Cascade Gateway Border Data Warehouse Upgrade & BIFA Integration Project
Report #2

Project ITS Architecture

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1. Introduction

The Border Information Flow Architecture (BIFA) was developed jointly by the U.S. Federal Highway Administration (FHWA) and Transport Canada to ensure that technologies deployed at border crossings interact efficiently with one another. Based on existing U.S. and Canadian National Architectures, the tool is designed to be used for Intelligent Transportation Systems (ITS) project implementation at or near border crossings, as a template for border area regional ITS architecture updates, and to support the transportation planning process

1.1 Border Data Warehouse Upgrade & BIFA Integration Project

The Whatcom Council of Governments (WCOG) received funding through Transport Canada's BIFA Pilot Project Funding Program in 2010 to support ongoing public and private planning operations of the Cascade Gateway border crossing system[1], and to advance the BIFA itself. The project was designed to build on an existing data archive and show how the BIFA can help plan cross-border ITS implementations. The project had three objectives:

1. Improve the binational Cascade Gateway Border Data Warehouse
2. Use the BIFA template to develop a project architecture that will be compatible with both U.S. and Canadian regional ITS architectures
3. Provide guidelines for other regions considering the BIFA for their cross-border ITS projects, and recommendations for future BIFA development.

This architecture fulfills the second objective of the project. More in-depth reporting of the project as a whole can be found in **Border Data Warehouse Upgrade & BIFA Integration Project Report #1: Final Report** A detailed account of the development of this architecture, suggestions for other regions developing binational ITS project architectures, and recommendations for BIFA and architecture developers is available in **Border Data Warehouse Upgrade & BIFA Integration Project Report #3: Recommendations for BIFA and Architecture Developers**.

1.2 BIFA Architecture Final Report

The following architecture is based on the **Border Information Flow Architecture** document[2] which is an example of a regional ITS architecture.

2. Scope of the Architecture

2.1 Geographic Scope

The Cascade Gateway is the system of four border crossings between Whatcom County, Washington State in the United States and the Lower Mainland of British Columbia in Canada. The crossings include: Peace Arch/Douglas (Interstate 5/B.C. Highway 99); Pacific Highway (State

[1] The Cascade Gateway is the system of four border crossings between the Lower Mainland of British Columbia, and Whatcom County in Washington State. The crossings include Peace Arch/Douglas, Pacific Highway, Lynden/Aldergrove, and Sumas/Abbotsford-Huntingdon ports-of-entry.

[2] Border Information Flow Architecture Final Report, Prepared by the National ITS Architecture Team for the Federal Highway Administration, U.S. Department of Transportation and Transport Canada, January 2006: http://www.ronice.com/bifa/bifadocument01-19-06.pdf

Route 543/B.C. Highway 15); Lynden/Aldergrove (State Route 539/B.C. Highway 13); and Sumas/Abbotsford-Huntingdon (State Route 9/B.C. Highway 11).

The scope of this project extends north to 8th Avenue in B.C., and to the variable message sign (VMS) on Interstate 5 south of Bellingham, WA.

2.2 Timeframe

This project is scheduled to operate for the next five years through 2015.

3. Stakeholders

Although the geographic scope of the project includes numerous stakeholder agencies and organizations, the following are key stakeholders for this specific project:

- **B.C. Ministry of Transportation (BCMOT)** - The provincial agency that is responsible for managing, operating, and/or maintaining province-owned transportation infrastructure (roads, airports, transit, railways). Services provided include advanced traffic management, traveller information, and other ITS services.
- **Bureau of Transportation Statistics (BTS)** – The U.S. Research and Innovative Technology Administration's Bureau of Transportation Statistics is the government agency charged with data gathering, analysis and distribution of transportation data.
- **Canada Border Services Agency (CBSA)** - Canadian Border Services Agency (CBSA) is responsible for border services including customs. The work of the CBSA includes: processing commercial goods, travellers, and conveyances, and identifying and interdicting high-risk individuals and goods; conducting secondary inspections of food and agricultural products imported by travellers at airports; conducting intelligence, such as screening visitors and immigrants and working with law enforcement agencies to maintain border integrity and ensure national security; and engaging in enforcement activities, including investigations, detentions, hearings, and removals.
- **U.S. Customs & Border Protections (CBP)** – US Customs and Border Protection is a part of the Department of Homeland Security (DHS) and is responsible for managing the nation's borders and ports-of-entry, preventing the passage of individuals or goods from entering the United States unlawfully.
- **WA State Department of Transportation (WSDOT)** - Department of Transportation of a US State that is responsible for managing, operating, and/or maintaining state-owned transportation infrastructure (roads, airports, transit, railways). Services provided include advanced traffic management, traveler information, and other ITS services.

- **Whatcom Council of Governments (WCOG)** - The Metropolitan Planning Organization (MPO) and Regional Transportation Planning Organization (RTPO) for Whatcom County, WA and the lead agency for the International Mobility & Trade Corridor Project (IMTC). WCOG also maintains the Regional ITS Architecture for Whatcom County.
- **Other databases and applications** - Online systems which query and use the database through the Application Programming Interface (API).
- **Private sector probe information providers** - Stakeholders who have vehicle probe information that can be shared with other agencies in the region. This would include stakeholders that generate probe information from commercial vehicle fleets, cell phones, or from general traveler information system.

4. Operational Concept

This section defines each stakeholder's current and future roles and responsibilities in the operation of the Border Data Warehouse.

All roles and responsibilities and under the **Cascade Gateway Archived Data Systems** project area.

BCMOT

- Collect and disseminate information on border crossing status and schedules.
- Collect and disseminate data from highway weigh-in-motion counters.

WSDOT

- Collect and disseminate information on border crossing status and schedules.
- Collect and disseminate data from highway weigh-in-motion counters.

WCOG

- Collect transportation related data (traffic counts, accident history, etc.) to provide basic data quality, data privacy, and metadata management.
- Sharing data with other archived data systems in US and along the border - either transferring the data or providing catalogs of the data housed in each archive to create a virtual data warehouse.

5. Inventory

Each stakeholder agency operates and maintains equipment or ITS systems within the Border Data Warehouse, as defined below. Note that the following stakeholders may have other ITS systems in the region that are not included below because they do not relate specifically to the automated sharing of data in this specific project.

Stakeholder	Element	Description	Subsystems & Terminators	Status
BCMOT	BCMOT Field Equipment	Represents field equipment such as sensors, CCTV, and Dynamic Message Signs, traffic signal controllers, etc., operated and managed by provincial traffic agencies.	Roadway Subsystem	Existing
BCMOT	Southbound Border Traveler Information System	Southbound Advanced Traveler Information System run by BCMOT which includes border wait times for passenger vehicles on three variable message signs and the BCMOT website. System will extend to all four Cascade Gateway ports-of-entry.	Archived Data Management Subsystem; Information Service Provider; Alerting and Advisory Systems	Existing
CBSA	CBSA Inspection Systems	Field equipment used to determine lane type (Standard car, NEXUS, bus, commercial vehicle, FAST, etc.).	Other Border Inspection Systems	Planned
Other Databases and Applications	Systems Using Warehouse API	Agency Systems that use data put into data warehouses or archives.	Archived Data User Systems (Terminator)	Planned
Private Sector Probe Information Providers	Private Sector Probe Information Systems	Agency Systems that use data put into data warehouses or archives.	Information Service Provider	Planned
Private Travelers	User Information Device	Personal Computers, PDAs, web-enabled cell phones, etc. used by individuals to access information concerning traffic conditions, incidents, weather, routing, trip planning, and border crossing information	Personal Information Access	Existing
BTS	US Bureau of Transportation Statistics Systems	Bureau of US government that would collect data from Border Information administration systems (e.g. ACE) and then provide that data to archives in the architecture.	Archived Data Management Subsystem	Existing
US CBP	CBP Inspection Systems	Bureau of US government that would collect data from Border Information administration systems (e.g. ACE) and then provide that data to archives in the architecture.	Other Border Inspection Systems	Planned
WSDOT	Northbound Border Traveler Information System	Northbound Advanced Traveler Information System run by WSDOT which includes border wait times for passenger and commercial vehicles on two variable message signs and the WSDOT website. System extends to all four Cascade Gateway ports-of-entry.	Archived Data Management Subsystem; Information Service Provider; Alerting and Advisory Systems	Existing

Stakeholder	Element	Description	Subsystems & Terminators	Status
WSDOT	WSDOT Field Equipment	Represents field equipment such as sensors, CCTV, and Dynamic Message Signs, traffic signal controllers, etc., operated and managed by state traffic agencies.	Roadway Subsystem	Existing
WCOG	Cascade Gateway Border Data Warehouse	Data collection and warehousing system to collect transportation related information from the region. Archived data used to support planning activities.	Archived Data Management Subsystem	Existing

6. Needs and Services

Given the limitations of the original border data warehouse and feedback from system users and stakeholders, seven core needs were identified:

1. The warehouse needs to maintain existing features (including but not limited to port and detector data, e-mail automated reports, downloadable files, and custom queries).
2. The warehouse needs to present data in a clear, concise manner that is easy for inexperienced end-users to find what they are looking for.
3. The warehouse needs to provide data in downloadable and exchangeable formats that are easy to understand and capable of being used on multiple platforms.
4. The warehouse needs to quickly and efficiently pull data from the archive.
5. The warehouse (website and data archive) needs to be developed in such a way as to make it simple to modify and maintain in the future.
6. The warehouse needs to be designed in a way that administrators can monitor the health of the warehouse and be alerted of errors.
7. The warehouse needs to be built for future expansion and increased archiving requirements.

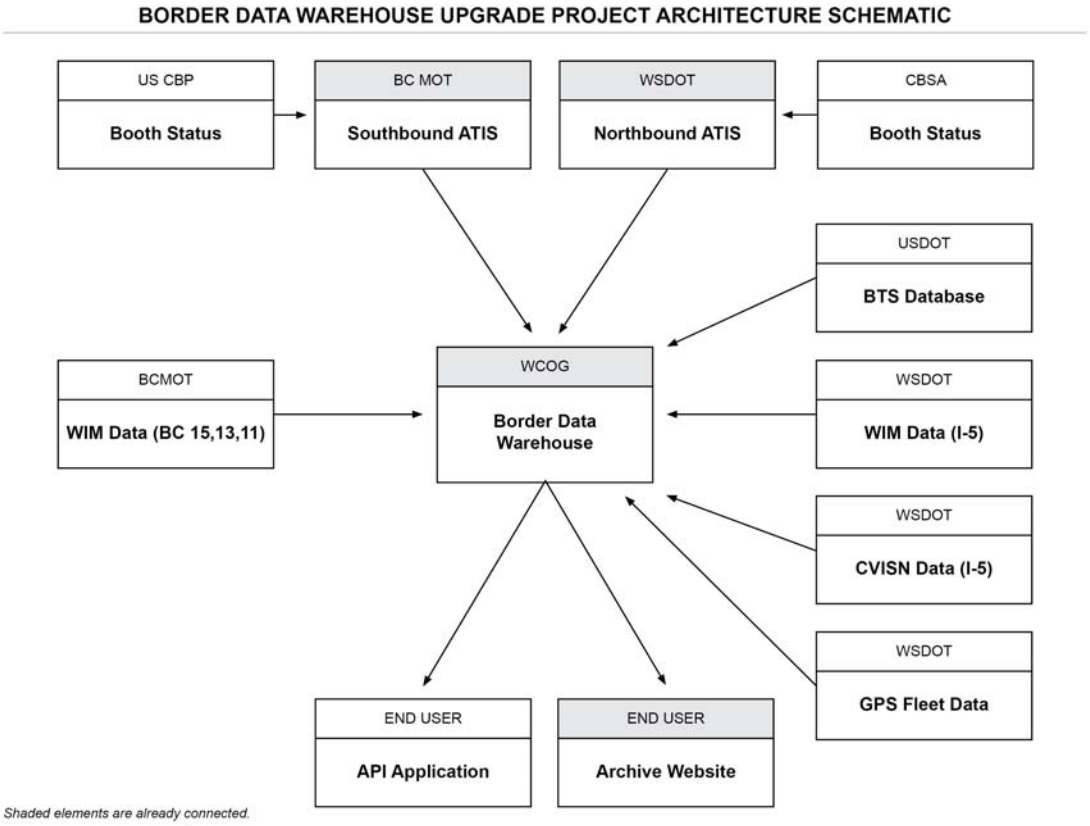
To respond to these needs, the following service areas were either implemented as part of the project or are planned to be implemented:

BIFA Market Package Name	US Market Package	Canadian Market Package	Description	Elements	Status
AD2 – ITS Data Warehouse – US-Canadian Planning	**AD2** – ITS Data Warehouse	**AD2** – Archived Data Warehouse	This market package includes collection of archived data by US or Canadian state, provincial, or regional organizations from multiple agencies and data sources spanning modal and jurisdictional boundaries. It performs the additional transformations and provides the additional meta data management features that are necessary so that all this data can be managed in a single repository with consistent formats. The potential for large volumes of varied data suggests additional on-line analysis and data mining features that are also included in this market package in addition to the basic query and reporting user access features.	BCMOT Field Equipment; Cascade Gateway Border Data Warehouse; Systems Using Warehouse API; BTS Systems; WSDOT Field Equipment	Existing
AD3-Archived Data Virtual Warehouse – Canada	**AD3**-ITS Virtual Data Warehouse	**AD3** – Archived Data Virtual Warehouse	This market package for Canadian Data Warehouses provides for the exchange of archive data between different archives.	Cascade Gateway Border Data Warehouse	Existing
AD3- ITS Virtual Warehouse - US	**AD3**-ITS Virtual Data Warehouse	**AD3** – Archived Data Virtual Warehouse	This market package for US Data Warehouses provides for the exchange of archive data between different archives.	Cascade Gateway Border Data Warehouse	Existing
ATIS01 –Border Traveler Information	**ATIS1**-Broadcast Traveler Information	**ATIS1**-Broadcast Traveller Information	This market package collects traffic conditions, advisories, general public transportation, toll and parking information, incident information, roadway maintenance and construction information, air quality and weather information, and broadcasts the information to travelers using technologies such as FM subcarrier, satellite radio, cellular data broadcasts, and Internet web casts. The information may be provided directly to travelers or provided to merchants and other traveler service providers so that they can better inform their customers of travel conditions. Different from the market package ATMS6 - Traffic Information Dissemination, which provides localized HAR and DMS information capabilities, ATIS1 provides a wide area digital broadcast service. Successful deployment of this market package relies on availability of real-time traveler information from roadway instrumentation, probe vehicles or other sources.	Northbound Border Traveler Information System; Southbound Border Traveler Information System	Existing

ATIS06- Transportation Operations Data Sharing	**ATMS06**-Traffic Information Dissemination	**ATMS06**-Traffic Information Dissemination	This market package makes real-time transportation operations data available to transportation system operators. The Information Service Provider collects, processes, and stores current information on traffic and travel conditions and other information about the current state of the transportation network and makes this information available to transportation system operators, facilitating the exchange of qualified, real-time information between agencies. Using the provided information, transportation system operators can manage their individual systems based on an overall view of the regional transportation system. The regional transportation operations data resource represented by the Information Service Provider may be implemented as a web application that provides a web-based access to system operators, an enterprise database that provides a network interface to remote center applications, or any implementation that supports regional sharing of real-time transportation operations data.	Northbound Border Traveler Information System; Southbound Border Traveler Information System	Planned
ATMS02-Probe Surveillance	**ATMS02**-Probe Surveillance	**ATMS02**-Probe-Based Flow Monitoring	This market package provides an alternative approach for surveillance of the roadway network for Provincial MoTs or State DOTs. This market package provides dedicated short range communications between the vehicle and roadside is used to provide equivalent information directly to the Traffic Management Subsystem. This approach utilizes vehicle equipment that supports toll collection, in-vehicle signing, and other short range communications applications identified within the architecture. The market package enables traffic managers to monitor road conditions, identify incidents, analyze and reduce the collected data, and make it available to users and private information providers. It requires one of the communications options identified above, roadside beacons and fixed-point to fixed-point communications for the short range communications option, data reduction software, and utilizes fixed-point to fixed-point links between the Traffic Management Subsystem and Information Service Provider Subsystem to share the collected information. Both "Opt out" and "Opt in" strategies are available to ensure the user has the ability to turn off the probe functions to ensure individual privacy. Due to the large volume of data collected by probes, data reduction techniques are required, such as the ability to identify and filter out-of-bounds or extreme data reports.	Private Sector Probe Information Systems	Planned

7. Interfaces and Information Exchanges

The original project design was based on a schematic developed by the project team representing stakeholders and information to be shared with the border data warehouse.

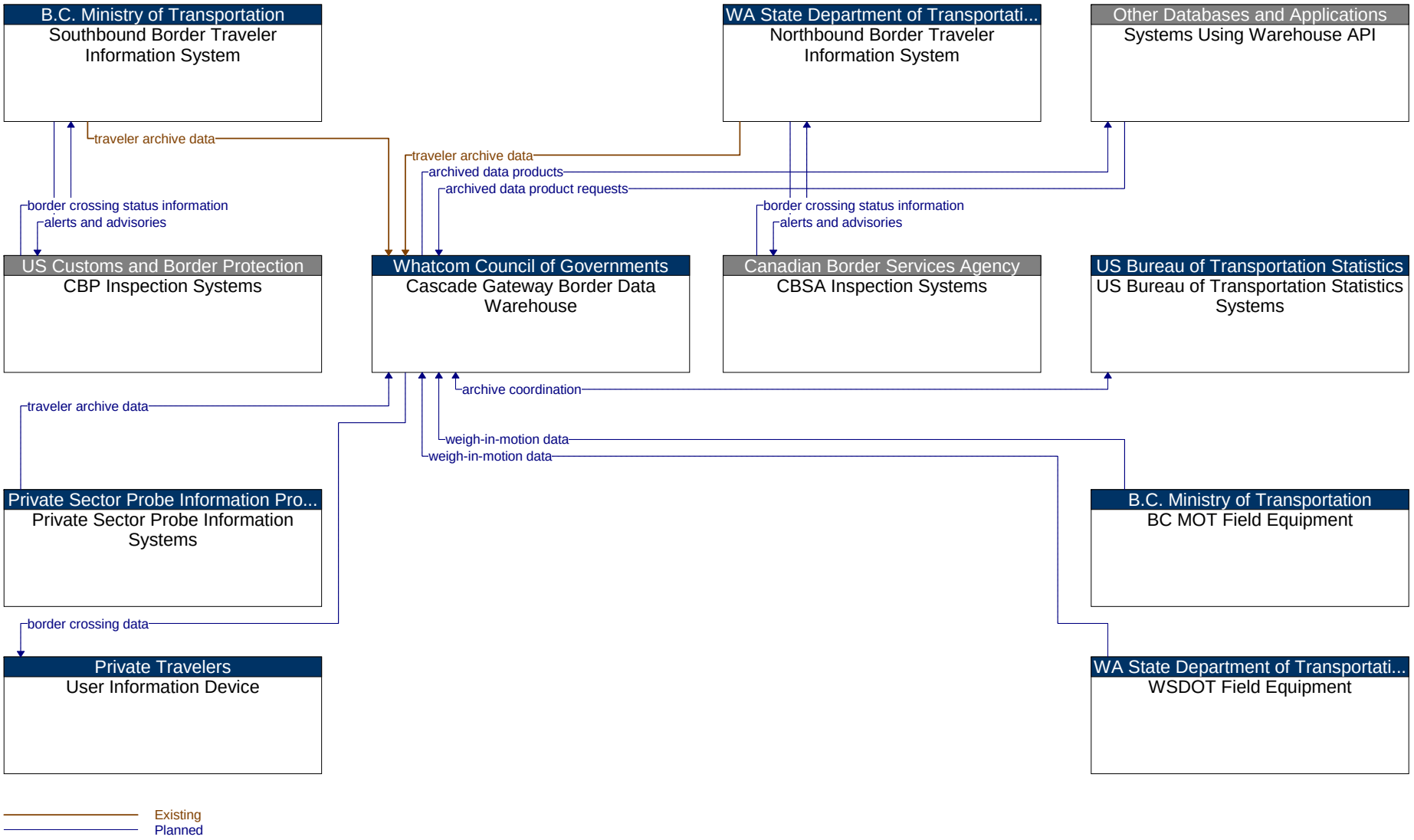


The following table illustrates the flow of information between system elements and status of that connection. More specifics on these interfaces and information flows can be found in the Turbo Architecture version of this project architecture.

Source Element	Flow Name	Destination Element	Status
BCMOT Field Equipment	Weigh-in-motion data	Cascade Gateway Border Data Warehouse	Planned
Cascade Gateway Border Data Warehouse	Archived data products	Systems Using Warehouse API	Planned
Cascade Gateway Border Data Warehouse	Archive coordination	US Bureau of Transportation Statistics Systems	Existing
Cascade Gateway Border Data Warehouse	Border crossing data	User Information Device	Existing
CBP Inspection Systems	Border crossing status information	Southbound Border Traveler Information System	Planned

Source Element	Flow Name	Destination Element	Status
CBSA Inspection Systems	Border crossing status information	Northbound Border Traveler Information System	Planned
Northbound Border Traveler Information System	Traveler archive data	Cascade Gateway Border Data Warehouse	Existing
Northbound Border Traveler Information System	Alerts and advisories	CBSA Inspection Systems	Planned
Private Sector Probe Information Systems	Traveler archive data	Cascade Gateway Border Data Warehouse	Planned
Southbound Border Traveler Information System	Traveler archive data	Cascade Gateway Border Data Warehouse	Existing
Southbound Border Traveler Information System	Alerts and advisories	CBP Inspection Systems	Planned
Systems Using Warehouse API	Archived data product requests	Cascade Gateway Border Data Warehouse	Planned
US Bureau of Transportation Statistics Systems	Archive coordination	Cascade Gateway Border Data Warehouse	Existing
WSDOT Field Equipment	Weigh-in-motion data	Cascade Gateway Border Data Warehouse	Planned

Diagram of Border Data Warehouse Information Flows



8. Functional Requirements

Functional requirements describe the activities performed by each ITS element within the border data warehouse project.

For this project, generalized requirements were defined from the Turbo Architecture BIFA file. There were also detailed requirements developed in the Systems Requirements documentation (see **Border Data Warehouse Upgrade & BIFA Integration Project Report #1: Final Report**).

Requirements defined in BIFA Turbo Architecture File

The following functional requirements are defined from the Turbo Architecture file and come directly from the U.S. National Architecture examples.

Element	Functional Area	Requirement	Status
BCMOT Field Equipment	Roadway Traffic Information Dissemination	The field equipment shall provide data from weigh-in-motion detectors to the data archive.	Existing
Cascade Gateway Border Data Warehouse	ITS Data Repository	The center shall collect data to be archived from one or more data sources.	Existing
		The center shall store the archived data in a focused repository that is suited to a particular set of ITS data users.	Existing
		The center shall include capabilities for performing quality checks on the incoming archived data.	Existing
		The center shall include capabilities for error notification on the incoming archived data.	Existing
		The center shall include capabilities for archive to archive coordination.	Existing
		The center shall provide the capability to execute methods on the incoming data such as cleansing, summarizations, aggregations, or transformations applied to the data before it is stored in the archive.	Existing
		The center shall respond to requests from the administrator interface function to maintain the archive data.	Existing
	Traffic and Roadside Data Archival	The center shall collect traffic sensor information from roadside devices.	Planned
	Virtual Data Warehouse Services	The center shall provide capabilities to access "in-place" data from geographically dispersed archives. These capabilities may include analysis, data fusion, or data mining.	Existing
		The center shall support the collection of archived data from other archives on an as-needed basis. (This minimizes the need to duplicate the comprehensive set of data from the remote archives in the local data warehouse.)	Existing
		The center shall provide the local archived data schema to other archive systems.	Existing

Element	Functional Area	Requirement	Status
Northbound Border Traveler Information System	Virtual Data Warehouse Services	The center shall coordinate information exchange with a local data warehouse.	Existing
Private Sector Probe Information Systems	ISP Probe Information Collection	The center shall aggregate collected traffic probe data, calculate route segment travel times, route segment speeds, and route usage, and disseminate to other centers.	Planned
Southbound Border Traveler Information System	Virtual Data Warehouse Services	The center shall coordinate information exchange with a local data warehouse.	Existing
US Bureau of Transportation Statistics Systems	On-Line Analysis and Mining	The center shall support the interface with Archive Data User Systems for requests for analysis of the archive data.	Existing
		The center shall provide the capability to perform activities such as data mining, data fusion, summarizations, aggregations, and recreation from archive data. This may include multidimensional analysis, selective summarization and expansion of data details, and many other advanced analysis services.	Planned
		The center shall receive the user's systems requests and develop the request to retrieve the data from the archive.	Planned
User Information Device	Personal Basic Information Reception	The personal traveler interface shall provide access to the data warehouse.	Existing
WSDOT Field Equipment	Roadway Traffic Information Dissemination	The field equipment shall provide data from weigh-in-motion detectors to the data archive.	Planned

Requirements defined by System Requirements

Although generalized requirements were provided to the project from the pre-established functional areas and requirements above, the project used a more highly-defined list of requirements as both a deliverables list from the website/archive developer and for verification for the project.

This detailed requirements list pertains only to the Cascade Gateway Border Data Warehouse element.

Detailed Requirements		High Level Requirements	
1.1.1	The data shall be presented in calendar format.	1.1	The warehouse needs to present data in a similar fashion to the existing website.
1.1.2	The data shall be viewable by port-of-entry.		
1.1.3	The data shall be viewable by direction.		
1.1.4	The data shall be viewable by either detector or crossing.		
1.1.5	The data shall be queriable by custom query.		
1.2.1	The website shall allow users to sign up for automated email reports.	1.2	The warehouse needs an automated sign-up for email reporting that users can sign up for and define the thresholds for reporting themselves.
1.2.2	The website shall allow users to define the type of reports they are interested from a set of options.		
1.2.3	The website shall allow users to unsubscribe from reports.		
2.1.1		2.1	The website needs a better user guide online and help section.
2.1.2	The website administration shall allow administrators to write and edit help sections.		
2.2.1	The website shall separate out data sets using tabs at the top of the page for each data type.	2.2	The warehouse needs to incorporate the new data sets in a clear manner.
2.2.2	The website shall develop the visual display of each data type in a similar manner.		
2.2.3	The website shall be designed in such a way that a finite number of data sets can be displayed at the top of the page.		
2.3.1	The website shall use an online mapping system to display detectors.	2.3	The warehouse needs to have geo-coded detector and system maps for users to more easily access port-level data and individual detector data.
2.3.2	The website shall use an online mapping system to display port-of-entry crossing symbols.		
2.3.3	The website mapping shall be zoomable and allow end users to pick specific detectors from the map itself.		
2.3.4	The website shall allow administrators to input the geo-location of each detector and automatically display this detector on the map.		
2.3.5	The website shall allow administrators to edit the locations of detectors and crossings using an editing tool.		
2.4.1	Website data shall be displayed in data tables and in charts.	2.4	The website chart views needs to be dynamic and allow for end-user customization of scales, timelines, and comparisons.
2.4.2	Website charts shall be designed in a way to allow users to customize the visual display.		
2.4.3	The website chart views shall be printable.		
2.5.1	The website shall be designed in such a way that NEXUS port data and similar direction/port data can be displayed separately or together.	2.5	The website data views need to allow for easy combinations of port data (i.e. NEXUS lane data with the rest of the port data) for simpler queries.
2.6.1	The website needs to be developed as per section 508 of the Rehabilitation Act of 1973 for accessibility for all users.	2.6	The website needs to be developed as per section 508 of the Rehabilitation Act of 1973, as amended

Detailed Requirements		High Level Requirements	
2.6.2	The website developers shall instruct the administrators on how to maintain the website in such a way as to continue to keep all aspects of the site accessible to all users.		(29 U.S.C. 794d) for accessibility for all users.
3.1.1	The website shall have a tab for reports.	3.1	The website should include static reports which summarize typical wait times and how a particular day compares to an average of such days. This requirement can be handled by way of "Saved Queries" for which the results can be printable.
3.1.2	The reports shall be configurable and organizable by website administrators.		
3.1.3	The reports shall be viewable on screen or downloadable as .csv or equivalent file types.		
3.1.4	The website shall be able to list any number of canned reports for viewing.		
3.1.5	The reports shall be designed in such a way that they are always kept current (i.e. new data is included in the report query).		
3.2.1	The website shall include a custom query tool for end users to run unique reports on all sets of data.	3.2	The custom query tool needs to allow for different aggregations, including a daily time output (in addition to minute, hour, and am/pm outputs).
3.2.2	The custom query shall result in multiple output types including data table, chart, and downloadable file.		
3.2.3	The custom query tool shall allow users to select date ranges and days of the week.		
3.2.4	The custom query tool shall allow users to group by month, day of week, day, am/pm, hourly, or by five minute increment.		
3.2.5	The custom query tool shall allow users to query multiple detectors or crossings at a time.		
3.2.6	The custom query tool shall allow users to query by holiday.		
3.2.7	The custom query tool shall allow users to aggregate data by various measures, including average, max, min, and sum values.		
3.2.8	The custom query tool shall allow users to view multiple measures of data in one query (i.e. volume, wait times, etc.).		
3.3.1	The warehouse shall have an associated interface to allow data to be shared with other websites.	3.3	The warehouse needs an API interface to allow the data to be “pushed” to other websites, agencies, or applications for greater dissemination of data.
3.3.2	The warehouse API shall be designed in such a way as to maintain the security and integrity of the original database.		
3.4.1	The website shall produce viewable charts that can be printed; and the associated data can be downloaded in CSV format	3.4	The website charts need to be able to be printed and downloaded for end-user reports.
3.5.1	The warehouse data shall be available in downloadable formats including but not limited to .csv format.	3.5	The warehouse data needs to be able to be downloadable in .csv format.
4.1.1	There shall be no more than a five second delay for each page load on the website.	4.1	The warehouse access speeds need to be improved.
4.1.2	Large custom queries shall take no longer than ten seconds to load and display.		

Detailed Requirements		High Level Requirements	
4.1.3	The website shall provide a loading or waiting symbol for any query or page load that takes longer than a few seconds.		
4.2.1	The warehouse shall be stored on a server with enough capacity to house exponentially increasing volumes of data.	4.2	New hardware needs to be identified to facilitate speedy data queries and increasing storage requirements.
4.2.2	The warehouse shall be stored on a server designed in such a way that website function is separated from data storage to facilitate faster response times.		
4.2.3	The warehouse data backups shall be stored in a location that will not impact the speed or functionality of the website.		
5.1.1	The website developers shall develop documentation on how the warehouse has been developed; hardware specifications; programming knowledge needed; and how and where data are stored.	5.1	Documentation needs to be developed so the functioning of the warehouse is clear and specific for future developers.
5.1.2	The website developers shall prepare documentation on how the warehouse should be maintained.		
5.1.3	The website developers shall prepare documentation on how administrators can make changes to the website.		
5.2.1	The website shall be designed using a common programming language and on a common server operating system.	5.2	Database and website formats need to be in an accessible programming language that allows for multiple developers to easily understand and address future issues.
5.2.2	Any customized components of the warehouse software shall be described in detail in documentation with instructions on how that component ties into the full warehouse/website.		
5.3.1	The warehouse administration shall allow administrators to add or edit data feeds into the system.	5.3	System needs an easy way to incorporate changes to data transfer technologies or locations so that the administrator can manually change data interfaces.
5.3.2	The warehouse administration shall allow administrators to be alerted if changes occur to the data feeds in the system.		
5.4.1	The warehouse shall preserve XML files downloaded from partner agencies in a backup location no longer than one month after the date.	5.4	The system needs a way to preserve a month's worth of XML files from partner agencies in case of website maintenance issues.
5.4.2	The warehouse shall have an alert if there are problems in downloading data from partner agencies.		
5.5.1	The warehouse shall automatically select loop detectors for volume counters based on proximity to the border crossing.	5.5	The system needs a way to alert administrators if volume detectors are not selected, and to allow administrators to easily select loop detectors to be used for volume counts.
5.5.2	If a border crossing in the system does not have one or more volume loop detectors selected, it shall alert the administrator.		

Detailed Requirements		High Level Requirements	
5.6.1	The warehouse shall be designed in such a way that administrators can access and change the base code for the warehouse and website.	5.6	Because the code for this site will be developed with U.S. public funds, WCOG needs to retain the ability to access and change the code and allow other developers to access it.
5.6.2	The warehouse developers shall provide documentation on the code used for the website and warehouse.		
6.1.1	The warehouse shall have an automatic alert to notify administrators when data is not received from a partner agency.	6.1	The warehouse needs a monitoring system to alert administrators when the site is down; when data packets are not received from each contributing data source; or if the backup of data fails. It also needs to create reports for evaluating performance.
6.1.2	The warehouse shall have an automatic alert to notify administrators when the website is down.		
6.1.3	The warehouse shall have an automatic alert to notify administrators if a backup of the data and website fails.		
6.1.4	The warehouse shall have an automatic alert to notify administrators if a new crossing or new detectors have been added to the system.		
6.1.5	The warehouse shall have an automatic alert to notify administrators if GPS data is missing for a detector.		
6.1.6	The warehouse shall have an automatic alert to notify administrators if an error occurs with the automated email system.		
6.1.7	The warehouse shall have an automatic alert to notify administrators if the server storage space reaches critical capacity.		
6.1.8	The warehouse shall have a report available for administrators that lists performance for existing detectors, crossings, data packets, and daily tasks.		
6.2.1	The website shall display color coded symbols on each calendar or day view relating to the percentage of data packets received.	6.2	The warehouse needs a color-coded flagging system (i.e. green for good, yellow for caution, red for danger) for each day or month of the day/month view which would be determined by a) the number of data packets received and b) the quality of those data.
6.2.2	The website shall display warnings to end users who run queries or analyses using data flagged as red.		
6.3.1	The warehouse shall be developed with a defined set of maintenance functions that are performed regularly to clear logs, erase backups, and continue the health of the server.	6.3	The warehouse needs an automated, scheduled clearing of logs and other files and a maintenance protocol needs to be established for long-term server health.
6.3.2	The warehouse developers shall provide administrators with a list of daily/monthly maintenance functions and instructions on how to change that schedule or functions.		
6.4.1	The warehouse administration shall be designed in such a way that administrators can change any automatic aspect relatively easily and edit data fields.	6.4	The back-end should allow administrators to view data logs, clear logs, update FTP locations and passwords, update port names and details, and choose data counters.

Detailed Requirements		High Level Requirements	
7.1.1	The warehouse shall be designed to automatically look for new ports-of-entries and detectors in each packet of data and to automatically display that new data.	7.1	The system needs to incorporate additional ports seamlessly as long as data streams abide by the established schema.
7.1.2	The warehouse shall be designed to alert administrators when a new port-of-entry or detector is included in the system.		
7.1.3	The warehouse shall provide steps for administrators to customize information for each new port-of-entry or detector.		
7.2.1	The warehouse shall be developed in a way that the archiving of data and the display and functioning of the website are separated.	7.2	The system needs to separate the storage of archived data and the functioning of the website for greater usability.
7.2.2	The warehouse design shall be fully documented.		
7.3.1	The warehouse hardware shall be able to store no less than 100gb of data.	7.3	The system has to be built to store an exponentially increasing amount of data packets.
7.3.2	The warehouse hardware shall be designed in such a way that additional storage capacity can be added without re-designing the warehouse structure.		
7.4.1	The warehouse hardware shall be designed to store differing types of data and different file types.	7.4	The system has to be expandable to store and display differing types of data, including but not limited to commodity data, corridor travel times, lanes open, weigh-in-motion detector data, CVISN, data, etc.
7.4.2	The warehouse shall be designed so that new data feeds from multiple agencies and different types of equipment can be added in an incremental fashion without impacting the rest of the system.		
7.4.3	The website shall be designed in a way that allows for expanding data types across the tabbed menu bar.		
7.4.4	The website shall allow users to query the different data types available.		
7.4.5	The addition of new data shall not impact the existing data.		

9. Standards

The Border data warehouse uses a standardized XML schema developed by BCMOT and WSDOT to share and store information in the archive. More information about the schema is available in **Border Data Warehouse Upgrade & BIFA Integration Project Report #1: Final Report**.

For possible international standards as developed by standards development organizations, standards were selected from the BIFA version of Turbo Architecture. The following standard was considered applicable:

- **ATIS General Use**: Advanced Traveler Information Systems (ATIS) General Use Standards Group – Developed by SAE

10. Project Sequencing

Most ITS activities under the original scope of work have been completed. The following tasks are still pending:

- Booth Status Data: This is a priority for stakeholders in order to improve the quality of data in northbound and southbound border traveler information systems.
- Weigh-in-Motion Detector Data: Although WSDOT weigh-in-motion hardware was improved for this project the mechanisms for transmitting and archiving data from the equipment is still in planning stages.
- GPS fleet data automation: The archive has been developed with existing GPS fleet data from vendors but a more automated transfer of purchased data would be needed to keep the information current. A display and query function would also need to be added to the website.
- CVISN data set: The possibility of using existing readers along Interstate 5 that collect transponder data on trucks traveling between the Port of Seattle and the border was examined as part of the project. The effort involved in hooking up communication for this data set was too extensive for the initial project but future efforts may be able to include this.

11. Agreements

Funding Agreements

GCA 6521: Cascade Gateway Border Data Warehouse Upgrade & BIFA Integration US Funding Agreement - Agreement between WA State Department of Transportation and Whatcom Council of Governments to complete the Cascade Gateway Border Data Warehouse Upgrade & BIFA Integration project. Status: Completed.

BIFA 2010-04: Cascade Gateway Border Data Warehouse Upgrade & BIFA Integration Canadian Funding Agreement - Agreement between Transport Canada and Whatcom Council of Governments to complete the Cascade Gateway Border Data Warehouse Upgrade & BIFA Integration project. Status: Completed.

Data Sharing Agreements

- Verbal Agreement – BCMOT and WCOG: BCMOT continues to share data from the southbound ATIS system with the Border Data Warehouse. No formal agreement is in place.
- Verbal Agreement – WSDOT and WCOG: WSDOT shares data from the northbound ATIS system with the Border Data Warehouse. No formal agreement is in place. Should the WIM data become available it too will be shared with the warehouse as per verbal agreement.
- Verbal Agreement – BTS and WCOG: WCOG uses data from the BTS website to populate its freight data tab on the warehouse website. This is through discussions with BTS representatives.

12. Architecture Maintenance

This project architecture is for the Cascade Gateway Border Data Warehouse only. As changes are made to the archive the Turbo and report versions of the architecture will be updated periodically.

The project architecture will also be incorporated into the revised Whatcom Regional ITS Architecture being developed in 2012.

B.C. is in the process of starting an update for their provincial ITS architecture and will be given this project architecture for incorporation into that plan.

14. For More Information

This architecture is also available as a Turbo Architecture file, formatted in both U.S. and Canadian versions. Contact WCOG (information below) to receive a copy.

The Cascade Gateway Border Data Warehouse is available online at: www.CascadeGatewayData.com.

Project reports, appendices, and all documentation are available on the project website which can be found at www.wcog.org/border.

More information is available by contacting:

Whatcom Council of Governments
314 E. Champion Street, Bellingham, WA 98225
(360) 676-6974

imtc@wcog.org

Further Reading

1. **Border Information Flow Architecture Final Report**, January 2006, National ITS Architecture Team: http://www.ronice.com/bifa/bifadocument01-19-06.pdf
2. **Border Data Warehouse Upgrade & BIFA Integration Project Report #1: Final Report,** September 2011, Whatcom Council of Governments
3. **Border Data Warehouse Upgrade & BIFA Integration Project Report #3: Recommendations for BIFA and Architecture Developers,** September 2011, Whatcom Council of Governments