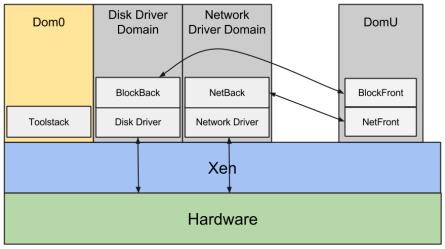
The following **master theses** are part of an open-source project regarding nuclear magnetic resonance (no prior knowledge required). Language can be **English or German**, please reach out or come by for questions and other available topics.

A Reasonably Secure Operating System: Open-Source Xen, Alpine Linux, ARM



For x86 based systems, Qubes OS exists to improve security by virtualization and compartmentalization. To circumvent the Intel ME and other x86 vulnerabilities, an open-source ARM-based Laptop such as the Pinebook Pro is targeted. The task involves configuring U-Boot and the hypervisor XenARM for the RK3399 SoC to run Dom0, driver DomUs for e.g. USB and networking isolation, application DomUs and provide a global UI with window manager for active graphical AppVMs. All domains will run Alpine Linux, which provides Xen support. Besides applications of mixed criticality and high stability in embedded systems (e.g. automotive industry), this setup is intended to provide highest possible privacy and data security in ordinary desktop computing.
Experience with embedded systems, virtualization and GNU/Linux is recommended.

`https://wiki.xenproject.org/wiki/Xen_ARM_with_Virtualization_Extensions_whitepaper`

FPGA-Based Pulse-Programmer for NMR Spectroscopy

NMR requires generating MHz pulses of microsecond duration with nanosecond precision. Since the RF coil is used for Tx and Rx sequentially, similarly precise gate-switching has to be performed during acquisition. The depicted Altera-based LimeSDR software defined radio is open-hardware and -source and well capable of performing these tasks. The objective is to customize the existing work to the present application of a dual-channel LF-NMR spectrometer and provide a simple interface for common pulse sequences.
Experience with FPGA programming and embedded systems are recommended.

Doll 2019 "Pulsed and continuous-wave magnetic resonance spectroscopy using a low-cost software-defined radio" doi.org/10.1063/1.5127746

RF Front End for NMR Pulse Generation and Signal Acquisition

As interface between the aforementioned SDR and RF coil, circuitry to high-power amplify the generated pulse signal, low-noise amplify the free induction decay following a pulse and digitally switching Rx/Tx in between is needed. Due to the inherent weakness of FID signals, SNR, precise, yet adjustable matching and shielding are of high priority. The PCB is to be designed in KiCAD with spatial and power constraints for mobile use.
Experience with communications engineering and PCB design is recommended.

BEM/FEM Shim-Coil Simulation for NMR B_0-Field Shimming

The performance of NMR spectrometers is heavily determined by the homogeneity of the static magnetic field B_0. To correct inaccuracies due to e.g. mechanical fabrication in permanent-magnet based arrays, the field is often actively *shimmed* with shim-coils. For 3rd order shimming, a set of 15 coils is arranged around the target volume and driven by precise current sources. The boundary element method has recently been employed in determining corresponding coil designs and can incorporate physical constraints better than the previously used target field method. The objective of this thesis is to determine the respectively required current distribution on the cylindrical boundary surrounding the target volume (magnet array center) with the BEM and derive practical coil designs, which can be tested via 3D-printed coil structures.
Experience in field simulation, FEM or BEM is recommended.

Shou 2010 "MRI Coil Design Using Boundary-Element Method With Regularization Technique: A Numerical Calculation Study" doi.org/10.1109/TMAG.2009.2037753