Enterprise Data Management Council

Report of workshop, October 2013

Financial Industry Business Ontology (FIBO)
Technology Summit
San Francisco, CA June 5 - 6 2013

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Disclaimer

Any opinions, findings, and conclusions or recommendations expressed in this material of those of the author(s) and do not necessarily reflect the views of members of the Enterprise Data Management Council, Wells Fargo Bank, or any of the organizations affiliated with the Summit participants.

Acknowledgements

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Once upon a time, there were no standard definitions of financial terms and the financial institutions could interpret the meaning of the rules and regulations of the industry each in their own way. Everyday, new financial instruments and transaction types were invented. One day, major companies in business for many decades began to collapse and the world fell into a severe economic crisis. Because of that, many sectors of the world’s economy realized that their true financial status could not be understood. Because of that, an effort was launched by the industry to develop a Financial Industry Business Ontology (FIBO) - a common vocabulary based on international standards, that would enable companies to better communicate within and among themselves and would enable regulators to perform meaningful oversight as required by laws. Until finally data became more harmonized and transparent, Congress and the regulators were confident of the provenance of answers to their questions of the industry, and having commonality of financial data terms was a direct benefit to the financial institutions themselves and the customers in which they support.

Dennis E. Wisnosky

EXECUTIVE SUMMARY AND RECOMMENDATIONS

The Enterprise Data Management Council, with the support of Semanticweb.com, organized a workshop called the FIBO Technology Summit on June 5-6 2013 in San Francisco, CA USA. The goal of the Summit was to begin to build a community of the best minds in the Ontology community to focus on critical technology and collaboration needs to support the Finance Industry.

1. Operational Ontologies
2. Semantic Rules
3. Visualization
4. Scalability

More than 60 leaders from different IT and business sectors and academia brought varying perspectives to the meeting. The result was a roadmap in each of the need areas as well as a broad list of recommendations as follows:

•Organize: Create a Semantic Technology Coordination Leadership team with a fixed membership and published meeting schedule. There is a need for a team of the best minds in finance, IT and, mathematics and business to be brought together to focus on how to best use Semantic Technology to achieve the goals of FIBO.
• **Fund:** Identify sources and a coordination process for semantic technology funding. Literally millions of US$ are focused annually on research in Defense, Autos and Energy with specific goals established.\(^1\) Comparative spending to solve real problems and contribute to the process of knowledge management is trivial by comparison.

• **Sustain:** Implement a Semantic Technology Laboratory (Center of Excellence) as a formal mechanism for the advancement of semantic technology. Arguably springing out of the discipline of Artificial Intelligence\(^2\), for all practical purposes, Semantic Technology was incarnated by the US DoD. Its principal application has been in Healthcare and Pharma, where much research and development has been done in the development of open source software.\(^3\) Example noted universities\(^4,\,5,\,6\) have well developed Semantic Technology programs. However, there is a notable lack of dedication in any one university to the Finance Domain.

• **Link:** Publish and maintain a directory of participants and a listing of publications/resources for the advancement of semantic technology. SemanticWeb.com and other sources do well in this task. It would be useful to work with Media Bistro to expand this offering and have a track dedicated to ontology, inference-processing and risk analysis.

• **Meet:** Implement annual Semantic Technical and annual Semantic Applications in the Finance Domain Summits as checkpoints of progress. Building a research and development community of practice must be a directed effort. The building number of seminars and symposiums dedicated to this field is excellent. However, each is general in nature. The only known symposium dedicated to Semantics in Financial Services\(^7\) was over subscribed. The FIBO Technology Summit itself had an expectation of 25 participants. There were over 60 in attendance.

• **Publish:** Provide a mechanism for participants to publish articles and research related to semantic technology implementation. The International Journal on Semantic Web and Information Systems\(^8\) is an archived journal of original manuscripts. While this is useful, a journal dedicated to directed topics would accelerate the advancement of this technology and its adoption.

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\(^1\) The Obama industry has the goal of 1 Million electric vehicles by 2015. Firm goals and firm dates could be set for Risk Data Aggregation, as an example in the Finance Industry.


\(^3\) Stanford Center for Biomedical Informatics Research

\(^4\) Texas A&M Ontological Semantic Technology Laboratory

\(^5\) Rensselaer Institute for Data Exploration and Applications (IDEA)

\(^6\) [http://ncor.us](http://ncor.us)

\(^7\) Demystifying Financial Services Semantics Conference: March 13, 2012

\(^8\) [http://www.iijswis.org/IJSWIS.pdf](http://www.iijswis.org/IJSWIS.pdf)
The value proposition for adopting these recommendations as the means to assure the advancement and adoption of FIBO is overwhelming. American Banker says that the cost to comply with Dodd-Frank is between US$150-US$350M/per year/per organization – with no added value. FIBO adoption will reduce this cost significantly and provide added value for both the banks and for the regulators. There are two primary reasons for this assertion. 1) An ontology allows for (2n-1), which is near linear semantic integration of data, rather than (n² - n) integration. This is because an ontology provides a canonical model by which multiple disparate database or message elements can map to a common semantic integration layer. For example, at a cost of US$200,000/database, integration of 10 data stores with an ontology (FIBO) is US$3.8M and US$18.8M without an ontology. 2) Software development and maintenance time and effort is reduced by 40% to 80% according to some industry figures and case studies.

9 Semantics: The Next Big Issue in Big Data - American Banker...
10 http://ontolog.cim3.net/cgi-bin/wiki.pl?LeoObrst, and others. Most researchers have the cost for data integration at >>$200,000/data store.
11 MPHASIS (HP) presentation material
PREFACE TO THE SUMMIT

The need for an entirely new approach to financial data management has been studied and documented by the National Science Foundation (NSF) and academics for several years. A 2010 NSF workshop\(^{12}\) citing §154 of the Dodd-Frank Act mandating that the Office of Financial Research (OFR) contain a Data Center (OFR/DC) to manage data for the new office so that it could: Publish financial instrument reference data, Publish legal entity reference data, Publish data reporting standards and formats, and Collect contractual positions and transactions data among other findings concluded that: “Financial risk and information managers across the industry and regulatory community should: establish semantic models that reflect best practice in knowledge representation; establish and adopt precise data definitions based on sound ontologies for all basic financial data; and promote sound standards for all metadata management.” This finding states precisely the purpose of FIBO. A second workshop\(^{13}\) Next Generation Community Financial Cyberinfrastructure for Managing Systemic Risk further defines the needs for: “A blueprint for developing community infrastructure that builds synergy among multi-disciplinary needs and opportunities and academic disciplines”. “A detailed specification of the infrastructure including datasets, annotations, ontologies, tools, metrics, ground truth, benchmarks and use cases.”

The regulatory community in response to Section 719(b) of the Dodd-Frank Act which requires the SEC and the CFTC (collectively the “Commissions”) to jointly study the “the feasibility of requiring the derivatives industry to adopt standardized computer-readable algorithmic descriptions which may be used to describe complex and standardized financial derivatives,” has come to similar conclusions\(^ {14}\) - that there is both the need, and that it is technically feasible, to describe financial contracts algorithmically (in this case Derivatives).

Further the Basel Committee on Banking Supervision in June 2013 issued for comment a paper entitled Supervisory Framework for Measuring and Controlling Large Exposures\(^ {15}\). Their conclusion is startlingly similar to that of the NSF in other words: “A need to Reengineer the Global Financial System”. According to the Basel Committee, this would entail:

- “A simplified and replicable method of calculating exposure to risk that can be universally applied to sources of transactions that are reconcilable to

\(^{15}\)http://www.bis.org/publ/bcbs246.pdf
accounting records

- Global identification standards for legal entities, products and financial events to facilitate the aggregation and comparison of risk exposure data within and between financial institutions and across the industry
- A ‘Big Data’ framework that is able to provide regulators and others with complete and accurate real-time information relating to the global financial system

This needs statement is summarized by the Basel Committee as “an intelligent semantic network for systemic risk analysis.” This is the very essence of FIBO.

Work done to date by companies with broad commercial interests (Google, Facebook, Linkedin, IBM (Watson), others) shows that this goal can be achieved. In addition, work in the academic research community (Duke, Oxford, others) has shown that there is great potential for both combining results and providing focus.

In late 2012, the question within the Council became how to bring these worlds together in a cooperative environment. The conversation began with the goal being construction of a roadmap of short term, mid term and long term requirements in technology areas deemed crucial to the success of FIBO. These technologies were described broadly as:

1. **There is a need for a mechanism for the generation of Operational Ontologies from Business Conceptual Ontologies.**

2. **There is a need for a mechanism for generation of business rules/axioms for analytics (i.e. how to convert regulatory requirements into rule statements).**

3. **There is a need to be able to demonstrate the business value of FIBO and of the content of the data discoverable through both the FIBO Conceptual Ontology and the various FIBO Operational Ontologies as they evolve.**

4. **There is a need to be able to automatically convert a picture into an Ontology. This picture may be of a concept, a question, or a statement such as a rule.**

5. **There is a need to be able to link FIBO in all of its aspects to other Ontologies from other industries and disciplines that may not seem to be related to FIBO. That is, there is a need for Shared Semantics at the massive scale of the financial system.**
A search was conducted to identify the people and the companies who are known to be leaders in each of these areas without regard for their relations to the financial community. The list yielded only a little over 100 people. This shows the still nascent level of this technology. It was decided to hold a “by invitation only” event to attract these selected individuals. Finally, the discussions turned to the most efficient practical venue. For the past nine Junes, the Semantic Technology & Business Conference has been held in the San Francisco Bay Area. There could be no better choice than tagging on to this event where the majority of these 100 or so practitioners would already have convened. The team at SemanticWeb.com (a Mediabistro property; Nasdaq: MBIS) readily consented to this idea.

The plan was fleshed out as a hypothesis and is displayed in APPENDIX A – FIBO Technology Summit Hypothesis and Technology Areas.

Letters of invitation (Appendix B) were personally emailed to perspective participants. Appendix A was attached to the invite letter and each recipient was asked to take issue with the hypothesis. There were no issues reported.

A link in the letter directed the invitees to register and to self select two of the five technology areas for their participation. As results were received, it became clear that the technologists invited had little interest in technology area three so the decision was made to combine areas three and four.

A leader and a scribe were drafted to manage each of the four technology areas. An agenda was established which ran two technology sessions in parallel with time before and after each session for joint deliberation.

The final organization of the Summit is the subject of the next section.
### ORGANIZATION OF THE SUMMIT

The Summit was organized for the second afternoon and the third morning of SemTechBiz 2013 on June 4-5, 2013 with an evening cocktail event. The sessions began with a well reasoned charge from EDMC Managing Director, Michael Atkin – Appendix C. Mr. Atkin chronicled the history of IT application in the Finance Industry that he has witnessed. He outlined the problems facing the industry today and challenged the experts to collectively work on solutions. The established agenda was:

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<th>Time</th>
<th>Session</th>
<th>Speaker</th>
<th>Location</th>
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<tr>
<td>1:00 pm</td>
<td>Keynote: Business Case for FIBO</td>
<td>Michael Atkin (EDM Council)</td>
<td>Franciscan C</td>
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<tr>
<td>1:30 pm</td>
<td>General Session: FIBO Operational Ontology</td>
<td>David Newman (Wells Fargo)</td>
<td>Franciscan C</td>
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<tr>
<td>2:00 pm</td>
<td>General Session: Critical Challenges and FIBO Roadmap</td>
<td>Dennis Wisnosky (EDM Council)</td>
<td>Franciscan C</td>
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<tr>
<td>2:30 pm</td>
<td>Break</td>
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<tr>
<td>2:45 pm</td>
<td>Breakout Sessions</td>
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<td>Franciscan C-D</td>
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<td>Session 1: From Business Conceptual to Operational Ontologies</td>
<td>Elisa Kendall (Thematix)</td>
<td>Franciscan C-D</td>
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<td></td>
<td>Session 2: Executable Semantic Rules</td>
<td>Benjamin Grosof</td>
<td>Franciscan C-D</td>
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<tr>
<td>4:45</td>
<td>General Session: Breakout session summaries and guidance</td>
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<td>Franciscan C</td>
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Clear and concise goals were presented to the attendees:

1. Create a sustainable mechanism for ongoing collaboration and coordination among the leaders in the semantic community.

2. Solve the core technical challenges required to ensure the adoption of semantic technology and inference-based processing.
–**Current State/Gap Analysis:** What is the current state of research and development for each of the technical challenges we've defined?

–**Deliverables and Roadmap:** What is the “end game” as well as the “incremental milestones” (with target timescales) for each of these technical challenges?

–**Technical:** What are the most important technical capabilities that must be developed to support adoption and implementation?

–**Operational:** What are the core issues, obstacles and constraints that we need to overcome in order to advance this technology?

3. Provide a clearinghouse for coordinated funding and project visibility as well as a formal research exchange mechanism in support of semantic technology implementation.

Because of the goals of comparing and integrating findings from the four sessions, a common report-out format was provided for the lead and the scribe of each session.

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<tr>
<th>Current State Assessment</th>
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<th>Technical Capability Requirements</th>
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<td>What are the most important technical capabilities that must be developed</td>
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<th>Deliverables and Timeframes</th>
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THE WORKING SESSIONS

The Preface to the Summit section of this report discussed the overwhelming demand for the ability to discover and understand the meaning of financial data within financial institutions as now stipulated by laws and regulations. What has been the private sector response to this requirement?

Arguably, Semantic Web technology began serious development in the mid 1990’s sponsored by the US Department of Defense (DoD) Defense Advanced Research Projects Agency (DARPA). Much of this work was classified and its use by the DoD and its contractors continues to be mainly in what is referred to as the Dark World. Migrating to the private sector, Semantic Technology has been utilized internally by the largest IT firms for nearly two decades and within the last five years introduced as product options (IBM\(^\text{16}\), Oracle\(^\text{17}\), TIBCO\(^\text{18}\)). In large firms that make their market on the web, Semantic Technology has been hidden behind product offerings (Google, Facebook, Linkedin, Apple). Much of this capability was through acquisition (Google – Applied Semantics 2003, Metaweb 2010), Apple (Siri 2010), Microsoft (Powerset).

Startups, many of which are listed in Appendix A, have focused on a particular technology and in some cases on a particular market. The academic community, with only a few exceptions (RPI, Stanford, MIT, National University of Ireland, Galway) is largely made up of individuals with specific research agendas. These few exceptions also concentrate on more narrow areas of research. Stanford University publishes the most widely supported products under the Protégé name. As a practical matter, only the FIBO work done by the EDMC has begun migration through the OMG standards process to support the financial industry. \(^\text{19}\)

\(^\text{17}\) http://download.oracle.com/otndocs/tech/semantic_web/pdf/oradb_semantic_overview.pdf
\(^\text{19}\) Amazon has more than 12,000 publications that appear from a search of Books - “Semantic Web”. Thirty of these publications are preorders from August 2013 to April 2014. Clearly, there is intense and growing interest and many opinions of the meaning of meaning.
These FIBO Technology Summit working sessions were designed as classical brainstorming activities applying the standard rules of brainstorming:

1. There are no dumb ideas
2. Don’t criticize other people’s ideas
3. Build on other people's ideas
4. Reverse the thought of “quality over quantity”
5. One conversation at a time
6. Stay focused

Following a brief introduction by the Council to vector the discussion, each Technical Area lead and Scribe met with their group for intense and lively discourse keeping in mind that:

1. FIBO will be a family of heavily annotated ontologies, each built according to the same rules and standards - EDMC, OMG and others will publish these rules and standards.
2. FIBO must be able to link to other domain ontologies that don’t obey these rules and standards - Real Estate, Insurance, Health Care and more.
3. FIBO will have many stakeholders and, we hope, far more users from Government, industry and academia – all view points must be considered
4. Each technology area may consider topics that overlap into other areas – rules, for example, is a consideration in each of the other three technology areas.
5. There is a growing demand for FIBO – considering that while no ontology is ever finished, the use of each can begin with a single triple.

The sections below show the further definition of each challenge, the build-up, the report-out and discussion.

**Work Session Definition - Challenge one - There is a need to generate operational ontologies from conceptual ontologies in RDF/OWL.**

1. The current process of building, verifying and converting the relevant parts of a conceptual ontology to an operational ontology is manual and arduous.

2. The manual approach is not scalable and needs to be automated.
3. Software to represent and generate operational ontologies is needed.

4. Software (such as the Ontology Pitfall Scanner) to evaluate the correctness/validity of the ontology is needed.

Facilitator: Elisa Kendall, Thematix Partners, LLC
Scribe: Patrick Greenfield, Wells Fargo

Work Session Build-up – In the FIBO Financial Industry Domain, the FIBO Conceptual Ontology (FIBO-CO) is intended to be a canonical model of the primary business terms (Concept) used in the industry and how each is related. FIBO-CO is, of course, specified at a high level of abstraction, but is represented as an OWL-compliant, logically consistent ontology that has been modularized to foster extension and reuse. Operational usage may include additional ontologies that extend, reuse, or abstract partitions from the FIBO-CO, and will likely be specific to a particular organization’s way of managing a business unit or a business process. Derivatives will be covered as a high-level category of financial product in the FIBO-CO, for example. But the conceptual knowledge defining Credit Default Swaps, a type of Derivative, might be required only in the operational ontologies for specific organizations or applications, and so only those would reuse the relevant FIBO-CO modules. Over time, one might expect there to evolve industry operational best practices with respect to reuse of specific partitions of FIBO-CO for given applications that themselves could become reference models in the FIBO family. Thus FIBO Business Conceptual and Operational Ontologies are two sides of the same coin as shown in the figure below20.

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While both FIBO Conceptual Ontologies and FIBO Operational Ontologies are being built today, doing this is extremely labor intensive. There exist neither the rules nor the tools to build either in such a way that there is a seamless path from a conceptual ontology to an operational ontology or even to link the two automatically where they intersect, as is shown in the next figure.
There are many examples of Conceptual Ontologies and of other Concept Models serving as the source of operating models\textsuperscript{21} \textsuperscript{22} \textsuperscript{23}. And, in our every day world:

- A Flight Plan to flying the AC
- The map of the entire US to a route map for particular trip
- Storyboarding the movie to making the movie
- A block diagram to a schematic diagram

The Conceptual Ontology is the model of all that is possible or may be possible in the reality described by the model. In this sense, there is only a single Conceptual Model for a single reality.

This model is ‘extended’ by various and many operational models.

For example, Operational Ontologies may be equivalent to business units or contracts or instruments, etc., depending upon how the particular financial institution operates. These Operational Ontologies are linked to the Conceptual Ontologies typically through subclass relationships. For example, the Conceptual Ontology might contain a node labeled “Derivatives”. A particular Operational ontology might be linked to this node through “Credit Default Swaps” – a subclass or a type of Derivative. The essence of this challenge is to discuss mechanisms for building and maintaining this alignment.

\textsuperscript{21} Conceptual Ontology Intersection for Mapping and Alignment of \textellipsis link.springer.com/chapter/10.1007%2F978-3-642-35208-9_
\textsuperscript{22} An approach to conceptual ontology integration with an ontology \textellipsis dl.acm.org/citation.cfm?id=2183095
\textsuperscript{23} From a Conceptual Ontology to the TELOS Operational System \textellipsis www.researchgate.net/.../228685332_From_a_Conceptual_Ontology_to_th..
Given the goals and this starting point, about 30 experts led by Elisa Kendall had a very lively discussion. Their report-out, in the standard format is below.

There are many ways to build and to maintain ontologies. The main purpose of the FIBO Foundations Ontology, as an OMG standard, is to lay the groundwork for success by establishing a common vocabulary and a common process for FIBO as it evolves to serve its many constituents. While the Council has an excellent start, the purpose of this session was to lay the set the stage for this growth. This was accomplished.

**Current State Assessment** clearly shows the infant nature of the ability to satisfy this technical need. The community is transitioning from highly idiosyncratic, mostly home grown methodologies. These ontologies are not based upon standards, tend to be understood by only the few SMEs who built them and are not thus extensible themselves, or able to be linked to other models. It is also clear that this technology need area overlaps greatly the other three, especially rules. This overlap includes rules for how to ensure that the intersecting concepts (**Classes and properties**, **Definitions**, **Namespaces**, **Annotations**) have the same meaning in both the conceptual ontology and the operational ontologies, and an ontology of business rules that will enable operational ontologies to be executed.
**Technical Capability Requirements** revolve primarily around the need for tools to build and to manage ontologies. This is a highly collaborative environment. The very strength of a graph database, that for all practical purposes, it is infinitely extensible, is also its greatest weakness. There is a need to document guidance on how to understand the constraints that must be followed, so as to not break an existing ontology, and how to automatically map between ontologies. That is, from a technical perspective - how to make extensions that work. There is a need for a process to ensure validation of ontologies and software to guarantee that this has happened before an ontology is published.

**Obstacles and Constraints** fall into 3 categories:

1) the need to agree and prioritize use cases that will have a critical mass of intellectual support and funding,
2) approaches to building and testing ontologies that are both sufficiently flexible to handle all use cases and sufficiently rigid that they ensure that construction and testing rules are obeyed,
3) the fact that ontologies and standards that are logically companions to FIBO such as address and country code are not yet mature themselves.

Category 1 should be in the purview of FIBO developers and practitioners to simply agree on the most significant problem areas and to redirect the minds of people and funding.

Category 2 demands that the attention of disciplines such as mathematics, knowledge management and traditional software development be redirected to semantic technology.

Category 3 calls for building FIBO in the open and asking for the cooperation of many standards bodies and SMEs from other disciplines.

**Near Term, Actionable Deliverables and Timeframes** were identified to begin the process of achieving the goals of this technology area. There is a need to generate operational ontologies from conceptual ontologies in RDF/OWL. Each is currently underway and on schedule within OMG-EDMC FIBO Foundations and FIBO-BE standards process.
Work Session Definition - Challenge two - There is a need to convert requirements (e.g. regulatory rules) into executable semantic rule statements.

1. We need an efficient mechanism to turn government regulations into a standards-based rules language.

2. Are tools such as the Rules Interchange Framework (RIF) or the Web Ontology Language (OWL) sufficient?

3. There is a need for regulations to be written in a restricted natural language.

4. There is a need to extract semantic content from text (e.g. the terms and conditions associated with legal documents and financial instrument contracts).

Facilitator: Benjamin Grosof, Benjamin Grosof & Associates
Scribe: Elie Abi-Lahoud, University College Cork

Work Session Build up – In this technology area – laws, regulations and policies are synonymous with rules. The FIBO nirvana is complete and unambiguous understanding of Financial laws, Regulations and Policies, *i.e.* rules. The double benefits of this are that the financial institutions will know precisely how to manage their business processes to be in compliance, and the regulators will know precisely who is compliant and who is not. An additional benefit is that the cost of compliance with a potential new law, regulation or policy can be computed in advance of publication. This is because the benefit of a reduction in risk to the cost of change can be actually computed.

Rules are the air of the financial industry. Rules are of three types:

- Data Rules
- Structural Rules
- Operative Rules

Data rules are constraints on vocabulary. That is, they describe what is allowable domain content – what content can be in the FIBO. What are the primary concepts within that content and what are the relationships between those concepts. They
are defined by a modeling language and organized by an ontology. Rules ensure that the meaning of concepts and their usage are agreed upon – their semantics are understood. Rules allow for cases where different concepts might be used to mean the same thing, or have overlapping meaning under certain circumstances – a contract may have the same meaning as an instrument in some cases, for example. Soldiers and Sailors and Airman are all Service Members. This is provable in a given domain and perhaps only within a particular context in a given domain. The FIBO-CO is intended to provide the domain vocabulary for financial contracts at an abstract level. The various FIBO Operational Ontologies will be specific to contracts, instruments, processes, organizations, etc. as described in the technology area 1 discussion.

How these vocabularies can be people readable and machine readable at the same time depends upon structural and operational rules. Structural and Operational rules\(^\text{24}\) are also part of the vocabulary of the domain. Structural Rules are equivalent to laws and regulations: “A subsidiary of a bank or savings association shall complete a separate loan/application register. The subsidiary shall submit the register, directly or through its parent, to the agency that supervises its parent”.\(^\text{25}\) “The Board may waive the application of §206.4(a) of this

\[\text{Base Business Rules on Fact Types} \quad \text{Associate Concepts to define Fact Types} \quad \text{Define Noun Concepts} \quad \text{Operative Business Rules} \quad \text{Structural Business Rules} \quad \text{Fact Types (Verb Concepts)} \quad \text{Noun Concepts} \quad \text{Vocabulary} \quad \text{Develop Vocabularies and Rules to represent them (starting with terms for the concepts)}\]


\(^{25}\) Title 12: Banks and Banking PART 203—HOME MORTGAGE DISCLOSURE (REGULATION C)
part to a bank if the primary Federal supervisor of the bank advises the Board that the bank is not reasonably able to obtain necessary services, including payment-related services and placement of funds, without incurring exposure to a correspondent in excess of the otherwise applicable limit.” Structural rules establish clearly what is allowed and not allowed to occur within a domain. The issue over time becomes interpretation of these rules. Rules expressed by an ontology are unambiguous. They are interpreted in a precise and unique way and are applied in the context of the business by the operational rules. Operational rules (operative rules) describe when and how the structural rules should be applied. In the actual structural rule on waivers above, an operational rule might be: “Determine if the bank is reasonably able to obtain necessary services”. If yes, do not grant a waiver.”

Today people make these determinations. When these behavioral rules are expressed in an ontology, however, they will be machine readable and executable. For this to be a reality, the processes of the domain must be described in a people readable and machine readable (executable) model, and realized in a Business Process Management System (BPMS) or similar applications or services.

There are many choices in BPMSs’. Most use the OMG Business Process Model and Notation (BPMN) standard for representation purposes. Recently at least six vendors in the Business Process Modeling (BPM) space have shown the ability to interchange business process models with no loss of data or standard visualization.

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26 Title 12: Banks and Banking PART 206—LIMITATIONS ON INTERBANK LIABILITIES (REGULATION F)
27 http://www.omg.org/spec/BPMN/2.0/
A BPMN ontology was developed by the US DoD\textsuperscript{29} and is currently working its way through the OMG standards process. In the meantime, it has been proven that a Business Process Model using this ontology can be executed and can invoke behavioral rules in real time\textsuperscript{30} 31.

The desired scenario is to support automatic and unambiguous interpretation of finance domain laws regulations and policies so that they are both machine readable and people readable. The BPM community has been moving in this direction for decades. The rules community has been doing the same. The rapid emergence of Services Oriented Architecture (SOA) orchestrated in the cloud makes this realization both possible and necessary.

Consider, for example that the regulators must aggregate data from many, many sources and understand the meaning of this data according to the rules of Dodd-

\footnotesize{\begin{itemize}
\item \textsuperscript{29}\url{http://ontolog.cim3.net/file/work/OntologySummit2012/2012-03-01_Ontology-for-Systems-Federation-n-Integration/OntologySummit2012_Business-Enterprise-Architecture-Ontology-Development--DenisWisnosky_20110301.pdf}
\item \textsuperscript{30}\url{http://www.afei.org/events/1A03/Documents/DayOne_3B_Chow.pdf}
\item \textsuperscript{31}\url{http://www.bpmnstitute.org/resources/presentations/executable-bpmn-bpmn-ontology-based-engine}
\end{itemize}}
Frank. An executable Business Process Model invoking a business rules engine efficiently and effectively could provide this capability.

Given the goals and this starting point about 30 experts led by Benjamin Grosof had a very lively discussion. Their report-out, in the standard format is below.

Business rules management, decision support, and rule-related technologies are represented by a mature technology field and community for decades, with products from large companies as well as open source projects in use for many years. During this session it became clear that there is no agreement on a best approach to interpreting rules that are at least partially encoded in an ontology, or on any one specific execution strategy. There was agreement on the necessity, and that most likely any practical capability will require multiple approaches.

**Current State Assessment** – Rules engines fall into three primary categories: Declarative Logic Programs, First Order Logic and its subsets and supersets, and Common Logic (which is also a classic first order logic). There are advantages and disadvantages for each of these categories, and there are both proprietary and open source choices. It was agreed that Rulelog best meets the long term requirements for FIBO, but that Rulelog is early in commercialization. Clearly, decisions going

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forward must be made collaboratively and keeping in mind the evolving work of W3C on the Rules Interchange Format (RIF)\textsuperscript{33}, the RuleML\textsuperscript{34} community, and the OMG on the Semantics of Business Vocabulary and Business Rules (SBVR)\textsuperscript{35} and a number of other standards in the rules space, such as the Production Rule Representation (PRR)\textsuperscript{36} standard and emerging work in decision management, all of which have or will have interaction patterns with RDF/OWL.

**Technical Capability Requirements** – Expressive power must be sufficient to handle exceptions and change. Rules engines must allow defeasibility, \textit{i.e.}, have the ability to handle a hierarchy of rules no matter their form. They must be scalable computationally and have the ability to evolve as knowledge changes within its own domain and as it is linked to other domains. They must support cost-efficient Knowledge Acquisition (authoring) methods for known knowledge and knowledge interchange and translation. They must also fit within the enterprise software/data environment and have an implementation/maintenance path consistent with well accepted commercial software and best practices.

**Obstacles and Constraints** - Legacy (rule) systems are expressively limited, because they use subsets of logic programs (LP). Production rules dominant in the business rules sector are often poorly built semantically\textsuperscript{37} (though some vendors, including IBM\textsuperscript{38}, TIBCO, and Fair Isaac are beginning to support the use of OWL ontologies to provide the vocabulary to be used as the basis for rule development). Business rules are often temporal and probabilistic – for example regulations nearly always have waivers and constraints. They are not rigid and deterministic which are much easier computationally. Thinking of, and coding, rules as triples is not common practice. Natural Language Processing (NLP) for real-time automated knowledge acquisition has severe issues with accuracy and computational scalability.

**Near Term, Actionable Deliverables and Timeframes** - It was suggested to establish a Proof of Concept (PoC) by expressing RegW\textsuperscript{39} rules in RuleLog and align the result with FIBO concepts. Use SBVR to capture interpretation of RegW - to generate a shared vocabulary and as a middle step between the original text and RuleLog, then to align the SBVR shared vocabulary with FIBO concepts. Flora-2\textsuperscript{40}, now published as open source could be used for this purpose.

\begin{itemize}
\item \textsuperscript{33} http://www.w3.org/TR/rif-rdf-owl/
\item \textsuperscript{34} http://ruleml.org/
\item \textsuperscript{35} http://www.omg.org/spec/SBVR/
\item http://domino.watson.ibm.com/library/CyberDig.nsf/papers/A9777F4EDB2552AE85257B34004C4EB3/$File/rc25363.pdf
\item \textsuperscript{36} http://www.omg.org/spec/PRR/
\item \textsuperscript{37} http://www.tmrfindia.org/series/ebookV2-C2.pdf
\item \textsuperscript{38} http://ceur-ws.org/Vol-874/paper10.pdf
\item \textsuperscript{39} http://www.investopedia.com/terms/r/regulation-w.asp
\item \textsuperscript{40} http://flora.sourceforge.net
\end{itemize}
Work Session Definition - Challenge three - There is a need to visually represent all forms of semantic content.

1. Visual representations of ontologies for both technical and non-technical users are needed to support analytical understanding and deliver business value.

2. There is a need to generate RDF/OWL from visual motifs that is rigorous enough to support reasoning.

3. What is the best way to generate visual representations of the content returned from semantic queries?

Facilitator: Steve Ray, Carnegie Mellon
Scribe: Mark Temple-Raston, Citi

Work Session Build up – This is partial list of the many, many visualization tools which was presented to the team.

• CropCircles
• GoBar
• GrOWL
• IsAViz
• Jambalaya
• OntoGraf
• OntoSphere
• OntoViz
• OWLViz
• TGVizTab
• TopBraid Composer

Visualization of FIBO and its reference to instance data must consider the needs of:

• Ontologists
• Business Users
  o Bankers
  o Regulators
- Service Providers of software
- Service Providers of consulting
- Trade Associations
- Standards Bodies
- SMEs

This is a wide and diverse audience with many many different views including:

- For Developing
- For Authoring
- For Validating
- For Discovery
- For Reference
- For Analysis

Different viewers will see the same data in different ways. This famous illustration\(^1\), known to have first appeared in the late 1800's, makes this clear. Is it a young woman or an old woman? The brain can see either or both. Both are

\(^1\) http://mathworld.wolfram.com/YoungGirl-OldWomanIllusion.html
different views of exactly the same data.

Given the goals and this starting point, about 30 experts led by Stephen Ray had a very lively discussion. Their report-out, in the standard format is below.

The dichotomy of this technology challenge is that its solutions seem so obvious, but they are not. The “Observer effect” is well known in IT\(^{42}\), the physical sciences\(^{43}\) and to Star Trek\(^{44}\) aficionados. This is the phenomenon of looking at how the data evolves, and how such changes affect the data. With business data, this often happens with the practice of round tripping. That is, the observer ‘corrects’ the data in the visualization tool that is connected in real time to the actual data store. Precautions must be taken to manage this practice while, at the same time, allowing extreme access and flexibility to visualization of ontologies and their referenced instance data.


**Current State Assessment** – Visualization falls into the general category of Human Interface research. The list of tools resulting from this work seems to be nearly endless, including: CropCircles, GoBar, GrOWL, IsAViz, Jambalaya, OntoGraf, OntoSphere, OntoViz, OWLViz, TGVizTab, TopQuadrant - TopBraid Composer, KeyLines, Franz - Gruff, Adaptive, Gephi, Cytoscape, E6TOwl, Knowledge Explorer, Quantum4D, Enterprise Architect, Magic Draw UML + the Visual Ontology Modeler, Knoodle, Visio, PowerPoint, Excel, Jalapeno, JS Plum, Tableaux, Centrifuge, IDEFTools, RDF Gravity, Information Lens, Simile, Neon, KD Viz and others. The challenge becomes both understanding the underlying logic of a particular tool and the fact that most use their own proprietary data structure. The preference for FIBO is tools based upon open standards and available as open source. At least 20 visualization tools are free or nearly so. At least seven tools are dedicated to reading RDF triple stores and another 17 are Protégé visualization plug-ins.

**Technical Capability Requirements** – There must be a common understanding of visualization usage:

- Must be useful to business
- Must be intuitive
  - Query generators are not usually useful visualization engines
  - Can be used by “non-geeks” - Models and tools are data rich but usually not intuitive to use
- Must be designed for the specific audience. What capabilities do they need, what is their tolerance for a “technical” user interface?
- Must have “help resources” to support the delivery of value (not just limited to print)
- Must be able to be managed by SMEs

A value proposition of semantics is having flexibility in support of ad-hoc query capabilities. Visualization capabilities need to be as flexible as an ontology to allow for scenario-based modeling with the capability to:

- Manage the flexibility of the query
- Manage all links and relationships
- Prioritize the importance of components
- Understand the perspective in which the user wants to understand content

It would be useful to have a library of useful queries

- Ensure that useful queries can be reused
- Provide a catalogue of both use cases and queries based on use cases

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46 [https://confluence.ontotext.com/display/ResearchSpace/RDF+Visualization](https://confluence.ontotext.com/display/ResearchSpace/RDF+Visualization)
• Provide guidance on what tools are useful for which "use case" (and use case type)
• Provide a Usability Matrix (what tools are useful for what application)
• Provide standard views

Visualization Layout must be very flexible
• Must have the capability to ensure that the "relative position" of concepts on a page correspond to their location within an ontology
• Must have the ability to scope/discriminate based on “priorities” and “dimensions”
• Must have layout capabilities to make the visualization diagram useful in terms of continuity and orientation

A strong dashboard functionality that is needed
• Based on views/profiles
• Incorporating alerts and triggers
• With automated generation of “inferences” – even if not specified by the user
• Must have ability to perform (view from) root cause perspective (i.e. for a stress test or living will)

**Obstacles and Constraints** - Include the need for additional focus and funding theme common to each challenge. The very variety of tools provides meaningful choices, but the inability to exchange data causes rework and unnecessary expense. The lack of a common iconography for the meaning of shapes and colors exacerbates this problem because users must often relearn what the pictures mean. There must be consideration to “entitlement control” and the protection of sensitive data. It must be assured that a user or a hacker cannot reverse engineer marketplace intelligence from a visualization tool. There is concern about the lack of how visualization tools relate to the raw data, i.e., when a bank sends data and a regulator incorporates this data into a visualization tool, it must not change the meaning of the data.

**Near Term, Actionable Deliverables and Timeframes** were identified that can primarily be accomplished by both literature research including those identified in footnotes 30 and 31 and by a survey that could be conducted on among EDMC members.

1: Build a Catalog of Use Cases
2: Perform Usability Study on what types of tools and how are they used, and who are the users and what capabilities do they need
3: Study and report on what tools work well with other tools
4: Build a Catalog of Visualization Tools including a feature matrix
Work Session Definition - Challenge four - There is a need for shared semantics and analytics at the massive scale of the financial system.

1. We need mechanisms to better share ontologies and to integrate controlled vocabularies.

2. We need the ability to better leverage predictive analytics with semantically obtained graph structures.

3. We need to be able to support semantic processing and inference-based reasoning at the massive scale associated with the financial system.

Facilitator: Dave McComb, Semantic Arts

Scribe: Mike Ucshold, Semantic Arts

Work Session Build up – In his excellent kick off to the SemTechBiz Conference, “Semantic Technology, Ready for Prime Time”, David McComb used the path to “Open-Linked Data” pioneered by Tim Berners-Lee to answer this question.47

FIBO will be deployed into the ecosphere of “Linked Open Data”. Therefore, where

47 http://www.w3.org/DesignIssues/LinkedData.html
FIBO intersects with data is more the responsibility of an organization in the
development of related domain applications, FIBO will link to that data, not replicate
that data. For example, given that geospatial information is accessible in an existing
ontology\(^{48}\), one could use that together with FIBO to represent bank branch
locations. Therefore, there is no reason to make this ontology part of FIBO. Instead
it will be linked to FIBO. The above picture from a 2006, describes the evolution and
the benefits of linked open data. The path to today was through .pdf and other open
license file formats that allowed files to exchanged easily. Then structured data
could be exchanged through proprietary file formats with proprietary software such
Excel. Open File formats such as Comma Separated Values (CSV) allowed data to be
exchanged without proprietary software. Open Standards such as RDF, OWL and
SPARQL from the W3C that operate through Universal Resource Identifiers and
URLs – or Cool URIs, a term coined by Berners-Lee, were the next step to being able
to link data – provided that certain rules are obeyed.\(^{49}\)

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, using the
   standards (RDF\(^{49}\), SPARQL).

4. Include links to other URIs so that they can discover more things.

In 2010, Berners-Lee added his star rating system that is depicted in the figure
above on the path to Linked Open Data.

In his talk, David McComb likened Linked Open Data to children’s “Tinker Toys”.\(^{50}\)
Tinker Toys\(^{51}\) have only sticks and spools. One stick (Predicate) and two spools
(Subject and Object) can be combined to make a simple toy. This would be the


\(^{49}\) [http://inkdroid.org/journal/2010/06/04/the-5-stars-of-open-linked-data/](http://inkdroid.org/journal/2010/06/04/the-5-stars-of-open-linked-data/)


equivalent of a single RDF Expression: Dennis is a person. The spools are nodes in an RDF graph.

Spools can be URIs to locations in the Web, or of other various types, including

specific values (Literals). Dennis Lives in Naperville.

Extending this Tinker Toy metaphor to the web of things exactly makes the case for this challenge to seek ways to obey the rules of Open Linked Data, or perhaps create new rules applicable to the deterministic domain finance.

In this example below, data describing Wall Street Bank in the yellow box at the top of the picture is contained in its ontology and linked at the time of a SPARQL query to answer questions about ownership hierarchy and counterparty exposure.52

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52 David Newman in many presentations of proof of concept Operational Ontology using Allegrograph and Gruff from Franz, Inc.
This data will be distributed worldwide. As Linked Open Data, subject to as yet to be decided access control, ultimately it must be possible to ask any question at any time, much as is shown in the below figure, and return an accurate response.\textsuperscript{53}

Given the goals and this starting point about 30 experts led by Davd McComb had a very lively discussion. Their report-out, in the standard format is below.

\textsuperscript{53} Dennis E. Wisnosky EDM Council.
This challenge is common to the entire semantic web community.\textsuperscript{54} Summers and Salo in their paper “Linking Things on the Web: A Pragmatic Examination of Linked Data for Libraries, Archives and Museums” discuss the genealogy of linked data including issues and predict future directions. His thesis is the need for all data describing all things in all libraries, archives and museums to be linked. David Booth, in his paper “RDF as a universal Healthcare Exchange Language”\textsuperscript{55} poignantly says: “Imagine a world in which all healthcare systems speak the same language with the same meanings covering all healthcare.” He then adds: “What would it be like? “Better treatment, Better research, Lower cost”. His Goal: True semantic interoperability.

In the Financial Domain, the goal would remain true semantic interoperability, for Better Transparency, Data Provenance, Lower Cost. The conclusion of experts in these three domains is the same. Data described in RDF is the only practical approach. The question that this challenge team worked on answering is how to make this a reality.

\textsuperscript{54} http://arxiv.org/abs/1302.4591
\textsuperscript{55} http://dbooth.org/2013/munnecke/DavidBooth-rdf-as-universal.pdf
Current State Assessment – There are a number of ontologies from which FIBO could borrow using OWL mapping constructs including exemplary ontologies\(^{56}\) and Open Ontology Repository\(^{57}\). The Ontology Based Standards\(^{58}\) movement begun in 2009, continues to gain traction. The biggest issue is dealing with change management. A variety of roll-back and roll-forward approaches exist\(^{59}\). Protégé has a Changes Tab and a Version Log Generator. WebProtege\(^{60}\) version 2.0 is supported by various case studies for how to manage ontology development and maintenance. Nevertheless, It is agreed that this is the most critical consideration in the evolution of the Semantic Web.

The science of reasoning across many different ontologies is evolving rapidly. OFR is concerned with Risk/Contagion analytics. Work in related fields could be applied in the Finance Domain for these analytics. US DoD integrates OWL and Baysian reasoning\(^{61}\) into PR-OWL (probabilistic OWL) that could be relevant to the Finance Domain. Lessons can be learned from the use of real-time Complex Event Processing and Predictive Analytics for real time operational risk management in DoD and Homeland Security. BioTech and Pharma have also pioneered this technology\(^{62}\). In the Finance Domain references also exist for risk management ontologies.\(^{63}\) Problems to be overcome are primarily scale and complexity of data management.

**Technical Capability Requirements** – Annotations available as URLs are required to easily link to references and to other ontologies. Robust versioning rules must be developed and automated to satisfy the need to distinguish stable versioned concepts from those with a lot of churn. Proxies are useful to point to real concepts, however, there is a need for automated back mapping links to determine what concepts are semantically grounded to ’me’. An appropriate modularity and sourcing. Infrastructure for metadata would enable dynamic composibility by extracting portions of a larger ontology.

There are many approaches and a reasonable amount of controversy on the subject

\(^{56}\) http://ontologydesignpatterns.org/wiki/Ontology:Main
\(^{57}\) http://ontolog.cim3.net/cgi-bin/wiki.pl?OpenOntologyRepository
\(^{58}\) http://ontolog.cim3.net/cgi-bin/wiki.pl?OntologyBasedStandards
\(^{59}\) http://www.sciencedirect.com/science/article/pii/S0950705112001323
\(^{60}\) http://webprotege.stanford.edu/#List:coll=Home
\(^{62}\) http://semanticweb.com/semantic-web-for-healthcare-part-3-rd-from-bench-to-bedside_b698
\(^{63}\) http://www.academia.edu/1932976/An/owl_ontology_for_risk_management_basel_II_standard
of semantic reasoning at over very large scale data store, especially in real time. Clearly research is required over a reasonable number of financial domain use cases such as: Systemic risk and Stress testing with various risk thresholds. Exposing all data stores with SPARQL endpoints is a first step. Ultimately, real-time configurable algorithms based on probabilistic OWL, most likely executing in a Hybrid Cloud will be necessary for reasonably predictive analytics. The reason for this is that instance data will be temporal and resident in the systems of 2nd and 3rd parties such as partners and regulators.

**Obstacles and Constraints** – Processing time is typically named the number one obstacle. However, increasingly real world experiments have shown that new approaches make this to be a specious argument even in the traditional sense with a single processing node. The semantic web of open linked data totally changes this paradigm. Searches over this web are simply not practical with relational data stores largely because the data could not be found. The constraint then becomes how fast a search can be accomplished. There are many architectures that may be employed. Most likely the successful architecture will be a hybrid cloud that permits federated searches over structured and unstructured data some of which is indexed and some of which is not. For proof of the ability to overcome these obstacles and constraints, funding must be applied to several proof of concept use cases sing anonymized real data of serious importance to the regulators.

**Near Term, Actionable Deliverables and Timeframes** - FIBO must be delivered with at least a minimal infrastructure that practitioners can use both to search and extend FIBO. Example of such an infrastructures include: OOR.net, Protege and Watson. FIBOpedia would be a useful name for this service. Establish a Proof of Concept sanctioned by OFR with a regulator. For example; CFTC has established Swap Data Repositories (SDRs) that are required to gather interest rate and credit index swap trades from their customers and aggregate and report this data quarterly. “The commission now receives data on thousands of swaps each day. So far, however, none of our computer programs loads this data without crashing,” said Scott O’Malia, a CFTC Commissioner earlier this year. FIBO could solve this problem.

Finally, it was suggested that the Council respond to and NSF-OFR “Dear Colleague” letter that was published in May 2013 asking for concept papers in support of, Financial Research and Analysis and Management (CIFRAM). The Council submitted

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64 [http://answers.semanticweb.com/questions/10917/scalable-owl-dl-reasoner-for-very-large-a-box](http://answers.semanticweb.com/questions/10917/scalable-owl-dl-reasoner-for-very-large-a-box)


67 sandbox.OOR.net

68 [http://protege.stanford.edu](http://protege.stanford.edu)


70 [http://www.ft.com/intl/cms/s/0/7771ec7a-90ce-11e2-862b-00144feabdc0.html#](http://www.ft.com/intl/cms/s/0/7771ec7a-90ce-11e2-862b-00144feabdc0.html#)
a paper in July, “Combining Four Ontologies to aggregate Instance data in support of, Financial Research and Analysis and Management (CIFRAM)”. The figure below depicts this concept.
SESSIONS SUMMARY

FIBO is a model. Mankind has built models for thousands of years. Their purpose has always been the same – to improve our understanding of our world. With this understanding comes the ability to manage at least certain parts of our world. That is, it should be possible to manage those domains constructed by people.

Prior to this workshop, the organizers postulated five technology challenges which later became four:

1. Operational Ontologies
2. Semantic Rules
3. Visualization
4. Scalability

For four hours each, many of the brightest minds in the semantic web discipline contemplated the way forward in each of these technology areas as has been presented in the above sections.

Common themes emerged across the four areas. These themes are consistent with the principles of ontologies:

FIBO is a model of the financial industry. This model is built with certain primitive constructs familiar and agreed to by principles working in the industry – it is people readable. Within this model are the rules under which this industry operates. With these rules it is possible to find the answer to any question about the state of the industry or any participant in the industry – it is machine readable. These answers must be displayed in a form familiar to the person or to the machine asking the question. There should be no limit to the size of the model. The model must dynamically configure itself without breaking the rules by which it is constructed. The ultimate goal of the model is that it is executable. Because it is executable, it can automate operations within the industry in a way that is consistent with governing laws, regulations and policies. The model is the infrastructure of the industry.

71 http://www.mat.univie.ac.at/~herman/papers/modtheoc.pdf
APPENDIX A – FIBO Technology Summit Hypothesis and Technology Areas

FIBO Technology Summit

Concept outline

HYPOTHESIS

1. FIBO is in a Unique Position

   a. FIBO represents ontology of the contract within the financial industry. This common language is an essential requisite for regulatory oversight as well as efficient operational management within financial institutions. FIBO is unique and relevant.

   b. We are standing at the intersection of two critical use cases: one for classification of financial concepts based on basic elements and how they legally relate to one another; the other for inference-based processing combining the common language of the contract with structured business rules/axioms to foster relationships and perform complex analytics. This represents a high visibility and important use case combination.

   c. FIBO has been constructed as an open source project based on collaboration among a large and diverse group of professionals. FIBO could be viewed as one of the largest collaborative development projects within either the financial industry or among the semantics community. This is a model that can be leveraged for the future.

   d. FIBO is at a relatively advanced stage. The EDM Council, OMG, financial institutions and semantic technology companies have invested multiple person-years in its development. The financial
community has embraced the importance of the activity and is
devoting resources to ensure that FIBO accurately reflects their
business reality. The semantic community and OMG are coalescing
around this mechanism as an important demonstration of semantic
viability. This activity is well beyond the conceptual stage but is not
yet complete.

2. **FIBO is at an Important Juncture**

a. FIBO Foundations and FIBO-Business Entities represent the first of a
suite of standards for expressing the contractual basis of the financial
industry. The first set of standards is scheduled to be released
September 2013. The timing is ideal.

b. We are standing at the precipice of a number of technical
implementation issues ... the migration from modified UML to
RDF/OWL ... the conversion from business conceptual to operational
ontologies ... the development of a standard methodology for
developing, extending and integrating FIBO into production
environments ... visual design of ontologies...visual representations of
semantic queries, ...ability to scale semantic systems to reflect the
massive quantities of data flowing across the global financial
ecosystem...ability to converge semantic processing with predictive
analytics in order to better monitor emerging institutional and
systemic financial risks ... the practical application of the OMG
time/date standard ... and the techniques for semantic alignment
(shared semantics) across domains.

3. **The Maturity of FIBO has Significant Implications**

a. The development of a common contractual language for the financial
industry holds great potential in support of financial stability analysis.
It is an essential pre-requisite for complex analysis and it represents
an important step forward for the financial industry as well as the
global regulatory community.

b. The application of semantic technologies (inference-based
processing) to the complex analytical challenges of systemic risk
represents a milestone for the regulatory community (and the public
at large). Without this capability, it is hard to imagine how those responsible for financial stability will accomplish their objective.

c. The collective activities around FIBO present a unique opportunity for the semantic technology, regulatory, financial industry and academic communities to align on a common objective.

THE FIBO TECHNOLOGY SUMMIT

1. The current FIBO ecosystem includes traditional solution providers (IBM, Oracle, Teradata, etc.), niche semantic players (Revelytx, Franz, Cambridge Semantics, Thematix, Adaptive, Yarc Data, FirstRain, etc.), financial institutions, market authorities and regulators. The traditional solution providers lack the incentive to disrupt their existing business models in order to realize the full potential of semantics. The niche players lack the resources to invest in the future of uncertain business opportunities. Financial institutions, market authorities and regulators are unfamiliar with and adverse to what they see as risk in adopting ontologies and semantic processing. A change in this dynamic is necessary in order for both FIBO and semantic technology to escape from their restrictive “zones of proximal development.”

2. Our proposal is to invite the leading minds in the semantic and ontology communities to come together and work collaboratively (using FIBO as the mechanism) to realize the promise of combining both the “ontology of the contract” and semantic technology toward a higher purpose. As part of the experience we will provide exposure to all known technical deficiencies to the collective technology leadership for their consideration. The FIBO Technical Summit can be a vital mechanism to bring these diverse resources together toward a common objective – and (in the process) help the practice of knowledge management take a giant step forward.

Technical Issues/Challenges for FIBO Summit

The Enterprise Data Management Council (EDMC) www.edmccouncil.org has been developing the Financial Industry Business Ontology (FIBO) for several years with Communities of Interests (CoI) self chosen from its members. FIBO Business Entity (FIBO BE) and FIBO Foundation will be published in 2013 as Object Management
Group (OMG) [www.omg.org](http://www.omg.org) standards along with at least one referenced Operational Ontology.

As a result of these efforts, the business need and the potential of FIBO is generally understood. As the basic science and underlying tooling has evolved, it has also become clear that there is a critical need for significant advances for FIBO to be developed and utilized at the scale required in the Financial Industry in at least the five critical areas outlined below.

6. **There is a need for a mechanism for the generation of Operational Ontologies from Business Conceptual Ontologies.** A business Conceptual Ontology is an annotated high level graph that shows and logically links all legal entities, processes, instruments, etc. in the Financial Industry. It is like a roadmap of the industry. It is intended for this Conceptual Ontology to be readable and understood by executives working in the industry. He or she should be able to easily see his or her role in their business and how their business is connected to other roles and businesses. From the FIBO Conceptual Ontology it must be possible to generate W3C standard RDF/OWL data stores. These data stores are the seeds of industry best practice Operational Ontologies. These Ontologies must be people readable, machine readable and executable. Currently the process of building, verifying and converting the relevant parts of the Conceptual Ontology to an Operational Ontology is essentially manual and arduous. The process is not scalable to the needs of the industry. There is a need for software to substantially automate this process.

7. **There is a need for a mechanism for generation of business rules/axioms for analytics (i.e. how to convert regulatory requirements into rule statements).** Regulations are often written in language that can have several interpretations. The effect of regulations on the Industry and on the Regulators themselves is often not known for years. A regulation described as Ontology has a clear and unambiguous meaning. However, this process is manual and dependent on the individuals with knowledge of the both law, and the Semantic Web. We must find an efficient way to turn regulations into W3C compliant OWL through the Rules Interchange Framework (RIF). There are many approaches as to how to do this. If we could start from scratch, regulations would be written in a Controlled Natural Language (CNL) and then a CNL machine would generate the ontology of the regulations. This
should be the long-term goal. The near-term goal is to use a computer to parse regulations, and then hand the results to the regulation writers and ask them if the computers says what they meant to say in the regulation. There is a need for software that incrementally moves the Government and the Industry toward a clear and unambiguous understanding of regulations.

8. **There is a need to be able to demonstrate the business value of FIBO and of the content of the data discoverable through both the FIBO Conceptual Ontology and the various FIBO Operational Ontologies as they evolve.** This includes:
   a. Representation of ontologies to non-technical users (to enable their participation in the development process)
   b. Presentation of ontologies to business audiences in forms, symbols and terms typical of the Industry
   c. Presentation of the data contained within Ontologies such as:
      i. Spreadsheet representation
      ii. Graphic representation as business facing diagrams
      iii. Use of Open Source Business Intelligence Engines

There is a need for Semantic Web software that is friendly to non-technical users and also adheres to W3C and OMG technical standards.

9. **There is a need to be able to automatically convert a picture into an Ontology.** This picture may be of a concept, a question, or a statement such as a rule.
   a. Visual design of ontologies including network graphs
   b. Visualization of the results of SPARQL queries
   c. Rigorous representation of business rules (e.g. using “R”)

Semantic Web technologies have evolved from mathematics and logic. To this extent Ontologies are the natural providence of engineers and scientists. There is a need for software that converts pictures into Ontologies sufficiently rigorous to support reasoning.

10. **There is a need to be able to link FIBO in all of its aspects to other Ontologies from other industries and disciplines that may not seem to be related to FIBO.** That is, there is a need for Shared Semantics at the massive scale of the financial system. This includes:
    a. Ability to link to external ontologies and extend FIBO as concepts are developed
    b. Mechanism to share ontologies and integrate controlled vocabularies
    c. Automated insertion of code (automated enhancements)
d. Ability to converge predictive algorithms with semantically processed data

e. Leveraging semantics and graph patterns with analytics (tools) 
Software to build ontologies, test the mathematical correctness of ontologies such as the OntOlogy Pitfall Scanner, known as OOPS, massively scale semantic platforms and maintain the ontologies (FIBOs) is a universal problem that must have at least a v1.0 solution.
APPENDIX B – Sample letter of invitation

I am writing to you to extend a personal invitation to participate in an exclusive event being held in conjunction with this year’s Semantic Technology & Business Conference (SemTechBiz) in San Francisco. The details of this event are outlined in the attachment.

Perhaps you are aware that the Enterprise Data Management Council (EDMC) started several years ago to develop a Financial Industry Business Ontology (FIBO). The majority of the Western world’s financial institutions, and many of their suppliers are members of the Council. Beginning with the challenge of Sarbanes-Oxley, Basel III, and reinforced by the Dodd-Frank Act, it has become clear to the technical community in these organizations that relying on methods of the last century to comply with new requirements is simply cost prohibitive. In fact, American Banker says that the cost to comply is between U$150-U$350M/per year/per organization – with no added value.

FIBO is well on its way to changing this. By the end of this year, OMG will publish two of many FIBO standards that will serve as the beginning of a common vocabulary for the banks and for the regulators.

But, more must be done faster. SemanticWeb.com (Media-Bistro) has generously offered to share their venue for SemTechBiz 2013 with the EDMC for a no cost to the invitees to the FIBO Technology Summit. This event will be the afternoon of 4 June and the morning of 5 June in the San Francisco Hilton where the Conference is being held.

If you choose to attend SemTechBiz, you must register and pay the fee. But, the FIBO Technology Workshop will cost you nothing but work. You and a select number of other notables in this field are being asked to look at these five FIBO needs below and detailed in the attachment. Pick out the 2 of them that interest you the most.

11. There is a need for a mechanism for the generation of Operational Ontologies from Business Conceptual Ontologies.
12. There is a need for a mechanism for generation of business rules/axioms for analytics (i.e. how to convert regulatory requirements into rule statements).

13. There is a need to be able to demonstrate the business value of FIBO and of the content of the data discoverable through both the FIBO Conceptual Ontology and the various FIBO Operational Ontologies as they evolve.

14. There is a need to be able to automatically convert a picture into an Ontology. This picture may be of a concept, a question, or a statement such as a rule.

15. There is a need to be able to link FIBO in all of its aspects to other Ontologies from other industries and disciplines that may not seem to be related to FIBO. That is, there is a need for Shared Semantics at the massive scale of the financial system.

At the event, on the 4th, after an introduction to FIBO and a charge to the assembled, teams will be formed in these areas to go off and to consider: 1) Where does technology exist that could be immediately applied? 2) What developments are ‘just around the corner’ that FIBO could use? 3) What are the true longer term research needs? Each team will be asked to report their findings in detail on the 5th. We are expecting words and a roadmap that the Council can use as a true research agenda – focused on FIBO, but useful to the Semantic Technology community at large.

Please consider this event and these areas. Then go to https://www.eiseverywhere.com/semtechbizsf2013?categoryid=496939. There you can register for the FIBOTechnologyWorkshop. You will see a drop down that opens up the link to this invitee only FIBO Technology Summit which is free to you. You can indicate in which technology area you would like to participate and you can also register for the entire symposium.

Hope to see you there,
APPENDIX C – Michael Atkin Charge to the Assembly

1. I am the chair of the Data and Technology Committee and charged with helping the OFR define the pathway forward from a data perspective. And they understand the importance of data comparability. They understand that without data standards (i.e. identifiers, language of the financial contract and classification) – they won’t be able to provide oversight over the unruly financial industry. I sit on the Financial Stability Board’s Public Sector Advisory Group helping to implement a legal entity identification standard. So you need to fix this data problem. The second is that the banks have to implement an aligned data infrastructure. This includes identifiers, metadata, naming conventions and harmonized data definitions. This is the infrastructure mandate for data management. All around the financial industry from the financial institutions themselves to the regulators that oversee them to the data vendors that serve them – the objectives of transparency, financial stability and cross-asset market surveillance are tailor made for the promise of precise language, based in contractual reality, combined with executable business rules, integrated with other taxonomies, aligned with messaging and managed via inference processing. We don’t really understand data as meaning. We don’t really understand that this is not a data processing or IT problem. We don’t have aligned data glossaries across business units. At the moment, data management is on the agenda of every financial institution. It covers all known financial instruments. It covers business entities and the roles they play in financial processes. The semantic community.

2. FIBO Technology Summit – Opening Remarks

Michael Atkin, Managing Director, EDM Council

June 4, 2013

3. I spent the majority of my professional life as the scribe, analyst, advocate, facilitator and therapist for the information industry. I started with the traditional publishers and then moved on to my engagement in the financial information industry. I watched the business of information evolve through lots of IT revolutions ... from microfiche to Boolean search to CD-ROM to videotext to client server architecture to the Internet and beyond.
4. At the baseline of everything was the concept of data tagging - as the key to search, retrieval and data value. I saw the evolution from SGML (which gave rise to the database industry). I witnessed the separation of content from form with the development of HTML. And now we are standing at the forefront of capturing meaning with formal ontologies and using inference-based processing to perform complex analysis.

5. I have been both a witness to (and an organizer of) the information industry for the better part of 30 years. It is my clear opinion that this development – and by that I mean the tagging of meaning and semantic processing is the most important development I have witnessed. It is about the representation of knowledge. It is about complex analytical processing. It is about the science of meaning. It is about the next phase of innovation for the information industry.

6. Let me see if I can put all of this into perspective for you. Because my goal is to enlist you into our journey. I know (with absolute certainty) that we are standing at a breakthrough moment and I’m fortunate enough to have a front row seat in many of these discussions. Some of you may know that I run the EDM Council and have been preaching the gospel and advising financial institutions around the world on the data mandate for many years – and now they care. And they care at the top of the house. And they care enough to deal with the huge task of changing how their organizations operate. And they care enough to usher in a whole new infrastructure across their organizations and across the world. This is truly a big deal.

7. I am a member of the US Treasury’s Financial Research Advisory Committee. This is the mechanism created by the new Office of Financial Research to implement data standards and conduct research about systemic risk. I am the chair of the Data and Technology Committee and charged with helping the OFR define the pathway forward from a data perspective. And they understand the importance of data comparability. They understand that without data standards (i.e. identifiers, language of the financial contract and classification) – they won’t be able to provide oversight over the unruly financial industry. And they are starting to understand the importance of semantic processing as the pathway through the analytical minefield of interconnected global risk.

8. I am a member of the Technical Advisory Committee of the Commodity Futures Trading Commission. They are sitting in the midst of a data wildfire
– and they know it. They need to facilitate transparency in the derivatives market. They need to understand how these bespoke contracts actually work. They need to standardize product identification. They need to classify these instruments so they can be aggregated and linked. They need to align data meaning with messaging standards. They need to validate and normalize data across exchanges and across geography. And they need to support complex analytics based on ad-hoc scenarios and on-demand – when threats to financial stability begin to emerge. It’s the penultimate use case for both ontologies (the language part) and inference processing (the technology part).

9. I sit on the Financial Stability Board’s Public Sector Advisory Group helping to implement a legal entity identification standard. This standard is only the first step. The real goal is for reporting about ownership structures, control relationships and intercompany linkages. And the light is beginning to shine – not just on the importance of the identifier, but on the role of ontologies about ownership and control and in understanding the nature of (what David Newman describes as) transitive exposure. This is about understanding who finances whom, who owns whom, who guarantees whom, who is obligated to whom – what happens under what conditions and ultimately “do I get paid before you do” in the advent of another financial crisis. This (of course) is the focus of FIBO for business entities – the first standard that we are releasing in partnership with the OMG.

10. And this story continues. We are right now working with the Bank of England to align their liquidity reporting requirements to FIBO – so that there is clarity in reporting and an ability to do comparative analysis. We are right now working with some of the largest banks in the world to align their data repositories in order to do consistent aggregation - so that they can perform the range of stress tests now being mandated by the Federal Reserve. We are right now working with Fannie Mae and the housing regulators to align data … to integrate it into the MISMO XML messaging schema … and to help them unravel the dynamics of the mortgage-backed securities market.

11. But most importantly, we are right now gearing up to address the most important new objective within this wonderful new Age of Transparency. Earlier this year, the Basel Committee on Banking Supervision released a very important document – affectionately known as the Basel Risk Data Aggregation Principles (or Basel RDA).
This document is the result of an evolutionary process. The evolution began just after the 2008 crisis as the global market authorities started documenting what went wrong and what we need to fix as a result. In 2009 the SEC and CFTC jointly released a study specifying that the only way through the minefield of complexity was to specify these complex financial instruments based on the underlying facts that define them. And that the financial industry should partner with government and academia to implement this “algorithmic capability” (that’s the term they used). This is their important study known to DC policy wonks as Section 719(b) of the Dodd-Frank Act.

In 2010, the Senior Banking Supervisors Group (these are the heads of the world’s leading central banks) released a study that defined the concept of a “risk data appetite framework” and made the strong and intractable connection between risk management and data. The story went something like this ... we regulators are entrusted with a bunch of new tasks (financial stability, transparency and all that). In order to accomplish these new tasks we need comparable data across your organizations and across the industry so we can feed them into our models and run our economic scenarios. Plus we regulators are not technically capable of doing the reconciliation – so the onus is on you (the banks) to deliver aligned data. Oh and by the way – if you can’t do this, we would be very worried about your internal ability to control over your own risk. So you need to fix this data problem.

This year, the Basel Committee released the RDA principles document. This document takes the SBSG recommendations up a few notches and mandates the implementation of this control environment. The 14 RDA principles say three things about data that give me hope and get me charged up. The first is that the ability to aggregate risk is mandatory and that executive management is responsible for making sure that happens. This is the governance mandate for data management. The second is that the banks have to implement an aligned data infrastructure. This includes identifiers, metadata, naming conventions and harmonized data definitions. This is the infrastructure mandate for data management. And the final part is that the banks must have the ability to aggregate risk across business units on demand and in response to ad-hoc economic scenarios. And while the financial institutions and the regulatory authorities don’t fully understand it yet – this is the semantics mandate for the financial industry.
12. And this, the “they don’t know it yet” part ... is the essence of the challenge that lies before us. All around the financial industry from the financial institutions themselves to the regulators that oversee them to the data vendors that serve them – the objectives of transparency, financial stability and cross-asset market surveillance are tailor made for the promise of precise language, based in contractual reality, combined with executable business rules, integrated with other taxonomies, aligned with messaging and managed via inference processing.

It is an outstanding use case for ontologies and for semantic triples. It is backed with the threat of regulatory mandates. It is designed to be implemented via standards. And it is combined with the necessary governance to ensure that we don’t ignore the problem due to concerns about business case or fall victim to the unfortunate “curse of the short view” that is so prevalent among large financial institutions.

13. And so, while we have the financial industry use case with all the regulatory trimmings – we don’t have complete awareness. We don’t really understand data as meaning. We don’t really understand that this is not a data processing or IT problem. We don’t have aligned data glossaries across business units. We don’t even know how to spell metadata – let alone utter the “o” world in polite company. We live a world of reconciliation. We know how to deal with operational crisis on a tactical basis. We’ve been practicing that reality since the dawn of credit.

14. But I’m undaunted. In fact, I’m excited. Data management has risen like a phoenix, crawled out of the depths of the back office and is no longer considered as the ugly stepchild of IT. At the moment, data management is on the agenda of every financial institution. In fact, it is one of the top issues on the agenda of executive management within the financial industry.

15. It is also the hot topic of the day within the regulatory community. Regulators, market authorities and agencies around the industry are waking up to the fact that they cannot accomplish their new goals of unraveling the complexity of the global financial market without comparable data and without a shared view about the “things” in our world, the “facts” about these things and about how the “relationships” among these things work in reality.

16. But we are at the beginning of the journey, not the end. Awareness is essential. Global economic crisis and tough regulatory oversight was
necessary to change the orientation of this industry. But awareness and drivers are not sufficient. We have work to do. And we don’t have a huge window of time in which to operate.

17. But we do have a good start. The EDM Council has been developing the ontology of the contract as a collaborative project under the leadership of Mike Bennett for the past 5 years. This is the Financial Industry Business Ontology (or FIBO). It exists. It covers all known financial instruments. It covers business entities and the roles they play in financial processes. It covers lots of the basic concepts of risk, transactions, corporate actions, issuance, guarantee and collateral. It plays nicely in the sandbox with other ontologies and with messaging taxonomies. And it’s governed by the technical rigor of the OMG standards process.

18. We do have a standard methodology for FIBO developed and implemented under the steady hand of Dennis Wisnosky and in partnership with the OMG architecture board under the tireless dedication of people like Elisa Kendall and Pete Rivette.

19. We do have a robust illustration of an operational ontology showing the intersection of interest rate swaps, credit default obligations and legal entity relationships under the direction of the remarkable David Newman from Wells Fargo and his OTC derivatives team. We do have ametadata repository and a means of extracting FIBO in RDF/OWL thanks to Adaptive. We do have good working relationships with other stakeholders including the messaging schemas, the SemTech community, the financial institutions and the regulatory agencies in the US, UK and Europe. So we’re in a fairly good place.

20. What we need to complete this picture however – is you. The semantic community. There are some real technical challenges that need to be solved – like the four that have been teed up for this Summit. We do have to be able to deliver on the promises that we are making. And the stakeholders are seriously listening to the promises – mainly because they have real tasks to accomplish and this is the right pathway forward.

21. What I fear however is fragmentation rather than harmonization. I see lots of activity – but not a sufficient mechanism for achieving alignment among the banks, the regulators, the semantic community, academia, the ontologists and the data vendors. That’s what we hope to see emerge out of this event –
the mechanism for alignment – the process for collaboration – and the means to collectively step up to the challenge.

22. We are standing at that rare moment – the perfect storm (if you will) between business objectives, regulatory mandates and data as the fundamental pillar that links these things together. It’s been a long time coming and (as Rahm Emanuel once said) – “shame on us if we waste a good crisis.” Thank you.
## APPENDIX D - PARTICIPANTS

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<thead>
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<th>Name</th>
<th>Position</th>
<th>Company/Institution</th>
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<td>Craig</td>
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