INTERNET-DRAFT ~~There are 3 issues highlighted like this.~~
<draft-ietf-ipp-collection-04~~3~~.txt>

Roger deBry
Utah Valley State College
T. Hastings
Xerox Corporation
R. Herriot
Xerox Corporation
K. Ocke
Xerox Corporation
P. Zehler
Xerox Corporation
~~March 31,~~May 4, 2000

Internet Printing Protocol (IPP): The 'collection' attribute syntax

Abstract

This document specifies an OPTIONAL attribute syntax called 'collection' for use with the Internet Printing Protocol/1.0 (IPP) [RFC2565, RFC2566], IPP/1.1 [ipp-mod, ipp-pro], and subsequent versions. A 'collection' is a container holding one or more named values, which are called "member" attributes. A collection allows data to be grouped like a PostScript dictionary or a Java Map. This document also specifies the conformance requirements for a definition document that defines a collection attribute.

~~The 'none' out-of-band attribute value is also defined for use with the collection.~~

The full set of IPP documents includes:

Design Goals for an Internet Printing Protocol [RFC2567]
Rationale for the Structure and Model and Protocol for the Internet Printing Protocol [RFC2568]
Internet Printing Protocol/1.1: Model and Semantics (this document)
Internet Printing Protocol/1.1: Encoding and Transport [IPP-PRO]
Internet Printing Protocol/1.1: Implementer's Guide [IPP-IIG]
Mapping between LPD and IPP Protocols [RFC2569]

The "Design Goals for an Internet Printing Protocol" document takes a broad look at distributed printing functionality, and it enumerates real-life scenarios that help to clarify the features that need to be included in a printing protocol for the Internet. It identifies requirements for three types of users: end users, operators, and administrators. It calls out a subset of end user requirements that are satisfied in IPP/1.0. A few OPTIONAL operator operations have been added to IPP/1.1.

The "Rationale for the Structure and Model and Protocol for the Internet Printing Protocol" document describes IPP from a high level view, defines a roadmap for the various documents that form the suite of IPP specification documents, and gives background and rationale for the IETF working group's major decisions.

The "Internet Printing Protocol/1.1: Encoding and Transport" document is a formal mapping of the abstract operations and attributes defined in the model document onto HTTP/1.1 [RFC2616]. It defines the encoding rules for a new Internet MIME media type called "application/ipp". This document also defines the rules for transporting over HTTP a message body whose Content-Type is "application/ipp". This document defines a new scheme named 'ipp' for identifying IPP printers and jobs.

The "Internet Printing Protocol/1.1: Implementer's Guide" document gives insight and advice to implementers of IPP clients and IPP objects. It is intended to help them understand IPP/1.1 and some of the considerations that may assist them in the design of their client and/or IPP object implementations. For example, a typical order of processing requests is given, including error checking. Motivation for some of the specification decisions is also included.

The "Mapping between LPD and IPP Protocols" document gives some advice to implementers of gateways between IPP and LPD (Line Printer Daemon) implementations.

Table of Contents

Table of Tables

1 Problem Statement

The IPP Model and Semantics [ipp-mod] supports most of the common data structures that are available in programming languages. It lacks a mechanism for grouping several attributes of different types. The Java language uses the Map to solve this problem and PostScript has a dictionary. The new mechanism for grouping attributes together (called 'collection' mechanism) must allow for optional members and subsequent ~~extension of the collection.~~addition of new members.

The 'collection' mechanism must be encoded in a manner consistent with existing 1.0 and 1.1 parsing rules (see [ipp-pro]). Current 1.0 and 1.1 parsers that don't support ~~collections will~~the 'collection' mechanism must not confuse collections or parts of collection they receive with ~~attributes that they do support.~~other attributes.

2 Solution

The new mechanism is a new IPP attribute syntax called a 'collection'. As such, each collection value is a value of an attribute whose attribute syntax type is defined to be a 'collection'. Such an attribute is called a collection attribute. The name of the collection attribute serves to identify the collection value in an operation request or response, as with any attribute value.

The 'collection' attribute syntax is a container holding one or more named values (i.e., attributes), which are called member attributes. Each collection attribute definition document lists the mandatory and optional member attributes of each collection value. A collection value is similar to an IPP attribute group in a request or a response, such as the operation attributes group. They both consist of a set of attributes.

As with any attribute syntax, the document that defines a collection attribute~~definition document~~ specifies whether the attribute is single-value (collection) or multi-valued (1setOf ~~collection).~~

collection). If the attribute is multi-valued (1setOf collection) each collection value MUST be a separate instance of a single definition of a collection, i.e. it MUST have the same member attributes except for OPTIONAL member attributes. If we view each collection definition as a separate syntax type, this rule continues the IPP/1.1 notion that each attribute has a single type or pattern (e.g. "keyword | name" is a pattern). Without this rule, the supported values would be more difficult to describe and the mechanism defined in item 4 of section 1.1would not be sufficient.

The name of each member attribute MUST be unique for a collection attribute, but MAY be the same as the name of a member attribute in another collection attribute and/or MAY be the same as the name of an attribute that is not a member of a collection. The rules for naming member attributes are given in section 1.1.

Each member attribute can have any attribute syntax type, including 'collection', and can be either single-valued or multi-valued. The length of a collection value is not limited. However, the length of each member attribute MUST NOT exceed the limit of its attribute syntax.

The member attributes in a collection MAY be in any order in a request or response. When a client sends a collection attribute to the Printer, the order that the Printer stores the member attributes of the collection value and the order returned in a response MAY be different from the order sent by the client.

A collection value MUST NOT contains two or more member attributes with the same attribute name. Such a collection is mal-formed. Clients MUST NOT submit such malformed requests and Printers MUST NOT return such malformed responses. If such a malformed request is submitted to a Printer, the Printer MUST (depending on implementation) either (1) reject the request with the 'client-error-bad-request' status code (see section~~13.1.4.1)~~

~~ISSUE 01: In attribute groups [ipp-mod] allows a Printer either (1) to reject a request with duplicate named attributes OR (2) to choose exactly one of the attributes as the one to be used. Should we REQUIRE the Printer to reject duplicate named attributes in a collection value as stated above or allow the Printer to choose one member attribute as a second alternative as we do with attribute groups?~~13.1.4.1), or (2) accept the request and use only one of each duplicate member attribute..

3 Definition of a Collection Attribute

This section describes the requirements for any collection attribute definition.

~~*3.1Member Attribute Naming Rules*~~

~~Each collection attribute MUST have a unique name within the scope in which the collection attribute occurs. If the collection attribute occurs as a member of a request or response attribute group, it MUST be unique within that group, same as for any other attribute. If a collection attribute occurs as a member attribute of another collection, the collection attribute MUST have a unique name within that collection value, same as for any other attribute.~~

~~Each member attribute in a collection value MUST have unique name within that collection value. Member attribute names MAY be reused between different collection attributes. An example is the "media" attribute which MAY be used as a job template attribute (see [ipp-mod]) and in a collection (see section 6.1 for an example). All attribute names that are reused MUST have an identical syntax. All attribute names that are reused MUST have a similar semantics. The semantic difference MUST be limited to boundary conditions and constraints placed on the reused attributes. All attributes that are not reused from elsewhere in the IPP model MUST have a globally unique name.~~

~~Assume that it is desirable to extend IPP by adding a Job Template attribute that allows the client to select the media by its properties, e.g., weight, color, size, etc., instead of by name as the "media (type3 keyword | name) Job Template attribute in IPP/1.1 (see [ipp-mod]). The first rule is that the existing attribute MUST NOT be extended by adding the 'collection' attribute syntax to the existing "media" attribute. That would~~

~~cause too many interoperability problems and complicates the validation and defaulting rules as well. Instead, a new attribute will be defined with a suffix of "-col" (for collection), e.g., "media-col" (collection).~~

~~For a second example, suppose it is desirable to extend IPP by allowing the client to select the media for the job start sheet. Again, this would not be done by adding the 'collection' attribute syntax to the existing "job-sheets" (type2 keyword | name) Job Template attribute. Instead, a new "job-sheet-col" (collection) Job Template attribute MUST be introduced. The member of the "job-sheet-col" collection might be:~~

~~"job-sheet-type" (type3 keyword | name)~~
~~"media" (type3 keyword | name)~~

~~if any of the "media-supported" (1setOf (type3 keyword | name)) Printer attribute values could be specified for job sheets. The reason that the "job-sheet-type" member attribute isn't named simply, "job-sheet", is because its values only indicate the type, and don't imply any media, while the "job-sheets" (type2 keyword | name) Job Template attribute do imply a media. This example illustrates when a member attribute can be the same as another attribute (in this case a Job Template attribute) and when the member attribute MUST have a different name.~~

~~If the definers of the "job-sheet-col" (collection) attribute intended that the System Administrator be allowed to have a different set of media values for job sheets than documents, then the definition document for the "job-sheet-col" collection attribute would have the following member attributes instead:~~

~~"job-sheet-type" (type3 keyword | name)~~
~~"job-sheet-media" (type3 keyword | name)~~

~~Then the supported values would be included in a separate "job-sheet-media-supported" (1setOf (type3 keyword | name)) Printer attribute.~~

~~3.2~~3.1 ~~Remaining rules for a collection attribute definition~~Information to Include

When a specification document defines an "xxx" collection attribute, i.e., an attribute whose attribute syntax type is 'collection' or '1setOf collection'; the definition document MUST include the following aspects of the attribute semantics. Suppose the "xxx" collection attribute contains ~~an "aaa" member attribute. A simplified~~N member attributes named "aaa1", "aaa2", ~~example of a collection specification is given in section 6 that conforms to these rules.~~…, "aaaN" ("aaaI" represents any one of these N member attributes).

~~1.~~The name of the collection attribute MUST be specified (e.g. ~~"xxx").~~

1. "xxx"). The selection of the name "xxx" MUST follow the same rules for uniqueness as for attributes of any other syntax type (as defined by IPP/1.1) unless "xxx" is a member attribute of another collection. Then the selection of the name "xxx" MUST follow the rules for uniqueness defined in item 5a) of this list.

2. The collection attribute syntax MUST be of type 'collection' or '1setOf collection'.

3. The context of the collection attribute MUST be specified, i.e., whether the attribute is an operation attribute, a Job Template attribute, a Job Description attribute, a Printer Description attribute, a member attribute of a particular collection attribute, etc.

4. An "xxx-supported" attribute MUST be specified and it has one of the following two forms:

   a) "xxx-supported" is a "1setOf collection" which enumerates all of the supported collection values of "xxx". If a collection of this form contains a nested collection, it MUST be of the same form.

      For example, "media-size-supported" might have the values {{x-dimension:210, y-dimension:297},{x-dimension:297, y-dimension:420}} to show that it supports two values of "media size": A4 (210x297) and A3 (297x420). It does not support other combinations of "x-dimension" and "y-dimension" member attributes, such as 210x420 or 297x297 and it does not supported non-enumerated values, such as 420x595.

   b) "xxx-supported" is a "1setOf type2 keyword" which enumerates the names of all of the member attributes of "xxx": "aaa1", "aaa2", …, "aaaN". If a collection of this form contains a nested collection, it MAY be of either form. See item 5a) below for details on supported values of member attributes.

      For example, "media-col-supported" might have the keyword values: "media-size" and "media-color".

5. The member attributes MUST be defined. For each member attribute the definition document MUST provide the following information:

   a) The member attribute's name (e.g., "aaa") MUST be unique within the collection being defined and MUST either ~~(1)~~

      i) reuse the attribute name of another attribute ~~if the member~~(that is unique across the entire IPP attribute ~~shares the~~name space) and have the same syntax and semantics ~~with the other~~as the reused attribute (if the condition of item 4b) above is met). For example, a member attribute definition could reuse the IPP/1.1 "media" attribute.

      ~~a)~~ii) potentially occur elsewhere in the entire IPP attribute name space. (if the condition of item 4a) above is met). For example, a member attribute could be "x-dimension" which could potentially occur in another collection or ~~(2)~~ as an attribute outside of a collection.

      iii) be unique across the entire IPP attribute name space (if the condition of item 4b) above is met). For example, a member attribute could be "media-color" which must unique be across the entire IPP attribute name space.

   b) Whether the member attribute is REQUIRED or OPTIONAL for the Printer to support

   c) Whether the member attribute is REQUIRED or OPTIONAL for the client to supply in a request

d) The member attribute's syntax type, which can be any attribute syntax, including '1setOf X', 'collection', and '1setOf collection'. If this attribute name ~~is the same as~~reuses the name of another attribute (case of ~~option a-1~~item a1 above), it MUST have the same attribute syntax, including cardinality (whether or not 1setOf).

e) The semantics of the "aaa" member attribute. The semantic definition MUST include a description of any constraint or boundary conditions the member attribute places on the associated attribute, especially if the attribute ~~is the same as another attribute used in a different context (case of option a-1~~reuses the name of another attribute (case of item a1 above)

~~f)the supported values for the "aaa" member attribute, either enumerated explicitly or specified by the values of a referenced attribute which may be specified by either:~~

~~– the attribute's definition~~

~~–~~f) ~~a Printer attribute, such as "aaa-supported", which contains the explicit values supported. The "aaa-supported" attribute is a Printer attribute and not in a collection. For example, if a collection contains the "media" attribute and its supported values are specified by the "media-supported" attribute, the "media-supported" attribute is the same Printer attribute that the "media" attribute uses.~~The supported values for the each "aaaI" member attribute (of the member attributes "aaa1", "aaa2", …, "aaaN") is specified by one of two mechanisms.

i) If "xxx-supported" is a "1setOf collection" (see item 4a) above), the value for each "aaaI" is specified in each collection value of "xxx-supported" in the context of other member attributes. That is, "xxx-supported" enumerates all supported values of "xxx".

ii) If the value of "xxx-supported" is a "1setOf type2 keyword" (see item 4b) above), the supported values of "aaaI" are the values specified by either i) the "aaaI-supported" attribute or ii) the definition of the member attribute "aaaI" within the document defining the "xxx" attribute. The values of each member attribute "aaaI" are specified independently of other member attributes though a Printer is not required to support all combinations of supported values.

For example, "media-col-supported" might have the keyword values: "media-size" and "media-color". Using the first method for defining supported values (an "aaaI-supported" attribute), the collection values of "media-col" are combinations of values of "media-size-supported" and "media-color-supported".If "media-size-supported" has the values of '210x297' and '297x420' and "media-color-supported" has the values of 'white' and 'pink', the Printer might support only the combinations 'white-210x297', 'pink-210x297'and 'white-297x420', and not 'pink-297x420'.

If a collection contains a member "aaaI" whose syntax type is "text", the supported values would probably be defined by the definition of "xxx" rather than by the attribute "aaaI-supported".

g) the default value of ~~"aaa"~~each "aaaI" member attribute if it is OPTIONAL for a client to supply the "aaa" member attribute in a request. The default value is specified by ~~either:~~ in the attribute’s definition within a document and MUST be one of the following:

~~– the attribute's definition~~

~~– a Printer attribute, such as "aaa-default", which may have a collection value~~

~~– or an implementation defined algorithm that takes into account the values of the other member attributes of the collection value and/or an "xxx-default" (collection) Printer attribute which specifies the default for the entire collection attribute~~

~~h)Depending on the collection attributes context, it MUST follow the additional rules specified below for the various contexts.~~a fixed default

i) a mechanism by which the Printer determines default

ii) an indefinite default that is left to the implementation.

iii) an attribute that the Printer uses to determine the default

6. The default value of "xxx" if a client does not supply it. The default value is specified by in the attribute’s definition within a document and MUST be one of the following:

   a) a fixed default

   b) a mechanism by which the Printer determines default

   c) an indefinite default that is left to the implementation

   d) a Printer attribute "xxx-default" which is a collection with the same member attributes as "xxx". Though optional member attributes may be absent in which case the Printer uses the defaulting rules of item 5g) above.

7. The "xxx-ready (1setOf collection)" attribute if human intervention is required to make many of the supported values available. For example, "media-col" is an attribute which has a "ready" attribute. Most attributes do not have a "ready" attribute.

3.2 Nested Collections

A member attribute may have a syntax type of 'collection' or '1setOf collection', in which case it is called a nested collection attribute. The rules for a nested collection attribute are the same as for a collection attribute as specified in section 1.1.

~~the preceding "xxx" collection attribute. The "yyy" collection attribute contains "bbb" member attribute. Therefore, in the rules in section 3.2, substitute "yyy" for "xxx" and "bbb" for "aaa".~~

~~3.4~~4 Collection Attributes as ~~Operation Attributes~~Attributes in Operations

~~The definition documents that define a collection attribute for use as an operation attribute MUST follow these additional rules:~~

~~a)Define in which operation requests the collection attribute is intended to be used.~~

~~b)Define in which operation responses the collection attribute is intended to be used.~~

~~*3.5Collections as Job Template Attributes*~~

~~The definition documents for collection attributes that are specified to be Job Template attributes (see [ipp-mod] section 4.2) MUST have associated printer attributes with suffixes of "-supported" and "-default" (or indicate that there is no "-default"), just as for any Job Template attribute. Certain Job Template collection attributes also have an associated Printer attribute with "-ready" (for example, see the "media-ready" attribute in [ipp-mod]). Furthermore, member attributes of Job Template attributes are addressed using the same suffix convention.~~

~~See also section 3.6 on the interaction of collections and the Get-Printer-Attributes and Get-Jobs-Attributes operations.~~

~~For the following rules assume the "xxx" (collection) example from section 3.2 is a Job Template attribute.~~

~~1)There MUST be two associated printer attributes. The attributes are "xxx-supported" and "xxx-default"~~

~~2)The "xxx-default" is a collection attribute with a syntax identical to the "xxx" specification in section 3.2~~
~~.~~

~~Each member attribute has the same name as in the "xxx" definition.~~

~~A Get-Printer-Attributes operation MUST return the "xxx-default" (collection) Printer attribute and all the member attributes. Any default values that have been set MUST be returned. Any default values that have not been set MUST return the member attribute with the 'no-value' out-of-band attribute value (see [ipp-mod] section 4.1).~~

~~3.If the definition of the collection attribute does not mention an "xxx-ready" attribute then it is assumed that one is not defined, though implementer's are free to support an "xxx-ready" as an extension.~~

~~4.The collection attribute definition document MUST define an "xxx-supported" attribute with either a syntax of '1setOf type2 keyword' or '1setOf collection':~~

~~If the definition uses the '1setOf type2 keyword' attribute syntax, it MUST be the attribute keyword names of all of the member attributes that the Printer implementation supports in a Job Creation operation. Furthermore, the definition MUST include corresponding definitions of each of the "aaa-supported" attributes that correspond to each "aaa" member attribute. Then a client can determine~~

~~the supported values of each member attribute in the Job Template collection attribute. See examle in section 6.4.~~

~~If the definition uses the '1setOf collection' attribute syntax, then the values are the supported instances of the "xxx" (collection) attribute that a client can supply in a Job Creation operation. It is expected that this second approach will be used for small collections whether the number of possible collection values is small. For example, a "media-size" (collection) member attribute in which the member attributes are "x-dimension" (integer) and "y-dimension" (integer). The pairs of integers are just like keywords as far as the client localization is concerned, except that if the client doesn't recognize a size pair of numbers, it can display the numbers. See example in section 6.1.2.~~

~~a)The keywords returned lists all the contained member attribute names. This example would return the "aaa" keyword.~~

~~b)The list is recursive and lists all the member attributes of the contained collections. In section 3.3 the printer would return "aaa" and "bbb" for collection "xxx"~~

~~c)The encoding convention allows the reconstruction of the collection structure. This rule will allow the client to reconstruct the collections. The client would know that "aaa" is a member of collection "xxx". It can also be derived that collection "bbb" is a member of collection "yyy". See section 7 for more information on encoding.~~

~~d)To obtain the supported values for any member attribute a client performs a Get-Printer-Attributes operation explicitly requesting the member attribute name with the suffix "supported". If a member attribute is itself a collection rule 4 above applies to the member attribute.~~

~~*3.6Collections and Get-Printer-Attributes and Get-Job-Attributes operations*~~

~~The behavior of collection attributes for "job-templates", "job-description", and "printer-description" attribute group names is similar to any other attribute. Simple attributes return the attribute and its value. For a collection attribute, the collection and its entire set of member attributes and their values are returned. This includes any collection values containing collection attributes, its member attributes and their values. The same logic applies for the "-default" and "-ready" printer attribute associated with the "job-template" attribute group.~~

~~The semantics for "-supported" is different for a collection (see section 3.2). Here the focus is on the member attributes that the collection supports. This solution allows for extension of collections and allowing the member attributes of a collection to vary (i.e., mandatory and optional member attributes). Once a client determines what member attributes are supported in a collection a subsequent request can be constructed to determine the supported values for the member attributes.~~

~~Another advantage of that the behavior of the "-supported" printer collection attribute is limiting the amount of data that is returned on general queries. A Get-Printer-Attributes operation that returns all the attributes of a printer will not have to return what may turn out to be extensive lists of "-supported" attribute values. An example might be "media-col" that could be a representation for media using a collection that goes beyond the information currently provided by the job-template attribute "media". The "media-col" could~~

~~now be used to represent a job's media, insert sheets and inserted tab sheets. An IPP Printer implementation would return the member attributes for each of the "-supported" collections.~~

~~*3.7Client submission of collection attributes and collection attribute defaulting*~~

~~When a client supplies a partially specified collection attribute, the Printer supplies the missing member attributes in an implementation-dependent manner (see section 3.2 item 4g) above. Therefore, a client SHOULD query the Printer's "xxx-default" (collection) attribute, display all of the member attributes that the client allows the user to change, allow the user to make any changes, and then submit the entire collection to the Printer. Then the variability in defaulting between different implementations will not cause the user to get unexpected results.~~

~~**4New Out-of-band attribute value**~~

~~This section defines out-of-band values (see the beginning of [ipp-mod] section 4.1) for use with attributes defined in this and other documents. As with all out-of-band values, a client MUST NOT supply and a Printer MUST NOT support an out-of-band attribute value in an operation request and/or response unless the definition document explicitly allows or requires such usage. As with all out-of-band values, the document that defines its usage MUST indicate with which operation requests and/or responses and with which attributes or attribute syntaxes the out-of-band value is allowed or required.~~

~~*4.1'none'*~~

~~'none'~~	~~The feature controlled by the Job Template attribute with the 'none' attribute value MUST NOT be applied to the job. Specifically, this value allows the client to override the Printer's "xxx-default" attribute value for the Job Template attribute, if one exists, and REQUIRES the Printer not to apply the feature to the job. In order for a client to be able to supply the 'none' out-of-band attribute value, the 'none' out-of-band attribute value MUST be one of the values in the corresponding "xxx-supported" Printer attribute. When returning a Job object in a Get-Job-Attributes or Get-Jobs response, the Printer MUST return in the response any requested attributes that had been supplied with the 'none' out-of-band value when the Job was created.~~

~~This out-of-band attribute value allows a client to specify "turn-off" a feature that is specified by an attribute whose value is a collection. Because a client specifies a value, the Printer MUST use the client-specified value and not the Printer's default value.~~

~~This out-of-band value also allows the system administrator to explicitly configure certain "xxx-default" Printer attributes to indicate that there is no default.~~

~~If a Printer supports the use of the 'collection' attribute syntax for an "xxx" attribute, a Printer MUST support the use of the "out-of-band" value 'none' in the "xxx", "xxx-default", and "xxx-supported" attributes, if supported.~~

~~4.1.1~~4.1 ~~Encoding of the 'none' out-of-band attribute value~~General Rules

~~The encoding of the 'none' out-of-band attribute value is 0x14 (see [ipp-pro]). The value-length MUST be 0 and the value empty.~~ A collection value is like any other IPP/1.1 value, except that it is structured. The rules for attributes with collection values are the same as for attributes of any other syntax type (see IPP/1.1), be they in any group of a request of a response.

4.2 Unsupported Values

~~1.~~The rules for returning an unsupported collection attribute are an extension to the current rules:

1. If the entire collection attribute is unsupported, then the Printer returns just the collection attribute name with the 'unsupported' out-of-band value (see the beginning of [ipp-mod] section 4.1) in the Unsupported Attributes Group.~~The encoding technique makes it easy for a Printer that doesn't support a particularcollection attribute (or the collection attribute syntax at all) to simply skip over the entire collection value, since the entire contents of the collection value look like a single 1setOf (see section 7).~~

2. If a collection contains unrecognized, unsupported member attributes and/or conflicting values, the attribute returned in the Unsupported Group is a collection containing the unrecognized, unsupported member attributes, and/or conflicting values. The unrecognized member attributes have an out-of-band value of 'unsupported' (see the beginning of [ipp-mod] section 4.1). The unsupported member attributes and conflicting values have their unsupported or conflicting values.

5 Example definition of a collection attribute

In some printing environments, it is desirable to allow the client to select the media by its properties, e.g., weight, color, size, etc., instead of by name. In IPP/1.1 (see [ipp-mod]), the "media (type3 keyword | name) Job Template attribute allows selection by name. It is tempting to extend the "media" attribute syntax to include "collection", but then existing clients could not understand default or supported media values that use the collection value. To preserve interoperability, a new attribute MUST BE added, e.g., "media-col (collection)". The following subsections contain a sample definition of a simplified "media-col" attribute. The definition ~~This example definition is for a collection attribute called "media-col". It meets the requirements for a definition document that defines a collection attribute given~~follows the rules in section 3. ~~The "media-col" collection attribute is a Job Template attribute. This collection attribute is simplified and fictitious and is used for illustrative purposes~~

~~only.~~Note: we picked the name "media-col" because the name "media" is already in use. Ordinarily the collection attribute would have a name like any other attribute and would not end in "col".

The member attributes of "media-col" attribute ("media-color (type 3 keyword)" and "media-size (collection)") both follow the naming rules of item 4a3 of section 3, i.e. the names are unique across the entire IPP attribute name space. The member attributes of the "media-size (collection)" member attribute ("x-dimension (integer(0,MAX))" and "y-dimension (integer(0,MAX))") both follow the naming rules of item 4a2 of section 3, i.e. they potentially occur elsewhere in the IPP attribute name space.

5.1 media-col (collection)

The "media-col" (collection) attribute augments the IPP/1.1 [ipp-mod] "media" attribute. This collection attribute enables a client end user to submit a list of media characteristics to the~~Printer as a way to specify the media more completely to be used by the~~ Printer. When the client specifies media using the "media-col" collection attribute, the Printer object MUST match the requested media exactly. The 'collection' consists of the following member attributes:

Table 1 - "media-col" member attributes

Attribute name	attribute syntax	request	Printer Support
media-color	type3 keyword | name (MAX)	MAY	MUST
~~media-size~~	~~type3 keyword | collection~~	~~MAY~~	~~MUST~~
~~media-name~~	~~type2 keyword | name~~	~~MAY~~	~~MAY~~
media-size	collection	MUST	MUST

The definitions for the member attributes is given in the following sub-sections:

5.1.1 media-color (type3 keyword | name(MAX))

This member attribute identifies the color of the media. Valid values are 'red', 'white' and 'blue'

The "media-color-supported" (1setOf (type3 keyword | name(MAX))) Printer attribute identifies the values of this "media-color" member attribute that the Printer supports, i.e., the colors supported.

If the client omits this member attribute, the Printer determines the value in an implementation dependent manner.

5.1.2 media-size (collection)

This member attribute identifies the size of the media. The 'collection' consists of the member attributes shown in Table 2:

Table 2 - "media-size" collection member attributes

Attribute name	attribute syntax	request	Printer Support
x-dimension	integer (0:MAX)	MUST	MUST
y-dimension	integer (0:MAX)	MUST	MUST

The definitions for the member attributes is given in the following sub-sections:

5.1.2.1 x-dimension (integer(0:MAX))

This attribute identifies the width of the media in inch units along the X axis.

5.1.2.2 y-dimension (integer(0:MAX))

This attribute identifies the height of the media in inch units along the Y axis.

The "media-size-supported" (1setOf collection) Printer attribute identifies the values of this "media-size" member attribute that the Printer supports, i.e., the size combinations ~~supported.~~

~~6.1.3~~supported. The names of the member attributes are the same as the member attributes of the "media-size" collection attribute, namely "x-~~media (type3 keyword | name)~~

~~See job template attribute "media". Additional restrictions on "media" in this collection are that the "media" member attribute value must be valid based on the size and color. When invalid names are given based on the size or color, the size or color value takes precedence.~~

~~The "media-supported" (1setOf (type3 keyword | name(MAX))) Printer attribute identifies the values of this "media" member attribute that the Printer supports, i.e., the media keywords and names supported.~~dimension", and "y-dimension", since they have the same attribute syntax and the same semantics.

5.2 media-col-default (collection)

The "media-col-default" Printer ~~attributes specify~~attribute specifies the media that the Printer uses, if any, if the client omits the "media-col" and "media". Job Template attribute in the Job Creation operation (and the PDL doesn't include a media specification). The member attributes are defined in Table 1. A Printer MUST support the same member attributes for this default collection attribute as it supports for the corresponding "media-col" Job Template attribute.

~~If the value of the "media-col-default" attribute is the 'no-value' out-of-band (see [ipp-mod] section 4.1) or the 'none' out-of-band value (see section), the Printer does not apply a default value.~~

5.3 media-col-ready (1setOf collection)

The "media-col-ready" Printer attribute identifies the media that are available for use without human intervention, i.e., the media that are ready to be used without human intervention. The collection value MUST have all of the member attributes that are supported in Table 1~~, plus the "media" (type3 keyword | name(MAX))~~ .

~~member attribute itself (see [ipp-mod] section 4.2.11), in order to indicate the unique keyword or name for each ready medium.~~

5.4 media-col-supported (1setOf type2 keyword)

The "media-col-supported" Printer attribute identifies the keyword names of the member attributes supported in the "media-col" collection Job Template attribute, i.e., the keyword names of the member attributes in Table 1 that the Printer supports.

6 A Second Example Definition Of A Collection Attribute

In some printing environments, it is desirable to allow the client to select the media for the job start sheet. The reason for not adding the 'collection' attribute syntax to the existing "job-sheets" Job Template attribute is the same as for "media". Instead, a new Job Template attribute is introduced, e.g. "job-sheet-col (collection)".

The member attributes of "job-sheet-col" attribute ("job-sheets (type 3 keyword)" and "media (type3 keyword | name)") both follow the naming rules of item 4a1 of section 3, i.e they reuse existing IPP attributes. According to the rules, their supported values come from the existing IPP attributes: "job-sheets-supported" and "media-supported". However, their default values do not come from "job-sheets-default" and "media-default", respectively. Rather the definition of "job-sheet-col" says that "job-sheets (type 3 keyword)" is required and if "media (type3 keyword | name)" is absent, the Printer uses the same media as the rest of the job uses.

If "job-sheet-col" attribute were defined to contain the member attribute "job-sheet-media (type3 keyword | name)" instead of "media (type3 keyword | name)", then the definition would also have to specify a "job-sheet-media-supported (1setOf (type3 keyword | name))" whose values would be independent of "media-supported (1setOf (type3 keyword | name))" and would be set separately by a System Administrator.

The actual text for the definition of the attribute is left as an exercise for the reader.

7 Encoding

This section defines the additional encoding tags used according to [ipp-pro] and gives an example of their use.

7.1 Additional tags defined for representing a collection attribute value

The 'collection' attribute syntax uses the tags defined in Table 3.

Table 3 - Tags defined for encoding the 'collection' attribute syntax

Tag name	Tag value	Meaning
beg~~in~~Collection	0x34	Begin the collection attribute value.
endCollection	0x37	End the collection attribute value.
memberAttrName	0x4A	The value is the name of the collection member attribute

When encoding a collection attribute "xxx" that contains an attribute "aaa" and is not inside another collection, the encoding follows these rules:

1. The beginning of the collection is indicated with a value tag that MUST be syntax type 'begCollection' (0x34) with a name length and Name field that represent the name of the collection attribute ("xxx") as with any attribute, followed by a ~~value length of 0 and no Value field, since the collection attribute's name doesn't~~value. The Printer MAY ignore the value and its length of MAY be 0. In the future, ~~have a value.~~however, this field MAY contain useful information, such as the collection name (cf. the name of a C struct).

2. ~~The member attributes are encoded as consecutive pairs of attributes as if they are~~Each member attribute is encoded as a sequence of two or more values that appear to be part of a single multi-valued attribute, i.e. 1setOf. The first value after the 'begCollection' value has the attribute syntax ~~memberAttrName~~'memberAttrName' (0x4A) and its value holds the name of the first member attribute ~~("aaa") and the~~(e.g. "aaa"). The second value holds the ~~member attribute's value~~first member's attribute value, which can be of any attribute syntax, except 'memberAttrName' or 'endCollection'. If the first member's attribute value is multi-valued, the third value holds the second value of the first member's value. Otherwise, the third value holds the name of second member attribute (e.g. "bbb") and its attribute syntax is 'memberAttrName'. In this case, the fourth member's value is the value of "bbb".

   ~~memberAttrName. If the member attribute has multiple values, they are represented as any 1setOf values, namely, each Name field has a zero length and the rest represents the next~~Note that the technique of encoding a 'collection' as a '1setOf' makes it easy for a Printer that doesn't support a particular collection attribute (or the collection attribute syntax at all) to simply skip over the entire collection value.

3. The end of the collection is indicated with a value tag that MUST be syntax type 'endCollection' (e.g. 0x37) and ~~MUST~~MAY have a zero name length and a zero value length. ~~So even though it has a zero name length, it is the end of this collection value.~~In the future, this field MAY contain useful information,such as the collection name that matches the one in the 'begCollection' .

~~4.~~It is valid to have a member attribute that is, itself, a collection attribute, i.e., collections can be nested within collections. This is represented by the occurrence of a member attribute ~~which~~that is of attribute syntax type 'begCollection'. ~~It~~Such a collection is terminated by a matching ~~'endCollection'.~~

4. 'endCollection'. The name of such a member attribute is in the immediately preceding value whose syntax type is 'memberAttrName'.

~~5.~~It is valid for a collection attribute to be multi-valued, i.e., have more than one collection value. If the next attribute immediately following the 'endCollection' has a zero name length and a tag of 'begCollection', then the collection attribute is ~~multi-valued, as with any attribute.~~

5. a multi-valued collection, as with any attribute. This statement applies to collections within collections and collections that are not in collections.

7.2 Example encoding: "media-col" (~~1setOf~~ collection)

The collection specified in section **Error! Reference source not found.**is used for the encoding example shown in Table 5. The example also shows nested collections, since the "media-size" member attribute is a 'collection. The encoding example represents ~~two 4x6-index cards, one blue and one white and takes 217 octets.~~ a blue 4x6-index cards and takes 216 octets. The Appendices contains more complex examples.

Additional examples have been included in the appendices.

The overall structure of the two collection values can be pictorially represented as:

```
"media-col" =
        {       "media-color" =  'blue';
                "media-size" =
                {       "x-dimension" = 6;
                        "y-dimension" = 4 ~~} };~~
        ~~{       "media-color" =  'white';~~
        ~~        "media-size" =~~
        ~~        {       "x-dimension" = 6;~~
        ~~                "y-dimension" = 4 }  };~~
                }
        },

```

The full encoding is in table 4. A simplified view of the encoding looks like this:

Table 4 - Overview Encoding of "media-col" collection

Tag Value	Name	Value
begCollection	media-col	""
memberAttrName	""	media-color
keyword	""	blue

memberAttrName	""	media-size
begCollection	""	""
memberAttrName	""	x-dimension
integer	""	6
memberAttrName	""	y-dimension
integer	""	4
endCollection	""	""
endCollection	""	""

Table 5 - Example Encoding of ~~1setOf~~"media-col" collection ~~with nested collection~~

Octets	**Symbolic Value**	**Protocol field**	**comments**
~~0x34~~	~~beginCollection~~	~~value-tag~~	~~beginning of the "media-col" collection attribute~~
0x34	begCollection	value-tag	beginning of the "media-col" collection attribute
0x0009		name-length	length of (collection) attribute name
media-col	media-col	name	name of (collection) attribute
0x0000		value-length	defined to be 0 for this type
			no value (since value-length was 0)
0x4A	memberAttrName	value-tag	starts a new member attribute: "media-color"
0x0000		name-length	defined to be 0 for this type, so part of 1setOf
			no name (since name-length was 0)
0x000B		value-length	length of "media-color" keyword
media-color	media-color	value	value is name of 1st member attribute
0x44	keyword type	value-tag	keyword type
0x0000		name-length	0 indicates 1setOf
			no name (since name-length was 0)
0x0004		value-length	
blue	blue	value	value of 1st member attribute
~~0x4A~~	~~memberAttrName~~	~~value-tag~~	~~starts a new member attribute: "media-color"~~

Octets	**Symbolic Value**	**Protocol field**	**comments**
0x4A	memberAttrName	value-tag	starts a new member attribute: "media-size"
0x0000		name-length	defined to be 0 for this type, so part of 1setOf
			no name (since name-length was 0)
0x000A		value-length	length of "media-size" keyword
media-size	media-size	value	Name of 2nd member attribute
~~0x34~~	~~beginCollection~~	~~value-tag~~	~~Beginning of the "media-size" collection attribute which is a sub-collection~~
0x34	begCollection	value-tag	Beginning of the "media-size" collection attribute which is a sub-collection
0x0000		name-length	0 indicates 1setOf
			no name (since name-length was 0)
0x0000		value-length	collection attribute names have no value
			no value (since value-length was 0)
0x4A	memberAttrName	value-tag	starts a new member attribute: "x-dimension"
0x0000		name-length	defined to be 0 for this type, so part of 1setOf
			no name (since name-length was 0)
0x000B		value-length	length of "x-dimension" keyword
x-dimension	x-dimension	value	name of 1st sub-collection member attribute
0x21	integer type	value-tag	attribute type
0x0000		name-length	0 indicates 1setOf
			no name (since name-length was 0)
0x0004		value-length	length of an integer = 4
0x0006		value	value of 1st sub-collection member attribute
0x4A	memberAttrName	value-tag	starts a new member attribute: "y-dimension"
0x0000		name-length	defined to be 0 for this type, so part of 1setOf
			no name (since name-length was 0)
0x000B		value-length	length of the "y-dimension" keyword

Octets	**Symbolic Value**	**Protocol field**	**comments**
y-dimension	y-dimension	value	name of 2nd sub-collection member attribute
0x21	integer type	value-tag	attribute type
0x0000		name-length	0 indicates 1setOf
			no name (since name-length was 0)
0x0004		value-length	length of an integer = 4
0x0004		value	value of 2nd sub-collection member attribute
0x37	endCollection	value-tag	end of the sub-collection
0x0000		name-length	defined to be 0 for this type, so part of 1setOf
			no name (since name-length was 0)
0x0000		value-length	defined to be 0 for this type
			no value (since value-length was 0)
			~~**Second collection value in set:**~~
~~0x34~~	~~beginCollection~~	~~value-tag~~	~~beginning of the collection~~
~~0x0000~~		~~name-length~~	~~indicates still part of 1setOf~~ ~~Note: name of member collection attribute is in the memberAttrName value~~
			~~no name (since name-length was 0)~~
~~0x0000~~		~~value-length~~	~~defined to be 0 for this type~~
			~~no value~~
~~0x4A~~	~~memberAttrName~~	~~value-tag~~	~~starts a new member attribute: "media-color"~~
0x37	endCollection	value-tag	end of the 1st collection value in 1setOf
0x0000		name-length	defined to be 0 for this type, so part of 1setOf
			no name (since name-length was 0)
~~media-color~~	~~media-color~~	~~value~~	~~name of 1st member attribute~~
~~0x44~~	~~keyword type~~	~~value-tag~~	~~keyword type~~
~~0x0000~~		~~name-length~~	~~0 indicates 1setOf~~
0x0000		value-length	defined to be 0 for this type
			no value (since value-length was 0)

8 Legacy issues

IPP 1.x Printers and Clients will gracefully ignore collections and its member attributes if it does not understand the collection. The begCollection and endCollection elements each look like an attribute with an attribute syntax that the recipient doesn't support and so should ignore the entire attribute. The individual member attributes and their values will look like a 1setOf values of the collection attribute, so that the Printer simply ignores the entire attribute and all of its values. Returning unsupported attributes is also simple, since only the name of the collection attribute is returned with the 'unsupported' out-of-band value (see section 4.2).

9 IANA Considerations

This attribute syntax will be registered with IANA after the WG approves its specification according to the procedures for extension of the IPP/1.1 Model and Semantics [ipp-mod].

10 Internationalization Considerations

This attribute syntax by itself has no impact on internationalization. However, the member attributes that are subsequently defined for use in a collection may have internationalization considerations, as may any attribute, according to [ipp-mod].

11 Security Considerations

This attribute syntax causes no more security concerns than any other attribute syntax. It is only the attributes that are subsequently defined to use this or any other attribute syntax that may have security concerns, depending on the semantics of the attribute, according to [ipp-mod].

12 References

[ipp-mod]
Isaacson, S., deBry, R., Hastings, T., Herriot, R., Powell, P., "Internet Printing Protocol/1.1: Model and Semantics" draft-ietf-ipp-model-v11-06.txt, March 1, 2000.

[ipp-ntfy]
Isaacson, S., Martin, J., deBry, R., Hastings, T., Shepherd, M., Bergman, R. " Internet Printing Protocol/1.0 & 1.1: IPP Event Notification Specification" draft-ietf-ipp-not-spec-02.txt, work in progress, February 2, 2000.

[ipp-pro]
Herriot, R., Butler, S., Moore, P., Turner, R., "Internet Printing Protocol/1.1: Encoding and Transport", draft-ietf-ipp-protocol-v11-05.txt, March 1, 2000.

[RFC2565]
Herriot, R., Butler, S., Moore, P., Tuner, R., "Internet Printing Protocol/1.0: Encoding and Transport", RFC 2565, April 1999.

[RFC2566]
R. deBry, T. Hastings, R. Herriot, S. Isaacson, P. Powell, "Internet Printing Protocol/1.0: Model and Semantics", RFC 2566, April 1999.

[RFC2567]
Wright, D., "Design Goals for an Internet Printing Protocol", RFC 2567, April 1999.

[RFC2568]
Zilles, S., "Rationale for the Structure and Model and Protocol for the Internet Printing Protocol", RFC 2568, April 1999.

[RFC2569]
Herriot, R., Hastings, T., Jacobs, N., Martin, J., "Mapping between LPD and IPP Protocols", RFC 2569, April 1999.

[RFC2616]
R. Fielding, J. Gettys, J. Mogul, H. Frystyk, L. Masinter, P. Leach, T. Berners-Lee, "Hypertext Transfer Protocol - HTTP/1.1", RFC 2616, June 1999.

13 Author's Addresses

Roger deBry
Utah Valley State College
Orem, UT 84058
Phone: (801) 222-8000
EMail: debryro@uvsc.edu

Tom Hastings
Xerox Corporation
737 Hawaii St. ESAE 231
El Segundo, CA 90245
Phone: 310-333-6413
Fax: 310-333-5514
e-mail: hastings@cp10.es.xerox.com

Robert Herriot
Xerox Corp.
3400 Hill View Ave, Building 1
Palo Alto, CA 94304
Phone: 650-813-7696
Fax: 650-813-6860

e-mail: robert.herriot@pahv.xerox.com

Kirk Ocke
Xerox Corp.
800 Phillips Rd
M/S 139-05A
Webster, NY 14580
Phone: (716) 442-4832
EMail: kirk.ocke@usa.xerox.com

Peter Zehler
Xerox Corp.
800 Phillips Rd
M/S 139-05A
Webster, NY 14580
Phone: (716) 265-8755
EMail: peter.zehler@usa.xerox.com

14 Appendix A: Encoding Example of a Simple Collection

The overall structure of the collection value can be pictorially represented as:

```
" media-size " =
        {       "x-dimension" = 6;
                "y-dimension" = 4
        }
```

A simplified view of the encoding would look like this:

Table 6 - Overview Encoding of simple collection

Tag Value	Name	Value
begCollection	media-size	""
memberAttrName	""	x-dimension
integer	""	6
memberAttrName	""	y-dimension
integer	""	4
endCollection	""	""

Note: "" represents a name or value whose length is 0.

680 **Table 7 - Example Encoding of simple collection**

Octets	**Symbolic Value**	**Protocol field**	**comments**
0x34	begCollection	value-tag	beginning of the "media-size" collection attribute
0x000A		name-length	length of (collection) attribute name
media-size	media-size	name	name of (collection) attribute
0x0000		value-length	defined to be 0 for this type
			no value (since value-length was 0)
0x4A	memberAttrName	value-tag	starts member attribute: "x-dimension"
0x0000		name-length	defined to be 0 for this type, so part of 1setOf
			no name (since name-length was 0)
0x000B		value-length	length of "x-dimension" keyword
x-dimension	x-dimension	value	name of 1st collection member attribute
0x21	integer type	value-tag	attribute type
0x0000		name-length	0 indicates 1setOf
			no name (since name-length was 0)
0x0004		value-length	length of an integer = 4
0x0006		value	value of 1st collection member attribute
0x4A	memberAttrName	value-tag	starts a new member attribute: "y-dimension"
0x0000		name-length	defined to be 0 for this type, so part of 1setOf
			no name (since name-length was 0)
0x000B		value-length	length of the "y-dimension" keyword
y-dimension	y-dimension	value	name of 2nd collection member attribute
0x21	integer type	value-tag	attribute type
0x0000		name-length	0 indicates 1setOf for media-size
			no name (since name-length was 0)
0x0004		value-length	length of an integer = 4
0x0004		value	value of 2nd collection member attribute
0x37	endCollection	value-tag	end of the collection
0x0000		name-length	defined to be 0 for this type, so part of 1setOf
			no name (since name-length was 0)
0x0000		value-length	defined to be 0 for this type

Octets	**Symbolic Value**	**Protocol field**	**comments**
			no value (since value-length was 0)

15 Appendix B: Encoding Example of 1setOf Collection

The overall structure of the collection value can be pictorially represented as:

```
"media-size-supported" =
        {       "x-dimension" = 6;
                "y-dimension" = 4
        },
        {       "x-dimension" = 3;
                "y-dimension" = 5
        };
```

A simplified view of the encoding would look like this:

Table 8 - Overview Encoding of 1setOf collection

Tag Value	Name	Value
begCollection	media-size-supported	""
memberAttrName	""	x-dimension
integer	""	6
memberAttrName	""	y-dimension
integer	""	4
endCollection	""	""
begCollection	""	""
memberAttrName	""	x-dimension
integer	""	3
memberAttrName	""	y-dimension
integer	""	5
endCollection	""	""

Table 9 - Example Encoding of 1setOf collection

Octets	**Symbolic Value**	**Protocol field**	**comments**

0x34	begCollection	value-tag	beginning of the "media-size-supported (1setOf collection" attribute
0x00014		name-length	length of (collection) attribute name
media-size-supported	media-size-supported	name	name of (collection) attribute
0x0000		value-length	defined to be 0 for this type
			no value (since value-length was 0)
0x4A	memberAttrName	value-tag	starts member attribute: "x-dimension"
0x0000		name-length	defined to be 0 for this type, so part of 1setOf
			no name (since name-length was 0)
0x000B		value-length	length of "x-dimension" keyword
x-dimension	x-dimension	value	name of 1st collection member attribute
0x21	integer type	value-tag	attribute type
0x0000		name-length	0 indicates 1setOf
			no name (since name-length was 0)
0x0004		value-length	length of an integer = 4
0x0006		value	value of 1st collection member attribute
0x4A	memberAttrName	value-tag	starts member attribute: "y-dimension"
0x0000		name-length	defined to be 0 for this type, so part of 1setOf
			no name (since name-length was 0)
0x000B		value-length	length of the "y-dimension" keyword
y-dimension	y-dimension	value	name of 2nd collection member attribute
0x21	integer type	value-tag	attribute type
0x0000		name-length	0 indicates 1setOf
			no name (since name-length was 0)
0x0004		value-length	length of an integer = 4
0x0004		value	value of 2nd collection member attribute
0x37	endCollection	value-tag	end of the collection
0x0000		name-length	defined to be 0 for this type, so part of 1setOf
			no name (since name-length was 0)
0x0000		value-length	defined to be 0 for this type
			no value (since value-length was 0)
0x34	begCollection	value-tag	beginning of the 2nd member of the 1SetOf "sizes-avail " collection attribute
0x0000		name-length	Zero length name indicates this is member of previous attribute

Octets	**Symbolic Value**	**Protocol field**	**comments**
		name	no name (since name-length was 0)
0x0000		value-length	defined to be 0 for this type
			no value (since value-length was 0)
0x4A	memberAttrName	value-tag	starts member attribute: "x-dimension"
0x0000		name-length	defined to be 0 for this type, so part of 1setOf
			no name (since name-length was 0)
0x000B		value-length	length of "x-dimension" keyword
x-dimension	x-dimension	value	name of 1st collection member attribute
0x21	integer type	value-tag	attribute type
0x0000		name-length	0 indicates 1setOf
			no name (since name-length was 0)
0x0004		value-length	length of an integer = 4
0x0003		value	value of 1st collection member attribute
0x4A	memberAttrName	value-tag	starts member attribute: "y-dimension"
0x0000		name-length	defined to be 0 for this type, so part of 1setOf
			no name (since name-length was 0)
0x000B		value-length	length of the "y-dimension" keyword
y-dimension	y-dimension	value	name of 2nd collection member attribute
0x21	integer type	value-tag	attribute type
0x0000		name-length	0 indicates 1setOf
			no name (since name-length was 0)
0x0004		value-length	length of an integer = 4
0x0005		value	value of 2nd collection member attribute
0x37	endCollection	value-tag	end of the 1setOf collection value
0x0000		name-length	defined to be 0 for this type, so part of 1setOf
			no name (since name-length was 0)
0x0000		value-length	defined to be 0 for this type
			no value (since value-length was 0)

16 Appendix C: Encoding Example of Collection containing 1setOf XXX attribute

The overall structure of the collection value can be pictorially represented as:

```
"wagons" =
        {       "colors" = red, blue;
                "sizes" = 4, 6, 8
        }
```

A simplified view of the encoding would look like this:

Table 10 - Overview Encoding of collection with 1setOf value

Tag Value	Name	Value
begCollection	wagons	""
memberAttrName	""	colors
keyword	""	red
keyword	""	blue
memberAttrName	""	sizes
integer	""	4
integer	""	6
integer	""	8
endCollection	""	""

Table 11 - Example Encoding of collection with 1setOf value

Octets	**Symbolic Value**	**Protocol field**	**comments**
0x34	begCollection	value-tag	beginning of the "wagons" collection attribute
0x0005		name-length	length of (collection) attribute name
wagons	wagons	name	name of (collection) attribute
0x0000		value-length	defined to be 0 for this type
			no value (since value-length was 0)
0x4A	memberAttrName	value-tag	starts a new member attribute: "colors"
0x0000		name-length	defined to be 0 for this type, so part of 1setOf
			no name (since name-length was 0)
0x0006		value-length	length of "colors" keyword
colors	colosr	value	value is name of 1st member attribute

Octets	Symbolic Value	Protocol field	comments
0x44	keyword type	value-tag	keyword type
0x0000		name-length	0 indicates 1setOf wagons
			no name (since name-length was 0)
0x0004		value-length	
blue	blue	value	value of 1st member attribute
0x44	keyword type	value-tag	keyword type
0x0000		name-length	0 indicates 1setOf wagons
			no name (since name-length was 0)
0x0003		value-length	
red	red	value	value of 1st member attribute
0x4A	memberAttrName	value-tag	starts a new member attribute: "sizes"
0x0000		name-length	defined to be 0 for this type, so part of 1setOf
			no name (since name-length was 0)
0x0005		value-length	length of "length-avail" keyword
sizes	sizes	value	Name of 2nd member attribute
0x21	integer type	value-tag	attribute type
0x0000		name-length	0 indicates 1setOf wagons
			no name (since name-length was 0)
0x0004		value-length	length of an integer = 4
0x0004		value	1st value for 1SetOf integer attribute
0x21	integer type	value-tag	attribute type
0x0000		name-length	0 indicates 1setOf
			no name (since name-length was 0)
0x0004		value-length	length of an integer = 4
0x0006		value	2nd value for 1SetOf integer attribute
0x21	integer type	value-tag	attribute type
0x0000		name-length	0 indicates 1setOf
			no name (since name-length was 0)
0x0004		value-length	length of an integer = 4
0x0008		value	3rd value for 1SetOf integer attribute
0x37	endCollection	value-tag	end of the collection

Octets	Symbolic Value	Protocol field	comments
0x0000		name-length	defined to be 0 for this type, so part of 1setOf
			no name (since name-length was 0)
0x0000		value-length	defined to be 0 for this type
			no value (since value-length was 0)

17 Appendix D: Full Copyright Statement