Parallax
ADVANCED RESEARCH

Ohio Federal Research Network
Driving Innovation Through Strategic Partnerships

# WELCOME!

# Emcee: Karen Posey

## OFRN Consultant

Karen is Founder & CEO of KP Strategies a Management Consulting Firm with a proven track record with the Air Force, Academia & Industry.

KP Strategies provides strategic expertise to help Executive Leaders get to the real problem they are trying to solve, define what success looks like, leverage insight from key stakeholders and strategizing on the best way to accomplish their goals working “smarter vs. harder”.

Karen knows how to simply the message, engage the teams and navigate political situations to ultimately execute the mission.

# Agenda

| | |
|---|---|
| 8:30-9:00 | Networking |
| 9:00-9:15 | Welcome! OFRN Program & Session Goals |
| 9:15-9:30 | AFRL Digital Engineering Transformation. *What it is and why it's important.* Dr. Michael Gregg |
| 9:30-9:45 | Quantum Communication, Dr. John Lekki |
| 9:45-10:00 | AFRL / NASA Q&A |
| 10:00-11:00 | Opportunities Overview |
| 11:00-12:00 | Opportunity Discussion / Networking |

# Opportunity Days Goal

**Help Ohio Industry and Academia win new R&D business and funding**

# OFRN History

**$51.4M**
**State Funding, Fiscal Years 2016-2021**

**R&D Aligned with Federal Partners' Priorities**

- AFRL
- NASA
- NAMRU-D
- NASIC

## FRN Funding Focus

| | BASIC Research and Development | Applied Research and Development | Advanced Technology Development | Demonstration and Validation | Engineering and Manufacturing | RDT&E Management Support | Operational Systems Test and Validation |
|---|---|---|---|---|---|---|---|
| DOD RDT&E Level | 6.1 | 6.2 | 6.3 | 6.4 | 6.5 | 6.6 | 6.7 |
| AFOSR FOCUS | | | | | | | |
| NASA | TRL1 | TRL2 | TRL 3 | TRL 4 | TRL 5 | TRL 6 | TRL 7 | TRL 8 | TRL 9 |
| | Basic Principles | Concepts Application Focus | Analysis and Experiments | Concept and Breadboard in Laboratory | Component and Breadboard Validation in Realistic Environments | System / Subsystem prototype demonstration in realistic Environment | System prototype demonstration in Operational Environment | Actual system completed and qualified through test and demonstration | Actual system proven through successful mission operations |

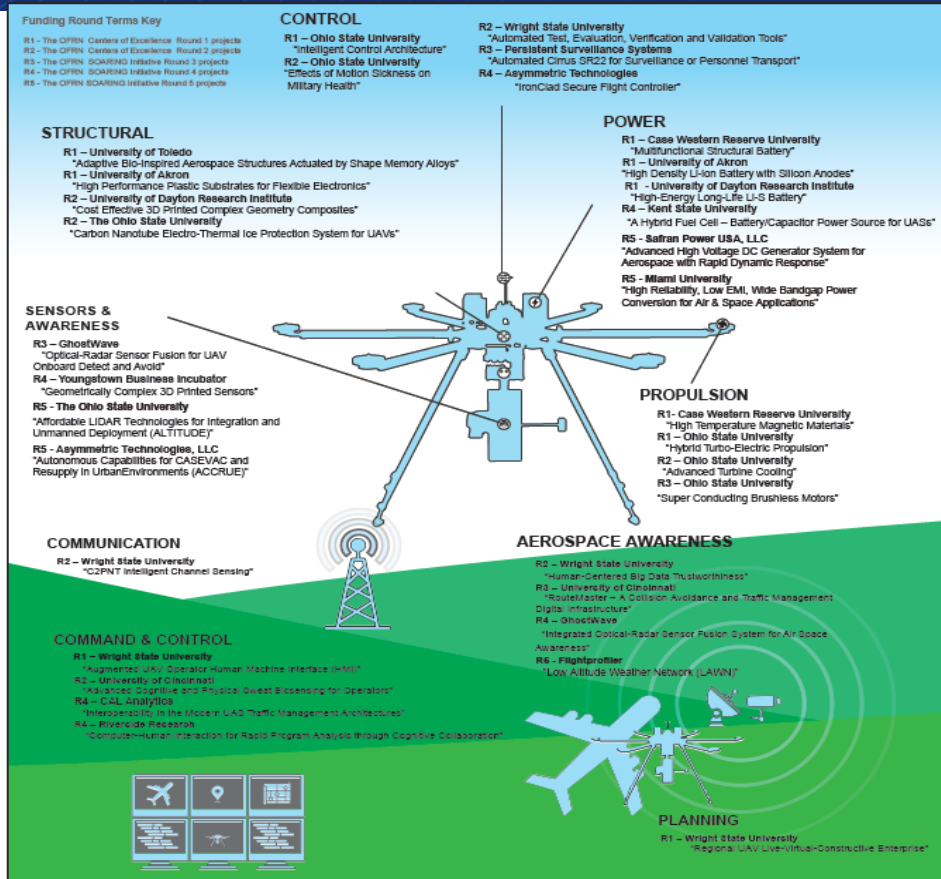
FRN COE Focus
Mission Application Research for NASA, AFRL, NAMRU and NASIC

# OFRN Funding

## Round 5 - Soaring

### Federal Partners' Areas of Interest

1. Vertical Take-Off & Landing (VTOL)
2. Situational awareness & Proliferated surveillance systems
3. Patient care in austere and contested environments
4. Personal exposure devices
5. Acceleration effects
6. Enabling human-machine teaming using brain-machine interfaces
7. Advanced power systems applicable to aviation propulsion, micro-grids and lunar surface operations
8. Quantum communications
9. Applications of commercial satellites to humanitarian, disaster, and defense topics
10. Large data set triage
11. Journal article warning and correlation



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# Program Impact

Ohio Federal Research Network
Driving Innovation Through Strategic Partnerships

**Collaboration**

**21**
Academic Partners

**97**
Business Partners

**10**
New Companies

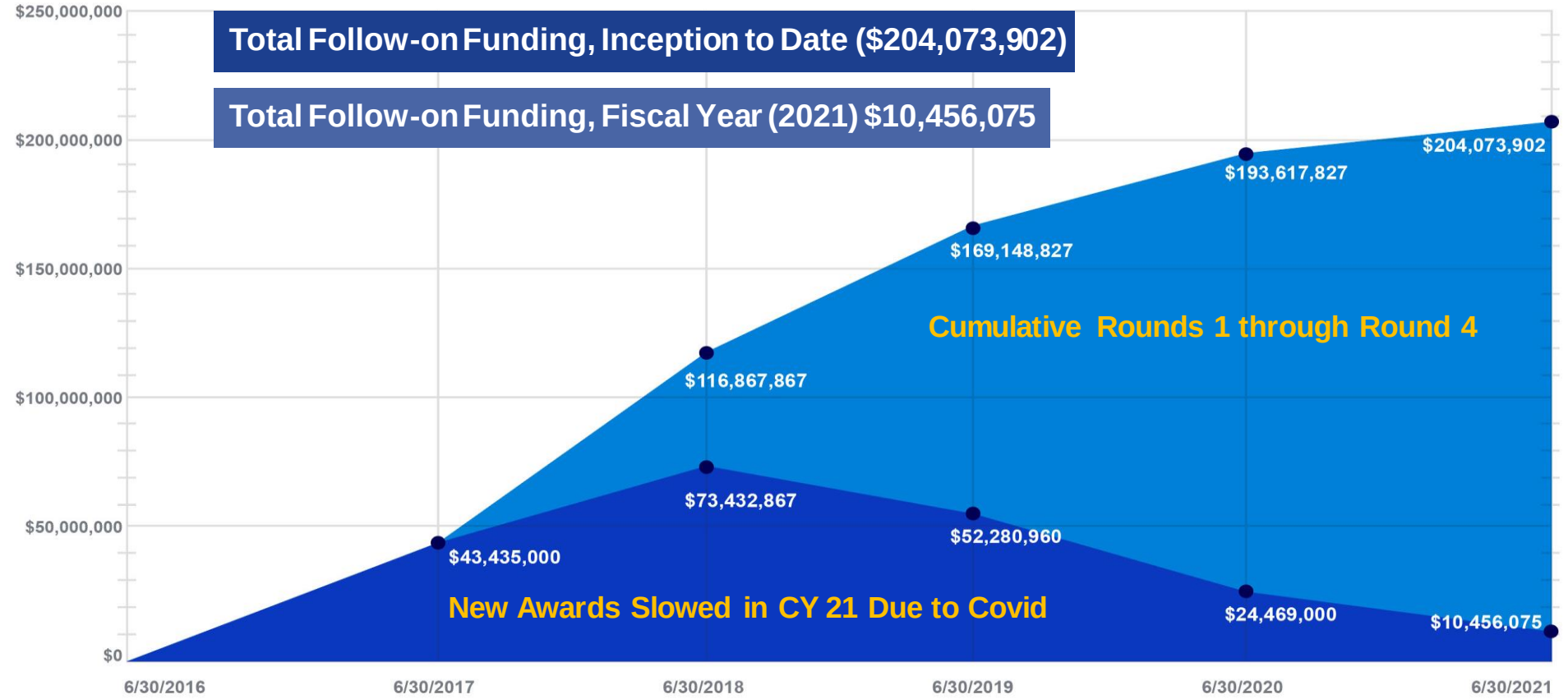
**$350M+**
Proposal Pipeline

**$204M**
Awarded in Follow-On Funding

**$34.6M**
Industry-Sponsored Research

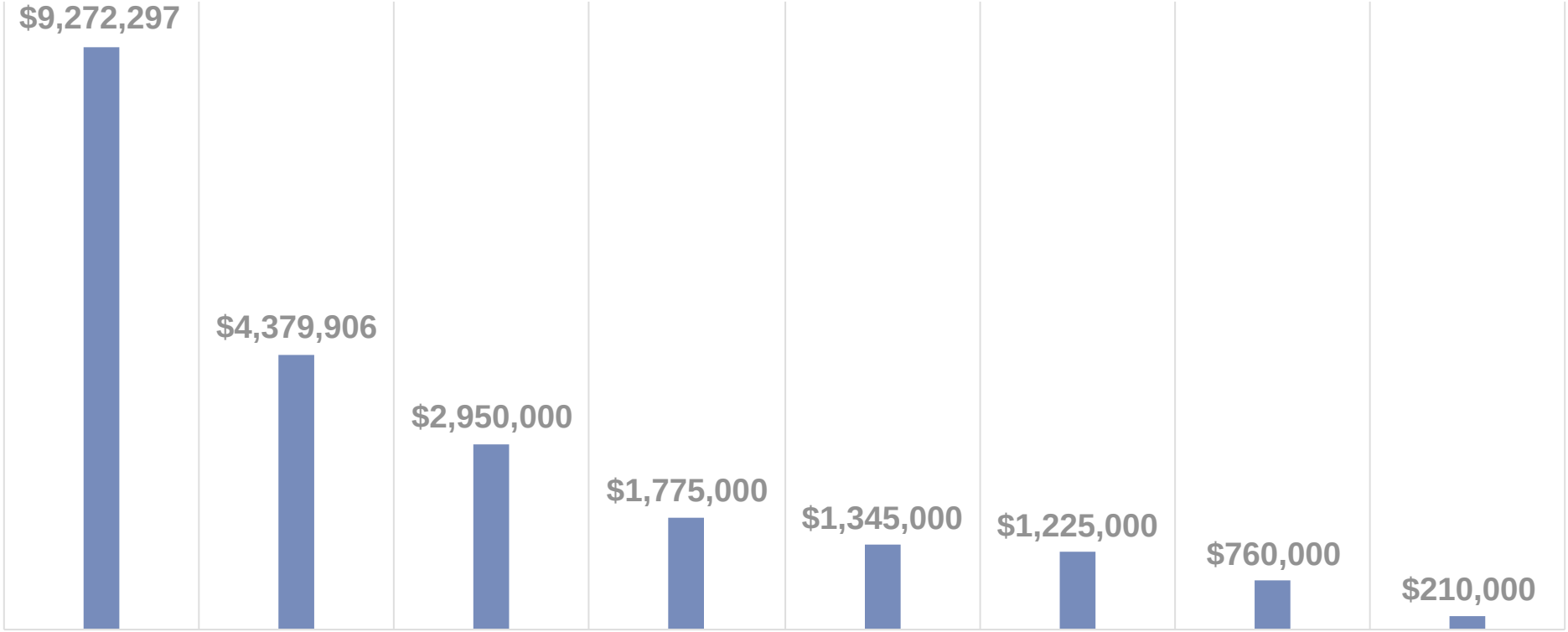
**$164M**
Federal Funding

# OFRN Follow-on Funding



# SBIR/STTR

## OFRN Value by Agency



# SBIR/STTR

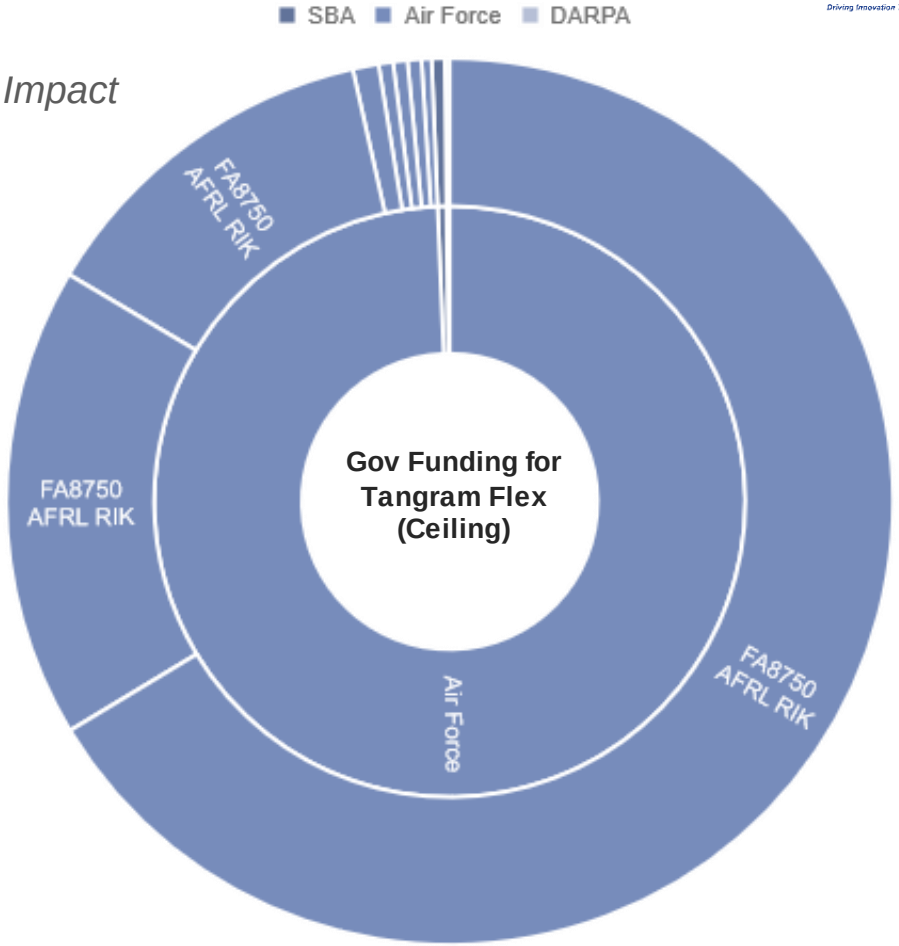
## OFRN Value by Round

# Spinout Companies

*Lifetime U.S. Government Funding Impact*

| | | |
|---|---|---|
| Akron PolyEnergy | $ | 199,900 |
| 3Dnol | $ | 182,090 |
| Fenix Magnetics | $ | 1,162,188 |
| Kairos Research | $ | 6,868,145 |
| Thermomorph | $ | 455,672 |
| Tangram Flex | $ | 143,157,168 |

| | | |
|---|---|---|
| **Total** | $ | 167,658,318.97 |
| Air Force - All | $ | 157,929,340 |
| Army | $ | 256,000 |
| DARPA | $ | 2,037,197 |
| DOE | $ | 849,600 |
| IARPA | $ | 4,460,000 |
| NASA | $ | 182,090 |
| Navy | $ | 239,966 |
| NSF | $ | 105,672 |
| SBA | $ | 1,598,453 |



U.S. AIR FORCE

USSF

AFRL

# *Impact of Digital Transformation*

**Dr. Michael Gregg, Director**

**Aerospace Systems Directorate**

# Digital Transformation Imperatives

## VISION: DELIVER NEW CAPABILITY TO THE WARFIGHTER AT THE SPEED OF RELEVANCE

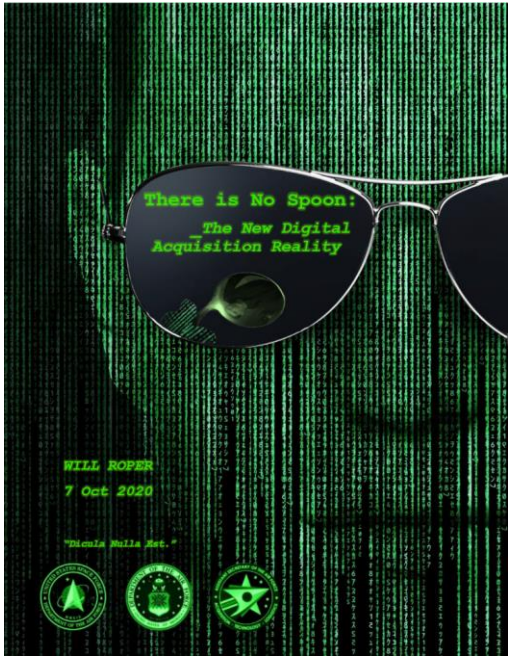

To accelerate the implementation of the Air Force S&T 2030 Strategy, we must:

- Focus on fewer technologies that show the highest payoff in terms of military utility and cost effectiveness through rigorous analysis; and
- Continue to improve the efficiency of resource management

Digital Transformation - including Digital Engineering - facilitates rapid innovation, iteration, and fielding of new warfighter capabilities via the coevolution of technology-enabled operational and system concepts

# The Impetus for Digital Transformation

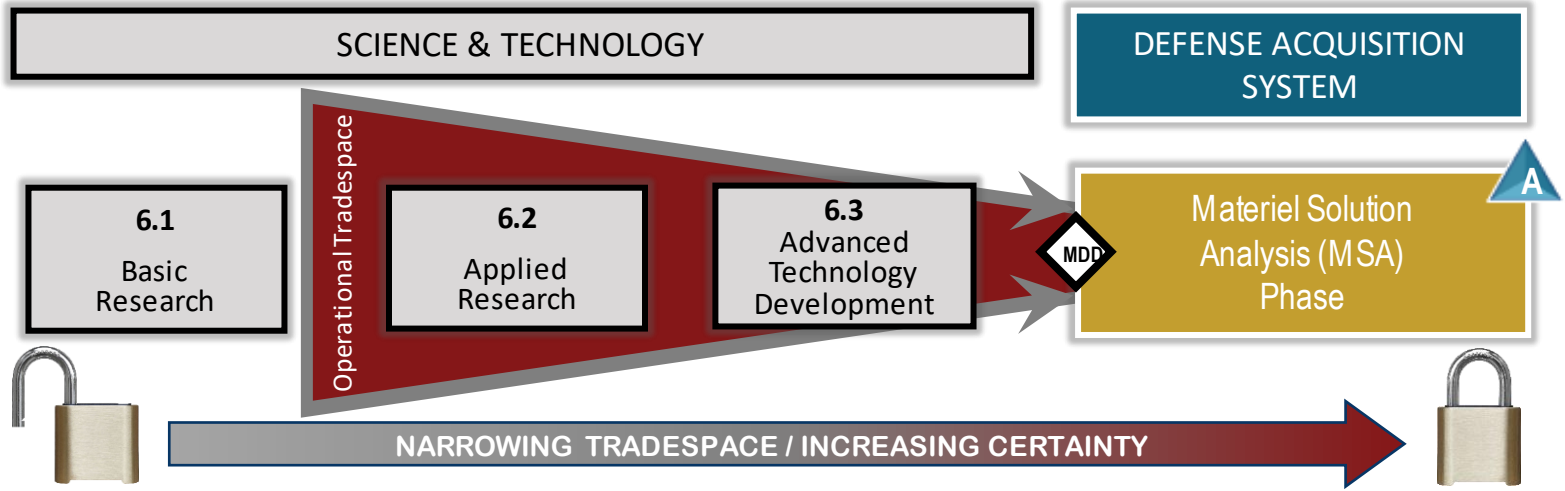
## SPEED AND AGILITY IN WEAPON SYSTEM ACQUISITION





"eCreate Before you Aviate"

# Science & Technology vs. Acquisition Programs of Record




REQUIREMENTS
ARCHITECTURES
CONOPS
PROCESSES
MILESTONES
TECH REVIEWS
DELIVERABLES
STANDARDS
CRITERIA

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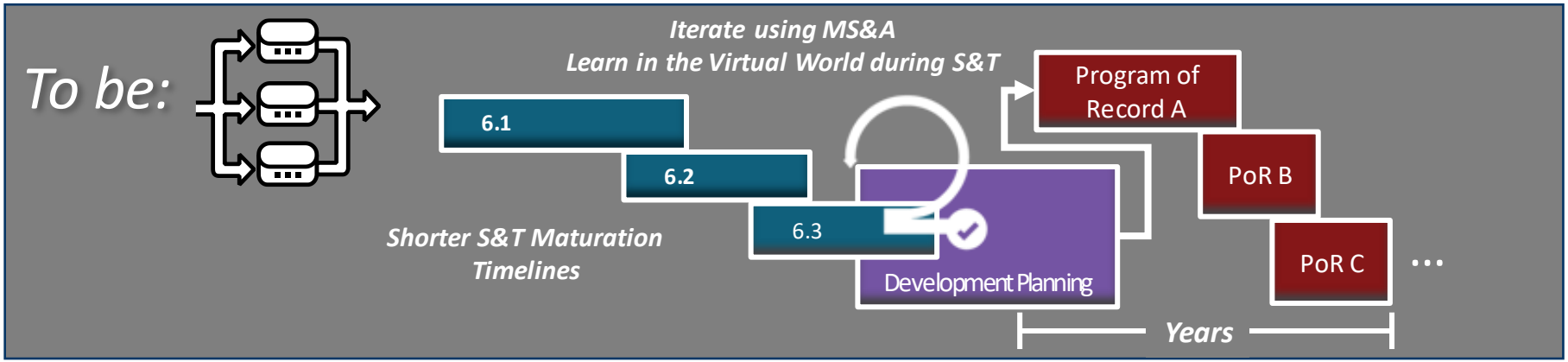
# Goal: Accelerated Technology Maturation & Seamless Transition

# Digital Transformation for AFRL

clever nimble skillful dexterous

## DEFT

- Advanced MS&A across the Lifecycle
- Novel Mission & Vehicle Concepts
- Attritable Vehicles
- Autonomy
- Open Architectures
- Gov't-owned Designs
- Agile Manufacturing
- Genus / Century Series

What

model-based integrated continuum

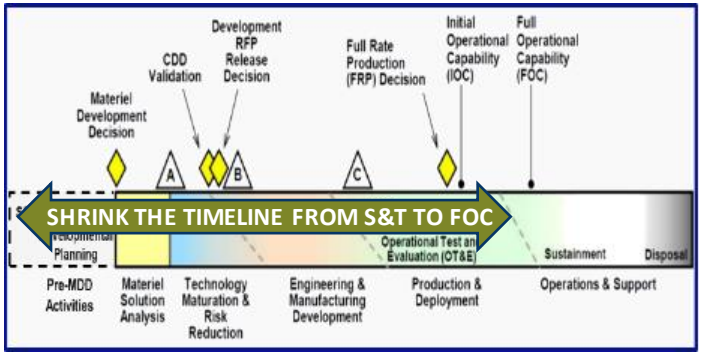
## DIGITAL


- Digital Collaboration
- Digital Processes
- Digital Activities
- Digital Artifacts

How

innovative RADICAL GROUNDBREAKING

## DISRUPTIVE



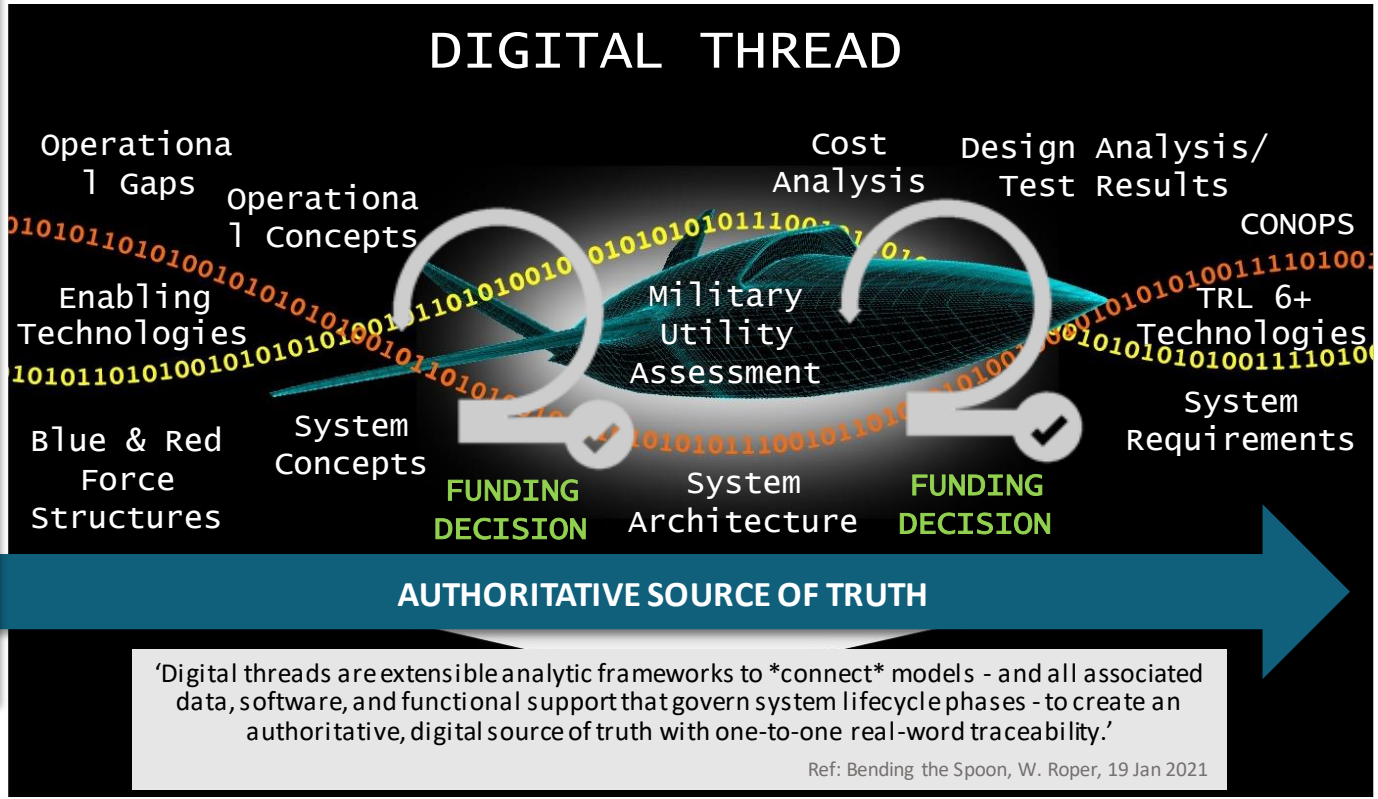

- Expedite prototype development
- Facilitate transition to a Program of Record
- Reduce programmatic and implementation risk
- Reduce lifecycle costs

Why

***AFRL's Approach to Digital Transformation Must Enable Us to be DEFT and DISRUPTIVE***

# Vision: Digital Threads Bridge the Gap from S&T to MDD

- Digital Engineering Starts at Concept Ideation
- Modeling, Simulation, & Analysis Inform Investment Decisions
- Models & Data Used for Reporting, Reviews, & Approvals
- Models & Data Define the Concept's Evolving Tech Baseline
- Authoritative Source of Truth Keeps Activities Coherent



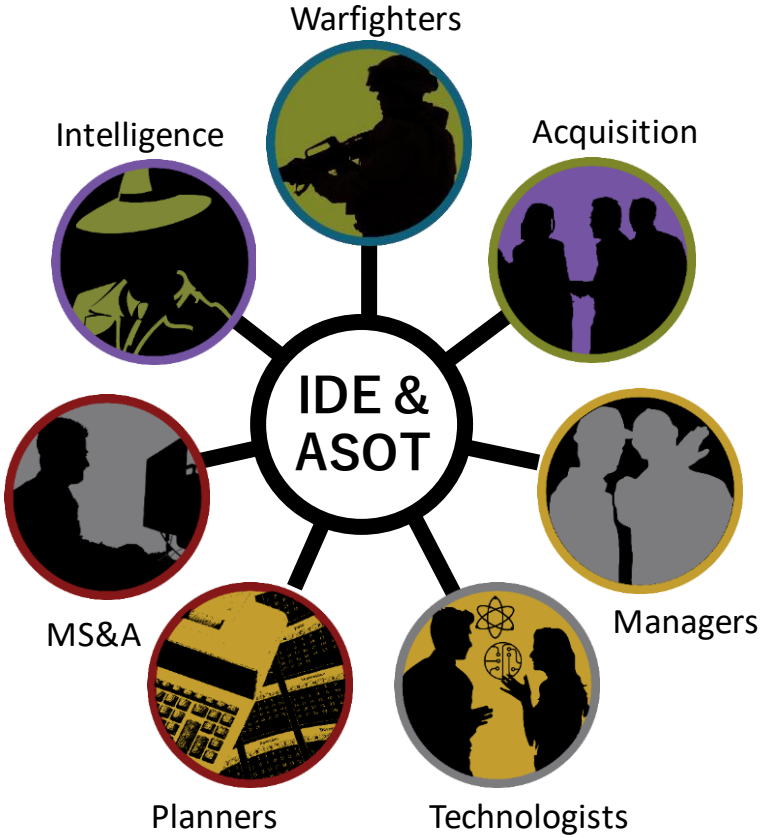

'Digital threads are extensible analytic frameworks to *connect* models - and all associated data, software, and functional support that govern system lifecycle phases - to create an authoritative, digital source of truth with one-to-one real-word traceability.'

Ref: Bending the Spoon, W. Roper, 19 Jan 2021

# Vision: Seamless Digital Communication & Collaboration

INTEGRATED DIGITAL ENVIRONMENT (IDE) ENABLES ONLINE COLLABORATION AMONGST ALL STAKEHOLDERS

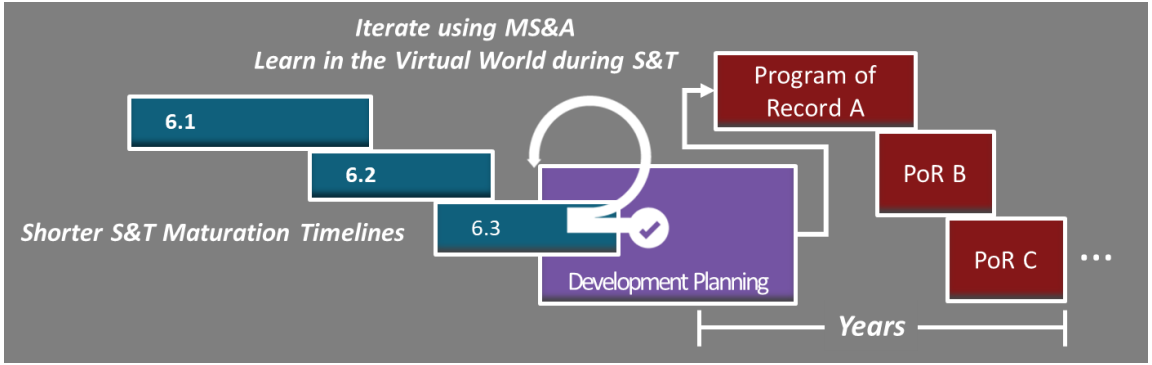
INTEGRATED DIGITAL ENVIRONMENT (IDE) ELIMINATES MANUAL DATA TRANSFER

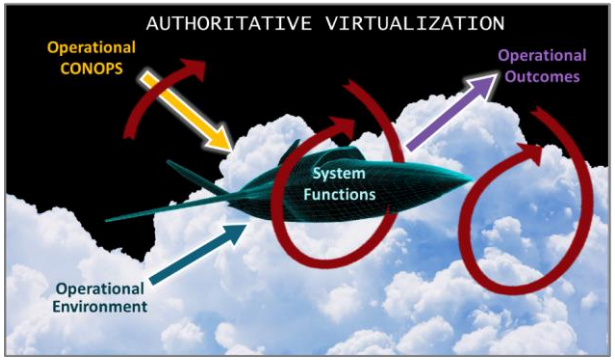


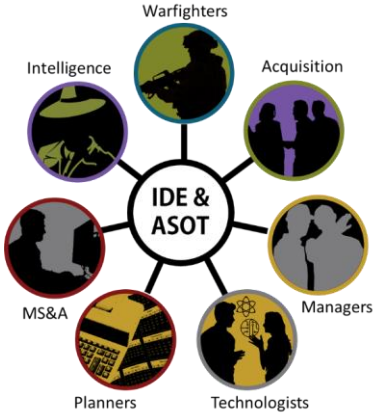

AUTHORITATIVE SOURCE OF TRUTH (ASOT) KEEPS DISPARATE ACTIVITIES SYNCHRONIZED

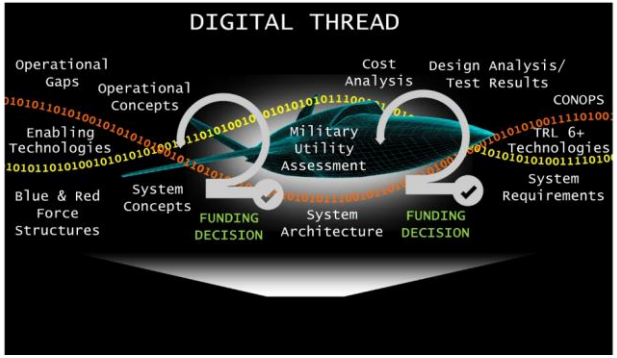
AUTHORITATIVE SOURCE OF TRUTH (ASOT) PROVIDES TRACEABLE RECORD OF DECISIONS AND ASSOCIATED MODELS AND DATA

# Summary

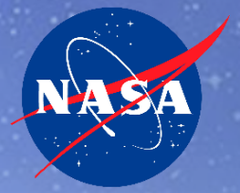


National Aeronautics and Space Administration




# Quantum Communications in Aerospace

**Ohio Federal Research Network Opportunity Day**

**February 3, 2022**

**John Lekki, NASA GRC**

# NASA's Vision

Vision: We reach for new heights and reveal the unknown for the benefit of humankind

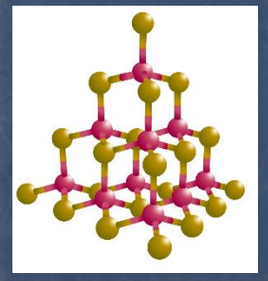
Mission: Drive advances in science, technology, aeronautics, and space exploration to enhance knowledge, education, innovation, economic vitality and stewardship of Earth

# A vision for the future space-based quantum network

Image credit: NASA TDRS

$$$

**Monetary transfers between financial institutions secured by Quantum Comm**

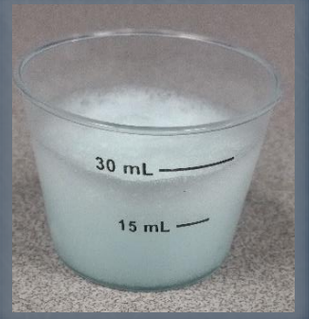


New Materials

Image credit: NASA/Marshall Space Flight Center

**Researchers access the research power of centralized quantum computers and maintain confidentiality**

Quantum Network




Breakthroughs in Medicine

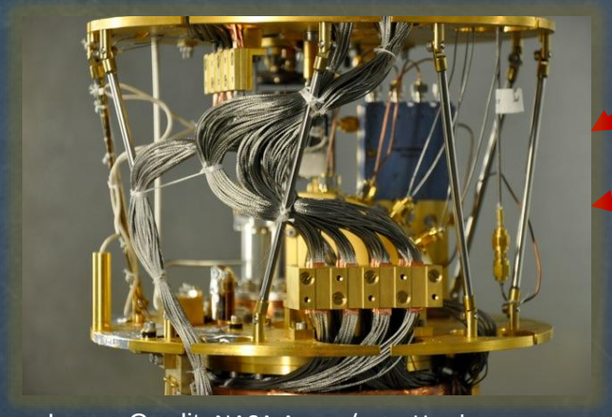


Image Credit: NASA Ames / John Hardman

Image credit: NASA TDRS

**Quantum Sensor arrays may be used to monitor local aquifers**

$$$

# Potential Quantum network applications

## QUANTUM INTERNET

- Connect users to quantum computers
- Blind (private) quantum computing
- Quantum cloud computing

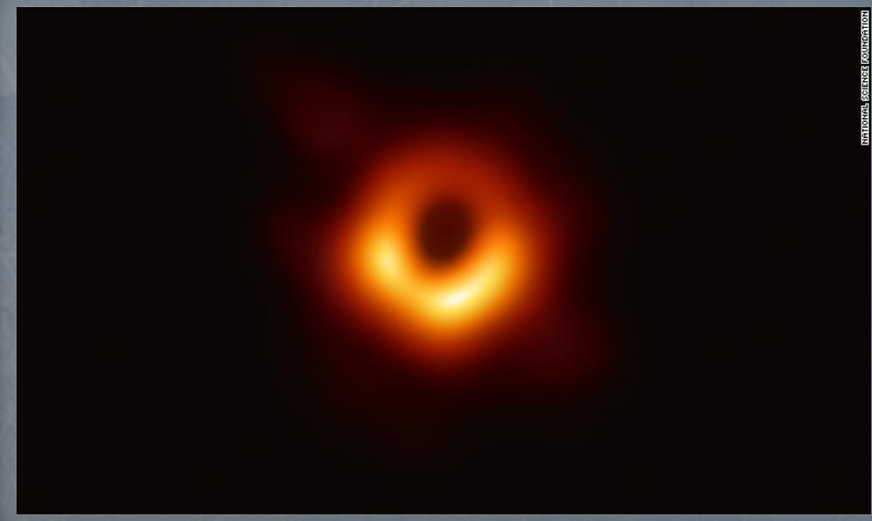
## QUANTUM ENHANCED SENSOR ARRAYS

- Entangled Optical Telescopes (Long Baseline Interferometry)
- Entangled Atomic Vapor Cells
- Entangled Atomic Clocks

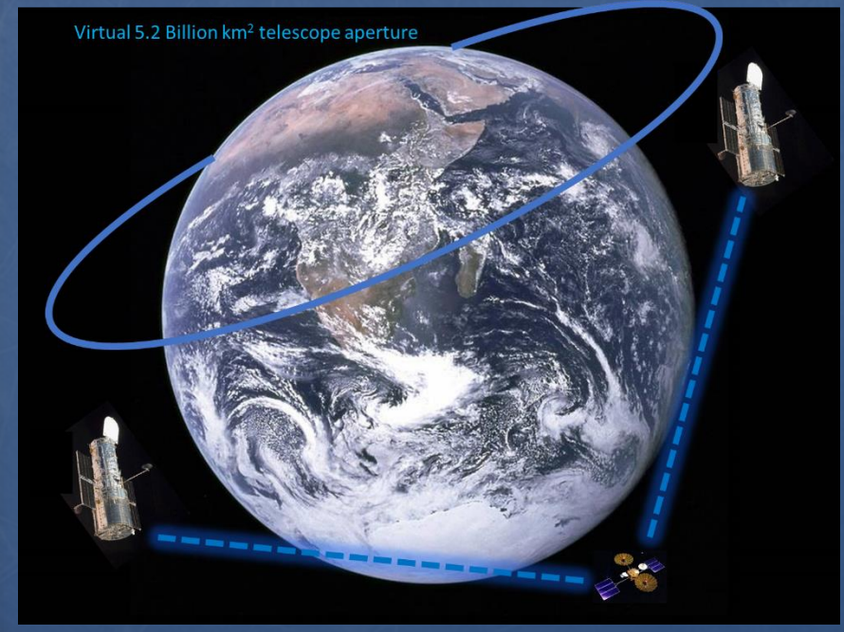
## ENHANCED COMMUNICATION CAPABILITY

- Secure Quantum Communication Links
- Synthetic optical communication transmitter / receiver arrays

**The enormous value of large sensor arrays has recently been dramatically shown by the imaging of a black hole in the center of galaxy M87**



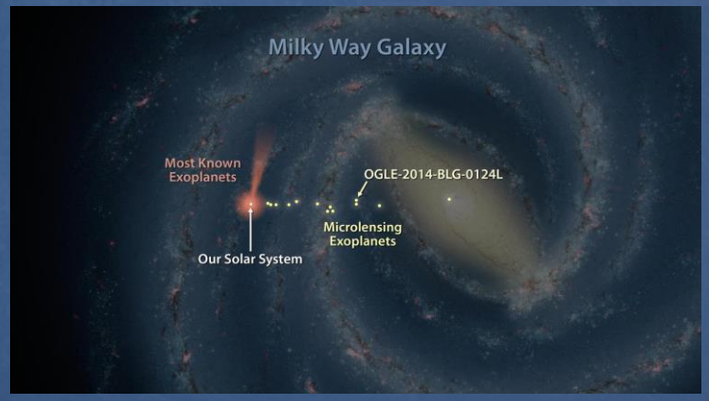

*The first picture of a black hole from radio telescope array*
*Image Credit: Event Horizon Telescope Collaboration.*



# Next-generation entangled sensor networks

## Long Baseline Interferometry

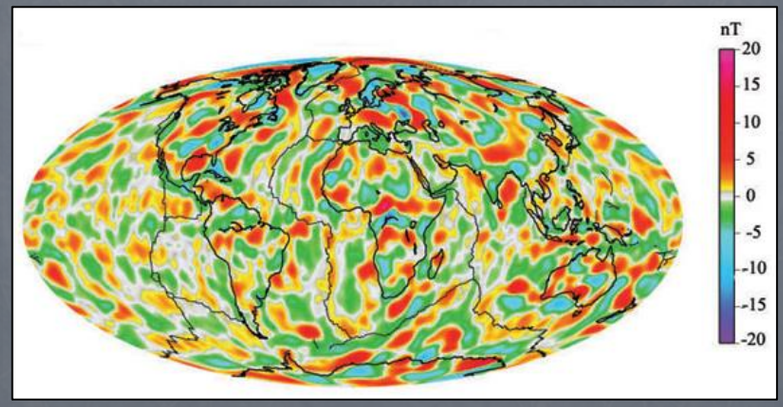
**Benefits:** High resolution exo-solar imaging of never-before-seen celestial bodies and surfaces




*Map of Exoplanets found in our Galaxy – artist concept*
*Credit: NASA/JPL-Caltech.*

## Atomic Vapor Cells

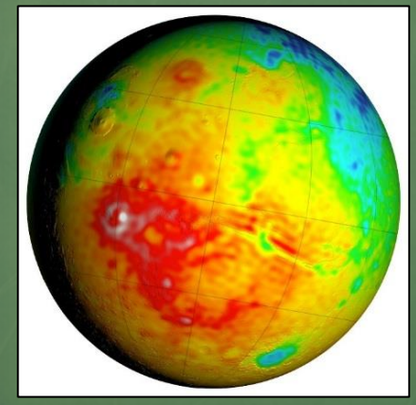
**Benefits:** High resolution imaging of sun/planet/moon magnetic fields




Credit: Terrence Sabaka et al./NASA GSFC.

## Atomic Clocks

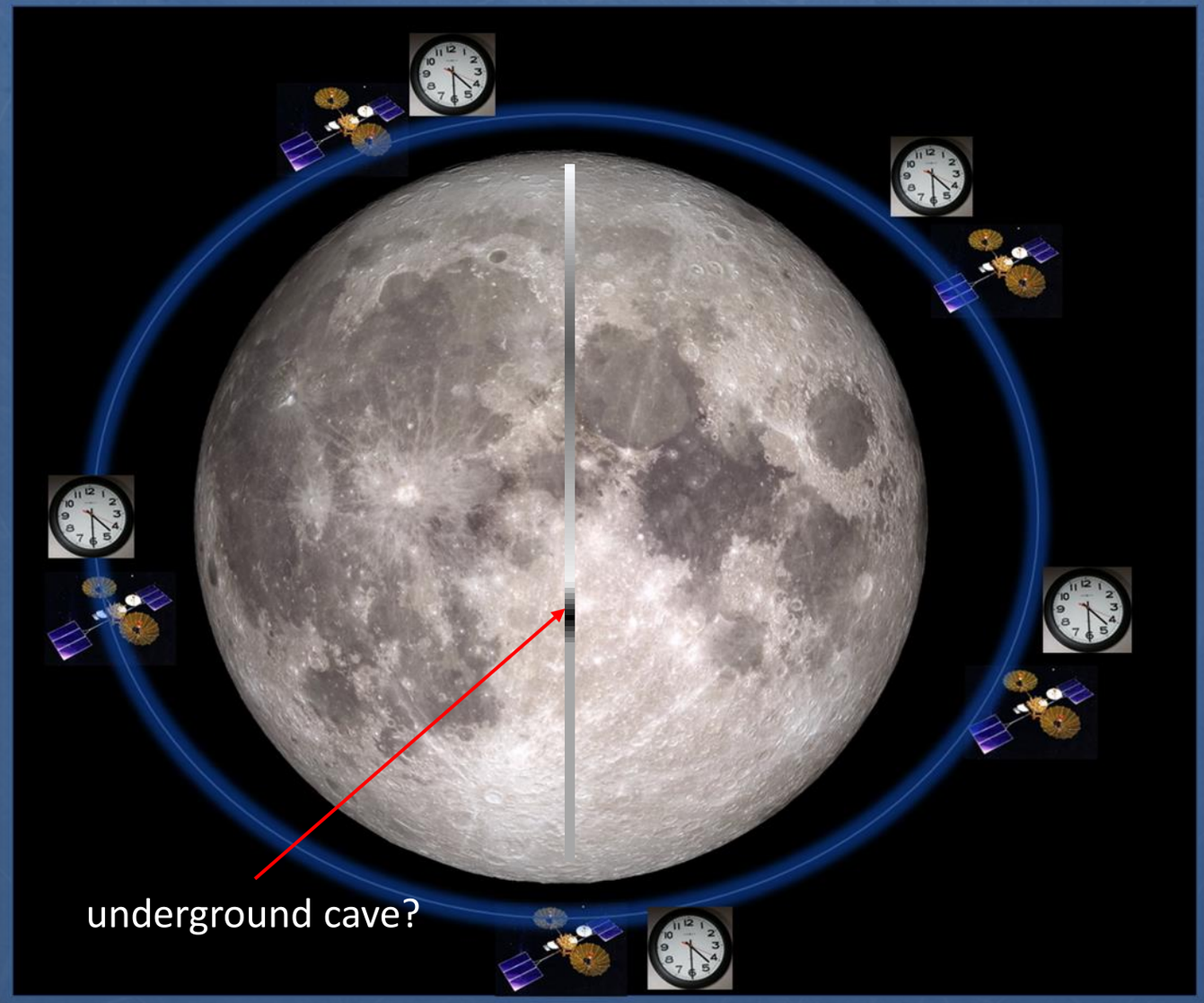
**Benefits:** High accuracy global timing system. High resolution imaging of celestial gravitation fields. Location of gravimetric sources, such as underground caverns.



*Variations in thickness of Mars Crust from gravitational pull on orbiters*
*Credit: NASA/GSFC/Scientific Visualization Studio.*

# Entangled network of atomic clocks potential benefit

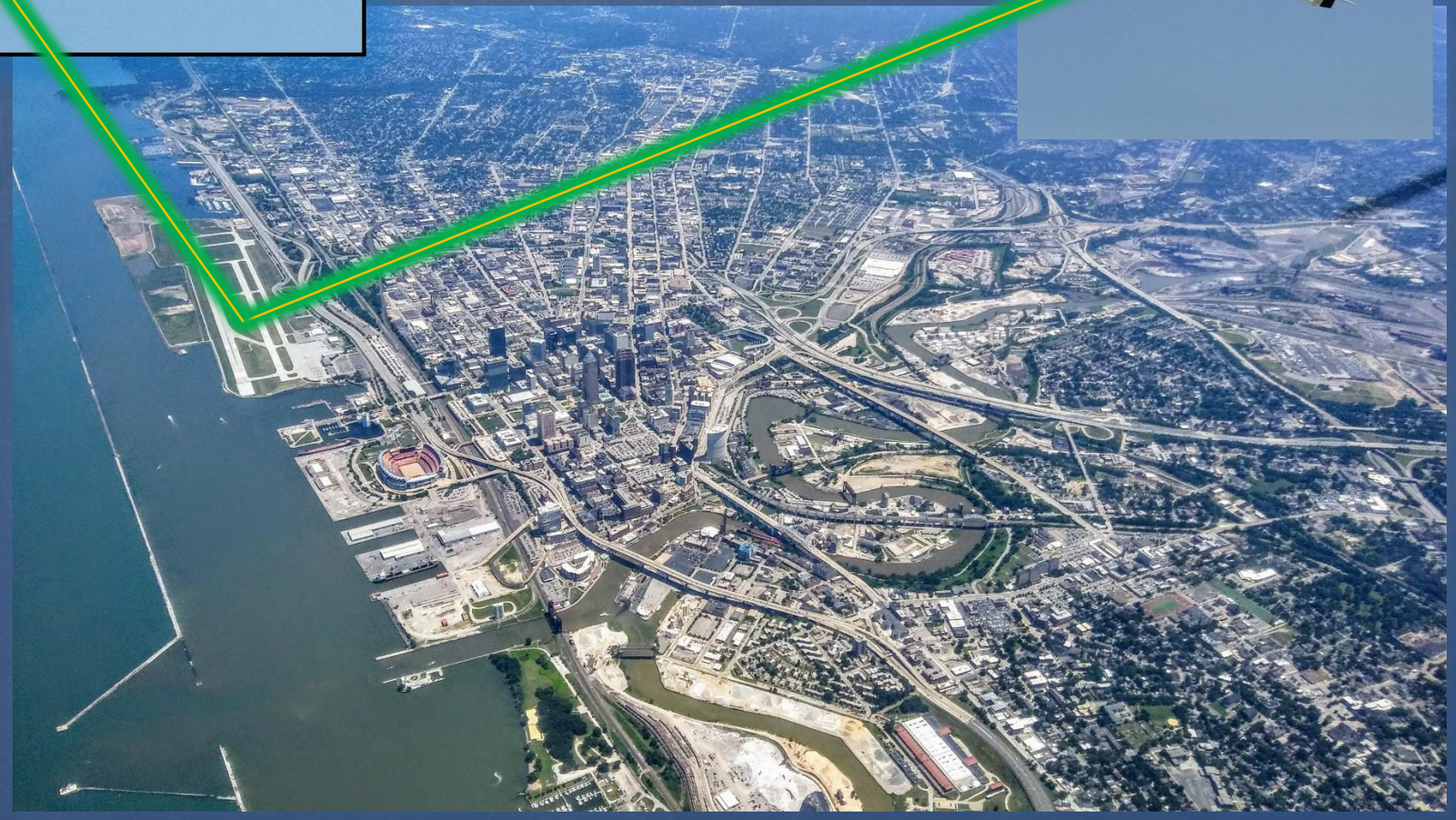
Future advances in atomic clocks could possibly allow fractional frequency certainty beyond $10^{-20}$ after 100 seconds.




**Concept from: P. Komar, et. al., "A quantum network of clocks." arXiv:1310.6045v1 [quant-ph] 22 Oct 2013.**

**Image Credit:**
NASA/GSFC/Arizona State University; TDRS.

# Quantum communications for secure aircraft links

- UAM could be systematically loaded with quantum distributed crypto keys
- Quantum Key Distribution has provable security for transmission of cryptographic keys between trusted nodes
- In flight trusted nodes can be seen

# NASA GRC capabilities

## NASA Quantum Communication Analysis Suite

- Perform dynamic simulations
- Enable specification and design of space, airborne or ground based communications systems
- Fully quantum mechanical model allows for calculation of entanglement distribution rates as well as state fidelities


## NASA Quantum Metrology Laboratory

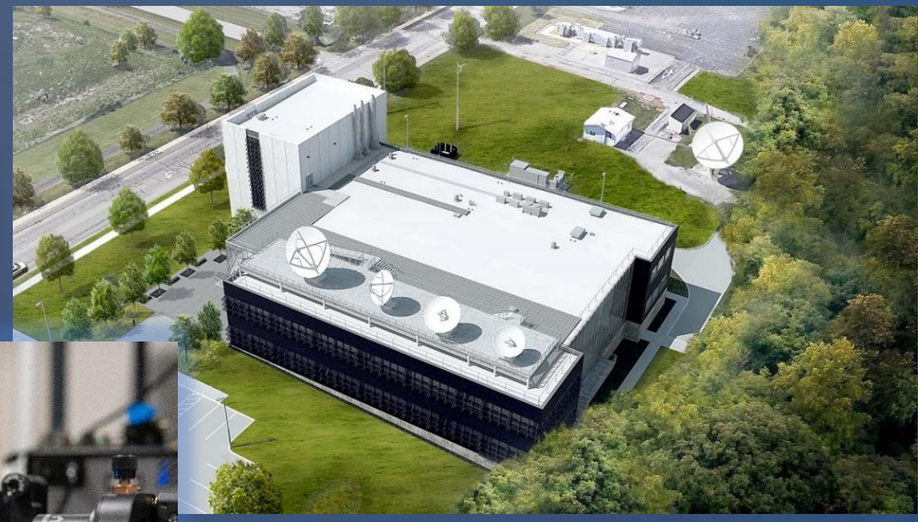


Image Credit:
NASA/Ross Barney Architects

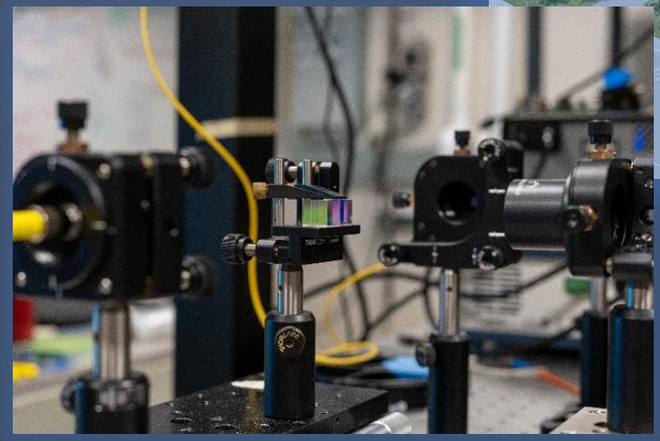


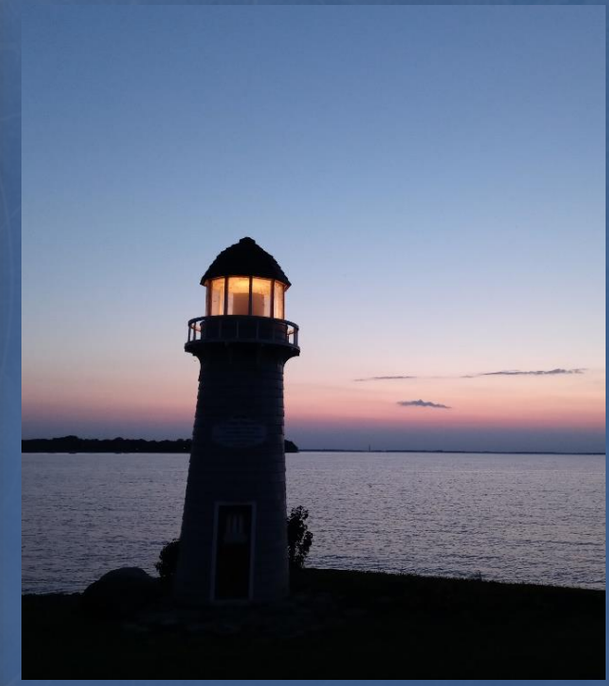
Image credit: NASA/Tyler Fairchild

**To be located in the new Aerospace Communication Facility at NASA GRC**

**Goal:** Make low TRL technologies ready for aerospace applications
**Current effort:** Develop testbed consisting of hardware, software, systems, and models required for component metrology for spacecraft and aircraft quantum communication systems

# What is needed?

- In general, looking for quantum optical components with low Size, Weight, Power and Cost (SWaP-C)
  - Integrated photonic circuits that include sources, detectors, quantum circuits, high speed modulators and switches to enable highly stable and compact quantum flight systems
  - Non cryogenic single photon detectors
- Airborne key distribution systems and platforms (ad hoc)
- Scalable quantum memory
- High efficiency optical interconnects
- Optical beacons
- Authentication protocols
- Flight optical terminals
  - Fiberoptic interfaces to flight optical terminals
  - Co-Integration of classical communication, quantum communication, pointing, tracking and imaging into optical terminals
- Ground terminals for the distribution of qbits to parked and in flight aircraft



# Previous NASA funding opportunities for quantum communication

Quantum Communications Small Business Technology Transfer Program (STTR) topic

- STTR pairs small businesses with research institutions
- 4 Awards in 2021

Quantum Sensors STTR topic

- 2 Awards in 2021

NASA Early Stage Innovation Space Technology Research Grants topic “Development of Quantum Communication Technologies”

- Academia focus
- 1 Award in 2021

# Links for NASA calls for proposal

NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES)
https://nspires.nasaprs.com

Small Business Innovation Research (SBIR) & Small Business Technology Transfer (STTR) Program
https://sbir.nasa.gov/