Toll Interface Software Design Submittal
for the
Tampa Hillsborough Expressway Authority
Reversible Express Lane
Intelligent Transportation System

Contract # 51.31.01
Task Work Order Number 3

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Revision List			
Date	**Revision**	**Checked By**	**Notes**
01/24/06	0	RSC	Initial Submittal
6/30/2015	1	WEW	Kapsch Update

1.1 TOLL INTERFACE

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GENERAL NOTE TO READER:
Much of the information contained in this design assumes that the reader is, at least, somewhat familiar with the THEA Reversible Lane ITS project.

DISCLAIMER:
Graphics, Screen Captures and Figures representing the User Interface for the proposed software design show, in many instances, the actual format, form or capture from other projects, or test systems, which use DYNAC™.

While these images portray the context and conventions from other systems, the User Interface and Control System delivered as part of the THEA REL ITS project will contain the correct labels, feature sets and terms commensurate with the project conventions.

1.2 SUBSYSTEM OVERVIEW

The Toll Interface software will enable the TMC staff to manage the Open Road Tolling Lane Controller (ORT LC or LC) provided with the reversible lane system. This subsystem will provide the interface between the users, the central computer system, and ORT LC field controllers. It will include a fully integrated communications driver, an operations-level command interface in DynGate™ and a graphical status interface.

The ORT LC communications driver will provide the central computer system with the ability to communicate, via the THEA ITS network, with the field ORT LCs for remote control and monitoring.

The operations-level command interface in DynGate™ will consist of a push button command for the "switch" directions request to the LC.

The graphical status interface enables the user to monitor the LC status as well as send command/status requests to control the Toll Plaza's direction of revenue collection.

1.3 GENERAL DESCRIPTION

The Toll Interface (IFC) Software will include all components needed to remotely control and monitor the status of the ORT LC and enable users to control the lane direction. The following figure illustrates an overview of the Toll Interface.

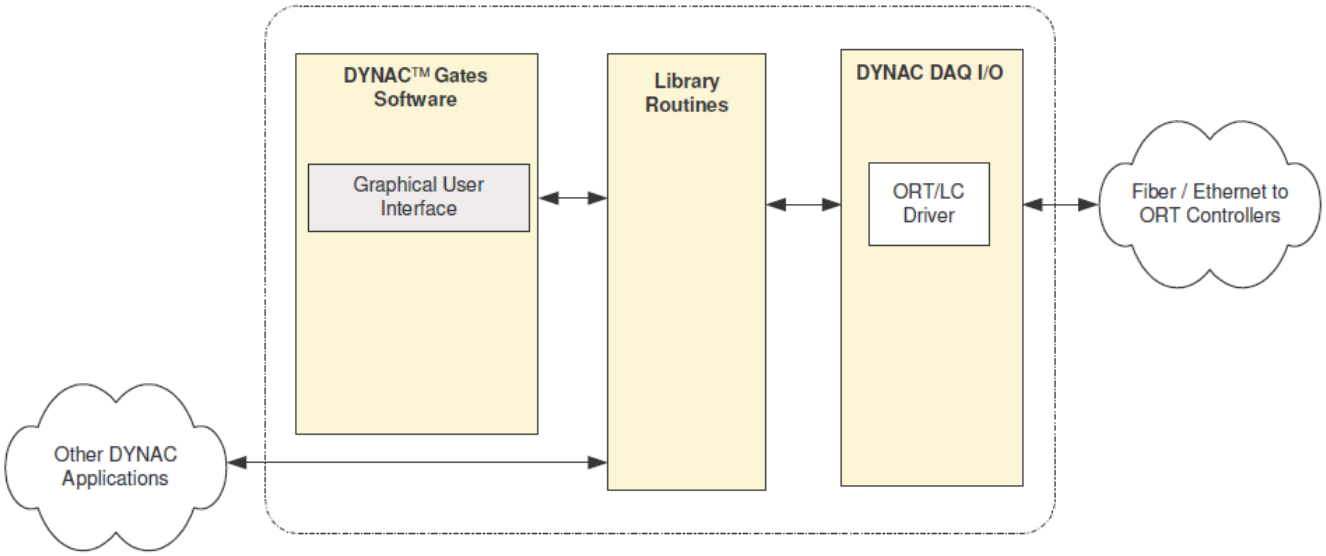

Figure 1-1: Toll IFC Overview

Other DYNAC™ applications that access the same data as the ORT LC Driver include DYNAC™ Graphics and Points control.

The central computer system will connect to the ORT LC with the serial port via terminal servers. The use of a series of terminal servers for the connectivity to the LC is to support the project's requirement to isolate the LC-specific communication with the DYNAC™ system from the TMC network.

In the event that remote TMC command/control is not available or not functioning normally, a local monitor and keyboard will be provided at the ORT LC for local direction command/control.

The ORT LC driver will enable the central computer system to communicate with the ORT LC. The driver will periodically query the ORT LC for lane status as well as control the ORT LC in response to instructions from TMC personnel using the DYNAC™ GUIs.

1.4 Detailed Description Toll Interface Software

The Toll IFC software will be a low-level communications interface to ORT LC hardware by using a multi-thread driver.

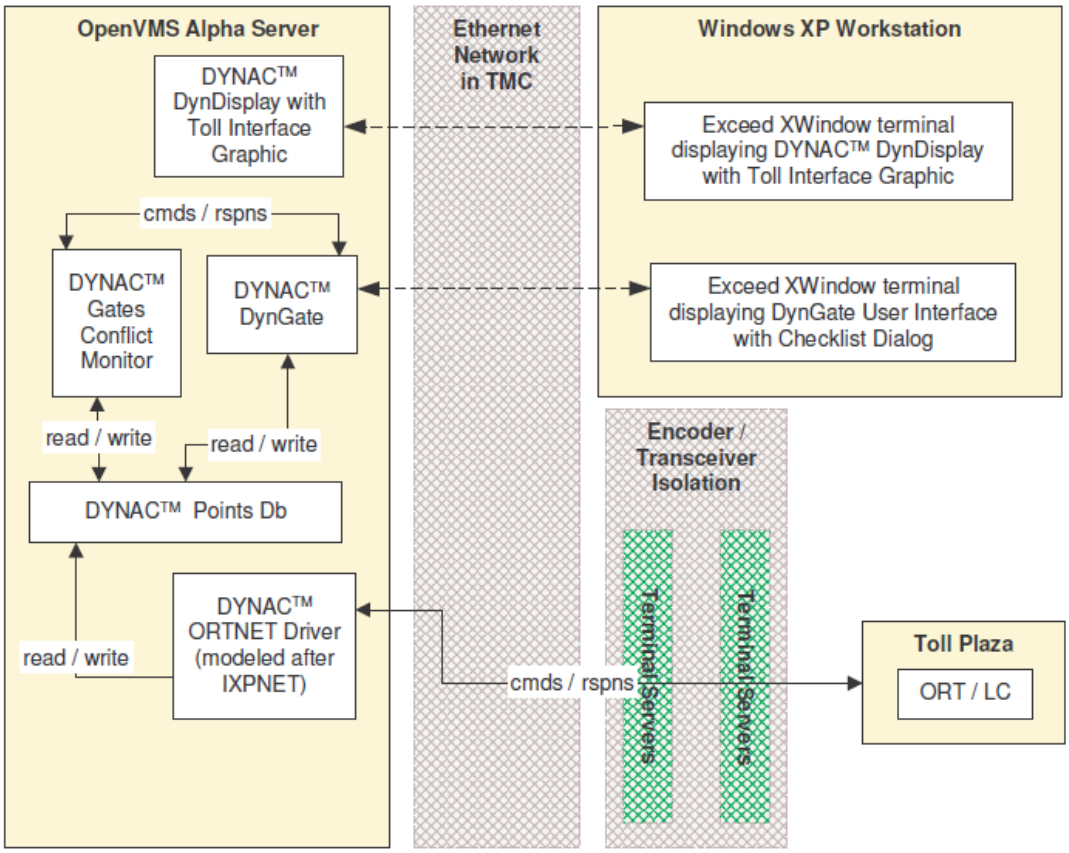

Figure 1-2: Inter-Process Communication

The driver will poll the ORT LC periodically to get the status and lane direction information then update the points in the DYNAC™ Points Database (Db). The multi-thread driver will receive the commands from the GatXMI Checklist (see Figure 1-3) or directly from manual control of the Points via the Db or DYNAC™ graphics then send the command to the ORT LC.

The LC will process the requests and respond with a command status. Once the ORT LC Driver has received a response from the controller it will update the DYNAC™ Points Database.

During normal operations the requests and commands will come from the GatXMI Checklist. During testing, however, users will be able to directly modify Point values to execute the requests and commands.

1.4.1 Protocol

- TMC commands the LC to switch directions. See message format below where the Message ID is “switch”.
- LC acknowledges that it received the command by responding to the TMC with a message. See message format below where the Message ID is “acknowledged”.
- When the LC processes the command, it then sends the TMC a message. See message format below where the Message ID is “processed”.
- It was desirable to have the message format the same. In order to provide message context, the Message ID field is utilized.
- TMC will also send a periodic message to poll the LC what direction it is in; Message ID is “status”. The LC will respond with a status message where the Message ID is “health”. Direction information is included in the health response from the ORT system.

1.4.2 Data Structure

Example:

```
                  1           2           3           4
        12345678901234567890123456789012345678901234

<STX>01,   42A63C17,101111,02S,09,00,00,00,              ,FFFF<NL><ETX>
       ^    ^          ^       ^    ^  ^  ^   ^
       |    |          |       |    |  |  |   |
       |    |          |       |    |  |  |   +-----> LC VES status code (hex)
       |    |          |       |    |  |  +---------> LC AVC status code (hex)
       |    |          |       |    |  +------------> LC AVI status code (hex)
       |    |          |       |    +---------------> LC Mode (decimal)
       |    |          |       +------------------------>Lane Number (ASCII)
       |    |          +---------------------------------->Plaza Number (decimal)
       |    +-------------------------------------------->(hex),Tue Jun 7 17:30:15 2005 PDT
       +-------------------------------------------------> Message ID, Switch direction (decimal)
```

Where:

- <STX> = start of text = 0x02 (hex)
- FFFF = is a place holder representing the Cyclic Redundancy Calculation (CRC) for character positions 1 through 44 indicated in the example above.
- <NL> = new line = 0x0A (hex)
- <ETX> = end of text = 0x03 (hex)

Detailed Specifications:

Field/ Variable Name[1]	Size (bytes)	Value	Description
	1	0x02 (hex)	STX (start of text).
uwMessageId	2	(ASCII, 2-digit decimal) See message recap	See Protocol and example.
	1	0x2C (hex)	Comma separated value (CSV).
tDateTime[2]	8	(ASCII, 8-digit hex) C language time_t value	Date/Time stamp of when the message is sent. It represents the number of seconds elapsed since 00:00:00 on January 1, 1970; Coordinated Universal Time (UTC).
	1	0x2C (hex)	Comma separated value (CSV).

ucPlazaNumber	6	(ASCII, 6-digit decimal)
		Value
		• = **101111**
			• LC - indicates the message is applicable for this specific plaza.
			  ○ 101111
			• TMC - the plaza number that is being command by the message.
			  ○ 101111

	1	0x2C (hex)	Comma separated value (CSV).

ucLaneNumber	3	(ASCII, alphanumeric)	• LC - indicates the active direction.
			  ○ 02S = Westbound, Tampa
			  ○ 03S = Eastbound, Brandon

			• TMC - the lane number that is being commanded by the message.
			  ○ 02S = Westbound, Tampa
			  ○ 03S = Eastbound, Brandon

	1	0x2C (hex)	Comma separated value (CSV).

eMode	2	(ASCII, 2-digit decimal)	• LC
			  ○ 01 = Close = the LC is NOT ready for revenue collection.
			  ○ 02 = Open = the LC is ready for revenue collection.
			• TMC
			  ○ 0x20 = space padded.

	1	0x2C (hex)	Comma separated value (CSV).

ucAviStatus	2	(ASCII, 2-digit hex)	• LC - AVI subsystem health.
			  ○ 0x01 = warning
			  ○ 0x03 = passing
			  ○ 0xff = failure
			• TMC
			  ○ 0x20 = space padded.

	1	0x2C (hex)	Comma separated value (CSV).

ucAvcStatus	2	(ASCII, 2-digit hex)	• LC - AVC subsystem health.
			  ○ 0x01 = warning
			  ○ 0x03 = passing
			  ○ 0xff = failure
			• TMC
			  ○ 0x20 = space padded.

	1	0x2C (hex)	Comma separated value (CSV).
ucVesStatus	2	(ASCII, 2-digit hex)	• LC - VES subsystem health.

			○ 0x01 = warning ○ 0x03 = passing ○ 0xff = failure • TMC ○ 0x20 = space padded.
	1	0x2C (hex)	Comma separated value (CSV).
ulSpare	8	0x20 (hex)	Space padded. For future use.
	1	0x2C (hex)	Comma separated value (CSV).
uwCrc	4	(ASCII, 4-digit hex)	CRC calculation.
	1	0x0A (hex)	New line for record separation.
	1	0x03 (hex)	ETX (end of text).

Table 1-1: Central Computer System to ORT LC

1.4.3 Message Recap

Message IDs from the TMC will have odd values and Message IDs from the LC will have even values. For each message the LC receives from the TMC, the LC will respond with a message.

Message ID	Message Name	Type	Source	Destination	Comments
01	Switch	Command	TMC	LC	TMC commands the LC to switch direction. See also message 98.
02	ACKnowledged	Event	LC	TMC	LC responds with message 02 when it receives message 01 from the TMC. If the requested direction not active, then LC initiates the direction change process.
03					Not Used
04	Processed	Event	LC	TMC	LC completes the direction change process.[1] LC sends message 04.
05	Status	Command	TMC	LC	TMC polls the LC status (configurable at the TMC). See also message 98.
06	Health	MOMS	LC	TMC	LC responds with message 06 when it receives message 05 from the TMC.

98	NACK	Event	LC	TMC	LC responds with message 98 when • LC receives message 01 with an unsupported Plaza/Lane Number.[2] • LC receives message 05 with an unsupported Plaza/Lane Number.[2] • LC identifies a CRC error. • LC receives a message in an unsupported format.

Table 1-2: Message Recap

Note:

1. LC informs the Plaza that TMC changed direction using mode change reason codes in messages 8016 (lane close) and 8024 (lane open). This provides a positive communication of the event with the plaza.
2. If the TMC sends 101112 to ORT system with plaza number 101111, the ORT system will respond with a NACK message.

1.4.4 Configuration

This section describes the availability of the configuration parameters in the DYNAC™ environment and how engineers and technicians can access the data and modify their values to vary the systems dynamic state.

The ORT LC will exist in the DYNAC™ environment as an RTU and have both analog and digital I/O points in the DYNAC™ Points Database. The ORT LC, and its I/O control and data points, will be defined in the RTU text file and loaded into the system via the RTU loader. The RTU definitions will be static and unavailable to the engineers and technicians for dynamic change but the digital I/O points used for sending commands to the RTU will be available for dynamic changes.

The Communication Ports, the Data Rates and Data Configuration bits will be defined in the Port text file and loaded into the system via the Port loader. The Communication Port Data will be static and unavailable to the engineers and technicians for dynamic change. The driver will use the RTU control points, Data Rates and Data Configuration bits to communicate with the ORT LC. The Data Configuration bits will be available to the engineers and technicians for dynamic change and the driver will respond to these changes in near real time.

1.4.5 User Interface

This section describes the availability of the operational data in the DYNAC™ environment and how TMC Operators can access the data and modify their values to vary the systems dynamic state.

During normal TMC operations, the operator will be requesting changes to the state of the Reversible Express Lane system. The operator will be required to send a “switch” command to the ORT LC except the cases involving checklists for only the US-301 entrance. It should be noted that the system will only require an operator to send the “switch” request is the desired state is different than the current state. Once processed and confirmed the operator will be allowed to continue the process of changes the state of the Reversible Express Lane system.

Figure 1-3 represents what the TMC operator will see during the process of sending a “switch” command to the ORT LC via the DynGate™ Main User Interface Checklist Dialog.

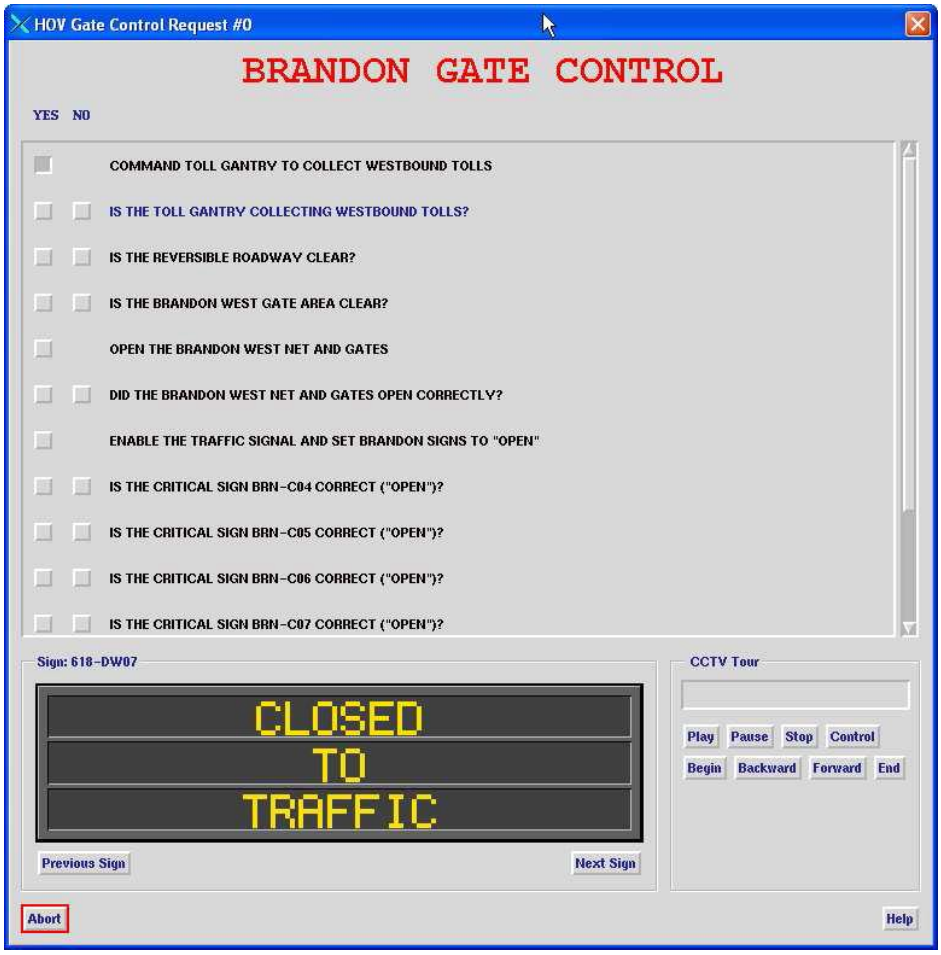

Figure 1-3: ORT LC “Switch” command via DynGate™ Checklist

Once the “switch” request is sent to the ORT LC, the acknowledgment, status poll and confirmation of processed request stages must be satisfied. Figure 1-4 and Figure 1-5 are Pop-Up Warning Dialogs that an operator will see if all the stages of processing are not completely satisfied.

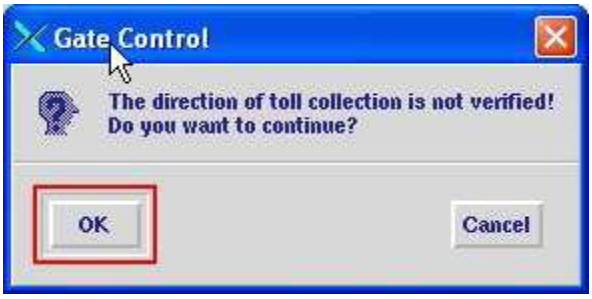

Figure 1-4: Warning of No Verification

Figure 1-5: Warning of Incorrect Direction

If these Pop-Up Warning Dialogs were to occur the operators will be allowed to continue the process of changing the state of the Reversible Expressway Lane but a message indicating the exact failure would be sent to the Event Log.

The TMC Operators will be able to see the dynamic data from the LC, as shown in Figure 1-6, in the ORT LC Status Box.

ORT LC STATUS				
DIRECTION	MODE	AVI	AVC	VES
WEST	OPEN	WARN	PASS	FAIL

Figure 1-6: ORT LC Status Box

The ORT LC Status Box will be part of the graphic display available to the TMC Operators in the DynGate™ Main Interface. This overall view is represented in Figure 1-7.

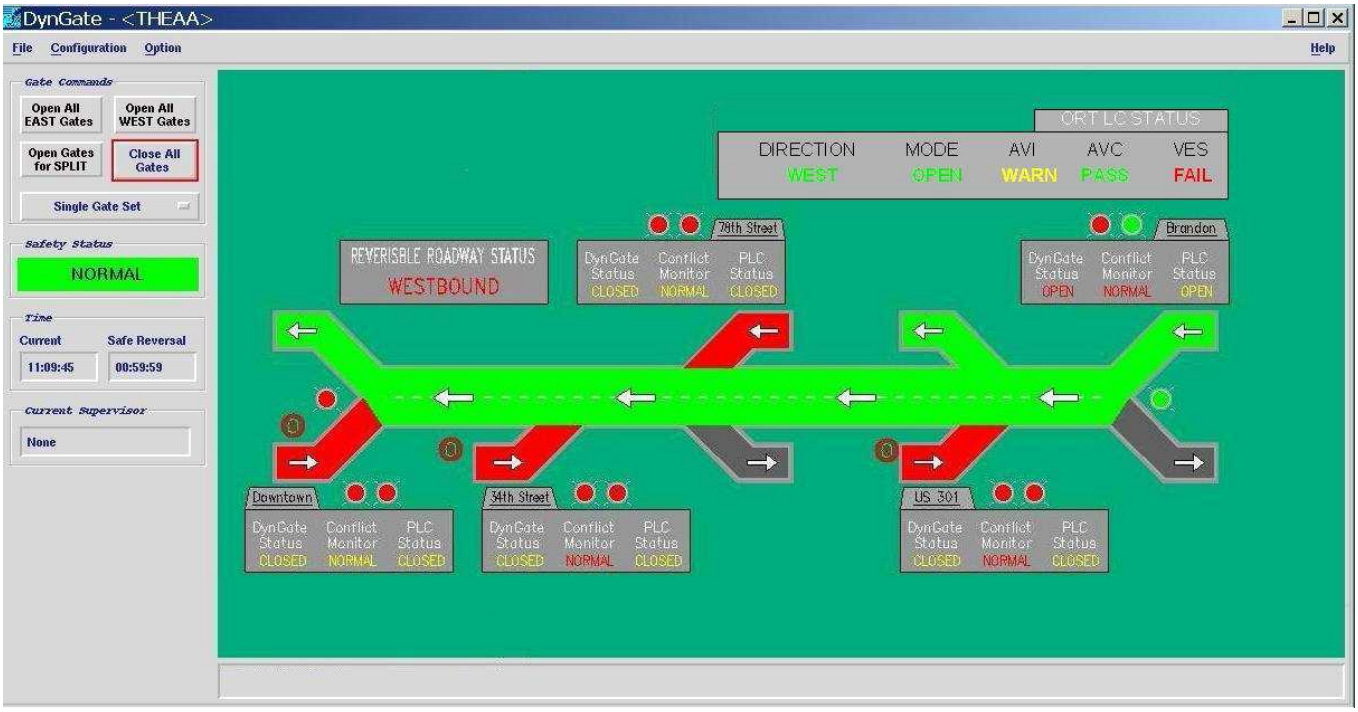

Figure 1-7: DynGate™ Main Interface

1.4.6 Alarms

This section describes the alarms that will be generated in response to the failure cases illustrated in Table 1-3. DYNAC™ alarms are described in detail in the Task 2 System Design Document.

Alarm Case	Alarm Type	Responsibility	Alarm Category and Priority
Communications have FAILED	Double Ended	ORTNET	Cat = n, Priority = 2 ; where n is the category assign to ORT driver network
GCM determines that LC is in "wrong" toll collection "direction"	Double Ended	GCM	Cat = 7, Priority = 7

Table 1-3: Alarm Conditions for ORT LC Interface