SIMDAT

Data Grids for Process and Product Development using Numerical Simulation and Knowledge Discovery

Project no.: 511438

Grid-based Systems for solving complex problems – IST Call 2

Integrated project

Deliverable

D20.1.1 Specification of Meteorological scenario for connectivity test case

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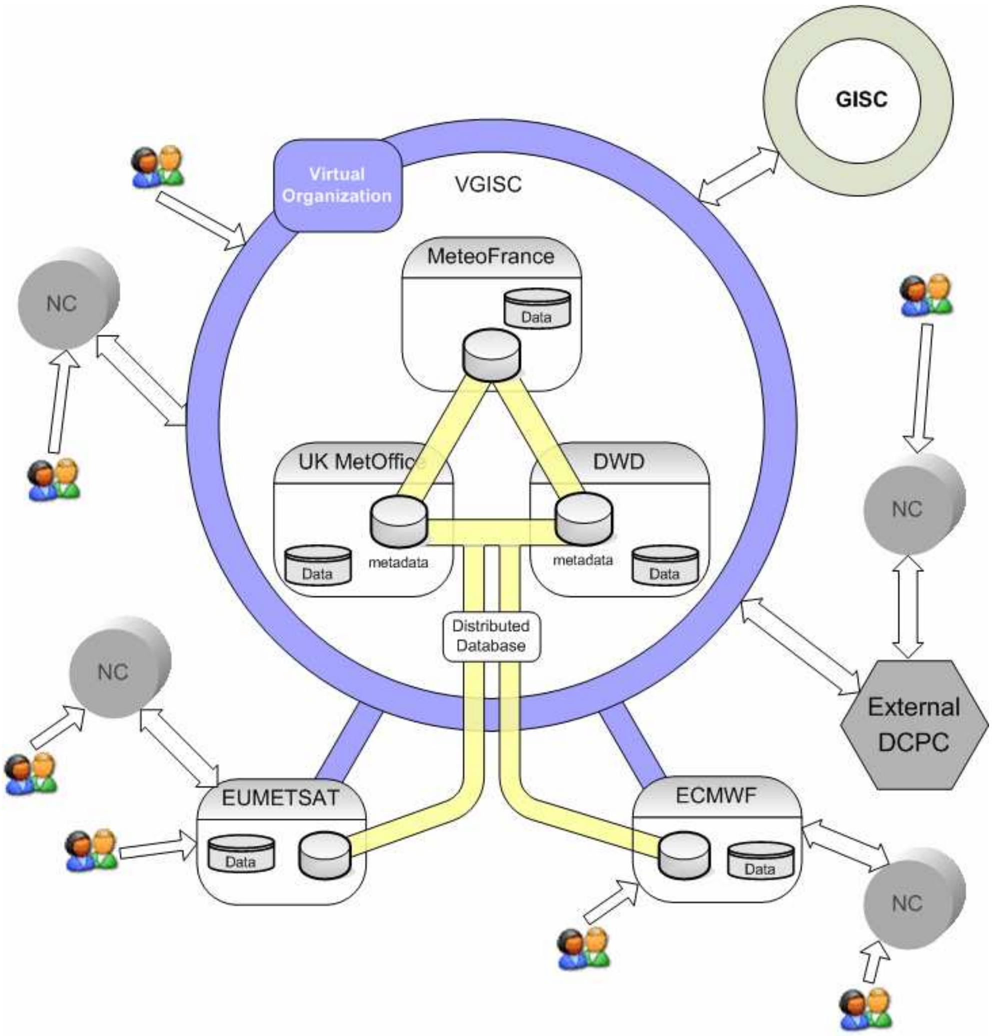
1 INTRODUCTION

This document details what will be done for the demonstrator month 12.
Data exchanges are the foundation of the core meteorological activities. Observation data is continually collected by earth observation systems such as automatic or manned station, aircrafts, ships, etc. These data are fed into real-time databases and used as input to numerical weather prediction system running on high performance computer facilities. The outputs of such models are then redistributed to weather forecast centres to be used by forecasters for the creation of value added products targeted at end-users. The observation data and the model outputs are archived for research use and climate studies.
The SIMDAT project will help to develop a virtual and consistent view to this vast amount of distributed data and provide a secure, reliable and efficient access to them, in order to support research and operational activities of the meteorological community.
The national weather services of France, Germany and the UK in cooperation with the European Centre for Medium-Range Weather Forecasts (ECMWF) and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) plan to develop a common infrastructure for the collection and sharing of distributed meteorological data: the Virtual Global Information Systems Centre (V-GISC). The V-GISC concept will be developed within meteorology activity of the SIMDAT project.
Some key elements of the project are:

- Improve visibility and access to data through a comprehensive discovery service based on metadata development,
- Add value to existing datasets by enabling diverse databases to be used as a unique virtual resource,
- Offer a variety of reliable delivery services,
- Provide a global access control policy managed by the partners and integrated into their existing security infrastructure.

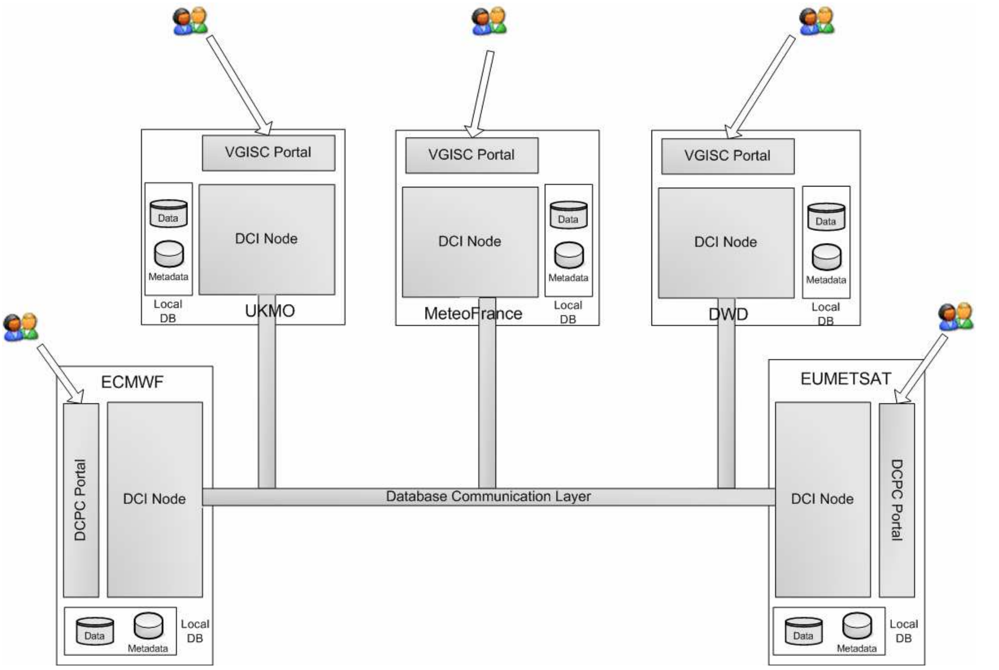
Figure 1 describes the V-GISC within the FWIS architecture.



1. Data Communication Infrastructure

1.1 V-GISC infrastructure overview

Based on the requirements and use cases defined in ***D18.1.1 Consolidated Meteorology Requirements***, a first architecture of the V-GISC software called Data Communication Infrastructure (DCI) is presented using a component view. This is a conceptual view detailing the V-GISC functionalities and might not reflect the final implementation.

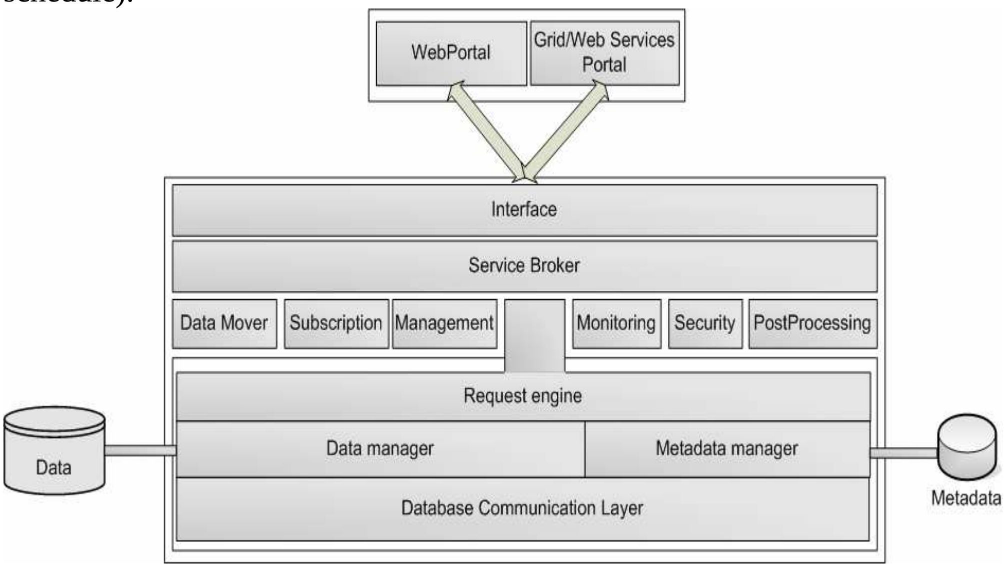


2. **DCI Architecture**

In order to create the virtual database, a DCI node is installed on each partner site. DCI nodes are interfaced with local legacy databases and are linked with the other nodes through a dedicated secure communication channel called the Database Communication Layer (DCL).

A global catalogue describing the data accessible through the DCI is hosted by all the DCI nodes and is constantly synchronized through the DCL.

A Web Portal gives access to the catalogue and let users discover, select and retrieve datasets. A Grid/Web Service Portal is also available for batch clients. Users can also subscribe to datasets that will be delivered according to dissemination policies (e.g. as soon as the data is available, or on a given schedule).



3. **DCI node component view**

The following components are part of the DCI node:

1 Grid Infrastructure Components:

1.1 Web Portal. Using the portal, users can browse or search the catalogue, select datasets and either subscribe to them for later dissemination or download them immediately. Through this interface, an operator and an administrator have access to all monitoring and management operations provided by the DCI.

1.2 Grid/Web Services Portal. This portal provides a Web/Grid Service access to external users mainly for batch purposes. It provides the same services as the Web portal (catalogue browsing, datasets retrievals and subscriptions, DCI management, DCI monitoring, etc).

1.3 DCI Node Interface. This is the user's entry point to the DCI. It uses either Web/Grid services, java RMI or a bespoke protocol.

1.4 Service Broker. This is the controller of the DCI node. It receives queries from the Interface layer and transforms them into a series of calls to the different components. For instance, to serve a user who wants to retrieve a dataset, the Service broker authenticates and authorizes the user calling the security component. It submits the request to the database layer. If necessary the post processing service is called to assemble data from several sources or prepare the data as asked by the user. The data mover service is then called to send the data to the user.

1.5 Subscription Component. This component implements a scheduler in order to support user subscription and data dissemination policies. It facilitates management of the user's subscription preferences.

1.6 Data Mover. This component is responsible for efficient data transports between DCI node and client and between the DCI nodes. Several transport protocols like FTP, HTTP, GRID FTP, etc could be implemented.

2 Distributed Data Access Components:

The virtual database layer is split in four essential components:

2.1 Request Engine. This component will handle the request expressed into a unified request language to access the meteorological databases. The Request Engine will parse and validate requests before passing it to the Metadata Manager.

2.2 Metadata Manager. This is the component managing the catalogue. The catalogue is a database containing information about what data are available and where they are located in the V-GISC. Users should have access to the same catalogue from whichever DCI node they connect to, therefore, each node of the DCI will have copy of the whole catalogue.Currently, each of the partners have their metadata catalogue as schema of relational databases or as index of flat files, or simply built-in the file names. The Metadata Manager is accessed to locate the queried data and passes the request to the Data Manager. The Metadata Manager also receives catalogue updates and is synchronized with the Metadata Managers of the other nodes in order to maintain a unique global catalogue.

2.3 **Data Manager.** This component interfaces the local databases. Requests expressed in the unified request languages will be translated to local request languages. The Data Manager manages a local cache in order to improve the performance of the most popular datasets extractions.

2.4 **Database Communication Layer (DCL).** This component maintains a constant connection between the DCI nodes in order to exchange all the synchronization information between the nodes (catalogue, virtual organisation updates, etc).

3 Virtual Organization Components:

3.1 **Security Component.** This component is responsible for the security services of the DCI node. It authenticates all the incoming users and DCI nodes. The authentication will be based on a standard PKI with generation of certificates delivered by a Certificate Authority (CA). It also authorizes the users to only perform operations appropriate to their access credentials and the data access policy. The security component maintains an audit of all activities and transactions for billing and non-repudiation purposes.

3.2 **Management Component.** This component provides the interfaces to manage the DCI. It facilitates management of users, databases and the catalogue.

3.3 **Monitoring Component.** This component provides the monitoring services of the DCI. It allows operators to check that data and metadata acquisition are on schedule, to supervise the state of the different DCI nodes, monitor user data transfers and interrupt, delay or promote data transfers as appropriate.

4 Ontology Component

4.1 **Metadata Manager.** This is the component managing the catalogue. The partners of the V-GISC project have decided that the common catalogue of metadata will be represented using the *WMO core metadata* standard, a standard based on the ISO-19000 series of standards used for geo-referenced data, in particular the ISO-19115 standard. The WMO core metadata is an XML based standard. Currently, each of the partners have their metadata catalogue as schema of relational databases or as index of flat files, or simply built-in the file names. An Ontology will be built in order to define the catalogue structure.

4.2 **Request Engine.** This component will handle the request expressed into a unified request language to access the meteorological databases. An Ontology will be built to define the structure of the query language.

5 Service Analysis Components

5.1 Post Processing Component. Some value-added processing may need to be applied to the datasets to deliver them as asked by the user. For example if the datasets are retrieved from different DCI nodes, they have to be aggregated and delivered as data single entity. Other post processing operations like interpolations, resolution transformations or plot generation could also be applied to the data. This component may implement some or all of these processes.

2 MONTH 12 DEMONSTRATOR

2.1 Overview

The DCI has to be built to federate all the partner's data repositories. Three main challenges have to be solved in order to build the DCI:

- ***Implement a Virtual Database providing the following services***:
  - Create a unified view of all the shared datasets through a distributed catalogue.
  - Define a metadata format containing information to locate and identify the data, to describe the data access policy and to describe the available meteorological data for discovery.
  - Maintain the distributed catalogue amongst the partners using synchronization mechanisms
  - Give access to the legacy meteorological databases
  - Implement data replication and cache mechanisms
  - Preserve the data integrity

- ***Implement Data Access Services:***
  - Collection and dissemination services that supports various efficient and reliable transport mechanism
  - Quality of Service (QoS): Traffic prioritization, Queuing mechanisms
  - Discovery service by browsing a hierarchical catalogue or using a keyword search engine
  - Interactive interface authorizing humans to easily access the data
  - Batch interface authorizing programs to easily access the data

- ***Implement a Virtual Organization:***
  - A set of necessary security services to access the V-GISC (single sign-on authentication, authorization, audit, etc)
  - V-GISC management (users, data policies, etc)
  - V-GISC monitoring and control (users, transfers, V-GISC infrastructure, etc)

2.2 Demonstrator Objectives

The aim of the demonstrator is to validate that V-GISC can be built on a distributed and loosely coupled Grid architecture. Grid technologies will be used to offer external interfaces to the V-GISC and to federate the partner's data repositories.

The main objectives of the demonstrator are the following:

A. **Build the virtual database foundations**

A trivial catalogue presenting a unified view of a selection of datasets will be available on each DCI node.

Catalogue synchronization mechanisms will be explored in order to define a final strategy for the V-GISC. The DCI nodes will be interconnected to exchange synchronization information and maintain a unified catalogue.

For the demonstrator, the connectivity between at least 3 partners will be developed. Access to at least one legacy database will be implemented, while the other nodes will hold sample data in a database local to the node. Only a small subset of the data available in the legacy database will be described in the catalogue.

Web services or Grid technologies such as OGSA-DAI will be used to build the interface to the databases. This will demonstrate how legacy databases can be integrated within the virtual database.

B. Implement the authentication service of the VO

The authentication service (AuthN) will be developed within the demonstrator and it will deliver single sign-on credentials to users. The AuthN will be based on the Public Key Infrastructure (PKI). This will demonstrate how users authenticated by any node can be given access to other nodes.

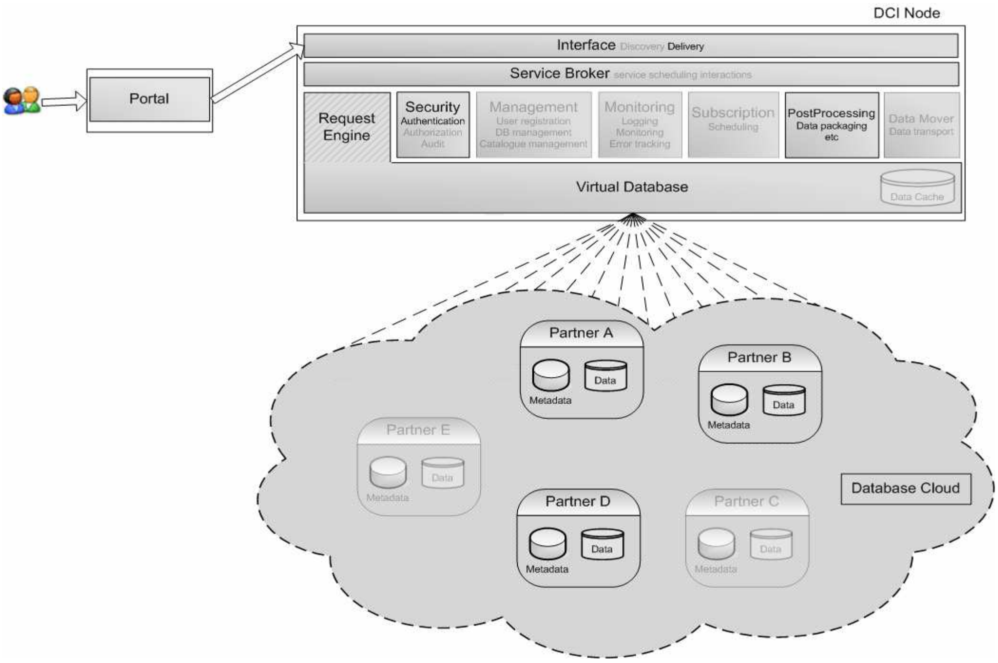
Each partner will be able to register users to the VGISC. A registration authority will be implemented as a DCI module to provide the user's registration facilities.

For the demonstrator, a trivial authorization service (AuthZ) will be implemented which will grant access to data to any authenticated user.

C. Implement part of the Access services

A portal providing a basic access to the virtual database functionalities will be built. This portal will provide an interactive access using web technologies and a batch access using Grid technologies. This will demonstrate that programs and humans can access the virtual database service. It will also demonstrate that the Virtual database service can be integrated in a wider Grid. A data transport mechanism will be developed to exchange data and information between the V-GISC nodes. Trivial data transfer mechanisms will be used between nodes and users.

The picture below highlights the functionalities that will be demonstrated



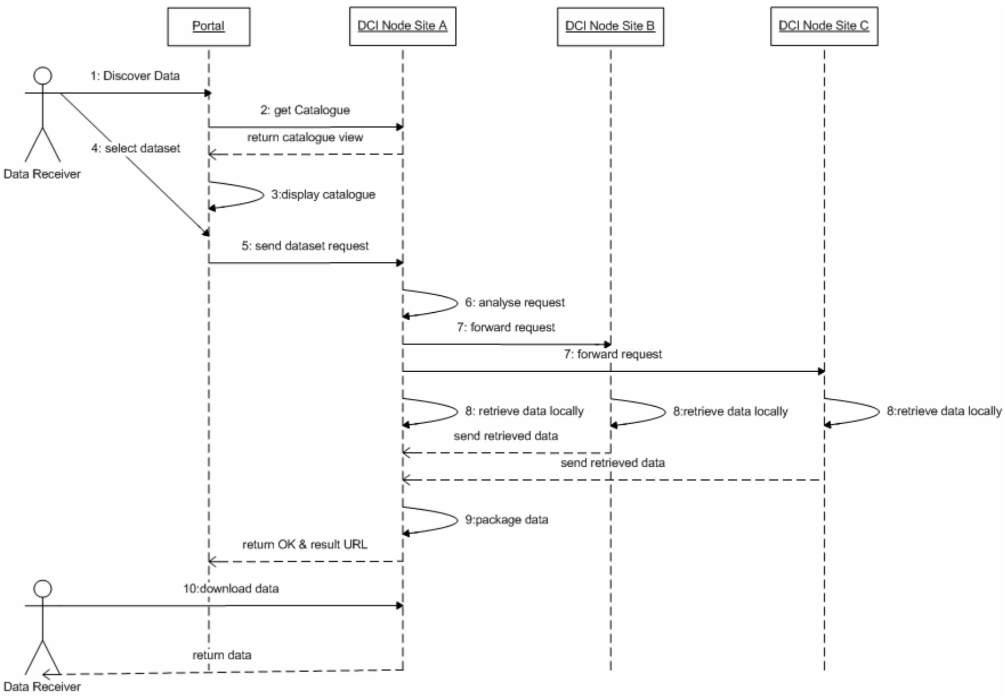
4. **Demonstrator Functionalities**

2.3 Demonstrator Scenarios

The diagrams below summarize the two scenarios that will be demonstrated.

2.3.1 Scenario A: Retrieve real time data.

The user browses the catalogue, discovers and selects data located at three DCI nodes. This will demonstrate how to retrieve and download data hosted by different DCI nodes

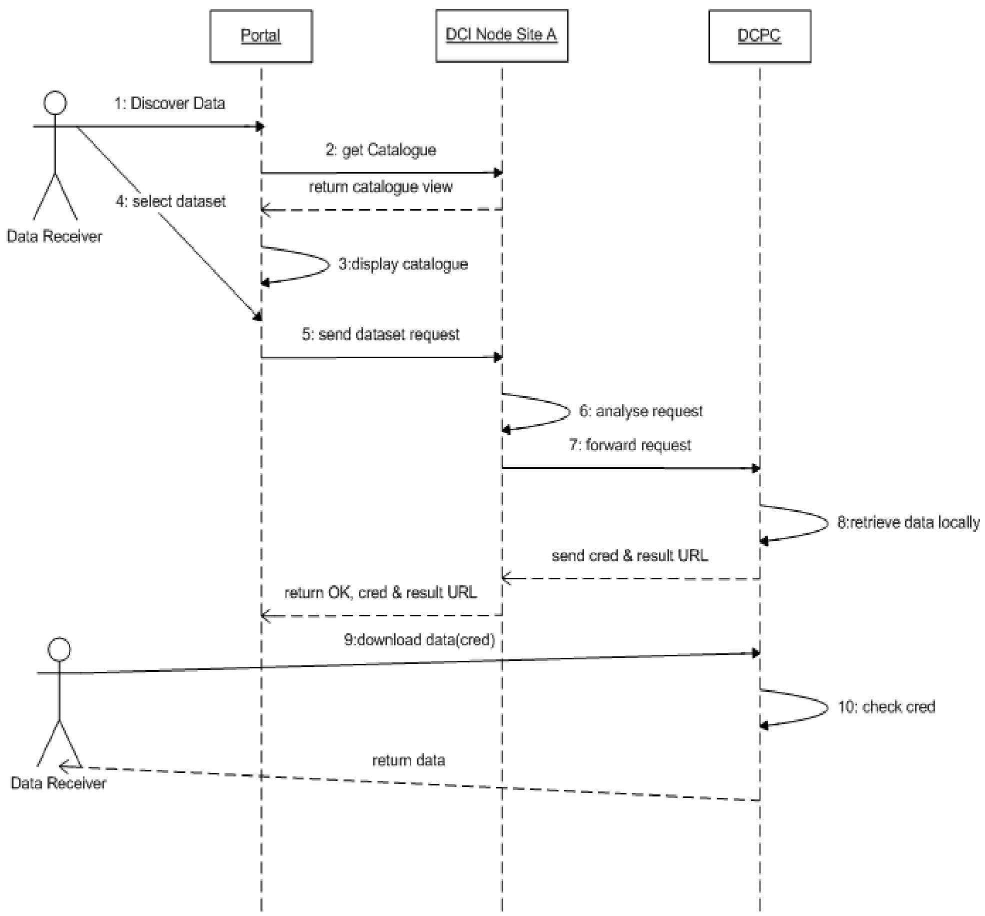


5. **Retrieve real-time data Scenario**

1. **Discover Data**. A user browses the catalogue. The Portal gets the catalogue (**2**) from the DCI node A and displays it (**3**).
4. **Select Dataset**. The user selects several datasets he or she wants to retrieve. Once the user is authenticated and authorized, a request representing the select data is built and passed to the DCI Node A (**5**)
6. **Analyse Request**. The request is validated by the Request Engine of the DCI node A. The Metadata Manager is consulted in order to locate the data.
7. **Forward Request**. The request is despatched to Data Managers of the DCI nodes A, B and C.
8. **Retrieve Data Locally.** The data is retrieved locally by the Data Manager of each DCI node and sent to the node that received the original request.
9. **Package Data.** The Data is received on node A and assembled.
10. **Download Data**. The user can now click on the link and download the retrieved data.

2.3.2 Scenario B: Retrieve Internal DCPC data.

The user browses the catalogue and discovers a dataset hosted by an internal DCPC . Here is demonstrated how the V-GISC can access data from an internal DCPC.



6. Retrieve internal DCPC data Scenario

1. Discover Data. A user browses the catalogue. The Portal gets the catalogue (**2**) from the DCI node A and displays it (**3**).

4. Select Dataset. The user selects several datasets he or she wants to retrieve. Once the user is authenticated and authorized, a request representing the select data is built and passed to the DCI Node A (**5**)

6. Analyse Request. The request is validated by the Request Engine of the DCI node A. The Metadata Manager is consulted in order to locate the data. The request is forwarded (**7**) to the DCPC hosting the data.

8. Retrieve Data. The data is retrieved and prepared locally at the DCPC. Once done a URL containing a credential (token valid for a short period of time) is sent back to the user through the DCI node A.

9. Download Data. The user clicks on this URL to access the data. The credential is checked and if valid (**10**), the user can download the data.

2.4 Capabilities

The demonstrator will deliver the following capabilities:

- Single sign-on authentication based on PKI (Certificate Authority). Users presenting a valid X509 certificates are authenticated from any portal.
- Trivial authorization. Users authenticated are authorized to retrieve any kind of data presented.
- Registration Authority. The deployed CA will also provide a Registration Authority to each partner (RA). Each partner will be able to register its users.
- Interconnect the DCI nodes to form a virtual database. A trivial implementation of a serverless network will be implemented.
- Build a simple catalogue synchronized on each DCI node.
- Discover data by browsing a catalogue.
- Retrieve dataset composed by data hosted on different DCI nodes.
- Partial access to the legacy databases using Grid/Web services.
- Provide a batch interface using Grid/Web services.
- Provide an interactive interface using a Web Browser.

2.5 Assumption, dependencies and risks

The main risks encountered are due to the moving and fairly unstable Grid middleware landscape. All OGSA compliant Grid middleware implementations are currently in transition from the OGSI standard to the new WSRF standard. OGSI and WSRF are derived from completely different models, thus any components developed using OGSI-derived middleware will have to be redesigned and redeveloped for WSRF. WSRF compliant middleware such as Globus Toolkit 4, OGSA-DAI WSRF or gLite will not be available before summer 2005 and cannot yet be used to implement the V-GISC demonstrator.

Moreover the study of Grid technologies such as GRIA, Globus Toolkit 3 and Data Grid middleware such as OGSA-DAI, has showed that for the moment these technologies cannot fulfill the requirements of the V-GISC synchronization layer (DCL). The DCL is the core of the virtual database and provides synchronization mechanisms to maintain a unified catalogue amongst the partners. It has to be robust, secure, and reliable and has to provide very good performances in term of response time and data transfers.

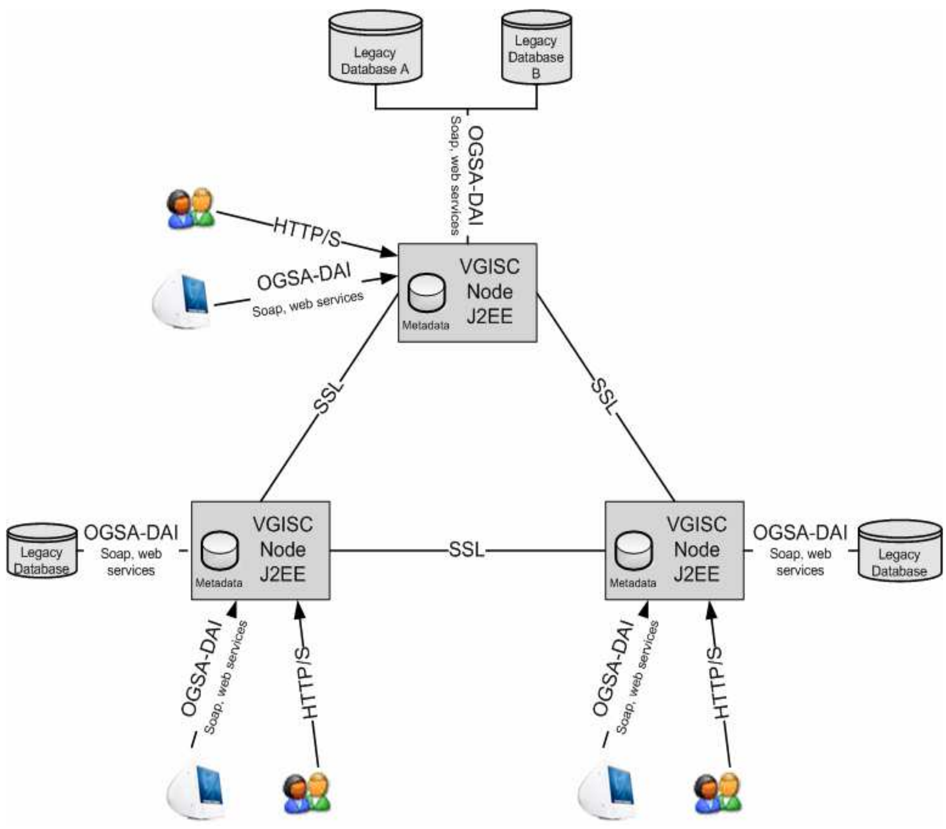
The DCL will be designed using a loosely coupled Grid-like architecture. It wil be based on J2EE components from the ECAccess framework developed by ECMWF that offers remote access to ECMWF computing and archiving facilities. The ECAccess security and transport components will be used to develop the DCL but it will be done in such a way that it will be possible to replace these components with Grid components as they become ready for operations.

Then where appropriate Grid technologies will be used to access legacy meteorological databases (using Web Services or OGSA-DAI). The Data Manager will use OGSA-DAI or Web Services to connect to the local/legacy database. Grid technology will be also used to provide batch interfaces to the V-GISC.

Furthermore, in parallel with the implementation of the demonstrator, the project team will track the development of the WSRF compliant middleware and, where possible, identify a migration path to adopt GRID technologies for the DCL.

A DCL based on OGSA-DAI as a communication layer will be evaluated.

The diagram below describes the demonstrator architecture.



7. Demonstrator Architecture Overview

2.6 Technology requirements

The technology requirements are summarized below. Consult the document D18.1.1 Consolidated Meteorology Requirements to have the complete and detailed list of requirements. The requirements in ***bold italic*** are the ones valid for the demonstrator.

2.6.1 Basic Grid Infrastructure Requirements

- **Provide an infrastructure across the 5 partners as basis for higher level services and capable of supporting the wide variety and larges volumes of data**
- Provide interfaces to achieve interoperability with standards and protocols used by other FWIS actors (GISC, DCPC)
- Provide an extendable and scalable interface able to accept new partners
- Provide Quality of Service (QoS): Traffic prioritization, request cost evaluation, queuing system
- Provide resources management and scheduling service
- ***Provide robust and efficient transport for node-to-node and node-to-client data exchange***
- Provide mechanism to transport very large data volumes
- Support web services
- ***Provide secure connections between the V-GISC nodes***
    - ***Send inter-nodes commands securely***
    - Metadata, data integrity
- To offer functionality for subscribing to datasets
    - Receive them according to a dissemination policy

2.6.2 Distributed Data Access Requirements

- ***Provide functionalities to search for and find datasets of interest***
    - ***Human to formulate queries directly to catalogue (interactive access)***
    - Machine-to-machine queries (batch access)
- ***Provide the unified view of all the shared datasets through a distributed catalogue***
- ***Provide reliable and efficient synchronization mechanisms to maintain the distributed catalogue amongst the partner's catalogue***
- Provide mechanism to replicate and cache the data across the V-GISC nodes
- Provide mechanism for a node to quickly announce to the other nodes the availability of some special datasets (storm warnings, etc).
- ***Provide an Interface with existing meteorological databases (flat file repositories, RDBMS database, off-line archives, XML DB)***
- ***Efficient and secure data transfer***
- Provide automated dissemination of all observed data and products, both real-time and non real-time (Push model)
    - Scheduling system
    - Traffic prioritization
- ***Provide the ability to easily add new databases within the VGISC***

- Provide mechanism like queuing systems, request cost estimation in order to control how the users can use the system and always offer the same quality of service (QoS)
- Provide database administration in such a way that each partner will continue to manage his own databases.

2.6.3 Virtual Organization Requirements

- Provide a set of security services allowing users to securely access the datasets
    - ***Authenticate users and servers of the V-GISC***
    - Authorize users
    - Implement a global access control policy managed by each partner and integrated into their existing security policies
- V-GISC management (users, data policies, etc)
- V-GISC monitoring and control (users, transfers, V-GISC infrastructure, etc)

2.6.4 Ontology Requirements

- Build an ontology that captures, for each partners:
    - ***What metadata are available***
    - ***What query language are used to access the local data repositories***
    - What data policies are in place
- Add to this ontology the description of the WMO core metadata
- Use this ontology to:
    - Identify what extensions to the WMO core metadata are needed in order to fulfil the V-GISC requirements
    - Define a unify way to query data from the partners (unified request language)
    - Define a way to describe all possible data policy
    - Implement mapping tools between
        - local metadata and extended WMO core metadata
        - local query language and unified query language
    - Implement the catalogue (database schemas...)

Please note that a complete ontology is not required for implementing the demonstrator, as it will be based on a simplified catalogue.

2.6.5 Knowledge Discovery Requirements

None for the demonstrator month 12.

2.6.6 Workflow Requirements

None for the demonstrator month 12.

2.6.7 Integration of analysis services requirements

None for the demonstrator month 12.

3 GLOSSARY

Term	Definition
WMO	World Meteorological Organization
FWIS	Future WMO Information System
GTS	Global Telecommunication System
RA-VI	One of WMO region
GISC	Global information System
V-GISC	Virtual GISC
DCPC	Data Collection and Production Centre
External DCPC	DCPC outside the V-GISC virtual organization
Internal DCPC	DCPC integrated within the V-GISC virtual organization
NC	National Centre
DCI	Data Communication Infrastructure
DCL	Database Communication Layer
AuthN	Authentication Service
AuthZ	Authorization Service
OGSA	Open Grid Service Architecture
OGSI	Open Grid Service Infrastructure
WSRF	Web Service Resource Framework
J2EE	Java 2 Platform, Entreprise Edition
OGSA-DAI	Open Grid Services Architecture Data Access and Integration
GT3	Globus Toolkit 3
GT4	Globus Toolkit 4
JGroups	A toolkit for reliable multicast connections
gLite	Ligtweight Middleware for Grid Computing (EGEE project)