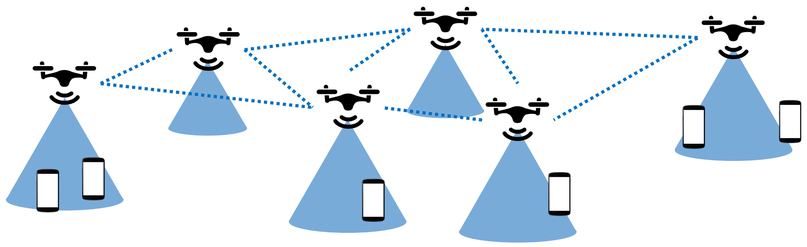
A Software-defined Control Approach for Autonomous UAV Networks

Lorenzo Bertizzolo, Salvatore D'Oro
Institute for The Wireless Internet of Things at Northeastern University, Boston, MA, USA
E-mail: {bertizzolo.l, doro.s}@northeastern.edu

Problem: controlling UAV Networks

- **Wireless networks of Drones**: Drones are *wireless-capable flying nodes forming a full-stack mesh network in the sky.*



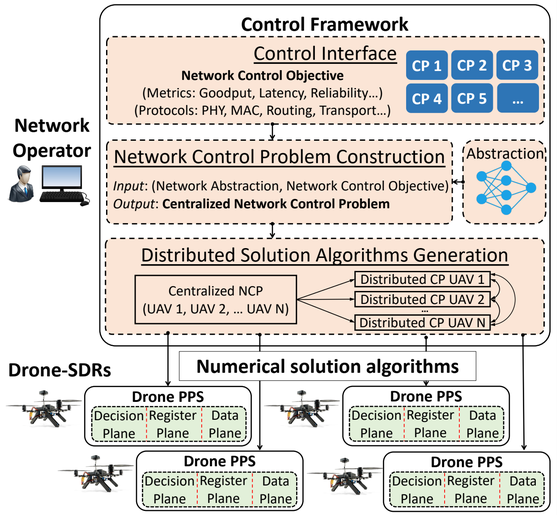
- **Network Control Problem**: *How to control a UAV Network in an elastic, programmable, and optimized fashion?*

Proposed Solution

- **SwarmControl**
  A SDN-principled control framework for UAV networks

- **Components:**
  - The Control Framework
  - The Drone Programmable Protocol Stack (DPPS)

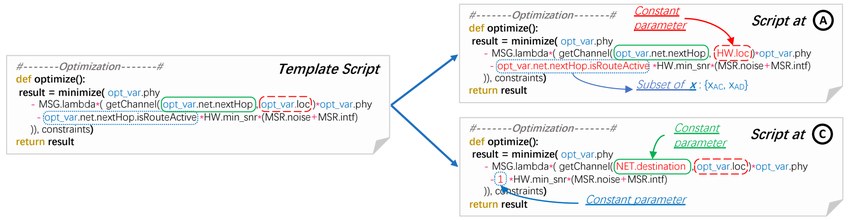
- **Workflow:**
  1) A Network Operator (NO) dictates the behavior of the network via the control framework
  2) The control framework formulates and distributes parametrized distributed control problems to the Drones
  3) The Drones solve the distributed optimization programs through the DPPS in a distributed fashion achieving network optimality for the dictated control behavior



Implementation

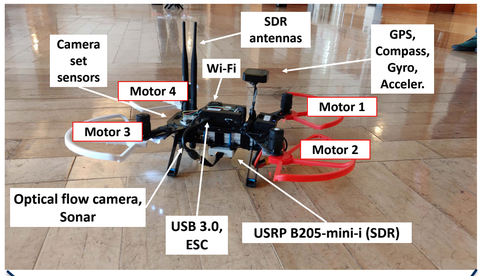
- The **Control Framework** employs *decomposition theory* to convert the centrally-defined control behavior into distributed control problems template scripts

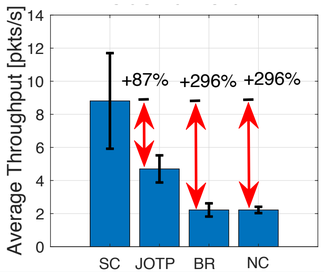
- The **Drone Programmable Protocol Stack** interprets the template scripts in *real-time*, solving the distributed control problems with fresh network state parameters

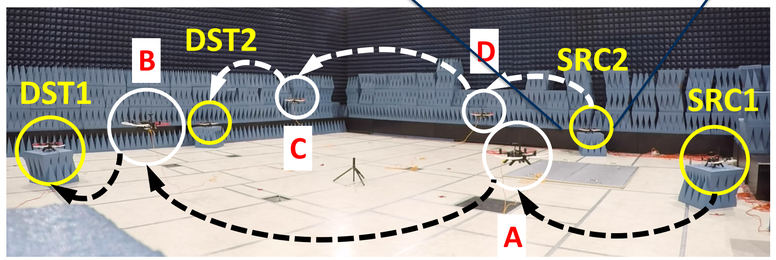


SwarmControl Main Contributions and Results

1) **SwarmControl** provides the Network Operator with a *unified abstraction of the distributed UAV Network*
2) It allows definition of *complex control problems* through a central *Control Framework*
3) It automatically transforms centrally-defined control into *distributed optimization programs*
4) Experimental evaluation proves its *flexibility*, *adaptability*, and *optimality* (+159% network Th.)







References

L. Bertizzolo, S. D'oro, L. Ferranti, L. Bonati, E. Demirors, Z. Guan, T. Melodia, and S. Pudlewski. 2020. SwarmControl: An Automated Distributed Control Framework for Self-Optimizing Drone Networks. In Proc. of IEEE Conf. on Computer Communications (INFOCOM).

Video of the experiments: https://tinyurl.com/SwamrControUAVSIXponential