



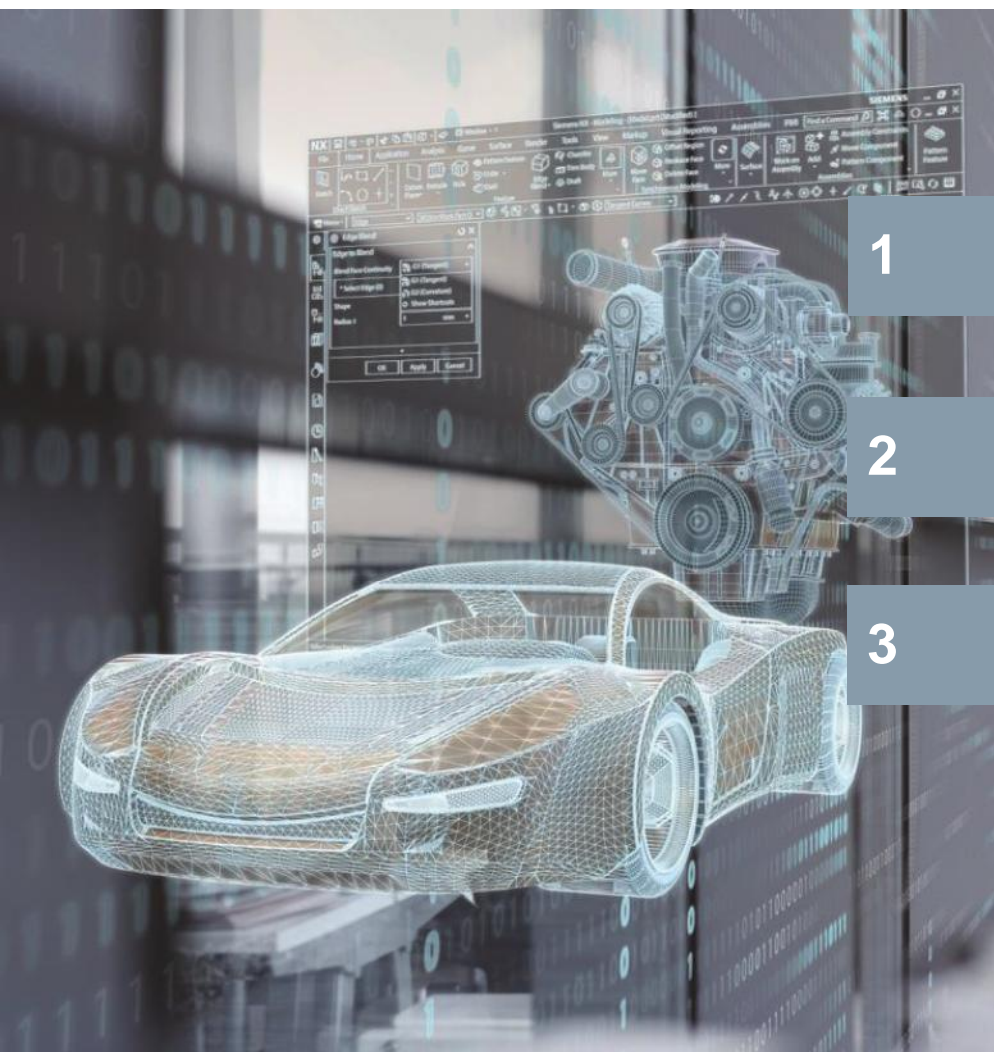
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Ingenuity for life

Pass-by noise testing & engineering webinar

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Realize innovation.

Pass-by noise testing & engineering webinar



1

Pass-by noise regulations

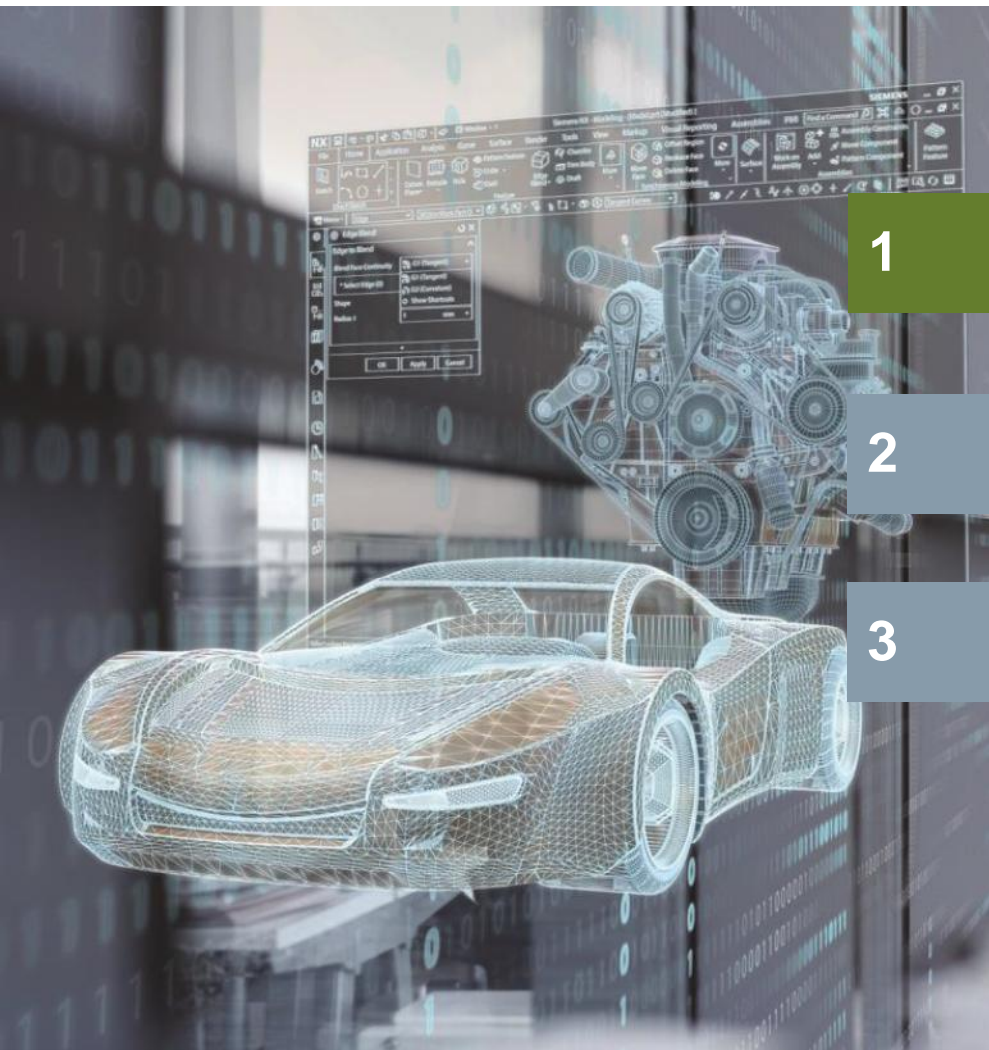
2

Pass-by noise offering

3

Pass-by noise engineering techniques

Pass-by noise testing & engineering webinar



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Pass-by noise regulations

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Pass-by noise offering

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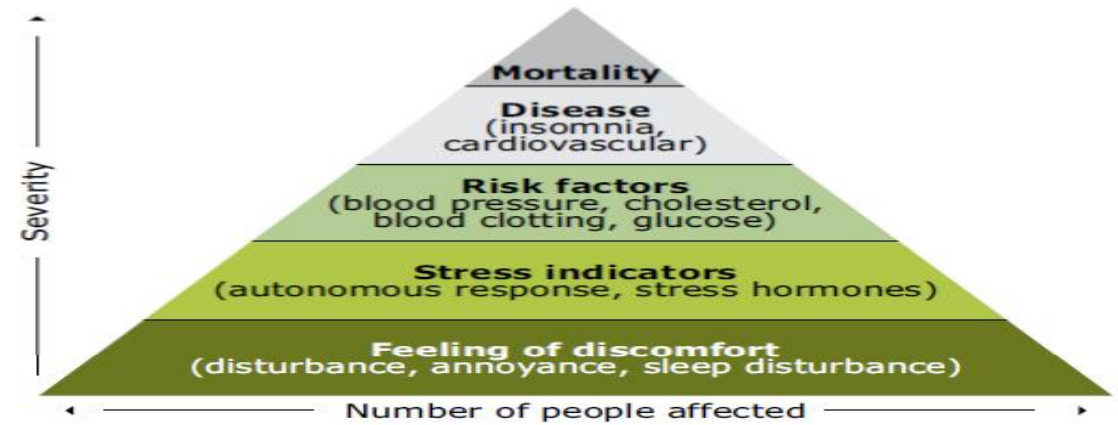
Pass-by noise engineering techniques

Pass-by noise regulations

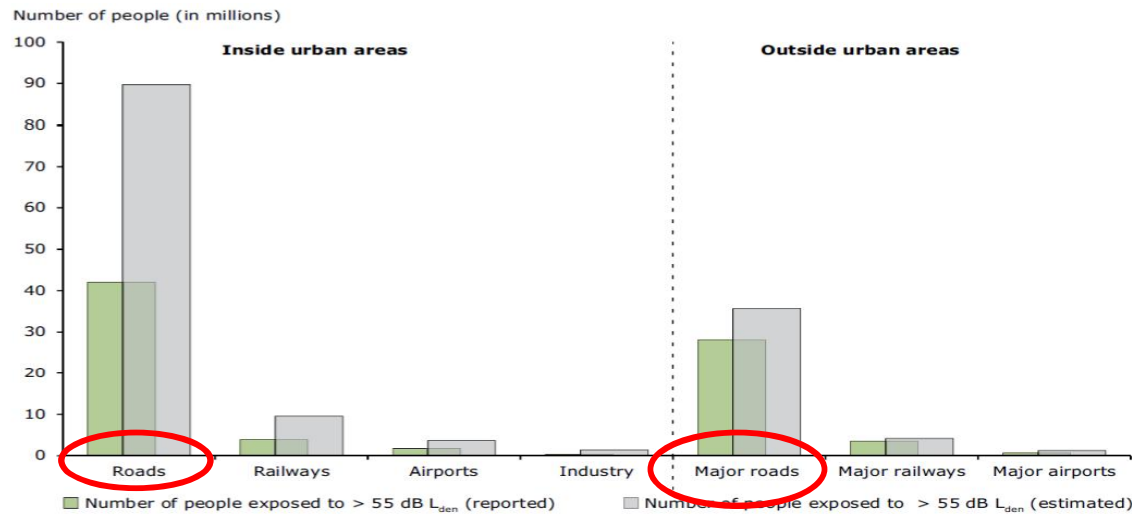
European Union's measures to reduce pass-by noise exposure



Source: Dublin City Council, 2012.



Source: Babisch, 2002, based on WHO, 1972.



Tackle the problem at the source

- Further reduce vehicle emission
- Appropriate test methodology

ECE.R51.03



In the mean time in the European Parliament...

Update March 2016:

After negotiations between EC and EP, a compromise was reached and approved by vote in the EP in 2014-2015

3-phase introduction in 2016, 2020, 2024

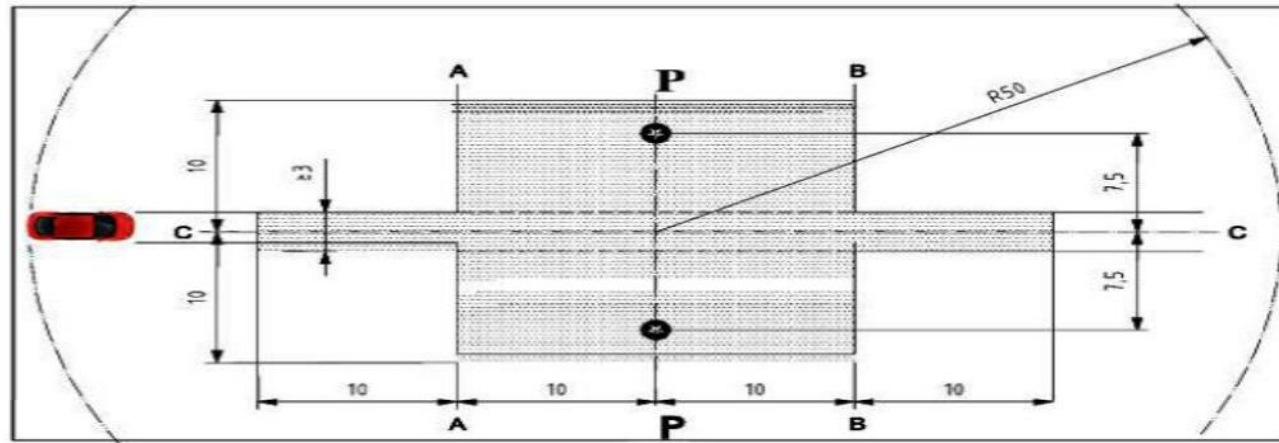
At these dates, all new vehicle types should comply to new limits

2 years after – so 2018, 2022, 2026 – all new production vehicles should comply to these noise limits

The EU directive is called “Directive 2007/46/EC”

Further documented in European Regulation No 540/2014

What are the differences between the old and new ISO standard?



Old ISO 362

Enter track (A-A') at 50 km/h, followed by WOT acceleration

Only Test WOT

Test gear 2 and gear 3

New ISO 362

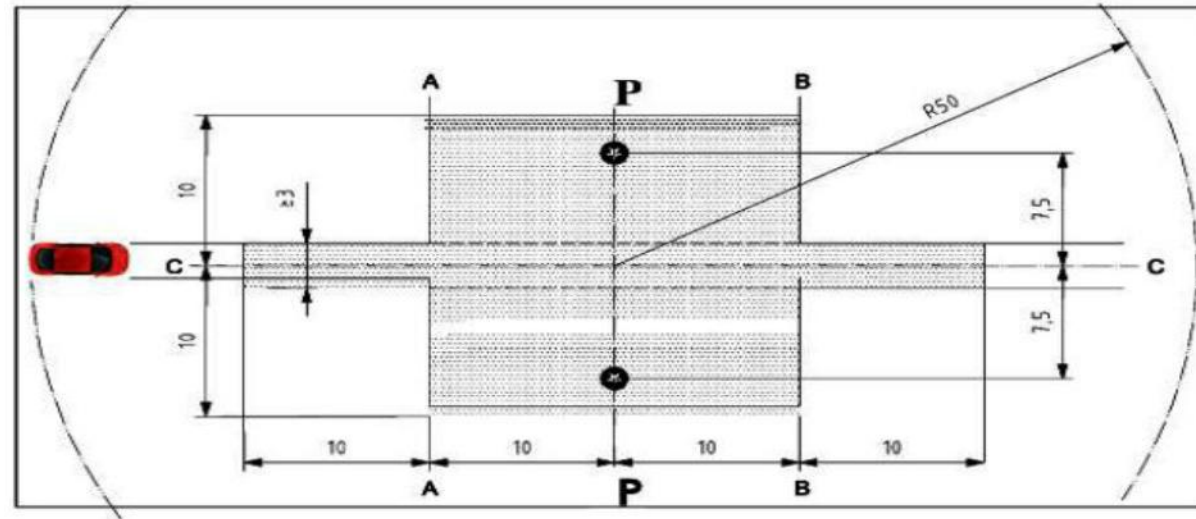
WOT acceleration when entering track (A-A'), reach 50 km/h at P-P' line

Test WOT and constant speed

Gear to be tested depends from power to mass ratio of vehicle

IMPLICATIONS

What is the difference in speed between the old and new ISO standard?



Old ISO 362
Enter track (A-A') at 50 km/h, followed by WOT acceleration

New ISO 362
WOT acceleration when entering track (A-A'), reach 50 km/h at P-P' line



**At which speed should you enter the track with new ISO?
NEED for guidance**

IMPLICATIONS

How do the test conditions between old and new ISO change?

Old ISO 362

Only Test WOT

New ISO 362

Test WOT and Constant speed

More test data generated that needs to be combined into the final pass-by noise value

Old ISO 362

Always test gear 2 and gear 3

New ISO 362

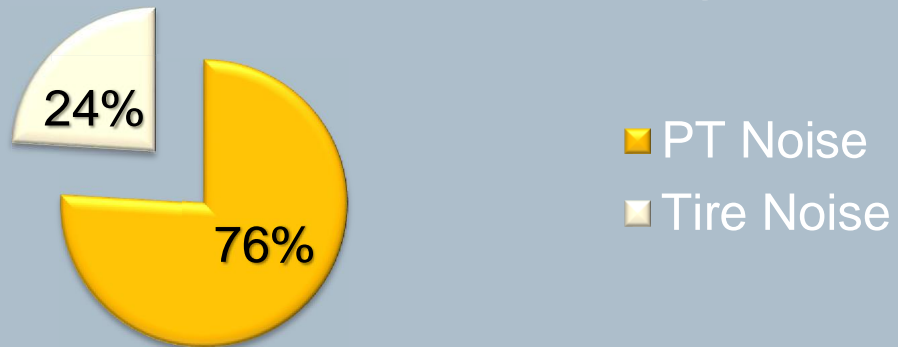
Gear to be tested depends from power to mass ratio of vehicle

Some vehicles tested in very high gears means that engine speed is very low and contribution of engine decreases and importance of tires increases

Impact of new ISO 362 – Powertrain versus tires

ECE-R51.02 (current)

Shares in 2nd gear

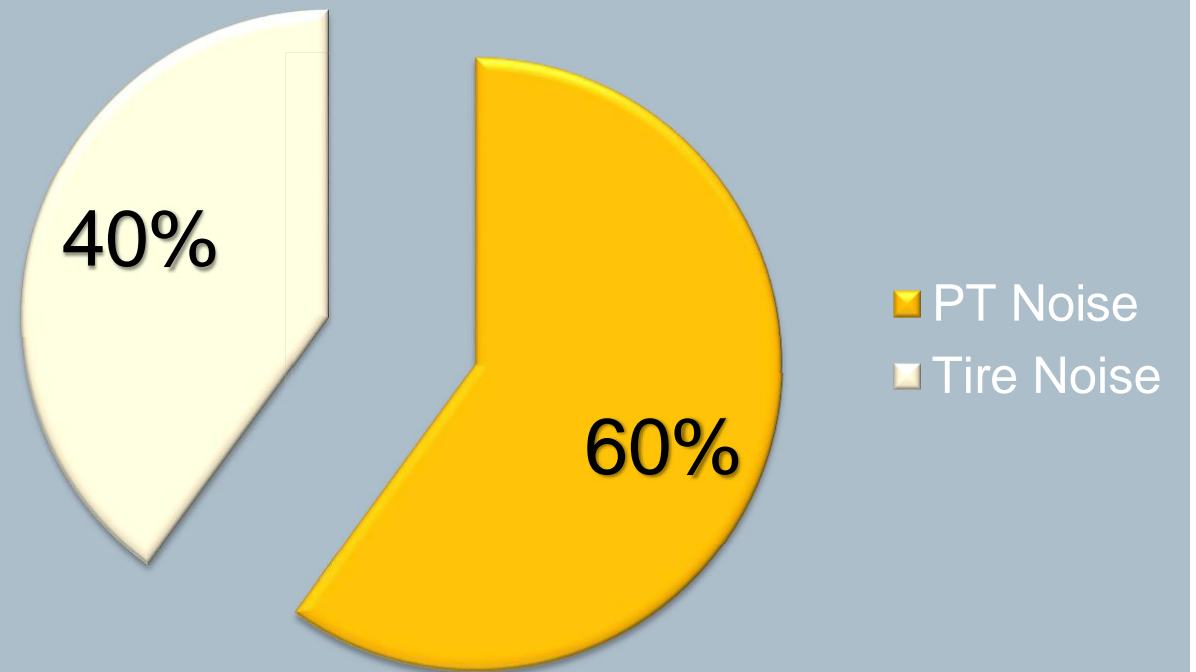


Shares in 3rd gear

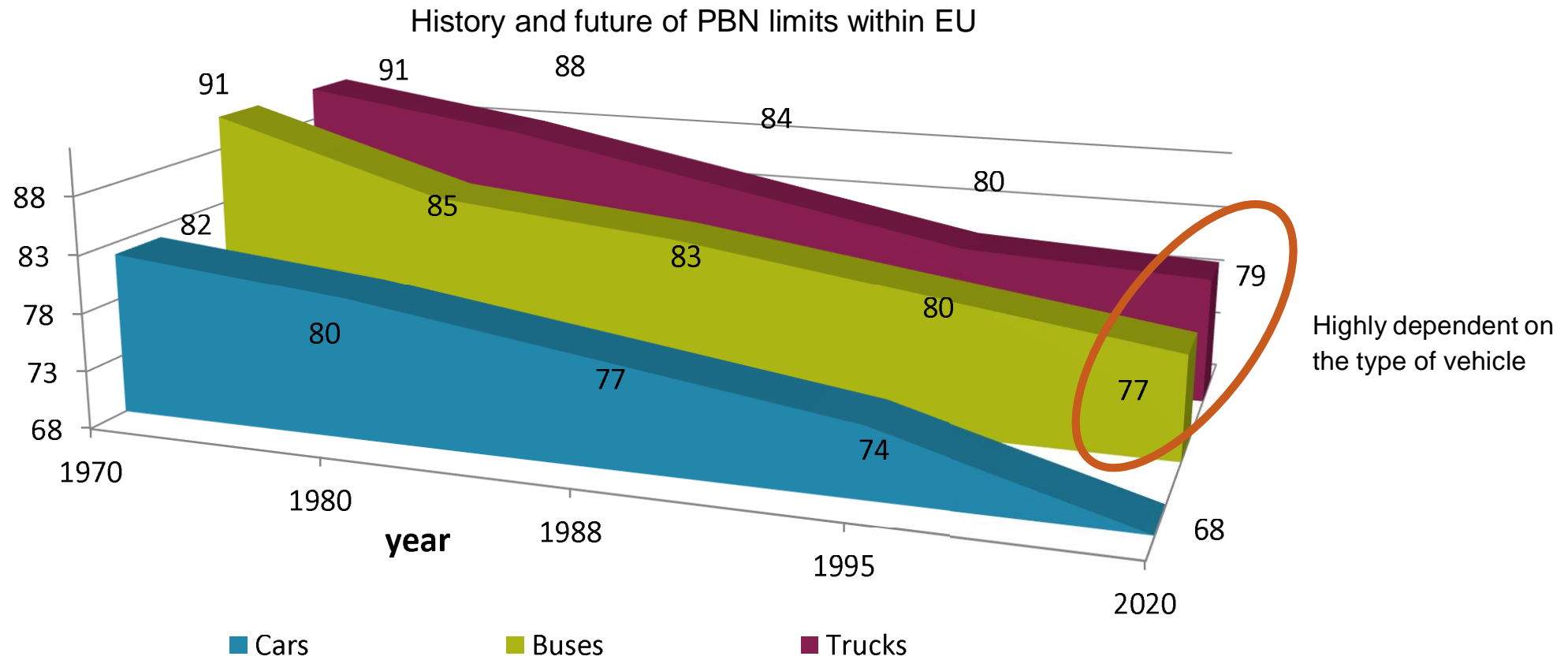


ECE-R51.03 (new)

Shares in all gears



New pass-by noise limits



- New pass-by noise limits will be harder to comply to: - 6 dBA for passenger vehicles

M-vehicles: for carriage of passengers

Vehicle Category	Vehicles used for the carriage of passengers	2016	2020	2024	
		Phase 1	Phase 2	Phase 3	
M ₁	PMR ≤ 120	72	70	68	Your regular car
	120 < PMR ≤ 160	73	71	69	
	PMR > 160	75	73	71	Sport cars!
	PMR > 200, no. of seats ≤ 4, R-point height < 450mm from the ground	75	74	72	
M ₂	M ≤ 2.5 t	72	70	69	
	2.5 t < M ≤ 3.5 t	74	72	71	
	M > 3.5 t; P _n ≤ 135 kW	75	73	72	
	M > 3.5 t; P _n > 135 kW	75	74	72	
M ₃	P _n ≤ 150 kW	76	74	73	2026
	150 kW < P _n ≤ 250 kW	78	77	76	
	P _n > 250 kW	80	78	77	

N-type vehicles: for transportation of goods

Different categories allow for various regional type of vehicles

Vehicle Category	Vehicles used for the carriage of goods	2016	2020/22(N2)	2026
		Phase 1	Phase 2	Phase 3
N ₁	$M \leq 2.5 \text{ t}$	72	71	69
	$M > 2.5 \text{ t}$	74	73	71
N ₂	$P_n \leq 135 \text{ kW}$	77	75	74
	$P_n > 135 \text{ kW}$	78	76	75
N ₃	$P_n \leq 150 \text{ kW}$	79	77	76
	$150 \text{ kW} < P_n \leq 250 \text{ kW}$	81	79	77
	$P_n > 250 \text{ kW}$	82	81	79

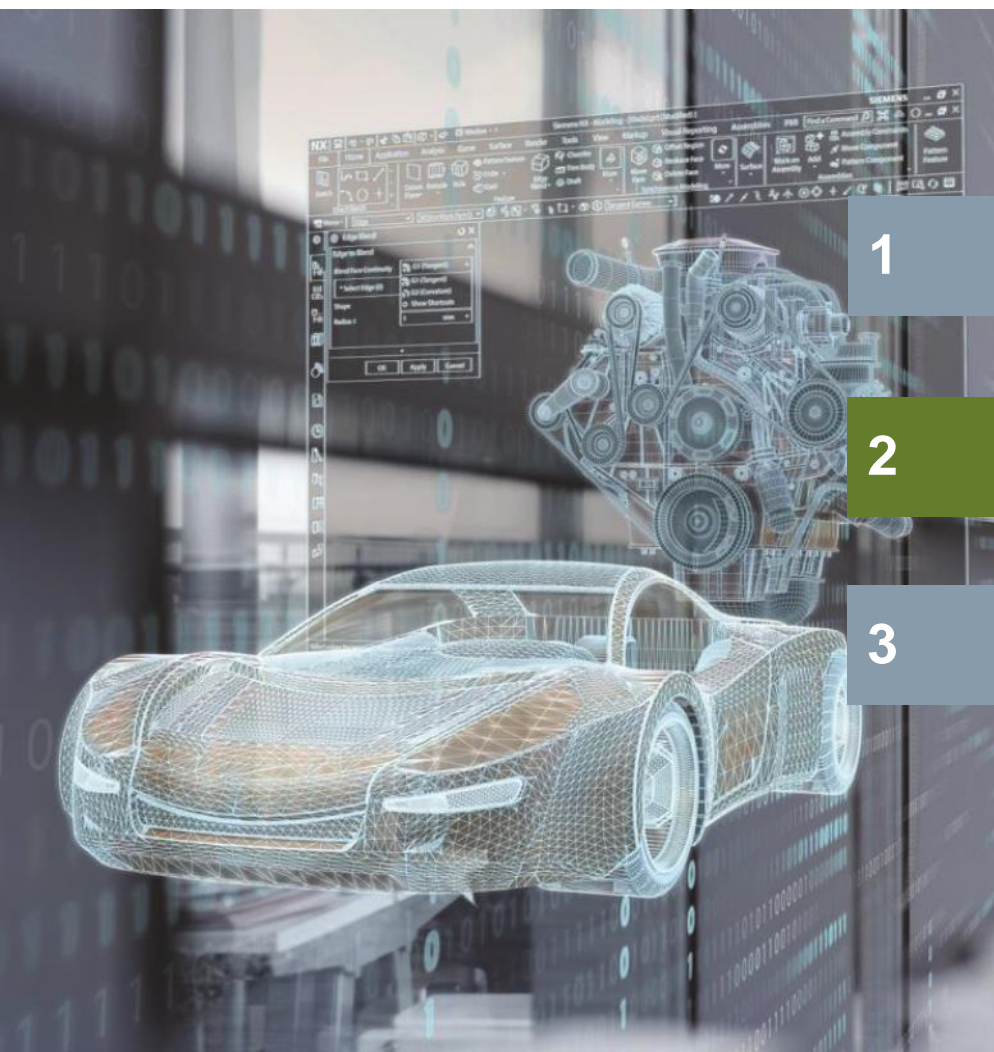
After a lot of protest from different organizations reduced from 81dB(A) to 79dB(A).

ASEP

Additional sound emission provision

- M1 and N1 vehicles have to comply with additional testing: **ASEP**
- **Additional Sound Emission Provisions** cover higher acceleration and higher engine speeds
- ASEP test NOT mandatory to execute when applying for type-approval, but vehicle needs to comply
 - ASEP tests will be required frequently, some A-OEM's decide to test each vehicle
- Idea:
vehicle pass-by noise needs to remain within certain limits when testing at different speed and RPM conditions than the ones tested during normal PBN test
 - ASEP tests require high amount of WOT test in different gears AND engine speeds

Pass-by noise testing & engineering webinar



1 Pass-by noise regulations

2 Pass-by noise offering

3 Pass-by noise engineering techniques

Track-only configuration

TRACK



Speed radar



Weather station



PBN Conditioner & Data acquisition



Microphones



Light barriers & reflectors

IN-VEHICLE

- No instrumentation in-vehicle:*
- *Kickdown estimated from speed*
 - *RPM estimated from speed*

Track-based configuration

TRACK



Speed radar



Weather station



PBN Conditioner & Data acquisition



Microphones



Light barriers & reflectors

IN-VEHICLE



RPM & Kickdown sensors



Standalone PBN Conditioner

In-Vehicle configuration

TRACK



Speed radar



Weather station



PBN Conditioner & Data acquisition



Light barriers & reflectors

IN-VEHICLE



RPM & Kickdown sensors



Standalone PBN Conditioner

In-Vehicle configuration

TRACK



Speed radar



Weather station



Standalone PBN Conditioner



Wireless Microphones



Light barriers & reflectors

IN-VEHICLE



RPM & Kickdown sensors

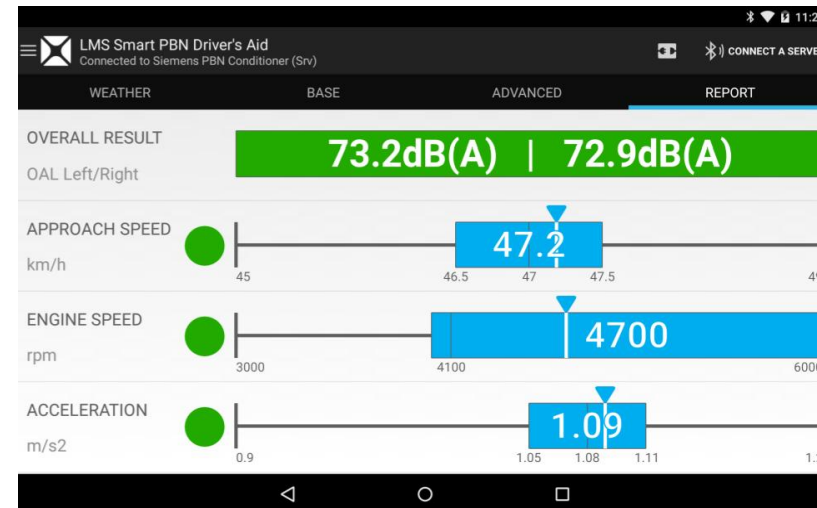
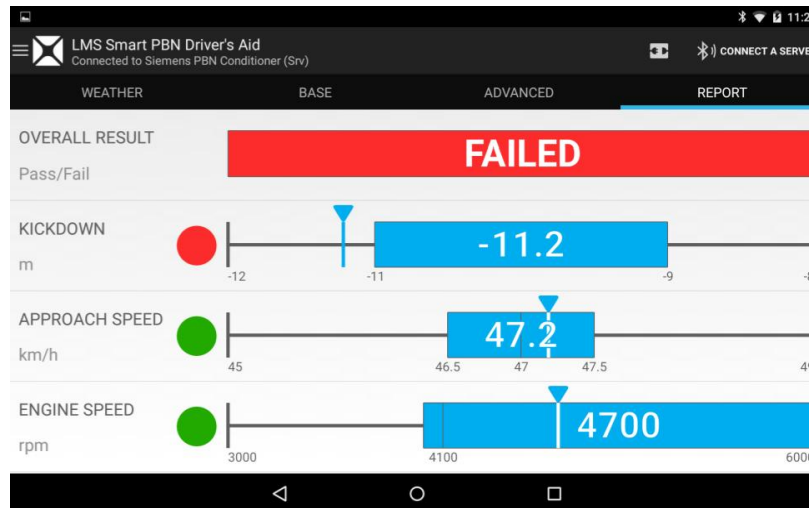
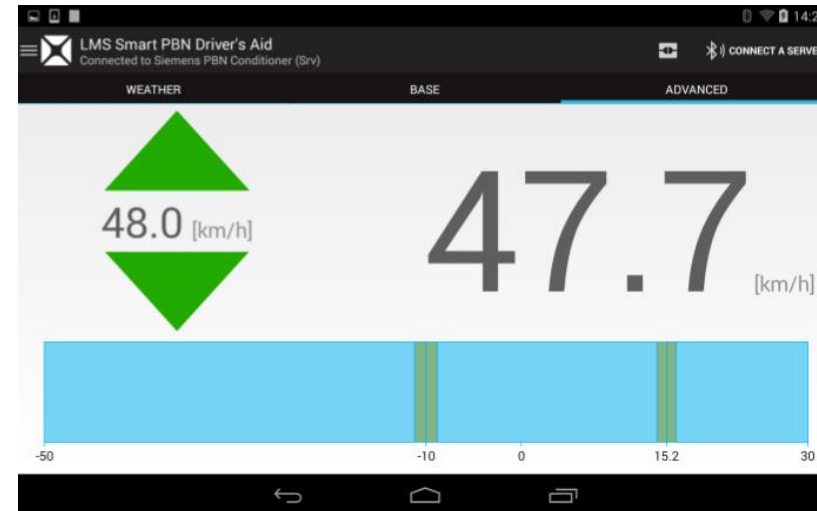
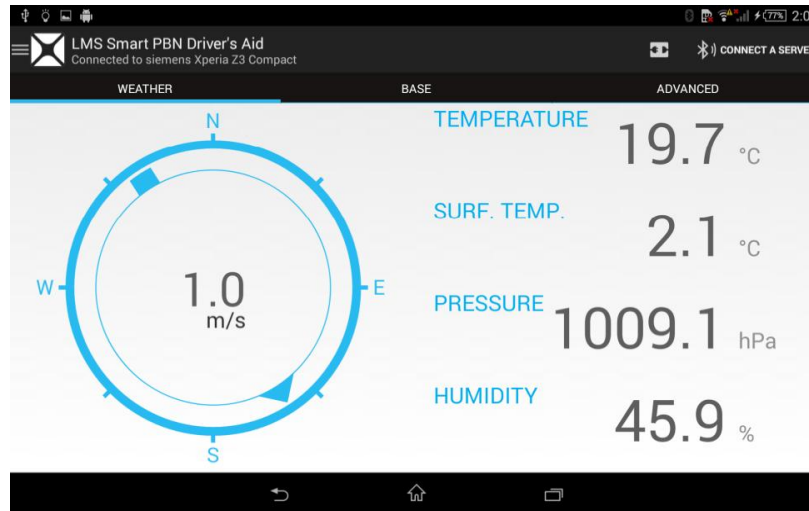


PBN Conditioner & Data acquisition

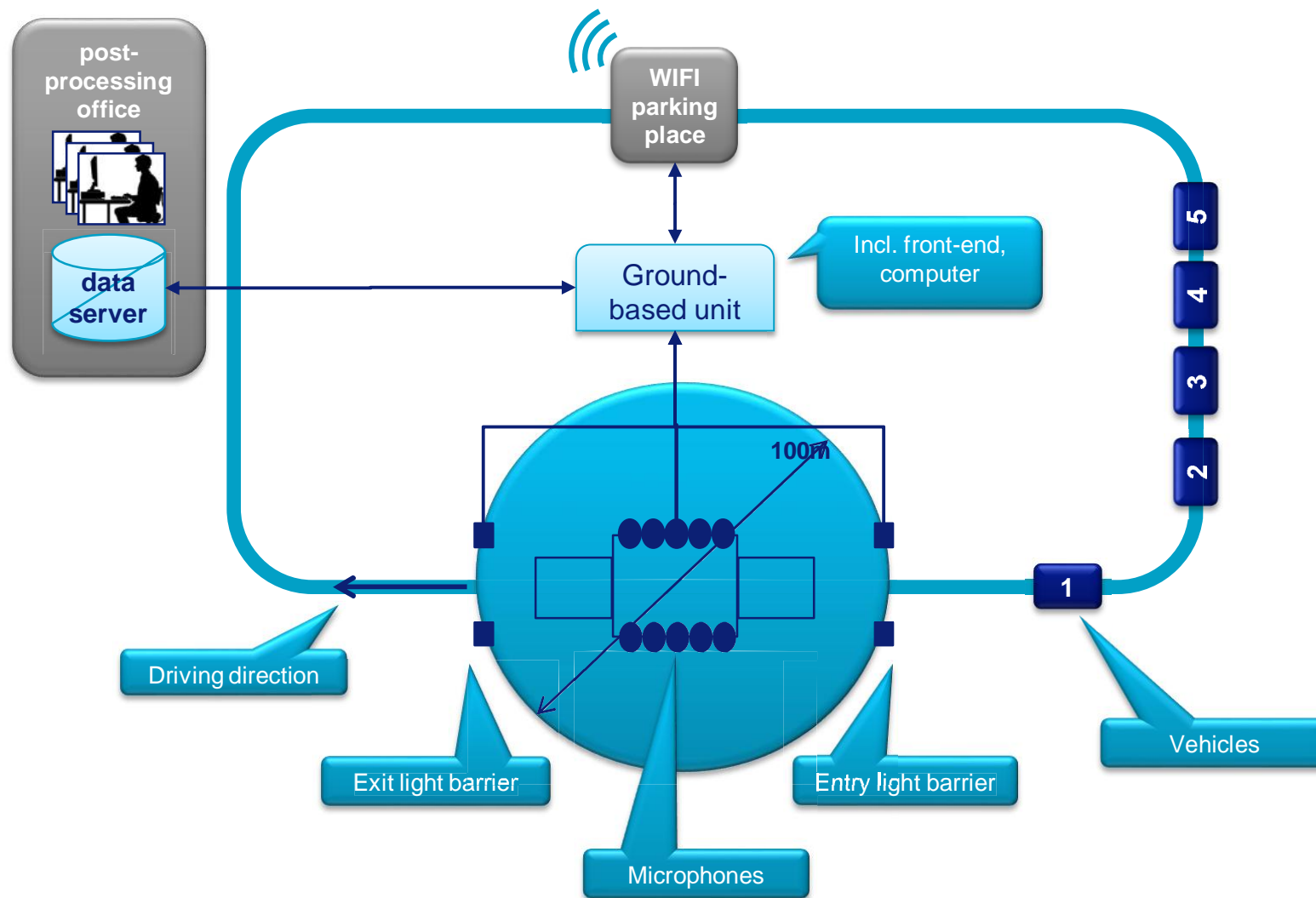
LMS Smart PBN Driver's Aid app

Guiding the driver to be successful

SIEMENS



Future of exterior pass-by noise testing? *Multi-vehicle solution*



LMS pass-by noise testing

Your key benefits

SIEMENS

1. Efficiency & Ease of Use

- Talking the language of the standards
- Online visualization & monitoring, Driver's Aid
- Intermediate report, Validation & Reporting

2. Turning Data Into Assets

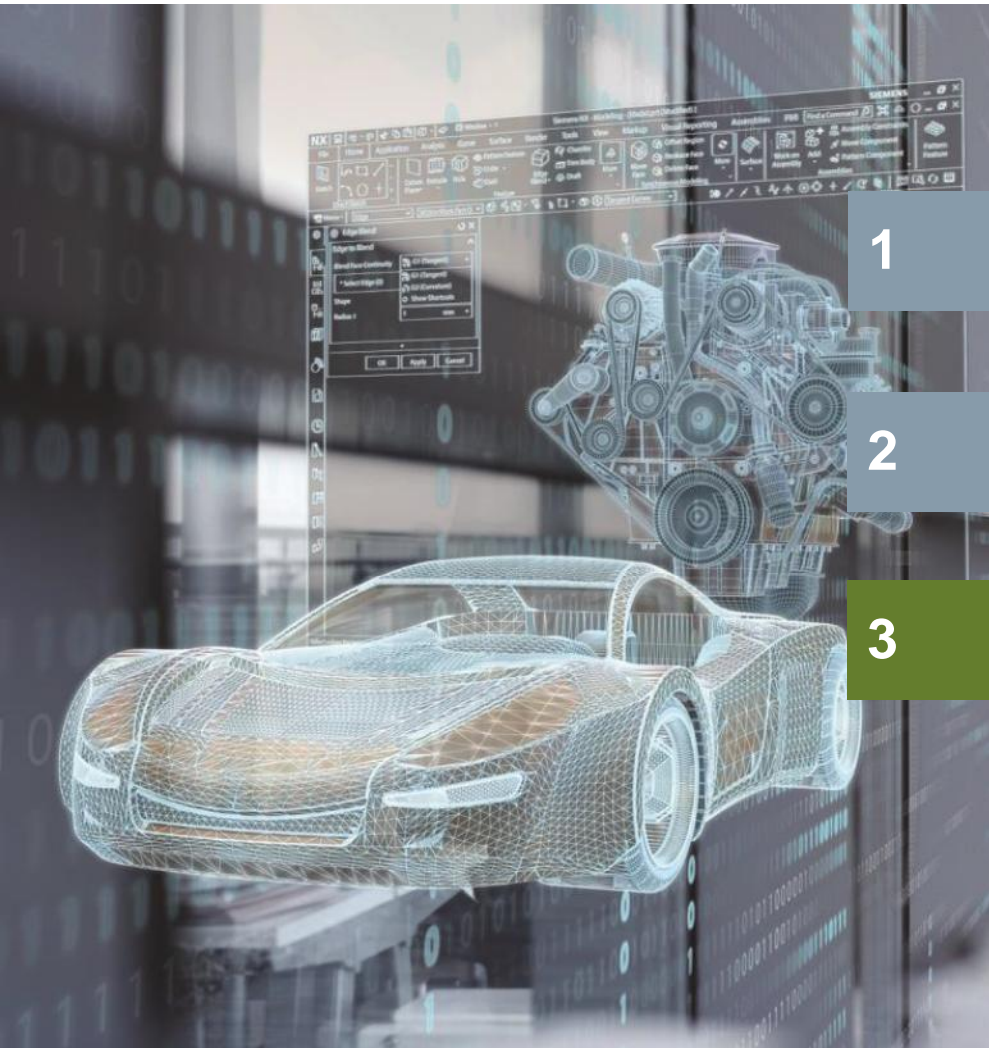
- Data Documentation – before the test
- Data searching and reporting – after the test
- Data Management – company wide

3. Engineering Insight

- PBN Engineering
- Advanced post-processing capabilities
- More insights for the PBN engineer
- Efficient PBN Data Comparison



Pass-by noise testing & engineering webinar



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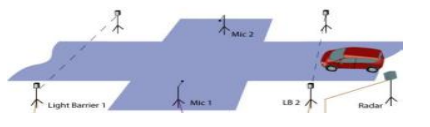



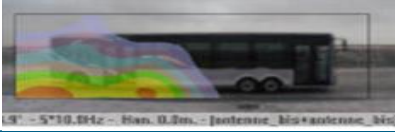

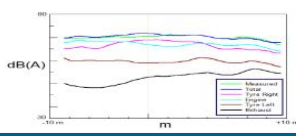
Pass-by noise engineering techniques

LMS Pass-by noise engineering solutions

Powered by LMS Test.Lab & LMS SCADAS Platforms

SIEMENS

Increased level of insight on how to reduce PBN levels

Type approval test	Exterior PBN for homologation tests		
In-vehicle data acquisition	Add-on In-vehicle data acquisition & analysis		
Interior Pass-by noise	Best in class in-room pass-by noise		
Acoustic Arrays	Troubleshoot contribution of sub-systems		
Subsystem masking	Noise contribution analysis based on insulation (masking) of subsystems:		
Enhanced source contribution analysis	ASQ based Sub system noise contribution analysis:		

Increasing potential to improve PBN performance

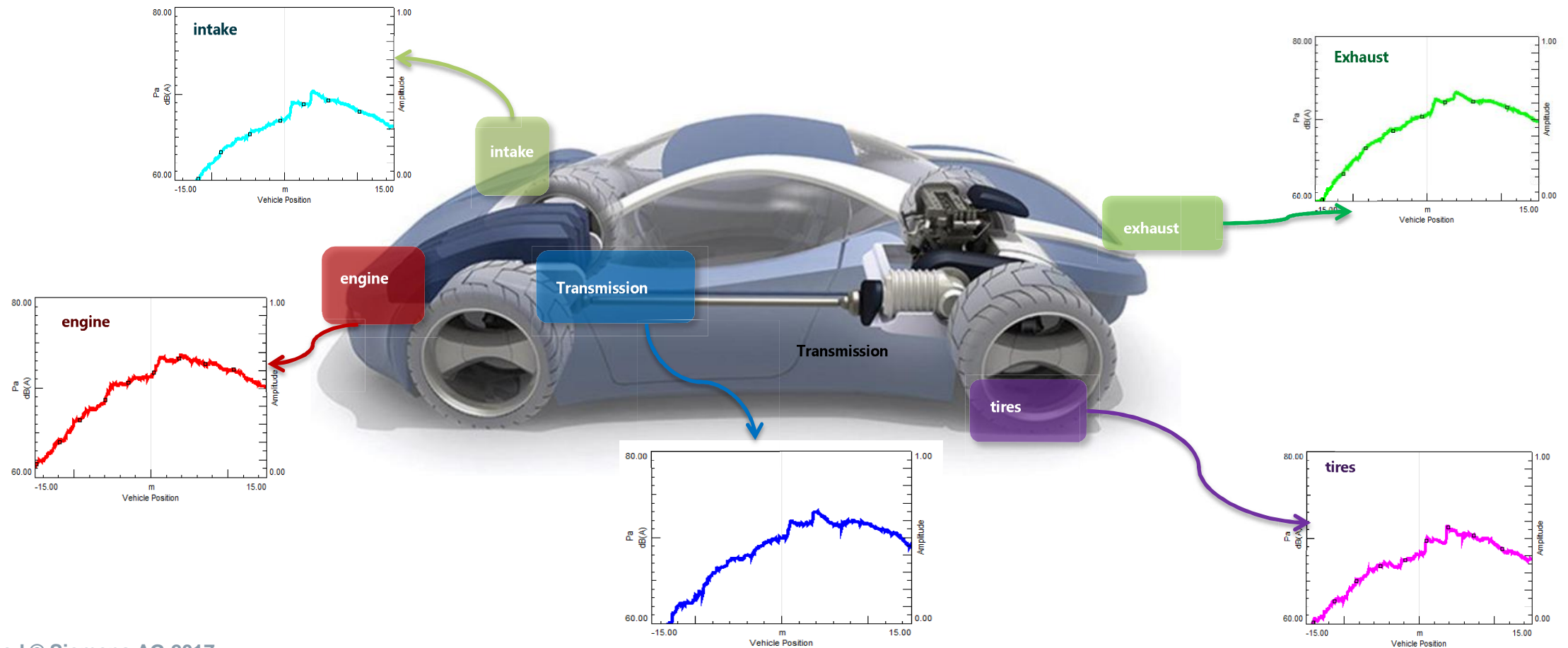
Reduce exterior noise to meet regulations

Pass-by Noise Engineering – Contribution Analysis

Excessive Pass-by noise levels

Pass-by noise engineering

- Understand subsystems contributions
- Subsystem target setting



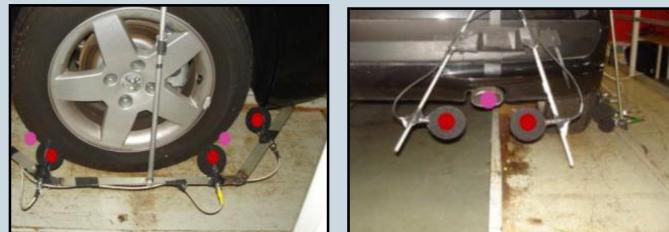
Pass-by noise Airborne Source Quantification (ASQ) in a nutshell

Sources

Engine – Exhaust – Tires – Intake

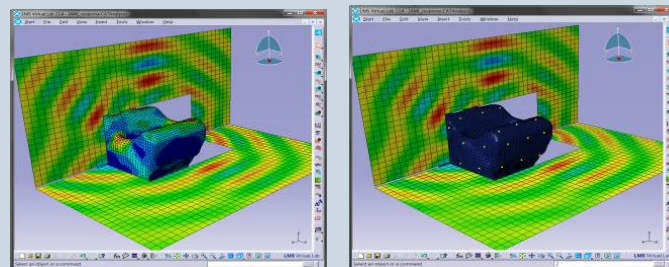
Test Based

Based on ASQ technology



Simulation based

Identify equivalent monopole sources based on simulated response



Transfer

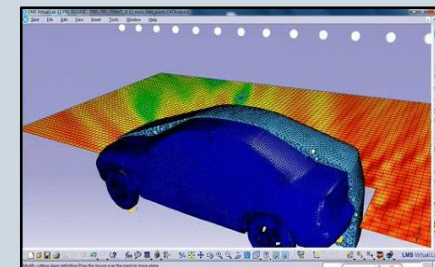
Test Based

Use Volume Velocity source to measure transfer functions (NTFs)

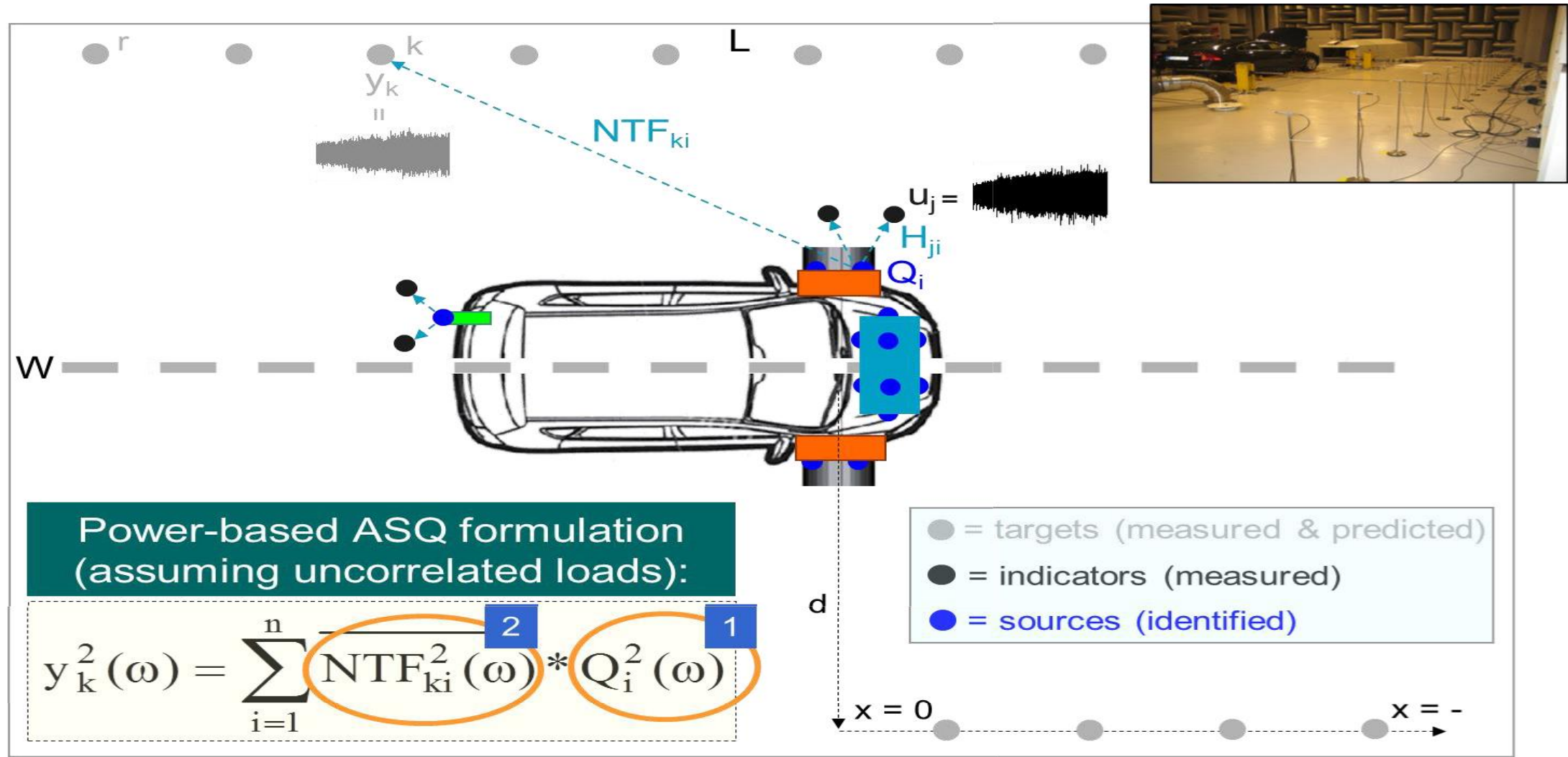


Simulation Based

Compute NTFs for a specific acoustic engine bay design (FEM AO solver)



Pass-by noise engineering – Time domain source contribution analysis

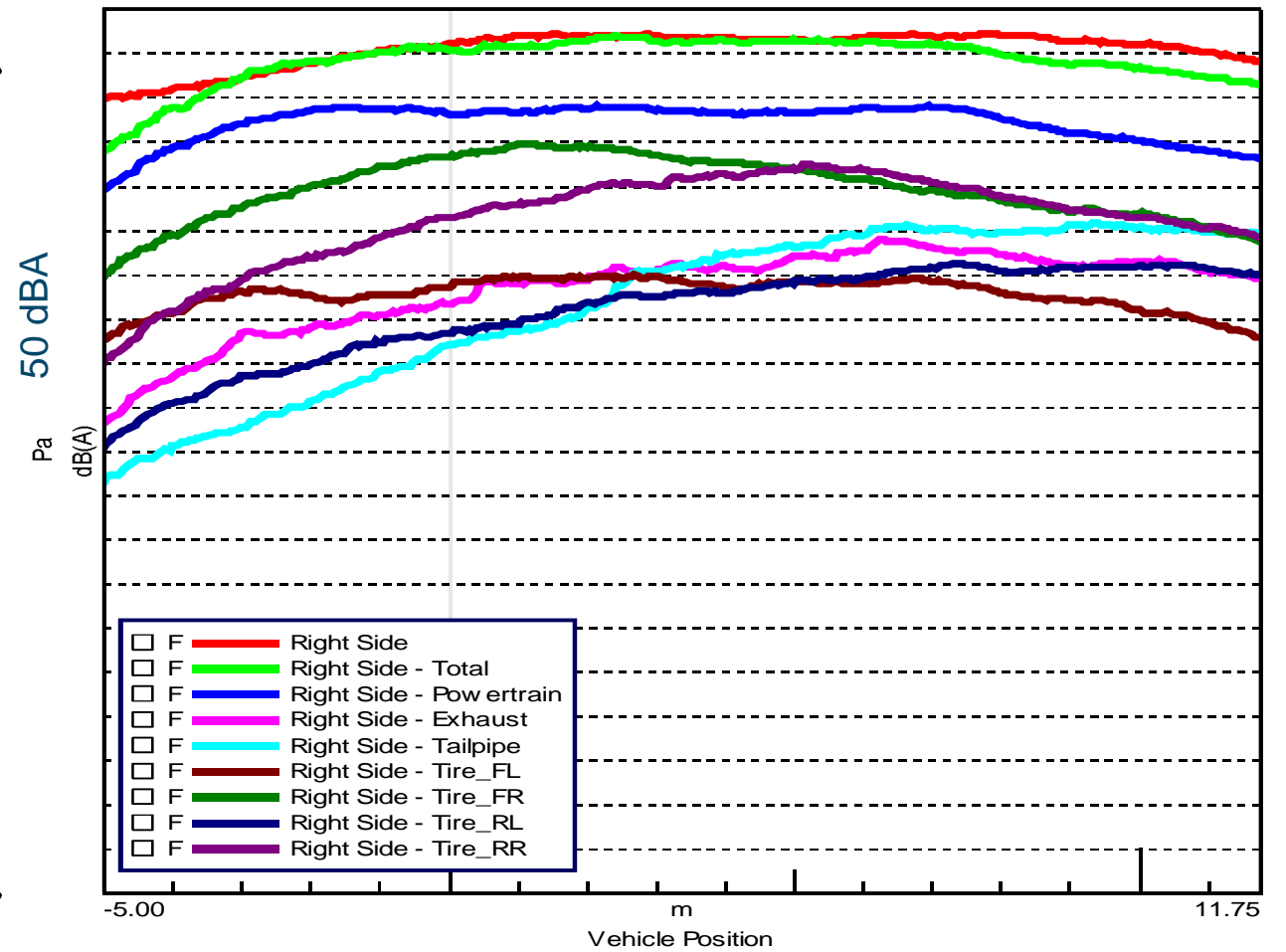
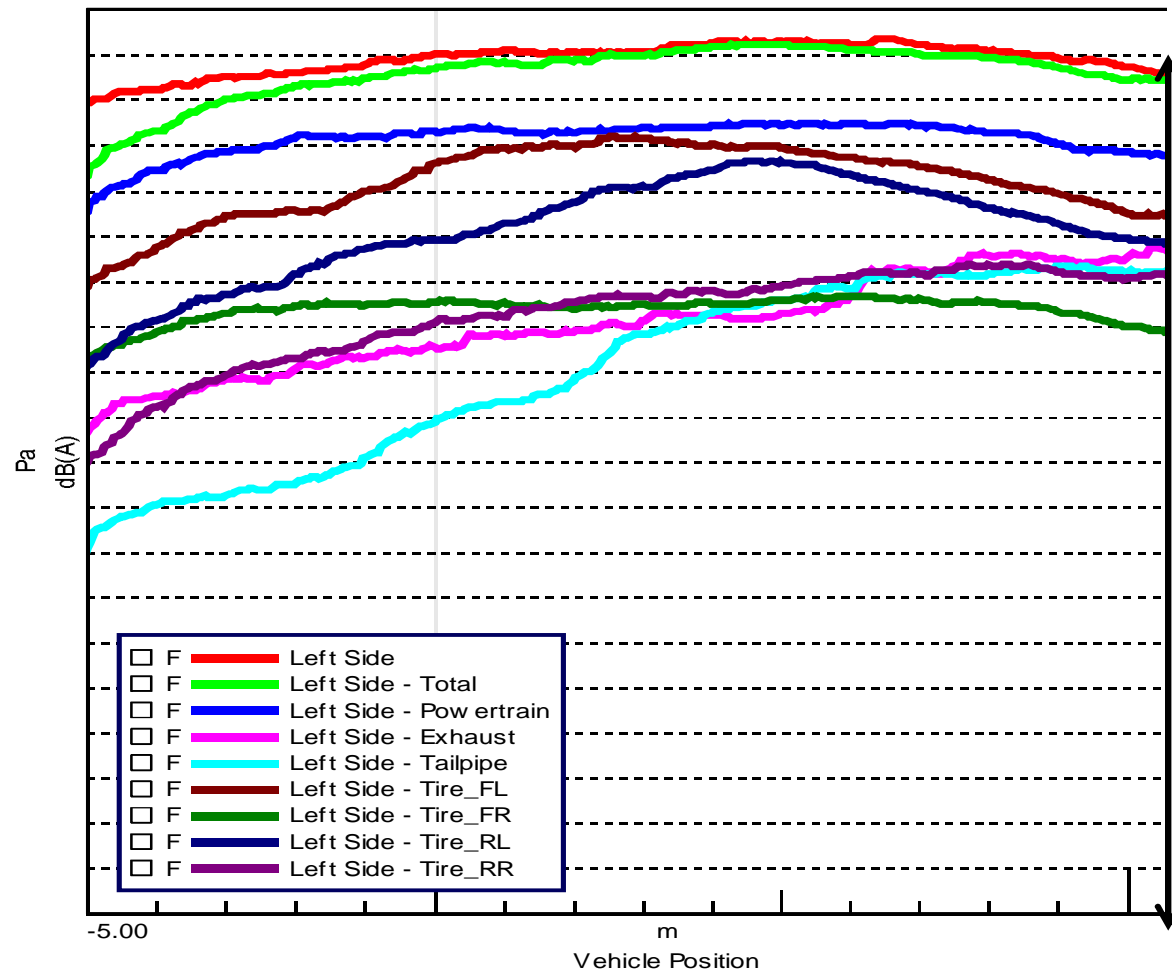


Pass-by source contribution analysis

Contribution plots



tire type A – Gear 3 Acceleration

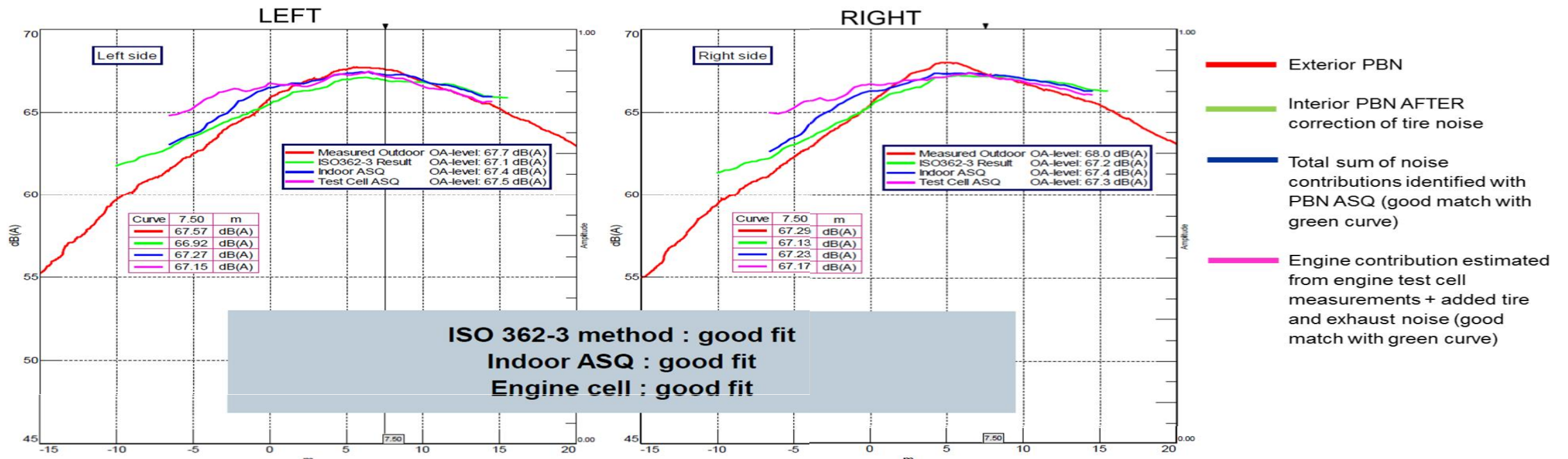


On the road to Pass-by noise synthesis ...

Why Pass-by noise ASQ is the right technology to control?

Built upon the Pass-by noise ASQ technology

Make Early predictions of Pass-by noise based on engine test bench measurements

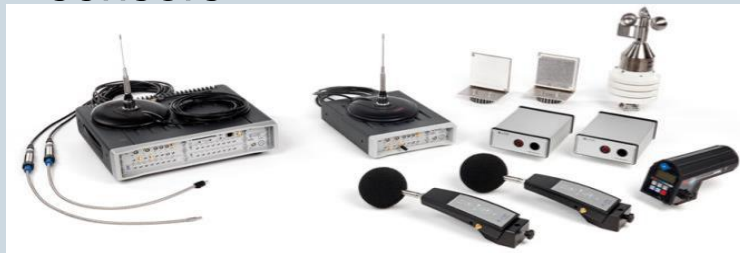


Summary

Efficient pass-by noise testing

EASY & FAST to SETUP

- One cable (power + measurement)
- LED feedback
- Flexibility in how to instrument sensors



HELP to efficiently test according to new ISO standard

- Software guidance (e.g. suggestion for speed)
- Driver's aid (incl. beep)
- Efficient reporting

Validation checks

	Value	Deviation
Approach Speed [(km/h)]	41.332	-4.830
Test Condition	Within Tolerance	-
Test Speed [(km/h)]	45.033	-4.967
Acceleration Stabilization [%]	71.320	-
Acceleration [(m/s ²)]	2.113	0.689
Kick Down [m]	Not Measured	-
Throttle Release [m]	Not Measured	-
Ambient Conditions	Not Measured	-

Overall

OA Level [dB(A)]

Deviation Previous Run [dB(A)]

Direction

Overview **Valid**

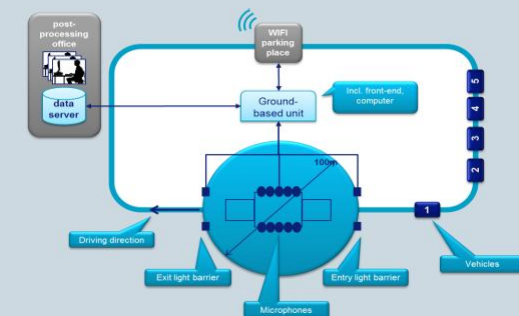
LMS Smart PBN Driver's Aid
Contracted to Siemens PBN Conditioner (DIN)

WEATHER BASE ADVANCED

48.0 [km/h] 47.7 [km/h]

EXTENDABLE towards a pass-by noise engineering solution

- Track-based vs. in -vehicle
- Adding sensors (microphones)



Simcenter solutions for Automotive NVH & Acoustics



Legislation and regulation



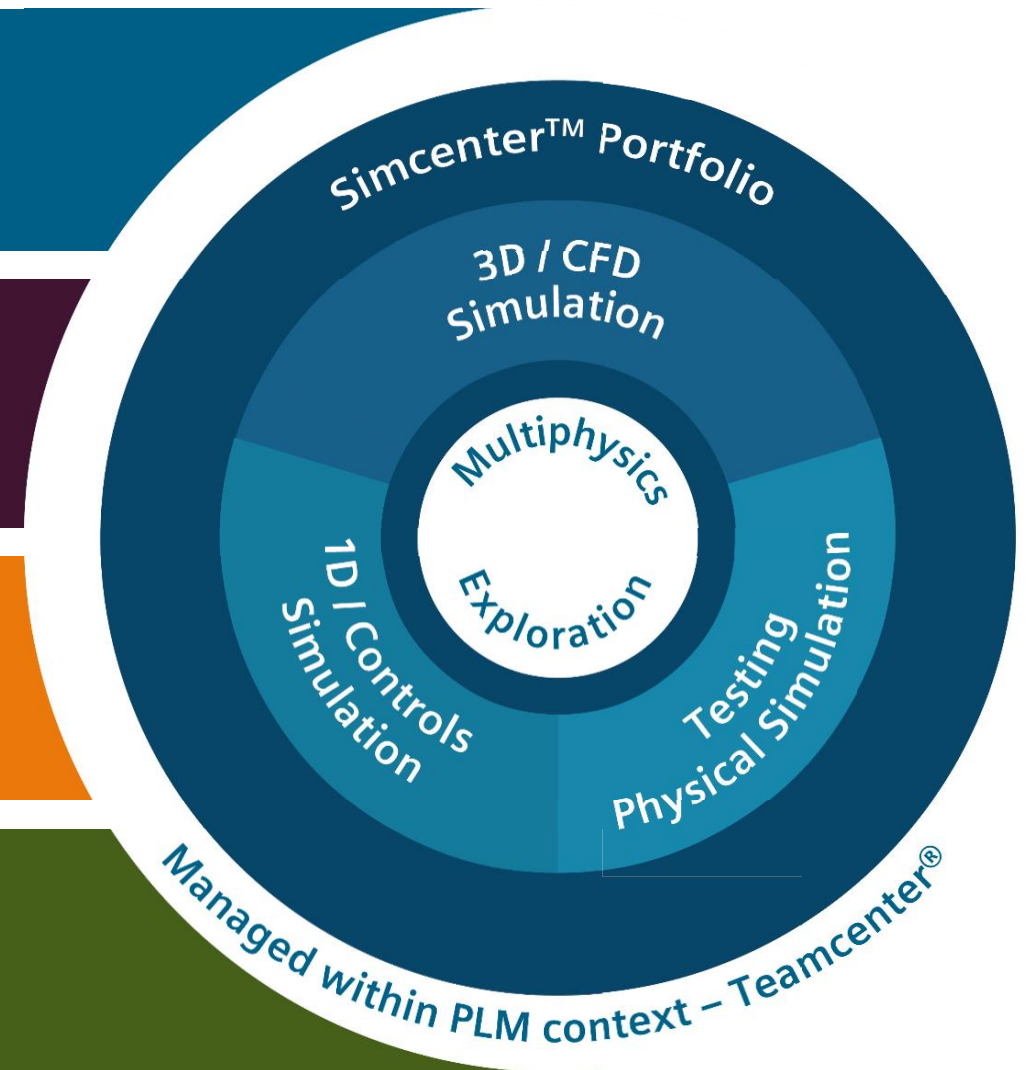
New powertrain concepts



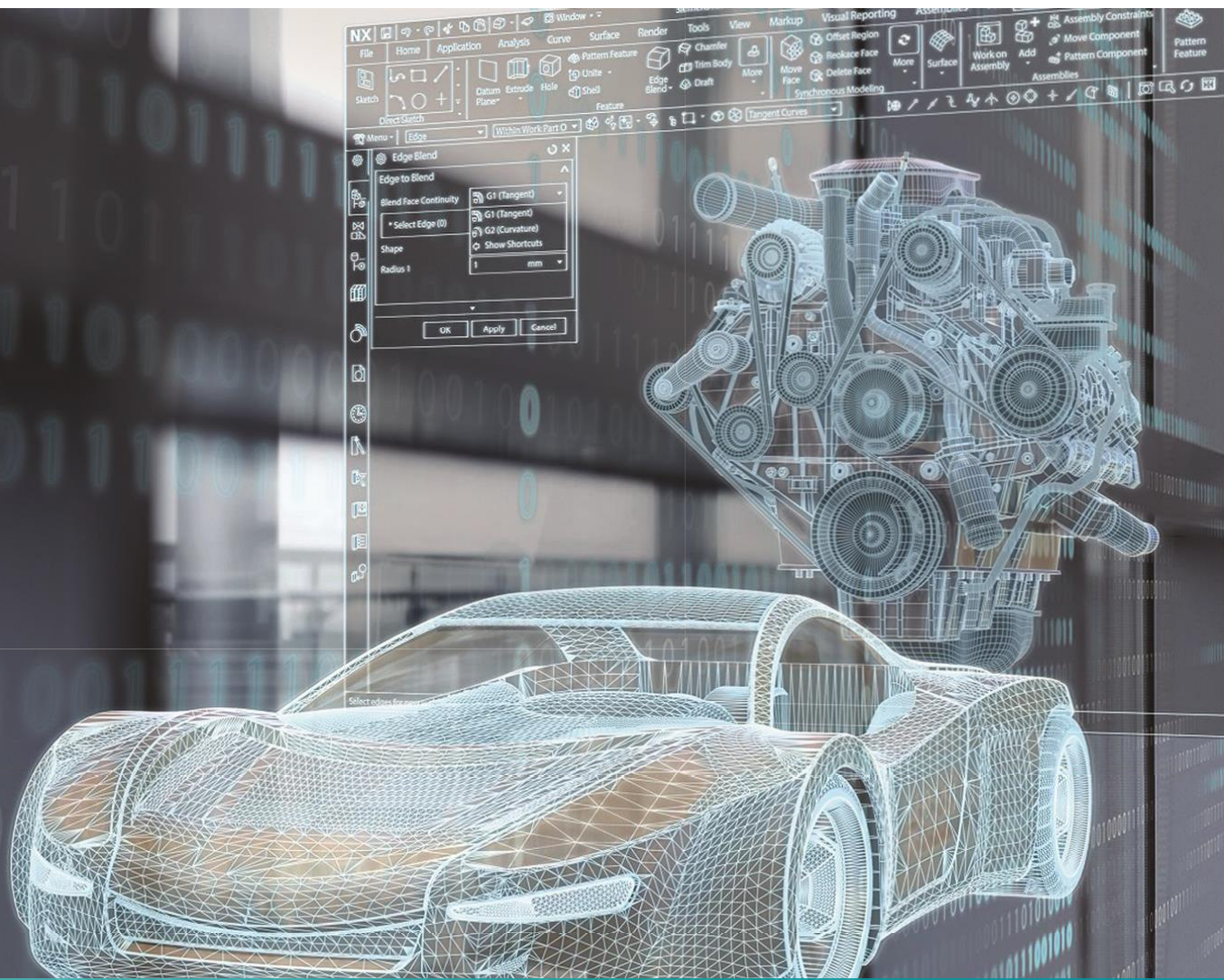
Lightweight structures



Increase vehicle performance



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