Exploring the Intersection of NVIDIA Omniverse, Digital Twins, and the Industrial Metaverse Through Advanced 3D Modeling Technologies

Sponsored by: Dell Technologies and NVIDIA

Arnal Dayaratna
October 2023

OVERVIEW

Recent years have witnessed increased interest on the part of technology suppliers and their customers in the digitization of physical objects and products such as automobiles, proteins, pharmaceuticals, real estate and architecture, spacecraft, and the weather. The intensification of this interest in the modeling of 3D objects and systems is attributable, in part, to increased awareness and adoption of GPUs in application development. The deepened integration of GPUs into development technologies empowers developers to create 3D models and systems of increasingly complex objects and processes that have an accuracy and adaptability that was previously unavailable because of the lack of requisite computational power.

SITUATIONAL OVERVIEW

NVIDIA Omniverse is a software development platform for connecting and building 3D pipelines, tools, applications, and services based on OpenUSD. The platform responds to the contemporary need of organizations to develop models of complex processes, objects, and systems by providing a development platform that specializes in digital twin and industrial metaverse development. The platform features connectors to an expansive universe of third-party development technologies that specialize in 3D modeling and architecture. Examples of technologies that NVIDIA Omniverse supports include Autodesk 3ds Max, Autodesk Alias, Blender, Autodesk Revit, McNeel Rhinoceros, Epic Games Unreal Engine, Autodesk Maya, and Unity. The platform's support of third-party modeling technologies, as well as most common CAD formats via direct import or third-party conversion to Universal Scene Description (OpenUSD), empowers distributed teams to collaborate in shared workspaces to build digital solutions that leverage functionality from a multitude of discrete applications.

This ability to centralize contributions from artists and development teams accelerates development by providing a shared workspace that development teams can use to build complex applications from a multitude of modeling applications. Moreover, NVIDIA Omniverse features modular and extensible components and developer tools that enable the creation of microservices, extensions, APIs, and net-new applications.

The Omniverse platform supports development from engineers, designers, artists, and content creators who are interested in creating models of 3D processes and systems. The platform's

foregrounding of microservices development empowers organizations to rapidly build scalable tools, applications, and services that can be accessed by distributed teams. Powered by a multitude of GPUs on NVIDIA RTX workstations or in the cloud, Omniverse enables developers and artists to create high-fidelity, physically accurate simulations of complex processes without concerning themselves with the foundational infrastructure on which those simulations run.

Definitions

Digital twins and the industrial metaverse constitute two examples of modeling technologies that have enhanced the ability of organizations to model complex processes, objects, and systems.

Digital Twins

A digital twin is a virtual representation of an object or system that incorporates simulated data in conjunction with data that is derived from its real-world counterpart. Digital twins enrich and accelerate product testing, accelerate product development, expedite the resolution of product-related issues or bug fixes, and reduce product development costs. Moreover, digital twins lead to improved customer satisfaction as well as enhanced innovation. In the context of software development, digital twins accelerate and enrich the development of digital solutions.

Industrial Metaverse

The metaverse refers to the next generation of the internet that is characterized by interconnected 3D virtual worlds and environments. Whereas the internet enabled the transfer of 2D information such as text, images, and videos, the industrial metaverse unlocks insight into how connected physical processes and scenarios can be designed, monitored, and optimized. Because the metaverse connects 3D virtual worlds that are experienced via monitors, television screens and, on occasion, augmented reality/virtual reality (AR/VR) glasses, it should be understood not as a place but rather as a 3D iteration of the internet that transforms 2D web pages into 3D spaces and environments.

The industrial metaverse refers to industrial use cases or attributes of the metaverse such as 3D representations of manufacturing facilities and industrial appliances and devices. One notable benefit of the industrial metaverse is the opportunity to provide users with deepened insight about the user experience of an object or process designed within it. Another important benefit of the metaverse is the opportunity to train users on the use of objects in hazardous or precarious operating environments and conditions.

NVIDIA Omniverse Architecture

The Omniverse platform is made up of a collection of fully customizable and extensible foundation applications and core platform components, giving developers the capabilities needed to develop custom tools, workflows, and applications.

Example platform components of interest to developers include:

- **Omniverse Kit:** A toolkit for developers to create their own custom tools and extensions that streamline their workflows
- **Omniverse Connect:** Opens the portals that allow content creation tools to connect to the Omniverse platform
- **Omniverse Nucleus:** Allows users to store, share, and collaborate on project data and provides the unique ability to collaborate live across multiple applications

While Omniverse Connect illustrates the platform's ability to integrate content generation technologies, Omniverse Kit underscores its support for the development of dedicated applications, microservices, and plug-ins. Meanwhile, Omniverse Kit enables developers to leverage integrations from disparate technologies to create net-new applications that either are standalone or serve as an input to another application. Omniverse Nucleus serves as a storage infrastructure that streamlines the ability of distributed teams to share and collaborate on data that is used in the service of building a larger application.

Universal Scene Description

The Omniverse Platform is built on Universal Scene Description, an open source standard for representing 3D scenes and facilitating collaboration regarding such representations. Developed by Pixar Animation Studios, OpenUSD has become widely adopted in the content generation industry for the representation of 3D scenes as evidenced by vendors and products such as Autodesk (Maya), Houdini (Solaris), and Epic Games (Unreal Engine). One of the notable attributes of OpenUSD is that it was created as a foundational library that other applications could be built upon. Omniverse is the first application that was built entirely around USD, and as such, 3D representations within the Omniverse platform are exemplary of the OpenUSD standard. That said, Omniverse extends the capabilities of OpenUSD to enable live collaborations with other applications that include McNeel Rhinoceros and Autodesk 3ds Max. This live collaboration functionality empowers engineers to change a model in a third-party application and witness how those changes impact a 3D representation in the NVIDIA Omniverse platform in real time. Another notable feature of OpenUSD is that it enables the creation of complex assets that can be shared across an ecosystem of compatible technologies and artists, designers, developers, and engineers. The ability of OpenUSD to enable the sharing of complex 3D representations between and among supporting technologies means that distributed teams can leverage the Omniverse platform to richly collaborate on the production of large-scale virtual worlds and digital twins.

Because NVIDIA Omniverse is built on OpenUSD, the range of third-party applications with which it interoperates continues to grow rapidly. This growth can be tied to OpenUSD experiencing increased adoption across a wide range of industry verticals that include architecture, engineering, construction, and operations (AECO) and manufacturing. Moreover, deepened adoption of the OpenUSD standard in the retail and factory and warehouse planning industry verticals positions NVIDIA Omniverse to gain traction among content creation technologies that specialize in non-3D use cases such as multivariate analytics and scenario planning.

The Omniverse platform's ability to seamlessly integrate content creation technologies empowers organizations to leverage a multivalent portfolio of content generation technologies to create and understand 3D representations for digital twin and industrial metaverse use cases. The ability to integrate data from different sources enables builders to obtain a holistic, full-context picture view that would be difficult to otherwise obtain. For example, enterprises can leverage Omniverse to view architectural and mechanical CAD data together. By enabling the conjunction of different data sets, Omniverse empowers teams to make more informed decisions using integrated data that facilitates new insights, opportunities, and collaborations.

IDC expects that the August 2023 announcement of the Alliance for OpenUSD (AOUSD), an organization dedicated to the standardization and development of Pixar's USD technology, will lead to deepened adoption of the OpenUSD standard. AOUSD seeks to enhance the interoperability of OpenUSD by developing written specifications that increase transparency and collaboration about its

evolution. Enhanced standardization about the OpenUSD standard is likely to expand the universe of organizations and technologies that support and define its requirements.

Case Studies

The case studies in the sections that follow explore how enterprises use the Omniverse Platform.

BMW

BMW leverages NVIDIA technologies to increase automation in 30+ factories around the world. BMW leverages NVIDIA Omniverse for factory planning and simulation, inclusive of the NVIDIA Isaac platform for robotics, the NVIDIA EGX edge computing platform, and the NVIDIA Aerial software development kit to deliver 5G networking to its factory floor.

As a result of developing custom applications and workflows on the Omniverse platform, BMW noted the following benefits:

- 30% increased resource utilization efficiency
- 30% decrease in planning time and errors
- 20% reduction in the use of autonomous moving robots that are used as transport vehicles in manufacturing processes
- 72 times reduction in review time (BMW reduced design freeze times from 3 days to 1 hour by building a custom Omniverse OpenUSD application.)
- Enhanced insight into the effect of design variations and reduced costs due to the use of digital twins

These enhancements are illustrative of the platform's ability to model complex 3D processes that include autonomous collaboration between robots and other machines that execute manufacturing processes. Omniverse empowers manufacturing operators to visualize the trajectories of and interactions between robots and autonomous machines on the manufacturing floor. In addition, the platform enables operators to understand how variations in manufacturing processes translate into downstream repercussions related to cost, quality, and performance.

BMW commented on the ability of Omniverse to connect its portfolio of disparate tools and deepen collaboration between discrete developer teams as follows:

> It all starts with planning – a complex process in which we need to connect many tools, data sets, and specialists around the world. Traditionally we are limited as data is managed separately in a variety of systems and tools. Today we are developing custom Omniverse applications to connect our existing tools, know-how, and teams in a unified view.

> For the first time, we are able to have our entire factory in simulation. Global teams can collaborate using different software packages like Revit, CATIA, or Point Clouds to design and plan the factory in real-time 3D. The capability to operate in a perfect simulation revolutionizes BMW's planning processes.

Here, BMW notes that the ability to simulate its factories "revolutionizes" its "planning processes" by enabling global teams to collaborate in ways that were previously not possible.

Sony Pictures Animation

Sony Pictures Animation uses the Omniverse platform to develop workflows that connect its globally dispersed artists, allowing them to collaborate in real time via a single pane of glass and understand how their work influences each other, as well as the final animated product.

Salient benefits include:

- Acceleration of the production of animated entertainment from days to minutes
- Cost reduction due to streamlined editing and collaboration
- Ability of artists to Review real-time updates to their models and contributions, thereby reducing the time required to edit and revise drafts
- Support for asynchronous, distributed contributions from distributed creator teams, thereby accelerating production because artists are not bound to a linear workflow
- Improvements in quality related to the artists' ability to view high-fidelity drafts and seamlessly collaborate with other artists in the process of iteratively editing those drafts.

In addition, Sony Pictures Animation leverages the platform to support the increased use of artificial intelligence to design characters and simulate facial expressions and body language. Omniverse also helps Sony Pictures create lifelike animation for characters in motion. As such, Omniverse supports an evolving role for animators that increasingly involves training machine learning models to create relevant animations as opposed to manually creating animations from scratch.

Lowe's

The retail company Lowe's noted how Omniverse enables developers to test thousands of digital iterations to the layout of stores and products prior to making physical changes as follows:

> We leverage a Universal Scene Description pipeline that aggregates native CAD from tools including Revit, Maya, AutoCAD, and SketchUp. These will enable our retail associates and planners to collaborate in real time to understand sales performance and identify anomalies. We can run CI/CD processes that test and validate thousands of store and product layouts before making any physical changes to our stores. With Omniverse, we are pulling store data together in ways that have never been possible.

This ability to aggregate data from different sources empowers Lowe's to obtain insights that would otherwise have been difficult to achieve.

Deployment

NVIDIA Omniverse Enterprise is provided to enterprises as an annual software subscription, and the platform runs on NVIDIA-Certified, RTX-enabled workstations and servers, giving customers the flexibility to choose from a variety of deployment options, based on their team size and workload requirements.

NVIDIA-Certified Systems are purpose built, tested, and optimized to handle the scale and complexity of industrial workloads and use cases.

Designers and engineers who are collaborating on product design reviews might deploy on physical workstations or virtual workstations streamed from the datacenter.

Teams conducting batch tasks like rendering, synthetic data generation for AI training, or workloads that can run headless might transition their workloads to a datacenter.

Teams developing and operating digital twins might deploy on NVIDIA OVX, which is specifically architected to power datacenter-scale, physically accurate industrial digital twin simulations.

The platform's flexible architecture can enable the creation, consumption, and modification of complex 3D models, large-scale virtual worlds, and digital twins. Put differently, NVIDIA Omniverse's ability to empower developers, artists, and creators to simulate the behavior of physical objects via digital twins and develop applications to support industrial metaverse use cases is facilitated by NVIDIA RTX GPUs, which support the execution of advanced computing operations at scale.

NVIDIA Omniverse is also available via select public cloud deployments that similarly support NVIDIA RTX GPUs. In addition, NVIDIA plans to make NVIDIA Omniverse APIs available to developers in the near future.

Dell Workstations and Computing Infrastructures

Dell Precision workstations, powered by NVIDIA RTX GPUs, are designed to deliver the scalability and performance required for computationally intensive workloads that are typical of those specific to NVIDA Omniverse. In addition, workstations empower organizations to obtain secure and localized control of workloads that includes enhanced visibility into performance and resource consumption. The ability of workstations to provide insight into resource consumption positions operators to optimize costs associated with computationally intensive workstreams such as 3D modeling or the digitization of complex, interrelated objects and systems.

For example, Dell Precision workstations with NVIDIA RTX capabilities support real-time ray tracing and advanced artificial intelligence, machine learning, and deep learning across NVIDIA Omniverse workloads. The Dell Precision 7960 Tower can support up to 4TB of DDR5 4,800MTps ECC memory and four NVIDIA RTX 6000 Ada cards, thereby equipping users for the computationally intensive workloads that are characteristic of 3D modeling at scale, digital twins, and the industrial metaverse. Meanwhile, the Dell Precision 7780 mobile workstation supports the NVIDIA RTX 5000 Ada Generation GPU and delivers impressive graphics performance in conjunction with artificial intelligence and virtual reality support by means of Dell Optimizer for Precision. Both workstations bring enhanced scalability to NVIDIA Omniverse solutions and the workstreams associated with their production and editing. In addition to the Dell Precision 7960 Tower and Dell Precision 7780, the Dell Precision Mobile Workstation empowers users to reap the performance, scalability, and reliability benefits specific to the Precision workstation series in conjunction with mobile device functionality. This ability to harness high-performance computing functionality from a mobile device empowers NVIDIA Omniverse developers to contribute from a mobile workstation without experiencing performance diminution. Dell Precision workstations deliver the requisite degree of performance, scalability, and reliability to the computing resources of organizations in ways that empower them to support NVIDIA Omniverse development either from desktop workstations or from datacenter computing infrastructures.

Finally, Dell PowerEdge servers and their use of NVIDIA L40 GPUs deliver datacenter computing infrastructure that supports high performance for computationally intensive tasks such as real-time ray tracing and the generation of data sets for the rendering of 3D objects and systems. These servers provide computational resources for NVIDIA Omniverse Enterprise as well as the modeling of 3D objects and their attendant behaviors, at scale. All this means that Dell PowerEdge Servers empower

organizations with the computing resources to support collaborations between hundreds of creators and the modeling technologies they use.

One of the advantages of Dell infrastructure is that it helps organizations adopt an enterprisewide strategy for modeling 3D objects, processes, and systems at scale and enhancing those models by means of generative AI technologies. For example, NVIDIA RTX workstations enable the integration of generative AI solutions into applications because of their ability to support high-performance computing at scale. As such, Dell infrastructures empower organizations to create simulations and physically accurate representations of objects and processes that include additional functionality delivered by generative AI applications.

NVIDIA Omniverse is enabled by a rich ecosystem of Dell infrastructure technologies that deliver the computing power required to support computationally intensive tasks specific to modeling 3D objects, systems, and their associated behaviors. Dell provides a multivalent landscape of workstations and datacenter computing resources that collectively enable organizations and individual creators to leverage the power of the NVIDIA Omniverse platform to create models of complex 3D systems.

CHALLENGES/OPPORTUNITIES

Challenges

Developer Shortage

One of the challenges faced by NVIDIA Omniverse involves the worldwide shortage of developers and its impact on the availability of skilled developer talent. IDC forecasts that by 2025, the worldwide shortage of professional developers will grow to 4 million, or 15% of the labor pool required by organizations to fulfill their digital transformation objectives. The worldwide shortage of developers represents an inhibitor to the adoption of NVIDIA Omniverse because skilled developer talent is required to maximally harness the power of digital twins and the industrial metaverse.

Opportunities

Maturation of Technologies That Specialize in Modeling Objects and Processes

Catalysts for the deepened adoption of NVIDIA Omniverse include the increased maturation of technologies for modeling business processes, objects, and systems. Examples of technologies that specialize in the modeling of objects and processes include the following categories and associated examples:

- **Modeling and architecture tools:** Technologies that specialize in the modeling and architecture of processes, objects, systems, and enterprises are maturing. Examples include SAP's Signavio Process Manager, Software AG, and Avolution.
- **Digital twin technologies:** Digital twin technologies are proliferating because of their ability to augment automated testing and enable multivariate product development-related analytics.
- **The industrial metaverse:** The maturation of the industrial metaverse and attendant technologies for creating models of objects in a 3D virtual environment facilitates collaboration between a multitude of stakeholders.

The ability of NVIDIA Omniverse to connect to and support real-time collaboration among distributed teams of artists, engineers, and developers differentiates it from existing modeling technologies. Users of the NVIDIA Omniverse platform can leverage best-of-breed integrations with third-party

technologies for specific use cases to create high-fidelity 3D models that integrate the strengths of individual tools. Moreover, NVIDIA Omniverse's support for OpenUSD positions the platform to expediently support the growing ecosystem of modeling tools that similarly support the OpenUSD standard.

Low-Code Development Capabilities and AI/ML-Assisted Developer Tools

NVIDIA Omniverse's low-code development capabilities democratize the development experience to professional resources who lack in-depth proficiency with custom coding and scripting. In addition, the platform's ability to streamline the use of artificial intelligence to enhance digital solutions provides developers with abstracted technologies that infuse intelligence into digital solutions. The conjunction of the availability of low-code and AI-assisted development functionality mitigates against the developer shortage by providing developers who lack proficiency with command-line coding the tools that simplify the developer experience. As a result, the Omniverse platform democratizes development to professional resources who do not have the job title of developer and subsequently renders the development experience accessible to knowledge workers more generally.

CONCLUSION

NVIDIA Omniverse is unique in the landscape of industrial metaverse and developer platforms because of its ability to support high-performance computing workloads, the integration of artificial intelligence and machine learning, live streaming, real-time ray tracing, and immersive experiences. Moreover, the platform's foundational architecture in the OpenUSD standard ensures its compatibility with an expansive open ecosystem of technologies that similarly support OpenUSD and, as a result, can seamlessly connect to the NVIDIA Omniverse platform. NVIDIA Omniverse's interoperability with a rich ecosystem of third-party modeling technologies empowers developers, artists, designers, and content creators to rapidly create, update, and operationalize high-fidelity 3D models to support digital twins, the industrial metaverse, and generalized modeling use cases across a multitude of industry verticals that include the automotive industry, industrial IoT, energy, and media and entertainment.

The platform's architecture positions it to support the incipient ecosystem of generative AI technologies in the form of connectors to third-party technologies that use generative AI as well as the delivery of indigenous generative AI functionality within the NVIDIA Omniverse platform. In keeping with its support for generative AI technologies, NVIDIA Omniverse can be used by a wide range of developer personas and builders of digital solutions that include command-line developers, low-code developers, designers, artists, and content creators more generally. The platform's ability to support real-time collaboration between and among distributed teams further contributes to its competitive differentiation within the landscape of development technologies for the industrial metaverse.

About IDC

International Data Corporation (IDC) is the premier global provider of market intelligence, advisory services, and events for the information technology, telecommunications, and consumer technology markets. With more than 1,300 analysts worldwide, IDC offers global, regional, and local expertise on technology, IT benchmarking and sourcing, and industry opportunities and trends in over 110 countries. IDC's analysis and insight helps IT professionals, business executives, and the investment community to make fact-based technology decisions and to achieve their key business objectives. Founded in 1964, IDC is a wholly owned subsidiary of International Data Group (IDG, Inc.).

Global Headquarters

140 Kendrick Street
Building B
Needham, MA 02494
USA
508.872.8200
Twitter: @IDC
blogs.idc.com
www.idc.com