

# AUTONOMOUS VEHICLE LOCALIZATION BY LEVERAGING CELLULAR CONNECTIVITY

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# CADILLAC SUPER CRUISE



- 2018 Cadillac CT6 Sedan
- Launched Q3 2017 in US and Canada
- Optional Feature
- Safe & Reliable Hands-Off Operation on North America highways
- Level 2 Automation: Driver Assist Feature (0 to 85 mph)

# VIDEO

[https://youtu.be/\\_rxW68ADIdI](https://youtu.be/_rxW68ADIdI)

# CADILLAC SUPER CRUISE TECHNOLOGY

## High definition redundant cameras (front, side, rear)

- Lane marker identification

## Long range and short range radar

- Object detection

## 6 DOF MEMS Inertial Measurement Unit

- Vehicle orientation and motion

## LIDAR-surveyed precise map (<10 cm absolute accuracy)

- Remotely updated over-the-air through 4G LTE

## Single-frequency, GNSS corrections through 4G LTE

- Precise satellite clocks, orbits, atmospheric delay
- GPS/GLONASS
- Trimble RTX service
- 1.8 meter (95%)



**4G**  
LTE

# CADILLAC SUPER CRUISE MY2018 CONNECTED FEATURES

- **Precise map updates**
  - Construction areas
  - Fresh road surveys
- **Continuous GNSS corrections**
  - Reduces errors in GPS/GLONASS signals
  - Supplements camera for lane identification
  - Active whenever ignition is on
- **Continuous Super Cruise diagnostics**
  - Vehicle system monitoring
- **OnStar emergency call**
  - Automatic call if driver becomes incapacitated while using Super Cruise
- **Over-the-air software updates for critical vehicle controllers**



# CONNECTIVITY AND AV – FUTURE ROADMAP

## V2X Capabilities

- Vehicle-to-Vehicle communication for lane merges and traffic awareness
- Issues under consideration:
  - DSRC 802.11p vs. Cellular V2X
  - Importance of accurate vehicle location
  - Vehicle-to-Infrastructure use cases and infrastructure deployment

## Precise map creation concept:

- Deliver camera images via cellular to map server
- Precise road segments computed at server and delivered to vehicle
- Vehicle localizes itself to precise road information
- Could potentially provide more timely map updates (requires favorable data transport costs)

## 5G

- High bandwidth, low latency

# CONNECTIVITY AND AV – ENGINEERING CHALLENGES

## RF Complexity and Interference

- GNSS, cellular bands, DSRC/C-V2x vs. Wi-Fi
- RF noise from nearby electronics (Ethernet, LVDS video, wireless charging)

## Fast pace of technology change vs. lengthy automotive development

- Forcing automakers to maximize speed-to-market through new partnerships
- Growing dependence on emerging technology and startups
- Greater use of HIL simulation & modeling
- Add or update Apps through unique General Motors App Framework at scale and with speed

## Safety cannot be compromised

- Requires ASIL certification of HW/SW components
- Redundancy will continue to be critical for autonomous vehicles
  - Redundant sensors (camera, Lidar, IMU, GNSS, maps)
  - Redundant communication (multiple carriers, supplement cellular with satellite)
- Leverage GM experience with connected services and technology integration to continue to provide sensor and communication redundancy going forward