

## Cyberinfrastructure for Al@Edge Sharing scientific data via OSN

Wolfgang Gerlach OSN webinar Research Drivers and Software 2020

Pete Beckman, Rajesh Sankaran, Nicola Ferrier, Scott Collis, Charlie Catlett, Eugene Kelly, Valerie Taylor, Mike Papka, Ilkay Altintas, Jim Olds, Kate Keahey, Frank Vernon, Dan Reed, and many more....







Example: Hyperspectral SPECIM Camera: PFD VNIR with 768 bands (2734 x 1312) x 768 x 2bytes = **5.1GB image** 

1 sample every 5 min Twilight to twilight on June 21 = **1TB** 

We need a parallel computer with each sensor!



#### Sensors



Al @ Edge

**Powerful** Parallel Edge Computing



Artificial Intelligence **Deep Learning Inference** Lightweight Training

Edge computing and deep learning with feedback for continuous improvement



Reduced, Compressed data

New inference (model) Adaptive steering

HPC



Deep Learning Training Simulation / Forecast

# Why Live on the Edge?



#### More data than bandwidth

 Spallation neutron source, light source, SW defined radios, HD Cameras, LIDAR, radar, hyperspectral imaging, grid micro-synchrophasors, etc.

## Latency is important

- Quick local decision & actuation; adaptive sensing & control systems

#### Privacy/Security requires short-lived data: process and discard

- Compromised devices have no sensitive data to be revealed
- Resilience requires distributed processing, analysis, and control
  - Predictable service degradation, autonomy requires local (resilient) decision

## •Quiet observation and energy efficiency

- Vigilant sensors, transmit only essential observations, not big data streams



Environment Ambient, UV, IR light Visibility Magnetic Field Vibration Sound pressure Temperature Relative humidity Barometric pressure

# Array of Things

(First units built and deployed in 2016)



#### Air Quality

PM 1, 2.5, 10 Carbon monoxide Ozone Sulfur dioxide Nitrogen dioxide Hydrogen sulfide Total reducing gases Total oxidizing gases

#### Edge Computing or "AI at the Edge" Research:

<u>Computer Vision</u>: Flooding, traffic flow, safety (bike helmet use, pedestrian patterns...), use patterns of public spaces, cloud cover <u>Computer Audio</u>: Noise components, sound events

The "Array of Things" (AoT) was an NSF-funded Major Research Instrumentation project in partnership with the City of Chicago, led by the University of Chicago and Argonne National Laboratory. The underlying hardware and software used is Argonne's Open WAGGLE platform. (wa8.gl)





## Edge Vision Cameras on Array of Things Nodes



## WHAT DOES "AI-AT-THE-EDGE" ENABLE?



Autonomous Adaptive Sensing

Leadership Team





(NU: Director)





(UIIlinois; AoT)

Ilkay Altintas (SDSC: Data)



Scott Collis (NU: ARM)

Valerie Taylor UChicago: Broader Impacts)



Dan Reed

Jim Olds (GMU; Life Sci, Risk) (Utah; Architecture)



**Eugene Kelly** (CSU; NEON)

Irene Qualters (LANL: Advisory Committee Chair)



Triggered Computation,





#### **Education & Training**





NEON

SAGE S

Cyberinfrastructure for

sagecontinuum.org

NSF

AI at the Edge





CAGO

HPC / Cloud

## **SAGE** Partner Instruments









AoT: *Neighborhood* scale urban environment and activity.

HPWREN/WIFIRE: *Regional* Environmental Conditions and Events.



HPWREN SDSC SAN DIEGO SUPERCOMPUTER CENTER



NEON: *Continental* scale ecology and environment.

Nedola Construction Network



## Ecology: NSF NEON & Sage AI@HPC + AI@Edge = Intelligent Forecast & Sensing



NEON: National Ecological Observatory Network. Multi-decade project to understand changing ecosystem

81 field sites, 100K data samples each year.

Sage will deploy AI@Edge to link with AI@HPC and detect interesting phenomenon and notify scientists in real time

From bats to migrating animals to clouds...







# 1) Sage Blade









Testbed for latest Al@Edge Hardware



# **SAGE Technical Architecture**



## SDR: SAGE Data Repository

#### Currently: Sensor data in csv files:

#### Data access in SAGE (work in-progress)

- Sensor data in database
  - API for sophisticated search queries
  - CKAN data portal for UI
- Live stream of sensor data
- Object store for large files



€) ⇒ @ @	D A https://www.mcs.anl.gov/research/projects/waggie/downloads/datasets/index.php			
Waggle Datas	ets:			
We suggest following the Reperimental Data link at the bornom of this gauge and reading the linked page before downloading the datasets.				
Download Links:				
A. Recent CSV:				
I. NUCWR-MUGS.complete	c.recent.csy - 65.00 B (Updated: October 21 2020 13:30:59 CST)			
2. AoT_Detroit.complete.rec	ent.csx - 65.00 B (Updated: October 21 2020 13:30:53 CST)			
3. Rane , Test.complete.recen	LOX - 65.00 B (Updated: October 21 2020 13:30:59 CST)			
4. AoT_NIU complete recent	LCNY - 65.00 B (Updated: October 21 2020 13:30:54 CST)			
5. AoT_Stanford.complete.to	cent.csx - 65.00 B (Updated: October 21 2020 13:30:55 CST)			
6. AoT Bristol complete rec	cnt.cax - 65.00 B (Updated: October 21 2020 13:30:51 CST)			
7. Waggle Tokyo.complete.r	ccent.csy - 65.00 B (Updated: October 21 2020 13:31:01 CST)			
A Aut Trippin complete sec	ett est - 224 72 KB (Deduted: October 21 2020 13:30:56 CST)			

## SAGE object store

- Training data from SAGE nodes (and users)
  - Images
  - Videos
  - Sound files
  - LIDAR data
  - Multispectral images
  - ...
- Machine learning models created by SAGE users



## SAGE object store – API server

- Supported storage backend: S3-style API
- RESTful API (similar to S3 path-style addressing model)
- "virtual" buckets:
  - UUID names to prevent namespace conflicts
  - One file (or dataset) per bucket
    - (A dataset consists of files sharing the same metadata)
  - Metadata
  - Ownership & Permission control
- Access:
  - JSON REST API
  - python client library
  - command line client
  - SAGE website (not yet)

## SAGE object store – API server



- Sage users authorize via OAuth2 access tokens
- Access management: FULL\_CONTROL, WRITE, READ, WRITE\_ACP, READ\_ACP
- Open source, Golang
- implementation & documentation:

https://github.com/sagecontinuum/sage-storage-api

## SAGE object store – API server

#### For those interested...

https://github.com/ sagecontinuum/sage-storage-api

🗊 🔒 https://githu	120% *** 5	9 t2 🧟 🗞	
	Getting started		
	docker-compose up		
	This starts a test environment without token verification.		
	Usage		
	export SAGE_USER_TOKEN= <your_token> or export SAGE_USER_TOKEN=user:testuser</your_token>		
	export SAGE_STORE_URL="localhost:8080"		
	Create bucket		
	<pre>curl -X POST "\${SAGE_STORE_URL}/api/v1/objects?type=training-data&amp;name=mybucket"</pre>	-H "Authorization: s	sage \${S
	Example response:		
	<pre>{     "id": "5c9b9ff7-e3f3-4271-9649-70dddad02f28",     "name": "mybucket",     "owner": "testuser",     "type": "training-data" }</pre>		
	optional query fields:		

# Questions?



