I E R S E T

INSTITUT EUROPEEN DE RECHERCHE
SUR LES SYSTEMES ELECTRONIQUES
POUR LES TRANSPORTS

Modeling the Radiated Emission of Micro-controllers

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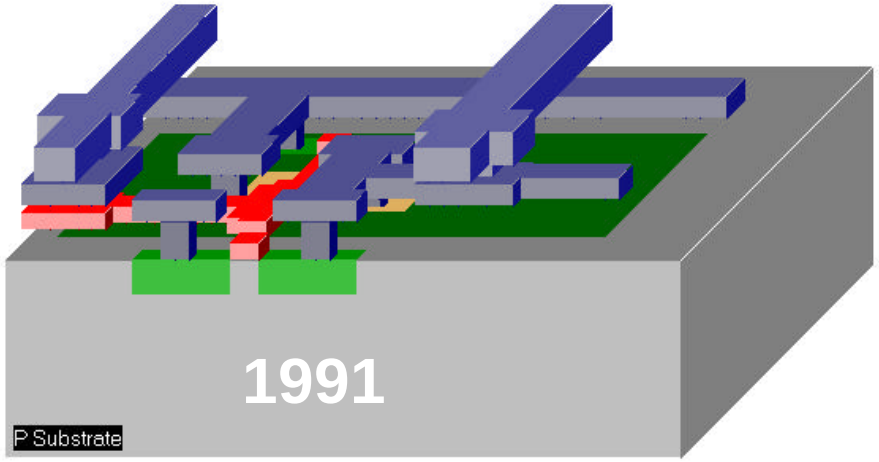
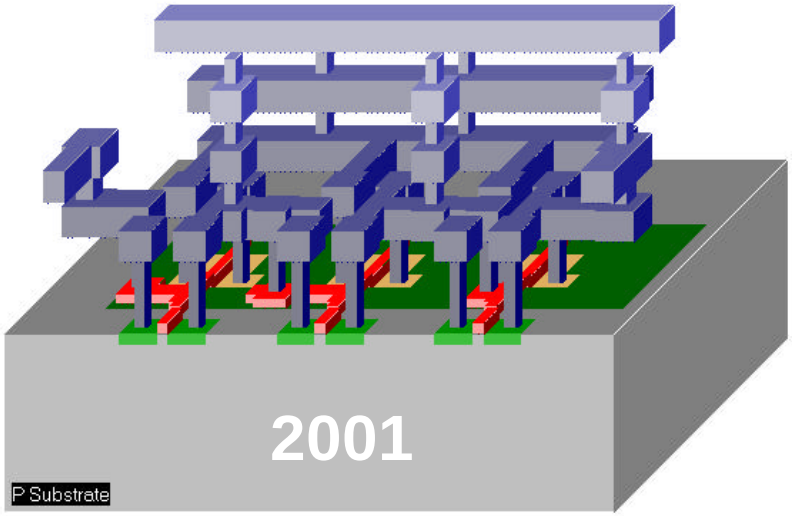
1. Context of the study

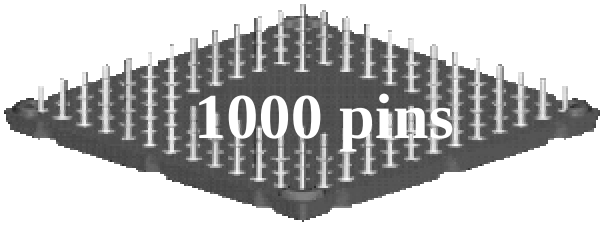




- 0.7µm, 2 metal layers
- Up to 100,000 devices on a chip
- CPU frequency 50MHz

- 0.12µm, 6 metal
- Up to 200,000,000 devices
- CPU frequency 1GHz

10 years of evolution



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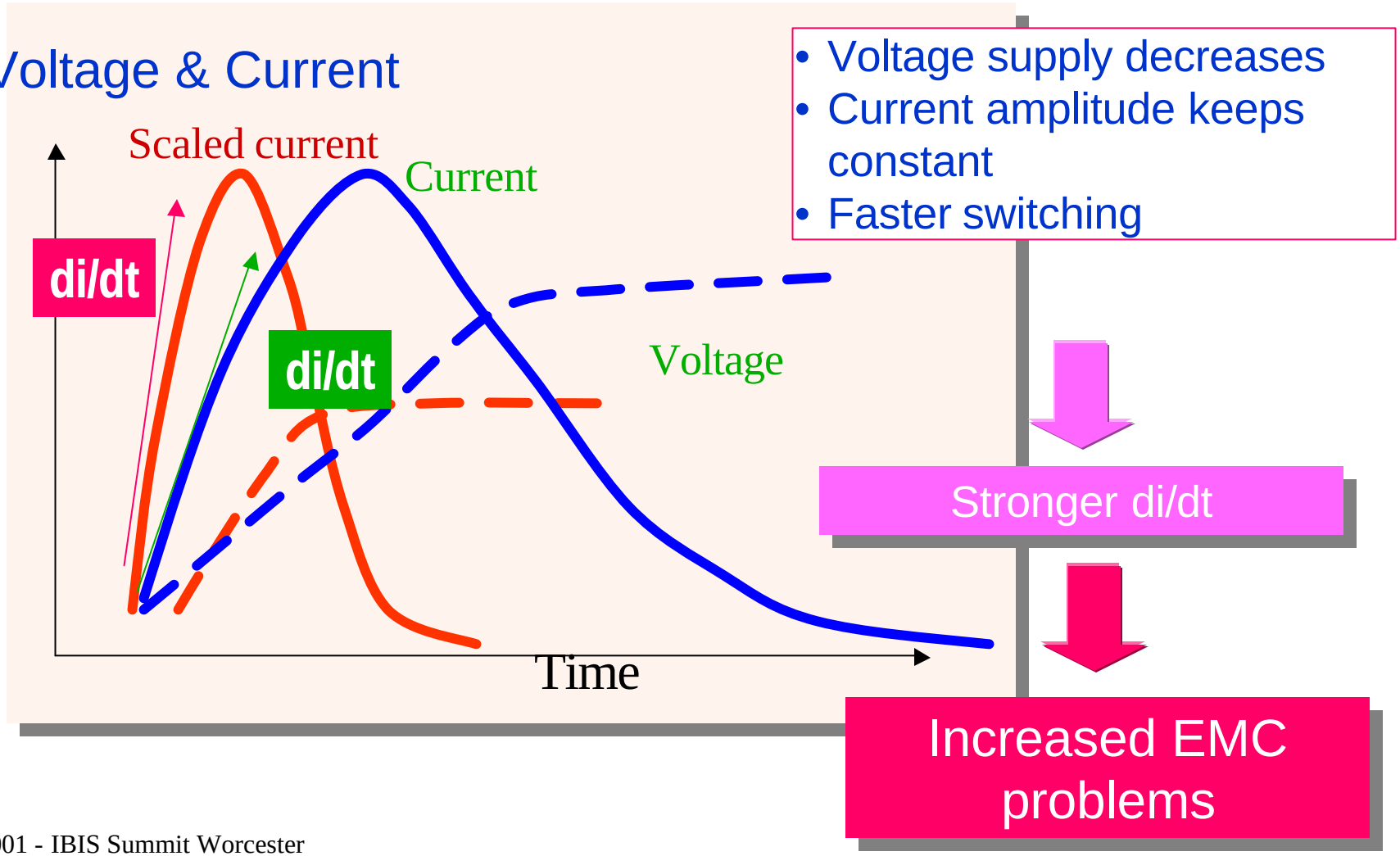
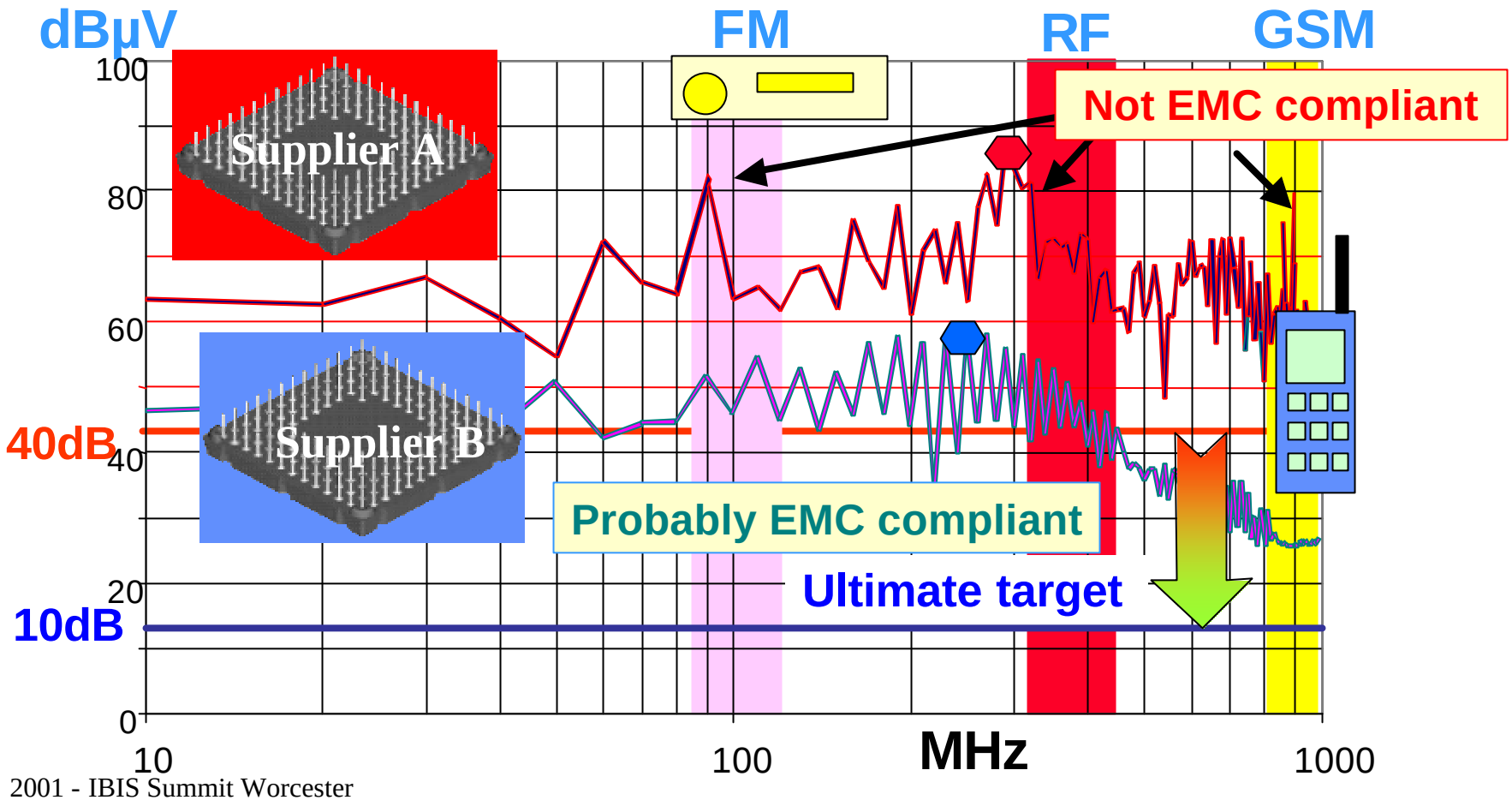


1. Context of the study

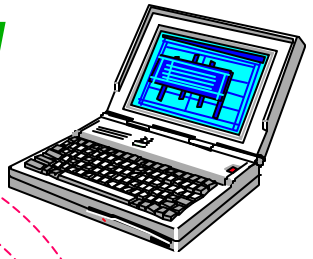
Low parasitic emission is a key argument



1. Context of the study

Example for automotive

Interference with local RF & Bluetooth links
433 MHz, 2.5GHz



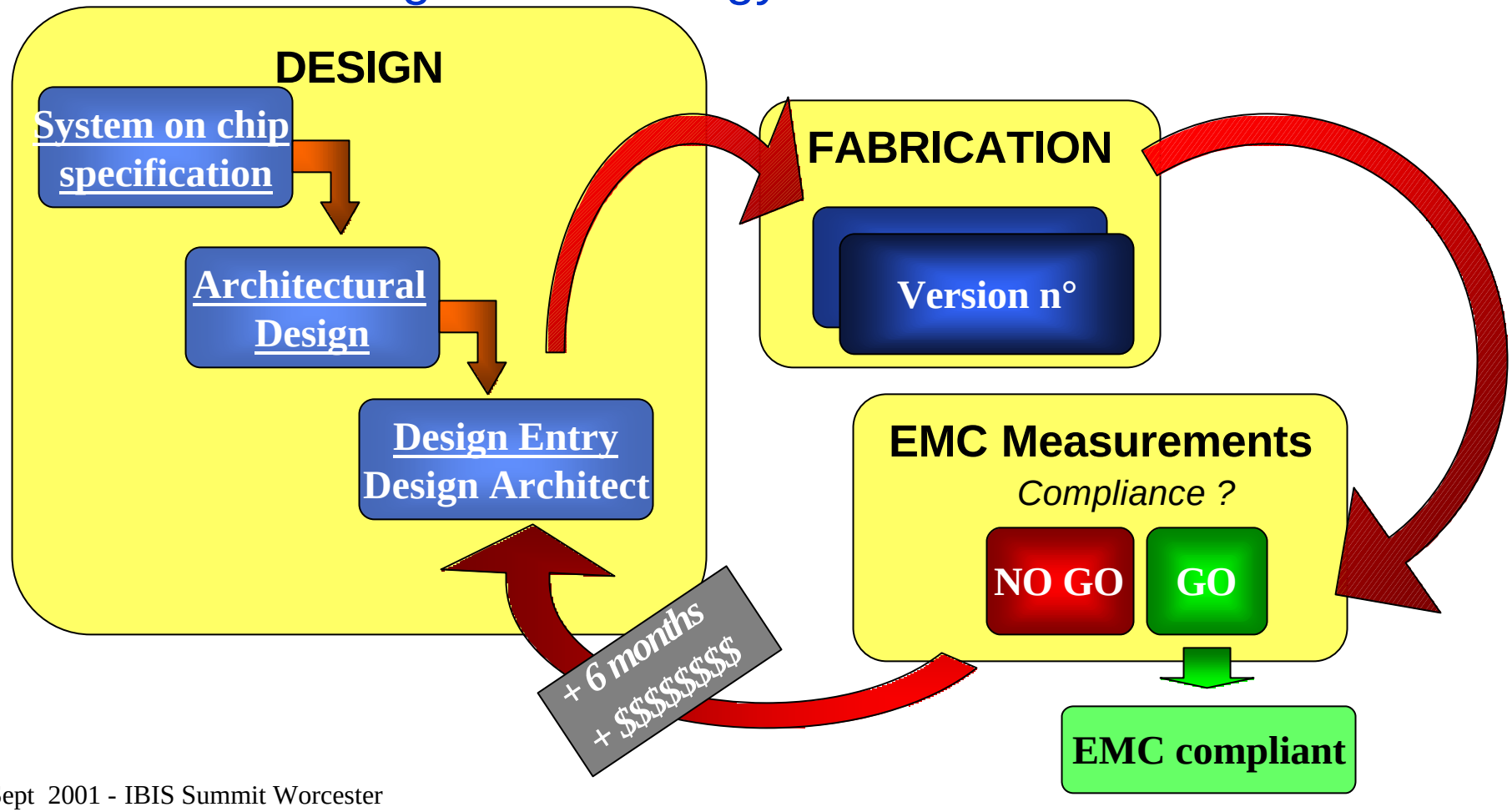
Parasites internal devices (ABS)

Interference with mobile phone
900, 1800,1900MHz

Similar EMC problems in aerospace

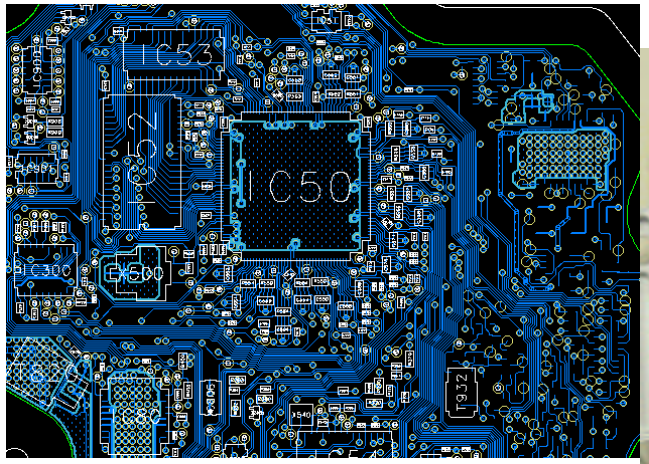
2. System Design Methodology for EMC

Obsolete Design Methodology

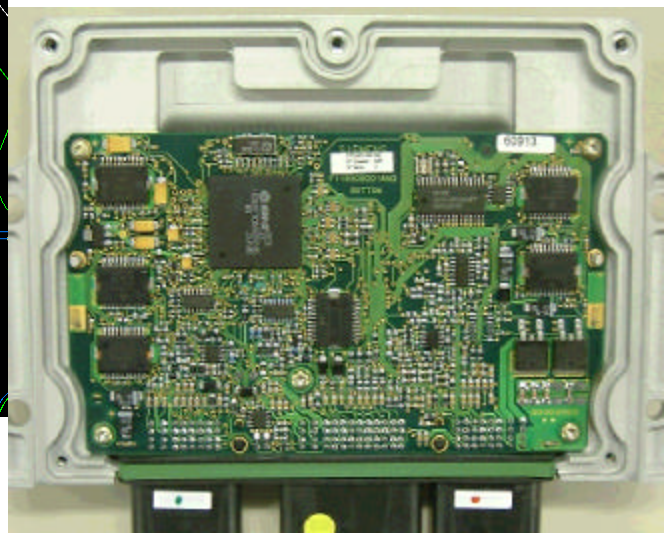


2. System Design Methodology for EMC

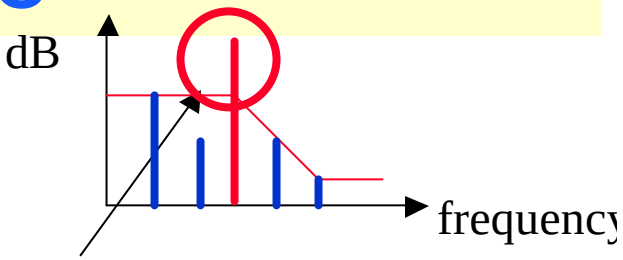
Obsolete Design Methodology

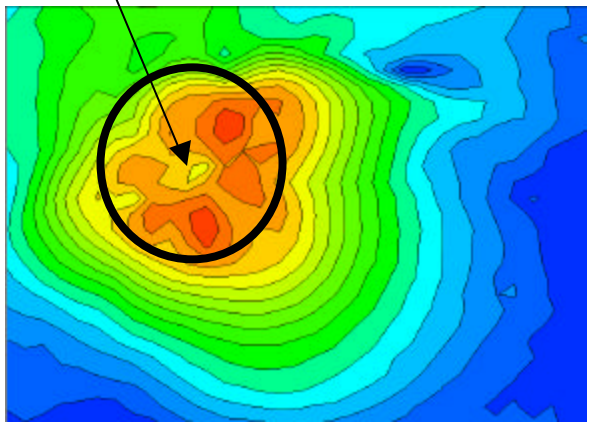


PCB design



Prototype board



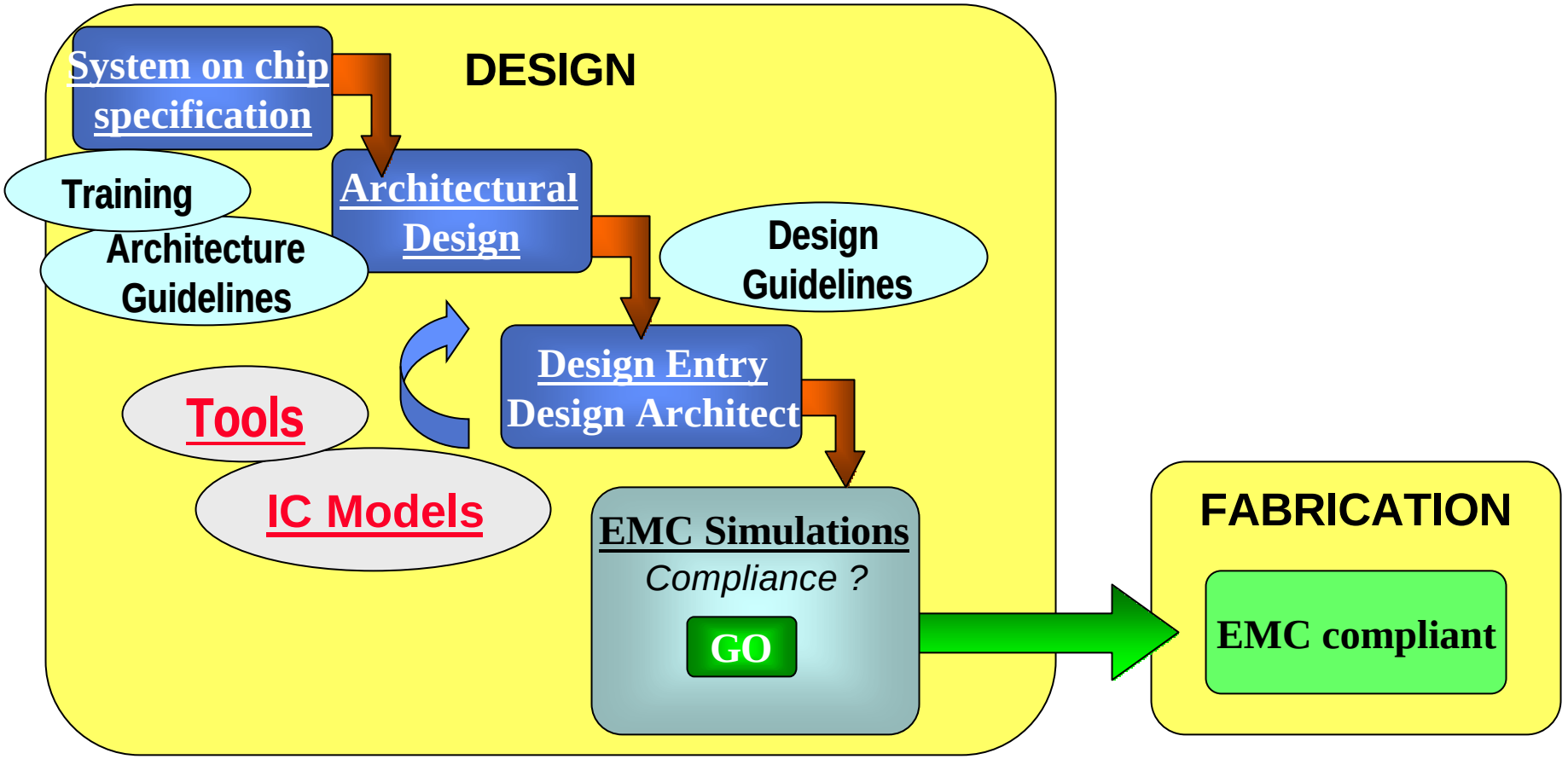


EMC scan

Electromagnetic incompatibility found too late

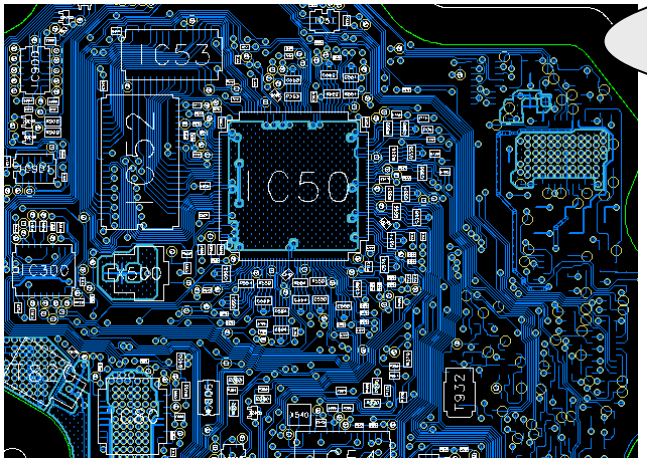
2. System Design Methodology for EMC

Target Design Methodology



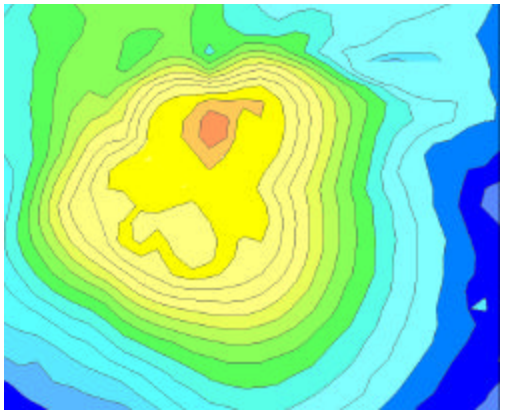
2. System Design Methodology for EMC

Target Design Methodology



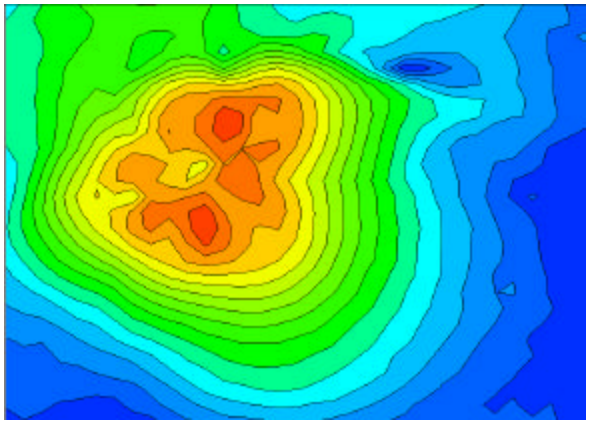
PCB design

With IBIS



Wrong prediction of the radiated emission

With IBIS and core model



Good forecast of radiated emission

A core model is mandatory for accurate emission prediction

2. The IERSET project

European Research Centre on Electronics for Transportation
identifies and co-ordinate co-operative research.

Project EMC for ICs

Objectives

- Definition and validation of a model to be used in PCB CAD tools to guarantee the EMC of electronic systems
- One model from 1MHz to 1GHz, for conducted *and* radiated emission

2. The IERSET project

ICEM (*Integrated Circuit Electromagnetic compatibility Model)*

Technical work at IERSET Toulouse, France

1997-2001

Draft standard

UTE

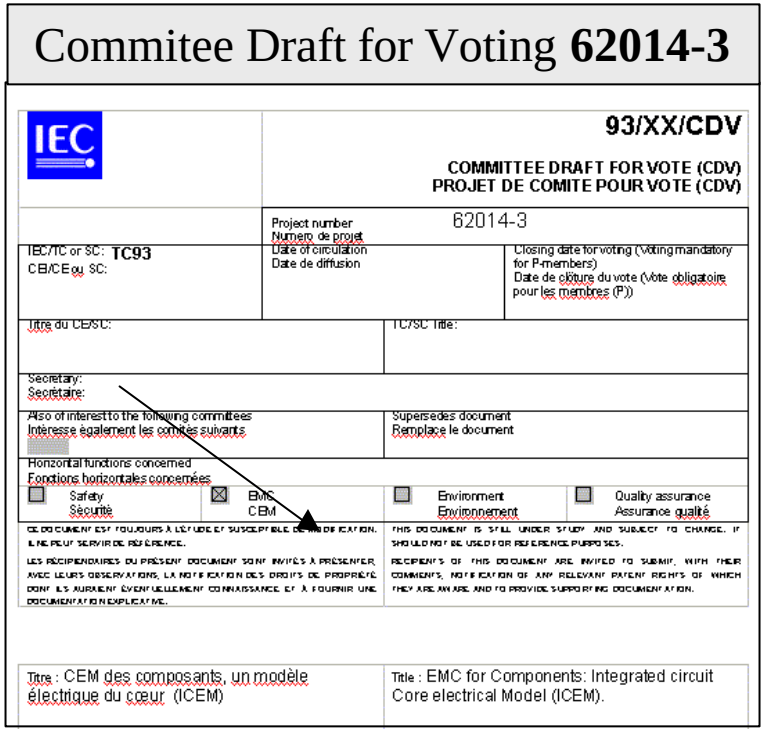
France

02/2001

ICEM Cookbook *version 1.c aug. 2001*

08/2001

Commitee Draft for Voting **62014-3**



IEC

93/XX/CDV

COMMITTEE DRAFT FOR VOTE (CDV)
PROJET DE COMITE POUR VOTE (CDV)

Project number / Numero de projet: 62014-3

IEC/TC or SC: TC93
CEI/CE ou SC:

Date of circulation / Date de diffusion

Closing date for voting (Voting mandatory for P-members) / Date de clôture du vote (Vote obligatoire pour les membres (P))

Titre du CE/SC:

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Secretary: / Secrétaire:

Also of interest to the following committees / Intéresse également les comités suivants

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Horizontal functions concerned / Fonctions horizontales concernées

☐ Safety / Sécurité ☒ EMC / CEM ☐ Environment / Environnement ☐ Quality assurance / Assurance qualité

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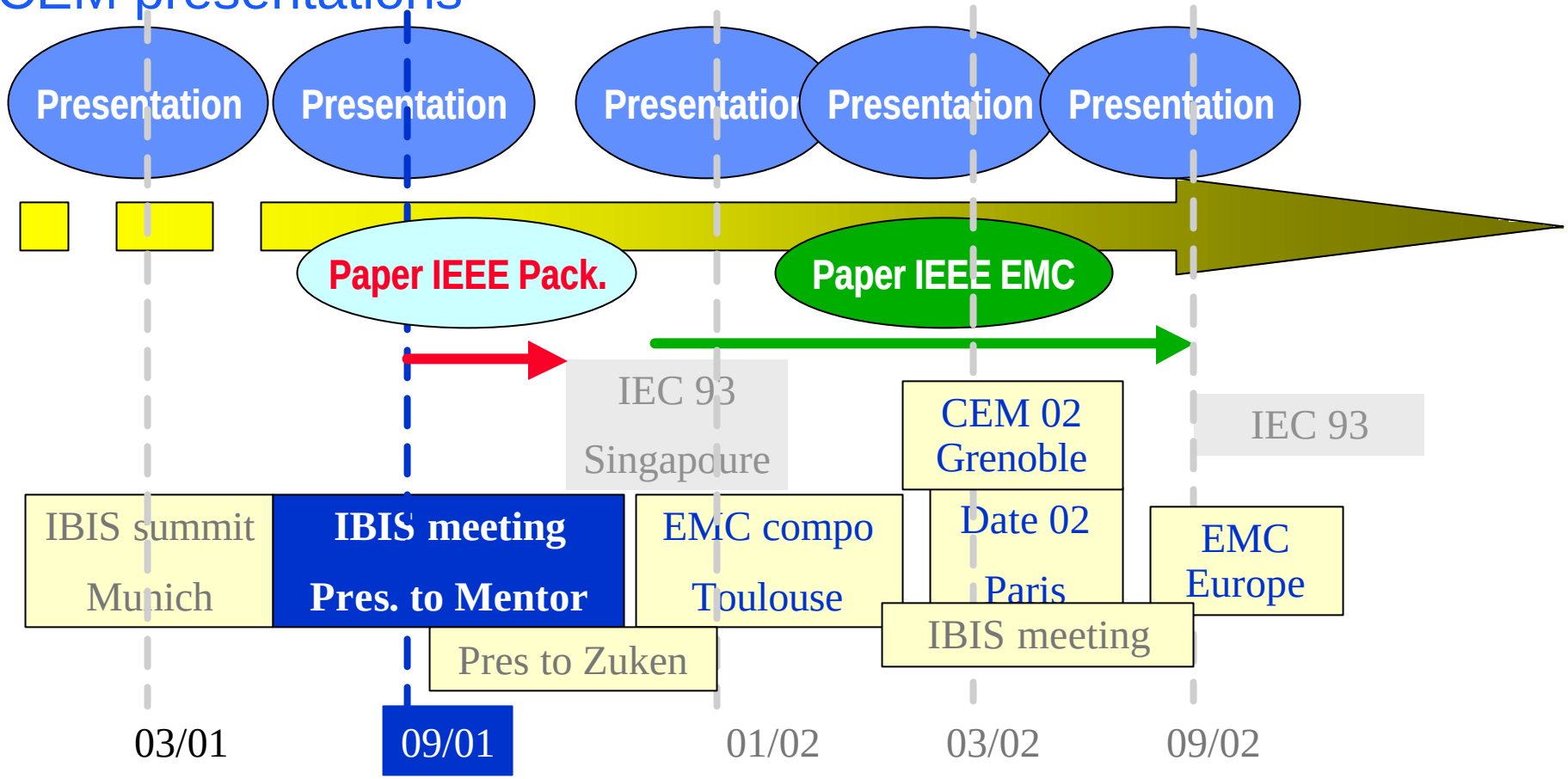
Titre : CEM des composants, un modèle électrique du cœur (ICEM)

Title : EMC for Components: Integrated circuit Core electrical Model (ICEM).

05/2001

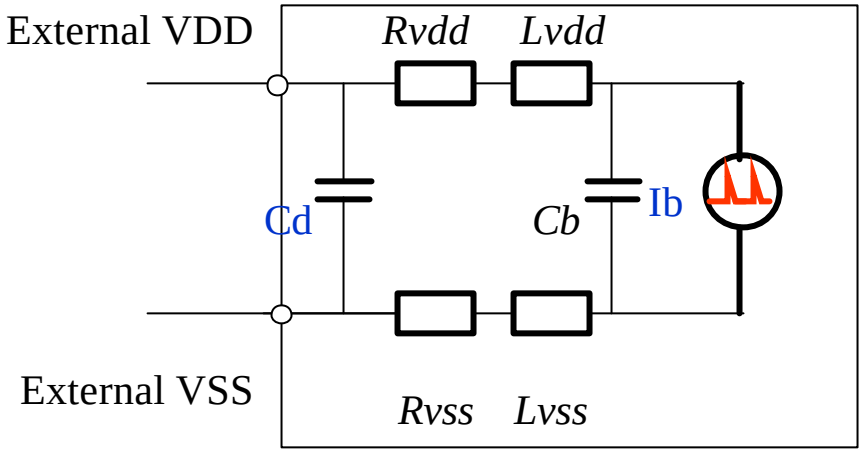
2. The IERSET project

ICEM presentations

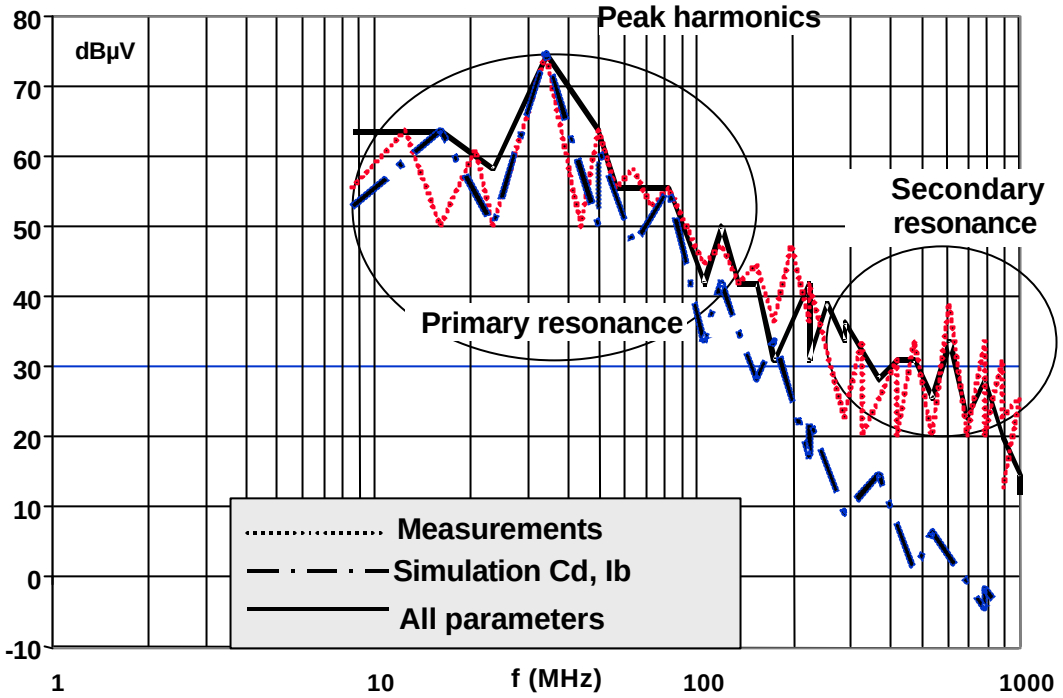


4. Core Emission Model

ICEM includes a simple core model, not handled by IBIS



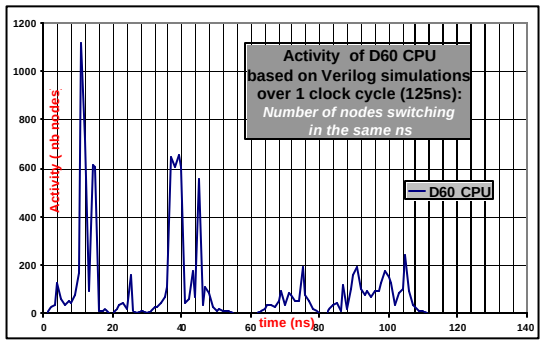
Basic parameters	Cd, Ib
Advanced param.	R,L,Cb

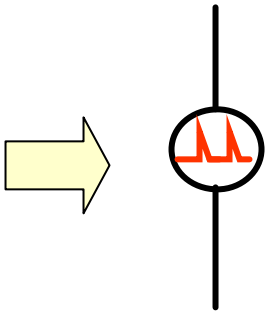


4. Core Emission Model

Current generator estimation

Physical Transistor level (*Spice*)	Interpolated Transistor level (*Powermill*)	Gate level Activity
Huge simulation	*Difficult adaptation to usual tools*	*Simple, not limited*
Limited to analog blocks	*Limited to 1 M devices*	*Fast*
		Not very accurate

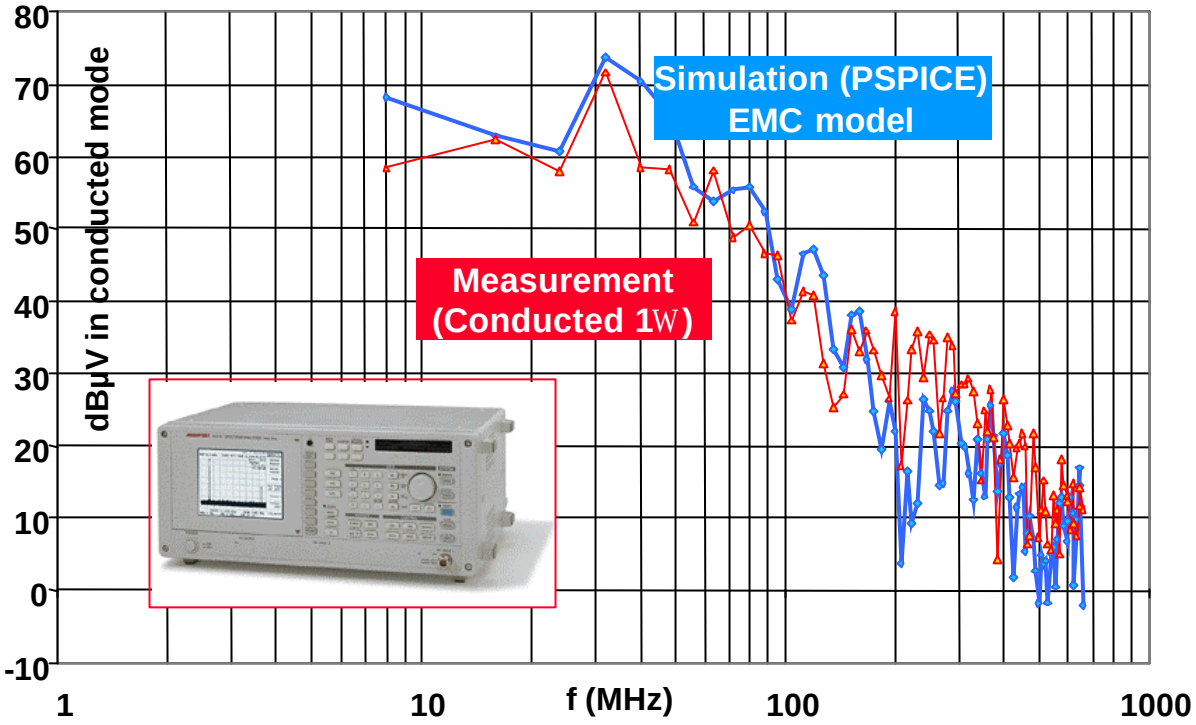


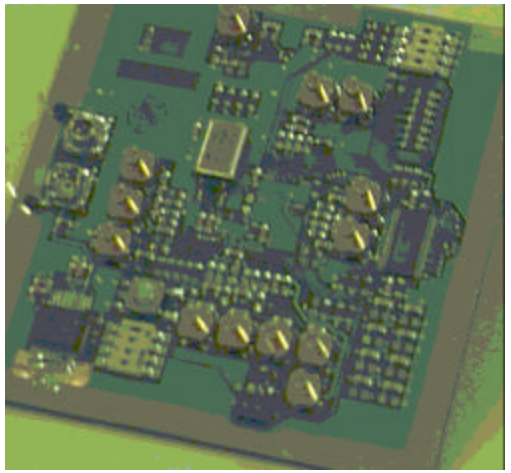


Equivalent Current generator Ib

5. Emission Model with IOs

Validation for a 16 bit micro-controller



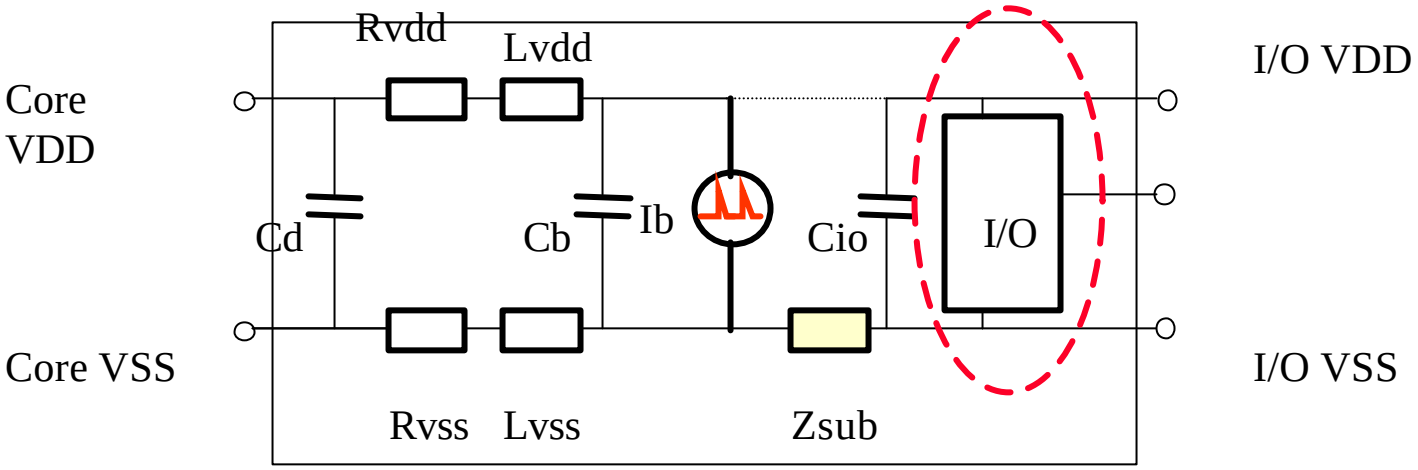


Comparison between simulation and measurement on a 16 bit micro-controller

Within 10dB, but I/Os not handled

5. Emission Model with IOs

Add IBIS I/O data



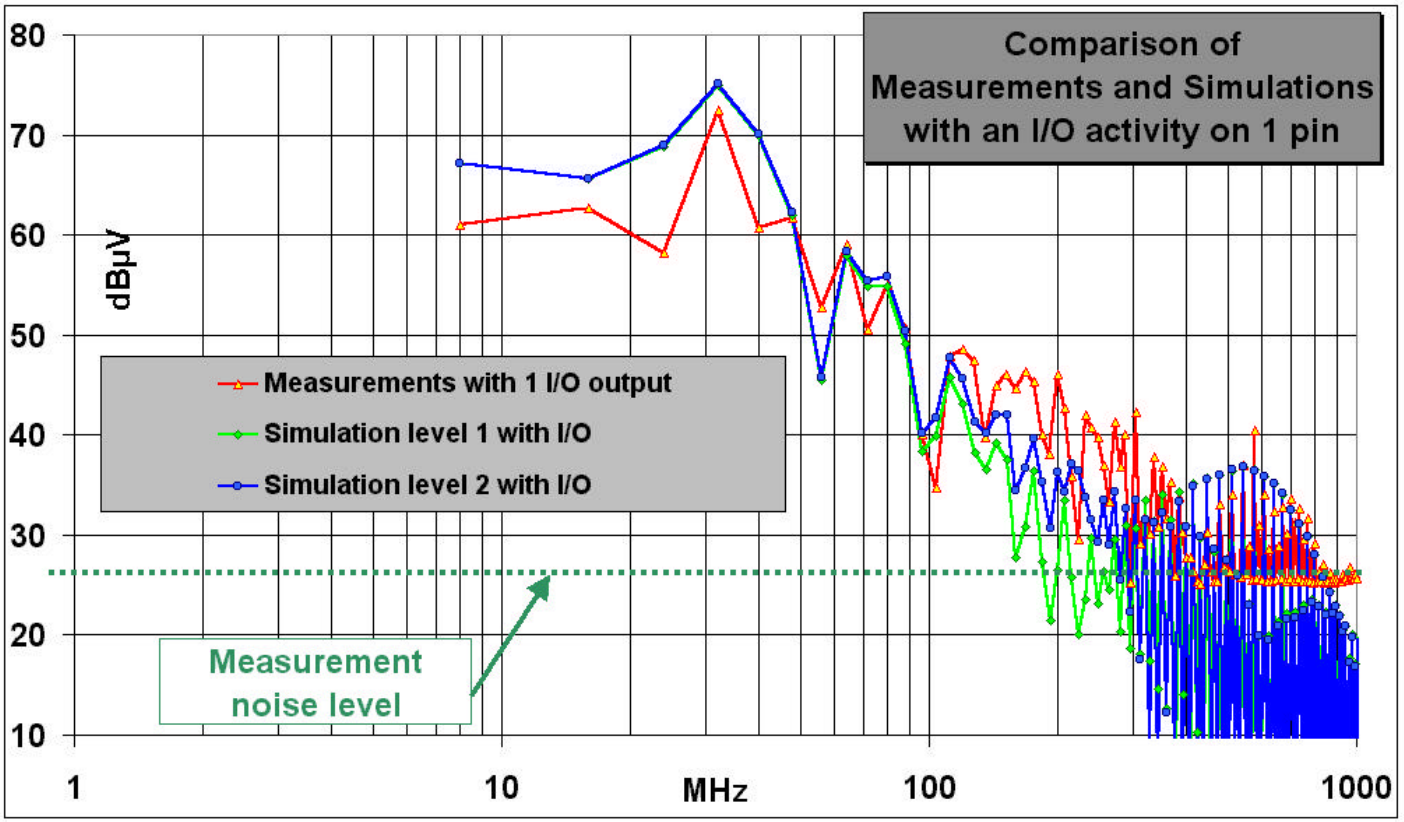
Zsub: basically a 1-10Ω serial resistance

Cio : decoupling capacitance for IO supply

IO block: reuse of IBIS

5. Emission Model with IOs

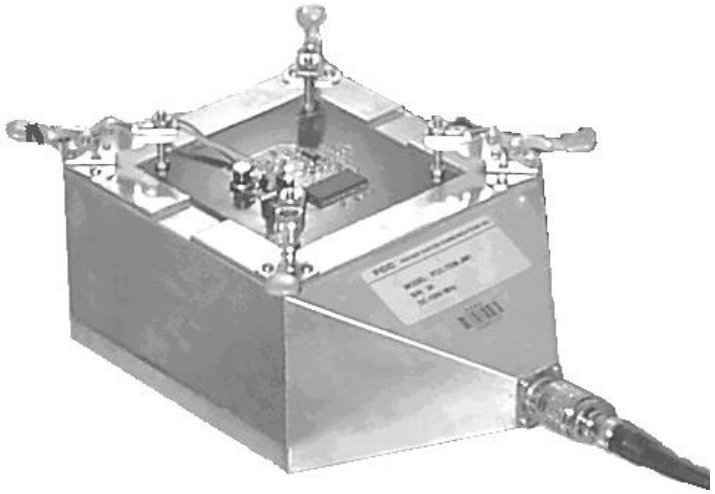
Validation

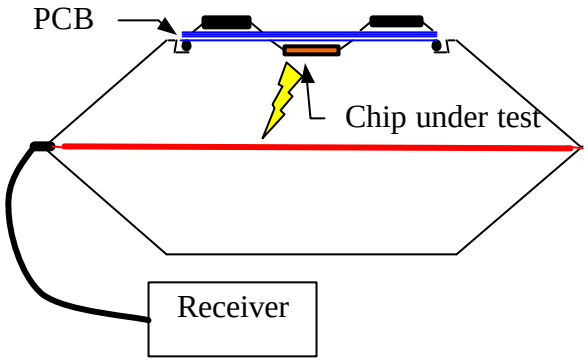


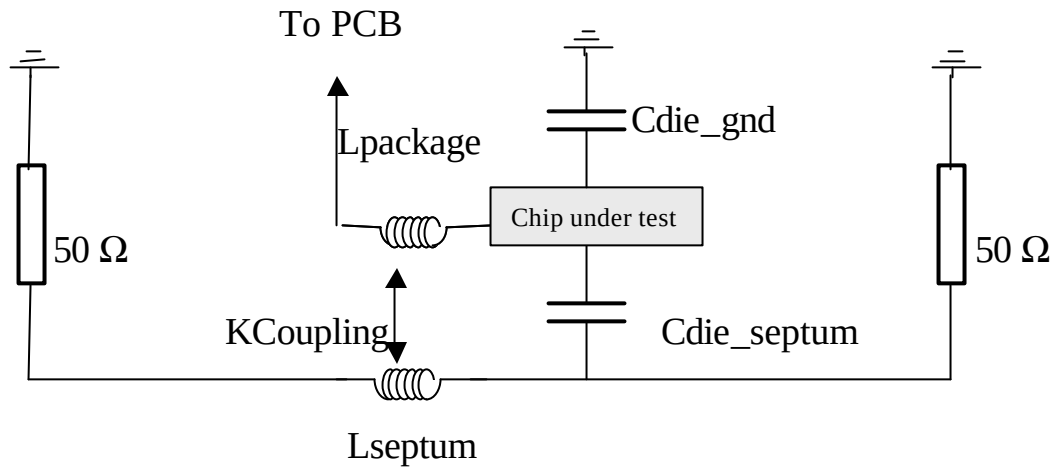
IO modify the spectrum at high frequencies (>300MHz)

6. Emission in TEM cell

Proposed model: capacitance & inductance coupling

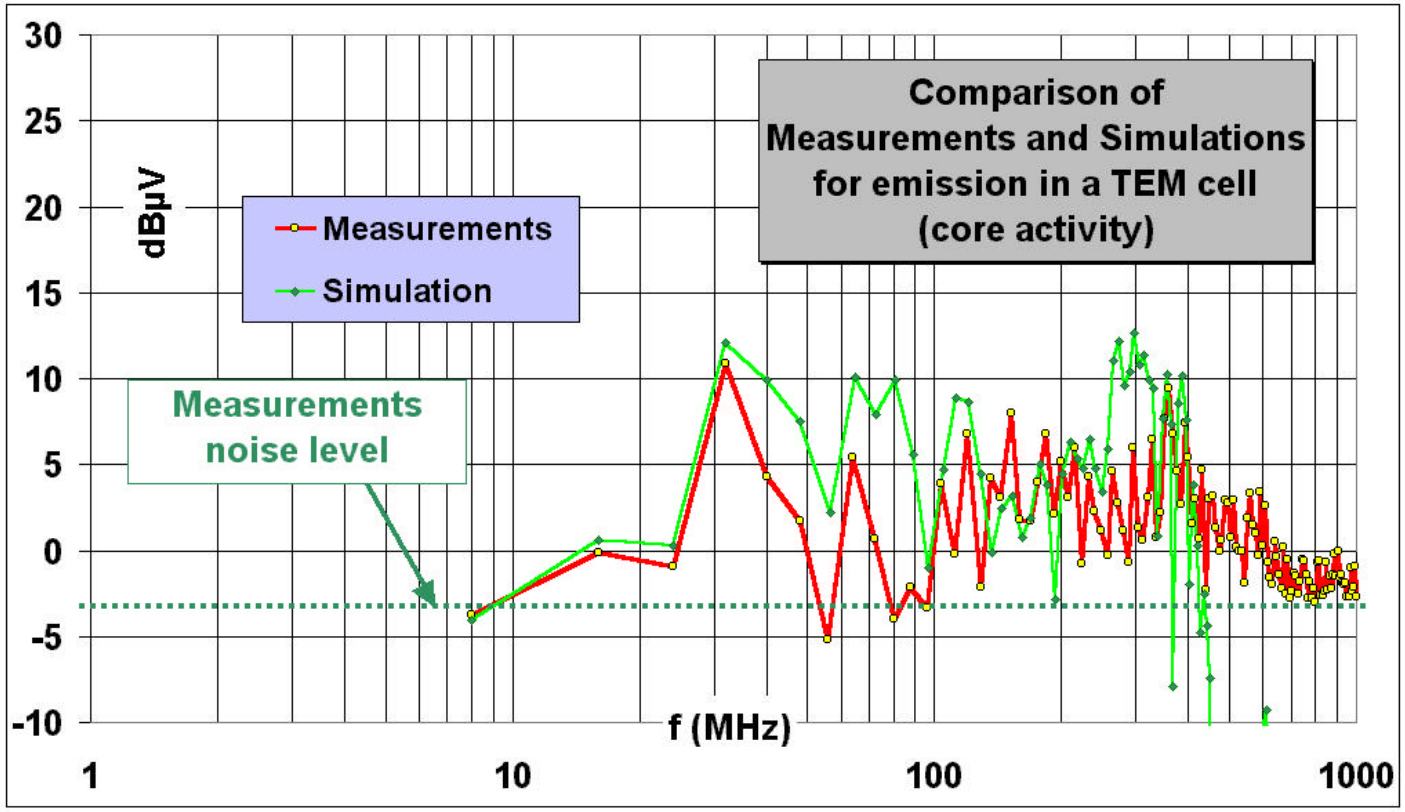






6. Emission in TEM cell

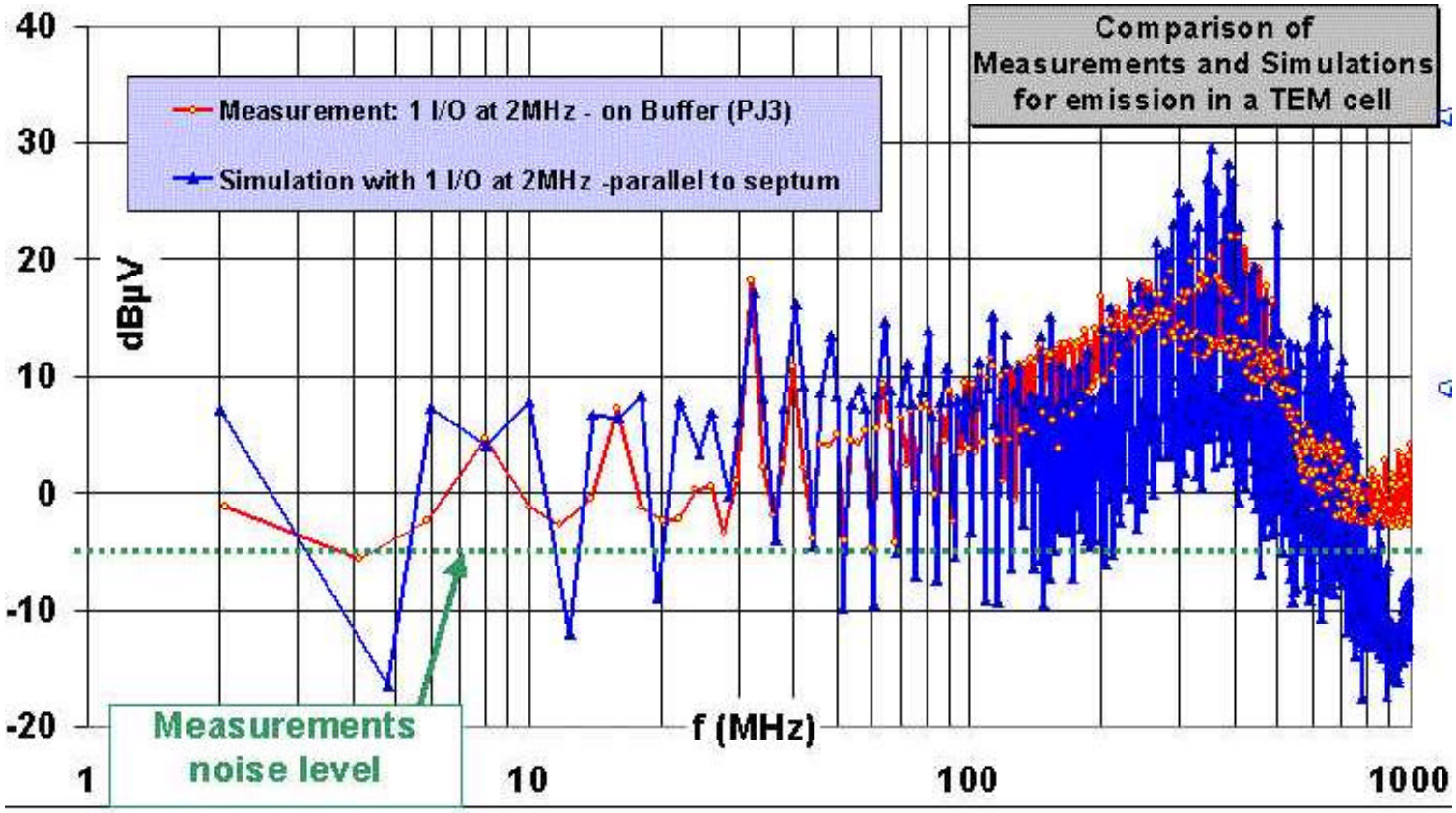
Validation for the core alone



- Model fits correctly up to 400MHz
- At high frequencies, close from noise floor

6. Emission in TEM cell

Validation for the core & IOs



- Model fits correctly up to 800MHz
- At high frequencies, IO effects dominate

Conclusion

- Technology scale down illustrated
- More complex chips increase parasitic emission
- An EMC model for Ics is mandatory
- A simple model has been proposed
- Satisfactory prediction of conducted emission
- Prediction of the core emission in TEM investigated
- Model proposal standardized by UTE (ICEM)
- Presentation and promotion to CAD & IC providers