Statewide Send and Receive Patient Record Exchange

Technical Specification Appendix, HPDPlus Implementation Guide

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HPDPlus Implementation Guide

Statewide Send and Receive Patient Record Exchange

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1 Document History

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Revision History

Revision Number	Revision Date	Summary of Changes	Author
V0.1	08/30/2011	Draft 0.1	Vince Lewis
V0.2	09/20/2011	Draft 0.2	Vince Lewis
V1.0	10/05/2011	Renamed as version 1.0 after successful Subgroup ratification	Sean Kelly
V1.1	12/20/2012	Updated after environmental review	Lin Wan, Salim Kizaraly
V1.1.1	01/03/2014	Update to provide implementation guidance regarding using this spec to support a multi-provider directory environment, and document section restructuring	John Donnelly, Nagesh (Dragon) Bashyram

Reference Documents

Please see the following documents for more information:

Document Name	Version	Author
Statewide Send and Receive Patient Record Exchange Technical Specification	V1.0	Vince Lewis, Sean Kelly
Statewide Send and Receive Patient Record Exchange Technical Specification	V1.1	Lin Wan, Salim Kizaraly

Distribution List

This document has been distributed to the following participants:

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2 Introduction

2.1 Purpose of This Appendix

This appendix, and its parent document, the Statewide Send and Receive Technical Specifications Draft v1.1, outline how the Healthcare Provider Directory (HPD) profile can be expanded for use with the S&I Provider Directory data model, the so called HPD Plus. It is expected that the HPD Data model as implemented in LDAP will eventually be upgraded to S&I compliance, though this could take some time. HPD has adopted many extensions specified in HPD Plus recently in IHE Change Proposal 601.

This appendix also shows how the DSMLv2 based HPD can be adapted to use a Relational Database (RDB) persistence model, and not rely on an LDAP server. This can be done with a few constraints, but without changes to the HPD wsdl found in the technical spec, and without changes to the DSMLv2 xml schema (dsmlv2.xsd) also found in the technical spec. This type of implementation is called HPD Plus RDB.

In order to demonstrate this capability to its fullest, a proof-of-concept (POC) was built. The techniques described in this appendix to emulate LDAP with an RDB (for example Multivalued fields) were actually tested before describing their use.

3 Use Cases

Two uses are the models for the comparison of the LDAP vs. RDB persistence mechanisms. Each of these cases was fully modeled and tested using HPD Plus LDAP and RDB. Details for Provider Search are presented in the HPD Plus sample section. The query and response interface of the two implementations are identical conforming to HPD and HPD Plus specifications.

3.1 Provider Search

This use case represents probably the primary functional use case. A user looks up a colleague based on name and retrieves the desired direct address

1. Search of provider by first and last name (substring)
2. Pick a provider, get list of organizations
3. Pick an organization; Get a list of services with detailed information for the selected provider/organization
4. Pick the Direct service and get the Direct Address.

3.2 Organization Search

A variation is when a user knows a practice, and wants to get the direct address of a specific provider in that practice. The steps involved are:

1. Get a list of organizations by searching with an organization name (approximate match)
2. Pick an organization; get a list of providers with information such as name
3. Pick a provider; get a list of service details
4. Pick the Direct service and get the Direct Address

4 Standardized Organizational Unit (ou)

In order to make HPD standardized the organization unit name for each of the primary entities must be specified. For HPD Plus there are really 5 primary objects. HPD has defined the OUR for 3 types: individual provider, organizational provider, and credential. The new objects individual-organization relationship, and electronic services, originally proposed by HPD Plus, has been adopted by HPD as extension in IHE Change Proposal 601. However, HPD has not defined the standard OUs for these new objects. The POC implementations used the following standardized OUs, as defined in the Statewide Send and Receive Technical Specifications v1.1, across the LDAP and RDB. Each OU in the LDAP implementation mapped to a table in the relational model as seen in the HPD Plus RDB Relational Map.

HPD Object	LDAP Organization Unit	RDB Table
Individual Provider	HCProfessional	PROVIDERS
Organizational Provider	HCRegulatedOrganization	ORGANIZATIONS
Individual-Organization	HPDProviderMembership	MEMBERSHIPS
HPDProviderCredentials	HPDCredential	CREDENTIALS
Electronic Services	HPDElectronicService	SERVICES

5 Standardized Distinguished Name (dn)

In order to make HPD more standardized for consumer implementation it is recommended that the fields comprising the distinguished names (primary Keys) for all organization unit objects be specified. The POC implementations used the following standardized dns across the LDAP and RDB. The mapping of the dn attributes to the table PK is seen in the HPD Plus RDB Relational Map.

HPD Object	LDAP dn example	RDB Table Primary Key Field
Individual Provider	dn="uid=1,ou=HCProfessional,dc=hpd,dc=org"	PROVIDER_ID
Organizational Provider	dn="uid=1,ou=HCRegulatedOrganization,dc=hpd,dc=org"	ORGANIZATION_ID
Individual-Organization	dn="hpdMemberId=2,ou=HPDProviderMembership,dc=hpd,dc=org"	HPD_MEMBER_ID
HPDProviderCredentials	dn=" credentialId=2,ou=HPDCredential,dc=hpd,dc=org"	CREDENTIAL_ID

HPD Object	LDAP dn example	RDB Table Primary Key Field
Electronic Services	Dn= “hpdServiceId=4, ou=HPDElectronicServices, dc=hpd,dc=org”	SERVICE_ID

6 S & I Object types

6.1 Multivalued Fields

Many of the HPD and HPD Plus fields are defined a “Multilvalue”. As such, there would be no practical relational way of handling each and every associative relationship. This suggests that a way of storing multiple distinct values for a field within a single record was needed. In the Proof-of-Concept uses a Pipe (‘|’) Delimited format was used the persistence. The pipes were parsed as the HPD response was formed, supplying multiple values to response attributes.

6.2 Complex Fields

Postal addresses in LDAP are composed of several sub-fields. The individual subfields within the address are to be separated by the “$” symbol. The S&I Framework dictates several other complex fields. S&I calls them objects but they are not true objects in the LDAP sense.

6.2.1 Postal Address

Example: `1234 Main St.$Anytown, CA 12345$USA`

`See` LDAP: Syntaxes and Matching Rules [RFC4517] section 3.3.28

6.2.2 Telephone Number

Example: `+1 512 315 0280`

`See` LDAP: Syntaxes and Matching Rules [RFC4517] section 3.3.31

Telephone Number is a single string in LDAP, it is recommended that usage (Per S&I) is added using the $ delimiter.

6.2.3 Digital Certificate

Digital certificate is a single string in LDAP, it is recommended that usage (Per S&I) is added using the $ delimiter.

6.2.4 Email

Email is a single string in LDAP, it is recommended that usage (Per S&I) is added using the $ delimiter.

6.2.5 Credential and Electronic Service

These two complex fields are actually represented in HPD by distinct objects and thus would have their own organization units. In HPD Plus RDB, this means they have their own tables. See the LDAP Relational Map for more details.

7 Technical Specifications

HPD Plus is intended to provide not only an enhanced LDAP model that supports the S & I Framework Electronic Services Model, but to provide guidelines for using the HPD interface, with the DSMLv2 schema against a relational database model for the directory. In order provide this functionality a subset of the LDAP technical specification, as it is use by DSMLv2 needs to be supported. By using this subset, a standard for querying can be maintained with a relational persistence mode. The LDAP tech spec is made up of several modules. Specifically these are:

1. LDAP: The Protocol [RFC4511]
2. LDAP: Directory Information Models [RFC4512]
3. LDAP: Authentication Methods and Security Mechanisms [RFC4513]
4. LDAP: String Representation of Distinguished Names [RFC4514]
5. LDAP: String Representation of Search Filters [RFC4515]
6. LDAP: Uniform Resource Locator [RFC4516]
7. LDAP: Syntaxes and Matching Rules [RFC4517]
8. LDAP: Internationalized String Preparation [RFC4518]
9. LDAP: Schema for User Applications [RFC4519]

Any implementation of HPD Plus, which does not use LDAP persistence, but does use the HPD Plus schema, should implement parts of LDAP Technical Specification. The following constraints on the LDAP specification are imposed by this document for an HPD Plus implementation:

1. LDAP: The Protocol [RFC4511]
   Using HPD/DSMLv2 over the SOAP providers a substitute for the actual LDAP protocol. The DSMLv2 xml schema provides the message structure of the requests, in this case specifically the search request. Only the search request is valid in the HPD Plus implementation. The SOAP Protocol and the HPD wsdl provide the transaction structures required to relay the request and response messages.

2. LDAP: Directory Information Models [RFC4512]
   The information model can be in any form, it does not have to conform to the DIM

3. LDAP: Authentication Methods and Security Mechanisms [RFC4513]
   Security requirements are provided by the Security Standards section of this document and this specification is not required.

4. LDAP: String Representation of Distinguished Names [RFC4514]
   Only String representation of Distinguished names will be used in the HPD/DSMLv2 call. For example:

   <dsml:searchRequest dn="ou=HCProfessional,dc=hpd,dc=org" scope="singleLevel"
   derefAliases="derefFindingBaseObj">

5. LDAP: String Representation of Search Filters [RFC4515]:
   Extensible Matching is not required.

6. LDAP:Uniform Resource Locator [RFC4516]:
   HPD is SOAP based and uses the http: protocol. This specification is not required.

7. LDAP: Syntaxes and Matching Rules [RFC4517]
   Syntax rules, as they apply to the HPD Plus Schema attributes, are required. Matching rules as they apply to S & I query fields are required.

8. LDAP: Internationalized String Preparation [RFC4518]
   Internationalization is not currently required.

9. LDAP: Schema for User Applications [RFC4519]
   Schema attribute and objects, as they apply to the HPD Plus schema, are required.

8 HPD Plus Sample Requests and Responses

It should be pointed out that LDAP does not support the concept of a Join, like a relational database. Query is step by step and often based on loops. Therefore each of the use cases is broken down into several requests and responses. These can either correspond to the workflow or be hidden from the user where applicable.

The S&I Framework ESI Query and Response specification states that a conforming Provider Directory will support the following types of queries:

1. Find individual
2. Find unique individual
3. Find organization
4. Find unique organization
5. Find organizations for unique individual
6. Find individuals for unique organization
7. Find individuals and organizations

The sample requests and responses below illustrate how HPD Plus can support these types of queries.

8.1 Provider Search Use Case in RDB

1. Search of provider by first and last name (substring)

This query is a “Find Individual” query as defined by the ESI Query and Response specification.

HPD Plus RDB Request:

```
<soap-env:Envelope xmlns:soap-env="http://www.w3.org/2003/05/soap-envelope">
  <soap-env:Body>
    <dsml:batchRequest xmlns:dsml="urn:protocol.dsml.opends.org" xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:xsi="http://www.w3.org/2001/XMLSchema- instance">
      <dsml:searchRequest dn="ou=HCProfessionals,dc=hpd,dc=org" scope="singleLevel" derefAliases="derefFindingBaseObj">
        <dsml:filter>
          <dsml:and>
            <dsml:substrings name="Sn">
```

```
                                        <dsml:initial>Smit</dsml:initial>
                                    </dsml:substrings>
                                    <dsml:and>
                                        <dsml:substrings name="givenName">
                                            <dsml:initial>Jo</dsml:initial>
                                        </dsml:substrings>
                                    </dsml:and>
                                </dsml:and>
                            </dsml:filter>
                            <dsml:attributes>
                                <dsml:attribute name="HcSpecialization"/>
                                <dsml:attribute name="hpdProviderMailingAddress"/>
                                <dsml:attribute name="Cn"/>
                            </dsml:attributes>
                        </dsml:searchRequest>
                    </dsml:batchRequest>
                </soap-env:Body>
            </soap-env:Envelope>
```

HPD Plus RDB Response:

```
<S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope">
   <S:Body>
      <batchResponse xmlns="urn:protocol.dsml.opends.org">
         <searchResponse>
            <searchResultEntry dn="uid=2,ou=HCProfessional,dc=hpd,dc=org">
               <attr name="hpdProviderMailingAddress">
                  <value>123 FORTH ST^^NY^NY^123345</value>
                  <value>234 FIFTH ST^^NY^NY^123345</value>
               </attr>
               <attr name="uid">
                  <value>2</value>
               </attr>
               <attr name="HcSpecialisation">
                  <value>ORTH</value>
               </attr>
               <attr name="Cn">
                  <value>DR JOHN SMITH</value>
               </attr>
            </searchResultEntry>
            <searchResultDone>
               <resultCode code="0"/>
            </searchResultDone>
         </searchResponse>
      </batchResponse>
   </S:Body>
</S:Envelope>
```

2. Pick a provider, get a list of organizations

Using the Provider distinguished name of dn="uid=2,ou=HCProfessional,dc=hpd,dc=org", one can get the list of organizations the provider is associated with. This query is a “Find Organizations for Unique Individual” query as defined by the ESI Query and Response specification.

HPD Plus RDB request:

```
<soap-env:Envelope xmlns:soap-env="http://www.w3.org/2003/05/soap-envelope">
    <soap-env:Body>
        <dsml:batchRequest xmlns:dsml="urn:protocol.dsml.opends.org" xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:xsi="http://www.w3.org/2001/XMLSchema- instance">
            <dsml:searchRequest dn="ou=HPDMembership,dc=hpd,dc=org" scope="singleLevel"
derefAliases="derefFindingBaseObj">
```

```
                        <dsml:filter>
                                <dsml:and>
                                        <dsml:equalityMatch name="hpdHasAProvider">
                                                <dsml:value>2</dsml:value>
                                        </dsml:equalityMatch>
                                </dsml:and>
                        </dsml:filter>
                        <dsml:attributes>
                                <dsml:attribute name=hpdHasAnOrg"/>
                                <dsml:attribute name="hpdHasAService"/>
                        </dsml:attributes>
                </dsml:searchRequest>
        </dsml:batchRequest>
    </soap-env:Body>
</soap-env:Envelope>
```

HPD Plus RDB Response:

```
<S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope">
    <S:Body>
        <batchResponse xmlns="urn:protocol.dsml.opends.org">
            <searchResponse>
                <searchResultEntry dn="hpdMemberId=2,ou=HPDMembership,dc=hpd,dc=org">
                        <attr name="hpdHasAnOrg">
                                <value> uid=30,ou=HCRegulatedOrganization, dc=hpd,dc=org</value>
                        </attr>
                        <attr name="hpdMemberId">
                                <value>2</value>
                        </attr>
                        <attr name="hpdHasAService">
                                <value>vHPDElectronicService,dc=hpd,dc=org</value>
                        </attr>
                </searchResultEntry>
                <searchResultEntry dn="hpdMemberId=3,ou=HPDMembership,dc=hpd,dc=org">
                        <attr name="hpdHasAnOrg">
                                <value> uid=40,ou=HCRegulatedOrganization, dc=hpd,dc=org </value>
                        </attr>
                        <attr name="hpdMemberId">
                                <value>3</value>
                        </attr>
                        <attr name="hpdHasAService">
                                <value>hpdServiceId=4,ou=HPDElectronicService,dc=hpd,dc=org</value>
                                <value>hpdServiceId=3,ou=HPDElectronicService,dc=hpd,dc=org</value>
                        </attr>
                </searchResultEntry>
                <searchResultDone>
                        <resultCode code="0"/>
                </searchResultDone>
        </searchResponse>
    </batchResponse>
  </S:Body>
</S:Envelope>
```

For the organizations returned in the response above, one can used the organization ID returned and query to get more attributes of the organization. This is a “Find Unique Organization” query as defined by the ESI Query and

Response specification. Below is an example.

HPD Plus RDB request:

```
<soap-env:Envelope xmlns:soap-env="http://www.w3.org/2003/05/soap-envelope">
    <soap-env:Body>
        <dsml:batchRequest xmlns:dsml="urn:protocol.dsml.opends.org" xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:xsi="http://www.w3.org/2001/XMLSchema- instance">
            <dsml:searchRequest dn="ou=HCRegulatedOrganization,dc=hpd,dc=org" scope="singleLevel"
derefAliases="derefFindingBaseObj">
                <dsml:filter>
                    <dsml:or>
                        <dsml:equalityMatch name="uid">
                            <dsml:value>30</dsml:value>
                        </dsml:equalityMatch>
                        <dsml:or>
                            <dsml:equalityMatch name="uid">
                                <dsml:value>40</dsml:value>
                            </dsml:equalityMatch>
                        </dsml:or>
                    </dsml:or>
                </dsml:filter>
                <dsml:attributes>
                    <dsml:attribute name=”HcRegisteredName"/>
                    <dsml:attribute name="hpdProviderPracticeAddress"/>
                </dsml:attributes>
            </dsml:searchRequest>
        </dsml:batchRequest>
    </soap-env:Body>
</soap-env:Envelope>
```

HPD Plus RDB Response:

```
<S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope">
    <S:Body>
        <batchResponse xmlns="urn:protocol.dsml.opends.org">
            <searchResponse>
                <searchResultEntry dn="uid=30,ou=HcRegulatedOrganization,dc=hpd,dc=org">
                    <attr name="HcRegisteredName">
                        <value> JOHN SMITH PRIVATE PRACTICE</value>
                    </attr>
                    <attr name="hpdProviderPracticeAddress">
                        <value>123 FORTH ST^^NY^NY^123345</value>
                    </attr>
                </searchResultEntry>
                <searchResultEntry dn="uid=40,ou=HcRegulatedOrganization,dc=hpd,dc=org">
                    <attr name="HcRegisteredName">
                        <value> CLINIC A</value>
                    </attr>
                    <attr name="hpdProviderPracticeAddress">
                        <value>100 Main Ave^^New York^NY^12345</value>
                    </attr>
                </searchResultEntry>
                <searchResultDone>
                    <resultCode code="0"/>
```

```
                </searchResultDone>
            </searchResponse>
        </batchResponse>
    </S:Body>
</S:Envelope>
```

User can make a selection on the organization based on organizational attributes returned.

3. Pick an Org; Get List of service details for one of these provider/organizations

JOHN SMITH AT CLINIC A has two services. One can use the service IDs returned in the previous query for provider and organization relationship to get more information on the services. This can be considered part of a “Find organizations for unique individual” query as defined by the ESI Query and Response specification where service information about the individual-organization relationship is returned.

HPD Plus RDB Request:

```
<soap-env:Envelope xmlns:soap-env="http://www.w3.org/2003/05/soap-envelope">
  <soap-env:Body>
    <dsml:batchRequest xmlns:dsml="urn:protocol.dsml.opends.org" xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:xsi="http://www.w3.org/2001/XMLSchema- instance">
        <dsml:searchRequest dn="ou=HPDElectronicService,dc=hpd,dc=org" scope="singleLevel" derefAliases="neverDerefAliases"
sizeLimit="100">
            <dsml:filter>
                <dsml:or>
                    <dsml:equalityMatch name="hpdServiceId">
                        <dsml:value>3</dsml:value>
                    </dsml:equalityMatch>
                    <dsml:or>
                    <dsml:equalityMatch name="hpdServiceId">
                        <dsml:value>4</dsml:value>
                    </dsml:equalityMatch>
                    </dsml:or>
                </dsml:or>
            </dsml:filter>
            <dsml:attributes>
                <dsml:attribute name="hpdServiceAddress"/>
                <dsml:attribute name="hpdIntegrationProfile"/>
                <dsml:attribute name="hpdContentProfile"/>
            </dsml:attributes>
        </dsml:searchRequest>
    </dsml:batchRequest>
  </soap-env:Body>
</soap-env:Envelope>
```

HPD Plus RDB Response

```
<S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope">
        <S:Body>
            <batchResponse xmlns="urn:protocol.dsml.opends.org">
                <searchResponse>
                    <searchResultEntry dn="hpdServiceId=3,ou=HPDElectronicService,dc=hpd,dc=org">
```

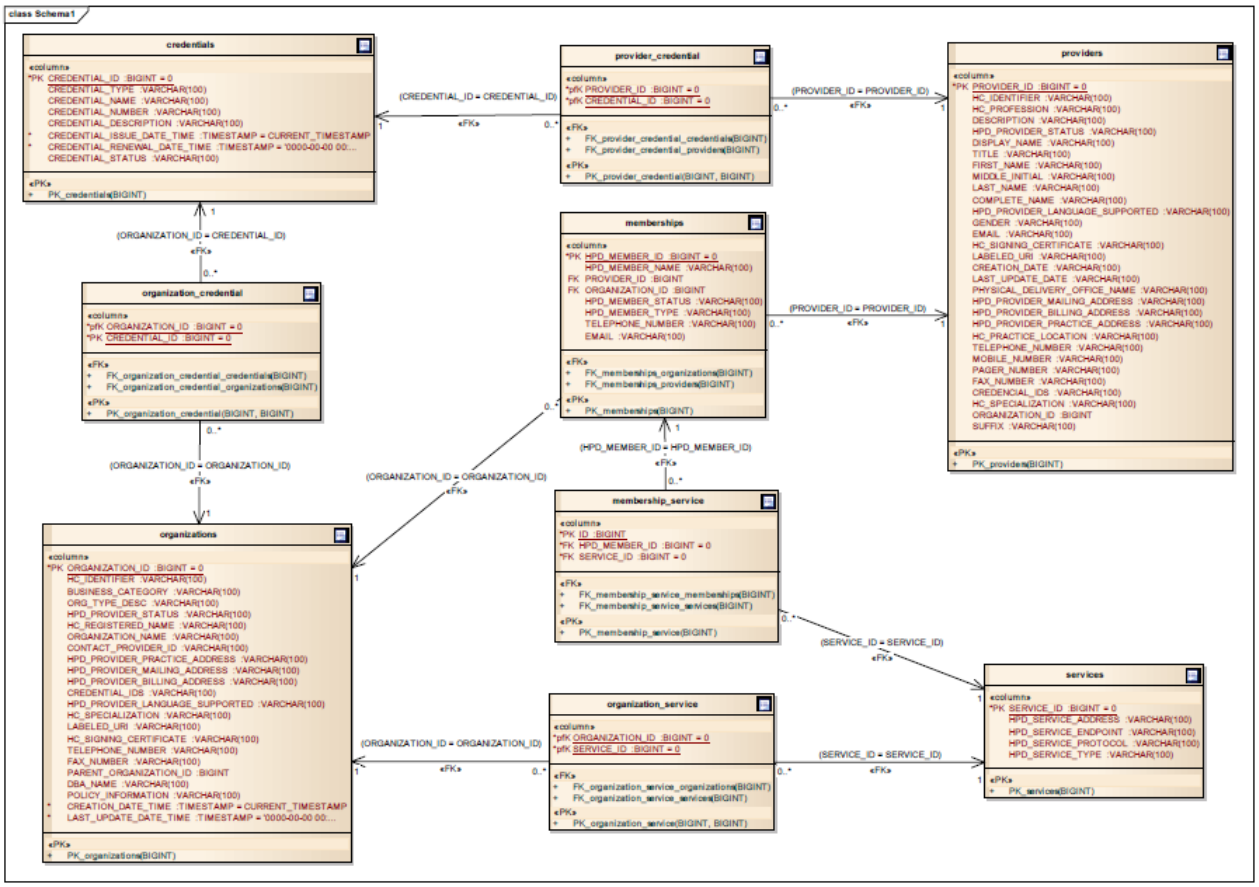
```
                                        <attr name="hpdContentProfile">
                                                <value>PDF</value>
                                        </attr>
                                        <attr name="hpdServiceAddress">
                                                <value>DOCTOR_SMITH@CLINICA.HISPA.COM</value>
                                        </attr>
                                        <attr name="hpdIntegrationProfile">
                                                <value>DirectProjectSMTP</value>
                                        </attr>
                                        <attr name="hpdServiceId">
                                                <value>3</value>
                                        </attr>
                                </searchResultEntry>
                                <searchResultEntry dn="hpdServiceId=4,ou=Services,dc=hpd,dc=org">
                                        <attr name="hpdContentProfile">
                                                <value> XDS:DocumentRepository:Provide&Register </value>
                                        </attr>
                                        <attr name="hpdServiceAddress">
                                                <value>HTTP://CLINICA/REPOSITORY</value>
                                        </attr>
                                        <attr name="hpdIntegrationProfile">
                                                <value>SOAP</value>
                                        </attr>
                                        <attr name="hpdServiceId">
                                                <value>4</value>
                                        </attr>
                                </searchResultEntry>
                                <searchResultDone>
                                        <resultCode code="0"/>
                                </searchResultDone>
                        </searchResponse>
                </batchResponse>
        </S:Body>
</S:Envelope>
```

8.2 Provider Search Use Case in LDAP

The query and response interactions with a LDAP backed HPD Plus implementation should be the same as those for an RDB backed HPD Plus implementation. The only differences will be in the backend on how the HPD interface interacts with the persistent data store. In the RDB case, searching is done by SQL operations, whereas in the case for an LDAP backed HPD implementation, searching will be done via LDAP interactions.

9 HPD Plus RDB Relational Model

The following is the relational data model used in the POC for HPD Plus. It's provided as a sample. Implementations of HPD Plus can define their own backend data model provided their query and response interface conforms to the HPD Plus specification.



9.1 HPD PLUS RDB LDAP to Relational Map

The following is the mapping of LDAP attributes to relational data model used in the POC for HPD Plus. It's provided as a sample. Implementations of HPD Plus can define their own backend data model provided their query and response interface conforms to the HPD Plus specification.

LDAP ORGUNIT	LDAPATTRIBUTE	DBTABLE	DBFIELDNAME	DBType
Providers	uid	PROVIDERS	PROVIDER_ID	BIGINT(20)
	hcIdentifier		HC_IDENTIFIER	VARCHAR(100)
	hcProfession		HC_PROFESSION	VARCHAR(100)
	Description		DESCRIPTION	VARCHAR(100)
	hpdProviderStatus		HPD_PROVIDER_STATUS	VARCHAR(100)
	displayName		DISPLAY_NAME	VARCHAR(100)
	Title		TITLE	VARCHAR(100)
	givenName		FIRST_NAME	VARCHAR(100)

LDAP ORGUNIT	LDAPATTRIBUTE	DBTABLE	DBFIELDNAME	DBType
Providers	uid	PROVIDERS	PROVIDER_ID	BIGINT(20)
	initials		MIDDLE_NAME	VARCHAR(100)
	Sn		LAST_NAME	VARCHAR(100)
	Cn		COMPLETE_NAME	VARCHAR(100)
	hpdProviderLanguageSupported		HPD_PROVIDER_LANGUAGE_SUPPORTED	VARCHAR(100)
	Gender		GENDER	VARCHAR(100)
	Mail		EMAIL	VARCHAR(100)
	HcSigningCertificate		HC_SIGNING_CERTIFICATE	VARCHAR(100)
	labeledURI		LABELED_URI	VARCHAR(100)
	physicalDeliveryOfficeName		PHYSICAL_DELIVERY_OFFICE_NAME	VARCHAR(100)
	hpdProviderMailingAddress		HPD_PROVIDER_MAILING_ADDRESS	VARCHAR(100)
	hpdProviderBillingAddress		HPD_PROVIDER_BILLING_ADDRESS	VARCHAR(100)
	hpdProviderPracticeAddress		HPD_PROVIDER_PRACTICE_ADDRESS	VARCHAR(100)
	HcPracticeLocation		HC_PRACTICE_LOCATION	VARCHAR(100)
	telephone		TELEPHONE_NUMBER	VARCHAR(100)
	Mobile		MOBILE_NUMBER	VARCHAR(100)
	Pager		PAGER_NUMBER	VARCHAR(100)
	facsimileTelephoneNumber		FAX_NUMBER	VARCHAR(100)
	credentialName		CREDENCIAL_IDS	BIGINT(20)
	hcSpecialization		HC_SPECIALIZATION	VARCHAR(100)
	memberOf		ORGANIZATION_ID	BIGINT(20)
	suffix		SUFFIX	VARCHAR(100)

LDAP ORGUNIT	LDAPATTRIBUTE	DBTABLE	DBFIELDNAME	DBType
Organizations		ORGANIZATIONS		
	uid		ORGANIZATION_ID	BIGINT(20)
	hcIdentifier		HC_IDENTIFIER	VARCHAR(100)
	businessCategory		BUSINESS_CATEGORY	VARCHAR(100)
	orgTypeDesc		ORG_TYPE_DESC	VARCHAR(100)
	hpdProviderStatus		HPD_PROVIDER_STATUS	VARCHAR(100)
	HcRegisteredName		HC_REGISTERED_NAME	VARCHAR(100)
	o		ORGANIZATION_NAME	VARCHAR(100)
	ClinicalInformationContact		CONTACT_PROVIDER_ID	VARCHAR(100)

LDAP ORGUNIT	LDAPATTRIBUTE	DBTABLE	DBFIELDNAME	DBType
Organizations		ORGANIZATIONS		
	hpdProviderPracticeAddress		HPD_PROVIDER_PRACTICE_ADDRESS	VARCHAR(100)
	hpdProviderMailingAddress		HPD_PROVIDER_MAILING_ADDRESS	VARCHAR(100)
	hpdProviderBillingAddress		HPD_PROVIDER_BILLING_ADDRESS	VARCHAR(100)
	credentialName		CREDENTIAL_IDS	VARCHAR(100)
	hpdProviderLanguageSupported		HPD_PROVIDER_LANGUAGE_SUPPORTED	VARCHAR(100)
	HcSpecialisation		HC_SPECIALIZATION	VARCHAR(100)
	labeledURI		LABELED_URI	VARCHAR(100)
	HcSigningCertificate		HC_SIGNING_CERTIFICATE	VARCHAR(100)
	telephone		TELEPHONE_NUMBER	VARCHAR(100)
	facsimileTelephoneNumber		FAX_NUMBER	VARCHAR(100)
	memberOf		PARENT_ORGANIZATION_ID	BIGINT(20)
	dbaName		DBA_NAME	VARCHAR(100)
	policyInformation		POLICY_INFORMATION	VARCHAR(100)

LDAP ORGUNIT	LDAPATTRIBUTE	DBTABLE	DBFIELDNAME	DBType
Memberships		MEMBERSHIPS		
	hpdMemberId		HPD_MEMBER_ID	BIGINT(20)
	hpdMemberName		HPD_MEMBER_NAME	VARCHAR(100)
	hpdHasAProvider		PROVIDER_ID	BIGINT(20)
	hpdHasAnOrg		ORGANIZATION_ID	BIGINT(20)
	hpdMemberStatus		HPD_MEMBER_STATUS	VARCHAR(100)
	hpdMemberType		HPD_MEMBER_TYPE	VARCHAR(100)
	hpdHasAService		SERVICE_ID	BIGINT(20)
	hpdMemberTelephone		TELEPHONE_NUMBER	VARCHAR(100)
	hpdMemberEmail		EMAIL	VARCHAR(100)

LDAP ORGUNIT	LDAPATTRIBUTE	DBTABLE	DBFIELDNAME	DBType
Credentials		CREDENTIALS		
	credentialId		CREDENTIAL_ID	BIGINT(20)
	credentialType		CREDENTIAL_TYPE	VARCHAR(100)
	credentialName		CREDENTIAL_NAME	VARCHAR(100)
	credentialNumber		CREDENTIAL_NUMBER	VARCHAR(100)
	credentialDescription		CREDENTIAL_DESCRIPTION	VARCHAR(100)
	credentialIssueDate		CREDENTIAL_ISSUE_DATE_TIME	TIMESTAMP
	credentialRenewalDate		CREDENTIAL_RENEWAL_DATE_TIME	TIMESTAMP
	credentialStatus		CREDENTIAL_STATUS	VARCHAR(100)

LDAP ORGUNIT	LDAPATTRIBUTE	DBTABLE	DBFIELDNAME	DBType
Services		SERVICES		
	hpdServiceId		SERVICE_ID	BIGINT(20)
	hpdServiceAddress		HPD_SERVICE_ADDRESS	VARCHAR(100)
	hpdServicePayload		HPD_SERVICE_ENDPOINT	VARCHAR(100)
	hpdServiceProtocol		HPD_SERVICE_PROTOCOL	VARCHAR(100)
	hpdServiceType		HPD_SERVICE_TYPE	VARCHAR(100)

10 Testing LDIF file

```
version: 1
DN: dc=hpd,dc=org objectClass: domain objectClass: top
dc: hpd
DN: ou=HCProfessionals,dc=hpd,dc=org objectClass: organizationalunit objectClass: top
ou: HCProfessionals

DN: HcIdentifier=ABCD,ou=Providers,dc=hpd,dc=org objectClass: top
objectClass: person
objectClass: organizationalperson objectClass: inetorgperson objectClass: HCProfessional objectClass: HPDProvider
HcIdentifier: ABCD
HcProfession: Doctor HCSpecialization:Orthopedic Surgeon cn: Thomas Jones
description: This is the description for Thomas Jones. employeeNumber: 0
givenName: Thomas sn: Jones
homePhone: +1 225 216 5900 initials: ASA
l: Panama City
mail: Provider1@maildomain.net mobile: +1 010 154 3228
pager: +1 779 041 6341
postalAddress: Thomas Jones$01251 Chestnut Street$Panama City, DE  50369 postalCode: 50369
st: DE
street: 01251 Chestnut Street telephoneNumber: +1 685 622 6202 uid: thomas.jones
memberOf:HcIdentifier=Org123,ou=Organizations,dc=hpd,dc=org hpdCredential:Number=1,ou=Credentials,dc=hpd,dc=org

DN: HcIdentifier=BCDE,ou=Providers,dc=hpd,dc=org objectClass: top
objectClass: person
objectClass: organizationalperson objectClass: inetorgperson objectClass: HCProfessional objectClass: HPDProvider
HcIdentifier: BCDE
HcProfession: Doctor HCSpecialization:Ear Nose Throat cn: John Smith
description: This is the description for Aaccf Amar. employeeNumber: 0
givenName: John sn: Smith
homePhone: +1 225 216 5901 initials: JS
l: Panama City
mail: Provider2@maildomain.net mobile: +1 010 154 3228
pager: +1 779 041 6341
postalAddress: John Smith$01251 Wallnut Street$Panama City, DE  50371 postalCode: 50371
st: DE
street: 01251 Walnut Street telephoneNumber: +1 685 622 6202 uid: john.smith
memberOf:HcIdentifier=Org234,ou=Organizations,dc=hpd,dc=org
```

DN: HcIdentifier=CDEF,ou=Providers,dc=hpd,dc=org objectClass: top
objectClass: person
objectClass: organizationalperson objectClass: inetorgperson objectClass: HCProfessional objectClass: HPDProvider
HcIdentifier: CDEF
HcProfession: Doctor HCSpecialization:OBGYN cn: Jane Smith
description: This is the description for Aaccf Amar. employeeNumber: 0
givenName: Jane sn: Smith
homePhone: +1 225 216 5900 initials: JS
l: Panama City
mail: Provider3@maildomain.net mobile: +1 010 154 3228
pager: +1 779 041 6341
postalAddress: Jane Smith$123 Oak Street$Panama City, DE 50371

postalCode: 50371 st: DE
street: 123 Oak Street telephoneNumber: +1 685 622 6201 uid: jane.smith
memberOf:HcIdentifier=Org234,ou=Organizations,dc=hpd,dc=org

DN: ou=Organizations,dc=hpd,dc=org objectClass: organizationalunit objectClass: top
ou: Organizations

DN:HcIdentifier=Org123,ou=Organizations,dc=hpd,dc=org objectClass: top
objectClass: organization
objectClass: HCRegulatedOrganization objectClass: HPDProvider
HcIdentifier: Org123
o:Dr. Thomas Jones Private Practice
HcRegisteredAddr: Dr. Thomas Jones Private Practice$01251 Chestnut Street$Panama City, DE 50369

DN:HcIdentifier=Org234,ou=Organizations,dc=hpd,dc=org objectClass: top
objectClass: organization
objectClass: HCRegulatedOrganization objectClass: HPDProvider
HcIdentifier: Org234 o:Panama City Clinic
HcRegisteredAddr: Panama City Clinic$01251 Wallnut Street$Panama City, DE 50371

DN: ou=Memberships,dc=hpd,dc=org objectClass: organizationalunit objectClass: top
ou: Memberships

DN:hpdMemberId=1,ou=Memberships,dc=hpd,dc=org objectClass: top
objectClass: HPDProviderMembership hpdHasAnOrg:HcIdentifier=Org123,ou=Organizations,dc=hpd,dc=org
hpdHasAProvider:HcIdentifier=ABCD,ou=Providers,dc=hpd,dc=org hpdMemberEmail:testABC@org123.com
hpdHasAService:hpdServiceId=1,ou=Services,dc=hpd,dc=org^hpdServiceId=2,ou=Services,dc=hpd,dc=org^hpdServiceId=3,ou=
Services,dc=hpd,dc=org hpdMemberId:1
hpdMemberName:Dr Thomas Jones Private Practice

DN:hpdMemberId=2,ou=Memberships,dc=hpd,dc=org objectClass: top
objectClass: HPDProviderMembership hpdHasAnOrg:HcIdentifier=Org234,ou=Organizations,dc=hpd,dc=org
hpdHasAProvider:HcIdentifier=ABCD,ou=Providers,dc=hpd,dc=org hpdMemberEmail:tesABC@org234.com
hpdMemberId:2 hpdMemberName:Panama City Clinic

DN:hpdMemberId=3,ou=Memberships,dc=hpd,dc=org objectClass: top
objectClass: HPDProviderMembership hpdHasAnOrg:HcIdentifier=Org234,ou=Organizations,dc=hpd,dc=org
hpdHasAProvider:HcIdentifier=BCDE,ou=Providers,dc=hpd,dc=org hpdMemberEmail:testBCDE@org234.com
hpdMemberId:2

```
DN: ou=Services,dc=hpd,dc=org objectClass: organizationalunit objectClass: top
ou: Services

DN:hpdServiceId=1,ou=Services,dc=hpd,dc=org objectClass: top
objectClass: HPDElectronicService hpdServiceAddress:directadd@direct.com hpdServiceProtocol:SMTP hpdServiceType:Direct
hpdServicePayload:CCD^PDF hpdServiceId:1

DN:hpdServiceId=2,ou=Services,dc=hpd,dc=org objectClass: top
objectClass: HPDElectronicService
hpdServiceAddress:https://shinnytest.gsihealth.com:8181/DocumentRepository_Service/DocumentRepository
hpdServiceProtocol:SOAP
hpdServiceType:IHE Repository hpdServicePayload:CCD^PDF hpdServiceId:2

DN:hpdServiceId=3,ou=Services,dc=hpd,dc=org objectClass: top
objectClass: HPDElectronicService

hpdServiceAddress:https://shinnytest.gsihealth.com:8181/DocumentRegistry_Service/DocumentRegistry
hpdServiceProtocol:SOAP
hpdServiceType:IHE Registry hpdServicePayload:CCD^PDF hpdServiceId:3

DN: ou=Credentials,dc=hpd,dc=org objectClass: organizationalunit objectClass: top
ou: Credentials

DN:credentialNumber=1,ou=Credentials,dc=hpd,dc=org objectClass: top
objectClass: HPDProviderCredential credentialName:Credential A credentialType:certification credentialNumber:1
```

11 Appendix I: Impl. Guidance Regarding Using HPDPlus v1.1 (and other Existing HPD Specs) to Support a Federated Provider Directory Environment

11.1 Purpose

This appendix has been added to the HPDPlus Implementation Guide to provide additional guidance regarding the approaches for and challenges in utilizing this and other existing Provider Directory (PD) specifications for deployments involving multiple PDs. The source of this guidance is empirical feedback from Provider Directory (PD) deployments that have been recognized and included in an ONC-sponsored Federated PD Pilot program in Q3-4 2013. The objectives of this pilot program were twofold: 1) to provide a communication forum for PD deployments being undertaken throughout the United States to discuss their requirements and approaches for the operationalizing of a community solution involving more than one PD, and 2) to provide feedback to the broader EHR and HISP stakeholder community as to the challenges and successes of their federation approaches using existing standards in order to inform the IWG membership and the ONC in the completion of a nationwide Federated Provider Directory specification and associated implementation guidance.

11.2 Provider Directory Landscape

The PD specification standards that were recognized as appropriate for this pilot program were:
IHE HPD
IHE HPD with CP-601
IWG HPDPlus 1.0
IWG HPDPlus 1.1
Other standards-based solutions were also allowed if they provided operational approaches to the same use cases as identified in these listed standards and/or offered unique PD federation solutions.

[Note: A new HPDPlus specification and Implementation Guide published in Q3 2012 by the ONC's PD ModSpec team was also offered as a deployment option but it was determined that this specification was not available in time to be deployed in near-production pilots. As a result, this ONC-sponsored specification is also intended to be informed by this pilot program feedback report.]

The PD landscape encountered in most of the pilots was a mixture of the available HPD standards listed previously. As such, one of the initial challenges confronting a pilot was to define a game plan for addressing the different technical and operational nuances of these different specifications. Resolution of Pd utilization policies across the communities was also an initial requirement. The inability to resolve these policy differences within the pilot program timeframe did impact a couple of the targeted PD deployments in more than one of the PD Pilot communities from being able to complete the exchange objective of the program.

The PD deployments and the associated vendors participating in this pilot program and providing feedback reflected in this appendix are:

PD Pilot Community	IT Product Vendor(s)	PD Specs Encountered
Michigan MiHIN- Florida FLHIN - Surescripts (Snowbird pilot)	Salesforce (MiHIN impl instance) Harris Surescripts	IWG HPDPlus 1.0 IWG HPDPlus 1.1 DSML 2.0 Gateway PD ModSpec via REST (explored)
NYeC- HEALTHeLINK (NY Pilot)	MedAllies Mirth	IWG HPDPlus 1.0
California Pilot [NCHIN, RAIN, OCPRHIO, San Diego Health Connect, Santa Cruz HIE, CHeQ at UC Davis Health System]	Mirth Internally-developed PD solutions (RAIN, CHeQ) California Trust Framework (PD Aggregation)	IHE HPD w CP601 IWG HPDPlus 1.1

PD Pilot Community	IT Product Vendor(s)	PD Specs Encountered
National Association of Trusted Entities (NATE) Pilot [Utah HIN, California NCHIN, Santa Cruz HIE]	Secure Exchange Solutions Mirth	IHE HPD w CP601 IWG HPDPlus 1.1

Although included within the scope of the Pilot Program, inclusion of an actual EHR "edge system" in the query/response transactions executed as part of pilots was not accomplished. That is, all PD Pilot Community transactions were triggered by a simulated query being placed on the PD with the primary deliverable being the resolution of this query against multiple PD's. Due to the short duration and the lack of direct EHR involvement in the pilot program there was limited engagement of providers in this program. At least some providers were engaged at NCHIN, which has been participating in provider directories through NATE for several months.

11.3 Use Cases / Transactions Executed By the Pilots

The following query and response transactions were performed to address the noted use cases as part of the pilot program deployments.

1. The primary use case for Direct in the California and NATE Pilots is for referrals or other transitions of care. Therefore, the primary use case for provider directories was to discover Direct addresses to use in referrals or other transitions of care. Search based on name, address, and specialty was explored.
2. Due to interoperability issues with the existing specs, PD replication was utilized as an initial phase of sharing PD information in the Snowbird Pilot. In this regard, this pilot was able to import and export each other's provider data using spreadsheets so that we demonstrated replicated directories that each implementation's client could use to search for external providers. In practice several participants imported full images from other participant's directories.
3. In the NY Pilot, the PD's queried multiple provider directories in a test environment searching by physician name, city specialty.

11.4 Interoperability Issues Encountered and Approaches Deployed to Address PD Federation

Although a number of issues were identified in multiple of the pilots, the specific feedback for each of the PD Pilot Community is listed below in order to better associate the challenges noted with the detailed technical environments identified in section 11.2.

PD Pilot Community	Snowbird pilot
Interoperability Issues	*Mismatches in messages, data definitions, field lengths, schemas, WSDL's etc?.* We experienced a difference in some field validation rules (e.g.: Fax numbers were required by Surescripts and not required by MiHIN – Surescripts opted to change their edit rules). Generally, the mismatches were easy to reconcile, however lack of agreement on required fields and permissible values between systems was a constant source of challenges. In particular, the systems in production did not support the same electronic service conventions and the HPD+ service relationship model is considerably more complicated than could be supported in two of the participants' directories. Some of the PD products only support Direct addresses for individual providers, whether others support the full specification requirements of individuals, organizations, and the association attribute linking the two. The multi-parameter/multi-object use cases (ex: Find Organizations for Unique Provider) are complicated queries to implement because of the use of DSML 2.0 as the query interface and language. The language constructs do not allow for join operations in a query so any multi-object query must be implemented as multiple (in most cases 3 distinct) queries. In the stated example a query would be done on the Provider based on an attribute. This would then be followed by a query on the Memberships using information found for the provider. Finally a query would need to be performed on the Organizations using data from Memberships. This not only has an impact on implementation but may also impact operation performance of such use cases. In addition, when using a RESTful exchange environment, multiple queries needed to be executed in order to accommodate LDAP requirements in lieu of using the SOAP-based DSML Gateway. The DSML Gateway provided a high-level api which was more efficient than the multiple lower level queries. *Confusion or ambiguities in the HPD specs leading to different interpretations in the deployed solutions?* The documents describing 1.0 and 1.1 definitions are not consistent within themselves and this led to errors in our implementation (e.g. some of the 1.1 documents had pictures from 1.0).

PD Pilot Community	Snowbird pilot
Interoperability Issues (continued)	*Other (onboarding, exchange of certificates, etc.)?* None.
PD Federation Approach Deployed	Phase 1 - Federation was achieved by replication Phase 2 - Search query orchestration extended to achieve federation among multiple HPD instances is being explored.

PD Pilot Community	NY Pilot
Interoperability Issues	*Mismatches in messages, data definitions, field lengths, schemas, WSDL's etc?* Current implementations of federated searches require pre-knowledge of: Directory URL, Bind DN (i.e., a user identity with search capabilities), Bind password. *Confusion or ambiguities in the HPD specs leading to different interpretations in the deployed solutions?* None specifically encountered. *Other (onboarding, exchange of certificates, etc.)?* None.
PD Federation Approach Deployed	PD Federation was successful in a test environment but further work is needed to bring it into a full production environment involving edge-system interaction.

PD Pilot Community	California pilot
Interoperability Issues	*Mismatches in messages, data definitions, field lengths, schemas, WSDL's etc?.* There were a number of issues identified: 1. There were differences in the level and method of authentication required for web service connections. 2. There were different interpretations of fields within the LDAP implementations. For example, identification of "state" within an address field might include spaces in the text string or might not, might include standard two-letter state abbreviations or other representations, etc. 3. There were different interpretations of the enumerated values in fields that might be used as filters in a query. For example, specialty was sometimes represented using the AMA provider taxonomy and sometimes using the ISO standard 21298.

PD Pilot Community	California pilot
Interoperability Issues (continued)	*Confusion or ambiguities in the HPD specs leading to different interpretations in the deployed solutions?* The current specifications from IHE and from IWG are closer to statements of a standard than an implementation guide. There was a great deal of discussion on how to interpret the overall structure of the underlying LDAP implementation, the exact format for values of fields in HPD/HPD+, what enumerated values should be used for fields within HPD/HPD+, how to construct complex queries, etc. Many of these items are detailed in the IHE HPD specification but not in the IWG HPD+ specification. Some of them were not detailed in either. Both HPD and HPD+ still provide many options, and we still believe there is significant need for a true implementation guide. *Other (onboarding, exchange of certificates, etc.)?* None.
PD Federation Approach Deployed	California exposed a single statewide orchestration service ("statewide directory service" or "SDS") with knowledge of all local provider directories. The preferred method for placing queries in California was to place them against the SDS, which in turn placed queries against appropriate local directories, collecting and aggregating responses as a single response. Individual peer-to-peer queries were enabled as well, but not encouraged and not as widely implemented.

PD Pilot Community	NATE pilot
Interoperability Issues	*Mismatches in messages, data definitions, field lengths, schemas, WSDL's etc?.* Plenty of these, even in limited use case. Some to be expected, some resulting on the loose specifications. WSDLs of the HPDCR601 and HPD+ are sufficiently different to require distinct implementations, which is far from ideal. Results were also differing wrt to specification. For example, the format of the postal address (awkward as it is) could have key tags for address elements as "$CITY" or "$ CITY" which makes it harder to parse. Specialty search terms are also inconsistent across implementations as some use NUCC nomenclature and others – ISO.

PD Pilot Community	NATE pilot
Interoperability Issues (continued)	Direct addresses also can be found in different parts of the model depending on implementation, though it should be noted that wherever they are placed, the queries to find Direct address may have to be executed in more than one step, which makes this an expensive (resource-wise and bandwidth-wise) exercise. The purpose of the specs is provider search (by a patient?), not Direct address search (for another provider), so even as HPD seems applicable being about the only option, it is at cross purposes with provider Direct address search which will hamper adoption and meaningful use. *Confusion or ambiguities in the HPD specs leading to different interpretations in the deployed solutions?* None specifically encountered. *Other (onboarding, exchange of certificates, etc.)?* Policy issues were not a significant issue since the pilot was within NATE infrastructure and certificates are posted to the NATE bundle and distributed through it.
PD Federation Approach Deployed	This was not a specific focus of this pilot as there is a federated environment in CA, but not across NATE..

11.5 Suggested Improvements in the PD Specifications and Tools to Enable a Nationwide Federated PD Environment

The following improvements and tools have been suggested in aggregate from the PD Pilot Communities.

11.5.1 Improvements to Specifications and Implementation Guides

a. Issuance of a single HPD specification and an associated Implementation Guide with examples of appropriate WSDLs and a reference implementation.
b. A robust glossary of terms and applicable value sets.
c. Provide a solution for supporting multi-parameter/multi-object use cases (ex: Find Organizations for Unique Provider) more efficiently. [The language constructs do not allow for join operations in a query so any multi-object query must be implemented as multiple (in most cases 3 distinct) queries]
d. Better guidance on security, technology standards, and acceptable interoperability policies across state lines.

11.5.2 Improvements to Tools or Services

a. An automated acceptance test suite that issued a set of well-defined queries and verified the responses against a canonical provider database. If possible, allow the test utility to support a sequence of releases of the standard to allow for incremental adoption by the vendor/organization PD communities.
b. A higher-level query API – at the ModSpec 7 level, for example – that scales better when transmitted over networks.