InSPIRE

Innovation Summit for Preparedness & Resilience

Chad^2 – How Expononential Increases in Technology are Impacting Public Safety

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01 | Introduction

Meet the presenters

Chad Council

Chad Beam

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Meet the presenters

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Chad Beam

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Objective

Explore advanced and emerging topics in public safety, current and perceived maturity levels, and potential avenues for advancing research and development.

Underlying problem

How do we get from here → To here?

Operational Need

Identify the best way to segment search areas/predict the appropriate amount of resources and workload

Technical Solution

Utilization of best practices, POST, and other research into PAWSAR through MITLL (and then wider applicability for items like wildfire evacuations)


05
Panel Discussion
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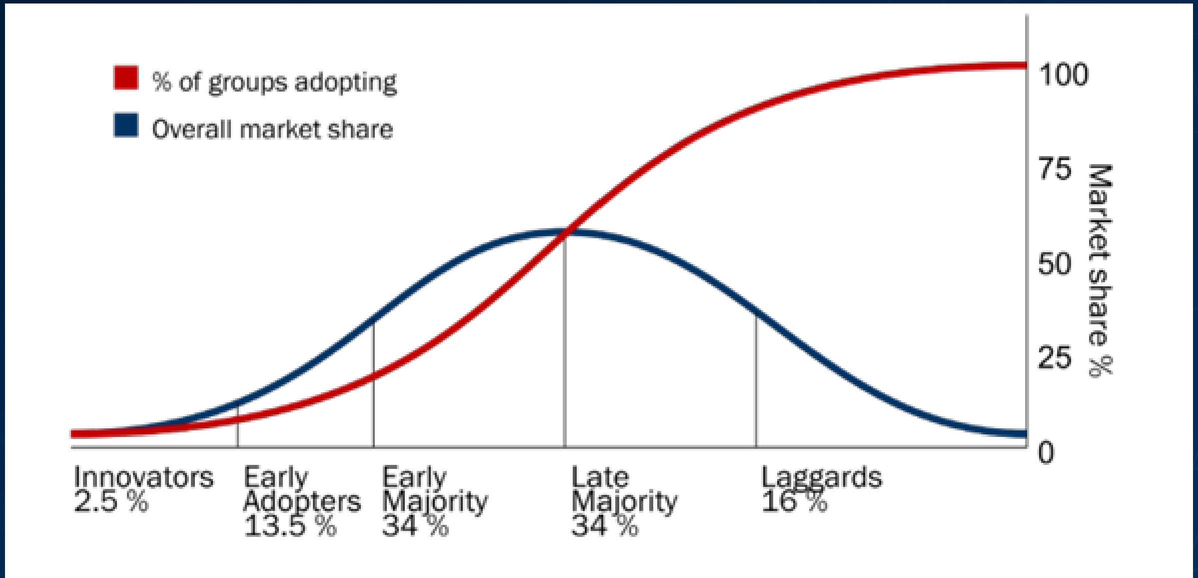
InSPIRE
UNIVERSITY OF NORTH CAROLINA
CHARLOTTE
THE DUBOIS CENTER
AT UNC CHARLOTTE CENTER CITY
CHARLOTTE

Problem Statements

1. Technology is advancing so rapidly that public safety stakeholders lack the avenues to define requirements, test and exercise within current policies and procedures, and make fiscal decisions.
2. The research and development community moves faster than public safety stakeholders can provide feedback, and narrowly-focused projects limit SME input.
3. The private sector/developer community is fragmented into competing or disassociated technologies without a holistic view into how public safety stakeholders can or will use their technologies.
4. Technology has become so complex that gaps between operational requirements and technical feasibility is misunderstood.

Accelerating Adoption

TRL 9	Actual system “flight proven” through successful mission operations
TRL 8	Actual system completed and “flight qualified” through test and demonstration (ground or space)
TRL 7	System prototype demonstration in a space environment
TRL 6	System/subsystem model or prototype demonstration in a relevant environment (ground or space)
TRL 5	Component and/or breadboard validation in relevant environment
TRL 4	Component and/or breadboard validation in laboratory environment
TRL 3	Analytical and experimental critical function and/or characteristic proof-of-concept
TRL 2	Technology concept and/or application formulated
TRL 1	Basic principles observed and reported



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02 Technology Interconnectedness

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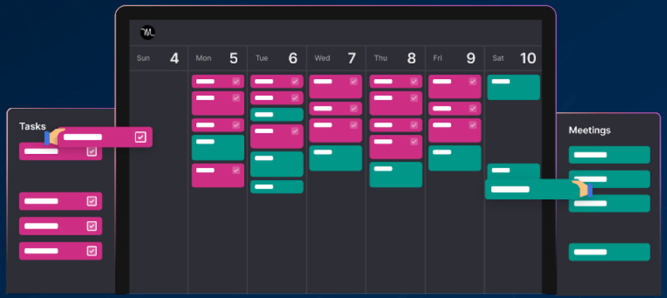
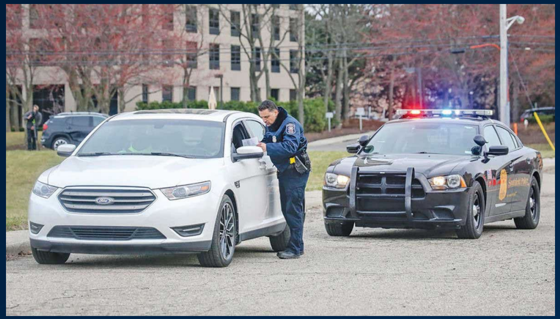
From public tool to public safety use

Why did the police officer go to art school? Because he wanted to learn how to draw his weapon! 😄





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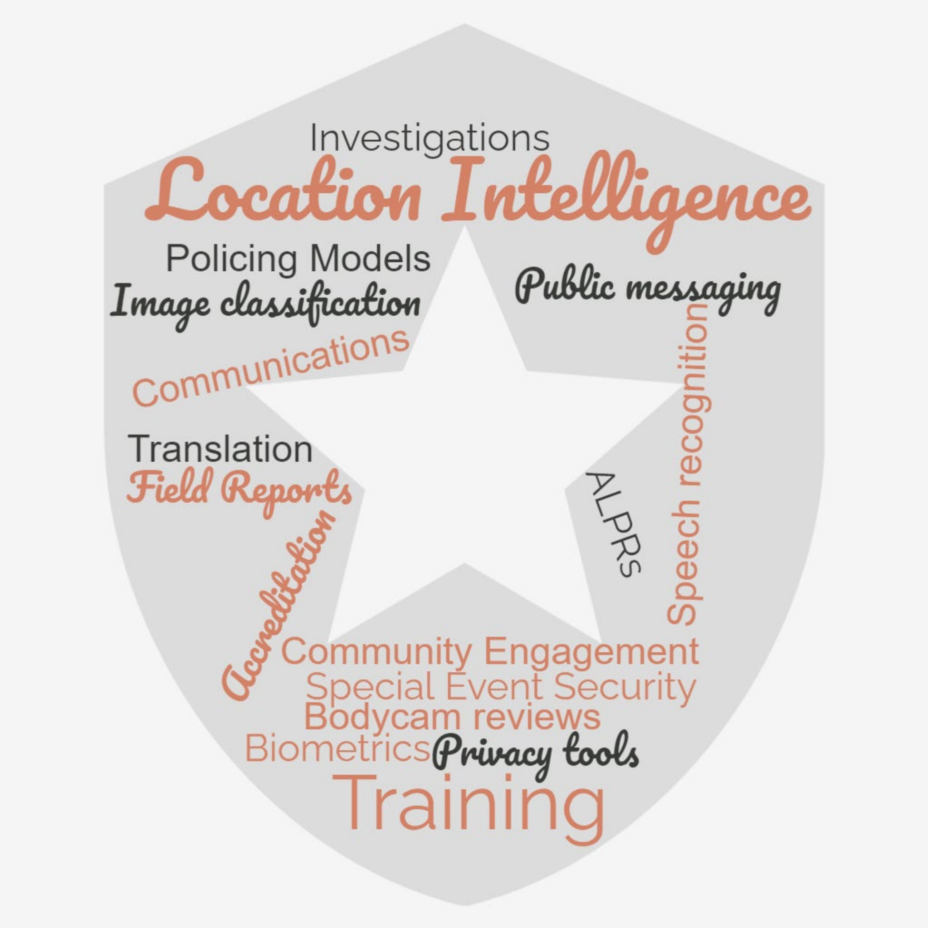
What are some use cases?



What are some challenges?


POLICE


POLICE

The chosen model only uses publicly available data

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We pivot to an open-sourced model so we can use our own data

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Next challenge: What is the difference between the 8B and 70B parameters models? Do we have enough compute power to run them?

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What does this mean?

	Meta Llama 3 8B	Gemma 7B - It (Measured)	Mistral 7B Instruct (Measured)
MMLU 5-shot	**68.4**	53.3	58.4
GPQA 0-shot	**34.2**	21.4	26.3
HumanEval 0-shot	**62.2**	30.5	36.6
GSM-8K 8-shot, CoT	**79.6**	30.6	39.9
MATH 4-shot, CoT	**30.0**	12.2	11.0

	Meta Llama 3 70B	Gemini Pro 1.5 (Published)	Claude 3 Sonnet (Published)
MMLU 5-shot	**82.0**	81.9	79.0
GPQA 0-shot	39.5	**41.5** CoT	38.5 CoT
HumanEval 0-shot	**81.7**	71.9	73.0
GSM-8K 8-shot, CoT	**93.0**	91.7 11-shot	92.3 0-shot
MATH 4-shot, CoT	50.4	**58.5** Minerva prompt	40.5

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How do we even deploy it?

HUGGING FACE

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- Now we need to fine tune
- And we need to prepare our data to even be ingested
- And then do some prompt engineering
- Maybe do a little manual evaluation and some red teaming to validate the results
- Look for gender, racial, linguistic, cultural, and other biases

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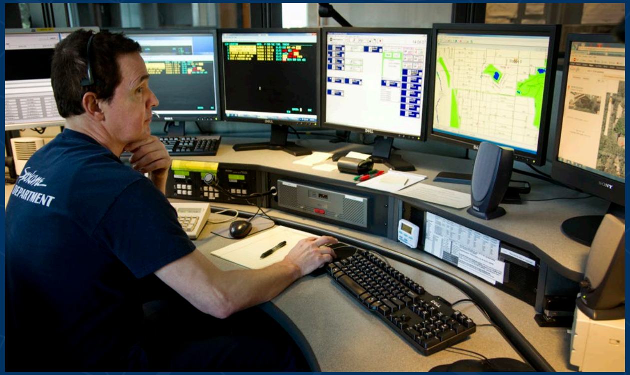
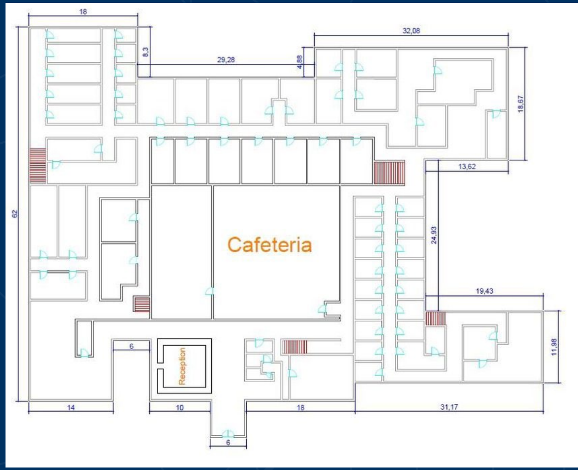
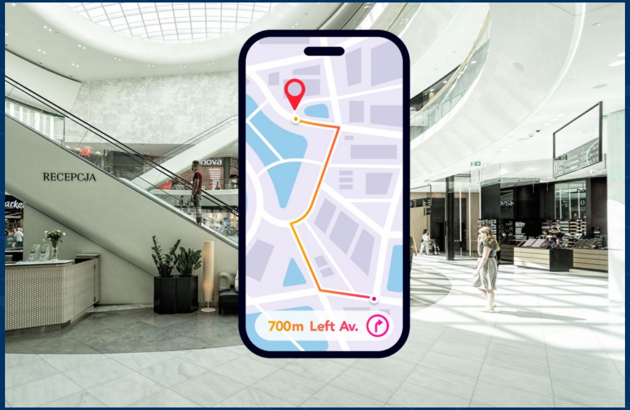
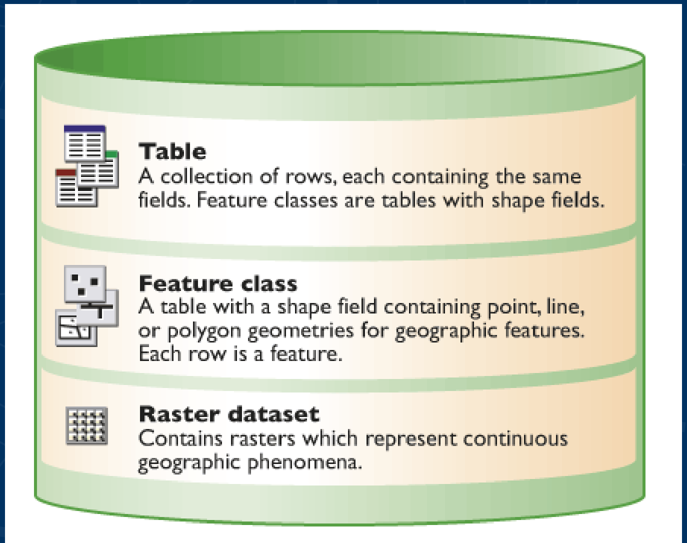
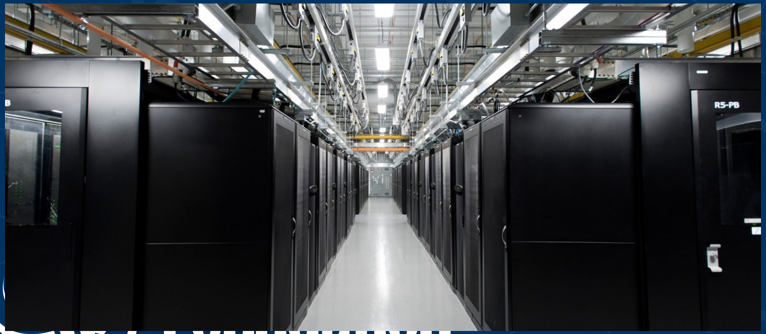


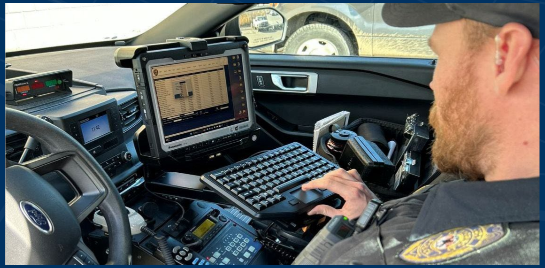
matter + THREAD











ChatGPT 4o

Pick outfit to look good on camera

Overcome procrastination

Python script for daily email reports

What to do with kids' art

You are a coding expert who specializes in ETL processes for public safety data.

ChatGPT can make mistakes. Check important info.

Advanced Technology In Public Safety: 2024 Workshop

Chad Council

NAPSG InSPIRE 2024

3-October-2024

LINCOLN LABORATORY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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Workshop Concept

Find the right people

- Hand select a small group of representative experts from across the country

Get them together

- Convene a 2 day workshop on Advanced Technology in Public Safety

Workshop the challenges

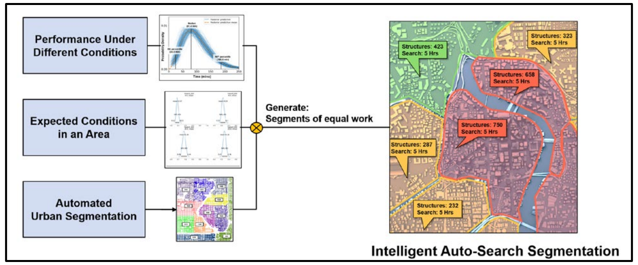
- Establish a collaborative forum
- Identify or reaffirm current and future mission and operational priorities
- Cross reference with technical viability
- Brainstorm future visions

Venue: DOT Volpe Center

DOT Volpe Center Conference Room, supported by FEMA Region 1 was an excellent venue.

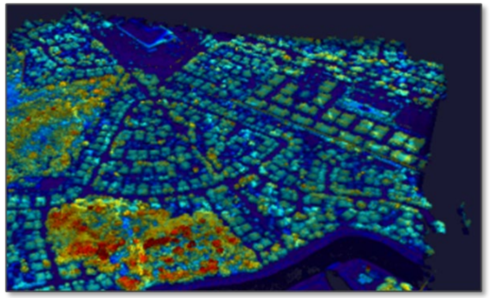
Day 1 Format

Scenario &
Baseline Framework



PAWSAR: R&D Example

AI/ML in Public Safety



Remote Sensing

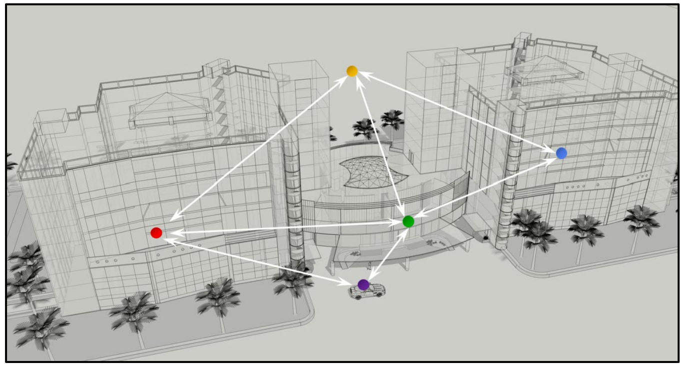
Morning: background and level setting

Afternoon: Topic specific discussions

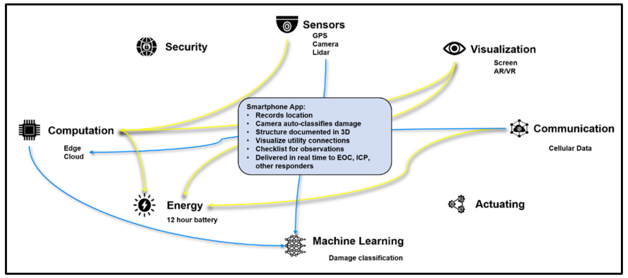
Each session included a short primer on the topic by an MIT LL expert followed by facilitated discussion.

Day 2 Format

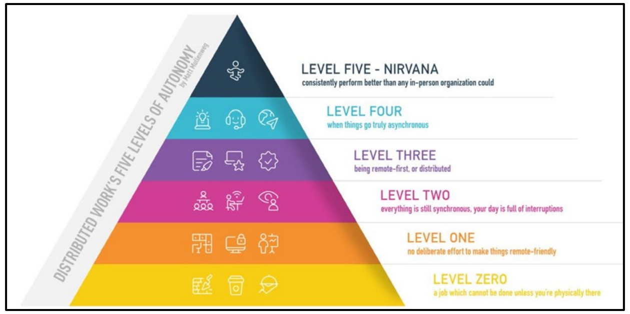
Robotics in Disaster Response and Public Safety



Indoor Localization



Supporting Infrastructure



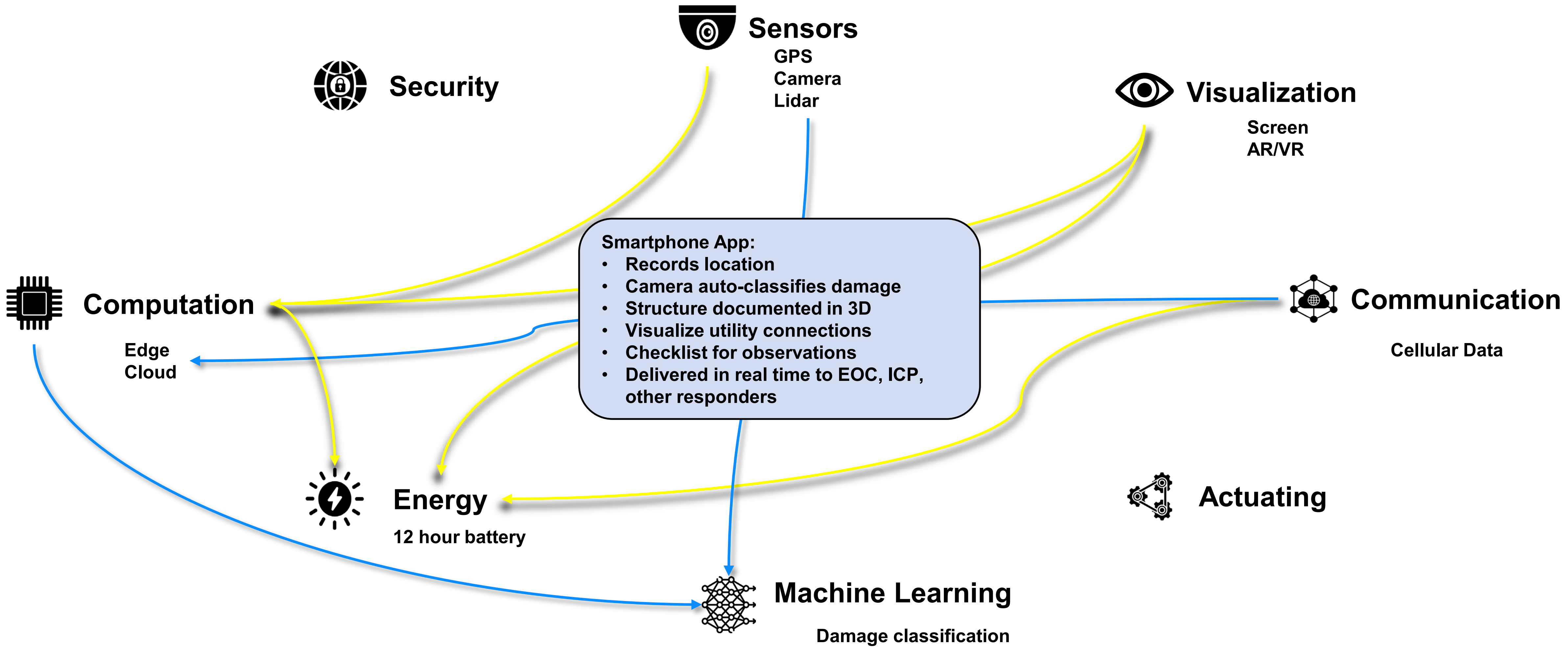
EOC of the Future

Morning: Recap and topic specific discussions

Afternoon: Topic specific discussions

Day 2 followed the same structural format and built on the content from Day 1.

Technology Interconnected Relationships: Smartphone Structural Triage



Technology Interconnectedness

Remote Sensing:
Informed Decisions and Actions

AI/ML:
Informed Decisions and Actions

EOC Operations:
Future Concepts

Robotic Assisted Public Safety:
Ground, Air, Water

Sensors
- Higher Resolution
- Smaller Size
- Broader sensitivity

Computation
- Edge computing
- Super computing
- Cloud computing
- GPU computing

Visualization
- Augmented reality
- Virtual reality
- 3D Visualization

Machine Learning
- Image classification
- Predictive analytics
- Large language models

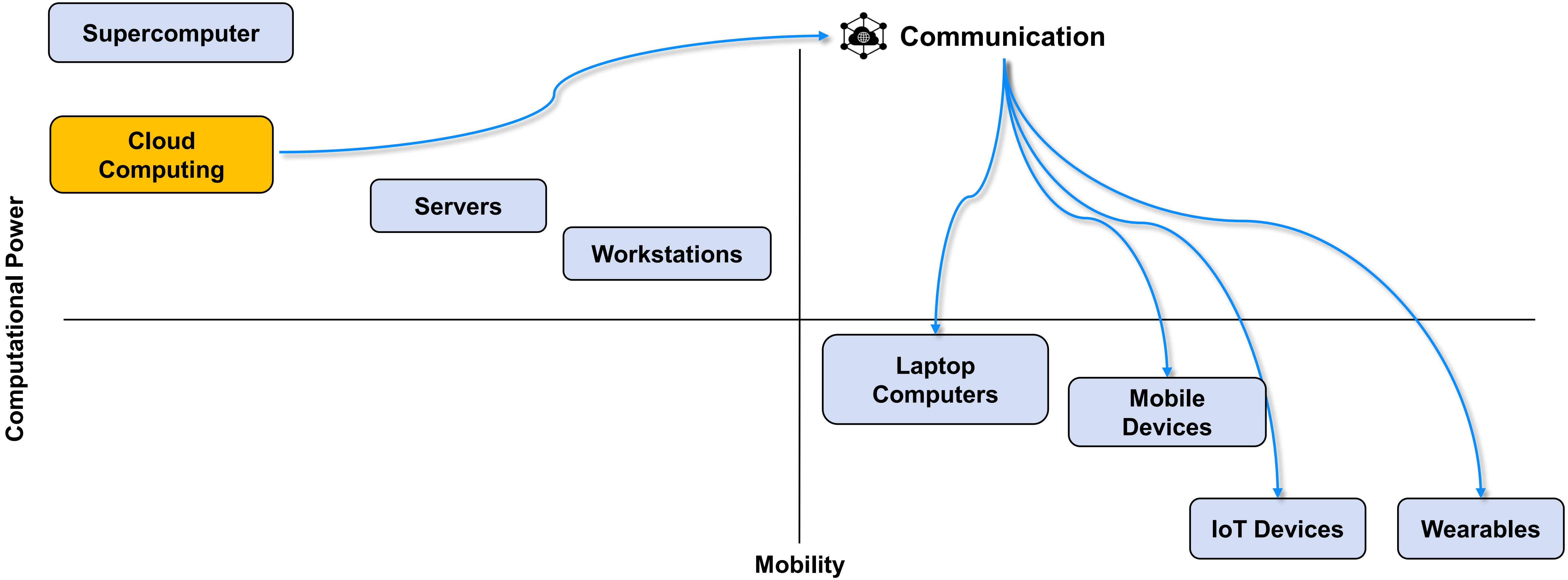
Security
- Encryption
- Authentication

Energy
- Battery power density
- Energy harvesting

Communication
- Bandwidth
- Power requirements
- Architectures

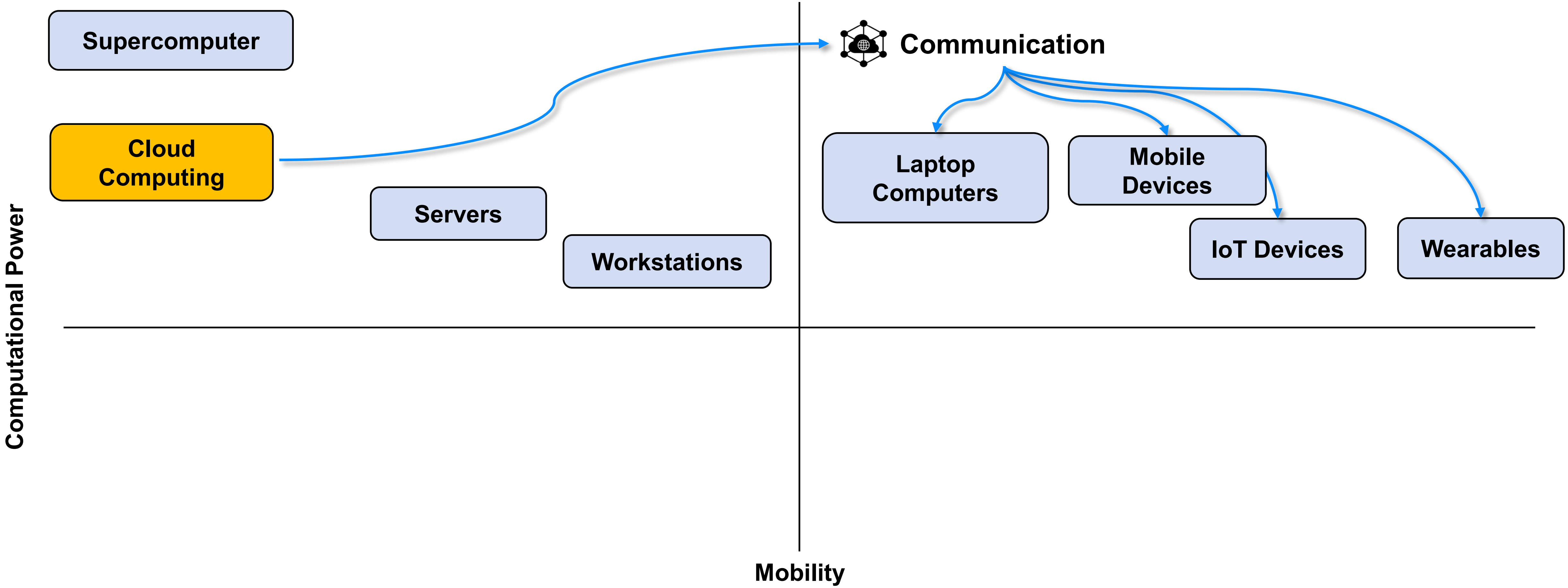
Actuating
- Actuator size
- Power requirements
- Operating environments

Computation



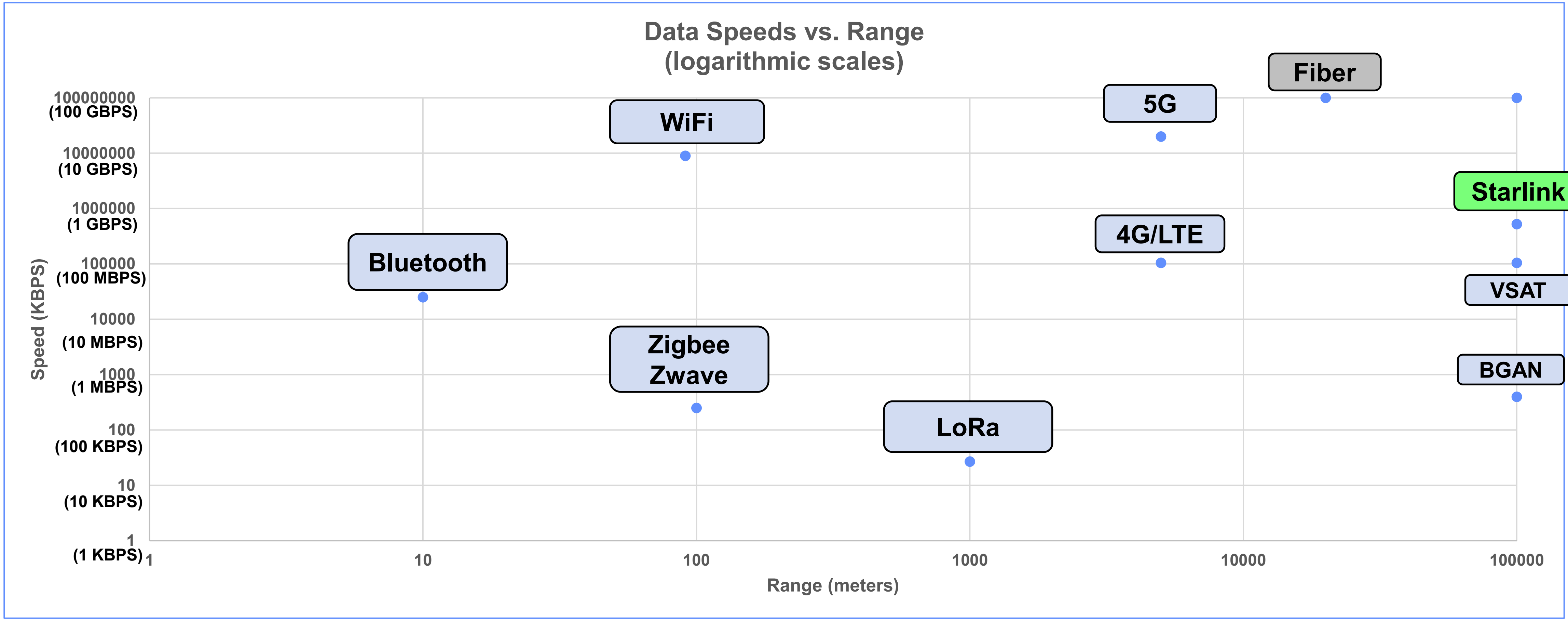
Computer power continues to increase and become more mobile, enabling may new capabilities.

Computation



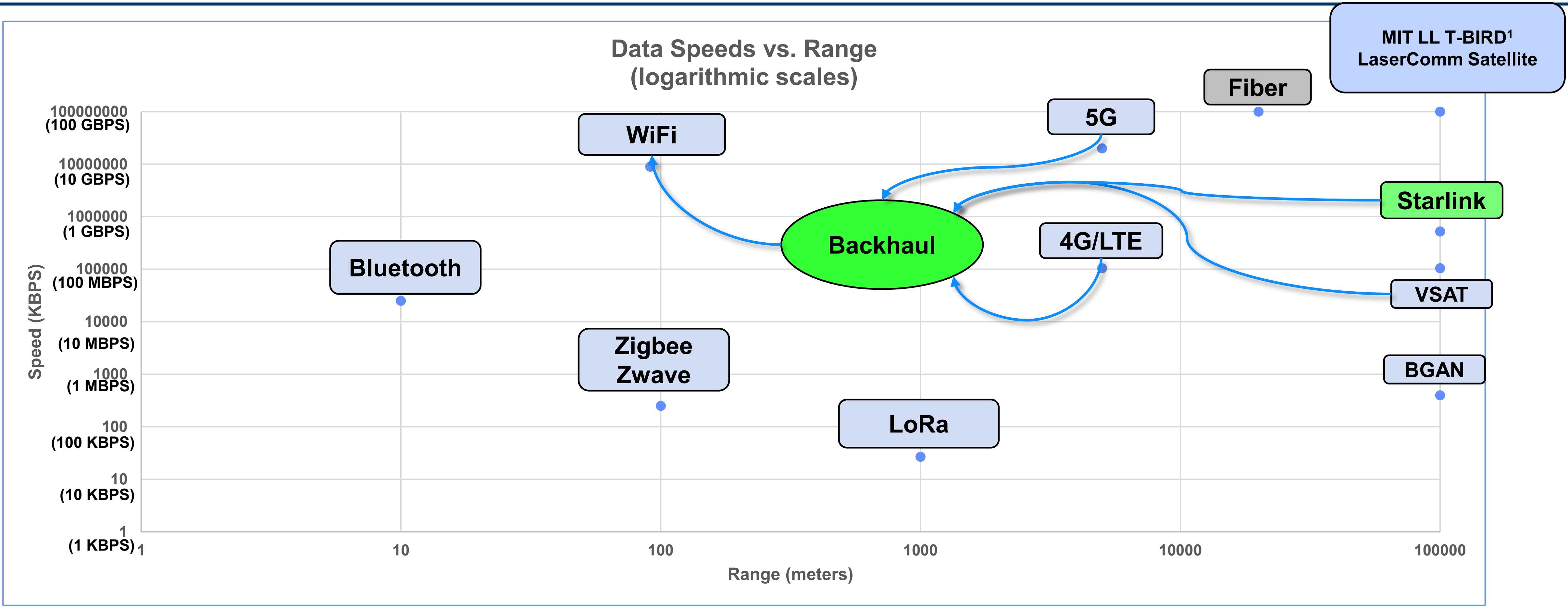
Robust, high bandwidth communications can dramatically increase the compute power available to the edge.

Communications



Improvements in wireless communication data rates at greater range continue to improve public safety capabilities.

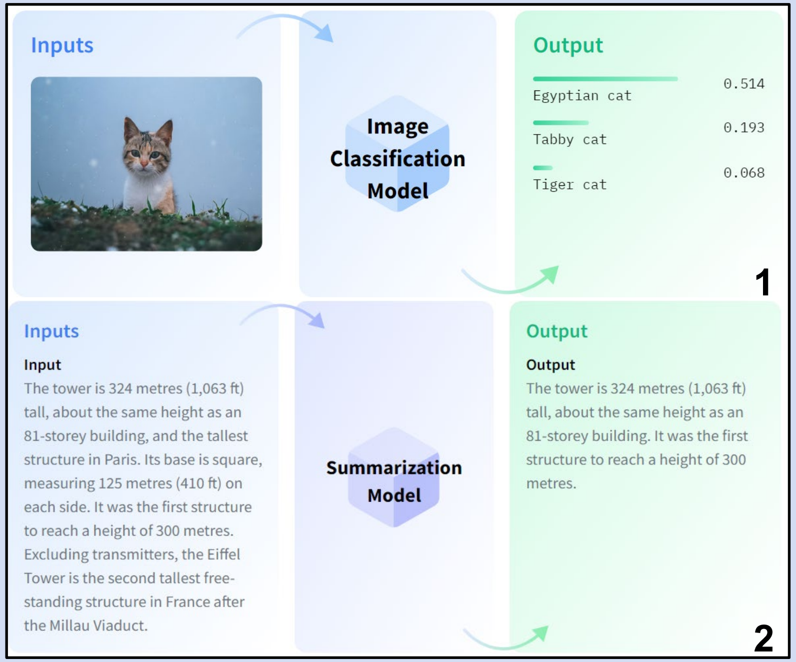
Communications



Improvements in wireless communication data rates at greater range continue to improve public safety capabilities.

1: https://www.ll.mit.edu/news/communications-system-achieves-fastest-laser-link-space-yet

InSPIRE Focus Areas



Artificial Intelligence

Remote Sensing

Robotics

This subset of workshop topics was selected based on attendee feedback.

1: Image Classification Task Image: https://huggingface.co/tasks/image-classification
2: Summarization Task Image: https://huggingface.co/tasks/summarization
3: Remote Sensing Image: https://huggingface.co/datasets/MITLL/LADI-v2-dataset
4: Boston Dynamics promotional video

Artificial Intelligence

1700s

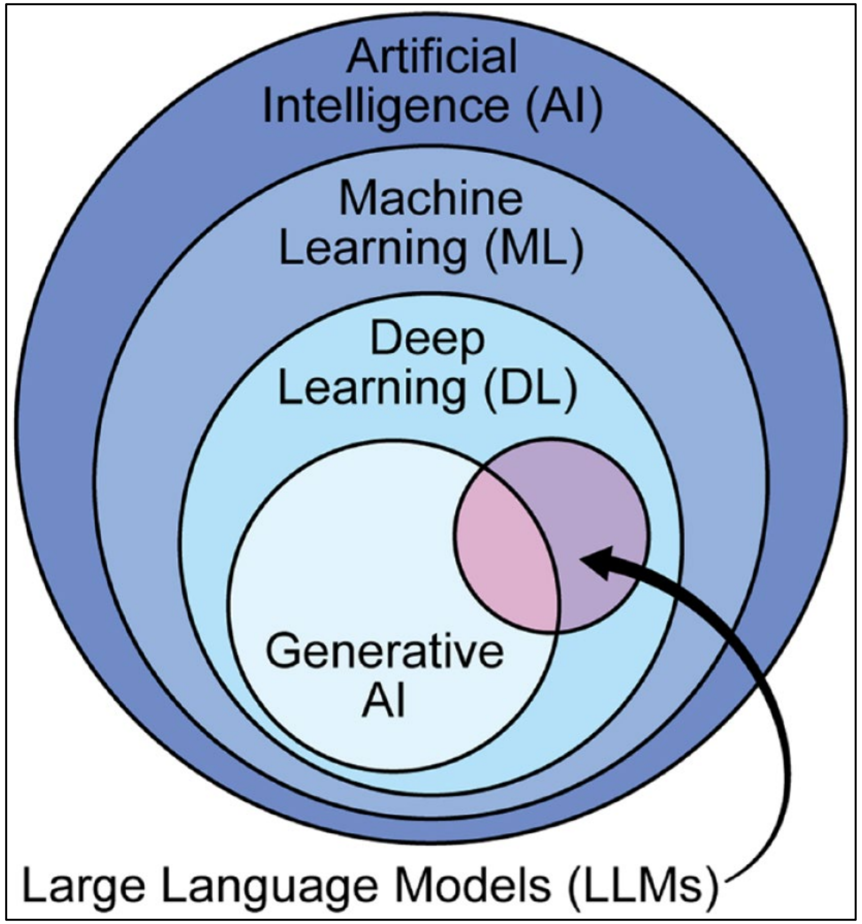
- Gulliver's Travels
- **Bayes Theorem**

1900s

- Electromechanical computation
- **Solid state computation**
- Perceptron
- AI Winter #1

2000s

- **Big Data**
- AI Winter #2
- **Computation density (GPU)**
- **Cloud architectures**



Artificial Intelligence concepts have been evolving for decades and encompasses many different subtopics

Image: Shahab, Omer & El Kurdi, Bara & Shaukat, Aasma & Nadkarni, Girish & Soroush, Ali. (2024). Large language models: a primer and gastroenterology applications. Therapeutic Advances in Gastroenterology. 17. 10.1177/17562848241227031.

Large Language Models

- Text summarization/extraction
- Translation
- Question answering
- Categorization/classification

DALL·E
ANTHROPIC Claude
MISTRAL AI_
Google Gemini
Meta LLaMA 3.1
ChatGPT
Midjourney

Capabilities

- Searching through documents & websites
- Automatic report generation from notes/data
- Natural language interfaces
- Monitoring news/social media streams

Chatbot, tell me joke

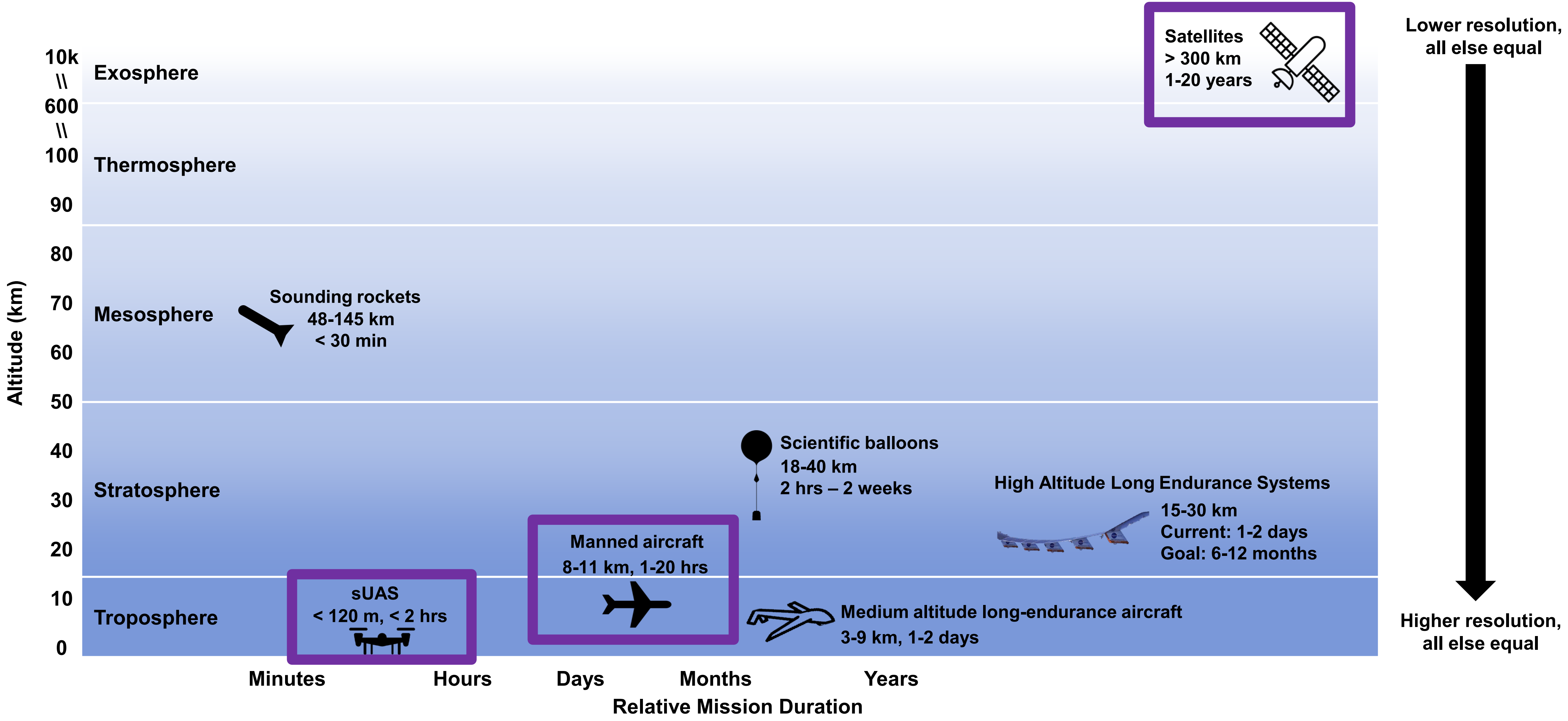
I got an email about how to read maps backwards. It was spam.

Applications

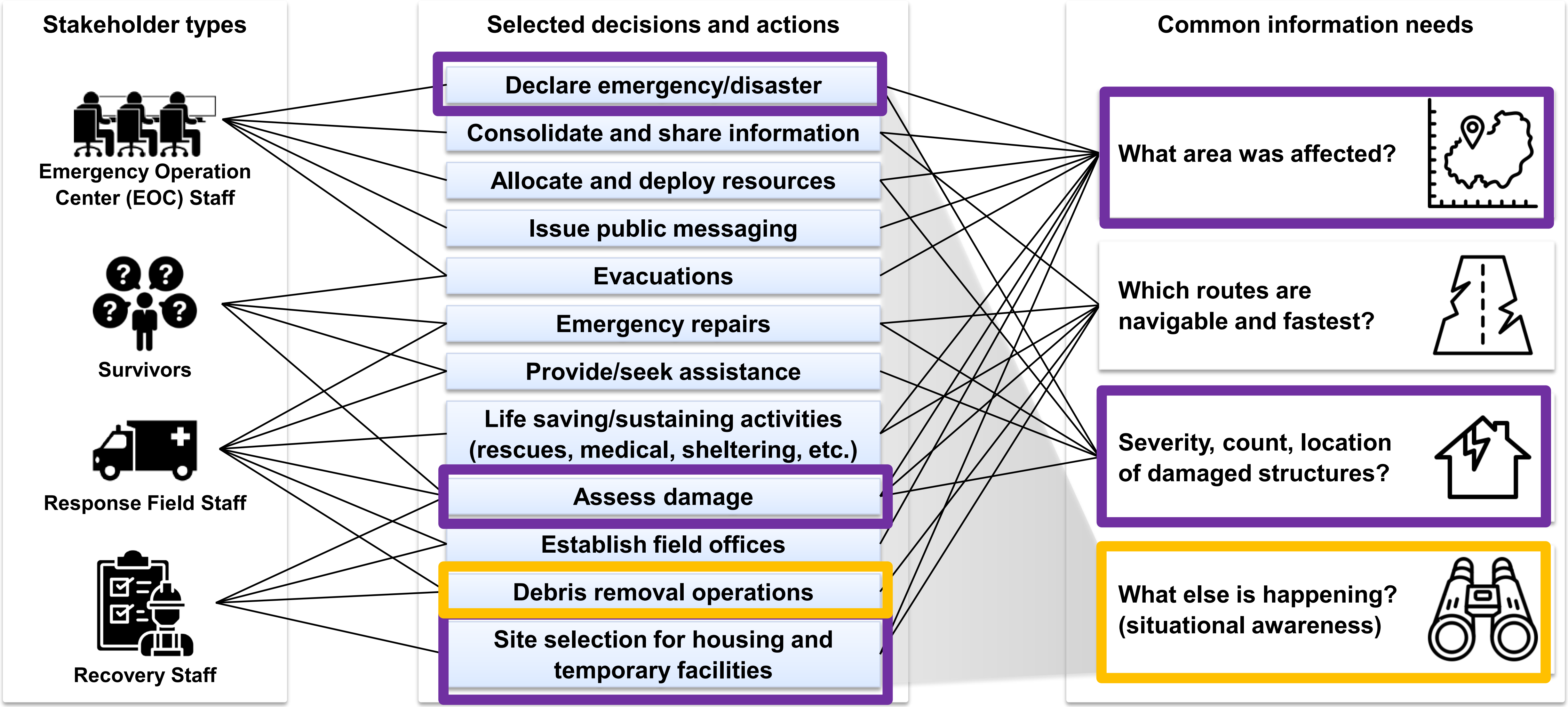
- Accuracy and reliability
  - LLMs are prone to “hallucinations,” where they make up facts
  - May pull from inaccurate sources
- Bias, fairness
  - LLMs reflect the biases in their training data
- Computational requirements
  - Computationally expensive, usually accessed on the cloud as a service
- Ethical considerations
  - Not entirely mapped out

Challenges

Remote Sensing



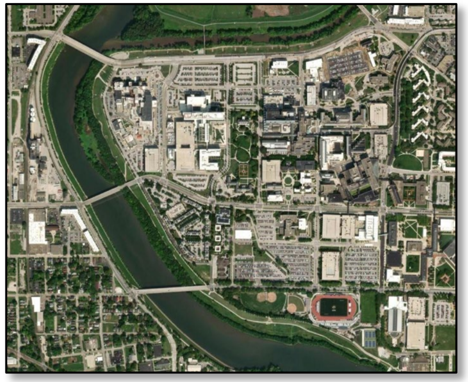
Current focus of many remote sensing efforts



*Many planning and resilience-oriented use cases are not represented here.

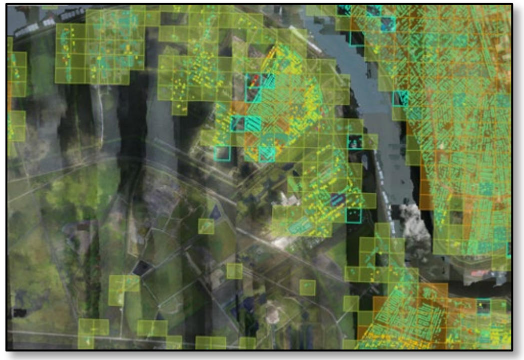
Remote Sensing

- Overhead view of areas
- Color imagery
- Thermal imagery
- Material identification
- 3D Models



Capabilities

- Damage and debris assessment
- Hazard boundary estimation
- Event planning
- Monitoring regions for change in land use

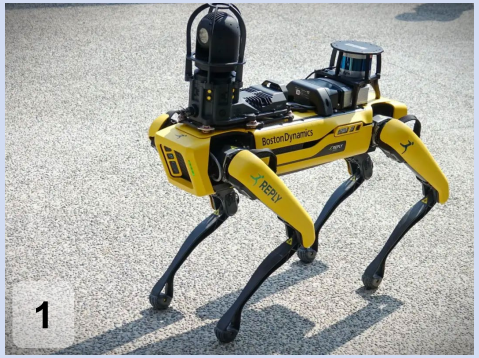


Applications

- Cost
- Timing and weather
  - Availability is dependent on satellite location and atmospheric conditions
- Data sharing
  - Data logistics and contracts can make it difficult to share
- Regulations
  - Privacy
  - Agency and flight
- Exploitation capacity
  - Human/machine processes
- Trust in AI/ML products
  - How good is good enough?

Challenges

Robotics



Legged (Quadruped/Humanoid)

Wheeled/Tracked

Land

Fixed Wing

Multi-Rotor

Air

Underwater

Surface Craft

Water

Robots are best employed for tasks that are dull, dirty, or dangerous.

[1] MikeDotta/Shutterstock
[2] Clearpath Robotics
[3] Zipline
[4] Pascal Deloche/Getty Images
[5] US Navy
[6] Clearpath Robotics

Robotics

- Remote Sensing
- Environment Manipulation
- Medical Support
- Incident Support


1

Capabilities

- Searching places that are dangerous to humans
- Rubble Removal
- Medical Supply Delivery
- Mobile Beacon or Repeater


2

Applications

- Autonomous extent
  - Performing tasks independently without human intervention
  - Safety Protocols
  - Fail-safes and redundancy
- GPS and Wireless-Denied Environments
  - Ability to control + electricity
- Human-Robot Interactions
  - Amount operator reasonably control
  - Survivor-robot interactions
  - Operator-robot interactions
- Extreme Terrains and Operating Conditions
  - Water + fine particulates

Challenges

[1] IEEE
[2] Taylor & Francis

04 Group Breakouts

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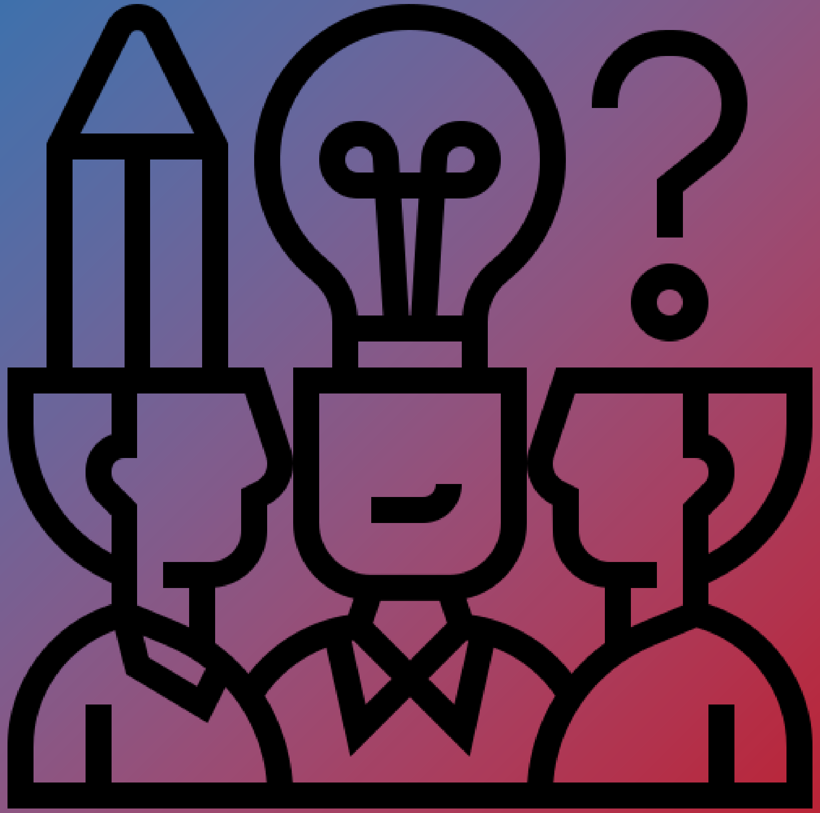
Objective

Determine significant challenges and possible solutions to pressing operational and technical workflows.



How it will work

- In groups, identify challenges to your agency and/or discipline.
  - If needed, operational and technical challenges have been provided
- Work through the challenges in relation to the topics presented.
- We will brief back at the end.

Example - Operational

- Problem: The US&R environment is too complex and dangerous for personnel to operate. There are limited US&R resources available in my jurisdiction.
- Solution: Autonomous systems (aerial, ground, underwater) with local mapping data.
- Barriers: Solutions must be low-cost, easily used by public safety personnel, rugged, etc.

Example - Technical

- Problem: Geospatial data from neighboring jurisdictions/agencies lack interoperability. This includes operational, disaster, and other data sources.
- Solution: AI/ML learning to automatically extract, transform, and load based on industry standards.
- Barriers: Limited personnel with experience in AI/ML, data security concerns, bandwidth concerns.

Example Challenges

Operational

- Limited indoor mapping, tracking, and navigation capabilities
- Staffing for specialized teams/equipment
- Disparate technology among neighboring agencies

Technical

- Lack of standards/interoperability
- Sensitivity around public safety data and info sharing
- Compute power for real-time operations
- Data complexity

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Challenges from breakout groups

- Interagency cooperation (inter/intra jurisdiction)
- Career fire vs volunteer fire technology (different software and some paper)
- Indoor localization (coming)
- Language and culture (AI solution, partly there)
- Systems integration (cost, effort)
- Everyone has unique requirements, so tech implementation is a challenge
    - Fire apparatus example – always custom
- Federal -> SLTT-> gradient
- Turnover in staffing/strategic planning
- No bandwidth to maintain what tech we already have – new tech is a challenge
    - What's the real benefit to the organization?
- Money. $. Does a purchase decrease our work, or will it increase our work?
- Technical training availability (cost, time)

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Challenges from breakout groups : page 2

- Overarching problem: standardization.
- Accreditation is an example
- Policy
- Red tape
- Data sharing / trust
- Scale: small versus large department – how to standardize requirements so solutions can scale
- Blanket ban on AI due to policy.
  - Iterative, evaluating successes, generational staff changes.
- Staffing is prohibitively expensive (e.g. data scientist)

BEST SESSION EVER

- But we still miss Chad
- Operational vs technical requirements and language
  - How to best convey operational need to the folks who solve/fix it
- Simulating VR experiences for firefighters for better training
- Legislatives have a mandate to map schools – public safety wifi

THANKS!

Do you have any questions?
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napsgfoundation.org/

@napsgfoundation

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