



Lunar Surface Innovation

C O N S O R T I U M

Extreme Access Focus Group Telecon

July 8, 2021

We'll start around 3:03

Dr. Angela Stickle
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JHU Applied Physics Laboratory

Facilitator_ExtremeAccess@jhuapl.edu



JOHNS HOPKINS
APPLIED PHYSICS LABORATORY

Today's Agenda

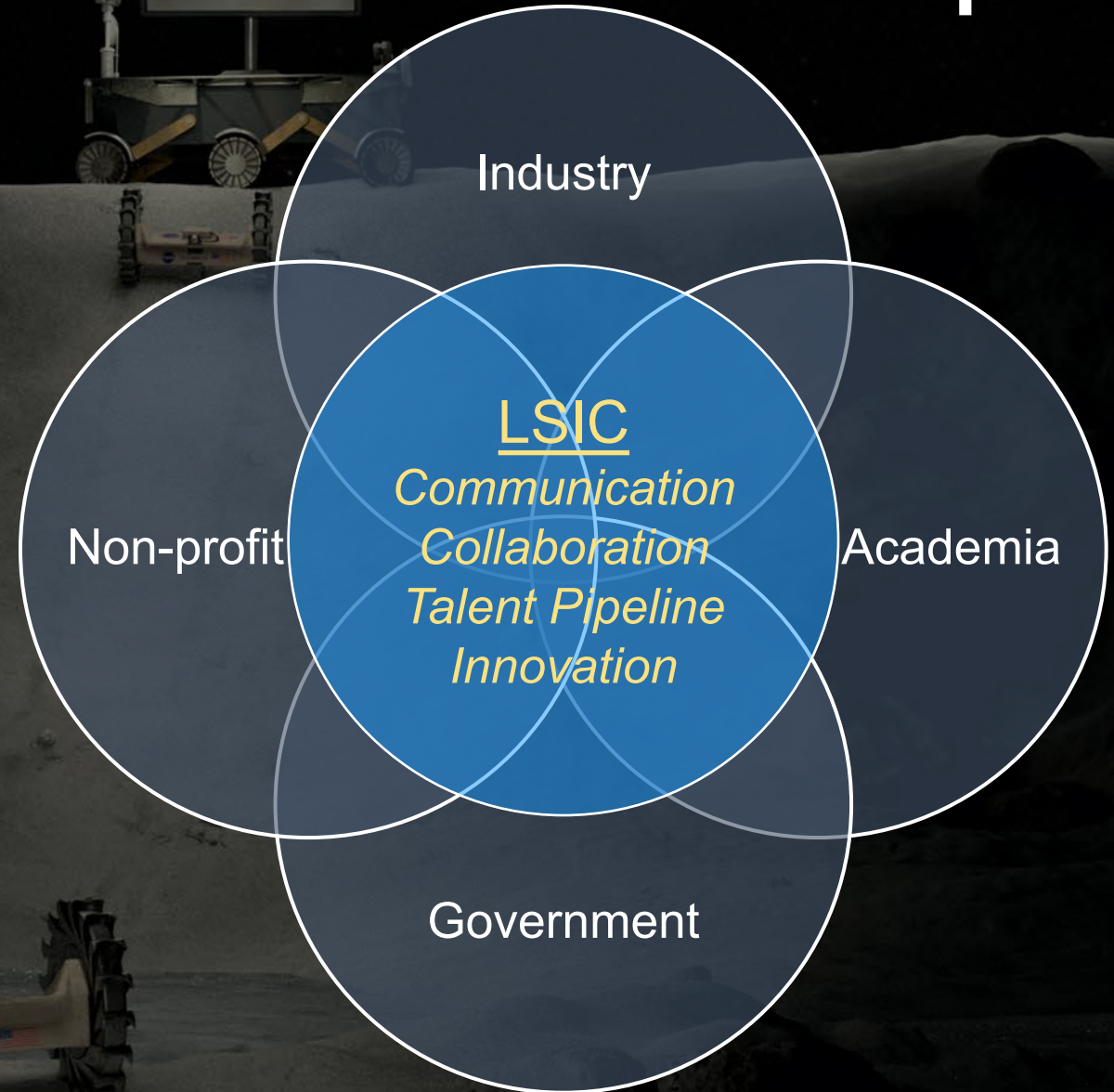
The background of the slide is a dark, grayscale image of a lunar surface. In the upper center, a lunar lander is visible, with a rover positioned in front of it. The terrain is covered in dust and small rocks, with a large shadow cast by the lander and rover. The overall scene is dimly lit, emphasizing the rugged and desolate environment of the moon.

- Year 2!
- LSIC Focus Group Updates
- Upcoming Meetings/Opportunities
- Subgroup Introductions
- Technology Spotlights
- Open floor and Discussion

Happy birthday Extreme Access Focus Group!

Our first telecon was June 18, 2020

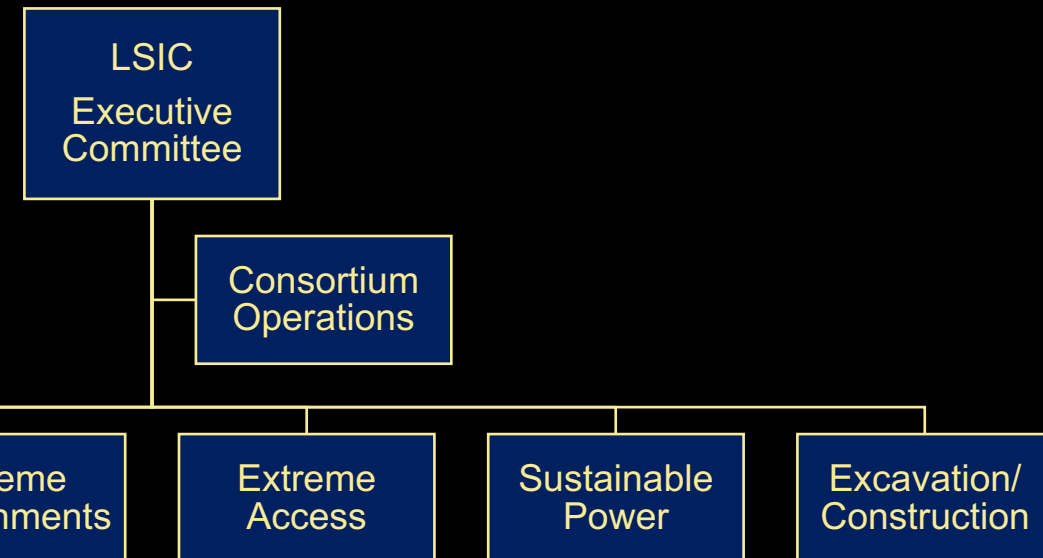
1. Harness the creativity, energy and resources of academia, industry, non-profits, and government in order for NASA to keep the United States at the forefront of lunar exploration
2. Identify lunar surface technology developments most in need of sponsor support and communicate those to NASA
3. Provide a central resource for gathering and disseminating information, results, and documentation



Charter & Structure

- **Technology** – Accelerate the development of key lunar surface infrastructure capabilities
- **Collaboration** – Enable meaningful partnerships across industry, academia, and government that leverage common goals and objectives for establishing lunar surface infrastructure capabilities
- **Communication** – Create information paths and relationships to best match needs with opportunities
- **Future Workforce** – Ensure that the U.S. maintains the workforce needed for sustained space exploration

The LSIC is a nationwide alliance of universities, non-profit research institutions, commercial companies, NASA centers and program offices, and other government agencies with a vested interest in our nation's campaign to establish a sustained presence on the Moon.



Technology Focus Groups ➤

Value to You

- Communication and information
- Access to contextual information for lunar surface
- Understanding the technology landscape and development plans for other sectors
- Early identification and collaboration with developers of emerging technologies
- Influence into setting of standards together with greater community
- Ability to identify technology gaps and suggest technical priorities for NASA
- Partnerships for maturation and implementation of new technology
- Recruiting of new talent
- Frequent communications with sponsor
- Visibility into technology development



LSIC Code of Conduct and Other Resources

Resources: LSIC Resources

LSIC and LSII Resources

- [Code of Conduct \(PDF\)](#)
- [Welcome Package \(PDF\)](#)
- [Listserv Overview \(PDF\)](#)
- [NASA Lunar Surface Innovation Initiative](#)
- [NASA Space Technology Mission Directorate](#)
- [Lunar Simulants](#)

<http://lsic.jhuapl.edu/Resources/LSIC-Resources.php>

[Dashboard](#) / [Extreme Access Home](#) / [EA Monthly Meeting](#) 

 [Edit](#)  [Save for later](#)  [Watching](#)  [Share](#) 

8 July 2021

Created by Angela Stickle, last modified just a moment ago

Welcome to the July meeting of the Extreme Access Focus group!

Add a comment below to sign in and discuss.

Please add yourself to the [Who's Who](#) if you haven't had a chance. Feel free to add any info about what you're hoping to

Discussion Topics

[LSIC general updates](#)

[Subgroup Introductions](#)

Technology Spotlights

[Technology Spotlight: Cody Kelly \(GSFC\), LunaSAR \(search and rescue beacons for the Moon\)](#)

[Technology Spotlight: Tim Crain and Matt Atwell \(Intuitive Machines\), Lunar Mico-nova Deployable Hopper](#)

 [Like](#) Be the first to like this

No labels 



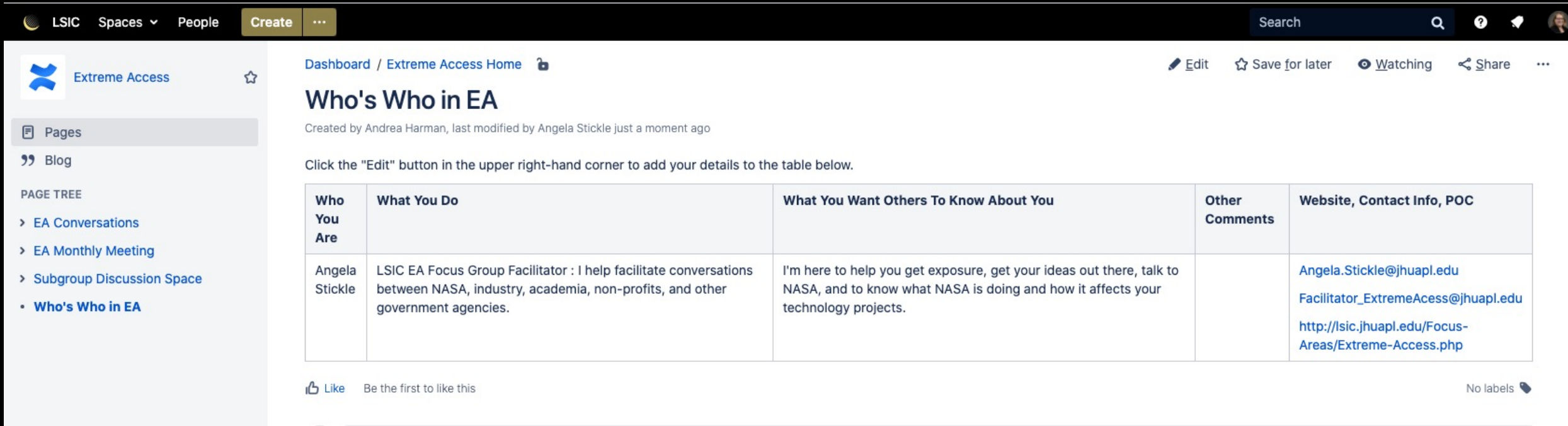
Write a comment...

1. Add a comment to sign in
2. Selecta an agenda topic and comment your thoughts
3. Follow-up after the telecon to continue to discussion!

Confluence is an important resource to provide asynchronous discussion opportunities and a record of conversations

Get to know the community

<https://lsic-wiki.jhuapl.edu/x/0IVf>



LSIC Spaces People Create ... Search

Extreme Access

Dashboard / Extreme Access Home

Who's Who in EA

Created by Andrea Harman, last modified by Angela Stickle just a moment ago

Click the "Edit" button in the upper right-hand corner to add your details to the table below.

Who You Are	What You Do	What You Want Others To Know About You	Other Comments	Website, Contact Info, POC
Angela Stickle	LSIC EA Focus Group Facilitator : I help facilitate conversations between NASA, industry, academia, non-profits, and other government agencies.	I'm here to help you get exposure, get your ideas out there, talk to NASA, and to know what NASA is doing and how it affects your technology projects.		Angela.Stickle@jhuapl.edu Facilitator_ExtremeAccess@jhuapl.edu http://lsic.jhuapl.edu/Focus-Areas/Extreme-Access.php

Like Be the first to like this No labels

Who's Who in ISRU: <https://lsic-wiki.jhuapl.edu/display/ISRU/Who%27s+Who+in+ISRU>

Who's Who in Surface Power: <https://lsic-wiki.jhuapl.edu/display/SP/Who%27s+Who+in+LSIC-Surface+Power>

Who's Who in E&C: <https://lsic-wiki.jhuapl.edu/pages/viewpage.action?pageId=6260179>

Who's Who in EE: <https://lsic-wiki.jhuapl.edu/display/EE/Who%27s+Who+in+LSIC-EE>

LSIC | Surface Power User Survey

- Inventory of potential lunar surface power users and needs
- The information you provide will shape our feedback to NASA, which can **directly influence future solicitations** and the direction of the field.

Responses will be anonymized, and can be updated on Confluence as technologies develop

<https://forms.gle/yhvxA3xoYKMAU587>



Power User Survey

The Lunar Surface Innovation Consortium Surface Power Focus Group is conducting an inventory of potential lunar surface power users and needs. The purpose of this Power User Survey is to capture the power needs of different systems that will be used for lunar exploration and human presence on the Moon.

How much power does it take to accomplish a primary objective of your system?
How long does it take to accomplish this primary objective? *

Your answer

What are the power needs of this technology's/system's operation during periods of lunar night (electrical and/or thermal)? Consider shorter and longer durations as appropriate for your relevant lunar environment.

LSIC | Workshop Power Beaming for the Lunar Surface

July 22-23, 12:00-5:00 pm ET

Day 1: Context and Demand

Day 2: Deeper Technical Discussions

The challenge of delivering power across the lunar surface is exceptional. The absence of infrastructure, operations in permanently shadowed regions, and unique aspects of the lunar environment provide a potential niche for power beaming solutions. In this LSIC workshop, we will explore the role of wireless power transfer, or power beaming, to deliver power on the lunar surface.

Day one of the workshop will engage a broad audience through content covering context and demand as well as an overview of power beaming, with time for small group break-out discussions on power beaming use-cases. This will both inform the lunar community of the scope of what is possible with power beaming, as well as provide power beaming experts an opportunity to engage with lunar experts for a wholistic understanding.

Day two will delve deeper into technical talks and discussions, with plenary talks on power beaming technologies recently funded by NASA, a panel discussion, “challenges and critical steps to advance power beaming,” and technically-focused breakout sessions.

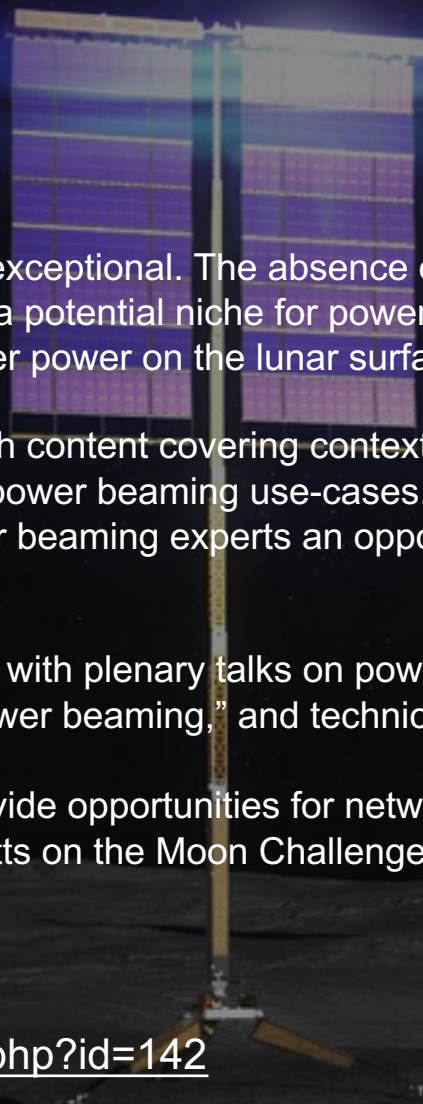
We encourage participation from all stakeholders, and will provide opportunities for networking and forming partnerships to pursue opportunities in power beaming, such as the pending second phase of the Watts on the Moon Challenge.

Registration:

<http://lsic.jhuapl.edu/News-and-Events/Agenda/index.php?id=142>

Confluence Discussion:

<https://lsic-wiki.jhuapl.edu/display/SP/Power+Beaming+Workshop>



- **Save the date : August 20th, 2 PM - 4:30 PM, Eastern**
- An extended monthly meeting in lieu of regular meeting.
- Workshop Theme: **High-TRL Technologies for initial infrastructure development and LLP.**
- Tentative Agenda:
 - NASA E&C Roadmap.
 - Break-out sessions:
 - High-TRL technology for initial infrastructure development
 - Power needs for E&C
 - Panel discussion on Landing and Launch Pads (LLP)

Your participation will help shape these activities. More information will be shared in the coming weeks.



Save the Date! LSIC 2021 Fall Meeting

- November 3-4, 2021
- Hybrid Meeting, in-person events taking place at Bowie State University (Bowie, MD)
- Please fill out this short survey to assist with planning:
 - <https://forms.gle/DpdnJM5LPiXwcste7>



Upcoming Meetings

- Focus Group Telecons (2nd Thursday each month, 3-4 pm EST)
 - July 8, 2021
 - August 12, 2021
- Lunar Surface Science Workshop
 - Fundamental and Applied Lunar Surface Research in Physical Sciences (August 18-19, 2021)
 - Free, but **registration is required, deadline Aug. 13**
 - <https://www.hou.usra.edu/meetings/lunarsurface2020/>

This physical sciences workshop will focus on:

- Lunar dust and its properties, behavior, and mitigation
- Life support and thermal management
- Materials flammability and habitat fire safety
- Extraction of water-ice from regolith research, including separation, purification, electrolysis, and liquefaction
- Lunar environment and its effects on materials
- Lunar research in extraction, processing, and handling
- Lunar research for advanced manufacturing
- Fundamental physics research on the lunar surface



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 - <https://www.hou.usra.edu/meetings/lunarsurface2020/>
- LSIC Surface Power – Power Beaming Workshop (July 22-23, 12:00-5:00 pm ET)
 - **Registration Closes July 14**
 - **This event is not exclusive to LSIC, and the registration link can be shared with other interested parties**
 - Day 1: Context and Demand
 - Day 2: Deeper Technical Discussions

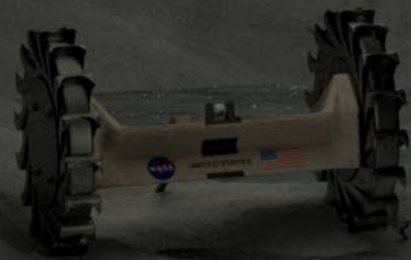


Other Notes of Interest

- PNT subgroup meeting, 15 July 3 pm ET
- TRN subgroup kickoff, early-mid July

- Current Funding Opportunities:
 - SpaceTech-REDDI-2021 Appendix F1: Tech Flights Now Open
 - Mandatory Preliminary Proposal (MPP) is due July 26, 2021, at 5:00 pm ET
 - <https://tinyurl.com/NASA-21FO-F1>

- <http://lsic.jhuapl.edu/Resources/Funding-Opportunities.php>





LSIC Extreme Access Year 2 Goals

Vision: Build a community specializing in technology required to access, navigate, and explore surface and subsurface areas on the Moon. Identify areas of interest in technology development, evaluate readiness, and provide a resource for members to gain & share information, network, and discuss technology needs for lunar exploration.

Year 2 Goals:

Identify mission/system elements needed to provide access in challenging lunar environments, including identifying specific technology needs and gaps, prioritizing development timelines, and providing a general roadmap and recommendations for needed technology, testing, and demonstrations.

- *PSRs and lunar pits/lava tubes were chosen as high priority environments*
- *We will work with the EE group to identify environment requirements and challenges*
- *Conduct at least 1 technical interchange meeting*

Build a community and develop collaborative relationships among members

- Inclusive monthly telecons with member technology spotlights
- Provide networking opportunities at large LSIC meetings, mentoring through LSIC channels
- Community-led subgroups for in depth discussions and networking

We are now on Step-3/4!

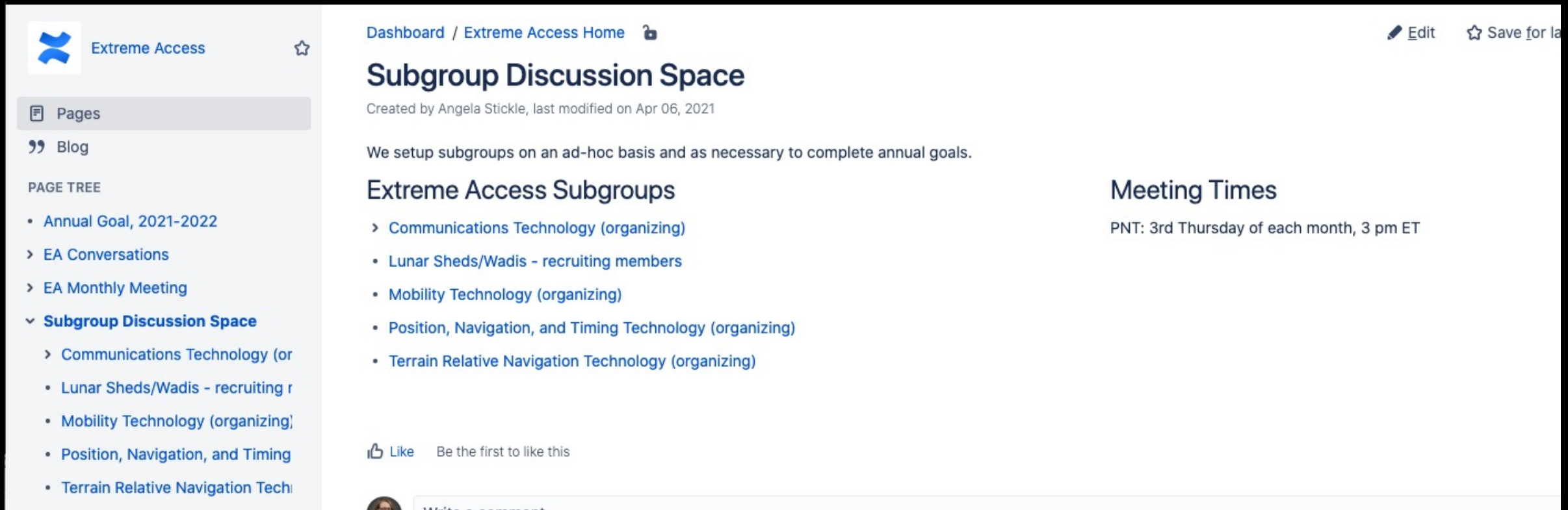
- ✓ Identify areas and/or environments of interest
- ✓ Pick 1-2. –PSRs and Lunar pits/lava tubes
- 3. Identify specific architectures to enable exploration of these areas. What are the environments like? What are the needs for mobility, PNT, comms, autonomy?
- 4. Evaluate current technology availability, compare to what is needed for (3). This will likely involve standing up several smaller subgroups.
- 5. Identify gaps, prioritize which are more important to close first
- 6. Roadmap, determine recommendations for specific tech development and/or demos
- 7. Throughout: keep in mind where will need input or tech crossover from other focus groups. Where does technology development require multiple inputs?
- 8. Write a report of some sort

An aerial view of a lunar base on a dark, rocky surface. In the center, a large white and yellow lander is parked. To its left, a tall antenna structure stands. In the foreground, three satellite dishes are arranged in a row. A small rover is visible in the upper left, and another rover is partially visible in the lower right. The terrain is rugged and uneven.

LSII | Extreme Access

Developing technologies that enable humans or robotic systems to efficiently access, navigate, and explore previously inaccessible lunar surface or subsurface areas

- Technical areas of interest include:
 - Mobility
 - Navigation and hazard detection
 - Autonomous Systems
 - Communication
 - Avionics
 - Accessing steep slopes, rocky terrain, or subsurface voids
 - Operating in PSRs, surviving lunar noon/night
 - Long-duration missions and sample return

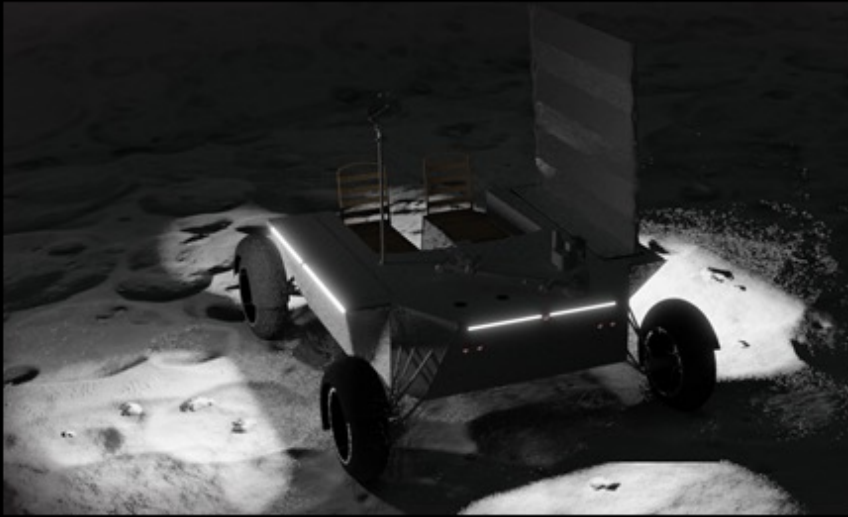


The screenshot shows a Confluence page for 'Extreme Access'. The page title is 'Subgroup Discussion Space', created by Angela Stickle on April 06, 2021. The main content states: 'We setup subgroups on an ad-hoc basis and as necessary to complete annual goals.' Below this is a section titled 'Extreme Access Subgroups' with a list of five items: 'Communications Technology (organizing)', 'Lunar Sheds/Wadis - recruiting members', 'Mobility Technology (organizing)', 'Position, Navigation, and Timing Technology (organizing)', and 'Terrain Relative Navigation Technology (organizing)'. To the right, there is a section titled 'Meeting Times' with the text 'PNT: 3rd Thursday of each month, 3 pm ET'. The left sidebar shows a navigation menu with 'Pages', 'Blog', and a 'PAGE TREE' containing 'Annual Goal, 2021-2022', 'EA Conversations', 'EA Monthly Meeting', and 'Subgroup Discussion Space' (which is expanded to show the same list of subgroups as the main content).

Subgroup formation to facilitate more in-depth discussions of technology and gaps

- Recruiting deputies and participants.
- Expectation: 1 subgroup meeting (outside EA monthly telecon) to discuss ongoing tasks
- We will have occasional report-outs at regular monthly telecons
- Confluence can be used for discussion and resource compilation

- LSIC EA Subgroup Coordinator: Alice Cocoros (Alice.Cocoros@jhuapl.edu)
- PNT Technology – Lead: Sarah Withee, Deputy: Marshall Eubanks
 - Meetings 3rd Thursday, 3 pm ET
- TRN Technology – Lead: Carolina Restrepo, Deputy: Ike Witte
- Mobility Technology – Lead: Maneesh Kumar Verma, Deputy: Kevin Kempton
- Communications Technology – Lead: Juno Woods, Deputy: Konrad Nieradka
- Lunar Sheds/Wadis –Lead: Joseph Galante



Reach and operate at sites of scientific interest in extreme surface terrain or free-space; crewed and uncrewed

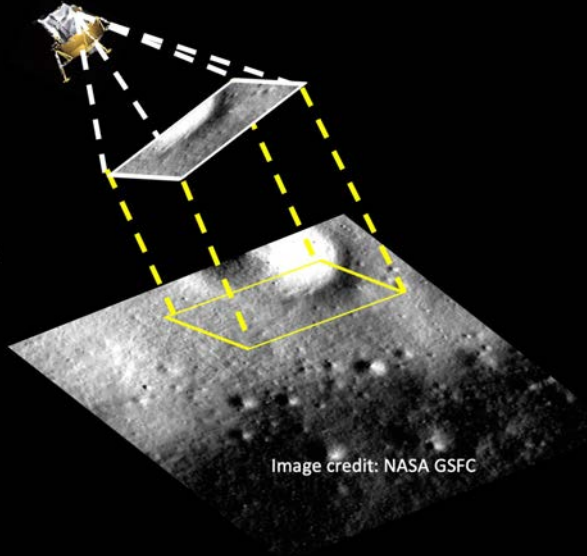
- *Surface Mobility*
 - *Above (and Extreme-Terrain)*
 - *Below*
- *Small-Body and Microgravity Mobility*
- *Collaborative Mobility*
- *Mobility Components*
 - *Robot Navigation (in cooperation with PNTSG)*
 - *Level of Autonomy*
 - *Crew's safety*
 - *Deployment*
 - *Power*

- ***Who is it for?*** All who are interested in overall design and operations of lunar mobile platforms
- ***What do we do?*** Help NASA prioritize development of mobility technologies and provide novel alternatives to standing problems.
- ***Where do we meet?*** Zoom Online Platform (Link TBD)
- ***When do we meet?*** Every 3 weeks on Thursdays starting TBD at TBD hrs.

Next Steps:

- *Establish current state of mobility technologies/missions*
- *Identify potential missions planned by different space agencies and companies.*
- *Identify and evaluate future missions' goals and solutions proposed.*
- *Identify and establish state-of-the-art technologies for problems faced by proposed missions.*
- *Establish technology development map/Technology candidates/Types of missions – types of mobile platforms/ConOps Alternatives /Functionalities/Locomotion methods/ etc.*

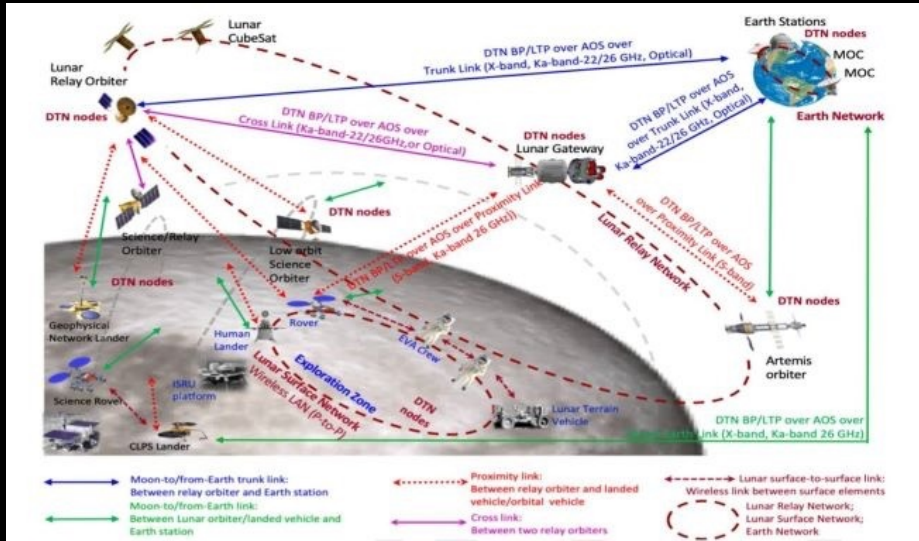
EA TRN Quad Chart



- *Overall goal: Discuss gaps and needs for Lunar Terrain Relative Navigation*
 - *Lunar data sets*
 - *Hardware/software issues*
 - *Mapping or analysis tool limitations*
 - *Terrain rendering tools*

- *Virtual Monthly meeting topics:*
- *Collect and share TRN related information that applies to any mission*
- *Discuss available tools and data sets*
- *Presentations on TRN, Hazard Detection related topics*

- *First meeting in July 2021*
- *Discussion will focus on outcomes of the Workshop on Lunar Mapping for Precision Landing held in March*
- *POCs*
 - *APL: Alice.Cocoros@jhuapl.edu*
 - *NASA: Carolina.i.restrepo@nasa.gov*



• Subgroup Goal

- Determine what technologies for extreme access exploration of the lunar surface:
 - § already exist
 - § need to be modified for lunar surface work (dust mitigation, dealing with electrostatic discharge, etc.)
 - § need to be developed
- Identify a timeline for technologies that are not currently ready to fly, as well as potential providers, to avoid duplication of effort

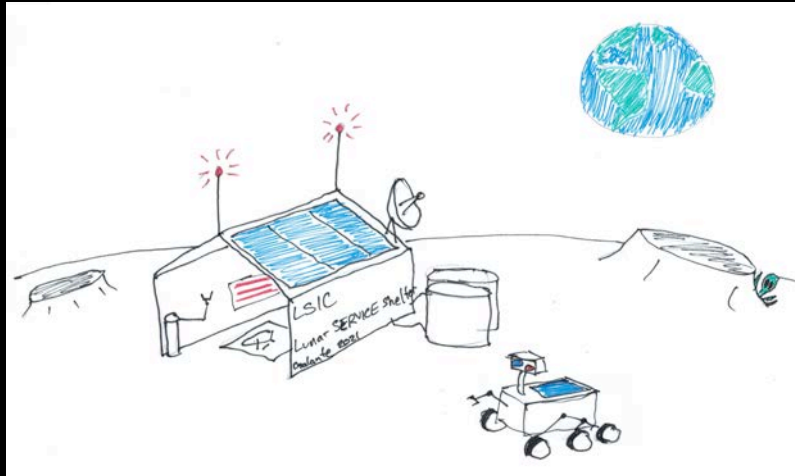
• Top level questions to address

- Suitability of different comms options for specific EA environments (PSRs, lavatubes, polar regions, etc.)
- What kind of tech demos on the lunar surface are necessary to bring comms systems to a higher TRL level?
- What tech demos are already planned and by whom? Which demos should be undertaken by NASA or others?
- What comms solutions are current planned missions using for extreme environments?

• Meetings, next steps, contact info

- First discussion will be held July 8 at 3 pm ET
- Meetings will be announced on EA listserv
- Contact Juno Woods for more info

Lunar Surface Environs Robotic Vehicle Inspection Cleaning rEcharging (SERVICE) Shelters



Goal: Identify services/standards for Lunar mobility platform servicing at various levels of development

- *What services/standards are in place for CLPS landers?*
 - *What extra services can be offered at little to no additional cost?*
- *What services/standards are needed for exploration class missions? Lunar base support? ISRU mining operations?*
- *What infrastructure, information, standards, policies, and incentives should NASA put in place to spur private sector investment?*

Notional surface mobility services

- *Power generation/recharging*
- *Visual inspection*
- *Thermal shelter against lunar night, lunar noon (equatorial)*
- *Dust removal (charged particle shower)*
- *Earth communications relay, navigation beacon*
- *Maintenance, repair, spare part repository*
- *Hydrogen, Oxygen, Water production via ISRU*

Subgroup Next Steps

- *Survey capabilities by existing CLPS providers*
- *Survey surface mobility developers for desired capabilities*
- *Compile/maintain desired/available services listing*
 - *Host on wiki, periodic reporting at LSIC meetings?*
- *Identify critical technology gaps and TRL maturation activities*
- *Suggest services and relevant standards for various tiers of mission concepts*

Technology Spotlight

**Dr. Tim Craine and Matt Atwell– Intuitive Machines Micro-nova
Deployable Hopper**

Technology Spotlight

Dr. Cody Kelly– LunaSAR



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- Confluence is our record of discussions and a good repository
 - Confluence is free to you and available to all registered LSIC members
 - We will be using Confluence to document discussions and provide resources to LSIC members. All focus groups have a separate page so it's a good collaboration space.
 - To request an account, please email Andrea Harman: ams573@alumni.psu.edu
- Technology Spotlights/Lightning Talks at monthly telecons
 - Anyone can volunteer to give a lightning talk (10-20 mins)
 - Email Angela or Sarah, or comment on Confluence, to sign up!
- Updates to the webpage - <http://lsic.jhuapl.edu/Focus-Areas/Extreme-Access.php>
 - Notes, slides, recordings from telecons posted here

Follow the Code of Conduct for all Focus Group communications

Contact information

LSIC Director: Rachel Klima, SES-LSIC-Director@jhuapl.edu
<http://lsic.jhuapl.edu>

Focus Group Area	Listserv address	Facilitator
In-Situ Resource Utilization	LSIC_ISRU@listserv.jhuapl.edu	Karl Hibbitts
Surface Power	LSIC_Power@listserv.jhuapl.edu	Wes Fuhrman
Extreme Environments	LSIC_ExtremeEnvironment@listserv.jhuapl.edu	Ben Greenhagen
Extreme Access	LSIC_ExtremeAccess@listserv.jhuapl.edu	Angela Stickle
Excavation and Construction	LSIC_ExcavationConstruction@listserv.jhuapl.edu	Athonu Chatterjee
Dust Mitigation	LSIC_DustMitigation@listserv.jhuapl.edu	Jorge Núñez



LSIC Meeting Cadence

- **Bi-Annual Meetings (Spring and Fall)**
 - May 11-12 Spring Meeting (accepting Abstracts now)
- **Monthly Focus Group Meetings**
 - 2nd Tuesday of the Month 3:00-4:00 pm – Extreme Environment
 - 2nd Thursday of the Month 3:00-4:00 pm – Extreme Access
 - 3rd Wednesday of the Month 3:00-4:00 pm – ISRU
 - 3rd Thursday of the Month 12:00-1:00 pm – Dust Mitigation
 - 4th Thursday of the Month 11:00 am-12:00 pm – Surface Power
 - Last Friday of the Month 3:00-4:00 – Excavation and Construction
- **Thematic Workshops (as identified by FGs and NASA POCs)**
 - Workshops In development Funding, CLPS Provider, and Power Beaming

STMD Opportunities for Academia and Industry

STMD anticipates awarding ~\$600M to academia and industry supporting 2020 solicitations & awards

STMD Tipping Point Multiple Awards: *Jan – Mar 2020*

\$250M

Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR) Phases I, II, II-E, Civilian Commercialization Readiness Pilot Program (CCRPP), Sequential: *Phase I Solicitation Jan – Apr 2020*

\$212M

Announcement of Collaborative Opportunity (ACO): *Jan – Mar 2020*

\$10M

Flight Opportunities Tech Flights: *Feb – May 2020*

\$10M

Early Career Faculty (ECF): *Feb – Apr 2020*

\$6M

Early Stage Innovations (ESI): *Apr – Jun 2020*

\$9M

NASA Innovative Advanced Concepts (NIAC) Phases I, II, III: *Phase I Solicitation Jun – Jul 2020*

\$4M

Space Technology Research Institutes (STRI): *Jun – Aug 2020*

\$30M

NASA Space Technology Graduate Research Opportunities (NSTGRO): *Sep – Nov 2020*

\$19M

SmallSat Technology Partnerships (STP): *Sep – Nov 2021*

\$3M

Centennial Challenges: *Varied release dates*

\$8M

NextSTEP Broad Agency Announcements (BAAs): *Varied release dates*

Varies

Lunar Surface Technology Research (LuSTR) Opportunities: *Coming soon!!!*

\$30M

Note: Funding awards are approximate and subject to change

Open Solicitations as of June 5, 2020

Solicitations were/will be open in the timeframe specified in italics