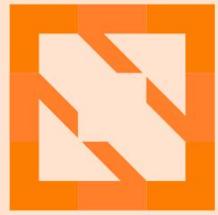




KubeCon



CloudNativeCon

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Europe 2022

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WELCOME TO VALENCIA





KubeCon



CloudNativeCon

Europe 2022

# Incremental Deep Learning For Satellite with KubeEdge and MindSpore

Xiaoman Hu, Huawei

Yue Bao, Huawei

Zhipeng Huang, Huawei





KubeCon



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Europe 2022

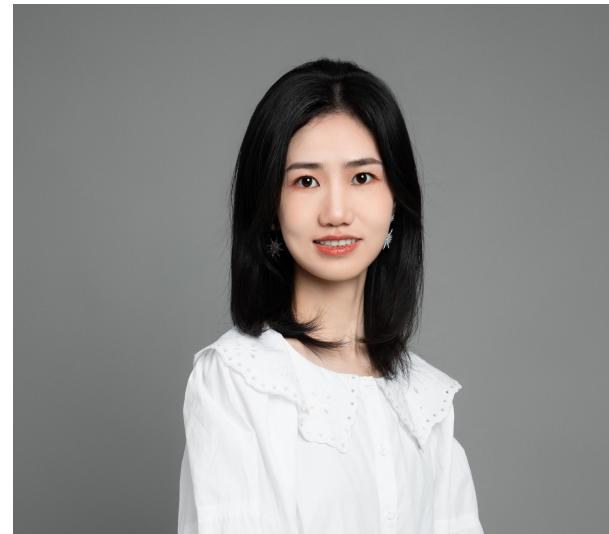
# Bio

## Huawei Cloud and AI Open Source Team

- KubeEdge/Volcano/Karmada
- K8S Policy WG/CNCF Security TAG



**Xiaoman Hu**  
Principle Engineer  
*Huawei*

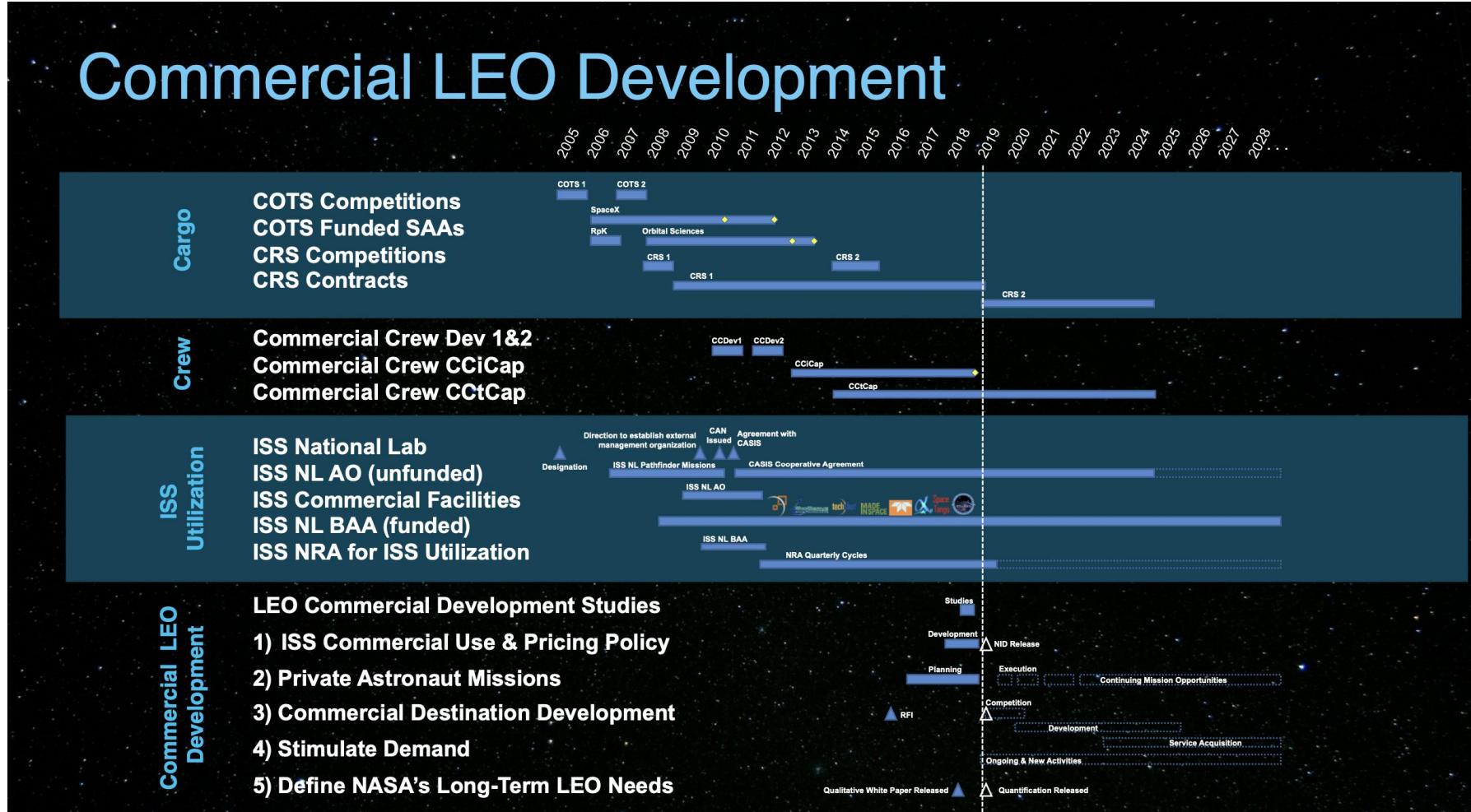


**Yue Bao**  
Software Engineer  
*Huawei*



**Zhipeng Huang**  
Director, AI Open Source  
*Huawei*

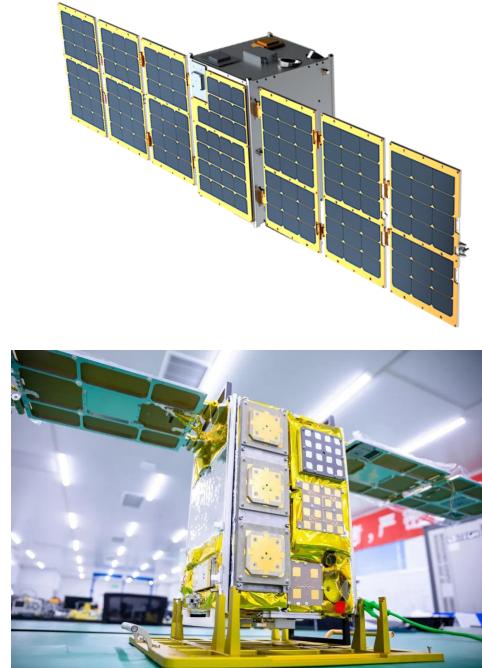
# Low Earth Orbit Satellites



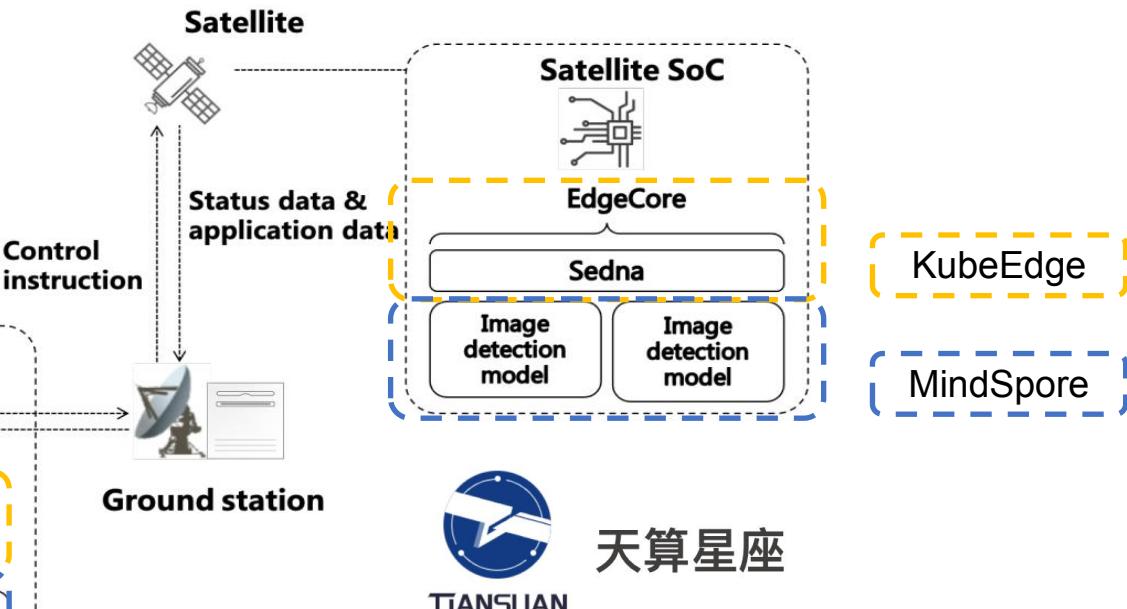
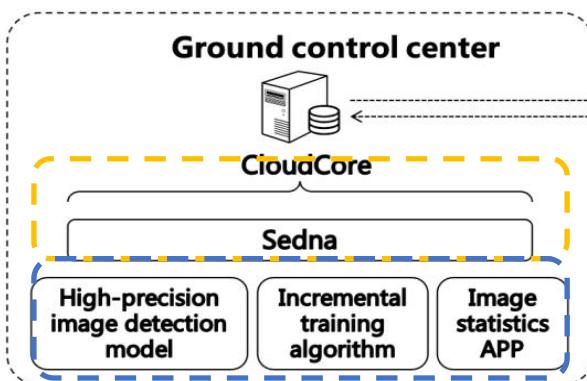
An Overview and Status of NASA's Five-Point Plan to Foster a Robust Economy in Low-Earth Orbit, Future In-Space Operations (FISO) Telecon, Doug Comstock ,September 18th, 2019

- LEO Satellites has been the recent focus of space technology development
- Although its promising future, key challenges lies:
  - ❖ **Constellation Management**
    - ❖ Automatic satellite tracking and failure detection
  - ❖ **Communication Issues**
    - ❖ On-Board Automation, Orbit-Earth Comms, real time data sync
  - ❖ **Space Traffic Management**
    - ❖ Health, Debris, Collision Monitoring
  - ❖ **New Application Scenarios**
    - ❖ Climate change, space mining, deep space learning

# Cloud Native + AI For Space



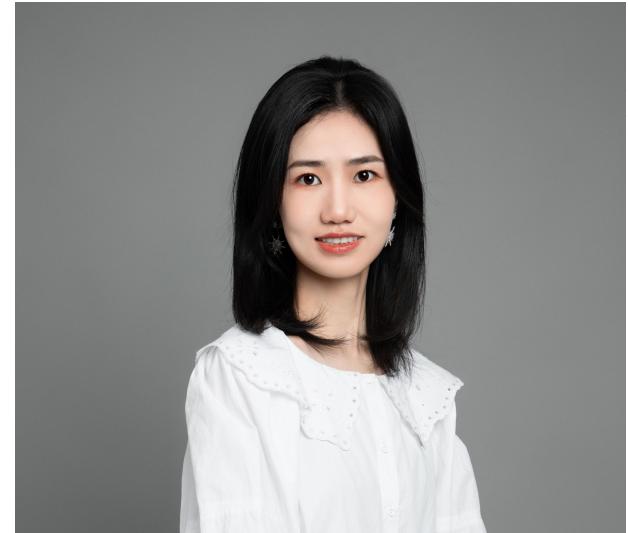
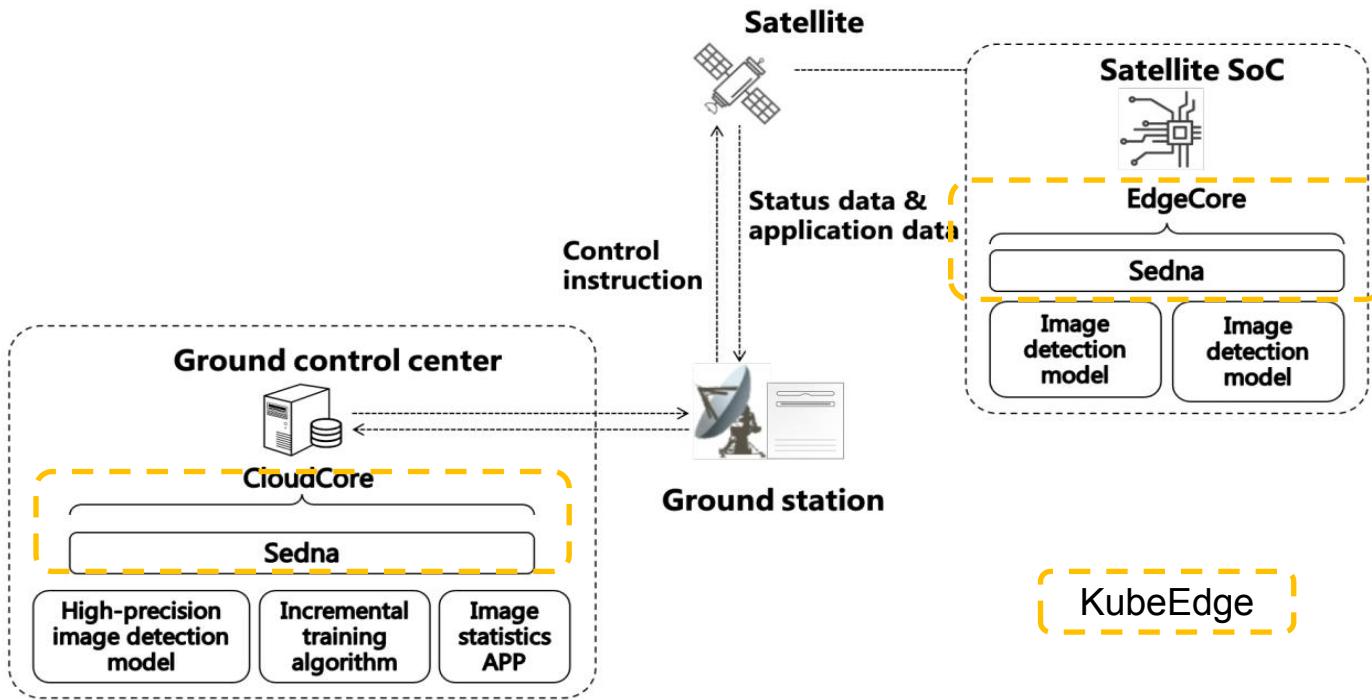
Number	Orbital Altitude	Mass	Battery Capacity	Spectrum	Uplink Rate	Downlink Rate	ISLs	Processors
1	500±50km	≤ 30kg	118Wh – 236Wh	X-band	0.1Mbps – 1Mbps	100Mbps – 600Mbps	NO	CPU/NPU
2	500±50km	≤ 30kg	118Wh – 236Wh	X-band	0.1Mbps – 1Mbps	100Mbps – 600Mbps	NO	CPU/NPU
3	500±50km	≤ 30kg	118Wh – 236Wh	X-band	0.1Mbps – 1Mbps	100Mbps – 600Mbps	NO	CPU/NPU
4	> 500km	> 50kg	> 360Wh	X, Ku, Ka bands	≥ 200Mbps	≥ 1Gbps	YES	CPU/NPU/GPU
5	> 500km	> 50kg	> 360Wh	X, Ku, Ka bands	≥ 200Mbps	≥ 1Gbps	YES	CPU/NPU/GPU
6	> 500km	> 50kg	> 360Wh	X, Ku, Ka bands	≥ 200Mbps	≥ 1Gbps	YES	CPU/NPU/GPU



<http://www.tiansuan.org.cn/>

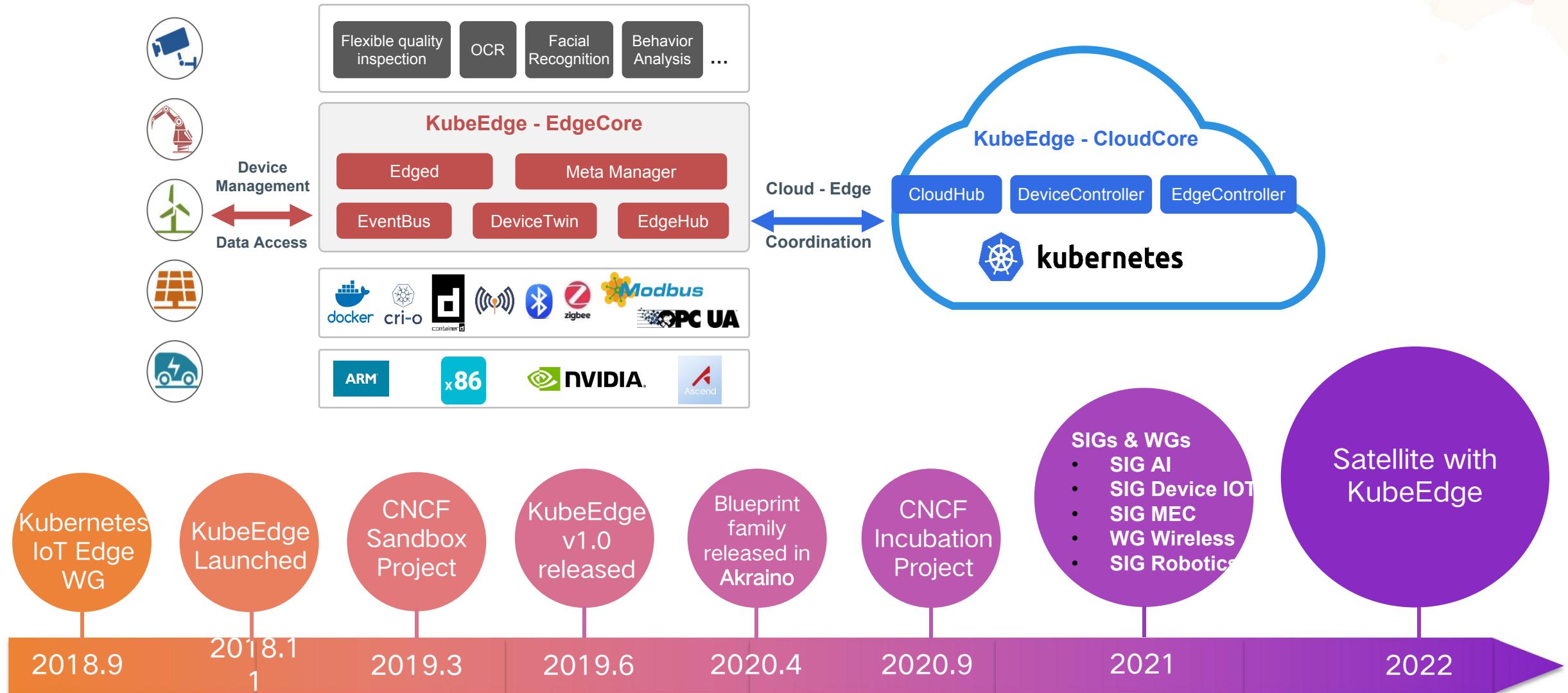
- Working with BUPT, PKU, CMCC on the **Tiansuan Constellation** with Tiansuan-1 launched in Sep 2021;
- Shipped with **CNCF KubeEdge** and **MindSpore** to address the challenges of :
  - ❖ On-orbit computation to minimize orbit-earth communication for better life span
  - ❖ Edge-cloud real time inference and Incremental deep learning for SAR type task

# Cloud Native For Space

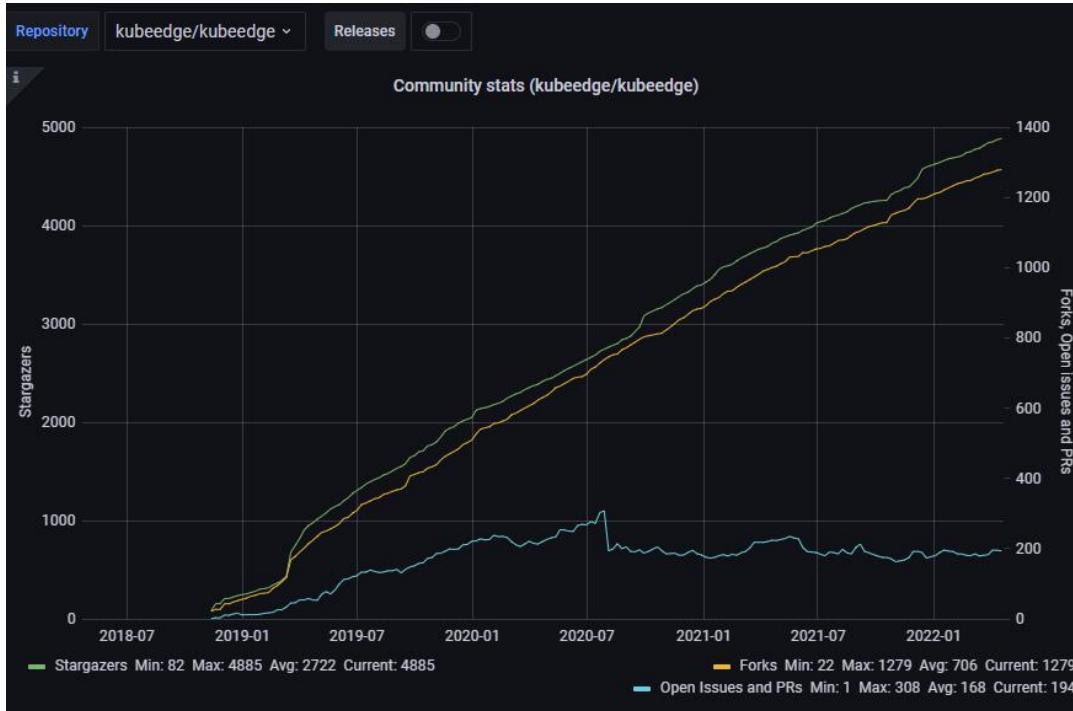


**Yue Bao**  
Software Engineer  
*Huawei*

# KubeEdge



# Community Growth



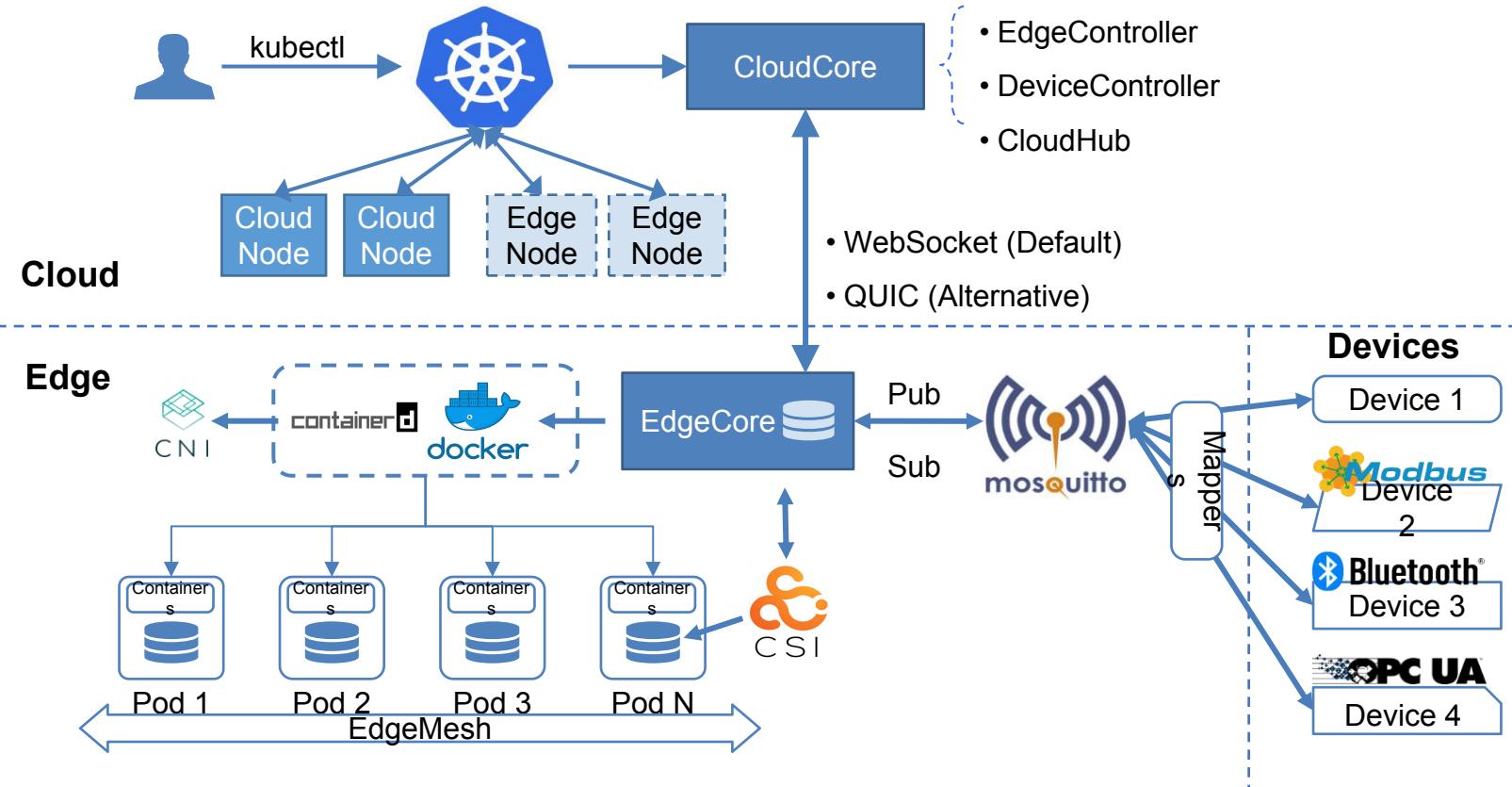
Contributors 243



**5.2k+ Stars  
1.3k+ Forks  
950+ Contributors  
240+ Code Submitters  
70+ Organizations**

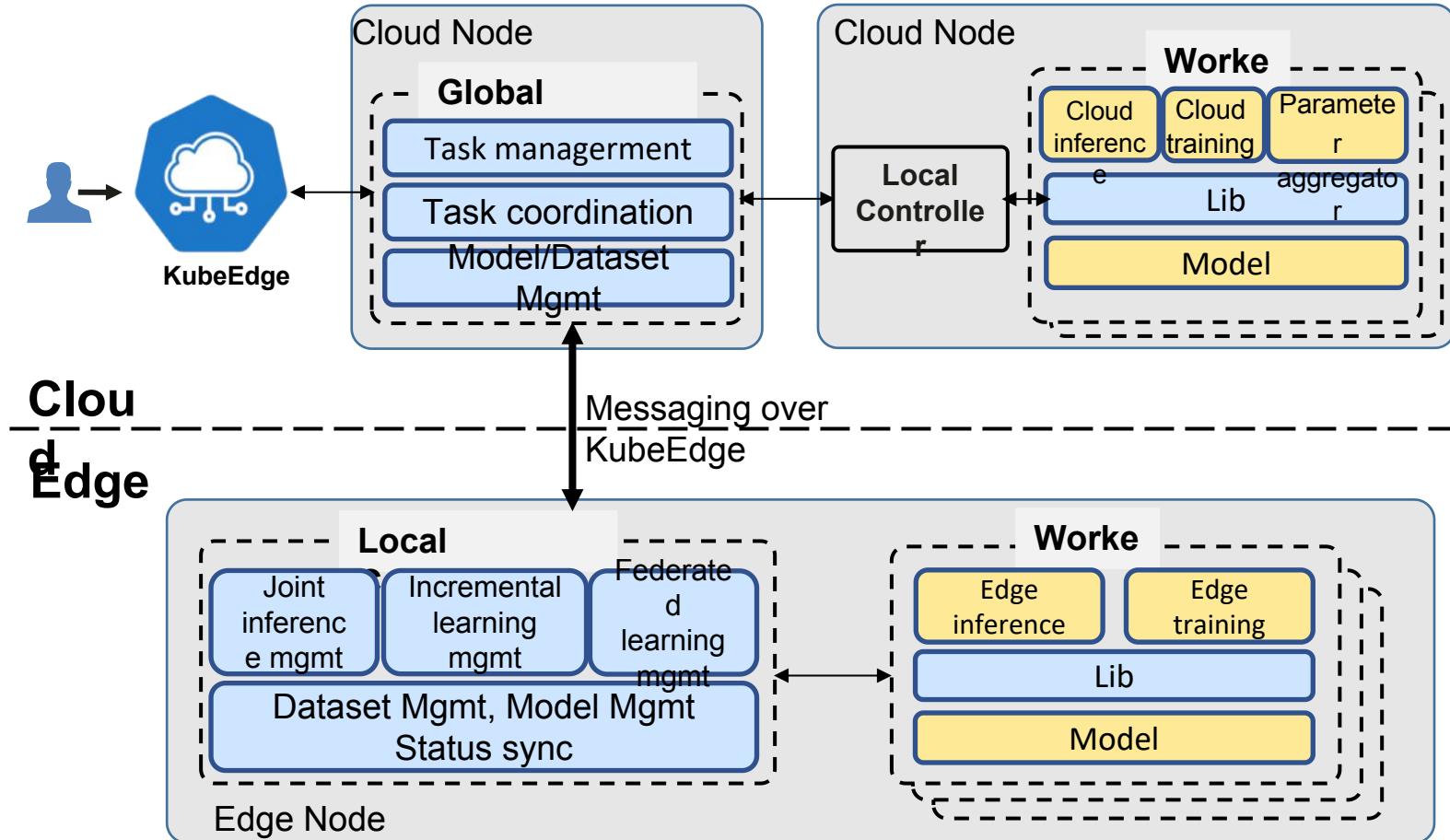


# KubeEdge Architecture



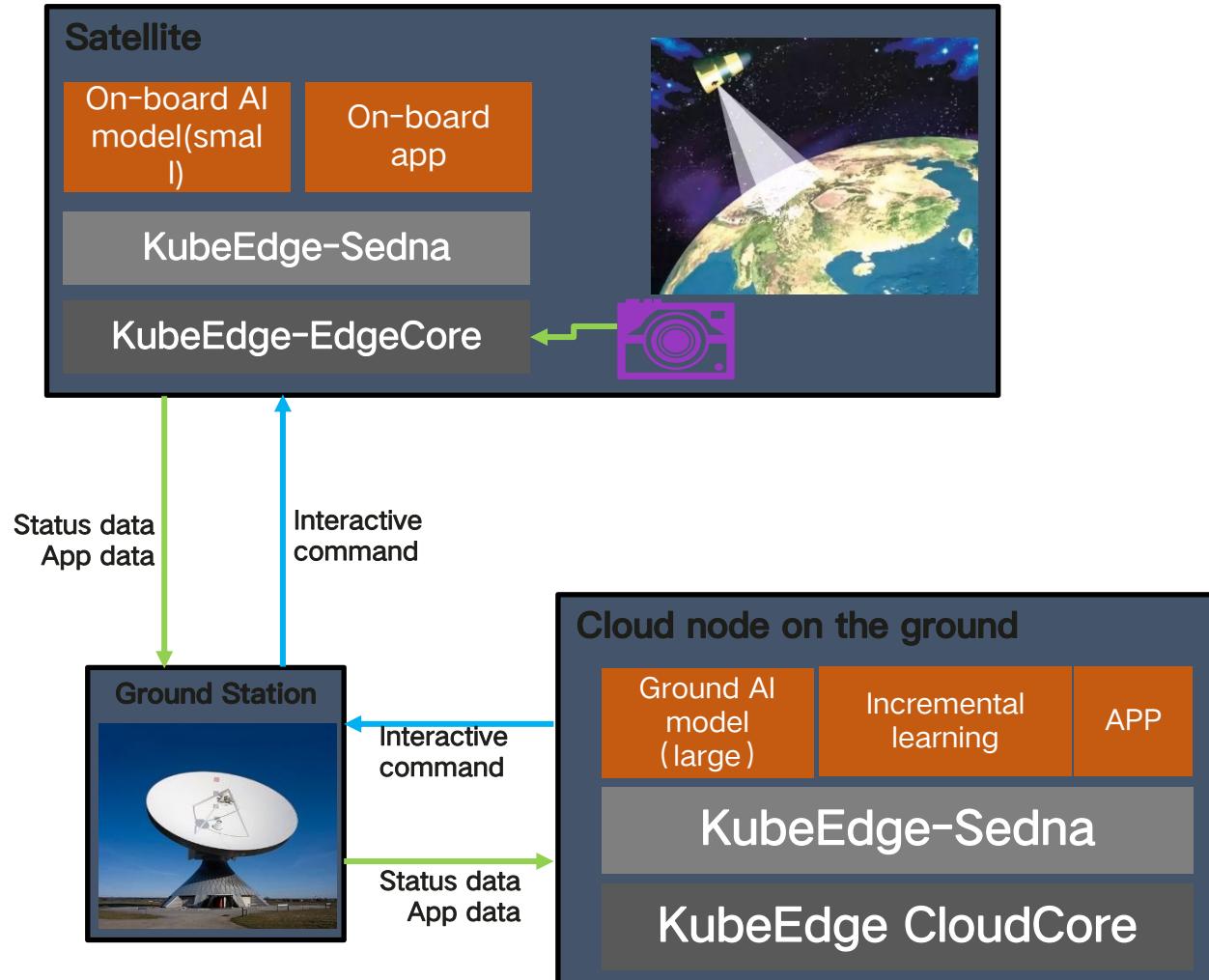
- Native Kube-API at Edge
- Seamless Cloud-Edge Coordination
- Edge Autonomy
- Low Resource Readiness
- Simplified Device Communication
- Cloud View of Global Metrics Data

# KubeEdge Sedna



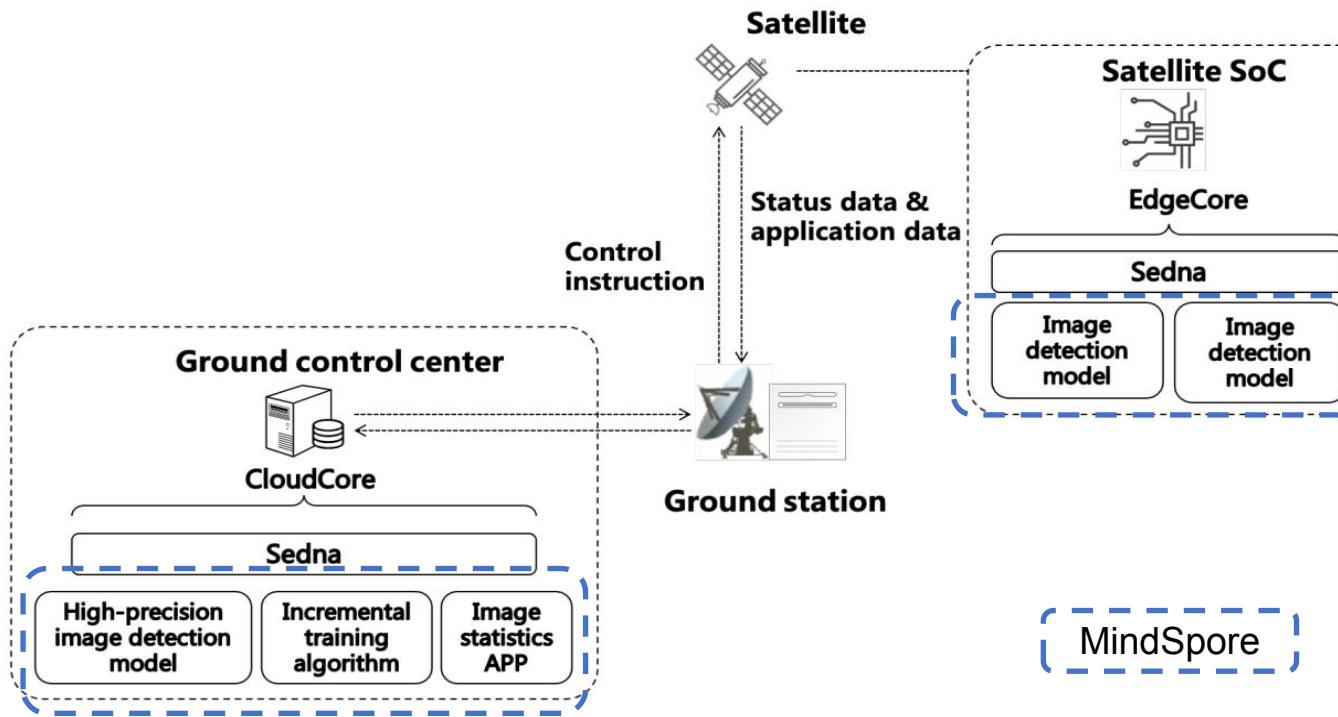
1. Global Manager
  - Manages AI tasks
  - Coordinates tasks between edge and cloud
2. Local Controller
  - Manages end-to-end local processes
  - Manages local models and datasets
3. Worker
  - Runs training and inference tasks based on AI models
4. Lib
  - Provides APIs for developers

# Cloud-Native Satellite



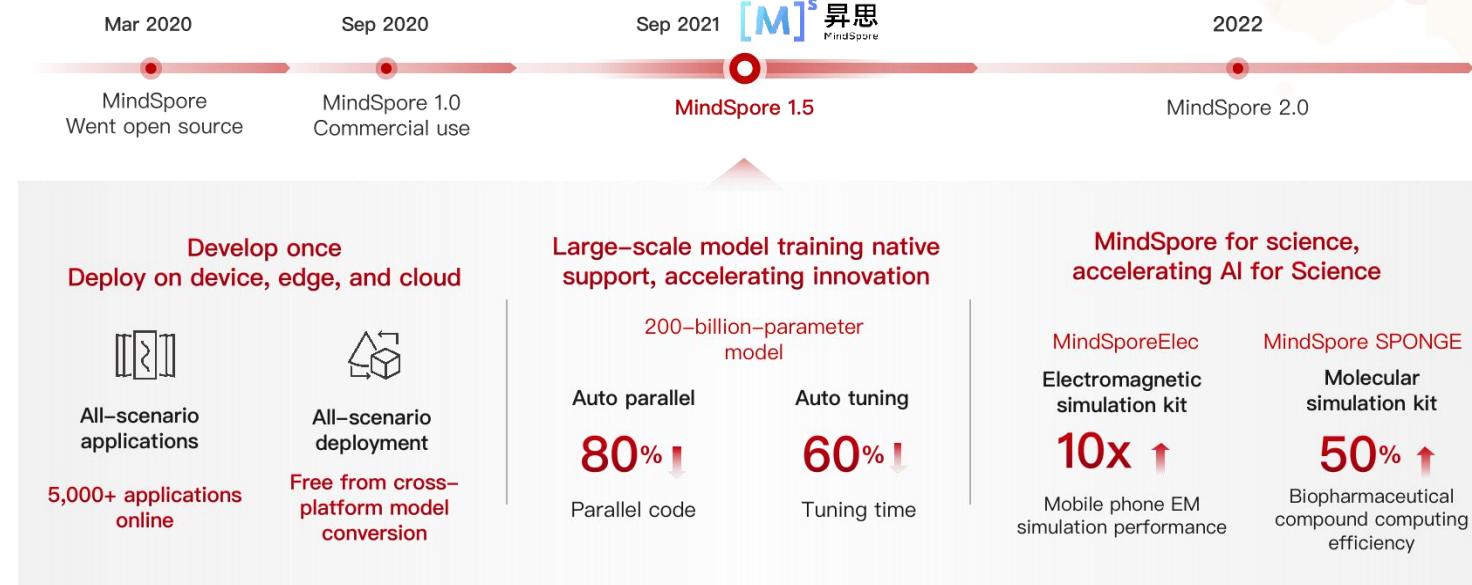
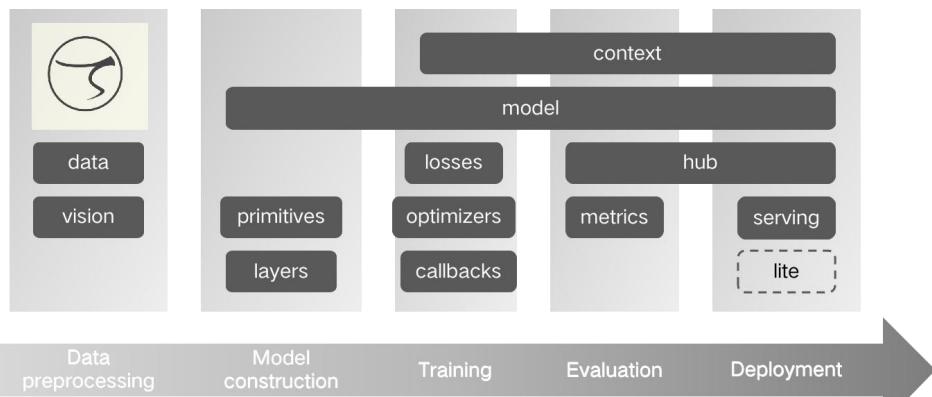
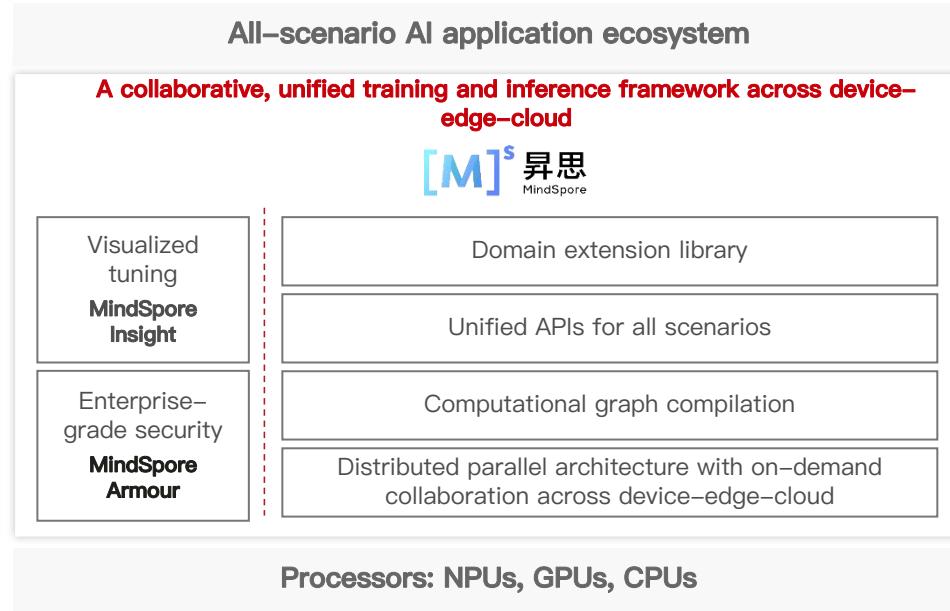
- Lifecycle Management for edge node and cloud-native applications
- Highly reliable satellite-ground data transmission and synchronization
- Multi-model joint inference, less satellite resource consumption
- Incremental learning, auto tuning, higher model accuracy
- Unified IoT device modeling, easier device access

# AI For Space

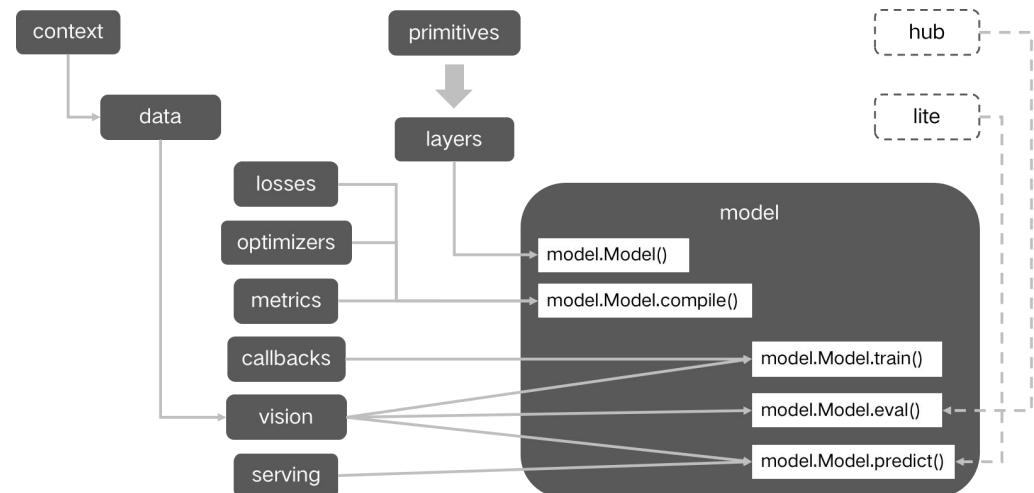


Xiaoman Hu  
Principle Engineer  
*Huawei*

# MindSpore: Open Source All-Scenario AI Framework



- TinyMS is entry-level developer oriented high level API toolkit for MindSpore
- <https://tinyms.readthedocs.io/>



# MindSpore: Top Open Source Community Building in China

## Industry ecosystem

**5,000+ enterprises**

Finance, healthcare, manufacturing,  
digital government, etc.

## Technology ecosystem

**300+** models

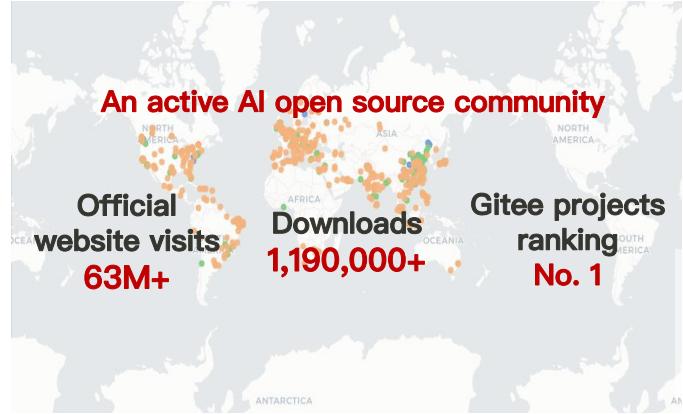
**300+** top conference papers

PCL-L foundation model, remote  
sensing, and biopharmacy

## Open source ecosystem

**4,000+ contributors**

20 SIGs, 25,000+ stars



## MindSpore Study Group (MSG)

**15 cities** in China and **7 countries** outside China  
Online and offline activities  
10 campus activities with OpenI community

## Community Driven Solutions

### Nature Protection

First-ever pre-trained model  
for Sanjiangyuan ultra-red  
cam-corder

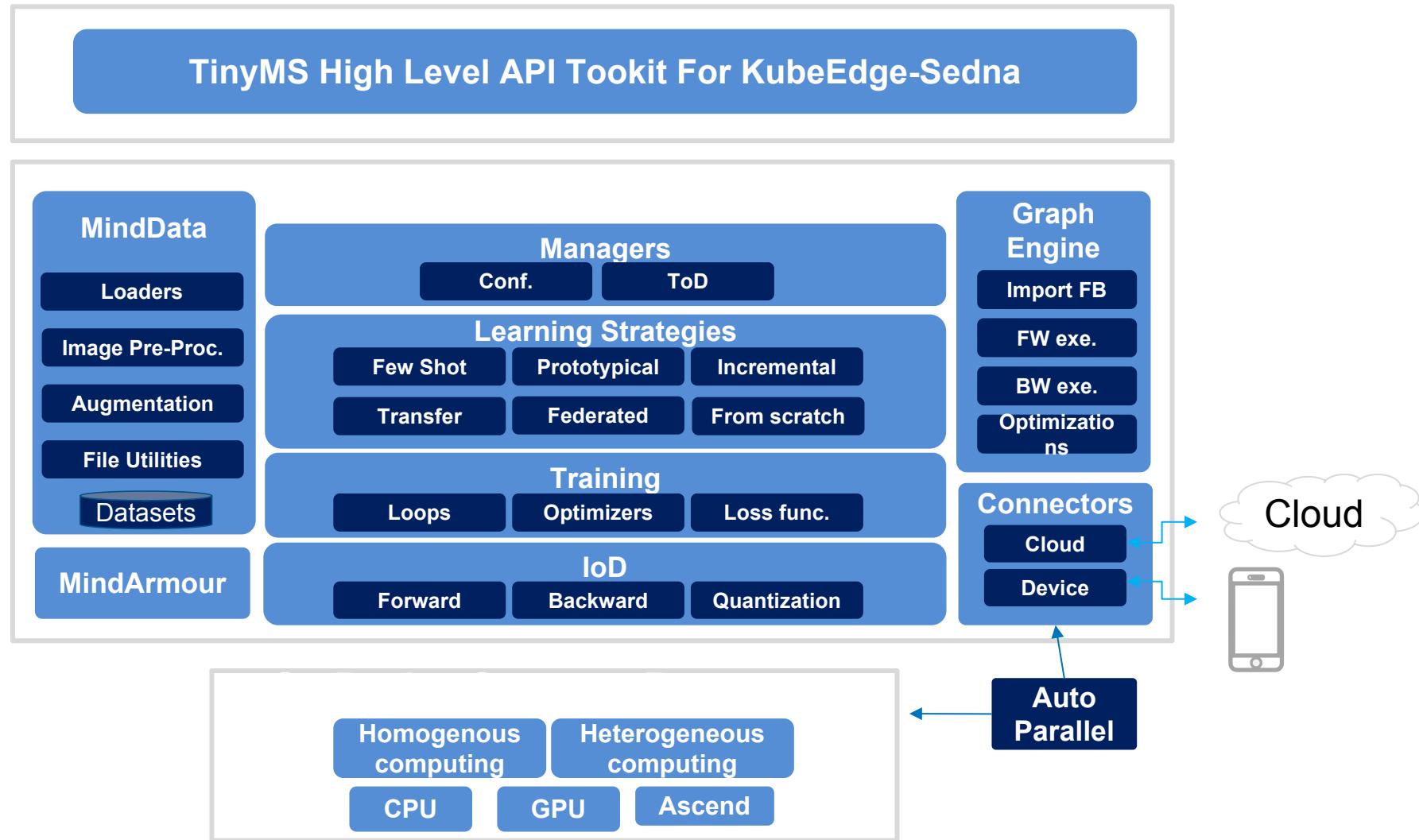
全场景AI框架 MindSpore 联合山水自然保护中心，  
将AI技术应用于实际的生物多样性保护场景，  
共同开展三江源地区红外相机照片AI物种识别模型训练合作，  
实现首次基于国产框架的开源模型  
用于支持三江源红外相机物种识别。

### Tie-dyeing craft

Cycle-GAN for  
Tangible cultural  
heritage

AI加密艺术家宋婷女士与 MindSpore 社区结缘，  
合作了一项AI跨界项目，  
用 MindSpore 的GAN模型  
对世界保护非物质文化遗产扎染的图案进行训练，  
生成新的扎染图案来保护传承非遗工艺。

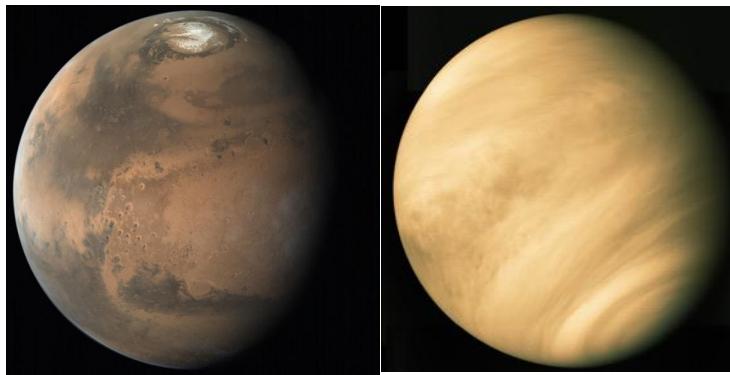
# MindSpore: Incremental Deep Learning Made Simple



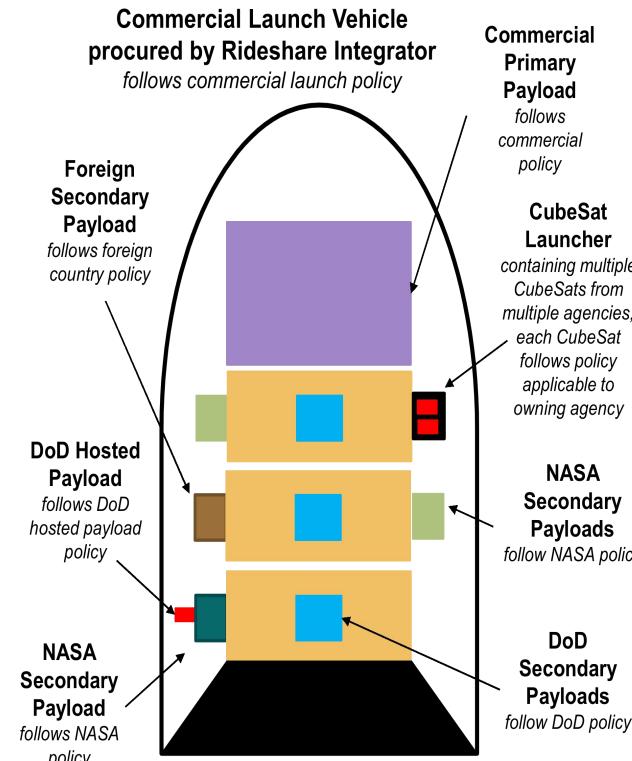
## AI Workflow in Tiansuan-1 Use Case

- Predeployed MindSpore **yolov3-tiny model** with Sedna Edgecore via TinyMS (around 30M which fits in satellite memory)
- Sedna Cludcore performs incremental learning task via MindSpore, **only updates weighs of the non-backbone layers** for “hard samples”
- Sedna Cludcore pushes **compressed partial model** ( around 3M fits 1Mbps uplink) to Sedna Edgecore via MindSpore
- Sedna Edgecore **redeploys new model** via TinyMS

# Deep Space Learning and Cloud Native Space Computing



Concept for 570 Day Crewed 2033 Mars Orbital Mission Using Current Technology Systems,  
JHoppy Price, JPL/CalTech, March 30, 2022, FISO Telcon



## Look Into The Future:

- Deep Space Learning for EO/MO/VO missions** that facilitate automatic constellation forming or smallsat/cubesat fleet management
- Cloud Native Policy for multi-tenant ride-sharing** smallsat/cubesat resource isolation and security/privacy
- Cloud Native Space Computing** that enables better Orbit-Ground or Orbit-Orbit communication, monitoring and resource management.

Navigating the Policy Compliance Roadmap for Small Satellites, Barbara Braun and Sam Sims  
The Aerospace Corporation, January 12, 2022, FISO Telcon

# Join the futuristic open source community !



- Github: [github.com/kubeedge](https://github.com/kubeedge)
- GitHub: [github.com/mindspore-ai](https://github.com/mindspore-ai)
- Website: [kubeedge.io/](https://kubeedge.io/)
- Website: [mindspore.cn/en/](https://mindspore.cn/en/)



Official website



@MindSporeOSS



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