Michael Feilen
03.07.2014

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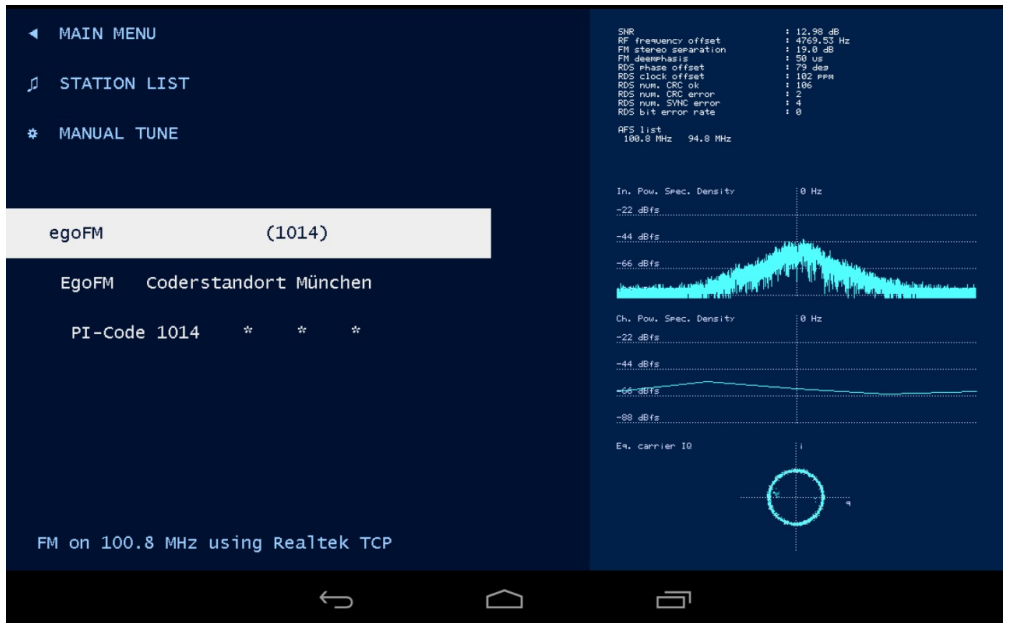
Outline

- Introduction to Wavesink
- Architecture
- Performance

- DAB vs. DRM (incoherent vs. coherent)
- DRM+ in VHF III

What is Wavesink?

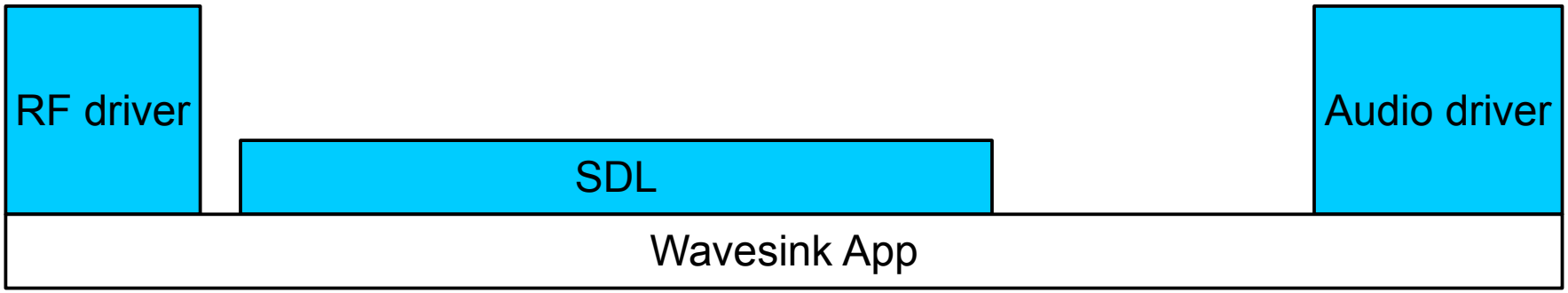
- Software-defined VHF radio demodulator
- FM/RDS, DRM+, DAB+
- Fixed-point C
- Cross-platform UI
- RF frontends:
  USRP, RTL2832,
  Funcube, RAW



Architecture

Wavesink App

Architecture



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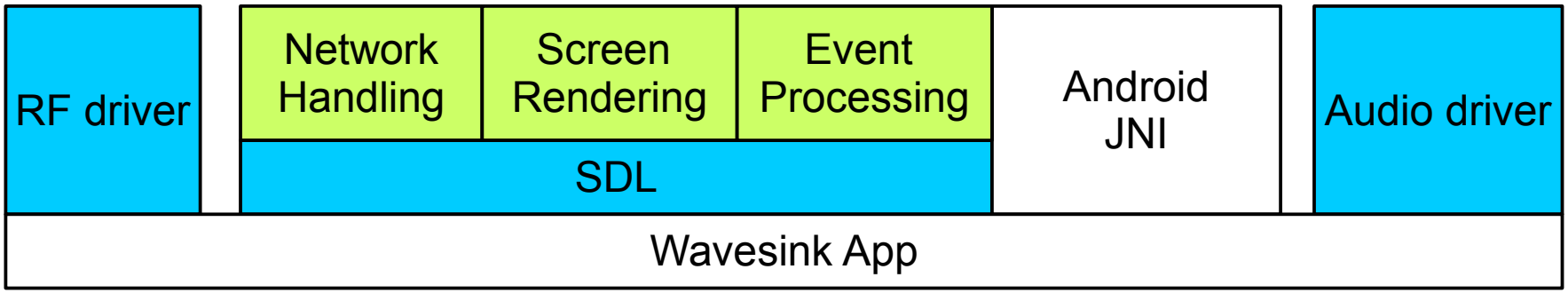

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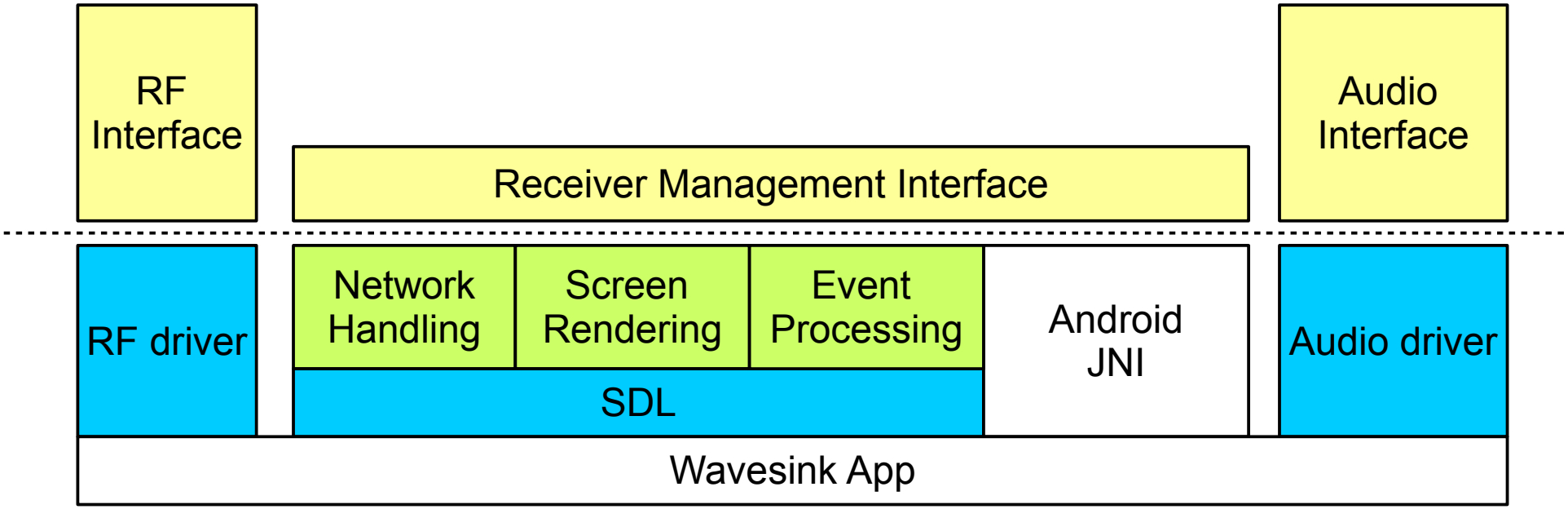

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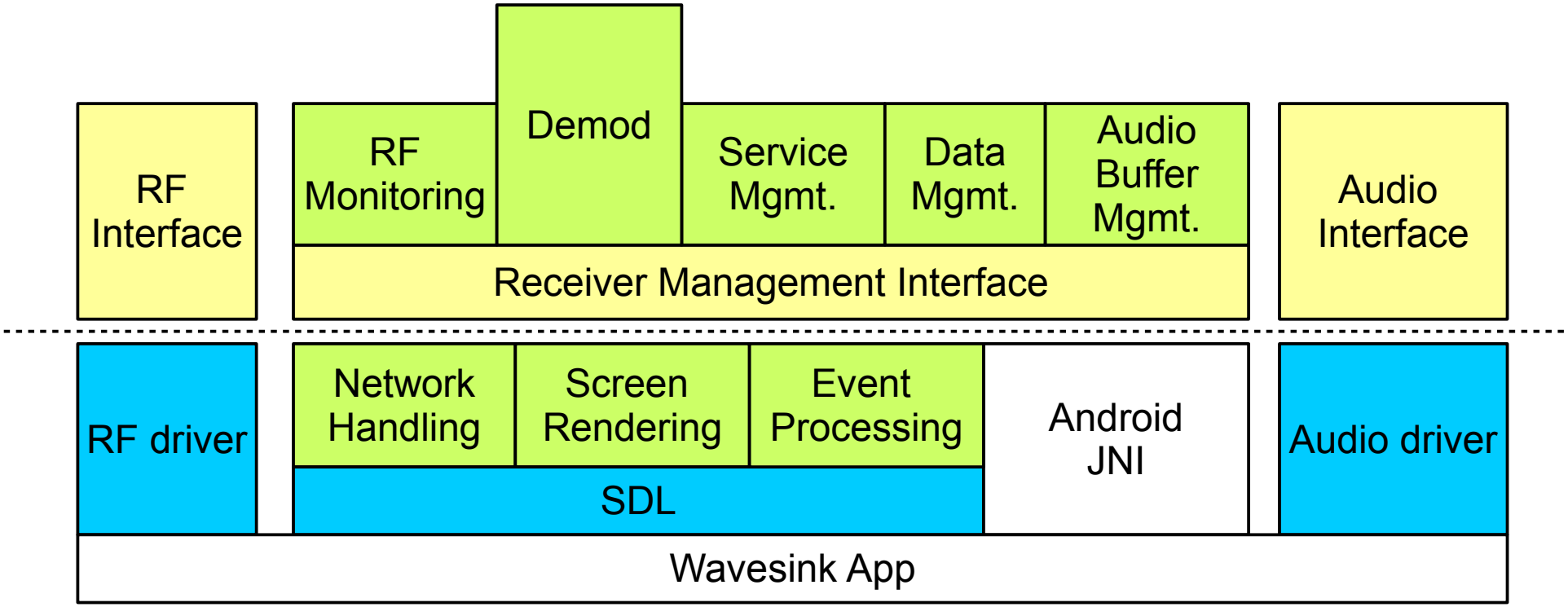

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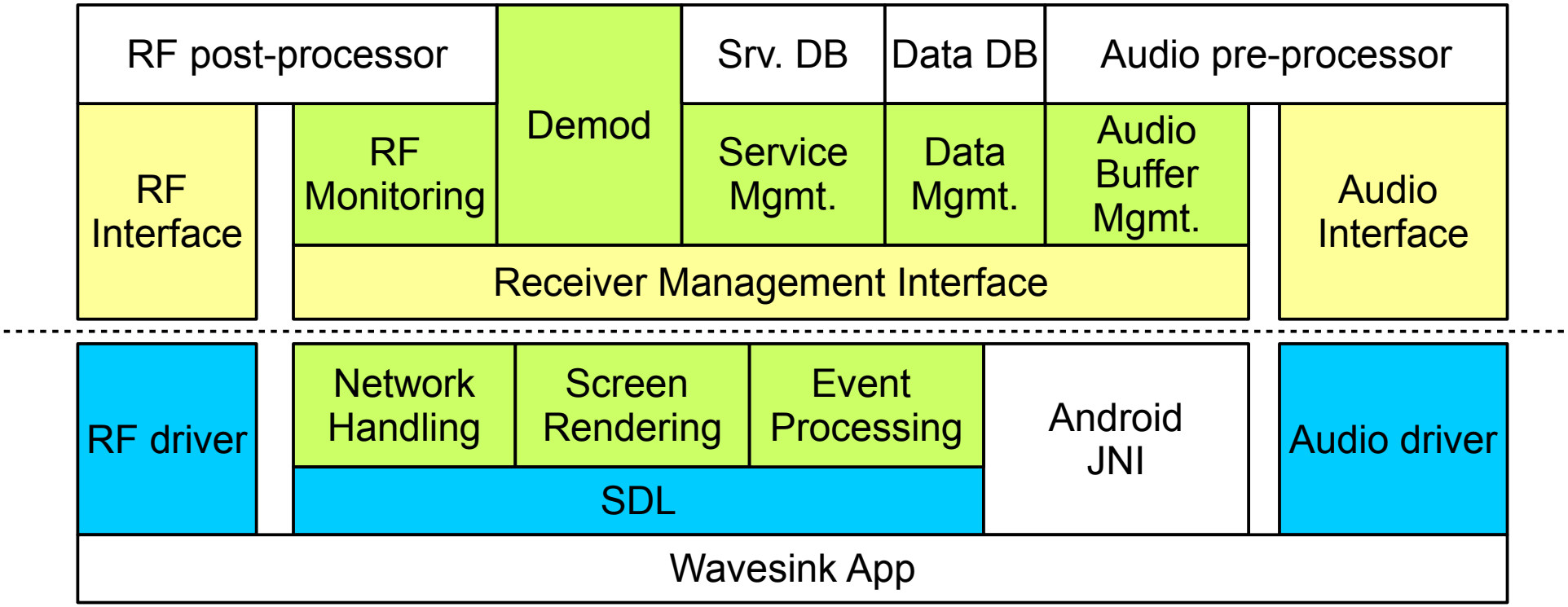

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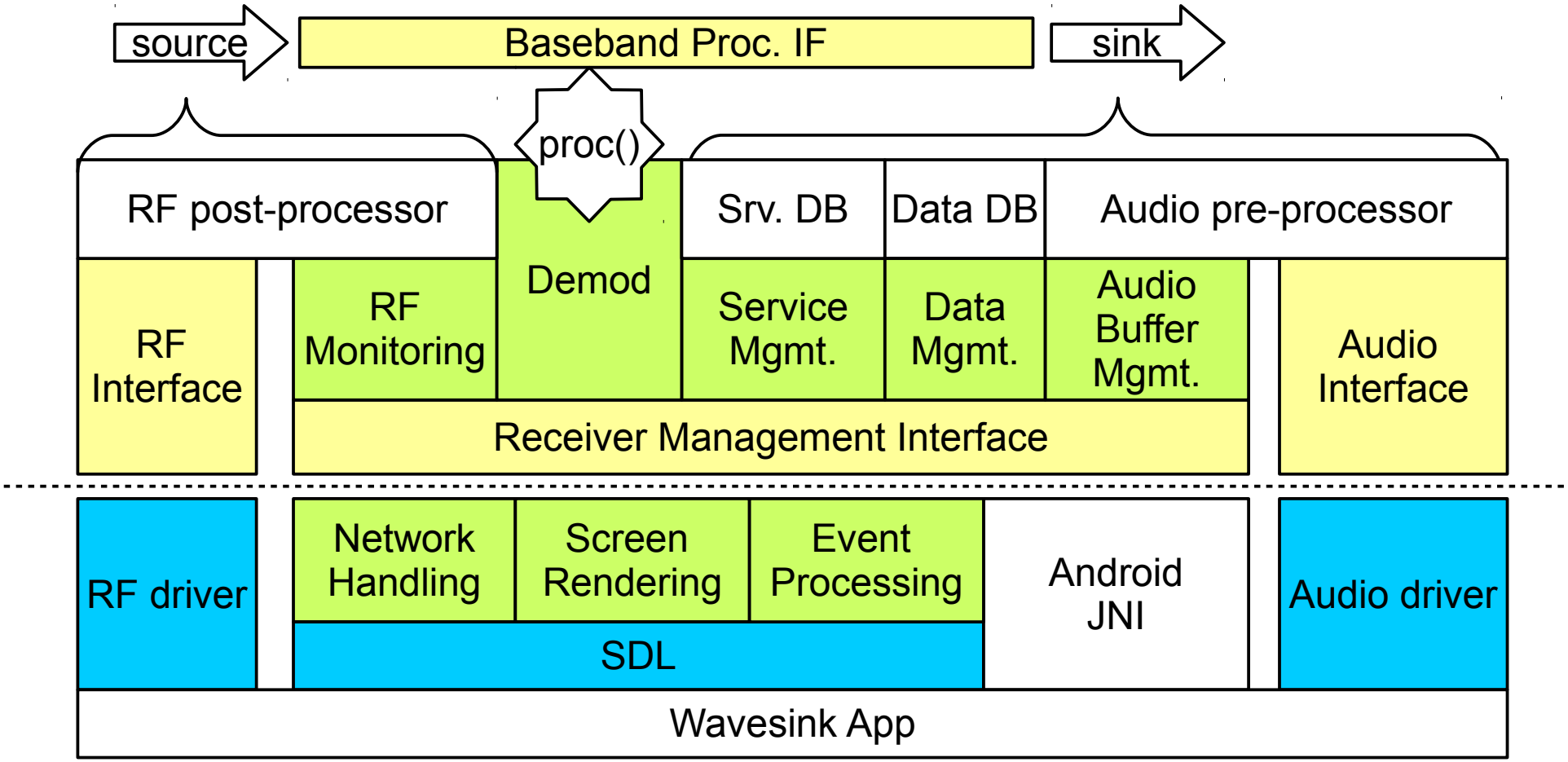

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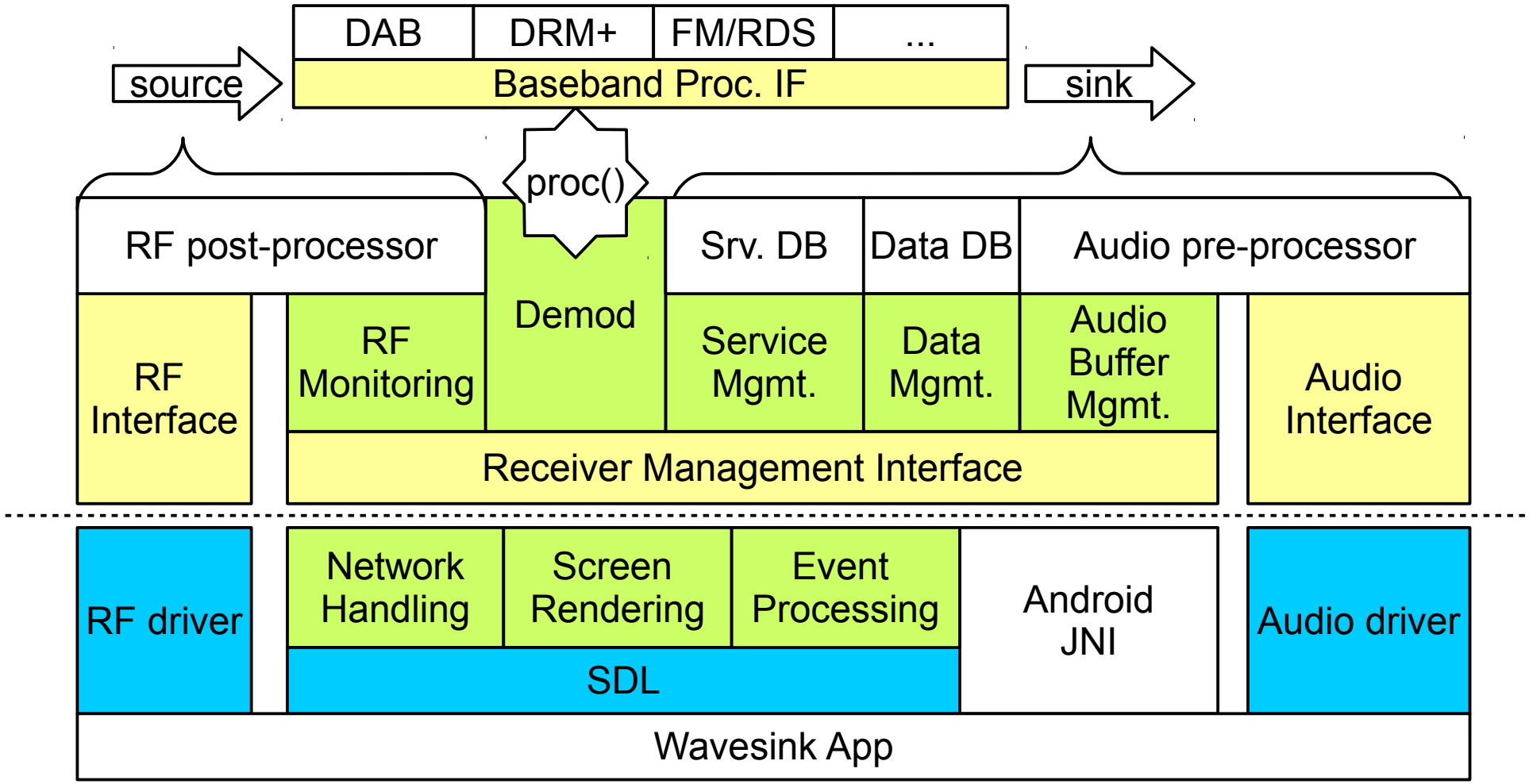


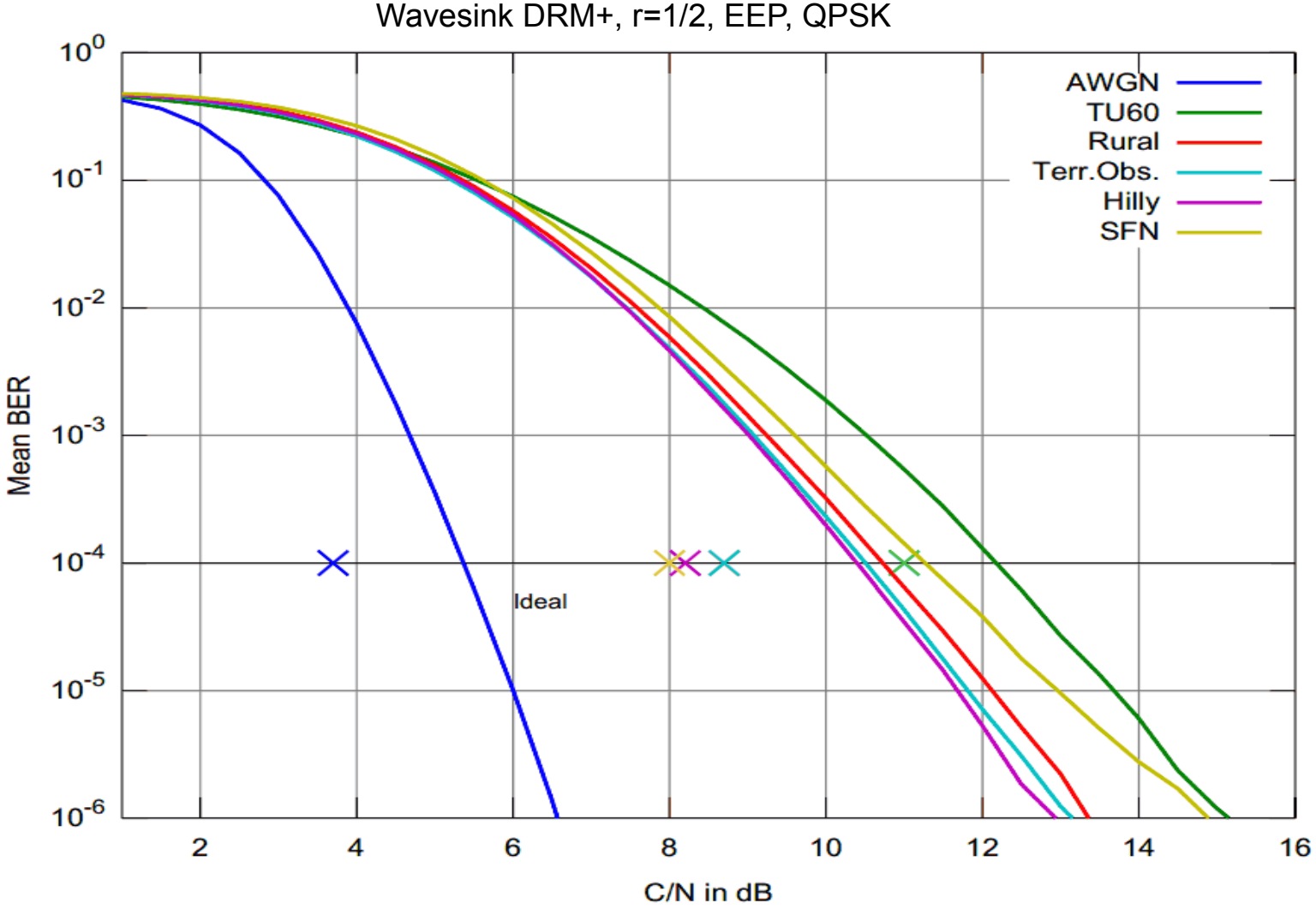
FM/RDS Demod

- CMA channel equalizer
- PLL demod with IIR-phase equalizer
- Pilot PLL with group delay equalizer
- SNR-based difference-signal weighting
- Coherent DBPSK RDS demodulator with phase and amplitude tracking

DRM+ Demod

- Demod not 192 kHz based (faster) :)
- Bilinear channel estimation (no MMSE)
- Clock, frequency, time offset tracking
- LLR energy tracking
- Soft-decision Viterbi decoding (no MLC dec.)
- DCP MDI output

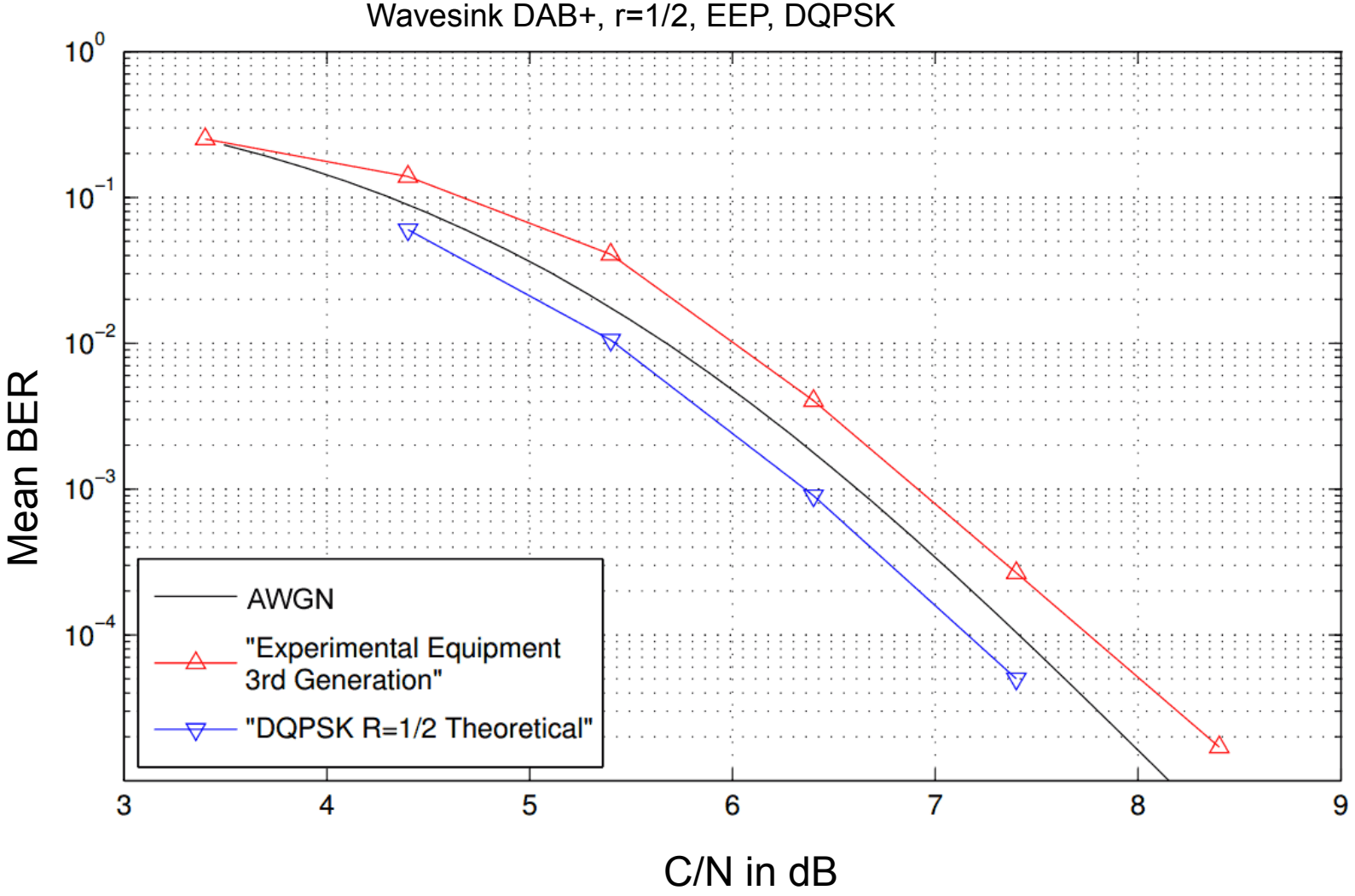
DRM+ Performance



DAB+ Demod

- Optimized FFT with combined deinterleaving
- Frequency, time offset tracking
- Soft-decision Viterbi decoding
- IR estimation

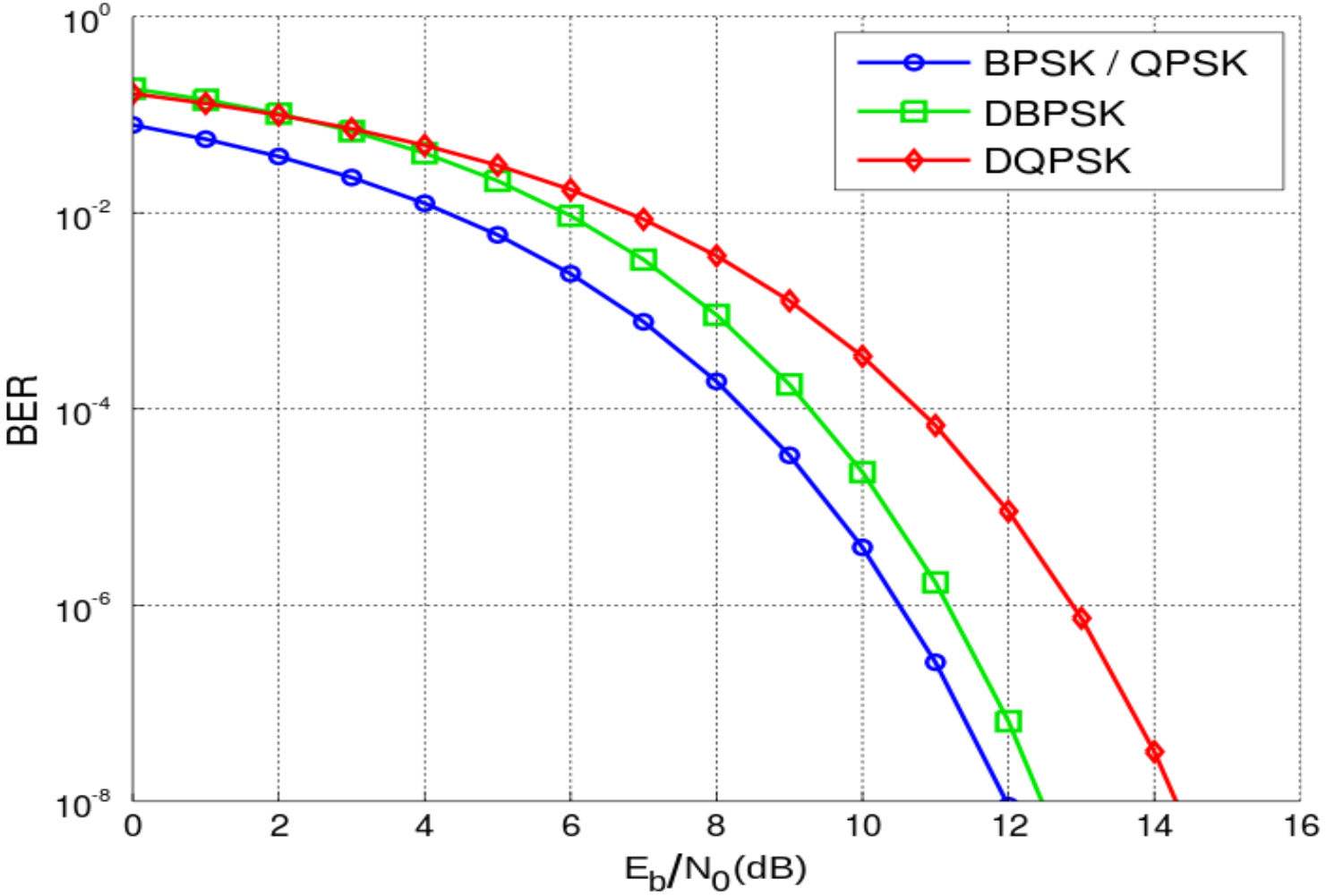
DAB+ Performance



And now ...

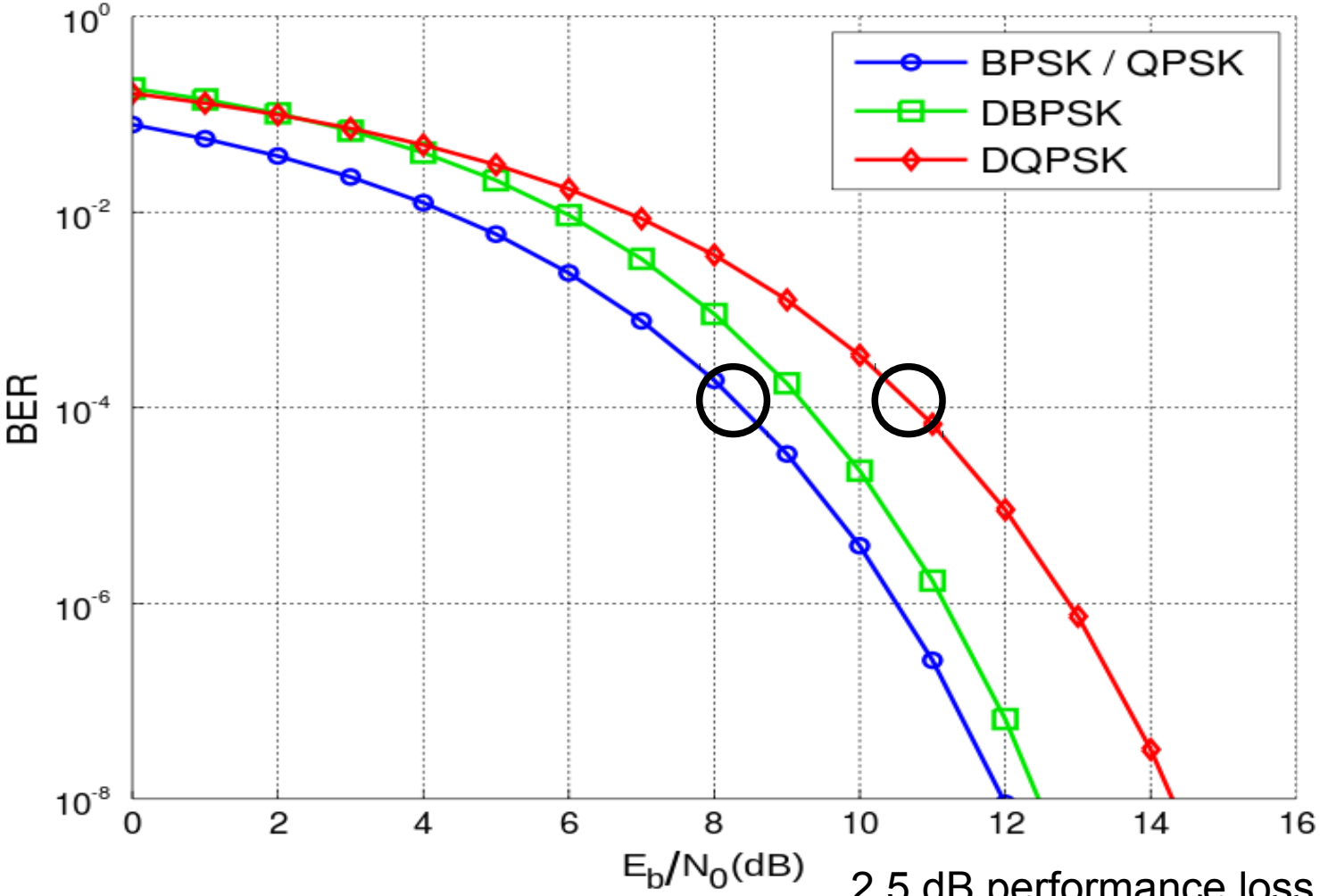
... to something somewhat different

Coherent (DRM) vs. Incoherent (DAB)



Quelle:
Wikipedia

Coherent (DRM) vs. Incoherent (DAB)



Quelle:
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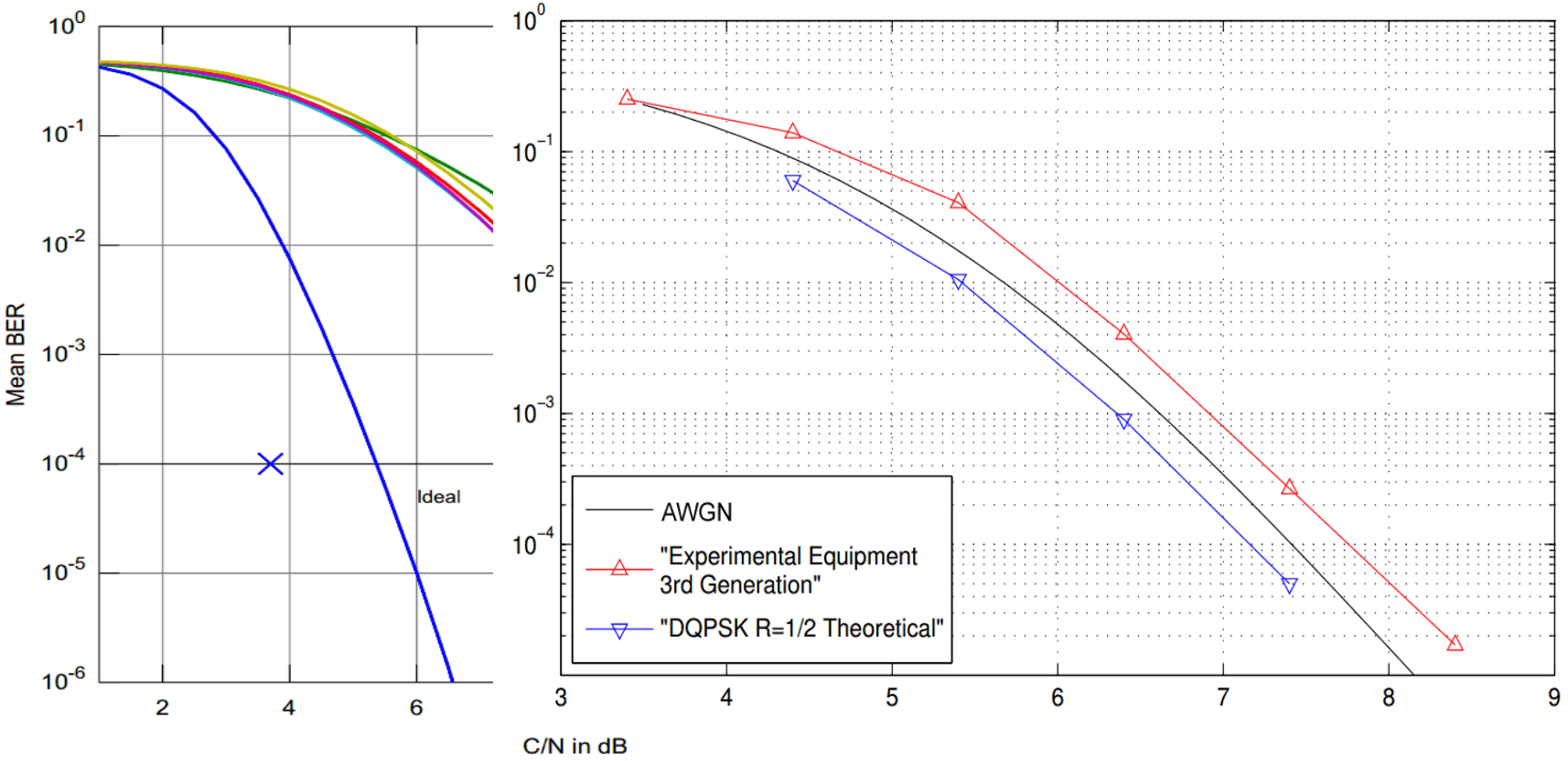
2,5 dB performance loss @ BER 10^-4

Coherent (DRM) vs. Incoherent (DAB)



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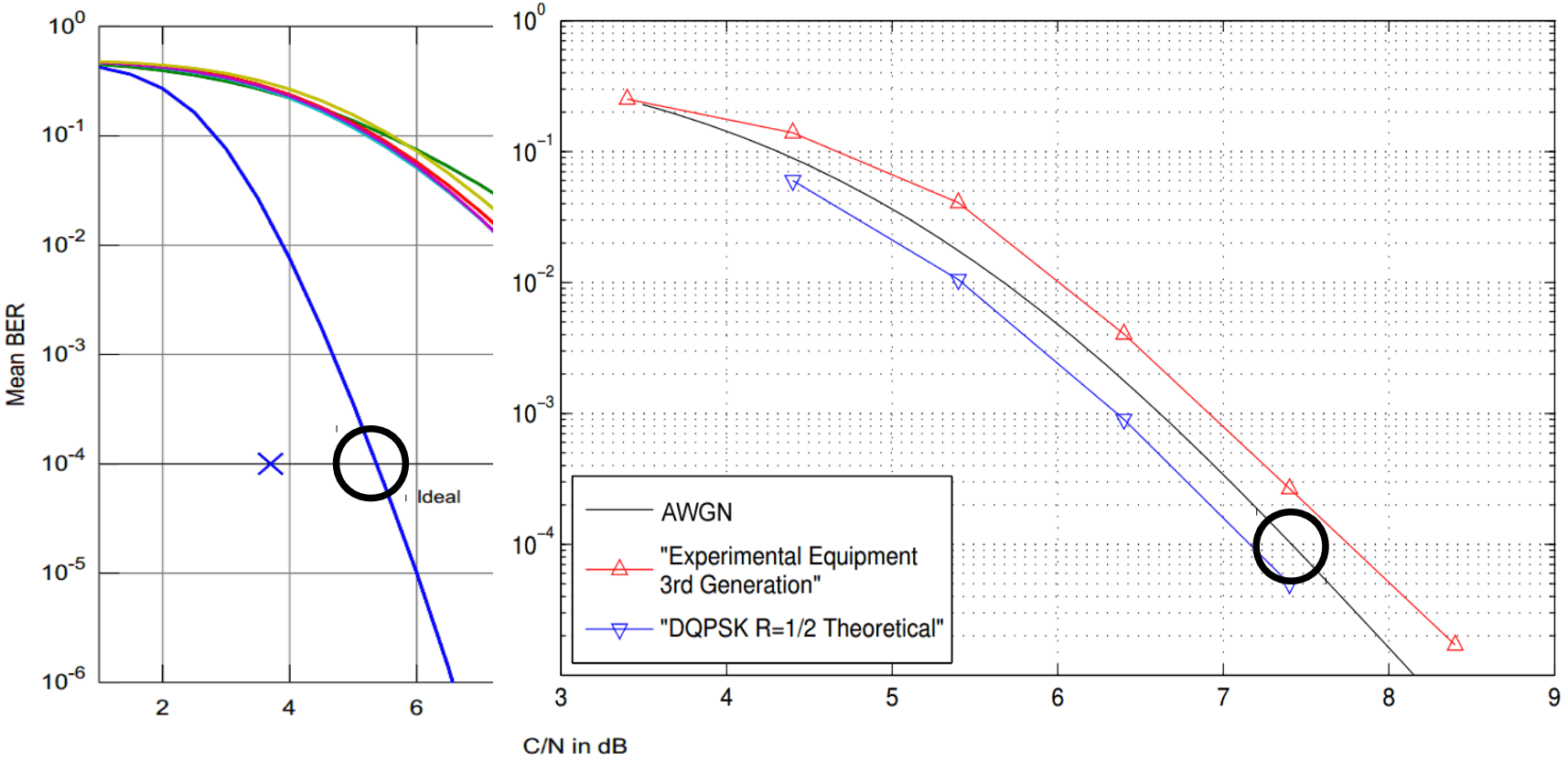
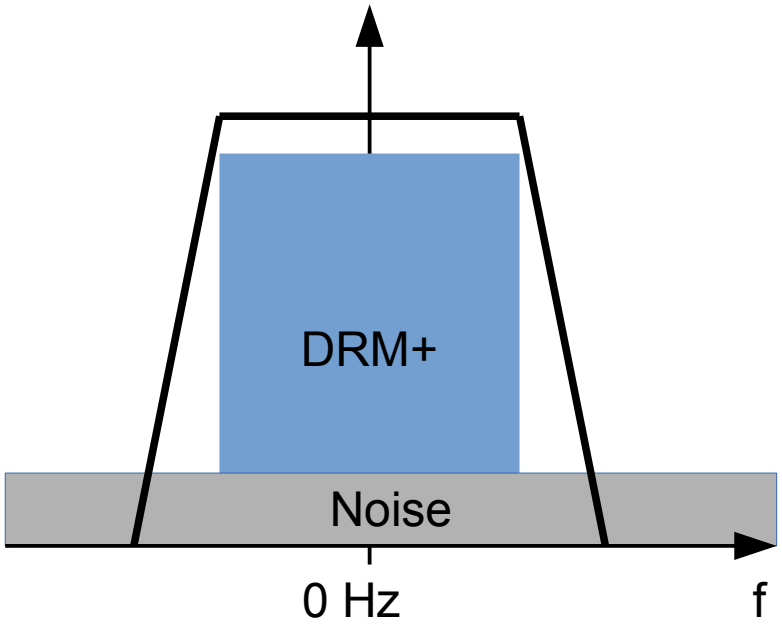


2,5 dB performance difference

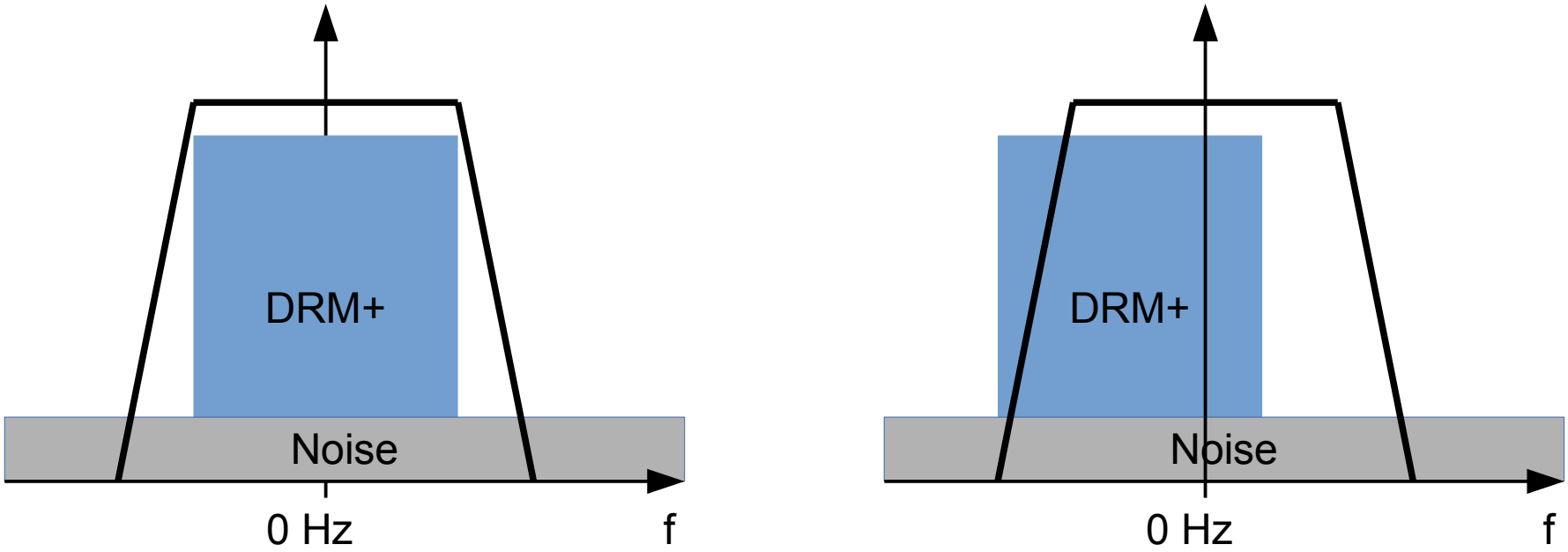
DRM+ in VHF

- Effect of frequency offset



DRM+ in VHF

- Effect of frequency offset



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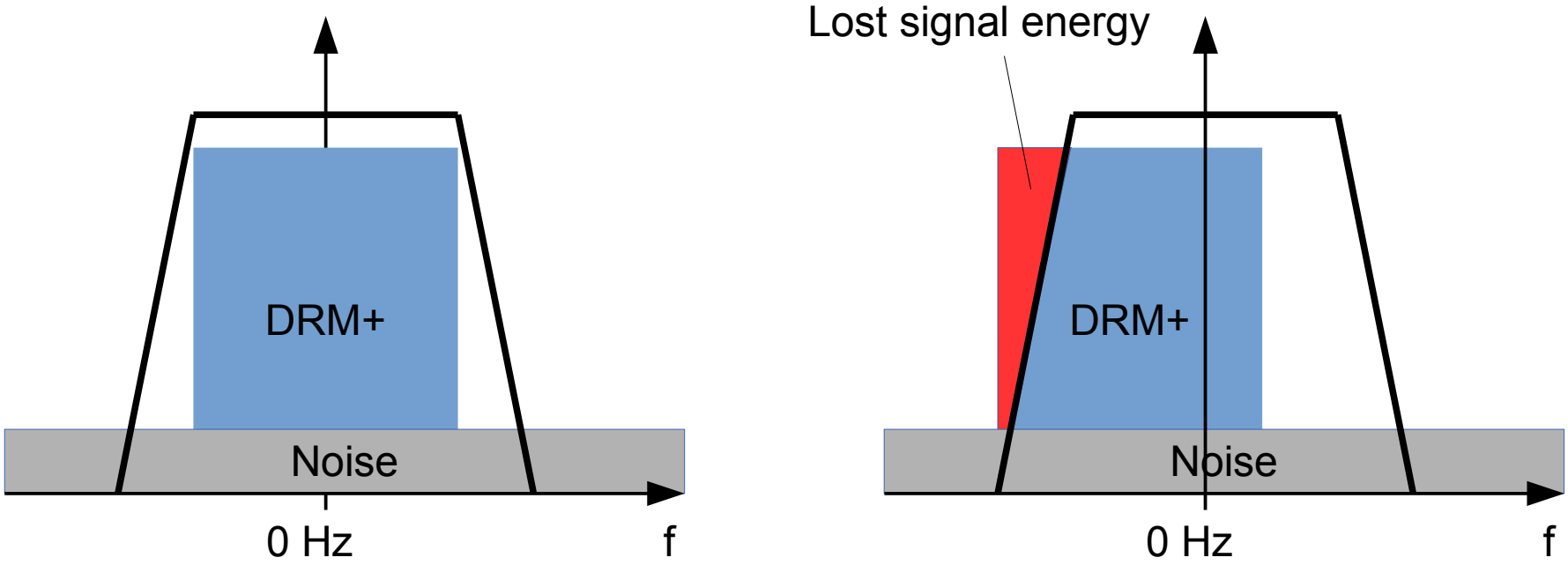

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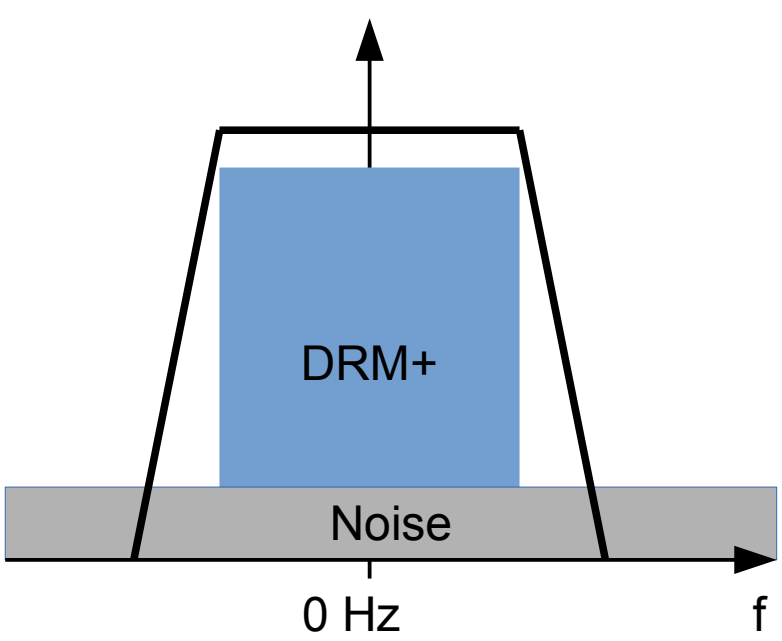
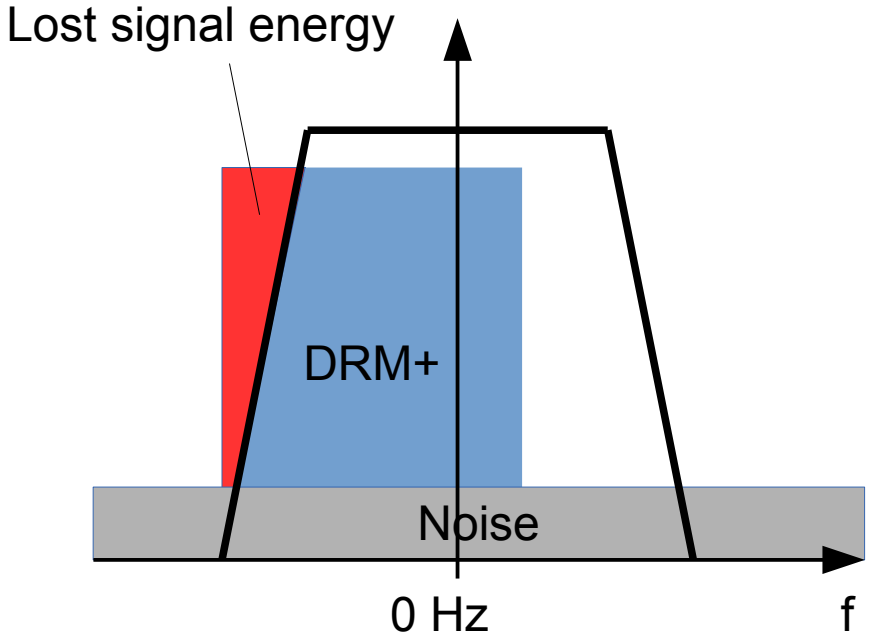
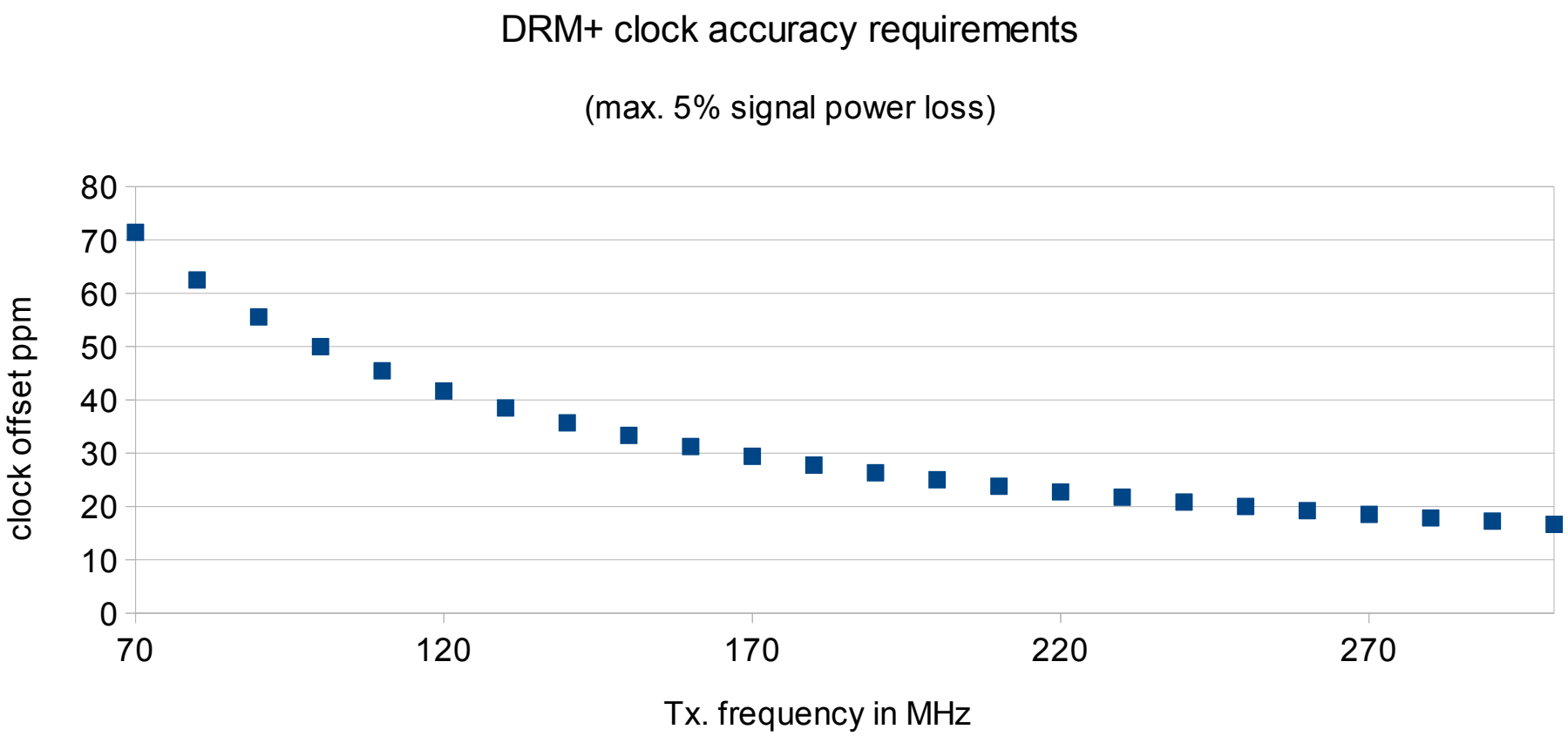




Can cause problems during acquisition

DRM+ in VHF


DRM+ clock accuracy requirements
(max. 5% signal power loss)
clock offset ppm
80
70
60
50
40
30
20
10
0
70
120
170
220
270
Tx. frequency in MHz

DRM+ in VHF

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- Receiver moves → Doppler freq. shift
- Doppler shift → Time-selective fading

  Pilot-period in time must satisfy Shannon-Nyquist theorem (channel estimation)

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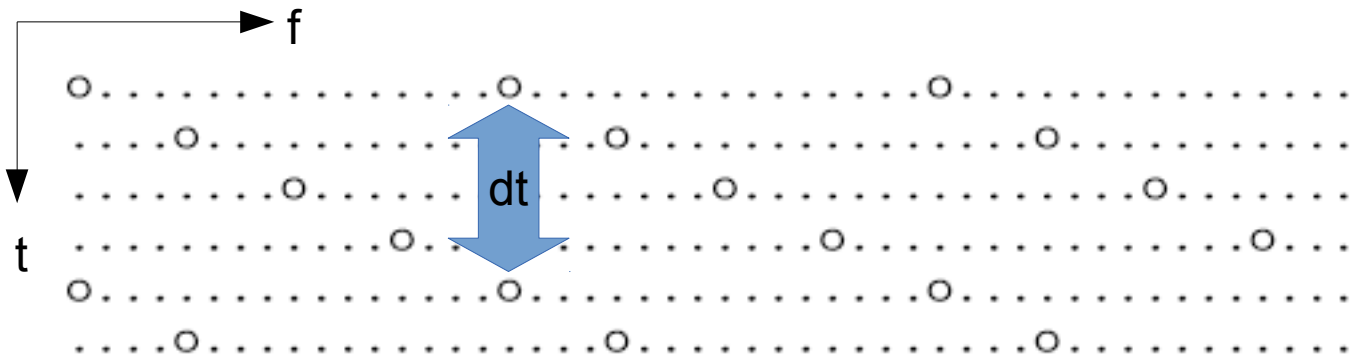
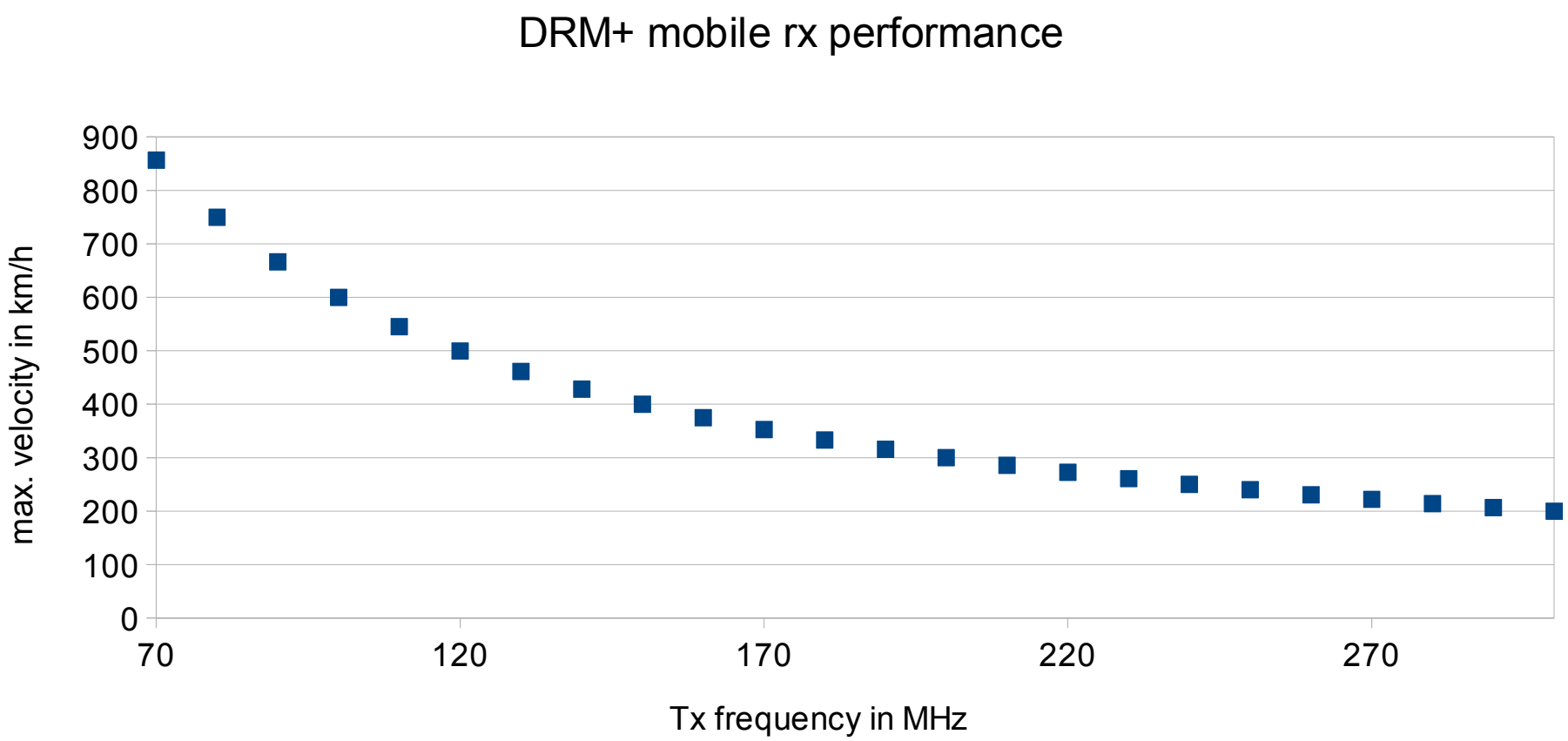


DRM+ in VHF


DRM+ mobile rx performance
max. velocity in km/h
900
800
700
600
500
400
300
200
100
0
70
120
170
220
270
Tx frequency in MHz

Conclusion

- Low-cost software-defined receiver available
- SDR allows update functionality (no new HW)
- Internet backlink on smartphones
- DRM+ feasible for VHF Band III