Information technology and data architecture always evolve to meet the shifting trends in business enterprise. Over the last twenty-five years, information technology met the information demands of business through the wholesale adoption of the Relational Database, followed by its natural progression into the Data Warehouse. There are growing demands for a new type of data architecture – one that can accommodate the new adaptive, virtual enterprise model, based on the integration of web services and widespread, heterogeneous information.

Trends in the enterprise workplace are toward the ‘virtual enterprise’: widespread web-enabled applications utilizing disparate data sources. Researchers are using terms like ‘on demand’, ‘adaptive enterprise’ and ‘virtualization’ to describe the new business environment. According to John Van Decker, senior program director at META Group:

“Enterprises are increasingly expecting an integrated platform that meets the need for a global view of their information in order to seize market opportunities effectively and improve competitive position. Too often firms are disappointed with the information disconnects associated with a multiple-point solution approach. We see information integration that addresses this critical requirement as a major opportunity for software vendors.”

Many software companies are racing to create software that manages the adaptive, on-demand enterprise. As expected, many different approaches are being utilized to integrate and manage the data structures and connectivity of the new model’s underlying ‘virtual enterprise information’. This paper advocates an approach of using intelligent metadata to adapt existing databases and data warehouses to deliver an integrated platform that provides a global view of a company’s information.

The Intelligent Metadata approach to information virtualization solves both ‘back-end’ information integration problems and ‘front-end’ Business Intelligence bottlenecks.

RT Intelligence LLC was founded by a long-time practitioner of information virtualization. RT Intelligence has developed a new approach for integrating disparate enterprise information and web services. RT Intelligence’s approach is to add a new layer of intelligent metadata to the traditional database metadata currently driving relational databases and data warehouses. RT Intelligence’s approach follows the natural evolution of database theory toward the next higher level of metadata abstraction:

Commenting on the new adaptive, virtual enterprise, IDC analyst Chris Willard said, "The computing industry has moved forward over time by moving technology to the next higher level of abstraction. Each time that happens, the technology is available to a larger group of people. Virtualization is now well into the early-adopter stage and is beginning to make it into the majority," he said.

A new layer of intelligent metadata just extends the database metadata in existing databases and data warehouses. So RT Intelligence’s approach for building and managing virtual enterprise information is the quickest and least expensive way to ‘virtualize’ a company’s existing data infrastructure.

The intelligent metadata approach to enterprise virtualization has another outstanding set of benefits for a company: it results in a sharp boost in corporate Business Intelligence productivity. Many tasks heretofore relegated to manual I.T. staff labor, such as producing reports, graphs and queries for users, will be suddenly automated to a much larger extent.

The adaptive enterprise must be able to react to changing events and corporate business environments quickly. Those corporations which must rely on their I.T. staff to perform manual procedures to adjust the information systems and infrastructure to accommodate changing business situations will simply be left behind to their more agile competitors.

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1 The author developed and sold virtual information solutions starting in 1989 through Vinsoft International Corp., with ‘Vinsoft’ standing for ‘virtual information network software’.

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Intelligent Metadata: a key to information integration and to Business Intelligence

What does RT Intelligence’s intelligent metadata consist of, and how is it utilized?

RT Intelligence has developed a metadata product, *Intelligence Stack*, which integrates existing databases and data warehouses into a virtual enterprise server by utilizing its patent pending intelligent metadata approach.

*Intelligence Stack* loads the database metadata (but not the data itself) of an organization’s disparate databases and data warehouses. But *Intelligence Stack* includes another layer of metadata schema, consisting of concepts (‘ontology’) and semantics, which fills the ‘semantic gap’ between users and their database information.

The conceptual metadata layers are hierarchical, with more abstract concept models as ‘parents’ of the more specific concept layers. RT Intelligence refers to these hierarchical concept layers as ‘stacks’. RT Intelligence’s products utilize a hierarchy of abstract concepts in a semantic / conceptual repository called *OntoloNet*. This repository includes business rules, definitions and conditions at each concept level (formally these are called ‘ontologies’). Then ‘stacked’ on top of *OntoloNet* are specific conceptual and semantic layers, which RT Intelligence calls ‘corporate intelligence stacks™’. Below is an example Corporate Intelligence Stack, for a Healthcare Management company.

![Corporate Intelligence Stack Diagram](image)

Note that the concept models for a specific company (in this case, a healthcare organization) are organized as specific subject area models, each representing one or more actual databases for the company. These individual subject area concept models are ‘stacked’ on top of a concept layer containing the company’s ‘common Information Objects’.

The one-time process for constructing the Corporate Intelligence Stack is called ‘intelligization’. Intelligization consists of three subprocesses: dbCertification, queryCertification, and semanticCertification.

The Coupling intelligent Metadata and Semantic Search for Business Intelligence solutions
Intelligent Metadata:  
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Of particular importance to the new adaptive enterprise is the ability to deliver accurate and timely information to the corporate managers, analysts and often customers. RT Intelligence includes, along with its virtual enterprise data integration technology, an ‘answer delivery system’: an automated process which starts with natural language user requests for information.

The ‘intelligence’ in RT Intelligence's intelligent metadata is provided by a core RT Intelligence product: RT Intelligence NLP, a Natural Language Processor (NLP) module. RT Intelligence NLP ‘understands’ natural language based user requests, in context of the concepts and semantics in concept layers, described below.

RT Intelligence’s Natural Language Processor (NLP), RT Intelligence NLP, coupled with its open-architecture knowledge repository, OntoloNet, converts the natural language user requests into the concept layers in a target Corporate Concept Stack.

Intelligence Stack comes with a built-in set of Business Intelligence (B.I.) tools, featuring a Semantic Natural Language. These NL based tools utilize intelligent metadata for much more rapid delivery of Business Intelligence: executive queries, reports, graphs, dashboards:

RT Intelligence’s built-in B.I. tools:
- Studio – a rapid reporting tool which produces enterprise reports in one-third the time and cost of convention reporting tools.
- Answer Exec – an automated ad hoc query tool for executives and analysts to use natural language requests for immediate, precise answers without the IT department having to write reports.
- Answer Dashboard – an executive dashboard which features management alerts based on user-defined conditions and business rules.

The ‘proof is in the pudding’ when it comes to Business Intelligence tools. Below is a snapshot of an actual end user report generated from a user request typed in on a browser:

“Total the seafood product order amounts.”

The RT Intelligence Intelligence Stack automatically returned, in three seconds, the following enterprise report to the user’s browser:
Notice that the left panel presents ‘Report Presentation Options’. These are the ‘end user reporting’ options which constitute one of the two functional products within Intelligence Stack: Answer Studio.

For the end user report shown above, here is the SQL command that was automatically created and executed against a client database by Intelligence Stack:

```
SELECT CATEGORIES.CATEGORYNAME AS [CATEGORY NAME],
      PRODUCTS.PRODUCTNAME AS [PRODUCT NAME],
      PRODUCTS.QUANTITYPERUNIT AS [QTY PER UNIT],
      PRODUCTS.UNITPRICE AS [PRODUCT PRICE],
      PRODUCTS.UNITSINSTOCK AS [UNITS IN STOCK],
      PRODUCTS.UNITSONORDER AS [UNITS ON ORDER],
      PRODUCTS.REORDERLEVEL AS [REORDER LEVEL],
      SUM( ORDERDETAILS.QUANTITY * PRODUCTS.UNITPRICE )
     AS [TOTAL EXTENDED PRICE]
FROM PRODUCTS,
     CATEGORIES,
     ORDERDETAILS,
     ORDERS
WHERE PRODUCTS.CATEGORYID = CATEGORIES.CATEGORYID
  AND ORDERDETAILS.PRODUCTID = PRODUCTS.PRODUCTID
  AND ORDERDETAILS.ORDERID = ORDERS.ORDERID
  AND (CATEGORIES.CATEGORYNAME = 'SEAFOOD')
GROUP BY CATEGORIES.CATEGORYNAME,
        PRODUCTS.PRODUCTNAME,
        PRODUCTS.QUANTITYPERUNIT,
        PRODUCTS.UNITPRICE,
        PRODUCTS.UNITSINSTOCK,
```

Total Seafood Product Order Amounts

<table>
<thead>
<tr>
<th>PRODUCT NAME</th>
<th>QTY PER UNIT</th>
<th>UNIT PRICE</th>
<th>UNITS IN STOCK</th>
<th>UNITS ON ORDER</th>
<th>REORDER LEVEL</th>
<th>TOTAL EXTENDED PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cameron Tuna</td>
<td>15 kg lak.</td>
<td>$226.50</td>
<td>82</td>
<td>0</td>
<td>0</td>
<td>$39,580.50</td>
</tr>
<tr>
<td>Kona</td>
<td>12 - 200 ml.</td>
<td>$31.08</td>
<td>31</td>
<td>0</td>
<td>0</td>
<td>$22,148.28</td>
</tr>
<tr>
<td>Boston Clam Meat</td>
<td>24 - 14 oz</td>
<td>$18.49</td>
<td>123</td>
<td>0</td>
<td>30</td>
<td>$19,048.30</td>
</tr>
<tr>
<td>Nond-Ost Malgebnis</td>
<td>10 - 200 g</td>
<td>$25.08</td>
<td>10</td>
<td>0</td>
<td>15</td>
<td>$14,775.54</td>
</tr>
<tr>
<td>Scagino</td>
<td>24 - 250 g</td>
<td>$19.00</td>
<td>112</td>
<td>0</td>
<td>20</td>
<td>$14,540.60</td>
</tr>
<tr>
<td>Jack’s New England Clam Chowder</td>
<td>12 - 12 oz cans</td>
<td>$9.65</td>
<td>65</td>
<td>0</td>
<td>10</td>
<td>$9,669</td>
</tr>
<tr>
<td>Espagne de Bourgogne</td>
<td>24 valves</td>
<td>$13.25</td>
<td>62</td>
<td>0</td>
<td>20</td>
<td>$6,664.75</td>
</tr>
<tr>
<td>Speckfeld</td>
<td>4 - 460 g glasses</td>
<td>$12.00</td>
<td>95</td>
<td>0</td>
<td>0</td>
<td>$6,644.00</td>
</tr>
<tr>
<td>Kinsu</td>
<td>2 kg box</td>
<td>$8.00</td>
<td>24</td>
<td>0</td>
<td>5</td>
<td>$8,004.40</td>
</tr>
<tr>
<td>Rejske Sild</td>
<td>1 kg skg</td>
<td>$9.50</td>
<td>5</td>
<td>70</td>
<td>15</td>
<td>$14,760.50</td>
</tr>
<tr>
<td>Ribs Kasar</td>
<td>24 - 150 g</td>
<td>$15.00</td>
<td>101</td>
<td>0</td>
<td>5</td>
<td>$4,200.00</td>
</tr>
<tr>
<td>Gradw lax</td>
<td>12 - 600 g</td>
<td>$26.00</td>
<td>11</td>
<td>50</td>
<td>25</td>
<td>$83,647.20</td>
</tr>
</tbody>
</table>

Total count: 12

(Email: Request: 'Total the seafood product order amounts. ')

$141,623.09
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PRODUCTS.UNITSONORDER,
PRODUCTS.REORDERLEVEL
ORDER BY SUM( ORDERDETAILS.QUANTITY * PRODUCTS.UNITPRICE ) DESC

Actual solutions, not just theory

RT Intelligence’s methodology and intelligent metadata approach parallels the initiatives in the World Wide Web Consortium (W3C) in many respects (semantic web, ontology, topic maps). What is different about RT Intelligence’s approach, contrasted to the work of the W3C research scientists, is that RT Intelligence has actually produced practical, demonstrable solutions through its products:

- End users can obtain immediate, precise answers from corporate databases by simply typing full-sentence natural language requests.
- Reports and graphs can be produced by end users themselves, without having to wait on their I.T. staff to write these reports.
- Corporate managers can get instant and accurate information from disparate databases for decision making, allowing their organizations to adjust business strategies immediately.
- Corporate databases and data warehouses empowered with RT Intelligence’s intelligent metadata deliver global enterprise views of integrated corporate data sources.
- Organizations can create a global integrated information platform in a matter of weeks with RT Intelligence’s Intelligence Stack and immediately get Business Intelligence reports and queries from its built-in B.I. tools: Answer Exec and Answer Studio. These B.I. tools are included with a free one-year license in Intelligence Stack, and selectively renewable through annual license agreements.

Each client company who has a license for one or more Answer Studio ‘seats’ will register one or more analysts as ‘designated Answer Studio analysts’. Using the Report Presentation Options shown on the snapshot report, an analyst can rapidly enhance or modify the default Report (shown in the snapshot). Since Intelligence Stack automatically creates the database-oriented SQL command for a report, the client company can utilize non-IT personnel for this report ‘beautification’.

RT Intelligence’s solution can also be used to rapidly produce ‘default reports’ in seconds, and automatically send the SQL command and other report parts through an application program interface (API) into popular Business Intelligence products to be professionally beautified. Other reporting options include saving report reports to Excel or as a PDF file.

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Maptrieve™. Maps on-the-fly from natural language

RT Intelligence’s solution automatically creates a map ‘on-the-fly’ from a natural language request. ‘Control Click’ on the link below, and on the report, click the “Show Map” link on the left side.

http://67.166.213.148:8080/AnswerServer/servlet/StartSession?orgID=RT Intelligence&emailQueryNum=17436

Maptrieve senses ‘mappable objects’ in the result set (e.g., postal codes, addresses), and if anything in the answer is ‘mappable’ a map is automatically generated.

Using intelligent metadata for merging inter-related facts from disparate databases

The RT Intelligence intelligent metadata allows information from disparate databases to be merged and integrated at the concept level, instead of standardizing on a single set of database structures. This ‘concept level mapping’ allows users to access the virtual enterprise through natural language.

RT Intelligence's virtual integration architecture is shown in the diagram below.

Notes:
1. When configured to merge inter-related facts from disparate databases, RT Intelligence utilizes a patent-pending notion of ‘conceptual joins’.
2. An astounding capability of RT Intelligence’s approach is that a single natural language user request can generate individual query commands simultaneously on up to 10,000 disparate systems, all within ten seconds.
3. Intelligence Stack can manage ‘virtual information’ from existing production databases and data warehouses.
   The enterprise version of Intelligence Stack also serves as a corporate data warehouse by loading corporate database data through a built-in ETL feature.
4. The diagram above also depicts the OntoloNet knowledgebase as getting “smarter through normal usage”. As new terms are introduced by RT Intelligence’s users, these new terms are then redistributed to RT Intelligence’s other clients, so that the natural language understanding power of RT Intelligence NLP is rapidly increased. Ultimately the goal of an exact answer search engine is to understand all user requests.

Summary

Many corporations are shifting their database and enterprise application resources to on-demand virtual enterprise platforms capable of supporting the adaptability and agility required in today's business environment. RT Intelligence has addressed these needs through an ‘intelligent metadata’ approach, adding a layer of concept and semantic metadata to the database metadata.

RT Intelligence's Intelligence Stack utilizes its intelligent metadata approach to map disparate database constructs to ‘concepts’, instead of mapping directly to other data constructs. This concept level mapping approach allows the company’s B.I. tools, Answer Studio, and Answer Exec to automatically generate immediate, precise answers from ‘global views’ of the virtual enterprise information. These precise answers are automatically formatted and delivered to the end user’s web browser or wireless device. RT Intelligence's intelligent metadata is itself distributed, since the Semantic portion of the intelligent metadata is housed in the RT Intelligence RT Intelligence NLP, coupled with RT Intelligence’s open-architecture knowledge repository, OntoloNet.

Through intelligent metadata, RT Intelligence can quickly integrate an organization's databases and data warehouses into a virtual enterprise server and at the same time can boost the speed and
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accuracy of Business Intelligence reports, graphs and queries to the organization’s managers and users.
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Author's bio:

Marvin Elder is the founder and President of RT Intelligence LLC, a company utilizing concept models, semantics and relational theory to build highly automated software systems for the Information Technology field.

Mr. Elder has over thirty-five years of experience in data architecture, database administration, I.T. management, technology research and software invention. Among his inventions were:

- one of the first real-time wireless applications (ready-mix concrete dispatching and order entry),
- the first PC-based fourth generation language (4GL) with built-in natural language (Salvo) -- a product featured on the front cover of the PC Magazine as one of the "nine best database products of the year", for which he was voted Future Computing's Software Entrepreneur of the year,
- a CASE tool which included a built-in IDEF1X data modeling tool and which automatically generated ready-to-run relational database applications (Inroads),
- a business rules engine used for real-time pricing of yellow page ads, and
- a business rules engine used in Medicare / Medicaid billing in long-term health care.

His latest technological contribution is a more intelligent set of metadata, which combines an open architecture repository of general ontologies (OntoloNet), a semantic Natural Language Product (RT Intelligence), a new type of ‘virtual enterprise server’ which maps disparate databases to core corporate concepts (Intelligence Stack), a set of natural language B.I. tools for rapid report generation (Answer Studio), ad hoc queries (Answer Exec) and an automatic map generator (MapTrieve). The same underlying architecture has also spawned product designs for natural language interfaces to web services (Fact Express) and to wireless devices (Vobots).

Mr. Elder holds an undergraduate degree from the University of Texas (Austin) and an MBA degree from Southern Methodist University, with advanced studies in Operations Research and Decision Theory.

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