VISITING COMMITTEE ON ADVANCED TECHNOLOGY (VCAT or Committee)
MINUTES OF THE OCTOBER 16th and 17th, 2018 MEETING
BOULDER, CO

ATTENDANCE:

Visiting Committee Members Attending
Adler, Allen
Alexander, Jay
Brooks, Rodney
Colwell, Rita
Fischer, George
Garvey, Michael (Mike)
Ishak, Waguih*
Jackson, Dana (Keoki)
Ku, Katharine
Prafullchandra, Hemma*
Sizer, Theodore (Tod)
Vasko, David
Wasserman, Gail

Designated Federal Officer
Shaw, Stephanie

NIST Leadership Board
Boehm, Jason
Brockett, Del
Copan, Walter
Deodhar, Nuthan
Dowell, Marla
Fangmeyer, Robert*
Harary, Howard
Kimball, Kevin
Lin, Eric
Mackey, Elizabeth
Messerly, Clyde
Molnar, Michael
Neumann, Daniel
Olthoff, James
Porch, Susanne
Romine, Charles*
Schiller, Susannah*
Singerman, Phillip
Williams, Carl

NIST Staff
Aksyuk, Vladimir*
Barbosa, Nicholas

NIST Staff Continued
Beall, Kellie*
Bedner, Mary*
Beers, Kate*
Burrus, James
Cooksey, Gregory*
Espinal, Laura
Evans, Heather
Fasolka, Michael
Fitzgerald, Ryan*
Goldstein, Barbara
Grove, Thomas
Hanna, Nancy*
Hardis, Jonathan*
Hickernell, Robert
Ivy, Nahla*
Janezic, Michael
Jeanette, Benjamin
Kauffman, Leah*
Kerney-Willis, Tricia*
Kramer, John*
Kushmerick, James*
LeBrun, Thomas*
Lehman, John
Liepa, Torey
Luce, Emily
Materese, Robin*
Migdall, Alan*
Nadal, Maria*
Nastus, Joseph
Nam, Sae Woo
O'Brian, Thomas
Orr, Dereck
Parkhurst, Emily
Schlatter, Katie
Shaw, Gordan*
Shyam-Sunder, Sivaraj
St. Pierre, James*
Stavis, Samuel*
Strouse, Gregory
Teske, Michael*
Vanek, Anita
Voss, Britta
Wilkinson, Richard*
Witherell, Paul*

NIST Staff Continued
Wright, John*
Zangmeister, Rebecca*
Zielinski, Paul

Others
Ambrose, Mitch – Science Policy Analyst, American Institute of Physics*
Broz, Joseph – Strategy and Applied Sciences Department, SRI International
Powers, Daniel - CO-LABS
Price, Brynmor – University of Colorado Boulder

*Participated Remotely

Tuesday, October 16, 2018

Call to Order - *Dr. Rita Colwell, VCAT Chair*

Dr. Colwell called the meeting to order at 8:30 a.m. and reviewed meeting logistics. Dr. Colwell gave a brief report on neutron research. Dr. Colwell summarized primary focus areas of the meeting that included quantum science, and a continuation of the VCATs study of technology transfer with a specific focus on the NIST-on-A-Chip (NoAC) program. Dr. Colwell turned the meeting over to Dr. Copan.

SESSION I: NIST UPDATE

NIST Update and Agenda Review – *Dr. Walter Copan, Under Secretary of Commerce for Standards and Technology and NIST Director*

Dr. Copan's overview covered a number of issues including an update on organizational and personnel changes since the VCAT last met, a review of the current budget situation, updates on programmatic activities and a preview of NIST's strategic planning efforts. Dr. Copan's full talk can be seen here: https://www.nist.gov/sites/default/files/documents/2018/10/15/1._walter_copan_nist_update_and_agenda_review_v2.pdf

With respect to organizational and personnel changes Dr. Copan updated the VCAT on the merger between the Physical Measurement Laboratory (PML) and Center for Nanoscale Science and Technology (CNST) that was effective as of October 1, 2018. The reorganization incorporates the CNST staff into PML, creating two new divisions and adding 71 employees to PML. The organization will allow for better integration of work relevant to quantum science, advanced sensors, and advanced electronics. The branding and identify of the CNST as a user facility will be maintained after the realignment. Dr. Copan also updated the VCAT on the national search underway for the NIST Associate Director for Laboratory Programs. The search for this position has reached the finalist rounds of candidate interviews and will be coming to a conclusion within the next month. Dr. Copan also introduced NIST's new Chief Safety Officer, Dr. Elizabeth Mackey who brings a strong understanding of NIST's research programs and particular expertise in radiation safety to the position. Dr. Copan provided an update on the current budget situation, noting that NIST is currently dealing with three budgets simultaneously including implementation of current year programs, the status of the FY2019 bills on the hill, and preparations and discussions for the FY 2020 Budget request. Currently NIST is on a continuing resolution which means it is operating at the Fy18 enacted levels of $1.4 billion, until a final negotiated budget is enacted for FY 2019. Both the House and Senate marks for FY 2019 would indicate that funding for NIST would be comparable to that provided in FY 2018 with support for continued renovations of Boulder Building One Wing 5.

Dr. Copan reviewed progress that NIST has made in a number of programmatic areas. Dr. Copan highlighted NIST's important role in the development and implementation of a National Initiative on Quantum Information Science and the work that NIST has done internally to focus the planning of its research programs in this space. Also reviewed were NIST efforts to develop a NIST Privacy framework. Dr. Copan reviewed the release of the Immediate Occupancy Report that defines steps that could be taken by communities in the areas of building design, community needs, and other areas to improve the ability of buildings and communities to remain habitable and functional in the wake of a natural disaster. This effort was part of NIST's work in community resilience which remains a priority for the institution. Dr. Copan updated the VCAT on NIST's efforts around Artificial Intelligence including the steps NIST has taken to provide staff with greater access to tools and training for AI via Coursera, and the installation of a new IBM Power9 computing platform that will support NIST efforts to apply technologies and machine learning and AI solution to metrology. Dr. Copan's remarks also touched on NIST's continuing role in supporting advanced manufacturing, highlighting the recent release of the White House Strategy for American Leadership in Manufacturing, which NIST had a major role in developing, and the work that MEP is doing to strengthen cybersecurity in the Defense supply chain.

Dr. Copan provided a high-level overview of the strategic planning efforts underway at NIST. The plan is aimed at ensuring that NIST is put in the best position to meet the challenges of the future both from a programmatic and organizational perspective. As we look to the future, NIST must be prepared to help the nation adopt to a rapidly evolving technology landscape. Of fundamental importance to NIST is our ability to build programs in and adapt to emerging science and technology areas like artificial intelligence and quantum science, as well as continuing to pursue research that will open new frontiers. Being able to do this will require committed leadership and engagement from the entire NIST community to ensure that we can recruit and retain the best staff, deliver services in the most efficient and effective manner possible, improve our facilities, and build a culture that brings out the best in all our staff. Dr. Copan summarized the efforts that have been undertaken to create a strategic framework for NIST including visiting Baldrige winners to identify best practices that could be applied at NIST; analyzing key societal and technological trends; and conducting a Strength, Weakness, Opportunities, and Threat (SWOT) analysis with different segments of the NIST staff. Based on this work, NIST leadership has developed the following four strategic goals for NIST.

1. **Goal – Position NIST to Advance U.S. Science and Innovation –** NIST will make sure that it has the workforce, organizational structures, and partnerships to support the development and adoption of emerging technologies critical to innovation and the economic competitiveness of the United States.
2. **Goal – Maximize NIST's Stakeholder Impact through High-Value Service Delivery**– NIST will optimize service delivery, streamline processes, and strengthen stakeholder engagement to transform technology transfer.
3. **Goal – Create the Infrastructure for a 21st Century Research Institution** – NIST will make sure that it has both the physical and IT infrastructure to carry out its programs.

Goal – Build a One NIST Culture – Ensure that our workforce of federal staff and NIST associates are united around NIST's mission and are valued for the expertise they bring.

The VCAT will be updated on progress towards developing and implementing the plan at future meetings.

Dr. Copan also reviewed with the VCAT steps that NIST was taking to identify and address the causes of apparent inequities in promotions at NIST for women and minority researchers in order to improve the environment for all staff at NIST. NIST is currently work on a number of efforts including invited speakers, enhanced training, and an external study that will look specifically at equity disparity among NIST's workforce.

Discussion:

The group discussed the following topics:

- The visibility and success of the framework for cybersecurity on a global scale and a parallel need for the U.S. to have a similar position for smart manufacturing internationally to compete with the vision of China and Europe.
- How the VCAT can support the budgetary needs of NIST, and make sure that the impact and importance of NIST's work is well understood by stakeholders.
- NIST's role in supporting supply chain security needs for semiconductors
- Workforce needs in emerging technology areas.

For more information, see Dr. Copan's presentation.

NCNR Update and APS Neutron Report – *Dr. Dan Neumann, Leader, Neutron Condensed Matter Science Group, NIST Center for Neutron Research*

Dr. Neumann, Leader of the Neutron Condensed Matter Science Group at NIST provided a brief overview of the NCNR and the recently released APS report, *Neutrons for the Nation.* Dr. Neumann informed the VCAT on the important role that the NIST Center for Neutron Research (NCNR) plays in nation's scientific and innovation

ecosystem -- with neutron measurements providing a powerful tool to understand the structure and dynamics of a number of physical and material systems.

The NCNR is a user facility, serving more than 2,700 researchers around the world through peer-reviewed proposals. NIST NCNR builds and operates world-class neutron-scattering instruments, providing access to industry, and academia. The NCNR operates 29 instruments with 6 instruments run in partnership with NSF through the Center for High Resolution Neutron Scattering.

Dr. Neumann also highlighted the recently released APS study *Neutrons for the Nation,* which highlights the importance of neutron facilities and the declining position of the U.S. in this field. Currently the NCNR, which is over 50 years old and licensed until 2029 is only one of 3 neutron research facilities in the U.S. In contrast, the rest of the world has been increasing construction of new neutron sources. There is a reactor under construction in Lund, Sweden, which is a 2-billion-euro investment by the European community in neutron techniques. Another one is under development in Russia, which will be the largest research reactor upon completion, and three new facilities are scheduled for construction in China.

The VCAT will further explore this issue and the vision for the future of the NCNR at the February 2019 meeting.

SESSION II: QUANTUM SCIENCE

Update on NIST Quantum Plans – *Dr. Carl Williams, Acting Director, Physical Measurement Laboratory, NIST*

Dr. Williams provided the VCAT with an update on NIST's efforts and plans for work in the area of quantum information science which NIST defines as a mechanism to exploit unique quantum properties such as coherence, superposition, entanglement, and squeezing to acquire, transmit, and process information in ways that greatly exceed existing capabilities.

NIST has played a major role in shaping the Administration's approach to Quantum Information Science which is consistent with the National Quantum Initiative Act that passed the House on September 13, 2018. Under the House version of the National Quantum Initiative Act NIST is specifically called out to continue and expand QIS research and development of measurement and standards infrastructure; train scientists in QIS, establish or expand existing partnerships or consortia; hold workshops once a year with stakeholders; and report results to Congress no later than 2 years. In addition, the act would give NIST "Other Transactions Authority (OTA)" for work related to NQI activities. NIST has begun talking with Canadian and United Kingdom counterparts about planning activities to achieve these requirements.

Dr. Williams reviewed with the VCAT the framework for NIST's quantum activities which focuses on foundational quantum science and metrology; quantum engineering (the new focus of NIST's efforts in this space), and the Quantum SI (dissemination of weights and measures through quantum standards). A major focus of the quantum engineering efforts is the establishment of the Quantum Economic Development Consortium which was covered in separate briefing to the VCAT. Dr. Williams also reviewed NIST's internal planning efforts focused on quantum including a 2-day workshop that took place and saw the participation of over 100 NIST researchers and managers. A key output of the workshop was the discussion of a potential grand challenge for NIST that could serve as a focusing point for NIST's research efforts in this field. One idea that received significant traction was the concept of the development of a prototype quantum network that could distributed and store entangled states of light and maintain that entanglement for sufficient time to support R&D, sensing, and metrology.

Discussion:

The group discussed the following topics:

- The specific standards that may be needed to advance the field;
- The balance between basic and applied research and dissemination.

For more information, see Dr. Williams' presentation.

Plans for the Quantum Economic Development Consortium (QED-C) – *Dr. Joseph Broz, Vice President, Strategy and Applied Sciences Department Head, SRI International*

Dr. Broz gave the VCAT an overview of the plans and ongoing efforts underway with NIST and SRI to establish a Quantum Economic Development Consortium. Dr. Broz set the stage with a brief historical perspective, highlighting the creation of the semiconductor industry in the late 40s as a parallel for where quantum industry is today, and how a consortium can help mobilize the community during the early stages of the industry. Dr. Broz discussed how the purpose of the QED-C will be to support enabling technology in research and development (R&D); to facilitate industry coordination and interaction with government agencies; and to provide the government with a collective industry voice in guiding R&D investment priorities and quantum workforce issues

Dr. Broz outlined the objectives of the planned QED-C that include: determining workforce needs essential to the development of quantum technologies; providing efficient public-private sector coordination; identifying technology solutions for filling gaps in research or infrastructure; highlighting use cases and grand challenges to accelerate development efforts; and fostering the sharing of intellectual property, efficient supply chains, technology forecasting, and quantum literacy.

Currently the United States quantum industry is nascent and fragmented. The QED-C will help build a stronger supply chain for research and industrial productivity. It offers efficiency by coordinated public-private funding and coordinated funding among multiple federal agencies as well as encouraging nontraditional industry partners. Having an opportunity to gather information through these mechanisms will make a more seamless set of dimensions for the U.S. industry by closing the gap between the U.S., Europe, and China. Performance standards are needed so that companies can look at quantum devices and evaluate the need.

The QED-C is by and for U.S. industry to support economic growth. This includes members that would self-identify as members of the quantum industry community. It also includes equipment suppliers, instrumentation original equipment manufacturers, materials companies, service providers, and end users. The QED-C will also engage the academic community, standards development organizations, professional societies, investment community, and international partnerships.

The deliverables for the QED-C for the first two years are to focus on workforce requirements and actions; gap identification and needed enabling technology and infrastructure; develop needs assessments for instruments and tools; and provide input to the U.S. government for R&D programs.

The proposed phased QED-C organizational structure would start with a technical advisory committee and a governing board. Dr. Broz stated he would serve as executive director should the governing board ask him to stay on for a period of time.

Dr. Broz briefly discussed the organizational and operational structures of the QED-C including, governance, dues, and IP policies. Currently there are 29 companies, a robust mix of large and small companies with a broad array of interests in QIS that have signed a letter of intent to join the consortium.

Discussion:

The group discussed the following topics:

- Would there be any universities or academia in the consortium;
- What other agencies would be in the consortium;
- What is the competing consortium.

For more information, see Dr. Broz's presentation.

SESSION III: NIST-on-A-Chip

NIST-on-A-Chip Program Overview – *Dr. James Olthoff, Acting Associate Director for Laboratory Programs, NIST*

Dr. Olthoff provided an introduction to the NIST-on-A-Chip (NoAC) program. The advances NIST has made have happened faster than anticipated and the commercial interest has grown at a faster pace. There are currently seven companies interested in commercializing these technologies. NIST needs to have scientists better prepared to think universally about where they're going with the commercialization of technology transfer activities, how to plan for it rather than just letting it happen.

The NoAC program is a suite of quantum-based measurement technologies. It will take measurement services out of the lab and directly to the end user and can be deployed nearly anywhere at any time.

Dr. Olthoff stated the approach is to accelerate the commercialization of NoAC technologies. The Technology Partnerships Office sets the strategy for how NIST engages with industry. Laboratory programs set the direction for all research programs at NIST. The Business Operations Office (BOO) provides project management and process engineering support for NIST services.

For more information, see Dr. Olthoff's presentation.

Technology Transfer Role of the Technology Partnerships Office – *Mr. Paul Zielinski, Director, Technology Partnerships Office*

With a primary focus of the VCAT being NIST's role in technology transfer Mr. Paul Zielinski, Director of the NIST Technology Partnerships Office provided an overview of technology transfer efforts at NIST. Mr. Zielinski's talk highlighted the broad array of tools that NIST uses to transfer knowledge and technology to our stakeholders including access to user facilities, industry consortium, and CRADAs (cooperative research and development agreements).

Mr. Zielinski provided the VCAT an overview with specific efforts NIST is undertaking to improve NIST technology transfer including:

- Efforts to reduce the time associated with partnership formation. NIST is working on efforts to make partnering move more quickly by streamlining processes and removing unnecessary formalities. NIST is continuing to modernize the agreements process and the TPO has been working with the Business Operations Office to utilize Service Now, an electronic system, to further reduce the paperwork and process times. In the area of patent disclosures NIST has eliminated the need for a formal review process and has also applied the Service Now platform to enable the electronic submission and tracking of invention disclosures. The transparency provided by the system incentivizes all participants in the process to keep things moving.
- Efforts to better align NIST's SBIR program with NIST priorities and increase the number of stage 2 awards.

Mr. Zielinski also provided the VCAT members with an overview of recent NIST trend data with respect to patents, licenses, and CRADAs.

Discussion:

The group discussed the following topics:

- Without formalities, how does NIST ensure the most important patents are being addressed;
- The ratio of disclosure to filings and how are they tracked;
- What is the financial incentive to file a disclosure?

For more information, see Mr. Zielinski's presentation.

NIST-on-A-Chip Technologies and Implementation – *Mr. Gregory Strouse, Deputy Associate Director for Management Resources, Acting Associate Director for Measurement Services, PML*

Mr. Strouse provided the VCAT with an overview of what NIST is doing with its NIST on A Chip (NoAC) program, an effort NIST is making to transfer the breakthroughs that it has made in quantum metrology into commercializable technologies that can be manufactured at scale providing NIST quality standards and sensors directly where our customers need them, thereby eliminating the need for a costly calibration chain. Mr. Strouse is directly invested in this effort with two patents in commercialization mode.

Currently NIST calibrates about 14,000 artifacts per year for industry. NIST must be able to maintain traceability chain over time to ensure measurement certainties, which is a very expensive modality. Being able to move into quantum-based chip scale standards will be transformative both for NIST and industry. If one looks at the example of temperature measurements, the potential impact of NoAC devices becomes readily apparent. Temperature is the second-most-measured unit in the world. If NIST can create a chip-scale device that costs around $1,000, and is intrinsically calibrated, as opposed to a process that is extremely sensitive to disruptions that costs $10,000 a run and requires $1 million worth of supporting infrastructure to support it, it becomes obvious how disruptive such a technology could be.

NIST has already had some initial successes with developing and commercializing chip scale technology. The chip-scale atomic clock, created here in Boulder has been commercialized and now it sits in cell phone towers all over the country. This one component plays a critical role, directly providing the accurate timing needed for a multi-trillion-dollar industry. Currently NIST has 24 different quantum SI chip-scale devices in development. Some are more mature than others, but NIST either has existing CRADAs with industry or is negotiating partnerships for all of these technologies. The current portfolio of NIST efforts covers a broad range of measurement needs including resistance, voltage, temperature, radiometry, pressure, vacuum, humidity, and laser power.

Discussion:

The group discussed the following topics:

- NIST should quantify the economic value being generated by these technologies;
- How NIST designs and fabricates the chips;
- Development of NIST's technology roadmap for the entire program.

For more information, see Mr. Strouse's presentation.

NIST-on-A-Chip Technology Transfer Pilot – *Ms. Anita Vanek, Director, Business Operations Office, NIST*

Ms. Vanek gave an overview of the NoAC pilot program as an approach that NIST could adopt to help accelerate the commercialization of NIST technologies more broadly. The pilot program is built around three key approaches: the formation of a cross disciplinary cross organizational team that combines all the relevant expertise; aggressive use of portfolio management to coordinate execution and drive results; and, focused continuous improvement through ongoing programmatic review.

The goal of this pilot is to utilize portfolio management to better integrate the entire technology transfer process from research to product commercialization. The program is focused specifically on the delivery of NoAC devices in order to ensure that NIST is best positioned to influence the global marketplace for metrology applications and to disseminate the NIST Quantum SI.

As discussed earlier the NoAC program is related to NIST's efforts in quantum science and is aligned with the goal to improve NIST measurement dissemination. The research encompassed by the program is multidisciplinary and involves multiple parts of the NIST laboratories. There are already mature products and others on their way. Multiple partners are actively engaging NIST. The pilot program has the potential to revolutionize measurement services and will impact multiple industry sectors.

Discussion:

The group discussed the following topics:

- Are the robotic process automations pervasive;
- NIST's business plan and pricing guidance;
- What is NIST's marketing strategies for NoAC;
- How will NIST protect the national security interests around these technologies, while balancing the need for international dissemination of weights and measures capabilities.

For more information, see Ms. Vanek's presentation.

SESSION IV: Technology Transfer

Establishment of Technology Transfer Subcommittee – *Dr. Walter Copan, Under Secretary of Commerce for Standards and Technology and NIST Director*

Dr. Copan reviewed the establishment of the Technology Transfer Subcommittee to be chaired by VCAT member, Ms. Katharine Ku. The subcommittee will develop recommendations focused on strengthening NIST's delivery of advanced technology to enhance national security and improve our Nation's economic competitiveness and quality of life. The Subcommittee is specifically charged to:

1. Review NIST's current technology transfer policies and practices, and provide the Subcommittee's recommendations on the principles that should drive these policies and practices for effectively engaging the business community and communicating with stakeholders;
2. Assess NIST's performance in the development and dissemination of work products and knowledge and recommend improvements. Specific areas that the Subcommittee should address include the development and use of intellectual property and collaborative research.

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Update on Progress with Lab 2 Markey and ROI Initiative – *Dr. Shyam Sunder, Senior Science Advisor, NIST*

Dr. Sunder provided the VCAT with an update on NIST's ongoing activities with respect to the Return On Investment Initiative (ROI). As was discussed with the VCAT in the past, the federal research and development investment is approximately $150 billion per year, with one-third invested in federal laboratories and two-thirds invested at university and industry R&D institutions. NIST in partnership with the White House has embarked on a course of work to strengthen and improve the efficiency of current Federal Technology transfer practices as part of the Presidents Lab-to-Market Cross Agency Priority (CAP) goal. The Lab-to-Market CAP goal is co-led by the Department of Commerce, through NIST, and OSTP. NIST and OSTP coordinate across the government through the National Science and Technology Council where there is a Lab-to-Market Subcommittee that coordinates, reviews, and implements priorities for the CAP goal. The goals are to maximize the transfer of federal investments in science and technology into value for America, to meet current and future economic and national security needs, and to attract greater private-sector investments.

NIST is supporting the Lab-to-Market CAP goal through its efforts on the ROI by identifying critically needed improvements to federal technology transfer policies, practices, and efforts. Throughout this process NIST has sought broad input from federal R&D, intellectual property, and technology transfer stakeholders through a request for information process, and through town hall meetings across the country. NIST has analyzed this input and has prepared a draft Green Paper which lays out a number of potential actions that could be taken to improve or clarify existing technology transfer related legislation, regulation, or policy.

The green paper, which is a consultation document, will be completed in the November-December time frame. When it will be released for feedback. for the final Green Paper is intended to be published in the second quarter of 2019.

Discussion:

The group discussed the following topics:

- How the ROI initiative is not necessary for NIST but for the country;
- How to measure success and economic impact analysis;

For more information, see Dr. Sunder's presentation.

SESSION V: JILA

JILA Overview – Impact of Joint Institutes on NIST Mission – *Dr. Carl Williams, Acting Director, Physical Measurement Laboratory, NIST & Dr. Thomas O'Brian – Chief of the Quantum Physics Division, NIST*

Dr. Williams provided a brief overview of how NIST uses joint institutes to enhance our mission delivery focusing on the 2 joint institutes operated by PML. The oldest institute being the Joint Institute for Laboratory Astrophysics (JILA), which dates back to 1962 and the other is the Joint Quantum Institute (JOI) at the University of Maryland (UMD) which was established in 2006 and modeled after JILA. In 2014, working with the Information Technology Laboratory, NIST extended the relationship at the UMD to establish the Joint Center for Quantum Information and Computer Science.

JILA has evolved significantly over its existence and now encompasses 28 JILA fellows and over 300 researchers (students and postdocs). JQI is tripartite with NIST, UMD, and participation and support of

research of the National Security Agency and involves 180 people there today and is the largest institute in the U.S. working in this domain.

The scientific output of these institutes is considerable. More than 200 articles per year come out of JILA, with an h-index of 112.

Dr. O'Brian gave a more detailed overview of JILA. JILA has pioneered new technologies for research and measurement that are used across NIST, universities, and industries all around the world. In training, JILA is building the workforce for the quantum information society of today and the future for small and large companies. In transformation, JILA is continuing to expand in new areas such as creating, controlling, and measuring quantum man-body systems to enable quantum measurements, quantum computing, and quantum simulation. One of the key things is continual evolution, staying on the cutting edge and anticipating what NIST and the nation need in terms of technology and training.

NIST employees at JILA have a unique appointment at the Colorado University (CU) campus called "adjoint", which means they are employees of the university as well as the federal government, yet they do not receive any money from the university. It allows them to supervise graduate students and postdocs, teach classes, serve on committees, and have the same footing as regular faculty members, which makes a difference.

JILA has been recognized by producing three Nobel Prizes in Physics, three MacArthur Genius Fellows, eight members of the National Academy of Sciences, and five members of the Academy of Arts and Sciences. National Academy of Sciences and U.S. News and World Reports has giving high praise to JILA and NIST for its award-winning measurement science.

For more information, see Dr. Williams' presentation and Dr. O'Brian's presentation.

SESSION VI: Advanced Communications R&D

CTL Overview – *Dr. Marla Dowell, Director NIST Communications Technology Laboratory, NIST*

Dr. Dowell informed the VCAT that the mission of the Communications Technology Laboratory (CTL) is to accelerate and support advanced communications for both federal and commercial sectors. CTL is one of six laboratories within NIST and one of three technology laboratories, with efforts focused on communications. CTL was established in 2015. The CTL organizational structure is one, Public Safety Communication Research, which is supporting the development of nationwide public safety broadband network; two, RF Technology, which is the fundamental research and standards to characterize both integrated circuits and systems, both wires and wireless; three, the National Advanced Spectrum and Communications Test Network (NASCTN), which is a neutral body to address spectrum sharing challenges among commercial and federal users; and four Wireless Networks, which is theoretical and experimental research in wireless networks, protocols, digital communication systems and components.

Next Dr. Dowell reviewed CTL's four priority areas and the goals: public safety communications; trusted spectrum testing; spectrum sharing; next generation wireless communications. In the area of public safety NIST is working to support standards research, development, test, and evaluation for first responder communications. In the areas of trusted spectrum testing NIST is working to coordinate and provide robust test processes, validated data, and trusted analysis to improve spectrum-sharing agreements, and inform future spectrum policy and regulations. In the area of spectrum sharing NIST is working to advance measurement science infrastructure to investigate, quantify, and mitigate the many factors that impact the ability, and inability, of disparate wireless communications systems to coexist and operate as intended. Finally, in the area of next generation wireless the focus of the work is on the advancement of the measurement science infrastructure for next generation wireless communication systems (e.g. mmWave radio channels).

The budget for CTL is roughly $80 million. About a quarter of the funds come from STRS, and 61 percent come from Public Safety Auction Funds, which expire in FY 2022. A significant portion of CTL funding also supports work in other labs across NIST including ITL, PML, and EL. This leverages partnerships to accelerate the outcomes in priority areas.

Discussion:

The group discussed the following topics:

- Where communications will stand in 2022;
- NIST's relationship with the Federal Communications Commission.

For more information, see Dr. Dowell's presentation.

SESSION VII: NIST Boulder Facilities Update

Overview of NIST Boulder Facility Projects – *Mr. Clyde Messerly, Assistant Director for Design & Construction, Office of Facilities & Property Management, NIST*

Mr. Messerly updated the VCAT members the status of the facilities renovated and the facilities still in need of renovation. He stated that strides have been made, but there is still a long way to go to enable researchers to perform the needed science of tomorrow.

He continued by stating that the Boulder site is about 206 acres, and the main development zone is 83 acres, which is located around Building 1. Half the acreage is tribal area and cannot be built on. The campus was established in 1950 with eight original buildings. Building 1 is eligible for listing on the Historic Register. Fifty-four percent of the facilities are in poor to critical condition according to Department of Commerce standards. There is $204 million in deferred maintenance backlog in Boulder, not including Wings 4 and 5 because those are slated for renovation.

The majority of backlog is utility infrastructure. A master plan with a 20-year vision and framework has been developed. New laboratories and a parking structure will be developed. The entrance stays the same. The laboratories will be connected, and the campus center will be with the administrative areas.

In FY 2018, the funding for Boulder started with Wing 5 programming and design. Replacing the high-speed switches will change the electrical feeds, but it will not affect computers and equipment. In FY 2019, feedback from House and Senate marks, Boulder will get approximately $65 to $67 million; however, looking to the future, 2020 to 2030, $90 million is needed for continuing renovation of Building 1, Wing 4. It is projected that by 2021, renovation to Wing 5 will be completed. There will be a relocation of the computer facility and some of the laboratories.

He concluded by stating that a 20-year implementation plan is being developed for the master plans for both Boulder and Gaithersburg. They will be developed separately but then will be combined for one funding structure.

Discussion:

The group discussed the following topics:

- The perimeter security at the Boulder campus;
- Will the renovations just modernize the laboratories or create new capabilities;

- The inadequacy of the current facilities to move forward in quantum science and engineering

For more information, see Mr. Messerly's presentation.

Administrative Business & Adjourn

Dr. Colwell stated that she was pleased with the parallel facilities request for both Boulder and Gaithersburg campuses. She stated the importance for VCAT members to visit the Hill in February, that this is needed to provide justifications for these facilities in Boulder and Gaithersburg so that NIST can do the genuine science and technology and meet engineering needs. She also said a case should be made about accelerating the construction at this time. VCAT members should be equipped with appropriate information to help in this effort, so that voices can be heard in Congress independently and as the VCAT Committee group as a whole.

In closing, Dr. Copan thanked all who participated in the meeting. He also encouraged the VCAT members to be in contact with each other in preparation for a visit to the Hill as well as the Technology Transfer Subcommittee work. He also stated that some of the initial efforts for the ROI initiative will include feedback on the green paper by looking at implications for the nation as well as for NIST early adoption. He also mentioned in closing that any insights or comments from the VCAT members, their companies and/or organizations would be valuable in NISTs commercialization pathway in reference to NoAC.

There were no public comments offered.

Adjournment

The meeting was adjourned at 11:33 AM.
I hereby certify that to the best of my knowledge; the forgoing minutes are accurate and complete.

Stephanie Shaw, Designated Federal Officer, NIST Visiting Committee on Advanced Technology
Dr. Rita Colwell, Chair, NIST Visiting Committee on Advanced Technology