IBIS & Modelling Needs for a fast EMI & Power Integrity Analysis of PCB's

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Goal of this Presentation

To give a brief overview on todays state of the art EMC screening techniques (EMC Expert System approach) and the needed model information for that.

Reflect this to the information currently included in IBIS models today and the IBIS future plans.

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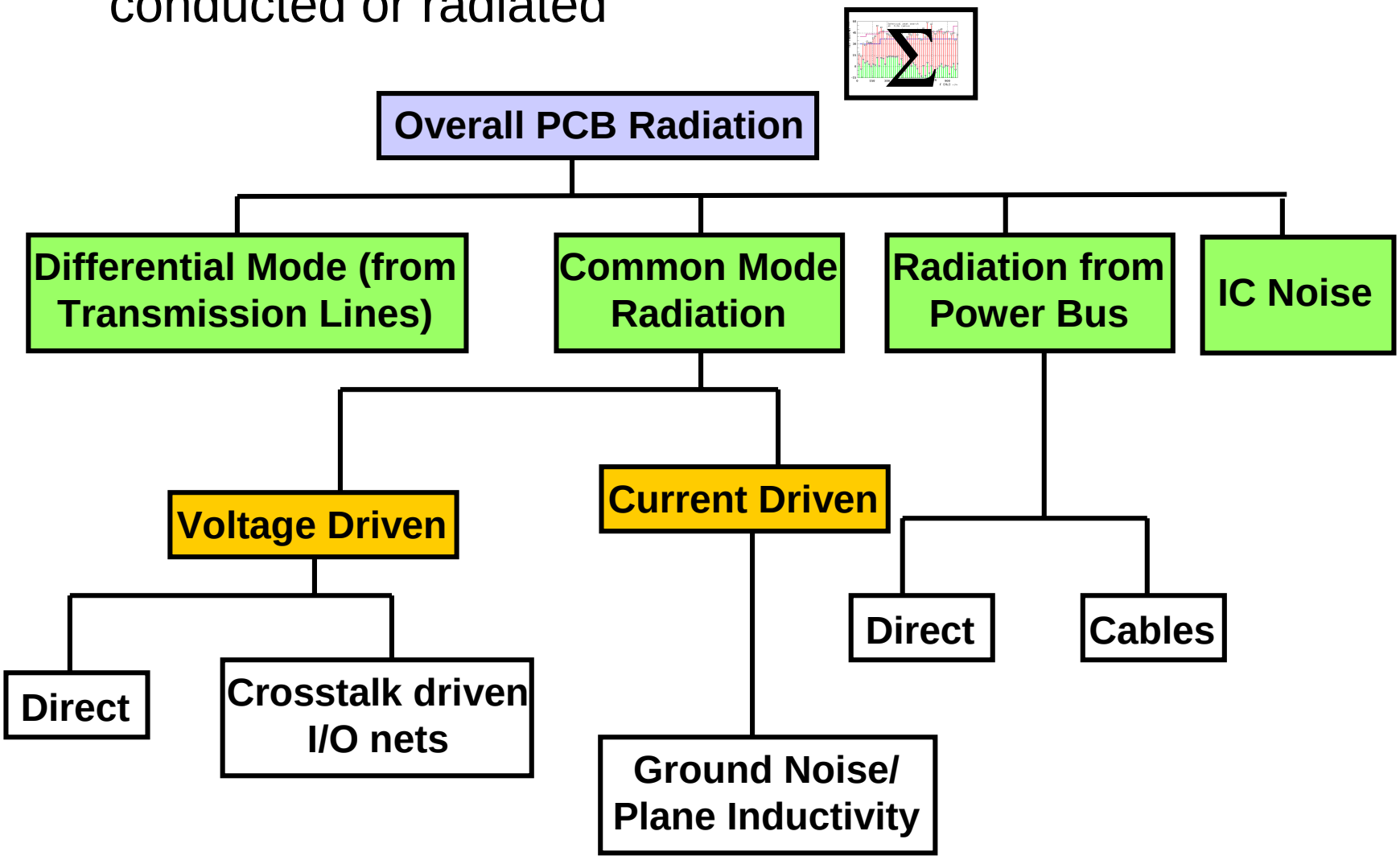
Content

- Motivation/Introduction in EMC-Expert System based EMI analysis of printed circuit boards
- Data needed for EMI screening
- IBIS and EMI analysis today (Birds and more)
- Gap analysis/modelling needs for EMI board screening

Signal Emissions/EMI

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



„EMC Expert System“-Approach

- Modular approach: separated into single algorithms, covering a specific EMI effect, individually
- Based on circuit models (→ Motivation)
  - ✓ for **differential-** & **common mode** radiation
  - ✓ for **Power Bus** analysis
- Approach verified by measurements & numerical computations
- Developed within the “EMC-Expert System Consortium”, headed by the University of Missouri, Rolla, USA (UMR)
  - Members incl.: IBM, Sony, GM, Ford, NCR, SUN, Zuken, Mentor, etc.
  - www.emclab.umr.edu/consortium
- Goals:
  - Fast identification of critical areas & configurations
  - Estimation of potential radiation levels
  - Usable within the design-flow, by **non-experts**, too!

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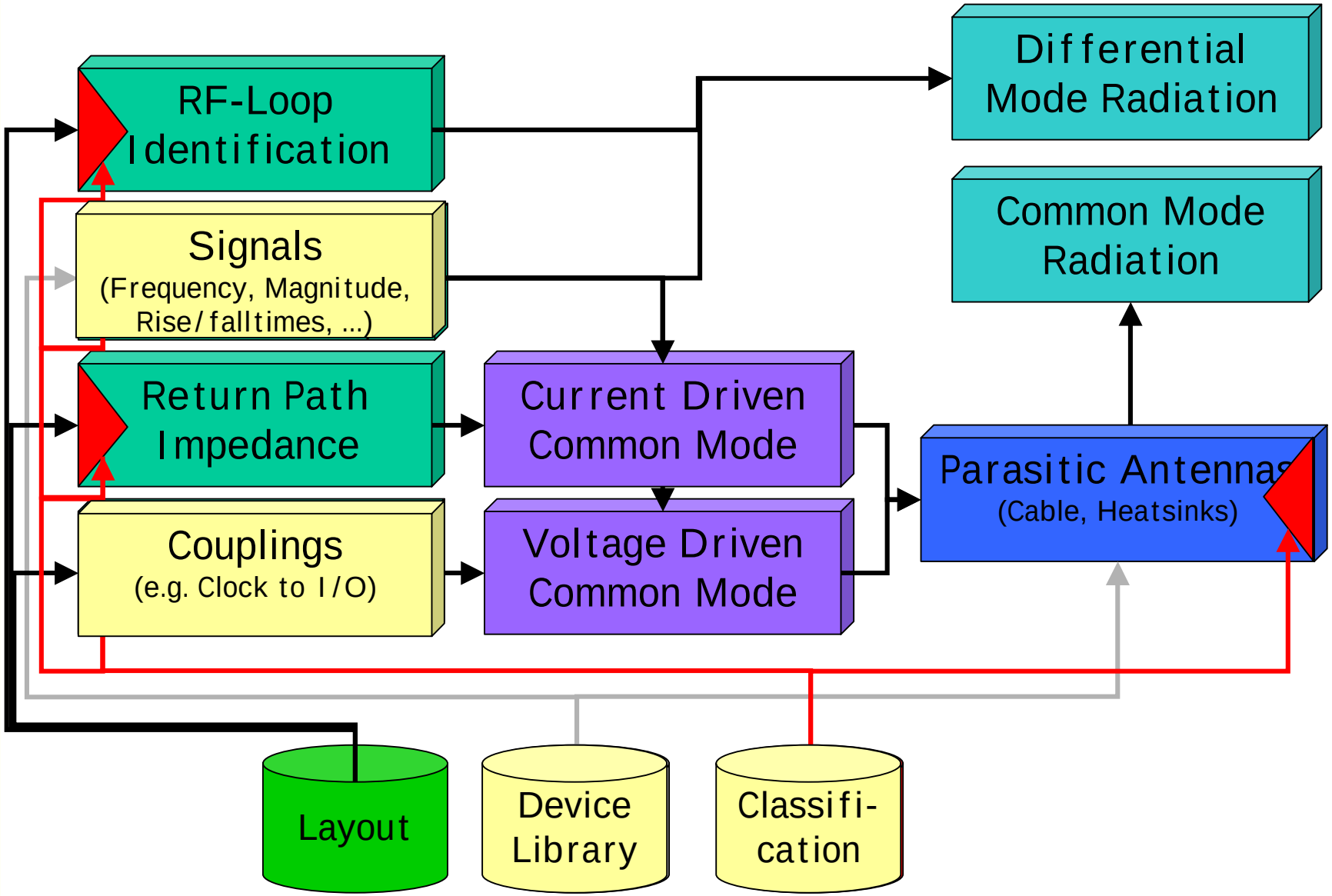
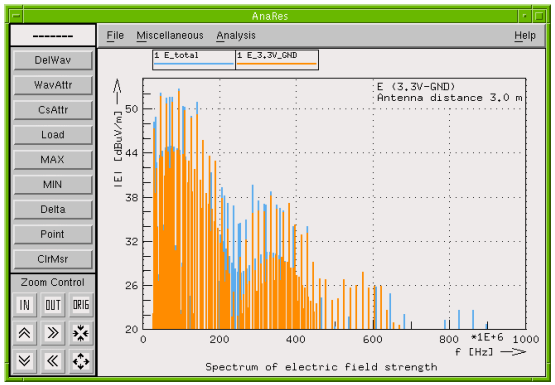
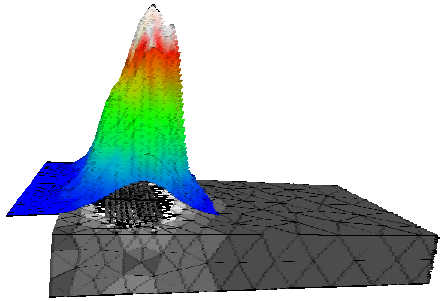
Expert System EMI Analysis – how it works & where models are important

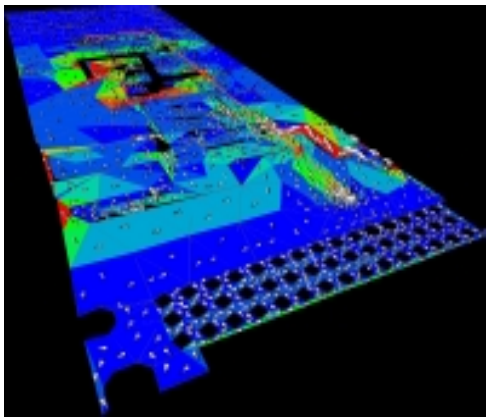


IBIS for EMI analysis

- The analysis of differential mode EMI can utilize informations from models/IBIS (determination of signal currents by SI simulations), then the computation of the fields from the estimated currents is done
- Common mode is most of the time neglected in this approaches
- IBIS models repesent voltage versus time (edges) or voltage versus current (clamps)
- EMC needs information on current versus time
- Do we have to care that much ? → A variation within the model accuracy of 10 % would lead to an impact of 1 dB in the EMI results, 100 % will results in 6 dB difference







IBIS – Models and EMI

An IBIS Model consist of:

- Pullup, Pulldown, GND Clamp, Power Clamp U-I-Diagram
- Ramp-Data (dV/dt) or Rising and Falling Waveforms
- Package-Parameters
- Voltage Range

Parameter for EMC Expert System EMI -Models:

- U-I-Data $\rightarrow R_{out}$
- Capacity-Parameters $\rightarrow C_{out}$
- Ramp-Data, Waveforms $\rightarrow t_r$, t_f
- Voltage Range, Waveforms $\rightarrow U_{oL}$, U_{oH}

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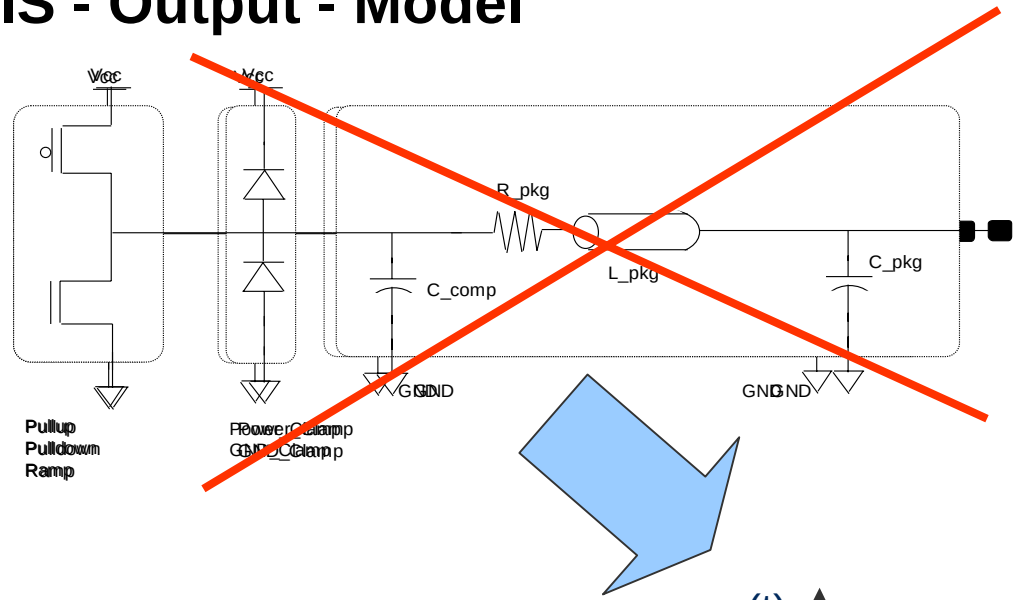
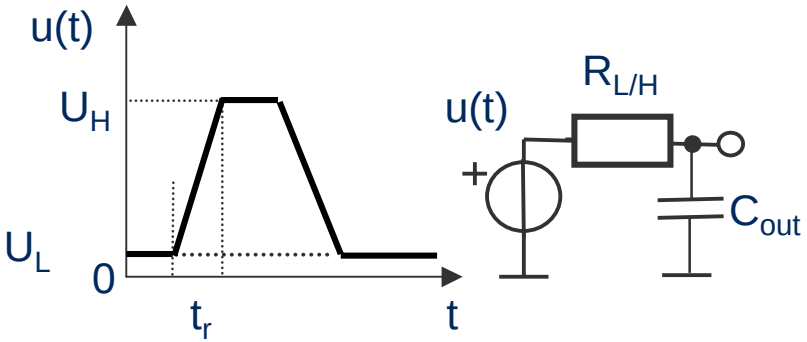
Models in EMC Expert System Context

IBIS - Output - Model

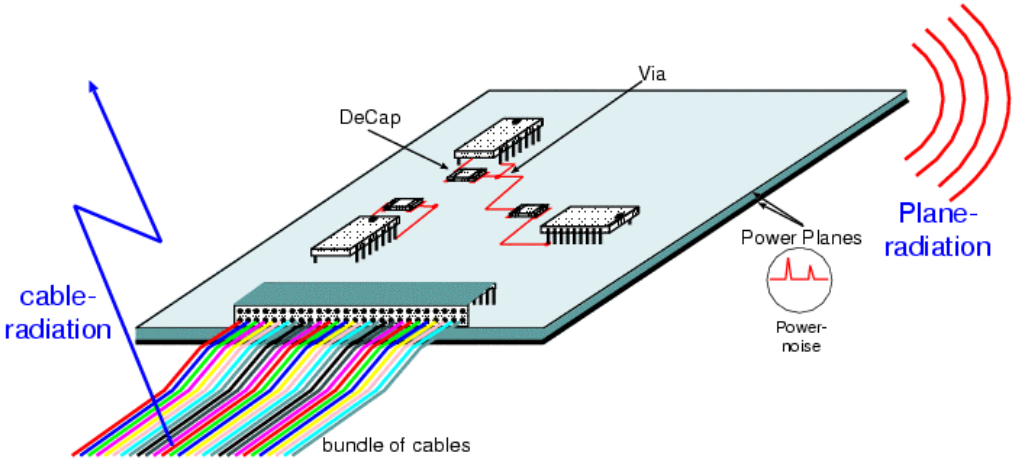


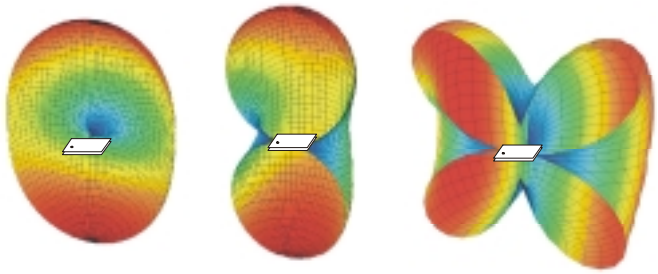


EMC Expert System - Output - Model

Power Bus Noise

- Power Planes may act as efficient antennas



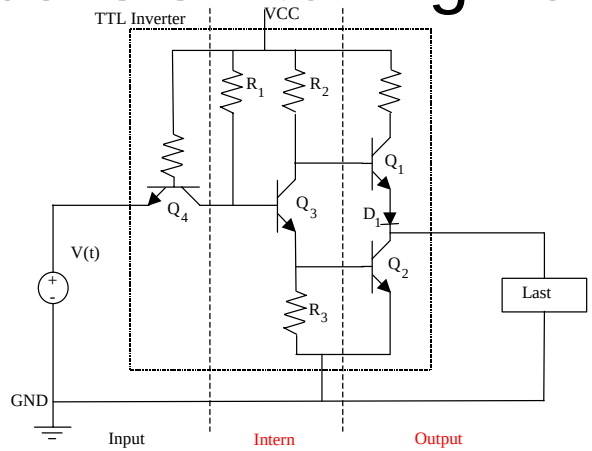


f = 500 Mhz
(1,0- Mode)

f = 740 Mhz
(0,1- Mode)

f = 900 Mhz
(1,1- Mode)

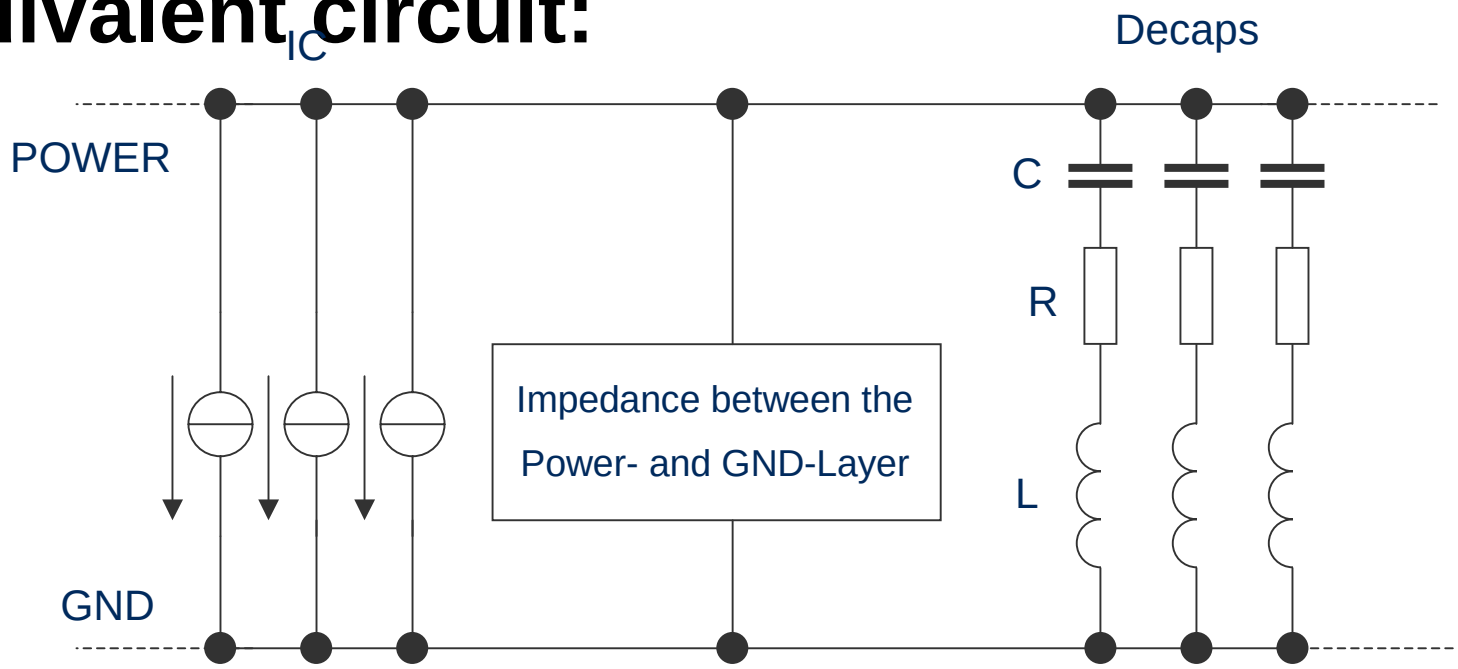
- Driving source is switching noise of ICs



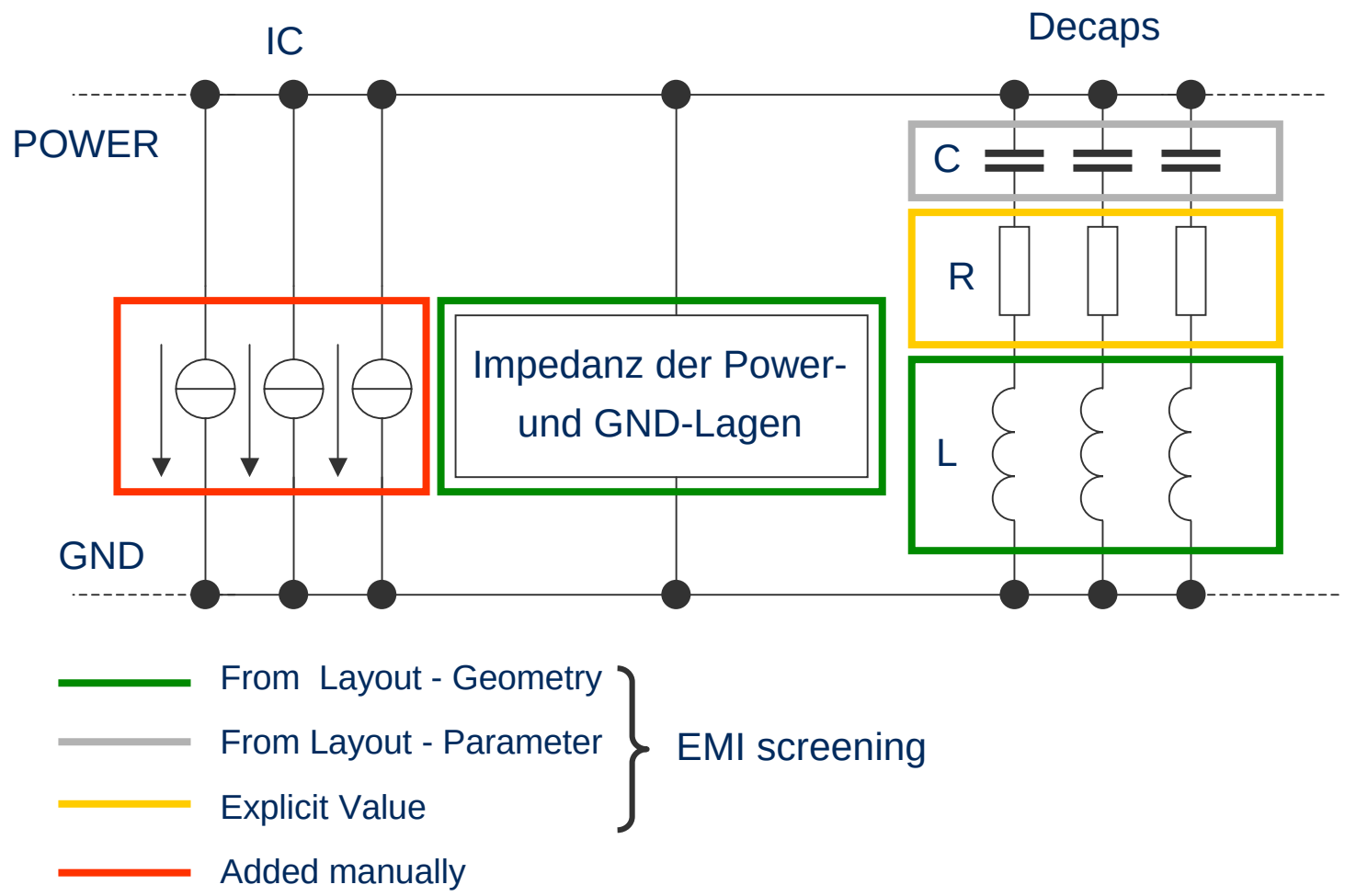
Power - Bus - Model

In IBIS it is not considered!

Equivalent circuit:



Power - Bus - Model



How to find the C_{pd}-Value

- The Expert System approach can ges the C_{pd}-value in the dependance on IC technology.

- Sources for C_{pd}-Value:
  - Data sheets
  - Calculating from power dissipation

$$P_{total}(f) = P_{static} + P_{dynamic}(f)$$

$$P_{dynamic}(f) = P_{Transient}(f) + P_{Load}(f)$$

$$= \left[C_{PD} \cdot f_{input} \cdot V_{CC}^2\right] + \left[C_{Load} \cdot f_{output} \cdot V_{CC}^2\right]$$

EMI Parameters in IBIS

- EMI bird (released some time ago, now approved)
- Bird 74.2 (Guy de Burg/Mentor Graphics) → Cpd values mainly
  - Component and model based parameters
  - New IBIS keywords:
    - [Begin EMI Component]
    - [End EMI Component]
    - [Type] → Device Type (Active or Connector for identifying IO nets)
    - [Domain] → Digital, Analog, Digital_analog (mixed)
    - [Family] → UNDEF, TTL, CMOS, ECL
    - [Cpd] → Power dissipation capacitance (Internal parasitic capacitance) for estimating power bus current and noise voltage (and from that the radiation)
    - [Pin EMI]
    - [Pin Domain EMI]
    - [Model EMI] → used to describe the EMI parameters associated with a [Model], either Model_emi_type, Domain, Con_spec with parameters like: Unshielded, Shielded, Shielded_pwr, Con_to_shield, Ferrite.

ICEM and SPICE

- Further activities to model for EMI analysis:
  - ICEM defines a current based model for the radiation of/from ICs
  - SPICE (various)
  - IMIC (japanese SPICE extension)

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Semiconductor Vendor Activities

- Some semiconductor vendors commit to ICEM (Atmel, Motorola, Infineon)
- More ???

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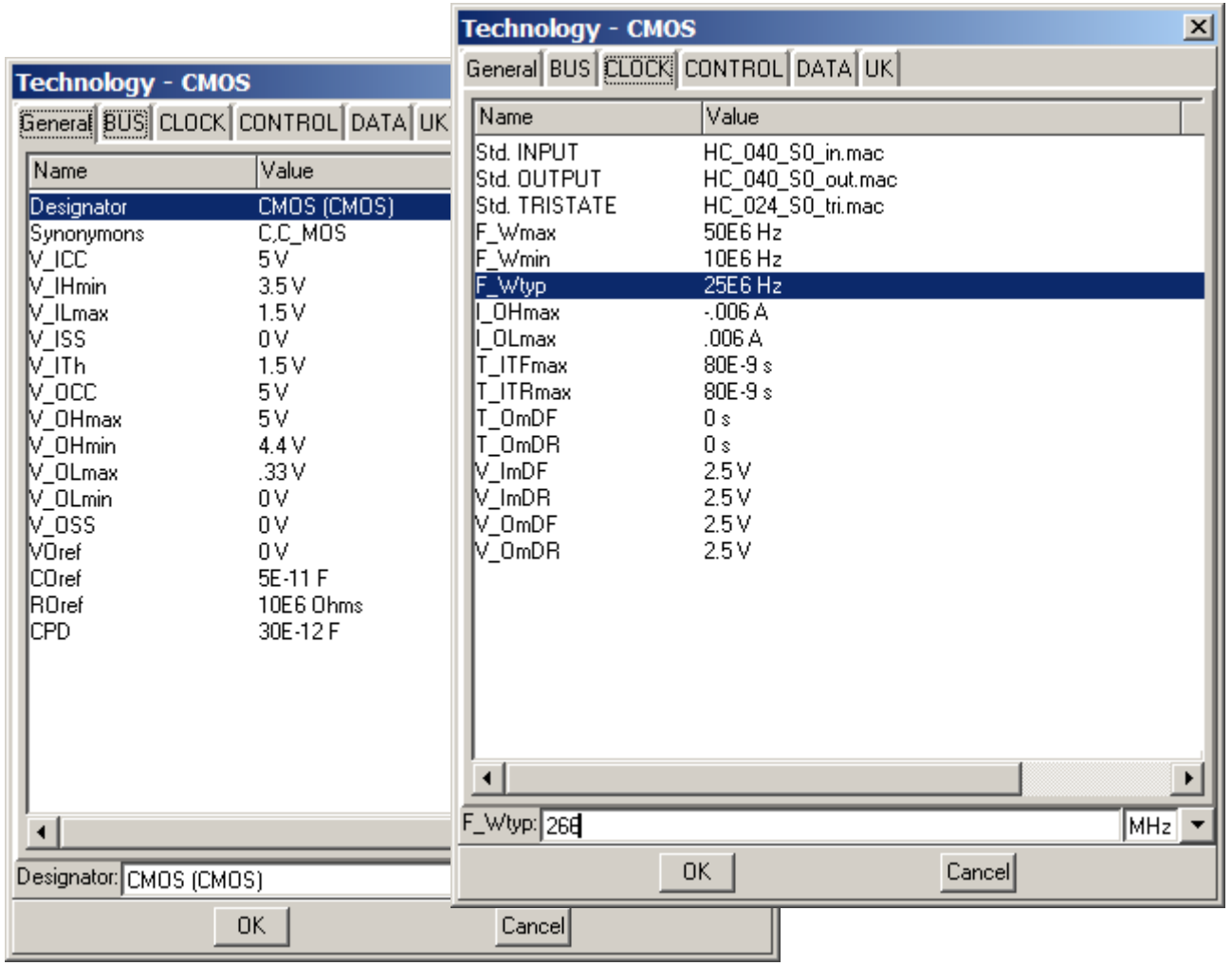
Current Solution

- Technology depended parameters according to Expert System algorithm needs can be modified by the user



Conclusion & Outlook

- Beside SPICE various modelling activities try to cover EMC in future as well :
  - SPICE MOS level models will further improve (BSIMx)
  - High level languages extend to model analog behaviour (VHDL-AMS, Verilog AMS)
  - ICEM/IMIC
  - IBIS ML common umbrella for these
- From EDA vendor (and from users) point of view there are still many things to do !!!