TAPR

PACKET STATUS REGISTER

PSR #86 WINTER 2003

president's corner

Amateur Radio & 802.11

BY JOHN ACKERMANN, N8UR

It's an interesting coincidence that the main unlicensed frequency bands used for wireless networking overlap with ham bands. It's not a new thing for hams to take advantage of this fact by using hardware designed for "Part 15" operation at 900 MHz and 2.4 GHz under amateur rules; I was personally involved in such a project about 10 years ago.

But in the last year, and particularly in the last few months, the idea of using 2.4 GHz 802.11b (sometimes called "Wi-Fi") wireless devices has really taken off. The ARRL has launched a "High Speed Multimedia" task force that's not only done good work, but has also generated a lot of publicity. TAPR has launched a mailing list (**ham-80211@lists.tapr.org**) dedicated to this topic, and we plan to have in-depth presentations on 802.11 technology at the DCC this fall.

I'm as intrigued as anyone by the idea of using inexpensive commercially-available gear to do high speed digital radio — after all, faster bits are better bits. And 11 megabits per second is pretty fast.

However, before we invest a lot of energy (and money) building an 802.11 infrastructure, I think we should look carefully at the environment we live in to make sure we're not making a risky investment.

The problem lies in the advantage: 802.11 is attractive to hams because it's abundant and it's cheap. But it's only abundant and cheap because we're piggybacking off the unlicensed users who outnumber us by thousands to one.

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Submission Guidelines

TAPR is always interested in receiving information and articles for publication. If you have an idea for an article you would like to see, or you, or someone you know, is doing something that would interest digital communications, please contact the editor (**psr@tapr.org**) so that your work can be shared with the Amateur Radio community. If you feel uncomfortable or otherwise unable to write an article yourself, please contact the editor for assistance. Preferred format for articles is plain ASCII text (Microsoft Word is acceptable, please save the document as Rich Text Format - .RTF). Preferred graphic formats are PS/EPS/TIFF (diagrams, black and white photographs), or TIFF/JPEG/GIF (color photographs). Please submit graphics at a minimum of 300 DPI.

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All those users mean lots of opportunity for interference to our attempts at DX (and with Wi-Fi, that's anything over a mile), and unlike the past when interference to ham operations typically came from single sources, now there may be hundreds of potential interference sources. And, despite the fact that the law is on our side in any contest between Part 97 and Part 15 (sorry for the US-centric references!), the reality is that your neighbors aren't likely to turn off their Wi-Fi cards or cordless phones (lots of those inhabit the 2.4-GHz Part 15 band, too) in deference to your 10-mile path.

But that's actually the easier problem to deal with. Consider the reverse situation. Hams aren't the only ingenious folks, and lots of ISPs have gotten the idea that 802.11 can be used for metropolitan area networks. They're using the same hardware we are to shove signals farther than the 802.11 designers had in mind. Like ours, their links are pretty fragile.

Now imagine what happens when a ham fires up his 10-mile link, taking advantage of Part 97 to run a lot more ERP than the Part 15 crowd is allowed. Suddenly, the ISP's customers, who happen to be in the ham's beamwidth, find that their throughput has gone down, or worse, their connection disappears entirely. It'll be "those damn hams" just like in the days of TVI. And, even though we're in the right, we'll get the bad press.

This wouldn't be so bad if it were Joe Ham vs. Joe ISP. But there are a lot of big players involved, and we've already seen attempts, both open and covert, to enhance the position of Part 15 users against interference sources like our licensed transmissions. The reality is that, rightly or wrongly, the public's perception of our "value proposition" isn't what it was, and today's auction-driven FCC is a different beast than the Friendly Candy Company of the old days.

The bottom line is that it's not at all clear that we could withstand a determined onslaught by the wireless industry to elevate the position of Part 15 devices *vis-a-vis* hams. There's a real danger that Part 15 could end up with greater protection from interference than Part 97.

Now, am I saying we shouldn't experiment with the cheap and plentiful Wi-Fi gear that's out there? Absolutely not! We should definitely keep working and learning how we can take advantage of this kind of technology. But, at the same time, we should be considering several things.

First, let's look for ways to get the benefit of Wi-Fi on our other bands where we don't have to coexist with Part 15 users. We have lots of microwave spectrum that's at ever-increasing risk because of our failure to use it, and this phenomenon gives us an opportunity to address that failure.

A "simple" solution would be a transverter using a Wi-Fi card as its driver, with an output on our 3300 or 5600 MHz bands. I put "simple" in quotes because TAPR has the scars to show that RF projects are never as easy as they seem, but one like this may be quite feasible. And, frankly, a product like this is important to our future. TAPR doesn't currently have anyone working on something like this, but (I say this with some trepidation) we'd be prepared to support a team trying to develop a Wi-Fi transverter.

Second, let's see if we can use Wi-Fi for things *other* than Internet access and long-haul links. In other words, we should use Wi-Fi to complement, not necessarily replace, our existing ham services. For example, Wi-Fi could provide a link between the APRS station in your car, and your laptop while you sit in the coffee shop (hams in Seattle

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are doing this already). There have to be other opportunities like this, and we'd like to hear about them.

Finally, a growing number of Wi-Fi enthusiasts are building networks and pushing long-haul link; it's hard to distinguish some of the things they're doing from what we'd like to with Wi-Fi. Should we try to turn them into hams? To be frank, many are interested only in extending Internet access, and when they learn that ham links can't legally do that, the conversation ends with a "why should I bother?" But there are probably some Wi-Fi experimenters who deep in their hearts have the ham spirit, and we should try to bring them into our ranks. TAPR is currently working on a strategy to reach these folks through targeted marketing.

DCC 2003

I'm happy to announce that the location and date for the 2003 Digital Communications Conference have been set. Mark your calendars for September 19-21, 2003, and plan to make your way to Hartford, Connecticut. The DCC will be at the Windsor Marriott Airport Hotel, just north of Hartford and just south of the Hartford airport. We'll have a great conference with the added benefit of seeing the height of the New England autumn leaf season.

And remember that it's not too early to start thinking about papers and presentations for the DCC. Lots of TAPR people have been working on neat projects, and now is the time to write them up for the DCC Proceedings.

Hamvention 2003

Although we've been focusing on finalizing arrangements for the DCC, let's not forget about the Dayton Hamvention, coming up in just a few months. We'll once again have the TAPR Digital Forum on Friday morning, and the Digital BASH on Friday evening. See you there!

New 802.11 E-List

BY DARRYL SMITH, VK2TDS

Given the increased interest in Amateur applications for 802.11b, we have decided to add another mailing list for discussions specifically on its implementation in the ham radio world.

The list is designed to be a meeting place for all 802.11b experimenters — regardless of where in the world they are located, or what protocol changes are being advocated.

If you wish to join this mailing list, the best way is probably to visit the following URL: **www.tapr.org/cgi-bin/lyris.pl?enter=ham-80211&text_mode=0**.

To post to this mailing list, send an e-mail to

ham-80211@lists.tapr.org

TAPR has also received the following letter from the ARRL High Speed MultiMedia (HSMM) Working Group thanking us for providing this much needed resource.

"We would like to officially express our appreciation to the TAPR Board of Directors and all other TAPR members for the activation of this new reflector. By providing open access to discussion, questions and answers, etc., specifically focused on 802.11b technology, this reflector will significantly help ensure that Part 97 adaptation of 802.11b is state-of-the-art.

"Further, not only has TAPR provided a much needed 802.11b general forum, it is also helping one of the long term goals of the ARRL HSMM WG by encouraging new younger, fresh-minded, high technology oriented recruits into the Amateur Radio service. This will go a long way toward keeping our avocation vital, exciting, and growing over the decades ahead.

"Thank you TAPR!

"Warm 73, John Champa - K8OCL ARRL Chairman High Speed Multimedia WG (**www.arrl.org/hsmm**)"

The TAPR Project Policy

TAPR was started in 1982 as a non-profit Amateur Radio operator organization. TAPR was created from the desire to expand digital communications by building the first American TNC kit for the Amateur Radio operator community in 1982. The TNC effort would remain the focus of the TAPR group for many years.

Original design effort bought together talented engineers and Amateur Radio operators, which naturally evolved to building other kit projects. TAPR has had its fiscal financial world in the red and black. The red years almost ended TAPR. The turnaround from red to black fiscal management was the result of identifying kit projects, which were not available by any other source and were of a nature that Amateur Radio operators had to have one.

TAPR is a volunteer run R&D organization and not a full-time business. As such, we focus on projects that Amateur Radio operators just got to have! Small projects are encouraged, however, the time to put together each kit and office personnel to process many small orders have proven to be time and fiscally difficult.

We have found that digitally challenging projects attract talented Amateur Radio operators and engineers and present to them an opportunity to experiment with other talented experimenters. The Amateur Radio operator community needs to have a place for talented and gifted Amateur Radio operators to express themselves and to have an R&D organization to put up resources to help make things happen. Our charter is R&D, scientific and educational, as identified in our bylaws. The term "Enabling Technology" is what we like to think as any project that can cause new ideas to be generated from a basic project, i.e., PIC-E and T238 APRS Wx Station. The dues for members and profit from kits are used to pay for R&D projects, the *PSR* and compensation to our year round office personnel and their facilities.

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This Project Policy statement covers how TAPR sponsors R&D projects and identifies what important steps are normally needed (that have been successful) to get TAPR sponsorship.

This Project Policy statement will cover the basic elements to 'propose a project' and basic 'project template documentation elements,' which should provide a consistent and a methodic process management tool.

The basic elements to a proposed development project are:

- Idea formation
- Proposal elements
- TAPR Board of Directors (BOD) reviews
- TAPR BOD assigns a TAPR Project Manager
- Design team development
- Alpha/beta testing
- Project readiness
- SIG development
- Marketing planning

The basic project template documentation elements are:

- Proposal submission form
- BOD voting form
- Memorandum of Understanding (MOU) template
- Construction Manual template
- Web page and mailing list procedures
- SIG development form
- Marketing package guide

Putting it all together, the template documentation supports the development process, which the assigned TAPR Project Manager will use to assist in the project development stages, as an example:

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- Idea formation (from an individual or group)
- Proposal elements
  - Proposal submission form (fill out the form on the Web site)
- TAPR Board (BOD) reviews
  - BOD voting form
- TAPR BOD assigns a TAPR Project Manager
  - Possible Memorandum of Understanding (MOU) template
- Design team development
  - Individual and or group and TAPR Project Manager
  - Construction Manual template
  - Board layout and parts support from TAPR available through TAPR Project Manager
- Alpha/beta testing
- Project readiness
  - Web page and mailing list procedures
- SIG development
  - SIG development form
- Marketing planning
  - Marketing package guide

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There are several ways project development can be proposed to TAPR. Each is handled, as necessary, to ensure the end-product is sellable to Amateur Radio operators. We usually look at a small product as being successful with 100+ orders, medium products as 500+, and large as being 2000+. Successful meaning covering all the facilitating costs and generating some research profit for more projects!

Here are a few examples of developer methods that have been used in the past to bring ideas to product:

1. Idea needs seed money; idea and R&D plan approved by Board; money provided for idea; beta testing; kit made. Builders get recognition and building tools. TAPR has all rights, such as intellectual property and usually makes it all public domain.

2. Idea is available and no seed money needed; money needed to get it in kit/semi kit form (PCB's, parts, etc.) for beta-testing. Builders get recognition and building tools. TAPR negotiates rights.

3. Idea is complete and ready for beta and kit-building. Builders gets royalty ~5%

4. Idea is complete and is beta-tested and is kitted or complete product provided. Builders negotiate profit margin.

We have some of the most talented people around and beta-testing with these people really makes the product well-tested and provides the builder with peer recognition through the Digital Communications Conference. It must also be recognized that peer recognition from the most talented people in Amateur Radio exists!

TAPR's goal is to get neat technology into the hands of Amateur Radio operators. We have reasonable buying power for parts, and have skills available for PCB layout, etc., though probably not for a large project.

Being a low volume provider of kits means no high volume availability benefits in ordering printed circuit boards and parts. Therefore, the low volume financial model that TAPR has painfully discovered over the years, is to sell the product with a 50% markup over manufacturing cost to cover overhead. These costs cover office space, office-staffing, credit card orders, parts inventory management, shipping/handling, *PSR* publishing, Web-site maintenance, and other expenses. Compensation for the developer needs to be such that the cost + royalty + markup still results in the product selling for a price that people will pay.

OneTech '02 Technical Symposium

17 November 2002, Canberra, Australia

BY DARRYL SMITH, VK2TDS

For those that are not familiar with the Australian call sign designations, VK1 is the small region of about 300,000 people called the Australian Capital Territory, the Australian equivalent of the District of Columbia. Our national capital, Canberra, is the city within this area of 55 x 45 miles wide, of which over half is nation park bordering Australia's snowfields. It is also known for having one of NASA's three deep space tracking stations, known locally by its Australian Aboriginal name, Tidbinbilla (**www.cdscc.nasa.gov**).

I live a bit over two hours drive away near the city of Sydney in New South Wales state also known as VK2 — with a population of 5 million people — that surrounds VK1.

The OneTech event is an annual event down in VK1 with aims similar to the DCC held in the USA each year, albeit on a smaller scale. See **www.vk1.wia.ampr.org**. Rather than taking place over three days, OneTech is a full Sunday of talks and presentations on any technology that might be of interest to those attending (**www.vk1.wia.ampr.org/OneTech'02/index.html)**. The Wireless Institute of Australia (WIA), which puts on the event, is the oldest wireless organization in the world. Being a regional conference, the attendance at the conference was smaller than you would expect at a DCC — but not by much.

I was at OneTech for two reasons. I was asked to talk about 802.11 in ham radio months before the event, and since a speaker dropped out, I also spoke giving a 45 minute overview of the DCC in Denver, CO. Interestingly, the speaker who dropped out was talking about Australia's first home-grown satellite since OSCAR 5.

RS-485 in the Shack

One of the 'Ah-Ha' moments for me was hearing a talk by Kerry, VK1KRF (**www.qsl.net/vk1krf/**), about RS-485 in the shack using PIC processors. This sparked my interest — that maybe this should be an area that TAPR looks at. He has an antenna rotator with RS-485 control — made from an old security camera pan and tilt head from the USA Embassy in Canberra. He also had general input and output devices, DTMF decoders — everything. He has even built a computer-controlled phasing harness.

His view is that if it moves, put a US$1 processor on it with RS-485. One pair of wires with the addition of power and ground does it all. And the front end can be programmed in Visual Basic. VB also handles contention for the Com port.

It is amazing to see what Kerry has achieved —and it is so logical. The core to what he has done is a small amount of serial programming dealing with differential signaling, with a very simple parser. Kerry decided that every device would have its own address, and be accessed with short ASCII commands. Simple, but effective.

Make Ham Radio Illegal

Australia's most famous Ham, Dick Smith, VK2DIK, (who I am not related to unfortunately) flew in literally for a few hours. Dick made his fortune with the Dick Smith Electronics (**www.dse.com.au**) stores that he sold years back, but which are now as popular as Radio Shack, but more technical.

His three books on basic electronics have been required reading in Australia for years for teenagers and slightly younger. Last I checked one of the volumes was in its 23rd printing

What makes Dick unique is that he is an Adventurer: He was the first person to fly a helicopter around the world in the early 1980s, taking a new Bell Jet Ranger from the factory. His means of communication was ham radio! He was also the first person to fly a helicopter to the North Pole during a round the world flight to both poles. He later headed the Civil Aviation Safety Authority for a time —

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which most people believe was a total disaster.

Dick made a comment that when he got CB Radio legalized in Australia, sales went almost to zero overnight. Seems that teenagers were buying the units because they were illegal. He suggested that if you make ham radio illegal — or at least the HF bands — then you will attract the young people back.

He commented that he thinks that adventurers will soon be doing events without Iridium phones and GPS receivers so that they can bring the challenge back. Dick also commented that during a storm flying solo across the Atlantic he rang his wife from his Iridium phone to her cell phone. He thought she was in Sydney, but was really in Saks 5th Avenue in New York. He commented at not really needed ham radio to keep in contact when that sort of thing is possible.

BushLAN

One of the other talks was from the Australian National University on BushLAN using low frequency television spectrum to connect regional Australia to the Internet. Basically, this is a University project that has got some significant press in Australia thanks to a broadband enquiry.

It involves putting high speed packet radio gear on 70 MHz and using it for the last '5 to 10 miles' that tends to be the issue in Australia. (Here in Australia we have people who own more land than New York State, and have less than 100 people living on it. Guess how far the nearest telephone exchange is?)

More information on BushLAN can be found at **wwwrsphysse.anu.edu.au/BushLAN/**

TAPR Activities

TAPR was given the opportunity to not only promote ourselves at the talks, and give out membership forms, but also to donate a prize — a copy of *Wireless Digital Communications* by Tom McDermott — to be awarded for Technical Excellence to Peter, VK1NPW. Peter has been pivotal to getting APRS going in VK1, including several Wides and an IGate. He is well-respected for 'getting his hands dirty' with radio technology, and in practice. The local hams are heavily into providing radio communication for car rallies, as 'emergency communications' exercises, and Peter recently instrumented six cars during a rally as an APRS exhibition to the organizers and fellow hams.

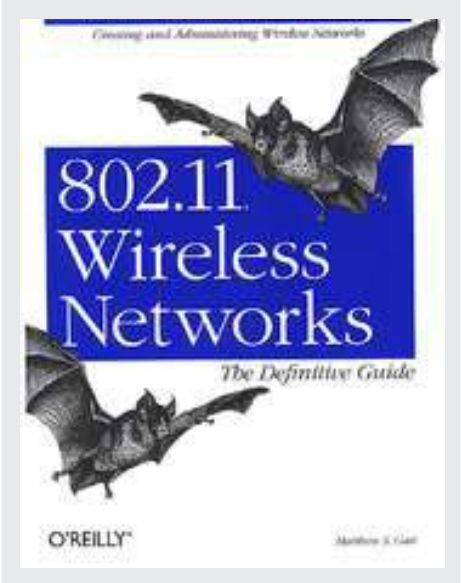
IN THIS PHOTO, THE BUSY ORGANIZER, PETER ELLIS VK1KEP, PRESENTS THE PRIZE TO PETER WESTERHOFF VK1NPW.

TAPR awarded a runner up award of a DCC Proceedings to one of the members of BushLAN so that they could learn what TAPR is doing, and hopefully, a journal that they can publish some of their research in. This is particularly important since the BushLAN people are not generally hams and are not familiar with how we can support them.

Lastly, one of the local hams was presented with a book on programming PIC processors from my personal collection so that he could try something new.

Book Review

BY DARRYL SMITH, VK2TDS



I have been a Spread Spectrum person from way back — having first become interested in the subject back when I was doing my degree at University in the early 1990s. Back then, Spread Spectrum was just starting to emerge with the 2-Mbit/s WaveLan card available if you could afford it. Regardless of the cost, I saw that Spread Spectrum was going to emerge eventually as a powerhouse of modern technology.

For my thesis, I looked at some of the issues involved in a half-duplex Spread Spectrum radio network, and worked out that if these issues could be solved, then half-duplex was the way to go in a large distributed network.

So here we are a few years later, and the IEEE has come up with a standard they have called 802.11, which is taking the world by storm, thanks to the ease of interfacing low-cost and high-bit rates. A lot of us have used wireless networks, but how many of them know what goes on behind the scenes?

I spent about six months searching for books on the internals of 802.11 and found myself buying book after book for a scant chapter on the protocol. In most cases, the book was saying just what I already knew, usually looking at the physical layer, and ignoring the upper layers.

Until I started reading *802.11 Wireless Networks* by Matthew S. Gast (O'Reilly & Associates, 2002), I did not know much at all about the underlying technology. After reading this book, I realized that I knew a huge amount about the underlying technology of 802.11, and at the same time, I knew very little.

I should say at the outset that I have not looked past the first 150 pages of this book — the other 300 pages look interesting, but are looking more at issues such as the physical layer, and implementation.

The biggest thing that this book taught me was how similar AX.25 packet radio and 802.11 wireless Ethernet are. After all, 802.11 is basically just a version of AX.25 on steroids, optimised, and expanded. The heritage is obvious when you start looking at the details. In 802.11, a base station call sign is called and SSID. In AX.25, the SSID is the numeric identifier at the end of the call sign.

The book goes into great detail describing all the fields of the various packet formats, as well as all the timers that are built into the system. The reader is left with the impression that a lot of thought has gone into the design of the protocol, and that a lot of effort has gone into how to present this information to the reader.

I suspect that you would have problems using this book to implement the link layer of 802.11, but that really isn't the purpose of this book — it is more to explain the details. I have used this book to analyze the performance of 802.11 when the distance between two stations is increased beyond what would normally be considered the logical limit.

In this case, I found that most of the information I needed was detailed or could be inferred from the book. This makes the book far better than any other book on the subject that I have found.

This book is full of hidden gems, such as the 7-page chapter on performance tuning. The table included in this book detailing the tuneable parameters not only lists what the parameter does, but also what happens when you increase it and decrease it.

One novel section of the book deals with using the Etherial software to listen to the packets being broadcast over air. This is extremely useful to anyone attempting to debug a wireless installation.

On the minus side, I have found that there are about 100 pages devoted to specific hardware that limits the life of this book — although, I must admit that the concepts introduced in these sections are likely to outlive the actual products.

My copy of this book was purchased from OpAmp Technical Bookstore in Hollywood, CA. People wanting to buy a copy of this book mail order are encouraged to purchase one from the ARRL at **http://www.arrl.org/catalog/?item=8884**.

3D Environments and Mars: A Follow-up from the 2002 DCC

GREG JONES, WD5IVD

If you were at the DCC this past fall, you heard me speak about the potential of 3D environments for the presentation of information. Since that presentation, several interesting products have been released. The most notable is from Keyhole, Inc. Their *Earthviewer* software combines high-resolution satellite and aerial imagery, elevation data, GPS coordinates, and overlay information about cities and businesses over a 3D streaming map. I am including URLs at the end of the article. It is worth a few minutes to look over the site.

IMAGE FROM EARTHVIEWER.COM (**HTTP://WWW.EARTHVIEWER.COM/**)

The software my group has been developing that I demonstrated at the DCC is moving forward. If you are interested in Mars, then you might be interested in hearing about our Mars on-line project. Instead of trying to do something someone with a lot more money than we have has already done with *Earthviewer*, we decided to try something more out of this world.

I had been following the Mars Global Surveyor (MGS) mission for several years now. One of its science packages is the Mars Orbiter Laser Altimeter (MOLA). The purpose of the instrument was to gather altitude information on the surface of Mars. The MOLA instrument was designed and built by the Laser Remote Sensing Branch of the Laboratory for Terrestrial Physics at Goddard.

The MOLA science team has been able to produce in the last year a very accurate set of altitude numbers for the surface of Mars. The current data set includes over 1 million points of reference covering almost 98% of the surface of the planet. The US Geological Service has an outstanding map of this data plotted in 2D that shows the details of Mars. Unfortunately, the instrument has not collected altimeter data since June 30, 2001, when a critical oscillator malfunctioned. The science team since then has been working on making the data more accurate taking into account orbital information.

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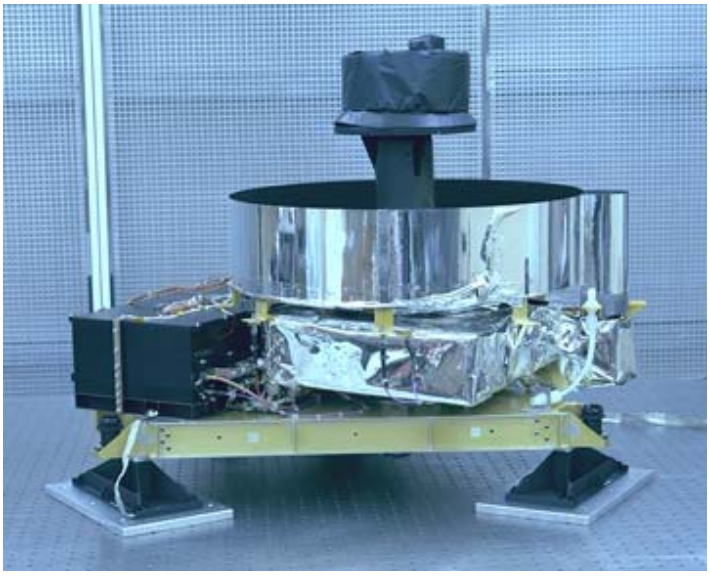

THE MARS ORBITER LASER ALTIMETER (MOLA-2). (IMAGE CREDIT: NASA/GSFC LASER REMOTE SENSING BRANCH)

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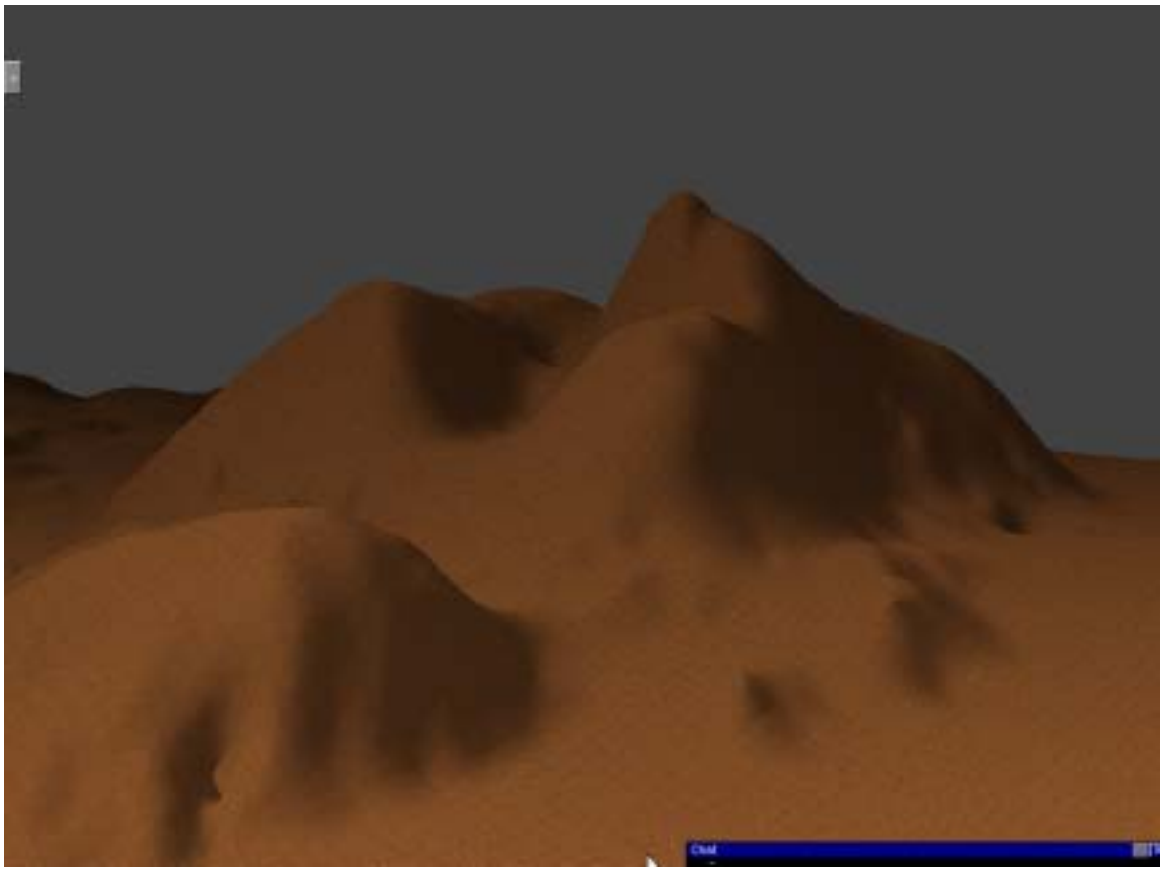
When the new MOLA dataset was released shortly after the DCC, I thought it presented an excellent demonstration of our software concept. We decided to take the MOLA data and place it into our on-line 3D streaming technology. The alpha version of Mars On-line went active on January 8, 2003. Here are some screen captures from the alpha server.



NICHOLSON CRATER, CENTRAL PEAKS AS VIEWED FROM ONE SIDE OF THE CRATER WALL.

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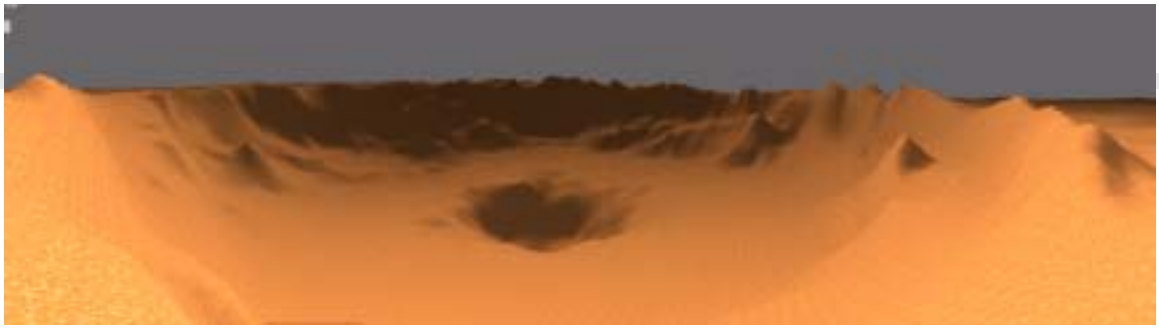

PANORAMA SHOT USING *PHOTOSHOP* OF ANOTHER CRATER AT 15.5S, 296.5E. NOT SURE WHICH ONE IT IS.

PANORAMA SHOT USING *PHOTOSHOP* OF OLYMPUS MONS, TOP CONE (MARS_19.0_227.0).

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I personally spend time each day exploring the face of the planet looking for interesting features. Since we placed a bookmark system on-line that references the over 1400 listed USGS features for Mars, it is even easier to jump from spot-to-spot on the face of Mars. Right now, we are only supporting the basic viewer functions, since the system is running off my home broadband connection. When we relocate in the coming weeks, we will turn on the personal tracking and audio system. That way you can see where others are at and then go talk to them over built-in audio system.

If you think this is something you would like to play with, we are looking for more testers. If you have an Internet-connected basic computer (PIII, 500 MHz, 256 Mbytes memory or better) that supports some form of 3D accelerated graphics adapter (like a Geforce2 or TNT2), then sign up for the beta-testing phase. The more the merrier! Visit our W,eb page and select the Mars On-Line project, then click on Access to fill-out the beta request.

References:

Created Realities Group: **http://created-realities.com**

Keyhole Earthviewer: **www.earthviewer.com/**

MOLA image retrieved from **http://ltpwww.gsfc.nasa.gov/tharsis/background.html**.

USGS Map of Mars: **http://ltpwww.gsfc.nasa.gov/tharsis/ngs.html**

A really outstanding a color one at: **http://geopubs.wr.usgs.gov/open-file/of02-282/**

MOLA Science Page: **http://ltpwww.gsfc.nasa.gov/tharsis/**

USGS Lists Features on Mars: **http://planetarynames.wr.usgs.gov/mare/mareTOC.html**

Extending Icom OPC-581 Extension Cables for Icom IC-706s

BY EMILE 'BUTCH' ALLINE K8KO, **K8KO@ARRL.NET**

Here is a method to extend the Icom extension cable (part number OPC-581) for the IC-706 (the original version). There are no internal modifications required, but stripping and soldering the cable is very tedious since the conductors are very fine and interlaced with polymer cords. I extended mine to a total length of 135 feet by splicing in commonly available rotator cable. I used Wireman #301 cable with 2 conductors at 18 gauge and 6 conductors at 22 gauge. Heavier gauges would be desirable for longer distances. Do not use lighter gauge cables such as Cat 5.

I have used this setup for over a year and have not been able to discern any differences between operating with or without the longer cable attached. Note that I am using the original model IC-706. Other models may work differently.

Here is the pin out for the extension cable:

Pin #	Icom cable color	Icom Function	Rotator cable
1	Yellow	LXRD – Rx cpu data	22 ga.
2	Red	LTXD – Tx cpu data	22 ga.
3	Blue	8 VDC - power	18 ga.
4	Red w/ copper shield.	AF – speaker audio	22 ga.
5	Copper shield	Gnd – ground for 8 VDC	18 ga.
6	Lt. Ga. White w/grn shield	Mic – Microphone	22 ga.
7	Green shield	Mic Gnd – Mic ground	22 ga.
8	Hvy. Ga. White	PWK – power switch	22 ga.

Solder all shields together with pin 5's copper shield. Make sure all solder joints are good and verify with an ohmmeter. My cable measured from 2.4 to 4.5 ohms end-to-end. Insulate all conductors from ground and from each other. Weather-proof and strain-relieve as required.

Feedback appreciated.

Digital Radio Mondiale and Amateur Radio Implications

DON ROTOLO, N2IRZ

In the January/February issue of *QEX*, Cédric Demeure and Pierre-André Laurent presented an article describing the DRM system and an adaptation of that standard for Amateur Radio. In this article, I will re-explain, hopefully n an easier to understand fashion, the basics of how Digital Radio Mondiale (DRM) works and discuss some of the implications for Amateur Radio.

Digital Radio Mondiale (**www.drm.org**) is a consortium of many companies and broadcasters, promoting a new standard for shortwave broadcasting that is completely digital. The digital signal fits within a 4.5-kHz shortwave broadcast channel, is compatible with most existing broadcast transmitters, and offers superior reception and sound fidelity. The digital signal can be superimposed on a compatible analog signal, allowing both types of receivers to hear the signal. If you want to learn about the gory technical details, you can download a copy of the standard, which is administered by EDSI, at (**www.edsi.org**) — just search on DRM.

The digital signal itself can be considered as a series of narrow bandwidth carriers spaced across the full signal bandwidth. Most of these carriers are COFDM (Coded Orthogonal Frequency Division Multiplexing) signals carrying program data (e.g., audio). A few are used for the FAC (Fast Access Channel), which carries the basic technical details required by the receiver to tune in the signal. This information is very brief, and repeated very often, so that listeners just tuning in hear the signal with hardly any delay. There are also a few specially modulated carriers, which are used for fine frequency tuning adjustments and pattern synchronization at the receiver, as well as to help characterize the HF channel response.

Lastly, we have the SDC, or Service Description Channel. The SDC carries information about the broadcast to listeners, such as artist and title, along with frequency and program schedules and the like. Also included in the SDC is further information for the receiver on how to decode the main signal. Instead of being interleaved with the main digital signal, the SDC is periodically sent every so often instead of the main signal, for example, 1/10 second every 3 seconds.

The basic channel is 4.5-kHz wide with a carrier every 40 to 65 Hz or so. The number of carriers, their spacing, and their modulation scheme, can be varied within certain boundaries by the broadcaster to produce a signal with a greater or lesser degree of robustness. Which encoding scheme is selected depends upon the broadcaster's expectations of propagation to the intended audience. The encoding scheme can be changed on the fly without the listener noticing, since all the necessary information about the encoding scheme in use is contained within the signal. The information is repeated frequently, on the order of every second.

Wider broadcast channels can utilize the additional bandwidth to enhance the audio fidelity or send other supplemental data, such as images. To accommodate a wider available bandwidth, one or more 4.5-kHz wide blocks of carriers are added to the signal. The additional carriers in the extended channel width carry only program data — the format and supplemental data are always in the basic 4.5-kHz channel to provide a compatibility mode. That is, even a receiver that can only 'see' the basic 4.5-kHz channel will still get a useable signal, but perhaps not the enhancements from the wider bandwidth.

To get an idea of what the signal looks like, and how it carries data, imagine a PSK31 signal. [In case you've been in a cave for the past few years, PSK31 is a mode intended for HF keyboard-to-keyboard QSOs. It uses Phase-Shift Keying (PSK) modulation, and is only 31 Hz wide. Operators use a virtual DSP modem, realized through a PC sound card and software.]

A PSK31 signal can send about 40 words per minute of text, which is something like 27 bits per second. Now, instead of just plain PSK, digitally encode each signal so that many signals right next to each other can be differentiated because their unique digital codes are "orthogonal," or non-interfering. In other words, each individual carrier's

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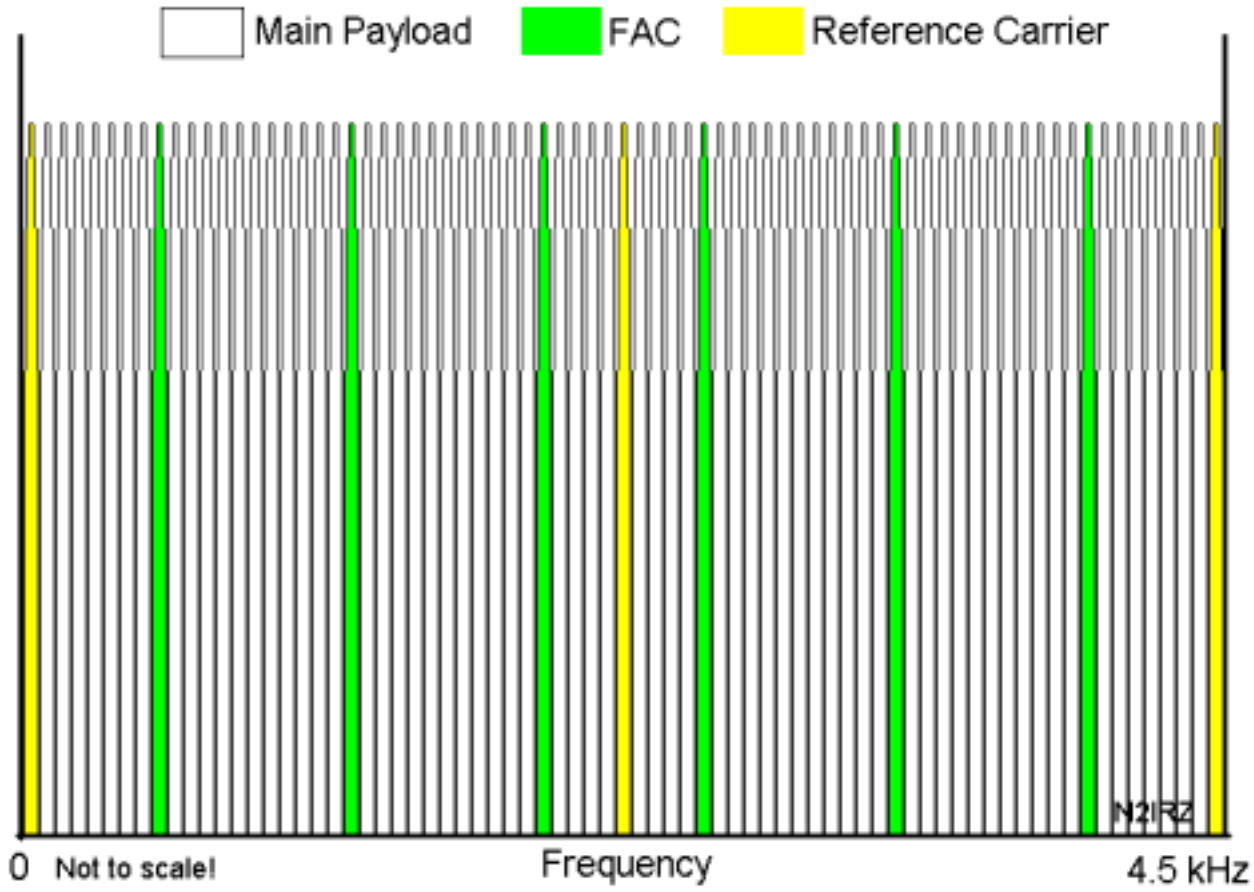

FIGURE 1: A REPRESENTATION OF THE SPECTRUM OF A 4.5-KHZ WIDE BASIC DRM SIGNAL. ALTHOUGH MOST OF THE COFDM CARRIERS ARE DELIVERING THE PAYLOAD (I.E., AUDIO), THERE ARE ALSO THE FAC AND REFERENCE CARRIERS, ALONG WITH THE SDC. SEE TEXT FOR DETAILS.

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data can be recovered, even if they overlap their neighbors a little, since they are orthogonal. Now, put one of these signals every 30 Hz or so, or maybe every 50 Hz if you want a really robust signal. Repeat until your bandwidth — 4.5 kHz for DRM — is used up. Leave a few of those signals in standard slots — where every receiver knows to look for them — for housekeeping data and synchronization signals, and you have a basic DRM signal.

In this example, we could fit about 150 carriers into 4.5 kHz. Use 130 for program data (leaving the rest for housekeeping, etc.) at 27 bits per second, you end up with over 3500 bits per second. The actual DRM standard manages around 20 to 25 kbit/s for a 9 or 10-kHz channel, which can degrade to as low as about 10 kbit/s for a highly robust signal. These relatively high data rates are achieved through efficient modulation techniques such as 64-QAM.

DRM squeezes even more fidelity and robustness out of a signal by using efficient encoding schemes, such as MPEG-4 with SBR for music and a CELP encoder for voice only. Voice encoders with toll-quality audio and low bit rates are common and well known. The SBR (Spectral band Replication) feature used for MPEG-4 encoding is

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extremely interesting, and contributes enormously to the perception of high-fidelity music in a low bandwidth application.

The high frequency (above 5 kHz) sounds in music fall into two general categories, periodic and noise-like. Periodic signals are generally related to what appears in the lower audio frequencies — overtones of instruments, for example. Noise-like sounds are more independent of the lower frequencies, with white-noise-like sounds such as cymbal crashes, maracas, or voiced sibilants. The SBR method takes these sounds and encodes a simple representation into the digital signal. For periodic signals, the related lower audio frequencies are also used, while only the timing, duration, and intensity of noise like sounds are sent. A noise synthesizer at the receiver then creates synthetic 'hissing' noises (carefully crafted, of course) and the human ear is tricked into hearing a much wider bandwidth than actually exists.

The above discussion is not absolutely accurate from a technical point of view, but the details are not critical to an understanding of how the system functions. For those who want to know the real numbers, look up some of the references.

Amateur Radio

The purpose of the *QEX* article was not to promote DRM, but to discuss the modifications and considerations necessary for Amateur Radio usage. The company that Pierre-Andre and Cedric work for — Thales Communications SA (formerly Thomcast) in France — didn't modify the DRM standard for Amateur usage out of the goodness of their hearts. They foresee a viable market in the HF bands used by military and commercial users, which happen to have needs similar to Amateurs. However, being hams, they fully understand the value of gaining the cooperation of radio amateurs in the design, testing, and ultimate usage of this modified standard. They also think this is too cool to be kept from other Amateurs!

Digital Radio Mondiale also understands the very valuable expertise available in the radio amateur community. On their Web site, Radio Amateurs are invited to sign up for participation in their on-air testing. While most of the test transmissions so far have been directed to the European continent, North America is considered an important testing area as well. Radio Canada International is already sending test transmissions, and wider testing is scheduled. If you're really interested, you can purchase and download DRM receiver software for your sound card equipped PC. Visit the DRM Web site for details.

While many of the characteristics of the DRM signal were kept, some changes were necessary for Amateur use. The number of carriers was reduced to accommodate the 3 kHz bandwidth restriction. The auxiliary data streams were modified, eliminating the SDC and simplifying the FAC. Only the voice mode is implemented, since music has no place in Amateur Radio transmissions, allowing for a simpler and more robust vocoder to be used. A CRC (Cyclic Redundancy Check, a form of error detection) is added to the data stream to enhance the error rate. Some changes to accommodate the PTT nature of Amateur transmissions, and to increase compatibility with existing transceivers, were also made. As with many digital modes, the transmit and receive audio encoding are handled in software and a PC sound card.

Radio equipment requirements are not so critical. Ideally, the radios should have an audio bandwidth of 3 kHz for both transmit and receive. If a rig's bandwidth is somewhat lower, the signal should still be useable, but at the expense of requiring a higher signal to noise ratio.

The sound quality is much higher than Amateurs are used to. First of all, there's practically no background noise in the voice signal. Any existing QRM or QRN on the channel, which is normally demodulated and added to the audio in a conventional analog receiver, is completely ignored by the digital decoder. In a recent interview, Doug Smith, KF6DX, compared the received audio to an FM signal, with that "full-quieting" quality to it. Also, since nearly the full 3 kHz-bandwidth is being used, as is a very efficient

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encoding scheme, more of the original voice bandwidth appears at the receiver than with analog systems. The result is better than toll-quality. Specifically, the received audio was given a subjective MOS (Mean Opinion Score) of 3.5, where 3.0 is the standard for toll-quality audio (something people would pay for, such as telephone), and higher numbers mean better audio. If you've ever listened to conventional SSB, you'd know that it is somewhat less than toll-quality audio.

Aside from the obvious — digital QSOs — how else can we use this exciting new mode? I see the extra data capability of the signal — whatever isn't being used for voice becomes available for data — as the part of this system just begging for new ideas. How about automated contest logging? Once the exchange is complete, I just squirt my information directly into your computer-logging program, and you do the same. Don't even need a keyboard! What about sending an SSTV image while continuing the conversation? There's no need to stop talking anymore. Maybe automated channel allocation, where you call CQ in a standard frequency, and your radios decide where the quietest channel is and QSYs automatically. Perhaps when I send CQ, I can also include in the data stream more details on what I'm looking for — specific topics of conversation, or DX countries, or info about myself — whatever. That's just a few in-the-box thoughts that I have had. I can just imagine what the out-of-the-box thinkers might come up with!

The DRM standard modified for Amateur Radio was used on November 22, 2002, for the first HF digital voice contact to span the Atlantic Ocean. Doug Smith, KF6DX, and Didier Chulot, F5MJN, (using F8KGG) completed this historic QSO on 15 meters. They operated on SSB, but could just as easily have used AM or FM. The signal was sent using unmodified Ten-Tec equipment and Thales Communications' Skywave 2000 HF Voice software. The software is expected to become available to Amateurs later this year.

Now that we know it works, what are we waiting for?

DCC 2003 in Conn.

BY STAN HORZEPA, WA1LOU

The 2003 installment of the ARRL/TAPR Digital Communications Conference (DCC) will be in ARRL headquarters backyard. Yes, the 22nd installment of this great radio technology event will occur just a few miles up the Interstate from W1AW.

To be precise, the DCC will take place at the Hartford/Windsor Marriott Airport Hotel in Windsor, Connecticut, on the weekend of September 19-21, 2003. The hotel is 6 miles south of Bradley International Airport (BDL) and 13 miles north of ARRL Headquarters in Newington.

The hotel room rate is $99.00 single and double. (Check out the hotel's Web page at **www.marriott.com/dpp/PropertyPage.asp?MarshaCode=BDLAP**.)

Folks planning to present papers at the DCC should start preparing them now. September will be here before you know it.

And consider using the DCC as the starting off point for a fall vacation in New England. Boston, Cape Cod, and the Berkshire Mountains are all within a few hours drive and the weather in late September in Southern New England can't be beat!

THE HARTFORD/WINDSOR MARRIOTT AIRPORT HOTEL IN WINDSOR, CONNECTICUT, IS THE SITE OF THIS YEAR'S DCC.

TAPR MEMBERSHIP	Price	Member Price	Qty	Total	Kit Code
New		$20.00			0
Renewal, Enter Membershp Number here:		$20.00			0
KITS					
PIC-E(ncoder)	$65.00	$58.50			16
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Compact FlashCard Adapter (FlashCard not included)	$59.00	$49.00			16
T-238 Weather Station	$134.00	$120.60			16
TAC-2 (Totally Accurate Clock) (requires a GPS receiver to operate)	$139.00	$125.00			16
Differential GPS (requires a GPS receiver to operate)	$199.00	$179.00			16
DAS (DTMF Accessory Squelch) (as seen in December 1995 *QST*)	$68.00	$61.20			8
TAPR 9600 bit/s Modem	$80.00	$72.00			8
Bit Regenerator (for regenerative repeater operation)	$10.00	$9.00			1
Clock Option (for regenerative repeater operation)	$5.00	$4.50			1
PK-232 Modem Disconnect (to simplify external modem connection)	$20.00	$18.00			2
PK-232MBX Installation Kit (for 9600-bit/s modem installation)	$20.00	$18.00			2
XR2211 DCD Modification	$20.00	$18.00			2
State Machine DCD Modification	$20.00	$18.00			2
State Machine DCD Modification with Internal Clock (for KPC-2)	$25.00	$22.50			2
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TNC2 Version 1.1.9 with KISS EPROM (includes command booklet)	$15.00	$13.50			4
TNC2 Version 1.1.9 command booklet	$8.00	$7.20			2
TNC2 WA8DED EPROM (ARES/Data standard 8-connection version)	$12.00	$10.80			2
TNC1 WA8DED EPROM	$12.00	$10.80			2
TNC2 KISS EPROM	$12.00	$10.80			2
TNC1 KISS EPROM	$12.00	$10.80			2
PK-87 WA8DED EPROM	$12.00	$10.80			2
TrackBox EPROM	$15.00	$15.00			2
MX-614 Modem IC	$8.00	$8.00			2
PUBLICATIONS					
Digital Communications Conference (DCC) Proceedings					
2002 DCC No. 21 (printed copy)	$20.00	$18.00			8
2001 DCC No. 20 (printed copy)	$10.00	$9.00			8
2000 DCC No. 19 (printed copy)	$15.00	$13.50			8
1999 DCC No. 18 (printed copy)	$15.00	$13.50			8
1998-2000 DCC Nos. 17-19 (CD & available printed copies)	$50.00	$45.00			4
1998-2000 DCC Nos. 17-19 (CD only)	$33.00	$30.00			4
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1981-1991 DCC Nos. 1-10 (CD & available printed copies)	$33.00	$30.00			4
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TAPR Spread Spectrum Update	$18.00	$17.10			16
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Wireless Digital Communications	$39.99	$38.79			28
Packet Radio: What? Why? How?	$12.00	$10.80			8
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Packet Status Register Vo. 1 (Nos. 1-17, 1982-85)	$20.00	$18.00			16
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Packet Status Register Vo. 3 (Nos. 37-52, 1990-93)	$20.00	$18.00			16
Packet Status Register Vo. 4 (Nos. 53-68, 1993-97)	$35.00	$31.50			16
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Garmin GPS-20/25 Interface/Power Kit	$40.00	$36.00			8
Garmin GPS-20/25 Data Cable	$15.00	$15.00			2
Garmin GA-27 GPS Antenna (w/MCX conn., mag. & suction mounts)	$75.00	$67.50			8
Oncore UT+ GPS	$169.00	$149.00			28
Oncore VP Interface/Power Kit	$40.00	$36.00			8
Oncore GT+ GPS	$149.00	$129.00			28
Motorola Antenna 97 (w/BNC connector and magnetic mount)	$65.00	$58.50			8
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