ResourceSync

Towards a Web-Based Approach for Resource Synchronization

Herbert Van de Sompel
Los Alamos National Laboratory
@hvdsomp

ResourceSync is funded by
The Sloan Foundation

ResourceSync

Problem Perspective

Technical Directions

An Experiment

Q&A

ResourceSync Core Team – NISO & OAI

Cornell University & OAI:
Berhard Haslhofer, Carl Lagoze, Simeon Warner

Old Dominion University & OAI:
Michael L. Nelson

Los Alamos National Laboratory & OAI:
Martin Klein, Robert Sanderson, Herbert Van de Sompel

NISO:
Todd Carpenter, Nettie Lagace, Peter Murray

ResourceSync Technical Group

- Manuel Bernhardt, Delving B.V.
- Richard Jones, JISC
- Graham Klyne, JISC
- Stuart Lewis, JISC
- Kevin Ford, Library of Congress
- David Rosenthal, LOCKSS
- Christian Sadilek, Red Hat
- Shlomo Sanders, Ex Libris, Inc.
- Sjoerd Siebinga, Delving B.V.
- Jeff Young, OCLC Online Computer Library Center

ResourceSync

Problem Perspective

Technical Directions

An Experiment

Q&A

ResourceSync Problem

- Consideration:
  - Source (server) A has resources that change over time: they get created, modified, deleted, moved, …
  - Destination (servers) X, Y, and Z leverage (some) resources of Source A.
- Problem:
  - Destinations want to keep in step with the resource changes at Source A: resource synchronization.
- Task of ResourceSync effort:
  - Design an approach for resource synchronization aligned with the Web Architecture that has a fair chance of adoption by different communities.
    - The approach must scale better than recurrent HTTP HEAD/GET on resources.

ResourceSync Use Cases

- arXiv mirroring.
- Metadata and content transfer from Europeana partners to central Europeana hub.
- Synchronization, local caching of Linked Data content.
- Recurrently collecting Memento metadata from IIPC web archives to central aggregator.
- Keeping up-to-data with resources that reside on a Web server.

- Use cases have different requirements regarding synchronization accuracy:
  - Synchronization coverage: perfect …… good enough
  - Synchronization speed: fast …….. fast enough

Web Context

- The context in which resource synchronization will take place is the Web.
- Resources considered for synchronization:
  - Are identified by dereference-able URIs.
  - Are cache-able.

=> Caveat: It is understood that resources that require client-side processing (e.g. hashbang URIs) cause problems.

3 Synchronization Needs

- Overall, there are 3 distinct needs regarding resource synchronization. All 3 are considered in scope for the effort:

  1. Baseline matching: An approach to allow a Destination that wants to start synchronizing with a Source to perform an initial catch up – Dump.
  2. Incremental resource synchronization: An approach to allow a Destination to remain up-to-date regarding changes at the Source.
  3. Audit: An approach to allow checking whether a Destination is in sync with a Source – Inventory.

Change Notification – Content Transfer

- Distinguish between two aspects related to incremental resource synchronization:

  2.a. Change notification: An approach to allow a Destination to understand that a Source's resource has changed; and what the nature of the change is.

  2.b. Content transfer: An approach to allow a Destination to update its holdings to reflect the change the resource underwent at the Source.

=> For both, PUSH or PULL approaches are conceivable.

Selective Synchronization

- There is a need to be able to synchronize with a limited set of a Source's resources: selective synchronization.
  - This leads to the notion of channels for resource synchronization.
  - The need for channels is most apparent for resource synchronization but may have to be carried through in baseline matching and audit.

=> This raises an issue:

- The definition of channels by the Source is straightforward, yet may not meet the Destination's needs.
- The definition of channels by a Destination is less straightforward.

Memory

- For robustness, both change notification and content transfer may need a memory function to allow for synchronization after a Destination has missed updates:
  - Catching up on change notifications - Digests.
  - Catching up on resource versions - Mementos.

⇒ However, it would be beneficial if resource synchronization could operate in a memory-less mode in cases where less than perfect sync is acceptable.

⇒ An important architectural consideration is where that memory should reside: Source, intermediary.

Changes Only – Entire Resource

- Two approaches for content transfer:

  2.b.1. Synchronization is achieved by transfer of the entire resource.

  2.b.2. Synchronization is achieved by transfer of resource changes only.

⇒ Focus is on (2.b.1) because of complexities re content-type-specific resource segment description and re-assembly instructions involved in (2.b.2).

⇒ Focus re (2.b.1) is on content transfer using a PULL, not PUSH, approach.

Event Types

- Event types to be considered for change notifications:
  - Tier 1:
    - Regarding resources: create ; delete ; update ; new dump ; new inventory
    - Regarding channels: removed from channel ; added to channel
  - Tier 2:
    - Regarding resources: move ; copy

⇒ Focus is on Tier 1 and on events pertaining to single resources.

⇒ Tier 2 and consideration of groups of resources (e.g. URI templates, URI regex) is postponed.

Resource Representations

- Resource representations are subject to synchronization:
  - But limited to those that can be requested using protocol parameters for the resource's URI.

=> Caveats:

- It is understood this causes problems in light of resource representation *personalization*, e.g. geo-dependent representations.
- If the change notification function is provided by 3rd party instead of Source, change notifications may be *subjective* to the 3rd parties perspective.

Discovery

- Several Discovery needs arise:
  - Regarding change notification channels:
    - How to find channels that provide change notifications for a given Source Server?
    - How to find information about the nature of the changes that are communicated on such channels?
  - Regarding dumps and inventories:
    - Where to obtain the most recent dump?
    - Where to obtain the most recent inventory?
  - Regarding memory:
    - Where to obtain digests?
    - How to access Mementos?

And Also …

- Authorization: For baseline matching, resource synchronization (change notification, content transfer), and audit a distinction may be required between Destinations that are authorized or unauthorized to perform these functions.

- Embargo: How soon after a resource change are parties allowed to know about it, to act upon it?

- Trust in a change notification channel:
  - Can a change notification channel that provides information about a given Source Server be trusted?

ResourceSync

Problem Perspective

Technical Directions

An Experiment

Q&A

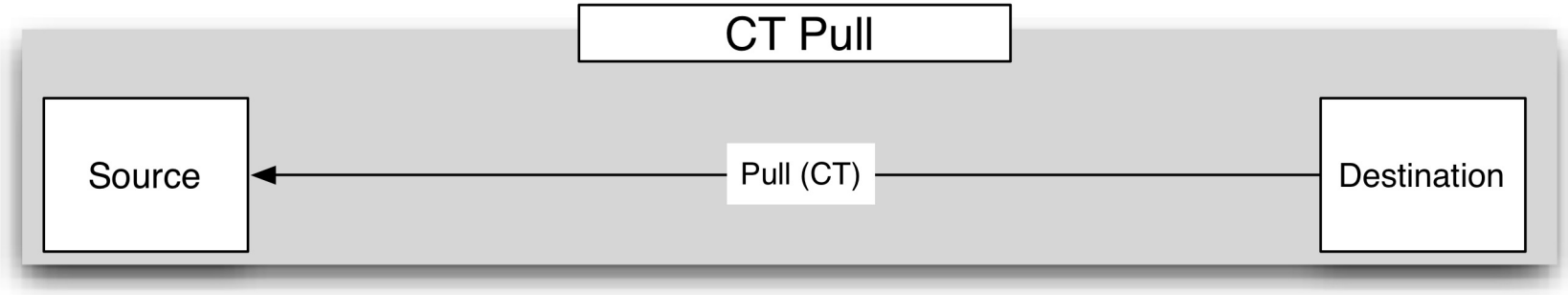
ResourceSync Architectural Challenges

1. Initial Baseline Synchronization ~ Dump
2. **Incremental Synchronization**
    1. **Change Notification (CN)**
        - **Alert that something happened (create, update, delete)**
    2. **Content Transfer (CT)**
        - **Transfer of just the change or the full resource**
3. Audit to ensure Consistency

Incremental Synchronization - Architectures

Trivial Approach:

- Retrieve every resource and compare to current copy

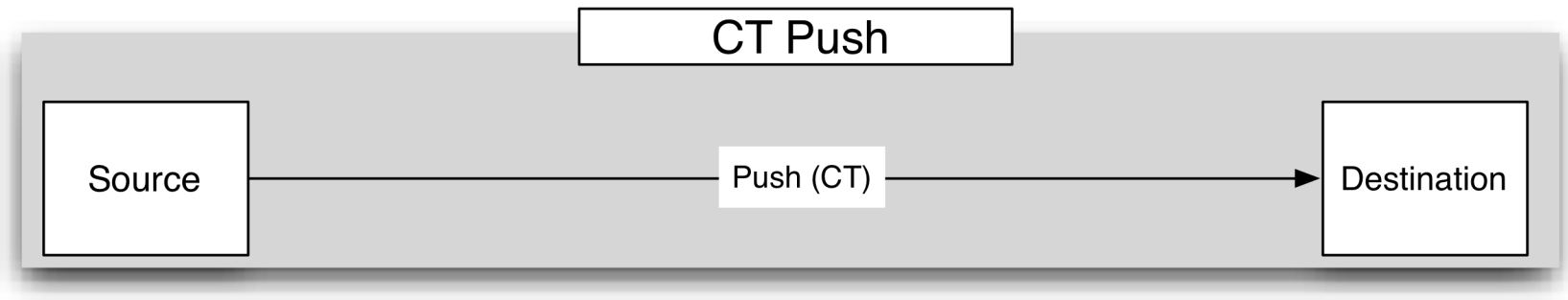


- Not scalable: too many wasted, large transactions
- No way to discover newly created resources

Incremental Synchronization - Architectures

Theoretically Optimal Solution:

- Whenever a resource changes, push only the change to the appropriate Destinations

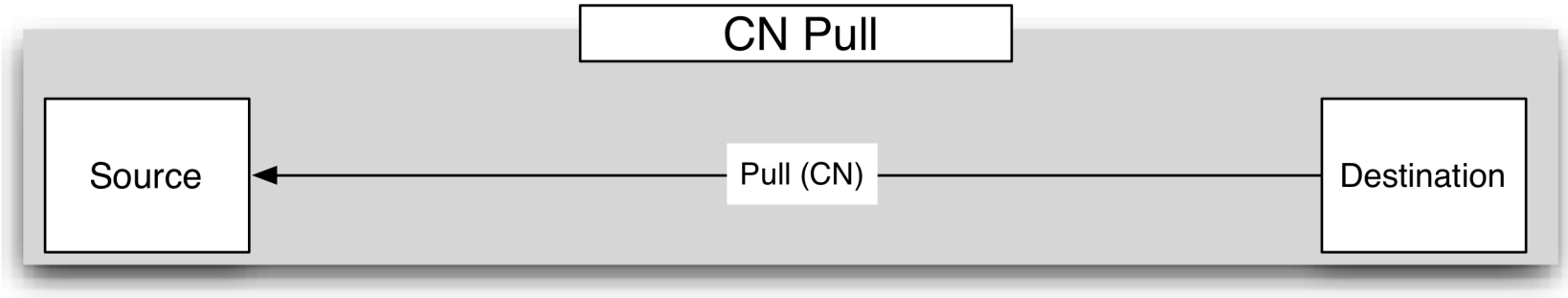


- No wasted transactions, only as much data transferred as needed
- Newly created resources are discovered
- But overly burdens the source! Not economically viable
- Q: Sweet point between Trivial and Optimal?

Incremental Synchronization - Architectures

Trivial Approach plus Conditional GET (If-Modified-Since):

- Retrieve every resource if it has changed

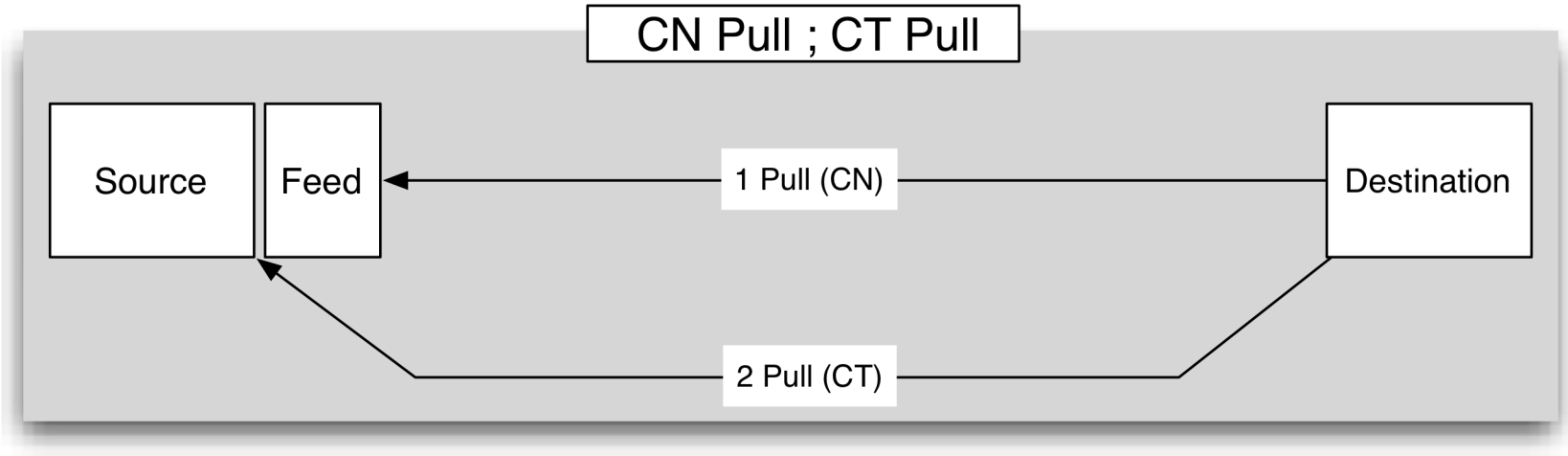


- Still not scalable: too many wasted transactions
- Still no way to discover newly created resources

Incremental Synchronization - Architectures

Simplest Workable Model:

- Introduce a Feed of change notifications for all resources
- Atom, RSS, OAI-PMH, SiteMaps, etc.

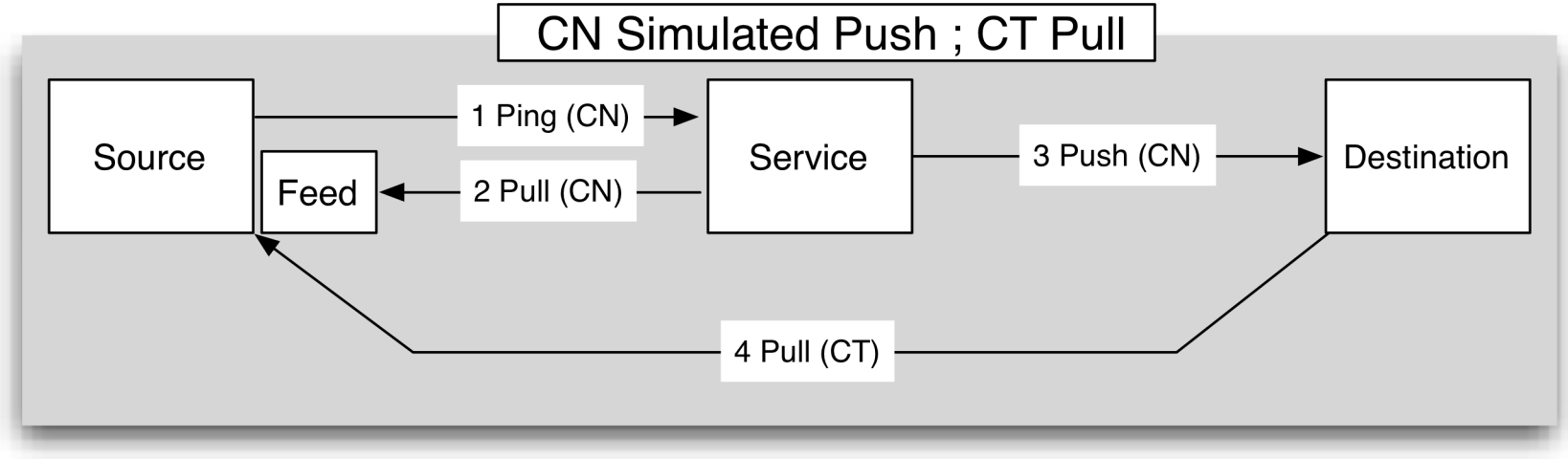


- Significantly reduces wasted transactions
- Newly created resources are discovered
- But still not very efficient as Destination doesn't know when to pull

Incremental Synchronization - Architectures

Feed Extension Solution:

- Continue the Feed paradigm, but introduce an aggregating Service, and have the Source ping the Service when there's a change (simulated push)

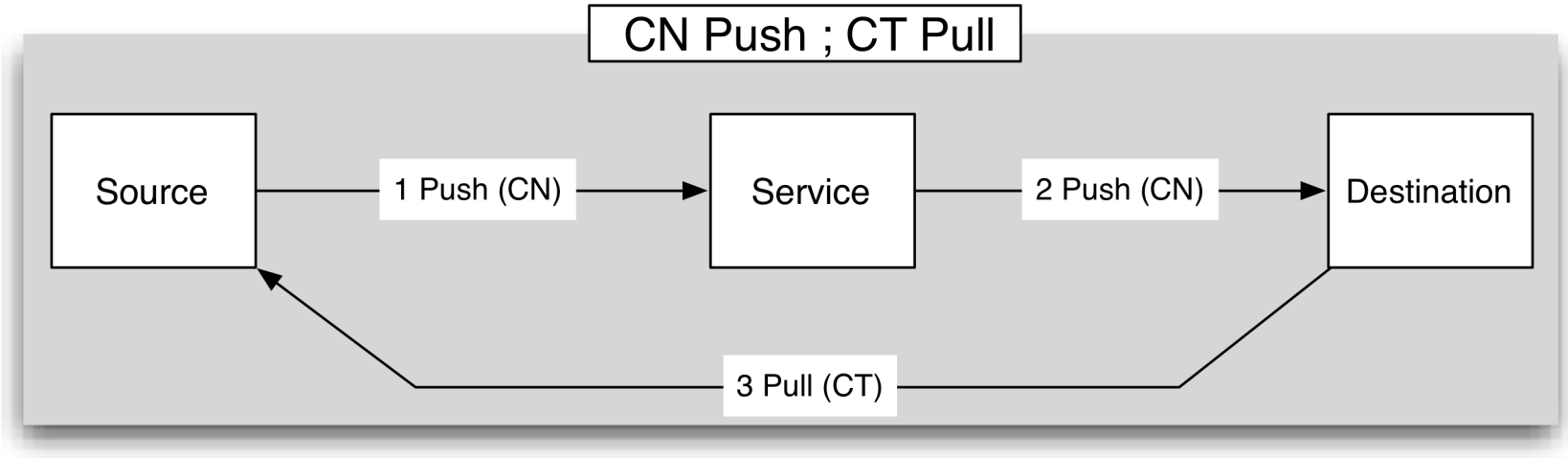


- No wasted transactions, but pull will get already-seen notifications
- Only advantageous if Source already supports a Feed

Incremental Synchronization - Architectures

Push Solution:

- Instead of ping+pull, Source can push the change notification



- No wasted transactions, no wasted data transfer
- Service maintains subscriber list, not Source
- Change Notification from Source is easier than a Ping+Feed if no feed is already available, and minimally harder than just a Ping

Change Notification - Protocols

- Atom PubSubHubbub (PuSH)
- XMPP
  - PubSub extension
  - BoSH (XMPP over HTTP)
- Comet / HTTP Streaming
  - Open an HTTP connection and keep reading from it
  - Bayeux Protocol
- Long Polling
  - Keep HTTP connection open until a message, then reopen
  - BoSH, Bayeux option
- WebSockets
  - NullMQ / ZeroMQ
  - XMPP over WebSockets?

Ongoing Investigations

- Change Notification - XMPP & XMPP PubSub & bleeps
  - LANL
  - Ongoing Experiment with LiveDBPedia
- Change Notification - Comet / HTTP Streaming & bleeps
  - ODU
  - Bayeux Protocol via Faye Implementation
- Change Notification - Change Simulator
  - Cornell U
  - Generate configurable change notifications
  - Use as standardized input to different systems for testing
- Baseline Matching & Audit
  - Cornell U
  - Looking into Sitemap protocol extension

ResourceSync

Problem Perspective

Technical Directions

An Experiment

Q&A

LiveDBpedia Synchronization Experiment

- Propose a synchronization approach:
  - Push for resource change notification: XMPP PubSub
  - Pull for resource synchronization: HTTP GET
- Use LiveDBpedia's ad-hoc synchronization tool to create a LiveDBpedia-LANL.
- Test the proposed approach to allow third parties:
  - To be aware of changes to subject-URIs of LiveDBpedia-LANL
  - To synchronize with subject-URIs of LiveDBpedia-LANL

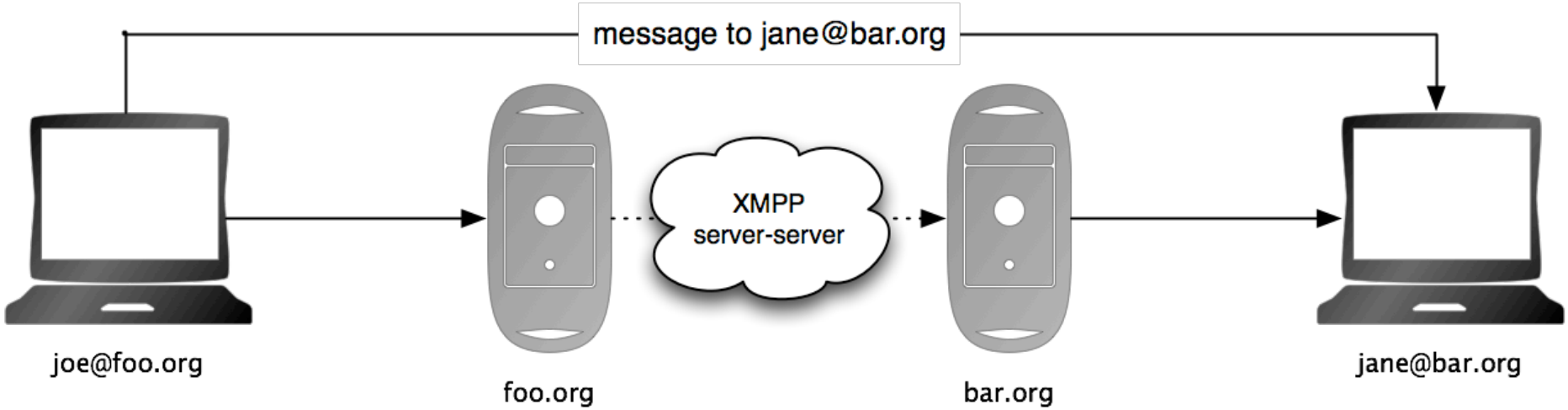
<XMPP Intermezzo>

XMPP

Extensible Messaging and Presence Protocol - XMPP: Client to Client(s) communication with help of intermediate servers (cf IM)

- Based on Jabber (1999)
- See http://xmpp.org
- 3 Core RFCs:
  - XMPP CORE – RFC 6120 - http://xmpp.org/rfcs/rfc6120.html
  - XMPP Instant Messaging and Presence – RFC 6121 - http://xmpp.org/rfcs/rfc6121.html
  - XMPP Address Format – RFC 6122 - http://xmpp.org/rfcs/rfc6122.html
- Multitude of extension specifications, see http://xmpp.org/xmpp-protocols/xmpp-extensions/
- Extensive toolkit: clients, servers, libraries – see http://xmpp.org/xmpp-software/

XMPP Architectural Diagram

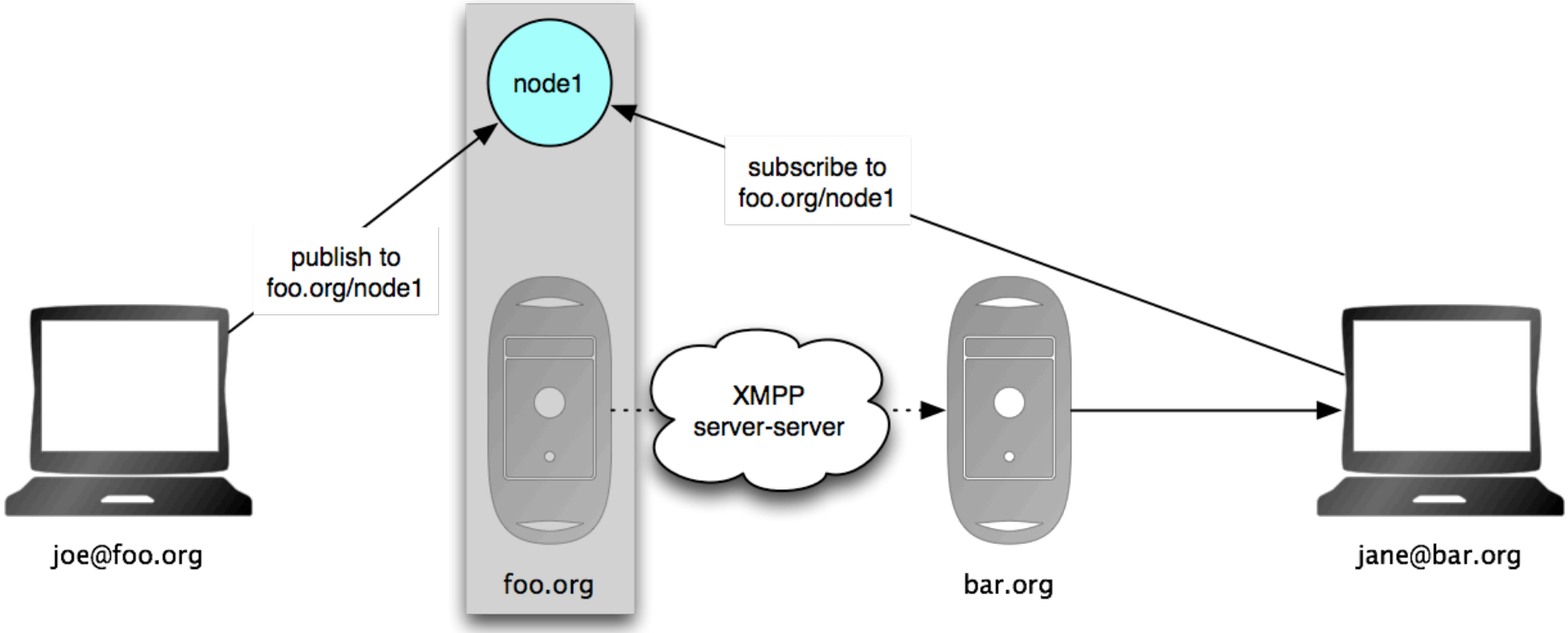


XMPP PubSub

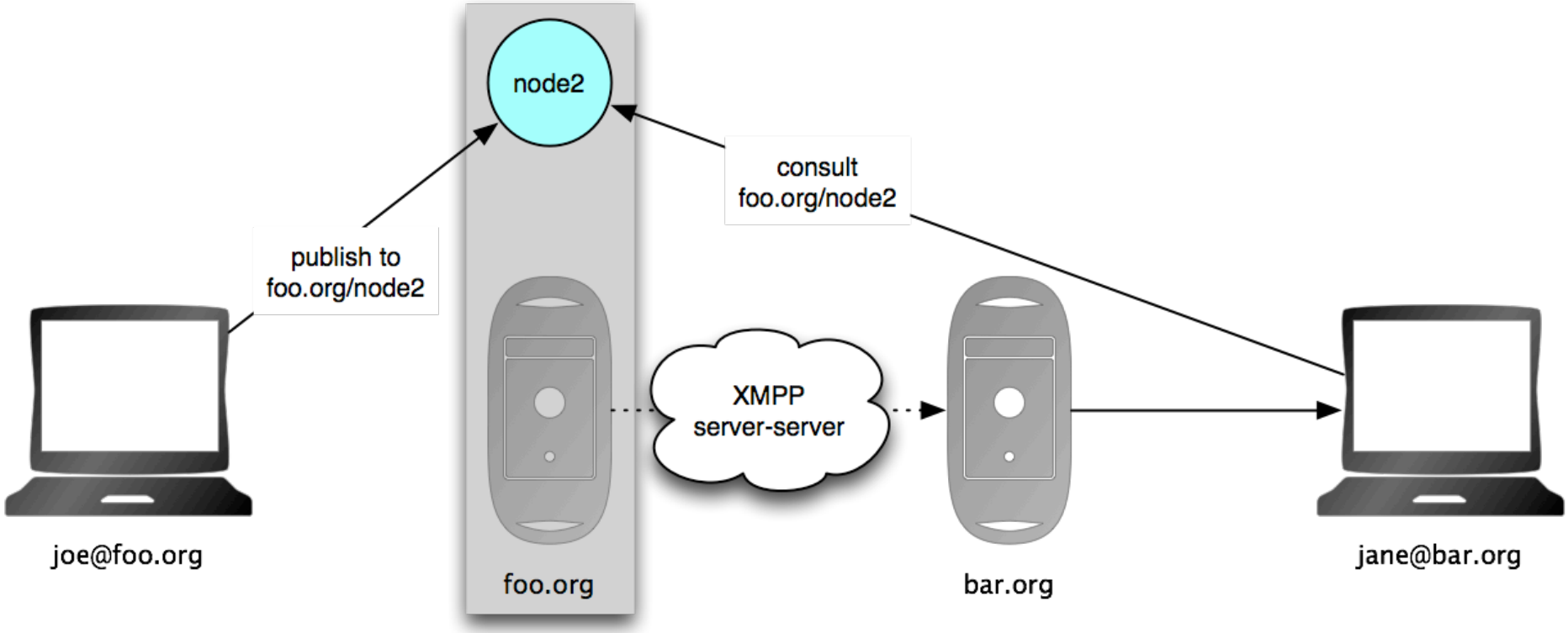
XMPP Publish-Subscribe: Client to Subscription Service, Subscription Service to Client(s) communication (cf Twitter)

- One of the XMPP extensions http://xmpp.org/extensions/xep-0060.html
- Apple Notifications based on XMPP PubSub
- Available tools, see http://xmpp.org/about-xmpp/technology-overview/pubsub/#impl-client
  - XMPP Servers with PubSub support:
    - ejabberd , OpenFire , Tigase , SleekXMPP
  - XMPP libraries with PubSub support:
    - Strophe (C, JavaScript), XMPP4R (Ruby), SleekXMPP (Python), PubSub Client (Python)

XMPP PubSub Architectural Diagram



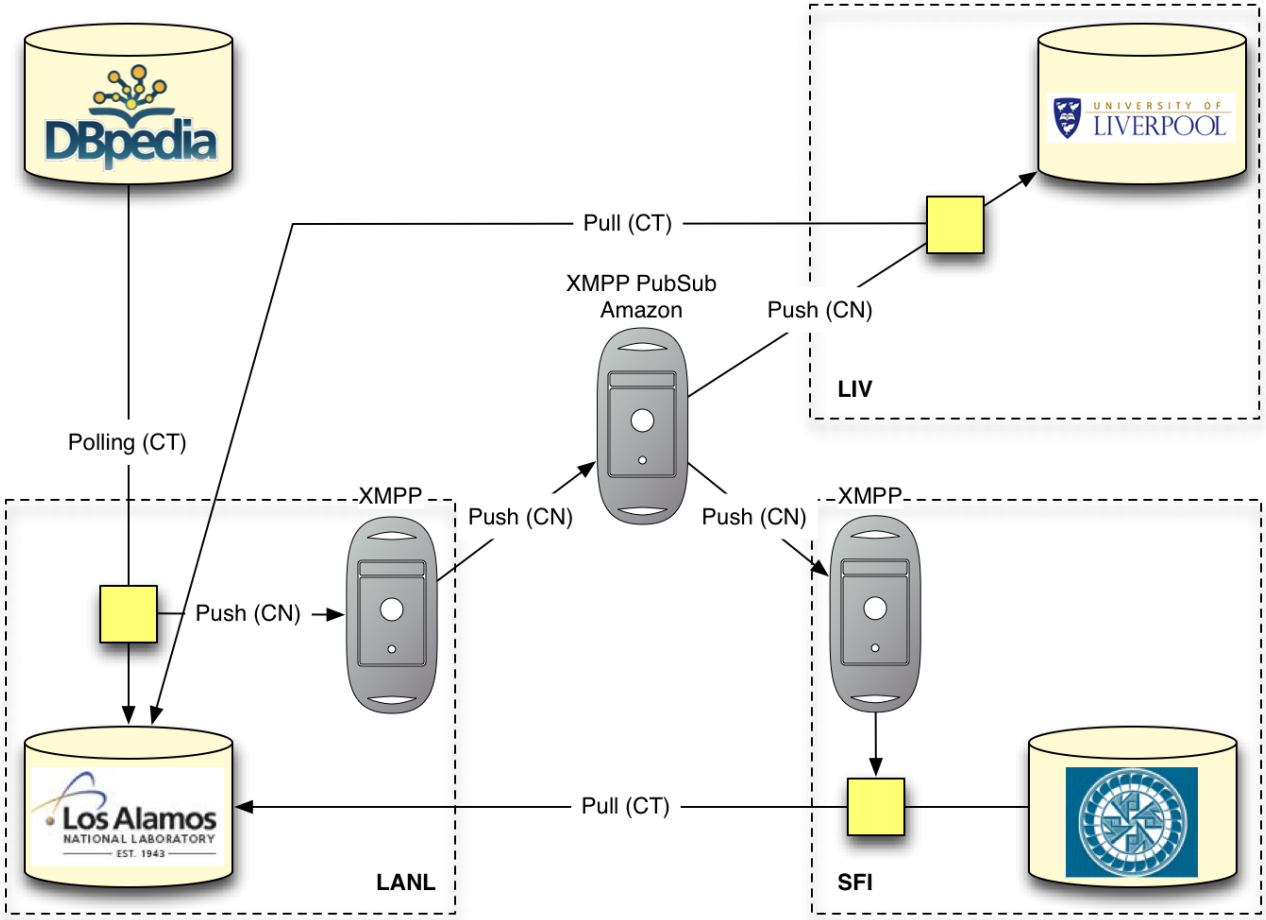
XMPP PubSub Architectural Diagram



</XMPP Intermezzo>

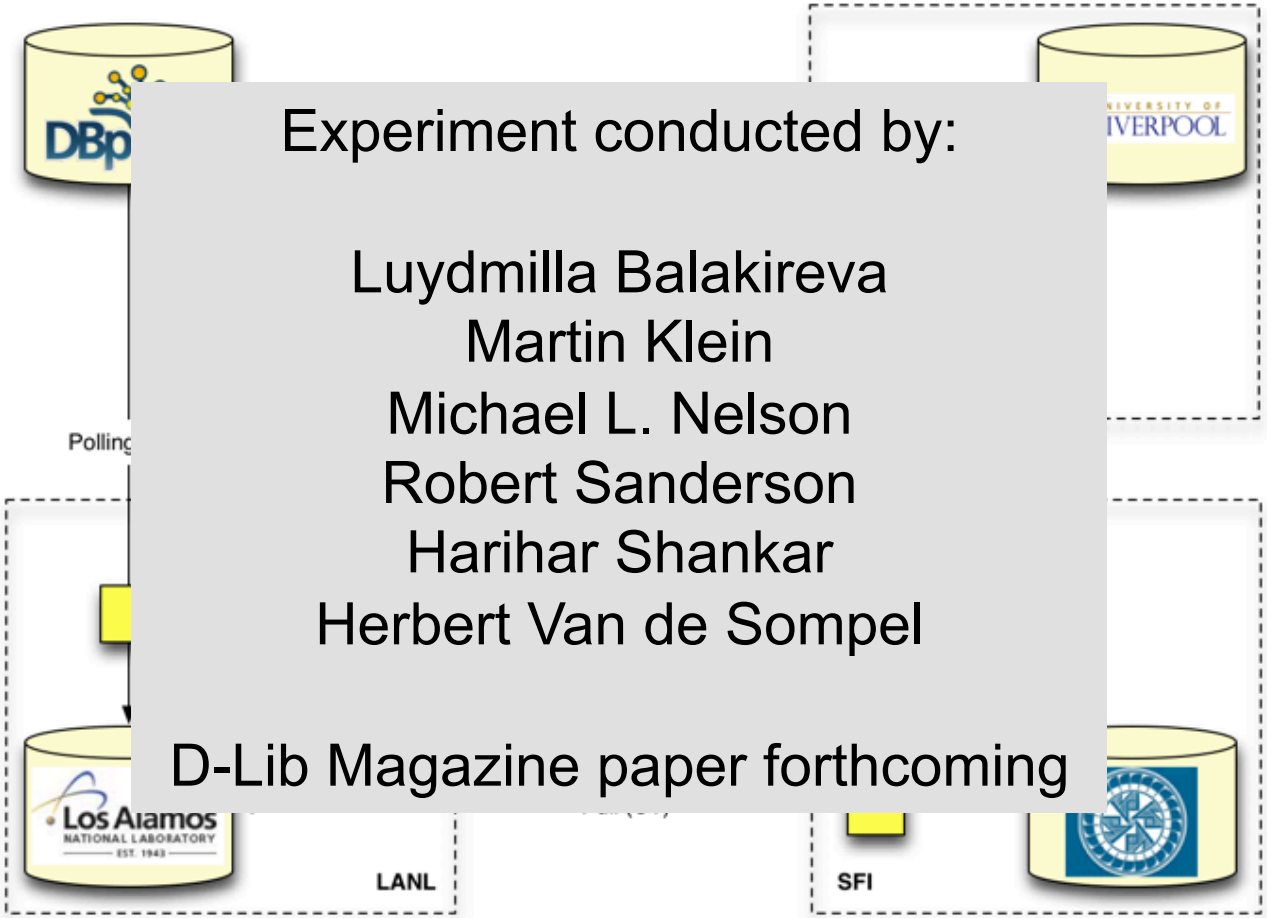
LiveDBpedia-LANL Experiment:

Testing a Push/Pull ResourceSync Approach



LiveDBpedia-LANL Experiment:

Testing a Push/Pull ResourceSync Approach



Experiment conducted by:

Luydmilla Balakireva
Martin Klein
Michael L. Nelson
Robert Sanderson
Harihar Shankar
Herbert Van de Sompel

D-Lib Magazine paper forthcoming

Characteristics of Push/Pull Synchronization Approach

- Overall approach:
  - Change Notification – Push - XMPP PubSub
  - Resource Synchronization – Pull – HTTP GET

XMPP PubSub for ResourceSync Experiment

- LiveDBpedia-LANL sends change notifications using XMPP PubSub.
  - Has multiple PubSub Nodes on a 3rd party PubSub server, e.g.:
    - DBpedia_all
    - DBpedia_business
    - DBpedia_music
    - …
  - LiveDBpedia-LANL sends change notifications to appropriate PubSub Node
  - PubSub Node passes change notifications on to Node Subscribers

Characteristics of Push/Pull Synchronization Approach

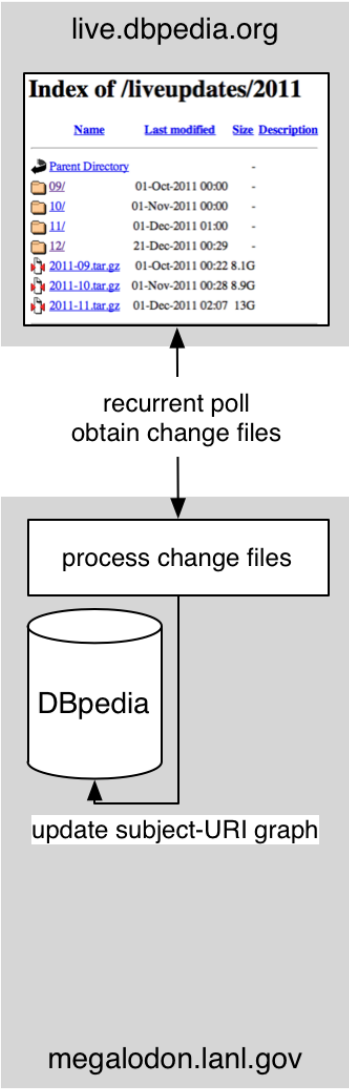
- Change types supported:
  - Create / Update / Delete for HTTP-URI-identified resources
  - No Move ; No Copy ; No Fragment Update
  - No HTTP-URI wildcarding

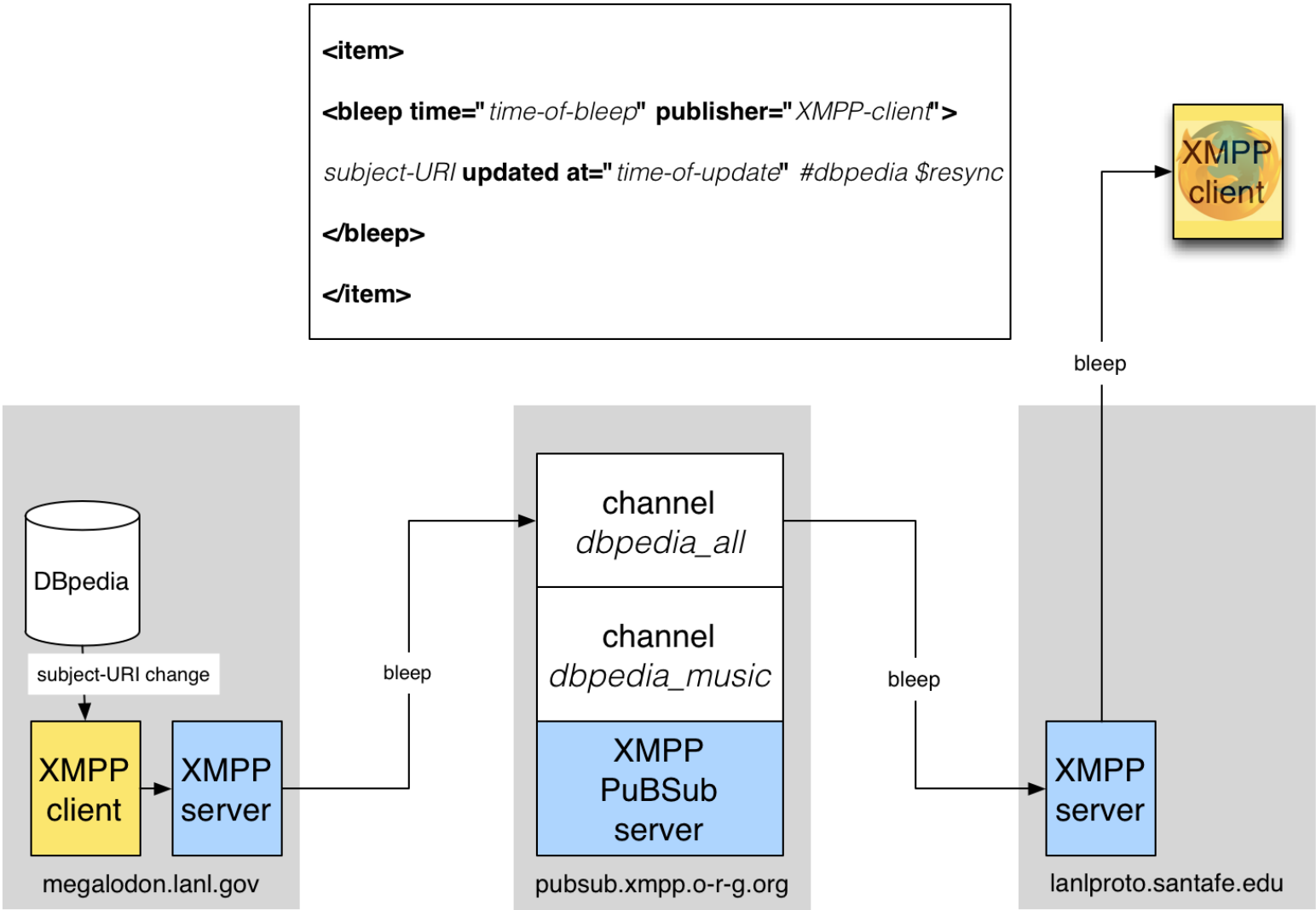
Characteristics of Push/Pull Synchronization Approach

- Notification language - Inspired by Tweets (but for machines)
  - General-purpose **<bleep>** element carried in XMPP **<item>**
  - Content of **<bleep>**:
    - Text that is writeable & readable by machine and human
    - In the experiment
      - *URI* **created at=“***time-of-create***” #***hashtag*
      - *URI* **updated at=“***time-of-update***” #***hashtag*
      - *URI* **deleted at=“***time-of-delete***” #***hashtag*
    - **time** of bleep and **publisher** of bleep in message headers

```
http://megalodon.lanl.gov/dbpedia/data/Paris
  updated at=“2012-03-05T19:54:39Z”#dbpedia
```

Change Notification


live.dbpedia.org
Index of /liveupdates/2011
Name Last modified Size Description
Parent Directory -
09/ 01-Oct-2011 00:00 -
10/ 01-Nov-2011 00:00 -
11/ 01-Dec-2011 01:00 -
12/ 21-Dec-2011 00:29 -
2011-09.tar.gz 01-Oct-2011 00:22 8.1G
2011-10.tar.gz 01-Nov-2011 00:28 8.9G
2011-11.tar.gz 01-Dec-2011 02:07 13G
recurrent poll
obtain change files
process change files
DBpedia
update subject-URI graph
megalodon.lanl.gov


<item>
<bleep time="time-of-bleep" publisher="XMPP-client">
subject-URI updated at="time-of-update" #dbpedia $resync
</bleep>
</item>
XMPP client
bleep
DBpedia
subject-URI change
XMPP client
XMPP server
megalodon.lanl.gov
bleep
channel dbpedia_all
channel dbpedia_music
XMPP PuBSub server
pubsub.xmpp.o-r-g.org
bleep
XMPP server
lanlproto.santafe.edu

Bleeps Streaming into Browser

Username: hvdsomp@lanlproto.s

Password: •••••••

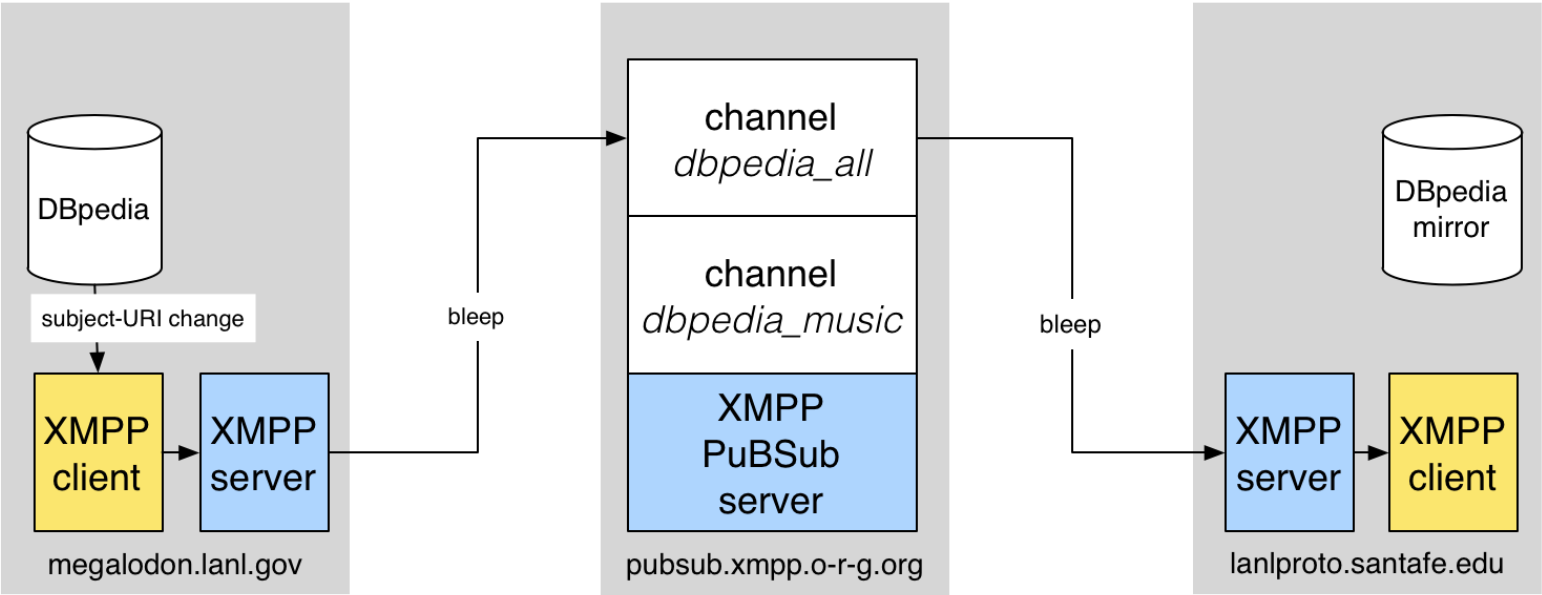
Load: 5.6% 2.5%

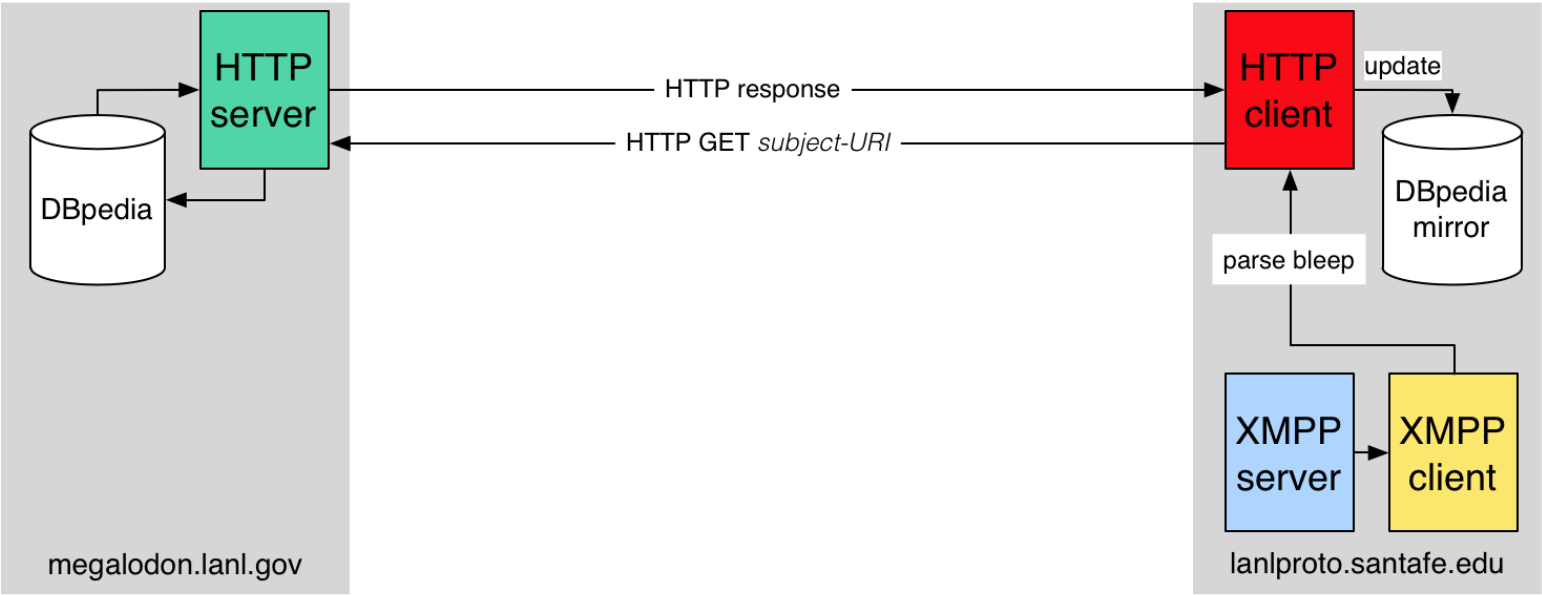
```
                         [all_replay]: http://megalodon.lanl.gov/dbpedia/data/Rotten_Ralph updated at="2011-12-23T11:59:15Z" feature="memento" #dbpedia $resync
                         [all_replay]: http://megalodon.lanl.gov/dbpedia/data/Rotten_Ralph updated at="2011-12-23T11:59:15Z" feature="memento" #dbpedia $resync
                         [all_replay]: http://megalodon.lanl.gov/dbpedia/data/Rotten_Ralph updated at="2011-12-23T11:59:15Z" feature="memento" #dbpedia $resync
[all_replay]: http://megalodon.lanl.gov/dbpedia/data/National_Register_of_Historic_Places_listings_in_Scotts_Bluff_County,_Nebraska updated at="2011-12-23T11:59:15Z" feature="memento"
                                                                                                                                                 #dbpedia $resync
[all_replay]: http://megalodon.lanl.gov/dbpedia/data/National_Register_of_Historic_Places_listings_in_Scotts_Bluff_County,_Nebraska updated at="2011-12-23T11:59:15Z" feature="memento"
                                                                                                                                                 #dbpedia $resync
[all_replay]: http://megalodon.lanl.gov/dbpedia/data/National_Register_of_Historic_Places_listings_in_Scotts_Bluff_County,_Nebraska updated at="2011-12-23T11:59:15Z" feature="memento"
                                                                                                                                                 #dbpedia $resync
                       [all_replay]: http://megalodon.lanl.gov/dbpedia/data/Pica_d%27Estats updated at="2011-12-23T11:59:15Z" feature="memento" #dbpedia $resync
                       [all_replay]: http://megalodon.lanl.gov/dbpedia/data/Pica_d%27Estats updated at="2011-12-23T11:59:15Z" feature="memento" #dbpedia $resync
                       [all_replay]: http://megalodon.lanl.gov/dbpedia/data/Pica_d%27Estats updated at="2011-12-23T11:59:15Z" feature="memento" #dbpedia $resync
                        [all_replay]: http://megalodon.lanl.gov/dbpedia/data/Braimah_Kamoko updated at="2011-12-23T11:59:15Z" feature="memento" #dbpedia $resync
                        [all_replay]: http://megalodon.lanl.gov/dbpedia/data/Braimah_Kamoko updated at="2011-12-23T11:59:15Z" feature="memento" #dbpedia $resync
                        [all_replay]: http://megalodon.lanl.gov/dbpedia/data/Braimah_Kamoko updated at="2011-12-23T11:59:15Z" feature="memento" #dbpedia $resync
        [all_replay]: http://megalodon.lanl.gov/dbpedia/data/I%27ll_Be_Home_for_Christmas_%281998_film%29 updated at="2011-12-23T11:59:15Z" feature="memento" #dbpedia $resync
        [all_replay]: http://megalodon.lanl.gov/dbpedia/data/I%27ll_Be_Home_for_Christmas_%281998_film%29 updated at="2011-12-23T11:59:15Z" feature="memento" #dbpedia $resync
        [all_replay]: http://megalodon.lanl.gov/dbpedia/data/I%27ll_Be_Home_for_Christmas_%281998_film%29 updated at="2011-12-23T11:59:15Z" feature="memento" #dbpedia $resync
[all_repla     p://megalodon.lanl.gov/dbpedia/data/National_Register_of_Historic_Places_listings_in_Searcy_County,_Arkansas updated at="2011-12-23T11:59:15Z" feature="memento" #dbpedia
                                                                                                                                                            $resync
[all_repla     p://megalodon.lanl.gov/dbpedia/data/National_Register_of_Historic_Places_listings_in_Searcy_County,_Arkansas updated at="2011-12-23T11:59:15Z" feature="memento" #dbpedia
                                                                                                                                                            $resync
[all_repla     p://megalodon.lanl.gov/dbpedia/data/National_Register_of_Historic_Places_listings_in_Searcy_County,_Arkansas updated at="2011-12-23T11:59:15Z" feature="memento" #dbpedia
                                                                                                                                                            $resync
                              [all_replay]: http://megalodon.lanl.gov/dbpedia/data/Geodesy updated at="2011-12-23T11:59:10Z" feature="memento" #dbpedia $resync
                              [all_replay]: http://megalodon.lanl.gov/dbpedia/data/Geodesy updated at="2011-12-23T11:59:10Z" feature="memento" #dbpedia $resync
                              [all_replay]: http://megalodon.lanl.gov/dbpedia/data/Geodesy updated at="2011-12-23T11:59:10Z" feature="memento" #dbpedia $resync
            [all_replay]: http://megalodon.lanl.gov/dbpedia/data/List_of_museums_in_and_around_Copenhagen updated at="2011-12-23T11:59:10Z" feature="memento" #dbpedia $resync
            [all_replay]: http://megalodon.lanl.gov/dbpedia/data/List_of_museums_in_and_around_Copenhagen updated at="2011-12-23T11:59:10Z" feature="memento" #dbpedia $resync
            [all_replay]: http://megalodon.lanl.gov/dbpedia/data/List_of_museums_in_and_around_Copenhagen updated at="2011-12-23T11:59:10Z" feature="memento" #dbpedia $resync
                           [all_replay]: http://megalodon.lanl.gov/dbpedia/data/Simple_Plan updated at="2011-12-23T11:59:10Z" feature="memento" #dbpedia $resync
                           [all_replay]: http://megalodon.lanl.gov/dbpedia/data/Simple_Plan updated at="2011-12-23T11:59:10Z" feature="memento" #dbpedia $resync
                           [all_replay]: http://megalodon.lanl.gov/dbpedia/data/Simple_Plan updated at="2011-12-23T11:59:10Z" feature="memento" #dbpedia $resync
                               [all_replay]: http://megalodon.lanl.gov/dbpedia/data/Kassar updated at="2011-12-23T11:59:10Z" feature="memento" #dbpedia $resync
                               [all_replay]: http://megalodon.lanl.gov/dbpedia/data/Kassar updated at="2011-12-23T11:59:10Z" feature="memento" #dbpedia $resync
                               [all_replay]: http://megalodon.lanl.gov/dbpedia/data/Kassar updated at="2011-12-23T11:59:10Z" feature="memento" #dbpedia $resync
                [all_replay]: http://megalodon.lanl.gov/dbpedia/data/List_of_psychedelic_rock_artists updated at="2011-12-23T11:59:10Z" feature="memento" #dbpedia $resync
                [all_replay]: http://megalodon.lanl.gov/dbpedia/data/List_of_psychedelic_rock_artists updated at="2011-12-23T11:59:10Z" feature="memento" #dbpedia $resync
                [all_replay]: http://megalodon.lanl.gov/dbpedia/data/List_of_psychedelic_rock_artists updated at="2011-12-23T11:59:10Z" feature="memento" #dbpedia $resync
                     [all_replay]: http://megalodon.lanl.gov/dbpedia/data/University_of_Hartford updated at="2011-12-23T11:59:10Z" feature="memento" #dbpedia $resync
                     [all_replay]: http://megalodon.lanl.gov/dbpedia/data/University_of_Hartford updated at="2011-12-23T11:59:10Z" feature="memento" #dbpedia $resync
```

http://megalodon.lanl.gov/strophe/

Resource Synchronization

```
<item>
<bleep time="time-of-bleep" publisher="XMPP-client">
subject-URI updated at="time-of-update" #dbpedia $resync
</bleep>
</item>
```

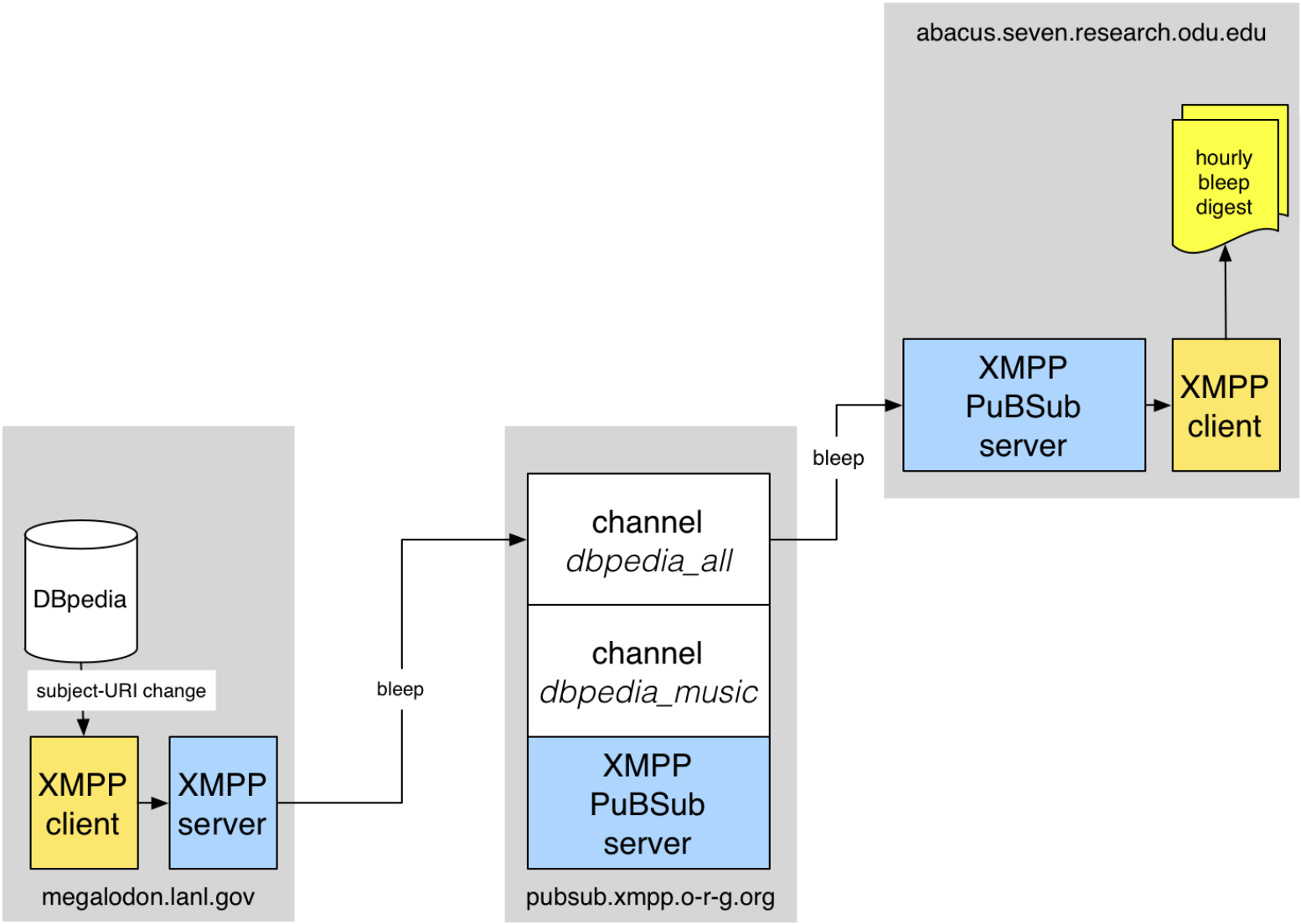



HTTP server
DBpedia
megalodon.lanl.gov
HTTP response
HTTP GET subject-URI
HTTP client
update
DBpedia mirror
parse bleep
XMPP server
XMPP client
lanlproto.santafe.edu

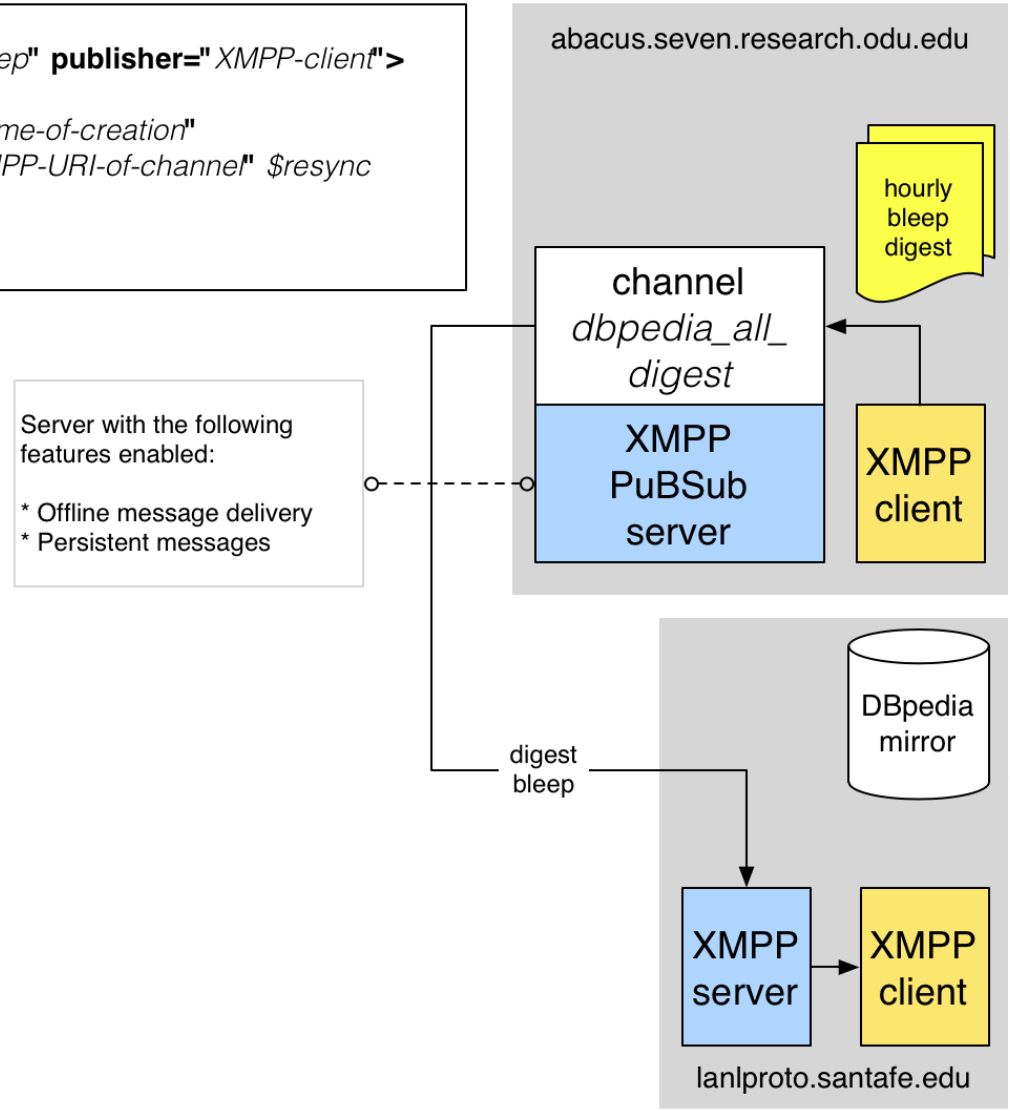
Characteristics of Push/Pull Synchronization Approach

- Robustness - notification memory:
  - Zero memory at source/intermediate/destination.
  - Notification memory provided by autonomous 3rd party service:
    - Separate XMPP PubSub server with support for Offline Delivery and Message Persistence;
    - Consumes bleeps from source and archives them;
    - Publishes an hourly digest of archived bleeps;
    - Sends out a $resync notification re the availability of a new digest.

Notification Memory


abacus.seven.research.odu.edu
hourly bleep digest
XMPP PuBSub server
XMPP client
bleep
channel dbpedia_all
channel dbpedia_music
XMPP PuBSub server
pubsub.xmpp.o-r-g.org
bleep
DBpedia
subject-URI change
XMPP client
XMPP server
megalodon.lanl.gov

```
<bleep time=" time-of-bleep"  publisher=" XMPP-client">

digest-URI created at=" time-of-creation"
           digestOf=" XMPP-URI-of-channel"  $resync

</bleep>
```



Digests

Index of /digest

Name	Last modified	Size	Description
Parent Directory		-	
dbpedia_all/	31-Jan-2012 16:00	-	
dbpedia_applied_sciences/	30-Jan-2012 17:22	-	
dbpedia_arts/	31-Jan-2012 15:25	-	
dbpedia_business/	30-Jan-2012 17:22	-	
dbpedia_culture/	31-Jan-2012 15:25	-	
dbpedia_history/	30-Jan-2012 17:22	-	
dbpedia_music/	31-Jan-2012 15:25	-	

Apache/2.2.17 (Ubuntu) Server at abacus.seven.research.odu.edu Port 8080

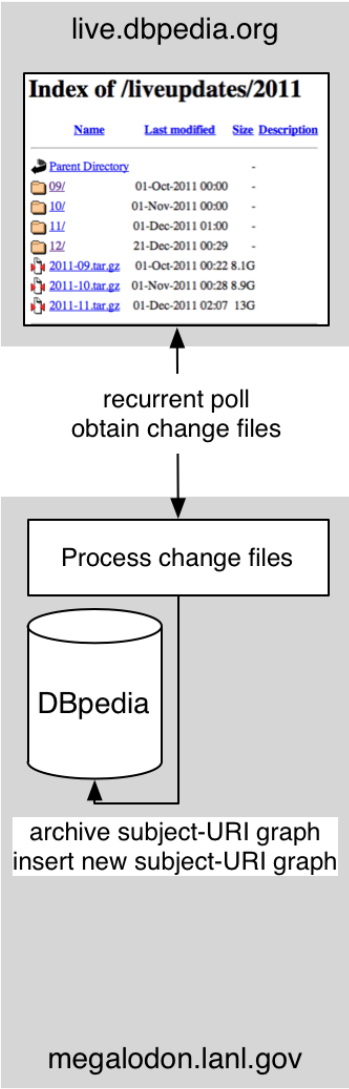
http://abacus.seven.research.odu.edu:8080/digest/

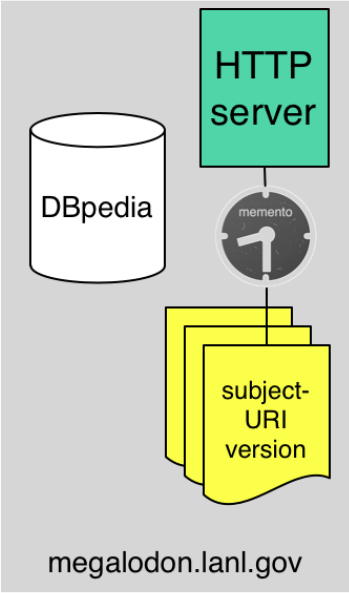
Digest

```
http://megalodon.lanl.gov/dbpedia/data/Wycombe_Wanderers_F.C.__Scott_Rendell__1 deleted at="2012-01-
31T22:00:00Z" feature="memento" #dbpedia $resync
http://megalodon.lanl.gov/dbpedia/data/List_of_Legion_of_Super-Heroes_publications updated at="2012-01-
31T22:00:00Z" feature="memento" #dbpedia $resync
http://megalodon.lanl.gov/dbpedia/data/PBOC_Motorsports_Club updated at="2012-01-31T22:00:00Z"
feature="memento" #dbpedia $resync
http://megalodon.lanl.gov/dbpedia/data/Yoo_Ji-tae updated at="2012-01-31T22:00:00Z" feature="memento"
#dbpedia $resync
http://megalodon.lanl.gov/dbpedia/data/Yoo_Ji-tae updated at="2012-01-31T22:00:00Z" feature="memento"
#dbpedia $resync
http://megalodon.lanl.gov/dbpedia/data/Strong_Enough_to_Bend updated at="2012-01-31T22:00:00Z"
feature="memento" #dbpedia $resync
http://megalodon.lanl.gov/dbpedia/data/Wycombe_Wanderers_F.C. updated at="2012-01-31T22:00:00Z"
feature="memento" #dbpedia $resync
http://megalodon.lanl.gov/dbpedia/data/Kennet_School updated at="2012-01-31T22:00:00Z" feature="memento"
#dbpedia $resync
http://megalodon.lanl.gov/dbpedia/data/Kyoto_design_declaration updated at="2012-01-31T22:00:11Z"
feature="memento" #dbpedia $resync
http://megalodon.lanl.gov/dbpedia/data/Kyoto_design_declaration updated at="2012-01-31T22:00:11Z"
feature="memento" #dbpedia $resync
http://megalodon.lanl.gov/dbpedia/data/Kyoto_design_declaration updated at="2012-01-31T22:00:11Z"
feature="memento" #dbpedia $resync
http://megalodon.lanl.gov/dbpedia/data/Portal:Contents/Outlines/History_and_events updated at="2012-01-
31T22:00:11Z" feature="memento" #dbpedia $resync
http://megalodon.lanl.gov/dbpedia/data/WikiProject_Hungary/Participants updated at="2012-01-31T22:00:11Z"
feature="memento" #dbpedia $resync
http://megalodon.lanl.gov/dbpedia/data/Yann_M%27Vila updated at="2012-01-31T22:00:11Z" feature="memento"
#dbpedia $resync
http://megalodon.lanl.gov/dbpedia/data/Yoo_Ji-tae__1 updated at="2012-01-31T22:00:11Z" feature="memento"
#dbpedia $resync
http://megalodon.lanl.gov/dbpedia/data/Nicholas_Tomaszewski updated at="2012-01-31T22:00:11Z"
feature="memento" #dbpedia $resync
http://megalodon.lanl.gov/dbpedia/data/First_Crusade updated at="2012-01-31T22:00:11Z" feature="memento"
#dbpedia $resync
http://megalodon.lanl.gov/dbpedia/data/First_Crusade updated at="2012-01-31T22:00:11Z" feature="memento"
#dbpedia $resync
http://megalodon.lanl.gov/dbpedia/data/First_Crusade updated at="2012-01-31T22:00:11Z" feature="memento"
#dbpedia $resync
http://megalodon.lanl.gov/dbpedia/data/Category:2001_in_sports updated at="2012-01-31T22:00:11Z"
feature="memento" #dbpedia $resync
http://megalodon.lanl.gov/dbpedia/data/Airspeed_Courier updated at="2012-01-31T22:00:11Z" feature="memento"
#dbpedia $resync
```

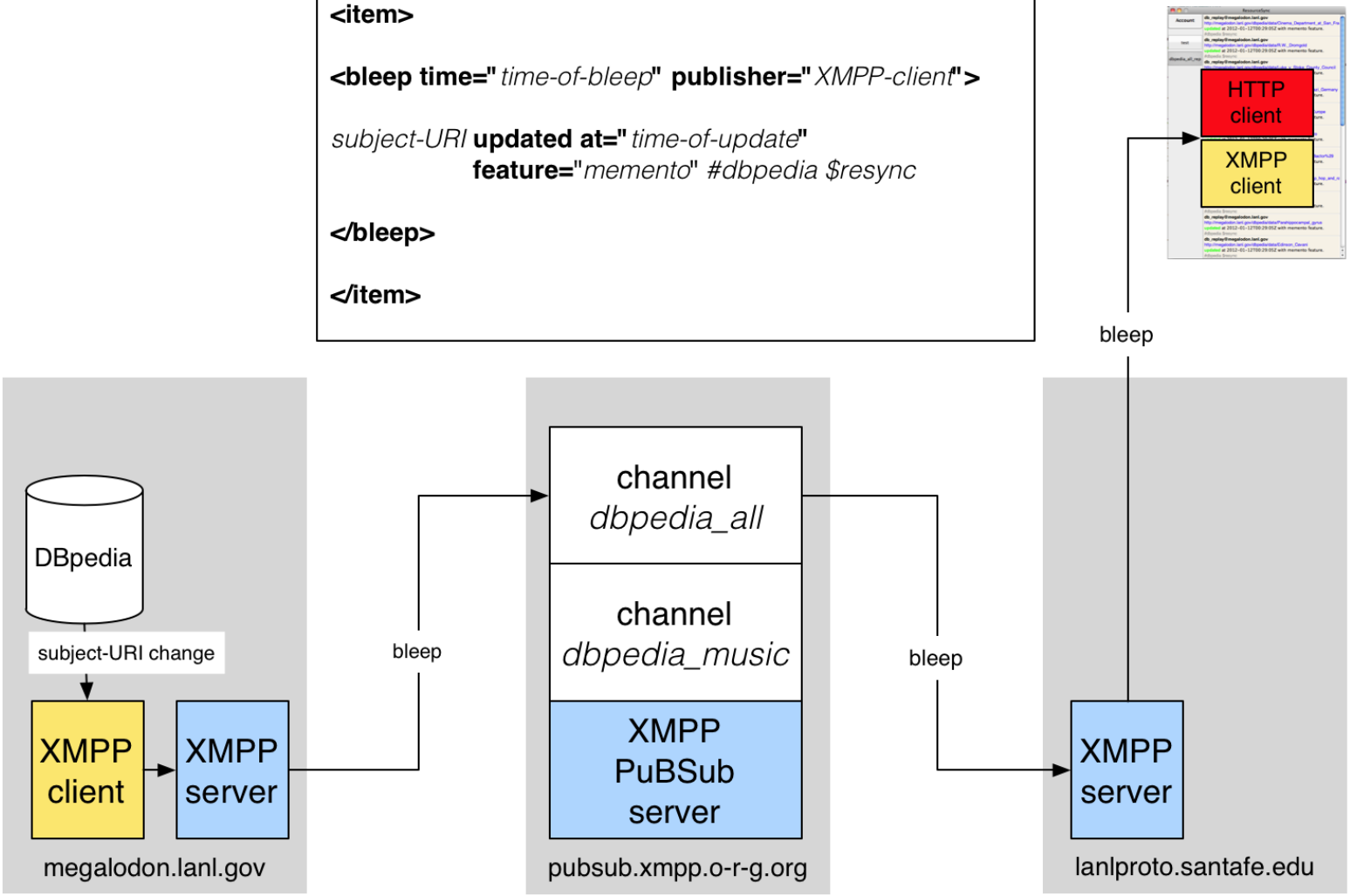
http://abacus.seven.research.odu.edu:8080/digest/dbpedia_all/most_recent.txt

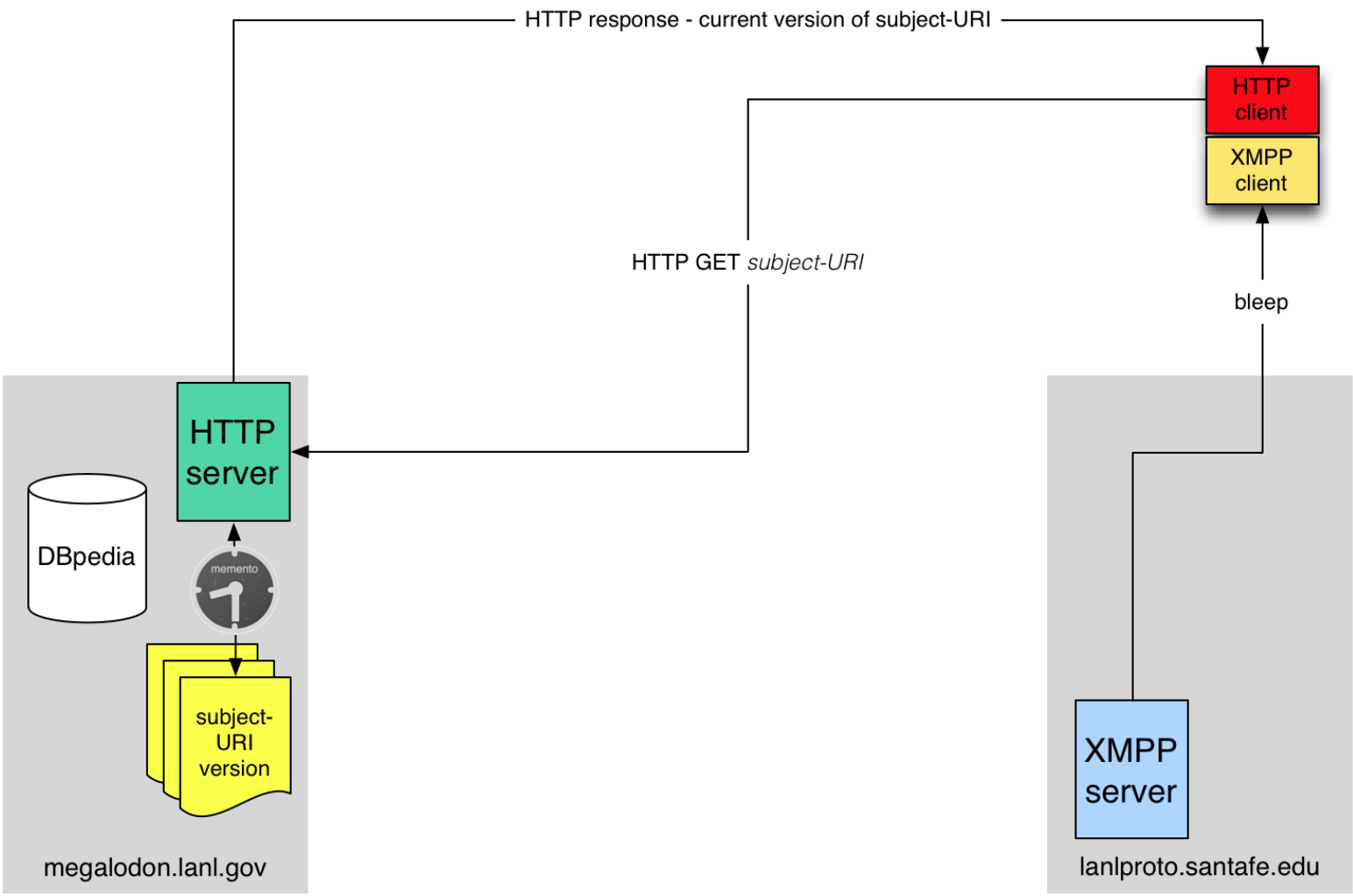
Resource Version Memory

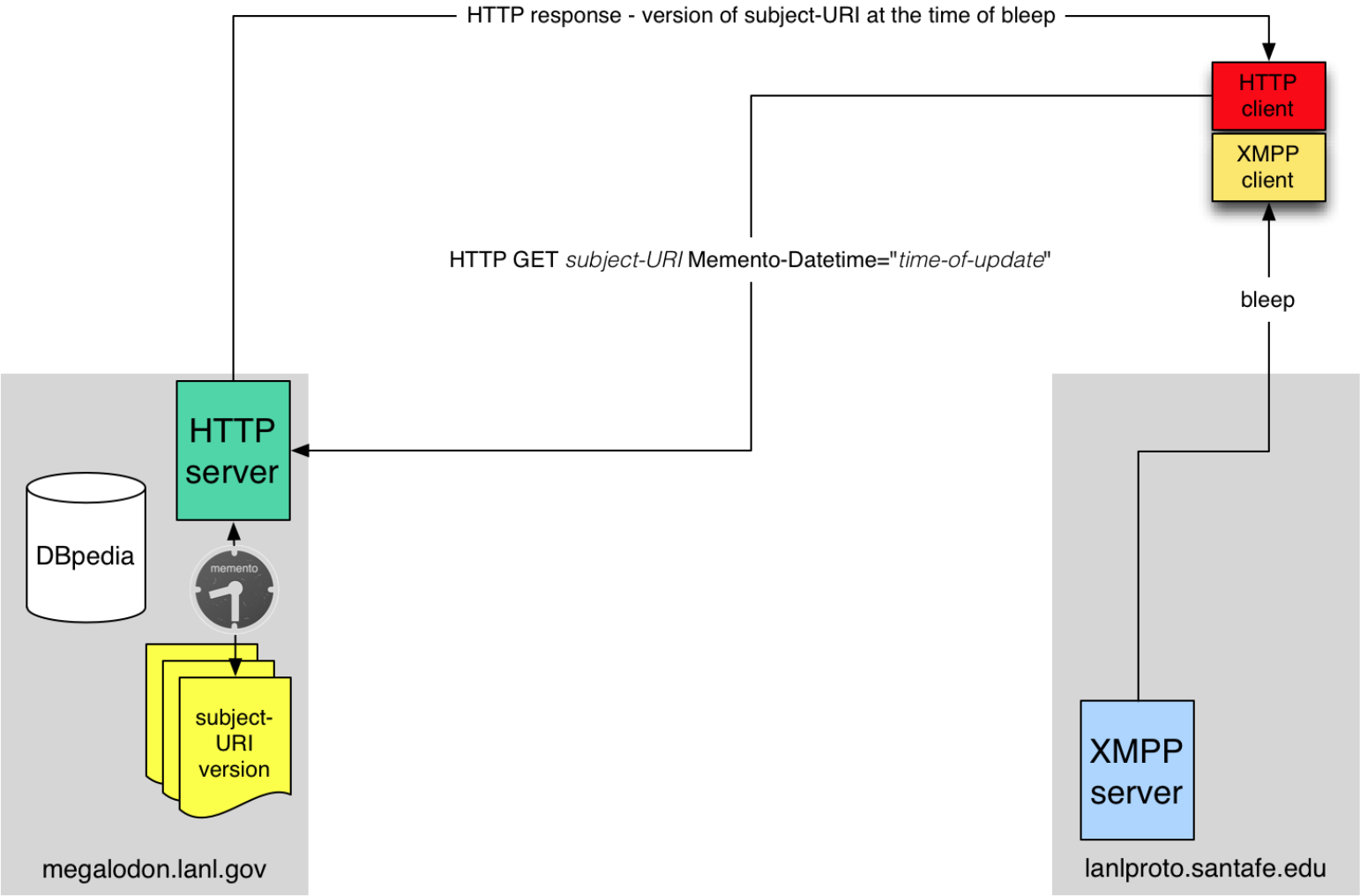

live.dbpedia.org
Index of /liveupdates/2011
Name Last modified Size Description
Parent Directory -
09/ 01-Oct-2011 00:00 -
10/ 01-Nov-2011 00:00 -
11/ 01-Dec-2011 01:00 -
12/ 21-Dec-2011 00:29 -
2011-09.tar.gz 01-Oct-2011 00:22 8.1G
2011-10.tar.gz 01-Nov-2011 00:28 8.9G
2011-11.tar.gz 01-Dec-2011 02:07 13G
recurrent poll
obtain change files
Process change files
DBpedia
archive subject-URI graph
insert new subject-URI graph
megalodon.lanl.gov


HTTP server
DBpedia
memento
subject-URI version
megalodon.lanl.gov

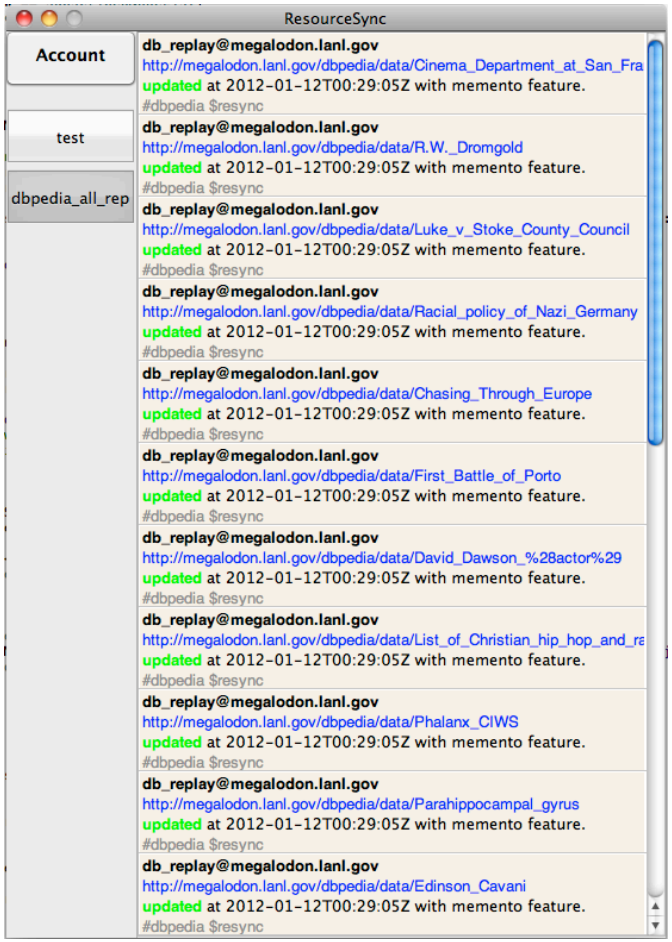
```
<item>

<bleep time="time-of-bleep" publisher="XMPP-client">

subject-URI updated at="time-of-update"
            feature="memento" #dbpedia $resync

</bleep>

</item>
```



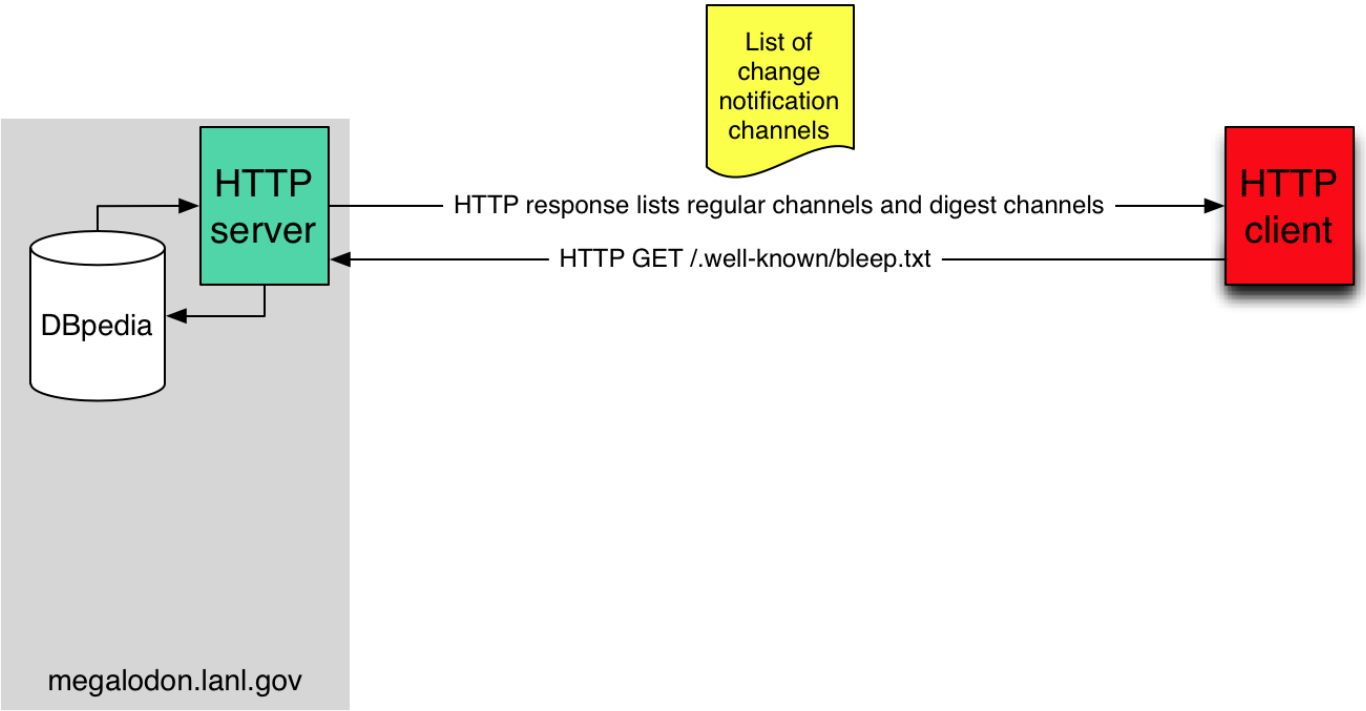

HTTP response - current version of subject-URI
HTTP client
XMPP client
HTTP GET subject-URI
bleep
HTTP server
DBpedia
memento
subject-URI version
megalodon.lanl.gov
XMPP server
lanlproto.santafe.edu


HTTP response - version of subject-URI at the time of bleep
HTTP client
XMPP client
HTTP GET subject-URI Memento-Datetime="time-of-update"
bleep
HTTP server
DBpedia
memento
subject-URI version
megalodon.lanl.gov
XMPP server
lanlproto.santafe.edu

Synchronizing Resource Versions



Discovery of Notification Channels


List of change notification channels
HTTP server
HTTP response lists regular channels and digest channels
HTTP client
HTTP GET /.well-known/bleep.txt
DBpedia
megalodon.lanl.gov

Discovery of Notification Channels – well-know URI

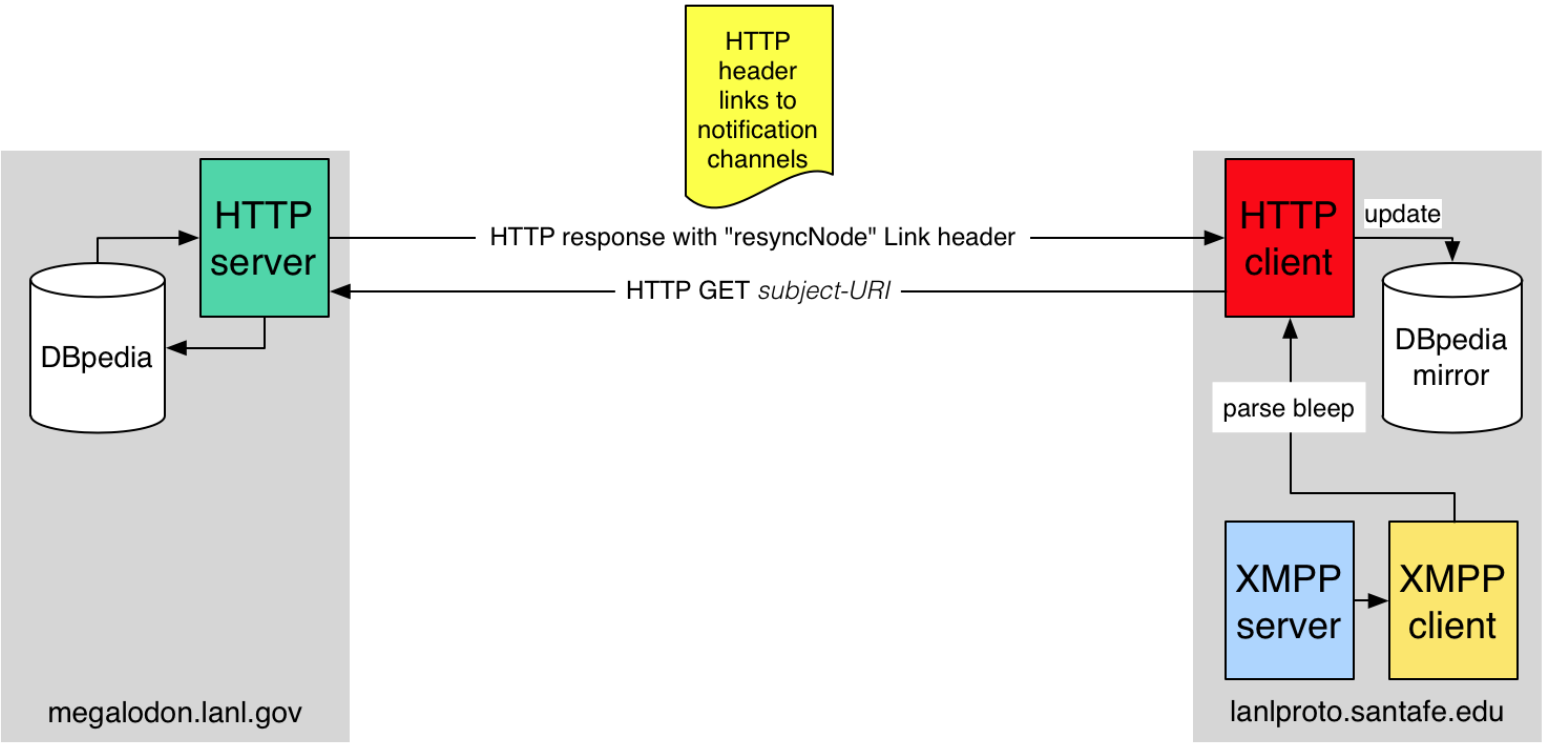
http://megalodon.lanl.gov/.well-known/bleep.txt

http://megalodon.lanl.gov/.well-known/bleep.txt

Apple Yahoo! Google Maps YouTube Wikipedia News (134) Popular OCE Secure ...ess SSL VPN


```
{
  "xmpp:pubsub.xmpp.o-r-g.org?;node=dbpedia_applied_sciences": {
    "description": "DBPedia updates from the Applied_Sciences Category tree",
    "language": "resync"
  },
  "xmpp:pubsub.xmpp.o-r-g.org?;node=dbpedia_music": {
    "hasDigest": "xmpp:pubsub.xmpp.o-r-g.org?;node=dbpedia_music_digest",
    "description": "DBPedia updates from the Music Category tree",
    "language": "resync"
  },
  "xmpp:pubsub.xmpp.o-r-g.org?;node=dbpedia_business": {
    "description": "DBPedia updates from the Business Category tree",
    "language": "resync"
  },
  "xmpp:pubsub.xmpp.o-r-g.org?;node=dbpedia_culture": {
    "description": "DBPedia updates from the Culture Category tree",
    "language": "resync"
  },
  "xmpp:pubsub.xmpp.o-r-g.org?;node=dbpedia_history": {
    "description": "DBPedia updates from the History Category tree",
    "language": "resync"
  },
  "xmpp:pubsub.xmpp.o-r-g.org?;node=dbpedia_arts": {
    "description": "DBPedia updates from the Arts Category tree",
    "language": "resync"
  },
  "xmpp:pubsub.xmpp.o-r-g.org?;node=dbpedia_all": {
    "hasDigest": "xmpp:pubsub.xmpp.o-r-g.org?;node=dbpedia_all_digest",
    "description": "All of the DBPedia updates",
    "language": "resync"
  }
}
```


http://megalodon.lanl.gov/.well-known/bleep.txt


HTTP header links to notification channels
HTTP server
DBpedia
megalodon.lanl.gov
HTTP response with "resyncNode" Link header
HTTP GET subject-URI
HTTP client
update
DBpedia mirror
parse bleep
XMPP server
XMPP client
lanlproto.santafe.edu

Discovery of Notification Channels – Link Header

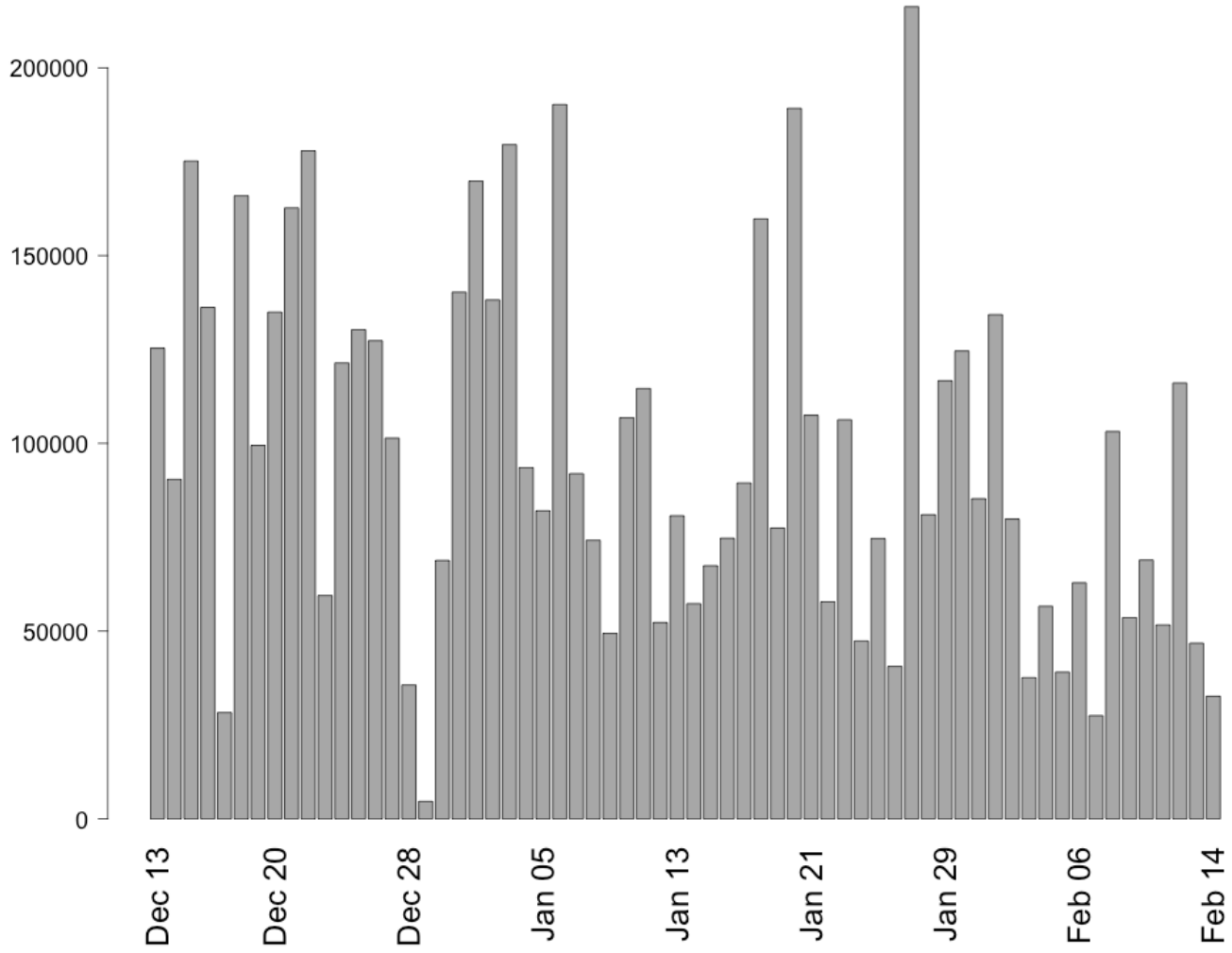
- `curl –I http://megalodon.lanl.gov/dbpedia/data/Mexico`

```
HTTP/1.1 200 OK
Date: Mon, 30 Jan 2012 23:59:41 GMT
Server: Apache/2.2.21 (Unix) DAV/2 mod_fcgid/2.3.7-
  dev mod_wsgi/3.3 Python/2.4.3
Link: <http://megalodon.lanl.gov/dbpedia/timegate/
  http://megalodon.lanl.gov/dbpedia/data/
  Mexico>;rel="timegate",<xmpp:pubsub.xmpp.o-r-
  g.org?;node=dbpedia_all>;rel="resyncNode”
Content-Length: 48932
Content-Type: text/html
```

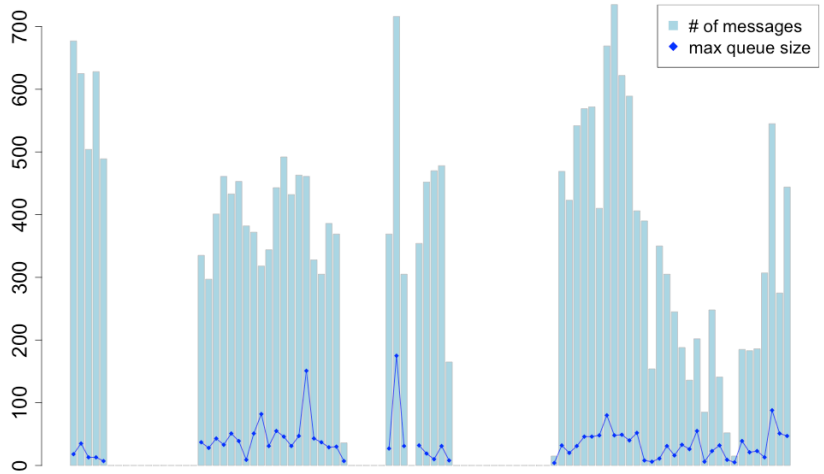
http://megalodon.lanl.gov/dbpedia/data/Mexico

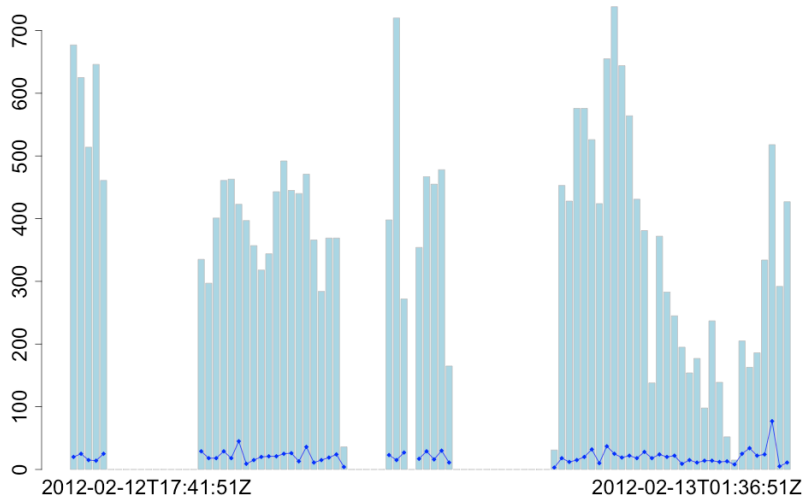
And it actually syncs!

Average of 2 Change Notifications per Second



Bleeps Versus Queue Size





Bleeps Versus Queue Size

Run	Total	Diff LANL-LIV	MaxQ LIV	MaxQ SFI
1	13,819	4 (0.03%)	120	57
2	32,453	2 (0.006%)	389	65
3	6,910	1 (0.01%)	93	44
4	24,400	5 (0.02%)	175	77
5	11,850	0 (0.0%)	84	57
6	14,937	4 (0.03%)	98	61
total	104,369	16 (0.015%)		

Diffs After 8-Hour Runs

Run	Total	Diff LANL-LIV	MaxQ LIV	MaxQ SFI
1	13,819	4 (0.03%)	120	57
2	32,453	2 (0.006%)	389	65
3	6,910	1 (0.01%)	93	44
4	24,400	5 (0.02%)	175	77
5	11,850	0 (0.0%)	84	57
6	14,937	4 (0.03%)	98	61
total	104,369	16 (0.015%)		

Content Transfer Volume in 24 Hours

- LiveDBpedia changesets:
  - Compressed: 149 Mb
  - Uncompressed: 4.2 Gb
- HTTP GET from SFI to LiveDBpedia-LANL:
  - Uncompressed: 1.8 Gb
  - Compressed: 180 Mb

ResourceSync

Towards a Web-Based Approach for Resource Synchronization

Herbert Van de Sompel
Los Alamos National Laboratory
@hvdsomp

ResourceSync is funded by
The Sloan Foundation