Bianca Caiazzo

Modelling and Control of Electric and Energy Grids

Tutor: Prof. Stefania Santini   **co-Tutor: Prof. Amedeo Andreotti**
                Doctoral Cycle: XXXV   **Year: First**

Academic Year 2019-2020

Background & Info

- **MSc degree in Management Engineering, University of Naples Federico II**

- **Working team: DAiSy Lab (Prof. Stefania Santini)**

- **Co-Tutor: Prof. Amedeo Andreotti**

- **PhD start date: Academic Year 2019-2020**

- **Scholarship type: "UNINA"**

itee PhD
information technology
electrical engineering

Research Topic (1/2)

- **Designing distributed control architecture for collaborative autonomous Multi-Agent System (MASs).**

- **Application to Smart Grid (SG), e.g. power system restoration, power system voltage control, Microgrid (MG) operation control, as well as control design for a MG consisting of Distributed Generators (DGs), energy storage devices and controllable loads.**
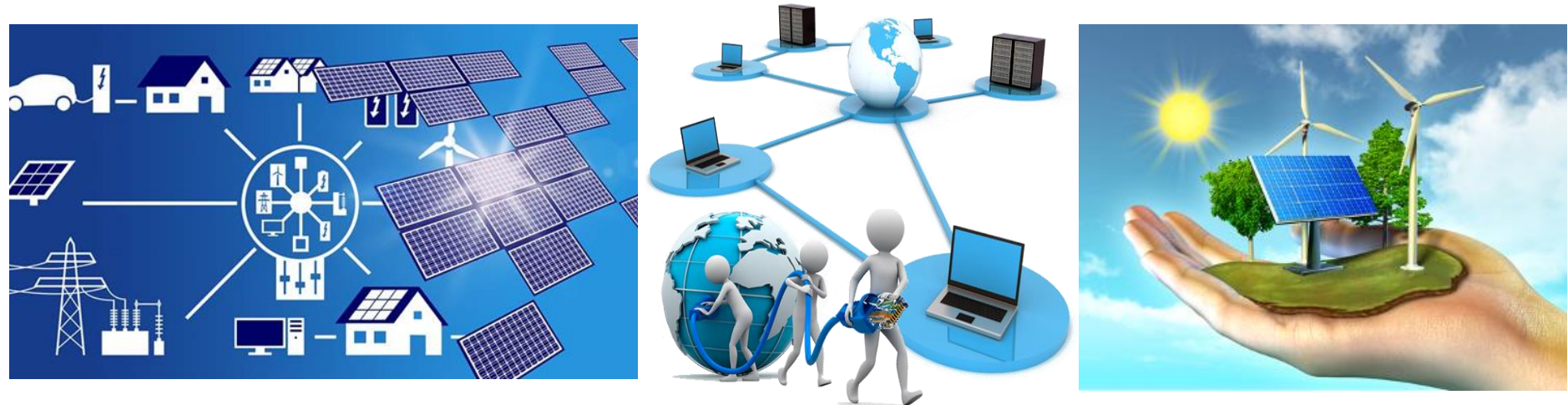
Research Topic (2/2)

- **In the above mentioned technical field, Collaborative Control of agents, sharing information through communication links (wired or wireless), is usually solved by neglecting unmodeled dynamics, time-varying environmental conditions and/or communication delays.**

- **The aim of the research is devising strategies that are robust with respect to uncertainties and latencies that may arise in real networked systems.**

- **The idea is to tailor the theoretical results also with respect to practical problems or new technological paradigms, e.g. for some innovative Power Grids applications.**
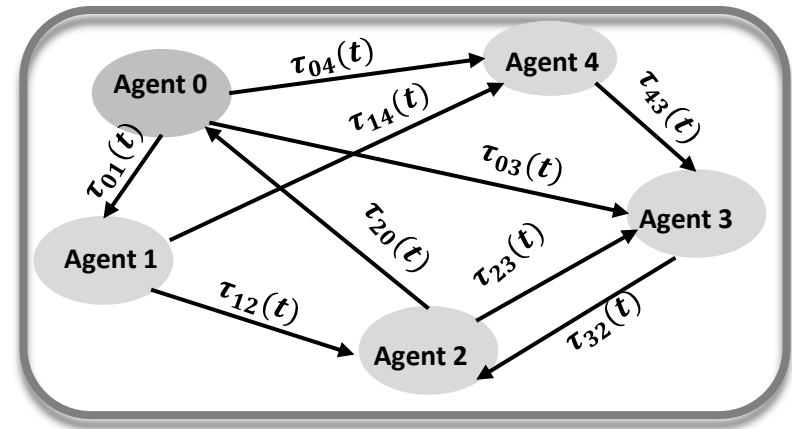
My First Year: Study & Training Activities (1/2)

- **The main focus of my first year activity is the acquisition of concepts related to distributed cooperative and adaptive control strategies in the presence of communication time-delay and their application to Power and Smart Grids.**

'20° IEEE International Conference on Environment and Electrical Engineering (EEEIC) - Presentation of the paper 'Robust-Finite Time Voltage Restoration in Inverter-based Microgrids via Distributed Cooperative Control in the presence of communication time-varying delay'.

Attended the EECI 2020 International Graduate School on Control – "Time-Delay and Sampled-Data System", by Prof. Emilia Fridman and Prof. Pierdomenico Pepe.

Attended the "Model Predictive Control" course offered by the IMT School for Advanced Studies Lucca, by Prof. Alberto Bemporad.

- **MPC could be a suitable solution for power system application due to the embedded prediction mechanisms, which is attractive for systems greatly dependent on demand and renewable energy sources.**

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My First Year: Study & Training Activities (2/2)

Other attended courses are listed as follows:

- **Scientific Programming and Visualization with Python**

- **Matlab Foundamentals**

- **Innovation Management, entrepeneurship and intellectual property**

- **Big data analytics and business intelligence**

- **Machine Learning**

- **Intelligenza Artificiale**

Research activity:
Problem Statement(1/2)

■ **Research activities aim designing of distributed and fully decentralized cooperative control strategies for cyber-physical energy systems, e.g. Smart Grids, Microgrids. The foundamental issue is the robust regulation of Distributed Generation plants which can also incorporate renewable and alternative energy sources.**
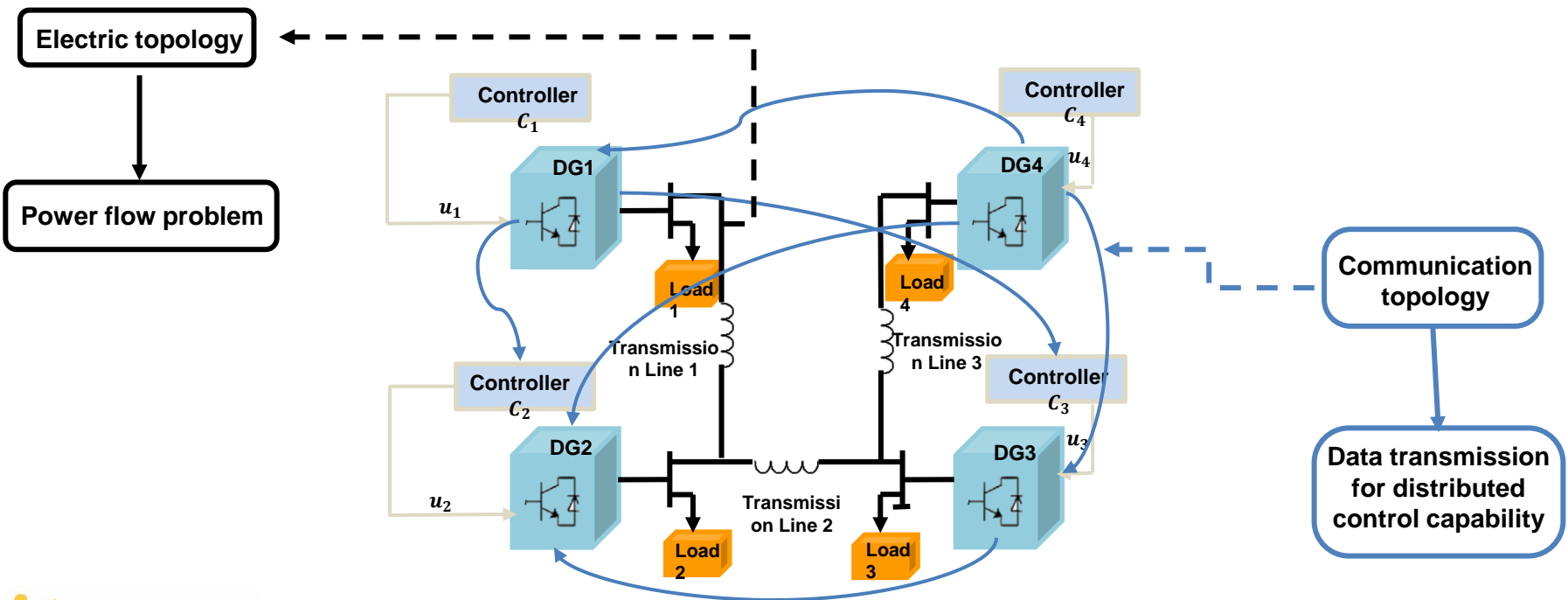
Research activity:
Problem Statement (2/2)

Results we will let to solve the open problem of exploiting clean and renewable energy sources and will allow, according to "Green Growth" frame in Horizon 2020 program, to develop smart grid technologies where renewable energies sources added to conventional power grid systems!

Smart micro-grid as an efficient and safe way to use clean energy.

My Products

- **Andreotti, A., Caiazzo, B., Petrillo, A., Santini, S., & Vaccaro, A. (2019). Decentralized Smart Grid Voltage Control by Synchronization of Linear Multiagent Systems in the Presence of Time-Varying Latencies.** *Electronics*, *8*(12), 1470 (<u>Published:</u> 3 December 2019).

- **Andreotti, A., Caiazzo, B., Petrillo, A., Santini, S., & Vaccaro, A. (2020, June). Robust Finite-time Voltage Restoration in Inverter-Based Microgrids via Distributed Cooperative Control in presence of communication time-varying delays. In** *2020 IEEE International Conference on Environment and Electrical Engineering and 2020 IEEE Industrial and Commercial Power Systems Europe (EEEIC/I&CPS Europe)* **(pp. 1-6). IEEE** <u>**(Published).**</u>

Next Year

- The main objective is to take into account the presence of different DGs that, hence, have to be managed via the networked control paradigm. More specifically, the aim is the design control actions able to guarantee resilience with respect to:

  i. time-varying loads due to sudden environmental changing

  ii. time-varying parameters

  iii. time-varying communication delays and other possible security threats.

- Besides robustness and resilience of the proposed methodologies, another important issue to be addressed is related to the achievement of the stability in a *finite-time* interval so to guarantee prescribed transient behavior.

- Testing and validation on realistic benchmark configurations integrating the widespread DG units are the final goals. The IEEE standard test systems will be examine for the applicability of proposed model.

I Year Credits

- The first year activities and the outlook on the second year can be summarized as:

	Courses	Seminars	Research	Tutorship	Total
Bimonth 1	1.6	2.5	5.9	0	10
Bimonth 2	3.3	0.2	6.5	0	10
Bimonth 3	4	0.8	5.2	0	10
Bimonth 4	15.6	3.7	4	0	23.3
Bimonth 5	9.6	0	5	0	14.6
Bimonth 6	3	0	7	0	10
Total	**37.1**	**7.2**	**33.6**	**0**	**77.9**
Expected	**min20-max40**	**min5-max10**	**min10-max35**	**min0–max1.6**	

Thanks for your time!