Efficient TCP/IP remote connection via shortwave: WWAN with the PACTOR-IP-Bridge, PTC-IInet as Gateway

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TCP/IP via shortwave (HF) is no longer something exotic and has already left the experimental stage. A few professional coast stations world wide (in Germany Kiel-Radio) already use a PACTOR-IP-Bridge (PIB) developed by **SCS** many years ago to offer their customers a first class and flexible HF-Service.

TCP/IP as an integral “Internet Protocol” is used to network computers. It is not relevant whether is consists of an local (house internal, LAN) or global (Internet, WAN). Apart from the necessary protocol-software every computer requires a hardware interface to connect/network physically to another one. In the case of a local LAN connection a modern computer already has an Ethernet connection/socket for that.

If somebody wants to connect to a computer on a far away place, the telephone line is the means on the physical layer. The telephone line is also the usual way to connect to the Internet. Because a computer does not have a direct connection for the telephone cable, a modem must be connected between the computer and the telephone line i.e. a DSL modem. The modem connects the computer to the telephone line and with this also to the Internet. If you wish to (or must) connect wirelessly to the Internet or transfer data then one has to rely on radio technologies. If only the cable between the DSL modem and the PC is to be replaced, just to be free to move within a range of a few meters, then Bluetooth or WLAN (Wireless Local Area Network) can be used, both is a relatively broadband data transfer technology via radio on 2.4 GHz.

However what does somebody do if he is many kilometers or even 1000’s of kilometers away from a telephone line and a DSL modem? He would need a so-called WWAN (Wide Wireless Area Network). Exactly this possibility is covered with the PACTOR-IP-Bridge (PIB) together with a HF Transceiver. Basicly the PIB works like a WLAN accesspoint, however with shortwave specific characteristics: While a WLAN accesspoint combines a modem, transceiver and antenna in one tiny housing, for setting up of a PIB a shortwave radio must be connected with the PACTOR modem and the whole certainly connected to an efficient shortwave antenna. Just like the WLAN, also the PIB data transfer system generally consists of two parts: A permanently installed transceiver (with WLAN this would be the accesspoint), which is usually connected to the Internet via the telephone cable. This basis station is called the host. The client (user) is the mobile transceiver. Here it concerns the actual participants in a service, thus the "user". At least on the physical side (excluded the individual in front of the PC), as already mentioned, these participants are also called "clients".

While the typical WLAN Client is for example a battery operated laptop PC or PDA, the PIB client (just like the host) consists of a suitable shortwave station. Normally a PIB client is installed in a mobile unit i.e. a ship or a larger land vehicle but also remote places like bush hospitals, Polar Ice Stations, etc can be connected to the Internet via a PIB.

Using shortwave, the possible distance between the host and client is only limited by the actual propagation conditions. This means that distances of several 1000 km can be “bridged”. Of course the speed of the data transfer is important, people want to transfer their data as quickly as

possible, and for this a high bandwidth is necessary. WLAN is implemented with a high bandwidth at high frequency and short distances, with PIB exactly the opposite is the case. The bandwidth is small because of the lower frequency, but the distance can be very large. To use figures: for PIB normally a bandwidth of 2.4 kHz is used (shortwave SSB voice channel). Because of limiting the bandwidth to this relatively small value the use of normal amateur HF-transceivers is possible. The data rate is dependent on the quality of the channel, and under best conditions can reach 5000 bits/s[1].

That does not sound very much for users used to DSL and WLAN but it is a lot if the alternative is nothing, or at the best an expensive satellite communication link. For text based emails and small files the data transfer rate is completely sufficient. If one wants to transfer a large amount of data then patience is necessary. Also surfing in Internet which is theoretically possible does not seem really practical, even with ISDN today's websites take some time to download. For special applications though, a PIB friendly site could be established, similar to the WAP server for mobile telephones.

Those who have ever dealt with network technologies may well say, that TCP/IP as network protocol is not really suitabe for being transmitted over shortwaves. It uses a lot of bandwidth and has an appreciable overhead "administrative data" which the user never sees. To transfer an email one has to transmit much more data then just the useful part because of the large overhead of the TCP/IP protocol. This disadvantage can be almost completely eliminated. The PIB only transfers the necessary data and reconstructs the missing data at both ends so that the network protocol (TCP/IP) is again complete and the computers involved are satisfied.

As already mentioned above, one has to distinguish between the host and client. For both the PACTOR modem (PTC) in PIB mode acts just like a normal telephone modem. Even when today ISDN and DSL modems are more usual, most operating systems can still work well with telephone modems. Telephone modems do not use the normal command interpreter e.g. the PTC command mode that signals readiness with the cmd: prompt, and a clear text command is answered with a clear text reply. A Telephone modem is controlled by the so-called HAYES command set. Exactly this command set is understood by the PTC in PIB mode and it replies to the PC exactly like a telephone modem.

How does the connection of a PTC to the PC look like in practice?

The Client side: The Windows operating system can use the PTC exactly like a telephone modem to dial in. The setting up of the modem or Dial-Up-Network can for example use the connection assistant. The only special thing to take account of is that instead of the usual telephone number the alphanumeric callsign of the host station must be entered. The PTC acting as a modem, connects via PACTOR with the distant station and signals the PC operating system that it is online. All services of the Internet connection can be used e.g. HTTP, FTP, POP3, SMTP….

Of course now the usual PC programs can be used for the appropriate service, i.e. Outlook for email, and Netscape for surfing in Internet. But this general "online" mode has its drawbacks. Many programs like virus scanners, Real-Player and the operating system itself look for updates and try to download these if they are available. Such downloads in the background overload the PIB connection completely, and one is advised to close down these programs and disable any

[1]In practice the average data throughput is often higher than the "9600 Bit/s"-MIL-STD-modems with 3.4 kHz of necessary bandwidth.

auto update features previously to using the PIB. A firewall that watches Internet access to the outside world is highly recommended for the PIB client side.

The Host side: The host station has two main tasks; on the one hand, it must accept a "connect" via PACTOR from the client-station and manage the Data transfer via shortwave. This is mainly the job of the PACTOR- modem. On the other hand it must manage the connection to the Internet and act as a gateway for the data between HF and Internet. In the standard configuration the host station consists of a HF transceiver (with antenna) a PTC-IIpro as modem and an Internet capable PC, online via DSL, ISDN or analogue modem. The host PTC is connected to this PC. The operating system on this PC must be configured in a way that enables it to act as a gateway. A suitable operating system is of course a necessity, as is the appropriate user knowledge on how the gateway is to be configured. The latter has proved in the past a particularly difficult hurdle. Most of the PIB host stations work with the operating system Linux: It is free and the important configuration parameters are easier to access. All in all Linux is little more transparent than for example Windows, which does not mean it would not function exactly the same with Windows. To make the configuration under Linux easier **SCS** offers a CD that boots a standard PC with a KNOPPIX based Linux system. In this system all the settings necessary for a PIB gateway have been made and may act as an example for the configuration of a host-PC.

PTC-IInet, the easiest solution for the host side:

To make using the PIB on the host side even easier, in a further step the Linux PC has been integrated into the PACTOR modem itself! This combination of the PACTOR modem and Linux PC is called PTC-IInet and is the newest member of the PTC-II series. To call the very barebones integrated Linux computer a "PC" may seem to be overdoing things, because it does not have a connection for either a keyboard, a mouse or a display. The only interface to the outside world that the PTC-IInet offers is a network connector (RJ45 Ethernet 100/100). Of course the PTC-IInet also has a transceiver connection for audio and PTT including as well as transceiver control. With the aid of a "patch cable" the PTC-IInet is connected to a router, like any other PC in a network. If the router is connected to the Internet, e.g. using a DSL modem, then all connected PC's including PTC-IInet are automatically "online". The PTC-IInet is allocated an IP address via DHCP. Alternatively a fixed IP address can be assigned to it. The PTC-IInet is pre-configured so that the user (system administrator of the host station) only has to make minimal adjustments to the settings. For example he must set the callsign and audio output amplitude to modulate the transceiver. Other settings e.g. transceiver control are optional. To configure all the parameters of the PTC-IInet it has a web interface, which means it runs a web server internally. Thus the PTC-IInet configuration can be carried out via a web browser from any PC on the network. Theoretically it is even possible to configure the PTC-IInet from any point on the earth via Internet. To this means it is only necessary that the router is appropriately configured (firewall partly opened).

With this the PTC-IInet offers a comfortable possibility to remotely control the transceiver via the Internet. Because the PTC-IInet includes a small terminal program it is even conceivable to remotely perform a Pactor connection via the Internet. Therefore a radio station with PTC-IInet can be used from any point on earth.

After the system administrator has carried out the few necessary settings the PTC-IInet is ready to accept "connects" to its own callsign. If now a PIB client calls the PTC-IInet via shortwave, then the client is (after the few moments needed for the automatic login procedure) connected to the

Internet, and can work as if the user had a “direct” Internet connection.. With the radio connection the client side notices only that the data rate is rather less than with ISDN or similar. To avoid “unwanted visitors” being able to use that Internet gateway the PTC-IInet administrates a list of valid users and their passwords. In this way one is protected from unwanted visitors.

PTC-IInet as (A)PRS Server:

As an additional application the PTC-IInet can for example act as a “(A)PRS host”. The position datagram received via the connected transceiver can for example be “packaged” in an email and send automatically over the Internet to a freely configurable email address, or simply as a UDP-datagram, forwarded to a server that makes the collected positions available via Internet. In this way it is very easy to make a position data collection system. All one needs is a V/U/HF receiver with a connected PTC-IInet as receiving station. The more receiving stations available the more likely that a datagram is received, whereby the reliability of the whole system in the case of (local) interference or datagram collision is increased. Because the installation of a receive station with the aid of a PTC-IInet is very easy and very little resources are needed, there are hardly any obstacles to setting up a network of many receive stations.

To make the transfer of positions datagram via shortwave more reliable, **SCS** has developed a new modulation method that can be used for (A)PRS and HF Packet-Radio. The narrow band variety with a bandwidth of 500 Hz proves itself with a high robustness against fading, multipath conditions and packet errors (static bursts) as well as a high tolerance against misdjustments. Frequency deviations of up to ±250 Hz are tolerated without sacrificing sensitivity. Because of this, a tuning display is not necessary. This new method can therefore be described as “plug and play” for shortwave with a clear conscience. At the moment the data rate is 600 Bit/s average, later an increase to 1200 Bit/s within a bandwidth of 500 Hz is possible. The new modulation method can replace the old error prone 300 Baud FSK Packet.

For the (A)PRS datagram various “speedlevels” can be set with the new modulation method. In the case of a network with only a few users (therefore with fewer receiving stations/repeater), a more robust datagram can be used, that although takes longer than the lesser robust /quicker type, but can still be received under very bad signal conditions. Because the demodulator recognizes all possible variants automatically (“autobaud”) a network can grow successively: As the number of users and radio stations increase, a faster (shorter packets) “speedlevel” should be used.