The European HAMNET

A large scale high speed radio network

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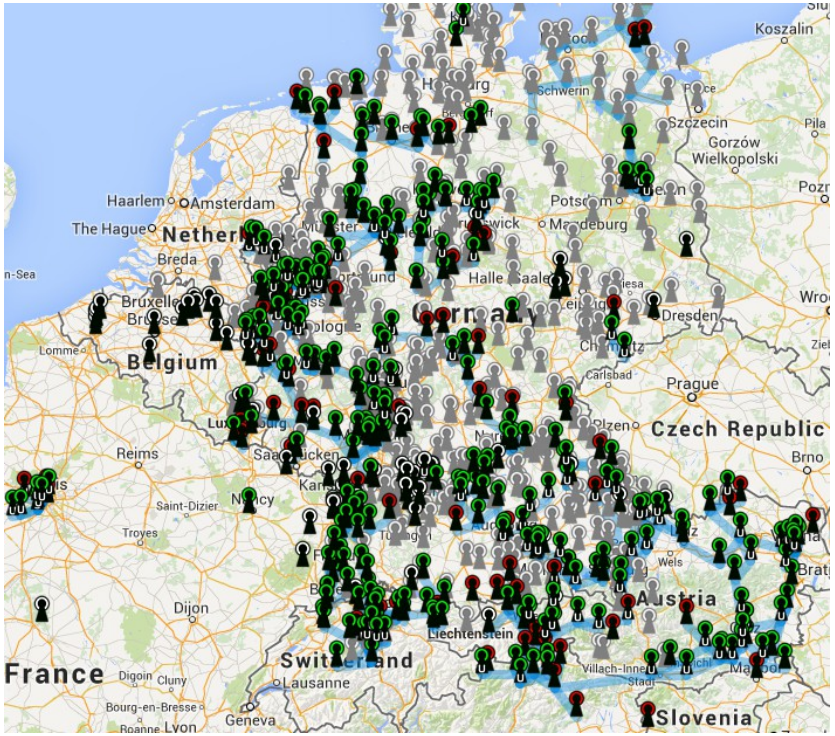


http://hamnetdb.net → Map

User access

Interlinks

db0fhn:~$ whois dg8ngn

- VHF/UHF/Microwave Manager DARC e.V.
- Active in Frequency Management DARC e.V.
- 44Net IP-Coordination Team, Germany

  (Thomas, DL9SAU / Egbert, DD9QP / Jann, DG8NGN)
- One of the founders of the D-Star ircDDB network

  (Hans-Jürgen, DL5DI / Michael, DL1BFF / Jann, DG8NGN)

- Profession: System Engineer for Spectrum Monitoring Systems at Rohde & Schwarz Munich

Abstract

The HAMNET is a **high speed amateur radio multimedia network** based on commercial wireless devices using mainly the **6cm band**.

It covers mostly the German speaking region in Europe and is about to grow over the language border.

It is using the international coordinated **IP-address space of the AMPRNet** (**44.0.0.0/8**) and AS numbers out of the 16-bit and 32-bit **private AS number space** to interconnect active regions by external **BGP routing**.

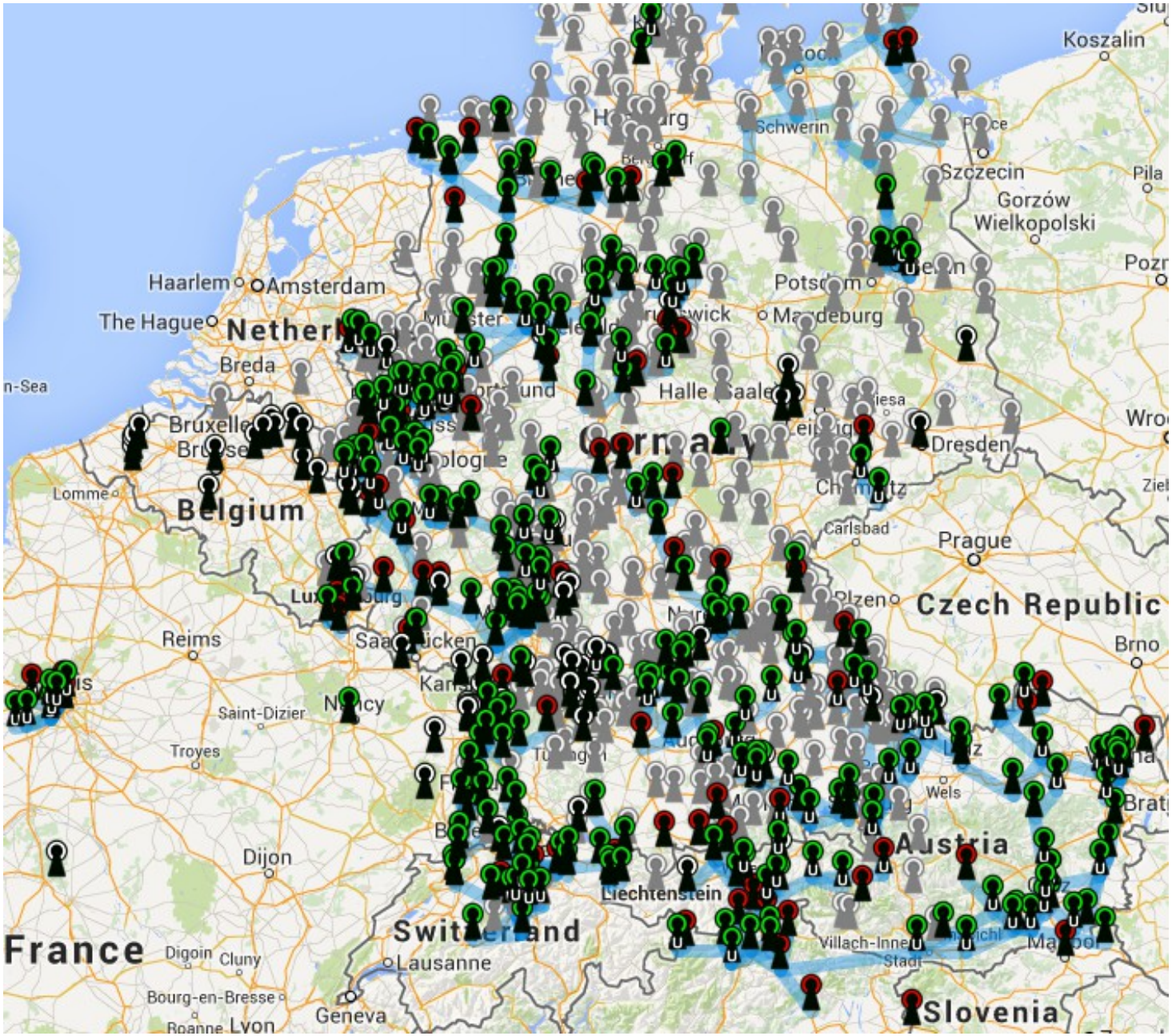
This paper documents how this network has been deployed and how it is **interconnected** with the international **AMPRNet** and the **Packet Radio** World.

It will show which **tools** have been developed and customized for **link planning**, **spectrum** and **network management**.

Moreover it will show the **challenges** we meet with **authentication**, **spectrum regulatory questions** and **non-line-of-sight wireless user access**.

Finally the vision of a huge **intranet for radio amateurs** with **end-to-end communication** capabilities will be presented.

The network


Koszalin
Schwerin
Szczecin
Pila
Gorzów
Wielkopolski
Haarlem
Amsterdam
The Hague
Breda
Potsdam
Magdeburg
Halle
Dresden
Bruxelles
Belgium
Lomme
Carlsbad
Prague
Czech Republic
Plzen
Brno
Reims
Saint-Dizier
Troyes
Dijon
Wels
Austria
Liechtenstein
Switzerland
France
Digoin
Cluny
Lausanne
Bourg-en-Bresse
Geneva
Lyon
Villach-Inne
Slovenia

Standard Deployment Example Mikrotik

2.3 GHz User Access Antenna
~20 $

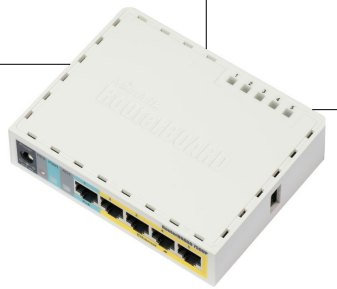
up to 32dBm

2.3 GHz user access trx
Mikrotik Metal 2SHPn
~99 $

23dBi

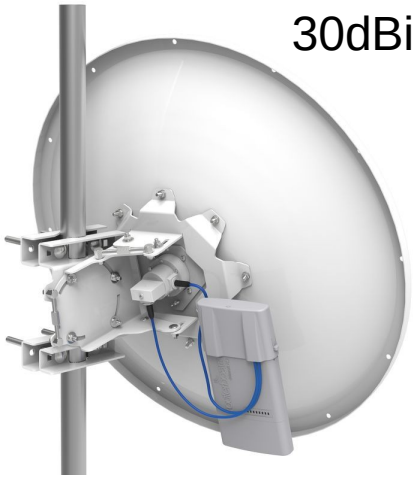
LAN+PoE

LAN+PoE



LAN+PoE

30dBi



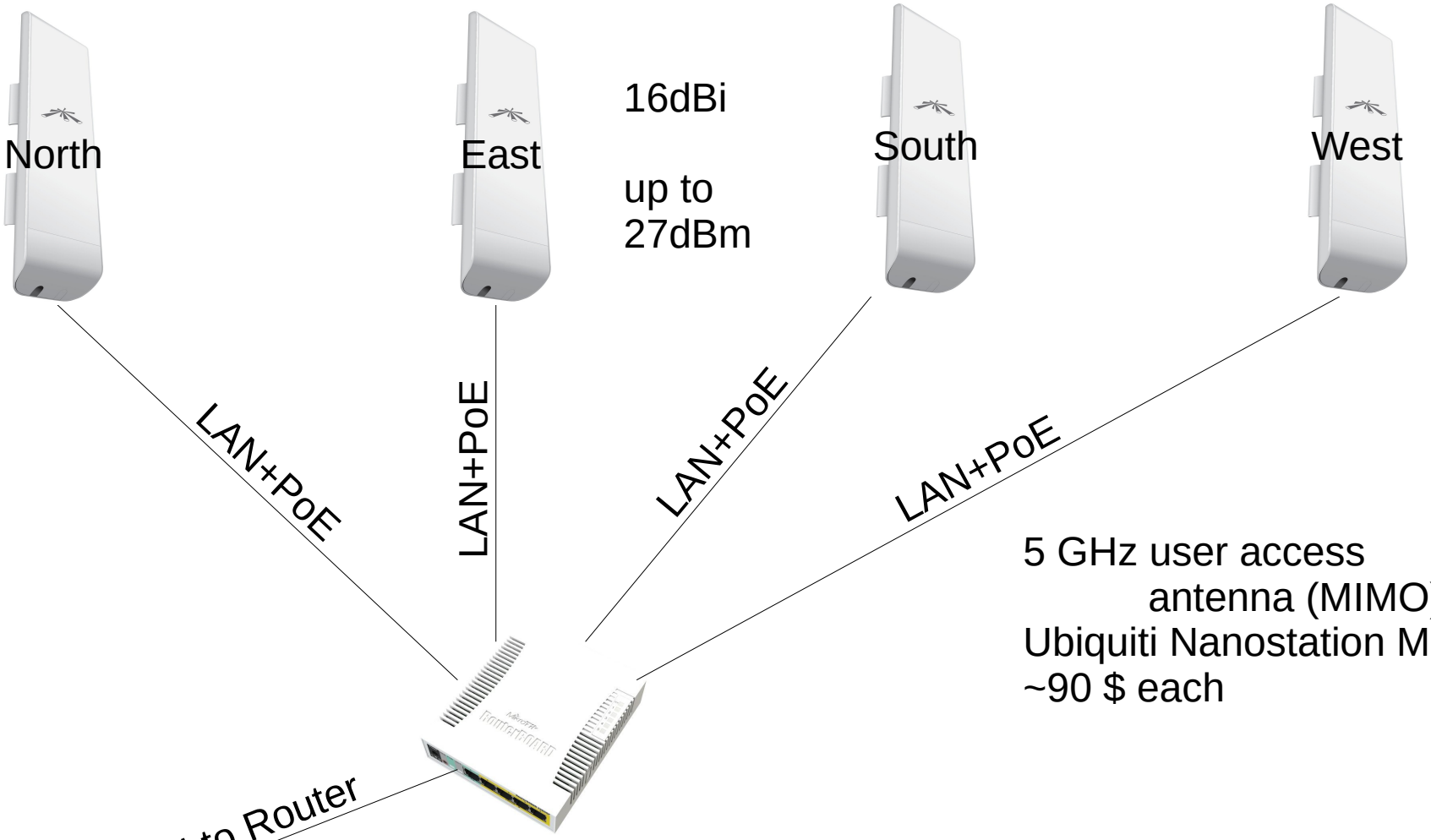
5 GHz mid range link
antenna (MIMO)
+ build-in trx
Mikrotik QRT-5
~169 $

Router with 4x PoE out
Mikrotik RB750UP
~59 $

5 GHz trx (MIMO)
Mikrotik BaseBox5
~89 $

5 GHz long range link
antenna (MIMO)
Mikrotik mANT30 PA
~129 $

Standard Deployment Example
Ubiquiti User Access



Network Management – Principles & IP Allocations

- Keeping the experimental nature of amateur radio
  - Regional network management
  - Active regions will get enough resources (**IP-addresses**, **AS-numbers**)
  - Active regions will „speak“ **eBGP** to neighbors
- IP numbers for German regions will be provided by the German IP coordination team

Network	Country	Co-Ordinator
44.0.0.0/8	Global	WB6CYT [Brian Kantor]
44.130.0.0/16	GERMANY	DG8NGN [Jann Traschewski]
44.224.0.0/15	GERMANY	DG8NGN [Jann Traschewski]

https://portal.ampr.org/networks.php

Network Management – ASN allocations (16 bit)

- The HAMNET is using the private AS space as noted in RFC 1930 (AS64512 to AS65535)

RFC 1930 Guidelines for creation of an AS March 1996

10. Reserved AS Numbers

The Internet Assigned Numbers Authority (IANA) has reserved the following block of AS numbers for private use (not to be advertised on the global Internet):

64512 through 65535

Network Management – ASN allocations (16 bit)

- The allocation to different countries is not yet coordinated in a global way, thus we try to synchronize our wikis with recent changes:

  DL: http://www.de.ampr.org/dokumentation/as-nummern

  OE: http://wiki.oevsv.at/index.php?title=Routing_-_AS-Nummern

This is the central documentation place for the allocation of AS numbers used within the AMPRNet.

	Country	ASN Block	local documentation
OE	Austria	64512-64599	Wiki
I	Italy	64600-64619	Wiki
DL	Germany	64620-64683	List or WHOIS-Search
LX	Luxemburg	64684-64685	Wiki
CR	Croatia	64686-64690	Wiki
PA	Netherlands	64691-64694	Wiki
S5	Slovenia	64695-64704	Wiki
HA	Hungary	64705-64707	Wiki
EA	Spain	64708-64719	Wiki
HB	Switzerland	64720-64739	Wiki
HB0	Liechtenstein	64740-64741	Wiki
F	France	64742-64777	Wiki
ON	Belgium	64778-64788	Wiki
TA	Turkey	64789-64799	Wiki
SP	Poland	64800-64839	Wiki
YO	Romania	64840-64849	Wiki

* Test and BGP-Confederations 65510-65534 Wiki

Network Management – ASN allocations (32 bit)

- The amateur radio community requested a private AS number block within the 32 bit range
- RFC 6996 reflects the new private AS number block 4200000000 to 4294967294
- No coordination – just experiments and thoughts how to coordinate

RFC 6996 Private Use AS Reservation July 2013

5. IANA Considerations

IANA has reserved, for Private Use, a contiguous block of 1023 Autonomous System numbers from the "16-bit Autonomous System Numbers" registry, namely 64512 - 65534 inclusive.

IANA has also reserved, for Private Use, a contiguous block of 94,967,295 Autonomous System numbers from the "32-bit Autonomous System Numbers" registry, namely 4200000000 - 4294967294 inclusive.

These reservations have been documented in the IANA "Autonomous System (AS) Numbers" registry [IANA.AS].

Routing within a region

- Each region is free to use its favorite routing protocol (e.g. OLSR, B.A.T.M.A.N., OSPF, internal BGP)
- Internal BGP is often used
  - Full Mesh: Each node needs to talk to each other node (more traffic, does not scale → n(n-1)/2 BGP links necessary)
  - Route Reflector: Each node needs to talk to the route reflector (Single point of failure)
  - BGP Confederation: ASN block 65510 to 65534 is used as internal AS numbers

Deployment - Sites

- Get in touch with anybody on this site: http://hamnetdb.net/?m=util&func=maintainer

Maintainers with write-access in this database:

Callsign	Full Name	Comment	Edited
db1hdn	Dennis	Admin DB0ROW, DB0RTN	364d dh6bb
db5jl	Detlev	C21	536d dg8ngn
db7mj	Peter	Sysop DB0ESS	477d dl8mbt
db7yi	Michael	Sysop DB0PM	595d dg8ngn
db8zp	Peter	Sysop DB0TAN	403d dg8ngn
dc1dmr	Matti		92d dh3wr
dc1nf	Dieter	Sysop DB0ADS	303d dg8ngn
dc1paa	Michael	Sysop DB0ALU	557d dg8ngn
dc1rd	Rainer	Sysop DB0SL	423d dg8ngn
dc2ve	Frank	Verwaltung AS64650	538d dg8ngn
dc4ab	Andreas	Sysop DB0DLX	293d dk2crn

- They can create an account for you to edit the database
- Or ask me (dg8ngn@darc.de) to get you an account

Deployment - Sites

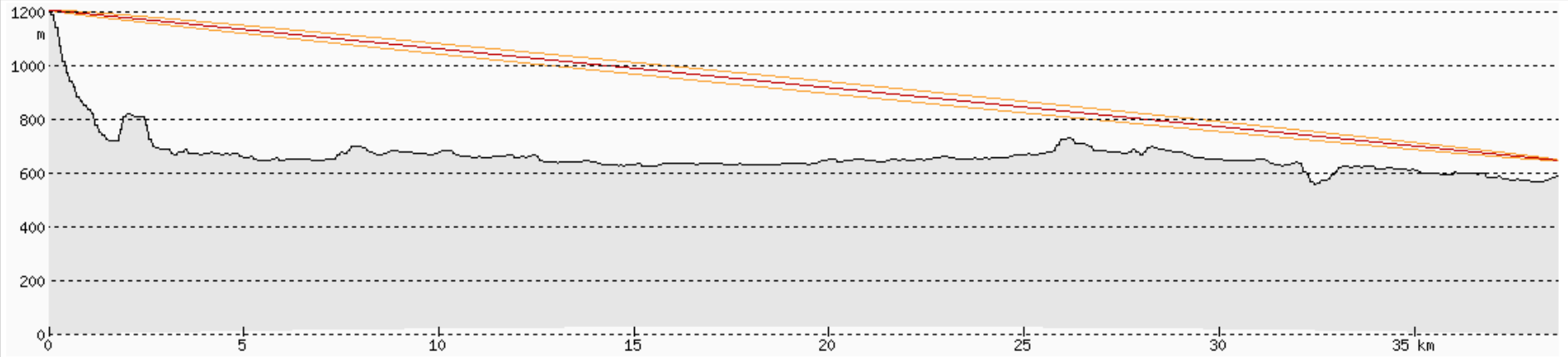
- Login to http://hamnetdb.net
- Click on „Sites“
- Press „New Site“
- Fill the following data into the form:
  - Call sign
  - Descriptive Name
  - Latitude, Longitude and meters above **ground**
  - Comma separated list of maintainers

Deployment - Sites

- Click onto your site and scroll down the list
- Have a look for nearby sites and check the link profile by clicking „Profile“

Other sites near db0isw:

	Site	Name	Distance	Direction	Above ground	Edge	
	No Call	Herzogstand	19.6 km	223.6°	20 m		Profile | Show in linktool
	db0pme	Hintereck / Gmund am Tegernsee	21.2 km	84.5°	5 m	⊕	Profile | Show in linktool
	db0pm	Brenten / Hausham	26.7 km	85.2°	9 m	⊕	Profile | Show in linktool
	db0abx	Laber	33.9 km	240.8°	5 m		Profile | Show in linktool
	No Call	Raisting EMC-Turm	34.3 km	304.3°	35 m		Profile | Show in linktool
	dl0igi	Hohenpeissenberg	36.1 km	281.9°	50 m		Profile | Show in linktool
	dm0gap	Wank / Garmisch-Partenkirchen	36.6 km	226.7°	8 m	⊕	Profile | Show in linktool
	db0ona	Hohenpeissenberg	36.8 km	281.5°	4 m	⊕	Profile | Show in linktool
	db0dba	München DEBA-Hochhaus	38.6 km	0.6°	61 m	⊕	Profile | Show in linktool



Profile image is Copyright 2012 Michael Kosowsky. All rights reserved. Used with permission. For more information visit HeyWhatsThat.

- Check for line of sight (5 GHz) and get in touch with the operator

Deployment – Link Budget

- You might want to calculate your link budget to estimate the data rate you could achieve
- Check your data sheet of your TRX (e.g. Mikrotik QRT 5)

  → Gain is 23 +/- 1dBi

	TX power / RX sensitivity
TX/RX at MCS0	30dBm / -96dBm
TX/RX at MCS7	24dBm / -78dBm
TX/RX at 6Mbit	30dBm / -96dBm
TX/RX at 54Mbit	27dBm / -80dBm
Frequency range	4900-5920MHz

  → TX level at MCS7 (Modulation and Coding Scheme: 64-QAM with Coding rate 5/6) will be 24dBm

  → RX at MCS7 needs -78dBm of receiving power level

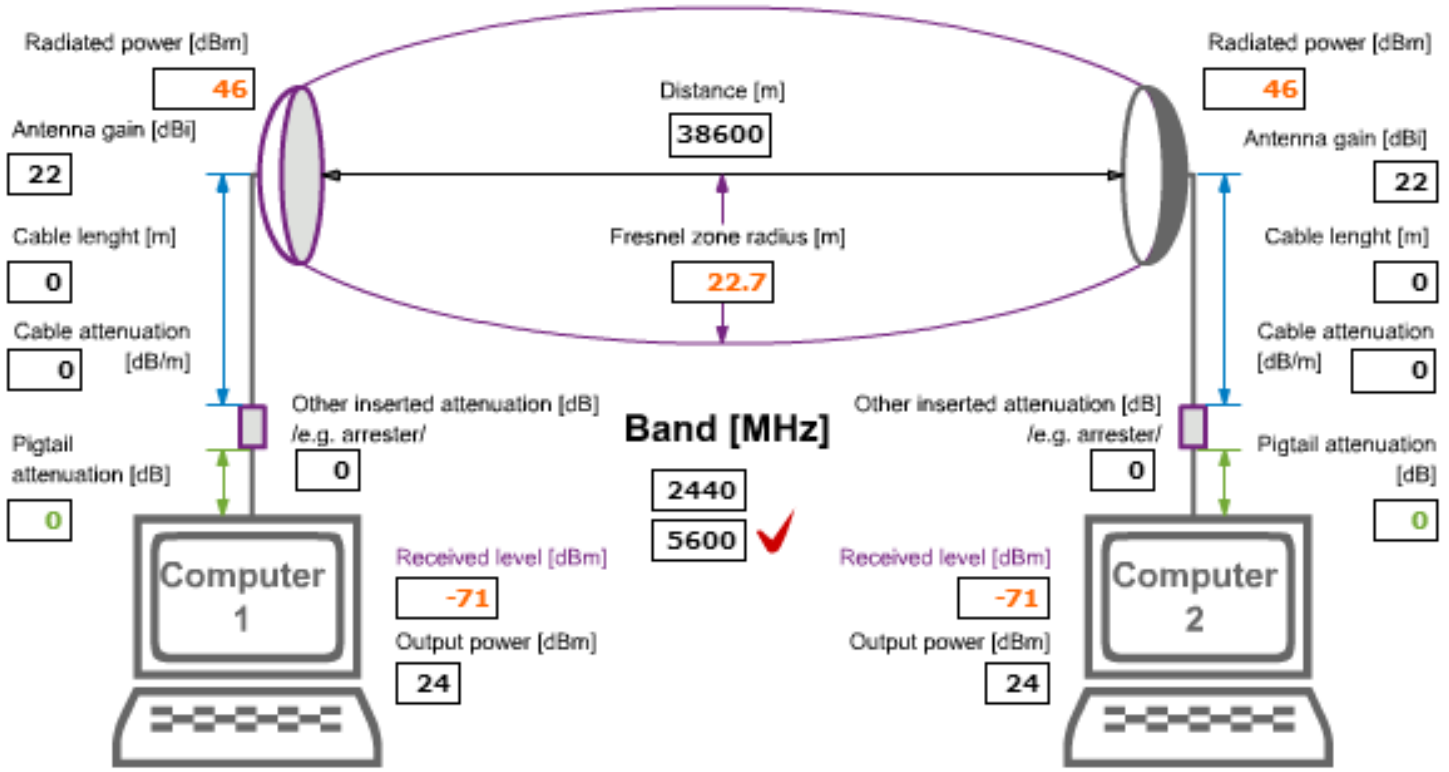
- Check additional losses of antenna gain by looking into chart „gain vs. frequency“ (if provided by manufacturer)

Deployment – Link Budget

- There are many link budget calculation tools on the web
- Pick one and put the worst case values in (e.g. http://en.jirous.com/calculation-wifi):

Fresnel zone

Fresnel zone is an area where most of the power between antennas is transmitted, it is cigar shaped. If there is a barrier in this area, the transmission attenuation increases. Calculated radius is in the middle of the link and at the end it decreases.



Deployment – Link Budget

- Estimated receiving level is -71dBm, so we have 7dB left for inaccuracy (e.g. unknown frequency/gain behavior)
- Keep in mind that changing bandwidth from 20 MHz down to 10 MHz will give you 3dB more gain (respectively 6dB by narrowing down to 5 MHz) but the throughput will suffer from the same factor (divided by 2 respectively 4)
- Running 2 spatial streams (horizontal and vertical polarization) at the same time will give us 130 Mbit/s:

MCS index	Spatial streams	Modulation type	Coding rate	Data rate (Mbit/s)			
				20 MHz channel		40 MHz channel	
				800 ns GI	400 ns GI	800 ns GI	400 ns GI
7	1	64-QAM	5/6	65.00	72.20	135.00	150.00
15	2	64-QAM	5/6	130.00	144.40	270.00	300.00

http://en.wikipedia.org/wiki/IEEE_802.11n-2009

Deployment – Spectrum Regulatory

- Before deploying a radio link you need to check the rules which apply for your country
- Germany
  - Automatic radio stations need a special license (they get a special call sign e.g. „db0xyz“) from the regulation authority „BNetzA“ (200,- € per call sign)
  - Different rules will apply per band or even frequency ranges (e.g. max. 15W ERP >30 MHz and 10 MHz bandwidth maximum) by law

Deployment – Spectrum Allocation Status

- On the most GHz bands we do only have secondary status and need to take care that the primary user will not be disturbed
- Germany
  - If applying for a license the regulatory authority will send a request to the primary user
  - If the primary user is fine with the planned frequency usage a permission will be given by the regulatory authority (takes currently around 4 to 5 month)

Deployment – Spectrum Sharing

- Sharing with Wifi (Germany)

Amateur	Wifi
Max. 15W ERP	Max. 1W ERP (if DFS „Dynamic Frequency Selection“ and TPC „Transmit Power Control“ is used)
Need special License	No license necessary
Bandwidth limited	40 MHz and more
Further Restrictions and Rules (need to identify, no encryption, limited content)	Radar Detection must be implemented in the upper 5 GHz band

Question: Is it all worth just for 12dB more gain considering that most of the wifi networks doesn't take care on DFS, TPC and Radar Detection?

Deployment – Spectrum Sharing

- Sharing with Radars is possible due to spectrum management (license for radio links only if primary user has agreed)

Wifi emissions without radar detection disturbing weather radars...

Rain: Romania
Wifi: Slovakia and Poland

http://www.radareu.cz

Deployment – Spectrum Sharing

- Sharing with other Amateur Radio Applications
  - Have a look into the IARU Band plan
  - Have a look into your national Band plan
- Germany
  - We are running different kind of digital links (Digital ATV, Packet Radio, HAMNET)
  - The Band plan should specify „bandwidth“ for certain frequencies rather than „application types“ to be able to consolidate the applications
  - e.g. DATV-links can carry TCP/IP, HAMNET can carry IPTV and Packet Radio → Build a large backbone for any kind of amateur application

Deployment - Identification

- Radio amateurs need to identify in regular intervals
  - ESSID (e.g. HAMNET-DB0ABC-DB0XYZ)
    - But is a transmission coming from DB0ABC or DB0XYZ?
      → Only valid with fixed convention (e.g. AP-Mode = first call sign and Station-Mode = second call sign)
      → How to handle Point-to-Mulitpoint Links?

Deployment - Identification

- Using locally administered MAC-addresses
  - Encoding of call sign into the free bits in a MAC-address

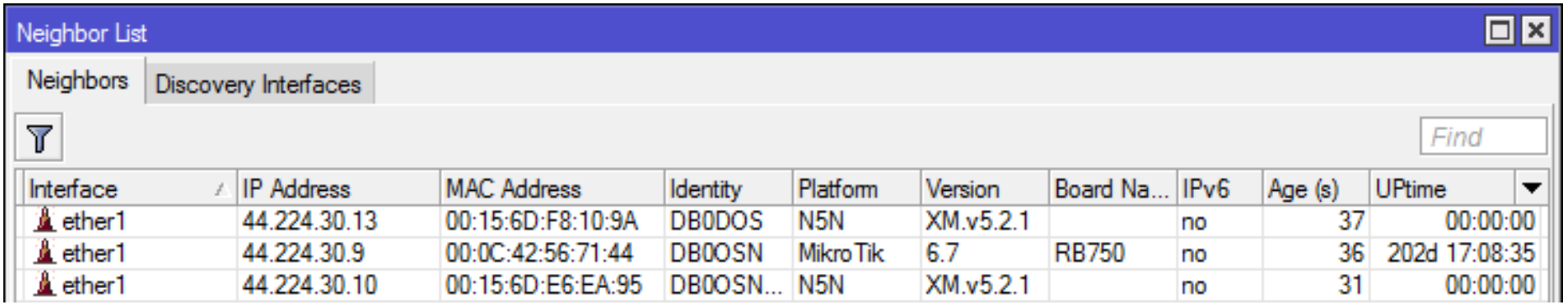
```
 Byte 6   Byte 5   Byte 4   Byte 3   Byte 2   Byte 1
RRRRRRXX RRRRRRNN RRRRRRSS RRRRRRSS RRRRRRSS RRRRRRSS
8 Bit  1 8 Bit  1 8 Bit  1 8 Bit  1 8 Bit  1 8 Bit  1

R = Bits for coding the call sign
S = Bits for the station identifier (SSID)
N = reserved for future applications
X = Standardbits according to IEEE 802
    Bit 1: 0 = unicast / 1 = multicast
    Bit 2: 0 = globally unique / 1 = locally administered
```

Details and Tools/Scripts available (in German) on:
http://db0fhn.efi.fh-nuernberg.de/doku.php?id=projects:wlan:proposal

Deployment - Identification

- Neighbor Discovery Protocols
  - There are plenty of neighbor discovery protocols in the wild (CDP, LLDP, MNDP, ...)
  - Just set the „Identity“ to your call sign and you're fine



Interface	IP Address	MAC Address	Identity	Platform	Version	Board Na...	IPv6	Age (s)	UPtime
ether1	44.224.30.13	00:15:6D:F8:10:9A	DB0DOS	N5N	XM.v5.2.1		no	37	00:00:00
ether1	44.224.30.9	00:0C:42:56:71:44	DB0OSN	MikroTik	6.7	RB750	no	36	202d 17:08:35
ether1	44.224.30.10	00:15:6D:E6:EA:95	DB0OSN...	N5N	XM.v5.2.1		no	31	00:00:00

Neighbor List of HAMNET Station „DB0DOS“
(Mikrotik and Ubiquiti Devices)

Deployment – AS/IP-Subnet-Allocation

- Regions need to get an AS- and IP-Allocation
  - The German IP Coordination is taking care

```
# ---------
# HAMNET-DL
# ---------
# AS-      AS-                  NETWORKS          NETWORKS            NETWORKS
# NO       NAME                 BACKBONE          USER/SERVICES       PACKET-RADIO

*                                                 44.225.254.0/23 # Anycast

64625      DISTRIKT-C-625-AS    44.224.10.0/23    44.225.20.0/22      44.130.56.0/24
64626      DISTRIKT-B-626-AS    44.224.12.0/23    44.225.24.0/22      44.130.60.0/24
                                                                     44.130.99.0/24

64627      DISTRIKT-L-627-AS    44.224.14.0/23    44.225.28.0/22      44.130.146.0/24
64628      DISTRIKT-S-628-AS    44.224.16.0/23    44.225.32.0/22
64629      DISTRIKT-D-629-AS    44.224.18.0/23    44.225.36.0/22
64630      DISTRIKT-U-630-AS    44.224.20.0/23    44.225.40.0/22      44.130.59.0/24
64631      DISTRIKT-T-631-AS    44.224.22.0/23    44.225.44.0/22      44.130.53.0/24
                                                                     44.130.61.0/24
```

http://www.de.ampr.org/dokumentation/as-nummern/as-list-de

Deployment – AS-Allocation

- Information is reflected in the HAMNETDB

The Hamnet-Database Show: Map Fullscreen Map OSM

	AS	Name	Maintainer	Comment	Edited
	AS64625	DISTRIKT-C-625-AS	dl3mbg,dg8ngn	Oberbayern	567d dl8mbt
	AS64626	DISTRIKT-B-626-AS	dg8ngn	Franken	598d dg8ngn
	AS64627	DISTRIKT-L-627-AS	dd9qp	Niederrhein - WES, KLE	162d dd9qp
	AS64628	DISTRIKT-S-628-AS	dg1cpa	Distrikt Sachsen	510d dd9qp
	AS64629	DISTRIKT-D-629-AS	dl7uaz	Berlin	594d dg8ngn
	AS64630	DISTRIKT-U-630-AS	dl8rds,dg8ngn	Ostbayern	594d dg8ngn
	AS64631	DISTRIKT-T-631-AS	dg8ngn	Schwaben	595d dg8ngn

http://hamnetdb.net/?m=as

Deployment – IP-Subnet-Allocation

- Information is reflected in the HAMNETDB

	Subnet-IP	Type	Own AS	Parent	Radio parameters / Comment	Edited
	44.130.53.0/24	AS-Packet-Radio	-	AS64631		393d dg8ngn
	44.130.56.0/24	AS-Packet-Radio	-	AS64625		393d dg8ngn
	44.130.59.0/24	AS-Packet-Radio	-	AS64630		393d dg8ngn
	44.130.60.0/24	AS-Packet-Radio	-	AS64626		399d dg8ngn
	44.130.61.0/24	AS-Packet-Radio	-	AS64631		393d dg8ngn
	44.130.99.0/24	AS-Packet-Radio	-	AS64626		186d dg8ngn
	44.130.146.0/24	AS-Packet-Radio	-	AS64627	Distrikt-L Packet-Radio Netz	162d dd9qp
	44.224.10.0/23	AS-Backbone	-	AS64625		665d dg8ngn
	44.224.12.0/23	AS-Backbone	-	AS64626		594d dg8ngn
	44.224.14.0/23	AS-Backbone	-	AS64627	Distrikt-L Backbone Netz	579d dg8ngn
	44.224.16.0/23	AS-Backbone	-	AS64628		594d dg8ngn
	44.224.18.0/23	AS-Backbone	-	AS64629	Berlin Backbone Netz	585d dl7uaz
	44.224.20.0/23	AS-Backbone	-	AS64630		594d dg8ngn
	44.224.22.0/23	AS-Backbone	-	AS64631		594d dg8ngn
	44.225.20.0/22	AS-User/Services	-	AS64625		689d dl8mbt
	44.225.24.0/22	AS-User/Services	-	AS64626		594d dg8ngn
	44.225.28.0/22	AS-User/Services	-	AS64627	Distrikt-L User/Services Netz	579d dd9qp
	44.225.32.0/22	AS-User/Services	-	AS64628		594d dg8ngn
	44.225.36.0/22	AS-User/Services	-	AS64629	Berlin User-Service Netz	458d dl9sau
	44.225.40.0/22	AS-User/Services	-	AS64630		688d dl8mbt
	44.225.44.0/22	AS-User/Services	-	AS64631		688d dl8mbt

http://hamnetdb.net/?m=subnet

Deployment – „IP-Subnetting“

- Each region gets a /23 for the backbone (transfernetworks) and a /24 for user-/services (sitenetworks)
- Best practice:
  - Each site has a single router
  - Each site gets a /27 network from the maintainer (leave the next /27 free in case a network needs to be increased)
  - The sitenetwok will be announced by the router to the network
  - The sitenetwork can be splitted „internally“ at the site into several networks (e.g. /28 for users and /28 for services) → easy firewalling
  - Each site uses a /29 transfer network to interconnect to another site

Deployment – Network Documentation

- The HAMNETDB provides network management capabilities
- Data structure (AS, Hosts, Subnets, Sites):
  - Hosts belong to sites (user defined)
  - Hosts belong to subnets (by nature)
  - Subnets belong to AS (user defined)

  → The HAMNETDB is able to visualize data

Deployment – Network Documentation Example

Site db0zm (München-Freimann Studentenstadt)

Show: Map | Fullscreen Map | OSM

Coordinates: 48.184086,11.611249 - 48°11.05' N 11°36.67' E - 48°11'02" N 11°36'40" E
Elevation: 65 m above ground

Maintainer: **dl8rds,dg8ngn,dl8mbt,dd5ki**

Am Standort ist auch
- 2m FM Relais DB0ZM 145.750
- 70cm FM-Relais DB0NJ 438.775
- 70cm DMR-Relais DB0NJ 439.4375
- 2 Kameras von http://www.foto-webcam.eu

Site configuration: https://www.dropbox.com/s/0sd219kow4lb23f/DB0ZM.gif

*Last edited 2013-12-07 by **dl8mbt***

db0zm (München-Freimann Studentenstadt) bb-db0tvm.db0zm 44.224.10.49 Station WDS (NStreme) 000c423a644c	Backbone-Network 44.224.10.48/29 5685MHz,10Mhz,horizontal	**db0tvm** (München Olympiaturm) bb-db0zm.db0tvm 44.224.10.54 AP Bridge (NStreme) 000b6b234bca 4.4km - 256.2° - Show in Linktool
db0zm (München-Freimann Studentenstadt) bb-db0wai.db0zm 44.224.10.46 Station WDS (NStreme) 000c4260e61f	Backbone-Network 44.224.10.40/29 5825MHz,10Mhz,horizontal	**db0wai** (München Thalkirchen) bb-db0zm.db0wai 44.224.10.41 AP Bridge (NStreme) 000c4260f560 8.6km - 207.5° - Show in Linktool
db0zm (München-Freimann Studentenstadt) bb-db0ebe.db0zm 44.224.10.73 Station WDS (NStreme) 000c436fb3f2	Backbone-Network 44.224.10.72/29 5795MHz,10Mhz,vertikal	**db0ebe** (Ebersberg Aussichtsturm) bb-db0zm.db0ebe 44.224.10.78 AP Bridge (NStreme),23dBi 000c426fb3f2 28.0km - 111.8° - Show in Linktool

Deployment – Network Documentation Example

Contains the following hosts:

	Host-IP	M	Hostname	Type	Site	Radio parameters / Comment	Edited
	44.224.10.46		bb-db0wai.db0zm	Routing-Radio	db0zm	Station WDS (NStreme)	584d dg8ngn
	44.224.10.49		bb-db0tvm.db0zm	Routing-Radio	db0zm	Station WDS (NStreme)	584d dg8ngn
	44.224.10.73		bb-db0ebe.db0zm	Routing-Radio	db0zm	Station WDS (NStreme)	378d dg8ngn
	44.224.10.74		lnk-db0ebe.db0zm	Service	db0zm		584d dg8ngn
	44.225.20.193		router.db0zm	Service	db0zm	Routerboard RB433AH (WAI, TVM)	584d dg8ngn
	44.225.20.194		allstarlink.db0zm	Service	db0zm	2m FM-Relais DB0ZM	667d dg8ngn
	44.225.20.195		eoip.db0zm	Service	db0zm	Routerboard RB411AH (EBE)	667d dg8ngn
	44.225.20.196		hamnetdb.db0zm	Service	db0zm	Raspberry PI mit Debian - ProxyPa..	506d dl8mbt
	44.225.20.197		webcam-nord.db0zm	Service	db0zm	Kamerarechner WL500GP OpenWRT - h..	589d dl8mbt
	44.225.20.198		webcam-sued.db0zm	Service	db0zm	Kamerarechner WL500GP OpenWRT - h..	589d dl8mbt
	44.225.20.199		dmr.db0zm	Service	db0zm	db0nj 439.4375 MHz, Motorola DR30..	269d dl8mbt
	44.225.20.200		proxmox.db0zm	Service	db0zm	Server for Virtual Machines	7m dg8ngn
	44.225.20.201		ipmi.db0zm	Service	db0zm	Remote Console	7m dg8ngn
	44.225.20.202		winxp.db0zm	Service	db0zm	Windows VM	6m dg8ngn
	44.225.20.203		dhcp-44-225-20-203.db0zm	DHCP-Range	db0zm	assigned dynamically	0s system
	44.225.20.204		dhcp-44-225-20-204.db0zm	DHCP-Range	db0zm	assigned dynamically	0s system
	44.225.20.205		wetter.db0zm	Service	db0zm	Wetterstation Davis Vantage Vue -..	102d dl8mbt
	44.225.20.206		netio.db0zm	Service	db0zm	Schaltsteckdose - 1: DMR-Relais D..	269d dl8mbt

18 entries.

Deployment – Network Documentation Example

Surrounding subnets:

	Subnet-IP	Type	Own AS	Parent	Radio parameters / Comment	Edited
	44.224.10.0/23	**AS-Backbone**	-	AS64625		665d dg8ngn
	44.224.10.40/29	Backbone-Network	-	AS64625	*db0zm,db0wai* - 5825MHz,10MHz,horizontal	691d dl8mbt
	44.224.10.48/29	Backbone-Network	-	AS64625	*db0tvm,db0zm* - 5685MHz,10MHz,horizontal	691d dl8mbt
	44.224.10.72/29	Backbone-Network	-	AS64625	*db0zm,db0ebe* - 5795MHz,10MHz,vertikal	691d dl8mbt
	44.225.20.0/22	**AS-User/Services**	-	AS64625		689d dl8mbt
	44.225.20.192/28	Site-Network	AS65530	AS64625	*db0zm*	264d dg8ngn

6 entries.

Surrounding AS:

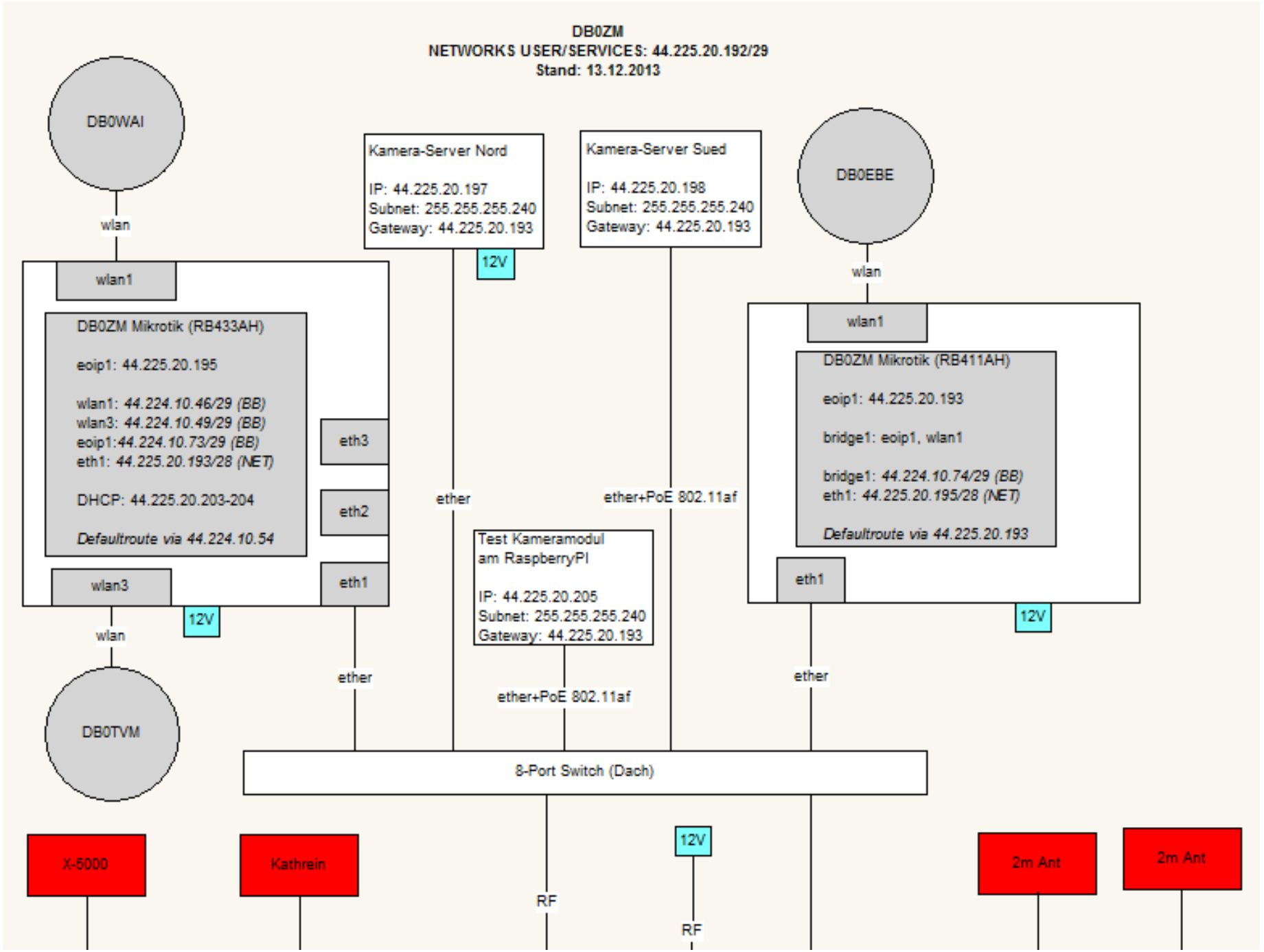
	AS	Name	Maintainer	Comment	Edited
	AS64625	DISTRIKT-C-625-AS	dl3mbg,dg8ngn	Oberbayern	567d dl8mbt

1 entry.

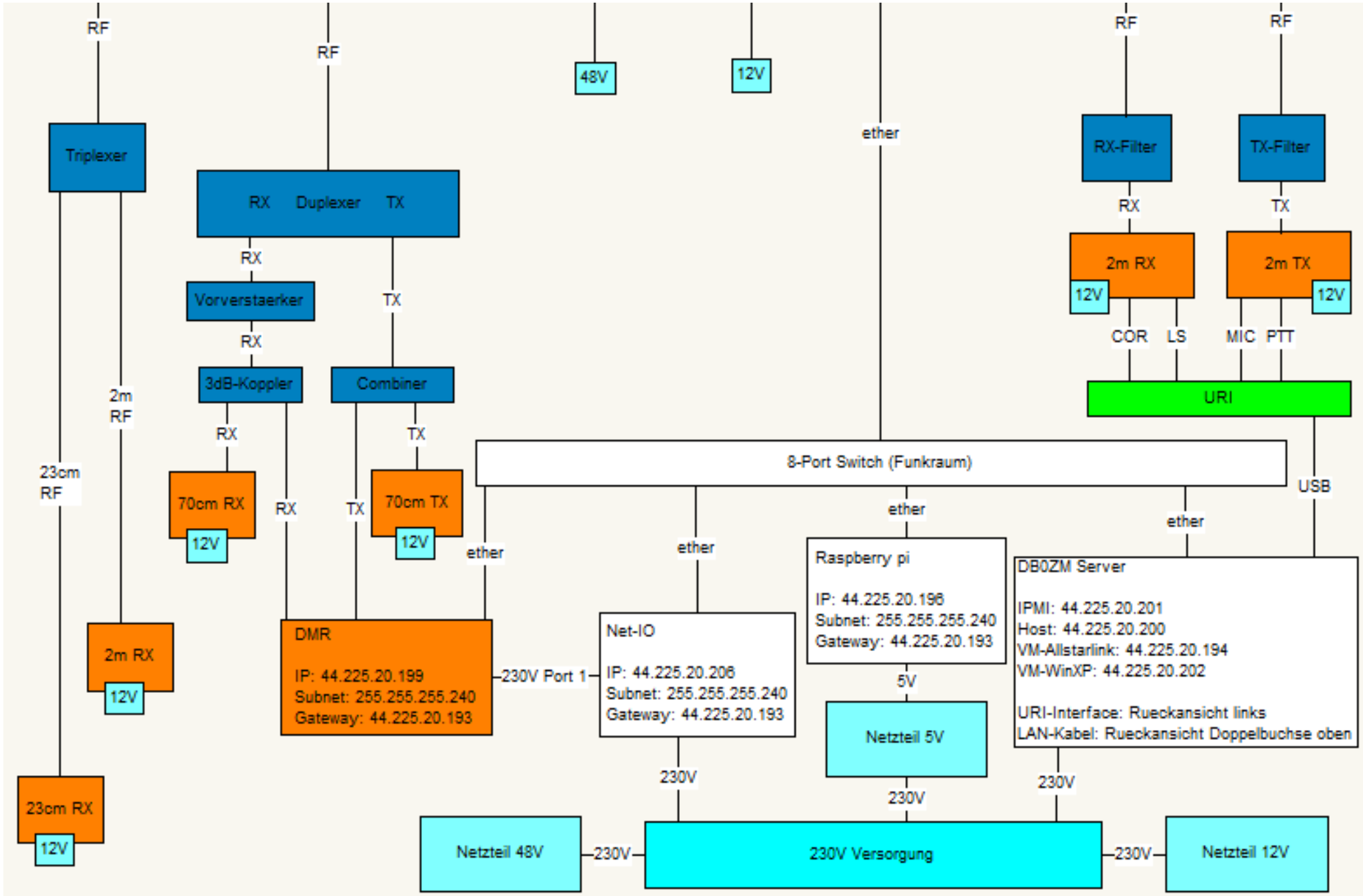
Other sites near db0zm:

	Site	Name	Distance	Direction	Above ground	Edge	
	db0tvm	München Olympiaturm	4.4 km	256.2°	200 m		Profile | Show in linktool
	dl0muc	Clubstation Chaos Computer C..	5.0 km	228.0°	30 m		Profile | Show in linktool

Deployment – Network Documentation Example



Deployment – Network Documentation Example



Deployment - Typical User Setup

Netzwerkkabel

Dach

Lokale Geräte über WLAN angebunden

POE

Stromeinspeisung

44.0.0.0/8
HAMNET / AMPRNet

DSL-Router (z.B. FritzBox)

DSL-Anschluss

Lokale Geräte über LAN angebunden

Defaultroute

Keep 44.0.0.0/8 for radio amateurs only !

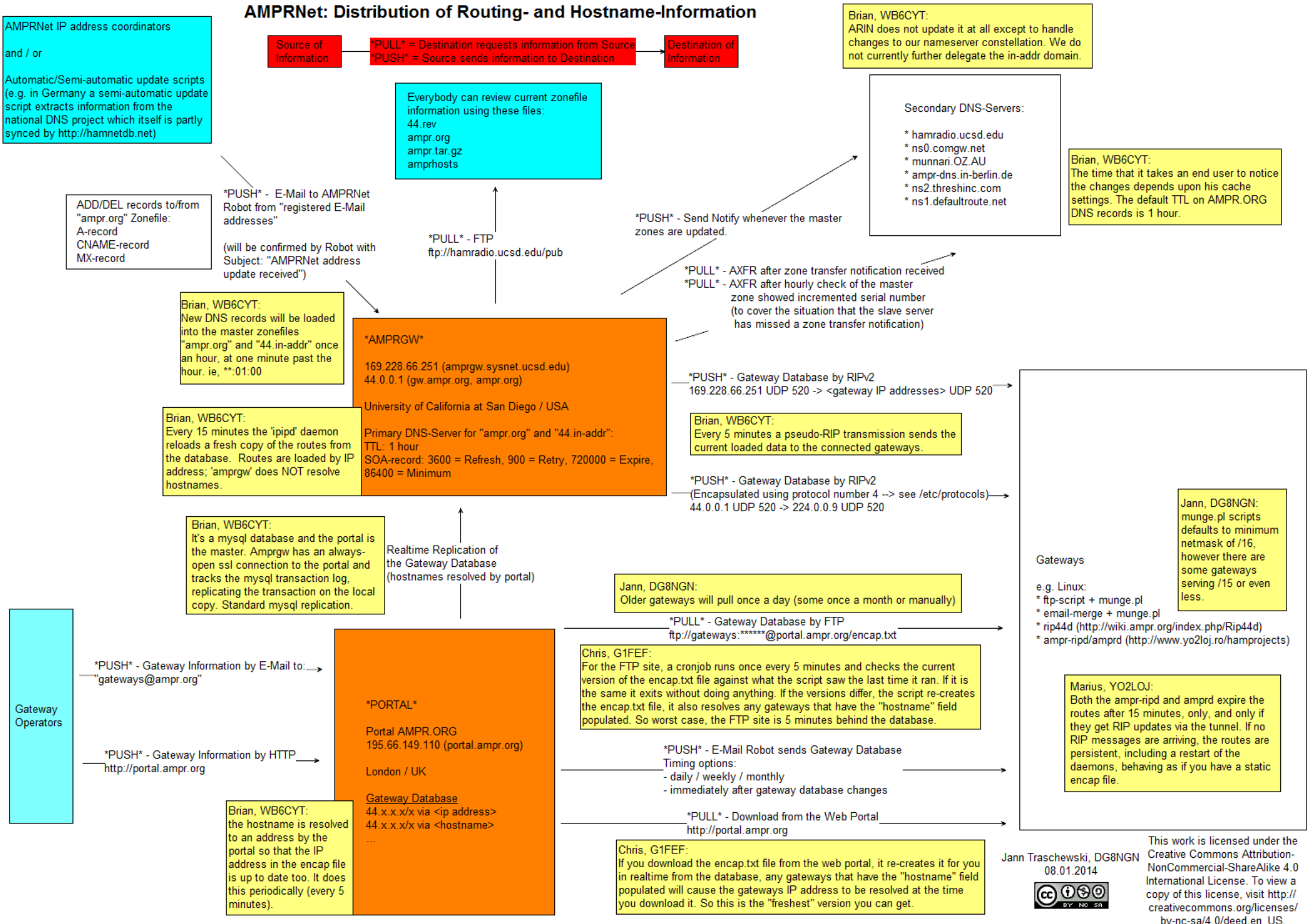
Deployment – DNS

- Each region can run its own DNS Server
- In Germany there is a national DNS concept in place running under „de.ampr.org“
- The HAMNETDB can generate DNS zone files for downloading

Deployment – DNS

- Running a DNS Server is quite some work, so we offer a service to host „HAMNETDB-synchronized“ zones at DB0FHN
- DB0FHN is a DNS-Hub in Germany and will exchange with our other two DNS-Hubs DB0RES and DB0TUD
- At DB0TUD there is a script which synchronizes the *.de.ampr.org information to the flat ampr.org zone
- There is a dataflow diagram of the international distribution of hostname information available

AMPRNet: Distribution of Routing- and Hostname-Information



Jann Traschewski, DG8NGN
08.01.2014

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Interconnection with the AMPRNet

- Single Point of Failure: DB0FHN (University of applied scienes Nuremberg)
- Import of IPIP-Routes into the HAMNET
- Registered as a gateway on portal.ampr.org for several subnets

Details of gateway	
Title	141.75.245.225
Hostname	
Gateway IP	141.75.245.225
Originally added	2012-06-22 13:39:06
Last modified	2014-01-08 07:54:16
Status	Active
Subnet	44.130.0.0 / 16
Subnet	44.133.128.0 / 17
Subnet	44.134.189.0 / 24
Subnet	44.134.190.0 / 23
Subnet	44.142.0.0 / 15
Subnet	44.144.0.0 / 16
Subnet	44.161.0.0 / 16
Subnet	44.224.0.0 / 15
Notes	gateway area: Germany, Austria, Switzerland, Luxembourg, Italy (South Tyrol), Spain, Belgium maintained by: Jann Traschewski, DG8NGN (jann@gmx.de) notes: Gateway between IPIP-Net, IP-over-AX.25-Net, HAMNET services: VPN-Access to AMPRNet and AX.25 via AXUDP, OpenBCM Mailbox, Convers web: http://db0fhn.efi.fh-nuernberg.de

Extracted from https://portal.ampr.org

- There is even a dataflow diagram of the IP Routing available

AMPRNet: IP-Routing and Data Flow

Brian, WB6CYT:
Here's a current list of the authorized BGP-announced 44/8 subnets.

13.12.2013:

44.16.15.0/24
44.24.192.0/24
44.24.240.0/20
44.74.128.0/24
44.98.254.0/24
44.127.128.0/24
44.130.99.0/24
44.135.120.0/24
44.135.216.0/23
44.136.138.0/23
44.136.150.0/23
44.136.158.0/23
44.136.224.0/24
44.136.227.0/24
44.139.0.0/16
44.140.0.0/16
44.144.0.0/16
44.161.252.0/22
44.169.48.0/20
44.208.0.0/16

Internet

44.0.0.0/8

AMPRGW

169.228.66.251 (amprgw.sysnet.ucsd.edu)
44.0.0.1 (gw.ampr.org, ampr.org)

University of California at San Diego / USA

Gateway-Database (44.x.x.x/x via <public ip address>)
DNS-Database (see "AMPRNet Routing Information.png")

Direct Connected Gateways

(will announce their 44net block directly to the Internet using BGPv4)
--> http://www.ampr.org/tos.txt (7b)

Traffic from Internet to AMPRNet Mesh-Network encapsulated using protocol number 4 --> see /etc/protocols

(forwarded if destination IP address has A-record in "ampr.org" zonefile)

Traffic from AMPRNet to Internet Mesh-Network encapsulated using protocol number 4 --> see /etc/protocols

Implementation on Linux using "ip rule"

(Traffic from AMPRNet to AMPRNet will be dropped!)

44.0.0.0/8

Communication only possible if the Direct Connected Gateways take part in the Mesh-Network

Hack:

Special Gateway which is not source-route filtered

(avoid routing loops at local gateway using "ip route throw" or "ip route blackhole" of own prefixes)

44.0.0.0/8

Mesh-Network using "ipencap" for Peer-to-Peer Traffic
(see "AMPRNet Routing Information.png" to understand the distribution of the Gateway-Database)

IP-over-AX.25 Networks

Wireless Networks

VPN to Endusers

Jann Traschewski, DG8NGN
06.01.2014

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Interconnection with the Packet Radio Network

- DB0FHN connects to the Packet Radio Node „IGATE“ (available in the Flexnet based land)

```
DG8NGN: Verbunden mit DB0FHN
(X)NET/LINUX V1.39 Digipeater Nuremberg Institut of Technology. Loc: JN59NK.
Shortcuts: "help", "info", "mailbox", "shell", "admin"
=>c igate

link setup (6)...
*** connected to IGATE
This is IGATE. Internetgatewaysystem for the Packet Radio Network.

Please type "einfo" (english).
Bitte "info" (deutsch) eingeben.
Please type "czinfo" (czech).
Please type "plinfo" (polish).
=>arp

IP              Iface   Hardware                        Min.  Used
44.130.60.100   AX25    DB0FHN-10                          0 10829
44.130.90.100   AX25    DB0TUD-10                          0 17615
44.130.254.1    AX25    DG8NGN-10                          0   307
44.130.254.254  AX25    IGATE                              0     0
=>ipr

IP-Routes of 44.130.254.254:

IP-Net            M Iface    via IP              use
44.130.254.0     24 AX25                         739
44.130.90.0      24 AX25     44.130.90.100     20979
                  0 AX25     44.130.60.100     41417
=>_
```

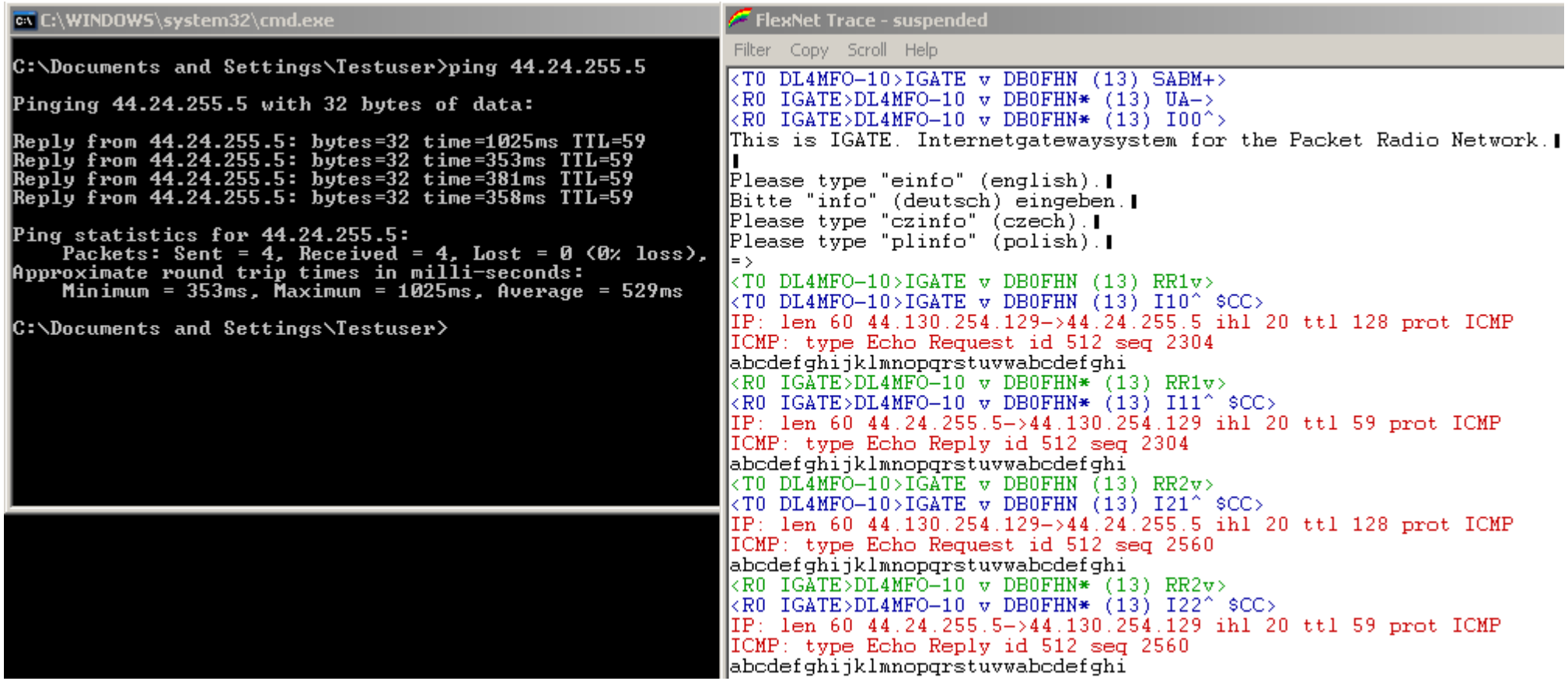
Interconnection with the Packet Radio Network

- The allocation for IGATE is 44.130.254.0/24 and is splitted into fixed addresses 44.130.254.1 to 44.130.254.127 (e.g. DG8NGN = 44.130.254.1) and dynamic addresses 44.130.254.128 to 44.130.254.253
- Connect with a Packet Radio Terminal to IGATE via your access digipeater and type „GETIP“

```
DL4MFO: Verbunden mit DB0FHN
(X)NET/LINUX V1.39 Digipeater Nuremberg Institut of Technology. Loc: JN59NK.
Shortcuts: "help", "info", "mailbox", "shell", "admin"
=>c igate

link setup (6)...
*** connected to IGATE
This is IGATE. Internetgatewaysystem for the Packet Radio Network.

Please type "einfo" (english).
Bitte "info" (deutsch) eingeben.
Please type "czinfo" (czech).
Please type "plinfo" (polish).
=>getip

Your_Ipaddress: 44.130.254.129

=>
=>arp

IP              Iface   Hardware                    Min.  Used
44.130.60.100   AX25    DB0FHN-10                     0 11028
44.130.90.100   AX25    DB0TUD-10                     0 17677
44.130.254.1    AX25    DG8NGN-10                     0   315
44.130.254.129  AX25    DL4MFO                    57596     0
44.130.254.254  AX25    IGATE                         0     0
=>_
```

Interconnection with the Packet Radio Network

- Insert the new IP address in your IP stack and try a ping



- Instructions how to interconnect Packet Radio Nodes (XNet) to the HAMNET or AMPRNet are available

Motivation or „why?“

- The easy answer: „Why not?“

  → „Why?“ is not a valid question in a hobby

- Seriously:

  → Most administrators just want to attach repeaters to the internet. So why not deploying the local network with net44 addresses rather than RFC1918 addresses (10.0.0.0/8, 172.16.0.0/12 and 192.168.0.0/16)?

  It doesn't hurt. Just apply for an IP range and use it (even if not interconnected to the AMPRNet, **yet**).

Motivation – Connection to net44

- Provide and use services on net44
- Trusted network
  - Packets from net44 are supposed to come from an amateur radio operator
  - Providing gateways to RF is OK without further authentication of the individual amateur (e.g. access to the Packet Radio Network, access to shared Remote Transceivers, ...)
- End-to-End communication
  - NAT is evil...
  - No need to struggle around with portforwarding

Motivation – Building a RF backbone

- Backbone for services (cf. Packet Radio Network – BBS, Convers, …)

  Transport of:

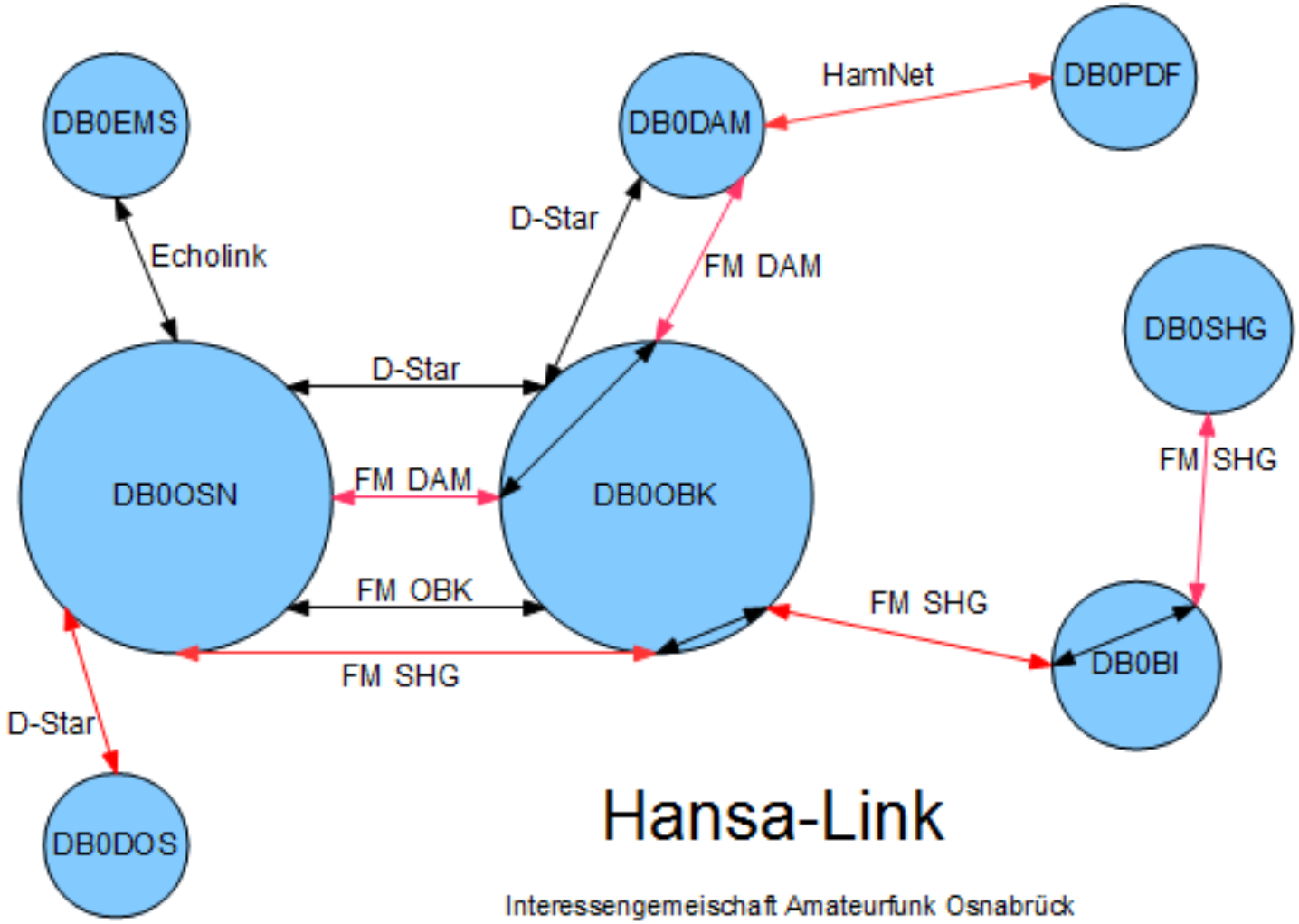
  - DATV, VoIP (DMR, D-Star, Echolink), Packet Radio
  - whatever you can transport on TCP/IP...
- Build an independent network for emergency communication (where the funding could come from...)
- It is cool - „Because we can...“

Motivation – Learning & Experimentation

- Building your own Internet
  - Technology you usually don't get in touch with (Routingprotocols, Server-to-Server VPNs, DNS-Hosting, …)
  - Peering with other groups around the world
- Building your own backhaul
  - GHz wave propagation
  - System Integration of backhaul technology

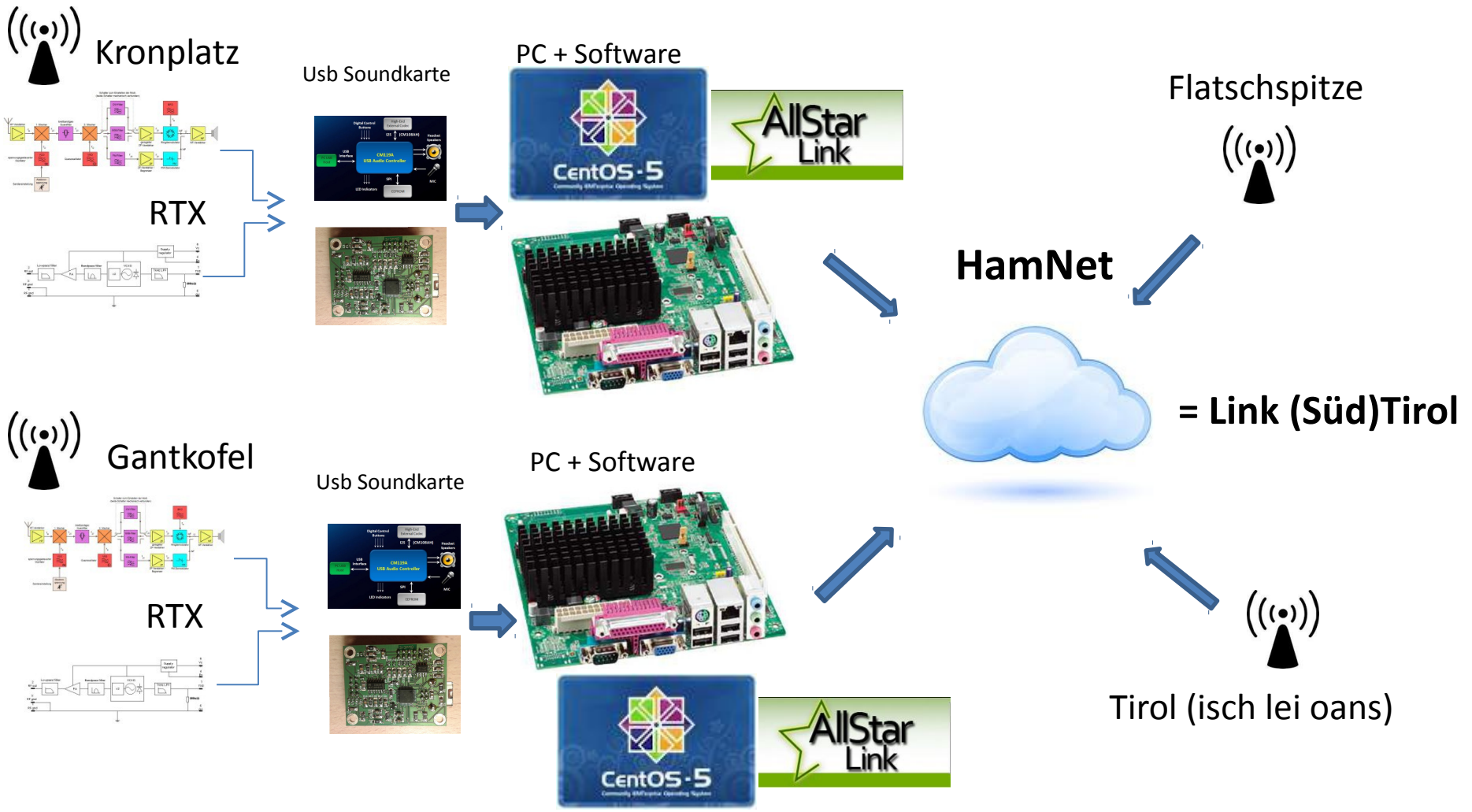
Application Examples - FM Repeater Group (SVXLink)

- Hansa-Link Network



Application Examples - FM Repeater Group (Allstarlink)

- Link (Süd) Tirol



Application Examples – ATV Livestreaming

Home
Startseite

ATV
Info rund ums Fernsehn

Hamnet
Datennetz für Benutzer

Anwendungen
Was YL/OM machen kann...

Multimedia
Bilder und Videos

Ortsverband Eschweiler

Anwendung - Live-Streaming

Details | Kategorie: Anwendungen Erstellt am 23. April 2012 Veröffentlicht am 23. April 2012 Geschrieben von Ralf DH3WR
Zugriffe: 3220

Hier wird in einem Flashplayer Live-Stream von Amateurfunkstationen angezeigt. Benutzer können hier ebenfalls ihren eigenen Kanal bekommen. Bitte mit rwth-afu@online.de Kontakt aufnehmen.


DB0KWE Livstream
ATV-Livebild das im Moment in Weisweiler ausgestrahlt wird


DB0KO Livestream
ATV-Livebild das im Moment in Köln ausgestrahlt wird


DL9KAR Livestream
Bei Bedarf kann Bernd hier einen Videostream senden


DH3WR Livestream
Bei Bedarf kann Ralf hier einen Videostream senden

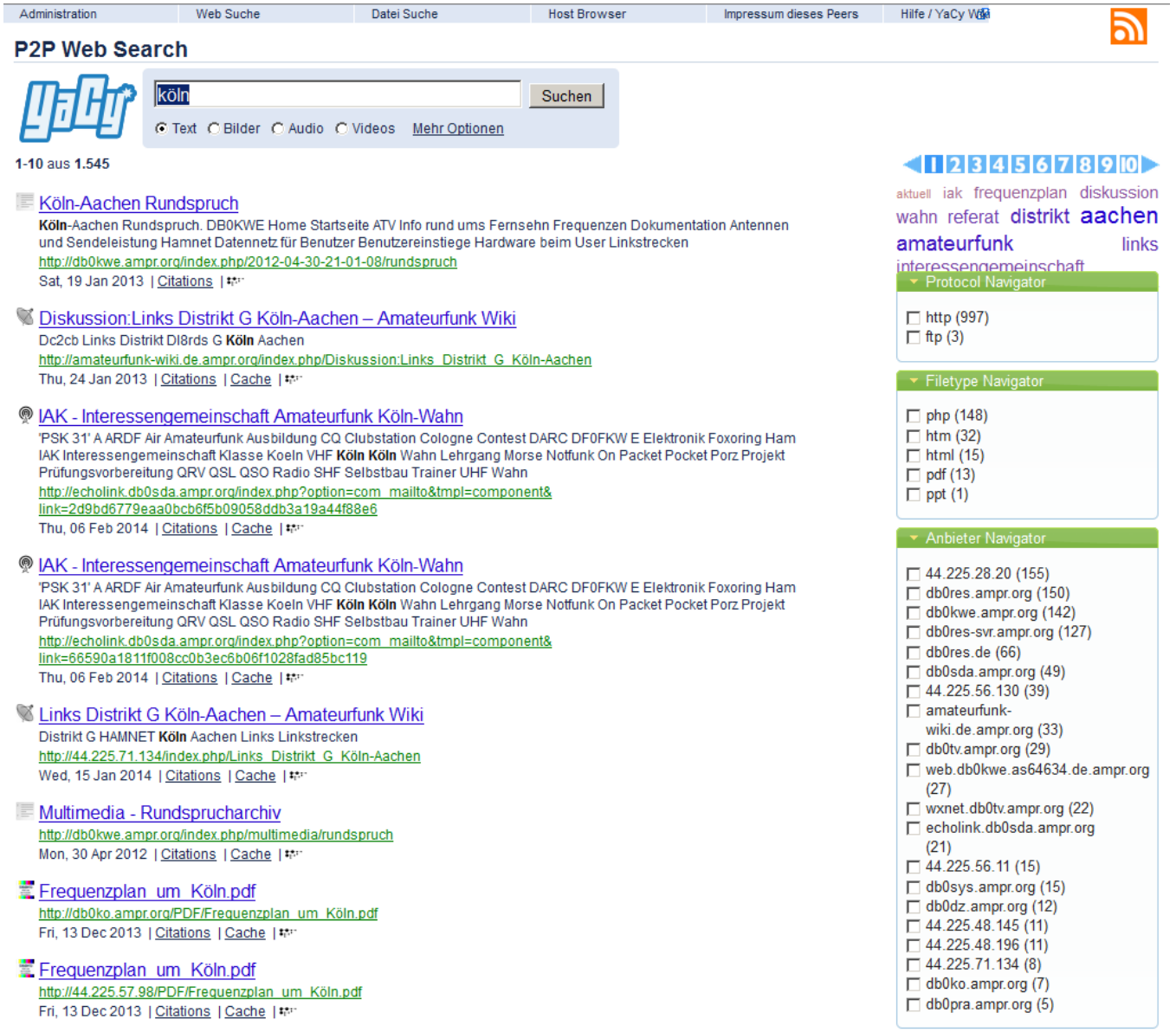

DF5KT Livestream
Bei Bedarf kann Norbert hier einen Videostream senden


DL2KBH Livestream
Bei Bedarf kann Dieter hier einen Videostream senden

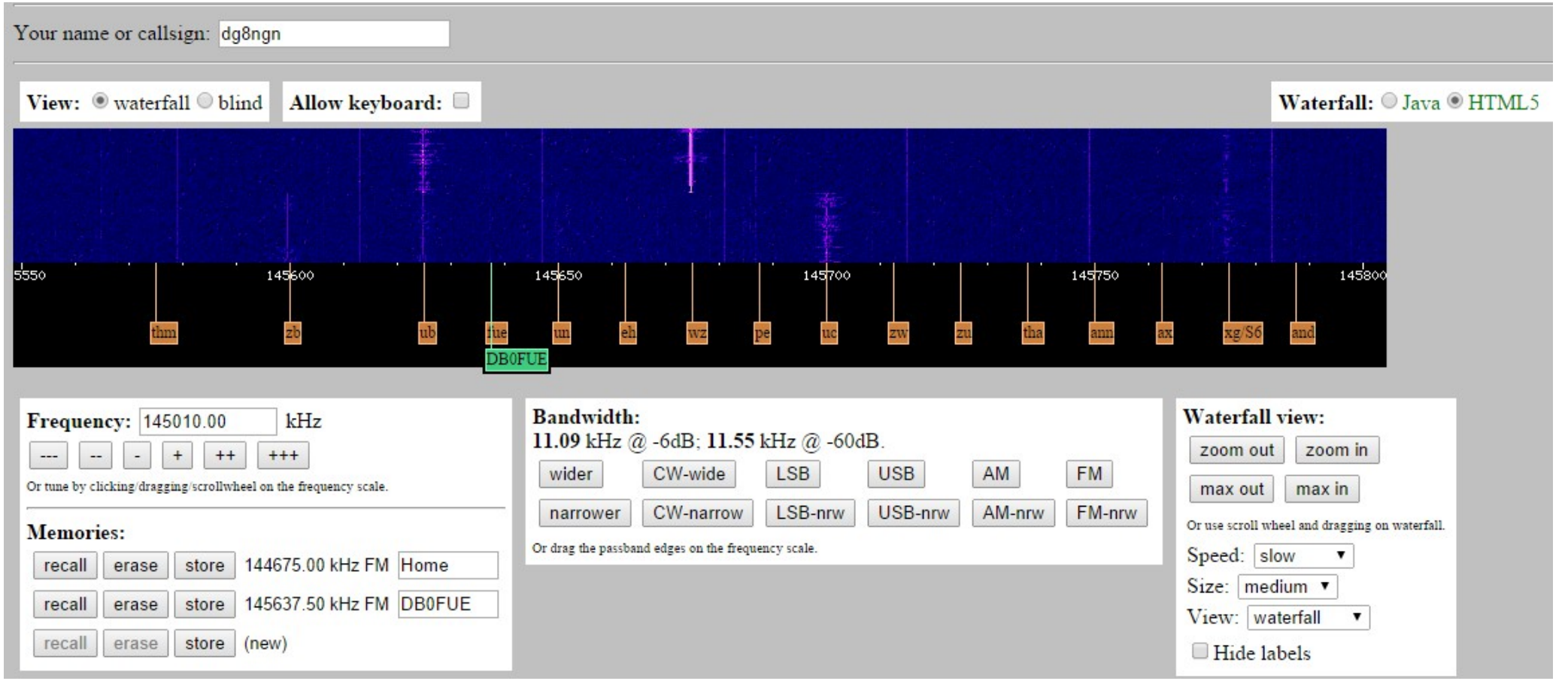
test Livestream
ATV-Livebild das im Moment in xxx ausgestrahlt wird

Application Examples – Social Network

Application Examples - Searchengines



Application Examples - WebSDR



http://websdr.org

Application Examples - Webcams

http://www.foto-webcam.eu

ToDo – More bands

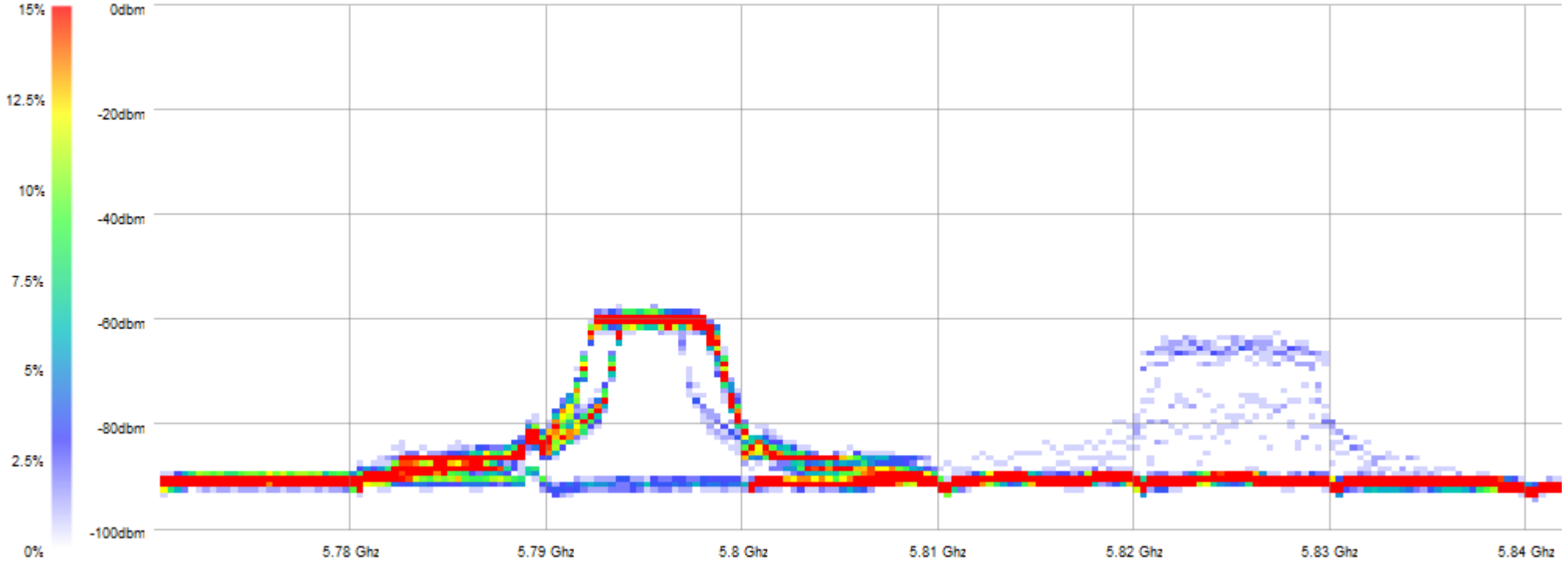
- 9cm: More expensive compared to 6cm/13cm
- 3cm: Ubiquiti PowerBridge M10
  - not much power
  - high price

- 24 GHz: Ubiquiti airFiber AF24
  - short range (license free band)
  - high price

- Selfmade Up-/Downconverter?
  - Full duplex with Mikrotik NStreme Dual possible
    - One card in TX mode
    - One card in RX mode

ToDo – Filters

- 5 MHz bandwidth
  - +/- 20 MHz → own signal seen again (lower level)
  - +/- 40 MHz → own signal seen again (less lower level)
- 10 MHz bandwidth
  - +/- 40 MHz → own signal seen again (lower level)



Todo – Better Routing Protocols

- Most routing protocols doesn't take changing conditions on a radio link into account
  - Packet loss (any kind of reason, e.g. Interference)
  - Changing troughput due to adaptive modulation and coding (AMC)
  - TX-ccq and RX-ccq (Client connection quality)

  → Flapping routes, unreliable connections...

- There are some protocols to test (B.A.T.M.A.N., OLSR, Mikrotik MME)
  - Protocols can be tested within a region, however sometimes communication between two stations might be better routed using a path through an external autonomous system...
  - Routing protocols need to be supported by the platforms

Todo – User Access Technology

- Connectivity more important than speed
- Reduced bandwidth = less noise → longer range
- Lower band = better for non-line-of-sight requirements
- **Wishlist**
  - 70cm band: 2 MHz, 1 MHz, 500 kHz, **200 kHz**, 100 kHz
  - 23cm band: 10 MHz, 5 MHz, 2 MHz, **1 MHz**, 500 kHz, 200 kHz (10 MHz / 5 MHz available from Doodlelabs)

- We already run D-Star DD 128kbit/s User Access on 23cm on net44

ToDo – Access to net44

- Access to network 44 needs to be improved
  - by RF (more sites, more bands, more technology)
  - by VPN (more VPN dial-in gateways)
  - by IPIP (better instructions how to join)
  - by BGP direct connected networks (more material to convince local ISPs to announce net44 networks)
- Access to network 44 needs to be simplified
  - Better instructions
  - Easier ways to connect
  - Better worldwide concept

Vision – Intranet for radio amateurs

- We want to create a huge intranet for radio amateurs using network44
  - Users should be able to provide services for radioamateurs in an easy way (e.g. end-to-end communication to single devices)
    - webcam.dg8ngn.ampr.org
    - web.dg8ngn.ampr.org
    - notebook.dg8ngn.ampr.org
  - The chicken-egg problem will be solved by content on the network
    - Hambook (Facebook for radio amateurs on net44)
    - Interconnected search engines to find content (yacy)

Vision – Authentication platform

- Providing services for radio amateurs on the internet leads always to the same question:

  How can I authenticate radio amateur operators?

- We need a global and easy solution to answer this question for services like:

  D-Star, Packet Radio, Access to net44, Echolink, Allstarlink, DX-Clusters, …

- Once we have a global solution more applications with access through the internet will be available due to easy implementation for programmers