

# Data Management in Capital Markets: How Semantic Web Technologies can Help

## Abstract

Spends on data management continue to dominate budgets, especially in information-intensive sectors like capital markets. New, tech-savvy firms are using innovative technology levers on abundant data to influence traditional capital market business models. It is in this battleground of information, business logic, data and technologies that semantic web thinking underpinned by ontologies offers a way forward. Ontologies and semantic web technologies enable capital market firms to answer a key question: how much do the systems actually understand their own design, the business logic involved, and the data handled? In this paper, we discuss how ontologies and semantic web technologies can provide a spectrum of capabilities – from information management to artificial intelligence led decision making – in a ‘machine-led’ capital markets firm.

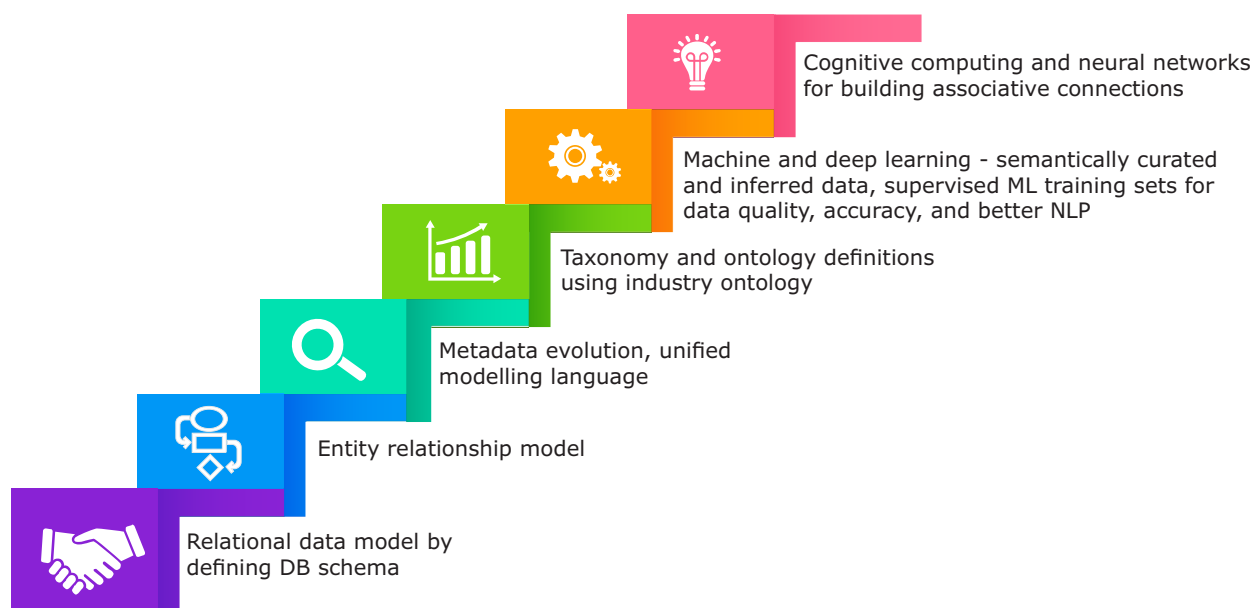
## The Need for Ontologies and Semantic Web Technologies

Data management costs are ever increasing with firms having to acquire data from multiple sources, transmit and distribute data across the organization, and store it for future retrieval. Demand for data from clients, senior management, and global regulators is also growing by the day. With many firms investing heavily on operational and technological transformation projects, the focus is on data access and delivery, upgrading legacy data architectures using hubs, virtualization, warehouses, or data-as-a-service (DaaS) solutions. Tackling cost and efficiency issues is also a priority; firms are leveraging technologies such as machine learning (ML), robotics, and artificial intelligence (AI) in this regard.

Despite such initiatives, there is disconnect between data management, business logic, and systems design. In fact, it is this isolation of data from its contexts that leads to complexity in data management and the constant need for alignment with the business logic, regulatory rules, and changing system design. This disconnect cannot be addressed effectively just by linking design artifacts and programs with data elements – such linking is inherently human-centric. Human centric linking makes data management highly rigid, necessitating frequent changes to accommodate the ever-evolving data requirements. Technology solutions too are not able to single-handedly address this issue as they lack the flexibility, depth, and the intelligence required from a business perspective. Here's where ontology and semantic technologies come in.

### Overcoming the Data Challenges

An integrated data management solution built using a combination of semantic web technologies and ontological representation has the potential to address most of the data management and reporting challenges across data governance, integrity, and controls. The technology can potentially enable semantic search, apply AI based neural network algorithms, and provide insights based on the knowledge representation. Ontologies bridge the gap between human induced knowledge and machine induced knowledge (see Figure 1).



**Figure 1: Evolution of Ontology Concepts**

Information can be organized into formal knowledge graphs by identifying the entities, facts, synonyms of financial terms, and the various relationships between the entities. Data is stored in silos within organizations, which makes it difficult to search or retrieve data from disparate applications and systems – the knowledge graph resolves these challenges. The existing legacy data in relational models can also be mapped to the knowledge graph using natural language processing (NLP) and ML technologies. The content can then be queried using a semantic search platform built on NLP technologies instead of time-consuming and error-prone keyword based searches.

Ontology has come a long way over the years: starting from generic industry ontology, it has expanded to defining enterprise specific ontology, building knowledge graphs for interpretation, and learning and forecasting using NLP and ML technologies. Cognitive computing has enabled the use of neural networks to read and interpret knowledge graphs and plays a role in associative learning to facilitate structured and unstructured data interpretation. We believe that the availability of ontology and cognitive services through the as-a-service consumption model will evolve over a period of time.

## Use Cases from the Financial Services Industry

Let's examine a few areas where the application of ontologies and semantic web technologies has resulted in operating model changes in capital market firms.

### **Investment research and advisory**

Availability of the right data at the right time is critical to making sound investment decisions. Search platforms that leverage the wider ecosystem of market data providers, investment and market research firms, companies' regulatory filings, social networks, news, and so on, to provide the right information at the right time would be a boon. With markets becoming more connected and competitive, intelligent solutions that allow investment and portfolio managers to use their own (natural) language to search for relevant information from huge volumes of structured and unstructured data are the need of the hour. In our view, solutions built using ontologies and semantic web technologies would be ideal. For example, a portfolio manager or a financial advisor would need to browse through a huge number of news reports, blogs, and analyst recommendation reports while making investment decisions. A search interface that allows natural language based queries like, 'show all documents where the price of ABC stock is greater than \$100' would be a boon. The free text is annotated based on ontology, linked to the various other entities as per the defined ontology, and the results are filtered and ranked thereby improving accuracy and relevance. Investment decisions based on such accurate results have the potential to generate alpha returns for investors and unlock exponential value for firms.

### **Legal and compliance**

Legal professionals and compliance officers within investment firms generally have to manually browse through hundreds of documents to identify the right set of obligations and ensure compliance. Non-compliance can result in adverse reputational and financial consequences. Semantic modelling of ontologies can facilitate quick search and extraction of legalese, thereby providing firms easier access to their legal information and help assess compliance with obligations mandated by regulatory bodies. AI-powered bots that use semantic technologies to translate, interpret, and respond to humans in natural language can also be built using the above framework, which in turn will help unlock exponential value by lowering the risk of non-compliance and reputation loss and avoiding regulatory attention and penalties.

### **Regulatory and risk reporting**

Financial institutions are required to aggregate financial and risk data from multiple sources like order and trade execution data, market data, transaction data, corporate actions data, investment data, and so on to comply with regulations such as

BCBS 239, fund reporting, and MiFID II. In addition, systems that trigger early warning signals to warn against insider trading, fraud, and anti-money laundering too process data from varied sources. Banks face challenges in visualizing the data connections across disparate data sources, ensuring data lineage and accuracy, and preventing latency. Integrating information into a single enterprise data model is a time consuming process and the location of the data across disparate systems and applications further complicates the situation.

Using ontology based knowledge graphs for regulatory and risk reporting can help resolve these challenges by providing a model that maps the data elements to multiple data repositories and isolated systems and improves data lineage. Risk identification is facilitated as the hidden systemic interdependencies are better captured and represented through ontologies. Quicker detection of non-compliance risk and fraud is facilitated through real-time automated alerts and early warning signals underpinned by predictive analytics — all this coupled with easier data access enables CFOs and risk officers to mitigate risk and improve the overall risk management function. In addition, an ontology based model brings in a higher degree of scalability and flexibility to accommodate new reporting requirements without having to invest substantially in altering existing data models.

## In a Nutshell

Traditional capital market firms have a lot to gain from intelligent technologies - AI, ML, and deep learning have the potential to deliver strategic advantages ranging from efficiency gains to service differentiation to customer engagement. In our view, the financial services industry is moving toward a 'machine-led' paradigm, where amplifying the ability of machines to go beyond the traditional parameters of scale and speed to the scope of business knowledge and logic will become critical. It is in such amplification that ontologies and semantic web technologies provide a way forward. Academia too is carrying out research on how ontologies can help ML and deep learning algorithms to enable efficient semantic search. Though market data providers have slowly started adopting ontologies and semantic web technologies for data retrieval and publication, industry-wide adoption might take longer, but as soon as firms recognize the benefits the technology can deliver, adoption will gain traction. We believe that firms that proactively take steps to adopt this technology will gain a competitive edge and forge ahead of their peers.

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Avinash Patil is a consulting partner with the Capital Markets practice of TCS' Banking, Financial Services, and Insurance (BFSI) business unit. He has over 20 years of experience and has anchored several large transformation engagements for TCS' clients in multiple geographies. Patil has authored several white papers on subjects of interest in the capital markets domain and has been a speaker at industry events such as IDC Financial Insights summit, Enterprise Data World's FIBO Conference, and CordaCon London 2018. He holds a Bachelor's degree in Aerospace Engineering from the Indian Institute of Technology, Kharagpur, India.

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