

ANZLIC – THE SPATIAL INFORMATION COUNCIL NATIONAL POSITIONING INFRASTRUCTURE (NPI) POLICY

PURPOSE OF THE POLICY

The purpose of this policy is to outline a set of principles for the provision of a national positioning infrastructure (NPI) that will ensure sustainable, nationally compatible deployment of GNSS Continuously Operating Reference Stations (CORS) infrastructure capable of accommodating a variety of providers and ensuring an efficient and effective Australia wide coverage and service for the positioning needs of a diverse user community.

BACKGROUND

Positioning Infrastructure underpins the referencing and application of the majority of spatial data. In Australia the term “positioning infrastructure” is used to describe a very broad array of infrastructure elements that include:

- **Ground based survey marks.** These have historically been used to realise the geodetic datum and provide user access to the resulting coordinate system. Increasingly, these survey marks are maintained for specific applications like a coordinated cadastre, or in areas where GNSS positioning is not possible.
- **GNSS space segment.** In addition to the operational systems: USA’s Global Positioning System (GPS) and Russia’s GLONASS, there are now several other Global and Regional Navigation Satellite Systems (GNSS/RNSS) proposed or under development. Galileo is a comprehensive system under development by the European Union. Japan, China and India are developing GNSS/RNSS constellations. Realisation of these systems and modernisation of GPS and GLONASS will usher in a new era of enhanced, world-wide position, navigation and timing (PNT) capabilities. Importantly, these space based navigation and timing signals are presently accessible and expected to continue to be fully accessible to Australian PNT users. Further, Australia will be one of the few countries in the world able to access all of these systems, offering a potential coverage advantage compared to other parts of the world. While of fundamental importance to Australia’s positioning industry, this segment of the positioning infrastructure is not directly under Australian control.
- **GNSS ground control segment.** This element of the positioning infrastructure consists of ground stations used by the operators of the GNSS space segment to provide satellite orbit and time determination, system control and system integrity monitoring. A subset of these stations also has an uplink capability to the satellites.
- **Space Based Augmentation Systems (SBAS).** This element of the positioning infrastructure encompasses a set of communication satellites with ground based GPS tracking systems to distribute differential GPS (DGPS) correction data to SBAS purpose built GNSS receivers. Unlike the USA’s WAAS (Wide Area Augmentation System) Australia is not currently covered by a government funded SBAS. Australia is, however, covered by two privately owned SBAS which are targeted to specific applications.
- **Ground Based Augmentation Systems (GBAS)** encompass a set of ground based tracking stations and ground based communication systems (e.g., internet) to distribute

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correction data to purpose built GNSS receivers. There are three types of GBAS in Australia. One is the Australian Maritime Safety Authority’s GPS Beacon system which transmits differential GPS (DGPS) signals approximately 150 nautical miles out to sea. The second is an aviation specific GBAS operating at Sydney airport as one of the first such systems in the world. The third approach to GBAS is to use Continuously Operating Reference Stations (CORS). GNSS CORS consist of commercial grade geodetic GNSS receiver / antenna sets mounted on permanent monuments. A CORS can transmit single baseline corrections or when clustered into a network individual CORS data is retrieved via a permanent communication connection and collected, processed and re-distributed from network hubs or processing centres. The GNSS equipment is often collocated with additional sensors (e.g. weather stations). Importantly the data from these CORS can be used for a wide variety of applications, including, but not limited to, real-time precise (i.e., centimetre) positioning.

- Non-GNSS location devices.** A number of non-GNSS positioning systems are widely used (e.g. Radio-frequency identification or RFID, lasers, total stations, wireless, inertial). These systems offer a cost/benefit advantage for specific applications where GNSS does not provide sufficient coverage or required accuracy (e.g., lasers for accurate height control). Some of these systems will be in permanent locations and augment existing positioning infrastructure (e.g., Locata can be deployed to support mining operations). Others will provide temporary positioning infrastructure linked into CORS infrastructure (e.g. laser and GPS combinations or Smart stations combining total stations and GPS). The integration of non-GNSS technologies with GNSS can be expected to grow in popularity, capability and availability over the coming years. As a result, non-GNSS positioning systems will need consideration with respect to their role in a National Positioning Infrastructure policy.

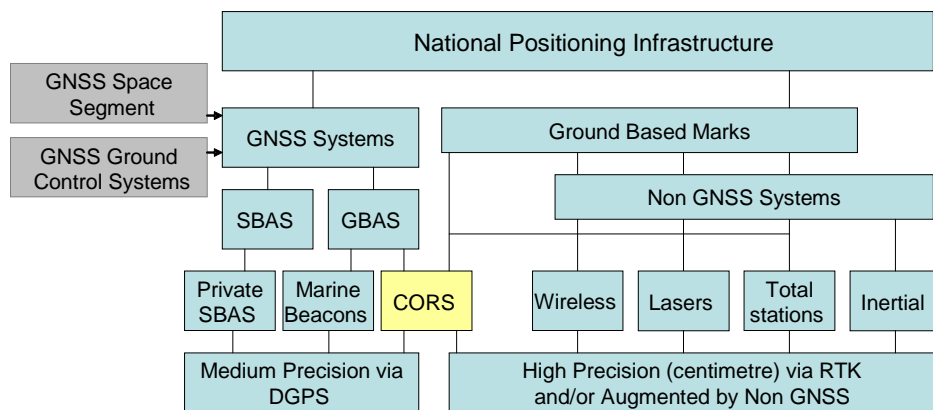


Figure 1: National Positioning Infrastructure

Figure 1 shows that the National Positioning Infrastructure (NPI) covers a number of technologies.

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CORS networks are at the core of this overall infrastructure and will be the focus of this policy. As a result the integration of non-GNSS technologies is outside the scope of this policy.

INTRODUCTION

Precise positioning has emerged as a critical capability for many sectors of the Australian economy including agriculture, mining, engineering and construction. Increasingly it is also a cornerstone of asset management, logistics and navigation for public and private transport and is a key element for counter terrorism, emergency management and border protection. Precise positioning will transform the Australian economy just as large scale road and rail infrastructure transformed economies in the 20th century.

It is estimated that a well co-ordinated nationwide, high quality positioning infrastructure will generate at least \$32 billion in additional productivity gains over the next 20 years, provided Australia completes the coordinated development of a national CORS network (Allen Consulting Group; Nov 2008).

While early development of the CORS infrastructure is desirable and will deliver positioning capabilities to Australian governments and industry yielding significant economic benefits, this early development is not currently funded or coordinated on a national basis. CORS infrastructure will however continue to be rolled out in this ad hoc manner, with the rate of the roll out determined by the levels of investment that can be made by various public and private sector players. Regardless of the rate of development of the infrastructure, it is timely to develop a national policy that will help steer the development of Australia's precise positioning infrastructure in a coordinated way so as to deliver optimum benefits to the nation as soon as possible.

ANZLIC, representing the key government agencies in Australia, which will play a role in the development of a national positioning infrastructure (NPI), has therefore developed this policy to provide a set of guiding principles that will assist in ensuring Australia has a viable positioning infrastructure that meets the economic, environmental and social needs of Australia.

BENEFICIAL OUTCOMES OF A NPI

The following benefits will flow from a well co-ordinated nationwide, high integrity NPI:

- Accelerated realisation (by users and operators) of the economic, environmental and societal benefits for Australia of an enhanced national GNSS positioning capability;
- A strengthened and sustainable National Geospatial Reference System (NGRS) from which trusted positions can be derived;
- A unified framework within which multiple providers of positioning-related products and services can thrive;

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- Maximised use and reduced duplication of precise positioning infrastructure while fostering competition and innovation in value-add segments of the value chain (minimise cost of access and maximise quality of position). (See Figure 1 for examples of how duplications might be reduced);
- Increased awareness of the possibilities and capabilities of positioning infrastructure across government and private industry;
- Increased accessibility of authoritative position information; and,
- Transformation of current positioning procedures and practices to yield significant productivity gains for a number of Australian industries.

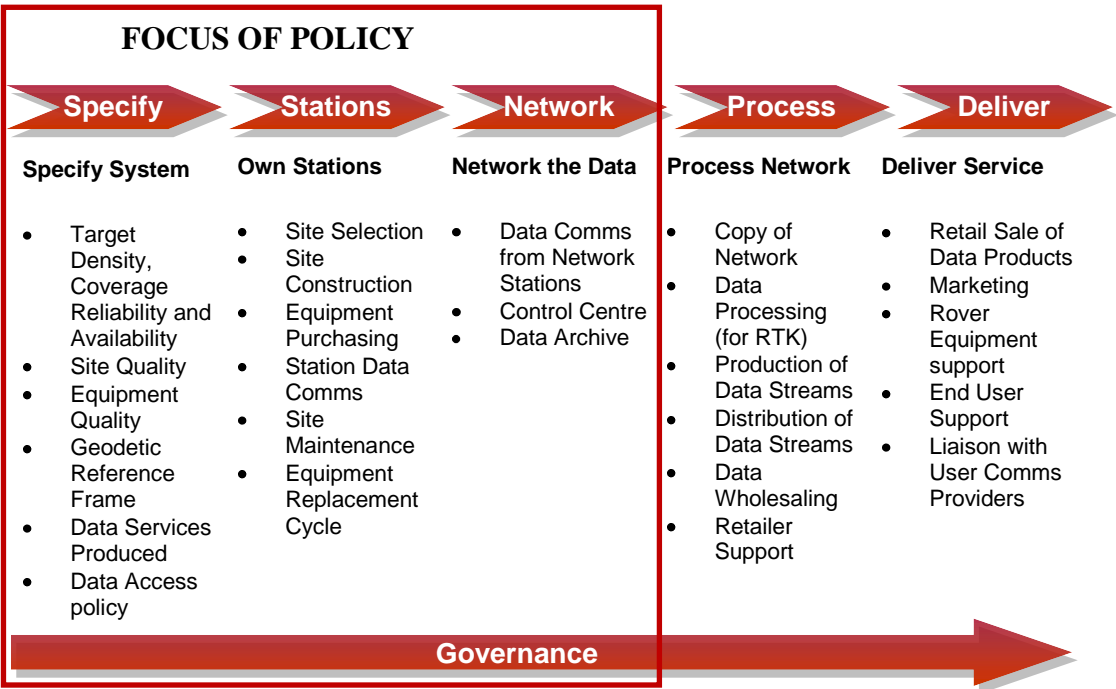


Figure 2: The various roles played in the establishment and operation of GNSS CORS (Higgins 2009)

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POLICY

Vision: To maximise the environmental, economic and social benefits of a national positioning infrastructure

The ability to accurately determine the 3D position of objects on the earth's surface has become increasingly common. As a result, positioning is today being used by specialists and non-specialists alike, for a growing number of applications (e.g. surveying, construction, mining, precision agriculture, asset capture, tracking, navigation, emergency response, law enforcement, insurance, security, climate/weather forecast and recreation). In order to maximise the benefits of positioning and the enabling infrastructure, and to provide assurance to users of the fitness for purpose of the position outputs, guiding principles are required to enable the consistent and reliable determination and use of position information.

This policy aims to provide guidelines and high-level definitions for the principles, responsibilities and requirements of CORS based positioning infrastructure. It also describes the attributes of the derived position that constitute fitness for purpose.

The following guiding principles will underpin the achievement of beneficial outcomes:

The national positioning infrastructure must be developed in accordance with the following guiding principles:

- 1. Purpose**
Including Fitness for Purpose, Flexibility and Extensibility
- 2. Interoperability**
Including Compatibility and Integratability
- 3. Performance**
Including Availability, Accuracy, Reliability and Integrity
- 4. Governance**
Including Transparency, Quality Assurance Access and Entitlements
- 5. Privacy**
Including respecting the privacy rights of NPI users

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Purpose

With the rapid growth in GNSS and continued technological development it is essential that the design and implementation of a national positioning infrastructure be flexible and extensible so as to accommodate future developments and remain coherent and effective. The system must also be able to accommodate historical approaches to precise positioning.

Policy

The National Positioning infrastructure, including all its component networks, shall be flexible and extensible to enable optimal use in current and future precise positioning activities across government, commercial, research and private domains.

Implementing the Policy

Implementation of the policy is as follows:

- ANZLIC has overall responsibility for the policy, including reviewing the policy on a regular basis; and
- ANZLIC will delegate the implementation to its Standing Committee, the Intergovernmental Committee on Surveying and Mapping (ICSM). ICSM is directed to establish a broadly based coordination body to develop an implementation plan for this policy. This body will be known as the ICSM GNSS CORS Coordination Group and will be a permanent sub-committee of ICSM.

Benefits

The national positioning infrastructure is available Australia wide and fit for purpose in a range of applications and services to realise environmental, economic and social benefits.

Interoperability

The interoperability of a positioning infrastructure relates to its ability to:

- Be interoperable domestically and internationally;
- Support applications of varying technical capability (e.g. highly technical networked real-time kinematic through to single base single frequency post processing applications);
- Supply services across multiple applications, for multiple users and using equipment from multiple manufacturers;
- Integrate with other technologies; and
- Ensure ongoing functionality.

A positioning infrastructure should be able to support a range of applications and services capable of utilising the position information generated. Additionally, an infrastructure

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should support the integration of other sensors and technologies with its positioning system components.

Policy

The National Positioning Infrastructure, and its component networks shall be interoperable on a national and international basis.

Component networks consist of collections of CORS (one to many) who are collectively operated by a single custodian.

Implementing the Policy

- To be included in the NPI any CORS shall:
 - implement open standards and platform independent protocols for hardware, data formats and communications, and;
 - be related to an authoritative coordinate reference frame (datum) to facilitate compatibility with other CORS and with spatial datasets.
- To implement this policy there is a need to promote:
 - this policy to infrastructure developers;
 - the use of open standards to achieve interoperability;
 - the use of position information as a valuable component for a variety of services, and;
 - research into technology integration.

Benefits

- Enables the development of a coordinated NPI based on multiple contributors.
- Allows data to be integrated with a range of other information in order to provide enhanced services.
- Maximises the value from investment in infrastructure through:
 - minimising expenditure;
 - avoiding duplication of effort and investment;
 - maximising the value from integration of technologies, including enhanced services; and
 - future-proofing infrastructure to the maximum extent possible.

Performance

With respect to positioning infrastructure, performance relates to:

- The implementation, monitoring and maintenance of CORS infrastructure;
- The use of positioning systems to serve multiple purposes;
- The speed with which a position can be determined and/or processed into meaningful information (e.g. a set of navigation instructions); and
- The quality of data output in terms of accuracy, availability and reliability.

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Positioning systems should be implemented, monitored and maintained in an efficient manner. The use of standards for interfaces, data and positioning methods will help to achieve this efficiency. In addition, the positioning infrastructure should be used to its maximum capacity, wherever possible, and for as many different purposes as possible.

The operational speed of the positioning system (including bandwidth, latency and throughput) should also be carefully planned, based on expected use. Importantly, the infrastructure should not inhibit the speed with which position information can be accessed by users wherever possible.

Policy

The NPI shall deliver the minimum necessary infrastructure to deliver an effective and efficient capability through:

- Optimum network design; and
- Optimum station performance in the network including data products, data latency and data quality.

Implementing the Policy

The ICSM GNSS CORS Coordination Group shall:

- Develop and promulgate criteria for optimum network and station performance;
- Develop and promote the use of standards and guidelines to facilitate efficient operation and maximum coverage; and
- Develop a national plan defining existing and planned infrastructure locations and equipment and preferred locations for future infrastructure so that the coordination group can actively encourage investment into underserved areas.

Benefits

- Increased operational efficiency for applications that rely on positioning.
- Reduced duplication of positioning infrastructure/components
- Maximum use of physical infrastructure elements (e.g. CORS)
- A high integrity NPI

Governance

Governance encompasses all aspects of managing the positioning infrastructure including the CORS, quality of positioning, system access, availability and entitlements.

Policy

- To participate in the NPI, CORS networks shall participate in a clear and transparent governance
- Each NPI component network will have a custodian responsible for its management and operation.

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Implementing the Policy

- The ICSM GNSS CORS Coordination Group shall:
 - Develop the NPI's business and technical governance framework considering issues such as custodianship, certification and legal traceability and assignment of appropriate responsibilities, accountabilities and entitlements;
 - Establish links with appropriate telecommunication organisations to ensure appropriate distribution of NPI services; and
 - Establish links with the broader non-CORS positioning infrastructure providers.
- Custodians should implement risk management measures to ensure certainty that the positions generated using their infrastructure are what they purport to be, and to adequately address potential legal liabilities.

Benefits

- Enhanced confidence in overall NPI;
- Clarity of roles, responsibilities, contributions and entitlements;
- Responsibility for each given positioning infrastructure element is recognised and unambiguous;
- Positioning infrastructure elements are managed according to best practice;
- Commercial arrangements are more straightforward;
- Custodians provide accountability to the users of the NPI.

Privacy

Determining the position of people raises the issue of privacy. Users of positioning devices that have only receiving capability are in full control of their position information. In comparison, users of devices that both receive positioning signals and transmit a resolved position to some sort of central server are potentially at risk of their privacy being compromised. In response, the NPI must rely on and conform to the Information Privacy Act 2000 and the best practice guidelines for spatial information privacy developed by ANZLIC (2004), along with the forthcoming Spatial Information Privacy Guidelines.

Policy

Privacy legislation shall remain the primary tool to address potential invasion of privacy through position-related applications

Implementing the Policy

- The ICSM GNSS CORS Coordination Group shall prepare educational materials describing the privacy risks involved in position determination and recommend practices to avoid or mitigate against such risks.

Benefits

The privacy of NPI users is protected.

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References

"Higgins M.B., 2008, An Organisational Model for a Unified GNSS Reference Station Network for Australia, Journal of Spatial Science, Vol. 53, No. 2, December 2008"
Available at <http://sites.google.com/site/higoogins/Home/publications...>

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Guidelines for the ICSM NPI Coordination Group

The National Positioning Infrastructure should be implemented, monitored and maintained such that individual CORS networks making up the infrastructure complement and are compatible with one another. In particular:

- Reference stations should be placed such that they improve the geometry of existing CORS networks in the vicinity wherever possible.
- Reference stations should be re-used by multiple positioning systems (i.e. Galileo receivers collocated with GPS and Glonass receivers preferably using the same antenna).
- Individual CORS networks should contribute to a common national framework that leads to interoperability, compatibility and integration.
- The establishment of a positioning infrastructure should be coordinated to ensure maximum coverage from the combined efforts of CORS providers.
- Standards for the establishment of CORS should be agreed upon and mandatory for any station to be considered for inclusion in the national network.