DRIVERLESS FUTURES

Scenario-Based Intelligence

Fall 2014

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Overview

Self-driving road vehicles represent a **disruption** that is unprecedented in both magnitude and scope.

At the same time, the extent and timing of self-driving vehicles' commercialization depends on the outcome of many uncertain forces that will play out in ways that **no one can accurately predict.**

Strategic Business Insights (SBI) has a **proven process** for considering the wide range of issues and uncertainties surrounding self-driving vehicles in a systematic way.

Driverless Futures uses this process to address the question: **What is the future of driverless cars, trucks, and other road vehicles from a global perspective?**

What are driverless road vehicles?

US NHTSA Autonomy Levels			
	Definition	System Example	Vehicle Example
1	Function-specific automation	Electronic stability control	Every new car sold in EU, US, Canada
2	Combined function automation	Stop-and-go cruise control with automatic steering	Select models from major automakers
3	Limited self-driving capability	Vehicle controls all safety functions some of the time; driver must occasionally assume control	Google driverless car (2010); experimental vehicles from automakers and universities
4	Full self-driving automation	Vehicle is in total control at all times; human only provides destination input	Zoox Yolo; Google driverless car (2014); similar concept vehicles

Examples: Levels 1 and 2

TOYOTA

- The only manufacturer to have integrated driver-attention-monitoring system into the “signal path” for level-1 and level-2 autonomous systems
- Infrared cameras monitor driver’s head position, helping the system determine if the driver is paying attention and informing system response

Toyota’s Active Driver-Monitoring System

SUBARU

- Deployed first stereo-camera array for enabling level-1 stop-and-go cruise control

AUDI

- Offers drivers a choice between different degrees of autonomous control when engaging self-steering cruise control

Subaru’s EyeSight System

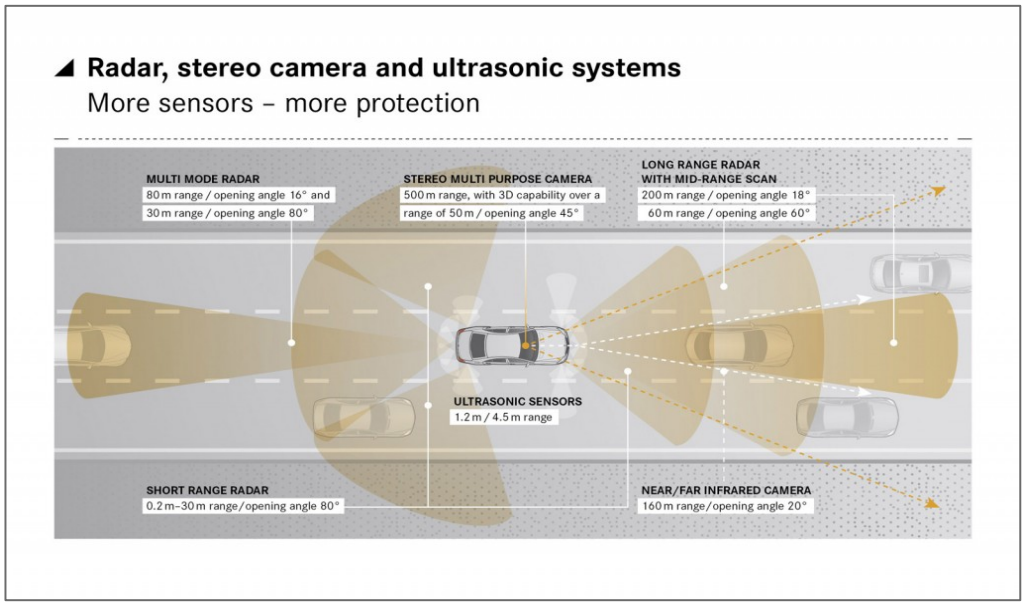
NISSAN

- First manufacturer to offer a “hands-free” level-2 driving experience

Examples: Level 2

MERCEDES

- Manufactures the most capable level 2 autonomous vehicle commercially available today
- Key Mercedes system differentiators:
  - Steering-assist functionality engages together with cruise control (does not require separate activation), delivering a better user experience
  - Seamless functionality across large speed range (0-124 mph)
  - System tracks and responds to adjacent-lane vehicles and obstacles



Examples: Level 2.5

TESLA

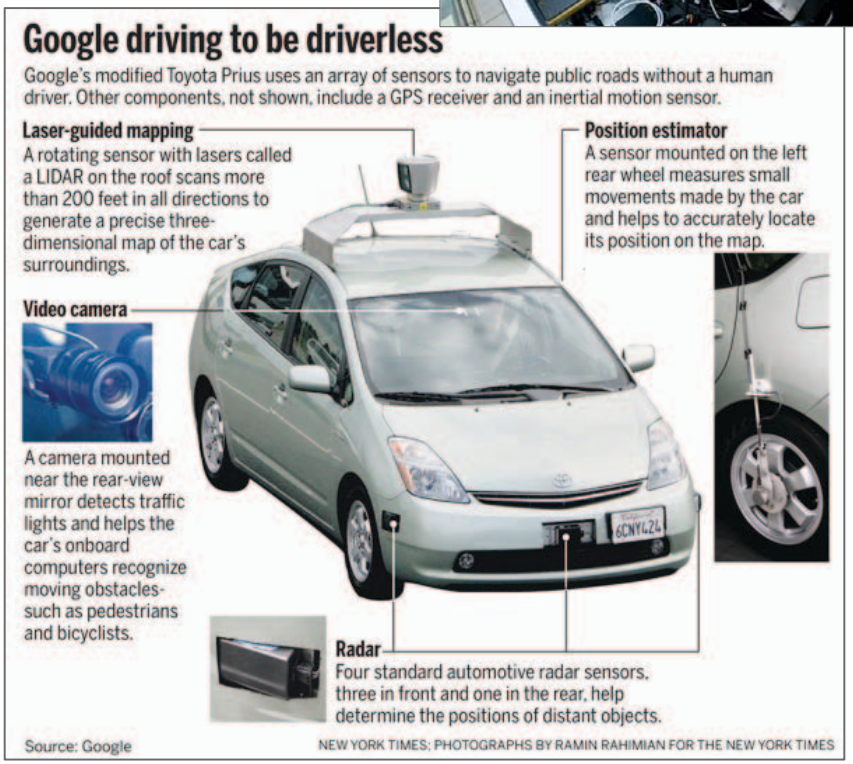
- When engaged, Autopilot system:
  - Keeps the car centered in its lane of travel
  - Changes lanes automatically at driver's direction (turn signal)
  - Manages speed automatically according to real-time traffic conditions, optical traffic-sign recognition, and fused multisensor input
  - Uses a single camera for lane, sign, and signal recognition
- All Tesla Model S vehicles in production as of Fall 2014 come equipped with all hardware necessary to run Autopilot
- New features can be rolled out over the air as they are developed and validated

Mobileye's single-camera system can respond to traffic lights and negotiate intersections

Examples: Level 3

GOOGLE

- Most high-profile level-3 autonomous fleet
- Large amount of highway testing; very limited urban testing
- Precision navigation relies on multiple probe-vehicle lidar passes and server-based data processing
- Drivers are very bad at “taking control”
- Autonomous mode cannot handle rain, fog, or snow; Google has no current plans for how to address this
- Vehicles are now licensed in California



AUDI, MERCEDES

- Have received level-3 vehicle licenses in California

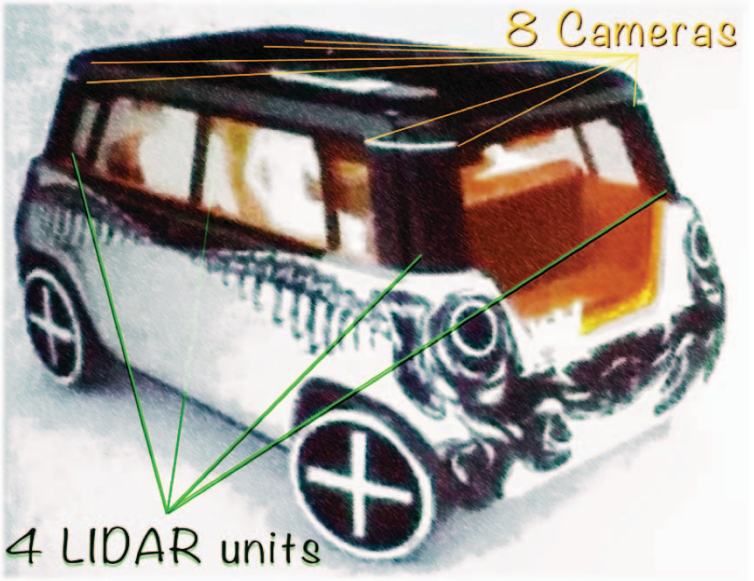
Examples: Level 4

GOOGLE

- Two-passenger light vehicle limited to 25mph
- Initial testing will be on Google's main campus in Mountain View, California
- Test vehicles must retain manual controls (including steering wheel and pedals) to satisfy California regulators

ZOOX

- Concept rendering only
- Bidirectional – either end is "front"; Passengers face each other inside
- Each quadrant of car has its own computer, camera, and lidar system
- Vehicle can operate safely even if one lidar system goes offline



Net impacts could be enormous.

In the United States alone, driverless cars could save

- **$563 billion** in costs from injuries and fatalities
- **$158 billion** in fuel costs
- **$149 billion** in costs from roadway congestion
- **$422 billion** in lost productivity
- **28,800** lives

Every year. — *Morgan Stanley*

"Our vision is that no one is killed or injured in a new Volvo by 2020." — *Ander Eugensson, Head of Govt. Affairs, Volvo*

Many industries could be disrupted.

Agriculture

Automotive

- Manufacturing
- Sales/Leasing
- Financing
- Service
- Materials

Entertainment

Energy

- Conventional
- Natural Gas
- Smart Grid
- Energy Storage

Health Care

Human Resources

Information Tech

- Connectivity
- Cybersecurity
- Internet of Things
- Telematics

Infrastructure

- Construction
- Management

Insurance

- Vehicle Insurance
- Health Insurance
- General Liability

Logistics

Manufacturing

Public Administration

- Urban Planning
- Public Safety
- Land Use

Retail & Hospitality

Transportation

- Personal
- Transit
- Trucking
- Multimodal
- Railway

No one knows when the biggest disruptions will occur.

"In **less than a year**, you'll be able to go from highway on-ramp to highway exit without touching any controls." *— Elon Musk, CEO Tesla*

"Completely driverless cars are **20 to 30 years** away." *— John Capp, Dir. Active Safety, GM*

Series-built cars with autonomous functions "will be technically feasible **this decade**." *— Rupert Stadler, CEO Audi*

"Nissan will be ready with … Autonomous Drive in multiple vehicles by the year **2020**." *— Nissan USA*

"Self-driving cars that include driver control are expected … before **2025** and self-driving 'only' cars are anticipated around **2030**." *— IHS*

"Self-driving vehicles [will comprise] 75 percent of the traffic stream by **2040**." *— IEEE*

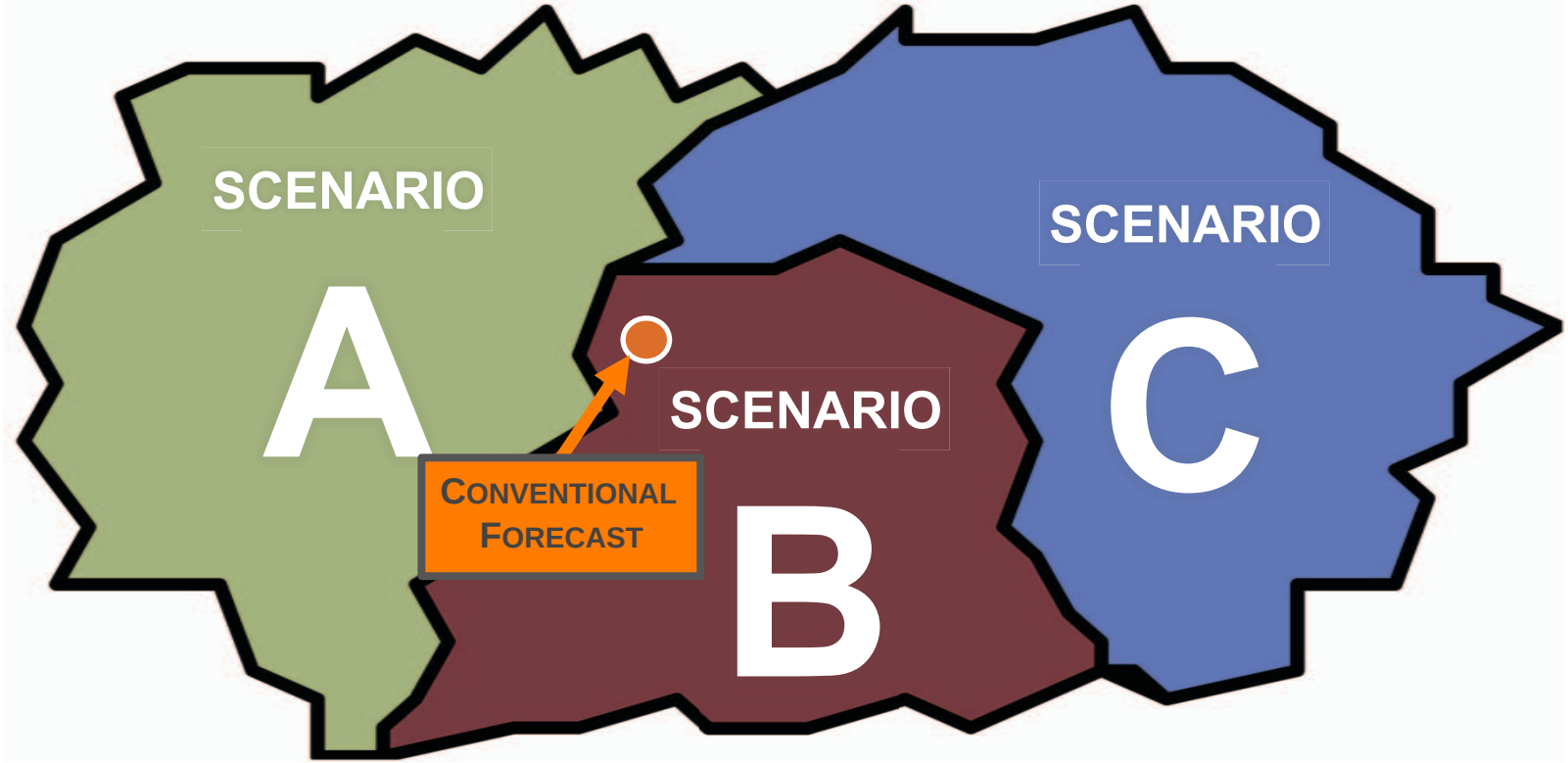
Many hundreds of forces influence the timing and nature of the outcome.

Here are just a few:

- **TECHNOLOGY READINESS** — *Will self-driving cars work? How well will they work?*
- **SYSTEM COST** — *Will they be affordable? If so, when? By whom?*
- **REGULATIONS** — *What will be permitted? Where will it be permitted? When?*
- **CUSTOMER ACCEPTANCE** — *Will people trust, resent, and/or exploit self-driving cars?*
- **CONNECTIVITY REQUIREMENTS** — *How much bandwidth is needed? How often?*
- **MARKETS** — *Who will be the customers for self-driving technologies?*
- **URBAN ADAPTATION** — *How will cities welcome/leverage/limit self-driving cars?*
- **BUSINESS MODELS** — *Who will own the cars? How will people pay to access them?*

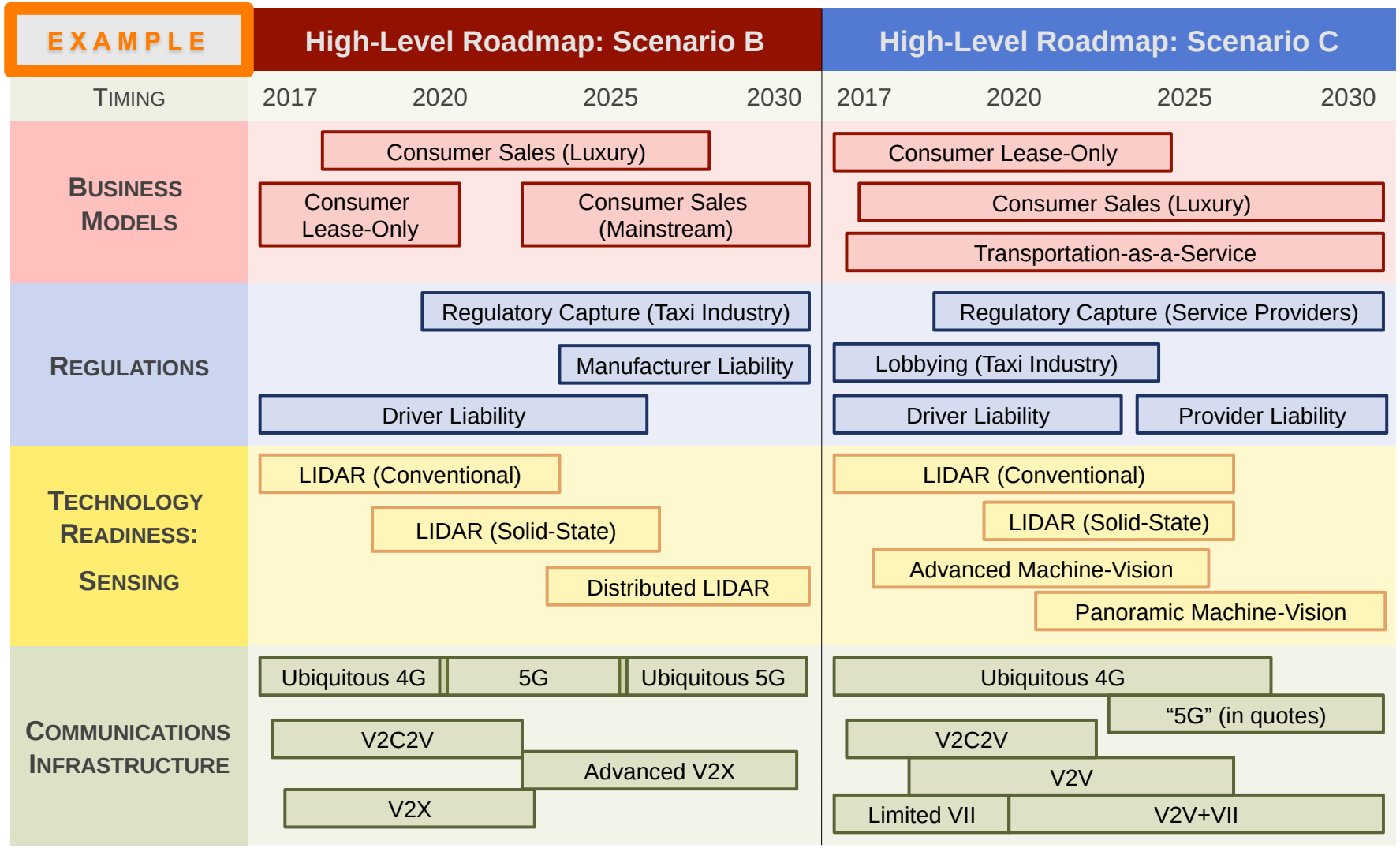
SBI's scenarios provide a sound basis for addressing uncertainty.

Conventional forecasts, including "most likely" cases, fall short.



Scenarios are not predictions. Scenarios are descriptions of alternate plausible futures.

Scenario-based roadmaps illustrate the whole business environment.



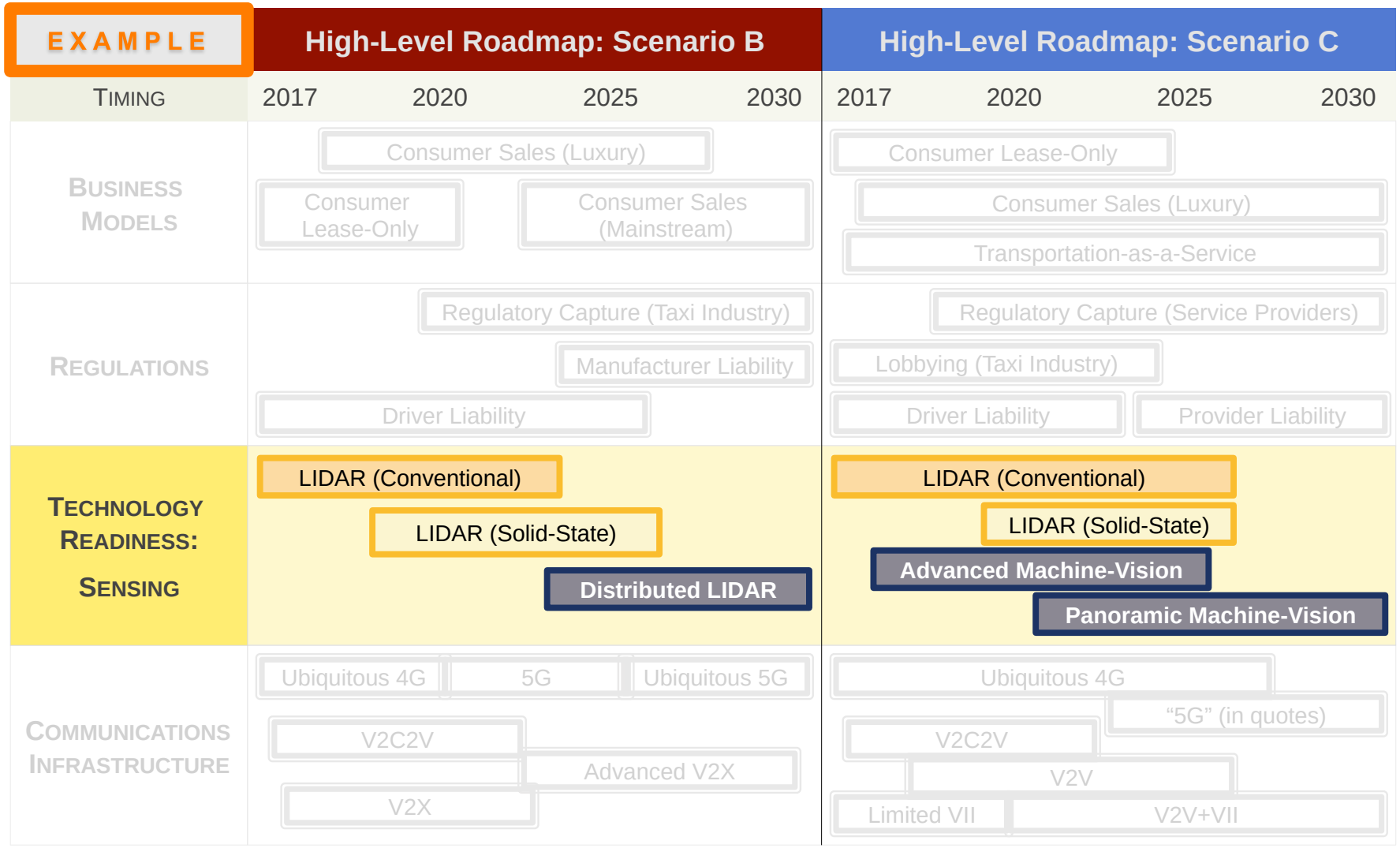
Detailed charts show connections between roadmap elements.

EXAMPLE

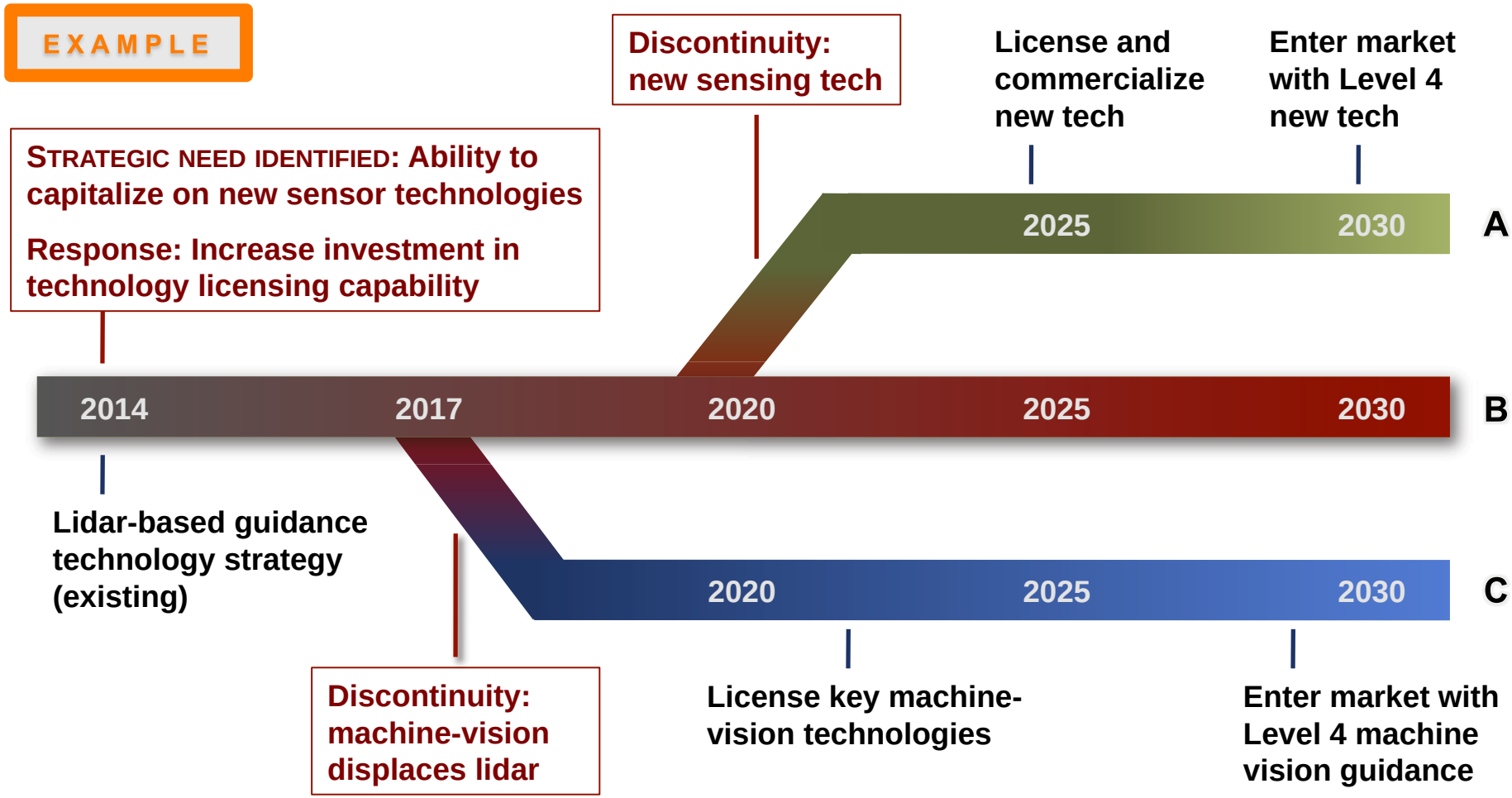
Autonomous Road Vehicles
Product/Service/Technology Matrix

REQUIRED TECHNOLOGIES		PRODUCTS AND SERVICES: B2B Products/Services									End-Consumer Products/Services												
		Example Product	Product Example	Exemplary Product	Example B2B Product	Example B2B Service	B2B Service Example	B2B Combined Product-Service Example	Example of Service on Offer	Service Example	Example Service	End-User Product	End-User Service Example	Services and Products for End Users	Exemplary Product or Service	Example 992	Example Service 3.14	Example Service 42	Product for End-Users	Another Example	An Example of a Service	Service and/or Product Integrated Example	Example System Services	Total
T1:	Example	■				■	■			■	■	■			■	■	■	■	■	■		■		13
T2:	Another Example	■				■	■	■			■	■			■	■	■	■	■	■	■	■	■	15
T3:	A Third Example											■												1
T4:	Fourth Example									■														1
T5:	Another Example		■	■	■				■				■	■				■				■		8
T6:	Example Technology			■				■					■								■			4
T8:	Example Tech 12	■	■	■	■	■	■	■			■	■	■	■	■	■	■	■	■	■	■		■	19
T9:	Example Technology 72	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	21
T10:	A Technology Example					■					■	■				■			■	■				6
T11:	Example of a Technology	■	■					■		■											■			5
T12:	Technology Example 29	■	■	■	■					■			■	■										7
T13:	Tech Example: Example			■	■			■					■	■							■			6
T14:	More Examples		■						■													■		3
T15:	Exemplary Example Technology								■	■												■		3
T16:	Technology Example 42										■							■						2
T17:	Stand-In for a Technology						■																	1
T18:	Tech Example 95		■		■									■		■						■		5

Roadmaps reveal discontinuities between possible futures.



Examining discontinuities helps companies identify strategic needs.

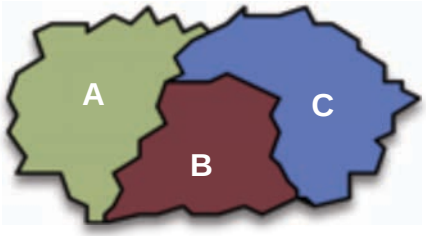


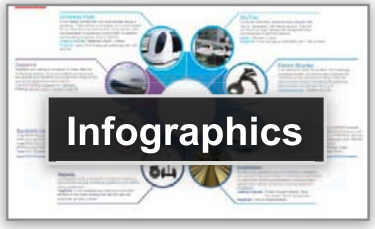
Companies use scenarios and roadmaps to:

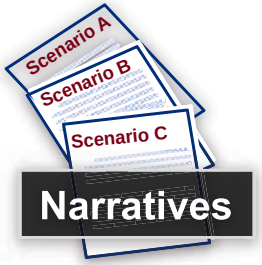
- **Enhance** strategic awareness
- **Develop** robust strategic action plans
- **Validate** technology and research investments
- **Identify** promising new business opportunities
- **Match** internal capabilities to future market needs
- **Monitor** events that impact successful plan implementation
- **Propagate** long-term strategic thinking
- **Consider** an outside view

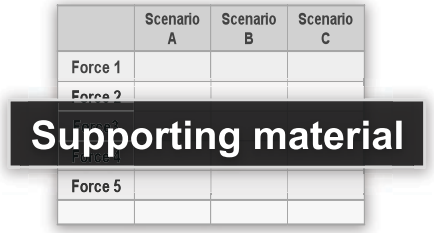
Driverless Futures deliverables:

- **Scenarios** — Three scenarios consider the wide range of issues and uncertainties surrounding self-driving vehicles and form the basis of the comparative roadmaps. Infographics, narratives, and supporting material bring the scenarios to life.

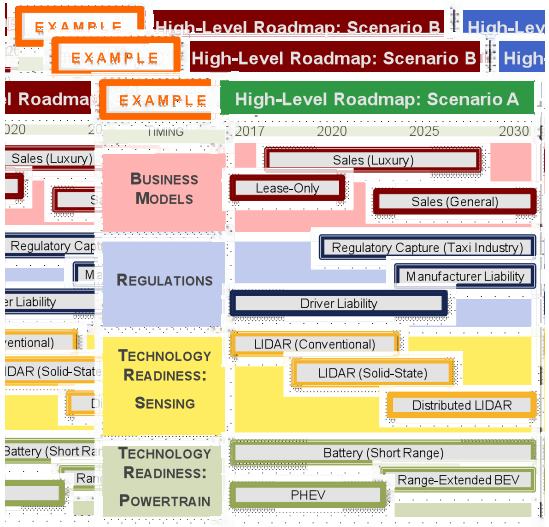






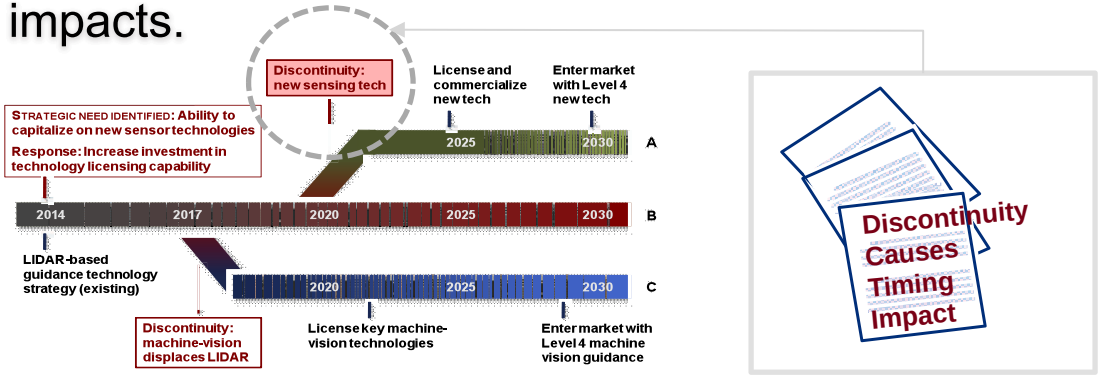


- **Comparative Roadmaps** — Three roadmaps (one per scenario) show the timing and progress of key elements, illustrating links between elements, discontinuities between scenarios, and the impacts of potential future developments. Covering the whole business environment, roadmaps provide a basis for developing robust action plans and monitoring events that may impact successful implementation.



Driverless Futures deliverables: (cont'd)

- **Detailed, Research-Based Analyses of Three Select Discontinuities** — Three reports, sourced from SBI's internal knowledge base and original research, further explore discontinuities, their potential causes and timing, and their potential impacts.



- **Online Access to Rapid-Fire Updates** — Continuously updated database tracks developments relevant to the select discontinuities, providing clients with ongoing updates and analysis of new developments and their implications.
- **Client Briefing** — Client-private; hosted at client or SBI facility.
- **Consultation** — Direct access to analyst team.
- **Price:** $45,000

Why work with SBI?

- SBI has **decades of experience** in scenario planning for commercial and government enterprises.
- SBI's scenarios teams include **consumer-behavior experts** from SBI's world-leading VALS™ service.
- SBI works with clients to identify and map new opportunities based on emerging technology and market insights. **We combine ongoing research with consulting services.** Our research services operate across industries and cover a very broad range of technology, market, regulatory, economic, and social developments.
- SBI has a long **history of working with major automakers, their suppliers, regulators, and other stakeholders** in automotive, intelligent transportation systems, and related industries.
- SBI is the former Business Intelligence division of **SRI International** that has worked with clients on opportunities and change since 1958. Headquartered in Silicon Valley—with offices in Japan, the United Kingdom, and New Jersey—we have a global reach and work across a wide range of government and business sectors.