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PURSUIT MANAGEMENT:
FLEEING VEHICLE TAGGING AND TRACKING TECHNOLOGY

Award #: 2010-IJ-CX-K022

October 31, 2013

Final Technical Report

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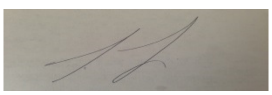
Signature: ______  _____Date:_____________
Title: President

Name: Keo Hadsdy

Signature:____________________________ Date:_____________

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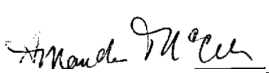
Signature: ____  ___ Date:_____________
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Executive Summary:

Problem Statement:

Since the late 1980s, The National Institute of Justice (NIJ) and Law Enforcement Agencies (LEAs) worldwide have been seeking a solution to better manage police pursuit outcomes.

StarChase has developed a tagging and tracking technology that allows law enforcement to deploy a GPS tag onto a fleeing vehicle. This allows the pursuing vehicle to fall back and drive a slower, safer tactical interdiction.

The launcher contains two GPS tags and is installed into the grill of the police vehicle with the interior control panel and/or remote key fob providing deployment capabilities. When the officer deploys the GPS tag on the fleeing vehicle, the tag begins to transmit location based updates in "real-time" which is every 2-5 seconds.

Available Data:

Pursuits are a widely known liability for LEAs and the statistics surrounding them are often discussed. Here are the most relevant facts:

1. 55,000+ injuries per year (Lewinski, 2013)
2. 360+ officer and civilian fatalities per year (pursuitsafety.org: NHTSA FARS data)
3. $1.3+ Billion in jury-awarded damages (AELE Law Library, Case Summaries 1988-2007)

The following is a snapshot of pursuit settlements summarized from recent years:

Pursuit Settlements 2006-2014

Settlement Year	Jurisdiction	Award Total	Link/Source:
2008	Chicago, Illinois	28,217,883	https://vjcl.files.wordpress.com/2014/05/2-1-iris-smw-3-31-14.pdf
2011	Chicago, Illinois	6,580,000	https://vjcl.files.wordpress.com/2014/05/2-1-iris-smw-3-31-14.pdf
2006	Chicago, Illinois	6,100,000	https://vjcl.files.wordpress.com/2014/05/2-1-iris-smw-3-31-14.pdf
2014	Los Angeles, California	5,000,000	http://www.scpr.org/news/2014/08/20/46124/la-approves-5-million-settlement-for-family-of-man/
2014	Houston, TX	5,000,000	http://www.news10.net/story/news/nation/2014/07/28/houston-police-chase-lawsuit-5-million-dollar-settlement/13300007/
2007	Chicago, Illinois	4,311,607	https://vjcl.files.wordpress.com/2014/05/2-1-iris-smw-3-31-14.pdf
2014	Cleveland, Ohio	3,000,000	http://www.cleveland.com/court-justice/index.ssf/2014/11/cleveland_police_settlement_ch.html
2010	Chicago, Illinois	3,000,000	https://vjcl.files.wordpress.com/2014/05/2-1-iris-smw-3-31-14.pdf
2006	Leawood, KS	2,980,000	http://cjonline.com/stories/011806/bre_chasesettlement.shtml
2011	Petersburg, Virginia	2,059,000	http://www.richmond.com/news/article_ea5d00ca-5f3a-5119-9b67-f69b0bde2fc8.html
2012	Chicago, Illinois	1,385,000	https://vjcl.files.wordpress.com/2014/05/2-1-iris-smw-3-31-14.pdf
2008	Washington, DC	1,200,000	https://www.prisonlegalnews.org/news/2008/aug/15/12-million-settlement-for-childrens-death-during-dc-police-chase/
2008	Cleveland, Ohio	1,000,000	http://www.cleveland.com/court-justice/index.ssf/2014/11/cleveland_police_settlement_ch.html
2011	St. Louis, Missouri	700,000	http://www.stltoday.com/news/local/crime-and-courts/settlement-in-st-louis-crash-sheds-light-on-police-pursuit/article_9f7473ec-f0ad-53cd-96e5-9e57d9f4a463.html
2013	Yakima, Washington	400,000	http://www.yakimaherald.com/news/yhr/tuesday/1423844-8/city-of-yakima-reaches-settlement-for-death-in

The settlements and research references above are based upon limited information available to the industry. There is no mandatory pursuit reporting system for law enforcement and as a result, the data is extrapolated from multiple disparate sources. For instance, the fatalities referenced from the Fatality Analysis Reporting System (FARs) report only report on state and federal highway fatalities. Sources, such as PursuitSAFETY, indicate fatalities are two to three times higher when considering local and municipal road ways.

The monetary estimate is also dramatically low as it does not include out-of-court settlements, LEA health care costs, related agency property damages and overall lost productivity to all involved. The supporting listed settlements totaling nearly $70 million are a small fraction of sourced awards that were a newsworthy headline or article. It is worth noting that Chicago is largely identified because they are one of the few cities that post litigation and subsequent settlements. Seven years (2007-20012) of data identify *nearly $50 million in pursuit related settlements and this is only in Chicago*.

Despite the fractured data, the need for a better alternative to the traditional police pursuit is obvious as news headlines continue to reflect tragic outcomes on a daily basis. StarChase solicited the award based upon successful beta trials and the following summarizes the research goals of the cooperative agreement.

Research Goals:

StarChase received this award in FY 2011 and an initial part of its implementation was a meeting with our program manager, the Pennsylvania State Center of Excellence Associate Director, and the Pursuit Management Technical Working Group. During the meeting we informed those gathered that much of the generation II (SC GEN II) technology development was nearly complete. Field trials and several technology improvements, where officer feedback would be invaluable, were a next stage goal for fielding the product and establishing the system as a valued pursuit management tool for the law enforcement community. As a result of this meeting we focused on the following goals in the Statement of Work.

1. Establish four test beds with 10 units per test bed in a variety of agencies (urban/rural) and environmental conditions (desert/rain) to evaluate the system's performance capabilities. The goal of the test beds was to evaluate criteria as mutually determined by the customer, technology provider and NIJ. Targeted outcomes included an evaluation of system capabilities, user friendliness and to collect data on real-world tagging case studies and summarize the outcomes.
2. The engineering improvements were established based upon the current SC GEN II pursuit management system with suggestions from our LEAs for customer improvement:
    a. Integrate an on-board compressor into the SC GEN II system in order to reduce the operational costs of the system and to ensure a stable PSI to deploy the projectile consistently when tagging a fleeing or high-risk vehicle.
    b. Explore adhesive alternatives for a broader range of environmental conditions. The existing adhesive was limited when temperature dropped below 32^{o} F and also showed less than optimal performance in wet environments. Improvements in this area will allow the system to be used in a broader range of geographic areas.
    c. Explore targeting and range finding capabilities to measure distance to target/vehicle. This approach provides an officer both visual and audible confirmation when in range of the target vehicle.

Background and Research Results:

The research was designed to provide user feedback on the system's performance and the engineering improvements explored under the goals of the cooperative agreement. The agreement also sought to gather user case study details of tagging events in the field to determine if the system reduces the risks and liabilities associated with high-speed pursuits.

StarChase and the NIJ worked collaboratively with Dr. Geoff Alpert in order to develop the research methodology and protocols for the field trials. This technical report includes a proposed Research in Brief (RIB) that summarizes our test bed results (*see attached Appendix 1:StarChase/NIJ Report Proposed RIB)*. Dr. Alpert has been involved in pursuit research for more than 20 years. He is a prior chair and current professor for the University of South Carolina's Criminology Dept. Dr. Alpert's past research includes interviews with incarcerated individuals involved in past police pursuits. The interviews provided data collected from three different correctional facilities. "One of the more interesting findings from the suspects concerned their willingness to slow down when the police stopped chasing them. Approximately 75% reported that they would slow down when they felt safe. They explained that on average, they would have to be free from the police show of authority by emergency lights or siren for approximately two blocks in town and 2.5 miles on the freeway" (Schultz, Hudak & Alpert, *FBI Law Enforcement Bulletin,* 2010). Alpert's data from this agreement has generated positive leading indicators to support this prior research. The case study examples included in the proposed RIB indicate the following:

- On average, a tagged suspect slows to within 10 miles of the posted speed limit in less than two minutes.
- Case study examples experienced no injuries, no fatalities and no property damage.
- An 80+% apprehension rate.

The engineering goals also allowed StarChase to test technology improvements in the field and gain agency feedback.

The first system improvement involved the ability to integrate an on-board air compressor. The integration of the on-board air compressor was the least complicated of the explored system improvements. The compressor is now separated from the launch system and this allows for a smaller footprint for the launcher unit in the grill of the vehicle. It allows the launcher to deploy a GPS tag at a stable PSI without the ongoing maintenance and expense of using a compressed air canister which was previously used. StarChase selected a commercial of the shelf (COTS) air compressor which met all of the governmental and environmental specifications necessary for vehicle installation. After passing the bench testing in the laboratory, and trialing the unit in our test vehicle, the compressor was installed on all units at our first two test bed locations. The agencies gave immediate positive feedback of preference for this approach versus maintaining the system with replacement canisters. This air compressor is now part of our standard product.

Our engineering challenge increased as we began working on the improved performance of our adhesive in a wider range of environmental conditions. We worked with a variety of other consultants/vendors, and gave them the criteria for improved performance. The vendor's insights were incorporated in order to improve adhesion for off-angle tags by increasing the tag's time-on-target at impact and by improving flight characteristics. StarChase was able to successfully reduce the density of the nose cone to increase time-on-target.

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The subsequent adhesive research led to identifying a new proprietary adhesive, which allows for successful deployment at dew-point and its technical specifications allow for deployment at 8^{o} F, below our current cold weather temperature limits. The solution produced additional benefits by lowering the temperature required for successful adhesion. This allows for an in-the-barrel, ambient temperature reduction of over 30^{o}, and lowers the temperature required for the projectile's successful adhesion. For the agencies using the system, this equated to improved shelf life and faster system arm time.

At present, StarChase and our adhesive consultants agree; in a true wet environment (rain/snow) there is still a hydroplane effect occurring on the target at time of impact. We plan to continue exploring design alternatives. The improved adhesive and nosecone have been deployed to all of our customers.

The final engineering goals focused on an officer's ability to know when they are within range of a target prior to deploying a GPS tag ensuring ease of use during deployment. The goal was to provide the officer both a visible and an audible signal when they are in range of the suspect vehicle.

We explored multiple technologies to measure distance to target including infrared optic (IR), laser reticle, sonic and radar. The technologies evaluated each had specific benefits but the cost of the improvement was a primary concern as we evaluated the overall cost to the system. The IR optic and the sonic commercially available solutions were low cost but unfortunately failed at the bench test. The radar option was very expensive (with an $800 to $1,200 expense added to the system cost before expenses for design integration even began).

The solid state laser dynamic range detection (SSL DRD) passed our bench test and was integrated into our test vehicle; the system provided an audible tone when in range. This method prevents an officer from deploying a tag when out-of-range. The tone helps officers know when they are in or out of target range. StarChase elected to move forward with the SSL for in-vehicle testing. Today, the distance/range detection module uses a COTS based SSL. The laser module is successfully installed in a portion of vehicles in Arizona with the remaining vehicles acting as a control group. We are gathering data to determine if the distance to target solution improves performance. The performance evaluation will include officer feedback on ease of use; we will then determine if the increase in price provides enough added-value to the law enforcement community.

Dissemination:

StarChase has shared the data generated during the cooperative agreement with the NIJ and we will continue to share/publish this information with the following key audiences: the general public; the National Institute of Justice; law enforcement agencies represented at the local , state and federal levels; stakeholder organizations with both political and key NGO affiliations such as the insurance industry and advocacy groups such as PursuitSAFETY, MADD; and other key interested technologists within the Department of Defense and law enforcement space.

StarChase's website (starchase.com) features a *News* page which shares current news reports highlighting pursuit related information and media, company announcements and media coverage of our solution.

We have also shared case study events with the NIJ and once cleared through the NIJ and the related agency, the case studies are shared as success stories on our website. We continue to share tagging events and outcomes with our program manager:

http://www.nij.gov/nij/topics/law-enforcement/operations/pursuit/technology-developments.htm#remotetracking)

The proposed Research in Brief (RIB), will be released to all law enforcement community trade magazines and related organizations. The proposed RIB will be presented during the upcoming International Association of Chiefs of Police (IACP) conference in October 2014 at the NIJ Saturday track session.

We will also disseminate to law enforcement periodicals and media outlets such as the FBI *Law Enforcement Bulletin*, NLECTC's *Tech Beat*, The Police Executive Research Forum, the International Association of Chiefs of Police, the National Sheriff's Association, the National Organization of Black Law Enforcement Executives, The Fraternal Order of Police, Commission on Accreditation for Law Enforcement Agencies and any related programs such as COPs and BJA.

We have received past positive news coverage in the past from *USA Today, Popular Mechanics, Popular Science, Jane's, WIRED Magazine* and many other relevant news outlets such as *ABC World News*, *CBS This Morning* and *FOX News*. We are also reaching out to traditional law enforcement market publications such as Police One and Officer.com.

The evidence of safe outcomes revealed in our case studies creates an opportunity for legislators to have a positive national impact on citizen safety with a tool that makes a difference for law enforcement officers serving our communities. We are actively working with our government representatives to support initiatives that allow LEAs to trial the technology with the support of grant funding including the Justice Assistance Grant (JAG), Community Oriented Policing Services (COPS) and Governor's Highway Safety Association grants with funding provided by NHTSA.

The dissemination strategy is a critical part of the program conclusion as agencies are actively seeking additional grant funding in order to adopt the technology. We are working collaboratively with LEAs and public risk pools/to demonstrate cost/benefit analysis to specifically address the reduction in risk and related liabilities when StarChase is part of a police force's toolbox.

This technical report summarizes the results of our cooperative agreement. The NIJ has been studying police pursuit outcomes since the late 1980s and has been seeking a solution to this ongoing problem. We are pleased that the preliminary research data indicates StarChase is a "game changing technology" that is making a tactical difference in the ongoing management of police pursuits, reducing agency risk and improving community safety.

I. Introduction:

Problem Statement:

The National Institute of Justice (NIJ) and Law Enforcement Agencies (LEAs) worldwide have been seeking a solution to better manage pursuit outcomes since the late 1980s.

StarChase has developed a tagging and tracking technology solution that allows law enforcement to deploy a GPS tag onto a fleeing vehicle. This allows the pursuing vehicle to fall back and develop safer tactical intervention methods.

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2006	Chicago, Illinois	6,100,000	https://vjcl.files.wordpress.com/2014/05/2-1-iris-smw-3-31-14.pdf
2014	Los Angeles, California	5,000,000	http://www.scpr.org/news/2014/08/20/46124/la-approves-5-million-settlement-for-family-of-man/
2014	Houston, TX	5,000,000	http://www.news10.net/story/news/nation/2014/07/28/houston-police-chase-lawsuit-5-million-dollar-settlement/13300007/
2007	Chicago, Illinois	4,311,607	https://vjcl.files.wordpress.com/2014/05/2-1-iris-smw-3-31-14.pdf
2014	Cleveland, Ohio	3,000,000	http://www.cleveland.com/court-justice/index.ssf/2014/11/cleveland_police_settlement_ch.html
2010	Chicago, Illinois	3,000,000	https://vjcl.files.wordpress.com/2014/05/2-1-iris-smw-3-31-14.pdf
2006	Leawood, KS	2,980,000	http://cjonline.com/stories/011806/bre_chasesettlement.shtml
2011	Petersburg, Virginia	2,059,000	http://www.richmond.com/news/article_ea5d00ca-5f3a-5119-9b67-f69b0bde2fc8.html
2012	Chicago, Illinois	1,385,000	https://vjcl.files.wordpress.com/2014/05/2-1-iris-smw-3-31-14.pdf
2008	Washington, DC	1,200,000	https://www.prisonlegalnews.org/news/2008/aug/15/12-million-settlement-for-childrens-death-during-dc-police-chase/
2008	Cleveland, Ohio	1,000,000	http://www.cleveland.com/court-justice/index.ssf/2014/11/cleveland_police_settlement_ch.html
2011	St. Louis, Missouri	700,000	http://www.stltoday.com/news/local/crime-and-courts/settlement-in-st-louis-crash-sheds-light-on-police-pursuit/article_9f7473ec-f0ad-53cd-96e5-9e57d9f4a463.html
2013	Yakima, Washington	400,000	http://www.yakimaherald.com/news/yhr/tuesday/1423844-8/city-of-yakima-reaches-settlement-for-death-in

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Despite the fractured data, the need for a better alternative to the traditional police pursuit is obvious as news headlines continue to reflect tragic outcomes on a daily basis. StarChase solicited the award based upon successful beta trials and the following summarizes the research goals of the cooperative agreement.

Research Goals:

In order to further validate the technology and improve the system's capabilities the company entered into a cooperative agreement with the NIJ to:

1. Engineer/develop additional system improvements into our Generation II operating platform based upon officer/institutional feedback and design modifications that are beneficial to the user with regard to functionality and cost.

2. Implement four key test beds with 10 units per test bed to reflect varying agency structures and environmental conditions. The goal of the research is to gain user feedback on the system's capabilities in a variety of scenarios.

Research Rationale:

The research is intended to provide user feedback on the system's performance with the engineering improvements explored under the goals of the cooperative agreement and to gather user case study details of tagging events in the field to determine the system's ability to reduce the risks and liabilities associated with high-speed pursuits.

II Methods and Results:

II.A Methodology:

StarChase Pursuit Management Technology (SC GEN II) was the initial platform for the proposed additional improvements. SC GEN II met law enforcement's criteria for use in the field. *(See Appendix 2 for summary of SC GEN II platform.)*

The research and development goals are intended to determine which improvements would be fielded by law enforcement while balancing user friendliness and cost of improvements on a per unit basis.

SC GEN II was established and operational prior to the cooperative agreement and was the basic model for the proposed test beds, engineering improvements and furthering of the adhesive performance.

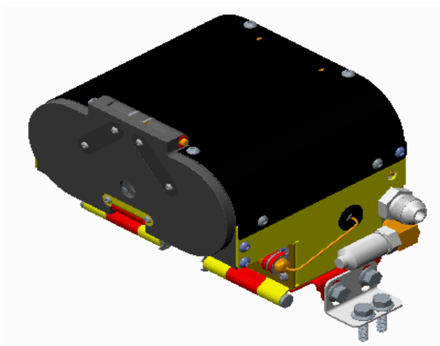

Figure 1: SC GEN II – Launcher

Figure 2: SC GEN II - Console/Launcher Controller

Our program methodology encompassed both research in the field and development in the laboratory. We used multiple evaluation tools to allow rigorous testing and data collection under each stated goal category.

In collaboration with our NIJ program manager, Joseph Cecconi (succeeded by Brian Montgomery) and Dr. Geoff Alpert, the research protocols and design methods were established for data collection. Dr. Alpert worked with LEAs, StarChase and the NIJ to implement the data collection process in the field.

Our technical development in the laboratory included initial evaluation and design modeling via PRO-E software in order to design and/or select prototypes as well as best 'commercial off-the-shelf' (COTS)component candidates. Once the prototype was developed, or COTS part selected, it was first brought into the laboratory environment for integration and bench testing with our SC GEN II launcher and projectiles. Based upon laboratory results the prototype, or COTS selection, would then be installed in our test vehicle. After testing in real-world environments, StarChase would then manufacture additional 'limited rate initial production' (LRIP) models or purchase 1-10 COTS units for fielding and trialing at the test bed level. The engineering results were disseminated via the test beds and/or directly to NIJ in our progress reports. The following is specific to each of the program goals:

II.B Methodology , Results and Conclusion for Goal #1:

Goal : *Set up four test beds with police agencies of varying structure, with 10 launch systems per test bed to profile pursuit-related risk reduction officer/user behavior and feedback.*

Methodology:

The research methodology for goal one required a multi-stage process that included reviewing and analyzing the official records of the agencies involved and talking with both the officers involved in pursuits using StarChase technology and those who were impacted by its use, but did not use the technology first-hand.

The research protocol required several necessary steps:

1. The test bed agencies using StarChase provided their pursuit policies and training documents for review by the research team. These documents set the basis for analysis of the official documentation being created for the officer surveys and interviews.

2. Brief discussions with the assigned point of contact for each agency took place after the documentation was received and reviewed. The discussions helped determine the specific methodology and timing for site visits and data collection.

3. While slight differences occurred among the agencies, the data collection procedures all followed a similar pattern:

a. Discussions with the agency's assigned point of contact concerning the history of pursuits in the agency and any perceived concerns by command staff, and request for pertinent documentation.

b. Review of documentation by research team, including policies, training materials, completed pursuit review forms and accountability documentation.

c. Initial Site Visit Protocol
    i. Interviews with policy maker(s) and points of contact.
    ii. Survey of officers who have been involved in pursuits
    iii. Interviews with officers who have used StarChase Pursuit technology.
    iv. Review of post-incident data from StarChase.us, the secure map-based tracking site. Officers are instructed to attach the mapping information to the questionnaire they completed.

4. Compilation and Analysis of Data.

   Phase One: Pursuit Management Technology without improvements.
   Phase Two: Pursuit Management Technology with mid-test improvements.

5. Checking findings and review case studies with the agency point of contact.

6. Write Report.

7. Present results to individual participating agencies.

8. Final Report Writing and submission of Report to NIJ.

As a final step, StarChase worked with the NIJ and Dr. Alpert to produce a list of research questions. The questions were answered by the officers via Survey Monkey, an internet site for fielding surveys, polls and questionnaires. *(See attached Appendix #3 for Methodology and Questionnaire).* This methodology was the basic procedure followed for each of the test beds. The results below discuss some of the challenges faced by StarChase in successfully establishing the system and collecting data.

Test bed results:

Some of the largest hurdles StarChase faced with the test beds included the time estimated to establish the test beds, on-going training and subsequent data collection.

The agencies considering the program had to evaluate program participation, develop protocol for the installation and use of the system, and then incorporate installation and officer training into their operating procedures and schedule. This process took much longer than StarChase anticipated and required us to extend the data collection of GPS tags (*Appendix #1*) to the end of 2013.

The time to train was also challenging and when the vehicle was subject to a rotating pool of officers versus assigned to a specific officer, it required an additional time investment from both StarChase and the agency to train all users. Training key patrol and dispatch officers is a critical component of effectively using the system. StarChase hired a full-time driver/trainer in January 2013. This addition to our team has improved our relationships with the agencies and enhanced the amount and quality of the data the agencies were willing to share with StarChase.

In the early stages of the program, it was challenging to collect data post pursuit. There are a myriad of reasons for this challenge including geographic distance, building a relationship with the officers and just allowing for an officer's very busy schedule. The combined commitment to further this technology, from the agencies, our researcher, and StarChase, led to the proposed Research in Brief.

We determined the need for a control group was minimal due to statistics available from pursuit data sources such as the IACP pursuit database and the NHTSA's Fatality Analysis Reporting System

(FARS.) This aspect of the data collection was deemed unnecessary and cancelled after discussions with our currently assigned program manager, Brian Montgomery.

We also learned to prequalify an agency in order to ensure a pre-established protocol for pursuit management which integrated StarChase *(See Appendix #4 for an example of pursuit policy integrating StarChase.* ***NOTE: This is labeled not for public distribution****).*

Using SurveyMonkey to gather the related data has also been challenging. Although two of the agencies have submitted their information, using SurveyMonkey, the process for receiving data from the agency has evolved in order to better accommodate the agency's busy schedule. StarChase often receives a great deal of detailed information directly from the agency. Even with the improved reporting, the RIB indicates StarChase only knows of deployments approximately 60% of the time.

StarChase pulls reports at the time of pursuit from the tracking database in order to accurately track the most relevant facts: date, time, duration of the pursuit, time to return within 10 miles of the posted speed limit, arrests, accidents and injuries (or other related liabilities) and general description of the event. Unlike the majority of pursuit statistics, we do not rely on the officer's memory to gather measurable data. When a tag is deployed to a suspect vehicle the data generated by the GPS tag is loaded to a secure server for analysis. *(See Appendix 5 for sample screen shot and tracking report).*

Status:

StarChase has test beds established with four agencies and each site has 10 launch systems installed into police vehicles. In addition, a large southwest agency is participating in the data collection process with seven systems. We are currently installed with four agencies: two urban, one semi-rural along with a border agency.

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The following summarizes the status of each test-bed location:

1. Southwest Border: **Installed in August, 2011 and full trained/operational** as of **October, 2011**. StarChase determined that the units were not driven frequently enough and the location was less than desirable for deployment opportunities. There is a pending request to move the units to a location where the units will be exposed to more tagging opportunities based upon the number of pursuits and drug interdictions.

2. West Coast Desert (semi-rural): **Installed in January, 2012** and **fully trained as of April 2012.** The agency continues to be cooperative and enthusiastic. However, they were concerned that the urban placement of the launch systems restricted use and moved all of the units to the to a high desert location which more frequently experiences pursuits, drug interdictions, human smuggling and stolen vehicles. StarChase reinstalled these units in April of 2013 and again trained all users**.** We have since returned for additional training and software updates.

3. East Coast Urban: **Installed on June 24, 2012** with and **full trained October 2012**. The deployment and training went smoothly but because of the scheduling and rotation of the officers/users, it is difficult to keep officers using the system trained due to the number of users. StarChase provided additional training to support the new users so that the officers rotating through know how to use the system. The tag event(s) associated with this agency are part of the database and included in Dr. Alpert's RIB which is pending publication in Q3 2013. Ultimately, this agency discontinued the test beds and units were uninstalled by StarChase in late Q4 2013.

4. Southwest Urban: Police Department is the fourth test bed and was **installed at the end of Q1 2013** with **training completed early Q2 2013**. After working with the agency to complete additional training, they have begun to use the system with regularity and their frequent tags are part of the RIB. The agency submitted, but was turned down, for a second grant from NIJ in order to measure training requirements for the deployment of 60 units. The 60 unit deployment is the agency's suggested deployment rate in order to significantly reduce the pursuit management risks to the agency. They agency continues to seek funds for additional deployments.

5. Southwest (semi-rural) State Agency is contributing data to the program as well. They report use of the system on a regular basis and have recovered millions in drugs and stolen vehicles. *(See Appendices #6A and #6B: The appendix details case study examples).*

Research Summary:

The 36 case studies submitted, combined with Dr. Alpert's onsite interviews, are positive leading indicators which support this research. Our case study examples included in the RIB indicate the following:

- On average, tagged suspect slows to within 10 miles of the posted speed limit in under two minutes
- Case study examples experienced no injuries, no fatalities and no property damage.
- Data indicates a +80+% apprehension rate.

The data indicates use of the StarChase system is making a tactical difference by improving officer safety, reducing liability and increasing community safety.

II.C Methodology, Results and Conclusion for Goal #2:

Goal: *Explore adhesive alternatives for use in a wider range of environmental conditions.*

Methodology:

StarChase explored a variety of Pressure Sensitive Adhesives (PSA) and modifications to our nosecone configuration to improve our GPS projectile.

Prior to the launch of the cooperative agreement/award StarChase was using a 3M adhesive formula. We were meeting with success in the field however, in extreme climates, such as those experienced in the southwest region, there were intermittent unexplained failures and there was no solution to improve this adhesive's ability to adhere in wet conditions, its 'wet stick.'

In the earliest stages of the cooperative agreement StarChase contracted with two adhesive consulting groups. They provided input on the following adhesive characteristics StarChase had defined in order to address the goal stated above.

- ✓ Elongation
- ✓ Softening Point
- ✓ Penetration
- ✓ Adhesion in extreme environments
- ✓ Elastic Recovery
- ✓ High/Low Temperature Flexibility
- ✓ Peel/Stick Strength with Pressure Sensitivity Adhesion (PSA).

In addition to trialing several pressure sensitive adhesive (PSA) samples in the laboratory, we also explored alternative nosecone designs in order to increase the adhesion surface and penetration of the PSA into the nosecone. The modifications were designed with a balance between impact and resistance to high humidity, heat and cold conditions.

The principle goal of the new design was to improve flight characteristics of the projectile nose cone, improve off-angle adhesion for off-angle surfaces and improve wet adhesion.

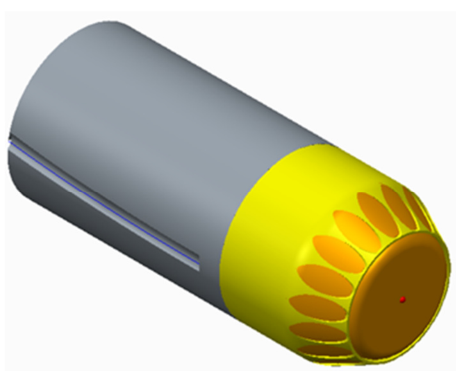

Figure 3: New Nose Cone

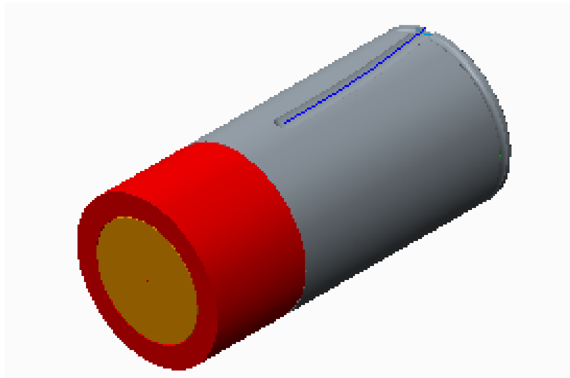

Figure 4: Existing Nose Cone

Results:

Figure 4:

- New Nose Cone - After thorough evaluation and testing in multiple environments the revised nose cone exhibited unstable flight characteristics. Furthermore the reduction in density demonstrated the need for additional exploration to meet the objectives of the goal.

- Formula No. AD-7-69B. Results were unstable and unpredictable in the area of “T-Peel” /fast-tack and moist environments. This formula and design did not warrant further testing. The table below describes the testing.

- Multiple samples were tested in parallel. Initially, one adhesive projectile from each sample was loaded in the launcher and tested for flight and adhesion. The results are summarized below.

New Nose Cone - Formula No. AD-7-69B						
Location	Cycle	Speed/Status	Target Mat	Road Condition	Condition	Pass/Fail
Virginia	5	50-70	Metal &ABS	Paved	Hot (80F)	Pass
Virginia	10	N/A	Metal &ABS	Bench Test	Hot (80F)	Pass
Arizona	10	N/A	Metal &ABS	Bench Test	Hot (80F)	Pass
Virginia	10	55-70	Metal &ABS	Paved	Extreme Cold (25F)	Fail
Virginia	10	N/A	Metal &ABS	Bench Test	Extreme Cold (25F)	Fail
Virginia	10	N/A	Metal &ABS	Bench Test	Dampness	Fail

Table 1: Formula No. AD-7-69B

Fix: Stationary
N/A: No Speed
Hot: 75˚F - 95˚F
Humidity: Relatively 98˚F
Cycle: Two projectiles per cycle
Dampness: Dew Point
Cold: 35˚F - 45˚F
Extreme Cold: (-10˚F) to (+27˚F)

Second adhesive candidate:

- Thorough evaluation in a variety of environments, and data collection in multiple moist weather conditions showed the physical characteristics of this adhesive provided only a slight improvement over the prior adhesive. The formula proved to be unstable and unpredictable in the area of “T-Peel”/fast-tack and moist environments. The condensed table below describes the test results.

Adhesive Candidate 2						
Location	Cycle	Speed/Status	Target Mat	Road Condition	Condition	Pass/Fail
Virginia	5	50-70	Metal &ABS	Paved	Hot (80F)	Pass
Virginia	10	N/A	Metal &ABS	Bench Test	Hot (80F)	Pass
Arizona	10	N/A	Metal &ABS	Bench Test	Hot (80F)	Pass
Virginia	10	55-70	Metal &ABS	Paved	Extreme Cold (25F)	Fail
Virginia	10	N/A	Metal &ABS	Bench Test	Extreme Cold (25F)	Fail
Virginia	10	N/A	Metal &ABS	Bench Test	Dampness	Fail

Table 2: Adhesive Candidate 2

Fix: Stationary
N/A: No Speed
Hot: 75˚F - 95˚F
Humidity: Relatively 98˚F.
Cycle: Two projectiles per cycle
Dampness: Dew Point
Cold: 35˚F - 45˚F
Extreme Cold: (-10˚F) to (+27˚F).

After unsatisfactory outcomes from testing with leading formulas, StarChase began working with an additional adhesive vendor adhesive. This third adhesive produced significant improvement in the field and we have been able to expand our capabilities based upon testing and subsequent field deployments.

The third formula was the selected adhesive based upon testing, over 100 deployments in our laboratory, together with field trials, it indicated much improved performance characteristics.

StarChase continued with an additional 100 projectile deployments to test for cycle time and extreme temperature performance.

Performance testing Locations:

- Arizona for hot, low humidity testing
- Texas for hot, high humidity and dampness conditions
- Virginia Beach, Virginia. Laboratory and road testing with high and low temps
- Extreme cold weather down to (-10F˚) achieved via refrigerated controlled test area

StarChase also continued to explore additional mechanical property improvements and reduced the density of the nose cone and adjusted the heating configurations to create broader application environments and stronger adhesion. *Appendix 7*, Projectile Nosecone Specifications, *Figure 1*, shows the density changes implemented. *Figure 2-3* also details the baselines specified for adhesion temperature control.

After evaluating multiple formulas and vendors, the third formula's "T-Peel" was revealed as the most stable and best performing formula. This selection provided the best adhesion performance in the widest range of environments and temperatures. As a final step in this configuration, StarChase has deployed projectiles with the improved adhesive formula to all test beds. The table below provides characteristics of the test results.

Third Formula Test Results						
Location	**Cycle**	**Speed/Status**	**Target Mat**	**Road Condition**	**Condition**	**Pass/Fail**
Arizona	30	65-97	Metal	Freeway	Hot	Pass
Arizona	20	35-45	Metal	Dusty-Terrain	Hot	Pass
Arizona	10	45-85	Metal	Normal/Paved	Hot	Pass
Texas	40	35-45	Fiber Glass	Normal/Paved	Humid	Pass
California	30	35-45	ABS-Plastic	Normal/Paved	Hot	Pass
Virginia	60	55-70	ABSA	Normal/Paved	Cold	Pass
Virginia	60	N/A	Metal	Stationary	Extreme Cold	Pass
Virginia	3	65-75	Metal	Normal/Paved	Hot	Pass

Table 3: Third Formula Production

N/A: No Speed
Hot: 75˚F - 95˚F.
Humid: Relatively 98˚F
Cycle: Two projectiles per cycle
Dampness: Dew Point
Cold: 35˚F - 45˚F
Extreme Cold: (-10˚F) to (+27˚F).

Third Formula: Currently deployed with the following agencies.

- Multiple Southwest Agencies
- East Coast and Southeast Agency
- West Coast and Midwest Agency

The following documents adhesive testing of third formula at the StarChase laboratory:

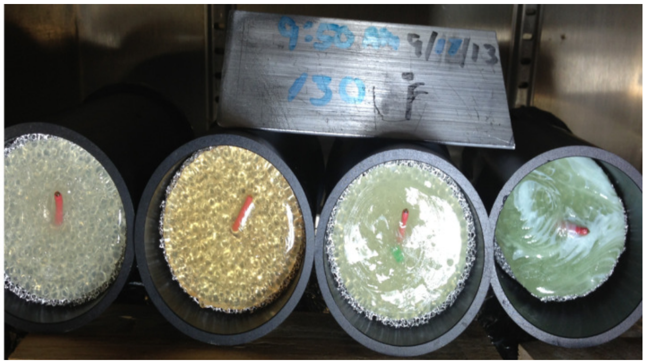

Figure 5: Adhesion Environmental Heat Chamber T&E

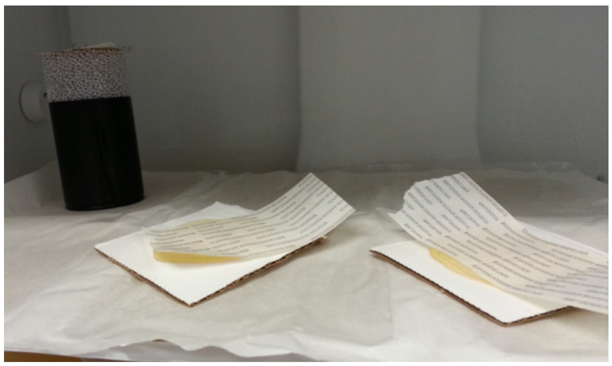

Figure 6: Adhesion Environmental Freezing Chamber T&E

Figure 7: Adhesion Physical T&E in Freezing Zone

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Conclusion:

The adhesive research met with positive results:

We were able improve wet stick in reference to dew point. This is significant for early morning pursuit events.

The adhesive cold weather deployment was reduced by 8^{o} F with a caveat that in snow and/or high humidity conditions the adhesive reverts back to a wet stick limitation.

The new adhesive also allowed StarChase to reduce the required ambient temperature in the barrel. An added benefit of lowering the required ambient temperature was an improved shelf life for the adhesive, as well as a quicker deployment sequence for the officer in the field.

The nosecone has incorporated a reduction in density, allowing for additional time on target. This results in an increase in successful tags.

See Appendix 7 (Figures 1-3), Nosecone Technical Specifications details the nosecone, density table and software syntax changes for ambient temperature and subsequent temperature analysis for improved 'time to arm' the system.

At this time, StarChase and our adhesive consultants agree that in a true wet environment (rain/snow) there is still a hydroplane effect occurring on the target at the time of impact. To combat this, StarChase will revisit a projectile mechanical design approach that incorporates the modified density of the nose cone as well as modified projectile configurations. We expect to continue exploring this challenge.

II.D Methodology, Results and Conclusion Goal #3: Air Compressor System

Goal: *Explore adding an air-compressor to the system in order to eliminate the nitrogen canisters as a power source, reduce operating cost, stabilize launch pressure, and reduce system maintenance.*

Methodology:

Replacing nitrogen canisters with an affixed air-compressor is a one-time expense solution. This integrated system eliminates a user's need for checking and verifying the nitrogen canister's status in terms of form, fit, and exchangeability and improves system performance and safety to personnel.

StarChase integrated the SC GEN II system with an on-board air-compressor. The compressor supplies the necessary air pressure via inputs from an integrated digital pressure transducer. Together the air compressor/transducer configuration of the system ensures consistent, safe operation and reliable projectile trajectory. Integrating an air-compressor system allowed SC GEN II to maintain the desired pressure to successfully deploy tags in varying environments. Accurate system pressure is consistently obtained as the SC GEN II is capable of:

- Reliable measurement of current and required air pressure for successful operation.
- Calculation of required pressure to support an adequate discharge of air to launch projectile.
- Maintenance of compressed air in a stable condition with no PSI fluctuation with minimal power requirements.

See Figures: 8 through 10 and Appendix: 8, Figure 4 and 5 for Air Compressor integration.

The following requirements summarize our baseline search for an appropriate COTS solution for integration into the system.

1. Air compressor system
2. Electrical/mechanical integration with pressure transducer
3. Pressure relief port and relay
4. Mechanical interface
5. Electrical control module

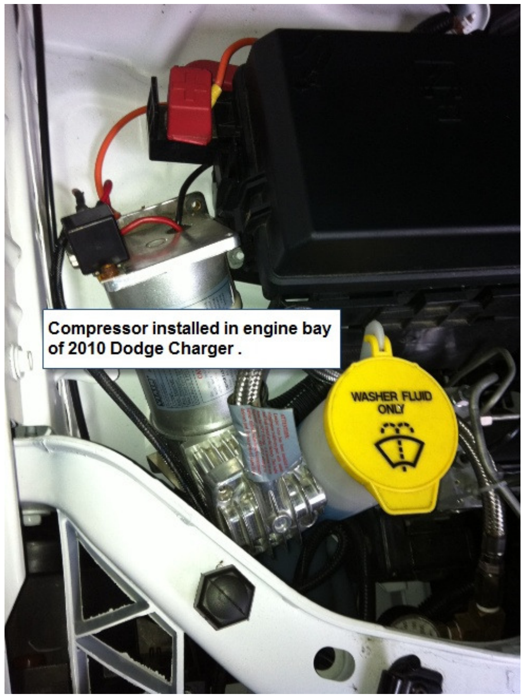

Figure 8: Air Compressor Physical Installation

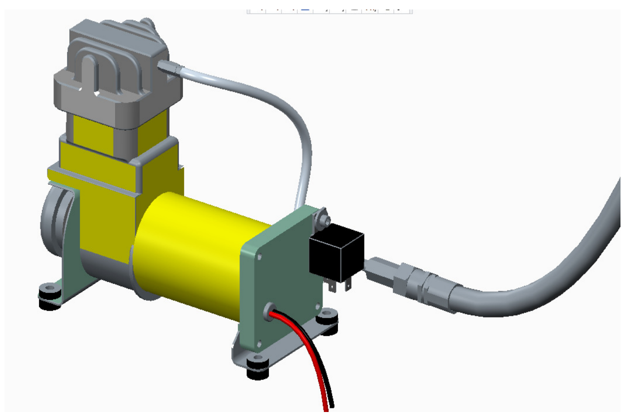

Figure 9: Air Compressor Interface Model

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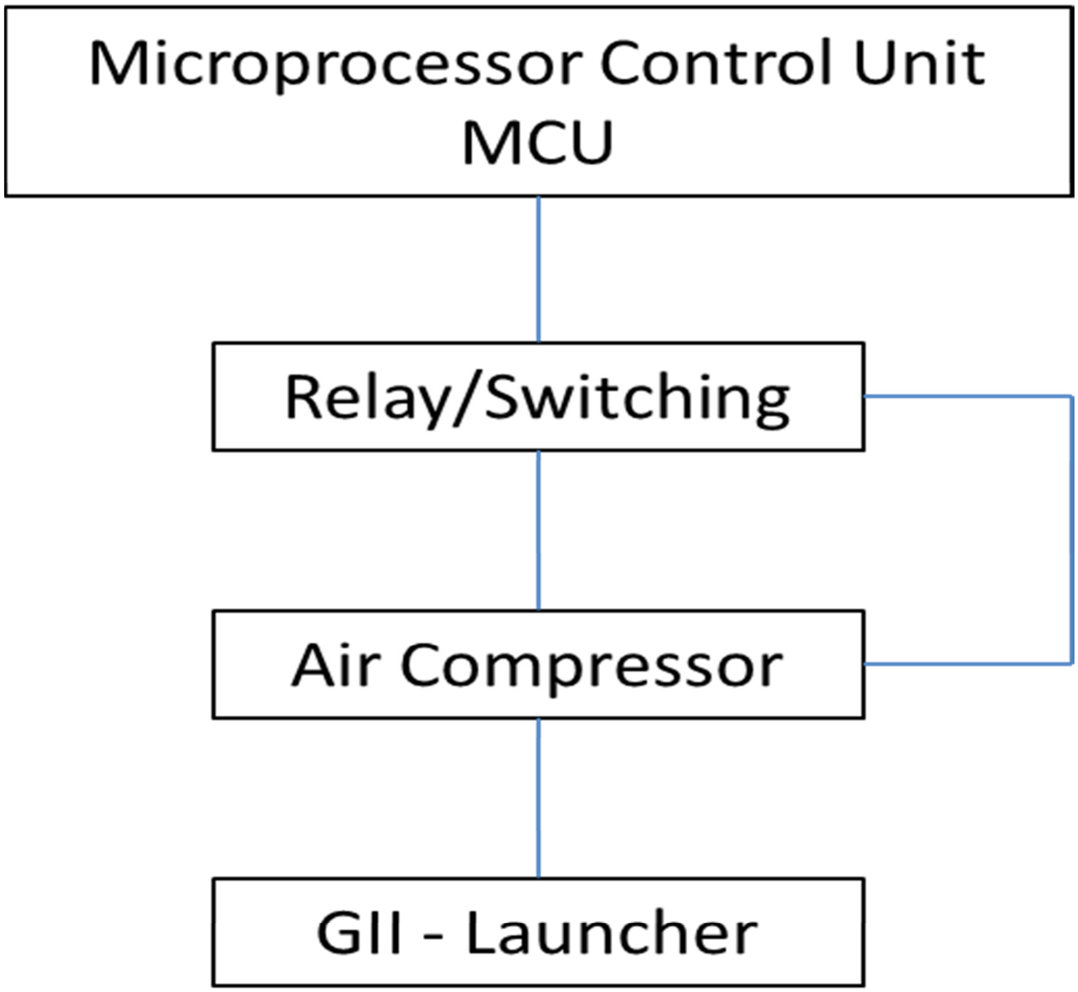

Figure 10: Air - Compressor & Flow Charge

Results:

The compressor has been integrated into the system on all fielded test bed units. This improvement has significantly increased reliability while reducing the recurring expense of nitrogen canisters with a onetime manufacturing cost.

The purpose of this goal was to evaluate the reliability and cost effectiveness of an automatic air compressor system. The reviews from law enforcement agencies at all field test beds have been very positive and this feedback, together with the attendant cost savings, resulted in a permanent

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integrated solution going forward. The following are benefits of the SC GEN II configuration with the air-compressor:

- Provides dynamic pressure without requiring any officer input. System status is indicated via a red/green LED light.
- System delivers immediate pressure at the time of the event. This has significantly increased system reliability and accuracy.
- Safety limits are incorporated with a safety valve that will trigger if psi is above set point. If triggered system will bleed air down to the default set point.
- Maintenance-free operation for the agency

Conclusion:

Replacement of the nitrogen canisters in favor of an air compressor was a SC GEN II solution which reduced system maintenance and operating expense every time an officer deployed a tag. Another significant benefit is it provides the required pressure on demand.

II.E Method – Methods, Results and Conclusions Goal #4: Develop Distance Range Detection (DRD):

Goal: *Targeting and range finding capabilities to measure distance to target/vehicle.*

Methodology:

- Evaluate several COTS solutions based upon system requirements with balanced consideration toward increase cost of units versus performance.
- Incorporate the preferred system which is able to embrace the variations of climatic conditions, shock, vibration and environmental hazards during typical use.
- Design an embedded system that is integrated into the SC Gen II console to provide audio impulse tones and visual cues. This will allow officers to determine the distance between the launcher and the suspect vehicle. When trained, an officer can easily distinguish when a vehicle is in range for deployment.

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Results:

<u>The table below shows results of testing four different approaches to the problem</u>

Experimental Devices			
Description	**Cost**	**Performance**	**Decision**
Option #1 – IR Optic	$22 - $56	Fail/Analog Output	
Option #2 – Laser	$110 - $400	Selected	x
Option #3 – Sonic	$22 - $63	Fail/Air Compression	
Option #4 – Radar	$800 - $1200	Cost Ineffective	

Option #1: IR-Optic was the initial COTS component selected for evaluation to integrate into the SC GEN II system. The IR-Optic measures between a law enforcement vehicle and a suspect vehicle by sensing the signal in multiple stages and positions; such as fixed or moving. The IR-Optic system device basically transmits “Pulses/IR Signals” or “Pulse Width Modulated (PWM)” signals at high frequency response to the SC Gen II Console platform when objects have been detected.

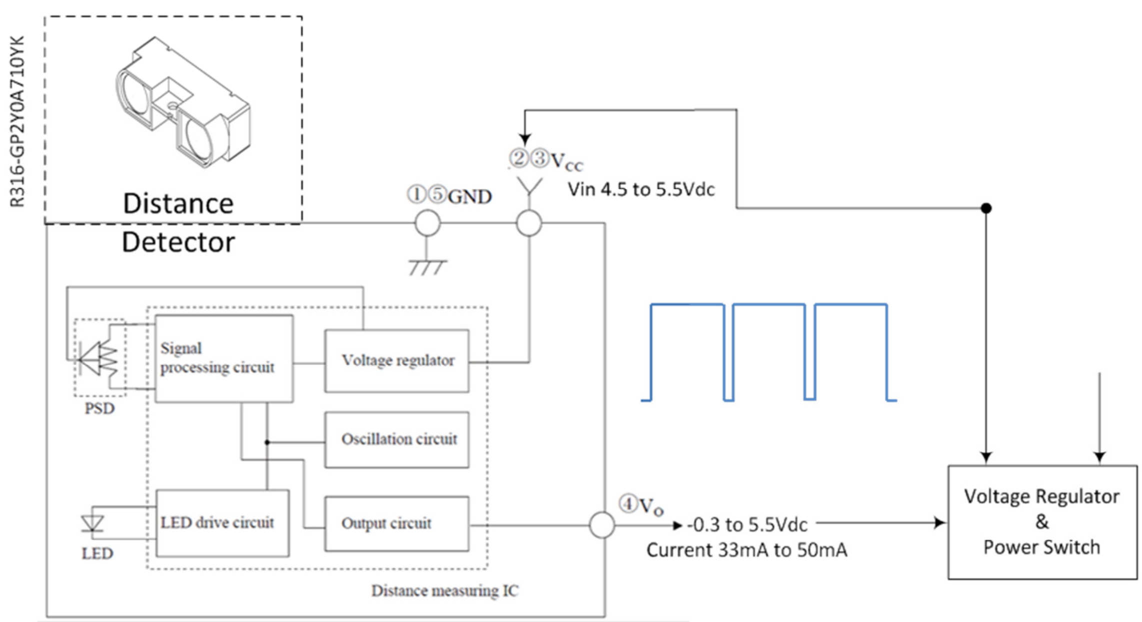

Figure 11: DRD – IR-Optic Sensor Initial Phase I

StarChase laboratory experiments and physical test results revealed that the IR-Optic failed to reliably return signals. The primary weakness was sensitivity to ambient and road noise. These interferences caused the power output and internal logic to quickly overload.

The IR-Optic was rejected as a final design into the SC GEN II system, as the device proved unreliable:

- Automotive turn signal and brake lights confused inputs.
- Ambient light confused inputs.
- Sensitive to small objects transient noise.

Option #3: The ultra - sonic sensor is a commercial product that is compliant with the US – FCC and RoHS guidelines. The ultra-sonic sensor was the second device selected to implement and test on the SC GEN II system for distance/range detection.

The design was modeled to define, measure and detect high speed chase distances between vehicles via ultrasonic burst signals. These ultrasonic waves are transmitted through the air. The receivers amplify the signals and digitally convert the sound waves into the distance measurement output. The transducer converts the signal to the sender and receiver while sensing/detecting objects within a parameter’s set range.

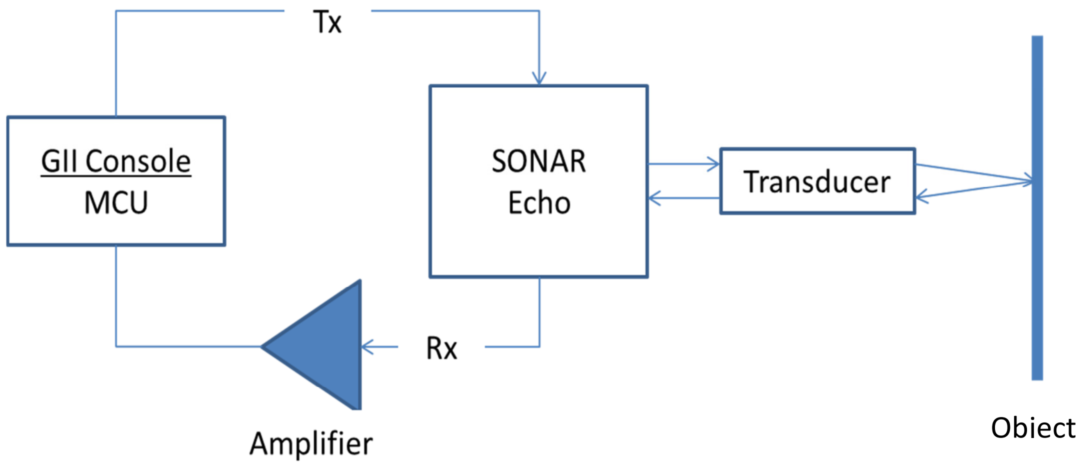

Figure 12: DRD - Ultrasonic Sensor Phase II

StarChase laboratory experiments and real-world road testing were used to evaluate the ultrasonic configuration. The results determined that the ultrasonic sound waves produced unpredictable sound interception from the noise of road speed, sound pressure, and other acoustic pressures that reflected and interfered with functionality. The device was unusable at speeds above 25 mph.

The table below shows the ultrasonic evaluation of speed and temperature variables:

Ultrasonic Test Configuration – Locate: Virginia					
Index	Temperatures (F˚)	Speed (Mile)	Test Subject	Distance Set (ft.)	Signal Strength–
1	55	35	Metal	18	Low Returned
2	55	45	Metal	16	Low Returned
3	55	55	Plastic	10	Low Returned
4	65	55	Firebird Glass	18	Very Low Returned
5	75	65	Firebird Glass	16	Unknown/Interrupted
6	85	25	Metal	5	High Returned
7	45	5	Metal	16	No Returned

Table 4: Ultrasonic Test & Evaluation

Ultrasonic sensor design was not a consideration for the SC GEN II system, because of the extreme unreliability of the device for the application due to naturally occurring sound and vibrations interfering with the necessary feedback to have the system operate reliably.

- Condition of target surfaces difficult to detect.
- Object distance detection was unstable during pursuit speeds.
- Weak signal returns created erratic results.

Option #4: Radar is a commercial product that is compliant with US – FCC and RoHS guidelines. Radar was the third device type selected for implementation. Based on the extremely high COTS cost, and the additional cost to integrate, StarChase determined the radar approach was not cost-effective and concluded, based on total development cost, it was not a viable technology solution for the system.

- Cost of the radar device was too high.
- Engineering and testing equipment cost deemed too high.
- Prototypes to run the first article trial tests and evaluations were too costly.
- Compliance with US-FCC was deemed costly based on potential design changes.

Solid-State Laser (SSL) was the last of the four devices selected for testing and was selected over IR-Optic, Sonic, and Radar. SSL provides a favorable system architecture, electrical physical layout, electrical schematic, and mechanical/physical system. This option includes an electrical interface module and solid state laser distance range detector**.**

Option #2 (Final selection): The Solid-State Laser Distance Range Detector (SSL DRD) is a commercial product that is compliant with the US – FCC and RoHS guidelines. This product was selected to be integrated into the SC GEN II system to define dynamic range to target. Low rate initial production estimates indicated cost effectiveness when buying in larger quantities.

The SSL DRD, uses an eye-safe laser beam to establish and determine the distance from the law enforcement vehicle to a suspect's vehicle. The program goal is to increase ease-of-use to support officers when targeting a suspect's vehicle. SSL DRD provides the officer with the ability to easily know when a suspect's vehicle is in range.

This configuration utilizes a laser pulse/beam directed at a moving object (suspect vehicle) in order to measure and calculate the signal's reflection off the suspect's vehicle. The signal returning to the SSL receiver is measured for precise time and wavelength thus determining the distance to target. At the same time the system will alert officers that the system is ready to perform:

- Automatic detection of forward object from 3ft. to 20ft. relative to the officer's SC GEN II equipped vehicle.
- Automatic audible alert using "impulse" tone when object is detected in range and tone suppression when object is out of range.
- Provides accurate and fast response time/microseconds.
- Ability for user to override DRD if necessary to launch GPS projectile with or without DRD feedback.

One SSL DRD system was integrated into the StarChase test vehicle. Prior to the deployment of the DRD system StarChase tested and evaluated the system over six hundred and seventy two (672) hours by automatically arming the system every fifteen (15) minutes. This is equivalent to running the system, non-stop, for 28 days.

SSL DRD - Currently deployed and integrated with Gen II systems operated by a southwest agency for continued feedback.

- Four systems with SSL DRD are deployed. These systems have been operating for more than twenty thousand miles on the installed vehicles.

- User feedback supports further exploration of the SSL DRD. The primary downside to the SSL DRD is the increased cost for an already cost conscious law enforcement community. The benefits show very positive results for the user, but further study must be given to balance the increase in user friendliness and results, with the total cost of ownership equation.

- The following appendices detail the technical specification for the SSL DRD integration with the SC GEN II system:

See Appendix 9: Range Detection – System and Subsystem Interface

Figure 6, DRD-System Signal Interface
Figure 7, DRD-Internal and External Interface
Figure 8, DRD-Subsystem Functionality Flow Chart
Figure 9, DRD-System Functionality Flow Chart

The SSL DRD is shown below in figure 13 & 14:

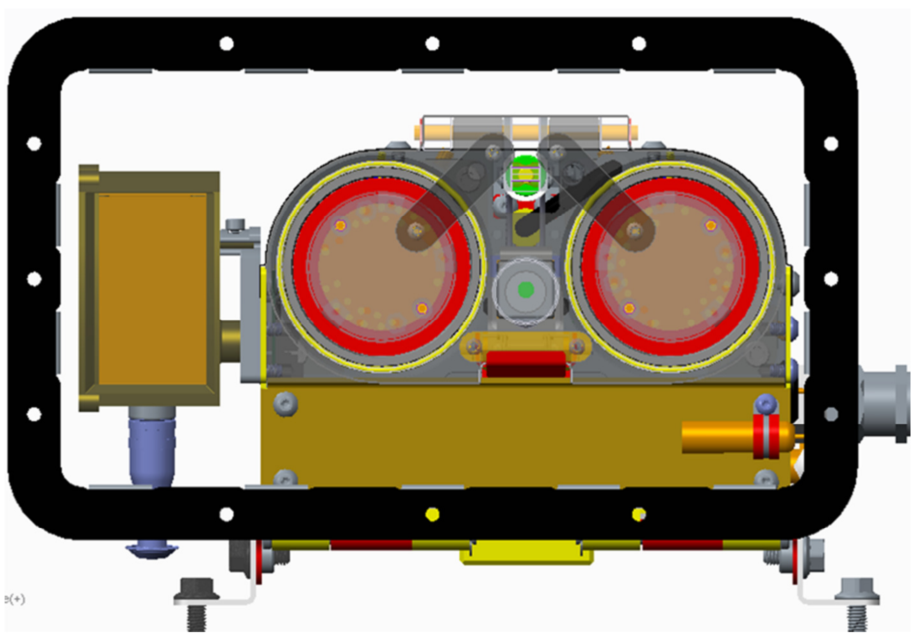

Figure 13: DRD - Model Interface

Figure 14: DRD - Physical Interface

Conclusion:

The final SSL DRD selection was laboratory tested and also fielded with law enforcement users. The users had prior experience with StarChase technology and had used the technology successfully without the additional SSL DRD technology.

While the overall feedback was positive with respect to providing an alert when a vehicle is in or out of range, the overwhelming consideration is the increased cost to the agency. In an already difficult economic environment for state and local law enforcement agencies the additional cost to provide what could be a limited performance improvement will need to be weighed cautiously.

StarChase will continue to gather feedback for this goal and will continue to investigate economical ways to implement this technology into the current SC GEN II architecture.

III. References:

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IV. Dissemination of Research Findings:

StarChase has shared the data generated from this cooperative award with the NIJ and we will continue to share and publish this information with the following key audiences: the general public; the National Institute of Justice; law enforcement agencies at the local, municipal, state and federal levels; stakeholder organizations with both political and key NGO affiliations; and other key interested technologists within the Department of Defense and law enforcement space such as license plate reader and tire deflation device manufacturers as well as those working on tag, track and locate devices.

Starchase.com's *News* page shares current reports for StarChase and important pursuit related information for law enforcement. We receive regular press inquiries asking if the technology is available in other markets and seeking grant funding to trial the technology . Agencies reach out to us for demonstrations and connect with us via social media outlets to gain additional information about the technology.

Throughout the agreement, we have shared impactful events once cleared by the customer and NIJ:

http://www.nij.gov/nij/topics/law-enforcement/operations/pursuit/technology-developments.htm#remotetracking)

The proposed Research in Brief will be released to all law enforcement communities when Dr. Alpert speaks at the upcoming 2014 IACP Conference in Orlando at the Saturday, NIJ track session in October. He will specifically address the research outcomes of the test beds and the officers' feedback on the user friendliness of the system. Prior to the IACP conference we are mailing post cards and an email campaign in support of this dissemination.

The research will be released to other core audiences including other related stakeholder organizations such as NHTSA, PursuitSAFETY and Officer Down Memorial Page, and associations related to the insurance industry.

We will also disseminate to law enforcement periodicals and media outlets such as the FBI Law Enforcement Bulletin, NLECTC's Tech Beat, The Police Executive Research Forum, the International Association of Chiefs of Police, the National Sheriff's Association, the National Organization of Black Law Enforcement Executives, The Fraternal Order of Police, Commission on Accreditation for Law Enforcement Agencies and any related programs such as COPs and BJA.

We have received past positive news coverage in the past from *USA Today, Popular Mechanics, Popular Science, Jane's, WIRED Magazine* and many other relevant news outlets such as *ABC World News*, *CBS This Morning* and *FOX News*. We are also working with traditional law enforcement market publications such *as Police One* and *Officer.com*.

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The evidence of safe outcomes revealed in our case studies creates an opportunity for legislators to have a positive national impact on citizen safety with a tool that makes a difference for law enforcement officers serving our communities. We are actively working with our government representatives to support initiatives that allow LEAs to trial the technology with the support of grant funding including the Justice Assistance Grant (JAG), Community Oriented Policing Services (COPS) and Governor's Highway Safety Association grants with funding provided by NHTSA.

The dissemination strategy is a key part of the program conclusion as agencies are actively seeking additional grant funding in order to adopt the technology. We are working collaboratively with LEAs and insurance agency risk managers to determine a cost/benefit analysis protocol to specifically address the reduction in risk and related liabilities when StarChase is part of a police force's toolbox.

This technical report summarizes the results of our cooperative agreement. The NIJ has been studying police pursuit outcomes since the late 1980s and has been seeking a solution to this ongoing problem. We are pleased that the preliminary research from StarChase indicates a game changing technology is making a tactical difference in the ongoing management of police pursuits and reducing agency risk and liability.

Appendix 1

STARCHASE REPORT

Proposed Research in Brief

Geoffrey P. Alpert

University of South Carolina

July 31, 2014

This project was supported by Award No. 2010-IJ-CX-K022, awarded by the National Institute of Justice, Office of Justice Programs, U.S. Department of Justice. The opinions, findings, and conclusions or recommendations expressed in this publication/program/exhibition are those of the author(s) and do not necessarily reflect those of the Department of Justice

In order to investigate how StarChase functions in the real-world, the experiences of two different types of agencies were examined. Both an agency that patrols highways and freeways, the Arizona Department of Public Safety, and a large urban police department, the City of Austin, Texas were assessed. This Report describes the experiences as reported by officers who are most familiar with the technology and activities in the two agencies.

The Arizona Department of Public Safety

During the night of 31 January 2013, Officer Korey Lankow of the Arizona Department of Public Safety took me on a ride-along to observe him during his shift and to discuss his experiences with StarChase. After signing the Consent Form and briefing me on my responsibilities as a civilian observer, Officer Lankow took me with him while he performed his customary tasks. Officer Lankow stopped a number of vehicles for a variety of violations and interacted with the drivers and passengers in a professional and courteous manner. Once the traffic stops ended, he briefed me on what he was looking for and how he interpreted the cues and signs he observed from the drivers and passengers. He explained to me the potential hiding places for drugs on the different vehicles he stopped, and how he read the driver's signals and cues.

The driving time was spent discussing the issues of pursuits in general and StarChase specifically. Officer Lankow has deployed StarChase 21 times and is likely the person who has deployed it more often than anyone else in the line of duty. He has deployed it using the remote and interior triggers and at low speeds and high speeds. He has had successful applications, with subsequent apprehensions and seizures of contraband and unsuccessful applications where the projectile did not stay on the vehicle. Overall, he believes StarChase is a device that has made policing less risky for himself, the community and the fleeing suspects and their passengers.

StarChase is a device that is designed to tag and track a vehicle that flees from the police. It involves firing a projectile that has a GPS sending unit embedded into a projectile that is deployed from the police car. The projectile has adhesive that adheres to the target vehicle without the driver knowing about it. On 1 February, I spent time with Officer Keith Duckett of the Arizona Department of Public Safety who has deployed StarChase ten times and is currently waiting for the device to be installed in his new vehicle. I also spoke to Major Larry Scarber of the Southern Patrol Bureau. Officer Rob Telles was not available during my site visit but has deployed StarChase three times. The following observations reflect a compilation of the officers' comments, ideas, perspectives and thoughts that were discussed during my two day site visit with the Arizona Department of Public Safety officers.

The Arizona Department of Public Safety has been an agency that has historically been involved in a relatively large number of pursuits. The Southern Patrol Bureau, whose headquarters is in Tucson, is responsible for a large area and population including highways and freeways where drug smugglers are known to travel. The officers are trained to look for a variety of cues to help them determine the likelihood of someone carrying drugs or drug money. StarChase is designed to track violators without raising the risk to the public and was welcomed by the Arizona Department of Public Safety and its officers who were selected to test it.

StarChase requires that it be armed or "warm up" before deployment, which takes approximately 10 seconds. The normal process is for officers to arm the unit prior to initiating a stop so it is ready for use. This process also involves the use of a laser light to aim the projectile. Officers do not always arm the system and usually do so only when they have indicators that there is a reasonable chance the suspect will flee. When pressed about the indicators, the officers rely on their "gut" feeling and experience to decide when to arm StarChase. The officers did explain that certain types of vehicles have better potential hiding places than others and are used more often by drug smugglers.

As with any new technology, there are aspects of StarChase that are improved with testing and experience. The officers explained that after only a few deployments in training and experience aiming StarChase they become comfortable in its use and limits. The most complicated aspect of StarChase is aiming it by manipulating the unit by using the internal controls and/or by steering the police car to point the device, which is aided by a laser light. Training and experience can bring an officer to a comfort level, but the tasks involved in aiming the unit at high speeds can be tricky and risky. During the beginning phases of testing, officers had experience with cartridges that did not stick to the target vehicles. Some of the early applications failed as the cartridges would bounce off the targets. This failure was reported and corrected by the manufacturer and recently these officers have not experienced any failures. [1] Another issue raised was the timing of the device that armed StarChase. In one instance an officer was concerned about the potential of a target vehicle fleeing and armed StarChase in

[1] Major Scarber has reported that other officers, Casey Yartym and Howard McDonald, have experienced recent failures where the projectiles failed to stick to suspect vehicles.

anticipation of the stop. Unfortunately, the stop did not occur immediately and StarChase "cycled off" and when the officer went to deploy, it was not armed and ready. While the officer admitted it was his error in not re-arming the unit, it is important to understand that they have a lot of things to think about and if possible the technology should assist them as much as possible.

Before deploying StarChase, it is necessary to aim it with use of the laser beam. The current units utilize a small green laser or beam to help the officer aim the unit. The light shows as a dot on the vehicle which is the target location. The officer can aim the unit by manipulating it with directional controls inside the vehicle. It can also be aimed by steering the car to improve the contact point until the dot is where the cartridge is intended to hit. While I did not observe this light from a target vehicle, I did hear a suspect ask about the green light he saw in his rear-view mirror prior to being pulled over.

Normally, the arming, aiming and deploying StarChase is a relatively simple set of tasks that takes minimal training to become proficient. The major difficulty with StarChase is during high-speed deployments, possibly at speeds between 80 – 100 MPH. These deployments require the officer to drive fast and within 20 feet of the target vehicle before StarChase can be deployed. While the officers were comfortable with their abilities to drive aggressively to deploy StarChase, they agreed that not all officers would want to take those risks by driving so fast at such a close proximity to the fleeing vehicle. The officers also were comfortable that many officers would be comfortable executing such a maneuver and that many officers have asked how they could get a StarChase in their vehicle.

Once StarChase is deployed successfully the officers terminated their active attempt to pursue the fleeing suspect by turning off all emergency equipment and slowing down and blending into traffic. This allowed the fleeing suspect to “escape,” and after realizing the police were no longer trying to catch them they would slow down. StarChase creates data that shows the exact time, speed and distance that “tagged” vehicles travel until they slow down or return to the speed limit. The officers report that they would have terminated many of the pursuits in which they tagged vehicles because of the risks created by the traffic congestion, extreme speeds, and/or other environmental factors. Some of the pursuits would have been continued and the outcome while unknown may likely have ended negatively with crashes or injuries. Without StarChase many offenders would have escaped and many of them and innocent civilians could have been injured. Because of the tagging and tracking, many of them were arrested without incident and their contraband seized. An interesting but unintended consequence of Star Chase was noted by Major Scarber. He is aware of several situations where officers under his command have not initiated stops of vehicles that have been confirmed as stolen, or when the officer has a belief that the driver may flee, when a police vehicle with Star Chase is in the area. Rather than initiating the stop, the officer will call for the police vehicle with Star Chase to tag the vehicle before initiating the stop. While it is not known how many vehicles have fled in these situations, it is an important behavior to document in the future. See Appendix A for 36 case studies of successful applications of StarChase.

One specific example (case study #2) of a successful tag involved a pick-up truck with nine "illegal" teenage girls from Mexico. The driver of the pick-up pulled over when the officer initiated an enforcement stop but fled as the officer approached the vehicle after stopping it.

StarChase was remotely activated. The vehicle fled at a high rate of speed and slowed only after the driver realized he wasn't being chased. The pick-up was tracked to the "stash house," the girls were located hiding in the pick-up and brought to Immigration Customs Enforcement (ICE) and interviewed. Arrests were made and the girls stated they were told they were headed to the east coast to be maids and housekeepers for wealthy Americans, it is very likely they were headed to be traded as sex slaves. As the officer said, "Drugs/ money/weapons/stolen vehicles receive much attention, but human life is more valuable than all of these. Without this technology, I would have pursued the truck and based on the recorded speeds after fleeing, all occupants may have been killed if the vehicle crashed. This was an incident I wanted to share because it involved possible loss of human life; priceless."

This example shows why the officers are very enthusiastic about the future of StarChase. They recommended its use by other agencies but caution that it requires risk taking and advanced driving skills. The selection of officers who use it is an important consideration.

Austin, Texas Police Department

On July 2, 2014 I met with Officer Marcus Davis, at the Technology Unit of the Austin, Texas Police department (APD). Officer Davis is in charge of keeping track of the StarChase deployments for APD and is an expert in the technology and conducts the training for the APD officers. He relayed that StarChase has been deployed 25 times in the 13 months that it has been available at APD, and they have a success rate of 55%, meaning that the GPS Tags stuck to the vehicle and arrests were made in each of the successful deployments.

He explained that in some deployments, even when the GPS Tags did not stick on the targeted vehicle, drivers pulled over because they were startled by the noise of the Tag hitting the car. He showed several videos of those events as well as other deployments when the Tags stuck to the targeted vehicles. He also explained that most of the unsuccessful deployments were due to the officers not following training and deploying the Tags in wet weather or not lining up the target properly. He showed several videos of these examples.

Officer Davis stated that he has spoken to the deploying officers and has heard multiple comments that they feel safe and more confident with StarChase as they can keep more distance between them and the suspect vehicle and do not have to take unnecessary driving risks. He concluded our conversation by stating how much he liked the StarChase technology as an added tool in the officer's toolbox, and said, "I would buy stock in the company."

Summary

This initial assessment of the experiences from two different law enforcement agencies showed great promise for StarChase and its ability to be a "game changer" for law enforcement. While there are selection issues for officers, and it will be necessary to check and perhaps modify training protocols and proficiency testing, the results of successful applications to date are impressive. Suspects whose vehicles are tagged behave as if they are free from the police and slow down when the police stop chasing, in many cases within a minute. The behavior of the fleeing suspects demonstrates no knowledge that they are being tracked by a GPS system that pinpoints their location and speed in real time. In most cases, officers have tactically apprehended suspects and seized vehicles and contraband without creating a risk to the public, themselves or the suspect or any passengers.

The present assessment is a preliminary step in an evaluation process that will require an in-depth analysis of multiple StarChase units used by different officers in a variety of agencies. A comprehensive evaluation will need to explore deployment decisions and strategies, data on effectiveness and results of applications in different situations and environments, officer's and suspect's perceptions of StarChase and the impact of the technology on the organization, including behavior changes of officers who are not using Star Chase.

Appendix A

Case Studies

StarChase has the ability to track fleeing suspects, and apprehend them without a dangerous pursuit. The anecdotal information provided by officers who have used the device is impressive and shows how well the technology performs in the field. One of the major concerns of a pursuit is the behavior of the fleeing suspect who drives dangerously and recklessly, often checking his or her rearview or side mirrors to determine where the pursuing police car is located and if it still has its emergency lights illuminated and if it is still chasing. Up until now, the only information we have had concerning the actions of the fleeing driver is an estimate of the pursuing police officer or the fleeing suspect (Schultz et al., 2009). StarChase sends back real-time information on the speed, direction and location of the target vehicle to the computer that maintains communication with StarChase. There are a total of 36 case studies submitted with this report.

The data was collected from the established NIJ test beds and StarChase customers, who have agreed to participate in the data collection. When a tag is successfully deployed, there have been no follow-on high-speed pursuits, loss-of-life, injuries or property damage and. Out of the 36 case studies, there were a total of:

- 13 stolen vehicles recovered with no property damage
- 25 humans rescued due to human smuggling plus three children that were in a fleeing vehicle during the pursuit.
- 2 DUIs resolved with no loss-of-life
- Over 4000 lbs. of drugs recovered
- 44 Arrests were made

On average, the case studies also report the time to return to within 10 MPH of a posted speed limit is under two minutes and a +80% apprehension rate. 10 MPH is an estimate of the time it takes for a vehicle to blend into traffic and return to “normal driving behavior” which is no longer aggressive, evasive or impulsive.

Case Study #1

A vehicle was identified as stolen by the officer. The vehicle took off reaching a top speed of 78 MPH and the total tracking time was 3 Min 50 Sec. The officer did not chase and 1 Min 40 Sec after being tagged, the vehicle slowed within 10 MPH of the speed limit. There were no injuries, accidents or property damage. There were three arrests and a gun recovered.

Case Study #2

A vehicle was observed that the officer suspected was transporting drugs or people. The vehicle took off reaching a top speed of 68 MPH and the total tracking event lasted 4 Min 31 Sec. The officer did not chase and within 2 Min 45 Sec after being tagged, the vehicle slowed within 10 MPH of the speed limit, and it was driven to a house where officers arrested the driver and rescued nine young females.

Case Study #3

A vehicle was observed that the officer suspected was stolen. The vehicle took off reaching a top speed of 90+ MPH and the total tracking event lasted 24 Min. The officer did not chase and 15 Min after being tagged, the vehicle slowed within 10 MPH of the speed limit. The driver of the stolen vehicle was arrested, the vehicle was recovered.

Case Study #4

The officer suspected a car was carrying narcotics and was travelling almost 100 MPH. The tracking event lasted 5 Min 31 Sec and there was no chase. 4 Min after being tagged, the vehicle slowed within 10 MPH of the speed limit. The driver of the stolen vehicle was arrested along with one other, the vehicle was recovered and 500+ lbs. of drugs was confiscated.

Case Study #5

A vehicle was observed at 84 MPH and the officer suspected it was stolen. The tracking event lasted 10 Min 40 Sec and there was no chase. 2 Min 30 Sec after being tagged, the vehicle slowed within 10 MPH of the speed limit. The driver of the stolen vehicle was arrested along with one other, and two children were safely removed from the vehicle.

Case Study #6

A vehicle was observed that the officer suspected was carrying narcotics in the car. The tracking event lasted 18 Min and there was no chase. 6 Min after being tagged, the vehicle slowed within 10 MPH of the speed limit. 200+ lbs. of drugs were confiscated.

Case Study #7

A vehicle was observed at 90+ MPH and the officer suspected there were narcotics in the car. The tracking event lasted 2 Min and there was no chase. 50 Sec after being tagged, the vehicle slowed within 10 miles per hour of the speed limit. 700 lbs. of drugs were confiscated.

Case Study #8

A vehicle was observed at 83 MPH and the officer suspected it was carrying narcotics. The tracking event lasted 12 Min and there was no chase. 3 Min after being tagged, the vehicle slowed within 10 MPH of the speed limit. Two arrests were made, 1600 lbs. of drugs and a vehicle were recovered.

Case Study #9

A vehicle was observed at 85 MPH and the officer suspected it was a drug scout car. The tracking event lasted 50 Min. and there was no chase. 6 Min after being tagged, the vehicle slowed within 10 MPH of the speed limit. No arrests were made, but the vehicle was recovered.

Case Study #10

Officer proactively tagged a stolen vehicle. Tagged at 17 MPH and the vehicle yielded. It did not exceed the speed limit.

Case Study #11

Officer tagged a stolen vehicle with a top speed of 50 MPH and the driver did not exceed the speed limit. Driver originally fled but was found and arrested. The tracking event lasted 2 Min.

Case Study #12

Officer tagged a suspected DUI and the entire tracking event lasted 2 Min 42 Sec. The individual did not exceed the speed limit and was arrested for DUI with a top speed of 47 MPH.

Case Study #13

Officer tagged a suspended license plate and the tracking event lasted 3 Min 30 Sec with a top speed of 56 MPH. Suspect arrested prior to urban no pursuit area and did not exceed the speed limits.

Case Study #14

Officer tagged a suspected DUI and the entire tracking event was 2 Min 43 Sec. The tag was deployed at 54 MPH and the vehicle did not exceed speed limit. Arrest was made.

Case Study #15

Vehicle failed to yield and officer tagged at 63 MPH as was headed into urban area. Lower speeds allowed safer navigation through narrow streets and intersections. The tracking event lasted 8 Min and 20 Sec. The time to return to within 10 MPH of the speed limit was 11 Sec. An arrest was made.

Case Study #16

The suspect failed to signal turn and was involved in a suspected narcotics transaction. Suspect fled and officer tagged the vehicle at 58 MPH. Suspect yielded and arrest was made. Total time of tracking event lasted 5 Min 38 Sec and time to return to within 10 MPH of the speed limit was 1 Min.

Case Study #17

A vehicle failed to yield was tagged as it took off at a slow speed. The vehicle pulled over and the driver on fled on foot with another passenger hidden in the backseat. The second passenger moved into the driver’s seat and took off. Dispatch then notified officers of the tagged vehicle's movement and coordinated a stop on it. The event reached a top speed of 44 MPH and the tracking event lasted 4 Min 19 Sec. The second driver was arrested and one young child was found unharmed in the rear of the suspect vehicle. The vehicle did not exceed the speed limit.

Case Study #18*

The officer attempted to pull over a vehicle for a seatbelt violation and mismatched tags. After failing to yield to lights and sirens, the vehicle was tagged and escaped from Iowa into Nebraska. The fleeing offender reached maximum speeds of 88 MPH and was driving for the state line. The state patrol agency asked a neighboring state patrol, who was previously trained by StarChase, to log-on and track the vehicle. The officers tracked the vehicle into a state park and an arrest was later made with no accidents, injuries or property damage. This tracking event lasted 26 Min 25 Sec and the time to return to within 10 MPH of the posted speed limit was 1 Min 44 Sec.

Case Study #19*

The officer identified a stolen vehicle that was involved in a carjacking. The vehicle was tagged and did not exceed the maximum speed limit. There were no injuries, accidents or property damage. There were two arrests and the tracking event lasted 11 Min 5 Sec.

Case Study #20*

The officer identified a stolen vehicle with two suspects. One with two outstanding warrants, one with active probable cause for armed robbery. The vehicle was tagged at 50 MPH and did not exceed the speed limit. Two arrests were made with no accidents, injuries or property damage. The tracking event was 7 Min 52 Sec.

Case Study #21*

The officer identified a homicide suspect. The vehicle was tagged but the officers did not back off due to the severity of the charges. The suspect was apprehended/arrested without incident. No data on max speeds or duration of this event. There were no accidents, injuries or property damage.

Case Study #22*

The vehicle was successfully tagged using the officer remote while fleeing a traffic stop. The vehicle was tracked into a nearby municipality and the suspect was apprehended by another local agency with 225 lbs. drugs. The suspect was arrested with no accidents, injuries or property damage. The tracking event was 5 Min 49 Sec and it did not exceed the maximum speed limit.

Case Study #23*

The officer tagged a stolen vehicle. The suspect immediately bailed and was tracked by K-9. The suspect was arrested with no accidents, injuries or property damage. The vehicle did no exceed the maximum speed limit. The duration of the tracking event lasted 15 Sec.

Case Study #24*

The officer tagged a stolen vehicle with four occupants. The driver was arrested with no accidents, injuries or property damage. The duration of the tracking event lasted 8 Min 52 Sec with a high speed of 82 MPH. The time to return to within 10 MPH of the posted speed was 6 Min 59 Sec.

Case Study #25*

The officer tagged a stolen vehicle. The suspect stopped the car and ran before he was safely apprehended. The duration of the tracking event lasted 11 Min 5 Sec and the offenders did not exceed the speed limit.

Case Study #26*

The officer tagged a stolen vehicle with four occupants. The suspects stopped and ran, 3 of 4 were apprehended. The suspects were known gang members and established patterns of auto theft and vehicle burglary were reduced immediately after arrests. The duration of the tracking event was less than 1 Min and the offenders did not exceed the speed limit.

Case Study #27*

The officer tagged the stolen vehicle and traced it to a previously unknown vehicle dumping location. The officer thought that the tag missed but it bounced off the ground and stuck to underbody of car. The suspect was not apprehended due to delay in officer/dispatch looking for tag. There is no data provided on maximum speeds or duration of the event.

Case Study #28*

The officer tagged the stolen vehicle and two suspects were apprehended without incident. The duration of the tracking event lasted 9 Min 19 Sec with a high speed of 93 MPH. The time to return to within 10 MPH of the posted speed was just over 1 Min. At times, the speed exceeded the 10 MPH variance of posted speed with no aggressive or evasive behavior.

Case Study #29*

The K9 unit ID'd the stolen vehicle and tagged the car twice. The first round hit the suspect's bumper sticker and began to peel the bumper sticker off. The second round stuck as well. Both tags worked as designed and the officer was able to track the suspect a short distance to a 7-Eleven. There were no injuries, no pursuit and no property damage. Three arrests were made. The duration of the tracking event was 42 Sec with a high speed of 27 MPH.

Case Study #30*

The officer successfully tagged a stolen mini-van. The duration of the tracking event lasted 45 Sec with a high speed of 27 MPH. No additional details shared.

Case Study #31*

The officer deployed the tag onto a suspected drug load. The officer successfully tagged the suspect at 80+MPH and was tracked until he slowed down enough to deploy stop sticks. The officer recovered most of the 15-17 UDAs with no injuries, accidents or property damage (aside from the blown tires). The duration of the tracking event was 32 Min 39 Sec with a high speed of 93 MPH. The time to return to within 10 MPH of the posted speed was under 1 Min of being tagged. At times, speeds picked up due to the event's duration but there was no aggressive or evasive behavior.

Case Study #32

The officer successfully tagged the suspects' vehicle when he failed to pull over. There were no injuries, property damage or further incidents. The duration of the tracking event was 1 Min with a high speed of 30 MPH. The speed limit was not exceeded.

Case Study #33

When the suspect failed to stop, the officer was able to successfully tag the vehicle and apprehend the suspect without incident. The duration of the tracking event was 2 Min 59 Sec with a high speed of 93 MPH. The time to return to within 10 MPH of the posted speed was 2 Min 24 Sec.

Case Study #34

The officer deployed the tag onto a suspected drug load that evaded. The officer tagged and tracked the suspect to location with air support assistance. The officer used StarChase mapping to act as central dispatch. The offender was US Citizen carrying 1100+ lbs. of drugs. The tag lead to a safe apprehension, assets seized, no accidents, injuries, or property damage. The duration of the tracking event lasted 28 Min 13 Sec with a high speed of 99 MPH. The time to return to within 10 MPH of the posted speed was under 30 Sec. At times speeds picked up due to the event's duration but there was no aggressive or evasive behavior.

Case Study #35

LPR showed the vehicle as stolen; officer deployed the tag onto the stolen vehicle after the suspect evaded. The officer coordinated with a neighboring jurisdiction and was able to safely stop and apprehend the offender. The stolen vehicle was recovered with no accidents, injuries, or property damage. The duration of the tracking event lasted 10 Min 28 Sec with a high speed of 87 MPH. The time to return to within 10 MPH of the posted speed was 54 Sec.

Case Study #36*

Officer successfully tagged vehicle in the rain. The duration of the tracking event lasted 1 Min 4 Sec with a high speed of 32 MPH. More details to come.

* These data were provided by a non-NIJ funded test bed but still a StarChase customer.