THE GERMAN (CENTRAL EUROPEAN) PACKET RADIO NETWORK: AN OVERVIEW

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1. Fundamentals: frequency allocations and BAPT regulations

Packet radio operation In Europe made its beginnings in larger scale in the mid-80s. First access was made in the two-meter-band, but soon the single available channel (1 44,675 MHz) used to be overcrowded in densely populated area:;. Because there is significantly less space for amateur radio frequencies In Europe our packet radio network was successfully estabilshed in the 70cm and 23cm band during the last 8 years Tab. 1 summarizes an overview of German frequency allocation for amateur radio and its packet radio usage between 50 and 2000 MHz; regulations in other European countries is similar but more restricted almost

One of the main reasons for the controlled growth of a homogeneous packet radio network can be seen in the German amateur radio regulations for automatic (unattended) radio station (like repeater, packet radio nodes, radio beacon or similar). The responsible amateur needs a special permission issued to radio clubs (not to individuals). The German Bundespost / BAPT as the telecom authorities will not accept any request for a node permission if the recommendation from the DARC (German Amateur radio club) or another radio club is missing; so all nodes have to be coordinated.

This procedure shows pros and cons. In the past the process often was accompanied by severe discussions with demotivated (future) node sysops waiting for their permission for many months or even years. Additional interference came from the necessity for the consent of military authorities which own the 24cm band as primary users.

But central coordination also has a large advantage: the realization of a common and homogeneous network concept instead of single nodes or regional node clusters This conceptual work was not born by a single mind, but has been created on a couple of sysop and user meetings in 1986/87, and has since been adapted to the changing needs and perspectives of packet radio operation. As a result of this procedure it is now accepted by a majority of active amateurs who fill the concept with life.

The network described in the following sections exists (with minor modifications) in all Germany, Switzerland, The Netherlands, Belgium and Luxembourg, parts of France and Austria; Italy, Slovenia, Czeckoslovakia, Poland, Denmark and Great Britain have access to it.

2. The network structure: exclusive duplex links between nodes

When network planning started in 1986 we had the chance to use the experience of our own experiments and of other packet radio networks.

The idea of a client-server relationship between user and dedicated network suggests a separation of user access and network backbone to different communication channels

The simple single backbone channel suffers from the same problems as the single channel user network, as there are collisions by dead-time and hidden-station effects between several nodes. The only chance to estabilsh collision free communication paths within the network is the installation of an exclusive channel for each node-to node link, either in time division by assigned time slots or in frequency division by different channel frequencies.

Band	Frequency/MHz	Status	PR channels	PR usage
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70cm	430-440	primary	11 simplex 25 kHz IO duplex 25 kHz (7.6 MHz shift)	network access network access
33cm	not available	-	-	-
24cm	1240-1300	secondary	19 duplex 50 kHz (59 MHz shift) 14 duplex 50 kHz (28 MHz shift)	backbone links network access

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the realisation of frequency normals of a certain stability is simplier than that of synchronized time bases at different sites
narrow continuously available channels allow transmission with less energy per bit than time shared broadband channels

Any independent traffic over several frequency channels at one site normally implies the use of different frequency bands to avoid interference between the transceivers. Such a coarse frequency separation may be realized for user access and backbone in general, but not between the individual radio links for several reasons:

a large number of links (up to 10 from one site)
the large-area coordination of a limited number of exclusive frequency bands is very difficult
the same hardware should be usable for all link transceivers

A possible alternative solution is the choose of one band for all links with two well separated sub-bands in combination with the classification of all nodes in one of two classes: one group transmitting in the lower sub-band (class A node) and another using the higher sub-band (class B node). This allows collision-free links between A and B nodes, but none between nodes of the same class - a restriction that is acceptable.

From these basics a concept was born that uses the 430-440 MHz band for user access and the 1240-1300 MHz band for links, the last one with two 1 MHz wide sub-bands at the band limits (1240-1241 MHz, 1299-I 300 MHz). Each node-to-node link is estabished on an individual frequency pair spaced by 59 MHz; all links use highly directional antennas which can be realizied in the 24 cm band with small dimesions and low output powers ranging from 0.5-10 W to minimize any interference.

Such links are free of collisions and therefore allow high data throughput at relative low data rates. The radios operate simplex with tx/rx shift ("half duplex") or full-duplex using independent receivers and

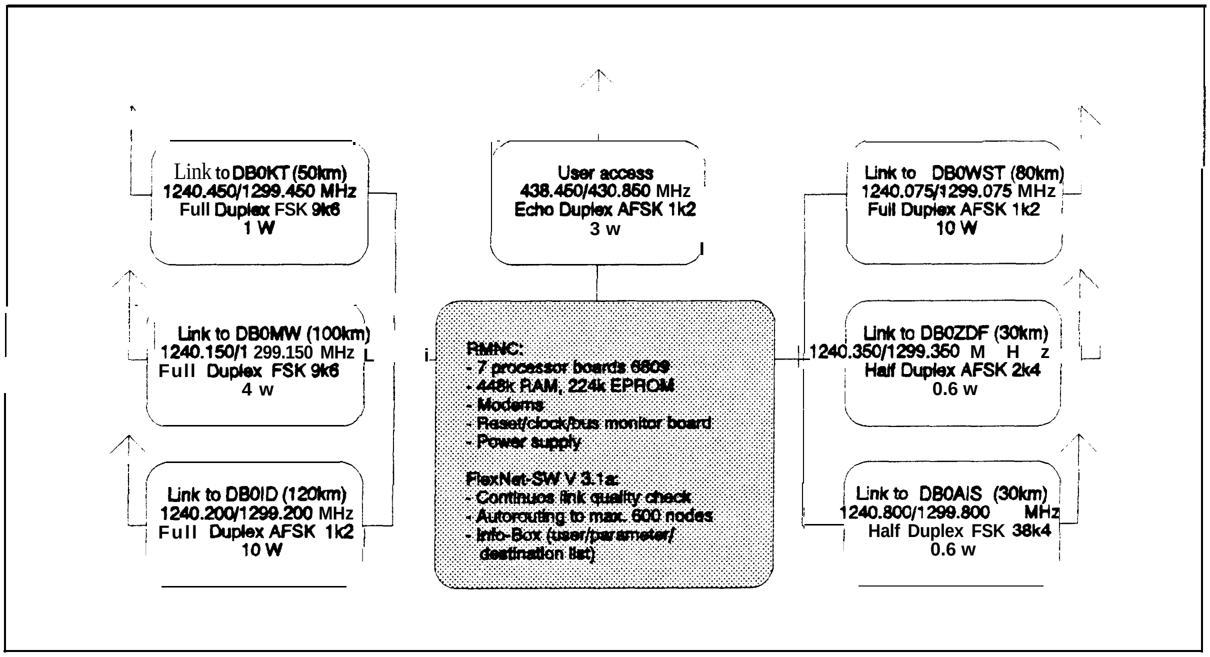

Fig. 1: Block diagram of a typical German network node (RMNC type)

transmitters and duplex filters. A network node consists of one multichannel node controller, one or two user access radios and 2...10 link radios. A typical node of this type (DBODA near Frankfurt) is shown in a block diagram in Fig. 1.

3. The node hardware: controller and radios

The described multichannel approach needs multichannel node controllers. German PR network started using a cluster of TNC-2 connected via serial interface with the well known diode matrix.

But soon a special hardware has been designed using a parallel bus system for interchannel communication within the node. It consists of simple 6809-based processor boards, each providing one 8530 as HDLC controller. With 64kB RAM and 32kB EPROM resources are limited but sufficient because of the high parallelity (a node with 10 channels has then 640 kB for data, the code located in EPROM). This node controller system is called RMNC (Rhein-Main-NC) and is now wide-spread in Central Europe.

In addition, other systems have been developed: the (NETROM)-TNC cluster has often been replaced by a hybrid system of TNC-2s with one Atari ST or IBM PC as routing processor connected by a serial ring daisy-chaining the boards. But this hardware suffers from low data throughput on the ring at higher radio data rates.

Single IBM-PCs with SCC slot cards are also used either with TCP/IP packages or a node version of the well-known BayCom program, but their number is small.

For the moment new node controllers are under design, e.g. a V25 and a 68302 based system, both with specialized DMA capable HDLC-I/Os. Their use is still restricted because of the continuing software development,

The radios used are partly Japanese manufactured voice NBFM radios, partly surplus professional equipment, and partly home-brewed transceivers. The user access (430 MHz) is often duplex (repeater like) with digital echo for collision avoidance; duplexers and independent rx/tx circuits are needed then, The links (1240/1299 MHz) can be half or full duplex. For that purpose several crystal controlled 1.2-GHz radio kits have been designed by one of the authors (DF9IC) which are wide-spread (many hundred units installed). Either AFSK (1k2 and 2k4), direct FSK (9k6), scrambled FSK (G3RUH type, 9k6 to 38k4), AQAM (9k6) or AQPSK (4k8) are used as modulation type.

Future work will focus on the use of higher frequencies and higher data rates. Recently the first user access points have been set up in the 1240 MHz band which will operate 9k6 or 19k2 scrambled FSK and might support in future 32k or 64k QPSK. The new links will move to the 6-cm and 3-cm microwave bands because all 19 24-cm link channels are nearly occupied. Twice 20 MHz have been reserved for packet radio links on each band using the same duplex concept, allowing data rates above 100kb/s to 1 Mb/s.

4. The node software: NETROM/TheNetNode, FlexNet, others

The available node software depends often on the type of hardware used. Hardware independence is difficult to achieve if small processor systerns are used which need careful software optimization for high speed.

NETROM on Z-80 based TNC-2s is now mostly replaced by better systems. TheNetNode has more features and gives better results, using one routing processor with more ressources. But this software does not support well the node type used with its many backbone channels.

The FlexNet software developed by DK7WJ makes use of the 6809 RMNC system described above. Its actual version 3.1 supports automatic link quality test measuring continously the response time of a link and network-wide stable auto-routing based upon this link quality. Each node administrates a complete list of all other known nodes together with their estimated response time as the sum of the measured link quality on the optimum route. This information is forwarded to the neighbour nodes with a special internode communication protocol. The node supports up to 76,8 kb/s per port, and about 300 kb/s totally. The software kernel (written in C) is also ported to other platforms like 68332 but these implementations are not yet available for general use.

A similar router is also used in a node version of the BayCom software (DL8MBT) running on IBM PCs with 8530 slotcards. Its speed performance is inferior, but it has some additional features due to the available mass storage medium, as e.g. routing down to the user.

For the mentioned V25 hardware a node software with compatible router is under development also but not yet fully operating.

5. BBSs and DX clusters: a network service function

Following the given concept all stations with service functions, running unattended round the clock and handling large data volumes, like BBSs, DX clusters or TCP/IP servers, are seen as a part of the network equivalent to network nodes. They have access to it via the same collison-free links as used for internode backbone. Often they are located at the same site together wit a node with user access and are connected to it by means of a wire link.

BBSs are running with the DF3AV software on IBM compatible PCs, serving more than 25 users at the same time. S&F is taking place completely within the network, using the same communication channels as the user traffic does. Some other BBS software is also in use, often running on UNIX workstations together with the KA9Q package. Few BBS have access to additional shortwave ports to allow world wide data transfer.

DX clusters are also frequently used by shortwave and VHF DXers. Through their link feature info from whole central Europe is available in each cluster.

6. The result: a powerful and flexible amateur network

The German PR network consists of about 210 nodes, using 650 exxclusive links for backbone communication, 50 BBS and 20 DX clusters are on the air. The total number of users is between 5.000 to 10.000, but with different levels of activity.

Each BBS distributes 100.. .300 Mb/month to its users. S&F of private mails takes place network-wide within one hour, direct response times of some seconds per digitpeating node are achieved. During rush hour some nodes run more than 200 user QSOs at the same time (most of them on the backbone). A big node with 10 links, six of them with 9600 Baud, handles up to 8 Mbyte/h.

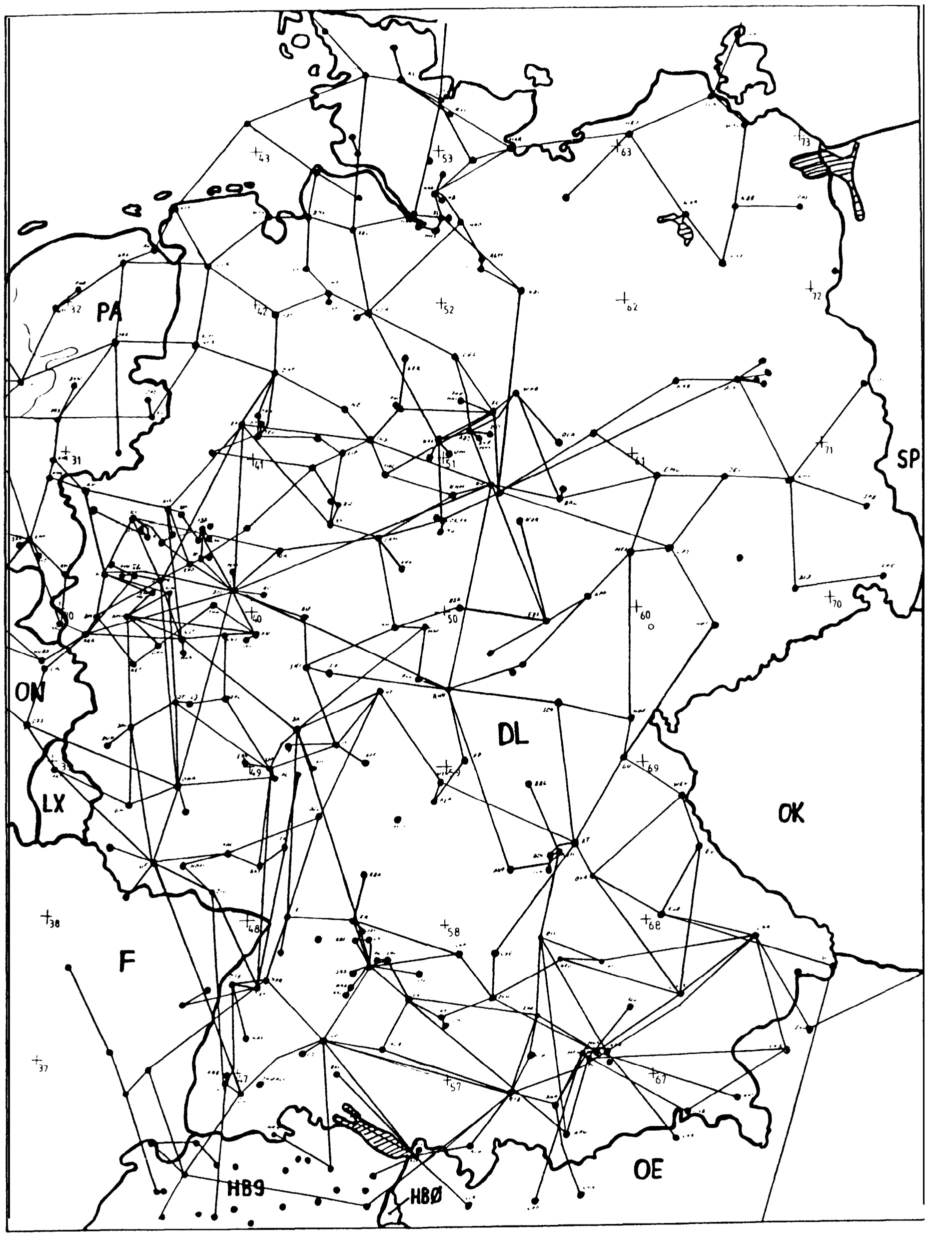

Fig. 2: The German PR network

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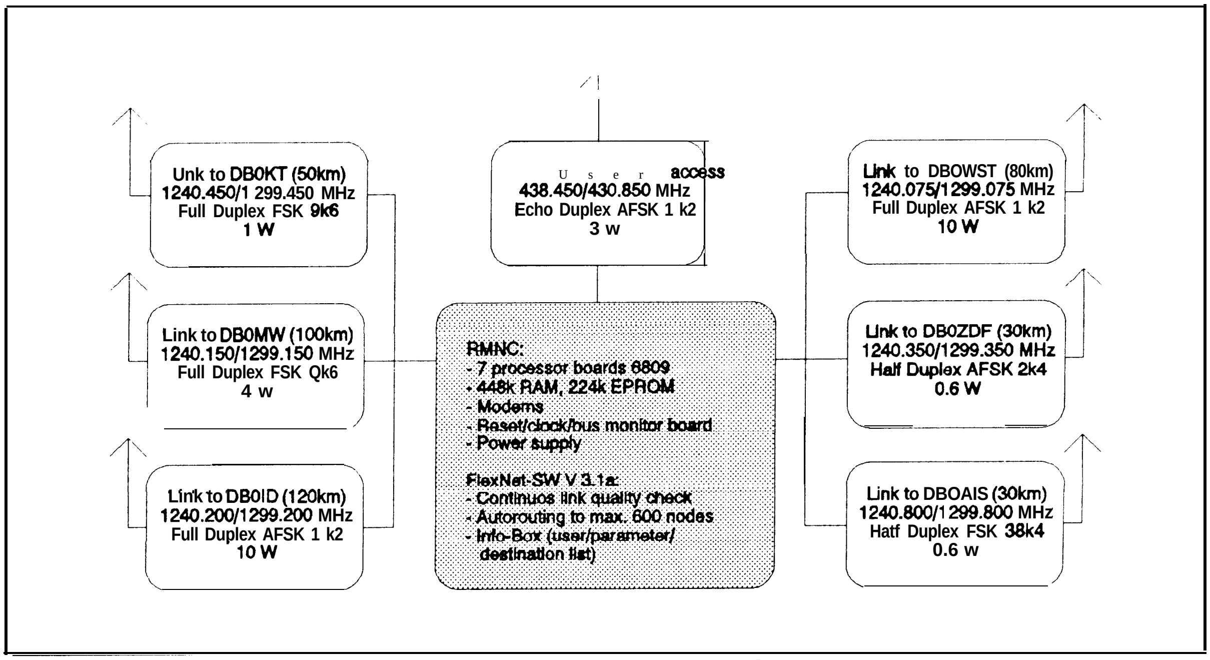

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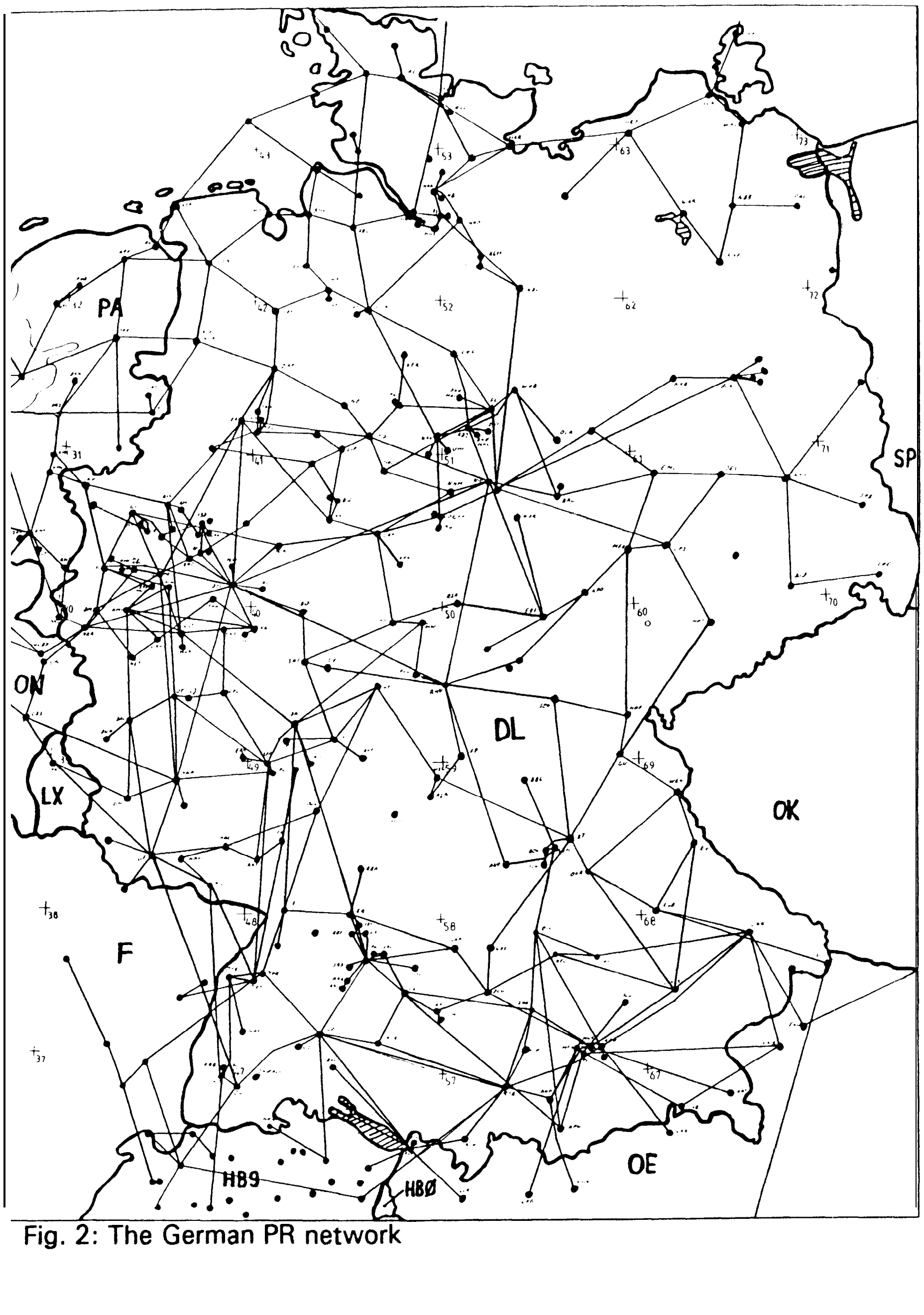

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