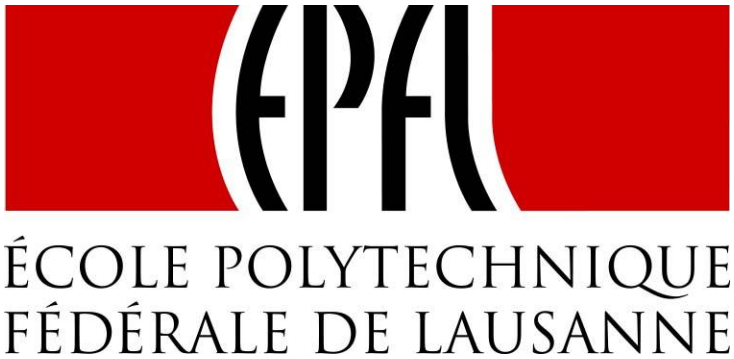
School of Computer Science and Communication Systems
Master in Computer Science



Bandwidth efficient object recognition for drone swarms

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Project Overview

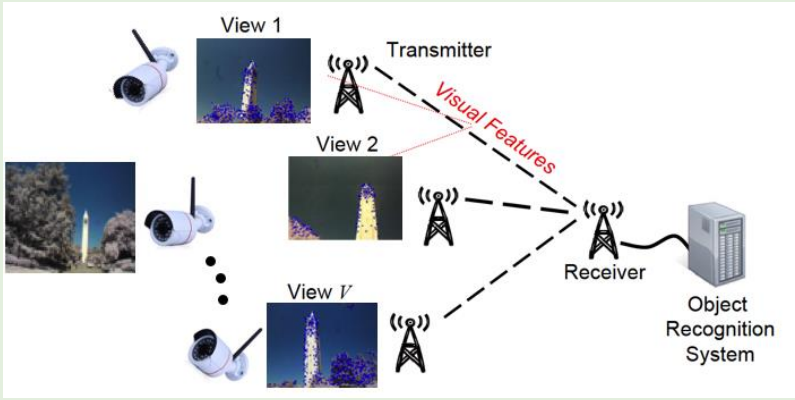
- Motivation
  - Detection Accuracy: prediction by single drone may be unreliable
  - Consensus: autonomous swarms may need to agree on whether a given target is present
  - Bandwidth efficiency: especially relevant in urban environment

- Goal
  - Determine the presence/absence of a target object with high accuracy

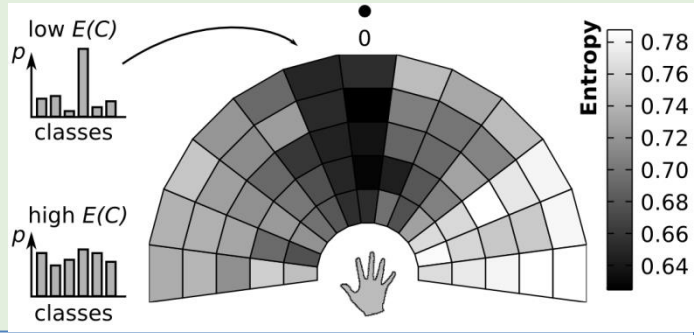
- Proposed approach
  - Exploit multiple viewpoints
  - Estimations are done locally by each drone
  - Limited information exchange to save power, bandwidth and for scalability

Related Work

- A. Rahimpour *et al.,* "Distributed Object Recognition in Smart Camera Networks," 2016 IEEE Int. Conf. on Image Processing (ICIP), 2016.
  - Feature extraction performed by each camera
  - Feature sent to a base station, which performs object detection
  - Lack of an autonomous set of devices that triggers other events

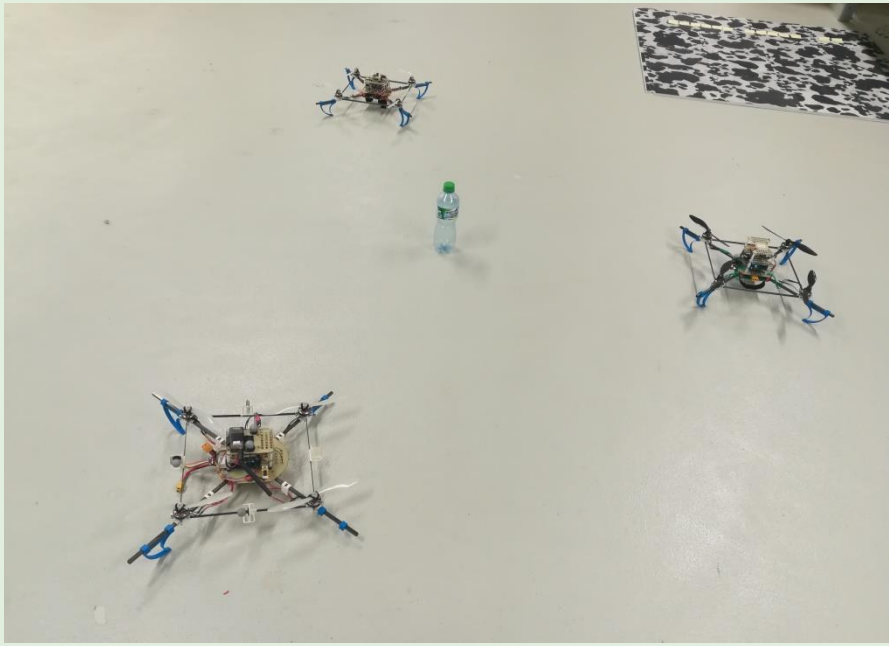


- H. Medeiros et al., "Distributed Object Tracking Using a Cluster-Based Kalman Filter in Wireless Camera Networks," IEEE Journal of Selected Topics in Signal Processing, 2008.
  - Distributed Kalman filter
  - Different goal
- A. Giusti et al., "Cooperative sensing and recognition by a swarm of mobile robots," IEEE/RSJ International Conference on Intelligent Robots and Systems, 2012.
  - Interesting communication and consensus protocol
  - Human-computer interaction
  - Different setup, different goal
  - Classification task



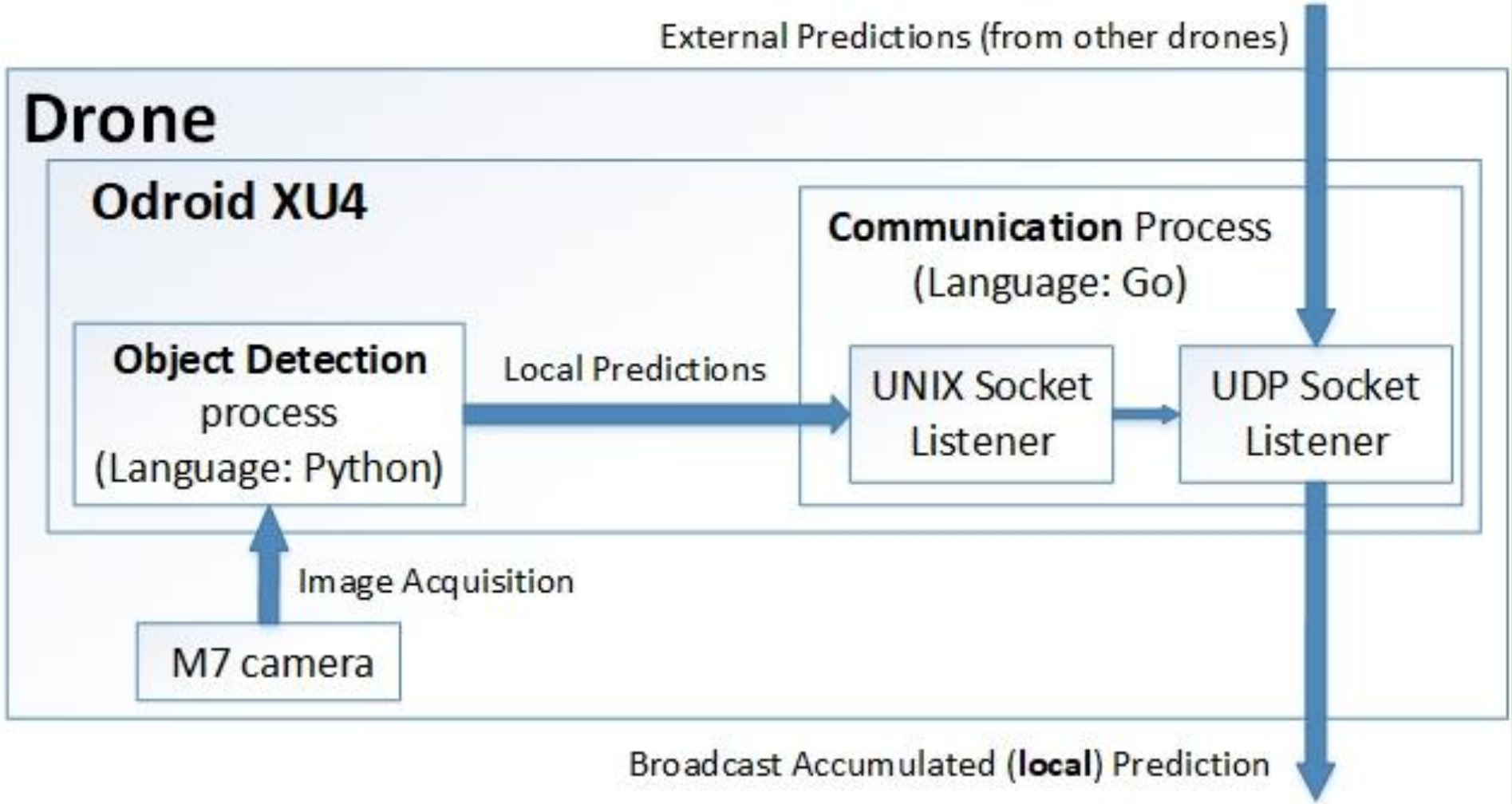
Hardware Selection and Validation

- Hardware selection
  - Project inputs
    - Single-board computers: Odroid XU4
    - Image Acquisition: M7 camera
  - Our proposal
    - Connectivity: WiFi Module 5

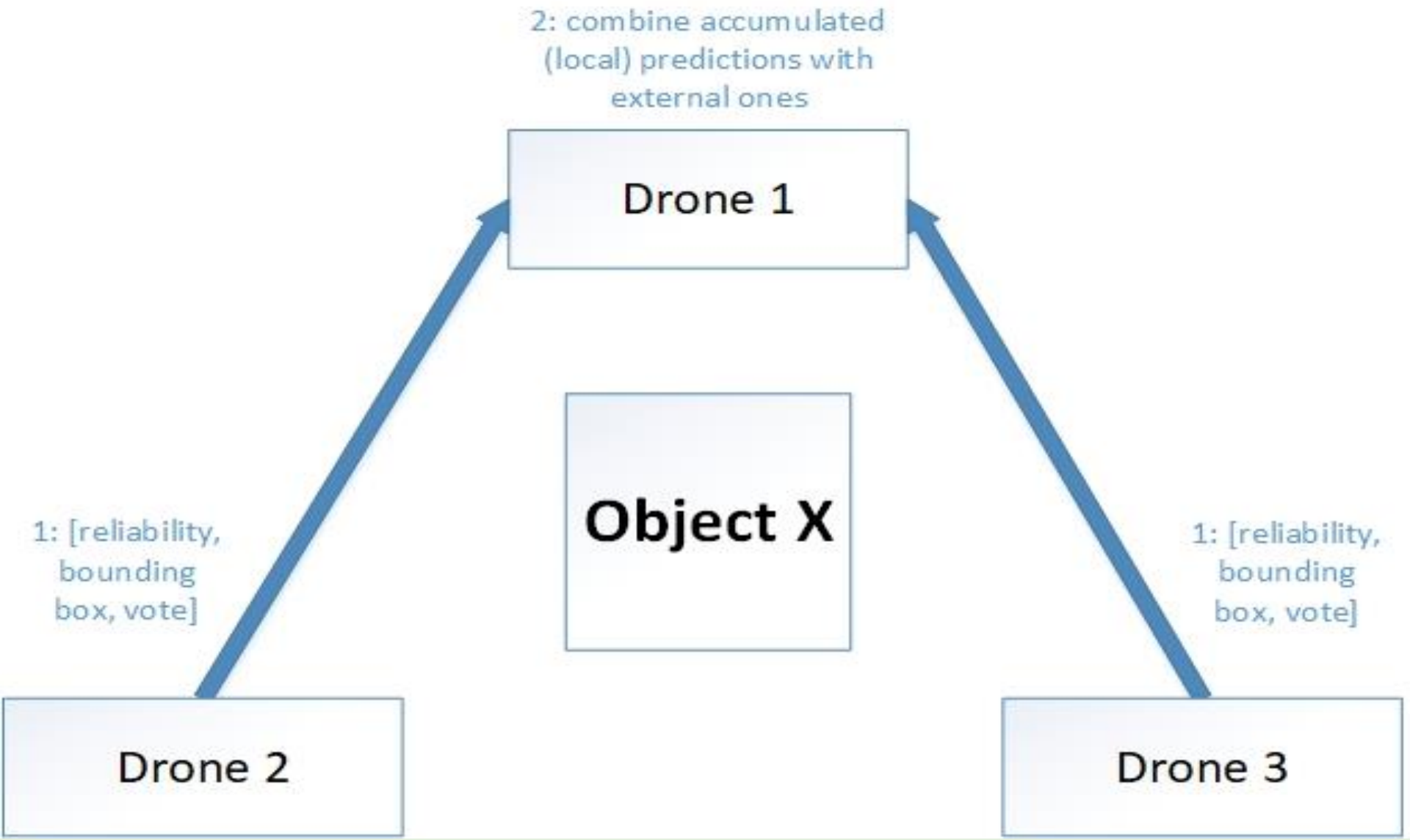


- Hardware validation
  - **Connectivity tests**
    - Adhoc mode compatibility
    - Network throughput
    - Network stability
  - **Object detection tests**
    - Setup of a machine learning framework on the ARMv7 architecture
    - MSCOCO pre-trained neural network
    - Average computational time: 200ms per prediction
    - Accurate predictions over a defined set of objects (e.g. bottle, keyboard)

Protocol Design: Intra-host Computations



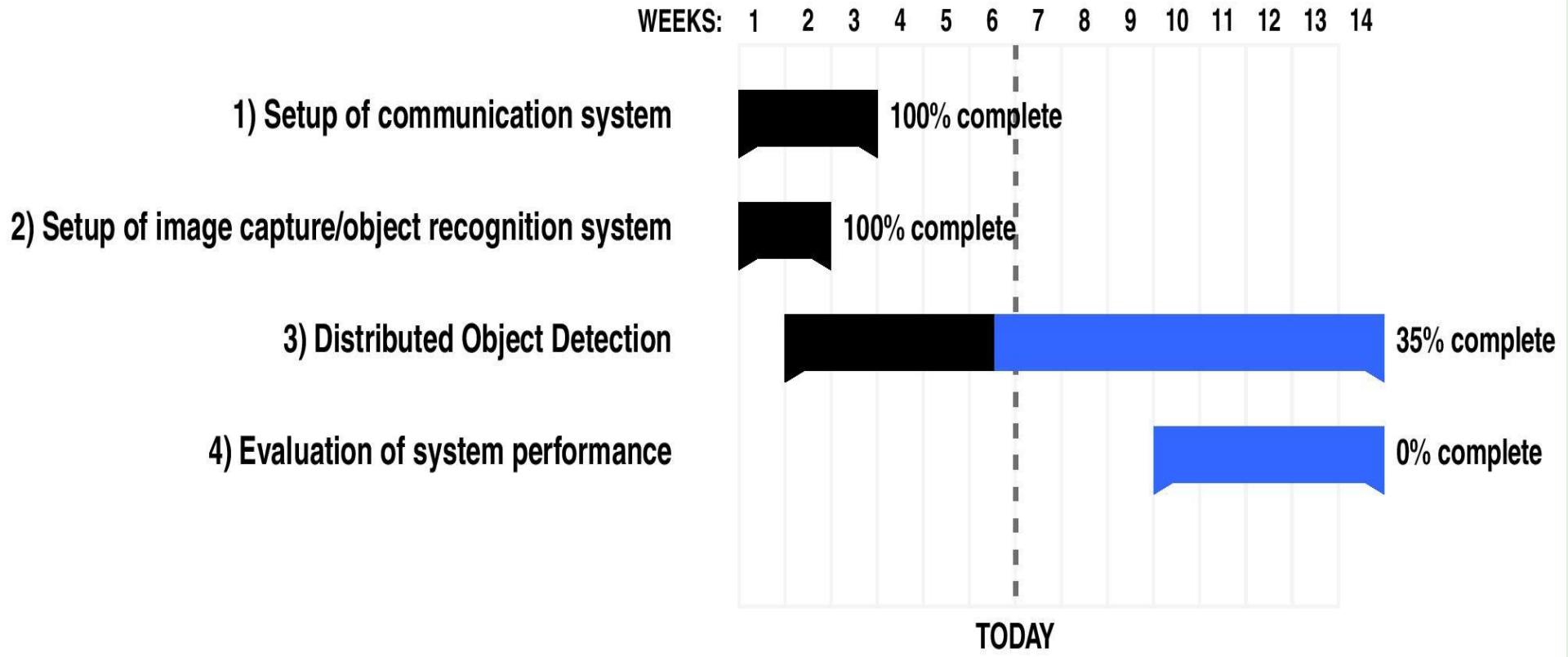
Protocol Design: Inter-host Communication



Protocol Design: Main Challenges

- Give the proper weight to each device's prediction
- Reach a consensus
- Handle packet losses

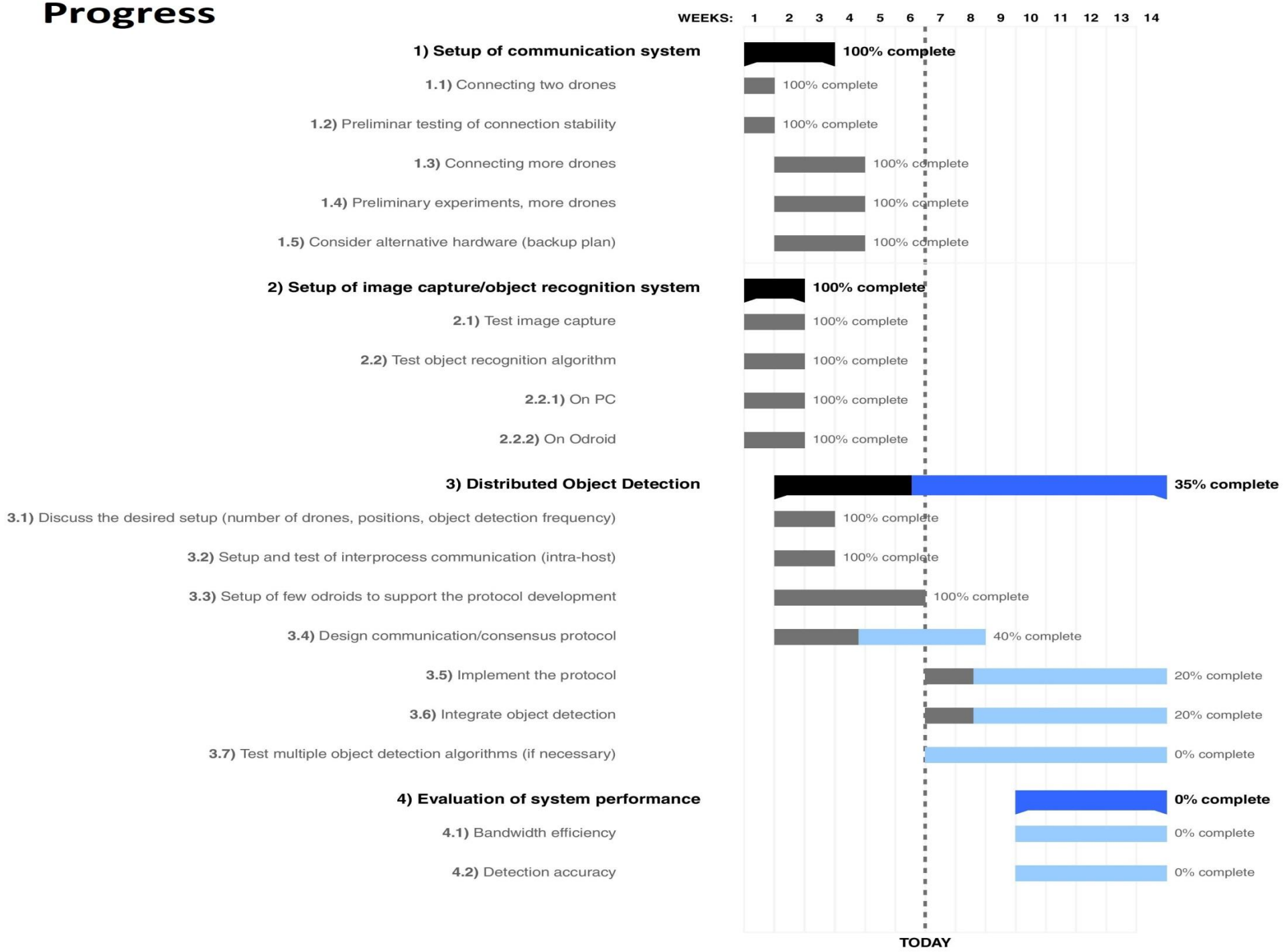
Progress


WEEKS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14
1) Setup of communication system
100% complete
2) Setup of image capture/object recognition system
100% complete
3) Distributed Object Detection
35% complete
4) Evaluation of system performance
0% complete
TODAY

THANK YOU FOR YOUR ATTENTION!

ANY QUESTIONS?

Progress


WEEKS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14
1) Setup of communication system
100% complete
1.1) Connecting two drones
100% complete
1.2) Preliminar testing of connection stability
100% complete
1.3) Connecting more drones
100% complete
1.4) Preliminary experiments, more drones
100% complete
1.5) Consider alternative hardware (backup plan)
100% complete
2) Setup of image capture/object recognition system
100% complete
2.1) Test image capture
100% complete
2.2) Test object recognition algorithm
100% complete
2.2.1) On PC
100% complete
2.2.2) On Odroid
100% complete
3) Distributed Object Detection
35% complete
3.1) Discuss the desired setup (number of drones, positions, object detection frequency)
100% complete
3.2) Setup and test of interprocess communication (intra-host)
100% complete
3.3) Setup of few odroids to support the protocol development
100% complete
3.4) Design communication/consensus protocol
40% complete
3.5) Implement the protocol
20% complete
3.6) Integrate object detection
20% complete
3.7) Test multiple object detection algorithms (if necessary)
0% complete
4) Evaluation of system performance
0% complete
4.1) Bandwidth efficiency
0% complete
4.2) Detection accuracy
0% complete
TODAY