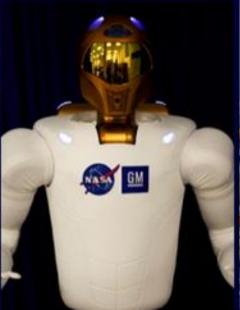
FUTURE VEHICLE COMPUTER SYSTEM IN A FIVE-SCREEN WORLD

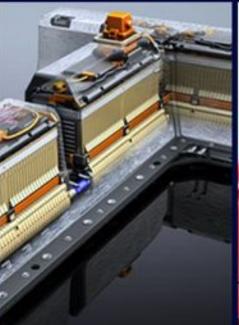


Byron Shaw

Managing Director, Advanced Technology, Silicon Valley















URBAN CHALLENGE: MEGACITIES

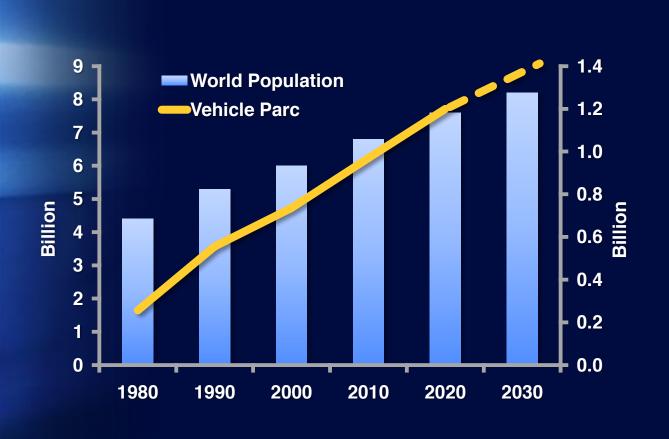
- By 2030, 60% of the world's population will live in urban areas, up from 50% today
- Within 20 years, 80% of wealth will be concentrated in cities
- As the urban population increases, traffic congestion in large metro areas will become an even bigger issue







PERSONAL MOBILITY MUST BE REINVENTED FOR THE 21st CENTURY



Technology Challenges

- Energy
- Safety
- Congestion
- Smart Materials
- Connectivity
- Manufacturing

TECHNOLOGY DRIVERS

Challenges	Stretch Goals
■ Energy	Low-cost renewable energy
■ Safety	Autonomous crashless vehicles
Congestion	Congestion-free routing/ parking
Smart Materials	Multi-component composites
Connectivity	Open architecture electronics
Manufacturing	Agile, real-time manufacturing

CARS THAT DON'T CRASH







AND AUTONOMOUS DRIVING



CURRENTLY AVAILABLE CRASH AVOIDANCE TECHS (2010 AND 2011 GM MODELS)

Lane Departure Warning





Cadillac DTS Cadillac STS



Buick Lucerne

LDW w/Traffic Sign Recognition







Opel Insignia Opel Astra

Speed/Curve Advisor







Cadillac STS **Cadillac DTS Cadillac SRX**

Rear Back-Up Video











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

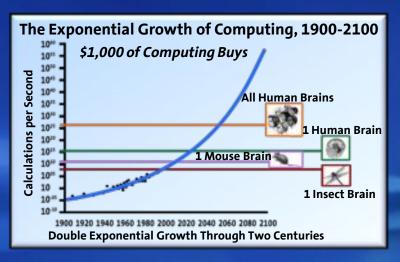
Side Blind Zone Spotter Mirror





Chevrolet Traverse

ROADMAP TO AUTONOMOUS DRIVING



Functionality

Limited Intervention

(No Control)

Alerts/Warnings

- Lane Departure Warning
- Traffic Sign Memory
- Forward Collision Alert
- Side Blind Zone Alert

Full-Speed Adaptive Cruise Control (Stop & Go)

- Collision Mitigation Braking
- Low Speed Avoidance (Virtual Bumper)
- Lane Keep Assist

On-Demand/Shared Control

- Freeway Assisted Driving (limited conditions) hands free, w/eyes on road
- Auto Lane Change
- Collision Avoidance w/Braking & Steering

Autonomous Driving

- Increasing Autonomous and Avoidance Capability
- Integrated Sensing w/V2X Connectivity

ADVANCED SAFETY TECHNOLOGY STREAM

Technical Complexity

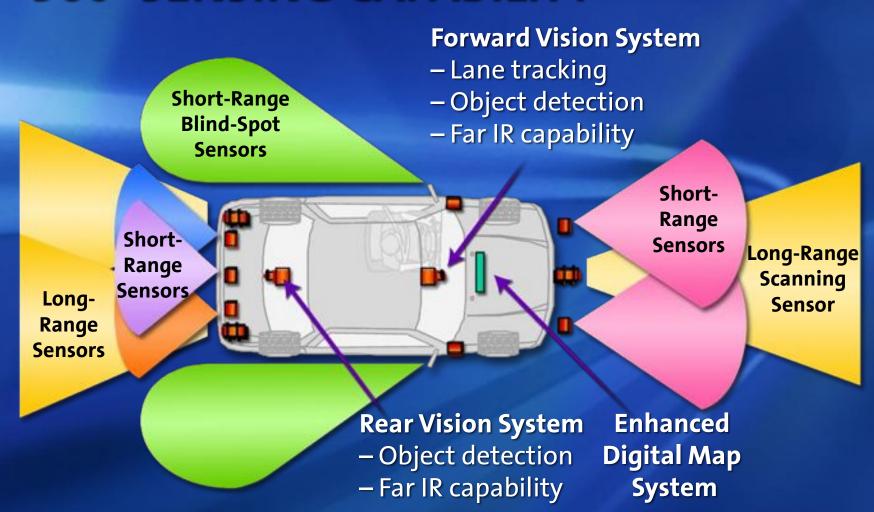
Collision Avoidance (Steering) Vehicle-to-Vehicle Communication Vehicle-to-Infrastructure Communication Steer-by-Wire Lane Keeping Forward Collision Avoidance (Braking) **Driver Performance Monitor** Lane Sensing/Warning **Active Roll Control Forward Collision Warning Adaptive Cruise Control Vision Enhancement Near Obstacle Detection Electronic Stability Control Adaptive Variable-Effort Steering Semi-Active Suspension Traction Control Anti-Lock Braking Systems**

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





360° SENSING CAPABILITY



TECHNOLOGY DRIVERS

Challenges Stretch Goals

- Energy Low-cost renewable energy
- Safety Autonomous crashless vehicles
- Congestion Congestion-free routing/ parking
- Smart Materials Multi-component composites
- Connectivity Open architecture electronics
- Manufacturing Agile, real-time manufacturing

REINVENTING PERSONAL URBAN MOBILITY: EN-V (ELECTRIC, NETWORKED VEHICLE)



EN-V AUTONOMOUS SYSTEM COMPONENTS AND FEATURES

DSRC antenna



Smart phone for remote parking and retrieval



Forward vision sensor for object and collision detection



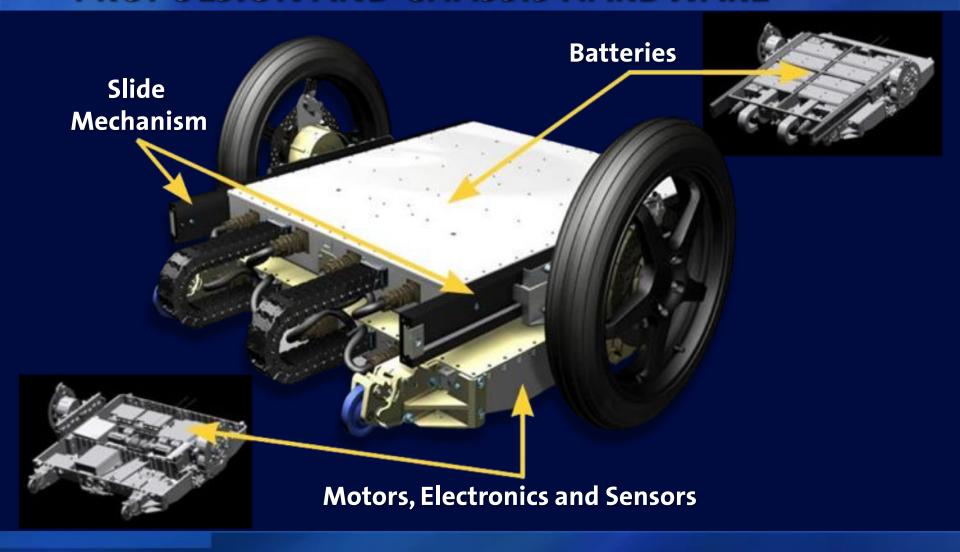
Forward range sensors for slow speed object and collision detection







BY-WIRE SKATEBOARD CONTAINS PROPULSION AND CHASSIS HARDWARE



TECHNOLOGY DRIVERS

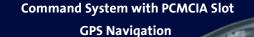
Challenges

Stretch Goals

- Energy Low-cost renewable energy
- Safety Autonomous crashless vehicles
- Congestion Congestion-free routing/ parking
- Smart Materials Multi-component composites
- Connectivity Open architecture electronics
- Manufacturing Agile, real-time manufacturing

VEHICLE ELECTRONICS AND SENSORS

Rear-Passenger Flat-Panel Displays



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)

EXAMPLES OF UPCOMING FEATURES AND SERVICES

- Smartphone interface
- Rear Seat Entertainment with mobile digital Satellite TV
- Advanced Navigation with camera view (Augmented Reality)

- Wireless charging
- GM-specific Apps
- Software Defined Radio
- Ubiquitous connectivity
- Full Cloud connectivity



EXAMPLES OF UPCOMING FEATURES AND SERVICES

Advanced Navigation with Augmented Reality



On-board Real-time Diagnostics

BACK

7,500 Tire Rotation and Inspections due

Tell me more about this

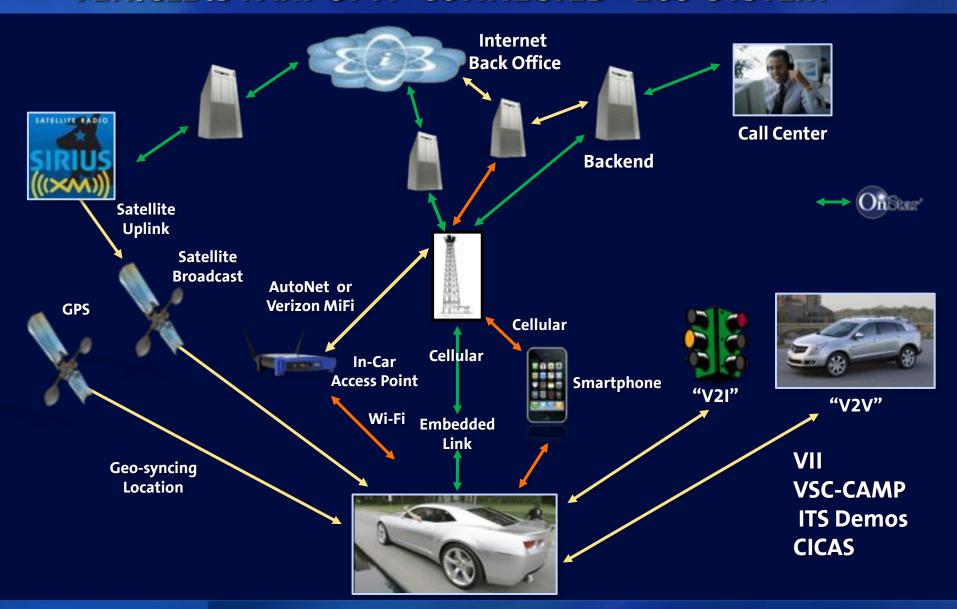
Call my dealer

Call an OnStar Advisor to schedule service or find me a dealer

Please send a note to my dealer to contact me via email

Delete this reminder

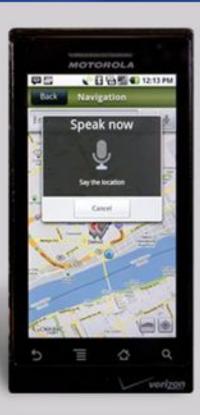
VEHICLE IS PART OF A "CONNECTED" ECO-SYSTEM



SMART PHONE MOBILE APPS



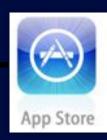




CONSUMER ELECTRONICS IS DRIVING MANY OF TODAY'S IN-VEHICLE "CONNECTIVITY" FEATURES

iPhone and App Eco-system





Personal Media





Pervasive GPS



Social Networking



facebook.



ANY TIME ANY CONTENT ANY WHERE



Personal Navigation











Mobile Data Plan







EXAMPLES OF GROWING FEATURES AND SERVICES EXISTING NEW EMERGING

(Primarily Vehicle Centric)

(Primarily Consumer Centric)

Safety & Security

Personalized **Location Based Services (LBS)**

Content Download from Cloud

Diagnostic Services

Personal Device Connectivity

Advanced Prognostics

Customer Care

Smart Phone Apps for EV

Mobile Commerce

Navigation Traffic & Weather

Eco Navigation

V2I Application

Personal Device Connectivity

Social **Networking** **EV Smart Grid** Connectivity with V2G

CURRENT DNA

Energized by Petroleum

Powered Mechanically by Internal Combustion Engine

Controlled Mechanically

Stand-alone

Totally Dependence on the Driver

Vehicle Sized for Max Use – People and Cargo

NEW DNA

Energized by Biofuels, Electricity, and Hydrogen

Powered Electrically by Electric Motors

Controlled Electronically

"Connected"

Semi/Full Autonomous

Driving

Vehicle Tailored to Specific Use



Electric, Networked Urban Mobility Concept

