

A **Professional** but yet **Low-Cost**

Software-Defined Radio (SDR)

Field-Test Setup for DRM+, DRM30, FM and AM.

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Tagung des Deutschen DRM Forums

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Outline

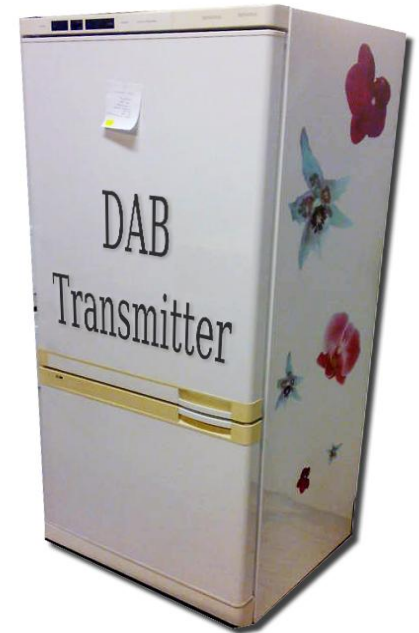
- **Introduction**
- Getting On-Air
 - The modulator software **Spark**
 - Getting the RF out of the PC with the **USRP**
 - The transmission chain at a glance
- The Receiver Equipment
 - Getting the RF into the PC with the **Perseus**
 - The demodulator software **SoDiRa**
 - The reception chain at 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

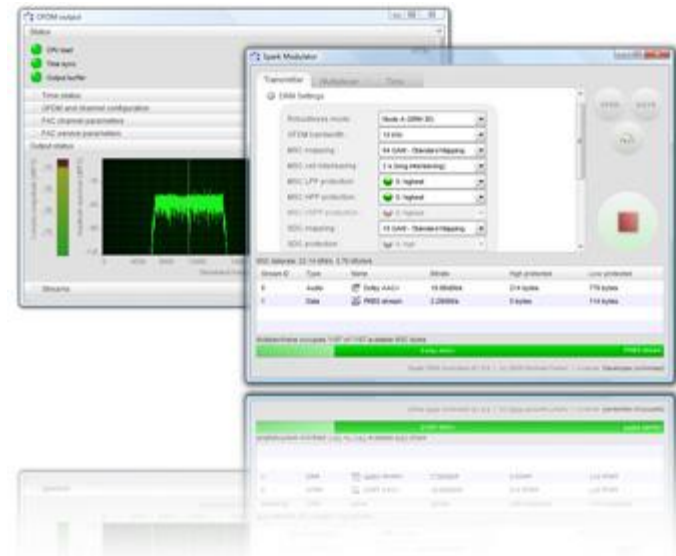


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What is Spark?

- 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 😊
 - ...



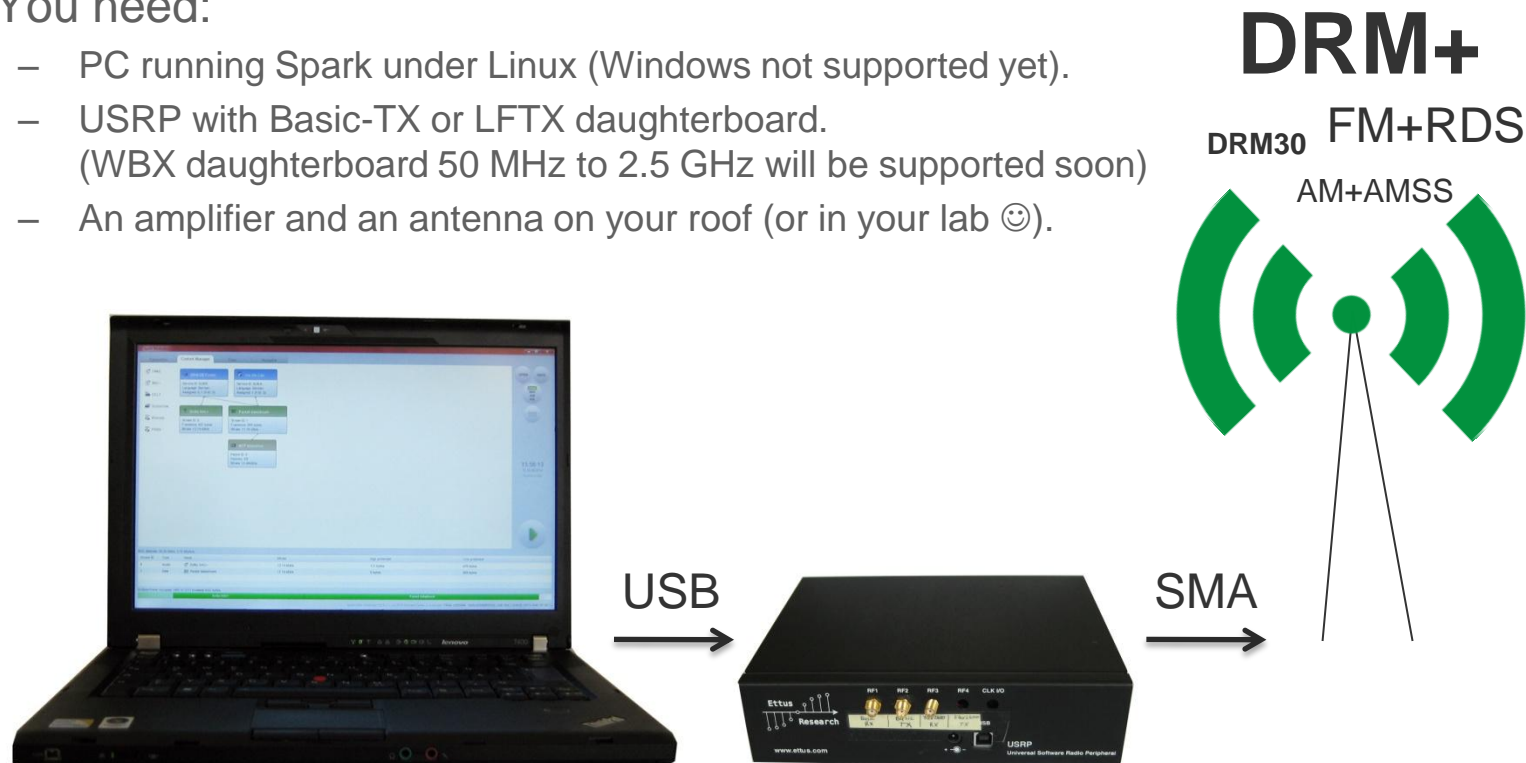
What is the USRP?

- A flexible SDR transceiver developed by 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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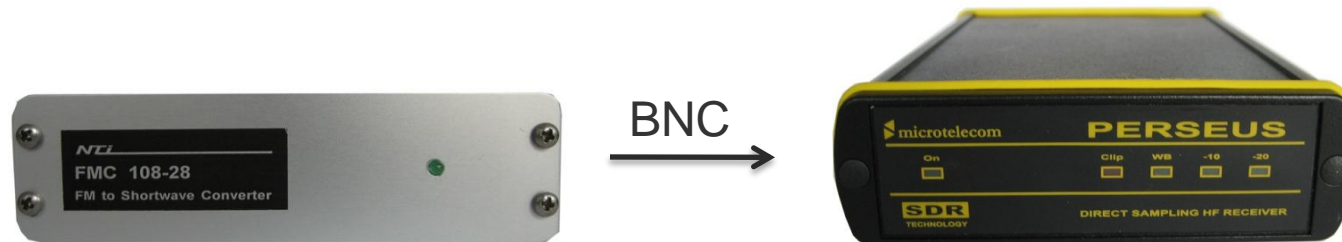
Getting the RF into the PC with Perseus

- 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

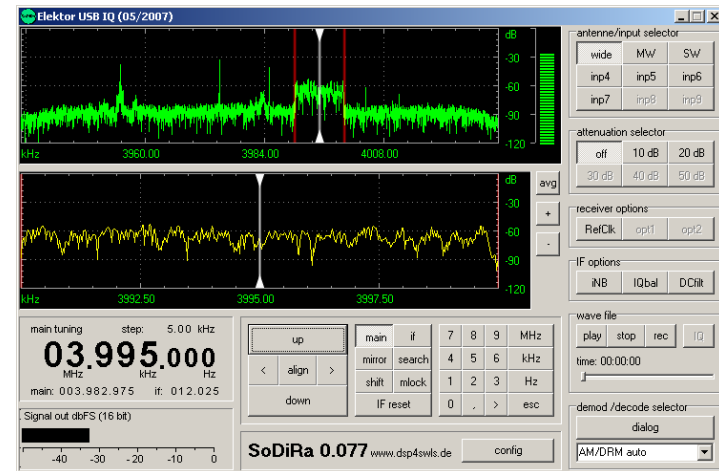
- Developed by Rudolf Ille in the year 2010 [4].
- Static modulation from the VHF band II to baseband, i.e. from 80 to 108 MHz to 0 to 30 MHz and High linearity.
- → Perfect for FM and DRM+ receptions with the Perseus receiver.



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).

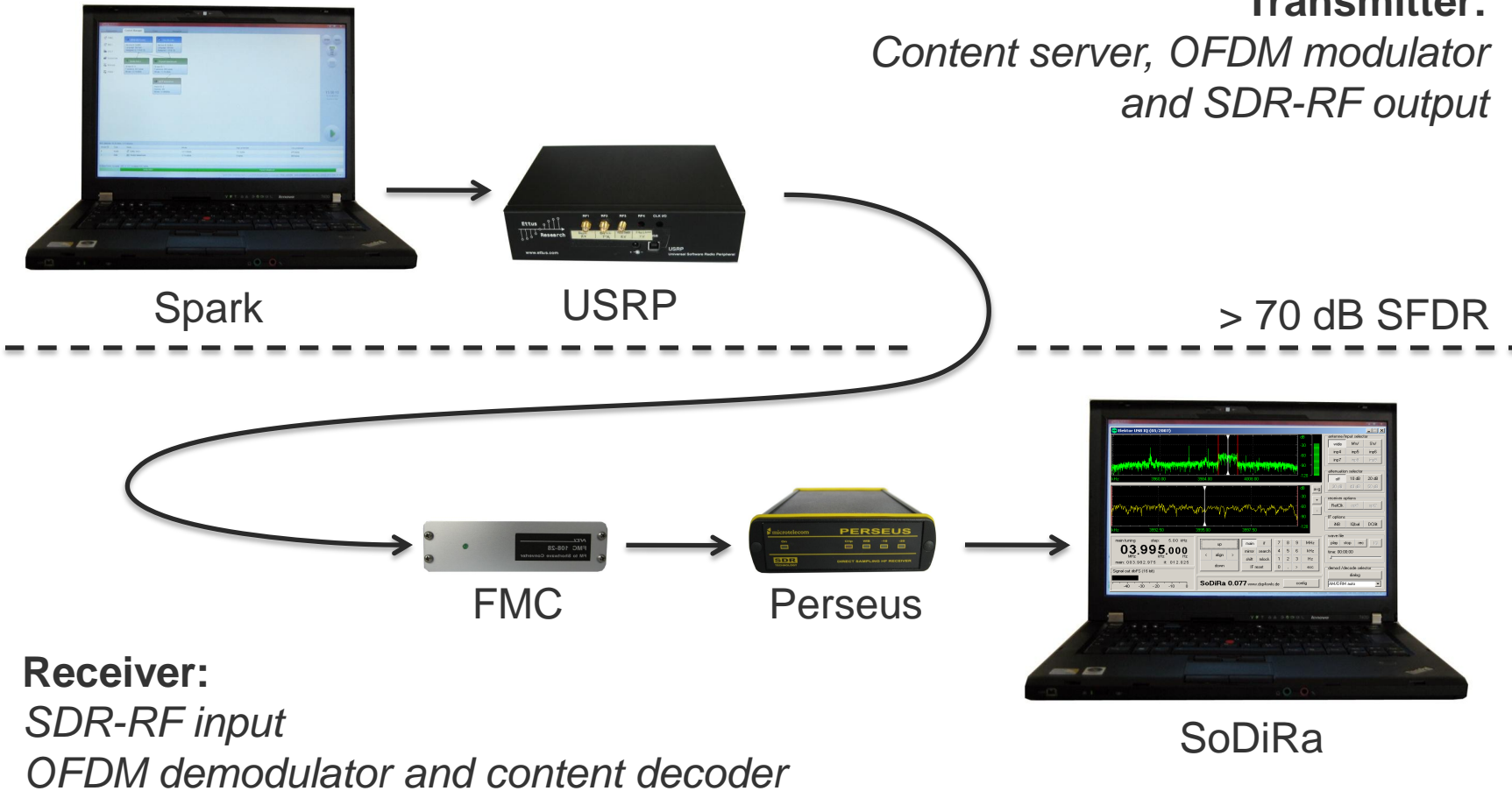


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Putting It Together

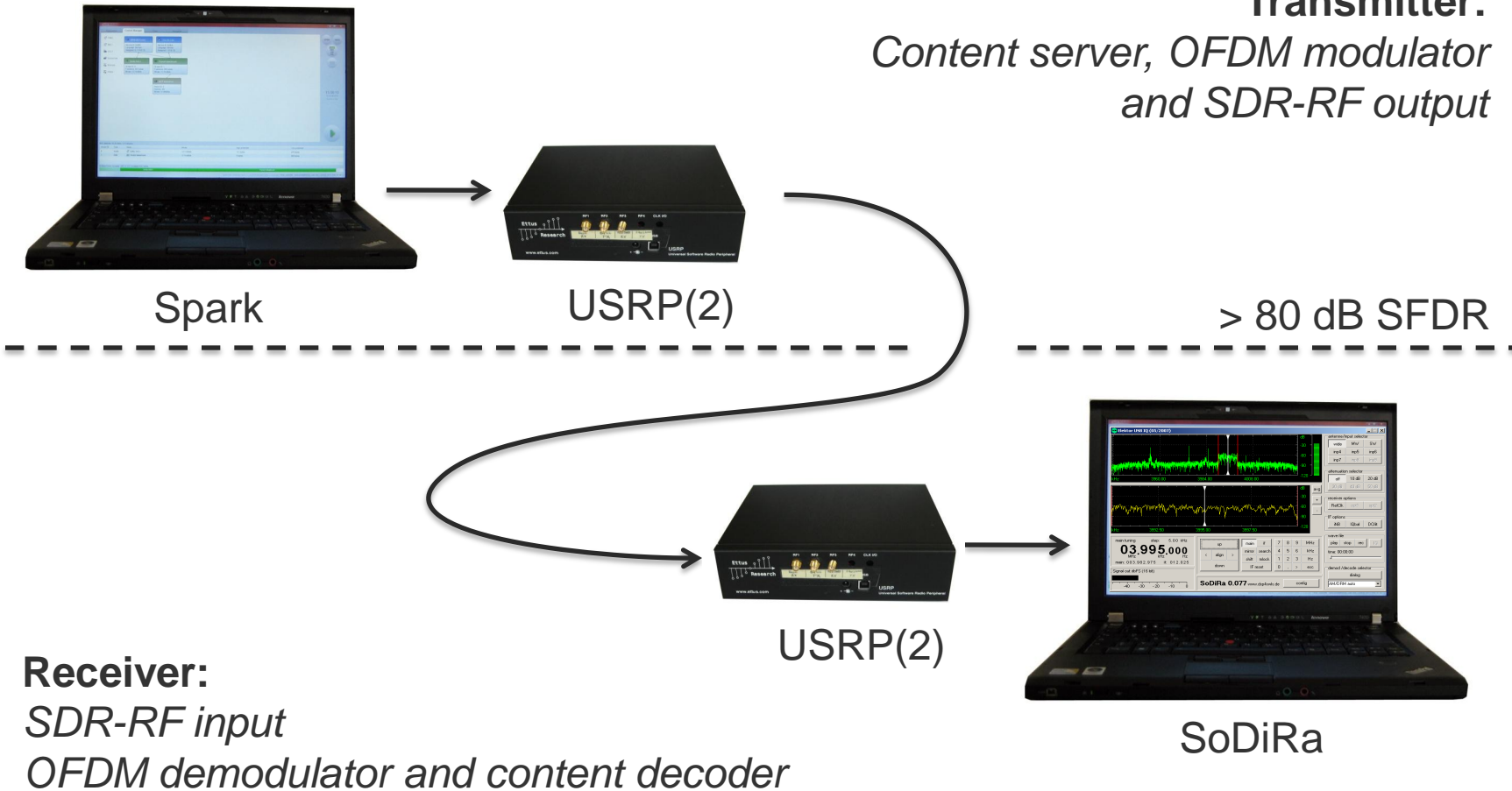
Transmitter:
*Content server, OFDM modulator
 and SDR-RF output*



Receiver:
*SDR-RF input
 OFDM demodulator and content decoder*

Putting It Together – The Future.

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



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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 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
- [2] The Universal Software Radio Peripheral (USRP), www.ettus.com
- [3] Perseus, SDR receiver by Microtelecom, www.microtelecom.it
- [4] FMC VHF converter by NTI, www.nti-online.de
- [5] SoDiRa multi-standard SDR receiver, www.dsp4swls.de
- [6] CELT, www.drm-sender.de/celt_in_drm.pdf

Thank you!

Questions?

I  DRM