

**Hearing of the House Committee on Science, Space, and Technology
Subcommittee on Environment**

“NOAA Utilization of Commercial Remote Sensing Data”

Wednesday, May 20, 2015 - 10:00 AM - RHOB 2318

**Testimony of Dr. Scott Pace
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Thank you, Mr. Chairman, for providing an opportunity to discuss the important topic of weather data policies and the challenges facing NOAA in the utilization of commercial remote sensing data.

From 1990 to 1993, I was a civil servant in the U.S. Department of Commerce, working in the Office of Space Commerce in the Office of the Deputy Secretary. I believe the Office continues to have an important role to play in promoting the growth of U.S. commercial space activity and I was glad to see the support from this Committee in its approval of H.R. 2263, the Office of Space Commerce Act.

While at Commerce, I had the privilege of working on Title II of the Land Remote Sensing Policy Act with Barry Beringer, the former chief counsel of the House Committee on Science. In the aftermath of the Cold War, Title II reformed the U.S. commercial remote sensing licensing process and removed regulatory barriers to space-based commercial remote sensing. This reform was successful beyond our somewhat modest expectations, leading to a more dynamic, information-driven global industry.

The idea of buying data from commercial sources for the needs of NOAA is not a new one. While at Commerce, we had debates over whether NOAA should explore the purchase of wind profile information and perhaps be an “anchor tenant” for newly emerging firms. We did not pursue this course as NOAA’s limited budget was already committed to existing programs with well-known requirements. Funds were not available for experiments; even ones that offered long-term cost savings.

While at Commerce, we worked with the National Space Council on policy guidelines to encourage the growth of commercial space activities. We recognized the many different roles the government might play, not only as a customer and anchor tenant, but also as a regulator and support of R&D that was too risky for the private sector. Years later at NASA, these ideas of using government supports and purchasing power to leverage private sector innovation were put into practice in the commercial cargo program for the International Space Station.

Today, NOAA is facing both opportunities and challenges in taking advantage of an increasingly sophisticated, innovative commercial remote sensing industry to meet its mission needs. Industry capabilities are greater than ever before, but so are the budget pressures and expectations placed on NOAA to meet the nation's needs for weather forecasts and warnings.

Global Trends

Access to space-based information capabilities and technologies is virtually ubiquitous, and access to space launch services is nearly so. The past decade has witnessed an increasing number of mostly American entrepreneurial firms seeking non-traditional markets. The growth of Big Data and location-based services applications has created significant new demand for geospatial data. The fusion of data from multiple sources will allow motivated nations, multinational companies, and even small groups or individuals to improve their access to previously unavailable information that can have potential strategic implications.

Private capital and sovereign wealth funds are reshaping international space markets. The amount of investment funds available from major U.S. information technology firms is such that they can acquire almost any space-based information technology they may require. Along with capital sources, international models of satellite ownership are changing. Countries are increasingly able to satisfy their space data and communications requirements through services from satellites they do not own.

The significance of private funding and development of new capabilities is coupled with the reality of globalization. Not only are modern space capabilities becoming ubiquitous but private funding also means that new and unexpected capabilities may be developed elsewhere in the world. To date, it has been to the advantage of the United States that innovative space activities have been concentrated in U.S. companies. This advantage is predicated on a timely and responsive domestic regulatory process and favorable economic conditions, but these cannot be assumed to be a given.

Unfortunately, the U.S. Government is adapting too slowly to these changes to mitigate harm to an industrial base more suited to the unique but increasingly expensive and slow government approach in areas such as space launch and space platform architectures. At the same time, the U.S. Government is not effectively positioned to leverage the potential opportunities and benefits from these trends.

Commercial Remote Sensing Regulation

I am currently a member of the NOAA Advisory Committee on Commercial Remote Sensing (ACCRES). Our committee has noted these global trends and in particular, the increasing promise of small satellite constellations and unmanned air vehicles to provide innovative services. The world of commercial remote sensing today is very

different from that of January 1993 when the Department of Commerce issued the first high-resolution (three-meter) license for a commercial electro-optical satellite. Commercial data sources are of great important to meeting the needs of the National Geo-spatial Intelligence Agency but they cannot replace the capabilities of the National Reconnaissance Office. Similarly, commercial data sources are unlikely to replace the GOES and POES satellites used by NOAA. Private firms can, in particular cases, complement government capabilities in ways that lower the overall cost and risk of meeting the agency's mission.

Securing benefits from private data sources is not easy. In particular it requires both a shift in the agency's mindset and appropriate resources for implementation, both financial and human capital. ACCRES summarized its concerns in a February 2015 letter to the Secretary of Commerce, and I would like to highlight a few key points that apply to NOAA's weather data needs as well as to U.S. government policy toward commercial remote sensing more generally.

On government regulation in a changing world:

In order to maintain leadership and U.S. strength in this area, the Committee believes that a fundamental rethinking about satellite remote sensing – and especially commercial remote sensing – is necessary as the driver of the U.S. government's approach to policy and regulation. Agencies continue to think about remote sensing as a traditional aerospace technology when, in fact, it is increasingly an information technology, requiring a different regulatory philosophy and regulatory actions.

Increasingly, U.S. firms are shifting from the traditional business model of selling images to one of conveying information from satellite imagery combined with a number of sources. Agencies also continue to harbor a view that space-based assets should be considered differently from a wide range of emerging sensors – such as drones – within a rapidly changing geospatial ecosystem. While historically understandable, this perspective is increasingly obsolete.

We submit that U.S. government stakeholders must tailor policy and regulations to reflect the fact that remote sensing is no longer a U.S.-only, exclusively satellite-based effort, but is instead a global information technology that relies on a wide range of platforms.

On NOAA resources for commercial remote sensing licensing:

The Committee recognizes NOAA's daily efforts to perform a wide range of regulatory functions on behalf of the Department, especially with respect to licensing, license follow-up actions, compliance monitoring and enforcement. One of the most important challenges, as with most technologies, is that effective regulation is often slowed down by outdated law, policy, regulatory requirements or

practice, thereby hindering the effective application of limited agency resources from the areas most needed or of greatest risk.

The Committee finds NOAA's resources to be inadequate to the tasks that it has to perform in support of U.S. interests. There has also been an explosion in the numbers of foreign and domestic ground stations for NOAA/NESDIS to inspect – which it is required to do each year by law – with an estimated 100 sites in over 20 countries expected by FY 2016. A corresponding increase in foreign agreements is expected to be required in the coming years.

Herein lies an important paradox: we have a U.S. policy that directs us to lead, yet because of restrictive thinking, U.S. firms are unable to exploit our own technology to directly compete with foreign competitors. The Committee believes that NOAA needs a new approach to receive, process, and respond quickly to its constituents, given this astonishingly fast-paced remote sensing environment.

We also believe that NOAA and the Department have the authorities to create relief from impractical regulatory enforcement actions, such as the need to visit ground stations. Today, a smart phone or tablet could effectively function as a ground station; and thus as a practical matter, NOAA should be allowed to shift the enforcement and inspection missions to a verification and complaint-driven inspection system to better manage compliance risks.

The Commercial Remote Sensing Act of 2015 (H.R. 2261) is a constructive step in addressing the challenges faced by NOAA in meeting its regulatory responsibilities. The agency needs to both streamline its processes and receive additional resources to meet a growing workload. NOAA also needs the active cooperation of other agencies, notably the Departments of State and Defense, in more quickly adjudicating license applications. Delays and uncertainties in licensing new technical capabilities are impeding the ability of U.S. firms to innovate and puts them at risk of following, not leading, global competitors.

NOAA is facing important risks in commercial remote sensing other than a lack of regulatory resources. The United States has been a leader in openly sharing environmental data from civil scientific satellites with researchers worldwide. This practice is also followed by many countries, but not as widely as the scientific community would like. Access to international environmental data sets for climate change research is uneven with some countries hoping to monetize the data in a commercial-like manner. Some forms of public-private partnerships, created in response to domestic budget constraints, also encourage restrictions that constrain scientific research in an effort to gain revenue.

If the government needs certain kinds of data, an independent and objective “build versus buy” analysis can help decide whether it should own and operate its own system or buy the data from an outside supplier. In some cases, the rights to access and distribute privately owned data for scientific research might simply need to be

purchased. The government has no right to free access to other forms of private intellectual property even for purposes of scientific research. On the other hand, as the experience with Landsat showed, efforts to sell many kinds of space-derived data may make no economic sense. Free distribution of data can result in greater public and private benefits if users are not initially deterred by prices, even low ones. The promotion of commercial remote sensing is sometimes seen as being in competition with the open exchange of scientific data, as defined by the data sharing principles of the Group on Earth Observations. This need not be the case and a “one size fits all” policy should be avoided that either infringes on private property rights or encourages governments to act like for-profit firms.

Another source of risk, affecting public and private remote sensing alike, is radiofrequency interference. In particular, the commercial demand for spectrum to support terrestrial mobile broadband services has increased pressures on many bands used for space services and scientific applications. The problem is particularly acute in the 1-3 GHz range. GPS radio occultation measurements use receivers with very wide front-ends to acquire weak signals. Accurate measurements would be impaired if high-powered communications networks were to be deployed in the bands adjacent to GPS. Protection of radio spectrum is a foundational requirement for ensuring the utility of GPS and Earth exploration satellite services (EESS) used by NOAA and NASA. A recent study by The Aerospace Corporation shows potential interference to the Emergency Managers Weather Information Network as a result of LTE (Long Term Evolution, a standard for wireless communications) operations in the 1695-1710 MHz band.

Choices for Government Use of Commercial Data

The purchase of data as opposed to ownership of a satellite system means a subtle shift in the role of the agency toward being a consumer of what industry chooses to provide rather than a customer who specifies what is to be provided. For agencies, including NOAA, there are strengths, weaknesses, opportunities, and threats associated with the use of commercial data and public-private partnerships to meet their mission needs. Among the strengths and opportunities are the potential for cost savings, more rapid innovation, and the alignment of private investment with public good needs. Among the weaknesses and threats are a loss of in-house expertise, dependency on private resources for the performance of public missions, and fewer mechanisms for agency control of cost, schedule, and performance.

For policy-makers, a fundamental question is what the respective roles of government and industry should be. If public funds are being expended, then there should be a mission focus on creating a public good. Exactly how those public goods are created can be debated. Private, commercial benefits are a desirable but secondary objective. Purchases of commercial data should be in response to meeting the priorities and requirements of the government.

For policy-makers and industry, a second task is getting the market analysis correct. Privatization is when industry provides goods and services previously provided by governments. Commercialization is a more difficult task in that industry has to serve private demand in addition to government demand. Meeting private market demand with competing private providers using private capital at risk is the essence of commercialization. It can be difficult to assess the size of addressable markets for new data products and judge the amount of capital required to come to market. Yet doing so is a necessity in deciding whether a commercial data buys are viable and sustainable.

For agency leaders, they need to conduct their own analyses of alternatives in how to best meet their mission requirements. In deciding whether to “make” data with their own system or to “buy” data from others, NOAA needs to decide how to allocate risks between what it provides and what it expects others to provide, to assess the regret costs if a private provider fails to perform as expected, and what fallback options exist. Most critically, NOAA needs to gain and retain in-house expertise to ensure due diligence and oversight of public funds, whether used for traditional acquisitions, public-private partnerships, or commercial purchases.

Finally, policy-makers and agency leaders need to decide how to balance a diverse set of national interests in commercial remote sensing. Through an enlightened regulatory regime, the promotion of space commerce can be done in ways that also advance U.S. national security and international leadership. Similarly, through enlightened partnerships with the private sector, public goods in scientific research, weather forecasting, and environmental stewardship can be gained at less cost and with greater innovation. In doing so, the United States can be a model and shaper of international practices as space capabilities become more global and diverse.

Conclusions

Given the critical importance of NOAA’s weather satellite programs, the first priority should be the on-time implementation of the current GOES and POES programs. These are unique platforms that will not be soon replaced by commercial providers.

Second, NOAA should foster the creation of private sector options to meet its needs, much as NGA has done in working with U.S. industry to meet national security needs. In acquiring commercial data, NOAA should ensure that it gets sufficient rights so that data sets can be shared for scientific, non-commercial purposes. It should ensure that it has sufficient insight into how the data were generated so that scientific peer review can independently assess conclusions based on those data.

There should be procurement “on-ramps” to enable experimentation and large-scale innovation in parallel with current government systems and international partnerships. In its own self-interest, NOAA should be open to alternatives as industry develops. It will be more risky to pursue only traditional acquisitions

without a mixed portfolio that includes non-traditional and commercial procurements.

In cooperation with the space industry, NOAA should be a strong domestic and international advocate of preventing interference to the radio spectrum upon which it relies. This particularly includes the Meteorological Aids Service (MetAids) used by radiosondes, the Earth Exploration Satellite Service (EESS) used for remote sensing, and the Radionavigation Satellite Service (RNSS) used by GPS. Spectrum protection is and will continue to be challenging due to commercial demands for more spectrum.

Finally, NOAA can and should be a leader in fostering the competitiveness of the U.S. commercial remote sensing industry through its regulatory role. It also can and should be a leader in promoting scientific cooperation and data sharing in accordance with the international data sharing principles of the Group on Earth Observations. NOAA is at the center of a rapidly changing global environment in which it can leverage private sector capabilities to meet public needs. In order to succeed, NOAA needs to proactively shape the rules and practices of this environment and not merely respond to it.

Thank you for your attention. I would be happy to answer any questions you might have.

Attachment A – Letter from ACCRES to the Secretary of Commerce

February 2015

Memorandum to: The Secretary of Commerce
Administrator, NOAA
Assistant Administrator for Satellites and Information Services, NOAA

From: Advisory Committee on Commercial Remote Sensing (ACCRES)

Subject: Perspectives and Outlook on U.S. Commercial Remote Sensing

The purpose of this memorandum is to convey the Committee’s perspectives and outlook on U.S. commercial remote sensing, consistent with our charter under the Federal Advisory Committee Act (5 U.S.C. 5). It also details the Committee’s projected work plans, with NOAA’s endorsement. The ideas offered here are for your general consideration; most importantly, a number of them pertain to expected U.S. national security decision meetings that you will be invited to participate in over the next few months.

In sum, we are concerned that a combination of factors puts U.S. leadership in commercial remote sensing at risk. We have not yet adapted our mindset to the shift of these capabilities from an aerospace technology to an information technology, and how that should affect policy and regulation. We are also concerned that the deep national security legacy often creates an imbalanced view of the wide range of impacts created by commercial remote sensing, which also undermines U.S. policy goals.

BACKGROUND AND CONTEXT

The world of satellite remote sensing is changing dynamically, with important consequences for U.S. commercial, foreign policy and national security interests. U.S. policy needs to be able to respond quickly to such change, lest there be unintended consequences for these interests. NOAA bears important licensing, compliance monitoring, enforcement and other regulatory responsibilities on behalf of the U.S. government, as well as coordination of inputs provided by other U.S. government agencies. NOAA also plays an important role in helping shape national policy related to commercial remote sensing, and by extension on global developments.

ACCRES is chartered to provide information, advice and recommendations to the Under Secretary of Commerce for Oceans and Atmosphere on matters related to the U.S. commercial remote sensing space industry, and on NOAA’s activities to carry out the responsibilities of the Department of Commerce set forth in the National and Commercial Space Programs Act of 2010 (51 U.S.C. 60101 *et seq.*). The perspectives shared here are based on our decades of broad and deep experience with remote sensing issues that include detailed study of global remote sensing markets, involvement in a wide range of national security activities, and commercial industry practice.

In many ways, the United States has achieved the bold bipartisan vision laid out for leadership in commercialization of remote sensing satellites since the 1970s and reasserted in national space policy in 1994 (PDD-23) and again in 2003 (NSPD-27). While current national policy affirms U.S. intent to lead in this area, that goal is often undermined by a failure to fully implement policy guidance, due to agency mindsets and actions. These drag heavily on U.S. interests in a dynamically changing global satellite remote sensing market and an expanding global geospatial ecosystem that includes terrestrial, airborne and space components.

It is the view of this Committee that a combination of internal NOAA issues, external U.S. national security perspectives and a variety of other issues have put U.S. leadership in commercial remote sensing at risk. We detail some of those issues here, along with some ideas on how to bring agency actions into better compliance with national policy directions.

CHANGING OUR MINDSET

The United States has an extraordinary legacy in the use of satellite remote sensing for military and intelligence purposes, and increasingly for civil, environmental and commercial purposes. The nation's use of satellite remote sensing for security, public safety and scientific purposes remains unparalleled today. However, this great accomplishment is sometimes overshadowed by concerns over how information generated by remote sensing satellites is used by others. While countries like Canada, France, Israel and Japan have well-established satellite capabilities, countries like Azerbaijan, Egypt and Vietnam are taking advantage of fast-moving satellite technology and processing developments to become new entrants in the market. A country no longer needs its own domestic space industry to have access to world-class space-based information capabilities. Emerging space powers represent sources of technology, learning, business models and innovation that challenge U.S. interests.

In order to maintain leadership and U.S. strength in this area, the Committee believes that a fundamental rethinking about satellite remote sensing –and especially commercial remote sensing –is necessary as the driver of the U.S. government's approach to policy and regulation. Agencies continue to think about remote sensing as a traditional aerospace technology when, in fact, it is increasingly an information technology, requiring a different regulatory philosophy and regulatory actions. Increasingly, U.S. firms are shifting from the traditional business model of selling images to one of conveying information from satellite imagery combined with a number of sources. Agencies also continue to harbor a view that space-based assets should be considered differently from a wide range of emerging sensors – such as drones – within a rapidly changing geospatial ecosystem. While historically understandable, this perspective is increasingly obsolete. We submit that U.S. government stakeholders must tailor policy and regulations to reflect the fact that remote sensing is no longer a U.S.-only, exclusively satellite-based effort, but is instead a global information technology that relies on a wide range of platforms.

INTERNAL NOAA ISSUES

The Committee recognizes NOAA's daily efforts to perform a wide range of regulatory functions on behalf of the Department, especially with respect to licensing, license follow-up actions, compliance monitoring and enforcement. One of the most important challenges, as with most technologies, is that effective regulation is often slowed down by outdated law, policy, regulatory requirements or practice, thereby hindering the effective application of limited agency resources from the areas most needed or of greatest risk.

The Committee finds NOAA's resources to be inadequate to the tasks that it has to perform in support of U.S interests. Over 40 licenses have been issued in the five years since FY 2010, as compared to 26 between FY 1996 – 2010. There has also been an explosion in the numbers of foreign and domestic ground stations for NOAA/NESDIS to inspect – which it is required to do each year by law – with an estimated 100 sites in over 20 countries expected by FY 2016. A corresponding increase in foreign agreements is expected to be required in the coming years.

Technical and business model innovations by current and prospective U.S. licensees push the regulatory envelope: developments involving smaller satellites, new sensor types (e.g., video, hyperspectral) and U.S. satellite companies participating on foreign platforms or in foreign constellations require careful consideration from a regulatory perspective. Herein lies an important paradox: we have a U.S. policy that directs us to lead, yet because of restrictive thinking, U.S. firms are unable to exploit our own technology to directly compete with foreign competitors. The Committee believes that NOAA needs a new approach to receive, process, and respond quickly to its constituents, given this astonishingly fast-paced remote sensing environment.

We also believe that NOAA and the Department have the authorities to create relief from impractical regulatory enforcement actions, such as the need to visit ground stations. Today, a smart phone or tablet could effectively function as a ground station; and thus as a practical matter, NOAA should be allowed to shift the enforcement and inspection missions to a verification and complaint-driven inspection system to better manage compliance risks.

WORK OF THE NOAA INTELLIGENCE TASK GROUP

Last month, NOAA created an Intelligence Task Group to consider the classified viewpoints of the Department of State, the Department of Defense and the Intelligence Community. This Task Group was given only a very short period of time to interact with NOAA and other U.S. government colleagues. Yet this discussion is vitally important, both to the Committee's efforts as well as to the broader U.S. government conversation that must take place, as soon as possible. Security considerations have added both time and complexity to NOAA's regulatory requirements, as noted above.

The work of the Task Group is classified, so we can only share general observations here. The Committee is very concerned that the security perspectives on U.S. commercial remote sensing remain locked in an anachronistic and outdated mindset, especially with regard to

attempts to limit collection or commercial sale of imagery data (known also as “shutter control” or more recently as “modified operations”).

Current security assessments, in the opinion of the Task Group, do not reflect an objective understanding of the uniqueness of U.S. commercial satellite imagery in supporting a variety of missions. U.S. capabilities are looked at overwhelmingly through the lens of how they are aiding our adversaries in achieving their aims. The assessments tend to amplify potential threats to U.S. security interests from commercial satellite imagery while downplaying the benefits of them, such as in their role supporting humanitarian operations, providing shareable information to diplomatic and military allies, or as sources of innovation. Assessments also frequently neglect to mention the many other ways in which an adversary can gain information even if U.S. systems are restricted, such as from foreign commercial satellites, or even how U.S. security aims might be reached without restrictions. They also fail to recognize the decades of trust, in practice, between U.S. industry and the U.S. government on security matters. Most importantly, they tend to value short-term, parochial considerations over longer-term, strategic interests of the United States. In short, the current approach is creating greater risks for the United States than is necessary or desirable.

Further, these assessments often fail to recognize the real world blending of many other technologies that are, in effect, creating both spatial and temporal transparency. Many advanced capabilities such as GPS, data from cell phones, UAVs, social media and others are being merged with U.S. and foreign commercial satellite imagery in geographic information systems in order to create extremely sophisticated and high value information. Consequently, treating commercial satellite imagery as though it were the only means of gathering information is ineffective in managing national security risk. Ultimately, the Committee is concerned that our failure to take a holistic view of these capabilities could create conditions that damage U.S. industry and U.S. security at the same time.

The Task Group’s discussions with government officials about “modified operations” reflected an improved government understanding of the impact of such actions and the absolute need to limit the area and the time of such actions, consistent with a compelling national security case. Here the bar is set appropriately high: requests for such modified operations must be requested by the Secretary of State or the Secretary of Defense and made by the Secretary of Commerce. The Committee has offered to review specifically a set of criteria from the Department of Defense to U.S. combatant commands for initiation of modified operations. We strongly encourage the U.S. government to fully train and exercise around these ideas to understand the practical effects and outcomes.

But other ideas that the Task Group has heard – such as the creation of non-image/non-commercial sale “blackout” lists and technical downgrading of imagery – fail to recognize the significant economic and non-economic costs of regulation in a very competitive global environment. Finally, any regulatory action that looks like extensive “prior restraint” (more technically described as a “preempted commercial transaction”) will likely require new legislative authority that inevitably would be challenged in court.

MOVING AHEAD

The Committee would be pleased to engage you and your staff on additional details not conveyed in this memorandum. Given the ACCRES meetings held to date, and the broad experience and perspective we bring, we can serve as a resource for the Department and others on the future of U.S. commercial remote sensing issues. We have asked NOAA to lay out a schedule for future meetings so that the Committee can organize our workload, including the role of public input within the spirit of the Federal Advisory Committee Act.

Consistent with the ACCRES Charter and the support of NOAA, the Committee proposes a number of short follow-on papers for your consideration:

-- **Why and How to Regulate?** We recognize that regulation exists to ensure compliance with U.S. law as well as foreign policy and national security objectives. Given the rapid shift away from an aerospace model to an information model, and given the reality of imagery as information, what are the purposes and parameters of regulation of commercial remote sensing companies? How can we reevaluate regulation of commercial remote sensing satellites to avoid unintended harm to U.S. foreign policy, national security, and economic interests? What areas beyond frequency allocation and orbital management require regulation, and why?

-- **NOAA internal review:** We wish to continue to help NOAA streamline their own internal licensing, license follow-up, compliance monitoring and enforcement activities, consistent with existing authorities. We do believe that NOAA has a number of existing authorities to do this. We also believe that there may be ways to facilitate licensing actions by creating templates for existing and new capabilities, such as the establishment of “safe harbor” provisions to protect past decisions.

--**Review of other U.S. government activities, including NSPD-27 review:** NOAA has requested that the Committee provide input on other U.S. government efforts regarding commercial remote sensing, including the proposed National Security Council review.

Points of contact: NOAA/NESDIS at NOAA and Chair, ACCRES.

Scott Pace

Dr. Scott Pace is the Director of the Space Policy Institute and a Professor of the Practice of International Affairs at George Washington University's Elliott School of International Affairs. He is also a member of the faculty of the Trachtenberg School of Public Policy and Public Administration. His research interests include civil, commercial, and national security space policy, and the management of technical innovation. From 2005-2008, he served as the Associate Administrator for Program Analysis and Evaluation at NASA.

Prior to NASA, Dr. Pace was the Assistant Director for Space and Aeronautics in the White House Office of Science and Technology Policy (OSTP). From 1993-2000, Dr. Pace worked for the RAND Corporation's Science and Technology Policy Institute (STPI). From 1990 to 1993, Dr. Pace served as the Deputy Director and Acting Director of the Office of Space Commerce, in the Office of the Deputy Secretary of the Department of Commerce. He received a Bachelor of Science degree in Physics from Harvey Mudd College in 1980; Masters degrees in Aeronautics & Astronautics and Technology & Policy from the Massachusetts Institute of Technology in 1982; and a Doctorate in Policy Analysis from the RAND Graduate School in 1989.

Dr. Pace received the NASA Outstanding Leadership Medal in 2008, the US Department of State's Group Superior Honor Award, *GPS Interagency Team*, in 2005, and the NASA Group Achievement Award, *Columbia Accident Rapid Reaction Team*, in 2004. He has been a member of the US Delegation to the World Radiocommunication Conferences in 1997, 2000, 2003, and 2007. He was also a member of the US Delegation to the Asia-Pacific Economic Cooperation Telecommunications Working Group, 1997-2000. More recently, he has served as a member of the U.S. Delegation to the UN Committee on the Peaceful Uses of Outer Space in 2009, and 2011-15. Dr. Pace has been a member of the NOAA Advisory Committee on Commercial Remote Sensing (ACCRES) since 2012. Dr. Pace is a former member of the Board of Trustees, Universities Space Research Association, a Member of the International Academy of Astronautics, an Associate Fellow of the American Institute of Aeronautics and Astronautics, and a member of the Board of Governors of the National Space Society.