National Aeronautics and Space Administration

Technology & Innovation Committee of the NASA Advisory Council

Ames Research Center
Moffett Field, CA

August 2, 2011

MEETING MINUTES

G. M. Green, Executive Secretary

Dr. William Ballhaus, Chair

Technology and Innovation Committee
Ames Research Center
Moffett Field, CA
August 2, 2011

MEETING MINUTES
TABLE OF CONTENTS

Meeting Report prepared by
David J. Frankel, consultant
Zantech/ P B Frankel, LLC

Tuesday, August 2, 2011

Opening Remarks (FACA Session)

The NASA Advisory Council (NAC) Technology and Innovation (T&I) Committee meeting was convened by Mr. G. M. (Mike) Green, Executive Secretary. A brief safety briefing was provided. Mr. Green announced that the meeting was a Federal Advisory Committee Act (FACA) meeting open to the public. The Committee meeting will be followed by a plenary NAC meeting and reception for all the NAC's committees. Committee members were reminded to submit comments on the minutes from the last Committee meeting.

Opening Remarks and Thoughts

Mr. Green introduced Ms. Esther Dyson, Chair. Ms. Dyson welcomed everyone to the meeting and reviewed the agenda. The Committee will be looking in depth at NASA's intellectual property (IP) portfolio.

Office of Chief Technologist Update

Mr. Green introduced Dr. Michael Gazarik, Deputy Chief Technologist, Office of Chief Technologist (OCT), who participated telephonically. Dr. Gazarik reviewed the ten space technology programs in the OCT and described which ones were fully funded and which ones were only engaging in planning activities. Dr. William F. Ballhaus, Jr. noted that there are key industrial base issues and advised that synergism could be developed between NASA and the Air Force at Kirkland Air Force Base for the Flight Opportunities (FO) program. Flights in the FO program will be suborbital and would be flown fairly frequently, compared to orbital frequencies. Dr. Susan X. Ying recommended that the major milestones in the FO program be identified on OCT's key roadmaps. Dr. Gazarik reviewed charts on Space Technology Grand Challenges, the Technical Area Breakdown Structure, and Investments in Technology. Ms. Dyson expressed an interest in receiving more information on accomplishments, rather than plans. Mr. Green noted that this has been delayed, in part, because OCT has been waiting to receive roadmap recommendations from the National Research Council (NRC). Dr. Ballhaus asserted that the NASA process is one that should be informed by the NRC.

Dr. Gazarik described how several vendors are looking at multiple suborbital flights per day. He discussed NASA's approved Operating Plan for FY2011. Space Technology is funded at $350 million and is transitioning from formulation to implementation. Awards have been announced or are soon to be announced for several Space Technology Programs, including NASA Innovative Advanced Concepts (NIAC), Space Technology Research Fellowships (STRF), Game Changing Development (GCD), Technology Demonstration Missions (TDM), and FO. Charts were reviewed on several FY2011 projects, including Deep Space Optical Communications, a Low Density Supersonic Decelerator, Hypersonic Inflatable Aerodynamic Decelerators, Satellite Servicing, and Human-Robotic Systems. The latest solicitation information and relevant notices are posted on OCT's website (http://www.NASA.gov/offices/OCT/home/solicitations.html). Eighty-one Space Technology

Graduate Fellowships were announced for the Fall 2011 semester. A chart on the proposed FY2012 budget for Space Technology was reviewed. At $1,024 million, it represents approximately five percent of the President's $18.7 billion request for NASA. It includes $310 million for Exploration Technology Development and Demonstration activities that have been moved from the Exploration Systems Mission Directorate. Charts showing FY11 and FY12 funding for OCT projects, by technical area, were discussed.

Ms. Dyson thanked Dr. Gazarik for his presentation.

Update and Discussion of NASA Technology Transfer and Intellectual Property (IP) Activities

Mr. Green introduced Ms. Courtney B. Graham, Associated General Counsel, Commercial and IP, NASA Office of General Counsel. Ms. Graham described the development of NASA's IP policy. Recommendations made in 1993 during the Clinton Administration included technology transfer training for all employees, partnerships with industry, improved metrics to measure technology transfer performance, infusing technology into the private sector through mission objectives and grant proposal evaluation, requiring technology transfer plans in NASA contracts, and amending NASA's Vision-Mission-Values document to state that technology transfer is a major mission objective. In 2004, NASA's technology transfer efforts were defunded and replaced by an approach called the "Enterprise Engine," which refocused the Agency's partnership efforts on developing technologies with specific applications to NASA's mission needs. This coincided with the Bush Administration's implementation of the Vision for Space Exploration. In 1984, the Bayh-Dole Act was enacted and required that NASA ceased taking title to patents developed by NASA-funded contractors. This has significantly reduced the inventory available for NASA's patent licensing portfolio.

Ms. Graham noted that small business disclosures are nine to one over large business disclosures, and that there appears to be a compliance problem with large contractors. Charts were presented on the number of NASA licenses and NASA patents that have been issued. In 1999, 47 licenses were issued, compared to eight licenses issued in 2008. From 1990-95, 736 patents were issued, compared to 374 patents in 2005-09. She explained that NASA spends 80-90 percent of its funds on contractors, has 18,000 civil servants, of whom 60 percent or 10,000 are engineers, and that the majority of those engineers are engaged in managing the contracts. The National Academy of Public Administration released a report in November 2004, finding that the issues of technology and technology transfer are multinational, that small businesses are an increasing source of innovation for new technology, and that disagreement among Congress, NASA, and the Office Of Management and Budget (OMB) has created significant uncertainty throughout NASA's technology transfer network. The report also found that organizations in the technology transfer network operate at the margins of the Agency's overall operations, lack executive support, and are likely to be at odds with each other. The report recommended, among other things, a strong leadership commitment to technology transfer and relocating the Innovative Partnership Program Office to the Administrator's Office to provide Agency-wide accountability.

Dr. Ying recommended using the recently established technology funding allocations as a basis for making strategy decisions on protecting NASA's patent portfolio. Ms. Graham agreed with the concept. She discussed charts illustrating budget allocations among the various federal agencies for research and development. It was noted that the President's Office of Science and Technology Policy, in 2009, issued a Strategy for American Innovation, which did not include NASA as an element of the strategy. Ms. Graham explained that due to external changes, NASA will likely never regain the level of technology contributions it made during the Apollo program, and that the Agency is still suffering from cuts to the technology transfer program made in FY 2004.

Mr. Green introduced Mr. Douglas Comstock, Director, Innovative Partnerships Office, OCT. Mr. Comstock briefed the Committee on NASA's IP policy. He presented several charts showing the statutes that have been enacted on this subject since 1958. The National Aeronautics and Space Act is the original mandate for NASA to transfer valuable technology to benefit U.S. industry. Federal agencies that operate or direct federal laboratories must have a formal technology transfer program. The Bayh-Dole Act permits small entities to retain title to inventions developed under federal funding agreements. Small entities that retain title must commercialize the invention and grant the government a license. NASA Policy Directives, Procedural Requirements, and Strategic Goals for technology transfer and licensing were reviewed.

In response to a question from Mr. Gordon Eichhorst, Mr. Comstock explained that NASA does not have resources to monitor how NASA technology is used outside the U.S.. NASA patent applications have been decreasing over the last few years. The ability to do something with a patent is limited by resources. OCT manages NASA's intellectual property through the Innovative Partnerships Office at NASA Headquarters and at each NASA Center. Charts were reviewed on new technology reporting, patent application filings, patents issued, new licenses executed, and income from licensing activity. A Request for Proposal will be released next year for no-cost intellectual property marketing and brokerage services. A Licensing Best Practices Group has been formed. A Lean Six Sigma Kaizen on NASA Intellectual Property Management is planned for September. Its goals include sharing best practices and building consistency, streamlining processes, and increasing the number of patents and licenses. Mr. Gordon observed that NASA is not receiving all the technology that it is paying for, and that the leakage must be addressed. Dr. Ying counseled that it is important to have a strategy and to use judgment in determining which technologies should be protected through patents.

Ms. Dyson thanked Ms. Graham and Mr. Comstock for their presentations.

Commercialization and IP in Industry

Ms. Dyson introduced Mr. Henry Tirri, Senior Vice President, Nokia, Inc. Mr. Tirri is Nokia's Chief Technology Officer and leads Nokia's Research Laboratories, which has 13 sites around the world. He explained that he would not be presenting any slides or written materials in order to avoid the need to obtain legal department approval for his presentation. Nokia faces a dilemma similar to NASA's: how to balance the need to conduct research with the need to identify assets that are valuable to the company. Protecting software is rather new. Today, even usage patterns are getting patented. It is important to create a culture where people understand that there are areas where IP research is valuable and areas where it does not make sense. Some patents may be fundamental and become huge, while others become essentially useless. That must be accepted in a patent portfolio. Judgments have to be made and that comes with a cost. Filing for patents and maintaining them is expensive for Nokia because it markets in over 200 countries. Revenues from patents are five to ten times the cost.

Mr. Tirri discussed the researcher's role in the disclosure and patent process. People need to be motivated and, therefore, all the high-tech companies use build-in incentives. They are part of the employee's scorecard. When a patent proves to be important in litigation, or some other aspect, the employee receives additional money. Lab directors are given targets for patent filings. He observed that NASA's numbers for patents look very tiny. Dr. Ballhaus asserted that Nokia's IP management is driven by the fact that it is in a very competitive business. Mr. Tirri explained that patenting becomes very sporadic without an incentive system. Money is a good motivating factor; another factor is pride from producing a patent. Nokia tries to do technology transfer and to license it out in a way that gives access to subsequently developed technology without any charges. Nokia has a business development strategy: you find technology; you try to get it to the business development units; if it is not usable in the foreseeable future, you actively look for external partners. Research organizations cannot be limited to just research; you need to include people who look for business opportunities. There is always going to be a "pipeline" for IP research because it takes ten years or more for it to mature. He has to look at the areas in which Nokia is investing and be in alignment with the company's strategy. At Nokia, IP research is owned by the legal department; they have targets and they handle the negotiations.

Mr. Tirri recommended that NASA look to CERN, the European organization for nuclear research, for a model. It is government funded and more complex than NASA because it is international. It has a technology transfer office that acts as a liaison to disseminate new technology. It has 8,000 researchers; some just care about the science, while others are interested in spinning off small companies. He reemphasized that NASA's numbers seem "super small." Processes are not enough; a culture must be created where people value protecting and developing IP. You have to help the people understand that the investment requires protection. Many people have a passion to make an impact, and do not value the system. Mr. Tirri explained that a high PhD percentage and publication serves two purposes. First, it provides an external quality measure. Second, it is a ticket for collaboration. Universities do not want to collaborate with people who do not publish; publishing is how they know that someone has the requisite skills. The competition for good researchers is high; if you do something that is limiting, it will be very destructive to the organization's ability to recruit and retain employees. The IP research protection process implementation can have a negative effect. Everyone understands the need for the process; if the processes kill time, however, that generates great concern.

Internationally, IP research protections are becoming more critical. Generally, Europe is a huge regulatory issue area. North America is more litigious, and the Far East is the largest consumer market, where regulatory issues become the showstopper. Growth economies will need technologies that are not as important in North America. That can be a missed opportunity if it is not taken into account. Dr. Ballhaus opined that the researcher's incentive is to develop a reputation, which is embellished when the researcher's technology is used elsewhere. Mr. Tirri explained that the times have changed and that in academia today, most universities have licensing offices.

Ms. Dyson thanked Mr. Tirri for sharing his time and his insights.

JPL: Patents, Technology Transfer and IP

Ms. Dyson introduced Dr. Ken Wolfenbarger, Manager, NASA Jet Propulsion Laboratory (JPL) Innovative Technology Transfer Partnerships Office. Dr. Wolfenbarger described how JPL was founded. He presented a chart showing the seventeen spacecraft and nine space instruments that JPL has developed for deployment across and beyond the solar system. California Institute of Technology (Caltech) operates JPL for NASA. Under the Bayh-Dole act, Caltech has the right of first refusal to patent new technology developed at JPL. One quarter of the income from those patents goes to the innovators. Funding for JPL comes from NASA. All patent activity at JPL, however, is supported by Caltech's office of General Counsel. Ms. Graham explained that JPL is treated as a NASA Center and Caltech is treated as a NASA contractor. A chart describing the technology transfer process was reviewed. There are six components to the process: invent, disclose, assess, protect, make known, and transfer. A chart providing historical data on equity sales and royalties was presented.

Dr. Wolfenbarger discussed the functions performed by his office. The office is located on campus and works with the innovators to help them get technology out the door. The innovator is an important customer, and he wants to encourage them to come to his office. He explained that the provisional patent disclosure process is used to protect inventions, without incurring the expense involved in filing for a patent, while prospects for commercialization are investigated. Patent attorneys are retained based on their subject matter expertise. This creates additional value for the patent and leads to stronger patent claims. Strong enforcement sends a signal out to the marketplace that Caltech is serious about its IP investment. Licensing agents have full authority to make deals and can close on a deal in a single day; this helps get inventions into the marketplace. Deal making was formerly done by the legal staff. The most revenue comes from equity in startups using venture capital funding. He asserted that this is one policy change that would make a significant difference at NASA. The best mode for success is to allow the innovator to be a participant in the startup company. Charts were presented showing how JPL's patent production and licensing revenues compare with other entities. Slides were shown on JPL startup collaborations and successfully transferred technology innovations.

Ms. Dyson thanked Dr. Wolfenbarger for his presentation.

Optical Communications Project Update

Ms. Dyson introduced Mr. William Farr, Manager, Optical Communication Technology Program, NASA JPL. He explained that optical communications are important because they allow up to 100 times increased deep space data returns over present radio frequency (RF) communications. This means an increased science data return. It will enable better imaging resolutions for astrophysics and Earth science, and a "tele-presence" that uses live high definition video. He described the basic telecommunications tenet: in a well-designed system, the data rate is proportional to received power. Thus, the same data rate at 10 times a specified distance requires either 100 times the receiving antenna's area, 100 times more transmitted power, or a transmitted beam that is 10 times narrower. The advantage in optical communications arises because beam width equals wave length divided by antenna diameter ($\Theta = \lambda/D$).

Different domains, e.g., terrestrial, low Earth orbit (LEO), and deep space, will require different solutions for optical communications. A chart was presented showing the status for developing optical communications for the different domains. NASA is at the forefront for deep space optical technology. Laser communications from an Earth orbit is well-proven and is transitioning to operations. No deep space optical communications has yet been demonstrated and technology advancements in this area are required. Mr. Farr discussed the space propagation range-squared loss formula. He explained that space is defined as 2 million kilometers (km) and that interplanetary distances are much larger. The moon is .4 million km from Earth and Mars is 60 million km at its closest range. Applying the range-squared loss formula, communications from Mars would suffer from a 22,500 times larger signal loss than deep space. A chart showing a potential deep space optical scenario was presented.

Optical communications offer improvements over RF performance in pointing, modulation, and detection. Mr. Farr discussed the key technologies that need to be developed for deep space optical communications. Current mass and power requirements prevent optical communications from being competitive with existing deep space RF telecommunications systems. Charts were presented discussing spacecraft disturbance isolation, a space receiver, a space laser, a ground receiver detector array, technology development goals vs. the state of the art, and a proposed schedule for deep space optical communications technology development. These technologies will provide benefits in optical light science, precision ranging for planetary studies and astrophysics, improved vibration isolation for high resolution cameras, laboratory instruments and nanofabrication, ultimate sensitivity cameras for near-infrared imaging, and single photon detector arrays for semiconductors and superconducting.

Ms. Dyson thanked Mr. Farr for his presentation.

<u>Robotic Satellite Servicing Project Update</u>

Ms. Dyson introduced Mr. Preston Carter, Director, Game-Changing Technology Division, NASA OCT. He briefed the Committee on developments in satellite servicing technology. The first satellite capture, repair, and redeployment mission was the Solar Max Satellite in 1984. The first Hubble repair and servicing mission was in 1993. There are numerous spacecraft at geosynchronous orbit (GEO): over 100 are government-owned and over 360 are commercial communications satellites. Each year, on average, two satellites run into technical difficulties and require disposal, four satellites prematurely exhaust their propellant supply, two satellites are inadvertently placed into incorrect orbits, and 20 satellites reach the end of their designed mission life and are retired. Mr. Preston suggested that significant national security interests could be assisted through satellite servicing. Between 1990 and 2010, 584 unclassified GEO missions were launched globally; 88 of those missions have ended and could have benefited from satellite servicing. Recent NASA activity was discussed. The Robotic Refueling Mission (RRM) was launched on STS-135. NASA is conducting a Manned GEO Servicing (MGS) joint study with the Defense Advanced Research Projects Agency (DARPA). Potential robotic servicing functions include inspection, relocation, deployment failure resolution, refueling, adding components, replacing parts, and other services that extend the life or capabilities for on-orbit assets. NASA is developing strategies for supporting and developing commercially-financed, -developed, -owned and - operated on-orbit robotic servicing capabilities for existing and future spacecraft. NASA is also developing exploration technologies for complex human/robotic servicing, assembly, and missions beyond LEO.

Mr. Carter introduced Dr. Robert Ambrose, Chief, Johnson Space Center (JSC) Software, Robotics and Simulation Division. He discussed the critical technologies for satellite servicing that are identified in the NASA Technology Roadmaps, which are currently under review by the NRC. NASA will collaborate with industry, and other agencies and organizations in developing the critical technologies, and will use the International Space Station (ISS) for technology demonstrations. Mr. Carter noted that NASA is not planning a mission to repair satellites. Rather, NASA intends to help create a domestic commercial industry. Graphs showing the technology development readiness levels and development risks for critical technology were presented. The risks include in-space propulsion, robotic manipulation, rendezvous and docking, sensing and perception, and navigation. The recommended path forward will include providing matured robotic technology for ISS visiting spacecraft, for commercial efforts, for national security, and for Exploration. In response to a question from Ms. Dyson, Dr. Ambrose described the resources and capabilities that could be offered to a commercial partner for satellite servicing. These include six technologies related to satellite servicing, tools to conduct precision repair and replacement activities, special robotic tools for refueling, integration, and test facilities, autonomous rendezvous and capture sensor technology, space cube high-speed computer systems, a robotics front-end system that includes active arms, an approach and rendezvous system, tools to accomplish capture, repair, and replacement tasks, and mission integration and testing at NASA's Goddard Spaceflight Center. Dr. Ambrose noted that robotic technology has produced 45 patents to date and has led to a terrific partnership with General Motors.

Ms. Dyson thanked Mr. Carter and Dr. Ambrose for their presentations.

Discussion and Recommendations (T&I Committee)

Ms. Dyson observed that the Committee is not in a position to present any new Recommendations to the Council. Mr. Eichhorst asserted that the Shuttle program termination is an opportunity to remind people that NASA is at technology's forefront. Mr. Green noted that there has been a call for a national technology policy, and that Dr. Bobby Braun has been laying the basis for it. Dr. Ballhaus asserted that the key is leadership. Dr. James Reuther warned that NASA's top line budget is under heavy pressure and that NASA's priorities are being defined by Congress. He counseled that unless there is a target in the budget reserved for technology, it will be zero. He added that NASA will not be able to bring in the right new people if it does not maintain a technology investment base, and that NASA's age demographic is not going in the right direction. Dr. Ballhaus observed that there is not a defined mission for the human space program. Dr. Alain Rappaport recommended paying more attention to employee recognition, without worrying about revenue. He suggested developing a model for a living document that would be connected to examples for national competitiveness and communicate the value that NASA creates.

Adjournment

Ms. Dyson thanked the Committee Members for their contributions. She thanked Mr. Green and the support staff for their efforts. The meeting was then adjourned.

Appendix A

Agenda

NAC Technology and Innovation Committee Meeting
August 2, 2011
NASA Ames Research Center
Ames Conference Center, Mezzanine Room
Dial in 866-804-6184
PC 6428446

August 2, 2011 -

8:00 a.m.	Welcome and overview of agenda/logistics (FACA Session) Mike Green, Executive Secretary
8:05 a.m.	Opening Remarks and Thoughts Esther Dyson, Chair
8:15 a.m.	Office of Chief Technologist Update Mike Gazarik, NASA Deputy Chief Technologist
9:00 a.m.	Update and Discussion of NASA Technology Transfer and IP activities Courtney Graham, NASA OGC, and Doug Comstock, Office of Chief Technologist
9:45 a.m.	Break
10:00 a.m.	Commercialization and IP in Industry Mr. Henry Tirri, Senior Vice President and Head of the Nokia Research Center
11:00 a.m.	JPL: Patents, Technology Transfer and IP Mr. Ken Wolfenbarger, JPL Commercial Programs
12:00 p.m.	Lunch (On own)
12:45 p.m.	Optical Communications Project Update William Farr, NASA-JPL
1:30 p.m.	Robotic Satellite Servicing Project Update Preston Carter, Director of Game-Changing Technology Division, NASA OCT
2:15 p.m.	Discussion and Recommendations (T&I Committee)
2:45 p.m.	Adjournment
3:00 p.m.	NAC Plenary Session with all 9 Committees and Administrator Ames Auditorium Bldg. N201
4:15 p.m. - 5:30 p.m.	NAC Plenary Reception with Committee Members Building N200 Lobby

Appendix B

NAC COMMITTEE ON TECHNOLOGY AND INNOVATION
Membership
August 2, 2011

Ms. Esther Dyson, Chair	EDventure Holdings
Dr. William (Bill) F. Ballhaus, Jr., Vice-Chair	Consultant
Mr. G.M. (Mike) Green, Executive Secretary	NASA Headquarters
Mr. Gordon Eichhorst	Aperios Partners LLP
Dr. Charles (Matt) Mountain	Space Telescope Science Institute
Dr. Dava Newman	Massachusetts Institute of Technology
Dr. Alain T. Rappaport	Consultant
Dr. Susan X. Ying	The Boeing Company

Appendix C

Technology and Innovation Committee Meeting
Ames Research Center
Moffett Field, CA
August 2, 2011

MEETING ATTENDEES

Committee Members:

Esther Dyson, Chair	EDventure Holdings
William (Bill) Ballhaus, Jr., Vice-Chair	Consultant
G.M. (Mike) Green, Executive Secretary	NASA Headquarters
Gordon Eichhorst	Aperios Partners LLP
Alain Rappaport	Consultant
Susan X. Ying	The Boeing Company

NASA Attendees:

Ambrose, Robert	NASA/JSC
Caglar, Orel	NASA/JPL
Carter, Preston	NASA Headquarters
Comstock, Doug	NASA Headquarters
Farr, William	NASA/JPL
Ford, Ken	NAC
Gazarik, Michael	NASA Headquarters
Graczyk, Indrani	NASA/JPL
Graham, Courtney	NASA Headquarters
Reuther, James	NASA Headquarters
Shafto, Mike	NASA Headquarters
Wolfenbarger, Ken	NASA/JPL

Other Attendees:

Frankel, David	Zantech/ P B Frankel LLC
Tirri, Henry	Nokia

Appendix D

Technology and Innovation Committee Meeting
Ames Research Center
Moffett Field, CA
August 2, 2011

LIST OF PRESENTATION MATERIAL

1) Space Technology Status and Update [Gazarik]
2) Technology Transfer—Bringing Innovation to NASA and the Nation
3) Technology Transfer at NASA [Graham]
4) Intellectual Property Management [Graham, Comstock]
5) Patents and Technology Transfer at JPL [Wolfenbarger]
6) Optical Communications [Farr]
7) Satellite Servicing Technology Development [GCDPO]