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Establishing an Integrated Control Platform Architecture for Hydrogen Pipe Network

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Abstract: This study was conducted to establish a hydrogen pipe network integrated control platform architecture for integrated management of full cycle information and data using digital twin technology, which is widely used in general industry and construction industry. To this end, we present a hardware configuration diagram for platform operators and service delivery methods, and an architecture(functional configuration diagram) for the development of a hydrogen pipe network integrated control platform. The results of this study conducted through the above process are summarized as follows. First, to establish the platform basic structure, the platform hardware configuration diagrams for WEB server, WAS server, DB server, BIM file conversion server, storage, and backup were presented. Second, the architecture(functional configuration diagram) for the hydrogen pipe network platform, platform utilization interface, external system, hydrogen pipe network standard system, and BIM-based hydrogen pipe network digital twin construction was presented to secure consistent data and manage information standards for each construction stage.

Key words: Building Information Modeling(BIM), Hydrogen Pipe Network, Platform, Architecture

1. INTRODUCTION

Due to global warming and climate change, which are global concerns, the international community has established and actively promoted policies for carbon neutrality. The government of the Republic of Korea is actively supporting systems, policies, and R & D that are essential for the hydrogen economy and the hydrogen industry through major ministries such as the Ministry of Trade, Industry and Energy and the Ministry of Land, Infrastructure and Transport. However, the technology related to the construction and operation of large-diameter hydrogen pipe and hydrogen pipe network suitable for large-capacity demand to be applied to the hydrogen city development has technical limitations, and it is time to develop the technology accordingly.Therefore, it is necessary to secure design, construction, and operation technologies applicable to hydrogen cities and to develop infrastructure technologies that can consistently and standardically manage various information generated by each stage of the life cycle of the project. In this study, we propose a hydrogen pipe network integrated control platform architecture.

The above purpose of this study may be elaborated further as follows:

1) It presents the platform basic structure and platform hardware configuration diagram for various information generated during hydrogen pipe network construction.

2) Based on this, we propose a BIM-based hydrogen pipe network digital twin architecture for securing consistent data and managing information standards for each stage of construction.

2. PLATFORM HARDWARE CONFIGURATION DIAGRAM

2.1. Platform basic structure

The basic hardware of the integrated control platform of the hydrogen pipeline network, which is the result of this study, consists of firewalls such as WEB server, WAS server, DB server, BIM conversion server, storage, backup, relay server, platform operator, service method, and number of users. Because no details have been confirmed, a basic configuration level of planning has been established.

2.2. Hardware confiruration diagram

The WEB server for the hydrogen pipe network integrated control platform is a server that provides web pages or files through a web browser and HTTP protocol, and the static contents of the web site are processed, and the dynamic contents are requested to the WAS server. The WAS server is a web application server, and the server that receives and processes the dynamic contents request from the web server and delivers the result to the web server is constructed, and the WAS server is suggested to perform business logic or database interworking of the web application. In addition, the DB server is a database server, and a server that stores and manages data used in a web application is constructed. The DB server receives and processes a database-related request from the WAS server and transmits the result to the WAS server.The BIM conversion server constructs a server that converts the BIM file into another format or extracts the information of the BIM model, and the BIM conversion server receives and processes the BIM-related request from the web server or WAS server and transmits the result to the web server or WAS server. Storage is a device that stores data created or used in web servers, WAS servers, DB servers, and BIM conversion servers, and backup is a device that regularly copies data stored in storage and stores it in another location. Backup was built to prevent data loss or damage and enable data recovery, and other firewalls and relay servers were built to strengthen network security, manage traffic, and improve service connectivity. The firewall was built to protect internal data by blocking attacks or intrusions from the outside. The relay server is located between the client and the server and relays requests and responses, performs caching, load balancing, and compression, and is presented in a configuration that matches the security level of the server environment including the platform. The configuration diagram for the above is shown in Figure 1 below.

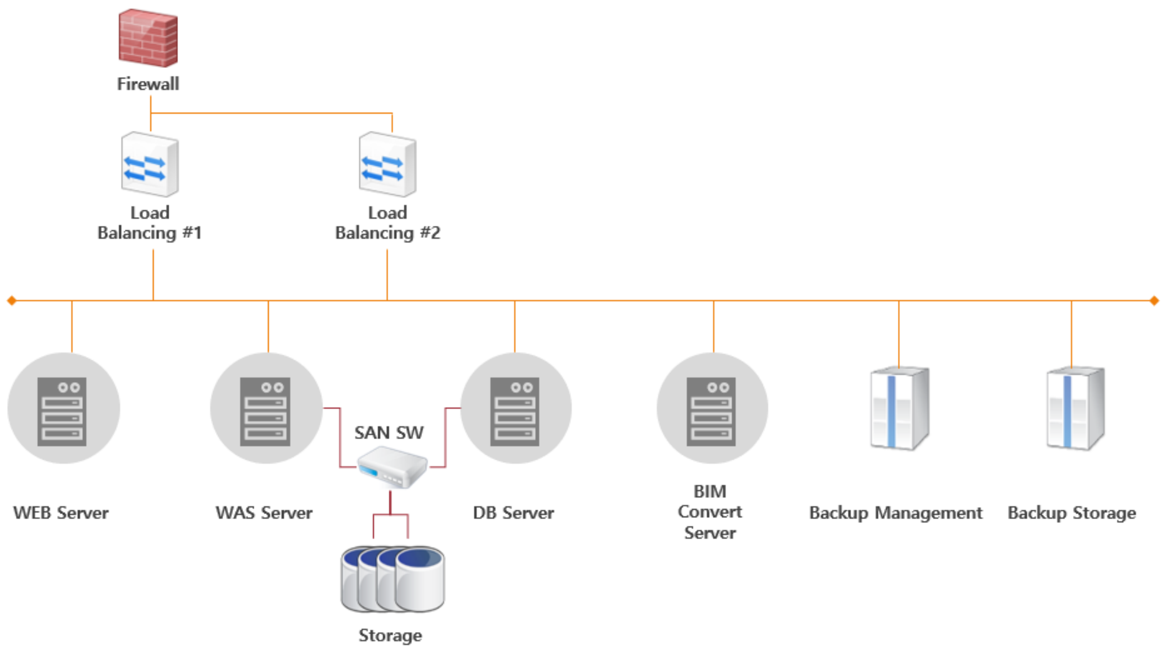

Figure 1. hydrogen pipe network hardware diagram

3. THE HYDROGEN PIPE NETWORK INTEGRATED CONTROL PLATFORM ARCHITECTURE OF THE DIGITAL TWIN BASE

The hydrogen pipe network integrated control platform consists of CDE (Common Data Environment) and platform basic modules. CDE is an environment in which the geometric information, attribute information, and related digital data of the BIM model are stored and managed in an integrated manner, and the platform basic module is the core of the platform. It is a program whose core functions are modularized so that almost no changes occur even if the user interface is changed through function modules. In addition, the user interface is built to respond to the user's needs by accessing the core functional module and CDE through the API of the platform. The external system that needs to be linked can also be linked with the system through the API, and the digital twin data used in the platform can be used regardless of the type of BIM authoring tool. ISO 16739, IFC format, which is a neutral format of international standards, is utilized. After the quality of the given level irregularity is secured through the BIM data automatic quality review module, it is transformed to necessary data in CDE and data inputted with IFC is used.The above-mentioned digital twin-based hydrogen pipe network integrated control platform architecture is shown in the following figure 2.

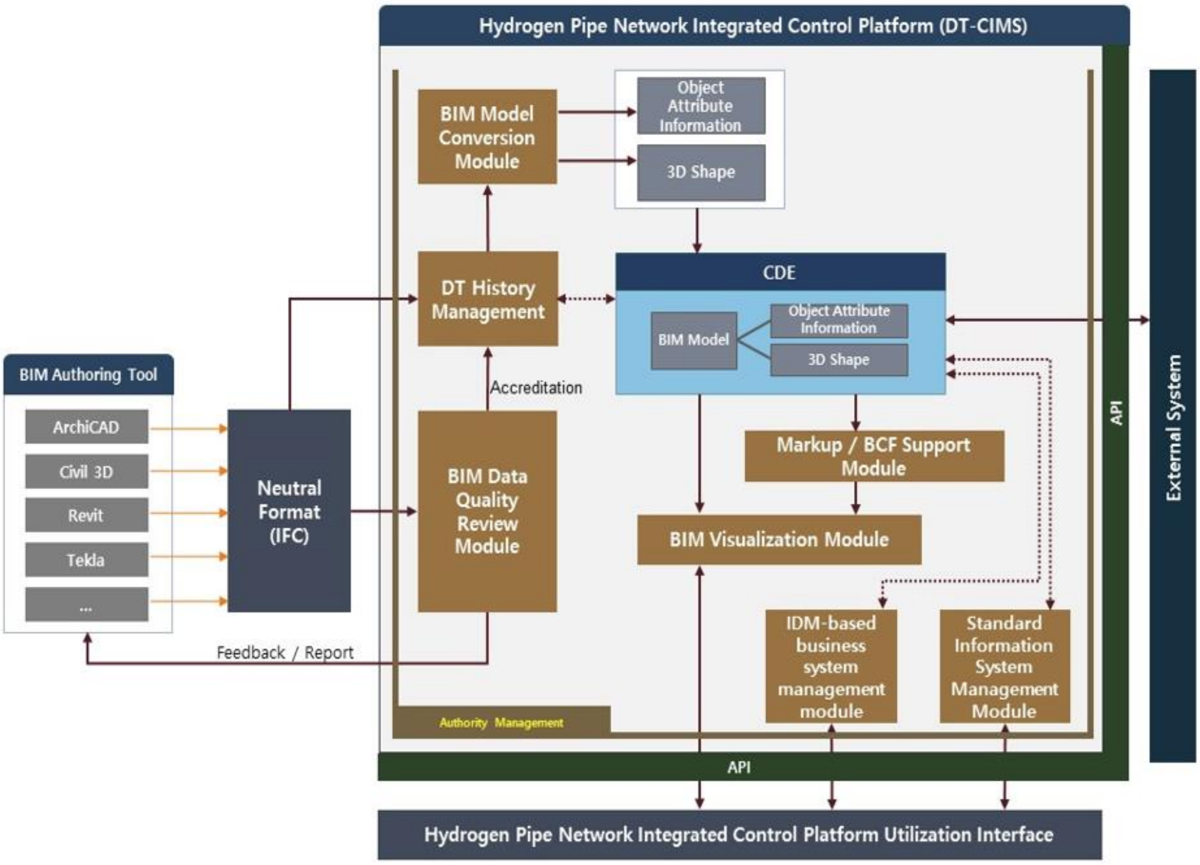

Figure 2. Concept of Digital Twin-based Hydrogen Pipe Network Integrated Control Platform Architecture

The interface of the digital twin-based hydrogen pipe network integrated control platform provides the functions required by the user through the API of the CDE and the platform basic module of the hydrogen pipe network platform, and the user uses the hydrogen pipe network platform through the hydrogen pipe network platform utilization interface. The external system is linked through the API, and real-time information of the IoT sensor mounted on the facility can be stored and utilized as data on the platform through the API. In addition, the control of the equipment through the IoT sensor can be done through the API, and various external systems can be developed through the API service specification of the platform, so that various extensions can be utilized.In the case of the standard system, the platform basically applies the openBIM-based information system and domestic and international BIM-related standards and guidelines, and identifies and presents the object classification system, attributes and libraries that should be defined separately in the hydrogen network.

4. CONCLUSION

First, The basic structure of the hydrogen pipe network integrated control platform is presented, and hardware configuration diagrams for WEB server, WAS server, DB server, BIM conversion server, storage, backup, and other firewalls and relay servers are presented.

Second, Based on the above contents, we proposed a digital twin-based hydrogen pipe network integrated control platform architecture that utilizes platform utilization interface, external system linkage, hydrogen pipe network standard system and BIM technology.

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