

AERPAW: Advanced Wireless Meets Aerial Autonomy—At Scale

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North Carolina State University



2026 PAWR PI Meeting September 28, 2026



OUTLINE

The Testbed – What does AERPAW actually operate?

Capabilities – What can researchers actually do?

From NSF-Funded Testbed to Sustainable Research Infrastructure

Outreach – How we build and support our community

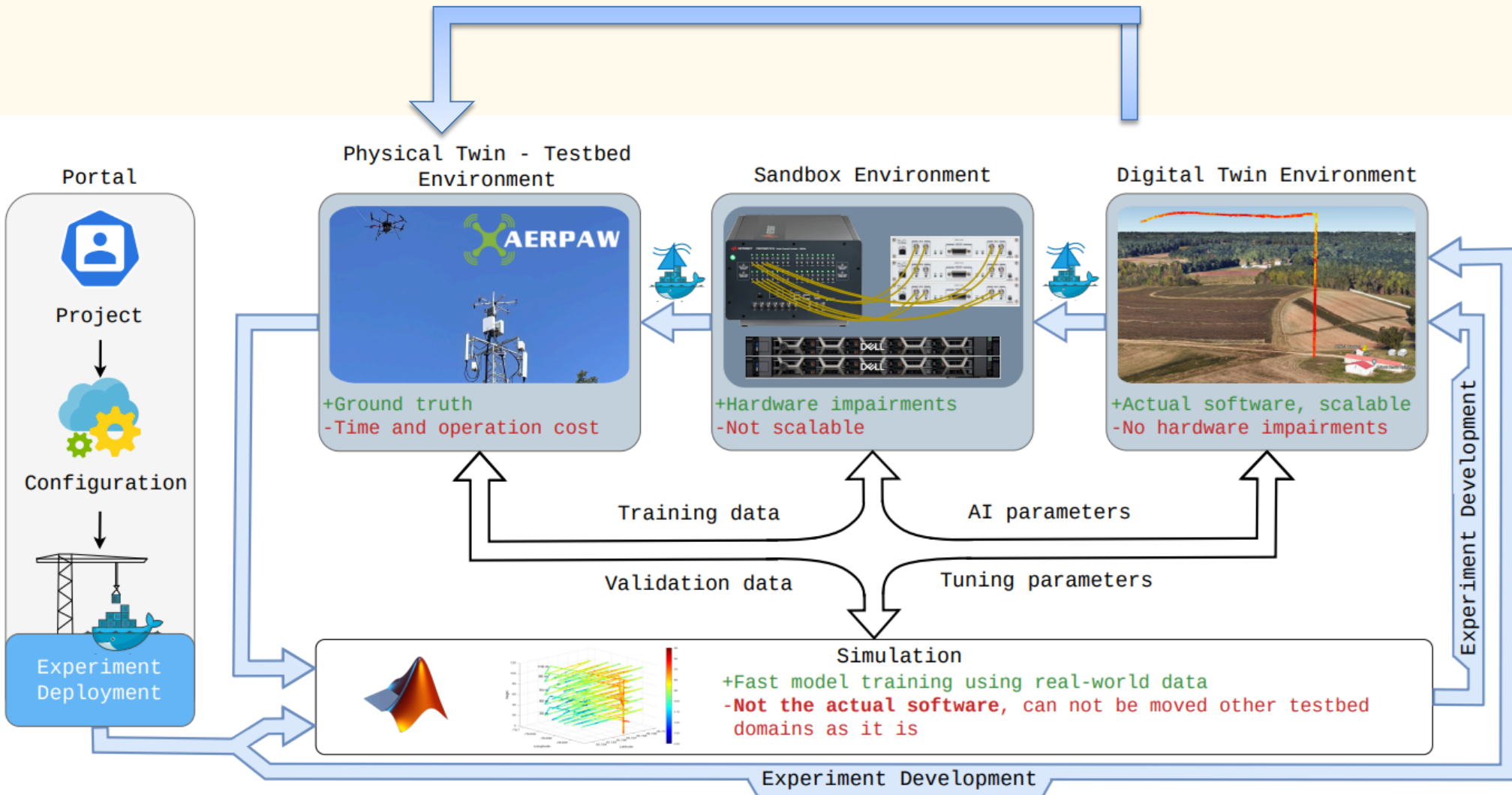
Impact – What difference is AERPAW making?

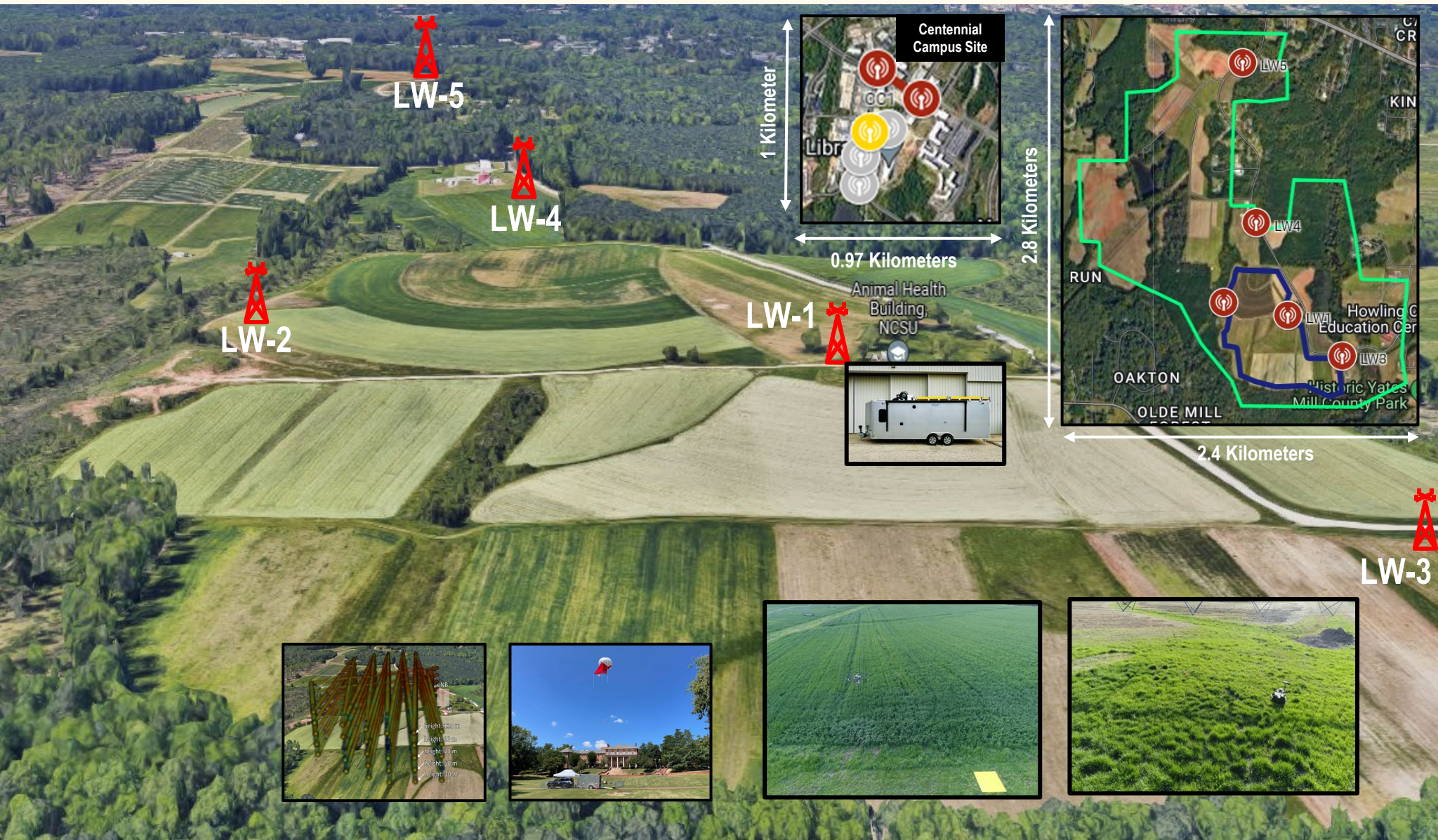
Lessons Learned Operating AERPAW

Future Outlook

The Testbed

What does AERPAW actually operate?





O-RAN
Global
PlugFest

Fall 2024

Plugged in

 PlugFest
Host

KEYSIGHT Test Automation - Wave3

File Settings Tools View Help

Pathwave Test Automation TC 3.2.5.1.1

Test Plan Wave3*

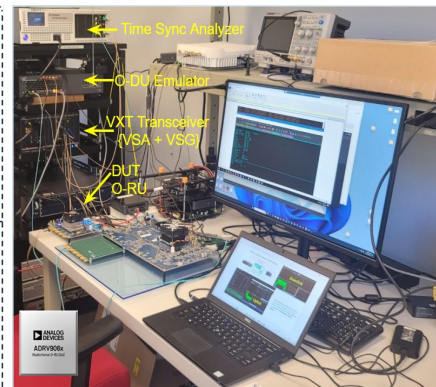
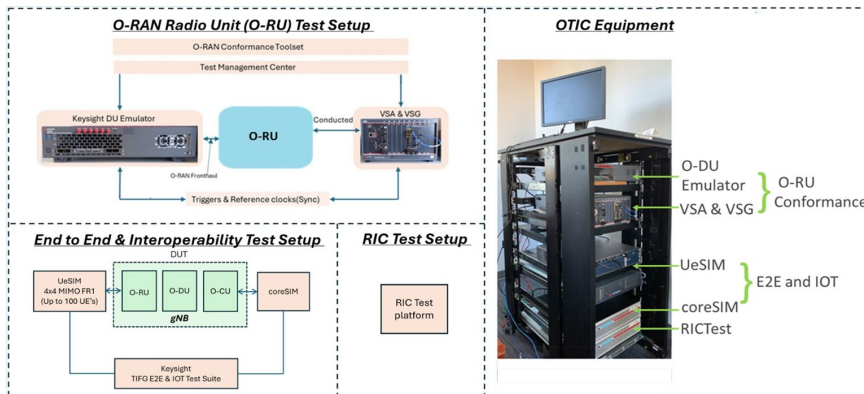
Completed in 2m 57s

Name	Verdict	Duration	Flow	Type
3.2.5.1.1 UC Plane OR Scenario Class Base R3PDP DL/UL	Pass	2m 30s	Keysight O-RAN Radio Unit Test Automation Solution / Test Cases / V	Download
Configure Pathwave Signal Generator	Pass	15.60s	Keysight O-RAN Radio Unit Test Automation Solution / Pathwave Sig	Download
Switch Ports	Pass	1m 17s	Basic Steps / Dialog	Download
UpLink	Pass	53.47s	UpLink	Download

0 0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.0 3.1 3.2 3.3 3.4 3.5 3.6 3.7 3.8 3.9 4.0 4.1 4.2 4.3 4.4 4.5 4.6 4.7 4.8 4.9 5.0 5.1 5.2 5.3 5.4 5.5 5.6 5.7 5.8 5.9 6.0 6.1 6.2 6.3 6.4 6.5 6.6 6.7 6.8 6.9 7.0 7.1 7.2 7.3 7.4 7.5 7.6 7.7 7.8 7.9 8.0 8.1 8.2 8.3 8.4 8.5 8.6 8.7 8.8 8.9 9.0 9.1 9.2 9.3 9.4 9.5 9.6 9.7 9.8 9.9 10.0 10.1 10.2 10.3 10.4 10.5 10.6 10.7 10.8 10.9 11.0 11.1 11.2 11.3 11.4 11.5 11.6 11.7 11.8 11.9 12.0 12.1 12.2 12.3 12.4 12.5 12.6 12.7 12.8 12.9 13.0 13.1 13.2 13.3 13.4 13.5 13.6 13.7 13.8 13.9 14.0 14.1 14.2 14.3 14.4 14.5 14.6 14.7 14.8 14.9 15.0 15.1 15.2 15.3 15.4 15.5 15.6 15.7 15.8 15.9 16.0 16.1 16.2 16.3 16.4 16.5 16.6 16.7 16.8 16.9 17.0 17.1 17.2 17.3 17.4 17.5 17.6 17.7 17.8 17.9 18.0 18.1 18.2 18.3 18.4 18.5 18.6 18.7 18.8 18.9 19.0 19.1 19.2 19.3 19.4 19.5 19.6 19.7 19.8 19.9 20.0 20.1 20.2 20.3 20.4 20.5 20.6 20.7 20.8 20.9 21.0 21.1 21.2 21.3 21.4 21.5 21.6 21.7 21.8 21.9 22.0 22.1 22.2 22.3 22.4 22.5 22.6 22.7 22.8 22.9 23.0 23.1 23.2 23.3 23.4 23.5 23.6 23.7 23.8 23.9 24.0 24.1 24.2 24.3 24.4 24.5 24.6 24.7 24.8 24.9 25.0 25.1 25.2 25.3 25.4 25.5 25.6 25.7 25.8 25.9 26.0 26.1 26.2 26.3 26.4 26.5 26.6 26.7 26.8 26.9 27.0 27.1 27.2 27.3 27.4 27.5 27.6 27.7 27.8 27.9 28.0 28.1 28.2 28.3 28.4 28.5 28.6 28.7 28.8 28.9 29.0 29.1 29.2 29.3 29.4 29.5 29.6 29.7 29.8 29.9 30.0 30.1 30.2 30.3 30.4 30.5 30.6 30.7 30.8 30.9 31.0 31.1 31.2 31.3 31.4 31.5 31.6 31.7 31.8 31.9 32.0 32.1 32.2 32.3 32.4 32.5 32.6 32.7 32.8 32.9 33.0 33.1 33.2 33.3 33.4 33.5 33.6 33.7 33.8 33.9 34.0 34.1 34.2 34.3 34.4 34.5 34.6 34.7 34.8 34.9 35.0 35.1 35.2 35.3 35.4 35.5 35.6 35.7 35.8 35.9 36.0 36.1 36.2 36.3 36.4 36.5 36.6 36.7 36.8 36.9 37.0 37.1 37.2 37.3 37.4 37.5 37.6 37.7 37.8 37.9 38.0 38.1 38.2 38.3 38.4 38.5 38.6 38.7 38.8 38.9 39.0 39.1 39.2 39.3 39.4 39.5 39.6 39.7 39.8 39.9 40.0 40.1 40.2 40.3 40.4 40.5 40.6 40.7 40.8 40.9 41.0 41.1 41.2 41.3 41.4 41.5 41.6 41.7 41.8 41.9 42.0 42.1 42.2 42.3 42.4 42.5 42.6 42.7 42.8 42.9 43.0 43.1 43.2 43.3 43.4 43.5 43.6 43.7 43.8 43.9 44.0 44.1 44.2 44.3 44.4 44.5 44.6 44.7 44.8 44.9 45.0 45.1 45.2 45.3 45.4 45.5 45.6 45.7 45.8 45.9 46.0 46.1 46.2 46.3 46.4 46.5 46.6 46.7 46.8 46.9 47.0 47.1 47.2 47.3 47.4 47.5 47.6 47.7 47.8 47.9 48.0 48.1 48.2 48.3 48.4 48.5 48.6 48.7 48.8 48.9 49.0 49.1 49.2 49.3 49.4 49.5 49.6 49.7 49.8 49.9 50.0 50.1 50.2 50.3 50.4 50.5 50.6 50.7 50.8 50.9 51.0 51.1 51.2 51.3 51.4 51.5 51.6 51.7 51.8 51.9 52.0 52.1 52.2 52.3 52.4 52.5 52.6 52.7 52.8 52.9 53.0 53.1 53.2 53.3 53.4 53.5 53.6 53.7 53.8 53.9 54.0 54.1 54.2 54.3 54.4 54.5 54.6 54.7 54.8 54.9 55.0 55.1 55.2 55.3 55.4 55.5 55.6 55.7 55.8 55.9 56.0 56.1 56.2 56.3 56.4 56.5 56.6 56.7 56.8 56.9 57.0 57.1 57.2 57.3 57.4 57.5 57.6 57.7 57.8 57.9 58.0 58.1 58.2 58.3 58.4 58.5 58.6 58.7 58.8 58.9 59.0 59.1 59.2 59.3 59.4 59.5 59.6 59.7 59.8 59.9 60.0 60.1 60.2 60.3 60.4 60.5 60.6 60.7 60.8 60.9 61.0 61.1 61.2 61.3 61.4 61.5 61.6 61.7 61.8 61.9 62.0 62.1 62.2 62.3 62.4 62.5 62.6 62.7 62.8 62.9 63.0 63.1 63.2 63.3 63.4 63.5 63.6 63.7 63.8 63.9 64.0 64.1 64.2 64.3 64.4 64.5 64.6 64.7 64.8 64.9 65.0 65.1 65.2 65.3 65.4 65.5 65.6 65.7 65.8 65.9 66.0 66.1 66.2 66.3 66.4 66.5 66.6 66.7 66.8 66.9 67.0 67.1 67.2 67.3 67.4 67.5 67.6 67.7 67.8 67.9 68.0 68.1 68.2 68.3 68.4 68.5 68.6 68.7 68.8 68.9 69.0 69.1 69.2 69.3 69.4 69.5 69.6 69.7 69.8 69.9 70.0 70.1 70.2 70.3 70.4 70.5 70.6 70.7 70.8 70.9 71.0 71.1 71.2 71.3 71.4 71.5 71.6 71.7 71.8 71.9 72.0 72.1 72.2 72.3 72.4 72.5 72.6 72.7

Band	CC	SCS	BW	EVM RMS [%]	EVM RMS Limit High [%]	Payload	Payload Match	Pass / Fail Verdict
78	3500.0 [30]	Mu1	RL1_300 M	0.451	18.500	FM23	True	Pass

Test case duration(sec): 50.7

[illegible]

Plug fest test setup with ADI Titan O-RU

- Participated in the following plugfests: Fall 2024, Spring 2025, Fall 2025, Spring 2026, Fall 2026 (ongoing)
- Connecting with industry for testing
- Three test setup available at AERPAW OTIC
 - O-RU conformance test setup (used in Fall'24 plug fest)
 - End to End and IOT test setup (to be used in Spring'25 plug fest)
 - RICTest platform

Capabilities

What can researchers/instructors/industry actually do?

Air-to-Ground
Channel
Modeling

UAV-based
Spectrum
Sensing &
Monitoring

Digital Twins
for Wireless
Networks

5G/6G & Next-
Gen Aerial
Networks

AI & ML for
Network
Optimization

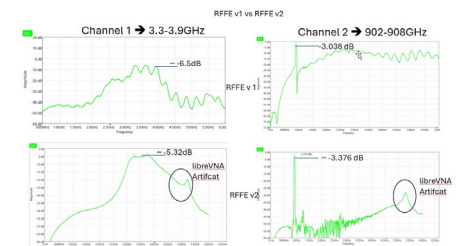
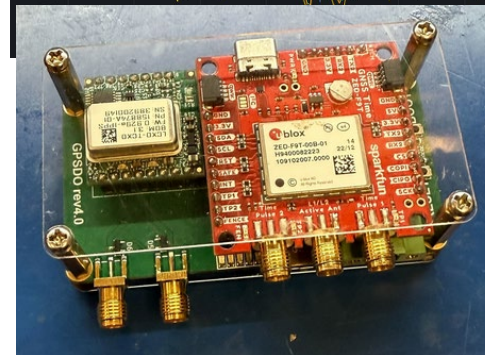
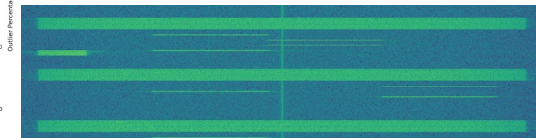
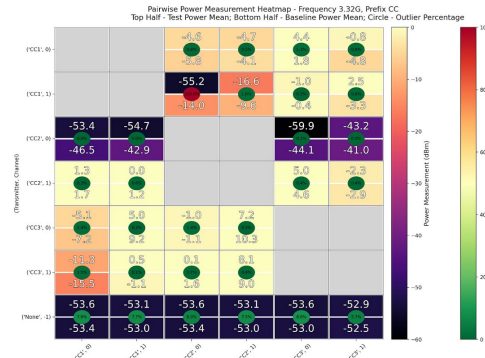
RF-Based UAV
Detection &
Identification

Autonomous
Trajectory &
Mission
Planning

Localization &
Source
Tracking

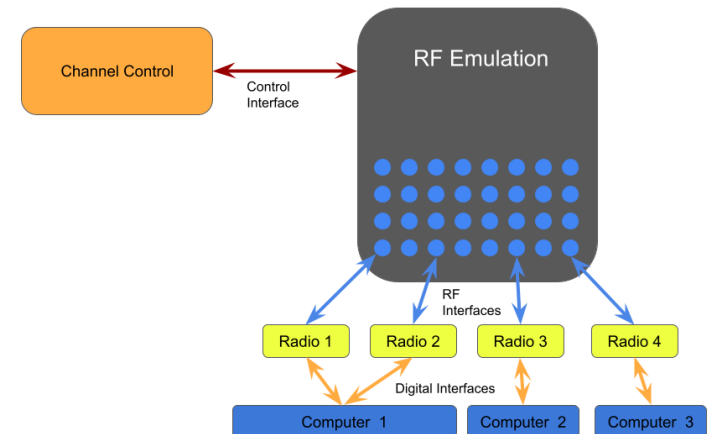
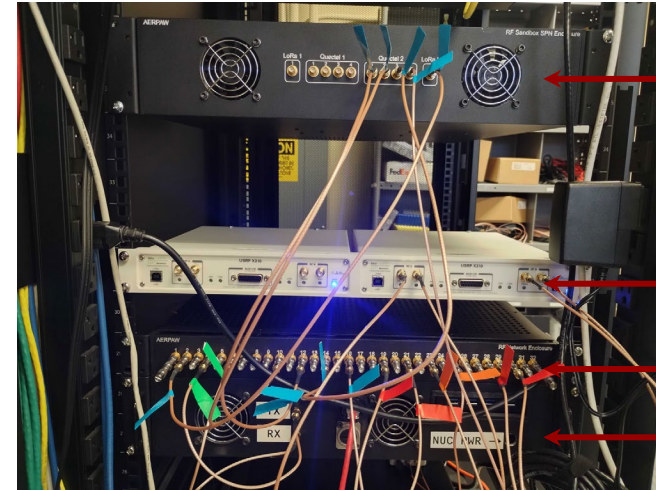
Design enhancement, process optimization, capabilities upgrade within the current deployment or future expansion

- 5G experiments with OAI (with soft and COTS UEs). Sample experiments.
- Fixed nodes radio front end monitoring
- Enclosure temperature monitoring
- Radio and vehicle checks for all nodes just about to participate in an experiment
- Expanded our radio front ends for three bands
- GPS-DO for time and frequency synchronization

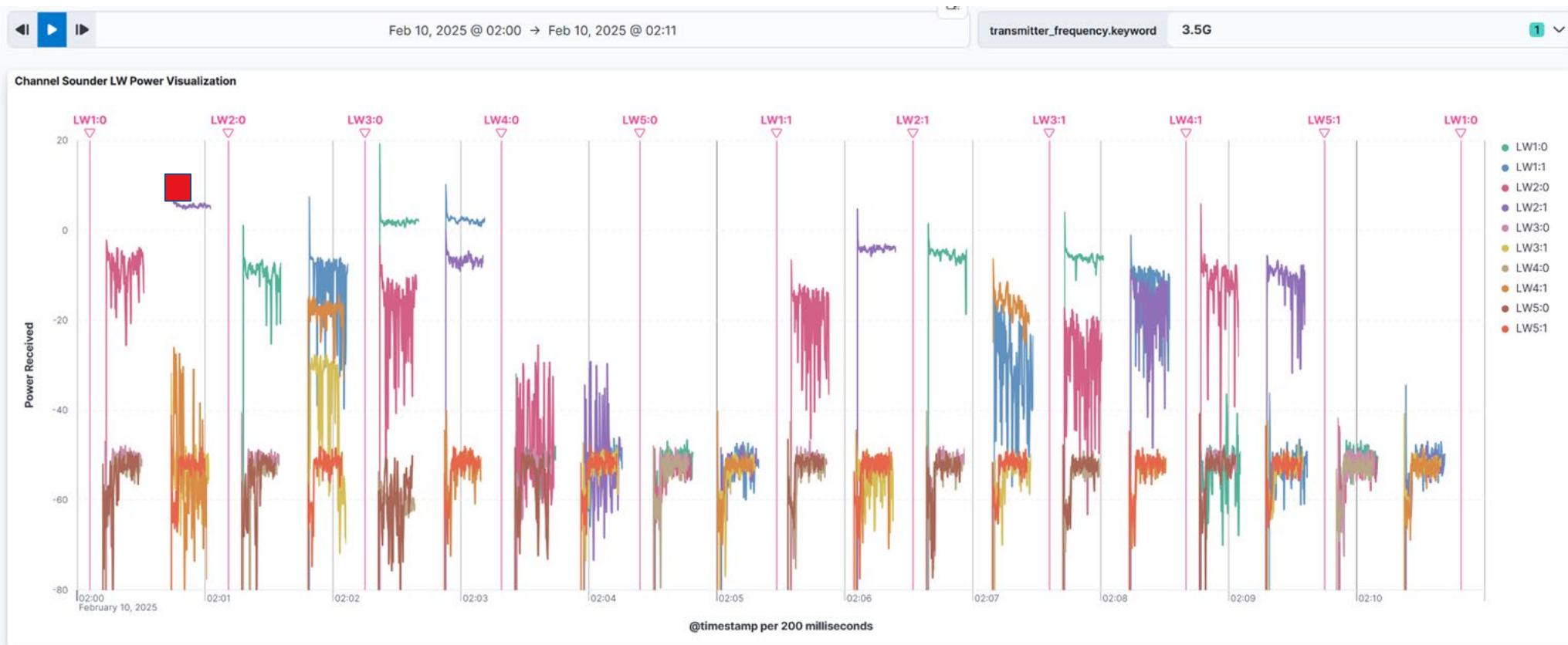


Sandbox Development

- Our ... third testbed instance!
 - Development mode (SITL)
 - **Sandbox** mode (HITL)
 - Testbed mode (real thing)
- 4 x FN + 2 x LPN + 2 x SPN + PROPSIM + RF Network
- Intense software and hardware development



RF Front End Health Monitoring



Platform Automation

- Seamless end-to-end user engagement
- Sessions tracking for billing purposes
- Portal-Sandbox integration

Alpha Testing Experiment23 - session history

search...

Search

Type	Active	Scheduled	Started	Started By	Ended	Ended By	Run Time	Ops Actions
testbed	True	---	---	---	---	---	waiting to start	Schedule End
emulation	False	Feb. 13, 2025, 9:18 a.m.	---	---	---	---	cancelled by user/operator	No Action
development	False	---	Dec. 4, 2023, 5:15 p.m.	mjmushi@ncsu.edu	Jan. 9, 2024, 8:31 a.m.	mjmushi@ncsu.edu	35 days, 15:15:59	No Action

Important!

Large Portable Node Limit Reached for Sandbox Environment!
**The Sandbox Environment is not setup to handle a total of more than 1 large portable nodes. It will be unavailable for this experiment unless 1 or fewer large portable nodes are selected.

Fixed Resources

Centennial Campus Resources

CC1

CC2

CC3

Lake Wheeler Resources

LW1

LW2

LW3

LW4

LW5

Portable Resources

Large Portable Nodes

LPN1

LPN2

LPN3

LPN4

LPN5

LPN6

Large AERPAW Portable Node 2

Small Portable Nodes

SPN-Android

SPN-LoRa

SPN-Quectel

Targeted Resources

Node Number	Resource Node Name	Change Node Number
1	LPN1	↑ ↓
2	SPN-Android	↑ ↓
3	LPN2	↑ ↓

Save

Back

From NSF Funded Testbed to Sustainable Research Infrastructure

Operations
Transition

- Hiring
- Sustainability Planning
- Risks Analysis
- Governance Structure

Business
Modeling

- Service Center
- TSLUA
- Consulting contracts

Outreach &
Engagement

- Programming

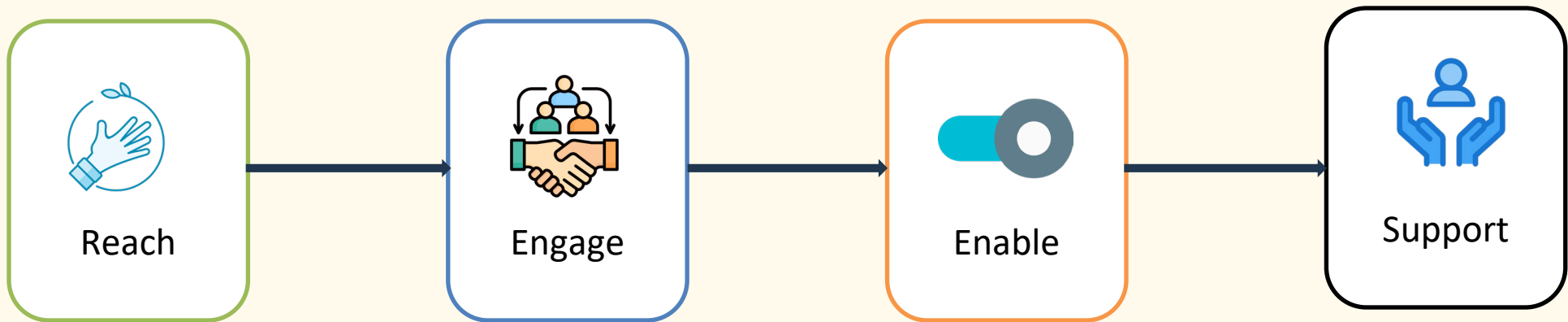
Onboarding &
Support

- Industry
- Academia
- Government

2024--?

Outreach

How we build and support our community



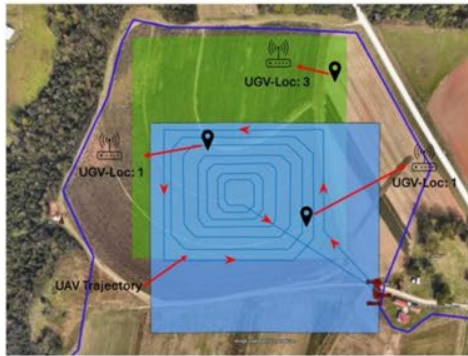
- [Website](#)
- [Newsletter](#)
- Social media ([YouTube](#), [LinkedIn](#), [X](#))
- [Webinars](#)
- Conferences

- Workshops
- Competitions
- Field demonstrations
- One-on-one meetings
- Tutorials

- Research ideas
- Proposals
- Projects
- Partnerships

- Google group
- [Bug Bash](#)
- [Office hours](#)
- [Documentation](#)
- Emails
- [Inquiry form](#)

AERPAW Student Competitions: Generate Extensive Data



Challenge #1: AFAR (2023)

Localize a stationary rover using narrowband signal observations from a UAV.

5 finalist teams • Winners: Eagles (UNT), SunLab (UGA), NYU Wireless

[Learn more about AFAR →](#)



Challenge #2: AADM (2025)

Optimize a UAV's trajectory to download data from towers as fast as possible.

22 participating teams • Winners: Influx (Utah), Neural Flyers (NC State), IMPRESS (UGA), WiMNet (Columbia)

[Learn more about AADM →](#)



AORA STUDENT CHALLENGE

AERPAW Open Research on Autonomy

Registration deadline: Dec 31, 2026
Experiment Submission: April 30, 2027



The Challenge

Design your own concept combining **autonomous UAS with 5G/6G wireless — fully open-ended**. Build with **GNU Radio, srsRAN (LTE) + OCUDU (5G), or OpenAirInterface (OAI)**.



Digital Twin → Testbed

Stage 1: develop and evaluate in AERPAW's Digital Twin, open to all registered teams. **Stage 2:** the top 6 finalists deploy unmodified on AERPAW's real aerial wireless testbed.



Review & Evaluation

A five-member committee of wireless and UAS experts scores novelty, stability, reproducibility, clarity of the reports, and potential impact.

STUDENT PRIZES (Expected to Increase if new sponsors identified)

1st Place

\$5,000

+ USRP B206mini

2nd Place

\$3,000

+ USRP B206mini

3rd Place

\$2,000

4th–6th Place

\$500 each

Runner-up awards

TIMELINE



SPONSORS

Platinum: ODC **Gold:** NI **Silver:** Keysight Technologies, AUVSI North Carolina

Bronze: Vadum, Thurling Consulting

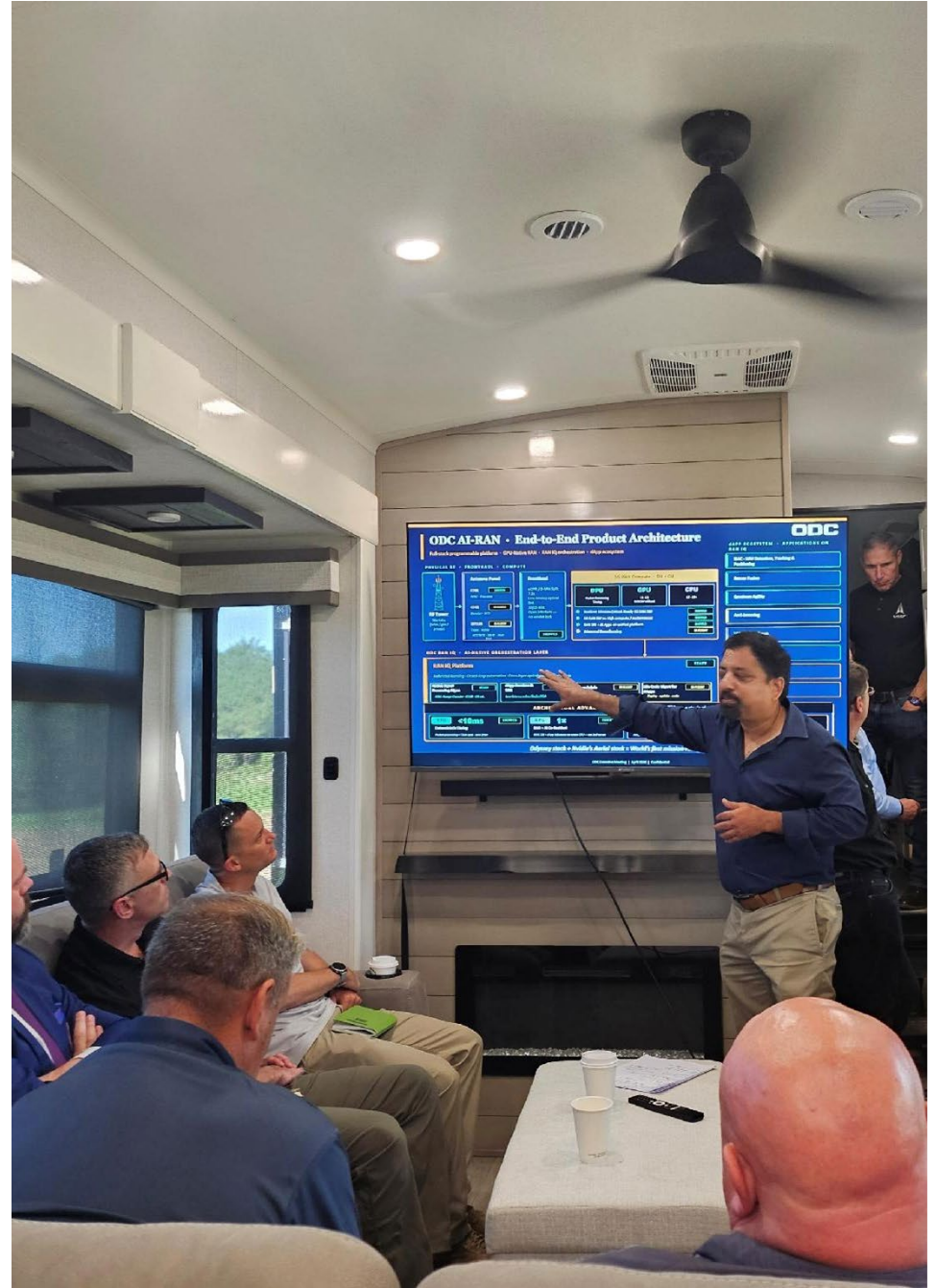
Interested in sponsoring AORA's student awards? Contact aerpaw-contact@ncsu.edu

Scan to Register

For more Info:

<https://aerpaw.org/>







New conversation



My groups



Recent groups



All groups



Public groups



Starred conversations

AERPAW Users



Conversations

99+



Approved

99+



Pending



People



Members



Pending members



Banned users



About



My membership settings



Group settings



AERPAW Users

External

200 members

1-30 of 280



Welcome to the AERPAW Users mailing group! If you use AERPAW, or intend to use it, or are just interested in staying in touch with AERPAW preparatory to potentially using it, please join this forum. The AERPAW team will post informational messages and announcements here that are relevant for users of AERPAW. Specific questions about AERPAW experiments or usage may also be posted here, and may receive responses from the AERPAW team, or other users. However please note that (i) this is not the appropriate source to gather general information about AERPAW - navigate to aerpaw.org and then the User Manual for that; (ii) this is not the forum for requesting specific help for issues with specific experiments - please use the ticketing system as provided to you as an active AERPAW Experimenter.



aerpaw-...@ncsu.edu

AERPAW September Webinar — Overview of the Duranta OpenAirInterface RAN+UE Stacks — AERPAW Mon...

9:00 AM



aerpaw-...@ncsu.edu

AERPAW Quarterly Newsletter — AERPAW Quarterly Newsletter April–August 2026 Updates The AERPAW t...

Sep 14



oh...@txstat..., AERPAW Oper... 2

SSH Connection Timeout – Experiment 1495 / Canonical Experiment 1436 – Good morning Adrian, I'm so...

Sep 4



Gautham ..., ... AERPAW Op... 12

Unable to access the experiment nodes – You're welcome and I'm sorry for an inconvenience this may hav...

Aug 31



Suhani Gulati

Reminder Tomorrow (8/28) - AERPAW Monthly Webinar — AERPAW and O-RAN Operations — August 28th ...

Aug 27



Magreth Mushi

Invitation: AERPAW Monthly Webinar @ Fri Aug 28, 2026 10am - 11am (EDT) (null) — AERPAW Monthly Web...

Aug 22



Suhani Gulati

AERPAW Monthly Webinar — AERPAW and O-RAN Operations — AERPAW and O-RAN Operations — August ...

Aug 20



Suhani Gulati

Help Us Update the AERPAW Publications Page — Hi everyone, We've recently updated the AERPAW public...

Aug 18



joarde...@gm..., AERPAW Op... 3

Issue with OEO Console — Hello, Yes, things are working perfectly now. I can see the nodes and the experi...

Aug 13



AERPAW Operations

AERPAW Facility Transition and Temporary Service Impacts — Dear AERPAW Community, We would like to ...

Jul 27



Suhani Gulati

AERPAW Monthly Webinar — 3GPP Update: The Latest News Regarding the 6G Cellular Standard — 3GPP ...

Jul 27



oh...@txstat..., AERPAW Oper... 5

AERPAW Experimenter Role Request — Hi Adrian, I looked into the error message you recieved and it looks ...

Jul 23



Tristan Mullins, ... Julian Reder 7

"Hello AERPAW!" Tutorial UGV Geofence Issue — No problem, glad you could get it worked out. Thanks, Jul...

Jul 12



skylerh...@g... , AERPAW Op... 7

OEO Console not Displaying Nodes — Good morning Skyler, I'm glad its working! Do you still need the sche...

Jun 22

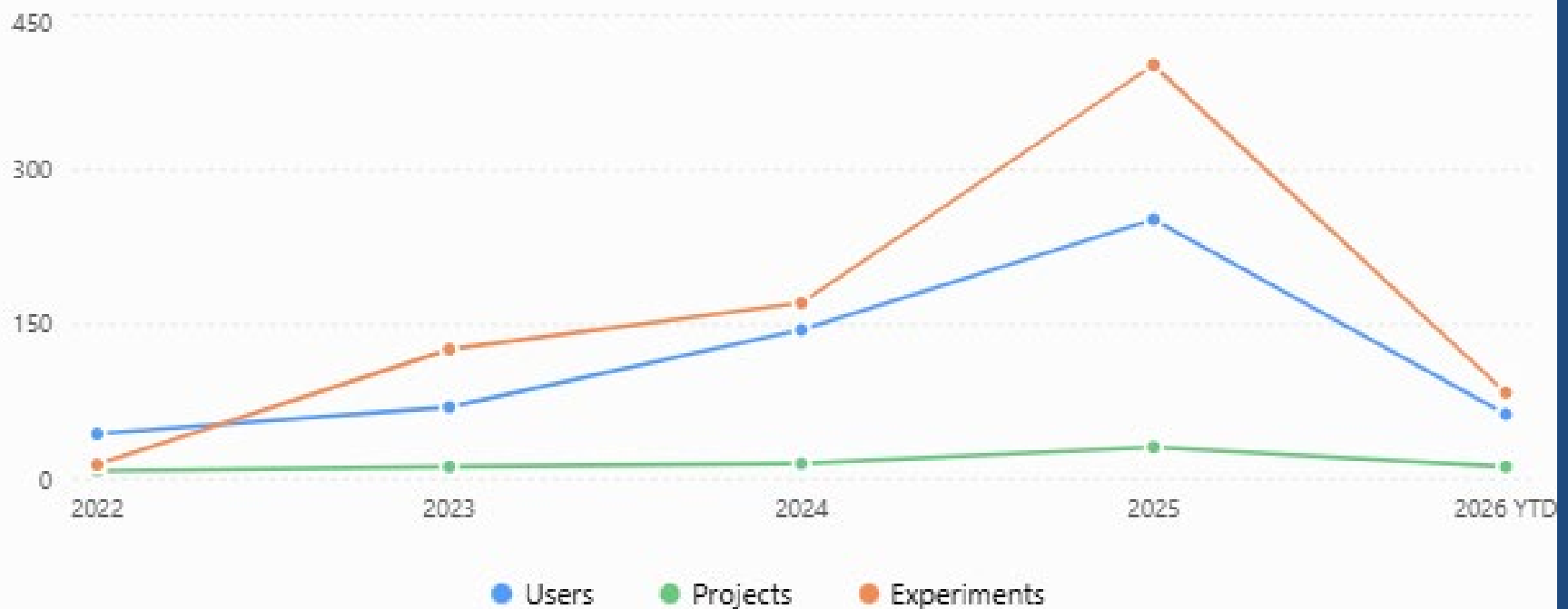


Impact

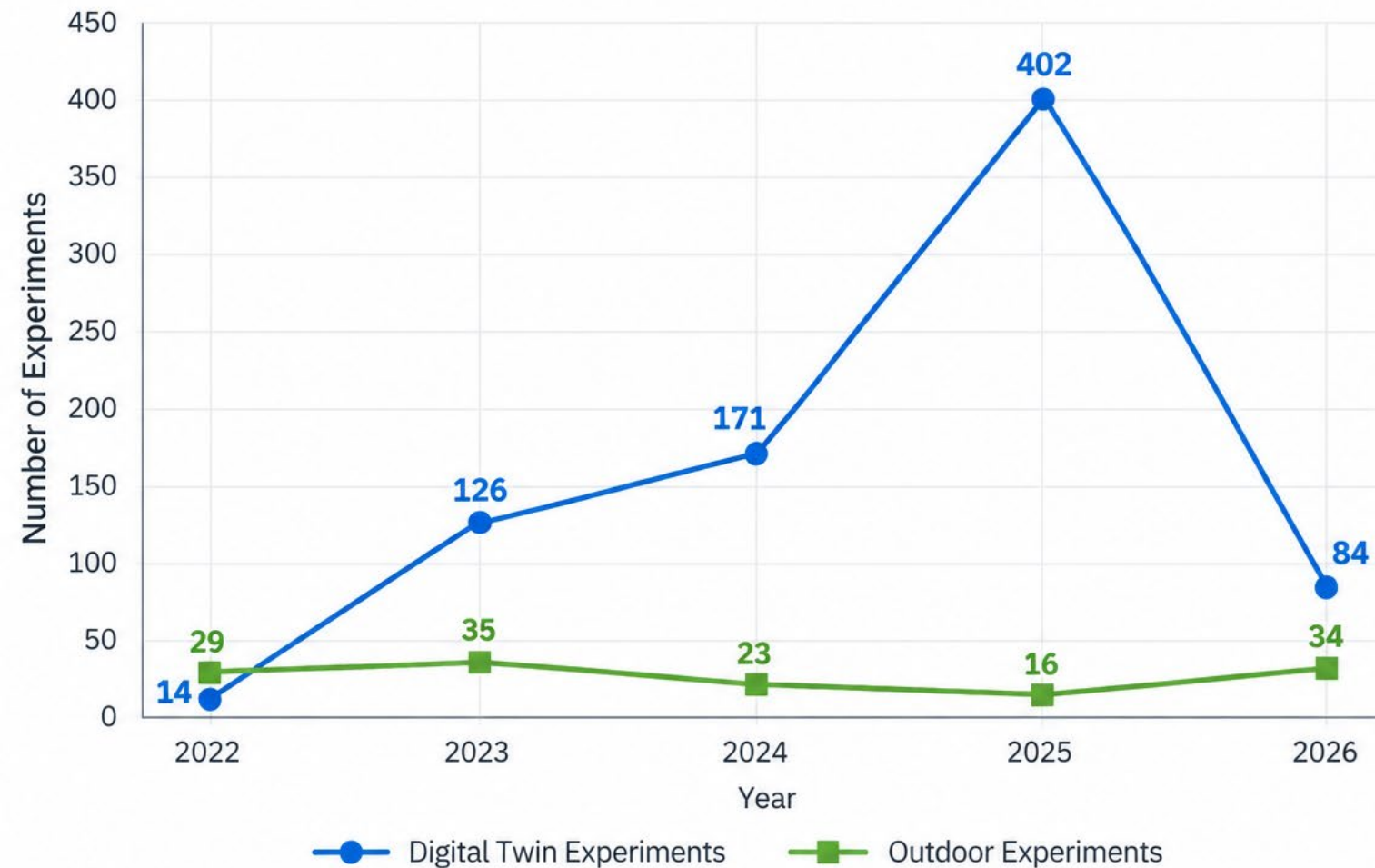
What difference is AERPAW making?

AERPAW Platform Usage

Annual users, projects, and experiments, 2022–2026.



Insights: ACW, AADM, AERPAW in the classroom



From virtual experimentation to real-world validation.

The Digital Twin and outdoor testbed work together to support the full research lifecycle.

Key Takeaways

- 1 Digital Twin experiments are steady.**
The Digital Twin provides a consistent and scalable environment for development, testing, and iteration, leading to steady experimentation.
- 2 Outdoor experiments are very diverse.**
Outdoor experiments vary widely in scope and complexity; a single experiment can take months and use all towers (e.g., ODC and other large-scale trials).
- 3 Weather affects field access.**
Weather conditions (e.g., rain, wind, lightning, extreme heat) impact how often we can safely conduct outdoor experiments.

Total Experiments (2022–2026)

Digital Twin

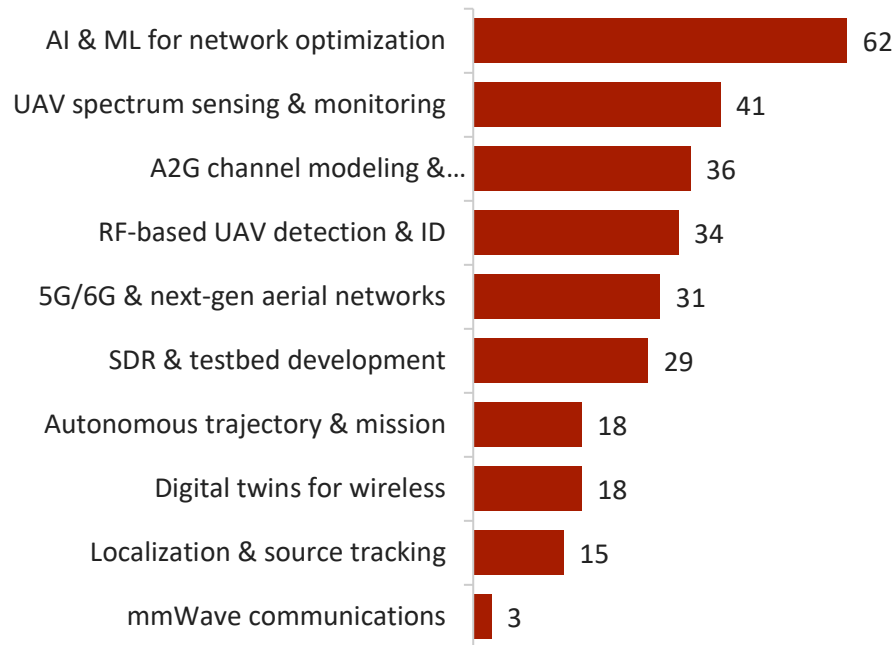
797

Outdoor

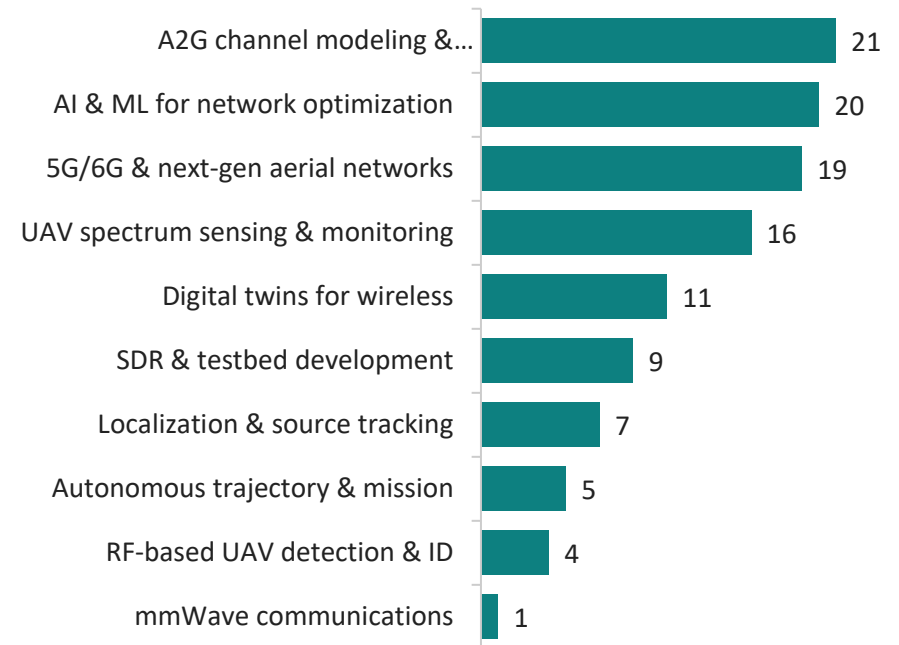
137

Research Areas — Publications and Datasets

Publications per Research Area (of 139)



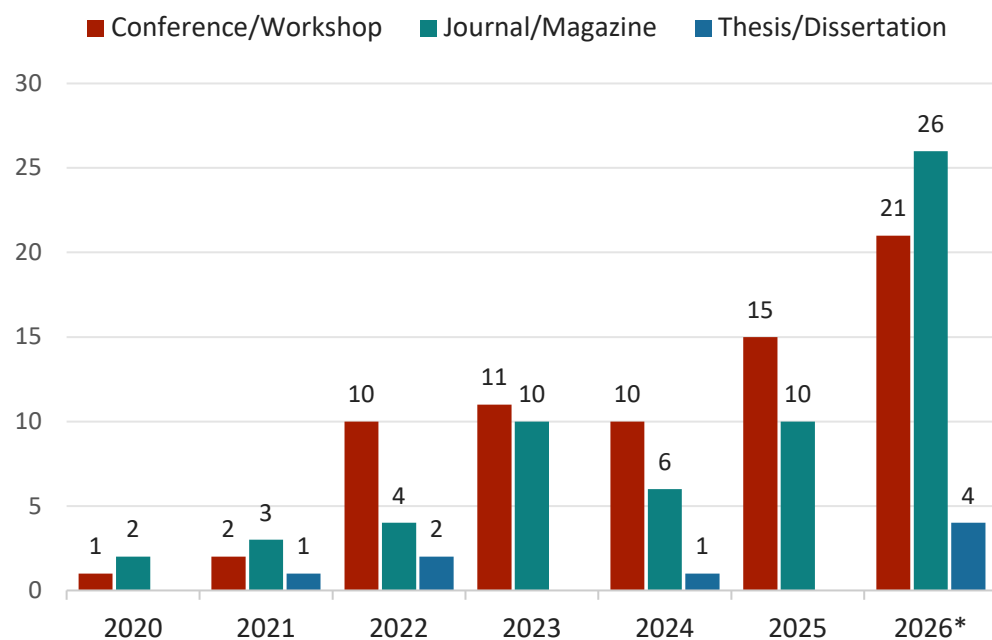
Datasets per Research Area (of 34)



AI/ML leads publications (62 papers), while **A2G channel modeling spans the most datasets** (21). 287 area tags across 139 papers (~2 per paper). Dataset areas are inherited from linking publications, excluding the 20-dataset survey record (Raouf et al., 2026) that would otherwise flatten the ranking.

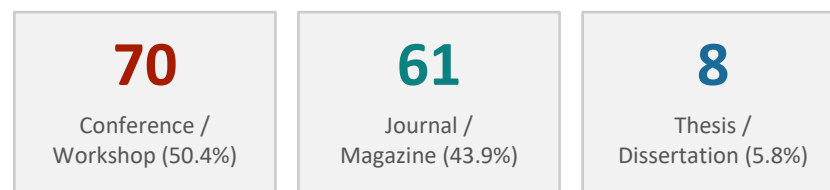
Publication Types and External Adoption

Publications per Year by Type

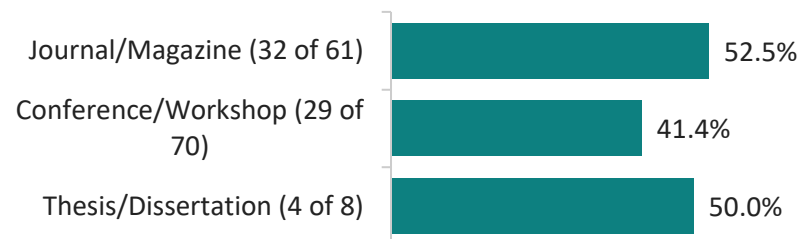


2026: journals overtake conferences for the first time (26 vs. 21) — the testbed is maturing from demonstration papers toward archival results.

All-Time Mix (139 publications)



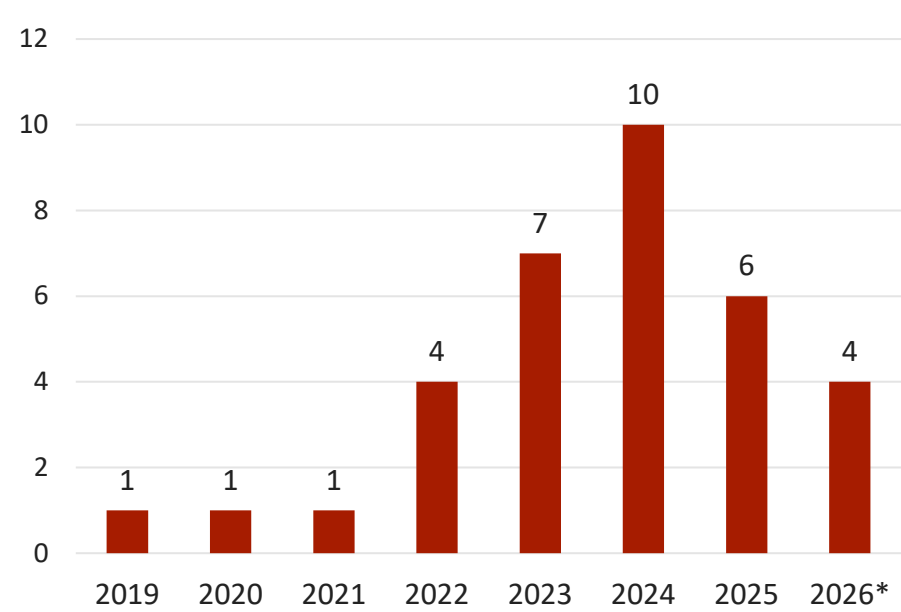
Externally Led Share by Type



- **External authors now lead in journals (52.5%)** — a strong adoption signal, since archival papers reflect sustained use of the datasets
- **2022–2026:** 67 internal vs. 63 external papers (48.5% external)

Dataset Growth and Coverage

Datasets Released Per Year (*2026 partial)



Ten Most Frequently Applied Tags (26 in total)

Drone	Platform	16
Rural	Environment	15
Trajectory	Research type	10
Urban	Environment	10
3.3 GHz	Technology	9
4G LTE	Technology	8
Propagation meas.	Research type	8
85 MHz – 6 GHz	Technology	8
Helikite	Platform	8
Spectrum occupancy	Research type	8

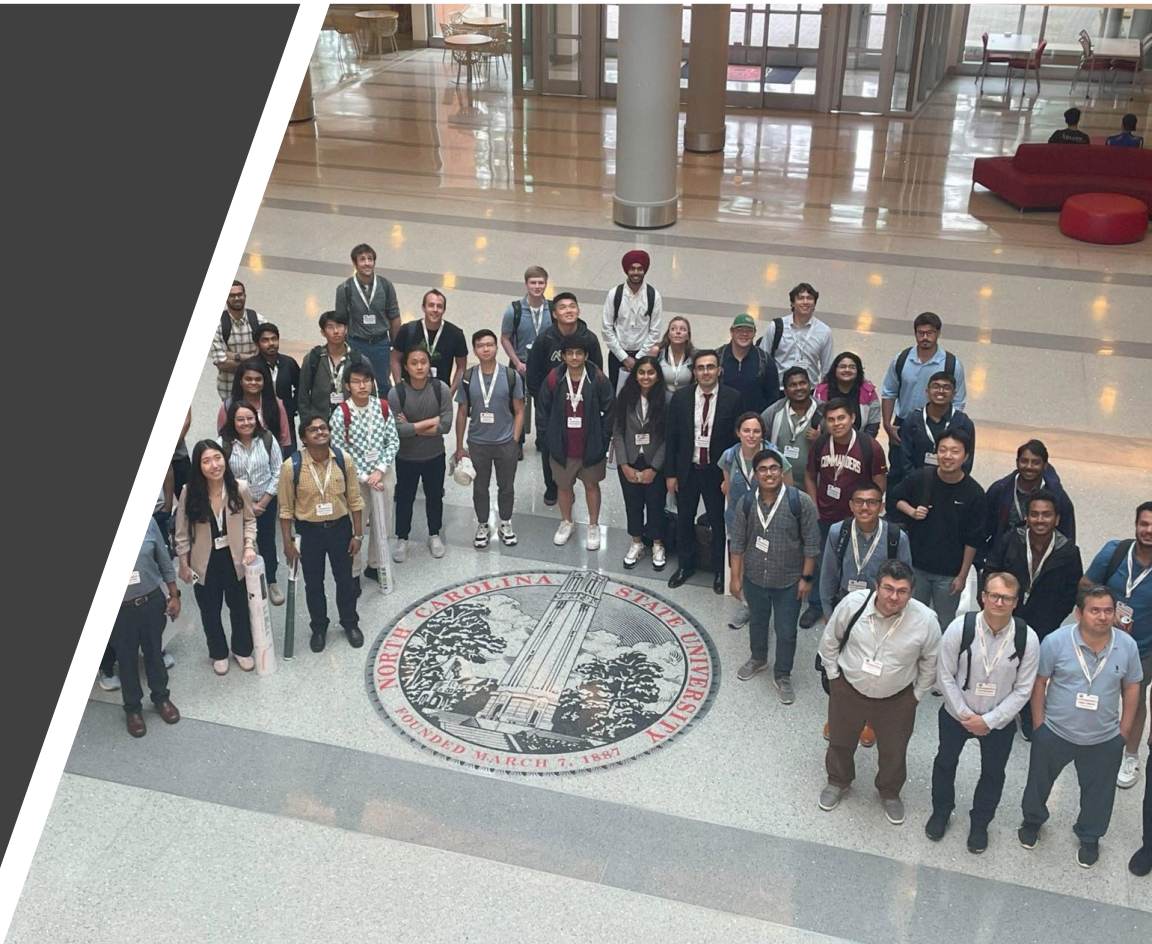
User Stories

<https://aerpaw.org/user-stories/>

Impact theme	What AERPAW enabled	Example user stories
Simulation → Reality	Validate simulations and algorithms in realistic field environments	Kevin Dee; Prasad Calyam
Autonomy at Scale	Design, execute, and study sophisticated autonomous UAV missions	Keiwan Soltani; Anirudh Kamath
AI/ML Validation	Test ML and reinforcement-learning approaches in realistic wireless environments	Ahmed Ibrahim; Prasad Calyam
Unique Data & Measurements	Access aerial channel, spectrum, localization, trajectory, and telemetry data	Gunes Karabulut-Kurt; William Bjorndahl
Next-Generation Networks	Investigate resilient 6G, UAV swarms, aerial communications, and non-terrestrial networking	Shih-Chun Lin; Gunes Karabulut-Kurt



• Workforce development



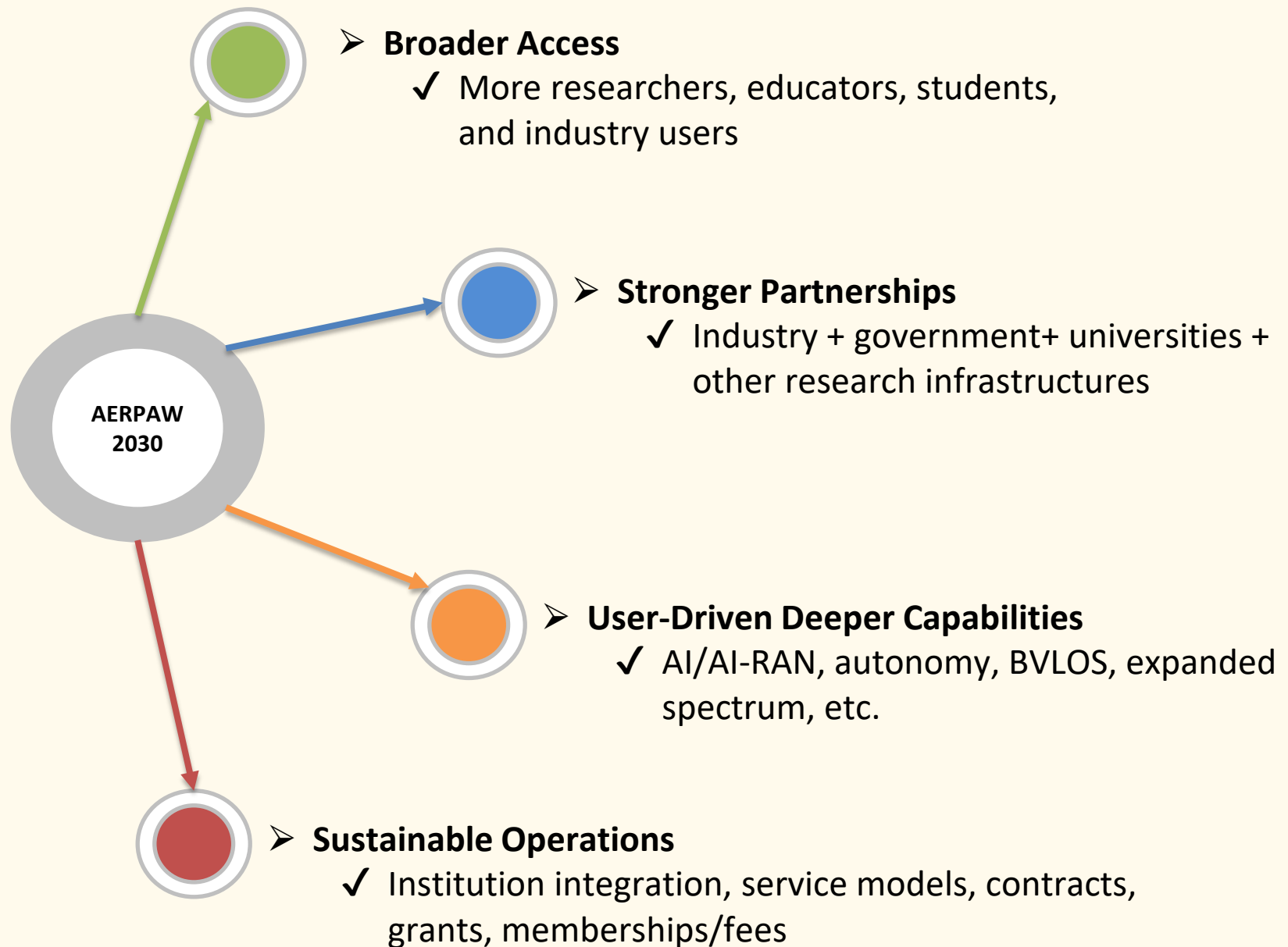
Lessons Learned Operating AERPAAW

- **Flexibility has an operational cost.**
 - ✓ The more customizable the experiment, the more integration and staff support it requires.
 - ✓ BYOD
 - ✓ Pre-proposal process
- **Community building is part of infrastructure operations.**
 - ✓ Workshops, challenges, webinars, user groups, and one-on-one engagement are not peripheral activities.
- **Get the business model right early.**
 - ✓ Understand the full cost of operating and sustaining the infrastructure early, and develop a business model that accounts for staffing, maintenance, technology refresh, field operations, and user support.
- **Lower the barrier to the first experiment.**
 - ✓ Digital Twin, tutorials, documentation, and direct support matter enormously.

Lessons Learned Operating AERPAW

- **Sustainability must be designed early.**
 - ✓ Technology, institutional ownership, staffing, governance, partnerships, and revenue models have to evolve together.
- **Academic vs. industry work cadence**
 - ✓ SOPs do not align; how flexible are you willing to be?
- **Evolve without disrupting.**
 - ✓ Research infrastructure must continuously adopt new technologies and capabilities while maintaining reliable services for existing users.
- **Build for users, not just technology.**
 - ✓ A technically sophisticated platform only creates impact when researchers can use it.

Future Outlook





AERPAW is not just a testbed—it's a COMMUNITY!

Use, Partner, Engage

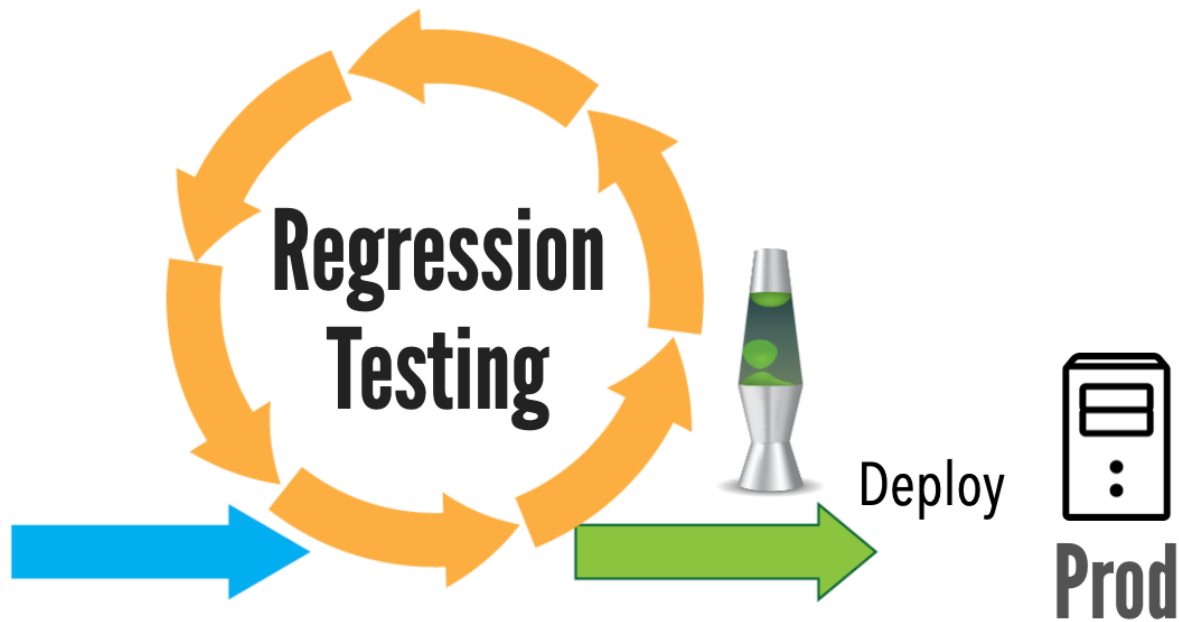


Contact Email: aerpaw-contact@ncsu.edu

Follow us on LinkedIn: <https://www.linkedin.com/company/aerpaw/>

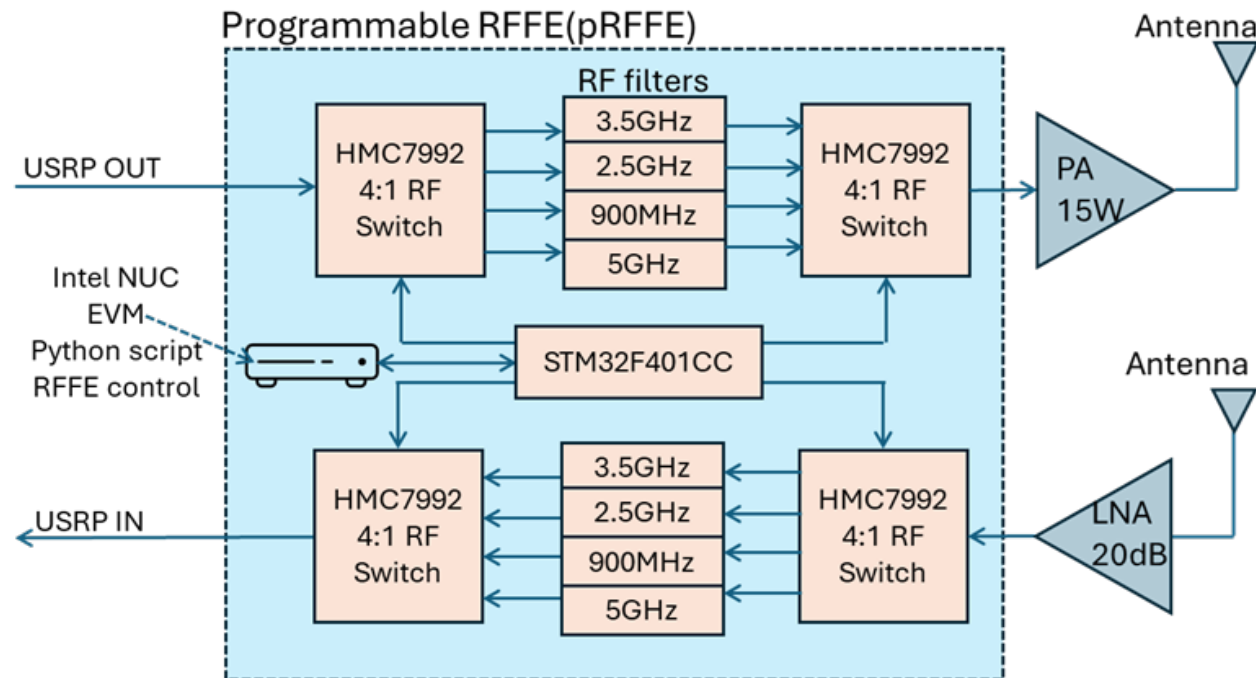
Join our User Email Group: send a blank email to group-aerpaw-users+subscribe@ncsu.edu

Automated Regression Testing



AERPAW Programmable RF Front End (1)

- Currently, Diplexer based band filters are used in AERPAW Fixed nodes.
- Need to physically rewire these filters for more than two RF bands.
- This issue solved by a programmable RF filter bank with a 4:1 RF switch capable up to 6 GHz.



- STM32F401CC ARM processor used for command & control through GPIO.
- Wireless experiment running in NUC EVM selects the RF band through a python script.

AERPAW User Highlight: Joseph Camp, Professor Southern Methodist University (1)

Problem Statement:

- Modern UAVs use complex antennas, but researchers often treat their radiation patterns as simple spheres or static shapes.
- In real-world flight, drone tilt, banking, and airframe obstruction cause "nulls" (dead zones) in the signal that are difficult to predict.
- Existing models require massive amounts of measurement data, which is time-consuming and expensive to collect for every new drone model.

Solution Approach:

- The team developed SPARK, which uses "Kernels" to describe the antenna pattern.
- Instead of needing thousands of data points, SPARK can reconstruct a highly accurate 3D radiation pattern using only a sparse measurements.

How AERPAW is Used:

- 3D antenna radiation patterns measured in an anechoic chamber via the AERPAW testbed are used to evaluate the proposed concept (see [AERPAW Dataset-7](#)).
- Ray trace over UAV flight trajectory to provide corresponding real-world measurements and ray-trace simulation data (see AERPAW [Dataset-21](#))



Joseph Camp



William Bjorndahl

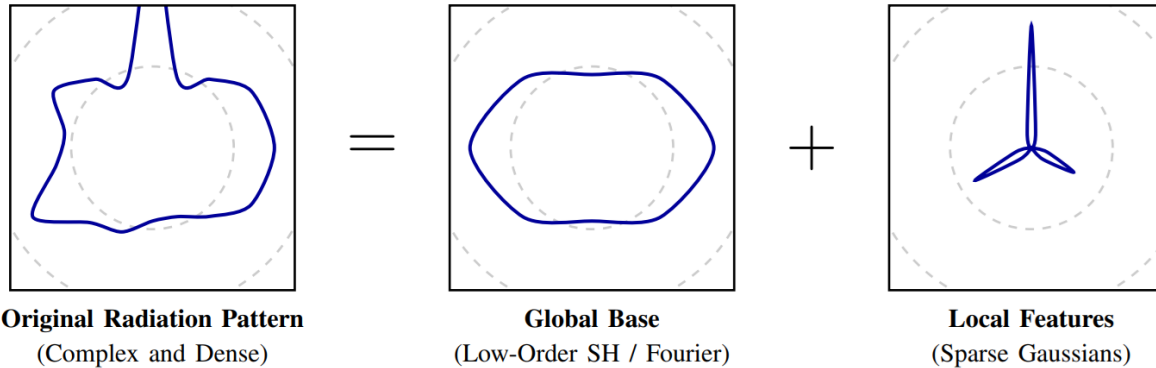


AERPAW Publications since May 2025:

- 1) William Bjorndahl and Joseph Camp, "BeamMix: 3D Gaussian Mixture-of-Experts for Element-Space Wireless Channel Modeling", to appear at ACM MobiSys, 2026.
- 2) William Bjorndahl, Mark O'Hair, Ben Zoghi, Joseph Camp, "[SPARK: Sparse Parametric Antenna Representation using Kernels](#)", to appear at IEEE INFOCOM, 2026.
- 3) William Bjorndahl, Maninder Pal Singh, Farhad Nouri, Joseph Camp, "PropSplat: Map-free RF Field Reconstruction via 3D Gaussian Propagation Splatting", to appear at IEEE DySPAN, 2026.

AERPAW User Highlight: William Bjorndahl, Ph.D. Candidate Southern Methodist University

Representative Results



Joseph Camp



William Bjorndahl



“As we go through customer discovery interviews for NSF I-Corps I am actively thinking about ways to further utilize the AERPAW platform and its datasets. Currently, the datasets related to either spectrum or UAV tracking/localization especially come into mind.”

William Bjorndahl, Ph.D.

Candidate, Southern

TABLE I: MSE vs. parameter count (values scaled by 10^{-3}).

Antenna	f (MHz)	SH MSE		SPARK MSE
		36p	121p	
SA-1400	915	4.83	4.05	4.59
	2100	10.06	9.81	10.11
	3500	20.83	20.73	7.15
	5500	26.08	25.60	15.26

AERPAW User Highlight: Gunes Karabulut-Kurt, Professor, Polytechnique Montreal

Problem Statement:

- Standard Deep Learning models are accurate but act as "black boxes," offering no physical insight into signal behavior.
- Traditional physical models are explainable but too simple to capture complex, real-world UAV propagation environments.

Solution Approach:

- Uses Kolmogorov-Arnold Networks (KAN), which employ learnable functions on edges to create transparent, symbolic mathematical expressions.
- Incorporates physical laws (Free-Space Path Loss, Two-Ray models) as adaptable biases, ensuring the AI remains grounded in electromagnetics.

How AERPAW is Used:

- Researchers utilized the AERPAW UAV Air-to-Ground (A2G) dataset, containing 3D positioning and multi-frequency signal measurements.
- AERPAW's outdoor testbeds provided the diverse terrain and "noisy" data needed to prove PIKAN's flexibility over rigid theoretical models.



Gunes Karabulut-Kurt



POLYTECHNIQUE
MONTRÉAL

WORLD-CLASS
ENGINEERING



Kursat
Tekbiyik



Antoine Lesage-
Landry

AERPAW Publications since May 2025:

- 1) Kursat Tekbiyik, Güneş Karabulut Kurt, and Antoine Lesage-Landry, "[PIKAN: Physics-Inspired Kolmogorov-Arnold Networks for Explainable UAV Channel Modelling](#)," in Proc. IEEE Aerospace Conf., Mar. 2026.
- 2) Kursat Tekbiyik, Güneş Karabulut Kurt, and Antoine Lesage-Landry, "Physics-Inspired Kolmogorov-Arnold Networks based UAV Channel Models", to be submitted to IEEE Trans. Wireless Commun., May 2026.

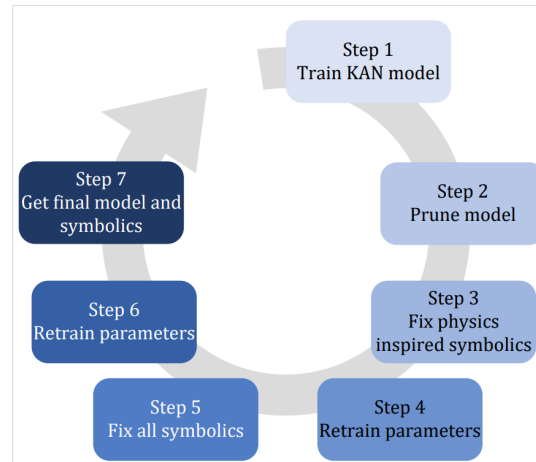
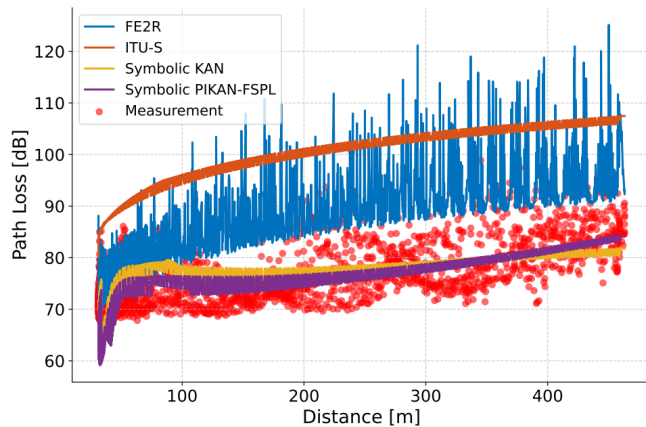
AERPAW User Highlight: Gunes Karabulut-Kurt, Professor, Polytechnique Montreal



POLYTECHNIQUE
MONTRÉAL

WORLD-CLASS
ENGINEERING

Representative Results



Models	MAE	RMSE	ρ
UMa LoS	63.831	68.719	0.398
UMa NLoS	90.194	91.162	0.675
FE2R	9.474	12.047	0.573
ITU-S	19.405	20.377	0.661
Symbolic Base KAN	4.058	4.883	0.596
Symbolic PIKAN-FSPL	3.751	4.759	0.677
Symbolic PIKAN-2R	4.120	4.949	0.594

"AERPAW enables access to high-fidelity 3D air-to-ground channel data across different altitudes and trajectories, along with multi-protocol experimentation, which is essential for validating next-generation aerial and non-terrestrial networks, expanding to satellite constellations."

**Gunes Karabulut-Kurt, Professor,
Polytechnic Montreal**

AERPAW User Highlight: Prasad Calyam, Professor University of Missouri-Columbia

Problem Statement:

- Traditional centralized solvers for real-time UAV trajectory planning scale poorly: they are infeasible for onboard use (energy and compute limits) during missions with limited connectivity.

Solution Approach:

- The team used a Graph Attention Network (GAT) to identify and remove "low-utility" edges from the mission graph
- This reduces the search space by focusing only on the most promising flight corridors. A Guided Local Search (GLS) algorithm then refines the route on this sparse subgraph, allowing the UAV to find near-optimal paths without needing a cloud-based solver.
- Edge-Intelligence: The entire pipeline is designed to run on embedded hardware (like NVIDIA Jetson) to enable autonomous decision-making

How AERPAW is Used:

- The framework was explicitly tailored for the AERPAW Autonomous Aerial Data Mule (AADM) Challenge, where UAVs must collect data from multiple ground stations and return within a fixed energy budget.
- AERPAW Phase-1 deployment maps (Lake Wheeler site) are used to simulate realistic UAV-to-station communication networks and flight corridors.



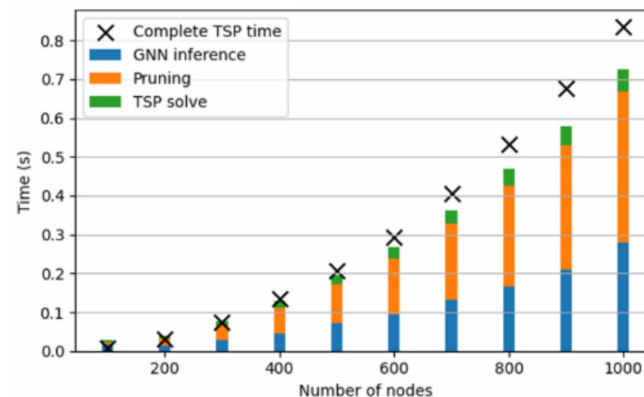
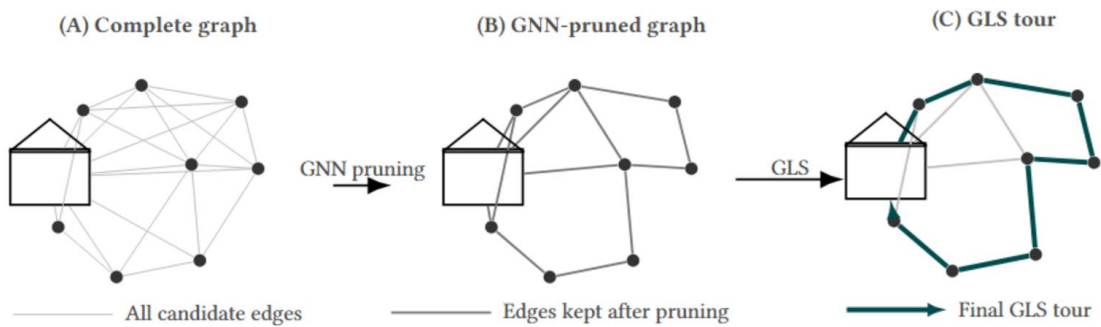
Mizzou
University of Missouri

AERPAW Publications since May 2025:

- 1) C. Bhamidipati, W. Echols, J. Lopez Olivares, K. Markley, S. Srinivas, P. Calyam, "[Edge-Enabled Scalable Routing via Graph Neural Network Pruning and Metaheuristic Optimization](#)," in Proc. ACM Workshop on Edge Intelligence (EI), held in conjunction with the ACM IEEE Symposium on Edge Computing, Dec. 2025.
- 2) C. Bhamidipati, Z. Murry, A. Morel, C. Qu, S. Srinivas, P. Calyam, "Cross-Layer Deep Reinforcement Learning for Real-Time Multi-Drone Delivery from Mobile Depots under Uncertainty," submitted to IEEE ITS Journal, 2025.

AERPAW User Highlight: Prasad Calyam, Professor University of Missouri-Columbia (2)

Representative Results



“AERPAW allows us to validate our simulation study results in a realistic field testing setups, which has helped us to improve the technology readiness levels of our research products”, Prasad Calyam, Professor, University of Missouri-Columbia

AERPAW User Highlight: Ahmed Ibrahim, Associate Professor, Florida International University (1)



Problem Statement:

- Traditional "fixed-path" UAV routing for data collection missions fails to account for the dynamic wireless environment, leading to long mission times and poor data throughput.

Solution Approach:

- The FIU team used the AERPAW development environment as a high-fidelity "Digital Twin" to simulate the exact physical and RF characteristics of the Lake Wheeler testbed.
- They implemented a Reinforcement Learning (RL) agent that learns the optimal flight path by balancing energy consumption against the amount of data collected from ground nodes.

How AERPAW is Used:

- The "Develop-to-Deploy" workflow allowed the researchers to train their ML models in the AERPAW emulator and then move directly to the outdoor testbed with minimal software changes.
- By using AERPAW's predefined "Portable Nodes" and UAV configurations, the team ensured their results were repeatable and comparable to other research on the platform.



Ahmed Ibrahim
Associate Professor



Joarder Jafor Sadique
PhD Candidate
(defended March 2026)

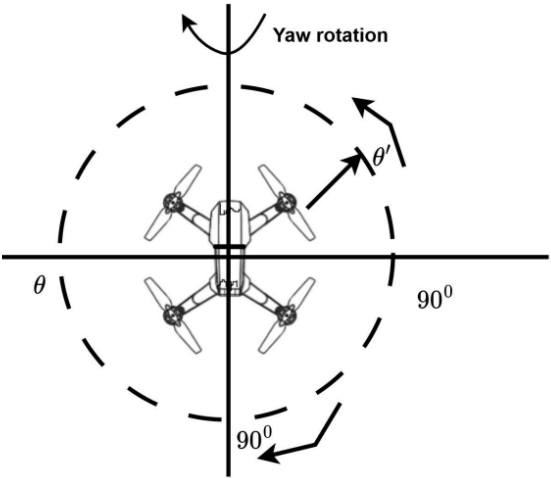
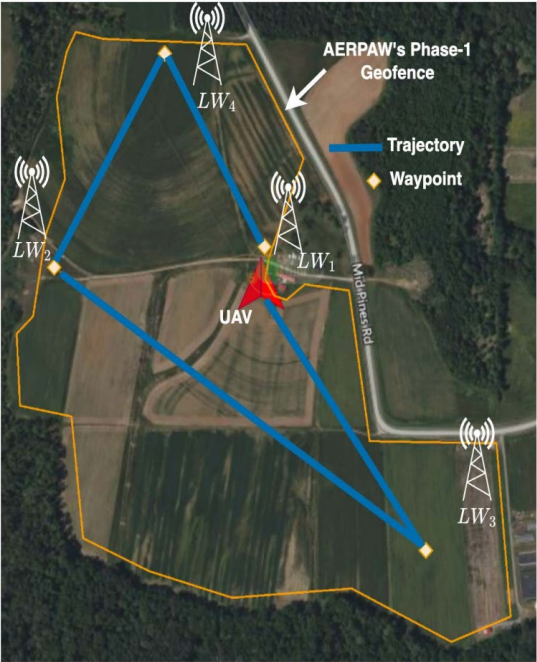
AERPAW Publications since May 2025:

- 1) J. J. Sadique, M. R. Khan, and A. S. Ibrahim, "[UAV-aided fast data collection via machine learning using AERPAW's digital twin](#)," in Proc. ACM Workshop Wireless Network Testbeds, Experimental Evaluation & Characterization (WiNTECH), pp. 89–96, 2025.
- 2) J. J. Sadique and A. S. Ibrahim, "Aerial Link Scheduling over Riemannian Manifolds Using AERPAW's Digital Twin," submitted to IEEE Communications Magazine, Mar. 2026.

**AERPAW User Highlight: Ahmed Ibrahim, Associate Professor
Florida International University (2)**



Representative Results



$$\theta' = \arg \max_{\theta \in \Theta} \gamma(\theta),$$

Algorithm	Downloaded Data (%)	Remaining Data (%)	Time Utilized (s)
Baseline	35.58	64.42	349.86
ML-DC	85.59	14.41	500

Figure 1: UAV-based data collection scenario.

AERPAW User Highlight: Shih-Chun Lin, Associate Professor, North Carolina State University

Problem Statement:

- 6G Non-Terrestrial Networks (NTNs) face dynamic channel conditions and jamming that can sever critical C2 links.
- Traditional networks need manual intervention to re-establish dropped connections: too slow for high-speed, autonomous UAV swarms.

Solution Approach:

- The team introduced RASHND (Resilient Adaptive Self-Healing Network Design), which uses inter-node communication to allow a swarm to "heal" itself when a node loses its primary link.

How AERPAW is Used:

- While initial tests used a local SDR testbed, AERPAW's outdoor field environment was used subsequently to validate the self-healing algorithms under realistic long-range propagation.
- AERPAW's programmable nodes allowed the team to emulate varying network conditions and validate that the swarm could maintain connectivity despite active signal degradation.

"AERPAW allowed us to emulate real-world UAV scenarios and validate the robustness of our algorithms, effectively complementing our static experimental setup."

Sambrama Hedge, PhD Student, NC State University



NC STATE
UNIVERSITY

Representative Results

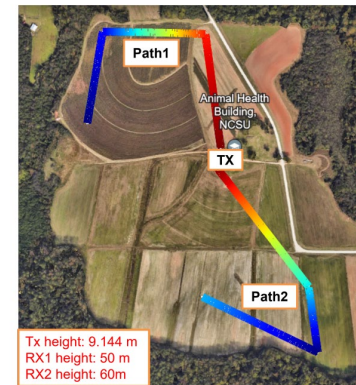


Fig. 13: Path for AERPAW experiments.

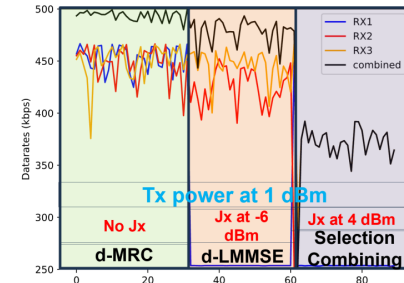


Fig. 9: Data rates for bitstream data for outdoor testbed.

AERPAW Publications since May 2025:

- 1) S. Hegde, V. Srirama Rohit Kantheti, L. C. Chu, E. Blasch, and S. Lin, "[Autonomous Self-Healing UAV Swarms for Robust 6G Non-Terrestrial Networks](#)", in Proc. of IEEE INFOCOM Workshop, Tokyo, Japan, May 2026.

AERPAW User Highlight: Mehmet Kurum, Associate Professor, University of Georgia

Problem Statement:

- Passive microwave radiometers used for Earth observation face increasing interference from expanding wireless communication systems and spectrum usage.
- Lack of large-scale, labeled RF datasets limits the development of robust data-driven interference detection and mitigation techniques.

Solution Approach:

- Develop a UAS-based microwave radiometer system integrated with AERPAW to collect real-world interference data with ground truth.
- Design data-driven, end-to-end learning models for RFI detection, characterization, and mitigation using deep learning and reinforcement learning.

How AERPAW is Used:

- AERPAW provides a city-scale wireless testbed with aerial and ground nodes to generate realistic interference scenarios.
- Supports controlled experiments with varying transmission power, mobility, frequency bands, and multi-user interference conditions.



NSF SWIFT-SAT: Integrated Testbed Ensuring Resilient Active/Passive Coexistence (INTERACT): End-to-End Learning-Based Interference Mitigation for Radiometers. Award No. 2332661 & 2332662

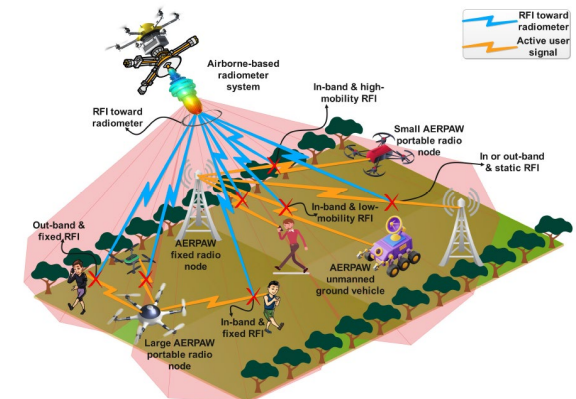
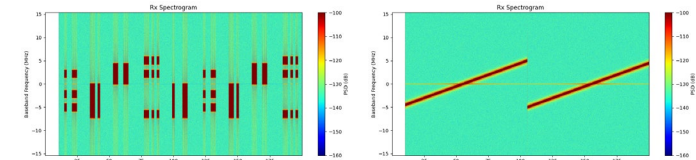


Figure 1: Illustration of the proposed drone-based passive radiometer system and AERPAW interference generation tests.



Transmitted from AERPAW Fixed Nodes

Publication: A. M. Alam, M. Kurum, and A. C. Gurbuz, "RFI-Net: Enhancing Passive Sensing through Deep Learning Based Time-Frequency Domain Radio Frequency Interference Detection and Mitigation," submitted to IEEE Transactions on Geoscience and Remote Sensing, 2025 [\[Preprint\]](#)

AERPAW User Highlight: Ali C. Gurbuz, Associate Professor, NC State University



NC STATE
UNIVERSITY

Problem Statement:

- Non-cooperative UAVs in urban, suburban, and rural areas.
- Risks associated with active radars, e.g., detection of the source.

Solution Approach:

- Use of 5G networks as passive RF illuminators for UAV detection.
- UAV detection through customized ISAC signal processing.

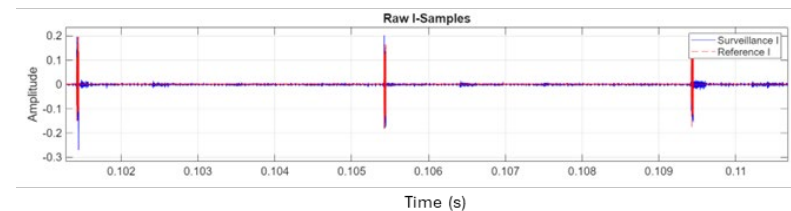
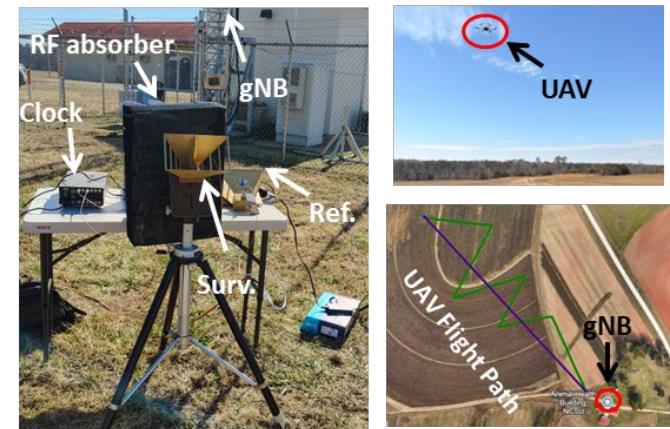
How AERPAW is Used:

- The AERPAW 5G base station (3355 MHz) transmitting SSB signals was used for UAV detection.
- AERPAW UAVs were flown and illuminated by 5G SSB signals and detected using SDR-based ISAC processing.

Future Work:

- Different types of NextG signal waveforms can be used for ISAC testing at AERPAW.
- Different types of UAVs and trajectories can be used to test different UAV detection scenarios.

ISAC Experiments and Results with 5G at AERPAW



AERPAW User Highlight: Fraida Fund, Assistant Professor, Tandon School of Engineering, NYU

Problem Statement:

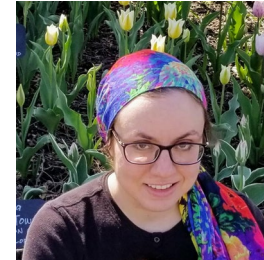
- Unavailability of teaching materials and class problems that are small enough to be practical, yet complex enough to require real understanding - problems students can't simply brute-force with compute.

Solution Approach:

- Develop AERPAW-based teaching materials to use in class and share publicly for other instructors to integrate into their curriculum.
- This reduces the time and the learning curve to conduct experiments using the AERPAW platform and makes the learning experience feel tangible.

How AERPAW is Used:

- Turned the Find-a-Rover challenge into an interactive assignment for machine learning class.
- Students run experiments in real time, observe how their models behaved, and make informed decisions. 18 students in summer 2024, 90 in spring 2025.



Adopted materials:

- 1) Kennesaw University - EE3702 - <https://teaching-on-testbeds.github.io/rf-fingerprint/>

Ready early adopters

- 1) Ilknur Aydin, Farmingdale State College, NY
- 2) Joseph Camp, Southern Methodist University, TX
- 3) Ashwin Ashok, Georgia State University, GA
- 4) Georgios Sklivanitis, Florida Atlantic University, FL
- 5) Prasad Calyam, University of Missouri, MO
- 6) Izzat Alsmadi, Texas A&M University-San Antonio, TX
- 7) Mehmet Kurum, University of Georgia, GA
- 8) Ismail Guvenc, North Carolina State University, NC
- 9) Fatemeh Afghah, Clemson University, SC
- 10) Shivendra Panwar, New York University, NY
- 11) Yuchen Liu, North Carolina State University, NC

AERPAW User Highlight: Keiwan Soltani, Doctoral Researcher, Missouri University of S&T (Mushi)

Problem Statement:

- Need to validate UAV performance and reliability under **high-speed, sustained flight conditions**, where both hardware limits and data fidelity become critical.
- Limited access to platforms that provide **both real-world testing at scale and deep, low-level telemetry (e.g., ESC/motor data)** for advanced research analysis.

Solution Approach:

- Designed a **series of four interrelated experiments**, each pushing AERPAW drones to **top-speed (20 m/s) sustained flight regimes**.
- Leveraged AERPAW's **"program-it-yourself" experimentation model** to iteratively design, submit, and refine experiments independently in the virtual environment before execution.

How AERPAW is Used:

- Executed experiments seamlessly on AERPAW's **7 sq km outdoor testbed**, with all flights completing successfully on the first attempt.
- Accessed **custom, low-level telemetry (ESC/dataflash logs)** enabled by AERPAW's open, researcher-friendly platform and hands-on support from the team.



AERPAW Publications since May 2025:

- 1) K. Soltani, F. Coro, S. Silvestri, and S. K. Das. "UAVDCH: Multi-Channel UAV Data Collection via Dual Cluster Heads in IoT Sensor Networks" under review in Transactions on Emerging Topics in Computing Journal.

AERPAW User Highlight: Anirudh Kamath, Graduate Researcher, University of Utah

Problem Statement:

- Design and execute an autonomous UAV-based data collection mission to integrate communication planning, UAV control, and data collection strategies into a robust and reliable mission workflow.

Solution Approach:

- The approach employs an iterative method that determines the ideal destination to fly towards in a periodic manner taking into account the provided challenge data volume distribution.

How AERPAW is Used:

- The framework was explicitly tailored for the AERPAW Autonomous Aerial Data Mule (AADM) Challenge, where UAVs must collect data from multiple ground stations and return within a fixed energy budget.
- Integrated communication planning, UAV control, and data collection strategies into a robust and reliable mission workflow. We used the Digital Twin to plan flight trajectories, configure the UAV programmatically, collect data, and iteratively refine our design through repeated experimentation.



AERPAW Publications since May 2025:

1) **M. S. Hossen, C. Dickerson, O. Ozdemir, A. Gurses, M. R. Sarbudeen, T. Zajkowski, A. M. Alam, E. Tucker, W. Bjorndahl, F. Solis, S. Javed, A. Kamath, X. Tang, J. J. Sadique, K. L. Hermstein, K. A. Mahmud, J. A. S. Vilorio, S. Hawkins, Y. Cui, A. Dey, Y. Liu, A. Gurbuz, J. Camp, R. Ahmad, J. van der Merwe, A. I. Mohamed, G. Zussman, M. Kurum, N. Kamesh, Z. Guan, D. Pados, G. Skilvanitis, I. Guvenc, M. Sichitiu, M. Mushi, and R. Dutta, “[UAV-Based Wireless Multi-modal Measurements from AERPAW Autonomous Data Mule \(AADM\) Challenge in Digital Twin and Real-World Environments](#),” submitted to *IEEE Data Descriptions*, Feb. 2026.**

Other Recent User Interactions (Examples)

- Dryver Huston, Professor (ME): University of Vermont
 - Radar-based (including UWB) sub-surface sensing with UAVs and UGVs
- Lingjia Liu, Professor, Virginia Tech Univeristy (ECE)
 - 3D radio environment maps and OTFS
- Kevin Dee, PhD student, UC Irvine
 - Closed-Loop Sensing, Modeling, and Communications for Wildfire
- Sylvia Ratnasamy, Professor, UC Berkeley
 - Resilient Wireless Data Transport for Disaster Recovery using LT3 Multipath Coding
- VINES Track-2 teams that we provided collab. letters
- Companies as possible users:
 - Keysight, Cerberus, Open Device Alliance, RTI, Ericsson...



Dryver Huston visit at Lake Wheeler to discuss AERPAW use for their PAWR supplement (March 2026)



Digital twin experiments at AERPAW by the UC Irvine team

