#### **OPENDIGITALRADIO.ORG**

#### **DAB/DAB+ for community radio**

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#### Plan of the presentation

- DAB/DAB+ infrastructure
- Some figures for professional setup
- Software Defined Radio and Open tools
- Demonstration
- Discussion



## DAB+ infrastructure



#### DAB/DAB+/DMB transmission infrastructure



Source: www.worlddab.org



#### Infrastucture

- Encoder: create the DAB+ HE-AAC audio stream
- Ensemble Multiplexer: Gather all the streams (+data)
- Modulator: Create the digital radio signal
- Amplifier: pump up the jam ;-)
- Mask Filter: to meet BAKOM spectrum requirements
- Antenna: radiate the jam
- + communication lines (STL) between studio, multiplexer and transmitter sites

For single frequency network of many transmitters, add:

GPS synchronisation clocks



## DAB+ professional setup



#### Typical prices for professional equipment

Equipment	Professional
DAB+ Encoder	~4000€
Transmission to operator	Leased line: 500-1500€/month
DAB multiplexer	~15'000€
Modulator	~10'000€
250 Watt effective amp	~20'000€
Mask Filter	1500-2500 €
Antenna	500 € (dipole) - 2000 € (panel)



## Typical price for professional sites

Investment:

- Small site (~500W) : ~ 50'000 €
- Big site (>1kW) : 120'000 €
- + accessories (mast, etc)
- + installation
- + engineering, bakom, ORNI/NIS

Running costs

- Rent, Electricity, Cooling
  - Typical for an operator: 2000-10'000 Frs/month



#### **Professional solutions**

- High Investment&Operational costs (CAPEX/OPEX)
  - increase with the number sites and SFN
- But division by the number of stations
- Finally turns out to be cheaper than FM for national or big broadcasters
- Often not affordable for local/community/non commercial broadcasters
- Proprietary solutions
- Operator solution not easily scalable





Digital radio broadcast, far too complex/costly for small radios or experimenters ?





# It may not be the case anymore...



## Software defined radio



#### Traditional approach of radio transmission/reception

- Specific dedicated hardware
- Low volumes, high prices
- Limited flexibility
- Few possibilities of evolution







ond The audio in

#### Software Defined Radio (SDR) Principle



- Software (de-)modulation
  - Can run on a standard PC platform
- Generic hardware
  - « Like a soundcard » but for radio waves

=> High flexibility, limited by CPU/Interface



## PC platform nowadays



- Powerful enough to perform live encoding, multiplexing and complex modulation (COFDM) on a single PC
- High speed interfaces
- Incredibly low price considering the complexity and processing power



#### A great blackbox !





#### Democratisation of Software Defined Radio

- USRP: Universal Software Radio Peripheral
  - Open hardware solution sold by Ettus for 700\$
  - Schematics, FPGA code available to the public
  - Can transmit or receive signals up to 15MHz BW







#### USRP: Universal Software Radio Peripheral





#### What you can do with the USRP and a PC

- FM RDS transmission and reception
- DAB/DAB+ transmission (CRC-mmbTools)
- DRM/DRM+ transmission/reception (Spark, Dream)
- DVB standards, possible but no open projects yet
- Local GSM Network (OpenBTS project)
- GPS receiver
- Aircraft beacon receiver
- Passive Radar
- DECT, RFID, Wifi, etc



# SDR projects for broadcasting



#### **DAB Software Radio**



http://mmbtools.crc.ca



- Developed by Communication Research Center (CRC), Canada
  - Francois Lefebvre, Pascal Charest
  - First public demo at IBC2006
  - Presented to WorldDMB TC, Eindhoven 09/2006
- CRC-DABMUX: DAB/DAB+/DMB Multiplexer
- CRC-DABMOD: DAB Mode II OFDM modulator (no SFN)
- Other tools for slideshow, CELT, DAB+, etc
- Open sourced in 2009-2010 (GPL license)



### Opendigitalradio.org

- Warning ! These tools are <u>not</u> turnkey solutions
- Experimental

www.opendigitalradio.org:

 Document experimentations on digital radio broadcasting using open tools and hardware techniques





#### Spark

Spark Modulator					SFDM output
Transmitter	Content Manager	Time	Autopilot		Status
(ARC FAAC	Spark			OPEN SAVE	CPU load Time sync
CELT	Language: German Assigned: 0				Output buffer
<sup>1</sup> Slideshow					OFDM and channel configuration
Website	5) Dolby AAC+			UPDATE	> FAC channel parameters
PRBS	Framesize: 1107 bytes Bitrate: 22.14 kBit/s			20:44:30 SU 06.06.2010	<ul> <li>FAC service parameters</li> <li>Output status</li> </ul>
				Synchronized	Image: second
C datarate: 22.14 kBit/s	s 2.76 kByte/s	Bitrate	High protected	Low protected	g
0 Audio	tance €) Dolby AAC+	22.14 kBit/s	244 bytes	863 bytes	-1001
iltiplexframe occupies 1	107 of 1107 available MSC byte	S Dolby AAC+			-120

- DRM/DRM+ encoder/multiplexer/modulator
- Not Free/Open but trial and licensed versions (windows)
- http://www.drm-sender.de



## Demo!

Encoding, multiplexing, modulating, transmitting 12 DAB+ live programme



# Practical cases with DAB and CRC mmbtools



### Application: Performance at Label Suisse festival





- Live local broadcasting of 8 DAB channels
- Audio from a video projection of 8 music bands playing
- First licensed DAB transmission fully open source



#### Application: Performance at Label Suisse festival





- DAB transmission by Maxxima
  - Video projection by MXLab



More information on http://www.opendigitalradio.org







## Application: Multiplatform & Hybrid Radio demo



 Generation of DAB (+Slideshow), FM RDS, DRM broadcast signals



#### Application: EBU Multiplatform Hybrid demo at IBC





#### DAB/DAB+ (and FM, DRM, streaming) in a box







#### Hardware for local DAB/DAB+ transmission





## Application: The EBU demo at IBC 2010

- Local DAB coverage at IBC
- DAB/DAB+ live and DMB pre-recorded
- Equipment for DAB transmission:
  - PC: ~800€
  - Linux, gnuradio, CRC-mmbTools: 0€
  - USRP + RF frontend: 1150\$ (~820€)
  - Amplifier 35 Watts CW, 6W OFDM: ~ 150€
  - VHF Mask Filter, 6 cavities: 1300 €
  - VHF 5dB 3 elements Antenna: 300€
  - Small equipment: 100€
  - TOTAL: ~ 3500 €



#### Under development

- Higher power transmission for coverage of a city
- Temporary digital licence (Maxxima radio project)



600W (CW) class AB amplifier development (by Stan Roehrich Maxxima.org)



## Amateur radio DRM trial in Sottens using Spark





• 4.5kHz, Mode B, MSC 16QAM, EEP code rate 0.5, AAC audio at 4.8kbit/s

• 4.5kHz, Mode B, MSC 64QAM, EEP code rate 0.5, AAC Audio, MOT Slideshow at 2.56 kbits/s







# Great, I want to build my digital radio bouquet over my city tomorrow ! How to ?



# Possibilities for real DAB+ local Ensemble



#### Software Defined Radio benefits



- SDR lower the costs by shifting to generic hardware
- Enable flexible multiplatform transmission (and reception)
- Still experimental but this could change rapidly...



#### Implications in the longer term

- Digital Broadcasting transmission gets democratized
- Enabling innovation, local broadcasting, etc
- Lowering costs

What do commercial solutions offer then ?

- Turnkey solutions
- Quality hardware for RF transmission (amplification, etc)
- Service and support
- Sophistication (user interface, special features)



#### Some examples from the past

#### FM

- Used for broadcasting since 1955
- Democratisation in the eighties => community radio explosion (many of them became today's big private radio groups)
- Audio
  - From separate instruments/effects to software plugins







#### Reality

- Experimental, THIS IS NOT A TURNKEY SOLUTION Further work needed to test it 24/24, improve tools No SFN solution
- Mixed solutions with professional equipment possible
  - Total DAB in Ireland: CRC MUX + pro. modulator/amp
  - Kanal Plus in Denmark: CRC MUX and MOD, pro amp
- Costs are divided by the number of participants in a mux.
- Public/private digital radio: Big networks (many transmitters), SFN High availability redundant systems => expensive
- Community radio:

Local

Can live with lower reliability (as for streaming)



## Example of figures (estimation !)

	Equipment	Professional	Open/SDR approach
	DAB+ Encoder	~4000€	500€ or 2000€ unlimited number of programs
	Transmission to operator	Leased line: 500-1500€/month	Internet stream 50-100€/month
	DAB multiplexer	~15'000€	Free (E1 card for pro. modulator: 1000€)
	Modulator	~10'000€	Free, USRP set: 1500\$
	1 kiloWatt effective amp	~20'000€	= (Not done yet)
	Mask Filter	1500-2500 €	= (Not done yet)
OPF	3 elements antenna	500 € (dipole) - 2000 € (panel)	Plumbing costs ;-)



#### Conclusion

- We believe Digital Radio is now possible for local, community stations (technically)
- Creation of small digital islands instead of big regional coverages

We have not spoken of political aspects

- License, Spectrum access
- Market regulation, competition



## Are you ready ?





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