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Poster: Round Trip Time Measurement Over Microgrid Power Network

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Round Trip Time Measurement Over Microgrid Power Network

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Abstract

- This poster demonstrates an integrated Microgrid (MG) testbed that allows MGs endpoints to share their current, voltage and power values using a Network Published Shared Variable (NPSV) technique. We present Round Trip Time (RTT) measurements for time sensitive MG control traffic in the presence of varying background traffic as an example of quality of service measurement.

Introduction

- We consider the problem of how is the variation of RTTs of Microgrid (MG) control packets between MG endpoints affected by the presence of background traffic? We hypothesise that if the intensity of the variance of background traffic is large, this will cause greater variance in the measured RTT values between MG endpoints. We present how the RTT changes in the presence of different intensities of background traffic in Fig. 2 to motivate what this study examines.

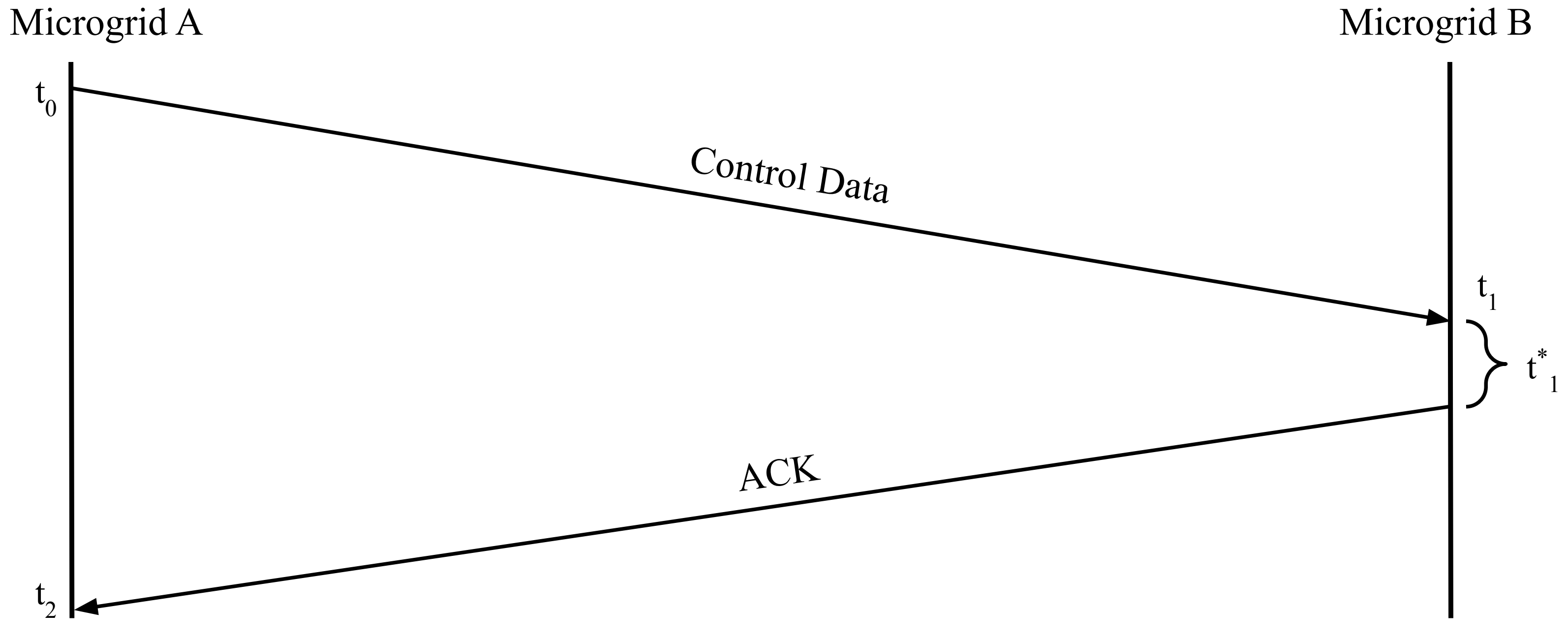


Figure 1. MG A sends a control data message to MG B. An acknowledgement message, ACK, is sent to MG A from MG B. The RTT is t_2 - t_0. High variance in RTT slows down the rate of convergence in MG control systems.

Why this study is important ?

- An examination of network RTTs is important [1] as variation in RTT of MG control packets slows down the rate of convergence of MG control systems which seek to achieve a consistent reference voltage, power and current.

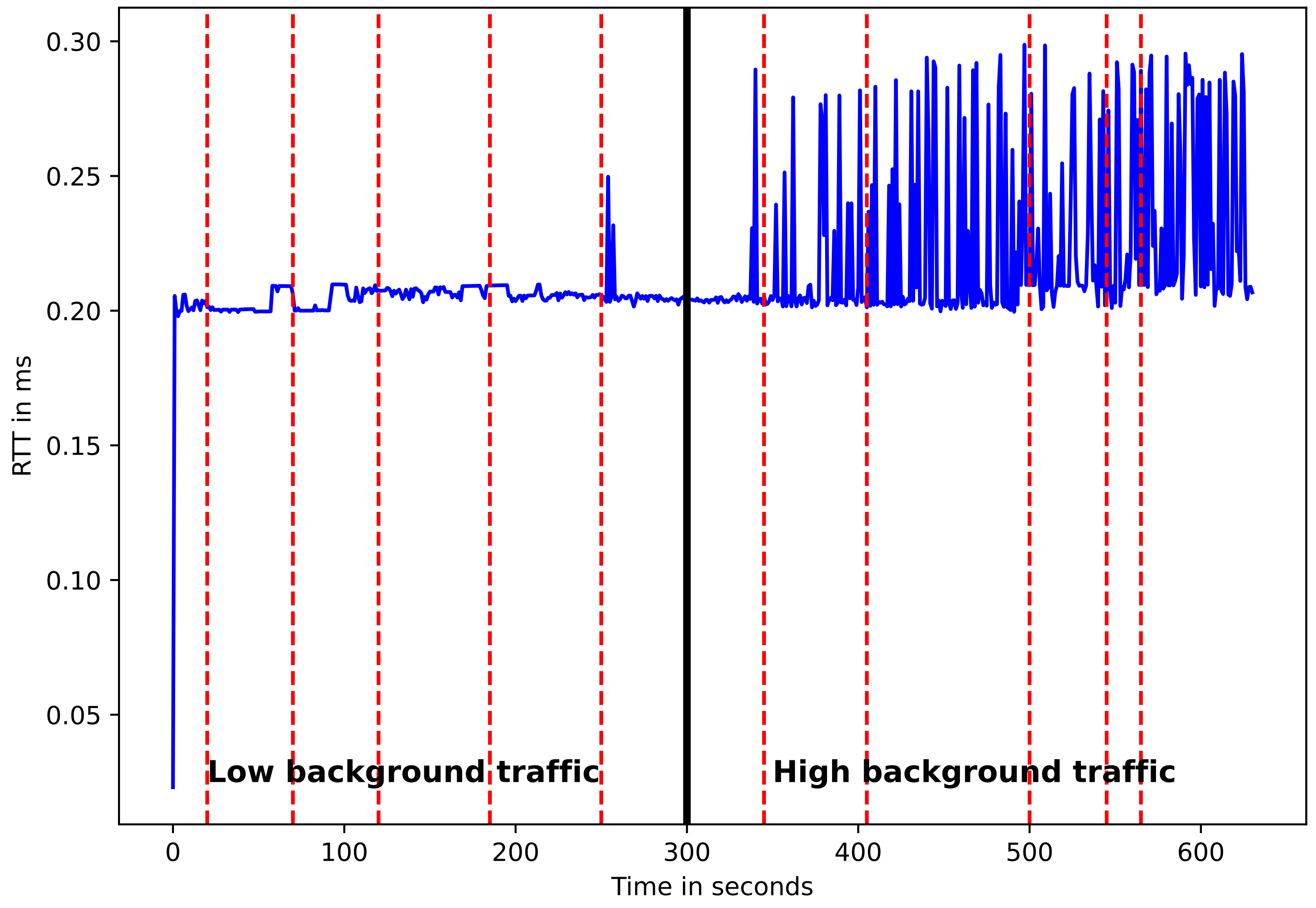


Figure 2. The high RTT values occur when the high background traffic is present. The dashed red lines represent the times the resistance is changed. MG control packets are transmitted from one endpoint to other endpoints when the resistance is changed.

Testbed Design and Methodology

- Integrated MG testbed consists of three Direct Current (DC) sources, varying resistance and PCs which are connected via a Layer-2 (L2) switch which is presented in Fig. 3. We inject different patterns of background traffic into the existing L2 network between MG endpoints.
- We contribute the Network Published Shared Variable (NPSV) algorithm which manages the transmissions of control packets between MG endpoints. We illustrate the First In, First Out architecture and buffering in NPSV in Fig. 4. MG testbed circuit diagram is depicted in Fig. 5.

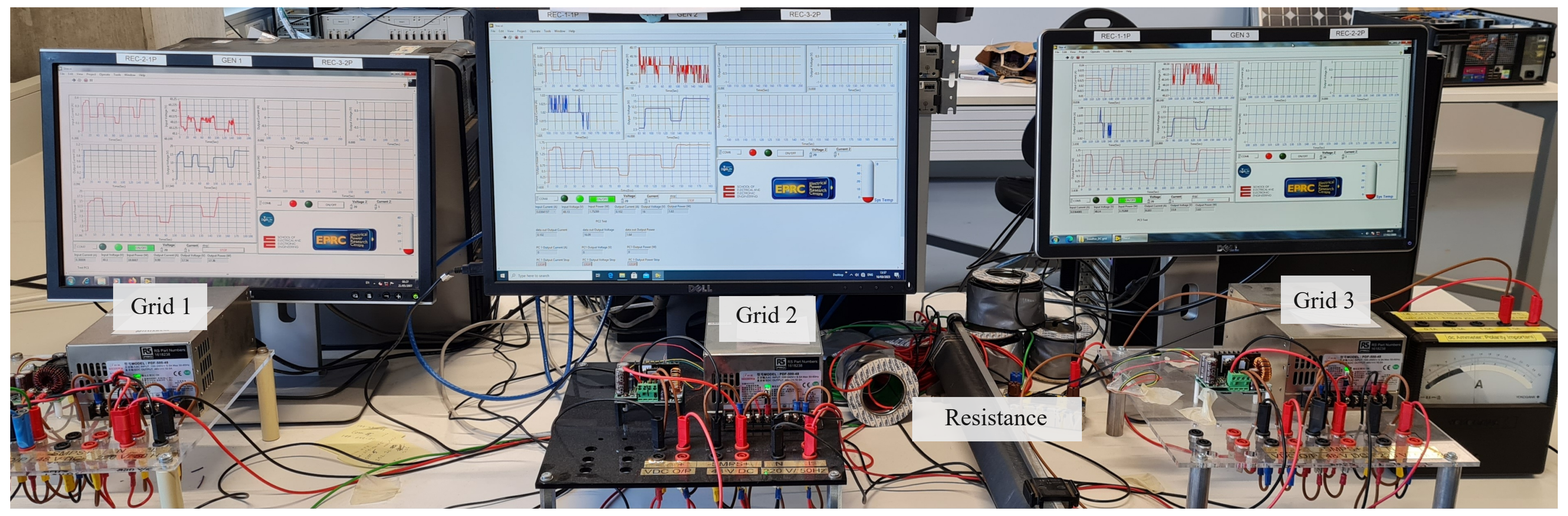


Figure 3. An integrated MG testbed is comprised of 3 DC sources, resistance and PCs. The LabVIEW interface shows the instant current, voltage and power values on PCs' monitors. When the variable resistance is changed, MG endpoints send the control data to re-allocate output power across the testbed.

What does this testbed look like in real life ?

- This testbed represents the connection of different MGs which are located in different places. For example, Grid 1 could be a wind turbine placed at home. Grid 2 and Grid 3 could be Photovoltaic panels placed at neighbours' houses. These devices are connected via power and network connection and perform fair load sharing.
- Varying resistance could be house-hold appliances such as washing machine.

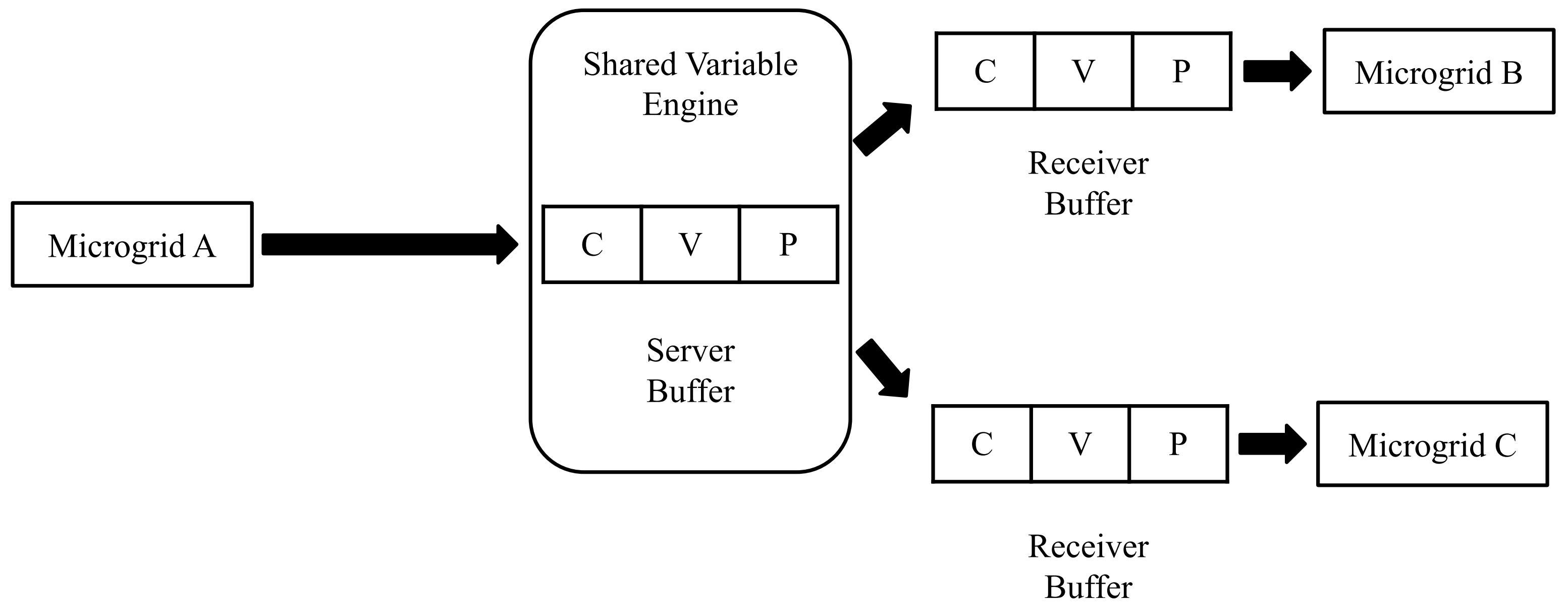


Figure 4. The LabVIEW's LogosXT algorithm is responsible for the buffer management. Current, voltage and power data are transmitted to the receivers if the buffer is completely full or after 10 ms expired.

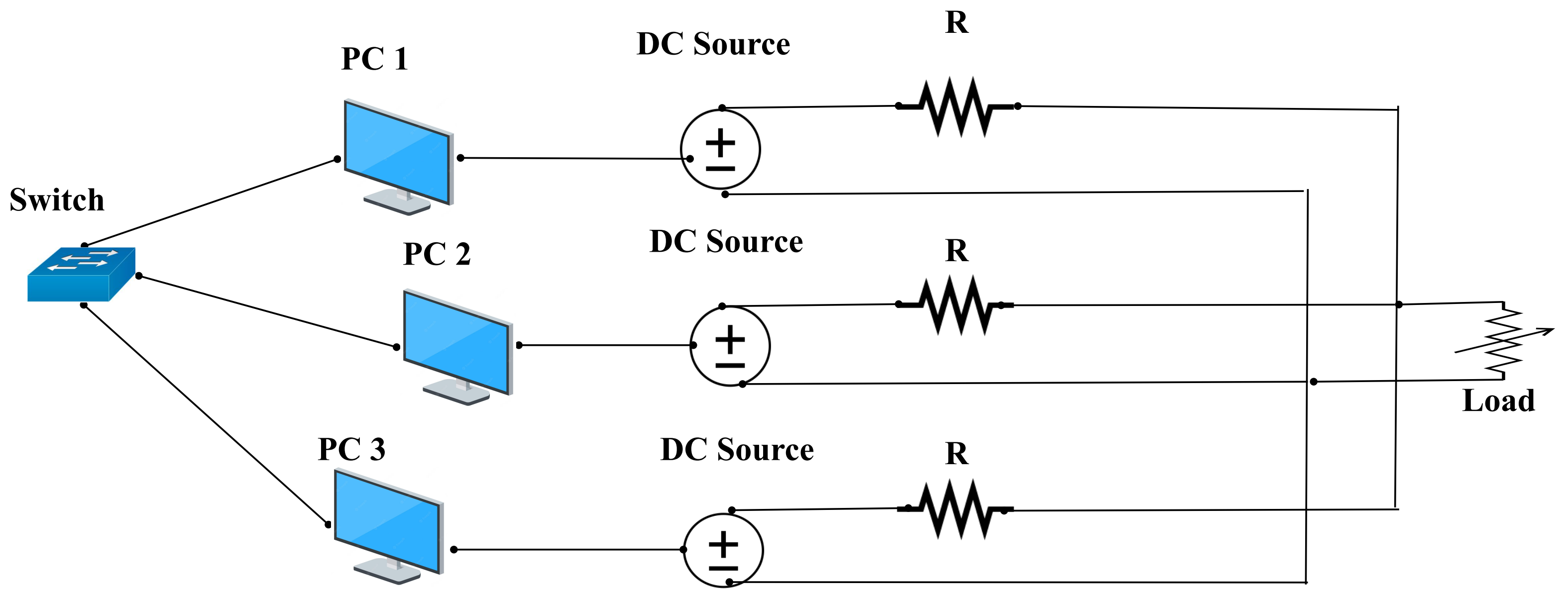
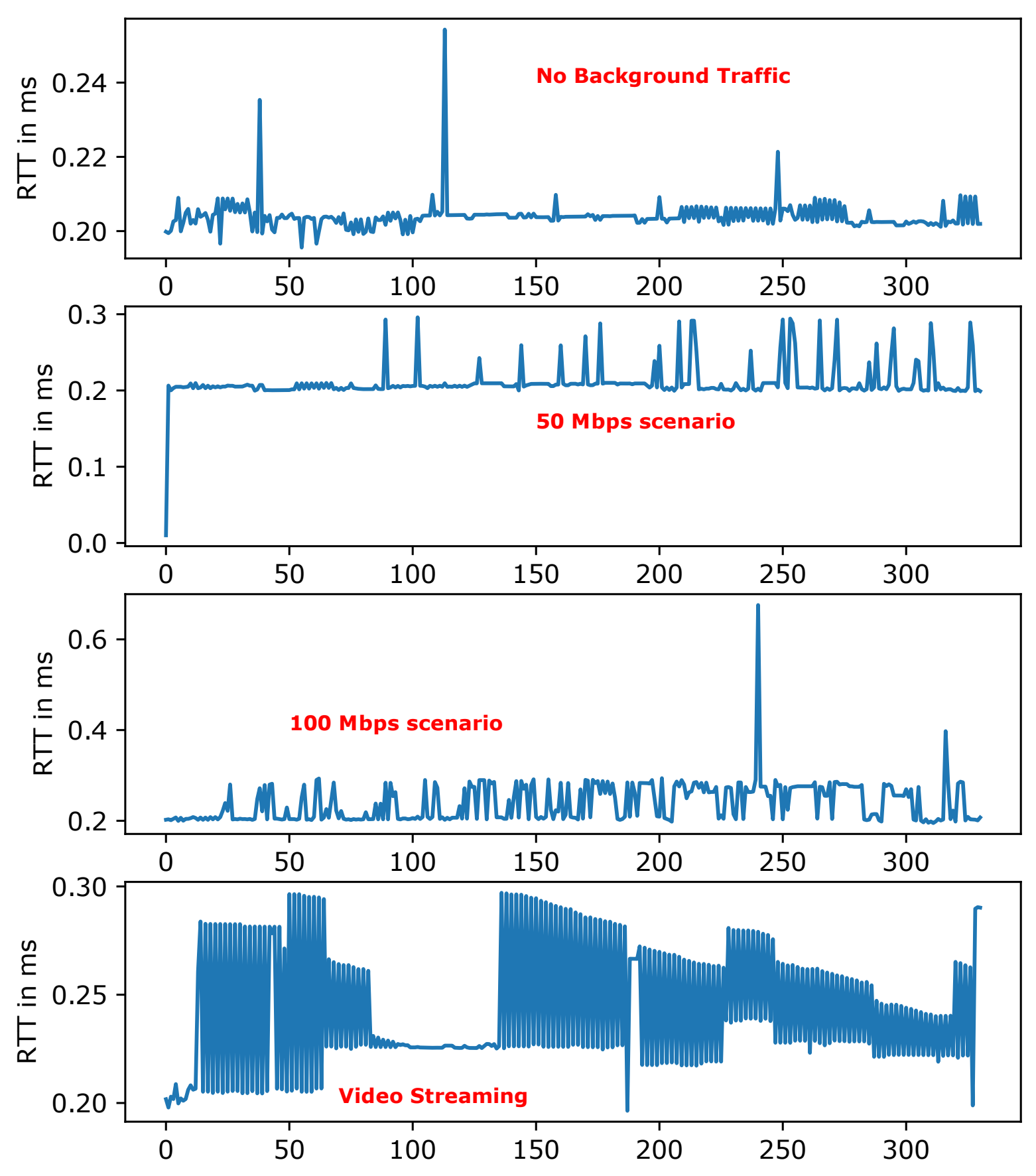


Figure 5. MG Testbed Circuit Diagram. The connection between different PC/MG endpoints is established via a L2 switch.

Results

- The results show that a high variance in the background traffic bit-rate leads to a high variance in the measured RTT values for MG control packets [2]. Future work will consider how Machine Learning can be used to predict future system state by modeling load and congestion [3][4].



Y-axis represents the RTTs in milliseconds.
X-axis shows the time domain in seconds.

Figure 6. The Video streaming session causes higher RTT values which means that the rate of convergence of MG control system is slower compared with the other experiments.

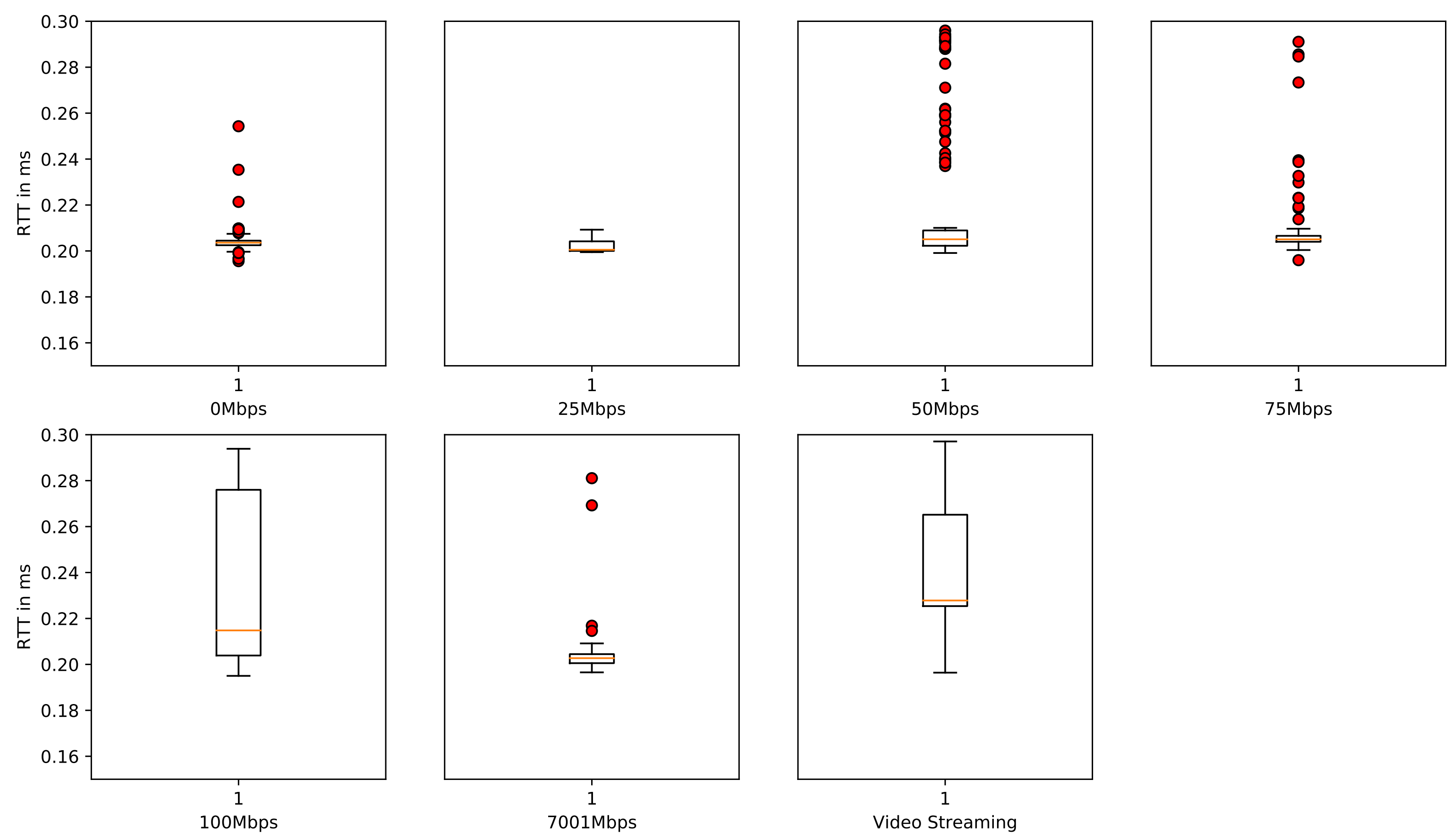


Figure 7. High variance of RTT values can be seen in 100 Mbps and Video streaming cases. Y-axis represents the RTT values in millisecond. These values are only given in the leftmost figure in each row.

Conclusions

- We found that Video streaming which represented a high variance in background traffic case caused greater RTT values.

Acknowledgement

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References

[1] S. Sengupta, H. Kim, and J. Rexford, "Continuous in-network round-trip time monitoring," in *SIGCOMM '22: ACM SIGCOMM 2022 Conference, Amsterdam, The Netherlands, August 22 - 26, 2022*, F. Kuipers and A. Orda, Eds. ACM, 2022, pp. 473–485. [Online]. Available: https://doi.org/10.1145/3544216.3544222

[2] Y. Kutlu, R. de Fréin, M. Basu, and A. Malik, "Round trip time measurement over microgrid power network," in *32nd Irish Signals and Systems (ISSC) Conference*, 06 2023, pp. 1–6.

[3] R. de Fréin, "The data-centre whisperer: Relative attribute usage estimation for cloud servers," in *2016 24th European Signal Processing Conference (EUSIPCO)*, 2016, pp. 687–691.

[4] R. de Fréin, O. Izima, and A. Malik, "Detecting network state in the presence of varying levels of congestion," in *2021 IEEE 31st International Workshop on Machine Learning for Signal Processing (MLSP)*, 2021, pp. 1–6.