

University of Luxembourg

Parallel Computing & Optimization Group (PCOG)



Parallel Computing and Optimization Group

- **20+ Researchers/Engineers**

- 1 Professor - Pascal Bouvry

- 2 Research Scientists

- 3 Postdocs

- 10 PhD students

- 4 Engineers

- Master students

- From France, Belgium, Romania, Thailand, Egypt, China, etc.



Research Thematic

- Parallel / Decentralized computing :
Cloud/Grids/Clusters/Ad-Hoc Networks
- Optimisation/Search : From exact to meta

Application Domains

- Robust/sustainable/efficient HPC/Grid/Cloud/IoT
- Next generation networks and protocols
- Internet Shopping/Cloud brokering
- Systems Bio-medicine
- Information/Document Management for Bio and Finance
- Smart Cities - UAVs

On-Going Projects and collaborations

■ ILNAS/ANEC:

Digital Trust / Standardization in :

- ✓ Big Data
- ✓ Cloud Computing
- ✓ Smart Cities



■ LCSB:

- ✓ Knowledge maps
- ✓ Geo-Fencing



■ Examotive

- Fleet placement optimization



International Project involvement



- Grid'5000
- COST ICT Actions
 - ✓ IC1305: Network for Sustainable Ultrascale Computing (NESUS)
 - ✓ IC1406: High Performance Modeling and Simulation for Big Data Applications
 - ✓ IC16228: Gamenet Game Theory for Networks
- ERCIM 2008 - present
- IEEE
 - ✓ Steering IEEE TCSC GreenIT
 - ✓ Vice-Chairman IEEE CIS Cloud computing
 - ✓ Vice Communication chair IEEE Sustainable Computing
 - ✓ Co-Founder on TCSC for Cyberphysical systems
 - ✓ Part of editorial boards of IEEE Cloud Magazine, IEEE Transactions on Sustainable Computing editorial boards and, Springer journal of Scalable Computing and Elsevier SWEVO (Swarm and Evolutionary computation)

International Collaborations

- France: INRIA, CNRS, Universities of Lille, Bordeaux, Grenoble, Toulouse, ENS Lyon
- Italy: Trento, Bologna
- Germany: Fraunhofer
- Poland: Warsaw, Poznan, Krakow Universities of Technology
- USA: NDSU
- Australia: University of Sydney
- Thailand: KMUTT, NECTEC
- Mexico: CICESE Research Center
- Spain: Universities of Cadiz and Malaga
- Uruguay: University of Uruguay Republic
- Columbia: Universidad de los Andes
- Vietnam : HUST
- etc.



UL High Performance Computing Facility

UL HPC Platform: Sites/Data centers



Kirchberg
(CS.43, AS 28)



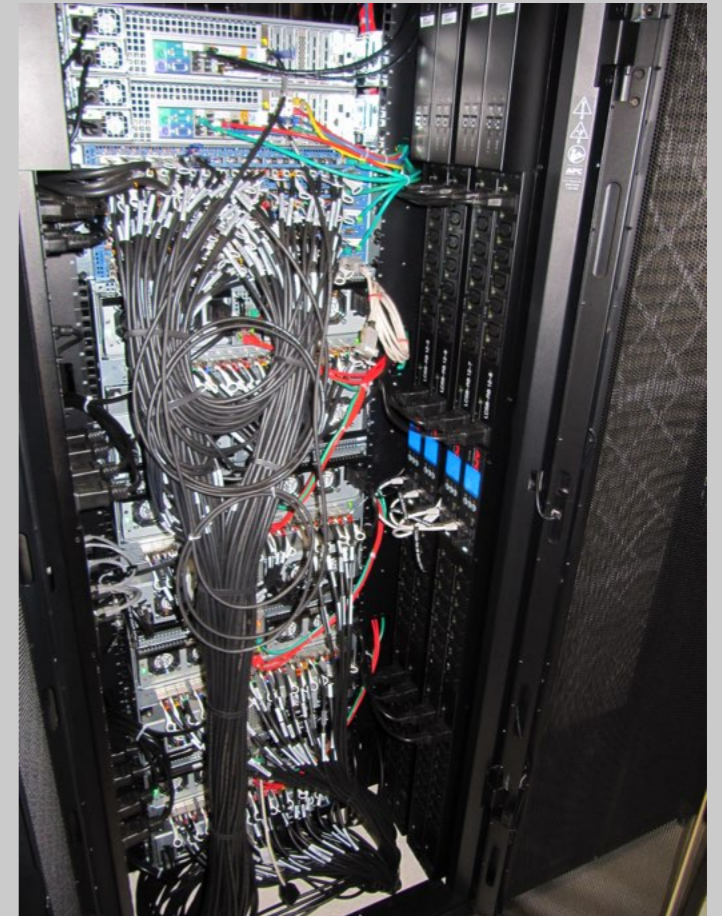
Belval
(Biotech I, CDC/Maison du Savoir)



2 sites /
 ≥ 4 server rooms



UL HPC Platform: Computing capacity



4 clusters
87 TFlops
518 nodes
5316 CPU cores
34512 GPU cores

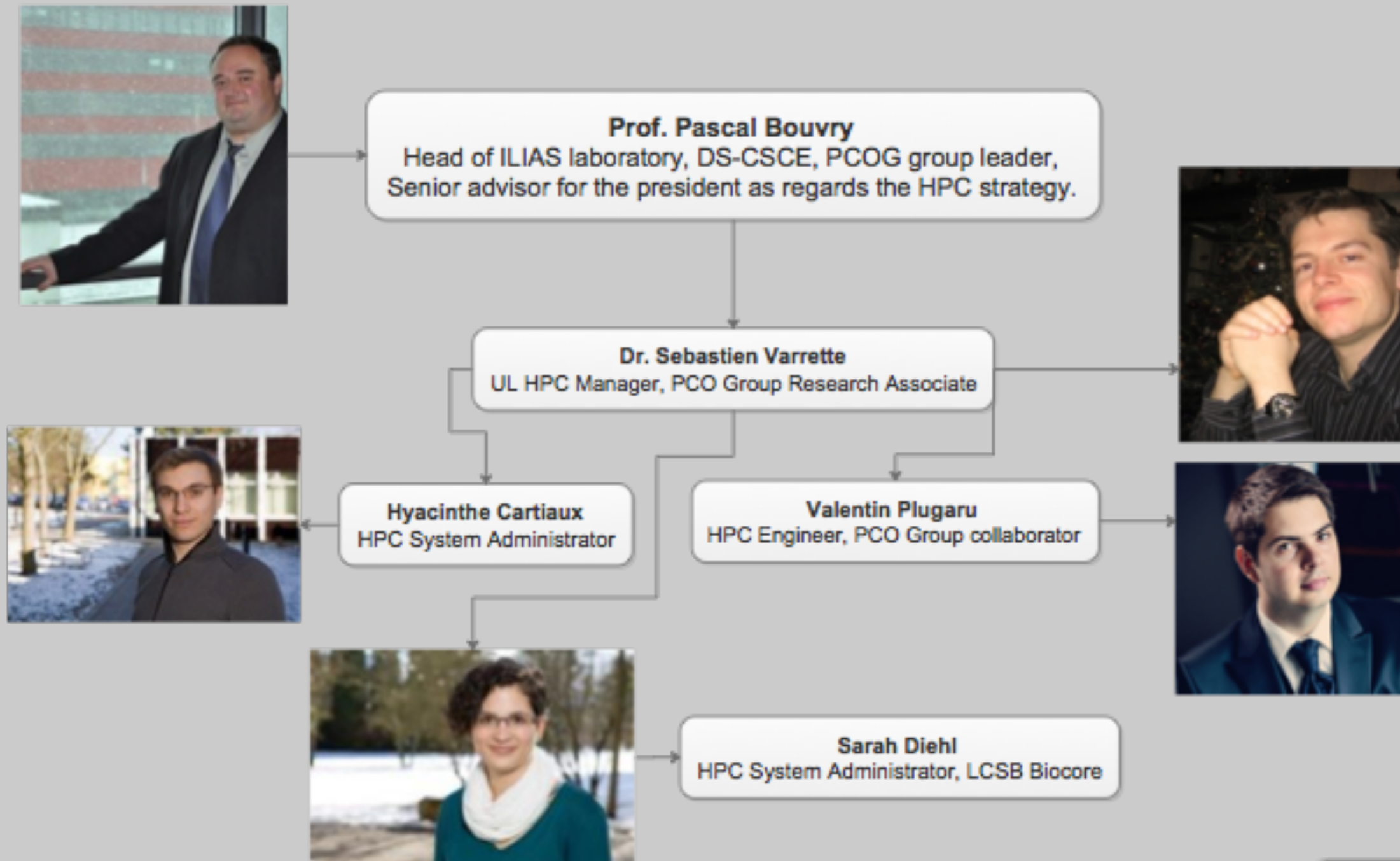


UL HPC Platform: Storage capacity



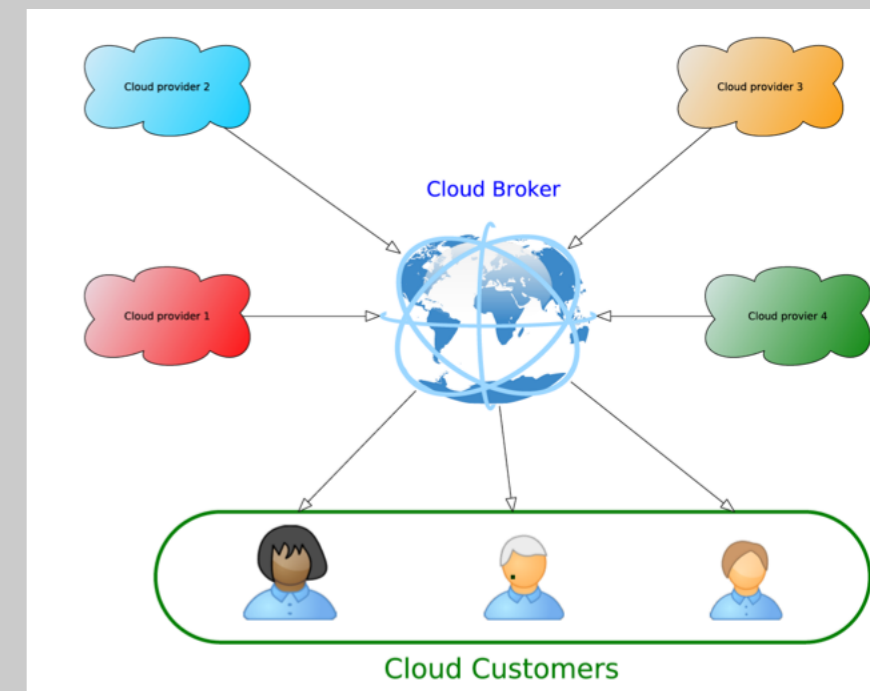
4 distributed/parallel FS
1 558 disks
3.598 PB + 1.516 PB (Backup)





Projects Overview

- Online shopping and Cloud brokering optimisation
- Collaboration with Poznan University of Technology
 - ✓ Team of Prof. Blazewicz
- Contributions
 - ✓ Novel mathematical models
 - ✓ Complexity analyses
 - ✓ Framework of novel exact and approximate optimisation methods
- Cooperation with the industry



ShopD	  	49\$	 9\$
ShopZ	  	39\$	 12\$
ShopA	 	29\$	 15\$

In result IShOP chooses optimal solution with lowest total including necessary shipments

- **ASIMUT: Aid to Situation Management based on MUtlmodal, MultiUAVs, Multi-level acquisition Techniques**
- **First EDA project in Luxembourg**
- **Design, optimisation and validation of the mobility models (simulation)**
 - Coverage of surveyed area
 - Connectivity preservation of the UAVs
 - Randomness of the surveillance movement
 - Energy conservation



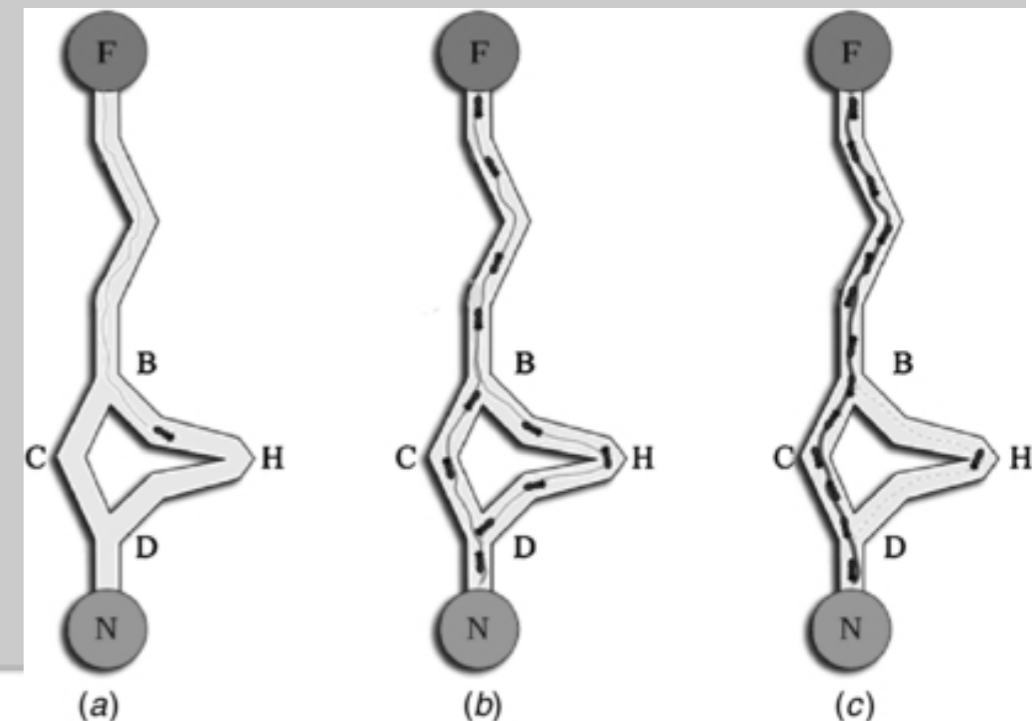
Source: Purdue University

ASIMUT Output



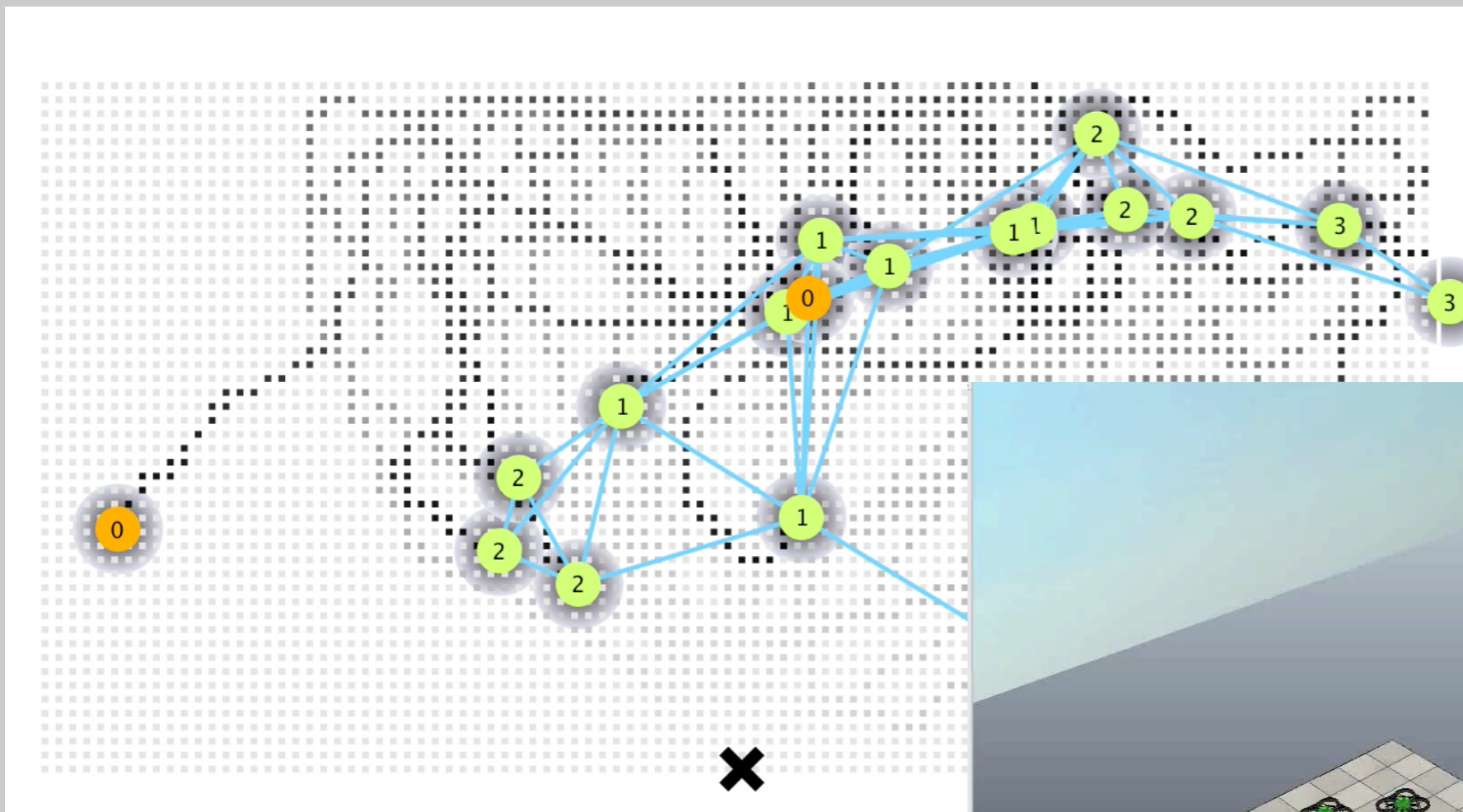
Ant Colony Optimization (ACO)

- Nature-inspired technique – based on ants
- Able to find shortest route from nest to source
- Stigmergy: ants are unsophisticated, but collectively they can perform complex tasks
 - ✓ They communicate using pheromones
 - ✓ They lay trails of pheromone

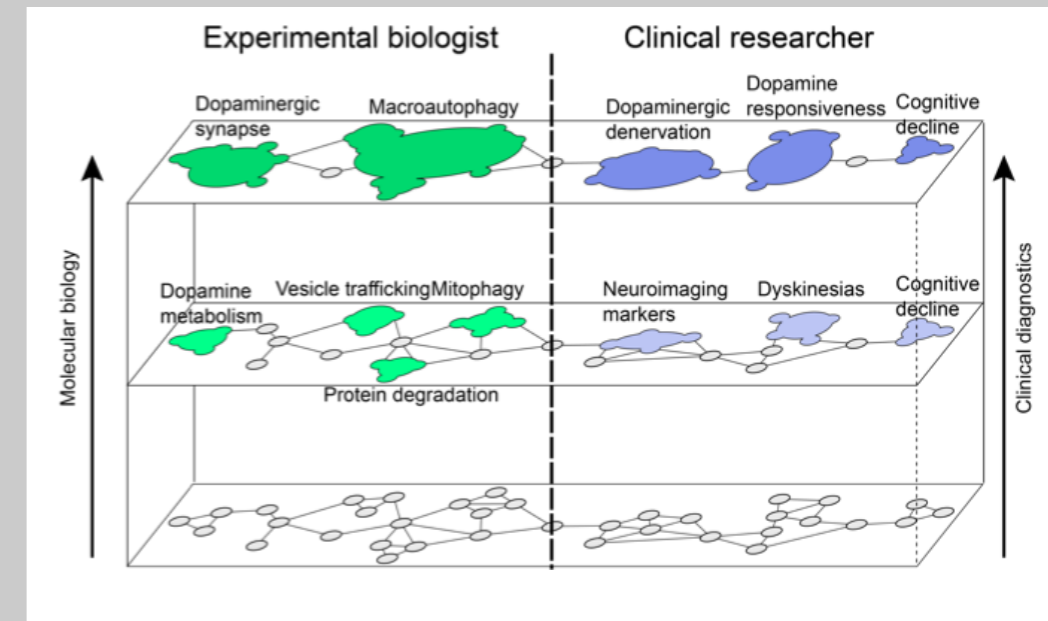
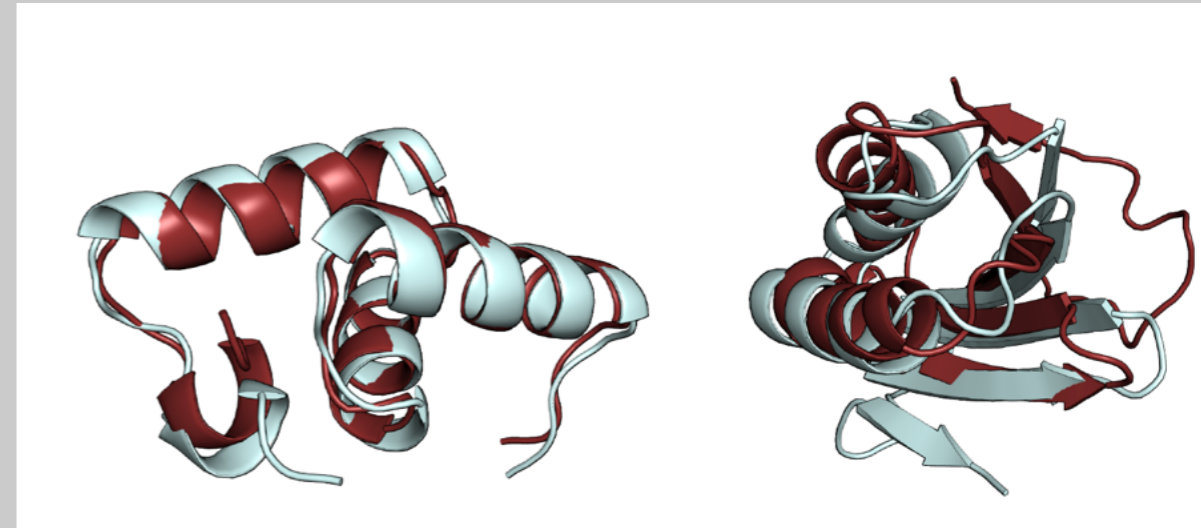


Area Surveillance

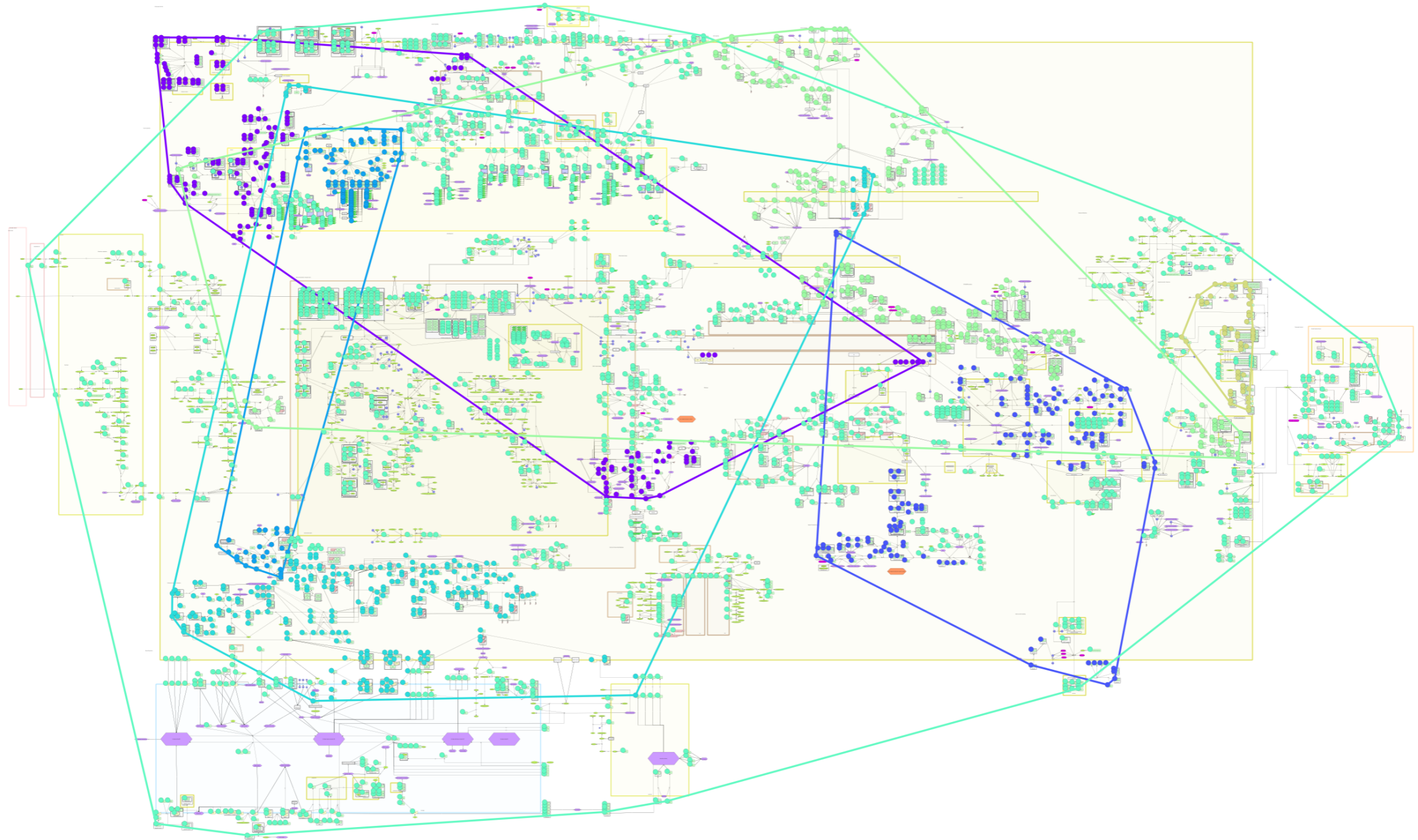
Theoretical and realistic simulations



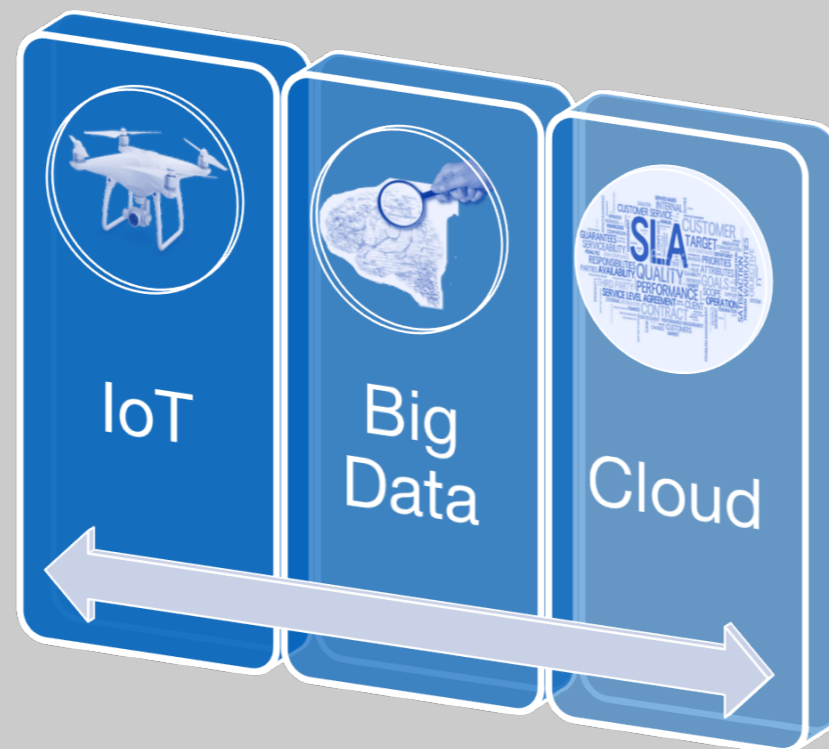
- Inverse Folding Problem for proteins [EVO2015]
 - ✓ Development of novel diversity preserving metaheuristics
- Visualisation of biological knowledge
 - ✓ Parkinson disease map
 - ✓ Bi-level optimization
 - ✓ Development of novel nature-inspired clustering algorithms



New insights – an example

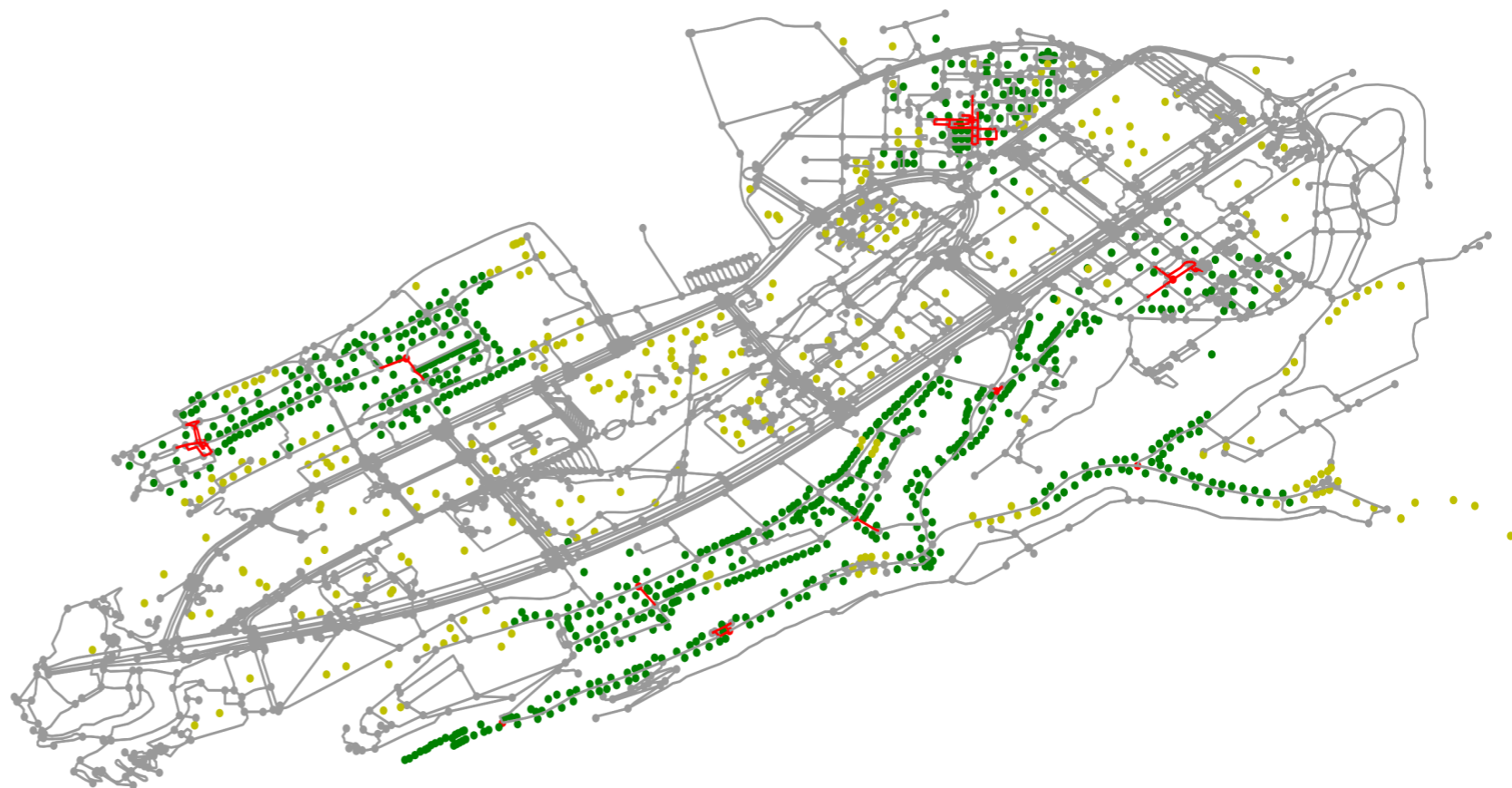


- 4 years research project co-funded by ILNAS - UL/SnT
- 3 PhD students + 1 Postdoc dedicated to the project
- ILNAS/ANEC/UL personnel will also participate



Digital Trust

- Fleet placement optimization
 - Novel problem models
 - Real data
 - Efficient optimization methods



Merci | Thank you | Danke !

