ON-LINE DISTRIBUTION OF DIGITAL TOPOGRAPHIC DATA

Michel Gilbert

Natural Resources Canada, Centre for Topographic Information

mgilbert@rncan.gc.ca

Commission IV, WG IV/2

KEY WORDS: Topographic data, e-commerce, geographic information system, distribution of geospatial data, web mapping

ABSTRACT:

One of the main activities of the Centre for Topographic Information in Sherbrooke (CTIS) is distributing digital topographic data (DTD) of the Canadian landmass. For a number of years, customers have been able to obtain DTD by contacting the CTIS Customer Support Group. The team has established a procedure for processing orders and delivering products to customers. CTIS has used new Internet technologies to develop a system that enables users to search, consult, order, pay and download a variety of digital products quickly, efficiently, and fully automatically 24 hours a day, 7 days a week.

Users are able to access the data distribution system using their Internet browsers. The interface consists of a series of HTML pages that guides the customer in selecting the data that correspond to his needs. The user's completed request is transmitted to a transaction server, which extracts, converts, and delivers the data. The extracted data may come from a variety of sources, including spatial databases and files. Moreover, they can be converted into different transfer formats, and different coordinate systems before being delivered to the user's individual directory on the CTIS FTP site. The system has been deployed on a 3-tier architecture that ensures autonomy between the various system components, secure access to data sources, minimal processing on the client side, and easy system expandability in response to demand.

In conclusion, CTIS's future plans with respect to the distribution of topographic data will be presented. This discussion will include new formats and products that will be integrated into the current site, as well as new technologies that bring the development towards services to display and access geospatial information.

RÉSUMÉ:

Une des principales activités du Centre d'information topographique de Sherbrooke (CITS) consiste à distribuer des données topographiques numériques (DTN) du territoire canadien. Depuis plusieurs années, les clients peuvent se procurer des DTN en contactant l'équipe responsable du service à la clientèle du CITS. Cette équipe a mis en place une procédure pour assurer le traitement de la commande et la livraison des produits aux clients. Profitant des possibilités offertes des nouvelles technologies associées à Internet, le CITS a développé un système qui permet aux utilisateurs de rechercher, consulter, commander, payer et télécharger les différents produits numériques à distance de façon plus rapide et efficace et automatique 24 heures par jour, 7 jours par semaine.

Ce nouveau système de distribution des données est accessible à partir de navigateur Internet de l'utilisateur. L'interface entre le fournisseur et l'utilisateur consiste en une série de pages html permettant de guider le client dans la sélection des données qui répondent à ses besoins. Une fois complétée, sa requête est transmise à un serveur de transactions qui effectue l'extraction, la conversion et la livraison des données. L'extraction des données peut provenir de différentes sources de données incluant des fichiers et des bases de données spatiales et les données extraites peuvent être converties dans les différents formats de transfert et dans différents systèmes de coordonnées. La livraison des données s'effectue sur le site FTP du CITS dans un répertoire réservé à l'utilisateur. Le déploiement du système est basé sur une architecture trois tiers. Ce déploiement assure une indépendance entre les différentes composantes du système, une sécurité d'accès aux sources de données, une charge de traitement minimale du côté client et une extension facile du système en fonction de la demande.

Pour conclure, les plans futurs du CIT-S qui concernent la distribution des données topographiques seront présentés. Ce dernier volet abordera les nouveaux formats et les nouveaux produits qui seront éventuellement intégrés au site actuel, ainsi que le développement de services d'affichage et d'accès de l'information géospatiale basés sur les nouvelles technologies.

1. INTRODUCTION

The Centre for Topographic Information in Sherbrooke (CTIS) is responsible for the distribution of digital topographic data (DTD) of the Canadian landmass that it has produced. The increasing use of the Internet, the e-commerce, the use of databases to store geospatial data, and the recent development in Web mapping technologies have contributed to leading us to review our traditional ways of distributing our DTD products. Taking into account this new environment, the new CTIS data distribution system enables users to access geospatial information more quickly, safely and efficiently.

The CTIS online data distribution system has two components. The first is geared to provide continuous DTD access to customers on a subscription basis, while the second enables users to purchase DTD using e-commerce. The section below entitled "Online Purchasing and Subscriber System" deals with the various components and features of this system. The paper ends with a section on Data Access Services that describes CTIS's future plans with respect to the distribution of topographic data that focus on the access to the data using mapping services (Web Mapping Server) and feature services (Web Feature Server) based on the implementation specifications of the Open GIS Consortium (OGC).

2. PURCHASING AND SUBSCRIBER SYSTEM DESCRIPTION

The system is designed to support Online Purchasing and Subscriber data order and delivery. Online Purchasing is designed for low data volume consumers of CTIS. This mode enables users to buy DTD products via e-commerce, using a credit card or another mode of payment. Basically it's a payment per transaction approach, including lifetime data usage rights.

The Subscriber section is designed to support DTD data order and delivery for users who have previously acquired a subscription license. This license provides broader and more economical access to DTD products over a predefined region. Data usage rights, however, are restricted to the life of the subscription. The Subscriber section requires authorization (login) and licensee validation (region); no payment task is involved here since a subscription is paid only once a year (through an upfront payment). The rest of the paper will focus on system description. There will be no further reference to the Subscriber component since both subsystems are very similar.

The system gives access to various CTIS products. The user can order any of the available CTIS Digital Topographic Data (DTD), namely the National Topographic Data Base (NTDB), the Canadian Digital Elevation Data (CDED), the Updated Road Network (URN), Administrative Boundaries, and CANIMAGE. All characteristics of our products are included in the online distribution system in terms of content, data formats, metadata, and coordinate systems.

2.1 Framework Architecture

The system was developed in cooperation with the private sector. The contracting firm participated in system design and setting the look and feel of the Web site, while ensuring that Treasury Board Web interface requirements were complied with.

The firm was also involved in the Java programming required to implement the different functionalities of the Web site. CTIS own contribution to this new system and its Web interface focused mainly on providing the content and the data conversion environment required for vector data format translation as well as the Webmaster, direct customer support, and system maintenance.

The system was developed entirely in Java programming language based on a Java framework developed by the private sector. The framework gives CTIS common tools for software development and system architecture that required communication between systems and software components (database, Web clients, and servers). The next diagram (Figure 1) illustrates the major framework components.

2.2 Online Purchasing Web Site Architecture

The user accesses the CTIS Web site through its own Internet browser (NetScape, Internet Explorer). The application is a thin client, accessed from HTTP and HTTPS communication protocols. The system has been deployed using a 3-tier architecture that ensures autonomy between the various system components, secure access to data sources, minimal client processing, and easy system expandability in response to demand.

The presentation level (1st tier) presents information, receives requests, and controls the user interface. The software applications used to communicate with users at this level are the Web server (Apache) and the servlet runner (Tomcat). Java servlets communicate with applications services developed as Enterprise Java Beans (EJB) components using the Internet Inter-ORB Protocol (IIOP). Servlets are Java classes used for user requests and responses.

The logic level (2nd tier) implements the business rules and is available to the presentation level. This level constitutes the central key of the system and it protects the data from direct user access and it protects the presentation level for data model changes. On the application server side, queries received from Java servlets are processed by EJB components, which access different databases at the data level through JDBC (Java DataBase Connectivity).

The data level (3rd tier) is responsible for data storage, which includes two major databases. One contains information related to our products and clients; the other contains the geospatial data available for distribution.

From a data-flow perspective (Figure 2), the user accesses the CTIS Web server using its own Internet browser. Through the use of Java servlets and EJB components, the application server interacts with CTIS clients and products metadata database. The user completes an order session by submitting the transaction. Once the data order is ready for processing, the data delivery system takes over. This subsystem extracts the required Digital Topographic Data (DTD) from the geospatial database or disks and processes them according to user requirements and products selected. The resulting data are then copied to CTIS FTP site for the user to download. Processing is generally completed within minutes, but could be longer depending on the number of files ordered. The user is advised via email that processing has been completed.

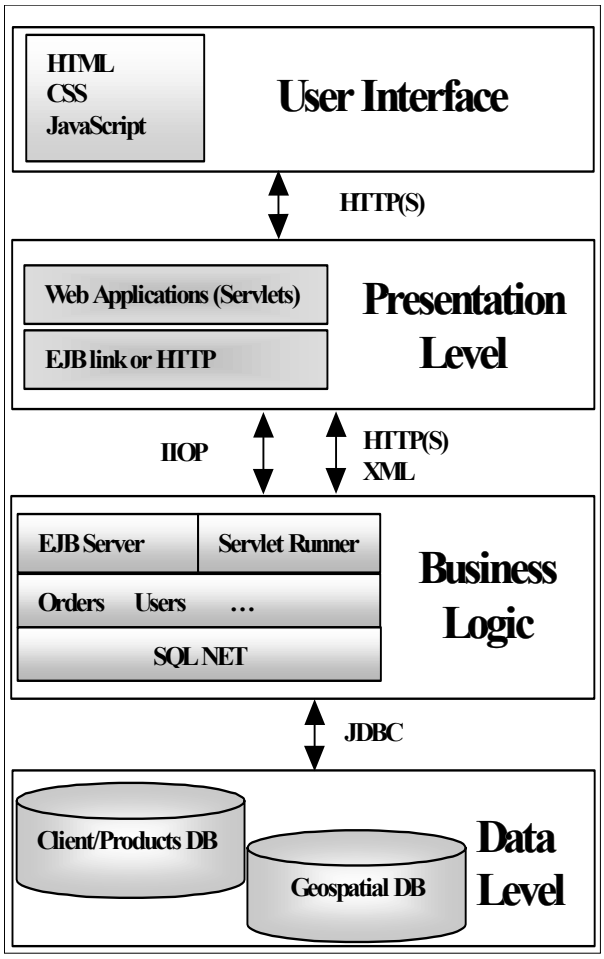

Figure 1. 3-tier Architecture Diagram

From a data-flow perspective (Figure 2), the user accesses the CTIS Web server using its own Internet browser. Through the use of Java servlets and EJB components, the application server interacts with CTIS clients and products metadata database. The user completes an order session by submitting the transaction. Once the data order is ready for processing, the data delivery system takes over. This subsystem extracts the required Digital Topographic Data (DTD) from the geospatial database or disks and processes them according to user requirements and products selected. The resulting data are then copied to CTIS FTP site for the user to download. Processing is generally completed within minutes, but could be longer depending on the number of files ordered. The user is advised via email that processing has been completed.

2.3 Data Delivery Service

Data Delivery includes extracting the geospatial data from the database or disks, converting the data into the required GIS format, and transferring the generated files to the user's FTP directory as shown. The Data Delivery Service first receives an order ID number. It then looks for it and extracts the corresponding information from the clients and products metadata database and prepares the data conversion.

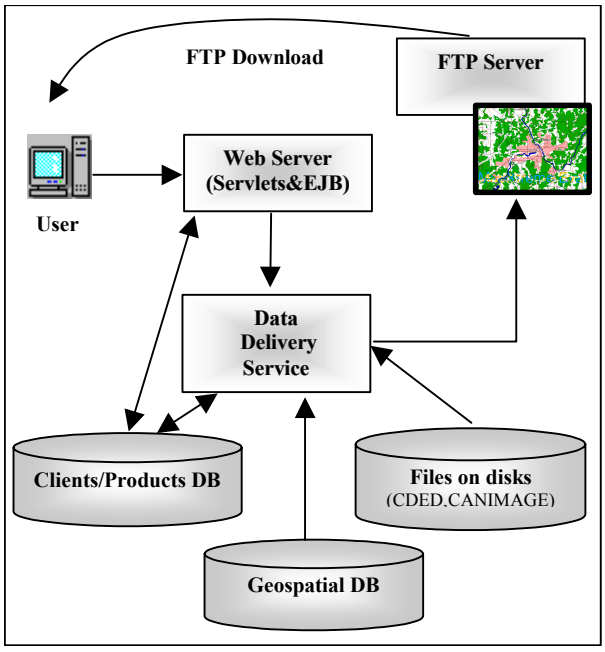

Figure 2. Data Flow Overview

2.4 Data Delivery Service

Data Delivery includes extracting the geospatial data from the database or disks, converting the data into the required GIS format, and transferring the generated files to the user's FTP directory as shown. The Data Delivery Service first receives an order ID number. It then looks for it and extracts the corresponding information from the clients and products metadata database and prepares the data conversion.

A transaction command (one order item) is then sent to the conversion process queue, which looks for an available conversion process to send the transaction command to. The first available conversion process will then perform the DTD conversion and the resulting data files will be created. The FME (Feature Manipulation Engine) software is used to convert vector spatial data. This subsystem can easily be expanded by adding FME licenses on additional CPUs. For the CANIMAGE product, PCI software is used to create and enhance the ortho-image.

The transaction services are controlled by a queue manager that handles how processing is shared and distributed among the available computer resources. Once data conversion is completed, the Data Delivery Service sends the user a data-delivery confirmation by e-mail.

2.5 Web Site Components

The search engine, shopping cart, identification forms, payment, and data translation are the system's five major components.

The search component allows users to search for products that are available. A user can search for a specific product using textual criteria or by browsing graphical indexes of regions of Canada. The textual criteria that can be specified are the National Topographic System (NTS) map sheet number and the date (new since). The user can use the indexes to build his or her own list of data sets by clicking directly on the map. The

search component uses the CTIS clients and products metadata database. The delivery service accesses the database to obtain the list of available products that correspond to the user's search criteria. It can also provide the metadata for the items found.

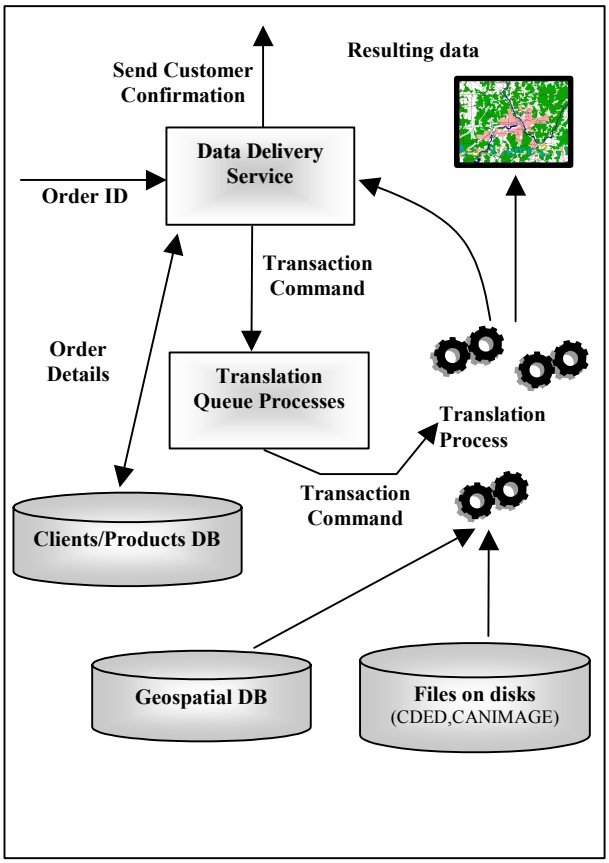

Figure 3. Data Delivery Service

The shopping cart allows users to build a DTD order, keeping track of the items selected from the different searches carried out. Each item in the cart includes the product identifier, type, version, edition, options (data transfer format, themes, etc), and price. The cart has a view function that enables users to display the geospatial data as images for most of products. Shopping-cart features also enable the user to remove items, modify an item's options, view product metadata, and see the detailed price. The cart can be saved anytime for checkout at a later date.

The identification component provides the means for gathering and recording the customer identification information required to acquire the topographic data. This component also identifies and validates users who already have a user name and password, then extracts the information needed from the CTIS clients and products metadata database to complete the purchase and deliver the data.

Five different modes of payments can be used: credit card, cheque, customer and government accounts, and other. The payment component uses a 128-bit Secure Socket Layer (SSL) and a VeriSign certificate to secure transactions. In addition, credit-card transactions are handled by a specialized electronic payment provider. The provider takes charge of the payment, performs a real-time credit validation, and serves as the link with government financial services to acknowledge the transaction. The credit-card number is never seen nor stored on the CTIS side. Payment by credit card allows for a fully automated data distribution system, while minimal operator intervention is required with the other types of payment, for which the process cannot be fully automated.

Once the credit-card validation provider acknowledges authorization of payment by sending an authorization number, the purchase order is recorded in the database. The confirmation signals the Data Delivery Service to process the purchase order. Refer to the previous section for a complete description of this service.

Credit-card authorization is initiated when the customer, connected to CTIS Web site, requests Online Purchasing. At payment time, the customer is redirected to an Internet Secure (third party) Web service via HTTPS. Internet Secure interacts with the bank to commit the payment and get an authorization number.

Every night, the departmental financial system downloads the daily transactions recorded in our system by FTP. Since the bank sends a daily report of the transactions to the department financial system every day, financial information can be reconciled and corrected, if needed.

3. DATA ACCESS SERVICES

Implementing the online purchasing system has enabled CTIS to automate data sales and distribution. This system has made it possible to respond to the needs of traditional users of Geographical Information Systems (GIS) and geospatial data. In order to broaden our customer base and better serve users, CTIS is now turning to emerging technologies that support standardized interoperable solutions that allow access to Web-based, wireless access to geospatial data.

3.1 Data Access for Visualization

As a first initiative to make geomatics accessible to a broader segment of users, CTIS launched Toporama as a new product in fall 1999. Toporama (http://toporama.cits.rncan.gc.ca) is a Web site that provides access to free topographic images of Canada. It is a raster representation of part of the contents of CTIS's NTDB and ortho-rectified Landsat 7 products. In addition, Toporama offers simple navigation and localization tools to help and guide users through the images.

In light of recent developments for accessing geospatial data, CTIS initiated the establishment of Web Mapping applications to replace the first version of Toporama. In fact, Web Mapping Technology is changing the rules for spatial technology applications and opening new opportunities. Web Mapping is an innovative Web-based system that allows users to define map compositions and deploy them on the Internet. More people are using the Web to get geospatial information. As the Web Map Server base grows, users have an easier time getting and making maps via the Web. Furthermore, it enables providers of spatial information to more readily set up servers that provide maps to users. In addition, the Open GIS Consortium (OGC) has played a role in developing open interface specifications. This has impacted on the interoperability that enables network communication among server applications and access for

displaying, merging, and converting spatial information from multiple sources.

As a participant in the Canadian Geospatial Data Infrastructure (CGDI) Development Network, CTIS recently implemented a service that complies with Open GIS Consortium (OGC) Web Map Server implementation specifications. The system includes three components: the Spatial Data Warehouse, Web Map Server, and Viewer application.

The CTIS **Spatial Data Warehouse** contains data sets in vector (NTDB, URN, Boundaries), raster (Landsat 7 images), and grid (CDED) formats that correspond to our products. The Data Warehouse is a database that integrates data from more than one data source. The operational data included in the database is organized to support easy and efficient access and to allow users to discover new relationships and data patterns by navigating and mining the large volume of data. In our case, the Spatial Data Warehouse differs from our source database to allow better viewing and faster access performance.

The CTIS **Web Map Server** component provides access to the Data Warehouse. It is a Web-based, server-side application that complies with the Web Mapping Server (WMS) 1.1.1 OGC Implementation Specification, including the map cascading capability that allows customers to access multiple, distributed geospatial information data stores across the World Wide Web. The Map Server responds to WMS operation via HTTP from any compliant WMS. For example, the Map Server returns a GIF or JPEG map image for a WMS getMap operation request. The Map Server recognizes the getCapabilities, getMap, and getFeatureInfo WMS requests.

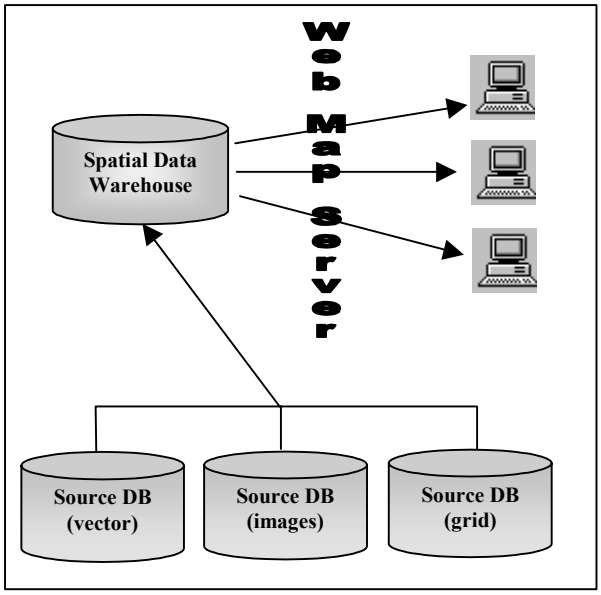

Figure 4. CTIS WMS Architecture

The **Viewer** component is a client-side application that allows users to spatially browse data warehouses served from any Web Map Server that is compliant with the Web Map Server OGC implementation specification. The Viewer can be accessed over the Web using a Web browser. The application is divided into several sections. The View section includes the image of the current map, showing the selected layers, navigation tools, and the legend. The Layer section contains the tools that allow users to interactively create their own maps by selecting data stores, themes, and layers that are available.

Web Mapping technology will help us improve access to our geospatial information. Software developers will be able to exploit the services that CTIS will provide for applications related to geoprocessing, decision support and analysis. Users will also benefit from having ready access to up-to-date geospatial data without the worry of storing and updating them. In the coming year, CTIS will provide public access to our data and applications. We will then extend services that take advantage of the extraction and transaction operations supported by Geographic Mark-up Language (GML) and Web Feature Server (WFS) OGC standards.

4. CONCLUSIONS

The new CTIS Web site is operational since May 2001. The new Web site complies with the Government On-line initiative, uses the common "Canada look and feel," and demonstrates the federal government's commitment to offering its products and services on the information highway. Moreover, it highlights the shift to Web-based commerce for every transaction component, from ordering to payment and delivery.

The online purchasing section is one of the main additions to the new Web site. It enables the Centre to sell topographic data to a wide-ranging public. The system is fully automated, from product search to data delivery, including secure credit-card transactions. Similar to the online purchasing system, the subscriber system automatically delivers topographic products ordered by users who have previously purchased a CTIS Subscription license for Digital Topographic Information.

In the years to come, CTIS will improve its spatial data distribution system by providing new search tools, new products, and new data and metadata formats. Interoperability is becoming a requirement to enable access to nationwide data services. As a national geospatial data custodian, CTIS will contribute to the Canadian Geospatial Data Infrastructure development network by implementing Web Map Service and eventually services to access the data that are compliant with international standard.

5. REFERENCES

CubeWerx, 2001. *CubeStor for Oracle*, User Manual, version 2.10. Canada, September 20, 2001.

CGDI Architecture Working Group, 2001. *Architecture Description, Canadian Geospatial Data Infrastructure*, January 19, 2001.

McKee, L., 2001. *Web Mapping Guide – Technology Trends*, Open GIS Consortium Inc. http://www.geoplace.com/gr/webmapping/technology.asp (accessed 1 March 2002).

Open GIS Consortium Inc., 2001. *Web Map Service Implementation Specification*, Open GIS Consortium Inc., Version 1.1.0, 2001-06-21.

Simoneau, B., 2001. *Online Distribution of Digital Topographic Data*. Digital Earth 2001 Conference, Fredericton, New Brunswick, June 2001.