A Professional but yet Low-Cost Software-Defined Radio (SDR) Field-Test Setup for DRM+, DRM30, FM and AM.
Outline

• Introduction
• Getting On-Air
  – The modulator software Spark
  – Getting the RF out of the PC with the USRP
  – The transmission chain at a glance
• The Receiver Equipment
  – Getting the RF into the PC with the Perseus
  – The demodulator software SoDiRa
  – The reception chain at a glance
• Putting It Together
• Conclusion and Outlook
Introduction

• The Past:
  – Professional devices were bulky and expensive.
  – Computers were expensive, less reliable and not powerful enough for SDR.
  – Multiple DSPs had to be used in transmitters and receivers.
  – Few high quality transmitter and receiver devices for digital broadcasting were available.

• The Present:
  – Professional equipment is less bulky (but still expensive).
  – More and more affordable PC-SDR hardware enters the market.
  – Modern PC-SDR transceivers have a remarkable SNR performance.
  – Computers have become cheap, reliable and powerful enough to handle even demanding SDR applications.
  – Cheap single-DSP receiver solutions are available.

For field-trials and low-cost permanent setups:

Use a PC with SDR hardware
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What is Spark?

- A Software-Defined Radio (SDR) modulator for DRM, DRM+, FM+RDS and AM+AMSS developed by Michael Feilen in 2005 [1].
- The software was used for the DRM+ field-trials in Kaiserslautern.
- Spark serves as DRM30 content server and modulator in Canada and Denmark.
- … and furthermore:
  - Ethernet MDI signal provider.
  - MDI → OFDM modulator.
  - A receiver testing software.
  - A test-signal generator.
  - Easy to use.
  - Not a toy, but something fun to play with 😊
  - …
What is the USRP?

- A flexible SDR transceiver developed by a Mark Ettus in 2005 [2].
- Fully open-source (even the hardware).
- Uses four 14 bit digital-to-analog converters (DAC) running at 128 MS/s.
- FPGA-based signal processing chain.
- PC communication via USB.
- Various daughterboards available for modulation up to 2.5 GHz.

**NOTE:**
- The USRP could also be used as a multi-standard receiver unit.
- Successor USRP2 is available and even more powerful.
- There exists free open-source DAB transmission software for the USRP.
The Transmission Chain at a Glance

- You need:
  - PC running Spark under Linux (Windows not supported yet).
  - USRP with Basic-TX or LFTX daughterboard.
    (WBX daughterboard 50 MHz to 2.5 GHz will be supported soon)
  - An amplifier and an antenna on your roof (or in your lab 😊).
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Getting the RF into the PC with Perseus

- Two solutions:
  - Using the USRP (Rx chain)
  - Using the Perseus HF receiver.

- The Perseus HF receiver was published by Nico Palermo in the year 2007 [3].
- The receiver is connected to the PC via USB and accessed via RateMonkey®.
- Alias-free bandwidth: 0-30 MHz.
- Preselection filterbank.
- High sensitivity >100 dB.
- But unfortunately not capable of sampling signals above 30 MHz 😞
VHF Band II Downconverter

- Developed by Rudolf Ille in the year 2010 [4].
- Static modulation from the VHF band II to baseband, i.e. from 80 to 108 MHz to 0 to 30 MHz and High linearity.

- Perfect for FM and DRM+ receptions with the Perseus receiver.
SoDiRa, the Free Multi-Standard PC Receiver

- SoDiRa is a free multi-standard DRM30/DRM+/FM/AM decoder and was published in 2007 by Bernd Reiser [5].
- Runs on a Windows machine and requires a sound-card interface.
- Remote-control for various analog tuner frontends.
- For DRM+, a complex baseband sample rate of 96 kS/s is sufficient.

AND NOT TO FORGET DREAM FOR AM AND DRM30 😊
The Receiver Chain at a Glance

- You need:
  - An antenna on your roof (or in your lab 😊).
  - PC running SoDiRa under Windows.
  - A VHF converter (FMC) to do DRM+ or FM for the Perseus.
  - An SDR sampling receiver, e.g. the Perseus (or the USRP).
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Putting It Together

Transmitter:
Content server, OFDM modulator and SDR-RF output

Receiver:
SDR-RF input
OFDM demodulator and content decoder

Spark → USRP → FMC → Perseus → SoDiRa

> 70 dB SFDR
Putting It Together – The Future.

Transmitter:
Content server, OFDM modulator and SDR-RF output

Receiver:
SDR-RF input
OFDM demodulator and content decoder

Spark USRP(2) USRP(2) SoDiRa

> 80 dB SFDR
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Conclusion

- Low-cost professional digital broadcasting and reception is possible.
- Software transmitter and receiver chains for DRM+, DRM30, FM and AM are available.
- Field-trials have proven that PC-based solutions have become reliable.
- FM stations with a limited budget can afford to try DRM+ by using PC-based solutions and even switch back to FM as a fallback option.
- PC SDR hardware has become affordable and powerful.

Outlook

- SDR receivers will find their way into mobile devices.
- Integrated high-rate SDR frontends will become cheaper.
References

[1] Spark, a multi-standard SDR transmitter, [www.drm-sender.de](http://www.drm-sender.de)
[3] Perseus, SDR receiver by Microtelecom, [www.microtelecom.it](http://www.microtelecom.it)
[4] FMC VHF converter by NTI, [www.nti-online.de](http://www.nti-online.de)
[5] SoDiRa multi-standard SDR receiver, [www.dsp4swls.de](http://www.dsp4swls.de)
Thank you!

Questions?