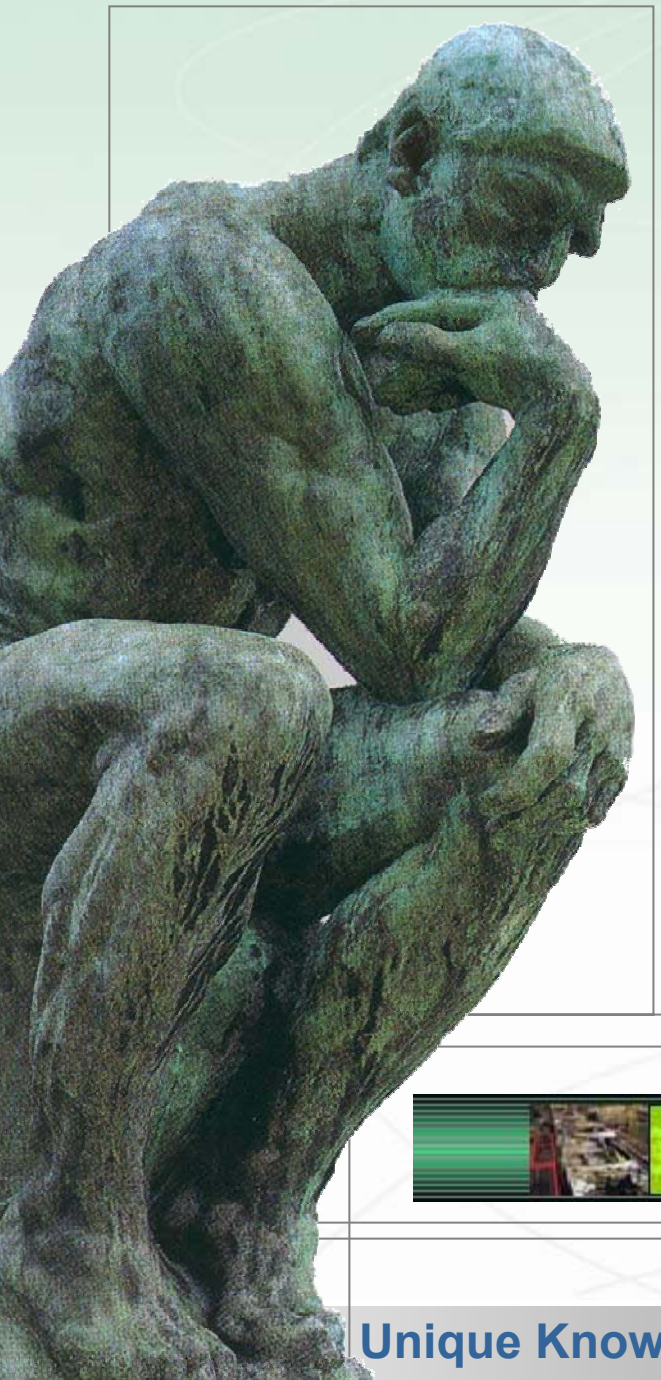


dufournier TECHNOLOGIES

Tyre Monitoring System

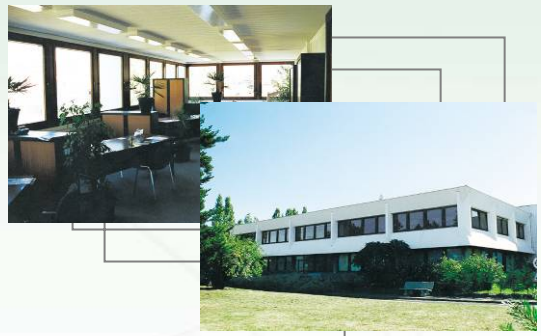
&

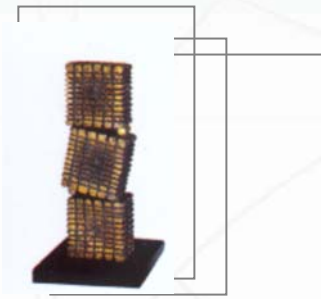
Wear Monitoring System

Presentation

The Company

- DUFOURNIER TECHNOLOGIES is a company organized around a team of experts in:
  - Tyre-suspension and vehicle dynamics,
  - Automotive Electronics and measurement,
  - Model and simulation.





1999 SIEMENS Automobile Electronics Trophy

The Company has been founded by Arnaud Dufournier in 1999.

It is located in France near Clermont-Ferrand.

Technical Services

The services offered by DUFOURNIER Technologies are based on a unique know-how:

- The knowledge of the tyre internal functioning,
- The analysis of the tyre-suspension system based on objective criteria.

Advantages:

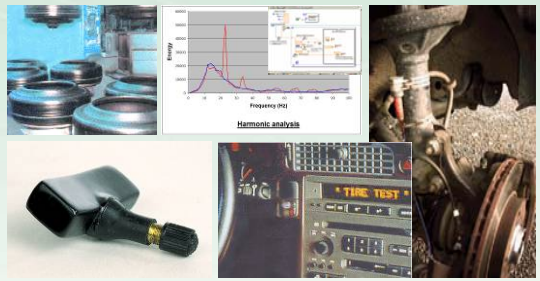
- ✓ **An analytical approach based on objective criteria.**
- ✓ **An underexploited domain to break away from the competition.**
- ✓ **A global vision and system-based analysis: chassis - suspensions - tyre - ground.**
- ✓ **A physical approach adapted to the needs of the customer.**

Technical Services

- The company operates in three complementary areas:

Dufournier Technologies

Product development:
Engineering of electronic systems associated with tyres.

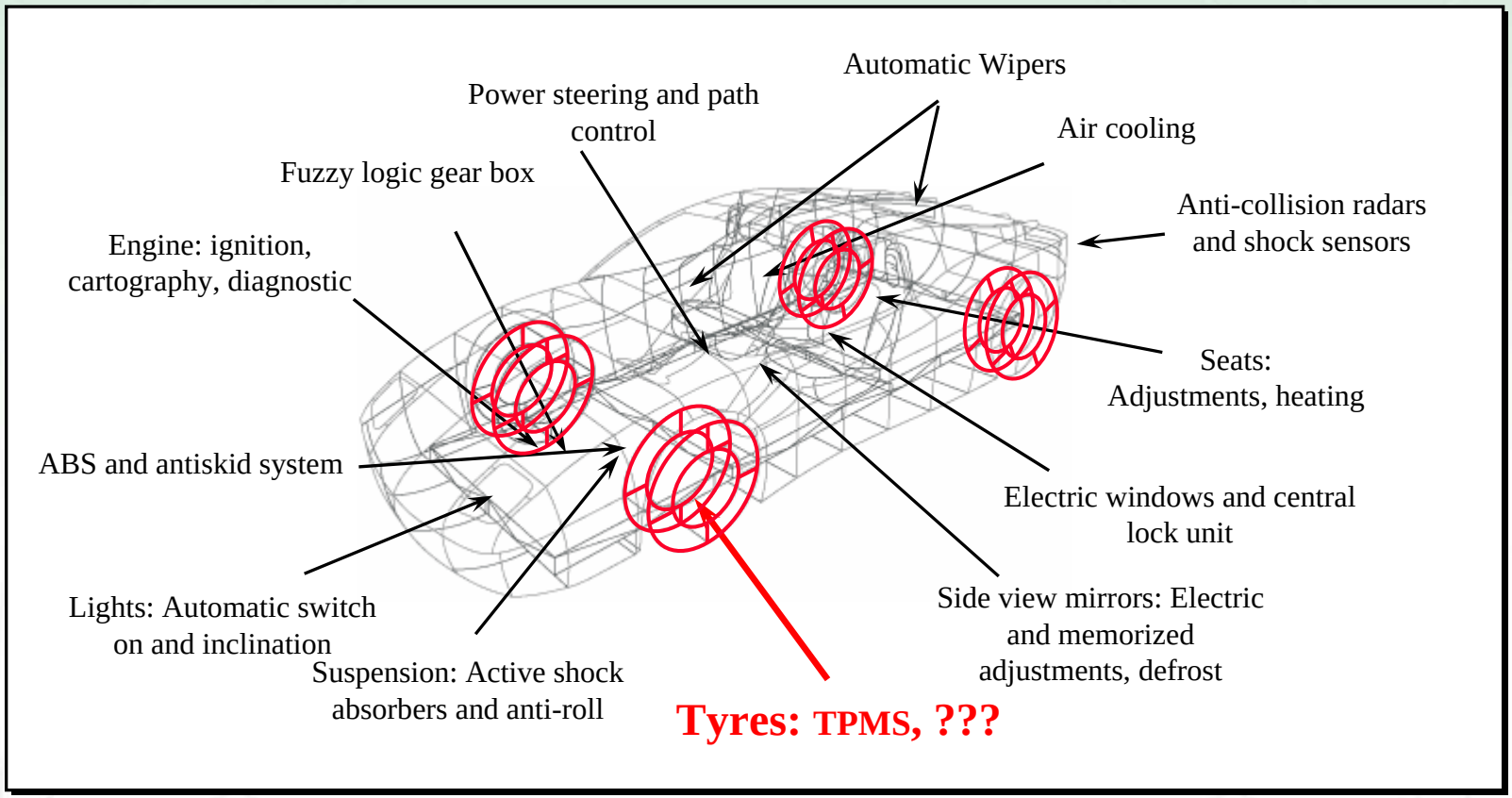


Measurements:
Engineering and development of tyre, suspension and body measurements

Tyre Suspension engineering:
Tyre-suspension system development, modelling & simulation and optimisation.

Preliminary Observation

- In nowadays' cars, everything is under control:



Preliminary Observation

With respect to the tyre:

TPMS monitors the internal air pressure and temperature

Nevertheless

- **Tyre's physical integrity is absolutely not monitored**

a damaged tyre (road-hazard, cuts, off-road use…) is not detected by any system in the vehicle.

- **Tyre's wear is not controlled**.

Preliminary Observation

With respect to the tyre:

TPMS monitors the internal air pressure and temperature

Nevertheless

- **Tyre's physical integrity is absolutely not monitored**

→ **Tyre Monitoring System**

- **Tyre's wear is not controlled.**

→ **Wear Monitoring System**

Tyre Monitoring System

Technical Presentation

Tyre Monitoring System TMS

- Objective of the TMS device

To monitor the physical integrity of tyres in use.

Inform the driver and the embedded systems.

Tyre Monitoring System TMS

- Technical statement

From a mechanical point of view, tyre deficiencies come from:

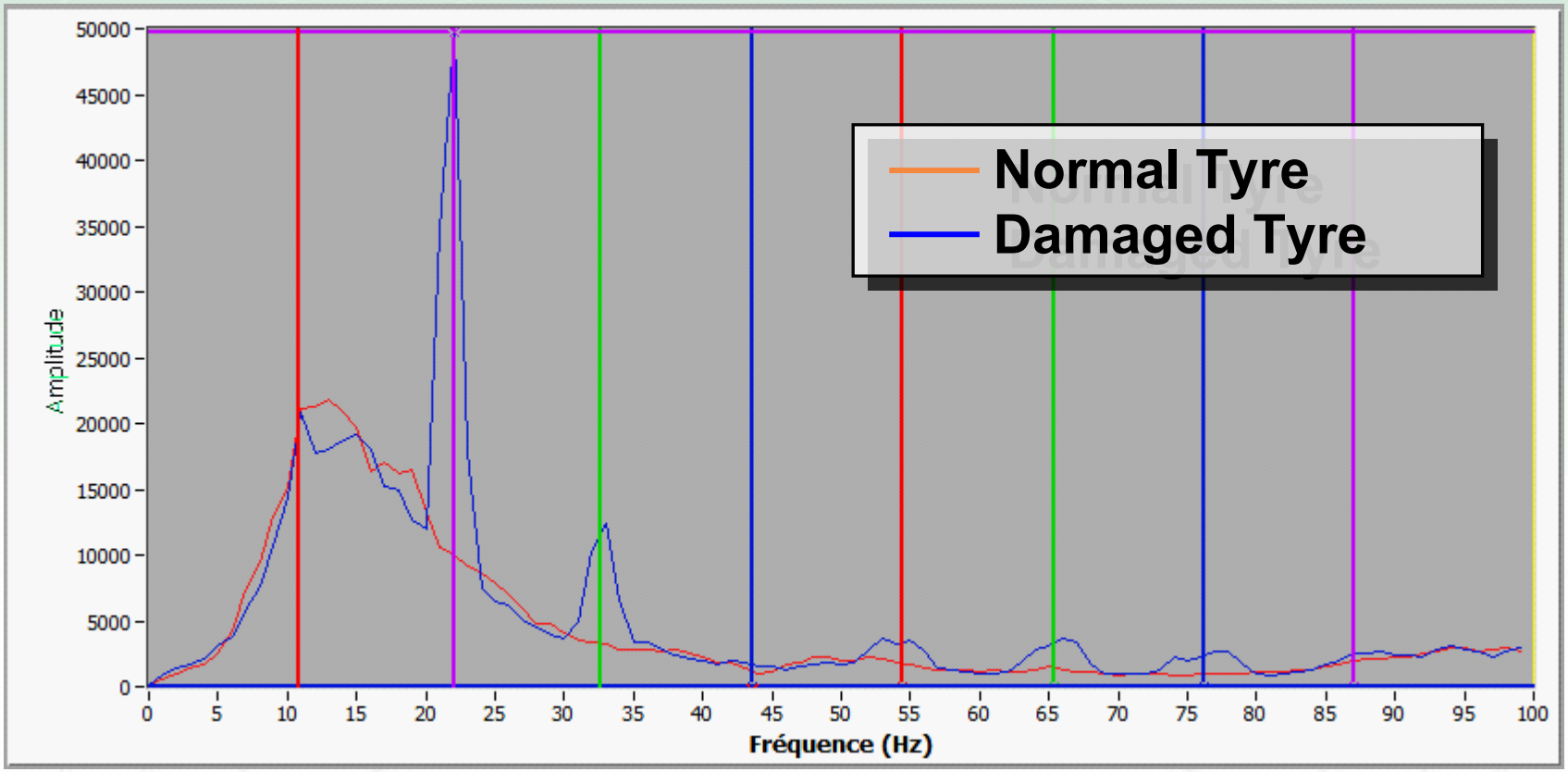
- A separation of the tread or plies
- Or an accidental weakness of the tyre structure (bulge, carcass ply deformity).

TMS : Principle

These deficiencies lead to a local change of the dynamic radius.

This generates a specific accelerometric signature.

TMS : Principle



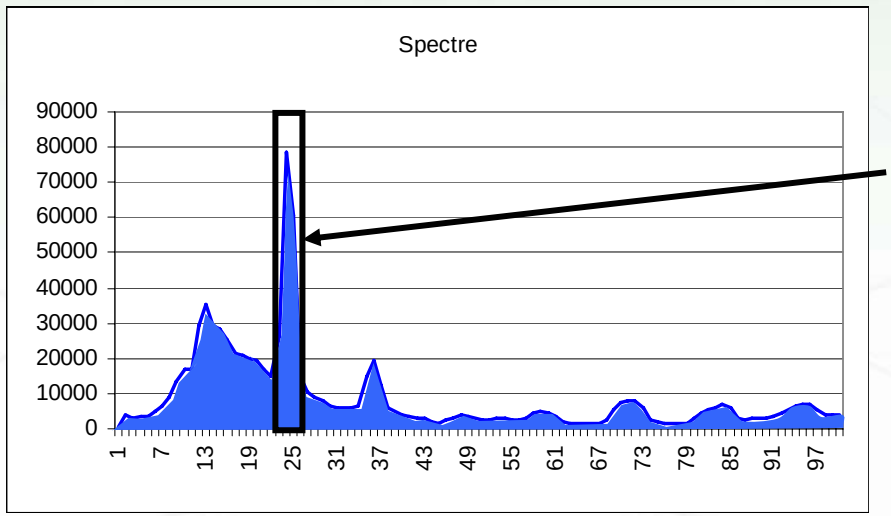
TMS : Technological approach

Extraction of basic information

V(t) → Speed

Γ(t) → Hub acceleration

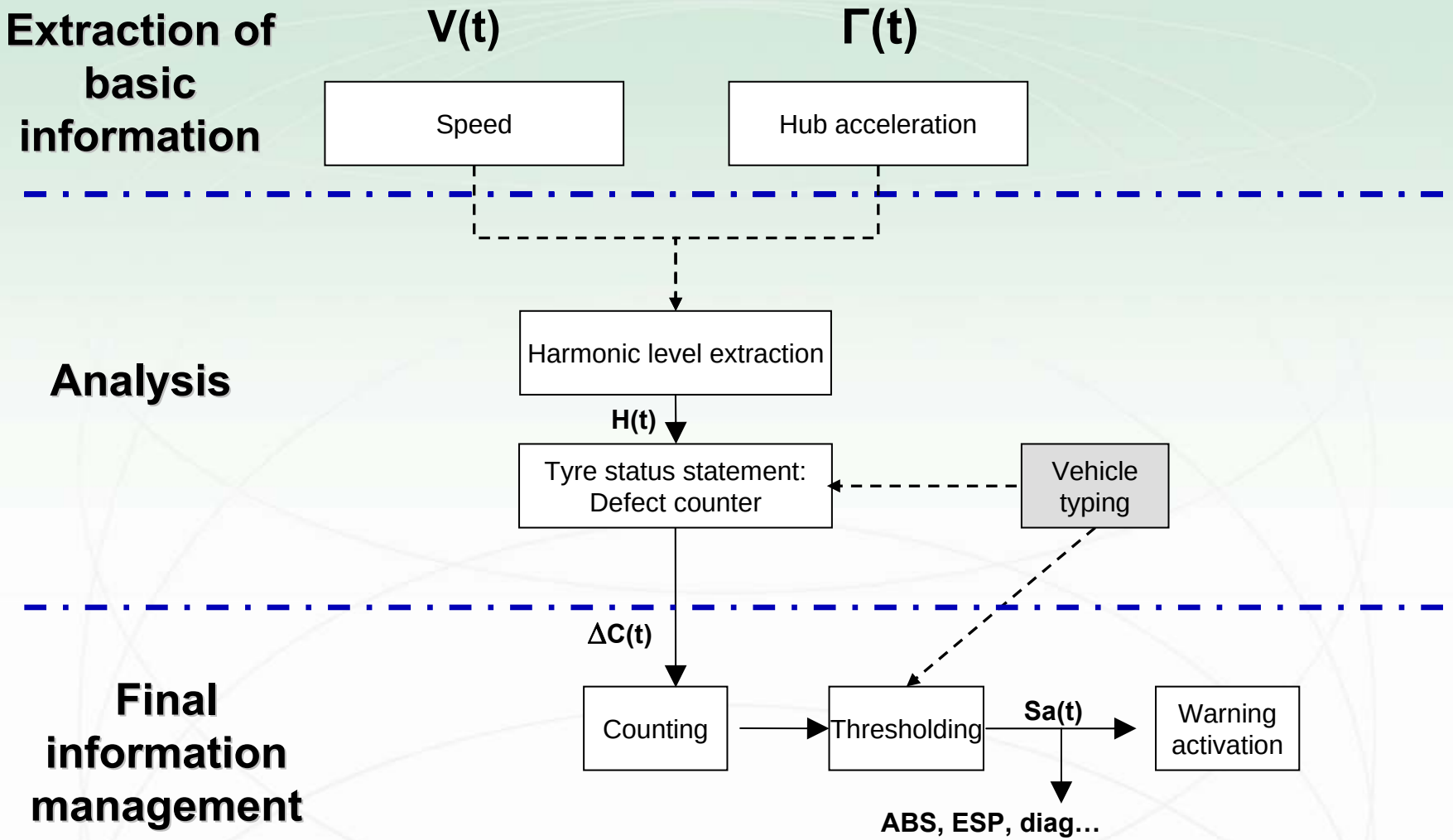
Analysis



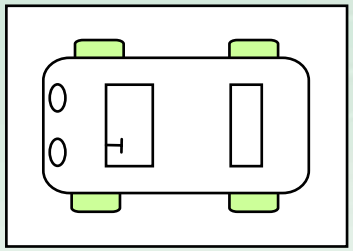
Harmonic extraction

Of course, in the true device, harmonic extraction doesn't use spectrum, but correlation between speed and hub acceleration which highly reduces processing.

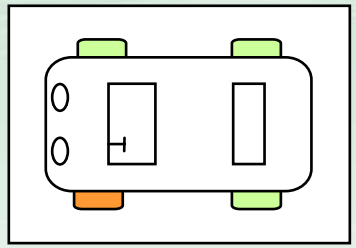
TMS : Technological approach



TMS : Technological approach



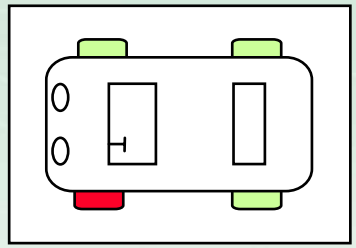
Normal State



Deficiency detected

Does not justify an immediate stop of the vehicle, but:

- **Use restriction: speed < 90 Km/h**
- **Have the tyre looked at by an expert**



Major Deficiency

Serious danger for vehicle occupants and the load

- **Immediate stop of the vehicle and tyre substitution.**

Wear Monitoring System

Technical Presentation

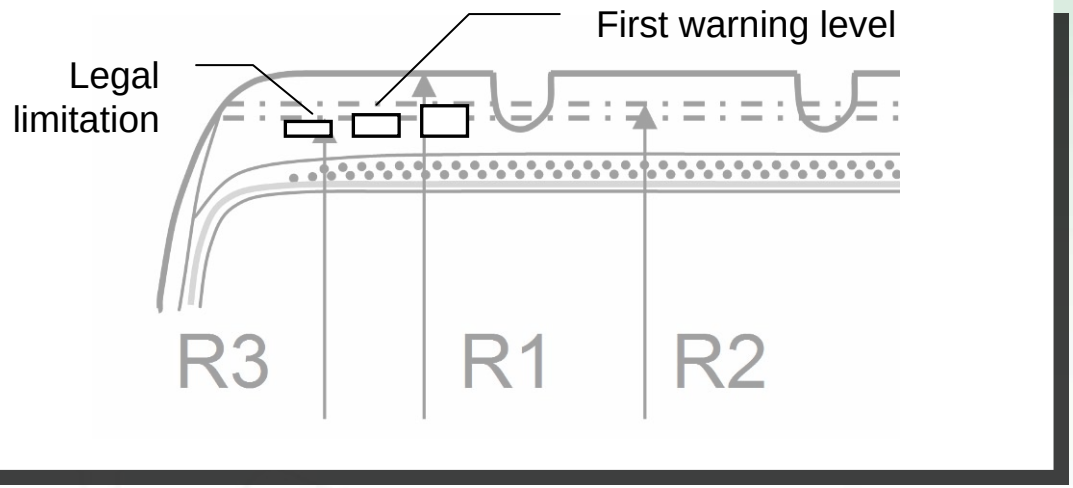
Wear Monitoring System WMS

- Objective of the WMS device

To monitor the wear level of tyres in use.
Inform the driver and the embedded systems.
Evaluate tyre's autonomy.

WMS : Principle

- Wear level



Tread wear indicators

1st level codification **A**

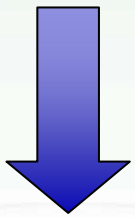
2nd level codification **B**

3rd level codification **C**

Indicators appear when the corresponding wear level is reached.
Levels are identified with respect to their codifications.

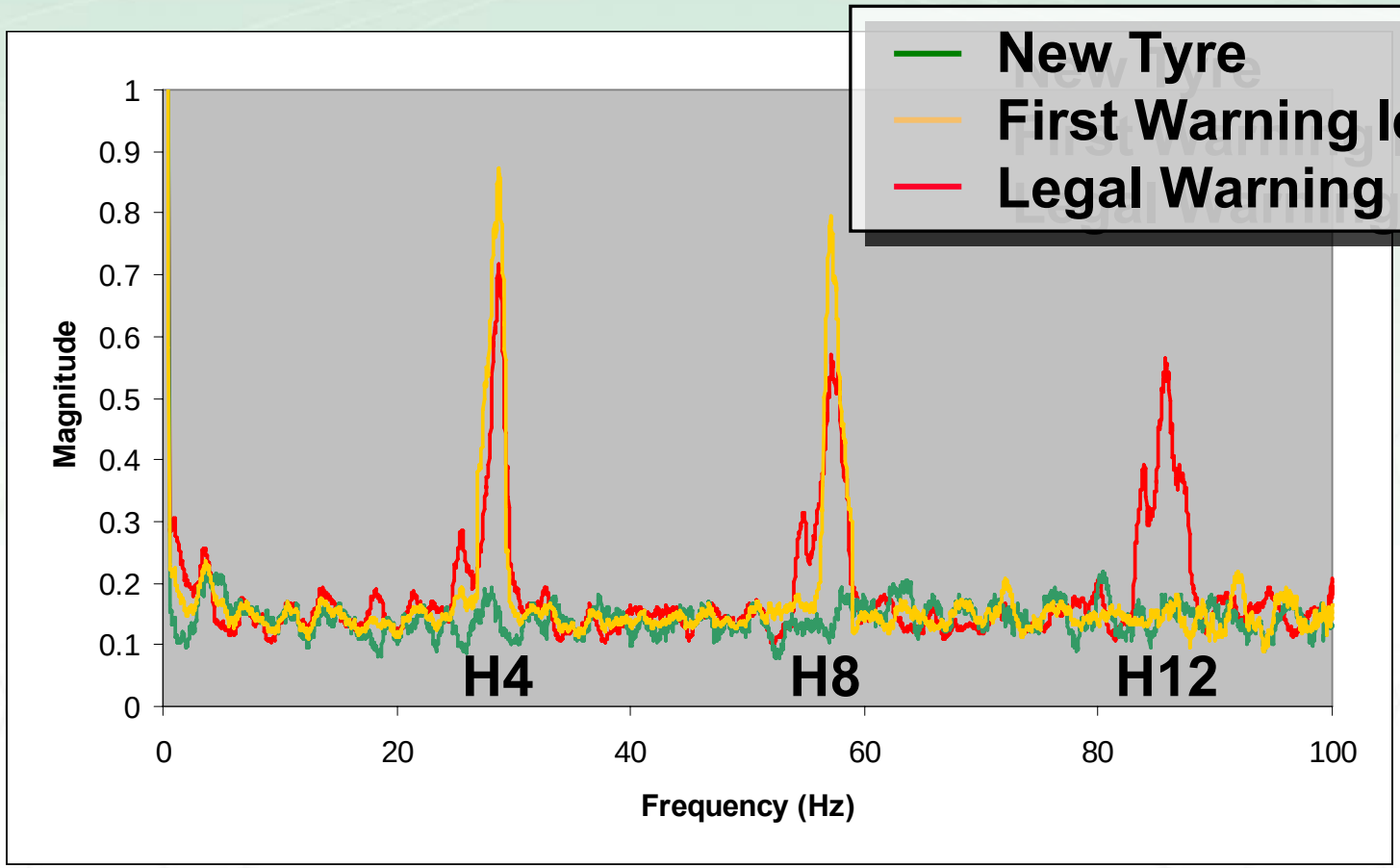
WMS : Principle

Tyre wear leads to appearance of indicators.



This generates an optical specific multi-harmonic signature.

WMS : Principle



Of course, in the true device, harmonic extraction doesn't use spectrum, but correlation between speed and optical signal which highly reduces processing.

WMS : Principle

Wear indicators

Rubber profile or doping

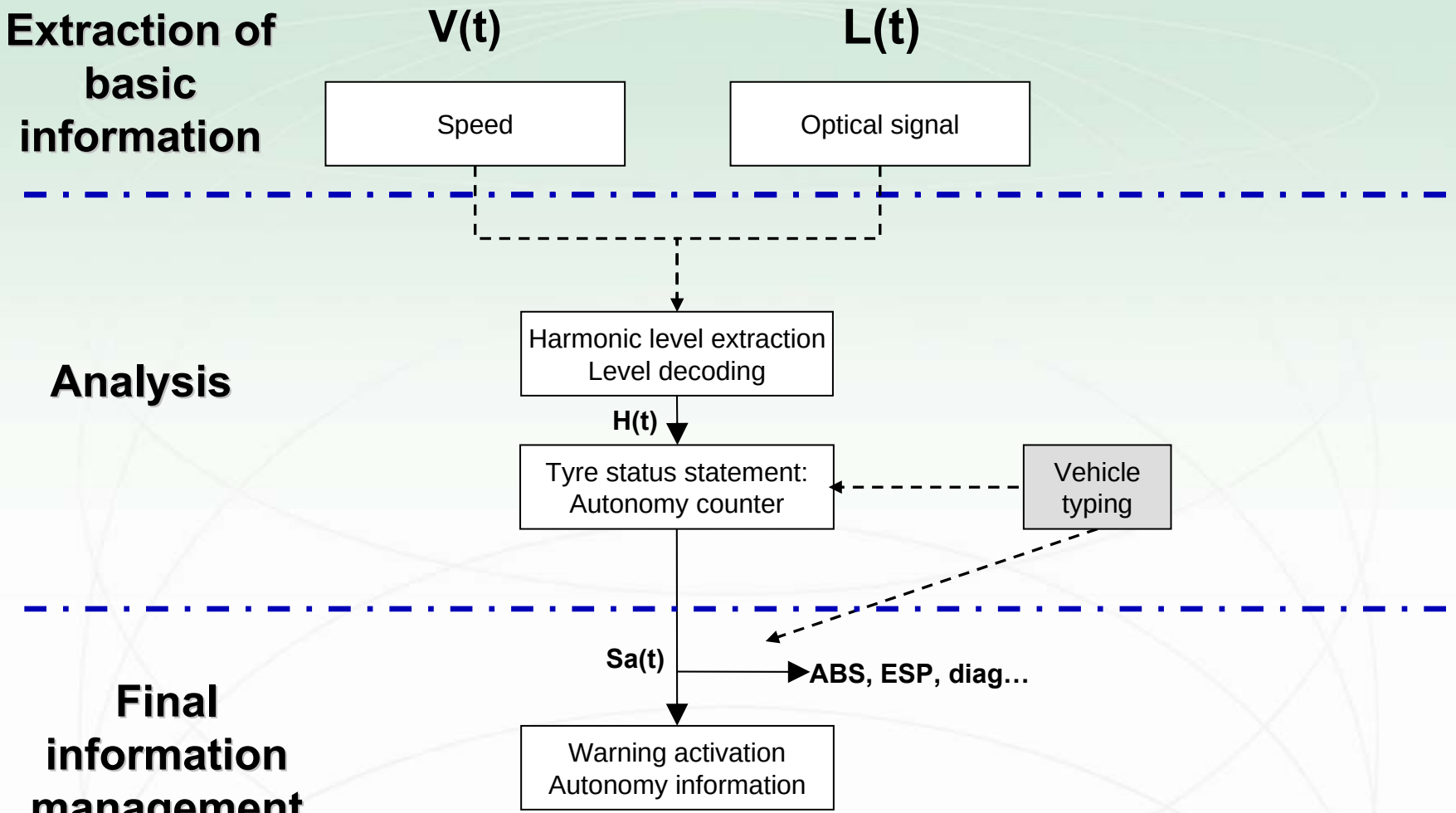
Sensors

Diodes

ECU

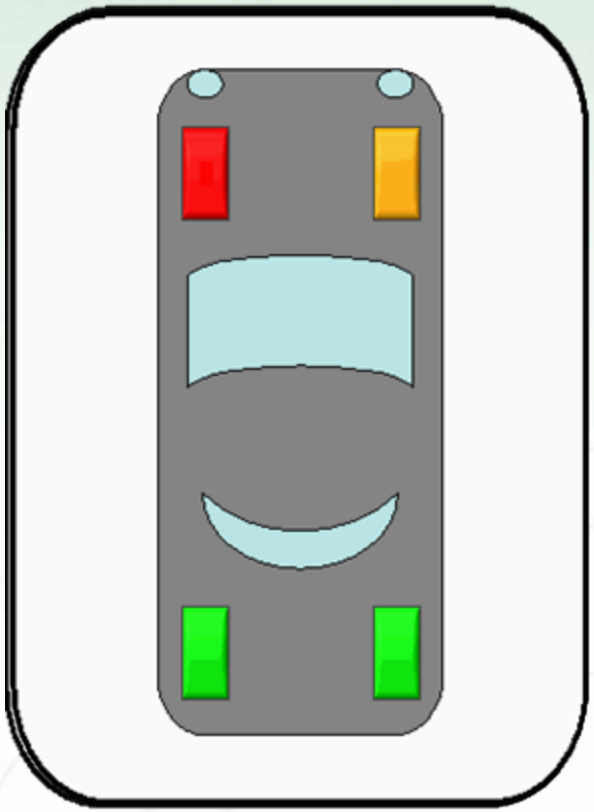
Preferably included in ABS Unit

WMS : Technological approach



WMS : Principle

Information management strategy



Autonomy (km):
Front Left : To be changed immediately
Front Right : To be changed soon
Rear Left : 17 586
Rear Right : 17 024

Tyre Monitoring System

&

Wear Monitoring System

Assets

TMS-WMS Assets

- Commercial advantages

  → Highly readable functions.

  Wear, damaged

  → Safety functions.

  Continuous evaluation of each tyre state.

  Improves ABS and ESP functions.

  → Essential complement for TPMS

  (complementary monitoring function: monitors the re-inflated tyre after under inflated use).

TMS-WMS Assets

- Phase 1 : TPMS

→ Air pressure is measured

- Phase 2 : TPMS + TMS + WMS

→ **Tyres are under control**

TMS-WMS Assets

- Technical-economical advantages

  - The higher the deficiency or the more critical the context is (higher speed), the faster the warning is.

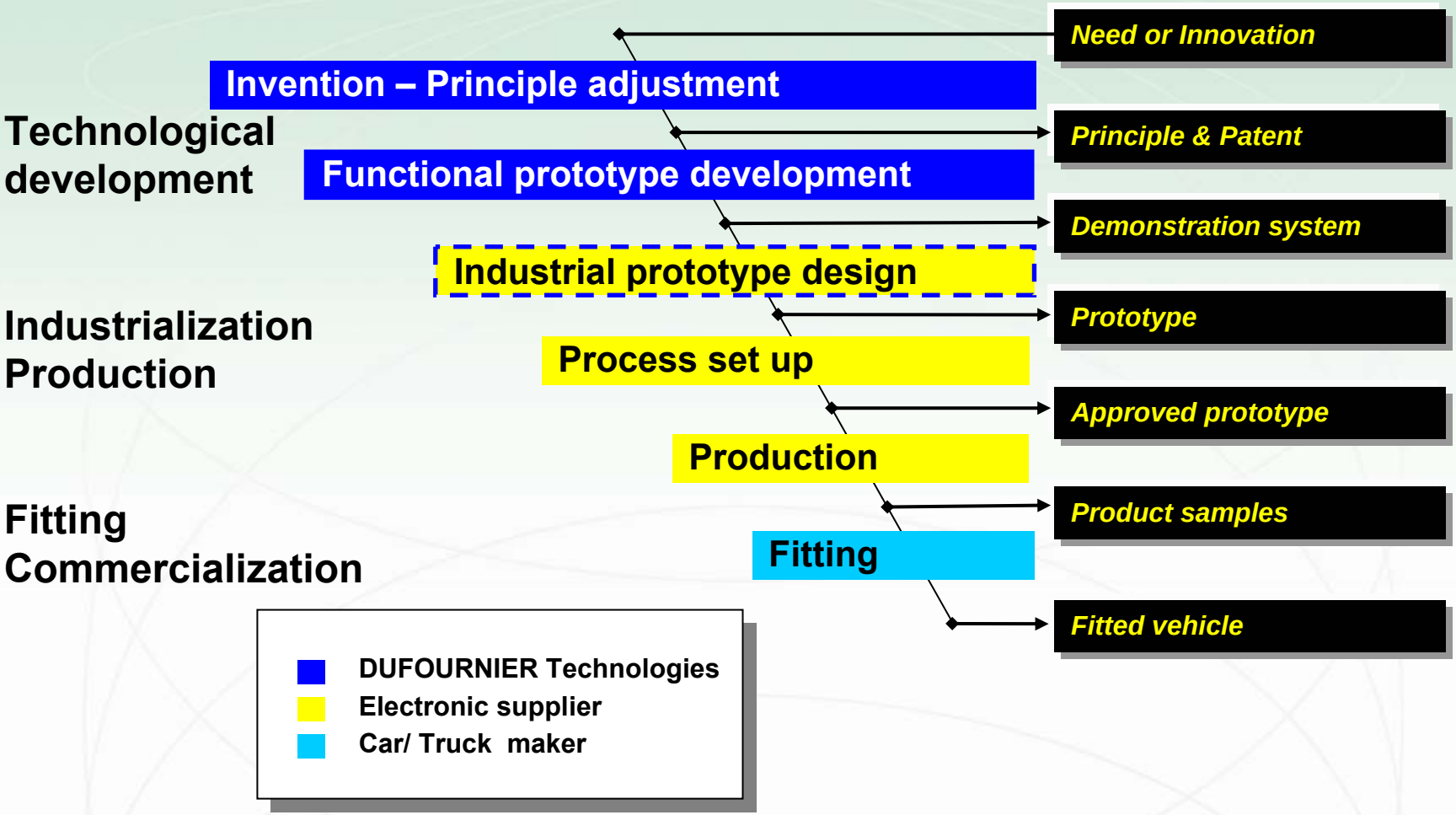
  - Easy integration with other functions (ABS, TPMS, diag…)

  - Requires only low cost sensors and small CPU: Shock sensors, diodes.

Market Introduction

- Applications
  - City cars
  - Minivan and family saloons
  - Luxury cars and GT
  - SUV
  - Commercial vehicles and Trucks

Technical and industrial positioning



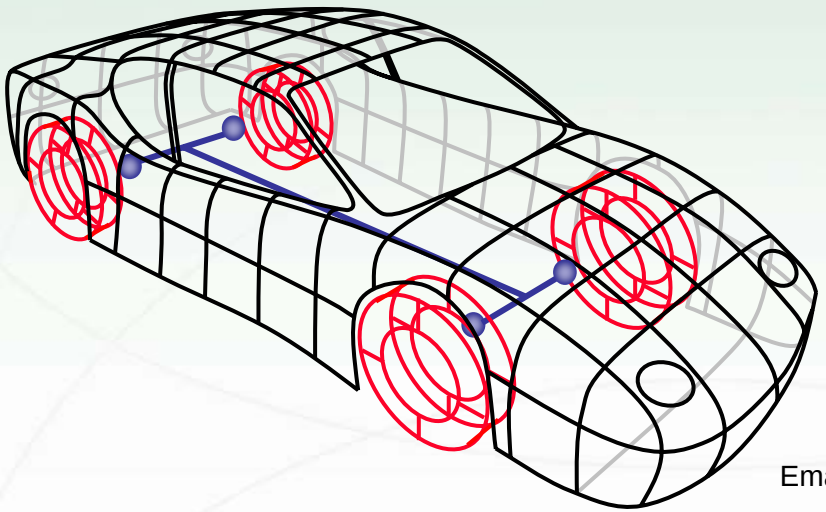
Conclusion

TMS & WMS offers :

- **S**ystems providing a visible safety service for the end customer.
- **U**nique development opportunity.
- **N**ext step in TPMS evolution.

An offensive innovation strategy to differentiate from competition.

TMS WMS





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Unique Know How - Physical Approach - Tyre Vision