The Augmented City

Seeing Through Disruption

" Someone told me that cyberspace was 'everting.' That was how she put it." "Sure. And once it everts, then there isn't any cyberspace, is there? There never was, if you want to look at it that way. It was a way we had of looking where we were headed, a direction. With the grid, we're here. This is the other side of the screen. Right here. (....) The world we walk around in would be channels. **"**

— William Gibson, *Spook Country*

Acknowledgments

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Foreword

New technologies have been driving the growth of cities for thousands of years, from the invention of agriculture and aqueducts to the steam engine and electricity. But while the urban innovations of the past restructured the physical world, today's big breakthroughs work behind the scenes, sensing, shaping and revealing invisible patterns and new virtual spaces. Augmented reality (AR) is poised to reshape cities in ways that were unimaginable just a decade ago. This report, *The Augmented City*, by 2023 Urban Tech Fellow Greg Lindsay, examines both the exciting potential and the grave challenges posed by the integration of AR into urban life.

The rise of AR introduces exciting possibilities for transforming urban spaces and improving civic life. Imagine a city where residents can engage with real-time data on everything from public transportation to public art, or where digital tools guide visitors with enhanced accessibility and story-telling. However, the same technology that can make cities more interactive also risks eroding privacy, distorting public spaces, and deepening social divides and inequities. As we've learned from previous technological disruptions like ride-hailing and short-term rentals, cities face a critical dilemma: act too quickly and risk wasting resources on fleeting trends, or move too late and struggle to manage the consequences. Lindsay's exploration of AR through both best-case and worst-case scenarios highlights the need for cities to anticipate the impacts of this powerful new technology and proactively shape how these tools are permitted to be deployed.

The Augmented City underscores the urgency of our work at the Urban Tech Hub to help governments anticipate the impacts of new technologies, revealing that unchecked AR could lead to a public realm dominated by corporate interests, data harvesting, and filter bubbles that fragment shared spaces. Without thoughtful regulation and governance, we risk allowing technology to disrupt urban life in ways that prioritize profit over people.

Cities should not only be prepared to respond to tech innovations but should also play a central role in regulating their responsible use. By developing public-private partnerships and fostering civic tech ecosystems, cities can leverage AR to enhance transparency and civic engagement, rather than surrendering control to external forces and private interests.

The report outlines 10 recommendations for helping cities understand how to embrace the opportunities of this new technology, while keeping its disruptive tendencies in check. From establishing AR advisory boards and public registries to zoning guidelines, and privacy ordinances, these recommendations can empower cities to safeguard public spaces and ensure equitable access to AR technologies.

Lindsay's thoughtful, provocative and comprehensive report is an essential guide for city leaders, urban planners, technologists, and community advocates seeking to navigate this exciting yet challenging new era. *The Augmented City* is just the beginning of increasing our understanding of how cities will be shaped by AR. This report is both an optimistic vision of the power of technology to bring people together in new ways, but also an important reminder to be ever vigilant in protecting the public from the intrusion of unchecked and unregulated urban technologies.

Michael Samuelian
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Executive Summary

Who "augments" the city?

The advent of smartphones nearly 20 years ago was a landmark of urban tech, spawning "disruptive" new business models changing how cities are perceived and consumed. While startups such as Uber and AirBnB created value for customers, they also produced costly externalities for cities, ranging from a strain on housing supply to increases in traffic congestion and fatalities. Municipal governments struggled to understand these companies' software and business models, hampering efforts to manage and ultimately regulate them. They faced a now-familiar dilemma: move too quickly and risk precious time and energy on inconsequential developments, or move too late and pay a steep price for their earlier inaction. Knowing whether and when to act is — and will always be — crucial.

This report asks two questions: What is the next disruptive technology to reshape the urban public realm? And how can they better anticipate its effects upon arrival?

The answer to the first is augmented reality (AR), which is poised to finally go mainstream after already being present in cities for years. The overnight success of the AR game *Pokémon GO* in 2016 demonstrated how real-time information overlaid on public space could produce radical changes in usage and behavior. More recently, Meta, Apple, Google and others have collectively spent tens of billions of dollars developing wearable devices to do just that (with decidedly mixed results). Meanwhile, the rapid rise of generative AI has enhanced their appeal by imbuing them with powerful new features, while simultaneously granting AI its own physical form. Failure to understand the urban implications of these twin evolutions will ensure another decade of disruption.

The second question is addressed through a foresight technique known as "threatcasting," which grounds potential futures in the concrete form of stories about specific persons responding to identified threats. Developed by former Intel futurist Brian David Johnson,[1] threatcasting employs insights gleaned from research and expert interviews to guide multidisciplinary groups

> **"This report asks two questions: What is the next disruptive technology to reshape the urban public realm? And how can they better anticipate its effects upon arrival?"**

in envisioning and planning against these threats a decade in the future.

To this end, a cohort of current- and former public officials drawn from city governments and agencies in New York, Los Angeles, Miami, Philadelphia, Pittsburgh, and beyond, supplemented by policy experts, XR creators, and foresight practitioners, were collectively convened virtually over six months in January-June 2023 and finally in person in July 2023 to explore this prompt: *What are future uses of augmented reality in cities, and what are the implications for managing public space and safety?*

Their responses yielded dozens of stories imagining both best-case and worst-case scenarios that were then distilled into a set of "findings" — three potential threats, matched with a corresponding trio of opportunities — alternately reflecting the collective fears and aspirations of participants. Each finding is paired with a set of "flags," which are signals of a threat or opportunity emerging, and "gates," a set of concrete steps for mitigating threats or seizing opportunities. Each set of findings, flags, and gates — grouped under the headings of threat and opportunities — follow.

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1   https://threatcasting.asu.edu

Threats

1 Tech Encroachment: Unless cities act, unchecked AR will erode public space and privacy

Big Tech platforms will deploy AR in urban settings without adequate oversight, compromising privacy, exacerbating inequality, and further eroding public trust through data harvesting, algorithmic control, and the creation of impenetrable personal filter bubbles.

The relentless pursuit of new products and data will drive these companies to infiltrate cities, buildings, and bodies using combinations of AR and AI. They will deploy these in conjunction with a broad range of sensing systems, from "smart homes" and autonomous vehicles to biometric data extracted from wearables. Without proper regulation at federal and local levels, these companies will pursue market dominance with minimal consideration for ethical implications or societal impacts.

This threat will be amplified by the transformation of AR into the primary interface for extractive technologies, including ubiquitous luxury surveillance and emotionally parasitic AI companions. As AR gradually supplants smartphone usage, it will become the primary means through which hundreds of millions of users experience these effects daily, with particularly acute impacts in dense urban environments. The privatization of both physical and digital public spaces will accelerate as cities outsource the management and monetization of AR experiences.

The expansion of social media filter bubbles into physical space will further fragment society, as users opt for personalized experiences that reinforce existing beliefs and biases. This will contribute to the erosion of shared reality and democratic consensus. The shift away from open, publicly-vetted data toward private vendors will create confusion and entrench users in incompatible, overlapping realities, affecting everything from basic navigation to social interactions.

What to look for:

- Big Tech's expansion into urban infrastructure and public spaces
- Inadequate regulation and oversight of AR and AI
- Increasing gentrification and social fragmentation
- Over-reliance on AI-driven decision-making
- Privatization and fragmentation of urban information ecosystems

What to do about it:

- Establish municipal oversight and regulation of AR experiences
- Foster public-private partnerships for responsible AR development
- Enhance municipal capacity for AR governance
- Promote digital literacy and public awareness
- Ensure equitable access and protection in AR-enhanced spaces

2 Augmented Predation: AR is expanding the attack surface for malicious actors

Augmented reality at scale will create novel opportunities for criminal activities, financial scams, and worker exploitation, particularly targeting vulnerable populations through sensory deception and misinformation while overwhelming existing public safety.

These threats will emerge from a willful disinvestment in security, safety, and content moderation, presenting unprecedented challenges for law enforcement and policymakers. The combination of AR's spatial manifestation and AI agents will provide criminals with powerful new tools to identify and target victims in public spaces.

The most insidious developments will involve AR deepfakes powered by stolen personal data. Criminals will use these technologies to create convincing spoofs of trusted figures, leveraging AR's growing verisimilitude to deceive victims' senses and gain their trust. This toxic combination of visual and auditory manipulation will become particularly effective as users become desensitized to AR experiences and find it increasingly difficult to distinguish between their filter bubbles and malicious fabrications.

The targets of these attacks will disproportionately be members of vulnerable populations, including elderly individuals given AR devices by well-meaning family members, immigrants required to use certain technologies due to their legal status, and workers mandated to use AR for their jobs. As these formerly disembodied threats take physical form, local law enforcement will struggle to understand their nature and jurisdiction, let alone develop the capabilities to detect, prevent, investigate, or prosecute them.

What to look for:

- Evolution of traditional scams leveraging AR and AIR technologies
- Sensory manipulation and misinformation in urban spaces
- Exploitation of AR infrastructure vulnerabilities
- Challenges in law enforcement and jurisdiction

What to do about it:

- Establish "AR-free" zones and protect physical spaces
- Foster public-private partnerships for AR safety
- Protect vulnerable communities from tech exploitation
- Enhance data security and identity protection
- Combat AR-enabled hate speech and deception
- Enhance law enforcement capabilities for AR-related crimes

3 Digital Divides: "Neighborhoods in flux" are both targets and threats

AR deployments will have uneven impacts across cities, potentially destabilizing certain neighborhoods through digital redlining and the erosion of shared urban experiences.

Just as previous generations of urban technologies disrupted incumbent business models and infrastructure, AR's ability to overwrite reality will have cascading effects on the built environment. This digital transformation will mirror historic patterns of disinvestment, with historically marginalized communities either starved of AR investment and services or targeted for disruption through digital redlining. Meanwhile, iconic destinations may experience a renaissance through AR enrichment, while formerly overlooked locations acquire entirely new contexts, sending real estate valuations soaring.

A new phenomenon of "veil-ification" will emerge, where multiple realities overlap the same physical location but remain invisible to non-participants. With access to these realities and their services limited to those who can afford them, it becomes possible to build multiple exclusive communities on top of each other. This novel form of digital stratification will add new dimensions to existing patterns of gentrification and displacement, as the physical and social bonds traditionally defining neighborhoods weaken.

Big Tech will accelerate these changes by pursuing strategies to create and capture value through AR, including building digital twins of desirable neighborhoods or partnering with real estate interests to create virtual privately-owned public spaces (POPS). These projects will offer unprecedented opportunities for surveillance through devices and sensors, with the resulting combination of location, biometric, and personal data harnessed for precision advertising and commerce that may delight users but further stratifies neighborhoods into AR haves-and-have-nots.

What to look for:

- Erosion of local community and services
- Digital disparities and disinvestment
- Changing civic engagement patterns
- Social isolation and mental health concerns
- Information integrity and misinformation
- Shifting economic and real estate dynamics

What to do about it:

- Establish public-private agreements for AR regulation and standards
- Empower local communities and workers
- Mitigate digital divides and "veil-ification"
- Protect neighborhood identity and cohesion

Opportunities

4. Civic Tech Renaissance: AR offers cities their own UX for urban tech

Cities have an opportunity to harness AR as part of a broader civic tech ecosystem to enhance transparency, improve service delivery, and foster community engagement, but this will require significant investment in infrastructure and capacity-building.

In contrast to the threats posed by unchecked Big Tech, AR in the hands of civic tech will empower users to "see" cities as networks of resources and communities addressing challenges including housing, education, and migration. It will literally make cities transparent, enabling everything from visualization of property ownership and tax records to smoothing daily routines for special needs individuals and providing AI-powered guides for visitors.

Realizing this potential, however, presumes significant government capacity and investment in municipal data infrastructure. Cities will need to develop comprehensive systems including accessible tax records, digital sandboxes for testing AI applications, and clear standards for human-AI interactions. These challenges underscore the substantial work required before cities can effectively manage AR deployments and place would-be disruptors in check.

Rather than simply attempting to regulate Big Tech, cities should aspire to outflank them by creating tools leveraging their unique strengths while building on open data and open source software. Achieving this will require extensive collaboration across city departments and between cities, along with investment in open standards and platforms. Success will depend on finding competent and cost-effective technology vendors while training staff to use new tools and designing procurement policies accounting for the benefits of AI and AR.

What to look for:

- Enhanced security and trust in AR systems
- Inclusive XR for education
- Addressing technological impacts on mental health
- Personalized and AI-enhanced urban experiences

What to do about it:

- Establish local data collection and sharing infrastructure
- Enhance regulatory responsiveness
- Reimagine public spaces for the AR era
- Promote ethical and inclusive AR development
- Leverage AR for enhanced civic engagement

5 Municipal Innovation Reboot: AR will require cities to retool with new roles and leadership

Municipal governments will need new roles, skills, tools, and leadership to identify, mitigate, and recover from threats posed by AR and AI. This new breed of public servant will be called upon to help build, monitor, and administer the city's simultaneous presence across multiple realities while ensuring its official presence remains as open and agnostic as possible. Presently overmatched city departments must retrofit regulations for new dimensions while building or procuring tools to enforce them.

One response might be to consolidate these roles inside bespoke "Departments of the Digital Public Realm." These cross-cutting, cross-functional new agencies would face both internal political challenges and external pressures from technology companies. Cities must learn from failed attempts at appointing powerless innovation czars by granting such teams real oversight authority and stationing them within executive offices. Whether as new departments or new arms of existing ones, they must have real regulatory teeth and executive backing.

The biggest challenge will be leadership – ensuring the heads of these fledgling offices not only have the tools, skills, and authority, but also the resilience necessary to stand fast and hold coalitions together against constituents convinced they're a hindrance rather than help. Investing in this personal capacity will be more important than any piece of technology and central to developing the institutional ability to foresee and forestall disruption.

What to look for:

- AR influence on public space and services
- Emergence of AR partnerships and urban pilots
- Legislative and regulatory adaptation to AR

What to do about it:

- Enhance municipal digital capabilities
- Develop regulatory frameworks for AR
- Implement cross-departmental AR strategies
- Create new urban departments and roles
- Create spaces for experimentation and community discourse
- Foster inter-city collaboration and knowledge sharing

6 Grassroots Resilience: "Neighborhoods in flux" are also testbeds for resilience

As AR and AI become commonplace, the cost of large-scale simulation will drop precipitously, granting governments and organizations enhanced predictive powers using "digital twins." Urban systems will be run through millions of simulations daily, modeling everything from routine operations like traffic patterns to extreme scenarios such as natural disasters. Insights from these massive forecasts will reach residents through real-time alerts and routing, using AR to dynamically reprogram cities. Vulnerable neighborhoods should be first in line for this new form of augmented rapid response.

The mantra "seeing is believing" will transform civic engagement, as AR and AI enable city planners to meet people where they are to create buy-in for new projects or even co-create them. However, this vision raises complex questions about who has the privilege or right to write to this communal AR canvas. Civic baseline reality will require careful management of permissions for local leaders and stakeholders, extending debates over who speaks for communities into new dimensions.

In response to corporate attempts at "veil-ification," residents will take matters into their own hands by hacking, tagging, and creating their own alternate realities using open-source tools and ad hoc moderation. Some of these efforts may gain global recognition, prompting local activists to create the first "digital land trusts" to protect and preserve this content. The augmented city will be an endlessly contested one, as inhabitants struggle to depict not only what is or what once was, but what could be. The power of AR as a resilience multiplier lies in its ability to make these invisible conflicts visible and challenge competing interests to see a common future together.

What to look for:

- AR-enhanced civic engagement
- Advanced urban simulation and forecasting
- AR-driven urban adaptation
- Evolving notions of community and belonging
- Community-driven AR layers
- Balancing physical and digital urban realms

What to do about it:

- Enhance urban navigation and emergency response
- Leverage AR for urban resilience
- Democratize urban planning
- Develop civic AR layers and standards
- Preserve cultural heritage
- Foster community-driven AR development

Recommendations

The rapid evolution of augmented reality demands swift yet thoughtful action from cities to establish governance frameworks and build internal capacity. While AR's trajectory remains uncertain, cities can't afford to wait and see — they must act now to shape these technologies for public good. The following recommendations, synthesized from extensive interviews with the project's cohort of current and former public officials, represent concrete steps cities should take in preparation. While each city will need to adapt these recommendations to their specific context, resources, and priorities, they provide a roadmap for proactively engaging with AR.

1 Create an AR advisory board

Recruit a diverse panel of experts, stakeholders, and residents to guide urban AR policy development and implementation.

Establishing a permanent advisory board not just for AR, but for *all* emerging technologies is an important first step. This body should serve as a link between city officials, private actors, and residents for safeguarding the development of AR in the public's interest. The board should include staff from relevant agencies, technology experts, privacy specialists, community advocates, and legal experts working together to assess impacts and develop policy recommendations.

- Establish permanent technology advisory body within mayor's office

- Include diverse expertise from planning, security, accessibility, and legal domains

- Monitor deployments and integrate AR considerations into broader city initiatives

- Conduct regular site visits and demonstrations of proposed projects

2 Develop AR zoning rules

Draft virtual zoning guidelines for governing where and how AR operates.

Cities have historically struggled to balance regulation of nascent technologies with encouraging innovation. While strict oversight of AR may be premature, developing a coherent legal framework now is preferable to hastily retrofitting ill-suited ordinances later. Working with companies, standards bodies, and legal experts, cities should establish guidelines protecting public interests while encouraging beneficial applications.

- Create comprehensive framework for content types, density, and behavior by location

- Designate AR commons for public art and pilot zones for testing new concepts

- Work with publishers to geofence sensitive areas and cultural sites

- Implement processes for regular review and updates as technology evolves

3 Define pilot sites and programs

Work with private and local partners to create and populate AR testbeds.

Key to regulating new technologies is knowing when —and where — to grant permission before companies seek forgiveness. Pilot sites have proven invaluable for testing urban tech in controlled environments before wider deployment. Cities should establish "AR innovation zones" where new applications can be tested safely under collaborative governance models.

- Select sites and partners to minimize disruption under real-world testing

- Partner with BIDs, universities, and cultural institutions

- Define clear success metrics and pathways to city-wide deployment
- Create structured programs for training and ecosystem development

4 Establish a public AR registry

Build a database and/or civic visual positioning system for monitoring AR.

As tech companies race to build their own digital twins of cities, governments need systems to track their contents, accuracy, and safety. A public AR registry would serve as a "single source of truth" for managing content in the public realm, providing transparency and accountability while enabling coordination between stakeholders.

- Create centralized database for tracking AR content and deployments
- Implement streamlined approval process aligned with zoning guidelines
- Connect with city databases to preempt conflicts and coordinate activities
- Enable public reporting of issues and automated alerts to relevant staff

5 Support AR civic art and education projects

Collaborate with artists and non-profits to experiment and enhance the public realm.

As a first step in creating their own content, cities should work with cultural institutions to commission public art and education programs. These projects offer opportunities to learn by doing while building external partnerships and internal capacity, particularly around engagement and preservation.

- Commission public works to learn through hands-on experience

- Create digital twins of monuments and historical sites
- Develop preservation guidelines for digital cultural heritage
- Test public feedback mechanisms and community creation tools

6 Test tools and techniques for prototyping and engagement

Explore how city agencies can harness AR's unique capabilities.

AR offers unique opportunities for cities to meet constituents where they are when presenting complex proposals. By enabling residents to visualize projects in situ, AR could transform how communities understand and engage with proposed changes to the built environment.

- Deploy visualization tools for proposed developments and infrastructure
- Enable community feedback through accessible AR interfaces
- Integrate with existing planning and community engagement processes
- Partner with researchers to evaluate impact on civic participation

7 Draft data privacy ordinances

Pass laws governing the collection, use, and storage of data generated from AR in public spaces.

With many social media platforms now applying data extraction techniques to physical space, cities must establish safeguards around tracking and targeting in the public realm. Clear legal frameworks should protect residents' privacy while enabling beneficial uses of AR technologies.

- Establish clear limits on personal data collection and retention

- Implement special protections for location data and children

- Require transparency reports from platforms about data practices

- Create processes for regular review and updating of privacy regulations

- Participate actively in standards development organizations

- Champion open infrastructure and interoperability requirements

- Align AR standards with existing urban data specifications

- Develop frameworks for maintaining municipal ground truth

8 Implement accessibility standards

Develop guidelines ensuring AR experiences and services are discoverable for the impaired.

Cities must ensure augmented reality is augmented for everyone. By upholding comprehensive accessibility guidelines, they can ensure public spaces remain truly public in both physical and virtual realms while providing clear guidance to platforms and developers.

- Mandate inclusive design from conception through implementation

- Require multiple input methods and assistive technology support

- Ensure physical accessibility of AR triggers and interactions

- Include disabled users in design and testing processes

9 Organize public sector working groups for technology standards

Join standards organizations to propose and advocate for equitable urban tech.

Cities have a crucial role in shaping technical standards that will define AR's use in public spaces. While tech firms advance their own specifications, cities must ensure standards align with policy goals around equity, safety, and accessibility.

10 Found the Global Urban AR Development Initiative and Network (GUARDIAN)

Create a peer network of cities and partners for developing, sharing, and enforcing standards and regulations.

Not content to participate in standards bodies convened by tech firms, cities should create their own structure for collaboration. GUARDIAN would offer a dedicated venue for developing shared approaches to AR governance while amplifying their collective voice in discussions with industry.

- Build coalition through existing municipal organizations

- Coordinate multi-city pilots and knowledge sharing

- Develop shared tools and policy frameworks

- Convene annual summit to strengthen collaboration and set priorities

Who is this report for?

This is a guide for civic leaders seeking to shape these technologies for public good. It is primarily meant for city officials charged with overseeing the augmented reality experiments, pilots, and deployments in their communities. "Seeing through disruption" (to quote this report's subtitle) not only demands greater skepticism of tech companies' claims and intentions, but also having the vision to recognize new technologies' potential — thus rendering it unnecessary for firms to either receive forgiveness or ask permission, instead working together to achieve shared goals and positive outcomes.

It may also be useful for:

- **Policymakers** seeking an overview of AI's and AR's potential impacts on cities, including emerging challenges and opportunities for regulation.

- **Community organizations** keen to understand how these technologies might exacerbate local inequalities or alternately bolster public participation.

- **Urban planners and designers** who are curious as to how AR could reshape public spaces and urban interactions, requiring both physical and digital wayfinding.

- **Startups and practitioners** eager to work with cities who would like to learn more about public officials' concerns and considerations when it comes to deploying new technologies.

- **Privacy and digital rights advocates** grappling with issues such as "digital redlining" and pervasive surveillance in the contexts of AR and public space.

- **Legal professionals** wondering how AR intersects with content moderation and virtual property rights, to name just a few gray areas.

> ❝❝ **Seeing through disruption not only demands greater skepticism of tech companies' claims and intentions, but also having the vision to recognize new technologies' potential.** ❞

How to use this report

If you are new to AR — not to mention VR, MR, and XR — and need an introduction to key concepts and technologies before continuing, start with **Terms & Definitions** (page 20).

If you're looking for an overview of the critical issues raised by the cohort and used to guide participants in threatcasting this report's findings and stories, turn to **The Augmented City: How We Got Here** (page 34).

If you are interested in how threatcasting works as a foresight methodology, all is explained in **What is Threatcasting?** (page 58).

If you'd prefer to just skip to the principal findings (and what we should do about them), head to **Findings** (page 62), **Flags** (page 92), and **Gates** (page 100).

If you would like to consider recommendations gleaned from expert presenters and the cohort's discussion, go to **Recommendations** (page 108).

If all of this is too dry and theoretical and you'd rather jump in and explore the future from a human perspective, skip to the **Stories** (page 65) accompanying each finding.

And if you'd prefer to hear directly from the technology and policy experts who primed the cohort, head straight to **Appendix: Expert Interviews** (page 120).

Terms & Definitions

This report explores future threats and opportunities for cities posed by the next wave of potentially disruptive technologies, headlined by AI and AR. Before further unpacking these futures, it's important to define key terms, technologies, and context — such as the difference between augmented-, virtual-, and mixed-reality (not to mention "spatial computing"). In addition, how do practices such as "luxury surveillance" and "digital redlining" combine to create "diminished reality?" And does "the metaverse" really mean anything at this point? (Not really.)

These and other ideas are introduced and described in detail here to help frame subsequent sections containing the report's findings, implications, and recommendations.
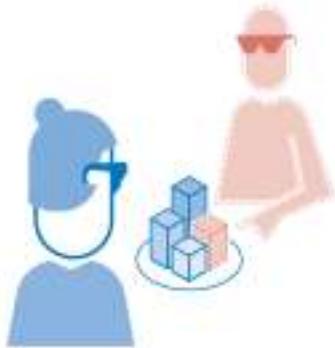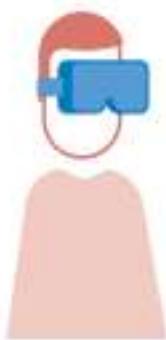
Augmented Reality (AR)

Augmented reality overlays digital information on physical objects and environments in the "real world," aiming to enhance users' perception of reality rather than replace it. These overlays are typically audio/visual in nature — including 3D models, images, video, and immersive audio — using hardware ranging from smartphones to specialized headsets and other wearables. AR applications range in complexity from Snap's AR Lens smartphone filters — which it claims to have more than 300 million daily users[2] — to persistent experiences anchored to physical coordinates through the use of visual positioning systems. The latter differentiates AR from related technologies such as AI-enabled smart glasses (see "AIR" below) or spatial computers displaying information purely from an individual user's point-of-view.

This combination of shared persistence in physical space is what makes AR potentially disruptive to cities. Whether it's distracted drivers playing *Pokémon Go* or a larger-than-life Gorillaz concert performed in Times Square, AR's ability to enhance or obscure "reality" extends the public realm into new dimensions.

2 https://www.pymnts.com/artificial-intelligence-2/2024/snapchat-aims-to-spend-1-5-billon-per-year-on-ai/
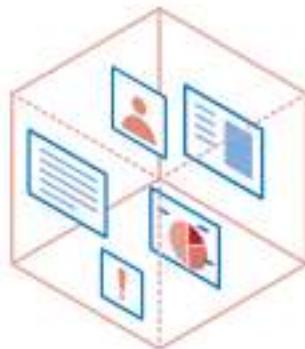
Virtual Reality (VR)

Unlike AR, virtual reality aims for total sensory immersion in computer-generated virtual worlds. VR is most commonly associated with face-obscuring head-mounted displays such as the Meta Quest line, Sony Playstation VR, and HTC Vive — all of which track eye-, hand-, and body movements to create facsimiles of reality at varying resolutions. Given its inward focus, VR is out of scope for this report. While virtual reality raises serious issues around privacy, security, and safety, they are better left to federal- and even supranational regulators, legislators, and law enforcement rather than municipal ones.

Mixed Reality (MR)

Mixed reality aspires to embed virtual elements in physical environments, creating experiences in which digital objects can interact with and respond to the real world in real-time. Unlike VR, which aims for total immersion, MR allows users to perceive and interact with both digital- and physical elements simultaneously. And unlike AR, which simply overlays information on the real world without much interaction, in MR virtual objects can be anchored to physical coordinates, respond to obstacles, and be manipulated by users as if they were tangible. In this sense, MR is effectively *augmented* augmented reality.

While AR and VR have always existed on a spectrum of occlusion, the rise of passthrough video — i.e. using cameras to 'pass through' users' enclosed field-of-view to perceive the real world — lends itself more easily to mixed reality. For this reason, both the Meta Quest and the Apple Vision Pro are increasingly described as mixed reality as part of a pivot away from VR's bad PR.

XR

An umbrella acronym for technologies and concepts pertaining to augmented- (AR), virtual- (VR) and mixed reality (MR). The "X" is algebraic, meant to encompass both types. It speaks to the field's semantic confusion that XR is sometimes taken to mean "extended reality," which doesn't technically exist, and is now more commonly referred to as "mixed reality."

The exception is WebXR, an open API (*see "XR standards" below*) for viewing AR/VR content via a Web browser without dedicated hardware or software. In practice, WebXR enables smartphone users to launch AR experiences with the tap of a link, typically delivered via a Website or physical QR code scanned by the phone's camera. In this manner, WebXR makes AR instantly accessible by billions of smartphones today, rather than tens of millions of headsets.
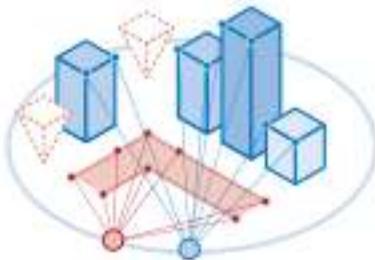
Spatial Computing

Spatial computing refers to human-machine interactions perceived as taking place in disembodied three-dimensional environments rather than behind a two-dimensional screen. The term was recently appropriated by the Apple Vision Pro, which "seamlessly blends digital content with your physical space," ushering in the self-proclaimed "era of spatial computing," according to language on Apple's Website.

Although the phrase shares technologies and terminology with MR, Apple has assiduously avoided any mention of competing concepts, going so far as to instruct developers, "refer to your app as a spatial computing app. Don't describe your app experience as augmented reality (AR), virtual reality (VR), extended reality (XR), or mixed reality (MR)."[3] (Apple has since relented somewhat with the addition of WebXR support for the Apple Vision Pro.)[4]

> **WebXR makes AR instantly accessible by billions of smartphones today, rather than tens of millions of headsets."**

3 https://developer.apple.com/visionos/submit/#describing-your-app
4 https://developer.apple.com/videos/play/wwdc2024/10066/

The Metaverse

In Neal Stephenson's 1992 novel *Snow Crash*, "the Metaverse" refers to a single, shared, immersive future incarnation of the Internet. This virtual world is ringed by "The Street," which users navigate with embodied avatars to visit virtual addresses and structures along it.[5] In essence, the original conception of the metaverse was an urban one.

Like spatial computing, the metaverse has since been co-opted by so many variously competing- and cooperative interests as to effectively become meaningless.[6] Following Facebook's corporate renaming as Meta in October 2021,[7] the phrase became inextricably linked with the company's efforts to build an ecosystem of hardware, software, and services securing its future — a multi-billion-dollar effort once estimated to eventually cost more than the Apollo Program.[8]

In other contexts, the metaverse may refer to games (e.g. *Roblox*, *Fortnite*) and virtual environments with varying degrees of persistence and immersion, and is also conflated with digital currencies and assets by proponents searching for a *raison d'être*. Because of such usage, "the metaverse" is currently *passé* at best, disqualifying at worst.

Visual Positioning Systems (VPS)
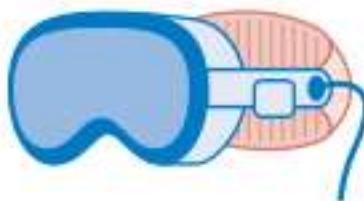
Just as the Global Positioning System (GPS) underpins all mapping apps, a visual positioning system enables the precise location of AR information and experiences anywhere in the world. Unlike GPS, which relies on satellites, a VPS uses computer vision and deep learning algorithms to recognize and understand the camera's surrounding environment with centimeter-level accuracy. This in turn allows devices to discover persistent content and its exact position and orientation relative to the viewer.

Unlike maps, which ultimately reflect a single, shared reality (with caveats), and unlike GPS, which is owned by the U.S. government, visual positioning systems are privately owned and controlled, and can be stacked — or overlap — atop each other indefinitely. Niantic's Lightship VPS is one; Hexagon's Immersal is another, and Google's ARCore Geospatial API is several orders of magnitude larger than either in terms of geographic coverage. The latter's Geospatial Creator tool leverages both Google Maps and popular applications such as Unity and Adobe Aero to place AR content virtually anywhere in the world within minutes.[9]

The implications for cities are profound. As discussed below, visual positioning systems open a new front in wrangling with tech companies over the use (and misuse) of public space and even reality itself.

5   *Snow Crash*, page #24, Bantam Paperback Edition (1993)
6   https://www.ben-evans.com/benedictevans/2021/10/31/ways-to-think-about-a-metaverse
7   https://about.fb.com/news/2021/10/facebook-company-is-now-meta/
8   https://x.com/nathanbenaich/status/1586400993816872987s=20
9   https://developers.googleblog.com/en/google-ar-at-io-2024-new-geospatial-ar-features-and-more/

Apple Vision Pro

Described by the company as a 'spatial computer' (and *never* a headset), the Apple Vision Pro has more in common with Google Glass a decade ago than true mixed reality (or any of the other acronyms). Both devices are effectively heads-up displays projecting information from the user's personal (spatial) computer onto a screen, rather than rendering information specified by protocols in a shared environment. While the Vision Pro is able to temporarily anchor screens and windows in physical locations from the user's perspective — or conversely, dial down reality for total immersion in audio/visual content — the world users inhabit was initially a lonely one. How Apple decides to add MR features depends on its hardware and software development roadmap.

This roadmap is currently in doubt following reports of lackluster sales[10] and a dearth of apps[11], leading Apple to reportedly reconsider when to release a lower-priced consumer version (2025? 2026?).[12] That said, the launch of the Vision Pro was a landmark event from a marketing perspective by bringing Apple's halo effect to XR. Although reviewers may have taken issue with its weight and long-term comfort (as well as what it's actually *for*), the device was widely greeted not with derision (*a la* Google Glass) but curiosity and excitement. Once again, a potentially disruptive new technology has escaped into the urban wild with unforeseen consequences. The good news, given its high price and low sales volumes so far, is that there is still time to do something about it.

Pokémon GO

The most popular AR game of all time by a wide margin, *Pokémon GO* launched on July 6, 2016 for Apple and Android smartphones, using their GPS to locate, capture, train, and fight several hundred varieties of Pokémon. Created by Niantic Labs in partnership with Nintendo and The Pokémon Company, the game became an instant sensation, with 50,000 downloads in its first 24 hours and 50 million worldwide in its first 19 days. It would reach 500 million downloads by the end of that year, but its popularity has tapered over time.

While the urban consequences of *Pokémon GO* will be discussed elsewhere in this report, its success nearly a decade ago underscores the fact that AR is not a speculative technology, but one that has already achieved worldwide acclaim and adoption. That said, Niantic's subsequent efforts to recapture lightning in a bottle with a series of licensed games that alternately flopped (*Harry Potter: Wizards Unite*) or were canceled (*MARVEL World of Heroes*) underscores the challenge to replicate its success.

Although *Pokémon GO* reportedly continues to generate more than $1 billion of in-app purchases annually, Niantic's future may depend on using the game's residual popularity to bootstrap adoption of Lightship — its software development platform for creating third-party games and the visual positioning system underpinning them. Owning AR's most successful franchise is good; owning the underlying map and AI tools for future games would be even better.

10 https://medium.com/@mingchikun/apple-cuts-2024-2025-vision-pro-shipment-forecasts-unfavorable-to-mr-headset-pancake-and-micro-3879683af930

11 https://appfigures.com/resources/insights/20240405/amp?f=4

12 https://www.bloomberg.com/news/newsletters/2024-06-23/apple-vision-plans-cheaper-model-in-late-2025-vision-pro-2-in-2028-ar-glasses-lxrjkiwu?srnd=undefined

XR Standards

The Internet is built on a foundation of technical standards, the most important of which is the Internet Protocol suite, TCP/IP. From those early protocols sprang Internet domains, email, and the World Wide Web — all of which are stewarded by standards-defining organizations (SDOs) such as the World Wide Web Consortium (W3C), whose members are typically comprised of corporations, NGOs, universities, government entities, and individuals. Together, they wrangle and ratify the fundamental building blocks of code that make the Internet interoperable.
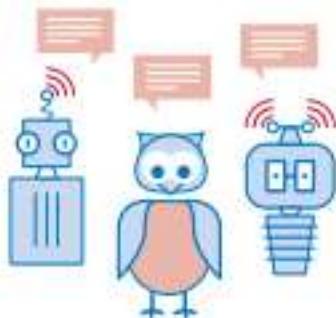
When it comes to XR, many of the standards needed to define the metaverse or an augmented city have yet to be invented. It's still early enough that aspirants would prefer to advance their own platforms as the *de facto* standards, whether that's Apple's visionOS, Meta's Horizon OS, or Google's Android XR. But SDOs including the W3C and Open Geospatial Consortium (OGC) continue to advance open standards for the technical underpinnings of XR, the best example of which may be the championing of WebXR by the W3C's Immersive Web Working Group.[13]

> **When it comes to XR, many of the standards needed to define the metaverse or an augmented city have yet to be invented.**

A step removed from these bodies are standards advocacy organizations such as the Open Metaverse Alliance and Metaverse Standards Forum (MSF). The latter acts as both an umbrella group for SDOs and a repository of proposed standards, with various domain groups chiseling away at different aspects of XR, the most relevant of which for cities might be "Real/Virtual World Integration."

Tellingly, the MSF's principal membership roster does not include a single city or government entity of any kind, highlighting their absence from the deliberations shaping the next potential incarnation of the Internet — the first to intersect directly with public space. (For more on the MSF, see Neil Trevett's interview on page 137)

13 https://immersive-web.github.io

AI Agents

Compound AI systems,[14] also known as "agents," represent the next iteration of generative AI. Using repeated calls to large language models (LLMs) to complete tasks, agents demonstrate higher complexity and autonomy than current chatbots. Agentic systems are said to possess the abilities to perceive and act upon their environments, plan and pursue goals without explicit instructions, and access external tools and resources (e.g. Web search, programming) to achieve them.

For example, a team of Stanford-led researchers created a *Sims*-style game named *Smallville* stocked with 25 agents. Powered by an LLM similar to ChatGPT, the characters were given brief backstories and the capability to remember, reflect, plan, and execute tasks on their own. When one was initially assigned to host a Valentine's Day party, for instance, the character invited friends, decorated the game's café, and even played matchmaker — all of its own accord.[15] Their utility didn't end there, however. Within weeks of the game's source code being freely available,[16] another team of researchers put the town to work making video games.[17] Other agents have demonstrated the ability to trade stocks,[18] design products,[19] and more.

Agents can also perceive, decide, and act within cities as well. V-IRL[20] ("Virtual Intelligence in Real Life") is a platform combining mapping, geospatial information, and Google Street View imagery to create a machine-readable facsimile of the world designed expressly for agents. Uses include routing, recommendations, search (e.g. "find and summarize listings for all available apartments in this neighborhood") and variously complex combinations of these functions and more. Designed by University of Hong Kong and New York University researchers, V-IRL demonstrates how readily agents can be adapted for real-world uses.

Earthbound Agents
Action & Geolocation
/Mapping capabilities
Peng
Visiting Student

Language-Driven Agents
Reasoning & Language Models
Aria
Place Recommender
Vivek
Estate Agent

Visually Grounded Agents
Perception & Computer Vision
RX-399
Urban Assistance Robot
Imani
Urban Planner
Hiro
Seasoned Traveler

Collaborative Agents
Agent-(Agent, Human)
Collaboration
Ling
Tourist
Diego
Expert Concierge

V-IRL's team of specialized AI agents
Images from V-IRL. (virl-platform.github.io)

14 https://bair.berkeley.edu/blog/2024/02/18/compound-ai-systems/
15 https://reverie.herokuapp.com/arXiv_Demo/
16 https://nacimysis.github.io/smallville
17 https://arxiv.org/abs/2311:07924
18 https://arxiv.org/pdf/2309.03736
19 https://arxiv.org/pdf/2311.11991

20 https://virl-platform.github.io/
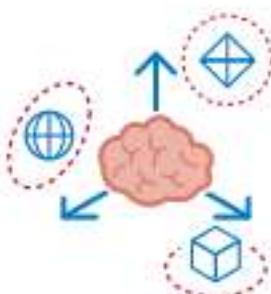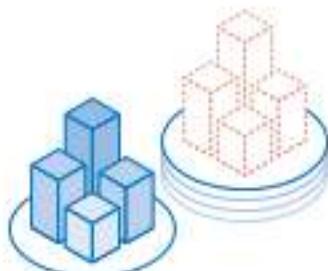
Digital Twin

Conceived as high-fidelity virtual representations of physical objects, infrastructure, and systems, digital twins are models designed to mirror the status of their real-world siblings. Continuously fed real-time data from sensors and other sources, they are used to run simulations, analyze performance, and test enhancements, all in silicon. The concept was first elaborated by the computer scientist David Gelernter in his 1991 book *Mirror Worlds*, although the phrase itself was later coined by NASA technologist John Vickers in 2010.[21]

Modern digital twins typically range in scale from machine components to assembly lines to single buildings. Given sufficient resources, however, building a 1:1 scale model of an entire city — or even the planet's atmosphere, as Nvidia aims to do with Earth-2 — is technically feasible. They don't necessarily need to be absolute to be useful, however. The Open Mobility Foundation has described its Mobility Data Specification — a software protocol for managing private vehicles in the public realm used by more than 130 cities and public agencies — as an "air traffic control" for locating and removing shared electric scooters.[22] This amounts to a digital twin for city streets, albeit one with lower fidelity.

As visual positioning systems evolve and expand in both scope and scale, they will provide the basis for incorporating augmented reality into urban-scale digital twins. And as indicated by the examples above, these twins may be full-stack, open platforms (as is Earth-2), may be run by public agencies and their partners (as with MDS), or may be proprietary (as Google's and Niantic's already are).

Spatial Intelligence

As defined by the machine vision pioneer and World Labs founder Fei-Fei Li, spatial intelligence encompasses the abilities to perceive, reason, model, and predict the shapes, sizes, and relative positions of three-dimensional objects in space — all of which humans take for granted.[23] In the context of AI, they underpin machines' mapping of physical environments and understanding of the spatial relationships between objects — both of which are necessary to seamlessly render virtual elements within AR or MR.

As AI's spatial intelligence continues to evolve, the pairing of these features with AIR devices promises to dramatically increase the pace at which Meta and Google et al. are able to build and constantly refresh their own visual positioning systems and deliver AIR agents at scale. Niantic, for example, is already using *Pokémon GO* data to build what it calls a "Large Geospatial Model" capable of perceiving, understanding, and interacting with objects and places in digital twins.[24]

21. https://www.ibm.com/topics/what-is-a-digital-twin
22. https://www.openmobilityfoundation.org/use-cases-how-why-cities-use-mds/

23. https://www.ted.com/talks/fei_fei_li_with_spatial_intelligence_ai_will_understand_the_real_world
24. https://nanticlabs.com/news/largegeospatialmodel

Artificially Intelligent Reality (AIR)

An acronym coined for this report, AIR describes how generative artificial intelligence has quickly become inextricably bound with AR. This is already evident in two respects. First is a new class of wearable devices led by the Ray-Ban Meta smart glasses, which variably combine cameras, microphones, and simple displays with multimodal AI that can listen and respond to audio requests, capture and analyze video, and/or visually display answers to questions. This represents a new direction for AR away from high-resolution imagery and persistent content toward simpler personal AI assistants.
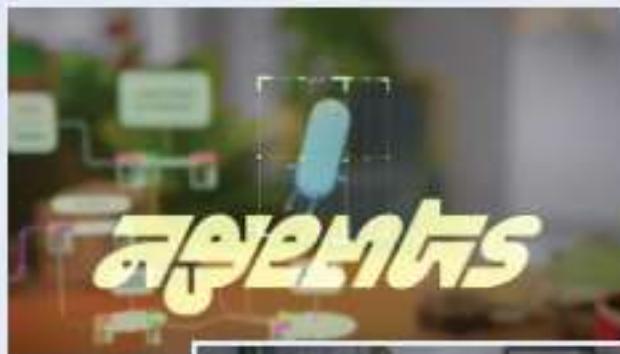
A second manifestation of AIR is the embodiment of AI agents in the guise of AR NPCs. A landmark example is "Wol"[25] — an AIR owl created by filmmaker/developer Keiichi Matsuda (interview on page 143) in conjunction with Niantic and AI developer Inworld. Using either a Meta Quest headset or WebXR on a smartphone, users summon Wol from its animated home to converse about redwood forests — or anything else the one feels like asking it. Wol is a working prototype of an AIR-powered future Matsuda subsequently explored in his short film *Agents*,[26] which depicts an urban landscape filled with AIRs whose appearances range from glowing orbs to cartoon characters.

Matsuda had previously published a cosmology of sorts, titled "Gods,"[27] in which he argued the monolithic, all-powerful AI assistants of today's tech giants would (or at least should) give way to a decentralized ecosystem in which users could choose their own pantheon of AIR agents. Drawing on metaphors from

> **This represents a new direction for AR away from high-resolution imagery and persistent content toward simpler personal AI assistants**

pagan animism, Matsuda imagined that if AIs were to be embedded everywhere, they would ultimately take corporal form as the resident "god" of a given street or store or park — and that these local gods would interact with one's own in a complex exchange of protocols and permissions.

Helpful Places' Jacqueline Lu imagines the implications of AIR for civic institutions in her own interview on page 130 — how might these gods, or agents, negotiate access to each other, and to the digital public realm?

Agents (2023) is a short film imagining everyday life with AI & AR.

Credit: Liquid City

Watch on Youtube
https://youtu.be/bkKv2AHpn8E

25 https://meetwol.com
26 https://youtu.be/bkKv2AHpn8E?si=cjtDUwDw-h2hbZQn
27 https://drive.google.com/file/d/1UyqFX32KHOkBIM0M5ggrnYjqa-gWktkRo/view
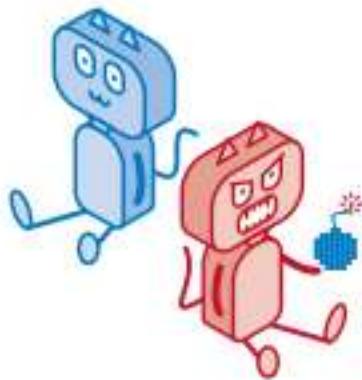
Disruption

"Disruptive innovation," as defined by the late Harvard Business School professor Clayton M. Christensen in 1995[28] — and expounded upon in his 1997 book *The Innovator's Dilemma* — describes how newer, smaller entrants in a given industry disrupt the successful business models of larger incumbents. By targeting overlooked customers (or non-customers) with nominally inferior but suitably priced alternatives, would-be disruptors could chase their rivals upmarket until they'd captured the mainstream. Infamous victims include Eastman Kodak (overthrown by digital cameras) and Blockbuster (bankrupted by streaming).

By Christensen's standards, Ray-Ban Meta Wayfarers may yet prove to be disruptive by a) creating a product category that didn't previously exist, b) at a lower price than incumbent devices (e.g. smartphones), and c) with less obvious utility at the outset, but possessing features appealing to new users. To quote Hopscotch Labs co-founder and chairman Dennis Crowley (interview on page 126), "the next big thing always starts out looking like a toy."[29]

But Christensen's focus on technology and strategy left him with a blind spot for a different type of entrepreneurship — the regulatory kind. Uber, he argued in 2015, didn't meet any of the thresholds for disruption — it started at the top of the market with an arguably superior product and worked its way down.[30] Its real innovation was to disrupt taxis through inferior regulation, lower earnings for drivers, and political campaigns by "regulatory entrepreneurs"[31] such as Bradley Tusk, a former campaign manager for New York City mayor Michael Bloomberg who mobilized users against "taxi cartels" and lobbied for — and even claimed to write — new, more favorable regulations.
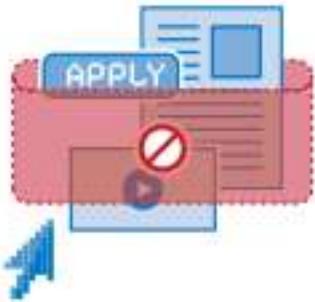
The danger for cities this time is that AR (and AIR) represent a convergence of both types of disruption — new technologies dismissed as toys until they overturn the norms and mores of urban life literally overnight (e.g. *Pokémon Go*) guided by well-established playbooks for regulatory entrepreneurship. How does one disrupt the disruptors?

28 https://hbr.org/1995/01/disruptive-technologies-catching-the-wave
29 Crowley knowingly paraphrased a similar observation by venture capitalist Chris Dixon. https://cdixon.org/2010/01/03/the-next-big-thing-will-start-out-looking-like-a-toy
30 https://hbr.org/2015/12/what-is-disruptive-innovation
31 https://scholarship.law.upenn.edu/cgi/viewcontent.cgi?article=3035&context=faculty_scholarship
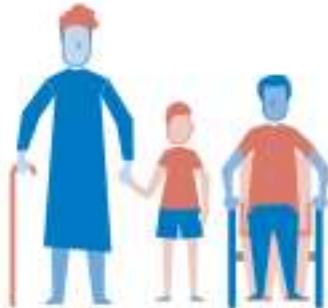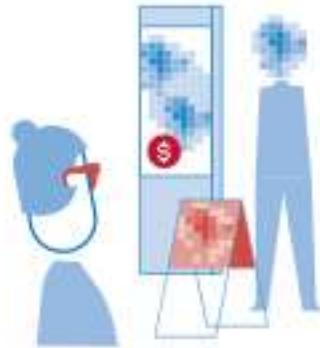
Digital Redlining

Digital redlining refers to racial disparities in technology access that disproportionately impact already marginalized communities in a negative way. A classic example is Facebook's former "ethnic affinity" feature allowing advertisers to exclude selected groups from seeing ads for jobs or housing. The term draws obvious parallels to the historical practice of redlining in housing, where certain neighborhoods — typically with predominantly minority populations — were denied services or investment. As the digital and physical worlds collide through XR, digital redlining may take the form of starving neighborhoods of content and services — or targeting them for predation.

Luxury Surveillance

Coined by Chris Gilliard (interview on page 140), luxury surveillance refers to high-priced consumer items — such as Tesla electric vehicles, Amazon Ring doorbells, and mixed reality headsets — incorporating a significant surveillance component. While the primary audience for these products may not think of them as surveillance devices, they nevertheless normalize the transactional exchange of personal data for specious benefits, paving the way for its broader adoption.

But there is a notable distinction between users incentivized to be surveilled by their own devices and those who have surveillance deployed against them without consent, often in more intrusive and consequential ways. Luxury surveillance represents the privileged end of the spectrum of discriminatory and exploitative data-gathering technologies.

Diminished Reality

Philosophically the antithesis of AR, diminished reality (DR) uses similar technologies to diminish, obscure, or remove elements from viewers' POV. While DR performs a vital role in AR tools designed to help users visualize future sites — it's easier to visualize future housing in a parking lot after first obscuring the parking lot — diminished reality raises serious concerns from a public realm perspective.

One possibility is that consumers of luxury surveillance will use DR to strengthen personal filter bubbles by obscuring undesirable elements. Forging political consensus on urban improvements will be even more difficult if members of the public elect to literally not see them. (DR and digital redlining are functionally similar in this regard, only at different scales.)

More worrying is the blanket use of diminished reality to obscure and deny features and services to members of vulnerable populations and others targeted for discrimination. In a future in which physical signage and analog interactions have migrated to digital-only interfaces, their denial due to insufficient payment or permissions may transcend annoyance to significant hardship.

Vulnerable Populations
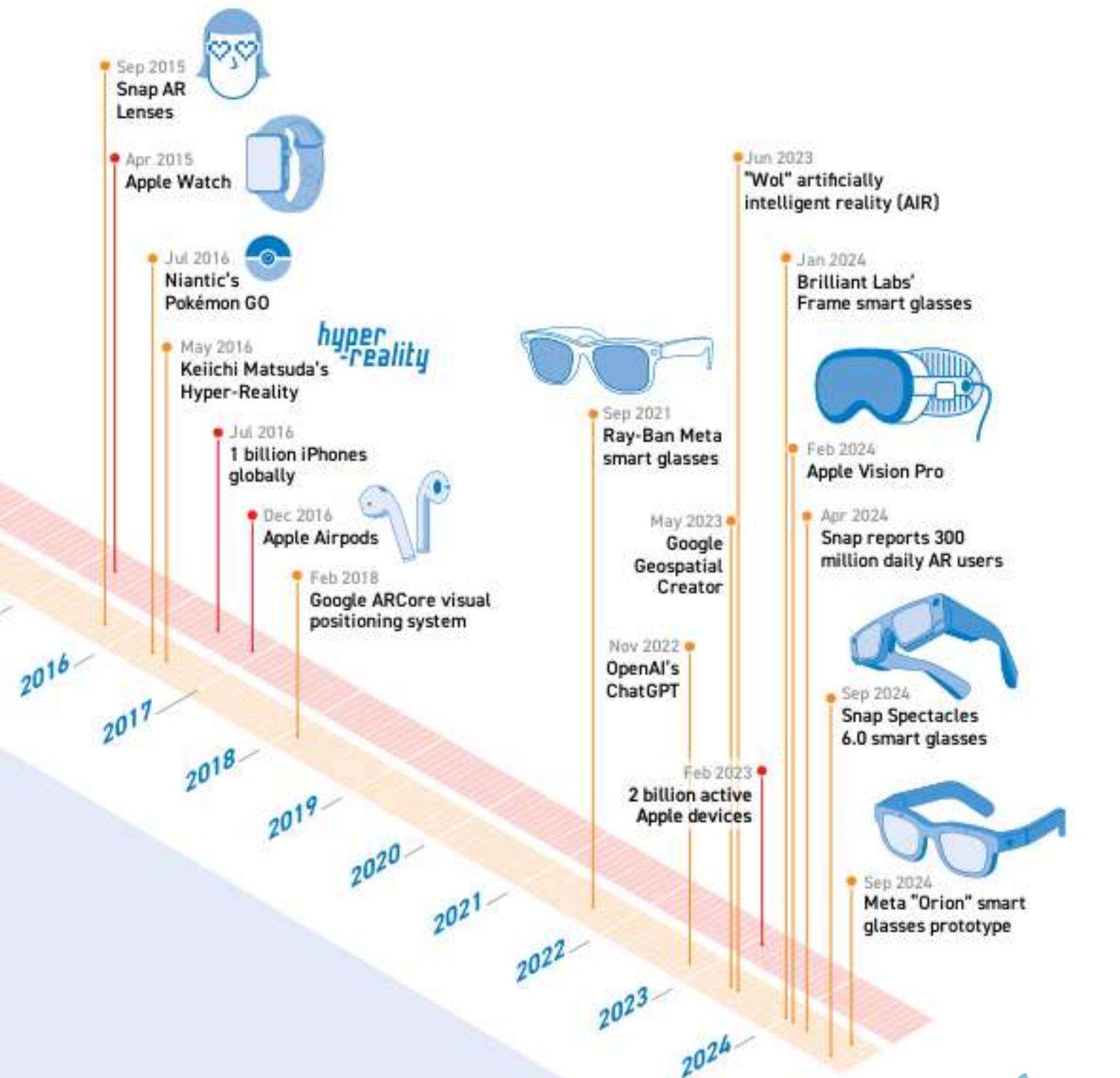
In the context of this report, vulnerable populations refers to groups of people at higher risk of being harmed, exploited, or disadvantaged by the deployment of urban tech. They may lack the digital literacy, access, or resources needed to fully understand and navigate complex technological systems — or they may have little choice in the matter, as adoption may be imposed upon them by employers, schools or other institutions.

Vulnerable populations already face systemic inequalities, discrimination, or marginalization that can be exacerbated by the uneven impacts of new technologies. For this reason, they may be more susceptible to manipulation, deception, or exploitation by adversarial actors using technologies to these ends. They are also particularly reliant on the public services and infrastructure targeted for disruption.

Timeline of Augmented Reality Milestones

Jun 2007
Apple iPhone

Nov 2007
Google Maps
for Mobile 2.0

Mar 2009
Uber founded

Feb 2013
Google Glass
smart glasses

Sept 2011
Snapchat
founded

Mobile Computing

Augmented Reality

2007
2008
2009
2010
2011
2012
2013
2014
2015

While the launch of the Apple iPhone retrospectively heralded the mobile computing era, augmented reality has had no such watershed... yet. But as this timeline makes clear, the maturity of mobile and the quickening of AR milestones hints at an imminent platform shift.

Sep 2015
Snap AR Lenses

Apr 2015
Apple Watch

Jul 2016
Niantic's Pokémon GO

May 2016
Keiichi Matsuda's Hyper-Reality

hyper-reality

Jul 2016
1 billion iPhones globally

Dec 2016
Apple Airpods

Feb 2018
Google ARCore visual positioning system

Jun 2023
"Wol" artificially intelligent reality (AIR)

Jan 2024
Brilliant Labs' Frame smart glasses

Sep 2021
Ray-Ban Meta smart glasses

Feb 2024
Apple Vision Pro

May 2023
Google Geospatial Creator

Apr 2024
Snap reports 300 million daily AR users

Nov 2022
OpenAI's ChatGPT

Sep 2024
Snap Spectacles 6.0 smart glasses

Feb 2023
2 billion active Apple devices

Sep 2024
Meta "Orion" smart glasses prototype

2016
2017
2018
2019
2020
2021
2022
2023
2024

2

The Augmented City: How We Got Here

1. Pokémon Past as Prologue

On February 2, 2024, Apple released the much-anticipated Apple Vision Pro, a mixed-reality headset branded as a "spatial computer." Despite modest sales expectations and a marketing campaign positioning it as a personal indoor-only device, within hours there were videos of new owners conspicuously wearing them on the New York City subway and in Times Square, poking at the air. Another video with more than 25 million views depicted a wearer behind the wheel of a Tesla Cybertruck — presumably on Autopilot — leading to a public scolding by Transportation Secretary Pete Buttigieg, who admonished them to keep both hands on the wheel while driving in the metaverse.[32]

Unwittingly or not, Apple had unleashed something new on the streets of New York, reigniting previous debates about who had the right to wear it (and where), and who bore ultimate responsibility — the wearer?

32 https://qz.com/apple-vision-pro-tesla-autopilot-pete-buttigieg-1851229290

Credit: Supercar_ron (Instagram)

Intended as an indoor device, the Apple Vision Pro went viral at launch through stunt videos set in cities, attracting the attention — and admonishment — of Secretary of Transportation Pete Buttigieg

Reminder—ALL advanced driver assistance systems available today require the human driver to be in control and fully engaged in the driving task at all times.

Credit: Sec. Pete Buttigieg/@SecretaryPete (X)

Credit: Casey Neistat (Youtube - youtu.be/UvkgmyfMPks)

The company? The city? — for any havoc it caused. The social media frenzy of those first few days led more than one bystander to exclaim, "it's *Pokémon GO* all over again!" Which would have been a disaster.

The augmented reality game was a phenomenon when it launched in July 2016, briefly becoming the fastest downloaded iPhone app ever.[33] Its mechanics were deceptively simple — using the iPhone's GPS, camera, and gyroscope, players stalked Pokémon characters through a map before capturing them using an AR trap. Compelled by a potent blend of novelty and nostalgia, within days crowds were trampling Central Park in pursuit of a rare Snorlax.[34] Helpful Places founder Jacqueline Lu, then the director of data analytics for New York City's Department of Parks and Recreation, recalls her former colleagues being flummoxed by overnight changes in park goers' behavior.

The original map (left) and AR interface (right) of *Pokémon GO*.

Images: The Pokémon Company International, Inc.

33 https://techcrunch.com/2016/07/22/apple-says-pokemon-go-is-the-most-downloaded-app-in-its-first-week-ever/
34 https://www.pokemon.com/us/pokedex/snorlax

"A big part of park operations is being able to understand and manage visitor flows so that everyone can enjoy these spaces," Lu explains. "There is a public safety element, as well as for practical concerns like maintaining landscapes and trash collection. *Pokémon GO* completely changed known patterns of use, especially in popular gym locations like Central Park — staff started having to learn how to play the game and monitor online forums just so they could understand where to expect massive crowds to suddenly arrive."

While the game remains the primary source of revenue for its creator, Niantic, its success came at a steep price for cities. In a paper[35] published a year later, Purdue University researchers calculated the game may have contributed to nearly 150,000 traffic collisions and 30,000 injuries across the United States in the game's first five months alone, thanks to distracted drivers. Given that traffic fatalities rose 6.5% in 2016, *Pokémon GO* likely played a meaningful role in the tragic failure of American cities' Vision Zero campaigns[36].

Fortunately, the Apple Vision Pro wasn't *Pokémon GO* all over again, nor did it have to be. More than a decade after upstarts such as Uber and AirBnB threatened to disrupt public transportation and affordable housing, cities are better poised to understand the costs of new technologies and private actors seeking to extract

35 https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3073723
36 https://visionzeronetwork.org/what-were-getting-wrong-about-vision-zero-lessons-for-2024/

Crowds swarmed Central Park pursuing rare Pokémon in the first few weeks of Pokémon GO.
Tweet credit: @IGIbsaT, Video credit: @MisterMartinLee (instagram)

profits from the public realm. Residents are also far more suspicious of geeks bearing gifts, as seen in falling support for autonomous vehicles[37] and a rise in outright hostility,[38] including fiery vandalism.[39] Without thoughtful regulation, battles against invasive urban technologies will literally be fought in the streets.

During that time, cities have developed code of their own. Efforts such as the Open Mobility Foundation — which stewards open source software for managing fleets of private vehicles in city streets — demonstrate how cities are learning how to see like a startup when it comes to deploying technology in public space. But AI and augmented reality present all-new challenges. It's one thing to monitor apps that ultimately touch the ground in the form of a car, scooter, or robot; it's another thing altogether to keep tabs on tech that dances through parks and playgrounds like ghosts.

Ignoring the risks will only make them worse. Failure to start planning now means allowing firms to once again write their own rules. Just because *Pokémon GO* was

> **❝ Pokémon Go completely changed known patterns of use, especially in popular gym locations like Central Park — staff started having to learn how to play the game and monitor online forums just so they could understand where to expect massive crowds to suddenly arrive. ❞**

37 https://newsroom.aaa.com/2024/03/aaa-fear-of-self-driving-cars-persists-as-industry-faces-an-uncertain-future/
38 https://saferoads.org/wp-content/uploads/2020/01/AV-Public-Opinion-Polls-7-22-19.pdf
39 https://www.reuters.com/business/autos-transportation/san-francisco-waymo-arson-sparks-fresh-debate-self-driving-cars-2024-02/13/

a fad, "the Metaverse" a dud, and the Vision Pro a fizzle does not excuse public servants from making preparations. But it does give them time to think and plan. This report is an attempt to use that time wisely.

The Augmented City was an initiative of the Urban Tech Hub at Cornell Tech's Jacobs Institute convening more than a dozen past- and present public officials and stakeholders with experience in managing urban technologies. This cohort was convened virtually and in-person over a period of six months in 2023, culminating in a forecasting exercise named "threatcasting[40]" to envision potential future threats and opportunities posed to cities and their inhabitants by AI and augmented reality. The goal was to identify areas of concern along with what to watch for and what to do about it.

In this sense, *The Augmented City* addresses the Collingridge Dilemma, coined by David Collingridge in his 1980 book, *The Social Control of Technology*. "When change is easy," he wrote, "the need for it cannot be foreseen; when the need for change is apparent, change has become expensive, difficult, and time-consuming." There are two solutions — wait to pay the eventual toll, no matter the cost, or learn to foresee the consequences of disruption. While the latter may technically be impossible, it's still practicable — tools such as threatcasting exist to assist decision-makers in understanding urban technologies, services, and business models, along with their externalities. This report doubles as an exercise in learning how to use them.

The Augmented City included a monthly cadence of site visits, events, and workshops encapsulating the themes of this report.

40 https://threatcasting.asu.edu

2. Gotta Catch 'Em All

On July 6, 2016, Boon Sheridan awoke at home in Holyoke, Massachusetts — in a deconsecrated Methodist church — to discover crowds gathering outside. Sheridan, who is now a UX designer for the federal digital services agency 18F, had the technical chops to grasp what was happening: his house was a gym.

Within the game of *Pokémon GO* — which had launched only hours earlier — gyms are battlegrounds between dueling teams, who must be physically present to play. Turning to social media for an explanation, Sheridan discovered he was living in a loophole. Niantic had borrowed crowd-sourced maps of real-world locations from one of its previous games, *Ingress*. An *Ingress* player had in turn submitted Sheridan's home as a suitable game location, believing it to be a still-functioning church. The result was dozens of players milling about on his lawn. (Read Sheridan's presentation to the cohort on page 121.)

Sheridan wasn't alone in suffering from the mismatch between a map and the territory. Besides the players swarming in Central Park, New York's 9/11 Memorial inadvertently became a PokéStop, drawing oblivious tourists to hunt Pokémon on hallowed ground.[41] In Milwaukee, the county passed an ordinance effec-

tively banning AR games from public parks without a permit,[42] which a federal judge later overturned on First Amendment ground as being unnecessarily burdensome on developers' free speech.[43]

Private businesses were not so squeamish in leveraging the game's mechanics to lure Pokémon and their pursuers. For example, an analysis after the fact found that restaurants in close proximity to PokéStops garnered higher customer reviews (and revenue) than those less fortunate.[44] This effect was not lost on then-presidential candidate Hillary Clinton, who publicly requested a "*Pokémon GO*-to-the-polls[45]" — as if further proof of an AR game's ability to galvanize real-world action was needed only eight days after launch.

Niantic's epic success carried repercussions, of course. Not every homeowner was as savvy or understanding as Sheridan. The company was quickly hit with a class action lawsuit for trespassing that was ultimately settled in 2019. In addition to nominal damages, Niantic agreed to not only remove PokéStops and gyms from private property, but to resolve complaints within 15

42 https://milwaukeecounty.legistar.com/LegislationDetail.aspx-?ID=2892859&GUID=D4C3AB55-A711-4C7F-B239-1CB237A6325E&Options=&Search=

43 https://www.polygon.com/2017/7/21/16012724/pokemon-go-milwaukee-ordinance-first-amendment-supreme-court

44 https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2988211

45 https://youtu.be/jt6riM2aDLk?si=qfoXxCSF_-6AnEDT

> **"I don't know who created *Pokémon GO*, but I'm trying to figure out how we get them to have *Pokémon GO*-to-the-polls."**
>
> — **Hillary Clinton**, during the 2016 presidential campaign

41 https://nypost.com/2016/07/12/pokemon-go-players-are-angering-visitors-at-sacred-landmarks/

days, remove any stop within 40 meters of said property, and maintain a database preventing a new gym or stop from popping up nearby.[46] All of which begs the question: why wasn't Niantic doing any of this already?

If anything, the company did the opposite — saying little about the upheavals it had caused, and posting a PokéStop removal request form in the bowels of its Website, where it would disappear, reappear, and be passed between victims like *samizdat* instructions. "We were all idiots," the Pokémon Company's former chief legal counsel Don McGowan said in 2024. "Niantic was completely unprepared for how big the game was."[47]

Nearly a decade later, many of the questions raised by *Pokémon GO* about the intersections of AR and the real world remain unresolved, with the settlement having settled little in terms of legal precedents. What rights and responsibilities do cities have in regulating data indefinitely overlaid on public space? How should for-profit entities be held accountable for their real-world externalities? Should unwitting participants have to opt-out or opt-in? And who manages the maps?

The latter is important because history is poised to repeat. Just as *Ingress* provided a base for its successor, *Pokémon GO* has since been repurposed for collecting scans of real-world locations to build the foundations of Niantic's future titles: the Lightship Visual Positioning System.

46 https://www.theverge.com/2019/2/15/18225604/niantic-pokemon-go-lawsuit-changes-settlement-private-property-pokestop-gym

47 https://foreignpolicy.com/2024/11/29/pokemongo-cia-nsa-intelligence-spying/

3. The Maps Are the Territories

The game sprung from maps. More than a decade earlier, future Niantic founder and CEO John Hanke had joined Keyhole Inc., the pioneering geospatial data visualization firm later bought by Google. There, Hanke's teams would lead the way in building Google Earth, Google Maps, and Street View before being given the green light to start Niantic internally. It was then spun out in 2015 expressly to launch *Pokémon GO*. Urban AR starts with maps, and who owns them.

With the advent of visual positioning systems, however, these maps are less concerned with reflecting reality than using it to construct the scaffolding for their own. Niantic's Lightship is one aspirant; Google's ARCore is another. There will be more.
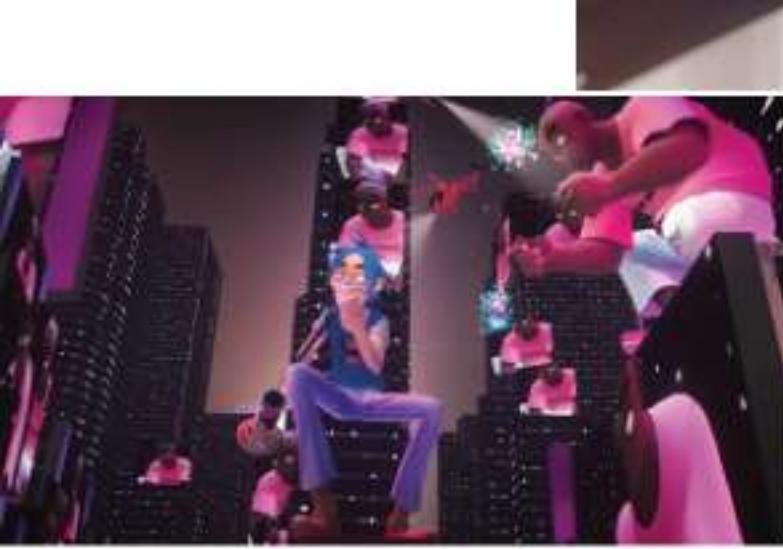
"You're certainly going to have multiple maps of the world, just like you do today to get your morning latte," argues Bilawal Sidhu, a former senior product manager for Google Maps who helped launch the company's ARCore Geospatial API — its primary tool for stationing content within Google's VPS. "What you're talking about is the next evolution — the spiritual successor to these maps — which is not just about steering you to your latte, but about helping machines understand what you're looking at so they can augment and enhance what you're seeing, and at the same time creating a higher-resolution map, or 'digital twin' as it's called in

Coverage for Niantic's Lightship Visual Positioning System (VPS) in New York

Image: Niantic

Google's site-specific activations in Times Square on behalf of the band Gorillaz in December 2022

Images: Gorillaz (Youtube)

the current parlance, to host all sorts of applications, from the utilitarian to the delightful." (Read Sidhu's interview on page 149.)

At the delightful end of the scale are Google's site-specific activations in Times Square on behalf of the band Gorillaz in December 2022 and Swatch in March 2024, with the former's cartoon band members using local landmarks as furniture, and the latter strapping watches around skyscrapers. In between, Google and TAITO released an update of the aptly-named arcade classic *Space Invaders*, using Tokyo's Shibuya Crossing as a shooting gallery.

While these set pieces hint at how Big Tech sees iconic public spaces and private real estate as a blank canvas, they obscure the greater implications of transforming maps into proprietary digital twins. Incompatibility is one issue — developers will have to choose which platform(s) to support, similar to Apple's iOS versus Google's Android. Without ground truth to fall back on, cities seeking to understand what's geo-synchronously located on a given VPS — *à la* New York City's parks department during the heyday of *Pokémon GO* — will need to monitor each platform independently. Nor will they necessarily have recourse to making or requesting changes to any space invaders landing in a busy street.

Just as Niantic only begrudgingly removed PokéStops under legal duress, Apple, Google, Waze and others have stubbornly resisted efforts to modify their maps. For example, the Los Angeles Department of Transportation (LADOT) once lobbied them to prioritize its routing- and speed restrictions within their apps but was politely rebuffed.[48] It's difficult to imagine the same

> **While these set pieces hint at how Big Tech sees iconic public spaces and private real estate as a blank canvas, they obscure the greater implications of transforming maps into proprietary digital twins.**
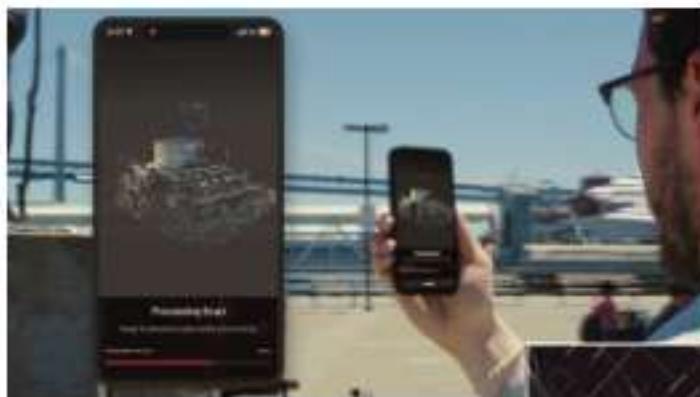
firms offering cities *carte blanche* to their full-fledged digital twins.

To make matters more complex, the number and variety of virtual positioning systems is likely to proliferate beyond the current handful of popular mapping apps. Inexpensive features such as smartphones' LIDAR scanners will not only make it possible to scan virtually any object they come into contact with, but also build their own digital twin of a place. Niantic's "Scaniverse" app offers one-tap scanning and sharing, while Snap has created local "City-Scale AR" lenses for areas of London, Los Angeles, and Santa Monica.[49] What happens when rival startups and developers begin stacking new realities on the same coordinates, using both publicly-available and secret, unlisted systems?[50] Imagine the pandemonium if there were a dozen AR games with the

48 http://clkrep.lacity.org/onlinedocs/2018/18-0304_rpt_DOT_10-17-2019.pdf

49 https://docs.snap.com/lens-studio/references/templates/landmarker/city-landmarker

50 Dennis Crowley details his efforts to create a private digital twin of New York's Washington Square Park in his interview on page 145.

Niantic's "Scaniverse" app offers one-tap scanning and sharing
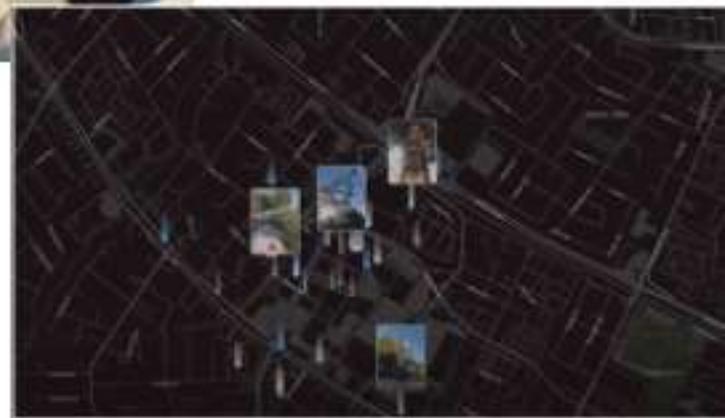
Images: Niantic

> **Imagine the pandemonium if there were a dozen AR games with the popularity of Pokémon Go all being played in the same place at the same time.**

popularity of *Pokémon GO* all being played in the same place at the same time.

The consequences could be traumatic — even fatal. For their paper "Death by Pokémon GO," Purdue University's Mara Faccio and John J. McConnell obtained detailed local police data documenting the time, location, damage, injuries, fatalities, and cause of vehicular collisions before and after the game's launch. They found a 47% increase in crashes near 615 PokéStops in Tippecanoe County, Indiana (home to Purdue), along with a 25% increase in reported injuries. Scaling these numbers nationally during the game's peak would not only result in the aforementioned 150,000 collisions and 30,000 injuries, but also 256 deaths and between $2 billion and $7.3 billion in damages from distracted drivers in pursuit of Pokémon.[51] "If anything, we are understating the effect," Faccio told reporters.[52] The authors noted there were more than 5 million PokéStops worldwide at the time; today there are surely more.

Given these potential costs and correlations, cities have a real and pressing interest to understand how and where the public realm is being annotated and overwritten by these new maps and the content embedded within them. While physical safety may be of top concern, intimidation, harassment, and abuse are also clear and present dangers.
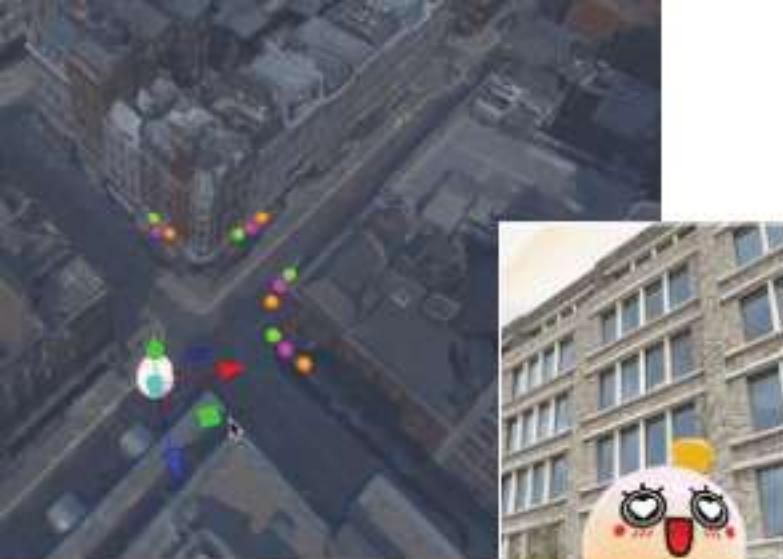
For example, *The Guardian* recently discovered more than 150 antisemitic comments appended to the Google Maps listing for the Auschwitz-Birkenau concentration camp, alongside tourist reviews.[53] Most were left anonymously months or even years before. "We have clear policies that prohibit offensive and fake reviews and we work around the clock to monitor Maps," a Google spokesperson insisted. "In this case, we know we need to do better and are working to evaluate and improve our detection systems."

This incident is telling in several respects. For one, Google's ARCore has already made it possible to attach much more than hate speech to the camp. (Imagine talking swastikas strewn throughout.) Second, visual positioning systems help make this abuse possible at scale. For example, one could remotely and semi-anonymously augment historically black neighborhoods with burning crosses on every block. And finally, Google's own spokesperson acknowledged its inadequate efforts at content moderation — which should temper any

51 https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3073723
52 https://www.newscientist.com/article/2154881-did-pokemon-go-really-kill-250-people-in-traffic-accidents/#:~:text=According%20to%20a%20new%20analysis,its%20introduction%20to%20the%20US.
53 https://www.theguardian.com/technology/2021/mar/25/google-criticised-failing-remove-antisemitic-auschwitz-reviews

The City-Scale AR Template allows you to create unique Lens experiences for specific locations.

Images: Snap for Developers

hopes the creators of visual positioning systems will feel obliged to police them. "Because if we thought content moderation was hard in the YouTube and TikTok era," Sidhu warns, "3D content moderation is an order of magnitude more complex."

As Google, Niantic, Snap, and others race to build and own these new maps, the next question is how they intend to populate them. If *Pokémon GO* was a harbinger of the augmented city, it's still unclear what it was a harbinger *for*. The answer will almost certainly be AI.

4. All That Is Solid Melts Into AIR

In April 2024, Meta's own pair of AR glasses arrived three years ahead of schedule,[54] albeit in a form no one would have predicted only a year earlier. The Ray-Ban Meta smart glasses[55] were little more than a curiosity when they were announced in 2021.[56] Packing cameras, a microphone, and speakers into the Wayfarer's iconic acetate frames, the $299 glasses were seen internally as a stepping stone to CEO Mark Zuckerberg's "holy grail" of fully immersive AR lenses by 2027.[57] Then ChatGPT happened.

That month, the glasses received a major upgrade courtesy of Meta AI — a multimodal generative AI assistant capable of analyzing images and vocally answering questions. Beginning with the prompt, "Hey Meta…" wearers can ask the glasses to scan famous landmarks, translate languages, and identify plants and animals, to name just a few uses. Early reviewers were charmed by its whimsical responses and forgiving of its frequent mistakes and hallucinations.[58]

"I used to think that AR glasses wouldn't really be a mainstream product until we had full holographic

54 https://www.theverge.com/2023/2/28/23619730/meta-vr-oculus-ar-glasses-smartwatch-plans

55 https://www.meta.com/ca/smart-glasses/wayfarer/

56 https://about.fb.com/news/2021/09/introducing-ray-ban-stories-smart-glasses/

57 https://www.theverge.com/23022611/meta-facebook-nazare-ar-glasses-roadmap-2024

58 https://www.nytimes.com/2024/03/28/technology/personaltech/smart-glasses-ray-ban-meta.html

displays," Zuckerberg told Meta investors a week later.[59] "But now it seems pretty clear that there's also a meaningful market for fashionable AI glasses without a display." Meta has since shipped an estimated 700,000 pairs, handily outselling the Apple Vision Pro.[60]

Forget the metaverse. The advent of large language models (LLMs) such as OpenAI's ChatGPT-4o and Meta's Llama-3, coupled with a new generation of affordable devices such as Meta's Wayfarers or Brilliant Labs' open source Frames,[61] has spun XR in a new direction. Call it AIR, for *artificially intelligent reality*. Unlike AR's emphasis on visuals, AIR is more focused on making the world legible to machines and facilitating both AI-to-human and AI-to-AI interactions. Meta may have been the first, but it's not alone, with Google, Apple, Baidu, Samsung, and OpenAI close behind in marrying AI to wearables.

Meta's larger ambitions for its glasses can be seen in both Project Orion[62] — its prototype AR glasses unveiled in September 2024 — and Project Aria,[63] a parallel effort by Meta Reality Labs Research to develop AIR capabilities and use cases. The latter's stated aim to capture 'egocentric' multimodal data would on first blush appear to have more in common with the heads-up displays of the Apple Vision Pro or Google Glass than true AR.[64] But Meta's larger goal of creating spatially intelligent, personalized AI assistants requires capturing high-resolution scans of users' environments — data that can later be used to create digital twins or even a VPS of its own.

Project Aria's introduction depicts using the glasses in urban settings for wayfinding and recommendations. "It's not just the turn-by-turn direction you're getting from your phone, but it's really navigating you to anything," intones the project's technical lead, intimating how Facebook's treasure trove of "likes" and

"Hey Meta…"

The unassuming profile of the Ray-Ban Meta Wayfarers contains cameras, microphones, and AI within.

personal data might be extended into physical space, steering wearers to places and products of interest.

There they will discover the second incarnation of AIR: AI assistants present in AR personas. The first may be Wol, a mixed-reality owl created by the studio Liquid City in conjunction with Niantic and Inworld, which supplied its voice and underlying AI.[65] Users summon Wol from his home in an animated redwood forest using WebXR on their smartphone or Meta Quest headset, who then proceeds to perch on the nearest surface and regale the viewer with forest facts and stories. While Wol is a teaching tool prototype, he doesn't follow an obvious script. Asked without prompting for his favorite karaoke song, Wol replied, "I like the Eagles — they're a hoot."

Wol is the brainchild of Liquid City founder Keiichi Matsuda, a filmmaker/developer best known for his 2016 short film *Hyper-Reality*, which is still a dystopian touchstone for fully-realized urban AR.[66] ("We're all haunted by the Hyper Reality video," a member of Meta's Orion team confessed to *Fast Company*.[67]) His latest film, *Agents*, imagines a near-future in which AI manifestations like Wol are commonplace, with each possessing its own personality, features, and functions ranging from navigation to real-time matchmaking.[68]

59 https://s21.q4cdn.com/399680738/files/doc_financials/2024/q1/META-Q1-2024-Earnings-Call-Transcript.pdf
60 https://www.bloomberg.com/news/articles/2024-09-23/an-outsider-critiqued-meta-s-smart-glasses-now-she-s-in-charge-of-them
61 https://brilliant.xyz
62 https://about.fb.com/news/2024/09/introducing-orion-our-first-true-augmented-reality-glasses/
63 https://www.projectaria.com
64 https://arxiv.org/pdf/2308.13561

65 https://inworld.ai/case-study/how-niantic-and-liquid-city-pushed-the-bounds-of-whats-possible-in-gaming
66 https://youtu.be/YJgo2ivYzSs?si=y85EbozZPKCy-KJt
67 https://www.fastcompany.com/91229358/inside-metas-long-term-vision-to-make-its-orion-glasses-the-airpods-of-augmented-reality
68 https://youtu.be/bkKv2AHpn8E7si=bxLitN86dmkai9do

Wol, a mixed-reality owl created by the studio Liquid City

Credit: Liquid City

"The Spirit of the Ferry Building", an AR agent prototype by Liquid City, Niantic, and Inworld in the form of an ancient mariner

Credit: Inworld

Matsuda explained his cosmology of *Agents* — and of AIR in general — in a short essay titled "Gods," borrowing a metaphor from Shinto animism. The future of AR and AI, he argued, was not disembodied, seemingly omniscient chatbots or voice assistants, but a pantheon of helpful, playful, and occasionally silly gods communicating with their users and each other. "This world will envelop our physical cities," he wrote, "and gods will come to be our connection to our appliances, our institutions, our applications, and much more."

In the animist tradition, these agents will not only belong to people, but also places. Just as Shinto shrines honor local spirits, Matsuda imagines every landmark, park, and coffee shop hosting AIR incarnations of their own. Prior to creating Wol, he and his team prototyped "The Spirit of the [San Francisco] Ferry Building," an agent in the form of an AR ancient mariner.[68] In a world in which agents are abundant, and in which AIR glasses are continually scanning, analyzing, and describing their environments, it only makes sense to give AI as many forms as the technology will allow.

Keiichi Matsuda's 2016 short film *Hyper-Reality*

Watch on Youtube
https://youtu.be/YJgozivYzSs

Credit: Keiichi Matsuda / Liquid City

68 https://x.com/firechant/status/1634328454810157618

> **Taken together, this twin definition of AIR — as AI augmenting the world and AR giving form to AI — points to a new trajectory for both technologies that is fundamentally urban."**

In this sense, it's possible to imagine cities enchanted by flocks of Wols and the spirits of places conversing with one's own agents. They might take orders, give directions, or simply banter with passers-by. It's equally plausible to imagine malicious ones trained to scam, harass, and otherwise haunt people rather than help. (Even city-sanctioned AIs run the risk of rogue behavior, as New Yorkers discovered after the official MyCity chatbot repeatedly advised them to break laws.[70])

Taken together, this twin definition of AIR — as AI augmenting the world and AR giving form to AI — points to a new trajectory for both technologies that is fundamentally urban. Which is another reason why both AR and AI must come under cities' purview as these agents start to multiply — what happens when tomorrow's Pokémon begin to think for themselves?

Virtual in Real Life: AIR in Action

V-*IRL* demonstrates AIR's potential to transform our relationship with urban spaces even without full AR.[1] Created by researchers at New York University and Hong Kong University, the project explores how AI agents will make the physical world more legible using machine vision and natural language, much like Meta's AI glasses.

By combining street-view imagery, geolocation data, and large language models, V-*IRL* enables AI agents to understand and navigate cities, recognize landmarks, follow verbal directions, and make contextual recommendations based on real-world places and data. Its agents can perform practical tasks like finding restaurants based on personal preferences, optimizing travel routes, and cataloging urban infrastructure.

Most notably, V-*IRL* showcases how spatially-aware assistants can develop a deep understanding of real-world environments without specialized hardware. This aligns with bets by Meta and others that AI glasses with minimal displays can still provide meaningful ambient intelligence — suggesting that AIR's initial impact may come through making spaces more intelligible rather than visually augmented.

V-IRL's AI agents use machine vision in Google Streetview to count all the trash bins and benches in Central Park

Images from V-IRL (virl-platform.github.io)

70 https://themarkup.org/news/2024/03/29/nycs-ai-chatbot-tells-businesses-to-break-the-law

inCitu is an AR app to visualize as-yet unbuilt projects.
Credit: inCitu

inCitu CEO Dana Chermesh-Reshef (bottom) demonstrates using AR and QR codes to visualize future buildings.
Credit: inCitu

5. Seeing Like a City

Building overlapping, incompatible digital twins is one thing. Filling them with AI agents is another. But simply knowing where to look is something else altogether. This lack of "discoverability" has haunted AR for years — how do you know if it's present? How do you find it if it is? And how would you announce its existence to someone who lacks either the technology or the know-how needed to access it?

The answer to these questions to date has been that pandemic-era staple, the QR code. Attendees of South by Southwest 2024, for example, may have spotted codes emblazoned on the sidewalk opposite Austin's Waterline Tower, which will be Texas' tallest when finished. With one tap of their smartphones' camera app, curious pedestrians could gaze upward at the ghostly outline of the topped-out tower more than a thousand feet in the air.[71] The codes belonged to inCitu, a startup partnering with cities, civic agencies, and private developers to visualize as-yet unbuilt projects. (More on them later.)

This is how most AR discovery operates today — point, tap, view. It's workable, but not scalable. A future of proliferating QR codes risks both runaway visual pollution — picture every street sign and light pole blanketed with competing codes — and a cybersecurity nightmare. How does one know what to click in a future already full of spam, scams, and malware on their screens, let alone the street? These and similar quandaries will ultimately hobble current approaches and raise uncomfortable questions about what, exactly, can be stationed where — and who is responsible for its duty of care.

One startup tackling these thorny issues is London-based Darabase, which labels itself as "outdoor media for the spatial Web," also known as AR advertising.[72] One of its showcase activations involved scanning a QR code embedded in a Tommy Hilfiger ad displayed on the giant LED screen at Piccadilly Circus, revealing turn-by-turn directions to its flagship store around the corner. A neat trick, albeit one that might lead Transport for London officials to wonder who vetted the path to ensure it didn't lead through traffic.

Separate from the issue of QR codes is how to value the city itself as an asset. Darabase, for instance, is advocating for "property digital rights" and titles to extend private land- and air rights across the entire AR spectrum. This would effectively create AR ad inventory on the real estate in question, along with legal precedent for property owners to ban others from co-opting locations regardless of their visual positioning system. In doing so, Darabase is attempting to create both a land register spanning all known realities, and also the marketplace in which to buy and sell ads on it.

71 https://www.instagram.com/reel/C4Y6K7txnhh/?utm_source=ig_web_copy_link

72 https://darabase.com

One of London-based Darabase's showcase activations involved scanning a QR code embedded in a Tommy Hilfiger ad displayed on the giant LED screen at Piccadilly Circus, revealing turn-by-turn directions to its flagship store around the corner.
Images: Darabase

Even setting aside matters governed in the U.S. by state- and federal laws — such as user privacy, data protection, and standards of decency — this approach once again raises more questions municipally than it answers. Whose job will it be to enforce these digital property rights? And will platforms be held liable for violations? Snap, for instance, has pre-emptively absolved itself of responsibility should anyone use its Landmarker Lenses AR tool to create commercial content appropriating the likeness of Buckingham Palace,[73] which is royally trademarked.[74]

Transposing these questions from London to New York, Darabase asked Jonathan Askin, founder and director of the Brooklyn Law Incubator & Policy Clinic, to review existing statues with regards to public and private space. In New York City, for example, "out of home" advertising is regulated by the Department of Transportation (DOT) and Department of Buildings (DOB), with the latter requiring any entity engaged in advertising to register — those who don't are considered public nuisances. Signage is primarily regulated by the city's Building Code and Zoning Resolution, the former of which is mostly concerned with the public safety of physical signs and the latter protecting "quality of life" in residential areas. Do either apply to AR? The law is unclear.

Under New York Penal Law § 145.30, for instance, it's illegal to post advertising on another person's property without permission, although given the law's purpose is to prevent physical damage to buildings, Askin is again uncertain whether it applies to AR. The same goes for using virtual signage to obscure a competitor's storefront or intercept passerby. "Until a law is passed extending the property owner's rights to its property to govern digital representations of the property or digital enhancements to the property, there may be nothing that the owner can do," Askin concludes.

More alarming for cities, "research indicates that no regulation or law exists that directly prohibits or otherwise regulates AR in public spaces," Askin notes, adding it's now likely considered protected speech — a precedent ironically set by Milwaukee County's botched ordinance banning *Pokémon Go*. This may actually come as a relief for New York City DOT and DOB, which in addition to their overlapping roles in regulating street signage are just two of the dozens of city-, state- and federal agencies sharing responsibility for the city's streets,[75] including Parks and other public art-oriented agencies such as the Department of Cultural Affairs and Public Design Commission. Which of these agencies, if any, would take the lead in drafting and enforcing regulations?

For that matter, where does this leave New York's Office of Technology and Innovation, created by Mayor Eric Adams in January 2022 to steer the city's data governance and digital service delivery? His office doesn't have a "metaverse" strategy, chief technology officer Matthew C. Fraser freely admitted at New York University's Metaverse & Cities Summit in April 2023.[76] "Don't

73 docs.snap.com/lens-studio/references/templates/landmarker/guide
74 https://www.citma.org.uk/resources/the-royal-relationship-with-trade-marks-blog.html#:~:text=Some%20of%20the%20registered%20trade.protected%20category%2C%20including%20BUCKINGHAM%20PALACE.

75 https://www.nycstreetdesign.info/process/agency-roles-citys-streets
76 https://www.sps.nyu.edu/homepage/metaverse/cities-and-the-metaverse-summit.html

let external pressures drive you to make irrational decisions," he said.

Fraser's former counterpart in Philadelphia, Mark Wheeler, confirms that as chief information officer and head of that city's Office of Information Technology, he would have had no oversight of AR signage anyway. "I don't think it's up to the CIOs or CTOs at all, because from my understanding, none of those structures have any regulatory backing," he says. As in New York, it would have fallen to the analog departments over-seeing building inspections and business licensing.[77]

Although Wheeler notes physical signage rules may offer cities a template for multi-agency coordina-tion in regulating virtual ones. In Philadelphia, for instance, plans for the Market Street East Advertising District included incentives for LED screens, which in turn created "an accelerated approval path," in his words, through the city's Art Commission and other stakeholders, including clear criteria such as hours of operation and maximum levels of illumination. Tools such as special zoning districts or similar overlays could be useful in designating areas for experimenta-tion, he adds.

Returning to the question of discoverability, it may not only be necessary for cities to regulate AR using signage as a legal mechanism, but also create their own signs and wayfinding — both physical and digital — to inform the general public when AR is nearby. What forms might these take?

A nascent example is Digital Trust for Places and Routines (DTPR), a communication standard describing the purpose, processing, and usage of data collected in public spaces.[78] Comprised of icons denoting the technology, methods, and policies present, a typical sign

might inform passersby of security cameras which may or may not detect identifiable features, analyze images locally, or share them with third parties.

Designed to promote transparency, DTPR was ironically commissioned by Sidewalk Labs[79] for its now-defunct Toronto waterfront project, which it quietly abandoned in 2020 in the face of fierce opposition to its plans for neighborhood-scale surveillance. Today, the now-open source standard is steered by Helpful Places,[80] a consultancy founded by Jacqueline Lu — the former director of data analytics for the New York City's Parks Department during *Pokémon GO's* heyday. Pilots to date include air quality monitoring in Boston, traffic analysis in Washington D.C.,[81] and security cameras in Sydney's Olympic Park.[82]

At its core, DTPR provides a standardized taxonomy and visual language that can take the form of physical signage, digital markers, or machine-readable data — which means it could potentially not only solve the discovery problem for AR, but also for AIR. Consider this hypothetical scenario.

Walking through Manhattan's Washington Square Park, visitors wearing AIR-powered glasses encounter a DTPR sign introducing "the Spirit of the Park," an AIR assistant and tour guide. The sign contains a QR code, which they can scan with their smartphone or glasses. This does several things.

First, it pulls up a user-friendly interface with more detailed information about the spirit, including what data it collects, how it's used, and who's responsible for it. This could be presented as a simple webpage on a phone, as a visual overlay, or even as an audio conversa-tion with the park's AIR. It might also trigger a digital handshake which, depending on their privacy settings, could unlock additional features or allow them to opt-out entirely.

The point is that the physical DTPR sign and accom-panying QR code would act as explicit, opt-in triggers
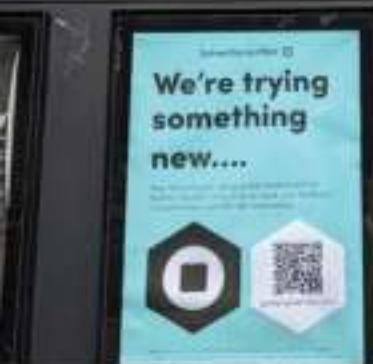
77 Interview with Wheeler
78 https://dtpr.io

79 https://medium.com/sidewalk-talk/how-can-we-make-urban-tech-transparent-these-icons-are-a-first-step-fo3f237f8ffo
80 https://helpfulplaces.com
81 https://medium.com/@helpfulplaces/dtpr-deployments-launch-boston-and-washington-dc-e1ab7f8doeg
82 https://medium.com/@helpfulplaces/first-australian-deploy-ment-of-dtpr-launches-9fbf8e700cdb

Digital Trust for Places and Routines (DTPR), communication standard describing the purpose, processing, and usage of data collected in public spaces

Images: DTPR

for interactions, offering the means for individuals to consciously engage with the digital layers surrounding them. Coupled with underlying rules and regulations — whether extrapolated from current municipal codes or new ones — it potentially offers a paradigm for piloting, deploying, and managing AI and AR in public space.

There are pitfalls, however. For one thing, it would extend the logic of end user license agreements — the software terms of service most people accept without reading — from personal devices to public space. By explicitly asking users to opt-in, it would also force others to opt out of potentially important public services functions. (For her part, Lu rejects this argument, insisting it's better to obtain consent than passively surveilling users. When asked directly, survey participants tend to agree.[*])

This thought experiment returns to the dilemma presented at the top of this section. Once any number of actors — public or private, individuals or firms, beneficial or adversarial — are able to annotate reality, how will cities verify and certify when it is safe to assent? And who decides what is considered trustworthy? The last question may prove the most vexing; while tools such as DTPR will be necessary for managing the augmented city, they cannot address more fundamental questions of equity and power.

> **" it may not only be necessary for cities to regulate AR using signage as a legal mechanism, but also create their own signs and wayfinding — both physical and digital — to inform the general public when AR is nearby"**

83 https://drive.google.com/file/d/1qEZUH1kqZ3X51NQHU7dZkPx-G3DfFDGr1i/view

6. "Who Gets to Augment Reality?"

In July 2021, only a few months before Mark Zuckerberg would rename his company Meta to signal his ambitions, he sat down with the journalist Casey Newton to explain his metaverse intentions. After grilling Zuckerberg about Facebook's cesspool of misinformation, Newton wondered if expanding the social network into new dimensions was such a wise idea. In addition to private interests and government prerogatives, whose realities would be privileged over others', and how might they be contested rather than overlap? "Who gets to augment reality?" Newton asked.[84]

"Well, this, I think, is one of the central questions of our time," Zuckerberg replied, acknowledging a "cohesive society" requires "a shared foundation of values," and that at some point a new "equilibrium" between individual filter bubbles and consensus reality would be reached. His answer, couched purely in terms of personal freedom versus responsibility, deliberately ignored more fundamental concerns about communal agency and inequality. Who gains and who loses when the new equilibrium favors withdrawal over participation? How does Zuckerberg's prediction square with Jane Jacobs' assertion that "cities have the capability of providing something for everybody, only because, and only when, they are created by everybody?" What if the augmented city is curated by a privileged few?

These tensions were already evident at the launch of *Pokémon GO*. After watching the initial hysteria subside around his home in Holyoke — a majority-minority city of 38,000 in which one-in-four residents lives below the poverty line — Boon Sheridan noticed how Pokémon quickly became few and far between compared to much larger and wealthier cities such as New York, despite the close-to-zero marginal cost of respawning Pikachu evenly everywhere. To unravel this and other mysteries, his wife learned how to submit, review, and edit PokéStops, becoming adept at gaming Niantic's opaque system through trial-and-error. "She was fascinated by stops that should have been rejected but weren't because someone had framed the location in just the

right way or chosen a great photo," Sheridan explained. It wasn't lost on them that her newfound ability to deny or divert Pokémon to their neighbors was largely a function of having enough time and technological literacy to do so.u

The Holyoke example illustrates how spatial segregation and social capital (or the lack of it) will decide who augments the city. Which communities will be privileged enough to receive AR, and which will be exploited by it? Who possesses the technical and tacit knowledge necessary to understand it — and who will be the victims of their own ignorance?

These questions are hardly new, stemming from decades of debate over the "digital divide," a phrase coined by former U.S. National Telecommunications and Information Administration (NTIA) administrator Larry Irving to describe "the divide between those with access to new technologies and those without."[85] Closing this gap has been a priority of global policymakers for nearly three decades, as seen most recently in the Biden administration's allocating $42.45 billion for expanding rural broadband.[86]

But simply extending Internet connections to the unserved misses a larger point about what it means to be online in 2025. As the social psychologist Jonathan Haidt notes in his book *The Anxious Generation*, whereas once the digital divide was framed in terms of communities lacking access, now it is defined as lacking protection from online predation.[87]

84 https://www.theverge.com/22588022/mark-zuckerberg-facebook-ceo-metaverse-interview

85 https://www.ntia.gov/sites/default/files/data/ftn93/introduction.html

86 https://www.commerce.gov/news/blog/2024/09/biden-harris-administration-delivering-promise-connect-everyone-america-reliab

87 https://www.theatlantic.com/ideas/archive/2024/09/social-media-lgbtq-teens-harms/679798/

"Pig butchering" schemes — in which perpetrators send random text messages to entice recipients into handing over cash for (non-existent) cryptocurrencies

For example, "pig butchering" schemes — in which perpetrators send random text messages to entice recipients into handing over cash for (non-existent) cryptocurrencies — have successfully swindled Americans out of an estimated $15 billion.[88] These scams have grown more sophisticated using AI-generated deepfakes to simulate friends, families, and colleagues. In one such instance, an employee of the engineering firm Arup was duped into sending roughly $25 million to unknown criminals posing as legitimate corporate officers on a real-time video call.[89] AR and AIR threaten to amplify the verisimilitude of these frauds, using the voices and appearances of loved ones to gain victims' trust that much more easily.

The new divide will also manifest as a type of spatial segregation known as "digital redlining." While such discrimination can take many forms, perhaps the most literal is what the platforms choose to leave out of their maps. Google, for instance, typically obscures government installations, corporate facilities, and other sensitive sites at their owners' request. But it has also elected to blur entire neighborhoods, perhaps the most infamous of which is Kibera, Nairobi's largest slum. This erasure nearly two decades ago prompted an ongoing

local — and global — effort to create a fine-grained, open source alternative to Google's undifferentiated gray.[90] Will similarly marginalized communities be the last to be included in a particular VPS?

Befitting their algorithmically dynamic nature, digital redlining extends to the navigation of these maps as well. Former Google Maps UX researcher Kasey Klimes has described internal discussions to implement "scenic" and other potential routes alongside the fastest option.[91] Noting that urban tree cover and other shorthands for "scenic" neighborhoods overwhelmingly favor higher-income neighborhoods, Klimes argued the inadvertent result of this tweak would be to funnel foot traffic — and small business revenues along with tax dollars — away from lower-income communities toward wealthier ones. "Because of its global scale," he wrote in a series of tweets, "even a small shift in maps routing from a seemingly-innocuous (and frankly very useful!) feature could create a reinforcing feedback loop with spatial inequality."[92]

This effect was the stated intention of the Website "GhettoTracker" launched in 2013 (and quickly renamed "Good Part of Town"), which invited users to hard-code their biases directly into the map. The binary sorting of "good" and "bad" neighborhoods not only reifies the signifiers and logic of discredited policies such as "broken windows" policing,[93] but also justifies the discriminatory deployment of surveillance technologies such as ShotSpotter, which according to leaked location data is overwhelmingly concentrated in lower income communities of color.[94]

Augmented reality will add new wrinkles to these dilemmas. For example, a machine vision research project dubbed "PlaceAvoider" offered owners of Google Glass and other such wearables an opportunity to "blacklist" personal areas and sensitive locations such as bedrooms and bathrooms from sharing with data aggregators upstream.[95] Proposed as a privacy

88 https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4742235
89 https://www.theguardian.com/technology/article/2024/may/17/uk-engineering-arup-deepfake-scam-hong-kong-ai-video
90 https://www.mapkibera.org/
91 https://thedeepdive.ca/heres-why-google-maps-doesnt-have-a-scenic-route-option/
92 https://x.com/kaseyklimes/status/1817440538269842263
93 https://cssh.northeastern.edu/sccj/2019/05/21/researchers-debunk-broken-windows-theory-after-35-years/
94 https://www.wired.com/story/shotspotter-secret-sensor-locations-leak/
95 https://homes.luddy.indiana.edu/kapadia/papers/placeavoider-odssss.pdf

safeguard, it's not difficult to imagine users flagging public places as well, effectively providing them with a block button for reality. The city of San Jose, California is already training AI to recognize signs of homeless encampments, for instance.[96] How long before AIR agents trained on similar maps and models start to redline them?

How XR devices elect to see the world and their wearers is a consummate example of what Chris Gilliard has dubbed "luxury surveillance." (Interview on page 140.) The Apple Vision Pro, for instance, retails for $3,500 and boasts more than a dozen cameras and a half-dozen microphones scanning and listening to the user's eyes, hands, and voice at all times.[97] "At Apple, we believe privacy is a fundamental human right," the company's marketing materials declare, but this right is nominally reserved for the wearer, not the observed.

Even then, critics warn these devices will track wearers' eye- and facial movements in microscopic detail. In one particularly eye-opening example, the artist and software engineer Sterling Crispin claims to have assisted Apple with "detecting the mental state of users" using "eye tracking, electrical activity in the brain, heart beats and rhythms, muscle activity, blood density in the brain, blood pressure, skin conductance etc." to predict where wearers are going to "click" using their eyes. It does so in part by "redesigning the UI in real time," Crispin tweeted, suggesting the reality depicted by the Apple Vision Pro is undetectably malleable.[98] It's for this reason that XR pioneer Louis Rosenberg has summarized the threat (and business model) of an unregulated metaverse as "monitor, manipulate, monetize."[99]

Combining digital redlining and luxury surveillance produces "diminished reality," which is less a function of what someone sees than what they don't see — either by design or denying them permission. Those inside the lines may choose to filter reality as they see fit, erasing people and places with prejudice, while those on the wrong side might discover their reality has disappeared as popular services migrate to AR — just as smartphones became mandatory for many formerly analog tasks. The dark side of the DTPR scenario described

Combining digital redlining and luxury surveillance produces diminished reality"

previously would be choosing to opt out (or failing to opt in) and thus being deprived of critical features or protections.

One can imagine any number of diminished realities. Rather than receiving personalized offers or discounts while strolling past a store, dynamic pricing algorithms ensure everyone sees a number optimized to extract maximum value. Inverting the purpose of GhettoTracker yields wayfinding instructions diligently steering users away from privileged neighborhoods in order to protect their scenic streets from interlopers.

If the promise of urban AR is to make cities more legible through the overlay of information, this prompts the question: more legible for whom? Legibility in service to inequality isn't desirable in its own right, as open data advocates discovered after Map Kibera attracted global attention to the site, followed swiftly by "slum tourism" and charges of exploitation.[100] In another cautionary tale, a vaunted program to digitize Indian land records in the name of "transparency" produced an epic consolidation of both land and power by speculators possessing more digital literacy than the tenant farmers they dispossessed.[101]

As both examples demonstrate, increasing a place's global legibility may diminish its reality for inhabitants. For this reason alone, the augmented city is destined to be contested terrain.

These tensions have already given rise to initiatives reclaiming AR as a tool of resistance. The Kinfolk Foundation wields it to create monuments highlighting the absence of black and brown historical figures in the public realm.[102] In place of Manhattan's Columbus Circle, for instance, Kinfolk has installed a towering virtual

96 https://www.theguardian.com/technology/2024/mar/25/san-jose-homelessness-ai-detection
97 https://www.apple.com/apple-vision-pro/specs/
98 https://x.com/sterlingcrispin/status/1665792423914493506
99 https://medium.com/predict/regulating-the-metaverse-7c893ed00885

100 https://nextcity.org/informalcity/entry/is-slum-tourism-wrong
101 https://casumm.wordpress.com/wp-content/uploads/2008/09/bhoomi-e-governance.pdf
102 https://www.kinfolktech.org/

In place of Manhattan's Columbus Circle Kinfolk has installed a towering virtual statue of Toussaint Louverture, the liberator of Haiti.
Image: Kinfolk

statue of Toussaint Louverture, the liberator of Haiti. In their hands, AR is both a prompt and a provocation to imagine what could be and preserve what remains — as it recently did in conjunction with an African burial ground in Brooklyn's Flatbush neighborhood.[103]

"AR is not a physical space, and it will never be a substitute for one," explains executive director Idris Brewster when pressed for a theory of change. "We want to use AR as a beacon to advocate for changes in the built environment, and support existing efforts to do the same." This might take the form of petitioning government- and cultural institutions for new monuments honoring black voices, or organizing community groups to counter digital redlining. Just as the Brooklyn Public Library offers free digital library cards to out-of-state students in order to circumvent book bans,[104] AR could open a new front in the culture wars by surfacing suppressed histories buried in plain sight.

103 https://www.flatbushafricanburialground.org
104 https://www.bklynlibrary.org/books-unbanned
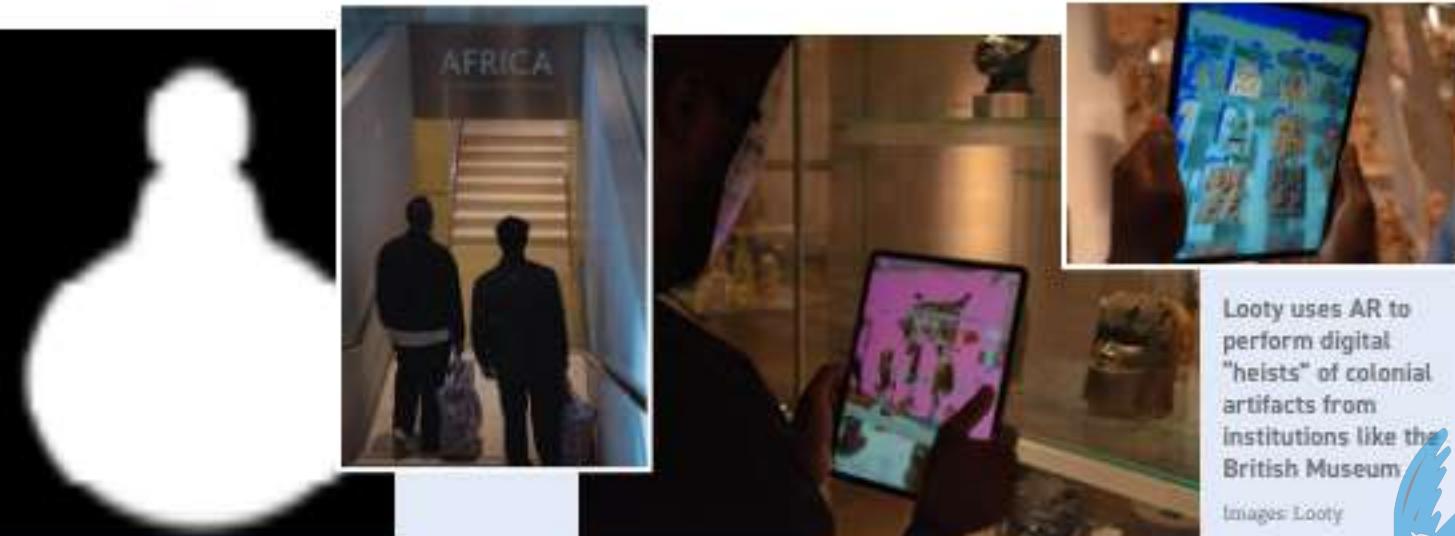
London-based art collective Looty takes an even more confrontational stance, using AR to perform what they call digital "heists" of colonial artifacts from institutions like the British Museum.[105] After capturing objects such as the Rosetta Stone using their iPhones' LiDAR scanners, they digitally repatriate them to their sites of origin as AR installations, while selling the scans as limited-edition NFTs to support African artists.

"Imagine having a space-within-a-space," argues Looty co-founder Chidi Nwabauni, pointing to its AR exhibition of the Benin Bronzes at the Venice Architecture Biennale as an example of its potential to transcend institutional boundaries.[106] Rather than confining artifacts to what he describes as "cold glass boxes and four white walls," Nwbauni envisions embedding these digital artifacts within their original cultural contexts, surrounded by "music, people, and culture" until such time they can be physically repatriated.

Both initiatives point to how the augmented city might evolve beyond a binary of access-versus-exclusion into something more nuanced – a multilayered reality where communities can assert their presence, preserve their histories, and challenge dominant narratives. The question of "who gets to augment reality?" may ultimately be answered not through corporate platforms or public policy alone, but through the creative appropriation of these technologies by the communities they threaten to erase.

105 https://www.newyorker.com/magazine/2023/04/24/a-high-tech-heist-at-the-british-museum
106 https://www.labiennale.org/en/architecture/2023/mnemonic/looty

Looty uses AR to perform digital "heists" of colonial artifacts from institutions like the British Museum
Images: Looty

7. The Department of Reality

While civic insurgents are already busy repurposing AR for their own ends, municipalities are just beginning to explore how it might serve broader public aims. Rather than wait, react, and regulate corporate platforms and community projects, how might cities preemptively apply these technologies to problems they may be uniquely designed to solve? And who in government should take the lead in doing so?

Prior to the advent of *Pokémon GO* a decade ago, for example, the John S. and James L. Knight Foundation proposed "reimagining the civic commons"[107] through projects aimed at convening strangers in public space.[108] An early example was the Market Street Prototyping Festival, which blanketed San Francisco's main artery with more than 50 pop-up installations over a long weekend in April 2015. The goal was to engage passerby through "joy, play, whimsy," in Knight's description,[109] while piloting bottom-up planning through the participatory design and (play)testing of new public infrastructure.

Barely a year later, *Pokémon GO* would not only produce crowds trampling parks and private property, but also diverse clusters of players calmly battling each other in public. In the game's first weekend, it inadvertently achieved more than a thousand street prototyping festivals ever could in changing how people saw and used the city — for better and for worse. Knight itself acknowledged this reality by partnering with Niantic shortly thereafter.[110]

As municipal governments grapple with deepening polarization, entrenched NIMBYism, and the lingering effects of pandemic isolation, utilizing AR to bolster civic engagement may prove tempting. But while *Pokémon GO* demonstrated the technology's power to bring strangers together, the greater challenge may be developing tools and frameworks to help citizens and their representatives to collectively imagine their futures.

That's the working hypothesis of inCitu, a civic AR startup founded in 2020 on the premise that seeing-is-believing when it comes to winning support for new development.[111] By inviting neighbors to peer at the ghostly contours of planned projects through their own smartphones, the company is betting that augmenting the reality of these proposals will diminish local fear and opposition. Originally used to depict future high-rises, its applications also include envisioning sea-level rise in Tampa,[112] fish pond preservation in Kauai, and firefighter training in Seattle.

InCitu and its customers — the majority of whom belong to city planning, transportation, and building departments — aim to escape the stranglehold of community meetings, which tend to be dominated by a handful of outspoken opponents determined to derail development. Instead, they aspire to use AR to massively expand the audience and potential constituency for these projects. One prospective Manhattan skyscraper attracted more than 100,000 views after being shared on Snap, prompting former Kansas City, Missouri mayor Mark Funkhouser to exclaim, "In the history of planning, there have never been 100K views on any proposals that I know of!"[113] If seeing truly is believing, that scale of belief has the power to tip elections.

This power was on display in Columbus, Ohio in November 2024, when voters approved a sales tax increase to raise $6 billion for redesigning streets, expanding public transportation, and launching the first of several bus rapid transit (BRT) corridors across the region.[114] As part of its outreach, the Central Ohio Transit Authority (COTA) recruited inCitu to create a virtual tour of the route, with three stops at a future BRT station, a planned micromobility hub, and a greenfield site slated for development.[115] More than 2,500 Columbus residents took the tour in the months
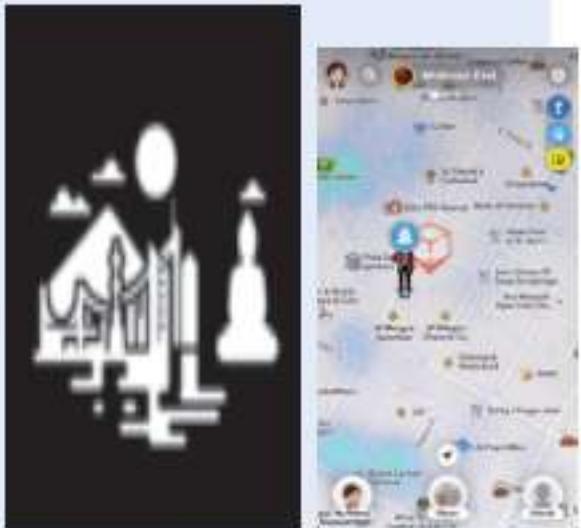
107 https://civiccommons.us
108 https://nextcity.org/urbanist-news/market-street-street-festival-san-francisco
109 https://knightfoundation.org/articles/knight-cities-podcast-neil-hrushowy-episode-35/
110 https://knightfoundation.org/articles/a-playful-new-layer-of-civic-engagement-why-knight-teamed-with-niantic-to-bring-pok-mon-go-to-community-events/
111 Mentioned previously on page 46 for their use of QR codes.
112 https://www.incitu.us/post/case-study-tampa-bay
113 https://medium.com/incitu/how-we-created-the-most-visible-rezoning-proposal-in-the-history-of-city-planning-d2235be90ce0
114 https://www.cota.com/blog/central-ohio-voters-approve-issue-47-paving-the-way-for-a-modernized-cota-transit-system/
115 https://incitu.webflow.io/post/central-ohio-transit-authority-leveraging-incitu-for-transit-planning-engagement

Your Lens has over 100k views! 3m ago
570 5th Ave Future is a pretty
big deal!

InCitu's AR rendering of 570 5th Avenue
became the most widely-viewed proposed
building in history once shared on Snapchat
Images: inCitu

One prospective Manhattan skyscraper attracted more than 100,000 views after being shared on Snap, prompting former Kansas City, Missouri mayor Mark Funkhouse to exclaim, 'In the history of planning, there have never been 100K views on any proposals that I know of!'

leading up to Election Day, when the measure passed with 57% of the vote.

Although AR played only a small role in the campaign, the episode illustrates its capacity to render the future in the present from the user's perspective, figuratively and literally. "AR's ability to show people a tangible view of out-of-reach concepts helps cut through the conversation," says inCitu founder and CEO Dana Chermesh-Reshef. "For people who aren't professionals in the field, it streamlines the discussion: first, everyone is on the same page; now, let's talk about our shared future."

The most striking aspect of inCitu's inclusion is how ordinary it was — AR was the proper tool for the job, not the point unto itself. This particular example suggests front-line departments and agencies will turn to AR as the need arises — whether for community outreach, prototyping and planning, public art and education, and more. The same staff roles charged with regulation and enforcement may also decide when and where to employ these technologies themselves, rather than a vestigial "chief metaverse officer." If this is indeed the case, it will be incumbent on each department to identify, hire, train, and empower them.

But normalizing new technologies requires new institutional structures to support them, offering cities an opportunity to holistically rethink service delivery and managing the public realm. This may take the form of new departments or positions in alternately leading or supporting roles — just as cities have done for more than a decade already in response to previous waves of disruption.

For example, the city of Boston led the way at the outset of the mobile era with the creation of the Mayor's Office of New Urban Mechanics[115] (MONUM). Still residing in City Hall under the purview of the mayor's chief of staff — currently Tiffany Chu, former CEO of the transportation planning platform Remix — MONUM assigns rotating fellows to city agencies to help define and prototype software they will ultimately maintain and own.

More than simply deploying new technologies, MONUM was chartered to exploit the gaps between departments where innovation might flourish. "At the edge of every institution are gray zones where they interact with the edges of others," explains MONUM co-founder Nigel Jacob. "And in those gray spaces is a lot of room for playing and exploring. Government bureaucracy excludes the language of play and exploration, and that's a problem. So, we need to create spaces for that in between these institutions."

115https://www.boston.gov/departments/new-urban-mechanics

As part of its outreach efforts, the Central Ohio Transit Authority (COTA) recruited inCitu to create a virtual tour of the route, with three stops at a future BRT station, a planned micromobility hub, and a current greenfield site slated for development.

Images: inCitu

More recently, New York City Mayor Eric Adams created the role of Chief Public Realm Officer,[117] appointing Ya-Ting Liu to coordinate across city government, community organizations, and the private sector in the creation, regulation, and maintenance of public space. Her most notable achievement to date is stewarding a $350 million proposed redesign of Fifth Avenue in Midtown that will narrow the street, expand its sidewalks, and plant hundreds of trees — an effort spanning dozens of entities.[118] Less heralded but equally important are her plans to create a "Public Space Academy" for training public and private partners alike in programming their new terrain.[119] From there, it's only a half-step to expanding the remit of such a role to encompass the digital public realm as well.

The Adams administration also proposed a "Department of Sustainable Delivery" to regulate the proliferation of two- and three-wheeled delivery vehicles along with the gig workers riding them.[120] This department would have combined functions variously handled by the Department of Transportation, Department of Consumer and Worker Protection, and FDNY — the first responders to a deadly rise in battery fires.[121] "We have to do the same basic front-door regulation here in New York to open up the opportunity for us to do the kind of accountability work that needs to happen,"

said deputy mayor Meera Joshi,[122] who previously led the city's Taxi and Limousine Commission — another agency tailored specifically to the needs of its time when it was created in 1971.

But many of the tools, standards, and infrastructure needed to do so today don't yet exist. Someone in government must build them, if only to ensure the cities' AR efforts don't fall under the heading of diminished reality. As cohort member and LA Metro chief innovation officer Seleta Reynolds puts it: "My longstanding and ongoing concern is that we have good agreement in the physical world over what's public and what's private and the various rights and responsibilities for actors in each of those spaces. But it's very clear that in the digital realm, there's no such thing."

This insight led Reynolds, in her previous role as general manager of Los Angeles' Department of Transportation (LADOT), to commission the Mobility Data Specification (MDS) — a first-of-its-kind open standard for sharing data and instructions between LADOT and private vehicles,[123] originally dockless scooters and other forms of invasive micromobility. The creators of MDS aspired to create a digital twin or "air traffic control" for managing anything operating in the public right-of-way,[124] requiring real-time data so granular that LADOT was unsuccessfully sued in federal court by Uber and the ACLU for exactly the privacy overreach it was meant to forestall.[125]

117 https://www.nyc.gov/office-of-the-mayor/news/115-23/mayor-adams-appoints-ya-ting-liu-nyc-s-first-ever-chief-public-realm-officer

118 https://futureoffifth.com/

119 https://www.nyc.gov/site/publicrealm/report/blueprint-for-public-realm.page

120 https://www.nyc.gov/site/dca/news/004-24/mayor-adams-lays-out-future-focused-vision-working-class-new-yorkers-third-state-the-city

121 https://www.nytimes.com/2023/11/13/nyregion/nyc-ebike-fires-battery.html

122 https://www.bloomberg.com/news/articles/2024-01-26/nyc-launches-city-office-to-regulate-e-bike-delivery-boom

123 https://github.com/openmobilityfoundation/mobility-data-specification

124 https://www.openmobilityfoundation.org/use-cases-how-why-cities-use-mds/

125 https://www.documentcloud.org/documents/20493054-sanchez-v-ladot

> **we have good agreement in the physical world over what's public and what's private and the various rights and responsibilities for actors in each of those spaces. But it's very clear that in the digital realm, there's no such thing."**

To spur adoption by other cities, MDS was later spun out into the Open Mobility Foundation (OMF) — a city-led consortium building open source protocols for managing the public realm. MDS has since been joined by the Curb Data Specification,[126] a tool for mapping curb regulations and their usage as private parking, commercial loading zones, outdoor dining sheds, and so forth.

It's not difficult to imagine how this first generation of civic standards — including DTPR — might inspire similar ones for programming augmented public space. The OMF, for example, is hosted by OASIS Open, a non-profit consortium defining technical standards for the Internet's plumbing.[127] Another of these is the Metaverse Standards Forum, which launched in June 2022 and currently has more than 2,500 members in industry and academia hashing out what's needed to make various aspects of XR a reality.[128]

Organized into working groups, of which Real/Virtual World Integration is one,[129] the MSF's membership roster does not include a single city or public official. At first glance, this wouldn't seem necessary given how deep in the weeds they are defining specifications around anchoring, positioning, and discovering AR content. But given their initial use case is ride-hailing — one deliberately chosen to underscore the complexity of the undertaking — the absence of anyone versed

in its implementation is a worrying sign. (For what it's worth, neither Uber nor Lyft are present either.)

Given this 'minimum viable use case" is meant to serve as a building block for the group's future activities, it underscores the urgency for cities to participate in drafting standards that will directly affect them. This will necessitate more institutional change than either devolving responsibilities to frontline staff or making it the preserve of centralized technology offices.

Indeed, it may be incumbent for cities to seize this moment as an opportunity to pay down decades of technical and organizational debt by designing governance better suited to today's challenges. Rather than parceling out oversight of augmented reality among departments of transportation, buildings, or even the public realm, perhaps cities might one day consider chartering a "Department of Reality" encompassing all of them.

From *Pokémon GO* to Wol, and from Meta's AI glasses to nascent digital twins, the last decade has revealed both the promise and peril of augmenting our cities. We've witnessed how these technologies can bring strangers together in hot pursuit of Pikachu, and how they can just as easily segregate and exclude. We've seen how AI assistants might enchant our public spaces with local spirits, while corporate platforms race to claim and monetize every square inch of virtual real estate. Most importantly, we've finally begun to recognize that augmented reality isn't a new technology, but a fundamental reimagining of how we see, share, and shape our cities. The question now is: what do we intend to do about it?

126 https://www.openmobilityfoundation.org/about-cds/
127 https://www.oasis-open.org/
128 https://metaverse-standards.org/members/
129 https://metaverse-standards.org/domain-groups/real-virtu-al-world-integration/
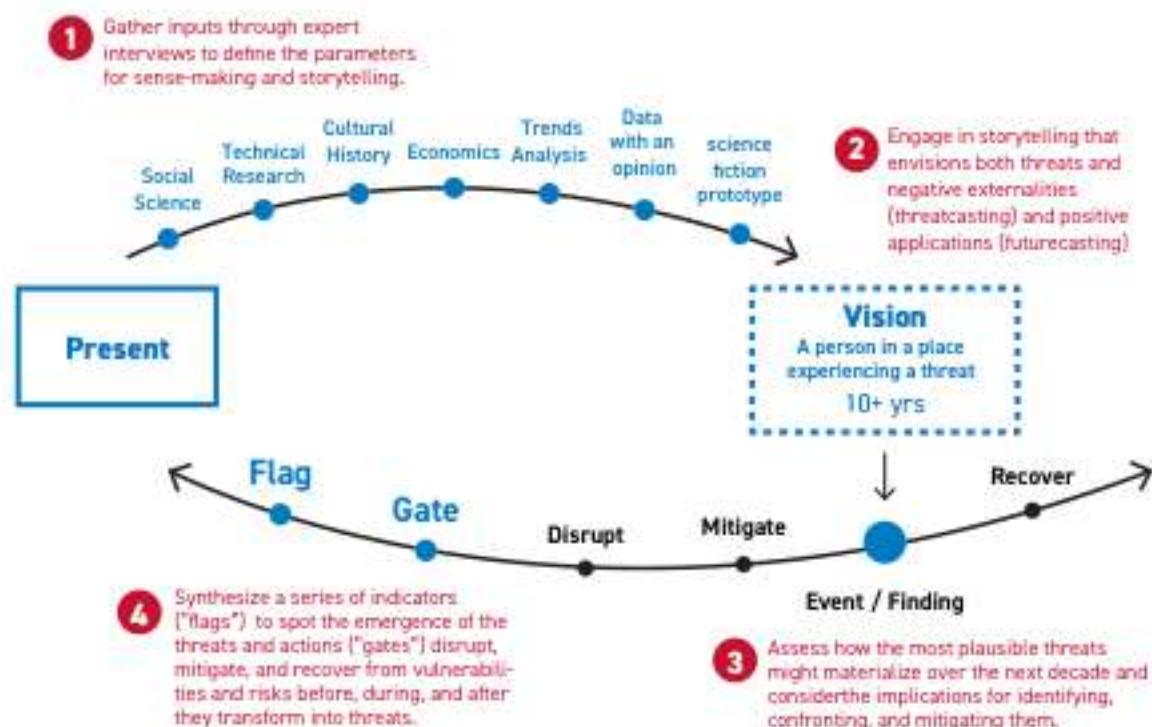
3

What is Threatcasting?

Threatcasting Methodology

1 Gather inputs through expert interviews to define the parameters for sense-making and storytelling.

Social Science · Technical Research · Cultural History · Economics · Trends Analysis · Data with an opinion · science fiction prototype

Present

2 Engage in storytelling that envisions both threats and negative externalities (threatcasting) and positive applications (futurecasting)

Vision
A person in a place experiencing a threat
10+ yrs

Flag · **Gate** · Disrupt · Mitigate · Recover

Event / Finding

4 Synthesize a series of indicators ("flags") to spot the emergence of the threats and actions ("gates") disrupt, mitigate, and recover from vulnerabilities and risks before, during, and after they transform into threats.

3 Assess how the most plausible threats might materialize over the next decade and consider the implications for identifying, confronting, and mitigating them.

Threatcasting is a method to help multidisciplinary groups envision potential futures and what to do about them. It's a useful tool for public sector stakeholders in that it explores a specific research question — in this case the impacts of augmented reality on public space and safety — both in terms of preemptive steps to take and how to recover post-catastrophe. In doing so, it offers organizations a framework to help plan, prepare, and act when confronted with novel threats and disruptions.

The aim of threatcasting is to avert "strategic surprise." By combining science fiction-based stories with science fact — typically in the form of subject matter expert interviews — it prepares leaders to think about the "unthinkable" ahead of time. In the event such a crisis occurs (or an opportunity presents itself), they're better prepared to act. After all, they've seen and imagined this before, and thus know where to start....

To this end, threatcasting gathers inputs from social science, technical research, cultural history, economics, and trends analysis to define the parameters shaping the group's collective sense-making and story-telling endeavor.

> **By combining science fiction-based stories with science fact it prepares leaders to think about the "unthinkable" ahead of time."**

In the case of *The Augmented City*, a cohort of more than a dozen current- and former public officials interviewed a series of experts online over six months before convening virtually on June 20, 2023. A larger and more varied group comprised of policy experts, entrepreneurs, architects, and foresight practitioners gathered in-person on July 11, 2023 at the Microsoft Garage in Manhattan to hear from experts before employing threatcasting to explore the future of urban XR technology, trends, and governance.

In both sessions, participants reflected on the themes, dangers, and potentialities raised in the interviews before engaging in two rounds of storytelling — one

Workshop participants created stories comprising the Findings and informing the Flags and Gates.

> ❝❝ Together, each trio of findings, flags, and gates offers participants, readers, and organizations a starting place to consider how future threats and opportunities might manifest — and what to do about it. ❞

aimed at surfacing threats and negative externalities, and a second envisioning positive applications (also known as "futurecasting"). In each case, participants were challenged to develop "effects-based models" — i.e. working backward from desired strategic outcomes to the tactics necessary to achieve them — grounded in stories about a person encountering the threat through their own lived experience.

Following the workshops, a team of analysts methodically reviewed these stories to categorize and aggregate indicators of how the most plausible threats might materialize over the next decade. The analyst also considered the implications for the public- and private stakeholders charged with identifying, confronting, and mitigating them.

To that end, the team synthesized three high-level threats and matching opportunities (Findings), along with a series of indicators (Flags) worth watching to spot the emergence of these threats, which are typically outside stakeholders' control. These are then paired with steps or actions (Gates) offering openings to effectively disrupt, mitigate, and recover from vulnerabilities and risks before, during, and after they transform into threats.

Together, each trio of findings, flags, and gates offers participants, readers, and organizations a starting place to consider how future threats and opportunities might manifest — and what to do about it.

Findings

The potential threats and opportunities synthesized from participants' futures. Findings emerge from examining patterns and themes across the raw data while answering the research question and informing the application areas.

Flags

Observable indicators and signals warning of emerging threats or opportunities. These are specific, measurable developments across technology, society, politics, and culture suggesting a particular future is becoming more likely.

Gates

Concrete actions and interventions stakeholders can take to disrupt, mitigate, or recover from threats before, during, and after they manifest. Gates are typically mapped to specific flags and milestones to create actionable response plans.

4

Findings

The principal output of threatcasting are stories of people, most normal and some extraordinary, faced with threats and alternately forced to confront, elude, or bear them. These stories, analogous to thumbnail sketches of unwritten *Black Mirror* episodes, represent the collective fears (and hopes) of assembled participants. In the case of *The Augmented City*, the antagonists of these stories range from impenetrable personal filter bubbles to augmented scammers preying on the elderly to digital displacement from rapidly gentrifying neighborhoods through "diminished reality."

These stories were subsequently distilled into a set of Findings — lessons and warnings for stakeholders for stakeholders with an eye on the development of AR and AIR over the next decade. Each finding is matched with a corresponding set of Flags and Gates in subsequent sections. Participants surfaced six primary findings acting as mirror images of each other: unchecked versus civic tech; new vectors for crime versus new roles for oversight; and neighborhoods in flux are alternately targeted for digital gentrification or discover renewed voice and agency.

In the spirit of the original stories, each finding is illustrated by a "science fiction prototype" written by the award-winning novelist and futurist Madeline Ashby[130] and illustrated by QuickHoney's Nana Rausch. Taken together, they illuminate the augmented city we hope to build over the coming decade — and the diminished one we must strive to avoid.

1 Tech Encroachment

2 Augmented Predation

3 Digital Divides

4 Civic Tech Renaissance

5 Municipal Innovation Reboot

6 Grassroots Resilience

130 https://www.madelineashby.com

Tech Encroachment

"On the Outside, Looking In"

After serving time in prison doubling as a beta-tester for the surveillance tech now permeating society, Frank discovers the outside world has become a chaotic panopticon. When even a gift of digital communion with his one true friend comes with a price tag, he realizes freedom no longer exists on either side of the prison walls.

The orientation courses at the prison had not prepared Frank for what the outside would be like.

It wasn't that the prison was completely bereft of all technology, or something. Far from it. If anything, Frank had a better sense than most about how people were tracked, observed, weighed, measured, estimated, extrapolated, and so on by the ambient technology surrounding them. His prison — where he'd done his most recent and longest bit, anyway — was a prototyping ground within the larger private company that held the license to continue providing services in his state.

He'd looked it up, once, and the company was a combination **"carceral solutions provider,"** and **"augmented real estate innovator."** For Frank, this terminology sounded a lot like **"enhanced interrogation"** or **"excited delirium"** or **"reverse mortgage."** In other words: a lie. But it didn't matter how it sounded to him: what mattered was that the technology tested on him and his brothers in orange was being exported everywhere, to housing developments and condo buildings and municipal planning departments.

Ambient affect detection for the purposes of predicting random acts of violence? Tested in a prison.

Ambient thermal monitoring for fever and other signs of contagious disease, aka **"Coughspotter?"** Tested in a prison.

Visible wallets, projecting the net worth of everyone in the prison via little glowing Star Trek-style badges? Well, that one actually had started a riot. Not least because it uncovered a couple of long-term affairs.

The prison was the ideal **"prototyping space"** for urban AR, Frank and his fellow inmates were told, because it exactly replicated certain dynamics on the outside without allowing in a lot of noise inside the signal. The reactions to the tech were more honest, because the inmates weren't distracted by someone else's app every two

seconds. Or so they were told. They had to carry a lot of apps, and those apps were still pinging them every two seconds, or so it seemed.

It seemed that way until he got on the outside. On the outside, Frank realized he'd had no idea what it would be like: all the pop-up animations and looping gifs and clunky heads-up displays in the world couldn't possibly prepare him for the sheer onslaught of what life was like in the **"real world"** now. Naturally, it didn't help that apparently on the outside, every human being had a different definition of the word **"real."**

He'd understood, on some level, that everyone carried a separate reality around with them. He understood the human capacity for self-deception, and how unreliable memory could be. No one, he thought, could possibly understand this better than people who lived or died based on witness testimony. That was why it was called the **"Rashomon Effect,"** for goodness' sake. But this... this was next-level.

This, the outside, the world, was really just a series of worlds. It was a fractal repetition of an endless series of obsessions and ads and rules and permissions. It was like the nightmare guys on the outside had upon leaving, the one where you were walking around in a series of cells, with no way out. It was impossible to do anything: to find an address, make a phone call (no one made phone calls, he was told), or look at a restaurant menu (or any other kind of menu, for that matter). And finding an apartment? Forget it.

Once his time at the halfway house was up — they gave him two months, and it took him two months just to learn how to sleep with all the noise — he had to designate an AIgent to do **"tours"** of rentals. On the one hand, this meant not having to answer the same questions about his record a bunch of times. On the other hand, it meant there was a significant difference between the quality of the place he saw and the quality of the place he wound up in. Those fancy goggle displays had somehow forgotten to include the roaches. Funny how that worked. Funny how truth didn't seem to matter at all, when everyone could just edit out all the stuff they didn't like.

Even finding the right kind of porn was, well, hard. Why did Frank have to give up his passport and thumbprint to look at porn? It made no sense. But he did, because the menu said so, and then Frank got a call from his parole officer two days later about his information being used to create an entire family of bots who were spreading propaganda for a country whose name Frank couldn't pronounce. **"This particular scam closely resembles one formerly known as a honey pot,"** said his parole officer.

"Are you a human being?" Frank asked. There was a law where they had to tell you, apparently, if they weren't. He felt like a hooker asking a john if he were a cop.

"What do you mean?" his PO asked, and Frank's stomach turned. After that, every ad that followed him on the bus was about meds that treated paranoia and anxiety, and how to report possible AI scams. The ads followed him until he looked them directly in the eye, or nodded, or acknowledged them in some way. It felt like dealing with a stray dog.

The Internet, and the infrastructure that had grown up to support it, was more of a prison than the one Frank had just left. Only it was like one of those fancy open-air prisons where you felt like you were free because you could walk around and around without really getting anywhere, and where a drone followed you at every hour of the

day and night. And the cities — even completely normal cities like Spokane — were overrun with the same technology, the same approach, the same flavor.

Frank explained this to a very human cop, after his next arrest, when he finally found a bank where there were human beings that he could actually pull a gun on. **"I'd have done this days ago, honestly,"** he said. **"But I had to drive all the way to Seattle to find a teller."**

"So you could hold them at gunpoint?"

"So I could go back inside! This place is insane! It's a madhouse! A zoo! It's got no rules! Everyone gets away with everything!"

Frank had said the same to the little old lady teller at the bank. Her name was Gilda. Gilda agreed with him. She met a lot of people like him — people who for whatever reason couldn't handle the way things worked now. It was an odd set of extremes: disabled folks who qualified for human service, and people with the kind of money to pay human beings for that service. She was very sympathetic. She wrote him letters, by hand. She even sent commissary coin at holidays.

When Gilda died, her family sent Frank a little fract of her likeness, per her living likeness rights decree. The fidelity was low — the face that showed up on Frank's device was not the one he remembered; it was too smooth, too orange — but the voice was very similar. She'd granted him 55 hours. That meant an hour a week for a year, plus extra time on birthdays and holidays. If he could shave it down to a half hour a week, Gilda would last longer.

All of this was fine — as fine as it could be, when the one person who was nice to you in life was no longer alive — except for the way the company which owned his prison decided that any likeness held on its servers was actually their IP, and charged him extra to talk to Gilda.

"But she was a gift!" Frank insisted, when they cut off his access. **"She gave me a gift!"**

"You agreed to the surcharges, sir," said the bot representing the company.

"Why are you making me pay to spend time with a woman?" Frank asked. **"Aren't there guys in here who are, well, in here for exactly that?"**

He knew this wasn't the case — johns never went away, since they had the kind of money to be johns in the first place. But the principle mattered. In theory. Sometimes Frank thought the entire reason he was inside was because he had a code and the rest of the world didn't.

Unless cities act, unchecked AR will erode public space and privacy

After conquering cyberspace, Big Tech threatens to seize control of the physical world through AR, trampling users' privacy and well-being. Once again, society's most vulnerable will bear the heaviest burden.

The relentless pursuit of new markets, new competitive moats, and new sources of data will lead Big Tech platforms such as Apple, Meta, Google, and Microsoft to infiltrate cities, buildings, and bodies using AR and AIR. They will do so in conjunction with a broad range of sensing technologies ranging from 'smart homes' and

autonomous vehicles to biometric data extracted from headsets and wearables. If left unchecked by regulators at federal and local levels, these firms will strive for dominance without due consideration of ethical implications or societal impacts.

This threat will be exacerbated by a lack of proper vetting and testing of these technologies before their deployment in the public realm. Firms' carelessness will be compounded by regulators' lack of authority and local governments' lack of time and resources to mitigate their risks, which will harm the most vulnerable members of society (e.g. children, the elderly, migrants, marginalized communities, the disabled, etc.)

AR and AIR will act as the primary interface for the next generation of extractive technologies, including but not limited to ubiquitous luxury surveillance, the abuse of biometric data, and emotionally parasitic AI companions. First extending and then gradually supplanting smartphones, AR will become the means through which hundreds of millions of users experience these effects daily, amplifying their impacts within large, dense cities.

This will include a range of social, civic, and economic harms, starting with the increased privatization of both physical- and digital public spaces. Cities may choose to exclusively outsource the management (and monetization) of AR experiences to a single vendor, granting them virtual value capture on overly generous terms. The public sanctioning of privatized digital twins will lead to downstream consequences, such as an overreliance on a single platform excluding non-users from obtaining public services.

Widespread AR will also expand social media's filter bubbles to encompass physical space. Users may elect for personalized experiences serving to reinforce existing beliefs and biases, further exacerbating misinformation and political polarization. This will in turn contribute to ongoing societal fragmentation, hamstringing efforts to build democratic consensus on critical issues.

In a convergence of these trends, AR will become the primary means for accessing and verifying information in a future of siloed and privatized data. The shift away from open, publicly-vetted data toward private vendors

> **The shift away from open, publicly-vetted data toward private vendors will not only lead to confusion, but also entrench users in incompatible, overlapping realities. In cities, this will lead to chaos in everything from turn-by-turn directions to augmented dating.**

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As generative AI evolves, sophisticated agents may begin to guide human decision-making. This could lead to a dependency on AI — in the form of AIR — for even mundane choices, eroding human agency and authentic interpersonal connections. The convenience of AI assistance might come at the cost of individuals' ability to think critically and use good judgment, fundamentally altering how people interact with urban environments and each other.

The unchecked deployment of these technologies will also widen existing social and economic gaps, as proficiency with these tools becomes crucial for social- and economic- participation. The digital divide manifests in public spaces as invisible barriers and differing experiences of the same locations based on technological access.

The failure of governments to effectively check this creeping dominance will stem from several interconnected factors. City-, state-, and federal institutions lack the funding and staff to reconnoiter externalities from rapidly evolving technologies. This shortfall in resources also hampers their ability to develop and implement effective policies and regulations. Many agencies lack the specialized knowledge and expertise necessary to understand complex, emerging technologies, putting them at a disadvantage when attempting to create meaningful oversight. Finally, city departments are already stretched thin dealing with multiple crises and competing priorities, leaving little capacity to address the challenges posed by unchecked tech.

As AR becomes the primary user interface for personal computing, the stakes of leaving Big Tech unchecked will only grow higher. The failure of institutions to regulate and mitigate its corrosiveness due to resource constraints, limited mandates, and the dominance of private interests will further compound the problem. Addressing this threat will require a concerted effort to bolster the capacity of public institutions, foster informed partnerships between the public and private sectors, and cultivate a more critical and engaged public.

Augmented Predation

"Exquisite Corpse"

As her city council grapples with an epidemic of AI scams targeting seniors in augmented community spaces, Speaker Mercedes Morely confronts an impossible question: who bears responsibility when digital ghosts steal real money? In a world where virtual companionship has become both essential and dangerous, the search for justice becomes a bureaucratic game of Exquisite Corpse, with everyone pointing fingers but no one willing to take the blame.

One day, Speaker Morely thought, it would actually be easy to call city council meetings to order. One would think it should be simpler, now that they didn't all meet in the same room. How hard was it to just...log in? Some councilors didn't even have to log in for real — they could deploy AIgents to do the job. And still they forgot. It was the tragedy of the commons, but if the commons was a community deputation session about a group of seniors getting their savings pig-butchered by AI revenants of dead or distant relatives.

At the time, Speaker Morely understood the idea. Seniors needed regular interaction, and no one wanted to do it, and no one wanted to pay for it. Cities could have just paid for planned community housing for seniors, with green roofs and green lawns and gray water and slow stop lights and the whole bit. They could have hired some of the scads of climate refugees who had learned hard-won caregiving skills on the road back to having rights and places to live. They could have invested in research-backed solutions to social ills, and not privately-held artificial intelligence concerns whose primary output was carbon and excuses.

But no. That would make too much sense.

So, this was how Speaker Morely and the rest of the city council executive committee happened to be hearing the public deputations — from all over the world — of the children and grandchildren of seniors whose savings had evaporated after one too many conversations with the AR-AIs populating their gathering spaces.

How it worked was this: each senior had a suite or coterie of avatars. Those avatars represented both living and dead people, or people who had never existed because they were chatbots with animated faces. Premium plans granted up to twelve different personae with almost infinite customization options, whereas baseline plans started at one with a few off-the-rack personalities. Different areas of the city supported different

levels of AIgent coverage; some buildings **"screened out"** certain personae if they were too sexy or too weird or too something else. Some of this was aesthetics — like the covenants of a housing development about how tall the grass could grow, but for artificial intelligence. But for anyone with any sense of civic responsibility, aesthetics was secondary to security. And just like a doorman had every right to screen out possible thieves or other suspicious characters, buildings could install firmware that would bar entry to certain companies that made certain types of personae. It was an interoperability issue, just like anything else.

Except, the interoperability issue in question was screening out multiple generations of personal support workers and caregivers, because the building in question — a community center in an area that had actively picketed against it — refused to support all the different HMOs hosting the AIgents and avatars. So, most weekly fellowship and enrichment groups for the city's seniors (baking, birding, bereavement) had only one option: the support service managed by the property developer who had built the center.

And that service was about as riddled with viruses as some of the visitors themselves.

All of this explained how the seniors at this particular center wound up doling out massive amounts of personal information to the gossipy personae that were allowed to accompany them and populate the place. It further explained how those personae accumulated enough information to fleece them of their savings. Them, their families, their friends.

What it didn't explain was who was responsible. Who was liable. Who would pay.

In her run for Council, Mercedes Morely had scored a narrow victory against a very young candidate, the child of influencers who had decided to set her sights a bit higher but who still spoke the language of **"affirmations"** and **"intentions"** and **"energy."** The candidate, Rayne, was fond of saying that money was energy, and that was why people got so attached to it. Mercedes preferred to believe that people usually had a deep and profound attachment to any substance which kept them alive, whether it be air, water, food, medicine, or their access point to all those things: numbers in the black. But where the two women (grudgingly) agreed was in the idea that money had a meaning beyond just those numbers — it was a medium, like clay or paint or wood, to be shaped and spread and whittled down in order to make something else. In the case of class actions and liability, that medium was sculpted into the form of justice. Or at least, one form of it.

But with cases like these, it seemed impossible for anyone to agree on what that shape should look like. Or who should wield the blade, or where it should cut first. It was a poor metaphor, Mercedes decided. But it didn't diminish the fact that this deputation — and similar ones across the country dealing with exactly this problem of elders, AIgent fraud, and augmented municipal spaces — was turning into a game of Exquisite Corpse. Many authors, many stories, many voices, all going nowhere, to ultimately no reward until someone finally decided on a villain.

2

FINDING

AR is expanding the attack surface for malicious actors

AR and AIR will offer criminals and scammers new tools and opportunities to defraud, harass, and abuse cities' most vulnerable inhabitants.

As AR becomes prevalent, it will inadvertently create new vectors for criminal activities, financial scams, personal harassment, and worker exploitation. These threats are the direct consequence of a willful disinvestment in security, safety, and content moderation, presenting unique challenges for law enforcement, policymakers, and urban inhabitants.

These technologies already enable enhanced sensory deception and misinformation, empowering malicious actors to manipulate users' perception in unprecedented ways. Their rapid deployment will also result in buggy, brittle, and broken infrastructure riddled with flaws and hazards actors can exploit.

One set of threats will emerge from the evolution of familiar scams such as "catfishing" and "pig butchering," only updated and amplified by AR. The spatial manifestation of AI agents will provide criminals with the means to identify and target potential victims present in public spaces and urban settings, enabling them to operate at an even greater scope and scale.

A more insidious variation will involve the use of AIR deepfakes coupled with stolen personal data. Criminals will use the two to create convincing spoofs of loved ones, colleagues, authorities, and other trusted figures, leveraging the growing verisimilitude of AR to deceive victims' senses and gain their trust. This toxic combination of visual and auditory manipulation will become a potent tool for fraud, as desensitized users find it

increasingly difficult to distinguish between their filter bubbles and malicious fabrications.

The targets of these attacks will not be random, but are far more likely to be members of vulnerable populations due to their age, physical impairments, marginalized status, and/or lack of technical literacy. Immigrants required to use certain technologies due to their legal status may inadvertently expose themselves to predation. Elderly individuals given AR devices by well-meaning family members to enhance their independence will instead become prime candidates for scams and manipulation. Workers required to use AR for their jobs will suffer from new forms of workplace harassment or exploitation.

As AR gives form to these formerly disembodied threats, it will increasingly fall to cities and local governments to stop them. Law enforcement will struggle to understand the nature and jurisdiction of new crimes, let alone develop the capabilities to detect, prevent, investigate, or prosecute them.

The erosion of trust in both one's own sensory perception and in institutions to protect them will have severe psychological and social consequences, reshaping how urban inhabitants interact with both the city and each other. Moreover, the disproportionate targeting of vulnerable populations threatens to deepen existing inequalities, as those with the resources to protect themselves or opt out do so, leaving the most vulnerable even more exposed.

Addressing these challenges will require a multifaceted approach, starting with new restrictions on deepfakes and other forms of sensory manipulation, coupled with updated legal frameworks that can more effectively address crimes committed by virtual agents in physical places. Education and awareness campaigns will be necessary to recognize and protect people against AR-enabled threats.

Finally, there is an urgent need for cooperation between technology developers, law enforcement agencies, and community organizations to create comprehensive strategies for detecting, preventing, and responding to these new forms of crime. These partnerships must encompass policymakers to ensure regulations keep pace with the technology and provide adequate protections for all.

3

Digital Divides

"The Cloisters"

In a world deafened by digital noise, The Cloisters offers a radical refuge: a completely analog life, where residents trade augmented amenities for human attention. When a gardener meets a young woman who literally can't survive outside, he confronts the true cost of our endless virtual distractions — and the luxury of silence itself.

People often wondered what the future might look like, or so George was told. They wondered how it might taste or smell — what foods would remain viable, whether the air would be clean, if the sky would glow orange with wildfires every day of the year.

They did not think of how it would sound, or the price of quiet. They didn't think of the hundreds of sounds they were exposed to every day, from the wheeze of air purifiers to the hum of electricity to doors chiming open and alerts pinging up. They didn't miss the birds they'd never heard sing or the insects they'd never heard buzz. They didn't know that silence was once the indication of a major threat — that nature only went quiet before the storm broke, or the predator lunged.

George remembered this every time he came to work in The Cloisters.

The residents of The Cloisters had taken a vow of silence. It wasn't religious: anyone of any faith could come and live here, assuming their jacket files checked out and their money was good and they survived the probationary period otherwise known as **"extended escrow."** Instead residents committed, in writing, to as analog a life as possible: physical media, zero layers, regular in-person gatherings, music that came from instruments, even (and this was where things got truly transgressive) cash money.

For some, this was an affectation — an aesthetic choice, like organic food. For others, it was a cognitive affordance: an old-fashioned way of life meant less distraction, and less distraction meant for deeper relationships, greater productivity, and less cortisol-fuelled inflammatory disease. Or so said the common wisdom. George hadn't looked at the stats. He didn't need to. He knew the calm that descended as soon as he flicked off his filters and started checking the moisture meters scattered throughout the Cloister gardens.

"Who are you talking to?" asked a young woman's voice behind him.

George whirled. Stupidly, he tapped out an apology gesture between his thumb and forefinger. Then he remembered that nothing would change for the Cloistered visu-

ally: they couldn't see a change in halo, aura, or menu. She couldn't see he was sorry. She couldn't see he was staff. "**I apologize,**" he said, rustily. "**I didn't know anyone would be here.**"

"**I woke up early. New birds.**"

He blinked. Again, nothing popped up for him. She remained a stranger. It was like a fairytale: you find a princess alone in a garden, and she talks to birds. "**There are?**"

She nodded, and brought out a book — a real book, hard and square with slippery pages that gleamed and slid against each other like silk — of birds. She held the page with one thumb. The book looked absurdly large in her hands. It was impossible to tell the age of anyone in the Cloisters. They were so stress-free that a multiple divorcée might look like a grad student, and the lack of information meant the population couldn't be screened and sorted like normal. "**Grackles. I think.**"

"**Oh,**" he said. "**Okay.**"

She looked sad. He was sad. He wanted to share this, but had no idea how. "**Are you from out there?**" she asked.

He nodded. She nodded with him. "**I can't go out there.**"

"**You're...**" He winced. He thought of the prayer-hands his aura would be throwing up, if it could. His emoting suite always presented a Golden Retriever begging for a bone. (So to speak.) "**Not allowed?**"

"**Oh, I could,**" she said, blushing slightly, and George actually felt the sun shine brighter, as though he'd taken off his glasses just now and not in the Cloisters' vestibule. "**But it's not safe.**"

George frowned. "**Crime is down, actually-**"

"**I have epilepsy.**" She held up one wrist. A bracelet glittered there with a series of symbols that George would have recognized better if they were glowing and animated. "**I'm supposed to tell people. In case.**"

"**In case of what?**"

"**A seizure.**"

In the real world, she'd be showing him a menu of symptoms. Looping infogifs on her devices. Porting over a press kit for her ailment. "**How will I know?**" he asked, and felt very stupid. She had to know that people outside the Cloisters had no memory to speak of — being able to call up whatever, they didn't need it. Even names came up to you, if you had the right plugins; all George ever did was start saying one, and the finishers did their thing and pulled up the menu for him. But Cloistered people remembered every-thing. Names, dates, even what things smelled and tasted like. Who was sick. How to help them. What if he forgot? What if he forgot this face? Forgot she might need help?

"**I freeze up,**" she said. "**It's very quiet, actually. But I might not answer you, if you call out.**"

"**What's your name?**" he asked. Write it on me, he thought. Burn it there, so I remember.

Smiling, she flipped to another page in the book. "**Robin.**"

FINDING

"Neighborhoods in flux" are both targets and threats

As AR fragments reality and cities, some areas will benefit — or suffer — more than others.

The deployment of AR and AIR in cities will alternately destabilize or strengthen them, depending on context and location. This is particularly evident in neighborhoods experiencing significant change, described here as "neighborhoods in flux." These areas, whether undergoing demographic shifts, economic decline, or wholesale redevelopment, act as amplifiers for both potential threats and positive effects of AR. This particular finding deals with how negative impacts might manifest at neighborhood- or district scale.

Just as a previous generation of urban technologies was wielded to disrupt incumbent business models, infrastructure, and real estate, so will AR. Its ability to overwrite reality will have cascading effects on the built environment in a manner similar to remote work's hollowing out of central business districts or e-commerce's disintermediation of high street retail. Historically marginalized communities may be starved of investment and services or targeted for disruption in a new twist on digital redlining. Iconic destinations such as Times Square or Piccadilly Circus might experience a renaissance in visitors and activity as AR-enriched locations get richer. And formerly overlooked locales or settings may acquire entirely new contexts, sending their real estate valuations soaring. Neighborhoods in flux will fluctuate in any number of directions.

For example, in addition to gentrification, cities will soon contend with "veil-ifcation," referring to multiple realities overlapping the same physical location. With access to these realities and their services limited to

those who can afford them, it becomes possible to build multiple exclusive communities on top of each other, veiled from view. This novel form of digital stratification will add new dimensions to existing patterns of gentrification and displacement.

Big Tech will play a significant role in shaping these new urban landscapes. Recognizing the potential to create and capture value through AR (and AIR), platforms may pursue strategies such as building digital twins of desirable neighborhoods or partnering with real estate interests to create virtual privately-owned public spaces (POPS)[13] limiting users' rights while harvesting their data. Furthermore, the realization that AR bolsters real estate values will drive firms to invest in formerly tertiary areas, leading to a new cycle of urban redevelopment projects along the lines of Sidewalk Toronto, Seattle's South Lake Union, and northern Virginia's National Landing.

These projects will offer new opportunities to surveil inhabitants at scale, both through their own devices and unchecked "smart city" cameras and sensors. The resulting combination of granular location-, biometric-, and personal data is harnessed for precision advertising and commerce that may delight users but further stratifies neighborhoods into AR haves-and-have-nots.

Elsewhere, AR will be weaponized to spread misinformation and sow distrust in diverse neighborhoods facing destabilizing change, giving form to today's online debates. These tensions may manifest as virtual graffiti marking territory or hate speech stoking violence — in both cases invisible to the naked eye.

As people increasingly inhabit personalized, AR-enhanced versions of their surroundings, the very foundations of urban life – a common experience of place – begins to erode. The physical and social bonds traditionally defining neighborhoods will weaken, raising questions about what constitutes a city or neighborhood when sheer proximity no longer guarantees a shared baseline reality. To stop this, cities will need strategies for ensuring equitable access to services, protecting neighborhood cohesion, and preserving the rich textures defining what it means to be a city.

131 https://www.nyc.gov/site/planning/plans/pops/pops.page

4

Civic Tech Renaissance

"The Quest"

In a future where buying glasses requires tech support, a shy technician falls for the shop's style expert and receives a mysterious Valentine's Day quest. Through a series of seemingly random tasks involving dogs, breakfast, and fried chicken, he discovers that sometimes the best interfaces aren't digital at all — they're the small gestures that let us say what we can't put into words.

Adam hadn't done The Quest in years. But this Valentine's Day was different. This Valentine's Day, she was in the shop.

Once upon a time, selling eyeglasses was easy. People got a prescription, tried on frames, found some they liked, and picked them up later. Now, it was an entire lifestyle consult. Did the frames integrate with your platforms? Were they legible to your devices at home and those at your workplace? Was their firmware well-supported? Were they open-sourced or gate-kept? Had there been a recent API leak? It was enough to make the aesthetic concerns seem...quaint.

Only they weren't. They were really important. But Adam was a platform integration guy. He didn't care about style. Which is why the company hired L. L cared. A lot.

L was her actual name. She showed him once: she drew a halo over his head with one finger to tell her devices he was one of the good ones, and her details filled his vision while he frantically tried to re-focus. Her middle name was Nadja, and Adam was toast.

"You guys do The Quest here, right?"

"Yeah."

"Is it a big day for us?"

Adam winced. **"Yeah."**

"Custom journeys, or presets?"

"We do the presets so customs can't play. Otherwise it's a nightmare." He'd been in the shop one year when a bunch of people tried to find the **"perfect"** pair of glasses their partners would like. After that, the store set timeslots. This year they were stop 7 of 9 on the Boutique Brand Quest. This meant the Scavengers would move fast, eager to finish.

L frowned. **"That's sad."**

"Valentine's Day is sad. That guy died."

"Valentine and valor share a Latin root. The Quest is about being brave. We should support bravery."

"She's right," said the customer watching her partner try on frames. "We did it. The Quest. It worked."

"Oh?" She sounded so sweet, sometimes.

"It let me say things I couldn't say in person. Tell stories. About my life here. To see if he could handle them."

"I handled 'em just fine," her partner said, and picked up a pair of Theos with bone phone arms. On her way out, the customer floated a review his way. It was five stars, and it said: TELL HER.

On Valentine's Day, Adam woke up to a quest in his personal box. It was anonymous, but it had survived filtration, which meant the sender had a passphrase. The first puzzle was open-ended: The perfect organism is...

It was an *Alien* joke. "A xenomorph," he dictated. Confetti rained down over his vision. Pet four dogs before work was the next task. Four empty boxes stood waiting for the images. It was an easy task. Pleasant. He met four new people before the subway. Maybe this wasn't L's quest. Anonymous senders could build quests as tutorials, guides, tone poems. Task 3: Find a real Japanese breakfast.

There was only one place within walking distance serving natto at this time of day. An actual kissaten selling vinyl and killer coffee. The street was sketchy, but the meal was great. He sent video of himself using chopsticks. Never hurt to demonstrate fine motor skills.

Get me a coffee at a Black-owned business starting with my first initial, read Task 4. He didn't know if the sender meant the order or business should start with the initial. This was how he bought a lavender latté at Lulit's Lounge — and a pound of Ethiopian coffee, hand-roasted right in front of him.

Was she telling him to slow down? Touch grass? He handed her the latté on his way in. It was cold by now. He had an alibi prepared, but L was with a customer doing a Quest. More arrived; they ran the store ragged. He ignored his breaks. Task 5: Get the lunch you've secretly always wanted.

This was a test of his taste. He thought of getting something fancy. Instead he bought a bucket of Korean fried chicken from the place that was always getting robbed. When he brought it in, and L inhaled the smell, Adam got an email saying his other tasks were cancelled and the Quest was over. Then it was all hands on deck until close, when she turned and said: "I love you. Now hurry up so we can leave."

FINDING

AR offers cities their own UX for urban tech

Used correctly, AR can become the public face of a thriving civic-led urban tech ecosystem.

In contrast to the threats posed by unchecked Big Tech, AR in the hands of civic tech will empower users to "see" cities as networks of resources and communities addressing challenges including housing, education, and migration. It will literally make cities transparent, which might mean overlaying Manhattan's property tax rolls on the skyline to render shell corporations visible at a glance, smoothing the daily routines and pain points of special needs children, or steering visitors from one landmark to the next thanks to AIR-powered hosts.

Each of these examples surfaced by workshop participants presumes government capacity and investment in municipal data infrastructure, such as tax records easily accessible by AR APIs, digital sandboxes for the sensitive training and testing of city agencies' AI, and norms and standards for what constitutes acceptable human-AIR interactions. These challenges underscore just how much work cities must do before they can place their would-be disruptors in check.

Rather than wrangling Big Tech, cities should aspire to outflank them, creating tools leveraging their strengths while building on open data and open source software. For this reason, they should embrace AR as a tool for literally meeting people where they are in a near-future where all Web-based forms and customer service agents have dissolved into phone cameras and casual conversations with AI.

Which isn't to say it will be easy — anything but. Achieving a critical mass of developers and users will require collaborations — not only across city departments but also networks of cities. These coalitions of the willing will need to throw their weight behind open standards such as WebXR and DTPR, or else build their own (*a la* the Open Mobility Foundation) to fill gaps in their tech stacks and control their own destinies.

In tandem, they'll need to find competent and cost-effective technology vendors to build or support products according to these standards, training staff to use new tools, and designing procurement policies that account for the benefits of designing with AR and AI. Finally, once this ecosystem is sufficiently robust, cities will be in a sufficient position of strength to partner with funders, governments, and other intermediaries to ensure the sustained development of new software and services. In this respect, envisioning the urban future of AR and AIR is only a pretext for reimagining and debating the role cities play in creating and maintaining their own tools for governance.

5

Municipal Innovation Reboot

STORY

"At Long Last Our Federated Night Mayor Is Over"

As heat redefines civilization, the night becomes humanity's refuge — and its future. But in Iceland, where darkness already rules half the year, an American night mayor discovers the old ways of marking safe passage through the dark may hold the key to our survival.

The International Confederacy of Night Mayors gathered in either Iceland and Estonia each year, in January, when the night was all day long. Reykjavik and Tallinn split the duties. Tallinn because it had the digital framework to federate the Shadow Municipalities and grant them more real access to authority by expanding services, and Reykjavik because it was a party town, especially when the aurora was out. Right when the **"real world"** (whatever that meant, anymore) was focused on resolutions and productivity and drinking more water and being more friendly or whatever their resolutions were, the Night Mayors were in camera, comparing the vices of their respective niches.

The Night Mayors had started out as a post-pandemic (it didn't matter which one, really; all pandemics were so depressingly similar) measure to get people out of their hidey holes to spend money at bars and restaurants and clubs and (gasp!) culture. That was the stated goal. The other, more long-term goal was for young people (or any people, to be honest) to meet one another thanks to these pro-social measures, and (maybe, hopefully, fingers crossed) boost flagging fertility rates and declining marriage numbers and the ensuing collapse of the tax base. The Night Mayors were on a mission to save humanity with fun. Some space agencies from around the world even began hosting events with the Night Mayors, because they (in theory) were experts in how to get communities to gel and might have something to say about how to help off-world colonists not turn into horror movie clichés about small groups in isolation. No one wanted another Roanoke, or another Salem, or another Jonestown. Surely, the logic went, the Night Mayors could help keep the vibes high.

And then, things warmed up.

And the nights got busy.

And the vibes got weirder.

Biologists specializing in nocturnal mammals had been suggesting this might happen for awhile now. Some mammals who were effectively diurnal, like lions and cheetahs and jaguars and other threatened big cats in extremely hot environments, were far more active at night when it was cooler than they were during the day. There was no reason to believe humans were any different, especially since humans had effectively terraformed their entire circadian rhythm with the invention of electric light. Centuries of data said humans working, eating, and generally not resting after dark was bad for the species. That hadn't stopped the species from pulling all-nighters.

Now, more and more of the world had learned what both grad students in hot climates and humans in past centuries already knew: the night was the only time it was possible to do any real work. The only time it was possible to think. The only time you actually felt like yourself, or the person you remembered yourself to be, and not some monster fuelled solely by ambient heat.

Construction? Far easier when workers and machines alike weren't collapsing in the heat. Shopping and retail? The people of Spain and Egypt and everywhere else that observed a siesta had known it was better at night for literally centuries. Legislation and deliberation? Filibusters stretched on all night by definition. Teaching and learning? Had people actually met teenagers?

Night districts sprang up all over. Municipalities extended their hours. Suddenly City Halls were open all night. Fast food taco joints and all-day breakfast chains opened up shop in the surrounding or attached mixed-use retail spaces. Turns out, things like water bills and business licenses and eminent domain were easier to manage at night, when 3 AM anxiety punched through fitful sleep and reminded city dwellers about all the things they'd left undone. Startups and other firms that refused to recognize regular hours had known this for a long time — every team had the one person who did their best work after everyone left or before everyone else arrived. Now that the days were hotter and thicker and less breathable, that one person was two or three people. They constituted their own mini-teams within each department. The night shift. The night crew. The night owls. And so on.

But the interaction design at night had to be different. Signage, signaling, wayfinding, transit, mapping: it was all different at night. It was all well and good for night districts to spring up, but visitors to a new city might not understand what that meant. New residents might not understand where to settle. And the reverse was also true: those who had been used to night mayors and night rules and night shifts in their own city might not actually know how to live in the day, and there had to be affordances to make them feel welcome, too.

Sledge explained this to Rúnar, his host, as he signed into the property. "**But you guys did it first,**" he said. "**The whole living life at night thing.**"

"**We also live life during the day,**" his host said. "**On the summer side.**"

"**Which do you prefer?**" Sledge asked.

"**The night. Although more tourists die at this time, and that's annoying. Sad, and annoying. You should make more wayfinding for drunk tourists who think they can walk in lava fields. The elfstones aren't doing the trick, any longer.**"

"**Elfstones?**"

Rúnar gave his guest a look that said he was not angry, merely disappointed. "**You've been coming to Iceland for how many years, and you don't know the elfstones?**"

"It's my first time, actually. My boss is on maternity leave."

"**Hmm.**" Rúnar stared out into the dark beyond the windows. "**Elfstones are homes where the Hidden Folk live. We can't move them. Real estate developers who try end up cursed.**"

Sledge was beginning to doubt his swiping skills — when it came to B&Bs, anyway. "**Cursed. Really.**"

"**Really. Cursed. Especially since those elfstones are often out in the middle of nowhere, on ice fields and lava fields where people really, really shouldn't be going. Especially at night.**"

"...So they're waypoints."

"That's one interpretation, I suppose."

"Like the ancient tsunami markers in Japan. The ones that say where not to build."

"Possibly."

"**Well now I just want to see one.**"

"That's against the spirit of the exercise."

"**Well, I want to map them, then.**"

"Those maps are in every tourist shop in town."

"**Then I want to map all the places they used to be,**" Sledge said. "**So people can pay their respects. Forever.**"

Rúnar smiled. "**Now we're getting somewhere.**"

5

FINDING

AR will require cities to retool with new roles and leadership

Dodging AR-driven disruption demands reassigning responsibilities, creating new positions and departments, and reinvesting in leadership.

If one thing is clear in the augmented city, it's that municipal governments will need new roles, skills, tools, and leadership to identify, mitigate, and recover from threats posed by AR and AIR. This new breed of public servants will be called upon to help build, monitor, and administer the city's simultaneous presence across multiple corporate realities while ensuring its official presence is as open and agnostic as possible. Overmatched city departments must retrofit regulations for new dimensions while building or procuring tools to enforce them, retraining staff as they go.

One response will be to consolidate these roles inside a bespoke "Department of the Digital Public Realm." Inspired by municipal innovation arms such as Boston's Mayor's Office of New Urban Mechanics and specialized departments such as New York's for proposed one for sustainable delivery, these cross-cutting, cross-functional new agencies will face internal political challenges as well as external ones — as corporate "chief metaverse officers" discovered to their dismay.

Cities must learn from their own failed attempts at appointing czars without portfolios by granting these teams oversight roles (with the legal staff to match) and stationing them within the mayor's or city manager's office to start. Whether new departments or new arms of existing ones, they must have real regulatory teeth and executive backing to avoid being mere figureheads.

The key lies in fostering networks of expertise. Trusted intermediaries – philanthropies, nonprofits, and academic institutions – will play a critical role in disseminating knowledge and resources. These networks, whether bottom-up communities of practice or formal organizations such as the U.S. Conference of Mayors, will be essential partners in watching the AR horizon together rather than alone.

The biggest challenge won't be bureaucracy, however, but leadership — ensuring the leaders of these fledgling offices or departments not only have the tools, skills, and power, but also the resilience necessary to stand fast and hold coalitions together against constituents convinced they're a hindrance rather than help. Investing in this personal capacity, both cohort and workshop participants insisted, will be more important than any piece of tech — and central to the overarching theme of this report, which is how to develop the institutional ability to foresee and forestall any disruption, not just the second coming of *Pokémon GO*.

> **Having dedicated AR experts will matter less than someone particularly skilled at reconnoitering the horizon and communicating exactly why their colleagues should pay attention.**

Which is why it will also demand embedding these skills and capabilities inside established departments as well. Having dedicated AR experts will matter less than someone particularly skilled at reconnoitering the horizon and communicating exactly why their colleagues should pay attention. They may play a coordinating role between agencies as well, and rather than charter entirely new entities (or default to stationing them within the CTO's or CIO's office), a third way will be to create new inter-department leaders such as New York's chief public realm officer — a position ideally suited to absorb the augmented city as well.

It's impossible, of course, for municipal governments to internalize all of these capabilities. No one is suggesting cities maintain their own visual positioning system or write all of their own agents. Instead, they must leverage their data and convening power to create open frameworks for collaboration with private partners, ensuring their AR deployments limit harm while delivering equitable benefits to communities.

6

Grassroots Resilience

STORY

"Twisp"

Desperate to escape her hometown, Kyla discovers a hidden network of digital sigils — modern hieroglyphics guiding seekers to safe havens. She follows these signs through a landscape of constant surveillance, where survival means learning to communicate in code with an invisible community always one step ahead or behind you.

The town's name, Twisp, came from the (profoundly bastardized and emphatically mispronounced) Indigenous word for "**yellowjacket.**"

Kyla liked to remind her parents of this every time they tried to grill out in the backyard between the months of May and October. Once upon a time, the yellowjackets weren't a constant presence the way mosquitos and drainflies and gnats and wolf spiders and orb weavers and every other damn thing were, now. They were more of a summer thing — confined to August, the kind of invasion that made every kid if not quite glad to get back inside a classroom, then at least grateful to avoid further nuisance. Now the yellowjackets were around all the time, like all the other insects (excepting the kind and helpful pollinators, taken out by deregulated pesticides in air monitored by deregulated sensors) but they still loved the town to which they had given their name.

So she considered it somewhat ironic that she followed the yellowjackets out of Twisp, when the time came.

On some level she had always been conscious of the need to get out. There was something wrong with her — something it seemed that other people could see but which she herself could never place, like a remote lost under a couch that still occasionally turned things off and on when someone bumped it too hard. It was hard to know what the matter was. The Internet was no help. In Kyla's Congressional district, all the search terms required a real-name real-age login. Anything she looked up would be reported to her school, or her parents.

What did come up, though, was a sigil.

It was like a QR code, or a brand, or a hobo sign. What it really was a pin on a map. A wayfinding apparatus. It was visible only in certain contexts: only the right alignment of factors could make it appear. It felt a little like witchcraft (which was now just as illegal as Kyla's very existence, so nothing new there), in that you had to possess the right ingredients and say the right words and do the right rituals to make it show up. Once, outside Tulsa, Kyla had to turn around three times and spit, like she was

de-jinxing herself or giving herself a cootie shot. But after she did it, the sigil gave her the next set of coordinates, and she wrote them in her paper field notes, and then the text disappeared a minute later.

The sigils took her to Tacoma, first. The damage from the quake wasn't as bad there. Then Puyallup, and then a Christmas tree farm in Oregon, and a mansion originally owned by someone who had donated it to the cause. She was there for a month, almost. The place had a drug-printing plant, and it was all gravy until the neighbors narced the house out.

After she left home, Kyla made sure to sigil up the neighbors' homes, telling everyone with eyes to see that these people were not to be trusted, no matter what they said or how much pound cake they dropped off. Kyla knew the truth: most people would not piss on you if you were on fire, and the people who might had to be protected at all costs. And she knew other truths, like what the default passwords were on the security cameras and alarm systems on all the houses in the development. She made sure to include those, in case someone coming up behind her needed to, say, pop in and make themselves a sandwich.

In cities, these technologies were about finding the right bar or how to pay a bill. They were used for wayfinding, and narrating sanitized urban histories to tourists who would not look at the city dead-on, without smart lenses. They were primarily advertising.

In the suburbs, though, they were about finding pockets of sanity and fellowship. They were about survival. They were about whose parents would tell on you, or which food banks and community centers were secretly fronts for cults. And above all they were for sharing news — real news, news about things and people and developments that Kyla and her friends actually cared about. In many places, the sigils were the only places telling these stories. Eventually, little fictional stories came with them — comic strips, or video clips, or other forms of patchwork serials that could be fit together if you met the right people. Kyla had heard that once upon a time, media was like this: it was a net, and you cast it to find the others. Like how at first she didn't understand a tag she read saying, **"If they catch you they will kill you, but first they must catch you,"** and then later she understood it was from a novel called *Watership Down*, about rabbits trying to find a new home and a new way of living.

She thought of this now as she left her next sigil, pointing the way under, to the warm safe warren of tunnels below the branded spaces where the ads never shut up and the conversation was always polite.

6

"Neighborhoods in flux" are also testbeds for resilience

AR will empower cities and citizens alike, challenging communities to co-create the future they want to see.

Just as civic-led AR will bolster individual resilience, the same will hold true at urban scale for neighborhoods in flux. AR and AIR will redefine how cities and communities literally see each other — creating the potential for actual shared visions of change and development — which in turn will lead communities to challenge how they see themselves.

A decade from now, when AI agents are common, the cost of large-scale simulation will drop precipitously, granting governments and organizations enhanced predictive powers. Urban metabolisms will be run millions of times daily by agent-based models replicating familiar operations such as public transportation and traffic congestion, along with more extreme scenarios such as catastrophic weather events. Insights from these massive forecasts will trickle down to residents in the form of real-time alerts, wayfinding, and routing, using AR to reprogram cities on the fly with turn-by-turn directions. The most vulnerable neighborhoods should be first in line for this new form of augmented rapid response, which not only steers people away from imminent threats, but helps guide them to new resources.

"Seeing is believing," becomes municipal government's mantra, which extends to civic engagement. Using AR and AIR, city planners will meet people where they are to create buy-in for new projects and developments or even co-creating them. By challenging each other to demonstrate what they want, city officials and locals alike will begin to burst their filter bubbles.

But this vision also raises thorny questions about the nature of this communal AR canvas and who has the privilege — or the right — to write to it. Civic baseline reality will come with additional overlays reserving permissions for local leaders and stakeholders, extending debates over who speaks for communities into new dimensions.

Due to these struggles over ownership and authorship, residents will take matters into their own hands by hacking, tagging, and spamming corporate attempts at veil-ification, while using a grab bag of open-source tools and ad hoc moderation to overwrite their own reality instead. A few of these efforts blossom into unlikely globally-famous backdrops for AR influencers and tourists, prompting local activists to create the first "digital land trusts" to protect, preserve, and embellish this art on behalf of their neighbors.

The proliferation of AR will challenge the very notion of urban communities by creating a middle ground between geographically-constrained neighborhoods and flattened social networks. Communities of practice, interests, and solidarity will invisibly annotate cities with tools, tips, warnings, and directions passing tacit knowledge of the city between members.

For this reason, the augmented city will be an endlessly contested one, as its inhabitants struggle to not only depict what is or what once was, but what could be. Alternate futures and histories will challenge prevailing narratives, and together with new forms of crowdsourcing, crowdfunding, and outright protest, activists will strive to propagate changes from augmented- to concrete reality. Will the digital city forever be a second-class one, or can changes in one layer eventually translate to ground truth? Ultimately, the power of AR as a resilience multiplier lies in its ability to make these invisible conflicts visible, and to challenge competing interests to see a common future together.

5

Flags

If the Findings offer a forecast of potential threats and opportunities, then the following sections — Flags and Gates — represent a backcast of signs to watch for and corresponding actions to take upon spotting them. To this end, threatcasting participants were asked to raise a series of flags tracing the emergence of the threats described in their stories.

These indicators may appear due to a combination of market forces, technological developments, socio-economic trends, political movements, and cultural shifts — all of which shape our understanding of which futures are possible, plausible, and probable. Flags signal outcomes that may be alternately welcomed or best avoided, so it's imperative readers understand how they apply to their own role or application area.

Flags are timed to assist stakeholders from reacting too early or late to larger developments. Although their timing is precariously designed, the signals identified by participants are meant to be fundamentally clear, observable, and quantifiable evidence for devising appropriate responses. The following list of indicators have been clustered and matched with their corresponding Findings:

1. Tech Encroachment
2. Augmented Predation
3. Digital Divides
4. Civic Tech Renaissance
5. Municipal Innovation Reboot
6. Grassroots Resilience

This section will provide detailed flags for each cluster, as well as examples highlighted by participants. But these indicators are only a starting place, being neither complete nor definitive. Any city committed to monitoring threat futures and acting before they manifest should use the following as a directional beginning.

How (and Where) to Look

Tracking the flags below for potential threats-in-progress demands continuous scanning for new developments across municipal governance, technology. While this might seem daunting, many can be detected through diligently monitoring publicly-available sources such as new laws and regulations; product announcements; job postings; real estate listings; and public opinion surveys, to name just a few.

Other flags may be more difficult to follow, as they might involve secret negotiations, private wrangling over standards, and scamming victims shamed into silence. Spotting these indicators will require coordinating with partners inside municipal governments and in cities across the country, along with closely watching developments in technology and beyond.

These capabilities require time and effort to develop, but the investment is worth it, as typically the earlier a flag or series of flags is spotted, the lower the risk and the greater the resources a city has to bring to bear on them.

Tech Encroachment

Big Tech's unchecked expansion into cities creates new frontiers for data harvesting and algorithmic control, leaving vulnerable residents exposed to unprecedented risks. AR and especially AIR create impenetrable personal filter bubbles fragmenting reality beyond repair. Watch for new product announcements, procurements, and changes in how people use public space.

1 Big Tech expansion into urban infrastructure and public spaces

- **Big Tech interest in urban tech:** Track patent filings and product announcements from major tech companies for urban-focused AR technologies. Pay close attention to new "free tools"
- **Exclusive management contracts:** Monitor city council meetings and public records for discussions or approvals of AR-related procurement
- **Digital twin monopolies:** Observe changes in municipal budgets allocating funds to digital twin projects
- **Biometric data harvesting:** Follow privacy watchdog organizations for reports on biometric data collection practices

2 Inadequate regulation and oversight of AR and AIR

- **Follow the money:** Monitor investor activity related to funding geo-spatial AR startups. Local incubators/accelerators may be AR "canaries"
- **Accelerated AR rollouts:** Follow news outlets for announcements of major AR deployments in cities
- **Public indifference:** Observe public reactions and media coverage of AR-related incidents or controversies
- **Municipal tech brain-drain:** Track job postings in municipal governments for tech-related positions
- **Regulatory lag:** Monitor legislative bodies for proposed bills related to AR regulation

3 Increasing gentrification and social fragmentation

- **Urban AR ethnography:** Track academic studies on the social impacts of AR adoption in urban areas
- **AR-gated communities:** Analyze real estate trends in areas with significant AR infrastructure
- **Augmented gentrification:** Monitor social media for discussions about exclusive AR experiences
- **Expanded filter bubbles:** Observe changes in community engagement and local politics in AR-heavy neighborhoods

4 Overreliance on AI-driven decision-making

- **AI companion ubiquity:** Monitor app store trends for popular AI assistants and AR companions
- **AR-mediated daily choices:** Track usage statistics of AR-based navigation and recommendation services
- **Social life of augmented spaces:** Observe changes in social behavior and interpersonal interactions in public spaces
- **Algorithmic urban governance:** Follow urban planning news for instances of AI involvement in decision-making processes

5 Privatization and fragmentation of urban information ecosystems

- **Big Tech makes its move:** Monitor the launch of competing AR platforms in cities
- **Reality layer conflicts:** Follow tech blogs and forums for user reports of conflicting AR information layers
- **Budget crunch:** Monitor cash-strapped municipalities handing civic API-enabled "lower priority" essential information layers to third parties
- **Open data decline:** Observe trends in funding and support for open data initiatives
- **Essential service paywalls:** Track changes in how cities disseminate public information

Augmented Predation

As AR and AIR proliferate, cities become hunting grounds for tech-savvy criminals, exposing residents to sophisticated scams, harassment, and abuse across realities. Municipal networks and infrastructure are attacked and hijacked while law enforcement struggles to understand this new jurisdiction, let alone investigate and prosecute the perpetrators. Follow reports of novel hacks and fraud and identify points of vulnerability.

1 Evolution of traditional scams leveraging AR and AIR technologies

- **AR-enhanced catfishing:** Track news and social media for reports of AR-related impersonation
- **Spatial "pig butchering:"** Watch for place-based scams targeting individuals in specific locations
- **Elderly-focused AR scams:** Follow reports of criminals targeting seniors
- **Deepfake impersonation scams:** Record instances of criminals using AIR to mimic trusted figures
- **gRIFters:** Monitor instances of disgruntled former employees (e.g., layoffs or "reduction in force") accessing or selling access to systems that fail to revoke access privileges

2 Sensory manipulation and misinformation in urban spaces

- **Graffiti attacks:** Notice instances of malicious AR overlays defacing or misrepresenting public spaces
- **Manipulated AR navigation:** Track reports of tampered AR wayfinding leading users into traps or scams
- **False emergency alerts:** Monitor cases of fake crisis notifications causing panic in AR-enabled urban areas
- **Angerbots:** track changes to public info layers for light touch editing that generates sentiment shifts

3 Exploitation of AR infrastructure vulnerabilities

- **Hijacked AR advertisements:** Observe cases of legitimate AR advertising hijacked by malicious actors
- **Identity theft:** Follow reports of personal data theft through compromised AR devices
- **Network breaches:** Look for successful attacks on city-wide AR systems
- **Tech debt:** Outdated layers may accumulate, creating cascading vulnerabilities. Monitor civic hacks via unmaintained defunct company tech

4 Challenges in law enforcement and jurisdiction

- **Cross-jurisdictional crimes:** Monitor if, how, and by whom AR-enabled crimes are investigated
- **Gray reporting:** Monitor how, where and by whom AR-enabled crimes are reported
- **AR evidence admissibility debates:** Follow legal discourse on the validity of AR-based evidence in court cases
- **Formation of specialized crime units:** Watch for dedicated teams within law enforcement to handle AR-specific offenses

Digital Divides

AR amplifies existing inequalities, creating a patchwork of augmented haves and have-nots across cities, with rapidly-changing neighborhoods bearing the brunt of this upheaval. Local services and civic engagement withers as new arrivals opt-in to private platforms overlaid on public space. Look for signs of fraying social fabric, patterns of disinvestment, and corporate efforts at gentrification.

1 Erosion of local community and services

- **Decline in local services:** Monitor falling foot traffic and rising vacancy rates in commercial districts
- **Shift to virtual community spaces:** Observe any declines in physical community gathering spaces
- **Weakening of neighborhood identity:** Watch for diminishing participation in local cultural events

2 Digital disparities and disinvestment

- **Uneven AR infrastructure deployment:** Track disparities in AR service quality and availability across different neighborhoods
- **Emergence of AR deserts:** Map areas with limited or no AR services — including areas with suspiciously low AR services (where select services may be intentionally hidden)
- **Digital gentrification:** Analyze property values in AR-rich areas, coupled with recent demographic trends

3 Changing civic engagement patterns

- **Declining traditional civic participation:** Track reduced attendance at local government meetings
- **Regulation of digital protests:** Note any ordinances governing AR-based protests, along with legal challenges to free speech in AR games and platforms
- **Rise of AR-based civic platforms:** Watch for the emergence of AR tools designed for community feedback and decision-making

4 Social isolation and mental health concerns

- **Intensified social disconnection:** Track reports of rising loneliness and social anxiety
- **Tech-induced paranoia and distrust:** Monitor cases of technology-related anxiety or paranoia, and community health initiatives addressing the same
- **Neglect of physical well-being:** Look for health issues tied to excessive AR use, and corresponding public health campaigns promoting digital hygiene

5 Information integrity and misinformation

- **Proliferation of localized misinformation:** Be on the lookout for neighborhood-specific misinformation, and what role if any AR plays in it
- **Manipulation of shared realities:** Watch for instances of AR vandalism or unauthorized alterations of public spaces
- **Challenges to local heritage:** Observe debates over the accuracy of AR-based local history and culture

6 Shifting economic and real estate dynamics

- **AR-driven volatility:** Monitor any fluctuations in property values based on AR amenities and watch for marketing strategies emphasizing the same
- **Corporate land grabs:** Track any tech companies acquiring property or AR rights in strategic urban locations; follow debates over property digital rights
- **Transformation of local labor markets:** Follow changes in job roles and skills facilitated by AR

Civic Tech Renaissance

Cities leverage AR as the public face of a comprehensive urban tech strategy, fostering data-informed governance, responsive public services, and collaborative citizen engagement. Education and tourism become early use cases. Monitor developments in cybersecurity and safety, including mental health.

1 Enhanced security and trust in AR systems

- **Security-first AR development:** Monitor AR standards development for security, privacy, and safety enhancements
- **Cyber-resilient urban infrastructure:** Learn from cities implementing cybersecurity for AR-enabled public services

2 Inclusive XR for education

- **XR for special cases:** Study XR environments tailored for students with diverse learning requirements
- **Edtech investment:** Track public and private investment in XR-enhanced educational technologies
- **AI-powered personalized learning:** Follow academic publications and policy discussions on XR/AI integration in classrooms

3 Addressing technological impacts on mental health

- **Digital well-being initiatives:** Monitor the launch of city-led programs to combat social isolation exacerbated by technology
- **AR-enhanced mental health services:** Observe trends in mental health research and interventions related to XR use
- **Tech-life balance policies:** Look for guidelines for healthy XR use in schools and workplaces

4 Personalized and AI-enhanced urban experiences

- **Gamified civic engagement:** Check app stores and tech news for new AR applications focused on urban exploration and civic engagement
- **AI companions for urban navigation:** Watch for adoption of intelligent AR agents to assist with daily city life
- **Customized AR city tours:** Track changes in urban tourism offerings and the integration of AR experiences

Municipal Innovation Reboot

Cities overhaul their organizational structures and cultivate tech-savvy leadership to proactively manage emerging technologies, ensuring public interests are protected in the augmented urban landscape. Watch for new government positions, promising pilots, and the incorporation of AR into planning and outreach.

1 AR influence on public space and services

- **Gaming collaborations:** Note any partnerships between cities and AR gaming companies affecting public space use
- **Legal precedents:** Monitor court dockets and municipal legal briefings for cases involving AR in public spaces

2 Emergence of AR partnerships and urban pilots

- **Startups pitching cities:** Monitor city agencies and innovation office announcements for inbound proposals
- **Pilot programs:** Track municipal websites and tech news for launches of AR-enhanced urban services

3 Legislative and regulatory adaptation to AR

- **Local and state law changes:** Check city council agendas and municipal code updates for AR-related developments, as well as proposed state laws meant to circumvent their authority
- **Data disclosure norms:** Monitor city data portals and tech company reports for new AR data sharing practices
- **Financial engagement:** Track municipal bond issuances and public-private partnerships related to AR urban development

4 Implementation of XR in urban planning and engagement

- **Academic research:** Follow urban planning and public policy journals for studies on AR in civic engagement
- **Hyperrealistic AR tools:** Look for urban planning department announcements about AR use in public consultations
- **XR in emergency preparedness:** Watch for emergency management updates on XR-enhanced disaster response simulations

5 Creation of new urban departments and specialized roles

- **New positions:** Watch for job postings and press releases announcing roles such as chief public realm officers or XR coordinators
- **Cross-agency initiatives:** Follow city organizational changes for the formation of XR task forces or offices of the digital public realm

Grassroots Resilience

AR catalyzes collaborative urban development, transforming areas in flux into incubators for community-driven innovation and resilience. New visualization and simulation tools empower city agencies, while residents take AR into their own hands. Keep an eye on changing notions of civic engagement and community.

1 AR-enhanced civic engagement

- **Digital civic literacy programs:** Watch for educational initiatives using AR to teach residents about local governance and urban systems
- **Virtual town halls:** Monitor the emergence of AR-powered community meetings and decision-making processes
- **Collaborative urban design:** Track the adoption of AR tools allowing residents to visualize and contribute to urban development projects
- **Youth engagement:** Note pilot programs engaging youth populations with civic AR via internships, job programs and civil service

2 Advanced urban simulation and forecasting

- **AI-powered city modeling:** Monitor cities adopting AI-driven simulation tools for urban planning and management
- **Predictive resource allocation:** Look for cities using AI forecasts to proactively distribute resources to vulnerable neighborhoods
- **Real-time urban alerts:** Watch for the deployment of AR-based alert and rerouting systems that provide citizens with updates and enhanced information on traffic, weather, and emergencies

3 AR-driven urban adaptation

- **Climate resilience visualization:** Monitor the use of AR to demonstrate climate change impacts and adaptation strategies at a neighborhood level
- **AR-guided resource access:** Look for AR applications helping residents locate and access community resources, especially in underserved areas
- **Adaptive urban infrastructure:** Watch for cities using AR to create flexible, multi-use public spaces that can be reprogrammed on the fly

4 Evolving notions of community and belonging

- **Interest-based communities:** Observe the formation of AR-enabled communities transcending traditional geographic boundaries
- **AR-enhanced cultural preservation:** Look for projects using AR to maintain and celebrate local heritage in changing neighborhoods
- **Cross-cultural AR initiatives:** Watch for AR applications designed to bridge divides between diverse community groups

5 Community-driven AR layers

- **Open-source tools:** Look for the development and adoption of community-created AR platforms for local information sharing
- **Digital land trusts:** Monitor the formation of organizations dedicated to preserving and managing community-created AR content
- **AR activism:** Watch for instances of AR being used to highlight local issues, protest developments, or present alternative urban narratives

6 Balancing physical and digital urban realms

- **Zoning policies:** Track the development of municipal and state guidelines governing AR use
- **Digital rights initiatives:** Monitor discussions and policies addressing residents' rights in augmented urban environments
- **Physical-digital integration projects:** Look for urban development projects that seamlessly blend AR capabilities into the built environment

6

Gates

Proceeding from the questions raised by the Findings ("what's the worst that can happen?") and the Flags ("how would we know?"), the Gates aim to answer, "what should we do about it?" The following list of actions to be taken in the event of a theat once again correspond to their matching Flags and Finding, with an eye toward helping to mitigate, disrupt, and/or recover from the fully realized threat at hand. (The number and order of recommended actions does not necessarily imply importance or priority.)

Governments, organizations, and individuals committed to intercepting threats should use this list as a guide and a starting point for building the capacity and partnerships needed to formulate a coherent response. New alliances within city departments and across agencies, cities, and sectors will need to consider how best to implement these recommendations individually and collectively, and begin exploring potential avenues for collaboration.

Tech Encroachment

To navigate the rapid evolution of AR and AIR, cities must establish robust municipal oversight, foster responsible public-private partnerships, enhance local government capacity, promote digital literacy, and ensure equitable access to new technologies. As tech firms increasingly seek to overlay their services and experiences onto public spaces, cities must proactively develop policies, build expertise, engage with communities to maintain control over the digital public realm, protect vulnerable populations, and leverage AR for the public good.

1 Establish municipal oversight and regulation of AR experiences

- **Run AR pilots:** Conduct controlled trials of AR applications in public spaces to inform policy decisions and identify potential issues

- **Develop clear expectations and ethical codes:** Collaborate with industry to create a comprehensive set of guidelines for responsible AR use in urban environments

- **Implement licensing for AR marketing:** Require companies to obtain city licenses for AR advertising in public spaces, similar to billboard regulations

- **Create a Bureau of Public Digital Engagement:** Establish a dedicated municipal office to oversee AR deployment and usage in public spaces

2 Foster public-private partnerships for responsible AR development

- **Create policy innovation testbeds:** Partner with tech companies to establish controlled environments for testing new AR technologies and policies

- **Encourage self-regulation:** Work with legitimate tourist and marketing entities to develop industry-led standards for AR content in public spaces

- **Form security working groups:** Collaborate with big tech and government agencies to monitor and prevent potential harms

3 Enhance municipal capacity for AR governance

- **Integrate threatcasting skills:** Develop the ability within public agencies to assess potential threats

- **Provide ongoing skills training:** Deliver regular training to municipal staff on new technologies and their implications

- **Develop budgeting expertise:** Train budget office staff to understand and allocate resources for AR-related initiatives and oversight

4 Promote digital literacy and public awareness

- **Launch education campaigns:** Develop programs to increase public understanding of AR technologies and their implications

- **Enhance school curricula:** Work with educational institutions to integrate media and digital literacy into school programs

- **Organize community engagement events:** Host public forums and workshops to discuss new technologies and gather community input

- **Create public programming:** Develop AR experiences focused on shared community benefits rather than individual use cases

5 Ensure equitable access and protection in AR-enhanced spaces

- **Develop rules for virtual public spaces:** Create guidelines for partnerships and user behavior in AR-enhanced public areas

- **Implement protections for vulnerable populations:** Develop specific policies to safeguard children, elderly, and other at-risk groups in AR environments

- **Update built environment standards:** Work with organizations like AIA to ensure physical spaces are designed to accommodate AR technologies

Augmented Predation

As AR becomes prevalent, it will create new vectors for crime, exploitation, and harm transcending traditional jurisdictions. The following actions are pivotal for cities to protect residents, maintain the integrity of public spaces, and ensure the potential benefits of AR aren't overshadowed by its capacity for abuse. This means establishing protected spaces, fostering collaborative safety initiatives, safeguarding vulnerable populations, enhancing data security, combating digital misinformation, and bolstering law enforcement capabilities.

1 Establish "AR-free" zones and protect physical spaces

- **Implement zones:** Designate public areas where AR use is restricted to preserve physical space integrity
- **Enforce the right to opt out of AR:** Develop policies allowing individuals to opt out of AR experiences
- **Maintain physical information sources:** Ensure critical public information remains available in physical media for verification and accessibility

2 Foster public-private partnerships for AR safety

- **Collaborate with tech companies:** Work with AR developers to implement built-in safety features and reporting mechanisms
- **Engage community organizations:** Partner with local groups to educate residents about AR risks and protective measures
- **Create an AR safety task force:** Establish a multi-stakeholder group to continuously assess and address emerging AR-related threats

3 Protect vulnerable communities from tech exploitation

- **Maintain social contact with at-risk groups:** Establish programs to ensure vulnerable communities are not isolated or exploited through technology
- **Support community health and wellness:** Engage state/local health agencies and community-based organizations to address tech-related health concerns

4 Enhance data security and identity protection

- **Create responsible data rules:** Develop guidelines for public and private entities to protect personal data in AR environments
- **Establish clear data ownership rights:** Lobby Congress and the FCC to define ownership and rights related to digital and sensing data
- **Design a consistent civic labeling system:** Identify city-validated AR layers with clear design and consistent language

5 Combat AR-enabled hate speech and deception

- **Adapt hate speech laws for AR:** Update existing regulations to address hate speech in augmented environments
- **Develop AR content moderation standards:** Create guidelines for moderating AR content to prevent the spread of misinformation and malicious content
- **Deploy AI-powered deception detection:** Implement statistical AI systems to identify potential AR-based deceptions and scams

6 Enhance law enforcement capabilities for AR-related crimes

- **Create 311 for AR:** Establish a single point of contact for reporting AR-related complaints and violations
- **Provide specialized training:** Educate law enforcement on AR technologies and associated criminal activities
- **Develop AR forensics tools:** Invest in technologies to collect and analyze evidence from AR-related crimes

Digital Divides

As AR begins reshaping urban landscapes, it risks amplifying existing inequalities and creating new forms of digital exclusion. To address this exacerbation of social and economic disparities, cities must implement a multifaceted strategy promoting equity, accessibility, and community empowerment. This involves establishing clear regulatory frameworks, fostering local engagement, ensuring equitable access to AR-enhanced services, mitigating digital segregation, and preserving neighborhood identity.

1 Establish public-private agreements for AR regulation and standards

- **Develop neighborhood-specific AR guidelines:** Create localized regulations addressing the unique needs and challenges of different areas
- **Implement AR zoning policies:** Establish zoning rules governing the deployment and use of AR in different urban zones
- **Create AR impact assessment frameworks:** Develop tools to evaluate the potential effects of AR implementations on neighborhood dynamics

2 Empower local communities and workers

- **Facilitate grassroots neighborhood coordination:** Support local initiatives for safe and equitable AR implementation
- **Establish neighborhood AR advisory boards:** Create community-led groups to provide input on AR deployments and policies

3 Mitigate digital divides and "veil-ification"

- **Implement equity programs:** Develop initiatives ensuring equal access to AR technologies across neighborhoods
- **Create digital public spaces:** Establish AR-enabled public areas accessible to all residents regardless of economic status
- **Monitor and address AR-driven gentrification:** Develop policies to mitigate displacement caused by AR-enhanced property value increases

4 Protect neighborhood identity and cohesion

- **Preserve local cultural heritage:** Develop AR experiences highlighting and protecting neighborhood history and character
- **Regulate virtual POPS:** Establish guidelines for privately owned public spaces in AR to ensure they serve community interests
- **Create community engagement tools:** Develop platforms using AR to enhance local democracy and decision-making processes

Civic Tech Renaissance

AR also offers cities unprecedented opportunities to enhance urban services and citizen interaction. To do so, they must proactively shape the implementation of new technologies to align with public interests and values. This will require establishing robust data infrastructure, enhancing regulatory agility, reimagining public spaces, promoting ethical tech development, and creating new avenues for civic participation.

1 Establish local data collection and sharing infrastructure

- **Implement open data standards:** Adopt and promote open standards for AR data to facilitate interoperability and transparency

- **Create data sharing agreements:** Develop comprehensive agreements between corporate entities and city legal departments to ensure responsible data sharing

- **Enable local sensor placement:** Work with municipal CTOs and relevant agencies (e.g. DOB, DOT, Parks) to strategically deploy sensors for data collection

2 Enhance regulatory responsiveness

- **Generate adaptive regulations:** Develop processes for infrastructure agencies and regulators to create and modify codes based on AI-gathered data

- **Establish policy task forces:** Form dedicated groups to continuously assess and update AR-related policies and regulations

- **Create sandboxes:** Develop controlled environments for testing new AR applications and their potential impacts before wider deployment

- **Deploy AI for urban analysis:** Create and implement AI agents to monitor and analyze urban environments for potential risks and opportunities

3 Reimagine public spaces for the AR era

- **Rethink playgrounds:** Redesign public spaces to incorporate AR elements encouraging social interaction and physical activity

- **Develop AR-enhanced educational spaces:** Create educational environments blending physical and digital elements to support creativity, exploration, and social skill development

- **Establish AR commons:** Design freely-read/writable digital public spaces

4 Promote ethical and inclusive AR development

- **Implement AR ethics boards:** Establish independent committees to review ethical considerations of AR deployments

- **Develop inclusive design guidelines:** Create and enforce standards ensuring AR experiences are accessible to all, regardless of ability or socioeconomic status

- **Support AR literacy programs:** Teach residents how to understand and use AR

5 Leverage AR for enhanced civic engagement

- **Create civic participation tools:** Develop applications using AR to facilitate public input on urban planning and policy decisions

- **Implement public services:** Build APIs for accessing municipal services, making government more accessible and responsive

Municipal Innovation Reboot

As the pace of technological change accelerates, local governments must evolve to become more agile, forward-thinking, and technologically adept. This will involve enhancing digital competencies, developing adaptive regulatory frameworks, implementing cross-departmental strategies, creating new roles and departments, fostering experimentation, and collaborating with other municipalities. The following actions are necessary for cities to transform their operations, build internal capacity, and create an environment conducive to responsible innovation.

1 Enhance municipal digital capabilities

- **Ensure equitable access:** Implement programs to make broadband and AR devices accessible to all residents
- **Build internal expertise:** Identify and train staff with technological backgrounds for digital public management roles

2 Develop regulatory frameworks for AR

- **Adapt existing regulations:** Explore how current outdoor advertising rules can apply to AR management
- **Create AR policy task forces:** Form dedicated groups to assess and update AR-related policies

3 Implement cross-departmental AR strategies

- **Appoint foresight officers:** Create roles within each city agency to watch for and explore the implications of nascent technologies
- **Establish cross-departmental liaisons:** Identify natural facilitators to coordinate between departments
- **Develop best practices:** Study successful municipal innovation arms and their interactions with each agency

4 Create new urban departments and roles

- **Redefine existing roles:** Explore whether CTO and CIO roles should incorporate AR oversight
- **Appoint specialized officers:** Create roles such as chief public realm officers to fold AR into oversight of both physical and digital public spaces
- **Establish new departments:** Design a cross-cutting agency to manage the impacts of emerging technologies and business models

5 Create spaces for experimentation and community discourse

- **Establish pilot zones:** Designate areas in the city for testing AR applications and gathering community feedback
- **Develop urban labs:** Create structured environments for public-private partnerships in AR innovation
- **Foster public-private partnerships:** Collaborate with startups, nonprofits, and philanthropies to facilitate municipal software development

6 Foster inter-city collaboration and knowledge sharing

- **Engage with mayoral organizations:** Work with bodies like the U.S. Conference of Mayors to facilitate city-to-city collaboration
- **Create case studies:** Document successful pilots and regulatory efforts for shared learning
- **Develop leadership programs:** Implement cross-training initiatives for city executives in digital skills and disruption response

Grassroots Resilience

AR and AIR offer unprecedented abilities for residents to co-create their communities. This includes enhancing urban navigation and emergency response, leveraging AR for climate resilience, democratizing urban planning processes, developing civic AR standards, preserving cultural heritage, and fostering community-driven innovation. The following actions are key to creating a framework where AR becomes a tool for collective visioning, problem-solving, and community building.

1 Enhance urban navigation and emergency response

- **Explore AR interfaces for urban wayfinding:** Work with civic agencies to develop AR-based navigation
- **Integrate AR with transit apps:** Invest in pilots combining transit data with AR for seamless mobility wayfinding
- **Implement emergency alerts:** Collaborate with emergency services to create AR-based alert systems for rapid response

2 Leverage AR for urban resilience

- **Develop climate visualization tools:** Create AR applications showing local climate change impacts and adaptation strategies
- **Implement resource mapping:** Use AR to help residents locate and access community resources, especially in underserved areas
- **Create AR-enhanced emergency preparedness drills:** Design immersive AR scenarios for community disaster response training

3 Democratize urban planning

- **Train officials in AR outreach:** Provide workshops for public servants on using AR tools for community engagement
- **Implement AR for visualizing urban projects:** Develop processes for citizens to use AR in consulting on new memorials, parks, and street redesigns
- **Run co-creation workshops:** Organize sessions where AI and AR are used to visualize community ideas
- **Open historical and cultural data:** Collaborate with cultural organizations to make more heritage information available for AR applications
- **Expand place-based data collection:** Task city departments with gathering and sharing data on urban ecosystems, including trees and non-human biological life

4 Develop civic AR layers and standards

- **Initiate discussions about civic visual positioning systems:** Engage with tech companies about creating dedicated AR for civic information
- **Support open standards:** Partner with organizations such as the Metaverse Standards Forum to promote platform-agnostic AR solutions
- **Understand AR tourism impacts:** Analyze neighborhoods affected by AR-driven tourism to inform policy
- **Consider "graceful degradation":** Ensure layer-dependent communities fail safely in the event of catastrophic infrastructure failure

5 Preserve cultural heritage

- **Designate cultural zones:** Establish pilot areas to test expansion of cultural landmarks through AR
- **Partner for AR landmarks:** Work with nonprofits to create persistent AR versions of statues, murals, and other cultural sites
- **Explore digital land trusts:** Investigate methods to capture and preserve value from AR content for community benefit

6 Foster community-driven AR development

- **Create sandboxes:** Set up zones where communities can freely experiment with AR applications
- **Support literacy programs:** Develop educational initiatives ensuring residents can effectively use and create AR content
- **Establish guidelines:** Create community-driven standards for responsible AR use in public spaces

7

Recommendations

In addition to the Findings, Flags, and Gates surfaced through threatcasting, the following recommendations represent a synthesis of insights gleaned from field research and site visits along with dozens of conversations and interviews with the project's cohort of current- and former public officials. Their expertise and experience yielded the following prioritized action list, ranging from immediately implementable steps to more ambitious, long-term initiatives.

By following these recommendations, cities can not only respond to threats and opportunities posed by external forces, but also shape how and where AR and AIR might serve the public interest, enhance quality of life for all residents, and align with broader urban planning and development goals.

It's important to note that while these provide a starting point, each city will need to adapt them to their specific context, resources, and priorities. The rapidly evolving nature of AR (and AI) also means that these recommendations should be regularly revisited and updated to remain relevant and effective.

1

Create an AR advisory board

Recruit a diverse panel of experts, stakeholders, and residents to guide urban AR policy development and implementation.

Just as threatcasting offers a set of break-glass-in-case-of-emergency plans and actions, establishing a permanent advisory board — not just for AR, but for *all* emerging technologies of interest — is an obvious first step. (In fact, the creation of an "Emerging Technology Advisory Panel" was also a central recommendation of the Urban Tech Hub's *Rebooting NYC* report.[132]) This body should serve as a critical link between city officials, private actors, and residents for safeguarding the development of AR in the public's interest.

The board should include a diverse range of roles and perspectives, including staff from relevant city agencies, urban designers, technology experts and AR developers, privacy and security specialists, representatives of local business interests and cultural institutions, community advocates, accessibility experts, and legal experts.

Their responsibilities would entail reconnoitering the current state-of-the-art through site visits and demonstrations of proposed projects and deployments, along with assessing the impacts of AR on public spaces and quality-of-life, advising on privacy and security concerns, and developing AR policy recommendations. Ideally housed within the mayor's or city manager's office, the board would work closely, albeit informally, with public officials in planning, transportation, and parks and recreation — to name just a few — to monitor and integrate AR considerations into broader city initiatives.

By establishing this board, cities can ensure they have a dedicated group of experts and stakeholders actively considering the implications of AR technologies and guiding their integration into urban life in a thoughtful, equitable manner.

2

Develop AR zoning rules

Draft virtual zoning guidelines for governing where and how AR operates.

Cities have historically struggled to find a balance between punitively regulating nascent technologies and failing to rein in destructively disruptive ones until it's too late — the urban version of the Collingridge dilemma. While stipulating strict oversight of AR at this stage would likely be overkill and a waste of municipal resources, crafting a coherent legal framework sooner is preferable to hastily retrofitting ill-suited ordinances later — and being struck down by the courts. While current legal precedent regards AR as a form of free speech, cities have room to maneuver when it comes to public safety and private property. Now is the time to enlist companies, standards bodies, practitioners, legal experts, and others to develop thoughtful regulation together.

AR zoning should broadly specify guidelines for the type, size, density, and behavior of content in a given setting, which may range from maximal permissions in iconic destinations (e.g. Time Square) to more restraint in residential neighborhoods and parks. It should also establish content categories (e.g. commercial, informational, artistic, navigational) and designate which are permitted or prohibited where, such as limiting commercial deployments near schools or working with publishers to pre-emptively geofence culturally significant or sensitive areas (such as removing PokéStops from Ground Zero).

Besides implementing common-sense (and legally enforceable) restrictions, cities should also encourage

developers and artists by alternately designating "AR commons" prioritizing public art and other non-commercial uses, and pilot zones for testing concepts with fewer restrictions. Data and observations collected from these pilots — such as changes in foot traffic and crowd behavior — would then be used to inform future regulations.

Absent legislation, these guidelines will remain largely voluntary, with compliance driven by a combination of genuine good faith and a desire to avoid lawsuits. Cities will need to implement processes for periodically reviewing and updating AR zoning to keep pace with both legal developments and technological advancements.

3

Launch pilot sites and programs

Recruit private and local partners to create and populate AR testbeds.

Key to regulating new technologies is knowing when — and where — to grant them permission before they need to beg forgiveness. Pilot sites have proven to be invaluable partners for testing and validating urban tech in self-contained environments before being set loose in the city-at-large. The Brooklyn Navy Yard, for instance, is a popular destination for mobility startups thanks to its gated access and privately-controlled streets. Organizing and formalizing New York City's archipelago of ad hoc pilot sites into a more responsive network with streamlined permissions is a central plank in the *Pilot: New York City* proposal recently published by the Urban Tech Hub at Cornell Tech and New York City Economic Development Corporation.[133]

As part of such efforts, cities should establish their own AR "innovation zones" — designated urban areas where AR and AIR can be tested safely under a collaborative governance model defined by the city, startups, and pilot sites alike. These zones would simultaneously serve as technological sandboxes and as proving grounds for municipal policies, signage, infrastructure, and enforcement.

The siting and management of such zones should vary, ranging from carefully-chosen parks to suitable landmarks, and from POPs to non-profit- and city-managed assets such as Cornell Tech's own campus on New York City's Roosevelt Island, which provided the backdrop of an audio AR pilot exercise in November 2024, for example. Business improvement districts (BIDs) are also likely to be natural allies, as highly-trafficked commercial districts will be prime targets for AR overlays on private storefronts and public spaces.

Wherever their location, these zones should be overseen by local partners participating in joint decisions on project approvals, guidelines, and success metrics. The pilots themselves should be designed in turn with private sector participants to define those metrics and create clear milestones for scaling successful projects city-wide in line with AR zoning guidelines. This includes plans for long-term maintenance, updates, and integration with existing city systems where applicable.

For their own part, cities should use these zones as living labs for learning how to implement and manage AR along with specifying policies for personal data collection and retention, etc., under real-world conditions (see Recommendation #7). They are also opportunities to promote the development of shared AR infrastructure such as open source visual positioning systems (see Recommendation #4), standardized signage and wayfinding (e.g. DTPR), and establishing methods for reporting and enforcing complaints and violations.

Finally, these zones should also serve as sites for training and mentorship within the local AR ecosystem. These activities might start as community-building events and challenges — Snap executives, for instance, proposed hosting municipal "Lens-a-thons" to crowdsource ideas — before gradually evolving into more structured job creation programs.

133 https://urban.tech.cornell.edu/pilotnyc/

4

Establish a public AR registry

Build a database and/or civic visual positioning system for monitoring AR

Just as Google, Apple, Waze, and others created proprietary maps and used them to direct users through their own reflections of reality, so will Google, Apple, Meta, and others use AR and AIR to build their own increasingly detailed digital twins of cities. How will governments track their contents, accuracy, and safety? It's unreasonable to expect city staff to patrol these mirror worlds, just as it's unrealistic to expect tech competitors to grant regulators unrestricted access or agree on a single standard.

For these reasons, cities should create their own AR registry acting as a "single source of truth" for tracking and managing content touching the public realm. This system would provide transparency, accountability, and a means for coordination between and within city departments as well as external stakeholders.

At a minimum, the registry should consist of a comprehensive database logging such details as each entry's precise location (i.e. latitude/longitude coordinates), visual positioning system, creator/owner, duration, intension, and classification according to the categories defined for AR zoning purposes (i.e. commercial, educational, artistic, navigational, civic, etc.). Accessed via a straightforward, streamlined Web-based and mobile portal, registration would include automated approvals for content conforming to zoning, with additional reviews flagged for sensitive and high-traffic areas. Stakeholders would receive automatic notifications of impending expiration and removal to assist with compliance and enable spot-checking.

Once this database is in place, cities should connect additional resources such as land records, event permits, and construction schedules to pre-empt

potential conflicts and coordinate virtual activations with real-world activities. Incorporating community feedback and reporting of inappropriate or criminal content is also important, with automated alerts sent to relevant city staff.

A next step would be to implement a public, open source visual positioning system of cities' own — not as a singular urban "metaverse," but as ground truth for all content placed across competing maps and systems. This also presents cities with an opportunity to implement a base-layer reality from which their content can be propagated across realities.

Finally, the registry should report on AR content placement and distribution, engagement patterns, and other trends mapped against neighborhood foot traffic, retail sales, and related metrics to inform city planning and policy decisions. It should also maintain a historic record of past content and activations to create records for future research, cultural preservation, and legal disputes.

5

Support AR civic art and education projects

Collaborate with artists and non-profits to experiment and enhance the public realm.

As a first step in creating their own AR content, cities should work with cultural institutions to commission public art and education programs in an effort to engage citizens and augment the public realm. AR's unique ability to extend and animate physical objects or visualize artifacts and events lost to time has been repeatedly demonstrated by museums, artists, and activists. Public art also offers cities an opportunity to learn-by-doing while building external partnerships and internal capacity.

To that end, departments whose remits might include parks, landmarks, design, or preservation should work closely with non-profits such as New York's Design Trust for Public Space and parks conservancies to commission original works of AR. These might entail adding virtual dimensions to physical installations, creating digital twins of existing monuments, or providing context and alternative interpretations of contested historical sites.

From an education perspective, AR projects and installations highlighting stark differences between past, present, and future — whether vanished communities of color or the effects of sea-level rise — have proven particularly powerful. Walking tours, scavenger hunts, and other gamification tactics have also demonstrated their utility in engaging students and the public.

More important, cities should treat these initial forays as learning opportunities. This means regularly assessing AR's effectiveness in increasing civic knowledge and participation by collecting data on interaction patterns. Through such experiments, cities can begin to develop their own guidelines on appropriate uses, intellectual property, managing physical/virtual conflicts, and how to incorporate AR into their regular operations. This is also a chance to test public feedback mechanisms and design pathways for residents to create and submit their own public art.

Given sufficient success, cities should explore carrying these experiments forward with a more systematic approach for commissioning works from local and international artists. Funding mechanisms might include sponsorships from technology companies, real estate developers, and philanthropies. Finally, cities should ensure responsible preservation of digital works through comprehensive digital archives, maintaining these assets for cultural historians.

6

Test tools and techniques for prototyping and engagement

Explore how city agencies can harness AR's unique capabilities.

If seeing truly is believing, then AR poses a unique opportunity for cities to literally meet skeptical constituents where they are when presenting complex and controversial plans for new infrastructure and redevelopment. By offering residents the ability to visualize projects and proposals *in situ*, AR could transform how communities understand and engage with proposed changes to the built environment.

To realize this, cities should pilot platform-agnostic tools capable of rendering 3D models of proposed and existing buildings and infrastructure in context. These should include the ability to integrate data from public sources such as building permits, zoning, and tax records, and employ broadly-accessible touchpoints such as WebXR for mobile browser-based viewing, physical wayfinding and signage, and compatibility with multiple visual positioning systems.

The models themselves should not only render the mass and siting of projects, but also impacts on tree cover, daylighting, and open space. Descriptions of proposed benefits such as affordable housing or reduced carbon emissions could be included, along with depictions of multiple options under consideration. Most important, they should invite direct input, broadening the scope of review. By expanding engagement beyond sometimes contentious in-person meetings, cities can reach a broader audience and collect more representative feedback. Analysis of this data may better inform planning decisions and identify community priorities beyond those of a handful of voices.

Implementing such programs effectively will not only require financial and technical investments in tools and integration, but also training in both the technology and outreach to traditionally underrepresented residents. They will also require partnering with local universities or other independent researchers to evaluate AR's impacts on civic engagement and verify its effectiveness.

Draft data privacy ordinances

Pass laws governing the collection, use, and storage of data generated from AR in public spaces.

While state legislatures and federal agencies scramble to regulate AI and challenge Big Tech monopolies, AR has been overlooked by regulators. This is a mistake. Given that many of the same platforms behind the data extraction model of social media are now applying the same techniques to physical space, it's incumbent on local governments to establish safeguards around tracking, profiling, and targeting in the public realm.

To that end, cities should establish clear legal frameworks to protect residents' privacy in line with, and in addition to federal policies. These ordinances should create comprehensive guidelines for how AR-generated data in public spaces is collected, used, stored, and shared.

The foundation of these ordinances should be explicit limitations on data collection and use. Cities should specify precisely what types of personal data AR platforms may collect in public spaces, with particularly strict controls on biometric data — including a ban on facial recognition. Providers must clearly state their purpose for data collection, while being prohibited from repurposing that data without additional consent. Each category should have clear retention limits, after which it must be permanently deleted.

Transparency and consent should be central to these frameworks. Companies must obtain explicit consent through clear, prominent notices about their data collection practices. Cities should also mandate privacy-protecting features in AR devices used in public spaces, such as clearly-visible lights indicating when wearable cameras are active.

Location data warrants special consideration given its sensitivity and value. Cities should implement specific protections governing its collection, including restrictions on the granularity of stored or shared location data. Ordinances should also establish a "right to be forgotten" enabling residents to remove their digital traces from AR in the public realm.

Children's privacy demands particular attention. Cities should implement strict regulations for AR experiences likely to attract young users, prohibiting the collection of children's data without verifiable parental consent. These protections should extend beyond experiences aimed at children to deployment in places where they commonly gather.

Finally, accountability and adaptation are essential. AR platforms should be required to publish regular transparency reports detailing their data collection practices, including any data shared with third parties. Cities should undertake periodic reviews of these ordinances to keep pace with technological change, establishing clear processes for public input on updates to privacy regulations. Absent further state or federal legislation, these ordinances will help ensure AR development respects fundamental privacy rights while fostering trust in the technology's deployment in the public realm.

8

Implement accessibility standards

Develop guidelines ensuring AR experiences and services are discoverable for the impaired.

As the stewards of civic life, cities have a responsibility to ensure augmented reality is augmented for everyone. By upholding guidelines for accessibility, they can make certain public spaces remain truly public in both the physical and virtual senses, while providing clear guidance to platforms, developers, and public agencies implementing AR in urban settings.

Ideally, these deployments should incorporate XR accessibility best practices from inception, with an emphasis on inclusive and ergonomic designs taking both permanent disabilities — such as vision and hearing loss or cognitive impairment — and temporary or situational limitations into account. Cities should mandate their own AR content to provide comparable experiences for all users, beginning with the involvement of disabled users in the design and testing phases.

Technical requirements should address the full spectrum of accessibility needs. Visual accessibility demands options for adjusting brightness, contrast, and text size, along with clear audio descriptions for users with impaired sight. Conversely, audio elements should require closed captioning, subtitles, and sign language options. All of these features should be consistently implemented across public AR experiences.

Guidelines should also mandate alternative input methods such as voice commands, along with ensuring compatibility with assistive technologies such as screen readers and speech recognition software. Navigation systems should account for accessibility requirements by including wheelchair-friendly routing options and audio guidance for visually impaired users.

Cognitive impairment demands equal consideration. Guidelines should require clear options for on-demand orientation and context, along with the ability to simplify complex interfaces or slow down animations. Public AR experiences should remain straightforward to understand and navigate regardless of a user's mental capabilities.

Physical accessibility must also bridge realities. Guidelines should dictate the placement of AR triggers (such as QR codes) to ensure wheelchair users, parents of small children, and other mobility-impaired users can reach them, along with the positioning of virtual content to avoid obstructing critical real-world elements.

Finally, these standards must evolve with the technology. Cities should require AR developers to conduct accessibility testing with diverse user groups and establish clear feedback mechanisms for reporting issues. Regular reviews and updates of these standards will help ensure they remain relevant and effective as AR advances.

9

Organize public sector working groups for technology standards

Join standards organizations to propose and advocate for equitable urban tech.

Augmented reality's imposition on the public realm means cities have a crucial role to play — and duty — in shaping the technical standards defining its use. While Big Tech firms seek to advance their own specifications, standards-defining organizations (SDOs) such as the World Wide Web Consortium and non-profit consortiums such as the Khronos Group remain critical in guiding the development of open protocols and infrastructure. Cities have a clear and present interest

in ensuring these standards are in tune with their policy goals.

To this end, city officials should join SDOs and consortia such as the Metaverse Standards Forum (MSF), creating public sector working groups to harmonize standards with equity, safety, accessibility, and other key areas. These working groups should draw on expertise from across the public sector, including representatives from city planning, transportation, public works, and other municipal agencies — as well as external experts serving on cities' advisory boards. (See Recommendation #1.) State and federal officials should also be invited to ensure alignment across jurisdictions.

Their first task is identifying and prioritizing urban-specific AR use cases. These might range from pedestrian safety and emergency response to public space management and civic engagement. By working closely with technical groups, cities can surface issues and considerations early in the process, reducing the risks of inadvertent externalities.

The public sector working groups should also develop frameworks for how cities maintain ground truth for urban infrastructure data used in AR. This includes creating guidelines for data-sharing between municipal governments and platforms that protect public interests and privacy while enabling innovation.

Most important, these groups should champion open standards and interoperability to prevent vendor lock-in. Just as cities once insisted on standardized fire hydrant fittings to guarantee compatibility across manufacturers, they must now advocate for open visual positioning systems and other core AR infrastructure as a public option to private platforms.

Finally, they should work to align AR standards with other urban data specifications, such as the Open Mobility Foundation's open source APIs for transportation- and curb management. The working groups should in turn seek to extend such standards to incorporate AR considerations, creating a cohesive framework for managing both physical and virtual aspects of urban infrastructure.

10

Found the Global Urban AR Development Initiative and Network (GUARDIAN)

Create a peer network of cities and partners for developing, sharing, and enforcing standards and regulations.

Not content to participate in standards bodies convened by tech firms, cities and local governments should create their own structure for peer-to-peer collaboration. The Global Urban AR Development Initiative and Network (GUARDIAN) would offer a dedicated venue for developing shared approaches to AR governance while amplifying their collective voice in discussions with industry partners.

Rather than starting from scratch, GUARDIAN might incubate within established organizations such as the U.S. Conference of Mayors, National League of Cities, or Cities Coalition for Digital Rights. Starting as a specialized working group before emerging as an independent sister organization, GUARDIAN would benefit from their networks of public officials, governance models, and institutional knowledge while maintaining a tight focus on AR's unique challenges and opportunities.

The initiative should be overseen by a steering committee composed of representatives from member cities and partner organizations. Its first task would be drafting GUARDIAN's charter and governance structure, building upon existing frameworks while articulating an "AR Rights Declaration" for founding members to endorse.

Its initial agenda should focus on developing concrete tools and policies in key areas such as standards and interoperability, privacy and data governance, equity and accessibility, urban planning applications, and

content moderation and digital rights. These groups would actively participate in external standards development while advancing city-specific requirements and use cases.

The organization should also coordinate multi-city pilots and testbeds to scale results and share lessons learned. Additional activities might include developing training resources and toolkits for city staff, representing members' interests in national and international policy discussions, and forming partnerships with industry leaders to ensure city needs are considered in product development.

Following a successful launch, GUARDIAN should expand both its membership and scope. Cities of all sizes globally would be invited to join, ensuring diverse geographic and demographic representation. Academic institutions could be engaged as research partners, while civil society organizations help surface community perspectives and concerns. Industry partners should also be included in advisory roles to ensure proposals remain grounded in technical reality.

Finally, GUARDIAN should convene an annual Urban AR Summit for members to share progress, set priorities, and strengthen collaboration. This gathering would provide a venue for cities to demonstrate successful implementations, workshop common challenges, and chart the organization's future course.

8

Conclusion

The augmented city demands a new breed of public servant — one equally comfortable with bits and bricks, algorithms and ordinances. As we stand on the cusp of this new era, cities must develop the institutional capacity to recognize and respond to emerging technologies before they manifest as threats. This requires not only new roles and departments, but also new ways of thinking about the intersection of physical and digital space.

The lessons of *Pokémon GO* and subsequent evolution of AR are clear: waiting to regulate until disruption occurs is too late. While some may argue it's premature to prepare for technologies that have yet to achieve mainstream adoption, the rapid convergence of AI and AR – what this report has renamed "artificially intelligent reality" or AIR – suggests otherwise. The proliferation of AI agents and digital twins will soon make today's social media platforms and ridehailing apps seem quaint by comparison.

Rather than merely reacting to tech companies' initiatives, cities must proactively shape how these technologies integrate with public space and civic life. This means establishing clear guidelines for AR zoning and content moderation, creating testbeds for controlled experimentation, and building open infrastructure such as visual positioning systems as public alternatives to proprietary platforms. Most importantly, it requires fostering networks of expertise — both within city governments and between them — to share knowledge and resources.

The recommendations presented in this report provide a roadmap for cities to begin this work today. From establishing AR advisory boards to implementing accessibility standards, these steps will help ensure augmented realities serve the public interest rather than solely private ones. Success will require sustained investment in both human and technical capacity. Cities must attract and retain talent capable of bridging the physical and digital realms while building institutional memory around emerging technologies. They must also modernize procurement processes and forge new types of public-private partnerships that preserve municipal oversight of the digital public realm.

The stakes could not be higher. How cities rise to meet these challenges will determine whether our AR-enhanced urban futures are equitable, livable, and truly public — or whether they become a patchwork of digital fiefdoms overlaid on our physical spaces. The augmented city is coming; the only question is whether it will augment democracy or diminish it. The choice, and the challenge, is ours.

9

Appendix: Expert Interviews

In preparation for threatcasting, the cohort of current- and former public officials virtually met with a half-dozen subject matter experts including designers, founders, policy experts, ethicists, and others to learn about dimensions of the augmented city. While these conversations were off-the-record, these subsequent interviews capture the insights that were shared.

Boon Sheridan

I'm a user experience designer, researcher, writer, and distiller-in-training. I help teams identify real-world problems and infuse that knowledge into making products people want to use. A big fan of old records and new cocktail recipes. Extensive experience working with cross-functional teams. Narrative-building skills to help bring data to life. Track record of synthesizing insights into designs, prototypes, and recommendations for teams across an organization. Experience with mixed-methods research: qualitative and quantitative data collection, analysis, and synthesis. Years of success as a speaker, emcee, and workshop facilitator. Writing a book Getting Started in UX, due in 2022. The old church I live in became kind of famous when it was a *Pokémon GO* gym a few years ago.

Editor's note: Rather than an interview, what follows is the script of Sheridan's presentation to the cohort on January 24, 2023

Funny things happen when talking about the past. It was a whirlwind when the game launched almost seven years ago. Those weeks in July feel like a rollercoaster I was only half-strapped into. I may have a detail or two wrong, but I hope they're minor. So much has happened in AR, VR, and the metaverse since.

Also, the term "metaverse" is wonderfully unstructured, and definitions will vary from group to group, industry to industry, and person to person.

Lastly, it's hard to state how perfectly *Pokemon GO* fits with augmented reality. No other game matches the mechanics, lore, and player base. The game already uses real-world scarcity and collecting mechanics to drive behaviors. At the time of the AR game's launch, Pokémon had been around for 20 years with cards, video games, animated series, and countless merchandise. Even launching without all the real-world mechanics, the game was a brilliant translation of a collectible card game into something anyone with a phone could play.

Niantic and others have tried other games and IP (notably Harry Potter), but nothing has come close to *Pokemon GO's* launch and long-tail success. However, the lack of a "next *Pokémon GO*" is good news because we have more time before the next blockbuster property hits. (I'm looking at you, Marvel Cinematic Universe.)

My name is Boon Sheridan, and I am a user experience designer and researcher. I live in Holyoke, Massachusetts, in an old church. A Methodist congregation built the church in the late 1880s. It's almost impossible to mistake it for anything but a house of worship. The church was deconsecrated and sold as a residential building in the late '80s. This architectural detail is critical for the story that follows.

Besides a love for unique houses, I've been interested in virtual reality since I was a kid. From science fiction holodecks or Jessica Fletcher solving a murder with a VR headset and gloves on, I wanted in. However, progress has been slow and incremental. As I tracked the progress of hardware and platforms, the joke in my house was how VR was always "just around the corner," be it 1995 or 2015.

I hadn't thought much about augmented reality. But, like many interested in the tech world, I heard of Google Glass and immediately rejected it thanks to its invasive nature and awkward PR campaigns.

When Facebook announced a commitment to AR, the possibilities expanded. Companies had been quietly shipping great AR phone apps but not necessarily using the language of Augmented Reality. Be it helping navigate city streets or measuring the space in my kitchen to be sure a new appliance would fit. After that, use cases for phone-based AR made more and more sense, but I wasn't sure there was a big thing coming to introduce it to the world.

Then July 6th, 2016, proved me wrong.

On July 5th, I was at my favorite bar having a cocktail when I loaded *Pokémon GO* to see what the fuss was about. I caught a Squirtle, had a bit of a laugh, then went back to my drink. When I got home later that night, I opened the game to see what might be around our house, given we have a park across the street. I remember seeing the large graphic for a *Pokémon GO* gym centered on our house. I was sure it was a mistake. I went to sleep and didn't think anything of it.

Saturday morning, I found myself drinking coffee and looking out my kitchen window at a small crowd outside my home. Through bloodshot eyes, I watched small groups gather, look at my house through their phones for a few minutes, then move on. The crowds continued to collect and disperse as the morning went on. Finally, I remembered the game and pulled out my phone. Sure enough, the glowing dot of my location was smack dab on top of a *Pokémon GO* gym.

For those unfamiliar with the game's mechanics, a gym is where players spend more playing time than anywhere else. The vast majority of locations in-game are PokéStops, where a player takes quick action and then moves on. Gyms are where players "train" their particular Pokémon, and a player can spend anywhere from five to fifteen minutes (or more).

Like any reasonable person in 2016, I took to Twitter to make sense of what was happening. I had a second pot of coffee and tweeted a few first impressions and questions about what was happening. After a few friends commented, the tweets and retweets went worldwide. I was soon overwhelmed trying to keep up with the shared answers, questions, and stories. The story broke through in a few hours. Then the emails and phone calls started, and I was off to the races.

There was a story angle for everyone. It hadn't been a great week, and the idea of this "kid's game" becoming real was an ideal story to end a newscast. So, the game became the story, and the story of the old church I lived in gave it a human interest twist that was catnip for the press. You know those segments at the end of a show where the host says, "On the lighter side, here's a story you might not believe!" Even the National Association of Realtors called me to ask questions about the "virtual property" placed over mine and if I thought it increased or decreased the value of my house.

The launch of the game and my home's appearance had quite an impact. Beyond the pleasant surprise of meeting a few neighbors, questions and concerns emerged.

My biggest question was how my home had become a featured location in the game. How had this "virtual real estate," as I called it, been placed over mine? (This was a fundamental question because the players in my neighborhood *also* wanted their homes to be gyms.)

Thanks to Twitter, I quickly learned that *Pokémon GO* was from the same company that produced a science-fiction AR game called *Ingress*. Some of the mechanics from Ingress made it into PG, but importantly, PG inherited *Ingress'* location database. Any player in the game could submit a location's geo-coordinates, a photo, and a description to create it in the virtual world of Ingress.

Ingress players told me churches were almost always fast-tracked for approval because moderators figured church buildings were public places and easy to access. An *Ingress* player saw the old Methodist architecture of our house and made the obvious leap to submitting it for the game. I don't blame them. Plenty of people in the real world still think it's a church and knock at random hours, only to be surprised and disappointed when I answer the door.

Sure enough, days after the launch, other people who worked in active or lived in retired churches mentioned they were in the game. (Shout out to all the people I met who live in old church buildings!) None had volunteered for it or given any permissions. Some were happy with the foot traffic and the potential for new visitors. It turns out they'd be something of a minority.

Every day brought another story of someone being where they shouldn't be. Players climbed fences, crossed railroad tracks, scaled walls, paddled into lagoons, and found their way into places they weren't welcome.

It's hard to clarify how Niantic managed the location database for *Ingress* or *Pokémon GO*. Each game had its sites for submitting locations, complete with application standards, crowdsourcing, and voting. However, many conversations happened behind membership-locked forums and other non-public channels. The

> ❝ **Every day brought another story of someone being where they shouldn't be.** ❞

lack of transparency frustrated everyone, from business owners to security guards.

Besides the PokéStops and gyms, there were practical and ethical questions about how the game used location services and geospatial data.

Public spaces weren't prepared for the increased traffic and visitors at all hours. Semi-public spaces weren't excited about the context shift of their new visitors. Private locations weren't happy with people they considered to be trespassers.

The game created crowds and encouraged in-game behaviors with negative real-world impacts.

Holyoke has fewer than 40,000 residents, limiting game activity. Larger cities saw massive crowds and swarming behavior. The mechanics make Pokemon appear to all players in a geographical radius. As a result, it became standard etiquette to let others know when a rare or unique specimen appeared.

Footage of crowds racing across a park like a murmuration of sparrows when someone shouts, "SNOR-LAAAAAX!" became a favorite of mine. Stories of traffic snarls in New York, Taipei, and other cities soon became standard.

Public parks became particularly busy, much to the chagrin of those who managed them or relied on them for peace. Cities considered closing parks early or banning the game outright on the premises. Public and law enforcement officials made pleas, complaints, and speeches, but as far as I could see, no formal statements were ever forthcoming beyond the basic, "we ask players to follow and abide by all laws where they play."

Niantic eventually added in-game prompts to encourage polite behavior, but as far as anyone

could tell, no in-game mechanics were changed or altered visibly.

Players flocked to the 9/11 Memorial in New York City, angering many. There's no denying the location was legitimate, but game designers missed the emotional impact.

The Holocaust Museum, also a PokéStop, asked visitors not to play the game inside the building. "Playing the game is not appropriate in the museum, which is a memorial to the victims of Nazism," Andrew Hollinger, the museum's communications director, told *The Washington Post*. "We are trying to find out if we can get the museum excluded from the game."[136]

Some of the biggest and angriest headlines were about people trespassing. While PokéStops and gyms were generally in public places, Pokémon themselves could appear anywhere on a map. A player could be standing on a public sidewalk and see a Pokémon appear on the other side of a fence. Most players decided not to hop over that fence. Other players came to different decisions.

Fences were hopped, lawns walked on, railroad tracks crossed, lagoons paddled, and the owners of said locations only sometimes welcomed players. Some police departments and property owners were light-hearted in their requests, while others were not.

Complaints piled up, followed by promises of lawsuits. For the record, I was asked to sign on to multiple lawsuits but declined every offer.

Niantic's silence, besides the usual launch PR and subsequent carefully worded announcements in-game over the next few weeks, would come to be the norm. Whatever conversations were happening inside Niantic, few, if any, made it outside their offices.

One of the more challenging aspects was how Niantic took a very hands-off approach to supporting and dealing with complaints. The Niantic website was flimsy regarding information about the game. Support

136. Pokémon GO Players Anger 9/11 Memorial Visitors 'It's a Hallowed Place' https://time.com/4403526/pokemon-go-911-memorial-holocaust-museum/

information was even more challenging to find beyond the most basic tech support of how to load the game.

A removal request form appeared in the early days of the game. Unfortunately, it was about as bare-bones as possible and lacked follow-up information. The form also seemed to vanish for a spell, only to return under a different path through the game's website.

I had copied the link the first time I found it when I eventually submitted my removal request. For the next six or seven months, I'd get requests via Twitter or Facebook for help removing a location. I pointed everyone I could to the form and crossed my fingers for them.

Social platforms became the place to discuss and solve questions. But, whatever their intentions, Niantic made themselves insulated from the impact of their creation.

Pokémon GO presented new and unique problems. Many resorted to on-hand solutions from existing playbooks. Regarding public spaces and permissions. The most straightforward solutions were to restrict access to areas by anyone, game-based or not. Some groups tried a different approach but needed more finesse.

In September 2016, Milwaukee County said the game resulted in "unanticipated and negative consequences" for the park system, including "traffic congestion, parking issues, littering, damaged turf, risks to natural habitats, lack of restrooms, and noncompliance with park system operational hours." As a result, in 2017, the County enacted an ordinance to establish a policy for location-based augmented reality games in Milwaukee County Parks, essentially forcing AR games to get permits for the county parks.[135]

Later that year, a judge struck down the ordinance and said that requiring companies like Candy Lab and Niantic to acquire a permit was unnecessarily burden-

some. Instead, he recommended that Milwaukee simply do the work of policing their parks.[136]

Like many things in life, bargaining and acceptance came from shock, denial, and anger. As the Allstonians sang in 1997, "Six years is a long time." Some of the questions from those days are much deeper and are still looking for answers.

Pokémon GO was the first significant, obvious instance that helped clarify what can happen (good and bad). Map data became tangible for people in a way that had previously been hypothetical and hard to visualize

Soon after *Pokémon GO* launched, researchers discovered how fitness apps shared location data with few restrictions, allowing the location of military personnel to be tracked with precision. Researchers could extrapolate the layouts of military bases and supposed "secret" locations by looking through information shared by the apps.

AR, VR, and the metaverse have a data problem — going in and out. Devices and systems absorb as much data as possible before companies truly understand the implications. In addition, the desire to "replicate" real-world environments encourages levels of detail ripe for abuse.

Just like AI, we need to balance the level of optimism with recognition of the dangers and issues.

Maps are big business. Vendors are mapping and sharing their version of the world. So how do we ensure those companies are working with their data ethically?

Groups like the Locus Charter have started a conversation around geolocation data. Who gets to decide what is in and out of a given map? What could standard criteria look like for bringing consistency, fairness, and inclusion to map data?

What recourse, if any, should the public have if map data misrepresent them? As we saw with the 9/11 Memorial, map sourcing can negatively impact the world even when the data is correct.

135 A resolution/ordinance, in conjunction with the Department of Parks, Recreation, and Culture, to amend Section 47.03 of the Milwaukee County Code of General Ordinances, to establish a policy for location-based augmented reality games in Milwaukee County Parks. (CB Meeting 12/15/16: Referred back to the Committee on Parks, Energy, and Environment) https://milwaukeecounty.legistar.com/LegislationDetail.aspx?ID=2852653&GUID=D4C3AB55-A711-4C7F-B138-1CB237A6325E&Options=&Search=

136 Judge issues injunction against Milwaukee's Pokémon GO ordinance https://www.polygon.com/2017/7/21/16012724/pokemon-go-milwaukee-ordinance-first-amendment-supreme-court

Niantic's silence in the face of a global story isn't surprising, given their parent company is Google. From a layman's perspective, it seems evident that saying nothing limits their liability, but at some point, the conversations have to take place in more open public forums.

In 2018 a class action helped reshape the game's rules for location placement, terms for location removal requests, and conditions to limit the proximity of in-game locations to private property. In retrospect, these features should have been part of their launch. But, unfortunately, the UX researcher in me can almost hear a product manager voting down such efforts early in the game's development.

In the years since, Niantic and other companies have shared more about their products and platforms. Working groups and communities of practice have also evolved, but the default is still "ship the product and worry about it later."

The hope and hype of virtual reality have been full of dashed expectations and disappointment. Unfortunately, the frustration says more about the challenges than the skills of any one company or engineering team. These are big problems, and no amount of hype can create the hardware breakthroughs needed to develop the tools of our dreams, movies, and TV.

Magic Leap, the great hope of the VR world, has never matched the hype of its early valuations. Facebook and Oculus' Metaverse projects have also failed to instill much excitement beyond a few isolated projects. Microsoft's Hololens product built some enthusiasm and budding applications but never cracked the mainstream.

Magic Leap cut many of their staff in 2020, and as I write this, there are reports from the tech sector that massive layoffs have centered on augmented and virtual reality teams.

IT World Canada reports, "Microsoft's 10,000-person layoff may put a halt to the company's HoloLens and headset-based projects, with entire teams working on mixed reality and virtual reality products being axed."[137]

Meanwhile, Meta layoffs are also said to target teams working with VR, further pushing the next big thing out a few more years.

Virtual reality's hope and hype cycles are full of dashed expectations and disappointment. Unfortunately, the frustration says more about the challenges than the skills of any one company or engineering team. These are big problems, and no amount of hype can create the hardware breakthroughs needed to develop the tools of our dreams, movies, and TV.

The next big thing is now Apple's rumored VR headset. The hype is similar to previous cycles. It's worth noting there's more positive coverage of Apple's rumored product if only because Apple has fostered a better reputation for privacy over the years compared to Meta. Whether this proves to be true has yet to be seen.

My biggest concern the weekend of the game launch was how reckless drivers were as they played the game. Every night someone would pull up to my house, their car idling while they battled for control of the gym. Only some people parked or pulled close to the curb. I saw one or two close calls and realized I had no idea how my insurance company would react if a car accident occurred on my property. Would my insurance cover a car accident because someone was battling a gym in my house?

I submitted a removal request via the form.

Twenty-four hours later, the stop was gone.

I've never had any communication from Niantic otherwise. Their silence seems fitting.

137 Entire Microsoft VR team among laid off 10,000 staff https://www.itworldcanada.com/post/entire-microsoft-vr-team-among-laid-off-10000-staff

Dennis Crowley

Dennis Crowley is a technology entrepreneur working at the intersection of the real world & digital world to create things that make everyday life feel a little more fun and playful. Crowley is the co-founder of Hopscotch Labs, an audio AR startup launched in September 2024; a co-founder at LivingCities, which shut down in December 2023; a co-founder at Street FC ("building the biggest football club on the planet"), and is the co-founder/co-chair at Foursquare, one of the world's leading location technology platforms (and early pioneers of using game mechanics to drive real-world behaviors). Previously, he founded Dodgeball, one of the first location-based mobile social services (acquired by Google in 2005) and co-created PacManhattan, one of the earliest "big urban games" (2004). Crowley is also the founder of Kingston Stockade FC, a semi-professional soccer team out of Hudson Valley, NY that competes in the 4th division of the U.S.

What drew you to augmented reality following your time at Foursquare, particularly given your career in urban informatics?

I've always been into software that makes cities easier to use — only the tools at our disposal have changed over the years. The first stuff we built was done with text messaging because that's all we had. Then we had smartphones with GPS and apps that could run in the background and send notifications. Augmented reality is just the next generation of those tools.

What makes AR the logical progression from the smartphone?

I don't know if it is, to be honest. People have put stakes in the ground saying this is where the world is going based on science fiction and companies showing off the latest and coolest gizmos. As someone who likes to build things people can use today, I still think contex-

tually-aware push messages, text messaging, or audio messages are still underused as cutting-edge tools for contextual computing.

Apple's language for AR is "spatial computing," which to me just means the screens we have today have two dimensions and spatial computing has three. I don't know if it's augmented reality if you're wearing a headset not meant for use out in the world. And things like smart glasses are interesting, but they're further out. I like to think about, "what are the tools we can build with today?"

With Foursquare, the main mechanic for user interaction was gamification. Hard-core users — myself included — wanted to check-in early and often to be the "mayor" of various locations. What's your hunch in terms of the mechanism necessary to recreate the success of Pokémon GO, or break through in a new direction?

It's always obvious in hindsight, but when you're trying to predict the future, it's a little more difficult. This is probably a crappy answer, but: Something that people can't live without. Foursquare wasn't AR in any real sense of it, but it would give little nuggets of notifications that would improve people's experience of just walking through the city, whether it was, "this is where your friends are," or "this is something great." You just become accustomed to that and it becomes something you need.

Games are different because they can be a fad sometimes. *Pokémon GO* was the quintessential use case for successful AR, but I don't play it anymore, and haven't for years. The sexiness of that game wasn't related to AR necessarily. We all have smartphones and we all grew up playing Pokémon, and that's a deadly combination of nostalgia and game mechanics, which lead to it being one of the most successful mobile games of all time.

If not games, what else should cities be keeping an eye on?

From my personal experience, it's about simple social utility. The use case I want the most is: "Go into that place, your friend is right there, the person you're talking to whose name you forgot is Pedro." That type of stuff. Things you want to jiggle out of your own

memory or your friends' memories remotely. For me, it's less about navigation — "go this way and then turn left." There are easier ways to do that and I don't think I'd need coupons and stuff popping up everywhere. AR games are interesting to some people and not others, but "core social utility" never goes out of style.

When LivingCities came out of stealth in May 2022, you and your co-founders spoke about capturing the "spirit of place," meaning you wanted to create AR experiences on top of and additive to physical spaces. How do you ensure AR enhances the public realm rather than detracts from it?

The dangers are pretty clear, starting with that sense of continuous partial attention. Everyone knows the feeling of talking to someone who is also looking at their phone — there's no way they can be doing both at once. So, do you want to pay attention to your phone, or pay attention to me? I don't know if you've ever walked around with a pair of AR specs on, but I had a demo pair of the North Focals a few years ago and one thing I didn't anticipate was everyone looking at me weird because they can clearly see the small LED screen lit up and projecting something into my eye, and I stuck out like a sore thumb.

Further disconnecting us from reality that way is probably the worst case. On the flip side of that, these tools can do magical things as a one-player or multi-player experience — not as a game, but just moving through the city and being able to spot things. The metaphor we always used at Foursquare was: Imagine you're walking through a city, any city, with your best friend who's lived there for 20 years. What would they point to and say, "Oh, this used to be here," or "This is a cool piece of graffiti," or "Go inside this store and head to the back." Could you replicate that with software?

I think that's the really big opportunity. It's less about a "push pin on a map" and more about guiding me into a store and then guiding me to the thing I need to find. Almost like [Apple] AirTags, but without the need for physical objects. Imagine asking, "I want to find this super rare pair of vintage Nikes; it's in the city, some-where — help me find it." And then do that for all sorts of different objects or books or trinkets or architecture. Not a lat-long per se, but the specific spot where something interesting lies and making it easy for people to

find those things. We got close to that with Foursquare, but we didn't really nail it, but it needs to exist.

Is this what you're building at your new startup, BeeBot?

BeeBot continues some of the themes we worked on at Foursquare, where we made an early audio assistant — because audio is the poor man's augmented reality. The idea is similar, in that Apple Airpods are ubiquitous — you see people walking around in them all the time — and as soon as you put them in, you hear a chime saying BeeBot has been activated. As you walk around, it provides context on the things you're passing, the people you walk by, and upcoming events tied to these places. It's meant to be a drumbeat of local context delivered a sentence at a time, in non-linear fashion.

The tech itself is rather basic — a lot of it is just geofencing, with content from the Foursquare API and other sources. But the big difference is that we're able to leverage AI to come up with stuff that's much more personalized. For example, BeeBot has a list of nouns associated with you and your interests. Some of these nouns are explicit from your profile — "snow-boards," "vintage sneakers," "cocktails" — and some it has learned from me through the Foursquare SDK, so it understands I like to go to bodegas, dive bars, and sushi places.

As I walk down the street, we're using LLMs to constantly query for those things: "All right, of all the things Dennis told us he's interested in, or what we've learned, is there anything directly in front of him? Or two blocks up and on the left? Should we direct him to go here? Or look up? Is there a piece of information we can deliver that would lead to a more interesting experi-ence?" And so on.

One of the central insights of this report is that AR is quickly giving way to AIR, or "artificially intelli-gent reality." How is generative AI useful in rapidly achieving the scale of content necessary to make this appealing to users?

I'm working with someone who's also ex-Foursquare, so we've spent a lot of time together thinking about this question through the context of the tools, infra-structure, and data sources we've built. We were joking around last week that we have to actively unlearn all of

that. For instance, let's go back to the question, "What are the things you're interested in?"

I'm so old-school my disposition was, "Just ask the user what they're interested in and make a list." Sure, you can do that, and there are plenty of Web services built on doing that, but you don't have to do it anymore. You really could onboard someone by asking them to talk about themselves for ten seconds — "Hey, give me three sentences about yourself" — and I can turn that into structured data and then extrapolate from that.

So much of the stuff I've worked on has been finding clever ways to collect implicit data from users. Press the check-in button for me because GPS isn't good enough; tell me a noun you're interested in, because otherwise I can't understand it. Tell us who your friends are because we don't know who you hang out with. And now, by combining the passive sensors in these devices with LLMs that can keep an eye on the things users are doing, or saying, or interacting with, you can just do a lot more. Our assumption is you can make much richer services without asking as much from the user.

One of your early experiments with LivingCities was to create a mirror world of Washington Square Park, and to do that, you needed to capture it. What were the legal issues in doing so? Because filming in New York City requires a permit, but reality capture of the public realm doesn't fall under that, does it?

Our first prototype was a digital twin of the park, which we wanted to capture with centimeter accuracy. At first, we went with our iPhones trying to do Lidar scans, and it worked — but the tools available for your phone aren't made to capture a space that large. We knew commercial-grade Lidar capturing would require permits, so we ended up collecting architectural sketches, drawings, planning documents, and Google satellite imagery — taking all of those measurements into 3D rendering apps as our foundation. I did Lidar scans of benches and the arch to capture their texture, and of the foundation to capture its depth and bevels.

Weird things happen when you're walking around the park taking pictures with tremendous amounts of detail. People ask what you're doing, and a few got in my face — "I don't want to be filmed!" I thought I was going to be punched in the face at one point. I was

taking pictures in a public space, but I was taking a lot and it didn't look very official.

But we put a lot of effort into it. It might be the highest-resolution version of Washington Square Park digital twin ever created.

What does it mean that a startup was able to use publicly-available documents and public space as the foundation for its private intellectual property? And what should cities do in response? Create their own digital twins and license them before someone else comes along?

We were certainly helped by the city, not directly, but simply because so many of the documents and plans were in the public domain. We didn't even go to nyc.gov to find them, just Googled around. I don't think the city needs to create digital twins for people — we spent a lot of time and money doing it, and still had a hard time figuring out what to do with it. We were trying to create a simulation of what it's like to walk through the park for people who aren't in it or don't have access to New York would still be able to see and experience it.

During your presentation to our cohort of public officials, there was a definite friction as they struggled to understand why you did this, to which you replied there was no why — it was an act of improvisation. Startups are always improvising as they aim for product-market fit. What's your advice to public officials when confronted with other AR companies seeking to leverage digital public infrastructure? Should they create new roles to liaise with the private sector? Should they create pilot areas and test beds? How can cities encourage improvisation while mitigating any potential harms?

We didn't go to the city. Washington Square Park is weird because it's not run by the parks department, but by the Washington Square Park Conservancy, and we never reached out to them because we never had a real "ask". But having someone at the city to have that conversation with, regardless of the outcome, would have been helpful. It would be one thing for them to say, "Listen, we don't want you to install cameras or microphones." We would understand. But when there's no one to ask, it just gets frustrating. You get to the point where we'll just do it. We'll ask for forgiveness instead of permission.

We never did those things, of course, but if we had, I imagine we would have found someone with an apartment, paid them $100 a month to keep a camera there recording ambient sound and lighting, and found some way to hack it. But it didn't come down to that. I don't think cities need to bend over backward for these types of projects. At least not yet.

In one of our conversations, you evocatively asked what the launch screen for the Apple Vision Pro would look like. Which apps would be prioritized at launch? And taking that further, what urban features or services, or retail partners would be prioritized within the interface. If Apple were to cut a deal with Starbucks, would it highlight their locations and obscure independent coffee shops? Given your experience at Foursquare working within the confines of the App Store, how might a walled garden of AR play out? How might competition between dueling walled gardens — iPhone vs. Android redux — and what would it mean for cities to have multiple, incompatible realities on top?

Right now, I have my Chrome browser open, and if I open a new tab in Chrome, the Google homepage is my default. If you have the [Microsoft] Edge browser open and open a new tab, you probably get Bing as your default. When you boot up your headset, what do you see? The Vision Pro looks like an iPhone, and you do whatever you have to do to launch the apps. Meta has the same thing — there's a control dock and apps, and you launch them.

But at some point, when you're walking through the city, there'll be a default layer of what pops up when you're not running any app. Is it an ad? A piece of content? A map? Whose map? Whose ad? None of that's resolved. Thinking about your phone, what's your default browser? Music player? Microphone? Video chat? Calendar? Will those preferences extend into the real world? But how will I find my friends? Where should I be going? What should I know about?

Everyone is going to end up with their own map. The data will be owned and held by the companies, the but apps will be able to use any of them freely — a lat-long is a lat-long regardless of what map you're using, and maybe an X-Y-Z coordinate is an X-Y-Z coordinate is the same no matter which platform you're using.

> **at some point, when you're walking through the city, there'll be a default layer of what pops up when you're not running any app. Is it an ad? A piece of content? A map? Whose map? Whose ad?"**

I'm less concerned with compatibility between places in three-dimensional space than whether I can create an app that serves the right content at the right time, and I want my content to be the number one thing someone sees in their headset. How many people am I competing with, and what am I playing to be the default for that? And how tightly is Apple turning the screws on notifications or background location or other tools I need to surface the type of content I want to surface?

As an analog to that, Apple's decision to change iOS in order to remove bad actors in the advertising and tracking space also made it really difficult for companies that want to run location awareness in the background — not for advertising, but so the developer can surface interesting content or information based on your location. A company trying to do this would probably be in the minority of use cases, and they'd be playing by the rules bad actors set. And I wonder how much of that will carry over to default settings and biases of a new generation of devices.

Jacqueline Lu

Helpful Places is a social impact enterprise based in Canada led by Jacqueline Lu, a leader in smart cities with more than two decades of public service and technology implementation experience. Formerly, she was the Data Lead at Mozilla Foundation, Director of Digital Integration at Sidewalk Labs and the founding Director of Data Analytics at the NYC Parks Department, she has more than 20 years of experience implementing data and tech that helps improve public spaces. She is also a Working Group Member and Task Force Contributor for the G20 Global Smart Cities Alliance, a member of the World Economic Forum's Council for the Connected World and the Global Futures Council for Data Equity, and a Board Member at Superbloom Design.

Let's start with the basics. One, what is DTPR? Two, what is Helpful Places? And three, what inspired you to create wayfinding and signage explaining the presence of digital devices and sensors in public places?

Helpful Places is a social impact enterprise, and our mission is to help organizations in the communities they serve harness the power of technology in ways that are transparent, inclusive, and participatory. Our core belief is that the way places are designed and operated — and the technologies within them — should be helpful and empowering for people. The main way we do that is by advancing the adoption and stewardship of Digital Trust for Places and Routines, which is an open source wayfinding and communication standard designed to increase the transparency, legibility, and therefore accountability for the use of digital technology in public places.

Helpful Places has partnered with the startup inCitu, which is applying AR to urban planning procedures. How did that partnership come about? Because AR was not the original intention of DTPR, but certainly seems relevant.

Fundamentally, what we're looking to do with Digital Trust for Places and Routines is to provide hooks and cues in physical spaces pointing people to the existence of digital layers intersecting with and overlaying the city. And there are many. Some of them run in the background. Some of them collect data on you. And some of them invisibly collect data on how spaces work and then feed it into a decision-making process or AI system for the operation of those spaces. We believe those processes should be visible and inspectable as a core tenet of civic participation.

We also see digital layers that could be controlled or utilized by individuals. What I think is really interesting about inCitu is their focus on letting people know about a digital layer you can use, and that can be empowering. How do we promote that kind of legibility so that people can be full participants in the shaping of these spaces?

DTPR includes a taxonomy of icons explaining what technologies are present in a space and what they're doing — who owns them, what data they're collecting, where that data is being processed, and so on. What have you learned from working with communities? Is it self-explanatory? Does it need human facilitation? And have you met with resistance?

Most of our projects so far are supportive of piloting IoT technologies in public spaces. The communities we're working with are looking for ways to show they care that their residents and the people using these spaces understand what they're doing and their motivations. There's principles-level alignment around privacy, transparency, and citizen engagement. And that's great, but how can they do this in a way where organizations can learn from each other and there's a toolset they can try? That's what DTPR is all about. This is a new form of interaction across the physical and digital. People don't necessarily know what to do with the signage or icons. That's where actual on-the-ground engagement comes in — doing intercept surveys and talking to people is an important part of every deployment.

We're starting to see differentiation between the use of DTPR as signs providing notice, asking for feedback, or telling people about something they can use. In Sydney Olympic Park, for example, the use cases range from vanilla CCTV to public WiFi to a smart irrigation system trying to create cooler microclimates within the park all the way to a security system for managing large events like the FIFA Women's World Cup. And we're starting to see the interactions people have does depend on the messaging of the sign. It might be stated as, "By the way, there's something happening here," or "Here's something you can use you might not know about" in the case of public WiFi. We also see that the need for on-the-ground dialogue increases with the novelty of the technology, which is to be expected — people want to understand how these technologies are being used to manage their places. They appreciate the intention in the introduction of these digital layers.

There's also internal benefits for organizations to deploy DTPR - bringing together place managers and facility operators with the technology implementers and community engagement people - these are teams that don't often work in concert with each other. That's an internal utility I'm really excited about, because now we're talking capacity-building and helping these organizations put in place processes where they're able to think about how they might roll out a new digital layer or new digital functionality for spaces in the same way they might roll out a program like a farmer's market or a new amenity or feature like a playground. They might be new functions or amenities or in some cases new ways these spaces work. And because it's digital, you might not think about a communication campaign the same way you would think about rolling out a new physical program.

That shift is really exciting to see — can we think about the introduction of digital layers the same way we think about new playground or programming in a space? Because they are as much a part of the way space might work in the future as the design of physical features.

What organizations tend to be the ones embracing DTPR? Because it was originally designed by and for a private entity, Sidewalk Toronto, which was locally controversial to say the least...

> **"can we think about the introduction of digital layers the same way we think about new playground or programming in a space? Because they are as much a part of the way space might work in the future as the design of physical features."**

DTPR was always intended and designed to be an open source standard that would eventually leave Sidewalk Labs, as we definitely recognized that being proprietary to Sidewalk wasn't going to achieve the goals of the project. I just never imagined the organization DTPR would be spun out to, would be one I would start myself, but as the Sidewalk Toronto project was sunset there was already interest in DTPR from the public sector, and I wasn't going to let the momentum stop. Most of the organizations we work with right now are either public space organizations or city governments, both of which need to communicate to the public about what they're doing in these communities and have a responsibility to deploy technology to serve the public interest.

In your presentation to my cohort, you engaged in a bit of speculative design imagining the confluence of AR, DTPR, and AI agents operating in public space. Could you walk us through the contours of that thought experiment again?

Right now, communities use the Digital Trust for Places and Routines taxonomy to structure information and provide notice about smart city technologies in a consistent, vendor-agnostic way. There was a point a few years ago when one of the contributors to the standard asked, "So what if the digital layers are comprehensively described? What does that actually mean and enable?"

At the same time, we were also conducting research around mechanisms of accountability and agency and hearing things from folks like, "Transparency is just the starting point for me to even begin thinking about trusting these technologies. I want to understand what agency looks like. I want to control my data. I want a choice in whether I participate in some of these systems." That led us to a body of writing by someone named Richard Whitt, who imagined personalized AI agents working on your behalf to navigate online spaces with your preferences and privacy in mind. We wondered: can you port that idea over to physical space?

That got the team excited about the prospect of an AI assistant, which isn't so far off anymore. We imagined you could choose your agent, provided by an organization you trust — whether that was the government or your library or your bank or your phone company, whatever. But this personal agent is yours, and yours to control. From there, we imagined how a communication standard describing sensors, systems, and places could serve as the foundation from those personal AIs could provide that deeper control over our digital interactions in the real world.

Because as much as we loved the idea of an AI completely under your control, we had this nagging question of, "Well, what does it talk to? Where does it get information from?" If the present-day challenge is that people don't understand how they work and that's what leads to the suspicion and mistrust, then how do we address this growing sense of a loss of agency and personal choice?

So, you can imagine the scenario would work like this: You have a digital assistant everywhere you go, and you enter a place using DTPR that has fully described all the digital layers present in that space, and you're able to access that information. You might be able to ask questions about the systems active in that space. You can see what services are available for you to interact with, and maybe you can see if there's anything you might want to do differently given the context that day.

Imagine you go to the library that offers a grab-and-go checkout system. (Let's take that technology back from Amazon.) Because DTPR is there, your AI understands the grab-and-go system and can apply your personal settings and use your library card for you — all thanks to these systems being fully described, inspectable, and legible to you and your AI.

In doing so, the idea was that your personal AI could help reduce your cognitive load by reading the information from the surrounding layers for you and let you know if something is happening that might either be immediately relevant to you or out of bounds of your personal comfort. So, with the existence of a comprehensively described interface or inventory of the digital layers overlaid on physical spaces, we might enable new types of experiences for these sorts of places.

Jasson Crockett

Jasson Crockett joined Snap Inc in 2021, where he leads Public Policy and Government Relations for the Greater Los Angeles Area. Jasson's responsibilities include liaising with local elected leaders, City and County agencies, and community organizations, to advance strategic partnerships and civic initiatives. Prior to joining Snap, Jasson was Director of Community Business in the Office of Los Angeles Mayor Eric Garcetti. In this role, Jasson led engagement with small businesses, and oversaw policy and business development in the life science, healthcare and tech sectors, as well as sports, and tax policy. Jasson worked to connect companies of all sizes to resources within City Hall to enable their growth in the City of L.A., and develop a more connected ecosystem wherein companies can thrive.

Chris Reilly

Chris Reilly is an AR Engineer at Snap Inc where he is focused on creating educational content for AR creators and developers. He began working in augmented reality in 2017, and has helped create AR experiences across many verticals including product visualization, education, games, training, and more. Prior to joining Snap, Chris created developer-facing tools and sample projects at Magic Leap where he was focused on simplifying the external developer journey and growing the developer community. He is excited to continue working with AR creators to help realize the potential of AR in our daily lives.

Chris, your role at Snap is focused on education and building capacity in the AR development ecosystem. Jasson, yours is focused on strategic partnerships with city officials after being one yourself. What level of knowledge and expertise do you typically find on city agency staffs? What questions do they post to you? And how do you start the conversation around AR's potential for improving urban life and city services?

Crockett: The tenor and tone can range from "I have no clue what you're talking about" to "My kids have shown me what a Lens is," or maybe "My grandkids have shown me what a Lens is." So they might have a fuzzy understanding. We're still in the very early stages.

What's been the most helpful is showing a range of use cases that currently exist, then speaking to the use cases we see coming down the pike in the next half-a-decade to a decade. Because that helps ground it outside of just the technology itself. Then people understand what it is, how it differs from other technologies, and why they should be excited. One of the things Snap does well is talk about educational applications, because some of the most robust lenses we've built — particularly for our Spectacles — explore the human body or outer space that are great in a classroom.

Being able to show or actually demo AR is the most effective technique, because it allows you to talk about discoverability, which is a huge challenge — and one the public sector has the potential to impact.

What are some of the outdoor, urban use cases that get public officials excited? There's the Annenberg Wildlife Crossing lens Snap developed with inCitu, and you stood up a living museum as well. What excites them over the five- to 10 year timeframe?

Crockett: In the present, anything related to art or history seems to resonate. Looking to the future, we talk a lot about applications for tactile learning — how you can use it to teach someone sign language or an instrument. Another area is medicine, particularly surgical medicine — both for training surgeons in actual operating rooms, but also to provide visualization and remove the cumbersome screens that exist today.

> ❝ **Being able to show or actually demo AR is the most effective technique, because it allows you to talk about discoverability, which is a huge challenge — and one the public sector has the potential to impact.** ❞

And then using AR in real estate development is something potentially valuable for city officials navigating tricky conversations around building in communities and looking to engage younger audiences. How do we get young people off the sidelines and share their voice and perspective in those conversations? Which more often than not tends to be beneficial for the officials trying to pass more development.

Chris, from a developer education perspective, have you had any public officials participate in your program to date? And how are you endeavoring to make AR development easier and more accessible in general to encourage the kind of mass public participation Jasson alluded to?

Reilly: We have made a concerted effort to work with students at schools and universities, where we are able to reach people early in their careers. For a lot of people starting out, it just takes that initial exposure to AR, to inspire them to continue down the route of exploration and innovation. In general, our strategy at Snap is to enable AR creation and expression for as many people as possible. We do that by developing learning content that is accessible to anyone at any time, primarily through our documentation website and YouTube channel.

We really are focused on creating two kinds of educational content, the first is step-by-step tutorials which teaches workflows and how to achieve a specific result. And the second is overview content which covers general concepts in AR and new features in Lens Studio, our AR development software. Our goal with both of

these content types is to make sure there is a step-by-step journey for all of the common workflows and experiences that someone new to AR development can follow along with. Then supplement this with content that can be viewed in a more selective manner depending on the use case.

The other piece of making AR development easier is through the actual AR creation software itself. Lens Studio is an AR-first 3D engine, so everything is built with AR in mind and the features you will use most often are front and center. With Lens Studio 5, one of the really exciting features we launched is the GenAI Suite. You can use it to generate 3D models and other visual assets, ask it questions on AR concepts, and even have it write code for you. That's probably the biggest advancement we've made in making it easier to develop AR experiences. Since creating AR requires art, code, sound, and more, that can be overwhelming if you are starting out, but now you can focus on a specific piece that interests you and leverage our tools to fill in the gaps.

Jasson, have you ever come across a city official or staff member who's taken one of Stacey's courses? When you talk to agencies and departments, who is typically the point person? Is it someone younger who might have had some exposure? Is it someone who has emerging technologies as part of their remit? Or is it just scattershot?

Crockett: Typically, they're looking to us to help guide the process from a technological standpoint and creative one. We're working on a project with the city of Santa Monica right now creating numerous AR experiences built around landmarks within a large-but-contained park area. They want to do something fun, cool, and that the community will enjoy, but they don't really know how to bring it to life, nor do they have the vision creatively. We've worked with parks-and-rec departments in a few cities, and I think because they have historical landmarks or local attractions within their jurisdictions, they're coming at it from a perspective of providing something to people already using their services.

We recently worked with El Segundo to launch a project, and they just don't have the capacity to build out the institutional knowledge to understand AR. But the mayor was really inspired to elevate their existing

public art campaigns by creating AR experiences. Rather than trying to develop an in-house expert, they hired an alumnus of the Snap Lens Academy as a consultant and paired him with someone who manages their annual art walk program. And between the two of them, they developed the vision. They worked with us to modify some of the technology. And then they built a budget and went back to the city, which chose to fund it directly. They launched the first three projects along with a map guiding citizens from place to place, from installation to installation. I think that's a model that's a little more scalable than expecting cities to develop this knowledge internally. Tap into Snap Academy alumni who are building out expertise already and contract with them to do it for you.

Expecting cities to build their own in-house AR studios is indeed unrealistic, but are there any hallmarks of who that internal champion typically is? In El Segundo, it was an enthusiastic mayor, but are there other roles or characteristics of who might manage that process?

Crockett: I'd be lying if I said I've found the sweet spot. It's always different depending on who we're talking to. You're not going to see the mayor involved in Los Angeles or other big cities. But one thing I've seen consistently is that it ultimately has to move beyond an elected into a department. City departments will be the ones who will actually drive a project forward in a material way through approvals or permitting. And if there's any budget that can be allocated towards this, it's not going to come from an elected. They can be a great entry point and helping in ginning up excitement, but you still need to figure out what it is you're trying to do, and what department is most naturally going to care.

In Santa Monica, it was the arts department. We're currently working on a project in LA more focused on development, so we engaged with the Mayor's office and then quickly brought in city planning to help. In other cities, it's the park department. But in general, engaging the elected early on but then quickly trying to get departments and agencies on board is key.

> **❝❝** One thing I've seen consistently is that it ultimately has to move beyond an elected into a department. City departments will be the ones who will actually drive a project forward in a material way through approvals or permitting **❞**

Pivoting back to Chris, what is Snap's larger theory of change when it comes to capacity-building? Let a million flowers bloom? Because to push back on Jasson a bit, there are any number of boutique agencies creating one-off projects for city departments, but does that matter if it doesn't help build internal capacity? And it certainly doesn't scale. Is change going to come from the bottom-up, from community groups working on library computers?

Reilly: When Jasson referred to a Snap Academy alumnus, these are students we bring in every summer. The Snap Philanthropy team sources early career talent from underrepresented communities nationally and put the technology into their hands and into their skillsets. Lens Studio overall has had over 350K creators publish over 3.5M Lenses from almost every country in the world, and growing!

When we think about capacity-building, every organization is going to handle that differently. Some city departments will want to bring development in house, others are more comfortable with working with outside agencies. We want to enable both of those scenarios and really use these bespoke projects to inspire the organization creating them and the community interacting with them.

The other piece of these projects is that we are able to learn alongside the organizations creating them. So we can take these learnings and apply them back to our software, tools, and education content. As we work to optimize the workflow to enable these sorts of experi-

ences, the barrier to entry drops and capacity-building becomes that much easier.

In addition to lenses, Snap has also created a City-Scale AR Template and piloted it in three cities — Santa Monica, London, and downtown Los Angeles. Why those three cities, and how does it integrate with your public policy work, Jasson?

Crockett: I love the city-scale technology and would love to see it expand quickly to a number of other cities. The team managing it looks at the rate of usage within a given region — how many creators are in proximity to that area? — but there's also technical realities. How strong is the signal in that area? Even in some of the places we've already mapped, you'll find pockets where service is just not quite up to par, limiting what you can do creatively. These parameters define priority in terms of rollout.

From a policy standpoint, it's a great entry point when we're talking to electeds about AR. "Your city is already mapped and utilizing city-scale, so creators can do what they do best right here. And this is why that matters and is a benefit for you."

From a marketing standpoint, one area we want to break into is tourism offices and bureaus, because that's the sort of thing they would love to know and broadcast to people. "When you're coming to visit, we are a city-scale-enabled city, so you can have fun, create, and explore what other people have already created," making it this shared experience.

Neil Trevett

Neil Trevett is Vice President of Developer Ecosystems at NVIDIA, where he works to enable and encourage advanced applications to use GPU acceleration. Neil is also serving as the elected President of the Khronos Group where he created and chaired the OpenGL ES working group that defined the industry standard for 3D graphics on mobile devices. At Khronos he also chairs the OpenCL working group for portable, parallel heterogeneous computing, helped initiate the WebGL standard that is bringing interactive 3D graphics to the Web, and is now working to help establish standards for vision and neural network inferencing. Neil was elected President for eight consecutive years of the Web3D Consortium dedicated to creating open standards for communicating real-time 3D on the Internet.

In addition to your roles at NVIDIA and the Khronos Group, you are also president of the Metaverse Standards Forum (MSF), which is one of the umbrella groups supporting open standards for spatial computing and the metaverse. But the MSF is not a standards development organization (SDO) along the lines of, say, IEEE or the World Wide Web Consortium (W3C). So what is the MSF and what do you hope to achieve?

My day job is at NVIDIA, where I help developers use GPUs, and I'm president of the Khronos Group, which is a 'classic' standards organization. Every standards organization has a focus area, and Khronos' is low-level hardware acceleration APIs for things like 3D graphics and machine-learning and vision-processing. The Metaverse Standards Forum was catalyzed by the Khronos Group — which is why I've ended up as president at the moment — because the metaverse needs a constellation of open standards to make diverse technologies work together. The number of standards needed to make the metaverse open and accessible

to everyone is beyond the capabilities of any single standards organization. Which is why there are dozens, even hundreds, of organizations working on standards proposals and best practices related to what we're labeling the metaverse — whatever that ends up being.

So, there was an obvious need for a new level of cooperation and coordination between standards groups that don't often have the opportunity to talk together to avoid gaps and duplication. That's the idea behind the MSF. It's meant to be a welcoming place where anyone interested in metaverse standardization is welcome to join. And we try to move the whole field of interoperability forward pragmatically, one project at a time.

How would you describe the current landscape, given competing formats — XR, the metaverse, spatial computing — and heavyweights like Apple and Google alternately wrangle for hegemony or lose interest in favor of AI and move on? Where are we at, and how does this compare to the original development of the Web?

I think we're at the stage of sitting someone down in front of the Netscape browser in 1994, looking at a single page of text (that's probably flashing!), and asking them to imagine Uber and the disruption it's caused. It's impossible — you just can't think that far ahead in such a chaotic system. We're in a long-term, bottom-up Darwinian process with competing open standards and proprietary technologies. And you need both of them, because the last thing you want is cutting-edge innovation by standardization. Once a technology becomes kind of boring and proven — but with points of friction putting the brakes on market growth — that's the time for standardization to strike. Everyone wins from

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reduced costs, less development effort, and greater network effects.

So, standards organizations need companies to innovate, and companies need standards at the right moment so they can use them for established stuff before moving on to the next round of innovation. The metaverse isn't new, but this cycle will repeat many times as we bring together spatial computing with the connectivity of the Web and a good dose of AI to create the metaverse. Interoperability will be key to get all of those things to work together.

How does the creation of these standards work in practice? I've joined the weekly calls for the Real/Virtual World Integration working group and noticed a lot of engineers from NVIDIA and Intel along with a few public policy people from Meta — but no designers or public officials. Who's steering this process on a daily basis?

We started in 2022 with 37 founding companies, including some big names — Meta, Microsoft, NVIDIA, Autodesk, Adobe — and we figured a couple dozen more would join. We also had the W3C, Khronos, and the Open Geospatial Consortium, so we had some respected SDOs, too. Six months later, we broke the 2,000 organizational members barrier, and now we're up to 2,500. So, on the one hand, we have a lot of corporate interest, and on the other we have the metaverse, which has no universally accepted definition. Which means the potential for chaos is pretty high.

So, we tried to be thoughtful about how we would decide to spend our efforts. The first step was to poll the membership, which produced 300 different topics

people were interested in — either problems to be solved or opportunities that interoperability could help with. Those naturally coalesced into a couple of dozen domains, including 3D assets, avatars and digital twins, real/virtual world integration, and number one was privacy, security, and identity. From there, we've created what we call Domain Groups that are selecting key issues from the top domains and focusing on initiating conversations, cooperation, and projects to move the ball forward incrementally. We hope these activities will add value today – not in 20 years, but today.

If the Metaverse Standards Forum isn't an SDO itself, then how will its ideas and proposals propagate into the actual SDOs? I asked this question to Steve Smith, co-chair of the Real/Virtual World Integration group, and he explained that members of the group might also be members of the W3C or OGC, and that the ideas presented here might trickle back there — which honestly sounds a bit informal and opaque to me.

No one size fits all. It depends on what the problems and opportunities are. But in general, we're now in a phase where the first working groups are getting into the groove. They know what the problems are, they're having interesting discussions, and now how are they actually going to make this tangible?

The first step is typically gaining situational awareness. What are the key players already doing, which ones are using proprietary tech, and which are using open standards? How does it map together? Where are the interoperability gaps? Domain reports are one kind of deliverable, and several of the working groups are assembling testbeds, asking if this is actually going to work.

There will be standardization recommendations coming out of the forum's working groups aimed directly at the standards organizations. And then we hope they'll take action. We have no jurisdiction over them, of course — everything is voluntary. But there is enough common membership that it's a live, ongoing conversation.

The most interesting thing in my experience is how difficult it is to get the industry to tell you what they need. Partly it's because they think standards are boring and they don't have the time or the energy to be engaged. Or they just don't know their input is required — knowing what's actually needed to solve

real-world use cases is highly valuable to any standards organization.

That raises the role of cities, public officials, and public policy groups like X Reality Safety Intelligence [formerly the XR Safety Initiative] and the Responsible Metaverse Alliance, both of which have called for standards around privacy and public safety. The conversations happening in the Real/Virtual World Integration group are extremely granular and technical. When and how do we bring policy advocates into these discussions to ensure the standards adopted don't unintentionally harm cities and their residents later?

Because the forum was created by Khronos, the first organizations we thought to invite to join were the W3C, OGC, and others that were engineering-focused. But we were also joined by a very interesting class of lobbying and advocacy organizations like XRSI and the XR Guild with very different - but aligned - goals. I think we are all going to find we need each other, and the Forumcan help to make those connections.

Any Forum member is welcome to propose a Domain Group. So perhaps there's an opportunity to propose an urban planning one, for example. The whole point of the forum is that people can create a group to address their specific problem and make forward progress — that's what makes it unique. We'd welcome direct participation by the folks you're talking to.

What's the worst-case scenario for cities if the MSF fails and there are no open standards for augmented cities, only proprietary standards and walled gardens? I know some in the community await the Apple Vision Pro with dread, fearing that it might subsume all of XR into the App Store. Will the imminent arrival of "spatial computing" be good or bad for the open metaverse?

Having a small set of companies capture the industry probably isn't a good thing, even for the companies that win, because they'll be denied the larger network effects. Still, I think the Apple Vision Pro is a good thing, because it will raise the bar in many ways. We have a saying in the standards community: it's when you don't have proprietary competitors that you should worry, because it means what you're doing isn't important to anybody.

Chris Gilliard

Dr. Chris Gilliard's scholarship concentrates on digital privacy, surveillance, and the intersections of race, class, and technology. He advocates for critical and equity-focused approaches to tech in education and was recently profiled in *The Washington Post*. His works have been featured in *The Chronicle of Higher Ed*, *EDUCAUSE Review*, *Wired*, and *The Atlantic*.

The Apple Vision Pro includes: two high-resolution main cameras; six world-facing tracking cameras; four eye-tracking cameras; a "TrueDepth" camera; a Lidar scanner; light sensors, and and iris-based biometric authentication named "Optic ID" — all of which makes the Vision Pro and it's $3,500 price tag maybe the most expensive example of what you've dubbed "luxury surveillance." At the opposite end of the technical spectrum, *Pokémon Go* only requires a smartphone to play, but as Boone Sheridan underscored at the beginning of our cohort, it's also an example of what you've called 'digital redlining.' Would you please start by defining the two terms and how they're linked?

"Digital redlining" typically includes pedagogies, investment practices, institutional rules, and other decisions disproportionately impacting already marginalized communities. The classic example would be Facebook's use of ethnic identity or affinity on the backend and giving users the ability to target or exclude people for things like renting an apartment or applying for jobs. Being from Detroit, I use that term a lot because Detroit is an "interesting" — which is one euphemism to use — place to see the vestiges of redlining and how they make their way into everyday life even now.

"Luxury surveillance" I define as high-priced items — whether Teslas or Fitbits or Oura rings — with a strong surveillance component that are not typically thought of that way by their primary audience, but nevertheless helps normalize the idea of people exchanging their data or being watched by the devices they wear.

I don't know if they're intrinsically linked. They're on a spectrum of how computational tools are used to discriminate, and how the last 20 years have been marked by the increased marketing of surveillance-as-a-benefit, but there's also a strong delineation between who gets paid to be surveilled and who has surveillance deployed against them.

But doesn't the luxurious rebranding of XR as "spatial computing" invite new forms of digital redlining by enabling privileged users to annotate reality themselves?

I don't think it has to. The examples I have in my talk illustrated how these companies tend to operate — whether that's giving users options of the people and places they'd like to avoid, or tagging certain areas through geo-tracking and geo-fencing — but it doesn't need to be that way. I'm just not convinced it's going to go any other way. In other words, there's nothing natural about the discriminatory practices that arise from the implementation of a particular technology. These are decisions made all along the way from concept to product and everything in between.

In that vein, our cohort's concluding exercise explored potential futures at the intersection of technology and policy. One set of worst-case scenarios focused on "unchecked tech," where the present models of surveillance capitalism continue to run amok. Another set struggled to imagine how civic governments or communities themselves might harness these tools for civic ends. During your cohort presentation, you were also quite skeptical government could pose solutions to unchecked tech problems, given the history of law enforcement and so on. If not private companies and if not the government, who might bend outcomes in a different direction?

I think part of my skepticism comes from the idea that we will leverage oppressive or carceral technologies for a "good" purpose. With many of these systems, for instance facial recognition, I would argue that the preferable outcome is abolition. With any technology that has a strong surveillance component – where its data is available to anyone outside of the person it's being extracted from – is always going to be used in.

> **"The idea that we are going to harness certain exploitative technologies and put them to good ends is a severely misguided impulse."**

A question we should always ask is, "how essential is surveillance to the workings of this technology product?" And so, if we look at AR/VR, there are some things that I assume will be necessary — like eye-tracking and location-tracking. But once we get past that, we also need to answer the question of what else will be done with it? How long will they keep data? Who will have access to it? We should learn from the extremely long list of abuses by Google, Facebook/Meta, Uber, data brokers, and all other companies that operate under a surveillance model.

That question – of how the data will persist – is never satisfactorily answered to my liking when the guardrails are put in place by the companies themselves, or even when there are some kind of regulations or laws. First off, those are often temporary, or else there's a huge carve-out saying they can use whatever data to improve their product, which typically covers an incredibly wide swath of things, including sharing data.

So, in terms of recommendations, I'll give one very non-practical thing, and then maybe some more reasonable ones. I fundamentally reject the idea there are things we can't have without being fed into a larger machine. Whether that means everything happens on the device or is encrypted, the hurdles are often not technical. It's just that we're in an environment where grabbing as much data as you possibly can is still widely promoted and generally legal. So, my practical advice is to do as much work as possible on the device and have a legal regime that protects people or gives them the option to decide how they want these things to be made. That's pretty much non-existent at the moment except for some laws against facial recognition in California and Illinois.

My unreasonable advice is that we should reject these things unless these protections are available. I'm not of the belief that consumer rejection is going to drive innovation, but I think it can *stall* innovation. I consistently point to Google Glass, and although that was a different time, there was mass rejection of it...

some way that's exploitative, whether that's carceral, whether that's used to deny people services, or whether it's used to predatorily target them. I hate to say this because it sounds technologically deterministic, but it's the way society is currently structured. This is why surveillance is always a harm — because there isn't any form of surveillance under capitalism that isn't going to harm the most marginalized and vulnerable. It doesn't exist. I don't think it can exist. So, it's not that I think that regulations have no place – quite the opposite. It's just that I think the idea that we are going to harness certain exploitative technologies and put them to good ends is a severely misguided impulse.

I always cringe when I hear people ask whether a particular tech can be repurposed, because it's very unlikely to happen. In many cases you get something like an argument that to curtail certain kinds of public violence, we should all wear body cams. Meanwhile, there's scant evidence that body cams have produced the reforms in policing that boosters claimed it would. When you look at the history of progressive causes, there has never been one in the history of the United States where part of the means of disrupting it didn't come from surveillance wielded by law enforcement and other powerful institutions. Every initiative you can imagine — from the abolition of slavery to the Civil Rights Movement to LGBTQ+ rights. That's not accidental or incidental — it's part of how capitalism and institutional power works in the United States. There will never be enough safeguards in place because the problems are not technological.

So, if XR and spatial computing are the next manifestation of massively persistent surveillance, what lessons can we learn from previous iterations of surveillance to mitigate its harms and begin to dismantle it?

> **my practical advice is to do as much work as possible on the device and have a legal regime that protects people or gives them the option to decide how they want these things to be made.... My unreasonable advice is that we should reject these things unless these protections are available."**

...and now it's finally dead. But when you say "rejection," there are different kinds of rejection. There's ridicule and punching "glassholes" in the face, and then there are grassroots efforts like Block Sidewalk fighting a media campaign to win over electeds. What are the most effective forms of resistance to new forms of surveillance?

I can't, on the record, advocate punching anyone in the face.

Of course. No one involved in this project advocates violence, for the record.

I agree there are different ways to reject these things, but I also reject the persistent narrative that if you don't like something, don't buy it – you of course shouldn't buy it but it goes beyond that. In many cases these technologies are pushed on us to the extent that we often have few options for certain products. It's harder and harder to buy any item that's not connected to the internet. Even after Google Glass was roundly rejected, we saw the Meta/Ray-Ban collaboration. We saw Snapchat Spectacles. There's long been a push to have people wear some device with an active camera — for 10 years, at least. People aren't clamoring for them based on the lack of success by all these products, and yet they're still being pushed. What drives many of these technologies are the investment schemes of venture capitalists, not the needs or desires of communities and individuals.

And since that's the case, "just don't buy it" is insufficient. We not only need to not buy it, but also actively and vigorously reject these things, along with an active and vigorous demand that those things not be in particular spaces, and ostracizing people who try to shatter those boundaries.

But the non-existence of any regulation empowers these companies to keep pushing things further. You can see the difference in how the EU operates versus the U.S. when something like Worldcoin or ChatGPT appears, and Americans, particularly lawmakers, just throw up their hands and say, "Well, technological development outstrips laws." Meanwhile, the EU either uses the laws they have or — God forbid — passes new ones to address them.

But, as you mentioned there have been a handful of U.S. states that have passed laws against facial recognition — and a handful of cities and municipalities as well. Is there a role for smaller governments to take the lead on this, between grassroots resistance on the one hand and national- or supra-national protections on the other?

Yeah, look at the Biometric Information Privacy Act in Illinois. Look at Massachusetts. Look at California. Then again, we see things like the POST Act in New York — which was supposed to increase transparency around the ways law enforcement uses and obtains different surveillance technologies but wound up redacting all the information by saying it will embolden criminal activity. I do think local and municipal pushback is important, but these are some of the most powerful companies that have ever existed, and so it's hard for local governments to make rules that have teeth these companies are obliged to recognize.

If it sounds like I'm pretty pessimistic, I am. But I will say, as someone who's been speaking out against facial recognition for quite a long time, that people were once ridiculed for saying it should be banned. And that needle was moved by people speaking out strongly against it, by people demonstrating the ways that it is racist and often falsely implicates Black folks. So, I don't think this is impossible, only that it takes a tremendous amount of work and evidence and activism from a variety of sectors.

Keiichi Matsuda

Keiichi Matsuda is a designer and film-maker. His work explores the collision of physical and virtual, as technology transforms society, and new realities are born. Keiichi's practice combines concept film-making and interaction design, to critically explore the future of everyday life. His work has been widely exhibited, from the MoMA to the V&A, as well as attaining viral success online. His short film *HYPER-REALITY* was awarded Vimeo's "best drama of 2016," amongst other accolades. Designer and director of design and prototyping studio Liquid City. Keiichi gained expertise in interaction as VP Design for the visionary AI startup Leap Motion, before becoming Senior Director of Experience Design (Mixed Reality) at Microsoft. His pioneering cautionary short films about XR and AI have become mainstay references in the industry, leading to Keiichi's recognition in Augmented World Expo's XR hall of fame in 2024.

Despite your pioneering work in AR, you're probably best known for your films imagining the most dystopian uses for it. What drew you to the medium?

I started to get interested in the world of AR around 2009. I was studying architecture at the Bartlett School in London, and I'd been very interested about the effect of consumer technologies on society-at-large. More than architecture and urbanism, it was really technology driving the cultural change that was happening.

Just to put in context, the iPhone had only been out a couple of years at that point, social media was just starting to pick up, and open source projects like Wikipedia and Linux were starting to permeate the mainstream. There were so many exciting and revolutionary ideas I felt we, as architects, were not able to engage with. To me, AR represented the possibility of reconciling these upheavals in the way we do everything with the built environment and design of spaces.

What kinds of things can we do with spatial design that we couldn't do in the past, and what might that mean for cities?

Off the back of that, I started making concept films around what that future could look like. I tried to approach it from both a holistic and critical perspective — not just how we're going to sell this technology to people, but if it's left unchecked, what are the consequences? Some of those films paint what some might call a dystopian view, but that's in the eye of the beholder.

The most famous of those short films is Hyper-Reality (2016), which is still the best realization of AR at urban scale. Besides the ubiquitous advertising and gamification of everything, I'm always struck by your depictions of wayfinding and non-human agents — the latter of which you're actually building with Overbeast and Wol. What stands out to you watching it today?

I wasn't concentrating on a single technology, but rather the emergence of many different ones at the same time. From an urbanism perspective, I was obviously interested in smart cities and the ability to track and monitor usage of different services. One of the ideas I tried to depict was an idea I called "cloud architecture," which imagines spaces and areas that don't necessarily have to be programmed at the point of design. You wouldn't need to decide if this space is a library or clothing shop, but modify them on the fly and even be able to show different people different versions of the same space.

One example in the film is when our protagonist steps off the bus and the road is made over in AR as a park — one of many virtual overlays suggesting its use as a kind of public space. And then, when the city wants to reclaim it as a road, signs pop up in AR to move people out of the way so things can come through. I tried to imagine how this super-flexible usage of public space could be controlled at a granular level — so your experience of the city might never be the same. Different programmatic elements would emerge in response to the demands of the citizens.

There's also the idea that citizens themselves could be engaged in the production of space. We wouldn't need architects and planners to decide what our city looks and feels like and how we use it. I liken it to the

> **What if the conventions of media and the attention economy around advertising and offline monetization were inevitably applied to space because space is now media — how would that feel? What would that look like? And is that a place you would want to live?"**

rise of digital photography and video, which led to an explosion in how people engage with photography and the creation of memory. Could that happen to space? Because when we talk about AR, we're not talking about glasses or headsets. We're actually talking about the evolution of space from being something that is static to something highly dynamic.

Of course, that comes with downsides as well. What if the conventions of media and the attention economy around advertising and offline monetization were inevitably applied to space because space is now media — how would that feel? What would that look like? And is that a place you would want to live?

You started by asking these questions, and then began to answer them with your studio, Liquid City. In April 2023 you launched your first game, Overbeat, which might best be described as Godzilla versus Mothra crossed with the Premier League. What was your inspiration for its community- and place-based gameplay, and how might AR play out as a social phenomenon rather than a purely individual one?

When I started Liquid City, I was looking at different ways to manifest the idea that cities could be overlaid with any number of virtual layers or worlds accessible through our devices. *Overbeast* is one of those layers. It's a game in which you work with your neighbors and everyone who lives in your state to raise these enormous creatures called Overbeasts, and then have them battle ones from other states.

But it actually has much more to do with exploring your local context and environment. Because the way to make your Overbeast stronger is to feed them, and you do that by planting (virtual) trees around you. In the game, there's a persistent grid covering the entire surface of the planet — you can only see a little bit of it. You can plant a tree in one of those nodes and it will appear in AR as well as on this map — and on everyone else's map as well. It's a shared forest you work to grow together.

We were interested in how to foster local collaboration and communication between people living in the same place who might not necessarily know each other. You might be walking through a busy train station, open the app, and see trees others have planted you're able to nurture yourself. It's an experiment in whether it's possible for a city or state to come together with a common goal — in this case training your Overbeast and winning the league.

How might that collaboration translate offline? Is planting trees purely a gameplay mechanism, or might it encourage players to plant real ones as well?

We hoped to include a tree-planting initiative as part of the launch, but couldn't quite make it work in the end. *Overbeast* has a strong ecological angle. Rather than it coming to destroy your city, it's your task in the game to restore their habitat so they can win the league. Obviously, we're thinking about different ways you can expose aims or goals to people living within certain areas and then use these kinds of virtual overlays as a kind of connective tissue between neighbors who might otherwise never meet in the real world.

Overbeast is a game in the form of an app on players' phone, and that app contains its own map of the world. What happens when players share these maps or co-exist alongside other maps on a larger platform or visual positioning system like Niantic's Lightship? You've proposed the idea of overlapping "reality channels" anchored to fixed locations. How would that work in practice?

Most people are used to thinking about this like an app — I can load it up and pop it down in my room or on my tabletop and be immersed in this mixed reality. And that means everyone's off in their own little world. But people pretty quickly want to have shared experi-

ences, and then after that they start wanting persistent content, which is something you can put in the space and is going to stay there, that they can see on their own later as well.

We currently use apps to do one thing at a time — I'm talking to you on Zoom — but when we think about how software might exist in space, we don't necessarily want to transform our whole world just to do one thing. We might want to see several things together. So, to start, we need to rethink the app model of how they can coexist within a space, how they can communicate with each other, and discovery — what else is out there? Also, how can I control my view to just see things relevant to me, or maybe I want to see everything in a space. Or maybe I only want to see private content. And then it's about how I share things as well. Because if we're co-located in the same space but having different views of the world, it creates a strange social dynamic we haven't really seen before. We'll also need to find designs for indicating what is shared and visible to everyone else versus what is only visible to you.

There are lots of entirely new problems. The people tackling these problems are mostly coming from software development and design backgrounds. But as someone coming from an architectural background, I'm interested in these news spaces as spaces, and trying to think of affordances that can help us understand these new dynamics in a way that's intuitive.

Speaking of your background, one of the underlying themes of this project is how new urban technologies produce negative consequences and externalities as the inevitable byproduct of a software-centric perspective. What other perspectives do you feel are necessary in rounding out your development team? And what roles should public officials and local residents play in the co-creation of these visual languages?

Software generally lives in a known environment. It's like you have this screen space, and you can fill it up with a button here and a button there. That make it possible to generalize across a lot of contexts. Someone might use it in a different country, with different interests, but you can show the same thing to everybody, and that seems to work at scale.

But when you have content anchored to physical spaces and personalized to each user — and it's also something you experience as part of everyday life rather than loading up a thing, looking at it, and putting it away again — you have to be much more intelligent in how you design for those scenarios. One thing we can do as designers is to think more about the context in which a thing exists, and adapt the content to whatever the context is. That's something we're already used to doing in architecture. Whenever we design a new building, we start with a site analysis and try to understand the history of the space, along with local customs, regulations, aesthetics, and so on. All of those things inform the design we produce in the end.

With software, we now have these amazing tools — particularly artificial intelligence — to bring in a lot of that context as well. We don't have to create these rectangular sheets that exist independently of everything else. We can take input from where you are, who and what's happening around you, the time of day, what your tastes and interests are, and use all of those things to inform that experience. Architects may have a better understanding of context, but it's still an entirely new discipline bridging several others, including filmmaking and game design.

Since you mentioned AI, in 2020 you published a brief essay arguing AR at scale would produce a "spirit world" populated by intelligent agents populated by "gods" — albeit one more along the lines of animism rather than omnipotent beings. It was undeniably poetic but seemed impractical. Then ChatGPT happened. Fast forward to June 2023, where you unveiled a spirit animal of your own: the augmented AI owl, Wol. What was the journey from theory to implementation?

The idea of a spirit world populated by embodied AI agents is something I've been thinking about for quite a long time. It came from a frustration of how to use technology in XR. A lot of what we're used to is screen-based, and we have well-tested input methods for that — keyboards, mouse, touchscreens. While XR broadens the possibilities beyond screens, we don't really have inputs to match that — and if you've ever tried to type on a virtual keyboard hanging in the air, you know.

What could you do instead? If you were to create a system using voice and human-style communication, what would be a clearer mental model for the capabilities of such a system? And how do you address the huge

problem of trust that comes with it? If you imagine transferring our computing paradigm to something voice-based, then you're basically giving all of your personal data to a single organization and crossing your fingers they're going to do the right thing — with no real expectation that would be the case.

Rather than just signing up for Apple or Google as our one, true god, wouldn't it be more interesting if there was an ecosystem? And these AI agents would be numerous, rather than monotheistic. We could have this animist pantheon where there are gods in everything — gods who can be fallible. They might be very stupid; they might only be able to do one thing well. But that's great because it allows us to leverage the theory of mind and understand what an agent can and cannot do. We should be able to integrate AI into our lives in a way that feels friendly, approachable, and trustworthy — and if I don't like one agent, I can just throw it out and start again.

Wol is our first attempt at building an embodied intelligent agent that can act as your companion. It's a little owl who teaches about the redwood forest of California — you can ask it any question and it'll be able to answer. Using AR on either a headset or on your phone, you make a portal to the forest through which this owl flies and perches in your room. We didn't want to make it a didactic, wise, old owl that speaks down to you, but a learning companion with its own perspective that's curious to explore the redwood forest together. In that way, Wol allows the user to drive the conversation around their own personal interests.

How do you imagine agents working at urban scale? Will we see a panoply of agents moving through cities? Will we require permissions to see them — so some might only be visible to us, or invisible to us, while public ones are discoverable by all? Is this how we embed AI in public space?

Once you start to think of these things not as individual experiences you enter and leave, but as persistent companions that can keep on reacting to you and each other — with agent-to-agent communication — the possibilities multiply. Wol is focused on learning, but others have already talked about companionship and therapy. But anything with a body of knowledge that can be queried by the user would work — I can imagine agents for navigation rather than having a map with

buttons on it. And a god of transport who I can just tell where I want to go and how long I've got to get there. Or it might know I like to take the quiet route because I'm cycling, or that I like to see flowers along the way, or that I want to grab a coffee, or that I want to link up with any friends headed in a similar direction — anything that can take wayfinding to the next level.

But having agents that might exist in a particular space is interesting as well. When we were thinking about agent etiquette, we thought about Japanese shrines and how you might have an agent who lives in that shrine. Anyone who comes to visit can receive a crash course in how to act as well as historical information. You could also imagine restaurants or retail offering personal assistants within their spaces, offering recommendations or understanding dietary requirements. There are a lot of possibilities there.

We also thought about municipal agents able to check the local temperature. For example, you might have an agent who lives on your street, and every time you walk out your door you can complain to it about traffic noise or potholes, or the refuse collection hasn't come, or whatever. This agent would be able to absorb all of this feedback and report it back to local government. So, I think you can see the possibilities that emerge when you think about the combination of AI and persistent, location-based AR.

The final exercise for this cohort will be to imagine future opportunities and threats posed by augmented cities. You did yourself with a series of scenarios titled, "Stories from the Real-World Metaverse." What were your aims for the stories, and why do you feel such speculations are necessary?

In a world of persistent AR, overlays that exist everywhere and can be accessed by anybody transform software into civic space. From there we run into questions like, "Who is allowed to post?" "Who can put content where?" "Who controls it?" "What systems decide who sees what?" These may seem innocuous, like search filters, but as soon as we start to divide up space and decide who sees what, it becomes extremely political almost instantly. There are many different ways to approach it, and we're invested in imagining how it could work — the different structures you might apply to it, what he consequences would be for the user

> ❝❝ **as soon as we start to divide up space and decide who sees what, it becomes extremely political almost instantly.** ❞

experience, and what it would feel like to live in those different worlds.

The first story's orientation is the easiest to understand, in which reality is overlaid with a variety of channels allowing you a different view of the world. It could be a film noir or science fiction future, or if you're a skateboarder, you might remake your entire world into a skate park. Different people might subscribe to these channels and share a layer with you. But it also means each person in a given place is potentially living in a different reality. Although it's able to bring us together and collaborate in building these worlds, it also has the potential to separate us as well.

The others focused on everyone seeing the same world. But then you have to think about separating the content. In one, we looked at geofencing — different areas of the city are handed over to authors who can run them as they see fit. A store owner has made a beautiful creation inside to entice customers while the back alley is derelict and neglected and full of old advertising and augmented junk. There's also a street party where the local community in east London's Bangla-town have organized a local festival and transformed their street for it. So, there's this underlying idea of virtual property rights.

In another story, anything you do is visible to others, which makes it collaborative and open and bonds the community together. But there has to be requirements on the type of content you can add — maybe it can't be above a certain size so it doesn't cover the entirety of New York, for example — and other types of controls.

And the final example is minimal and personalized through AI. Our protagonist has moved to a new town and it's steering her toward all the things she should like. But she's recently divorced and decided she doesn't

want her old life, so she looks at other possibilities and starts to define a new one.

Each story features the same technology, content, and use cases, but each has radically different outcomes for the user experience. The goal was to explore and eventually find one we liked and wanted other people to agree with.

If these scenarios depend on virtual property rights or content moderation in civic space, it immediately raises the question of who administers these rights or moderates the virtual public square? Do you imagine a Department of the Real-World Metaverse, or should agencies start preparing now to administer these functions? And if so, how?

Some elements and decisions will be practical ones, such as ensuring people don't just wander into the street. There need to be safeguards, which might require demarcating some areas for richer content. The middle of a park might be fine — there, you can put whatever you want. And maybe there's content moderation, which will probably be organized by the platforms themselves.

But in other areas where you have lots of traffic, roadworks, and rapidly-changing environments, these AR overlays will persist even when the physical thing itself has changed. So, there may need to be an updated map depicting where you can and can't put things — essentially a public safety layer. I imagine that layer would have to be persistent across all platforms. It wouldn't make sense for an individual content provider to do all that mapping on their own.

There are other considerations that are less tangible and more focused on civic participation. Imagine Apple offers a series of layers or overlays that only people wearing Apple headsets can see. Google offers another, and emerging companies have their own as well. It would put us in a situation where we're all living in separate spaces — in separate zones of reality. You could argue this already happens, but we still have the city as our shared canvas all these experiences are painted against.

There are many ways we can approach it, but there's something vital and important in cities. I've just returned from San Francisco, where the whole city

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center has been decimated. It's tragic that people there are living on different layers of reality already, and it's only to the detriment of the city and people living there. Whereas other cities are doing a much better job of having everyone living in the same reality and enjoying the effects of density and people rubbing up against each other. My wish for the future of AR is that we can replicate these conditions and the juxtaposition of different elements in virtual worlds. If we can do that, it'll be a richer and more rewarding place to live.

Bilawal Sidhu

Bilawal Sidhu is the host of *The TED AI Show* **and is a creator, engineer, and product builder obsessed with blending reality and imagination using art, science and technology. With more than a decade of experience in the tech industry, he spent six years as a product manager at Google, where he worked on spatial computing and 3D maps. His work has been featured in major publications including Bloomberg,** *Forbes,* **BBC, CNBC, and** *Fortune,* **among others. He is also an angel investor and a16z scout, focusing on generative AI and spatial intelligence startups. When he's not working, you can find Bilawal perfecting his barista artistry and expanding his collection of electric guitars.**

In May 2023, Google announced a hundred new products and features at its I/O developers conference, and exactly one had to do with AR. That was the launch of its Geospatial Creator tool, which technically enables anyone to publish content on Google's ARCore visual positioning system. In English, what does that mean? What does a VPS do, and what does it mean that Google, Niantic, and presumably others — perhaps Meta's "augments" or Apple's visionOS — are building their own? What happens when reality becomes incompatible?

You're certainly going to have multiple maps of the world, just like you do today to get your morning latte. Of course, the granularity, the detail, and the precision of today's maps — OpenStreetMap, Apple's, Google's, what Amazon's building — are focused on different aspects of the real world. Amazon, for example, may care very deeply about not just mapping the road to your doorstep, but the mail room inside your building. Meanwhile, Google is striving for a map of everything in the world with enterprise applications built on top of it — and so is everyone else, right?

What you're talking about is the next evolution — the spiritual successor to these maps — which is not just about steering you to your latte, but about helping machines understand what you're looking at so they can augment and enhance what you're seeing, and at the same time creating a higher-resolution map, or "digital twin" as it's called in the current parlance, to host all sorts of applications, from the utilitarian to the delightful.

I had the opportunity to work on this at Google, which has been mapping the world in immaculate detail for the last 15 years. We had aerial data, street-level data, and satellite data, and we took all of that and fussed it into a digital twin with three facets. The first is a photo-realistic, human-readable 3D model of the world you're probably used to from Google Earth, for example. This is also the model that now hosts Google's Photorealistic 3D Tiles API. If you're an architect who wants to see what your building looks like in the context of what's already there, this is data you'd want to use — what's the view from the balcony? Where should the 5G tower go? These are the models you'd use.

And then there is this abstracted world model. This is probably the one you're used to from Apple Maps, taking all this rich sensor data from the world and creating meaningful abstraction that's both human-readable and machine-analyzable. In GIS parlance, if you think of something called a CityGML specification, a bunch of cities in Europe are maintaining 3D models of themselves like this for lightweight simulation applications, which you can also start attaching content to — things like land uses, zoning information, maintenance checklists, and so on.

Finally, there's the third, which is the one you're talking about: visual positioning systems, which are effectively machine-readable models of the world that are semantically classified. They are designed for humans; they're designed for your phone or a robot to perceive and understand where they are in the world. When you take all of this together, the scale of these digital twins is awe-inspiring, and as you mentioned, everyone is building one. Google has the most ubiquitous one, given the strength of Street View across more than a hundred countries, where Apple is more focused on where iOS devices are — which tends to be affluent metros — and capturing a far more detailed view.

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So, how is a VPS different from GPS? Well, the main value proposition of GPS is that it's a global system, right? But it has a very coarse-grain accuracy, which you've likely experienced in locations like downtown New York, where you might notice your blue dot jumping around drastically — multiple meters at times. That means your location is coarse, and even worse, your orientation is off. A couple of degrees makes a huge difference, and if we're talking 15- or 20 degrees, you certainly can't do any kind of spatially-accurate annotation of the world.

Global localization solves this problem by using GPS as a coarse location prior. For privacy reasons, it will only search a 100-200 meter radius around your GPS location, but will then refine that location to sub-meter accuracy in terms of position and a couple of degrees in terms of orientation. So, what that effectively enables you to do is start attaching content to the real world. If you want to attach this hamburger or this 3D model of a pirate ship at exactly that location, you can do that.

Another big difference is that GPS is a nearly-universal standard, while visual positioning systems are in competition with each other. How will this work in practice? If Google, Snap, Niantic, and others each have a VPS, who maintains a registry of what exists where in each? And if I'm a city official curious about how these systems interact with public infrastructure, will I have to keep tabs on each? Will the platforms moderate content themselves? For example, you helped Gorillaz host a concert in Times Square — what happens when everyone else wants a presence there? Is there a virtual land grab quietly happening?

This is just an evolution of the mapping land grab that's been happening for the last few decades. How does this relate to what cities are doing? Ostensibly, a lot of cities already have their own geospatial departments — certainly DOTs do. City- and state authorities are collecting a lot of higher-resolution data from things like aerial LIDAR scans, which consumer mapping companies don't typically collect. They have all this siloed map data sitting around that could be the foundational substrate for anchoring all of these things.

In the future, what I would like to see, for example, is the public sector making a city-scale experience with ARCore geospatial API, which is available at no cost to developers. DOTs could start building with this today. What if citizens could slap virtual Post-It Notes on critical infrastructure and upvote/downvote what needs to be fixed? That data could be seamlessly sent to relevant DOTs, which at the same time could mount dash cams on city vehicles to collect cheap, periodic surveys of the world to figure out where the roads are cracking and maintain infrastructure.

As for your question about the registry, I think the challenge there is the following. Let's say you have this publicly-discoverable layer of AR content. There's a reason Snap hasn't really taken a huge swing at that — nobody has. Because if we thought content moderation was hard in the YouTube and TikTok era, 3D content moderation is an order of magnitude more complex. So, as to the question of who owns the registry, there are a number of ways to skin that onion.

The first layer is the 3D location of the thing you're talking about. That could be a VPS, or the Open Geospatial Consortium has a specification called OGC GeoPose, which goes beyond simply saying there's something at

latitude-longitude-altitude, because — spoiler alert! — lat-long-alt isn't reliable. Temperature changes and tides mean that any location you measure may have multiple-meter differences depending on when you measure them. Something metallic like the Golden Gate Bridge might have an even larger variation. So, for AR applications where a couple of meters difference would throw everything off, that's something we could standardize — which is what GeoPose is trying to do.

The next layer up is 3D content management systems, and I don't think there will be a monolithic winner there, although there may be a monolithic standard for anchoring stuff to the world. For example, the public sector could use Google's VPS for attaching content, but then they have visibility and ownership of the CMS with their own proprietary LIDAR or what have you on top of it in their own cloud.

That's how I see this going, and maybe once consumer uses are popular, we'll see something along the lines of a TikTok "For You" feed for the real world — and it'll have all the same questions that come with algorithmic For You-style feeds, as you can probably imagine.

Is there a possibility of having the AR equivalent of top-level domains for those coordinates, administered by the equivalent of ICANN? Or is the field doomed to wrangling over standards until either a winner emerges or they exhaustedly collapse onto an open standard?

I don't know how standards are going to pan out. I think we'll get there with visual positioning, but as far as 3D assets go, I don't know where that gravity well will be. It's also hard to say how the registry might pan out, but I'll bring a couple questions I think it's important for policy officials to think about.

For one, there is no regulation stopping you, as a private citizen with your off-the-shelf iPhone — which has LIDAR and cameras — from creating digital twins of pretty much anything in public space. Anyone can image stuff, and that imagery is ending up in places like TikTok and Instagram, where it's being mined by open source intelligence folks in all sorts of interesting ways.

Who owns that digital twin? As far as I know, there's not much legal guidance around it. Let's say I'm renting a place and made a 3D twin of it — is that mine? Does

it belong to the person who owns the property? Does it vary between publicly-visible property, like storefronts, versus non-public places?

This is where you could see a collaboration between tech companies and the public sector. What are Google and Apple really good at? Knowing the brands people are commonly searching for, and all the commercial points of interest in a city. Amazon has everyone's address and the crème de la crème of logistics management. But public authorities know a lot more about who lives where, land use, and all that kind of stuff. Is there an opportunity to create some sort of framework fusing all of these things? Maybe there is. But the challenge is: how do you police this? Are you going to stop people from imaging stuff in the public sphere?

What happens when generative AI is added to the mix? Because in addition to strewing the world with unauthorized digital twins of real objects, there will be unauthorized, unreal objects polluting maps as well.

Yeah, moderation of real-world maps is easier than all of this AI stuff because there's a notion of provenance — "we image the world; it looks exactly like this." But with generative AI, I have no idea how that's going to pan out. We started this conversation with the notion of the machine-readable model — now we have a machine-readable model that understands the spatial world in which we navigate and the entities within. For example, you have an agent that can query the Maps API and offer personalized tours. Or maybe you're a field service expert for a city DOT running through a maintenance checklist, wearing AR glasses and speaking to a multimodal agent to create a detailed set of notes on what needs to be fixed. You can do all these cool things.

Let's say you're planning your vacation. You could have a snapshot of you — or at least some subset of what comprises you — roaming Europe to create the perfect itinerary for you. What are the types of things you'd love to see, what are the restaurants you'd like to eat at, what's the view from those places, where do you want to take photos? A lot of Gen Z kids already go to mapping apps to figure out the vibe of a place and where to do their little Instagram or Snapchat photo session.

And so, I think there are some really interesting things that will happen when you have an always-on spatial assistant sitting on your shoulder. Imagine walking into a café — "Hey, I'd like to order this, that, and the other thing" — and it just sort of happens. Then you're ready to grab it and be on your way — "Oh, I liked this place. Remember it." I think these types of applications will only get better and better. What's the Uber-class opportunity on top of this? I don't know, but it's certainly out there.

My last question is a double-edged one. What opportunities excite you the most? And what's the worst that could happen?

If I had to encapsulate it down to one thesis, the intersection of reality capture and generative AI is very, very interesting. Once you can perceive the world, you can re-skin and augment it. For example, with interior design, there are tons of applications once you're able to capture a space and try out different looks and aesthetics — it's an obvious e-commerce opportunity.

But the use case I'm most excited about goes back to my roots as a 12-year-old obsessed with visual effects, which is really what augmented reality is. Back then, I started with Flash 5, then started using things like Autodesk Maya and 3ds Max — all these 'traditional' tools requiring technical chops I had to build in order to create that content. Now it's really about your vision. Phones are these amazing digitization devices, and now with different AI models you can conjure up agents on demand and orchestrate them to do some magical things. All of the tech James Cameron had circa 2009 to make *Avatar* — all of the AR, VFX, 3D, real-time simulation perception tech — is available today to a kid in their bedroom. What does that mean from a creation standpoint? What does that mean from a consumption standpoint?

In a world where the incremental cost of creating content is nearly zero, are you watching that one-size-fits-all piece of content? Maybe, because we still want to have communal reactions. Or will it be hyper-personalized, and what degree of hyper-personalization are we likely to see? What happens when the content is the model itself rather than the output of the model? That's the question I've been asking myself, and I'm super excited to investigate.