The Internet of Cars

A Catalyst to Unlock Societal Benefits of Transportation

Andreas Mai
Director Product Management Smart Connected Vehicles

March 2013
Disruptive Innovation?
A History of Connections

170 Years Ago: Invention of the Telegraph
100 Years Ago: Invention of the Radio
70 Years Ago: First general purpose electronic computer
40 Years Ago: First Internet connection
20 Years Ago: World Wide Web

Intelligently Connecting People, Process, Data, and Things

2003: 0.5B Connected Devices
2005: First Smartphone
2005: IP Traffic: 29 exabytes
2008: Video Traffic: 21 exabytes
2010: 0.5B Smartphones
2010: 7B Connected Devices
2012: 25M Connected Cars
2011: 90M Smartmeters
2012: 25M Connected Cars
2013: 10B Connected Devices
2015: 2/3rds Video Traffic
2016: IP Traffic: 1.3 zettabytes
2017: 300M Connected Cars
2018: 4.5B New People, 37B New Things
2020: 1B Smartphones
2020: 1B Smartmeters
2020: Global Cloud Market: 500% Growth
The Evolution of the Internet

Connectivity
Digitize Access to Information
- Email
- Web Browser
- Search

Networked Economy
Digitize Business Process
- E-commerce
- Digital Supply Chain
- Collaboration

Immersive Experiences
Digitize Interactions (Business & Social)
- Social
- Mobility
- Cloud
- Video

Internet of Everything
Digitize the World
Connecting:
- People
- Process
- Data
- Things

Business and Societal Impact

Intelligent Connections
Business Opportunity in an Evolving World

The Internet of Everything

Create and Expand New Markets and Services

Empower People/ Increase Efficiency

Create Better Experiences to Build Better Relationships

Deeper Insights for Greater Decision Making

Create and Expand New Markets and Services

Empower People/ Increase Efficiency

Create Better Experiences to Build Better Relationships

Deeper Insights for Greater Decision Making
Trends Transforming Transportation

Source: Cisco IBSG Automotive 2011
Many Connected Vehicle Profit Pools – Albeit Largely Disconnected, So Far…

<table>
<thead>
<tr>
<th>Car Manufacturers</th>
<th>Navigation</th>
<th>POI / LBS</th>
<th>Social Media</th>
<th>X-Mode Travel Assist</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TomTom</td>
<td>Foursquare</td>
<td>MySpace</td>
<td>TripIt</td>
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<tr>
<td></td>
<td>GARMIN</td>
<td></td>
<td>Twitter</td>
<td>Expedia</td>
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<tr>
<td></td>
<td>NAVTEQ</td>
<td></td>
<td>Facebook</td>
<td>Travelocity</td>
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<table>
<thead>
<tr>
<th>Finance</th>
<th>Infotainment</th>
<th>Productivity</th>
<th>PAYD Insurance</th>
<th>ITS Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ford</td>
<td>Netflix</td>
<td>Skype</td>
<td>Progressive</td>
<td>Lite-On</td>
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<tr>
<td>TOYOTA FINANCIAL SERVICES</td>
<td>Pandora</td>
<td>Salesforce.com</td>
<td>Songdo</td>
<td>MAS'DAR</td>
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<tr>
<td>CHRYSLER FINANCIAL</td>
<td>iTUNES</td>
<td>Microsoft Office</td>
<td>I NY</td>
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<thead>
<tr>
<th>Vehicle Telematics</th>
<th>Service Providers</th>
<th>Car Apps</th>
<th>Car Rental/Share</th>
<th>Road Pricing/VMT</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATX</td>
<td>verizon wireless</td>
<td>AVIS</td>
<td>Budget</td>
<td>US</td>
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<tr>
<td>Hughes Telematics</td>
<td>OnStar</td>
<td>Heitz</td>
<td>Heitz</td>
<td></td>
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<tr>
<td></td>
<td>verizon wireless</td>
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<thead>
<tr>
<th>OEM Car Care</th>
<th>Aftermarket Car Care</th>
<th>Online Business</th>
<th>Energy Producers</th>
<th>Road/Parking Ops</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMW</td>
<td>S N K</td>
<td>eBay</td>
<td>PG&amp;E</td>
<td>BECHTEL</td>
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<tr>
<td>KIA</td>
<td></td>
<td>Google</td>
<td>ExxonMobil</td>
<td>Cintra</td>
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<td></td>
<td></td>
<td>Costco Wholesale</td>
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<td></td>
<td></td>
<td>Amazon</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Jiffy lube</td>
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Internet of Cars: Unlocking $1,400 in Benefits per Vehicle, per Year

**Internet of Cars Service Providers**
- Traffic guidance, navigation, emergency services
- “Google on wheels,” PAYD insurance, location-based services

**Auto OEM/OES**
- Lower service/warranty costs
- New profit pools
- Architectural savings

**Vehicle User**
- Lower insurance
- Lower operation cost
- Less time stuck in traffic, more productivity

**Society**
- Fewer crashes
- Lower traffic/road/toll operation costs
- CO₂ reduction

Benefits per vehicle, per year

- $160
- $300
- $420
- $550

Source: Cisco IBSG Automotive and Economics Practices, 2011
The Internet Takes to the Road…

Running Transportation on Networked Information

Transportation Services Delivered by Technology

Safety and Security  Operational Efficiency  Travel Experience  Revenue Generation

Source: Cisco IBSG Automotive, 2011
Road to More Safety & Less Congestion Is Mainly Driven by Government Policy

- **Eco-Drive and On-Board Safety & Driver Assist**
- **V2V Safety & Driver Assist**
- **Smart Road Pricing/ VMT Tax**
- **V2I & Local Dynamic Traffic Management**
- **Connected Cybernetic Traffic Management**

Source: Cisco IBSG Automotive 2011
THE “Savior-App”: Strategic Asset for the Entire Car Insurance Value Chain

- **Usage & Behavior**
  - PAYD, PHYD, MHYD
- **Crash Prevention**
  - Vehicle and driver health monitoring
  - Safest-route
  - ADAS + V2V + V2I
- **Fast & Correct Response**
  - eCall/ ACN
  - Virtual Black Box
  - Driver vitals to first responders
- **Claims & Cost Containment**
  - Investigation costs
  - Fraud prevention and reduction (~80%)
  - Stolen vehicle tracking / location
- **Connected Law Enforcement**
  - Pay as you speed
  - Virtual violation detection and notification
  - Automated payment

Savings per connected vehicle and year:
$280 for insurance/ owner + $100 for society

Source: OctoTelematics, Cisco IBSG Automotive 2010
Marginal Return on U.S. Road “Business”

U.S. Roads:
4,000,000 Paved Road Miles
x $6,800,000 Price per Mile
= $27,000,000,000,000 Assets

$100,000,000,000 Fuel Tax + Tolls
= 0.4% Return on Assets

“Depreciated” over 250 Years

Source: An Analysis of the Current Investment Trend in the U.S. Toll Road Sector, MIT, 2008, Cisco IBSG Automotive 2011
# THE Future “Finance-Application”: Connecting for Smart Road Pricing

## Smart Road Pricing / Vehicle-Miles-Traveled Tax

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Occupancy</th>
<th>Congestion</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>Road Type</td>
<td>Fuel Economy</td>
<td>Emissions</td>
</tr>
</tbody>
</table>

Source: Cisco IBSG Automotive 2011
New Battleground: From Building Cars to Selling Travel Time Well Spent

Connecting the Value Chain

Extended Design and Supply Chain
- Garmin
- Cisco
- Google
- INRIX

Travel Experience & Location-Based Services
- ZAGAT
- Aha
- Groupon
- ParkingCarma

Distribution and Service Network
- RepairPal
- Betty
- CarsDirect
- Driveside

Marketing, Advertising, CRM
- AutoTrader
- CRM
- Facebook
- Twitter

CONNECTED within the car
CONNECTED to personal devices
CONNECTED around the car
CONNECTED to the cloud

Source: Cisco IBSG Automotive, 2011
Connectivity Enables New Services and Pricing Models

Service Options

- Bundled Packages
  - Total Mobility Cost Optimizer
  - Infotainment/ Productivity
  - Dynamic Travel Time Optimizer
  - B2C & B2B/G Service Platform
  - Connected Safety & Security
  - Connected Vehicle Care

On-Demand

Pricing Options

- Investment
  - Buy
  - Lease
  - Subscription

- Micro Payments
  - Pay per SW defined Feature
  - Pay per Use or Upgrade
  - Pay per Mile or Minute

Source: Cisco IBSG Automotive, 2010
Emergence of New Business Models

Smart Parking

Mobility On-Demand

Source: Web Research, 2011
Smart Shared Vehicle Concept: Dynamic Incentives for Redistribution

High Demand + Low Vehicle Stock = Low Drop-off Price

High Demand + Low Vehicle Stock = High Pick-up Price

Low Demand + High Vehicle Stock = High Drop-off Price

Low Demand + High Vehicle Stock = Low Pick-up Price

Source: Kent Larson, MIT, Meeting of the Minds, Boulder 2011

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## Making Mobility More Affordable for One Billion People

### Transportation & Communication Cost (Percent of Personal Income)

<table>
<thead>
<tr>
<th>Country</th>
<th>Today</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mexico</td>
<td>12%</td>
<td>17%</td>
</tr>
<tr>
<td>China</td>
<td>14%</td>
<td>15%</td>
</tr>
<tr>
<td>Thailand</td>
<td>15%</td>
<td>15%</td>
</tr>
<tr>
<td>India</td>
<td>15%</td>
<td>14%</td>
</tr>
<tr>
<td>Brazil</td>
<td>15%</td>
<td>13%</td>
</tr>
<tr>
<td>United States</td>
<td>17%</td>
<td>15%</td>
</tr>
<tr>
<td>Japan</td>
<td>59%</td>
<td>50%</td>
</tr>
<tr>
<td>Italy</td>
<td>54%</td>
<td>50%</td>
</tr>
<tr>
<td>France</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>Germany</td>
<td>58%</td>
<td>50%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>42%</td>
<td>50%</td>
</tr>
</tbody>
</table>

### Passenger Vehicle Stock (Millions)

- Today: 750
- 2020: 1,750

Reduce Cost to World Average of 24%

Source: EIU Data, Cisco IBSG Automotive 2010
Internet of Cars = Better Experience = Key Growth Market for Service Providers

Pervasive Computing

Users
Grow the number of mobile revenue-generating subscriptions

Ubiquitous Connectivity

Uses
Find more things users can do with their mobile devices

M2M Network

Usage
Drive the frequency with which people use mobile data services

Artificial Intelligence

Source: Cisco IBSG 2011
New Funding Models: Add Value and Enable New Vehicle & Travel Experiences

- Comes with car
- Basic plan for “free”
- Data & services for premium

Service Providers
- OBU paid via two-year plan
- “Kindle model”
- B2B co-funding
- Value added service kick-back

Navigation
- Pre-installed
- X months for free
- Click to purchase

Infotainment
- POI / LBS
- Productivity
- Online Business
- Social Media
- Car Apps

- Complements in-vehicle infotainment
- Pre-installed
- X months for free
- Click to purchase

- Navigation
- POI / LBS
- Productivity
- Online Business
- Social Media
- Car Apps

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The Fuel of the Internet of Cars: “Big Data” Analytics and Prognostics

- TSP
  - Remote Diagnostics
  - Connected vehicle care
  - Navi + traffic

- PAYD
  - Driver behavior
  - Driver vitals
  - Vehicle vitals
  - eCall/ ACN
  - Virtual Black Box
  - Vehicle recovery

- EV Clearing
  - Available station
  - Reservation
  - Charge amount
  - Price + payment
  - Smart grid data

- ITS
  - Cybernetic traffic management
  - Crash prevention
  - Smart road pricing

- And more...
  - Infotainment
  - B2B/G service platform
  - Smart LBS
  - Meshed maps

“Big Data” (U.S. Estimates)

- 300 M vehicles
- 7,000+ variables
- 24,000 for EVs
- Per day/ second

- 100 M drivers
- 100 trips/ month
- 500+ variables
- Per second

- < 5 M EVs
- < 5 M homes
- < 400 k public CS
- 500+ variables
- Per minute

- 15-45 M on route
- 2.5 M traffic lights
- 2 M cameras
- Billions of sensors
- 100+ use cases
- 500+ var. each
- Per millisecond

- 300 M drivers / passengers
- 5 M enterprises
- 100+ use cases
- 100+ var. each
- Per second

Source: Cisco IBSG Automotive 2012
Future Connected Cars Expected to Drive 1.5 GB of Monthly Data Traffic

Average Traffic Per Mobile Device Type 2017 [MBs/ Month]

- Laptop: 6,942 MBs
- Tablet: 4,223 MBs
- E-Book Reader: 2,880 MBs
- Smartphone: 2,576 MBs
- Smart Connected Vehicle: 1,545 MBs
- M2M: 266 MBs
- Non-Smartphone: 108 MBs

Source: Cisco Networking Index
In one year, 2016 to 2017, the net amount of mobile data traffic added will be 4X the total amount generated in 2012.

Source: Cisco VNI Global Mobile Data Traffic Forecast, 2012–2017
By 2017, global mobile data traffic will reach an annual run rate of 134 exabytes per year.

134 exabytes is equal to:

- 46 X all Mobile IP traffic generated in 2010
- 30 trillion images (e.g., MMS or Instagram)
- 3 trillion video clips (e.g., YouTube)

Source: Cisco VNI Global Mobile Data Traffic Forecast, 2012–2017
FCC Band Sharing Assessment is a Win-Win Opportunity for Wireless and ITS Community

Can 5 GHz band be shared without causing harmful interference to primary licensed users ITS?

500+ companies

FCC Technology Assessment:
Validate to the satisfaction of all stakeholders that Wi-Fi does not cause unacceptable interference to ITS operation

No

Yes

Spectrum is expected to remain exclusive to the primary licensed users

Foundation for innovation and faster deployment
Off-Loading Data and Switching Is Key to Improve Experience and Contain Cost

Source: Cisco IBSG Automotive 2011
How to Unlock the Societal Benefits of Intelligent Traffic Systems + Telematics?

**ITS**

**Connects Vehicles & Roads**
- V2X security requirement
- Smart road pricing/VMT
- Better traffic management
- Better road management
  - Less crashes
  - Less congestion
  - Less fuel and pollution
  - Compensate fuel tax erosion

**Telematics**

**Connects Vehicles**
- Connected safety & security
- Connected vehicle care
- B2B/G service platform/PAYD
- Dynamic navigation/LBS
- Infotainment/productivity
  - Better Crash “Safety”
  - Better user experience
  - Higher profitability

Source: Cisco IBSG Automotive, 2011

**Government Lead**

**Private Sector Lead**
Enterprise Grade Network is the Platform for the ITS Architecture
Internet of Cars is a Scale Business …

Source: Cisco Smart Connected Vehicles Team, 2013
... Especially as a Globally Competitive Business

Source: Cisco Smart Connected Vehicles Team, 2013
Cisco’s Role: End-to-End Architecture is Essential
– Especially for Scaling Globally

Public Cloud
Subscription-based Services

Private (OEM) Cloud
Data Center/Virtual Servers

Enterprise Cloud
Enterprise Video, Voice, Data

V2V Communication (802.11p)

Mobile WiFi Offload
Wi-Fi Hotspots, 802.11u, 3G/4G

DSRC Roadside Infrastructure
802.11p (V2I)

Consumer Network
Home/Dealership Wi-Fi Hotspots, Femtocells

Energy Service Providers
(Smart Grid)

Communications Service Providers, “Fog”

V2I/Upstream Communication (Wi-Fi, 3G/4G, 802.11p, etc.)

Software Client
WHAT? Content Appears Legitimate

WHO? Domain Owner Information

WHERE? Server Hosted in Ukraine

WHEN? Domain Registered Two Days Ago

HOW? Dynamic IP Address

CONTEXT
Global Context: Data Makes a Difference

Cisco SensorBase

Threat Operations Center

Advanced Algorithms

Global Threat Telemetry

Cisco Customers Protected

8:10 GMT

OEM 1

OEM 2

OEM ..
New OBU and RSU Business Models: Enabling Internet of Cars Services

TSP
PAYD
EV Clearing
ITS
And more…

IoC Services

Network

OBU NewCo
RSU NewCo

Subsidize OBU Upgrade For Right to Monetize Data & CV Services

Build & Operate WiFi + DSRC Network to Monetize Off-Load and ITS & LBS Services

Source: Cisco Smart Connected Vehicles Team, 2012
The Connectivity Infrastructure Could be a Profitable Business at 1/10th ¢ / VMT

<table>
<thead>
<tr>
<th>U.S. Roadside Equipment (RSE) PPP Revenue Model [US$ Million]</th>
<th>CapEx</th>
<th>P&amp;L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Total 5 Year RSE Investment (10 Depr.)</td>
<td>6,261</td>
<td>626</td>
</tr>
<tr>
<td>Repair/ Replacement</td>
<td>616</td>
<td>62</td>
</tr>
<tr>
<td>Operating Expenses</td>
<td>440</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal RSE Cost</strong></td>
<td><strong>1,128</strong></td>
<td></td>
</tr>
<tr>
<td>Hypothetical Margin</td>
<td>100%</td>
<td>1,128</td>
</tr>
<tr>
<td><strong>Revenue Required to Fund “RSE Business”</strong></td>
<td></td>
<td><strong>2,256</strong></td>
</tr>
</tbody>
</table>


~3,000,000,000,000 Per Month
20% Privatization of Federal Aid Highway System = $1.3 Trillion Value

Tolling and Privatization Scenario for U.S. Highway System

U.S. Highway Systems (Thousands of Miles)

- Federally Funded: 3,997 (971 miles)
- Not Federally Funded: 3,026 miles

189,000 Miles × $6.8M¹ per Mile = $1.3 Trillion

Select Top 20% by Priority:
- High Congestion
- High Crash
- High Repair

¹ Weighted average of price paid in Europe

Source: An Analysis of the Current Investment Trend in the US Toll Road Sector, MIT, 2008, Cisco IBSG Automotive 2011
Connecting the Mobility Value Chain: New Business Model Opportunities

Integrate...  Transform...  Develop  Source  Make  Sell  Deliver  Service

Vehicle

Energy

Service Provider

Infrastructure

ITS

New Services

Source: Cisco Smart Connected Vehicle 2013
Food For Thought...

15-20% Savings = $6-8 B

- ITS
- PAYD
- OBU
- VMT

1/10th

- CV SPs
- Auto OEM
- Society
- Vehicle User

~$110 B+

- $1.3T
- 20%

- Infra REITs
- Fuel Tax Share

33% of U.S. Cars

20% of U.S. Roads

550,000 Jobs

$1.3T

$20-30B

→ U.S. Budget

Source: Cisco IBSG Automotive 2012
Making the Internet of Cars a Business

Together We Can…

- Automotive
- Government
- Service Provider
- Infrastructure
- Insurance
- ITS

Source: Cisco Smart Connected Vehicle Team 2012
Thank you.
More Food for Thought on the “Internet of Cars”

- **Executive Summary:** A Business Case For Connecting Vehicles
- **Government:** A Catalyst to Unlock Societal Benefits of Transportation
- **Carriers:** Service Providers at a Crossroads
- **Automotive:** From Building Cars to Selling Travel Time Well-Spent
- **Insurance:** The Business of Preventing Crashes

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