# There's a remote possibility…

**This is the story of my five-year project to develop systems for the complete remote operation of an HF station. It describes the work that was done to obtain approval, and put two systems into operation, the successes achieved and the lessons learnt. The article also has a significant technical content describing not only the details of the components and technologies that I have used, but also looking at the pros and cons of some of the choices.**

My operating interest in 160m has been significantly curtailed by the small size of my back garden. I also have a relatively high background noise level, and my XYL does not think antennas make attractive garden ornaments! These were some of the reasons that I became interested in the remote operation of an HF station. I should make it clear, right at the start, that in the UK, this type of remote operation is not allowed as part of the normal licence conditions. I had, therefore, to obtain specific permission by applying for a 'Notice of Variation', or NoV. At the time, this was through the Radiocommunications Agency (RA), now Ofcom. I was granted the NoV in October 2001 as a special research permit which has allowed me to operate remotely since then. It is worth noting that a *receive-only* system could be implemented without needing any regulatory approval (OK1RD has set up such a system on a 50-acre site 40km from his home in Prague, for low-band receiving antennas).

Remote operation has many benefits, such as the ability to put up much better antennas for both transmit and receive than might be possible in a typical suburban garden, to be able to operate where there is much lower background noise on receive, as well as reducing the risk of causing interference to others. However, there are some issues with remote operation and I will be describing these and how I minimised them with the second system.

This is the first of three parts, in which I will cover what I mean by remote operation, the regulation issues, and describe the design of the

first system, the technologies used, as well as analysing how it performed in practice. Part two will cover the different technologies used to obtain the performance improvements of the second system. The approach I have taken with the second system is very specific to my interests and priorities and so the final part will look at some of the alternative approaches that are possible. By the end of 2006 I have to submit a report to the RSGB and Ofcom. Before producing this report I would like to undertake a wider consultation with others who are interested in remote operation, so I will also use the final part of the article as the starting point for this discussion.

## MY DEFINITION OF REMOTE OPERATION
There are probably several interpretations of what remote operation is, but what I wanted to achieve was the ability to operate a station that was out in the countryside away from the restrictions of living in a suburban area and to be able to take advantage of the benefits mentioned earlier. In my case, the remote location is several miles away but within 30 minutes' travelling time, which gives reasonable accessibility for the development and maintenance work. I decided very early on that the link between the two locations would be by dial-up telephone line and that the system would be for my personal use only.

## OTHER DEFINITIONS OF REMOTE OPERATION
In the USA there are some comprehensively-equipped remote sites, which are referred to as Internet Remote Base (IRB) systems, which have been set up by individuals allowing the system to be shared by a group of registered users. The access to these systems is via broadband

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**TECHNICAL FEATURE**

# Part One

# Remote HF operation made practical

Internet and it effectively allows access from anywhere in the world. (W4MQ and W7DXX are examples of these – see 'Web Search'). There are some major technical and regulatory issues with this approach, so I chose not to go down this route.

Returning to the simpler situation of a single user requiring a separation between the equipment and the operating position, there are a couple of variations from my interpretation.

1 Separating the operating position a short distance, but still within the boundary of the property. For example having a neat compact operating position in one room but the equipment in a basement, loft or shed. This is relatively easy to achieve, would not need regulatory approval, and would not have to contend with the limitations of using telephone lines.

2 Separating the operating position a long distance, say several hundred miles, but still within the same country as the license holder. This is technically quite feasible, but would have practical difficulties for access and maintenance.

Both of these variations could use some of the technologies that I have used, but there are other options that could be more appropriate.

### HOW THE PROJECT EVOLVED
In the mid 1990s, I made arrangements with a local farmer to use a field over a weekend for portable operation in the *CQ* WW 160m SSB contests. This temporary arrangement has developed into a more formal agreement where I rent part of the field and have a small room from which to operate. I now have a 108ft

modified Titanex vertical, a K9AY receiving antenna and have recently added a small tower and an HF beam, as the photograph shows.

In early 2000, I started to think about the potential of using the facilities at the farm but be able to operate them remotely from home. In May of that year I decided to fulfil a long-term ambition to visit the Dayton Hamvention in Ohio. There, a company called Kachina were not only displaying their computer-controlled rig (the 505DSP, which had no controls on the front panel at all) but also a ready-made system for remote control over a single dial-up phone line. I came back from the USA with the intention of trying to gain approval to use this system in the UK. I thought that a commercially-made system with good security and safeguard features might be more acceptable to the RA than an unproven homebrew prototype.

I started with the RSGB and I was put in touch with the Licensing and Advisory Committee (LAC). As my idea was completely new, there were no guidelines, so I started off by writing a detailed proposal and, in addition, I was asked to fill out many sets of forms (including closedown operators, similar to that required for repeaters). The LAC reviewed the proposal and after some modifications they put it to the RA via their regular meetings. The RA deliberated on this for some considerable time but, eventually, asked the Radio Investigation Service, to do an inspection. I was somewhat surprised to get a three-man delegation, complete with test equipment to examine and test the system. They showed considerable interest in it and we had an enjoyable and wide-

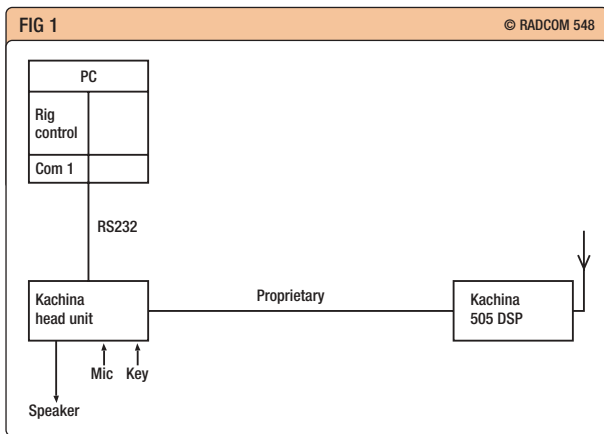**The beam which is fully-controllable remotely.**

FIG 1 © RADCOM 548

**Fig 1**
The Kachina set up for normal operation.
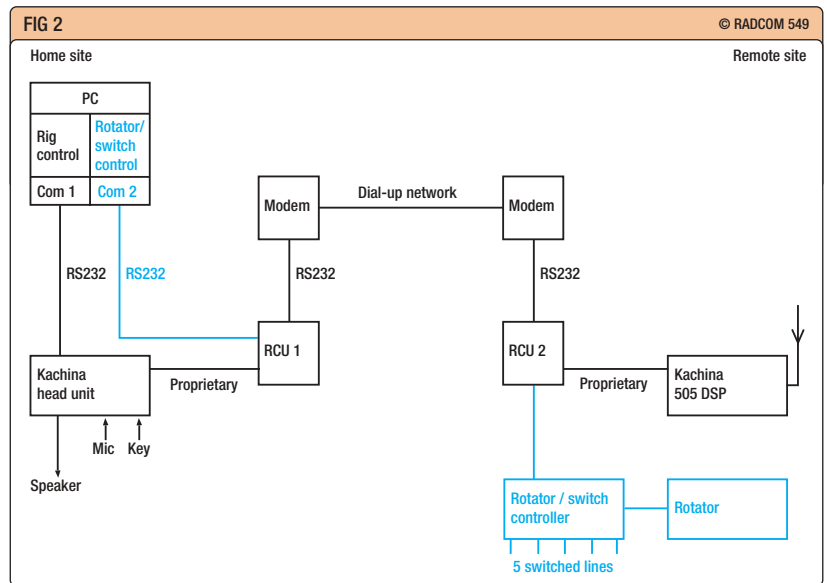
**Fig 2**
The Kachina set up for remote operation.



FIG 2 © RADCOM 549

ranging discussion about the issues. I received the NoV shortly after the inspection and had my first remote QSO on 2 November 2001. It had taken a total of 16 months from start to finish for the NoV to be issued.

### DESCRIPTION OF THE KACHINA SYSTEM

Since the early 1990s rigs have had 'CAT' interfaces to enable them to be computer-controlled. The early rigs had just a few functions such as band, frequency and mode that could be controlled from the computer but, since then, each new generation of rig has had more and more computer-control capability. As far as I am aware, of the transceivers aimed at the amateur market, only the Kachina and the Kenwood B-2000 [and the Ten-Tec Pegasus – *Tech Ed.*] went so far as removing the front panel completely.

**Fig1** shows the Kachina set up for normal home operation, and the photograph shows the control screen. To operate the rig, all the user interactions are via the computer keyboard and mouse. For example, band and mode changes can be made by clicking buttons or selecting from drop-down menus, level adjustments can be made with slider controls and these all generate one data stream of control commands which are passed to the rig via the proprietary interface. This control data stream is bi-directional as the rig passes information such as S-meter reading, power output and even temperature of the PA back to the computer. The black portion of **Fig 2** shows the system as configured for remote operation with the inclusion of the two proprietary Remote Control Units (RCUs) and two standard modems.

To operate remotely, a dialler program is used to initiate a link between the two RCUs via the modems, allowing the control data stream to be passed backwards and forwards between the rig and the computer. In receive mode, the audio is digitised in the remote RCU to create a second digital data stream which is then multiplexed with the

control data stream to give a single combined data stream which can then be passed through the modems and phone line back to the home RCU. There is some clever processing here that controls the quality of the audio digitisation dependent on the bandwidth available on the phone line. At the home RCU, the data stream is demultiplexed into its two component parts. The control stream updates the computer display and the audio is converted back to analogue, amplified and passed to the loudspeaker. In transmit mode, the reverse happens: the audio from the microphone is digitised in the home RCU, multiplexed, and then sent to the remote RCU where it is demultiplexed, with the control data stream controlling the rig and the audio being passed to the microphone input. As well as the basic rig control there is also the ability to include some additional remote switching that could be used for antennas as well as the ability to control a remote antenna rotator. The blue portion of Fig 2 shows how these additional controls can be added. The final photograph shows the setup at the remote site.

With a remote system, it is also necessary to consider what would happen if certain failures occurred, or if there was malicious intent to gain control of the system. The first and most fundamental security feature is that the phone number of the remote site is kept secret. In addition to this, the Kachina system adds two features to protect against these unwanted possibilities. As soon as the two RCUs are linked by the dialler, a safeguard feature, a watchdog timer, comes into play and every 15secs the two RCUs check that they can still communicate with each other. If the communication link fails for any reason, the remote RCU shuts down the transceiver, and the home RCU displays a message

informing that communication has been lost, as the photograph shows. This safeguard would prevent the rig from being stuck in transmit if the communication link failed. The other feature, which is for security, is to ensure that the remote site only accepts commands from the legitimate home site. Each RCU has an encoder/decoder which is controlled by a set of eight DIP-switches, and, unless these switches are set identically, the two RCUs cannot talk to each other. There are only 256 combinations of these dip-switch settings, but it provides yet another barrier to being able to gain control of the system, thereby preventing misuse.

### PRACTICAL EXPERIENCE

There were a few initial problems to be overcome, mainly with the dialler software, as the UK phone system and UK versions of the recommended modems were slightly different from those used in the USA; Kachina were very helpful in overcoming these problems. While I was waiting for the NoV to be approved I could not legitimately test the system between the two sites but, fortunately, I had the advantage of two phone lines coming into the house. This allowed me to test the system by having all the equipment at home and dialling out on one line and back in on the second line, so I could see what was happening at both ends of the system.

I got a tremendous buzz out of the first remote contact; there was a palpable sense of achievement after nearly 18 months' work since first having the idea. Rag-chewing was very straightforward, and I received many complimentary reports of the audio quality. After just over a year, I took the plunge and decided to use the system in the more pressured situation of a single-band 80m entry in the *CQ* WPX phone contest. It was

very enjoyable being able to use all the antennas at the remote site but still have all the creature comforts of operating from home. I worked for about five hours and recorded 151 contacts, not a massive score but it nevertheless gave me some additional and valuable learning experience.

When I started the project, I knew what some of the operating issues would be but, overall, this first system exceeded my expectations and, not only has it been interesting, but also very educational. It has shown that there is still scope for research, learning and self-training in the true spirit of amateur radio.

After gaining a variety of operating experience, I decided to analyse critically the aspects of remote operation that were significantly different from normal operating in order to see if there were ways of making improvements. This gave three areas to investigate.

1  **System Delays**. It was obvious that there would be delays in the system as the data streams had to pass over what I estimate to be 15 miles of phone line. I calculated that it would take the signals about 0.12ms to travel this distance, which turned out to be insignificant compared to the other delays introduced by the modems, telephone exchanges and in the audio digitisation. I really had very little idea what these delays would be but, in practice, they turned out to be quite noticeable and had a significant impact on the operation of the system. The first impact was on the transition from transmit to receive, when it was not uncommon to miss the first word of the other person's over. For casual rag-chewing this delay was noticeable, but not a significant problem. However, for contesting, when running a frequency, it was a definite limitation, and several times I missed the callsign of someone calling me quickly.

I had always planned to monitor my own signal from the remote station by listening on a second rig at home. The first time I tried to do this, I was surprised by the magnitude of the total system delays, and found it almost impossible to talk when the audio I was monitoring was delayed by such a significant amount. At the time I was not able to do any testing to measure the delay accurately but I estimated it to be something over half a second. The phone link between the two sites was using standard 56K dial-up modems, but the Kachina system was using the older V.34 protocol which has a maximum rate of 33.3k. What I hadn't fully realised was that this rate was rarely achievable in prac-

tice, and the best I could achieve reliably was about 24K and this had to satisfy both the control data and the digitised audio.

2  **Frequency tuning**. This was more difficult for two reasons. First there were the delays mentioned above which made it harder to tune in a signal when there was a significant delay between making the change and hearing the result; for contesting this made search and pounce quite a challenge. The second reason was using a keyboard as the user interface. We are all used to tuning by twiddling a knob, so it is not until you have to do it another way that you realise the simplicity, and convenience of the tuning knob. Tuning the Kachina is done by clicking on a digit of the frequency display and then using the up/down arrow keys to increase/decrease the selected digit. In addition the left/right arrow keys are used to move the cursor to an adjacent decade of the frequency display. Kachina did have an option of a tuning knob, which improved things a little, but the system delays were the major problem.

3  **Received audio quality**. This issue was even more surprising given the comments earlier on the reports of good transmitted audio quality. The received audio quality was never really good and was only acceptable if the received signal was strong, and well above the noise level. Anything less than this was harsh and tiring to listen to over an extended period (this was one of the things I learnt while doing the WPX contest).

### A MAJOR SETBACK AND PLAN FOR THE FUTURE

While I was waiting for the NoV, and before I had even used the system 'live', I learnt that Kachina had decided to leave the amateur market to concentrate on their commercial business. This meant that there was no future in the system and, if I had any major problems, there would be no support and I would be unable to continue. Fortunately, I have had no failures with either the rig itself or the remote control units. (Kachina have maintained their website so there is still detailed information available – see 'Web Search'.) However, I felt the need to plan for the future, so I started to think about a second system. This would then give me the opportunity to try to improve upon the three issues I described above. The first thing I did was to define a set of criteria for this second system which were:

1  to create a more open 'system framework' that was not dependent

on any one single manufacturer;
2  to reduce the system delays;
3  to improve the user interface for tuning;
4  to improve the quality of the audio;
5  to maintain the security and safeguard aspects.

I have spent around 18 months trying various approaches and have eventually completed the build of a second system. Because my NoV was so specific to the Kachina system I had to go back to Ofcom to get my NoV updated, which was approved in March 2005 and this has allowed me to implement the second system. After gaining further experience with the second system I am pleased that it has delivered improvements in all three areas where there were issues. The system delays have been reduced considerably, and I now have substantially better audio quality on both receive and transmit. The user interface for tuning has been improved and, as a by-product, there are some additional security and safeguard features, which are an added benefit. The second part of this article will look at the design of this second system in more detail. ♦

**The Kachina control screen.**

**The Kachina equipment at the remote site.**





| WEB SEARCH | |
| --- | --- |
| Remote base Yahoo Group | http://groups.yahoo.com/group/RemoteBase/ |
| W7DXX | www.lamonica.com |
| W4MQ | www.w4mq.com |
| Kachina | www.kachina-az.com |

# There's a remote possibility…

**This part will describe in detail the second system and how improvements were made to all three of the problem areas within the first system. The new system was also designed to have a more open structure which would make it more flexible, with the ability to substitute different components easily into different positions within the structure.**

Before deciding on the approach to the second system, I researched and experimented extensively, and the decisions I took were based on my own personal preferences and priorities. However, I can also understand why other people with a similar goal in mind might wish to make different choices. In the third and final part, therefore, I will examine some of the other approaches and technologies that could be employed and discuss where they might best be used and their relative advantages and disadvantages.

I had often envisaged a home station that would be capable of automating some of the activities that are required when deciding to follow a wanted spot from the DX Cluster. The rig will QSY to the correct band and frequency, the correct antenna will be selected and, if required, the beam will be rotated to point in the right direction and, finally, the auto-ATU will recall the last settings for that antenna and frequency. I would then be ready to listen for the station, fine-tune to the exact frequency and prepare to call at the right moment. What I never thought would happen is that I would be able to do all this remotely before I ever did it at home.

Here were three key decisions that shaped the design of the second system:

**1 Linking the two sites**. It was a fundamental premise that I would use a dial-up telephone line to link the two sites, so the first decision was to use the telephone line to extend my already-existing home local area network (LAN) to the remote site. This is a well-established requirement and can be implemented by devices called LAN modems. The main thing with this approach is that, whereas a home LAN would typically have a bandwidth in excess of 10Mb/s, the throughput of the LAN over the telephone line will be will be much slower and dependent on the type of telephone line used. To minimise the telephone line delays, I opted to upgrade from a normal analogue line to an ISDN (Home Highway) line, and this made a very big reduction to the delays in the system. (During the experimentation phase of the project, I built the LAN initially with analogue modems and then replaced them with ISDN modems. I made measurements using both designs, and the time a small packet of data took to travel over the network reduced to less than one-third. This improvement came from the fact that the link was now entirely digital, so there were no longer any analogue to digital conversions and it gave a solid 64Kb/s bandwidth compared to the 24Kb/s actually achieved with the analogue lines.) There are several other ways to implement a link between the two sites and I will discuss these further in Part 3.
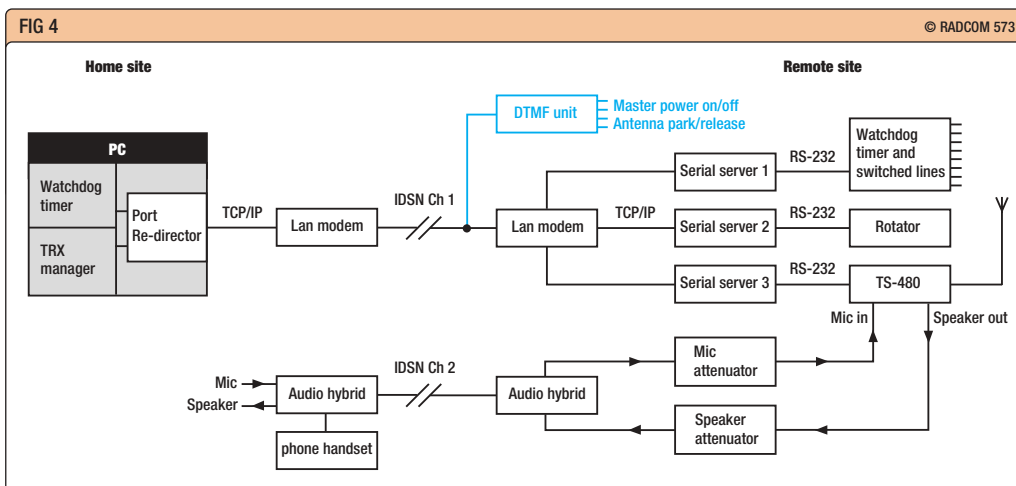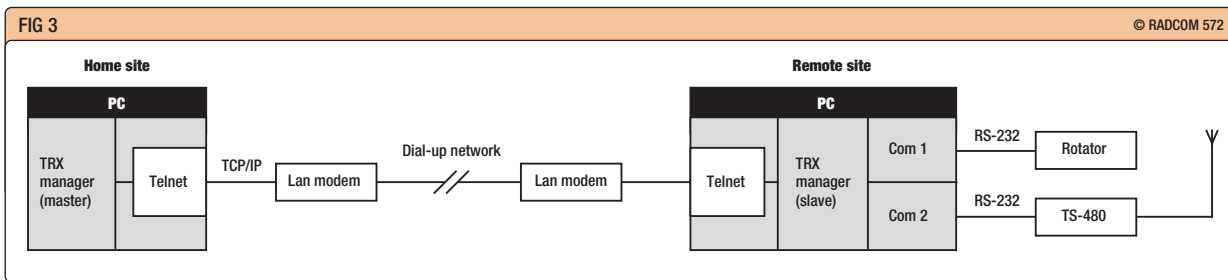
**2 The control program**. Rigs from most manufacturers now have an RS-232 'CAT' computer-control facility with the latest rigs being extensively specified. However, not many manufacturers provide a computer-control program to use with these facilities. Kenwood is the notable exception to this situation, and provides very good control programs for the TS-2000 and TS-480 ranges. Fortunately, there are many third-party rig-control programs available; some are specific to a particular rig or a particular manufacturer, but others cover most of the more popular rigs. I have investigated a few of these, but I soon found one that stood out from the crowd and that is *TRX-Manager* developed by Laurent, F6DEX. A key differentiating feature of this program is that it has been designed with a very efficient remote control capability built in. The program is very flexible and, in particular, there are several ways of frequency tuning which an operator can use according to his / her own preference. There is a simulated tuning knob that can be rotated using the mouse, there are up/down keys where the step size can be set by the user (I have found a 250Hz step size a very useful option) and also a similar mechanism to that used by the Kachina, except that it can use the left/right mouse buttons in addition to using the keyboard. This flexibility extends to the program, being 'OLE'-enabled (this is a programming technique to allow other programs to pass data to and from *TRX-Manager,* which is very powerful). The *Logic7* logging program is integrated this way and Larry, N8LP, has written a small program to allow a footswitch to be used. Even with the complexity of these powerful facilities, the quality of the software is excellent, and the quality of the support is even better! I should point out that I have no association with Laurent other than as a very satisfied customer. There is a very active and supportive Yahoo group, but Laurent himself is very accessible and responsive to enhancement requests.

**3 To PC or not to PC?** Here I mean personal computer not political cor-

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# Part Two

# Remote HF operation made practical

**FIG 3** © RADCOM 572



**FIG 4** © RADCOM 573



mon user interface which generates a standard set of control commands (which at this stage are completely rig-independent) that are sent over the LAN. At the remote site, *TRX-Manager* running in slave mode, converts the common standard commands into the specific commands that are necessary for the rig being controlled, and these are passed to the rig through the RS-232 port. A rotator can be controlled in the same way, and some switching can be implemented off the parallel port. (*TRX-Manager* does have a second method of remote operation called 'real remote control mode', which requires a very high-bandwidth link so is not suitable for a LAN based on phone lines, and only works with some of the recent transceivers.)

The approach without a remote PC came from N8LP (see 'Web Search'). Consider a normal home situation where there would simply be an RS-232 cable from the computer to the rig. Then imagine you break the RS-232 link and insert a converter, which translates the data from RS-232 to the LAN protocol, which allows the data to be sent to the remote site. At the remote end, another converter translates the signals back to RS-232 for the rig control. In practice, the RS-232-to-LAN
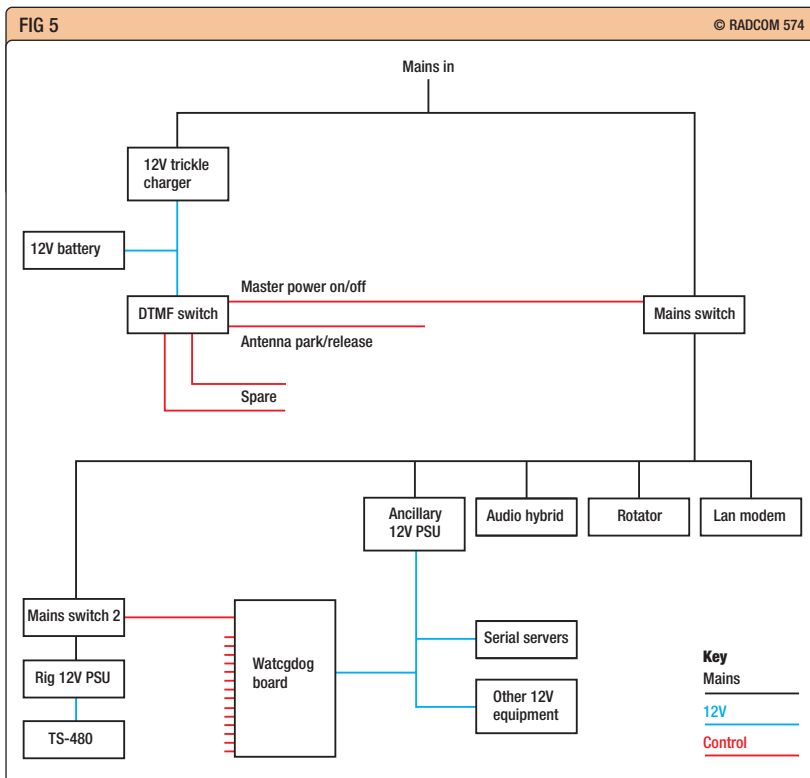
rectness! The decision whether or not to use a PC at the remote site is a crucial one that affects many of the subsequent lower-level decisions. I have to admit that many of the other people implementing remote control systems in other countries are using a PC at the remote site; however, I opted not to use a PC. Because this is such an important decision, I will describe how a remote system can be designed using *TRX-Manager* both with and without a PC, and then explain why I chose not to use one.

Obviously, there needs to be a PC at the home location in both cases. The PC approach uses two PCs linked over the extended LAN described earlier and the remote PC is the one that requires an adequate provision of RS-232 serial ports to control the various pieces of equipment (see **Fig 3**). *TRX-Manager* runs in master mode on the home PC and slave mode on the remote PC and they 'talk' to each other over the LAN using telnet, which is a common communication protocol. *TRX-Manager* in master mode has a com-

**Fig 3
Using a PC at the remote site.**

**Fig 4
Second system using serial servers.**

**FIG 5**

© RADCOM 574

Mains in

12V trickle charger

12V battery

DTMF switch

Master power on/off

Antenna park/release

Spare

Mains switch

Ancillary 12V PSU

Audio hybrid

Rotator

Lan modem

Mains switch 2

Watcgdog board

Rig 12V PSU

TS-480

Serial servers

Other 12V equipment

**Key**
Mains
12V
Control

Fig 5
**Power control switching.**

conversion at the home end is done using 'port redirector' software, and at the remote end uses a hardware device called a serial server. The *TRX Manager* software and any other programs can all work over the one LAN, permitting additional devices, each with its own serial server, to be addressed and controlled. This allows equipment such as a rotator, antenna switching, or even some of the newer linear amplifiers to be controlled remotely (**Fig 4**).

Why did I choose this approach rather than using a PC at the remote site? I have to admit some of the reasons might be slightly emotional rather than totally objective, but that is part of the decision-making process. My concerns about using a remote computer were first the stability and reliability of a *Windows*-based PC, particularly in the slightly hostile environment of my outbuilding at the farm, and second, the complexity of starting up and booting the PC remotely. I know a PC could be in sleep mode and be woken up when there is LAN activity; however, I prefer to have things switched off when not being used. So

my personal decision was to go for the serial server approach; for me, the simplicity of being able to power-up devices and for them to be immediately available for use was the deciding factor. However, I accept that there are some potential benefits of using a remote PC and I will cover these in the final part.

**TRANSMITTING THE AUDIO**
There were two issues with the audio on the Kachina system, the delay and the poor quality. These were both caused by the considerable signal processing that needed to be done on the audio to make the used bandwidth dynamically adaptable to the current phone line performance. Straightforward analogue-to-digital conversion, using dedicated purpose-built systems, can be done very efficiently without any noticeable delay. I stated earlier that one ISDN channel would be used for the LAN extension. All ISDN lines have two channels, but a Home Highway line has a key difference from a straight ISDN line, which is that each channel can be used in either digital *or analogue* mode. So my plan was to use the second chan-

nel in analogue mode for the audio and let the ISDN system provide the dedicated purpose-built capability to do the analogue-to-digital conversion efficiently and with high quality. I then had to find a way to interface the audio on to the phone line. As this was a subject I knew very little about, rather than spend more time on this research, I took the decision to buy a ready-made unit. It is known as a Telephone Balance Unit or Audio Hybrid, and is used in the broadcast industry to feed audio between an outside broadcast unit and the studio. There is quite a range of units available from the basic to the sophisticated. Some units offered higher-quality audio, but used digitisation which would introduce unwanted delays, so I chose a mid-range unit which provided two-way audio with simple analogue interfacing to the phone line. At the remote end, I just needed to add simple attenuators to get the audio levels correct (very similar to the common sound-card interfaces used for digital modes). At the home end, I could just plug the microphone straight in; there was enough output on the received audio to drive an efficient speaker directly.

**WATCHDOG TIMER**
This small but very important component, which is really an intelligent switch, took the longest time to develop, because I could not find a ready-made product. This essential safeguard feature has to detect if the communications link fails, and if it does, make the remote equipment safe by switching off the power to the critical components, and informing the operator at the home site. I eventually found an RS-232-controlled relay driver board that had provision for 16 relays, one of which would be the intelligent switch of the watchdog timer. The important thing about this board was that it contained some inbuilt timers which were programmable, thus allowing the watchdog function to be implemented. A small piece of code was loaded on to the board that would allow a relay to be switched on, but be subsequently controlled by a count-down timer which would switch the relay off if the timer timed-out. Back on the home PC, another program was written which could communicate with the board over the LAN using the

same serial server approach. This control program passes a command to the board every 10 seconds which resets the count-down timer so, as long as these resets are received, the watchdog relay stays activated. If more than two reset commands are lost, the watchdog relay will open and switch off the controlled equipment, and a warning message will be passed to the operator. As well as providing the watchdog function, the control program also provides buttons with which to switch any of the other 15 relays, which can be used for other control purposes.

### ENHANCED SECURITY AND SAFEGUARDS

My aim was at least to match the security and safeguard features of the Kachina system. As I experimented with different equipment, I realised that I could easily add some extra security features.

I said earlier that I like to have devices switched off, so this meant I had to have some means to turn the devices back on. To do this, I used a small telephone device which would auto-answer a phone call and contained four DTMF-activated relays. This device is the only one that is permanently powered on through a trickle-charged battery, and can sustain itself for several days without mains supply if required. One of the relays on this device is the master power switch and another is used for switching the antennas

from their grounded state when not in use, to an active state when required. The key feature of this device is that it is PIN-number protected so no part of the system can be activated without the correct PIN number being entered. It also has features to isolate itself after repeated failed PIN attempts. This is shown in blue in Fig 4. **Fig 5** shows the complete power control schematic using both the DTMF unit and the watchdog timer.

The LAN modems also had two features which provided an opportunity to tighten up the security. First, the remote modem will only respond and establish the LAN link when the correct ID and password are supplied by the home LAN modem when it tries to dial-in to the remote LAN modem. Second, as part of the build of the LAN, the two modems have to have a unique number assigned to them (their IP-address), the remote modem being set up only to accept data from the IP address that is assigned to the home modem. This provides a similar function to the DIP-switches on the Kachina system, but has more combinations available. It is an added obstacle, but would need further careful design by a network expert to make it completely secure.

### USING THE SYSTEM

The photograph shows the small amount of equipment required at the home site. The first step in

operating the system is to dial-in to the DTMF unit to activate the master power switch and the antennas. These are latching relays, so this function can use ISDN channel 1 and then disconnect, leaving it free. Next, the LAN link can be established between the two LAN modems re-using channel 1, and allow the watchdog timer to be started. Once this has been done, *TRX-Manager* can be started and, finally, the audio link established on channel 2, giving full remote control of the rig and two-way audio. At any time, the rotator can be turned or any other switching can be done as required. At the end of a session, the links can be closed down and then a final dial-in to the DTMF unit can ground the antennas and isolate the master power switch.

The reduced delays have made the second system much easier and slicker to operate. The transition from receive to transmit is quicker and it is now possible to monitor the remote station from home without difficulty. The reduced delays and the convenient tuning options in *TRX-Manager* have vastly improved the user interface. Finally, the audio quality is much better, and equally good on receive as it is on transmit, making it much easier to listen to – so much so that I am looking forward to a suitable contest in the near future where I can put this to the test.



Home equipment for the second system.

### THE FINAL PART

A key part of the design is the more open system framework which will give a sound basis on which different schemes could be designed for different circumstances. In the final part, I will describe some of the alternative technologies that can be used, and discuss their advantages and disadvantages. ♦

| WEB SEARCH | |
| --- | --- |
| LAN modems (3C891A) | www.3com.co.uk |
| Lantronix serial servers (UDS-10) | www.lantronix.com |
| Telephone DTMF switch | www.quasarelectronics.co.uk |
| Watchdog timer RS-232 board (VIOM) | www.phaedrusltd.co.uk |
| Audio hybrid (HY-03) | www.sonifex.co.uk |
| Port re-director software (serial/IP) | www.tacticalsoftware.com |
| TRX-Manager | www.trx-manager.com |
| N8LP, TRX-Manager add-ons | www.telepostinc.com |

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# There's a remote possibility...

This final part covers a few additional aspects of the second system, other miscellaneous details which I have discovered along the way, and plans for the future. It also discusses some of the alternative methods of implementing a link between the two sites and covers the pros and cons of each. Finally, I have to produce a report to the RSGB and Ofcom by the end of 2006; however, before I start on this, I would like to undertake a wider consultation with others who are interested in remote operation, and so I would like to use this article as the starting point for this discussion.

I am not a CW operator, but I have spent some time proving that remote CW is a feasible option using TRX-Manager and the TS-480; in fact, there are three possible ways of generating CW remotely.

♦ CW can be generated by CAT commands within the TS-480 itself, which is the approach I took. *TRX-Manager* has a CW tool which is a essentially a text-entry box, but also has some memories from which standard information can be recalled easily. This text is sent as CAT commands to the rig which then generates the CW at the remote site. This approach worked very well, but is obviously very specific to the TS-480. (If only it did CW receive as well!)

♦ Using *TRX-Manager* in its standard remote configuration with a remote PC, gives an additional option to generate the CW on a serial port on the slave computer from the text entry box running on the master computer. I do not know whether this approach would work with a remote serial port derived from a serial server. All *Windows*-based CW generators can have problems with erratic CW timing and *TRX-Manager* is no exception to this, though I understand faster computers tend to reduce the problem.

♦ The best and most generally-applicable approach would be to use *Winkey* by K1EL (see 'Web Search'), which would overcome the timing problem. Again *TRX-Manager* has an option to interface directly to *Winkey*.

## HOME RIG AUTO-TRACKING THE REMOTE RIG

I mentioned previously that (where frequency allowed) I wanted to monitor the remote signal from home. For simple testing it was not a problem to

**The Griffin PowerMate, a USB-interfaced rotary control. Photo: Griffin Technology**

tune the home rig manually but, once into everyday operating, I wanted the home rig to track the remote rig automatically. Again *TRX-Manager* had the solution, with a small additional application called *TRX-Synchro*. This application, obtains the frequency from *TRX-Manager* and generates CAT commands for any other rig that can be connected to another serial port on the home computer; in my case, this was a Yaesu FT-1000MP. I then feed the audio from both the remote rig and the local rig into an external speaker unit that has two selectable input sources and a headphone jack. When transmitting remotely I can listen to the actual transmitted signal, and when receiving I can switch between listening remotely or locally. There have been many occasions when I could hear stations remotely that I could not detect at all from home, which proves the value of the system.

## GRIFFIN POWERMATE AS A TUNING KNOB

As I have said before, having to tune the rig from a keyboard is one of my major dislikes, and although *TRX-Manager* has more options and flexibility than the Kachina did, I have spent some time looking for better options. The Griffin PowerMate (see 'Web Search' and the photograph) is a USB-interfaced rotary knob that that can be used to generate the

keystrokes used for tuning in a more convenient way. The anti-clockwise rotation of the knob can be equated to the '-' (minus) key to tune down, and clockwise rotation can be equated to the '+' (plus) key to tune up. The knob can be pressed and released to activate or deactivate a function and different keystrokes can be assigned when the knob is held depressed and then rotated: I use this last option to give a faster QSY rate across the band. I have found this a useful accessory which normally sits on the bench horizontally; I want to try mounting it vertically to see how it feels orientated this way.

### RS-232

When is a standard not a standard? RS-232 is in widespread use but, because there are so many options as to how it can be implemented, it is not as standard as you might think. During my experimentation I have used rigs from Yaesu, Icom and Kenwood, and their 'CAT' capabilities vary between the different manufacturers.

♦ **Icom** uses an efficient RS-232 implementation that lends itself to remote control applications, and works well using the serial server approach.

♦ **Kenwood** older rigs, such as TS-850, also have an efficient RS-232 implementation and they also work well using the serial server approach.

♦ **Kenwood** newer rigs, such as the TS-2000 and TS-480, are also well-suited to remote operation and work well with the serial server approach. These rigs have a greater CAT capability than most other rigs and use a more 'talkative' RS-232 implementation, there-

# Part Three, conclusion

## Remote HF operation made practical

fore needing a slightly greater bandwidth to operate effectively.

- **Yaesu**'s CAT capability works well when attached direct to a real COM port on a PC. However, there is something unusual about the Yaesu implementation of RS-232 which I have not been able to identify precisely, but is probably a timing problem. The consequence of this is that I have not been able to get my FT-1000MP to work with the serial server approach, even when connected to a hard-wired LAN at home. Unless a solution is found to this, any remote operation of a Yaesu rig would have to use a PC at the remote site.

### SITE LINK ALTERNATIVES

The second system established the idea of using a LAN as the main framework component, which I chose to implement using an ISDN line. There are several other ways that a LAN link can be implemented.

- **Leased Phone Line**. This is an expensive option, but would remove the delays caused by the switching within the telephone exchanges, and would increase the security. It is possible to lease lines with bandwidths from 64Kb/s up to 1Mb/s and way beyond.
- **Wireless Network** (Wi-Fi). This is a technology that has grown considerably over the last few years and products are readily available and affordable. It can provide abundant bandwidth (typically up to 10Mb/s) but the distance it can cover is limited. It would be a good option where it was required to extend a LAN within the boundary of your own property. Longer distances are achievable as long as there is an unobstructed line-of-sight path between the two sites, and it might be necessary to use directional antennas and optimise the gain of the Wi-Fi system carefully to stay within the Wi-Fi regulations.

| Table 1 | | |
|---|---|---|
| **Ping results (average, in ms) for 50 transits of a 32-byte packet.** | | |
| **Link Mechanism** | **Average Time** | **Max Time** |
| Dial-up | 168 | 238 |
| ISDN | 49 | 79 |
| Broadband | 32 | 35 |

- **Broadband**. This is also becoming widely-available at bandwidths of 500Kb/s or greater and has the advantage that distance is no object.

With Wi-Fi or broadband there are a couple of additional points to consider. I have not investigated these to any great depth and the unknowns were another reason why I kept to dial-up lines for both my systems. It would require some further research to understand fully the problems and any solutions. First, there would be a need to tighten up on the security, as we are all aware of how insecure the Internet is, unless specific precautions are taken. Second, there is the possibility, when packets are flying round the Internet, that some packets will go a different route from others, take longer to travel, arrive out of sequence, and this may affect the performance.

Various timing tests (using the ping function) were done during the experimentation. Table 1 shows some of the results in milliseconds for a 32-byte packet averaged over 50 tries and gives an idea of the speed differences between the different systems.

There is a further, slightly different way of exercising control over a LAN, and that is to use remote desktop software. This approach would have the control program running on a PC at the remote site, but the remote PC would be controlled from home using remote desktop software. The disad-



PHOTO: G3TXF
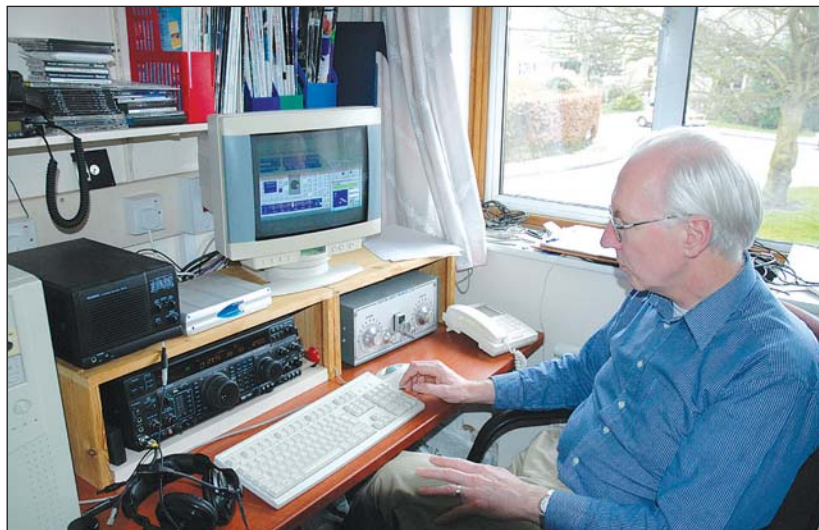
**G3UEG at the operating position of his remote station. The Powermate control knob can be seen in the bottom left-hand corner.**

**Table 2**

The combination of options that could be used. The choice is wholly subjective.

| Control Data | Audio | Comments |
|---|---|---|
| Packet over a radio link | Use an analogue dial-up line | See Note |
| Modems over a dial-up line | Share the single dial-up line | The Kachina approach |
| Modems over a dial-up line | Use a 2nd dial-up line | |
| 1 channel of ISDN | 2nd channel of ISDN as analogue | My second system |
| 1 channel of ISDN | Digital voice over ISDN 2nd channel | |
| Broadband | VoIP using broadband | |
| Broadband | Use an analogue dial-up line | |
| Wireless network | VoIP using wireless network | |
| Wireless network | Use an analogue dial-up line | |
| Leased line | VoIP using leased line | |

Note: The packet radio control link could possibly be used for a receive-only remote operation, but is probably not viable for transmitting because of security and regulatory reasons.

vantage of this approach is that it requires a large amount of screen graphic data to be sent over the network link, which would require a lot of bandwidth, and is very inefficient. Several people have reported trying this approach, but then have reverted to other methods.

Finally, as a technical option, TRX-Manager can provide an alternative way of linking the two sites that does not require a phone line at all, but uses conventional packet radio technology using suitable VHF or UHF equipment. This method can provide basic control facilities which would be limited by the slowness of the link but, most importantly, the legality of using this approach in the UK would need to be examined in detail. It might be feasible for a receive-only remote system.

### AUDIO TRANSMISSION ALTERNATIVES

Use of a wide-bandwidth link such as Wi-Fi or broadband would allow the audio to be sent over the single LAN connection using Voice over IP (VoIP), which has developed significantly over recent years. Microsoft Netmeeting has been around for a while but, more recently, a product called Skype (see 'Web Search') has been growing in popularity. These systems offer high quality audio, but they do include audio processing, which will inevitably introduce some additional delays into the system.

### MATRIX OF OPTIONS

**Table 2** shows the main combinations of options that could be used. Which option is chosen will depend on availability, distance between the two sites, and the balance between cost and performance.

### REASONS FOR USING A REMOTE PC

I have given my reasons for going down the serial server route but, as I said, there are several valid reasons for opting for a PC at the remote site.
- No need for special products such as port re-director software and serial servers, and probably cheaper if an old PC can be put into service.

- Would enable any rig with RS-232 capability to be controlled remotely without having to worry about compatibility with serial servers.
- Would allow any parallel port applications to be used (eg band decoders).
- If broadband or Wi-Fi were being used, a PC would be one option to implement the tighter security and also the decoding of the VoIP audio.

### ISDN IN ANALOGUE MODE

The digital side of the ISDN line has worked exactly as expected; however, I did have a number of problems when using it in analogue mode. It appears that some of the line voltages used for signalling are significantly different on an ISDN (Home Highway) line from those on a conventional analogue line. I found that the audio hybrid I used would auto-answer perfectly on an analogue line but not on the ISDN line. (This was eventually overcome with help from the manufacturers.) Also, originally I tried to have the two analogue devices, the DTMF unit and the audio hybrid, connected in parallel on the same line where, according to their respective specifications, they should be able to co-exist. I never resolved this, but found a work-around by putting the analogue DTMF unit in parallel with the digital control line, which worked because they never needed to be used simultaneously.

### NEXT STEPS

Some of my plans for the future are:-
- Tuning knobs again I am afraid, but this has just leapt to the top of my priority list. Gus, SM3SGP, has recently posted to the TS-480 reflector that, as part of the development of the SK3W contest site, they have discovered the protocol that is used on the cable that joins the rig body to the remote head and have successfully extended this cable over a broadband link. (see 'Web Search'). This would mean that the rig's own remote head could be used for control purposes and gives the normal tuning

mechanism that I have been striving for. The protocol is straightforward serial TTL, and I have identified some serial TTL-to-Ethernet converters which should do the job without needing any PCs. So I just need the time to do the further investigation work on this. (They have also discovered the protocol for the IC-706 remote head as well.)
- Try the digital modes.
- Revisit the option of using a remote PC, in particular how to boot it remotely.
- Try some newer serial servers that claim lower delays.
- Investigate remote-controlling a linear amplifier.
- Controlling a 'Preset ATU', which would take the frequency from *TRX-Manager* and, depending on which band segment the frequency was in, switch coil taps and capacitors in a matching unit at the base of my vertical which have been 'preset'. This would be necessary if using a remote linear amplifier.

Looking further forward, Dave, G8KKB, has suggested that in the future, as rigs become USB-enabled (as many ancillary products already are), it will be relatively straightforward to build USB-extenders to replace the serial port interfaces we use today which will have better performances and be able to handle the audio as well as the control data.

### THE WAY FORWARD

When my NoV was updated to allow me to use the second system, there was a requirement that I produce a report to be submitted to the RSGB and Ofcom by the end of 2006. I have not yet had any terms of reference for the report, but my guess is that the purpose of the report will be to help inform any decisions that will be made as to how remote operation might be regulated in the future. I have my own views on this, but I would also like to involve other people who are seriously interested in remote operation and/or have knowledge in areas such as broadband, secure networking and VoIP. So I would like to invite people to contact me, so that the report produced can take into account the views and expertise of a wider population.

I will be presenting a lecture/workshop session at this year's HF convention in October, and this will be an additional opportunity for anyone interested to contribute to the preparation of the report.

### WEB SEARCH

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|---|---|
| Griffin Powermate | www.griffintechnology.com/products/powermate |
| Microsoft Netmeeting | www.microsoft.com/windows/netmeeting |
| Skype | www.skype.com |
| Winkey | http://k1el.tripod.com/wkinfo.html |
| SK3W | http://sk3w.shacknet.nu/remote/ |