Louisiana Demonstration Project:

Wide Area Surveillance Radar and Sequential Gate for Traffic Management in Orleans and Jefferson Parishes, LA

Final Technical Brief

July 2015

HIGHWAYS FOR LIFE

Accelerating Innovation for the American Driving Experience.

U.S.Department of Transportation

Federal Highway Administration

FOREWORD

The purpose of the Highways for LIFE (HfL) pilot program is to accelerate the use of innovations that improve highway safety and quality while reducing congestion caused by construction. **LIFE** is an acronym for **L**onger-lasting highway infrastructure using **I**nnovations to accomplish the **F**ast construction of **E**fficient and safe highways and bridges.

Specifically, HfL focuses on speeding up the widespread adoption of proven innovations in the highway community. Such "innovations" encompass technologies, materials, tools, equipment, procedures, specifications, methodologies, processes, and practices used to finance, design, or construct highways. HfL is based on the recognition that innovations are available that, if widely and rapidly implemented, would result in significant benefits to road users and highway agencies.

Although innovations themselves are important, HfL is as much about changing the highway community's culture from one that considers innovation something that only adds to the workload, delays projects, raises costs, or increases risk to one that sees it as an opportunity to provide better highway transportation service. HfL is also an effort to change the way highway community decision makers and participants perceive their jobs and the service they provide.

The HfL pilot program, described in Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) Section 1502, includes funding for demonstration construction projects. By providing incentives for projects, HfL promotes improvements in safety, construction-related congestion, and quality that can be achieved through the use of performance goals and innovations. This report documents one such HfL demonstration project.

Additional information on the HfL program is at www.fhwa.dot.gov/hfl.

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16. Abstract

As a part of the HfL initiative, FHWA provided an approximately $1 million grant to the Louisiana Department of Transportation and Development (LADOTD) to improve the traffic flow of US 90B (West Bank Expressway), mitigate on-going congestion and crashes, and support work zone traffic and incident management during construction.

The innovations employed on this project included the use of a phased-array Doppler radar and corresponding operator interface for traffic monitoring, as well as a remotely controlled gate system for the on-ramps. LADOTD anticipates that these innovations will greatly reduce the congestion and crashes during the upcoming interchange construction. In addition, these innovative features will remain in place and continue to be functional for future construction activities.

17. Key Words		18. Distribution Statement	
Highways for LIFE, traffic flow, safety, Doppler radar, traffic monitoring, traffic management, remote controlled gate system		No restriction. This document is available to the public through the Highways for LIFE website: http://www.fhwa.dot.gov/hfl/	
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SI* (MODERN METRIC) CONVERSION FACTORS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
(none)	mil	25.4	micrometers	µm
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	millimeters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela per square meter	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	Newtons	N
lbf/in^2 (psi)	poundforce per square inch	6.89	kiloPascals	kPa
k/in^2 (ksi)	kips per square inch	6.89	megaPascals	MPa
		DENSITY		
lb/ft^3 (pcf)	pounds per cubic foot	16.02	kilograms per cubic meter	kg/m^3

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
µm	micrometers	0.039	mil	(none)
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela per square meter	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	Newtons	0.225	poundforce	lbf
kPA	kiloPascals	0.145	poundforce per square inch	lbf/in^2 (psi)
MPa	megaPascals	0.145	kips per square inch	k/in^2 (ksi)

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS AND SYMBOLS

ADT	average daily traffic
FHWA	Federal Highway Administration
HfL	Highways for LIFE
IRI	International Roughness Index
LADOTD	Louisiana Department of Transportation and Development
MVM	million vehicle-miles
OBSI	onboard sound intensity
OSHA	Occupational Safety & Health Administration
RTMC	Regional Transportation Management Center
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users

INTRODUCTION

HIGHWAYS FOR LIFE DEMONSTRATION PROJECTS

Highways for LIFE (HfL) is the Federal Highway Administration's (FHWA) initiative to advance longer-lasting and promote efficient and safe construction of highways and bridges using innovative technologies and practices. The HfL program provides incentive funding to highway agencies to try proven but little-used innovations on eligible Federal-aid construction projects. The HfL team prioritizes projects that use innovative technologies, manufacturing processes, financing, contracting practices, and performance measures that demonstrate substantial improvements in safety, congestion, quality, and cost-effectiveness. An innovation must be one the applicant State has never or rarely used, even if it is standard practice in other States. Recognizing the challenges associated with deployment of innovations, the HfL program provides incentive funding for up to 15 demonstration construction projects a year. The funding amount typically totals up to 20 percent of the project cost, but not more than $5 million.

The HfL program promotes project performance goals that focus on the expressed needs and wants of highway users. They are set at a level that represents the best of what the highway community can do, not just the average of what has been done. The goals are categorized into the following categories:

1. **Safety**
   a. Work zone safety during construction—Work zone crash rate equal to or less than the preconstruction rate at the project location.
   b. Worker safety during construction—Incident rate for worker injuries of less than 4.0, based on incidents reported on Occupational Safety and Health Administration (OSHA) Form 300.
   c. Facility safety after construction—Twenty percent reduction in fatalities and injuries in 3-year average crash rates, using preconstruction rates as the baseline.
2. **Construction Congestion**
   a. Faster construction —Fifty percent reduction in the time highway users are impacted, compared to traditional methods.
   b. Trip time during construction — Less than 10 percent increase in trip time compared to the average preconstruction speed, using 100 percent sampling.
   c. Queue length during construction—A moving queue length of less than 0.5 miles in a rural area or less than 1.5 miles in an urban area (in both cases at a travel speed 20 percent less than the posted speed).
3. **Quality**
   a. Smoothness—International Roughness Index (IRI) measurement of less than 48 inches/mile.
   b. Noise—Tire-pavement noise measurement of less than 96.0 A-weighted decibels (dB(A)), using the onboard sound intensity (OBSI) test method.

4. **User Satisfaction**
    a. An assessment of how satisfied users are with the new facility compared to its previous condition and with the approach used to minimize disruption during construction. The goal is a measurement of 4 or more on a 7-point Likert scale.

PROJECT OVERVIEW

As a part of the HfL initiative, FHWA provided an approximately $1 million grant to the Louisiana Department of Transportation and Development (LADOTD) to improve the traffic flow of US 90B (West Bank Expressway), mitigate on-going congestion and crashes, and support work zone traffic and incident management during construction. The key innovations on this project included the use of a phased-array Doppler radar and corresponding operator interface for traffic monitoring, as well as a remotely controlled gate system for the on-ramps.

PROJECT DETAILS

PROJECT LOCATION AND BACKGROUND

This LADOTD project is located on US Route 90 Business (West Bank Expressway) in the New Orleans metropolitan area of Louisiana, in Orleans and Jefferson Parishes. Figure 1 shows the location of the project along with a couple of roadways (where interchanges are to be under construction) and the Orleans and Jefferson Parish line.

Figure 1. Map. US 90B project location in Orleans and Jefferson Parishes.

US 90B is a six-lane, elevated freeway facility that carries a variety of commercial and commuter traffic between the residential communities and industrial facilities on the West Bank of the Mississippi River and downtown New Orleans, via the Crescent City Connection Bridge, connecting to I-10 East and West beyond downtown.

The elevated expressway connects at interchange points with a parallel three-lane, one-way service road system for local access at ground level. The average daily traffic (ADT) recorded in the vicinity was 97,600 vehicles in 2010 on the elevated portion, with the westbound lanes carrying 50.1 percent (48,930 vehicles) of the total traffic. Between 2008 and 2010, a total of 1,298 crashes were reported on the elevated segment of US 90B from the Orleans/Jefferson Parrish line to Harvey Canal. Using the ADT data, this translates to a crash rate of 4.58 crashes per million vehicle-miles (MVM). Among the total crashes, 556 crashes were reported from the westbound lanes, or equivalently 3.92 crashes per MVM. Table 1 summarizes the type of crashes that occurred in the westbound lanes between 2008 and 2010. As shown in the table, there were 109 injury and fatality crashes with an equivalent to a rate of 0.0054 per MVM.

Table 1. Crash statistics for westbound US 90B, between 2008 and 2010.

Crashes reported	Number of Crashes	Percentage of Total	Statewide Percent Average for Urban Freeways
Rear End	257	46.2	47.4
Sideswipe	135	24.3	19.1
Non-Collision/ Fixed/Run-Off-Road	53	9.5	21.1
Injury/Fatality	109 (106 injury, 3 fatal)	19.5	49.6

These crash statistics are considered fairly typical of urban freeway conditions, with the exception of the overall crash rate, which is significantly higher than the statewide average of 1.39 crashes per MVM. LADOTD was of the opinion that the primary factors for the average overall crash rate appear to be related to congestion and lane changing at weaving areas, lack of ramp capacity at off-ramp diverge points, particularly at Manhattan Boulevard, and the presence of the bridge barrier rail as a fixed object/roadway departure factor.

PROJECT DESCRIPTION

The first phase of the interchange project involves constructing a new westbound off-ramp from the elevated expressway and relocating the existing westbound onramp from Manhattan Boulevard. It was expected that this first phase would take at least 18 months. The second phase of the project is planned for the construction of the US 90B interchange at MacArthur Avenue.

PROJECT INNOVATIONS

The key innovation of this HfL project is the use of the phased-array Doppler radar, the corresponding operator interface, and the controlled gates to mitigate on-going congestion and crashes along the West Bank Expressway and support work zone traffic and incident management activities during construction of the interchanges. The elements of the innovation are further described below.

Regional Radar

The regional (phased-array Doppler) radar is expected to add significant and cost-effective enhancements to the New Orleans Regional Advanced Traffic Management System by providing surveillance of commuter arteries in the metropolitan New Orleans region from a single elevated site. Specifically, the operational implementation of this concept will employ unattended, low-power, non-hazardous microwave Doppler radar mounted on top of the US 90B Mississippi River Bridge No. 1, known locally as the Crescent City Connection. Figures 2 and 3 show pictures of the furnished radar system.

Figure 2. Photo. LADOTD's phased-array Doppler radar.

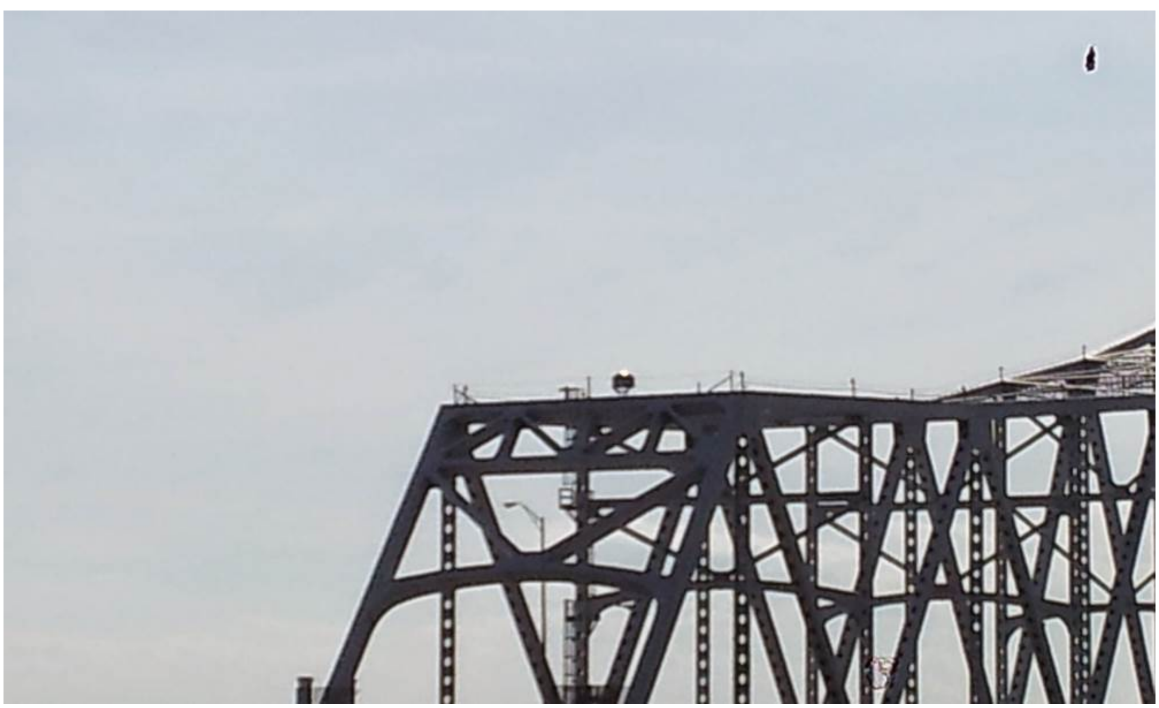

Figure 3. Photo. LADOTD's radar unit mounted on top of the Crescent City Connection Bridge No. 1.

The radar design is based on developed and proven techniques for military airborne surveillance and will include a phased-array antenna for electronic scene scanning and, simultaneously, rapid repositioning of several fixed radar beams. The absence of any moving parts, the all-solid-state design, and the unattended operation should result in extremely reliable performance over a long life span with low operating and maintenance costs. The use of the microwave portion of the electromagnetic spectrum will allow traffic monitoring through rain, fog, snow, haze, and smog. Use of the radar unit will allow monitoring of movement of individual vehicles on continuous segments of the roadway network over a wide area, including the elevated West Bank Expressway approaching the project site (Figure 4).

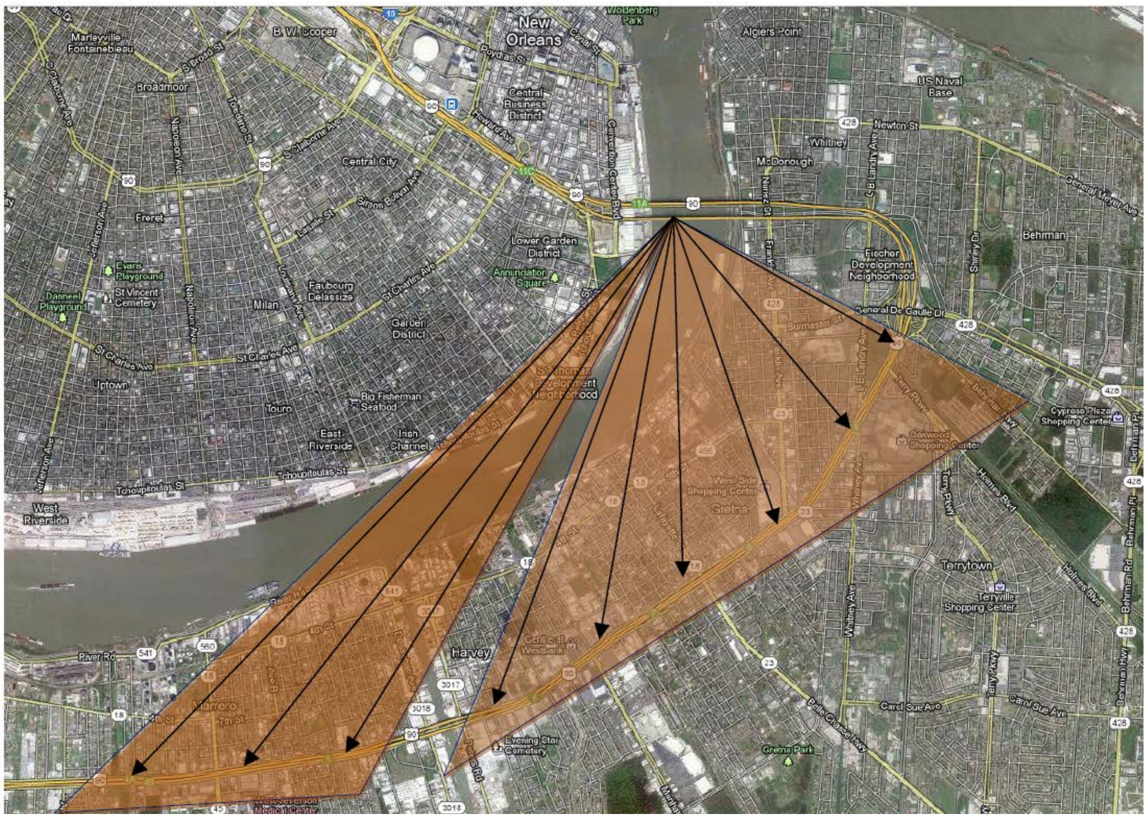

Figure 4. Photo. Approximate coverage of phased-array Doppler radar mounted on Crescent City Connection Bridge.

Installation of the radar unit and its command center was completed on March 14, 2015, and the system is currently going through a testing and burn period.

Operator Interface

An individual radar unit will relay its automatically reformatted data to and receive commands from the New Orleans Regional Transportation Management Center (RTMC) via cellular or ordinary telephone lines or other suitable wireless data link (Figure 5). The radar surveillance will provide accurate, real-time, highly responsive recognition of slowdowns and interruptions in traffic flow on the approaches to the interchange project area and nearby roadways to the RTMC, notifying the Center of backups on the approaches to the project site.

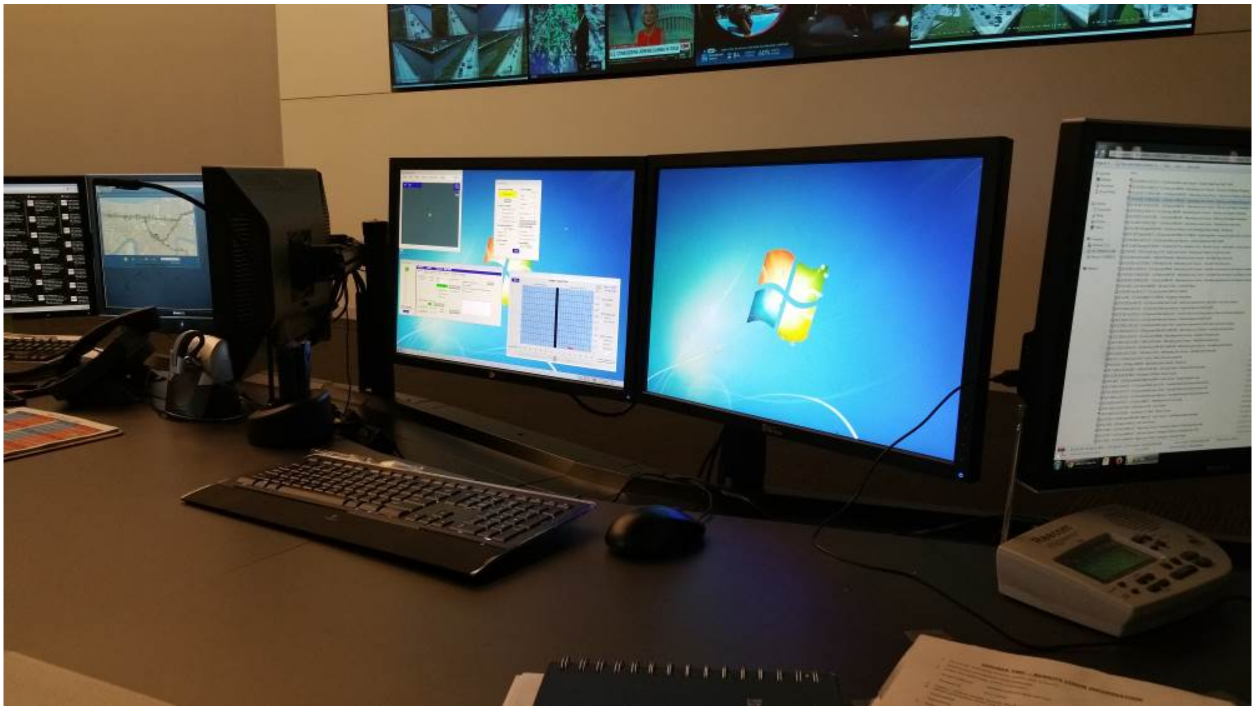

Figure 5. Photo. LADOTD's radar command center.

Ramp Controls

Upon notification to the RTMC, the ramp control system that utilizes an automated gate system that will allow an RTMC operator to activate closure of the Lafayette Street onramp to US 90 B west bound by means of flexible gates to the elevated West Bank Expressway structure to mitigate traffic congestion during peak hours. Currently, the foundations for the automated gates have been placed and the poles have been erected as shown in Figure 6.

SUMMARY

The goal of this project is to improve the traffic flow of US 90B (West Bank Expressway), mitigate on-going congestion and crashes, and support work zone traffic and incident management during construction. The innovations employed on this project included the use of a phased-array Doppler radar and corresponding operator interface for traffic monitoring, as well as a remotely controlled gate system for the on-ramps. LADOTD anticipates that these innovations will greatly reduce the congestion and crashes during the upcoming interchange construction. In addition, these innovative features will remain in place and continue to be functional for future construction activities.

Elements of this HfL project, particularly the phased-array radar and the operator interface, are expected to remain in place after the interchange projects are completed, to continue to augment the capabilities of the RTMC and to remain serviceable for future projects in the metropolitan region within the functional range of the radar site.

Figure 6. Photo. Foundations and poles for the automated gates.

ACKNOWLEDGMENTS

The project team acknowledges the invaluable insights and guidance of Highways for LIFE Team Leader Byron Lord and Program Coordinator Ewa Flom, who served as the technical panel on this demonstration project. Their vast knowledge and experience with the various aspects of construction, technology deployment, and technology transfer helped immensely in developing both the approach and the technical matter for this document. The team also is indebted to LADOTD Engineers Nelson Capote, Steve Strength (retired), Chris Morvant, and Li Yang and FHWA Engineers Mark Stinson, John Broemmelsiek, and Jerry Pitts, for their advice and assistance during this project.