

# SiocLog: Providing IRC discussion logs as Linked Data

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**Abstract.** The SiocLog software application supports social networking and online collaboration by observing the instant messaging (IM) discussions on some public IRC channels, archiving the discussion logs, and publishing them as Linked Data on the Web. The application provides Web addresses (`http` URIs) for information from the discussion channels, including the daily discussions and the participants. Linked Data practices and the SIOC vocabulary provide a standard way to ensure that all parties can easily access the raw data, e.g., to create mash-ups. The chat participants can further provide their Web ID to link to their FOAF personal profile, and the FOAF profile can confirm this link in return, creating trust. Consuming FOAF data helps to avoid re-entry of personal data and searching for friends on yet another social site. The profile can also link to the person's accounts on other social forums, thus connecting their divided social presence on the Web. We present how the software is being used on some IRC channels, and describe how this work connects IRC to the greater Web of Data.

## 1 Introduction

Instant messaging is one major form of social interaction and online collaboration, but it is traditionally disconnected from the Web, not least because of its immediate nature and the shortness of the messages. Various services try to bridge this gap. An area that pertains to social data is observing, archiving, analysing, and publishing of the discussions. Linked Data provides a framework for publishing data on the Web, parallel to documents.

After the background information in this section, we first motivate and then introduce the design and implementation of the SiocLog software<sup>4</sup> (see Figure 1), which observes discussions on Internet Relay Chat (IRC) and publishes them as Linked Data. Subsections describe how SiocLog deploys the SIOC vocabulary and the concept of a Web ID, as well as detail the software architecture. Sections on validation of the results and comparison to related work follow before we conclude in the end.

<sup>4</sup> <http://irc.sioc-project.org/>

## Some IRC discussion logs

- **#fenfire**: <http://fenfire.org> | logs at <http://irc.sioc-project.org/fenfire> | version 0.2 released | an RDF-based notetaking system and desktop environment under development
- **#foaf**: <http://www.foaf-project.org/> -- The Web, The World, Us, You and Them -- "There are two kinds of people in the world, those who believe there are two kinds of people in the world, and those who don't." -- UTF-8 charset please -- chatlogs <http://chatlogs.planetrdf.com/foaf/> --- email list is foaf-dev, see lists.foaf-project.org --- [wiki.foaf-project.org](http://wiki.foaf-project.org)
- **#ontomedia**: Ontomedia discussions. | This channel is being logged at <http://irc.sioc-project.org/ontomedia>
- **#sioc**: Get Semantic Radar 1.1: <http://tr.im/vbLF> | SIOC Project: <http://sioc-project.org/> | logs: <http://irc.sioc-project.org/sioc>
- **#swig**: Semantic Web Interest Group 24x7 publicly logged hack-'n'-chat. <http://www.w3.org/2001/sw/interest/> <http://swig.xmlhack.com/> Use <http://pastebin.com/> for code/graph snippets (often confused with the Interface Generator <http://www.swig.org/> )

Discussions	#fenfire	#foaf	#ontomedia	#sioc	#swig	Users
2009-08-10					72 lines	Anchakor Andy-L antont
2009-08-09					47 lines	arj bayan bblfish
2009-08-08					129 lines	bengee BenO
2009-08-07	23 lines	9 lines	202 lines	125 lines	268 lines	besbes bmanley bwm
2009-08-06			102 lines	77 lines	185 lines	CaptSolo carmen
2009-08-05		4 lines		20 lines	591 lines	charles2 Chouser
2009-08-04		94 lines		15 lines	286 lines	Cloud connolly_
2009-08-03				7 lines	532 lines	crisb2010 CS
2009-08-02					129 lines	csarven cygri
2009-08-01				5 lines	42 lines	dajoba danbri
2009-07-31		33 lines		26 lines	199 lines	DanC danja danja
2009-07-30		33 lines		154 lines	97 lines	darksatanic datakurre
2009-07-29		27 lines		59 lines	31 lines	dblick Deu der digikim
2009-07-28		8 lines		2 lines	338 lines	dmitry ulanov donaldr3
2009-07-27		2 lines			332 lines	drewp drhousenblas
2009-07-26					443 lines	drobilla dufft earle
						edd edsu emet ericP
						FabGandon Faith
						Finnson Fudo galie

[Front page](#) [About](#)

Search

Available formats

[content-negotiated](#)  
[html](#)  
[turtle](#) (see [SIOC](#))

Features



Fig. 1. Front page of a site powered by SiocLog, including channel topics and links to the document in other formats as well as to the user profiles, the channel profiles, and the daily logs.

### 1.1 Internet Relay Chat (IRC)

Internet Relay Chat (IRC) [9] is one of the earliest instant messaging systems, where people chat virtually on discussion *channels*. IRC continues to have an important role in certain circles, including Free Software development<sup>5</sup> as well as the World Wide Web Consortium<sup>6</sup> [7], and it would be useful to interlink these discussions as well as to provide a useful service for accessing and referring to conversations in these channels. Also, multiple active IRC discussion channels exist related to the Semantic Web and Linked Data. Due to its open nature, various systems enhance and cooperate on the chat *networks* that use the IRC protocol. Software agents, known as *bots* short for robot, employ the same interface to the system as application software.

Although the protocol lets people to choose any vacant *nickname* when they connect to a network and thus to freely assume a chat persona each time, some networks provide an additional *service* called `nickserv` for people to register their nicknames and to authenticate themselves repeatably.

<sup>5</sup> <http://freenode.net/>

<sup>6</sup> <http://www.w3.org/2001/12/zakim-irc-bot>

## 1.2 Linked Data

Linked Data [2] practices build a Web of Data to enhance the Web (traditionally of pages, or documents). It means that each piece of information can be accessed by following links: On conventional Web pages, a reader can follow links from page to page. Also, all documents (and some fragments) have a Web address that anyone can refer to from anywhere. Similarly, Linked Data documents apply this principle of linking by making all their information referrable via Web addresses on the Web of Data by providing a machine-readable (RDF) version of the data, using well-known vocabularies to represent the content. Thus, anyone can easily access the raw data based on standards, e.g., to create mash-ups.

One way to access Linked Data is SPARQL, which is the Linked Data counterpart to and similar to SQL. SPARQL is supported by software libraries such as Redland<sup>7</sup>, as well as by utility programs such as `cli.php` of ARC2 Starter Pack<sup>8</sup>. Tools such as NG4J<sup>9</sup> and Squin<sup>10</sup> strive to make the subtask of downloading data from the Web completely implicit in the declarative SPARQL queries.

## 1.3 Semantically-Interlinked Online Communities (SIOC)

Semantically-Interlinked Online Communities (SIOC) [5] is the standard vocabulary for expressing social content as RDF and Linked Data. In its basic form, it provides classes and properties to describe sites, forums, users and posts. An additional vocabulary module provides more specific versions of these, such as message boards, chat channels, blog posts, and polls.

SIOC is currently used to represent information from various types of social software such as collaborative work environments, bulletin boards and microblogging systems [3][10].

## 1.4 Web ID

A Web ID [1] is a Web address that identifies a person as a Linked Data item, instead of identifying a document such as a homepage or a personal profile. Following the Linked Data principles, the Web ID should still lead to a document with information about the person. For example, a Web ID such as `http://example.com/author#person` could lead to the Web page `http://example.com/author.html` or, if the client accepts RDF, to the Linked Data document `http://example.com/author.rdf`.

The standard way to describe personal profile information is the Friend of a Friend (FOAF) vocabulary.

<sup>7</sup> <http://librdf.org/>

<sup>8</sup> <http://tuukka.sioc-project.org/arc2-starter-pack>

<sup>9</sup> <http://www4.wiwiss.fu-berlin.de/bizer/ng4j/>

<sup>10</sup> <http://squin.sourceforge.net/>

## 2 Motivation

The system described here is a specific case of the Semantic Web and Linked Data approaches, and as such, its usefulness relies mostly in the adoption of these technologies. The general pursuit of interlinking online communities using these approaches has centered on the SIOC vocabulary. Most work around SIOC this far is on publishing social data, whereas data consumers are necessary for completing most use cases. With this background, the system here is mostly a publisher, with same motivation as earlier work on SIOC publishers, but it starts to consume some data as well.

Regarding the specifics of the application domain, IRC plays an important role in connecting people online and in enabling their collaboration. IRC conversations are a popular collaboration tool for Free and Open Source Software developers and other communities.

Such conversations may contain useful knowledge, such as answers to frequently asked questions, new ideas, analysis of bugs, etc. In order to preserve this information, channel managers would often record logs of conversations on the channel and post them online.

However, developers may participate in conversations on multiple channels, and similar topics may be discussed in a number of related channels (e.g., #foaf, #sioc, and #swig are all related to Linked Data). A limitation of current IRC conversation logging systems is that they just record and present what was said on each channel individually, not taking into account the relations described above.

People may also leave and join a channel a number of times a day (i.e., they may not be always present when conversations take place). Thus, they may need to re-establish the context of what was happening while they were gone.

This all motivated us to create SiocLog - a tool that not only records IRC conversations but also lets users explore relationships that exist on IRC, e.g., to collect together activities of a person across multiple IRC channels.

## 3 Design

The design of the SiocLog system is mainly an application of the Linked Data principles and technologies as well as the SIOC vocabulary to the domain of publishing IRC discussion logs. The following subsections describe some of the central design decisions.

### 3.1 Web addresses at SiocLog sites

Table 1 summarises the URIs that SiocLog sites provide. SiocLog mentions the corresponding legacy, non-Web URIs as synonyms (`owl:sameAs`) for wider compatibility and integration.

**Table 1.** Templates of the Web addresses at SiocLog sites. SiocLog asserts the legacy URIs as synonyms (`owl:sameAs`) of its `http` URIs.

	Linked Data/Web URI	Legacy URI
IRC network	<code>http://irc.sioc-project.org/#freenode</code>	<code>irc://freenode</code>
Channel	<code>http://irc.sioc-project.org/channel#channel</code>	<code>irc://freenode/%23channel</code>
Message	<code>http://irc.sioc-project.org/channel/0000-00-00#00:00:00.00</code>	N/A
Chat persona	<code>http://irc.sioc-project.org/users/persona#user</code>	<code>irc://freenode/persona, isuser</code>

### 3.2 Links at SiocLog sites

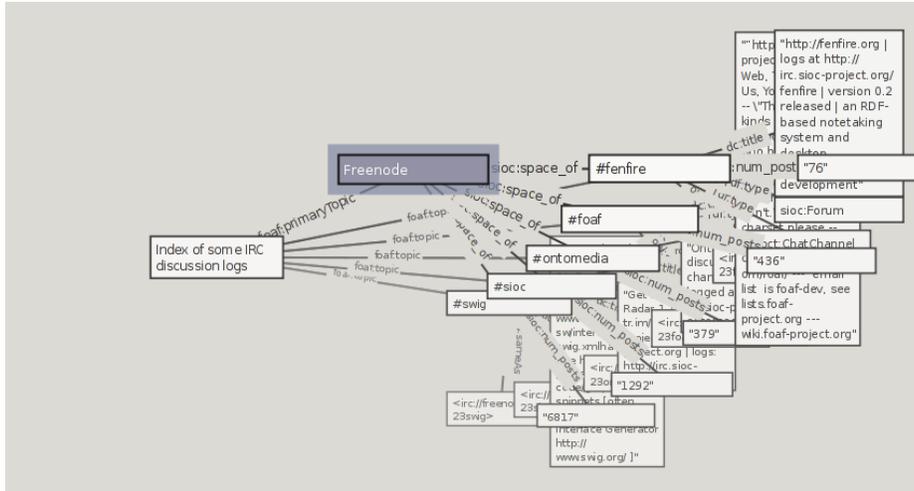
In addition to the conventional navigation links between the pages of a web site, SiocLog has Linked Data links. You can make queries that take advantage of these links, and download data by following these links. The meaning of the links is standardised via well-known vocabularies such as FOAF and SIOC. Figure 2 shows what the SiocLog site looks like initially when opened in a Linked Data browser.

Figure 3 describes how the data on the site links to other pieces of data. The topmost element is a `sioc:Space`, which represents an IRC network and which contains the users, channels and their posts. Linking to external Linked Data happens in two ways: a `foaf:Person` in a FOAF profile can be linked to (`foaf:holdsAccount`) a user, and a post can link explicitly with a URI to any Linked Data resource. Similarly, URIs in channel topics could be analysed as links to the topics.

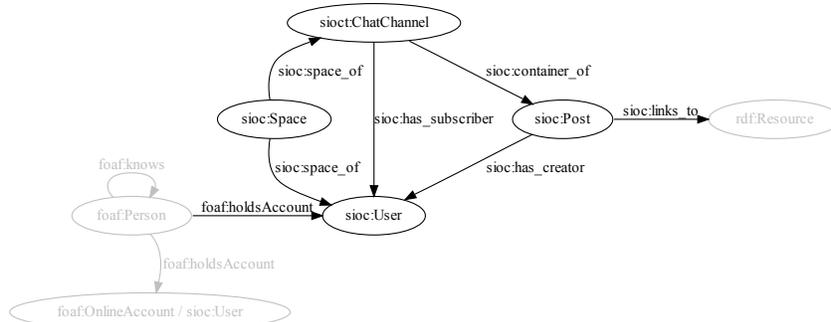
The link between a person and a user is valuable in many ways, because the FOAF profile can contain more links. For example, the `foaf:knows` links build an explicit social network between people, and this can now be used to infer a network and trust between IRC users. Also, the other `foaf:holdsAccount` links of a person imply a connection between the IRC user and the person's user accounts on other sites. In a simple but useful case, a person in multiple IRC networks and in multiple installations of SiocLog can be integrated based on these connections.

While IRC content is plain text and as such doesn't express rich semantics, it would be conceivable to interpret textual markup such as MicroTurtle<sup>11</sup>, which would turn each post into an arbitrary RDF graph. SiocLog would then publish these graphs along the textual content. An issue here is how to separate the provenance of the user from the one of SiocLog in a way that the potential data consumers would support. The traditional Semantic Web solution would be triple

<sup>11</sup> <http://buzzword.org.uk/2009/microturtle/spec>



**Fig. 2.** The initial view to a SiocLog site when opened in a Linked Data browser such as Fenfire [8]. More data and thus links is available to be loaded for each discussion channel and further along.



**Fig. 3.** Link types at SiocLog sites. An IRC network is represented as a `sioc:Space`. The grey resources and links are external.

## User Wikier

Front page > users > WikierAbout

Oldest and most recent messages from this user

[2009-06-25T05:58:50]	#sioc	<Wikier>	morning #sioc
[2009-07-13T07:29:55]	#swig	<Wikier>	<a href="http://blog.ifrade.es/2009/07/12/back-from-gcds/">http://blog.ifrade.es/2009/07/12/back-from-gcds/</a>
[2009-07-22T06:52:43]	#swig	<Wikier>	thanks for the pointer
[2009-07-30T10:35:41]	#sioc	<Wikier>	forget it xD

**Available formats**  
[content-negotiated](#)  
[html](#)  
[turtle](#) (see SIOC)

**User channels**  
[#sioc](#) (backlog)  
[#swig](#) (backlog)

 The person holding this user account claims to have the Web ID (FOAF) of <http://www.wikier.org/foaf#wikier>.

**Name** Sergio Fernández  
**Website** <http://www.wikier.org/>  
**Weblog** <http://www.wikier.org/blog>  
**Image** 

**Knows** [CaptSolo](#)  
**Knows** [Cloud](#)  
**Knows** [tuukkah](#)  
**Knows** [cygri](#)  
**Knows** [danbri](#)

Fig. 4. A user page by SiocLog, including the Web ID integration.

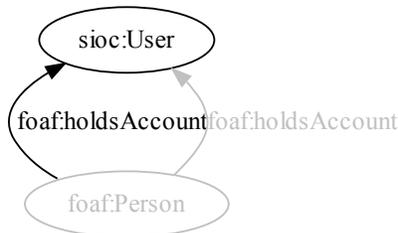
reification either as specified in RDF or by OWL property chains. We envision a more web-like solution where the graphs would be published at per-user sub-domains of the SiocLog domain (e.g. at <http://wikier.irc.sioc-project.org/>).

### 3.3 Web IDs at SiocLog sites

A chat persona can claim a Web ID and thus to be associated with an actual person. If available, SiocLog uses this information to load and display profile information, e.g., from a FOAF profile. For example, Figure 4 shows such a profile about a person (information about the `foaf:Person` that the Web ID resolves to). This way, the person doesn't need to enter data specifically for this site, making use of portability of Social Data [4].

One way to claim a Web ID is via `mttlbot`<sup>12</sup>, whose results SiocLog uses as one source of Web ID information. However, `mttlbot` doesn't require the claiming persona to be registered, i.e., it is possible to forge this information. More importantly, we wanted claiming to be possible using only standard IRC services.

<sup>12</sup> <http://buzzword.org.uk/2009/mttlbot/#project>



**Fig. 5.** The Web ID link (`foaf:holdsAccount`) can be claimed by a chat persona (`sioc:User`) in SiocLog (in black here) and by a person (`foaf:Person`) in a FOAF profile (in grey here). Together, they have full provenance to confirm the link.

Thus, SiocLog also includes a new way to claim a Web ID: A participant who has registered their nickname with the IRC network and is logged in (*identified*), can use the IRC command `/msg nickserv set property webid SomeWebID` to set their Web ID. This is a persistent setting, so the participant only needs to do this once. After this, the Web ID information is publicly available from the `nickserv` service as a part of the nickname’s metadata (*taxonomy*).

### 3.4 Verification of Web ID claims

To verify their Web ID claim, the person behind a chat persona can claim in the personal profile to be using the specific chat persona. When these claims point at each other, others can trust that the Web ID is in control of the same person as the chat persona (see Figure 5). However, people may still as usual give other false information (real name, photo, friends, etc.) about themselves in their personal profiles.

## 4 Implementation

The SiocLog software currently comprises circa 2000 source lines of code (SLOC) in Python and circa 1000 lines of (unabstracted) HTML page templates in the Zope Template Attribute Language (TAL). The only external dependencies are the software libraries Twisted<sup>13</sup> for network IO, SimpleTAL<sup>14</sup> for HTML template expansion, and Redland<sup>15</sup> for loading and querying Linked Data.

The architecture of the SiocLog software comprises four major components: the IRC interface, the data analysis, the data integration, and the Web interface.

<sup>13</sup> <http://twistedmatrix.com/>

<sup>14</sup> <http://www.owlfish.com/software/simpleTAL>

<sup>15</sup> <http://librdf.org/>

## 4.1 IRC interface

The responsibility of the IRC interface is to gather information and log it for later analysis. Because of the differing requirements, this component is split into two separate IRC bot programs. One needs to be reliable and thus preferably stable and simple, mostly passive discussion logger. The other needs to gather information about the chat personas from the nickname service, responding to queries from the other components.

To provide maximum information and flexibility for later data analysis, everything is logged in a text file as timestamped but otherwise raw lines of IRC protocol. The bots have been built specifically for SiocLog and on top of the Twisted network IO framework. As an alternative or in addition to the bots, log files could be imported from other systems.

## 4.2 Data analysis

The data analysis processes the raw IRC log files, selecting the relevant events, analysing their textual content and relation to other events in context, translating them to the SIOC model, and calculating statistics.

As IRC data is highly linear in nature, the data analysis is implemented as a pipeline of filters that process the events and as sinks that format the output. The first filters remove off-the-record messages and detect whether the message is from an authenticated user. Later filters select events that pertain to a specific channel, user, or time period, and analyse the textual content to extract links. The sinks aggregate statistics and produce a HTML, RDF, or raw representation of the events.

## 4.3 Data integration

The data integration queries the Web for information needed to combine the IRC log data with other Linked Data. It fetches and combines `mttlbot`'s knowledge<sup>16</sup> of nickname to Web ID mappings with SiocLog's own information. It also fetches data pointed to by the Web IDs, combines it with SiocLog's knowledge about chat personas, and renders the personal profiles.

Currently, this all is implemented as simple queries to temporary in-memory triple stores.

## 4.4 Web interface

Accepting HTTP requests via the CGI interface of a Web server, the Web interface depends on the data analysis and integration parts and publishes the results as Web pages in HTML and as Linked Data documents in RDF. This component does HTTP content negotiation, splits requested URIs into query parameters, drives the data analysis and integration tasks, as well as translates the results to the output format.

<sup>16</sup> <http://buzzword.org.uk/2009/mttlbot/graphs/knowledge>

**Listing 1.1.** Example SPARQL query over IRC data provided by SiocLog.

```
semwebquery -sparql "SELECT ?name WHERE {  
  ?person foaf:holdsAccount  
    <http://irc.sioc-project.org/users/melvster#user> .  
  ?person foaf:knows ?friend .  
  ?friend foaf:name ?name . }"
```

## 5 Validation

An installation of the software is in use on a few Linked Data related IRC channels since 118 days as of writing. Based on this experience, it has been reliable, and it has been convenient to be able to constantly improve the analysis, integration, and publishing parts on the fly. It has collected discussions of 291 chat personas on 5 channels this far, 22418 messages in total. For 51 chat personas in total, it knows the Web ID of the person behind them (41 from `mttlbot`, 18 set at `nickserv`; 52% of `#sioc` personas, 15% of `#swig` personas). Of these 51 Web IDs, 44 point to a valid RDF document which SiocLog is able to render reasonably. This far, 7 people have confirmed their Web ID claim in their FOAF profile.

To test browsability, we checked that given the site root URI, a Linked Data browser such as Fenfire [8] manages to browse all the Linked Data as published by the SiocLog installation. Further, the Semantic Web Client Library<sup>17</sup> gives prompt and correct results for some purely declarative SPARQL queries, for example, “names of the friends of the IRC persona `melvster`” in Listing 1.1.

The project *Towards linked sensor data for Hackystat*<sup>18</sup> is already at this phase consuming Linked Data from SiocLog to track the discussion activity of software developers.

FOAF Me<sup>19</sup> provides some simple integration with SiocLog. If a user doesn’t have a FOAF profile, SiocLog links to FOAF Me as a possible service for authoring one. FOAF Me will detect the linking and automatically pre-fill the profile with the respective IRC user as a nick name and as an external account. The FOAF Me project has further plans to consume the data from a SiocLog account in an activity feed view of the person.

### 5.1 Scalability

For the first two months of discussions on `#swig` logged by SiocLog, there were 191 participants, and 10948 messages with 662567 bytes of textual content. This is 1.6 megabytes of the raw text log format, or 5.3 megabytes of Turtle RDF format, or 3.2 megabytes of HTML web pages.

<sup>17</sup> <http://www4.wiwiw.fu-berlin.de/bizer/ng4j/semwebclient/>

<sup>18</sup> [http://socghop.appspot.com/student\\_project/show/google/gsoc2009/hackystat/t124022455248](http://socghop.appspot.com/student_project/show/google/gsoc2009/hackystat/t124022455248)

<sup>19</sup> <http://foaf.me/>

The current representation produces 5 RDF triples per user, 7 triples per channel, and 6 triples plus any enrichment per post. In total, these form 67192 triples. Assuming that the activity of the channel remains similar, a linear extrapolation predicts this would become 4 million triples in 10 years, which is not a challenge for modern RDF stores.

## 6 Related work

Dave Beckett's Logger<sup>20</sup> IRC bot has been publishing IRC discussion logs in RDF since year 2001. However, the output from Logger is somewhat outdated regarding Linked Data principles as it doesn't give the participants `http` URIs and corresponding information documents with links to more information, and it uses the old RDF container properties instead of SiocLog's implicit ordering of events based on `dc:date`. Further, Logger doesn't use the standard and rich SIOC (Semantically-Interlinked Online Communities) vocabulary in its RDF. Finally, Logger doesn't let chat participants declare their Web ID and thus doesn't link out to and integrate with FOAF network of people or the larger Web of Data in general.

Another application that converts non-Web social data to Linked Data is SWAML [6], which converts mailing list archives. Like SiocLog, SWAML can establish a link between the sender and their Web ID. As e-mail messages already unambiguously identify via sender address the person sending the message, SWAML can look up the Web ID in a search engine.

Another application that publishes small messages as Linked Data using the SIOC vocabulary is SMOB [10], which is a semantic microblogging system. Still, microblog posts are somewhat longer and more self-contained than IRC messages, so they are more like ordinary documents.

## 7 Conclusion

This paper introduced SiocLog—an application for collecting IRC conversations, making them available for reuse in other applications and services via the use of Linked Data, and for enabling rich access to knowledge contained in these conversations.

We described how SiocLog links together users and channels on which users engage in conversations. It can also bring in and integrate Linked Data from external sources, e.g., people's FOAF profiles.

While SiocLog as implemented deals exclusively with IRC content, a system supporting other instant messaging systems should be similar. The idiosyncrasies of each system will affect the best way to form URIs. The exact way of observing discussions will depend on the system, as protocols and chat culture vary. For example, where private chats are the norm, participants will need either to invite an observer bot, or to collect and publish the events themselves. There will also

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<sup>20</sup> <http://www.dajobe.org/software/logger/>

be differences in the exact form of discussions, such as whether channels have topics or only names.

This work envisions SiocLog as a significant part of the Web of Data, acting as an initial consumer and use case of FOAF data as well as providing other applications with real-time services such as user presence data or information about resources that people talk about right now. Further, by publishing rich, structured information about IRC conversations, SiocLog can help new studies of online communities and their behaviour to include data about real-time communication.

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## References

1. C. Au Yeung, I. Liccardi, K. Lu, O. Seneviratne, and T. Berners-Lee. Decentralization: The future of online social networking. In *W3C Workshop on the Future of Social Networking*, 2009.
2. C. Bizer, T. Heath, and T. Berners-Lee. Linked data — the story so far. *International Journal of Semantic Web and Information Systems, Special Issue on Linked Data*, in press.
3. U. Bojārs, J. G. Breslin, V. Peristeras, G. Tummarello, and S. Decker. Interlinking the social web with semantics. *IEEE Intelligent Systems*, 23(3):29–40, 2008.
4. U. Bojars, A. Passant, J. G. Breslin, and S. Decker. Social network and data portability using semantic web technologies. In *Social Aspects of the Web workshop (SAW 2008) at BIS 2008*, pages 5–19, 2008.
5. J. Breslin, A. Harth, U. Bojars, and S. Decker. Towards semantically interlinked online communities. In *Proceedings of the 2nd European Semantic Web Conference (ESWC2005)*, 2005.
6. S. Fernández, D. Berrueta, and J. E. Labra. Mailing lists meet the semantic web. In *Proceedings of the BIS 2007 Workshop on Social Aspects of the Web*, 2007.
7. M. Froumentin. Zakim — a multimodal software system for large-scale teleconferencing. In *Machine Learning for Multimodal Interaction*, pages 46–55. 2005.
8. T. Hastrup, R. Cyganiak, and U. Bojārs. Browsing linked data with Fenfire. In *Workshop on Linked Data on the Web*, 2008.
9. J. Oikarinen and D. Reed. Internet relay chat protocol. RFC 1459, Internet Engineering Task Force, 1993. Available at <http://www.ietf.org/rfc/rfc1459.txt>.
10. A. Passant, T. Hastrup, U. Bojārs, and J. Breslin. Microblogging: A semantic web and distributed approach. In *Proceedings of the 4th Workshop on Scripting for the Semantic Web*, 2008.