Metadata and Syndication: Interoperability and Mashups

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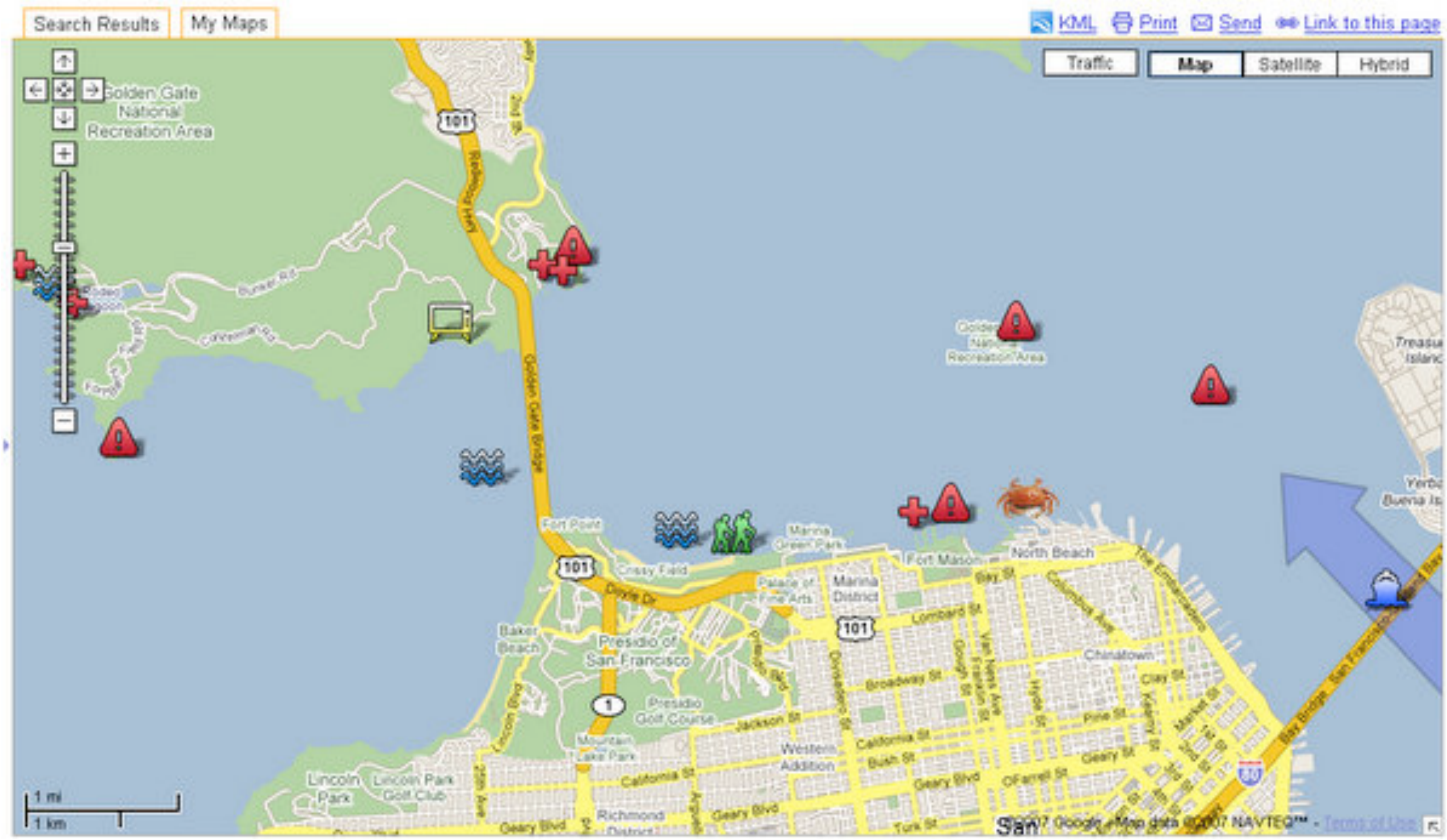
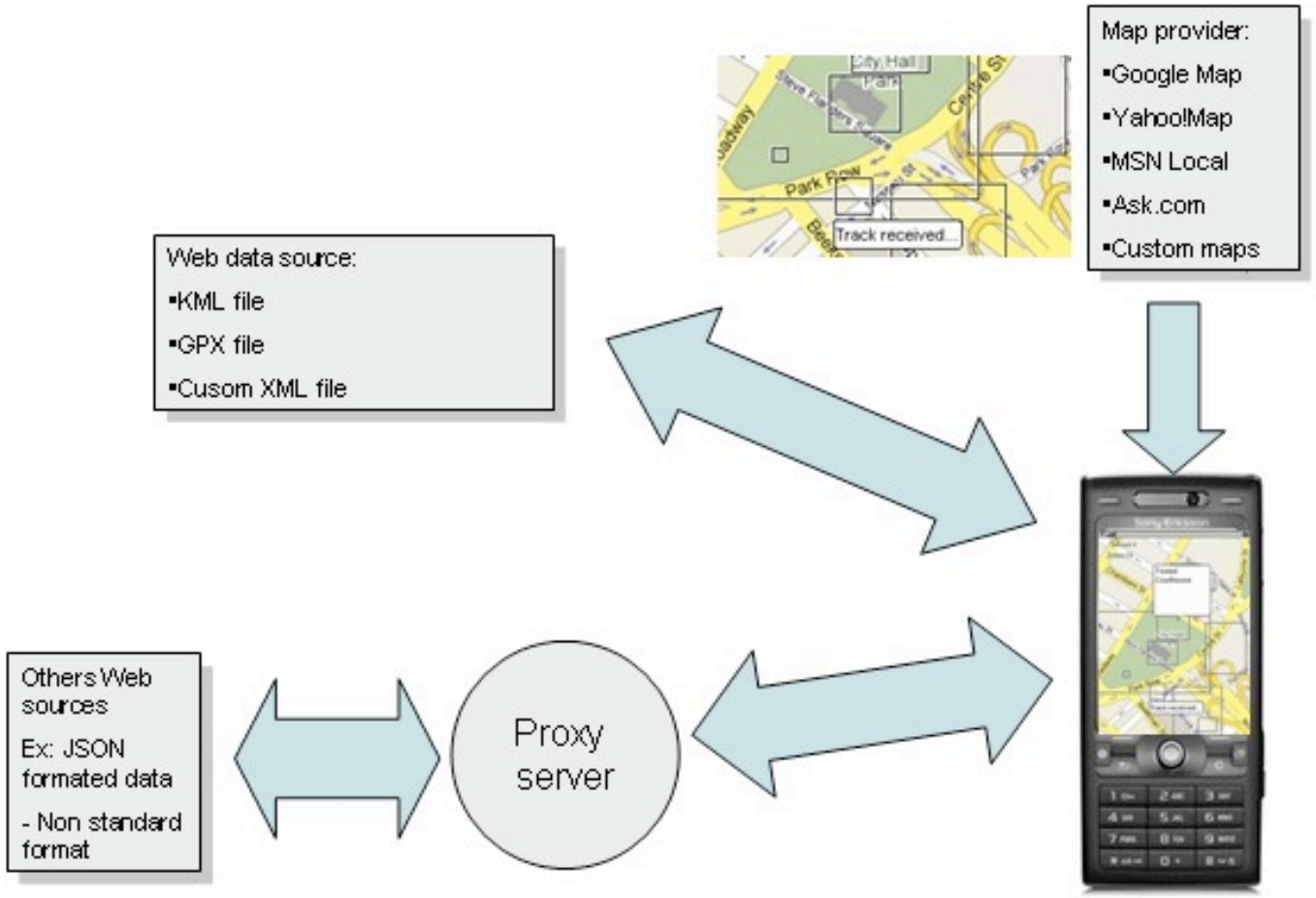
Mashups

- Combining data from several web sources
  - Treating the web as a database rather than a document store
- Post-processing that data
- Presenting the processed data

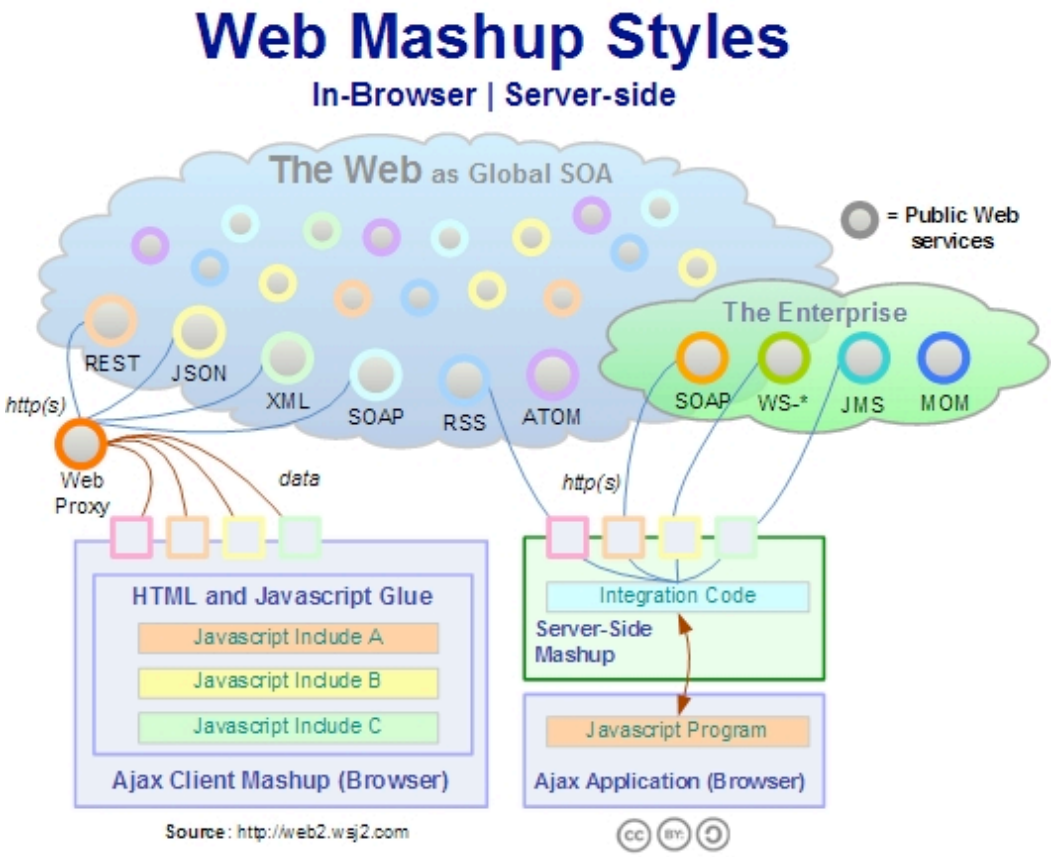


Search Results
My Maps
KML
Print
Send
Link to this page
Traffic
Map
Satellite
Hybrid
Golden Gate National Recreation Area
101
Bunker Rd
Golden Gate Bridge
Fort Point
Crissy Field
Marina Green Park
Fort Mason
North Beach
Palace of Fine Arts
Marina District
Doyle Dr
Baker Beach
Presidio of San Francisco
Presidio Golf Course
Lombard St
Broadway St
Jackson St
California St
Bush St
Geary Blvd
Western Addition
Chinatown
Clay St
Pine St
Lincoln Park
Lincoln Park Golf Club
Mountain Lake Park
Richmond District
Turk St
O'Farrell St
Van Ness Ave
Columbus Ave
The Embarcadero
Bay Bridge
Treasure Island
Yerba Buena Is
1 mi
1 km

Combining Data from Multiple Sources



Combining Data from Multiple Sources



Other types of mashups

What lies underneath?

- Getting heterogeneous systems to work together
- Providing the user with a seamless information experience
- Allow parameterization and interactive experience
  - AJAX

INTEROPERABILITY

Dimensions of Interoperability

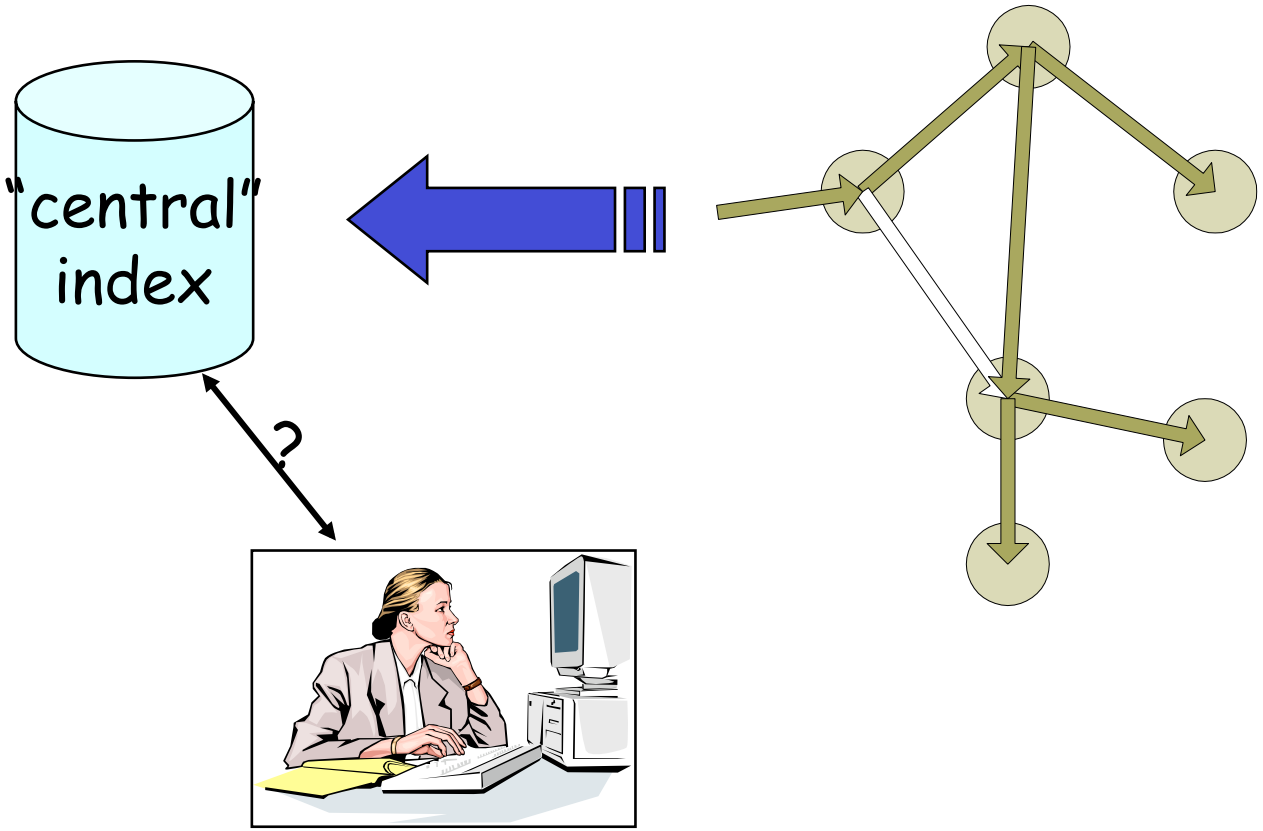
- Syntax
  - XML
- Semantics
  - XML Schema
  - RDF/RDFS
- Vocabularies/Ontologies
  - Dublin Core
  - Simple Knowledge Organisation System (SKOS)
  - OWL
- Content models
  - METS
  - FEDORA
  - DIDL
  - ORE

Contrast to Distributed Systems

- Distributed systems
  - Collections of components at different sites that are carefully designed to work with each other
- Heterogeneous or federated systems
  - Cooperating systems in which individual components are designed or operated autonomously

Base Interoperability: web interoperability (HTTP, HTML)

Crawling and Automated Processing (indexing)



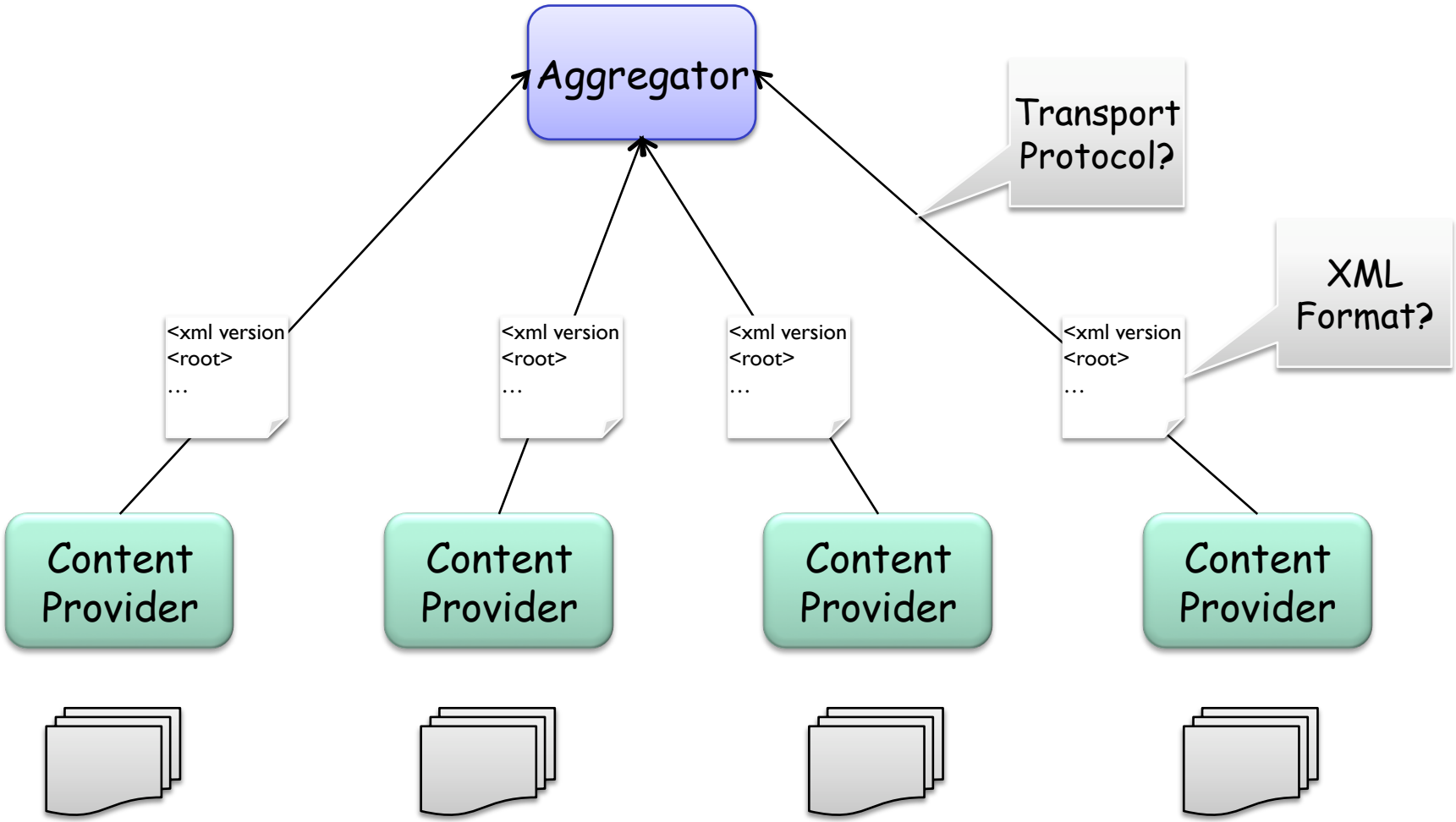
Crawlers and internet history

- 1991: HTTP
- 1992: 26 servers
- 1993: 60+ servers; self-register; archie
- 1994 (early) – first crawlers
- 1996 – search engines abound
- 1998 – focused crawling
- 1999 – web graph studies
- Current – personalized focused

Metadata aggregation and harvesting

- Crawling is not always appropriate
  - rights issues
  - focused targets
  - firewalls
  - deep web
  - Its not all text
- Other applications than search
  - Current awareness
  - Preservation
  - Summarization
  - Complex/compound object structure (browsing, etc.)

The general model



Syndication – RSS and Atom

- Format to expose news and content of news-like sites
  - Wired
  - Slashdot
  - Weblogs
- "News" has very wide meaning
  - Any dynamic content that can be broken down into discrete items
    - Wiki changes
    - CVS checkins
- Roles
  - Provider **syndicates** by placing an RSS-formated XML file on Web
  - Aggregator runs RSS-aware program to check feeds for changes

RSS History

- Original design (0.90) for Netscape for building portals of headlines to news sites
  - Loosely RDF based
- Simplified for 0.91 dropping RDF connections
- RDF branch was continued with namespaces and extensibility in RSS 1.0
- Non-RDF branch continued to 2.0 release
- Alternately called:
  - Rich Site Summary
  - RDF Site Summary
  - Really Simple Syndication

RSS is in wide use

- All sorts of origins
  - News
  - Blogs
  - Corporate sites
  - Libraries
  - Commercial

RSS components

- **Channel**
  - single tag that encloses the main body of the RSS document
  - Contains metadata about the channel -**title, link, description, language, image**
- **Item**
  - Channel may contain multiple items
  - Each item is a "story"
  - Contains metadata about the story (**title, description,** etc.) and possible **link** to the story

Simple RSS 2.0 Example

```
<?xml version="1.0" encoding="UTF-8"?>
<rss version="2.0">
  <channel>
    <title>NYT > Home Page</title>
    <link>http://www.nytimes.com/index.html?partner=rssnyt</link>
    <description>New York Times > Breaking News, World News &amp;amp; Multimedia</description>
    <language>en-us</language>
    <copyright>Copyright 2007 The New York Times Company</copyright>
    <lastBuildDate>Tue, 27 Feb 2007 16:05:01 EST</lastBuildDate>
    <image>
      <title>NYT > Home Page</title>
      <url>http://graphics.nytimes.com/images/section/NytSectionHeader.gif</url>
      <link>http://www.nytimes.com/index.html</link>
    </image>
    <item>
      <title>Wall Street Plummets After Chinese Stocks Take a Big Hit</title>
      <link>http://www.nytimes.com/2007/02/28/business/28stox.web.html?ex=1330318800&amp;amp;en=43b57471d
      <description>Stocks plunged in New York today after a sell-off in China rattled markets
        worldwide. </description>
      <author>JEREMY W. PETERS and DAVID BARBOZA</author>
      <guid isPermaLink="false">http://www.nytimes.com/2007/02/28/business/28stox.web.html</guid>
      <pubDate>Tue, 27 Feb 2007 15:55:12 EDT</pubDate>
    </item>
    <item>
      <title>Cheney Unhurt After Bombing in Afghanistan</title>
      <link>http://www.nytimes.com/2007/02/27/world/asia/27cnd-cheney.html?ex=1330232400&amp;amp;en=f3a3b16
      <description>A suicide bomber blew himself up outside the U.S. base at Bagram while Vice
        President Dick Cheney was inside. The Taliban claimed responsibility and said Mr.
        Cheney was the target.</description>
      <author>ABDUL WAHEED WAFA</author>
      <guid isPermaLink="false">http://www.nytimes.com/2007/02/27/world/asia/27cnd-cheney.html</guid>
      <pubDate>Tue, 27 Feb 2007 15:39:24 EDT</pubDate>
    </item>
```

RSS 2.0 Example - Namespaces

```
<?xml version="1.0" encoding="iso-8859-1"?>
<rss version="2.0" xmlns:photo="http://www.pheed.com/pheed/"
  xmlns:dc="http://purl.org/dc/elements/1.1/">
  <channel>
    <title>Natural Landscape Photographs</title>
    <link>http://www.photo-mark.com/cgi-bin/set.cgi?set_id=7</link>
    <description>A few natural landscape photographs.</description>
    <language>en-us</language>
    <item>
      <title>Windmill Farm with Cloud</title>
      <link>http://www.photomark.com/cgi-bin/set.cgi?set_id=7&amp;amp;n=0</link>
      <description>Windmill Farm at dusk with lenticular cloud, Wyoming</description>
      <category>In progress</category>
      <dc:creator>Mark Meyer</dc:creator>
      <dc:rights>Copyright 2001 Mark Meyer</dc:rights>
      <dc:coverage>Wyoming</dc:coverage>
      <dc:format>35mm Transparency</dc:format>
      <dc:subject> windmill farm lenticular cloud </dc:subject>
      <photo:imgsrc> http://www.photo-mark.com/webpix/ds/Windmillsa.jpg </photo:imgsrc>
      <photo:thumbnail> www.photo-mark.com/webpix/tn/Windmillsa.jpg </photo:thumbnail>


    </item>
    <item>
      <title>The Racetrack Playa</title>
      <link> http://www.photo-mark.com/cgi-bin/set.cgi?set_id=7&amp;amp;n=1 </link>
      <description>The Racetrack Playa</description>
      <category>In progress</category>
      <dc:creator>Mark Meyer</dc:creator>
      <dc:rights>Copyright 2003 Mark Meyer</dc:rights>
      <dc:coverage>Death Valley National Park, California</dc:coverage>
      <dc:format>4x5 Transparency</dc:format>
      <dc:subject> dry desert cracks </dc:subject>
      <photo:imgsrc> http://www.photo-mark.com/webpix/ds/racetrack.jpg </photo:imgsrc>
      <photo:thumbnail> http://www.photo-mark.com/webpix/tn/racetrack.jpg </photo:thumbnail>

    </item>
  </channel>
</rss>
```

RSS 1.0

```
<?xml version="1.0"?>
<rdf:RDF
 xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns="http://purl.org/rss/1.0/"
 xmlns:dc="http://purl.org/dc/elements/1.1/"
>
  <channel rdf:about="http://example.com/news.rss">
    <title>Example Channel</title>
    <link>http://example.com/</link>
    <description>My example channel</description>
    <items>
      <rdf:Seq>
        <rdf:li resource="http://example.com/2002/09/01/"/>
        <rdf:li resource="http://example.com/2002/09/02/"/>
      </rdf:Seq>
    </items>
  </channel>
  <item rdf:about="http://example.com/2002/09/01/">
     <title>News for September the First</title>
     <link>http://example.com/2002/09/01/</link>
     <description>other things happened today</description>
     <dc:date>2002-09-01</dc:date>
  </item>
  <item rdf:about="http://example.com/2002/09/02/">
     <title>News for September the Second</title>
     <link>http://example.com/2002/09/02/</link>
     <dc:date>2002-09-02</dc:date>
  </item>
</rdf:RDF>
```

Atom

- Attempt to rationalize RSS 1.x, 2.x divergence
- Encoding is up-to-date with current XML standards
  - namespaces
  - Schema
- Robust content model
  - Distinguishes between metadata and content (plain text, HTML, base-64 binary)
- Well-defined extensibility model
- IETF FRC 4287
  - http://www.ietf.org/rfc/rfc4287

Simple Atom Feed

```
<?xml version="1.0" encoding="UTF-8"?>
<feed xmlns="http://www.w3.org/2005/Atom"
   xml:lang="en"
   xml:base="http://www.example.org">
   <id>http://www.example.org/myfeed</id>
   <title>My Simple Feed</title>
   <updated>2005-07-15T12:00:00Z</updated>
   <link href="/blog" />
   <link rel="self" href="/myfeed" />
   <entry>
      <id>http://www.example.org/entries/1</id>
      <title>A simple blog entry</title>
      <link href="/blog/2005/07/1" />
      <updated>2005-07-15T12:00:00Z</updated>
      <summary>This is a simple blog entry</summary>
   </entry>
   <entry>
      <id>http://www.example.org/entries/2</id>
      <title />
      <link href="/blog/2005/07/2" />
      <updated>2005-07-15T12:00:00Z</updated>
      <summary>This is simple blog entry without a title</summary>
   </entry>
</feed>
```

Atom with namespaces

```
<?xml version="1.0" encoding="UTF-8"?>
<feed xmlns="http://www.w3.org/2005/Atom" xml:lang="en" xmlns:foaf="http://xmlns.com/foaf/0.1"
  xml:base="http://www.example.org" xmlns:dc="http://purl.org/dc/elements/1.1/">
  <id>http://www.example.org/myfeed</id>
  <title>My Simple Feed</title>
  <updated>2005-07-15T12:00:00Z</updated>
  <dc:creator>
    <name>James M Snell</name>
    <foaf:homepage rdf:resource="/blog"/>
    <foaf:img rdf:resource="/mypic.png"/>
  </dc:creator>
  <dc:contributor>
    <name>Jane Doe</name>
    <foaf:homepage rdf:resource="/janesblog"/>
    <foaf:image rdf:resource="/janespic.png"/>
  </dc:contributor>
  <link href="/blog"/>
  <link rel="self" href="/myfeed"/>
  <entry>
    <id>http://www.example.org/entries/1</id>
    <title>A simple blog entry</title>
    <link href="/blog/2005/07/1"/>
    <updated>2005-07-15T12:00:00Z</updated>
    <summary>This is a simple blog entry</summary>
  </entry>
  <entry>
    <id>http://www.example.org/entries/2</id>
    <title/>
    <link href="/blog/2005/07/2"/>
    <updated>2005-07-15T12:00:00Z</updated>
    <summary>This is simple blog entry without a title</summary>
  </entry>
</feed>
```

Atom Enclosures and Content Support (podcast)

```
<?xml version="1.0" encoding="UTF-8"?>
<feed xmlns="http://www.w3.org/2005/Atom">
  <id>http://www.example.org/myfeed</id>
  <title>My Podcast Feed</title>
  <updated>2005-07-15T12:00:00Z</updated>
  <author>
    <name>James M Snell</name>
  </author>
  <link href="http://example.org" />
  <link rel="self" href="http://example.org/myfeed" />
  <entry>
    <id>http://www.example.org/entries/1</id>
    <title>Atom 1.0</title>
    <updated>2005-07-15T12:00:00Z</updated>
    <link href="http://www.example.org/entries/1" />
    <summary>An overview of Atom 1.0</summary>
    <link rel="enclosure"
      type="audio/mpeg"
      title="MP3"
      href="http://www.example.org/myaudiofile.mp3"
      length="1234" />
    <link rel="enclosure"
      type="application/x-bittorrent"
      title="BitTorrent"
      href="http://www.example.org/myaudiofile.torrent"
      length="1234" />
    <content type="xhtml">
      <div xmlns="http://www.w3.org/1999/xhtml">
        <h1>Show Notes</h1>
        <ul>
          <li>00:01:00 -- Introduction</li>
          <li>00:15:00 -- Talking about Atom 1.0</li>
          <li>00:30:00 -- Wrapping up</li>
        </ul>
      </div>
    </content>
  </entry>
</feed>
```

Automated discovery of RSS/ATOM feeds

```
<!-- feed autodiscovery links -->
<link rel="alternate" type="application/atom+xml"
  title="XML.com Articles and Weblogs" href="http://www.oreillynet.com/pub/feed/20" />
<link rel="alternate" type="application/rdf+xml"
  title="XML.com Articles and Weblogs" href="http://www.oreillynet.com/pub/feed/20?format=rss1" />
<link rel="alternate" type="application/rss+xml"
  title="XML.com Articles and Weblogs" href="http://www.oreillynet.com/pub/feed/20?format=rss2" />
```

What RSS doesn't have

- Notion of a "collection" – corpus of documents that persist
- Technique for selectively requesting metadata from parts of the collection
- Notion of multiple descriptive types

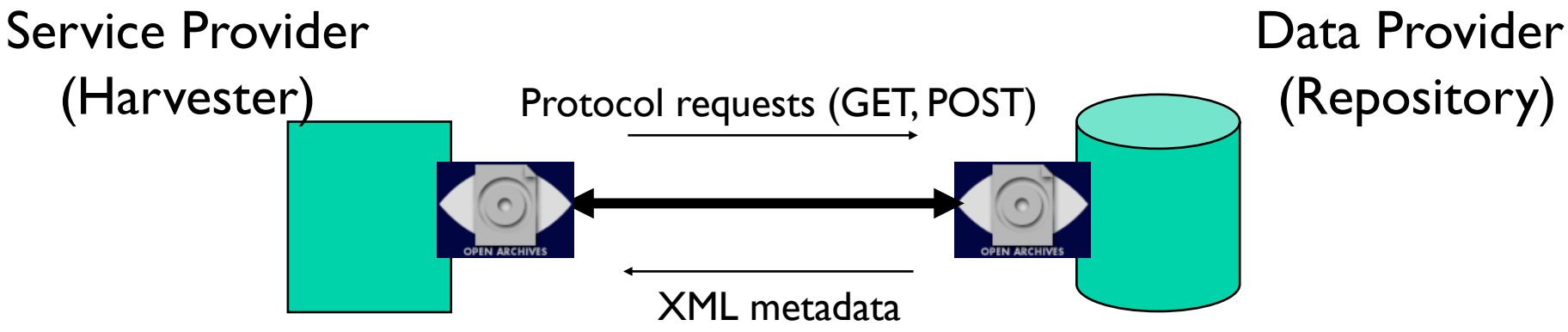
- These things are important for more "library-like" corpora, *e.g.*, museums, libraries, **repositories**

The Open Archives Initiative (OAI) and the Protocol for Metadata Harvesting (OAI-PMH)

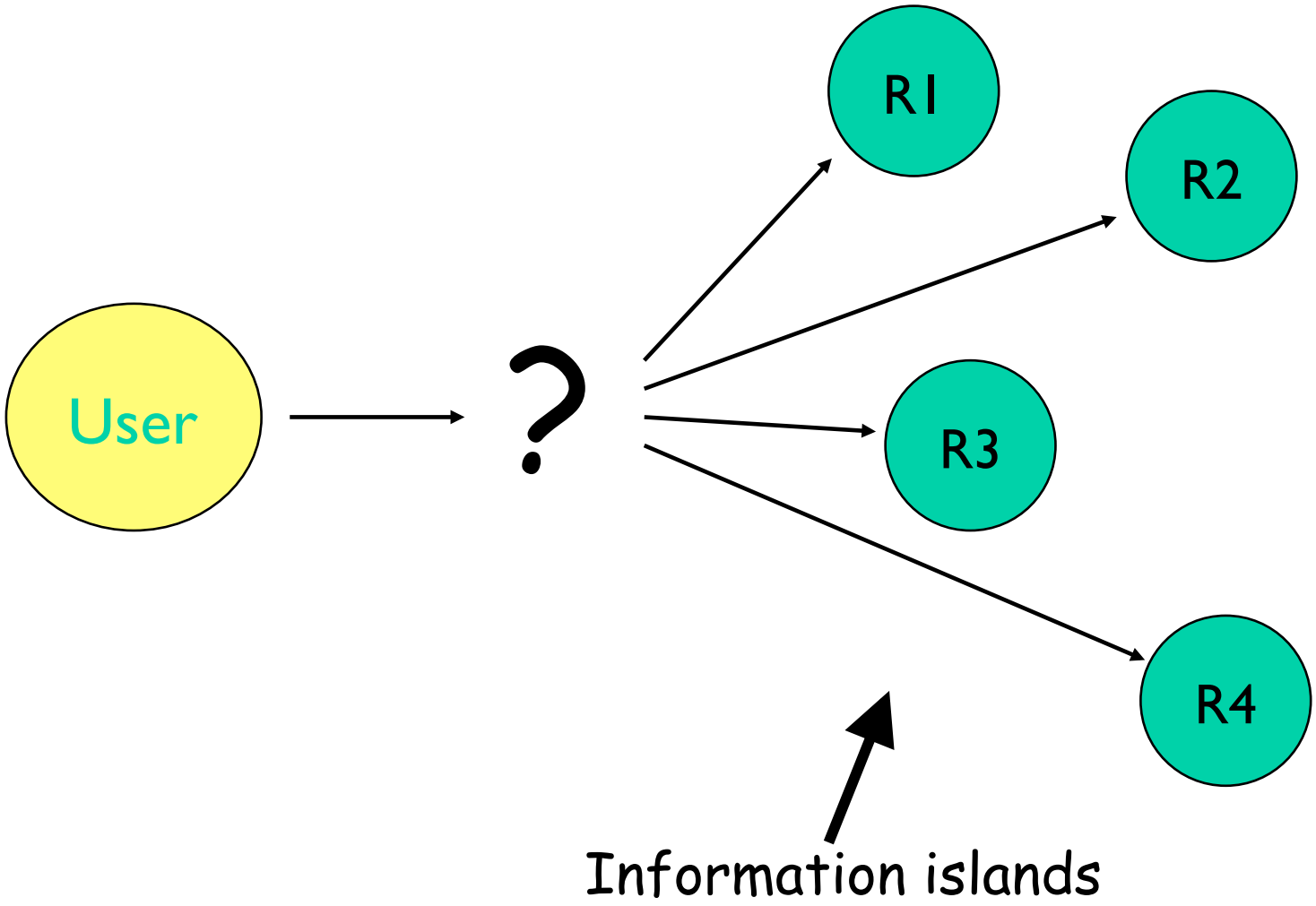
OAI-PMH

⇒ PMH -> Protocol for Metadata Harvesting http://www.openarchives.org/OAI/2.0/openarchivesprotocol.htm

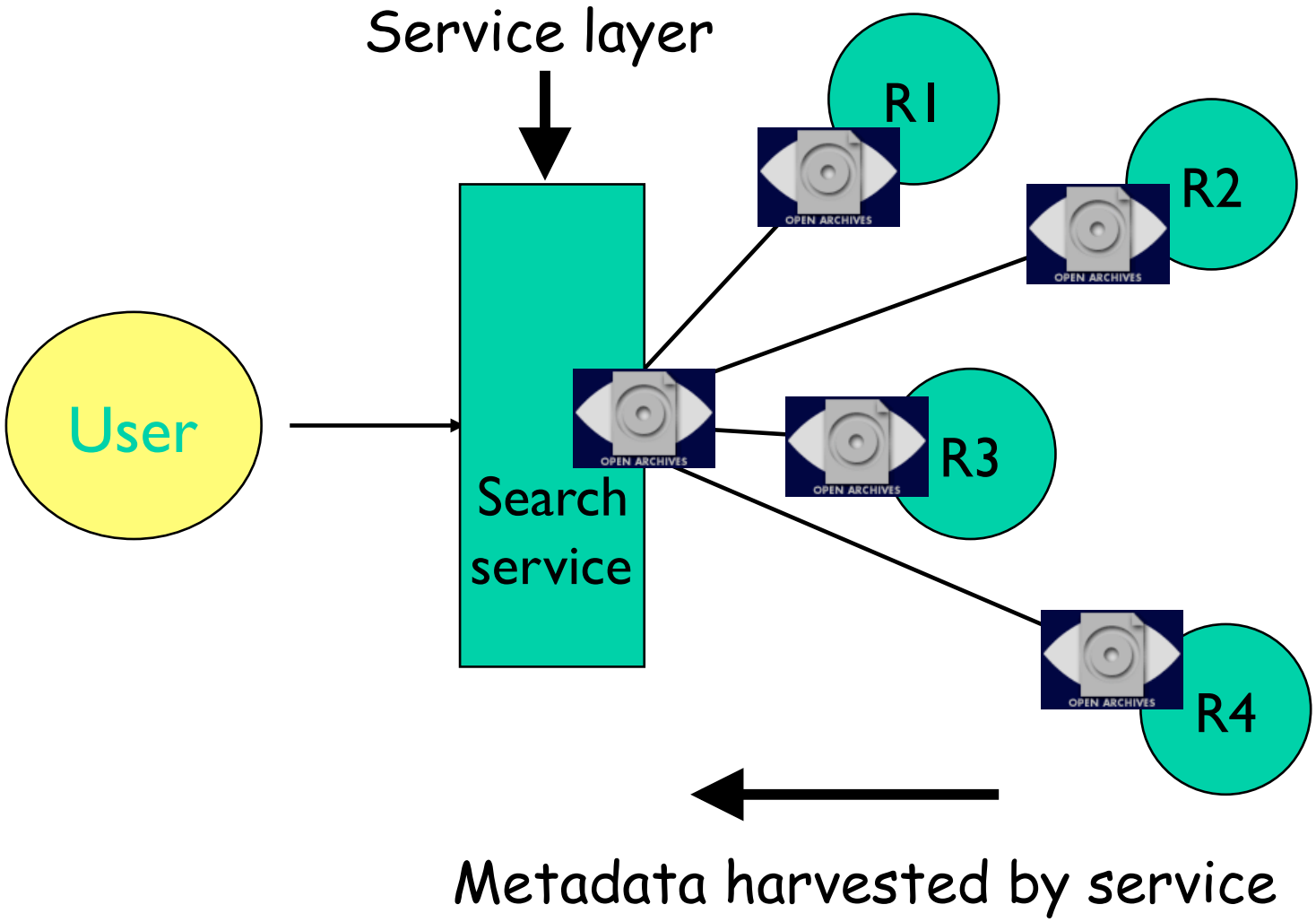
- Simple protocol, just 6 verbs
- Designed to allow harvesting of any XML (meta)data (schema described)
- For batch-mode not interactive use



OAI for discovery



OAI for discovery



OAI-based Search

- OAIster - http://www.oaister.org/

OAI-PMH Data Model

resource

item has identifier

all available metadata about this sculpture

item

Dublin Core metadata

MARC21 metadata

branding metadata

records

record has identifier + metadata format + datestamp

Identifiers

- Items have identifiers (all records of same item share identifier)
- Identifiers must have URI syntax identifiers must be assumed to be local to the repository
- Complete identification of a record is baseURL+identifier +metadataPrefix+datestamp

OAI-PMH verbs

metadata about the repository

harvesting verbs

Verb	Function
Identify	description of archive
ListMetadataFormats	metadata formats supported by archive
ListSets	sets defined by archive
ListIdentifiers	OAI unique ids contained in archive
ListRecords	listing of N records
GetRecord	listing of a single record

most verbs take arguments: dates, sets, ids, metadata formats and resumption token (for flow control)

OAI-PMH and HTTP

- OAI-PMH uses HTTP as transport
  - Encoding OAI-PMH in GET
    - http://baseURL?verb=<verb>&arg1=<arg1Val>...
    - Example: http://an.oa.org/OAIscript?
      verb=GetRecord&
      identifier=oai:arXiv.org:hep-th/9901001&
      metadataPrefix=oai_dc
- Error handling
  - all OK at HTTP level? => 200 OK
  - something wrong at OAI-PMH level? => OAI-PMH error (e.g. badVerb)
- HTTP codes 302 (redirect), 503 (retry-after), etc. still available to implementers, but do not represent OAI-PMH events

OAI and Metadata Formats

- Protocol based on the notion that a record can be described in multiple metadata formats
- Dublin Core is required for "interoperability"

OAI-PMH Responses

- All defined by one schema
  - http://www.openarchives.org/OAI/2.0/OAI-PMH.xsd"
- Generic Structure (Header and Body)

```
<?xml version="1.0" encoding="UTF-8"?>
<OAI-PMH xmlns="http://www.openarchives.org/OAI/2.0/"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation="http://www.openarchives.org/OAI/2.0/
                     http://www.openarchives.org/OAI/2.0/OAI-PMH.xsd">
 <responseDate>2007-02-28T12:50:01Z</responseDate>
 <request verb="ListRecords" metadataPrefix="oai_dc" set="mussm"
  >http://memory.loc.gov/cgi-bin/oai2_0</request>
 <ListRecords> [5168 lines]
</OAI-PMH>
```

Generic Record Structure

```
<record>
 <header>
  <identifier>oai:lcoa1.loc.gov:loc.music/sm1819.360010</identifier>
  <datestamp>2005-11-21T17:08:59Z</datestamp>
  <setSpec>mussm</setSpec>
 </header>
 <metadata>
  <oai_dc:dc xmlns:oai_dc="http://www.openarchives.org/OAI/2.0/oai_dc/"
   xmlns:dc="http://purl.org/dc/elements/1.1/"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xsi:schemaLocation="http://www.openarchives.org/OAI/2.0/oai_dc/
            http://www.openarchives.org/OAI/2.0/oai_dc.xsd">
   <dc:title>The hunter&apos;s horn, a new sporting cavatina /</dc:title>
   <dc:creator>Philipps, T.</dc:creator>
   <dc:subject>Cavatina</dc:subject>
   <dc:subject>Songs with piano</dc:subject>
   <dc:description>In bound volumes: Copyright Deposits 1820-1860</dc:description>
   <dc:publisher>New York: Geib and Co</dc:publisher>
   <dc:date>1819</dc:date>
   <dc:type>text</dc:type>
   <dc:type>musical notation</dc:type>
   <dc:identifier>http://hdl.loc.gov/loc.music/sm1819.360010</dc:identifier>
   <dc:language>eng</dc:language>
  </oai_dc:dc>
 </metadata>
</record>
```

PAI-PMH Requests

- http://memory.loc.gov/cgi-bin/oai2_0?verb=ListMetadataFormats
- http://memory.loc.gov/cgi-bin/oai2_0?verb=ListRecords&metadataPrefix=oai_dc
- http://memory.loc.gov/cgi-bin/oai2_0?verb=ListRecords&metadataPrefix=oai_marc

Selective Harvesting

- RSS is mainly a "tail" format
- OAI-PMH is more "grep" like
- Two "selectors" for harvesting
  - Date
  - Set
- Why not general search?
  - Out of scope
  - Not low-barrier
  - Difficulty in achieving consensus

Datestamps

- All dates/times are UTC, encoded in ISO8601, Z notation:
  `1957-03-20T20:30:00Z`
- Datestamps may be either fill date/time as above or date only (YYYY-MM-DD). Must be consistent over whole repository, 'granularity' specified in Identify response.
- Earlier version of the protocol specified "local time" which caused lots of misunderstandings. Not good for global interoperability!

Sets

- Simple notion of grouping at the item level to support selective harvesting
  - Hierarchical set structure
  - Multiple set membership permitted
  - E.g: repo has sets A, A:B, A:B:C, D, D:E, D:F
    If item1 is in A:B then it is in A
    If item2 is in D:E then it is in D, may also be in D:F
    Item3 may be in no sets at all

    http://memory.loc.gov/cgi-bin/oai2_0?verb=ListSets

Selective Harvesting Request

- http://memory.loc.gov/cgi-bin/oai2_0?verb=ListRecords&metadataPrefix=oai_dc&set=ahii&from=2004-01-01

Harvesting strategy

- Issue Identify request
  - Check all as expected (validate, version, baseURL, granularity, comporession…)
- Check sets/metadata formats as necessary (ListSets, ListMetadataFormats)
- Do harvest, initial complete harvest done with no `from` and `to` parameters
- Subsequent incremental harvests start from datastamp that is `responseDate` of last response

OAI-PMH – Has it worked?

- Of course, yes…
  - Very wide deployment
  - "millions and millions of records served"
  - Incorporated into commercial systems
- But….
  - NSDL experience has shown "low barrier" is not always true
    - XML is hard
  - Incremental harvesting model is full of holes