Power Metaverse

Use Cases Relevant to Grid Side & User Side

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01 Introduction of Power Metaverse

1 Background

- Nowadays, the energy system is growing more complex, with diverse and interconnected components. This complexity presents challenges for Situation Awareness beyond traditional reductionism.

- Advances in digitalization and technology are reducing costs and creating opportunities for power metaverse technology.

- Digital twins are 1-to-1 mapping from PE to VE, and they are limited to retrospective analyses of historical and current circumstances.

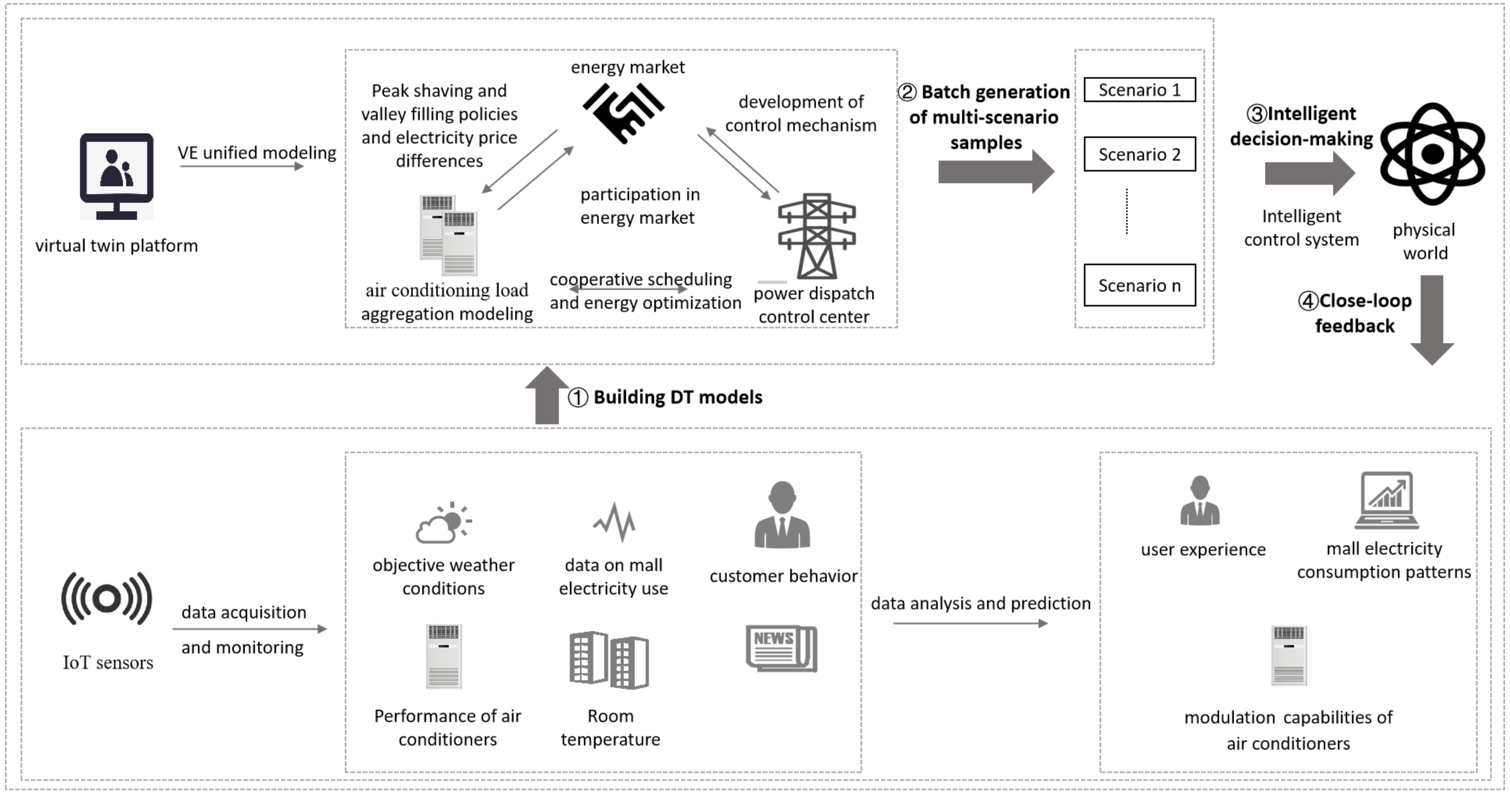
- Power metaverse(PM) is more complex and functional. After constructing VEs, it can create hypothetical virtual scenarios at will and make each of them evolve in order to accomplish 1-to-N projections from PE to VE while adhering to the fundamental principles.

02 Use Cases For Power Metaverse

2.1 User Side: Automatic Control For Air Conditioning

The application of PM technology to simulate the results of different air conditioning output strategies:

- the output status in the mall;
- the peak shaving and valley filling effects on the power grid.



- Inputs:climate conditions, customer flow, and comfort requirements;
- Controlled variables: air conditioning load;
- Outputs: room temperature and customer satisfaction.

Major requirements and key technologies:air conditioning load aggregation modeling, cooperative scheduling and energy optimization.

2.1 User Side: Automatic Control For Air Conditioning

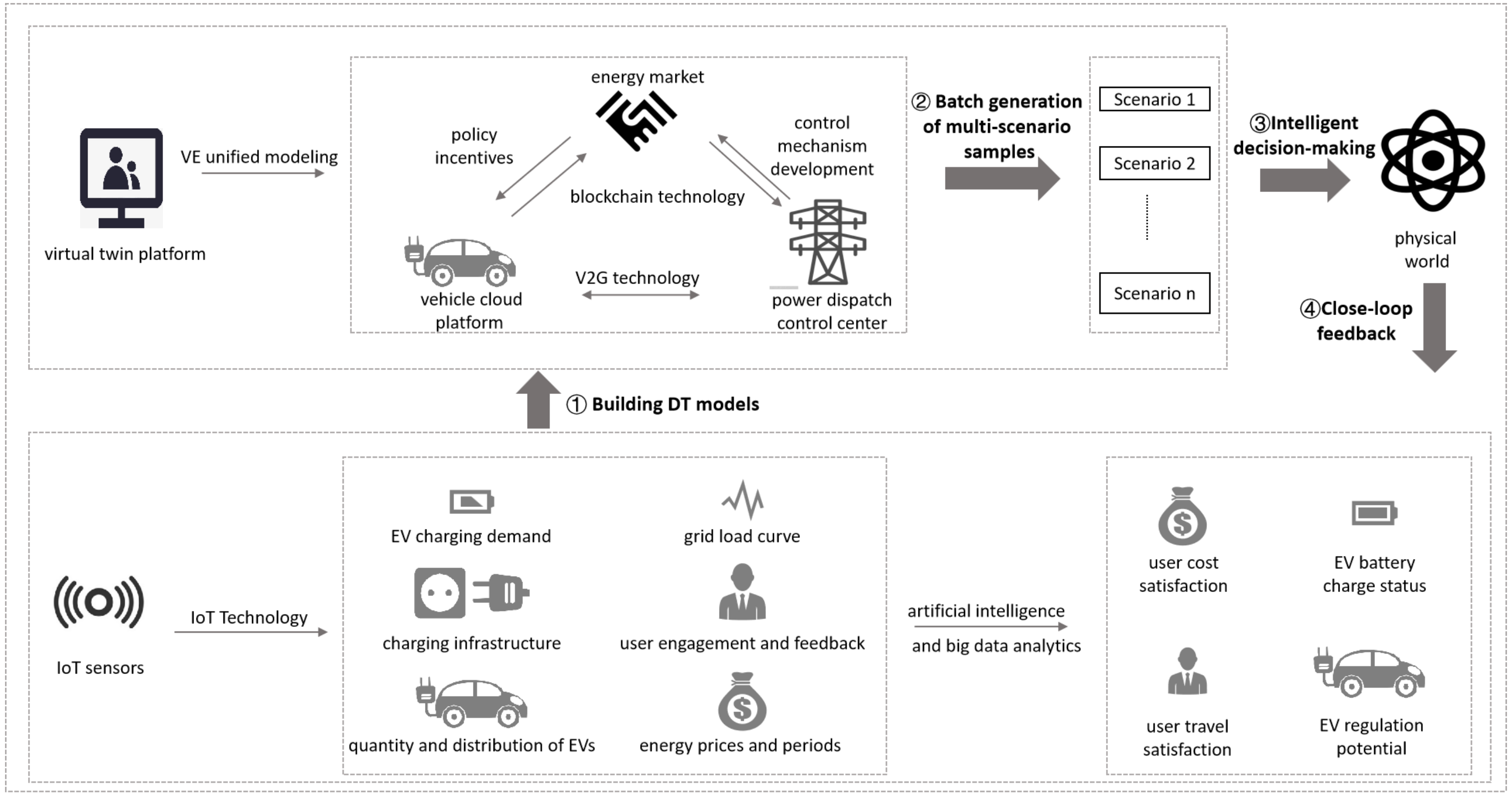
Operation Management and Monitoring Platform

This integration of the metaverse with air conditioning systems revolutionizes the way we experience and manage indoor climate control.

2.2 User Side: Electric Vehicles

PM technologies are used to explore more flexible charging and discharging strategies to achieve peak-shaving effects.

- Inputs: the user's stopping time, remaining car battery power, charging needs, and willingness to participate degree
- Controlled variables: charging power
- Outputs: EV battery charge status, user travel satisfaction, and cost satisfaction



Major requirements and key technologies: construction of charging infrastructure, vehicle cloud platform, V2G.

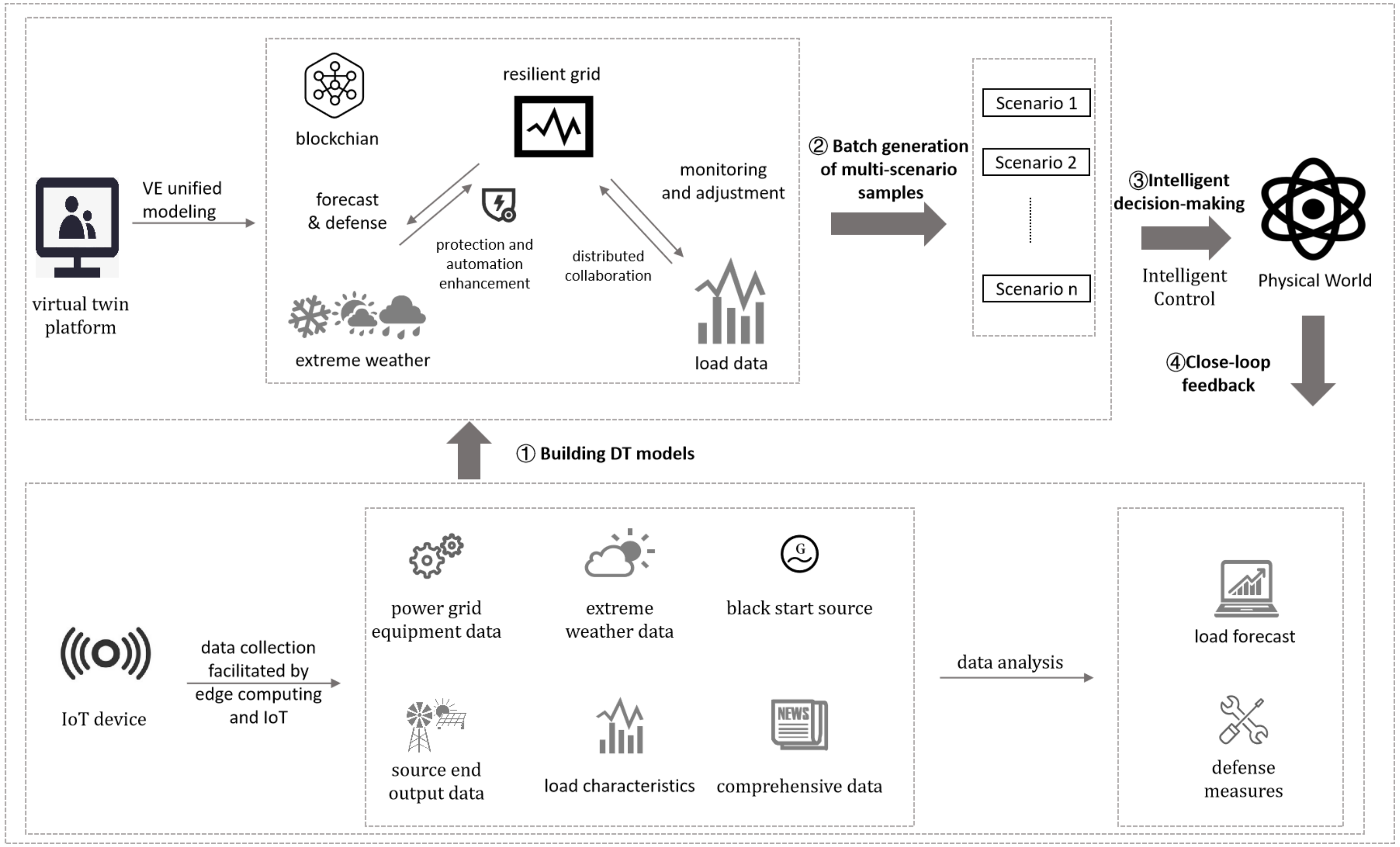
2.2 User Side: Electric Vehicles

The metaverse enables efficient electric vehicle management, allowing remote monitoring and control, full participation in peaking response.

2.3 **Grid Side:** Resilient Power Grids

The application of PM technology in a resilient grid through load prediction and defense under extreme weather conditions.

- Inputs: the equipment parameters in the grid, the load characteristics of various users, data from government emergency centers, government network information security centers, and department of water, gas and energy sources.
- Controlled variables: different extreme weather conditions
- Outputs: load forecasts, and corresponding defense measures.



Major requirements and key technologies: distributed coordination, edge computing, blockchain, IoT (Internet of Things).

2.3 **Grid Side:** Resilient Power Grids

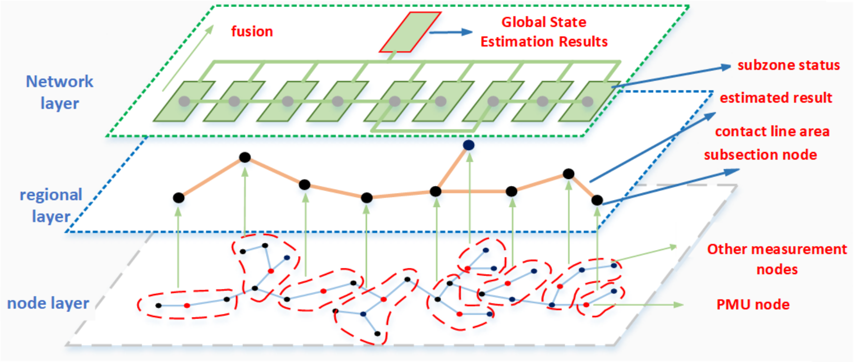
Super Typhoon

Flood Disaster

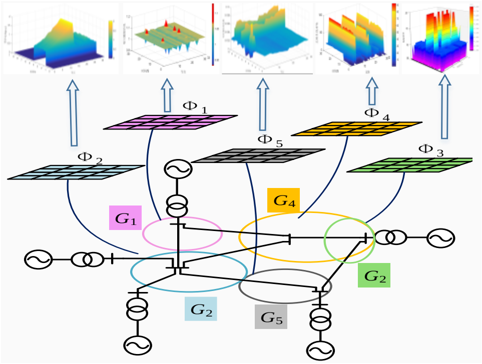
Snow & Ice Disaster

Earthquake

Status Assessment



Status Alert

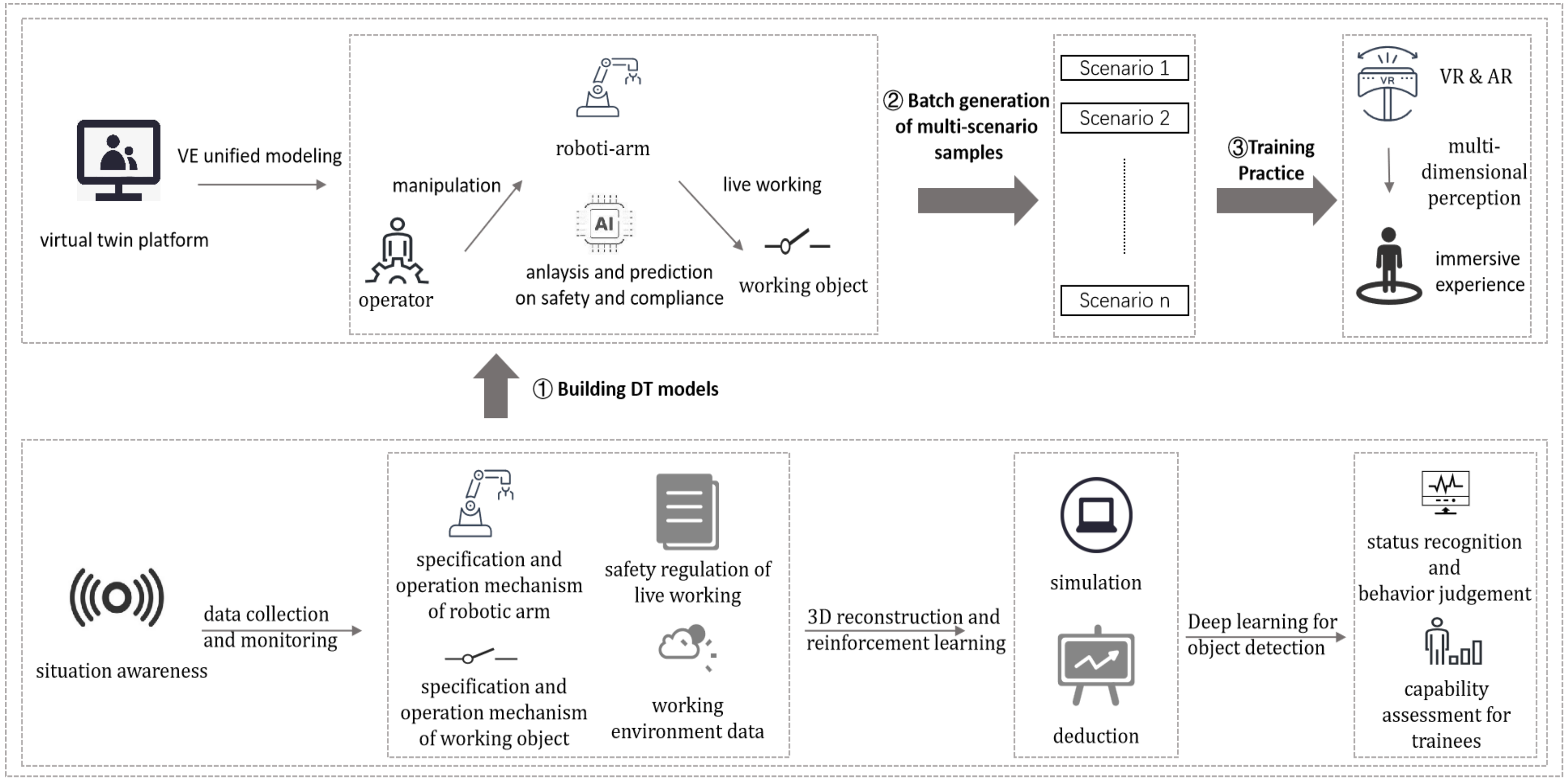


By analyzing the state of the power grid based on the temporal dimension and conducting cross-referencing of multiple faults, we can determine the causes of abnormalities and predict potential warning signs.

2.4 **Grid Side:** Training For Live Working In Distribution Network

Use the PM technology to build a training system for live working in distribution network.

- Inputs: manipulation actions of human
- Controlled variables: controlled actions like offset, extension, contraction, rotation of main body and joints of robotic arm.
- Outputs: forced actions of working object, together with the performance evaluation of working process in terms of safety and compliance.



Major requirements and key technologies: specifications and operation mechanism of robotic arm, specifications and operation mechanism of working object, situation awareness, virtual reality, augmented reality, and object detection are integrated in this application.

2.4 **Grid Side:** Training For Live Working In Distribution Network

Real-time data integration in the metaverse enhances the training's realism and prepares workers for dynamic scenarios. Leveraging the metaverse for training optimizes skill development and ensures proficient live working in distribution networks.

03 Prospects

3 Prospects

The metaverse can also be extended to other scenarios, offering a broader range of functionalities and providing efficient solutions.

■ In the field of Distributed Energy Resources (DER) regulation

The metaverse can optimize energy use usage while balancing the power system's load. For example, in storage areas such as food and pharmaceuticals, refrigeration equipment can be automatically adjusted in PM according to the load demand of the power system to maximize energy utilization.

■ In the field of energy transmission

Energy companies can utilize PM technology to monitor and manage energy transmission equipment in real time, analyze the main factors causing line loss and network congestion, optimize the transmission process, and improve the efficiency and reliability of energy transmission. Meanwhile, by leveraging virtual reality technology for network planning and optimization, the PM can provide intelligent energy transmission solutions.

■ In the field of electric power system planning

The PM can assist in optimizing the planning and design of power systems. By creating a virtual power system that simulates the power grid's topology, integration of renewable energy sources, load forecasting, disaster management, and recovery, the PM can provide comprehensive data support and decision assistance to designers.

Thanks For Your Attention