How NDS Fits into the Research Portfolio Now and in the Future

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Director, Safety Electronics & Innovation

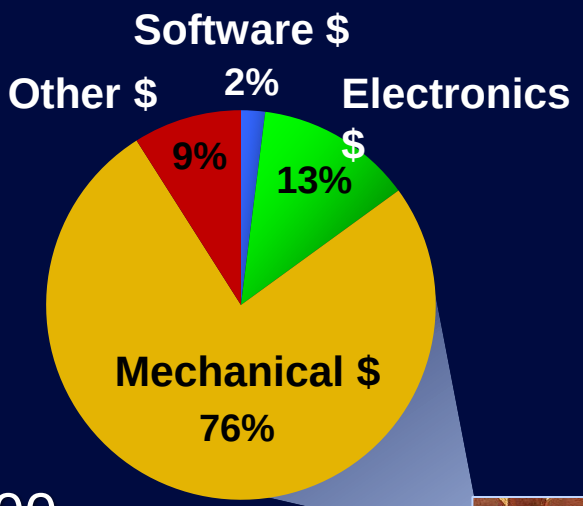
VEHICLE ELECTRONICS AND SENSORS

Rear-Passenger Flat-Panel Displays
Command System with PCMCIA Slot
GPS Navigation
DVD Player
LED Lamp Cluster
Head-Up Displays
Dashboard-Instrument Cluster
Telematic System
Climate Control
Electronic Power-Roof System
Radar Sensor
Transmission Control
Collision Avoidance
Adaptive Cruise Control
HID Headlamp
Memory Seat/Mirror/Steer
Airbag Control and Satellite Crash Sensors
Active Steering

Body Control
Suspension Control
Power Windows
Remote Keyless Entry
Seat Massage/HVAC
Adaptive Brake Lights
Parking Sensors
Rear-View Camera
Battery Management
Power Seats
Throttle Control
Engine Control Unit
Folding Door Mirrors
Eletrochromic Rear-View Mirrors
Car Radio
Antilock-Braking System/Electronic-Stability Program
Tire-Pressure-Monitoring System (TPMS)

VALUE OF ELECTRONICS AND SOFTWARE

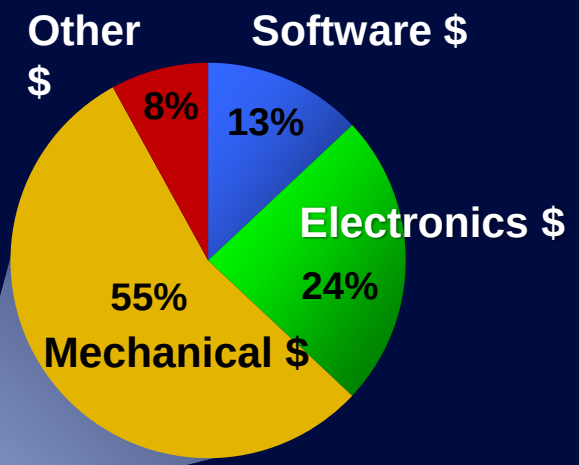
- More functions and features
- Less hardware
- Faster



- $400
- 20 ECUs
- 1M lines of code

2000 Average

Today's Average



- $1,200
- 75 ECUs
- 100M lines of code

Crash Avoidance Technologies Available Today

Lane Departure Warning (LDW)

Cadillac DTS
Cadillac STS

Buick
Lucerne

LDW w/Traffic Sign Recognition

"Opel Eye"

Opel Insignia
Opel Astra

Speed/Curve Advisor

Cadillac STS
Cadillac DTS
Cadillac SRX

Rear Vision Camera

Many Models

Electronic Stability Control

Many Models

Side Blind-Zone Alert

Cadillac DTS
Cadillac STS
Cadillac Escalade

Buick Lucerne
Buick LaCrosse

GMC Yukon/
Yukon Denali

Chevrolet Tahoe/
Suburban

Adaptive Cruise Control w/Forward Collision Alert

Cadillac DTS
Cadillac STS

Side Blind-Zone Spotter
rror

Chevrolet
Traverse

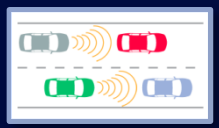
Dual Feature Front Camera: Lane Departure Warning and Forward Collision Alert

Chevrolet
Equinox

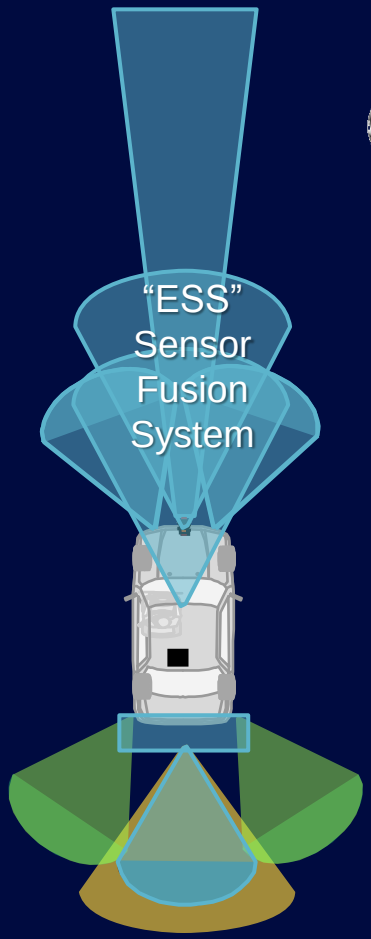
GMC Terrain

Adaptive Cruise Control and Auto Collision-Mitigation Braking

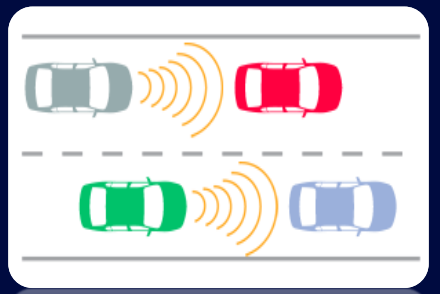
Opel Zafira



New Technologies for 2013 Models



Cadillac ATS
Cadillac XTS
Cadillac SRX



- Full Speed-Range Adaptive Cruise Control (Stop-&-Go Notifier)
- Auto Collision Preparation (includes Collision Imminent Braking)
- Low-Speed Emergency Braking
- Side Blind-Zone Alert + Rear Cross-Traffic Alert
- Haptic Safety Alert Seat Feedback

Future Systems, with More Capability,

Will Require Naturalistic Studies

GM

Unfortunately, some people are driving semi-autonomously (in vehicles that aren't)

CARS THAT DON'T CRASH

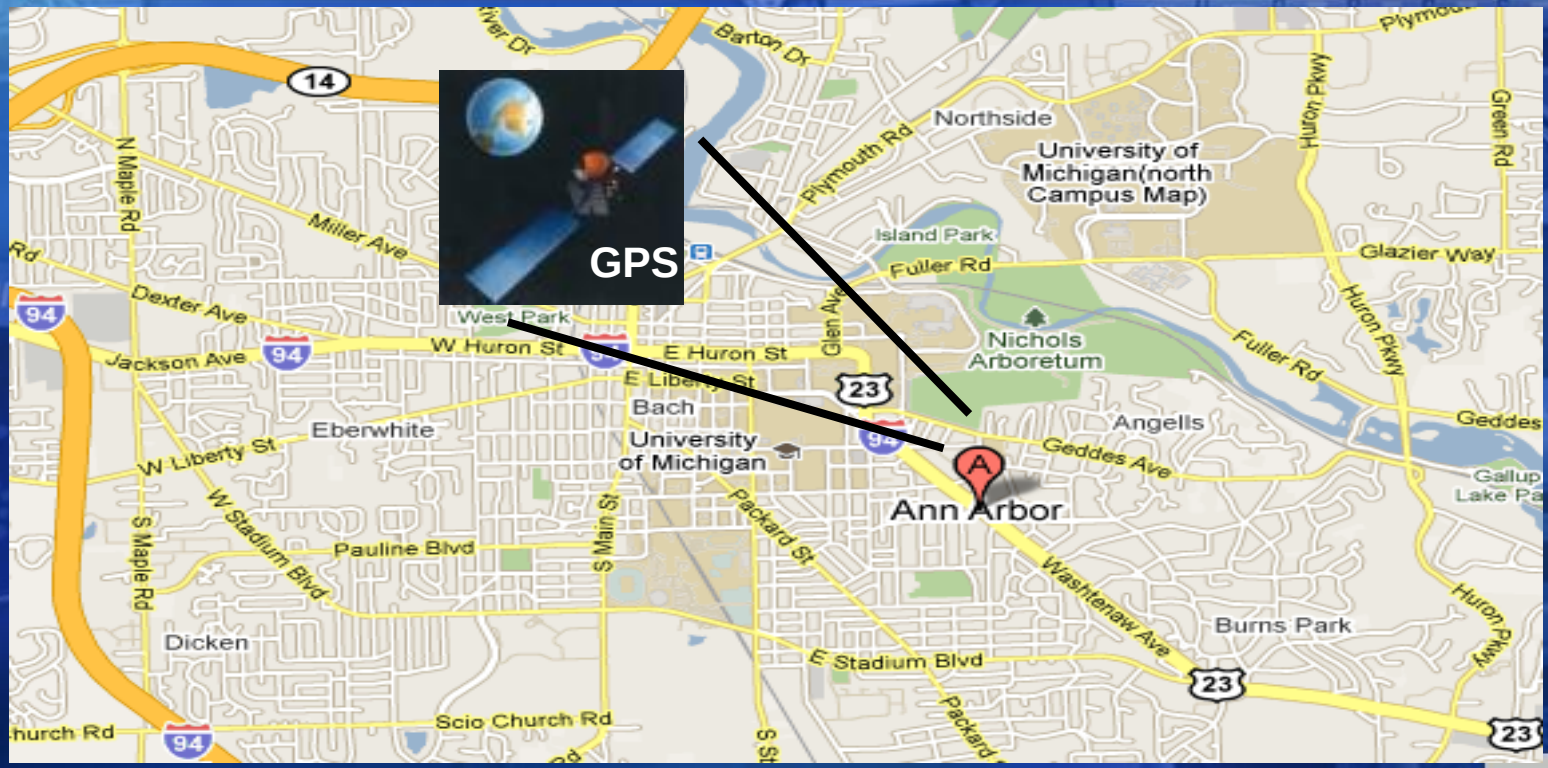
VEHICLES THAT DRIVE THEMSELVES

VEHICLES THAT DRIVE THEMSELVES

Where am I – GPS + digital maps

VEHICLES THAT DRIVE THEMSELVES

Where am I – GPS + digital maps

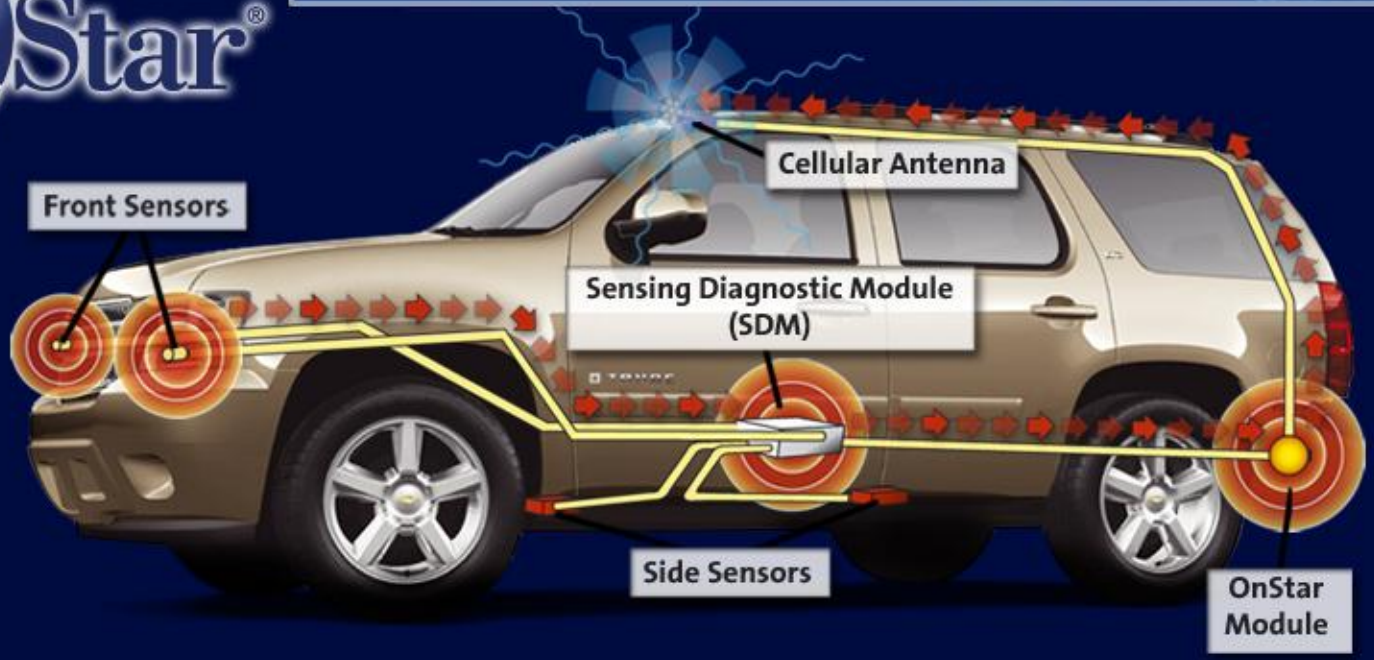


“CONNECTED VEHICLES” SINCE 19

6,000,000
SUBSCRIBERS

SAFETY AND SECURITY

OnStar®



VEHICLES THAT DRIVE THEMSELVES

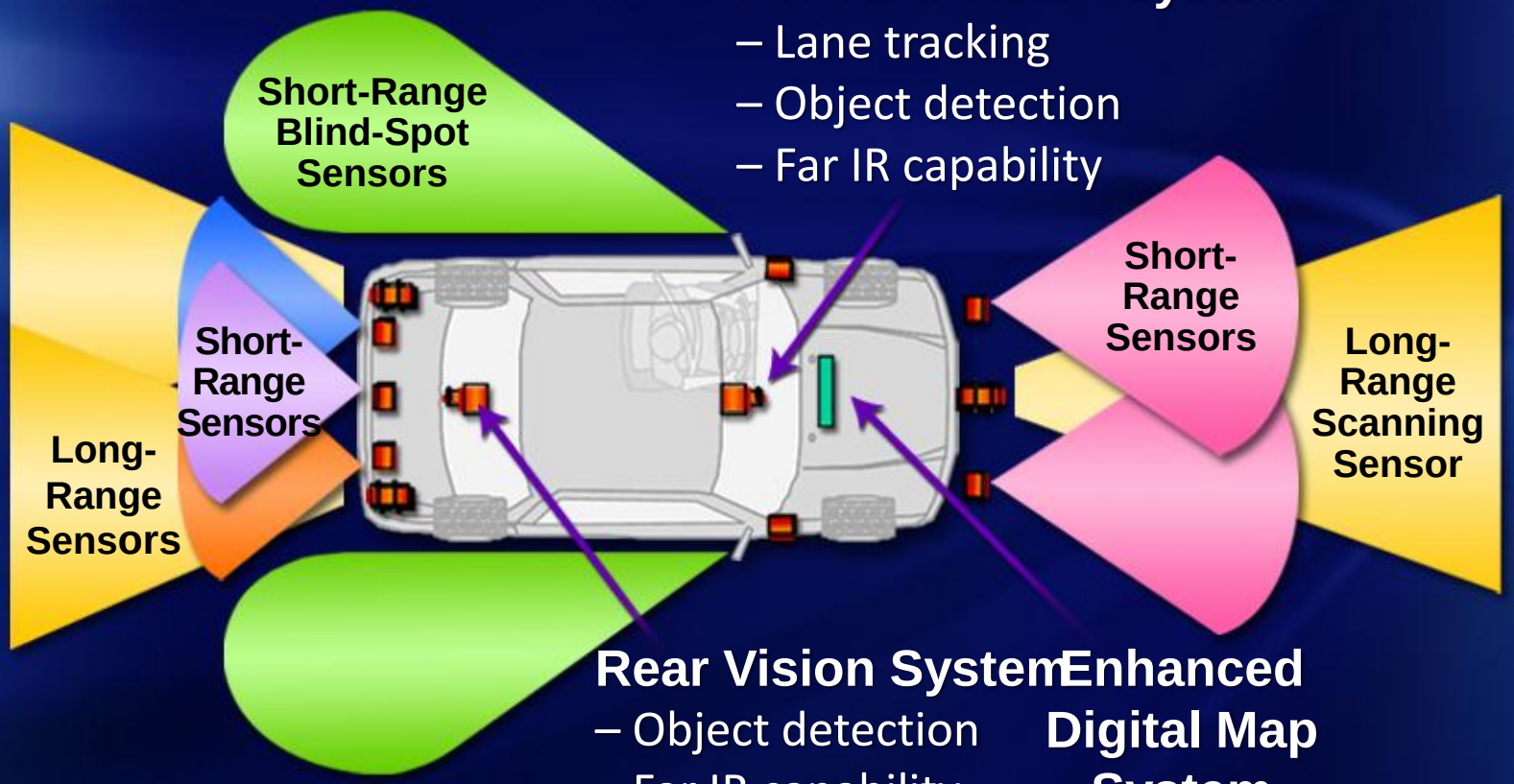
Where am I – GPS + digital maps

What's around me – 360°sensing (sensors + "V2V")

ENABLERS

Navigation and Active Safety Features

INTEGRATED SENSOR STRATEGY



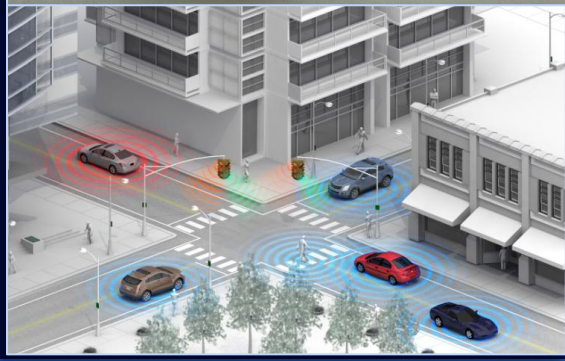
V2X TRANSPONDER INTEGRATION

APPLICATIONS

- Forward Collision Warning
  - – Detected
  - – Caution
  - – Warning

- Intersection Collision Warning

- Hard Braking Vehicle Ahead



VEHICLES THAT DRIVE THEMSELVES

Where am I – GPS + digital maps

What's around me – 360°sensing (sensors + "V2V")

Take me where I want to go – Software algorithms + electronic controls and actuators

ENABLERS

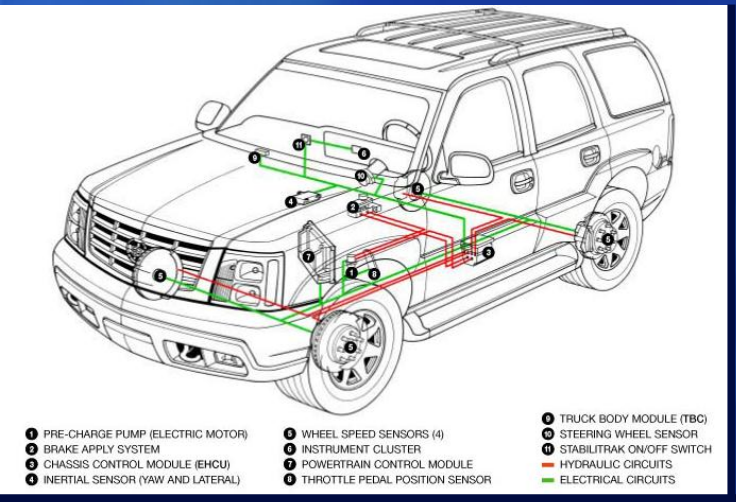
Navigation and Active Safety Features

On-Demand Assistance and Crash Avoidance

GM

NOVEMBER 3, 2007: "BOSS" WINS DARPA URBAN CHALLENGE

ELECTRONIC STABILITY CONTROL



VEHICLES THAT DRIVE THEMSELVES

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Who's in charge – Knowledge of driver state + vehicle capability