Tracker for ArcGIS Deployment Guide for ArcGIS Enterprise

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Contents

1   Introduction

It is estimated that over 3.5 billion people currently have a mobile device[1] with smartphone adoption continually increasing worldwide. Associated with this trend is the collection and usage of location information provided by these devices. This location tracking information can enable real-time operational awareness of workers in the field and can be applied to many use cases (see Background section for examples). This information is a natural fit for geographic information system (GIS) deployments.

The ArcGIS Platform can be delivered as a software-as-a-service solution through ArcGIS Online or as software that can be installed in your own infrastructure on-premises or in the cloud via ArcGIS Enterprise. Location tracking is offered as one of the platform's newest capabilities. Tracker for ArcGIS is the mobile app that effortlessly captures location tracking data and feeds this information into the platform; it works seamlessly with both deployment options.[2] In the latter case, as the deployment infrastructure is managed by an organization themselves, appropriate planning is required to ensure their infrastructure architecture is optimized to support the potential high volume of data generated.

This document contains relevant information that helps guide IT managers and GIS administrators in deploying Tracker for ArcGIS with ArcGIS Enterprise. The objective is to provide users with a high-level background, tips, and guidance as they implement their GIS solution that includes location tracking. This whitepaper discusses strategies and deployment considerations; it is not a detailed step-by-step implementation guide. Background knowledge of the ArcGIS Platform and IT concepts is not a requirement, but is strongly recommended. Be advised that GIS solutions will vary for different organizations and the concepts discussed in this document may need to be adjusted to meet the needs of their specific GIS implementation.

2   Background

Location tracking is important because it provides the real-time location of an organization's most valuable assets in the field: their mobile workers. When field personnel carry mobile devices, this capability captures and records their locations. This information can help to assess the effective allocation of personnel relative to service needs and to quickly adjust to changing conditions. Collecting location data can identify where work was performed and when, where productivity is being gained and lost in field activities, and if service level agreements (SLAs) are being met. This can also help enable organizations make better management decisions regarding their mobile workers.

Some example use cases for location tracking include:

- **Event situational awareness**: monitoring staff during planned events;
- **End of day assessments**: using location history to assess effectiveness of the day's mission to aid in planning the next day or phase;
- **Verifying mileage:** confirm the number of miles driven by a worker or the commitment to level of service by contractors;

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[1] Source: statista: Number of smartphone users worldwide
[2] Tracker for ArcGIS requires ArcGIS Enterprise 10.7 or later releases.

- **Vehicle locations:** validate the location of vehicles such as snowplows or garbage trucks to honor SLAs and to communicate their status with citizens;
- **Invasive species mapping**: verify the areas of a grid that were covered or missed;
- **Site planning**: confirm where market analysts have been to analyze the effectiveness of their assessments; and
- **Employee status**: VIPs traveling away from the office – monitoring their location(s) and security.

Another important aspect of location tracking information is privacy and compliance regulations. Organizations who collect tracking data in ArcGIS fully own their data and Esri does not sell or share the data to third parties. Esri values the privacy of its customers, distributors, and partners, as it is a principal component of establishing trust. Esri has created a general company Privacy Statement and a separate Products & Services Privacy Statement Supplement to ensure that customers receive the level of privacy they deserve and expect. This topic is discussed in more detail in the ArcGIS Location Tracking Privacy and Best Practices whitepaper.

2.1   Tracker for ArcGIS

Location tracking is an organization-wide capability in ArcGIS. When enabled, licensed users[3] can use Tracker for ArcGIS, a lightweight mobile solution that captures the locations of field staff, monitors where they are, and can help analyze where they have been. This helps decision makers gain real-time information to support critical field activities. Tracker has two key components (see Figure 1):

- A mobile app for Android and iOS[4]
- Track Viewer web app
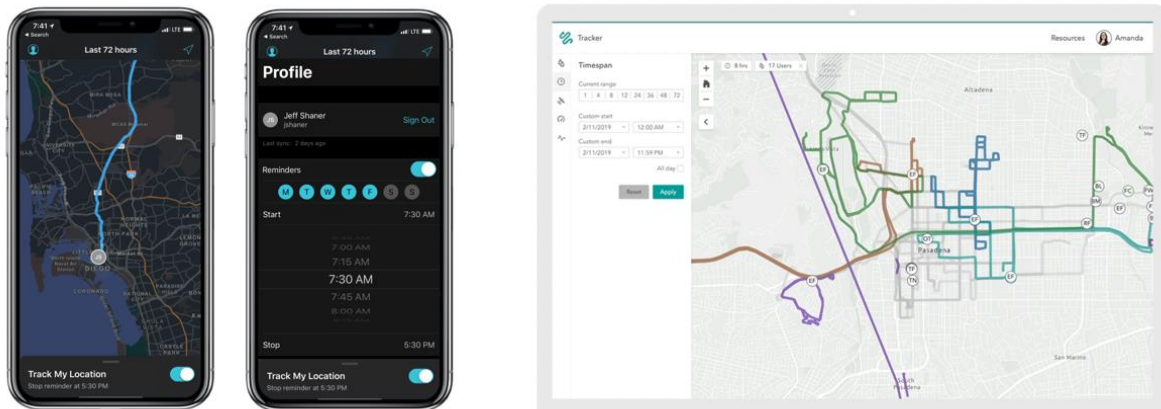
Figure 1: Tracker for ArcGIS mobile app and Track Viewer web app

The Tracker mobile app runs in the background of a device to capture location points and is optimized for low battery consumption. Mobile users schedule when they are tracked and can turn tracking on or off at any time. The app feeds tracks directly into a location tracking service[5] and it supports offline

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[3] Tracker for ArcGIS can be used with any ArcGIS User Type.
[4] The Tracker mobile app is available from the Google Play and Apple App Store, respectively.
[5] See help topic: Enable location tracking to learn more.

workflows. A *track* is a trail or the highlighted lines on a map used to display where the mobile users have been at a given point in time. When using an external GPS receiver with the mobile device, Tracker will utilize its improved location accuracy, but does not explicitly record any of the additional GPS metadata associated with the high-accuracy receiver beyond location information.[6]

The Track Viewer web app is accessed within ArcGIS Online or an ArcGIS Enterprise portal[7] via the App Launcher.[8] Users must have the "view location tracks" privilege to use this application[9], but mobile users can see their own tracks using the Map Viewer.[10] Administrators can create *track views*, which includes the list of mobile users being tracked and users that can view their tracks. A *track viewer* is a user that has the ability to see the tracks of other users.[11] The Track Viewer web app can be used by track viewers (e.g., managers and field staff supervisors) to view the tracks of their mobile workers. Within the Track Viewer web app, tracks can be filtered by: users, time span, accuracy, speed, and activity.

Behind the scenes, the location tracking service is stored as two feature layers:

- *Last Known Location (LKL) layer* → Stores the last known location for each mobile user; applicable for situational awareness use cases.
- *Tracks layer* → A full history of where each mobile user has been; applicable for analysis use cases.

Editor tracking is enabled on both layers and the default data retention period is 30 days. Track views can be used by other ArcGIS client apps such as: ArcGIS Pro and Explorer for ArcGIS for visualization and data interrogation.

When using Tracker for ArcGIS, three main roles[12] are typically defined for its use:

Role:	Privileges:	Tasks:
Administrator	Administrator	- Create track views - Grant access to track views - Configure retention period of location tracking data - Administer users and track viewers
Supervisor	View location tracks	View track view details, use in other apps
Mobile user	Viewer	Work in the field to generate location tracking data

Note: Two other separately licensed ArcGIS solutions ArcGIS Indoors and ArcGIS Mission also utilize location tracking capabilities in ArcGIS, but are not the focus of this document.

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[6] See the help topic, Overview of the location tracking schema to learn more.
[7] See section 2.2 to learn more about the ArcGIS Enterprise portal. The Tracker Viewer web app is not installed by default with ArcGIS Enterprise 10.7.x.; it is included with ArcGIS Enterprise 10.8 and later releases.
[8] See help topic Manage the app launcher to learn more.
[9] See help topic Location track security to learn more.
[10] See help topic View maps in Map Viewer to learn more.
[11] They need to be granted *View Location Tracks* privileges.
[12] In this instance, the term "role" is used in a conceptual sense and does not refer to ArcGIS Enterprise portal member roles.

2.2   ArcGIS Enterprise

ArcGIS Enterprise is the software offering from Esri that enables an organization to deploy the ArcGIS Platform within their own infrastructure. It offers a flexible deployment model, allowing use that is completely on-premises, connected or disconnected from the Internet, on physical hardware or in virtualized environments, in the cloud on Amazon Web Services, Microsoft Azure, or any cloud platform that provides virtual machines that meet the system requirements and specifications, or as an Esri managed service. Location tracking functionality is available with ArcGIS Enterprise 10.7 and later releases.[13]

ArcGIS Enterprise consists of four components (see Figure 2):

- **ArcGIS Web Adaptor**: Installs in a third-party web server, operates as a reverse proxy
- **Portal for ArcGIS**: Front-end user interface for mapping, data management, and sharing
- **ArcGIS Server**: Spatial server that enables GIS data and content to be shared as web services
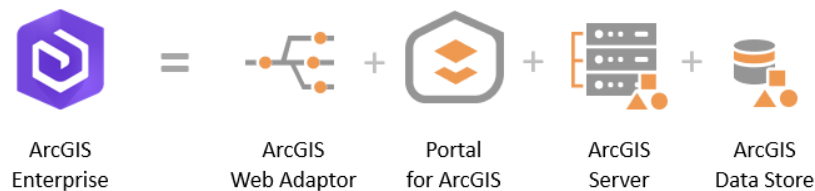- **ArcGIS Data Store**: Back-end repository to store spatial content

Figure 2: Components of ArcGIS Enterprise

These four components can be deployed in diverse combinations and patterns to support many different business workflows. In terms of security, both the Portal for ArcGIS and ArcGIS Server components can support separate security models[14] or share the same security model in a federated deployment.[15] Be advised, a federated security model is required to enable location tracking. Note: at the ArcGIS Enterprise 10.5 release, the concept of *ArcGIS Server licensing roles* was introduced – these "licensing roles" provide additional capabilities and may have some deployment implications beyond the four components (see section 2.3).[16]

An ArcGIS Enterprise base deployment[17] implies that all four components are deployed together to leverage the full capabilities of the ArcGIS Platform, see Figure 3.

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[13] An ArcGIS Enterprise Standard license or higher is needed.
[14] For more product security details see About configuring portal authentication and Control Access in ArcGIS Server.
[15] See help topic Federate an ArcGIS Server site with your portal to learn more.
[16] See help topic ArcGIS Server licensing roles to learn more.
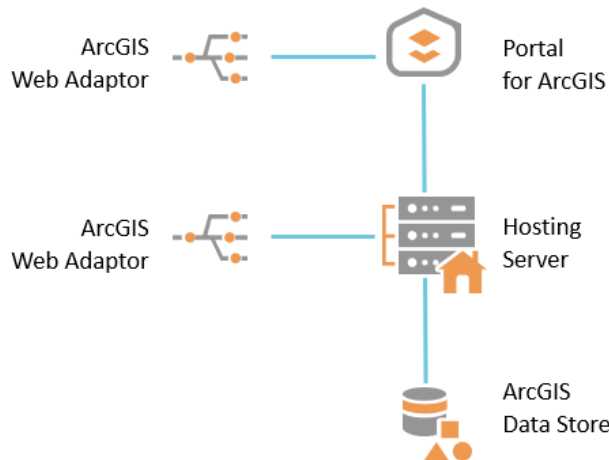[17] See help topic Base ArcGIS Enterprise deployment to learn more.

Figure 3: ArcGIS Enterprise Base Deployment

In a base deployment, the ArcGIS Data Store is registered with ArcGIS Server. One ArcGIS Server site is federated with Portal for ArcGIS and becomes its hosting server[18] - a dedicated GIS server to support Portal capabilities such as the Map Viewer analysis tools. Lastly, the ArcGIS Web Adaptor is used by Portal for ArcGIS and ArcGIS Server; however, customers can substitute their own load balancers in place of utilizing the ArcGIS Web Adaptor. All four components can be installed on the same machine or in a multi-machine deployment; the latter option is recommended for production deployments.

The ArcGIS Data Store is unique from the other components because it can be deployed in three different ways[19] depending on the type of data it will hold:

1. Relational data store: Stores hosted feature layer data;
2. Tile cache data store: Stores caches for hosted scene layers; and
3. Spatiotemporal big data store[20]: Stores real-time observational data and historical data.

In a typical ArcGIS Enterprise base deployment, the ArcGIS Data Store is configured as a relational data store. To enable location tracking functionality in ArcGIS Enterprise, the ArcGIS Data Store instance must also include a spatiotemporal big data store – this is where the location tracking service data is stored. The spatiotemporal big data store has been specifically designed and optimized to store large volumes of data, with the data being written at a high frequency rate. Figure 4 illustrates a conceptual diagram of an ArcGIS Enterprise base deployment with location tracking enabled.

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[18] See help topic Configure a hosting server to learn more.
[19] See help topic What is ArcGIS Data Store? to learn more.
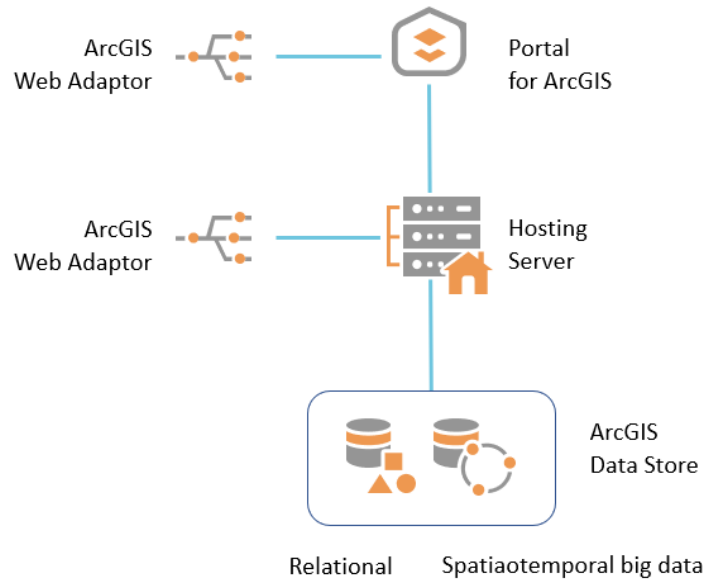[20] See help topic Managing spatiotemporal big data stores to learn more.

Figure 4: ArcGIS Enterprise Deployment Base Deployment with location tracking

The location tracking functionality is administered by an ArcGIS Enterprise portal administrator. They can activate location tracking and adjust settings by accessing the portal's *Settings > Location Tracking*, see Figure 5.[21] The length of time that location track data is kept is called the *retention period* and it can be set to 30 days, 90 days, 6 months, 1 year, or always. Keep in mind that the retention period set for tracks will impact the disk space required on the spatiotemporal big data store machines.
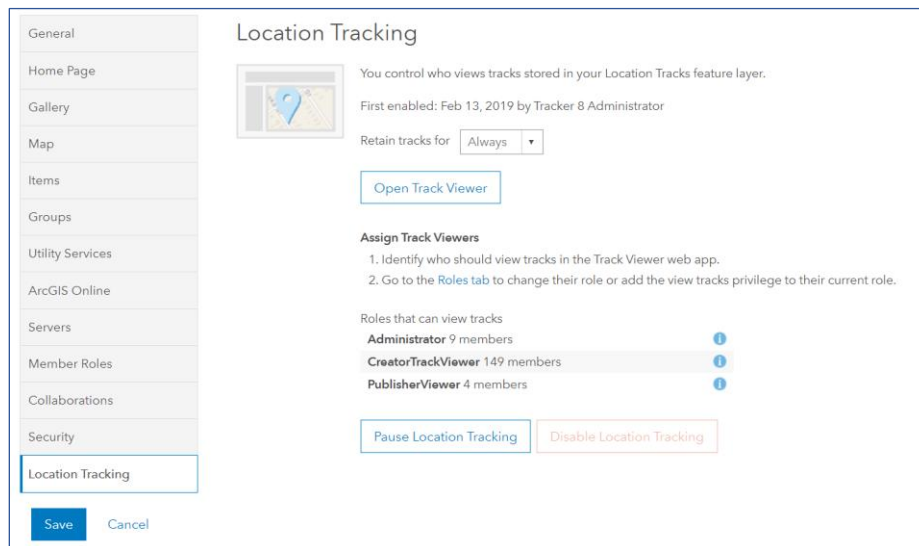

Figure 5: Location Tracking setting panel in the ArcGIS Enterprise portal

Additional details about the infrastructure architecture for enabling location tracking in ArcGIS Enterprise is discussed in Section 3.

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[21] See help topic Configure location tracking to learn more.

2.3   Location Tracking with other Solutions

Location tracking data can also be utilized with several other ArcGIS Solution offerings that are enabled via ArcGIS Server licensing roles (see footnote 16):

ArcGIS GeoEvent Server – GeoEvent Server is not required for Tracker[22]; however, it can be used to complement location tracking, for example enabling geofencing capabilities such as notifying when a worker has arrived or has left a work location/area.

ArcGIS GeoAnalytics Server – Analytical functions can generate new datasets from location tracking services. GeoAnalytics Server can be applied to location tracking data to provide meaningful insights by using the following tools:

- Reconstruct Tracks → This is useful for creating lines from track points to show direction and to generate new line work (which could be turned into a transportation network).
- Aggregate Points → Can be used to analyze coverage over an area, such as the area searched during a rescue operation or the percentage of a utility corridor covered when performing an inspection.
- Detect Incidents → When studying movement, this tool can identify rapid changes in speed if speed is an attribute in the data.
- Find Point Clusters → By using a density-based clustering method, frequently visited locations can be identified based on the movements of your workforce.

A detailed discussion on their deployment implementation(s) with ArcGIS Enterprise is beyond the scope of this document.[23]

3   Location Tracking – Backend Infrastructure

This section discusses the infrastructure architecture for ArcGIS Enterprise with location tracking functionality enabled. An overview of the common deployment options is presented, their pros and cons, along with some deployment recommendations. The deployment patterns are:

- ArcGIS Enterprise – Single machine architecture
- ArcGIS Enterprise – Multi-machine architecture[24]
- ArcGIS Enterprise – Multi machine architecture with High Availability

3.1   ArcGIS Enterprise – Single Machine Architecture

In this deployment pattern, all ArcGIS Enterprise components are installed on one machine, see Figure 6. The single-machine deployment components include: Portal for ArcGIS, ArcGIS Server, ArcGIS Data Store, and two installations of the ArcGIS Web Adaptor (one installation for traffic to the ArcGIS Enterprise portal and the other for traffic to ArcGIS Server). For the ArcGIS Data Store, the instance must be configured to be a relational and spatiotemporal big data store.

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[22] Tracker is meant for monitoring personnel, while GeoEvent is meant for monitoring vehicles.
[23] See *ArcGIS Enterprise: Architecting Your Deployment* Dev Summit 2020 tech session to learn more.
[24] In this whitepaper, the term "multi-machine" only refers to the ArcGIS Data Store component and not the entire ArcGIS Enterprise stack (see section 3.2). A comprehensive discussion of ArcGIS Enterprise multi-machine deployments is beyond the scope of this document.
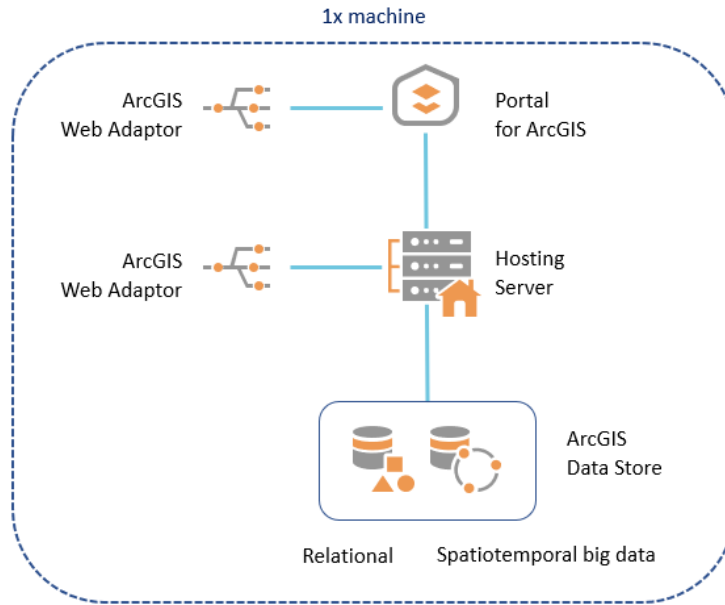
Figure 6: ArcGIS Enterprise Single Machine deployment for location tracking

Advantages
- Simplest on-premises deployment, as it only requires one machine
- Least expensive on-premises or cloud deployment option
- Reduced backend inter-component transport concerns due to consolidation to one system

Disadvantages
- Inadequate for supporting production scenarios requiring the spatiotemporal big data store and location tracking
- Availability and scalability limitations – single point of failure

This deployment can be used for prototyping, proof-of-concept and testing use cases only. Be advised, while this deployment is technically possible and included in this document for completeness, **it is NOT a recommended option for production environments**. The spatiotemporal big data store is meant to store large volumes of data, with the data being written at a high frequency rate – this aspect requires that a dedicated machine instance should be used. When attempting to configure a spatiotemporal big data store on the same ArcGIS Data Store instance as a relational data store, the software will display a warning notification, see Figure 7.
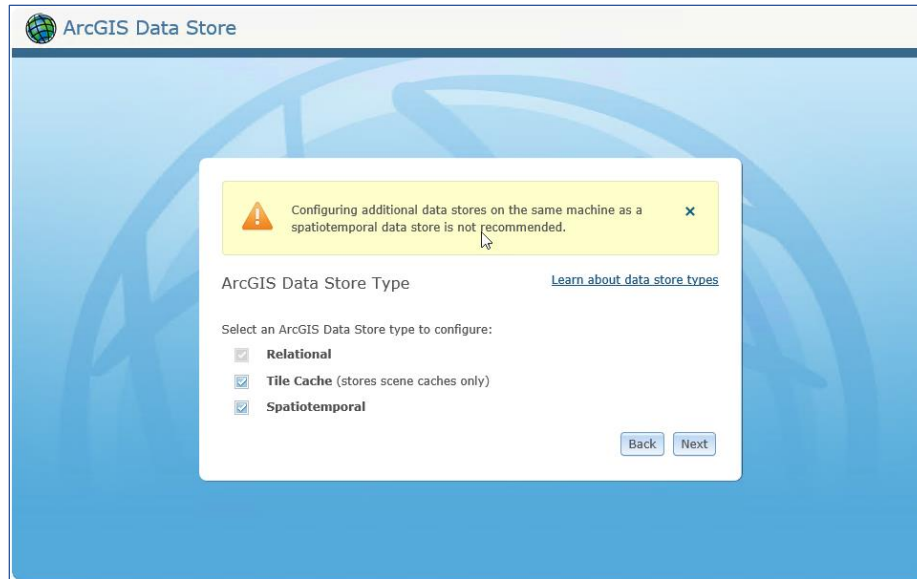
Figure 7: ArcGIS Data Store configuration wizard - warning message

As a best practice, to ensure that the ArcGIS Data Store is optimized for the expected high data volume and prevent data loss (e.g., if the system encounters a failure), several machines should be used for the ArcGIS Data Store.[25] **For production deployments of ArcGIS Enterprise with the location tracking service, a multi-machine deployment is strongly recommended.**

3.2   ArcGIS Enterprise – Multi-machine Architecture

As noted in section 2.2, the ArcGIS Enterprise components can be deployed across several machine instances, in many diverse combinations to support many different business workflows. For an ArcGIS Enterprise deployment with location tracking, the number of machines needed is partially determined by the scope of mobile users being tracked and their location data requirements.

Some common questions to consider when planning your ArcGIS Enterprise multi-machine deployment with location tracking enabled are:

- How many mobile users will be tracked?
- How frequently will the tracks be uploaded back to the server?
- How frequently will the LKL data be updated?
- What is the required retention period for the track data?
- What are the data failover requirements for the track data storage?
- Will the hosting server be used for other GIS purposes (in addition to supporting location tracking)?

For the purposes of this document, the minimal deployment architecture to support a production environment will be discussed. An effective minimal ArcGIS Enterprise multi-machine deployment should include 4 machines: one for the ArcGIS Enterprise base deployment and three that comprise the spatiotemporal big data store, see Figure 8.

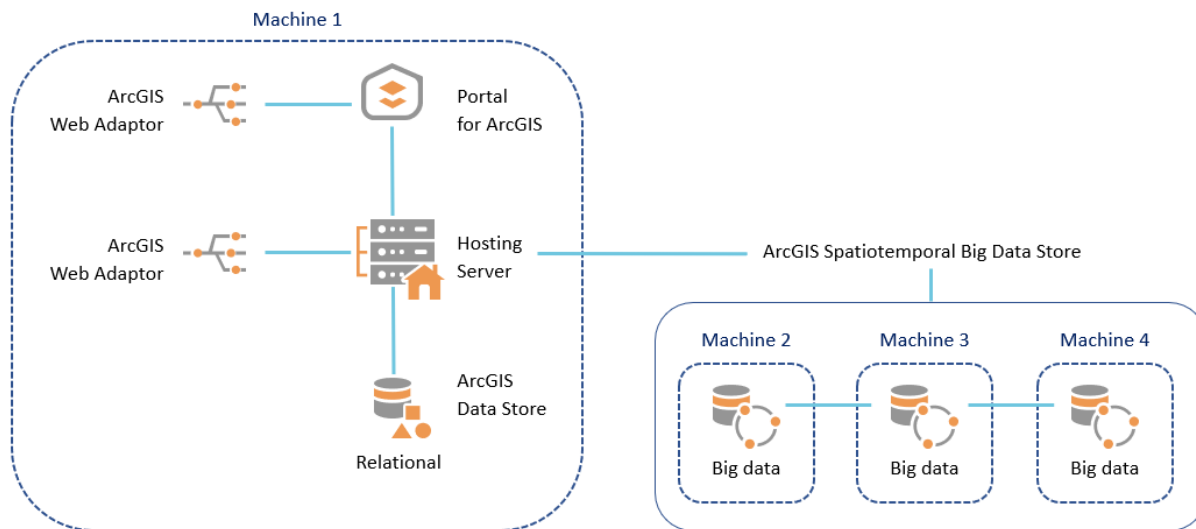[25] See help topic Spatiotemporal big data stores to learn more.

Figure 8: Minimal production ArcGIS Enterprise Multi-machine deployment for location tracking

In this deployment pattern, the ArcGIS Enterprise base deployment resides on its own machine. Machine 1 has its own dedicated resources to perform and support daily GIS operations for the organization. Location tracking is enabled and supported by machines 2, 3 and 4; each machine has the ArcGIS Data Store component installed and configured to be a spatiotemporal big data store. The single spatiotemporal big data store instance is composed of three machines and is registered with the hosting server.

The spatiotemporal big data store instance is distributed across the three machines to ensure that it can manage large volumes of data, with the data being written at a high frequency rate. This three machine architecture facilitates a process called *sharding* → this is a database technique where data is distributed and stored across several different disk locations.[26] This helps optimize scalability and prevents data loss[27]. For example, if one of the spatiotemporal big data store machines had a system failure, then redundancy is already built into the system. This ensures that the location tracking data is stored efficiently and will not be lost.

When location tracking is enabled in the ArcGIS Enterprise portal, the Tracks layer is created with 6 shards and the LKL layer is created with 2 shards. This is the minimum recommendation. For larger deployments, the Tracks layer should have 2 shards per spatiotemporal big data store machine or 1 shard for every 40 GB of Track data stored, whichever is higher. The LKL layer should have 1 shard per spatiotemporal big data store machine. The ArcGIS API for Python can be used to configure location tracking according to your needs.[28]

Recommended minimum system hardware specifications for this type of deployment:
- Machine 1: 8+ CPU with 60+ GB of RAM
- Machines 2, 3, and 4: each should have 8 CPU with 32 GB of RAM

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[26] See Shard (database architecture) to learn more.
[27] This is enabled via replication at the database tier, not the sharding process directly.
[28] See ArcGIS Python - arcgis.apps.tracker module to learn more.

This is the minimal ArcGIS Enterprise multi-machine deployment architecture to support location tracking for a production environment, however it can be adjusted depending on additional needs. For example, additional ArcGIS Server sites could be federated with the ArcGIS Enterprise portal to support other GIS workflows[29]; or additional machines could be added to augment the storage capacity of the spatiotemporal big data store. The amount of disk space allocated to the spatiotemporal big data store will depend on the number of mobile users being tracked and how long the track data will be kept. The following equation can help provide a rough estimate of the amount of storage required for the spatiotemporal big data store instance. This may vary based on an organizations' use of Tracker.

Storage (kB)=s*(r+1)*t*h*u*d

$$s = 0.8 \rightarrow size\ of\ track\ feature\ (kB)$$
$$r = 1 \rightarrow\ replication\ factor$$
$$t = 2000\ \rightarrow\ estimated\ number\ of\ tracks\ per\ user\ per\ hour^{30}$$
$$h = number\ of\ hours\ each\ user\ is\ tracked\ per\ day$$
$$u\ = number\ of\ users\ being\ tracked\ per\ day$$
$$d = data\ retention\ period\ (days)$$

For example, an organization that is tracking 100 users, 8 hours per day, with a 30-day retention period would need a minimum of approximately 76.8 GB of storage across their spatiotemporal big data store instance. Be advised that an odd number of machines in your spatiotemporal big data store instance should always be used; this is one of the requirements for an effective sharding deployment.

Advantages
- Significantly improved performance over a single machine deployment
- Meets many location tracking production environment requirements
- Adjustable deployment architecture, which can be customized (i.e., additional machines can be added) to meet the specific business requirements of individual organizations and their business workflows

Disadvantages
- Increased administrative overhead/complexity with multiple machines to maintain
- Increased total cost of ownership, since there are multiple machines in the deployment

For ArcGIS Enterprise 10.7, this deployment will support up to 1,000 Tracker for ArcGIS mobile users.

For ArcGIS Enterprise 10.7.1 and later releases, this deployment will support up to 10,000 Tracker for ArcGIS mobile users.

Note that there were significant internal software improvements between the two releases which greatly increased the support for location tracking mobile users. If your organization needs to support larger numbers of mobile users, please contact Esri Professional Services or your local Esri Distributor so they can help you deploy an optimized deployment architecture.

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[29] For example, enabling ArcGIS GeoEvent or GeoAnalytics Server (see section 2.3).
[30] Link to help topic: How does tracking work?; This parameter can vary depending on collection method, for example when walking it is a point per 5 meters, when driving it is a point per 30 meters.

3.3 ArcGIS Enterprise – Multi-machine Architecture with High Availability

Many organizations are interested in an ArcGIS Enterprise deployment using multiple machines, but also with high availability.[31] For the purposes of this document, high availability means the ArcGIS Enterprise deployment has a 99% or higher system uptime. This involves maintaining at least two active ArcGIS Enterprise instances and implementing failover mechanisms to automatically switch from one instance to the other when a machine failure occurs. During normal operations, the machines both respond to requests to provide both high availability and scalability. For components that operate in a primary and standby configuration, data is replicated automatically from primary to standby. This type of deployment is typically used to support mission or business-critical production environments.

In the case of an ArcGIS Enterprise highly available, multi-machine deployment with location tracking, it would require the minimal deployment architecture shown in Figure 9.
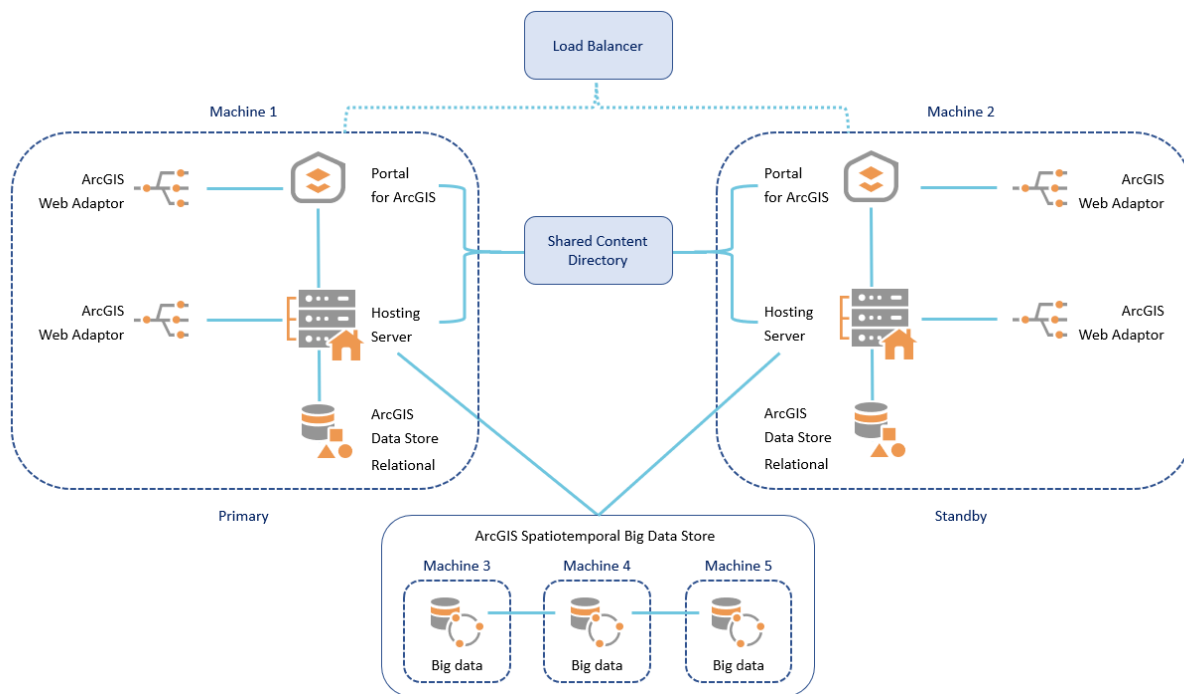

Figure 9: Minimal production ArcGIS Enterprise Multi-machine deployment with high availability

In this architecture, machine 1 and machine 2 both have Portal for ArcGIS, ArcGIS Server, and ArcGIS Data Store installed on them and are operating in a highly available configuration. Their ArcGIS Enterprise portals and GIS Servers are connected to a shared content directory, which consists of the portal content directory, and the GIS Server configuration store and server directories. The spatiotemporal big data store architecture remains the same as before (see Figure 8), but is registered to the hosting server. If the hosting server is a multi-machine site, all machines in the site will be able to write to and read from the spatiotemporal data store once it is registered. A load balancer is positioned

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[31] See help topic High availability in ArcGIS Enterprise to learn more.

in front of both ArcGIS Enterprise deployments and acts as the entry point to the deployment. In total, this deployment requires 5 machine instances. As discussed in the previous section, additional machines could be added to the deployment depending on SLA and business requirements.[32]

Advantages

- Provides a highly available deployment of ArcGIS Enterprise with location tracking
- Meets many location tracking production environment requirements
- Adjustable deployment architecture which can be customized (i.e., additional machines can be added) to meet the specific business requirements of individual organizations and their business workflows

Disadvantages
- Increased administrative overhead/complexity with multiple machines to maintain
- Increased total cost of ownership, since there are multiple machines in the deployment and a more complex infrastructure architecture

4   Conclusion

The intention of this whitepaper is to make the deployment process easier for enabling ArcGIS Enterprise with location tracking. When planning the ArcGIS Enterprise deployment architecture consider the number of Tracker mobile users and their location data requirements (see section 3.2) – both of these factors will affect the architecture requirements. Deploying Tracker for ArcGIS with ArcGIS Enterprise to support production environments requires a multi-machine architecture and the spatiotemporal big data store is a key component; its instance should be at minimum composed of three machines.

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[32] See help topic, Deployment scenarios for a highly available ArcGIS Enterprise to learn more.

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