Slide 1: Smart and Autonomous Systems (S&AS); NSF 16-608

Reid Simmons: Good afternoon, and thank you for joining this webinar. I am Reid Simmons; I'm a program director in the division of Information and Intelligent Systems of CISE and the lead program director for the Smart and Autonomous Systems program. I am joined today by Samee Khan, who is a program director in the Computer and Network Systems division of CISE.

Before we start, I would like to outline the schedule: The webinar will be one hour in duration; we will present for approximately 30-40 minutes, and then we'll take questions for the remainder of the hour. The question and answer session will be guided by the operator, so please follow the instructions from him or her when we have finished our part of the presentation. We have a quite a few participants today, so there may be a delay before you get an opportunity to ask a question. In addition, starting tomorrow, you may send questions to the email address listed on the bottom of each slide (aside from the title slide), and we will try to respond to them promptly.

Slide 2: The S&AS Team

Reid Simmons: As you are probably aware, the Smart and Autonomous Systems solicitation is new for fiscal year 2017. It is a collaborative effort within CISE, the Directorate for Computer and Information Science and Engineering. IIS, the Division of Information and Intelligent Systems, is represented by myself and program director Jie Yang; CNS, the Division of Computer and Network Systems, is represented by program directors Samee Khan and David Corman; CCF, the Division of Computing and Communication Foundations, is represented by Jack Snoeyink. Seta Bogosyan, from the Office of International Science and Engineering, handles issues related to international collaborations. And, we are ably supported by Daniel Hicks, a AAAS fellow with a background in philosophy and ethics.

Slide 3: Welcome

Reid Simmons: Let me begin by calling on Erwin Gianchandani, the Deputy Assistant Director in CISE, to welcome you and to say a few words about how Smart and Autonomous Systems fits into the broader picture at NSF.

Erwin Gianchandani: Good afternoon. My name is Erwin Gianchandani, and I am the Deputy for the Computer & Information Science & Engineering, or CISE, Directorate here at NSF. On behalf of all my colleagues across the Foundation, it is my pleasure to welcome you to today's webinar.

We are delighted to be able to introduce you to the Smart & Autonomous Systems, or S&AS, program solicitation this afternoon.

As you'll hear my colleagues describe in greater detail shortly, the focus of the S&AS program is to support fundamental research addressing how intelligent physical systems sense, perceive, and operate in environments that are dynamic, uncertain, and unanticipated.

I'm delighted to note that the S&AS solicitation is the culmination of the efforts of the research community – many of you – over the last couple years. For instance, there was an outstanding workshop back in 2015, funded by NSF and led by Vijay Kumar from the University of Pennsylvania, focused on research challenges in cyber-physical systems, robotics, and autonomy. That workshop built on the successes of the long-running Cyber-Physical Systems program, now in its tenth year, and National Robotics Initiative, now in its fifth year. The results of that workshop served to inform the S&AS program, as well as our CPS and NRI programs, which are also continuing.

More recently, we've seen tremendous interest in autonomy more generally. In fact, this was a topic of discussion at the White House Frontiers Conference hosted by President Obama in Pittsburgh, PA, just last month. And timed with that conference was the release of two important reports relating to autonomous systems and AI more generally -- including a strategic plan for Federal Research & Development investments in this space. Together, these reports cover the landscape of AI, including autonomy, including potential application sectors and associated impacts.

Our S&AS investment is also closely aligned with the "Human-Technology Frontier," one of 10 Big Ideas announced by NSF Director Dr. France Córdova at the May 2016 National Science Board meeting. Under the Human-Technology Frontier, NSF envisions interdisciplinary research as well as education to understand the benefits and risks of new technologies as we prepare for the future of work and productivity. Indeed, several of our investments in this space – including in CPS, robotics, and autonomy – are aligned with the Human-Technology Frontier.

Indeed, the Human-Technology Frontier recognizes that society today is on the cusp of a major transformation in work driven by combinations of autonomy, robotics, the Internet of Things, AI, and more. We envision this area to support research that demonstrates how intelligent systems work *with* people, not in place of them.

Before I close, let me thank Lynne Parker, the Division Director for Information and Intelligent Systems here in CISE whose leadership has been integral in not only NSF's efforts in these areas, but also for coordinating across agencies.

I also want to thank the entire S&AS program director team who have worked tirelessly behind the scenes to develop the S&AS program and continue to lead this effort.

And many thanks to all of you once again for joining us this afternoon – and for pushing the frontiers of this field.

Let me pass things back over to Reid to tell you the specifics of this exciting new solicitation.

Slide 4: Outline

Reid Simmons: Thank you, Erwin. The discussion today is intended to introduce you to the S&AS program, and to help you prepare and submit proposals that are consistent with the goals of the program. We will begin with an overview of why the program was created, what scientific and societal needs it fulfils, and discuss the overarching goal of the program and on what research themes the program is focusing.

We will then discuss the solicitation in more detail, introducing the two classes of projects supported by the program, their budget ranges, and information about the anticipated size and number of awards.

We then discuss the scope of the Smart and Autonomous Systems program and its relationships to other cross-cutting programs at NSF, specifically the National Robotics Initiative and the Cyber-Physical Systems program.

Finally, we will present some details that proposers should keep in mind when submitting proposals and answer questions. As mentioned, we will take questions by phone at the end, or you can submit questions to the email address listed at the bottom of each slide.

Slide 5: Autonomy: Definitions

Reid Simmons: The focus of this program is autonomy, but what is autonomy, exactly? Dictionary definitions are somewhat varied, but tend to agree that autonomy implies independence in making decisions, especially when making ethical decisions. Note that the second definition on this slide states that autonomous systems **can** make choices free of outside influence; this does not imply that autonomous systems **must** be free of outside influences, only that they have the freedom to disregard those influences. So, for instance, a truly autonomous system can take commands from a human, but also decide to disregard them if some other, more critical, issue arises.

Finally, a recently released OSTP report on the future of AI states that autonomy implies the ability to adapt behavior to different contexts. This is in contrast to automation, where machines behave precisely as specified by a person, according to a fixed set of rules. For true autonomy, it is not sufficient to know what to do, but also involves knowing why actions should be taken, reasoning about the consequences of those actions, adapting decisions to changing circumstances, and understanding the contexts in which certain actions may not be appropriate.

Slide 6: Need

Reid Simmons: Systems that interact with the physical world, such as robots and cyber-physical systems, are becoming increasingly prevalent in society, from manufacturing, to health-care, to service industries, to helping to monitor and maintain our infrastructure and natural resources. In the near future, we expect that they will be operating everywhere within our society, as well as places that are difficult, or impossible, for humans to go. The overall aim of such systems is to assist and/or augment people in their work and life but, to do so, it is often the case that the systems need to be highly autonomous. Note that this is not to say that autonomous systems should exclude human **interaction**, but rather that they should minimize the need for human **intervention**. For instance, just as we, as people, interact with one another on a regular basis, that does not contradict our beliefs that we are autonomous creatures. Likewise, our systems may interact with people, but still be highly autonomous, monitoring their own functioning, and repairing themselves or asking for assistance, when needed. They should be aware of their own capabilities and limitations, anticipate potential problems, and not act outside of their competency.

To enable long-term autonomy, systems will need to learn and adapt to changes. These include changes in the environment, either short or long term, changes to the system's hardware, such as failing components or hardware degradation, and changes to the system's tasks and missions, including learning new tasks without the need for explicit programming.

Finally, with the great power of autonomous systems comes great responsibility. Autonomous systems will need to act ethically, explicitly reasoning about tradeoffs between the achievement of mission goals and the social good. For instance, if a child darts into a roadway, an autonomous vehicle might need to decide between serving out of its lane and crashing versus hitting the child. Given uncertainty about what might occur – the child might stop in time, cars in the other lane might themselves swerve to avoid the accident – the decision about what is the most ethical action to take is often not easy to make. But, if we desire our systems to be truly autonomous, researchers will need to address such concerns.

Slide 7: Need

Reid Simmons: The critical need for research into autonomous systems is highlighted in several recent reports. In September 2015, an NSF-sponsored workshop took place to consider future directions in cyber-physical systems and robotics. The workshop participants highlighted **autonomy** as a potentially disruptive technology, and therefore strongly called for programs that helped advance a science of autonomy. The report presents drivers and metrics for developing and evaluating autonomous systems. This report was very influential in the formation of the Smart and Autonomous Systems program.

More recently, about a month ago, OSTP released two reports: 1) on preparing for the future of AI; and 2) a strategic plan for research and development in artificial intelligence. While the reports cover all of AI and touch on a broad range of research areas, they also call out autonomy and learning as two of the critical elements for future AI systems.

Finally, in its 2016 report, the 100 year study on AI raises concerns about the need for ethical and social considerations in the development of autonomous systems. While the report mainly concerns itself with ethical issues involved in creating such systems, it does give nod to issues surrounding the ethical behavior of such systems, themselves. For instance, it notes that "Ethical questions are also involved in programming cars to act in situations in which human injury or death is inevitable, especially when there are split-second choices to be made about whom to put at risk."

Slide 8: Goal

Reid Simmons: So, hopefully, the need for autonomous systems, along with some of the concerns that they raise, have been made clear. These issues helped give rise to the Smart and Autonomous Systems program, whose goal is to foster a community dedicated to advancing fundamental research into providing **Intelligent Physical Systems** with a high degree of autonomy, especially for long-term autonomy.

So, what is are Intelligent Physical Systems (or **IPS**)? For the purposes of this program, a **Physical System** is an integrated hardware and software system that interacts with an external physical environment, such as a car driving on a road, a mobile robot that travels through an office, an underwater vehicle, a smart sensor network monitoring the environment, or a smart grid keeping up with changes in supply and demand, as well as changes in the physical network itself. **Intelligent** Physical Systems are Physical System that exhibit five characteristics: they are **cognizant, taskable, reflective, ethical**, and **knowledge-rich**. We will go through each of these characteristics in turn, but I want to point out that the research themes of the program are aligned with these five characteristics, and every proposal to the S&AS program must address at least one of those themes. It is allowable for proposals to cover additional themes, as long as primary focus is on one, or more, of these five characteristics.

Slide 9: Cognizant

Reid Simmons: The first characteristic, and the first research theme, of the program is that IPS must be **cognizant** of their own capabilities and limitations. The issue here is that, in order to operate in complex domains with minimal human supervision or intervention, the systems must recognize when they have gotten into trouble and adapt their behaviors accordingly. More prudently, IPS should anticipate when they *possibly* may be heading for trouble and act to forestall any impending problems. This includes reasoning about possible exogenous events and reasoning about possible consequences of actions, including reasoning about alternate or contingent behaviors that may be applicable in particular situations.

IPS should also reason about when they do not have the capability to deal with the current situation, and not continue trying fruitless actions. In such situations, options include safing the system and asking people for assistance. In the latter case, it is important for the system to provide suitable situation awareness to the person, including explaining what they have been doing, and why, in ways that are readily understandable by people. And, in cases where the system is handing control off to people in dynamic situations, such as driving, the request for assistance must be made in enough time for the person to attain situation awareness and take over control. Such explanatory capabilities can also be used for introspection, where the system uses meta-reasoning to understand how its own behavior has resulted in certain outcomes, in order to avoid bad outcomes, or reinforce good outcomes, in the future.

As an illustrative example, consider a self-driving vehicle that is operating in autonomous mode. It has knowledge of the rules of the road, predictive models of how other vehicles are likely to behave, and models about how the conditions of the road, visibility, and the health of the vehicle itself impact its ability to drive safely. In situations where it determines that its driving ability is marginal, it should act to improve safety, for instance by slowing down and/or leaving more space with the vehicle in front. As the situation worsens, the vehicle should alert the driver, explain what conditions led it to doubt its ability to drive, and drive as safely as possible until the person takes over. Note that, in this case, while there is eventual human intervention, the vehicle itself is making the decisions about when to cede control, and similarly it should decide when it is feasible to take control back from the person.

Slide 10: Taskable

Reid Simmons: IPS should have the ability to reliably carry out high-level, goal-oriented objectives, accepting constraints on their behaviors, such as preferring optimal motion over energy efficiency, or vice versa, depending on the specifics of the mission. They should be capable of basing their actions on the particulars of the context, while still taking longer-term objectives into account. To aid in achieving their high-level goals, IPS may need to reason about their own sensing and communication behaviors, as well as taking actions that help them better achieve their own situation awareness. IPS should be able to achieve a wide range of tasks, in diverse environments, without the need for extensive programming.

People use many modalities for describing goals, including natural language, gestures, and graphically, such as by drawing maps. Similarly, we expect IPS to be able to accept instructions using similar modalities and, if necessary, engage in multi-modal dialog with humans to clarify any ambiguity in the goals. In addition, IPS should be easily interruptible, postponing a current task to carry out another, more important, task, and then returning, when feasible, to complete the original task (or to indicate when further progress is not possible). Ideally, IPS should reason about these issues – for instance, if achieving a higher priority task may preclude finishing the current lower priority task, or if the lower priority task is nearly done, then the system might decide to complete the lower priority task, if it determines that by doing so it will not jeopardize the higher priority task.

As an example, and pardon if this is not completely accurate with respect to actual underwater research, consider an autonomous underwater glider whose mission is to track and map the routes of certain species of fish within a given section of the ocean. The system might know, for instance, how to recognize the species, at what depth they normally swim, and how they use currents to travel. Based on this, the glider might plan to move to a location where it may find the fish and then start tracking, anticipating their likely movements based on knowledge of the currents in the area. In addition, the glider must act to conserve energy, to enable it to complete its multi-week mission; it must reason about when to surface in order to download data and relocalize; and it must be retaskable when it surfaces, if people want to modify or even completely change the mission.

Slide 11: Reflective

Reid Simmons: By **reflective**, we mean the ability to monitor, diagnose, and repair autonomously. IPS should be able to 1) reflect on how well they are operating in the face of component failure or degradation; 2) locate the source of the problem, perhaps using active probing; and 3) repair the problem, perhaps by using alternate behaviors that bypass the failed, or failing, component. Critically, IPS should be able to gracefully handle problems unanticipated by their designers, that is, they should be able to handle situations that were not initially modeled, or were modeled inaccurately.

Reflective systems should also learn to compensate for such failures, improving their behaviors over time. Learning can be through accumulated experience; observations of other IPS operating in similar conditions; observations of humans performing the task; or explicit instructions from people. IPS should be able to integrate multiple sources of knowledge to learn how to effectively handle new situations and new tasks.

An example of a reflective system is a network of sensors with reconfigurable hardware and software. The network would monitor its own functioning and diagnose problems that arise over time. Some of the problems may be solved through reconfiguration, to avoid the problem areas. Some of the problems may involve experimenting with the network to see how it behaves with the faulty components, and use that acquired knowledge to improve its performance, in terms of its capabilities for sensing, data processing, data storage, sensor placement,etc. As a last resort, the system may ask people for help, explaining the situation and, perhaps, describing what actions the people must take to return performance to the desired state.

Slide 12: Ethical

Reid Simmons: Ethics is one aspect of intelligent systems that has only recently begun receiving much attention by the autonomous systems community. In general, determining whether an action is “ethical” involves reasoning about the consequences of actions with respect to achieving the goals of the system and the consequences with respect to the overall social good. The social good can be defined both in terms of societal norms and legal rules. Sometimes the task and social objectives are in sync, and the system can simultaneously achieve its goals and promote the social welfare. Sometimes, however, the objectives are in conflict, and the system must reason about the trade offs involved, taking risk, costs, and benefits into account in deciding what to do in order to maintain the social good.

As an example of ethical reasoning, consider an aerial vehicle that is tasked with searching for a fugitive who is suspected of hiding out in a residential neighborhood. The vehicle is tasked with scouting the area and sending back photos to law enforcement, who will determine if the fugitive can be identified. As the vehicle flies around the neighborhood, it should be aware of the privacy concerns of the citizens, and try to avoid taking photos of innocent residents, when at all possible. On the other hand, the privacy concerns should not impede the system from achieving its goal of helping to catch the fugitive.

Perhaps a more graphical example is the one presented earlier – an autonomous vehicle that must make a split-second decision whether to swerve into oncoming traffic to avoid hitting a child who has darted into the road; injury, and perhaps death, is likely to occur in either case. Intelligent Physical Systems should recognize the associated moral imperatives and reasonably handle situations where multiple moral imperatives are in conflict.

Slide 13: Knowledge-Rich

Reid Simmons: Finally, IPS need significant amounts of knowledge in order to achieve the other characteristics. This knowledge comes in many forms, and Intelligent Physical Systems should be able to utilize these various forms of knowledge in whatever ways are appropriate to the task at hand.

Some example types of knowledge that are often important include both quantitative, or numeric, reasoning and qualitative, or symbolic, reasoning. In some situations, IPS may have sufficiently detailed knowledge of the world that quantitative reasoning is warranted, while in other situations, it may be appropriate to use high-level semantic knowledge to decide what actions to take. Mixing quantitative and qualitative reasoning is important, as systems may often need to plan at multiple levels of abstraction. For dealing with the physical world, probabilistic reasoning and planning may be beneficial, especially when combined with other forms of reasoning, such as commonsense reasoning. In short, there is no one type of knowledge that is best for all situations, and knowledge-rich IPS should utilize multiple models, at multiple levels of abstraction. To help them choose which models to use in what situations, IPS should also have knowledge of their own capabilities and reasoning processes, to enable them to introspect about how to achieve their goals, and which types, and combinations, of knowledge to utilize in order to do that.

Finally, as mentioned earlier, IPS should be capable of extending their knowledge base autonomously, through learning. The types of knowledge learned may similarly take many forms, from simple learning of parameters for models described as equations, to learning new semantic concepts, to learning semantic maps and other characteristics of the environment, to learning new models of how the system and the environment work, to learning new behaviors and strategies for achieving tasks. All this newly learned knowledge should be smoothly integrated into the existing knowledge base, enabling the IPS to become more capable, and more self-aware.

While almost any Intelligent Physical System could be an example of a knowledge-rich system, consider a smart grid that controls distribution of electricity to a large regional community. Such a system might use differential equations to model the flow of electricity in the grid and use numerical reasoning to understand how load being sensed at various locations correspond to demand for electricity in different parts of the grid. It may use semantic understanding of how those sensors work, and probabilistic reasoning about its confidence in what their readings reveal about the state of the grid, in order to decide which sensors may be providing faulty information, and should no longer be relied upon. Finally, it may use a combination of experiential knowledge and commonsense reasoning about anticipated events, such as the weather, weekends, holidays, and big sporting events, to predict what the load will be in the near future, to enable it to balance the load more effectively.

While there are undoubtedly other characteristics of Intelligent Physical Systems that are important, these are five characteristics that the Smart and Autonomous Systems program posits are critical for achieving long-term autonomy with minimal need for human intervention. Again, while proposers are free to include research into other characteristics of IPS in their submissions, the proposals must explicitly address, and focus on, at least one of these five characteristics.

I would now like to turn the presentation over to my colleague, Samee Khan, who will talk about specifics of the 2017 solicitation and submitting proposals.

Slide 14: Project Classes

Samee Khan: For this program, there are two project classes.

The **Foundational** class encapsulates research projects that advance fundamental knowledge pertaining to the IPS. These projects must focus on at least one of the research themes as described earlier. Although it is not necessary to utilize a physical testbed for the project evaluation, a thoroughly documented evaluation plan is mandatory.

The **Integrative** class encapsulates research projects that focus on the integration of at least two or more of the five research themes as described earlier. Contrary to the Foundational class, project evaluation must be done on a physical testbed. Moreover, because of the complexity of integration of at least two or more of the five research themes, we encourage the community to form teams of multiple PIs from diverse disciplines to propose projects for the Integrative class.

Slide 15: Award Information

Samee Khan: The anticipated funding for the Smart and Autonomous Systems program in the fiscal year 2017 is approximately $16.5M.

We expect to fund approximately 15 to 25 projects in the Foundational class with a budget range of $350K to $700K, and approximately 10 to 15 projects in the Integrative class with a budget range of $500K to $1.4M.

It is very important to note that in many NSF programs, the range of project class budgets are disjoint. The Smart and Autonomous program purposely has overlapping budget ranges to encourage PIs to submit to one class or the other, based primarily on their research objectives alone.

Do not let the budget cap guide your research objectives.

Slide 16: What Proposals are Good Fits for S&AS

Samee Khan: All NSF programs promote established or anticipated research thrusts. The Smart and Autonomous Systems program is no different.

Proposals from the research community, addressing the core foci of the program as outlined in the solicitation will be considered a "Good Fit." These proposals will primarily address how autonomous systems that require little or no human intervention can be conceived. These systems should adapt to changes in the environment, mission, and capabilities by reasoning, learning, self-awareness, and planning.

As stated in the program solicitation, the proposed projects must address at least one of the five research themes and must include an evaluation plan relevant to a well-described IPS. Proposers interested in exploring other research themes are strongly encouraged to contact the Smart and Autonomous Systems cognizant program directors.

Slide 17: What Proposals are Not Good Fits for S&AS

Samee Khan: Proposals that are primarily focusing on only software agents or only hardware design will not be a "Good Fit" for the Smart and Autonomous Systems program. NSF has several other programs that cater to such research activities.

Moreover, proposals primarily focusing on low-level control, formal verification and validation, and proposals primarily focusing on security also will be "Not Good Fit" for the Smart and Autonomous Systems program. For proposals with such foci, we encourage the proposers to consider other existing NSF programs.

Clarity on the scope of the Smart and Autonomous Systems program may be better understood by drawing a contrast to closely related existing NSF programs.

Slide 18: Relationships to Other Programs

Samee Khan: The Smart and Autonomous Systems program is closely related to the National Robotics Initiative program, NRI for short; and the Cyber-Physical Systems program, CPS for short. All of the three programs may have some commonalities. However, the NRI program is primarily focused on research in co-robots, human-robot interaction, self interaction, collaboration, and augmentation. The CPS program is primarily focused on research in unmanned and robotic systems, collaborative control, mixed initiative systems, design and real time systems verification, and trustworthiness.

Contrary to the NRI and CPS programs, the Smart and Autonomous Systems program is primarily focused on achieving autonomy, being self-aware, the system being adaptable, system exhibiting high-level planning and reasoning, and the system behaving ethically.

Slide 19: Eligibility Requirements

Samee Khan: Universities and colleges that are accredited and have a campus in the United States are eligible to submit proposals to the Smart and Autonomous Systems competition.

Moreover, non-profit organizations and non-academic organizations, which include research laboratories, museums, observatories, professional societies, and similar organizations within the United States that are associated with educational and research activities are also eligible to submit proposals to the Smart and Autonomous Systems competition.

Do note that at most 2 Smart and Autonomous Systems submissions are allowed in a given year for any PI, co-PI, or Senior Personnel. Again, the constraint on Senior Personnel is to be especially noted.

It also is important to note that personnel associated with industry or for-profit research laboratories are not eligible to be PIs, but can be sub awardees, providing that their budget is only a fraction of the total award amount. Also important to note is that Federally Funded Research and Development Centers can be sub awardees if they provide unique resources unavailable elsewhere.

Slide 20: Proposal Submission

Samee Khan: For the fiscal year 2017, the Smart and Autonomous Systems program has set forth a deadline of December 19, 2016 for proposal submissions. This deadline is for both classes of the proposals. We strongly encourage the community to carefully read the Smart and

Autonomous Systems solicitation and the Proposal and Award Policies Procedures Guide for a better understanding of the program and proposal preparation.

Do note that the Smart and Autonomous Systems program mandates yearly project representation at the annual PI meeting to be held in Washington DC. Consequently, travel to the yearly PI meeting must be accounted for in the submitted project budget.

Slide 21: Supplementary & Single Copy Documents

Samee Khan: The Smart and Autonomous Systems program will require proposers to detail a data management plan.

It is the responsibility of the Lead PI to submit a list of all project personnel and where applicable partner institutions. The list should include PIs and where applicable co-PIs, senior personnel, postdoctoral researchers, consultants, collaborators, sub awardees, and project advisory committee members.

A project with more than 1 PI must include a collaboration plan. The length of the plan must correspond to the complexity of the project.

If a postdoctoral researcher is involved in the project, then a postdoctoral mentoring plan is mandatory to be included.

It is also mandatory to include a single copy document that lists all of the collaborators of the proposal's PIs, co-PIs, and senior personnel. To assist with generating a single copy document, we encourage the proposers to utilize the Excel template available from the following URL: WWW dot NSF dot GOV forward slash CISE forward slash "C" "O" "L" "L" "A" "B"

Slide 22: Review Criteria

Samee Khan: Proposals submitted to the National Science Foundation are evaluated for the Intellectual Merit and Broader Impact.

In addition to the Foundation's review criteria, the Smart and Autonomous Systems program will evaluate each submission on how the proposed research achieves a high degree of autonomy for an IPS.

For the Integrative Projects, the Smart and Autonomous System program will also evaluate each submission on the innovation in system integration and the evaluations performed on physical testbeds.

Slide 23: Thanks!

Samee Khan: On behalf of the National Science Foundation, we would like to thank all of you for your time and would also like to thank you for your interest in programs at NSF.

The presentation just made and the Frequently Asked Questions will be made available in the subsequent days on the Smart and Autonomous Systems program website.

If you would have any questions pertaining to the Smart and Autonomous program, then please follow the directions of the operator to call in questions, now. Operator, we are ready to take phone-in questions.

Once again, we thank you all for your participation.