Collaborative Project

GeoKnow - Making the Web an Exploratory for Geospatial Knowledge

Project Number: 318159  Start Date of Project: 2012/12/01  Duration: 36 months

Deliverable 5.3.1

GeoKnow Generator Release for Data Web Background Knowledge Provisioning

<table>
<thead>
<tr>
<th>Dissemination Level</th>
<th>Public</th>
</tr>
</thead>
<tbody>
<tr>
<td>Due Date of Deliverable</td>
<td>Month 30, 31/05/2015</td>
</tr>
<tr>
<td>Actual Submission Date</td>
<td>Month 32, 31/07/2015</td>
</tr>
<tr>
<td>Work Package</td>
<td>WP5</td>
</tr>
<tr>
<td>Task</td>
<td>Task T5.3</td>
</tr>
<tr>
<td>Type</td>
<td>Report</td>
</tr>
<tr>
<td>Approval Status</td>
<td>Final</td>
</tr>
<tr>
<td>Version</td>
<td>1.0</td>
</tr>
<tr>
<td>Number of Pages</td>
<td>22</td>
</tr>
<tr>
<td>Filename</td>
<td>D5_3_1_Release_of_the_supply_chain_dashboard.pdf</td>
</tr>
</tbody>
</table>

Abstract: This deliverable presents the release of the Supply Chain Dashboard. It describes the anatomy and components of the application, the first full integration and its positioning within the GeoKnow Generator tool stack. It gives a brief summary of the work done so far towards this release and reference previous deliverables for further details.

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Project funded by the European Commission within the Seventh Framework Programme (2007 - 2013)
## History

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Reason</th>
<th>Revised by</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8</td>
<td>30/07/2015</td>
<td>Initial Version</td>
<td>Robert Isele, René Pietzsch</td>
</tr>
<tr>
<td>0.9</td>
<td>03/08/2015</td>
<td>Peer Review</td>
<td>Daniel Hladky</td>
</tr>
<tr>
<td>1.0</td>
<td>05/07/2015</td>
<td>Addressed reviewer comments</td>
<td>Robert Isele, René Pietzsch</td>
</tr>
</tbody>
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Executive Summary

The central result of WP5 is the Supply Chain Dashboard, which offers a unified spatial view on the logistics in the supply chain. It allows to observe the flow of material and accompanying information in real-time, to identify bottlenecks early and minimizes media breaks in the information flows. Companies benefit from the Supply Chain Dashboard by gaining a better picture of the current state of the supply chain and the spatial distribution of goods and products in the supply chain.

This deliverable presents the release of the Supply Chain Dashboard. It describes the anatomy and components of the application, the first full integration and its positioning within the GeoKnow Generator tool stack. It gives a brief summary of the work done so far towards this release and reference previous deliverables for further details.

The Supply Chain Dashboard is a web application for the supply chain manager. It allows to visualize the current supply chain network for a certain products bill of materials. Order and shipment information are read from EDI messages and shown in realtime in the dashboard. External background knowledge sources are integrated and related (linked) to suppliers to gain new insights and aid decision making in supply chain management. Supplier performance is evaluated in a supplier score card module and an analytics use case show how external BI can be incorporated.
## Abbreviations and Acronyms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>CSV</td>
<td>Comma-separated values</td>
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<tr>
<td>EDI</td>
<td>Electronic Data Interchange</td>
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<td>LOD</td>
<td>Linked Open Data</td>
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<td>NCDC</td>
<td>National Climatic Data Center</td>
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<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
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<tr>
<td>R2RML</td>
<td>RDB to RDF Mapping Language</td>
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<td>RDB</td>
<td>Relational Database</td>
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<td>RDF</td>
<td>Resource Description Framework</td>
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<td>SPARQL</td>
<td>SPARQL Protocol And RDF Query Language</td>
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<tr>
<td>VDA</td>
<td>German Association of the Automotive Industry</td>
</tr>
</tbody>
</table>
# Table of Contents

1 Introduction 6

2 Relationship to Other Tasks in WP5 7

3 Supply Chain Infrastructure 8
   3.1 New GeoKnow Generator Components 8
      3.1.1 Supply Chain Simulator 8
         3.1.1.1 Configuration 8
         3.1.1.2 Simulation Model 9
         3.1.1.3 REST API 10
      3.1.2 News Extractor 10
      3.1.3 Analytics 10
   3.2 Integration with GeoKnow Generator 11
      3.2.1 Sparqlify 12
      3.2.2 LIMES 12
      3.2.3 FOX 13
      3.2.4 Facete II 14

4 Supply Chain Dashboard 17
   4.1 Simulation Widget 18
   4.2 Map Widget 18
   4.3 Supplier Details Widget 18
   4.4 News Widget 19
   4.5 Xybermotive Widget 19
   4.6 Supplier Score Card 19

5 Conclusion and Future Work 22
1 Introduction

The central result of WP5 is the Supply Chain Dashboard, which offers a unified spatial view on the logistics in the supply chain. It allows to observe the flow of material and accompanying information in real-time, to identify bottlenecks early and minimizes media breaks in the information flows. Companies benefit from the Supply Chain Dashboard by gaining a better picture of the current state of the supply chain and the spatial distribution of goods and products in the supply chain.

The Supply Chain Dashboard is a web application for the supply chain manager. It allows to visualize the current supply chain network for a certain products bill of materials by showing the interrelations and delivery connections between suppliers on a map. Actual orders and shipment information are read from EDI messages and shown in realtime in the system. The dashboard integrates external background knowledge sources and relates these information with the selected supplier to gain new insights and aid decision making in supply chain management. Supplier performance is evaluated in a supplier score card module that calculates metrics based on the available internal and external knowledge. An analytics use case show how external BI can be performed on the central integrated RDF storage to further drill down into the available supply chain data.

The Supply Chain Dashboard utilizes RDF as the basis for data exchange throughout the whole supply chain. RDF allows for the definition and usage of various domain-specific vocabularies. Examples are master data management, orders and shippings, tracking systems information (live data) or logistics systems information. The originators of these data are loosely coupled in supply chains, as are the information systems that yield the data. By materializing these information in RDF, publishing (exposing of SPARQL endpoints) and interlinking is easily possible with the GeoKnow Generator. RDF furthermore allows linking and integration of data in a very effective way, making the integration with external knowledge easy.

This deliverable – D5.3.1 – targets the release of the Supply Chain Dashboard. The current report describes the anatomy and components of the application and the first full integration and its positioning within the GeoKnow Generator tool stack. It gives a brief summary of the work done so far towards this release and reference previous deliverables for further details.

This reports outlines the relation of this work package in relation to the other tasks of work package 5 in section 2.

In the course of the development of the Supply Chain Dashboard basically two main building blocks have been created:

- Supply Chain Infrastructure
- Supply Chain Dashboard

The Supply Chain Infrastructure is a set of software components that use and integrate with GeoKnow Generator components in order to generate and prepare the data on which the Supply Chain Dashboard will operate. The Supply Chain Infrastructure is shown in section 3.

The Supply Chain Dashboard is basically the front-end application for the supply chain manager it is presented in section 4.

Section 5 concludes this report and provides an outlook on future work.
2 Relationship to Other Tasks in WP5

Figure 1 illustrates the relationship between the different tasks in WP5.

![Figure 1: Position of D5.3.1 in WP5.](image)

The purpose of Task 5.1 is to provide a supply chain data set that builds the basis for the supply chain dashboard. Deliverable 5.1.1 provided the first version of the RDF supply chain data set based on an EDI data set that has been received from Schnellecke. The RDF supply chain data set contains both geographical features as well as temporal features. In addition, it delivered an RDF conversion tool that is capable of transforming EDI supply chain messages to RDF. The relevant message types of the VDA (German Association of the Automotive Industry) are supported at the moment.

Task 5.2 is intended to provide the Supply Chain Management Infrastructure, while Task 5.3 builds the Supply Chain Dashboard on top. This deliverable – D5.3.1 – reports about the release of the Supply Chain Dashboard.

The Supply Chain Dashboard (Task 5.3) has initially been delivered in course of D5.2.1 and has advanced since then. Deliverable D5.2.2 added RDF based configuration, integration of structured and unstructured background information, the news extractor and an integration in the commercial EDI solution Xybermotive. In course of deliverable D5.3.1 additional refactoring is applied so that the initially monolithic design of the Supply Chain Dashboard is finally separated in the Supply Chain Infrastructure and the Supply Chain Dashboard.

While deliverable 5.1.1 provided a static supply chain data set, the idea of Task 5.5 is to realize an evaluation environment that simulates the interaction between different suppliers and by that generates messages that can be consumed by the Supply Chain Dashboard.

Deliverable D5.4.1 addressed the goal of providing a simulation environment.

Finally, deliverable D5.5.1 will add an evaluation and test report including application and deployment guidelines. This allows for evaluating the dashboard on a realistic scenario.
3 Supply Chain Infrastructure

The Supply Chain Infrastructure is a set of software components that use and integrate with GeoKnow Generator components in order to generate and prepare the data on which the Supply Chain Dashboard will operate.

Figure 2 shows the generalized data flow of the supply chain use case. Figure 3 shows the positioning and integration with the GeoKnow Generator tool landscape.

Figure 2: Refined data flow within the Supply Chain Infrastructure.

3.1 New GeoKnow Generator Components

The following sections provide an overview of the components newly created in course of D5.3.1.

3.1.1 Supply Chain Simulator

The purpose of the supply chain simulator is to simulate the interaction between different suppliers and to generate messages that can be consumed by the Supply Chain Dashboard.

3.1.1.1 Configuration

The simulation is based on a configuration, which consists of two parts:

Suppliers: Each supplier is described by a name and a geographical location as well as additional properties
Products: The structured part list configuration extends the properties defined by schema:Product with attributes required to model part list information. The complete Bill of Materials (BOM) can be modeled for each product.

The configuration is based on an RDF vocabulary that has been specified in the course of GeoKnow. More information about the configuration vocabulary can be found in D5.2.2.

3.1.1.2 Simulation Model

The Supply Chain Simulator is based on the actor model. Actor models are a widely-used paradigm for implementing concurrent systems. In the context of actor models, an actor encapsulates its individual state and behavior. Actors communicate exclusively by exchanging messages which are placed into the recipient’s mailbox.

On startup, the simulator creates a supply chain network, based on the configured suppliers, their provided products and the structured part lists. For each node in the network, a supplier actor is generated, while each edge denotes a connection of a supplier to its sub suppliers.

Each supplier holds a state on which its behavior is based. The most important state variables for simulated suppliers are:

- An inventory of parts, which holds the quantities of all parts that are needed to build the products offered by the particular supplier.

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1. http://schema.org
• An order queue, which holds all orders that have been received, but have not been fulfilled yet.
• A demand forecast, which predicts the future demand for the offered products for specific timeframes.
• The reliability of this supplier. The reliability may be affected by external forces, such as natural disasters.

Suppliers receiving orders from their parent supplier and send orders to their sub suppliers based on these variables.

3.1.1.3 REST API

The simulator provides a REST API, which allows starting and stopping the simulation. The simulation speed can be changed or single step mode can be used.

3.1.2 News Extractor

The purpose of information extraction from news sources is to serve a supply chain manager with relevant background knowledge about its suppliers (company related information) or about the geographic location of the suppliers (spatial related information). Disasters, accidents, political instabilities or military activities for instance influence strategic spatial sourcing decisions. Likewise do company related information like hiring or release waves, stock volatility, product releases or financial reports about a supplier influence the sourcing strategy.

The news extractor implements the extraction step in our data flow and also integrates with FOX for annotation and enrichment. It is used to extract, annotate and enrich unstructured news sources (like news article or social media feeds). The information from these sources is linked to suppliers from the supply chain network and made available through the Supplier Details (cf. section 4.3) and News Widgets (cf. section 4.4) so that it can be incorporated in supply chain management decisions.

The extractor provides two modes of operation:

• A batch mode collects all available historic news for the derived search terms, annotates the extracted article texts and provides the results in the SPARQL endpoint for further utilization for the configured suppliers and the given simulation time frame.
• A REST interface allows for live requests to provide annotated results for a given list of search terms and a given date.

Refer to D5.2.2 for more details about the News Extractor.

An interface is defined where additional content provider can hook in in order to provide access to additional sources of unstructured information. D5.2.2 introduced the google news provider, D4.4.2 is going to exploit message streams from social media sources like facebook or twitter.

3.1.3 Analytics

The purpose of the analytics module is to enable the assessment of the performance of individuals suppliers according to various metrics as well as to answer user-defined queries on the integrated data sets.
As analytical queries may depend on external data that is not contained in the historical supplier messages itself, such as weather information, we enable the user to integrated background knowledge using tools from the GeoKnow generator. Integration includes the conversion of the input datasets to RDF as well as the interlinking of the internal supplier messages with the provided dataset. In D5.4.1, we presented a scenario that integrates weather data from an external provider for asking complex queries which correlate the supplier reliability to the weather conditions.

Based on the integrated data, the analytics module supports two use cases:

1. Supplier scorecard allows the performance assessment of each supplier based on various metrics. Traditional supply chain metrics, such as the suppliers timeliness, are included. We implemented a visual builder for supply chain scoring rules, which allows the specification of advanced performance metrics through an intuitive interface. The visual building as well as the evaluation of the scoring rules is implemented as a plugin to the Silk open source framework\(^2\).

2. The integrated data, together with the performance scores, can be exported to a BI-tool (RapidMiner). The BI-tool allows the user to drill-down into supplier scores and visualize scores by various dimensions. A screenshot of RapidMiner is shown in Figure 4

![Figure 4: RapidMiner used for evaluation of supplier performance.](image)

In addition, the Sparqlify tool from the GeoKnow Stack can be used for visual exploration of spatial data and the linkage between arbitrary concepts and spatial information. A comprehensive description of the analytics module can be found in D5.4.1.

### 3.2 Integration with GeoKnow Generator

The supply chain use case integrates data from several sources:

\(^2\)http://silk-framework.com
• EDI messages / Supply Chain Simulator messages
• NCDC weather observations and weather station
• Supply Chain Dashboard configuration (list of supplier, structured part list)
• News providers (google news, social media feeds)

We are using the GeoKnow Generator workbench in order to prepare the data to operate the Supply Chain Dashboard. The integrated and used tools comprise:

Sparqlify for RDB 2 RDF mapping
LIMES for interlinking
FOX for enrichment and annotation
Facete II for spatial exploration

The following sections describe in details how the individual GeoKnow Generator tools are used in the supply chain use case.

3.2.1 Sparqlify

Sparqlify\(^3\) is a SPARQL-SQL rewriter and part of the GeoKnow Generator tool chain. It enables the definition of RDF views on relational databases and query them with SPARQL. It uses a proprietary modeling language: *Sparqlification Mapping Language*\(^4\) (SML) but also includes a R2RML\(^5\) (W3C standard) to SML conversion tool.

We defined R2RML mappings for converting the NCDC csv data of weather stations (see listing 1) and daily observation (see listing 2) to RDF. Using the sparqlify R2RML to SML converter allows us to be standard conform and to run these mappings with sparqlify.

3.2.2 LIMES

The LIMES\(^6\) tool from the GeoKnow Generator stack fulfills the role of interlinking external data sources with the internal supply chain data (cf. linking step in the data flow shown in figures 2 and 3).

During data preparation we are using LIMES to link supplier locations with the nearest NCDC\(^7\) weather station.

The linking specification in listing 3 is used for this purpose (prefix definition omitted for brevity).

\(^3\)http://aksw.org/Projects/Sparqlify.html
\(^4\)http://sparqlify.org/wiki/SML
\(^5\)http://www.w3.org/TR/r2rml/
\(^6\)http://aksw.org/Projects/LIMES.html
\(^7\)ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/daily/
Listing 1: R2RML mapping to convert NCDC weather stations to RDF.

gkw:ncdc_stations
  rr:logicalTable [ rr:tableName "ncdc_stations" ; ] ;
  rr:subjectMap [ rr:class gkwo:WeatherStation ;
                   rr:template ""id"" ; ] ;
  rr:predicateObjectMap [ rr:predicate rdfs:label ;
                          rr:objectMap [ rr:column "name" ; ] ;
  ] ;
  rr:predicateObjectMap [ rr:predicate geo:alt ;
                          rr:objectMap [ rr:column "elevation" ; ] ;
  ] ;
  rr:predicateObjectMap [ rr:predicate geo:lat ;
                          rr:objectMap [ rr:column "latitude" ; ] ;
  ] ;
  rr:predicateObjectMap [ rr:predicate geo:long ;
                          rr:objectMap [ rr:column "longitude" ; ] ;
  ] ;
  rr:predicateObjectMap [ rr:predicate gkwo:stationId ;
                          rr:objectMap [ rr:column "id" ; ] ;
  ] ;
  rr:predicateObjectMap [ rr:predicate gkwo:hasObservation ;
                          rr:objectMap [ rr:parentTriplesMap gkw:ncdc_ghcn_daily_tmin ;
                                        rr:joinCondition [ rr:child "id" ;
                                                  rr:parent "id" ;
                                  ];
                        ] ;
  ] ;
Listing 2: R2RML mapping to convert daily NCDC weather observations to RDF (here for the minimum daily temperature).

```
gkw:ncdc_ghcn_daily_tmin
  rr:logicalTable [ rr:sqlQuery "SELECT u:id, u:date, u(CAST(u:value AS DECIMAL)/10) AS u:tmin FROM u:ncdc_ghcn_daily WHERE u:element = u:'TMIN" ];
  rr:subjectMap [ rr:class gkwo:WeatherObservation ;
                     rr:template '{"id"} - {"date"} ;
                   ] ;
  rr:predictableObjectMap [ rr:predicate gkwo:tmin ;
                           rr:objectMap [ rr:column '"tmin"' ;
                                         rr:datatype xsd:float ;
                           ] ;
                     ] ;
```

We are using FOX in the News Extractor component in order to enrich and annotate unstructured texts from news articles or social media feeds.

3.2.4 Facete II

The data corpus we are facing in the supply chain scenario yields spatial information related to non-spatial resources like orders or shipments. A tool that enables a drill down on both types of information resources is very handy for supply chain managers. We integrated the faceted exploration tool from the GeoKnow Generator - Facete II⁹ for visualizing and browsing the integrated data in the supply chain use case. Facete specifically allows a visual exploration of spatial data and the linkage between arbitrary concepts and spatial information.

Figure 5 shows the result of the integration of facete and background knowledge.

⁹https://github.com/GeoKnow/Facete2
Listing 3: Supplier Weather Station linking specification.

```xml
<LIMES>
  <SOURCE>
    <ID>Supplier</ID>
    <ENDPOINT>/home/sherif/LIMES/geoknow/supplier.enriched.ttl</ENDPOINT>
    <VAR>?s</VAR>
    <PAGESIZE>-1</PAGESIZE>
    <RESTRICTION>?s a schema:Place</RESTRICTION>
    <PROPERTY>ogc:asWKT</PROPERTY>
    <TYPE>TURTLE</TYPE>
  </SOURCE>
  <TARGET>
    <ID>WeatherStation</ID>
    <ENDPOINT>/home/sherif/LIMES/geoknow/ncdc-stations.ttl</ENDPOINT>
    <VAR>?w</VAR>
    <PAGESIZE>-1</PAGESIZE>
    <RESTRICTION>?w a gkws:WeatherStation</RESTRICTION>
    <PROPERTY>ogc:asWKT</PROPERTY>
    <TYPE>TURTLE</TYPE>
  </TARGET>
  <METRIC>hausdorff(s.ogc:asWKT, w.ogc:asWKT)</METRIC>
  <ACCEPTANCE>
    <THRESHOLD>0.01</THRESHOLD>
    <FILE>/home/sherif/LIMES/geoknow/supplier_weather_station_accepted.ttl</FILE>
    <RELATION>lgdo:near</RELATION>
  </ACCEPTANCE>
  <REVIEW>
    <THRESHOLD>0.001</THRESHOLD>
    <FILE>/home/sherif/LIMES/geoknow/supplier_weather_station_review.ttl</FILE>
    <RELATION>lgdo:near</RELATION>
  </REVIEW>
  <EXECUTION>Simple</EXECUTION>
  <GRANULARITY>4</GRANULARITY>
  <OUTPUT>TURTLE</OUTPUT>
</LIMES>
```
Figure 5: Facete II integrated with data from the Supply Chain Dashboard.
4 Supply Chain Dashboard

The Supply Chain Dashboard is the front-end for a supply chain manager to consume, search and explore spatial data for his supply chain network and to aid as a decision support system by allowing access to important performance metrics and background information.

The Dashboards basically allows to view and explore the data prepared and made available through the common RDF storage as well as show live updates on incoming orders or shipments.

The source code of the Supply Chain Dashboard is available in a private GitHub repository at:

https://github.com/GeoKnow/Supply-Chain-Dashboard

Figure 6 shows a screenshot of the Supply Chain Dashboard. The dashboard consists of individual UI-components (widgets).

![Supply Chain Dashboard Screenshot](https://github.com/GeoKnow/Supply-Chain-Dashboard)

Figure 6: Screenshot of the Supply Chain Dashboard.

The following widgets are available in the Supply Chain Dashboard:

**Simulator Widget** allows to control the simulation and to travel back and forth in time through the available data.

**News Widget** shows annotated and enriched background information from news sources about the selected entity.

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10 Accessible for the GeoKnow consortium members.
Map Widget used to display the spatial information such as supplier locations and the supply chain network graph as well as to select specific suppliers to examine their details and performance.

Supplier Details Widget show all attributes known about the selected entity.

Metrics Widget show metrics about the performance of the selected entity.

The developed widgets and its features and functions are further explained in the following sections.

4.1 Simulation Widget

The simulation widget is used to specify the point in time within the data that is of interest for the user. A live view can be set, showing in real time incoming orders and outgoing shipments as well as the updated metrics. Alternatively a certain point in time in the available historic data can be selected and the status of the supply chain including all suppliers metrics can be examined.

The UI controls of the widget allow to start and stop the simulation (run by the Supply Chain Infrastructure). The simulation itself was required as there is no integration to a backend system available that provides real live data. So the simulation has been implemented to overcome this drawback and act as the source for orders and shipment messages.

The widget further allows to slide through the available data (travel back and forth in time).

4.2 Map Widget

The map widget is the main area on the application. It is used to display the spatial information of the supply chain network namely the suppliers locations and the graph of supplier relations (sender -> receiver of items).

The widgets allows user interaction with the map as well as the selection of a certain supplier from the network. The selection of a supplier defines which detail information are to be shown in the news, details, xybermotive and metrics widget.

If the view mode has been set to live in the simulation widget the map view is regularly updated to reflect incoming orders or shipped items. Due orders are indicated in the info box attached to the suppliers location pin the numbers are live updated. Likewise the arrows of the supply chain network graph highlight incoming orders by blinking in green and outgoing shipments by blinking in red color.

4.3 Supplier Details Widget

The supplier details widget is used to show the master data of the supplier selected in the map widget. It yields information like address information and the location coordinates. The nearest weather station (from the NCDC weather stations) is shown along its coordinates too.

The Messages button can be used to drill down to a complete list of received orders or shipped items until the current point in time, as set in the simulation widget.
4.4 News Widget

The news widget uses the context of the supplier selected in the map widget. It shows for the selected entity background information gathered from unstructured news sources for the specified (or current) point in time.

A supply chain manager would typically consult this information to get an idea of the current company related news as well as news about the geographical location (city, state, country, etc.) of the supplier.

Being up to date about accidents, disasters, political incidents etc. can be crucial to take strategic sourcing decisions. The news widget is our approach to concisely serve these kind of information to the supply chain manager.

4.5 Xybermotive Widget

A special use case and demo was prepared by integrating the Supply Chain Dashboard with the commercial (Web) EDI solution Xybermotive. Figure 7 shows a screenshot of the Xybermotive inventory view.

For the purpose of integration two additional widgets have been realized that are shown in figure 8. After selecting a supplier from the map the inventory widget allows for viewing the supplier’s inventory and show how many items are on stock or available until a certain date (available to promise). A click on the alternatives button in the inventory reveals other supplier that carry the same item as well as the number of items available.

![Figure 7: Xybermotive Disposition View.](http://xybermotive.com)

4.6 Supplier Score Card

A supplier scorecard (the metrics widget, cf. figure 9) has been added to the Supply Chain Dashboard, which allows the performance assessment of each supplier based on various metrics. In this way, decision making in supply chain management is supported. Supplier scores are evaluated on-the-fly based on historic and currently incoming supply chain messages. Traditional supply chain metrics, such as the suppliers timeliness, have been implemented. In addition, a visual builder allows the specification of advanced performance metrics through an intuitive interface.

The visual metrics composition is based on the eccenca Data Integration tool, a commercial distribution based on the Silk Framework. Figure 10 shows a screenshot of the performance rule editor. In the shown

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11 [http://xybermotive.com](http://xybermotive.com)

12 [http://silk-framework.com](http://silk-framework.com)
Figure 8: Xybermotive inventory widgets, integrating live systems data in the Supply Chain Dashboard.

Figure 9: Supplier Scorecard Widget in the Supply Chain Dashboard

case a more complex metric is defined that is evaluated by a hierarchy of operators that are visually defined and connected in the Data Integration workspace. The shown metric computes the percentage of orders for which all of the items are received by customer in the quantities committed (upper part in the screenshot) and which are fulfilled on the customer’s originally committed date (lower part). The rule is evaluated on receiving new messages for each order (in the screenshot, orders are identified with the variable ?a). The shown metric consists of two parts. The upper part checks whether the ordered quantity has been shipped. It consists of the following operators:

- orderCount
- shippingsCounts
- sumCounts
- isComplete
The second part of the shown metric asserts that all shippings have been on-time by comparing the due date provided by the order with the dates of all shippings returning 1 or 0 accordingly. Finally, the aggregation operator aggregates the numbers from both operators by multiplying them.

For more details about the metrics definition and evaluation within the Data Integration tool see D5.4.1 and D5.2.2.
5 Conclusion and Future Work

This deliverable covered the final version of the Supply Chain Dashboard. We presented the results of the work done in course of WP5 so far and how the components of Supply Chain Infrastructure, GeoKnow Generator tool stack and the Supply Chain Dashboard work together. The generic data flow as well as the utilization of the generator tools to prepare and integrate the supply chain data for the dashboard has been summarized and the final state and the implemented widgets of the Supply Chain Dashboard have been presented.

The current implementation executes most computations, such as the evaluation of the performance metrics, in-memory. In order to scale the implementation to large datasets, an alternative Hadoop-backend based on Apache Spark is being implemented. The Hadoop-backend enables the analytics module to scale to big data sets by distributing computations on a cluster of machines. A complete scenario, including a large supply chain dataset, will be presented in D5.5.1.

In addition to the presented Supply Chain Dashboard for use on a Desktop PC, a mobile version of the Dashboard is currently being developed by IMP to be presented in D5.6.1.