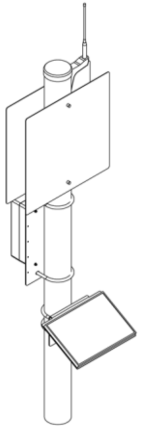
# Smart Sign Technology
## for Continuous Easement Interference Monitoring



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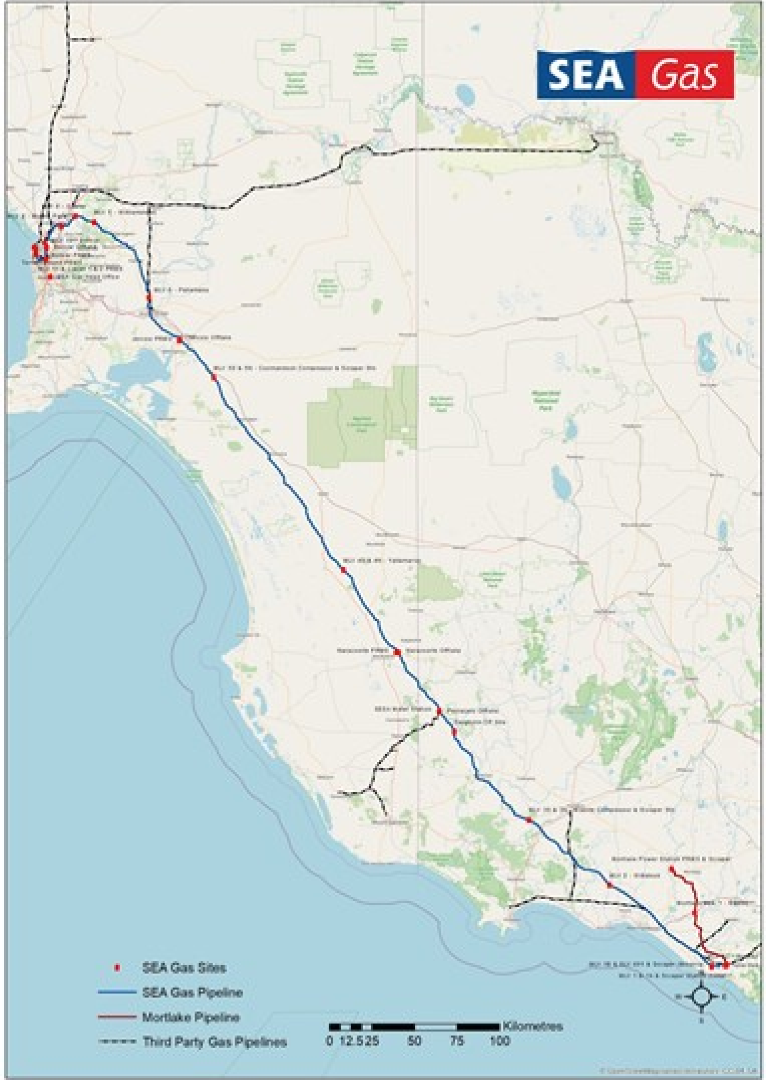



SEA Gas

- Own and operate 800km of high-pressure natural gas transmission pipeline system
- Provide 40-60% of South Australia's natural gas energy needs
- 1184 landholders on easement across SA & Vic
- Seeking to leverage operational technology to ***Work Smarter***

# Purpose

## To enhance pipeline safety management and public safety

- Australian pipeline operating standards are world leading
- Need to maintain high safety standards to avoid potentially catastrophic consequences

*[1] Ghislenghien, Belgium: July 2004*

*[1] ARIA, 2021, accessed 29 September 2021, <https://www.aria.developpement-durable.gouv.fr/fiche_detaillee/27681_en/?lang=en>.*

# Key Public Safety Controls

## External interference pose a significant risk to pipelines

- Gas transmission pipelines are buried to reduce possible interference
- Removal of this layer of protection increases risk
- Typical assurance activity is through patrolling the Right of Way, both air and ground, to monitor for threats
- Signage and pipeline awareness education as additional controls

# Industry Need

## Current patrol methods have limitations

- Aerial and road patrols only detect threats for the duration they are in the vicinity of any section of pipeline
- Patrols are resource intensive
- As easement activity increases so do the number of possible threats

# Alternate Technology Explored

- Satellite Photogrammetry
  - Issues with weather
  - High resolution is expensive
  - Economy of scale

- Drones
  - Need to be able to traverse 800kms in any weather
  - Not yet competitive at the scale required

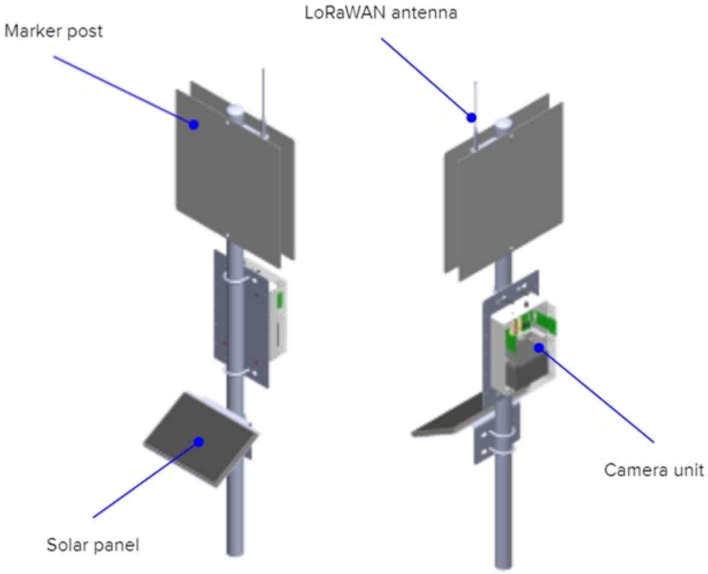

*Image from [2]*

*[2] Shipearly, 2023, accessed 29 September 2021* <https://shipearly.com/if-it-aint-broke-break-it/>.

# Proposed Solution

## A continuous and intelligent monitoring device – making the sign "smart"

- Sensors on existing pipeline easement marker signs
- Detect, analyse and identify threats using AI
- Identified threats are communicated to pipeline operator

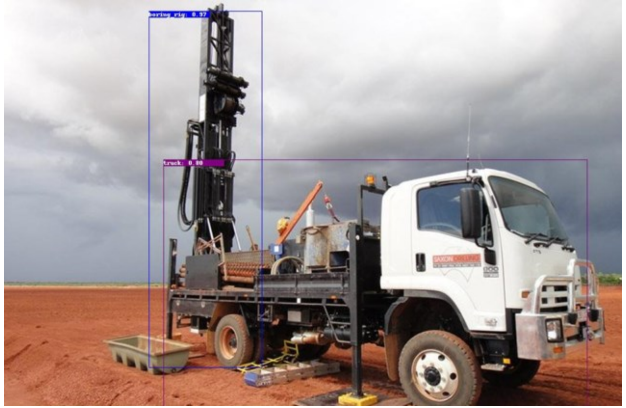


# The Artificial Intelligence

Threat identification

# Detecting Threats in Images

## An object detection approach



# You Only Look Once v4

## An object detection approach

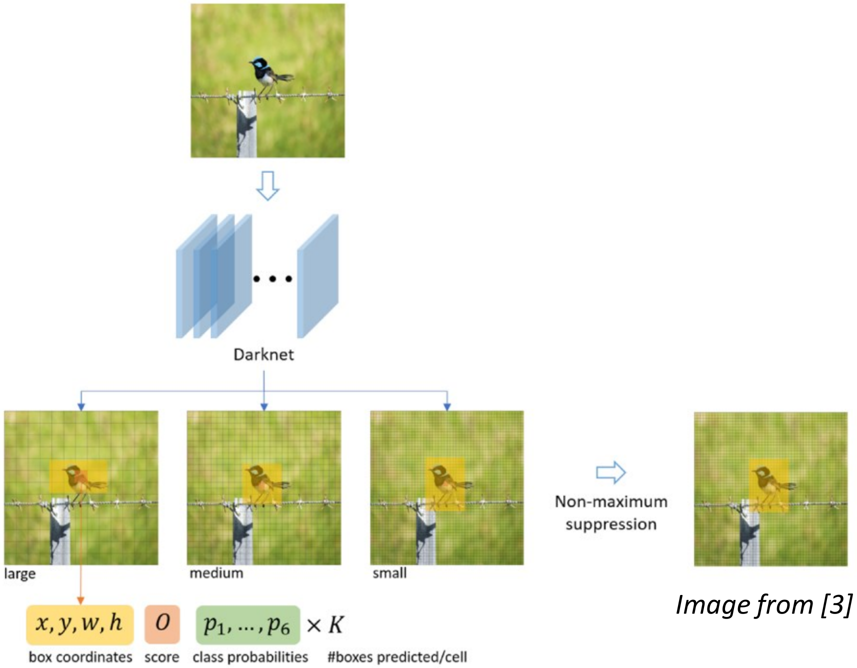



*Image from [3]*

- Based on Darknet Deep Neural Network [3]
- 49 millions parameters to optimise
- Pre-trained on ImageNet (14 million images)
- Able to detect objects on 3 different scales


[3] Barthélemy, J., Verstaevel, N., Forehead, H., & Perez, P. (2019). Edge-computing video analytics for real-time traffic monitoring in a smart city. Sensors, 19(9), 2048.
[4] Bochkovskiy, A., Wang, C. Y., & Liao, H. Y. M. (2020). Yolov4: Optimal speed and accuracy of object detection. *arXiv preprint arXiv:2004.10934*.

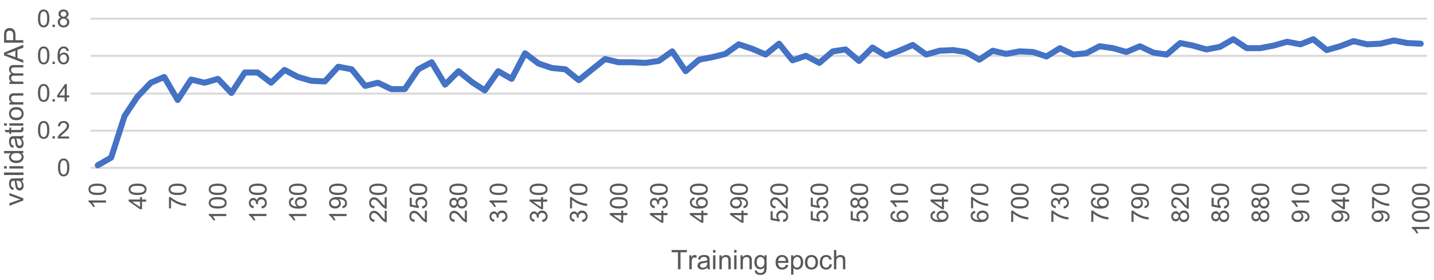
# Training the AI

## Edge computing architecture

- Database: 10,000+ images of different threats, including

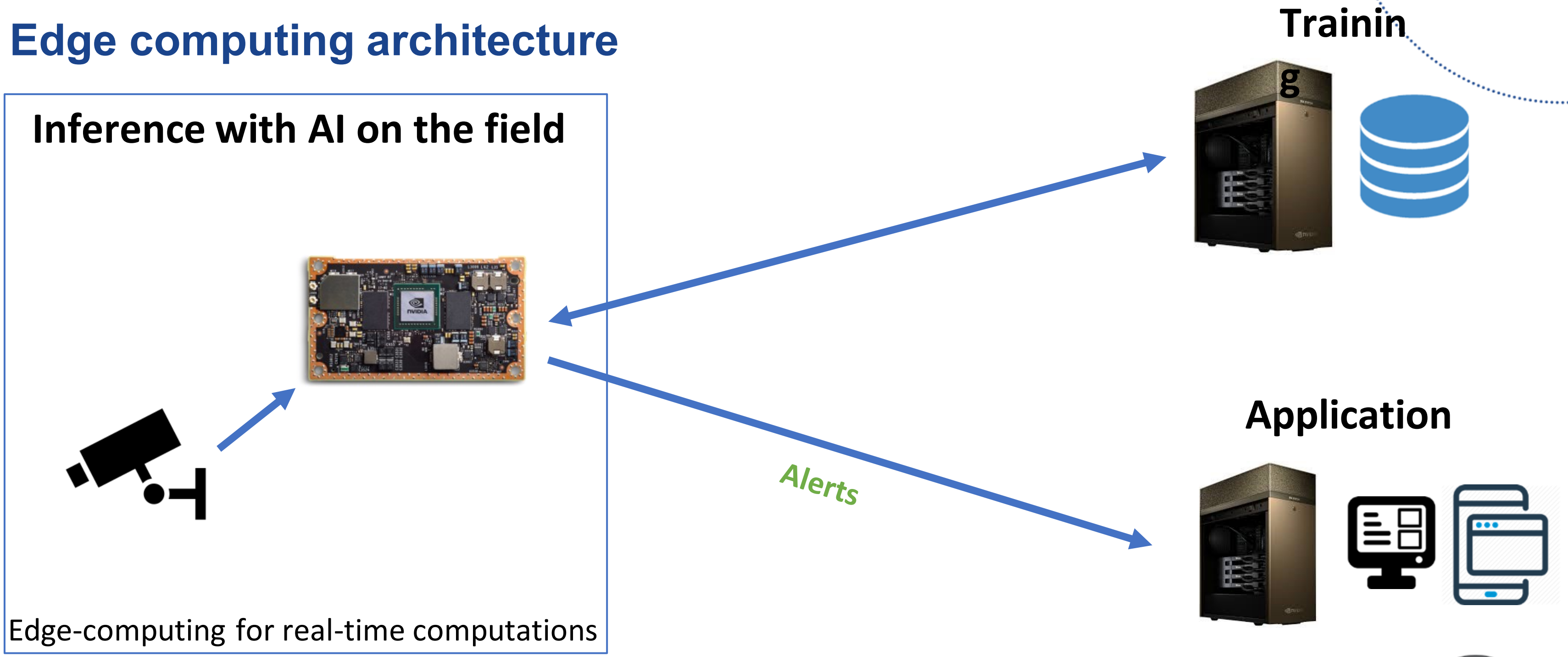
| | | |
|---|---|---|
| Person | Cable plough | Tractor |
| Car | Truck | Clay delver |
| Excavator | Bobcat | Ditch witch |
| Boring rig | Auger | Post driver |

- AI training and validation: Accuracy on par with SOTA – 0.70 mAP



# AI Deployment

## Edge computing architecture

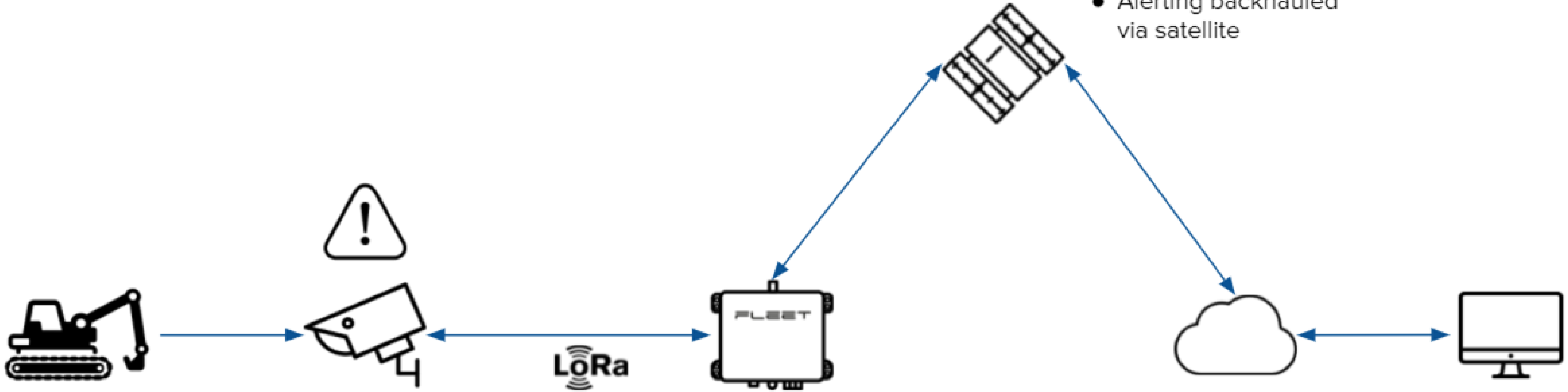


# The Sensor

An intelligent edge-computing device

# Threat Identification Process

- Alerting backhauled via satellite




- Camera monitoring the pipeline
- 3 images captured and processed every 15 mins
- Images initially sent to cloud during the training phase

- Data aggregated in Nebula
- Alerts surfaced in GAP

# Threat Identified by the AI

- Detection
- Confidence level calculation



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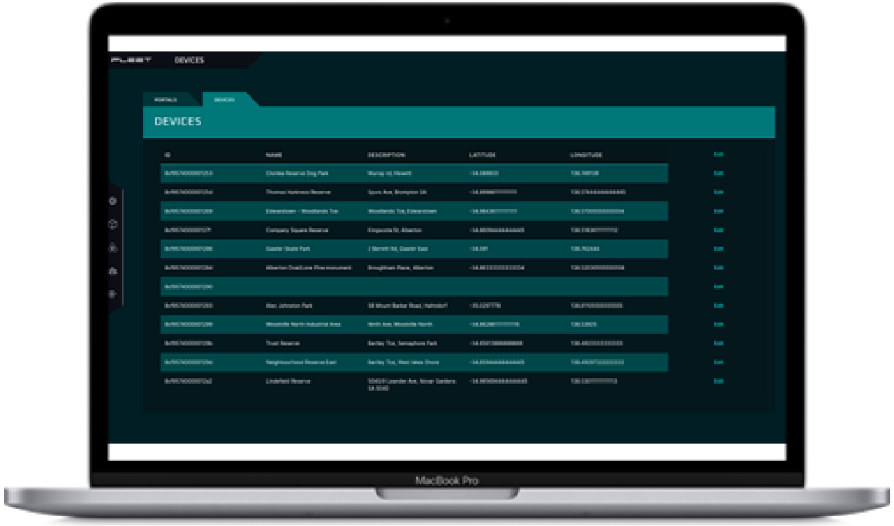
# Alert Data Received in the Portal

- Message aggregation
- Satellite backhaul


# Alert Received in Management Platform

- Network management
- Downstream connectivity

THREAT DETECTED → PORTAL DATA → ALERT RECEIVED* → ACTION DELIVERED




*Alert delivered to operational platform/s, action to be taken as required

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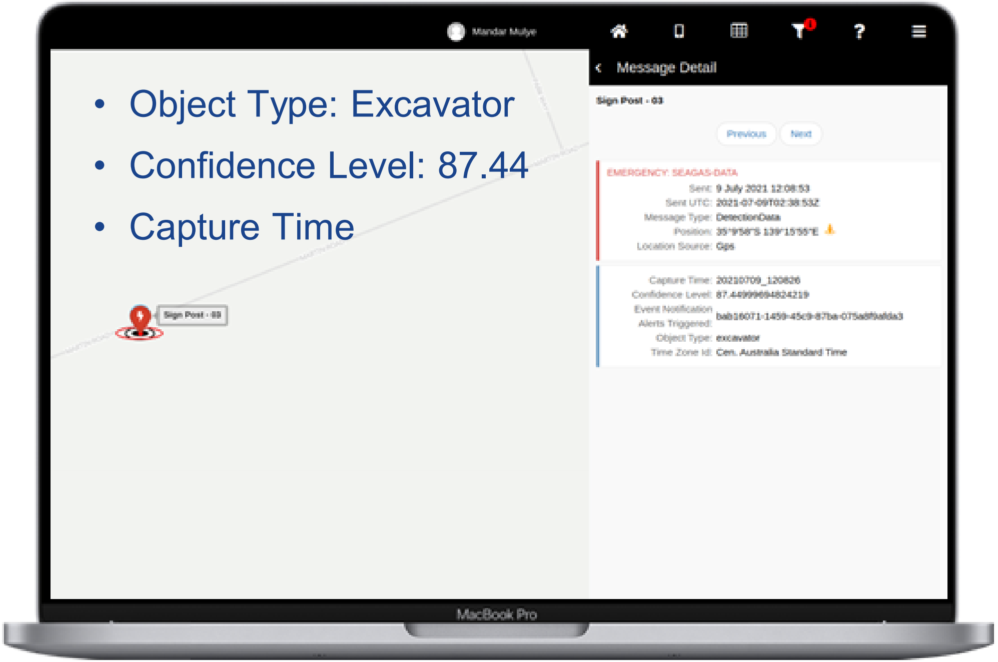
# Alert Data Visualised




- Surfacing alerts for users
- Driving notifications

# Staff Receive Alert

- **Call to action**




*Alert delivered to operational platform/s, action to be taken as required

# Challenges

X Pink tint and unstable brightness

✓ Pink tint removal and brightness control

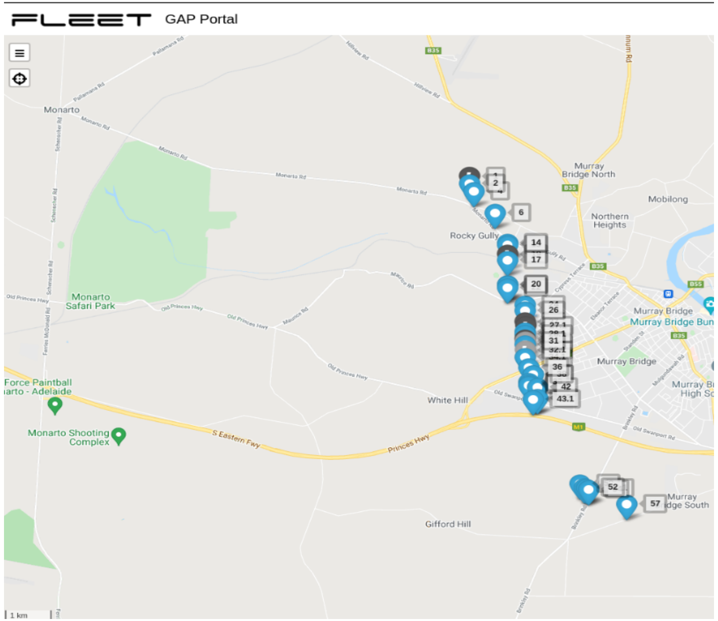
X Before calibration

✓ After calibration

# Field Test and Demo

# Current Deployment

## 3 Portal and 48 sensors




# Demo

# Conclusions and Future Work

# Conclusions

- **AI successfully trained**
  - 10k images
  - mAP of 70%
  - 12 types of threats

- **End-to-end solution currently being tested in the field**
  - 48 devices and 3 portals deployed
  - Long-range data transmission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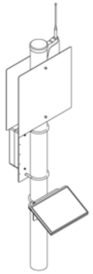
# Next steps



## Further training the AI

- Collecting more data
- Installing temporary devices

## Sensors

- Review the unit design with a focus on:
  - Deployability
  - Power consumption
- Device evaluation
  - Testing in urbanised environment
  - Integration of improvements and learnings into the next generation of sensor

# Enabling the decarbonisation of Australia's energy networks

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