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1. Motivation

Although computers became ubiquitous for some time now, they still don't help their users with their most basic information management needs: Make contacts, calendars, notices and to do items available across different devices and share them with my peers.

Existing solutions are either based on non-free software (Microsoft Outlook), brittle and unreliable¹ or require the user to trust his personal data to the commercial interests of a multinational corporation.²

This work uses an ongoing effort to draft a meta model for restful applications. Applying this meta model to the domain of this work may provide further insights into its general applicability and fit.

2. Requirements

These requirements include the features of CardDAV.[Dab11, sec. 1]

2.1. Scope

This work defines a protocol to share

2.2. Definitions

Kolab is the name of a software product ... TODO

A couple of related terms and concepts exist that all more or less overlap with the functionality provided by Kolab: Groupware, Personal Information Management/Manager (PIM), Group Information Management (GIM), Computer-supported cooperative/collaborative work, Knowledge management, (Enterprise) Content Management.

TODO: keinen der Terme benutzen.

2.3. General Requirements

Restful The application should obey the constraints of a rest application as specified in [Fie00].

TODO: 4 Grundconstraints von REST auflisten.

The above constraints are not an end in itself but lead to the following required or desirable properties:

- Cacheability (5.1.4) can keep the data available also in offline mode, improves performance and scalability.
- Simplicity helps to develop glue code to connect the application to other systems or to extend it.
- Modifiability allows to adapt the Groupware to changes in the organization.
- Reliability should not need additional justification.
- Administrative scalability means that intermediary components can be deployed independent of the administrator of the main application.

Other outcomes described by Fielding that may not be of importance for the present work are: scalability in terms of users, network performance and efficiency.

¹See comments on the individual projects in appendix ...

²Experiences with Android and Data in the cloud <http://keithp.com/blogs/calypso> (?)

2.4. User Classes and Characteristics

TODO: plain Web Browsers, Desktop applications (PIM Suites), JavaScript Gadgets/Widgets (see OpenSocial) probably with WebStorage³

2.5. Operation Environment

The application is expected to be installed in a Java servlet container like Tomcat or Jetty and to contact a separate storage component. The primarily targeted storage component is an IMAP server with a Kolab conform set of groupware folders. However the design should not restrict the extension to a document database like CouchDB, plain files, relational or XML databases.

2.6. Design and Implementation Constraints

2.7. Specific Requirements

2.8. Excluded requirements

Search It is not required that the server implements any means to search its data. It is not excluded that such a facility could be added later. It is however expected that searching could be implemented separately. This could be done either on a synchronizing client or as a separate system in the same administrative domain as the server.

Performance optimization The system is meant to inherit the benefits of a restful architecture. It should therefor be possible to attach separate caching intermediaries for read requests. Rather than concentrating on the performance of the implementation of read requests it should be taken care that the architecture supports external caching and thus avoids to serve the same read request multiple times.

Access Control The aspect of access control would broaden the scope of this work to wide. However it could be kept in mind, whether the proposed design could be enhanced by a separate access control design as proposed in [GZLW11].

Versioning WebDAV and therefor CalDAV and CardDAV support the versioning of resources as an extension to the HTTP protocol. Versioning is an important feature for a text authoring system that may have been the main target for the WebDAV protocol. It does however seem to be of little use for the resources considered here. The resources are mostly created in one session by one user and seldom modified.

Locking As with Versioning, this is feature of WebDAV is not considered. Instead of locking a resource HTTP supports conditional updates and leaves conflict resolution to the client.

Push notifications This work does not include any means to actively notify (push) a client about changes happening on the server. The client needs to initiate a request (pull) to the server to look for changes. However separate solutions exist⁴ to enable a push workflow on top of a feed based application.[WM09] It may therefor not be seen as a disadvantage to omit push notifications as a requirement.⁵

³<http://www.w3.org/TR/webstorage/> (2012-2-2)

⁴most notable PubSubHubBub <http://code.google.com/p/pubsubhubbub/> (2012-1-5)

⁵[Dab11, sec. 1] explicitly mentions missing “change notifications” as a “key disadvantage” of CardDAV.

3. Design

3.1. Overview

3.1.1. Structural and Behavioral Rest Model

Primary Resources: Contacts, Calendars, ... List Resources:

3.1.2. AtomPub

Rob Yates mailto:robert_yates@us.ibm.com: CalATOM <http://robubu.com/?p=6> (2012-01-05) Draft: CardATOM <http://robubu.com/?p=10> (2012-01-05)

Rob Yates drafted a CalATOM specification.[Yat07] It references another old draft (draft-snell-atompub-feature-12) to mark a collection as a CalATOM collection. This seems unnecessary since we can specify that a collection accepts calendar resources and thus marking a collection as a calendar.

Furthermore the draft mentions a capability to query for events in a given time range. There is no equivalent for such a request for contacts.

In rest the draft only repeats or references the atompub standard and the xcal format. This draft could therefor be seen as indication that the existing standards are almost sufficient to define GroupWare APIs.

Google Data API also uses ATOM, but puts their tags directly inside the “atom:entry” tag instead of putting all of the content in the content element of an atom entry.⁶

3.2. Components

Dispatcher The dispatcher selects the Java method (see 3.2) that should handle the request. The selection can depend at least on the path component of the requested URI, the media types accepted by the client as indicated in the request’s ACCEPT header and the HTTP verb.

Every project implementing JAX-RS[HS09] needs to have some kind of dispatcher component. The specification itself does not identify this component. It does however specify the algorithm a dispatcher needs to follow and a set of Java annotations which must be used to configure the dispatch. These annotations (PATH, GET for the HTTP verb and Produces) are demonstrated in listing 1.

Listing 1: Example of a JAX-RS annotated Resource class (by Marek Potociar)

```
@Path(" atm/{ cardId }")
public class AtmResource {
    '
    @GET
    @Path(" balance")
    @Produces(" text/plain")
    public String balance(@PathParam(" cardId") String card ,
                          @QueryParam(" pin") String pin) {
        return Double.toString(getBalance(card , pin));
    }
}
```

Alternative approaches to configure the dispatcher are not designated by JAX-RS. One possible alternative would be to expose an API to manually add dispatch routes at runtime

⁶<http://web.archive.org/web/20081120001246/http://www.snellspace.com/wp/?p=314> (2012-01-05)

and remove the corresponding annotations from the source code. This could have several advantages⁷:

- The path under which a resource type is served is decoupled from the code defining the behavior of the resource. This could enable the reuse of resource classes or methods in other contexts.
- The decision which media types can be consumed or produced may not depend solely on the resource class or method. A resource method may work on a domain specific data type and the set of supported media types may depend on the available converter between media types and the data type. A photo album resource may be able to consume any number of different image formats that another framework can convert to an internal image representation.
- The list of supported media types could be created programmatically. This enables reuse of set of equivalent media types or combination of media type categories for example to combine the sets of image, video and audio media types.
- The concept of resource classes could be replaced altogether. The life cycle of a resource class in JAX-RS defaults to the request scope. During one request only one resource method is called. Resource methods therefor by default don't share state through resource class attributes. It would therefor be possible to bind individual functors to dispatcher routes and thus composing the equivalent of a resource class at runtime.

Actions An action is basically the code that should be executed to respond to a client request. An action receives all information about a request and is connected to the application. It can use and manipulate the application state and produces a data structure representing the response. It can be compared to the “Request method” defined in JAX-RS.

ResourceConverters

CollectionStorage The collection storage interface offers the necessary means to store and retrieve resources. For clarity this interface is not further broken down into a read-only part and a full read-write interface.

A collection storage is instantiated with the knowledge of the collection it is responsible for. It therefor typically only returns resources that were previously stored through it although it may share its underlying persistency provider with other collection storage instances.

The life cycle of a collection storage is scoped to the application. It is therefor possible to attach memory based caching to this component.

GenericResourceAttributes

4. only draft below this section!

Why vCard/CardDav: many clients

Why OpenSocial / Portable Contacts:

- used by Google, LinkedIn,

⁷This section does not intend to dispute the advantages of annotation based configuration.

- used in Enterprise applications like Atlassian tools (Jira, Confluence, ...), Nuxeo CMS, ...
- OpenSocial can be used to implement inhouse portals and populate it with data from the companies GroupWare

5. Evaluation of APIs

5.0.1. Algermissen's Classification of HTTP-based APIs

Jan Algermissen, proposes a "Classification of HTTP-based APIs" in February 2010.⁸ He identifies and names a five level order of HTTP based APIs. Each level adds one constraint to be obeyed. The last level obeys all five constraints and is RESTful. (Table 1)

level name	constraint violated	violation description
WS-*	Identification of Resources	Only service endpoint is identified by URI. No resources exposed.
RPC URI- Tunneling	Manipulation of Resources through Representations	SOAP body contains operation name, message not transferred to manipulate resource state.
HTTP-based Type I	Self-Descriptive Messages	Message semantics depend on action specified in message body.
HTTP-based Type II	Hypermedia as the Engine of Application State	Application state machine known at design time.

Table 1: Classification of HTTP-based APIs after Algermissen

In addition to that, Algermissen also provides a list of "Effect on System Properties and Cost" of the different API styles and acknowledges that the initial costs of developing a REST API may be higher compared to the other styles but lower in the long run.

6. Existing Groupware data APIs

6.1. IMAP (Kolab)

Kolab uses an IMAP server as the data store and synchronization protocol for calendar and contact informations. I want to compare this approach to a restful one.

Advantages of IMAP:

- already there, since Mail uses it
- can store blobs/files so no need to map the iCal/vCard files to a relational scheme
- out of the box support for offline work and later synchronization (How does it solve editing conflicts?)

Disadvantages of IMAP:

- Complicate, 38 RFCs according to http://de.wikipedia.org/wiki/Internet_Message_Access_Protocol see also: <http://www.apps.ietf.org/rfc/ipoplist.html>

⁸ http://nordsc.com/ext/classification_of_http_based_apis.html (2011-12-08)

- All clients directly access the iCal/vCard files with no moderation layer in between. This means that no validation or normalization can be done. Schema updates can only be done if all clients cooperate.
- IMAP imposes a folder structure. Google's gmail is an example for another, tag based approach. Messages could have several tags. It is therefore hard to access Gmail via IMAP.
- Sam Varshavchik, the author of the courier Mail Transfer Agent explains the history of IMAP and claims that the IMAP standard is broken: <http://www.courier-mta.org/fud/>
- IMAP is so complicate that the IMAP wiki holds 10 pages of advises for IMAP client authors: <http://www.imapwiki.org/ClientImplementation> RFC 2683 "IMAP4 Implementation Recommendations" is a 23 pages document (cut 5 pages for verbosity) explaining how to implement another RFC standard. Is there any widely used standard that needs another RFC explaining how to implement it?
- http://en.wikipedia.org/wiki/Internet_Message_Access_Protocol#Disadvantages
- Some attempts to create a simpler alternative to IMAP:
 - <http://en.wikipedia.org/wiki/POP4>
 - http://en.wikipedia.org/wiki/Simple_Mail_Access_Protocol also here <http://www.courier-mta.org/cone/smap1.html>
 - http://en.wikipedia.org/wiki/Internet_Mail_2000
 - HTTP restful: <http://tools.ietf.org/id/draft-dusseault-httpmail-00.txt> mailing list: <https://www.ietf.org/mailman/listinfo/httpmail>
 - BikINI is not IMAP <http://bikini.caterva.org>
 - Outlook uses HTTP to communicate with Hotmail
 - another rest mail proposal: <http://www.prescod.net/rest/restmail/>
- more rants: <http://blog.gaborcselle.com/2010/02/how-to-replace-imap.html>
- IMAP issues found by the Chandler project <http://chandlerproject.org/bin/view/Jungle/IntrinsicI>

6.2. WebDAV, CalDAV, CardDAV

6.2.1. Is WebDAV restful?

Roy Fielding says no: <http://tech.groups.yahoo.com/group/rest-discuss/message/5874>

PROP* methods conflict with REST because they prevent important resources from having URIs and effectively double the number of methods for no good reason. Both Henrik and I argued against those methods at the time. It really doesn't matter how uniform they are because they break other aspects of the overall model, leading to further complications in versioning (WebDAV versioning is hopelessly complicated), access control (WebDAV ACLs are completely wrong for HTTP), and just about every other extension to WebDAV that has been proposed.

[...]

The problem with MOVE is that it is actually an operation on two independent namespaces (the source collection and destination collection). The user must have permission to remove from the source collection and add to the destination collection, which can be a bit of a problem if they are in different authentication realms. COPY has a similar problem, but at least in that case only one namespace is modified. I don't think either of them map very well to HTTP.

The discussion also continued on the microformats mailing list <http://microformats.org/discuss/mail/microformats-rest/2006-April/thread.html#217>.

see [Amu10] for a restful approach to properties.

Is ATOM an alternative to WebDAV?

AtomPub is different from DAV in two key respects:

- The client doesn't control where things go, the server does
- It is allowed and expected that an AtomPub server will look at the incoming information and change it (generate ID, timestamps, sanitize HTML, etc)

Tim Bray, <http://www.imc.org/atom-protocol/mail-archive/msg11271.html>

6.3. PortableContacts aka OpenSocial

6.3.1. Is OpenSocial restful?

Roy Fielding wrote a blog post about the "SocialSite REST API", stating that it isn't restful at all but clearly an RPC style API.⁹ Fielding was referring to SocialSite, which is however an implementation of the OpenSocial specification. Dave Johnson, a contributor to SocialSite, reacted on this critique by opening a discussion on an OpenSocial mailing list.¹⁰

I must admit, it is not clear to me how OpenSocial REST API violates the six rules that Roy stated.

The above quote warrants a short comment. I also thought before, that REST would be so simple that there wouldn't be much need for further studying. Every web developer has some understanding of URIs, HTTP and a bit less of Hypermedia. So it is easy to fall into the trap that everything build on top of HTTP would be restful. Now however, after some more reading about REST, I can easily find violations of the REST constraints in the OpenSocial specification.

Restful APIs are modeled around resources, their representations and links between them. The authors of the OpenSocial API however seem to have modeled their API around the concept of services:[Ope11, Social API Server, sec 2, Services]

OpenSocial defines several services for providing access to a container's data.

Fielding's critique Fielding listed some rules that a restful API must obey, but did not give explicit examples how OpenSocial violates this rules. The following section will provide such examples.

A REST API should not be dependent on any single communication protocol, [...] any protocol element that uses a URI for identification must allow any URI scheme to be used for the sake of that identification. *[Failure here implies that identification is not separated from interaction.]*

⁹<http://roy.gbiv.com/untangled/2008/rest-apis-must-be-hyperhertext-driven> (2011-12-06)

¹⁰http://groups.google.com/group/opensocial-and-gadgets-spec/browse_thread/thread/aff4ba7373e21284/201a413efa67c26e (2011-12-06)

OpenSocial defines a construct called “REST-URI-Fragment” which is a clear violation of the above rule. This URI fragment is simply an encoding of procedural parameters as elements of an HTTP URI:[Ope11, Core API Server, sec 2.1.1.2.2, REST-URI-Fragment]

Each service type defines an associated partial URI format. The base URI for each service is found in the URI element associated with the service in the discovery document. Each service type accepts parameters via the URL path. Definitions are of the form:

`{a}/{b}/{c}`

URIs can contain a query component that would be more appropriate to contain parameters. This would also have made it clearer to see that the specification actually defines services instead of resources. One test showing the misfit is to ask how dot-segments (‘.’ and ‘..’) inside the URI fragment are interpreted and whether this conforms with the letter and spirit of the URI standard.[BLFM05, sec 3.3] Another misfit can be seen in the URI fragment to retrieve one or multiple albums. In this case the ‘c’ part in the quoted definition above is actually a list of albums to retrieve separated by a slash.

Fielding’s second bullet point most likely refers to the **X-HTTP-Method-Override** header. This header is a widely used¹¹ workaround to allow the use of other HTTP methods than GET and POST from HTML forms or through firewalls.

The next two points again refer to a more serious issue:

A REST API should spend almost all of its descriptive effort in defining the media type(s) used for representing resources and driving application state[...]. *[Failure here implies that out-of-band information is driving interaction instead of hypertext.]* A REST API must not define fixed resource names or hierarchies[...]. *[Failure here implies that clients are assuming a resource structure due to out-of-band information[...]].*

The OpenSocial specification contains a lot of out-of-band information describing how to form URIs to access information or which methods to use on which URIs for different actions. This means that the OpenSocial API is not simple or intuitive to use but requires a client developer to read a lot of specification, thus violating the simplicity property of a restful architecture. Since the URIs are fixed in the specification and necessarily also in clients, the modifiability property is also violated.[Fie00, sec 2.3]

The following tables give some examples of the specified URIs:

The last URI in Table 3 is obviously missing an “s” behind **mediaItem**. This typo is present and unfixed in the OpenSocial spec since Version 1.0, released in march 2010. This is of course not a big issue in itself, but rather a sign that the specification is too verbose and does over-specify things that should rather be auto-discovered through hyperlinks.

Fielding mentions in a comment to the same blog post that the OpenSocial API “could be made so [restful] with some relatively small changes” but does not specify these changes. However some issues can easily be identified.

First the data structures defined in OpenSocial do not use URIs to refer to other resources. Instead they use Object-Ids that must then be inserted in the appropriate URI templates. Examples are the **recipients**, **senderId**, **collectionIds** of messages and the **ownerId** of albums. The person structure does not contain fields referencing other resources. Thus it does not obviously violate REST like the albums and messages. However it does so even worse since there are hidden references only defined out-of-band in the specification. One can retrieve the albums, relations or messages of a user by filling in the **userId** in one

¹¹<http://www.subbu.org/blog/2008/07/another-rest-anti-pattern> (2011-12-06)

URI fragment	Method	Description
/people/{User-Id}/@self	GET	profile for User-Id
/people/{User-Id}/@self	DELETE	remove User
/people/{User-Id}/{Group-Id}	GET	full profiles of group members
	POST	Create relationship, target specified by <entry><id> in body
	POST	Update Person
/people/{Initial-User-Id}/ {Group-Id}/{Related-User-Id}	GET	???
/people/@supportedFields	GET	list of supported person profile fields
/groups/{User-Id}/{Group-Id}	GET	one or all groups of a user
	PUT	update group
	DELETE	delete group
/groups/{User-Id}	POST	create group

Table 2: URI fragments for peoples and groups in the OpenSocial REST API

URI fragment	Method	Description
/albums/{User-Id}/@self	POST	create album
/albums/{User-Id}/{Group-Id}/{Album-Id}*	GET	one or multiple albums
/mediaItems/{User-Id}/{Group-Id}/{Album-Id}/ {MediaItem-Id}	GET	one mediaitem
/mediaItem/{User-Id}/@self/{Album-Id} (sic!)	POST	create mediaitem

Table 3: URI fragments for albums and mediaitems in the OpenSocial REST API

of the specified URI templates. If Users would just contain references to other resources related to a user, the specification could already be shortened a lot.

Another missed opportunity for a much more intuitive API is the relation of media items and albums. This seems to be poster child example for a collection (album) to collection-element (media item) relation which could have made use of the hierarchical character of URI paths. OpenSocial however requires the client developer to use two different URI templates. (Table 3)

A not so small change to OpenSocial would be to either use already standardized and registered media types where possible or to register new types where necessary. It seems that there are some already existing media types that could be a good fit for OpenSocial but only miss a canonical json representation for easy consumption by javascript applications. These are vCard for persons,¹² ATOM entries[NS05] for messages, activities and media items and ATOM categories, collections or workspaces[Gh07] for albums and groups. It would probably be necessary to add extensions to the mentioned media types but vCard and ATOM both already anticipated this need and provided mechanisms to do so.

The use of the ATOM format could promote the adoption of OpenSocial because developers could either reuse existing knowledge about ATOM or would be more motivated to learn about a system that is based on an already widespread format. In fact OpenSocial already mentions ATOM as a way to wrap OpenSocial data. However this wrapping does not build extend and reuse ATOM semantics as proposed above but just puts the OpenSocial data structures inside the entry/content element of ATOM. This kind of misuse of ATOM does of course not deliver any advantage on top of the existing plain JSON or XML repre-

¹²OpenSocial persons are based on portable contacts which in turn borrowed field names from vCards.

sentations.¹³ Consequently the newest OpenSocial specification deprecates any reference to the ATOM format.

In Algermissen's classification (5.0.1), the OpenSocial REST API would actually be "HTTP-based Type I" due to the lack of media types and direct hyper links between related resources. Algermissen writes that this level has the lowest possible initial cost of all HTTP APIs. Or in other words: The OpenSocial specification authors did not have to invest a lot to come up with this API specification but maintenance and evolution cost may be medium or high.

6.4. Others

[...] CAP failed because most of the active implementors at the time felt it had become too complex to implement - partly because it required implementing a "brand new" protocol (BEEP). The upshot of that was the CalDAV effort, which was based on an existing fairly well understood protocol - WebDAV. One of the benefits of using WebDAV was that it was easy to take "off the shelf" WebDAV software (server and client) and get a basic CalDAV implementation done very quickly. Indeed, several months after CalDAV was published, CalConnect held an interop event at which several server and client implementations were present and demonstrated basic interoperability - something that would have been hard to achieve with CAP.

– Cyrus Daboo¹⁴

7. ATOM

WebDAV vs. ATOM: <http://intertwingly.net/wiki/pie/WebDav> <http://intertwingly.net/wiki/pie/WebDavVsAtom> google webdav atom

Why didn't ATOM succeed (more)? <http://bitworking.org/news/425/atompub-is-a-failure> (2012-01-06)

Were I to propose CalDAV today it would probably be CalAtom

– Lisa Dusseault, February 29, 2008¹⁵

I gave a big sigh of relief when I read that, and I hope that the CardDAV folks take this to heart. Some parts of WebDAV (e.g., properties [...]) deserve to be taken out back and shot – although, as Lisa says, they were necessary because of the state of the art at the time. That doesn't mean we can't do better now.

– Ted Leung, March 6, 2008¹⁶

¹³compare Bill de Hora, Extensions v Envelopes. 11/2009 <http://www.dehora.net/journal/2009/11/28/extensions-v-envelopes> (2011-21-07)

¹⁴<http://lists.calconnect.org/pipermail/caldeveloper-l/2012-January/000135.html> (2012-01-04)

¹⁵<http://nih.blogspot.com/2008/02/nearly-two-years-ago-i-made-prediction.html> (2012-1-6)

¹⁶<http://www.sauria.com/blog/2008/03/06/google-contacts-and-carddav/> (2012-1-6)

8. Design and implementation of a restful Contacts API

8.1. Related Work

8.2. Design considerations

8.2.1. inline feeds or feeds with links?

- feeds could be dynamically created and inline only those entries that the client has not yet seen as indicated by the provided ETag or timestamp.
- Feeds with links will most probably result in many further requests by the client to get the individual entries
- Inline feeds may cause unnecessary work and deliver entries that the client has already seen
- A compromise could be to provide the first page of a paginated feed with links and all additional pages with inlined entries

A final decision about this subject should be done based on utilization and performance data of a real world installation.

8.2.2. Client Design considerations

9. Persistency for Groupware Data

Relational Databases vs. NoSQL databases vs. plain files

Relational databases are not practical for contacts, events or todos. Common patterns in systems that use relational DBs for that purpose:

- artificial limits of entries, e.g. only 3 email addresses per contact, because there are only three columns email1, email2 and email3.
- Fields for custom data like custom1 to customX
- EAV pattern: tables like: id, foreign_id, type, value

10. Synchronizing a large collection

How to efficiently synchronize a large collection of contacts with the server without checking each contact for changes?

Portable Contacts has a filter “updatedSince”.

How is synchronization done in CardDAV?

“Feed Paging for Efficient Feed Synchronization” thread at ATOM-Syntax <http://www.imc.org/atom-syntax/mail-archive/msg20060.html>

HTTP Delata encoding with Feed: http://www.wyman.us/main/2004/09/using_rfc3229_w.html (2012-1-6), implementations: <http://www.wyman.us/main/2004/09/implementations.html> (2011-1-6)

“There’s also an advanced technique involving etags which keeps track of when each etag was issued and if an old etag is sent with the request then everything since then is sent back in the response. Someone will chime in with the reference.” Eric Scheid, <http://www.imc.org/atom-syntax/mail-archive/msg19832.html> (2012-1-6)

Microsoft specification FeedSync (formerly Simple Sharing Extension) <http://feedsyncsamples.codeplex.com>, comment <http://notes.kateva.org/2008/01/microsoft-feedsync-what-heck-is-html> <http://web.archive.org/web/20081114142152/http://www.snellspace.com/wp/?p=818>

11. Mediatypes

To some extent, people get REST wrong because I failed to include enough detail on media type design within my dissertation. – Roy T. Fielding

from: Rest APIs must be hypertext driven¹⁷

11.1. Syntax vs. Semantic

The usage of standardized media types is one key difference between an API and a restful API. [Fie00, sec. 5.2.1.2] Only if the client has knowledge about the media type can it do something meaningful with it besides just receiving it. In that sense, the often used mime types `application/xml` or `application/json` are not really media types. They don't tell the browser or user anything meaningful beside the *syntax* of the data.¹⁸

To do anything meaningful with plain json or xml, the client programmer must normally look up the meaning or *semantic* of the data in the API documentation. The data therefor fails the self-descriptive constraint of REST.

Compare this with a mime type like `application/atom+xml`. It specifies the syntax (xml) and the semantic (atom) of the data. Of course somebody once needed to read the atom specification and program the client with the knowledge of how to process this media type. The purpose of standardized media types however is that there is a limited number of them and that they are reused by many sites and clients.

Large sites like Google, Facebook or Twitter can successfully attract enough developers to read their specifications and program clients accordingly. Usually one can also find client libraries that can help a lot. REST however envisions a decentralized web in which parties can interact without previous knowledge of each other. This becomes possible through the usage of well known predefined media types.

11.2. xml vs. json

The application section of the IANA mime type registration has 294 entries ending in “+xml” and only 3 ending in “+json”.¹⁹ This stands in contrast to the rise of public json APIs and the decline of XML APIs.²⁰

JSON is often preferred as a format over XML because it is perceived as easier to parse, process and smaller in size. XML in comparison is seen as complicate, slow to process and larger in size. A strong argument for JSON as the preferred format for JavaScript applications is that JSON is a subset of JavaScript.

A drawback of this mismatch between the preference of media type designers and API consumers is a possible duplication of work and incompatibilities across different APIs. If

¹⁷<http://roy.gbiv.com/untangled/2008/rest-apis-must-be-hypertext-driven> (2011-12-20)

¹⁸<http://blog.programmableweb.com/2011/11/18/rest-api-design-putting-the-type-in-content-type> (2011-21-20) and Web Resource Modeling Language <http://www.wrml.org> (2011-12-20) both by Mark Massé

¹⁹<http://www.iana.org/assignments/media-types/application/index.html> (2011-12-20)

²⁰<http://blog.programmableweb.com/2011/05/25/1-in-5-apis-say-bye-xml/> (2011-12-20) <http://www.readwriteweb.com/cloud/2011/03/programmable-web-apis-popping.php> (2011-12-21)

<pre><lang pref="1" id="fr" /> <lang pref="3" id="en" /></pre>	<pre>"languages": [{"id": "fr", "pref": "1"}, {"id": "en", "pref": "3"}]</pre>	<pre>"languages": { "fr": 1, "en": 3 }</pre>
(a) XML fragment	(b) unfriendly JSON	(c) less(?) unfriendly JSON

Figure 1: different ways to map XML to JSON

type of data	XML	JSON	semantic	microformat
Calendar	xCal	Google calendar API	http://www.w3.org/TR/rdfcal	hCalendar
Contact	xCard	portable contacts, jCard	friend of a friend	hCard
Resume	HR XML		Description of a Career	hResume

Table 4: data in different formats

two developers independently take the same XML media type as a model to develop a JSON format, they can still come up with different results. There is no standard mapping from XML schemes to JSON structures.

Instead, possible mappings have to trade of the preservation of all structural information against the “friendliness” of the resulting JSON structure.[BGM⁺11] Without going into detail, a JSON structure can be seen as friendly if it makes best use of JSON’s data types, is compact and easy to process. Figure 1 shows two different examples how to map data from XML to JSON with one of them using JSON number values, being more compact and probably easier to process.

in the area of semantic standardization. Questions whether and how contact information should also hold space for the place of birth and place and date of death of a person²¹ are independent from a data serialization format. So is the question whether and how to specify the sex or gender of a person.²²

Version 3 of vCard was published in 1998[HSD98] only a few months after the W3C published Version 1.0 of XML[PSMB98] and eight years before JSON became an official standard.[Cro06]

XML standards: xCal, xCard, XMPP, Atom

http://en.wikipedia.org/wiki/ECMAScript_for_XML (E4X) makes XML a first class language construct

Activity Streams has been defined from the beginning as an XML (ATOM) and JSON format.²³

Open-Xchange provides an (unrestful) HTTP/JSON API which is used by its javascript frontend.²⁴ The comprehensive documentation does not indicate whether the data structures for tasks, appointments, reminders and contacts were inspired by any standards. In any case the API documentation is a good example of the need for standard mime types in JSON format. The use case for this API also shows similarities to the use of OpenSocial for intranet frontends.

- <http://blog.jclark.com/>
- http://code.google.com/p/jaql/wiki/Builtin_functions#xml

²¹<https://datatracker.ietf.org/doc/draft-ietf-vcarddav-birth-death-extensions/> (2011-12-20)

²²<http://www.ietf.org/mail-archive/web/vcarddav/current/msg01778.html> (2011-12-20)

²³<http://activitystrea.ms/> (2012-01-21)

²⁴http://oxpedia.org/index.php?title=HTTP_API (2011-19-12)

- <http://www.webmasterworld.com/xml/3603303.htm>
- <http://www.xml.com/pub/a/2006/05/31/converting-between-xml-and-json.html?page=3>
- <http://goessner.net/download/prj/jsonxml/>
- <http://www.w3.org/2011/10/integration-workshop/agenda.html>
- <http://jsonml.org/>

11.3. Updates with alternative Mediatypes

How to handle updates, if the mediatypes are not isomorph?

How does Google handle PATCH in the calendar API?

Schnittmenge der Medientypen identifizieren

Einen kanonischen Medientypen festlegen für Updates?

Erweiterungsmöglichkeiten v. Medientypen nutzen um Isomorphie herzustellen

11.4. Mediatype conversion

JSON formats for collections: Collection+JSON Mime-Type (approved in July 2011) by Mike Amundsen²⁵ JSON ATOM serialization implemented by Apache Abdera²⁶

Some problems in loss-less conversion of ATOM to json:[Sne08]

- JSON has no equivalent for the `xml:lang` attribute.
- Dereferencable IRIs must be transformed to URIs.
- URIs relative to an `xml:base` attribute must be resolved, also inside XHTML content elements.
- Repeatable elements must be converted to arrays.
- The ATOM date format (RFC 3339) differs from the JavaScript Date serialization.
- ATOM content elements are versatile but should be represented more meaningful in JSON than just a plain String.
- ATOM supports arbitrary extensions via namespaces.

RFC 5023 "Collections are represented as Atom Feeds"

Is conneg (content negotiation) useful? No: Norman Walsh, 2003, it can lead to hard to debug bugs <http://norman.walsh.name/2003/07/02/conneg> (2011-1-9), Joe Gregorio, 2003, I can't communicate the mime type to request to a third service if I can only give an URI <http://bitworking.org/news/WebServicesAndContentNegotiation> (2011-1-9) Yes: Jerome Louvel, 2006, I could additionally provide URIs that override the accept headers with query parameters like `?format=json`. <http://blog.noelios.com/2006/11/15/reconsidering-content> (2011-1-9)

Which fields of portable contacts are derived from vCard: <http://wiki.portablecontacts.net/w/page/17776141/schema>

²⁵<http://amundsen.com/media-types/collection/> (2012-1-7)

²⁶<http://www.ibm.com/developerworks/library/x-atom2json/index.html> (2012-1-7) <https://cwiki.apache.org/ABDERA/json-serialization.html> (2012-1-7)

No single data representation is ideal for every client. This protocol defines representations for each resource in three widely supported formats, JSON [RFC4627], XML, and Atom [RFC4287] / AtomPub [RFC5023], using a set of generic mapping rules. The mapping rules allow a server to write to a single interface rather than implementing the protocol three times.

[Ope11, Core API Server]

In 2007, a project called microjson wanted to standardize json representations of micro-format data structures.²⁷

The project identified the need for a json schema:²⁸

If there are standard microJSON formats for transfer of certain datasets, there will be a need to validate that data to ensure that it is infact valid format. To validate a format you need something that details the structure, data content types and required data. Sounds like we'll be needing a schema for each microJSON format.

jCard example from microjson.org²⁹

```
{
  "vcard": {
    "name": {
      "given": "John",
      "additional": "Paul",
      "family": "Smith"
    },
    "org": "Company Corp",
    "email": "john@companycorp.com",
    "address": {
      "street": "50 Main Street",
      "locality": "Cityville",
      "region": "Stateshire",
      "postalCode": "1234abc",
      "country": "Someplace"
    },
    "tel": "111-222-333",
    "aim": "johnsmith",
    "yim": "smithjohn"
  }
}
```

11.5. Example: vCard

```
<?xml version="1.0" encoding="UTF-8"?>
<vcards xmlns="urn:ietf:params:xml:ns:vcard-4.0">
  <vcard>
    <fn><text>Simon Perreault</text></fn>
    <n>
      <surname>Perreault</surname>
      <given>Simon</given>
    </n>
  </vcard>
</vcards>
```

²⁷<http://notizblog.org/2007/09/16/microjson-microformats-in-json/> (2011-12-19)

²⁸<http://web.archive.org/web/20080524003749/http://microjson.org/wiki/Schemas> (2022-12-19)

²⁹<http://web.archive.org/web/20080517003233/http://microjson.org/wiki/JCard> (2011-12-19)

```

    <additional/>
    <prefix/>
    <suffix>ing . jr </suffix>
    <suffix>M. Sc.</suffix>
</n>
<bday><date>--0203</date></bday>
<anniversary>
    <date-time>20090808T1430-0500</date-time>
</anniversary>
<gender><sex>M</sex></gender>
<lang>
    <parameters><pref><integer>1</integer></pref></parameters>
    <language-tag>fr</language-tag>
</lang>
<lang>
    <parameters><pref><integer>2</integer></pref></parameters>
    <language-tag>en</language-tag>
</lang>
<org>
    <parameters><type><text>work</text></type></parameters>
    <text>Viagenie</text>
</org>
<adr>
    <parameters>
        <type><text>work</text></type>
        <label><text>Simon Perreault
2875 boul. Laurier , suite D2-630
Quebec , QC, Canada
G1V 2M2</text></label>
    </parameters>
    <pobox/>
    <ext/>
    <street>2875 boul. Laurier , suite D2-630</street>
    <locality>Quebec</locality>
    <region>QC</region>
    <code>G1V 2M2</code>
    <country>Canada</country>
</adr>
<tel>
    <parameters>
        <type>
            <text>work</text>
            <text>voice</text>
        </type>
    </parameters>
    <uri>tel:+1-418-656-9254;ext=102</uri>
</tel>
<tel>
    <parameters>
        <type>
            <text>work</text>

```

```

        <text>text</text>
        <text>voice</text>
        <text>cell</text>
        <text>video</text>
    </type>
</parameters>
<uri>tel:+1-418-262-6501</uri>
</tel>
<email>
    <parameters><type><text>work</text></type></parameters>
    <text>simon.perreault@viagenie.ca</text>
</email>
<geo>
    <parameters><type><text>work</text></type></parameters>
    <uri>geo:46.766336,-71.28955</uri>
</geo>
<key>
    <parameters><type><text>work</text></type></parameters>
    <uri>http://www.viagenie.ca/simon.perreault/simon.asc</uri>
</key>
<tz><text>America/Montreal</text></tz>
<url>
    <parameters><type><text>home</text></type></parameters>
    <uri>http://nomis80.org</uri>
</url>
</vcard>
</vcards>

<?xml version="1.0" encoding="UTF-8"?>
<vcards xmlns="urn:ietf:params:xml:ns:vcard-4.0">
    <vcard>
        <fn><text>Simon Perreault</text></fn>
        <n>
            <surname>Perreault</surname>
            <given>Simon</given>
            <suffix>ing. jr</suffix>
            <suffix>M.Sc.</suffix>
        </n>
        <bday day="02" month="03" />
        <anniversary format="date-time">20090808T1430-0500</anniversary>
        <gender>M</gender>
        <lang pref="1">fr</lang>
        <lang pref="2">en</lang>
        <org type="work">Viagenie</org>
        <adr type="work">
            <label>Simon Perreault
2875 boul. Laurier, suite D2-630
Quebec, QC, Canada
G1V 2M2</label>
            <street>2875 boul. Laurier, suite D2-630</street>
            <locality>Quebec</locality>
            <region>QC</region>

```

```

        <code>G1V 2M2</code>
        <country>Canada</country>
    </adr>
    <tel>
        <type>work</type>
        <type>voice</type>
        <uri>tel:+1-418-656-9254;ext=102</uri>
    </tel>
    <tel>
        <type>work</type>
        <type>text</type>
        <type>voice</type>
        <type>cell</type>
        <type>video</type>
        <uri>tel:+1-418-262-6501</uri>
    </tel>
    <email type="work">simon.perreault@viagenie.ca</email>
    <geo type="work">
        <uri>geo:46.766336,-71.28955</uri>
    </geo>
    <key type="work">
        <uri>http://www.viagenie.ca/simon.perreault/simon.asc</uri>
    </key>
    <tz>America/Montreal</tz>
    <url type="home">
        <uri>http://nomis80.org</uri>
    </url>
</vcard>
</vcards>

```

11.6. HFactor

Mike Amundsen defines a method to asses media types that he calls “HFactor”.³⁰ The HFactor distinguishes different types of support for links and indicates which of those are provided by a reviewed media type.

Amundsen did reviews of a couple of media types. Unfortunately these do not include `vcard+xml` or `calendar+xml`. I’ll try to identify the HFactors of both here.

The different types of link support have two letter acronyms and fall in two categories: Link support values, with the first letter “L” and Control data support, first letter “C”.

- Link Support for
 - LE embedded links (HTTP GET)
 - L0 out-bound navigational links (HTTP GET)
 - LT templated queries (HTTP GET)
 - LN non-idempotent updates (HTTP POST)
 - LI idempotent updates (HTTP PUT, DELETE)
- Control Data Support to
 - CR modify control data for read requests (e.g. HTTP `Accept-*` headers)

³⁰<http://amundsen.com/hypermedia/> (2011-12-21)

- CU modify control data for update requests (e. g. **Content-*** headers)
- CM indicate the interface method for requests (e.g. HTTP GET,POST,PUT,DELETE methods)
- CL add semantic meaning to link elements using link relations (e.g. HTML rel attribute)

12. Reusable components

Responsibilities of a media type aware code:

- validate
- provide accessors to read, write
- serialize, deserialize
- converters to other formats
- accessors to common interfaces (projection), e.g. common generic resource attributes or common attributes of a contact

Motivation für wiederverwendbare Komponenten im Zusammenhang mit Schreier: Möglichst wenig Code zu generieren, generierter Code benutzt wiederverwendbaren Code.

Candidate areas for re-usability:

- link building, URL parsing
- HTML form building, parsing
- generic properties of resources, id
- resource types
- question to storage: does resource still match ETag? Has changed since?
- all links of a resource: Link: intern/extern/undefined, href, rel, title, text, media type
- bool function matchesMediaType(), getMediaType() auf WrappedEntry
- Prüfung, ob ein Update durchgeführt werden soll, gemäß ETAG, ifnotchanged
- Möglichkeit, DatenKlassen mit DatenTypen zu definieren wie in eZ Publish um automatische Views und Edit Ansichten zu ermöglichen.
- Creation of resources: POST to collection with SLUG Header, PUT to URI, normalization of SLUG Header
- Pagination (building and parsing of next and previous URIs, implementation of RFC5005), querying the collections entries provider with the correct parameters (offset, limit).
- Storage interface with transaction support. An application may for example need to notify an indexing component after some resource has been changed. – No transaction support: Every action that must happen in a transaction together with the resource change must be handled by the storage layer, must be aware of the storage technologie.

Im Gegensatz zu Bildern, wie in [Sch11] können Kontakte komplett inline sein.

13. Hypermedia in RESTful applications

The model application is therefore an engine that moves from one state to the next by examining and choosing from among the alternative state transitions in the current set of representations.

[Fie00, sec. 5.3, p.103]

13.1. Hypermedia in OpenSocial

Webfinger, e.g. get a profile picture from an email address

Danger: One can trigger a http request by sending an email.

14. Selection of components

Apache Shindig for Open Social, includes client tests

<http://code.google.com/p/kolab-android/>

<https://evolvis.org/projects/kolab-ws/>

<http://packages.ubuntu.com/source/maverick/dovecot-metadata-plugin> <https://launchpad.net/ubuntu/maverick-8-0ubuntu1>

14.1. REST framework

Jersey recommended by [Kai11] above Restfulie and RESTeasy because of maturity and flexibility.

Jersey has a atompub-contact client/server example app.

Why not Jersey in the end?

- JAX-RS assumes, that Paths are defined on the classes that represent the resources.
 - This couples the “location” of a resource to its implementation.
 - This leads to copied code. Given an URL pattern like `/ {AUTHORITY} / {COLLECTION} / {ENTRY}` In this case the resource classes for authority, collection and entry would each need to parse the authority section of the path.
 - If paths are not defined on resource classes, it is not possible to make use of JAX-RS’ capabilities of declarative hyperlink building (`@REF` annotation).
- The dispatch to a request handler method has in our case three orthogonal parameters: HTTP verb, Media type, path. It would be preferable to handle these parameters independent of each other. The only way to handle at least the path dispatch separately is with the help of sub resources. This still leaves HTTP verb and Media type to be handled together.

The sub resource mechanism additionally suffers from the shortcoming that it does not allow to specify an empty path.³¹ This makes it impossible to return a sub resource and annotate a method that should handle the case that no additional path elements remain to be matched.

- Debugging is hard. It’s not trivial to find out, why Jersey did not select a request handler or provider as the developer intended.
- Jersey’s parameter injection can not be used together with a dependency injection framework like Guice or Spring.

³¹<http://java.net/jira/browse/JERSEY-536> (2012-01-21)

14.2. VCard

ical4j best documented best code is used by most active also supports icalendar is immutable!!!

15. Testing

How to test the ReST/CardDAV interface?

Portable Contacts test client at plaxo <http://www.plaxo.com/pdata/testClient>
<http://code.google.com/p/rest-assured/> <http://restfuse.com/>

A. Standards

A.1. Contacts / Persons

RFC 6450 vCard Format Specification

This document defines the vCard data format for representing and exchanging a variety of information about individuals and other entities (e.g., formatted and structured name and delivery addresses, email address, multiple telephone numbers, photograph, logo, audio clips, etc.). This is the new version and obsoletes RFCs 2425, 2426, and 4770, and updates RFC 2739.

RFC 6351 xCard: vCard XML Representation

This document defines the XML schema of the vCard data format.

Portable Contacts, OpenSocial

Portable Contacts defines contact data structures and a ReST API. It has been integrated in the OpenSocial standard.

Nepomuk Semantic Desktop Contact Ontology

Friend of a friend (FOAF)

FOAF is a

hCard

jCard

A.2. Calendaring

RFC 5545 Internet Calendaring and Scheduling Core Object Specification

iCalendar is the core data schema for calendaring information. This is the new version and obsoletes RFC2445

RFC 6321 xCal: The XML format for iCalendar

This specification defines a format for representing iCalendar data in XML. More specifically, is to define an XML format that allows iCalendar data to be converted to XML,

and then back to iCalendar, without losing any semantic meaning in the data. Anyone creating XML calendar data according to this specification will know that their data can be converted to a valid iCalendar representation as well.

CalWS RESTful Web Services Protocol for Calendaring

This document, developed by the XML Technical Committee, specifies a RESTful web services Protocol for calendaring operations. This protocol has been contributed to OASIS WS-CALENDAR as a component of the WS-CALENDAR Specification under development by OASIS.

Google Calendar API V3

While not being a standard, the Google Calendar API is RESTful and will surely be implemented by many client applications. It's remarkable that the API supports partial GETs returning only specified fields and the HTTP PATCH verb to update only specified fields.

Open Services for Lifecycle Collaboration (OSLC)

uses FOAF person http://open-services.net/bin/view/Main/OSLCCoreSpecAppendixA?sortcol=table;up=#foaf_Person_Resource

provides change management, some overlapping to iCal TODOs <http://open-services.net/bin/view/Main/CmSpecificationV2>

reference implementation: <http://eclipse.org/lyo>

A.3. Scheduling

RFC 5546 iCalendar Transport-Independent Interoperability Protocol (iTIP)

Scheduling Events, BusyTime, To-dos and Journal Entries; Specifies the mechanisms for calendaring event interchange between calendar servers. This is the new version and obsoletes RFC2446

RFC 6047 iCalendar Message-Based Interoperability Protocol (iMIP)

Specifies how to exchange calendaring data via e-mail. This is the new version and obsoletes RFC2447.

A.4. Relations and Links

Xhtml Friends Network (XFN)

One of the relations returned by Google's webfinger.

Webfinger

Webfinger in Firefox Contacts Add-On <http://mozillalabs.com/blog/2010/03/contacts-in-the-1>

RFC 6415 Web Host Metadata

Extensible Resource Descriptor (XRD)

A.5. out of scope

HR XML

The HR-XML Consortium is the only independent, non-profit, volunteer-led organization dedicated to the development and promotion of a standard suite of XML specifications to enable e-business and the automation of human resources-related data exchanges.

OMA Converged Address Book V1.0

Standard by the Open Mobile Alliance defining data structures and synchronization of contact data. It references vCard.

Open Collaboration Services

Also contains data structures for persons and events but does not reuse any known standard. See this thread: <http://lists.freedesktop.org/archives/ocs/2011-December/000136.html>

W3C Contacts API

A standard on how address books could be accessed on devices or from JavaScript inside a Web Browser. The standard references vCard, OMA Converged Address Book and Portable Contacts.

W3C vCard ontology

W3C PIM ontology

B. People, Groups and Organizations

People

Eran Hammer-Lahav

<http://hueniverse.com> Yahoo!, OAuth

Eliot Lear `jlear@cisco.com`

IETF Calsify WG chair

James Snell

<http://chmod777self.blogspot.com/>

Abdera committer

Julian Reschke `julian.reschke@gmx.de`

Lisa Dusseault

Lisa Dusseault is a development manager and standards architect at the Open Source Applications Foundation, where she's involved in the Chandler, Cosmo and Scooby projects.

Previously, Lisa came from Xythos, an Internet startup where she was development manager for four years. She has also been an IETF contributor on various Internet applications protocols for eight years now, and continues to do this kind of work at OSAF. She co-chairs the IETF IMAP extensions and CALSIFY (Calendaring and Scheduling Standards Simplification) Working Groups. She is also the author of a book on WebDAV and co-author of CalDAV, an open and interoperable protocol for calendar access and sharing.

Mark Nottingham

Mike Amundsen ;mamund@yahoo.com;
<http://amundsen.com>

Mike Conley

<http://mikeconley.ca/blog/> working on a new address book for Thunderbird: <https://wiki.mozilla.org/Thunderbird/tb-planning>

Peter Saint-Andre ;stpeter@stpeter.im;

IETF Calsify WG area director

Joseph Smarr

former Plaxo now Google presentation about portable contacts at vcarddav wg <http://tools.ietf.org/age>
2.pdf <http://josephsmarr.com> <http://anyasq.com/79-im-a-technical-lead-on-the-google+-team>

C. Implementations

C.1. Servers

Cyn.in

Python, Open Core

DAViCal

PHP, SQL storage, CalDAV, CardDav

eGroupWare

eXo Platform

Open Core, Java, AGPL, participates in OpenSocial?

Group-Office

PHP, AGPL

Horde

OBM Groupware

PHP, GPL

Open-Xchange

Java, In 2006 a Debian packaging attempt was canceled because upstream decided not to publish security updates for the open source version anymore.³²

owncloud

ownCloud supports syncing of calendar and contacts information via the CalDAV and CardDAV protocols.

Scalix

Open Core Scalix Public License (SPL) based on MPL, requires to show the Scalix Logo

Simple Groupware

PHP, GPL, SQL

SOG

CalDAV and CardDAV, written in Objective-C

Tiki Wiki

PHP, SQL Contacts <http://doc.tiki.org/Contacts>, Calendar <http://doc.tiki.org/Calendar> iCal export apparently no CardDAV/CalDAV many many features!

Tine 2.0

Tine is not eGroupWare

Zarafa

PHP, MySQL IIRC it uses an Entity-Attribute-Value pattern to store its data in the relational db.

Zimbra

Open Core, Own license (Zimbra Public License), RFP since 2008 open: <http://bugs.debian.org/cgi-bin/bugreport.cgi?bug=498316>

C.2. Clients

Spicebird

built on top of Thunderbird with Calendar

Thunderbird

CardDAV via SoCO connector <http://www.sogo.nu/fr/downloads/frontends.html>

WebiCal

Java, YUI, Web frontend for a CalDAV server, uses iCal4J

Evolution, Evolution Data Server

KDE Kontact, Akonadi

³²<http://web.archive.org/web/20100510133805/http://seraphyn.deveth.org/archives/10-Keine-Zukunft-in-der-freien-Version-von-Open-Exchange-auf-Debian.html> (2011-12-19)

more CardDAV

<http://wiki.davical.org/w/CardDAV/Clients> <http://en.wikipedia.org/wiki/CardDAV#Implementations>

more CalDAV

http://wiki.davical.org/w/CalDAV_Clients <http://en.wikipedia.org/wiki/CalDAV#Implementations>

C.3. Web Services

C.4. Others

D. Links

- <http://thesocialweb.tv>
- <http://www.vogella.de/articles/REST/article.html> REST with Java (JAX-RS) using Jersey - Tutorial
- <https://addons.mozilla.org/de/firefox/addon/restclient/>
- <http://dataportability.org/> still active?
- <http://tech.groups.yahoo.com/group/rest-discuss/messages/17242?threaded=1&m=e&var=1&tid=1> REST and Semantic
- <http://stackoverflow.com/questions/2669926/practical-advice-on-using-jersey-and->
- <http://macstrac.blogspot.com/2009/01/jax-rs-as-one-web-framework-to-rule.html>
- Calypso — CalDAV/CardDAV/WebDAV for Android and Evolution
- <http://www.xfront.com/files/articles-1.html>
- <http://buzzword.org.uk/swignition/uf>
- <http://json-schema.org/>
- Resource Directory Description Language (RDDL)

IANA link relations registry <http://www.iana.org/assignments/link-relations/link-relations.xml>

ATOM landscape overview <http://dret.typepad.com/dretblog/atom-landscape.html>

D.1. Apache Shindig

RPC vs. REST API for Shindig/OpenSocial: http://groups.google.com/group/opensocial-and-gadgets-spec/browse_thread/thread/a4ddf7cd09f90237/5cfa1658e1c1d698?lnk=gst&q=rest#5cfa1658e1c1d698
http://groups.google.com/group/opensocial-and-gadgets-spec/browse_thread/thread/d1a5627fb6e686ce/d27d47dee92a87b2 One argument was support for batching. A restful batching proposal didn't get consensus: https://docs.google.com/View?docid=dc43mmng_23fdbpp7hd&pli=1

Flow of REST requests in Shindig <https://sites.google.com/site/opensocialarticles/Home/shindig-rest-java>

Google+ is likely to become OpenSocial enabled: http://groups.google.com/group/opensocial-and-gadgets-spec/browse_thread/thread/1187241df6759a9a

Shindig issues to implement OpenSocial 2.0 https://docs.google.com/spreadsheet/ccc?key=0AihdZBncP3KzdGN3dVl3MFpIUlk2TXIyR3hfUDhHZUE&hl=en_US#gid=0

How Shindig supports extensions: <https://cwiki.apache.org/confluence/display/SHINDIG/Arbitrary+Extensions+to+Apache+Shindig%27s+Data+Model>

Videos about some 2.0 OS features http://groups.google.com/group/opensocial-and-gadgets-spec/browse_thread/thread/7b911edfb1bb3b4d

OS and RDF http://groups.google.com/group/opensocial-and-gadgets-spec/browse_thread/thread/20f62d627003509b

OpenSocial Development Environment (OSDE, Eclipse Plugin) <https://sites.google.com/site/opensocialdevenv>

<https://cwiki.apache.org/confluence/display/SHINDIG/Providing+your+own+data+service+implementation>

D.2. Socialsite

Oracle's (former Sun's) extension to Apache Shindig. Blog <http://blogs.oracle.com/socialsite>

E. TODO

- Does funambol.org has interesting implementations?

support Plain Text Format (text/plain), RFC5147 URI fragment identifier for plain text?

Sowohl Atom als auch AtomPub definieren XML-Vokabulare, die eine Erweiterung mit zwei Mechanismen unterstützen. Zum einen ist im Standard definiert, dass neue Elemente in diesen Vokabularen selbst von standardkonformen Prozessoren ignoriert werden müssen. [...] Gleichzeitig ist es überall dort, wo es nicht explizit verboten ist, möglich, Elemente aus anderen XML-Namespaces einzubetten.

[Til11, p. 102]

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