WHAT'S INSIDE

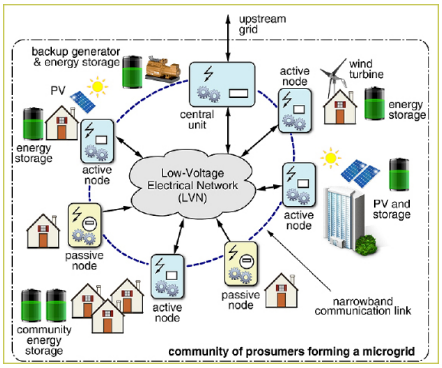
NE-ONE POWERS RESEARCH INTO SMART ENERGY DISTRIBUTION (MICROGRIDS) COMMUNICATIONS AT UNIVERSITY OF PADUA

Established in 1222, the University of Padua (Padova in Italian) is the second oldest university in Italy and one of the earliest universities in the world. Today, Padua continues to be one of the most prominent universities in Italy and Europe. It is made up of 32 departments and eight schools, which co-ordinate the courses managed by each department, as well as 49 specialization schools and 43 research and service centers. Padua also runs a host of centers, research organizations and science and technology hubs that are affiliated with the university.

Within the NEBULE project[1], funded by the Levi Cases Interdepartmental Research Centre,[2] the university's Department of Management and Engineering (DTG) has been researching on the communication and data management required in low-voltage power systems, like microgrids, and needed to understand the impact of communications networks on the delivery of information. To this aim, the research group at DTG led by Prof. Paolo Mattavelli and Dr. Tommaso Caldognetto deployed iTrinegy's NE-ONE Professional Network Emulator to recreate different network test scenarios.

THE REQUIREMENT

A microgrid can be regarded as an independent power network that uses local, distributed energy resources to provide grid backup or off-grid power to meet local electricity needs.



It can commonly range from a single building to a village of substantial size. Electricity is typically generated from a combination of sources, which could include fossil fuels and renewable resources. The grid needs to have controls to make all its parts work together including a distribution method to get power to where it is needed. It must also have a method of dealing with excess energy produced, exploiting electrical energy storage, or a way to make available that energy to support the main power grid. To facilitate this coordinated control, a microgrid requires a communication network to both acquire data from distributed resources (i.e. diesel generators, wind turbines, solar photovoltaic (PV) panels, hydro, geothermal, etc.) and send control signals back to these resources.

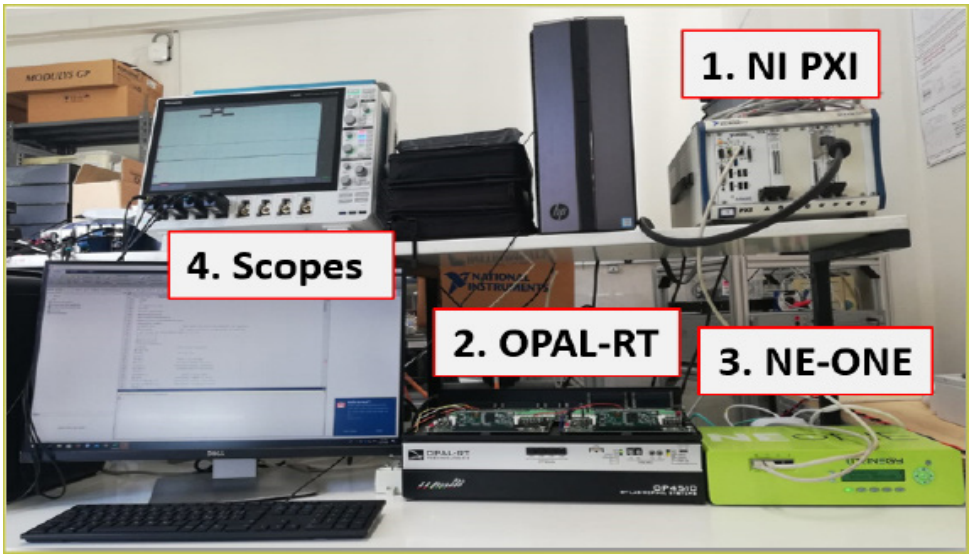
However, like any data network, the microgrid control system performance may be subject to delays, packet loss, packet corruption, packet duplication, packet reordering and transmission rate limits.

THE REQUIREMENT (CONT./)

In order to make their experimental testbench as realistic as possible, university researcher Dr. Tommaso Caldognetto and research assistant Hossein Abedini needed a way to create real-world network conditions in their test laboratories. Tommaso explains, “We were trying to find a way to emulate the main aspects of the communications between the different agents you may have in a microgrid scenario. We have control algorithms that can be executed centrally, locally, or distributedly in order to inject more or less power and allow optimal operation of the microgrid. So, communication is an important aspect in such a research scenario and we needed to find a solution to enable us to include communication-related issues in our lab set-ups. But we are power electronics engineers rather than network specialists so we needed something that would easily, yet accurately, address the communications aspects for us”.

THE SOLUTION

The team was already aware of network emulation as a way to recreate the communication channel following an earlier visit to another university in Germany. However, while the freeware solution proposed would be able to help Tommaso and Hossein, the amount of time required to set-up and use it, together with its rudimental capability, didn’t make this a viable option. In response, the team explored a range of commercial offerings and in the end chose iTrinegy’s NE-ONE Professional Network Emulator as it provided the right balance of affordability and ease-of-use. The NE-ONE Professional has been specifically designed with ease-of-use in mind and comes supplied with a set of built-in training videos to guide the user through set up and deployment, a feature that Hossein confirmed the team had found very helpful, together with the high standard of the product documentation.



The NE-ONE Professional Network Emulator provides the network impairments to “stress” the communication channels in the test network

ADAPTING TO THE EVOLVING COMMUNICATIONS MODEL

In the early days of smart microgrids, the industry was focused on communication by power line, but over time this has shifted towards the use of wireless protocols and now even 5G is being considered. Currently, the team are looking at the UDP transport mechanism but it is possible that TCP may also be used in the future. While the distances in microgrids are typically short and the associated latencies low (often less than 10 km and 10 ms respectively), there are multiple variables to consider including

ADAPTING TO THE EVOLVING COMMUNICATIONS MODEL (CONT./)

the impact of the materials used in house construction which can interfere with transmission of data to and from smart meters. In addition, if the microgrid is connected to the main power grid and public networks are used for data management then much greater latencies may be encountered. By using the NE-ONE Professional, the team are able to model a wide range of permutations in their research to determine the resilience of the communications element of the microgrid system and define its effective operational envelope.

PACKET CAPTURE

One feature of the NE-ONE Professional that the team have found particularly useful is its Packet Capture capability which gives them the ability to understand what is happening with regards to the RT simulator and Central Controller which are part of the network set-up. It allows the team to carry out deep analysis of the data flow and check if they are sending and receiving the data correctly at the expected rates.

NETWORK SCENARIO BUILDER

As the team are using an NE-ONE Professional Model 10 as part of their test set-up another feature they have access to is the Network Scenario Builder. Adopting an intuitive "Drag & Drop" approach, the Network Scenario Builder allows users to rapidly create a chronological network experience by simply combining multiple network types and conditions running over a graphically represented timeline. The realism of these test scenarios is further enhanced by selecting intelligent built-in transitions between each network segment to fully represent what happens in the real world. While it is not being actively used for the current research project, the Scenario Builder is seen as being useful for pushing the system under test to its limit by automatically degrading network links and so it is envisaged that it will be used in future projects.

CONCLUSION

When asked what value and return on investment the NE-ONE Professional has delivered the team commented, "It is allowing us to include in our set-ups aspects that would be otherwise difficult to investigate. In research laboratories we have close to ideal communication links so by using the NE-ONE Professional we are able to easily create real-world conditions which greatly enhances the realism of our testing and research, especially while using real-time simulation set-ups. Looking ahead, the power electronics community is approaching more and more system level applications so communications are going to play an increasingly important role so the NE-ONE Professional is going to be very useful to us."

Educational Institution Discounts
iTrinegy is keen to support educational institutions undertaking network-related research and provides discounted pricing. Please email info@itrinegy.com for more information.

[1]Project title: New economic, regulatory and technical drivers for a full exploitation of smart micro-grid based electrical power systems maximizing the connection of the distributed renewable resources
[2]http://levicases.unipd.it/en/

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