*Category 3*

# Sensing and Device Infrastructure

## *What Type of Infrastructure Does This Include*

**Internet of Things (IoT) Sensor Networks**
low-power, distributed, sensors that report in real time or at set intervals when data is needed, generating low or high-volume condition and environmental data.

**Smart and Multifunction Urban Infrastructure**
street furniture such as poles that host smart lighting, sensors, cameras, communications, EV charging and, in some cases, edge compute in one networked asset.

**Environmental Sensing Stations**
fixed and mobile multi-parameter monitors for air, water, noise, biodiversity, and climate.

**Transport Monitoring Systems**
high-bandwidth, safety-critical systems for traffic management, incident detection, and demand-responsive operations.

## *Key Attributes*

**The layer that captures the state of assets and the environment:** condition, performance, and environmental parameters, continuously and in real time. It is what turns a physical asset into a source of data.

Deployed across water and transport networks, the built environment, and natural environments: sensors on pipes and pumps, poles along streets, stations in catchments and along roads, and cameras across the transport network.

Ranges from cheap, numerous, low-power sensors deployed by the hundreds to networked street furniture and safety-critical transport systems that must not fail.

Because sensing touches communities, Country, and identifiable individuals, its deployment is a data governance and privacy question as much as a technical one.

## *The Landscape: Investment, Legislation, and Trends*

IoT sensor networks are growing rapidly across water, transport, and the built environment.

Smart and multifunction poles are moving from pilot to mature, with the City of Melbourne and the City of Sydney as reference deployments.

Transport monitoring is mature, with Transurban, TfNSW, and VicRoads as reference points, and environmental sensing is established in water and environment agencies.

First Nations data sovereignty, the AIATSIS Code of Ethics, and privacy expectations for camera-based systems shape how sensing data can be collected, stored, and used.

*References: AIATSIS Code of Ethics; Indigenous Data Sovereignty frameworks; applicable state privacy and surveillance legislation.*

## DUAL LENS: OPPORTUNITY AND FOOTPRINT

### *Sustainability Benefits of Digital Infrastructure*

**Predictive maintenance:** continuous condition data enables operators to intervene before asset failure, cutting material waste, unplanned outages, and premature replacement. The Sydney Water sewer blockage case study below is an example.

**Environmental evidence base:** real-time monitoring gives the measured data that sustainability reporting and climate adaptation need, and provides early warning for hazards.

**Asset consolidation:** multifunction poles combine lighting, sensing, communications, and charging into one asset, removing duplicate street infrastructure and its embodied carbon, as well as de-cluttering the footpath to enhance access needs.

**Demand-responsive operations:** transport monitoring enables dynamic traffic management that reduces vehicle emissions and measures modal shift for enhanced insights and reporting.

**Climate resilience:** monitoring of asset conditions, water levels, atmospheric and ground movement gives owners data to act just in time, protecting assets and communities before and during extreme weather events.

**Evidence for communities:** air quality, heat, noise and transport data help councils target action where need is greatest, and sensing co-designed with Traditional Owners can support caring for Country programs.

**Lower whole-of-life cost:** condition monitoring can help in deferring capital replacement and cut the cost of unplanned outages.

### *Digital Infrastructure Issues to Watch*

01 **E-waste and batteries at scale**
devices deployed at scale reach end of life together, and battery replacement across large fleets creates a recurring disposal task.

02 **Embodied carbon and refresh**
carbon in manufacture and installation, camera and sensor hardware refresh cycles, and limited visibility of where and how devices are made, can accumulate across large deployments.

03 **Data volume footprint**
high-bandwidth monitoring generates large data volumes that must be stored and processed, pushing part of the footprint into the data category.

04 **Governance and privacy risk**
sensing that touches communities, Country, and individuals carries data sovereignty and privacy obligations that, if unmet, become a social licence problem.

05 **Consent and surveillance**
cameras and sensors in public space, and on Country, need privacy, consent and First Nations data governance arrangements agreed before deployment, not after complaints arise.

06 **Unfunded running costs**
battery replacement, data storage, cyber security and maintenance are sometimes operational costs that can be missing from an early-stage business case,

## *The Key Questions*

Considerations that might help a member organisation build a business case for action and investment and to govern well are included in the table below.

**P** PROCESS
*Have we developed data governance and privacy assessment within sensing procurement, and required end-of-life and battery disposal planning up front?*

**O** ORGANISATION AND CULTURE
*Is accountability clear for data drawn from Country and communities, consistent with Indigenous Data Sovereignty principles?*

**T** TECHNOLOGY
*Are we specifying open data standards and replaceable nodes so the network survives platform changes rather than being stranded?*

**I** INFORMATION
*Have we defined what sensing data is retained, for how long, and how it feeds sustainability metrics without creating an unmanaged storage footprint?*

## *Applying This Across the Asset Lifecycle*

Below are five common questions you may face across the asset lifecycle, each from the perspective most likely to raise it.

Sensing deployment can outpace the development of the appropriate governance frameworks. The lifecycle lens is about defining data governance and end-of-life requirements early, before large scale deployment occurs.

### Planning

*State authority asset owner*

*"We are planning a large sensing network across public assets. What data governance and sustainability requirements should we define first?"*

Define data governance requirements up front. Clarify accountability for data drawn from Country and communities, consistent with Indigenous Data Sovereignty principles, and set privacy expectations for camera-based systems. Sensing scales faster than its governance, so decisions now shape social licence. Require end-of-life and battery disposal planning as a condition, given the scale.

### Design

*Sustainability consultant*

*"I am advising on a sensor network design. How do I keep it from becoming stranded technology, that is, obsolete or unusable well before the end of its intended life?"*

Specify open data standards and replaceable nodes so the network survives platform changes rather than becoming obsolete. Standards fragmentation is the main threat to the data's long-term sustainability value, so design for interoperability from the start. Favour low-power, long-lived sensors to reduce battery replacement and e-waste over the life.

### Construction

*Construction company sustainability manager*

*"We are deploying sensors and smart poles by the thousand. What is the construction phase risk?"*

Embodied carbon in manufacture and installation, e-waste and batteries at the scale of deployment, and devices sourced from high-risk supply chains, are the main risks. Seek modern slavery and battery mineral sourcing assurance from suppliers, coordinate installation to reduce duplicate street infrastructure and disturbance to street trees and footpaths, and set up take-back. Record device counts and specifications so the owner can plan end-of-life from day one.

### Operations and Maintenance

*Asset owner and operator*

*"Our sensors generate huge data volumes. Does operating all this data carry a sustainability cost?"*

Yes, storing and managing large volumes of data can carry a sustainability cost. Define what sensing data is to be retained, for how long, and how it feeds sustainability metrics, rather than storing everything by default. Retained data carries an energy and cost footprint in the underlying compute.

### End of Life and Renewal

*Asset owner and operator*

*"Our first generation of sensors is reaching end of life. How do we handle it sustainably?"*

Devices deployed at scale can create a significant e-waste and battery disposal task if not planned. Set end-of-life and battery pathways at procurement, prioritise reuse and recycling, and record volumes recovered. Renew with replaceable-node designs and open standards so the next generation avoids the same stranding risk.

## *The Cost of Inaction: Gaps in the Current Landscape*

**Governance lag**
sensing scales faster than the rules around it, so data sovereignty, privacy, and consent obligations trail deployment and are expensive to retrofit.

**Standards fragmentation**
without shared data standards, networks are stranded when platforms change, and cross-sector value never materialises.

**Unplanned end of life**
devices installed without an end-of-life plan become an e-waste liability that accumulates years later, for the future asset operator