Beyond Smart Cities

Exploring the Citiverse through European and Korean Approaches

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OPEN & AGILE SMART CITIES & COMMUNITIES

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Open & Agile Smart Cities & Communities (OASC) is a global network supporting local and regional authorities in their digital transformation journey. Together with its members, partners and experts, OASC helps build sustainable, resilient and inclusive communities through interoperability, digital innovation, artificial intelligence, and digital sovereignty. OASC contributes to European Citiverse projects and international standardisation activities, connecting the needs and experiences of cities and communities with the development of interoperable frameworks, practical solutions, and standards. Through its Minimal Interoperability Mechanisms (MIMs) and engagement in international initiatives, OASC supports an open, human-centric, and interoperable Citiverse.

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Published in November 2026.

This brochure was partially developed as part of the "ICT Convergence – Citiverse Standards Research Laboratory" project, funded by the Ministry of Science and ICT (MSIT) of the Republic of Korea.

Generative AI was used to support language editing and to create selected illustrations in this publication. The content was reviewed by the authors, who retain full editorial responsibility.

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Section 1: Overview

Digital change increasingly shapes how people live in cities: how they use services, meet one another, and participate in decisions about their surroundings. The Citiverse offers a way to consider these social, physical, and digital relationships together, and to ask how cities and communities can shape their development.

Europe and the Republic of Korea approach this from different starting points. Europe's emerging approach gives particular weight to public governance and shared (digital) infrastructure. Korea brings substantial experience with urban platforms and smart-city programmes, informing Citiverse research and standards.

Drawing on the institutional experience of Open & Agile Smart Cities & Communities (OASC) and the Smart City Association (SCA), this brochure examines these approaches and their potential complementarity. It considers how cooperation between Europe and Korea could connect Citiverse standards and research with practical urban applications, enabling partners to test approaches, share experience, and develop interoperable solutions that respond to local needs.





Section 2: Understanding the Citiverse

The Citiverse is an emerging concept for understanding and shaping an urban environment in which physical, digital, and social life is increasingly interconnected [1]. People inhabit and influence this environment through their relationships, activities, and use of services. This raises two key questions: how can stronger connections between digital technologies and the physical and social environment improve people's lives, and how can people continue to influence decisions that affect their lives in an increasingly digitalised and automated local environment.

Smart city work already pursues public value and participation. The perspective taken here considers how connected systems shape local life as a whole, and who can influence the shared rules and conditions under which they operate.

Local and regional authorities have often already invested in data platforms, digital services, and Local Digital Twins, which represent local places and systems, with many capabilities predating the Citiverse label. Artificial intelligence (AI), simulation, and immersive tools increasingly extend how people can understand and interact with their surroundings [2].

A proposal to change traffic flows, for example, may affect air quality, access to shops, and public space. Residents and planners could examine those effects together, using connected information to explore alternatives.

The goal of the Citiverse is to help cities and communities improve quality of life, develop more responsive public services, and enable meaningful participation in shaping local environments. Achieving this vision requires interoperability across dimensions, enabling different actors, systems, and services to exchange and use data, information, and knowledge while accommodating different organisational responsibilities, legal frameworks, and cultural contexts. For us, interoperability is therefore not only a technical requirement but also a foundation for digital sovereignty, public accountability, and cooperation between cities and communities, including privacy, security, and ethical principles as further essential considerations [3,19].

Section 3: Europe’s Approach

3.1 A question of public governance

European cities and communities have spent two decades investing in sensors, platforms, and digital services in pursuit of efficiency and better decision-making. Those investments remain important. As AI, digital twins, immersive technologies, and virtual worlds converge, they increasingly shape the environment in which people encounter public services and in which local decisions are prepared, tested, and made.

This makes public governance a central concern. A model can influence which options a city or community considers, whose experience is visible, and what counts as a successful outcome. The central question is therefore how cities and communities can retain meaningful oversight and influence over increasingly interconnected digital systems, ensuring that their development and use remain aligned with public interests, democratic accountability, and local priorities.

The European approach places public governance at the centre of the European Citiverse (or *CitiVERSE*) development. Its aim is to ensure that the emerging digital local environment remains open, accountable, and subject to public oversight.

3.2 Public value and shared infrastructure

The European Commission has framed the Citiverse as a flagship project of public interest [4]. Together with its accompanying pre-standardisation roadmap [5], the EU's stated ambition is an inclusive and sustainable Citiverse: decentralised, technology-agnostic, open, and accessible, reflecting European values and fundamental rights.

For OASC, this calls for open and interoperable public infrastructure that cities and communities can adopt, share, and adapt according to their needs. Modular architectures allow cities to build on existing investments and extend capabilities incrementally. Interoperability enables components from different providers to work together, supporting technological choice, reuse, and reduced vendor lock-in. Clear governance arrangements ensure that public authorities retain meaningful influence over their digital infrastructure and the services built upon it.

Residents, commuters, and visitors should participate in shaping their local environments, including the models and assumptions that affect them. Rights and accessibility must guide development from the outset. Cities and communities define the demand, the rules, and the outcomes; businesses and researchers innovate within them. Public accountability gives that innovation direction while leaving room for different approaches and providers.

3.3 An ecosystem taking shape

Europe's Citiverse ecosystem brings together cities and communities, industry, including SMEs, and research organisations to develop, demonstrate and reuse interoperable digital solutions. Its organising principle is to establish common foundations while allowing cities and communities to adapt solutions to their local needs and priorities.

The *Networked Local Digital Twins towards the CitiVERSE European Digital Infrastructure Consortium* (LDT CitiVERSE EDIC) [6] provides an institutional framework for cooperation between European cities and regions. Established in 2024, it aims to support the development of a connected European ecosystem of Local Digital Twins and the long-term adoption of shared digital capabilities.

Alongside the institutional development, EU-funded research and innovation projects are exploring what the Citiverse means in practice, with more on the horizon:

- x-CITE uses extended reality and AI for urban participation, environmental visualisation, and cultural experiences in Rotterdam, Flanders, and Tampere [7];

- SENSE explores participation and social connection through digital environments in Cartagena and Kiel [8];

- CU (European Citiverses Uniting for Inclusiveness) develops accessible Citiverse applications using Gothenburg's Local Digital Twin, involving families of children with disabilities in their design and evaluation [9];

- 3DxVERSE develops interoperable Local Digital Twins for sustainable travel and living, including in Almelo, Hamburg, and Timișoara [10];

- TWINE develops open and federated Web 4.0 infrastructure to enable interoperability between Local Digital Twins and immersive services. It aims to develop a new Minimal Interoperability Mechanism (MIM) for virtual-world services and demonstrate cross-city federation in Rotterdam, Tampere and Flanders [11]; and

- TWINVERSE develops a federated ecosystem of interoperable, AI-enhanced Local Digital Twins to support climate-neutral urban planning, simulation, and participatory decision-making across six European Mission cities [12].

These projects build on a broader European ecosystem of complementary initiatives. The EU Local Digital Twin Toolbox [13] provides reusable, open-source components that cities can adopt when developing Local Digital Twins. LDT4SSC [14] advances interoperability and federation between Local Digital Twins, while the European Data Space for Smart Communities (DS4SSCC) [15] supports trusted data sharing across organisations and sectors. BUILD [16] contributes to the implementation of the LDT CitiVERSE EDIC, supporting the adoption and scaling of shared Local Digital Twin capabilities.

Together, these initiatives illustrate how European Citiverse development builds on existing digital infrastructure while advancing new forms of interaction, cooperation and interoperability.

3.4 Interoperability and local control

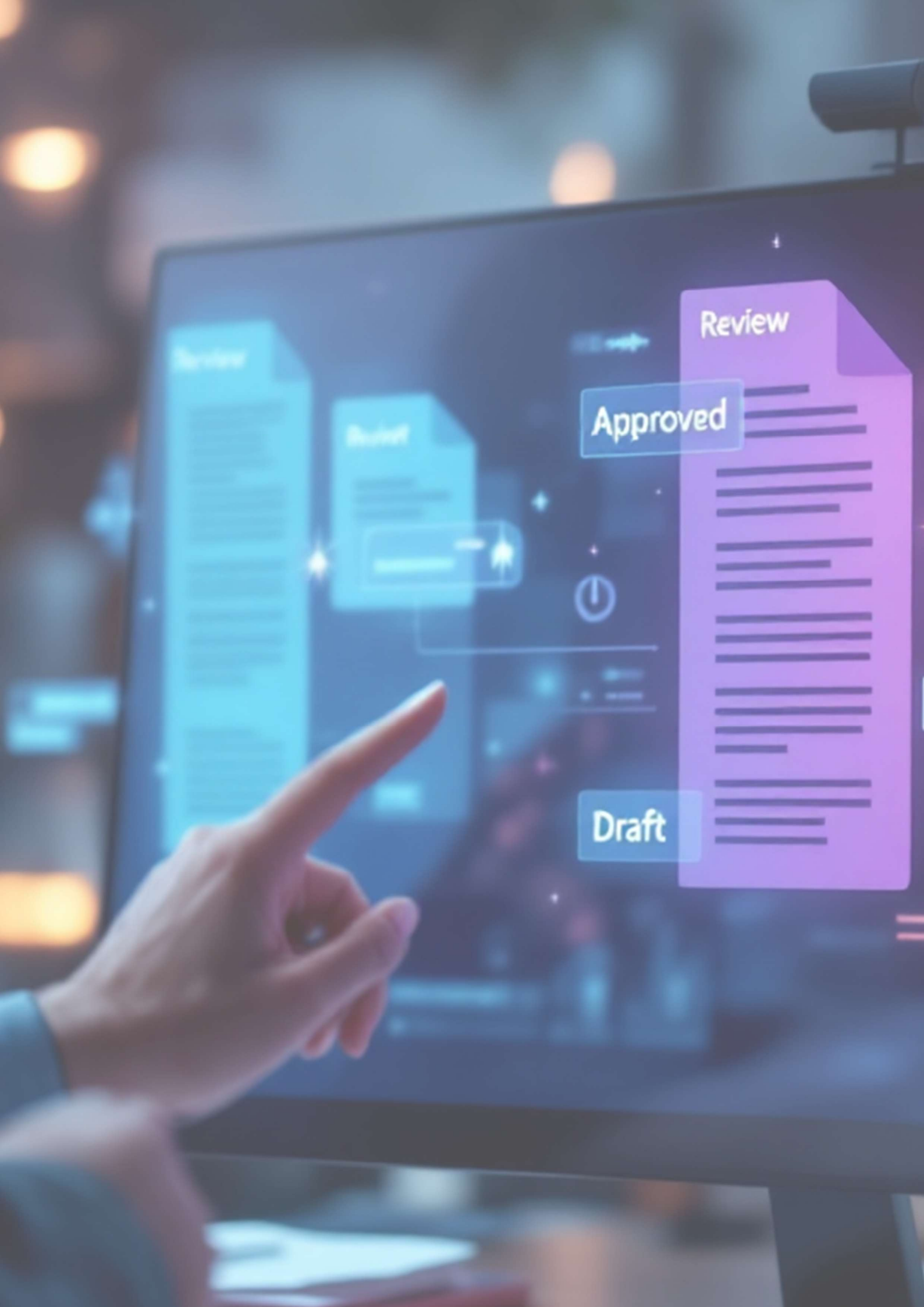
The European Citiverse builds on existing local digital infrastructure, connecting data spaces, shared data models, Local Digital Twins, AI-enabled services and immersive applications. Ensuring that these components can interact across different systems, providers, and communities, requires common interoperability approaches.

OASC's Minimal Interoperability Mechanisms (MIMs) [17] provide a common foundation for interoperability between data, systems, and services. They support incremental development and technological choice, allowing cities and communities to connect existing systems and adopt new capabilities without depending on individual providers. The concept and structure of MIMs are defined in ITU-T Recommendation Y.4505 [18].

However, interoperability extends beyond technical and semantic compatibility. Organisational responsibilities, legal frameworks, and cultural contexts also influence whether cities and communities can effectively exchange and reuse data, services and digital capabilities. The European Interoperability Framework for Smart Cities and Communities (EIF4SCC) [19] provides a broader perspective on these dimensions, helping public authorities retain control over their digital environments.

Through its involvement in European initiatives and international standardisation, OASC connects these interoperability principles with practical implementation. Emerging projects such as TWINE aim to extend interoperability mechanisms towards federated virtual-world services and immersive applications.

OASC and the Municipality of Rotterdam coordinate Track 16 on the Interoperable Citiverse within the ITU Global Initiative on AI, Digital Twins, and Virtual Worlds [20]. The track explores how the five interoperability dimensions mentioned above can support trustworthy Citiverse ecosystems, connecting practical city experiences with international cooperation and standardisation.


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Section 4: Korea’s Approach

4.1 Building on Korea’s Smart City Experience

Korea’s Citiverse-related work builds on earlier smart-city projects. Korean cities have used urban data platforms, digital twins, connected devices, and systems for managing city services. These were developed for smart-city needs, rather than as complete Citiverse systems [21, 22].

The national Smart City Innovation Growth Engine research and development programme (2018–2022) developed ways to collect and connect information from different city systems. Daegu and Siheung tested these tools on local issues, including transport, safety, the environment, and energy [21].

Korea’s Fourth Comprehensive Smart City Plan (2024–2028) calls for greater use of AI and digital twins in urban data hubs [22].

4.2 Citiverse as an Emerging R&D and Standardisation Agenda

Current Citiverse work in Korea focuses mainly on research and standards.

The CitiVerse Standards Research Laboratory is funded by the Ministry of Science and ICT. Its members include the Electronics and Telecommunications Research Institute (ETRI), SCA, and the Korea Electronics Technology Institute (KETI). They work on Citiverse standards and cooperation in Korea and abroad. SCA helps connect this research with smart-city stakeholders [23].

A key focus of this research is how existing urban data platforms, digital twins, AI tools, and virtual environments can be connected and used together. This approach explores how Korea can build on its existing smart-city infrastructure while developing Citiverse-specific capabilities [23, 24, 26].





4.3 Developing the Technical Foundation

Korean organisations take part in international standards work through ITU-T, the standardisation sector of the International Telecommunication Union. One work item, Y.citiverse-reqts, looks at requirements for Citiverse platforms and interoperability between city systems [26]. Another, Y.citiverse-ai-reqts, focuses on requirements for AI-enabled interoperability in Citiverse environments [24]. ETRI and Daejeon University are among the Korean participants.

The Citiverse Standardization Forum brings together government, companies, researchers, and other groups in Korea. It provides a place to discuss standards, research plans, and possible uses in cities [27].

4.4 Connecting Research with Cities, Communities and Industry

Korea’s organisations hold different types of information and skills. The Korea Land and Geospatial Informatix Corporation (LX), for example, works with mapping information and digital twins [25]. Local governments know their cities’ systems and needs. Researchers and companies can help develop and connect tools.

As this work moves towards city applications, residents and community groups can help assess whether a proposed service is useful and easy to use. That cannot be judged through a technical test alone.

4.5 From Research Towards Application

An important next step for Korea's Citiverse development is to evaluate emerging concepts, standards, and technologies through practical city-level applications. Such tests can show whether existing tools exchange information that city staff can use, and whether the organisations involved can work together.

They can also show whether an application meets a local need. The results can guide later research, standards work, and decisions about wider use.

Section 5: Comparing approaches and developing cooperation

5.1 Different trajectories and complementary experience

Europe and Korea approach Citiverse development from different but complementary starting points. European initiatives build on existing Local Digital Twins, urban data infrastructure, and interoperability frameworks, supported by collaborative research projects and emerging institutional structures such as the LDT CitiVERSE EDIC. Korea brings substantial experience with integrated urban platforms, national smart-city programmes, and coordinated research and standardisation activities.

Table 1: Comparison Europe-Korea

Aspect	Europe	Korea
Point of departure	Governance and interoperability frameworks, Local Digital Twins, and cooperation between cities	Experience with integrated urban data platforms, national smart-city programmes, and practical urban applications
Organising logic	EU-funded research and implementation projects, the EDIC, and partnerships bringing together cities, industry, and research based on common rules	National programmes and research initiatives bringing together government, research institutes, industry, and local stakeholders
Current Citiverse development	Shared infrastructure and tools, pilots exploring particular applications	Developing Citiverse-specific standards and technical requirements, building on existing smart-city capabilities
Interoperability and standardisation	Technical, semantic, organisational, legal, and cultural dimensions; MIMs and wider interoperability frameworks, addressing technical and institutional challenges	Developing technical requirements for Citiverse platforms and AI-enabled interoperability through national and international standardisation activities
Opportunity for cooperation	Testing shared frameworks against practical implementation challenges	Exploring and testing how emerging Citiverse standards and technical requirements can be applied to existing urban platforms and smart-city applications.

Europe brings agreed frameworks, its *LDT CitiVERSE EDIC*, and a broad understanding of interoperability. Korea brings urban platforms, geospatial capabilities, and experience from smart-city demonstrations. Neither represents a completed Citiverse model. Their different experiences create opportunities to connect emerging Citiverse standards with practical smart-city applications, allowing both regions to test approaches, exchange knowledge, and identify solutions that can be adapted to different local contexts.

Despite the different trajectories, both face the same constraint. The Citiverse is not one system but many, owned and run by different organisations, built at different times, and answerable to different rules. The main challenge is therefore not only how advanced individual technologies are, but also how different systems, organisations, and governance arrangements work together. Europe and Korea bring different but complementary experience in governance, interoperability, and smart-city implementation, with distinct priorities and approaches to Citiverse development. The starting points differ, but the challenge is shared between them.

International standards provide a common foundation for cooperation, but their practical implementation depends on more than technical compatibility. Connecting a Korean urban data platform with a European Local Digital Twin, for example, requires attention to shared data models and interfaces as well as organisational responsibilities, legal frameworks and local operating practices. Joint experimentation can therefore help identify both technical and institutional interoperability requirements, providing practical evidence to inform future standards and implementation guidance.

The practical solution is to understand interoperability holistically. Data-protection regimes differ. Procurement cultures differ. Assumptions about what belongs to the national level and what belongs to the local or regional authority differ, and those assumptions have often been embedded in systems long before anyone attempts to connect them. Joint work must also test whether connected systems fit the working practices of those who operate and use them. Effective cooperation is not automatic. It requires careful planning, practical testing, and adjustments based on experience.

By sharing practical experience and lessons learned, Europe and Korea could accelerate Citiverse development in both regions and contribute approaches that other cities and communities can adapt to their own needs. An approach developed jointly between Europe and Korea, tested in cities and communities on both sides, and grounded in openness and interoperability could inform how the Citiverse develops elsewhere more effectively than either region pursuing it alone.

Section 6: An invitation to collaborate

OASC and SCA invite cities, communities, researchers, and technology partners to help shape an open, interoperable, and human-centric Citiverse through shared experience and practical cooperation.

Building on complementary European and Korean capabilities, opportunities for collaboration include exchanging experiences from Local Digital Twin and Citiverse initiatives, exploring interoperability between urban platforms and immersive services, developing joint use cases, and contributing to international standardisation through ITU Study Group 20 and the Global Initiative on AI, Digital Twins, and Virtual Worlds.

Cooperation could begin with a shared implementation challenge and evolve into joint experimentation, research or implementation projects. Such activities could contribute to practical interoperability guidance, international standards, and future European or Korean funding initiatives.

OASC and SCA welcome partners from Europe, Korea, and beyond to explore opportunities for collaboration.

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