Authors: Rick Gould (Aerovironment), Roy LaRosa & YC Lee (Stratocomm)

CONTRIBUTION TO WAC IWG-2:
RATIONALE FOR THE PROPOSED CHANGES TO THE PRELIMINARY VIEW (PV) OF THE UNITED STATES REGARDING WRC-2011 AGENDA ITEM 1.20 (HAPS)
Respectfully submitted by Rick Gould on behalf of Aerovironment, Inc. and Roy LaRosa and YC Lee, on behalf of Stratocomm Corporation, February 11, 2009

WRC-2011 Agenda Item 1.20 and the Current Preliminary View (PV)

In its Resolution 734, the WRC-07, invited the ITU-R "to extend sharing studies [for HAPS] in bands already allocated to the fixed service…" Agenda Item 1.20 of WRC-2011 requires that conference "To consider the results of ITU-R studies and spectrum identification for HAPS Gateway links in the range between 5850 -7075 MHz," a band also allocated to several services.

The PV adopted on August 29, 2008 by the State Department's National Committee for the IRAC-R [for the specific purpose of submission to CITEL] concluded with the following statement:

> The identification of any spectrum for HAPS in the 6 GHz band should not *constrain…*any application of the services [in that band and adjacent bands]."

The Proposed Change

The most important change we propose to the PV of the United States on Agenda Item 1.20 (attached) would amend the last sentence in the existing PV to read:

> The identification of any spectrum for HAPS in the 6 GHz band should *insure the protection of existing services* in the range 5850-7075 MHz and in adjacent bands.

Rationale

This proposed change to the PV is the exact wording in Resolution 734 as agreed by all countries including the US at the WRC-2007.

The problem with the current PV is the word "constrain," which in the Radio Regulations is the antithesis of "to share"[1]. Webster's New Collegiate Dictionary defines "constraint" as "to confine," "to hold back" "to bring into narrow compass." Those senses are carried over into the Radio Regulations as a term of art. Typically, the word constrain appears in the Regulations as limitations on a radiocommunication service, e.g. "The use of band X by service Y shall not impose constraints on service Z" or "Service A shall not constrain the development and use of services B and C in band D."

[1] To "constrain" one service in a band used by other services is tantamount to saying "you can use the spectrum as long as we are not using it and you don't interfere with our use now or in the future "

Conversely, “ensuring protection of existing services” – the precise phrase used in Resolution 734 – has specific meaning in the Radio Regulations, implying protection of co-Primary services sharing a band. In such a regime, all services are protected by such procedures such as Advance Publication and Coordination. First-come, first-served is the general rule, but accommodation – changes to system parameters that would still allow one system to achieve its desired performance while reducing interference to others users of the band – is commonly done. The result is more efficient use of orbit and spectrum.

Co-Primary systems in all services which have access to a band can expand, extend and develop -- but they cannot do so at the expense of previously existing, Notified systems in any of the other Primary services. For example, ever since the EARC of 1965, the Fixed-satellite service has been making extensive, shared use of many bands previously allocated only to the terrestrial, fixed service. Reasonable restrictions on the technical parameters of systems in both services have made world-wide sharing feasible.

Resolution 734 calls for “studies of sharing,” not for exclusive preemption of the spectrum, which would make HAPS a Secondary service, before those studies have been completed. (A Secondary service is one which may neither cause interference to others, nor claim of protection from interference from others, regardless when those others began using the band.)

Sharing studies as envisioned by Resolution 734 are underway, but without waiting for results of those studies, the United States through use of the word “constrain” – has effectively made the premature decision that sharing is not possible -- before any studies have been completed -- and before those studies have described the levels of interference that might be caused -- and before those studies have described the ameliorating steps that could be taken to reduce any possible interference to acceptable levels.

HAPS need for Gateway Link spectrum

Gateway links are essential to connecting HAPS systems with terrestrial based networks for voice, data and video communications and to connect HAPS systems with the PSTN, with cell-phone providers, with world-wide providers of broadband communications and with television and sound broadcasters, that is, primarily for backhaul-type connectivity and not directly for end-user service links.

There are two reasons why additional spectrum in the 6 GHz band needs to be identified for HAPS gateway links.

One reason is the need to retain a limited spectrum identification for connecting user terminals with HAPS platforms, as in the case with the 47.2 – 47.5 and 47.9 – 48.2 GHz bands.

Without the identification of an additional 2 x 80 MHz spectrum in the 6 GHz band, for gateway links, those two, 300 MHz-wide, bands must be used *both* for two-way links between platform and user terminals *and* for two-way links between platforms and gateway stations. That means that the capacity of a HAPS system to serve user terminals would be reduced by about 25%, since 2 x 80 MHz of its limited spectrum would have to be diverted to provide gateway links.

A second reason for the identification of additional spectrum for gateway links is when the spectrum for user-terminal/platform links is not authorized for use as gateway links, as in the case of HAPS platforms serving as base stations for IMT, as permitted by Resolution 221. The S-band frequencies identified in that Resolution are to be used exclusively for transmissions between the HAPS platform base station and the cellular telephone users: They cannot be used for the gateway links that would be necessary to connect those calls to the PSTN and for INTERNET access.

Furthermore, the only other spectrum identified for use by HAPS that could be used for gateway links is the 47 and 49 GHz bands. But those bands are severely affected by high-rain-rates and would be unusable or impractical in tropical, humid parts of the world. However, the 6 GHz band now under consideration for gateway links would be quite suitable in such areas and would therefore be helpful in expanding cell phone and other service coverage to parts of the world with such climates that also have poor telecommunications infrastructure.

In both of these cases, in our view, the regulatory status (I.e. Primary or Secondary, etc.) must be the same as that of the platform/user terminal links.

If that was not the case, and systems of other services having allocations in the band identified for gateway links were allowed to expand without restrictions into the same geographic areas in which gateway stations were already operating, there would be interference between HAPS and those other, new, intruding systems.

Spectrum in the 47.2 - 47.5 GHz and 47.9- 48.2 GHz bands has been identified for use by HAPS since WRC-2000. HAPS are essentially co-Primary with other services in this and other bands. That means that the principle of “first-come, first served” applies and, with it, the procedures for Advance Notice (API) and Request for Coordination (AP4).

If HAPS gateways were required to cease operation to eliminate the interference, the entire HAPS system would be cut off from interconnection with the rest of the world. With that prospect, it is extremely unlikely that investors and operators would ever implement any HAPS systems.

Evolution of the Current Preliminary View

The PV started with Resolution 734 (WRC-07) which resolved simply:

> to invite the ITU-R to extend sharing studies, with a view to identifying two channels of 80 MHz each for gateway links for HAPS in the range from

> 5850 to 7075 MHz, in bands already allocated to the fixed service, *while ensuring the protection of existing services [emphasis supplied].*

The Draft PV of the Radio Conference Subcommittee (RCS) [of the IRAC, the Committee within NTIA/Department of Commerce representing government users of the radio frequency spectrum] adopted on August 7, 2008 added a phrase about adjacent bands. It stated:

> Identification of any spectrum for HAPS in the 6 GHz band should insure protection of all services in the 5850-7075 MHz band, *as well as in adjacent bands [emphasis supplied].*

What accounts for the addition of reference to adjacent bands? It is our understanding that the addition by the RCS of the phrase about adjacent bands was over a concern that emissions from government high-power radars in lower adjacent bands could cause interference to HAPS Platforms or Gateway stations.

We believe that if radars comply with the existing Radio Regulations on out-of-band emissions in conjunction with a small guard band between 5850 MHz and the lowest frequency of any spectrum identified for HAPS gateway stations, there would be no unacceptable interference to HAPS.

However, in adopting the current PV, the State Department's National Committee for the ITAC-R went a step further so that it concluded with the following statement:

> The identification of any spectrum for HAPS in the 6 GHz *band should not constrain the use of the 5850-7075 MHz band or the adjacent bands by any application of the services to which they are allocated.*

That change in wording from "protection of all services" to "should not constrain the use…[of the band] by any(!) application of the services to which they are allocated" would open the door to the unrestricted expansion of other systems into areas being served by HAPS gateway stations. That would be totally unfair and unreasonable and would be detrimental to a HAPS operator and could destroy its business.

View of other governments and international bodies

Consider the action relating to the US PV on HAPS taken by International ITU-R Working Party 5C at its November, 2008 meeting. The US contribution, Document USWP 5C/129, "Interference analysis modeling…", was an extensive, detailed, technical document that analyzed sharing between HAPS and other services in the prospective band. At its beginning, this contribution quoted Resolution 734 which called for "ensuring the protection of existing services." But it then added the following contradictory text:

> "...without unduly constraining the future operations and expansion of FSS, FS and other services."

That text clearly implies a different regulatory regime than the one used for co-Primary services (Advance Publication, Coordination, and first-come, first-served).

The International ITU-R Working Party in Geneva in November 2008 deleted that statement, retained all of the document's technical contents and restored the precise language of Resolution 734. It also added the following text:

> "Resolution 734, *recognizing h*) also indicates a potential limit on future deployment of existing services which must be taken into account when examining sharing studies [emphasis added]."

The current views of European Conference of Post and Telecommunications (CEPT) are also representative of international opinion on this issue. As noted in Document WAC/002(13.01.09) with regard to Agenda Item 1.20, the CEPT states that it "agreed to support extended studies, with the aim of ensuring adequate protection of existing services including conventional fixed service stations.

The Asia Pacific Telecommunication Union (APT), long a supporter of HAPS initiatives, can also be expected to oppose any such "without constraining" language. . APT was the initiator of the first Regional proposal leading to the need for gateway links and extension of the former Resolution 734 calling for certain sharing studies above 3GHz

Feasibility of Sharing

This proposal is not the place to prove decisively that sharing is feasible and practical. But it is a place to provide a likely scenario that indicates that it appears that the studies could potentially show that sharing would be feasible and practical with appropriate limitations and restrictions on system technical parameters.

Consider the following interference paths that could exist, based on the current International frequency allocations:

The 775 MHz band from 5850 – 6700 MHz,
(The FSS is allocated only in the EARTH-TO-SPACE (UP) DIRECTION
and the following interference paths could exist between HAPS and the FSS:

HAPS spectrum for Gateway links also in the UP direction
Interference path 1: From HAPS gateway transmitter to FSS space station receiver
Interference path 2: From FSS earth station transmitter to HAPS platform receiver.

With HAPS spectrum for Gateway links in the DOWN direction
Interference path 3: From HAPS platform transmitter to FSS space station receiver;
Interference path 4: From FSS earth station transmitter to HAPS gateway receiver.

The 375 MHz band, 6700- 7075 MHz,

Authors: Rick Gould (Aerovironment), Roy LaRosa & YC Lee (Stratocomm)

The FSS is allocated in both the EARTH-TO-SPACE (UP) and SPACE-TO-EARTH (DOWN) DIRECTIONS, And the following interference paths could exist between HAPS and the FSS:

For FSS in the EARTH-TO-SPACE (UP) direction, same situations as above, interference paths: 1, 2, 3 and 4:

For FSS in the SPACE-TO-EARTH (DOWN) direction, with Gateway links in the UP direction:
Interference path 5: from HAPS gateway transmitter to FSS earth station receiver and
Interference path 6: from FSS space station transmitter to HAPS platform receiver;

For FSS in the DOWN direction, with Gateway links also in the DOWN direction:
Interference path 7: from HAPS platform transmitter to FSS earth station receiver and
Interference path 8: from FSS space station transmitter to HAPS gateway receiver.

Finally, amending the International Radio Regulations to identifying a band for HAPS gateway links does not mean that all of these interference paths will necessarily be created. Note that Administrations can choose which services will be allocated within their own territories, as well as whether any frequencies identified for HAPS in the Radio Regulations may be used there, subject, of course, to the condition that services protected by the International RRs must be protected at the border and in space.)

Interference reduction techniques

Interference path 1 can be mitigated by siting the Gateway station so that its main beam does not point at a specific FSS space station, and that its sidelobes are reduced in compliance with a standard to be adopted. Aggregate interference from all HAPS gateway stations within line-of-site of an FSS Space station must be considered.

Interference path 2 can be mitigated by orienting the FSS Earth station so that its main beam does not point at the HAPS platform, that its sidelobes are reduced in compliance with a standard to be adopted and that it takes advantage of natural and artificial site shielding.

Interference path 3 can be mitigated by requiring the sidelobe performance of the HAPS platform antennas to confirm with a standard to be adopted. Aggregate interference from all HAPS platforms within line-of-sight to an FSS Earth station must be considered.

Interference path 4 can be mitigated by siting an FSS Earth station sufficiently far from a Gateway station (receiver), by reducing its antenna sidelobes in the direction of the Gateway station and by taking advantage of natural and artificial site shielding..

Interference paths 5-8 also need to be analyzed since the upper segment of the band, 6700-7075 MHz is also under consideration for use as HAPS gateway links.

Who are the proponents, or developers, of HAPS systems and technology?

There are at least five US companies developing HAPS systems and flight hardware. Several other companies around the world are also developing and promoting HAPS technology.

Aerovironment, Inc.

The author of this contribution and Roger Leclair participate on behalf of Aerovironment in IWG-1 (UAS), IWG-2 (HAPS), USWP 5B (UAS) and USWP 5C (HAPS). Aerovironment, Inc. developed several unmanned, solar-powered aircraft, one of which, Helios, set an altitude record for an airplane in sustained, level flight of over 96,000 feet. Helios also demonstrated its capability to act as a HAPS platform high above a metropolitan area to act as a: cell phone base station; a High-Definition television broadcasting station; and as a provider of two-way broadband communications – all of those services to an unmodified, stock, cell phone or to user terminals equipped with a 12-inch dish.

Aerovironment, a major manufacturer of unmanned aircraft, is also the developer of "Global Observer," an unmanned, hydrogen-powered airplane that could provide not only the wide variety of telecommunications services listed above, but could provide a multiplicity of functions for state, local and the national government and commercial services, from a high-altitude, loitering aerial platform: optical relay and sensing (crime surveillance, traffic information and control, natural disaster information, etc. etc.) and chemical sensing at all altitudes up to seventy or eighty thousand feet, etc.

StratoComm Corporation

StratoComm is a US based company that designs, builds, deploys and operates HAPS based systems for worldwide applications using stratospheric airships as the platform. StratoComm is a world leader and innovator in stratospheric airship and payload design and technology and is developing solutions for numerous customers around the globe. Their current focus is primarily in developing countries for underserved areas and populations. StratoComm's Roy LaRosa and Dr. Y.C. Lee were the principal authors of our contributions to the international WP5C meeting described above: "5C/4, Interference Modeling for HAPS Sharing" (which became Annex 9 to the Chairman's Report) and 5C/27 "Technical and Operational Characteristics of HAPS Gateway Links' (which became Annex 10 to the Chairman's Report).

StratoComm is now engaged in the implementation of a pre-HAPS transitional system, which is intended to provide multi-mode wireless communications to a large part of Cameroon in Africa.

"**Other High-Altitude Aircraft Programs in the US"**
"The descriptions of the following programs have been excerpted from Internet websites solely to indicate current technology developments that may be used in HAPS applications and do not necessarily imply endorsement of or agreement with any other sections of this contribution."

Lockheed Martin

The Lockheed Martin High Altitude Airship (HAA™), an un-tethered, unmanned lighter-than-air vehicle, will operate above the jet stream in a geostationary position to deliver persistent station keeping as a surveillance platform, telecommunications relay, or a weather observer. The HAA also provides the Warfighter affordable, ever-present Intelligence, Surveillance and Reconnaissance and rapid communications connectivity over the entire battle space. The technology is available now and ready for integration and flight test.

This updated concept of a proven technology takes lighter-than-air vehicles into a realm that gives users capabilities on par with satellites at a fraction of the cost (1 to 2 orders of magnitude less). The HAA will also integrate reconfigurable, multi-mission payload suites. HAA is significantly less costly to deploy and operate and other airborne platforms, and supports critical missions for defense, homeland security, and other civil applications. Its operational persistence eliminates the need for in-theater logistic support. In position, an airship would survey a 600-mile diameter area and millions of cubic miles of airspace.

In April 2008, the HAA program transferred from the Missile Defense Agency to the U.S. Army Space and Missile Defense Command (USASMDC), located at Huntsville, AL. The USASMDC is continuing the development and demonstration of the HAA to align with the USASMDC mission. USASMDC is the Army specified proponent for space, high altitude, ground-based midcourse defense and serves as the Army operational integrator for global missile defense; and conducts mission-related research and development. USASMDC conducts space and missile defense operations and provides planning, integration, control and coordination of Army forces and capabilities in support of U.S. Strategic Command.

Boeing, Lockheed Martin and Aurora Flight Services

The “Vulture” a hydrogen-powered high-altitude long-life (five-year) aircraft is being developed under a DARPA contract with Boeing, Lockheed Martin and Aurora Flight Services.

Non-US Companies and Organizations

Other companies active in the development of HAPS systems include Swiss-based Stratxx (with Swiss, German and other participants) and the Russian-based Astelcom, which is in charge of the Russian Ministry Program for development and operation of a HAP network. Siemens, one of the participants in that program, is developing the telecommunications equipment for deployment and operation of wireless broadband networks such as WiMAX (wireless DSL) and UMTS (mobile 3rd generation) and has received authorization for operation in the 1910-1980 and 2110-2170 MHz bands. Japan

and South Korea also have extensive HAPS development programs and the latter two have large research institutions devoted to HAPS technology and system implementation. Sky Station Australia has also a service and potential regional launch program.

HAPS work continues in the HAPCOS group of organizations coordinated by the University of York in the United Kingdom in a program previously funded by the European Union and involving academic and research institutions in several European countries.

Additional interest in HAPS elsewhere in the world was evidenced at WRC-07 by the several countries who added their names to the RRs relating to the use of the 27 and 31 GHz bands by HAPS in Regions 1 and 3 (5.537A and 5.543A: Bhutan, Cameroon, Korea (Rep. of), India, Indonesia, Iran (Islamic Republic of), Japan, Kazakhstan, Lesotho, Malaysia, Maldives, Mongolia, Myanmar, Uzbekistan, Pakistan, the Philippines, Kyrgyzstan, the Dem. People's Rep. of Korea, Sri Lanka, Thailand and Viet Nam. Russia and the CIS (now RCC) have been there since WRC03.

REFERENCES

Lockheed Martin HAA: www.lockheedmartin.com/products/HighAltitudeAirship/Index.htm

Vulture: www.aurora.aero/downloads/communications/pdf/apr_199.pdf

Vulture: www.the register.co.uk/2007/10/25/ink_storm_for_hydrogen_strato_bot_runner.up

Vulture: www. aviationnews.eu/?p=1832

Vulture: www.darpa.mil/TTO/solicit/BAA07-51/VULTURE_BAA_FINAL.pdf