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## Schema Publishing in X.500 Directory

### Status of this Memo

This memo defines an Experimental Protocol for the Internet community. This memo does not specify an Internet standard of any kind. Discussion and suggestions for improvement are requested. Distribution of this memo is unlimited.

### Abstract

The X.500 directory provides a powerful mechanism for storing and retrieving information about objects of interest. To interpret the information stored in the directory, the schema must be known to all the components of the directory. Presently, there are no means other than ftp to distribute schema information across the Internet. This is proving to be a severe constraint as the Directory is growing. This document presents a solution to the schema distribution problem using the existing mechanisms of the directory. A naming scheme for naming schema objects and a meta-schema for storing schema objects is presented. The procedures for fetching unknown schema from the directory at runtime are described.

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## 1. Introduction

The X.500 Directory [1] is now used for a wide range of applications from name/address lookup to network management, from restaurant information to bibliographic information services. This information is distributed and managed across a network of many autonomous sites. In order to interpret the information stored in the directory, the components of the directory must have knowledge about the structure and representation (schema) of the information held within the directory.

The distributed nature of the network and the relatively slow process of standardization have given rise to the challenging task of making accessible the information about the schema rules themselves. A mechanism for making the schema accessible to the functional components of the directory is urgently required.

The 1993 X.500 Directory Standard [2] has attempted to address the problem of schema management and distribution. The 1993 framework does provide the means for storing and retrieving schema information in the directory. However, the resolution of unknown OIDs will require both the DUA and the DSA to be compliant with [2].

In this document we propose a solution using the existing mechanisms of the directory [1] itself. We present a naming scheme for naming schema objects and a meta-schema for storing schema objects in the directory. The proposal allows the algorithmic resolution of unknown objects in the directory and in the absence of 1993 X.500 Directory Standard implementations provides an interim solution to the schema publishing problem.

## 2. Schema Management

The storage and retrieval mechanism provided by the directory is powerful and flexible. However, the key to the directory is the knowledge of the schema rules defined for the objects represented in the directory. To facilitate the diffusion of this knowledge appropriate schema management mechanisms need to be designed. Schema management involves:

- o Storage of schema information in the directory
- o Algorithmic access to and retrieval of schema information in the directory
- o Definition of rules for schema modification
- o Propagation of schema information from one component of the directory to other components of directory

In this document we concentrate on the aspect of schema access/retrieval from the directory. Since schema objects are defined and employed, the modification, addition and deletion of schema objects can be carried out using existing directory mechanisms. But the operational issue of synchronizing the schema with the DIB will require further attention. Similarly the issue of schema propagation requires further work and is outside the scope of this document. The strategy proposed in this document has a very simple and workable approach. No added DAP/DSP functionality is envisaged. At the same time by using the directory's distributed framework scalability problems are avoided. In essence, it allows the distributed storage of schema objects and proposes a naming scheme which allows algorithmic schema retrieval. Of course, on the down side, more than one directory read operation may be required to retrieve the information about an object and its attributes, as objects and attributes are stored as separate entries in the directory.

As schema information of all objects in a naming context are stored below the root entry of that naming context, the same DSA will be able to supply the schema information stored in that DSA. Thus there is no need to contact another DSA for resolving the schema of an object stored in the local DSA.

### 3. Storage of Schema Information in the Directory

The schema information may be stored and distributed using mechanisms external to the X.500 directory standard [5]. This document proposes storing schema information in the directory. It has the following advantages:

- o The components of the directory can access the schema information using the standard directory protocols.
- o The nature of the directory naturally allows the schema to be distributed. Schema used locally can be kept in the local DSA itself whereas schema for general objects like person, organization etc can be made available to all components of the directory by publishing it.

In the operational model, the schema information in the directory is expected to complement the schema information held in central repositories.

### 3.1 Naming Scheme for the Schema

The schema information is stored in a distributed manner. We propose a model in which each naming context stores the schema relevant to it.

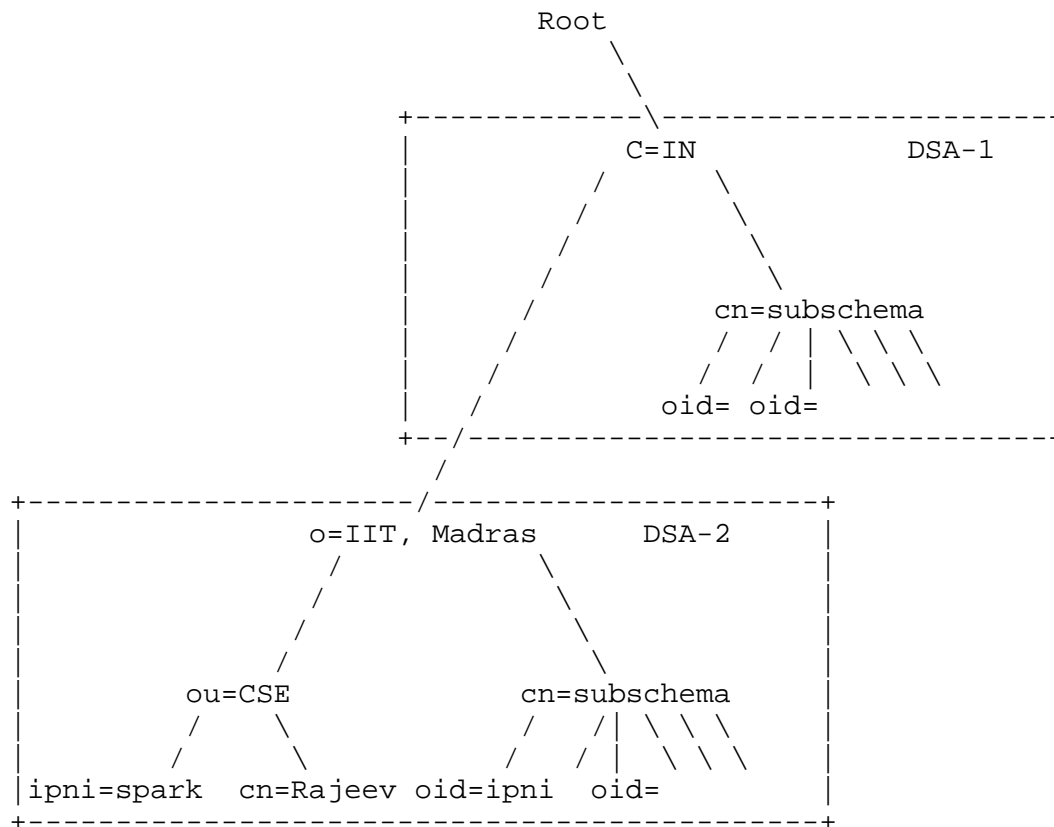


Figure 1: DIT with schema objects

To store the schema information, an object called subschema object is defined. This object can come anywhere in the Directory Information Tree (DIT). The subschema is defined as a subclass of Top. The subschema entry is stored below the root entry of a naming context. The root entry of a naming context must contain a subschema subentry, named {CN= Subschema}. This standard naming methodology is necessary so that the components of the directory can easily and algorithmically locate the schema entries. All schema information relevant to that naming context is stored below the subschema entry. Children of the subschema entry store information about objects, attribute types, attribute syntaxes or matching rules. The DIT

structure for storing schema information is shown in Figure 1. Schema for these objects are given in section 5.

#### 4. Retrieval of Schema from the Directory

When an unknown object is encountered by any component of directory during a directory operation, it proceeds the following way to resolve the schema.

The RDN component at the leaf-end of the name of the object whose schema is to be resolved is replaced by the RDNs "oid=<object identifier of the new object>, CN=subschema" and a read request is initiated for the newly formed name. If the entry is not found, two RDN components from the leaf-end of the name of the object are replaced by the RDNs "oid=<object identifier of the new object>, CN=subschema" and another read is attempted. The process continues until the read succeeds. For example, while resolving the schema of the object "IPNI=spark, OU=Department of Computer Science, O=Indian Institute of Technology, Madras , C=IN", if the schema of the object IPNI (IP Node Image) is not known to a component of the directory, the following procedure will be adopted.

Let the object id for the object IPNI be ipni. The RDN "IPNI=spark" is removed from the distinguished name of the entry and the RDNs "oid=ipni, CN= Subschema" is appended. The name thus formed is "oid=ipni, CN=subschema, OU=Department of Computer Science, O=Indian Institute of Technology, Madras, C=IN" A read request is initiated on this name. If the distinguished name "OU= Department of Computer Science, O=Indian Institute of Technology, Madras, C=IN" is the context prefix of a naming context, this read request will result in the directory returning the schema for the object IPNI. If it is not, the read operation will fail. In that case, a read operation is initiated with distinguished name "oid=ipni, CN= subschema, O=Indian Institute of Technology, Madras, C=IN". For the DIT structure shown in Figure-1, this query will succeed and the schema information will be returned. The schema for the requested object will always be located below the starting entry of the naming context in which the entry is located.

## 5. The Meta-Schema

experimental = 1.3.6.1.3

schema OBJECT IDENTIFIER  
 ::= {experimental 65}

schemaObjectClass OBJECT IDENTIFIER  
 ::= {schema.1}

schemaAttribute OBJECT IDENTIFIER  
 ::= {schema.2}

subschema OBJECT CLASS  
 Subclass of TOP  
 MUST CONTAIN {  
     commonName  
     - - For naming  
 }  
 ::= {schemaObjectClass.1}

objectClass OBJECT CLASS  
 Subclass of TOP  
 MUST CONTAIN {  
     objectIdentifier  
       - - This field stores the object identifier of object  
       - - represented by an object class entry. This attribute  
       - - is used for naming an object class entry.  
 }  
 MAY CONTAIN {  
     commonName,  
       - - This field is used to store the name of the object  
     mandatoryNamingAttributes,  
     mandatoryAttributes,  
     optionalNamingAttributes,  
     optionalAttributes,  
     obsolete,  
     description,  
     subClassOf  
 }  
 ::= {schemaObjectClass.2}

attributeType OBJECT CLASS  
 Subclass of Top  
 MUST CONTAIN {  
     objectIdentifier  
 }  
 MAY CONTAIN {

```
        commonName,  
        - - used to store the name of the attribute type  
        constraint,  
        attributeSyntax,  
        multivalued,  
        obsolete,  
        matchRules,  
        description  
    }  
    ::= {schemaObjectClass.3}  
  
matchingRule OBJECT CLASS  
    Subclass of Top  
    MUST CONTAIN {  
        objectIdentifier  
    }  
    MAY CONTAIN {  
        commonName,  
        matchtype,  
        description,  
        obsolete  
    }  
    ::= {schemaObjectClass.4}  
  
objectIdentifier ATTRIBUTE  
    WITH ATTRIBUTE-SYNTAX  
        objectIdentifierSyntax  
    ::= {schemaAttribute.1}  
  
mandatoryNamingAttributes ATTRIBUTE  
    WITH ATTRIBUTE-SYNTAX  
        SET OF OBJECT IDENTIFIER  
    ::= {schemaAttribute.2}  
  
mandatoryAttributes ATTRIBUTE  
    WITH ATTRIBUTE-SYNTAX  
        SET OF OBJECT IDENTIFIER  
    ::= {schemaAttribute.3}  
  
optionalNamingAttributes ATTRIBUTE  
    WITH ATTRIBUTE-SYNTAX  
        SET OF OBJECT IDENTIFIER  
    ::= {schemaAttribute.4}  
  
optionalAttributes ATTRIBUTE  
    WITH ATTRIBUTE-SYNTAX  
        SET OF OBJECT IDENTIFIER  
    ::= {schemaAttribute.5}
```

```
obsolete ATTRIBUTE
    WITH ATTRIBUTE-SYNTAX
        BOOLEAN
        -- DEFAULT FALSE
    ::= {schemaAttribute.6}

subClassOf      ATTRIBUTE
    WITH ATTRIBUTE-SYNTAX
        SET OF OBJECT IDENTIFIER
    ::= {schemaAttribute.7}

constraint ATTRIBUTE
    WITH ATTRIBUTE-SYNTAX
        Constraint
    ::= {schemaAttribute.8}

Constraint ::=Choice {
    StringConstraint,
    IntegerConstraint
}

StringConstraint ::= SEQUENCE {
    shortest INTEGER,
    longest  INTEGER
}

IntegerConstraint ::= SEQUENCE {
    lowerbound INTEGER,
    upperbound INTEGER OPTIONAL
}

attributeSyntax ATTRIBUTE
    WITH ATTRIBUTE-SYNTAX
        ASN1DataType
    ::= {schemaAttribute.9}

multivalued ATTRIBUTE
    WITH ATTRIBUTE-SYNTAX
        BOOLEAN
        -- DEFAULT FALSE
    ::= {schemaAttribute.10}

matchRules ATTRIBUTE
    WITH ATTRIBUTE-SYNTAX
        SET OF OBJECT IDENTIFIER
    ::= {schemaAttribute.11}

matchtype ATTRIBUTE
    WITH ATTRIBUTE-SYNTAX
```



```
    INTEGER {
        PRESENT                (0),
        EQUALITY                (1),
        ORDERING                (2),
        CASESENSITIVEMATCH     (3),
        CASEINSENSITIVEMATCH   (4)
    }
 ::= {schemaAttribute.12}
```

## 6. References

- [1] CCITT. "Data Communication Networks: Directory", Recommendations X.500 - X.521 1988.
- [2] CCITT. "Data Communication Networks: Directory", Recommendations X.500 - X.525 1993.
- [3] Barker, P., and S. Kille, "The COSINE and Internet X.500 Schema", RFC 1274, University College London, November 1991.
- [4] Howes, T., "Schema Information in the X.500 Directory", Work in Progress, University of Michigan, July 1992.
- [5] Howes, T., Rossen, K., Sataluri, S., and R. Wright, "Procedures for Formalization, Evolution, and Maintenance of the Internet X.500 Directory Schema", Work in Progress, June 1995.

## 7. Security Considerations

Security issues are not discussed in this memo.

## 8. Authors' Addresses

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