

## EXECUTIVE BRIEFING

# AI, Spatial Intelligence and the AI-Enabled Citiverse



## Foreword

This Executive Briefing has been developed by the 20 United Nations entities co-organizing UN Virtual Worlds Day 2026. It represents a collective assessment of how artificial intelligence, spatial intelligence and the AI-enabled citiverse are reshaping governance, urban development and global digital cooperation and what this means for ministers, mayors and senior policymakers.

This briefing builds on and complements the substantive deliverables developed by the [Global Initiative on AI and Virtual Worlds - \*Discovering the Citiverse\*](#). It is intended to serve as the authoritative reference document for [UN Virtual Worlds Day 2026](#), synthesizing key findings, strategic priorities and recommendations drawn from the broader body of work produced by the Initiative and its partners.

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Additional information and material related to this Executive Briefing are available at: <https://www.itu.int/metaverse/virtual-worlds/>. If you would like to provide any additional information, please contact Cristina Bueti (ITU) at: [virtualworlds@itu.int](mailto:virtualworlds@itu.int).

## Disclaimers

The opinions expressed in this publication are those of the authors and do not necessarily represent the views of their respective organizations or their members. In line with the UN principles, this report does not promote the adoption and use of any specific digital technology. It advocates for policies encouraging responsible use of AI and virtual worlds to advance the 2030 Agenda for Sustainable Development.

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# **EXECUTIVE BRIEFING**

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AI-Enabled Citiverse**

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# Abbreviations and acronyms

AI	Artificial Intelligence
API / APIs	Application Programming Interface(s)
AR	Augmented Reality
BIM	Building Information Modelling
DPI	Digital Public Infrastructure
ERP	Enterprise Resource Planning
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GeoAI	Geospatial Artificial Intelligence
GIS	Geographic Information System
IGO	Intergovernmental organization
IoT	Internet of Things
ISO	International Organization for Standardization
ITCILO	International Training Centre of the International Labour Organization
ITU	International Telecommunication Union
ITU-T	ITU Telecommunication Standardization Sector
MIMs	Minimal interoperability mechanisms
OASC	Open & Agile Smart Cities
OECD	Organisation for Economic Co-operation and Development
SDG / SDGs	Sustainable Development Goal(s)
SG20	Study Group 20 (Internet of Things, digital twins and smart sustainable cities and communities)
SlaaS	Spatial intelligence as a service
SROI	Social Return on Investment
UN	United Nations
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
UNECE	United Nations Economic Commission for Europe
UNECLAC	United Nations Economic Commission for Latin America and the Caribbean

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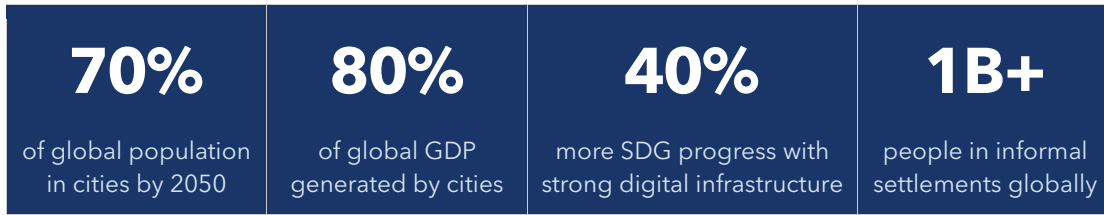
UN-Habitat	United Nations Human Settlements Programme
UNICC	United Nations International Computing Centre
UNICEF	United Nations Children's Fund
UNIN	United Nations Innovation Network
UNJSPF	United Nations Joint Staff Pension Fund
UNRISD	United Nations Research Institute for Social Development
UNU-EGOV	United Nations University Operating Unit on Policy-Driven Electronic Governance
WIPO	World Intellectual Property Organization
WMO	World Meteorological Organization
3D	Three-Dimensional

## Executive summary

UN Virtual Worlds Day 2026 convenes at a defining moment. Artificial intelligence, spatial intelligence and the AI-enabled citiverse are reshaping how governments govern, how cities deliver services, and how communities participate in decisions that affect their lives. This briefing developed with contributions from the 20 UN entities co-organizing the event distils the key findings, strategic priorities and governance recommendations relevant to ministers, mayors and senior policymakers worldwide.

01	<p>AI, spatial intelligence and the AI-enabled citiverse are reshaping how cities govern, plan and deliver services today.</p> <p>National, regional and local leaders who wait for technological maturity will inherit systems designed by others. The window to shape open, interoperable, people-centred foundations is narrowing.</p>
02	<p>AI paradigms, from generative and agentic to physical and spatial, are advancing in parallel and creating new governance challenges for local, regional and national governments.</p> <p>Different AI paradigms demand different regulatory, institutional and technical responses. Governments that treat all AI as a single category will be poorly equipped to manage its varied impacts.</p>
03	<p>The convergence of AI including spatial intelligence, with the AI-enabled citiverse creates transformative governance potential.</p> <p>AI can synthesise multisource urban data, while spatial intelligence help anchor outputs in three-dimensional physical contexts. The AI-enabled citiverse provides immersive simulation environments, together enabling the shift from reactive management to anticipatory governance.</p>
04	<p>By 2050, nearly 70% of the global population will live in urban areas; cities already generate over 80% of global GDP.</p> <p>The AI-enabled citiverse offers cities a platform to convert complexity into capability for infrastructure resilience, inclusive development, climate adaptation and participatory governance.</p>
05	<p>Interoperability is simultaneously a technical, policy and legal challenge and should be treated as a global public good.</p> <p>Fragmented standards, data sovereignty gaps and incompatible legal frameworks prevent cities from sharing solutions, learning from peers and scaling impact. Coordinated international standards are an essential prerequisite.</p>
06	<p>Five systemic challenges require structured policy attention.</p> <p>Technical complexity and interoperability gaps; trust, safety and inclusivity deficits; data quality and algorithmic transparency concerns; institutional readiness and skills gaps; and the risk of global digital fragmentation.</p>
07	<p>Five strategic priorities provide the governance framework for action.</p> <p>Translating global commitments locally; embedding data and simulation in decisions; building trusted, people-first AI; unlocking inclusive growth; and scaling through open standards and collaboration.</p>

## Key Statistics at a Glance

CORE  
MESSAGE

*Coordinate now on open, human-centred digital foundations or accept fragmented systems that entrench the inequalities we seek to overcome. The technologies are sufficiently early-stage that consensus on shared foundations is still achievable. The window is open but will not remain so indefinitely.*

**Who should use this briefing?**

This briefing is designed for senior decision-makers who must navigate the convergence of AI, spatial intelligence and immersive environments at policy level. It is primarily a strategic framing document, contextualising AI, spatial intelligence and the citiverse within global governance frameworks. Mayors and city leaders seeking immediate, practical implementation tools should refer to the companion City Leader's Field Guide: Preparing for the AI-Enabled citiverse<sup>1</sup>, which includes a Pulse Check, an Essential 20 Assessment and a 90-Day Action Plan. Section 6.6 of this briefing also provides city-level priority actions directly applicable by mayors. It is intended for:

- Mayors, deputy mayors, ministers and senior policymakers
- National Regulatory Authorities
- Chief digital officers, chief information officers and urban innovation leads
- Senior advisers in development, planning and public finance
- Representatives of international organizations and multilateral development institutions

**How can this report help?**

- Understand the strategic relevance of AI, spatial intelligence and the AI-enabled citiverse
- Identify key opportunities, systematic challenges, and governance implications
- Connect long-term priorities with practical implementation choices
- Support the foundations for trusted, inclusive and future-ready urban transformation

## 1 The Strategic Context: Understanding the Convergence

By 2050, urban areas will accommodate nearly 70 per cent of the global population.<sup>2</sup> As a result, pressure is intensifying on people who live in cities, as well as on the natural biosphere, energy and transport infrastructure, the built environment (including housing) and public services.

At the same time, a new digital information layer is emerging worldwide through the development of advanced communication networks under the sea, in the ground, in the air and in orbit around the earth in satellites. The most intense deployment of these networks is in cities. These networks, the sensors and devices they connect, and the data they transport, are now subject to evermore innovation due to the development of software defined networks and artificial intelligence (AI).

AI is developing exponentially, with widespread adoption initially focused on Large Language Models. Now AIs are being developed with geospatial intelligence and with spatial awareness so they can inhabit physical systems that navigate autonomously and also while connected to a digital infrastructure.

Governments are coming to terms with the implications. The Global Digital Compact (GDC) is a comprehensive global framework for digital cooperation and governance of digital technologies and artificial intelligence. It is part of the Pact for the Future, which was adopted at the UN Summit of the Future in September 2024. Its objective is to ensure that digital technologies are used responsibly and benefit all, while addressing the digital divide.

At the city level, the citiverse is an emerging, human-centred digital ecosystem that combines digital twins, virtual reality and AI to create interconnected 3D models of real-world cities. The citiverse is being developed by initiatives from the European Union and ITU that enable, for example, the simulation of urban planning, traffic management and improved services for inhabitants, in an immersive virtual space, thereby enhancing sustainability and citizen participation. The citiverse is benefitting from the work of “the [Global Initiative on AI and Virtual Worlds - Discovering the Citiverse](#)” and supports Sustainable Development Goal (SDG) 11, which aims to “make cities and human settlements inclusive, safe, resilient, and sustainable”.

At the same time, it is acknowledged that the data centres that host AI are energy intense. The International Energy Agency expects energy consumption by data centres to double between 2025 and 2030, potentially exceeding 1 000 Terawatt-hours by 2030<sup>3</sup>, roughly equivalent to Japan’s annual energy consumption. The transition to a sustainable energy supply, distributed by agile energy grids, is one aspect of the long-term success of AI. This energy transition underpins the sustainable development of smart cities.

The citiverse is a response to this convergence of rapid urbanization, an ever more sophisticated information layer enhanced by AI, and the transition to sustainable energy. It stands to support SDG 11, if the correct governance foundations are laid.

### 1.1 The technology layers that support urban intelligence

Several layers of technologies interact to form a new model of urban governance:

- **Sensors, connectivity and secure data management:** Sensors, cameras, phones and vehicles in cities generate huge amounts of data. Increasingly, cities collect some of this

data into secure cloud-based data lakes. This is often in addition to the data captured in software applications used by city administrations.

- **Artificial Intelligence (AI):** AI is increasingly being used to synthesise this vast urban data, revealing behavioural patterns and analytical insights that can lead to new evidence-based policy recommendations. AI enables the shift from retrospective reporting to anticipatory action.
- **Spatial Intelligence (SI):** SI anchors AI outputs in three-dimensional physical contexts. It enables AI to understand not only what is happening, but where it is happening, why it matters in that specific location, and how it relates to surrounding systems. By adding spatial context to AI-enabled analysis, spatial intelligence enables capabilities such as Geospatial AI (GeoAI), high-precision positioning, and programmable real-time spatial sensor streams with real world actuators.
- **The AI-enabled citiverse:** The citiverse aims to create shared pathways that enable interoperability for a city's departmental IT systems, along with the data from sensors and digital twins, with immersive visualization environments, creating a coherent and interoperable framework. This enables participatory co-design, the testing of policy interventions in low-risk virtual environments before physical commitment, and the sharing of experiences and know-how between cities and citizens<sup>4</sup>.

#### WHY IT MATTERS

*When an AI system identifies that a bin is full, spatial intelligence adds context: this bin is at a park entrance, experiences weekend surges, and has three nearby alternatives, enabling dynamic route optimization based on proximity, timing and real-world conditions. Without spatial intelligence, AI knows the what; with spatial intelligence, AI understands the where and why.*

## 1.2 Bringing smart cities alive with the AI-enabled citiverse

The AI-enabled citiverse is the next step in the smart city journey:

- **From passive observation to active simulation and programmability:** moving from dashboards that observe and track conditions, to digital twins that test and predict the long-term impact of real-world policy changes, to actuators that automatically change the physical world in pre-authorized circumstances. Such capabilities require clear safeguards, including human oversight, safety thresholds, liability arrangements, auditability and reversibility mechanisms.
- **From fragmented data to interoperable ecosystems:** city systems and data are notoriously siloed. Consolidating disparate data, using interoperability standards, and applying AI, enables more cross-departmental insight, leading to a more joined-up approach to city management.
- **From technocratic management to inclusive participation:** using immersive interfaces makes it easier for citizens to co-design urban spaces, visualize planned changes, and provide informed feedback grounded in spatial reality.
- **From reactive repairs to data-driven decision support:** shifting from fixing infrastructure to using AI to identify potential maintenance needs early. Rather than making automatic decisions, AI provides staff with timely insights to better plan repairs, helping reduce costs, prevent service disruptions, and keep humans in control of decision-making.

### 1.3 Connecting Global Commitments to Local Delivery

The Global Digital Compact (2024) envisions a people-centred digital future. The New Urban Agenda and the 2030 Agenda for Sustainable Development set ambitious directions. Their success ultimately depends on what happens at city and community level. AI, spatial intelligence and the AI-enabled citiverse are delivery mechanisms that bridge global commitments and local implementation:

- AI synthesises multisource urban data to identify priority intervention areas.
- Spatial intelligence maps urban priorities onto three-dimensional visualizations, helping to reveal inequalities and infrastructure gaps that may be less visible or harder to interpret through non-spatial analysis alone.
- The AI-enabled citiverse enables policymakers to simulate interventions such as affordable housing placement, green corridors, air quality improvement and emergency evacuation routes before committing resources.
- Context-informed physical AI and programmable infrastructure, when subject to appropriate safeguards, can support more responsive, resilient and adaptive urban systems.

Together, these actions help transform abstract global commitments into georeferenced, evidence-based urban action, identifying underserved areas, guiding investment toward the greatest social impact, and building accountability mechanisms that are spatial, measurable and visible. This means that commitments can be linked to specific places, communities, infrastructure gaps and delivery responsibilities, thereby enabling policymakers to monitor progress, compare impacts and adjust interventions over time.

## 2 The AI Spectrum: Governance Implications for Governments at All Levels

Artificial intelligence is not a single technology. AI paradigms, from generative and agentic to physical and spatial, are advancing in parallel and creating qualitatively new governance challenges for local, regional and national governments. Understanding these distinctions is essential for designing appropriate regulatory frameworks, procurement standards, capacity-building programmes and accountability mechanisms.

Each AI paradigm has specific implications for city governments, for national policy and for cross-cutting governance. The table below provides a structured overview for senior decision-makers.

<p><b>Generative AI:</b> AI systems that generates content such as text, images, audio, video, code, 3D environments from learned patterns. Generative AI is already widely deployed in urban services, policy drafting, public communications and planning documentation.</p>			
LOCAL / CITY	Automating citizen-facing communications; generating planning reports; producing synthetic training data for other AI models; enabling low-cost creation of immersive citiverse environments.	NATIONAL	Accelerating legislative drafting and policy analysis; enabling large-scale public consultation synthesis; transforming public sector productivity and service delivery at scale. <b>Governance challenge:</b> Misinformation and deepfake risks in public discourse; intellectual property and data privacy concerns; need for provenance standards and public sector AI use policies that ensure the factual integrity of generated content and adherence to regulatory constraints
<p><b>Agentic AI:</b> AI systems that autonomously plan, decide and execute multistep tasks with minimal human intervention. Agentic AI can operate continuously across city systems, taking actions not just providing recommendations on behalf of institutions.</p>			
LOCAL / CITY	Autonomous infrastructure monitoring and incident response; dynamic traffic and energy management; automated procurement and service scheduling, building on earlier automation practices but increasingly enhanced by agentic AI capabilities.	NATIONAL	Continuous policy monitoring and compliance checking; real-time budget optimization across departments; automated cross-agency coordination in emergency management; ensuring autonomy is dynamically calibrated to the public interest. <b>Governance challenge:</b> Accountability gaps when autonomous systems cause harm; loss of human oversight in critical public services; need for clear liability frameworks and mandatory human-in-the-loop thresholds

<p><b>Physical AI:</b> AI embedded in physical systems and robotic infrastructure enabling machines to perceive, reason and act in the physical world. Physical AI bridges the digital and built environment, making the AI-enabled Citiverse operational in three dimensions.</p>			
LOCAL / CITY	Autonomous maintenance robots for infrastructure inspection; AI-guided construction and urban retrofitting; smart sensors embedded in buildings, roads and utilities; autonomous emergency response systems.	NATIONAL	National infrastructure resilience systems; AI-managed energy grids and water networks; border and port management; defence and public safety applications. <b>Governance challenge:</b> Physical safety and liability standards for AI-operated infrastructure; cybersecurity vulnerabilities in connected physical systems; workforce displacement in manual and technical sectors.
<p><b>Spatial AI:</b> AI that perceives, interprets and acts within three-dimensional spatial environments. Spatial AI is the foundational intelligence layer of the AI-enabled Citiverse, enabling machines and systems to understand place, proximity, movement and physical context.</p>			
LOCAL / CITY	Geospatial analysis for urban planning and housing equity; real-time mapping of informal settlements; 3D simulation of development impacts; navigation and logistics optimization.	NATIONAL	National spatial data infrastructure; satellite imagery analysis for land use, climate monitoring and disaster response; cross-border infrastructure planning; territorial management. <b>Governance challenge:</b> Data sovereignty over national spatial assets; surveillance risks from pervasive spatial sensing; need for spatial data standards and governance frameworks at national and international level.

## 2.1 Cross-cutting governance implications

Across all four AI paradigms, several governance imperatives apply at every level of government:

- **Differentiated regulation:** A single AI governance framework cannot adequately address the distinct risk profiles of generative, agentic, physical and spatial AI. Governments need layered regulatory approaches that match oversight mechanisms to actual risk levels.
- **Multilevel coordination:** City governments are often the first point of contact for AI impacts on citizens, but lack the regulatory authority or technical capacity to govern AI systems developed at national or global level. Vertical coordination between local, regional, national and international governance levels is essential.
- **Procurement as governance:** Public sector procurement through interoperability requirements, algorithmic transparency clauses, data sovereignty conditions and human-oversight mandates is one of the most powerful governance levers available to governments at all levels.

- **Workforce and skills transitions:** Each AI paradigm creates distinct workforce displacement and reskilling pressures. Governments need AI-specific labour market intelligence and proactive skills investment strategies, particularly for public sector workers in roles most affected by agentic and physical AI.
- **Inclusive access as a core metric:** As AI systems become embedded in public infrastructure and service delivery, ensuring that elderly, disabled, low-income and digitally underserved populations can access and benefit from AI-powered services is a fundamental governance obligation, not an optional enhancement.

GOVERNANCE  
NOTE

*Spatial AI deserves particular attention from urban and national leaders: it is the foundational intelligence layer of the AI-enabled Citiverse, and decisions about spatial data governance, who owns it, who can access it, how it is shared, will determine whether the citiverse serves all citizens or only those with power and resources to shape its development.*



### 3 Emerging Opportunities

The convergence of AI, including spatial intelligence with the AI-enabled citiverse, opens transformative opportunities across governance, economic development and sustainable development. While these technologies are still at an early stage of development and adoption, forward-looking governments are beginning to explore how they can support more anticipatory, inclusive and evidence-based decision-making.

#### 3.1 Smarter and more resilient infrastructure

AI analyses IoT sensor streams to predict infrastructure failures detecting structural stress in bridges, pressure anomalies in pipelines, and capacity constraints in energy grids before breakdowns occur. Spatial intelligence contextualizes these predictions within three-dimensional urban topographies: identifying which bridge connects a hospital to a residential area, or which pipeline sits beneath a critical transit corridor. The AI-enabled citiverse enables decision-makers to simulate maintenance scenarios immersively, testing how different repair schedules affect traffic flow, emergency access and community services.<sup>5</sup> This integrated approach is estimated to be relevant to 72 per cent of SDG targets, transforming infrastructure from reactive repair to anticipatory, spatially informed orchestration.<sup>6</sup>

#### 3.2 Improved planning, simulation and spatial decision-making

- **Planning:** digital twins allow cities to rehearse the impacts of new infrastructure in virtual environments before physical commitment. A proposed metro extension can be tested for ridership, air quality impacts, displacement risks and accessibility months before construction begins.
- **Scenario simulation:** decision-makers can rapidly test hundreds of policy options: which park location improves air quality more? What is the 10-year carbon emissions difference between electric and hydrogen buses? Which housing density model best reduces spatial inequality, understood as the unequal distribution of infrastructure, services, opportunities and risks across different places and communities?
- **Spatial decision visualization:** leaders can see that a proposed high-rise will block 50 per cent of a neighbouring community's sunlight, or identify underserved areas where investments in housing or public services would have the greatest social impact.

#### 3.3 Economic and industrial development across value chains

AI, spatial intelligence, and the AI-enabled citiverse create new economic opportunities.

- **Upstream:** High-resolution 3D mapping and indoor positioning systems provide centimetre-level spatial accuracy.
- **Midstream:** Spatial Intelligence as a Service (SlaaS) – AI models trained on geospatial data for infrastructure prediction, emergency route optimization, and autonomous navigation.
- **Downstream:** Citiverse-native applications enable collaborative neighbourhood design, virtual public consultations, and emergency response training in photorealistic simulations.
- **Horizontal:** Interoperability standards ensure that spatial intelligence layers can be shared across implementations.

Economic value lies in the synergistic ecosystem where AI interprets spatial context, spatial intelligence anchors virtual to physical reality, and the AI-enabled citiverse provides the collaborative platform. Cities that get ahead will drive economic value for their innovation ecosystem and potentially themselves as platform providers.

### 3.4 Inclusive development: Pathways for developing countries

AI, spatial intelligence and the AI-enabled citiverse can be accessed through low-cost, open pathways that enable leapfrog development. Open spatial data combined with open-source GeoAI frameworks reduces deployment costs from millions to thousands of dollars. Cloud-based citiverse access removes the need for expensive 3D infrastructure, although immersive simulation, digital twins and photorealistic environments remain computationally and bandwidth-intensive. For limited-connectivity environments, lighter interfaces, mobile-first tools and non-immersive visualization options can provide more accessible entry points for visualizing proposed projects and supporting virtual public consultations. Research indicates that low-income countries with stronger digital infrastructure achieve 40 per cent more SDG progress than their peers.<sup>7</sup>

### 3.5 Advancing informal settlement upgrading

More than one billion people live in informal settlements lacking secure tenure, resilient infrastructure and basic services. AI-driven spatial analytics can improve the mapping of these areas, identifying infrastructure gaps and spatial inequalities not captured in traditional datasets. Spatial intelligence supports better integration between formal and informal systems. The AI-enabled citiverse enables communities, local authorities and stakeholders to co-design upgrading interventions and visualize outcomes before implementation, making planning more inclusive, evidence-based and accountable.

### 3.6 Strengthening anticipatory governance

The integration of AI, spatial intelligence and simulation tools enables the fundamental shift from reactive to anticipatory governance, one of the most significant governance innovations of the current era. Cities equipped with these capabilities can:

- detect emerging risks before they become crises, from infrastructure stress to climate vulnerability to public health pressures;
- test policy interventions virtually before physical or legislative commitment;
- provide citizens with immersive, georeferenced information about proposed changes to their communities; and
- build institutional learning loops that improve governance quality over time through systematic evidence on what works.

This shift is not merely technological, it is a transformation in the relationship between governments and the communities they serve, grounded in greater transparency, shared evidence, and collaborative decision-making.

## 4 Systemic Challenges

The opportunities described in Section 3 will only be realized if the systemic challenges facing national, regional and local governments are addressed from the outset. Five structural barriers require structured attention at every governance level.

### 4.1 Technical complexity and interoperability gaps

The AI-enabled citiverse requires gathering data from heterogeneous systems: Geographic Information Systems (GIS), Building Information Modelling (BIM), Internet of Things (IoT) sensors, AI platforms, digital twins, telecom network protocols such as 5G and future 6G systems, spatial positioning systems, video analytics feeds and enterprise resource planning (ERP) systems, but the absence of unified standards creates data silos that prevent coordination. Many cities' transportation, energy and water systems use incompatible data formats and protocols. Legacy infrastructure compatibility with new technology remains a structural constraint. Without common technical standards, cities cannot share solutions, replicate successes or collaborate across borders.

### 4.2 Trust, safety, inclusivity and reliability in physical-digital systems

When digital systems directly influence physical spaces and public services, failures cause real harm. Four dimensions require structured governance attention:

- **Trust:** whether citizens and institutions are willing to accept AI-informed decisions in traffic management, resource allocation and public service delivery.
- **Safety:** cybersecurity-by-design and alignment with national resilience frameworks. Cyberattacks on AI-integrated urban infrastructure can cause power outages, service paralysis and public safety crises.
- **Inclusivity:** ensuring that elderly, disabled and digitally underserved populations are not excluded and that no one is left behind while participation remains a choice.
- **Privacy:** collection and use of spatial and behavioural data must be governed by privacy-by-design, data minimization, clear purpose limitation and transparent consent mechanisms.
- **Reliability:** robust contingency and emergency protocols when systems fail. Digital systems on which cities depend for critical services must meet the same reliability standards as physical infrastructure.

### 4.3 Data quality, model accuracy and algorithmic transparency, and lifecycle alignment

AI-enabled urban systems depend on four connected governance foundations: high-quality data, accurate models, transparent algorithms and sustainable lifecycle management:

- **Data quality:** low-quality data leads to wrong decisions. Many cities' datasets are incomplete, outdated or biased<sup>8</sup> with insufficient sensors in low-income neighbourhoods being a common example.
- **Model accuracy:** how accurately does the digital twin reflect physical reality? What validation processes (i.e., AI audits standards and processes) ensure that simulation outputs can be trusted for high-stakes policy decisions?

- **Algorithmic transparency:** when AI recommends closing a public facility or reallocating resources, can decision-makers understand the logic? Explainability is essential for democratic accountability and must be required as a procurement condition.<sup>9</sup>
- **Lifecycle alignment:** digital twins require continuous updates and autonomous synchronization to prevent data decay. Who maintains and stewards them? Who funds them? Data infrastructure sustainability and resilience is a structural challenge, particularly for developing countries.<sup>10</sup>

#### 4.4 Institutional readiness, citizen consent & participation, skills and capacity gaps

Technology readiness does not equate to institutional readiness. Departments commonly lack cross-sector coordination capacity, producing duplicate investments and data fragmentation.<sup>11</sup> Consent mechanisms for spatial and behavioural data collection are frequently absent.<sup>12</sup> Planners may lack the AI literacy needed to interrogate model outputs;<sup>13</sup> elected officials may be unable to engage critically with AI-generated recommendations. Capacity-building must be embedded in project design from the outset covering technical skills, data governance, cybersecurity and procurement with long-term capability transfer built in to ensure continuity after project close.

#### 4.5 Risk of fragmentation at the local, regional and global levels

Without coordinated standards, systems will continue to evolve in ways that cannot readily work together. Existing local fragmentation prevents cities from replicating each other's successful models. Regional fragmentation prevents cross-border city clusters from coordinating. Global fragmentation risks a two-speed digital world that entrenches inequality, enables vendor lock-in and eliminates the economies of scale needed for equitable access. Geopolitical divergence in technology standards is already accelerating this risk. Without unified global indicators, cities cannot benchmark progress or share experiences effectively.



## 5 International Standards and Interoperability: A Multi-dimensional Challenge

Interoperability should be addressed across technical, organizational, semantic and legal layers, supported by sustained interoperability governance. Without structured interoperability frameworks, cities and countries will continue to develop incompatible systems, forgo economies of scale, and miss the opportunity to create the shared digital infrastructure that sustainable development requires. Interoperability must be treated as a global public good, a foundational condition for equitable access to the benefits of AI, spatial intelligence and the AI-enabled citiverse.

### 5.1 Five layers of interoperability

Effective interoperability requires alignment across mutually reinforcing layers: legal, organizational, semantic and technical interoperability, supported by an overarching interoperability governance layer. This layered approach is reflected in established interoperability frameworks, including the European Interoperability Framework,<sup>14</sup> and provides a useful way to understand interoperability as a multidimensional governance challenge rather than a purely technical issue.

#### Technical Interoperability

##### What it means

Common data formats, APIs, protocols and system architectures that enable different urban technologies to exchange data, services and information, and communicate securely. In the AI-enabled citiverse, this includes the technical interfaces and data integration services that allow GIS, BIM, IoT sensors, digital twins, AI platforms and city systems to work together.

##### Recommended approach

Adopt ITU-T Study Group 20 standards for digital twins and smart cities; OASC Minimal Interoperability Mechanisms (MIMs);<sup>15</sup> open APIs as a procurement requirement.

#### Semantic Interoperability

##### What it means

Ensuring that the precise meaning and format of exchanged data and information are preserved and consistently understood across systems and organizations. In the AI-enabled citiverse, this means that spatial sensor streams, AI model outputs and digital twin datasets from different systems carry consistent meaning when integrated.

##### Recommended approach

Adopt common data models, ontologies, vocabularies and metadata standards for urban, spatial and geospatial data. Require AI model outputs and digital twin datasets to include metadata defining data provenance, schema, quality and meaning, so that information can be reliably interpreted across systems, departments and jurisdictions.

### Organizational Interoperability

#### What it means

Alignment of business processes, responsibilities, expectations and working methods across public administrations, city departments and partner organizations so that they can work together effectively. In the AI-enabled citiverse context, this includes the coordination needed between transport, energy, planning, emergency, housing and digital departments, as well as the trust needed when organizational processes become interdependent.

#### Recommended approach

Establish shared coordination mechanisms and working arrangements across departments and partners. Document roles, responsibilities and decision-making processes; support trust-building between institutions; and include organizational readiness assessments in AI, digital twin and citiverse-related programmes.

### Legal Interoperability

#### What it means

Harmonization of liability regimes, intellectual property rules, data ownership frameworks and consent mechanisms, alongside the alignment of procedural rules and administrative protocols across jurisdictions to enable trusted data sharing between public sector actors.

#### Recommended approach

Develop model legislative clauses for cross-border urban data sharing; establish clear liability frameworks for AI-enabled public services; create standardized consent and data minimization requirements; and ensure that roles, responsibilities and service-level arrangements are legally clear.

### Interoperability Governance

#### What it means

The cross-cutting layer that coordinates decisions on interoperability frameworks, institutional arrangements, organizational structures, roles and responsibilities, policies, agreements and monitoring across all layers. Without governance, interoperability remains a one-off technical requirement rather than a sustained public capability.

#### Recommended approach

Establish interoperability governance mechanisms with a mandate across AI, spatial intelligence and citiverse systems. Align local and national approaches with relevant international and regional frameworks, including the European Interoperability Framework, ITU-T Study Group 20 standards and OASC work on interoperable cities. Embed interoperability monitoring, compliance, change management and re-use of services and data into major digital infrastructure programmes.

## 5.2 The role of international standards

International standards are the primary mechanism through which technical interoperability becomes practical reality at scale. They provide the common language that enables different systems, from different vendors, developed in different countries, to communicate and cooperate.

For AI, spatial intelligence and the AI-enabled citiverse, standards development is occurring across multiple bodies:

- **ITU-T Study Group 20 (SG20)**<sup>16</sup> on Internet of Things, digital twins and smart sustainable cities and communities provides the standardization backbone for the AI-enabled citiverse. Study Group 20's work on AI-spatial integration, digital twin architectures and citiverse protocols establishes the common technical foundations without which interoperability aspirations remain fragmented.

- **Open & Agile Smart Cities (OASC) Minimal Interoperability Mechanisms (MIMs)** provide a practical framework for cities to ensure that their digital systems can interact regardless of the technology provider. MIMs cover data models, application programming interfaces and ecosystem integration.
- **ISO/IEC/ITU standards** on AI, data governance and cybersecurity provide the baseline technical requirements that underpin trusted AI deployment in public sector contexts, including relevant work under ISO/IEC JTC 1/SC 42 on AI standardization, such as ISO/IEC 42002 and ISO/IEC 42005.
- **Open Geospatial Consortium (OGC)** standards, including CityGML and SensorThings API, provide important foundations for geospatial data modelling, sensing, and the integration of location-based information across urban systems.
- **W3C** standards support semantic interoperability by enabling structured, machine-readable data exchange and common approaches to linked data, metadata and web-based information sharing.
- **OECD AI Principles** and the Global Digital Compact provide the normative framework that international standards must reflect and operationalize.

Standards development must be inclusive. If standards are developed predominantly by technologically advanced countries and companies, they risk encoding the preferences and constraints of those actors into global digital infrastructure so further disadvantaging cities and countries in developing countries. Active participation by developing countries in international standards bodies is a governance priority, not a technical afterthought.

### 5.3 The cost of non-interoperability

The costs of failing to achieve interoperability are substantial and compound over time:

- Vendor lock-in, which reduces competitive pressure, increases long-term costs, and creates strategic dependence on private technology providers for critical public infrastructure.
- Knowledge immobility, which prevents cities from replicating successful models from other jurisdictions and forces repeated investment in solving already-solved problems.
- Data silos, which undermine the integrated urban intelligence that the AI-enabled citiverse requires and produce fragmented, contradictory evidence for policy decisions.
- Cross-border incompatibility, which prevents regional cooperation on climate adaptation, infrastructure planning and emergency management.
- Widening digital divides, as cities with fewer resources are locked into less capable, more expensive systems while technology-rich cities pull further ahead.
- Ecosystem stagnation, which prevents the emergence of a unified marketplace and stops local innovations from achieving the scale and network effects required for global growth.

#### POLICY IMPERATIVE

*Interoperability requirements should be embedded in every AI and digital infrastructure procurement decision made by public authorities: local, regional or national. The time to require open standards is before systems are built, not after vendor relationships are established and switching costs are prohibitive.*

## 5.4 Balancing standardization and innovation

A persistent concern in standards discussions is that mandatory standards may constrain innovation. This concern, while legitimate, should not prevent the adoption of baseline interoperability requirements. Experience from the Internet, mobile telecommunications and financial systems demonstrates that open standards create larger, more competitive markets, they do not suppress innovation. The imperative is to focus mandatory standards on the interfaces and data exchange layers that enable interoperability, while leaving implementation choices open to competitive market forces. Governments should champion this approach in multilateral settings and in their own procurement practices.

## 6 Five Strategic Priority Areas for Leaders

Drawing on the analysis of opportunities, challenges and interoperability imperatives in this briefing, five priority areas provide the action framework for ministers, mayors and senior policymakers. These priorities are mutually reinforcing: progress in any one area creates enabling conditions for the others.

### 6.1 Deliver global commitments locally

The Global Digital Compact, the 2030 Agenda and the New Urban Agenda set ambitious directions, but their success depends entirely on what happens at the city and community level. Three conditions are essential:

- **Alignment:** global digital commitments must explicitly map to city-level actors, responsibilities and resources. Implementation cannot remain an afterthought delegated without local capacity or mandate.
- **Translation:** abstract global goals must be converted into georeferenced, place-based action plans that local officials can understand, communicate and act upon within their specific contexts.
- **Accountability:** cities need clear mechanisms to report progress against global commitments, and to receive support when they fall short, rather than simply being measured against benchmarks that they played no part in setting.

### 6.2 Use data and simulation to make smarter and inclusive decisions

Cities and national governments need evaluation frameworks specific to AI, spatial intelligence and the AI-enabled citiverse. Three sets of metrics matter:

- **Spatial intelligence metrics:** what percentage of critical infrastructure has precise spatial positioning? Can transportation, energy and emergency systems share spatial context in real time?
- **AI-enabled citiverse metrics:** how accurately does the digital twin mirror physical reality? What percentage of virtually-tested solutions succeeds in physical deployment?
- **Development impact metrics:** a monitoring and evaluation framework measuring contributions to poverty reduction, shared prosperity, climate resilience and spatial equity.

#### DECISION TOOL

*Before any major infrastructure investment, leaders should require a digital twin simulation and scenario analysis. Running 100 virtual policy scenarios costs a fraction of reversing one poorly-designed physical intervention.*

### 6.3 Build trusted, people-first AI

Trust requirements are more demanding when digital systems influence physical spaces and when spatial data makes places and communities more legible to algorithms. Three governance mechanisms are essential:

- **AI transparency in spatial contexts:** citizens must be able to understand place-based AI decisions through clear and accessible explanations, supported by standardized methodologies for visualizing algorithmic logic in geographic context.

- **Spatial data governance:** collection and use of spatial and behavioural data must be governed by privacy-by-design, data minimization, clear purpose limitation and transparent consent mechanisms, with special protections for vulnerable groups.
- **Accountability mechanisms:** structured accountability chains should link virtual tests to physical implementations, ensuring that simulation parameters are recorded, validation responsibilities are assigned, transitions from virtual to physical deployment are reviewed, and responsibility for AI-informed decisions is clearly defined.

## 6.4 Unlock responsible, inclusive economic and social growth

The benefits of AI, spatial intelligence and the AI-enabled citiverse must reach all regions and all communities, not only those at the frontier of digital innovation. Three dimensions are central:

- **Support local ecosystems:** startups, SMEs and local technology actors across all geographies must be able to participate in, and benefit from the emerging value chain, not merely consume solutions developed elsewhere.
- **Invest in inclusive skills:** capacity, must be built especially for youth and underserved communities, combining technical training with governance literacy. The next generation will live longest with the consequences of today's digital infrastructure choices.
- **Adapt social return metrics:** economic growth must translate into reduced spatial inequality, improved quality of life and stronger community resilience, not only GDP metrics or innovation rankings. Existing approaches such as social return on investment (SROI) can be adapted to better capture place-based impacts, including how benefits and risks are distributed across different communities and urban areas.

## 6.5 Scale through global collaboration and adopt international standards

Without coordinated standards, fragmentation will prevent interoperability at the precise moment when the costs of incompatibility are highest. Three standards domains are critical:

- **Interoperable AI and spatial intelligence frameworks:** enabling seamless exchange of 3D, geospatial and behavioural data across systems, sectors and countries.
- **AI-enabled citiverse architectures and protocols:** ensuring synchronization between physical and virtual environments and interoperability across digital twins at scale, grounded in international standards (e.g. ITU-T Recommendations developed by ITU-T Study Group 20).
- **Trusted and inclusive citiverse governance frameworks:** advancing secure data sharing, privacy, algorithmic accountability and equitable access in AI-driven urban systems.

## 6.6 City leaders: From strategy to action

The five strategic priorities above establish the governance framework. This section translates them into concrete, city-level guidance for mayors and city leaders, addressing the four questions most relevant to local decision-making: what to decide, where to invest, what improves lives, and what risks to manage.

### Immediate decisions for mayors

- **Require public oversight for all AI-enabled digitalization of citizen-facing services.** Before approving new AI deployments in public services (traffic, benefits, permits), mandate

an algorithmic transparency review, a public consultation step and a fallback protocol. Consider suspending rollouts that cannot meet these conditions.

- **Adopt open standards in every digital procurement.** Reject bids that cannot demonstrate API openness and data portability. Proprietary lock-in in city systems is a long-term fiscal and governance liability.
- **Commission a city readiness assessment.** Use the Essential 20 Assessment in the companion City Leader’s Field Guide to identify where your city currently stands across data infrastructure, skills, governance and inclusion, before committing to new technology investments.

#### Where to invest: budget implications

- **Prioritize data infrastructure before AI applications.** AI systems are only as good as the data they process. Investing in sensor coverage, data integration and open data lakes yields returns across all subsequent AI applications. Cities that skip this step face repeated reinvestment cycles.
- **Plan for staff transitions alongside technology investments.** When AI takes over routine tasks (e.g. parking regulation monitoring), budget proactively to redeploy affected staff to higher-value services. Failure to do so creates both social costs and political risk.
- **Budget for simulation before construction.** Running 100 virtual policy scenarios via a digital twin costs a fraction of reversing one poorly-designed physical intervention. Allocate a digital twin simulation budget line alongside major capital infrastructure projects.

#### What improves lives in my city: political value

- **Apply a “life improvement” test to every AI initiative.** Before approving an AI project, require sponsors to demonstrate specifically how it reduces a citizen burden, improves a measurable service outcome, or advances equity. Projects that cannot answer this question clearly should not proceed.
- **Use the citiverse as a citizen engagement tool, not just a management one.** Let residents virtually experience a planned park, housing development or transport change before it is built. Cities that involve citizens in this way build trust and reduce opposition to necessary change.

#### What could go wrong if I don’t act: risk clarity

- **Waiting means inheriting systems designed by others.** Cities that delay engagement with AI and digital twin standards will find their infrastructure choices constrained by decisions made by technology vendors and other governments. The window to shape open, interoperable, people-centred foundations is narrowing.
- **Fragmented digital systems increase long-term fiscal and service risk.** Cities locked into incompatible proprietary platforms face escalating maintenance costs, inability to learn from peer cities, and fragmented evidence for policy decisions. Non-interoperability is not a neutral choice, it is a compounding liability.
- **Unmanaged AI deployment creates trust deficits that are hard to recover.** A single high-profile AI failure, biased resource allocation, a privacy breach, or an unexplained automated decision can set back public acceptance of beneficial AI applications by years. Governance frameworks built in advance are cheaper and more effective than crisis management after the fact.

For a complete 90-Day Action Plan with prioritized steps tailored to your city’s context, consult the companion City Leader’s Field Guide: Preparing for the AI-Enabled citiverse, available at <https://www.itu.int/metaverse/virtual-worlds/>.

Advancing these priorities requires dedicated multilateral cooperation. The [Global Initiative on AI and Virtual Worlds - Discovering the Citiverse](#), as a global collaborative platform, connects global digital commitments with city-level implementation, supports the co-development of responsible and interoperable solutions, and works to ensure that the AI-enabled Citiverse ecosystem is accessible to all countries, not only a few. Together with ITU-T Study Group 20, it provides the bridge between strategic vision and operational standards.

### The Global Initiative on AI and Virtual Worlds - Discovering the Citiverse

Launched by the International Telecommunication Union (ITU), the United Nations International Computing Centre (UNICC) and Digital Dubai, the [Global Initiative on AI and Virtual Worlds - Discovering the Citiverse](#) is a global collaborative platform supported by more than 70 international partners across governments, cities, industry, academia and civil society.

The Initiative advances the responsible, inclusive and interoperable development of the AI-enabled citiverse where artificial intelligence, spatial intelligence, digital twins and immersive systems converge to deliver real-world impact for people, cities and communities.

**This Executive Briefing builds on and complements two key deliverables developed by the Initiative:**

- **AI-Enabled Citiverse: A Strategic Blueprint for Cities in the Age of AI** - a governance-oriented vision document for mayors, ministers and city administrators.
- **City Leader's Field Guide: Preparing for the AI-enabled citiverse** - a practical readiness assessment with Pulse Check, Essential 20 Assessment and 90-Day Action Plan tools.

**It is further supported by a suite of thematic publications also developed by the Initiative:**

- AI-enabled Citiverse Use Case Library: Global Insights and Implementation Pathways
- AI-enabled Citiverse Use Case Library: City Administration, Services and Public Participation
- AI-enabled Citiverse Use Case Library: Urban Planning, Placemaking and Infrastructure
- AI-enabled Citiverse Use Case Library: Economic Development, Education and Tourism
- AI-enabled Citiverse Use Case Library: Public Safety, Health and Disaster Resilience
- AI-enabled Citiverse Use Case Library: Transport and Mobility
- No One Left Behind in the AI-enabled Citiverse

All publications are available at: <https://www.itu.int/metaverse/virtual-worlds/>

## 7 Relevance to Global Digital Cooperation

The ambitions of global digital cooperation risk remaining aspirational without concrete delivery mechanisms. AI, spatial intelligence and the AI-enabled citiverse offer precisely that: platforms that translate normative commitments into georeferenced, measurable and participatory action. Their relevance to global digital cooperation can be understood across four mutually reinforcing dimensions.

### 7.1 Spatializing digital public infrastructure

Digital public infrastructure is evolving from flat and static to three-dimensional and dynamic. Spatialized DPI adds geographic positioning, 3D modelling and real-time data streams to traditional digital identity and payment foundations. Emergency response systems display disaster impacts and evacuation routes in real time within the AI-enabled citiverse. Planning departments enable residents to virtually experience new project impacts on their communities before they are built. Countries with stronger digital infrastructure achieve 40 per cent more SDG progress than their peers.<sup>17</sup> and spatialized DPI is a critical component of that infrastructure dividend.

### 7.2 Interoperability as a global public good

The choice is between isolated implementations and interconnected ecosystems where interoperability is a global public good. Treating interoperability as a competitive advantage instead locks cities into proprietary systems, enables vendor capture and eliminates the economies of scale that could make these technologies universally accessible. The AI-enabled citiverse itself becomes the testbed, bringing transportation, energy and emergency systems together in virtual environments before physical deployment, demonstrating interoperability in practice before standards are finalized.

### 7.3 Trust and security as preconditions for adoption

When digital systems control physical infrastructure, the threshold for trust and safety is fundamentally higher than in consumer applications.<sup>18</sup> Cyberattacks can cause power outages and service paralysis; algorithmic bias leads to inequitable resource allocation; data breaches expose citizen locations and behaviours. Complementary frameworks spanning cybersecurity, data protection, AI accountability and physical dimensions are a prerequisite for responsible deployment.<sup>19</sup> Transparency, explainability and auditability are not optional features; they are the conditions under which public institutions can legitimately deploy AI systems that affect people's lives.

## 7.4 Inclusive access as the measure of success

Trust is only meaningful if access is universal. Inclusive access requires affordability (so that low-income communities access the same capabilities as wealthy ones), accessibility (so that rural and remote areas have sufficient connectivity), usability (so that elderly and disabled users can engage with digital urban systems), and empowerment (so that communities can shape, not merely consume, these technologies). The AI-enabled citiverse must offer multilingual, accessible interfaces, alongside lighter, non-immersive or mobile-first entry points where connectivity is limited, while recognizing that full immersive simulation and digital twin environments remain bandwidth- and compute-intensive, including for the more than one billion people currently living in informal settlements.<sup>20</sup>

## 8 Conclusion

AI, spatial intelligence and the AI-enabled citiverse are developing faster than international coordination frameworks can keep pace. Early choices create path dependencies. Today's decisions will shape urban governance for decades. Without shared understanding and coordinated action, fragmentation will emerge with systems evolving in ways that cannot readily work together, that entrench digital divides, and that exclude the communities most in need of the opportunities these technologies can create.

Yet this moment also presents a rare opportunity. Technologies remain sufficiently early-stage that consensus on open, interoperable, human-centred foundations is still achievable. The window is open, but it will not remain so indefinitely.

[UN Virtual Worlds Day 2026](#), convening in Geneva on 11-12 May, brings together governments, cities, international organizations, industry and civil society at precisely this inflection point. The [Global Initiative on AI and Virtual Worlds - \*Discovering the Citiverse\*](#), as a global collaborative platform, provides the mechanism to carry this momentum forward, turning commitments into coordinated action across borders, sectors and governance levels.

This briefing has set out the governance landscape: the spectrum of AI types reshaping public institutions; the transformative potential of spatial intelligence and the AI-enabled citiverse; the systemic challenges that must be addressed; the multidimensional nature of interoperability as a technical, policy and legal challenge; and the five strategic priorities that provide a practical governance framework for action.

The imperative is clear. Governments at all levels, local, regional, national and international must act together, grounded in the principle that the digital future must serve all people, in all cities, in all countries.

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