Presentation Script – RMPP Research Proposal, Steve Johnson

Slide 1: Reidentification of previously anonymized connected vehicles; is the industry keeping its promise on Privacy?

From 2014 to 2020 I was the Program Manager and Principal Investigator for a pilot deployment of Connected Vehicle (CV) Technology. This $24 Million research project was funded by United States Department of Transportation (USDOT) and awarded to my client who allowed me to serve in this critical role.

CV systems operate in a licensed wireless spectrum, enabling equipped vehicles to communicate directly with each other (Vehicle to Vehicle or V2V) as well as special roadside equipment (Vehicle to Infrastructure or V2I) Recent enhancements allow for smartphone users to also send and receive associated messages.

The foundation of the system of interoperable applications is based on the Basic Safety Message (BSM). BSMs are sent 10 times per second and contain real-time information on the vehicle, comprising data on the vehicle's sensors such as tire pressure, braking status, acceleration, turn signal status, etc. More importantly, it contains critical data used to perform CV Applications. This data includes, speed, heading, trajectory, path history, and sub-meter accuracy of position (Lat/Long/Elevation). The applications resident in all equipped vehicles and roadside equipment like traffic signal controllers, process algorithms to provide safety uses for eliminating distracted driver accidents, improving traffic congestion, and reducing carbon emissions.

As life/safety apps utilize the transmitted data, a strong chain of trust must be in place to ensure the messages are from a "trusted" source as of a given point in time. This system does NOT ensure against malfunctioning equipment or malicious compromise that has yet to be detected. A misbehavior detection and certificate revocation process is used to mitigate that risk. The misbehavior detection is made difficult by the rapidly changing vehicle ID (VID).

The regulatory and standards bodies for this technology implemented rules and processes for ensuring that personally identifying information (PII) about the vehicle and therefore, its owner was protected. Among these was anonymization of the VID. The current process randomly changes the VID every 5 minutes. (SAE J2945, 2020)

Slide 2: Abstract

I, like many others, believe CV offers perhaps our greatest hope of reaching "Vision-Zero, a goal to eliminate all traffic deaths attributable to distracted driving. (Visionzero.org)

However, many individuals hold the expectation of privacy as a sacred tenet of freedom. And whether an expectation of privacy **should** be applied here is not included in this study. The industry councils and regulators included privacy protection in the design process, thereby settling the question for this application of the technology and inherently "promising due care" in protecting that individual privacy.

This study seeks to: (Research Questions)

- Investigate the efficacy of currently implemented safeguards implemented for privacy and,
- Critically examine whether the next generation of safeguards under proposal will add any substantial improvement

Slide 3: Proposed Aims and Objectives

The study will be structured to demonstrate a substantive response to these research questions for academia, researchers, practitioners, and interested non-professionals.

To do that, the study will present:

- Summary of the CV technology, benefits to society, and challenges to secure implementation.
- A critical examination of the privacy threat surface and the existing mitigations in place.
- A review of contemporary literature covering privacy and security of vehicles, both CV equipped and non-equipped
- An experiment designed to test the author's thesis on the inherent weaknesses that still present vulnerability to PII.
- Proposed additional safeguards and research for improving the current state of practice.

Slide 4: Overview of representative CV apps.

To understand the potential societal benefit, the study will discuss several of the applications tested and fully operational in existing CV deployments across the U.S. (CVRIA, 2016)

- Intersection Movement Assist (IMA). IMA advises drivers of potential conflicts (crashes) in intersections. As the data is sent wirelessly, it is said to "see around corners". A distinct advantage in urban canyons presented by buildings and other obstructions.
- Pedestrian Collision Warning (PCW). PCW sends alerts to drivers (and pedestrians if smartphone enabled) when a target is moving into a crosswalk or in some cases from between parked cars.
- Emergency Electric Brake Light Warning (EEBLW). EEBLW sends an alert to drivers when an equipped vehicle ahead applies "hard braking". This eliminates accordion crashes where no one knows about the front car's situation until the car directly in front of them brakes.
- There are more than 70 other apps in development or already deployed.

Slide 5: CV Proliferation

As of July 2021, there were 69 active, operational CV deployments in the U.S. There were another 102 planned for immediate implementation. (Morder, 2022)
Early estimates for 2022 numbers, claim more than 80 deployed systems and more than 200 in the planning stages.

The above numbers refer to jurisdictional locations that have deployed roadside infrastructure to support CVs.

The number of equipped vehicles deployed by the USDOT CV Pilots is approximately 4,500, including 1,000 privately owned vehicles that were retrofitted by the Tampa Pilot, 400 commercial tractor-trailer trucks in Wyoming; and 3000 in New York, comprising both private fleet and City of New York fleet vehicles.

Meanwhile, the car makers have already been embedding CV devices in their new autos since 2017. Current estimates of new cars just waiting for the system to mature before activating their chain of trust to join in, ranges in the hundreds of thousands.
And the Calculated Annual Growth Rate (ACGR) projections are for 24% through 2027.

Slide 6: Proposed Research Design

So, for a quick recap, the study will seek to demonstrate existing weaknesses and potential solutions through the following means:

- **Critical Review of Literature**. There is substantial literature on the topic, including:
    - Research reports published by USDOT covering the CV Pilot Deployments
        - ConOps, system design documents, application design documents, research protocols and IRB reviews, security management procedures, data privacy plans, acceptance testing reports, lessons learned, and data repositories of recorded live CV communication logs.
    - Academic, peer reviewed research papers
    - Applicable standards, specifications and certification test protocols from SAE, IEEE, NHTSA and OmniAir.
    - Numerous technical articles from industry journals.
- **Presentation of a Thesis** that previously anonymized CVs may be reidentified with simple data visualization tools and using published, unrestricted CV data.
- **Conducting 2 experiments** to validate theory of re-identification ease. One based on current safeguards and a second based on simulation of proposed new safeguards pending implementation.
- **Offer suggestions for additional research**.
- **Discuss conflicting ethical issues between diverse models.**

Slide 7: Experiment 1

Experiment 1 uses published CV Data to visualize CV path movement in real-time on googlemaps. The visualization applies color coding to each recorded vehicle ID. As the travel path is revealed in real-time, the color change is easily captured, and the new ID can be correlated to the original vehicle

This allows the ID change to be “witnessed and recorded”, facilitating ongoing tracking of vehicle movement over a complete trip.

Slide 8: Experiment 2

Experiment 2 repeats experiment 1 but with the original data modified to simulate a newly proposed safeguard of imposing a silent period between ID changes. This experiment examines whether the imposed silent time is great enough to prevent tracking as in experiment 1.
Note the corresponding white space in the path progression. Thesis is that as vehicles disappear and reappear on the map, the proposed silent period of 5 seconds will not significantly impede reidentification.

Slide 9: Research Project Artefacts

This project will provide several opportunities to share findings with other researchers, practitioners, and industry regulators.

- Artifacts:
  - Raw CV Data vs. parsed data used in experiment
  - Visualization maps
  - Technical paper for publishing by SAE
  - Technical paper for presentation at TRB.

References:

Slide 1:
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Slide 2:
Vision-Zero Network (Unknown date) What is Vision Zero? Available from: http://www.visionzero.org [Accessed 2 April 2022].

Slide 4:
Published by Iteris for: Office of the Assistant Secretary for Research and Technology (OST-R), U.S. Department of Transportation (US DOT) Connected Vehicle Reference Implementation Architecture Available from: http://local.iteris.com/cvria/html/applications/applications.html [Accessed 3 April 2022]

Slide 5:
Morder Intelligence, (2022) Connected Vehicle Market – Growth, Trends, COVID-19 Impact, and Forecasts (2022-2027) Available from: https://www.mordorintelligence.com/industry-reports/connected-vehicle-market [Accessed 3 April 2022]

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