TP 13731

Port of Montreal Extranet Design

Summary Report

Prepared for
Transportation Development Centre
of
Transport Canada

by
Integration Project Team

December 2000

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by
R. Leblanc, N. Lavallée, D. Bélanger, et al.
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16. Abstract

Based on a solution identified in a previous study to improve the efficiency and productivity of container movement through the Port of Montreal, this report summarizes the design specifications of an Extranet for the Port community that will be used to develop and implement a full production system.

A four-step approach was used to develop and design these specifications:

Review the GE Information Services study entitled *Port Community Extranet System Validation* (TP 13531E);
Develop a list of prototype screens and validate them with nine different potential stakeholders;
Design Extranet specifications based on the screens, business workflows, and constraint highlights as discussed with the stakeholders in step two;
Review the final design with Port of Montreal IT group and obtain approval from TDC and the Steering Committee.

This summary report provides an outline of the Extranet's infrastructure, functions, database, security, and service level agreement. A detailed description of these, sufficient to develop an application and implement a functional system, can be found in the main report, TP 13715E.

This Extranet application, designed to adapt and evolve easily, is the next phase toward a fully integrated solution for container management at the Port of Montreal. It is recommended that the implementation pilot phase be executed with a limited group of carefully selected participants to fine-tune the solution for more general use.

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

GLOSSARY

ASA	Average Speed of Answer
ATT	Average Talk Time
CSM	Customer Service Manager
EDI	Electronic Data Interchange
FTP	File Transfer Protocol
GE	General Electric
HP	Hewlett Packard
HP-UX	Hewlett Packard Unix
HTTP	HyperText Transfer Protocol
IIS	Internet Information Server
IT	Information Technology
Kerberos	The authentication system of MIT's Project Athena. It is based on symmetric key cryptography.
LDAP	Light Directory Access Protocol
MS	Microsoft
OCR	Optical Character Recognition
OWO	Operations Work Order
POM	Port of Montreal
RFP	Request for Proposal
SLA	Service Level Agreement
SMTP	Simple Mail Transfer Protocol
SQL	Structured Query Language
SSL	Secure Socket Layer
TDC	Transportation Development Centre
TLS	Transport Layer Security
UNIX	A multitasking, multiuser operating system for microcomputers that was developed by AT&T and has enjoyed popularity among engineering and technical professionals
VPN	Virtual Private Network
XML	eXtensible Markup Language

1. BACKGROUND

The Transportation Development Centre (TDC) and the Port of Montreal (POM) have joined forces on an intermodal technology project designed to improve the efficiency and productivity of container movement through the Port. The current emphasis is on the terminal-truck interface, although it will later be expanded to all modes of transport. The project is part of a larger program designed to achieve fully integrated electronic document interchange among the Port's trading partners and other stakeholders through the implementation of Internet-based technology.

In this context, TDC has awarded a contract to BCE Emergis for the detailed design specifications of an Extranet for the Port of Montreal community. The Extranet solution was identified in a previous study (TP13531E) conducted by GE Information Services Canada for TDC. By taking advantage of the Internet's flexible electronic data exchange capabilities, the Extranet will enable EDI-capable Port stakeholders to communicate with non-EDI trading partners, using the Internet as a communication gateway. The Extranet system design advocates the use of open architecture and "best-of-breed" software solutions.

The specifications found in the design outline of the Port of Montreal Extranet are sufficiently detailed to be used to develop and implement a full production system.

2. SCOPE, APPROACH, AND METHODOLOGY

Two committees were created to fulfill the mandate: the Steering Committee, composed of executive personnel from the Port Authority of Montreal, the container terminals, and a logistics company, which validated the orientation of the study and helped the Project Committee to identify key players from whom to obtain information and validate the business workflow process; and the Project Committee, consisting of an expert in transportation systems technology from TDC, and two members each from POM's IT department and BCE Emergis's IT division.

A four-step approach was used to write the specifications for the Extranet:

1. Review the previous study conducted by GE Information Services Canada based on a series of interviews with various Port stakeholders and finalize the scope of the project with TDC and POM.

2. Develop a list of prototype screens for the final program and validate these screens by conducting several interviews with freight forwarders, Canada Customs, transport companies, terminals, shipping lines, and logistics companies. (A total of nine different stakeholders were consulted to validate these screens, with some stakeholders meeting up to three times.)

3. Design the Extranet itself based on the finalized screens, business workflows, and constraint highlights established with the various stakeholders during the interviews.

4. Review the final design with the Project Committee and obtain approval from TDC and the Steering Committee.

The objective of the Port of Montreal Extranet is to allow its members to improve their overall efficiency, especially in the area of gate congestion and truck-terminal interface. Key areas of improvement through implementation of the Extranet are:

1. Improved services to community members and potential end users;
2. Continuous container visibility to all members with appropriate user access;
3. Expanded community participating in the use of electronic commerce;
4. Reduced waiting times at the Terminal gate;
5. Improved and efficient communication among all members;
6. Fewer data entry errors and paperwork inaccuracies.

From a management point of view, the scope of the project as well as milestones, resources, and budget allocation were established to meet these six objectives.

The report entitled *Port of Montreal Extranet Design* (TP 13715E) comprises five sections:

1. **The Architecture section** describes the infrastructure aspects of the Extranet by presenting the various networks and components required to achieve functionality.

   It details, from a hardware and software perspective, the nature and particularities of the various components of the Extranet, and provides an estimate of the costs involved in building the Extranet according to the specifications described in the report.

2. **The Application section** describes all functions required to allow involved stakeholders (shipping lines, terminals, freight forwarders, trucking companies, and various government ministries) to exchange information related to containers. It includes descriptions of screens, information to be supplied, controls to be performed, search functions, container status, batch transactions, alerts, archiving, and reports.

   This section contains sufficiently detailed information for each function and constraint (business rule) to enable the application to be developed. The cost of developing such an application is not included in the analysis and should be provided in response to a future Request for Proposal (RFP).

3. **The Database section** describes the central database that holds and maintains all information related to containers. A detailed relational data model that comprises all objects, data elements, relations, lists of tables, and required fields, as well as a glossary of elements, are included in this section.

4. **The Security section** addresses the security design process for the Extranet. Security is a recurring process for which there is no unique or perfect solution. In this context, guidelines and recommendations are provided and a threat analysis of the Extranet is conducted to ensure security at a reasonable cost.

5. **The Operations / Service Level Agreement section** details the Service Level Agreement (SLA) Extranet community solution required by the Port of Montreal. The SLA outlines customer support services, the registration process, escalation procedures, and operating policies. It also defines the nature of the relationship between the Extranet provider and its members, including the roles and responsibilities of each of the participants (end users, super users, and the Port of Montreal).

In conclusion, the **Orientation and Future Development of the Extranet Functionality** section provides ideas on how the Extranet should evolve in the future.

Limitations and Exclusions

As agreed in determining the scope of the project, the Extranet design excludes the following:

- Preparation of partner/stakeholder “readiness”;
- Technical integration with terminal information systems, including interface required to create and send data to be imported into the central database;
- Design of interfaces/modules required to produce reports;
- Translation maps;
- Status of containers transported by rail;
- Management of partial containers.

3. RESULTS

3.1 Architecture

A successful Extranet depends on many factors ranging from technical issues to political aspects and administrative procedures. The technical factors are the most critical and also the most easily controlled aspects of the whole chain.

As illustrated in Figure 1, the infrastructure required by the Extranet includes all hardware components required to make the Extranet available, secure, auditable, and scalable. It also includes all software necessary to manage and monitor the infrastructure.

The following elements are represented in Figure 1:

- Layer 2 switch – Screened Network: **Diagram reference letter C**
- Layer 2 switch – Application Network & other internal networks: **Diagram reference letter H**
- Layer 2 switch – Management Network: **Diagram reference letter Q**
- VPN Concentrator: **Diagram reference letter R**
- Redundant Border Routers: **Diagram reference letter A**
- External Firewall: **Diagram reference letter B**
- Internal Firewall: **Diagram reference letter G**
- Firewall Console: **Diagram reference letter P**
- Active Directory Server – external: **Diagram reference letter D**
- Mail Server (smtp): **Diagram reference letter E**
- Web Servers: **Diagram reference letter F**
- Translator: **Diagram reference letter I**
- Transaction Server: **Diagram reference letter J**
- Active Directory Server – internal: **Diagram reference letter K**
- Database Servers: **Diagram reference letter L**
- Backup Server: **Diagram reference letter M**
- Monitoring Server: **Diagram reference letter N**
- Logging & Reporting Server: **Diagram reference letter O**
- Management Station(s): **Diagram reference letter S**
- Remote Management: **Diagram reference letter T**
- Ticketing System: **Diagram reference letter U**

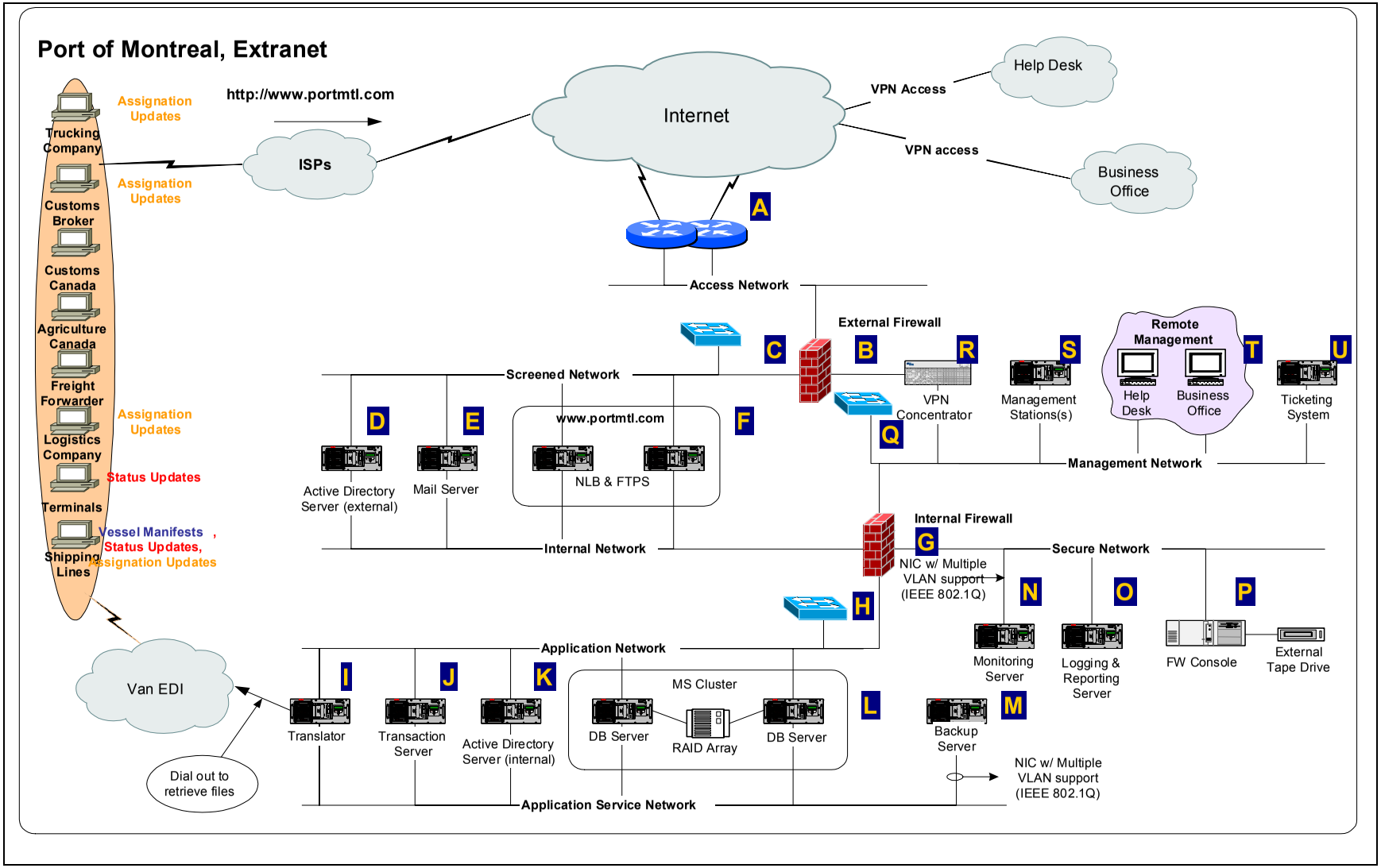

Figure 1 – Network Architecture Diagram

The infrastructure cost of the Extranet is based on the premise that all functions are implemented at the Port itself. Of course, these functions as well as others could be outsourced, thus lowering operational and equipment costs.

The Port of Montreal Extranet is designed to enable users to have real-time Internet access with up-to-date information on container status and availability. The Extranet is intended to enhance the overall productivity of the container delivery system by providing container pickup information to both terminals and truck drivers.

Service Level Requirements

- 24x7 availability and monitoring;
- 98.5% uptime;
- 8:00 to 18:00 Business Office hours;
- 24x7 Help Desk.

Sizing Requirements

The sizing requirements of the Port of Montreal Extranet hardware and equipment are based on the observed traffic of at most 1,000,000 containers transiting the Port each year.

Performance Requirements

Because of the rather small and closed community of interests in the Port of Montreal Extranet, at least in its initial stage, and because of the small amount of transactions, it is easily foreseeable that small to medium systems should suffice for the basic requirements in terms of performance.

The community of interest members and the number of users per community has initially been identified as shown in Table 1:

Table 1 – Estimated Number of Community Members

Community	Estimated number of members (max.)	Number of users (max.)	Total
Shipping Lines	12	4	48
Terminals	3	4	12
Freight Forwarders and Custom Brokers	25	4	100
Trucking Companies	25	4	100
Total	65	16	260

Infrastructure

The Extranet is a secure and highly available network, featuring the latest technology to better serve its users. Based mainly on Windows 2000 technology with an Active Directory Server for resource control and access, it offers an integrated solution for user management along with security features that may cover both the application and data levels.

The core system is an all Windows 2000 solution on Compaq hardware, offering the following advantages: ease of administration, widespread technology, and seamless integration of the different components. Cisco and Nortel equipment are used for telecommunications needs. Sun hardware and a UNIX operating system are used for firewalls and console because of their reliability. HP hardware with an HP-UX operating system using HP Open View is used for monitoring purposes.

3.2 Application

One of the most important recommendations from previous studies was to build an Extranet easily accessible through the Internet and available to each stakeholder involved in container manipulation at the Port of Montreal. This application is designed to fulfill the business requirements of the various stakeholders in the Port of Montreal community. It is the first step toward a fully integrated solution for container management at the Port of Montreal.

Several stakeholders are involved in container manipulation at the Port of Montreal:

1. Port of Montreal;
2. Shipping lines;
3. Terminals;
4. Freight forwarders and logistics companies;
5. Trucking companies;
6. Various government departments.

The main goal of the Extranet is to share information related to containers. Currently, there is no easy way for stakeholders to share information related to containers, which in most cases is transmitted by telephone or fax. Moreover, there is no commercial software on the market that can properly handle the various requirements of the stakeholders. Therefore, a customized application must be developed based on the specifications of the design document.

In the current implementation of the Extranet, the emphasis is put on containers handled by trucking companies. If the manipulation of these containers is improved, most of the Port's congestion problems can be solved. In the future, functions enabling railway companies to manage containers could also be added to the Extranet. In the interim, containers assigned to railway companies will be displayed by the Extranet for information and statistical purposes only.

The Extranet application will include several screens containing accurate and real-time information on import as well as export containers. Each stakeholder must regularly provide container information to the Extranet and share it with other stakeholders. The Extranet provides stakeholders with a number of ways to provide their information to the system. Batch transactions can be sent to the Extranet, which features a translator that accepts several different formats. Information can also be provided to the Extranet through on-line Web application screens, for stakeholders who do not have the facilities to send batch transactions.

Major functions of the application:

- **Screens to display information** related to voyages, bills of lading, containers, etc. These screens will vary according to stakeholder;
- **Specific screens to allow updates**. Access will be managed via username, password, and proper permissions.
- **Functions to upload information** with batch transactions. Six upload transactions have been defined: Voyage description, Bill of lading, Assign trucking company, Manage empty memo, Change container status, and Assign truck driver.
- **A translator** to allow stakeholders to choose a format in which they will upload information. EDI, FTP, and HTTP (XML) will be supported.
- **A function to download information** designed specifically for trucking companies to help them synchronize the information with their proprietary dispatch system.
- **Functions to maintain truck driver information database** (name, picture, employee number, etc.).
- **Functions to send alerts** by e-mail to related stakeholders. Alerts are sent when important container-related events occur.
- Specially designed **reporting software** (e.g., Cognos Impromptu).
- **Functions to copy data** from the current database to the reporting database and then to archive on tape.

Here is a list of some important functions available to stakeholders in order to provide or retrieve container information:

- Shipping lines to *Provide Voyage Description*;
- Shipping lines to *Provide Bills of Lading*, including all corresponding containers and their descriptions for import;
- Freight forwarders to *Assign Trucking Company to Container*;
- Freight forwarders to *Manage Empty Memos*, used mostly in the export process to provide information on where to pick up empties and what the pickup requirements are;
- Freight forwarders or trucking companies to *Provide Bills of Lading* to the Extranet for the export process;
- Terminals to provide all *Changes to Container Status* to the Extranet, including all releases for the import process;
- Trucking companies to *Assign Truck Driver to Container*;

- Trucking companies to keep information related to their drivers in the Extranet with the function *Manage Drivers*;
- Trucking companies to download information from the Extranet to their proprietary systems to produce internal work orders without having to re-enter the information;
- Trucking companies to upload processed information from their proprietary systems to the Extranet with the function *Truck Driver Assignment*.

The Extranet also includes additional functions to help stakeholders, including: alerts, which will be sent to specific stakeholders if information changed in the Extranet has a direct impact on them; and reports, which will also be available via a distinct database so as not to affect response time in the production database. The Extranet is designed so that business rules and new functions may easily be added. A role-checking module ensures close control of what information is accessed, by whom, and according to which business rules (constraints).

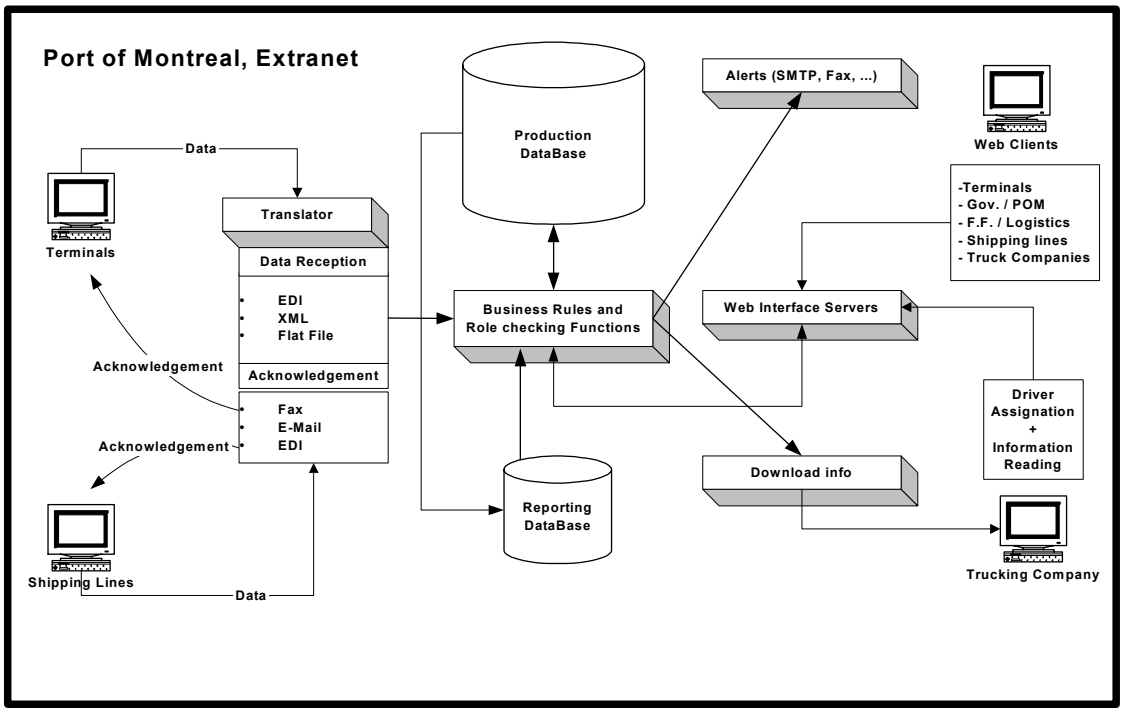

Figure 2 – Functions of the Extranet

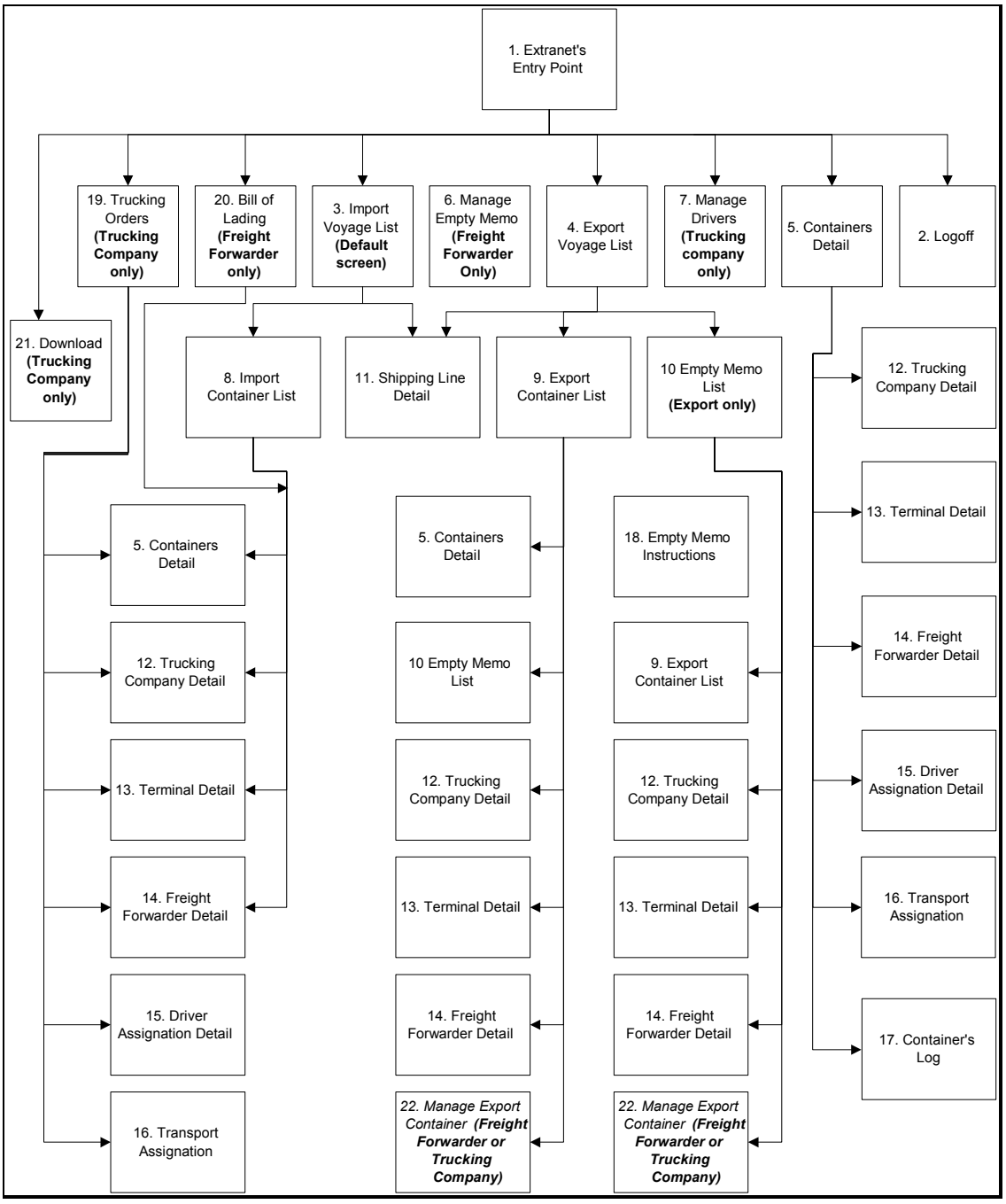

Figure 3 – List of Screens in the Extranet

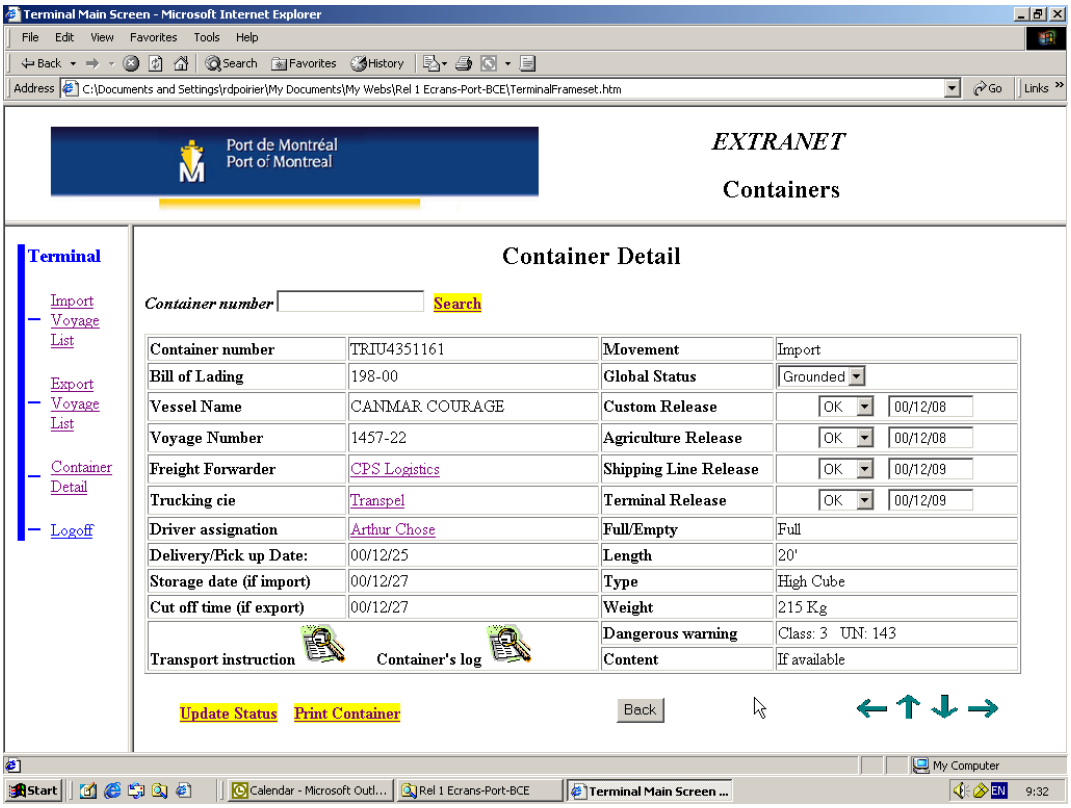

Figure 4 – Example of an Extranet Screen: Container Details - Terminal

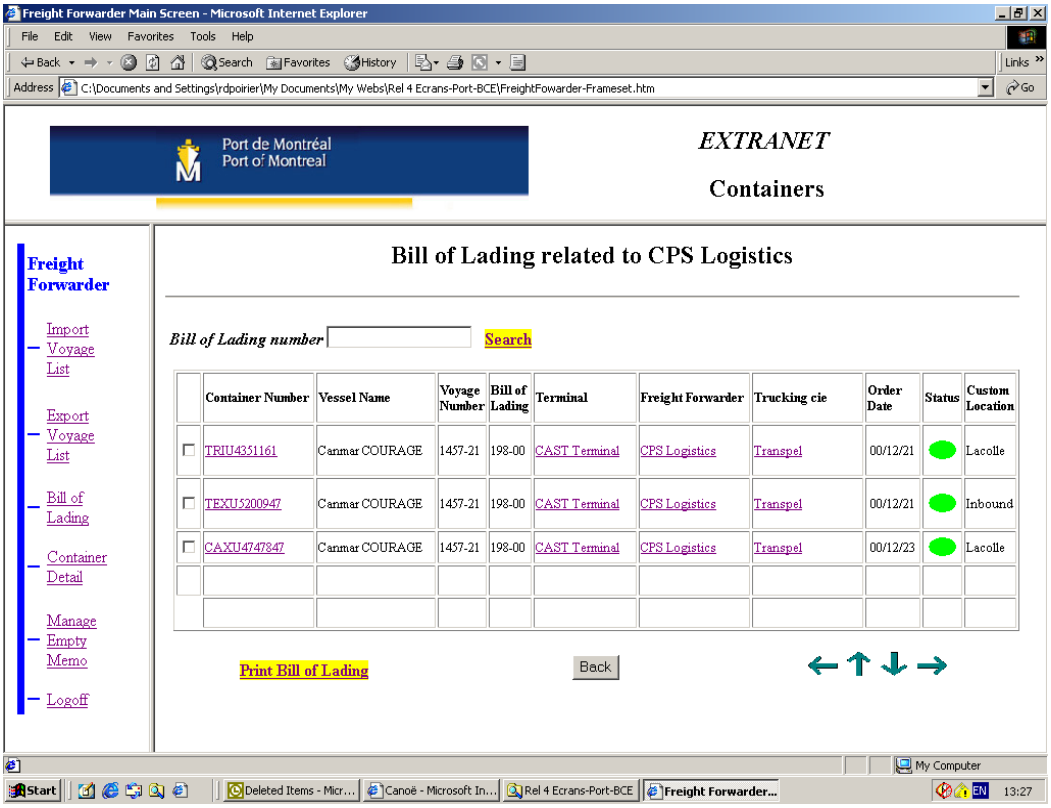

Figure 5 – Example of an Extranet Screen: Bill of Lading - Freight Forwarder

3.3 Database

The purpose of the Port of Montreal Extranet database is to collect and organize information sent by all stakeholders so that it is easily accessible and responds to the needs of the various stakeholders.

After determining the business rules of the terminals, freight forwarders, trucking companies, shipping lines, and government agencies, the Conceptual Data Model was designed to represent the key business concepts and constraints related to container status management, in the context of import and export terminals. A Physical Data Model was then derived to represent the business concepts and constraints in terms of database components. Sybase's Power Designer 7.5 case tool was used to perform these steps and generate the model for an MS SQL Server 2000 platform.

Figure 6 represents a high-level conceptual Extranet data model. The physical data model varies slightly from the conceptual one.

As shown in Figure 6, the data model is divided into four main areas, and each of these areas is subdivided into static and dynamic information:

- The **Shipping Line** area is represented by the pink boxes. Shipping lines are responsible for providing the Extranet with the vessel manifest for each voyage, which comprises all bills of lading related to that voyage.
- The **Terminal** area is represented by the green boxes. Terminals are responsible for providing the Extranet with event data for each container as they become available or change.
- The **Freight Forwarder** area is represented by the blue boxes. Freight forwarders are responsible for preparing the orders to carrier, which consists of assigning container transportation requests to specific trucking companies.
- The **Carrier** area is represented by the yellow boxes. Carriers are responsible for assigning a truck driver to each order to carrier by adding special instructions to the order for the driver (e.g., special equipment needed, truck number, etc.).

The database section of the Extranet design is very complete in terms of details and documentation. It covers all the elements of the database design, including:

- Table lists;
- Table columns list;
- Table indexes list;
- Reference list;
- Domain list;
- Business rules list;
- Graphical representation of the physical database tables, relationships, and entities.

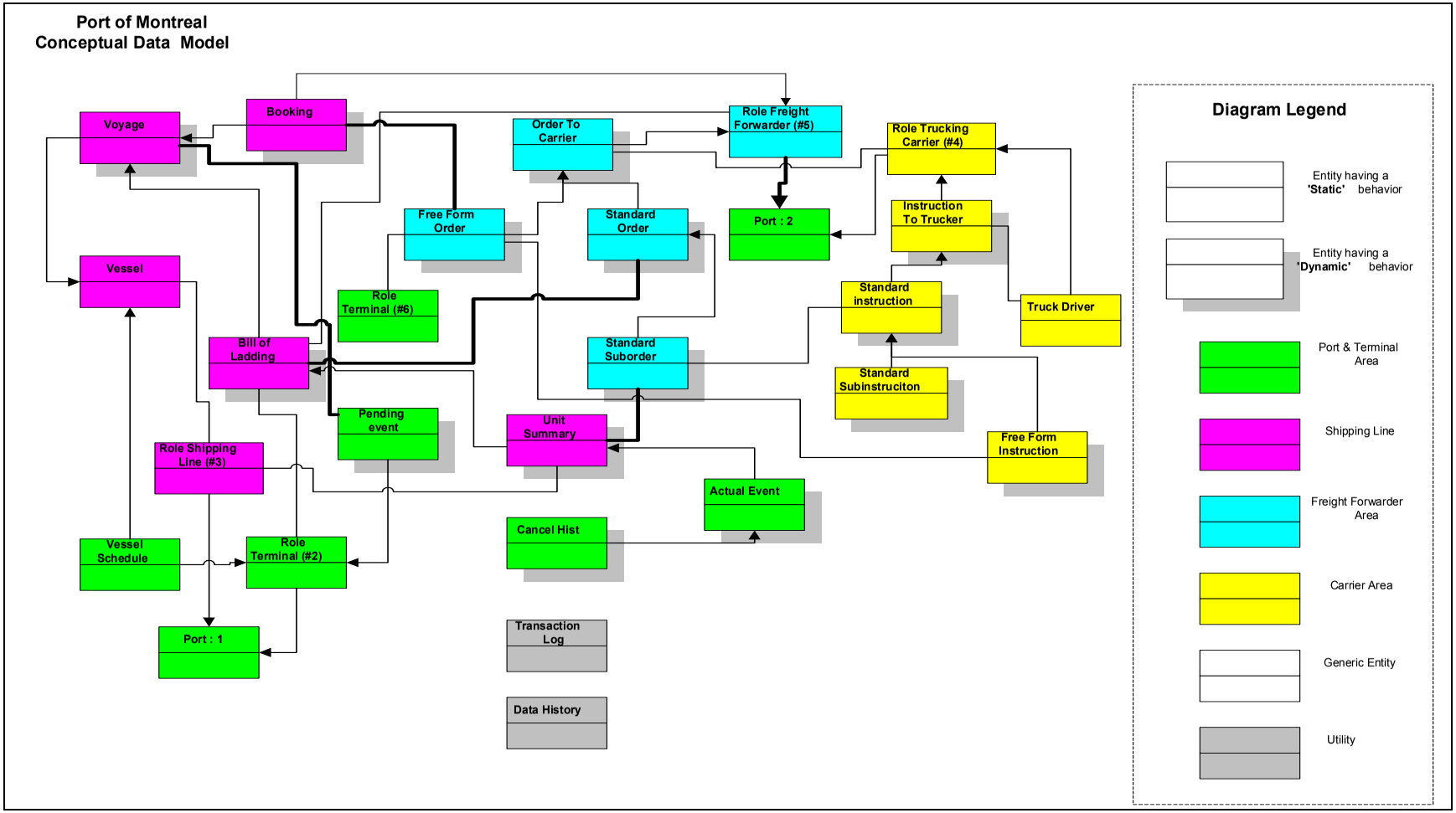

Figure 6 – Conceptual Data Model

3.4 Security

Various groups of stakeholders are involved in the Extranet, and improper or unauthorized access could have undesirable business consequences. A hierarchical structure is therefore necessary to group the different access families. A strictly controlled single logon should give network access only to authorized participants, and within the network, grant application and data access by applying strict business rules.

A secure Extranet requires a solution that takes into account high-level business requirements, cost-effectiveness issues, and appropriate security measures. It involves identifying threats to the Extranet, analysing the risk associated with each threat, and providing adequate countermeasures. Threats to the Port of Montreal Extranet include spoofing user identity, data tampering, repudiation, information disclosure, denial of service, and elevation of privilege.

Security solutions are closely connected to the architecture design. Solutions include authentication, authorization, auditing, privacy, integrity, availability, and non-repudiation.

This design relies on solutions based on Microsoft technologies (IIS 5.0, Windows 2000, SQL Server 2000, Active Directory Server) used with SSL/TLS and VPN. Windows 2000 Basic Authentication + SSL/TLS with Kerberos and LDAP (Active Directory Server) are used to provide a Single Logon for Extranet users. These concepts are illustrated in Figure 7.

New security technologies are being developed every day that promise much. They often deliver what they promised, but only cover a portion of the system's security. The challenge when choosing security technology is to find the right combination to achieve:

- **Equilibrium**: the right protection for all components against threats;
- **Heterogeneity and integration**: a variety of technologies that ensure a wide range of protection against hackers, work well together, and communicate with each other;
- **Ease of use**: easy to install and manage for the administrator and, most importantly, the end user;
- **Monitoring and proactive response**: technology that sends alerts when a problem occurs and is capable of launching a countermeasure or fix;
- **Sufficient support:** technology supported by back-end engineers and research teams to monitor emerging threats;
- **Availability of certified resources:** to ensure independence and access to quality resources;
- **Cost-effectiveness:** not only in terms of acquisition, but also in terms of manpower and equipment.

Making the Port of Montreal Extranet publicly available on the Internet is a desirable feature from both an economical and accessibility standpoint, but improper network security could lead to unwanted intrusions, causing political damage that could ruin the

credibility of the Extranet. The importance of implementing strong security measures should therefore not be underestimated.

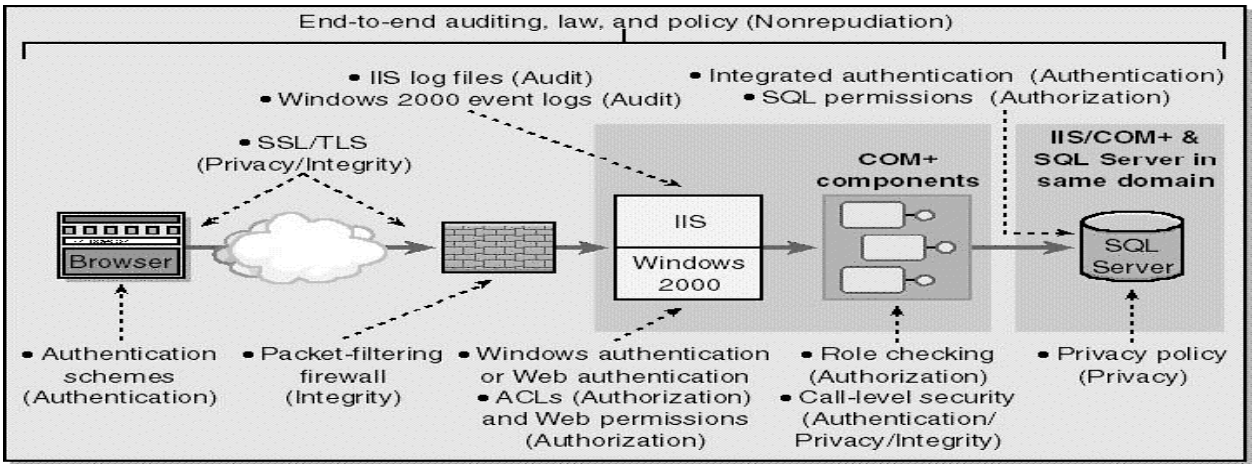

Figure 7 – Extranet Security Model (diagram from BCE Emergis publication entitled *Designing Secure Web-Based Applications for Microsoft Windows 2000)*

3.5 Operations / Service Level Agreement

The Extranet provider's priority commitments are to deliver the highest quality service and guarantee a high level of service for all activities over which it has control. To ensure a high level of service and efficiency, operations should be organized to offer problem resolution escalation procedures. A reported problem would therefore become the responsibility of Support Services and be resolved at the appropriate level. To complete the Extranet, Operations and the Service Level Agreement must be clearly defined.

- **Roles and responsibilities** are defined to identify who is responsible for what in the Extranet community;
- **Service Level expectations** of the Extranet include information on hours of operation, maintenance windows, and availability commitments.
- **Customer Support commitments** include the definition of and process for the **Help Desk** (how to handle operational problems) and **Business Office** (how to handle stakeholder registration), as well as the definition of **escalation procedures** to ensure problem resolution within the SLA.

Extranet Provider Customer Service and the *Technical Help Desk* should be set up with the following characteristics to provide a single point of contact for all stakeholders:

- All standard customer and support services should be offered in both French and English;
- Customer and support services should be equipped with a specific toll-free telephone number accessible throughout North America;
- Agents responding to calls should attempt to classify each call by level of difficulty and call priority, following a custom script and call-routing process.;

- The Help Desk should handle all technical requests and activities involved in problem resolution, and be responsible for trouble reporting;
- The Help Desk should initiate escalation procedures when resolution time is not achieved;
- The Help Desk should advise customers at regular intervals of the status of the problem resolution;
- The Business Office should handle all activities regarding registration and billing;
- The Business Office should handle all account information and billing inquiries;
- Technical support should be available on a 24/7 basis (except on holidays) for all components under the Extranet provider's control.

The Service Provider should nominate a Customer Service Manager (CSM), who would:

- Represent the Extranet provider;
- Act as the single point of contact between the super users (primary contacts from the Extranet member community) and the Port of Montreal Administrator;
- Manage the Operations Work Order (OWO);
- Obtain authorizations from the POM Administrator for company eligibility and OWO.

Each member company of the Extranet should nominate a super user, who would:

- Represent the members of the Extranet community (one per company);
- Provide the information required to set up the company's account in the Extranet;
- Authorize access to the Business Office for the company's end users;
- Act as the primary interface with the Extranet provider's CSM, Help Desk, and Business Office;
- Provide first-level support to the company's end users.

The Help Desk and Business Office should submit monthly reports to POM administration to validate SLA metrics and highlight aspects of the Extranet that could be improved. Reports should contain elements such as:

- Total calls received;
- Total calls answered;
- Average Speed of Answer (ASA);
- Average Talk Time (ATT);
- Total tickets opened;
- Total tickets closed;
- Total tickets closed on initial call;
- Number of billing queries;
- Average resolution time;
- Number of customer profile updates (add, modify, delete) received;
- Number of customer profiles created;
- Number of customer profiles modified or deleted;
- Number of Welcome Kits distributed;

- Volume of customer information (user ID, password) distributed;
- Number of problem tickets;
- Breakdown of tickets by problem category (urgent, high, routine) and further breakdown of customer problems;
- Percentage of problems within objectives;
- Percentage of problems surpassing objectives;
- Percentage of repeated problems.

Escalation Procedures

Call escalation procedures should be defined and documented. Internal escalation charts describe the vertical managerial and technical escalation levels. These charts must be followed to respect the Extranet provider's commitment to its customers.

Automatic escalation and notification to management, both at the provider and customer level, ensures visibility, documentation, and resolution within agreed target times. Escalation levels are defined as:

- First Level Support: provided by the Help Desk. If Help Desk personnel cannot resolve the problem, they should escalate to the appropriate second level of support. First level support is responsible for the problem and reports the resolution to the customer (escalating as required).

- Second Level Support: handles more complex problems. If the problem is unable to be resolved, it escalates to the next level.

- Third Level Support: involved only for very complex problems. All outstanding problems that can be fixed without having to go to the supplier are resolved.

3.6 Orientation and Future Development

As stated earlier, the Extranet application described in the report entitled *Port of Montreal Extranet Design* is the first step toward a fully integrated solution for container management at the Port of Montreal.

New functions can be added to the Extranet application to further improve container tracking and tracing. The following functions will be added to the Extranet application as soon as the current configuration has demonstrated appreciable gains in efficiency and productivity at the Port of Montreal:

- Functions for tracking and tracing containers handled by railway companies;
- Functions for handling several containers per order to carrier, rather than the current one-container-per-order basis;
- Functions to exchange information with other international ports that handle containers destined for POM;

- Integration with smart card authentication for truck drivers, that sends transactions to the Extranet when the driver arrives at or leaves from a specific terminal;
- Functions for electronic container billing and electronic transfer of funds for various stakeholders;
- Functions to view chassis and container images from terminal gate video cameras in order to assess damage and as well as the queuing situation at the gate. Images from highway cameras could also be integrated to provide information to trucking companies;
  Graphical representation of containers (different pictures for regular, open top, high cube, flat, or reefer);
  Integrated OCR line-scan cameras to identify container ID;
  Functions to produce official Extranet reports and documents (e.g., the Terminal Interface Release, documents for customs, etc.);
  Functions to allow trucking companies to acknowledge empty memos. Additional fields on screens could indicate to the freight forwarder that the trucking company has accepted the memo.

4. CONCLUSIONS AND RECOMMENDATIONS

The Extranet is an excellent solution for improving information sharing and efficiency at the Port of Montreal. The application is designed to evolve easily by adding new functions and business rules, and has the potential to achieve results in the six key areas targeted to improve overall communication among stakeholders in the Port of Montreal community.

The pilot Extranet implementation should be done with a limited number of carefully selected participants to fine-tune the solution for more general use and minimize end-user frustration. The involvement of senior management and syndicated workers in the implementation of the pilot is a key success factor.