UNIVERSITY OF Southampton
School of Electronics and Computer Science

Semantic Web Publishing

Dr Nicholas Gibbins
nmg@ecs.soton.ac.uk
32/4037

Linked Data

UNIVERSITY OF Southampton
School of Electronics and Computer Science

- Semantic Web is the Web for machines
  - Take existing data and republish it to the Web
  - Rely on hypertextual nature of the Web to facilitate linking between data
- How do we publish this data?
- What identifiers do we use?

Semantic Web Principles

UNIVERSITY OF Southampton
School of Electronics and Computer Science

- Anyone can make assertions about anything
- Entities are referred to using Uniform Resource Identifiers
- Based on XML technologies
- Formal semantics

Uniform Resource Identifiers

UNIVERSITY OF Southampton
School of Electronics and Computer Science

- What does a URI on the Semantic Web refer to?
  - A real world object?
  - A web page?
  - Both?
- What does a URI identify in general?
- What is a resource?
- What are the implicit semantics in a URI?

What is a resource?

UNIVERSITY OF Southampton
School of Electronics and Computer Science

- From RFC2396 (URIs):

  A resource can be anything that has identity. Familiar examples include an electronic document, an image, a service (e.g., "today's weather report for Los Angeles"), and a collection of other resources. Not all resources are network "retrievable"; e.g., human beings, corporations, and bound books in a library can also be considered resources.

  The resource is the conceptual mapping to an entity or set of entities, not necessarily the entity which corresponds to that mapping at any particular instance in time. Thus, a resource can remain constant even when its content - the entities to which it currently corresponds - changes over time, provided that the conceptual mapping is not changed in the process.

URIs, URLs and URNs

UNIVERSITY OF Southampton
School of Electronics and Computer Science

- Classical view – early to mid 1990s
  - Uniform Resource Locators specify the location of a resource (machine name, etc)
    - http:
  - Uniform Resource Names specify the name of a resource, independent of its name
    - isbn:

- Uniform Resource Identifiers are either URLs or URNs

URIs, URLs and URNs

UNIVERSITY OF Southampton
School of Electronics and Computer Science

- URL resolution is (usually) well-defined
- URNs don't necessarily have well-defined resolution semantics
  - Resolving names depends on context
  - What does resolution mean for URIs which do not refer to network resources?

Representational State Transfer (REST)

UNIVERSITY OF Southampton
School of Electronics and Computer Science

- Architectural principle for Web systems
  - Resources referred to by global identifiers (URIs)
  - Manipulated via a standard interface (http)
  - Network components (clients and servers) exchange representations of the resources
  - Connectors (caches, proxies) mediate requests

httpRange-14

UNIVERSITY OF Southampton
School of Electronics and Computer Science

- W3C Technical Architecture Group issue
  - “What is the range of the HTTP range dereference operation?”
  - Raised in March 2002
  - Closed in Jun 2005

- TBL’s original stance: HTTP URIs (without "#") should be understood as referring to documents, not cars

All resources are equal…

UNIVERSITY OF Southampton
School of Electronics and Computer Science

…but some are more equal than others

- The things identified by URIs are resources
- Some resources can be retrieved by dereferencing their URIs
  - Or rather, representations of some resources can be retrieved
- Some resources cannot be retrieved
  - People, cats, cars

Information Resources

UNIVERSITY OF Southampton
School of Electronics and Computer Science

- "Information resources are resources, identified by URIs and *whose essential characteristics can be conveyed in a message*"
  - An (abstract) document (with a URI) can be dereferenced to get an 'obvious' representation of that document
  - The majority of current Web resources are information resources

What makes an information resource?

UNIVERSITY OF Southampton
School of Electronics and Computer Science

- Consider the case of resources identified by HTTP URIs:

- If dereferencing the URI results in a 200 OK response code, the resource is an information resource
  - From the HTTP RFC: “an entity corresponding to the requested resource is sent in the response”
- If it results in a 303 See Other response, the resource could be any resource
  - “the response to the request can be found under a different URI and SHOULD be retrieved using a GET method on that resource”
- If it results in a 4xx (client error) or 5xx (server error) response, we can’t say either way

Linked Data Principles

UNIVERSITY OF Southampton
School of Electronics and Computer Science

Set of publishing practices for SW data:

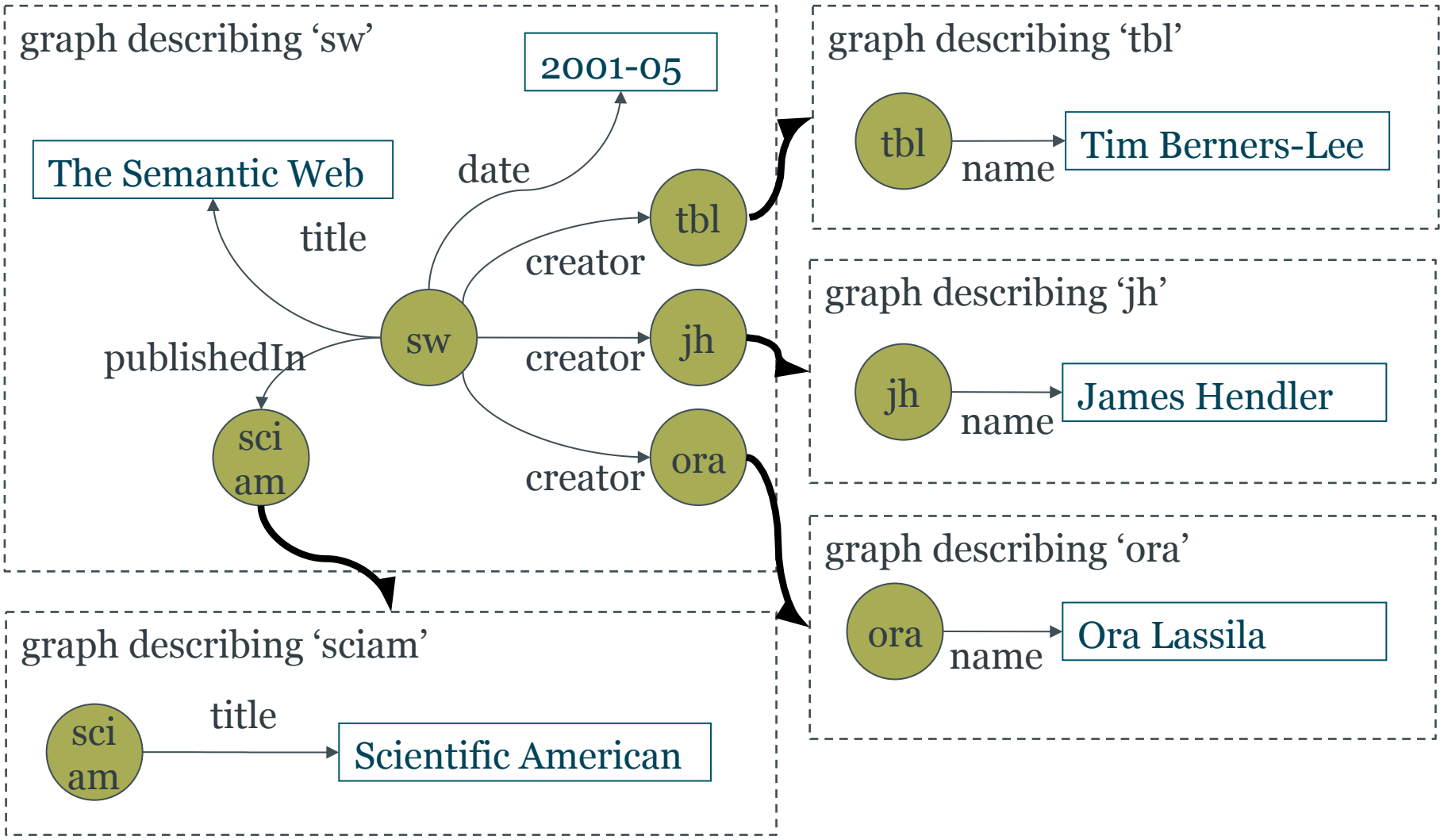
1. Use URIs as names for things
2. Use HTTP URIs so that people can look up those names
3. When someone looks up a URI, provide useful information
4. Include links to other URIs. so that they can discover more things

Effectively, putting the hypertext back into the Semantic Web

Simplifies integration between datasets while maintaining loose coupling

Example

UNIVERSITY OF Southampton
School of Electronics and Computer Science



RDF Publishing Example

UNIVERSITY OF Southampton
School of Electronics and Computer Science

In http://example.org/data.rdf

```
@prefix foaf: <http://xmlns.com/foaf/0.1/>
<#fred> <foaf:name> “Fred Smith”.
```

- We have a new resource: http://example.org/data.rdf#fred

Defining RDF Vocabularies

UNIVERSITY OF Southampton
School of Electronics and Computer Science

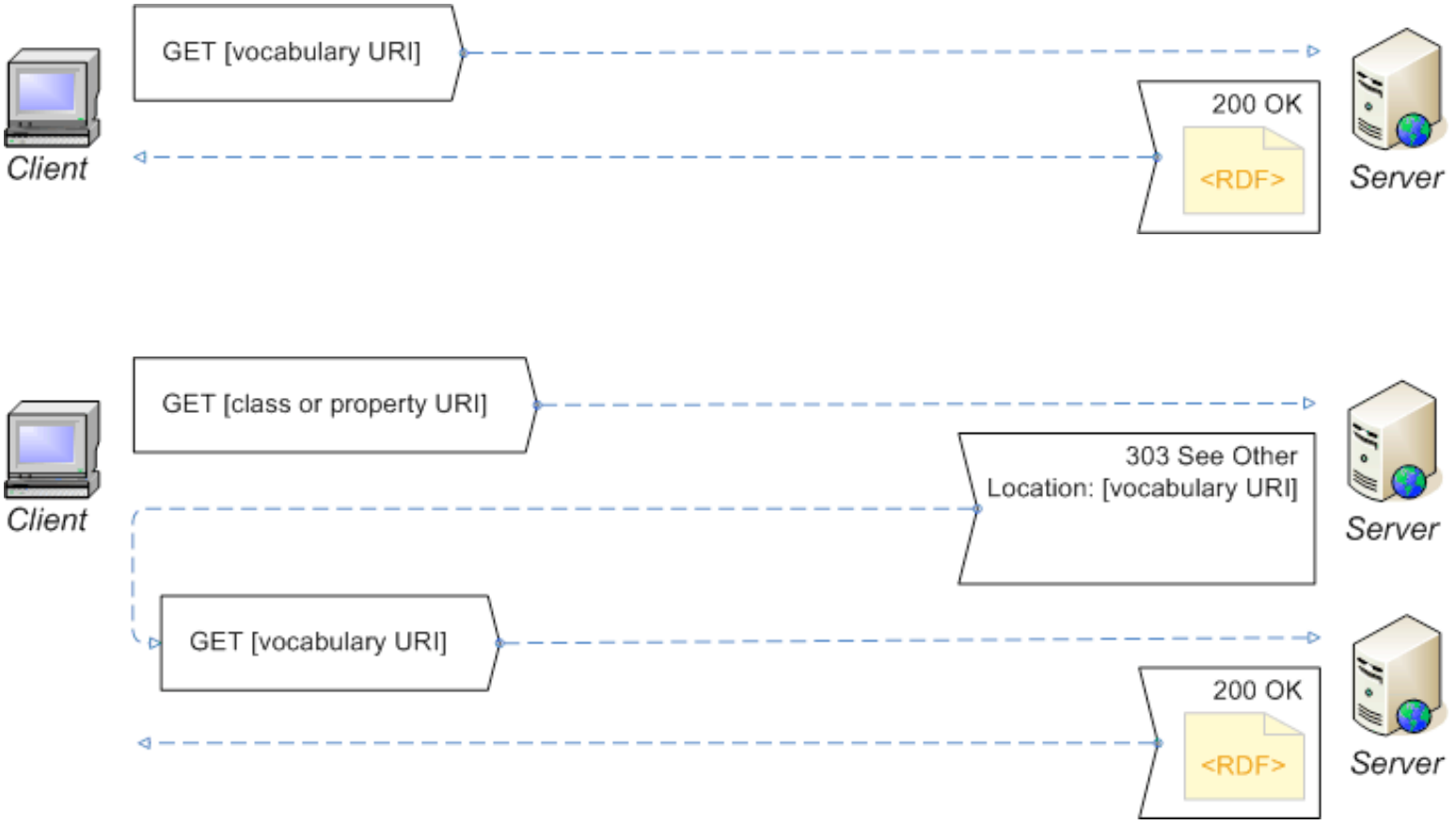
- SW Best Practice Recipes for Publishing RDF Vocabularies
- Distinguishes between ‘hash’ and ‘slash’ namespaces
  - http://example.org/ontology#foo
  - http://example.org/ontology/foo
- Uses content negotiation (HTTP Accept: header) to serve different representations of resources
  - Machine-readable RDF vs human-readable HTML

Minimal Hash Namespace

UNIVERSITY OF Southampton
School of Electronics and Computer Science

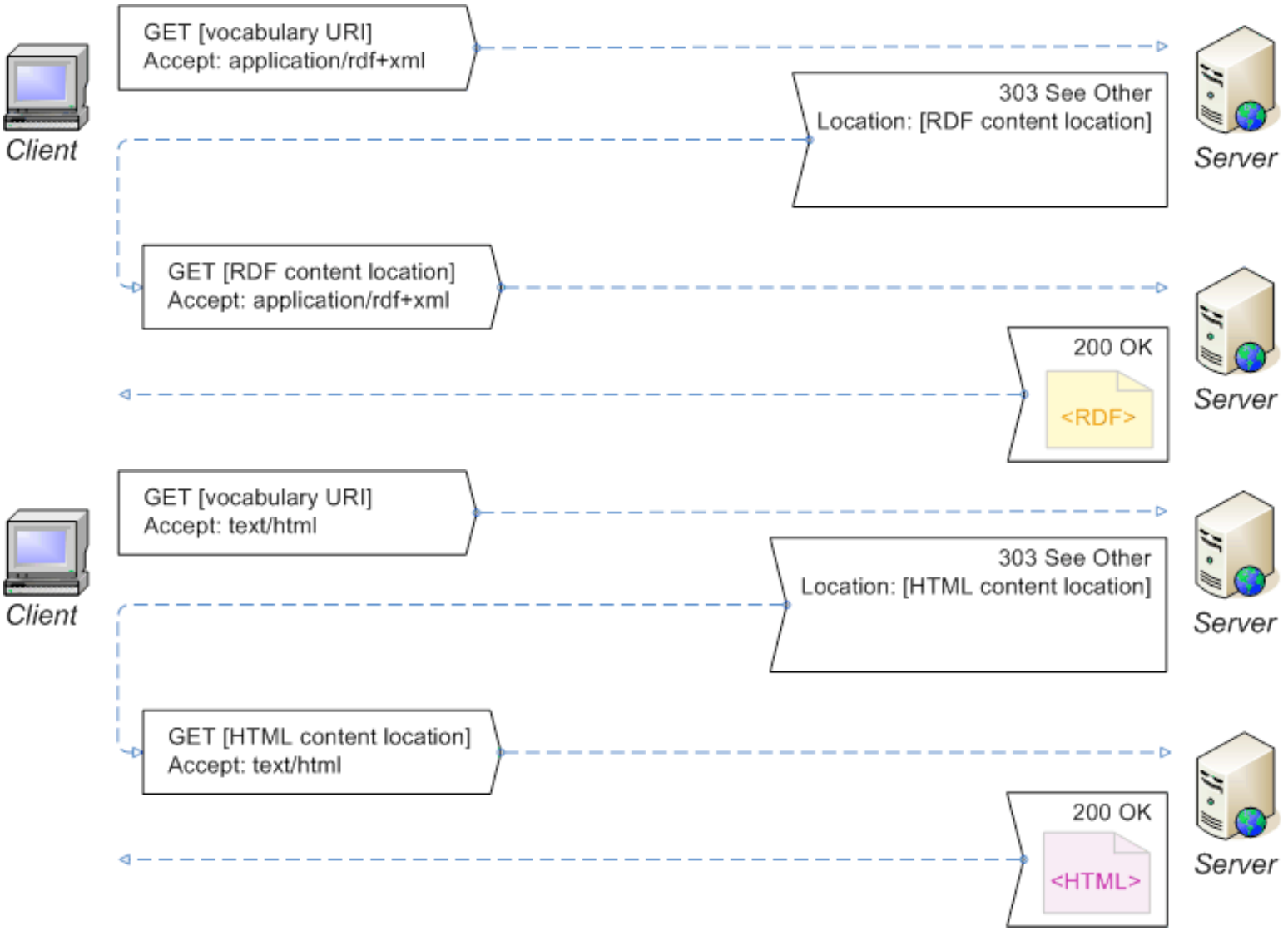
Minimal Slash Namespace

UNIVERSITY OF Southampton
School of Electronics and Computer Science



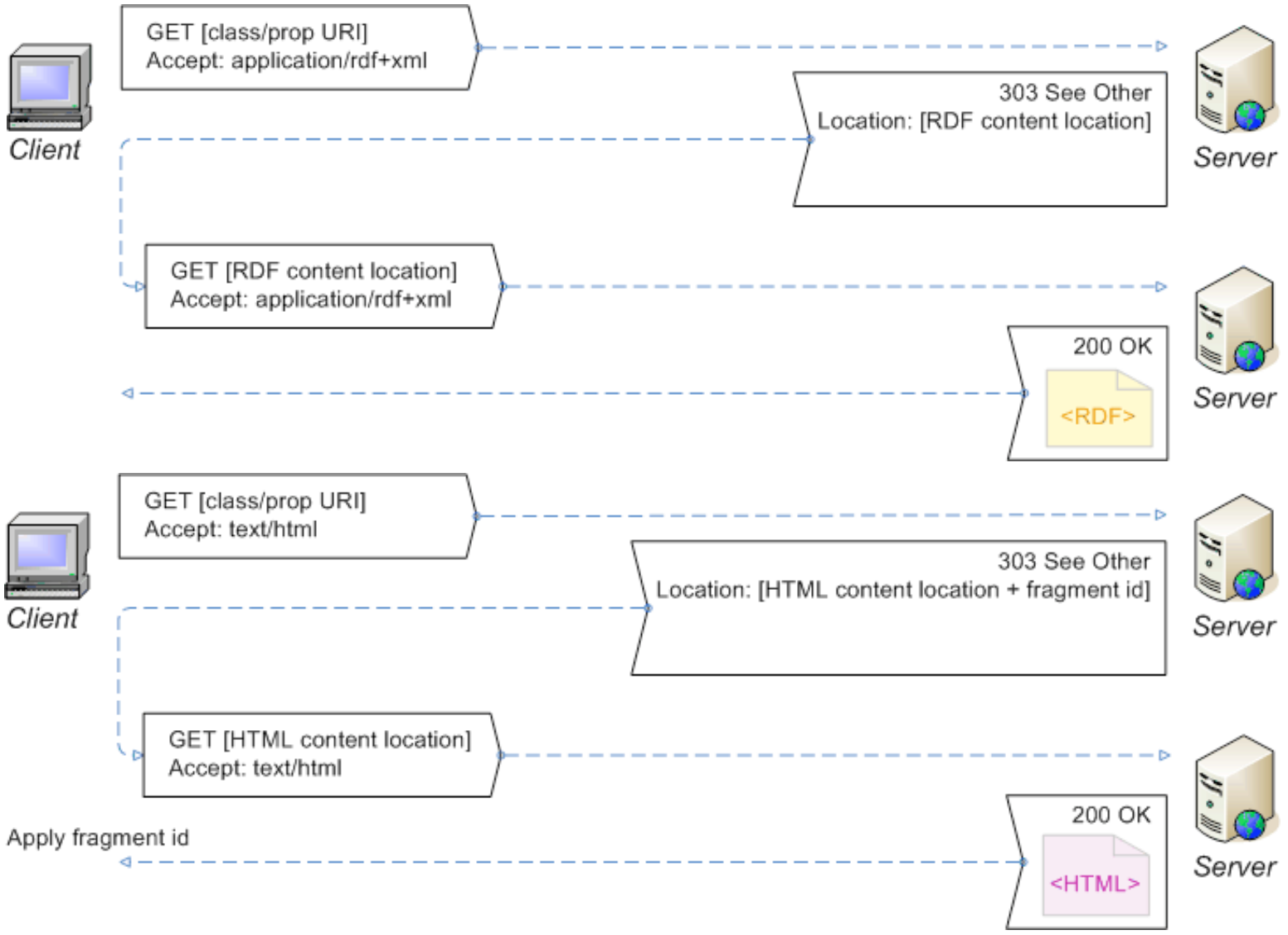
Extended Hash Namespace

UNIVERSITY OF Southampton
School of Electronics and Computer Science



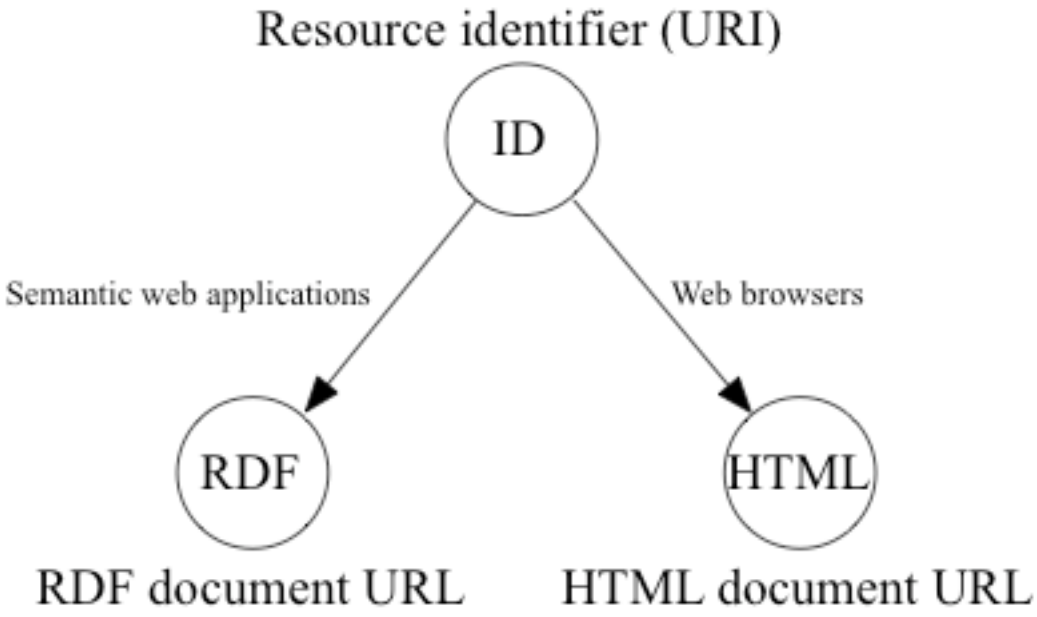
Extended Slash Namespace

UNIVERSITY OF Southampton
School of Electronics and Computer Science



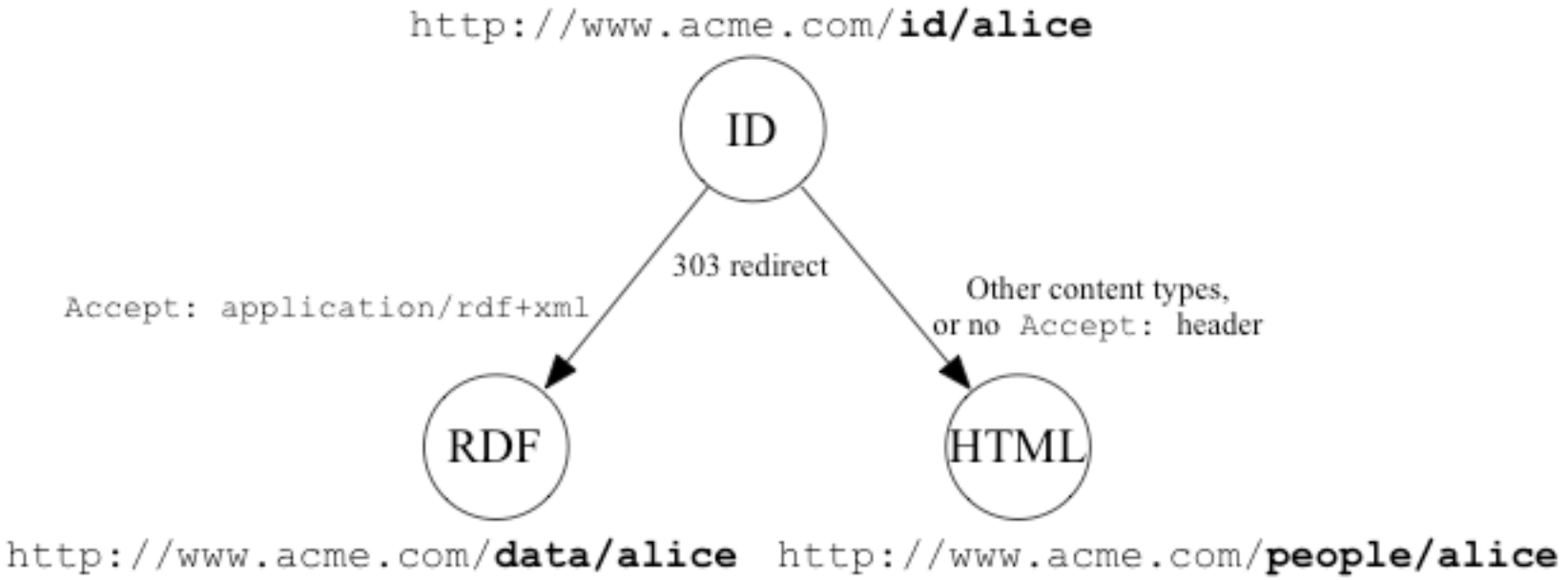
Cool URIs

UNIVERSITY OF Southampton
School of Electronics and Computer Science



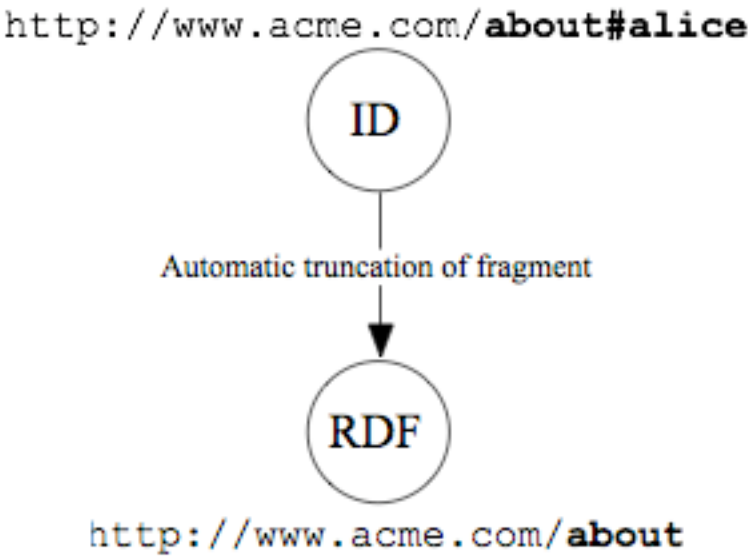
Cool URIs – 303 Pattern

UNIVERSITY OF Southampton
School of Electronics and Computer Science



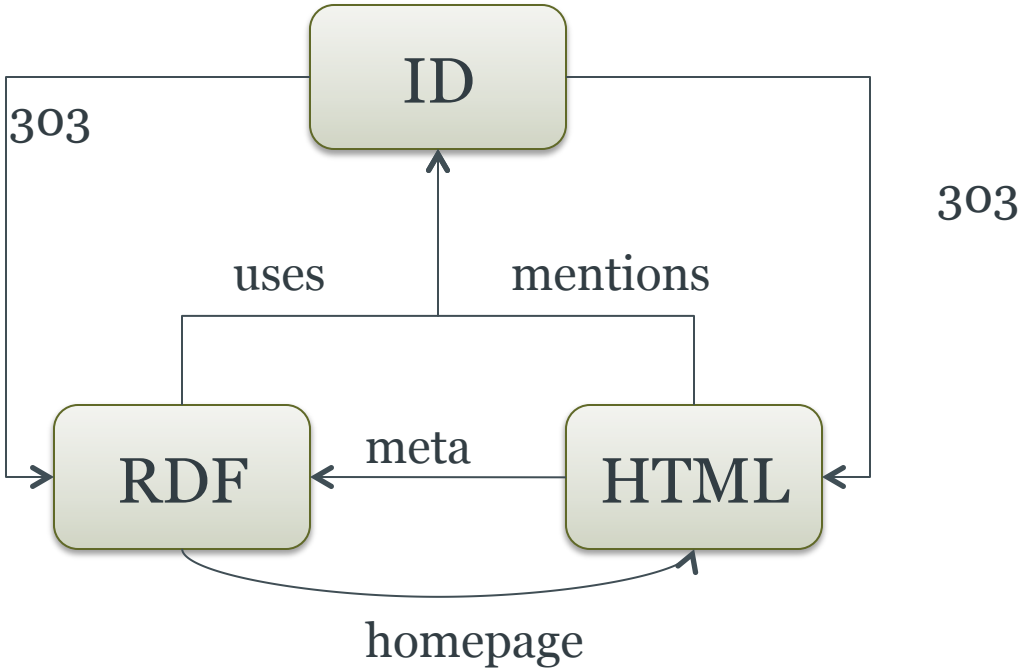
Cool URIs – Hash Pattern

UNIVERSITY OF Southampton
School of Electronics and Computer Science



Cool URIs

UNIVERSITY OF Southampton
School of Electronics and Computer Science



Cool URIs in ECS

UNIVERSITY OF Southampton
School of Electronics and Computer Science

ID URI: http://id.ecs.soton.ac.uk/person/1269
RDF URI: http://rdf.ecs.soton.ac.uk/person/1269
HTML URI: http://www.ecs.soton.ac.uk/people/nmg

Person URI: http://id.ecs.soton.ac.uk/person/1269
Role URI: http://id.ecs.soton.ac.uk/role/3370

Person RDF: http://rdf.ecs.soton.ac.uk/person/1269
Role RDF: http://rdf.ecs.soton.ac.uk/role/3370

More information

Open Data Homepage

5★ Data

Frequently Asked Questions

Apps

Data Catalogue

- Places
- Phonebook
- Academic Programmes
- Organisation
- Jargon
- Products & Services

SPARQL Endpoint

Feedback

- Suggestions
- Report a Problem
- Register an App

Credits

University of Southampton > Open Data

University of Southampton Open Data

The University of Southampton provides open access to some of our administrative data.

We believe that this will be of benefit to our own members and visitors, and increase the transparency of our operations.

Featured App:

Open Data Map

This tool is under development by Postgraduate students, it's a work in progress and so may break now and then, but it looks amazing. You can search for services on and near our campuses!

Linked Open Data

The executive summary: There's data we have which isn't in any way confidential which is of use to our members, visitors, and the public. If we make the data available in a structured way with a license which allows reuse then our members, or anyone else, can build tools on top of it without needless bureaucracy. That's common sense. We call it "Open Data".

For more on Open Data and it's benefits see these presentations by Southampton's Nigel Shadbolt and Tim Berners-Lee. They helped establish data.gov.uk the UK Government's Open Data site and are members of the Coalition Government's Transparency Board.

We publish our data in RDF format and link our identifiers to other sites in the Linked Open Data Web. This makes it much eaiser to merge data from multiple sources and other sites can link their datasets up with ours. Like the HTML Web, the whole is much greater than the sum of its parts, that's "Linked Data".

Show me the data!

Browse the list of datasets or view the links on the left to explore some of our data.

Southampton Data Blog
2011-04-14, 16:02h

Interview with Christopher Gutteridge
There's an interview with Christopher Gutteridge (me!) on this weeks Ubuntu UK Podcast. (If you're wondering, data.soutampton.ac.uk runs on virtual machine running Ubuntu) Actually, it's worth giving a shout out to the technologies we use, but I'll save that for a future post.

[April 1st Gag] PDF selected as Interchange Format
The following article is our prank for April 1st. Just to be clear PDF is a dreadful format to exchange data in. It was inspired, in part, by The Register wesbsite running the following picture and quote. Yes, I did say that, but I was talking about research and data communication. It was fun working [...]

New Formats
New ways to enjoy our data. We've added some links to the "Get the Data" box which let you see what formats are available. Some pages let you download RDF, others you can get back as tabular data, suitable for loading into Excel, amongst other things. Roughly speaking, pages about things have RDF versions, pages [...]

Grasping the nettle and changing some URIs
We've realised that using UPPER CASE in some URIs looked fine in a

It’s not quite
that simple…

rdfURIMeaning-39

UNIVERSITY OF Southampton
School of Electronics and Computer Science

- W3C Technical Architecture Group issue
  - Raised in July 2003
  - Currently open

- Is a given inference engine expected to take into account a given document under given circumstances?

- How does one avoid having to commit to things one does not trust?

HttpRedirections-57

UNIVERSITY OF Southampton
School of Electronics and Computer Science

- W3C Technical Architecture Group issue
  - "Mechanisms for obtaining information about the meaning of a given URI"
  - Raised in July 2007
  - Currently open

- Further consideration of the use of:
  - 303 HTTP status codes (and interaction with caching)
  - Other possible mechanisms for obtaining a description of a (non-information) resource (HTTP Link: header – see RFC2068)

UniformAccessToMetadata-62

UNIVERSITY OF Southampton
School of Electronics and Computer Science

- W3C Technical Architecture Group issue
  - “Given the URI of an HTTP-accessible information resource R, how can an agent learn the URIs of metadata documents about R authorized by the owner of the original URI”
  - Raised in March 2009
  - Currently open

Further Reading

UNIVERSITY OF Southampton
School of Electronics and Computer Science

- Architecture of the World Wide Web
  http://www.w3.org/TR/webarch/
- R.T. Fielding and R.N. Taylor, Principled Design of the Modern Web Architecture, *ACM Transactions on Internet Technology* 2 (2): 115–150
  http://www.ics.uci.edu/~taylor/documents/2002-REST-TOIT.pdf
- Uniform Resource Identifiers (URI): Generic Syntax
  IETF RFC2396
  http://www.ietf.org/rfc/rfc2396.txt
- Hypertext Transfer Protocol - HTTP/1.1
  IETF RFC2616
  http://www.ietf.org/rfc/rfc2616

Further Reading

UNIVERSITY OF Southampton
School of Electronics and Computer Science

- What do HTTP URIs identify?
  http://www.w3.org/DesignIssues/HTTP-URI
- W3C TAG issue httpRange-14
  http://www.w3.org/2001/tag/group/track/issues/14
- W3C TAG Issue rdfUriMeaning-39
  http://www.w3.org/2001/tag/group/track/issues/39
- W3C TAG issue httpRedirections-57
  http://www.w3.org/2001/tag/group/track/issues/57
- W3C TAG issue UniformAccessToMetadata-62
  http://www.w3.org/2001/tag/group/track/issues/62
- Dereferencing HTTP URIs
  http://www.w3.org/2001/tag/doc/httpRange-14/2007-05-31/HttpRange-14

Further Reading

UNIVERSITY OF Southampton
School of Electronics and Computer Science

- Cool URIs for the Semantic Web
  http://www.w3.org/TR/2007/WD-cooluris-20071217/
- Best Practice Recipes for Publishing RDF Vocabularies
  http://www.w3.org/TR/swbp-vocab-pub/

UNIVERSITY OF
Southampton
School of Electronics
and Computer Science

Embedding Semantic Web Data

Embedded Data

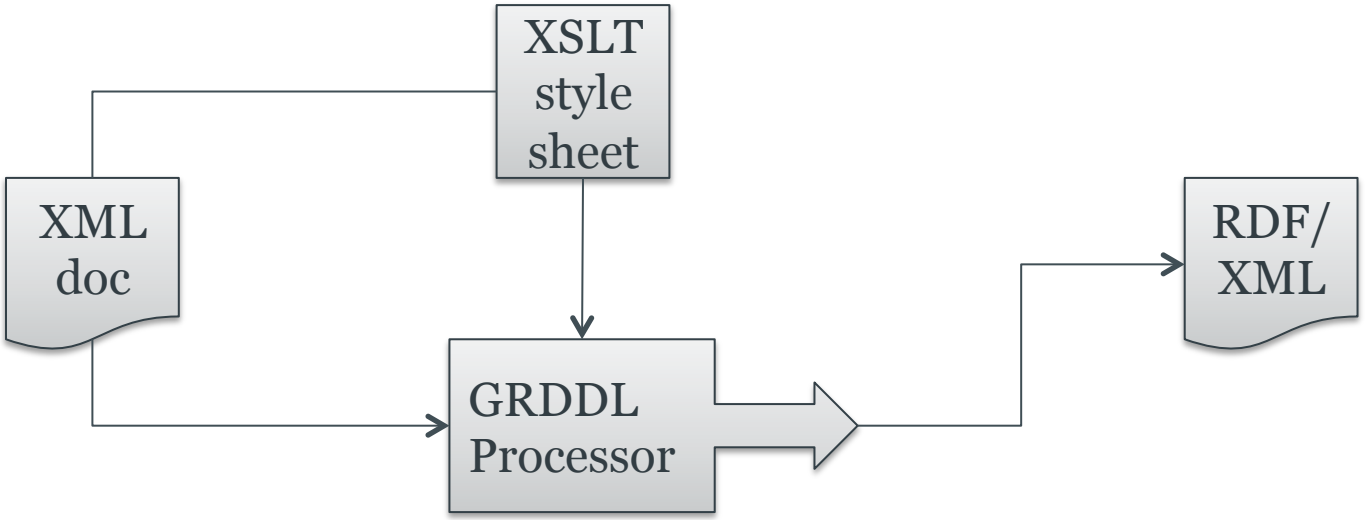
UNIVERSITY OF Southampton
School of Electronics and Computer Science

- Publishing patterns for linked data that we've already considered make the assumption that we're publishing directly in RDF/OWL
- What if the data already exists in a web resource, in some form?
- Republishing the data separately introduces redundancy, and the possibility of inconsistency - embed our SW data in the web resource
- Two main approaches:
  - GRDDL
  - RDFa

GRDDL

UNIVERSITY OF Southampton
School of Electronics and Computer Science

- Given a document in some XML format, how can we extract the relevant portions and make them available to SW agents?
- GRDDL (Gleaning Resource Descriptions from Dialects of Languages) uses XSLT stylesheets to transform documents



Using GRDDL with XML

UNIVERSITY OF Southampton
School of Electronics and Computer Science

- In well-formed XML, link to XSLT transformation using grddl:transformation attribute

- Need to introduce grddl: namespace

```
<html xmlns='http://www.w3.org/1999/xhtml'
      xmlns:grddl='http://www.w3.org/2003/g/data-view#'
      grddl:transformation="glean_title.xsl">
      <head>
            <title>Are You Experienced?</title>
            [...]
</html>
```

Using GRDDL with XHTML

UNIVERSITY OF Southampton
School of Electronics and Computer Science

- Link to XSLT transformation using link element
- Introduce GRDDL in profile

```
<html xmlns="http://www.w3.org/1999/xhtml">
        <head profile="http://www.w3.org/2003/g/data-view">
                <title>Some Document</title>
                <link rel="transformation”
        href="http://www.w3.org/2000/06/dc-extract/dc-extract.xsl" />
                <meta name="DC.Subject”
                content="ADAM; Simple Search; Index+; prototype" />
                        [...]
        </head>
        [...]
</html>
```

RDFa

UNIVERSITY OF Southampton
School of Electronics and Computer Science

- Yet another syntax for RDF…
- Designed for embedding structured data in web pages
- Stored structure in attributes (the ‘a’ in ‘RDFa’)

RDFa Example

UNIVERSITY OF Southampton
School of Electronics and Computer Science

```
<html>
        <head><title>Jo's Friends and Family Blog</title></head>
        <body>
                <p>I'm holding one last summer Barbecue,
                on September 16th at 4pm.</p>
                <p class="contactinfo”>
                Jo Smith. Web hacker at
                <a href="http://example.org">Example.org</a>.
                You can contact me <a href="mailto:jo@example.org">via
email</a>.</p>
        </body>
</html>
```

Showing an instance of a class

UNIVERSITY OF Southampton
School of Electronics and Computer Science

I'm holding one last summer Barbecue, on September 16th at 4pm.

I'm holding one last summer Barbecue, on September 16th at 4pm.

_:a <rdf:type> <cal:Event> .

Using properties

UNIVERSITY OF Southampton
School of Electronics and Computer Science

```
<p>I'm holding one last summer Barbecue, on September 16th
at 4pm.</p>
```

```
<p>I'm holding <span property="cal:summary">one last summer
Barbecue</span>, on September 16th at 4pm.
</p>
```

_:a <cal:summary> “one last summer Barbecue” .

Using properties

UNIVERSITY OF Southampton
School of Electronics and Computer Science

```
<p>I'm holding one last summer Barbecue, on September 16th at 4pm.</p>

<p>I'm holding one last summer Barbecue, on <span property="cal:start" content="20070916T1600-0500">September 16th at 4pm</span>.</p>
```

```
_:a <cal:start> "20070916T1600-0500" .
```

Identity

UNIVERSITY OF Southampton
School of Electronics and Computer Science

```
<p class="contactinfo”>
Jo Smith. Web hacker at
<a href="http://example.org">Example.org</a>.
You can contact me <a href="mailto:jo@example.org">via
email</a>.</p>
<p class="contactinfo” about=“http://example.org/staff/jo”>
Jo Smith. Web hacker at
<a href="http://example.org">Example.org</a>.
You can contact me <a href="mailto:jo@example.org">via
email</a>.</p>
```

Identity

UNIVERSITY OF Southampton
School of Electronics and Computer Science

<p class="contactinfo" about="http://example.org/staff/jo">
Jo Smith. […]

<p class="contactinfo" about="http://example.org/staff/jo">
Jo Smith. […]

<http://example.org/staff/jo> <foaf:name> "Jo Smith" .

Using existing links

UNIVERSITY OF Southampton
School of Electronics and Computer Science

```
<p about="http://example.org/staff/jo"> [...]
<a href="http://example.org">Example.org</a>.
You can contact me <a href="mailto:jo@example.org">via email</
a>.</p>
```

```
<p about="http://example.org/staff/jo"> [...]
<a rel="foaf:homepage"
      href="http://example.org">Example.org</a>.
You can contact me <a rel="foaf:mbox"
href="mailto:jo@example.org">via email</a>.</p>
```

```
<http://example.org/staff/jo> <foaf:mbox>
  <mailto:jo@example.org> ;
  <foaf:homepage> <http://example.org/> .
```

Datatypes

UNIVERSITY OF Southampton
School of Electronics and Computer Science

```
<span property="dc:date" content="2007-05-12"
datatype="xsd:date”>May 12th, 2007</span>
```

Further Reading

UNIVERSITY OF Southampton
School of Electronics and Computer Science

- Gleaning Resource Descriptions from Dialects of Languages
  W3C Recommendation 11 September 2007
  http://www.w3.org/TR/grddl/

- RDFa in XHTML: Syntax and Processing
  W3C Recommendation 14 October 2008
  http://www.w3.org/TR/rdfa-syntax/

- RDFa Primer
  W3C Working Group Note 14 October 2008
  http://www.w3.org/TR/xhtml-rdfa-primer/