



Information Only Technology Assessment – Automated Vehicle Occupancy Detection and Reporting Applications for the San Diego Association of Governments (SANDAG) Expression of Interest

RFI Number 5004567
Due December 1, 2014

Submitted by:
Xerox State & Local Solutions, Inc.
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Germantown, MD 20876

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November 26, 2014

Technology Assessment - Automated Vehicle Occupancy Detection
and Reporting Applications
San Diego Association of Governments
Attn: Greg Tatar
401 B Street, 10th Floor
San Diego, California 92101

RE: Request for Information – Automated Vehicle Occupancy Detection and
Reporting Applications

Dear Mr. Tatar:

We are pleased to submit this response to your Request for Information (RFI) for an
Automated Vehicle Occupancy Detection and Reporting Applications.

If you have any questions regarding our proposal, please do not hesitate to contact our
representative for this effort, Mr. Douglas Chastain, who can be reached as follows:

Douglas E. Chastain, P.E., MBA
VP Sales and Operations – Western US
Tel: 925.216.0483
E-mail: douglas.chastain@xerox.com

Xerox brings the depth of resources and financial capability necessary to deliver the best
overall value to the Sand Diego Association of Governments. I personally extend my
gratitude for considering Xerox in accomplishing your mission and goals.

Sincerely,

Mark Cantelli

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SANDAG VENDOR QUESTIONNAIRE
RFI - AUTOMATED VEHICLE OCCUPANCY DETECTION AND REPORTING APPLICATIONS

*(complete and return form with **EXPRESSION OF INTEREST**)*

Name of Company	Xerox State & Local Solutions, Inc.
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Company Contact Person	Mark Cantelli
Contact Person Title	Vice President and CTO
Contact Person Phone	(301) 820-4205
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Other than provision of access to the roadway for vendor installation, testing, maintenance, and removal, the limited test participation described above; and support in the permitting process, and interface with the existing I-15 Express Lanes, no funding or other resources will be required from SANDAG or any other agency.

Yes No

The product will be available for testing during fall winter 2014 2015

Yes No

Legal Status: Sole Proprietorship Partnership Corporation

1 Company Introduction

Xerox, a leader in imaging services for over half a century, has applied this expertise to the field of Occupancy Detection with our Xerox Vehicle Passenger Detection System and currently have this solution available to help all our clients with any of their occupancy detection needs.

Xerox

Xerox is more than 140,000 people serving clients in 180 countries and generating over \$21 billion in annual revenue; we are the world's leading enterprise for business process and document management.

Xerox services, technology and expertise enable workplaces—from small businesses to large global enterprises—to simplify the way work gets done so they can operate more effectively and focus more on what matters most: their real business. “From our earliest days, our purpose was never about making copies but making it easier to share information. Chester Carlson, the inventor of xerography, had a vision of ‘making office work a little simpler, a little less tedious and a little more productive.’ Making things simpler has always been in our DNA.”

We're helping customers in areas that you might not expect—going deep in several industries, like healthcare and financial services, and broad in important business functions like customer care and human resources. In the case of the Xerox Vehicle Passenger Detection System, we leveraged Xerox's deep expertise and history with image processing, video analytics, and computer machine vision. By coupling these capabilities with the understanding and capability that Xerox Services (formerly known as ACS) brings to the transportation market, we were able to deliver a solution that utilizes technology to solve a previously unsolvable problem—how to establish accurate passenger occupancy counts in High Occupancy Vehicle (HOV) and High Occupancy Toll (HOT) lanes.

Services

Business process outsourcing: We are the largest worldwide diversified business process outsourcing company with focused offerings in education, transportation, communication, healthcare, government, financial services, manufacturing, consumer goods and retail.

Our BPO services include:

- Human capital management, including total benefits outsourcing and strategic learning services.
- Finance and accounting outsourcing in areas like order-to-cash, payroll processing, travel and expense accounting, and treasury and cash management.
- Customer care services for activating accounts, collections, inside sales, and product/lifecycle support.
- Electronic health record and health information exchange management as well as transactional and systems support for healthcare providers and payers.
- Transportation services including public transit fare collection, automated toll collection, demand-based parking solutions, back-office processing, and related infrastructure installation and support.
- Services exclusive for federal, state and local government in areas that range from claims processing and human services support to transportation solutions.

Xerox and the Tolling Industry

Today Xerox provides solutions that address our customer's business critical mobility problems with an installed base of over 1800 tolling lanes and hosting some of the largest ETC Back Office Systems/Customer Service Centers in the world. We process over \$5 billion in ETC transactions per year on average – that is over 60 percent of all ETC transactions in the United States and represents over 1.6 billion ETC lane transactions.

Xerox VPDS Advantages

- Proven and successful implementations
- Financial backing of a *Fortune* 200 company
- Uses readily available commercial off the shelf products

Today, we serve the needs of 22 tolling agencies across the country. Our VECTOR 4G tolling program is customized for each of those agencies, producing extremely positive results in every case. We process over 95 million images per year and our highly trained Customer Service Representatives handle more than 21 million calls per year.

We design and maintain multiple complete toll collection systems and currently support 15 agencies that are members of the *E-ZPass*[®] Group (formerly the Interagency Group (IAG)) toll interoperable network. In this capacity, we process nearly 70 percent of the network's tolls transactions. We also operate interoperable revenue collection systems for two other leading toll networks: *FasTrak*[®] (California) and *SunPass*[®] (Florida).

2 Product Overview

REQUIREMENT: RFI Section II.A.2, p. 3

2. Product Overview: Describe the proposed product or system, including hardware components, software, necessary supporting equipment and systems, power and communications, and required system interfaces. Wherever possible, provide supporting information including specifications; cut sheets (including for third party software and equipment); process and workflow diagrams, and software and hardware architecture diagrams.

Xerox® Vehicle Passenger Detection System identifies the number of occupants in a vehicle with 98.9% accuracy for HOV-2 and 95.1% accuracy for HOV-3, at speeds ranging from stop and go to 100 mph.

The system uses video analytics to identify the number of occupants in a vehicle. Geometric algorithms detect whether a seat is vacant or occupied. If the setting on the HOT lane transponder doesn't match with the number of occupants, the system will take a snapshot of the vehicle's license plate and alert law enforcement to the violator. If the system determines that number of occupants in the vehicle does not meet the criteria to be in the lane (say HOV-3), the license plate and images from the vehicle can be transmitted to an enforcement officer. The enforcement office can then take appropriate action.

The system is constructed using a front image camera and a side image camera to capture the vehicle interior views. The system relies on cameras that are standard, commercial-off-the-shelf traffic cameras and also utilizes standard loops or lasers for detection and triggering. The Xerox algorithm which operates within the roadside video image processor performs the image analysis and establishes the count. The system can be configured to connect to fiber optics, Wireless Wide Area Networks (4G LTE) or to WiFi, depending upon the needs of the installation. In addition, the system can include a removable hard drive (currently up to 3 TB but will expand as storage densities increase) to store the images.

Enables Full Automation of Violations

Xerox® Vehicle Passenger Detection System identifies the number of occupants in a vehicle with 98.9 % accuracy for HOV-2 and 95.1% accuracy for HOV-3, at speeds ranging from stop and go to 100 mph. The high-quality images provided by the system, along with the evidence package enable full automation of violations as legislation allows.

Xerox VPDS

- High accuracy at highway speeds
- – HOV2 lane: 98.9% accuracy
- – HOV3 lane: 95.1% accuracy

Uphold the Integrity of Your HOV and HOT lanes

Enforcing the rules of the HOV/HOT lanes improves the customer experience for those who abide by the rules. It helps governments validate the integrity of HOV lanes.

- Available as a stand-alone product
- Uses commercially available camera equipment
- Easy to setup – roadside or overhead camera
- Determines windshield location with 99% accuracy
- High accuracy at highway speeds
 - HOV2 lane: 98.9% accuracy
 - HOV3 lane: 95.1% accuracy



Exhibit 1. Fixed Installation

Ideal for Privacy Advocates

For privacy purposes, facial images are redacted. With appropriate authorization, law enforcement or court personnel can view the unredacted photographs.



Exhibit 2. No Redaction

This is the original and untouched image.



Exhibit 3. Permanent Redaction

Faces are redacted. This cannot be undone.



Exhibit 4. Reversible Redaction

The option to reverse redaction is available with appropriate authorization.

*The entire image is redacted, but the redaction can be reversed
by an official with the correct key*

Your Choice of Mobile or Fixed Installation

Depending on your situation, you may choose between a fixed (Exhibit 1) and mobile installation (Exhibit 2). Both offer the same accuracy ratings, but have their own benefits.

Fixed Installation: In this type of installation, the camera is mounted in a fixed configuration on existing or new infrastructure. The Cameras, Illuminators, and Electronics Package (includes Video Image Processor) must be firmly attached to poles and/or gantries and trained to ensure optimal system performance. Training time for the system is minimal.



Exhibit 5. Mobile Installation

Mobile Installation: the system can also be deployed as a Mobile Unit. In the Mobile Unit configuration, a complete self-contained system is mounted on a trailer which can be transported from location to location to ensure that violation enforcement points can be moved around, in order to keep potential violators honest.

Installation Packages

We offer three different package levels to choose from.

1. Base Configuration. The base configuration that comes with every installation includes front image camera, front illuminator, side image camera, side illuminator, video image processor, power conditioning unit, and a trigger sensor to activate the illuminators and cameras.

2. Option 1 – Utilize Existing Sensors. The Xerox® Vehicle Passenger Detection System can also be connected to sensors that are already installed as part of existing infrastructure. Loop-based sensors or laser-based sensors are supported by the system using standard industry interfaces.

3. Option 2 – Integrate with License Plate Recognition. In order to create a violation and transaction package that includes license plate images and the results from a license plate recognition (LPR) module, the system can also be connected to a license plate recognition system—either an existing LPR system, or to our License Plate Recognition System.

Equipment Specifications

Table 1. Equipment Specifications

Specification	Value
Operating Temperature	-40°C to +70°C ambient*
Storage Temperature	-20°C to 80°C
Operating Humidity	20% - 80% RH non-condensing
Operating Supply Range	208/240 VAC
Operating Supply voltage Frequency	47 - 63 Hz
Rate of Speed	5 -100 MPH

Specification	Value
Data Storage	The data is encrypted and stored locally.
Data Communications	Store on local hard drive or connect to wireless or landline network

Table 2. Detection Accuracy

Detection Area	Level of Accuracy
Front Seat	99%
Back Seat	96%
Region of Interest Detection	99% Front, 90% Rear
Overall Human Readability	>99% Front, 91% Rear
* System temperature range can be tailored to local requirements	

3 Current Product Status

REQUIREMENT: RFI Section II.A.3, p. 3

3. Current Product Status: Describe the current manufacturing status of the product (e.g., preproduction testing, production, etc.).
- If not in commercial production, confirm that there is a workable prototype for testing.
 - If in commercial production, provide information on the specific products and systems in production, including model number/version.

The Xerox Vehicle Passenger Detection System - Available for Industry Testing

Xerox has conducted extensive internal trials on the Xerox Vehicle Passenger Detection System and is now offering the system for pilots to select agencies in order that the agencies can participate in the evaluation of the system. Xerox is seeking interested parties that will participate in the test and evaluation of the system, and then also contribute to the review of the results from the test. Lastly, Xerox and the member agency would collaborate on the publication of the test results.

Xerox VPDS

- Tested in Halifax, Nova Scotia
- Trial underway in Irvine, CA
- Demonstrated at ITS World Congress

Xerox Conducted an Extensive Trial in Halifax, Nova Scotia

Xerox has previously conducted a trial (fixed mount deployment) on a live roadway in Halifax, Nova Scotia. As part of this trial, Xerox reviewed over 250,000 vehicles which passed by the system and assessed whether the Vehicle Passenger Detection System had provided an accurate count of the occupants in the vehicle.

The data was gathered over a thirty day period. As part of the trial, the system generated a count for the number of occupants in the vehicles that passed by. The images which were captured were then evaluated by human reviewers who established an independent count of the occupants. These results were compared to establish an accuracy statistic.



Exhibit 6. Fixed mount deployment

The results that were produced were:

- **98.9 % Front Seat Accuracy** – This statistic indicates that 98.9% of the time the output from the automated vehicle occupant count for the Front Seat matched the count produced by humans reviewing the images that were captured.
- **96.2% Rear Seat Accuracy** – Similarly, 96.2% of the time, human review of the Rear Seat images produced the same occupancy count as the Xerox Vehicle Passenger Detection System.

Intelligent Transportation System World Congress 2014 (ITS WC 2014) Demonstrations

In September, 2014, Xerox conducted a series of demonstrations of the system at the ITS World Congress in Detroit, MI. During this event, participants were able to view the system performing. Xerox performed over 60 demonstrations of the system over a three day period. This demonstration was conducted using the Mobile Unit version of the system.

Xerox Has Several Other Pilots In The Planning Stage

Xerox recognized the need in the industry for Occupancy Detection and is currently planning other Pilots around the country to ensure testing results from a variety of environments and roadway configurations. Currently we are pursuing Pilots at these locations

- CalTrans District 12
- BATA
- Colorado Department of Transportation



**Exhibit 7. Mobile Unit
Demonstration**

4 Related Projects

REQUIREMENT: RFI Section II.A.4, p. 4

4. Related Projects: Provide a list of projects undertaken by the company that are related to vehicle occupancy detection and measurement, if any, including:
- i. size (dollar amount of engagement);
 - ii. start date and end date of contract or demonstration;
 - iii. results of implementation and testing and any documented performance data;
 - iv. locations, name and contact information of customers, particularly those in the United States and all customers in California.

The Most Applicable Project is an extensive internal trial conducted by Xerox on the Mackay Bridge in Halifax, Nova Scotia

The Halifax trial was an internal trial conducted during the month of October, 2013. The purpose of the trial was to assess the performance with live traffic. Previous tests conducted by Xerox were in controlled settings, but this test was conducted in conjunction with the Halifax-Dartmouth Bridge Commission.

1. The Halifax trial was conducted at no cost to the Client agency as it was intended to collect data for the purposes of proving out the system.
2. The dates that the trial was conducted were from October 11, 2013 – October 22, 2013.
3. Over 250,000 images were gathered during the course of the trial. The Xerox Vehicle Passenger Detection System generated automated occupancy counts for the vehicles, and these counts were compared to counts established by human reviewers of the images. The Xerox system provided accurate counts for the number of occupants in the Front Seat 98.9% of the time and accurate Rear Seat occupant counts 96.2% of the time.

Steve Snider, General Manager & CEO
Halifax Dartmouth Bridge Commission
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5 Proposed Test and Required Resources

REQUIREMENT: RFI Section II.A.5, p. 4

5. Proposed Test and Required Resources: Describe proposed testing. Provide a general explanation of total vendor resources (including labor, equipment, facilities) required for the testing and over what duration they will be required. Indicate what type of physical access to the devices will be required and the proposed method for installing and securing the devices.

Xerox Vehicle Passenger Detection System Test and Report Overview

In conducting the test and producing the results, the Xerox process would follow these steps:

1. Site selection and test design: Xerox would work with the agency to identify a location suitable for the pilot.
2. Equipment installation: after identifying the location, the system equipment would be installed by Xerox personnel with agency personnel providing access to the site location and any other support agreed to in the MOU.
3. Training period: training the system will require 1-2 days in order for the system to adjust to the location, angle of installation for the cameras, proximity to traffic, and other factors. In order to train, Xerox expects to review approximately 500 vehicles.
4. Data gathering: once in operation, Xerox and the agency will engage in a period of data collection. This is expected to be 3-4 weeks depending upon the daily traffic volume for the location.
5. Data analysis and comparison: Xerox and the agency will collaborate on reviewing the images and assessing whether the automated occupancy count matches the count as established by the human manual review of the images.
6. Report generation: Xerox and the agency will collaborate on developing a report summarizing the findings from the pilot.
7. System decommissioning: Xerox will remove the equipment with appropriate support by agency personnel.

Site Selection and Test Design

Xerox would plan to work with the agency to narrow down the possible site locations. Among the attributes Xerox and the agency would need to consider as part of the Site Selection and Test Design are:

1. Available space to install the system
2. Traffic volume should be sufficient to establish a meaningful trial
3. Ready availability of communications and power
4. Ability for technicians to install the equipment safely
5. Ease of access to the location to perform maintenance (if needed) or to retrieve images from hard drive (if the test design uses the hard drive as the data retrieval method)
6. Duration of pilot

Equipment Installation

After a location has been established, Xerox and the agency would collaborate to install the equipment. The expectation is that Xerox technicians or subcontractors would perform the work, with the agency providing access to key resources such as electrical power, mounting locations, and access to the roadway.

Training Period

Once the equipment is installed, Xerox technicians will conduct a training period for the system. This is expected to require two days during which Xerox technicians will evaluate most if not all of the images produced by the system. This period is intended to tune the system to ensure that camera angles are correct and that the system is calibrated for the local set up.

Data Gathering

After the training period, the system will collect a set of data that is comprised of:

1. Images of vehicles and vehicle interiors
2. Occupancy scores generated by the system

This data will be collected as determined in the test design, whether via a fiber optic connection, wireless connection or from a retrievable hard drive.

Data Analysis

After and during the designated data collection period (3-4 weeks), the Xerox team in cooperation with the agency will compare the results from the system versus the results generated by human review of the images collected. The level of agency participation is to be determined by the agency; however Xerox would request that the agency, at a minimum, assist in validating the results to ensure that the assessment is independent.

Report Generation

Xerox and the agency will then collaborate on developing a report summarizing the findings such that the data can be presented to agency management, and such that Xerox can also present the findings to other agencies and industry bodies (i.e. IBTTA).

System Decommissioning

At the conclusion of the data gathering phase, the Xerox team, with appropriate support from the agency, will remove the equipment from the location and decommission the installation.

Resource Requirements and Timing

The Xerox team is prepared to support the installation and management of the system. The effort is expected to require 7-9 weeks from site selection through data collection and analysis to report generation.

A high level plan is summarized below:

1. Site Selection: two (2) days; One (1) Xerox engineer plus agency support for access to site
2. Equipment Installation: Two (2) days; Five (5) Xerox personnel including electrical technicians, electrical engineer, research scientist, software engineer; agency personnel as needed for access to location. MOT responsibility to be determined.
3. Training: Three (3) days; Five (5) Xerox personnel—similar to Equipment Installation
4. Data Gathering (3-4 weeks): Minimal support; routine contact and monitoring with the system. May be remote monitoring if communications is available; may require hard drive retrieval.
5. Data Analysis: Xerox technician with support from agency. Approximately 500 images can be evaluated an hour. 100,000 images will require 200 technician-hours. Statistically significant results can be obtained with fewer data points.
6. Report Generation: Xerox Research Scientist (1), Xerox Product Management (1); agency personnel as designated. Two (2) weeks.
7. System Decommissioning: One (1) day; Two (2) Xerox personnel.