

Boulder Amateur Television Club **TV Repeater's REPEATER**

March, 2023
issue #124



BATVC web site: www.kh6htv.com

ATN web site: www.atn-tv.com

Jim Andrews, KH6HTV, editor - kh6htv@arrl.net www.kh6htv.com



Members of the Northern Illinois Bolltiecap Balloon Brigade, whose balloon went missing near the area where an unidentified object was shot down by a fighter jet over Alaska



K9YO Balloon May Have Been One of the Objects Shot Down by Air Force

Tnx to Mike, W3DIF, for sharing this news item with us from the London Daily Mail.

One of the mystery objects shot down by U.S. fighter jets amid ongoing near hysteria sparked by a Chinese spy balloon may have been a \$13 balloon launched by a group in Illinois. The Northern Illinois Bottlecap Balloon Brigade reports that one its balloons went "missing in action" around the same location and same time that a U.S. Air Force jet downed an unidentified object near Alaska using a \$380,000 Sidewinder missile.



The balloon hobby group said its K9YO balloon last reported its location shortly before 1 am on Saturday, February 11, near the coast of southwest Alaska. Later on Saturday, Canadian Prime Minister, Justin Trudeau announced that an unidentified object was downed over Canada's Yukon Territory, not too far from K9YO's last known location. Modeling shared by the balloon group shows that their balloon was headed in the direction of the Yukon before it vanished.

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Jim, KH6HTV, then wrote to Drew, AC3DS, in Fairview, PA --- " Well it looks like you need to warn your Junior High, STEM kids their balloon might be shot down by the US Air Force !" Drew replied -- "The kids and I discussed the possibility that this may be the case... Their first responses included: painting a bullseye on the side of the payload, painting a Chinese flag on the side, writing "smile, you're on camera" ! ! !

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ATV, maybe DATV from a BALLOON ? HELP WANTED !

I am requesting help from our readers of this ATV newsletter. Within the last few weeks, I have gotten several inquiries from hams across the USA, requesting advice on doing DATV from balloons. These are all hams working with junior high, high school, or college STEM students. Not sure if the latest surge in balloon ATV is related to the recent public publicity, or not ? The basic question, I keep getting is "Can we successfully send digital ATV from a small STEM balloon, and if so, how do we do it ?"

I have to admit to all of these inquiries, that I have ZERO experience with Balloon ATV. All of my ATV experience is land based. But, I do know there are some of our readers out there who do have balloon ATV experience, at least analog ATV. I just don't know who you are. Back in the analog ATV days, we heard a lot about video down-links from balloons. Now in the digital ATV era, I haven't heard reports of it happening. So, if you have any balloon ATV experience, analog or digital, and are willing to share your knowledge with others, please let me know and I will be the marriage co-ordinator and get you in touch with the new kids on the block who are begging for help. If you can help, send me a reply to: kh6htv@yahoo.com Plus, if you are also willing to write articles for this newsletter about balloon ATV, that would be great also.

A really big limitation to these high school STEM balloons is their size and weight limitations. These are not heavy lifter balloons. Their whole payload package of all the various experimental sensors, misc. electronics, radio transmitter(s), antenna(s) and batteries must be ultra-light.

Every inquiry I have gotten has asked about using my RF linear power amplifiers which put out Watts of RF power. I have been a "wet-blanket" for these because they were never designed for such service. They have big, heavy heat sinks, and being class AB linear amplifiers, they are not very efficient and pull a lot of DC current from a battery. Thus requiring a large, heavy battery.

So, I have pondered the question, can we do DATV successfully from a balloon using milli-Watts of power rather than Watts ? I have very recently gone through the following set of calculations for Drew, AC3DS. I think the answer is "Yes". But I would really like to have it confirmed or dis-proved by some of our readers out there with actual flight testing of DATV.

BALLOON 70 cm DATV CALCULATIONS

Jim Andrews, KH6HTV

4 Feb 2023

The question asked -- "Is a DTV transmitter running 150 mW sufficient to get a digital TV signal back to earth from a high altitude balloon at 100,000 ft (about 19 miles) ?"

I discuss propagation in my application note, AN-33a, "TV Propagation". There most of the emphasis is on terrestrial (i.e. over the surface of the earth) propagation. For your balloon situation, it is different.

Well, the first assumption I will make is that for this situation, we will come close to having a true "Free Space" rf path, free from terrestrial interferences, such as multi-path, etc. So let's start with the equations given on page 2 of AN-33a. --- reproduced here.

So after determining our radio horizon, the next issue to contend with is RF Path Loss. Path loss is the natural phenomena of radiating a certain amount of power but this power, again due to spherical geometry, gets spread equally over an ever expanding globe as it propagates away from the source. Thus the power density in watts/m² gets much smaller the further we get from the source. The formula for free space path loss based upon this geometry alone is:

$$\text{Free Space RF Path Loss(dB)} = 20 * \log_{10}(\text{f in MHz}) + 20 * \log_{10}(\text{D in Miles}) + 36.6 \text{dB}$$

Note in this equation the frequency dependency, For example, going from 70cm to 23cm bands we suffer about a 10 dB hit in path loss. A few quick calculations will give you an appreciation of the importance of path loss. As an example, for the 70cm band (430 MHz) we get: 0.1 mile => 69dB, 1 mile => 89dB, 10 miles => 109dB, etc.

To determine the best case situation for a particular rf path we need to include all of the major rf components. Calculations are done easiest in dB with power levels expressed in dBm and antenna gains expressed in dBi. To determine the power input into the distant receiver, we need to know:

$$\text{Rcvr Pwr(dBm)} = \text{Trans Pwr (dBm)} - \text{Trans Cable Loss (dB)} + \text{Trans Ant Gain (dBi)} \\ - \text{RF Path Loss (dB)} + \text{Rcvr Ant Gain (dBi)} - \text{Rcvr Cable Loss (dB)}$$

So, now let's run some calculations for your balloon situation.

Let's make the following assumptions:

Frequency (70cm) = 435 MHz, Altitude, distance D = 20 miles,

Transmitter DVB-T average power = 150 mW = +21.8 dBm

Transmit Antenna Gain = 0 dBi, Transmit coax cable loss = -0.5 dB

Receive Antenna Gain = +11 dBi (assume using short, 6 element Yagi Antenna)

Receive coax cable loss = -1 dB

Free Space RF Path Loss = $20 * \log(435) + 20 * \log(20) + 36.6 = -115.4$ dB

Received Power = +21.8dBm - 0.5dB +0dB -115.4dB + 11dB -1dB = **-84.1 dBm**

Now, going down-range from 20 miles directly overhead to 200 miles distant, this adds an additional -20 dB of path loss, dropping our optimum received power to -104 dBm. Video from the initial launch phase should be a piece of cake -- but from further down-range questionable.

So, how much power do we really need at our receiver ? I have over the years run a lot of sensitivity tests on ATV receivers. Both old AM-TV, VUSB-TV, FM-TV and more recently digital DVB-T. With any of them, I would be able to receive a -84 dBm signal. Granted the analog signals would not be perfect, but contain "snow". Digital would be P5.

I refer you also to my application note, AN-29, "DVB-T Receiver Sensitivity Measurements". In particular look at the summary tables on page 3. All of the sensitivity numbers reported there were measured in a lab, closed circuit (i.e. in coax), perfect environment. This would be the equivalent of your free space, balloon rf path.

We have run actual rf propagation field tests to confirm the coverage area of our Boulder, CO DATV repeater. We actually measured the received signal strength in dBm. The repeater was transmitting DVB-T, 6 MHz band-width, QPSK with the "normal" parameters of 5/6 FEC, 1080P. It was our experience, that the weakest terrestrial signal we were able to receive out in the field was typically about -90 to -92 dBm. The receiver used did include a pre-amp. Under those conditions, the lab measurement of the same receiver showed a sensitivity of -95 dBm and -99 dBm with the pre-amp. The difference we attributed to the real world environment complete with RFI and multi-path always present.

So what can you do to further improve matters, beyond increasing the transmitter power ? Most all are on the ground station, receiver side.

1. Well the first obvious one is to use a good low noise, pre-amp along with your receiver.
2. You could mount the pre-amp directly at the receive antenna. This would eliminate the receive coax cable loss from the equation.

3. You could use a higher gain Yagi antenna. The draw-back to this would be a narrower beam width of the antenna which would make pointing more difficult. For a balloon, you obviously will need both Azimuth and Elevation control of the antenna pointing.

4. You could use a diversity reception receiver with a second antenna. The diversity receiver automatically selects the best signal. This would greatly enhance your probability for success. If you used cross polarized dual antennas, it would compensate for the variable polarization as the balloon antenna swirls around. Hi-Des does make a diversity, DVB-T receiver for the 70 cm band. It is their model HV-122. It sells for \$329. (note: do not buy the 122A, nor the 122-2.4G models as their sensitivity on 70cm band is very poor).

5. Some improvements can be made to lower the required receive signal strength by changing the DVB-T digital parameters. See my app. note, AN-39c. If you stayed with a 6 MHz band-width, you could use the "poor channel" parameters of 720P and 1/2 FEC. By using an even narrower band-width of 2 MHz with 480i and 3/4 FEC, you can buy even more dBm reduction.

6. Redundant Receivers and Antennas -- To help insure success, having multiple receiving stations is strongly encouraged. Everyone knows the infamous "Dr. Murphy" almost always shows up to enforce "Murphy's Law" !!!

Transmit Antenna ? ---- I assumed 0dBi gain for this antenna. This is a big unknown area as to what antenna you plan to use on the balloon itself. Whatever your choice, you will need to rerun the calculations using it's gain.

Potential Balloon DATV Equipment: So what commercial, off-the-shelf, gear is available to used in your balloon ATV package? Most USA DATV hams are using gear from a company in Taiwan, called Hi-Des (www.hides.com.tw). Check out their web site, in particular, their on-line, E-Bay store.

DC-105-BB



DVB-T/ ISDB-T/ ISDB-Tb

HV-320 -PATV



DVB-T/ ISDB-T/ ISDB-Tb 400~800Mhz > +23dBm

Model DC-105-BB This looks quite attractive as a combo video camera and also a DVB-T modulator. It sells for \$229. The camera will give you full hi-def, 1080P resolution. Hi-Des tech support tells me the DVB-T modulator is comparable to their model HV-310. You will need an RF linear power amplifier as the max. output from the DC-105 is a low -2dBm (70cm).

If you prefer to use a different video camera, then you need a separate DVB-T modulator. Your choices are:

Model HV-310E Price is \$279. It accepts video input from either hi-def digital HDMI or std.-def (480i) analog composite video camera. Frequency coverage from 170 MHz to 1.3GHz (70cm, 33cm and 23cm ham bands).

Model HV-320E Price is \$399. It accepts video input from either hi-def digital HDMI or std.-def (480i) analog composite video camera. Frequency coverage from 100 MHz to 2.5 GHz (70cm, 33cm, 23cm & 13cm ham bands). (note: app. note, AN-59 compares the performance of the 310 and 320)

Again, you will need an RF linear power amplifier with either the 310 or the 320. Hi-Des does offer several versions of the 320 with a built-in amplifier for \$438. Each version is specific to only one ham band. The max. available DVB-T RF output power with the built-in amplifier is rated at +23dBm (200 mW).

Disclaimer: *While I have found the Hi-Des products to work well and they provide great tech. support, I have not personally evaluated either the DC-105 combo camera/modulator, nor any of the power amplifier versions of the HV-320 modulator.* ---- Jim, KH6HTV

70cm RF Power Amplifier:

In our previous issue #123 of this newsletter, we did a product review of an extremely low cost (\$15) rf amplifier from China. It is advertised on E-Bay as the "SBB5089+SHF0289". I found that it would be ideal for use in a balloon along with a DVB-T modulator. For the amp that I evaluated, I was able to get +22.4dBm (150mW) average DVB-T power out of it on the 70cm band.

SBB5089+SHF0289 Microwave Power Amplifier



0.1GHz~1.3GHz

10~30VDC

Gain 25dB,

1W

Another Possible Amplifier ? --- A modified version of the **KH6HTV Video model 70-7B** is another possibility. The standard 70-7B in the high power mode, puts out about 3.3 Watts (+35 dBm) average DVB-T power, but also sucks about 2.5 Amps from a 12 Vdc supply. If it is operated in the medium power mode, with a -5 dB drop in power down to 1 Watt (+30 dBm), the current drain drops to about 1.1 Amp. In the low power mode at 300 mW (+25 dBm), it pulls about 2/3 Amp. Thus, a throttled back 70-7B amplifier, re-packaged and mounted on a considerably smaller heat sink might also be an option.

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5.8 GHz, FM-TV from a Balloon ?

Jim, KH6HTV

OK, so long as we are talking about doing 70 cm DATV from a high altitude balloon, what about considering microwave, analog TV from a balloon. We have talked up the low cost, FPV drone video gear here in several previous issues of this newsletter, in particular, the low cost (\$30) combo, 5.8 GHz, FM-TV package from Amazon of the 600 mW, TS-832 transmitter and the companion RC-832 receiver.

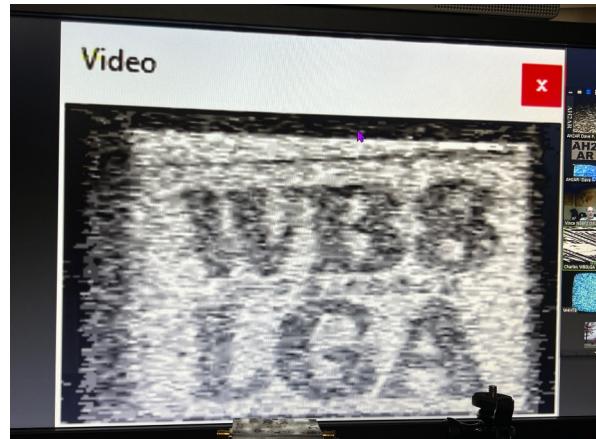
So, let's again run the RF path prediction equation. For a 20 mile path at 5.8 GHz, the free space path loss now is a whopping -137.9dB. For the following assumptions: +27.8dBm transmitter power, -1dB coax loss, 0dBi transmit antenna gain, -137.9dB path loss, +23dBi receive antenna gain (BBQ grill dish), 0dB coax loss (i.e. mount receiver directly on antenna), we thus calculate the received signal strength to be -88 dBm.

So, under ideal, free space conditions, is -88dBm good enough ? Well not really. Not if we want a perfect, snow free picture. See app. note, AN-55 "ATV Handbook", p. 12, Fig. 8, which compares receiver sensitivity for VUSB-TV, FM-TV, and DVB-T QPSK. For FM-TV, at -98dBm, we get a really weak, P1 picture. At -88dBm we are up to a P3 to P4 picture at best. Thus, even using a high gain receive antenna with it's narrow beam-width and pointing difficulties, the best we could hope to achieve would be a P4 picture.

Amazing 70 cm ATV DX first Contact!

Dave, AH2AR, from Dayton, Ohio reports ---

Bill White, WB8YIF in Little Hocking, Ohio had a two way QSO with WB8LGA located 100+ miles away in Morrow County, Ohio on Saturday. Incredibly enough, Bill's 19 element Yagi was only 9 ft off of the ground, and he was using Jim Andrews' 70 cm preamp with an SDR Dongle. Pictured here is what Bill was receiving on 439.250 MHz A5.



WEEKLY ATV ZOOM NET

Dave here, AH2AR in Dayton Ohio. You all are most welcome to join our ATV Zoom session on Wednesday evenings. We typically have about 18 check-ins from all over the country, to include the Northeast and Midwest and we always welcome folks interested in ATV. There are always technical discussions about ATV. You can also get a feel for what may be happening in your region of the

country with other ATVers who may be in the know regarding the possibility of finding someone in your area who may be interested in the ATV portion of amateur radio.

For details on logging into the Zoom meeting, contact Dave directly.

Cheers, Dave AH2AR

ATV in New England -- Call for Activity

Hello Jim --- I've been on ATV on a regular basis since the mid 1980's and live near the Connecticut coast. From a group of local ATV stations of about 15 and 3 repeaters we are down to 2 stations and no repeaters. Are there any ATV stations that you know about in the Northeast? I used to see ATV DX from all along the coast when the band opened. I'm on every Wed. at 8pm with analog TV and talk back on 144.340 from CT with Gerald, WA2FNQ on Long Island NY (www.wa2fnq.com). I use a cavity amplifier that can do about 300 watts sync tip.

73 de Bob, W1CTC, Orange, Connecticut

WWV 100th Anniversary Celebration

Radio broadcasting had its start in 1920, and by 1923 hundreds of stations competed for limited space. The new industry had trouble keeping on the right frequency, and the airwaves were a jungle. On March 6, 1923, the US Government began standard frequency broadcasts from radio station WWV to help stations tune their equipment and find their rightful place on the radio dial.

Presently the radio stations WWV and WWVB are located in Ft. Collins, Colorado. A three day 100th birthday celebration is planned for this week starting on Thursday evening, March 2nd with a couple of lectures. They will be streamed over the inter-net by the Northern Colorado Amateur Radio Club on their You-Tube channel. (<https://www.youtube.com/@NCARCstreams>) It starts at 5 pm, Mountain Standard Time (24:00 UTC). The Boulder, Colorado ATV Club, also plans to re-broadcast the talks over the W0BTW-DATV repeater. The repeater's video will also be streamed via the BATC server in the U.K.

On Friday, there will be tours of WWV and also NIST in Boulder, CO. On Saturday, the WWV Amateur Radio Club (wwvarc.org) is organizing an expo at the Fort Collins Museum of Discovery. It will include exhibits, talks and demonstrations of amateur radio. Our own BATVC will be represented there by Don, N0YE, and Jim, KH6HTV, who will be providing a demo table of ATV.

There will also be an HF special event station on the air March 6th to 12th. Their call sign is WW0WWV. They plan to operate 80-10 meters with CW, SSB and digital modes. For details, see their www.qrz.com page.

For more details, see the flyer on the last page of this newsletter.

FEED-BACK:

Feed-Back on Fewer ATV Hams:

Hello Jim --- I have been reading the threads about the lack of ATV amateurs in the US and the calls for assistance.

For information, back in the 80's we had over 100 ATV stations here in Melbourne Australia. There are drivers for this which is reflected in your Boulder ATV group.

1. Driver No 1 and the most important one, is a local ATV Repeater. Without this, stations often will not be able to work even across town and any stations out in the country rely on relatively infrequent openings.
2. The second driver is the availability of either kits, equipment or ready built units to get people on air.
3. The third driver which is equally important as the first, are persons who will take on a leadership role and publish articles, circulate giving talks and demonstrations, as well as encouragement and assistance to all and sundry.
4. The final one is a grouping of supporting amateurs who like a challenge and do not get bogged down in any local politics. A regular weekly net is also in the mix.

In Melbourne now we have about 22 stations capable of DATV (DVB-S/S2 and DVB-T), there is no analogue at all. We are well down on the 100 odd in the eighties but still doing relatively well. We even have a large local club that has its own DATV station.

Keep up the good work Jim. you are one of the important drivers in the US.

Best 73, Peter Cossins, VK3BFG, Melbourne, Australia

Feed-Back on Hi-Des 10 GHz Down-Converter: Information are here..... OE7DBH - Technik in Oberland - Seite 15 - OE7 Amateurfunkforum (oe7forum.at)

<https://www.oe7forum.at/viewtopic.php?f=7&p=2661#p2632>

All 3LNC70 are located in Austria and are sent to you from Austria.

Vy 73 de Darko, OE7DBH

Editor's Note: Darko's talk from 05.02.2022 does include more details, along with a short 1 1/2 minute YouTube video.

Feed-Back on Possible ATV Conference:

Rod, WB9KMO, Mesa, AZ, writes --- Need to give ATV Conference more thought. A lot of work and expense. Expanding ATV activity at Dayton Hamvention sounds more practical.

Roland, KC6JPG, Rancho Cucamonga, CA writes ---

Aloha Jim! --- What an AWESOME newsletter my friend! I especially enjoyed the Hamcation video with the introduction of the "working" Icom IC-905 transceiver. This soon to be available "off the shelf" turnkey microwave transceiver will be a game-changer, especially towards working the "amateur television" mode of operations from the IC-905. I am saving my pennies towards acquiring one when it becomes available as I would imagine a price tag of about \$3,000.00 to \$3,900.00 may be tagged for this unit when it becomes commercially available. It may be "sticker-shock" for most of us. We will see.

Also, Joel's idea of having an ATV conference is definitely needed. Whether it will be a regional event like he suggested (Las Vegas) or hosting a virtual ATV worldwide conference, having a yearly "convention" will be of great importance to our hobby as we can have ATV'ers from around the world to participate and collaborate towards the advancement of "off-the-grid" video / transmission / streaming technology within our hobby. Also, having a conference will be able to attract new licensed HAMS that enjoy or work in the video arts to become involved within our ATV community. Even more important is to demonstrate the vital need of ATV "off-the-grid video transmission" (RF) or "off-the-grid video streaming" (AREDN) during emergency operations (especially with the fires that erupted in your area, and our wildfires that erupt in SoCal), especially when "on-the-grid utilities" are inaccessible or disrupted. Fire protection and law enforcement agencies have benefited from our ATV repeater systems, especially those that have PTZ cameras installed on the towers.

Thank you Jim for a great issue. I will forward my articles on "ATV on DMR" and "Upcoming ATV events for 2023" this weekend.

Have a GREAT day Jim! SEE you on ATV soon! 73,~Roland

Roland Hoffman - KC6JPG

Digital Systems Director / Net Control Operations, Amateur Television Network

W0BTW Details: **Inputs:** 439.25 MHz, analog NTSC, VUSB-TV; 441MHz/6MHz BW, DVB-T & 1243 MHz/6MHz BW, DVB-T

Outputs: Channel 57 --- 423 MHz/6MHz BW, DVB-T, or optional 421.25 MHz, analog VUSB-TV. Also, secondary transmitter, FM-TV output on 5.905 GHz (24/7).

Operational details in AN-51a Technical details in AN-53a. Available at: <https://kh6htv.com/application-notes/>

W0BTW ATV Net: We hold a social ATV net on Thursday afternoon at 3 pm local Mountain time (22:00 UTC). The net typically runs for 1 to 1 1/2 hours. A DVD ham travelogue is usually played for about one hour before and 1/2 hour after the formal net. ATV nets are streamed live using the British Amateur TV Club's server, via: <https://batc.org.uk/live/> Select **ab0my or n0ye**. We use the Boulder ARES (BCARES) 2 meter FM voice repeater for intercom. 146.760 MHz (-600 kHz, 100 Hz PL tone required to access).

Newsletter Details: This is a free newsletter distributed electronically via e-mail to ATV hams. The distribution list has now grown to about 500. News and articles from other ATV groups are welcomed. Permission is granted to re-distribute it and also to re-print articles, as long as you acknowledge the source. All past issues are archived at: <https://kh6htv.com/newsletter/>

ATV HAM ADS

Free advertising space is offered here to ATV hams, ham clubs or ARES groups. List here amateur radio & TV gear For Sale - or - Want to Buy.



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The WWV Amateur Radio Club presents
“This is Radio Station WWV, Fort Collins, Colorado...”
Tune In: The WWV Frequency Celebration

Fort Collins Museum of Discovery Evening Lecture

Thursday, March 2, 2023, 5:00 – 7:00pm

“The History of WWV Frequency Broadcasts” – Glenn Nelson, WWV staff, National Institute of Standards and Technology (NIST)

“WWV as a Beacon for Citizen Science” – Dr. David Kazdan and Rachel Boedicker - Case Western Reserve University/HamSCI Aidan Montare - NIST Boulder/HamSCI

Seating is limited - please register at bit.ly/WWVARC:



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Please join us Thursday, March 2, at the Fort Collins Museum of Discovery, 408 Mason Court, Fort Collins, CO for the story of how WWV came to be and how WWV is used today by citizen science to foster cutting-edge ionospheric research.

There's more to Tune In: The WWV Frequency Celebration...

Friday, March 3 – Tours of the NIST Boulder Lab as well as WWV & WWVB near Fort Collins. 9-11am and 3-5 pm MST.

Registration Required – see the above QR code and URL

Saturday, March 4 - Tune In: The WWV Frequency Celebration @ the Fort Collins Museum of Discovery, 10:00 am – 3:00 pm in the free section of the museum. Learn about WWV and why it's an important part of our Nation's infrastructure as well as experience a variety of amateur radio exhibits and demonstrations throughout the museum!

<https://wwvarc.org/WWVFrequencyCelebration>

HamSCI
<http://hamsci.org>



NIST