Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the matter of:	)	
	)	
Technical Advisory Committee (TAC)	)	ET Docket No. 13-101
White Paper and Recommendations	)	
for Improving Receiver Performance	)	

COMMENTS OF Genesys Limited

Victor Shtatnov
President, Genesys Limited
One Oxford Valley, Suite 850,
Langhorne, PA 19047, USA
1-267-491-5375
genesys.ltd@comcast.net

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SUMMARY

Although an interference limits policy is a step in the right direction, the policy will not be effective unless there is a credible mechanism that enforces the creation of higher quality receivers and requires coordination in the market. The FCC is in a unique position to set in motion the industry change that needs to occur in order to more effectively use the wireless spectrum.

When setting interference limits, the FCC should consider three things. First, interference limits should be grounded firmly in existing technology so that receiver performance goals are achievable. Second, interference limits should take advantage of state-of-the-art technology and market innovations so that the interference limits do not quickly become outdated. Finally, the FCC should consider the economics of certain portions of the spectrum so that the users do not face an unrecoverable financial loss from the upgrade.

In order to get the most out of an interference limits policy, the FCC must consider solutions that provide the highest benefit for the lowest cost. Specifically, using custom designed antennas to filter out noises before they ever reach the receiver is the ideal solution. Pairing an improved antenna with more intelligent receiver and transmitter systems can allow for a tremendous improvement in efficient spectrum use.

Organizing a multi-stakeholder group that is disciplined in all technological areas, represents the wide array of stakeholders in the industry, and is tasked with a specific timeline for viable alternatives and recommendations is key to creating a solution that is technologically advanced and is fair and equitable to the parties.

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Genesys Limited ("Genesys") offers the following comments pursuant to Sections 1.415 and 1.419 of the Commission's rules and regulations (47 C.F.R. §§ 1.415, 1.419) and the Commission's invitation.

I. INTRODUCTION – STANDING

For the past eight years Genesys has been working in the field of electromagnetic compatibility to develop technologies that allow distinct signals to operate in close proximity on the RF spectrum. The goal of Genesys' development work is to ensure that RF signals will operate without causing interference to receivers and without receivers accepting interference or being overloaded by transmitters operating on adjacent frequencies. The company is comprised of a

team of scientists with many years of experience in the fields of electromagnetic compatibility and electromagnetic interference. Genesys has been active in providing specialized RF equipment to the US military for use in Iraq and Afghanistan and is now applying its technologies to civilian uses. Accordingly, Genesys is an interested party in these proceedings.

In the April 22, 2013 Public Notice (DA 13-801) the Commission requests public response to the questions below. Genesys' response follows each question.

II. RESPONSES TO SPECIFIC QUESTIONS OF THE COMMISSION – INTERFERENCE LIMITS POLICY APPROACH

What are the costs and benefits associated with this approach?

While the Commission's approach to defining interference limits is a step in the right direction, it will not, on its own, lead to a more efficient use of the wireless spectrum. Setting interference limits, such as a harm claim threshold, implicitly creates receiver standards that manufacturers can voluntarily choose to adopt. If they do not abide by those standards, then they risk having no legal recourse when their receivers become inoperable due to a competing signal. The most significant problem with this approach is that the market is already saturated with receivers that would fail if the FCC adopts the envisioned harm claim threshold. In addition, new receiver manufacturers will not want to adopt stricter receiver standards[1] unless all other devices must also abide by those standards.

The costs for receiver manufacturers are too high to make a voluntary adoption of stricter receiver standards effective. A "prisoner's dilemma" exists in the market. The current

[1] Although the Commission may not have the statutory authority to adopt receiver standards, the adoption of a harm claim threshold will effectively require receivers to meet a certain standard before having any legal recourse.

receiver/transmitter market is in a balanced state, with manufacturers of each understanding where the interference limits line, albeit fuzzy, lies. Transmitter manufacturers are required to build within prescribed standards. Receiver manufacturers currently build their receivers to withstand the interference from harmonics, intermodulation, overload, or similar that even a well-built transmitter may produce.

By creating non-mandatory receiver standards, the result of an interference limits policy, the Commission seeks to minimize the amount of lost RF space between neighboring signals, thereby using the wireless spectrum more efficiently. While both receiver and transmitter manufacturers want to use the wireless spectrum more efficiently, there are great costs to switching to the new standards if competitors do not also switch.

If non-mandatory receiver standards are imposed, receiver manufacturers can choose one of two options:

(a) invest heavily to meet the standards, which will likely raise prices and make their products less competitive, or

(b) continue producing their current receivers, which will continue to perform well unless there are changes on the transmitter side.

No receiver manufacturer would want to be the first to invest heavily in option (a) while competitors save costs and capture more customers with option (b). There is simply no unilateral benefit to strengthening the receiver.

Those receiver manufacturers that do not choose to make the switch to higher quality receivers face no real threat from a harm claim threshold. The market is already saturated with

receivers operating below the FCC's envisioned threshold, and it will take many years for consumers to stop using those receivers based on current churn and replacement cycles. If manufacturers choose to follow option (b) in order to keep manufacturing costs low, it will take even longer for all sub-par receivers to be phased out of the market.

Until the majority of receivers can successfully filter out unwanted emissions from nearby transmitters, the FCC will find itself in a challenging position. The FCC would be forced to either allow a new transmission, operating below the harm claim threshold, to make inoperable a huge number of existing devices, or once again, stand down and inhibit the new entrant and hinder market progress and technological evolution. While preventing the new transmissions, such as the FCC's response to LightSquared, is an undesirable result that hinders innovation, the alternative is even worse. Even if receiver standards had been in place two years ago, the FCC could not have compromised the entire GPS system just to allow a new wireless service provider to flourish.

When setting harm claim thresholds, the FCC should ensure that they are sufficiently high to create a major leap forward across the entire spectrum, with early retirement imposed on all devices not achieving the requisite standards by the date specified.[2] A gradual transition will be impossible because of the difficulty in coordinating the transition and the large fixed costs incurred with each component upgrade.

Two approaches can be considered for comparison: the gradual improvement in fuel economy for automobiles and the abrupt transition from analog to digital television transmissions. Unlike car manufacturers that must gradually improve the fuel economy of their vehicles over

[2] Harm claim thresholds would be sufficient to impose the early retirement of incompatible devices as long as alternative measures are used to push the majority of the industry into change.

time, the FCC cannot hope to ask for piecemeal and gradual improvement in receiver performance. The mileage that one car achieves does nothing to impact the benefits from better fuel mileage of another car. The wireless spectrum, on the other hand, requires industry-wide collaboration among all parties. Nobody benefits unless all users of neighboring frequencies collaborate to adopt equally strict standards. The only way to achieve such a collaboration is to set a mandate to reach a certain standard across the entire industry,[3] as was done by forcing all television signals to become digital as of a certain date. The FCC should set the harm claim thresholds, and then incentivize industry groups to create and adopt corresponding receiver standards.

Although it may seem heavy-handed to force such a costly upgrade and impose a strict deadline after which harm claim thresholds will be enforced without exception, the alternative would slow the industry to a halt as the current demand of wireless spectrum bandwidth quickly reaches capacity. With enough fair warning and realistic, yet progressive, demands for a device's ability to mitigate interference, the transition will go smoothly and pave the way for future innovation.

A further challenge of the FCC's interference limits policy approach is that it is insufficient to create change. If manufacturers wanted to unilaterally improve receivers, they would have done so. If the FCC merely imposes a harm claim threshold without employing other measures to force the industry into compliance, future companies like LightSquared may enter at any time. In such a case the FCC would be required to decide whether to enforce its own harm claim thresholds or stand down because devices on the market are not yet ready. The transition is inevitable and should

[3] We are not advocating that the same harm claim threshold exist for all frequencies, but rather that realistic and strict thresholds be imposed across the board at one time. The FCC should take into consideration the technical limitations of specific frequencies and the ability of companies operating in those frequencies to bear the costs of the change.

thus be carefully orchestrated by the FCC rather than waiting for the change to abruptly occur on its own when problems arise. The FCC, in fulfilling its mandate, must provide the proper spur and direction to the industry. The coordination of numerous stakeholders in the transition of analog television signals to digital, after all, was successful and so will be this transition in the wireless spectrum arena.

We believe that the FCC can provide the requisite spur to the industry if it (1) sets a harm claim threshold that is sufficiently strict yet reasonable, (2) ensures that the harm claim threshold has no ambiguity so that stepping over the threshold can clearly be proven through a simple, and cost-effective test, (3) provides a deadline after which it will enforce the harm claim threshold, (4) monitors industry change and helps coordinate the change necessary, and (5) constantly reaffirms that it will not back down from enforcing its interference limits policy. This kind of careful planning, monitoring, and strict enforcement will allow the necessary change to occur without the FCC mandating receiver standards directly.

Are there specific frequency bands or services that would particularly benefit from this approach or where implementation is straightforward and would be appropriate for a trial?

A trial of a specific frequency band will not provide sufficient data to learn about how to properly set receiver standards across the board. No single frequency is representative of the others. Creating a test city, similar to what was recommended by the President's Council of Advisors on Science and Technology, would be a more advisable approach. By utilizing this recommendation, the FCC could see first-hand the types of technologies that commercial providers can employ for more efficiently using the wireless spectrum. Such a test city will provide valuable, real-world data on how close the various signals can be located for effective

operation, thus allowing the FCC to set realistic interference limits and making future link budget computation easier.

Would proactive attention to establishing interference limits create more certainty in the marketplace for spectrum (re)allocations?

As discussed above, interference limits alone would do nothing to create change. Without other measures to force the market into improving receiver systems and transmitter systems, the market will be even less certain about how strictly the interference limits will be enforced. In the long-term interference limits will create certainty, but only after the market has reached equilibrium. The FCC must be careful in how it shifts the market from the current inefficient equilibrium to the more efficient one that is guided by interference limits. The real challenge lies not only in properly defining interference limits, but also in ensuring a smooth transition process.

The TAC white paper makes note that an interference limits policy approach may not be appropriate in all cases. Are there other policy approaches that should be considered?

Interference limits for receivers will work in most, if not all cases. The difficulty remains in defining where that limit should be. The definitions must vary across different uses and frequencies because of various factors that would impede a transition, such as technical limitations of technology for operating in that frequency and the ability of operators in the frequency to bear the costs of a transition. One particularly important service that cannot be compromised is that of wireless devices used to protect the health and safety of the public. Care should be taken when setting interference limits for those devices to ensure that groups responsible for health and safety can meet the interference goals without cutting back on essential services that benefit the public.

Are the incentives in the TAC white paper recommendations for improving receiver robustness to interference sufficient?

No. As discussed above, the FCC must issue what is effectively a strict mandate to abide by certain standards by a certain date. Voluntary receiver standards, without any coordination among constituents, will provide no benefit. A harm claim threshold, but only when implemented alongside other measures to encourage change, will be sufficient and avoid reliance on a potentially ultra vires policy that mandates receiver standards directly.

Are there other incentives not mentioned in the TAC white paper recommendations that should be considered?

Yes. The easiest way to achieve the goals of an efficient spectrum allocation is to focus holistically on the entire receiver, transmitter, and antenna system. Receiver standards alone will not provide sufficient benefits. For mobile devices, as an example, current antenna technology is being contorted and pushed to the limits of what physics will allow. With the consumer's need for smaller devices, conventional antennas cannot be further shrunk while still providing the necessary bandwidth. Without a focus on improving the antenna itself, receiver standards will seem to be ineffective because the real bottleneck is the antenna.

For a receiver to achieve maximum selectivity, its frequency response must follow the shape of the spectrum of the received signal. Ideally, the receiver will accept all the signal components of its corresponding transmitter while ignoring interference from other transmitters. Practically, doing so is incredibly difficult due to the constantly changing shape when different information is transmitted. Our internal research has shown that using an antenna tuned to the specific frequency, especially when the antenna itself also acts as a narrow band-pass filter, is the best way to achieve maximum tolerance of interference at very low costs.

Furthermore, in many instances the receiver system is already dealing with noise as well as modern technology and physics will allow. In such cases, the FCC should focus on suppressing spurious emissions from the transmitters themselves. The importance of the antenna really stands out in this respect, because the antenna can act as a selective filter or band-pass filter on both sides of the data link. On the transmitter side, the antenna can reduce interference to the receiver by not generating unwanted emissions in the first place.

Any harm claim threshold should be created with the understanding that great improvement can be achieved by focusing on the entire system of transmitters, receivers, and antennas. Focusing only on the receivers will lead to a harm claim threshold that is not strict enough to provide the necessary benefits over many years.

Should the Commission consider circumstances unique to each service, such as the diversity of devices available, the cost of replacement devices, typical replacement times, or sophistication of users that may impact the practicality, necessity, or sufficiency of such an approach?

Yes. Ignoring the unique circumstances would at best slow the transition process, and at worst irreparably damage certain industries. The Commission must look at all the factors to determine exactly where to draw the line for the harm claim threshold and how much time to give before a drop-dead date for outdated devices. Without knowing the limitations of each constituent, the Commission may end up pushing too hard for something that is not achievable.

How should the technological evolution of components and receiver design influence the timeframe and evolution of interference limits? In light of these issues, are there other alternatives, or other options within an interference limits policy approach, that should be considered for further analysis and/or small-scale pilot tests? What are the cost and benefit tradeoffs of these alternatives?

Technological evolution has progressed immensely in recent years, although the industry is slow to adopt these improvements due to the lack of benefit for the first mover, as described above. Cognitive radios, software-defined radios, and frequency agile radios are examples of

technologies that have shown tremendous promise but have yet to be fully implemented. The FCC should encourage the participation of both small and large companies that are pioneering developments in these fields because implementing these revolutionary technologies is the only way to provide a solution that will endure for many years to come.

Technologies currently exist to provide a lasting solution for efficient utilization of the wireless spectrum, but it is up to the FCC to set proper goals so that manufacturers fully realize the potential of these technologies and wireless users coordinate an effective use of the spectrum.

III. RESPONSES TO QUESTIONS OF THE COMMISSION – RECEIVER STANDARDS

As a general response to all of the Commission's questions regarding receiver standards, Genesys provides the following comments:

In setting harm claim thresholds, the Commission must be cognizant of the importance of both antenna design and receiver design. While innovations in antenna design have been long overlooked, new antenna technologies exist which would allow for greater receiver sensitivity and selectivity due to the antenna's ability to reject unwanted signals. The antenna design can act as a filter and improve receiver selectivity. The TAC White Paper concentrates strongly on unwanted signal rejection performed in the receiver circuitry, but entirely avoids the real possibility of performing the same task more efficiently and more economically by using well designed antennas.

An RF amplifier, being a non-linear device, produces some side effects. The passage of the signal through a nonlinear element generates harmonics. When harmonics coincide with the

frequency of the signal source, those harmonics mask out the intended signal and lead to a loss of received information. Another problem arises when a strong signal overloads the input stage, thus blocking, or at least reducing the sensitivity of, the RF receiver. Receivers using directional antennas are superior in that they can ignore unwanted signals, but the drawback is that they must be directed toward the transmitting antenna. On the other hand, a resonant antenna will perform a similar rejection of unwanted signals before the amplification stage and will also decrease signal attenuations by simplifying filter circuitry. Every situation requires a unique antenna. Focusing on new antenna technologies will reduce the need for costly improvements to the receiver itself. Without focusing on antenna design, the cost of achieving the FCC's desired performance goals will be unbearable for the market. Any harm claim threshold or receiver standard should consider antenna design and how it can be used in conjunction with a receiver to create the desired performance goals.

IV. RESPONSES TO SPECIFIC QUESTIONS OF THE COMMISSION – MULTI-STAKEHOLDER ORGANIZATIONS

What frequency bands would be most appropriate for considering the formation of a multi-stakeholder organization ("MSO") to develop technical parameters and methods for implementing interference limits policy?

Developing technical parameters for an interference limits policy opens the door to more than just a narrow discussion of where signals can be brought closer together to create more bandwidth. A MSO allows experts in the field to discuss the efficient allocation of the entire spectrum, even those portions currently not being used due to technological limitations. The problem the country is facing with limited spectrum resources can only be solved with a solution that incorporates many disciplines of knowledge in the field and combines them in a unified and

comprehensive way. The MSO will discuss how to utilize every portion of the spectrum in the most efficient way possible. That being said, all frequency bands, 0-500 kHz, 82-88 MHz, 156-162 MHz, 216-222 MHz, 450-512 MHz, 902-928 MHz, 2.4-2.45 GHz, 3.5-3.75 GHz, should be opened to discussion. White Space is a large portion of the spectrum, and it can be effectively used and provide great amounts of data bandwidth if properly allocated with appropriate interference limits.

Are there more effective methods of organizing a diverse group of stakeholders for developing such technical parameters?

The MSO should be comprised of representatives from all stakeholders, not just the largest ones. There are many tradeoffs in the precise definition of interference limits and all interested parties should have an opportunity to provide insights to ensure a fair and equitable policy.

What is the best way to initiate the formation of a multi-stakeholder group?

Participation from the general public should be encouraged via mediums of publication that do not merely attract large companies that may have an interest in maintaining the status quo. Experts in every subfield of radio communication should participate to ensure that the solution reached truly does consider the full extent and capabilities of modern technology. We recommend following an organizational model such as the National Defense Industrial Association (NDIA) or other appropriate civilian organization. Issue an industry wide call for a conference or group of conferences across the nation to discuss the initial kick-off of discussions, selections of industry leaders, and definition of areas of study required.

Should the FCC and NTIA perform band assessments to determine where possible future repurposing in a band might impact adjacent bands and develop plans and processes to ensure proper protections?

Yes. The goal of this policy is not merely to formulate a nearsighted solution, but rather to formulate a solution that paves the way for the future. To the extent that we can anticipate and provide proper safeguards for future technologies, we should do so before further change becomes prohibitively costly.

V. RESPONSES TO SPECIFIC QUESTIONS OF THE COMMISSION – ROLE OF THE F.C.C.

We seek general comment on whether and how the Commission should implement a policy that incentivizes improved interference tolerance of wireless systems. Specifically, should the FCC adopt a policy of employing interference limits in certain cases of neighboring bands and services?

The FCC should adopt a policy of employing interference limits, but interference limits do not alone create the necessary policy incentives. To have a strong policy incentive effect, the interference limits must be realistic, forward thinking, and strictly enforced. The limits must be realistic because failure of the majority of companies to meet those limits by a certain date will force the FCC into providing waivers to the limits or pushing back the deadline for compliance. Both options would improperly penalize the companies that did comply.

The interference limits must be sufficiently forward thinking and be grounded in the most novel technology so that companies will be assured that these interference limits will not be tightened again in the near future. No company wants to invest significant amounts of money if it cannot make a reasonable return on the investment. Finally, the FCC must not leave any hint of ambiguity in the specifically defined interference limits. There must be a realistic threat of guaranteed consequences for any manufacturer that does not abide by these limits after a certain

date. If there is ambiguity in the interpretation of the rules or in the enforcement of the rules, a non-compliant company with a strong market position will make a too-big-to-fail argument to the FCC and nullify the effectiveness of the policy.

Should the FCC adopt specific rules for establishing interference limits that are recommended by one or more multi-stakeholder groups?

Yes. Without a clear definition of how to determine whether a certain transmission is within its interference limit, the policy incentives of the limits themselves will fail. The definition must also be relatively inexpensive to enforce otherwise larger companies with a greater ability to bear the costs will win most arguments by default.

Should the FCC develop a compliance model similar to the one used in the context of CALEA, in which there is industry-led establishment of standards and solutions and the Commission would get involved only via special petition?

It is certainly better to let industry experts establish the proper standards by consensus, but there still must be a single body to enforce those standards.

We envision that the FCC could be a facilitator in a nondirective role with convening stakeholders. Also, the GAO recommends consideration of small-scale pilot tests of options for improving receiver performance. What should be the scope of an appropriate pilot test?

The FCC should do more than facilitate, it should be proactive in ensuring that the multi-stakeholder organization is making serious efforts at setting the proper harm claim thresholds. The FCC need not set a direction for the stakeholders, but it must ensure that progress is being made. Periodic reports and presentations to the FCC will ensure progress is on schedule. The FCC should approve the near-term, intermediate and long-term milestones set by industry. The milestones must be objectively measurable.

A small scale pilot test is also the proper way to move forward. The pilot test should be open to considering: solutions in the white space spectrum, implementation of Automatic Link

Establishment (ALE) technology based on MIL-STD-188-141 to increase the HF usability for data communications and video transmission, conversion of the spectrum in the 1755 – 1850 MHz bands for commercial use, implementation of a nationwide and interoperable wireless broadband network for our first responders, improvement of the reliability of the GPS system, and utilization of portions of the spectrum in the guard bands.

An additional approach that the pilot test will assist in fleshing out is the possibility of allocating the spectrum with more fluidity by using multi-frequency receivers with ultra-wideband coverage. Our internal tests of prototypes show great promise for a cognitive radio with multi-band parallel processing that can efficiently utilize portions of the spectrum currently unused. This "frequency harvesting" approach processes a large portion of the wireless spectrum; finds portions not being used; assembles those portions together in one wide, virtual band; and uses the band as needed. When new devices need a portion of the bandwidth, they split the bandwidth available in real time and continue to efficiently use the entirety of the bandwidth. Such a system would allow for the fluid allocation of resources in the most efficient way possible, reduce investment expense, and decrease implementation time.

The solution described above is just one option that should be considered in conjunction with determining interference limits. There are many other possibilities and the role of the MSO and the pilot test should be to expedite the process of determining which approach will be most practical and forward looking.

What role should the FCC play in encouraging and initiating industry action?

The FCC should encourage innovation and allow methods of testing technologies, such as in a test city for spectrum innovation. However, the FCC must make it absolutely clear that harm

claim thresholds will be enforced and that those who readily accept the new standards will benefit, while the foot-draggers will be left behind.

VI. GENERAL COMMENTS

We would like to emphasize once more the importance of the antenna design in any solution to more efficiently allocating spectrum bandwidth. The standard approach in radio receiver circuit design has not given serious attention to the antenna design, but has instead focused on processing the signal after it is received by the antenna. The effect of antenna noise on the system noise is poorly understood or ignored when the new systems are implemented.

Several sources of noise can affect a receiver. Thermal noise is present in all electronic devices, including the transmission media. Thermal noise is a function of temperature and cannot be avoided. That noise is frequency independent and affects the spectral efficiency. Other sources of noise, such as intermodulation, cross talk, and impulse noise are manageable.

While a properly constructed antenna produced from good conductive materials is important for minimizing thermal noise for the receiver, the antenna will still pick up noise from all objects lying in the antenna's field of view. The noise surrounding the antenna cannot always be predicted or controlled, but the antenna's response to that noise is the key to minimizing interference.

For example, the Genesys Engineering Team has been working on a slot-loop antenna designed for the HF-VHF band (A band) that allows for transmitting and receiving over a large range of the low frequency band while maintaining a small antenna profile. The small size of the antenna and ALE technology can significantly extend the HF usability for data communications

and video transmission. A Similar principle can be extended to cover higher frequencies. The developments that we have been able to achieve show the feasibility for implementing many of the concepts discussed above. Basing spectrum policy on the principles of new technological flexibility is critical in achieving the main goal of spectrum management and providing sufficient access to all.

We are confident that all stakeholders in the industry are interested in making better use of the wireless spectrum by properly mitigating interference. The solution can only be reached by working cooperatively and implementing the best technologies from all companies. The FCC's interference limits policy should be grounded in both existing technology and the technological advances that cooperation can bring forward.

Respectfully Submitted,

/s/ Victor Shtatnov

Victor Shtatnov
President, Genesys Limited
One Oxford Valley, Suite 850,
Langhorne, PA 19047, USA
1-267-491-5375
genesys.ltd@comcast.net