



# Cloud Digital Twin Concept for Distribution Systems

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## Digital Twin

is a digital simulation model that behaves in the same way as its real system. To realize a digital twin ...

1. We have to prepare the same simulation model as the real system.

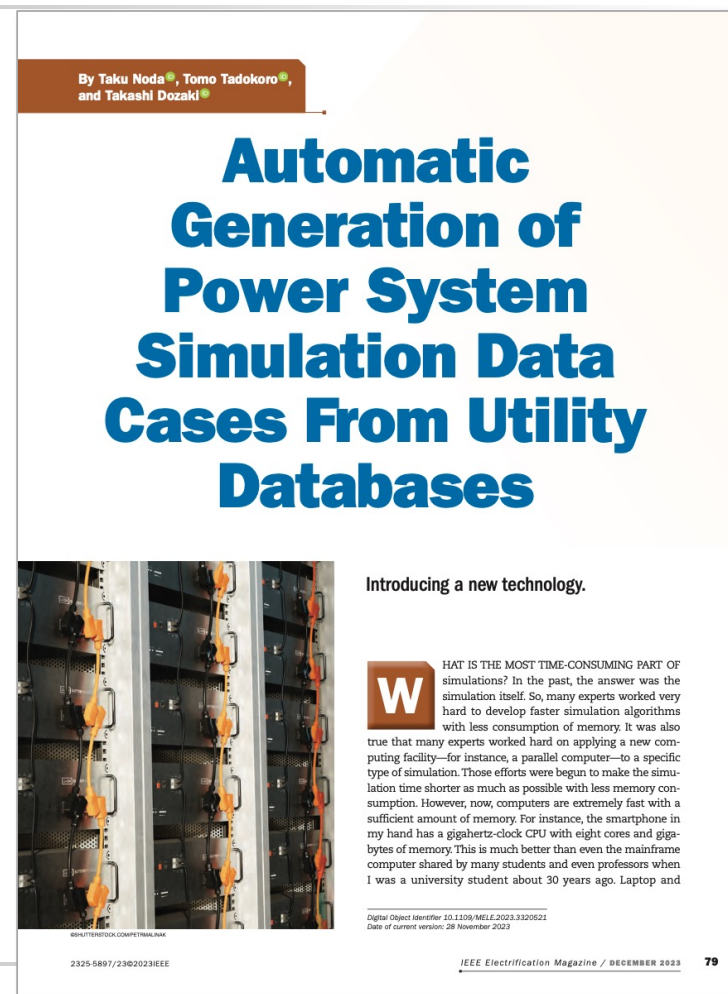
2. We need a computing facility which is fast enough for our purpose.

## What is the most time-consuming part of distribution simulations?

- ◆ In the past, the answer was the simulation itself.
- ◆ Now, the preparation of data cases for simulations.
- ◆ We have thousands of different distribution feeders. For each feeder, the topology changes.
- ◆ CRIEPI and seven T&D companies have developed the system called GriSim, which is usually used inside an intranet.
- ◆ GriSim automatically generates simulation data cases from utility DBs for power-flow and EMT simulation programs.

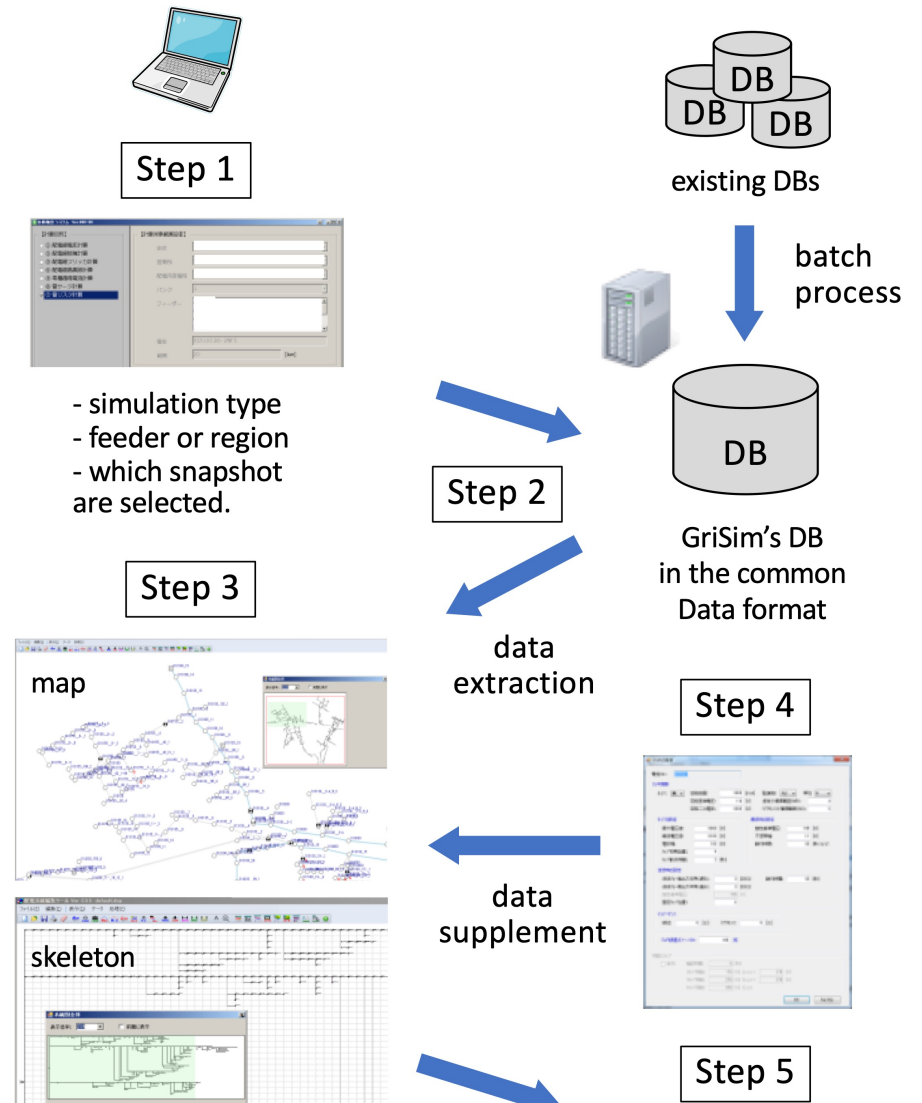
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- ◆ The development of GriSim and another system for transmission systems has been documented in the article (right).
- ◆ The development of GriSim has been carried out from Apr. 2016 to Mar. 2021.
- ◆ GriSim is used by seven T&D companies mainly for the assessment of renewable energy integration.
- ◆ The system for transmission systems is under development with all T&D co.'s.



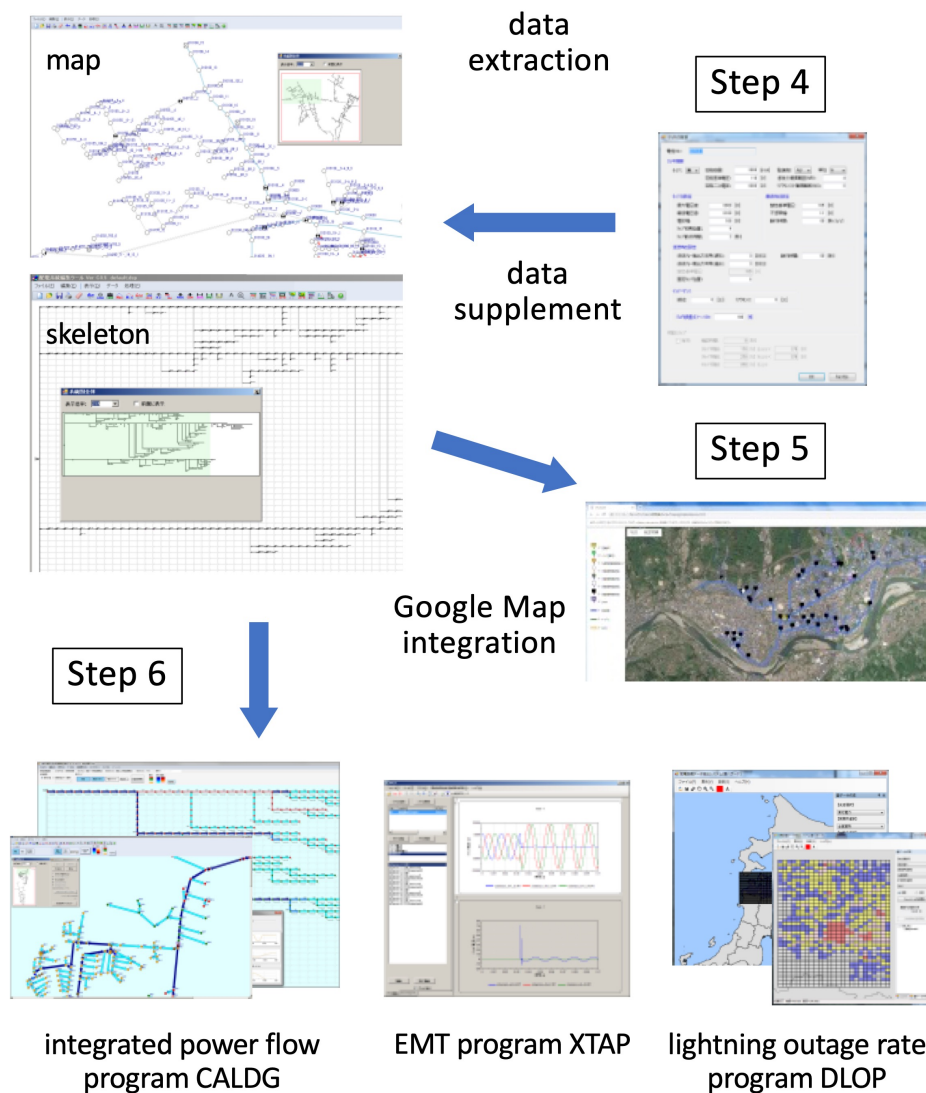
# How GriSim Works

- ◆ As a batch process, GriSim gathers necessary data into GriSim's DB in common format.
- ◆ Step 1: An engineer specifies a simulation type and a feeder.
- ◆ Step 2: The client extracts the data of the specified feeder.
- ◆ Step 3: Distribution substations, poles, overhead wires etc. are shown on a map or on a skeleton.



# How GriSim Works

- ◆ Step 4: The user supplements missing data at this point.
- ◆ Step 5: As an option, Google Map integration can be used.
- ◆ Step 6: The data case of the specified simulation type is automatically generated. In this case, the power-flow program CALDG, the EMT program XTAP and the lightning outage rate calculation program DLDP.



# Computing Facility for Distribution Digital Twin

- ◆ We have thousands of different distribution feeders. For each feeder, the topology changes. No fixed topology can be assumed.
- ◆ Rather than a real-time simulator, a “flexible” computing facility such as Amazon’s EC2 (elastic computing cloud) is preferred.
- ◆ Do we need hard real time for distribution simulations? We need a “fast” computing facility but not a hard real-time simulator.
- ◆ So, what we need is a “flexible” and “fast” computing facility so that any feeder can be simulated with a sufficiently fast speed.
- ◆ Now, Amazon’s EC2 can achieve a simulation speed which is faster than real time. It means that we can create a Cloud Digital Twin.

# Supporting Facts for Cloud Digital Twin

- ◆ In the past decade, there was a significant progress in the model-based design (MBD) technologies.
- ◆ Before the progress, the implementation of the control system of a facility, obtained as a result of simulations, involved manpower and errors. This justified the use of real-time simulators.
- ◆ Thanks to the MBD technology progress, the control system used in the simulations can be burnt into field programmable gate arrays (FPGAs). This now justifies no need of real-time simulators.
- ◆ In addition, vendors of distribution facilities are relatively-small and cannot afford real-time simulators.



# Conclusion

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- ◆ We would like to propose the following Cloud Digital Twin concept for distribution systems.
- ◆ By specifying a feeder, a simulation data case is automatically generated by extracting data from existing DBs. For this, we have developed GriSim with the seven T&D companies.
- ◆ The simulation data case generated is reproduced on a cloud computing facility such as Amazon's EC2 as a digital twin.
- ◆ A control system supplied by a distribution facility vendor is tested in the "Cloud Digital Twin," before deploying in an actual distribution system thus leading to a faster deployment.

## Reference

- ◆ T. Noda, T. Tadokoro and T. Dozaki, “Automatic Generation of Power System Simulation Data Cases From Utility Databases: Introducing a new technology,” IEEE Electrification Magazine, vol. 11, no. 4, pp. 79-85, Dec. 2023, doi: 10.1109/MELE.2023.332052. URL: <https://doi.org/10.1109/MELE.2023.3320521>
- ◆ T. Tadokoro, T. Noda, K. Ishimoto, N. Okada, S. Uemura and Y. Shumuta, “Automatic Generation of Input Data for Distribution System Simulation Programs,” 2018 IEEE Innovative Smart Grid Technologies - Asia (ISGT Asia), Singapore, 2018, pp. 25-29, doi: 10.1109/ISGT-Asia.2018.8467719. URL: <https://doi.org/10.1109/ISGT-Asia.2018.8467719>

If you have a questions or comments on this topic, let us know by leaving a message to this video.

Thank you very much for watching this video.



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