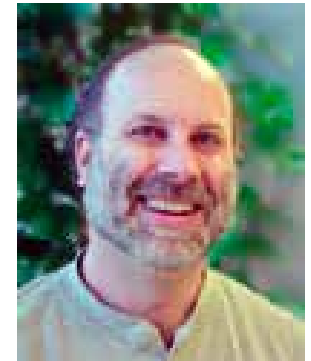# President's Corner

By Steven Bible, N7HPR, President, TAPR

Happy New Year and welcome to the Winter issue of TAPR's quarterly newsletter.

This issue of *PSR* includes a look back at one of our most successful Digital Communication Conferences. Written by the Managing Editor of *QEX*, Larry Wolfgang, WR1B, recounts his weekend in Seattle attending the 32nd installment of this TAPR-ARRL co-sponsored conference.

Our board member from Down Under, Darryl Smith, VK2TDS, looks back at the first two installments of the DCC, which went by the name "Computer Networking Conference" back then. Darryl reviews the papers from those conferences and notes how things have changed and haven't changed.

Meeting minutes from the DCC also appear in this issue of *PSR*. Board member George Byrkit, K9TRV, transcribed the goings-on at the in-person Board of Directors meeting, as well as the Annual General Membership Meeting. George ably subbed for our Secretary, who was unable to attend the DCC this year.

This issue also contains an article by Mike Schaffer, KA3JAW, describing how to build a multimode Software Defined Radio for $20!

By the way, TAPR elections during the DCC resulted finding myself back in the President's office, Jeremy McDermond, NH6Z, in the Vice President's seat, Tom Holmes, N8ZM, counting beans in the Treasurer's slot, and Stana Horzepa, WA1LOU, taking notes in the Secretary's role.

John Ackermann, N8UR, and Jeremy McDermond, NH6Z, were reelected to the Board of Directors, while Mark Thompson, WB9QZB, was elected to fill the slot vacated by Dan Babcock, N4XWE, who I wish to thank for his service on the Board. Meanwhile, Laura and John Koster, W9DDD, will continue to hold down the fort in our Richardson, Texas office.

We look forward to great expectations in 2014 and hope you will all be active in bringing those expectations to fruition.

73,

Steve Bible, N7HPR, President TAPR

###

TAPR is a community that provides leadership and resources to radio amateurs for the purpose of advancing the radio art.

My Favorite National Amateur Radio Event

By Larry Wolfgang, WR1B

(Originally published in *QEX*, January/February 2014)

In September 2013 I ventured to Seattle, WA for another ARRL/TAPR Digital Communications Conference. DCC is my favorite national Amateur Radio event, so I guess it is fitting that I write a little about it.

As many of you know, DCC is a three day event that includes two full days of technical presentations as well as an in-depth seminar on Sunday morning. In addition to the high-level technical presentations on Friday and Saturday, there are always some Introductory Sessions on Saturday. The local hosts this year —especially Tina (KD7WSF) and Steve (N8GNJ) Stroh — did an excellent job of promoting DCC in the local Seattle area. We had the highest attendance of any DCC in memory, and nearly filled the excellent presentation auditorium to overflowing!

This year's Intro Sessions focused on various aspects of digital voice transmission. There are always many attendees who want to learn more about D-Star, and we had that opportunity this year. A new "hot" topic in the digital voice realm was the FreeDV/Codec2 program. This system is of special interest because Codec 2 is an open source Codec. FreeDV uses SSB transceivers to transmit and receive digital voice signals. It is used primarily over HF, although nothing would prevent its use on VHF or higher frequencies.

All of the technical presentations are quite interesting, but a few really stood out for me. Heikki Hannikainen, OH7LZB, did an encore of his 2012 presentation by talking about the challenges involved with running a secure "authenticated" Amateur Radio service application on the Internet with his APRS web server www.aprs.fi. Heikki described some of the steps he takes to ensure that only licensed Amateur Radio operators can put a message out over his system, while not being overly complicated for either the ham who wants to use the system or for the site administrator.

John Hansen, W2FS, stirred up quite a bit of excitement over his "Raspberry Pi Applications in Digital Communications," and especially with his mobile APRS station and a new version of his popular TNC-X: TNC-Pi. For this and other reasons, I've decided I want a Raspberry Pi, to learn about this little computer. I've put one on my Christmas Wish List.

Adam Farson, VA7OJ, described his "Noise Power Ratio (NPR) Testing of HF Receivers." Adam described the measurements that he has made on Amateur Radio transceivers with this technique. At the time of the DCC, we were reviewing an article from Adam about this topic for QEX. I was able to discuss some revisions to the article with Adam in person, and he is in the process of revising it for us. I hope to bring you an article about NPR testing during 2014.

The Make movement definitely has some parallels with Amateur Radio, and it is great to see the enthusiasm that so many of these "do it yourself" experimenters can bring to our hobby. In addition to a video update from Chris Testa, KD2BMH, about his "HT of the Future," which he

first described at the 2012 DCC, this year we heard from Michael Ossmann, who described his "Hack RF: A Low Cost Software Radio Platform." Michael is working on marketing his project, which is a 30 Hz to 6 GHz radio, to the Information Security community. He uses an IF of 2.5 GHz to obtain 15 to 20 MHz bandwidth with 20 kbit sampling. You can find more about Michael's project at http://www.greatscottgadgets.com/hackrf/ .

Gary Pearce, KN4AQ, was again in attendance at the DCC, recording the presentations for his HamRadioNow TV website: http://arvideonews.com/hrn/. As he has done in the past, Gary will put the video on his website for your viewing pleasure, although it does not seem to be available yet as of this writing. This is a great way to learn about the technical presentations at DCC, but the conference is so much more than those presentations. It is an opportunity to talk with the presenters, share ideas with other attendees, and generally have a great time.

No discussion about DCC is complete without some mention of "The Play Room." Whether or not you are presenting a talk at DCC, you are encouraged to bring projects to display in the Demo room. There were tables with several of the projects presented in talks on display. John Hansen had his TNC-Pi APRS tracking system on display. Michael Ossmann had information about his HackRF project. Mel Whitten had a demonstration of the FreeDV digital voice system.

David Bern, W2LNX, has been experimenting with a Raspberry Pi to control a pair of inexpensive TV rotators to create an Az-El rotator system for satellite antennas. David was presenting this project at the AMSAT Symposium in November, so the DCC was an opportunity to shake out a few bugs. I have talked with David about writing about this project for *QEX*, so that is another one I hope to bring you in the pages of *QEX* in the not too distant future.

Next year's DCC is already in the planning stages, with preliminary efforts focused on holding it in the Austin, TX area on the weekend of Sep 5-7. Watch for announcements and start making your plans to attend now!

###

MicroHAMS Digital Conference - March 29

Announcing the seventh annual MicroHAMS Digital Conference! The event will be held on the main Microsoft campus located in Redmond, WA, on March 29, 2014. The agenda this year has a focus on Software Defined Radio, covering topics from the new NWDigitalRadio to local efforts for HamWAN and a new HPSDR Project.

For up-to-date information visit http://www.microhams.com/mhdc).

###

TAPR-Supported Projects Slashdotted

Three videos on TAPR-supported projects (Codec2 and Open Hardware) were Slashdotted at http://tinyurl.com/klxs25x.

###

Radio Computer Networking Conference – A Retrospective

By Darryl Smith, VK2TDS

This is the first of a series of articles looking back at how digital radio communications has changed over the last three decades or so, as seen through what is now known as the TAPR-ARRL Digital Communications Conference. The goal of this series is give an insight into the gems of technology that are stored in the proceedings and to announce the free download of the conference proceedings.

First Computer Networking Conference (CNC) – 1981

Back in 1981, the ARRL held it's first Radio Computer Networking Conference (CNC) in Gaithersburg, Maryland, coordinated by Paul Rinaldo, W4RI, and hosted jointly by the Radio Amateur Satellite Organization (AMSAT), and Amateur Radio Research Development Corp (AMRAD). All three are still around, although the CNC is now called the Digital Communications Conference.

From what I can work out looking at the proceedings, about 40 people were able to make the event. Looking back, there were two main areas of emphasis: networks and hardware.

You have to remember that those were the early days of packet radio, and AX.25 had not yet been finalized as a standard. In fact, Douglas Lockhart, VE7APU, described the VADCG 'Programmable Communications Controller' that for years many people would contend had advantages over AX25, spawning ham radio's own version of the Beta versus VHS wars. I remember back in the early 1990's having discussions about AX.25 and how VADCG seemed to more properly comply with Australian regulations at the time.

One of the things that struck me looking at the proceedings are the diagrams – and they look very familiar. If I could not read and just looked at the pictures, it would be easy to think that a modern short-range architecture such as ZigBee™ (802.14.4) was being described. It would seem that many of these modern technologies owe a great debt to ham radio.

Many of the articles look almost 'quaint' by todays standards of multi-gigabit transcontinental fibre links along with multi-megabit links to the mobile and home.

Since the papers were written even terminology has changed. The late Dave Ingram, K4TWJ, commented that "the projected network described in this paper was originally conceived with the purpose of interlinking communities and cities on a broadband basis." This was 'broadband' old school when it referred to a large bandwidth link over microwave or coax rather than a narrowband link more often used for voice communications. These days, 'broadband' refers to data connections of at least 256 kbps.

As an aside, Australia is working on a national project of Fibre to the Home (or Node) called the National Broadband Network. The funny thing is that I recently found a brochure from 1974 advertising that they had just finished building the National Broadband Network, which involved coax and microwave to each of the Australian Capital Cities.

At the time of the conference, even the concept of packet radio was not universal. Joe Kasser G3ZCZ, now a professor, described an RTTY network, which included RTTY repeaters in a

paper titled "From RTTY to Packets."

Hank Magnuski, KA6M, wrote on the "Care and Feeding of your Packet Repeater," describing the first 10 months operation of a packet radio repeater in Menlo Park, California. This repeater was apparently "100% compatible" with the VADCG protocol and used homebrew hardware, which included a Z80 CPU and WD1933 SDLC Converter.

Looking through the proceedings, the closing summary by David Engle, N6FTZ (now W6DE), provided the greatest insight into the development of digital communications. The following is a quote directly from the proceedings:

a) Standards are needed

b) Standards should allow Evolution

c) Standards should start at levels of agreement wherever they may occur

Second Computer Networking Conference – 1983

The Second Computer Networking Conference was held in San Francisco in 1983 and was hosted by AMRAD and the Pacific Packet Radio Society, organized by Hank Magnuski, KA6M, and Paul Rinaldo, W4RI.

Reading through the papers, it was obvious that things had quickly moved forward.

Looking back, one paper struck me as well and truly before its time, and one suspects was unheralded at the time. The paper was written by the late Robert Richardson, W4UCH, and was called "Packet Radio – A Software Approach."

In this article, Robert looked at sending and receiving VADCG packet on a TRS-80 computer using EXAR modulators and demodulators as the only external hardware. The traditionally expensive task of assembling and disassembling packets in a dedicated chip was moved into the host computer. This approach would be almost forgotten for many years until it was once again popularized by the Byonics TinyTracker.

Terry Fox, WB4JFI, presented the latest draft of the AX.25 Level Two protocol and presented a position paper on Level 3. Whilst the Level Two document continued to get updated over the years, we have yet to see a standardization of Level 3!

Even though the draft AX.25 protocol was published, it was not certain that it would be adopted. Douglas Lockhart, VE7APU, published an article about a Block Oriented Interface for CP/M and the VADCG TNC. The idea was to more closely link the VADCG TNC to the computer through a standardized interface. The paper was written at least partially in response to the previous CNC where the need for a standardized interface was highlighted without anyone actually implementing one.

This paper also included the assembler coder for the VADCG Packet Level TNC Driver for CP/M. This, along with associated programs was offered on single-sided single-density CP/M 5.25-inch floppy disk for $8 including postage.

In response to the recent release of the TAPR TNC, several papers talked about parts of the TNC design. These included Margret Morrison, KV7D, discussing real -time low-level software of the TAPR TNC and also designing the TAPR audio

input filter, co-authored with Dan Morrison, KV7B. The details in this second paper were interesting since the TAPR TNC included an MF10 switched capacitor filter.

This tutorial on the MF10 came in useful when reading the paper by Paul Rinaldo, W4RI, on the packet adaptive modem. This modem was designed for HF communications, and permitted use of signaling rates from 75 to 1200 bps. Reading the paper, it would appear as if one of the design goals was to extend the state of the art of packet radio on HF, which had been traditionally an RTTY domain. The paper also made reference to Automatic Repeat Request (ARQ) and Forward Error Correction experiments (FEC) on HF.

Other papers described work on PacSat's was described as well as emergency communications, just showing the breadth the conference has always had.

In Closing

I hope that this article has given you some idea of the hidden gems in the proceedings of the Computer Networking Conference. CNC proceedings and DCC 19 to 32 proceedings are available at http://www.tapr.org/pub_dcc.html; earlier DCC proceedings will be available real soon now.

TAPR Calendar

March 15 – *PSR* Spring issue deadline

April 15 – *PSR* Spring issue publication date

May 15 – Board of Director In-Person Meeting, Dayton, OH

May 16-18 – Dayton Hamvention

May 16 – TAPR-AMSAT Annual Dinner, Dayton, OH

July 15 – *PSR* Summer issue deadline

July 17-19 – ARRL National Centennial Convention, Hartford, CT

August 15 – *PSR* Summer issue publication date

Sept. 4 – Board of Director In-Person Meeting, Austin, TX

Sept. 5-7 – TAPR-ARRL Digital Communications Conference, Austin, TX

Oct. 15 – *PSR* Autumn issue deadline

Nov. 15 – *PSR* Autumn issue publication date

###

Board of Directors Meeting Minutes

TAPR Board of Directors Meeting
Thursday, September 19, 2013, Seattle, WA

Meeting called to order at 9:23 AM by Steven Bible

Minutes taken by George Byrkit

Board members present: Tom Holmes, Jeremy McDermond, John Ackermann, John Koster, George Byrkit, Steve Bible

Also present: Steve Stroh

Election of Officers: All current officers are willing to serve again in the same positions

Steve Bible: President

Jeremy McDermond: Vice President

Treasurer: Tom Holmes

Secretary: Stana Horzepa

John Ackermann moved to re-elect the current officers. John Koster seconded. All voted 'aye.'

The current officers are re-elected to their respective offices.

Potential candidates for the open board positions were discussed. Dan Babcock has notified the Board that he will not be standing for re-election.

John Koster: The TAPR office is alive and well. Orders for Alex have surged recently, likely to accompany Munin? Metis boards arrived. 11 of the 25 have sold. Some of the Metis bare boards have also sold.

There are still 12 Hermes boards in stock. The consensus seems to be to put most of them up for sale.

Other discussion occurred on how to sell PennyLane, Janus and other boards, including the possibility of offering a trade-in of Penelope on a PennyLane.

John Ackermann moved that we offer a trade-in program for the first 50 people who trade in a Penelope board plus $150 and receive a PennyLane board in exchange. Tom Holmes seconded the motion. Vote was taken. All were in favor. The plan is then to repurpose the traded-in Penelope boards as WSPR beacons as stand-alone boards.

Jeremy moved to lower the selling price of Janus to $91 each. John Ackermann seconded. All were in favor.

Tom Holmes presented a year-to-date report. Thru August 2013, sales are down $17,000 (from $60k to $43k). Some revenue increase is seen due to earlier booking of DCC revenues this year.

Jeremy explained some of the membership numbers: it is now easier to renew for multiple years. About 50% of those renewing have renewed for 2 to 5 years. This means that the membership dues that we receive will be less in the future, as we've already received the revenue.

DCC 2013 was discussed. Meal ticket counts were reported. Ability to break even on the conference is getting difficult to achieve. Conference fee (currently $90) will likely have to be raised for DCC 2014. How the proceedings of the DCC are published was discussed. ARRL handles the 'publication' (print-on-demand thru LuLu), the proceedings get an ISBN and is filed with the Library of Congress, and also published on the DCC website.

The board adjourned for lunch at 12:15 PM.

The board reconvened at 2:10 PM.

Some future projects were discussed. Jeremy McDermond mentioned a small buffer amp that would go from .5w to 5-10w. Jeremy is building several for himself.

Jeremy is considering work on a Metis II, which would use a Cyclone with 2 ARM cores (Cyclone 5 SE) for which Linux is available. Run Linux on the ARM cores to do the networking, and likely provide a web (server) interface for configuration, status and monitoring. There is likely a development board from Altera that will facilitate the project. This will use BGA packaging and not be readily makeable by hams.

A follow-up project would be a Mercury-II with 4 separate ADCs, which would allow a 4-square antenna array to be implemented.

Jeremy will speak to a few people, put together a plan, and get back to the board.

At 2:40 PM Jeremy McDermond had to leave. A quorum of 5 still was present.

John Ackermann showed his connector board for Hermes that provides break-out connectors for J16 connector. The demand from the interest list is at about 75 units. John would propose making 100 units. John wants to do a TADD-1 replacement. Design is pending and 'in the works'.

John is also thinking about a VHF-UHF (2m, 1.24m, 70cm) transverter, with .5 to 1 watt out. Tom Holmes pointed out that people like Down East Microwave do transverters better than we would likely be able to do.

Steve Bible is looking into hacking a BaoFeng UV-3R to see if it has much in the way of an SDR project in it.

Steve is encouraging getting back to TAPR's core of simple, small kits.

The board concluded its meeting at 5:00 PM

Respectfully submitted,

George Byrkit

###

Annual General Membership Meeting Minutes

TAPR Annual General Membership Meeting
Saturday, September 21, 2013, Seattle, WA

Meeting called to order by Steven Bible at 4:35 PM

Board Members Present: Tom Holmes, Jeremy McDermond, John Ackermann, John Koster, George Byrkit, Steve Bible

The officers as elected at the board meeting were presented to the membership in attendance at the AGM.

Tom Holmes gave a treasurer's report, explaining that TAPR has a lot of inventory that we'd like to sell to people, to increase our cash position.

The board elections were discussed. John Ackermann and Jeremy McDermond will stand for re-election. In addition, Mark Thompson and Bryan Hoyer also announced their candidacy. If anyone else is interested in running, they need to identify themselves to Steven Bible before the end of DCC.

A video report was received from Chris Testa and played to the members who were present.

Steve Bible discussed DCC 2014. He stated that the goal is to hold it in Austin, TX, on September 5, 6, 7 of 2014, the weekend after Labor Day.

The meeting was opened to questions or observations from the members.

- Steve Stroh opined that DCC is the premier thing that TAPR does.
- Someone suggested that we should find a way to continue the discussions of DCC on-line with a monthly 'newsletter.' Others opined that newsletters are so passe.'

- The suggestion was made to create a TAPR general list/yahoo group for discussion of things like 'when to hold DCC' and such.

The AGM was adjourned at 5:45 PM.

Respectfully submitted,

George Byrkit

###

$20 Multimode Software Defined Radio

By Mike Schaffer, KA3JAW

For this specialized piece of equipment, you will not be familiar with the manufacturers' nameplates as they are not your popular ham radio companies such as Alinco, Kenwood, Yaesu, Icom, JRC, MFJ or WinRadio. To date there are three company manufacturers: Ezcap, Compro and Terratec, along with other no brand clones.
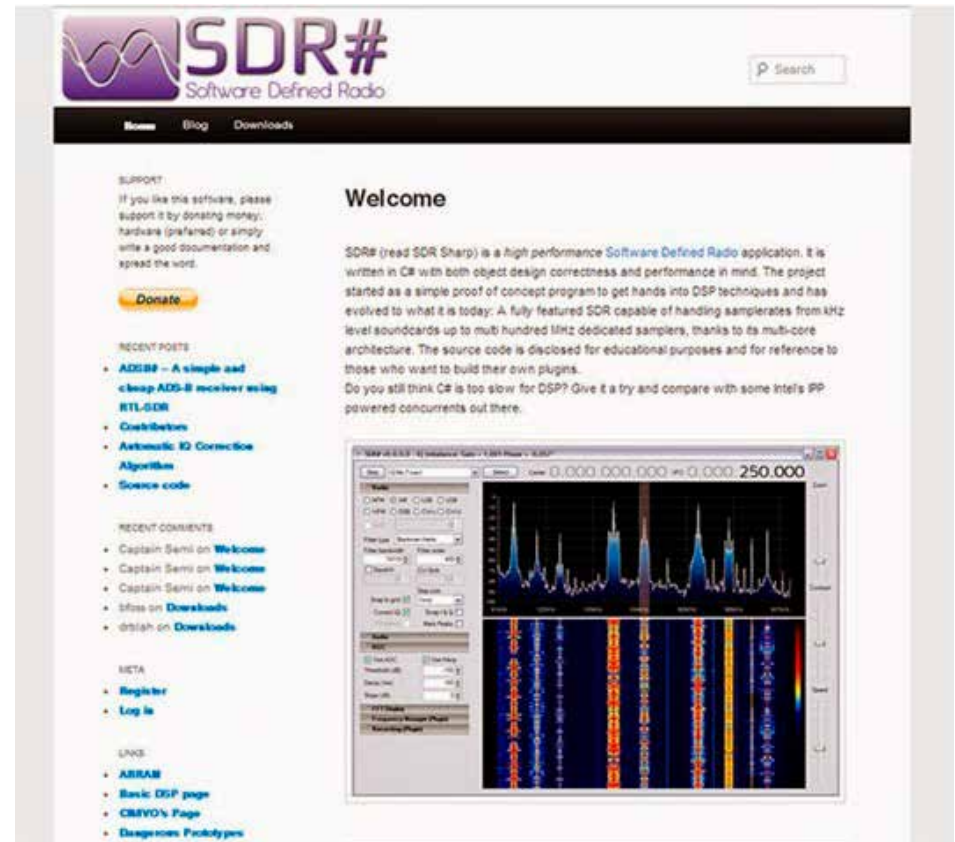
These devices have been used in Western Europe to watch terrestrial Digital Video Broadcasting (DVB-T) since 1998. These 2.75" (L) x 1.0" (W) x 0.5" (H) 0.7 ounce dongle (stick) devices connect to your computer via a USB 2.0 port.

They are useless in North America as we use a different standard called Advanced Television System Committee (ATSC) for digital transmission over terrestrial, cable, and satellite networks. However, they can be adapted as Software Defined Radios (SDR) for ham radio for the 6m (50 MHz), 2m (144 MHz), 1.25m (222 MHz), 70 cm (420 MHz), 33 cm (902 MHz), and 23 cm (1240 MHz) on some models.

There are two major chip sets built into the STL-SDR dongle: RF silicone tuner and the DVB-T COFDM (Coded Orthogonal Frequency-Division Multiplexing) demodulator.

Elonics, a global leader in RF technology headquartered in the United Kingdom since 2003, has an E4000 multi-standard CMOS terrestrial RF silicon tuner designed to interface directly to a digital demodulator and contains a fully integrated LNA, programmable RF filter, and RF mixers providing superior real world performance. The front end tuner covers the frequency range from 64 - 1700 MHz. However, reports have confirmed they can be made operable from 50 - 2200 MHz with a 150 MHz gap from 1100-1250 MHz on some models.

The heart of the E4000 is an innovative DigitalTune architecture, which allows the user to adjust the performance of the tuner for optimum linearity or noise figure according to significantly improve reception quality.

The demodulator is a Realtek RTL2832U high-performance DVB-T COFDM that supports a USB 2.0 interface with an 8-MHz bandwidth at

an IF (Intermediate Frequency) of 36.125 MHz, low-IF of 4.57 MHz, or Zero-IF output using a 28.8 MHz crystal and includes FM/DAB/DAB+ radio support. Embedded with an advanced ADC (Analog-to-Digital Converter), the RTL2832U features high stability in portable reception.

The state-of-the art tuner features proprietary algorithms including superior channel estimation, co-channel interface rejection, long echo channel reception, and impulse noise cancellation, and provides and ideal solution for a wide range of applications for PC-TV, USB dongle and MiniCard/USB, and embedded system via USB interface.

The SDR/GUI (Software Defined Radio/Graphical User Interface) application software is called SDR# (pronounced as SDR Sharp) and was authored by Youssef Touil in C# programming language. It is being offered as freeware (donation supported) for non-commercial, educational use. This software is a high-performance, fully-featured SDR capable of handling sample rates from kHz level sound cards up to multi-hundred MHz dedicated samplers, thanks to it's multi-core architecture. The application can demodulate NFM, AM, LSB, USB, WFM, DSB and RAW modes.

What makes this SDR fun to use are the two Fast Fourier Transformation (FFT) display modes: Spectrum Analyzer and Waterfall. FFT is a clever algorithm which can be used to transform a signal from the time domain to the frequency domain.

Youssef's website is http://www.sdrsharp.com. Feel free to ask questions on his webpage, SDR# Yahoo! group or #sdrsharp@freenode.

A video tutorial of the installation process by David Savidge, AF5DN, is here:

http://www.youtube.com/watch?v=MFqBj8gV0k4

And here is a video from Andy, M6PNP, performing an RTL-SDR 2-meter band scan: http://www.youtube.com/watch?v=YjqBn-LEx9Y

So where can you purchase this cutting-edge technological breakthrough product? The answer is eBay or similar on-line auction websites. Since the product comes directly from China or Hong Kong, expect to wait two to three weeks for mail delivery using free shipping.

By the way, the dongle also comes with a portable magnetic base telescopic antenna and USB cable.

Bonus: If you get tired of listening to the ham radio bands, you can tune-in to the FM broadcast band from 88 – 108 MHz in the WFM mode.

Minimum System Requirements:

- One available USB 2.0 port
- Pentium 4 CPU
- 512 MB RAM
- Graphic card supporting Direct X 9.0C
- 1 GB HDD space
- Windows XP/2000, Vista, WIN7, Linux

Notes:

1. The product comes with application software on a CD-ROM. You will not need it as you will use the SDR# (SDR Sharp) in its place.

2. Since they are intended for the Western European market, the antenna socket on the dongle is a 50 ohm female Belling-Lee IEC-16902 (Din) not the North American 75-ohm F-type. So, you will need a Belling-Lee-to-F cable connector adaptor to connect to the antenna.

###

Write Here!

PSR is looking for a few good writers, particularly ham radio operators working on the digital side of our hobby, who would like to write about their activities and have them published here in PSR.

You don't have to be Hiram Percy Maxim to contribute to PSR and you don't have to use *Microsoft Word* to compose your thoughts.

The PSR editorial staff can handle just about any text and graphic format, so don't be afraid to submit whatever you have to wa1lou@tapr.org. The deadline for the next issue of PSR is March 15, so write early and write often.

If PSR publishes your contribution, you will receive an extension to your TAPR membership or if you are not a member, you will receive a TAPR membership.

###

On the Net

By Mark Thompson, WB9QZB

Facebook

As you may know, TAPR has a Facebook page, www.facebook.com/TAPRDigitalHam.

However, I also created a TAPR Facebook Group, www.facebook.com/groups/TAPRDigital/.

If you have a Facebook account, "Like" the TAPR Facebook page and join the TAPR Facebook Group.

If you join the group click on the Events link and indicate you're Going to the events.

On Twitter, Too

Access the TAPR Twitter account at

www.twitter.com/taprdigital.

Also on YouTube

TAPR now has its own channel on YouTube: the TAPR Digital Videos Channel:

www.youtube.com/user/TAPRDigitalVideo.

At this time, there are a slew of videos on our channel including many from the TAPR-ARRL Digital Communications Conference (DCC) that you may view at no cost, so have at it!

###

PSR

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 TAPR, please contact the editor (wa1lou@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 (OpenOffice or *Microsoft Word* is acceptable). 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.

Production / Distribution

TAPR Officers

TAPR Board of Directors

TAPR is a not–for–profit scientific research and development corporation [Section 501(c)(3) of the US tax code]. Contributions are deductible to the extent allowed by US tax laws. TAPR is chartered in the State of Arizona for the purpose of designing and developing new systems for digital radio communication in the Amateur Radio Service, and for disseminating information required, during, and obtained from such research.

PSR Advertising Rates

TAPR is a community that provides leadership and resources to radio amateurs for the purpose of advancing the radio art.

Membership Application

TAPR

P. O. Box 852754, Richardson, TX 75085–2754

Phone 972–671–TAPR (8277), Monday–Friday, 9AM–5PM Central Time

E–mail taproffice@tapr.org   URL http://www.tapr.org

Join or renew online at https://secure.tapr.org/np/clients/tapr/login.jsp

Benefits of a TAPR Membership:
- *Subscription to the quarterly PSR*
- *10% off most TAPR kits and publications*
- *Access to the TAPR digital library*
- *Latest information on TAPR R&D projects*
- *Co-sponsor of the annual TAPR-ARRL Digital Communications Conference (DCC)*

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