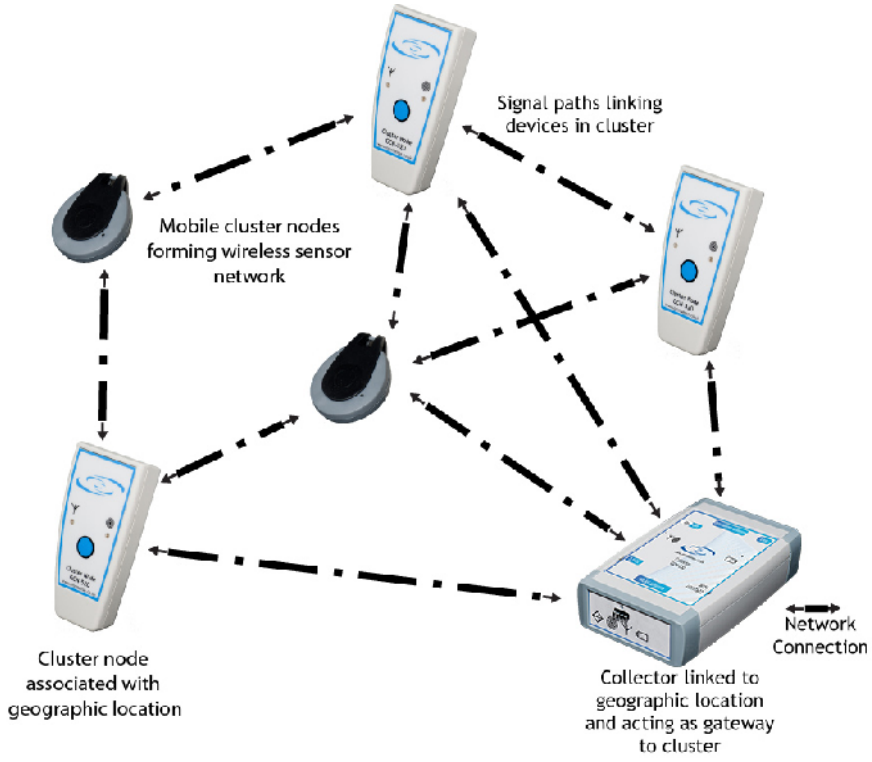
Rapid and Flexible Deployment Scenarios using the Omnisense Series 500 Geolocating Sensors

The Omnisense Series 500 cluster geolocation system lends itself to flexible and rapid deployment in ways not possible with conventional locating systems reliant on fixed receivers, transmitters, access points or anchor nodes. It is aimed at professional applications involving groups or teams of people and/or assets operating in a local area indoors or outdoors. Target applications include: emergency services, mining, healthcare, livestock monitoring, event management and sport.

Overview of the Series 500 System

Omnisense has created a new wireless sensor network system with true real-time geolocating capability to track people, animals and assets indoors and outdoors without the need for permanent or pre-installed infrastructure.



The system comprises a number of cluster node devices which communicate with one another using licence-exempt 2.45 GHz radio signals to form an adhoc mesh network. They use true radio range measurements to precisely determine how far they are from their neighbours in the network. Using the measured ranges the Omnisense Location Engine computes relative positions for all the devices in the network to high precision (1 to 3 metres) without needing any permanent or pre-installed infrastructure.

The system does not use specialised Access Points or Anchor Nodes – it is based solely on shared measurements amongst neighbouring sensor devices.

Each node is a small battery powered device containing the radio transceiver and a collection of additional sensors, including: accelerometer, magnetometer and optionally rate gyroscope and barometer. These sensors are used for additional motion and behaviour monitoring of the subject. A pair of LEDs provide information about the operating status of the device and network to the user, and a push button is available for use according to the needs of the application.

One of the sensors is packaged as a gateway device called the Collector which includes Ethernet interface and TCP/IP network allowing it to connect to external applications anywhere on the LAN or WAN (Internet). The Collector also provides essential management tools for configuring the sensors, accessible using the built in web interface. No external Position Processing application is required, all calculations take place within the sensor network; computed positions are delivered to user applications.

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Parameter	Description
Node size and weight	GCN520 : 95x46x24 mm, 70g (Standard node) GCN530 : 120x90x50 mm, 360g (Vehicle node) GCN510 : 56x44x15 mm, 30g GCN550 : 120x70x30 mm, 120g (Collector)
Radio specification	IEEE 802.15.4 at +10 dBm, and IEEE 802.15.4a at +17 dBm 2.45 GHz licence-exempt, ETSI and FCC compliant
Battery	Rechargeable or replaceable alkaline depending on sensor node
Operating Time	Depending on use profile of application: 1 day to 1 year
Operating range	At least 250 metres between nodes with line-of-sight
Location update rate	Depending on application and use requirements: 1 s to 60 s
Positioning accuracy	1 to 3 metres depending on environment and configuration Positions calculated using integrated Omnisense Location Engine
Auxiliary sensors	Accelerometer, magnetometer as standard Rate gyroscope and barometer optional
Network size	Up to 40 nodes, increasing to more than 1000 in the future.
Network connectivity	TCP/IP over Ethernet (Collector). JSON API for interface to 3rd party application software
Configuration and Management	Web interface in Collector

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Deploying the Series 500 system in real applications

When the Series 500 system is started from scratch it treats all devices as mobile and computes their relative positions within an arbitrary coordinate frame. This can be useful if all one wants to know is the relative positions (or distances) between the nodes, but in most applications it is helpful to provide some context. To do this we usually associate a number of the nodes with attributes of the environment: for example a doorway or other fixed feature. The number of devices that are fixed depends on what is needed from the system: it could be as few as three, although more typically 6 to 12 would be associated with the fixed environment.

This is done by choosing a specific coordinate frame, which may be the coordinate frame used on the map or plan of the environment we are operating in. Devices associated with the fixed environment don't move so we can fix them at the position they are placed, by entering their approximate coordinates using the web management interface on the Collector. Note that the positions do not need to be accurately input because the system only uses them as a guide to key the system positions to the chosen coordinate frame, however, it is helpful if at least a few devices have fairly accurate coordinates configured. The ability to use coarse positions for fixed devices, such as positions obtained by simply pacing the area or reading coordinates directly off a map, is what allows Series 500 systems to be rapidly deployed.

Sometimes it might be valuable to constrain devices in a semi-fixed way: for example to constrain only the height; or to limit their mobility along a baseline. Some of the ways these different constraints can be used is illustrated in the case studies described later.

Even though the Series 500 system is ideal for flexible systems and those requiring rapid deployment it is also advantageous in many fixed installations due to there being no need for cabling linking the fixed devices, and the low cost of the fixed devices. For the best accuracy it is advantageous to install more fixed devices than the minimum, and with good area coverage reliable performance at the 1 metre level can be achieved.

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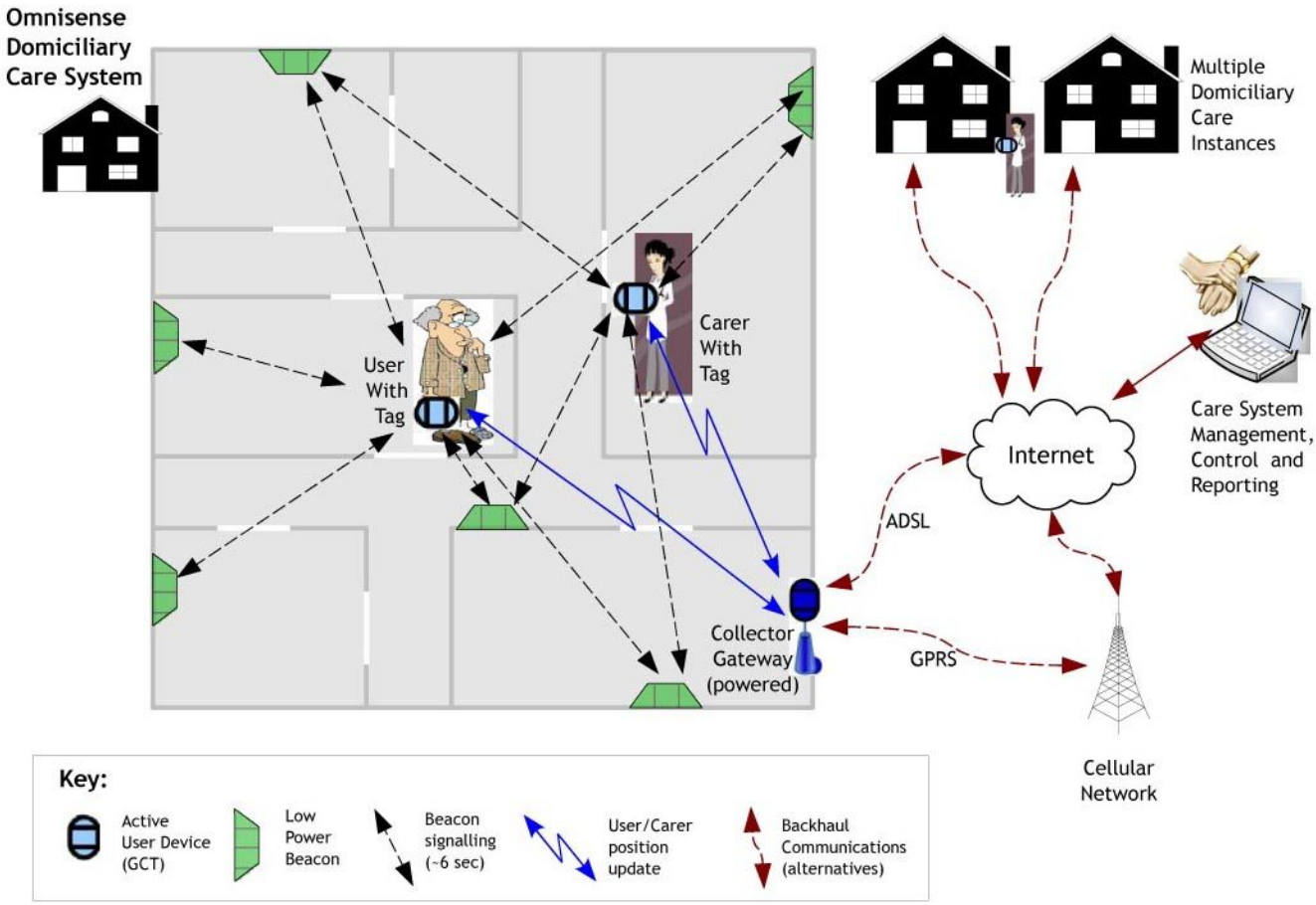
High precision tracking around premises

For some applications, such as healthcare, there is sometimes a need to monitor people around residential premises in order to provide the best possible level of care. Sometimes these residential applications can require high precision tracking in order to be able to reliably determine the precise whereabouts of the users, including reliable position in small rooms with dimensions under 2 metres. It is also particularly important to be able to distinguish between rooms upstairs and downstairs, and often positioning around the garden and outbuildings is also required.

Residential premises rarely have LAN cabling fitted, and often no Wi-Fi. Sometimes the system only needs to be installed and used for a limited period of time before being removed. The Series 500 system is easy to set up and it can be installed in a residential setting with very little effort, no specialist skills or tools required and no new cabling to install.

For high accuracy positioning around residential premises we'd normally use 8 to 12 nodes in fixed positions: typically four upstairs, four downstairs and four to cover the garden and outbuildings. Typically between 2 and 6 users would be tracked. In this application the accelerometer is used to monitor user behaviour and to detect falls. The button is used as a call or alert button that the user may press to call for help.

The Collector is connected to an Ethernet port on the broadband internet router allowing the care provider to remotely monitor user behaviour in real time. At the care facility multiple residential installations can all feed back into a common care management system.



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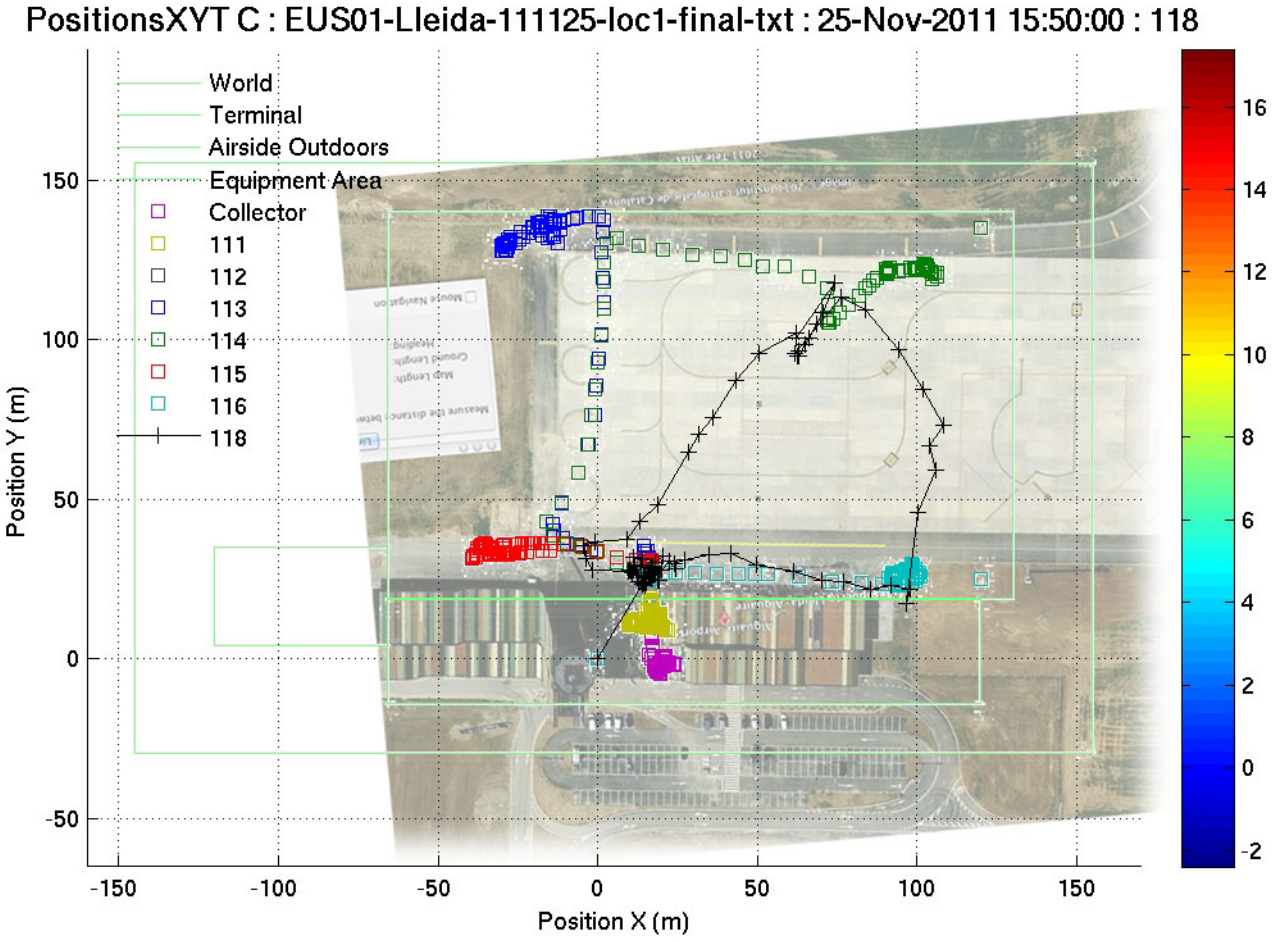
Case study: Rapid deployment at an airport

This exercise was run as a test of rapid deployment capability of the Series 500 system. It was conducted at Lleida airport in Spain, the objective being to track users around the airside apron area during a short time window of just 40 minutes. During this period the system had to be deployed, tracking tests performed and all the equipment retrieved.

The figure below shows traces of the “fixed” devices – shown by squares on the plot – and one mobile device – shown by the black crosses and connecting line. Three mobile devices were tracked in simultaneous testing, but the plot below only shows data for one to keep the chart relatively uncluttered. The traces are overlaid on a Google map image of the site.



The test was conducted as follows:

- The Collector (magenta) was installed in an office in the centre of the building, where power and network connection are available.
- Two devices were set up just inside and just outside the building (olive and black) near the collector. Their positions were fixed using the configuration tool in the Collector.
- Devices 115 (red) and 116 (cyan) were configured so that they were constrained to be positioned only along within a 5 metre wide horizontal corridor running along the front of the building.

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- At the start of the trial devices 115 and 116 were first deployed left and right of the front of the building. This established a baseline for deploying the rest of the system.
- Next the other two “fixed” devices, 113 (blue) and 114 (green), were taken to the two opposite corners of the apron. Their positions were not constrained and were being calculated by the system.
- Following this the tracking tests were conducted. The black track with crosses shows device 118 walking diagonally across the apron, then back along two sides. The other two mobile devices followed different paths around the site, but they are not shown on this chart.
- The “fixed” devices were then retrieved and brought back to the secure area at the front of the building.

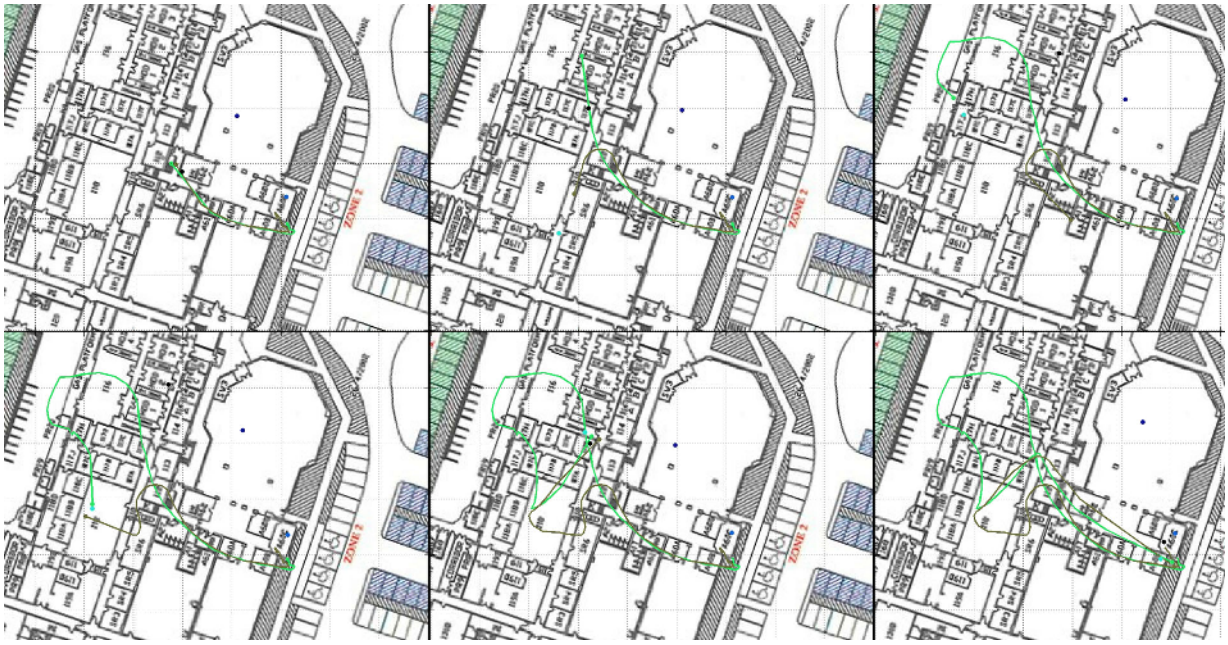
The chart shows how the system successfully tracked the “fixed” devices, including during deployment and recovery of the assets, even though they were not fixed, and successfully tracked the mobile nodes around the area.

This trial illustrates how the Series 500 system can be used off a baseline to track objects around an area, with minimal pre-configuration and deployment preparation. This operational scenario could be enhanced by using optional GPS measurements when they're available as a means to automatically retrieve and orientate the map image (GPS was not fitted to the devices used in this test, but is available as an option on some Series 500 products).

Case study: Lost asset recovery

In this trial the Series 500 system was used to find and recover a lost asset (one of the nodes). The asset (perhaps representing a missing colleague) was known to be in a building (large business premises), but not where in the building.

The set of images below show progress through the asset recovery exercise (from left to right, top to bottom).



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1. The recovery team enters the building leaving a first device in the atrium area (dark blue) and having set up operations in a suitable room (pale blue) two teams (green and brown) set off to recover the asset. They take with them a further device to deploy on the way (black).
2. Having reached the end of the corridor they leave the black device and split – the green team going right and the brown team left. At this point the signal from the lost asset (cyan) is detected, but the position fix is poor because it can see only one other device.
3. The green team circles round to the left and also detects the lost asset.
4. Both teams now converge on it and its position becomes more certain as they get nearer to it. The asset is recovered.
5. Both teams return to recover the left device (black).
6. Both teams plus recovered asset travel together back to the operations room.

This test illustrates how the Series 500 system was used to detect the signal from a missing asset, and then through the use of multiple devices forming a baseline first and then enclosing the object its position was pinpointed and the asset recovered.

Conclusions

The Omnisense Series 500 system is based on a novel approach to locating objects using radio signals. The flat adhoc architecture and sophisticated signal processing algorithms used allow systems to be deployed and used in flexible ways that have not been possible before now.

The first generation Series 500 products are available now. Omnisense is continuing development of the system and will be expanding both the range of devices available and the capabilities they provide.

Omnisense Limited is based in Cambridge UK. More information about Omnisense and our products can be found on our website http://www.omnisense.co.uk/ or by emailing info@omnisense.co.uk.

The Series 500 technology is covered by granted and pending patents owned by Omnisense Ltd.

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