

# ICEM (IC Emission Modelling)

## Current Status & Results from various R+D projects



**ZUKEN**

**Ralf Brüning**

*Zuken EMC Technology Center*

**the engineering consulting company**



# Goal of this Presentation

---

To give a brief overview on the ICEM (IC Emission Modelling) progress which has been reached with the aid of various EU funded MEDEA projects in the last couple of years.

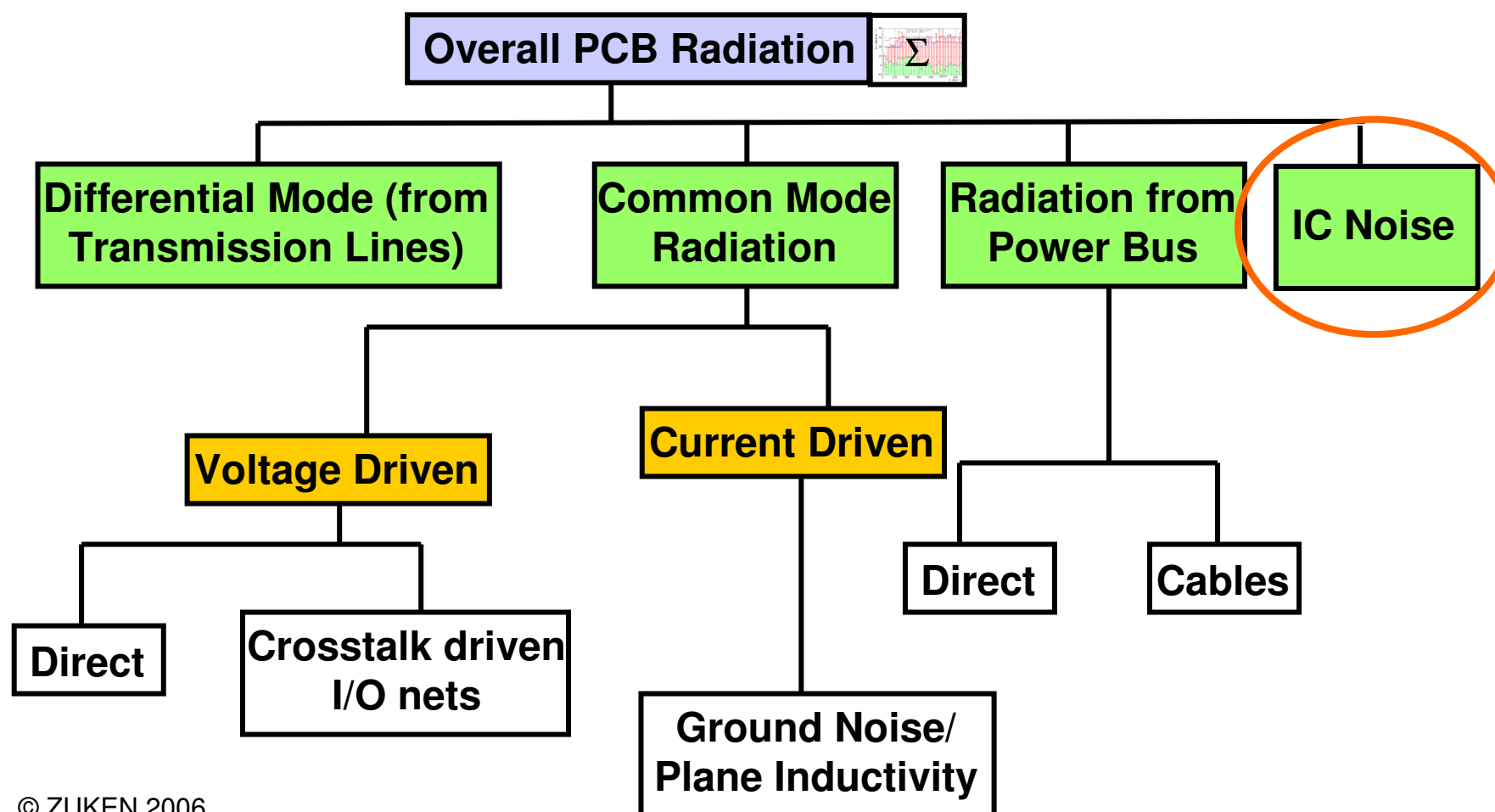
Some of the pictures are borrowed from Etienne Sicard (INSA).

## Preface:

- IBIS models represent voltage versus time (edges) or voltage versus current (clamps)
- EMC needs information on current versus time

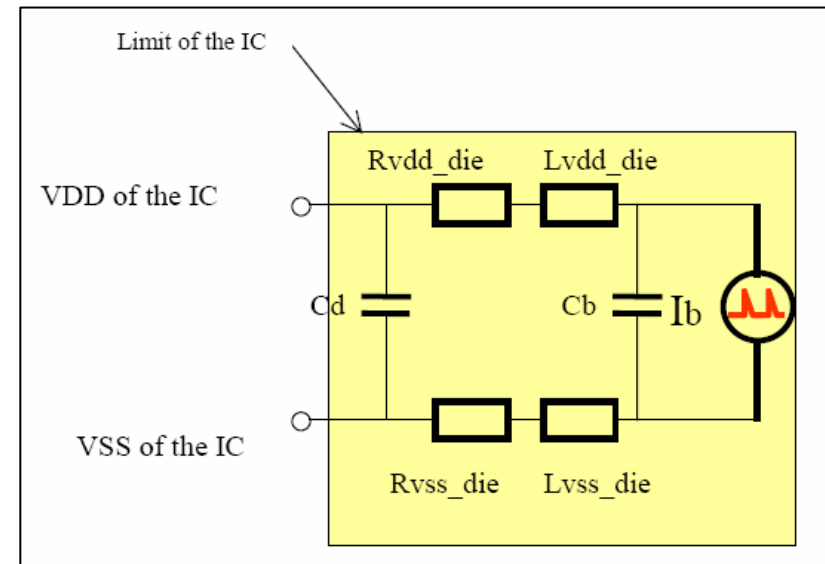
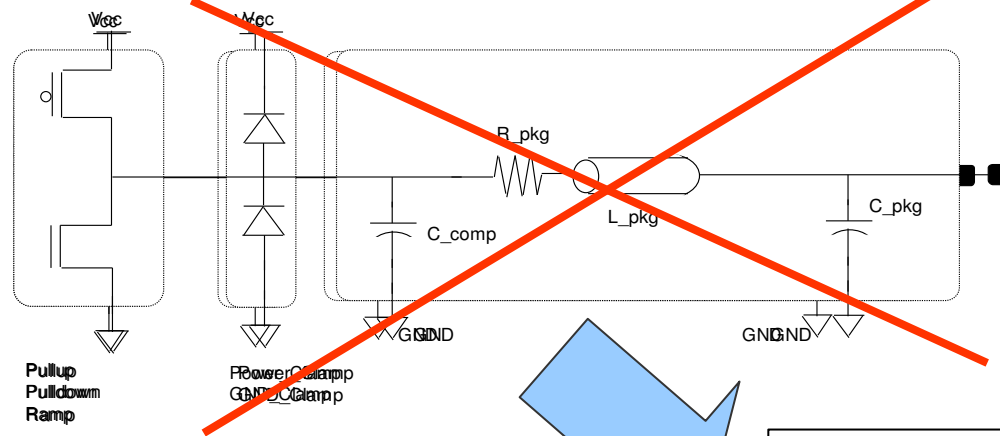
# Signal Emissions/EMI

- Emissions on PCB/HDI structures are coupled, conducted or radiated



# Models in EMC Context

## IBIS - Output - Model



## ICEM Model

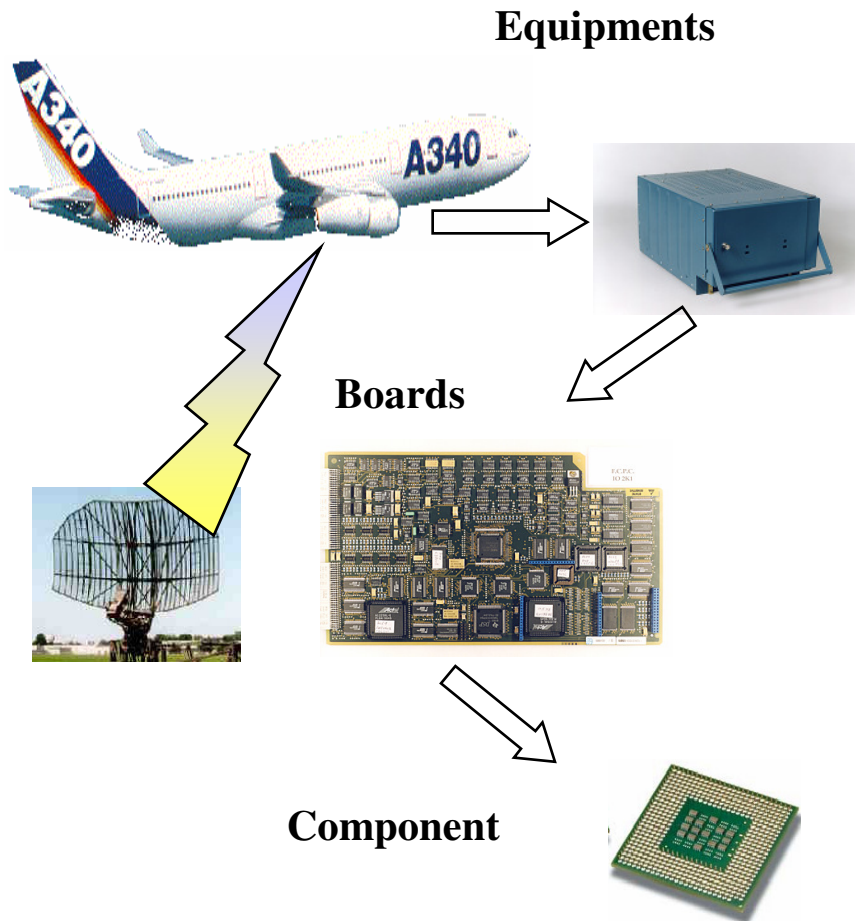


# IC Emission Modelling – required ?

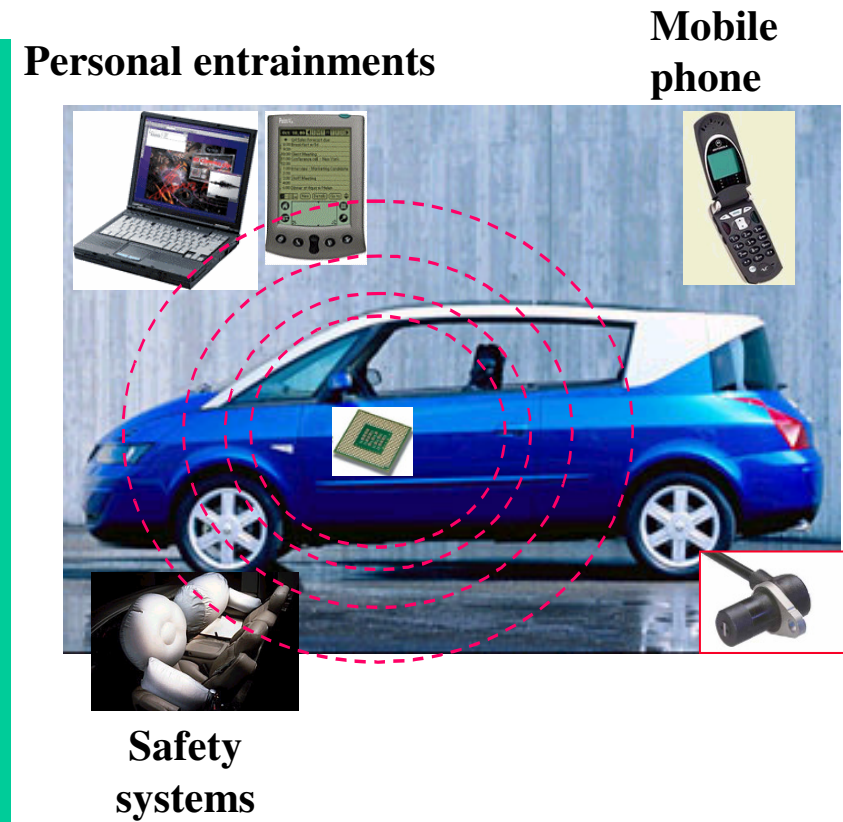
- IC emission modelling has been initiated and driven by mission critical electronic suppliers (aerospace, military)
- In the last 18 month there is a fast increasing demand from automotive electronics due to the higher sensibility of various electronic systems for common mode noise (i.e. widespreading of microcontrollers)
- EMC behaviour becomes for some applications part of buying/selecting criteria
  - ⇒ Infineon has committet to provide ICEM (alike) informations for further microcontrollers (Tricore and followers)
  - ⇒ ICEM will become subject of further EU R+D projects as well

# Driving Force: Automotive+Aerospace

## Susceptibility

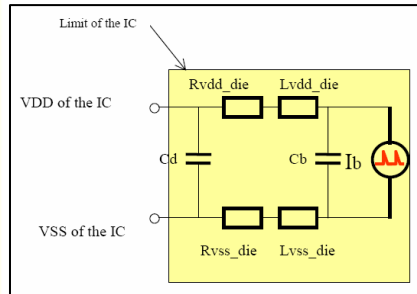


## Emission





# Content of an ICEM Model



$I_b$	Current source. Unit: Ampere Description: piece-wise-linear	Main source of parasitic emission considered in the model is the current source $I_b$ . The current shape may consist either of the time-domain description of the current versus time or as an equivalent triangular waveform. Typical values for $I_b$ are several mA, up to 1A for the amplitude, 0.5 to 5ns for duration, and 500ps to 50ns for the period.
$C_d$	Decoupling capacitance. Unit: Farad Description: discrete C	On-chip decoupling capacitance between VDD and VSS. $C_d$ is a physical coupling between the internal supply rails VDD (positive supply) and the ground rail VSS (0V supply). The origin of the capacitance $C_d$ is rail to rail or junction capacitance. Typical value ranges from 100pF (very small lcs) up to 20nF (0.18 $\mu$ m System-on-chip).
$L_{vdd\_die},$ $L_{vss\_die}$	Serial internal inductance. Unit: Henry Description: discrete L	The serial inductance $L_{vdd\_die}$ , $L_{vss\_die}$ , in serial with the local block capacitance $C_b$ creates a high frequency resonance effect. Typical value ranges from 0.1nH (very short connection to supply) up to 10nH (long connection).
$R_{vdd\_die},$	Serial internal	The serial resistance of the supply network models the path
$R_{vss\_die}$	resistance. Unit: Ohm Description: discrete R	that connects the block supply to the main supply ring. Typical value for $R_{vdd}$ , $R_{vss}$ are 0.5 to 50 ohm.
$C_b$	Block decoupling capacitance. Unit: Farad Description: discrete C	The local block decoupling $C_b$ is the local supply-to-ground capacitance placed in serial with the local current generator $I_d$ . It accounts for the equivalent decoupling capacitance of the block. Separating the block capacitance from the on-chip capacitance $C_d$ creates a second LC network ( $L_{vdd}$ , $C_b$ , $L_{vss}$ ) at the origin of a secondary resonance.

# ICEM Activities 2004-2006

- Various EU projects have covered ICEM in the past:

- LIMA
- EMC-Pack
- MESDIE
- Parachute (planned)

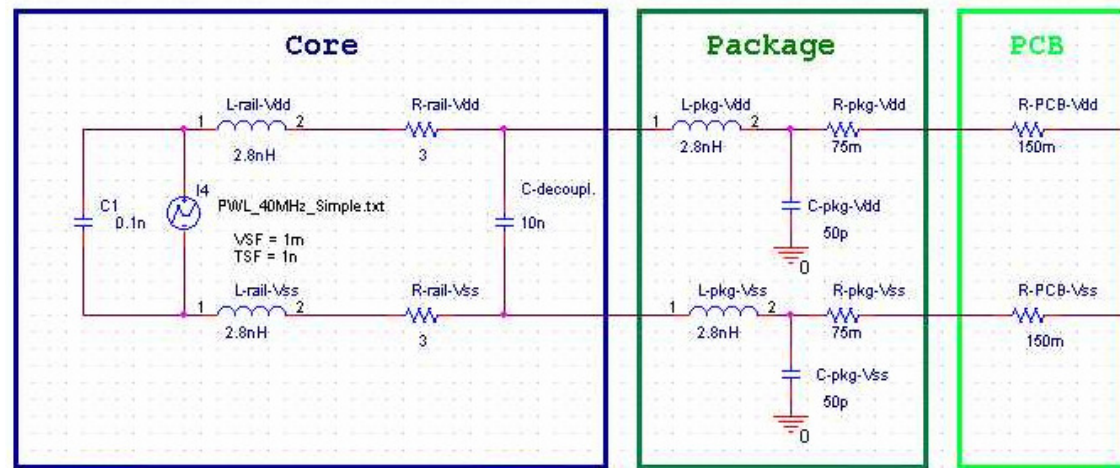


- Companies involved (excerpt):
  - Infineon, Philips, STM
  - EADS
  - Bosch, Conti-Temic
  - Zuken
- Scheduled/TBD:
  - Format to become IBIS standard under IBIS Multilangue ?
  - Model development and exploitation
  - Extraction of currents for EMC simulation
- Activities done so far:
  - Tooling
  - Model Development (Infineon TRICORE)
  - Model Validation (compare to measurement)



# Semiconductor Vendor Activities

- Some semiconductor vendors already have committed to ICEM for some IC families (Atmel, Motorola/Freescale, Infineon, Philips)
- Depends on the user demand



# Conclusion & Outlook

---

- ICEM is not at that status as expected by its initiators !
  - Only few models available
  - Only limited tool/simulation support
  - Conflicting with IMIC
- 
- This situation may change by the increasing user demand (automotive)