OAK RIDGE National Laboratory

Engineering AI for Self-driving Networks

NRE Panel @INDIS

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U.S. DEPARTMENT OF ENERGY

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Why AI : The Good, Bad and Ugly

The Good

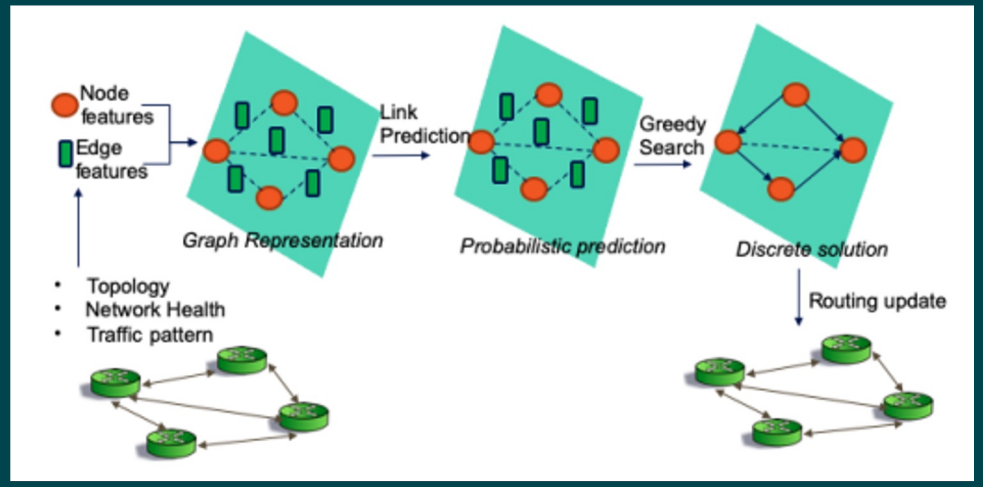
- Our perception of AI possibilities have opened ideas
- New paths previously not possible
- Network Role in Scaling (data, models, compute hardware)

The Bad

- False perception, bad actors, biased data

The Ugly

- Risks to society, jobs and education



SC22 INDIS HECATE Paper

Impacts on R&E Networks

- New Science workflows using AI
  - Data volume, processing speed and workflow needs
- Networks for Large-scale science
  - Science traffic is highly variable
  - Resources are often underutilized and expensive
  - Quality of Network Performance is crucial for Science
  - Today, new ‘kinds of workloads’ are emerging (AI, 5G/wireless, quantum, etc)

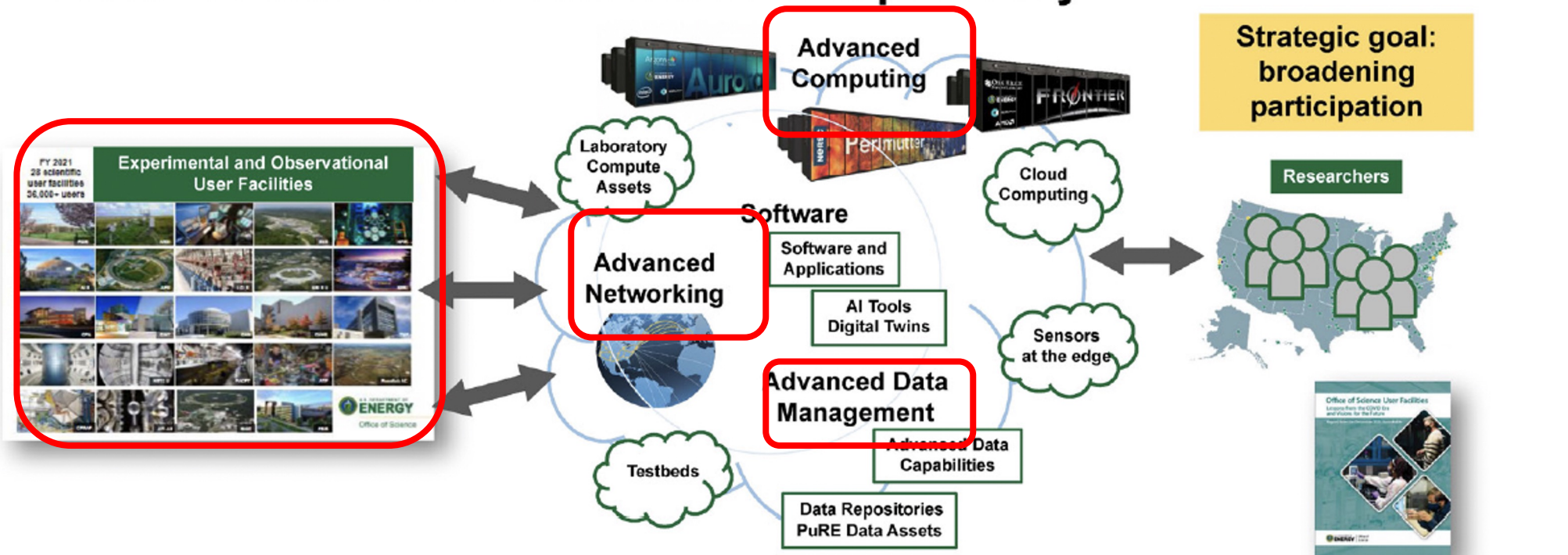
TOP 500
The List.

Speed: 1.194 exaFlops
606208 cores of “Trento”
8, 335,360 cores of ”Radeon I.”
Fastest Supercomputer 2023
Housed at ORNL

For Example: Collaborative Science Vision of Integrated Research Infrastructure

https://www.osti.gov

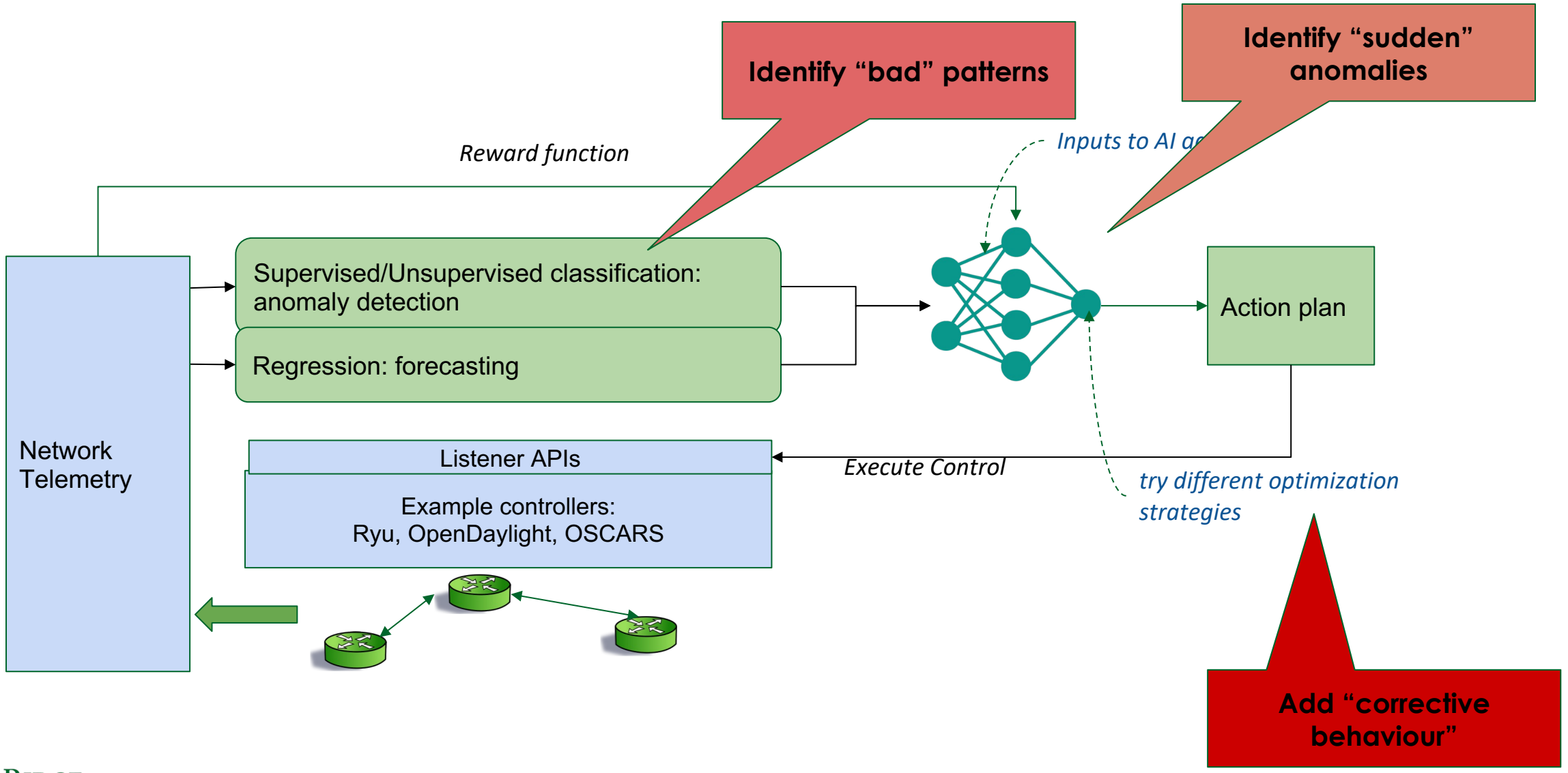
The vision: A DOE/SC integrated research ecosystem that transforms science via seamless interoperability



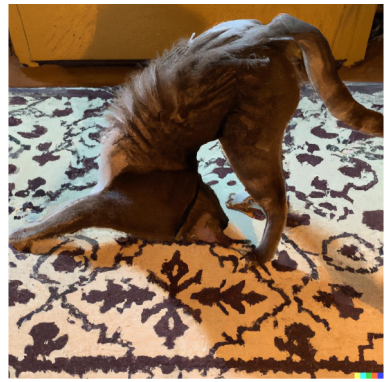
New modes of integrated science

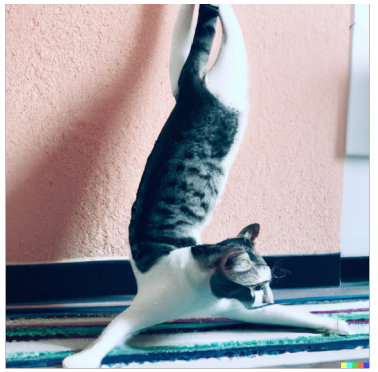
- Rapid data analysis and steering of experiments
- Novel models for multifacility allocation/utilization
- AI-enabled insight from dynamic, vast multimodal data
- Seamless user interconnectivity via federated IDs

Using AI to build “better” systems



Good of AI: ChatGPT examples





"cats doing yoga" produced on Dall-E

MA **You**

how can I check the operating system installed on a machine using terminal

ChatGPT

To check the operating system installed on a machine using the terminal, you can use various commands depending on the operating system. Here are commands for different operating systems:

For Linux distributions:

1. **Using `uname` command:**

```bash
uname -a
```

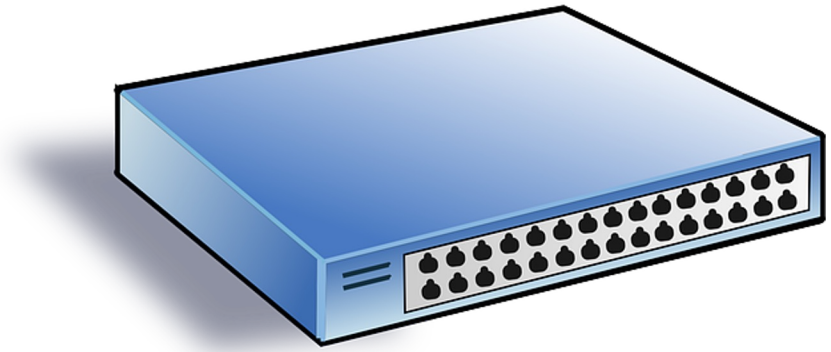
This command will display various system information, including the kernel version and system

Help configuring machines?

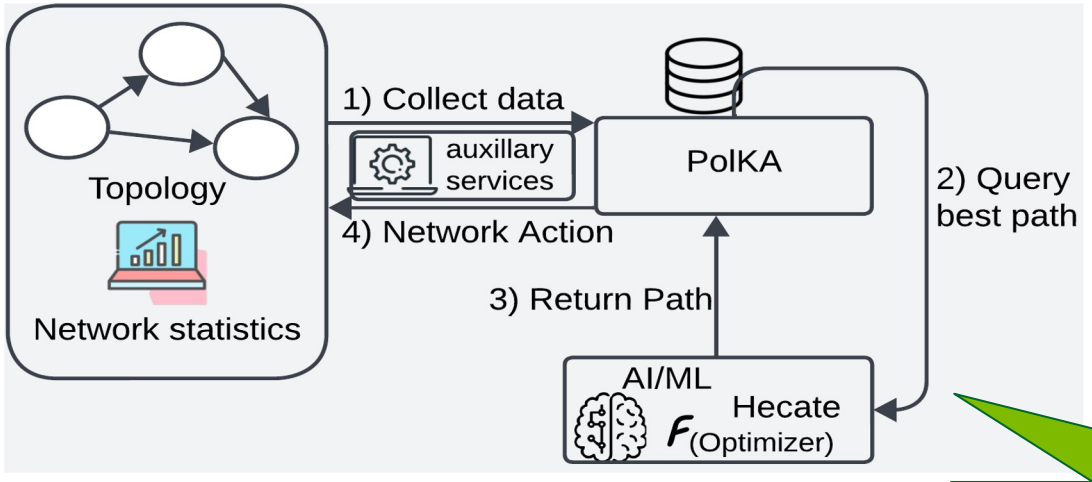
sections?
It's actually not very good!

Help installing grafana/influxdb (much better)

Good of AI: Self-driving ("Thinking") Network



- Previously Closed-box
  - Routers/Switches
  - No permissions to access hardware



PolKA-Hecate integration framework

- Software Control
- Open Source
- SDN
- Programmable networks
- GNA-G P4 labs, Fabric and other testbeds (funded by NSF, DOE, etc)

Paper "Framework for Integrating Machine Learning Methods for Path-Aware Source Routing" INDIS 5:00pm (HECATE+POLKA)

Bad of AI = Open Challenges: Thinking of new ways in Networks

- Moving compute into Network
  - Advanced in hardware means we can design bespoke for tasks (ASICs, FPGAs)
- Edge Classification to reduce traffic sent over network
- Responsible Eco-Efficiency solutions:
  - Trade-off accuracy versus energy

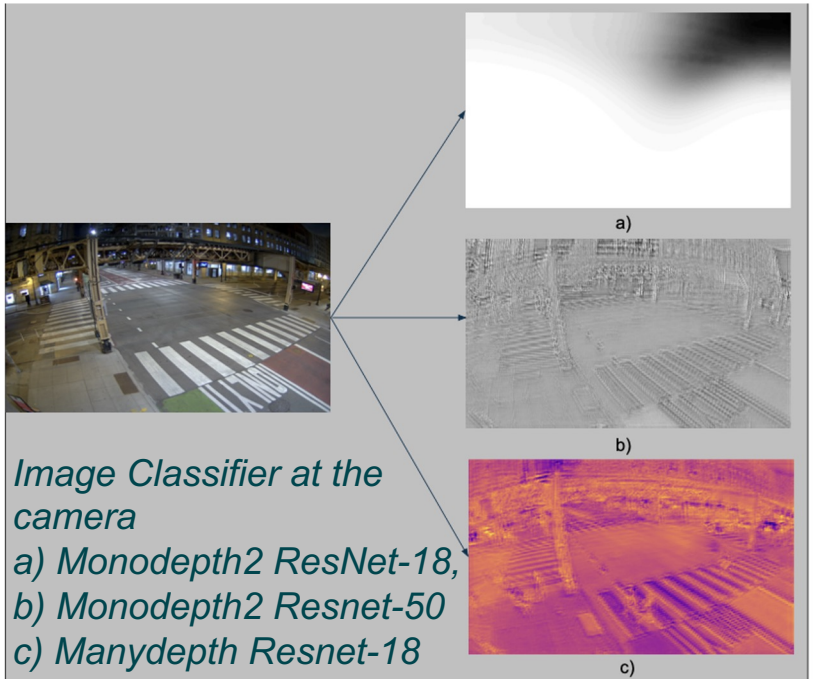
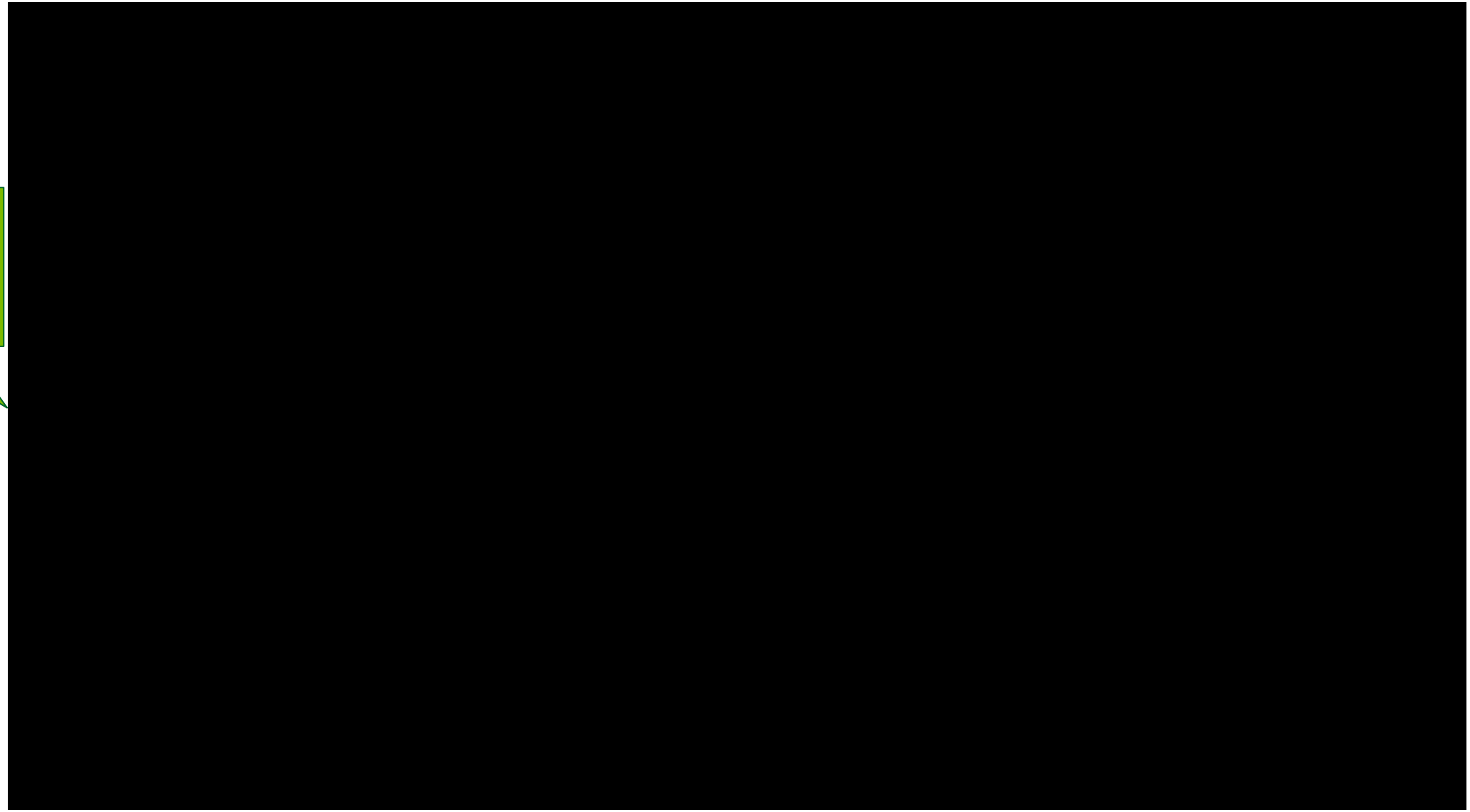


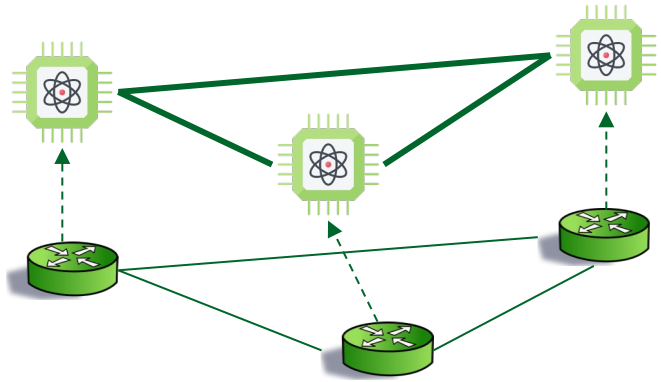
Image Classifier at the camera
a) Monodepth2 ResNet-18,
b) Monodepth2 Resnet-50
c) Manydepth Resnet-18

Classification at Edge: Anomaly Detection with 5G sensors

Reducing Network Impact

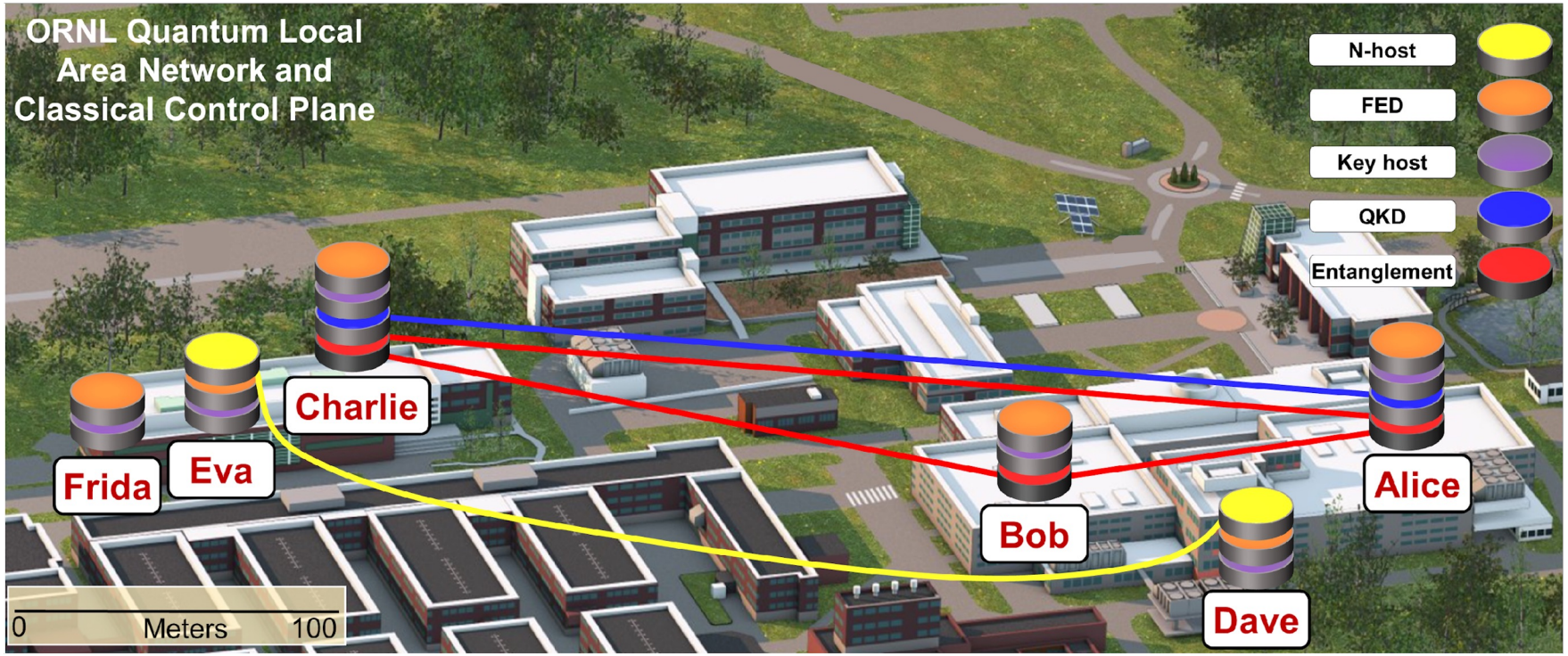


New Challenge: Quantum Networking is Here



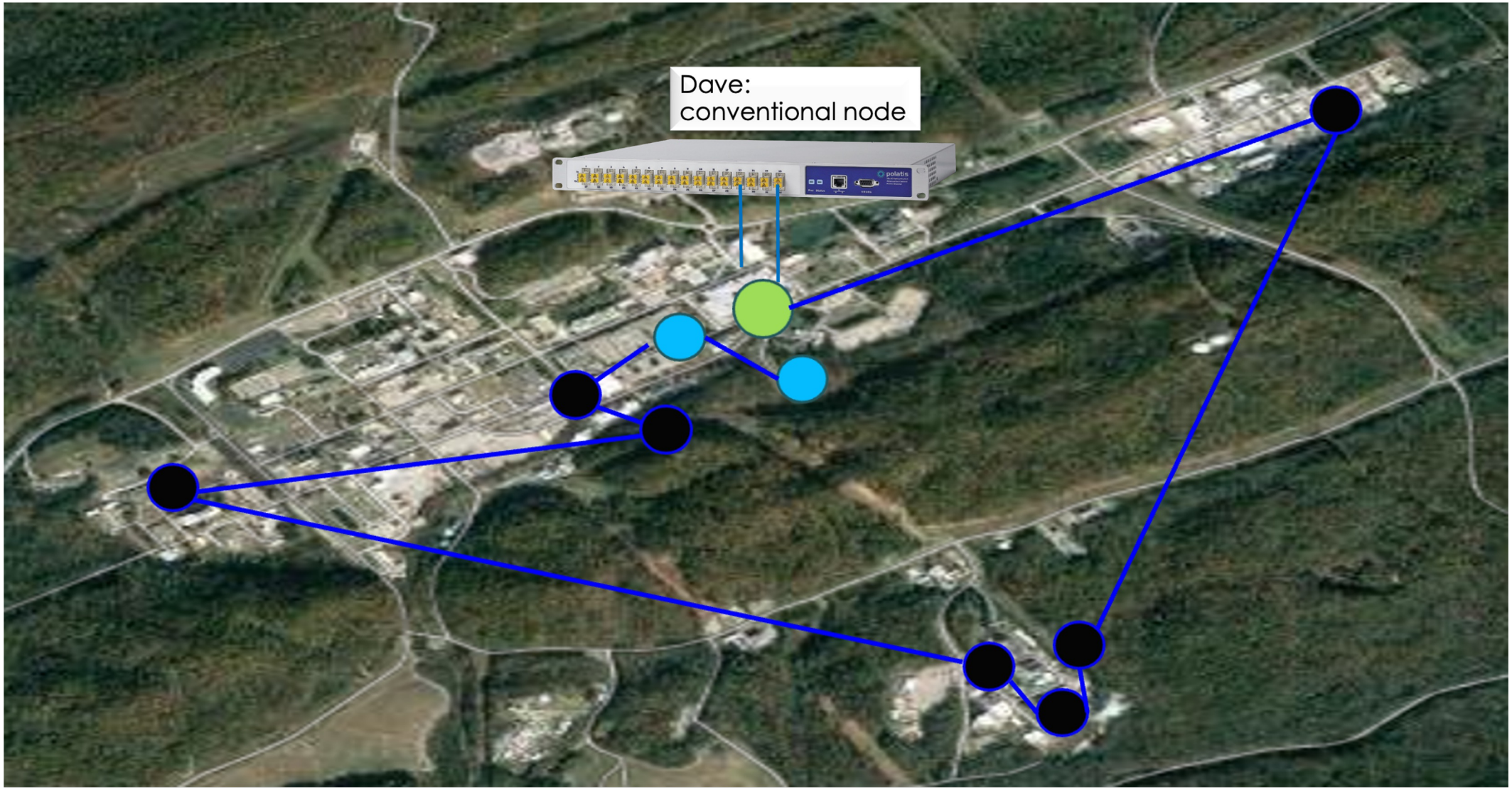
quantum/optic infrastructure (coexistence signals)

- More precision measurements
- Distributed quantum states through entanglement
  - need for repeaters, infrastructure, protocols and more



M. Alshowkan, et al., PRX Quantum 2 (4), 040304 (2021)

ORNL QLAN: the longest (300km) deployed dark fiber testbed in Lab Complex



Conclusions & Forward looking

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ORNL, UETN

- Networks are built for Customers
  - Coming up with New ways of using Network, not thought of before
  - New AI model bring opportunities, such as LLMs e.g. intent-based networking
- Creating new jobs and training
  - Student and engineers trained with AI use and access to open-source libraries
- Collaboration and talking to each other is key - sharing data, resources and tools