My name is Patrick Ward

I would like to speak to the issue raised by the Commission's Engineering Office with regard to the tests of the databases and the adequacy thereof.

I have used both the Telcordia Technologies Inc TV Bands Database System, and the Spectrum Bridge Inc Database System.

I have found that both frequency assignment database systems to be lacking in some respects although quite useful in many respects.

As a resident of Pie Town New Mexico, who enjoys the thrill of the dark skies of the high desert, as an optical amateur astronomer, I can affirmatively state we in Pie Town New Mexico are blessed with Bortal class I skies, the darkest skies in North America..

That is due to the distance between Pie Town and other cities.
Pie town is located in the heart of Catron County, NM, which has one of the lowest population densities of any county in the United States of America.

Because we are so isolated and so desolate in terms of population, in the high deserts of New Mexico, we have no streetlights are other forms of light pollution to interfere with optical astronomy.

For many of the same reasons the National Science Foundation and National Radio Astronomy Observatory (NRAO) in Charlottesville Virginia has determined that the very best place for radio astronomy in North America is in our Catron County, NM, and the adjacent western Socorro County, New Mexico.

Again, because of the lack of nearby cities and the lack of radio pollution, which is simply another form of electromagnetic pollution, just like light pollution, the Very Large Array of radio telescopes is located very near to Pie Town, New Mexico.

In fact, Pie Town has its own radio astronomy dish about 30 miles the Very Large Array of radio telescopes on the plains of St Augustin in Catron County, and western Socorro Counties in New Mexico.

The radio telescope in PieTown NM, is similar to the ones of the Very Large Array of radio telescopes and often works in conjunction with the VLA, to expand the resolution of the VLA.

However, it is also part of another constellation telescopes, located at 10 different locations around North America, the Virgin Islands, and in Hawaii. This constellation is known as the VLBA (or Very Large Baseline Array) of radio telescopes.

In our optical observatory we have a 20 inch telescope which we would like to make remote controllable, from distant universities and locations far away from our clear dark skies, so that

astronomers in light polluted areas can enjoy the Bortal 1 class viewing in the high desert at Pie Town New Mexico.
Likewise, radio astronomers, will come from all over the world to use the facilities to the VLA. The VLA is one of the principal tourist attractions and an economic magnet for the economies of Catron County and Socorro Counties, in New Mexico.

Whether light pollution interferes with an optical telescope, or radio pollution, (or as it ic commonly called, terrestrial radio interference, quite possibly predictable), occurs near the VLA or VLBA radio telescopes, the net effect is the same; science suffers, and precious data is lost.

Light Pollution to our optical telescope, or radio interference to our scientific brethren of the VLA and VLBA both adversely affect the economy of Pie Town, and Catron and Socorro Counties, which will suffer right along with the science, due to that unwarranted terrestrial interference.

As an optical astronomer, I am torn between the need for Catron County to pull itself up by its bootstraps and come into the 21st century with broadband readily available to all those needy residents who seek it; and the danger of radiofrequency pollution form wireless broadband.

Simply put, I cannot economically obtain broadband yet, in harmony, and in balance, with the need for radio silence for the radio observatories located here.

The "HughesNet" and to a lesser extent, "Wild Blue" satellite offerings, have been oversold to the point that they seldom ever even work at all, and then offer only sub-dialup connections, often at 300 baud or less)

Verizon Wireless in these counties can provide mobile "MiFi" over some cell towers, but only at a dismally slow 0.3KBS-50KBS (absolute maximum of 144KBS).
Verizon can not yet, and likely not anytime soon, offer 3G, 4G or LTE in Pie Town, NM

There is not even a local landline "Dialup" service provider with a local number in Pie Town NM, such that any slow "dialup" modem Internet connectivity is also long distance landline calling!

Out of desperation, I have concluded that the only hope a fast video uploading stream from our optical telescope video cameras, and the only hope for a genuine broadband availability in Catron County, and western Socorro County, is white-space wireless broadband Internet.

Since the "HughesNet" and 'Wild Blue' satellite offerings have been so oversold, they do not have enough bandwidth to sufficient to provide genuine broadband internet connectivity.

In our Counties the poor and often fixed income elderly have been defrauded as the low income residents of Catron County, and Socorro County have been force to sign long-term contracts to try to get some sort of satellite broadband only to discover they still have no broadband at all.

Many of the residents of Catron County Socorro County New Mexico live on fixed income, are elderly, and are being gouged by existing copper Internet providers such as GilaNet who can only provide Internet service in a few selected areas by DSL and not at many other areas.

The GilaNet service often falters, and the repairs are seldom provided, on any timely basis.

Most residents cannot afford any dial-up connectivity that is also a long-distance phone call.

We have no way of connecting to a broadband video uplink to export our video and still CCD optical telescope cameras imagery that we can produce with a deep space optical telescope.

We have no way to connect that the outside world with any kind of a high-speed digital broadband link that can upload real-time astrovideography back to universities and other astronomers; who may wish to to share and our joy of observations of the cosmos.

There is no real Internet connectivity with sufficient bandwidth and speed to carry a video stream from Pie Town NM..

I see "white space Internet" over the channels formally used by analog television services as the only hope.

We simply must bring the sort of broadband services required by scientific explorers, and regular old folks, tourists and business services to Pie Town and Catron County and Socorro County New Mexico, for economic, scientific and spiritual survival.

I also want to make this happen in a way that will not interfere with the existing Very Large Array of radio telescopes or the Pie Town NM dish or Very Large Baseline Array of radio telescopes that are employed by scientists worldwide to study the cosmos.

I have very serious concerns about the adequacy of the existing FCC, Telcordia Technologies Inc TV Bands Database System, and also about the Spectrum Bridge Inc database system.
When I tried to develop the precision frequency build-out plan for a white space wireless network that can cover the high desert in central west and northwest New Mexico these system failed my expectations that they would correctly protect the VLA and VLBA.

The existing Telcordia Technologies Inc TV Bands Database System, and also the Spectrum Bridge Inc system, seem to be complexly blind to the real requirements of our radio observatories, and simply do not protect the interests of the VLA and VLBA operations,

Using the existing databases provided by Spectrum Bridge Inc system, and provided by Telcordia Technologies Inc TV Bands Database System, both now allow potential white space broadband third harmonic interference, to radio astronomy, that should be perfectly predictable and easily preventable..

These databases do not seem to understand the specific frequency protection requirements of certain essential and mission-critical cosmological emission spectra that radio astronomers need and use every day.

Neither of the frequency allocation databases seems to have been programmed with sufficient "Situation Awareness" to properly protect these vital cosmological emission spectral lines so vital to radio astronomy.

The Very Large Array of radio telescopes needs certain frequencies set aside and protected from interference beyond the simple protected radio silence zones established by the FCC, the ITU and the IAU, and the NRAO.

These essential cosmological emission spectra are intrinsic to astrophysics' well known spectral emission bands for iodized hydrogen (21cm) and ionized hydroxyl groups (18CM) emitted in deep space, and it is absolutely vital, that they can be clearly observed without terrestrial interference.

The spectrum Bridge database systems and the Telcordia Technologies Inc TV Bands Database System, simply do not provide the needed protection as they are now configured.

For example, in the past, the FCC, (and the National Science Foundation, the International Astronomers Union (IAU), the International Telecommunication Union ITU), have failed to adequately protect vital frequencies that are required for observing the hydroxyl ion line which is composed of a group of six narrow spectral lines, between 1612 MHz and 1660 MHz that are absolutely vital for inquiry, as to locations in the cosmos that contain water and of newly discovered exo-planet that may contain life.

It seems that in the past, governmental agencies have allowed the frequency of 1620 MHz be utilized, improperly, as a satellite downlink usage, which is extremely close to 1612 MHz spectral line of the ionized hydroxyl group.

Somehow, the 1620 MHz assignment, was given to the downlinks of the Iridium satellite constellation, now operated by Boeing.
Because there's always six or so Iridium radio satellites within view of the Very Large Array radio telescopes, or the Very Large Baseline Array of radio telescopes that was a major radio telescope celestial interference mistake,

That spectrum management oversight error, has confounded radio astronomers, who are attempting to explore newly located possible exo-planet star systems, and other possible sources of ionized hydroxyl molecules in our Cosmos.

The VLA and other radio telescopes have been able, to some extent, to compensate for this unwarranted interference by designing elaborate special front-end filters.
Even those filters are not entirely effective, and interference still causes problems with the noise figure auto-calibration using a liquid nitrogen source to constantly keep track of what is the noise level of the front and amplifier so that absolute signal intensities can be derived accurately.

The VLA scientists attempting to study hydroxyl ion concentrations in specific areas of our universe, are now confounded by unnecessary noise, from a faulty frequency assignment to the Iridium satellite downlink; that constantly causes data corruption on these vital scientific observations. The needless interference to the VLA and VLBA will likely persist until the Iridium satellite constellation is retired.

I would like to state for the record that I am genuinely interested in making White Space Broadband Internet happen for Catron County, and western Socorro County, and Pie Town New Mexico.
However, I am torn between the circumstance of my radio astronomer brethren, who have been forced to deal with terrestrial interference though the side-lobes of their directional antennae and the urgent need to bring Broadband Internet to Catron County NM, and western Socorro County NM

The scientists at the VLA and VLBA should not have to work so feverishly, just to overcome existing sources of terrestrial radio frequency interference.

These usually unnecessary sources of terrestrial radio frequency interference, are caused by other government, commercial activities and military activities,

Many sources of terrestrial radio frequency interference exist which should have been preventable, such as the war on drugs/border patrol scheme that has an aerostat balloon, near Deming NM, with airborne radar focusing at the southern border with Mexico.
This airborne radar bounces signals off nearby mountain-tops which then backscatters radio interference into the side-lobes the VLA dishes some distance away.
This is a powerful, loitering air-born radar, and a source of problematic radio interference to the VLA and the VLBA .

White Sands proving grounds about 200 miles away, particularly in the spring, conducts war game exercises using aircraft with electronic countermeasures (ECM).
Electronic countermeasures consist of high-powered RF power amplifiers broadcasting broadband noise, which can completely paralyze the VLA data collection at that distance.
VLA and VLBA must now schedule scientific exploration at other times than when the White Sands proving grounds ECM interference is present.

Radar at Kirkland Air Force Base in Albuquerque NM can also cause interference to the VLA.

The last thing the Spectrum Management people at the VLA or the VLBA need is a new persistent and (mis)planned source of terrestrial radio interference that, for all time can, reduce the effectiveness of these wonderful radio telescope arrays that have the highest sensitivity radio frequency receivers on earth.

So, therefore, I have decided that I want to do everything possible to urge the FCC Commissioners, and the FCC Engineering Office to be sure that a near-term wireless broadband

deployment occurs in Pie Town, New Mexico that will cover the area between Pie Town NM, and Datil, NM and the surrounding high desert areas.

Datil, NM is located just outside the western edge of the VLA protection zone rectangle.

Pie Town, NM, however, is a very special case

Pie Town NM is located entirely ***within*** the 2.4 KM diameter protection zone around the Pie Town NM VLA/VLBA radio telescope.

The Pie Town NM radio telescope is also the only radio telescope on earth that functions BOTH as a local VLA radio telescope, and also functions as an essential central element in the VLBA.

The people of Pie town, NM, and Datil, NM desperately needed rural white space wireless Internet. These, are often poor individuals, who simply have no other access to broadband at all at any price.

There is some cell service in Datil, NM
In Pie Town NM, cell service is scarce or non-existent

There is a slight Verizon 1xRTT data connectivity in Pie Town, over distant cell towers near Datil, NM and Quemado, NM that can provide mobile or fixed Verizon "MiFi" over some cell towers, but only at a dismally slow 0.3KBS-10KBS (absolute maximum of 144KBS, but that never happens with a fringe area signal).

Along US 60, there is some availability of a DSL line, but only within a few of kilometers of the road.
However, the price of the service is about $120 per month. There is a charge from the telephone company, combined with the very expensive and unreliable DSL service provided by GiliaNet for another $75 per month, which is far out of reach of the budget of most of the elderly and poor folks, that comprise the bulk of the population of Catron and Socorro County.

Also, along US Route 60 in Pie Town, NM there is some dormant optical "dark fiber" two of which, (one for upload one for download) could be deployed to create a radio interference free Internet backhaul/backbone for Pie Town, NM and if required, also for Datil, NM

The lack of any sort of affordable broadband in Pie Town, NM and Datil, NM and Catron County NM and western Socorro County NM has prevented economic development, as no company wants to locate a place with such dismal broadband services.

In fact, many residents cannot even afford the very high price of plain old telephone service. Many nearby Indian reservations lack plain old tell the telephone service as well (which is also noisy and unreliable there).

This situation makes Catron County NM and western Socorro County NM, very risky places in which to live.

With the almost total lack of local medical services, and with no way to call for help, the people are in desperate need of some sort of reliable communication system that is affordable and actually works.

What better place could the FCC possibly choose to conduct real-world rural testing for the new white-space rural wireless broadband service, along with assessing and then effectively guaranteeing the long-term future protection of Radio Astronomy in mind?

By thoroughly testing white space wireless, at this specific location, we in Pie Town NM can then hopefully, work together with:

1) the FCC,
2) the NSF
3) the NRAO
4) the VLA Spectrum Management Office,
5) the VLBA Spectrum Management Office,
6) the ITU ,
7) the IAU,
8) Spectrum Bridge Inc TV Bands Database System
9) Telcordia Technologies Inc TV Bands Database System
10) Hopefully the TDF Foundation

to establish and help to codify, early on, the correct standards needed to protect the US (and the world's) radio astronomy establishment, from white space broadband Internet terrestrial interference.

Should the commission agree, and require that the developing white space broadband industry conduct beta testing of such rural deployment, at Pie Town, NM, and Datil NM, then a special subset of the widely deployed standard equipment could be researched, and developed.
These would then get special type-acceptance testing (that could only be done in Pie town, NM) with very high quality shielding standards, and extra high attenuation low-pass transmit filters standards.
Perhaps, these special white space transmitters would be mandated with special standards installation engineering practices robust support structures, and special frequency assignments that apply, only within an extended "White Space Radio Silence Zone," that would allow the use of white space radio broadband Internet nodes, even within the current radio silence zones. This could be accomplished, in harmony with radio astronomy community, by avoiding terrestrial interference with the side-lobes of the radio astronomers antennae entirely.

I urge the manufacturers, and the interested parties, such as Google, Microsoft, the TDF Foundation, Telcordia Technologies Inc, Spectrum Bridge Inc, the National association of Broadcasters, and the cable, and the wireless industries, to reply to this concept and embrace it.

I also urge the same interested parties to reply, (and then observe and participate) and to request that the FCC provide sufficient interference protection algorithms, placed into the frequency assignment software, to protect all white space Internet deployments and co-spectrum users.

I also ask that the same interested parties to join me in urging the FCC, and its Engineering Office to agree to conduct beta testing of such rural deployment at Pie Town, NM, with the intent to develop real-word and certifiable constraints and interference reduction and type-acceptance verification, with protection of radio astronomy, as well as co-spectrum user protection in mind.

That R&D, that can best be conducted in Pie Town, NM, and the lessons, (and likely surprises learned) there, and the interference reductions measured, and empirically accomplished there, should also go a very long way towards resolving the concerns of possible terrestrial interference; not only to radio astronomers, but also to existing TV broadcast, and TV translator services, the NAB, and to the Cable TV service providers.

Pie Town, NM is also the ideal place to develop effective methods and algorithms to update the deficient database currently used, with real-world testing, and intensive observation, and precision real world radio observatory empirical interference measurement.

Also, the FCC and the FCC Engineering Office should keep in mind that the Radio Astronomy community will need certain very precise specification information, from manufacturers, to be able to predict, or resolve issues of white space broadband Internet terrestrial interference.

In developing of type acceptance parameters needed to resolve interference issues in close proximity to exquisitely sensitive radio astronomy low noise receivers, the FCC Engineering Office should mandate that the following specifications be approved and clearly and indelibly labeled on each white space broadband Internet transmitter device:

TX Maximum Power (in DBM and Watts)
TX Frequency Range in Mhz
TX Maximum transmit bandwidth in VHF LOW band TV Channels 2-6 (54 MHz-88 MHz)
TX Maximum transmit bandwidth in VHF HIGH band TV Channels 7-13 (174 MHz-210 MHz)
TX Maximum transmit bandwidth in UHF band (54 MHz-88 MHz)
TX output filter parameters expressed as:

For Low Pass Filters:

1) filter cutoff frequency in MHz
2) filter attenuation at 54 MHz in DB
3) filter attenuation at 77 MHz in DB
4) filter attenuation at 698 MHz in DB
5) filter attenuation at 1333 MHz in DB
6) filter attenuation at 1396 MHz in DB
7) filter attenuation at 1420 MHz in DB
8) filter attenuation at 1612 MHz in DB
9) filter attenuation at 1720 MHz in DB
10) filter attenuation at 2792 MHz in DB
11) Maximum pass-band ripple in DB
12) Maximum stop-band ripple in DB

For Band-Pass filters

1) Lower filter cutoff frequency in MHz
2) Upper filter cutoff frequency in MHz
2) filter attenuation at 27 MHz in DB
3) filter attenuation at 54 MHz in DB
4) filter attenuation at 77 MHz in DB
5) filter attenuation at 698 MHz in DB
6) filter attenuation at 1333 MHz in DB
7) filter attenuation at 1396 MHz in DB
8) filter attenuation at 1420 MHz in DB
9) filter attenuation at 1612 MHz in DB
10) filter attenuation at 1720 MHz in DB
11) filter attenuation at 2792 MHz in DB
12) Maximum pass-band ripple in DB
13) Maximum stop-band ripple in DB

For Band-Stop Filters

1) Lower filter cutoff frequency in MHz
2) Upper filter cutoff frequency in MHz
3) filter attenuation at 54 MHz in DB
4) filter attenuation at 77 MHz in DB
5) filter attenuation at 88 MHz in DB
6) filter attenuation at 98 MHz in DB
7) filter attenuation at 108 MHz in DB
8) filter attenuation at 150 MHz in DB
9) filter attenuation at 174 MHz in DB
10) filter attenuation at 210 MHz in DB
11) filter attenuation at 322 MHz in DB
12) filter attenuation at 329 MHz in DB
13) filter attenuation at 406 MHz in DB
14) filter attenuation at 410 MHz in DB
15) filter attenuation at 470 MHz in DB
16) filter attenuation at 1333 MHz in DB
17) Maximum pass-band ripple in DB
18) Maximum stop-band ripple in DB

In addition the new frequency assignment algorithms must consider the following data field inputs, for each white space broadband Internet applicant's specific TV channel frequency allocation request.

Transmitter (TX) site geospatial coordinates including (Decimal) latitude, longitude, altitude.
Antenna height above average terrain (HAAT) in meters
Antenna height above the ground immediately beneath in meters
Antenna gain expressed in DBi

Antenna Directivity or Omni directional Yes/No?

1) Antenna Front to back ratio expressed in DB if directional
2) Polar Plot of antenna side lobes in horizontal plane (entered as a comma delineated Excel File) if directional
3) Polar Plot of antenna side lobes in vertical plane (entered as a comma delineated Excel File) if directional

Antenna pointing (if any)

1) altitude angle (0-90 degrees, an angle of antenna pointing above the true horizon (Using a spirit level) as opposed to the apparent horizon
2) azimuth angle (0-359 degrees an angle of antenna pointing referred to as angle with respect to true north, not magnetic or compass north)

Because most radio astronomy observatories are passive, and thus do not have protected contours, the new algorithms should assign a psedo-EIRP (Derived from the user input data listed above) to each passive radio observatory, dependent on the HAAT and power level, channel assignment, and geospatial coordinates of each potentially interfering white space applicant. That will allow a fully developed algorithm to create a pseudo protection contour that may need to be larger (for example a higher calculated pseudo EIRP) for UHF channels 14, 15, 24, 25, 26, 27, 28, and 37, than for the remaining UHF TV channels.

That way, proper consideration of the needs of present and future radio astronomers can take place, such that these new methods and algorithms can be incorporated into the existing white-space frequency protection databases so that the full and early deployment of the new white-space wireless broadband service can proceed rapidly nationwide.

Beta testing for radio telescope interference at Pie Town, NM, and Datil NM would not produce any significant long-term disruption of the radio observatories at the VLA and VLBA which are co-located only at Pie Town radio telescope. That is because most interference could be predicted and avoided, any unpredicted interference discovered at Pie town would be quickly be discovered via total cooperation between the offending emitters and the VLA Spectrum Management Office staff, and then quickly resolved while the remaining VLA and the VLBA Radio Telescopes continued normal operations some 30-3,080 miles away.

Thus in the rare event of an unpredicted interference surprise, the VLA and/or VLBA correlations could be instructed to simply discard the data-sets from Pie Town dish the time of the interference at the Pie Town dish while still getting uncorrupted data from all the other antenna sites in the arrays.

Pie Town, New Mexico, being located entirely within the 2.4 KM radius protected zone of the Pie Town radio telescope, is uniquely situated to resolve the following issue:

"How do you get white space Internet connectivity and cell phone service inside of a zone protecting a Radio Observatory for local residents as well as scientific staff, without creating unwarranted interference, or degradation of the signal to noise ratio of such sensitive radio astronomy receivers"

Clearly, this is a long-term problem for Pie Town NM, which needs to be resolved to allow it, and similarly situated communities near radio telescopes, to enter the 21st-century communications age, that is now so vital to the life, and economy of any community in the "Global Village Economy."

There is an urgent and persistent need to resolve this constraint on Pie Town, NM, efficiently, effectively, and deftly, without disrupting the VLA or the VL BA operations

Clearly, a fiber optic to the desk solution would eliminate interference from any Pie Town Internet access, given properly shielded computer equipment that complies with FCC Part 15 EMI Certification commission rules as to re-radiation from Certified Computer Systems.

That certainly is an option.

However that option alone, still tethers Pie Town residents to a desk, and denies them the mobile Internet connections that most US citizens now regularly use, expect, and take for granted.

I strongly urge the FCC to drill a little deeper than that obvious fiber-optic Passive Optical Network solution for places like Pie Town.
Residents near or within radio silence zones around radio telescope observatories, are kindly recruited by their country into "special service duty."

They have been asked to maintain radio silence to protect the scientific interest in keeping their skies forever Radio-Dark and Optically Dark so that humanity, and succeeding generations of humanities' offspring are assured an opportunity, in perpetuity to always be able to know and intimately understand humanity's place in an expansive universe.

Their reward for this special patriotic duty, should not, and cannot be excommunication from the "Global Village" and the "Information Age."

Therefore, I strongly urge the FCC to act now, to keep the residents of Pie Town, NM and others similarly situated in mind, and act now, to assure them equal opportunity mobile broadband Internet access though technical innovation, so that they too, may enjoy "Un-tethered and Mobile" in their internet connectivity.

I therefore urge that the FCC and the FCC Engineering Office now set out, as a resolvable constraint, on the frequency allotment database system, for white space broadband Internet implementation and deployment and insist that the new "White Space Broadband Internet Service" be deployable, within that technical constraint's parameters.

With very careful engineering; and acting deftly and carefully now, we can develop a way that preserves the radio "Dark Space" around Radio Observatories, while allowing white space Internet to operate even within the protected radio-quiet zones around sensitive radio telescopes, if and when necessary.

This should technologically achievable, because most of the frequencies of interest to radio astronomers, are well above the frequencies at which white space broadband internet will operate

This proposed radio telescope interference beta testing at Pie Town NM, is quite manageable because Pie Town, NM is quite a small town with only 100-200 or so inhabitants within the protected zone and the surrounding area.

I would urge the FCC and its engineering branch authorize, and require, the installation of three parallel Internet data delivery systems, at Pie Town, NM and fully explore and evaluate each, and cross-evaluate hybrids of each, to find sufficient technologically feasible hybrids of such systems.
Doing so should allow full protection of radio astronomy, while preserving mobile deployment of white space broadband Internet, even within the 2.4 KM protected zone.

The FCC should proceed to determine the correct channel assignment algorithms required to fully protect radio astronomy as follows:
1) A "fiber optic to the desktop" for the residents of Pie Town

2) Additionally, and for the purpose of beta testing
    a) micro cells
    b) nano cells
    b) pico cells
for cellular 3G, 4G and LTE voice and data services brought into the Pie town and Possibly Datil NM area via fiber optic backhaul.

Finally require the beta testing of a layer of
    a) Micro wireless white space broadband service cells,
    b) Nano wireless white space broadband service cells,
    c) Pico wireless white space broadband service cells,

The manufacturers should provide for testing:
    a) standard deployment mass-market full power versions, with standard part 15 Shielding from each manufacturer, for type-acceptance in or near radio observatory radio quite zones (To establish a "standard product" interference baseline)
as well as,(to determine if special versions which may be required be used within an "Extended White Space Radio Silence Protection Zone" for white space broadband Internet within a yet to be determined additional protection zone around radio astronomy sites)
    b) for testing, and trial use in such an extended zone if found to be needed, a specially designed and extensively shielded version for this beta testing that allow for continuously adjustable (in RF output power, level all the way up to the full power levels used in the contemplated nationwide white space Internet deployment), and

with each RF output stage deployed for testing also provided with a quantity of 6 additional output low-pass filter blocks, set to pass frequencies below 700 Mhz (-20DB per Octave per low pass filter block) that can be easily cascaded as needed to eliminate any harmonic interference. In addition, each of these test units should provide, an easy use manual way to implement the ability to block the use of any combination of specific TV channels, 2-51 of the vacant analog TV channels, whose second and third harmonics may happen to fall into the spectrum of certain precise spectral emission bands essential to radio astronomy.

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For example, frequency restrictions on the essential spectral lines of:

a) Ionized hydrogen at 21 cm with a 6-12 MHz guard band to allow for cosmological red shift or blue-shift.(Third harmonics of TV channels 14, 15.)
b) Similar restrictions for cosmological observations of 1612 MHz through 1660 MHz spectral lines for ionized hydroxyl molecules in the cosmos, (Thereby excluding UHF channels 24-28 to prevent third harmonic VLA and VLBA antennae side lobe terrestrial interference.)
c The ability to block UHF TV channel 37 to protect an essential radio astronomy spectral emission line. (a spectral line around the third harmonic of UHF TV Cannel 37 is known to be often used for noise-floor calibration of receivers at radio observatories.

I therefore recommend the following criteria to be FCC commissioners and the FCC engineering branch to assure that radio astronomy is properly protected:

There are five discrete spectral frequencies (that are quite narrow band cosmological spectral emission lines) that are absolutely essential to radio astronomers and that could be directly interfered with by an improper protection methodology for radio observatories, resulting from the white space deployment now in progress or contemplated in the vicinity of sensitive radio telescope receivers.

Although each of these frequencies is an extremely narrow spectral line resulting from narrow-band emissions of excited ions deep in space, the FCC and the promoters of white space broadband need to understand that:
These very narrow spectral emission lines are generally broadened by either blue-shift for objects that are approaching Earth or more likely red-shift provide from emitting objects or gasses in our universe moving at high velocities.
Therefore, simply protecting the narrowband spectral lines alone is insufficient.
We must also plan to protect a reasonable amount of deviation from those spectral center frequencies to allow for observation of highly-blue shifted, or highly red-shifted cosmological objects.

New discoveries in the field of cosmology have even revealed to us that possibility, we will soon discover that dark matter and dark energy may behave differently or opposite from regular matter, should we discover how to receive such signals.

Thus, we should allow for the possibility that receding dark matter objects may actually have a blue shift (which is exactly the opposite of the normal red shift for conventional matter).

Therefore, we should plan to preserve the ability of humankind to make such discoveries and our cosmos without undue interference from the contemplated white space broadband services.

Thus, we should plan now, to allow an adequate guard band, ***on either side these narrow spectral frequencies***, for each the five specific ion molecules or atoms that are likely to be of the most importance, and that also just happen to emit on frequencies that coincide with the third harmonic frequencies of UHF TV channels 14, 15, 24, 25, 26, 27, and 28.

It is somewhat likely that an additional protection zone enlargement (size to be determined by calculation and verified by an FCC experimental license study at Pie Town NM) around radio observatories that applies only to emissions on certain specific white space TV bands, including UHF TV channels 14, 15, 24, 25, 26, 27, 28, and 37. Perhaps, additional problem channels could be discovered, in a beta test at Pie Town NM,

The frequency allotment database system should develop a proximity algorithm derived experimentally (via a an experimental white space deployment permit for Pie Town and Datil NM) to develop a proximity algorithm that will properly determine whether:

1) to reduce the power level,
2) or to use micro-cells,
3) or to use nano-cells
4) or to use pico-cells,
5) or to use high attenuation (-60 DB to -140 DB Low Pass, Band Pass, or Band-Stop or combinations thereof,
6) or to use the restriction of certain frequencies,
7) or any combination of the above,
8) or any as yet undiscovered additional solutions

to allow for white space broadband systems that may deployed in the vicinity of radio telescopes, and even,when advantageous and required, within their existing protection zones, without causing VLA and VLBA antennae side lobe terrestrial interference.

There is a very real danger that non-linear operation of white space Internet broadband RF power amplifiers operating on UHF TV channels 14, 15, 24, 25, 26, 27, 28, and 37 near radio observatories without adequate frequency assignment algorithms and controls, could generate sufficient third harmonics, to interfere with the ionized hydrogen and ionized hydroxyl molecule spectral emission measurements, or receiver calibrations being carefully made at radio telescope observatories.

For the same reasons, UHF TV translators should be avoided on UHF TV channels 14, 15, 24, 25, 26, 27, 28, and 37 near radio observatories.

These harmonic emissions could potentially interfere with very low noise astronomy receivers. The commission should require enough guard bands for either a blues shift or red shift velocities that could be a significant percentage of the speed of light.

That means we must avoid, at all cost, deploying certain UHF television channels formally assigned to UHF TV when assigning channel allotments to the new white space broadband service when near operating radio astronomy observatories.

To avoid ill-conceived attempts to re-bias the RF power amplifiers deployed near radio telescopes the power amplifiers should be made sealed and tamper-proof.

The FCC may also wish to rule that special white space broadband Internet transmitters that are type-accepted for special operations near radio telescope have an administrator IP address registered and made available to the Spectrum Management Office at the nearby radio astronomy site.
That way, the Spectrum Manager at that site can locate an offending transmitter, and reduce its power to verify it as the offending transmitter, and flag it for repair, or in extreme cases shut it down, with proper with notice to the owner, until repairs can be made and the device's type-acceptance compliance recertified.

Interestingly, there is an existing UHF Translator
TRANS id: **1323339**
call sign: **K48HL-D** rx channel: **27**
associated call sign: **KOB**
Operating in Horse Springs, NM

That translator apparently violates the radio exclusion zone at the VLA, perhaps with FCC and VLA approval, and or interference remediation, such as more extensive than commercial off-the-shelf low-pass filtering.

That fact may bode well for a successful and fully mobile hybrid white space micro-cell deployment without harmful effects to the VLA or the VLBA.

If solutions can be developed to protect radio astronomy at Pie Town which is fully within the 2.4 KM quite zone radius at that dish, (a very challenging engineering task) then white space radio deployment will come away from that beta testing experience ready for prime-time full deployment, and with a full anti-interference toolbox.

The five frequencies of vital interest to radio astronomers that need to be protected, and that result from two different species of ions are as follows:

Hydrogen (HI) (21 CM) 1420.406 MHz 1370.0 - 1427 MHz

Hydroxyl radical (OH) (18CM) 1612.231 MHz 1606.8 - 1613.8 MHz
Hydroxyl radical (OH) (18CM) 1665.402 MHz 1659.8 - 1667.1 MHz
Hydroxyl radical (OH) (18CM) 1667.359 MHz 1661.8 - 1669 MHz
Hydroxyl radical (OH) (18CM) 1720.53 MHz 1714.8 - 1722.2 MHz)

Respectfully Submitted
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