custom code are not specified explicitly (using special XML elements). However, since files containing custom code are referenced in XML elements for custom commands, those files can be identified and moved to the first removable media by examining how they are referenced in the deployment descriptor.

2. **Files to be laid down during installation:** Also called "payload," those are the files to be copied to the target host during installation. Examples include the Java class files, shared libraries, executables, DLL, etc.

   Binding information for those files is specified in the media descriptor (see Section 4.3, "File Binding Information").

Since symbolic links are not supported consistently in all physical formats and the behaviors vary on different platforms, symbolic link support must not be assumed for IU packages. For example, ZIP files can not contain symbolic links, UNIX system symbolic links behave differently from the shortcuts on Windows. As a result, symbolic links can not be maintained in IU packages. Symbolic links should be created during installation using, for example, the `<addLink>` element (see [ACAB.SD0402]).

3.1.4 Optional Files

There are non-manifest files in an IU packages that are specified in neither the deployment descriptor nor the media descriptor. These files may be used by a particular installer technology during installation, or may provide useful information (such as "readme" files) that helps users install the package. They are usually included in IU packages to make the packages self-contained (for example, an executable JAR package file for Java-based install technologies) so the packages can be installed without additional prerequisites. This is also an important usability feature that allows vendor-specific functions to be included in the IU packages.

The only requirement for those files is that the installation of the IU package must not depend on the presence of those optional files. Namely, if the optional files are removed from the IU package and the resulting IU package is still valid and can still be installed according to the information specified in the deployment descriptor.

For example, for a Java-based install technology, the optional files could include the install engine, bundled JVMs (to be extracted and installed first on the target in order to execute the install engine), etc. In this case, the IU package is self-contained and the packaged install engine can be invoked to install the IU package. Those optional files can be safely removed from the IU package since the package without the optional files can still be installed using an external install engine that knows how to process IU packages.

Another example is that an install vendor could provide additional files containing help or information that provides guidance in aggregating the IU. This information may be used by the specific vendor installation IDE to improve usability.

3.2 Aggregation

An installable unit, or IU, package (the *aggregating* IU) may aggregate other IU packages (the *aggregated* IUs). The aggregation relationship is defined in the deployment descriptor of the aggregating IU by specifying linkage to the deployment descriptor of the aggregated IUs. This is defined in the IU deployment descriptor specification and related XML schema (see [ACAB.SD0402]).

There may be multiple levels of aggregation. However, examples in this section use a single level of aggregation.

Aggregated IUs may be included "in-line" in the aggregating IU, or referenced externally from the aggregating IU. Based on the aggregation relationship, aggregated IU packages may exist in the aggregating IU package or in an external package for the aggregated IU. Thus, when an IU aggregates other IUs, there may be multiple IU packages (including the one for the aggregating IU) required to be processed in order to deploy the aggregating IU.

Figure 3 illustrates an example of in-line and external IU aggregation. In-line and external aggregation relationships will be described in detail in the following sections.

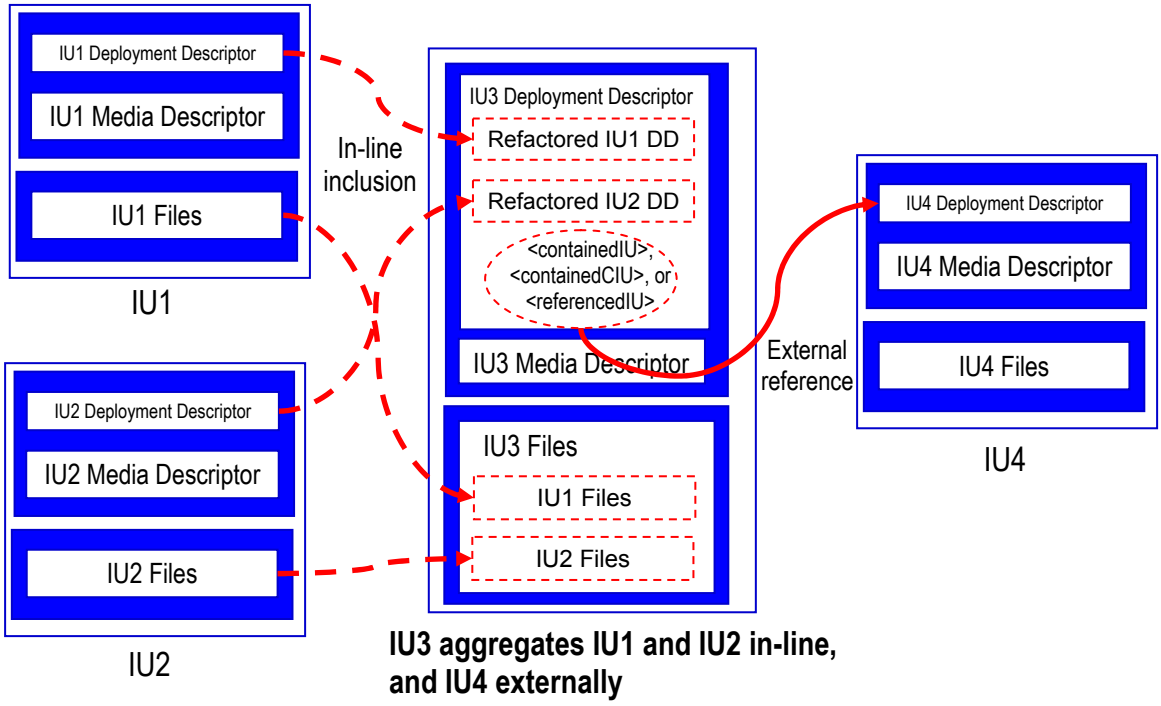


Figure 3 In-line and External IU Aggregation

3.2.1 In-line Aggregation

When an IU is aggregated in-line, its package contents are included as part of the aggregating IU package. Such aggregation should be conducted by a package creation tool (see Section 10, “Tooling”).

The aggregated IU deployment descriptor contents are refactored and included in the aggregating IU deployment descriptor. In the IUDD schema, the `<installableUnit>` element defines in-line aggregation relationship using Smallest Installable Unit (SIU), Configuration Unit (CU), Container Installable Unit (CIU), or Solution Module (SM), each of which specifies in-line aggregated IU.

For example, in Figure 3, `IU1` deployment descriptor is included as part of `IU3` deployment descriptor.

The process of refactoring aggregated IU deployment descriptors for in-line aggregation is dependent on the aggregation relationships as defined in the aggregating IU deployment descriptor (see [ACAB.SD0402]), and is outside of the scope of this specification.

In-line aggregation is used when the aggregated IU contents are available at the time of creating the package of aggregating IU. The aggregated IU files are specified in the aggregating IU (via the `<file>` element), and they are packaged in the aggregating IU package. Those files can be bound or relocated, like other aggregating IU files, through the aggregating IU media descriptor.

For example, in Figure 3, `IU1` files are part of `IU3` package and can be bound by the `IU3` media descriptor.

3.2.2 External Aggregation

When an IU is aggregated through external references, its package exists separately in its entirety. The aggregation relationship is defined via the use of elements of the type `iudd:ReferencedIU` that references the *deployment descriptor* of the aggregated IUs. Such elements include the `<containedIU>`, `<containedCIU>`, and `<referencedIU>` elements (see [ACAB.SD0402]).

The aggregated IU package is a complete IU package that has manifest and packaged files. Since all manifest files are co-located, through the reference to the deployment descriptor, the media descriptor and other package files of the aggregated IU can be located.

The external reference is reference to a `<file>` element that can be bound or remapped through the media descriptor of the aggregating IU. This is illustrated in Figure 4.

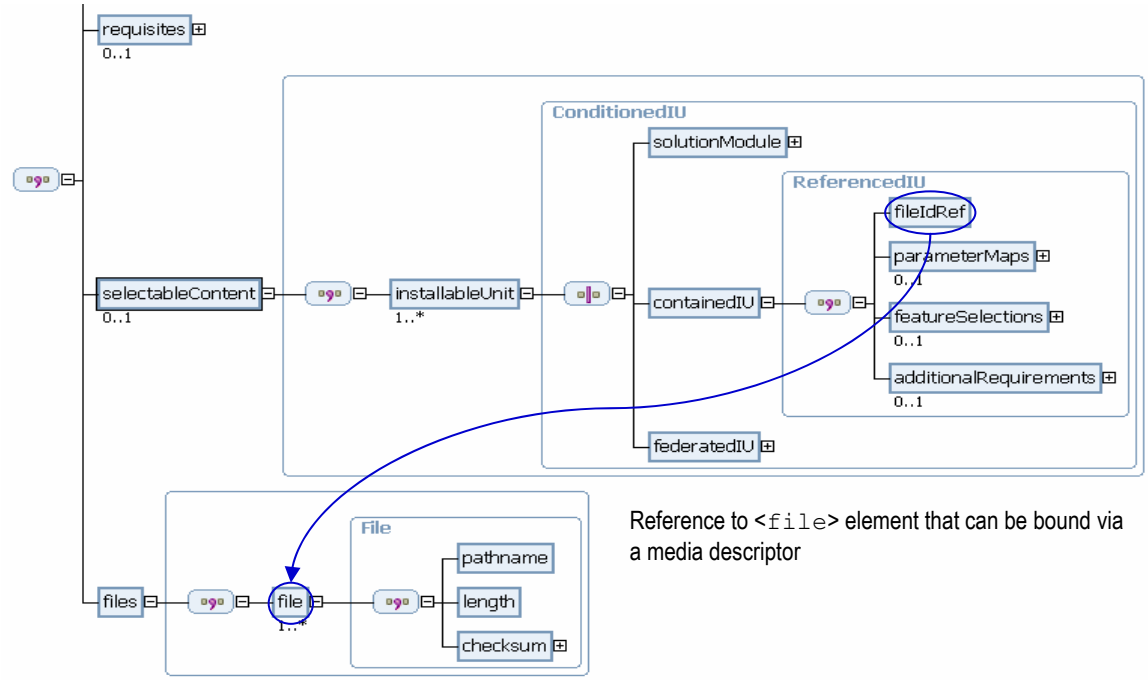


Figure 4 IUDD Schema: External IU Aggregation

The location and package type of the aggregated IU are flexible. Through the use of the media descriptor (see Section 4, "Media Descriptor"), the deployment descriptor location can be a local path, a folder in a ZIP file, a folder on a removable media, or any location in the network. This flexibility allows the aggregated IU package to be a single ZIP file, files on removable media, or files in local or network file systems (see Section 5, "Package Types").

For example, in Figure 3, `IU4` is aggregated by `IU3` through external reference. `IU4` media descriptor and associated packaged files can be located via the location of the deployment descriptor. The `IU4` package can be a ZIP file, a set of files on fixed-sized removable media, or a set of files in local or network file systems.

An externally aggregated IU package may be included as part of the aggregating IU package. Through the reference to its deployment descriptor, the aggregated IU package can be identified and manipulated (such as extraction). For example, in Figure 3, `IU4` package can be a ZIP file inside the `IU3` ZIP package. `IU4` ZIP package can be identified (through the reference in the deployment descriptor) and extracted if necessary.

There is no special requirement on how the pathnames (or file structure) for the referenced IU deployment descriptors should be arranged in the referencing IU. However, in the case of fixed-sized removable media, all (root or referenced) IU deployment descriptors should be located in specific folders on the first media, regardless of what is defined in the root IU deployment descriptor. This should be done through the use of media descriptor (see Section 4, "Media Descriptor").

4 Media Descriptor

The deployment descriptor specifies *what* files are in an IU package, but not *where* they are. Information about the file physical location (the *binding* information) is kept in a separate, optional media descriptor. This allows the same deployment descriptor to be used for different physical packages. Each physical IU package may have a media descriptor providing file binding information that describes specifically where each file is physically located. Only the files specified in a deployment descriptor can be bound in the associated media descriptor. If a file needs to be bound and accessed via the media descriptor, it must be specified in the IU deployment descriptor.

A media descriptor is optional. If it is not present, all files specified in the deployment descriptor have paths relative to the location of the deployment descriptor in the package. An installer can choose to override this default value via, for example, an install parameter.

There is at most one media descriptor per IU package to provide binding information for files defined in the deployment descriptor. If an IU package is aggregated in another IU package (see Section 3.2, “Aggregation”), the referenced deployment descriptor may have an optional associated media descriptor for the aggregated IU.

The following information is kept in a media descriptor:

1. The corresponding deployment descriptor path name relative to the media descriptor.

2. A default logical source may be defined and apply to files that are not explicitly bound in this media descriptor

3. Physical locations of the files in this package

4. Optionally the media descriptor can override the file path for selected files. This feature can be used to map to common files shared by several IUs.

   Note the path overridden is the location of the file within the package (see Section 5, “Package Types”). If the file path in the deployment descriptor is used for other purposes (for example, for intended install location), the original value in the deployment descriptor can still be used.

4.1 Overview and UML Representation

The UML class diagram in Figure 5 identifies the media descriptor structure and the relationship to the IU deployment descriptor.

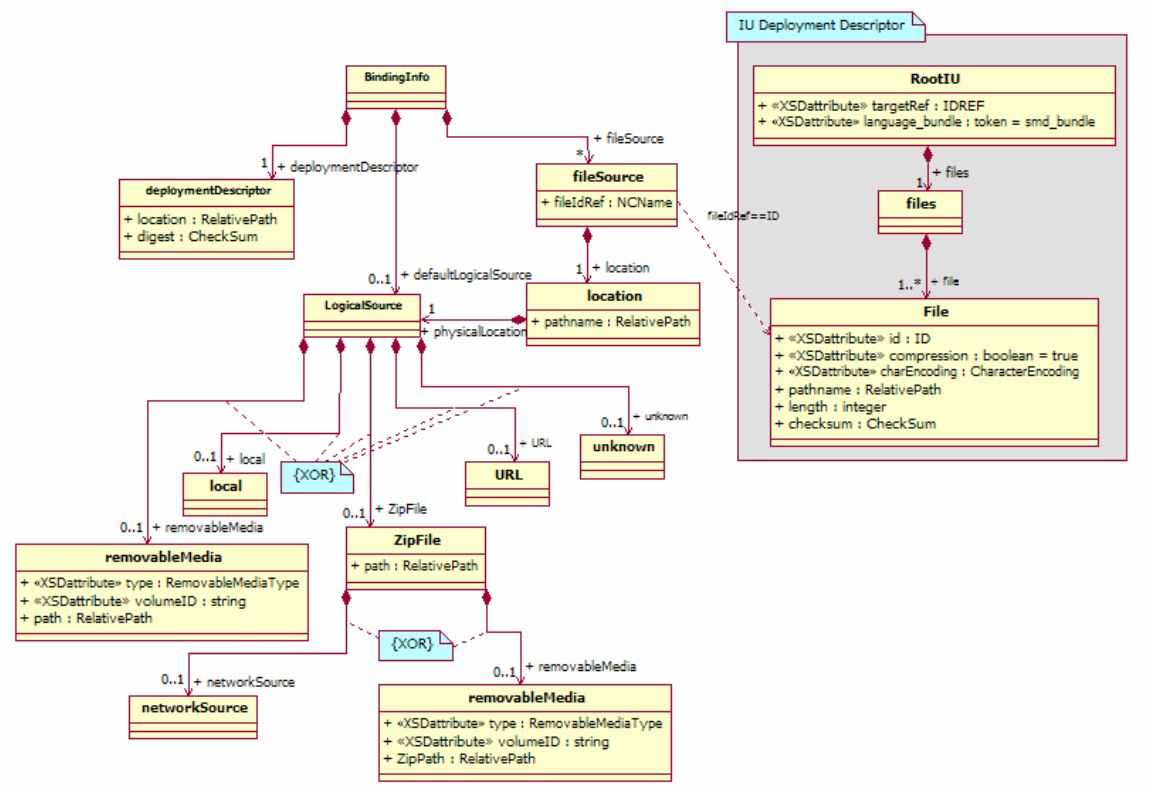


Figure 5 Media Descriptor Structure

The media descriptor XML schema overview is shown in

Figure 6.

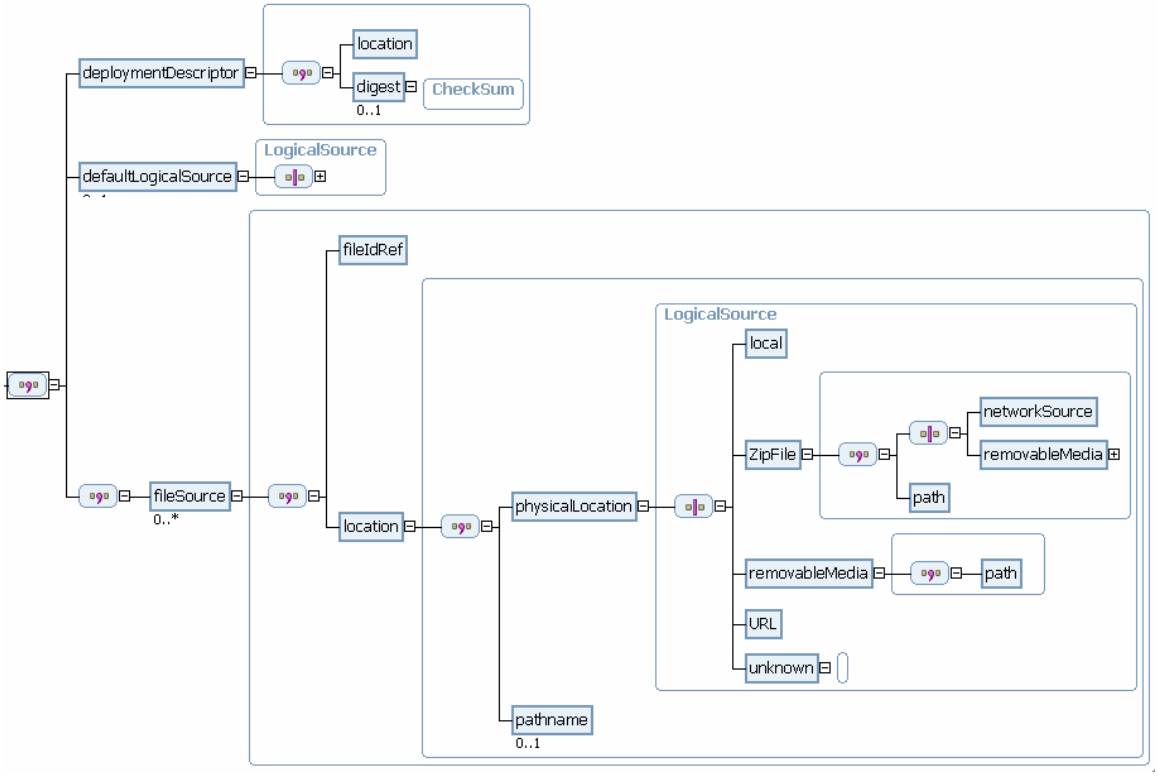


Figure 6 Media Descriptor Schema Overview

The root element in a media descriptor is `<binding>` of type `BindingInfo` which consists of the following information:

1. Element **deploymentDescriptor**
   The associated IU deployment descriptor. See Section 4.2.

2. Element **fileSource**
   The physical location, or the *binding* information, of the files specified in the IU deployment descriptor. A file defined in the IU deployment descriptor has at most one `fileSource` element in the associated media descriptor. See Section 4.3.

3. Element **defaultLogicalSource**
   This is the default physical location for files not explicitly bound via the `fileSource` element. This element is optional. See Section 4.4.

The relationship between the deployment descriptor and the media descriptor is illustrated in Figure 7. Details will be given in the remainder of this section to show how a media descriptor provides binding information for the associated deployment descriptor.

Note that the file size and digest information are specified in the deployment descriptor and *cannot* be overridden in the associated media descriptor. This ensures the file contents remain the same as they were when the deployment descriptor was created. These two pieces of information are used in signing and verifying IU packages (see

Section 6, “Security”). Again, the media descriptor can only specify *where* the files are, not *what* they are.

Through the use of media descriptors, different files – as defined in the same or different deployment descriptors – can be *mapped* to the same physical file. This provides flexibility for reducing the IU package size by sharing files.

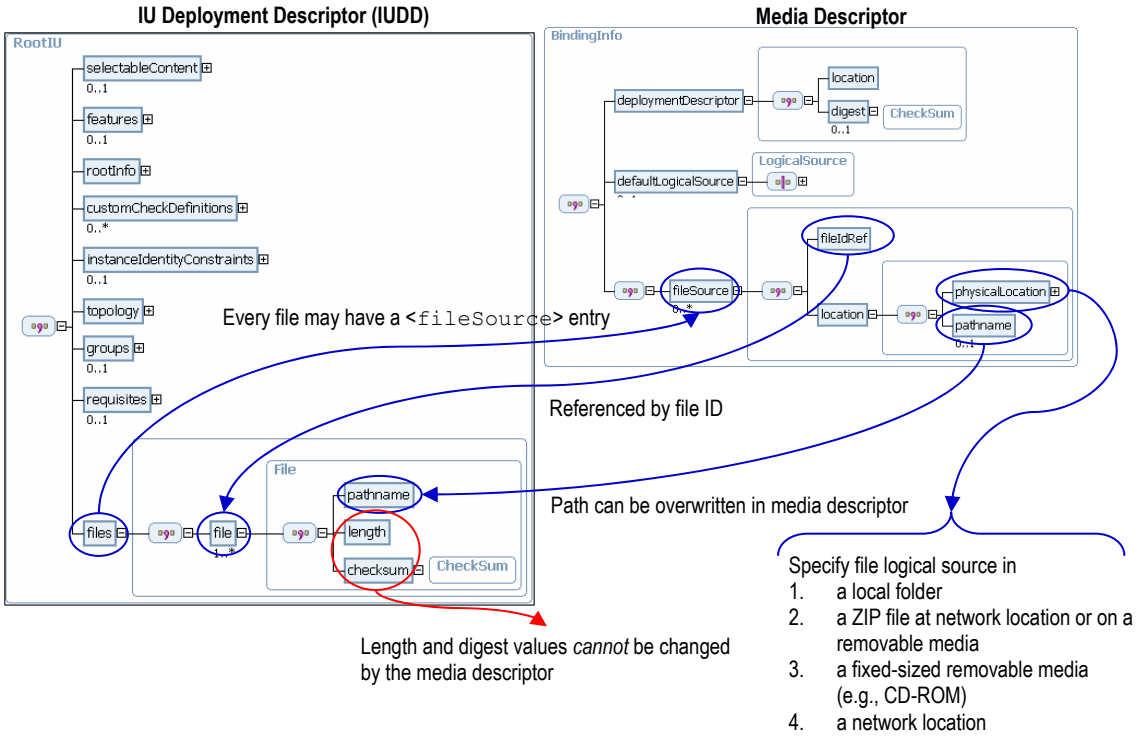


Figure 7 Deployment Descriptor and Media Descriptor

4.2 Deployment Descriptor Information

A media descriptor specifies the associated deployment descriptor information via the following elements:

- Element **location** [type=base:RelativePath]
  This is the deployment descriptor physical path. The path is relative to the media descriptor and links the media descriptor to the associated deployment descriptor. The current design requires deployment descriptor and media descriptor be located in the same folder and have fixed names, thus this path name is fixed and has ‘`packagedIU.xml`’ as the value.

  In the future this pathname can be used to locate the deployment descriptor if manifest files do not have fixed names or are located at different locations.

- Element **digest** [type=base:CheckSum]
  This is the optional message digest for the *entire* deployment descriptor. The optional digest value is used for security purposes (see Section 6, “Security”).

Below is the XML schema fragment for the deployment descriptor information in a media descriptor.

```
<element name="deploymentDescriptor">
  <complexType>
    <sequence>
      <!-- The IUDD (deployment descriptor) path relative to the media
      descriptor -->
      <element name="location" type="base:RelativePath"/>

      <!-- The digest value for the entire deployment descriptor -->
      <element name="digest" type="base:CheckSum" minOccurs="0">
        <annotation>
          <documentation>
            This is the digest value for the entire deployment
            descriptor.
          </documentation>
        </annotation>
      </element>
    </sequence>
  </complexType>
</element>
```

4.3 File Binding Information

Files specified in a deployment descriptor have paths relative to *logical sources.* A logical source, depending on the package types, can be mapped to any physical location. This allows the files to be packaged in a way that meets the user scenarios and needs. The mapping of logical sources is defined in the media descriptor.

If a media descriptor is not present, the default value of the logical source for *all* files defined in the deployment descriptor is the folder of the deployment descriptor.

The logical source information for a file consists of the following elements:

- Element **fileIdRef** [type=NCName]
  This is the value of the attribute `ID` for the corresponding `file` element in the IU deployment descriptor (see Figure 5 and Figure 7). For any `fileIdRef`, there must be a corresponding `file` element with a matching `ID` value in the associated deployment descriptor. For any file in the deployment descriptor, there should be at most one corresponding entry in the media descriptor.

  Below is the XML schema fragment for the `fileIdRef` element.

```
<element name="fileSource" minOccurs="0" maxOccurs="unbounded">
  <complexType>
    <sequence>
      <!-- The id for the iudd:File entry -->
      <element name="fileIdRef" type="NCName">
        <annotation>
          <documentation>
            This is the 'id' attribute of the iudd:File element in
            the IUDD file associated with this media descriptor.
          </documentation>
```

```
            </annotation>
          </element>
```

- Element **location** [anonymous type]
  For the specific file, this element defines the physical location of the logical source, and optionally overrides the file path. The physical location of the specific file is the logical source plus the file path.

  A media descriptor can only specify the physical locations for the logical sources, or override the file path. It can not modify the file sizes and digest values.

The `location` element consists of the following elements:

- Element **physicalLocation** [type=media:LogicalSource]
  This is the physical location of a file logical source. The physical location for a logical source can be a local path, a path in a separate ZIP file, a path on a fixed-sized removable media (such as CD-ROM), or any network location.

  A physical location is of the type the `media:LogicalSource` which is described in Section 4.3.1.

- Element **pathname** [type=base:RelativePath]
  This optional element defines a new file path relative to the physical logical source. If the file path is specified in the media descriptor, the one in the deployment descriptor will be ignored.

  Below is the XML schema fragment for the `pathname` element.

```
<!-- Optional new pathname. This value will override the
one defined in the deployment descriptor. -->
<element name="pathname"
  type="base:RelativePath" minOccurs="0">
  <annotation>
    <documentation>
      Optional new pathname. This allows mapping to
      different file path (including file name). If this
      is specified, the pathname in the 'file' element
      of the deployment descriptor is ignored. This path
      is relative to the physical source identified in
      the "physicalLocation" element.
    </documentation>
  </annotation>
</element>
```

4.3.1 Logical Source

The `LogicalSource` type specifies one of the following physical location types:

- Element **local** [type=base:RelativePath]
  This is a path relative to the media descriptor folder (which could be in a ZIP file, file system, network location, or fixed-sized removable media). This is typically used when the IU package is a ZIP file or located in a network location. For example, if the media descriptor is in the `/META-INF/` folder of a ZIP file, and a file is located in the `/FILES/` folder, the logical source should be a local path

'`../FILES`.'

Below is the XML schema fragment for the `local` element.

```
<choice>
  <!-- Local. Relative to the folder of the media descriptor. For example,
  in a ZIP file, this is relative to the /META-INF folder -->
  <element name="local"
    type="base:RelativePath">
    <annotation>
      This specifies a local path relative to the folder of the
      media descriptor.

      This path is a relative path and cannot begin with '/'.
    </annotation>
  </element>
```

- Element **removableMedia** [anonymous type]
  This element specifies a location in a fixed-sized removable media such as a CD-ROM. Such location is identified through the volume identifier and a path in the volume.

  Fixed-sized removable media (for example, CD-ROM and DVD) is a common package format for installation. Files could be located on such media. Due to its fixed-sized nature, there could be multiple volumes for large IU packages. For files located on such media, a volume identifier is given and a path relative to the specified volume root is specified.

  The removal media information is specified by

  - Element **path** [type=base:RelativePath]
    The file location on the media. This is always a relative path and is relative to the root of the media.

  - Attribute **type** [type=media:RemovalMediaType]
    This specifies the type of the media where the ZIP is located. Currently the supported media types (as defined in the "`RemovableMediaType`" type) are: CD-ROM, DVD, Diskette, and others.

  - Attribute **volumeID** [type=xs:string]
    This is the volume identifier for the specific media where the ZIP file is located. This value is used to identify the media. The installer processing this information will know how to locate the physical media based on the volume ID. The logic could be vendor or installer specific, and is outside the scope of this specification.

  Below is the XML schema fragment for the `removableMedia` element.

```
<!-- Removable Media (CD, DVD, etc.) -->
<element name="removableMedia">
  <annotation>
    <documentation>
      This support is for fixed size removable media such as CD or
```

```
            DVD. The package could span multiple such media. The number is a
            positive integer identifying the specific media. The logic of
            locating the specific media is outside of the scope of this
            schema and spec.
          </documentation>
        </annotation>
        <complexType>
          <sequence>
            <element name="path"
              type="base:RelativePath">
              <annotation>
                <documentation>
                  This path is relative to the specific media root. This is
                  where the filepath is relative to.

                  This path cannot begin with a "/."
                </documentation>
              </annotation>
            </element>
          </sequence>
          <!-- The storage media type. Currently only common storage types
          are supported. It is up to the consumer of the media descriptor to
          access each medai type. Maybe more info about the storage type is
          needed. -->
          <attribute name="type" use="required"
            type="media:RemovableMediaType">
          </attribute>
          <!-- The removable media volume identifier. -->
          <attribute name="volumeID"
            type="string" use="required"/>
        </complexType>
      </element>
```

- Element **ZipFile** [anonymous type]
  This specifies a folder in a ZIP file. ZIP [ZIP] is a commonly used compression format but the access to ZIP file is different from the access to regular file systems – the process requires decompression of the contents. So locations of this type need to be specified so installers can properly access the files.

  This is typically used in aggregation (see Section 3.2, “Aggregation”) when the file is a deployment descriptor in another IU ZIP package. For example, if the file path is ‘`packagedIU.xml`’ to indicate an aggregated IU deployment descriptor (through external aggregation) and the aggregated IU package is a ZIP file, this file should be mapped to `‘/META-INF/packagedIU.xml’` in the aggregated IU ZIP package.

  ZIP files can be located in a network location (including local, relative locations) or in a fixed-sized removable media such as a CD-ROM. In either case, a path within the ZIP file is specified by

  - Element **path** [type=base:RelativePath]
    The file path within the ZIP file. This is always a relative path and is relative to the root of the ZIP file.

  If the ZIP file is located in the network location, it is specified by

- Element **networkSource** [type=xs:anyURI]
  This specifies a location on the network. This value can be absolute or relative. A relative value can be used to specify a local ZIP file.

If the ZIP file is in a fixed-sized removable media, it is specified by

- Element **ZipPath** [type=base:RelativePath]
  This specifies the location of the ZIP file on the media. This is always a relative path and is relative to the root of the media.

  Note the difference between this value and the above **path** element which specifies the file path within the ZIP file.

- Attribute **type** [type=media:RemovalMediaType]
  This specifies the type of the media where the ZIP is located. Currently the supported media types (as defined in the "`RemovableMediaType`" type) are: CD-ROM, DVD, Diskette, and others.

- Attribute **volumeID** [type=xs:string]
  This is the volume identifier for the specific media where the ZIP file is located. This value is used to identify the media. The installer processing this information will know how to locate the physical media based on the volume ID. The logic could be vendor or installer specific, and is outside the scope of this specification.

Below is the XML schema fragment for the `ZipFile` element.

```
<element name="ZipFile">
  <annotation>
    This specifies the folder in a separate ZIP file. The folder is
    relative to the root of the Zip file. The ZIP file can be at any
    network location or on a fixed-sized removable media.
  </annotation>
  <complexType>
    <sequence>
      <choice>
        <!-- The ZIP file could be at a network location -->
        <element name="networkSource" type="anyURI"/>
        <!-- Or it could be on a CD/DVD/etc. -->
        <element name="removableMedia">
          <complexType>
            <sequence>
              <element name="ZipPath"
                type="base:RelativePath">
                <annotation>
                  <documentation>
                    The ZIP file path on the specific media. The path
                    is relative to the root and cannot begin with a
                    "/."
                  </documentation>
                </annotation>
              </element>
            </sequence>

            <attribute name="type" use="required"
```

```
                  type="media:RemovableMediaType"/>
                <!-- The removable media volume identifier. -->
                <attribute name="volumeID"
                  type="string" use="required"/>
              </complexType>
            </element>
          </choice>
          <!-- Path in the ZIP file relative to the root of
          the ZIP file -->
          <element name="path"
            type="base:RelativePath">
            <annotation>
              <documentation>
                This path is relative to the root of the ZIP file. It is a
                relative path and should not begin with a "/."
              </documentation>
            </annotation>
          </element>
        </sequence>
      </complexType>
    </element>
```

- Element **URL** [type=anyURI]
  This specifies a location on the network. This is any URI that allows the file to be anywhere on the network. This can be used to locate, for example, a deployment descriptor of an external aggregated IU package which exists on the network.

  Below is the XML schema fragment for the `URL` element.

```
    <!-- Network Location -->
    <element name="URL" type="anyURI">
      <annotation>
        <documentation>
          This points to any network location.
        </documentation>
      </annotation>
    </element>
```

- Element **unknown** [anonymous type]
  This specifies that the file is not bound and does not exist at any physical location. Such files might be bound later either via a modified media descriptor or directly by install parameters. For those files, their logical source physical locations are simply unknown and must be specifically marked as unknown.

  The following is the XML schema fragment for the `unknown` element.

```
    <!-- Unknown Location -->
    <element name="unknown">
      <annotation>
        <documentation>
          This indicates that the file is still not bound.  Not all the
          files need to be bound in an media descriptor. For example, an
          IU ZIP package could reference files located on the network. The
          network locations might not be known when the media descriptor
          in the ZIP file was created.

          Media descriptors can have unbound files. However, each file
          needs to be bound for the IU package to be processed.
        </documentation>
      </annotation>
      <complexType/>
    </element>
  </choice>
</complexType>
```

4.3.2 Default Logical Source

A default logical source may be explicitly defined in a media descriptor using the <defaultLogicalSource> element.

```
      <!-- Optional default logical source that is used for all files that
      do not have corresponding entries in the next section. This value
      overwrites the pre-defined default logical source (which is the
      deployment descriptor location). -->
      <element name="defaultLogicalSource"
        type="media:LogicalSource"
        minOccurs="0">
        <annotation>
          <documentation>
            This optional default logical source that is used for all files
            that do not have corresponding entries in the next section. This
            value overwrites the pre-defined default logical source (which
            is the deployment descriptor location).
          </documentation>
        </annotation>
      </element>
```

This is particularly useful when most of the files are relative to the same logical source.

The following example shows that, in the simplest case, all files defined in the deployment descriptor are relative to a sibling folder ‘FILES’ of the manifest folder.

```
<?xml version="1.0" encoding="UTF-8"?>
<media:binding
xmlns:media="http://www.ibm.com/namespaces/autonomic/solutioninstall/MEDIA"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.ibm.com/namespaces/autonomic/solutioninstall/MEDIA
media.xsd">
  <deploymentDescriptor>
    <location>packagedIU.xml</location>
    <digest type="MD5">6CE903B30B410F8A9E6BCF1F05A74864</digest>
  </deploymentDescriptor>
  <defaultLogicalSource>
    <local>../FILES</local>
  </defaultLogicalSource>
</media:binding>
```

4.4 File Binding Rules

For any file specified in the deployment descriptor, it must be either

- Bound explicitly or implicitly using the default logical source, or
- Unbound explicitly in the media descriptor using the <unknown> child element of the <physicalLocation> element (see Section 4.3, “File Binding Information”).

Unbound files in an IU package must be bound before the IU package is deployed. The program deploying the IU package should provide the binding information for all unbound files. This should be done by updating the media descriptor and replacing the <unknown> elements with proper binding information.

The following is the file binding algorithm for files specified in the deployment descriptor:

1. If the media descriptor file is not present, *all* files are located relative to the deployment descriptor location

2. If the media descriptor file is present

    a. If a file physical location is specified using `<unknown>` element, the file is not bound.

    b. If a file physical location is specified (see Section 4.3, "File Binding Information"), the file is located relative to the physical location as defined.

    c. If a file physical location is not specified

        i. If the default logical source is specified in the media descriptor (see Section 4.3, "File Binding Information"), the file is located relative to the default logical source as defined.

        ii. Otherwise, the file is located relative to the deployment descriptor location.

Applications deploying IU packages must follow the above file binding rules to locate files on physical media.

Note that a file being bound does not necessarily guarantee that the file is in the physical package. If any one of those files is missing in the installable unit package, the package is not valid (see Section 13, "Glossary of Terms"). Proper tooling should be used to validate an installable unit package (see Section 10, "Tooling").

It is not easy to maintain both the IU deployment descriptor and the media descriptor and keep the binding information synchronized. The binding rules described above suggest a best practice for providing binding information that requires minimum synchronization:

1. First, one should identify the most common physical layout for the installable unit package, and then assign the file paths in the IU deployment descriptor as relative to the folder of the deployment descriptor. Such arrangement allows the common physical format to be used *without* the need for a media descriptor (see the file binding rule #1 above) when possible.

    For example, if the package is most likely offered a ZIP file (see Section 5.1, "Single Zip File"), all file paths should be relative to the `/META-INF/` folder where the IU deployment descriptor resides. This allows the media descriptor to be optional in the ZIP package. And if the same layout is used for the package on a network location, media descriptor is not needed either.

2. If the IU package is offered in a different format that has a layout different from the one specified in the IU deployment descriptor, one should provide a media descriptor and map files to correct physical locations.

This recommended approach minimizes the need for a media descriptor for the common physical layout for the IU package, and uses the media descriptor to remap files to different physical layouts when necessary.

5 Package Types

This specification covers four physical IU package types that are commonly used by install technologies. This section defines standard package formats that can be processed by any installer technologies such as a software provisioning manager in an on-demand environment. However, the design also intends to allow enough implementation flexibilities and value-add extensions by installer vendors.

The four IU package types are: single Zip file, fixed-sized removable media, network location, and single executable.

5.1 Single Zip File

The first package type is in the ZIP file format ([ZIP]). In this format, all the installable unit files are packaged in a single ZIP file. Operations that can be applied to a ZIP file include lossless data compression ([ZLIB]), archiving, decompression, and archive unpacking. There are tools (for example, the JAR toolset in the JDK) and APIs (for example, the Java `java.util.zip` interfaces) available for ZIP operations. The detailed description of the ZIP file format and related operations is out of the scope of this specification.

The specific structure of an IU package ZIP file is defined as follows.

5.1.1 Manifest Files

All the manifest files (as defined in section 3.1.1, “Manifest Files”) must be located in the `/META-INF` folder. And the installer processing IU package ZIP files should always look for the manifest files in the `/META-INF` folder.

Other files in the package can be in any folder. But it is recommended that files be created outside the `/META-INF` folder.

- Deployment descriptor: the top level deployment descriptor for the IU must be named `packagedIU.xml`. Deployment descriptors for the child (referenced) IUs must also be named `packagedIU.xml` and located in folders outside the folder of the top level deployment descriptor.

  All file entries in the deployment descriptor have pathnames relative to the logical sources defined in the media descriptor (see Section 4, “Media Descriptor”).

- Media descriptor: the media descriptor must be named `IUMedia.xml`. The media descriptor specifies physical locations of files defined in the deployment descriptor.

  The file binding is straightforward (see Section 4, “Media Descriptor”). Files

defined in the deployment descriptor can reside anywhere inside or outside the ZIP file. However, it is recommended that an IU ZIP package should have all the files in the ZIP file.

- Digital signature `IUMeida.DSA` or `IUMedia.RSA`. See Section 6, "Security".

Figure 8 shows an example of how the binding information works for the files in the IU ZIP package. Local locations are used for referencing files in the ZIP file. Since local locations are relative to the folder of the media descriptor (`/META-INF`), "`../FILES`" is used to refer to folder `/FILES`.

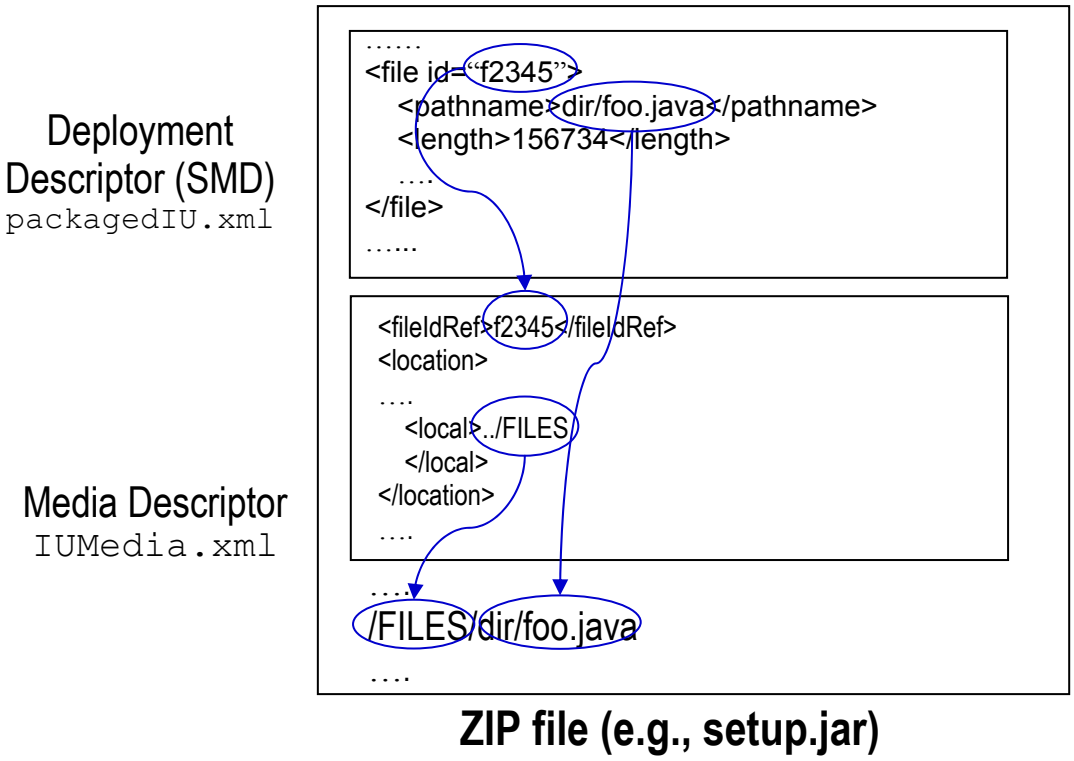


Figure 8 File binding information in the IU ZIP package

5.1.2 Non-Manifest Files

All the required files must have file entries in the deployment descriptor. The binding information should exist in the media descriptor. All files can reside anywhere inside or outside the ZIP file.

It is recommended that the custom install code be located in the `/FILES/CUSTOM` folder, and the payload files be located in the `/FILES` folder.

Optional files are not defined in the deployment descriptor, so there is no binding information in the media descriptor.

5.1.3 Aggregating IU ZIP Packages

Here is an example of an IU package referencing and including another IU ZIP package. In particular, it is shown how to bind the referenced IU deployment descriptor to the file in the ZIP package.

Suppose `IU1` references `IU2` in the `IU1` deployment descriptor as a file of pathname '`iu2/packagedIU.xml`' with file ID '`IU2_DD`.' If the `IU2` package is a ZIP '`iu2.zip`' included in `IU1` package under the '`/pkg`' folder, `IU1` media descriptor must contain proper binding information to map the file '`iu2/packagedIU.xml`' to `IU2` deployment descriptor file `/META-INF/packagedIU.xml` in '`iu2.zip`.'

As shown in Figure 9 below, the binding is achieved by mapping the `IU2` deployment descriptor (file with ID '`IU2_DD`' in `IU1` deployment descriptor) logical source to the folder `/META-INF/` in the ZIP file `/pkg/iu2.zip` included in `IU1` package. Note that since the '`IU2_DD`' file pathname is '`iu2/packagedIU.xml`' in `IU1` deployment descriptor, the path has to be overwritten to '`packagedIU.xml`.' The new pathname plus the logical source maps to the `/META-INF/packagedIU.xml` file in `IU2` package.

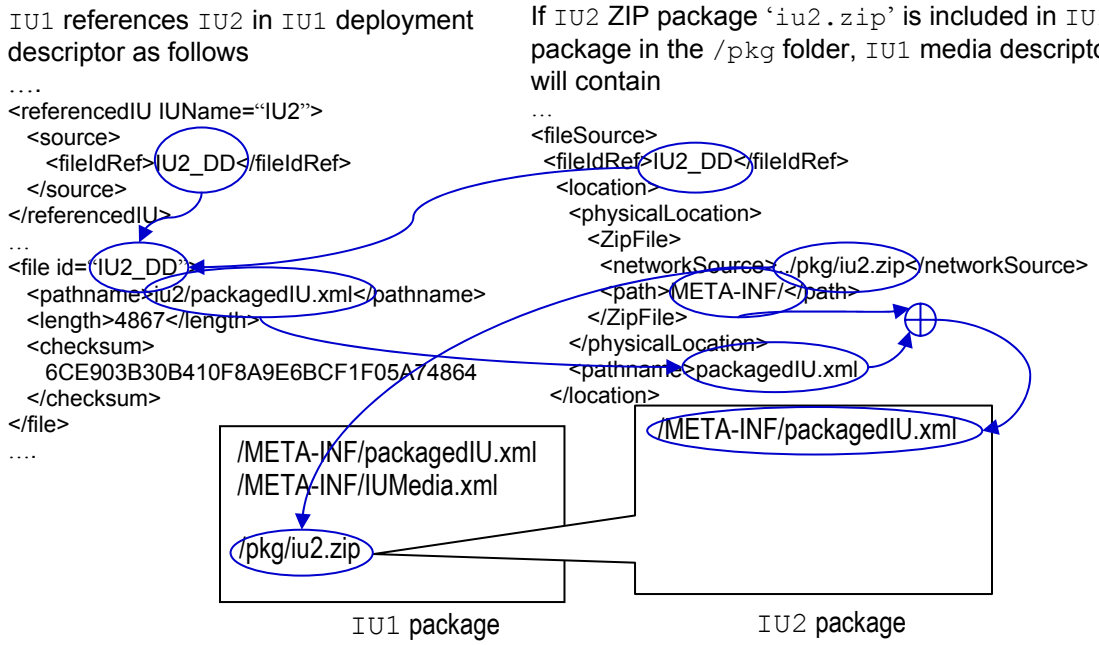


Figure 9 Aggregating a Referenced IU ZIP Package

5.2 Fixed-sized Removable Media

Fixed-sized removable media is a commonly used storage format. Examples include CD-ROM, DVD, Diskette, etc. The main characteristic of this package format is that the IU

package might be too big to fit on one single media, and the whole package may be split into one or more fixed-sized "volumes," each of which is stored on one media. In order to access a file identified in the deployment descriptor, specific media needs to be loaded. Thus the binding following are needed for files on fixed-sized removable medias:

1. A media volume ID string. This information should be used by the application processing the IU package to verify or locate the specific media volume. Although out of the scope of this specification, for well known media formats such as CD-ROM, DVD, or diskettes, there are standard ways to identify and retrieve the media volume information.

2. A pathname of the file on that specific media. In the media descriptor, the pathname for logical source is specified, which is used to construct the physical file pathname on the specific media volume.

Figure 10 illustrates an example of how the media descriptor is used to bind to files on a particular CD volume. In the example, a file is specified in the deployment with ID '`f2345`' and pathname '`dir/foo.java`.' The logical source of this file is '`/FILES`' folder on the CD volume '`cd4`.' This information is specified via the `<removableMedia>` element in the media descriptor: the `volumeID` attribute is set to '`cd4`,' and the `type` attribute is set to '`CDROM`.' The `<path>` element sets `/FILES` as the physical location of the logical source, thus makes the physical path of the file to be `/FILES/dir/foo.java` on CD volume '`cd4`.'

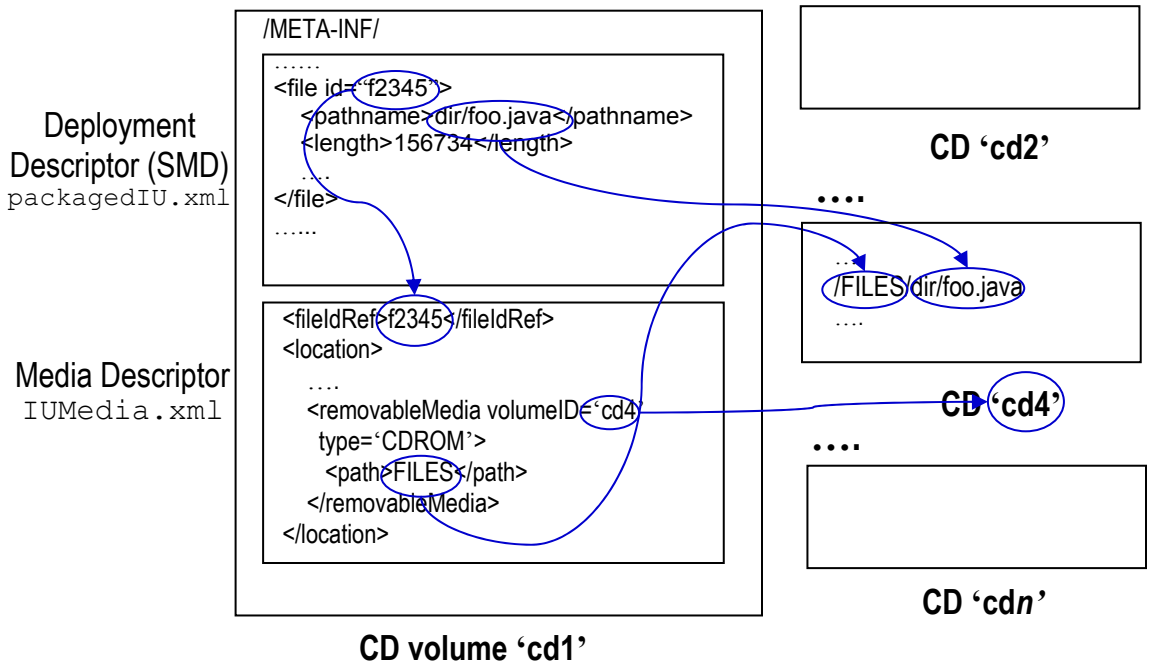


Figure 10 Fixed-sized Removable Media Example: IU Package on Multiple CDs

This specification does not cover how the package is split and how the volume sizes are determined. Also, the identification of the fixed-sized removable media (through the volume ID) and the access of the files on the media are out of the scope of this specification.

5.2.1 Manifest Files

The manifest files for the IU and child IUs should all be located in the `/META-INF/` folder in the *first* media. The IU manifest files should be defined as follows:

- Deployment descriptor: `packagedIU.xml`. File paths in the deployment descriptor are relative to respective logical sources. If a media descriptor is present, the binding is defined in the media descriptor. Otherwise, a default location is used for all logical sources.

- Media descriptor: `IUMedia.xml`. The logical sources are mapped to the media identifier plus the folder in the media.

- IUMedia.RSA or `IUMedia.DSA`: the digital signature containing the signed media descriptor and the public key certificate. See Section 6, “Security.”

When there are referenced (child) IUs, the manifest files for the root IU and the child IUs should be located in the following file structure on the first media:

- Referenced IU manifest files are located in the **/META-INF/*IUDIR*/META-INF** folder where *IUDIR* is defined as follows

    - For non-fix IUs (defined using the `<IUDefinition>` element; see [ACAB.SD0402]), it is the folder ***UUID* “-” *ver* “.” *rel* “.” *mod* “.” *lev*** (where *UUID* is the UUID for the IU, and *ver*, *rel*, *mod*, and *lev* are IU’s version).

      For example, a referenced IU of UUID “a01ee8dd1dd111b2a3f20800209a5b6b” and version 3.0.2.0 should have its manifest files in folder /META-INF/a01ee8dd1dd111b2a3f20800209a5b6b-3.0.2.0/META-INF

    - For fixes (defined using the `<FixDefinition>` element; see [ACAB.SD0402]), it is in the folder ***UUID* “-” *fixName*** where *UUID* is the UUID for the IU, and *fixName* is the fix name as defined in the `<fixIdentity>` element (see [ACAB.SD0402]).

      For example, a referenced fix of UUID “a01ee8dd1dd111b2a3f20800209a5b6b” and fix name “PTF4589” has its manifest files in folder /META-INF/a01ee8dd1dd111b2a3f20800209a5b6b-PTF4589/META-INF

Referenced IU manifest files are bound via the root IU media descriptor (since they are specified in the root IU deployment descriptor). Referenced IU payload files are bound via its own media descriptor (since they are specified in the referenced IU deployment descriptors).

5.2.2 Non-Manifest Files

Non-manifest files are located on the media. Required files physical locations are specified in the media descriptor using the volume identifier and the path on the specific volume. Optional files are not specified in the media descriptor although they are located on the media.

5.2.3 An Example

Suppose `IU1` references `IU2` and `IU3`. `IU2` is an IU and has UUID a01ee8dd1dd111b2a3f20800209a5b6b and version 2.1.0.0. IU3 is a fix and has UUID 8f64eabf1dd211b2a3f10800209a5b6b and fix name '`PTF43`'. Figure 11 shows that the manifest files for `IU1`, `IU2`, and `IU3` are all located on the first CD, and they follow the file structure as described in Section 5.2.1.

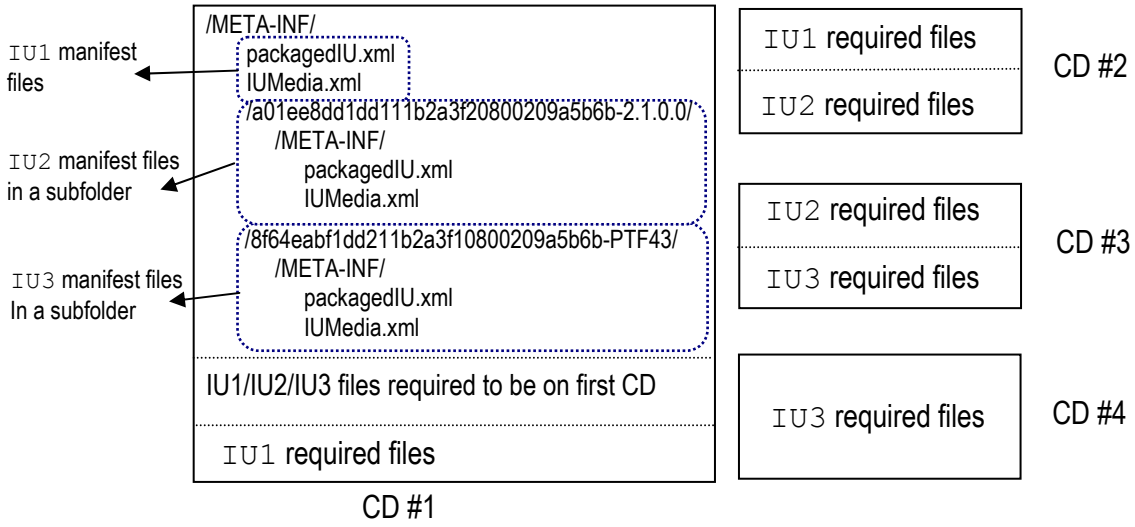


Figure 11 Referenced IU Manifest Files Are All Located On the First Media

5.3 Network Location

The package structure is similar to the ZIP package. All files including manifest files are located on the network and can be accessed using URI.

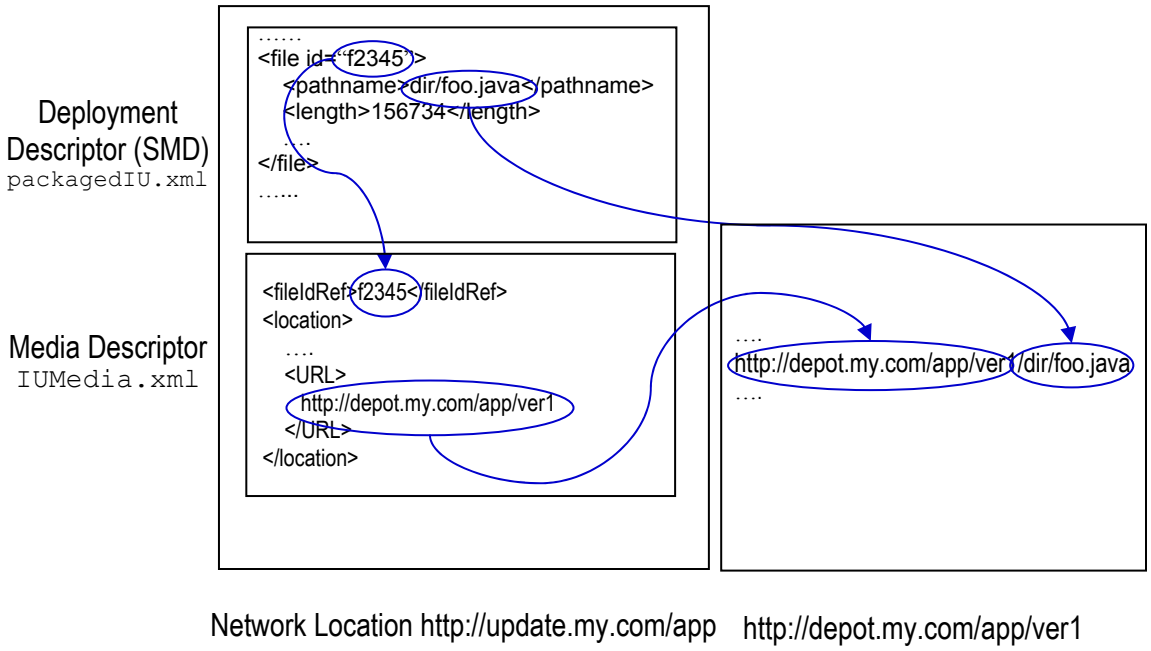


Figure 12 A IU Package Available From the Network

5.3.1 Manifest Files

- Deployment descriptor: `packagedIU.xml`. File paths in the deployment descriptor are relative to the respective logical sources. If a media descriptor is present, the binding is defined in the media descriptor. Otherwise, a default location is used for all logical sources.
- Media descriptor: `IUMedia.xml`. Logical sources are mapped to network locations via URIs.
- Digital signature: IUMedia.RSA or `IUMedia.DSA`. See Section 6, "Security."

5.3.2 Non-Manifest Files

All files can reside on the network and be accessible via URIs. Required files have binding information in the media descriptor. Optional files are not specified in the media descriptor.

5.4 Single Executable

Single executable files are self-contained and allow installation to take place by simply executing the files. All the files required for installation are included in the executables. Such executables are binary files and the format is platform specific and installer specific. Thus the format is *not* covered in this document.

Existing install technologies such as InstallShield (Windows or Multiplatform versions), Zero G, Wise, etc. all have the option to generate a single self-contained executable that allows “one-click” install. This is an important usability feature to most, if not all, install technologies.

However, in order for the executable install packages to be used in autonomic environments, there needs to be a standard way to generate the standard IU package formats defined in this specification. The requirement for executable install packages is that standard IU package formats or the logic to generate standard IU package formats is available from the executables.

To generate standard IU package formats, executables need to support one or more of the following command line options:

- -zip <file>: with this option, the executable can generate the IU package in a single ZIP file.

- -volume <dir>: with this option, the executable can generate the IU package for fixed-sized removable media format in possibly multiple volumes.

- -network <dir>: with this option, the executable can generate the IU package ready to put on a network location.

6 Security

One important requirement for the IU package design is to ensure the contents (manifest and other files) have not been tampered with before the IU package is deployed. In this section, a security architecture is defined to ensure the IU packages have not be changed after they are created. Installers (or any software modules) processing IU packages are required to support this security architecture. However, it is optional to enable the security feature for an IU package (see Section 6.1, "Signing IU Packages").

Another objective of this security model is that the signer can be identified and the identity can be validated by a fully trusted authority. This feature is important in particular when IU packages can be obtained from sources on the Internet. The package owner needs to be identified and validated before the package contents are installed and executed.

The IU package security architecture has a design similar to the one in the JAR security model. In essence, in this design the IU package is first *signed,* and a *digital signature* for the package is created and can later be used to *verify* the package. If contents have been changed after an IU package is signed, the verification will fail.

Since the IU package files can be located in different locations, this security architecture allows files to be verified individually in different locations to ensure the integrity of the IU package. The security model applies to any IU package types described in section 5, "Package Types."

There are a lot of related security topics surrounding the design in this section. Such topics include public key cryptography (authentication, public and private keys, digital signature, etc.), public key infrastructure (public key certificate, certificate authority, etc.) and message digest algorithms (MD5, SHA, etc.). The knowledge of those topics is assumed and will not be described in detail. [SCH] is a good reference on cryptography topics.

6.1 Signing IU Packages

Figure 13 shows the complete flow of the signing process. The process to sign IU packages is as follows:

1. Generate the digest values for files referenced in the deployment descriptor. The values are stored in the deployment descriptor.

2. Generate the digest value for the *entire* deployment descriptor. The value is put in the media descriptor.

3. Request a public key certificate from a certificate authority (CA). The request should include the signer's information and public key.

4. The CA issues a public key certificate for the signer. This certificate is signed by the CA.

5. Use the signer's private key to sign the media descriptor. The certificate and signed media descriptor are put together to generate a binary digital signature file.

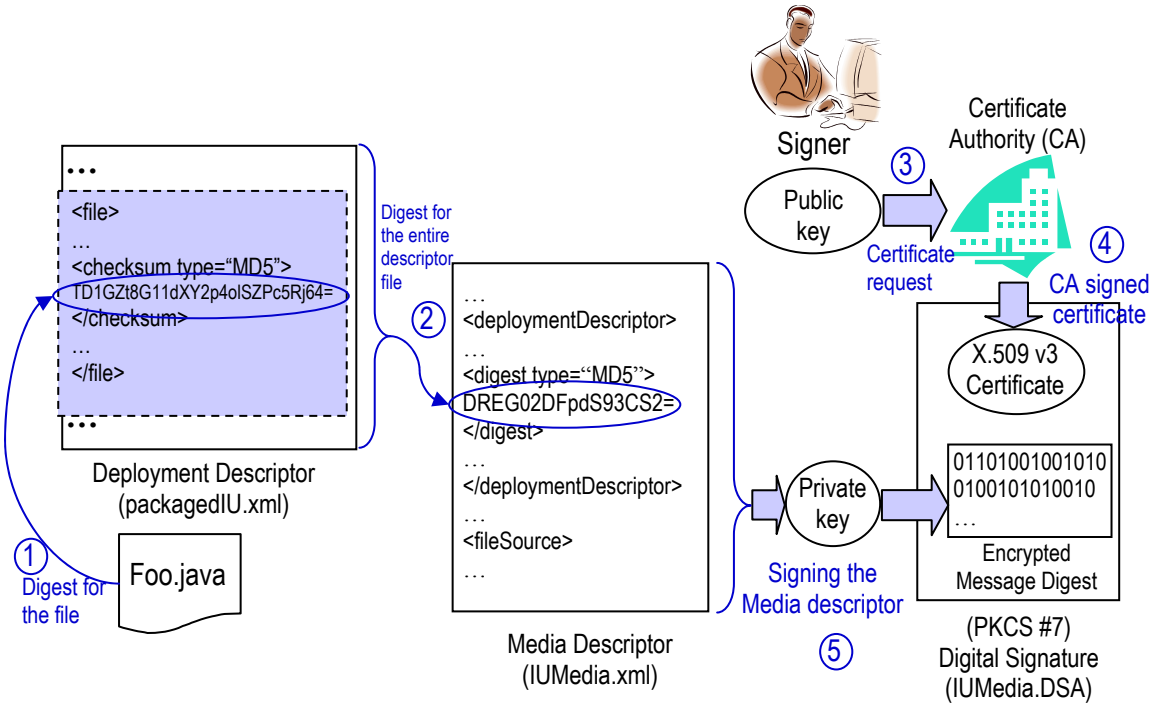


Figure 13 Signing an IU Package

The following sections describe the flow in more details.

6.1.1 File Digest Values in the Deployment Descriptor

Generating digital signatures is an expensive process. It will take too long to sign and verify every file in an IU package. So instead, message digest values for the files in the packages are computed and used for verification. The digest values are stored in the deployment descriptor. Only the media descriptor is digitally signed to ensure the digest values have not been tampered with.

Each file referenced in the deployment descriptor must have a digest value stored in the `<checksum>` element (of the type `base:CheckSum`). There are several algorithms that can be used to generate digest values. The supported algorithms are listed in the `base:CheckSum` type.

The following is an XML fragment example for a file entry in a deployment descriptor. In this example, the digest algorithm is MD5 and '`cf03015b052f7ca1c58a3b10669854ae530f25e0`' is the digest value.

```
…
<files>
…
  <file id="MyApp">
    <pathname>solution/myApp.jar</pathname>
    <length>4563</length>
    <checksum type="MD5">
       cf03015b052f7ca1c58a3b10669854ae530f25e0
    </checksum>
  </file>
…
</files>
…
```

6.1.2 Digest Value of the Entire Deployment Descriptor

A digest value is computed for the entire deployment descriptor. The supported algorithms are listed in the `base:CheckSum` type. Tooling that generates the deployment descriptors should support all of the message digest algorithms, and be able to generate correct digest values accordingly.

This digest value is stored in the media descriptor as part of the information for the associated deployment descriptor. This value is used later to verify the deployment descriptor (see Section 6.2.4, “Verifying the Deployment Descriptor”).

Below is an XML fragment example for a media descriptor that contains the digest value ‘`fcbb38898b63d2255b64de7799c4af3de6ce054e`’ for the associated deployment descriptor ‘`packagedIU.xml.`’

```
…
    <deploymentDescriptor>
       <location>packagedIU.xml</location>
       <digest type=”MD5”>
          fcbb38898b63d2255b64de7799c4af3de6ce054e
       </digest>
    </deploymentDescriptor>
…
```

6.1.3 Requesting a Public Key Certificate

A digitally signed file needs a public key to authenticate the file has not been tampered with. The public key and related signer information (identity, etc.) are stored in a public key certificate. It is a trust issue whether the public key certificate really comes from the signer identified in the certificate. This is one of the issues addressed by the *public key infrastructure* ([PKI]). In essence, there are certificate authorities (CAs) that are fully trusted. CAs sign and issue other public key certificates, after the certificate owner identities have been verified by CAs. CA certificates are required to authenticate the public key certificated issued by the CAs. Since the user environments need to manage a small number of the CA certificates, it is a much easier and simpler process.

At this stage of the signing process, the signer needs to request a public key certificate if not already available. The detail of this request process is out of the scope of this specification.

6.1.4 Issuing a Public Key Certificate

Once the CA verifies the identity of the requester for the public key certificate, CA generates a public key certificate that contains the signer identity information and public key.

The certificate can also be *self-signed* without involving a certificate authority. Since the identity of a self-signed certificate cannot be independently verified, self-signed certificates are typically used for testing purposes.

The certificates are in the format defined by X.509 v3 [X.509].

6.1.5 Creating Digital Signature

Now the media descriptor has the digest value of the deployment descriptor. It is only necessary to digitally sign the media descriptor using the private key of the signer. The digitally signed media descriptor and the public key certificate are put in a *digital signature* file. The digital signature file is an primary file used to verify the authenticity of the IU package. See Section 6.2.

The digital signature file has the PKCS #7 format ([PKCS #7]).

Two digital signing algorithms are supported: DSA and RSA ([DSA-RSA]). And the digital signature file has the name `IUMedia.DSA` and `IUMedia.RSA` respectively.

The digital signature file is co-located with the other manifest files.

Only one signer can sign an IU package.

6.2 Verifying Signed IU Packages

The flow of verifying signed IU packages is illustrated in Figure 14. The process to verify a signed IU packages is as follows:

1. Authenticate the certificate in the digital signature
2. Retrieve the public key from the certificate in the digital signature
3. Authenticate the signed media descriptor using the public key
4. Verify the entire deployment descriptor using the digest value stored in the media descriptor
5. Verify the files using the digest values stored in the deployment descriptor

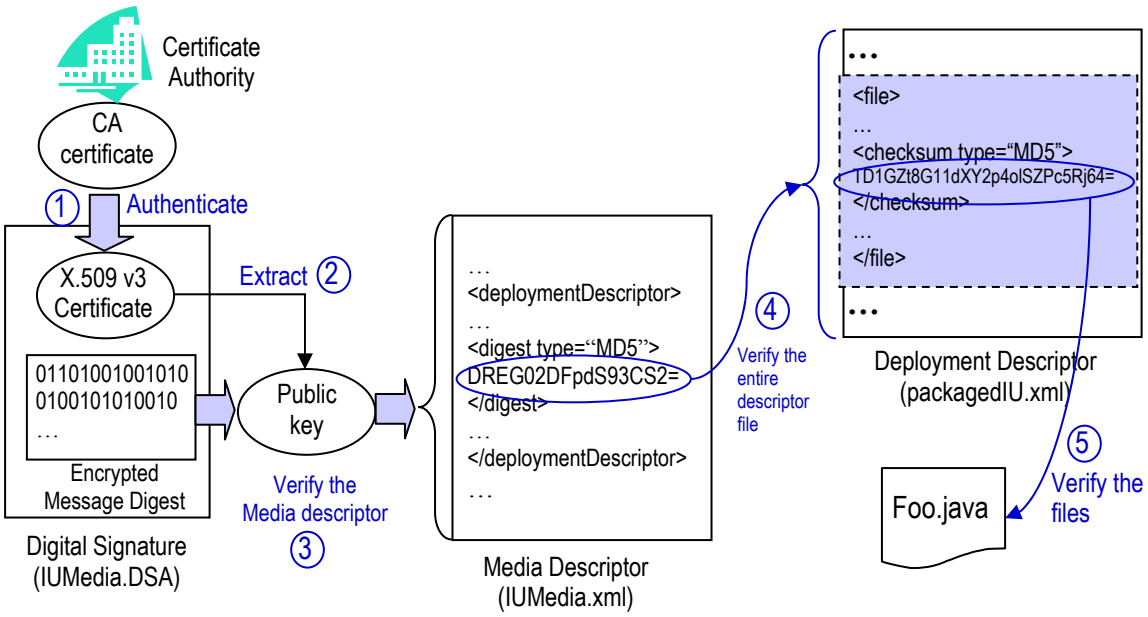


Figure 14 Verifying a Signed IU Package

6.2.1 Authenticating Certificate

The certificate in the digital signature contains the identity of the signer that signed the IU package. Before the IU package is installed, the signer identity needs to be authenticated to ensure the signer is who it says it is. If the certificate is signed by a certificate authority, this certificate can be authenticated using the CA's certificate which is fully trusted.

A certificate can be self-signed without a certificate authority. However, self-signed certificates cannot be authenticated and cannot be trusted since the package might have been created by someone impersonating the signer identity in the certificate. Thus the self-signed certificates typically are used for testing purposes.

It is up to the security policy of the installer or associated environment to decide whether self-signed certificates can be trusted.

6.2.2 Retrieve Public Key

The signer's public key is required to authenticate the signed media descriptor. The certificate in the digital signature has the public key. Once the certificate is authenticated, the public key can be retrieved from the certificate.

6.2.3 Authenticating Signed Media Descriptor

The signed media descriptor in the digital signature was signed using the signer's private key. The authentication process requires the use of the public key from the certificate.

The authentication process is based on the digital signing algorithm indicated by the signature file extension. This version of the specification supports the DSA and RSA signing algorithms.

If the authentication of the media descriptor failed, the whole verification process fails. Otherwise, the verification proceeds to the next step.

6.2.4 Verifying the Deployment Descriptor

Once authenticated, the media descriptor can be used to verify the deployment descriptor and other files in the IU package based on the digest values stored in the media descriptor.

A digest value is computed for the deployment descriptor, and then compared with the value stored in the media descriptor. Those two values need to match. If they do not match, the deployment descriptor must have been changed since the media descriptor has been authenticated and the digest value should be correct. In this case, the verification fails.

Otherwise, the deployment descriptor is verified and the contents have not been changed. The verification proceeds to the next step.

6.2.5 Verifying the Files

The binding information in a media descriptor provides the physical location of the files specified in the deployment descriptor. For each of those file, a digest value is computed and compared with the value stored in the deployment descriptor. If they do not match, the file located in the physical media has changed or is not the same as the one used to create the deployment descriptor. In this case, the verification fails. Otherwise, the file referenced by this file entry is verified and the contents have not been changed. This file can be safely used during the installation process.

7 Language Resource Bundles

Some information defined in the deployment descriptor may need to be translated into different national languages to provide national language support (NLS) *during* various software lifecycle management stages (for example, deployment or maintenance) for the IU packages. Examples include feature name, target description, manufacturer name, installation group, etc. Translated texts are located in one or more *language resource bundles* (one for each supported national language or *locale*).

Such information all have the type "`base:DisplayElement`" which defines such texts for that information as default text, Tooltip text, etc.

For further details about the *format* of the language resource bundles and how they are *used* with deployment descriptors, please see [ACAB.SD0402]. This specification addresses how language resource bundles are packaged and how references to them are linked to physical files in the IU packages.

Note that such information is *different* from the national language support (NLS) provided by the software via "language packs." Language packs are part of the installable units that are laid down during the installation, and are used by the software to provide NLS *after* the installation.

7.1 Key Design Requirement

One primary key design requirement is the ease of adding and removing language resource bundles in the IU packages, and dynamically updating the NLS of the packages without the need to update the manifest files (deployment descriptor or media descriptor).

The supported scenario is the following: A product can ship an IU package that has English support only while other national language supports – during or after the installation – are still in development. Once additional national language supports are available, additional language resource bundles can be simply added to the IU package, and additional national language support can be detected automatically the next time the IU package is deployed.

This requirement has influence on some design decisions and limitations. In particular, some language resource bundle information (such as what languages are supported, and what bundle files are present) is *not* maintained in the manifest files. The only way to obtain such information is to inspect the IU package contents directly (see Section 7.2 and 7.3). Another limitation is that language resource bundles may not be signed and verified (see Section 7.4).

7.2 Packaging Language Resource Bundles

Associated with an IU deployment descriptor, there is *one* single language resource bundle set with as many files as the supported locales. If an IU package includes referenced IU packages, each IU should have its own language resource bundle set.

A language resource bundle file contains the translated texts for a specific locale and the filename is in the following format:

<base name> "_" <language code> ["_" <country code>] [".properties"]

The *base name* is specified in the `<language_bundle>` attribute of the `<rootIU>` element. The *language code* is a language code as defined by ISO 639 (see [ISO639]), and the *country code* is a country code as defined by ISO 3166 (see [ISO3166]). A bundle file may have "`.properties`" as the file extension. For example, `iu1resource_en_US.propoerties` is a language resource bundle for US English, and `iu1resource_ja` is for Japanese.

The contents and format of a language resource bundle are specified in [ACAB.SD0402]. Note that default strings are specified in the IU deployment descriptor, and they will be used when there are no applicable translated strings available.

All the language resource bundles must be located in the `resources` subfolder in the IU deployment descriptor location. Note that they are in a fixed location so they can be located since the language resource bundle file information is not maintained in any of the manifest files.

The supported locales are *not* explicitly specified in the manifest file. Such information is determined dynamically based on the existing language resource bundles. This is made possible by locating the resource bundle files in a fixed location and by parsing the bundle filenames to obtain the locale information.

In packages of ZIP format (see Section 5.1), language resource bundles must be in the `/META-INF/resources` subfolder. In packages on network location (see Section 5.3), the languages resource bundles must be in the `resources` subfolder of the folder of the IU deployment descriptor.

In packages of the fixed-sized removable media format (see Section 5.2, "Fixed-sized Removable Media"), language resource bundles must be in the `/META-INF/resources` subfolder on the first media. The child (referenced) IU language resource bundles should all be located in the `resources` subfolder in their respective `META-INF` folder on the first media. For the example in Section 5.2.3, `IU2` language resource bundles should be located in the following folder on the first media.

/META-INF/ a01ee8dd1dd111b2a3f20800209a5b6b-2.1.0.0/META-INF/resources

7.3 Language Resource Bundle ZIP File

A *single* ZIP file (see [ZIP]) may exist in a `resources` subfolder and contain some *or* all the language resource bundles for the associated IU. The ZIP file name is fixed and has the format

<base name> ".zip"

where the *base name* is specified in the `<language_bundle>` attribute of the `<rootIU>` element. All the bundle files in this ZIP file should be located at the root folder. The file names and format of the resource bundle files remain the same.

This ZIP file provides an alternative packaging of the bundle set, and may simplify the management and transfer of the language resource bundle files.

If a resource bundle ZIP file exists, the process of determining the supported locales should also inspect the ZIP contents to obtain the supported locales by the resource bundle files in the ZIP file.

7.4 Security Consideration

As explained in Section 7.1("Key Design Requirement"), the language resource bundle file information is not included in the deployment descriptor. So the deployment descriptor may not have resource bundle files size and file signature which are required for signing and verifying the packaged files (see Section 6, "Security").

As a result, language resource bundles may not be signed or verified like the files specified in the deployment descriptors, unless they are specified explicitly in the deployment descriptor using the `<file>` element.

This is an important security implication that needs be noted when adding or updating the language resource bundles. If security is a major concern, language resource bundle files (including the bundle ZIP file) should have correct entries in the deployment descriptor so they can be signed and verified. And in this case, any changes to the resource bundle files must require updating the deployment descriptor and media descriptor.

7.5 An Example

Here is an example demonstrating how language resource bundle files are packaged in a CD package.

Suppose `IU1` specifies '`iu1resource`' in the `language_bundle` attribute of the `<rootIU>` element, and `IU1` references `IU2` which specifies '`iu2resource`' in the `language_bundle` attribute of its `<rootIU>` element. `IU2` is a non-fix IU that has version 3.0.1.0 and UUID `a01ee8dd1dd111b2a3f20800209a5b6b`. `IU2` has all

of its language resource bundle files in a single ZIP file which must be named ‘iu2resource.zip’.

Figure 15 shows the first CD of the IU1 package which includes the IU2 package. From IU1’s META-INF/resources directory, it can be determined that IU1 supports English, French, and German. Inspecting the ‘iu2resource.zip’ ZIP file indicates that IU2 supports additional Japanese and Korean.

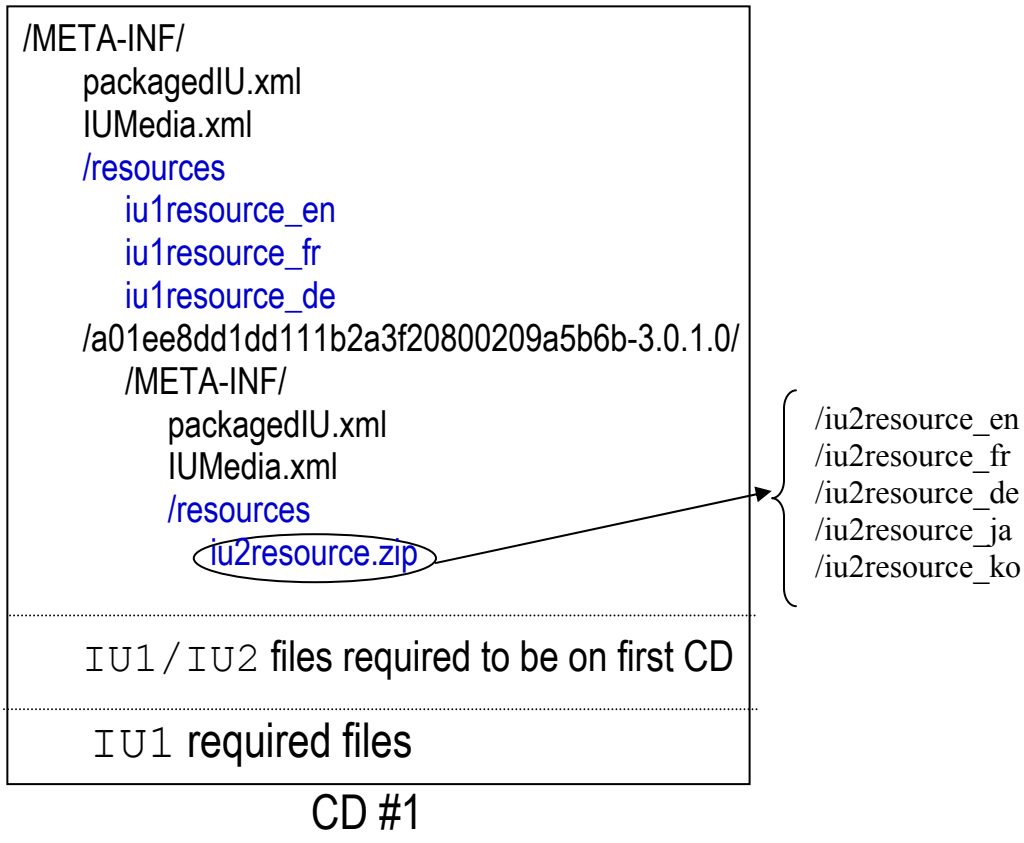


Figure 15 Language Resource Bundles in a CD Package

8 Relationship with Installer Technologies

The IU package format defined in this document needs to be adopted by the industry so software install packages are all in a common format that can be processed in a standard fashion across platforms. This cannot be done without the collaboration with leading industry installer technologies such as ISMP (InstallShield Multiplatform) by InstallShield or InstallAnywhere by Zero G.

One design objective in this document is to ensure the IU package format can be used as the native format by the leading installer technologies. Specifically,

- During the packaging time, those installer technologies can generate install packages in the format defined in this document. And those IU packages can be aggregated in other IU packages using the installer technologies.

- During the install time, those installers can process any IU package per the design in this document.

Common install capabilities among the packages created by different installer technologies are provided by the deployment descriptor (see [ACAB.SD0402]), media descriptor, and the IU package format. While such IU packages could be generated by different installer technologies, they can be processed during both packaging and install time in a standard fashion through the common descriptors and IU package format.

Based on those standards, installer vendors can add their own proprietary value-add extensions (as optional files) while complying with the standards. However, those proprietary extensions are not guaranteed to be understood and processed by other installer technologies.

For example, an installer technology can add its own graphical user interface (GUI) modules in the packages to provide interactive installation. Such GUI modules are added as optional files that can only be invoked by the vendor installer. For other installers, such GUI modules will not be used and thus can be removed from the package.

Before an installer technology fully adopts the standard descriptors and package format, an IU package can be integrated with the installer technology through “wrappers.” In this case, an IU package is included in the vendor-specific install package and is processed by custom install code. Through this interim integration, a standard IU package can be used with any installer technology that provides additional install capabilities such as GUI modules. Although such interim approach only provides minimum integration with existing installer technologies, it allows standard IU descriptors and packages to be used for new install packages before they are adopted by existing installer technologies.

9 Relationship with Existing Package Formats

There are many existing industry standard or de facto standard packaging formats. These range from native platform OS installation packages to higher level container artifact packages. Some key formats include but are not limited to those listed in Section 9.1.

According to the design pattern described in Section 2.5, "Background," it is an objective of this specification to be fully compatible with existing formats. There are no requirements or restrictions on a separately packaged artifact to be included in the proposed package. They are simply specified in the package as a file as described in Section 3, "Installable Unit Package."

The mechanisms and behavior of the included package are independent of the proposed format. During installation, the included package is exploded and processed appropriately. Similarly, the proposed package format may be included and independently processed by other packaging formats.

9.1 Existing Formats

9.1.1 J2EE

J2EE has well-defined application assembly and deployment requirements ([J2EE]). J2EE applications are composed of one or more J2EE components and one J2EE application deployment descriptor. The deployment descriptor lists the application's components as modules. A J2EE module represents the basic unit of composition of a J2EE application. J2EE modules consist of one or more J2EE components and one module level deployment descriptor. The flexibility and extensibility of the J2EE component model facilitates the packaging and deployment of J2EE components as individual components, component libraries, or J2EE applications.

J2EE application server is a container identified in the solution installation architecture. To deploy a J2EE application or stand-alone J2EE module to a J2EE container, one needs to encapsulate the J2EE file in a package per specification defined in this document. The installable unit deployment descriptor should specify J2EE container type and points to the J2EE file in the package.

To deploy the installable unit package, the J2EE touch point will extract the J2EE file along with other information (for example, configuration) from the IU deployment descriptor, then deploy the J2EE application or module per the J2EE standards.

9.1.2 Platform Package Formats

There are de facto package formats on various platforms. Examples include MSI on Windows, `rpm` on Linux, and `installp` on AIX. Each format comes with platform tools to manipulate the packages, but the capabilities vary by platforms. While the strategic direction is to use the platform independent package format defined by this document, platform packages will continue to be used by many legacy products or even future products (in particular non-IBM products).

The IU deployment descriptor has support for those well known platform formats by encapsulating them in the packages defined by this document. The operating system touch points will know how to deploy those packages properly using proper platform tools. There is, however, no mapping between platform packages and the IU packages.

9.1.3 OSGi Bundles

Overview of the Open Service Gateway Initiative (OSGi) is available at [OSGi]. OSGi gateway defines a service framework that requires services be packaged into *bundles* and download to the gateway device. A service bundle is a JAR that contains the following:

- Contains the resources implementing zero or more services. These resources may be class files for the Java programming language, as well as any other data (such as HTML help files, icons, and so on).
- States static dependencies on other resources, such as Java packages. If any dependencies are stated, the framework takes the appropriate actions to make the required resource available.
- Optionally contains classes that help the framework install, configure, activate and update a service.
- Declares which class should be used to start or stop a service.

The service framework also maintains the relationship between services implementations, and the dependencies between services and bundles.

Similar to the J2EE application server, the OSGi gateway service framework defines a hosting environment that fits in the solution installation architecture. OSGi bundles to the OSGi gateway is what the J2EE applications to the J2EE application server. Thus OSGi bundles can be encapsulated in an installable unit package defined by this document, and deployed through an OSGi gateway touch point.

9.1.4 Grid Services Deployment

The Open Grid Services Architecture (OGSA) includes a Grid service hosting environment. The Globus Toolkit 3.0 ([GT]) defines a simple deployment framework for packaging and deploying grid services to a Grid service hosting environment. The

packages are in Grid archives (GAR) files. A GAR file, like the package defined in this document, has an XML-based deployment descriptor and Grid service files to be deployed.

Building and deploying JAR packages are done via the *ant* tools (‘`ant makeGar`’ and ‘`ant deploy`’).

Deploying Grid services to the hosting environment can follow the design pattern as described in Figure 1. GAR files can be packaged in the common installable unit packages defined in this document, and deployment of the GAR files can be delegated to the Grid service deployment functions.

9.1.5 Eclipse

Eclipse is a hosting environment that allows new “plug-ins” to be installed in the environment. Eclipse has an architecture that specifies how plug-ins are packaged and installed in the Eclipse environment.

There are two aspects of the relationship between Eclipse installable unit packages and the common installable unit packages defined in this document. One is the similarity between the package structures; the other is how Eclipse package can be included in the common installable unit packages (according to the hosting environment design pattern described in section 1).

9.1.5.1 Packaging Construct

This section will briefly summarize the packaging and installation (including update) architecture on the Eclipse platform. For more information and documentation about the Eclipse platform, please refer to [Eclipse].

On the Eclipse platform, the basic installation and packaging construct is a *feature*. Features define the packaging structure for a group of related plug-ins, plug-in fragments, and optionally non-plug-in files. Features are packaging and installation constructs and do not play a role during Eclipse plug-in execution.

In Eclipse 2.0, the *feature archive* consists of multiple separate JAR files --- one JAR file per plug-in and fragment, plus one JAR file for the actual feature information. The feature information includes the manifest file which is the descriptor of the feature archive.

Custom install handlers can be provided as part of the feature archive to perform custom processing during the feature installation. As a general practice, install handlers should be provided in separate JAR files that should be signed, and sealed.

9.1.5.2 Installation

For initial install, the feature packages (probably part of a product) can be installed using the native installer or the Eclipse *update manager*. The Eclipse update manager is the most comprehensive install and update mechanism that checks and tracks dependencies,

installs the features, manages shared plug-ins, and discovers available updates from update servers. Native installers, on the other hand, can only install the features and have no access to other install and update features provided by the Eclipse update manager.

The current Eclipse update manager only has a graphical interface and cannot be used "silently." Native installers typically provide a silent mode.

9.1.5.3 Relationship with Installable Unit Packages

As mentioned earlier, the Eclipse platform is a hosting environment (see Figure 1 on page 7), and Eclipse feature archives can be included in common installable unit packages. Although the detailed architecture and design need to be defined and are out of the scope of this document, here are some potential design points. The deployment of Eclipse feature archives can be delegated to the Eclipse update manager, but the current update manager implementation needs to be enhanced. In particular, the update manager needs to expose its functions in non-interactive fashion, and the dependency and update management need to be consistent with the dependency management functions in the solution installation architecture.

10 Tooling

Tooling is required to create, update, and install the packages. In this section, we will describe the requirements for such tooling set. This section does not intend to provide normative description of the tooling, which should be covered thoroughly in separate specifications.

10.1 Packaging

This tool allows the users to create valid installable unit packages. This tool should support in-line and external aggregation. Ideally this tool is part of a complete install integrated development environment (IDE) which could provide additional features such as defining custom install logic, specifying GUI wizard sequences, and manipulating other parts of the packages.

This tool is targeted for the install developers to generate installable unit packages for their application or solutions.

The following sections describe the main functions of the packaging tool.

10.1.1 Non-interactive Build Capabilities

It is a common need to create installable unit packages during the build process which is often non-interactive and driven from the command line automatically. So the non-interactive build capabilities should be provided.

Such build capabilities should allow maximum automation, probably with build parameters specified in a file. Typically the build automation performs packaging specific files. The automation could also allow the update of the deployment descriptor based on the files to be packaged. For example, the information (size, message digest, etc.) in the `<file>` elements of the deployment descriptor needs to be updated based on the files to be packaged.

A typical scenario is as follows: The nightly build process successfully generates a new build. The build script then identifies newly generated files to be included in the package and runs the packaging tool silently to generate the package. Other packaging information (such as platforms and languages) remains unchanged and is specified in a project file used during the silent packaging process.

10.1.2 Validate the Packages

The packaging process needs to generate valid installable unit packages. Validation of the packages should be one of the main functions of the packaging tool. Such validation should include at the minimum the followings:

1. The package is in a format defined by this specification.

2. The deployment descriptor is a valid XML document.

3. All internally referenced files in the deployment descriptor are present in the package.

4. If the IU package is signed, the validation process should also verify that the package was properly signed and all the information was correctly stored in the package.

10.2 Subset Repackaging

This tool allows the users to create a *valid subset* from an existing installable unit package. The new package has a subset of the installable units in the original package. The repackaging process is meant for removing unneeded installable units.

The new package can have the same contents as the original package but in a different type. For example, an admin can repackage an IU package in CDs and make it available on the network. In this case, the contents are the same but the package formats are different (from CDs to network locations).

During the repackaging process, the original files used for packaging are only available through the existing installable unit package.

Some non-obvious packaging scenarios need to be supported by repackaging tools. Note different repackaging tools might be created to address specific scenarios.

1. After a product is installed and several patches are applied, customers might want to create a new package from the patched product base. This new package allows customers to install or replicate the patched – and oftentimes stable – product on other hosts.

2. A customer admin might want to create a new package from a product base package plus multiple (non-refreshing) fix packages. This new package allows customers to install the products with latest fixes with just one package (instead of applying multiple packages in sequence).

3. An admin might want to “simulate” the install process without actually installing the product. Through the process, files needed for install are identified and a new package is created to contain those files and a properly modified deployment descriptor that reflects the “fake” install.

This tool is targeted for the install developers or end users to generate new packages from existing ones.

The following sections describe the main functions of the repackaging tool.

10.2.1 Standalone GUI

The repackaging tool should have a standalone, user friendly GUI. There may be different GUI interfaces for use by install developers and end users respectively.

10.2.2 Re-signing the New Package

If the original package is signed, the new package should also be signed. However, the private key used to sign the original package might not be available (in particular, when an end user does the repackaging), so a different private key might be used.

10.2.3 Validation of the New Packages

The repackaging process is required to produce valid packages. And the repackaging tool should provide validation functions to help users validate the packages.

10.3 Installer

An installer installs the installable unit package. An installer is required to understand the IU package format, verify the package if it is signed, and conduct installation based on package contents (in particular the deployment descriptor) and user provided input.

The detailed specification of an installer is beyond the scope of this document.

11 Package Examples

In this section, several examples will be illustrated to show how this installable unit package can be structured.

11.1 A Simple Product

The following is a simple example to illustrate a package and the actual product structure it represents. Assume a trivial product containing six text files with the following structure:

```
--Product files
     foo1.txt
     foo2.txt
     dir1
       foo3.txt
       foo4.txt
     dir2
       foo5.txt
       foo6.txt
```

In addition to the files that create the product footprint there is utility code included in the package that performs post installation configuration:

```
--Utility files
     UpdateFoo.class
```

This set of files would be packaged in an installable unit package as shown in Figure 16.

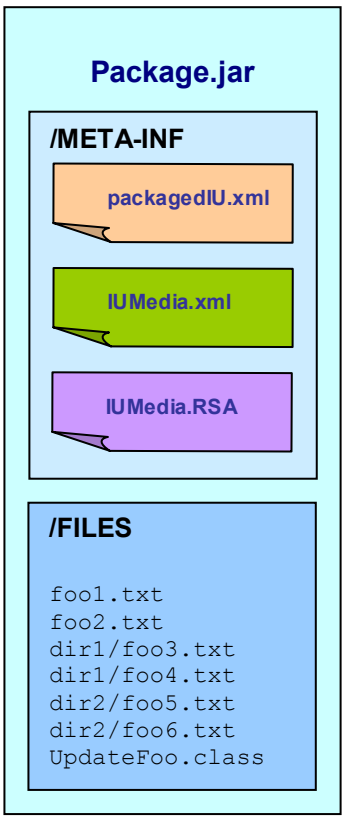


Figure 16 A Simple Product Package

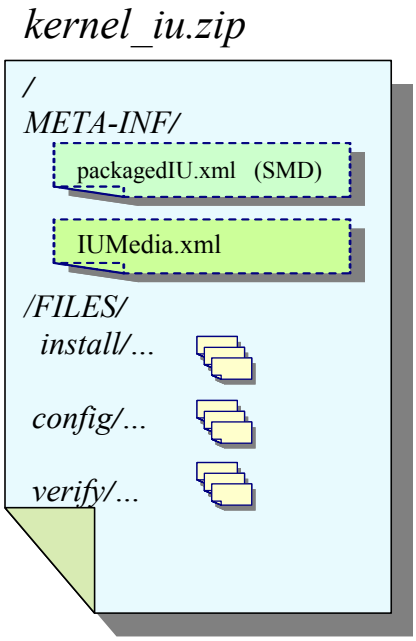
11.2 J2EE Application Server Kernel

Here is an example of installable unit package for a J2EE application server kernel. In this example, the package is a solution module that will be deployed to multiple hosting environments. The layout of the directory structure in the IU package `kernel_iu.jar` file:

- `/META-INF/packagedIU.xml`: the deployment descriptor for this solution module
- `/META-INF/IUMedia.xml`: the media descriptor for this ZIP file. Since the required files are located outside the `/META-INF` folder (the default logical source for the files), a media descriptor is needed to specify the logical source. In this case, it should be a local relative path "`../FILES/install`" for the installable files, "`../FILES/config`" for configuration action related files, and "`../FILES/verify`" for verification action related files.

- `/FILES/install/…` : this folder contains the installable files
- `/FILES/config/…` : this folder contains data, files, and scripts needed for configuration. Configuration actions are defined in the deployment descriptor.
- `/FILES/verify/…`: this folder contains data, files, and scripts needed for install verification. Verification actions are defined in the deployment descriptor.

The installer is not packaged in the IU package. Below is an illustration of a IU package ZIP file.



12 Media Descriptor Samples

12.1 A Media Descriptor for a ZIP Package

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- When the IU files are packaged in a ZIP file, the (deployment and -->
<!-- media) descriptors will be in the /META-INF folder. Other files can -->
<!-- reside outside the /META-INF/ folder. The physical location inside the -->
<!-- ZIP file is specified using the 'local' element in the -->
<!-- 'physicallocation'. Note that the 'ZipFile' element should not be used -->
<!-- in this case. -->
<!-- Based on the media.xsd v1.2f -->
<media:binding
xmlns:media="http://www.ibm.com/namespaces/autonomic/solutioninstall/MEDIA"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.ibm.com/namespaces/autonomic/solutioninstall/MEDIA
media.xsd">
  <!-- The deployment descriptor location. It should be in the same folder -->
  <!-- as the media descriptor (in the META-INF/ folder). -->
  <deploymentDescriptor>
    <location>packagedIU.xml</location>
    <digest type="MD5">6CE903B30B410F8A9E6BCF1F05A74864</digest>
  </deploymentDescriptor>
  <fileSource>
    <fileIdRef>file_245</fileIdRef>
    <location>
      <physicalLocation>
        <!-- Relative to the media descriptor folder (META-INF/ in the ZIP
        file). -->
        <!-- Suppose the path for 'file 245' is dir/foo.java, the path in
        the ZIP file will be /FILES/dir/foo.java -->
        <local>../FILES</local>
      </physicalLocation>
    </location>
  </fileSource>
  <fileSource>
    <fileIdRef>file 233</fileIdRef>
    <location>
      <physicalLocation>
        <!-- For files that reside in file systems outside this ZIP package,
        they can be specified using the <URL> tag -->
        <!-- Suppose the path for 'file 233' is dir/foo.java, the physical
        path for this file is file://home/dmsadmin/dir/foo.java -->
        <URL>file://home/dmsadmin/</URL>
      </physicalLocation>
    </location>
  </fileSource>
  <fileSource>
    <fileIdRef>file_356</fileIdRef>
    <location>
      <physicalLocation>
        <!-- Relative to the media descriptor folder (META-INF/ in the ZIP
        file). -->
        <local>../FILES</local>
      </physicalLocation>
      <!-- Allow mapping to a different name. And the path in the ZIP file
      is now /FILES/255c22ac34487008caab52f788958d31 -->
      <!-- If this is specified, the pathname value in the deployment
      descriptor is ignored. The file path in the ZIP file is
      /FILES/255c22ac34487008caab52f788958d31 -->
      <pathname>255c22ac34487008caab52f788958d31</pathname>
    </location>
  </fileSource>
  <fileSource>
    <!-- Reference to a 'file' entry in the deployment descriptor -->
    <fileIdRef>file 776</fileIdRef>
    <!-- Indicate that the file is located inside an external ZIP file. -->
    <location>
```

```
      <physicalLocation>
        <ZipFile>
          <networkSource>../pkg/Library.zip</networkSource>
          <!-- The folder (relative to the root) inside the Zip file. -->
          <!-- Suppose the path for 'file 776' is lib/audio.so (defined in
          the deployment descriptor) and the network location for the
          descriptors are at http://depot.my.com/applicationA, then the path
          for 'file 776' is in http://depot.my.com/pkg/Library.zip as
          /FILES/lib/audio.so -->
          <path>FILES</path>
        </ZipFile>
      </physicalLocation>
    </location>
  </fileSource>
  <fileSource>
    <!-- Reference to a 'file' entry in the deployment descriptor -->
    <fileIdRef>file 776</fileIdRef>
    <!-- Indicate that the file is located inside an external ZIP file on a
    CD. -->
    <location>
      <physicalLocation>
        <ZipFile>
          <removableMedia type="CDROM" volumeID="2">
          <!-- The folder (relative to the root) inside the Zip file. -->
          <!-- Suppose the path for 'file_776' is lib/audio.so (defined in
          the deployment descriptor). In this example, the physical file is
          /FILES/lib/audio.so in the ZIP file /IU2.zip on the CD-ROM with
          volume ID '2'. -->
            <ZipPath>IU2.zip</ZipPath>
          </removableMedia>
          <path>FILES</path>
        </ZipFile>
      </physicalLocation>
    </location>
  </fileSource>
  <fileSource>
    <!-- Reference to a 'file' entry in the deployment descriptor -->
    <fileIdRef>file 777</fileIdRef>
    <!-- Indicate that the file physical location is not known -->
    <location>
      <physicalLocation>
        <unknown/>
      </physicalLocation>
    </location>
  </fileSource>
</media:binding>
```

12.2 A Media Descriptor for a Package on CD-ROMs

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- In the case of CD package, the deployment descriptor and media -->
<!-- descriptor are both located in the first CD (under the /META-INF/ -->
<!-- directory). The files could span multiple CDs. The physical locations -->
<!-- are specified using the 'removableMedia' element. -->
<!-- Based on the media.xsd v1.2f -->
<media:binding
xmlns:media="http://www.ibm.com/namespaces/autonomic/solutioninstall/MEDIA"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.ibm.com/namespaces/autonomic/solutioninstall/MEDIA
media.xsd">
  <!-- The deployment descriptor location. It is in the same directory as -->
  <!-- the media descriptor. -->
  <deploymentDescriptor>
    <location>packagedIU.xml</location>
    <digest type="MD5">6CE903B30B410F8A9E6BCF1F05A74864</digest>
  </deploymentDescriptor>
  <fileSource>
    <!-- Reference to a 'file' entry in the deployment descriptor -->
    <fileIdRef>file_67</fileIdRef>
    <location>
```

```
    <physicalLocation>
      <!-- The CD number. -->
      <removableMedia volumeID="4" type="CDROM">
        <!-- Relative to the root folder of the CD -->
        <!-- Suppose the path for 'file 67' is lib/sound.so (defined in
        the deployment descriptor), the physical path is
        /FILES/lib/sound.so on CD #4 -->
        <path>FILES</path>
      </removableMedia>
    </physicalLocation>
  </location>
</fileSource>
<fileSource>
  <!-- Reference to a 'file' entry in the deployment descriptor -->
  <fileIdRef>file 356</fileIdRef>
  <location>
    <physicalLocation>
      <removableMedia volumeID='1' type="CDROM">
        <path>FILES</path>
      </removableMedia>
    </physicalLocation>
    <!-- Allow mapping to a different path name. -->
    <!-- If this is specified, the pathname value in the deployment
    descriptor is ignored. The real file path is
    /FILES/255c22ac34487008caab52f788958d31 on CD #1. -->
    <pathname>255c22ac34487008caab52f788958d31</pathname>
  </location>
</fileSource>
<fileSource>
  <!-- Reference to a 'file' entry in the deployment descriptor -->
  <fileIdRef>file_776</fileIdRef>
  <!-- Indicate that the file is located inside an external ZIP file. -->
  <location>
    <physicalLocation>
      <ZipFile>
        <networkSource>../pkg/Library.zip</networkSource>
        <!-- The folder (relative to the root) inside the Zip file. -->
        <!-- Suppose the path for 'file 776' is lib/audio.so (defined in
        the deployment descriptor) and the network location for the
        descriptors are at http://depot.my.com/applicationA, then the path
        for 'file 776' is in http://depot.my.com/pkg/Library.zip as
        /FILES/lib/audio.so -->
        <path>FILES</path>
      </ZipFile>
    </physicalLocation>
  </location>
</fileSource>
<fileSource>
  <!-- Reference to a 'file' entry in the deployment descriptor -->
  <fileIdRef>file 776</fileIdRef>
  <!-- Indicate that the file is located inside an external ZIP file on a
  CD. -->
  <location>
    <physicalLocation>
      <ZipFile>
        <removableMedia type="CDROM" volumeID="2">
        <!-- The folder (relative to the root) inside the Zip file. -->
        <!-- Suppose the path for 'file 776' is lib/audio.so (defined in
        the deployment descriptor). In this example, the physical file is
        /FILES/lib/audio.so in the ZIP file /IU2.zip on the CD-ROM with
        volume ID '2'. -->
          <ZipPath>IU2.zip</ZipPath>
        </removableMedia>
        <path>FILES</path>
      </ZipFile>
    </physicalLocation>
  </location>
</fileSource>
<fileSource>
  <!-- Reference to a 'file' entry in the deployment descriptor -->
  <fileIdRef>file_777</fileIdRef>
```

```
    <!-- Indicate that the file physical location is not known -->
    <location>
      <physicalLocation>
        <unknown/>
      </physicalLocation>
    </location>
  </fileSource>
</media:binding>
```

12.3 A Media Descriptor for a Package in a Network Location

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- In the case of network download package, the deployment descriptor and -->
<!-- media descriptor should reside at the same location. Other files can -->
<!-- reside anywhere on the network that can be identified using URI. -->
<!-- Based on the media.xsd v1.2f -->
<media:binding
xmlns:media="http://www.ibm.com/namespaces/autonomic/solutioninstall/MEDIA"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.ibm.com/namespaces/autonomic/solutioninstall/MEDIA
media.xsd">
  <!-- The deployment descriptor location. It is in the same location as -->
  <!-- the media descriptor. -->
  <deploymentDescriptor>
    <location>packagedIU.xml</location>
    <digest type="MD5">6CE903B30B410F8A9E6BCF1F05A74864</digest>
  </deploymentDescriptor>
  <fileSource>
    <!-- Reference to a 'file' entry in the deployment descriptor -->
    <fileIdRef>file 67</fileIdRef>
    <location>
      <physicalLocation>
        <!-- A network location URI. -->
        <!-- Suppose the path for 'file 67' is lib/sound.so (defined in
        the deployment descriptor) and the network location for the
        descriptors are at http://depot.my.com/applicationA, the location
        for 'file_67' is
        http://depot.my.com/applicationA/FILES/lib/sound.so. -->
        <URL>FILES</URL>
      </physicalLocation>
    </location>
  </fileSource>
  <fileSource>
    <!-- Reference to a 'file' entry in the deployment descriptor -->
    <fileIdRef>file 356</fileIdRef>
    <location>
      <physicalLocation>
        <URL>FILES</URL>
      </physicalLocation>
      <!-- Allow mapping to a different path name. -->
      <!-- If this is specified, the pathname value in the deployment
      descriptor is ignored. -->
      <!-- Suppose the path for 'file 67' is lib/sound.so (defined in the
      deployment descriptor) and the network location for the descriptors
      are at http://depot.my.com/applicationA, the location for 'file_67' is
      http://depot.my.com/applicationA/FILES/255c22ac34487008caab52f788958d31
      -->
      <pathname>255c22ac34487008caab52f788958d31</pathname>
    </location>
  </fileSource>
  <fileSource>
    <!-- Reference to a 'file' entry in the deployment descriptor -->
    <fileIdRef>file 776</fileIdRef>
    <!-- Indicate that the file is located inside an external ZIP file. -->
    <location>
      <physicalLocation>
        <ZipFile>
          <networkSource>../pkg/Library.zip</networkSource>
```

```
          <!-- The folder (relative to the root) inside the Zip file. -->
          <!-- Suppose the path for 'file 776' is lib/audio.so (defined in
          the deployment descriptor) and the network location for the
          descriptors are at http://depot.my.com/applicationA, then the path
          for 'file 776' is in http://depot.my.com/pkg/Library.zip as
          /FILES/lib/audio.so -->
          <path>FILES</path>
        </ZipFile>
      </physicalLocation>
    </location>
  </fileSource>
  <fileSource>
    <!-- Reference to a 'file' entry in the deployment descriptor -->
    <fileIdRef>file 776</fileIdRef>
    <!-- Indicate that the file is located inside an external ZIP file on a
    CD. -->
    <location>
      <physicalLocation>
        <ZipFile>
          <removableMedia type="CDROM" volumeID="2">
          <!-- The folder (relative to the root) inside the Zip file. -->
          <!-- Suppose the path for 'file 776' is lib/audio.so (defined in
          the deployment descriptor). In this example, the physical file is
          /FILES/lib/audio.so in the ZIP file /IU2.zip on the CD-ROM with
          volume ID '2'. -->
            <ZipPath>IU2.zip</ZipPath>
          </removableMedia>
          <path>FILES</path>
        </ZipFile>
      </physicalLocation>
    </location>
  </fileSource>
  <fileSource>
    <!-- Reference to a 'file' entry in the deployment descriptor -->
    <fileIdRef>file 777</fileIdRef>
    <!-- Indicate that the file physical location is not known -->
    <location>
      <physicalLocation>
        <unknown/>
      </physicalLocation>
    </location>
  </fileSource>
</media:binding>
```

12.4 A Simple Media Descriptor Using Default Logical Source

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- This sample shows that all files are relative to a single logical -->
<!-- source "../FILES" using the 'local' element. This sample demonstrates -->
<!-- that a media descriptor can be fairly simple. -->
<!-- Based on the media.xsd v1.2f -->
<media:binding
xmlns:media="http://www.ibm.com/namespaces/autonomic/solutioninstall/MEDIA"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.ibm.com/namespaces/autonomic/solutioninstall/MEDIA
media.xsd">
  <!-- The deployment descriptor location. It should be in the same folder -->
  <!-- as the media descriptor. -->
  <deploymentDescriptor>
    <location>packagedIU.xml</location>
    <digest type="MD5">6CE903B30B410F8A9E6BCF1F05A74864</digest>
  </deploymentDescriptor>
  <!-- All files in this packages are relative the logical source
  "../FILES". If this is a ZIP file package, all the files are in the /FILES
  folder. -->
  <defaultLogicalSource>
    <local>../FILES</local>
  </defaultLogicalSource>
```

```
</media:binding>
```

13 Glossary of Terms

Also see [ACGlossary] for common Autonomic Computing terms not defined here.

End user – An end user deploys the installable unit packages. An end user might repackage the install packages before deploying them. For example, for efficient distribution to large number of client machines, an administrator can repackage an installable unit package by removing contents that are not needed.

Install developer – An install developer is the developer creating the installable unit packages for a product or solution.

Installable unit (IU) – An installable unit is a logical component that can be selected for installation. Installable units can be aggregated together, so for example a product contains features, which contain components. An artifact is the physical component that contains a smallest installable unit, or that contains an aggregated installable unit whose components were manufactured as a single entity (e.g. a product). A solution module is an aggregated installable unit whose components were manufactured separately.

Installable unit package or **packaged installable unit** – A package that contains files to be installed, custom install code, and a deployment descriptor for an installable unit. Throughout this document, those two terms will be used interchangeably.

Installable unit package type – Installable unit packages can have different physical layouts. Each physical layout is a package type. The major differences among the various package types are the locations of the files and how the file bindings are expressed. This document covers four physical package layouts: single Zip, fixed-sized removable media, network location, and single executable.

Payload files – Those are the files that will be laid down on the target host during the installation. Those files do not include the custom install code invoked during the installation.

Valid installable unit package – An installable unit package is valid if the package contents meet the following criteria: the package is in a format defined by this specification; the deployment descriptor is a valid XML document; all internally referenced files in the deployment descriptor are present in the package; and, if the package is signed, all files have not been modified.

References

[ACAB.SD0402] Installable Unit Deployment Descriptor Specification

[ACGlossary] Miller et al, AC Architecture Board, *Autonomic Computing Terminology*

[CRM] OGSA Common Resource Management Specification

[DSA-RSA] DSA and RSA Key and Signature Encoding for the KeyNote Trust Management System
http://www.faqs.org/rfcs/rfc2792.html

[Eclipse] Eclipse project is at http://www.eclipse.org.
The documentation is at
http://www.eclipse.org/documentation/main.html

[GT] Globus Toolkit
http://www.globus.org/toolkit/

[ISO3166] Code for the representation of names of countries
http://www.iso.org/iso/en/prods-services/iso3166ma/index.html

[ISO639] Code for the representation of names of languages
http://www.w3.org/WAI/ER/IG/ert/iso639.htm

[J2EE] Java 2 Platform Enterprise Edition Specification, v1.3.

[MD5] Information about MD5 Message-Digest algorithm is available at
http://www.faqs.org/rfcs/rfc1321.html

[OSGi] Open Services Gateway Initiative. http://www.osgi.org/
OSGi Specification Overview
http://www.osgi.org/resources/docs/specoverview.pdf
Specification can be downloaded at
http://www.osgi.org/resources/spec_download.asp

[PKCS #7] PKCS #7: Cryptographic Message Syntax, Version 1.5
http://www.ietf.org/rfc/rfc2315.txt

[PKI] Public-Key Infrastructure (X.509)
http://www.ietf.org/html.charters/pkix-charter.html

[RFC2119] Key words for use in RFCs to Indicate Requirement Levels
http://www.ietf.org/rfc/rfc2119.txt

[SCH] "Applied Cryptography 2nd Edition" by Bruce Schneier
John Wiley & Sons, New York, 1996

[X.509] Internet X.509 Public Key Infrastructure Certificate and CRL Profile
http://www.ietf.org/rfc/rfc2459.txt

[ZIP] ZIP File Format Specification
http://www.pkware.com/products/enterprise/white_papers/appnote.html

[ZLIB] ZLIB Compressed Data Format Specification version 3.3
http://www.faqs.org/rfcs/rfc1950.html

Appendix A media.xsd

Below is the XML schema (`media.xsd`) for the media descriptor `IUMedia.xml`.

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- iudd:File is the common element referencing files in an IU package. -->
<!-- The <files> element has a seq of iudd:File -->
<!-- File references in iudd in general can be <fileIdRef> which -->
<!-- points to an iudd:File element (the 'id' attribute value) in the -->
<!-- package, or a path that points to files outside the packages. -->
<!-- The 'pathname' attribute of iudd:File type is relative to a physical -->
<!-- location such as a JAR file root folder, CD, and network location. -->
<!-- The media descriptor (1) defines the physical location of the -->
<!-- <files> element in IUDD,(2) optionally override the relative path info -->
<!-- of the <files> elements. -->
<!-- If the logical source is not used in the iudd:File element, the -->
<!-- media descriptor needs to have an entry for every <file> element -->
<!-- defined in the IUDD to specify the physical location. To override the -->
<!-- path, the media descriptor only needs to list the files to be -->
<!-- overridden. -->
<!-- The iudd:File elements are keyed off the 'id' attribute. -->
<!-- -->
<!-- The media descriptor also contains the signature/digest info for the -->
<!-- entire deployment descriptor. -->
<!-- -->
<!-- If the corresponding deployment descriptor has aggregated other IU -->
<!-- packages, the referenced path is for the deployment descriptors. There -->
<!-- should be  media descritpror for the referenced deployment -->
<!-- descriptors. -->
<schema
  xmlns="http://www.w3.org/2001/XMLSchema"
  targetNamespace="http://www.ibm.com/namespaces/autonomic/solutioninstall/MEDIA"
  xmlns:media="http://www.ibm.com/namespaces/autonomic/solutioninstall/MEDIA"
  xmlns:iudd="http://www.ibm.com/namespaces/autonomic/solutioninstall/IUDD"
  xmlns:base="http://www.ibm.com/namespaces/autonomic/solutioninstall/BASE"
  elementFormDefault="unqualified" attributeFormDefault="unqualified"
  version="1.2h">
  <annotation>
    <documentation>
      Media descriptor schema as defined in the ACAB.BO0307 for "IU Package
      Format" - Copyright (C) 2003 IBM Corporation. All rights reserved
    </documentation>
  </annotation>
       <import
    namespace="http://www.ibm.com/namespaces/autonomic/solutioninstall/BASE"
    schemaLocation="base.xsd"/> <import
    namespace="http://www.ibm.com/namespaces/autonomic/solutioninstall/IUDD"
    schemaLocation="iudd.xsd"/> <import
    namespace="http://www.ibm.com/namespaces/autonomic/solutioninstall/SIU"
    schemaLocation="siu.xsd"/>

  <element name="binding" type="media:BindingInfo"/>
  <complexType name="BindingInfo">
    <sequence>
      <!-- deployment descriptor that this media descriptor is associated
      with. Both are co-located. -->
      <element name="deploymentDescriptor">
        <complexType>
          <sequence>
            <!-- The IUDD (deployment descriptor) path relative to the media
            descriptor -->
            <element name="location" type="base:RelativePath"/>

            <!-- The digest value for the entire deployment descriptor -->
            <element name="digest" type="base:CheckSum" minOccurs="0">
              <annotation>
                <documentation>
```

```
              This is the digest value for the entire deployment
              descriptor.
            </documentation>
          </annotation>
        </element>
      </sequence>
    </complexType>
  </element>

  <!-- Optional default logical source that is used for all files that
  do not have corresponding entries in the next section. This value
  overwrites the pre-defined default logical source (which is the
  deployment descriptor location). -->
  <element name="defaultLogicalSource"
    type="media:LogicalSource"
    minOccurs="0">
    <annotation>
      <documentation>
        This optional default logical source that is used for all files
        that do not have corresponding entries in the next section. This
        value overwrites the pre-defined default logical source (which
        is the deployment descriptor location).
      </documentation>
    </annotation>
  </element>

  <!-- ##### The associated IUDD file info has (1) path, (2) size, (4)
  signatures (and others). ##### -->
  <sequence>
    <annotation>
      <documentation>
        If the logical source attribute is not used by the iudd:File
        type, each 'file' element should have binding info in the media
        descriptor.
      </documentation>
    </annotation>
    <element name="fileSource" minOccurs="0" maxOccurs="unbounded">
      <complexType>
        <sequence>
          <!-- The id for the iudd:File entry -->
          <element name="fileIdRef" type="NCName">
            <annotation>
              <documentation>
                This is the 'id' attribute of the iudd:File element in
                the IUDD file associated with this media descriptor.
              </documentation>
            </annotation>
          </element>
          <!-- Binding info: physical location and pathname override -->
          <element name="location">
            <annotation>
              <documentation>
                File info in IUDD has (1) path name, (2) size, (3)
                (optional) digital signature. The media descriptor can
                override information (1). (2) and (3) will not and
                cannot be modified by the media descriptor to ensure the
                package contents have not been changed.
              </documentation>
            </annotation>
            <complexType>
              <sequence>
                <!-- The physical location -->
                <element name="physicalLocation"
                  type="media:LogicalSource"/>

                <!-- Optional new pathname. This value will override the
                one defined in the deployment descriptor. -->
                <element name="pathname"
                  type="base:RelativePath" minOccurs="0">
                  <annotation>
                    <documentation>
```

```
                        Optional new pathname. This allows mapping to
                        different file path (including file name). If this
                        is specified, the pathname in the 'file' element
                        of the deployment descriptor is ignored. This path
                        is relative to the physical source identified in
                        the "physicalLocation" element.
                      </documentation>
                    </annotation>
                  </element>
                </sequence>
              </complexType>
            </element>
          </sequence>
        </complexType>
      </element>
    </sequence>
  </sequence>
</complexType>

<simpleType name="RemovableMediaType">
  <annotation>
    <documentation>
      Pre-defined types for fixed-sized removable media. All the formats
      (except the "Others" type) are well known.
    </documentation>
  </annotation>
  <restriction base="string">
    <enumeration value="CDROM"/>
    <enumeration value="DVD"/>
    <enumeration value="Diskette"/>
    <enumeration value="Others"/>
  </restriction>
</simpleType>

<complexType name="LogicalSource">
  <choice>
    <!-- Local. Relative to the folder of the media descriptor. For example,
    in a ZIP file, this is relative to the /META-INF folder -->
    <element name="local"
      type="base:RelativePath">
      <annotation>
        <documentation>
          This specifies a local path relative to the folder of the media
          descriptor.

          This path is a relative path and cannot begin with '/'.
        </documentation>
      </annotation>
    </element>
    <!-- Single ZIP -->
    <element name="ZipFile">
      <annotation>
        <documentation>
          This specifies the folder in a separate ZIP file. The folder is
          relative to the root of the Zip file. The ZIP file can be at any
          network location or on a fixed-sized removable media.
        </documentation>
      </annotation>
      <complexType>
        <sequence>
          <choice>
            <!-- The ZIP file could be at a network location -->
            <element name="networkSource" type="anyURI"/>
            <!-- Or it could be on a CD/DVD/etc. -->
            <element name="removableMedia">
              <complexType>
                <sequence>
                  <element name="ZipPath"
                    type="base:RelativePath">
                    <annotation>
                      <documentation>
```

```
                        The ZIP file path on the specific media. The path
                        is relative to the root and cannot begin with a
                        "/."
                      </documentation>
                    </annotation>
                  </element>
                </sequence>

                <attribute name="type" use="required"
                  type="media:RemovableMediaType"/>
                <!-- The removable media volume identifier. -->
                <attribute name="volumeID"
                  type="string" use="required"/>
              </complexType>
            </element>
          </choice>
          <!-- Path in the ZIP file relative to the root of
          the ZIP file -->
          <element name="path"
            type="base:RelativePath">
            <annotation>
              <documentation>
                This path is relative to the root of the ZIP file. It is a
                relative path and should not begin with a "/."
              </documentation>
            </annotation>
          </element>
        </sequence>
      </complexType>
    </element>
    <!-- Removable Media (CD, DVD, etc.) -->
    <element name="removableMedia">
      <annotation>
        <documentation>
          This support is for fixed size removable media such as CD or
          DVD. The package could span multiple such media. The number is a
          positive integer identifying the specific media. The logic of
          locating the specific media is outside of the scope of this
          schema and spec.
        </documentation>
      </annotation>
      <complexType>
        <sequence>
          <element name="path"
            type="base:RelativePath">
            <annotation>
              <documentation>
                This path is relative to the specific media root. This is
                where the filepath is relative to.

                This path cannot begin with a "/."
              </documentation>
            </annotation>
          </element>
        </sequence>
        <!-- The storage media type. Currently only common storage types
        are supported. It is up to the consumer of the media descriptor to
        access each medai type. Maybe more info about the storage type is
        needed. -->
        <attribute name="type" use="required"
          type="media:RemovableMediaType">
        </attribute>
        <!-- The removable media volume identifier. -->
        <attribute name="volumeID"
          type="string" use="required"/>
      </complexType>
    </element>
    <!-- Network Location -->
    <element name="URL" type="anyURI">
      <annotation>
        <documentation>
```

```
            This points to any network location.
          </documentation>
        </annotation>
      </element>
      <!-- Unknown Location -->
      <element name="unknown">
        <annotation>
          <documentation>
            This indicates that the file is still not bound.  Not all the
            files need to be bound in an media descriptor. For example, an
            IU ZIP package could reference files located on the network. The
            network locations might not be known when the media descriptor
            in the ZIP file was created.

            Media descriptors can have unbound files. However, each file
            needs to be bound for the IU package to be processed.
          </documentation>
        </annotation>
        <complexType/>
      </element>
    </choice>
  </complexType>
</schema>
```