

MEETING OF THE TASK FORCE FOR REVIEWING THE CONNECTIVITY AND TECHNOLOGY NEEDS OF PRECISION AGRICULTURE IN THE UNITED STATES

AUGUST 14, 2024

HYBRID MEETING: VIRTUAL; COMMISSION MEETING ROOM, FCC HEADQUARTERS, 45 L STREET NE, WASHINGTON, DC 20554

**10:00 AM CALL TO ORDER AND WELCOME,
ET ROLL CALL**

Emily Caditz, Designated Federal Officer
Dr. Michael Adelaine, Ph.D, Task Force
Chair

Roll Call: [highlighted in yellow if present]

Dr. Michael Adelaine, Ph.D., CIO & Special Advisor to the President; South Dakota State University (Dr. Adelaine)

Vice Chair:

Dr. Sreekala Bajwa, Ph.D., Vice President, Dean & Director; Montana State University College of Agriculture & Montana Agricultural Experiment Station (Dr. Bajwa)

Ryan Krogh, Manager, Production System Program Management; John Deere (RK)

Members:

Andy Bater, Farmer; Fifth Estate Growers LLC (AB)

Timothy Bradford, Jr., Ph.D., Director of Agronomy; Vayda, Inc. (Dr. Bradford)

Julie Bushell, CEO; Ethos Connected (JB)

Joseph M. Carey, SGE (JC)

Heather Hampton+Knodle, Vice President & Secretary; Knodle, Ltd. (HHK)

Carolyn Price, Executive Director; Upstate New York Towns Association (CP)

Brad Robison, CEO; Tallahatchie Valley Electric Power Association and Tallahatchie Valley Internet Services, LLC; President; MS Fiber (BR)

Joshua Seidemann, VP Policy and Industry Innovation; NTCA (JS)

Joy Sterling, Chief Executive Officer; Iron Horse Vineyards (Joy)

Dan Watermeier, Commissioner, Nebraska Public Service Commission (DW)

Andy Berke, USDA

Steven Hill, President, Satellite Broadcast Communication Association (SH)

Opening Remarks

- Dr. Adelaine – excited to have meeting in person and excited for presentations. Working groups have done a lot of work, people have been working hard and it shows. Hopes for rigorous discussion and good debate.

The Rulemaking Process

- Paula Silberthau, Attorney Advisor, OGC

- Gives presentation on the rulemaking process. Basic process is the issuance of an NPRM and publishing in Federal Register. This is followed by a comment period and internal review process. Followed by the adoption of formal order and rule. This process is required by the Administrative Procedure Act (APA).
- Describes the Notice of Inquiry (NOI) process and how the public and interested parties can inform the rulemaking process.
- Discusses the appeal process of final orders that are either done through Petitions for Reconsideration or Judicial Appeals and what issues (procedural or substantive) can be raised in either appeals process.
- Questions
 - AB: Over the term of the task force we have bumped into FACA Regulations that have prevented us from outreach to learn more about the sectors were studying. Is there a more direct path to recommend a NOI?
 - Answer: Two ways forward – can have a section in final report and recommendation for an NOI in specific matters or can post on own organization websites (can't be surveys) but can post general questions to try and obtain additional information from interested parties. Questions must be general enough to not trigger Paperwork Reduction Act (PRA). Options depends on how long task force lasts and when a final report from the task force is required. +
 - Dr. Adelaine: When were working on a recommendation of policy – how long would it take for the policy to be enacted by the Commission
 - Answer: Tough to answer. If within Commission delegated authority and agrees and info is sound, then NOI can be skipped and can go straight to an NPRM, which can take several months depending on the complexity of proposal/subject matter. Comment cycle + review on NPRM can easily take 90-120 days. Then go to Order with Commissioner majority – process altogether would take at least a year (extraordinarily fast pace)
 - HHK: Since recommendations are also directed at USDA, how does the interagency working group function, are individual notices needed or can information be shared across agency without the need for formal notices?
 - Answer: Can't speak to any detail but if there are interagency meetings and everyone involved is a federal employee then those meetings are exempt from FACA and continue indefinitely even after the Precision Ag task force has completed its work. Can't speak to the willingness to keep the interagency conversations going. As for data/information sharing, they possibly would not need a rulemaking for data gathering – it could just need an increase in personnel based on the recommendations. Its possible recommendations can be implemented without a formal rulemaking but can't speak to the specifics of USDA rules or requirements for these processes.

Precision Agriculture and Data Transparency

Presenter: Bernt Nelson, Economist, American Farm Bureau Federation (AFBF)

- AFBF Background: Grassroots organization where members vote on the county level. Is the leading voice of farmers and agriculture in DC and are engaging and developing the next generation of farmers, entrepreneur's, and food productions systems
- Precision Agriculture for AFBF Members: This involves the managing, tracking or enhancing crop or livestock production inputs, including seed, feed, fertilizer, chemicals, water and time, at a heightened level of spatial and temporal accuracy to improve efficiencies, commodity quality and yield, and positively impact environmental stewardship.
 - Farmers rely on some of the most sophisticated technology to produce affordable food, fiber, and fuel – US spends the least amount of disposable income on food in the world

- Advancements in technology permits farmers to expand working hours and work under weather conditions that are not possible when using basic farming equipment.
- Connectivity: This is a challenge for farmers in rural America but this is improving thanks to FCC and USDA efforts. Connectivity in rural America not only affects Precision Ag stakeholders but families/and communities as well. Although improvements have been made but more work is needed.
 - Experienced outages due to solar storms – a lot of companies were not prepared for this issue to transfer farmers from RTK system to wide augmentation so work could continue – changeovers took as much as 6 hours to transition systems to get machinery moving again.
 - Need connectivity to collect data from systems to measure input to output and analyze economics on an individual farm level.
- Issues
 - Cost: upfront cost for private wireless 5G with precision ag capabilities is about 55k plus an additional 6k/year for annual subscriptions which can include: Radio Access Network (RAN) equipment, Base Tower, and Labor. Cost also increases with the size of the farm
 - Challenging year in Agriculture: Commodity prices are down well below break even costs with input costs for things such as subscriptions remaining elevated this has created financial hardship for farms. Expecting six figure losses for many farms this year due to these issues.
 - Data Collection: Farmers are concerned about who owns and has access to the data collected. AFBF observed farmers concerns and started a working group that developed the Ag Data transparency policies and principals – The Privacy and Security Principles for Farm Data.
 - Drones and AI: Drones are being used more frequently to optimize agricultural processes and production to allow farms to be more efficient. When Drones are paired with AI to identify issues and learn fields, farming efforts can become increasingly more efficient but how can farmers using this type of technology know that their data is safe? Global market share is also a concern as large companies outside of the US control a lot of the drone market.

Questions:

- AB: What are your thoughts on the potential peril of replacing the outdated satellite GPS system in the US?
 - Answer: In terms of efficiency we have to keep these things moving forward. This is an area we are starting to fall behind in. We need more investment in ag research as this would be a key to success in this area. We're operating on dated systems and if we do not progress we will fall behind. This is a major concern in cattle industry. We need to remove barriers in adopting technologies and advance our technologies food costs will increase and our agricultural industry will be set back.
- SH: What is the concern of the continuing involvement of technology and having farmers decide for themselves about what they can get out of technology and any economic return?
 - Answer: You have to be investing in something that generates a return. Something that is going to be obsolete in a year is going to be a major deterrent in investment. Costs need to be worked into the equation for farmer investment in technology. Next generation is going to be absolutely key but affordability and longevity needs to be a consideration as working capital decreases.
- Dr. Bajwa: Farmers don't go to FCC website/map to determine if connections are available, wonders what AFBF and counterparts are doing any education or partnerships to address this problem? What should we be doing to include farmers to ensure accurate connectivity and map data?

- Answer: Discuss this issue very regularly. Its an obstacle but not a barrier – it takes trust building and interaction which AFBF does. Need to continue messaging and communication as its key to this.
- HHK: Was the private 5G cost breakdown for a 2500 acre farm?
 - Answer: its for an average situation – thinks the example was about that size. Its more about the area of coverage than the actual acreage of the farm. Its not uncommon for farmers to rent land 30-40 miles away from tower locations so access becomes difficult
- HHK: about hour fifteen in
- HHK: Do you think there’s additional data to inform us on this connectivity piece
 - Answer: Don’t know what data they have access without digging into it but can look into it and see what they can provide
- Joy: What are the top barriers preventing us from moving forward for being globally competitive and providing resources we need in US
 - Answer: number 1 issue right now in remaining a competitor is keeping our farmers farming and the sustainability of farming in the US. We need to make sure farmers are still able to financially remain farmers. Trying to grow or start a farm is a huge barrier – were in a down ag economy, we lost over 140k farms. Costs are up and prices are down and this financial barrier is the biggest piece. Second issue is ag research as these issues go hand in hand. Need to keep ag economy in a place where young/new farmers want to enter.

Overview of the U.S. National Science Foundation’s Investments in Precisions Agriculture and Connectivity

Presenters: Dr. Brandi Schottel, U.S. National Science Foundation; Dr. Ellen Zegura, U.S. National Science Foundation; Dr. Sudharman K. Jayaweera, U.S. National Science Foundation

- Dr. Brandi Schottel (Engineering Directorate)
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- Dr. Ellen Zegura (Computer and Information Science and Engineering - CISE)
 - NSF’s mission: promote progress of science, advance national health, prosperity, and welfare, and secure national defense. Discusses structure of NSF. Supports work that is long term science to potential use but also has a strong commitment to use inspired work. Discusses funding support for research, education, research infrastructure, and outreach/inreach/partnerships.
 - Discusses Digital and Precision Agriculture Workshop Report and Sustainable Precision Agriculture in the Era of IoT and AI as examples of how workshops such as these can advance goals.
 - Discusses general funding opportunities at NSF such as through program solicitations, dear colleague letters, supplemental funding, and EAGER/RAPID avenues.
 - Fourt different types of funded efforts: Institutes and Centers; research projects; education, research infrastructure
 - Discusses the institutes and centers developed by the NSF
 - Engineering Research Center – within it there is the Internet of Things for Precision Agriculture which focuses on technologies to increase production while minimizing the use of natural resources and the impact agricultural practices have on the environment. This program is at the end of the first five years and can be renewed for another five years
 - AI Research Institutes Program – 20 million over 5 years
 - There are 25 active institutes with the NSF – 5 of which are NIFA funded

- institutes. There has been an active set of AI institute efforts that are connected to agriculture and food
 - IUCRC: Center for Soil Technologies – partners between industries and universities that focuses on sensor development and integration of multi-scale knowledge of soil dynamics for predictions and decision making.
 - North Dakota Advanced Agriculture Technology Engine
 - Serves the state of ND and focuses on food systems and combining technology to improve agricultural practices and effects on the environment
 - Highlights programs related to agriculture
 - Cyber-Physical Systems (CPS) – one domain it focuses on is agriculture
 - This is a multi-agency program that includes NIFA, DOT, NIH (past), DHS with some focus on agriculture and smart and connected communities
 - Networking Technology and Systems (NeTS)
 - Covers wired and wireless work to develop future generations of networks and technological advances leading to that
 - NSF TIP Convergence Accelerator
 - One track of this program focuses on food and nutrition to transform food systems across the nation to ensure access to healthy, safe, and affordable food while also building sustainable agricultural and food practices.
 - Discusses undergraduate summer research programs (REU) that relates to food and plants such as the Plant Genome REU and Programmable Plant Systems REU. Also discusses INTERN model and benefits programs for graduate research opportunities.
 - Discusses NSF research infrastructure
 - Dr. Sudharman K. Jayaweera (Technology Innovation Partnerships - TIP)

Questions:

- RK: Is there something that isn't getting funded – is there more capacity to provide funding?
 - Answer EZ: Often have to turn down many worthy projects
 - Answer Brandi: Turned down more this year due to unexpected nature budget was delivered – definitely the worst part of the job is turning down these projects but its not unique to NSF it also happens at many other federal agencies.
 - Answer Dr. SJ: Bigger projects that carry multiple disciplines need more funding because they may not pertain to traditional NSF directorates and NSF may not have that kind of capacity. With sustaining efforts – need continuing funds from public funding to efficiently use NSF research efforts in the long run
- HHK: Are current projects and investments available to look at on the NSF website
 - Answer EZ: Yes, can do an awards search to view current active projects with project abstracts available for review. Can also include these in the chat
 - Dr. Brandi demonstrates how to find these projects
- Dr. Adelaine: Has NSF worked with other federal agencies to fund research projects that require more substantial funding.
 - Answer EZ: Yes we do and when that occurs we share in the decision making process with the federal agencies that are assisting. Helps us fund projects that we wouldn't otherwise be able to fund.
 - Answer Brandi: Gives examples of other joint funding projects that they have done with the USDA or NIFA

Working Group Update – Mapping and Analyzing Connectivity on Agricultural Lands

Presenters: Joseph Carey

- Grouped recommendations into five categories: Presentation of the Map (how public views it); Validation and Verification of the Map's Accuracy; The public Challenge Process; Sustainability of the Map; Awareness of the National Broadband Map and Outreach
 - Presentation of the Map – six recommendations
 - (1) Recommends the mobile map reflect performance consumers may typically expect considering both RF coverage and typical network load. (2) Recommends that the map include a clear legend, in terms an ordinary citizen can understand, for how the map is to be interpreted. (3) Recommends that viewing of the map by default be the satellite view when the mobile map is being viewed. (4) Recommends that Mobile Satellite Services be added to the National Broadband Map. (5) Recommends that USDA NASS produce a map layer that includes mobile coverage over agricultural land. (6) Recommends that the FCC produce a map (separate from the National Broadband Map) indicating where devices operating under TV white space (TVWS) rules can be used.
 - Validation and Verification of the Map's Accuracy – three recommendations
 - FCC establish an independent, on-the-ground sampling approach to verify mobile map accuracy that is sustainable over the long term – get out there and actually measure speeds/accuracy of connectivity availability. This is expensive and don't want to drive up costs – current approach via crowdsourcing isn't feasible in rural communities as the necessary participation level isn't there.
 - FCC should use propagation models that are open source and widely peer reviewed. FCC can do checks on it and accept/reject it – fundamental point is to base it on a mathematical model. Currently the big 3 are using different mathematical models – suggesting to standardize this and believes that this should at least be done for rural America. Suggests a research avenue for NSF be in the propagation modeling area.
 - FCC and USDA encourage and advocate for further research directed towards mobile mapping efforts over agricultural lands for improved accuracy.
 - The Challenge Process – five recommendations
 - FCC develop a mobile challenge process that is suitable for sparsely populated agricultural and tribal lands – fixed has been great but mobile has a long way to go. Problem is 5 of 8 measurements need to fail for challenge to rise to a level of FCC review – crowdsourcing measurements may work in urban areas but not in rural areas
 - When a challenge is submitted, the FCC inform the challenger of additional testing required in order for the challenge to be recognized and acted upon .
 - The FCC ensure that network operators do not inappropriately prioritize speed test traffic over ordinary network traffic. What we're worried about here is that the network operators may recognize speed tests are occurring and falsely make the performance appear better than it actually is
 - FCC should collaborate with all mobile phone manufacturers to make low level data such as RSRP, frequency and cell ID available on the official speedtest app – currently android does this but not Apple.
 - For transparency the location of pending and resolved mobile challenges in downloaded data files should include latitude and longitude; currently locations are identified only by H3 hex cell ID
 - Sustainability – four recommendations to ensure adequate funding to sustain the mapping process which includes:

- Independent, on the ground testing to verify network performance
 - Maintain the FCC speedtest app
 - Adequate funding for NASS to perform finer granularity census and surveys
 - Fund further federal research to make the map more accurate and less labor intensive to maintain, especially over agricultural and tribal lands.
- Awareness of the National Broadband Map and Outreach
 - FCC must promote more widely that there is a Map and that there is a challenge process – especially in agricultural communities
 - This is especially necessary if we go the crowdsourcing route.
- USDA and its Land Grant partners must educate agricultural, rural and tribal communities in awareness of the National Broadband Map and its application
- USDA and its Land Grant partners support these same communities to actively participate in the verification and challenge process
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Questions:

- Joy: Does the BEAD process challenges inform this map
 - Answer: BEAD is primarily for the fixed map and state broadband offices that they've communicated with are taking the FCC map as there base map to work from locally.
- HHK: What we learned is that through BEAD the states submit their own maps back to the FCC but the BEAD map cannot be updated by states overtime so it seems like you get one shot and its not an evolving map. This seems like a glitch in the system that needs to be addressed.
- RK: Are latitude and longitude mapped as well?
 - They don't appear by default – has to be turned on and only show up when you zoom in so you have to know where to zoom into.
- HHK: In visiting with NAST, it seems that if we were to have a publicly accessible map with lat/long youd have the ability to identify certain data that farmers may not want public.
 - FCC anticipates that most challenges are done based on roadways not private property but this is definitely a topic for discussion
- HHK: How do we increase capacity to carry more load as were only going to increase data as time goes on
 - Answer: Doesn't have a good answer for solving this but can explain why it's a difficult problem to solve.
- HHK: Could increasing low band towers help alleviate the load
 - Answer: Thinks its worth studying but doesn't know if it's a feasible solution

Working Group Update – Examining Current and Future Connectivity Demand for Precision Agriculture

Presenters: Joy Sterling

- Bandwidth – low does not mean no bandwidth. Its possible to do farming tasks on low bandwidth but in order to get the full benefit of technology available farms need more connectivity
 - One of the recommendations is targeting the BEAD funding for precision agriculture. BEAD funding flows through the states but final allocations have not been made and allocations should go towards precision agriculture
 - 5G fund for rural America through FCC – why not make this a last acre fund?
 - Suggest 5G is best spectrum for precision ag because of how used it is so hardware/infrastructure is already there
 - Some within the working group believe there should be a dedicated AG band – one thing we can look at is spectrum sharing, especially with the incorporation of AI as there are entire bandwidths are not being used

- Redundancy is key – getting fiber to the edge of the farm is so important in conjunction with building wireless facilities to have access to the working land.
- We need standards and agriculture needs a seat at the table in devising those standards – also need to ensure that agriculture is part of the 6G conversation
- We need a backup to satellite in the even of an attack on low orbit satellites that support our food/agricultural needs
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Questions:

- DW: Says the information about 99% of farms being within 25 miles of a tower is not accurate for Nebraska and wants to know where data is from because then if this is accurate then why do we need billions of funds in BEAD
- JC: Maybe we can auction off spectrums that were never auctioned off – in response to potential AG band
- JC: Can download National Spectrum Strategy – in response to a comment from Joy
- RK: Need to add some context into latency – were not implying that the speed of light isn't the fastest way to transfer data
 - Response: source was Sustainability Director for Ericson
- HHK: Proximity of crops to fiber – does the working group have any specific suggestions on accessing fiber? What policy changes on state/fed levels could incentivize this
 - Answer: Thinks BEAD or 5G routes are best for this
- Dr. Adelaine: Are you talking about dropping a fiber endpoint to every field? That's a lot and what would you do with them?
 - Answer: Doesn't really see the need to differentiate between household and farm.

Working Group Update – Accelerating Broadband Deployment on Unserved Agricultural Lands

Presenters: Heather Hampton+Knodle

- Interim Recommendations
 - Use of Geographic Based Build Out Requirements
 - Going forward, the FCC should consider geographic, rather than population, based build-out requirements that incorporate strong incentives to serve rural agricultural areas. There's an opportunity to really put this to the test with the 5G fund.
 - Incentives for Further Build Out After Initial License Term
 - The FCC should incentivize further network deployment by wireless licensees, in a manner consistent with the universal service objectives. If a company meets their benchmarks, maybe FCC can provide an incentive to expand further.
 - Overlay Use of Unused/Underused Portions of License Area
 - Carriers that have met their build-out requirements but have not served rural/agricultural portions of their license areas by the end of the build-out period should be subject to overlay use in those areas. If the spectrum is there, then there should be access to it.
 - Partitioning Unused/Underused Portions of License Area
 - Licensees that cede primary rural spectrum for deployment on farmlands, essentially partitioning at no charge, could be given some amount of bidding credit for use in future auctions. What ways can we work with companies that are underusing existing assets – especially in rural areas.
 - Promote Wireless Infrastructure Deployment
 - The FCC should urge the States and NTIA to encourage the submission of

- project ideas that include the provision of wide area connectivity. We want fiber as far/deep it can go but we also acknowledge we need more towers and available infrastructure to do this.
- Update Colo Void Policy
 - The FCC should work with the FAA to update “Colo Void Policy” to add critical low and mid-band spectrum.
 - Financial Incentives for Further Buildout
 - Granting agencies and Congress should explore offering bidding credits, tax credits, and other incentives.
 - Targeted Subsidy Program for Precision Agriculture
 - Programs such as a portion of the 5G fund may be necessary for sparsely populated areas where it is difficult for a commercial wireline, wireless, or satellite provider to serve.
 - New 5G Fund Should Consider New and Planned Deployments
 - FCC should avoid rushing creation of the 5G fund until there is a clear deployment picture, incorporating the fiber and wireless projects funded by the BEAD program. Don’t want to hold 5G deployment or development but what we have learned from BEAD is to be targeted in our efforts and get the resources where they need to go.
 - Facilitate (Allow) Funding from Multiple Sources to Build Service to Unserved and Underserved Areas on a Project Basis
 - Rural areas are high cost buildouts with low returns which inherently require greater resources to deliver service to unserved and underserved areas. Granting agencies should adapt eligibility requirements to allow for multiple funding sources for high cost areas. Don’t have unanimous agreement around this as providers view this as funding their competition.
 - Equip Local Permitting Authorities
 - Resources should be made available to these authorities to aid in permitting and siting. Could maybe include resources for training to get those in rural areas involved.
 - Update NEPA/NHPA Implementation
 - FCC should update its rules and policies for implementing NEPA and NHP, including the list of recognized “categorical 5 exclusions” from environmental and/or historic preservation review, for deployments likely to benefit unserved agricultural lands.
 - Cost-Based Permitting/Fee
 - The FCC should clarify that its cost-based fee standard applies beyond small cells and encourage state and local governments to adopt siting fee structures that incentivize rather than impede deployment (particularly in unserved agricultural areas).
 - Ongoing Efforts to Ensure Quality of Maps
 - The FCC should ensure that its maps of unserved and underserved locations, that are the foundation of funding decisions, are accurate. We need to continually update maps with accurate data of what types of services are being delivered.
 - Develop Playbook for Deployment
 - The FCC and USDA should work with non-profit organizations, trade associates, and other private parties to develop “playbooks” to guide deployment of precision agriculture connectivity solutions for various applications and use cases. It would be great to work with other government and nongovernment organizations for the development a playbook.
 - Establish Process of FCC and NTIA to Set Spectrum Priorities

- To make progress on the other past spectrum recommendations from the PATF, there should be a process that allows the FCC and NTIA to provide guidance to PATF on setting spectrum policy priorities. Larger issue here is ongoing conversations – we know our authority expires at the end of this year but needs will continue to evolve and its important to be mindful of that.
 - Encourage Use of Unlicensed and Licensed-by-Rule Spectrum
 - Do not discourage the use of networks that rely on unlicensed spectrum or licensed-by rule spectrum, including General Authorized Access spectrum in the Citizen Broadband Radio Service band (3.55 to 3.70 GHz); but also make a licensed option available. Lets not discourage use where spectrum is in place
 - Adoption of Rural Service Rules
 - When new spectrum becomes available for nongovernmental use, the FCC should consider whether it would be appropriate to adopt different allocations/service rules for urban and rural use.
 - Catalog Underutilized Spectrum
 - FCC should look for existing spectrum under 6GHz and especially under 2 GHz that is underutilized in rural areas, even if it is part of an existing geographic license that is mainly used in more densely populated areas. How can we put these spectrums to use, but first we have to know what’s out there.
 - Allocate Low Band Spectrum for Precision Agriculture
 - The FCC should look at allocating a sub-1-GHz spectrum for modest-speed Internet-Of-Things use such as a licensed version of LoRa with modestly higher power levels and coordinated, but not necessarily exclusive, channel allocations.
 - Develop Test Beds for Private Networks
 - FCC and USDA should develop additional private network experimental areas to determine the efficacy across a range of topographies and farm demographics. We think there are more opportunities to develop test beds that work with individual farms and communities
 - Accelerate Development of Direct Device (D2D)
 - The FCC should take further steps to facilitate use of D2D satellite connectivity to augment terrestrial communications solutions while also managing interference and other risks so that they do not undermine deployment efforts.

Questions:

- Joy: Says we have to rush on 5G rural plan (comment)
 - HHK Answer: Group would agree with that, just a matter of figuring out what to do to get it there.
- Dr. Adelaine: If you were going to categorize – what are the top 3 things to accelerate broadband deployment and what would be 3 barriers to this
 - HHK Answer: Targeted funding (includes incentives), siting, and improving access and utilization of existing tools that are already available would be what’s needed to accelerate deployment.
- Dr. Bajwa: Theres been mention of BEAD funding but have you thought about how to get more attention on mobile and not fixed since BEAD focuses on fixed?
 - HHK Answer: With BEAD funding there is some discretionary funding left to the states and some have already recognized precision ag as an area to use this funding. We do know enough that we need to have fiber to support anything we do with those towers. Looking at it as how to support tower buildout and discretionary funds.

Working Group Update – Encouraging Adoption of Precision Agriculture and Availability of High-Quality Jobs on Connected Farms

Presenters: Josh Seidemann

- The more we dug into our seven charges the more we uncovered is that this is a complex venn diagram that we're dealing with.
- Alleviating labor force shortages and increasing demand for high-skill workers
 - Is there a workforce shortage that's driving automation or is automation pushing people out of the labor market? More so that automation is coming into play at the same time as a workforce shortage.
 - Should utilize existing USDA programs to adopt ag tech.
- Federal, state and local coordination to promote adoption
 - Need to expand ability of farmers to utilize USDA loan and other programs for tech deployment.
 - Need to create incentive and benefit programs that consider farm size, job development, productivity savings/gains, and other criteria for loans and other funds
 - Support research into ROI strategies for common and specialty ag tech applications
- Promotion of post-secondary ag tech education
 - Need to enable resources to be administered by extension services to develop ag tech curriculum
 - Develop paid ag tech internship and apprenticeship programs that provide participants with remuneration as well as academic credits in 2 and 4 year programs
 - Convene stakeholder conferences between farmers, extension services, and state employment offices to identify gaps and develop solutions.
- Government, industry, and stakeholder partnerships
 - Farmers and coops can explore unlicensed spectrum where licensed or Federally supported services are not available
 - The ag industry is encouraged to explore partnerships and relationships with non-ag sectors who share common goals; land grant universities can offer a forum in which these relationships can be explored
- Obstacles farmers and ranchers face in adopting precision ag
 - Collaborative efforts among younger and older farmers can spur adoption among older farmers. We see a lot of these trends in broadband generally – this really seems to be rooted in when people were introduced to technology. We expect adoption of technology to maintain. There is some work to do here but overtime it will become a self-solving problem.
 - Cost of technology remains biggest barrier for small farmers. The cost of technology declines overtime but where we are seeing costs is subscription services and per acreage rates.
 - Affordability can be addressed by arrangements with service providers and coops.
 - Scalability can ease costs
 - Developments of autonomous machines may reduce the size of farm equipment and create more appropriate scales for small farms
 - University extensions can support research to model ROI strategies
- Work that has been done and lessons to learn
 - Identify and proactively incentivize relationships between the leading adopters and states (or regions) where similar relationships are less robust
 - Create programs and/or incentives for Manufacturers to develop deeper product lines that can be applied to smaller farms and non-commodity crops
 - Elevate awareness and understanding of how PA is an essential and expanding tool for farmers and producers for sustainable and even more cost-effective operations
- Metrics for tracking progress

- Can use many things to track progress. On the tech side, metrics could include sales, revenues, profits and a review of new tech on the market. While on the adoption side we can look at surveys of farmers, dealers, and service providers to see what type of technology is being adopted and to what extent. While on the productivity side, progress can be measured by surveying savings in areas like water, chemical, and labor costs while compared to productivity and yield increases.
- As of July 19
 - The adoption and jobs work group has hosted SMEs to present on the various charges
 - Modules outlining the background of the charge and concluding with recommendations have been drafted and circulated within the work group for review and editing
 - Two SME presentations remain, scheduled for July 26 and August 2
 - The work group has identified significant cross-over among issue discussions leading to a general impression that the issues assigned to the work group can be represented properly in a complex venn diagram

Questions:

- HHK: Did you see many industry partnerships at the community college level?
 - Answer: Specific industry partners were mentioned but they were more focused on funding for apprentices and giving funding/reimbursements to farms for apprenticeships.
- RK: As you mention incentives and loans have you thought about incentivizing the upfront purchase and not based on acreage usage?
 - Answer: This didn't come up but what we saw is that incentives are greater for smaller farms with fewer acres while we see more adoption on larger farms.
- HHK: Follow up on smaller farms, has there been any discussion on custom service models? Like drone application see and spray operations.
 - Answer: We talked about some of the specialization of services on smaller farms
- Dr. Bajwa: Was there any discussion on incorporating training high schools and incorporating this into the high school curriculum? We're seeing a decline in enrollment in higher education
 - Answer: Touched on this a bit and pitched education on high tech jobs in the agriculture industry to get exposure to middle school and high school to get students interested and involved in these fields
- Joy: In terms of making applications available to smaller farms and specialty crops – that's where the cloud becomes so valuable
- Dr. Adelaine: Mentions Frankenstein vegetables and an effort to get more out of products. As we promote precision ag and automation, do we need to be cautious with the public so that they don't turn away from these products?
 - Answer: with automation and you reduce the human labor costs through a particular field, you can pick what's ripe and leave what's there. With the shrinking of the machinery we think this could become an accessible option to pick products closer to ripeness
- Joy: Thinks technology can lead us to better tasting foods – uses Driscoll's as an example
 - Answer: WSJ had an article about Driscoll's and their processes

Open Discussion:

- JC: One of the groups suggested that let's make sure the spectrum that's sold is actually being used – should this be represented in a map?
 - SH Response: Thinks it would be pretty hard to represent this on a map because availability is – things won't be available consistently in the same year – availability will pop up sporadically
 - HHK thinks this can be represented with color codes
 - Joy: thinks because it's hard to do it's more important – thinks it's a problem when we

have underutilized spectrum and there are companies that are essentially warehousing it and not using it when others could use it if available. Thinks we have the technology to utilize the spectrum available.

- AB: Wants to follow up on an NOI for low band spectrum. We've heard that this is an ongoing issue since many pieces of tech utilized by farmers can work and function on these lower bands and wants to get moving on this. Knows NTIA is moving on getting new people involved on spectrum issues.
 - Joy: Adds that the small sensors Andy mentions can multitask
- JC: Agrees we need more low band spectrum for devices, but why have we not been more successful with TVWS – doesn't think this is a lack of spectrum, thinks something else is going on
 - Joy: Isn't TVWS primarily engineered by Microsoft?
 - JC says it should be taking off and doesn't have a good reason on why its not
 - JS: Have done things where TVWS was useful but a reason why companies are shying away from it is because it was another technology protocol that their employees had to master.
 - JC thinks some of the rule changes that have been adopted by the FCC addresses it – it explains the slow adoption but not the lack of usage we're seeing today
 - RK: When we looked into we were challenged to find devices and saw limited market availability and we would have to look into and develop our own devices. It became cost prohibitive to do
- Dr. Adelaine: Am I hearing that we want the adoption group to look into this particular question about TVWS/low band spectrum?
 - Andy Bater: Conceivably it's a task force recommendation – low band spectrum has been mentioned in several of the working groups
 - HHK: Thinks this will be a recommendation
 - Andy Bater: If an NOI is issued we can look at all low band spectrum including TVWS
- HHK: Somewhat related but seems to me that we need to develop transitions/adapters to connect the underused spectrum to people in these areas? There needs to be some well written/clear information provided to state broadband offices about priorities and criteria to support precision ag in every state.
 - Mike: So what you're asking is for the task force to put forth a recommendation to the FCC to inform states?
 - HHK: Basically yes – need to get states informed
- HHK: Our group still plans to meet – is there anything we need to look at/anyone we need to talk to?
 - Brad Robinson: Mentions funding – we don't have teams of attorneys/financial people to run these programs, they're smaller companies that will shy away from grant requirements. If the funding cant be implemented by these small local offices then its not going to be taken. A majority of this is being spread through grassroots efforts and it's a huge drain on company resources. Wants to streamline some of these requirements so that smaller companies can be more involved in localized broadband deployment
 - HHK: Asks Brad to share any specifics he has
 - Brad: Speed to market is critical here. Can streamlining be done between agencies
- JC: Can we still discuss states reporting back about maps – directed at HHK
 - HHK: Says she can share the specific state and discussion about the map and the BEAD effort. Will let him know about the work the state did to completely understand the broadband availability.
- Dr. Adelaine: Asks that chairs and vice chairs look at recommendations presented today and see where we might work together since it sounds like there was a lot of overlap.

Closing Announcements:

Dr. Michael Adelaine, Task Force Chair

Emily Caditz, Designated Federal Officer

- Thanks working groups for discussions and recommendations presented. A lot of work was done and discussion was great. Next meeting will be fully virtual and during the afternoon of September 18. Will hear updates from working groups on recommendations and could be a good opportunity to discuss any remaining issues or the executive summary. Another meeting will occur on October 15 that will be conducted in a similar way virtually. There is a statutory requirement to produce a final report at the end of the term. December 5 will be the last meeting where the task force will vote on a final report. To make sure the report ready for voting the FCC will need 30 days to review the report and to circulate it to the task force members for their review.

Next Meeting Date: September 18, 2024

October 15, 2024

December 5, 2024

Dr. Adelaine: adjourned the August 14 meeting

Federal Communications Commission

**MEETING OF THE TASK FORCE FOR REVIEWING THE CONNECTIVITY AND
TECHNOLOGY NEEDS OF PRECISION AGRICULTURE IN THE UNITED STATES**

August 14, 2024

AGENDA

10:00 AM EDT	CALL TO ORDER AND WELCOME, ROLL CALL	Emily Caditz, Designated Federal Officer Dr. Michael Adelaine, Task Force Chair
10:05 AM	THE RULEMAKING PROCESS	FCC Office of General Counsel, Paula Silberthau
10:20 AM	PRECISION AGRICULTURE AND DATA TRANSPARENCY	American Farm Bureau Federation, Bernt Nelson
10:50 AM	10 MINUTE BREAK	
11:00 AM	OVERVIEW OF THE U.S. NATIONAL SCIENCE FOUNDATION'S INVESTMENTS IN PRECISION AGRICULTURE AND CONNECTIVITY	U.S. National Science Foundation, Dr. Brandi Schottel U.S. National Science Foundation, Dr. Ellen Zegura U.S. National Science Foundation, Dr. Sudharman K. Jayaweera
11:45 AM	LUNCH BREAK	
1:05 PM	WORKING GROUP UPDATE	Mapping and Analyzing Connectivity on Agricultural Lands
1:25 PM	WORKING GROUP UPDATE	Examining Current and Future Connectivity Demand for Precision Agriculture
1:45 PM	15 MINUTE BREAK	
2:00 PM	WORKING GROUP UPDATE	Accelerating Broadband Deployment on Unserved Agricultural Lands
2:20 PM	WORKING GROUP UPDATE	Encouraging Adoption of Precision Agriculture and Availability of High-Quality Jobs on Connected Farms
2:40 PM	OPEN DISCUSSION	
3:15 PM	CLOSING ANNOUNCEMENTS AND NEXT MEETING DATE	Dr. Michael Adelaine, Task Force Chair Emily Caditz, Designated Federal Officer

THE RULEMAKING PROCESS

- Paula Silberthau, Attorney Advisor, OGC

Rulemaking and Procedures

- Congressional statutes created the FCC and delegated authority to the agency in the telecommunications space
- The FCC is tasked with creating the more specific rules and regulations that service the goals outlined in statutes
- These rules and regulations are (usually) adopted through the following process:
 - Notice of Proposed Rule [NPRM] → Comment and Review Process → Adoption of Order and final rules. In addition, the agency sometimes issues a Notice of Inquiry, which is more general in nature, before issuing the NPRM.
- Administrative Procedure Act (APA)
 - The APA is a statute setting forth rulemaking procedures with which all federal agencies must comply
 - Requires agencies to provide public with adequate notice of proposed rule followed by opportunity for comment
 - Requires publication in the Federal Register (both notices of proposed rules and adoption of final rules)

How an Idea Becomes a Rule Part 1

- Notice of Inquiry (NOI)
 - Unlike a Notice of Proposed Rulemaking (NPRM), an NOI is not required under the APA before adopting final rules. But, an NOI can be helpful to gather information and ideas from the public.
 - Issued to seek public input on a particular topic or issue and provides an opportunity for stakeholders to contribute to FCC decision-making processes
- Interested parties can submit comments, research, and data related to the inquiry
 - Input may address challenges, opportunities, and potential regulatory approaches
- FCC evaluates the information gathered from public input, research, and other sources
 - Analysis may involve assessing the impact of current regulations, identifying emerging trends, and/or evaluating the need for new regulations
- FCC may use the findings from the NOI to inform future rulemakings, policy decisions, or regulatory changes
 - The outcome may include reports, recommendations, or proposed actions based on the inquiry's findings

How an Idea Becomes a Rule Part 2

- Notice of Proposed Rulemaking (NPRM):
 - Proposal of new rules or changes to existing rules (along with an explanation of what the rules mean and the rationale for them)
 - Public input is invited through comments and reply comments
- Comment Period:
 - Individuals, organizations, and stakeholders can submit comments supporting or opposing the proposed rules
 - Responses to comments (reply comments) can also be submitted
- Rule Adoption:
 - FCC reviews comments and may revise the proposed rules based on feedback
- Final rules are adopted in an Order and published in the Federal Register, and become effective after a specified period, typically 30 to 60 days after publication in Federal Register. (Some rules take longer to become effective if they need review and approval by OMB due to paperwork requirements.)

Appeals of Final Orders

- Appeal
 - Petitions for Reconsideration. Interested persons may appeal final actions to the Commission within 30 days, but such appeals cannot be based on facts or arguments not previously presented except in very limited situations (e.g. changed circumstances). The filing of a petition for reconsideration is not a condition precedent to judicial review, and does not postpone the enforcement of the Order and rules about which the petition has been filed.
 - Judicial Appeals. An affected party can appeal the FCC's adoption of final rules to a United States Court of Appeals (with a subsequent review possible before the Supreme Court of the United States)
 - Typical types of challenges include:
 - Did agency comply with procedural requirements of the APA (e.g., provide adequate notice)?
 - Did agency exceed authority delegated to it by Congress (often turns on question of statutory interpretation)?
 - Did agency engage in reasoned decision-making (e.g., internally consistent; consideration of alternatives; consideration of the record)?



American Farm Bureau Federation®

**Precision Agriculture and Data Transparency
Policy Implications for AFBF Members**

Prepared for FCC Precision Agriculture Connectivity Task Force

Bernt Nelson, Economist, American Farm Bureau Federation

08/14/2024

Overview

- **Who we are**
- **Precision Agriculture for AFBF Members**
- **Connectivity**
- **Issues**
 - **Connectivity**
 - **Cost**
 - **Data**

Who We Are and What We Do

Over 6 Million Family Member, 51 states and Puerto Rico, 2800 counties



American Farm Bureau Federation®

Farm Bureau is the leading voice of farmers in Washington, DC, and our work goes well beyond policy issues. We're committed to engaging and developing the next generation of farm leaders, encouraging rural entrepreneurs, and giving back to our communities.

- AFBF President Zippy Duval

Precision Agriculture and Our Membership

“Man – despite artistic pretensions, his sophistication, and accomplishments, owes his existence to a 6-inch layer of topsoil and the fact that it rains”

- **Precision Agriculture: Managing, tracking or enhancing crop or livestock production inputs, including seed, feed, fertilizer, chemicals, water and time, at a heightened level of spatial and temporal accuracy to improve efficiencies, commodity quality and yield, and positively impact environmental stewardship.**
- **Farmers are: Biologists, Mechanics, Accountants, Entrepreneurs, IT techs, Managers, Business owners, Conservationists, Soil Scientists, Chemists, Physicists,**
- **U.S. Farmers rely on some of the most sophisticated technology in existence to efficiently produce the most affordable food, fiber, and renewable fuel supply in the world.**

How we use it



Challenges – Connectivity

- **Connectivity in rural America is improving thanks to the efforts of FCC and USDA.**
- **This impacts not only Precision Ag stake holders, but families across rural America.**
- **More work is needed.**



Solar Storms and Outages

Solar storms caused multiple outages for precision ag users around the world.



Challenges – Cost

- **According to a 2022 CoBank study, estimates the upfront cost for a private wireless 5G system with precision agriculture capabilities is about \$55,000 dollars plus an additional \$6,000 per year for annual subscriptions.**
- **This includes:**
 - **Radio Access Network (RAN) Equipment**
 - **Base Tower**
 - **Labor**
- **Challenging year in Agriculture**
 - **Commodity prices down**
 - **Input costs for things such as subscriptions remain elevated.**
 - **Creating financial hardship for farms**

Source: CoBank, How Co-ops Can Lead the Way for DIY On-Farm Broadband



Developing Policy Issues – Data

- **According to FCC Commissioner Brendan Carr, a single plant in a field can generate 18GB of data.**
- **This means the average corn field can produce 18 times the amount of data as the Library of Congress.**



Developing Policy Issues – Data

Ag Data Transparent

- In 2014, American Farm Bureau Federation (AFBF) observed that many of its farmer-members were concerned about the variety of new ag data products that were arriving on the market.
- To address concerns, AFBF hosted a series of meetings with farm groups and equipment manufacturers such as the American Soybean Association, National Corn Growers, John Deere, CNH, and others.
- Group drafted ***The Privacy and Security Principles for Farm Data***, or what today we call ag data's "***Core Principles***."
 - These Core Principles represented basic guidelines that ag tech providers should be following when collecting, using, storing, and transferring farmers' ag data. After publishing, 37 different companies signed onto the Core Principles, pledging to incorporate them into their contracts with farmers.

Ag Data Core Principles

- **Education**
- **Ownership of data**
- **Collection**
- **Access and Control**
- **Notice**
- **Transparency and Consistency**
- **Choice**
- **Portability**
- **Key Terms and Definitions**
- **Disclosure**
- **Data Retention**
- **Termination**
- **Unlawful and Anticompetitive Activities**
- **Liability Safeguards**

Developing Policy Issues – Drones & AI

- **Drones use is quickly becoming the next frontier in agriculture.**
- **Drones can be used for everything from scouting for weeds to spraying them.**
- **AI can be paired with drones to be adaptive, and learn the biology of crops and field.**
 - **Provide real time data, accomplishing tasks in minutes that would take a person hours**
 - **Save money by covering areas more efficiently and more accurately than a human**
 - **Monitor Soil Moisture to develop irrigation strategies**
 - **Drones can use AI to provide data driven insights to real time problems.**

Developing Policy Issues – Drones & AI

- **Can AI really provide real time solutions to actual problems in the field?**
 - **Weeds**
 - **Diseases**
 - **Livestock**
- **Is AI derived data safe and secure?**
 - **Global Market Share**
 - **How does a farmer know their data is safe?**

Questions?





Overview of the U.S. National Science Foundation's Investments in Precision Agriculture and Connectivity

Presentation to:
FCC/USDA Task Force on Precision Agriculture and Connectivity

Sudharman K. Jayaweera (TIP), Brandi Schottel (ENG), Ellen Zegura (CISE)

August 14, 2024

NSF'S MISSION

To promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense.

Director's Vision



Advance the frontiers of research into the future



Ensure accessibility and inclusivity



Secure global leadership

We are in a **DEFINING MOMENT**



Intensity of global competition



Urgent need for domestic talent



Broad support for science as path for solving global grand challenges

We can accomplish this vision with:

SPEED AND SCALE





Use-Inspiration

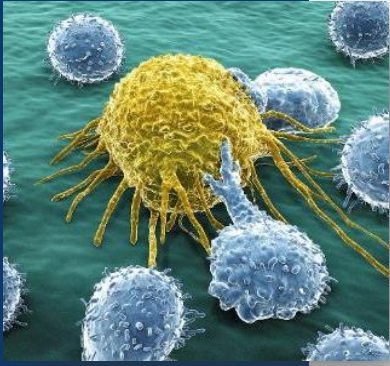
“Scientific investigation ... driven by the potential use to which the knowledge will be put.” (NOAA 2008, Stokes 1997)

Use-inspired exploration and discovery often involves *convergence research* and spans *both basic and translational activities*

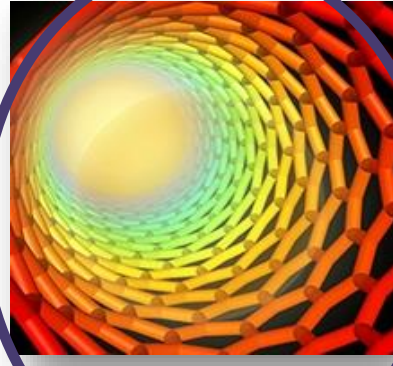
Food and Nutrition Security

Food and nutrition security is an important source of use-inspiration across NSF programs and investments

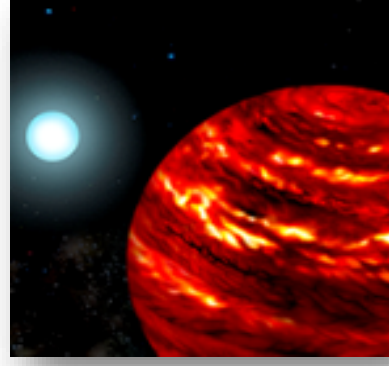
NSF's Directorates and Offices



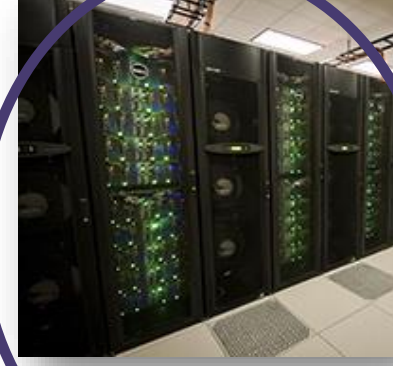
Biological Sciences



Engineering



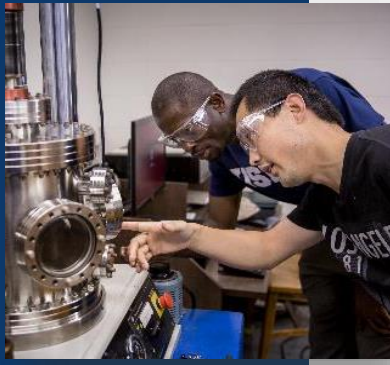
**Mathematical &
Physical Sciences**



**Computer & Information
Science and Engineering**



**Geosciences
(and Polar Programs)**



Integrative Activities



STEM Education



**Social, Behavioral &
Economic Sciences**



**Technology, Innovation,
and Partnerships**



**International Science &
Engineering**



Dr. Brandi Schottel (ENG), Dr. Ellen Zegura (CISE), Dr. Sudharman K. Jayaweera (TIP)



NSF's STRATEGIC THEMES

**Advancing
Emerging
Industries for
Economic and
National Security**

**Creating
Opportunities
Everywhere
(e.g., EPSCoR)**

**Building a
Resilient
Planet**

**Strengthening
Research
Infrastructure**



NSF funding supports...



Research

Investing in research to **increase the knowledge base** surrounding broadening participation.



Education

Using Interventions and capacity building to enhance access and opportunity to STEM education.



Research Infrastructure

Developing the tools and infrastructure needed to **broaden the research community**.



Outreach/Inreach/ Partnerships

Working with **external stakeholders**, the **research community**, and **NSF staff**.



Example: Workshops May 2021 (left), July 2023 (right)

National Science Foundation (NSF) Convergence Accelerator: Digital and Precision Agriculture Workshop Report



Sustainable Precision Agriculture in the Era of IoT and Artificial Intelligence

July 18-20, 2023

BARD AG-AI Workshop

Location: All Sessions will take place
at the Ben Gurion University Campus
in the W.A. Minkoff Senate Building (71A).

Website link:
<https://www.agaiworkshop.co.il/>



Book of Abstracts

Workshop Program



Types of Funding Opportunities

Program Solicitations

- Requests for proposals
- Contains program goals, instructions for proposal prep, award information
- Must also follow rules in the NSF rules doc PAPPG

Dear Colleague Letters

- Notifications of *special opportunities*
- Elevate a specific topic area *for existing solicitations*
- Competitions for *supplements to existing NSF awards and/or conferences*

Supplemental Funding

- *For existing awards*
- Up to 20% of original award amount to complete project activities
- Must contact a Program Officer (PO) before submitting

EAGER, RAPID

- High-risk, high-reward research proposal
- Not aligned with existing opportunity
- Can be solicited via DCLs, invited by a PO, or unsolicited
- Must contact a PO before submitting
- *Relatively rare*

Categories of Funded Efforts

Institutes and Centers

- Large scale, complex problems
- Generally multi-institution
- Long standing (e.g., Engineering Research Centers)
- Newer (e.g., AI Institutes)

Research Projects

- Most common NSF funding type
- Single or few PI efforts in response to solicitations
- Standing, core solicitations with broad scope
- Specialized solicitations

Education

- K-12, 2-year, 4-year
- Training
- Research Experiences for Undergrads (REUs)
- Research Experiences for Teachers (RETs)
- Graduate and postdoc fellowships (GRFP)

Research Infrastructure

- From campus-level to national-scale to international
- From general purpose to highly specialized
- Any combination of facilities, equipment, instrumentation, hardware and software, and supporting human capital



Institutes and Centers

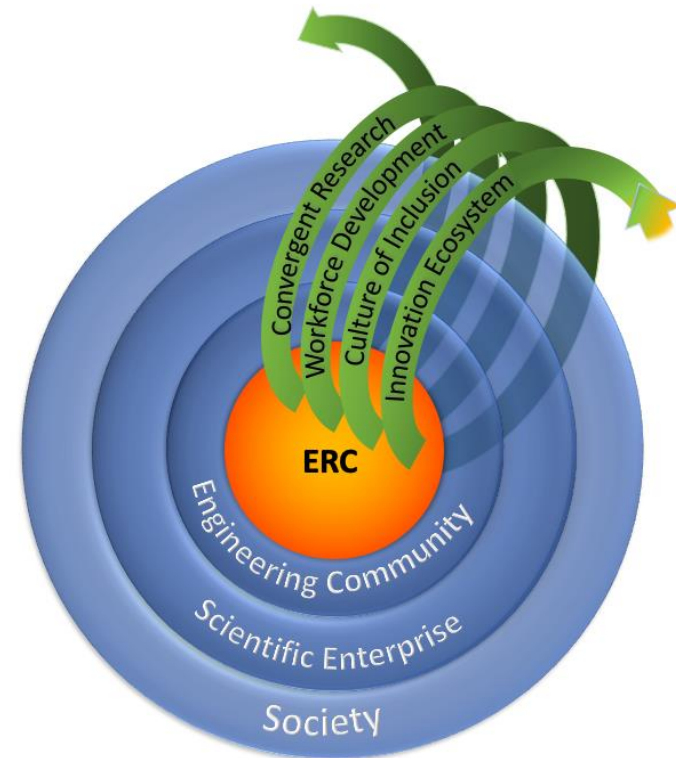


Engineering Research Centers (ERC)

Support convergent research, education, and technology translation leading to strong societal impacts; support lasts for up to 10 years (~\$52M)

Highlights:

- 75 ERCs supported since 1985
- 240 spinoff companies
- 900 patents
- 14,400 degrees to ERC students
- Numerous research outcomes enabling new technologies



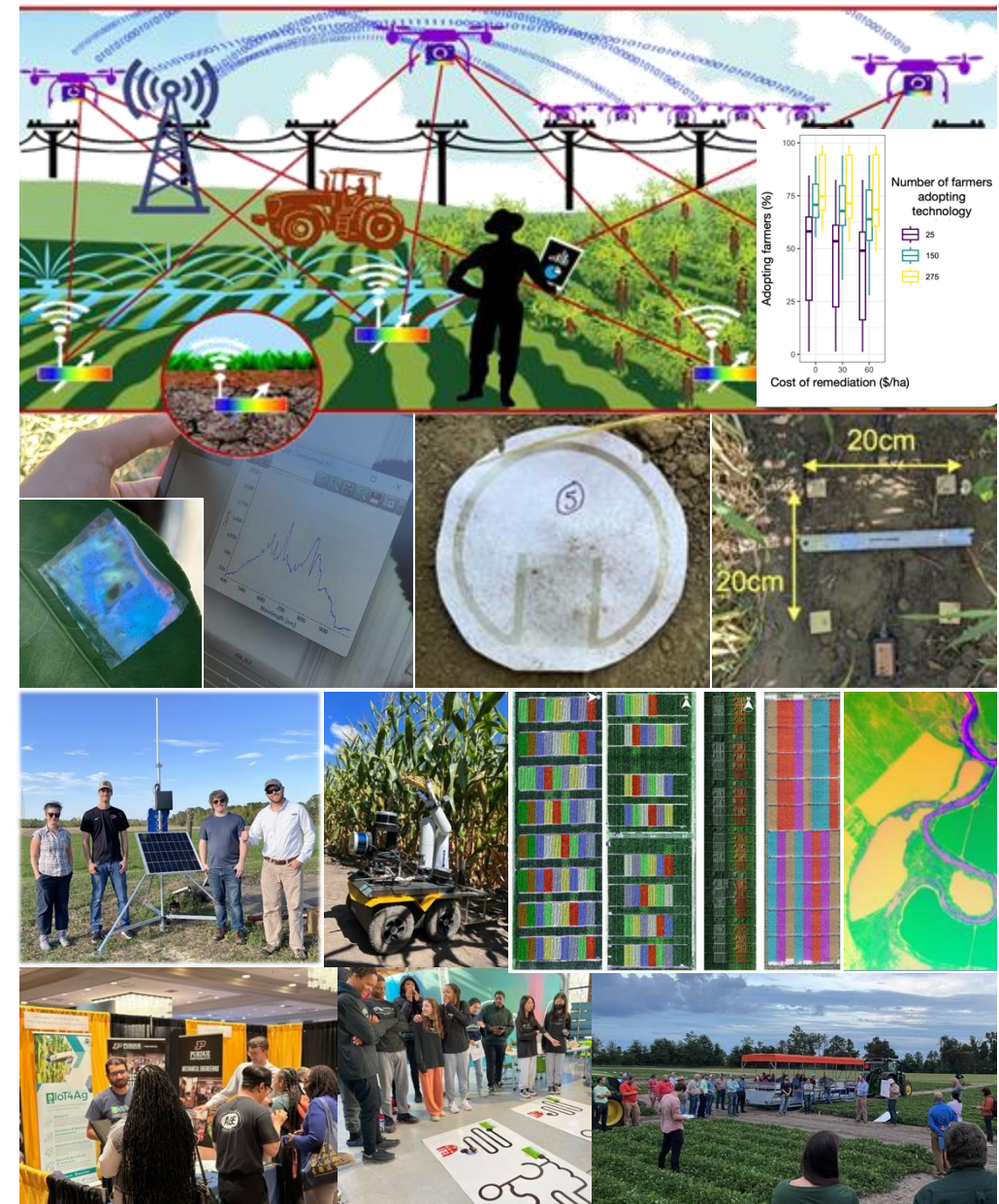


Vision: To ensure food, energy, and water security by advancing technology to increase crop production, while minimizing the use of energy and water resources and the impact of agricultural practices on the environment.

Mission: To create and translate to practice Internet of Things (IoT) technologies for precision agriculture and to train and educate a diverse workforce that will address the societal grand challenge of food, energy, and water security for decades to come.

Highlights Across ERC Foundational Components:

- Biodegradable Leaf and Soil Sensors and Air Batteries for Sensing
- Unmanned Agricultural Robotics for Mapping and Sampling
- Edge Computing and Communication for Agricultural Sensors
- Multi-Resolution Raster Data Fusion for IoT-enabled Ag Systems
- Improving Efficiency of Crop Input Applications from Modeling to Smart Application Systems
- Teach & Excite – Tech Meets Ag: K12 Outreach
- Education an Inclusive World: Pathway to PhD Program
- Enabling Professional Advancement: MSI and Practitioner Partnerships



NSF-led National AI Research Institutes Program

- \$20M (~4M/year) over 5 years
- Foundational and use-inspired AI research
- Innovation in AI education and workforce development
- New partnership development

AI Institutes and Funding Partners



A network of networks



Facilitator and Resource Center

- Directory of Institute contacts
- Advice on partnership inquiries

Learn more about AI Institutes at <https://aiinstitutes.org>



National Artificial Intelligence (AI) Research Institutes

Sustained investments in AI research in areas with the potential for long-term payoffs. Emphasis on convergent foundational and use-inspired research focused on societal challenges and enhancing national competitiveness in AI.

- **Goals of each Institute:**

- Significantly **advance research in AI** in a multi-disciplinary, multi-institutional collaborative setting
- Accelerate the development of **transformational, AI-powered innovation**
- **Grow a workforce** of future AI researchers and practitioners
- **Nexus points** for Institute-level collaboration between universities, federal agencies, industries, and nonprofits



25 Active Institutes

- 2020: First cohort of Institutes (5 NSF, 2 NIFA)
- 2021: Second cohort of Institutes (9 NSF, 2 NIFA)
- 2023: Third cohort of Institutes (6 NSF, 1 NIFA)

AIVO: <https://aainstitutes.org>

Link to all awards: [NSF Award Search](#)



USDA-NIFA AI Institutes



AI Institute for Next-Generation Food Systems (AIFS)

USDA-NIFA Integrate a holistic view of the food system with AI and bioinformatics to understand biological data and processes, addressing issues of molecular breeding to optimize traits for yield, crop quality, and pest/disease resistance; agricultural production, food processing and distribution, and nutrition.



AI Institute for Resilient Agriculture (AIIRA)

USDA-NIFA Transform agriculture through innovative AI-driven digital twins that model plants at an unprecedented scale.



AI Institute for Agricultural AI for Transforming Workforce and Decision Support (AgAID)

USDA-NIFA - Integrate AI methods into agriculture operations for prediction, decision support, and robotics-enabled agriculture to address complex agricultural challenges.



AI Institute for Future Agricultural Resilience, Management, and Sustainability (AIFARMS)

USDA-NIFA - Advance AI research in computer vision, machine learning, soft object manipulation and intuitive human-robot interaction to solve major agricultural challenges including labor shortages, efficiency and welfare in animal agriculture, environmental resilience of crops, and the need to safeguard soil health.



AI Institute for Climate-Land Interactions, Mitigation, Adaptation, Tradeoffs and Economy (AI-CLIMATE)

USDA-NIFA- Advance foundational AI by incorporating knowledge from agriculture and forestry sciences and leveraging these unique, new AI methods to curb climate effects while lifting rural economies.





IUCRC: Center for Soil Technologies



Center Mission: Support critical industries such as energy, climate, agriculture, telecomm, defense, & infrastructure through research in **remote sensing**, chemical, electrical, and hydrological **sensor development**, and integration of multi-scale knowledge of soil dynamics into **predictions and decision-making**.

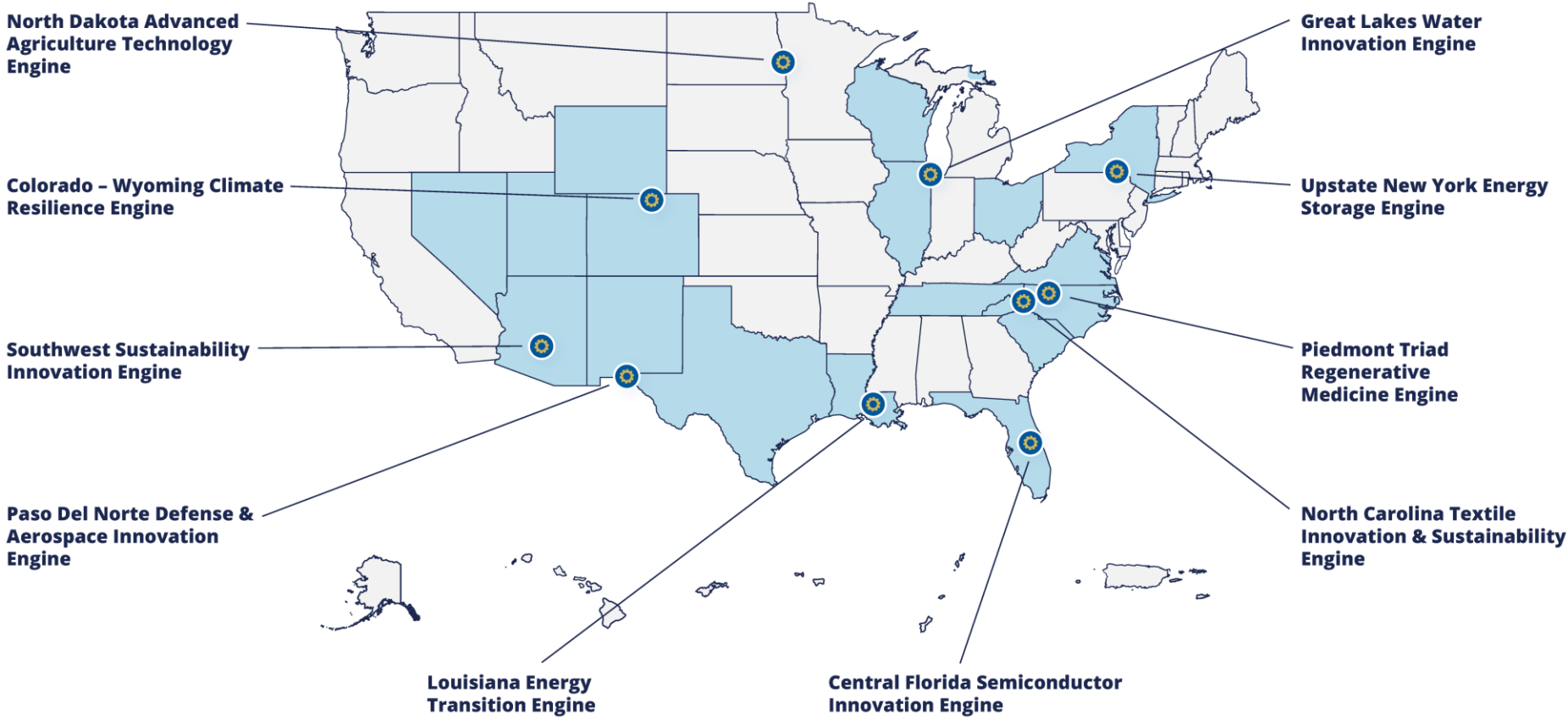
*Phase I NSF Support: \$600k/yr (operations)
Industry support: \$400k in Year 1 (research)*

Industry Advisory Board

University Partners



NSF Regional Innovation Engines (10 initial)



North Dakota Advanced Agriculture Technology Engine

Lead organization:

North Dakota State University

Region of service:

North Dakota (entire state)

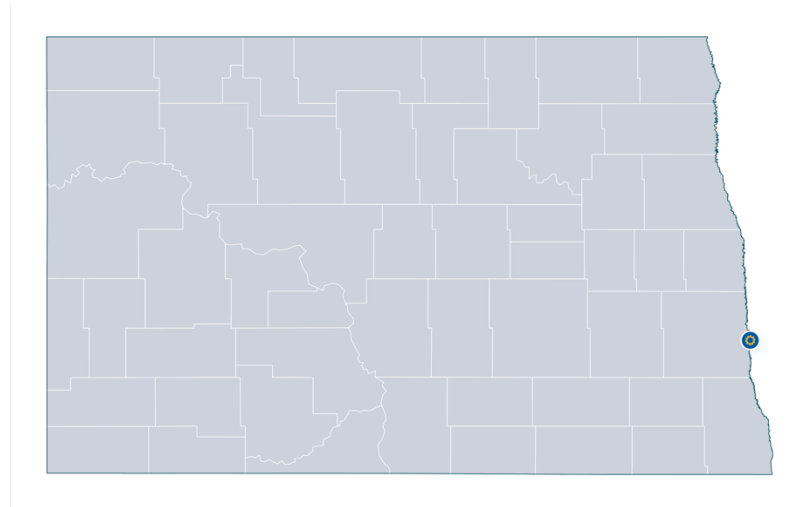
Aims:

Create resilient and secure food systems in North Dakota by combining advanced genomics, climate modeling, nanoscale sensors and computer networks to monitor and improve the growth of crops via strong networks of stakeholders across the state — including bringing tribal, rural and farming communities intentionally and meaningfully into the process of co-creating a blueprint for the future of agriculture and workforce development.

65 partners, \$160M over 10 years

Key Technology Areas:

Biotechnology, advanced computing and semiconductors, advanced materials, advanced communications, artificial intelligence, data and cybersecurity, disaster prevention and mitigation, robotics and advanced manufacturing..



Learn More:
www.FARMSfeedsttheworld.com

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- From general purpose to highly specialized
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Research Projects in Core Areas

Cyber-Physical Systems (CPS)

Deeply integrating computation, communication, and control into physical systems everywhere

Characteristics of CPS

- Pervasive computing, sensing and control
- Networked at multi-&-extreme scales
- High degrees of automation
- Scalable, interoperable, safe, usable
- Autonomy & human-in/on-the-loop

Application Domains



Critical Infrastructures



Energy & Industrial Automation



Healthcare and Biomedical



Transportation Systems



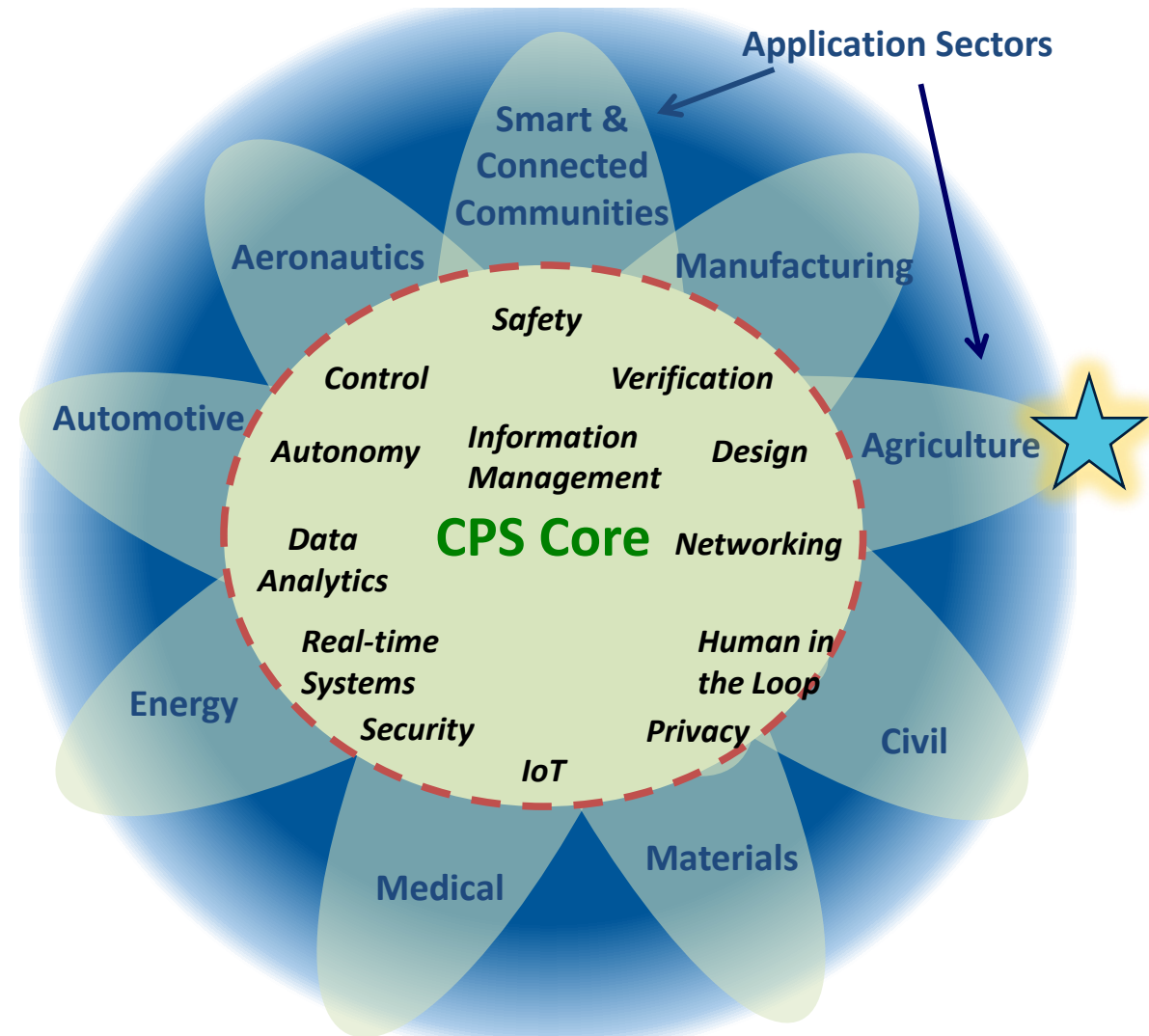
Agriculture

Overview of the CPS Program

The **goal** of the CPS program is to develop the core system science needed to engineer complex cyber-physical systems upon which people can depend with high confidence

Multi- agency: NIFA, DOT, NIH (past), DHS

More than \$400M, over 200 active projects since program start



FY 2023 Partnerships with Other Agencies



- **U.S. Department of Agriculture**
 - National Institute of Food and Agriculture



- **U.S. Department of Transportation**
 - Federal Highway Administration



- **Department of Homeland Security**
 - Science & Technology Directorate



- **National Institutes of Health (past)**
 - National Institute of Biomedical Imaging and Bioengineering
 - National Cancer Institute
 - National Center for Advancing Translational Sciences
 - Office of Behavior and Social Sciences Research



Selected Funded / Active Projects

- **CNS-1954556, Soumik Sarkar, Iowa State University**
 - *COALESCE: Context Aware Learning for Sustainable CybEr-Agricultural Systems*
 - Aims to transform CPS capabilities in agriculture to enable farmers to respond to crop stressors with lower cost, greater agility, and significantly lower environmental impact than current practices.
- **CNS-1932300, Ayan Dutta, University of North Florida**
 - *Towards Efficient and Secure Agricultural Information Collection Using a Multi-Robot System*
 - Aims to develop novel information collection techniques for autonomous mobile robots that collect, store, and share data in an efficient yet secure manner using blockchain.
- **CNS-2038853, Josiah Hester, Georgia Tech**
 - *Batteryless Sensors Enabling Smart Green Infrastructure*
 - This project builds Smart Green Infrastructure; augmenting GI with battery-free smart devices, powered by energy harvested directly from soil, which gather data, infer, actuate, and collaborate with each other.



Networking Technology and Systems (NeTS)

NeTS seeks to advance fundamental scientific and technological advances leading to the development of future generation networks

- Both ‘wired’ and ‘wireless’, from on-chip to Internet-scale, IoT, and other network systems
- Research that advances secure-by-design, high performance, robust and manageable networks

Selected Funded / Active Projects

- **CNS-2212050, Mehmet Vuran, University of Nebraska**
 - *Field-to-Edge Connectivity for Joint Communication and Sensing in Next-Generation Intelligent Agricultural Networks*
 - Experts in millimeter-wave communications, metamaterial and metasurface-inspired antenna array design, dynamic spectrum access, radio access networks, agricultural robotics, and sensor-based plant phenotyping aim to provide connectivity to rural farm fields and increase national competence.
- **CNS-2212575, John Byers, Boston University**
 - *Real-Time Liquid Wireless Networking for Data-Intensive Rural Applications*
 - Aims to address the essential building blocks of rural broadband – subject to environmental factors such as weather, terrain, foliage, crop types, and densities, operating over larger areas with less density than urban networks.
- **CNS-210701, Chandra Krintz, University of California – Santa Barbara**
 - *Detroit: A New End-to-end System for Practical and Accessible IoT*
 - Aims to develop a portable, multi-tier (sensors, edge, cloud) platform that supports "write-once-run-anywhere" programming for IoT devices, enabling secure IoT innovation to become broadly practiced, rather than solely the domain of distributed and embedded systems experts.



NSF TIP Convergence Accelerator

Track J – Food & Nutrition Security



Goal: Transform food systems across the nation to ensure access to healthy, safe and affordable food, as well as create sustainable agricultural forestry and food practices that consider the climate, regeneration and waste reduction. The track's focus also aligns with one of USDA's core priorities to ensure everyone in the country has consistent and equitable access to safe, healthy, affordable food essential to optimal health and well-being.

<https://new.nsf.gov/funding/initiatives/convergence-accelerator/updates/nsf-leads-federal-investment-agricultural-technologies>

- **\$35 million NSF investment**
- **Seven Phase 2 teams**
- **\$5 million per team, 36 months**



Track J: Food & Nutrition Security – Phase 2 Teams



Led by Pratt Institute



Led by George Mason University



Led by University of Arkansas



Led by Boise State University



Led by University of California, San Francisco



Led by University of Maryland, College Park



Led by University of Missouri, Columbia





Education

Education: Research Experiences for Undergrads



Plant
Genome
REU



Programmable
Plant Systems
REU

The USDA and NSF-funded **Plant Genome** Research Experiences for Undergraduates encompasses a wide variety of plant science research, including bioinformatics. This program involves labs and faculty members at both the Boyce Thompson Institute and Cornell University

[Click here for more information on the Plant Genome and Bioinformatics REU programs.](#)

The NSF-funded **Programmable Plant Systems** Research Experiences for Undergraduates is funded through CROPPS, the Center for Research on Programmable Plant Systems, and involves trans-disciplinary research that connects engineering and plant science. This **program involves labs and faculty members at both the Boyce Thompson Institute and Cornell University, as well as at the University of Illinois, Urbana-Champaign, IL**



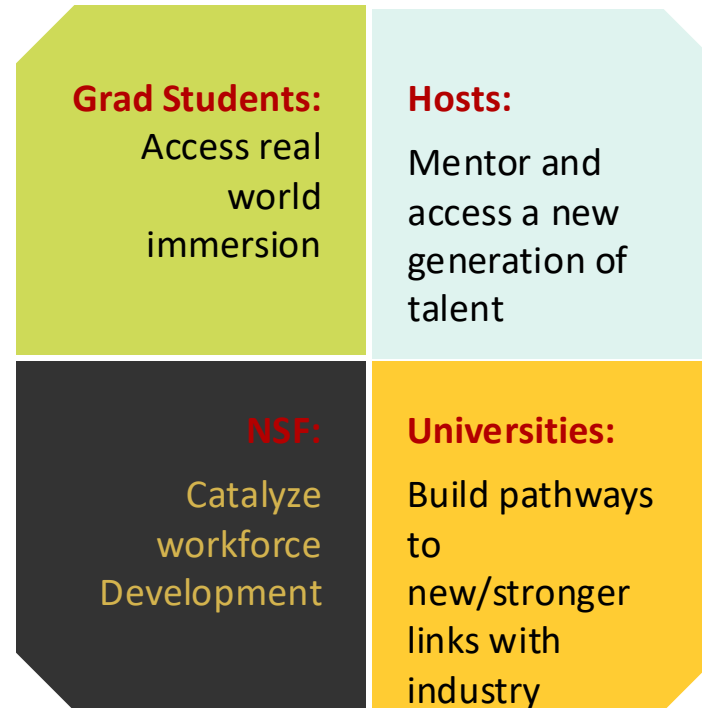
Education: INTERN Model and Benefits

Host organizations types:

- Industry laboratories or research and development groups
- Start-ups or small businesses
- Government agencies and National Laboratories
- Policy think-tanks
- Non-profit organizations

Other details:

- Supplemental to award
- Up to \$55K for up to 6 months
- Funds for faculty co-mentoring
- Open to international students
- NSF waives IP rights



1650+ INTERNs supported NSF-wide since FY17

A random sampling of Host Organizations





Research Infrastructure



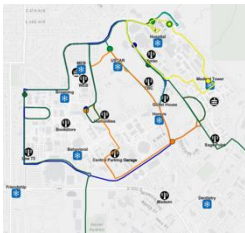
Example: Platforms for Advanced Wireless Research (PAWR) NextG Research and Testing

Salt Lake City, UT



**POWDER
RENEW**

Software defined networks
and massive MIMO



West Harlem, NY



Millimeter wave and
backhaul research



Raleigh, NC



AERPAW
Aerial Experimentation and Research
Platform for Advanced Wireless

Unmanned aerial vehicles
and mobility



Ames, Iowa



*Rural broadband and
precision agriculture*



Boston, Massachusetts



COLOSSEUM
at Northeastern University

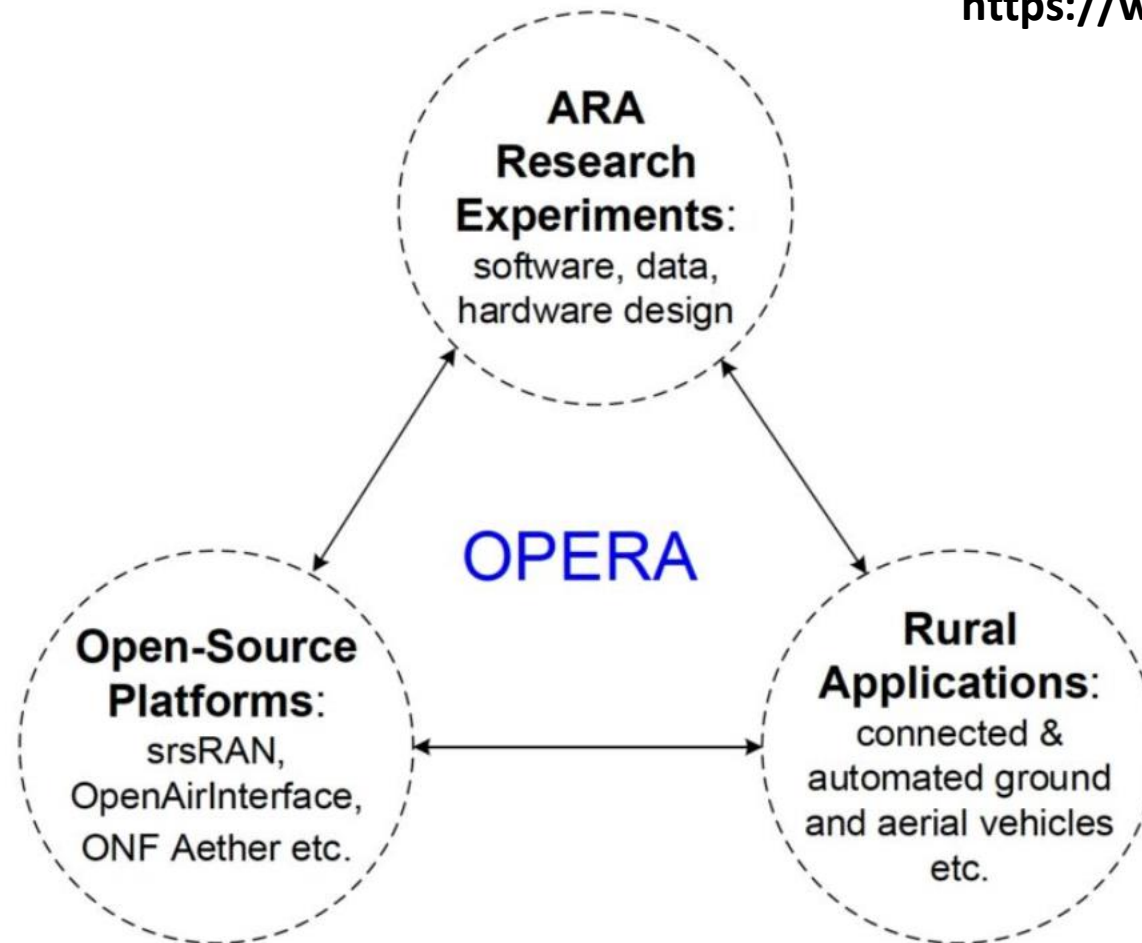
The World's Largest
NextG Wireless Emulator



ARAFest: August 25-27, 2024 in Ames, Iowa with Farm Progress Show

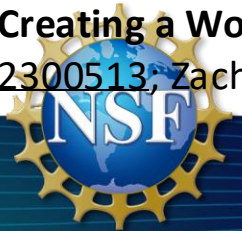
OPERA: Open-Source Ecosystem for Broadband Prairie (in conjunction with ARA Platform)

<https://wici.iastate.edu/opera/>



NSF Advanced Technological Education (ATE)

- **Creating a Sustainable Educational Pipeline for the Controlled Environment Agriculture Workforce through a Remote Dual-Credit High School to College Model**
[2301183](#); Richard Shultz; Santa Fe Community College
- **Creating an Agriculture Workforce Pipeline of STEM Technicians Trained in Water Analysis**
[2300420](#); Peter Fandel; Illinois Central College
- **Mobile Controlled Environment Agriculture Technician Education**
[2055223](#); Lew Nakamura; University of Hawaii
- **Advancing Precision Agriculture in the Urban Environment**
[2202151](#); Trentee Bush; Northeast Community College
- **Expanding Precision Agriculture Education and Certification to Secondary Students**
[2055728](#); Derrick Baker; Parkland College
- **Modernizing Agriculture Technician Education in Appalachian Northeast Georgia**
[2000444](#); Russell Logan; North Georgia Technical College
- **Grow with Rhodes: Expanding Awareness of Agriculture Technology Careers and Pathways**
[2300008](#); James Uphaus; Rhodes State College
- **Agricultural Robotics and Automation Technologies**
[2348815](#); Keith Olander, Central Lakes College
- **Cross-Pollination Skillsets: Growing Mechatronics and Agricultural Collaborations for Producing Skilled Agricultural Technicians**
Award Number: [2350254](#); David Berry; Virginia Western Community College;
- **Creating a Workforce Pipeline of Agriculture Drone Operators and Remote Sensing Technicians**
[2300513](#); Zachery Harber; University of Arkansas System

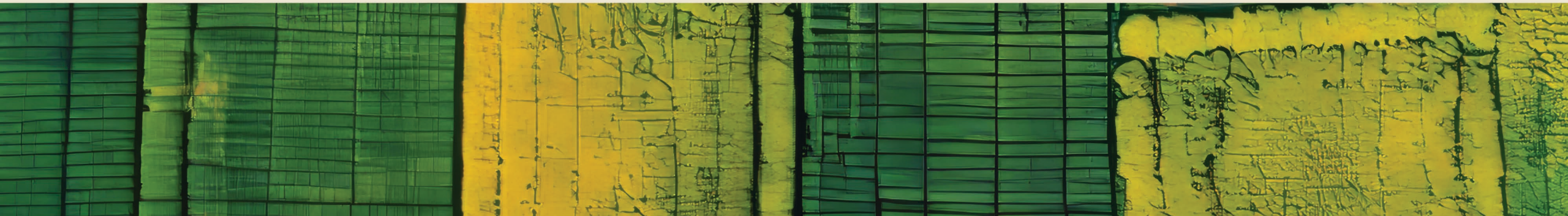




Discussion



TASK FORCE FOR REVIEWING THE
CONNECTIVITY AND TECHNOLOGY
NEEDS OF **PRECISION AGRICULTURE**
IN THE **UNITED STATES**





Initial Findings of the Mapping and Analyzing Connectivity on
Agricultural Lands Working Group for Review and Deliberation
by the Precision Agriculture Connectivity Task Force

1

MAPPING AND ANALYZING CONNECTIVITY ON AGRICULTURAL LANDS

Recommendation Categories

1. Presentation of the Map
2. Validation and Verification of the Map's Accuracy
3. The Public Challenge Process
4. Sustainability of the Map
5. Awareness of the National Broadband Map and Outreach

Presentation of the Map

The working group recommends:

- The mobile map reflect performance consumers may typically expect, considering both RF coverage and typical network load.
- The mobile map include a clear legend explaining, in terms an ordinary citizen can understand, how the map is to be interpreted.
- By default, the satellite view be enabled when the mobile map is being viewed.
- Mobile Satellite Services be added to the National Broadband Map.
- USDA NASS produce a map layer that includes mobile coverage over agricultural land.
- The FCC produce a map (separate from the National Broadband Map) indicating where devices operating under TVWS rules can be used.

Validation & Verification of the Map Data

The working group recommends:

- FCC establish an independent, on-the-ground sampling approach to verify Mobile Map accuracy that is sustainable over the long term.
- FCC should use propagation models that are open-source and widely peer reviewed.
- FCC and USDA encourage and advocate for further research directed towards mobile mapping efforts over agricultural lands for improved accuracy.

The Challenge Process

The working group recommends:

- FCC develop a mobile challenge process that is suitable for sparsely populated agricultural and tribal lands.
- When a challenge is submitted, the FCC inform the challenger of additional testing required in order for the challenge to be recognized and acted upon.
- The FCC ensure that network operators do not inappropriately prioritize speed test traffic over ordinary network traffic.
- FCC collaborate with all mobile phone manufacturers to make low-level data such as RSRP, frequency and Cell ID available on the official speedtest app.
- For transparency, the location of pending and resolved mobile challenges in download data files should include latitude and longitude; currently these locations are identified only by H3 hex cell ID.

Sustainability

Congress and FCC must ensure adequate funding to sustain the mapping process on an ongoing basis, including:

- Independent, on-the-ground testing to verify network performance.
- Maintain the FCC speedtest app.
- Adequate funding for NASS to perform finer granularity census and surveys.
- Fund further Federal research to make the map more accurate and less labor intensive to maintain, especially over agricultural and tribal lands.

Awareness and Outreach

- FCC must promote more widely the National Broadband Map and the challenge process, especially among agricultural communities.
- USDA and its Land Grant partners must educate agricultural, rural and tribal communities in awareness of the National Broadband Map and its application.
- USDA and its Land Grant partners support these same communities to actively participate in the verification and challenge process.



2

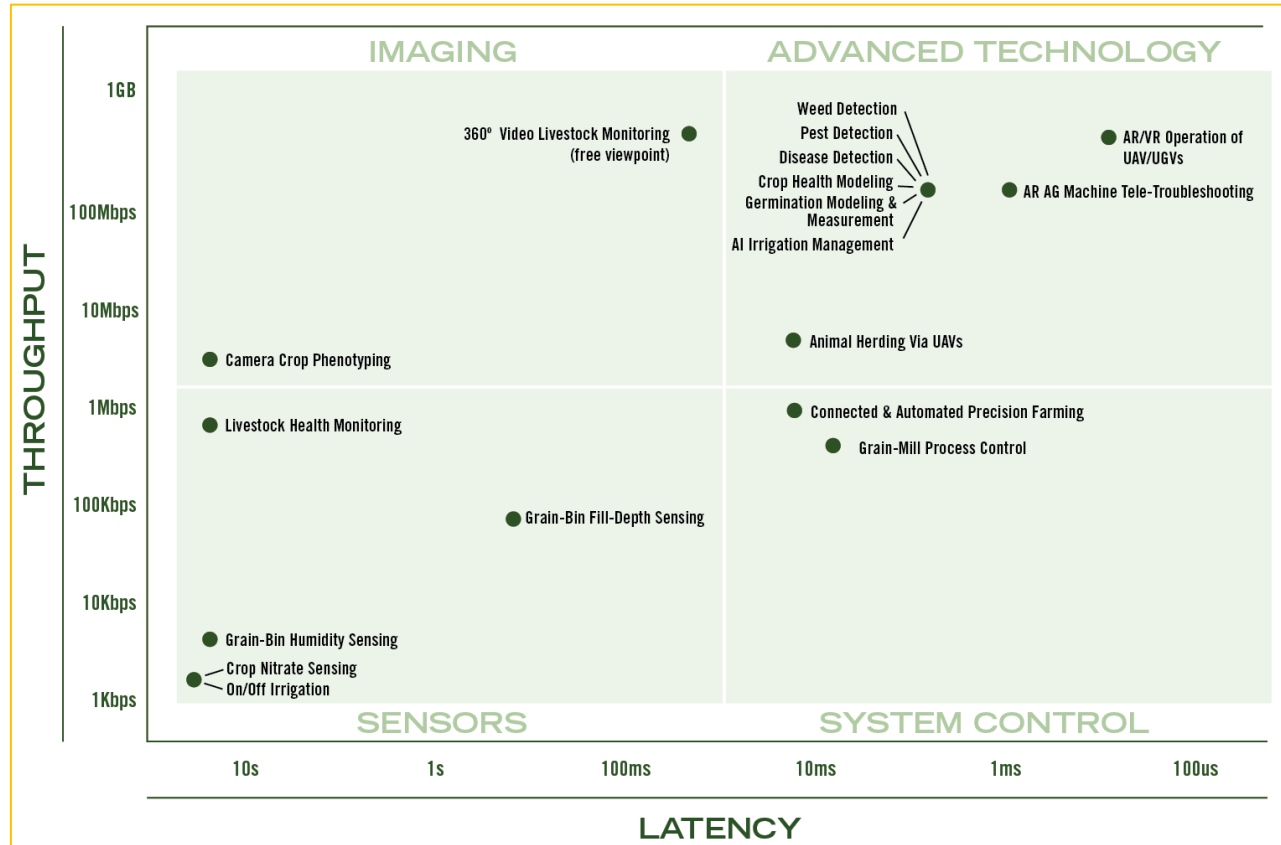
EXAMINING CURRENT AND FUTURE CONNECTIVITY DEMAND

Initial Findings of the Examining Current and Future
Connectivity Demand Working Group for Review and
Deliberation by the Precision Agriculture Connectivity Task
Force

Key Learnings:

1. Last term we cited the accelerating growth in technology. The accompanying volume of data being produced is also growing at an equally amazing pace.
2. “Data is the new tractor.” Jeff Rowe, Syngenta CEO, speaking at WSJ 2024 Global Food Forum.
3. The solutions to advancing technology and surging data generation are higher speeds (especially throughput) and more spectrum.
4. “Broadband inequality is a dollar issue not a technology issue.” - Ali Khayrallah, Ericsson.
5. Newly developed mapping tools of under and unserved rural locations suggest that fiber-to-the-farm *can* be achieved - *not* fiber to the field, but to enable Edge compute for data intensive processes.
 - 96.1% of all crops are within 10 miles of fiber.
 - 99.9% are within 25 miles
6. Farm to fork traceability *requires* last acre coverage essential for food security.
7. The “killer app” is a group of autonomous machines working together connected to cloud/edge compute ~ James Krogmeier, IoT4Ag
8. There is no “silver bullet”, single broadband provisioning solution to address current and future precision ag needs.

Bandwidth



While it appears the farm could operate on lower bandwidth within a bubble, this is an incomplete picture. Transmitting and analyzing collected data require higher throughput to be actionable in real time. Evolving technology and operations in the future will demand even more bandwidth.

Current Needs:

The working group recommends the following:

- "Last Acre" broadband connectivity.
- Achieve bandwidth standards of 100/100 and .5 ms latency.
- Target BEAD funding for Precision Agriculture, as final allocations are made, to extend fiber deployment to farm and ranch premises.
- Relaunch the \$9 billion 5 G Fund for Rural America to enable on farm crop monitoring systems i.e., IoT, autonomous tractors, variable rate irrigation.
- Allocate mid band spectrum for agricultural use to boost bandwidth.
- Open up un- and underutilized, unlicensed, lower band spectrum in the 400 MHz range for on-farm IoT connectivity.
- Invest in deployment and operations of private cellular networks where high performing public networks (CSPs) are not available to the Last Acre.
- Improve platform and device density capacity to deploy thousands of sensors across large farms/ ranches.
- Incentivize increase on farm data capacity/processing through highly secured Cloud Connectivity/Edge Compute to streamline the massive amount of data being generated, mitigating bandwidth limitations, and opening up new possibilities.
- Agriculture needs a seat at the table in creating standards that ensure interoperability, redundancy and security.

Future Needs:

The working group recommends the following:

- Analyze unserved/underserved areas post BEAD.
- Incentivize targeted build out of high-performance wireless connectivity – both terrestrial and satellite - to fill post-BEAD gaps.
- Ensure agriculture is one of the key verticals in development/deployment of 6G.
- Achieve bandwidth standards of 1GB/1GB and <.5ms latency for emerging use cases such as machine learning and training on high resolution imagery, which can create up to 1TB of data per day.
- Secure funding for post deployment, actual operations and maintenance.



Initial Findings of the Accelerating Broadband Deployment on
Unserved Agricultural Lands Working Group for Review and
Deliberation by the Precision Agriculture Connectivity Task
Force

3

ACCELERATING BROADBAND DEPLOYMENT ON UNSERVED AGRICULTURAL LANDS

- **Use of Geographic-Based Build-Out Requirements**

Going forward, the FCC should consider geographic- (rather than population-) based build-out requirements that incorporate strong incentives to serve rural agricultural areas

- **Incentives for Further Build-Out After Initial License Term**

The FCC should incentivize further network deployment by wireless licensees, in a manner consistent with the universal service objectives

- **Overlay Use of Unused/Underused Portions of License Area**

Carriers that have met their build-out requirements but have not served rural/agricultural portions of their license areas by the end of the build-out period should be subject to overlay use in those areas.

- **Partitioning Unused/Underused Portions of License Area**

Licensees that cede primary rural spectrum for deployment on farmlands, essentially partitioning at no charge, could be given some amount of bidding credit for use in future auctions

- **Promote Wireless Infrastructure Deployment**

The FCC should urge the States and NTIA to encourage the submission of project ideas that include the provision of wide area connectivity

- **Update Colo Void Policy**

The FCC should work with the FAA to update its “Colo Void Policy” to add critical low- and mid-band spectrum.

- **Financial Incentives for Further Buildout**

Granting agencies and Congress should explore offering bidding credits, tax credits, and other incentives

- **Targeted Subsidy Program for Precision Agriculture**

Targeted subsidy programs, such as a portion of 5G Fund, may be necessary for sparsely populated areas where it is difficult for a commercial wireline, wireless, or satellite provider to serve

- **New “5G Fund” Should Consider New and Planned Deployments**

The FCC should avoid rushing the creation of its “5G Fund” until it has a clear deployment picture, incorporating the fiber and wireless projects funded by the BEAD program

- **Facilitate (Allow) Funding from Multiple Sources to Build Service to Unserved and Underserved Areas on a Project Basis***

Rural areas are high cost buildouts with low returns which inherently require greater resources to deliver service to unserved and underserved areas. Granting agencies should adapt eligibility requirements to allow for multiple funding sources for high cost areas

- **Equip Local Permitting Authorities**

Resources should be made available to these authorities to aid in permitting and siting

- **Update NEPA/NHPA Implementation**

The FCC should update its rules and policies for implementing NEPA and NHPA, including the list of recognized “categorical 5 exclusions” from environmental and/or historic preservation review, for deployments likely to benefit unserved agricultural lands.

- **Cost-Based Permitting/Fee**

The FCC should clarify that its cost-based fee standard applies beyond small cells and encourage state and local governments to adopt siting fee structures that incentivize rather than impede deployment (particularly in unserved agricultural areas)

- **Ongoing Efforts to Ensure Quality of Maps**

The FCC should ensure that its maps of unserved and underserved locations, that are the foundation of funding decisions, are accurate.

- **Develop Playbook for Deployment**

The FCC and USDA should work with non-profit organizations, trade associations, and other private parties to develop “playbooks” to guide deployment of precision agriculture connectivity solutions for various applications and use cases.

- **Establish Process of FCC and NTIA to Set Spectrum Priorities**

To make progress on the other past spectrum recommendations from the PATF, there should be a process that allows the FCC and NTIA to provide guidance to PATF on setting spectrum policy priorities.

- **Encourage Use of Unlicensed and Licensed-by-Rule Spectrum**

Do not discourage the use of networks that rely on unlicensed spectrum or licensed-by-rule spectrum, including General Authorized Access spectrum in the Citizen Broadband Radio Service band (3.55 to 3.70 GHz); but also make a licensed option available

- **Adoption of “Rural” Service Rules**

When new spectrum becomes available for nongovernmental (e.g., mobile) use, the FCC should consider whether it would be appropriate to adopt different allocations/service rules for urban and rural use.

- **Catalog Underutilized Spectrum**

The FCC should look for existing spectrum under 6 GHz and especially under 2 GHz that is underutilized in rural areas, even if it is part of an existing geographic license that is mainly used in more densely populated areas.

- **Allocate Low Band Spectrum for Precision Agriculture**

The FCC should look at allocating a sub-1-GHz spectrum for modest-speed Internet-Of-Things use, such as a licensed version of LoRa with modestly higher power levels and coordinated, but not necessarily exclusive, channel allocations.

- **Develop Test Beds for Private Networks**

FCC and USDA should develop additional private network experimental areas to determine the efficacy across a range of topographies and farm demographics.

- **Accelerate Development of Direct to Device (D2D)**

The FCC should take further steps to facilitate use of D2D satellite connectivity to augment terrestrial communications solutions while also managing interference and other risks so that they do not undermine deployment efforts.



4

ENCOURAGING ADOPTION AND AVAILABILITY OF HIGH QUALITY JOBS

Initial Findings of the Encouraging Adoption and Availability of
High Quality Jobs Working Group for Review and Deliberation
by the Precision Agriculture Connectivity Task Force

Alleviating labor force shortages and increasing demand for high-skill workers

- Ag tech will be a key tool in addressing human labor shortages and increasing demand for skilled workers
- University extension services in coordination with farmers and technology developers will play an important role in identifying tech solutions and their impact on workforce
 - Recognize ag tech as a key tool in addressing human labor shortages and increasing demand for skilled workers.
 - Support industrial and educational efforts to upskill farm workers with training in both specific equipment and common core technology.
 - Transition to workforce structures in which automation decreases the need for human labor while increasing the need for more highly skilled workers.

Federal, state and local coordination to promote adoption

- Expand ability of farmers to utilize USDA loan and other programs for ag tech deployment
- Create tiered incentive and other benefit programs that contemplate the size of farm, job development, productivity savings/gains, and other criteria for loans, matching funds, and other benefits
- Support research into ROI strategies for common and specialty ag tech applications

Promotion of post-secondary ag tech education

- Enable resources to be administered by extension services to develop ag tech curriculum
- Develop paid ag tech internship and apprenticeship programs that provide participants with renumeration as well as academic credits in both 2-year and 4-year programs
- Convene stakeholder conferences between farmers, extension services, and state employment offices to identify gaps and develop solutions

Government, industry, and stakeholder partnerships

- Farmers and coops can explore unlicensed spectrum where licensed or Federally supported services are not available.
- The ag industry is encouraged to explore partnerships and relationships with non-ag sectors who share common goals; land grant universities can offer a forum in which these relationships can be explored.

Obstacles farmers and ranchers face in adopting precision ag

- Collaborative efforts among younger and older farmers can spur adoption among older farmers.
- Cost of technology remains biggest barrier for small farmers.
- Affordability can be addressed by arrangements with service providers and coops.
- Scalability can ease costs.
- Developments of autonomous machines may reduce the size of farm equipment and create more appropriate scales for small farms.
- University extensions can support research to model ROI strategies.

Work that has been done in this area and lessons from other contexts

- Identify and proactively incentivize relationships between the leading adopters and states (or regions) where similar relationships are less robust.
- Create programs and/or incentives for Manufacturers to develop deeper product lines that can be applied to smaller farms and non-commodity crops.
- Elevate awareness and understanding of how PA is an essential and expanding tool for farmers and producers for sustainable and even more cost-effective operations.
- Identify and create incentives for relationships between the leading adopters and states (or regions) where similar relationships are less robust.
- Create programs and/or incentives for manufacturers to develop deeper product lines that can be applied to smaller farms and non-commodity crops.
- Elevate awareness and understanding of how PA is an essential and expanding tool for farmers and producers for sustainable and even more cost-effective operations.

Metrics for tracking progress

- Metrics for progress will contemplate several categories
- On the technology side, metrics may include market indicators such as sales, revenues and profits alongside review of new technology available in the marketplace
- On the adoption side, metrics may include surveys of farmers, dealers, and service providers to identify type and extent to which technology is adopted for plant and animal farming
- On the productivity side, progress can be measured by surveying savings in areas such as water, chemical, and labor costs, coupled with productivity and yield increases

Work done, and to be done (as of July 19)

- The Adoption and Jobs Work Group has hosted SMEs to present on the various charges
- Modules outlining the background of the charge and concluding with recommendations have been drafted and circulated within the Work Group for review and editing
- Two SME presentations remain, scheduled for July 26 and August 2
- The Work Group has identified significant cross-over among issue discussions leading to a general impression that the issues assigned to the Work Group can be represented properly in a complex Venn diagram