Location Based Services:

Methodologies and Requirements

Network operators know that, in addition to providing critical connectivity and mobility for users of different classifications, wireless LAN networks provide a significant amount of invaluable information when appropriate data is extracted and analyzed. This data can greatly influence efficiencies in network operations, as well as drive the development and adoption of new network services.

An important and increasingly critical use of this extracted and processed data is in providing sophisticated location based services (LBS). There are several different methodologies to deliver reliable LBS information, and many respected network equipment and service providers utilize one or more of these to provide this critical location data. This paper will endeavor to concisely describe each method, as well as the equipment and data ingestion requirements of each leading vendor.

Core principles and potential limitations of varying location determining methodologies

Common Location Methodologies

- Received Signal Strength Indicators (RSSI)
- RF Fingerprinting
- Time of Flight (ToF)
- Angle of Arrival (AoA)
- Time Difference of Arrival (TDoA)
- Hybrid

Received Signal Strength Indicators - RSSI

RSSI is a measurement used in wireless communication systems to determine the strength or power level, expressed in decibels (dBm), of a received radio signal.

RSSI typically represents the power level of the received signal at the client device relative to a reference power level, and can be used to determine client distance from the access point. RSSI measurements from the client device to multiple reachable APs are simply compared to make a determination of the nearest AP to the client. Accuracy is best effort, usually to the granularity of a single room or zone, assuming APs are deployed one per room or zone; in less dense deployments, the accuracy of RSSI can become less accurate as the availability of adjacent APs to the client is reduced. In environments with more densely deployed APs, trilateration can be used to increase accuracy of location determination, but can be limited by the frequency of data resolution provided by the APs, which varies significantly by vendor.

RF Fingerprinting

To articulate client location based on RF Fingerprinting, RSSI values are entered into a database to identify varying distances and locations from each AP, and multiple samples are taken over time to capture the variations in signal strength. Relevant characteristics are extracted from the collected RSSI data, such as variation in signal strength as affected by physical and environmental conditions. The extracted features are used to create a unique fingerprint for each AP device and its immediate RF surroundings.

RF Fingerprinting systems then compare the extracted characteristics from the client device with the existing RF fingerprints in its database. Based on the similarity or matching criteria from the database, the system identifies the specific AP's RF fingerprint and determines client device location. This methodology can require extensive manual setup when used as the sole technology.

Time of Flight - ToF

ToF requires 802.11mc functionality to measure round-trip-time (RTT) from AP to client back to AP. By measuring the time it takes for a signal to complete this round trip, it is possible to estimate the distance between the two communicating devices. An analytics or LBS engine will utilize the RTT measurements between the client device and multiple APs, and perform a comparative triangulation to determine the position of the client device in relation to the known AP positions. This method does not rely on timing synchronization, as the RTT calculations are relative.

Angle of Arrival - AoA

Angle of Arrival (AoA) is a technique that can estimate the direction or angle from which a signal arrives at a receiver. By measuring the angle of arrival of a signal at multiple APs from a single client device, it is possible to determine the location of the client. AoA measurements are more accurate than simple RSSI measurement, but less accurate than time-based measurements. This method also requires precision when deploying the APs in order to ensure proper orientation to the maps being used in location determination. Height, location, and orientation are crucial to determine angles, as they use the known location of the antenna arrays in the AP. Accuracy of the results usually depends highly on the accuracy and detail of manual input and AP mapping. Usually requires MIMO, Beamforming, and fairly good AP antennas.

Time Difference of Arrival - TDoA

TDoA is a technique that estimates the location of a client device by measuring the time difference at which the signal arrives at multiple APs. By analyzing the time differences, it is possible to determine the position of the signal source. TDoA employs highly-synchronized clocks on the APs (usually NTP is good enough) to determine the relative difference of time each signal is received from client to AP. Where RF is a fairly known speed constant, distance from an AP can be determined with high precision. Location analytics systems will use TDoA data to triangulate multiple streams to determine client location. Accurate location determination requires a minimum of three AP streams to the client device, so requires reasonably dense AP deployment.

Hybrid

Some LBS systems employ a hybrid of AoA and TDoA to calculate location, and can provide higher precision and granularity of client location at the requirement of much more dense AP deployments.

Vendor Comparison

Cisco Requirements for LBS

- Cisco Wireless LAN Controller (WLC)
- Cisco Aironet APs
- Cisco Prime - unified management infrastructure
- Cisco Mobility Services Engine (MSE): MSE integrates with WLC and Prime to provide LBS calculations
- Optional: Cisco Connected Mobile Experiences (CMX) - Guest analytics, location based marketing, context-aware services

Provides simple location data visibility, actionable location based services require products from other vendors. Cisco provides device location using RSSI functionality, with the possibility of utilizing TDoA trilateration in very dense deployments with MSE.

Mist Requirements for LBS

- Juniper Mist APs, Cloud and AI Engine

Provides simple location data visibility, actionable location based services require products from other vendors. Juniper Mist relies heavily on the addition of virtual BLE beacons in order to provide location data.

Ruckus Wireless Requirements for LBS

- Ruckus Wireless APs
- Ruckus SmartZone Controller
- Ruckus Smart Positioning Technology (SPoT)

Provides location data via RSSI, with the ability to gain greater precision through a proprietary mobile app and RF Fingerprinting.

Extreme Networks Requirements for LBS

- ExtremeWireless APs: Extreme Networks offers a range of Wi-Fi access points that support location based services. These access points capture Wi-Fi signals and transmit them to the location engine for location determination.
- ExtremeWireless Controller (XCC)
- ExtremeAnalytics
- ExtremeLocation Engine - Spot, ToF and AoA
- Optional: ExtremeGuest - captive portal

Provides simple location data visibility, actionable location based services require products from other vendors. In the migration to cloud-based management, ExtremeCloud IQ (XIQ), ExtremeLocation engine has been less widely deployed and is slated for deprecation.

Aruba Requirements for LBS

- Aruba Mobility Controller, APs
- Aruba AirWave - centralized management
- Optional: Aruba Meridian - Application development platform that is mostly required when using beacon data, as client needs to report BLE information
- Optional: Aruba Beacons - standalone and AP-integrated BLE beacons
- Optional: Aruba Analytics and Location Engine (ALE) - "ALE is an advanced location engine offered by Aruba that enhances location accuracy and provides real-time and historical location data."

Provides simple location data visibility utilizing RSSI, but can add more functionality and accuracy with Aruba Meridian and BLE beacons. Actionable location based services require products from other vendors.

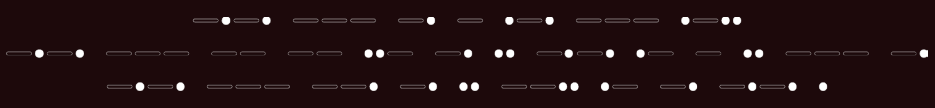
RG Nets Differentiators

The RG Nets rXg solution utilizes location data for services delivery and monetization within the current deployment model. Unlike monolithic vendor systems that provide administrative information but limited actionable functionality, RG Nets offers a myriad of features that enable a unique application and delivery of location based services. Here are some key capabilities of the RG Nets solution:

1. Location-Enabled Guest Portals: RG Nets enables the creation of guest portals that are location-aware; these portals can provide venue-specific information, enable marketing initiatives, leverage social media connections, and implement geofenced actions like time limited food specials or flash sale offers.
2. Vendor Neutral, Indoor and Outdoor Support: the RG Nets solution works with multi-vendor indoor and outdoor APs, independent of GPS availability. This means that location based services can be offered anywhere across any vendor WLAN and multi-RAN infrastructure, with seamless client mobility. Vendor RSSI reporting frequency varies, but utilizing features such as RADIUS Accounting, higher RSSI reporting frequency can be achieved.
3. Mobile Application Integration: RG Nets delivers location-enabled services with or without a mobile application, allowing flexibility in how guests access and interact with the delivered offers and communications.
4. Back-End Aggregated User Analytics: The solution offers comprehensive user analytics, including information about device details, usernames, email addresses, etc. This information can be utilized for location based guest tracking and analysis.
5. Integration with PMS/FMS/CRM: RG Nets' systems can integrate with Property Management Systems (PMS), Facility Management Systems (FMS), and Customer Relationship Management (CRM) platforms, allowing for seamless data exchange and enhanced guest experiences.
6. Device-to-Identity Correlation: The solution includes a device-to-identity correlation engine, enabling accurate identification and tracking of guests based on their devices.
7. SMS and Social Media Integration: RG Nets can integrate with SMS services and social media platforms, facilitating communication and interaction with guests based on their location and preferences.
8. Geofencing Automation: Geofencing capabilities allow for automated actions triggered by guests' entry, dwell time, or transitions between areas. This can include sending incentives, notifying staff, or dynamically changing network behavior.
9. User Segmentation and Network Behavior: Based on location information, RG Nets can automatically segment users on the network, enabling tailored access and services. For example, guests walking into a room can immediately have access to casting devices, printing services, sound systems, etc., which is particularly relevant in education settings

Conclusion

With proper planning, deployment and utilization, location based services can provide network operators with endless opportunities to deliver enhanced network services; the wrong systems, however, can create resource and time burdens that prevent the realization of their advertised benefits. The RG Nets solution offers various possibilities for leveraging location data and delivering beneficial network services, including enhanced guest engagement, dynamic and granular analytics, ensured compliance, and service upgrade opportunities. It provides a comprehensive platform that combines network management, guest services, and location based features in a single product solution, with a single pane of management. With the RG Nets solution, network operators can fully realize their LBS goals.



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