



Concurrent Technologies Solution Brief

Deploying Assured Position, Navigation & Timing (A-PNT)

From directions when you're driving, to the exact timing of stock trades, and the guidance of precision weapons, an accurate sense of position, the ability to navigate and synchronise time enable our modern society.

Position, Navigation and Timing (PNT) is critical to most of our foundational infrastructure. It enables phones to communicate, shipping containers to reach their destinations, and farmers to optimise crop yields.

Today, PNT relies on global navigation satellite systems (GNSSs) including the US Global Positioning System (GPS), the European Union's Galileo, Russia's Global Navigation Satellite System (GLONASS), and China's BeiDou.

The satellite-based augmentation system (SBAS) is a regional network of ground and satellite system that works to boost the accuracy and dependability of GNSS data.

The European Geostationary Navigation Overlay Service (EGNOS) is the European version of this system and the Wide Area Augmentation System (WAAS) is the United States equivalent. Japan has developed its Multi-functional Satellite Augmentation System (MSAS) to provide SBAS functionality.

India has launched its own SBAS programme (GAGAN) and China, Russia, South Korea, Australia and New Zealand have announced plans to start their own SBAS implementation.

 [Continued](#)

What is PNT?

The U.S. Department of Transportation has provided a summary of a National PNT Architecture:



Positioning (P)

The ability to accurately and precisely determine one's location and orientation two-dimensionally (or three-dimensionally when required) referenced to a standard geodetic system (such as World Geodetic System 1984, or WGS84).



Navigation (N)

The ability to determine current and desired position (relative or absolute) and apply corrections to course, orientation, and speed to attain a desired position anywhere around the world, from sub-surface to surface and from surface to space.

While this appears to be plethora of fragmented systems, they all comply with a common global standard and are therefore compatible and interoperable.

Each GNSS has its own ‘constellation’ of satellites, arranged in orbits about 20,000 km above the earth, to provide the desired coverage. Each satellite in a GNSS constellation broadcasts a signal that identifies it and provides its time, orbit and status.

These GNSSs are vulnerable to spoofing, jamming and cyber-attack so have become a single point of failure that puts military personnel, operations, and equipment at risk. Assured Positioning, Navigation, and Timing (A-PNT) systems rely on information from multiple complementary sources and/or multiple frequencies within a single constellation.

A-PNT is designed to provide the same or higher level of performance as the single GNSS systems currently used by military forces and civilian organisations.

Challenges of A-PNT Deployment

Developing and deploying an A-PNT solution presents challenges for prime contractors and system integrators.

- **Processing:** Data from multiple sources, received at different times and in different formats, must all be processed quickly and efficiently.
- **Connectivity:** That data must then be distributed to a range of other systems both in the field and in command centres.
- **Interoperability:** A-PNT solutions are part of larger systems so must work with other hardware and software.
- **Security:** At all points in the process, data must not only be protected but must also accommodate varying combinations of classified and unclassified information.
- **Ease-of-use:** The end user expects a seamless transition from their GNSS interface to a more powerful and secure A-PNT system.

How is A-PNT Implemented?

Military applications are uniting around the SOSA™ Technical Standard with OpenVPX™ technology as the hardware enabler of choice to ensure interoperability and alignment with open standards.

The Concurrent Technologies **PR A11/61d-RCx** is a 3U VPX plug-in card designed for high accuracy A-PNT applications.

 [Learn more about PR A11/61d-RCx](#)

Timing (T)

The ability to acquire and maintain accurate and precise time from a standard (Coordinated Universal Time, or UTC), anywhere in the world and within user-defined timeliness parameters. Timing also includes time transfer.

In military applications, PNT also requires position to be accurate within a few centimetres to, for example, know exactly where assets (i.e. military vehicles) are on the battlefield.

In terms of timing, there is a requirement at the system level for precise timing alignment of processing and I/O, for example RF transmission to/from the air.

Where is A-PNT used?

Typical military applications for A-PNT include Electronic Warfare (EW), Software Defined Radio (SDR) and radar processing.

The US Army’s program of record for A-PNT is called MAPS (Mounted Assured Precision Navigation and Timing System), which works and is being fielded but may not be cost-effective for applications across military branches.

Many complex systems using GPS need to transition to A-PNT and so additional complementary solutions to MAPS are needed.

PR A11/61d-RCx 3U VPX Plug-In Card (PIC)

Key Features

Runs a turnkey application allowing the user to configure the timing signals to the backplane, provide grandmaster clock plus assured position and navigation information over an Ethernet link.

- Suitable for use in extreme environments
- Supports the latest OpenVPX timing profiles
- Mitigates for GNSS jamming and spoofing
- Minimal timing drift during long periods of GNSS denial



Figure 1: 3U VPX PNT PIC

Block Diagram

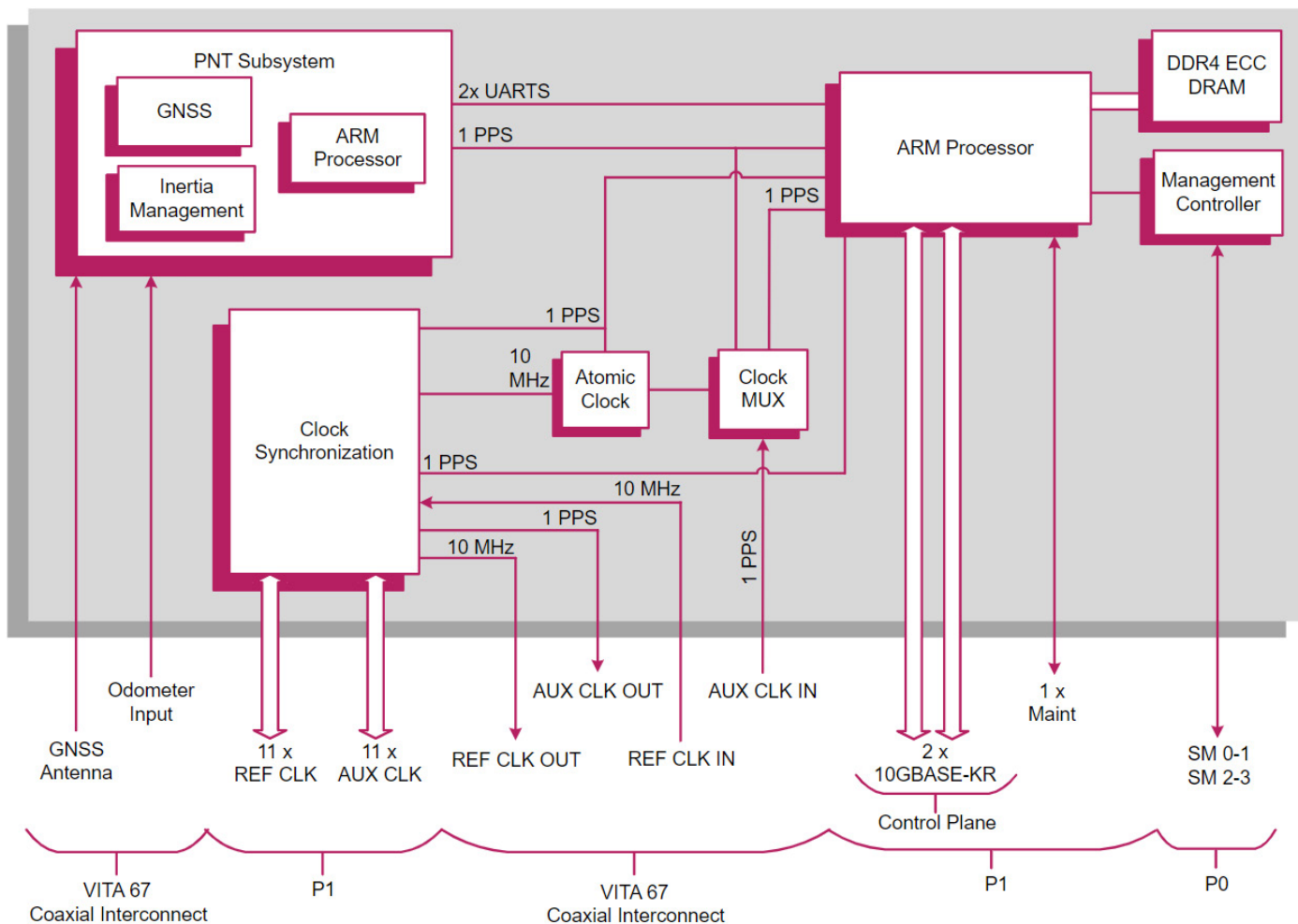


Figure 2: 3U VPX PNT PIC Block Diagram

Want to find out more?

[Download PR A11/61d-RCx Datasheet](#)

| Form Factor | Processor | Control Plane | |
|---|---|---|--|
| SOSA Compliant 3U VPX | Embedded Processor for control & management | 2x 10GBASE-KR | |
| GNSS Module | Assured PNT Features | Timing / Synchronisation Distribution | VITA 67 - Coaxial Interconnect |
| Multi-constellation Multi-frequency Interference and jamming mitigation | Chip Scale Atomic Clock (CSAC) Inertial Measurement Unit (IMU) | Differential radial clock distribution IEEE1588 PTP (802.1AS) Grandmaster NTPv4 | GNSS Antenna Input Odometer Input Ref Clocks in/out Aux Clocks in/out |

Table 1: Key features of 3U VPX PNT PIC

The GNSS module provides accurate timing reference and position, and also handles jamming and spoofing detection and reporting.

The Chip Scale Atomic Clock (CSAC) supports the accuracy and stability of the clock signals. It continues to provide a highly accurate timing reference if the primary GNSS reference is lost or compromised and then is disciplined back over a period of time once the GNSS signal is restored.

The Inertial Measurement Unit (IMU) tracks a relative position over time to validate GNSS signals and provide continued data if GNSS signals are compromised. The IMU provides additional ground truth information with by the triaxial gyroscope and a triaxial accelerometer.

The Concurrent Technologies PR A11/61d-RCx 3U VPX plug-in card also offers an odometer input, which is a common external sensor for ground vehicles is to provide another independent measurement of displacement and velocity that can aid the total navigation solution. An odometer is especially useful when the GNSS signal is denied, for example when traveling through a tunnel.

A-PNT Data Format

Connectivity over two 10GBASE-KR Ethernet interfaces is the basis of the timing and synchronisation distribution as well as for sending the A-PNT information to subscribers.

This data can be configured to follow the NMEA (National Marine Electronics Association) data format, an industry-wide defacto standard followed by many GNSS manufacturers. The card can also provide data in a GNSS raw format.

NATO Generic Vehicle Architecture (NGVA) Data Format & Generic Vehicle Architecture (GVA)

NATO Generic Vehicle Architecture (NGVA) is a NATO Standardisation Agreement (STANAG 4754), based on open standards to integrate military systems and to exchange data among vehicle subsystems. The UK GVA (Def Stan 23-009) also defines a data model approach for interoperability purposes. The NGVA standard is built upon the Data Distribution Services (DDS) infrastructure and adopts the data distribution protocol to interoperably exchange information among the various subsystems.

Concurrent Technologies is adding the NGVA format to its PR A11/61d-RCx 3U VPX plug-in card and has developed a proof-of-concept rugged small form factor system to demonstrate this use case.

(NATO) Generic Vehicle Architecture (N)GVA Assured Position Navigation Timing (A -PNT) Rugged SFF system

- “(N)GVA Ready” Assured Position Navigation Timing System
- Plug-In Ready to Go
- Dual 1000BaseT Ethernet connections
- GNSS Antenna Input connector
- Odometer Input
- Ref and Aux CLK In
- Ref and Aux CLK Out
- Anti Tamper / Tamper Evident

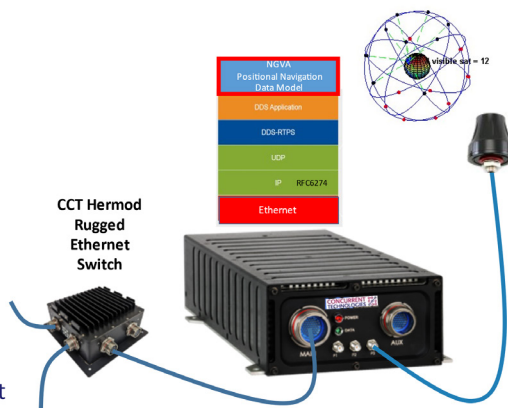


Figure 3: NVGA A-PNT Proof of Concept

Timing & Clock Distribution

Clock distribution networks synchronize the flow of data signals among synchronous data paths.

The design of these networks can dramatically affect system-wide performance and reliability.

Concurrent Technologies A-PNT solution offers both differential radial clock distribution and can act as a Precision Time Protocol (PTP) grand master following the IEEE 1588 protocol, as well as an Network Time Protocol (NTP v4) server.

As a VPX plug-in card the PR A11/61d-RCx can collect timing data from satellites and drive highly accurate (nanosecond accuracy) reference clocks to the backplane to keep the system – and associated systems in an overall vehicle architecture - aligned.

Conclusion

The demand for reliable, portable and integrated PNT-capable solutions, which are ITAR-free and built on Open Standards, has never been higher.

Concurrent Technologies is at the forefront of providing ruggedized, deployment-ready, PNT solutions, which facilitate accurate battlefield command and control integrations.

[Learn More About Our PNT Solutions](#)

What Makes PNT ‘Assured’?

Using multiple complementary PNT technologies that leverage proven and trusted techniques allows a system to arrive at the concept of a ‘truth’ in PNT terminology.

This validation of data by cross-verification is what makes PNT ‘Assured’. Using multiple constellations and frequencies is one method of validating GNSS data.

A-PNT systems also employ an Inertial Navigation System (INS), which uses rotation and acceleration information from an Inertial Measurement Unit (IMU) to compute a relative position over time.

The GNSS data and IMU data can operate in a symbiotic way, enhancing each other to provide a powerful navigation solution. An IMU is made up of six complimentary sensors arrayed on three orthogonal axes.

On each of the three axes is coupled an accelerometer and a gyroscope. The accelerometers measure linear acceleration and the gyroscopes measure rotational acceleration. With these sensors, an IMU can measure its precise relative movement in 3D space.

The INS uses these measurements to calculate position and velocity.

A Chip Scale Atomic Clock (CSAC) ensures stable and accurate timing when GNSS time signals are unavailable, further enhancing the reliability of the A-PNT truth.

GNSS Denial

Techniques are required to mitigate malicious interruption of GNSS service:

Jamming

Usually caused by interference to the signals at GNSS frequencies. However, jamming may also be caused by unintentional means, including space weather or faulty equipment that can radiate signals on the L1 frequency and jam GNSS signal reception.

Spoofing

GNSS spoofing is the provision of GNSS-like signals, transmitted locally and coded to fool the receiver to think it is somewhere it is not.

Not all GNSS denial is malicious. A GNSS receiver needs a clear line of sight to the satellites it is tracking. If the line of sight to a satellite is blocked by objects such as buildings or trees, the receiver cannot receive signals from that satellite. In locations that have a lot of obstructions, such as the downtown area of a large city, the obstructions can block so many satellites that the receiver cannot calculate its position or time.

The Concurrent Technologies PR A11/61d-RCx includes features to mitigate GNSS denial situations, including:

- Multi satellite constellation tracking
- Multi frequency
- Elevation masking
- Inertial Measurement Unit (IMU)
- Odometer

The spoofing and jamming detection provided is implemented within the GNSS receiver, once operation has started in a clear environment with valid GNSS signals, ideally from more than one constellation.

Spoofing detection tracks the signals and reports any suspicious changes. Jamming detection monitors the noise level and uses configurable thresholds to report continuous wave and broadband jamming.



Concurrent Technologies is an international ISO 9001:2015 company specializing in the design and manufacture of commercial-off-the-shelf and custom designed industrial computer boards for critical embedded applications.


The company, which was founded in 1985, has offices in the USA and UK, as well as a worldwide distributor network.

The company has a wide range of high-performance Intel® processor based VME, VPX™, CompactPCI® and AdvancedMC® products, which are complemented by an extensive offering of XMC (Express Mezzanine Card) products. Concurrent Technologies is a Titanium member of the Intel Partner Network Alliance.

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Would you like to find out more about our wide range of embedded computer solutions?

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