# Simulation of Powerline Communications with OMNeT++ in (static) Smart Grids


Dipl.-Ing. Holger Kellerbauer
Prof. Dr.-Ing. Holger Hirsch

University of Duisburg-Essen, Chair for power transmission and storage
Bismarckstrasse 81
457057 Duisburg, Germany
+49(0)203 379-4457

holger.kellerbauer@ets.uni-due.de

holger.hirsch@ets.uni-due.de

# What is Powerline Communication?

- **Basically: Use of existing mains network lines for communication – meaning both access and in home environments.**
- Works in the frequency range from 2 MHz to 30 MHz (in home BPLC and access BPLC) or below 500 kHz (only access PLC).
- Provides (theoretically) data rates up to 200 MBit/s (dLAN 200 BPLC) or 128 kBit/s (Prime PLC)
- All newer variants use some kind of OFDM with static notches on the PHY-Layer.
- Not yet fully standardized (but some exist, e.g. HomePlug, ITU G.hn, IEEE P1901.1 and P1901.2). Many proprietary solutions.
- Different features on MAC-Layer at each variant.

# Implemented Features

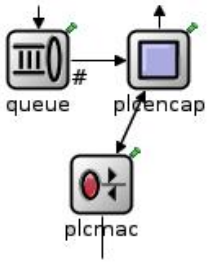
- MAC-Layer
  - CSMA/CA or TDMA or both (dynamic change)
  - Inter System Protocol (according to IEEE P1901)
  - (Static Notching +) Smart Notching
  - Priotitized Channel Access (up to 4 levels)
- PHY-Layer
  - Varying data rate
  - Varying packet error rate (correlated with data rate)
  - Length depending data rate decrease
  - Topology depending data rate decrease

# The different Modules

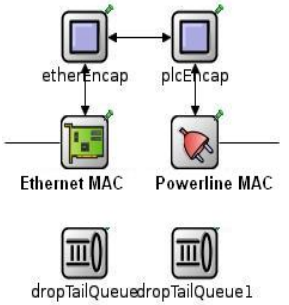
- **PLC Net Module**
  - Does the PHY-Layer management
  - Acts as central coordinator for a network (CCo)
- **PLC Encap Module**
  - Packs and unpacks the frames
  - Sets time stamps
- **PLC MAC Module**
  - Manages the channel access
  - Reacts on the PHY-Layer fluctuations
- **Data Collector Module** (Help module)
  - Collects data from every PLC unit in the net

# The different Compounds

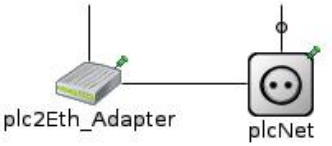
- **Internal PLC Modem**
  - Is a common use case for narrowband PLC
  - Works inside a standard host instead of Ethernet



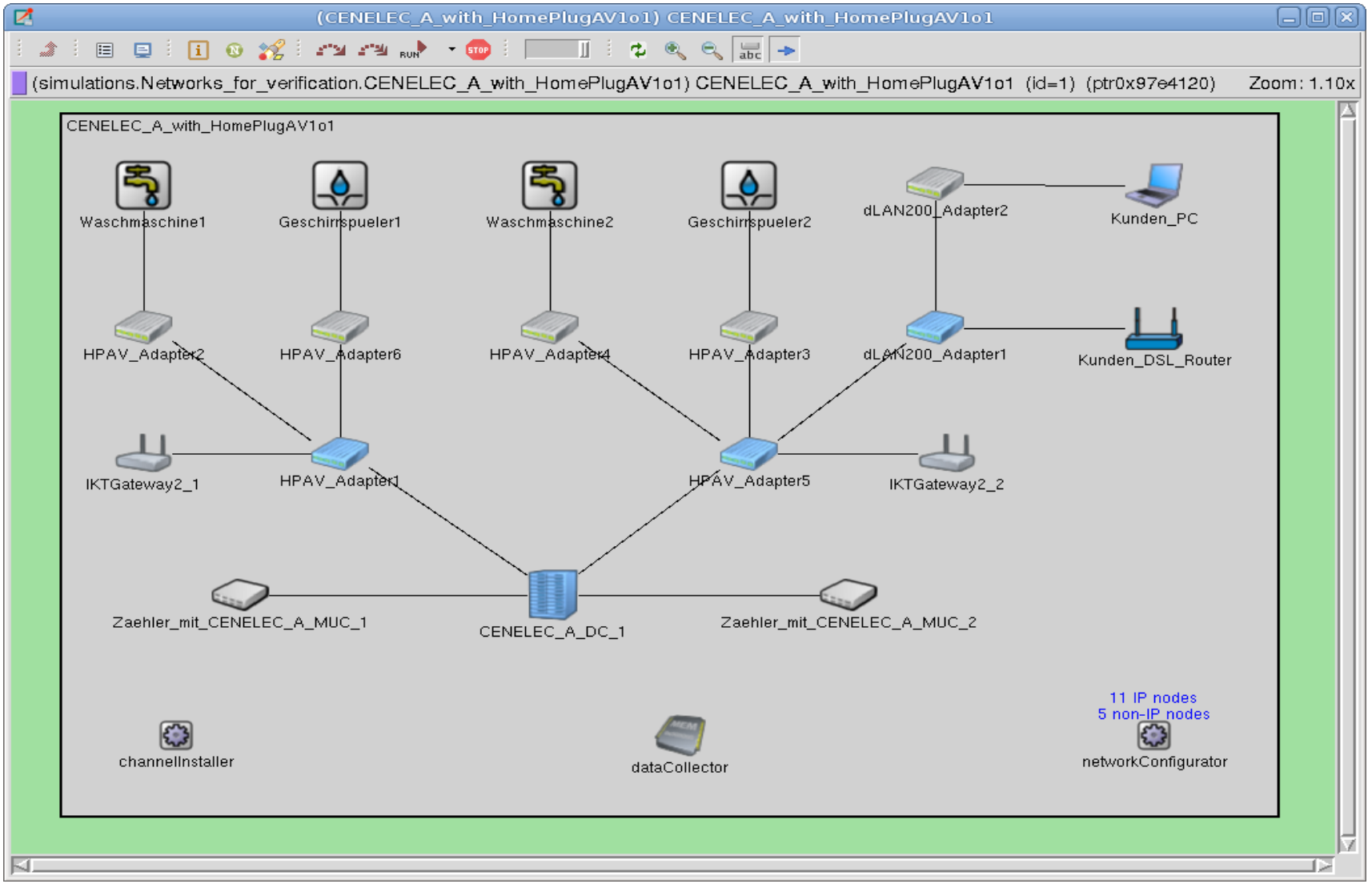

- **Socket Adapter Modem**
  - Is a common use case for broadband PLC
  - Works as a bridge between Ethernet and PLC



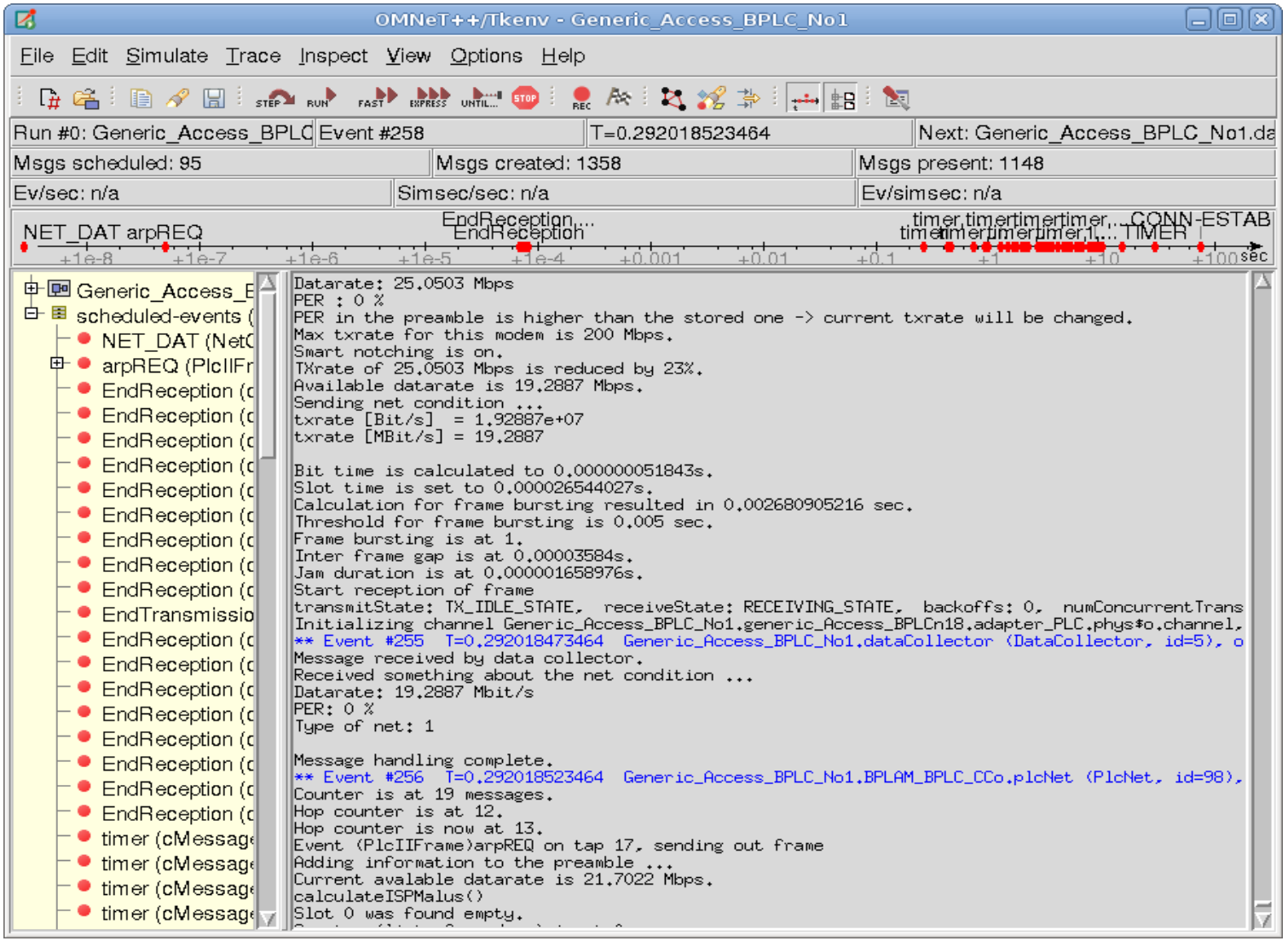

- **CCo Modem**
  - Is a variant of both with a PLC Net Module
  - One CCo is neccesary for every different system in a single mains network
    (this is meanwhile different from the information in the paper)



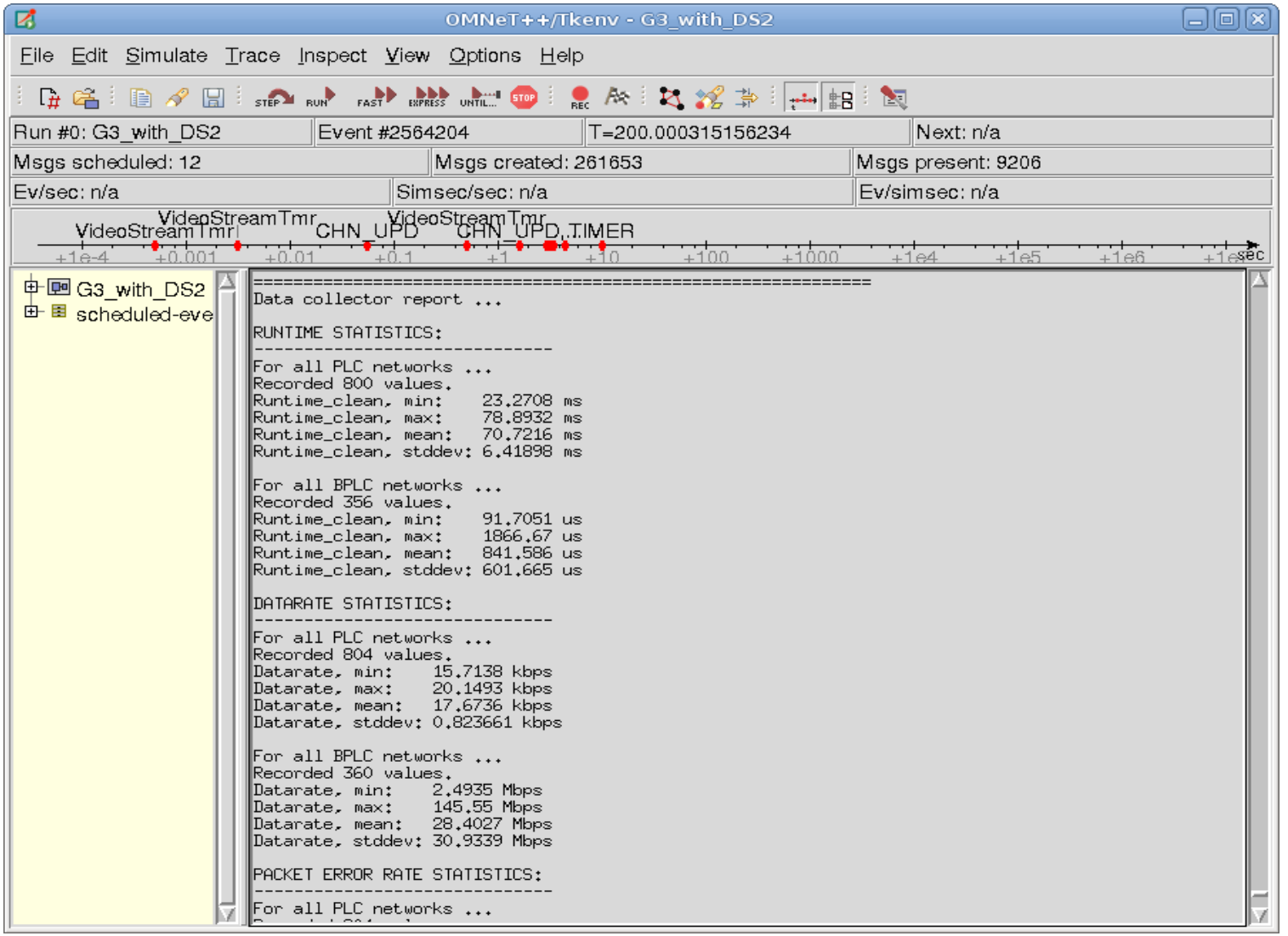
# A Sample Network



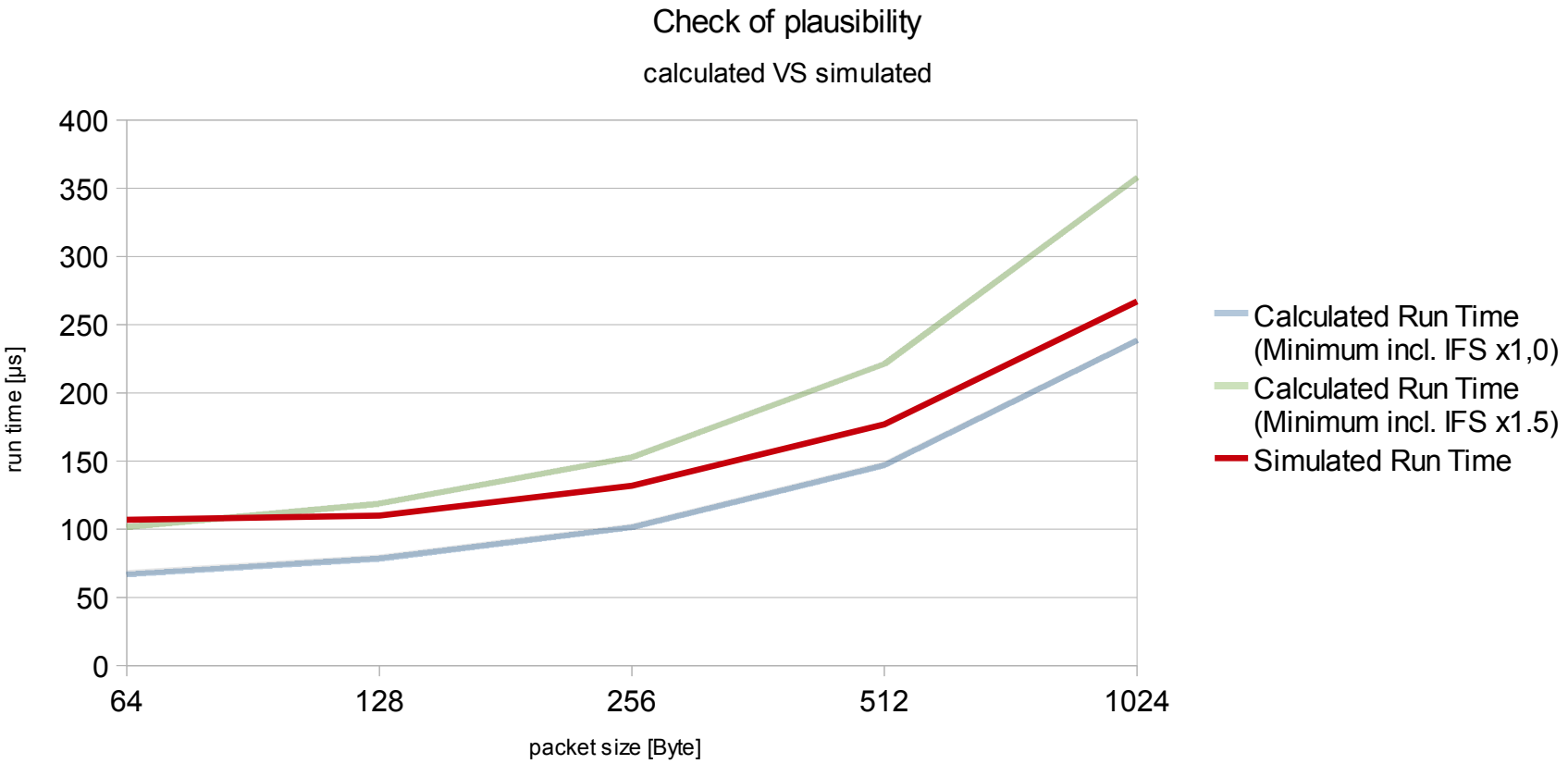
# Verification of the overall Behavior



# Sample Data Collector Output

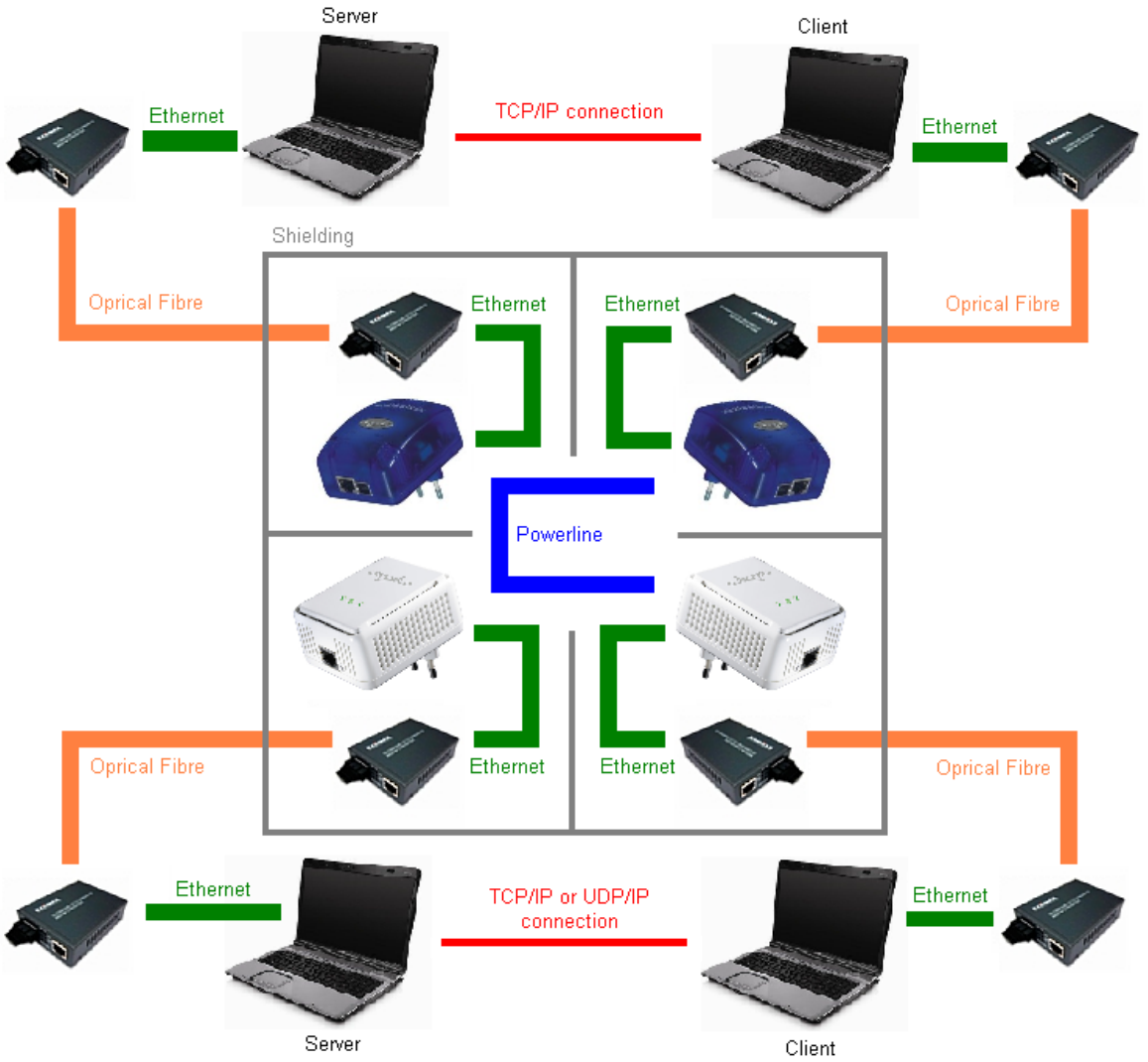


# Verification of the Run Times

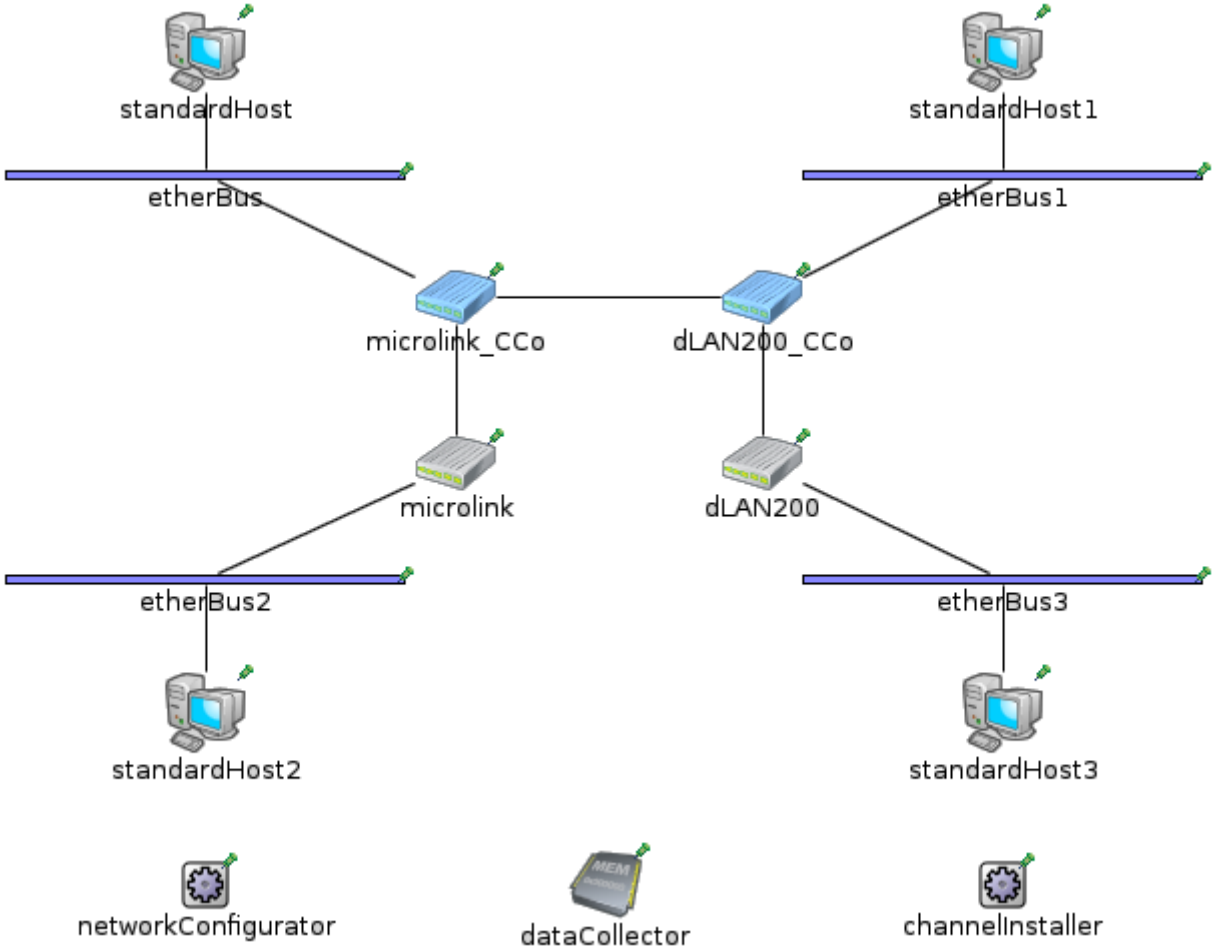



This result comes from a simple point-2-point connection network, which simulates devolo dLAN 200 modems.

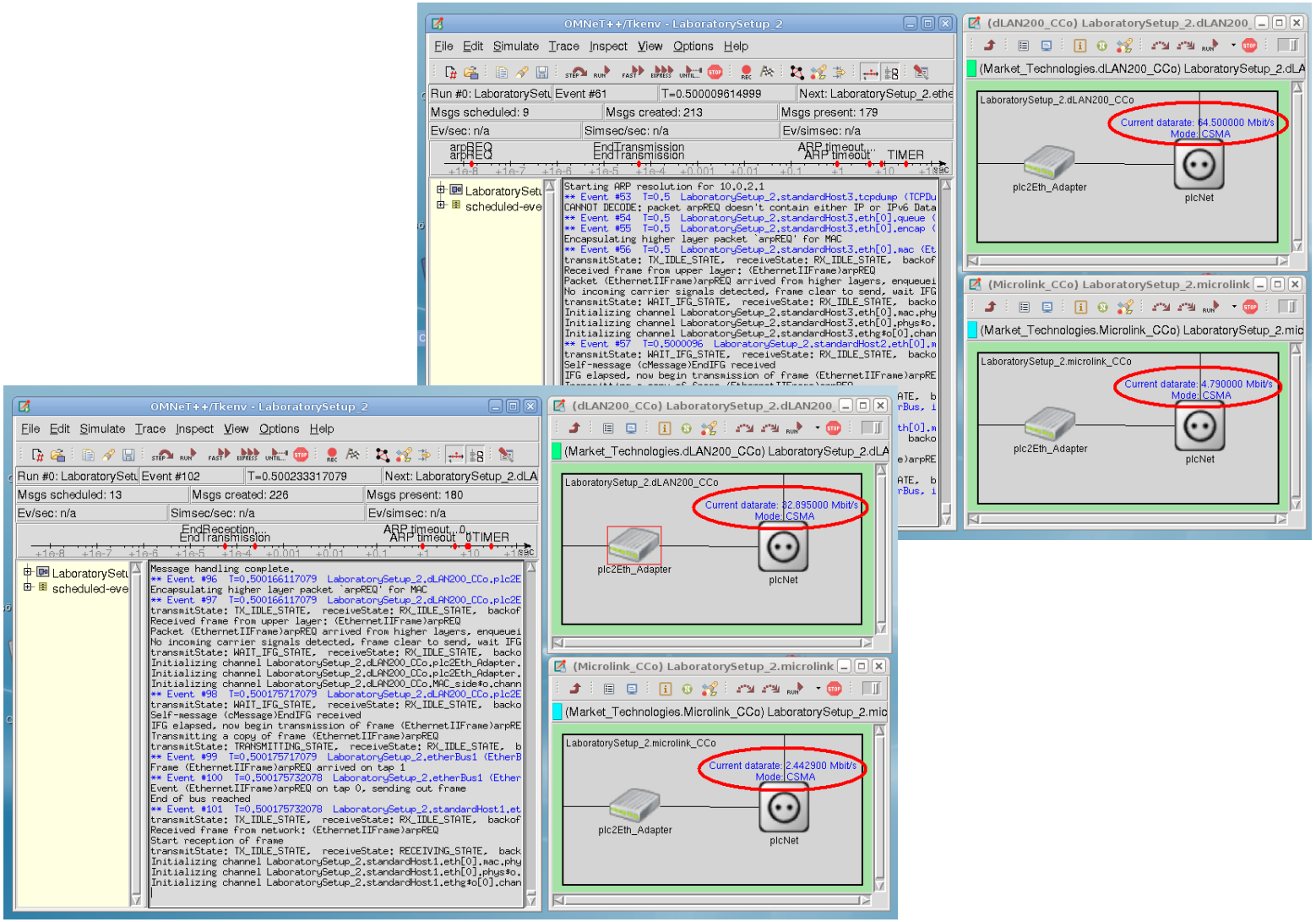
# A Real Testing Network



# Simulated Network



# Verification of ISP Behavior



# Results from the Simulation

TABLE II. CONFIGURATION FOR THE SIMULATION

| Parameter | Max. | Average | Min. |
|---|---|---|---|
| Fast PLC data rate | 200 MBit/s | 64.5 MBit/s | 6 MBit/s |
| Slow PLC data rate | 14 MBit/s | 4.79 MBit/s | 1.2 MBit/s |

TABLE III. SAMPLE RESULTS FOR THE SIMULATION

| Parameter | Measured | Simulated | Accuracy |
|---|---|---|---|
| Fast PLC data rate | 31.1 MBit/s | 31.18 MBit/s | 99.7 % |
| Slow PLC data rate | 2.33 MBit/s | 2.48 MBit/s | 93.9 % |

# Conclusion

- The toolkit provides a good base for the simulation of various existing PLC variants in a (rather static) smart grid environment.
- The more is known about the timing constants of a system, the more accurate is the simulation.
- Through the variation of parameters, the benefit of improvements can be estimated in advance.