PROKJETY W RAMACH KONKURSÓW CAS/V/POKL ORAZ CAS/VI/POKL

1. Uniwersytet w Luksemburgu:

1.1 Automatic detection and diagnosis of program faults (ADDOPF)

Software has an increasing use in systems and devices that pervade all the aspects of our life. Businesses, financial, health, communication, transportation and every other service of a modern society rely on software. Thus, a rising demand for its amplified reliability has long been established. In ADDOPF project we aim at proposing automatic techniques for the effective detection and diagnosis of software defects targeting on program faults.

Software testing and debugging techniques form the current practice for identifying and fixing software defects. However, these techniques are very expensive as they can consume 50% or even 60% of the total cost of the software development. Therefore, the need for automatic solutions is imperative, especially when high reliability is a mandatory requirement. In the absence of such solutions, i.e. current practice in industry, these activities must be manually performed making its cost exceedingly expensive.

The ADDOPF project addresses two crucial dimensions: establishing an empirical model of the faults' behaviour and the development of automatic testing and debugging strategies based on the established model. The challenging points of the project are:
1. the analysis of how faults are propagated, i.e., how a fault affects program behaviour, and fault correlation, i.e., the relationship between multiple faults within one program
2. the development of automated testing and debugging techniques taking into account the propagation and correlation properties of program faults.

2. Duński Uniwersytet Techniczny w Kopenhadze:

2.1 Design of systems for microwave breast cancer detection

Worldwide, more than a million women are diagnosed with breast cancer every year. It is the most common cancer and the second leading cause of cancer death in women today. Research over the last years indicates that microwave imaging might be an accurate method for breast cancer detection. The method is based on measurement of the complex transmission coefficient in several directions through the object to be imaged (the breast). This data is then used to reconstruct an image. This image should be used to detect cancer tissue. However, presently no commercial 3-D imaging system exist, so experiences with this type of images are limited. The long-term goal of the breast cancer project at DTU Elektro is to develop a system suitable for clinical test.

The microwave imaging system to be developed in this project employs a multi-element antenna array connected to a Vector Network Analyser (VNA) through a multichannel switching network, enabling multiport coherent measurements.

The project focuses on developing the hardware for gathering the needed data. The main components of the system are:

- 2-port network analyzer;
- Switching network;
- Antenna system;
- Control electronics.

The heart of the system will be the VNA, which is used to do the actual measurement. Since most VNAs only provide two ports, a switching network should be created to extend the two ports. This will make it possible to select one of the multiple antennas for transmission and another for receive as illustrated in Fig. 1.
The antenna system is already developed and is suitable to generate data for a 3D image.

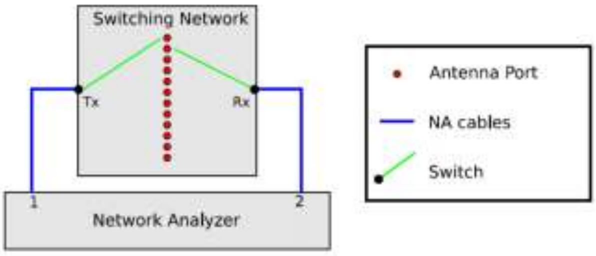


Fig.1. The switching network makes it possible to select one antenna for transmit and another for receive.

The goal of the project is to design fabricate and characterize the multiport switching network, which would provide a wide operating frequency range (from 0.5 GHz to 3+ GHz), maintain a high level of channel-to-channel isolation (over 100 dB) and high switching speed (in order of seconds). To achieve a high sensitivity it would probably be necessary to include a broad-band (of the-shelf) low-noise amplifier in each receive channel.
The project also includes an implementation of the computer control and data acquisition.

2.2 Design of millimeter-wave integrated power amplifiers (possibility for tape-out)

With the advent of smartphones, tablets and connected cameras, the number of users of wireless networks is dramatically increasing. Cisco forecasts an 18-fold increase in wireless data traffic between 2011 and 2016. As a consequence, the capacity of wireless network must be increased to face this data explosion. In that respect there is at present an increased interest to exploit the millimeter-wave (mm-wave) frequency range (30-300 GHz) for wireless backhauling. The primary motivation for moving to mm-wave frequencies are the availability of large absolute bandwidth, small system size, and highly directive antennas. The recent world-wide allocation of the E-band spectrum (71-76 and 81-86 GHz) provides the opportunity for line-of-sight radio links with "fiber-like" multi-gigabit data transfer rates. The E-band spectrum falls within an atmospheric window with low attenuation, making transmission over fairly long distances (up to 10km) possible. This makes E-band wireless links attractive not only for mobile backhaul applications but also for bridging the gaps in optical fibre networks. In the pursuit for ever higher data rates, the underexploited deep mm-wave bands above 100 GHz are attracting significant interest. In particular, the frequency bands around the atmospheric windows located at 140-GHz and 220-GHz are promising for this purpose.

The progress in semiconductor device technology, in particular compound semiconductor transistors such as High Electron Mobility Transistor (HEMT) and Heterojunction Bipolar Transistor (HBT) devices, enables the development of wireless communication circuits operating at frequencies well above 100 GHz. At such high frequencies, monolithic microwave integrated circuit (MMIC) technology is mandatory. The main bottleneck in mm-wave systems today is the power amplifier (PA). The high operation frequency of semiconductor devices, in particular Silicon based, has been obtained by aggressive geometrical downscaling. As a consequence, the available output power per semiconductor device is limited. InP technology is particular well suited for applications in the high end of the millimeter-wave frequency band and even in the sub-millimeter-wave frequency band.

The overall objective of the project is to demonstrate high power amplifier MMICs for emerging D-band (110-170 GHz) wireless communication network using European based InP DHBT technology. In particular, the potential and limitation of the InP DHBT technology currently under development at the III-V Lab in France should be investigated. For the proposed application an output power at around 20 dBm (100 mW) must be targeted. To complicate matters, it is foreseen that higher order modulation formats will be employed to enhance the spectral efficiency in future mm-wave wireless communication links and this dictates strict linearity requirements to the power amplifiers. Therefore the power amplifier performance should be optimized at the 1 dB compression point.

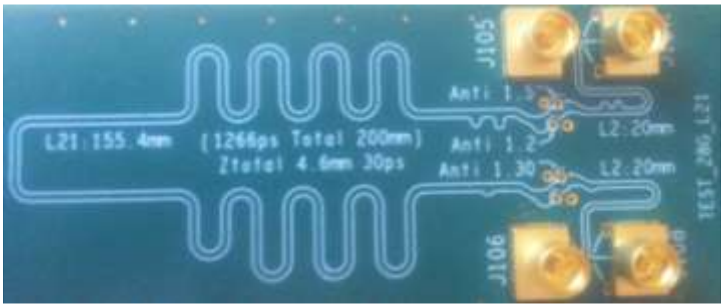
Several open issues should be addressed during the project. These are among others:

1) Transmission line implementation (inverted μ-Strip, CPW, ECPW, ACPS) and requirements for single-mode propagation (substrate thickness, finite ground plane, overall CPW size)
2) InP DHBT device performance at D-band (optimum biasing, numbers of device fingers, emitter ballasting)
3) Design a passive low-loss power combining structures at D-band frequencies.
4) Design a multi-stage balanced power amplifier at D-band frequencies using optimized power cells.
5) Investigation stability and thermal issues.

The power amplifier design should be performed in Agilent ADS and performance of critical passive structures verified in HFSS. The complete layout should be transferred to Cadence for final design rule check (DRC) and layout versus schematic (LVS) verification. Tape-out is expected regularly over the following three years period. Next tape-out is planned in early 2015.

2.3 EM modelling of high-speed via transitions (28G FR4 test-board available)

In this project the influence of high-speed vias on high-speed signal transmission up to 28 Gbit/s should be investigated. The vias connect traces on a 22-layers FR4 printed circuit board. The effect of nearby ground vias on the quality of the signal transmission must be accessed. The project will involve signal processing in Agilent ADS and electromagnetic modelling of the vias using the simulation tool HFSS. Experimental S-parameters measured to 65 GHz are available for several test-structures with and without nearby ground vias.



Figur 1: Test board with via transitions of varying geometry and nearby ground vias.

The following tasks can be proposed for this project:

1) Transform experimental data from frequency to time-domain and extract information about of transmission line parameters and analyze via transitions on the test boards.
2) Investigate plane radiation effects at via transitions using HFSS. What is the effect of nearby ground vias? What is the effect of simulation domain truncation on the parasitic modes? There is the return current path when no nearby ground vias are present?
3) Investigate the influence of ground vias on the Eye diagram quality of a real-world high-speed bit pattern.
4) Propose optimized via transitions for 28Gbit/s transitions.

The project is motivated by the fact that it seems to be a contradiction between EM simulation results showing that it is necessary to include several ground vias near via transitions and real life boards that still function well without these! The physical reason behind this difference must be better understood.

2.4 Microwave System for Medical Imaging

Worldwide, more than a million women are diagnosed with breast cancer every year. It is the most common cancer and the second leading cause of cancer death in women today. Research over the last years indicates that microwave imaging might be an accurate method for breast cancer detection. The method is based on measurement of the complex transmission coefficient in several directions through the object to be imaged (the breast). This data is then used to reconstruct an image. This image should be used to detect cancer tissue. However, presently no commercial 3-D imaging system exist, so experiences with this type of images are limited. The long-term goal of the breast cancer project at DTU Elektro is to develop a system suitable for clinical test.

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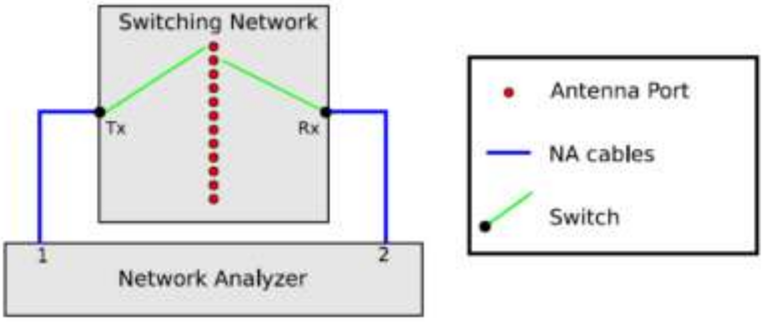

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The project also includes an implementation of the computer control and data acquisition.

2.5 RF coils for high-field MR imaging

Resolution enhancement in magnetic resonance imaging (MRI) is of a great potential for increased diagnostic accuracy in brain and spine imaging. Current clinical interests focus on 3 tesla scanners although it is already evident that even higher field strengths will be used to examine patients in the future. In the framework of scientific studies, MR scanners operating at 7 tesla have already been used in humans. The strongest argument in favour of switching to a higher field strength is the expected boost in signal-to-noise ratio. An improved spatial resolution might permit a better evaluation of anatomy so far only inadequately visualized by MRI. Also, imaging at higher field strengths has the potential to improve more sophisticated applications of MRI such as functional imaging (spectroscopy, flow imaging and the like). With the advent of high-field systems increased signal-to-noise ratio (SNR) offers smaller voxel sizes, but overall scan time is still a limiting factor for high-resolution brain imaging in a clinical setting. In this respect, parallel imaging is of a great benefit since it allows to achieve high-resolution imaging in clinically acceptable time frames. In addition, parallel imaging can also diminish the amount of image blurring and geometric distortions leading to obvious resolution and quality improvements without altering the acquisition matrix size. Another challenge in high-field scanners is the increase in the specific absorption rate (SAR). The amount of energy deposited in the body by a radiofrequency (RF) field is proportional to the square of the field strength and is thus significantly greater for high-field systems. The threshold for energy absorption in the body (primarily in the form of heat), is therefore more easily reached. This limits the scan times that are theoretically feasible on high-field scanners as the possible succession of pulses must be slowed down to prevent overheating. Various strategies are available to minimize the overall SAR. A promising technique is the mentioned parallel excitation, which can reduces RF energy deposition. An associated problem is the inhomogeneity of the RF fields within the patient at high field due to shorter wavelength in the body. The inhomogeneous electric field can produce localized thermal hot-spots easily reaching SAR threshold.

The purpose of the proposed study is to investigate the mentioned challenges of high-field MR imaging and, if possible, introduce new concepts to the design of RF coils. The study will be conducted at the Department of Electrical Engineering / DTU under supervision of Associate Prof. Vitaliy Zhurbenko, and in close collaboration with Hvidovre hospital in Denmark. Qualification of the candidate – master degree in electrical engineering or physics, and knowledge of electromagnetics and circuit design.

The Department of Electrical Engineering is the central department at the Technical University of Denmark within electrical and biomedical engineering. Including PhD students we have over 260 staff members. It is our goal to ensure research and engineering training at the highest international level. The department is organized into 7 sections and a number of cross professional centres.

Please read more about Department of Electrical Engineering and Electromagnetic Systems group on www.elektro.dtu.dk and www.ems.elektro.dtu.dk.

2.6 Photonics Technologies for Metro Access and Short Range Communication Systems

(Research topics to be defined after agreement with team leader prof. Idelfonso Tafur Monroy)

2.6.1 Projects in Fibre-wireless

- Upconversion methods (from baseband to millimeter wave)
- Advanced Modulation formats
- Transmission effects – hybrid channel fibre-aire
- Impairments such as antenna misalignment, multipath…
- Active distribution using optical switch

2.6.2 Design & simulation for Graphene based elements

- Inventory of design & simulation tools for graphene based devices
- Start simulation & design for:
  - Nano Antennas
  - Absorbers
  - Modulation
  - Coupling antenna & Photomixers
  - Coupling antenna & light source, modulators

with focus on mmw and Sub-Terahertz frequency range

2.6.3 Design & Device simulation for Silicon Photonics

- Inventory of design & simulation tools for SiP
- Choice of tool
- Start simulation & design passive element
- Create libraries
- From passive elements to modulators, ring resonators, etc..

Focus: Metro Access & Short Range Systems with Silicon Photonics

3. Politechnika Nantes:

3.1 Development of a tool-chain for the generation (compilation) of Linux kernel and related drivers depending on the target ARM-based SoC

This project aims at a rapid development of Linux distributions for a number of SBC (Odroid, Radxa, E9, ..) with multicore SoCs.

3.2 Development of a wearable server based on Odroid-W (IoT)

This project includes a number of multimedia services that can be provided via Odroid-W GPU including audio and video streaming. Before the activation of streaming services the server needs to be activated as an intelligent access point.