



Automated and Connected Vehicles

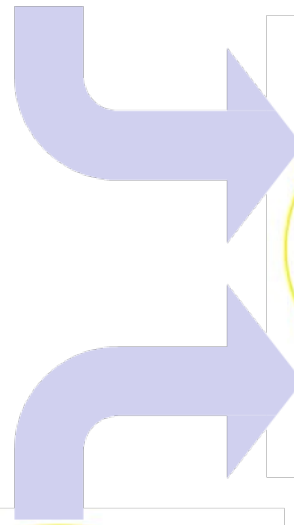
Philip Schaffner

MnDOT Policy Planning Director

Connected Automation

Autonomous Vehicle

Operates in isolation from other vehicles using internal sensors



Connected Automated Vehicle
Leverages autonomous and connected vehicle capabilities

Connected Vehicle

Communicates with nearby vehicles and infrastructure



Human

Machine

LEVEL 0

No Active Assistance System

Hands On
Eyes On



LEVEL 1

Longitudinal or Transverse Guide

Longitudinal or Transverse Guide

Hands On
Eyes On



LEVEL 2

Traffic Control

Longitudinal and Transverse Guide

Hands Temp Off
Eyes Temp Off



LEVEL 3

Awareness for Take Over

Take Over Request

Hands Off
Eyes Off



Autobahn (SA)

LEVEL 4

No Driver Intervention

No Take Over Request

Hands Off
Mind Off



City (Ride Sharing)

LEVEL 5

No Driver

Hands Off
Driver Off

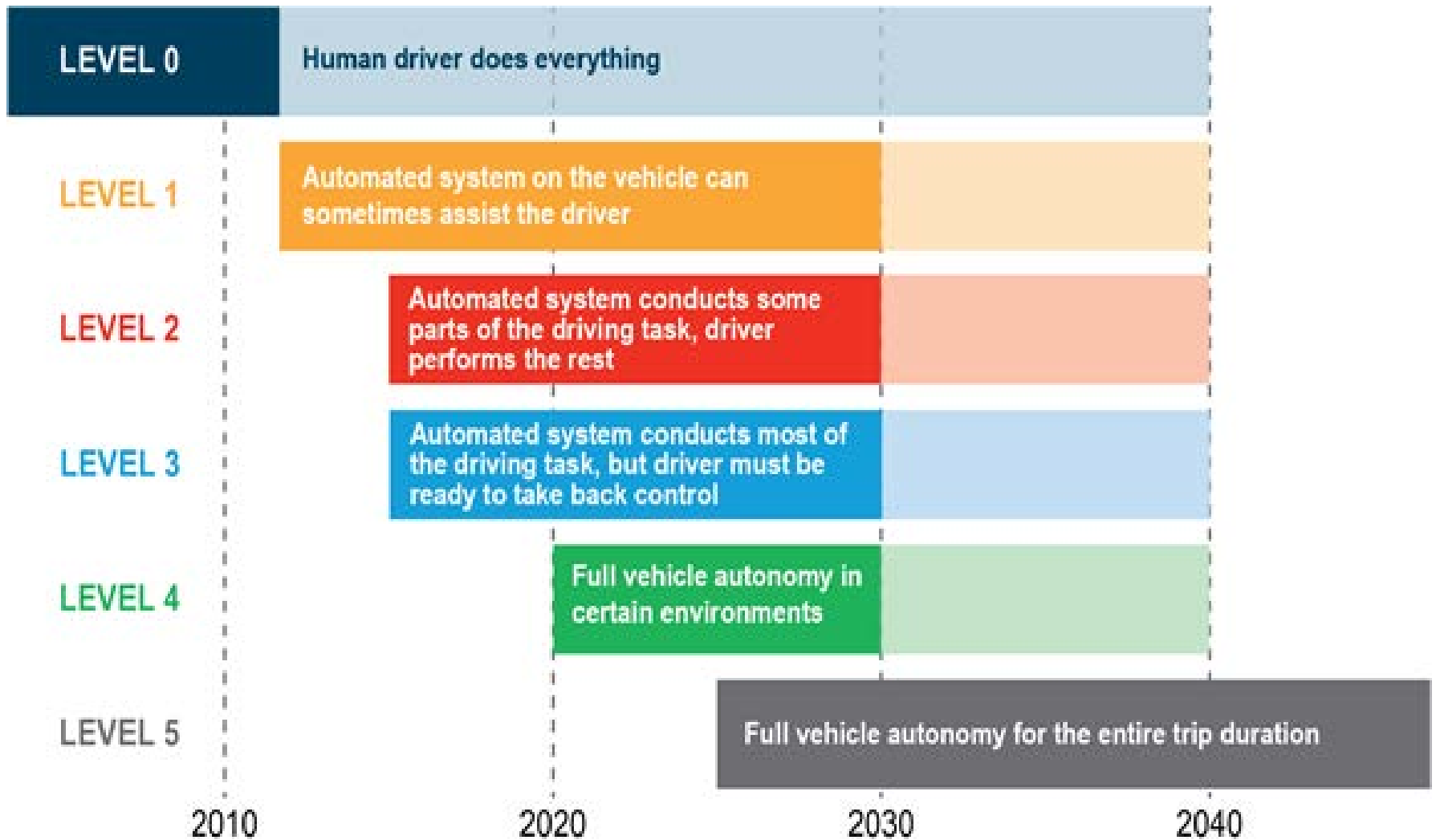


SAE Levels of Automation

Level 5 – The Self Driving Vehicle

- The vehicle is completely responsible for:
 - Steering, acceleration, decelerations
 - Monitoring the driving environment
 - Safe operation under all roadway and environmental conditions
- No steering wheels or pedals
- No human intervention ever

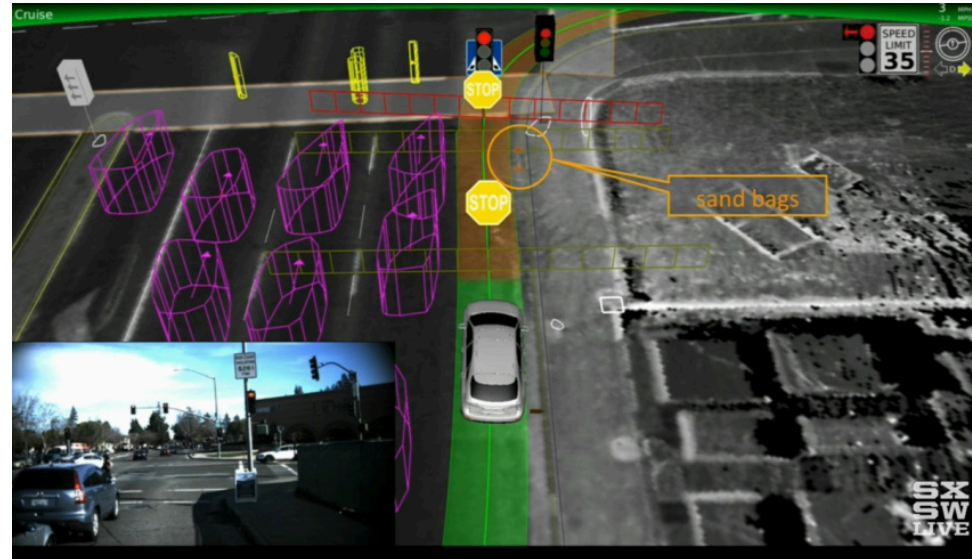
Commercial Availability



*Adapted from a forecast by University of Minnesota Researchers

Safety

- Autonomous vehicles do not get distracted / tired
- Potential reduction in traffic fatalities/serious injuries by several orders of magnitude
- Tesla Autosteer reduced crash rate by almost 40%
 - Tesla expects Autopilot 2 to achieve 90% reduction in crash rate

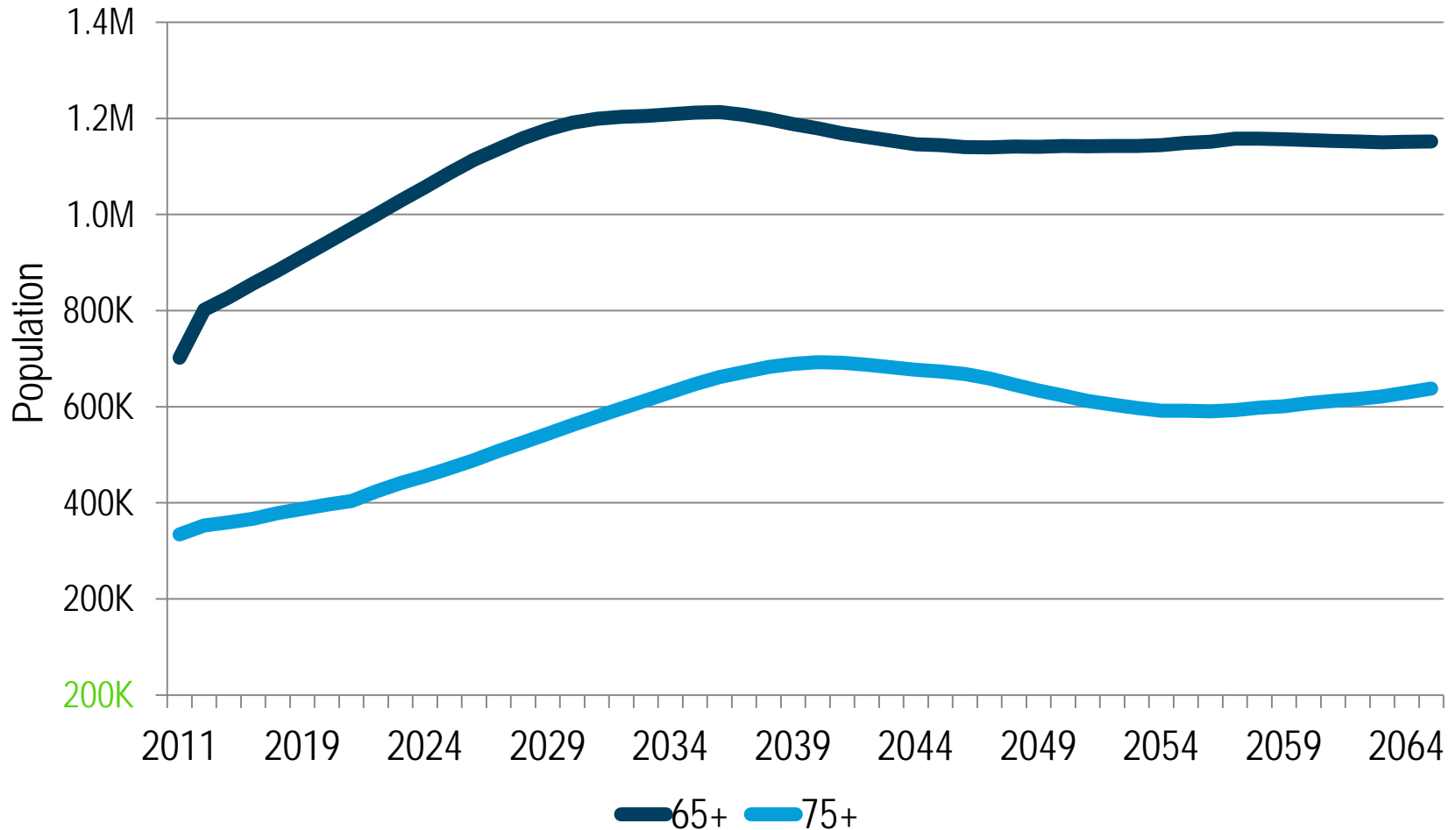


Mobility for People with Disabilities

- Huge potential, but not a given
- Many user-interface and vehicle design questions



Minnesota's Senior Population



- Potential changes in parking demands largely driven by ownership models
 - Owned autonomy will likely not reduce parking dramatically
 - May decrease the need for parking to be directly adjacent to destination
 - Shared autonomy could lead to massive reduction in required parking
 - Potential new requirement: loading/un-loading zones
 - Design new parking structures with other uses in mind

Congestion???

Despite crash reductions, increased lane capacity and more direct routing, congestion impact remains uncertain

- Increased willingness to travel longer distances
- Empty vehicles
- Increased access for people who currently don't drive
- Not the only trend affecting peak period travel patterns

Thinking beyond the car

Autonomous trucks & truck platooning

Ground delivery vehicles



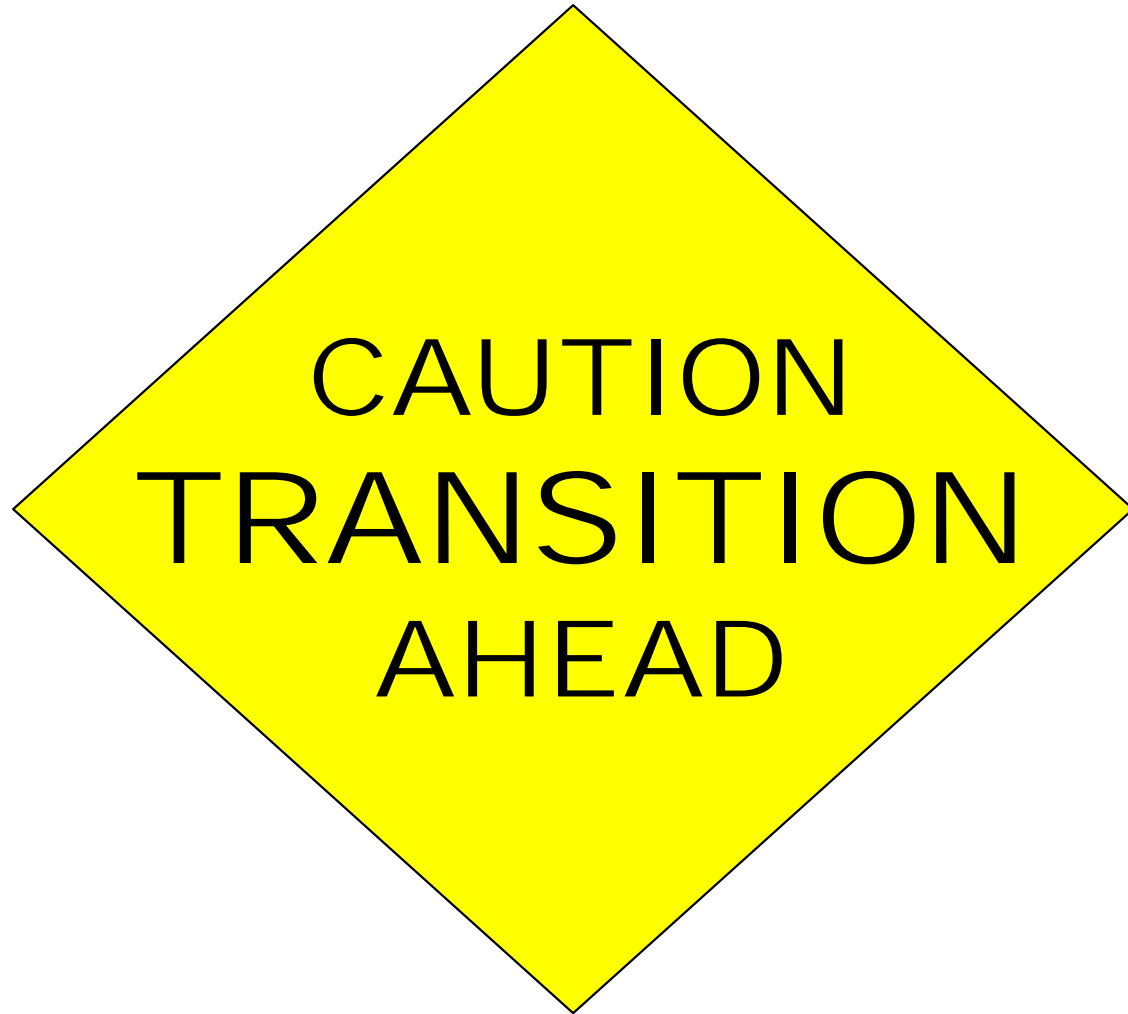
Implications for Transit

- May be adopted by or replace para-transit/dial-a-ride
- Could displace low-ridership routes, but...
- Autonomous vehicles will not eliminate all transit need

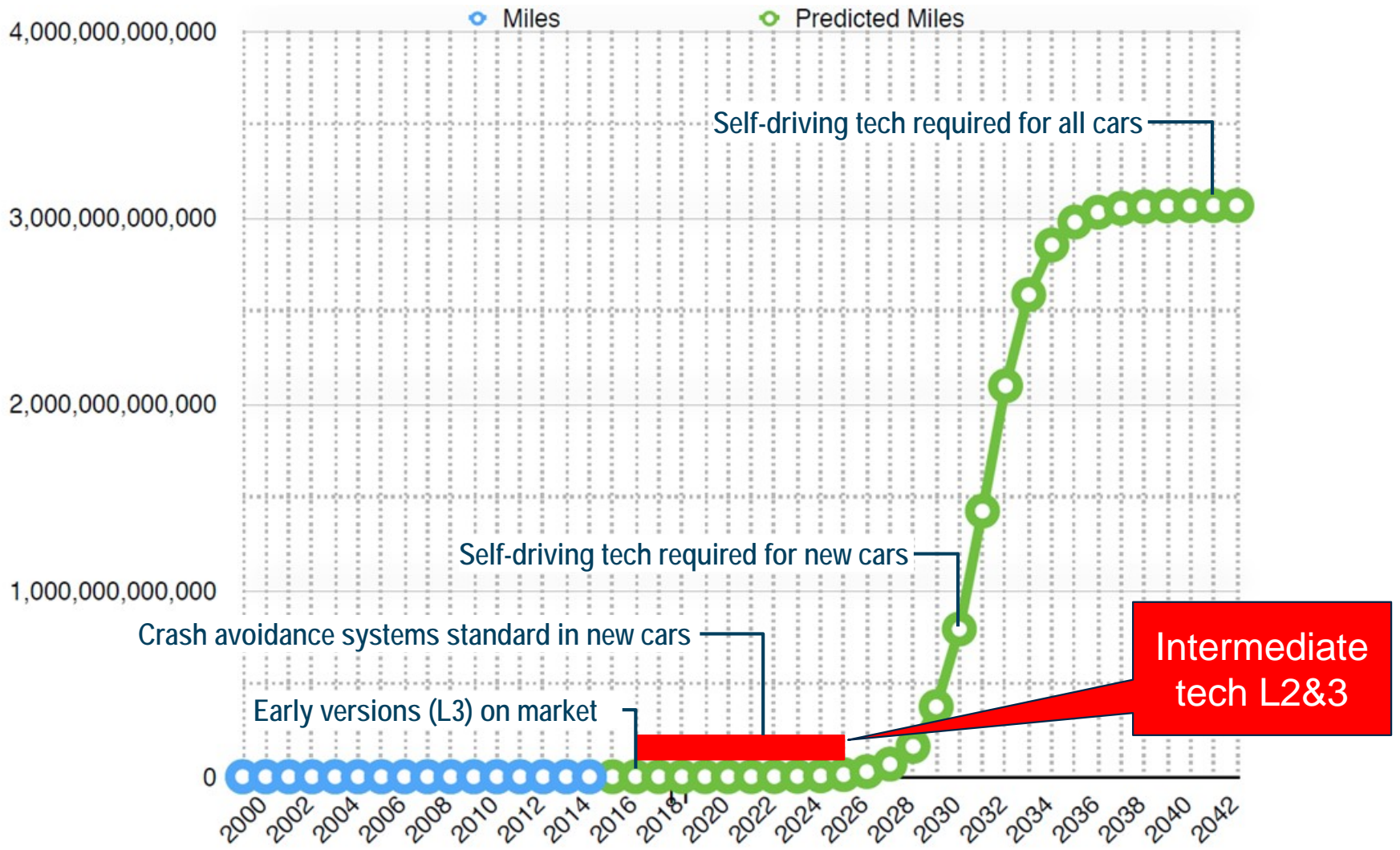


Change	Conf.	Description
Safety	High	One of the most highly touted benefits of AVs
Lane Capacity	High	Shorter following distances likely increase capacity
Parking	Med	"Mobility as a Service" model may significantly reduce parking need
Road Design	Med	"Our philosophy has always been, it has to work with the existing infrastructure" – Chris Urmson, Google
Vehicle Design	Med	Could see radical changes in design—particularly for freight delivery and logistics
Mobility for people with disabilities	Med	Likely significant improvement in service, but not a given and may not work well for all types of disability
Congestion	Low	Despite likely reduction in crashes and increased throughput, we could see dramatic increase in VMT
Timeline	Low	Exact timeline for adoption remains unclear – "inflection point" likely mid-to-late 2020s.
Vehicle Ownership	Low	Uber/Lyft vs. Tesla Models – likely some combination of both
Residential Preference	Low	Vehicle ownership model will likely have large impact on where people will choose to live – both "Up" and "Out" scenarios plausible

Level of Confidence



CAUTION
TRANSITION
AHEAD



*forecast by University of Minnesota Researchers

Autonomous Vehicle Adoption

What are the Challenges?



Snow / Ice

Salt



What are the Challenges?



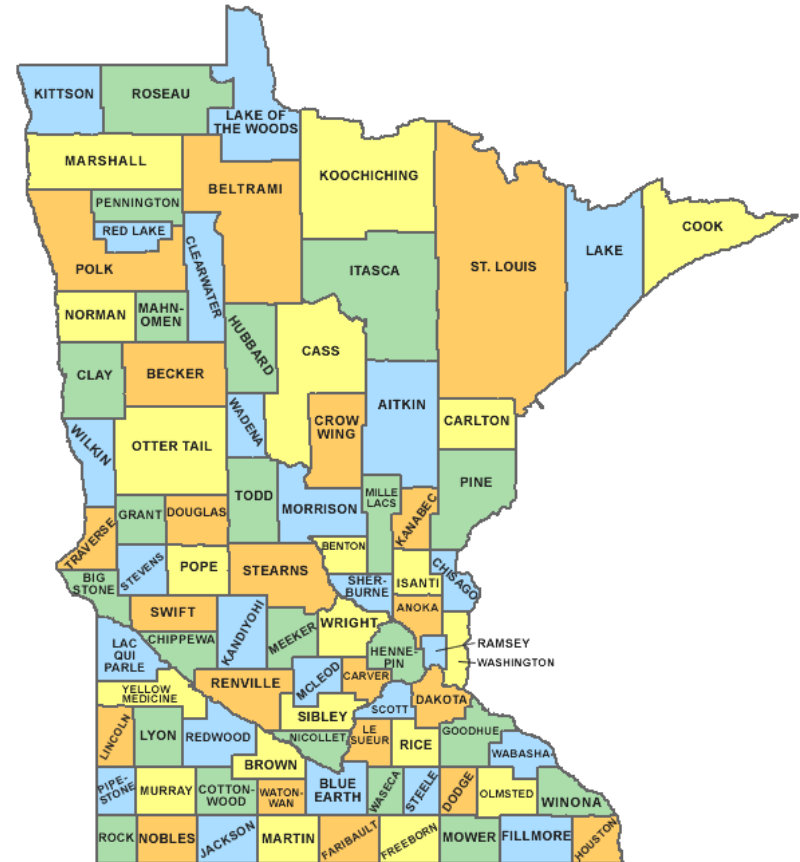
Workzones

Dynamic Road Conditions



What is Happening in Minnesota

- Interested in advancing AV and CV
- Testing
- Legislation
- Grant Opportunities
- Task Forces



Statewide - Jurisdictional Committee



Current MnDOT Projects / Initiatives

Autonomous Bus Project



Other MnDOT Projects / Initiatives

Superbowl Showcase

SPaT Challenge

Autonomous TMA Truck (CDOT)

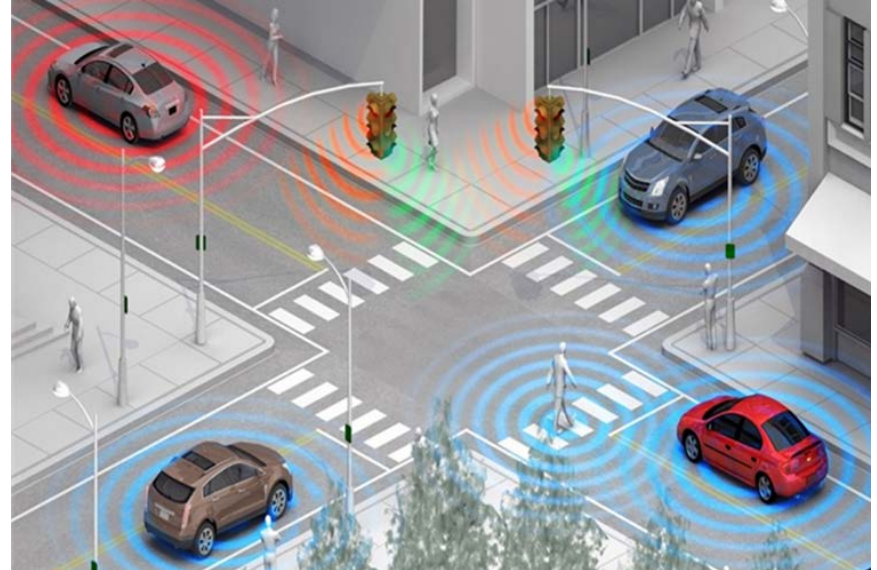
Scenario Planning

Guidestar

ITS Minnesota (Fall Forum)

Legal Review (Testing and Platooning)

Partnerships: CDOT / 3M / GoMentum



Contacts for More Info

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