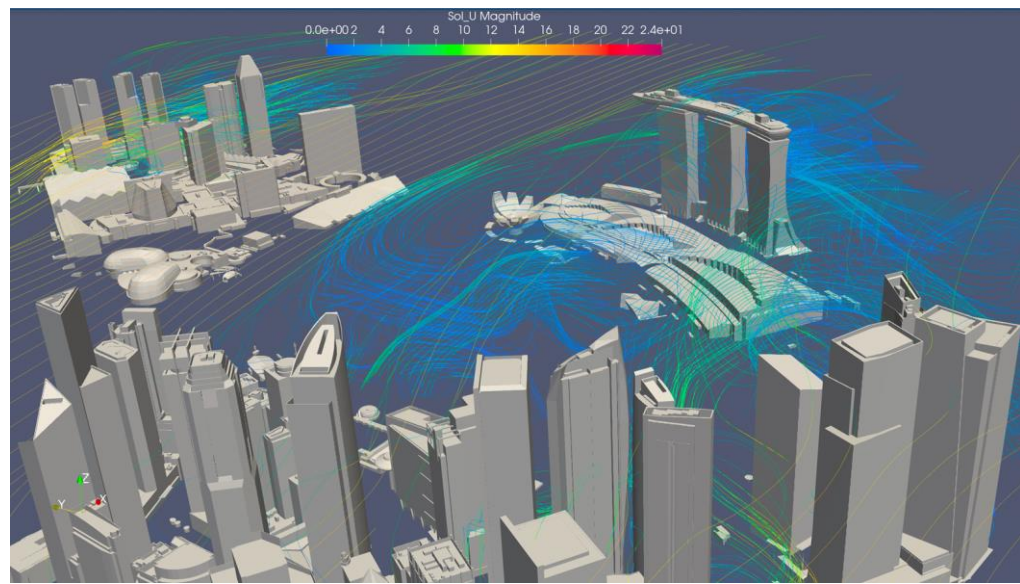


AQGeTAD: DRONE TRAJECTORY OPTIMIZATION UAS TRAFFIC MANAGEMENT Use-Case

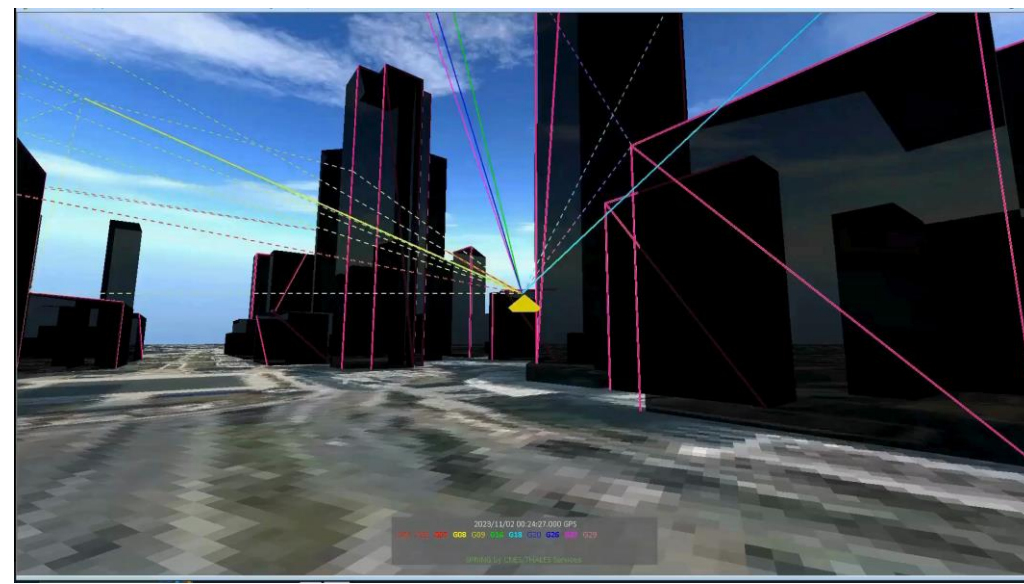
QUANTUM COMPUTING SHAPING THE FUTURE OF UTM

Frédéric **BARBARESCO**
Quantum Algorithms & Computing
Segment Leader
THALES

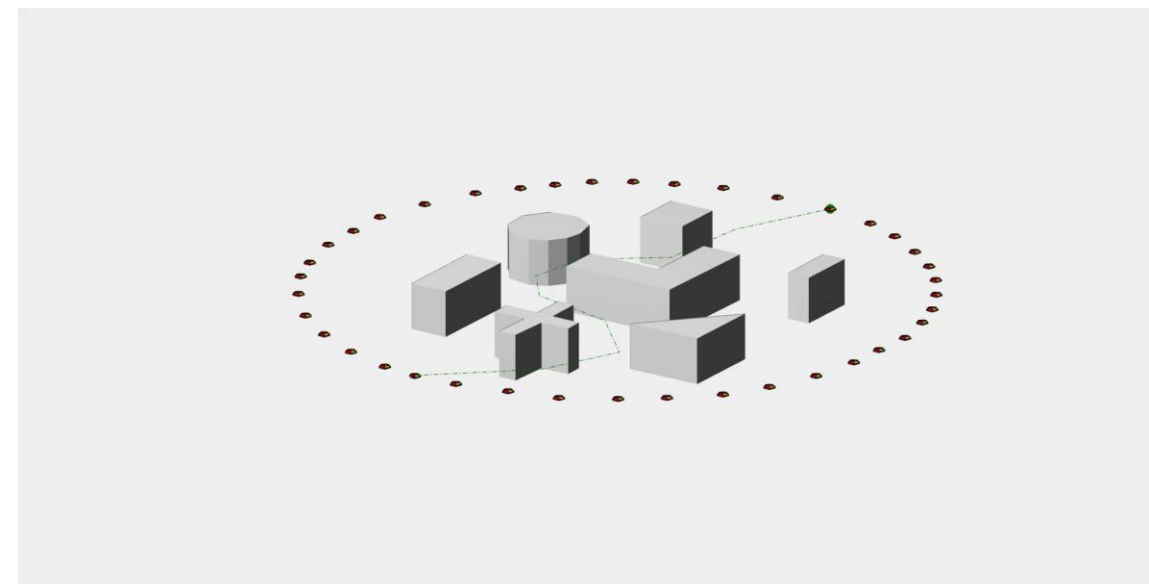




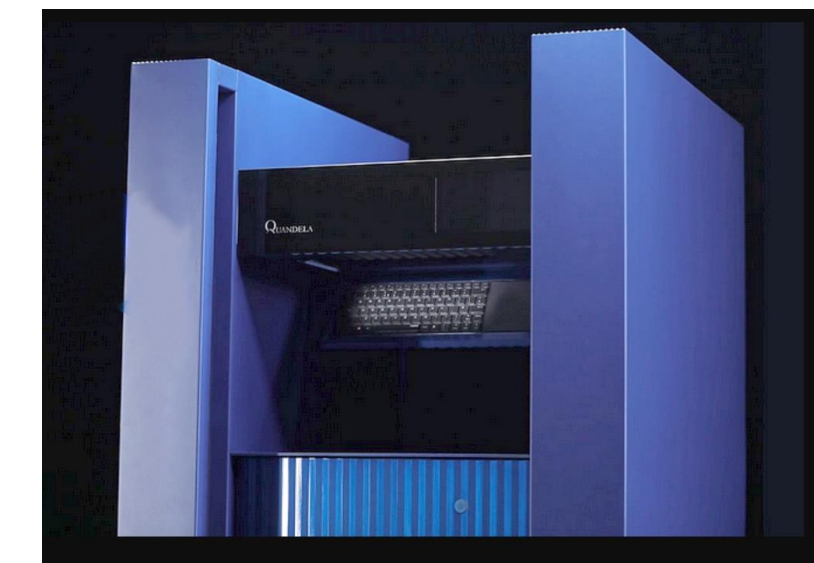
Wind/Turbulence Maps
(NO-FLY Zone)



GNSS Drone
Positioning Accuracy



Drone Trajectory
Optimization



Trajectory
Computation
on QPU

THALES Topsky UAS

Mission
Planning

UAV Operation
planning

Strategic	Tactic	Authority
TopSky – UAS Airspace Manager		
AIM & GIS	Conformance Monitoring	
Authorization & Notification	Strategic Deconfliction	
Risk Management	Fairness monitoring	
Emergency management	Noise management	

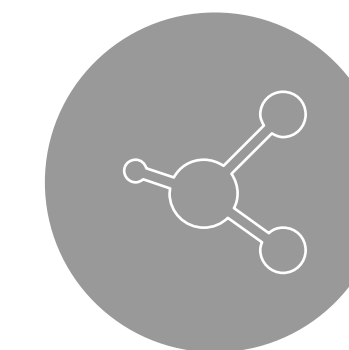
TopSky - UAS
Surveillance

Traffic &
Surveillance

Remote ID Service



Manage airspace
access

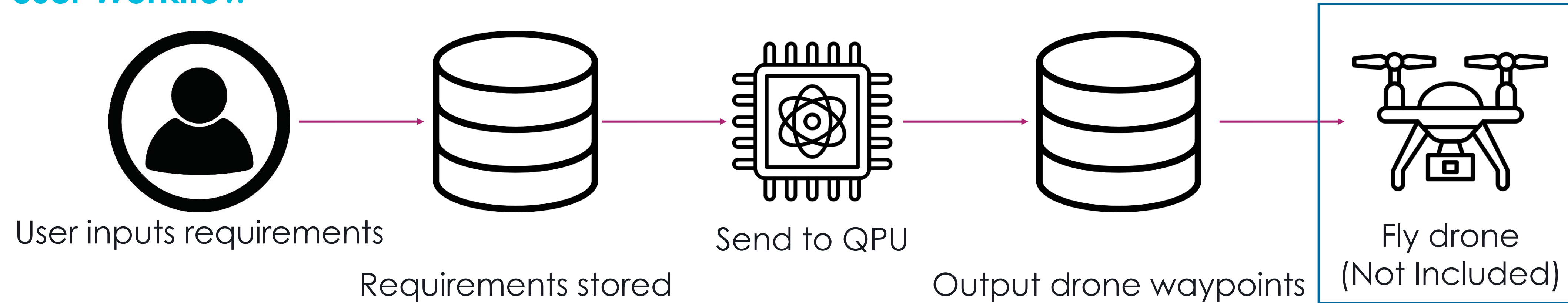


Monitor traffic
conformance

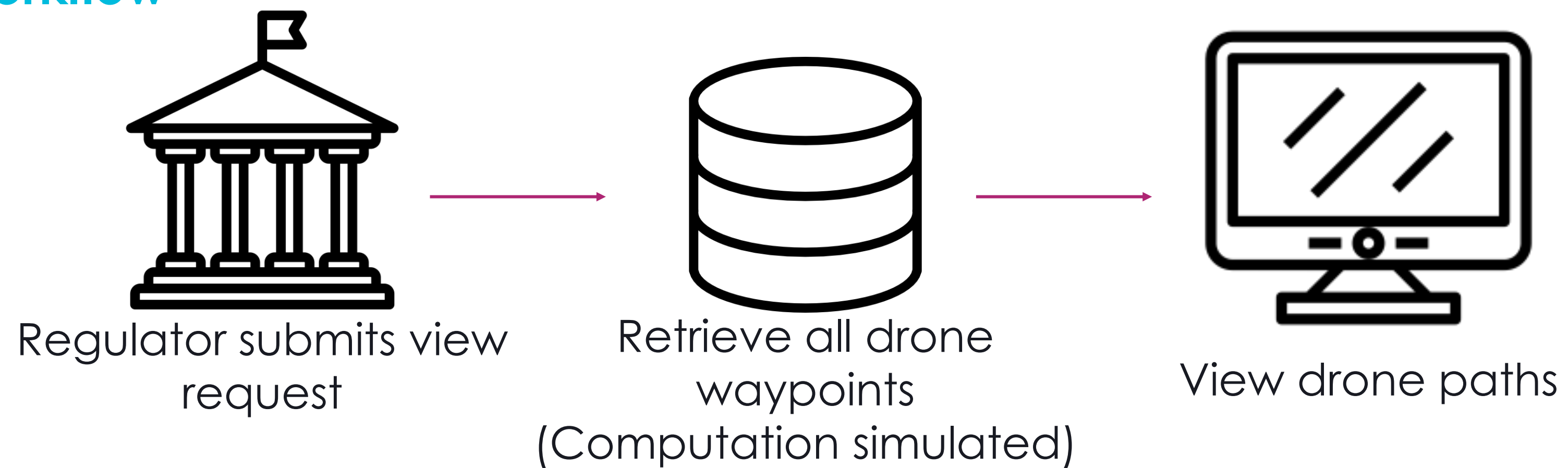


QPath end-to-end workflow

User Workflow

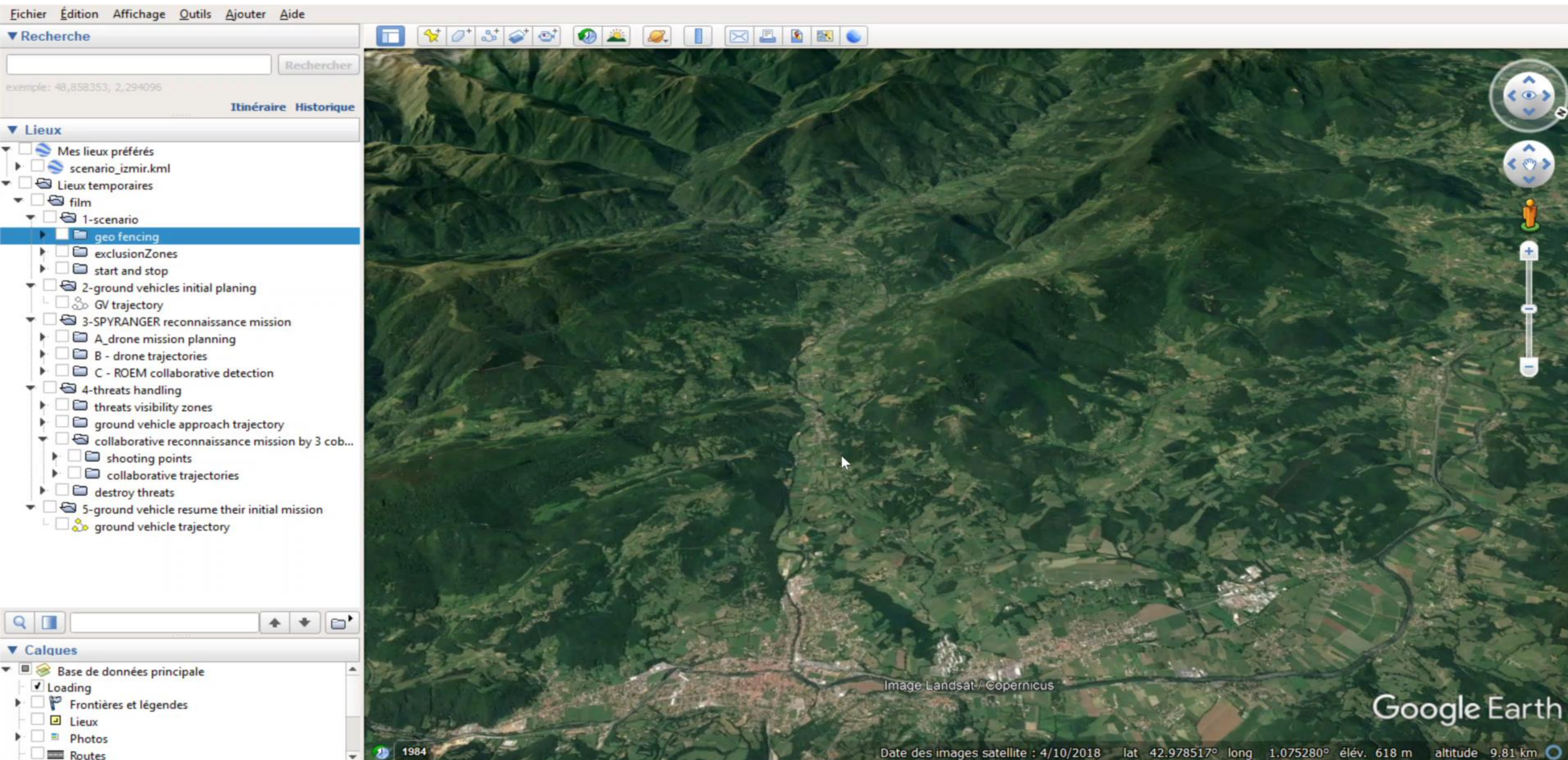


Regulator Workflow



Other applications: Mission-planning for collaborative **fleet/swarm** of drones

(safe landing proximity constraints, autonomy/energy constraints, « nofly zone » constraints, Gnss-Denied positioning accuracy constraints, communication constrained, observation constraints, ...)



QUANDELA

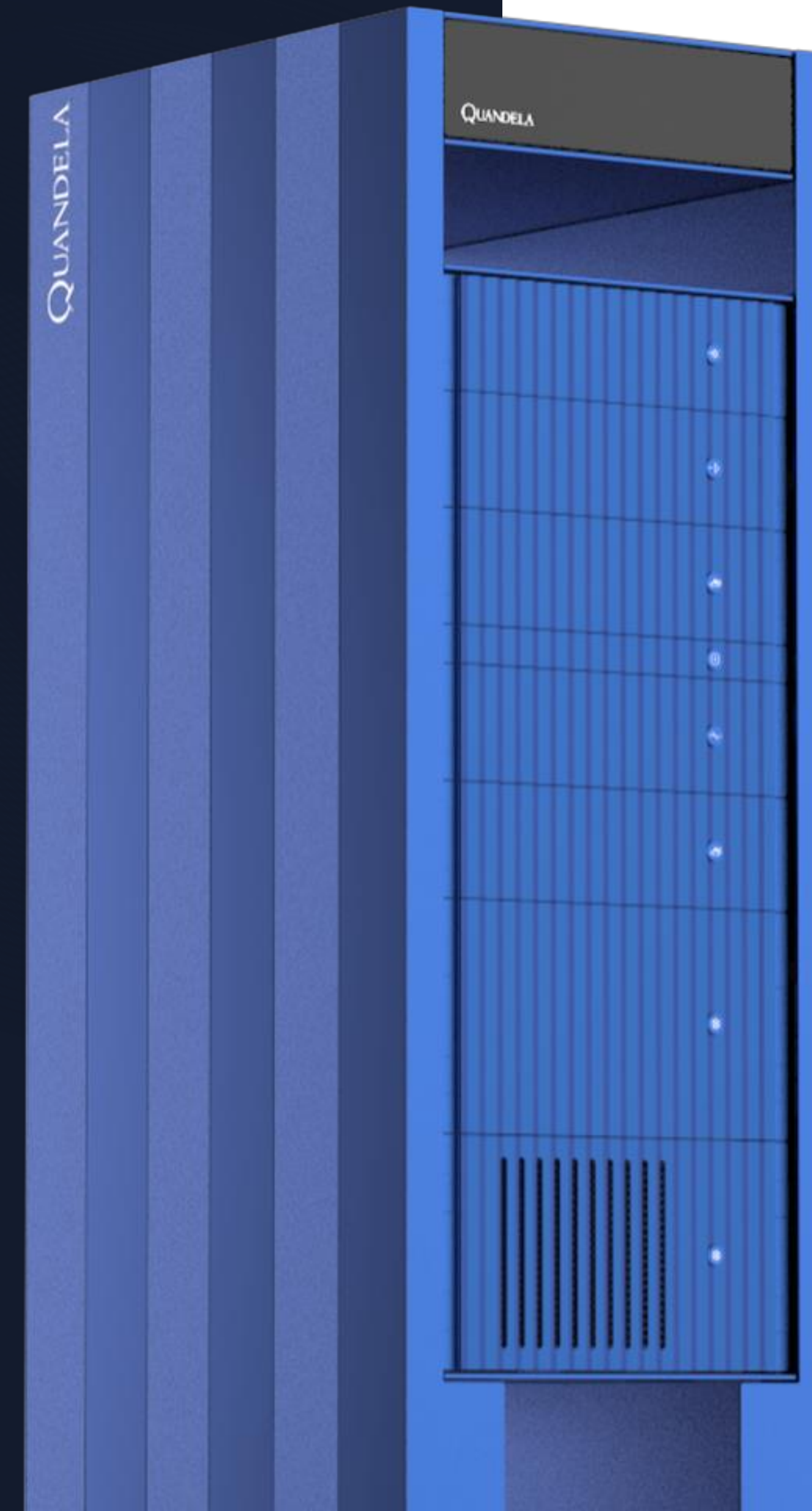
THALES

AQGeTAD - Quantum advantage for drone traffic management

Optimisation of drone trajectories using single photons decision making

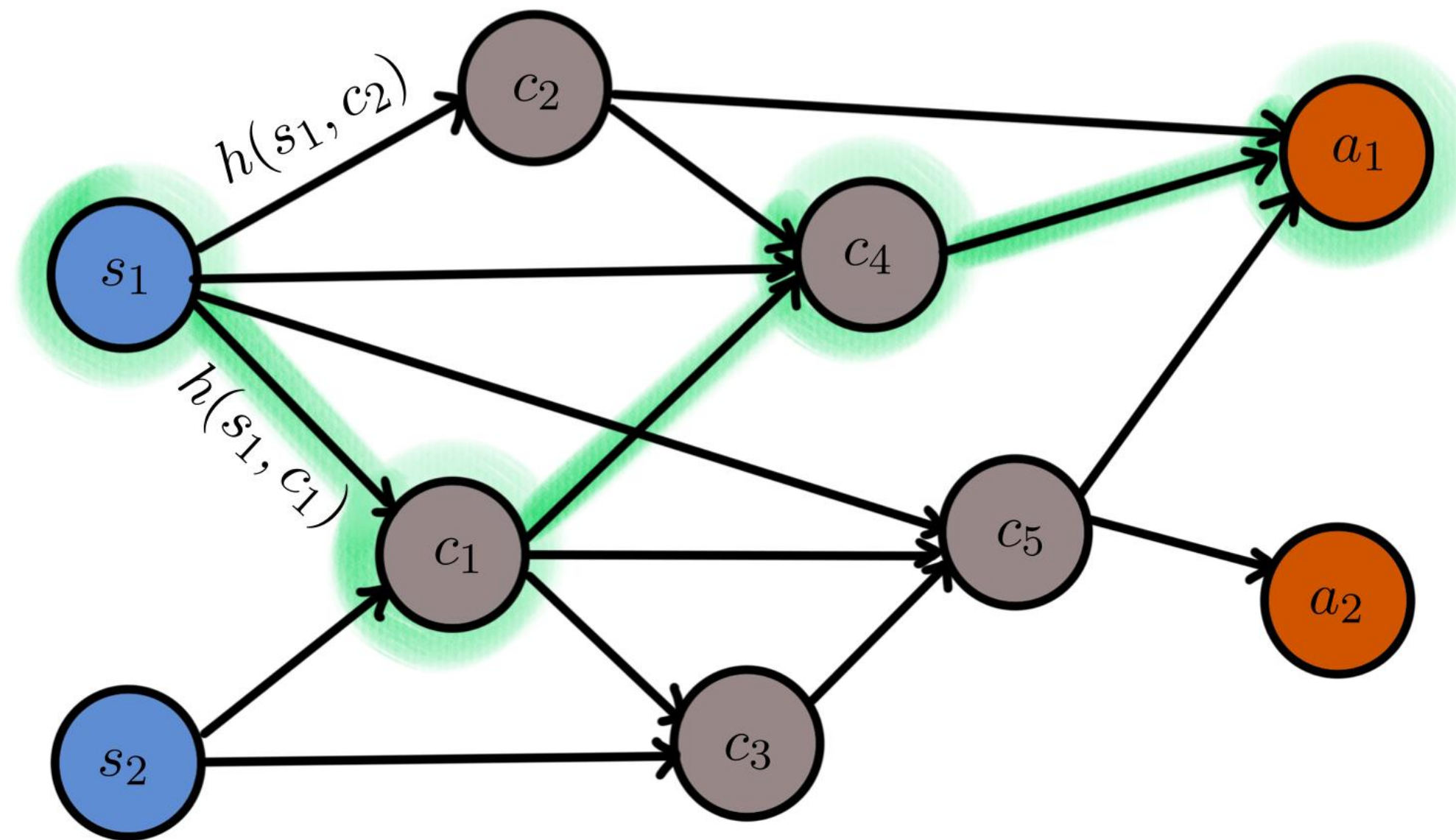
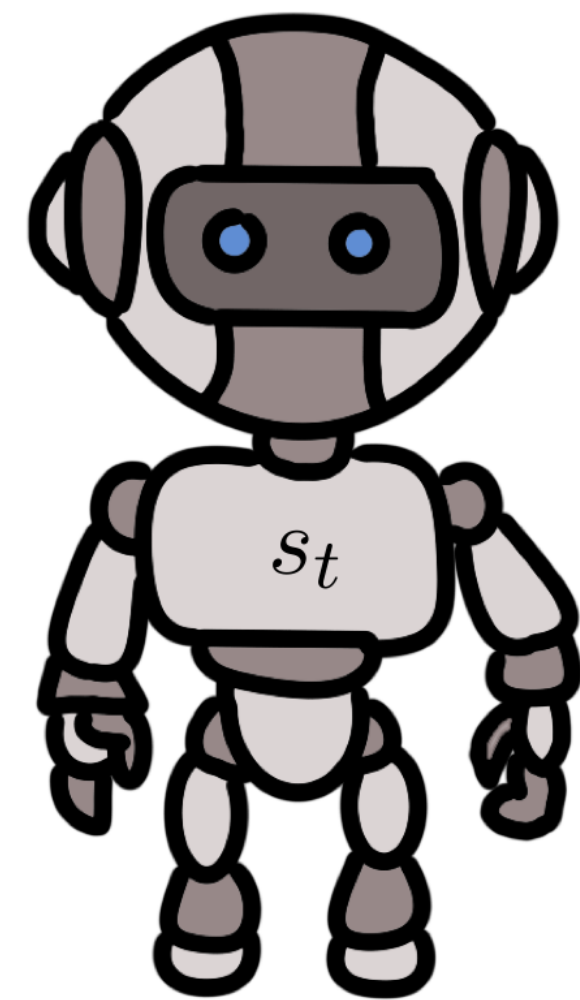
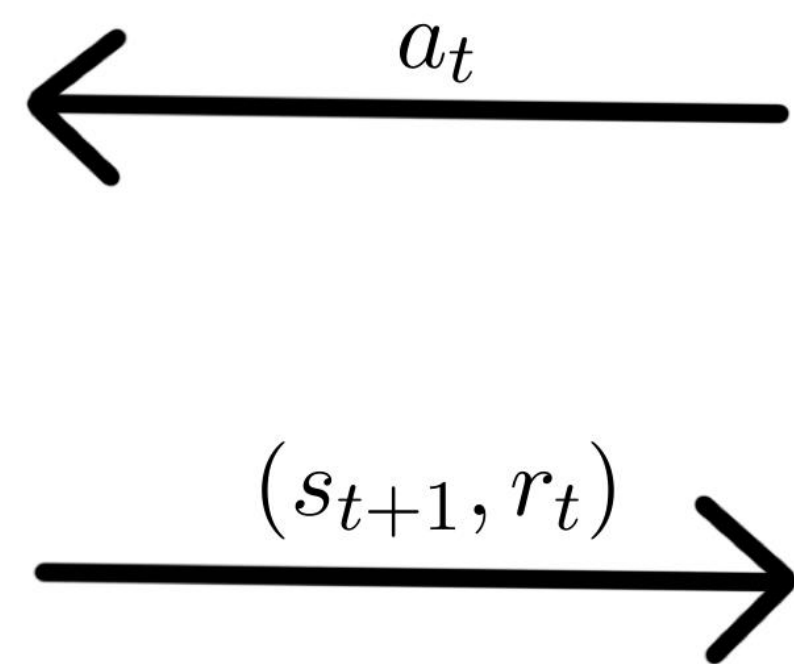
Arno RICOU

Credits to Giacomo FRANCESCHETTO for slides



Projective Simulation Reinforcement Learning and Decision Making

Environment

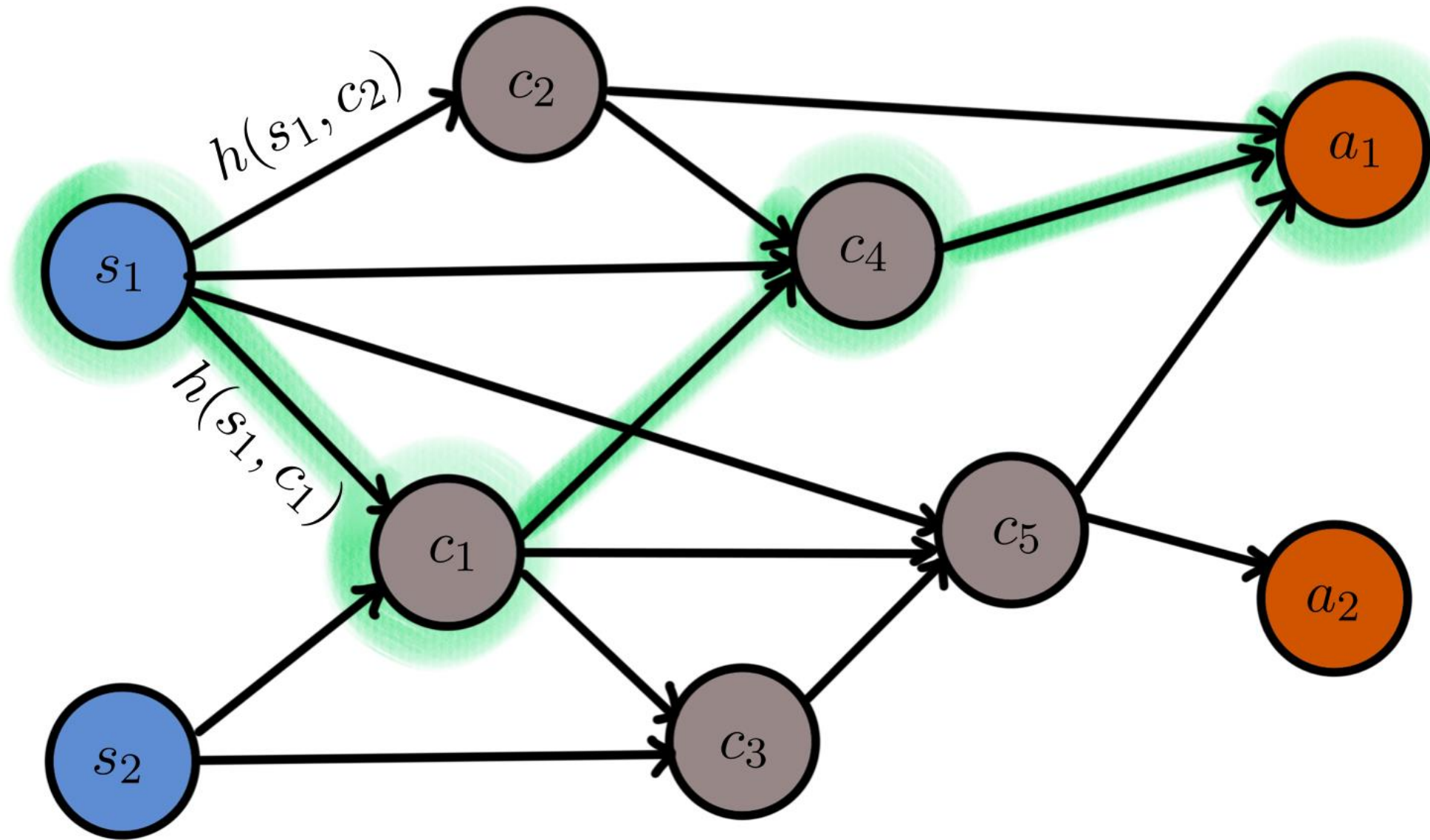


goal: maximize the long term accumulated reward

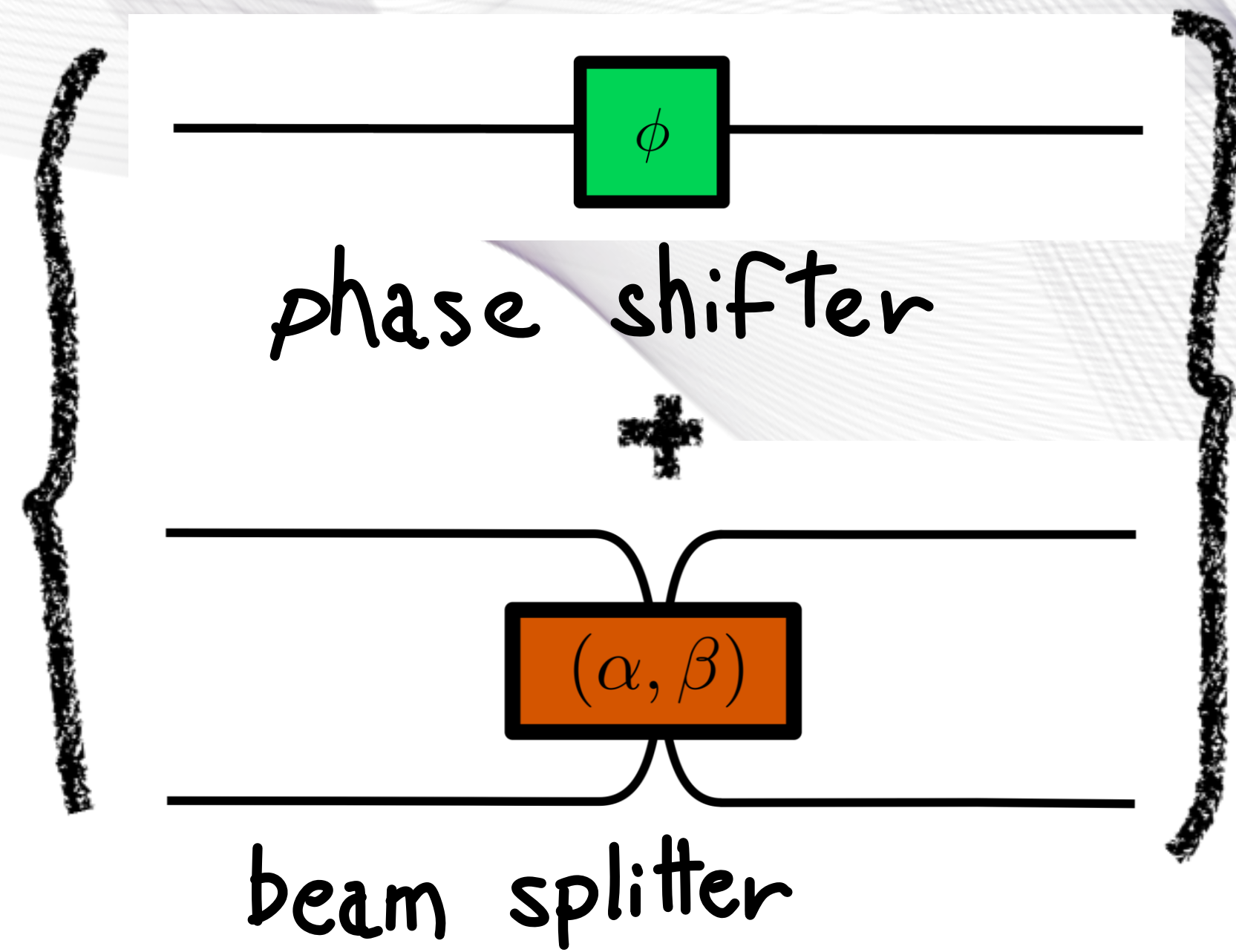
*random walk through the **Episodic Compositional Memory***

Quantum Optical Projective Simulation

Quantized episodic compositional memory (ECM)



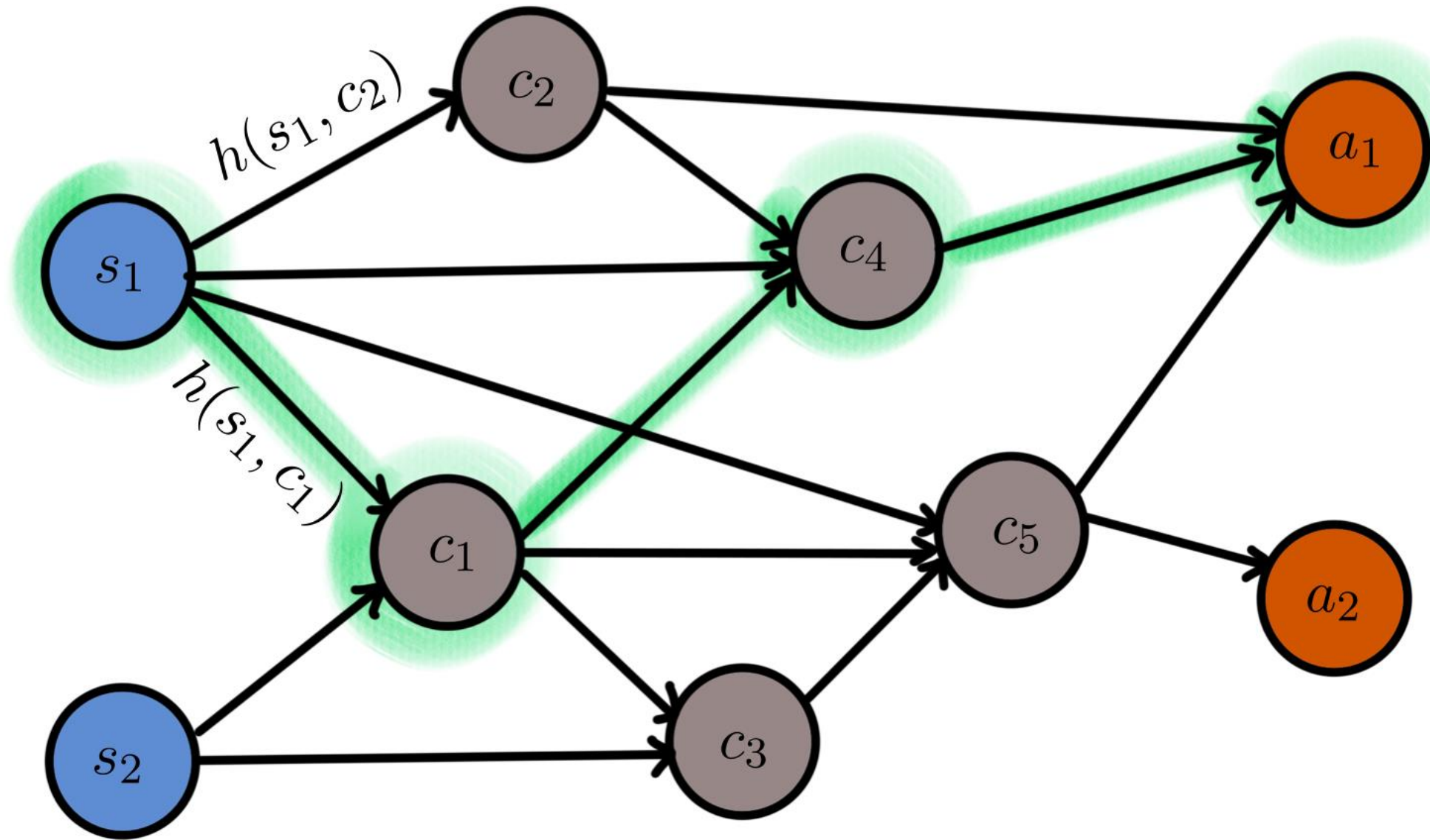
classical ECM



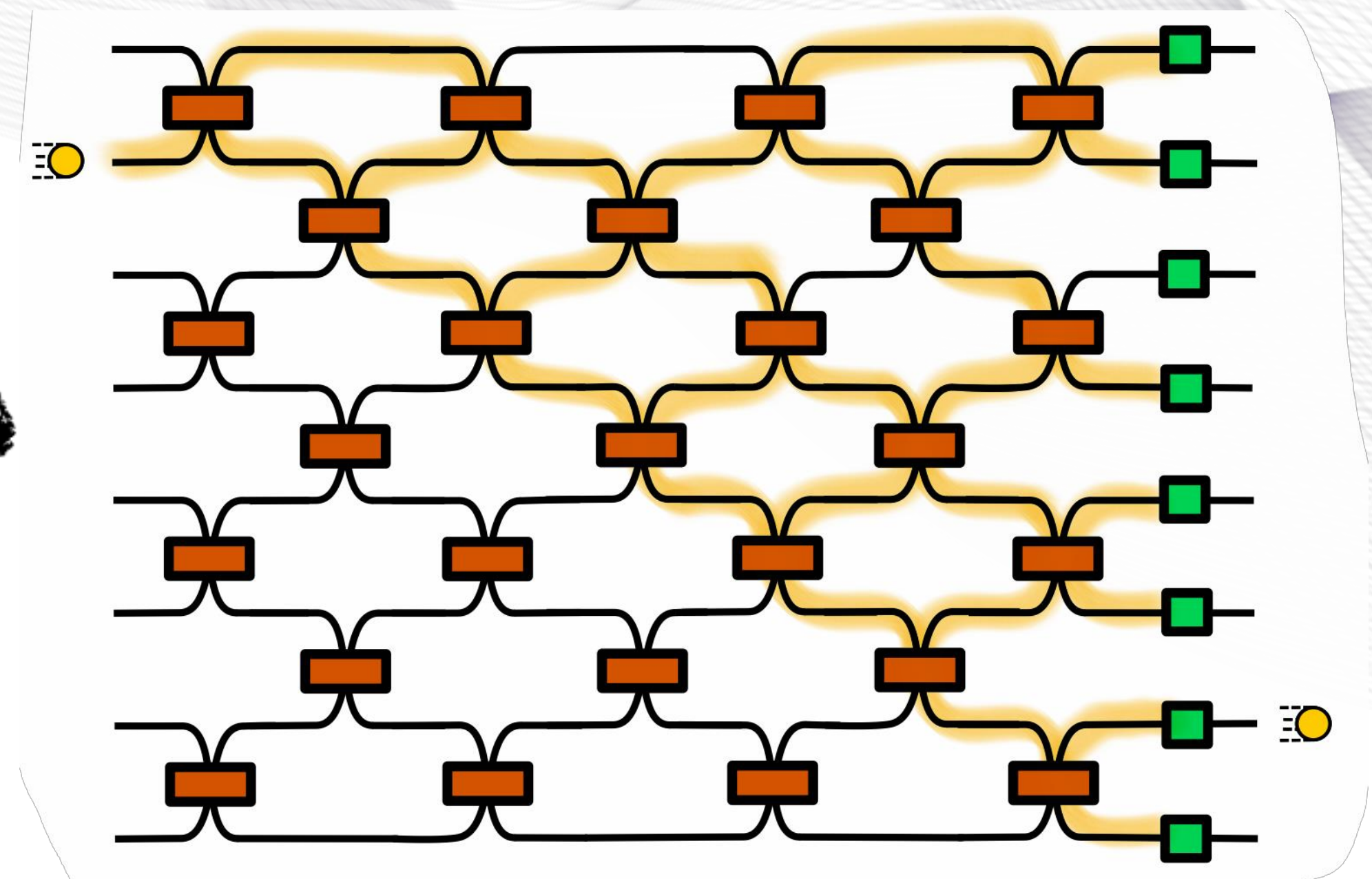
quantum ECM

Quantum Optical Projective Simulation

Quantized episodic compositional memory (ECM)



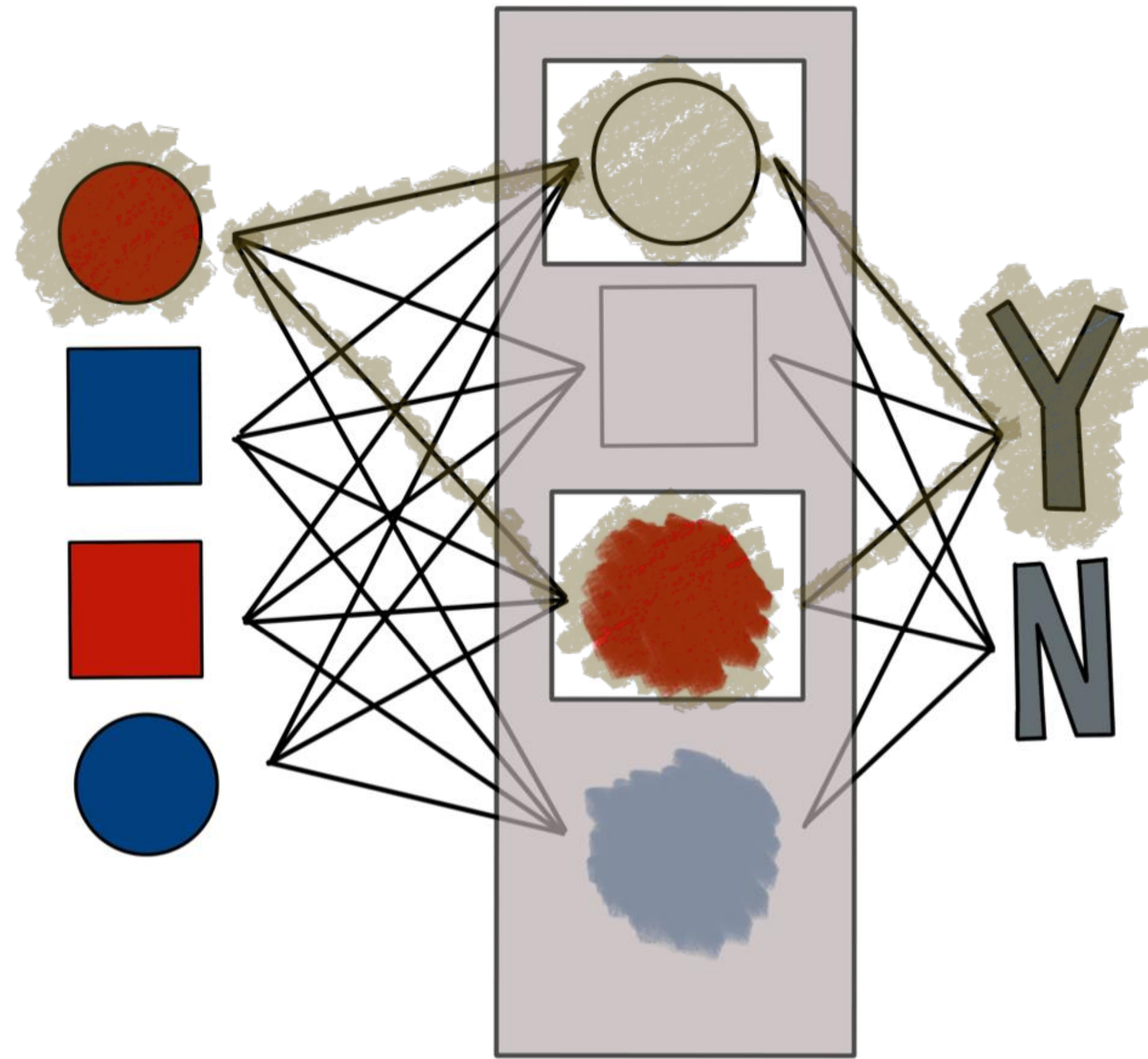
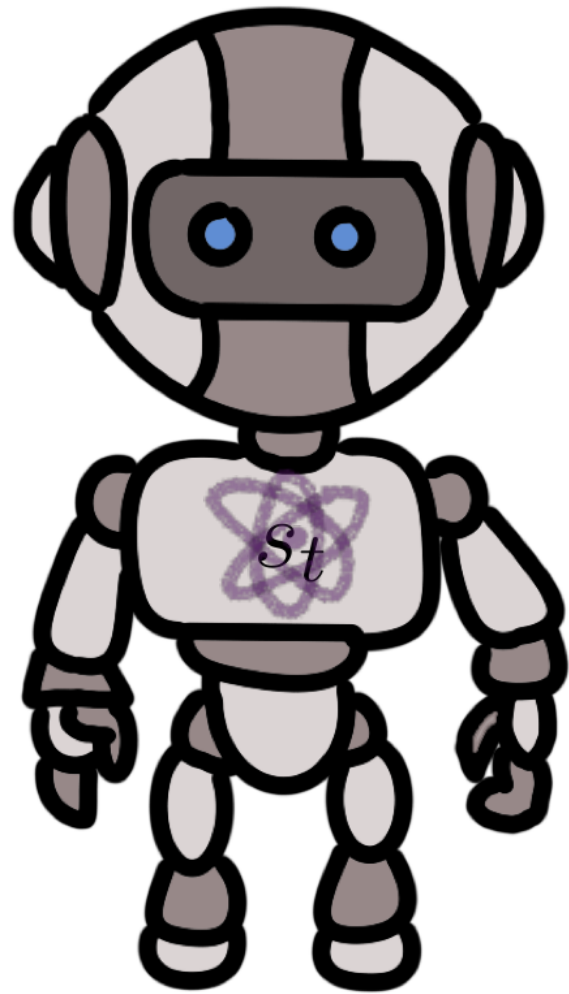
classical ECM



quantum ECM

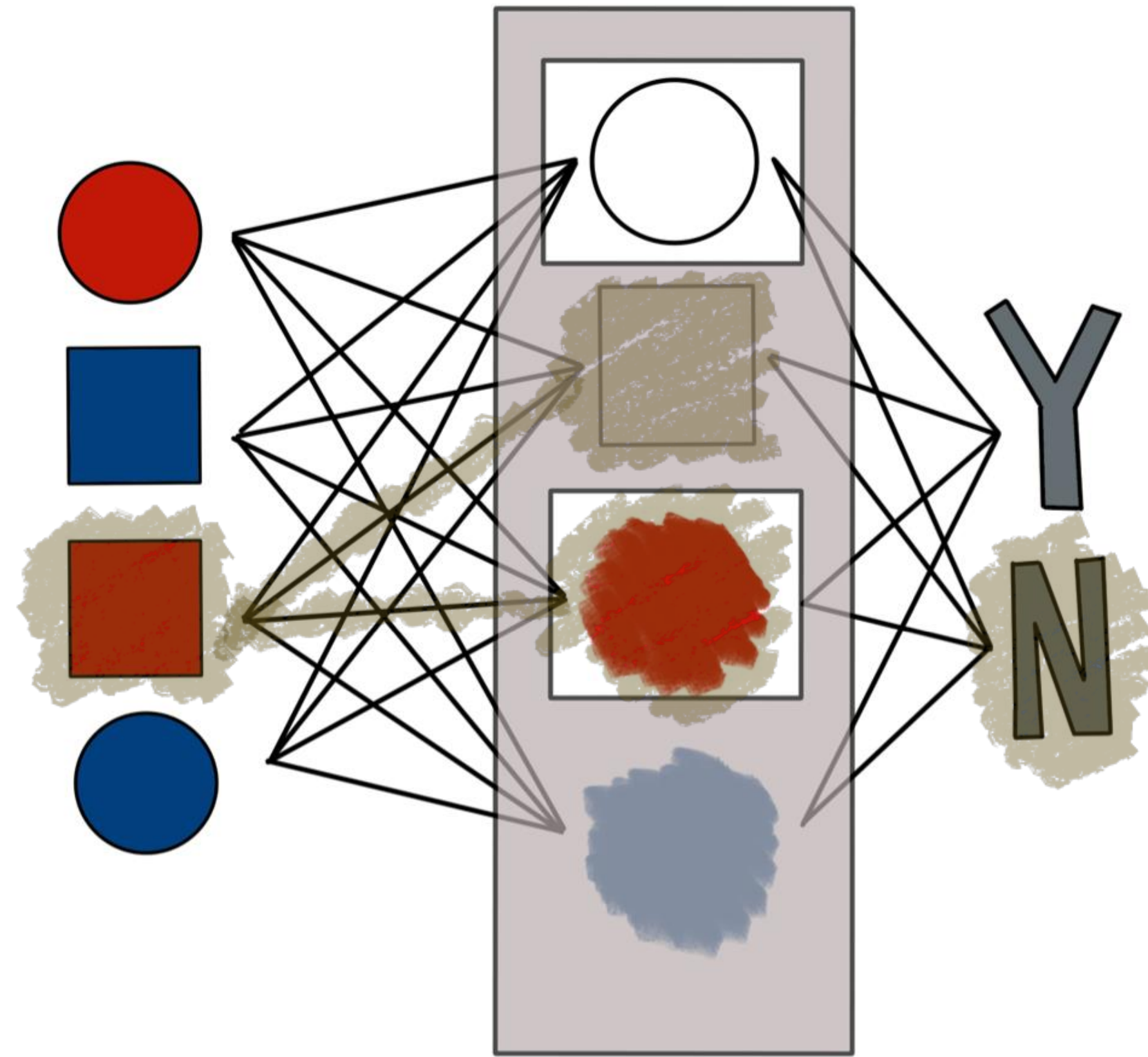
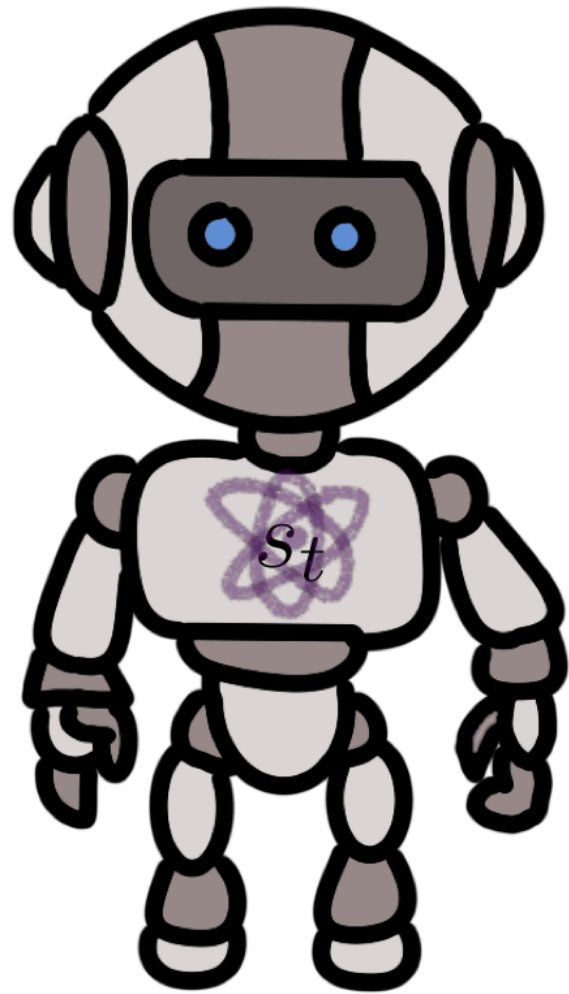
Quantum Optical Projective Simulation

A transfer-learning scenario : final stage



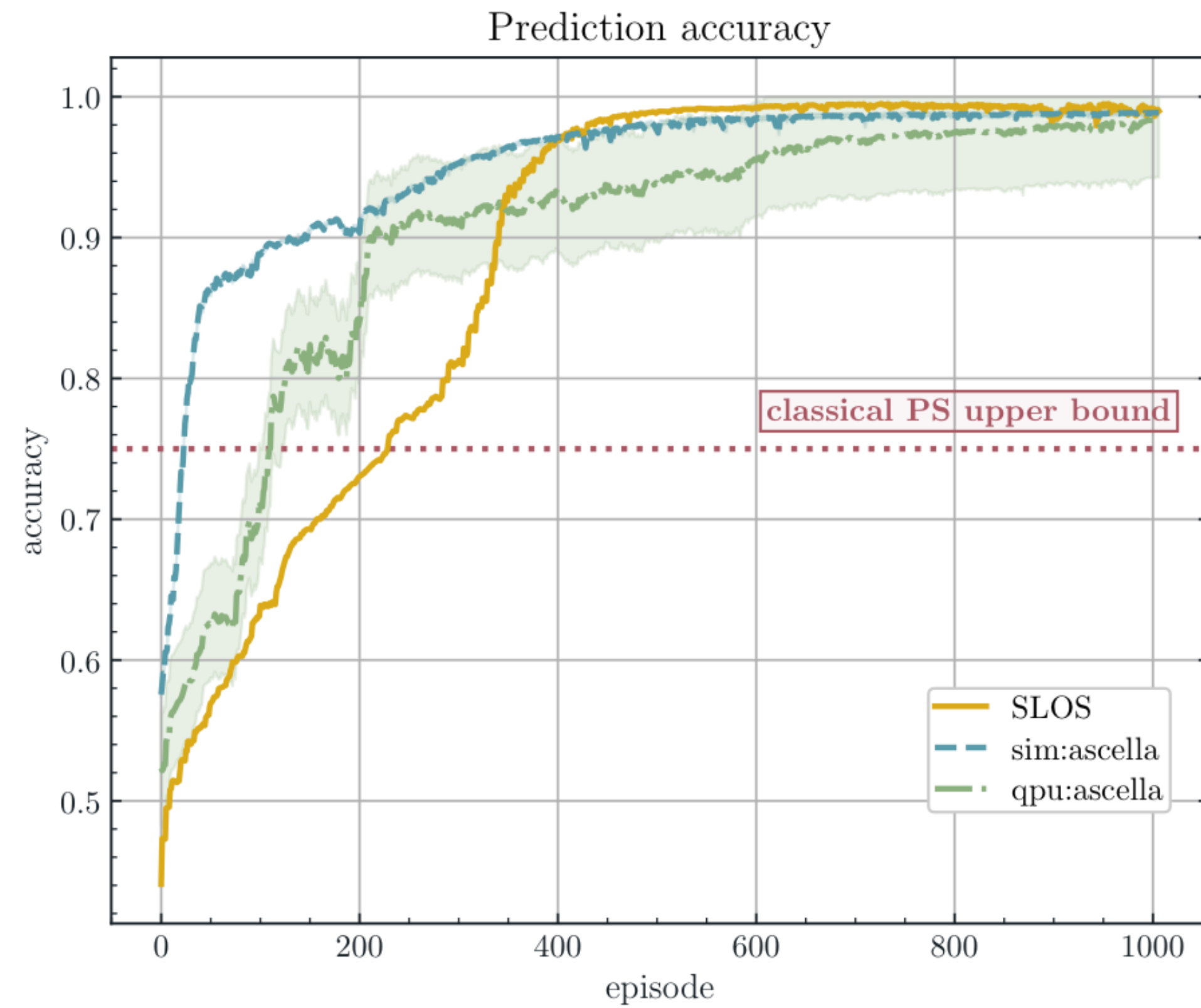
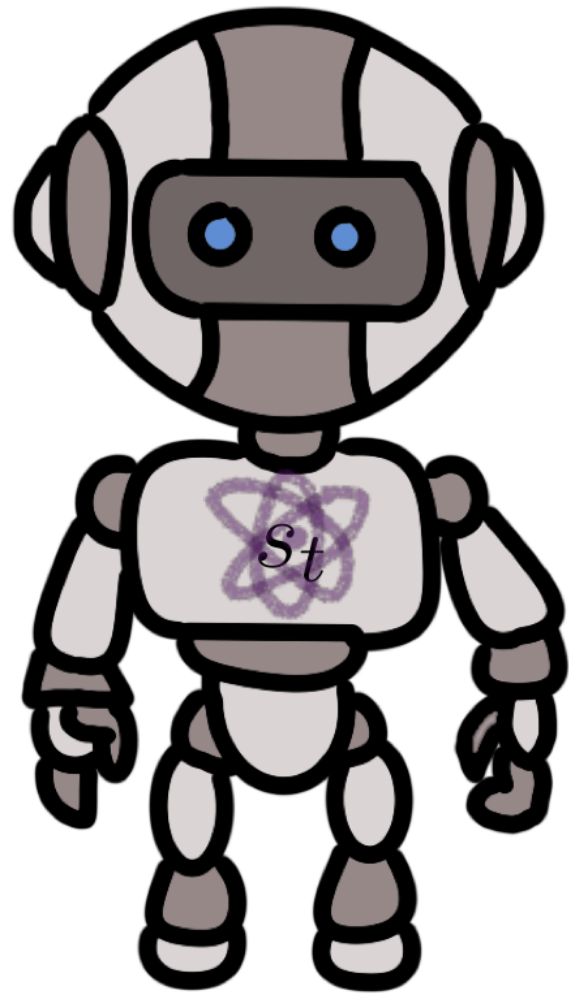
Quantum Optical Projective Simulation

A transfer-learning scenario : final stage



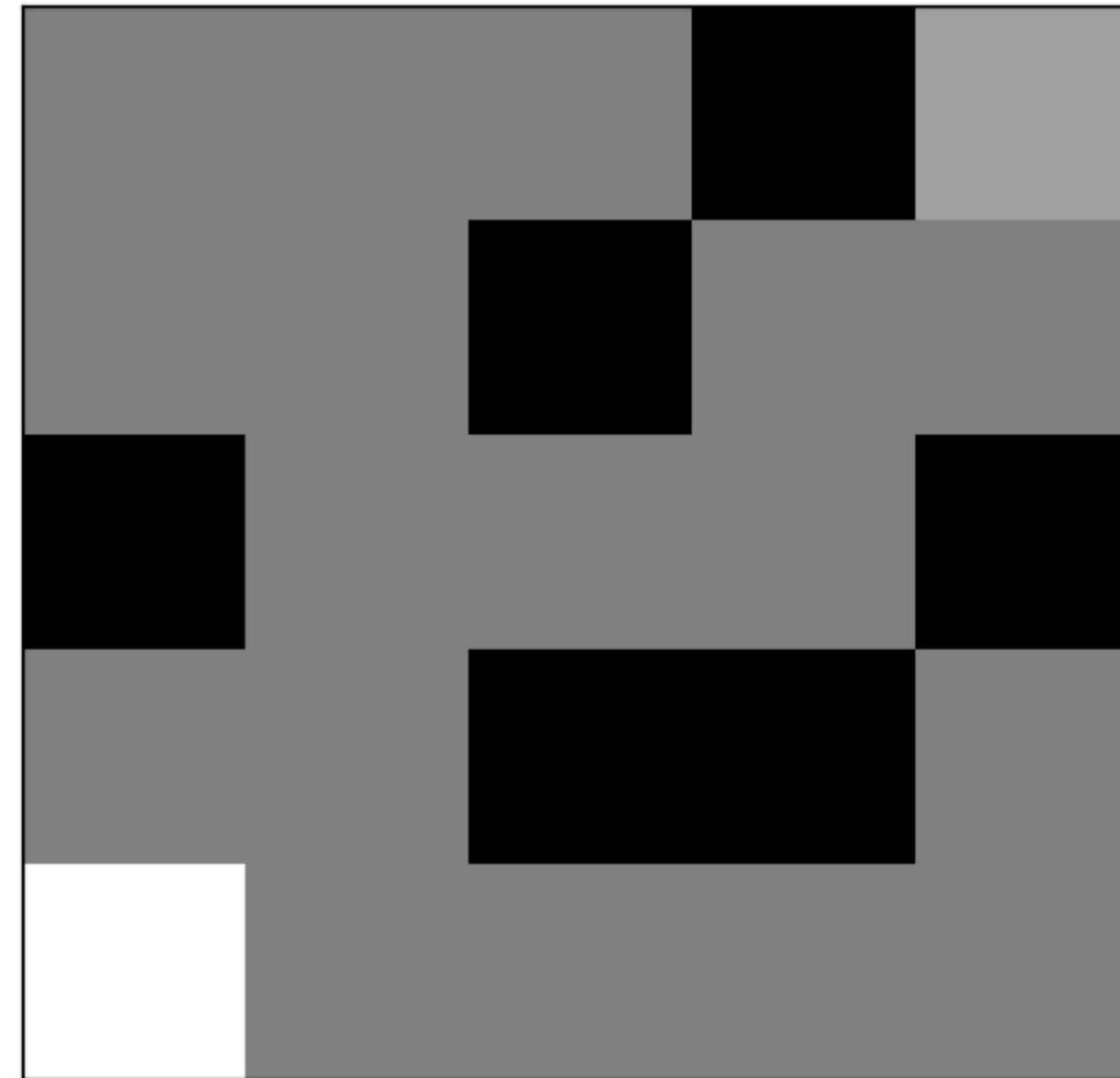
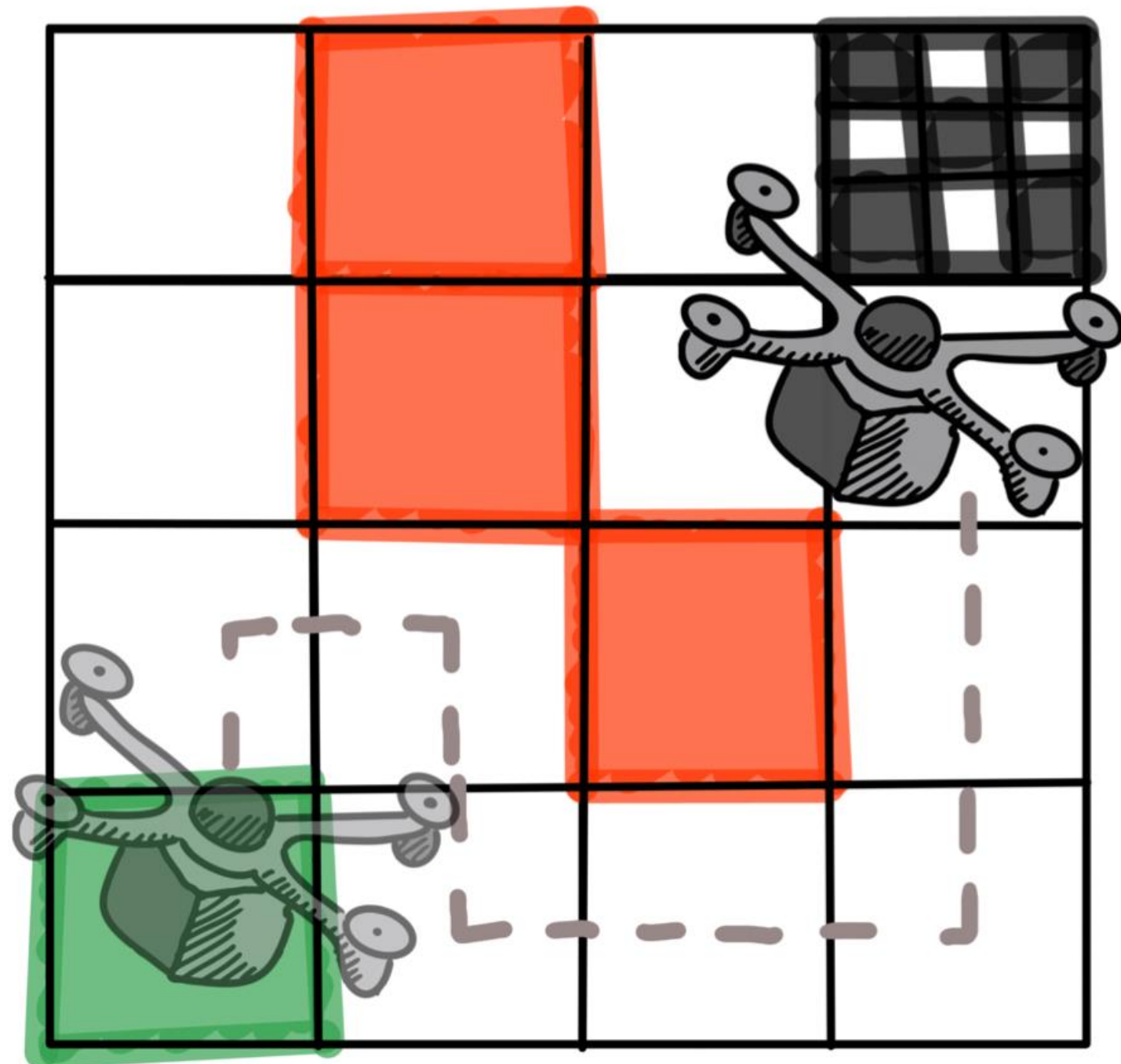
Quantum Optical Projective Simulation

A transfer-learning scenario : final stage







Quantum Optical Projective Simulation

QOPS solving a grid path-finding like problem

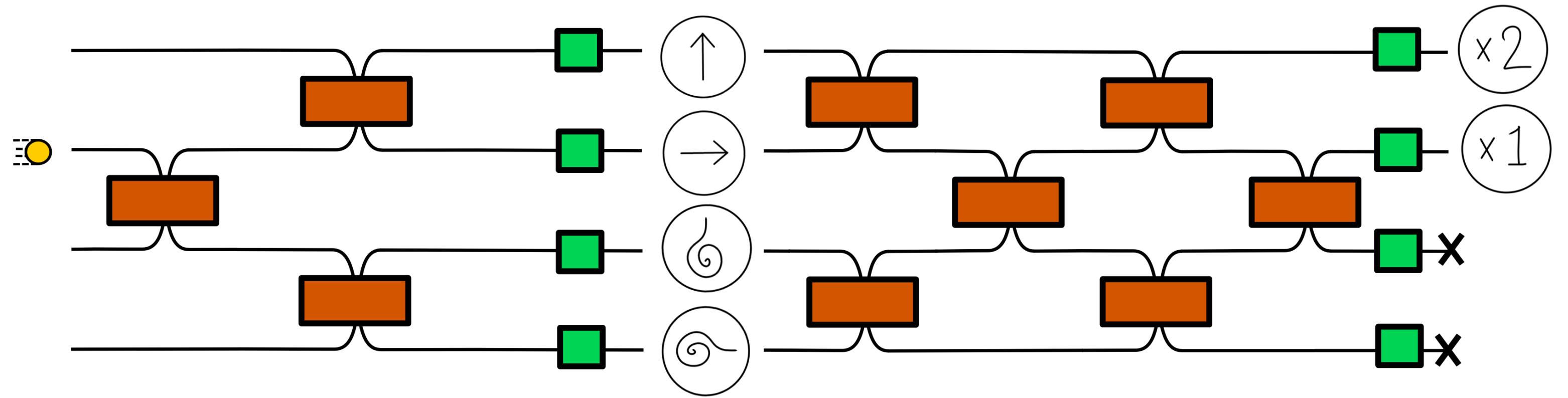
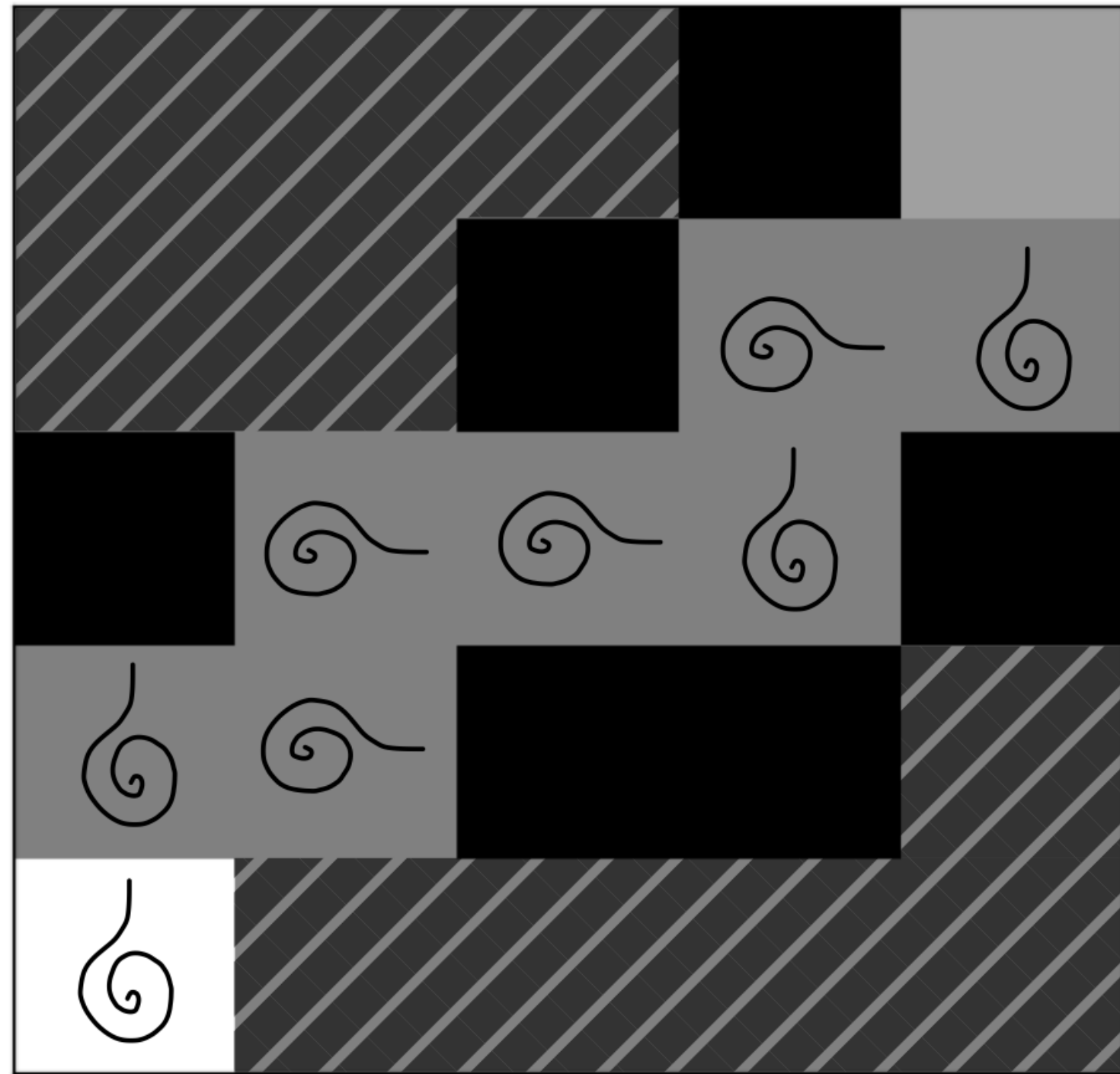


legend

	obstacle
	cell
	start
	finish

Quantum Optical Projective Simulation

QOPS solving a grid path-finding like problem



<i>grid point</i>	<i>direction</i>	<i>wind</i>	SLOS	
			p_{single}	p_{double}
(0, 0)	up	down	0.001	0.999
(0, 1)	right	down	0.993	0.007
(1, 1)	up	left	0.993	0.007
(1, 2)	right	left	0.000	1.000
(2, 2)	right	left	0.002	0.998
(3, 2)	up	down	0.000	1.000
(3, 3)	right	left	0.000	1.000
(4, 3)	up	down	0.000	1.000

Q Next steps

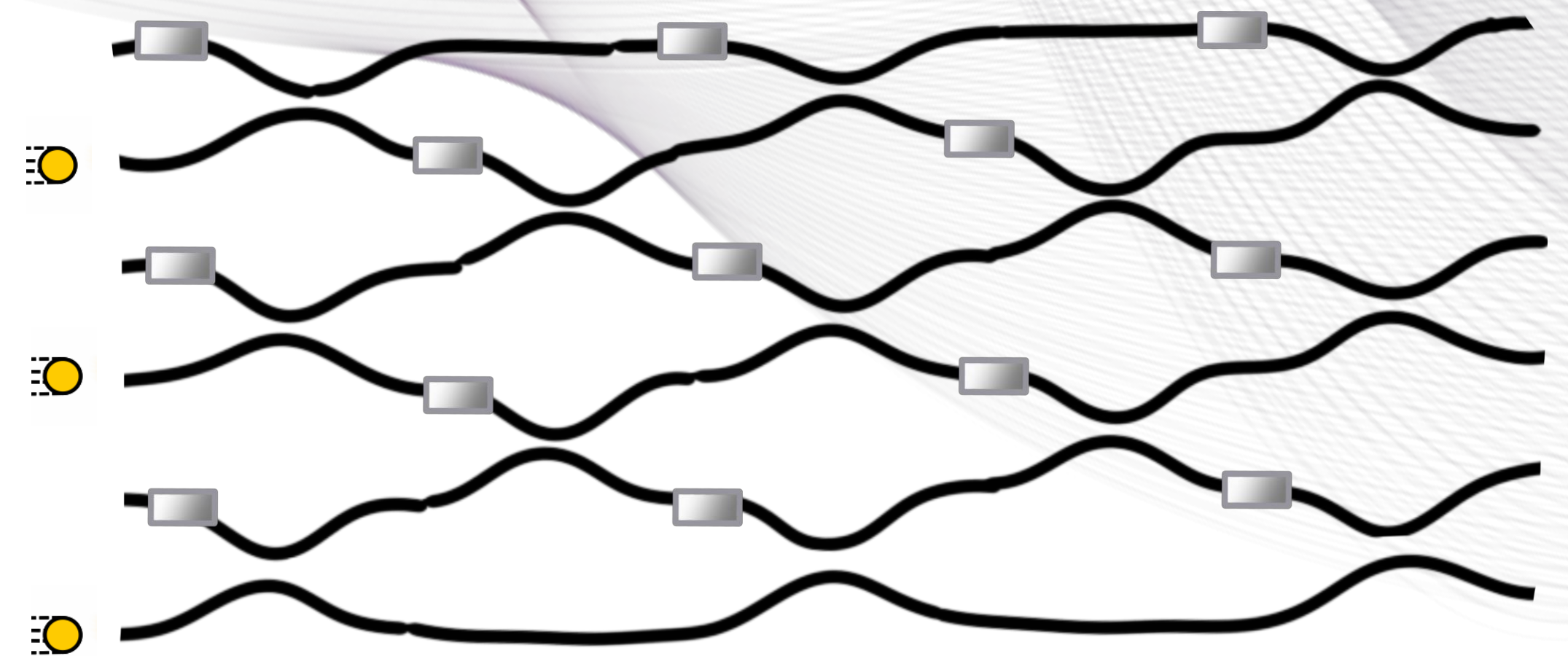


We also studied and will discuss this afternoon :

- *Multi-photon in the quantum ECM*
- *Entangled photons in quantum ECM*
- *New applications for collision prevention with drones*

And plan to :

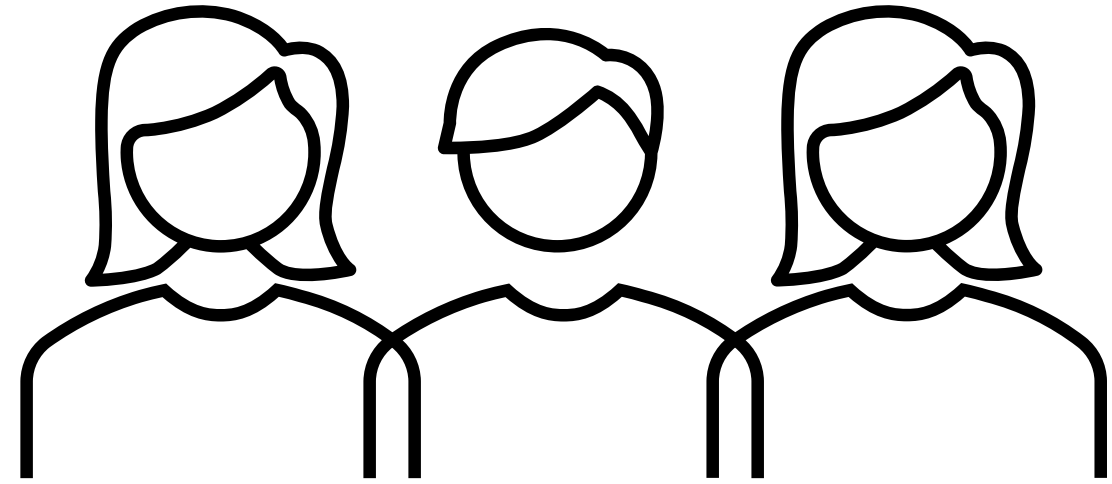
- *Implement on QPU multi-photon quantum ECM for collision prevention*
- *Optimize resources (modes, photons, parameters)*
- *Benchmark with classical SoA and predict when quantum advantage will happen*



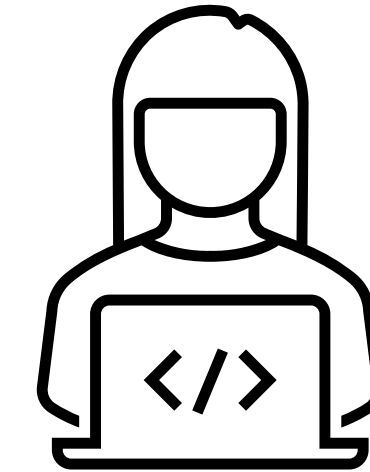
quantum ECM with multiple photons



Recruitment and advancement



3 internships of six months recruited by Quandela for AQGeTAD



1 applications engineer working on it



Work breakdown structure

