OPENAIR

Operational Network of Air quality Impact Resources

Sensing device deployment planning: high-level design template

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Overview

This OPENAIR template provides guidance on high-level planning for the deployment of a low-cost air quality sensor network. It will help you to consider and develop a plan for each step in this process, including locations, mounting solutions, power supply, and permissions.

Who should use this resource?

This resource provides extensive practical guidance relating to the deployment of a smart low-cost air quality sensing network. It is intended to assist local governments tasked with delivering an air quality monitoring project.

How to use this resource

As Figure 1 shows, it is recommended that you start with the OPENAIR *Identify template*, which supports creation of a business case and impact plan for a project. Step 2 is to use this deployment planning template alongside the OPENAIR *Technical requirements template* (as these two planning documents should be closely aligned). For a more detailed design process, see the Best Practice Guide chapter Sensing device deployment planning: detailed design.

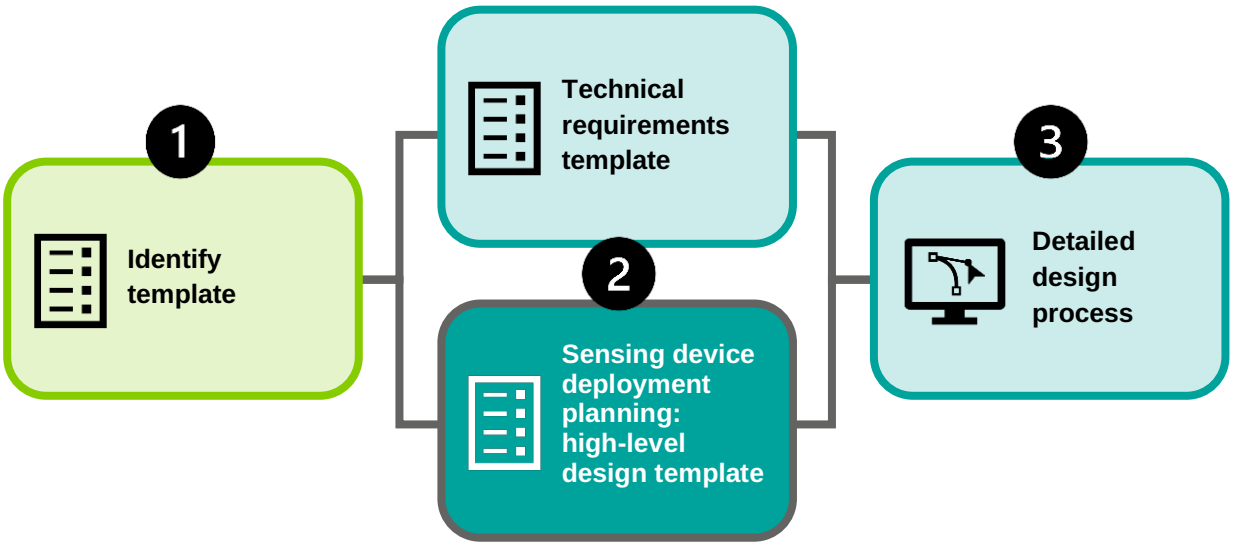

Figure 1. Overview of OPENAIR project planning and design templates

What is high-level design?

Planning a smart sensor network should ideally be done in two stages: high-level design, and detailed design. The OPENAIR Best Practice Guide chapters *Sensing device deployment planning: high-level design* and *Sensing device deployment planning: detailed design* contain more information on these two distinct design stages (as outlined in Table 1).

High-level design establishes the big picture details of a project. This process informs impact planning (e.g. confirming the feasibility of installing devices in a particular location of interest), and validates technical procurement choices (e.g. requirements for mains-powered devices in chosen locations).

Table 1. Overview of high-level and detailed design topics

High-level design	Detailed design
This template addresses the following high-level design topics: • General deployment locations • Mounting infrastructure • Power supply • Mounting solution(s) • Access and permissions planning.	This template does not address the following more detailed design topics: • Detailed deployment options • Preparation of approvals documents for detailed deployment options • Submitting/receiving approvals • Device labelling • Installation metadata capture methods and documents.

Process for high-level planning

High-level planning involves establishing what is required for your chosen data use case in key areas, which allows you to take the following actions:

1. Identify general deployment locations
2. Identify suitable mounting infrastructure
3. Select an appropriate power supply
4. Choose a mounting solution
5. Obtain access and permissions.

1. Identify general deployment locations

Aim: Identify one or more areas on a map where you plan to deploy sensing devices. It is not necessary to specify precise locations at this point.

TIP: Examples of general deployment locations in New South Wales:

- Central Station and surrounds
- Parramatta Park and surrounds
- Glebe Point Road
- Charlestown pedestrian precinct, Lake Macquarie.

Approach: General locations suitable for the deployment of sensing devices can be identified through a combination of three factors:

- support for your data use case
- viable communications coverage
- appropriate mounting infrastructure.

i. The location must support your data use case

To gather data that directly supports your data use case, one or both of the following statements must be true:

- Sensing devices must be located in a place that helps you to understand the impact of pollution on your chosen impact group.

AND/OR

- Sensing devices must be located in a place that helps you to understand the creation and dispersal of air pollution at and around a pollution source.

ii. The location must have viable communications coverage

Sensing devices must be able to reliably connect to a communications network from the chosen location.

TIP: At this early stage in the design process, acquire a detailed coverage map for your local government area. If you are engaging a communications contractor for a local area network, or for telecoms access, they can assist you with this. Check that your prospective location falls within a zone *expected* to have reliable coverage.

iii. The location must have the appropriate mounting infrastructure

You must have a general idea of the mounting infrastructure you intend to use in a general location.

Confirm your general deployment locations

Use Table 2 as a checklist to confirm the viability of each general location. Each row can be used for a different general location. You can refer to the next section for further details and guidance on mounting infrastructure, then return to complete the table.

Table 2. Location viability checklist

General deployment location	Does this location serve your data use case?	Communications coverage	Mounting infrastructure options
#1 **Name:** *(e.g. Central Square)*	Devices located in a place that helps you to understand the impact of pollution on your chosen impact group. ☐ Yes ☐ No AND/OR Devices located in a place that helps you to understand the creation and dispersal of air pollution at and around a pollution source. ☐ Yes ☐ No	☐ Strong (no concerns) ☐ Fair (site-specific checks will be particularly important) ☐ Marginal (you may find some viable sites, but expect it to be challenging) ☐ Unviable	☐ Local government-owned poles ☐ Third-party poles ☐ Other:
#2 **Name:**	Devices located in a place that helps you to understand the impact of pollution on your chosen impact group. ☐ Yes ☐ No AND/OR Devices located in a place that helps you to understand the creation and dispersal of air pollution at and around a pollution source. ☐ Yes ☐ No	☐ Strong (no concerns) ☐ Fair (site-specific checks will be particularly important) ☐ Marginal (you may find some viable sites, but expect it to be challenging) ☐ Unviable	☐ Local government-owned poles ☐ Third-party poles ☐ Other:

Please duplicate the bottom row of Table 2 as needed to complete an entry for each general location under consideration.

2. Identify suitable mounting infrastructure

Mounting infrastructure refers to physical assets on which sensing devices can be mounted. These need to be appropriate for the chosen data use case, and may be constrained by the location of the sensing network for a particular project.

Start by **auditing the potential mounting infrastructure** across all general locations, using Table 3. Include an assessment of each type of mounting infrastructure available (blank rows have been included for this purpose).

Table 3. Potential mounting infrastructure

Category	Type	Materials	Owners
Street poles	Street lighting – large standard (roads and thoroughfares)	☐ Steel ☐ Concrete ☐ Wood	☐ Local government ☐ Power utility ☐ Transport authority ☐ Private
	Smart poles – external mounting channel	☐ Steel	☐ Local government ☐ Transport authority
	Smart poles – internal mounting	☐ Steel	☐ Other
	Power lines – high voltage (HV)	☐ Steel ☐ Concrete ☐ Wood	☐ Power utility ☐ Transport authority ☐ Private
	Street lighting – small (parks)	☐ Steel	☐ Local government ☐ Power utility ☐ Private
	Regulatory road signage	☐ Steel	☐ Local government ☐ Transport authority ☐ Other
	Parking signage	☐ Steel	☐ Local government ☐ Other
	Other traffic-related poles (e.g. traffic lights or bridge supports)	☐ Steel	☐ Transport authority

Category	Type	Materials	Owners
			☐ Private ☐ Other
Bus shelters	Free-standing	Steel (extension mast required)	☐ Transport authority

Please duplicate relevant rows of Table 3 as needed to complete an entry for all potential mounting infrastructure.

Next, **assess the suitability** of the available mounting infrastructure. Table 4 describes the criteria used to assess the suitability of mounting infrastructure for the deployment of sensing devices.

TIP: A site visit to physically inspect prospective mounting infrastructure will usually be required to assess the criteria in Table 4. Google Street View can be a useful back-up tool for assessing specific locations, but should be used with caution as images can be out of date.

Table 4. Criteria used to assess mounting infrastructure

Critical/ not critical	Criteria	Description
Critical	Methodologically appropriate	Mounting infrastructure meets basic methodological requirements aligning with data use case, including: • preferred height above ground can be achieved • proximity to high thermal mass can be avoided • other contextual considerations (depending on use case).
Critical	Practically appropriate	Mounting infrastructure meets basic practical requirements that support operations, including: • viable power supply is possible • no significant communications interference or blockage • safe from vandalism, tampering, and theft • a structurally secure mounting solution is possible.

Critical/ not critical	Criteria	Description
Critical	Physically and safely accessible	Mounting infrastructure must be: • directly physically accessible by project staff OR a certified contractor (e.g. this might rule out various private premises) • safely accessible (e.g. this might rule out the median strip of a motorway).
Preferred (not critical)	Repeating infrastructure	Repeating infrastructure has a single blueprint repeated many times through the urban environment. Common examples are street poles, bus stops, and parking metres. Benefits include: • developing a single mounting solution that works for multiple deployments, keeping design work to a minimum • streamlining approvals • streamlining the installation process • keeping costs to a minimum. You may choose a location that does not contain repeating infrastructure, but does have a one-off mounting option. This is acceptable, so long as the critical criteria have been met.
Preferred (not critical)	Owned by your organisation	Mounting assets owned by your organisation are preferred options for device deployment. Benefits include: • approvals are faster/more straightforward • administration is simpler, particularly across the operational lifetime of the deployment • staff can maintain deployment across the operational lifetime, which enables easier arrangement of maintenance access, and can lower costs • greater flexibility in what and how you attach to the mounting. It is possible to deploy devices on mounting infrastructure owned by third parties. A common example are power and lighting poles owned by an energy utility. While this may present additional constraints, it may be the only viable option for certain locations.

Refer to the criteria in Table 4 to complete the checklist and evaluate the suitability of each type of mounting infrastructure available to you in Table 5. Refer back to Table 3 for the types of infrastructure you identified. Add rows as needed for each type of mounting infrastructure.

Table 5. Mounting infrastructure suitability checklist

Mounting infrastructure description	**Methodologically appropriate** (Y/N)	**Practically appropriate** (Y/N)	**Physically and safely accessible** (Y/N)	**Repeating infrastructure** (Y/N)	**Owned by your organisation** (Y/N)
(e.g. city-owned smart pole)	Y	Y	Y	Y	Y
[Replace with description of your available infrastructure]					

Please duplicate the bottom row of Table 5 as needed to complete an entry for each type of mounting infrastructure.

3. Select an appropriate power supply

Develop a high-level plan for power supply at each of your general locations. This need not be specific to individual mounting assets at this time.

First, consider your three possible power supply options (battery only, solar plus battery, and mains) in the context of:

- project requirements, technology choices, and resourcing capacity
- opportunities and constraints of the general location(s) and mounting assets you have chosen (e.g. if planning to use solar power, does your general location have adequate solar exposure? If mains power is required, is it accessible on the mounting assets identified?).

Table 6. Power supply checklist

General location	Power	Availability
#1 **Name:** *(e.g. Central Square)*	**Preferred power option**	**Availability**
	☐ Batteries only ☐ Solar + battery ☐ Mains	☐ Available and no access concerns ☐ Available but some access concerns ☐ Not available/accessible ☐ Not certain
	Back-up power option	**Availability**
	☐ Batteries only ☐ Solar + battery ☐ Mains	☐ Available and no access concerns ☐ Available but some access concerns ☐ Not available/accessible ☐ Not certain
#2 **Name:**	**Preferred power option**	**Availability**
	☐ Batteries only ☐ Solar + battery ☐ Mains	☐ Available and no access concerns ☐ Available but some access concerns ☐ Not available/accessible ☐ Not certain
	Back-up power option	**Availability**
	☐ Batteries only ☐ Solar + battery ☐ Mains	☐ Available and no access concerns ☐ Available but some access concerns ☐ Not available/accessible ☐ Not certain

Please duplicate the relevant rows of Table 6 as needed to complete an entry for each of your general locations.

4. Choose a mounting solution

Once the general locations for deployment are confirmed, the types of suitable mounting solutions will become clear. The next task is to list each type of mounting infrastructure, and develop a repeatable mounting solution for each.

MOUNTING SOLUTIONS
Most commercially available sensing devices come with mounting brackets and fittings. These mounting solutions may (or may not) be appropriate for a particular type of mounting infrastructure. In cases where standard mounting solutions are inappropriate, a custom mounting solution can be devised. A custom mounting solution may require pre-existing materials to be procured and integrated, or may require development of new, custom-designed components. Make sure you factor in the necessary time for design, approval, and fabrication of any custom solution in your project implementation plan.

Table 7 describes examples of common custom mounting solutions that may assist you in developing mounting solutions to meet your project's needs.

Table 7. Common custom mounting solutions

Custom mounting solution	Description	Approach
Custom smart pole connector	Connects to outer channel of a particular brand of smart pole on one end, and sensing device on the other end.	**Custom-designed component** Likely to involve fabrication of a new bracket, combined with a selection of standard components available from the smart pole manufacturer.
Pole extension mast	Extends the height of a street sign pole to achieve the desired device deployment height (e.g. 3.5m).	**Custom solution using standard materials** Achievable with standard poles, bolts, welding equipment, etc.
Custom bracket that allows screwing into a wooden pole	Most standard brackets connect to a pole using steel straps. To screw into wood, a connector plate with holes is required.	**Custom-designed component** A connector plate that can be added to the standard bracket.

Determine your mounting solution needs

Consider the mounting solution needs of your power supply equipment. Solar panels or external batteries may need to be mounted separately to sensing devices. Weight and wind loading may create additional engineering (and cost) requirements.

Determine the rough cost of delivering each complete mounting solution under consideration, and assess your options relative to project budget and internal resourcing capacity. Remember that costs will extend beyond the design and production of physical hardware, to include the cost of installation. Different mounting solutions may require different amounts of time and expertise from installers.

There may also be design constraints for mounting solutions that are imposed by the design of the mounting asset, existing policies, or the asset owner. These might include specifications for certain materials or engineering standards. Obtain relevant manuals or guidance documents, if they exist (e.g. a power utility company's documents detailing the correct mounting of third-party equipment to street poles).

Depending on your options and constraints, reassess your choice of general area or mounting assets for the project.

Determine what types of mounting solution are needed. Use Table 8 to identify the type of mounting solution required for each type of mounting infrastructure. List all the types of mounting infrastructure being considered in the left-hand column.

Table 8. Checklist to determine type of mounting solution

Mounting infrastructure description	Type of mounting solution required
(e.g. city-owned smart pole)	☐ Standard 'out-of-the-box' mounting solution ☐ Custom solution using existing components ☒ Custom solution using custom-designed components
[Replace with description of your considered mounting infrastructure]	☐ Standard 'out-of-the-box' mounting solution ☐ Custom solution using existing components ☐ Custom solution using custom-designed components

Please duplicate the bottom row of Table 8 as needed to complete an entry for each of your mounting infrastructure considerations.

5. Obtain access and permissions

Various types of permissions may be needed for accessing and installing mounting infrastructure. Regardless of where the mounting infrastructure is located or who owns it, you will need to get permission to attach a device and any additional components, to access power (if required) and ethernet (if required). Figure 2 outlines the steps in this process of obtaining access and permissions.

TIP: If your organisation owns the mounting infrastructure, access and permissions planning should be more straightforward. To access mounting infrastructure that belongs to a third party (e.g. a power utility), the process may be more complex and time-consuming.

Figure 2. Steps in the process of obtaining relevant access and permissions

Use Table 9 to establish a basic plan for gaining permissions and approval for each type of selected mounting infrastructure, and mark on the checklist when each action is complete.

TIP: In the detailed design phase, you will need to seek approval for all deployments. This involves developing an application that specifies all deployment locations, including details of each installation (i.e. what will ultimately be approved).

Table 9. Permissions and approval plan for mounting infrastructure

Mounting infrastructure description	To consider	Planning	Checklist
#1 **Name:** *(e.g. Central Square)*	What permissions are needed?	☐ General installation ☐ Solar panel ☐ Power (240V) ☐ Power over Ethernet (POE) ☐ Ethernet	☐ Obtain guidance documentation relating to mounting of hardware on poles, and establish options and constraints ☐ Establish application requirements, process, and time frame ☐ Establish follow-up process and documentation requirements ☐ Establish ongoing operational access requirements ☐ Submit generic/high-level proposal for mounting devices
	Organisations to engage	☐ Internal ☐ External - name of organisation:	
	Key contact person for the organisation	Name: Title: Email:	
#2 **Name:**	What permissions are needed?	☐ General installation ☐ Solar panel ☐ Power (240V) ☐ Power (POE) ☐ Ethernet	☐ Obtain guidance documentation relating to mounting of hardware on poles, and establish options and constraints ☐ Establish application requirements, process, and time frame ☐ Establish follow-up process and documentation requirements ☐ Establish ongoing operational access requirements ☐ Submit generic/high-level proposal for mounting devices
	Organisations to engage	☐ Internal ☐ External - name of organisation:	
	Key contact person for the organisation	Name: Title: Email:	

Please duplicate the relevant rows of Table 9 as needed to complete an entry for each of your mounting infrastructure selections.

Associated OPENAIR resources

Best Practice Guide chapters

Sensing device deployment planning: high-level design

This Best Practice Guide chapter explores the high-level design of a smart air quality monitoring network. It provides general guidance for selecting where to deploy devices, what to mount them on, how to mount them, and how to support their operation.

Sensing device deployment planning: detailed design

This Best Practice Guide chapter explores the detailed design of a smart air quality monitoring network. It builds upon high-level design activities and provides guidance for planning and documenting the details of specific device deployments.

Supplementary resources

Identify template

This template supports creation of a business plan and ‘data use action statement’ as strategic foundations for a smart low-cost sensing project.

Technical requirements template

This template is an extended practical step-by-step tool that supports the development of technical requirements for a smart air quality monitoring project. These requirements define the details of technologies (sensing devices, platforms, and services) that can meet the specific needs of a project and are intended to support procurement decision-making.

Further information

For more information about this project, please contact:

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This Best Practice Guide chapter is part of a suite of resources designed to support local government action on air quality through the use of smart low-cost sensing technologies. It is the first Australian project of its kind. Visit www.openair.org.au for more information.

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