CCNP Wireless IUWMS Quick Reference

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Chapter 1

Implement Location-Based Services

The term ***location-based services*** refers to the ability to locate an 802.11 device and provide services based on this location information. Services can be offered to the located device itself or to another application based on the device location. A typical example of a service offered to the located devices is a shopping mall or subway system map sent dynamically to your 802.11 PDA when you are close to these areas, and another is a special discount sent to your PDA when you walk by a store. Common services offered to other applications based on device location include alarms when a worker enters a hazardous area and location tracking of goods in a warehouse or a factory.

Location-tracking techniques depend on devices to be located being 802.11 compliant, and that the position should be provided in real time (or near real time). Because several measurements are usually needed to provide one position result, most location systems are actually defined as near real-time location systems (NRTLS).

NRTLS are typically intended to cover a relatively enclosed area, such as the following:

- An enterprise campus
- A large distribution facility
- A hospital facility

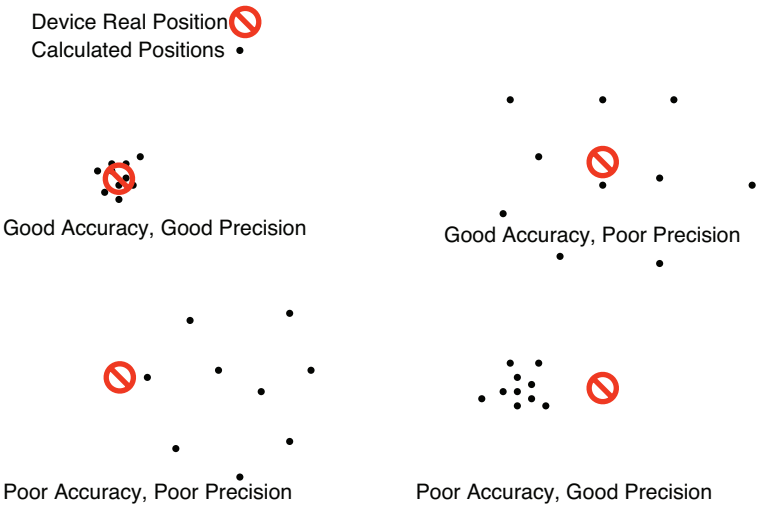
In the context of IUWMS, NRTLS applies only to 802.11 device tracking and is called ***Wi-Fi NRTLS***. Wi-Fi NRTLS allows tracking of Wi-Fi equipped mobile devices directly. When non-802.11 devices need to be tracked (workers, goods in a factory), an 802.11-compliant radio frequency identification (RFID) tag is usually attached to the device to be located. The measured position of the RFID tag is used to determine the non-802.11 device location.

 Please see page 118 for more details.

Understanding Location-Tracking Techniques

Determining a device's position based on an RF-signal is a challenging task. The final goal is to obtain both the accurate and precise location. ***Accuracy*** refers to the degree of conformity of a measured value. In other words, a calculated device location is accurate if it is close to the device's actual physical position. ***Precision*** refers to the degree to which repeated measurements will show the same, or similar, results.

FIGURE 1-1
Accuracy versus precision



Accuracy is key to providing efficient location information, and you can enhance accuracy by fine-tuning the system used for location detection, after deployment, with sample devices for which the actual position is known. Precision is needed to ensure that the algorithm used to calculate position from reported signal values can operate efficiently and consistently over time. Without precision, a device might seem to jump around all over a map, even if the device is not moving. Precision depends on the locate technique used and the environment. Of the many locate techniques, some are based the access point (AP) to which a device associates, others are based on calculated values such as time or angles, and still others are based on the device signal level.

 Please see page 118 for more details.

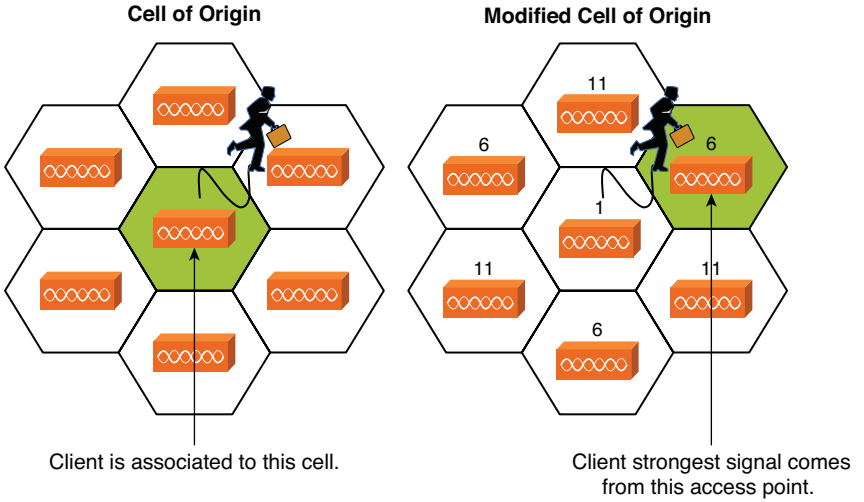
Cell of origin

The ***cell of origin***, or nearest cell, is the simplest radio frequency (RF) location-tracking technique. It gives the location of a client based on the cell to which the client is associated or registered. Both precision and accuracy are low because the result is just the entire cell itself, without any information on where in the covered area the device is supposed to be.

This poor result is worsened by the fact that the client might not be associated to the "nearest cell." For example, in multistory buildings, clients might be associated with an AP located on the lower or upper floor (whichever they are nearer), and thus appear on the wrong floor. Another example is roaming clients who stay associated with an AP even after they have left the normal covered area.

The big advantage of the cell of origin technique is that it is cheap and does not involve a complex location-tracking algorithm.

FIGURE 1-2
Cell of origin



 Please see page 118 for more details.

A variation to this technique is called ***modified cell of origin***. The client is not positioned in the cell of the AP to which this client is associated, but in the cell of the AP receiving the strongest signal from this client. This technique increases the overall precision, if the neighboring APs are able to detect the client. This might not always be the case when neighboring APs are on different channels, however, unless they scan the other channels or unless the client itself scans all channels.

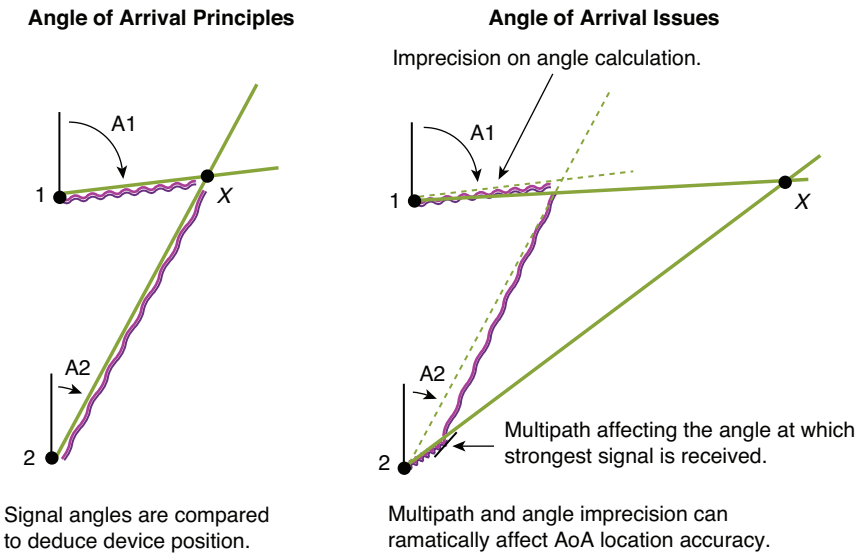
Both precision and accuracy are still low because the result is, here again, the entire cell itself.

This technique is also cheap and based on a basic location-tracking algorithm.

Angulation techniques

Angulation techniques rely on what is called the angle of incidence, or ***angle of arrival*** (AoA). A signal arrives from a device, and the device location is determined by the angle of the two points of measurement to this device.

FIGURE 1-3
Angle of arrival



To use AoA, your location-tracking system must meet a couple of requirements:

- The known stations must be calibrated with the same reference point (for example, north), so that the location-calculation engine can compare the angles.
- The known stations must be able to determine the device angle, which usually implies a rotating directional antenna.

Most 802.11 deployments do not have the required rotating directional antennas. Specific antennas could be put in place to allow AoA, but the accuracy allowed by AoA depends on the environment. Outdoors, with clear radio line of sight, AoA can be successfully used. Indoors, AoA accuracy and precision are badly affected by obstacles and reflections that create multipath issues and imprecision on the signal angle. For these reasons, AoA is not commonly used in 802.11-based location-tracking techniques, but it is widely used for VHF omnidirectional ranging (VOR) aircraft navigation systems.

Time techniques

Instead of using the angle at which a signal is received, some other techniques use the time taken by a signal to reach a receiver. This family of techniques has two main major components: the absolute time of arrival and the differential time of arrival techniques.

Absolute Time of Arrival

The ***absolute time of arrival***, often simplified into time of arrival (ToA), is based on absolute time measurements. It measures the time it takes for a signal to travel from an unknown mobile device *x*, to three or more known points.

This system relies on the fact that the RF signal travels at light speed, roughly 300 meters per microsecond (1 microsecond is 1 millionth of a second). Each receiver calculates the time taken by the signal to travel from the mobile device, deduces the distance from this device, and reports this distance to a location appliance. The location appliance then draws circular plots around each receiver, representing the distance between the mobile station and the receiver. The device is said to be located at the junction point of all drawn circles. Three receivers are needed to perform this calculation, called ***trilateration***.

 Please see page 118 for more details.