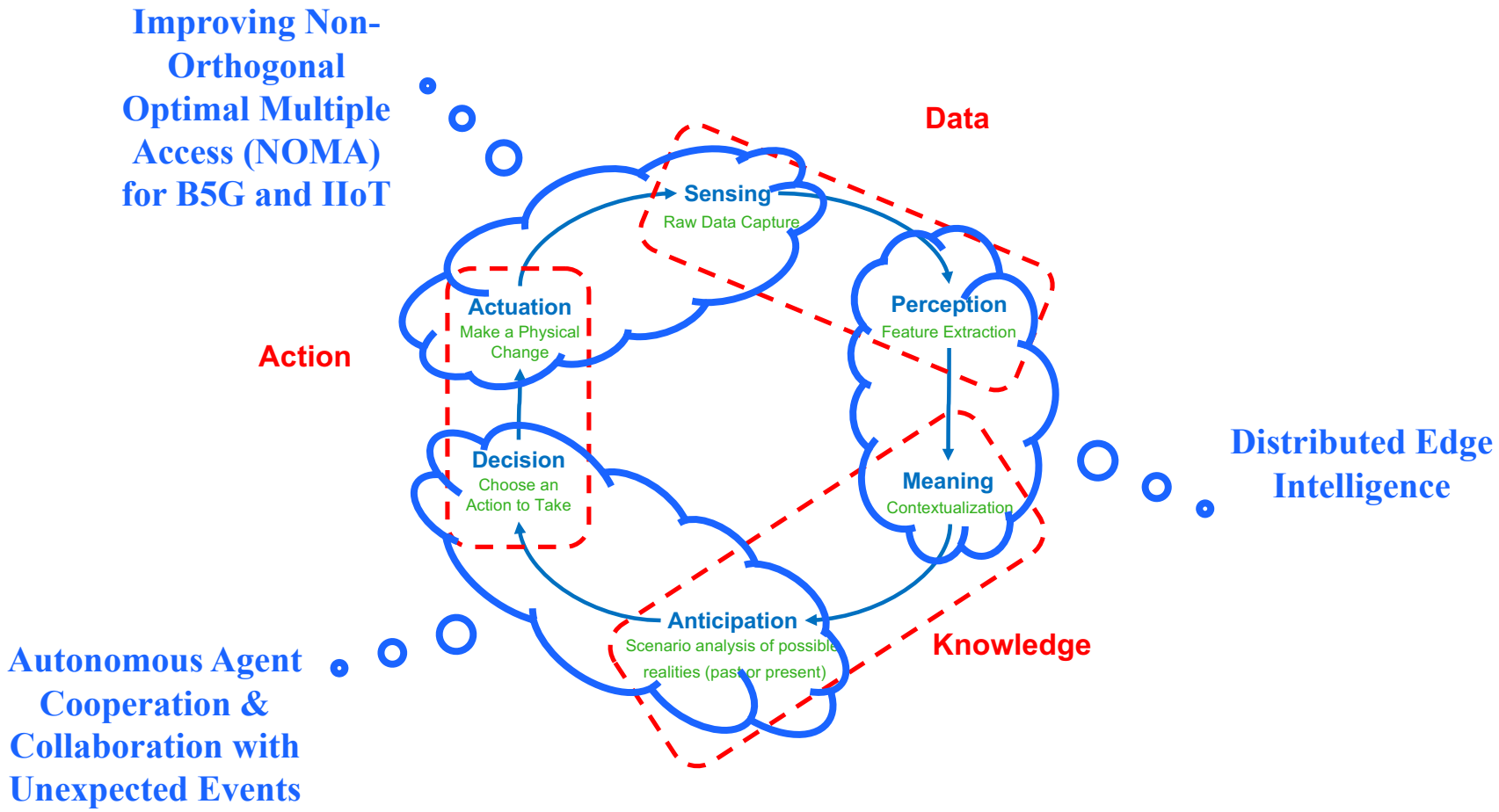
Augmented Machine Interaction Group

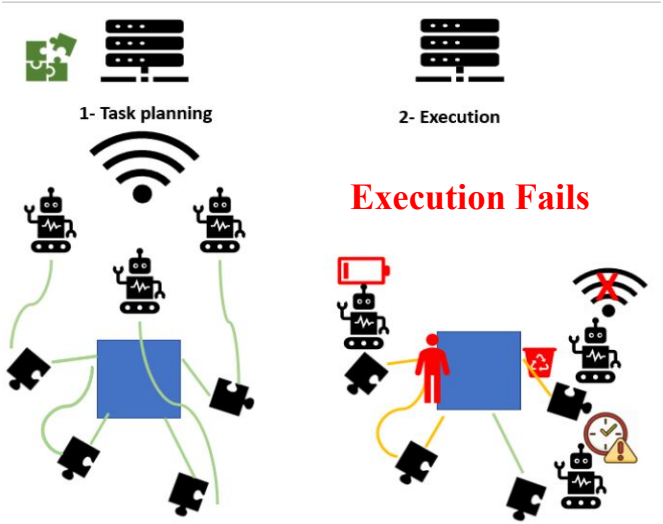
Internship proposals

Human/Machine-World Interaction Model vs. Relevant AMI Projects



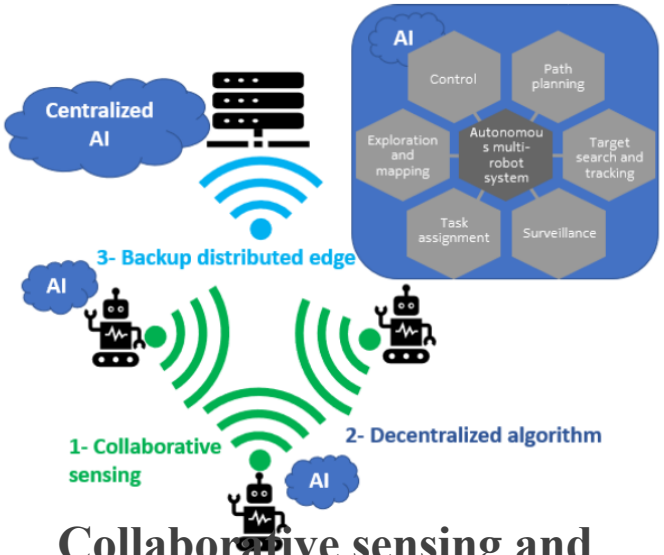
NOKIA

Autonomous Agent Cooperation & Collaboration with Unexpected Events



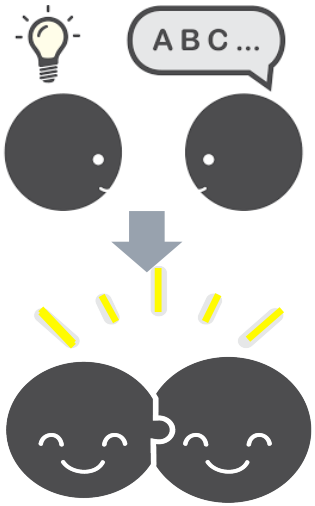
AI-driven agents fail when faced with real-world uncertainties

Cooperative agents should be capable of taking reliable real-time decisions and adapt to unexpected events



Collaborative sensing and distributed contextual AI algorithms

Distributed cooperative sensing and decision algorithms allow timely and accurate contextual responses to abrupt changes



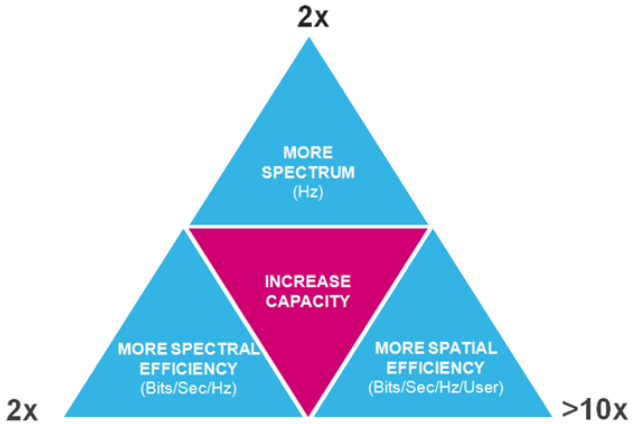
Build a reliable system with autonomous cooperating agents

Lightweight robust autonomous collaborative multi-agent system that can safely share the physical environment with humans

Enable cooperative resilient autonomous agents with limited resources in uncertain environments

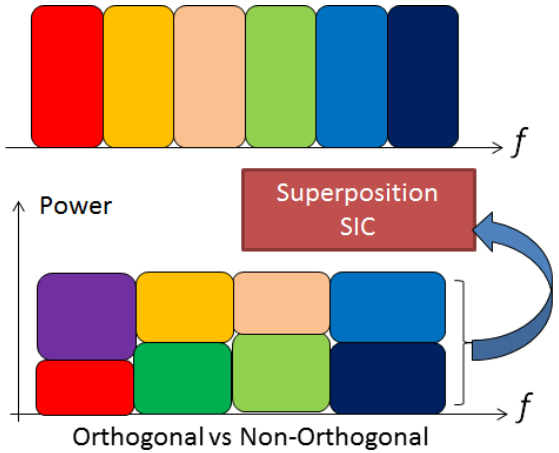
Improving Non-Orthogonal Optimal Multiple Access (NOMA) for B5G and IIoT

Calvin C. S. Chen, Lou Salaün



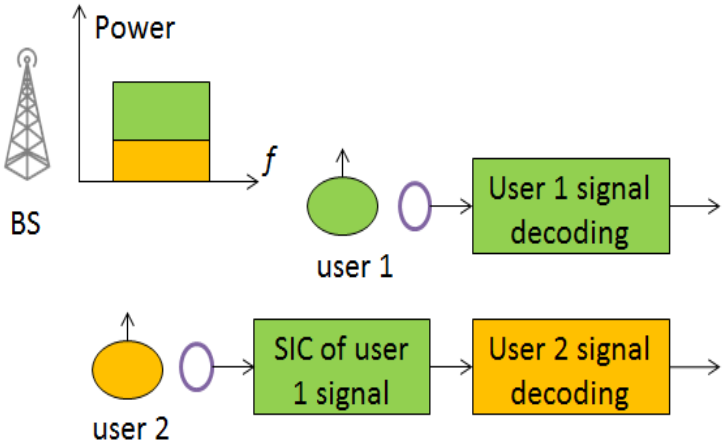
IIoT = CAPACITY LIMITS

B5G and IIoT require high network capacity, high spectral efficiency, massive connectivity, ultra-reliable low latency and user fairness



OPTIMAL NOMA HELPS

Current NOMA solutions are either high-complexity (slow) or very heuristic: we need provable polynomial time, optimal, low-complexity scheme

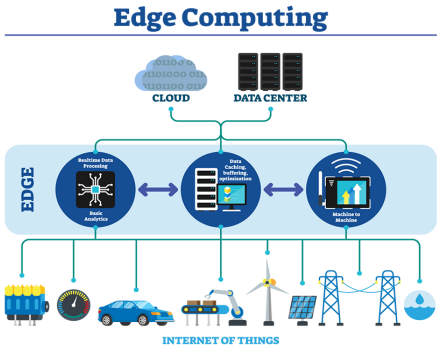


FAST NOMA DECODING

We solve critical hard NOMA optimization problem, achieve significant SE and EE gain, 10^1-10^4 computation time reduction, game-changing for B5G & IIoT new services

Enable more network capacity and new QoS in 5G/IIoT with optimal NOMA and efficient scalable decoding

Distributed edge intelligence



Distributed computing

- Leverage the heterogeneous computing resource across edge clusters
- Optimized workload distribution
- Flexible scheduling of tasks and operations

High responsiveness

- Closer to the data source
- Beneficial for time-critical tasks

Increased cost-effectiveness

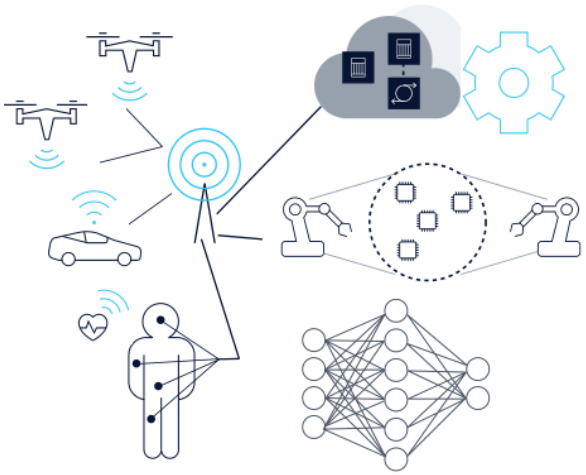
- Utilize the available edge servers
- Exploit heterogeneous accelerators
- Reduced CAPEX

Edge intelligence can enable more responsive AI-augmented services with better resource utilization

Internship positions

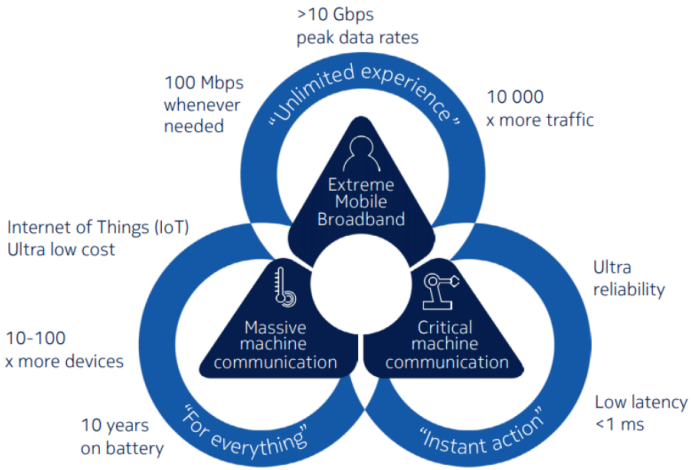
Massive Machine Type Communication in IIoT and Beyond 5G : Context

Dr. Calvin C. S. Chen (Nokia Bell Labs, Paris-Saclay) and Prof. Jean-Marie Gorce (INRIA)



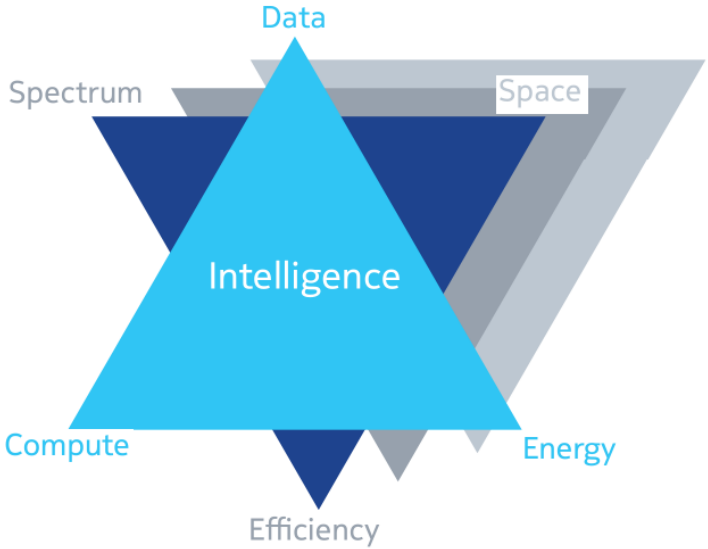
Future World

Connect the physical world, digital world and biological world, of ubiquitous computing, various knowledge systems, precision sensing and actuation, human/machine interface



Key Requirements

B5G and IIoT require high network capacity, high spectral efficiency, massive connectivity, ultra-reliable low latency (URLL) and user fairness



Six Dimensions to Design

Many problems have very high complexity and hard to optimize, besides expect effortless to use/control, high reliability, flexibility, accuracy and scalability

Enable machine type communication and massive connectivity in 5G/IIoT with optimality and scalability

Massive Machine Type Communication in IIoT and Beyond 5G : Scope

Dr. Calvin C. S. Chen (Nokia Bell Labs, Paris-Saclay) and Prof. Jean-Marie Gorce (INRIA)

Support massive number of connected devices
order of 10^6 devices/km^2 (3GPP Cat-NB1&2)

Multi-faceted optimization problem
PHY/MAC, user grouping, traffic scheduling, QoS, heterogeneity, dynamic & complex environment

Industrial automation and smart cities
modern warehouse, vehicles, surveillance system, crowd control, precision agriculture, healthcare

Intelligent MTC & resource management
data science, ML/AI, algorithm, perf. guarantee

Distributed and efficient scheme
analyze information locally, min. human intervention

Ubiquitous coverage and extremely low power
limited radio spectrum and computational capability

Today's solutions are mostly simple heuristics and fail with poor performance when system grows

Position: Machine Learning and AI Empowered Communications for IIoT/B5G

Dr. Calvin C. S. Chen (Nokia Bell Labs, Paris-Saclay) and Prof. Jean-Marie Gorce (INRIA)

Company: Nokia Bell Labs (Paris-Saclay) https://www.bell-labs.com

Contact person: Calvin (Research Scientist), chung_shue.chen@nokia-bell-labs.com

Starting time: Position available immediately and can also start in 2022 (5-6 months)

Criteria & Skills

- Optimization method, information theory, mathematics
- Machine learning and AI
- Radio resource allocation (e.g., wireless communications) and algorithms
- Simulation and computer implementation (e.g., using Python or Matlab)
- Teamwork spirit, highly self-motivated, interests and curiosity in scientific research

Machine Learning for Multi-Robot Path Finding

Dr. Lou Salaun (Nokia Bell Labs, Paris-Saclay)

- In multi-robot systems, the multi-agent path finding (MAPF) problem consists in finding for each robot the shortest collision-free path from a given source to a target destination.
- In many practical use-cases, the robots navigate in dynamic and unknown environments with various sources of uncertainties, i.e., mechanical imperfections (wheels can slip or get stuck), sensor noise, unforeseen obstacles, etc.
- MAPF algorithms must adapt in real-time to each robot's deviation, delay in communication and asynchronous decision making. For this reason, we consider the online MAPF paradigm
- While some preliminary solutions have been proposed to handle the communication and the navigation stochasticity, the general challenge remains open.

Position: Machine Learning for Autonomous and Distributed Multi-Robot Path Finding

Dr. Lou Salaun (Nokia Bell Labs, Paris-Saclay)

Company: Nokia Bell Labs (Paris-Saclay) https://www.bell-labs.com

Contact person: Lou (Research Scientist), lou.salaun@nokia-bell-labs.com

Starting time: Position available in 2022 (up to 6 months)

Goal:

- In this internship, we will develop a learning based distributed MAPF algorithm to enable autonomous robotic navigation without collision. Such algorithm must be robust to uncertainties and include an efficient communication scheme.

Explore Graph Neural Network: From Theory to Practice

Dr. Lou Salaun, Dr. Tianzhu Zhang (Nokia Bell Labs, Paris-Saclay)

- Graph Neural Network (GNN) is a deep learning paradigm that efficiently learns patterns from data with an underlying graph structure.
- GNNs have recently received increasing attention for their applications to recommender systems, bio-chemical graphs, social networks, and citations networks. GNN is a promising tool to solve currently intractable wireless resource management problems.
- Meanwhile, there has also been a trend to employ GNNs to solve optimization issues for the next-generation softwarized networks.
- With the rapid evolvement of mobile computing and Industrial Internet of Things (IIoT), more and more GNN-based algorithms are expected to solve complex tasks with graph data patterns

Position: Machine Learning for Autonomous and Distributed Multi-Robot Path Finding

Dr. Lou Salaun (Nokia Bell Labs, Paris-Saclay), Dr. Tianzhu Zhang

Company: Nokia Bell Labs (Paris-Saclay) https://www.bell-labs.com

Contact person: Lou (Research Scientist), lou.salaun@nokia-bell-labs.com

Tianzhu (Research Scientist), tianzhu.zhang@nokia-bell-labs.com

Starting time: Position available in 2022 (up to 6 months)

Goal:

- In this internship, we will explore the theory of GNNs, and implement a GNN-based algorithm to tackle a practical problem for network management and resource allocation in an IIoT environment.

Thank you

Email: tianzhu.zhang@nokia-bell-labs.com