Microsoft

A Dance with Intelligent Dragon Drones

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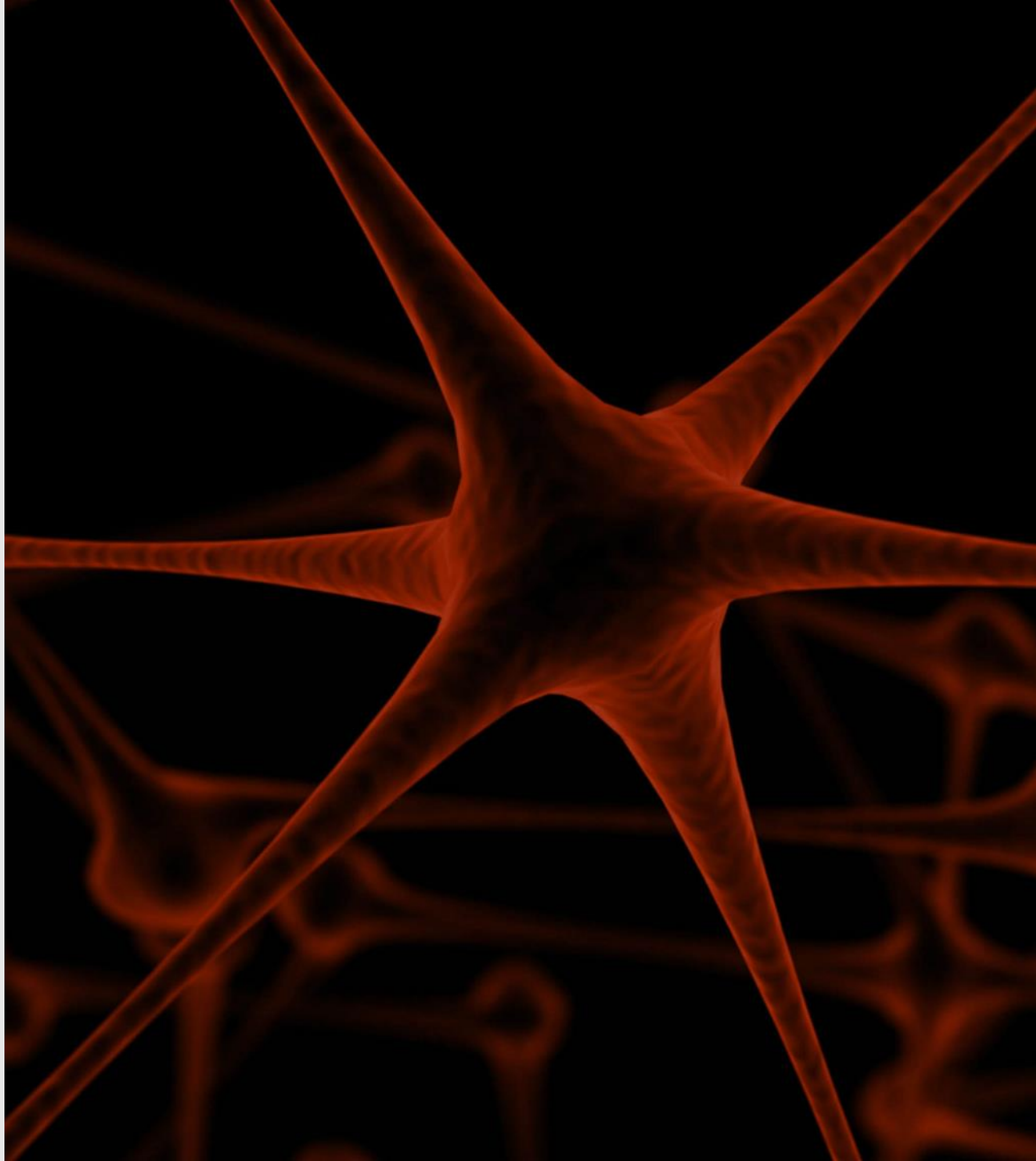

What the heck is this session about?

- Discuss compelling scenarios involving drones and the Cognitive Services
- Explain the problem of world hunger and how precision agriculture can help
- Demonstrate the power and simplicity of the Cognitive Services APIs

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By the year 2050, the world will have 9 billion people

We need to double food production to feed everyone

Precision Agriculture

Cameras, Drones, sensors

FarmBeats Gateway

Soil, crop health, irrigation, fertilizers, …

FarmBeats Gateway

Weather Data
(Rain, Wind, Pollen)

Microsoft Azure

Azure ML

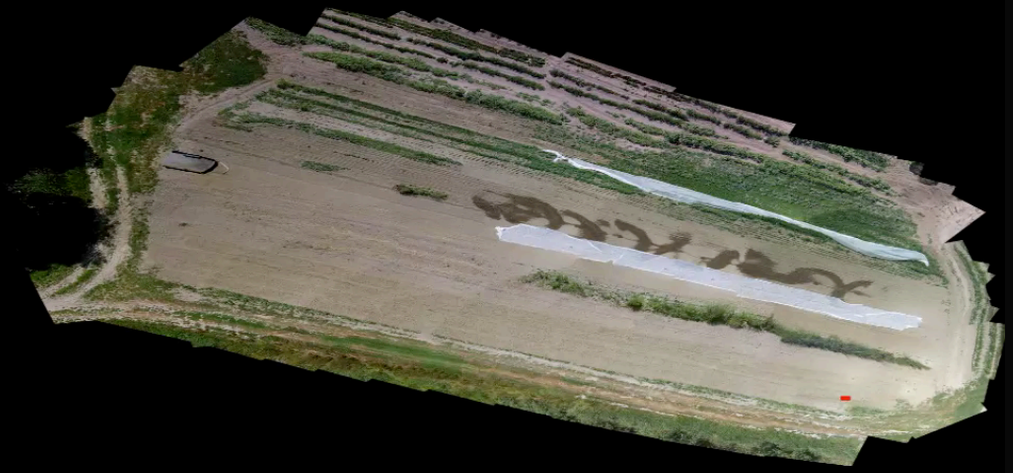
Analytics

Insights

Recommendations
(daily best practices)

2000 acres in upstate NY
Horticulture, animal farming, dairy, etc.

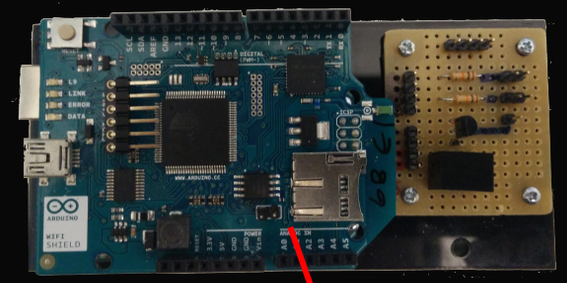
100 acres of farm in Carnation, WA
Rented out to small farmers
- Primarily horticulture

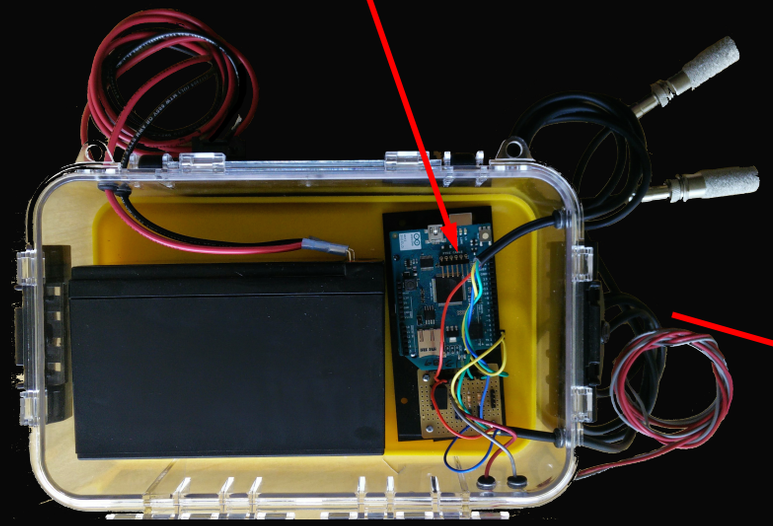


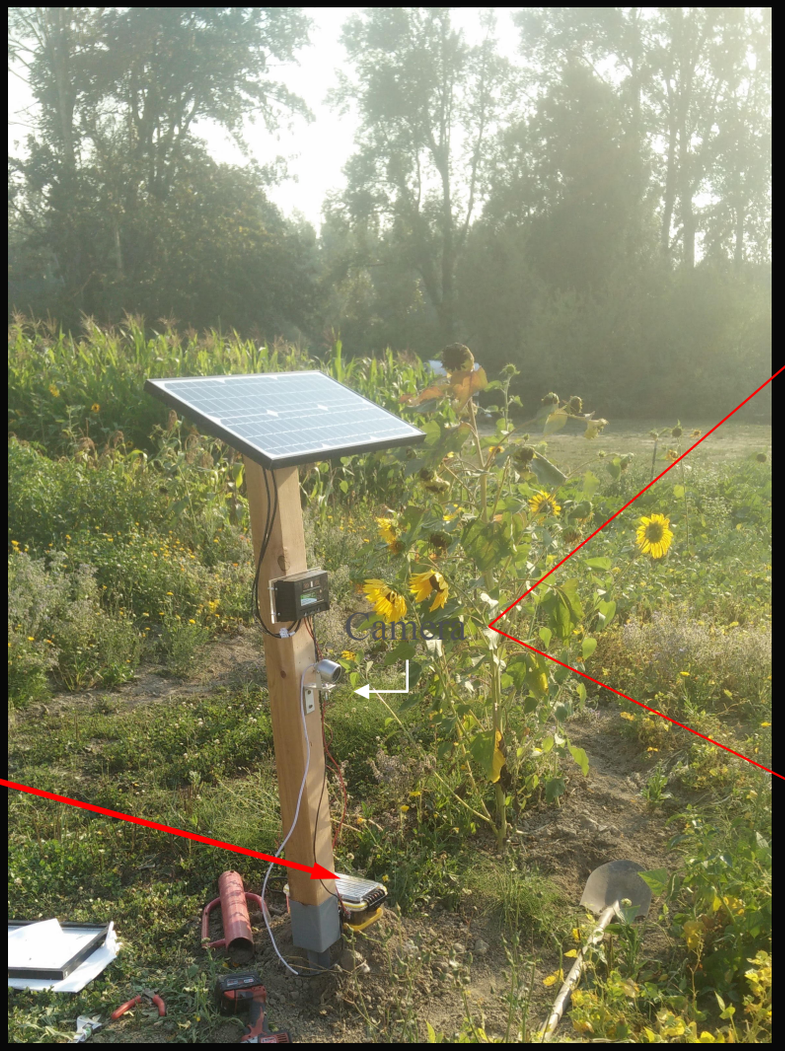
3D Walkthrough of Farm

Sensor Placement

Sensors on the Ground





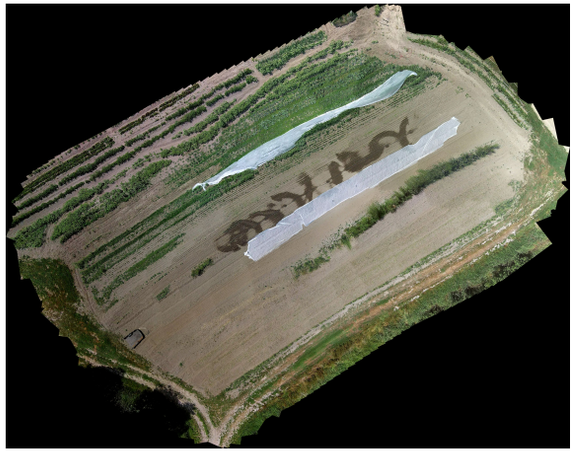


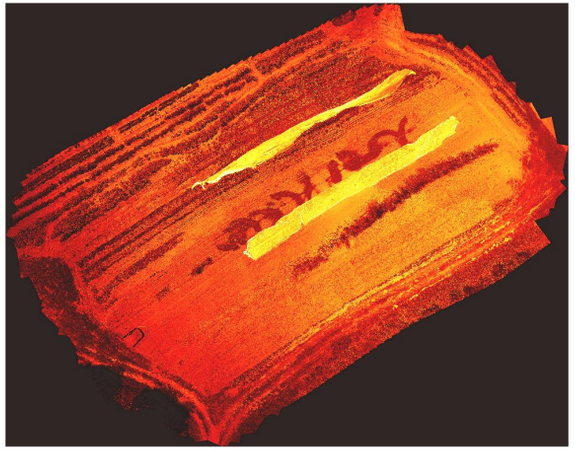
Fusing it all together

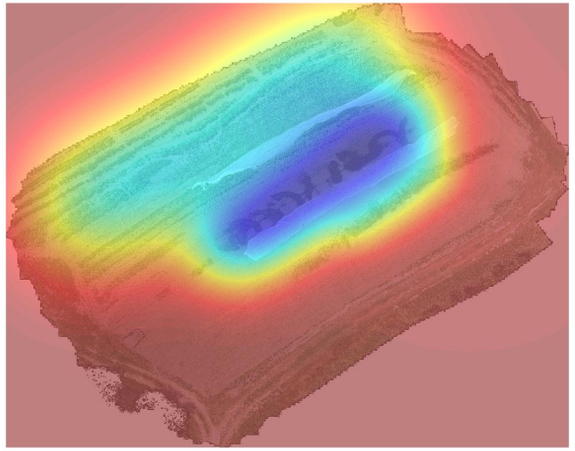
Ag Services

Yield estimation | Precision Irrigation | Pest Infection | Fertilizer application | …

Spatio-temporal view of the farm

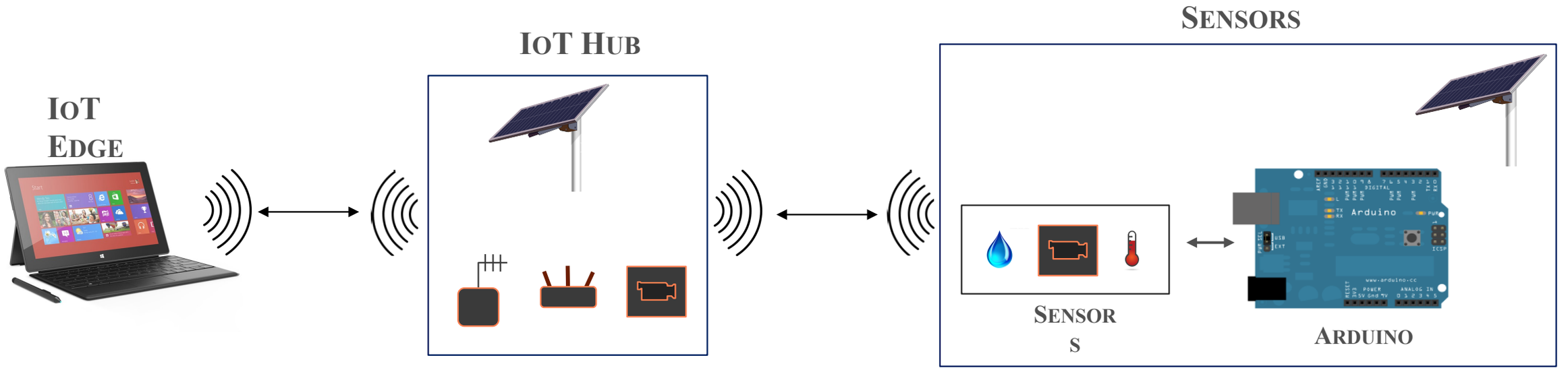




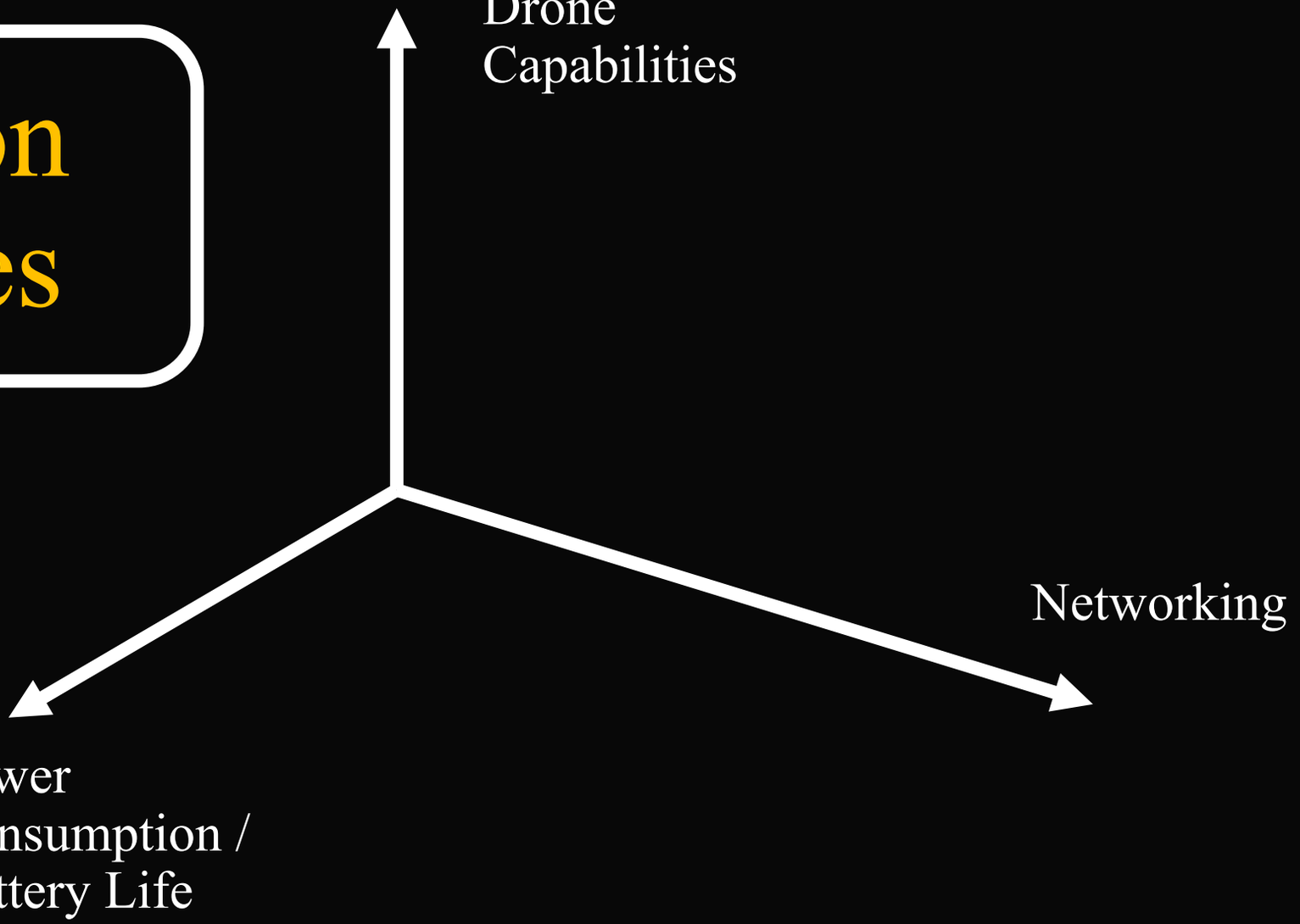


Sensors & UAVs

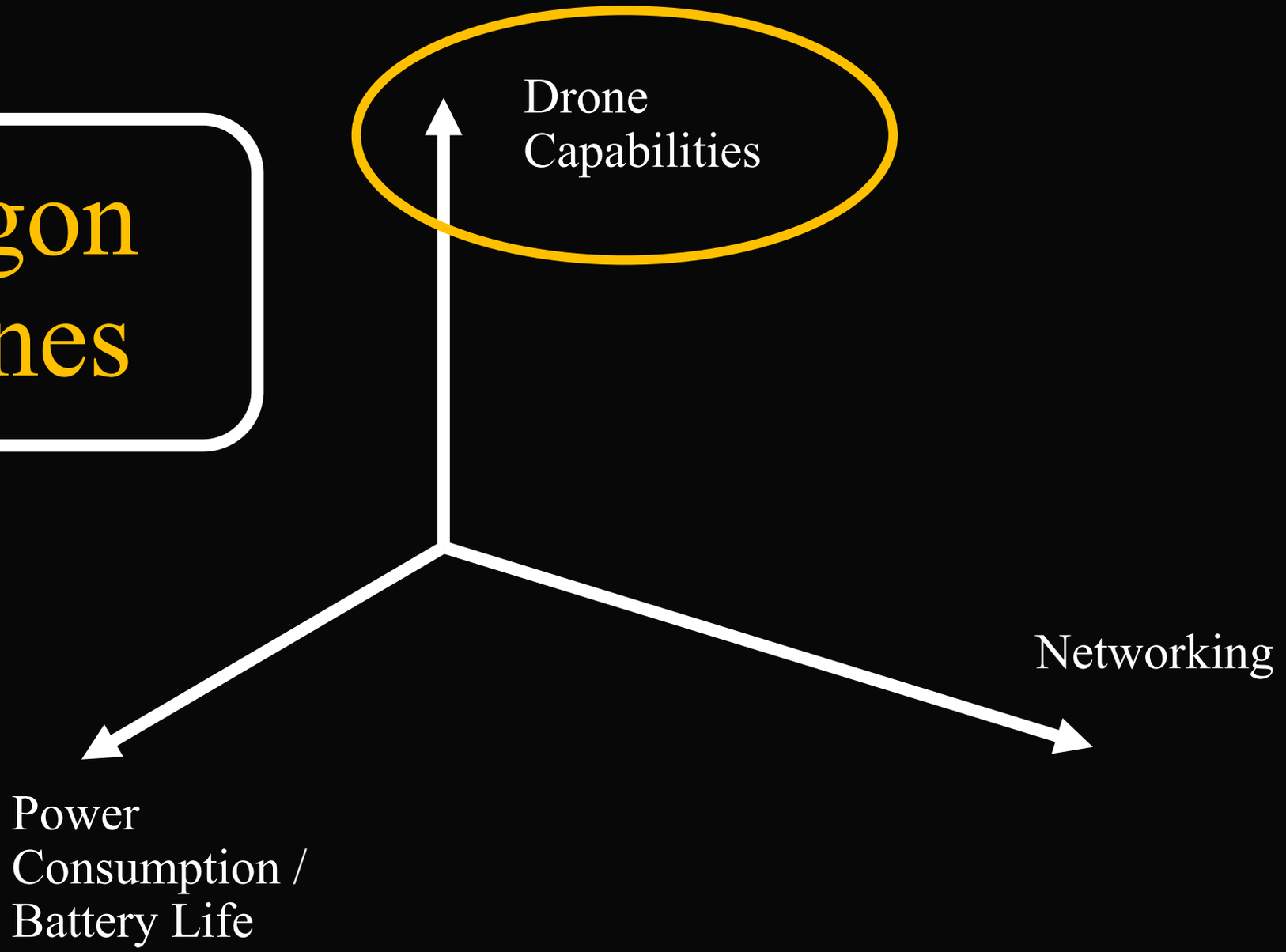
Connected Drones



Dragon Drones



Dragon Drones

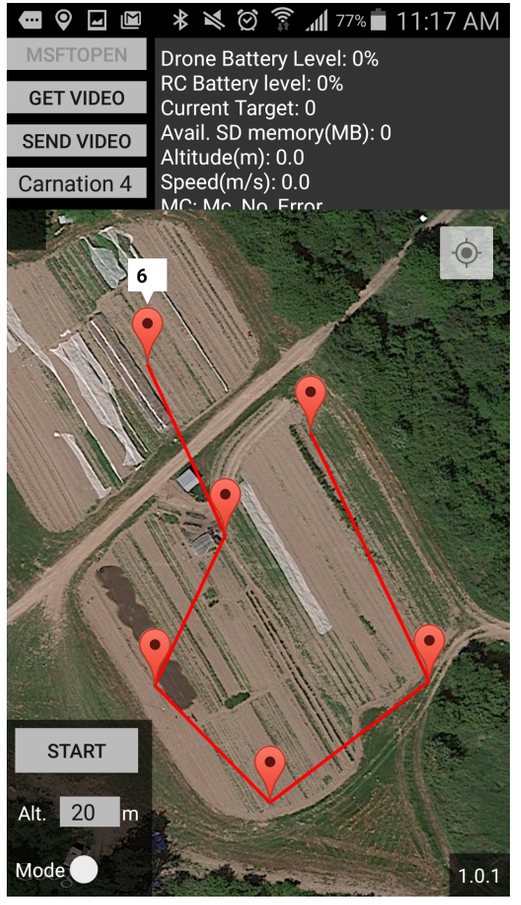


Drone Auto-pilot App

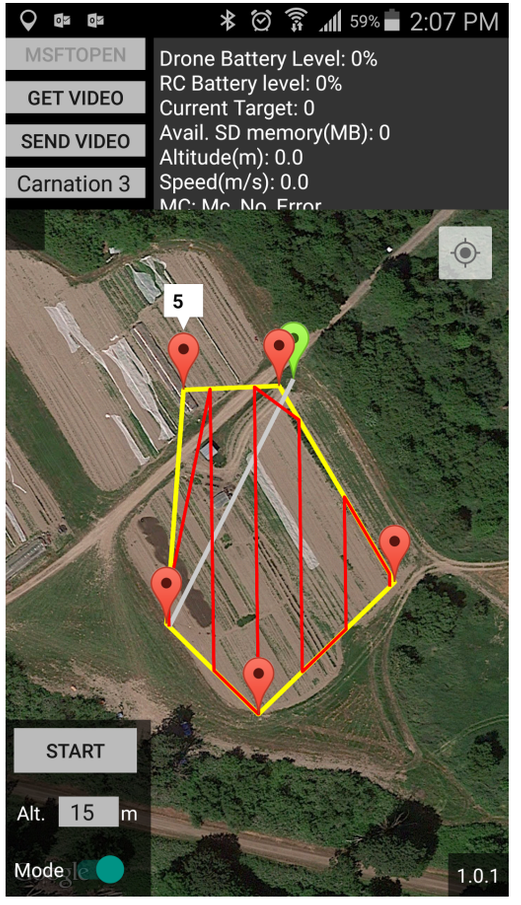
Features

- ✓ Simple user interface
- ✓ Supports two flight modes
  - point-selection mode
  - area-selection mode
- ✓ Estimates flight time
- ✓ Stores path history and telemetry
- ✓ Transfers video from drone to IoT edge
- ✓ Supports DJI Phantom2 and Inspire 1

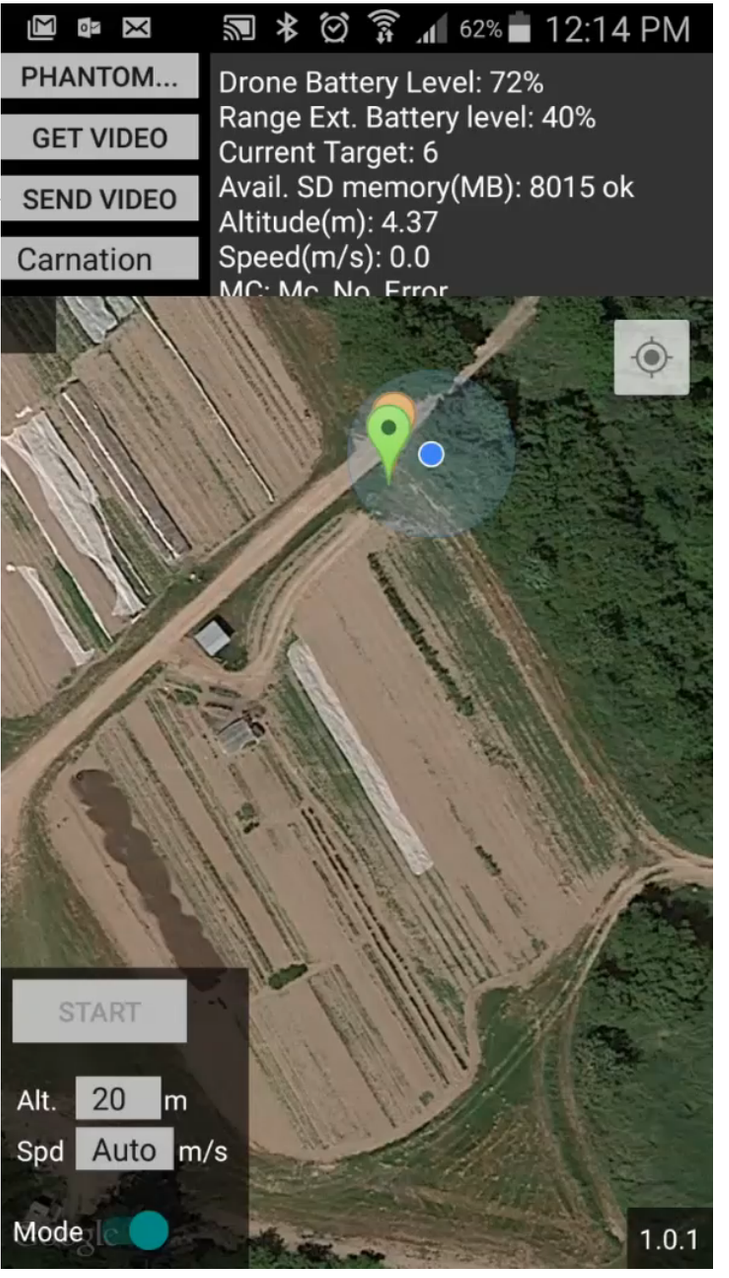
Point selection mode



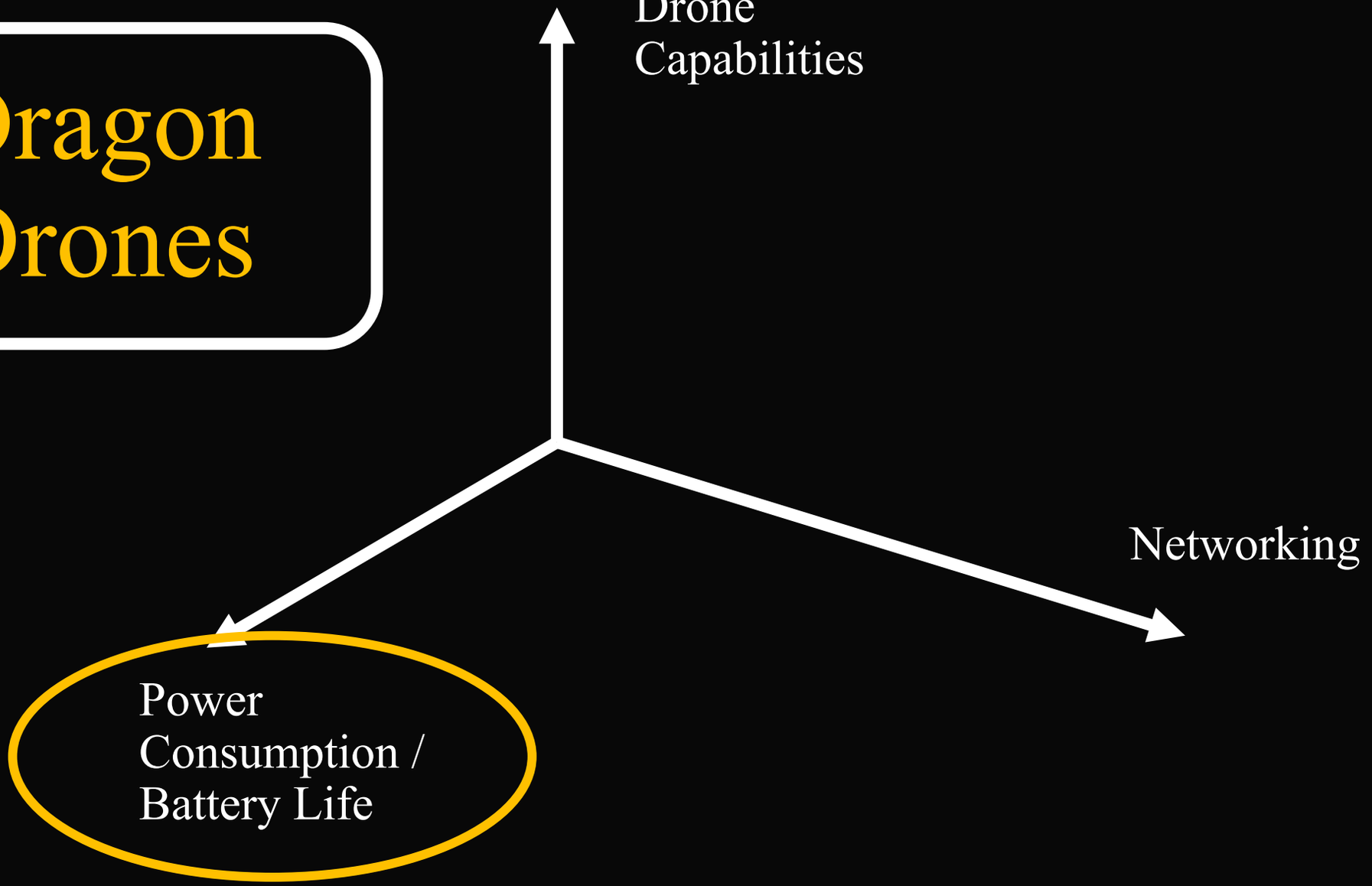
Area selection mode



Drone Auto-pilot App



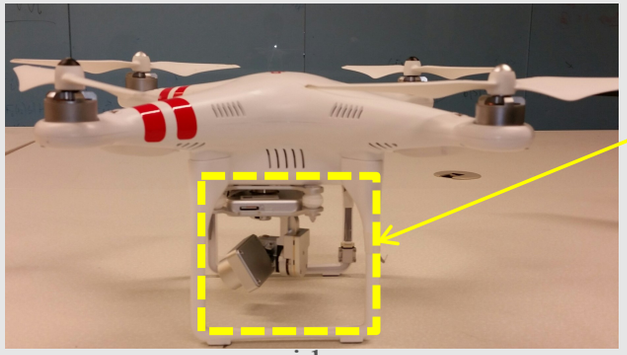
Dragon Drones



Types of Drones

- Omni-directional

Front

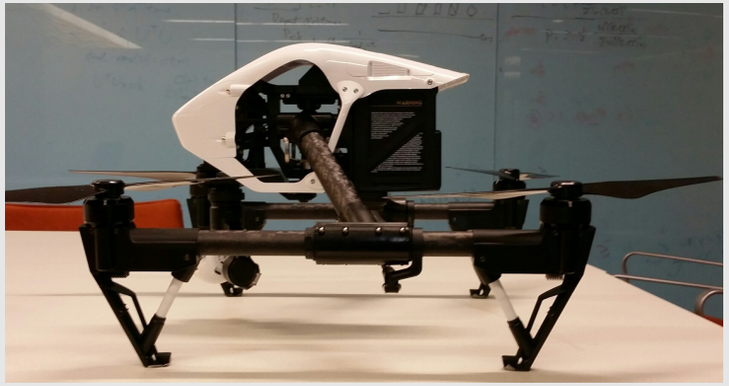


side

Omni-directional drones can have directionality by attaching a paper here

- Directional
  - Front – low drag
  - Side – high drag

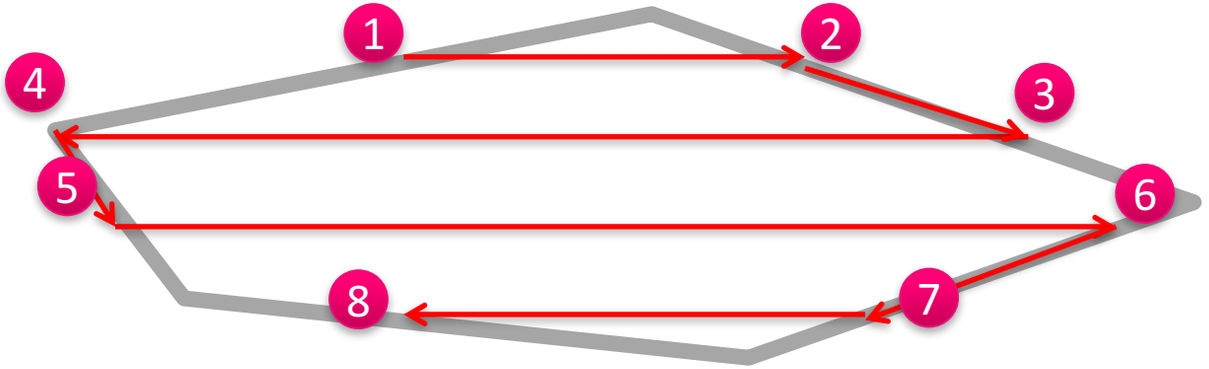
Front



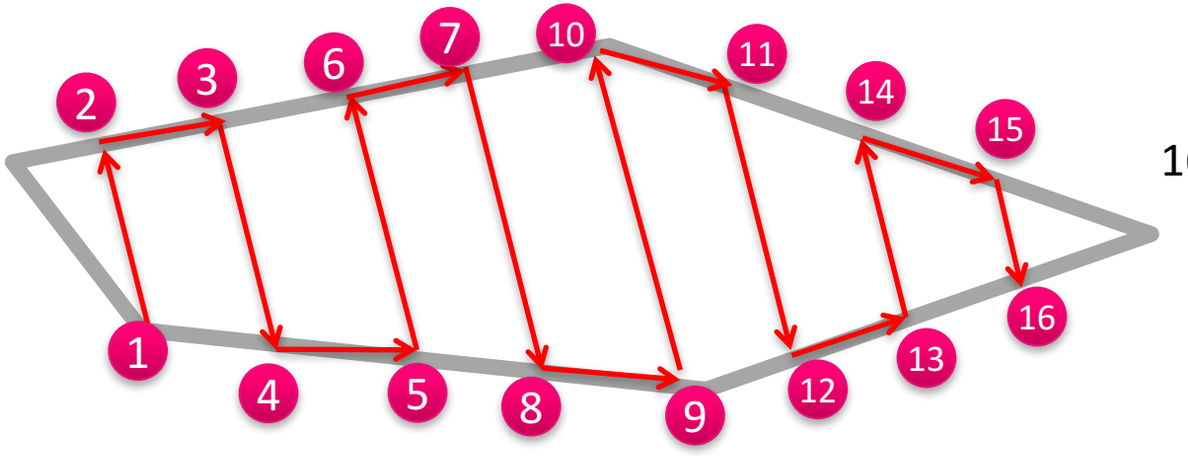
side

Area Coverage Algorithm

Drone stops and goes
or reduce its speed
at each waypoint.



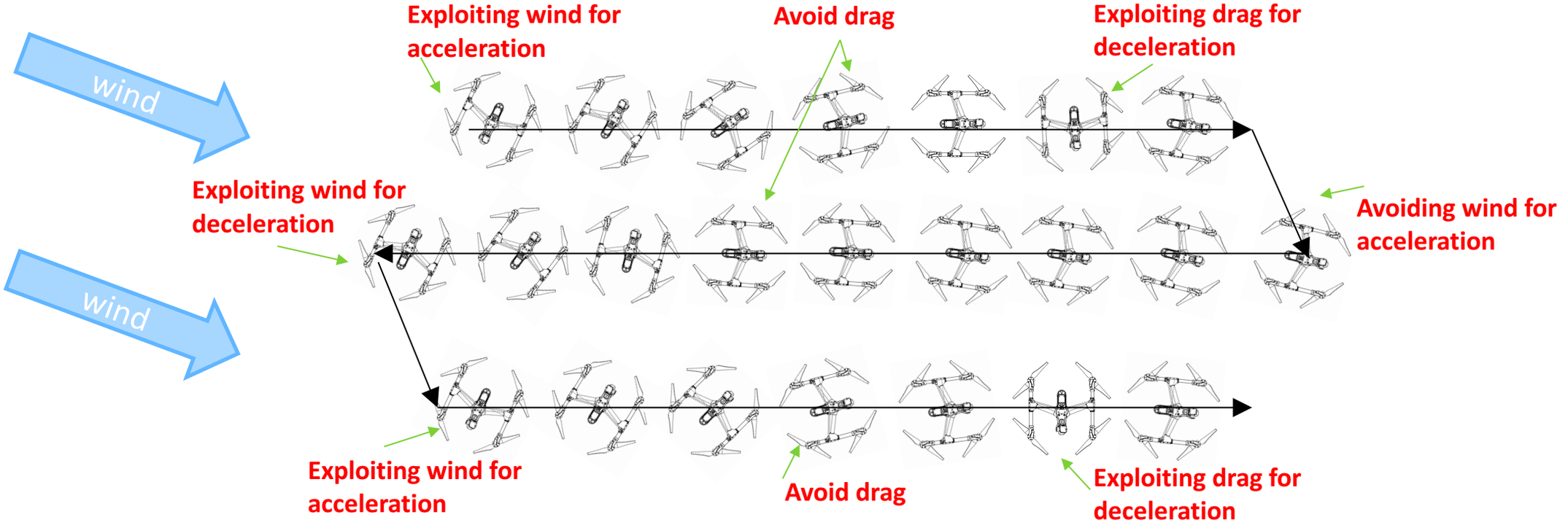
8 waypoints



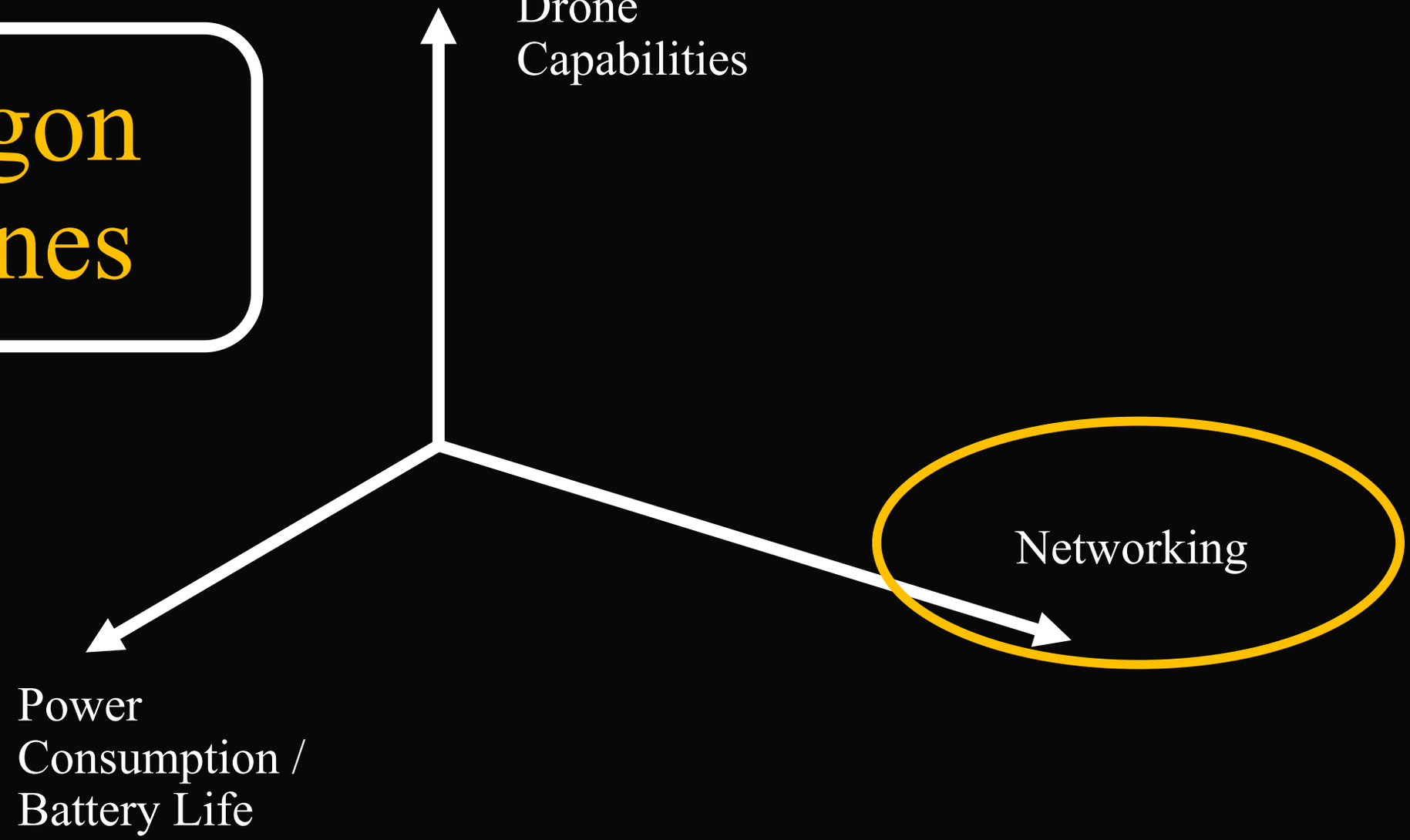
16 waypoints

Yaw Control Algorithm

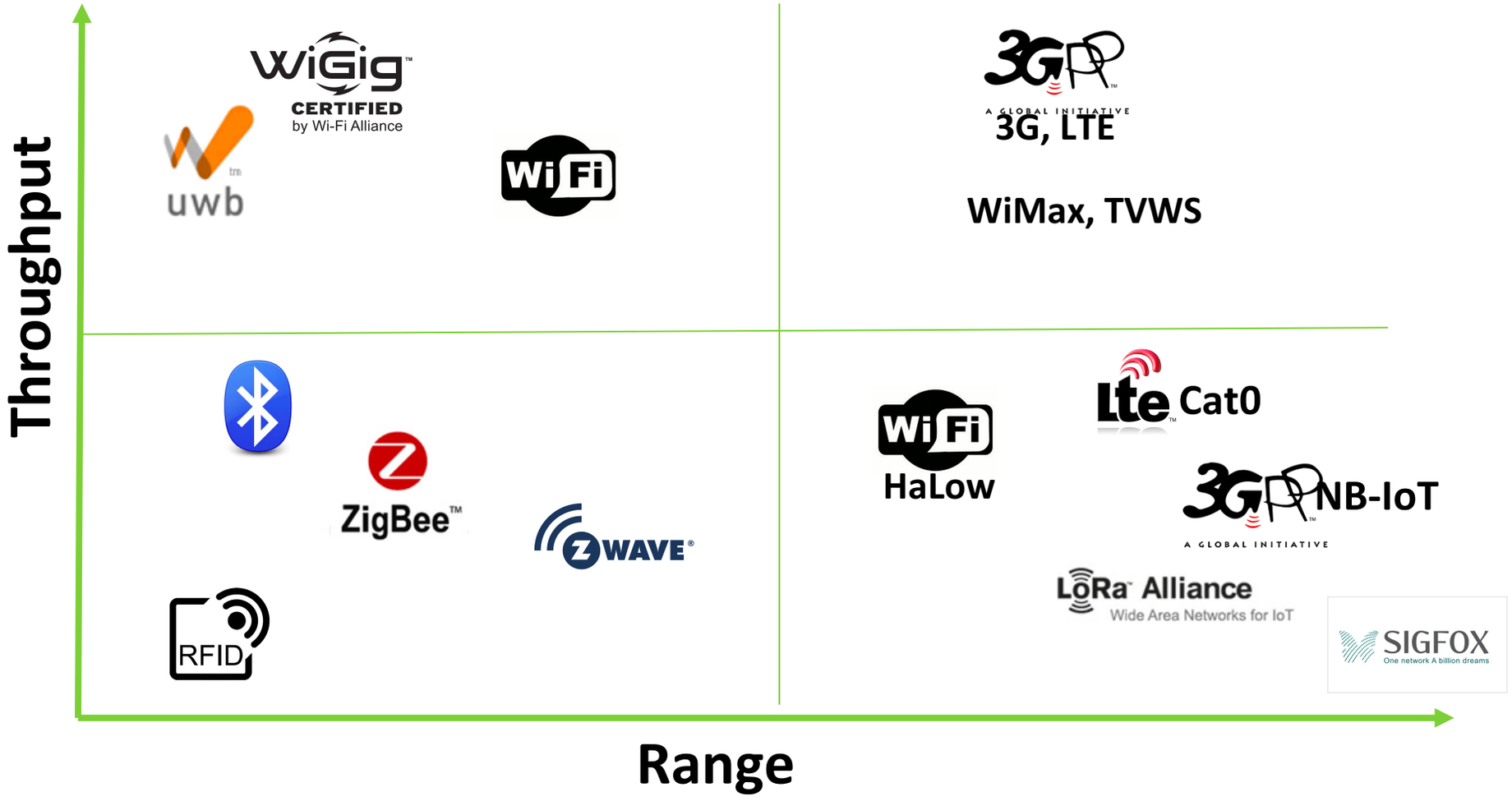
- Given a path and wind information, the drone changes its **yaw** in order to save energy.



Dragon Drones



Snapshot of available wireless technologies

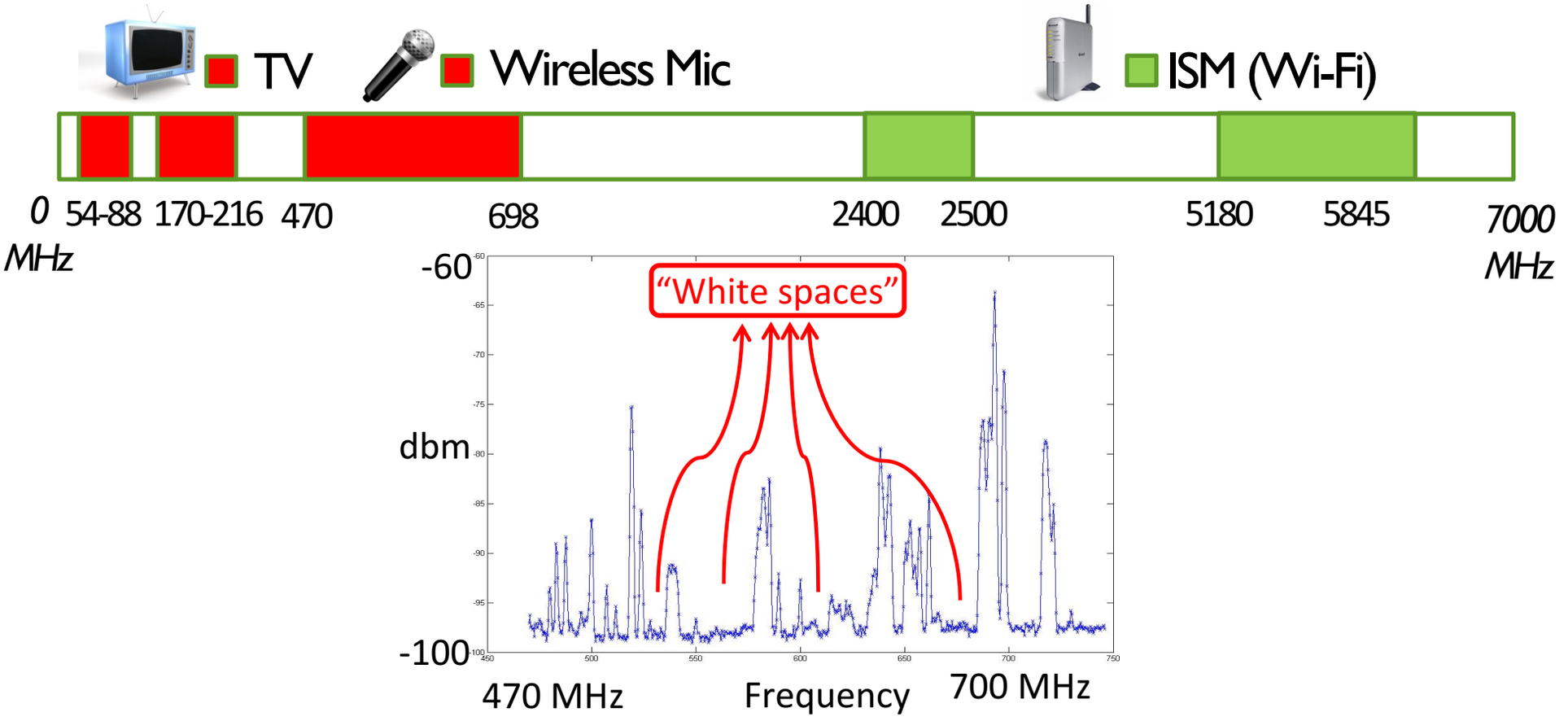


**Not to scale, Very rough estimates*

Long Range IOT Solution

Reuse existing silicon, but with custom firmware & driver

What are TV White Spaces?



White Spaces are *Unoccupied* TV Channels

Mawingu Project

Collaboration between Kenya's Ministry of Information and Communications, Microsoft, and Mawingu Networks.

Pilot delivering low-cost wireless broadband access to previously unserved locations near Nanyuki.

First deployment of solar-powered based stations together with TVWS to deliver high-speed Internet access to areas currently lacking even basic electricity. Base stations allow end-users to charge devices.

To maximize coverage and bandwidth, while keeping costs to a minimum, the Mawingu network relies on a combination of "license-exempt" wireless technologies, including Wi-Fi and TVWS.

Transforming Agriculture

TV Dinners

The Economist

Precision agriculture

TV dinners

Unused TV spectrum and drones could help make smart farms a reality

Sep 17th 2016 | CARNATION, WASHINGTON | From the print edition

ON THE Dancing Crow farm in Washington, sunflowers and squashes soak up the rich autumn sunshine beside a row of solar panels. This bucolic smallholding provides organic vegetables to the farmers' markets of Seattle. But it is also home to an experiment by Microsoft, a big computing firm, that it hopes will transform agriculture further afield. For the past year, the firm's engineers have been developing a suite of technologies there to slash the cost of "precision agriculture", which aims to use sensors and clever algorithms to deliver water, fertilisers and pesticides only to crops that actually need them.

Precision agriculture is one of the technologies that could help to feed a world whose population is forecast to hit almost 10 billion by 2050. If farmers can irrigate only when necessary, and avoid excessive pesticide use, they should be able to save money and boost their output.

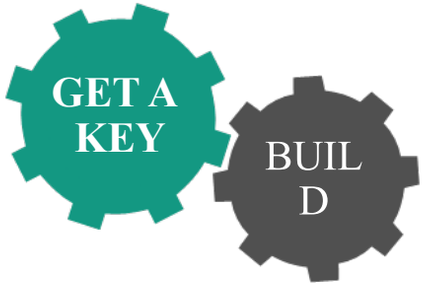
But existing systems work out at $1,000 a sensor. That is too pricey for most rich-world farmers, let alone those in poor countries where productivity gains are most needed. The sensors themselves, which probe things like moisture, temperature and acidity in the soil, and which are scattered all over the farm, are fairly cheap, and can be powered with inexpensive solar panels. The cost comes in getting data from sensor to farmer. Few rural farms enjoy perfect mobile-phone coverage, and Wi-Fi networks do not have the range to cover entire fields.

Why Microsoft Cognitive Services?

Easy

Roll your own with REST APIs

Simple to add: just a few lines of code required



Flexible

Integrate into the language and platform of your choice

Breadth of offerings helps you find the right API for your app

Tested

Built by experts in their field from Microsoft Research, Bing, and Azure Machine Learning

Quality documentation, sample code, and community support

Microsoft Cognitive Services

Give your apps a human side

Vision

From faces to feelings, allow your apps to understand images and video

Speech

Hear and speak to your users by filtering noise, identifying speakers, and understanding intent

Language

Process text and learn how to recognize what users want

Knowledge

Tap into rich knowledge amassed from the web, academia, or your own data

Search

Access billions of web pages, images, videos, and news with the power of Bing APIs

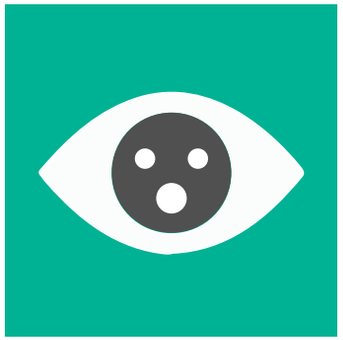
Vision

Computer Vision API

Distill actionable information from images

Face API

Detect, identify, analyze, organize, and tag faces in photos



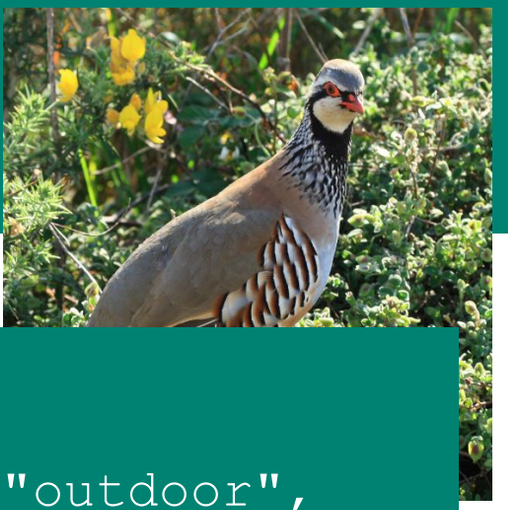
Emotion API

Personalize experiences with emotion recognition

Video API

Analyze, edit, and process videos within your app

How do I use them?



```
using Microsoft.ProjectOxford.Vision;
using Microsoft.ProjectOxford.Vision.Contract;

AnalysisResult analysisResult;
var features = new VisualFeature[] { VisualFeature.Ta
};

using (var fs = new FileStream(@"C:\Vision\Sample.jpg
{
  analysisResult = await visionClient.AnalyzeImageAsy
}
```

```
POST https://api.projectoxford.ai/vision/v1.0/analyze?
&subscription-key=<Your subscription key>
```

```
{
  "tags": [
    { "name": "outdoor",
      "score": 0.976 },
    { "name": "bird",
      "score": 0.95 } ],
  "description":
    { "tags":
      [ "outdoor", "bird" ],
      "captions": [
      { "text": "partridge
         in a pear tree",
        "confidence": 0.96 }
      ]
    }
}
```

Data

Computer Vision

Description, tags, clip art, line drawing, black & white, IsAdultContent/Score, IsRacy/Score, categories, faces, dominant colors, accent color

https://www.microsoft.com/cognitive-services/en-us/computer-vision-api

Emotions

Anger, contempt, disgust, fear, happiness, sadness, surprise, and neutral

https://www.microsoft.com/cognitive-services/en-us/emotion-api

Face

Bounding box, 27 facial landmarks, age, gender, head pose, smile, facial hair, glasses

https://www.microsoft.com/cognitive-services/en-us/face-api

Best Practices for Devs

Samples & SDKs exist

For ObjectiveC/Swift/iOS, Java/Android, C#/Windows, and Python (Jupyter notebook)

https://www.microsoft.com/cognitive-services/en-us/SDK-Sample?api=computer%20vision

Constraints

Computer Vision API describes images in English only

Face API detects up to 64 human faces in one image

Facial detection: JPEG, PNG, GIF (first frame), and BMP supported, image file size of 1KB-4MB, detectable face size 36x36-4096x4096 pixels, returned faces ordered by face rect size desc

Fun random details

FindSimilarFace has 2 modes: matchPerson (default, same person) and matchFace (similar faces)

FaceGroup API takes between 2-1000 candidate faces

Documentation: https://www.microsoft.com/cognitive-services/en-us/documentation

Demo

Facial verification: Can the “dragon” drone find Khaleesi?

Demo

Train faces for recognition
http://aka.ms/trainfaces
https://github.com/howlowck/train-faces

Challenges Working with Drones

- Networking
  - Connect to drone's SSID which doesn't access public internet
  - Workaround: data connection on phone, wired connection on laptop
- Network Latency
  - Needs resiliency when no internet is available (in some scenarios) - calling Cognitive Services is an online scenario that requires internet
  - Needs to be fast enough to be responsive (in some real-time scenarios)
- Picture Quality
  - Specs of camera (Parrot AR Drone 2.0): 1280x720 pixels (720p)
  - Requirements for Cognitive Services: detectable face size 36x36-4096x4096 pixels
- Complete pain to take on a plane


The first goal is to give a real-time view of the farm, a real-time pulse of the farm to the farmer.

Solving world hunger with the power of drones, networking research, machine learning, and IoT

Resources

Project [illegible]soft.com/en-[illegible]eats-iot-agriculture/

[illegible]nomist:

[illegible]economist.com/news/science-and-[illegible]nology/21707242-unused-tv-spectrum-and-drones-could-help-make-smart-farms-reality-tv-dinners

YouTube Video:

https://www.youtube.com/watch?v=pDgjOHY7sMI

FAQ

No yield numbers yet, but some data:

- Farmer needed 30% less water for his farm
- Farmer needed 44% less lime to maintain the pH
- Based on the recommendation, the carrots grew in half the time in another part of the farm

Costs

- Much less than existing solutions
- Drone + $150 per sensor (which includes solar panels and batteries). Need sensor per 5 acres.
- Working on bringing down cost of the sensor module to < $25

FAQ Part 2

TV WhiteSpace

- Throughput on a 6 MHz TV channel is about 18Mbps. This is bidirectional (up and down). This is achieved by existing off-the-shelf equipment.
- The most recent standard allows for double the throughput with multiple antennas.

Thank you.

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