



Agentic Predictive Maintenance for Government and Critical Infrastructure Solution Blueprint 1.0

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This blueprint serves as a comprehensive guide for technical buyers at end-customer organizations and system integrators. It provides detailed insights into the technical specifications, capabilities and integration processes of the solution. Focused on the needs and expectations of technical buyers, this document provides the necessary information to make informed decisions regarding the adoption and implementation of the technology. Additionally, the blueprint will help system integrators understand how to seamlessly incorporate the solution into existing systems, optimizing performance and ensuring compatibility. This document is crafted to facilitate a smooth transition from evaluation to deployment, empowering the audience with the knowledge to leverage the solution effectively.

Agentic AI has significant potential for managing urban and critical infrastructure in smart cities by improving efficiencies across infrastructure management, predictive maintenance and resource optimization. Digital twins and optimized urban infrastructure are examples of key applications. Agentic AI-powered digital twins represent virtual replicas of infrastructure and model urban environments to test infrastructure projects (e.g., new transit lines and housing developments) before implementation. Cities planners use these simulations to assess environmental, social and economic impacts. AI agents aggregate data from transportation, utilities and public feedback to evaluate proposed policies. For instance, they can model the effects of zoning changes on housing affordability or traffic patterns.

This blueprint, “Agentic Predictive Maintenance for Government and Critical Infrastructure,” illustrates best practices for using Intel technology including qualified AI systems, Software Development Kits (SDKs) and reference implementations to build Edge AI solutions that use digital twins for critical infrastructure predictive maintenance. This document can also be used as a design guide that documents key technologies and system requirements as well as demonstrates how best to utilize hardware platforms and software frameworks, providing a starting point for developers to custom-build applications based on their business needs. Overall, the blueprint acts as a proof of concept, demonstrating the practical viability and effectiveness of incorporating qualified AI systems and software applications into existing infrastructure to enable predictive maintenance and proactive planning for critical infrastructure.

Date	Revision	Description
October 2025	2025.2	Initial Release

1. Market Analysis

Globally, governments and economies rely on vast, intricate networks of roads, railways, electricity, water and internet systems, for which they make large investments in upkeep and maintenance. Because building anew is often cost-prohibitive, it is necessary to protect and invest in existing infrastructure. Maintenance is becoming a key focus for government agencies — they want to maximize the value of their existing investments and ensure their longevity rather than being forced to replace failing infrastructure with new projects. The Infrastructure Investment and Jobs Act (IIJA) of 2021 authorized \$1.2 trillion for construction projects, including \$4 billion for maintenance. As of 2025, just over 47% of those funds have been allocated. IIJA funding is contingent on demonstrating total lifecycle costing, which includes the expected life and expenses associated with initial build, subsequent upgrades and ongoing maintenance. The American Society of Civil Engineers (ASCE) warned of a \$3.7 trillion investment gap between planned infrastructure investments and what would be needed to have the nation's infrastructure in "good working order" in 2025, up from an estimated \$2.59 trillion in 2024.¹

The construction sector is on the cusp of a data-driven artificial intelligence (AI) and analytics revolution. Digitization and automation impact every aspect of construction, particularly in maintaining existing assets through the use of digital twins, remote monitoring and drone technology. Leading infrastructure owners and construction companies are now exploring AI and analytics to deliver predictive maintenance, anticipating maintenance requirements in advance and addressing them proactively.

Proactive maintenance relies on the early detection of small infrastructure defects before they escalate, which has been a time-consuming and resource-intensive task. However, state-of-the-art hardware now facilitates automated infrastructure inspections. Drones equipped with high-resolution imagery, thermal imaging and AI algorithms can detect structural weaknesses, identify potential maintenance needs and collect valuable data for further analysis. The market potential associated with intelligent and agentic digital twin systems for critical infrastructure systems is significant, driven by factors that include the following:

- **Advances in AI and ML:** AI and machine learning (ML) play a critical role in analyzing data, identifying patterns and predicting potential failures with increasing accuracy.
- **Sensor technologies:** The use of sensors allows for real-time monitoring of infrastructure health and performance, enabling proactive maintenance interventions.
- **Cost reduction and operational efficiency:** Organizations are increasingly seeking ways to minimize unplanned downtime, reduce maintenance expenses and optimize asset performance, making predictive maintenance an attractive option.
- **Government initiatives:** Governments are recognizing the strategic importance of predictive maintenance for infrastructure and supporting its adoption through research and development programs.



2. Use Cases

This solution blueprint supports a variety of use cases, including water management and planning, wildfire detection and disaster management and utility infrastructure and waste management. While the use cases discussed here are among the top applications, they represent just a subset of the potential supported by this technology.

2.1 Critical infrastructure

While critical infrastructure such as dams are the backbone of modern life, they are vulnerable to disruptions that can have far-reaching consequences. Technologies such as AI and digital twins are becoming essential for daily urban planning and infrastructure management. 3D models of infrastructure are created, while monitoring sensors feed real-time data back to those models post-construction, maintaining current digital representations. This continuous feedback enables predictive maintenance — twins can run stress simulations and forecast when infrastructure needs reinforcement long before physical deterioration appears. Agents can monitor infrastructure for early signs of wear or failure and send automated alerts to maintenance teams. Predictive maintenance of pipelines and equipment can be challenging because of the remoteness of facilities. Digital twins help model when pipelines need maintenance, while agents can monitor pipeline integrity and provide predictive analytics for drilling equipment and real-time monitoring of refineries and storage facilities.

2.2 Fire detection and management

Large buildings are structurally complex and pose challenges for emergency evacuation such as during a fire. Digital twins can model a full-scale multi-floor building to manage dynamic fire information, transform sensor data into temperature fields and forecast future fire development and hazardous zones in advance. They can also integrate real-time data from various sources, such as satellite imagery, sensors and weather stations, to create a comprehensive digital model to simulate wildfire behavior and potential impacts. AI agents can then be used for proactive prevention and efficient response during wildfire events.

2.3 Water management and planning

IDC predicts that 40% of large cities will have digital twins of their water resources to manage water supply, quality, resilience and behavioral change by 2027.² Water scarcity and increased climatic hazards are resulting in loss of life, damage and water contamination. In response, cities are investing in digital twins to help monitor water systems, manage water resources, explore risks and develop early warning systems for climatic hazards. DC Water created a digital twin fed with adjusted radar rainfall data into hydraulic models and were able to predict rain intensity in five-minute increments.³ AI agents can be used to generate public alerts, such as to warn households about likely backed-up sewers flooding in their areas, as well as to help mitigate those hazards by providing early warning to mobilize work crews.



2.4 Urban planning

Cities including Helsinki are planning new development using digital twins that consume data sources such as geographic information systems, energy usage, water bodies and transportation systems. Digital twins integrate live sensor feeds, historical data and AI-driven simulations to answer “what-if” questions about city operations. This approach represents a fundamental shift from static emergency procedures to dynamic, simulation-driven planning. Rather than relying on outdated response binders, cities can use interactive models showing real-time ripple effects of floods on transit, power and public safety systems. The use of AI agents can test mitigation strategies and deploy services automatically.

2.5 Energy consumption

Singapore is leveraging digital twins to optimize clean energy production by identifying the best location for solar panels based on light and temperature conditions.⁴ Smart campuses can optimize operations and reduce energy consumption using digital twins for planning. AI Agents can be instrumental in reducing energy consumption by optimizing resource allocation and predicting demand and managing energy distribution. Some representative use cases are shown in Figure 1.

	Use Case	AI Agent Application
 Critical Infrastructure Predictive Maintenance	Real-time anomaly detection, predictive analytics, automated fault alerts, infrastructure health monitoring	Monitor bridges, roads and utilities for early signs of wear or failure and send automated alerts for maintenance teams
 Wildfire & Disaster	Real-time monitoring through analysis of sensor data, satellite imagery combined with weather patterns and historical records to proactively respond to events	Predict high-risk locations and times for wildfire outbreak and broadcast real-time alerts, evacuation routes and infrastructure status updates during natural disasters
 Utility Infrastructure Management (Water, Waste)	Monitor systems, optimize operations, reduce consumption, explore risks and develop early warning systems	Predict back-up, predict water demand and notify users or provide early warnings or mobilize crews to areas proactively

Real-World Applications for Agentic Predictive Maintenance	
Singapore’s Digital Twin	- Virtual model of the city powered by AI agents to simulate policy changes before implementation - Resulting in 7% improvement in urban planning efficiency
Seoul’s Predictive Infrastructure Maintenance	- AI systems that autonomously inspect and schedule maintenance for critical infrastructure before failures occur - Reducing repair costs by approximately 25%

Figure 1. Key agentic digital twin predictive maintenance use cases for critical infrastructure.

3. Blueprint architecture and requirements

A digital twin for predictive maintenance on critical infrastructure generally includes the following stages, the relationships between which are represented in Figure 2.

- **Data collection and acquisition:** Data from IoT sensors to continuously monitor physical assets, combined with historical maintenance, operational and inspection data to establish a baseline and enable analytic comparisons.
- **Digital twin modeling:** Projection of the data collected into high-fidelity 3D models and digital replicas using point clouds, mesh or digital elevation models. Real-time sensor feeds continuously synchronize the digital twin with the physical asset, making the digital model a living representation.
- **Data integration and real-time sync:** Continuous real-time updates to reflect the asset's actual condition and behavior.
- **Advanced analytics and AI:** Predictive analytics for early-warning detection of anomalies, degradation or impending failure (e.g., corrosion, leaks).
- **Visualization and dashboarding:** Intuitive visualization of alerts, trends, failure forecasts and remaining useful life estimates for components, using dashboards to present health and performance metrics for fast, accurate decision-making.
- **Proactive maintenance scheduling:** Maintenance schedules generated and optimized based on predicted needs. Automated work orders and notifications to technicians for just-in-time maintenance or inspection, reducing costs from unnecessary or emergency interventions.
- **Continuous feedback and optimization:** Feedback from maintenance activities, inspections and repairs to refine models and predictions.

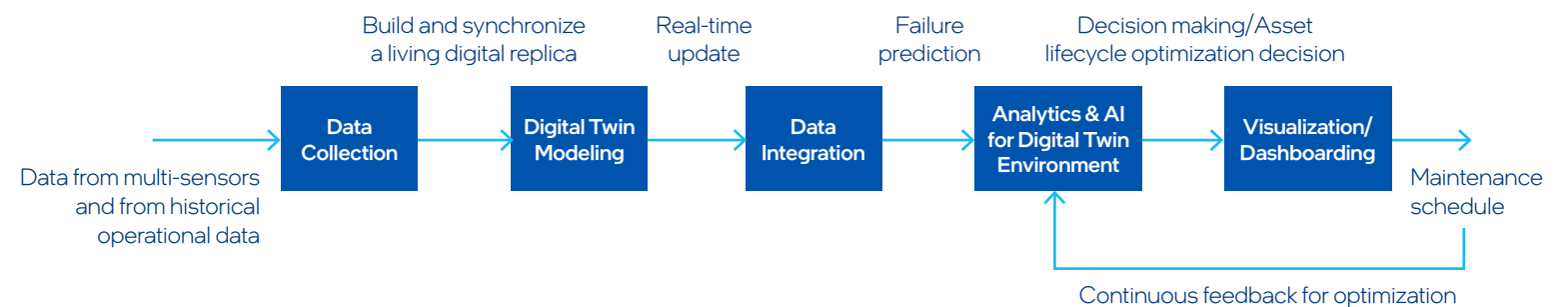


Figure 2. Intelligent digital twin for predictive maintenance — baseline pipeline.

3.1 Blueprint architecture

Figure 2 shows the baseline pipeline to deploy a digital twin with AI for automated and autonomous capabilities to enable predictive maintenance for critical infrastructure. Given the localized/regional and distributed nature of most of the critical infrastructure use cases, an edge deployment is most suitable and can offer affordable edge AI capabilities without an outsized dependency on the cloud. Figure 3 provides an overview on the multi-tier, edge-enabled intelligent and agentic digital twin for predictive maintenance of critical infrastructure, leveraging far-edge platforms and edge platforms at operational sites.

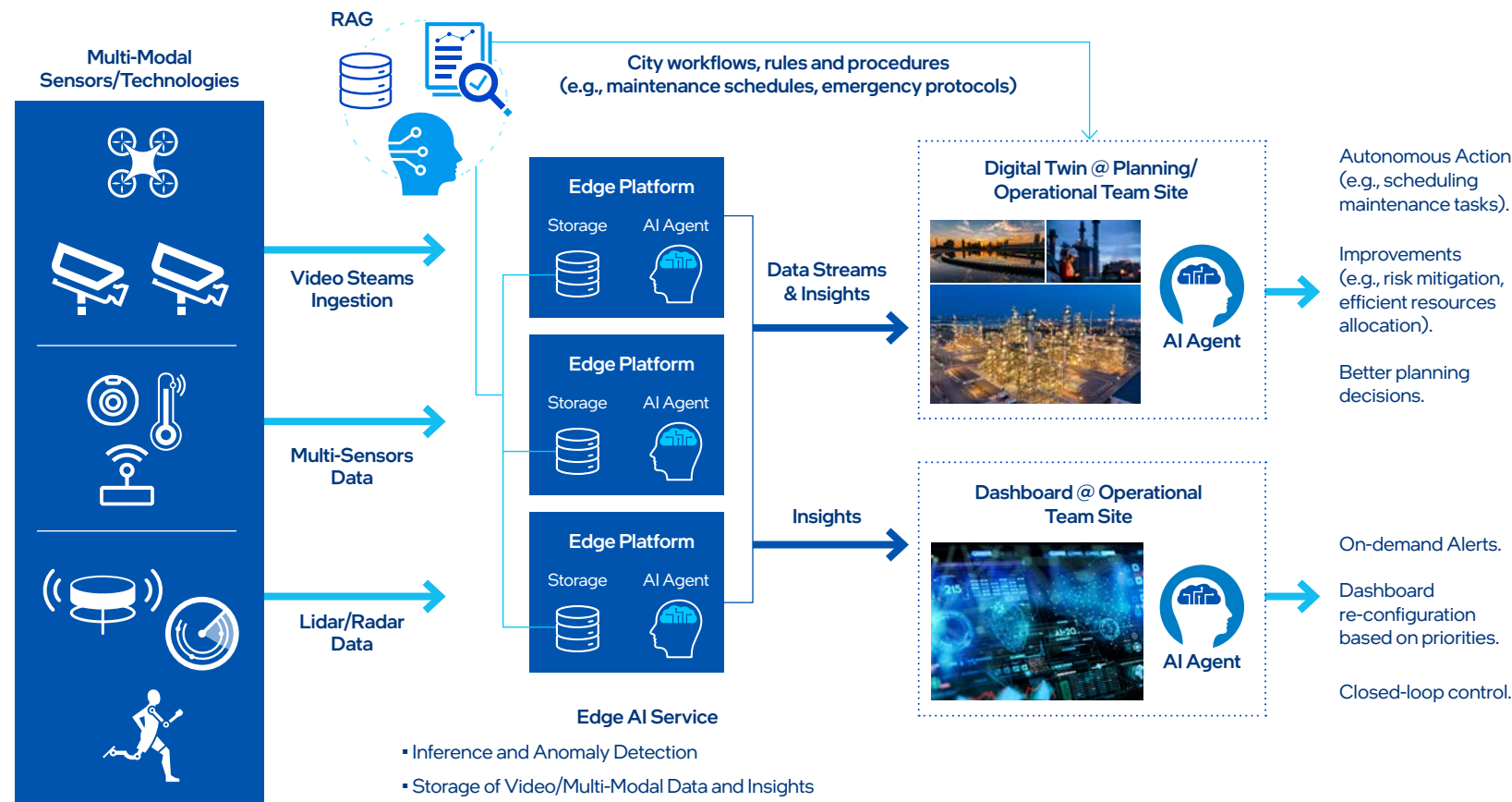


Figure 3. Blueprint architecture overview.



Section 3.2 represents Intel hardware positioning, and Section 3.4 presents available Intel software frameworks and tools to enable a multi-tier edge deployment for a digital twin solution for predictive maintenance for the critical infrastructure that draws on the baseline pipeline shown in Figure 2.

3.2 System hardware positioning

The Intel hardware portfolio across Intel® Core™ Ultra and Intel® Xeon® processors can support digital twins for different deployment scenarios, ranging from small scale with far edge deployment to large scale with edge data center deployment, as shown in Table 1.

Table 1. Hardware for digital twin deployment.

Hardware	
Intel® Core™ Ultra processor with integrated GPU	▪ Far edge for local anomaly detection
Intel® Xeon® W processor	▪ Operation and planning sites for digital twin and dashboard
Intel Xeon processor with discrete GPU	▪ Operation and planning sites for digital twin and dashboard ▪ Edge data center for regional anomaly detection

PC farms open additional opportunities for large-scale digital twin edge deployments, offering robust processing capabilities with Intel Core and Intel Core Ultra CPUs in affordable and power-efficient form factors. Examples of OEM PC farm solutions using Intel technologies are shown in Table 2.

Table 2. OEM solutions for PC farms.

OEMs	Form Factor	CPU and GPU
Premio Ref1 Ref2 Ref3	▪ Rugged edge platforms ▪ Ranges of form factors with support for multi-blade PC farms	▪ 7th-13th Gen Intel Core Ultra CPUs ▪ Discrete GPU support
Kontron Ref1 Ref2	▪ Rackmount with support for multi-blade PC farms	▪ Intel Core i7/i9 CPUs ▪ Discrete GPU support
Broadax Systems Ref1 Ref2	▪ Rackmount PCs	▪ Desktop Intel Core CPUs ▪ Discrete GPU support

3.3 Enabling software technologies, tools and frameworks

Examples of support from the solutions ecosystem are represented in Table 3.

Table 3. Enabling software technologies, tools and frameworks.

Software	
Digital twin	▪ Live digital twin to remotely inspect infrastructure using Intel® SceneScape for 3D spatiotemporal monitoring, multimodal cameras and sensor fusion ▪ Rendering capabilities using Intel OneAPI rendering toolkit for immersive visualization of the critical infrastructure environment
Edge inference services	▪ Anomaly Detection Service (Intel Open Edge Platform — Anomalib) ▪ Sample applications with AI models for anomaly detection optimized on Intel hardware through the Intel® Distribution of OpenVINO™ toolkit
Data storage and retrieval	▪ Video Data Management System (Intel VDMS) for storage of videos/ multi-modal data and insights from analytics ▪ On-demand queries for any video/data/metadata about anomalies
Geti Software	▪ Train AI models using publicly available data with annotation for critical infrastructure data (e.g., bridges and water utilities) ▪ Train AI models using provided data samples from the field and annotation

4. Norms and regulatory consideration guide

While agentic AI offers significant benefits, its implementation requires robust governance frameworks⁵ to address data privacy, security, bias mitigation and accountability. Examples are given in Table 4.

Table 4. Norms and regulatory considerations.

Key Norms and Considerations in Current Developments with Regulatory Priorities	
Data privacy and security	- Secure, encrypted data infrastructure is critical to prevent breaches and maintain public trust, particularly for applications such as public safety, traffic management and administrative services. - This necessitates compliance with regulations including the General Data Protection Regulation (GDPR) in the European Union.
Ethical and equitable AI use	- Frameworks must ensure that agentic AI decisions do not perpetuate biases or widen digital divides. - For example, traffic optimization systems should benefit all neighborhoods equally, avoiding disproportionate resource allocation to affluent areas.
Sustainability standards	- Agentic AI-driven energy grids and water management systems must align with global sustainability goals. - This includes optimizing renewable energy integration (e.g., solar/wind) and reducing emissions through dynamic traffic routing.
Cybersecurity protocols	- The U.S. Department of Homeland Security emphasizes secure-by-design principles. - This requires AI developers to embed defenses against adversarial attacks (e.g., manipulated sensor data in power grids).

In addition to ongoing development of frameworks and standards, regulatory efforts for agentic AI in government critical infrastructure and smart cities require collaboration between governments, developers and citizens to balance innovation with public benefit.

5. Commercial digital twin solutions with Intel technologies

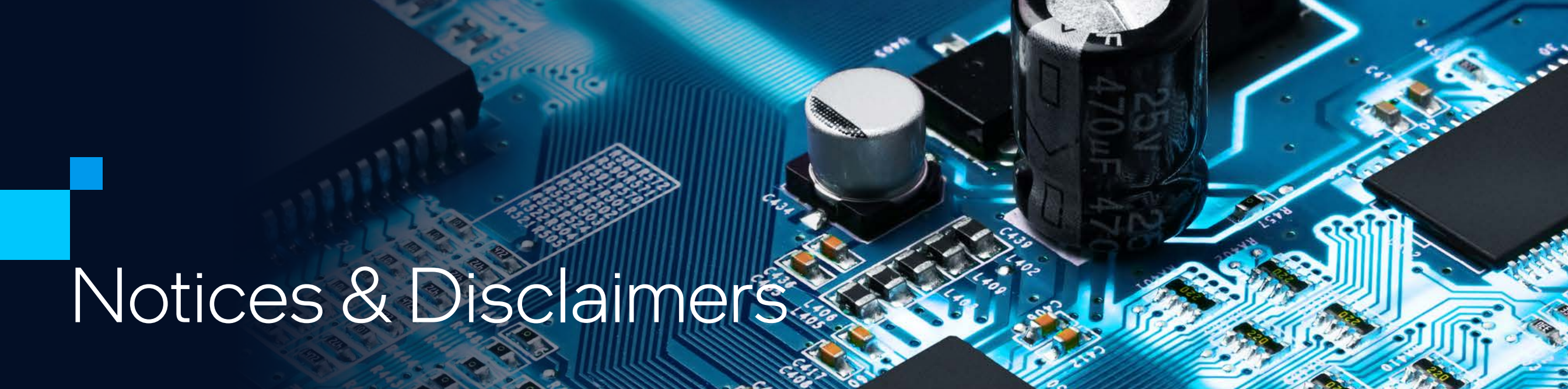
Commercial digital twin solutions are powered by Intel hardware platforms, including server-level and edge compute technologies. Examples of matching between digital twin solutions and Intel architecture-based hardware are shown in Table 5.

Table 5. Commercial digital twin solutions with Intel technologies.

Digital Twin Solution	Partner	HW Product	Details
Studio and Venue Twin Solution for Events and Venues (used in the 2024 Olympic Games) [Summary, Solution Brief]	OnePlan	Intel® Core™ processor-based system with Intel® Arc™ GPU	▪ Front-end modeling and visualization: initial creation and development, editing and rendering of 3D venue models on a desktop or local workstation
		Intel® Xeon® processor-based system	▪ Scalable backend compute infrastructure: deployment, detailed real-time simulations (including environmental impacts such as weather) and efficient planning and management workflows with concurrent access
LarkXR Solution [Summary]	Paraverse Technology	Intel Arc GPU with Intel Xeon processor-based servers and option for client platforms and integrated GPUs	▪ Platform for real-time cloud rendering, visualization and streaming infrastructure that enables comprehensive digital twin solutions
Intel® Automated Factory Solutions (Intel® AFS) Software Suite [Summary, Solution Brief1, Solution Brief2]	Sony	Intel Xeon processor-based system	▪ Factory simulation, visualization and optimization
		Intel Core processor-based edge PCs	▪ Front-end for the digital twin for data collection and some control functions
Digital Twin for Industrial Assets [Solution Brief]	Bosch	Intel Xeon processor-based system	▪ Virtual representation of the mission-critical assets that enable monitoring, management and optimization
Intellias Digital Twin Solution [Summary]	Intellias	Various Intel® hardware	▪ Virtual replicas of physical assets enabling intelligent utility management and asset monitoring ▪ Predictive models and real-time situational awareness in a 4D digital space (using Intel® SceneScape)

6. Appendix

Citation	Description
1	Predictive Maintenance: A New Approach to Extending the Life of Public Infrastructure.
2	IDC FutureScape, Worldwide Smart Cities and Communities 2023 Predictions.
3	Streamlined Sewer Pipe Inspection Analysis with Intel AI Technologies
4	IDC PlanScape, Digital Twins for Smart City.
5	RAND, Emerging Technology and Risk Analysis: Artificial Intelligence and Critical Infrastructure , April 2024.



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