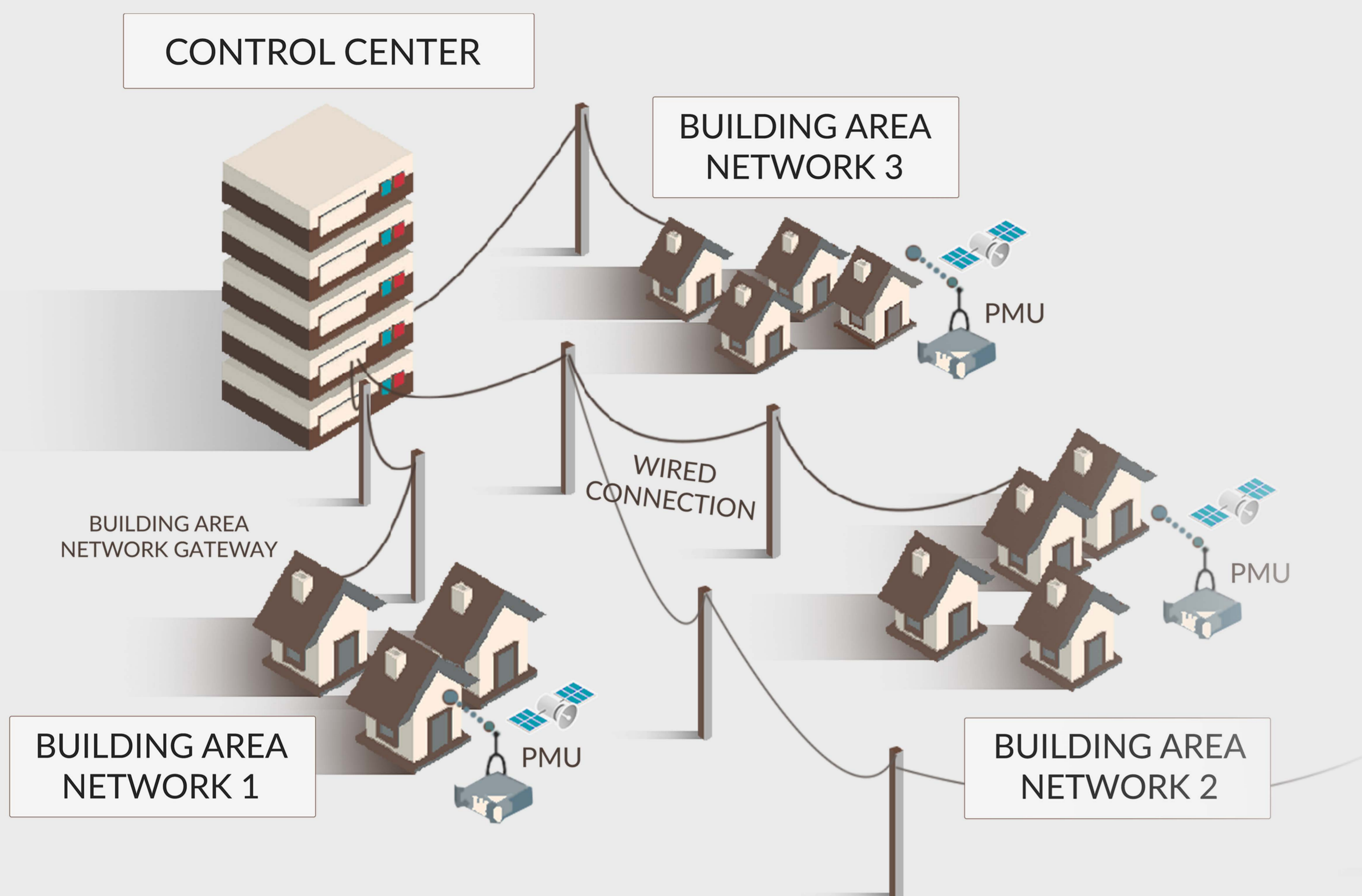


Quantum-Sim: An Open-Source Co-Simulation Platform for Research on Secure Quantum Key Distribution in Smart Grid Communications

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1- INTRODUCTION

In the IEEE Smart Grid roadmap for 2030, quantum communications have been recognized as an important topic for smart grids [1]. With a forecast of substantial adoption of optical fibre for smart grid communications by 2030, **QKD protocols have been proposed as a viable solution to long-term security problems.**

Our goal is therefore to provide the research community with a versatile co-simulation platform that can easily integrate and validate different scenarios, threats, and solutions in the context of quantum communication [2].

2- CO-SIMULATION

We propose a power flow-based co-simulation platform operating in discrete-time for low-voltage power grids and QKD protocols within the open-source MOSAIK framework [3].

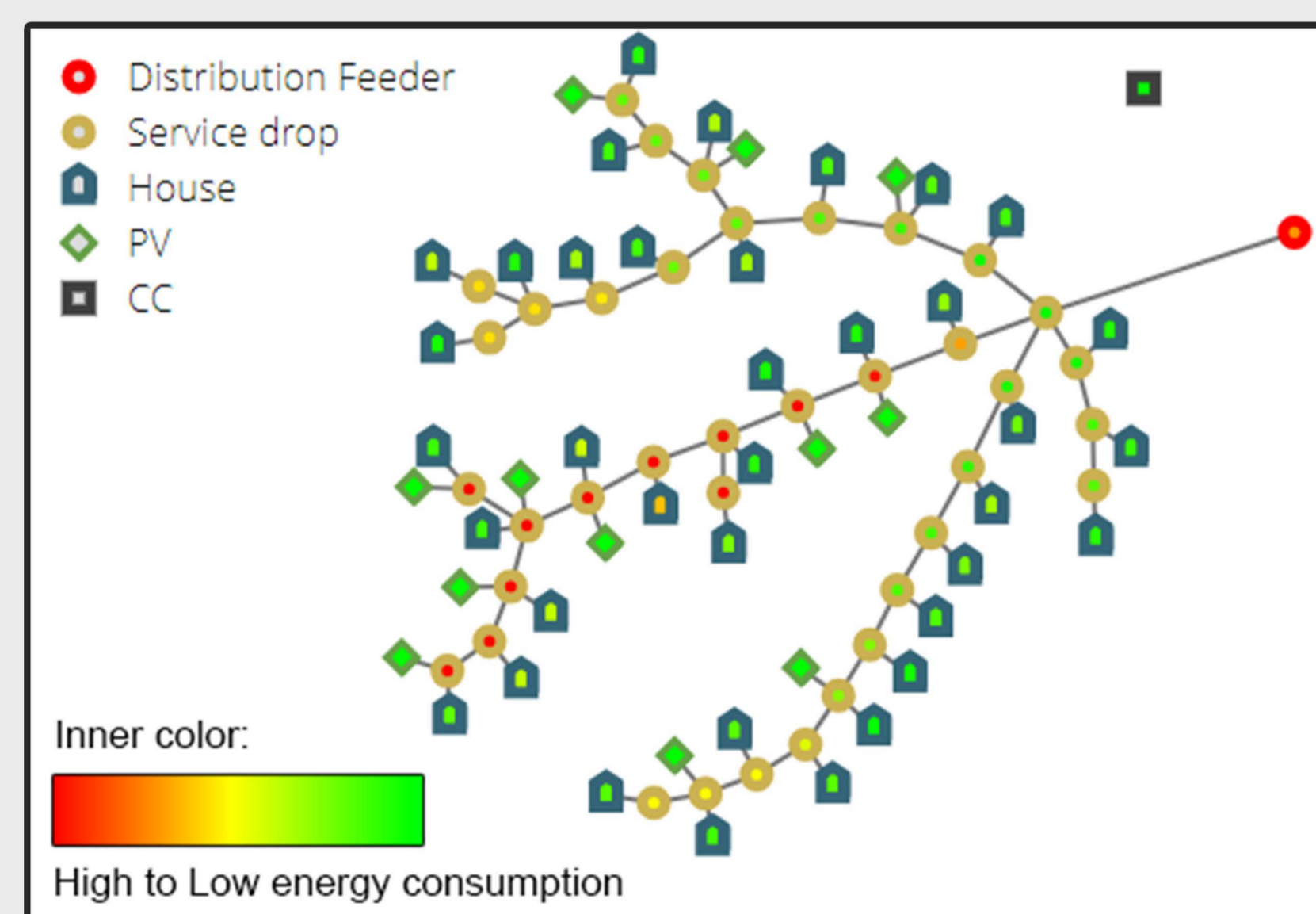
- Three QKD protocols: BB84, SARG04 and KMB09, with OTP and AES-256.
- Embedded customizable web-based interface for real-time visualization.
- A case study of quantum-based DR applications in a realistic distribution grid.
- Available for download as an open-source platform [4].

3- QKD PROTOCOLS

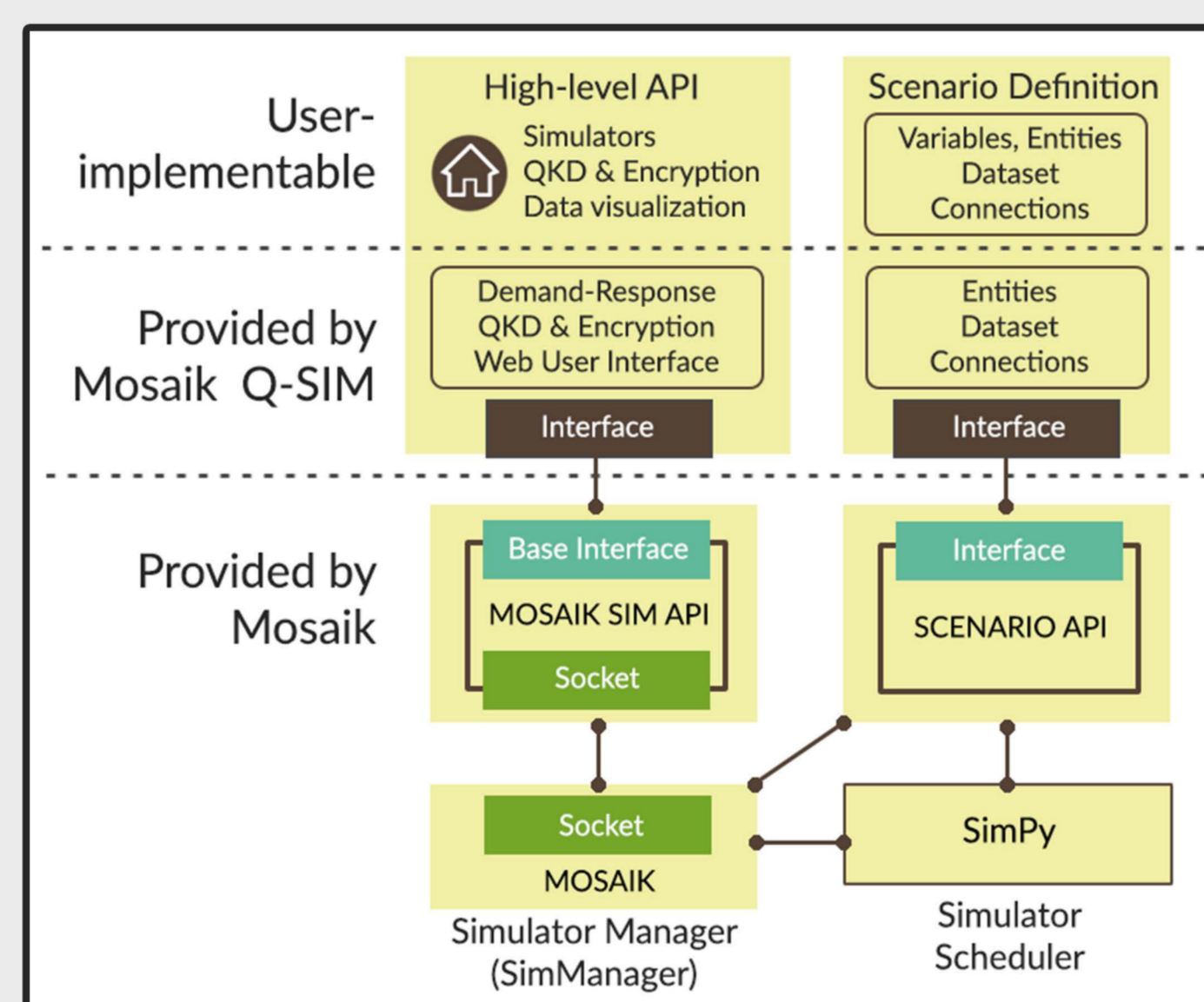


If the system is correctly configured, any attempt at observation or modification by Eve will be detected by Bob

4- Q-SIM PLATFORM

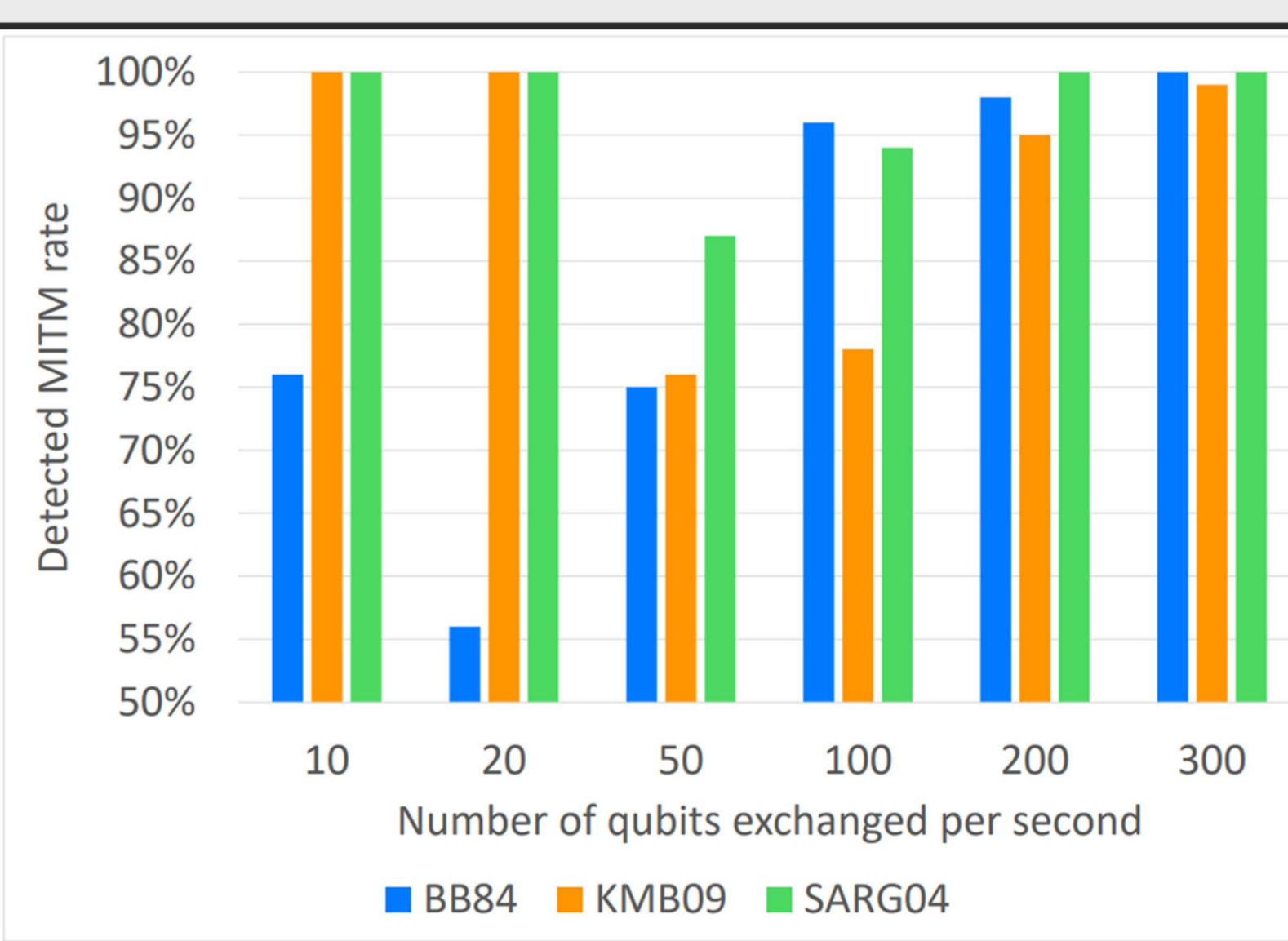


Topology of the distribution grid in simulation.

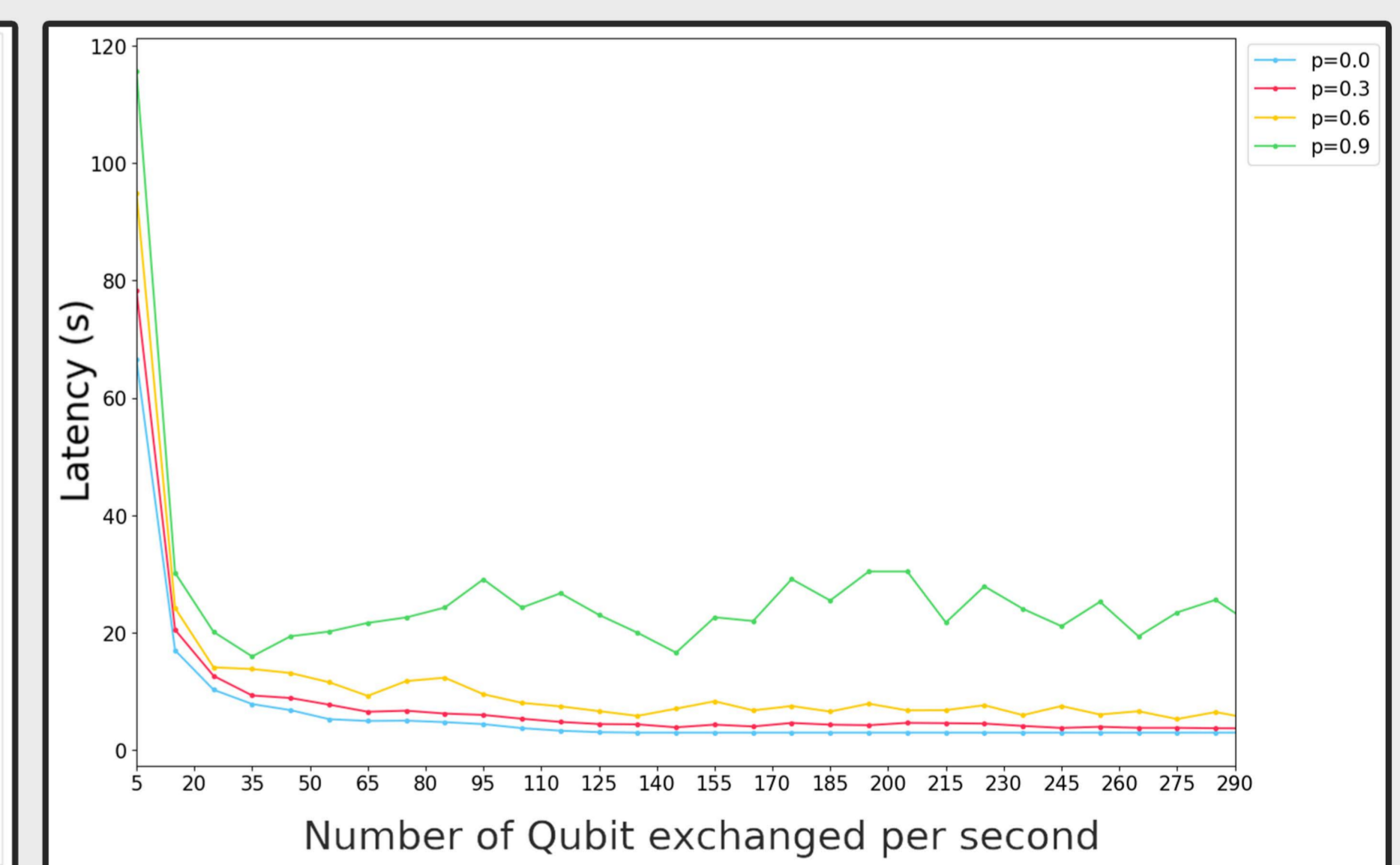


The MOSAIK Quantum-Sim Architecture

5- RESULTS



MITM detection performance of different QKD protocols



DR Latency with BB84 given different attack probabilities.

6- CONCLUSION

- QKD protocols can be a viable solution to ensure security while guaranteeing low latencies.
- Almost all attacks can be detected and ensure the confidentiality of communications, for example for DR.
- The protocols show an interesting synergy with the operation of smart grids, and the future smart grids infrastructure will allow the integration of these quantum protocols.

REFERENCES

- [1] S. Bush, S. Goel, and G. Simard, "IEEE Vision for Smart Grid Communications: 2030 and Beyond Roadmap," pp.1-19, Sep. 2013.
- [2] W. Lardier, Q. Varo, and J. Yan, "Quantum-Sim: An Open-Source Co-Simulation Platform for Quantum Key Distribution-Based Smart Grid Communications," accepted by the 2019 IEEE International Conference on Communications, Control, and Computing Technologies for Smart Grids (SmartGridComm) - Cyber Security and Privacy Symposium.
- [3] MOSAIK - A Flexible Smart Grid Co-Simulation Framework. [online] Available at: <https://mosaik.offis.de/> [Accessed 20 Apr. 2019].
- [4] W. Lardier, Q. Varo and J. Yan, "Quantum-Sim", (2019), GitHub repository, DOI: 10.5281/zenodo.3358908.

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