an “out of the box” Hardware Approach to secure an AllWeather Affordable Monodirectional Level 4* Driving System
* without transition demand from the driving system

Philippe Nobileau
contact@ze-drive.com

UNECE WP1 Sept. 2023
ZE-Drive equipped Motorway showing a “phantom” pseudo Level 4 Car sharing the left lane with conventional up to Level 2 traffic and 3 platooned ZE-Freight trucks coming behind the Jersey wall to move efficiently Goods around.

for Emergency Line Keeping System... ;
the vehicle’s left wheels ride contactlessly in a Gutter in Automated Driving

for an all Weather Emergency Braking...
a swinging 2g Braking Caliper grabs a Rail bordering the Gutter
Background years 90’
How it works

The infrastructure required for the deployment of ZE-Drive technology is minimalist and concentrated on the central strip separating freeways, integrated into the Jersey wall and the slotted gutters, without encroaching on conventional traffic lanes.

A 24 kg/m (16 lbs/ft) rail (in orange) is attached to the gutter. Sloped ramp sections (yellow-black striped) connect the pavement to the top surface of the rail.

In front of the left front wheel, a multi-sensor device continuously detects the lateral distance of the vehicle from the Jersey wall and, in ZE-Drive mode, reliably controls automatically the car steering in order to keep the left wheels centered on the dedicated curbed track in all weather conditions.
On the inside of the stub axles of the two left wheels, two retractable rollers (in red) are attached to temporarily take over the load of the left wheels when crossing the rail sideways.
AllWeather Emergency 2g Braking System
Why it’s better

**ZE-Drive** is currently the only Automated Driving System (ADS) capable of reducing stopping distance by 50% in dry weather and 75% in wet weather, which could save thousands of lives per year.

In addition, **ZE-Drive** has the potential to increase user confidence in Platooned Traffic through the emergency inertial activation of the 2 g braking system or in the event of an electrical "blackout" or cyber-attack.

The emergence in the current decade of a fleet of **ZE-Drive** equipped EVs, vans up to the "light truck" size capable of carrying out a substantial portion of the transportation done today by full size trucks (bus, tractor, semitrailer) with axle loads reduced from 13 Tons (18/20,000 lbs in the US) down to 2.25 Tons (5,000 lbs) will enhance the safety record of road transportation and open up prospects for dedicated, light expressways capable of running along large span for economical light overpasses or small diameter for economical light underpasses.
Proof of Concept and Validation

ZE-Drive propose to form a Joint Industry Project (JIP) to bring together:

- International Academia and Research Institutes
- Car Makers
- Motorway Constructors
- Toll Operators
- Power Distribution Network Public/Private Entities
- National Road Infrastructure Authorities
- National and International Road Safety Authorities
- Clean Mobility Authorities

...to validate through JIP demonstrations the viability and the readiness to market an AllWeather Affordable Monodirectional Level 4 Driving System

- Phase 1 (2024) Proof of Concept aims to demonstrate the ease of automated ZE-Drive lateral entry/exit on a 500 m track at a Transportation Research Center.

- Phase 2 (2025) will test the ZE-Drive powerful 2 g emergency braking system and demonstrate the platooning capability and the viability of ZE-Drive TBT/ELV 120 Volts DC power dynamic feed.

- Phase 3 (2026) will entail a ZE-Drive open road pilot installation to collect usage data and show case the technology to users and industry players.

A consensual international standard for the ZE-Drive curbed track will emerge from the JIP steering committee work.
A 40 tons, 13 meters testing wheel will be used to run 100,000 km endurance tests on entering/exiting the ZE-Drive gutter & testing of the Monodirectional Level 4 Driving System with power feed transmission up to 400 Amp. in ELV.
Roadmap

- **Phase 0 (2024)** aims to build ZE-Charge prototypes and install them on cars as well as designing a fatigue/homologation test bench for the collector and pavement bar on the “Roue de Grenoble”.

- **Phase 1 (2025)** aims to conduct extensive debris management of the dynamic current collector with the ZE-Feed cable and a 4 month Endurance Test on the “Roue de Grenoble”.

- **Phase 2 (2026)** aims to run a 12 km pilot installation on the M6202bis in the VAR valley which links the CARROS-LE BROC Logistic Base to the city of NICE.

<table>
<thead>
<tr>
<th>ZE-Charge SAS</th>
<th>ZE Feed Infrastructure</th>
<th>ZE-Feed/ ZE-Charge vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>80m</td>
<td>24 km</td>
</tr>
<tr>
<td>Development &amp; Launch Costs (€ ‘000)</td>
<td>Phase 0</td>
<td>Phase 1</td>
</tr>
<tr>
<td>Internet Site with Animations &amp; Videos</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>EVs equipped with ZE-Charge/Feed collectors and Bars</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>ZE-Charge Fatigue/Homologation test bench</td>
<td>15</td>
<td>45</td>
</tr>
<tr>
<td>ZE-Feed Debris Management Linear Test Bench</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>ZE-Feed Endurance Test “Grenoble Wheel” 100,000 km</td>
<td>350</td>
<td></td>
</tr>
<tr>
<td>ZE-Feed Manufacturing Plant Engineering</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>ZE-Feed Manufacturing Pilot Plant Construction</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>ZE-Feed Spool installation/removal truck (Eng-Constr)</td>
<td>50</td>
<td>200</td>
</tr>
<tr>
<td>M6202bis 12 km Open Road Test Demonstration</td>
<td>5800</td>
<td></td>
</tr>
<tr>
<td>Management and Tech Staff</td>
<td>10</td>
<td>80</td>
</tr>
<tr>
<td>SG&amp;A</td>
<td>5</td>
<td>40</td>
</tr>
<tr>
<td>Contingency</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>Total:</td>
<td>€9,7 Millions</td>
<td>60</td>
</tr>
</tbody>
</table>
3. Automated driving systems issuing transition demands should:

- Safely exercise dynamic control when engaged and interact with the driver through an effective and intuitive human-machine interface;

- Monitor the driver’s availability and manage the driver’s attention to ensure that the driver is ready and able to respond to a transition demand;

- Issue a transition demand when appropriate, in an effective manner with sufficient lead time for the driver to safely assume dynamic control;

- After issuing a transition demand, continue exercising dynamic control until the driver has taken dynamic control of the vehicle;

- Transition dynamic control safely and in a clear and foreseeable manner to the driver;

- Verify that the driver is exercising dynamic control at the end of a transition process;

- Perform a risk mitigation manoeuvre if the driver does not take over dynamic control.

IIII. Recommendations regarding automated driving systems issuing transition demands

ZE-Drive Hardware approach *and* Monodirectional automated control of the vehicle aims to remove the red requirements of the recommendations which require in fact SAE Level 4