New Technologies for All-Wheel Drive

A journey through the challenges of electrified AWD Powertrains

Dr. Harald Naunheimer, Vice President Future Products Magna Powertrain
Air Quality Concerns drive Zero Emission Powertrains

There is significant uncertainty in regional legislation

Consumer buying preferences will also drive electrification

The Industry is changing!
The History of 4WD Systems: Traction Focus

All-wheel drive systems are well known for improved traction to ensure mobility under severe conditions.

Maximum Acceleration

Asphalt ($\mu > 0.8$)

Acceleration 0.65g

Maximum Gradeability

Maximum Gradeability

Ice ($\mu > 0.1$)

Asphalt ($\mu > 0.8$)

Asphalt ($\mu > 0.8$)
Todays Customer Demand beyond Traction Focus

- Desired natural drivability
- Appropriate performance and safety
- Optimized traction for all driving conditions
- Differentiable modesplit
- Optimum efficiency for all day driving condition
- Excellent comfort of control
- Perfect handover and interaction to ESP

All-wheel drive: Needs-based, highly efficient and comfortable
Scaling Efficiency and Performance
Flex4 – Disconnect System

Flex4. The seamless connection.
Magna Powertrain’s FLEX4™ is a preemptive disconnect system which greatly increases the fuel efficiency of 4WD vehicles.

- True 2WD to 4WD vehicles by disconnecting all unnecessary components from the drivetrain.
- Non-moving parts do not cause friction and churning losses.
- 4WD is engaged only when required, therefore improving fuel efficiency and reducing CO₂ emissions.
4WD Torque Vectoring – Functional Benefits

**Traction**
- Ideal traction at high steering angle or kinematic slip
- No trade off between drivetrain bending and wheel slip
- Optimal vehicle shunting comfort at full 4WD performance

**Vehicle dynamics**
- True longitudinal torque vectoring and optimized self steering behavior
- Torque distribution independent of kinematic slip
- Realization of different vehicle dynamic modes possible

**Additional functionalities**
- “Wear free torque distribution”
- Compensation of tire diameter differences due to tolerances or wear
Functional Comparison of 4WD Architectures

<table>
<thead>
<tr>
<th>4WD architectures</th>
<th>WLTP CO₂ impact vs. 2WD</th>
<th>Vehicle Dynamics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard 4WD</td>
<td>+5% to +9%</td>
<td>O</td>
</tr>
<tr>
<td>Disconnect 4WD</td>
<td>+2%</td>
<td>O</td>
</tr>
<tr>
<td>eTC 48V 4WD System (el. Compound Planetary Gear)</td>
<td>approx. -5%</td>
<td>++</td>
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</table>

- Trade off in current 4WD driveline architectures
- eTransfercase 48V 4WD System is able to provide superior vehicle dynamics while reducing CO₂ emissions
- Longitudinal TV in 4WD/TV mode via ICE/EM powersplit
- Electric creeping in 2WD/Recup mode via P3 architecture
Scaling Hybrid Powertrains
Modular and scalable Building Blocks

Scalability means:
- Scalable functions on the entire vehicle
- Scalable powertrain functions
- Scalable software functionality
- Scalable components performance
E-Motor – the Key for Scaling Efficiency and Power

Scalability shifts from ICE to eMotor

Modular & Scalable Platform

OEM Benefit

- Reduced complexity
- Scalable functions
- Diversified OEM branding
- Package advantage
- High re-use of content

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Base Architecture Conventional ICE with DCT

- eMotor Power
- Acceleration 0-100 kph
- CO₂ Improvement
- Gradeability

- ICE Power
- ICE 100 kW
- 12 V Battery
- 7DCT300
- Fuel tank

Conventional ICE
Hybrid Scalability: 48V Mild Hybrid HDT 25 kW P2.5

- eMotor Power
- Acceleration 0-100 kph
- CO₂ Improvement
- Vehicle Dynamics
- Gradeability

**ICE Power**

**CO₂ Improvement**

**Gradeability**

**ICE 100 kW**

**7HDT300**

**12 V Battery**

**48 V Battery**

**48 V 25 kW**

**Inverter**

**Converter**

**Fuel tank**

- Conventional ICE
- 48V Mild Hybrid
Hybrid Scalability: Performance MHEV P2.5+P4

- eMotor Power
- Acceleration 0-100 kph
- CO₂ Improvement
- Gradeability

Conventional ICE 2WD
- 48V Mild Hybrid 2WD
- 48V: 25 kW P2.5 + 25kW P4

ICE Power

CO₂ Improvement

Gradeability

ICE 100 kW
12 V Battery
Plug-In Inverter Converter
48 V Battery
48 V 25 kW
Fuel tank

7HDT400

ICE

Hybrid Scalability: Performance MHEV P2.5+P4

Graz/Spielberg, May 9 to 10, 2019
Electrification & All-Wheel Drive Congress
Hybrid Scalability: Performance PHEV P4

- **eMotor Power**
- **Acceleration 0-100 kph**
- **CO₂ Improvement**
- **Vehicle Dynamics**
- **Gradeability**

**ICE Power VS eMotor Power**

**Conventional ICE**

**48V Mild Hybrid**

**48V : 25 kW P2.5 + 25kW P4**

**Conv. FR / P0 + PHEV 85 kW P4**

- **ICE 100 kW**
- **12 V Battery**
- **Plug-In Inverter Converter**
- **P0 10 kW**
- **7DCT400**
- **85 kW**
- **High Voltage (HV) Battery**
- **Fuel tank**
- **BCM**

**CO₂ Improvement**

**Acceleration 0-100 kph**

**Vehicle Dynamics**

**Gradeability**

**Fleet Electrification & All-Wheel Drive Congress**

Graz/Spielberg, May 9 to 10, 2019

**EAWD'19**
BEV Scalability: Differentiation by eDrive Power Range + Dynamics Performance

- **BEV FA P4 Low**
  - (85 kW + 85 kW) Entry

- **BEV FA P4 Low + RA P4 Mid**
  - (85 kW + 150 kW) Volume Performance

- **BEV FA P4 Mid + RA P4 High**
  - (150 kW + 250 kW) Sport Performance

**eMotor Power**

- Acceleration 0-100 kph
- Gradeability

**Vehicle Dynamics**

**High Voltage (HV) Battery**

**Inverter**

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Electrification & All-Wheel Drive Congress
Challenges of electrified AWD Powertrains

1. Change in significance of AWD with regard to image and functions
   - from permanently available with physically maximum drive torque
   - to needs-oriented, efficient and comfortable

2. Electrification offers new possibilities for brand and model differentiation
   - Scalability of performance and functions
   - Number of possible architectures grows strongly - complexity increases

3. Technology change offers opportunities for improved AWD functionality
   - New possibilities for vehicle handling, performance and safety

4. Competence in AWD systems only is not sufficient
   - Integration understanding for the entire electrified powertrain required
   - A huge challenge, but also a chance