Security Analysis of Next-generation Connected Vehicle based Transportation

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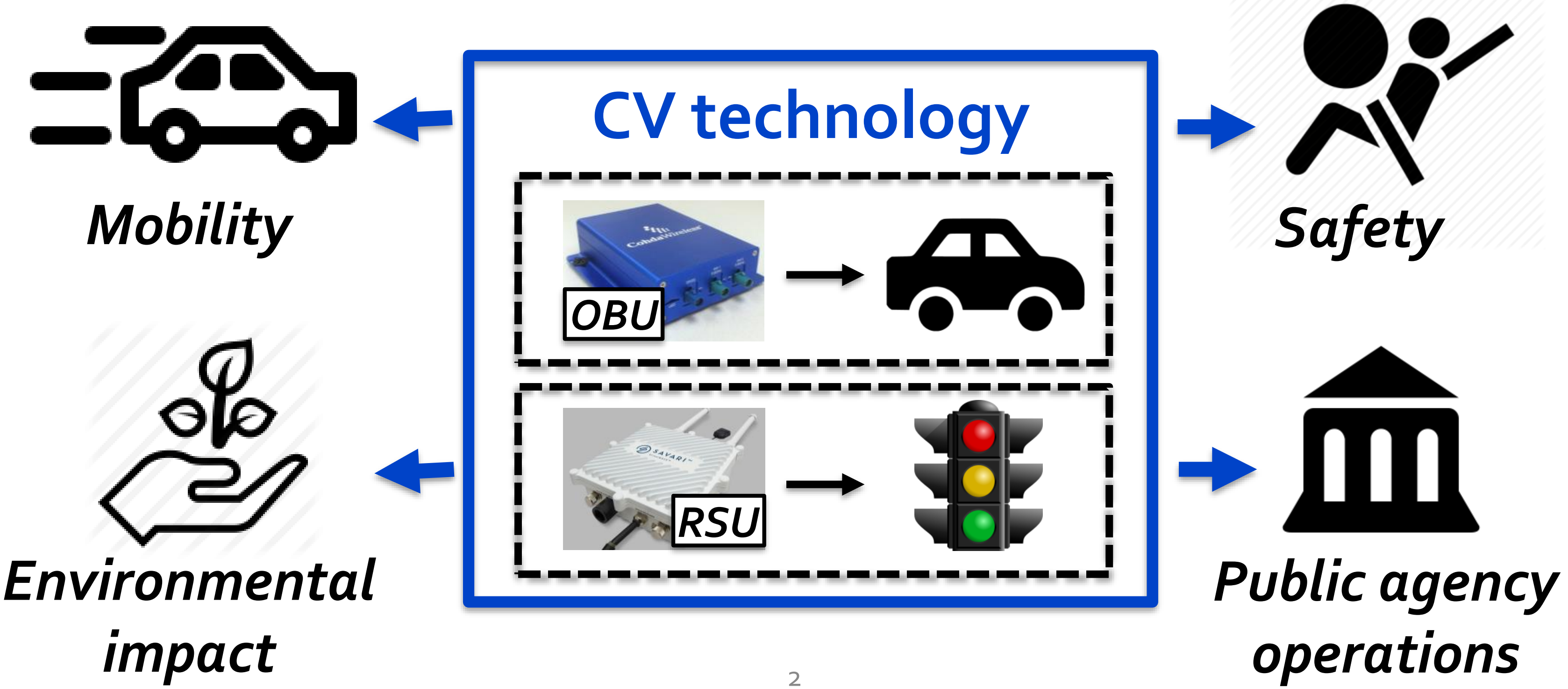
Background: Connected Vehicle (CV) technology

- Wirelessly connect vehicles & infrastructure
- **Goal**: Dramatically improve mobility, safety, environmental impact, & public agency operations



Mobility

CV technology

OBU

RSU

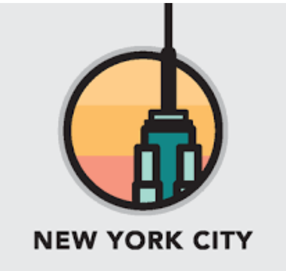
Safety

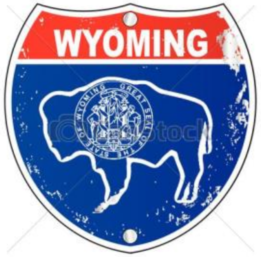
Environmental impact

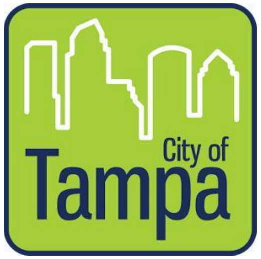
Public agency operations

Background: Recent advances

- Will ***soon*** transform transportation systems today
- 2016.9, USDOT launched **CV Pilot Program**
  - National effort to deploy, test, & operationalize CV-based transportation systems
  - Launched in **3 cities**







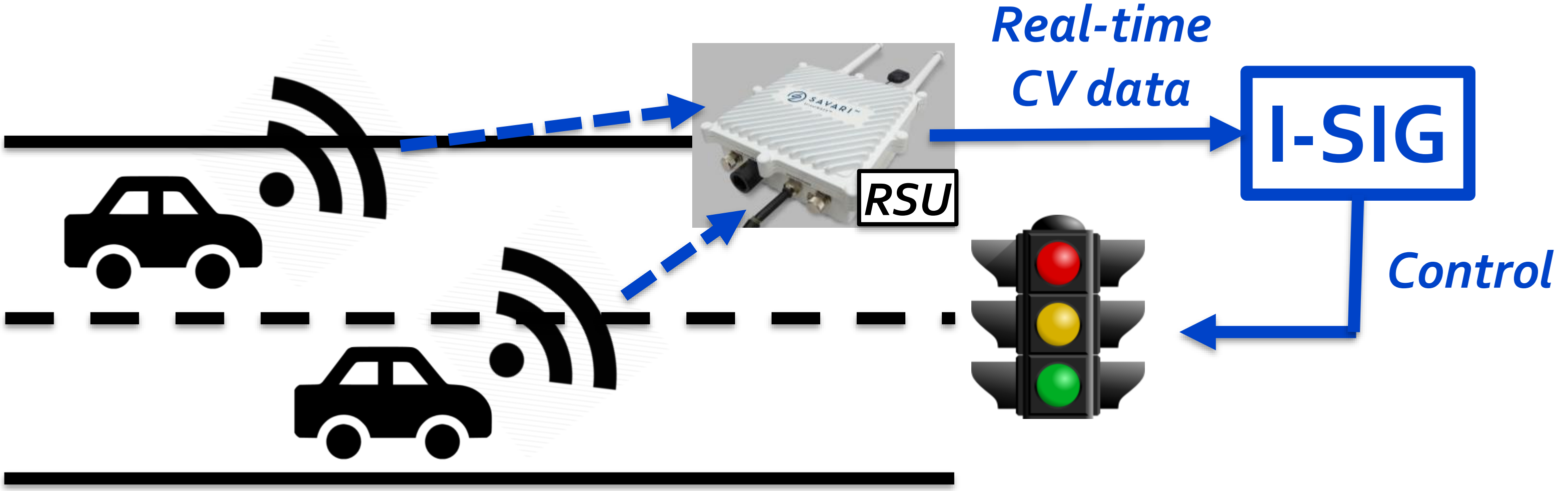
- 2016.11, USDOT proposed to ***mandate*** CV tech in ***all light-duty vehicles***, starting from ***as soon as 2020***

Cybersecurity of CV-based transportation

- However, such dramatically increased connectivity also opens a new door for **cyber attacks**
- **Highly important** to understand potential security vulnerabilities & new security challenges
  - Need to ensure ***security*** & ***safety*** for vehicles, transportation infrastructure, drivers & pedestrians
  - Need to perform study ***now*** so that they can be proactively addressed before nationwide deployment

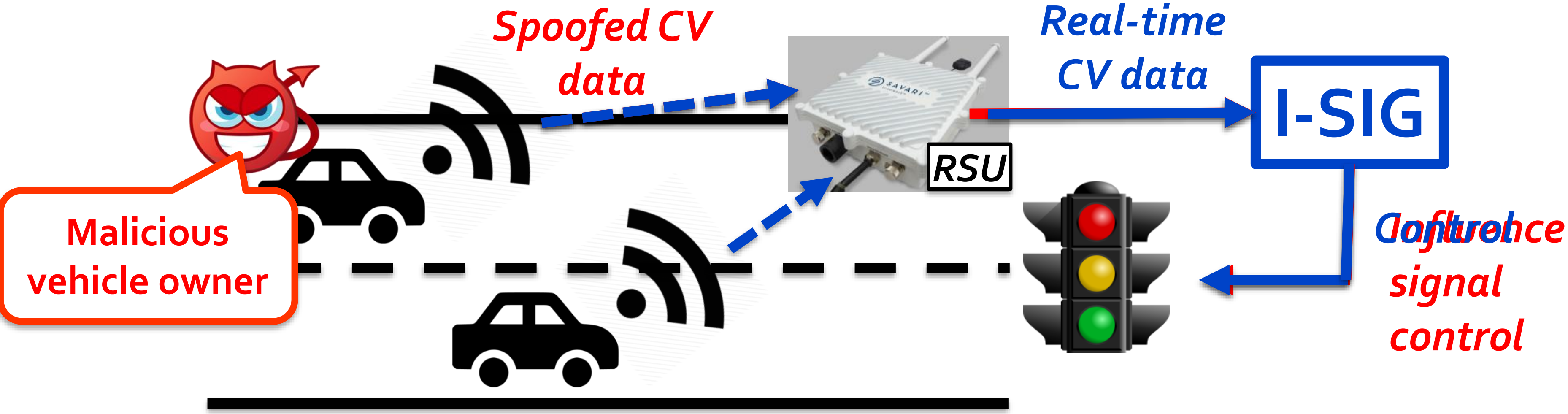
Our work

- Start by performing security analysis
- **Current focus**: Intelligent Traffic Signal System (I-SIG)
  - Use real-time CV data for intelligent signal control
  - USDOT sponsored design & impl.



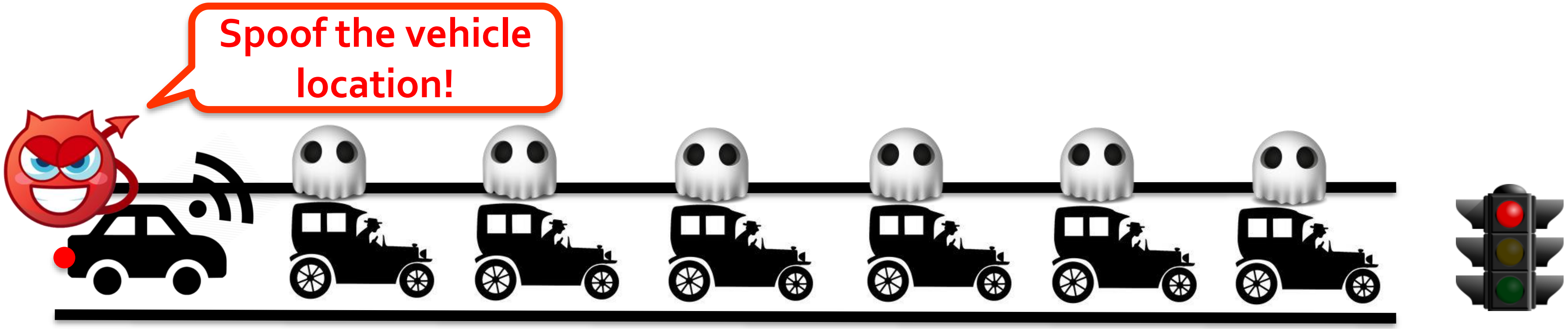
Threat model

- Start by performing security analysis
- **Current focus**: Intelligent Traffic Signal System (I-SIG)
  - Use real-time CV data for intelligent signal control
  - USDOT sponsored design & impl.
- **Threat model**: Malicious vehicles send spoofed data



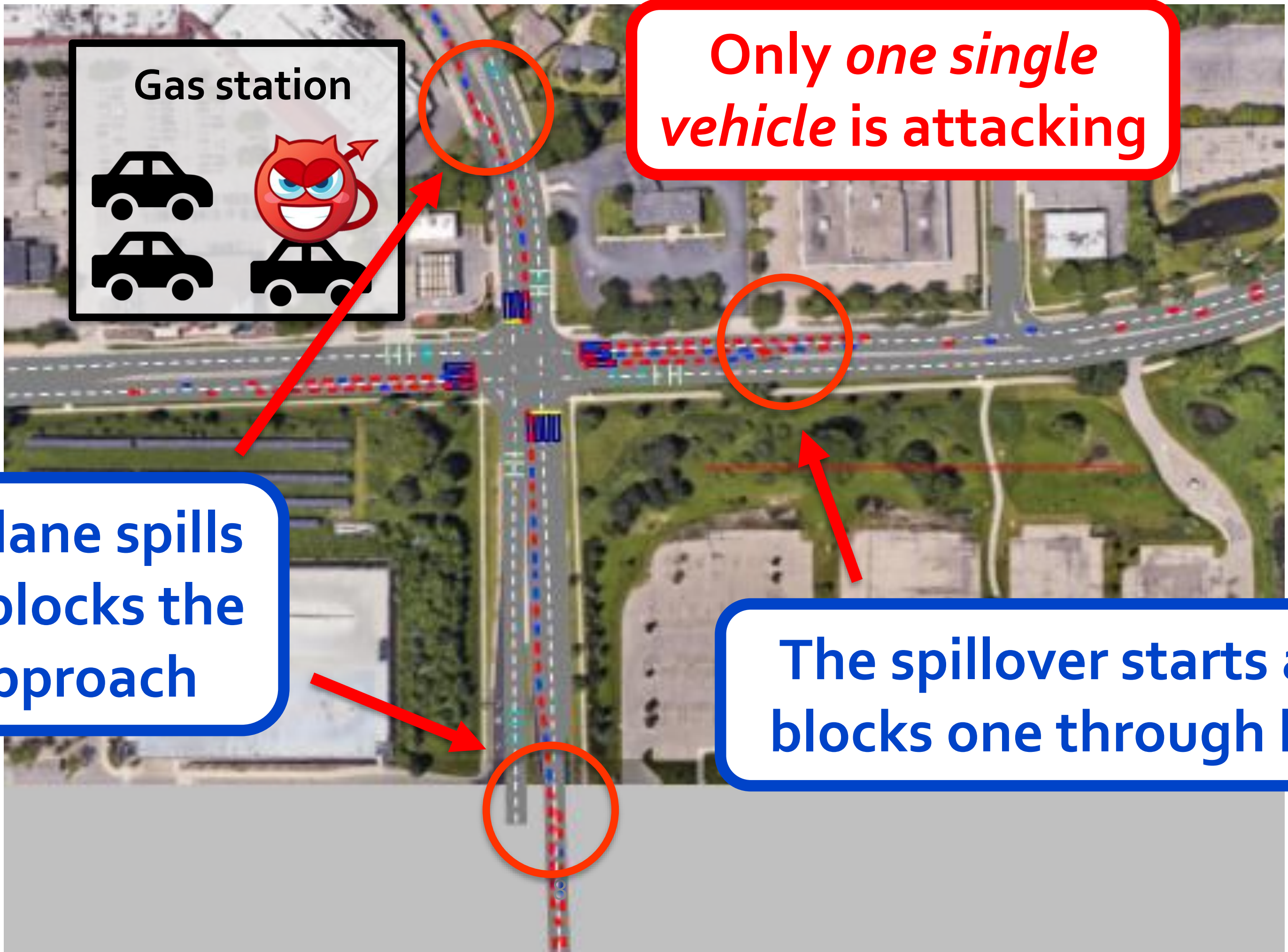
Preliminary results

- **Finding**: Vulnerability in the smart traffic control logic
  - Spoofed data from ***one single attack vehicle*** can greatly manipulate the traffic control
  - The smart control algorithm can be fooled to:
    - Add tens of ***"ghost" vehicles***
    - Extend green light by spoofing to a ***late arriving*** vehicle



Congestion attack results

- One car to cause massive road-blocking effect!



Only *one single vehicle* is attacking

Left-turn lane spills over and blocks the entire approach

The spillover starts and blocks one through lane

Open questions

- More security analysis
  - Other types of attack goals
    - ***Personal gain***: Reduce attack vehicle's travel time at the cost of others
    - ***Safety attack***: Increase the safety risk of a specific or a set of vehicles
  - Other CV-based transportation systems
    - ***60+ types of open sourced prototypes*** developed by USDOT
- Defense solution directions
  - Data spoofing detection
    - Systematically ***transform CV systems*** to include detection logic
  - Hardware-assisted data spoofing prevention
    - E.g., leverage Intel SGX, ARM TrustZone
    - Need systematic mechanism to ***partition protocol binaries***

- A full paper of our current findings will appear in NDSS’18
- Any comments?