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Abstract

The Open Virtualization Format (OVF) White Paper describes the application of DSP0243, DSP8023, and DSP8027, the specifications that comprise the Open Virtualization Format (OVF) standard. The intended audience is anyone who wants to understand the OVF package and its application to specific use cases. Some familiarity with virtualization and the general concepts of the CIM model is assumed.

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Foreword

The Open Virtualization Format White Paper (DSP2017) was prepared by the OVF Work Group of the DMTF.

This DMTF Informational specification has been developed as a result of joint work with many individuals and teams, including:

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1 Introduction

1.1 Overview

The Open Virtualization Format specification (OVF) provides the industry with a standard packaging format for software solutions based on virtual systems, solving critical business needs for software vendors and cloud computing service providers.

An OVF package can be used by an independent software vendor (ISV) to publish a software solution; by a data center operator to transport a software solution from one data center to another; by a customer to archive a software solution; or any other use case that can be met by having a standardized package for a software solution.

The following use cases are the main basis for OVF work:

1. The ability for ISV's to package a software solution that is capable of being used on more than one hypervisor.
2. The ability to package a virtual system or collection of virtual systems so they can be moved from one data center to another.

Other use cases and derivative use cases (i.e., subsets) are also applicable.

OVF version 1 has been widely adopted by the industry and is now an international standard.

OVF version 2 adds enhanced packaging capabilities, making it applicable to the broader range of use cases that are emerging as industry enters the cloud computing era.

OVF 2 adds the following features:

- Support for Network Ports
- Scaling at deployment time
- Support for basic placement policies
- Encryption of OVF packages
- Disk sharing at runtime
- Advanced Device Boot Order
- Advanced Data Transfer to Guest OS
- Support for Improved Internationalization - I18N
- Support of HASH Improved
- Updated CIM schema

OVF has adopted the Common Information Model (CIM), where appropriate, to allow management software to clearly understand and easily map resource properties using an open standard. The CIM_ResourceAllocationSettingData class and it's sub-classes for specific device types is used to specify the resources needed for the virtual system to operate.

OVF 2 supports network configuration and the IEEE Edge Virtual Bridging Discovery and Configuration protocols. This feature uses DSP8049 Network Port Profile to accomplish this. The CIM_EthernetPortAllocationSettingData class provides the essential properties.

This document aims to give details of the motivation, goals, design and expected usage of OVF, and should be read in accompaniment to the OVF specification of the same revision number.

1.2 Design Considerations

The rapid adoption of virtual infrastructure has highlighted the need for a standard, portable meta-data format for the distribution of virtual systems onto and between virtualization platforms. The ability to package a software application together with the operating system on which it is certified, into a format that can be easily transferred from an ISV, through test and development and into production as a pre-configured, pre-packaged unit with no external dependencies, is extremely attractive. Such pre-deployed, ready to run applications packaged with the configuration of the virtual systems required to run them are called virtual appliances. In order to make this concept practical on a broad scale it is important that the industry adopts a vendor-neutral standard for packaging such virtual appliances and the meta-data required to automatically and securely install, configure, and run them on any virtualization platform.

From the user's point of view, OVF is a packaging format for virtual appliances. Once installed, an OVF package adds to the user’s infrastructure a self-contained, self-consistent, software application that provides a particular service or services. For example, an OVF package might contain a fully-functional and tested web-server, database and OS combination, such as a LAMP stack (Linux + Apache + MySQL + PHP), or it may contain a virus checker, including its update software, spyware detector, etc.

Whereas many virtual appliances contain only a single virtual system, modern enterprise applications are modeled as service oriented architectures (SOA) with multiple tiers, each containing one or more virtual systems. A single virtual system model is thus not sufficient to distribute a multi-tier service. In addition, complex applications require install-time customization of networks and other customer specific properties. Furthermore, a virtual appliance is packaged in a run-time format with disk images and configuration data suitable for a particular hypervisor. Run-time formats are optimized for execution and not for distribution. For efficient software distribution, a number of additional features become critical, including portability, platform independence, verification, signing, versioning, and licensing terms.

The OVF specification describes a hypervisor-neutral, efficient, extensible, and open format for the packaging and distribution of virtual appliances composed of one or more virtual systems. It aims to facilitate the automated and secure management not only of individual virtual systems but also of the virtual appliance as a functional unit.

To be successful OVF has been developed and endorsed by ISVs, virtual appliance vendors, operating system vendors, as well as virtual platform vendors. The OVF specification promotes customer confidence through the collaborative development of common standards for portability and interchange of virtual systems between different vendors’ virtualization platforms.

The OVF format is intended to be immediately useful, to solve an immediate business need, and to facilitate the rapid adoption of a common, backwards compatible, yet rich format for packaging virtual appliances.

The OVF specification is complimentary to existing IT management standards and frameworks and promotes best-of-breed competition through openness and extensibility. The explicit copyright notice attached to this document is intended to avoid arbitrary, independent, piece-wise extensions to the format while permitting free distribution and implementation of the specification.

2 OVF Key Concepts

2.1 Virtual Appliances

A virtual appliance is a pre-configured software stack comprising one or more virtual systems. Each virtual system is an independently installable run-time entity consisting of an operating system, applications and application-specific data, as well as meta-data describing the virtual hardware that is required by the virtual system. Many infrastructure applications and even end-user applications that are accessible over a network, such as a DNS server, a bug tracking database, or a complete CRM solution composed of web, application and database tiers, can be delivered as virtual appliances. Delivering complex software systems and services as a pre-configured software stack can dramatically increase robustness and simplify installation.

Virtual appliances are changing the software distribution paradigm because they allow optimization of the software stack for the specific application and to deliver a turnkey service to the end user. For solution providers, building a virtual appliance is simpler and more cost effective than building a hardware appliance. The application is pre-packaged with the operating system that it uses, reducing compatibility testing and certification, allowing the software to be pre-installed in the environment in which it will run – by the ISV that develops the solution. For end users, virtual appliances offer an opportunity to dramatically simplify the software management lifecycle through the adoption of standardized, automated, and efficient processes that replace the individual OS and application specific management tasks used previously.

Virtual appliances need not be developed and delivered by 3rd party ISVs – the concept is equally useful and often used within an enterprise in which a virtual system template for a particular service is assembled, tested, and certified by an IT organization and then packaged for repeated, “cookie cutter” deployment throughout the enterprise.

Commonly, a software service is implemented as a multi-tier application running in multiple virtual systems and communicating across the network using a SOA model. Services are often composed of other services, which themselves might also be multi-tier applications or composed of other services. Indeed the SOA model naturally fits into a virtual appliance-based infrastructure, since virtual appliances are typified by the use of network facing, XML based management and service interfaces that allow composition of appliances to deliver a complete application.

For example, consider a typical web application that consists of three tiers. A web tier that implements the presentation logic, and application server tier that implements the business logic, and a back-end database tier. A straightforward implementation would divide this into 3 virtual systems, one for each tier. In this way, the application can scale from a fraction of a single physical host to 3 physical hosts. Another approach is to treat each tier as a service in itself. Hence, each tier can scale to a multi-virtual system service that provides a clustered solution. Again, taking the web-application as an example, a common scenario is to have many web servers, fewer applications servers, and one or two database servers. Implemented as virtual systems, each tier can scale across as many or as few physical machines as required, and each tier can support multiple instances of virtual systems that service requests.

Transport virtual system templates. One OVF may contain a single or many virtual systems (it is left to the developer to decide which arrangement best suits their application). OVFs must be installed before they can be run; a particular virtualization platform may run the virtual system from the OVF, but this is not required. If this is done, the OVF itself can no longer be viewed as a “golden image” version of the appliance, since run-time state for the virtual system(s) will pervade the OVF. Moreover the digital signature that allows the platform to check the integrity of the OVF will be invalid.

As a transport mechanism, OVF differs from VMware's VMDK Virtual Disk Format and Microsoft's VHD Virtual Hard Disk format or the open source QCOW format. These are run-time virtual system image formats, operating at the scope of a single virtual disk, and though they are frequently used as transport formats today, they are not designed to solve the portability problems; they do not help with a virtual system with multiple disks, or multiple virtual systems, or need customization of the virtual system at install time, or if the virtual system is intended to run on multiple virtualization platforms (even if the virtualization platforms claim support of the particular virtual hard disk format used).

Included within the OVF remit is the concept of the certification and integrity of a packaged virtual appliance, allowing the platform to determine the provenance of the appliance and to allow the end-user to make the appropriate trust decisions. The OVF specification has been constructed so that the appliance is responsible for its own configuration and modification. In particular, this means that the virtualization platform does not need to be able to read from the appliance's file systems. This decoupling of platform from the appliance means that OVF packages may be implemented using any operating system, and installed on any virtualization platform that supports the OVF format. A specific mechanism is provided for appliances to detect and react to the platform on which they are installed. This allows platforms to extend this specification in unique ways without breaking compatibility of appliances across the industry.

The OVF format has several specific features that are designed for complex, multi-tier services and their associated distribution, installation, configuration and execution workflow:

It directly supports the configuration of multi-tier applications and the composition of virtual systems to deliver composed services.

It permits the specification of both virtual system and application-level configuration.

It offers robust mechanisms for validation of the contents of the OVF, and full support for unattended installation to ease the burden of deployment for users, and thereby enhance the user’s experience.

It uses commercially accepted procedures for integrity checking of the contents of the OVF, through the use of signatures and trusted third parties. This serves to reassure the consumer of an appliance that it has not been modified since signed by the creator of the appliance. This is seen as critical to the success of the virtual appliance market, and to the viability of independent creation and online download of appliances.

It permits commercial interests of the appliance vendor and user to be respected, by providing a basic method for presentation and acknowledgement of licensing terms associated with the appliance.

2.2 Life-Cycle

The life cycle for a virtual system is illustrated in **Figure 1**:

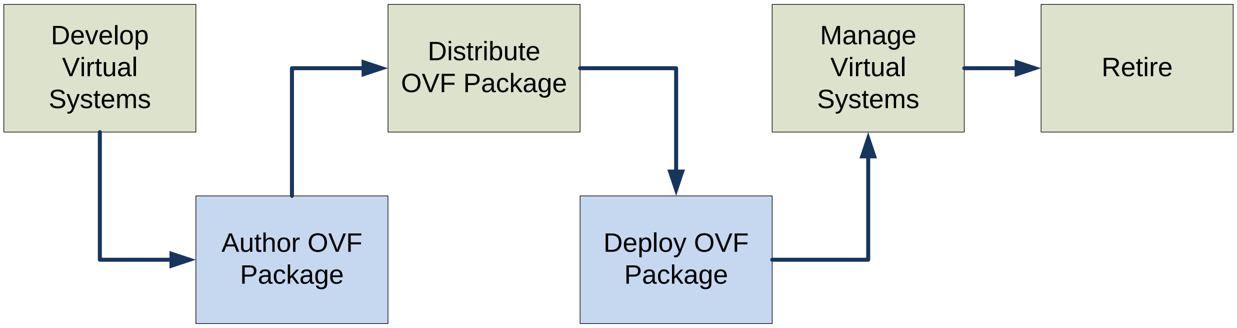


Figure 1 – OVF Package Lifecycle

An OVF package is built from components that have been developed or acquired by the OVF author. These are packaged into a set of files that comprise a virtual appliance, consisting of one or more virtual machines and virtual machine collections and the relevant configuration and deployment meta data. For example, a clustered database component might be acquired from a third-party ISV. The installed service is then managed and eventually retired. Distribution, management and retirement are outside the scope of OVF and are specific to the virtualization product used and the virtual appliance installed from the OVF.

Management includes, for example, ongoing maintenance, configuration, and upgrade of the appliance. These activities depend on the installed service and environment, not the OVF package. The OVF specification deals specifically with the authoring and deployment phases.

The OVF author function is illustrated in.**Figure 2**.

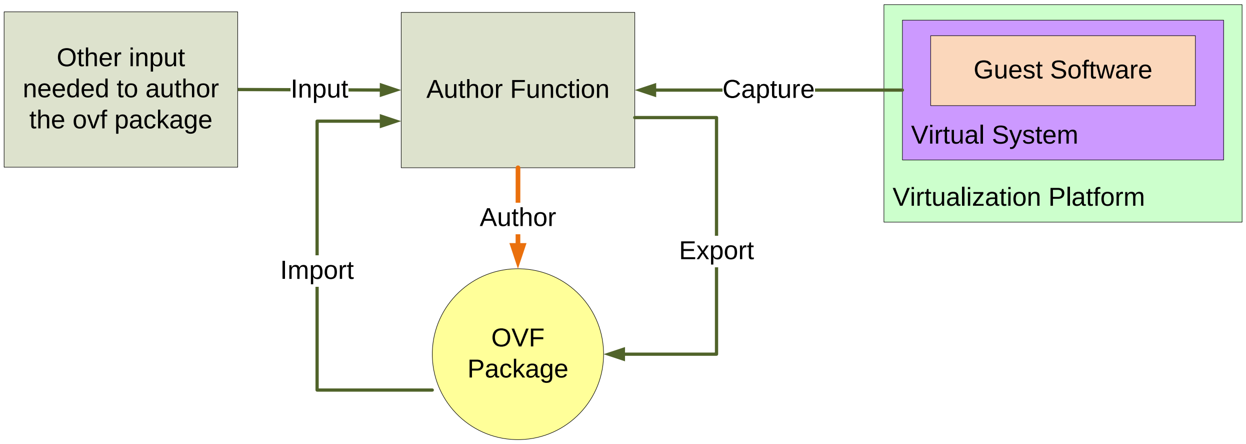


Figure 2 – OVF Author Function

In practice, OVFs are usually authored in two ways. The straight forward method is to use a text editor or an XML authoring tool to write an OVF XML descriptor following the OVF specification, then assemble the required images, and other files. An alternative method is also often used. This method relies on the ability of some virtualization platforms to export an OVF for a collection of virtual systems or machines. An OVF is exported from a running appliance. The “raw” exported OVF may be edited to become a new OVF package. This may be done for various reasons: improving portability between virtualization platforms or providing options for configuration are two common reasons. This edited exported OVF becomes a new OVF package.

The OVF deployment function is illustrated in **Figure 3** This diagram also is instructive as to the scope of work that is covered by the OVF work group.

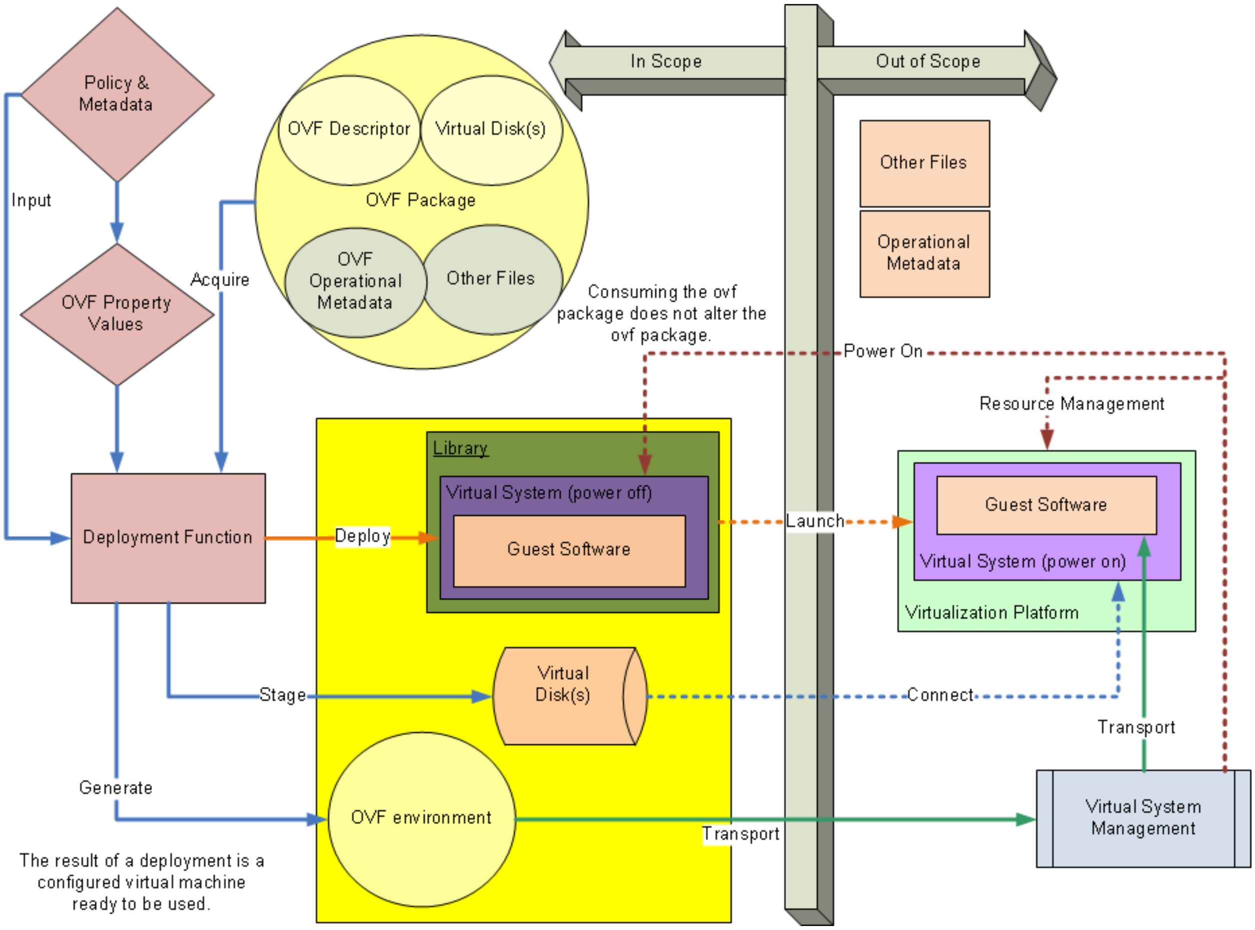


Figure 3 – OVF Deployment Function

The OVF operational metadata is information that may be needed for the proper operation of the virtual system or collection of virtual systems. The OVF operational metadata is a sub-set of the operational metadata that may be available when the virtual system(s) is powered on.

As shown in the diagram, the OVF deployment function transports the OVF environment to the virtualization platform. The OVF specification is flexible on the exact nature of the transport, but it can be thought of as placing media, like a CD ROM, into a virtual reader on the virtual machine and the media being read by the guest operating system each time the system starts up. The meta-data in the OVF environment is used for configuration after operating system startup and meeting other requirements of guest software and virtualization platform for the proper operation of the virtual appliance.

3 OVF Package

The OVF package provides a means to distribute software solutions deployed in a virtual system or collection of virtual systems. The OVF package consists of an OVF descriptor and related virtual disks. The OVF package exists as either a set of files referenced by a URL or as a compressed file with the '.ova' extension.

3.1 General XML concepts used in OVF

3.1.1 Element

An XML element is data container in the OVF descriptor. Each element begins and ends with an element type, i.e., element name, contained in an element tag. The element's start tag, e.g., <elementname> and the element's end tag, e.g., </elementname> delineate the element contents. An element can contain: other elements, text, attributes, or a mix of all of the these.

XML elements follow these naming rules:

- Names can contain letters, numbers, and other characters
- Names cannot start with a number or punctuation character
- Names cannot start with the letters xml (or XML, or Xml, etc)
- Names cannot contain spaces
- Any name can be used, no words are reserved.

3.1.2 Attribute

XML elements can have attributes that provide additional information about an element. Attributes often provide information that is not a part of the data. Attribute values are always be quoted using single or double quotes.

3.1.3 Substitution Group

A substitution group is a feature of XML schema that allows you to specify elements that can replace another element in documents generated from that schema. The replaceable element is called the head element and is defined in the schema's global scope. The elements of the substitution group are of the same type as the head element or a type that is derived from the head element's type.

In essence, a substitution group allows you to build a collection of elements that can be specified using a generic element. For example, if you are building an ordering system for a company that sells three types of widgets you might define a generic widget element that contains a set of common data for all three widget types. Then you can define a substitution group that contains a more specific set of data for each type of widget. In your contract you can then specify the generic widget element as a message part instead of defining a specific ordering operation for each type of widget. When the actual message is built, the message can contain any of the elements of the substitution group.

3.1.4 Global attributes used in the OVF

The following global attributes are defined in the OVF schema. Element specific attributes are also defined see 3.2.and 3.3

- required xs:boolean default="true" - determines whether import fails if the Section is not understood
- transport xs:string default="" - space-separated list of supported transport types</xs:documentation
- configuration xs:string - configuration from the DeploymentOptionSection element that this entry is valid for
- bound xs:string - range marker entry

3.1.5 Elements used in OVF

The root element of an OVF Descriptor is the Envelope element

The OVF schema uses substitution groups to provide extensibility. Two substitution groups are defined:

- Section element - a substitution group that contains section elements
- Content element – a substitution group that contains a virtual system element(s) or a collection of virtual systems element(s)

Elements that are direct children of an Envelope element:

- References element - a sequence of references to all external files
- NetworkSection element
- DiskSection element
- DeploymentOptionSection element
- Content element
- Strings element

Elements that are a substitution group for a Content element:

- VirtualSystem element
- VirtualSystemCollection element (may be nested)

Elements that are a substitution group for a Section element used in a Content element:

- AnnotationSection element
- ProductSection element
- OperatingSystemSection element
- EulaSection element
- VirtualHardwareSection element
- ResourceAllocationSection element
- InstallSection element
- StartupSection element
- EnvironmentFilesSection element
- BootDeviceSection element
- SharedDiskSection element
- ScaleOutSection element
- PlacementGroupSection element
- PlacementSection element
- EncryptionSection element

These elements have to be in the above order when used in an OVF descriptor.

Basic structure of an OVF Package:

```
ovf:Envelope
<xs:element name="References" type="ovf:References_Type">

<xs:element ref="ovf:Section" minOccurs="0" maxOccurs="unbounded">
<DiskSection>
      <Info> Describes all networks used in the package </Info>
<NetworkSection>
```

```
       <Info>List of logical networks used in the package</Info>
<DeploymentOptionSection>
       <Info>List of deployment options available in the package</Info>

<xs:element ref="ovf:Content">
       <VirtualSystemCollection ovf:id="Acme VSC">
        <Info>The packaging of the first virtual appliance</Info>

             <VirtualSystem ovf:id="Acme VS 1">
                    <Info>The packaging of the virtual machine 1</Info>
             <VirtualSystem ovf:id="Acme VS 2">
                    <Info>The packaging of the virtual machine 2</Info>

             <VirtualSystemCollection ovf:id="Widget VSC">
                    <Info>The packaging of the second virtual appliance</Info>

                    <VirtualSystem ovf:id="Acme VS 3">
                           <Info>The packaging of the virtual machine 3</Info>
                    <VirtualSystem ovf:id="Acme VS 3">
                           <Info>The packaging of the virtual machine 4</Info>

<xs:element name="Strings" type="ovf:Strings_Type" minOccurs="0"
maxOccurs="unbounded">
       <Info> Root element of I18N string bundle</Info>
```

3.1.6 Extensibility in OVF

The OVF schema use the XSD elements ‘any’ and ‘anyAttribute’ to extend the OVF descriptor and the OVF Environment to provide custom metadata. This feature allows OVF packages to meet a wide variety of use cases in the industry.

The following definitions come from the XML schema reference website. See http://www.w3schools.com/schema/schema_elements_ref.asp.

- any - Enables the author to extend the XML document with elements not specified by the schema
- anyAttribute - Enables the author to extend the XML document with attributes not specified by the schema
- ##any - elements from any namespace are allowed (this is default)
- ##other - elements from any namespace that is not the namespace of the parent element can be present

An extension at Envelope element level is done by defining a new member of the ovf:Section substitution group. An extension at Content element level is done by defining a new member of the ovf:Section substitution group. These new section elements can be used where sections are allowed to be present by the OVF schema. The Info element in each new section element can be used to give meaningful warnings to users when a new section element is being skipped because the deployment platform does not understand it.

A type defined in the OVF schema may be extended at the end with additional elements. Extension points are declared with an xs:any with a namespace="##other".

Additional attributes are allowed in the OVF schema. Extension points are declared with an `xs:anyAttribute`

The ovf:required attribute specifies whether the information in the element is required or optional. The ovf:required attribute defaults to TRUE. If the deployment platform detects an element extension that is required and that it does not understand it fails the deployment

On custom attributes, the information in the attribute is not required for correct behavior.

```
EXAMPLE 1:
    <!—- Optional custom section example -->
    <otherns:IncidentTrackingSection ovf:required="false">
        <Info>Specifies information useful for incident tracking purposes</Info>
        <BuildSystem>Acme Corporation Official Build System</BuildSystem>
        <BuildNumber>102876</BuildNumber>
        <BuildDate>10-10-2008</BuildDate>
    </otherns:IncidentTrackingSection>
EXAMPLE 2:
    <!—- Open content example (extension of existing type) -->
    <AnnotationSection>
        <Info>Specifies an annotation for this virtual machine</Info>
        <Annotation>This is an example of how a future element (Author) can still be
           parsed by older clients</Annotation>
        <!-- AnnotationSection extended with Author element -->
        <otherns:Author ovf:required="false">John Smith</otherns:Author>
    </AnnotationSection>
EXAMPLE 3:
    <!—- Optional custom attribute example -->
    <Network ovf:name="VM network" otherns:desiredCapacity="1 Gbit/s">
        <Description>The main network for VMs</Description>
    </Network>
```

3.2 OVF Top Level Elements

3.2.1 References element

The references element contains the references to all external files

3.2.2 NetworkSection element

See clause X for additional information on the `NetworkSection` element

```
<NetworkSection>
  <Info>List of logical networks used in the package</Info>
    <Network ovf:name="VM Network">
    <Description>The network that the service will be available on</Description>
    <NetworkPortProfile>
      <Item>
        <epasd:AllocationUnits>GigaBits per Second</epasd:AllocationUnits>
        <epasd:ElementName>Network Port Profile /epasd:ElementName>
        <epasd:InstanceID>1</epasd:InstanceID>
        <epasd:NetworkPortProfileID>1</epasd:NetworkPortProfileID>
        <epasd:NetworkPortProfileIDType>4</epasd:NetworkPortProfileIDType>
        <epasd:Reservation>1</epasd:Reservation>
      </Item>
    </NetworkPortProfile>
  </Network>
</NetworkSection>
```

3.2.3 DiskSection Element

The `DiskSection` element defines the virtual disks used by the virtual systems in the OVF package.

Any virtual disk format may be used, as long as the virtual disk format specification is public and available without restrictions. This supports the full range of virtual hard disk formats used for hypervisors today, and it is extensible to allow for future formats.

The virtual disk format may be a simple basic disk block format agnostic to the guest software installed. For example, VMware VMDK formats deal with 512 byte disk sectors stored in 64KB blocks, in a number of flat, sparse, and compressed variants. At deployment time, the virtualization platform creates virtual disks in a basic disk block format it prefers. The runtime virtual disk format may be identical to the distribution format, but is often different since it may not be efficient to run out of a compressed virtual disk format. The guest software installed has its own file system format, e.g., NTFS, EXT3, or ZFS. The OVF virtual disk though does not need to know the file system format.

The following example shows a description of virtual disks:

```
<DiskSection>
    <Info>Describes the set of virtual disks</Info>
    <Disk ovf:diskId="vmdisk1" ovf:fileRef="file1" ovf:capacity="8589934592"
          ovf:populatedSize="3549324972"
          ovf:format=
              "http://www.vmware.com/interfaces/specifications/vmdk.html#sparse">
    </Disk>
    <Disk ovf:diskId="vmdisk2" ovf:capacity="536870912"
    </Disk>
    <Disk ovf:diskId="vmdisk3" ovf:capacity="${disk.size}"
          ovf:capacityAllocationUnits="byte * 2^30"
    </Disk>
</DiskSection>
```

3.2.4 DeploymentOptionsSection Element

The following example illustrates a `DeploymentOptionsSection` element.

```
<DeploymentOptionSection>
  <Configuration ovf:id="minimal">
    <Label>Minimal</Label>
      <Description>Some description</Description>
  </Configuration>
  <Configuration ovf:id="normal" ovf:default="true">
    <Label>Typical</Label>
      <Description>Some description</Description>
  </Configuration>
     <!-- Additional configurations -->
</DeploymentOptionSection>
```

3.3 OVF Section Elements used in Virtual System & Virtual System Collections

The following OVF descriptor section elements may appear within a `VirtualSystem` or `VirtualSystemCollection` element.

3.3.1 AnnotationSection element

The `AnnotationSection` element is user-defined and can appear in `VirtualSystem` and `VirtualSystemCollection` elements. An `AnnotationSection` element is required to contain one and only `Annotation` element. `Annotation` elements are localizable. A suggested use for `Annotation` elements is to display them to the consumers as the package is deployed. Note that the `Annotation` element specified in OVF is not an XML Schema `Annotation` element.

```
<AnnotationSection>
    <Info>An annotation on this service. It can be ignored</Info>
    <Annotation>Contact customer support if you have any problems</Annotation>
</AnnotationSection >
```

3.3.2 ProductSection element

The `ProcductSection` element provides product information such as name and vendor of the appliance and a set of properties that can be used to customize the appliance. These properties will be configured at installation time of the appliance, typically by prompting the user. This is discussed in more detail below.

```
<ProductSection ovf:class="com.mycrm.myservice" ovf:instance="1">
   <Info>Describes product information for the service</Info>
   <Product>MyCRM Enterprise</Product>
   <Vendor>MyCRM Corporation</Vendor>
   <Version>4.5</Version>
   <FullVersion>4.5-b4523</FullVersion>
   <ProductUrl>http://www.mycrm.com/enterprise</ProductUrl>
   <VendorUrl>http://www.mycrm.com</VendorUrl>
   <Icon ovf:height="32" ovf:width="32" ovf:mimeType="image/png"
ovf:fileRef="icon">
   <Category>Email properties</Category>
   <Property ovf:key="admin.email" ovf:type="string"
ovf:userConfigurable="true">
        <Label>Admin email</Label>
        <Description>Email address of administrator</Description>
   </Property>
   <Category>Admin properties</Category>
   <Property ovf:key="app_log" ovf:type="string" ovf:value="low"
ovf:userConfigurable="true">
        <Description>Loglevel for the service</Description>
   </Property>
   <Property ovf:key="app_isSecondary" ovf:value="false" ovf:type="boolean">
        <Description>Cluster setup for application server</Description>
   </Property>
   <Property ovf:key="app_ip" ovf:type="string" ovf:value="${appserver-vm}">
        <Description>IP address of the application server VM</Description>
   </Property>
```

```
</ProductSection>
```

Note that the `ovf:key` attribute does not contain the period character ('.') or the colon character (':') and the `ovf:class` and `ovf:instance` attributes do not contain the colon character (':').

If only one instance of a product is installed, the `ovf:instance` attribute is not used.

The following illustrates the use of OVF `Properties` in a `ProductSection` element:

```
<ProductSection>
   <Property ovf:key="app.adminEmail" ovf:type="string" ovf:userConfigurable="true"
             ovf:configuration="standard">
        <Label>Admin email</Label>
        <Description>Email address of service administrator</Description>
   </Property>
   <Property ovf:key="app.log" ovf:type="string" ovf:value="low"
             ovf:userConfigurable="true">
        <Label>Loglevel</Label>
        <Description>Loglevel for the service</Description>
        <Value ovf:value="none" ovf:configuration="minimal">
   </Property>
</ProductSection>
```

In the example above, the app.adminEmail property is only user configurable in the standard configuration, while the default value for the app.log property is changed from low to none in the minimal configuration.

3.3.3 OperatingSystemSection element

The OperatingSystemSection element specifies the guest operating system used in a virtual system. The id attribute unambiguously identifies the version of the operating system. The id attribute is required. The id refers to an integer value from the ValueMap of the CIM_OperatingSystem.OSType property. The version attribute contains a string mapped to the id in the CIM_OperatingSystem.OSType Value. Both the Info (derived from Section) and Description elements may be externalized for localization or other purposes. See section 4.2 of this document for more details on externalization. The Version attribute is a symbolic string and cannot be internationalized.

This is an example of a section that specifies a Microsoft Windows Server 2008:

```
<OperatingSystemSection ovf:id="76">
   <Info>Specifies the operating system installed</Info>
   <Description>Microsoft Windows Server 2008</Description>
</OperatingSystemSection>
```

3.3.4 EulaSection element

The `EulaSection` contains the human readable licensing agreement for its parent, usually a `VirtualSystem` or `VirtualSystemHardware`. More than one `EulaSection` may be provided for one parent. The contents of the `License` element of each `EulaSection` are displayed to the user for acceptance when the OVF package is deployed. If unattended deployments are supported, provision is made for implicit acceptance of the `EulaSections`.

Eulas may be externalized for localization or to point to an external license document. See section **Error! Reference source not found.** of this document for more details on Internationalization.

This is an example `EulaSection`:

```
<EulaSection>
    <Info>Licensing agreement</Info>
    <License>
Lorem ipsum dolor sit amet, ligula suspendisse nulla pretium, rhoncus tempor placerat
fermentum, enim integer ad vestibulum volutpat. Nisl rhoncus turpis est, vel elit,
congue wisi enim nunc ultricies sit, magna tincidunt. Maecenas aliquam maecenas ligula
nostra, accumsan taciti. Sociis mauris in integer, a dolor netus non dui aliquet,
sagittis felis sodales, dolor sociis mauris, vel eu libero cras. Interdum at. Eget
habitasse elementum est, ipsum purus pede porttitor class, ut adipiscing, aliquet sed
auctor, imperdiet arcu per diam dapibus libero duis. Enim eros in vel, volutpat nec
pellentesque leo, scelerisque.
    </License>
</EulaSection>
```

3.3.5 VirtualHardwareSection element

The `VirtualHardwareSection` element describes the virtual hardware using the CIM resource allocation setting data model. This model is based on CIM_ResourceAllocationSettingData classes that specify CIM properties to describe the type and quantity of the resource being requested. The CIM Schema is available at http://www.dmtf.org/standards/cim.

This `VirtualHardwareSection` element describes the virtual devices in the hardware abstraction layer that is used by a virtual system. The CIM_ResourceAllocationSettingData has a list of devices. Some devices, such as the Ethernet port and Storage are subclassed with an extended set of properties.

In this particular case, a fairly typical set of hardware (500 MB of guest memory, 1 CPU, 1 NIC, and one virtual disk) is specified. The network and disk identifiers from the outer sections are referenced here. An incomplete or missing hardware section may cause the deployment to fail.

The following illustrates a `VirtualHardwareSection` element.

```
<VirtualHardwareSection>
      <Info>Memory = 4 GB, CPU = 1 GHz, Disk = 100 GB, 1 Ethernet nic</Info>
      <Item>
            <rasd:AllocationUnits>Hertz*10^9</rasd:AllocationUnits>
            <rasd:Description>Virtual CPU</rasd:Description>
            <rasd:ElementName>1 GHz virtual CPU</rasd:ElementName>
            <rasd:InstanceID>1</rasd:InstanceID>
            <rasd:Reservation>1</rasd:Reservation>
            <rasd:ResourceType>3</rasd:ResourceType>
            <rasd:VirtualQuantity>1</rasd:VirtualQuantity>
            <rasd:VirtualQuantityUnit>Count</ rasd:VirtualQuantityUnit>
      </Item>
      <Item>
            <rasd:AllocationUnits>byte*2^30</rasd:AllocationUnits>
            <rasd:Description>Memory</rasd:Description>
            <rasd:ElementName>1 GByte of memory</rasd:ElementName>
            <rasd:InstanceID>2</rasd:InstanceID>
            <rasd:Limit>4</rasd:Limit>
            <rasd:Reservation>4</rasd:Reservation>
            <rasd:ResourceType>4</rasd:ResourceType>
      </Item>
      <EthernetPortItem>
            <rasd:AllocationUnits>bit / second *2^30 </rasd:AllocationUnits>
```

```
             <epasd:Connection>VM Network</epasd:Connection>
             <epasd:Description>Virtual NIC</epasd:Description>
             <epasd:ElementName>Ethernet Port</epasd:ElementName>
             <epasd:NetworkPortProfileID>1</epasd:NetworkPortProfileID>
             <epasd:NetworkPortProfileIDType>4</epasd:NetworkPortProfileIDType>
             <epasd:ResourceType>10</epasd:ResourceType>
             <epasd:VirtualQuantity>1</epasd:VirtualQuantity>
             <epasd:VirtualQuantityUnits>Count</epasd:VirtualQuantityUnits>
      </EthernetPortItem>
      <StorageItem>
             <sasd:AllocationUnits>byte*2^30</sasd:AllocationUnits>
             <sasd:Description>Virtual Disk</sasd:Description>
             <sasd:ElementName>100 GByte Virtual Disk</sasd:ElementName>

             <sasd:Reservation>100</sasd:Reservation>
             <sasd:ResourceType>31</sasd:ResourceType>
             <sasd:VirtualQuantity>1</sasd:VirtualQuantity>
             <sasd:VirtualQuantityUnit>Count</sasd:VirtualQuantityUnit>
      </StorageItem>
</VirtualHardwareSection>
```

An example of a `ResourceSubTyp`e CIM property.

```
    <rasd:ResourceSubType>buslogic lsilogic</rasd:ResourceSubType>
```

The following example illustrates a `VirtualHardwareSection` element.

```
      <VirtualHardwareSection>
          <Info>...</Info>
          <Item>
              <rasd:AllocationUnits>byte * 2^20</rasd:AllocationUnits>
              <rasd:ElementName>512 MB memory size and 256 MB
reservation</rasd:ElementName>
              <rasd:InstanceID>0</rasd:InstanceID>
              <rasd:Reservation>256</rasd:Reservation>
              <rasd:ResourceType>4</rasd:ResourceType>
              <rasd:VirtualQuantity>512</rasd:VirtualQuantity>
           </Item>
           ...
           <Item ovf:configuration="big">
              <rasd:AllocationUnits>byte * 2^20</rasd:AllocationUnits>
              <rasd:ElementName>1024 MB memory size and 512 MB
reservation</rasd:ElementName>
              <rasd:InstanceID>0</rasd:InstanceID>
              <rasd:Reservation>512</rasd:Reservation>
              <rasd:ResourceType>4</rasd:ResourceType>
              <rasd:VirtualQuantity>1024</rasd:VirtualQuantity>
           </Item>
        </VirtualHardwareSection>
```

3.3.6 ResourceAllocationSection element

The ResourceAllocationSection element sets resource constraints that apply to the virtual system collction. In contrast the VirtualHardwareSection element applies to a specific virtual system.

The following illustrates a ResourceAllocationSection element.

```
<ResourceAllocationSection>
   <Info>Defines reservations for CPU and memory for the collection of VMs</Info>
   <Item>
      <rasd:AllocationUnits>byte * 2^20</rasd:AllocationUnits>
      <rasd:ElementName>300 MB reservation</rasd:ElementName>
      <rasd:InstanceID>0</rasd:InstanceID>
      <rasd:Reservation>300</rasd:Reservation>
      <rasd:ResourceType>4</rasd:ResourceType>
   </Item>
   <Item ovf:configuration="..." ovf:bound="...">
      <rasd:AllocationUnits>hertz * 10^6</rasd:AllocationUnits>
      <rasd:ElementName>500 MHz reservation</rasd:ElementName>
      <rasd:InstanceID>0</rasd:InstanceID>
      <rasd:Reservation>500</rasd:Reservation>
      <rasd:ResourceType>3</rasd:ResourceType>
   </Item>
   <EthernetPortItem>
     <epasd:Address>00-16-8B-DB-00-5E</epasd:Address>
     <epasd:Connection>VM Network</epasd:Connection>
     <epasd:Description>Virtual NIC</epasd:Description>
     <epasd:ElementName>Ethernet Port 1</epasd:ElementName>
     <epasd:InstanceID>3</epasd:InstanceID>
     <epasd:NetworkPortProfileID>1</epasd:NetworkPortProfileID>
     <epasd:NetworkPortProfileIDType>4</epasd:NetworkPortProfileIDType>
     <epasd:VirtualQuantityUnits>1</epasd:VirtualQuantityUnits>
  </EthernetPortItem>
  <StorageItem>
     <sasd:AllocationUnits>byte*2^30</sasd:AllocationUnits>
     <sasd:Description>Virtual Disk</sasd:Description>
     <sasd:ElementName>100 GByte Virtual Disk</sasd:ElementName>
     <sasd:InstanceID>4</sasd:InstanceID>
     <sasd:Reservation>100</sasd:Reservation>
     <sasd:ResourceType>31</sasd:ResourceType>
     <sasd:VirtualQuantity>1</sasd:VirtualQuantity>
  </StorageItem>
</ResourceAllocationSection>
```

3.3.7 InstallSection element

The InstallSection element is optional and is used only in the VirtualSystem element. If present, it is processed before the StartupSection element.

InstallSection elements enable the OVF author that a virtual system needs to boot before powering off after installation. Typically, when the boot occurs, the guest software executes scripts or other software from the OVF environment to complete the installation. The absence of an InstallSection element implies a boot is not necessary to complete the installation. For example, if the virtual system has no guest software or the guest software is completely installed in the system image, an `InstallSection` element is not needed.

Serveral virtual systems in a virtual system collection may each have an InstallSection defined. In this case, each virtual system is booted. The boots may be concurrent.

The value of the `initialBootStopDelay` attribute is the duration in seconds that the virtualization platform waits for the virtual system to power off. If the delay expires and the virtual system has not powered off, the installation is deemed to have failed. The default value for initialBootStopDelay is zero, meaning the there is no limit on the delay and the virtualization platform waits until virtual system powers itself off. The guest software on the virtual system could boot multiple times before powering off.

In the example below, the virtualization platform waits 5 minutes (300 seconds) for the guest software to power off the virtual system. If the virtual machine does not power off in 5 minutes, the installation is deemed a a failure. During the 5 minute wait interval, the virtual system could reboot several times.

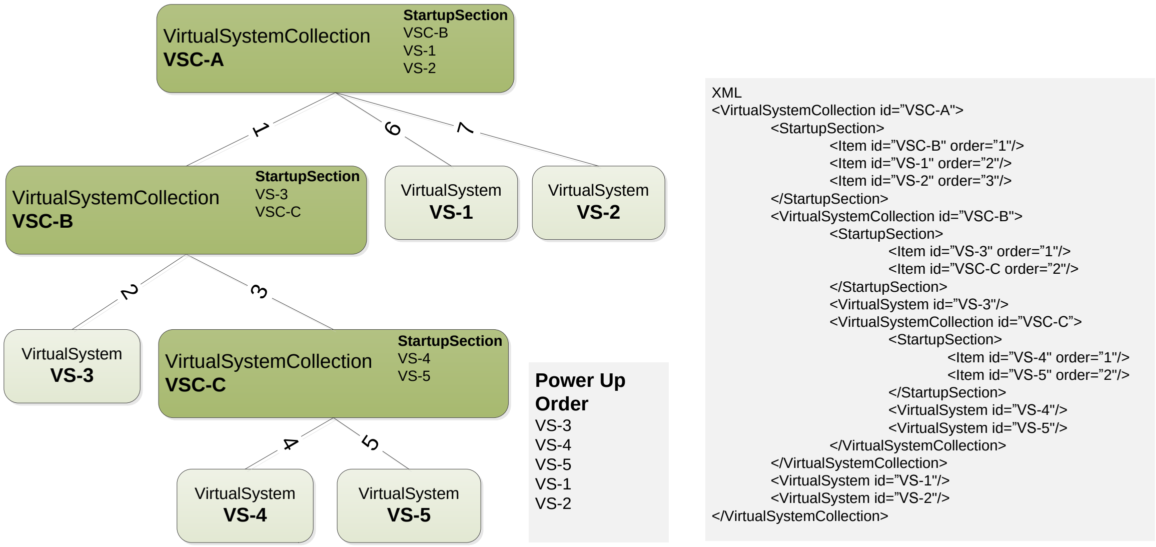
```
<InstallSection ovf:initialBootStopDelay="300">
  <Info>Specifies that the virtual machine needs to be booted after having
  created the guest software in order to install and/or configure the software
  </Info>
</InstallSection>
```

3.3.8 StartupSection element

The `StartupSection` element controls powering on and off of virtual system collections and is executed after InstallSection element(s) if any..

The `StartupSection` element is used in `VirtualSystemCollection` elements to specify the startup and shutdown order of the virtual systems. The `StartupSection` element is a list of `Item` elements. `Item` elements have attributes that control the order and timing of powering up and down The `Item` elements in a `StartupSection` element are scoped to the that element. Do not confuse these with `Item` elements in a `VirtualHardwareSection` element or `ResourceAllocationSection` element.

The attribute in an `Item` element references the `id` attribute of an element in a `Content_Type` substitution group. The `Content_Type` substitution group is a non-instantiable entity that can be polymorphically replaced by either a `VirtualSystem` element or a `VirtualSystemCollection` element. Thus, an `Item` element in a `StartupSection` element references either a `VirtualSystem` element or a `VirtualSystemCollection` element.. A `StartupSection` element may control powering up and down of both virtual systems and virtual system collections contained in the virtual system collection parent. This allows for recursive start up structures. See **Figure 4**.



Power Up Order
VS-3
VS-4
VS-5
VS-1
VS-2

```
XML
<VirtualSystemCollection id=”VSC-A">
        <StartupSection>
                <Item id=”VSC-B" order=”1"/>
                <Item id=”VS-1" order=”2"/>
                <Item id=”VS-2" order=”3"/>
        </StartupSection>
        <VirtualSystemCollection id=”VSC-B">
                <StartupSection>
                        <Item id=”VS-3" order=”1"/>
                        <Item id=”VSC-C order=”2"/>
                </StartupSection>
                <VirtualSystem id=”VS-3"/>
                <VirtualSystemCollection id=”VSC-C”>
                        <StartupSection>
                                <Item id=”VS-4" order=”1"/>
                                <Item id=”VS-5" order=”2"/>
                        </StartupSection>
                        <VirtualSystem id=”VS-4"/>
                        <VirtualSystem id=”VS-5"/>
                </VirtualSystemCollection>
        </VirtualSystemCollection>
        <VirtualSystem id=”VS-1"/>
        <VirtualSystem id=”VS-2"/>
</VirtualSystemCollection>
```

Figure 4 - StartupSection Traversal

The order of start up is determined by the value of the `order` attributes of the `Item` elements in a `StartupSection` element. The `order` attribute is a non-negative integer. If the `order` attribute of an `Item` element is zero, the virtual system or virtual system collection may be powered up at any time and the virtualization platform does not have to wait to start items with the next higher order value. Non-zero `order` attribute values are started in ascending numeric order of the order numbers starting at one. If the value of the order number is the same they may be started concurrently, but items with higher order numbers wait until lower number start.

Items are stopped in descending numeric order, with the exception of items with an `order` attribute value of zero, which may be stopped at any time. Items are permited to stop in a non-descending order in an implementation specifc maner unless the `shutdownorder` attribute is specified. The `shutdownorder` attribute allows the shutdown order to be specified in other than the reverse of the startup order..

Several optional attributes of the `Item` element support more detailed control of starting and stopping. The `startDelay` and `stopDelay` attributes specify the seconds to wait until executing the next step in the sequence. Both default to zero.

The `startAction` and `stopAction` attributes specify the actions to use in starting and stopping. Valid values for `startAction` are `powerOn` and `none.` The default is `powerOn.`. Valid values for the `stopAction` attribute are `powerOn`, `guestShutdown`, and `none.` The default is `powerOff`. If the `stopAction` attribute is set to `guestShutdown` the action taken is deployment platform specific.

The `waitingForGuest` attribute is a Boolean that allows the deployment platform to wait until the guest software reports readiness. The default value is `FALSE`. The communication mechansim is platform specific.

The following illustrates a `StartupSection` element.

```
<StartupSection>
  <Item ovf:id="vm1" ovf:order="0" ovf:startDelay="30" ovf:stopDelay="0"
    ovf:startAction="powerOn" ovf:waitingForGuest="true" ovf:stopAction="powerOff"/>
  <Item ovf:id="teamA" ovf:order="0"/>
  <Item ovf:id="vm2" ovf:order="1" ovf:startDelay="0" ovf:stopDelay="20"
     ovf:startAction="powerOn" ovf:stopAction="guestShutdown"/>
</StartupSection>
```

3.3.9 EnvironmentFilesSection element

The `EnvironmentFilesSection` element allows the conveyance of additional environment files to the guest software permitting additional customization. These files are conveyed at using the same transport media as the OVF Environment file.

The OVF Environment file is generated by the deployment function; however these additional environement files are not. The additional environment files are specified in the `EnvironmentFilesSection` element with a `File` element that has an `ovf:fileRef` attribute and `ovf:path` attribute for each file.

The `ovf:fileRef` attribute points to a `File` element in the `References` element. The `File` element is identified by matching its `ovf:id` attribute value with the `ovf:fileRef` attribute value.

The `ovf:path` attribute indicates the relative location in the transport media where the file is placed.

```
<Envelope>
  <References>
    ...
  <File ovf:id="config" ovf:href="config.xml" ovf:size="4332"/>
  <File ovf:id="resources" ovf:href="http://mywebsite/resources/resources.zip"/>
  </References>
  ...
  <VirtualSystem ovf:id="...">
    ...
  <ovf:EnvironmentFilesSection ovf:required="false" ovf:transport="iso">
    <Info>Config files to be included in OVF environment</Info>
    <ovf:File ovf:fileRef="config" ovf:path="setup/cfg.xml"/>
    <ovf:File ovf:fileRef="resources" ovf:path="setup/resources.zip"/>
  </ovf:EnvironmentFilesSection>
 ...
  </VirtualSystem>
  ...
</Envelope>
```

In the example above, the file config.xml in the OVF package will be copied to the OVF environment ISO image and be accessible to the guest software in location `/ovffiles/setup/cfg.xml`, while the file resources.zip will be accessible in location `/ovffiles/setup/resources.zip`.

3.3.10 BootDeviceSection element

Earlier versions of OVF allowed virtual systems to boot only from the default boot device. This was found to be a limitation in various scenarios that are encountered in OVF deployment.

a) If VM needs be setup to PXE boot from a NIC, there was no way to specify it. Similarly if VM needed to be setup to boot from a secondary disk or a USB device there was no way to set that up. Thus there was a need to be able to specify these alternative boot sources with their corresponding setting.

b) A further need was identified through implementation experience to be able to specify multiple boot configurations. For instance during the “preparation” phase of the OVF, it may be necessary for a Virtual System image to be patched using a fix-up disk to make it bootable.

The Common Information Model (CIM) defines artifacts to deal with boot order use cases prevalent in the industry for BIOSes found in desktops and servers. The heart of the artifacts is `CIM_BootSourceSetting` class that defines an individual boot source device like a NIC or a Disk that is the boot source. Each of the devices is identified by a unique ID specified in the CIM specification.

A boot configuration is defined by a sequence of boot devices under an aggregation class `CIM_BootConfigSetting`. Thus a sequence of one or more `CIM_BootSourceSetting` elements is aggregated into `CIM_BootConfigSetting`.

The OVF envelope allows multiple such boot configurations to be aggregated into the `BootDeviceSection`.element. Each such BootDeviceSection element can be part of a `VirtualHardwareSection` element.

A deployment function attempts to setup boot source sequence for a virtual system as defined in the boot configuration that it has chosen. The issue of choosing a boot configuration comes into play only when there are more than one boot configurations. The deployment function makes that choice based on the state of the deployment and the caption element in the boot configuration structure.

In the example below, the Pre-Install configuration specifies the boot source as a specific device (network), while the Post-Install configuration specifies a device type (hard disk).

```
EXAMPLE:
  <Envelope>
  ...
  <VirtualSystem ovf:id="...">
    ...
    <ovf:BootDeviceSection>
      <Info>Boot device order specification</Info>
      <bootc:CIM_BootConfigSetting>
        <bootc:Caption>Pre-Install</bootc:Caption>
        <bootc:Description>Boot Sequence for fixup of disk</bootc:Description>
        <boots:CIM_BootSourceSetting>
          <boots:Caption>Fix-up DVD on the network</boots:Caption>
          <boots:InstanceID>3</boots:InstanceID>           <!— Network device-->
        </boots:CIM_BootSourceSetting>
        <boots:CIM_BootSourceSetting>
          <boots:Caption>Boot virtual disk</boots:Caption>
          <boots:StructuredBootString>CIM:Hard-Disk</boots:StructuredBootString>
        </boots:CIM_BootSourceSetting>
      </bootc:CIM_BootConfigSetting>
    </ovf:BootDeviceSection>
    ...
  </VirtualSystem>
</Envelope>
```

3.3.11 SharedDiskSection element

The `SharedDiskSection` element allows a virtual disk to be referenced by multiple virtual systems to satisfy the needs of clustered databases. The file sharing system technology used is platform specific.

The `SharedDiskSection` element is a valid only at envelope level.

Each shared disk has a unique identifier for the OVF package. The `SharedDiskSection` element adds a an Boolean `ovf:readOnly` attribute that indicates whether read-write i.e. `FALSE`, or read-only i.e., `TRUE` is access is allowed.

The following example illustrates the basics of a `SharedDiskSection` element.

```
<ovf:SharedDiskSection>
  <Info>Describes the set of virtual disks shared between VMs</Info>
  <ovf:SharedDisk ovf:diskId="datadisk" ovf:fileRef="data"
```

```
    ovf:capacity="8589934592" ovf:populatedSize="3549324972"
    ovf:format="http://www.vmware.com/interfaces/specifications/vmdk.html#sparse"/>
  <ovf:SharedDisk ovf:diskId="transientdisk" ovf:capacity="536870912"/>
</ovf:SharedDiskSection>
```

The following example illustrates the use of shared disks for Oracle Real Applications Clusters (RAC) appliance. Shared data disks are used for Oracle Clusterware and Oracle database using Oracle Automatic Storage Management (ASM). The disks for installations of Operating System (system), Oracle Clusterware (crs_home), and Oracle DB (db_home) are backed by external File references. The shared virtual disks in this example have no backing by an external File reference, the deployment engine creates the shared disk appropriately to be shared by more than one VirtualSystem.

```
<ovf:References>
  <ovf:File ovf:id="system" ovf:href="system.img" ovf:compression="gzip"/>
  <ovf:File ovf:id="crs_home" ovf:href="crs_home.img" ovf:compression="gzip"/>
  <ovf:File ovf:id="db_home" ovf:href="db_home.img" ovf:compression="gzip"/>
</ovf:References>
<ovf:DiskSection>
  <ovf:Info>Virtual Disks</ovf:Info>
  <ovf:Disk ovf:diskId="system" ovf:fileRef="system" ovf:capacity="5368709120"
ovf:format="Raw disk image"/>
  <ovf:Disk ovf:diskId="crs_home" ovf:fileRef="crs_home"  ovf:capacity="2147483648"
ovf:format="Raw disk image"/>
  <ovf:Disk ovf:diskId="db_home" ovf:fileRef="db_home"  ovf:capacity="4294967296"
ovf:format="Raw disk image"/>
</ovf:DiskSection>
<ovf:SharedDiskSection>
  <ovf:Info>Virtual Disks shared at runtime</ovf:Info>
  <ovf:SharedDisk ovf:diskId="crs_asm" ovf:capacity="4294967296" ovf:format="Raw disk
image"/>
  <ovf:SharedDisk ovf:diskId="db_asm" ovf:capacity="12884901888" ovf:format="Raw disk
image"/>
</ovf:SharedDiskSection>
.....
<ovf:VirtualSystemCollection ovf:id="rac_db_asm">
  <ovf:Info>Sample Oracle RAC using ASM</ovf:Info>
  .....
  <ovf:ScaleOutSection ovf:id="rac_db">
    <ovf:Info>RAC DB</ovf:Info>
    <ovf:Description>Number of instances</ovf:Description>
    <ovf:InstanceCount ovf:default="2" ovf:minimum="2"
ovf:maximum="4"</ovf:InstanceCount>
  </ovf:ScaleOutSection>
  .....
  <ovf:VirtualSystem ovf:id="rac_db">
    <ovf:Info>RAC DB Instance</ovf:Info>
    .....
    <ovf:VirtualHardwareSection>
      <ovf:Info>System requirements: 8192 MB, 2 CPUs, 5 disks, 2 nics
      </ovf:Info>
      .....
      <ovf:Item>
        <rasd:Description>Disk 1</rasd:Description>
        <rasd:ElementName>Disk 1</rasd:ElementName>
        <rasd:HostResource>ovf:/disk/system</rasd:HostResource>
        <rasd:ResourceType>17</rasd:ResourceType>
      </ovf:Item>
      <ovf:Item>
        <rasd:Description>Disk 2</rasd:Description>
        <rasd:ElementName>Disk 2</rasd:ElementName>
        <rasd:HostResource>ovf:/disk/crs_home</rasd:HostResource>
        <rasd:ResourceType>17</rasd:ResourceType>
      </ovf:Item>
      <ovf:Item>
        <rasd:Description>Disk 3</rasd:Description>
        <rasd:ElementName>Disk 3</rasd:ElementName>
        <rasd:HostResource>ovf:/disk/db_home</rasd:HostResource>
        <rasd:ResourceType>17</rasd:ResourceType>
      </ovf:Item>
      <ovf:Item>
        <rasd:Description>Disk 4</rasd:Description>
        <rasd:ElementName>Disk 4</rasd:ElementName>
        <rasd:HostResource>ovf:/disk/crs_asm</rasd:HostResource>
        <rasd:ResourceType>17</rasd:ResourceType>
      </ovf:Item>
      <ovf:Item>
        <rasd:Description>Disk 5</rasd:Description>
        <rasd:ElementName>Disk 5</rasd:ElementName>
        <rasd:HostResource>ovf:/disk/db_asm</rasd:HostResource>
        <rasd:ResourceType>17</rasd:ResourceType>
      </ovf:Item>
      .....
    </ovf:VirtualHardwareSection>
  </ovf:VirtualSystem>
</ovf:VirtualSystemCollection>
```

3.3.12 ScaleOutSection element

The `ScaleOutSection` element allows dynamic configuration of the number of instantiated Virtual Systems in a `Virtual System Collection` element. Without a `ScaleOut` element in the `Virtual System Collection` element, the number of virtual systems and virtual system collections in a parent is fixed. The `ScaleOutSection` element specifies a minimum and maximum number of replicas to be created. At deployment time, the deployment platform chooses a value between the minimum and maximum `InstanceCount.` The consumer can be queried for the value or the deployment platform can make a determination based on other metadata. The `ScaleOutSection` element only appears in `VirtualSystemCollection` element, although both Virtual Systemd and Virtual System Collections may be replicated.

The following example illustrates a `ScaleOutSection` element.

```
<VirtualSystemCollection ovf:id="web-tier">
  ...
  <ovf:ScaleOutSection ovf:id="web-server">
    <Info>Web tier</Info>
    <ovf:Description>Number of web server instances in web tier</ovf:Description>
    <ovf:InstanceCount ovf:default="4" ovf:minimum="2" ovf:maximum="8"/>
  </ovf:ScaleOutSection>
  ...
  <VirtualSystem ovf:id="web-server">
    <Info>Prototype web server</Info>
    ...
  </VirtualSystem>
</VirtualSystemCollection>
```

In the example above, the deployment platform creates a web tier containing between two and eight web server virtual machine instances, with a default count of four. The deployment platform makes an appropriate choice (e.g., by prompting the user). Assuming three replicas were created, the OVF environment available to the guest software in the first replica has the following content structure illustrated below:

```
<Environment ... ovfenv:id=”web-server-1”>
  ...
  <Entity ovfenv:id=”web-server-2”>
    ...
  </Entity>
  <Entity ovfenv:id=”web-server-3”>
    ...
  </Entity>
</Environment>
```

Note that the OVF ids of the replicas are derived from the id of the prototype Virtual System by adding a sequence number. After deployment, all replica Virtual Systems will have a sequence number suffix and no Virtual System has the base id of the prototype. If there is a `StartupSection` element, then each replica has the same start up number. It is not possible to specify a start up order among replicas.

EXAMPLE:

```
<VirtualSystemCollection ovf:id="web-tier">
  ...
  <DeploymentOptionSection>
    <Info>Deployment size options</Info>
    <Configuration ovf:id="minimal">
      <Label>Minimal</Label>
      <Description>Minimal deployment scenario</Description>
    </Configuration>
    <Configuration ovf:id="common" ovf:default="true">
      <Label>Typical</Label>
      <Description>Common deployment scenario</Description>
    </Configuration>
    ...
  </DeploymentOptionSection>
  ...
  <ovf:ScaleOutSection ovf:id="web-server">
    <Info>Web tier</Info>
    <ovf:Description>Number of web server instances in web tier</ovf:Description>
      <ovf:InstanceCount ovf:default="4"/>
      <ovf:InstanceCount ovf:default="1" ovf:configuration="minimal"/>
  </ovf:ScaleOutSection>
```

```
...
</VirtualSystemCollection>
```

In the example above, a DeploymentOptionSection element is used control values for InstanceCount in a ScaleOutSection element. Values in a Scale Out Section can also be controlled through OVF Property elements. Properties are prompted for one time for each replica. If the author wants a Property shared among replicas, the Property can be placed in the containing Virtual System Collection.

3.3.13 PlacementGroupSection element

The PlacementGroupSection defines a placement policy for a set of VirtualSystems. It is used inconjunction with the PlacementSection.

Example of PlacementGroupSection elements:

```
<Envelope ...>
  ...
  <ovf:PlacementGroupSection ovf:id="PPid:01" ovf:policy="availability">
    <Info>Placement policy for group of virtual systems that need availability</Info>
    <ovf:Description>Placement policy for a database tier</ovf:Description>
  </ovf:PlacementGroupSection>
      ...
  <ovf:PlacementGroupSection ovf:id="PPid:02" ovf:policy="affinity">
    <Info>Placement policy for group of virtual systems that need affinity</Info>
    <ovf:Description>Placement policy for a web tier</ovf:Description>

  </ovf:PlacementGroupSection>

</Envelope>
```

3.3.14 PlacementSection element

The PlacementSection specifies on a Virtual System or Virtual System Collection the placement policy as specified in the PlacementPolicyGroup element to be used. This is done with an annotatation of the elements with placement policy membership id. More than one placement policy may be specified.

The following illustrates a Placement Policy used with Scale Out:

```
  <VirtualSystemCollection ovf:id="web-tier">
    ...
    <ovf:ScaleOutSection ovf:id="web-node">
      <Info>Web tier</Info>
      ...
    </ovf:ScaleOutSection>
    ...
    <VirtualSystem ovf:id="web-node">
      <Info>Web server</Info>
      ...
      <ovf:PlacementSection ovf:group=" PPid:01">
        <Info>Placement policy group reference</Info>
      </ovf:PlacementSection>
      ...
    </VirtualSystem>
  </VirtualSystemCollection>
```

In this example the virtual systems in the web tier should be placed on different virtualization platforms. The placement policy applied to a `ScaleOutSection` element means that the policy is applied to each virtual system instantiated by the deployment function.

The following illustrates a Placement Policy used without a Virtual System Collection:

```
<Envelope>
<ovf:PlacementGroupSection ovf:id="PP20" ovf:policy="affinity ">
    <Info>Placement Policy for group of VMs</Info>
    <ovf:Description>Placement policy for VSC20</ovf:Description>
</ovf:PlacementGroupSection>
       ...
        <VirtualSystem ovf:id=VSC21">
             <Info>Web server</Info>
...            <ovf:PlacementSection ovf:group="PP20">
                           <Info>Placement policy group reference</Info>
            </ovf:PlacementSection>

        </VirtualSystem>
         <VirtualSystem ovf:id=VSC22">
            <Info>Web server</Info>
...            <ovf:PlacementSection ovf:group="PP20">
                           <Info>Placement policy group reference</Info>
            </ovf:PlacementSection>

        </VirtualSystem>
        <VirtualSystem ovf:id=VSC23">
          <Info>Web server</Info>
...            <ovf:PlacementSection ovf:group="PP20">
                           <Info>Placement policy group reference</Info>
            </ovf:PlacementSection>

        </VirtualSystem>
        <VirtualSystem ovf:id=VSC24">
            <Info>Web server</Info>
...            <ovf:PlacementSection ovf:group="PP20">
                           <Info>Placement policy group reference</Info>
            </ovf:PlacementSection>

        </VirtualSystem>
</Envelope>
```

The following illustrates a Placement Policy used with nested Virtual System Collections:

```
<Envelope>
<ovf:PlacementGroupSection ovf:id="PP20" ovf:policy="affinity ">
    <Info>Placement Policy for group of VMs</Info>
    <ovf:Description>Placement policy for VSC20</ovf:Description>
</ovf:PlacementGroupSection>
<ovf:PlacementGroupSection ovf:id="PP22" ovf:policy="affinity ">
    <Info>Placement Policy for group of VMs</Info>
    <ovf:Description>Placement policy for VSC30</ovf:Description>
</ovf:PlacementGroupSection>
<ovf:PlacementGroupSection ovf:id="PP40" ovf:policy="availability ">
    <Info>Placement Policy for group of VMs</Info>
    <ovf:Description>Placement policy for VSC40</ovf:Description>
```

```
 </ovf:PlacementGroupSection>
      ...
    <VirtualSystemCollection ovf:id="VSC20">
...
            <ovf:PlacementSection ovf:group="PP20">
                           <Info>Placement policy group reference</Info>
            </ovf:PlacementSection>

        <VirtualSystem ovf:id=VSC21">
             <Info>Web server</Info>
...
        </VirtualSystem>
         <VirtualSystem ovf:id=VSC22">
            <Info>Web server</Info>
            <ovf:PlacementSection ovf:group="PP22 ">
                           <Info>Placement policy group reference</Info>
            </ovf:PlacementSection>
...
        </VirtualSystem>
        <VirtualSystem ovf:id=VSC23">
           <Info>Web server</Info>
...
        </VirtualSystem>
        <VirtualSystem ovf:id=VSC24">
            <Info>Web server</Info>
...
        </VirtualSystem>
   </VirtualSystemCollection>
    <VirtualSystemCollection ovf:id="VSC30">
...
            <ovf:PlacementSection ovf:group="PP20, PP40">
                           <Info>Placement policy group reference</Info>
            </ovf:PlacementSection>

        <VirtualSystem ovf:id=VSC31">
             <Info>Web server</Info>
...
        </VirtualSystem>
         <VirtualSystem ovf:id=VSC32">
            <Info>Web server</Info>
...
        </VirtualSystem>
        <VirtualSystem ovf:id=VSC33">
           <Info>Web server</Info>
...
        </VirtualSystem>
        <VirtualSystem ovf:id=VSC34">
            <Info>Web server</Info>
...
        </VirtualSystem>
   </VirtualSystemCollection>
    <VirtualSystemCollection ovf:id="VSC40">
...
            <ovf:PlacementSection ovf:group="PP40">
                           <Info>Placement policy group reference</Info>
            </ovf:PlacementSection>

        <VirtualSystem ovf:id=VSC41">
             <Info>Web server</Info>
            <ovf:PlacementSection ovf:group="PP22 ">
                           <Info>Placement policy group reference</Info>
            </ovf:PlacementSection>
...
        </VirtualSystem>
         <VirtualSystem ovf:id=VSC42">
            <Info>Web server</Info>
...
        </VirtualSystem>
        <VirtualSystem ovf:id=VSC43">
           <Info>Web server</Info>
...
        </VirtualSystem>
        <VirtualSystem ovf:id=VSC44">
            <Info>Web server</Info>
...
        </VirtualSystem>
   </VirtualSystemCollection>
</Envelope>
```

3.3.15 EncryptionSection element

For various reasons such as licensing it is desirable to have an encryption scheme enabling free exchange of OVF appliances while ensuring that only the intended parties can use them. The encryption scheme proposed in this specification utilizes existing encryption standards to incorporate this functionality in the specification,

The EncryptionSection provides a single location for placing the encryption algorithm related markup and the corresponding reference list to point to the OVF content that has been encrypted.

A document would typically use a single method of encryption, with a single key. However, the specification allows the flexibility to encrypt different portions of the OVF descriptor with different keys derived using different methods and communicated to the end user in different ways.

It is important to keep in mind that depending on which parts of the OVF descriptor have been encrypted, an OVF descriptor may not validate against the OVF schemas until decrypted.

The encryption uses XML Encryption standard 1.1 normatively to encrypt either the files in the reference section or any parts of the XML markup of an OVF document.

From an encryption standpoint, the important aspects that the standard defines are a) algorithm used for the derivation of the key used in the encryption b) block encryption algorithm used to encrypt the content using the key and c) method of transporting keys embedded in the OVF XML document. For each method of encryption used within the document, all the aspects that are necessary need to be defined based on the choice of the OVF author. For instance, the author may choose to embed the key used in the document, or they may choose to communicate the key to desired end user by other means.

The other aspect is a list of references to the markup sections in the OVF envelope, or the files in the reference section that are encrypted using the specific method. In order to be able to reference any section, use is made of the XML attribute named Id whose value of is used to point to it in the reference list.

The following illustrates conceptual structure of an `Encryption` section.

```
<! --- Start of encryption section ---!>
  <! ---- Start of Markup for encryption method 1 ----!>
    <! ---- Markup defining key derivation aspects per XML encryption 1.1 ----!>
    <! ---- Markup defining the usage of the key for encryption per XML encryption 1.1
---!>
    <! ---- Optionally, the markup for key transportation per XML encryption 1.1 ---!>
    <! ---- Start of markup for pointers to the list of XML fragments encrypted using
method 1---!>
        <! --- Pointer 1 ---!>
            .
            .
        <! --- Pointer N ---!>
    <! ---- End of markup for pointers to the list of XML fragments encrypted using
method 1 ---!>
  <! ---- End of Markup for method 1 of encryption ----!>

  <! ---- Start of the markup for encryption method N ----!>
        <! ---- Markup defining key derivation aspects per XML encryption 1.1 ----!>
        <! ---- Markup defining the usage of the key for encryption per XML encryption
1.1 ---!>
        <! ---- Optionally, the markup for key transportation per XML encryption 1.1 -
--!>
        <! ---- Start of markup for pointers to the list of XML fragments encrypted
using method 1---!>
        <! --- Pointer 1 ---!>
            .
            .
        <! --- Pointer N ---!>
  <! ---- End of Markup for encryption method N ----!>
<! --- End of encryption section ---!>
```

Below is an example of an OVF encryption section with encryption methods utilized in the OVF document, and the corresponding reference list pointing to the items that have been encrypted.

```
  <ovf:EncryptionSection>
<!--- This section contains two different methods of encryption and the corresponding
backpointers to the data that is encrypted ->
  <!--- Method#1: Pass phrase based Key derivation ->
<!--- The following derived key block defines PBKDF2 and the corresponding back
pointers to the encrypted data elements -->
  <!--- Use a salt value "ovfpassword" and iteration count of 4096 --->
 <xenc11:DerivedKey>
             <xenc11:KeyDerivationMethod
Algorithm="http://www.rsasecurity.com/rsalabs/pkcs/schemas/pkcs-5#pbkdf2"/>
<pkcs-5:PBKDF2-params>
```

```
                    <Salt>
                           <Specified>ovfpassword</Specified>
                    </Salt>
                    <IterationCount>4096</IterationCount>
                    <KeyLength>16</KeyLength>
                    <PRF Algorithm=”http://www.w3.org/2001/04/xmldsig-more#hmac-
sha256”/>
             </pkcs-5:PBKDF2-params>
…
<!–- The ReferenceList element below contains references to the file Ref-109.vhd via
the URI syntax which is specified by XML Encryption.
--->
<xenc:ReferenceList>
      <xenc:DataReference URI=”#first.vhd” />
<xenc:DataReference URI=… />
<xenc:DataReference URI=… />
</xenc:ReferenceList>
      </xenc11:DerivedKey>
    <!-- Method#2: The following example illustrates use of a symmetric key
transported using the public key within a certificate ->
<xenc:EncryptedKey>
             <xenc:EncryptionMethod
      Algorithm=”http://www.w3.org/2001/04/xmlenc#rsa-1_5”/>
                    <ds:KeyInfo xmlns:ds=’http://www.w3.org/2000/09/xmldsig#’
                           <ds:X509Data>
                    <ds:X509Certificate> … </ds:X509Certificate>
             </ds:X509Data>
             </ds:KeyInfo>
      <xenc:CipherData>
      <xenc:CipherValue> … </xenc:CipherValue>
      </xenc:CipherData>
<!–- The ReferenceList element below contains reference #second-xml-fragment” to the
XML fragment that has been encrypted using the above method --->
      <xenc:ReferenceList>
             <xenc:DataReference URI=’#second-xml-fragment’ />
             <xenc:DataReference URI=’…’ />
             <xenc:DataReference URI=’…’ />
      </xenc:ReferenceList>
    </xenc:EncryptedKey>
  </ovf:EncryptionSection>
Below is an example of the encrypted file which is referenced in the EncryptionSection
above using URI='Ref-109.vhd' syntax.
EXAMPLE:
<ovf:References>
<ovf:File ovf:id="Xen:9cb10691-4012-4aeb-970c-3d47a906bfff/0b13bdba-3761-8622-22fc-
2e252ed9ce14" ovf:href="Ref-109.vhd">
<!-- the encrypted file referenced by the package is enclosed by an EncryptedData with
a CipherReference to the actual encrypted file. The EncryptionSection in this example
has a back pointer to it under the PBKDF2 algorithm via Id=”first.vhd”. This tells the
decrypter how to decrypt the file -->
<xenc:EncryptedData Id="first.vhd" Type='http://www.w3.org/2001/04/xmlenc#Element' >
```

```
                           <xenc:EncryptionMethod
Algorithm="http://www.w3.org/2001/04/xmlenc#aes128-cbc" />
                                  <xenc:CipherData>
                                         <xenc:CipherReference URI='Ref-109.vhd'/>
                                  </xenc:CipherData>
</xenc:EncryptedData>
</ovf:File>
</ovf:References>
Below is an example of the encrypted  OVF markup which is referenced in the
EncryptionSection above using URI=’#second-xml-fragment’ syntax.
EXAMPLE:
<!—-  the EncryptedData element below encompasses encrypted xml from the original
document. It is provided with the Id “first-xml-fragment” which allows it to be
referenced from the EncryptionSection. -->
<xenc:EncryptedData Type=http://www.w3.org/2001/04/xmlenc#Element Id=”second-xml-
fragment”>
<!-- Each EncryptedData specifies its own encryption method. -->
       <xenc:EncryptionMethod Algorithm=http://www.w3.org/2001/04-xmlenc#aes128-cbc/>
       <xenc:CipherData>
              <!--- Encrypted content --->
              <xenc:CipherValue>DEADBEEF</xenc:CipherValue>
       </xenc:CipherData>
  </xenc:EncryptedData>
```

4 Authoring an OVF package

4.1 Creation

The creation of an OVF package involves the i) packaging of a set of VMs onto a set of virtual disks, ii) appropriately encoding those virtual disks, iii) attaching an OVF descriptor with a specification of the virtual hardware, licensing, and other customization metadata, and iv) optionally digitally signing the package. The process of deploying an OVF package occurs when a virtualization platform consumes the OVF and creates a set of virtual machines from its contents.

Creating an OVF can be made as simple as exporting an existing virtual machine from a virtualization platform into an OVF package, and adding to it the relevant metadata needed to correctly install and execute it. This transforms the virtual machine from its current runtime state on a particular hypervisor into an OVF package. During this process, the virtual machine's disks can be compressed to make it more convenient to distribute.

For commercial-grade virtual appliances, a standard build environment can be used to produce an OVF package. For example, the OVF descriptor can be managed using a source control system, and the OVF package can be built using a reproducible scripting environment (such as `make` files) or, through the use of appliance building toolkits that are available from multiple vendors.

When an OVF package is created, it can be accompanied with appliance-specific post-installation configuration metadata. This includes metadata for optional localization of the interface language(s) of the appliance, review/signoff and/or enforcement of the EULA, and resource configuration. It can also involve the addition of special drivers, agents and other tools to the guest to enhance (for example) I/O, timekeeping, memory management, monitoring and orderly shutdown.

The process of authoring the OVF descriptor is essentially putting together the building blocks for the virtual appliance. As indicated earlier a virtual appliance is typically defined by the description of the virtual systems composing the appliance, metadata regarding the appliance and the guest OS and a set of referenced files. The OVF descriptor is the central element to aggregate and reference all required information. The major building blocks of the OVF descriptor are sections. Chapter 3 introduces the various sections which can be used to describe the virtual appliance.

4.2 Internationalization

The OVF specification supports localizable messages using the optional `ovf:msgid` attribute. Localized messages can be used to display the user messages in the local language during deployment.

```
<Envelope ...>
   ...
  <Info ovf:msgid="info.os">Operating System</Info>
   ...
  <Strings xml:lang="da-DA">
    <Msg ovf:msgid="info.os">Operativsystem</Msg>
    ...
  </Strings>
  <Strings xml:lang="de-DE">
    <Msg ovf:msgid="info.os">Betriebssystem</Msg>
    ...
  </Strings>
</Envelope>
```

The example above defines an `Info` element within a section. The information in this section is related to the operating system of the virtual system. The attribute `ovf:msgid="info.os"` indicates that the String between start-tag and end-tag of the `Info` element can be replaced with a localized message. The localized message is referred by its message ID info.os. If there is a suitable localized message set in a `Strings` section, the default message “Operating System” is replaced by the localized message taken from the `Strings` section corresponding to the current region.

In the example above the localized strings are stored inside the OVF descriptor. Localized strings can also be stored outside the OVF descriptor using external string bundles. For example:

```
<Envelope ...>
   <References>
      ...
      <File ovf:id="da-DA-resources" ovf:href="danish.msg"/>
      <File ovf:id="de-DE-resources" ovf:href="german.msg"/>
      ...
   </References>
      ...
      <Info ovf:msgid="info.os">Operating System</Info>
      ...
   <Strings xml:lang="da-DA" ovf:fileRef="da-da-resources"/>
   <Strings xml:lang="de-DE" ovf:fileRef="de-de-resources"/>
</Envelope>
```

The localized message for “Operating System” is defined in the files danish.msg and german.msg. The format of the external message file german.msg is described in the example below.

```
<Strings
 xmlns:ovf="http://schemas.dmtf.org/ovf/envelope/1"
 xmlns="http://schemas.dmtf.org/ovf/envelope/1"
 xml:lang="de-DE">
   ...
   <Msg ovf:msgid="info.os">Betriebssystem</Msg>
   ...
```

```
</Strings>
```

In the top `Strings` section the `xml:lang` attribute is used to define the locale of the particular external message file. The external message file contains `Msg` elements for the localized messages used in the OVF descriptor.

Another method of using localized resources is to reference external files based on the current location. This can be used to e.g. display a license text based on the location. The license text is contained in a text file per location. The example shows how to reference an external plain text file to display a localized license.

```
<Envelope xml:lang="en-US">
   <References>
      <File ovf:id="license-en-US" ovf:href="license-en-US.txt"/>
      <File ovf:id="license-de-DE" ovf:href="license-de-DE.txt"/>
   </References>
    ...
   <VirtualSystem ovf:id="...">
      <EulaSection>
         <Info>Licensing agreement</Info>
         <License ovf:msgid="license">Unused</License>
      </EulaSection>
    ...
   </VirtualSystem>
    ...
   <Strings xml:lang="en-US">
      <Msg ovf:msgid="license" ovf:fileRef="license-en-US">Invalid license</Msg>
   </Strings>
   <Strings xml:lang="de-DE">
      <Msg ovf:msgid="license" ovf:fileRef="license-de-DE">Ihre Lizenz ist nicht
      gültig</Msg>
   </Strings>
</Envelope>
```

The License element contains an `ovf:msgid` attribute. In the Strings sections the `ovf:msgid` for the different locations is linked to a file reference using the ovf:fileRef attribute. The `ovf:fileRef` attribute has a corresponding entry in the References section of the OVF descriptor. The entry in the References section resolves to an external text file containing the license text.

4.3 Extensibility

The OVF specification allows custom metadata to be added to OVF descriptors in several ways (see x.y):

- New section elements may be defined as part of the Section substitution group, and used wherever the OVF schemas allow sections to be present.
- The OVF schemas use an open content model, where all existing types may be extended at the end with additional elements. Extension points are declared in the OVF schemas with `xs:any` declarations with namespace="`##other`".
- The OVF schemas allow additional attributes on existing types.

A design goal of the OVF specification is to ensure backward- and forward compatibility. For forward compatibility, this means that an OVF descriptor using features of a later specification (or custom extensions) can be understood by an OVF consumer that is written to either i) an earlier version of the specification, or ii) has no knowledge of the particular extensions. The OVF consumer should be able to reliably, predictably, and in a user-friendly manner, decide whether to reject or accept an OVF package that contains extensions.

4.3.1 Substitution Group

OVF supports an open-content model that allows additional sections to be added, as well as allowing existing sections to be extended with new content. On extensions, a Boolean `ovf:required` attribute specifies whether the information in the element is required for correct behavior or optional.

Additional sections can be inserted into the OVF descriptor by defining new members of the ovf:Section substitution group. This means the new section extends the base schema for a Section element. New sections can be used to define metadata that is not related to the existing sections defined in the OVF specification. The new `Section` has an `<Info>` element that is used to display information to the consumer regarding the section in case the deployment function does not understand the section.

The example shows the addition of a new `Section <ns:BuildInformationSection>`. The Section uses the namespace ns. The namespace is referenced in a parent element e.g. in the `<Envelope>` element: `<Envelope xmlns="http://schemas.dmtf.org/ovf/envelope/2" xmlns:ns=”http://acme.org/ovf/extension/ns”>`. As required by the `ovf:Section` substitutionGroup, the new section contains an `<Info>` element. The elements `BuildNumber, BuildDate, BuildSystem` are new elements. The elements are defined in the namespace schema referred. The `ovf:required` attribute is set to false to indicate that the deployment function warns but does not fail if it cannot implement the section.

Example of adding new section:

```
<ns:BuildInformationSection ovf:required=”false”>
    <Info>Specifies information on how a virtual machine was created</Info>
    <BuildNumber> ... </BuildNumber >
    <BuildDate> ... </BuildDate >
    <BuildSystem> ... </BuildSystem>
          ...
</ns:BuildInformationSection>
```

The XSD schema for the additional section in the example above looks as follows.

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:ns=http://acme.org/ovf/extension/ns
  xmlns:ovf=http://schemas.dmtf.org/ovf/envelope/2
  xmlns:xs=http://www.w3.org/2001/XMLSchema
  targetNamespace=http://acme.org/ovf/extension/ns
  elementFormDefault="qualified"
  attributeFormDefault="qualified">
<xs:import namespace=http://schemas.dmtf.org/ovf/envelope/2
  schemaLocation="dsp8023.xsd"/>
    <xs:element name="BuildInformationSection" type="ns:BuildInformationSection_Type"
    substitutionGroup="ovf:Section">
      <xs:annotation>
        <xs:documentation>Element substitutable for Section since
        BuildInformationSection_Type is a derivation of Section_Type
        </xs:documentation>
      </xs:annotation>
    </xs:element>
    <xs:complexType name="BuildInformationSection_Type">
    <xs:annotation>
      <xs:documentation>An ACME specific section.</xs:documentation>
    </xs:annotation>
      <xs:complexContent>
        <xs:extension base="ovf:Section_Type">
          <xs:sequence>
          <xs:element name="BuildNumber" maxOccurs="unbounded">
            <xs:complexType>
              <xs:anyAttribute namespace="##any" processContents="lax"/>
            </xs:complexType>
          </xs:element>
          <xs:element name="BuildDate" maxOccurs="unbounded">
            <xs:complexType>
              <xs:anyAttribute namespace="##any" processContents="lax"/>
            </xs:complexType>
          </xs:element>
          <xs:element name="BuildSystem" maxOccurs="unbounded">
            <xs:complexType>
              <xs:anyAttribute namespace="##any" processContents="lax"/>
            </xs:complexType>
          </xs:element>
          </xs:sequence>
          <xs:anyAttribute namespace="##any" processContents="lax"/>
        </xs:extension>
      </xs:complexContent>
    </xs:complexType>
</xs:schema>
```

The schema defines a `BuildInformationSection` substituition group for the `ovf:Section` section. The `BuildInformationSection` substituition group is of the `BuildInformationSection_Type` type. `BuildInformationSection_Type` type defines `ovf:Section_Type` as a base type and extends the `ovf:Section_Type` by the `BuildNumber`, `BuildDate` and `BuildSystem` elements.

4.3.2 Elements

New elements within existing sections can be added at the end of the section. The `Envelope`, `VirtualSystem`, `VirtualSystemCollection`, `Content` and `Strings` section do not support the addition of additional elements at the end of the section. The used namespace needs to be referenced in a parent element and different from the OVF namespace. Additional elements can be used to extend the information given for a particular section in the OVF descriptor.

An illustration of extending an existing section is given below.

```
<AnnotationSection>
    <Info>Specifies an annotation for this virtual machine</Info>
    <Annotation>This is an example of how a future element (Author) can still be
parsed by older clients</Annotation>
    <!-- AnnotationSection extended with Author element -->
    <ns:Author ovf:required="false">John Smith</ns:Author>
</AnnotationSection>
```

The example shows an additional element in the `Annotation` section. The element extends the `Annotation` section with information regarding the `Author` of the descriptor. The new element belongs to the ns namespace.

4.3.3 Attributes

A third option of extending an OVF descriptor with additional information is to add custom attributes into existing elements. These attributes can be used to extend the information given by an existing element.

```
<!—- Optional custom attribute example -->
    <Network ovf:name="VM network" ns:desiredCapacity="1 Gbit/s">
        <Description>The main network for VMs</Description>
    </Network>
```

The example above shows the addition of a `desiredCapacity` attribute for the Network element. The new attribute is defined in the `ns` namespace.

See ANNEX E for more detailed examples on OVF document extensions.

4.4 Conformance

The OVF specification defines three conformance levels for OVF descriptors, with 1 being the highest level of conformance:

- OVF descriptor only contains meta-data defined in the OVF specification, i.e. no custom extensions are present.
  Conformance Level: 1.
- OVF descriptor contains meta-data with custom extensions, but all such extensions are optional.
  Conformance Level: 2.
- OVF descriptor contains meta-data with custom extensions, and at least one such extension is required.
  Conformance Level: 3.

The use of conformance level 3 limits portability which means that the OVF package might not be deployed on any other virtualization platform than the one supporting the custom extensions.

4.5 Virtual Hardware Description

The hardware description shown below is very general. In particular, it specifies that a virtual disk and a network adaptor is needed. It does not specify what the specific hardware should be. For example, a SCSI or IDE disk, or an E1000 or Vlance network card is appropriate. More specifically, it can reasonably be assumed that if the specification is generic, then the appliance will undertake discovery of the devices present, and load relevant drivers. In this case, it’s assumed that the appliance creator has developed the appliance with a broad set of drivers, and has tested the appliance on relevant virtual hardware to ensure that it works.

If an OVF package is deployed on a virtualization platform that does not offer the same hardware devices and/or categories of devices that are required by the guest OS that is included in the appliance, non-trivial and non-obvious installation failures can occur. The risk is not that the appliance will run incorrectly – more that it will fail to install and/or boot, and that the user will not be able to debug the problem. With this comes the risk of increased volume in customer support calls, and general customer dissatisfaction. A more constrained and detailed virtual hardware specification can reduce the chance of incorrect execution (since the specific devices required are listed) but this will limit the number of systems upon which the appliance will correctly install and/or boot.

It should be borne in mind that simplicity, robustness, and predictability of installation are key reasons that ISVs are moving to the virtual appliance model, and therefore appliance developers should create appliances for which the hardware specification is more rather than less generic, unless the appliance has very specific hardware needs. At the outset, the portability of the appliance is based on the guest OS used in the virtual machines and the range of virtual hardware the guest OS supports.

Ideally, the appliance vendor will create a virtual machine that has device drivers for the virtual hardware of all of the vendor’s desired target virtualization platforms. However, many virtualization platform vendors today do not distribute drivers independently to virtual appliance vendors/creators. Instead, to further simplify the management of the virtual hardware / appliance interface, the OVF model supports an explicit installation mode, in which each virtual machine is booted once right after installation, to permit localization/customization for the specific virtualization platform. This allows the virtual machine to detect the virtualization platform and install the correct set of device drivers, including any platform specific drivers that are made available to the guest when it first re-boots (via for example, floppy or CD drives attached to the guest on first boot). In addition, for sysprepped Windows VMs, which need only re-installation and customization with naming etc, the re-boot technique allows naming and tailoring of the image to be achieved in an automated fashion.

The illustration multiple virtual hardware profiles for different virtualization platforms specified in the same descriptor.

```
<VirtualHardwareSection>
  <Info>500Mb, 1 CPU, 1 disk, 1 nic virtual machine, Platform A</Info>
     <System>
        ...
     </System>
     <Item>
       ...
     </Item>
     ...
</VirtualHardwareSection>
<VirtualHardwareSection>
  <Info>500Mb, 1 CPU, 1 disk, 1 nic virtual machine, Platform B</Info>
     <System>
        ...
     </System>
     <Item>
       ...
     </Item>
     ...
</VirtualHardwareSection>
```

This allows the vendor to tailor the hardware description to support different virtualization platforms and features. A specific virtualization platform may choose between any of the specific virtual hardware sections that it can support, with the assumption that the OVF deployment function will choose the latest or most capable feature set that is available on the local platform.

The example below shows how a specific type of virtual hardware can be defined. Multiple options for the `rasd:ResourceSubType` can be separated by a single space character. The deployment function can then choose which virtual hardware type to instantiate.

```
<Item>
    <rasd:ElementName>SCSI Controller 0</rasd:ElementName>
    <rasd:InstanceID>1000</rasd:InstanceID>
    <rasd:ResourceSubType>LsiLogic BusLogic</rasd:ResourceSubType>
    <rasd:ResourceType>6</rasd:ResourceType>
</Item>
<Item>
    <rasd:ElementName>Harddisk 1</rasd:ElementName>
    <rasd:HostResource>ovf:/disk/vmdisk1</rasd:HostResource>
    <rasd:InstanceID>22001</rasd:InstanceID>
    <rasd:Parent>1000</rasd:Parent>
    <rasd:ResourceType>17</rasd:ResourceType>
</Item>
```

4.6 Example Descriptors

The following examples have been provided as complete examples of an OVF descriptor. These examples pass XML validation.

Annex A illustrates an OVF descriptor for a single virtual system.

Annex B illustrates a multiple virtual system OVF descriptor.

Annex C illustrates an OVF descriptor for a single virtual system with multiple applications contained in it; i.e., a LAMP stack.

Annex D illustrates an OVF descriptor for a multiple virtual system with multiple applications contained in it, i.e., a LAMP stack with two virtual systems.

5 Deploying an OVF package

5.1 Deployment

Deployment transforms the virtual machines in an OVF package into the runtime format understood by the target virtualization platform, with the appropriate resource assignments and supported by the correct virtual hardware. During deployment, the platform validates the OVF integrity, making sure that the OVF package has not been modified in transit, and checks that it is compatible with the local virtual hardware. It also assigns resources to, and configures the virtual machines for the particular environment on the target virtualization platform. This includes assigning and configuring the (physical and virtual) networks to which the virtual machines are connected; assigning storage resources for the VMs, including virtual hard disks as well as any transient data sets, connections to clustered or networked storage and the like; configuring CPU and memory resources, and customizing application level properties. OVF does not support the conversion of guest software between processor architectures or hardware platforms. Deployment instantiates one or more virtual machines with a hardware profile that is compatible with the requirements captured in the OVF descriptor, and a set of virtual disks with the content specified in the OVF package.

The deployment experience of an OVF package depends on the virtualization platform on which it is deployed. It could be command-line based, scripted, or a graphical deployment wizard. The typical OVF deployment tool will show or prompt for the following information:

- Show information about the OVF package (from the *ProductSection*), and ask the user to accept the licensing agreement, or deal with an unattended installation.
- Validate that the virtual hardware is compatible with the specification in the OVF.
- Ask the user for the storage location of the virtual machines and what physical networks the logical networks in the OVF package is connected to.
- Ask the user to enter the specific values for the properties configured in the *ProductSection*.

After this configuration, it is expected that the virtual machines can be successfully started to obtain (using standard procedures such as DHCP) an identity that is valid on the local network. Properties are used to prompt for specific IP network configuration and other values that are particular to the deployment environment. Once the appliance is booted for the first time, additional configuration of software inside the appliance can be done through a management interface provided by the appliance itself, such as a web interface.

5.2 OVF Environment Descriptor

The OVF environment descriptor is an XML document that describes meta-data about the software installed on the virtual disks. The OVF specification defines the common sections used for deploying software, such as virtual hardware, disks, networks, resource requirements, and customization parameters. The descriptor is designed to be extensible so further information can be added later.

A virtual appliance often needs to be customized to function properly in the particular environment where it is deployed. The OVF environment provides a standard and extensible way for the virtualization platform to communicate deployment configuration to the guest software.

The OVF environment is an XML document containing deployment time customization information for the guest software. Examples of information that could be provided in the XML document include:

- Operating system level configuration, such as host names, IP address, subnets, gateways, etc.
- Application-level configuration such as DNS name of active directory server, databases and other external services. .

The set of properties that are to be configured during deployment are specified in the OVF descriptor using the ProductSection meta-data, and is typically entered by the user using a wizard style interface during deployment.

For instance, the OVF environment allows guest software to automate the network settings between multi-tiered services, and the web server may automatically configure itself with the IP address of the database server without any manual user interaction.

Defining a standard OVF environment does pose some challenges, since no standard cross-vendor para-virtualized device exists for communicating between the guest software running in a virtual machine and the underlying virtualization platform. The approach taken by the OVF specification is to split the OVF environment definitions into two parts: i) A standard *protocol* that specifies what information is available and what format it is available in, and ii) a *transport*, that specifies how the information is obtained.

The specification requires all implementations to support an ISO transport, which will make the OVF environment (XML document) available to the guest software on a dynamically generated ISO image.

5.3 Resource Conifiguration Options During Deployment

The OVF package has the ability to include resource configuration options for a virtual appliance. This makes it easy for the package consumer to get an initial setup without having go make individual resource decision based on the intended use. This is formatted as a human-readable list of resource configurations, for instance:

- Software evaluation setup
- 10-100 person workgroup setup
- 100-1000 person workgroup setup
- Large enterprise workgroup setup

The deployment function prompts for selection of a configuration. In addition to exact values, ranges can also be specified. For example, the memory size can be specified as being 600MB, and that the recommended range is between 500MB to 1000MB. Typically, a user will not be prompted to specify a value for a range when deploying an OVF package. The list of configurations described above is expected to be used to get to a good initial resource configuration. A range specification becomes useful when the installation later needs to be changed based on different resource needs.

Example list of configurations:

```
<DeploymentOptionSection>
    <Configuration ovf:id="min">
```

```
        <Label>Minimal</Label>
        <Description>Minimal setup</Description>
    </Configuration>
    <Configuration ovf:id="normal" ovf:default="yes">
        <Label>Normal</Label>
        <Description>Standard setup</Description>
    </Configuration>
    ... more configurations ...
</DeploymentOptionSection>
```

Resource requirement example:

```
<ResourceAllocationSection>
   <Info>Defines reservations for CPU and memory</Info>
   <Item>
        ... normal configuration ...
   </Item>
   <Item ovf:configuration="min">
        ... overwrites for minimal configuration ...
   </Item>
</ResourceAllocationSection>
```

`VirtualHardwareSection` example:

```
<VirtualHardwareSection>
  <Info>...</Info>
  <Item>
      <rasd:AllocationUnits>hertz * 10^6</rasd:AllocationUnits>
      <rasd:ElementName>1 CPU and 500 MHz reservation</rasd:ElementName>
      <rasd:InstanceID>1</rasd:InstanceID>
      <rasd:Reservation>500</rasd:Reservation>
      <rasd:ResourceType>4</rasd:ResourceType>
      <rasd:VirtualQuantity>1</rasd:VirtualQuantity>
  </Item>
  ...
  <Item ovf:configuration="big">
      <rasd:ElementName>1 CPU and 800 MHz reservation</rasd:ElementName>
      <rasd:InstanceID>0</rasd:InstanceID>
      <rasd:Reservation>600</rasd:Reservation>
      <rasd:ResourceType>3</rasd:ResourceType>
  </Item>
</VirtualHardwareSection>
```

5.4 Product Customization During Deployment Using Property Elements

The OVF descriptor can contain a description of the guest software, that includes information on customization provided through the OVF environment. This information is provided by the use of `Property` elements in the `ProductSection` of the OVF descriptor.

Each `Property` element has five possilbe attributes: `ovf:key, ovf:type, ovf:qualifiers, ovf:value, and ovf:userConfigurable.`

The `ovf:key` attribute is a unique identifier for the `property` element.

The ovf:type attribute indicates the type of value the property represents.

The ovf:qualifiers attribute specifies additional information regarding the ovf:type attribute so that CIM value maps can be used.

The ovf:value attribute is used to provide a value for a Property element.

The ovf:userConfigurable attribute determines if the value provided is a default value and changeable at deployment or is not changeable.

```
An example of the use of Property elements follows.<ProductSection>
     <Info>Describes product information for the service</Info>
     <Product>MyService Web Portal</Product>
     <Vendor>Some Random Organization</Vendor>
     <Version>4.5</Version>
     <FullVersion>4.5-b4523</FullVersion>
     <ProductUrl>http://www.vmware.com/go/ovf</ProductUrl>
     <VendorUrl>http://www.vmware.com/</VendorUrl>
     <Property ovf:key="adminEmail" ovf:type="string" ovf:userConfigurable="true">
        <Description>Email address of administrator</Description>
     </Property>
     <Property ovf:key="appIp" ovf:type="string" ovf:userConfigurable="true">
         <Description>IP address of the application</Description>
    </Property>
     <Property ovf:key="Gateway" ovf:type="string" ovf:value=”192.168.0.1”
ovf:userConfigurable="false" >
        <Description>Gateway address to be used</Description>
     </Property>
     <Property ovf:key="ValueMap Example" ovf:type="uint8"
ovf:qualifiers=”uint8,uint8,string” ovf:value=”1,2,three” ovf:userConfigurable="false"
>
        <Description>Value Map Example</Description>
     </Property>
</ProductSection>
```

ANNEX D contains a detailed example of customization of a complex multi-tiered application.

6 Portability

OVF is an enabling technology for enhancing portability of virtual appliances and their associated virtual machines. An OVF package contains a recipe for creating virtual machines that can be interpreted concisely by a virtualization platform. The packaged meta-data enables a robust and user-friendly experience when installing a virtual appliance. In particular, the meta-data can be used by the management infrastructure to confidently decide whether a particular VM described in an OVF can be installed or whether it’s rejected, and potentially to guide appropriate conversions and localizations to make it runnable in the specific execution context in which it is to be installed.

There are many factors that are beyond the control of the OVF format specification and even a fully compliant implementation of it, that determine the portability of a packaged virtual machine. That is, the act of packaging a virtual machine into an OVF package does not guarantee universal portability or install-ability across all hypervisors. Below are some of the factors that could limit portability:

- The VMs in the OVF could contain virtual disks in a format that is not understood by the hypervisor attempting the installation. While it is reasonable to expect that most hypervisors will be able to import and/or export VMs in any of the major virtual hard disk formats, newer formats may arise that are supported by the OVF and not a particular hypervisor.

- The installed guest software may not support the virtual hardware presented by the hypervisor. By way of example, the Xen hypervisor does not by default offer a virtualized floppy disk device to guests. One could conceive of a guest VM that would require interaction with a floppy disk controller and which therefore would not be able to execute the VM correctly.
- The installed guest software does not support the CPU architecture. For example, the guest software might execute CPU operations specific to certain processor models or require specific floating point support, or contain opcodes specific to a particular vendor's CPU.
- The virtualization platform might not understand a feature requested in the OVF descriptor. For example, composed services may not be supported. Since the OVF standard will evolve independently of virtualization products, at any point an OVF might be unsupportable on a virtualization platform that pre-dates that OVF specification.

The portability of an OVF can be categorized into the following classes:

- **Portability class 1**. Runs on multiple families of virtual hardware. For example, the appliance could be runnable on Xen, Sun, Microsoft, and VMware hypervisors. For level 3 compatibility, the guest software has been developed to support the devices of multiple hypervisors. A clean install and boot of a guest OS, during which the guest OS performs hardware device discovery and installs any specialized drivers required to interact with the virtual platform, is an example of Level 3 portability of an OVF. The "sysprep" level of portability for Microsoft Windows® operating systems is another example. Such OS instances can be re-installed, re-named and re-personalized on multiple hardware platforms, including virtual hardware.
- **Portability class 2**. Runs on a specific family of virtual hardware. This would typically be due to lack of driver support by the installed guest software.
- **Portability class 3**. Only runs on a particular virtualization product and/or CPU architecture and/or virtual hardware selection. This would typically be due to the OVF containing suspended virtual machines or snapshots of powered on virtual machines, including the current run-time state of the CPU and real or emulated devices. Such state ties the OVF to a very specific virtualization and hardware platform.

For use within an organization, class 2 or class 3 compatibility may be good enough, since the OVF package is distributed within a controlled environment where specific purchasing decisions of hardware or virtualization platforms can ensure consistency of the underlying feature set for the OVF. A simple export of a virtual machine will typically create an OVF with class 3 or class 2 portability (tied to a specific set of virtual hardware), however it is easy to extend the metaphor to support the export of class 1 portablity , for example through the use of utilities such as "sysprep" for Windows.

For commercial appliances independently created and distributed by ISVs, class 1 portablity is highly desirable. Indeed, class 1 portablity ensures that the appliance is readily available for the broadest possible customer base both for evaluation and production. Toolkits will generally be used to create certified "known good" class 1 packages of the appliance for broad distribution and installation on multiple virtual platforms, or class 2 portablity packages if the appliance is to be consumed within the context of a narrower set of virtual hardware, such as within a particular development group in an enterprise.

The OVF virtual hardware description is designed to support class 1 through class 3 portability. For class 1 portablity it is possible to include only very general descriptions of hardware requirements, or to specify multiple alternative virtual hardware descriptions. The appliance provider is in full control of how flexible or restrictive the virtual hardware specification is made. A narrow specification can be used to constrain an appliance to run on only known-good virtual hardware, while limiting its portability somewhat. A broad specification makes the appliance useful across as wide a set of virtual hardware as possible. This ensures that customers have the best possible user experience, which is one of the main requirements for the success of the virtual appliance concept.

ANNEX A
(informative)

Single Virtual System Example

Most of the descriptor is boilerplate. It starts out by describing the set of files in addition to the descriptor itself. In this case there is a single file (`vmdisk1.vmdk`). It then describes the set of virtual disks and the set of networks used by the appliance. Each file, disk, and network resource is given a unique identifier. These are all in separate namespaces, but the best practice is to use distinct names.

The content of the example OVF is a single virtual machine. The content contains 5 sections:

The following listing shows a complete OVF descriptor for a typical single virtual machine appliance:

```
<?xml version="1.0" encoding="UTF-8"?>
<Envelope xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns="http://schemas.dmtf.org/ovf/1/envelope"
    xmlns:ovf="http://schemas.dmtf.org/ovf/1/envelope"
    xmlns:vssd="http://schemas.dmtf.org/wbem/wscim/1/cim-
schema/2/CIM_VirtualSystemSettingData"
    xmlns:rasd="http://schemas.dmtf.org/wbem/wscim/1/cim-
schema/2/CIM_ResourceAllocationSettingData">

    <!-- References to all external files -->
    <References>
        <File ovf:id="file1" ovf:href="vmdisk1.vmdk" ovf:size="180114671"/>
    </References>
    <!-- Describes meta-information for all virtual disks in the package -->
    <DiskSection>
        <Info>Describes the set of virtual disks</Info>
        <Disk ovf:diskId="vmdisk1" ovf:fileRef="file1" ovf:capacity="4294967296"

ovf:format="http://www.vmware.com/interfaces/specifications/vmdk.html#sparse"/>
    </DiskSection>
    <!-- Describes all networks used in the package -->
    <NetworkSection>
        <Info>List of logical networks used in the package</Info>
        <Network ovf:name="VM Network">
            <Description>The network that the service will be available
on</Description>
        </Network>
    </NetworkSection>
    <VirtualSystem ovf:id="vm">
        <Info>Describes a virtual machine</Info>
        <Name>Virtual Appliance One</Name>
        <ProductSection>
            <Info>Describes product information for the appliance</Info>
            <Product>The Great Appliance</Product>
            <Vendor>Some Great Corporation</Vendor>
            <Version>13.00</Version>
            <FullVersion>13.00-b5</FullVersion>
```

```

<ProductUrl>http://www.somegreatcorporation.com/greatappliance</ProductUrl>
            <VendorUrl>http://www.somegreatcorporation.com/</VendorUrl>
            <Property ovf:key="admin.email" ovf:type="string">
                <Description>Email address of administrator</Description>
            </Property>
            <Property ovf:key="app.ip" ovf:type="string"
ovf:defaultValue="192.168.0.10">
                <Description>The IP address of this appliance</Description>
            </Property>
        </ProductSection>
        <AnnotationSection ovf:required="false">
            <Info>A random annotation on this service. It can be ignored</Info>
            <Annotation>Contact customer support if you have any problems</Annotation>
        </AnnotationSection>
        <EulaSection>
            <Info>License information for the appliance</Info>
            <License>Insert your favorite license here</License>
        </EulaSection>
        <VirtualHardwareSection>
            <Info>256MB, 1 CPU, 1 disk, 1 nic</Info>
            <Item>
                <rasd:Description>Number of virtual CPUs</rasd:Description>
                <rasd:ElementName>1 virtual CPU</rasd:ElementName>
                <rasd:InstanceID>1</rasd:InstanceID>
                <rasd:ResourceType>3</rasd:ResourceType>
                <rasd:VirtualQuantity>1</rasd:VirtualQuantity>
            </Item>
            <Item>
                <rasd:AllocationUnits>byte * 2^20</rasd:AllocationUnits>
                <rasd:Description>Memory Size</rasd:Description>
                <rasd:ElementName>256 MB of memory</rasd:ElementName>
                <rasd:InstanceID>2</rasd:InstanceID>
                <rasd:ResourceType>4</rasd:ResourceType>
                <rasd:VirtualQuantity>256</rasd:VirtualQuantity>
            </Item>
            <Item>
                <rasd:AutomaticAllocation>true</rasd:AutomaticAllocation>
                <rasd:Connection>VM Network</rasd:Connection>
                <rasd:ElementName>Ethernet adapter on "VM Network"</rasd:ElementName>
                <rasd:InstanceID>4000</rasd:InstanceID>
                <rasd:ResourceType>10</rasd:ResourceType>
             </Item>
            <Item>
                <rasd:ElementName>Harddisk 1</rasd:ElementName>
                <rasd:HostResource>ovf:/disk/vmdisk1</rasd:HostResource>
                <rasd:InstanceID>22001</rasd:InstanceID>
                <rasd:ResourceType>17</rasd:ResourceType>
            </Item>
        </VirtualHardwareSection>
        <OperatingSystemSection ovf:id="58" ovf:required="false">
          <Info>Guest Operating System</Info>
          <Description>Windows 2000 Advanced Server</Description>
        </OperatingSystemSection>
    </VirtualSystem>
</Envelope>
```

ANNEX B
(informative)

Multi-tiered Pet Store Example

This example will demonstrate several advanced OVF concepts:

- Multi-VM packages - use of the VirtualMachineCollection entity subtype
- Composite service organization - use of nested VirtualMachineCollection entity subtype
- Propagation of user defined deployment configuration.
- Deployment time customization of the service using the OVF Environment.
- The use of virtual disk chains to minimize downloads.
- Nesting of ProductSections for providing information about the installed software in an individual virtual machine

The example service is called Pet Store and consists of a front-end web-server and a database. The database server is itself a complex multi-tiered server consisting of two VMs for fault-tolerance.

B.1 Architecture and Packaging

The Pet Store OVF package consists of 3 virtual systems (WebTier, DB1, and DB2) and 2 virtual system collections (Pet Store and DBTier). The diagram below shows the structure of the OVF package as well as the properties and startup order of the virtual machines:

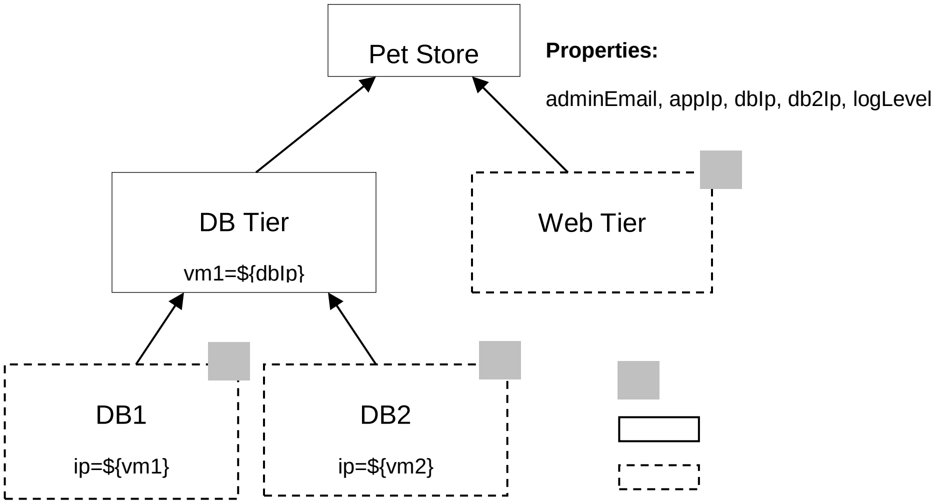


Figure 5 – Pet Store OVF Package

The complete OVF descriptor is listed at the end of this document. The use of properties and disk layout of the OVF is discussed in more details in the following.

B.2 Properties

The Pet Store service has 5 user-configurable properties. These are the key control parameters for the service that needs to be configured in order for it to start up correctly in the deployed environment. The properties are passed up to the guest software in the form of an OVF environment document. The guest software is written to read the OVF environment on startup, extract the values of the properties, and apply them to the software configuration. Thus, the OVF descriptor reflects the properties that are handled by the guest software.

For this particular service, there are two different software configurations, one for the Web tier and one for the Database tier. The properties supported in each software configuration are:

Table 1 illustrates the properties for the Web Guest Software:

Table 1 – Web Tier Configuration

Property	**Description**
appIp	IP address of the Web Server.
dbIp	IP address of the database server to connect to.
adminEmail	Email address for support
logLevel	Logging level

All properties defined on the immediate parent VirtualSystemCollection container is available to a child VirtualSystem or VirtualSystemCollection. Thus, the OVF descriptor does not need to contain an explicit ProductSection for each VM, as demonstrated for WebVM.

Table 2 illustrates the properties for the Database Guest Software:

Table 2 – Database Tier Configuration

Property	**Description**
Ip	IP address of the virtual machine
primaryAtBoot	Whether the instance acts as the primary or secondary when booting
ip2	IP address of the twin database VM that acts as the hot-spare or primary
log	Here the logging level is called log

The clustered database is organized as a virtual system collection itself with a specific set of properties for configuration: vm1, vm2, and log. This organization separates the database implementation from the rest of the software in the OVF package and allows virtual appliances (guest software + virtual machine configurations) to be easily composed and thereby promotes reuse.

The database software is an off-the-shelf software package and the vendor has chosen the "com.mydb.db" as the unique name for all the properties. This can be seen in the OVF descriptor with the inclusion of the ovf:class attribute on the ProductSection.

The ${<name>} property syntax is used to propagate values from the outer level into the inner nodes in the OVF Descriptor's entity hierarchy. This mechanism allows linking up different components without having to pre-negotiate naming conventions or changing guest software. Only properties defined on the immediate parent VirtualSystemCollection container are available to a child entity. Thus, properties defined on Petstore will not be available to a DB1. This ensures that the interface for a VirtualSystemCollection is encapsulated and well described in its parent VirtualSystemCollection, which makes the software composable and easy to reuse.

The OVF descriptor uses fixed non-user assignable properties to ensure that the two database virtual machines boots up into different roles even though they are, initially, booting of the exact same software image. The property named *com.mydb.db.primaryAtBoot* is specified with a fixed, non-user configurable value but is different value for the two images. The software inspects this at boot time and customizes its operation accordingly.

B.3 Disk Layout

The Petstore OVF package uses the ability to share disks and encode a delta disk hierarchy to minimize the size and thereby the download time for the package. In this particular case, we only have two different images (Database and Web), and if we further assume they are build on top of the same base OS distribution, we can encode this in the OVF descriptor as.

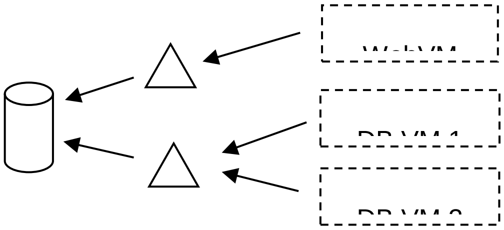


Figure 6 – Pet Store Virtual Disk Layout

Thus, while the package contains 3 distinct virtual machines, the total download size will be significantly smaller. In fact, only one full VM and then two relative small deltas need to be downloaded.

The physical layout of the virtual disks on the deployment system is independent of the disk structure in the OVF package. The OVF package describes the size of the virtual disk and the content (i.e., bits that needs to be on the disk). It also specifies that each virtual machine gets independent disks. Thus, a virtualization platform could install the above package as a 3 VMs with 3 independent flat disks, or it could chose to replicate the above organization, or something third, as long as each virtual machine sees a disk with the content described on initial boot and that changes written by one virtual machine does not affect the others.

B.4 Pet Store OVF Descriptor

```
<?xml version="1.0" encoding="UTF-8"?>
<Envelope
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns="http://schemas.dmtf.org/ovf/envelope/1"
    xmlns:ovf="http://schemas.dmtf.org/ovf/envelope/1"
    xmlns:vssd="http://schemas.dmtf.org/wbem/wscim/1/cim-
schema/2/CIM_VirtualSystemSettingData"
    xmlns:rasd="http://schemas.dmtf.org/wbem/wscim/1/cim-
schema/2/CIM_ResourceAllocationSettingData">
    <!-- References to all external files -->
    <References>
        <File ovf:id="base" ovf:href="base.vmdk" ovf:size="180114671"/>
        <File ovf:id="webdelta" ovf:href="webapp-delta.vmdk" ovf:size="123413"/>
        <File ovf:id="dbdelta" ovf:href="dbapp-delta.vmdk" ovf:size="343243"/>
    </References>
    <!-- Describes meta-information about all virtual disks in the package.
```

```
        This example is encoded as a delta-disk hierarchy.
     -->
    <DiskSection>
        <Info>Describes the set of virtual disks</Info>
        <Disk ovf:diskId="base" ovf:fileRef="base" ovf:capacity="4294967296"
            ovf:populatedSize="1924967692"

ovf:format="http://www.vmware.com/specifications/vmdk.html#streamOptimized"/>
        <Disk ovf:diskId="web" ovf:fileRef="webappdelta" ovf:parentRef="base"
            ovf:capacity="4294967296"

ovf:format="http://www.vmware.com/specifications/vmdk.html#streamOptimized"/>
        <Disk ovf:diskId="db" ovf:fileRef="dbdelta" ovf:parentRef="base"
            ovf:capacity="4294967296"

ovf:format="http://www.vmware.com/specifications/vmdk.html#streamOptimized"/>
    </DiskSection>
    <!-- Describes all networks used in the package -->
    <NetworkSection>
        <Info>List of logical networks used in the package</Info>
        <Network ovf:name="VM Network">
            <Description ovf:msgid="network.description">The network that the service
                will be available on</Description>
        </Network>
    </NetworkSection>
    <!-- Deployment options for the packages -->
    <DeploymentOptionSection>
        <Info>List of deployment options available in the package</Info>
        <Configuration ovf:id="minimal">
            <Label ovf:msgid="minimal.label">Minimal</Label>
            <Description ovf:msgid="minimal.description">Deploy service with minimal
                resource use</Description>
        </Configuration>
        <Configuration ovf:id="standard" ovf:default="true">
            <Label ovf:msgid="standard.label">Standard</Label>
            <Description ovf:msgid="standard.description">Deploy service with standard
                resource use</Description>
        </Configuration>
    </DeploymentOptionSection>
    <!-- PetStore Virtual System Collection -->
    <VirtualSystemCollection ovf:id="PetStore">
        <Info>The packaging of the PetStoreService multi-tier application</Info>
        <Name>PetStore Service</Name>
        <!-- Overall information about the product -->
        <ProductSection>
            <Info>Describes product information for the service</Info>
            <Product>PetStore Web Portal</Product>
            <Vendor>Some Random Organization</Vendor>
            <Version>4.5</Version>
            <FullVersion>4.5-b4523</FullVersion>
            <ProductUrl>http://www.vmware.com/go/ovf</ProductUrl>
            <VendorUrl>http://www.vmware.com/</VendorUrl>
            <Category ovf:msgid="category.email">Email properties</Category>
            <Property ovf:key="adminEmail" ovf:type="string"
ovf:userConfigurable="true">
                <Label ovf:msgid="property.email.label">Admin email</Label>
                <Description ovf:msgid="property.email.description">Email address of
                    service administrator</Description>
            </Property>
            <Category ovf:msgid="category.network">Network properties</Category>
            <Property ovf:key="appIp" ovf:type="string"
                ovf:userConfigurable="true">
                <Label ovf:msgid="property.appip.label">IP</Label>
                <Description ovf:msgid="property.appip.description">IP address of the
```

```
                    service</Description>
            </Property>
            <Property ovf:key="dbIp" ovf:type="string" ovf:userConfigurable="true">
                <Label ovf:msgid="property.dpip.label">IP for DB</Label>
                <Description ovf:msgid="property.dpip.description">Primary IP address
of
                    the database</Description>
            </Property>
            <Property ovf:key="db2Ip" ovf:type="string"
                ovf:userConfigurable="true">
                <Label ovf:msgid="property.dpip2.label">IP for DB2</Label>
                <Description ovf:msgid="property.dpip2.description">A secondary IP
                    address for the database</Description>
            </Property>
            <Category ovf:msgid="category.logging">Logging properties</Category>
            <Property ovf:key="logLevel" ovf:type="string" ovf:value="normal"
                ovf:userConfigurable="true">
                <Label ovf:msgid="property.loglevel.label">Loglevel</Label>
                <Description ovf:msgid="property.loglevel.description">Logging level
for
                    the service</Description>
                <Value ovf:value="low" ovf:configuration="minimal"/>
            </Property>
        </ProductSection>
        <AnnotationSection ovf:required="false">
            <Info>A annotation on this service</Info>
            <Annotation ovf:msgid="annotation.annotation">Contact customer support for
                any urgent issues</Annotation>
        </AnnotationSection>
        <ResourceAllocationSection ovf:required="false">
            <Info>Defines minimum reservations for CPU and memory</Info>
            <Item>
                <rasd:AllocationUnits>byte * 2^20</rasd:AllocationUnits>
                <rasd:ElementName>512 MB reservation</rasd:ElementName>
                <rasd:InstanceID>0</rasd:InstanceID>
                <rasd:Reservation>512</rasd:Reservation>
                <rasd:ResourceType>4</rasd:ResourceType>
            </Item>
            <Item ovf:configuration="minimal">
                <rasd:AllocationUnits>byte * 2^20</rasd:AllocationUnits>
                <rasd:ElementName>384 MB reservation</rasd:ElementName>
                <rasd:InstanceID>0</rasd:InstanceID>
                <rasd:Reservation>384</rasd:Reservation>
                <rasd:ResourceType>4</rasd:ResourceType>
            </Item>
            <Item>
                <rasd:AllocationUnits>MHz</rasd:AllocationUnits>
                <rasd:ElementName>1000 MHz reservation</rasd:ElementName>
                <rasd:InstanceID>1</rasd:InstanceID>
                <rasd:Reservation>500</rasd:Reservation>
                <rasd:ResourceType>3</rasd:ResourceType>
            </Item>
            <Item ovf:bound="min">
                <rasd:AllocationUnits>MHz</rasd:AllocationUnits>
                <rasd:ElementName>500 MHz reservation</rasd:ElementName>
                <rasd:InstanceID>1</rasd:InstanceID>
                <rasd:Reservation>500</rasd:Reservation>
                <rasd:ResourceType>3</rasd:ResourceType>
            </Item>
            <Item ovf:bound="max">
                <rasd:AllocationUnits>MHz</rasd:AllocationUnits>
                <rasd:ElementName>1500 MHz reservation</rasd:ElementName>
                <rasd:InstanceID>1</rasd:InstanceID>
                <rasd:Reservation>1500</rasd:Reservation>
                <rasd:ResourceType>3</rasd:ResourceType>
            </Item>
        </ResourceAllocationSection>
        <StartupSection>
            <Info>Specifies how the composite service is powered-on and off</Info>
            <Item ovf:id="DBTier" ovf:order="1" ovf:startDelay="120"
                ovf:startAction="powerOn" ovf:waitingForGuest="true"
ovf:stopDelay="120"
                ovf:stopAction="guestShutdown"/>
            <Item ovf:id="WebTier" ovf:order="2" ovf:startDelay="120"
                ovf:startAction="powerOn" ovf:waitingForGuest="true"
ovf:stopDelay="120"
                ovf:stopAction="guestShutdown"/>
        </StartupSection>
        <VirtualSystem ovf:id="WebTier">
            <Info>The virtual machine containing the WebServer application</Info>
            <ProductSection>
                <Info>Describes the product information</Info>
                <Product>Apache Webserver</Product>
                <Vendor>Apache Software Foundation</Vendor>
                <Version>6.5</Version>
                <FullVersion>6.5-b2432</FullVersion>
            </ProductSection>
            <OperatingSystemSection ovf:id="97">
                <Info>Guest Operating System</Info>
                <Description>Linux 2.4.x</Description>
            </OperatingSystemSection>
            <VirtualHardwareSection>
                <Info>256 MB, 1 CPU, 1 disk, 1 nic virtual machine</Info>
                <System>
                    <vssd:ElementName>Virtual Hardware Family</vssd:ElementName>
                    <vssd:InstanceID>0</vssd:InstanceID>
                    <vssd:VirtualSystemType>vmx-04</vssd:VirtualSystemType>
                </System>
                <Item>
                    <rasd:Description>Number of virtual CPUs</rasd:Description>
                    <rasd:ElementName>1 virtual CPU</rasd:ElementName>
                    <rasd:InstanceID>1</rasd:InstanceID>
                    <rasd:ResourceType>3</rasd:ResourceType>
                    <rasd:VirtualQuantity>1</rasd:VirtualQuantity>
                </Item>
                <Item>
                    <rasd:AllocationUnits>byte * 2^20</rasd:AllocationUnits>
                    <rasd:Description>Memory Size</rasd:Description>
                    <rasd:ElementName>256 MB of memory</rasd:ElementName>
                    <rasd:InstanceID>2</rasd:InstanceID>
                    <rasd:ResourceType>4</rasd:ResourceType>
                    <rasd:VirtualQuantity>256</rasd:VirtualQuantity>
                </Item>
                <Item>
                    <rasd:AutomaticAllocation>true</rasd:AutomaticAllocation>
                    <rasd:Connection>VM Network</rasd:Connection>
                    <rasd:ElementName>Ethernet adapter on "VM
Network"</rasd:ElementName>
                    <rasd:InstanceID>3</rasd:InstanceID>
                    <rasd:ResourceSubType>PCNet32</rasd:ResourceSubType>
                    <rasd:ResourceType>10</rasd:ResourceType>
                </Item>
                <Item>
                    <rasd:AddressOnParent>1</rasd:AddressOnParent>
                    <rasd:ElementName>SCSI Controller 0 - LSI Logic</rasd:ElementName>
                    <rasd:InstanceID>1000</rasd:InstanceID>
                    <rasd:ResourceSubType>LsiLogic</rasd:ResourceSubType>
                    <rasd:ResourceType>6</rasd:ResourceType>
                </Item>
                <Item>
                    <rasd:AddressOnParent>0</rasd:AddressOnParent>
                    <rasd:ElementName>Harddisk 1</rasd:ElementName>
                    <rasd:HostResource>ovf:/disk/web</rasd:HostResource>
                    <rasd:InstanceID>22001</rasd:InstanceID>
                    <rasd:Parent>1000</rasd:Parent>
                    <rasd:ResourceType>17</rasd:ResourceType>
                </Item>
            </VirtualHardwareSection>
        </VirtualSystem>
        <!-- Database Tier -->
        <VirtualSystemCollection ovf:id="DBTier">
            <Info>Describes a clustered database instance</Info>
            <ProductSection ovf:class="com.mydb.db">
                <Info>Product Information</Info>
                <Product>Somebody Clustered SQL Server</Product>
                <Vendor>TBD</Vendor>
                <Version>2.5</Version>
                <FullVersion>2.5-b1234</FullVersion>
                <Property ovf:key="vm1" ovf:value="${dbIp}" ovf:type="string"/>
                <Property ovf:key="vm2" ovf:value="${db2Ip} " ovf:type="string"/>
                <Property ovf:key="log" ovf:value="${logLevel}" ovf:type="string"/>
            </ProductSection>
            <StartupSection>
                <Info>Specifies how the composite service is powered-on and off</Info>
                <Item ovf:id="DB1" ovf:order="1" ovf:startDelay="120"
                    ovf:startAction="powerOn" ovf:waitingForGuest="true"
                    ovf:stopDelay="120" ovf:stopAction="guestShutdown"/>
                <Item ovf:id="DB2" ovf:order="2" ovf:startDelay="120"
                    ovf:startAction="powerOn" ovf:waitingForGuest="true"
                    ovf:stopDelay="120" ovf:stopAction="guestShutdown"/>
            </StartupSection>
            <!-- DB VM 1 -->
            <VirtualSystem ovf:id="DB1">
                <Info>Describes a virtual machine with the database image 
installed</Info>
                <Name>Database Instance I</Name>
                <ProductSection ovf:class="com.mydb.db">
                    <Info>Specifies the OVF properties available in the OVF 
environment</Info>
                    <Property ovf:key="ip" ovf:value="${vm1}" ovf:type="string"/>
                    <Property ovf:key="ip2" ovf:value="${vm2} " ovf:type="string"/>
                    <Property ovf:key="primaryAtBoot" ovf:value="yes" 
ovf:type="string"/>
                </ProductSection>
                <VirtualHardwareSection>
                    <Info>256 MB, 1 CPU, 1 disk, 1 nic virtual machine</Info>
                    <System>
                        <vssd:ElementName>Virtual Hardware Family</vssd:ElementName>
                        <vssd:InstanceID>0</vssd:InstanceID>
                        <vssd:VirtualSystemType>vmx-04</vssd:VirtualSystemType>
                    </System>
                    <Item>
                        <rasd:Description>Number of virtual CPUs</rasd:Description>
                        <rasd:ElementName>1 virtual CPU</rasd:ElementName>
                        <rasd:InstanceID>1</rasd:InstanceID>
                        <rasd:ResourceType>3</rasd:ResourceType>
                        <rasd:VirtualQuantity>1</rasd:VirtualQuantity>
                    </Item>
                    <Item>
                        <rasd:AllocationUnits>byte * 2^20</rasd:AllocationUnits>
                        <rasd:Description>Memory Size</rasd:Description>
                        <rasd:ElementName>256 MB of memory</rasd:ElementName>
                        <rasd:InstanceID>2</rasd:InstanceID>
                        <rasd:ResourceType>4</rasd:ResourceType>
                        <rasd:VirtualQuantity>256</rasd:VirtualQuantity>
                    </Item>
                    <Item>
                        <rasd:AutomaticAllocation>true</rasd:AutomaticAllocation>
                        <rasd:Connection>VM Network</rasd:Connection>
                        <rasd:ElementName>Ethernet adapter on "VM
Network"</rasd:ElementName>
                        <rasd:InstanceID>3</rasd:InstanceID>
                        <rasd:ResourceSubType>PCNet32</rasd:ResourceSubType>
                        <rasd:ResourceType>10</rasd:ResourceType>
                    </Item>
                    <Item>
                        <rasd:AddressOnParent>1</rasd:AddressOnParent>
                        <rasd:ElementName>SCSI Controller 0 - LSI
Logic</rasd:ElementName>
                        <rasd:InstanceID>1000</rasd:InstanceID>
                        <rasd:ResourceSubType>LsiLogic</rasd:ResourceSubType>
                        <rasd:ResourceType>6</rasd:ResourceType>
                    </Item>
                    <Item>
                        <rasd:AddressOnParent>0</rasd:AddressOnParent>
                        <rasd:ElementName>Harddisk 1</rasd:ElementName>
                        <rasd:HostResource>ovf:/disk/db</rasd:HostResource>
                        <rasd:InstanceID>22001</rasd:InstanceID>
                        <rasd:Parent>1000</rasd:Parent>
                        <rasd:ResourceType>17</rasd:ResourceType>
                    </Item>
                </VirtualHardwareSection>
                <OperatingSystemSection ovf:id="97">
                    <Info>Guest Operating System</Info>
                    <Description>Linux 2.4.x</Description>
                </OperatingSystemSection>
            </VirtualSystem>
            <!-- DB VM 2 -->
            <VirtualSystem ovf:id="DB2">
                <Info>Describes a virtual machine with the database image
installed</Info>
                <Name>Database Instance II</Name>
                <ProductSection ovf:class="com.mydb.db">
                    <Info>Specifies the OVF properties available in the OVF
environment</Info>
                    <Property ovf:key="ip" ovf:value="${vm2}" ovf:type="string"/>
                    <Property ovf:key="ip2" ovf:value="${vm1} " ovf:type="string"/>
                    <Property ovf:key="primaryAtBoot" ovf:value="no"
ovf:type="string"/>
                </ProductSection>
                <VirtualHardwareSection>
                    <Info>256 MB, 1 CPU, 1 disk, 1 nic virtual machine</Info>
                    <System>
                        <vssd:ElementName>Virtual Hardware Family</vssd:ElementName>
                        <vssd:InstanceID>0</vssd:InstanceID>
                        <vssd:VirtualSystemType>vmx-04</vssd:VirtualSystemType>
                    </System>
                    <Item>
                        <rasd:Description>Number of virtual CPUs</rasd:Description>
                        <rasd:ElementName>1 virtual CPU</rasd:ElementName>
                        <rasd:InstanceID>1</rasd:InstanceID>
                        <rasd:ResourceType>3</rasd:ResourceType>
                        <rasd:VirtualQuantity>1</rasd:VirtualQuantity>
                    </Item>
                    <Item>
                        <rasd:AllocationUnits>byte * 2^20</rasd:AllocationUnits>
                        <rasd:Description>Memory Size</rasd:Description>
                        <rasd:ElementName>256 MB of memory</rasd:ElementName>
                        <rasd:InstanceID>2</rasd:InstanceID>
                        <rasd:ResourceType>4</rasd:ResourceType>
                        <rasd:VirtualQuantity>256</rasd:VirtualQuantity>
                    </Item>
                    <Item>
                        <rasd:AutomaticAllocation>true</rasd:AutomaticAllocation>
                        <rasd:Connection>VM Network</rasd:Connection>
                        <rasd:ElementName>Ethernet adapter on "VM
Network"</rasd:ElementName>
                        <rasd:InstanceID>3</rasd:InstanceID>
                        <rasd:ResourceSubType>PCNet32</rasd:ResourceSubType>
                        <rasd:ResourceType>10</rasd:ResourceType>
                    </Item>
                    <Item>
                        <rasd:AddressOnParent>1</rasd:AddressOnParent>
                        <rasd:ElementName>SCSI Controller 0 - LSI
Logic</rasd:ElementName>
                        <rasd:InstanceID>1000</rasd:InstanceID>
                        <rasd:ResourceSubType>LsiLogic</rasd:ResourceSubType>
                        <rasd:ResourceType>6</rasd:ResourceType>
                    </Item>
                    <Item>
                        <rasd:AddressOnParent>0</rasd:AddressOnParent>
                        <rasd:ElementName>Harddisk 1</rasd:ElementName>
                        <rasd:HostResource>ovf:/disk/db</rasd:HostResource>
                        <rasd:InstanceID>22001</rasd:InstanceID>
                        <rasd:Parent>1000</rasd:Parent>
                        <rasd:ResourceType>17</rasd:ResourceType>
                    </Item>
                </VirtualHardwareSection>
                <OperatingSystemSection ovf:id="97">
                    <Info>Guest Operating System</Info>
                    <Description>Linux 2.4.x</Description>
                </OperatingSystemSection>
            </VirtualSystem>
        </VirtualSystemCollection>
    </VirtualSystemCollection>
    <!-- External I18N bundles -->
    <Strings xml:lang="de-DE" ovf:fileRef="de-DE-bundle.xml"/>
    <!-- EmbeddedI18N bundles -->
    <Strings xml:lang="da-DA">
        <Msg ovf:msgid="network.description">Netværket servicen skal være tilgængelig
på</Msg>
        <Msg ovf:msgid="annotation.annotation">Kontakt kundeservice i tilfælde af
            kritiske problemer</Msg>
        <Msg ovf:msgid="property.email.description">Email adresse for
administrator</Msg>
        <Msg ovf:msgid="property.appip.description">IP adresse for service</Msg>
        <Msg ovf:msgid="property.dpip">Primær IP adresse for database</Msg>
        <Msg ovf:msgid="property.dpip2.description">Sekundær IP adresse for
database</Msg>
        <Msg ovf:msgid="property.loglevel.description">Logningsniveau for
service</Msg>
        <Msg ovf:msgid="minimal.label">Minimal</Msg>
        <Msg ovf:msgid="minimal.description">Installer service med minimal brug af
            resourcer</Msg>
        <Msg ovf:msgid="standard.label">Normal</Msg>
        <Msg ovf:msgid="standard.description">Installer service med normal brug af
            resourcer</Msg>
    </Strings>
</Envelope>
```

B.5 Complete OVF Environment

The following lists the OVF environments seen by the WebTier and DB1 virtual machines (DB2 is is virtually identical to the one for DB1 and is omitted).

OVF environment for the WebTier virtual machine:

```
<?xml version="1.0" encoding="UTF-8"?>
<Environment
    xmlns="http://schemas.dmtf.org/ovf/environment/1"
    xmlns:ovfenv="http://schemas.dmtf.org/ovf/environment/1"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    ovfenv:id="WebTier">

    <!-- Information about hypervisor platform -->
    <PlatformSection>
        <Kind>ESX Server</Kind>
        <Version>3.0.1</Version>
        <Vendor>VMware, Inc.</Vendor>
        <Locale>en_US</Locale>
    </PlatformSection>

    <!--- Properties defined for this virtual machine -->
    <PropertySection>
        <Property ovfenv:key="adminEmail" ovfenv:value="ovf-admin@vmware.com"/>
        <Property ovfenv:key="appIp" ovfenv:value="10.20.132.101"/>
        <Property ovfenv:key="dbIp" ovfenv:value="10.20.132.102"/>
        <Property ovfenv:key="db2Ip" ovfenv:value="10.20.132.103"/>
        <Property ovfenv:key="logLevel" ovfenv:value="warning"/>
    </PropertySection>

    <Entity ovfenv:id="DBTier">
        <PropertySection>
            <Property ovfenv:key="adminEmail" ovfenv:value="ovf-admin@vmware.com"/>
            <Property ovfenv:key="appIp" ovfenv:value="10.20.132.101"/>
            <Property ovfenv:key="dbIp" ovfenv:value="10.20.132.102"/>
            <Property ovfenv:key="db2Ip" ovfenv:value="10.20.132.103"/>
            <Property ovfenv:key="logLevel" ovfenv:value="warning"/>
            <Property ovfenv:key="com.mydb.db.vm1" ovfenv:value="10.20.132.102"/>
            <Property ovfenv:key="com.mydb.db.vm2" ovfenv:value="10.20.132.103"/>
            <Property ovfenv:key="com.mydb.db.log" ovfenv:value="warning"/>
        </PropertySection>
    </Entity>
</Environment>
```

OVF environment for the DB1 virtual machine:

```
<?xml version="1.0" encoding="UTF-8"?>
<Environment
    xmlns="http://schemas.dmtf.org/ovf/environment/1"
    xmlns:ovfenv="http://schemas.dmtf.org/ovf/environment/1"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    ovfenv:id="DB1">

    <!-- Information about hypervisor platform -->
    <PlatformSection>
        <Kind>ESX Server</Kind>
        <Version>3.0.1</Version>
        <Vendor>VMware, Inc.</Vendor>
        <Locale>en_US</Locale>
    </PlatformSection>

    <!--- Properties defined for this virtual machine -->
    <PropertySection>
        <Property ovfenv:key="com.mydb.db.vm1" ovfenv:value="10.20.132.102"/>
        <Property ovfenv:key="com.mydb.db.vm2" ovfenv:value="10.20.132.103"/>
        <Property ovfenv:key="com.mydb.db.log" ovfenv:value="warning"/>
        <Property ovfenv:key="com.mydb.db.ip" ovfenv:value="10.20.132.102"/>
        <Property ovfenv:key="com.mydb.db.ip2" ovfenv:value="10.20.132.103"/>
        <Property ovfenv:key="com.mydb.db.primaryAtBoot" ovfenv:value="yes"/>
    </PropertySection>

    <Entity ovfenv:id="DB2">
        <PropertySection>
            <Property ovfenv:key="com.mydb.db.vm1" ovfenv:value="10.20.132.102"/>
            <Property ovfenv:key="com.mydb.db.vm2" ovfenv:value="10.20.132.103"/>
            <Property ovfenv:key="com.mydb.db.log" ovfenv:value="warning"/>
            <Property ovfenv:key="com.mydb.db.ip" ovfenv:value="10.20.132.103"/>
            <Property ovfenv:key="com.mydb.db.ip2" ovfenv:value="10.20.132.102"/>
            <Property ovfenv:key="com.mydb.db.primaryAtBoot" ovfenv:value="no"/>
        </PropertySection>
    </Entity>
</Environment>
```

ANNEX C
(informative)

Single Virtual System LAMP Stack Example

In this example we provide two concrete examples on how an OVF descriptor for a LAMP virtual appliance could look like. We show both a single-VM LAMP virtual appliance and a multi-VM LAMP virtual appliance. LAMP is an abbreviation for a service built using the Linux operating system, Apache web server, MySQL database, and the PHP web development software packages.

This examples show how the *ProductSection* can be used to specify both operating system and application-level deployment parameters. For example, these parameters can be used to optimize the performance of a service when deployed into a particular environment. The descriptors are complete, but otherwise kept minimal, so there are, for example, no EULA sections.

C.1 Deployment-time Customization

A part of the deployment phase of an OVF package is to provide customization parameters. The customization parameters are specified in the OVF descriptor and are provided to the guest software using the OVF environment. This deployment time customization is in addition to the virtual machine level parameters, which includes virtual switch connectivity and physical storage location.

For a LAMP-based virtual appliance, the deployment time customization includes IP address and port number of the service, network information such as gateway and subnet, and also parameters so the performance can be optimized for a given deployment. The properties that will be exposed to the deployer will vary from vendor to vendor and service to service. In our example descriptors, we use the following set of parameters for the 4 different LAMP components:

Table 3 illustrates the properties for the LAMP configuration

Table 3 – LAMP Configuration

Product	Property	Description
Linux	`hostname`	Network identity of the application, including IP address.
	`ip`	
	`subnet`	
	`gateway`	
	`dns`	
	`netCoreRmemMax`	Parameters to optimize the transfer rate of the IP stack
	`netCoreWmemMax`	
Apache	`httpPort`	Port numbers for web server
	`httpsPort`	
	`startThreads`	Parameters to optimize the performance of the web server
	`minSpareThreads`	
	`maxSpareThreads`	

	maxClients	
MySQL	queryCacheSize	Parameters to optimize the performance of database
	maxConnections	
	waitTimeout	
PHP	sessionTimeout	Parameters to customize the behavior of the PHP engine, including how sessions timeout and number of sessions.
	concurrentSessions	
	memoryLimit	

The parameters in *italic* are required configuration from the user. Otherwise, they have reasonable defaults, so the user does not necessarily need to provide a value.

The customization parameters for each software product are encapsulated in separate product sections. For example, for the Apache web server the following section is used:

```
<ProductSection ovf:class="org.apache.httpd">
    <Info>Product customization for the installed Apache Web Server</Info>
    <Product>Apache Distribution Y</Product>
    <Version>2.6.6</Version>
    <Property ovf:key="httpPort" ovf:type="uint16" ovf:value="80"
              ovf:userConfigurable="true">
        <Description>Port number for HTTP requests</Description>
    </Property>
    <Property ovf:key="httpsPort" ovf:type="uint16" ovf:value="443"
              ovf:userConfigurable="true">
        <Description>Port number for HTTPS requests</Description>
    </Property>
    <Property ovf:key="startThreads" ovf:type="uint16" ovf:value="50"
              ovf:userConfigurable="true">
        <Description>Number of threads created on startup. </Description>
    </Property>
    <Property ovf:key="minSpareThreads" ovf:type="uint16" ovf:value="15"
              ovf:userConfigurable="true">
        <Description> Minimum number of idle threads to handle request
spikes.</Description>
    </Property>
    <Property ovf:key="maxSpareThreads" ovf:type="uint16" ovf:value="30"
              ovf:userConfigurable="true">
        <Description>Maximum number of idle threads </Description>
    </Property>
    <Property ovf:key="maxClients" ovf:type="uint16" ovf:value="256"
              ovf:userConfigurable="true">
         <Description>Limit the number of simultaneous requests that will be served.
</Description>
    </Property>
</ProductSection>
```

The `ovf:class="org.apache.httpd"` attribute specifies the prefix for the properties. Hence, the Apache database is expected to look for the following properties in the OVF environment:

```
<Environment
    ...
    <!--- Properties defined for this virtual machine -->
    <PropertySection>
      <Property ovfenv:name="org.apache.httpd.httpPort ovfenv:value="80"/>
      <Property ovfenv:name="org.apache.httpd.httpsPort ovfenv:value="443"/>
      <Property ovfenv:name="org.apache.httpd.startThreads” ovfenv:value="50"/>
      <Property ovfenv:name="org.apache.httpd.minSpareThreads" ovfenv:value="15"/>
      <Property ovfenv:name="org.apache.httpd.maxSpareThreads" ovfenv:value="30"/>
      <Property ovfenv:name="org.apache.httpd.maxClients" ovfenv:value="256"/>
      ...
    </PropertySection>
    ...
</Environment>
```

C.2 Simple LAMP OVF Descriptor

A complete OVF descriptor for a single VM virtual appliance with the LAMP stack is listed below:

```
<?xml version="1.0" encoding="UTF-8"?>
<Envelope
    xmlns="http://schemas.dmtf.org/ovf/envelope/1"
    xmlns:ovf="http://schemas.dmtf.org/ovf/envelope/1"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:vssd="http://schemas.dmtf.org/wbem/wscim/1/cim-
schema/2/CIM_VirtualSystemSettingData"
    xmlns:rasd="http://schemas.dmtf.org/wbem/wscim/1/cim-
schema/2/CIM_ResourceAllocationSettingData"
    <!-- References to all external files -->
    <References>
        <File ovf:id="lamp" ovf:href="lamp.vmdk" ovf:size="180114671"/>
    </References>
    <!-- Describes meta-information about all virtual disks in the package.  -->
    <DiskSection>
        <Info>List of the virtual disks used in the package</Info>
        <Disk ovf:diskId="lamp" ovf:fileRef="lamp" ovf:capacity="4294967296"
            ovf:populatedSize="1924967692"

ovf:format="http://www.vmware.com/specifications/vmdk.html#streamOptimized"/>
    </DiskSection>
    <!-- Describes all networks used in the package -->
    <NetworkSection>
        <Info>Logical networks used in the package</Info>
        <Network ovf:name="VM Network">
            <Description>The network that the LAMP Service will be available
            on</Description>
        </Network>
    </NetworkSection>
    <VirtualSystem ovf:id="MyLampService">
        <Info>Single-VM Virtual appliance with LAMP stack</Info>
        <Name>LAMP Virtual Appliance</Name>
        <!-- Overall information about the product -->
        <ProductSection>
            <Info>Product information for the service</Info>
            <Product>Lamp Service</Product>
            <Version>1.0</Version>
            <FullVersion>1.0.0</FullVersion>
        </ProductSection>
        <!-- Linux component configuration parameters -->
        <ProductSection ovf:class="org.linuxdistx">
            <Info>Product customization for the installed Linux system</Info>
            <Product>Linux Distribution X</Product>
            <Version>2.6.3</Version>
            <Property ovf:key="hostname" ovf:type="string">
                <Description>Specifies the hostname for the appliance</Description>
            </Property>
            <Property ovf:key="ip" ovf:type="string">
                <Description>Specifies the IP address for the appliance</Description>
            </Property>
            <Property ovf:key="subnet" ovf:type="string">
                <Description> Specifies the subnet to use on the deployed network
                </Description>
            </Property>
            <Property ovf:key="gateway" ovf:type="string">
                <Description> Specifies the gateway on the deployed network
                </Description>
            </Property>
            <Property ovf:key="dns" ovf:type="string">
                <Description> A comma separated list of DNS servers on the deployed
                    network </Description>
            </Property>
            <Property ovf:key="netCoreRmemMaxMB" ovf:type="uint16" ovf:value="16"
                ovf:userConfigurable="true">
                <Description> Specify TCP read max buffer size in mega bytes. Default
is
                    16. </Description>
            </Property>
            <Property ovf:key="netCoreWmemMaxMB" ovf:type="uint16" ovf:value="16"
                ovf:userConfigurable="true">
                <Description> Specify TCP write max buffer size in mega bytes. Default
is
                    16. </Description>
            </Property>
        </ProductSection>
        <!-- Apache  component configuration parameters -->
        <ProductSection ovf:class="org.apache.httpd">
            <Info>Product customization for the installed Apache Web Server</Info>
            <Product>Apache Distribution Y</Product>
            <Version>2.6.6</Version>
            <Property ovf:key="httpPort" ovf:type="uint16" ovf:value="80"
                ovf:userConfigurable="true">
                <Description>Port number for HTTP requests</Description>
            </Property>
            <Property ovf:key="httpsPort" ovf:type="uint16" ovf:value="443"
                ovf:userConfigurable="true">
                <Description>Port number for HTTPS requests</Description>
            </Property>
            <Property ovf:key="startThreads" ovf:type="uint16" ovf:value="50"
                ovf:userConfigurable="true">
                <Description>Number of threads created on startup. </Description>
            </Property>
            <Property ovf:key="minSpareThreads" ovf:type="uint16" ovf:value="15"
                ovf:userConfigurable="true">
                <Description> Minimum number of idle threads to handle request spikes.
                </Description>
            </Property>
            <Property ovf:key="maxSpareThreads" ovf:type="uint16" ovf:value="30"
                ovf:userConfigurable="true">
                <Description>Maximum number of idle threads </Description>
            </Property>
            <Property ovf:key="maxClients" ovf:type="uint16" ovf:value="256"
                ovf:userConfigurable="true">
                <Description>Limit the number of simultaneous requests that will be
                    served. </Description>
            </Property>
        </ProductSection>
        <!-- MySQL  component configuration parameters -->
        <ProductSection ovf:class="org.mysql.db">
            <Info>Product customization for the installed MySql Database Server</Info>
            <Product>MySQL Distribution Z</Product>
            <Version>5.0</Version>
            <Property ovf:key="queryCacheSizeMB" ovf:type="uint16" ovf:value="32"
```

```
                ovf:userConfigurable="true">
                <Description>Buffer to cache repeated queries for faster access (in
                MB)</Description>
            </Property>
            <Property ovf:key="maxConnections" ovf:type="uint16" ovf:value="500"
                ovf:userConfigurable="true">
                <Description>The number of concurrent connections that can be
                served</Description>
            </Property>
            <Property ovf:key="waitTimeout" ovf:type="uint16" ovf:value="100"
                ovf:userConfigurable="true">
                <Description>Number of seconds to wait before timing out a connection
                </Description>
            </Property>
        </ProductSection>
        <!-- PHP component configuration parameters -->
        <ProductSection ovf:class="net.php">
            <Info>Product customization for the installed PHP component</Info>
            <Product>PHP Distribution U</Product>
            <Version>5.0</Version>
            <Property ovf:key="sessionTimeout" ovf:type="uint16" ovf:value="5"
                ovf:userConfigurable="true">
                <Description> How many minutes a session has to be idle before it is
                    timed out </Description>
            </Property>
            <Property ovf:key="concurrentSessions" ovf:type="uint16" ovf:value="500"
                ovf:userConfigurable="true">
                <Description> The number of concurrent sessions that can be served
                </Description>
            </Property>
            <Property ovf:key="memoryLimit" ovf:type="uint16" ovf:value="32"
                ovf:userConfigurable="true">
                <Description> How much memory in megabytes a script can consume before
                    being killed </Description>
            </Property>
        </ProductSection>
        <OperatingSystemSection ovf:id="99">
            <Info>Guest Operating System</Info>
            <Description>Linux 2.6.x</Description>
        </OperatingSystemSection>
        <VirtualHardwareSection>
            <Info>Virtual Hardware Requirements: 256MB, 1 CPU, 1 disk, 1 NIC</Info>
            <System>
                <vssd:ElementName>Virtual Hardware Family</vssd:ElementName>
                <vssd:InstanceID>0</vssd:InstanceID>
                <vssd:VirtualSystemType>vmx-04</vssd:VirtualSystemType>
            </System>
            <Item>
                <rasd:Description>Number of virtual CPUs</rasd:Description>
                <rasd:ElementName>1 virtual CPU</rasd:ElementName>
                <rasd:InstanceID>1</rasd:InstanceID>
                <rasd:ResourceType>3</rasd:ResourceType>
                <rasd:VirtualQuantity>1</rasd:VirtualQuantity>
            </Item>
            <Item>
                <rasd:AllocationUnits>byte * 2^20</rasd:AllocationUnits>
                <rasd:Description>Memory Size</rasd:Description>
                <rasd:ElementName>256 MB of memory</rasd:ElementName>
                <rasd:InstanceID>2</rasd:InstanceID>
                <rasd:ResourceType>4</rasd:ResourceType>
                <rasd:VirtualQuantity>256</rasd:VirtualQuantity>
            </Item>
            <Item>
                <rasd:AutomaticAllocation>true</rasd:AutomaticAllocation>
                <rasd:Connection>VM Network</rasd:Connection>
                <rasd:ElementName>Ethernet adapter on "VM Network"</rasd:ElementName>
                <rasd:InstanceID>3</rasd:InstanceID>
                <rasd:ResourceType>10</rasd:ResourceType>
            </Item>
            <Item>
                <rasd:ElementName>SCSI Controller 0 - LSI Logic</rasd:ElementName>
                <rasd:InstanceID>4</rasd:InstanceID>
                <rasd:ResourceSubType>LsiLogic</rasd:ResourceSubType>
                <rasd:ResourceType>6</rasd:ResourceType>
            </Item>
            <Item>
                <rasd:ElementName>Harddisk 1</rasd:ElementName>
                <rasd:HostResource>ovf:/disk/lamp</rasd:HostResource>
                <rasd:InstanceID>5</rasd:InstanceID>
                <rasd:Parent>4</rasd:Parent>
                <rasd:ResourceType>17</rasd:ResourceType>
            </Item>
        </VirtualHardwareSection>
    </VirtualSystem>
</Envelope>
```

ANNEX D
(informative)

Multiple Virtual System LAMP Stack Example

In this example is for an OVF descriptor for a LAMP virtual appliance could look like in a multi-VM LAMP virtual appliance. LAMP is an abbreviation for a service built using the Linux operating system, Apache web server, MySQL database, and the PHP web development software packages.

D.1 Two-tier LAMP OVF Descriptor

In a two tier LAMP stack, the application tier (Linux, Apache, PHP) and the database tier (Linux, MySQL) server) are run as separate virtual machines for greater scalability.

The OVF format makes it largely transparent to the user how a service is implemented. In particular, the deployment experience when installing a single-VM or a two-tier LAMP appliance is very similar. The only visible difference is that the user will need to supply two IP addresses and two DNS host names.

As compared to the single-VM descriptor, the following changes are made:

- All the user-configurable parameters are put in the *VirtualSystemCollection* entity*.* The ProductSections for Apache, MySQL, and PHP are unchanged from the single VM case.
- The Linux software in the two virtual machines needs to be configured slightly different (IP and hostname) while sharing most parameters. A new ProductSection is added to the *VirtualSystemCollection* to prompt the user, and the `${property}` expression is used to assign the values in each *VirtualSystem* entity.
- Disk chains are used to keep the download size comparable to that of a single VM appliance. Since the Linux installation is stored on a shared base disk, effectively only one copy of Linux needs to be downloaded.

The complete OVF descriptor is shown below:

```
<?xml version="1.0" encoding="UTF-8"?>
<Envelope
    xmlns="http://schemas.dmtf.org/ovf/envelope/1"
    xmlns:ovf="http://schemas.dmtf.org/ovf/envelope/1"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:vssd="http://schemas.dmtf.org/wbem/wscim/1/cim-
schema/2/CIM_VirtualSystemSettingData"
    xmlns:rasd="http://schemas.dmtf.org/wbem/wscim/1/cim-
schema/2/CIM_ResourceAllocationSettingData"
    <!-- References to all external files. -->
    <References>
        <File ovf:id="lamp-base" ovf:href="lampdb.vmdk" ovf:size="180114671"/>
        <File ovf:id="lamp-db" ovf:href="lampdb.vmdk" ovf:size="1801146"/>
        <File ovf:id="lamp-app" ovf:href="lampapp.vmdk" ovf:size="34311371"/>
    </References>
    <!-- Describes meta-information about all virtual disks in the package.
         This example is encoded as a delta-disk hierarchy.
    -->
    <DiskSection>
        <Info>List of the virtual disks used in the package</Info>
        <Disk ovf:diskId="lamp-base" ovf:fileRef="lamp-base" ovf:capacity="4294967296"
            ovf:populatedSize="1924967692"

ovf:format="http://www.vmware.com/specifications/vmdk.html#streamOptimized"/>
        <Disk ovf:diskId="lamp-db" ovf:fileRef="lamp-db" ovf:capacity="4294967296"
```

```
            ovf:populatedSize="19249672"

ovf:format="http://www.vmware.com/specifications/vmdk.html#streamOptimized"
            ovf:parentRef="lamp-base"/>
        <Disk ovf:diskId="lamp-app" ovf:fileRef="lamp-app" ovf:capacity="4294967296"
            ovf:populatedSize="2349692"

ovf:format="http://www.vmware.com/specifications/vmdk.html#streamOptimized"
            ovf:parentRef="lamp-base"/>
    </DiskSection>
    <!-- Describes all networks used in the package -->
    <NetworkSection>
        <Info>Logical networks used in the package</Info>
        <Network ovf:name="VM Network">
            <Description>The network that the LAMP Service will be available
            on</Description>
        </Network>
    </NetworkSection>
    <VirtualSystemCollection ovf:id="LampService">
        <Info>Virtual appliance with a 2-tier distributed LAMP stack</Info>
        <Name>LAMP Service</Name>
        <!-- Overall information about the product -->
        <ProductSection ovf:class="org.mylamp">
            <Info>Product information for the service</Info>
            <Product>My Lamp Service</Product>
            <Version>1.0</Version>
            <FullVersion>1.0.0</FullVersion>
        </ProductSection>
        <ProductSection ovf:class="org.linuxdist">
            <Info>Product customization for Operating System Level</Info>
            <Product>Linux Distribution X</Product>
            <Version>2.6.3</Version>
            <Property ovf:key="dbHostname" ovf:type="string">
                <Description>Specifies the hostname for database virtual
                machine</Description>
            </Property>
            <Property ovf:key="appHostname" ovf:type="string">
                <Description>Specifies the hostname for application server virtual
                    machine</Description>
            </Property>
            <Property ovf:key="dbIp" ovf:type="string">
                <Description>Specifies the IP address for the database virtual
                machine</Description>
            </Property>
            <Property ovf:key="appIp" ovf:type="string">
                <Description>Specifies the IP address for application server
                VM</Description>
            </Property>
            <Property ovf:key="subnet" ovf:type="string">
                <Description> Specifies the subnet to use on the deployed network
                </Description>
            </Property>
            <Property ovf:key="gateway" ovf:type="string">
                <Description> Specifies the gateway on the deployed network
                </Description>
            </Property>
            <Property ovf:key="dns" ovf:type="string">
                <Description> A comma separated list of DNS servers on the deployed
                    network </Description>
            </Property>
            <Property ovf:key="netCoreRmemMaxMB" ovf:type="uint16" ovf:value="16"
                ovf:userConfigurable="true">
                <Description> Specify TCP read max buffer size in mega bytes. Default
is
```

```
                    16. </Description>
            </Property>
            <Property ovf:key="netCoreWmemMaxMB" ovf:type="uint16" ovf:value="16"
                ovf:userConfigurable="true">
                <Description> Specify TCP write max buffer size in mega bytes. Default
is
                    16. </Description>
            </Property>
        </ProductSection>
        <!-- Apache  component configuration parameters -->
        <ProductSection ovf:class="org.apache.httpd">
            <Info>Product customization for the installed Apache Web Server</Info>
            <Product>Apache Distribution Y</Product>
            <Version>2.6.6</Version>
            <Property ovf:key="httpPort" ovf:type="uint16" ovf:value="80"
                ovf:userConfigurable="true">
                <Description>Port number for HTTP requests</Description>
            </Property>
            <Property ovf:key="httpsPort" ovf:type="uint16" ovf:value="443"
                ovf:userConfigurable="true">
                <Description>Port number for HTTPS requests</Description>
            </Property>
            <Property ovf:key="startThreads" ovf:type="uint16" ovf:value="50"
                ovf:userConfigurable="true">
                <Description>Number of threads created on startup. </Description>
            </Property>
            <Property ovf:key="minSpareThreads" ovf:type="uint16" ovf:value="15"
                ovf:userConfigurable="true">
                <Description>Minimum number of idle threads to handle request spikes.
                </Description>
            </Property>
            <Property ovf:key="maxSpareThreads" ovf:type="uint16" ovf:value="30"
                ovf:userConfigurable="true">
                <Description>Maximum number of idle threads </Description>
            </Property>
            <Property ovf:key="maxClients" ovf:type="uint16" ovf:value="256"
                ovf:userConfigurable="true">
                <Description>Limits the number of simultaneous requests that will be
                    served. </Description>
            </Property>
        </ProductSection>
        <!-- MySQL  component configuration parameters -->
        <ProductSection ovf:class="org.mysql.db">
            <Info>Product customization for the installed MySql Database Server</Info>
            <Product>MySQL Distribution Z</Product>
            <Version>5.0</Version>
            <Property ovf:key="queryCacheSizeMB" ovf:type="uint16" ovf:value="32"
                ovf:userConfigurable="true">
                <Description>Buffer to cache repeated queries for faster access (in
                MB)</Description>
            </Property>
            <Property ovf:key="maxConnections" ovf:type="uint16" ovf:value="500"
                ovf:userConfigurable="true">
                <Description>The number of concurrent connections that can be
                served</Description>
            </Property>
            <Property ovf:key="waitTimeout" ovf:type="uint16" ovf:value="100"
                ovf:userConfigurable="true">
                <Description>Number of seconds to wait before timing out a connection
                </Description>
            </Property>
        </ProductSection>
        <!-- PHP component configuration parameters -->
        <ProductSection ovf:class="net.php">
```

```
            <Info>Product customization for the installed PHP component</Info>
            <Product>PHP Distribution U</Product>
            <Version>5.0</Version>
            <Property ovf:key="sessionTimeout" ovf:type="uint16" ovf:value="5"
                ovf:userConfigurable="true">
                <Description> How many minutes a session has to be idle before it is
                    timed out </Description>
            </Property>
            <Property ovf:key="concurrentSessions" ovf:type="uint16" ovf:value="500"
                ovf:userConfigurable="true">
                <Description> The number of concurrent sessions that can be served
                </Description>
            </Property>
            <Property ovf:key="memoryLimit" ovf:type="uint16" ovf:value="32"
                ovf:userConfigurable="true">
                <Description> How much memory in megabytes a script can consume before
                    being killed </Description>
            </Property>
        </ProductSection>
        <StartupSection>
            <Info>Startup order of the virtual machines</Info>
            <Item ovf:id="DbServer" ovf:order="1" ovf:startDelay="120"
                ovf:startAction="powerOn" ovf:waitingForGuest="true"
ovf:stopDelay="120"
                ovf:stopAction="guestShutdown"/>
            <Item ovf:id="AppServer" ovf:order="2" ovf:startDelay="120"
                ovf:startAction="powerOn" ovf:waitingForGuest="true"
ovf:stopDelay="120"
                ovf:stopAction="guestShutdown"/>
        </StartupSection>
        <VirtualSystem ovf:id="AppServer">
            <Info>The configuration of the AppServer virtual machine</Info>
            <Name>Application Server</Name>
            <!-- Linux component configuration parameters -->
            <ProductSection ovf:class="org.linuxdistx">
                <Info>Product customization for the installed Linux system</Info>
                <Product>Linux Distribution X</Product>
                <Version>2.6.3</Version>
                <Property ovf:key="hostname" ovf:type="string"
ovf:value="${appHostName}"/>
                <Property ovf:key="ip" ovf:type="string" ovf:value="${appIp}"/>
                <Property ovf:key="subnet" ovf:type="string" ovf:value="${subnet}"/>
                <Property ovf:key="gateway" ovf:type="string" ovf:value="${gateway}"/>
                <Property ovf:key="dns" ovf:type="string" ovf:value="${dns}"/>
                <Property ovf:key="netCoreRmemMaxMB" ovf:type="string"
                    ovf:value="${netCoreRmemMaxMB}"/>
                <Property ovf:key="netCoreWmemMaxMB" ovf:type="string"
                    ovf:value="${netCoreWmemMaxMB}"/>
            </ProductSection>
            <OperatingSystemSection ovf:id="99">
                <Info>Guest Operating System</Info>
                <Description>Linux 2.6.x</Description>
            </OperatingSystemSection>
            <VirtualHardwareSection>
                <Info>Virtual Hardware Requirements: 256 MB, 1 CPU, 1 disk, 1
NIC</Info>
                <System>
                    <vssd:ElementName>Virtual Hardware Family</vssd:ElementName>
                    <vssd:InstanceID>0</vssd:InstanceID>
                    <vssd:VirtualSystemType>vmx-04</vssd:VirtualSystemType>
                </System>
                <Item>
                    <rasd:Description>Number of virtual CPUs</rasd:Description>
                    <rasd:ElementName>1 virtual CPU</rasd:ElementName>
                    <rasd:InstanceID>1</rasd:InstanceID>
                    <rasd:ResourceType>3</rasd:ResourceType>
                    <rasd:VirtualQuantity>1</rasd:VirtualQuantity>
                </Item>
                <Item>
                    <rasd:AllocationUnits>byte * 2^20</rasd:AllocationUnits>
                    <rasd:Description>Memory Size</rasd:Description>
                    <rasd:ElementName>256 MB of memory</rasd:ElementName>
                    <rasd:InstanceID>2</rasd:InstanceID>
                    <rasd:ResourceType>4</rasd:ResourceType>
                    <rasd:VirtualQuantity>256</rasd:VirtualQuantity>
                </Item>
                <Item>
                    <rasd:AutomaticAllocation>true</rasd:AutomaticAllocation>
                    <rasd:Connection>VM Network</rasd:Connection>
                    <rasd:ElementName>Ethernet adapter on "VM
Network"</rasd:ElementName>
                    <rasd:InstanceID>3</rasd:InstanceID>
                    <rasd:ResourceSubType>PCNet32</rasd:ResourceSubType>
                    <rasd:ResourceType>10</rasd:ResourceType>
                </Item>
                <Item>
                    <rasd:ElementName>SCSI Controller 0 - LSI Logic</rasd:ElementName>
                    <rasd:InstanceID>4</rasd:InstanceID>
                    <rasd:ResourceSubType>LsiLogic</rasd:ResourceSubType>
                    <rasd:ResourceType>6</rasd:ResourceType>
                </Item>
                <Item>
                    <rasd:ElementName>Harddisk 1</rasd:ElementName>
                    <rasd:HostResource>ovf:/disk/lamp-app</rasd:HostResource>
                    <rasd:InstanceID>5</rasd:InstanceID>
                    <rasd:Parent>4</rasd:Parent>
                    <rasd:ResourceType>17</rasd:ResourceType>
                </Item>
            </VirtualHardwareSection>
        </VirtualSystem>
        <VirtualSystem ovf:id="DB Server">
            <Info>The configuration of the database virtual machine</Info>
            <Name>Database Server</Name>
            <!-- Linux component configuration parameters -->
            <ProductSection ovf:class="org.linuxdistx">
                <Info>Product customization for the installed Linux system</Info>
                <Product>Linux Distribution X</Product>
                <Version>2.6.3</Version>
                <Property ovf:key="hostname" ovf:type="string"
                    ovf:value="${dbHostName}"/>
                <Property ovf:key="ip" ovf:type="string" ovf:value="${dbIp}"/>
                <Property ovf:key="subnet" ovf:type="string" ovf:value="${subnet}"/>
                <Property ovf:key="gateway" ovf:type="string" ovf:value="${gateway}"/>
                <Property ovf:key="dns" ovf:type="string" ovf:value="${dns}"/>
                <Property ovf:key="netCoreRmemMaxMB" ovf:type="string"
                    ovf:value="${netCoreRmemMaxMB}"/>
                <Property ovf:key="netCoreWmemMaxMB" ovf:type="string"
                    ovf:value="${netCoreWmemMaxMB}"/>
            </ProductSection>
            <OperatingSystemSection ovf:id="99">
                <Info>Guest Operating System</Info>
                <Description>Linux 2.6.x</Description>
            </OperatingSystemSection>
            <VirtualHardwareSection>
                <Info>Virtual Hardware Requirements: 256 MB, 1 CPU, 1 disk, 1
nic</Info>
                <System>
                    <vssd:ElementName>Virtual Hardware Family</vssd:ElementName>
                    <vssd:InstanceID>0</vssd:InstanceID>
                    <vssd:VirtualSystemType>vmx-04</vssd:VirtualSystemType>
                </System>
                <Item>
                    <rasd:Description>Number of virtual CPUs</rasd:Description>
                    <rasd:ElementName>1 virtual CPU</rasd:ElementName>
                    <rasd:InstanceID>1</rasd:InstanceID>
                    <rasd:ResourceType>3</rasd:ResourceType>
                    <rasd:VirtualQuantity>1</rasd:VirtualQuantity>
                </Item>
                <Item>
                    <rasd:AllocationUnits>byte * 2^20</rasd:AllocationUnits>
                    <rasd:Description>Memory Size</rasd:Description>
                    <rasd:ElementName>256 MB of memory</rasd:ElementName>
                    <rasd:InstanceID>2</rasd:InstanceID>
                    <rasd:ResourceType>4</rasd:ResourceType>
                    <rasd:VirtualQuantity>256</rasd:VirtualQuantity>
                </Item>
                <Item>
                    <rasd:AutomaticAllocation>true</rasd:AutomaticAllocation>
                    <rasd:Connection>VM Network</rasd:Connection>
                    <rasd:ElementName>Ethernet adapter on "VM 
Network"</rasd:ElementName>
                    <rasd:InstanceID>3</rasd:InstanceID>
                    <rasd:ResourceType>10</rasd:ResourceType>
                </Item>
                <Item>
                    <rasd:ElementName>SCSI Controller 0 - LSI Logic</rasd:ElementName>
                    <rasd:InstanceID>4</rasd:InstanceID>
                    <rasd:ResourceSubType>LsiLogic</rasd:ResourceSubType>
                    <rasd:ResourceType>6</rasd:ResourceType>
                </Item>
                <Item>
                    <rasd:ElementName>Harddisk 1</rasd:ElementName>
                    <rasd:HostResource>ovf:/disk/lamp-db</rasd:HostResource>
                    <rasd:InstanceID>5</rasd:InstanceID>
                    <rasd:Parent>4</rasd:Parent>
                    <rasd:ResourceType>17</rasd:ResourceType>
                </Item>
            </VirtualHardwareSection>
        </VirtualSystem>
    </VirtualSystemCollection>
</Envelope>
```

ANNEX E
(informative)
Extensibility Example

The OVF specification allows custom meta-data to be added to OVF descriptors in several ways:

- New section elements can be defined as part of the `Section` substitution group, and used wherever the OVF schemas allow sections to be present.
- The OVF schemas use an open content model, where all existing types can be extended at the end with additional elements. Extension points are declared in the OVF schemas with `xs:any` declarations with `namespace="##other"`.
- The OVF schemas allow additional attributes on existing types.

Custom meta-data is not allowed to use OVF XML namespaces. On custom elements, a boolean `ovf:required` attribute specifies whether the information in the element is required for correct behavior or optional.

The open content model in the OVF schemas only allows extending existing types at the end. Using XML Schema 1.0 it is not easy to allow for a more flexible open content model, due to the Unique Particle Attribution rule and the necessity of adding `xs:any` declarations everywhere in the schema. The XML Schema 1.1 draft standard contains a much more flexible open content mechanism, using `xs:openContent mode="interleave"` declarations.

E.1 Custom Schema

A custom XML schema defining two extension types is listed below. The first declaration defines a custom member of the OVF `Section` substitution group, while the second declaration defines a simple custom type.

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema
    targetNamespace="http://schemas.customextension.org/1"
    xmlns:custom="http://schemas.customextension.org/1"
    xmlns="http://schemas.customextension.org/1"
    xmlns:ovf="http://schemas.dmtf.org/ovf/envelope/1"
    xmlns:xs="http://www.w3.org/2001/XMLSchema"
    attributeFormDefault="qualified"
    elementFormDefault="qualified">

    <!-- Define a custom member of the ovf:Section substitution group -->
    <xs:element name="CustomSection" type="custom:CustomSection_Type"
substitutionGroup="ovf:Section"/>

    <xs:complexType name="CustomSection_Type">
        <xs:complexContent>
            <xs:extension base="ovf:Section_Type">
                <xs:sequence>
                    <xs:element name="Data" type="xs:string"/>
                </xs:sequence>
                <xs:anyAttribute namespace="##any" processContents="lax"/>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>


    <!-- Define other simple custom type not part of ovf:Section substitution group --
>
    <xs:complexType name="CustomOther_Type">
```

```
        <xs:sequence>
            <xs:element name="Data" type="xs:string"/>
        </xs:sequence>
        <xs:attribute ref="ovf:required"/>
        <xs:anyAttribute namespace="##any" processContents="lax"/>
    </xs:complexType>

</xs:schema >
```

E.2 Descriptor with custom extensions

A complete OVF descriptor using the custom schema above is listed below. The descriptor validates against the OVF schema and the custom schema, but apart from extension examples the descriptor is kept minimal and is as such not useful.

The descriptor contains all three extension types: a custom OVF `Section` element, a custom element at an extension point, and a custom attribute.

```
<?xml version="1.0" encoding="UTF-8"?>
<Envelope xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:vssd="http://schemas.dmtf.org/wbem/wscim/1/cim-
schema/2/CIM_VirtualSystemSettingData"
    xmlns:rasd="http://schemas.dmtf.org/wbem/wscim/1/cim-
schema/2/CIM_ResourceAllocationSettingData"
    xmlns:ovf="http://schemas.dmtf.org/ovf/envelope/1"
    xmlns="http://schemas.dmtf.org/ovf/envelope/1"
    xmlns:custom="http://schemas.customextension.org/1">

    <!-- Dummy References element -->
    <References/>

    <!-- EXAMPLE: Optional custom OVF section element with validation against custom
schema -->
    <custom:CustomSection ovf:required="false">
        <Info>Description of custom extension</Info>
        <custom:Data>somevalue</custom:Data>
    </custom:CustomSection>

    <!-- Describes all networks used in the package -->
    <NetworkSection>
        <Info>Logical networks used in the package</Info>
        <!-- EXAMPLE: Optional custom attribute -->
        <Network ovf:name="VM Network" custom:desiredCapacity="1 Gbit/s"/>
        <!-- EXAMPLE: Optional custom meta-data inserted at extension point with
validation
                      against custom schema -->
        <custom:CustomOther xsi:type="custom:CustomOther_Type" ovf:required="false">
            <custom:Data>somevalue</custom:Data>
        </custom:CustomOther>
    </NetworkSection>

    <!-- Dummy Content element -->
    <VirtualSystem ovf:id="Dummy">
        <Info>Dummy VirtualSystem</Info>
    </VirtualSystem>
</Envelope>
```

The OVF environment XML schemas contain extension mechanisms matching those of the OVF envelope XML schemas, so OVF environment documents are similarly extensible.

ANNEX F
(informative)
Change Log

Version	Date	Description
1.0.0	2009-02-17	First publication
1.0.1	2011-10-20	Errata publication
2.0.0	2013-02-19	wgv 0.2.0 fixed formatting, variables and annex headers, no text changes, baseline for compare
2.0.0	2013-02-20	wgv 0.2.1 added figures 2 & 3, added figure and table labels, inserted Forward
2.0.0	2013-02-21	wgv -0.2.2 updated operational metadata definition and Figure 3, fixed Petstore OVF descriptor
2.0.0	2013-03-26	wgv 0.2.5 updated document structure in clause 3.
2.0.0	2013-03-28	wgv 0.2.6 added in Marvin's edits in clause 2.
2.0.0	2013-05-07	wgv 0.2.7 added Maturi's SharedDiskSection, Shishir's Encryption & Boot Order, Larry extensiblity
2.0.0	2013-05-27	wgv 0.2.8 added Marv's input on OperatingSystemSection and EULA section and Peter's input.on authoring clause.
2.0.0	2013-05-30	wgv 0.2.9 Marv's updates on Install and Startup sections
2.0.0	2013-06-19	wgv 0.2.10 Marv's Annotation and Scale Out, Larry's PlacementGroup and Placement
2.0.0	2013-06-19	wgv 0.2.11 Peter's updates
2.0.0	2013-07-01	wgv 0.6.0 updates and clean up in preparation for work in progress
2.0.0a	2013-07-03	Work in progress release