Tools and Techniques for Ensuring Automotive EMC Performance and Reliability

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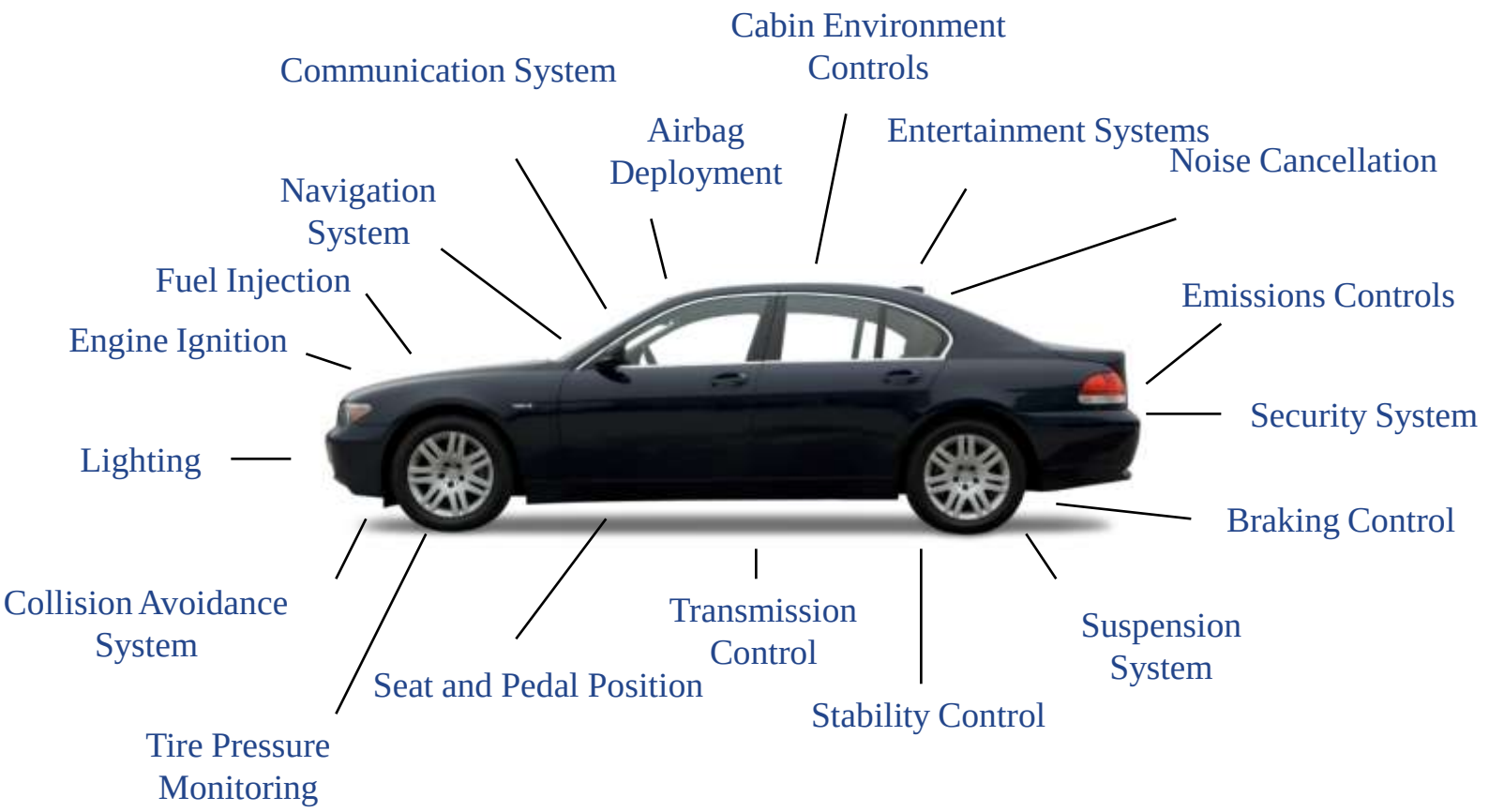
Automobiles are Complex Electronic Systems

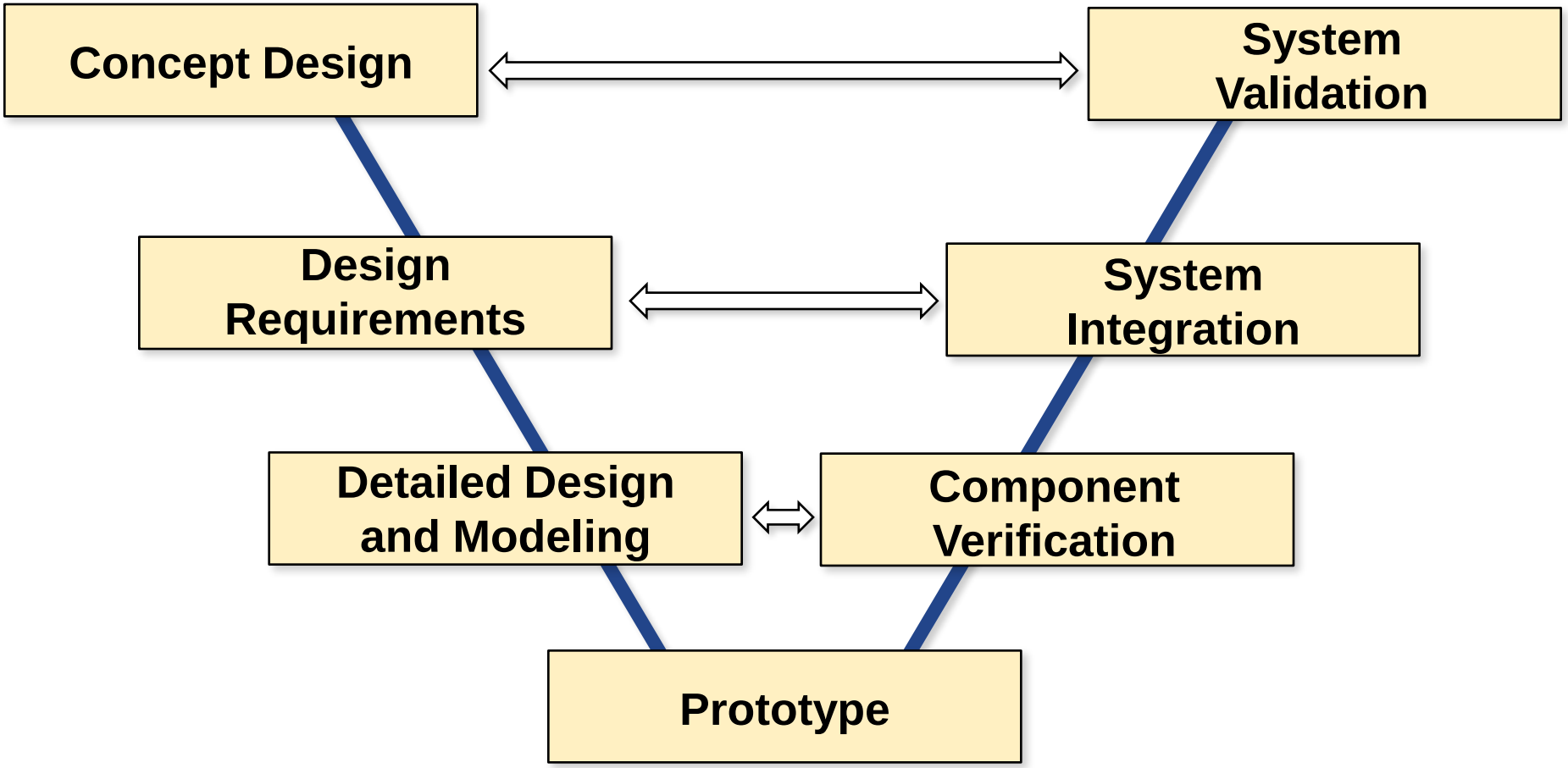


Automobiles are Complex Electronic Systems

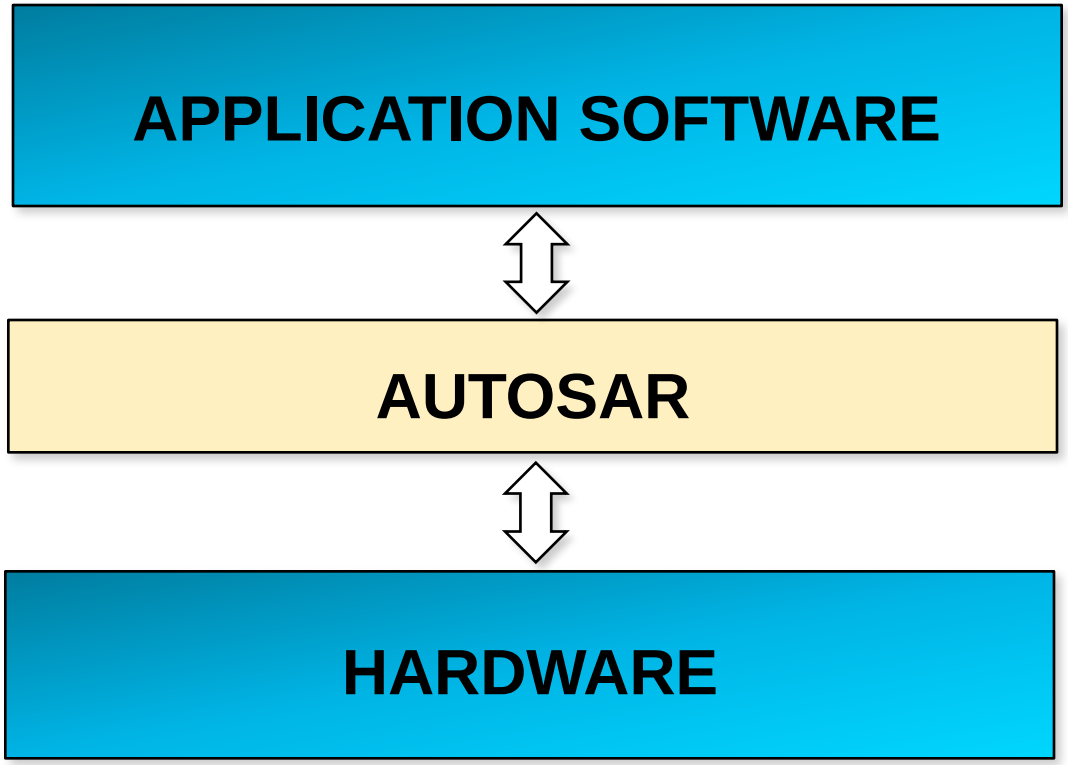
Current automotive electronics design and integration strategies are not sustainable.

Cars in the next decade will be very different from an electronics integration standpoint.

Product Development V-Model



AUTOSAR



Adaptive Cruise Control

Electronic Stability Control

Lighting Systems

…

A step in the right direction!

Cars in the future …

Cars in the future will have ONE reliable, low-cost, lightweight network that serves as the interface between every electronic sub-system in the vehicle.

- Less than 2 kilograms of wire harness
- Data from every sensor available to every system
- Secure, reliable high-speed communication
- Simple, open diagnostics
- Redundant, distributed processing
- Both wired and wireless communication

Cars in the future …

Cars in the future will distribute ONLY low-voltage digital signals and/or DC power to every electronic component.

- No PWM signals for power or control
- No analog signals
- At most 3 wires will be routed to any component
- Many components will require 1 or 0 wires
- Connectors will be small, reliable and low cost

Cars in the future …

Cars in the future will not generate strong electric or magnetic fields and will not be susceptible to these fields even though they generate and store significant amounts of electric energy.

- Balanced design and integrated control will eliminate the need to have wiring harnesses carrying strong, time-varying currents.
- Intelligent, computer aided layout will ensure that electronic systems do not generate and are not susceptible to electromagnetic interference.

Cars in the future …

Cars with intelligently designed electronic systems will be:

- Lighter
- More powerful
- More efficient
- Far more reliable.

Automotive Companies of the future …

The companies leading the development of truly integrated electronic systems will be the market leaders in the next decade.

- Market leaders in the electronics industry are the innovators, not the adopters.
- Simply adopting the latest, greatest electronic subsystems and **tacking them on** to existing automotive platforms is a strategy that will not succeed.

Automotive EMC Today

Automotive EMC Standards Organizations

- International Electrotechnical Commission (IEC)
  - CISPR, TC77
- International Organization for Standards (IOS)
  - TC22, SC3, WG3
- Society of Automotive Engineers (SAE)
  - Surface Vehicle EMC Standards Committee

Automotive EMC Standards

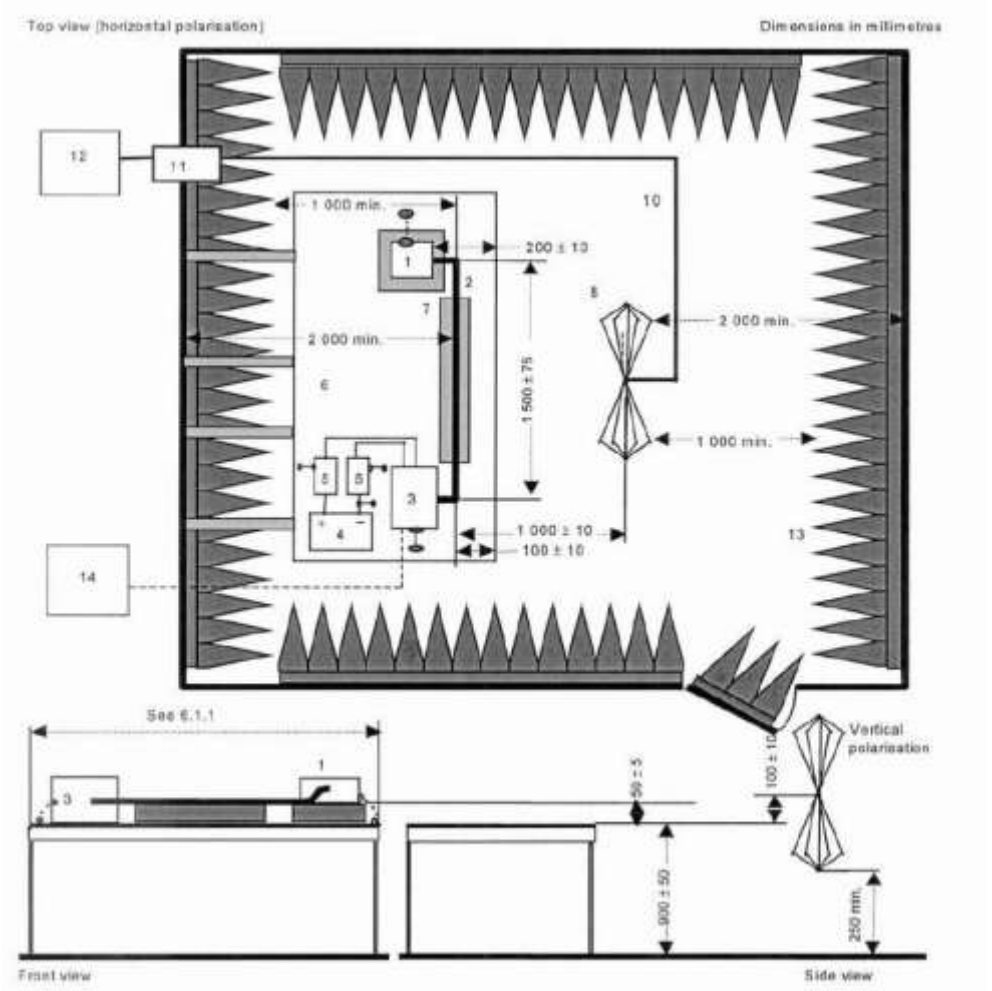
Emissions Tests:

- CISPR 12
  - Vehicle Level Emissions
- CISPR 25
  - Component Level Emissions
- SAE J551-5
  - 9 kHz – 30 MHz, Broadband
- IEC 61967
  - Integrated Circuit Emissions

Automotive EMC Standards

CISPR 25 ALSE

(Absorber Lined Shielded Environment)



Automotive EMC Standards

Vehicle Immunity Tests:

- ISO 11451-2, SAE J551-11
  - Radiated Field Immunity
- ISO 11451-3
  - On-Board Transmitter Susceptibility
- ISO 11451-4
  - Bulk Current Injection
- ISO 10606, SAE J551-15, IEC 61000-4-2
  - Electrostatic Discharge

Automotive EMC Standards

Vehicle Immunity Tests:

- SAE J551-16
  - Reverberation Chamber Immunity
- SAE J551-17
  - Power Line Disturbances
- ISO 11452-8
  - Magnetic Field Immunity
- ISO 10606, SAE J551-15, IEC 61000-4-2
  - Electrostatic Discharge

Automotive EMC Standards

Component Immunity Tests:

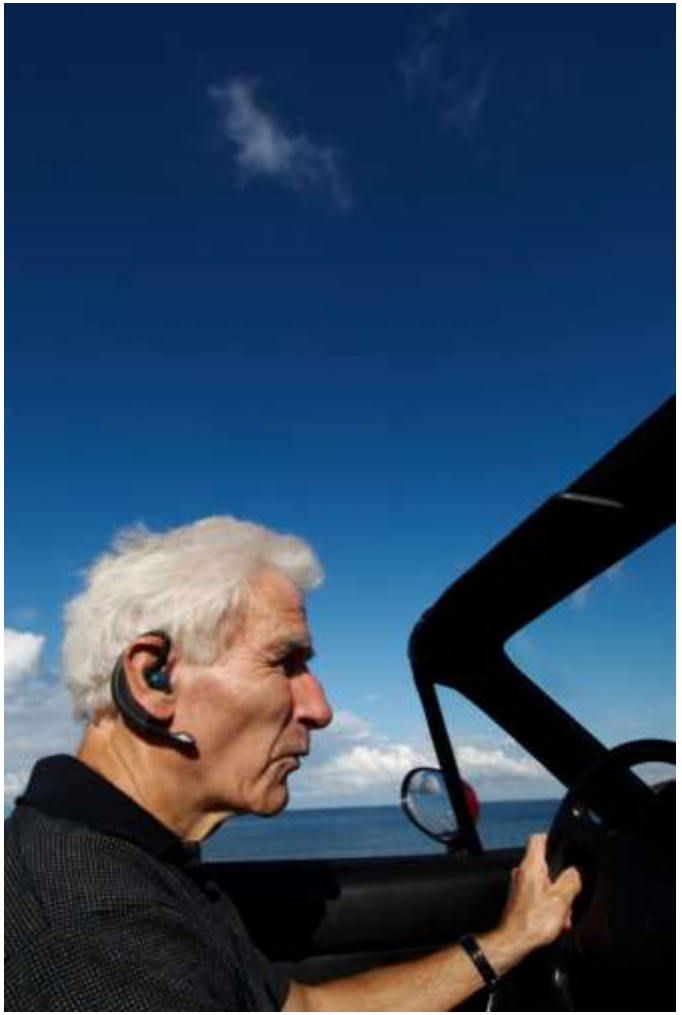
- ISO 11452-2
  - RF Immunity - ALSE
- ISO 11452-3
  - RF Immunity – TEM Cell
- ISO 11452-4
  - RF Immunity - BCI
- ISO 11452-5
  - RF Immunity - Stripline

Automotive EMC Standards

Component Immunity Tests:

- ISO 11452-7
  - Direct Injection
- ISO 11452-11 (Draft)
  - Reverberation Chamber
- ISO 7637-2,3
  - Transient Immunity
- ISO 10605
  - Electrostatic Discharge

New Automotive EMC Requirements



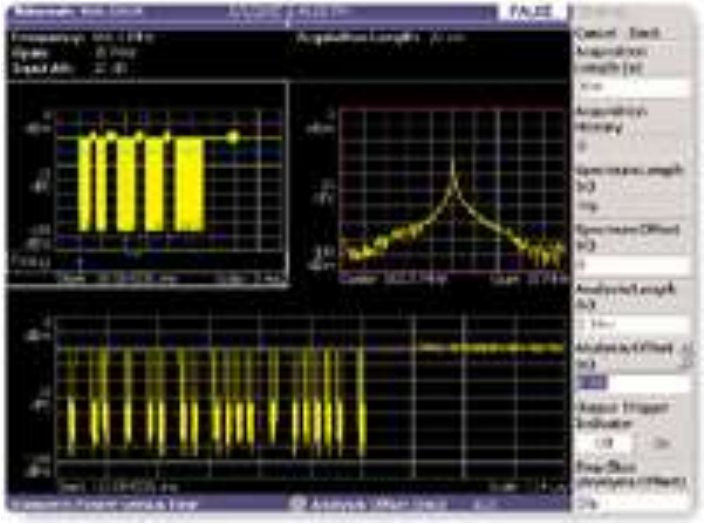
New Automotive EMC Requirements

Component-Level
EMC Testing

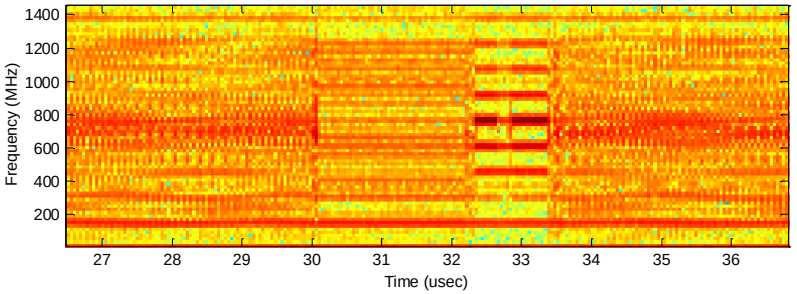
System-Level
EMC Performance

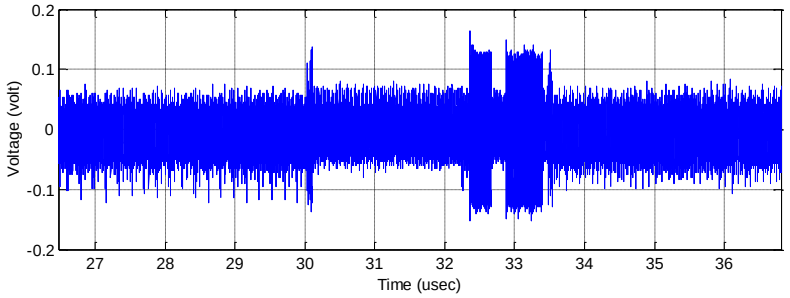
New Design Tools for Automotive EMC

Time/Frequency Domain Analyzers



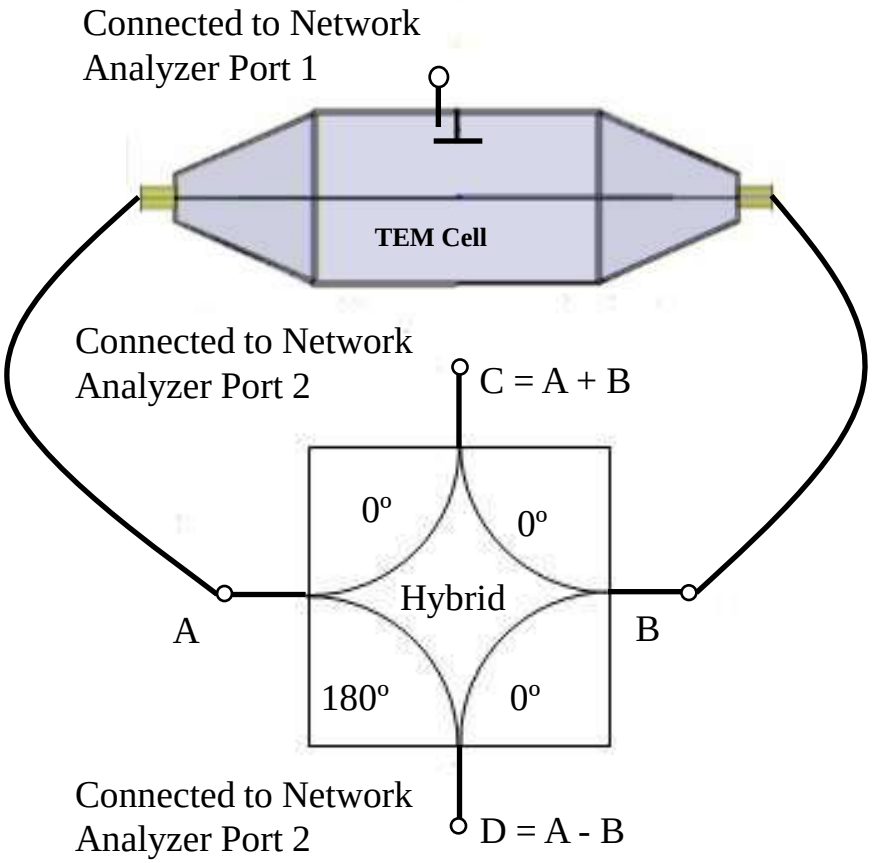
- Source Identification
- Source Characterization
- Narrow-Band Transient Capture



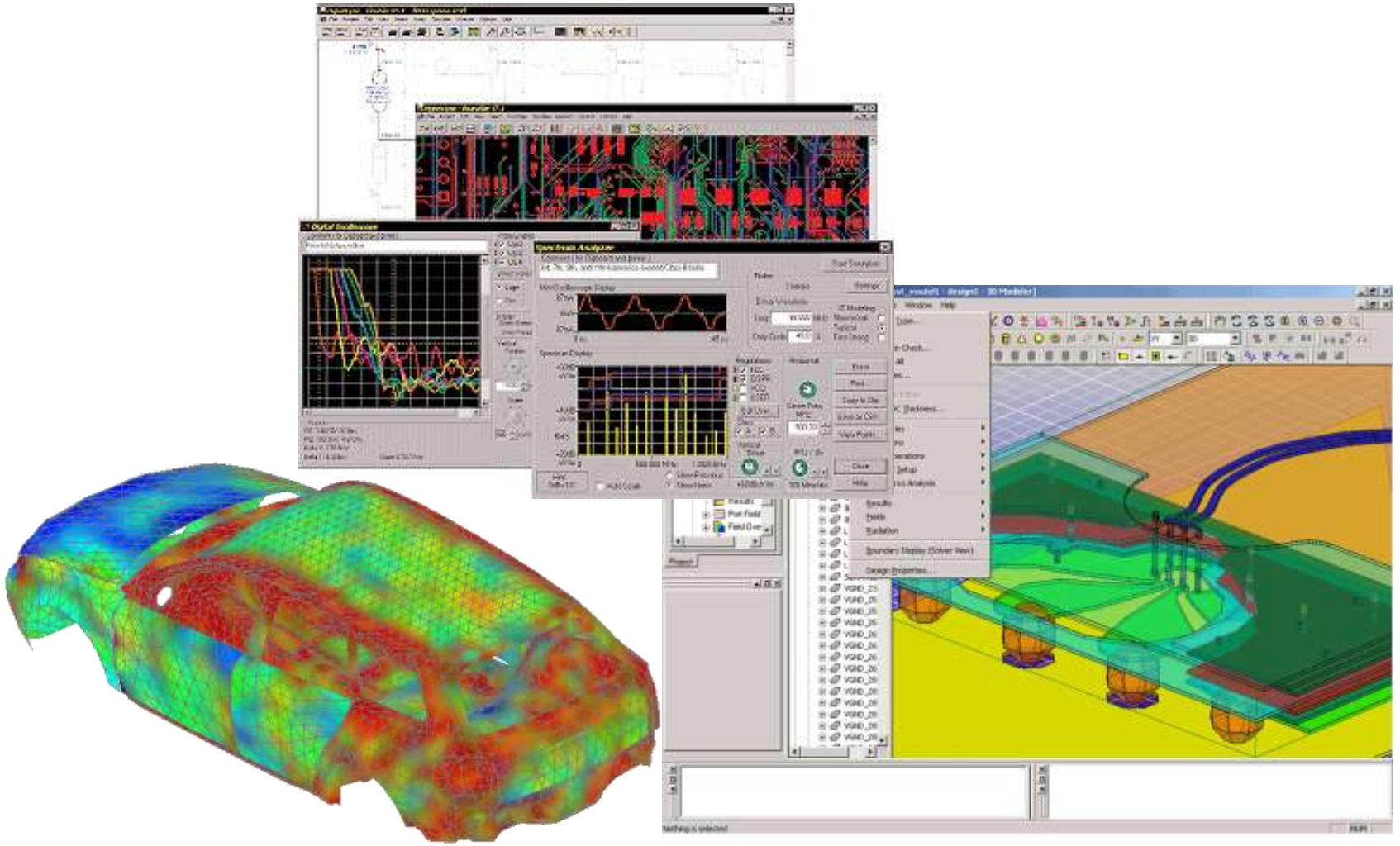


Component Testing for System Modeling

- Hybrid TEM-cell test to characterize electric and magnetic field coupling.
- Port characterization for conducted emissions modeling.
- Harness-free radiated emissions testing.

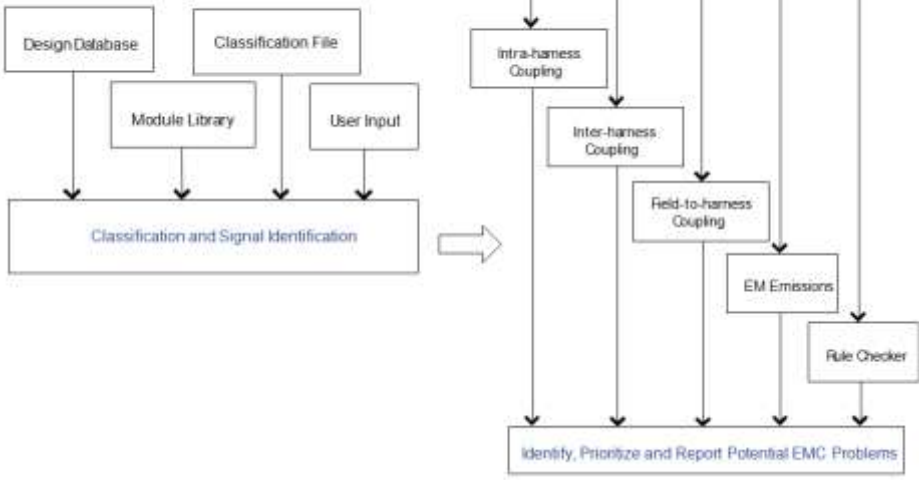


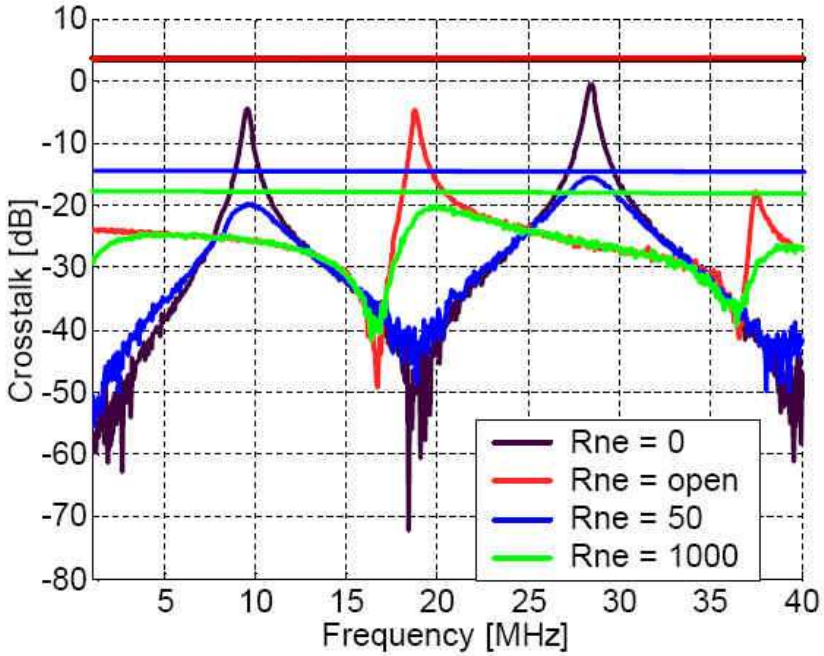
Numerical Electromagnetic Modeling Tools



Expert System Tools

- Reviews existing automobile specifications in a database.
- Looks for possible EMC problems
- Evaluates potential problems (likely worst case)





EMC Design Rule Checkers

Scan an automotive design looking for design rule violations.

- ⇧ Easier to understand what the software is doing
- ⇧ Easier to use

- ⇩ Few design rules apply in all cases
- ⇩ Can’t design a compliant automobiles with design rules

Final Thoughts

- Automobiles are complex electromagnetic environments
- Automotive EMC is a growing challenge / opportunity
- Today's cars are 4-wheel vehicles with dozens of computer systems
- Tomorrow's cars will be computer systems with 4 wheels
- **This is a great time to be an automotive electronics engineer!**