

# Analytics Exchange Tech Brief

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# Table of contents

Overview ..... 5

Component overview ..... 7

Server configuration architecture ..... 13

Sizing and performance considerations ..... 17

Example configurations ..... 21

Other configuration considerations ..... 25

AX security ..... 27

AX frequently asked questions ..... 31

AX Server requirements ..... 35

AX Server ports ..... 43

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# Overview

Analytics Exchange is a Java-based client-server platform designed to support a full range of processes from data analysis to continuous monitoring.

## Audience and purpose

Analytics Exchange (AX) is built using the best of open source technologies adhering to industry standards. This document is intended to provide technical details of the AX platform, including its components and underlying technical processes, for IT departments to assess their implementation, upgrade, and maintenance requirements.

## Key Features

### Schedule, automate, and access data from multiple sources

Analytics Exchange enables users to schedule and automate data extraction at off-peak hours and by-pass the need to request data from the IT department.

### Administer roles and access permissions

Manage which users have access to certain repositories and who can schedule data extraction.

### Use a centralized repository in a team environment

The server provides a centralized repository for all analytic tests and collections, which is shared among team members. This helps ensure standardization and repeatability of analytics.

### Boost security

All sensitive data is housed on the server, eliminating the risk of data being stolen or lost.

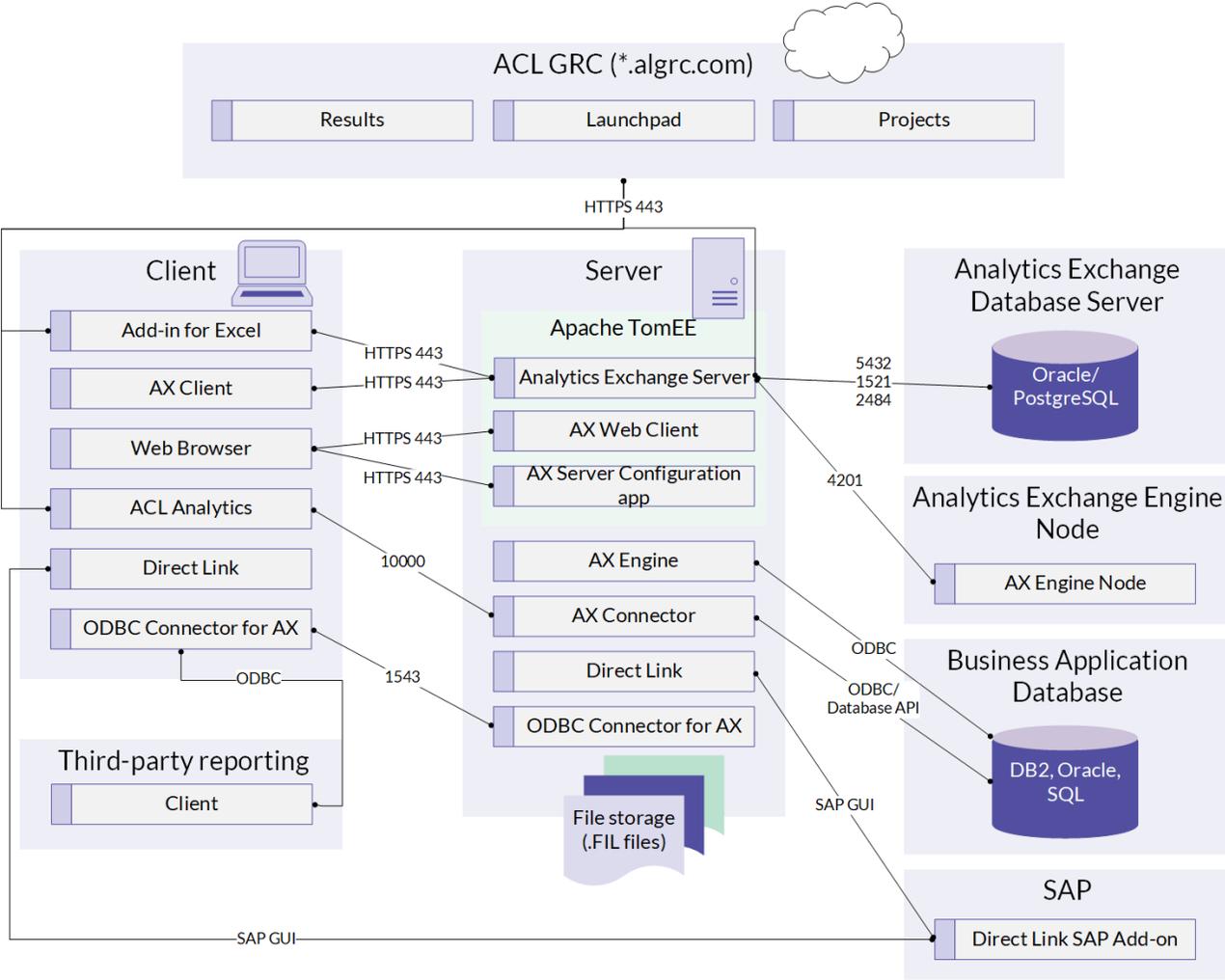
## Conduct deeper ad-hoc investigation on analytic results

After identifying exceptions using analytic tests, users may perform further analysis on data results. Users may leverage the web client or Add-In for Excel to investigate the results. Also, Analytics can be used to conduct ad-hoc investigations previously unidentified transactional anomalies, errors and discrepancies.

# Component overview

AX Server has two main components: a database and an application server. The database can be hosted on either a PostgreSQL database server or an Oracle database server. The TomEE application server includes a web server used to access the applications, security management, and it enables various internal parts of the system to communicate.

## Diagram



# Server components

## TomEE application server

The TomEE application server is an enterprise Java application server composed of Apache Tomcat and the J2EE environment. TomEE provides database connection pooling, transaction support, logging, application management, and application/interface authorization. AX Server, AX Web Client, AX Client, and the AX Server Configuration web app all run within the TomEE application server.

## Analytics Exchange Server

AX Server is central to the AX platform, providing the following services:

- **AX repository** – the repository provides storage and retrieval of analytics, tables, Analytics projects, data files, and any associated audit documents, such as Microsoft Word (.doc, .docx), Excel (.xls, .xlsx), .pdf, or other media files
- **AX user management** – user management includes account creation and managing permissions on repository content
- **Scheduler** – the Quartz scheduler is used by AX Server to schedule and run analytics for automation and continuous audit and monitoring
- **Central Authentication Service (CAS)** – CAS is used by AX Server to provide your choice of form-based or integrated Windows user authentication

## AX Web Client

AX Web Client is a web-based application installed on the AX Server where your organization's analytic content is centrally and securely managed and stored. AX Web Client is designed for non-technical specialists such as staff and executives who need to view and interact with audit content in AX Server, but who do not require the administrative functionality available in AX Client.

## AX Server Configuration

The AX Server Configuration is a web application to configure global server settings for AX Server. Some of these settings are configured by the setup wizard when you initially install AX Server, but you can change them if your system configuration changes.

## AX Engine

AX Engine is based on the same source code as Analytics but with no user interface allowing analytics to run without requiring user intervention. The AX Engine executes commands, functions, and scripts which can be scheduled using AX Client while the source data remains secure on the server.

## ACL Connector for Analytics Exchange service

The ACL Connector for Analytics Exchange service is an optional server-side component that handles requests from the ACL Connector for Analytics Exchange client driver. This component must be installed before you can establish an ODBC connection to analytic results data from a third-party reporting tool.

The ACL Connector for Analytics Exchange behaves like a stand-alone driver with the addition of the client/server connection required to interact with AX Server. The connection uses an efficient layered protocol and supports SSL encryption.

### Note

To support SSL encryption, you must generate a set of security certificates and install them on the AX Server machine using OpenSSL. When SSL is enabled, the connector uses OpenSSL to encrypt all data moving across the network connection.

## AX Connector

The AX Connector enables communication between AX Server and the Analytics client interfaces, using the `ac1se.exe` executable.

When AX data tables, Analytics projects, or analytics are exported from AX Server, the default behavior is for data files (.fil files) to remain on the server, although exporting data files for offline work is supported. Using the ability of Analytics to connect to AX Connector, AX Server allows remote access to data files residing in the repository. Sensitive data files remain on the server. This scenario might be preferred by your audit or IT department to meet your organizational or regulatory security policy.

The AX Connector supports direct access to Oracle, DB2 and SQL Server databases using native, RDBMS vendor-provided drivers.

## Direct Link

Direct Link adds SAP ERP data selection and extraction capabilities to the data access, analysis, and reporting capabilities of Analytics. It allows you to connect to your SAP system and extract data for use in Analytics.

## File storage

ACL data files (.FIL) used by the AX Connector, AX Engine, and , AX Server are stored on the Windows file system. This file system may be local to the server, on a NAS, or SAN.

## AX Server database

The AX Server database contains the AX Server metadata. Analytics data files (.fil files) are stored outside the database due to their potential size and to allow AX Connector and the AX Engine direct access. AX supports either PostgreSQL or Oracle as the AX Server database.

For PostgreSQL, the PostgreSQL server and the AX Server database can be installed and configured by the AX Server installer. For organizations that require Oracle, an Oracle DBA must first create a schema for AX to use. The DBA will provide database connection information that the AX Server installer can use to create AX Server database tables, stored procedures, etc.

The repository items and metadata stored in the AX database include, but are not limited to:

- AX repository structure including the names, IDs, and hierarchy of audit items such as collections and folders; the access rights to assigned to each collection and folder
- Analytics, related files, table layouts, result sets, and log files
- Analytic parameter sets and values
- User security identifiers (SID)
- Scheduling information such as schedules, history, and schedule status, etc

## AX Engine Node

AX Engine Node is an optional add-on component that can be installed on one or more servers dedicated to processing analytics. AX Engine Nodes allow you to move analytic processing off of the AX Server, and all but the smallest of audit departments with light audit usage should consider deploying this distributed server in their hardware architectural configuration.

By configuring one or more AX Engine Nodes, you can schedule multiple long running, data intensive analytics, or even run analytics during working hours, without negatively affecting the AX Server. By moving analytic processing to AX Engine Nodes, AX Server can dedicate its

resources to handling end user requests from AX Web Client and AX Client, providing increased productivity and a better user experience.

AX Engine Nodes are easily installed and configured. No separate license is required, allowing users to install and configure any number of AX Engine Nodes. The AX Server Configuration console provides the ability to add, remove, and configure each node. Each node can be configured with a maximum number of concurrent analytics, allowing each node to be configured based on capability and performance. If the analytic nodes are processing their maximum number of concurrent analytics, any further analytics are automatically queued by AX Server until an available AX Engine Node becomes available.

## Client components

### Add-In for Excel

The Add-In for Excel can be used with either Microsoft Office Excel 2016 or Microsoft Office Excel 2013. The Add-In for Excel provides secure access to audit items stored in the Working directory of AX Server directly from within Microsoft Excel. Using the Add-in, you can open and edit existing files, save new files, insert links to AX Server items, run analytics, and view analytic status. You can use the Add-in functionality in Microsoft Excel on its own, or in conjunction with AX Client.

### AX Client

AX Client is a thin client Java application that provides the user interface for managing the content, security, and users of AX Server. It comes with its own Java Runtime Environment (JRE), so a separate JRE need not be installed on each user's workstation.

### ACL Connector for Analytics Exchange

The ACL Connector for Analytics Exchange is an ODBC driver that connects to the latest result set for a target analytic. There is a 32-bit and a 64-bit version, and the the driver connects third-party reporting tools with results generated on AX Server.

### Internet browser

An internet browser is used to access the web components of AX.

## Analytics

Analytics runs on a user's workstation, where it provides a user interface for developing analytics that can be packaged and distributed as analysis apps, or scheduled and run in AX Server. When accessing server-side data and performing ad hoc desktop analysis or running scripts locally, Analytics may access server resources using AX Connector over TCP/IP, using default port 10000.

## Cloud components

### Launchpad

Launchpad is where users can manage their accounts, license activations, software downloads, and access to resources and cloud applications.

### Results

Results is a cloud-based collaboration, visualization, and remediation tool. Analysis results from Analytics or AX can be published to Results.

### Projects

Projects is a cloud-based tool for planning, managing, and executing audit work. Projects data can be imported into Analytics.

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# Server configuration architecture

System performance is impacted by the size and volume of data to be analyzed, frequency and complexity of analysis, concurrency usage of system clients and, finally, hardware configuration.

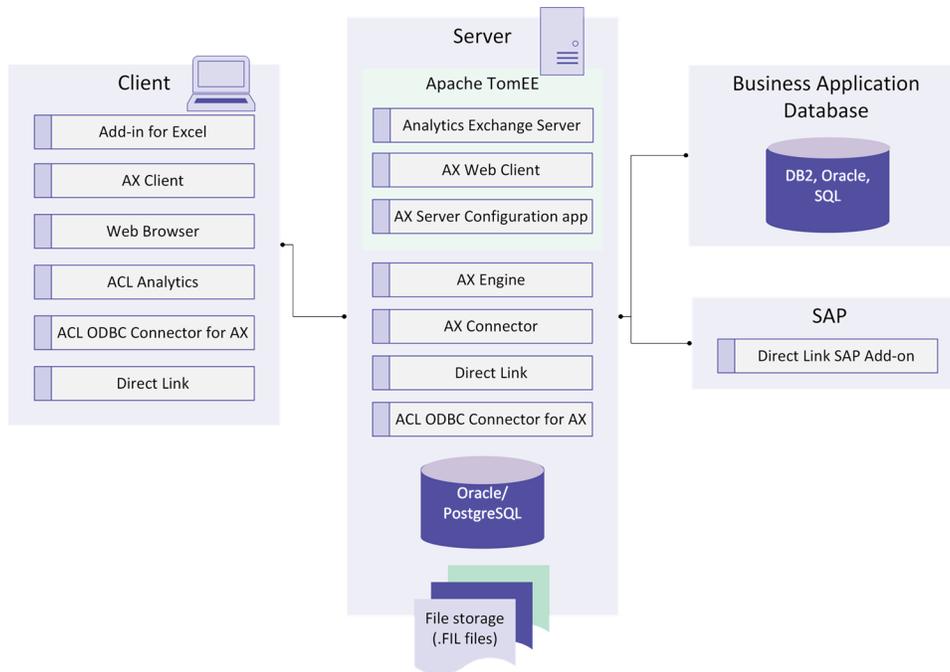
## Choosing a configuration

Since each of the factors affecting performance can greatly vary by customer, the following configurations are meant as a guide only and may need to be adjusted according to each organization's detailed usage scenarios. Without knowing these specifics, it is difficult for Galvanize to recommend a specific configuration. This document provides a starting point for planning, and further consultation with your Galvanize account representative is recommended before committing to a configuration.

AX allows different configuration options depending on your requirements. While it is possible to install all recommended Analytics Exchange components on a single physical server, you may want to consider using several servers for larger deployments.

## Single server configuration

For smaller implementations, AX can be configured with all required components installed on a single server. This is recommended for environments with a low-medium number of concurrent users and scheduled analytics.



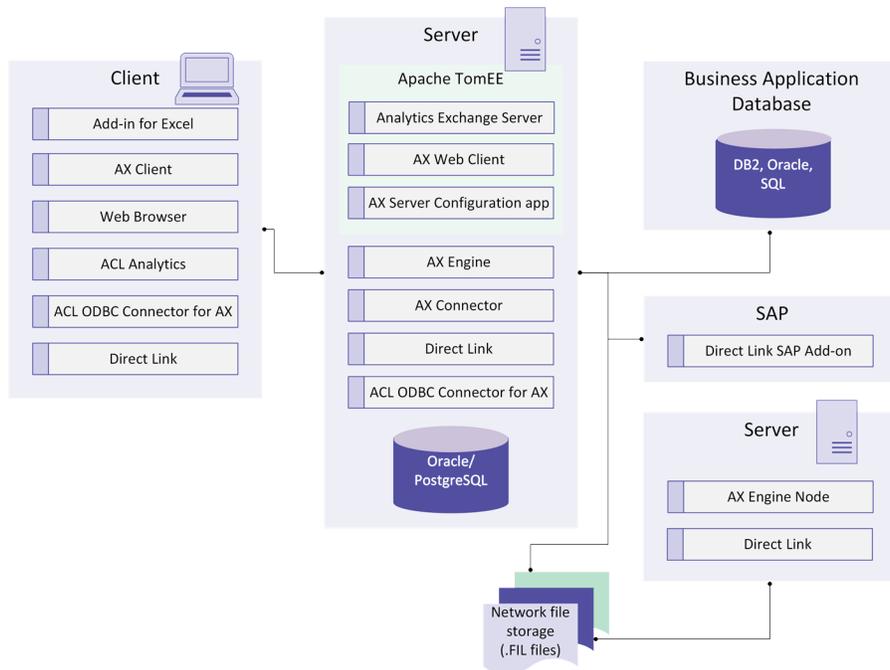
## Multi-tier server configuration

Load balancing for analytics is handled by AX Server randomly allocating jobs to one of the available analytic engine nodes until the maximum available concurrent analytics have been reached. When this happens, AX Server queues the analytics until an engine node is ready. The number of AX Engine Nodes required depends on the number of concurrent analytics expected to run. A minimum of one AX AX Engine Node is required for this configuration. Additional AX Engine Nodes can be added at any time.

### Note

In this configuration the AX file storage is moved off the primary server to a shared location. However, this file storage can remain on the primary server provided that the Engine nodes can access this file storage through a UNC path.

# Server configuration architecture



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# Sizing and performance considerations

## Solid state drive (SSD) versus hard disk drive (HDD)

AX Engine performance testing shows that solid state drives provide significant performance improvements over hard disk drives. Tests show that sorting the same 1 GB data file is 90% faster on SSD versus HDD.

Performance tests were conducted on systems with the following specifications:

Component	Details
Operating system	Windows 7, 32-bit
CPU	Intel Core 2 Quad processor
Drives	Western Digital 160 GB HDD

SSD specifications differ by manufacturer and are improving for every new model. Disk intensive AX Engine operations, such as sort, will benefit more from SSD than other operations, but SSD typically improves overall performance.

## Memory and CPU cores

Because AX Engine is single-threaded 32-bit application, increasing memory or number of CPU cores in the OS does not improve the performance of AX Engine. However it may improve the stability of the OS, especially when running many concurrent jobs.

## 32-bit versus 64-bit

Although it is a 32-bit application, running AX Engine on a 64-bit OS does provide a performance advantage over running on a 32-bit OS when running scripts against large data

files. For example, there is a 50% increase in performance when running the Count command on 30GB (35 million records) data file on a 64-bit OS versus a 32-bit OS.

## Sizing

Performance of the AX platform is affected by the following conditions:

### Location of AX Engine, repository, and job folders

AX stores data files in a flat file format in a Windows directory that is accessible by the AX Server. The location of this directory can be configured and supports local folders and shared folders. As users are analyzing the data interactively or through an analytic the speed in which the analytic engine can access this data can become the largest bottleneck in server performance. Therefore, the data throughput and disk I/O become the most significant system hardware constraint.

For efficiency and reliability when accessing data files:

- on a single AX Server configuration, Galvanize recommends storing data files locally on the AX Server
- on a multi-tier configuration environment, storing data files in NAS, SAN, or local drives will be equally valuable for AX Server performance

Your organization's network administrator will decide which is the most reliable and efficient storage location based on your specific network environment.

Configuration	Performance
Analytics data files stored in a remote folder with poor bandwidth	Poor
Analytics data files stored in a local folder on the same disk drive	Good
Analytics data files stored in a remote folder in a high performance NAS with good bandwidth	Better
Analytics data files stored in a local high performance solid state drive	Best

### Number and size of related files stored in repository

Non-Analytics data files, for example Excel files, PDFs, and Word documents, are stored in the AX database. Files that are generated by analytics, such as result files, are also stored in the

database. The number and size of these files are an important factor in sizing your AX database. Related files and non-Analytics result files cannot exceed 2 GB per file.

## Latency of connections between servers

There are a number of important connections between systems that can suffer from high latency. The most important connection is the connection between the AX Server and the database. Because the AX Server makes numerous calls to the database while users are browsing the repository, a latency of even 50ms can cause significant delays in the interface.

## Network bandwidth between systems

As with latency the network bandwidth between systems can also cause performance issues. Since Analytics allows access to virtually any size data file it can be common for large data transfers of 5GB – 500GB to occur between source systems and the AX Server. The size of these files varies significantly between organizations and should be investigated to determine the requirements for your environment.

## Complexity and impact of scheduled analytics

AX Server has the capability to run scheduled analytics on a continual basis. The number and complexity of these analytics varies greatly between customers and can range from a few analytics running every couple of weeks to hundreds of analytics running daily. Analytics consume resources on the server and can slow down other processes. Two recommended methods for avoiding slow performance on an AX Server are:

1. Schedule analytics to run during off peak hours.
2. Configure a separate server as an AX Engine Node to process analytics.

## Impact of concurrent users

AX performance is affected by the number of concurrent users connected to the system and the processing required by their activities. Performance is also impacted by system configuration choices, for example if the AX Database is running on a separate server, impact of other applications running on the AX Server and the hardware specifications of the server. Analytics has tested up to 30 concurrent users.

User action	CPU	Memory	Disk space	Data through-put	Network latency	Database size
Running an	High	Med	Variable*	High	Med	Variable

## Sizing and performance considerations

User action	CPU	Memory	Disk space	Data throughput	Network latency	Database size
analytic						
Downloading an Analytics table	Med	Low	Low	High	Med	Low
Working with a server table	High	Med	Variable	Low	High	Low
Working with a database table	High	Med	Low	Med	Med	Low
Archiving or restoring	High	Med	Variable	High	Med	Variable
Browsing AX repository	Low	Low	Low	Med	High	Low
Uploading Analytics tables	Med	Med	Variable	High	High	Low
Uploading related files	Med	Med	Med	Med	High	Variable

\* Variability depends on the size of the relevant files or database tables.

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# Example configurations

Because each customer's IT environment and usage patterns is unique, users can access and place loads on the system in many different ways. Server sizing should be re-evaluated against current and future needs once AX is in production in your environment.

Below are two usage scenarios and recommended initial configurations for each scenario.

## Temporary Storage

When running analytics, AX creates a temporary data file to execute commands against. If processing a 1GB data file, 2GB of storage is used during execution. For example, if you are running 10 concurrent analytics against 1GB data files, you will require 20GB of free space to execute the analytics. The temporary file is deleted upon completion.

## Configuration I: small team with light to medium analytics usage

### Team size and usage

- up to 50 person team with concurrency limited to a maximum of 10 users of analytics
- medium data size of less than 2 GB (100 MB typically)
- infrequent analytics with no more than 2 - 5 running concurrently, but could be up to 35 total

### Server hardware

Recommended server from AX System Requirements or equivalent VMWare server.

### Server configuration

All components may reside on one single physical box, including:

- **mandatory components** – AX Server, AX database
- **optional components** – Direct Link
- **RAM** – 16 GB RAM
- **Storage** – 200-500 GB

## Configuration II: large team with heavy analytics usage

### Team size and usage

- 100+ person team with concurrency limited to 50 users and more than 50 analytics
- medium data size of less than 2 GB
- frequent analytics

### Server configuration (recommended multi-tier server)

#### AX Server

- **server** – high performance with scalable processor
- **processors** – 8 cores
- **RAM** – 16+ GB
- **Storage** – 250+ GB

#### AX Server database

- tier 1 SAN with Fibre Channel if available. If you do not have a SAN, alternative solutions exist where IT can maximize throughput with multiple Gigabit Ethernet connections
- 50 GB storage
- Oracle or PostgreSQL

## Data files

- tier 1 NAS device with Fibre Channel if available. If you do not have a NAS, alternative solutions exist where IT can maximize throughput with multiple Gigabit Ethernet connections
- 50 GB storage
- Oracle or PostgreSQL

## AX Engine Node

- **server** – high performance with scalable processor
- **processors** – 8 cores
- **RAM** – 8 GB
- **Storage** – 250+ GB

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# Other configuration considerations

## Remote desktop access to server

While all required functionality for AX Server can be accessed through the various clients described above, in some instances you may want to consider providing remote desktop access to the server for a few select individuals responsible for the management of the AX Server. This optional access can be useful in troubleshooting server issues with the assistance of our Analytics Support Services team.

## Shared folders

In some cases, providing users with access to the AX file storage location may assist in some scenarios where large data files need to be manually transferred and managed on the server.

## Direct Link

The optional Direct Link solution provides AX and Analytics users direct and secure access to SAP ERP data when it's needed without having to rely on busy IT resources. Direct Link has achieved SAP interface certification designation for all SAP ERP releases. Direct Link requires the installation of a Direct Link SAP Add-on component on the SAP system(s), and a Direct Link client on the AX Server and on the client workstation.

## Archiving and restoring

Analytic scripts, results, and other data can be archived when no longer needed to be kept on file. Archiving takes a collection in AX, compresses it to a file, and stores it in the configured archive folder location.

Archived files can be restored, but they lose their original metadata, such as permissions and jobs.

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# AX security

## User accounts

AX Server user authentication is supported via Microsoft Active Directory. A user must be a valid Windows domain user. AX Server supports forests of trusted Active Directory domains. Users can then be added to the AX Server user list. AX Server does not store any user passwords in the database and authentication is confirmed via the Windows API each time a user attempts to login to the system.

If your organization does not employ Active Directory as your network authentication system, AX Server supports using local user accounts.

## User authentication

AX Server integrates with the *Central Authentication Service (CAS)*, which is installed with AX Server, and can be configured for either form-based or integrated Windows authentication.

Form-based authentication is a basic type of authentication where users are presented with a login page when authentication is required. The same login page is presented whether they are logging in to AX Client, or AX Web Client. The user is required to authenticate their account information by entering their username and password each time a new session starts. A new session is created each time the AX Client is started, or when an AX web application is accessed in a new browser window.

Silent authentication does not require the user to enter a username or password. It uses integrated Windows Authentication and Kerberos to validate the user who is accessing an AX application. The same user account that is logged into the PC is also the user account which is silently authenticated to access AX. Only Active Directory users are able to use silent authentication, and CAS must be registered on the Active Directory domain controller as a Service Principal Name (SPN). If silent authentication is configured, local user accounts can still be used, but they will require username and password entry.

You are required to choose the type of authentication you are going to use when you set up AX Server, but you can switch between the two authentication options at any time. For more information, see the [Administration Help Docs](#).

# Encryption

AX Server uses encryption in multiple areas, both storing the information and during communications.

Application	Encryption
Analytics to AX Server	Twofish 128-bit
AX Server to AX Client/AX Web Client	TLS 1.2 with AES-256 and SHA256RSA
Database passwords	RSA with 1024-bit key length. The AX Server database password is stored encrypted in <code>aclDatabase.xml</code> . Analytics passwords are stored encrypted in a table in the AX database

# Application security

Security is maintained centrally in the AX Server for the entire AX platform. Application security has two components.

## Role-based security

There are two primary roles for AX Client users and one role for AX Web Client users. Users can either be an Administrator or a User of the AX system. Administrators are able to see and manage all collections and their contents within the AX Server repository. Users are only able to access collections or associated folders for which they have been granted permissions. Users can also create their own collections and folders in the Working area and grant permissions to others.

## Collection and folder security

AX Server provides permissions for collections and folders (application permissions), which control what audit content logged-in users can access:

- **Full** – includes permission to create, modify and delete content or structure within a particular collection or folder. This includes the ability to run and schedule any Analytics within the folder. Users with full permission to the collection can grant additional users permission to that collection

- **Read Only** – includes permission to view all content within the collection or folder. Read only permission does not include the ability to run Analytics

When a collection is created, the creator has Full permissions by default. The creator must add any additional users to the collection to share it with other users. Users that are added at the collection level will automatically inherit the same permissions for all folders within the collection. These permissions can be modified at the folder level.

For more information, see the [Analytics Exchange Help Docs](#).

## Password security

For login and authentication, AX relies on the Windows operating system to validate user credentials. AX uses the `LogonUser()` Windows API for form-based authentication and Kerberos for silent authentication. AX does not store user names and passwords in the database for the purpose of authentication and user names are recorded in the change log as actions within the application. Session tokens are never written to disk. In the browser, session tokens are stored in an in-memory cookie and the server only keeps them in-memory.

## AX system accounts

The following system accounts are required by AX Server. If they do not already exist, they can be created during the AX Server installation:

- AX database service account for PostgreSQL
- PostgreSQL user account if PostgreSQL is used as the AX database server

Action	Performed by
Schedule AX analytic	TomEE service account
Run Now AX analytic	TomEE service account
AX Connector (initiated by Analytics)	Logged-in user

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# AX frequently asked questions

Is error handling performed within the application, database, or both?

Both application and database.

Our company has a product that secures our Intranet, will AX work with this environment?

Products like Evidian SSO Watch, Siteminder and IBM Webseal control access to resources within the corporate network. While we have had customers successfully use AX within these environments we do not perform any testing nor do we investigate all of the different ways these environments can be configured and therefore cannot guarantee AX will work properly.

What versions of Oracle, DB2 and SQL Server do you support for Direct Database connections?

- Oracle 12c
- Oracle 11g
- SQL Server 2008
- SQL Server 2012
- DB2 V9.7

Do you support Oracle Real Application Clusters (RAC) as a back-end database for AX?

No, AX does not support Oracle RAC at this time.

Which AX components are supported in localized environments?

English versions of AX Client and the Add-In for Excel can be installed and are supported in localized environments.

Can I use a NAS disk to store the AX repository?

Yes, we are aware of customers who are using NAS disks with AX.

Can I use SAN storage with AX?

Yes, we are aware of customers who are using SAN storage with AX.

Can I run AX on a virtual machine?

Yes, recommended server from AX System Requirements or equivalent VMWare server.

### Is Analytics ISO 9000/9001 Certified?

ACL is not ISO 9000/9001 certified and has no current plans to become so.

### How much compression can I expect from the Archive feature?

Results can vary but 80-90%, that is, compression of 100MB down to 10MB is common.

### Can I use an external scheduling application to run analytics on the AX Server?

Yes. AX 5 includes an API that allows an external scheduler to initiate analytics on the AX Server.

### What are the file size limitations?

All data is processed by the AX Engine using ACLScript and is subject to certain limits:

- Index files can be up to 2GB in size - the Unicode edition of Analytics supports far fewer indexed records than non-Unicode, due to the greater space required by Unicode data to encode each character
- AX related files and non-ACL result files have a 2GB limit

### What logging/auditing capabilities are available in AX Server?

AX Server records all collection, folder, and permissions events in the database.

### Can your solution consume web services provided by other applications?

Can be configured if necessary. AX can execute any command line job/batch through using the `EXECUTE` command from an Analytics script. For more information, see [EXECUTE command](#).

### Can I upgrade PostgreSQL that shipped with AX?

The PostgreSQL version included with AX Server is 9.6, later versions of PostgreSQL are not tested.

### Can I upgrade Tomcat that shipped with AX?

No.

### Can I upgrade the Java Runtime Environment that AX uses?

No.

### Where are data files stored in the AX repository?

Data files (.FIL) used by the AX Engine are stored in the following locations in the repository:

- the default location for AX tables is the Data\repository\datafiles folder on the server where AX Server is installed

- the default location for AX Connector files the Data\aclse folder where AX Server is installed

### Can AX encrypt data tables stored in the repository?

No. AX does not encrypt data natively. There are a number of other solutions available for data encryption:

- Microsoft EFS
- Microsoft Bitlocker
- Truecrypt
- Protegrity

### What is the recommended size for the AX database?

The storage requirements of the AX repository database depend on usage. More specifically, it depends on the total size of the files saved in the repository, such as Analytics Project files, related files, and result files. The rest of the repository is metadata with small storage needs.

Note that Analytics table data files (.FIL files) are not stored in the database, so they do not count toward database storage needs. 10 GB is a low starting point, but to leave room for future growth, 50-100GB is better, but the number can be any appropriate value based on usage expectations.

### Can you use a certificate with SHA256 encryption in AX Server?

Yes, SHA256 encryption can be used for an AX Server certificate.

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# AX Server requirements

For best AX Server performance, ensure your hardware and software meets the minimum requirements. Satisfactory production environment performance may require greater resources than the minimum specification.

## Hardware

Processor, memory, and hard disk requirements for production systems depend on the following factors:

- the number of concurrent users and their usage profiles
- the size of the data payload
- the desired response time

Component	Minimum	Recommendation
Processor	2.5 gigahertz (GHz)	Quad-core processor (or two Dual-core processors) at 3.5 GHz or higher
Memory (RAM)	8 GB	16 GB or higher
Hard disk	100 GB This is the approximate amount of disk space required to download, extract, and install the prerequisites. (AX Server is 4.5 GB)	200 - 500 GB Data storage requirements vary by the number of types of audit tests performed and the volume of transactions. Smaller implementations typically require 50GB per year, while larger implementations may require up to 500GB per year. For use in production, high-speed disk access and throughput is recommended.
Other	TCP/IP connectivity. The ability to connect to Launchpad is required during online server activation.	

# Software

## Caution

You must install the [KB2919355](#) Windows Updates before starting your Analytics Exchange installation on Windows Server 2012 R2. If you do not install this update, your Analytics Exchange installation cannot succeed.

Software requirement	Minimum	Recommendation
<b>Operating system</b>		
<ul style="list-style-type: none"> <li>○ Windows Server 2019</li> <li>○ Windows Server 2016</li> <li>○ Windows Server 2012 R2</li> <li>○ Windows Server 2008 R2 Enterprise Edition (64 bit)</li> </ul> <p><b>Note</b> Apply all critical Windows updates before installing AX Server. Running Windows Server using the Server Core (no GUI) option is not supported.</p>	Windows Server 2008 R2 Enterprise Edition (64 bit)	Windows Server 2016 or 2019
<b>Web browser</b>		
<ul style="list-style-type: none"> <li>○ Chrome</li> <li>○ Firefox</li> <li>○ Internet Explorer</li> </ul>	Internet Explorer version 11	Latest version of Chrome
<b>Optional integrated programming languages</b>		
<p>Python programming language</p> <p>When installing Python, you must also configure it to run on your system.</p>	Python 3.3.x (32-bit)	<p>Python 3.5.x (32-bit)</p> <p>Version 3.5.x is fully tested and supported. You may use a different version such as 3.3.x or 3.6.x, however these versions do not offer the same guarantee of testing and support as 3.5.x.</p>

Software requirement	Minimum	Recommendation
<p><b>Note</b></p> <p>You must install the requirements to use integrated Python functions in your analytics. If you do not intend to use this language, you do not need to install them.</p>		
<p>R scripting language</p> <p>Depending on the R CRAN packages you intend to use, you may need to add the R <a href="#">i386</a> 32-bit binary folder to your <code>PATH</code> environment variable.</p> <p><b>Note</b></p> <p>You must install the requirements to use integrated R functions in your analytics. If you do not intend to use this language, you do not need to install them.</p>	<p>R 3.3.1 (32 or 64-bit depending on Operating System)</p>	<p>R 3.2.3 or 3.2.5 (32 or 64-bit depending on Operating System)</p>
<p>To use the ACL Connector for Oracle, you must install:</p> <ul style="list-style-type: none"> <li>○ Oracle Instant Client 11g or 12c</li> </ul>	<ul style="list-style-type: none"> <li>○ You do not need to install Oracle Instant Client if you do not intend to use the ACL Connector for Oracle</li> <li>○ The bitness of Oracle Instant Client must match your operating system's bitness. If the 32-bit Instant Client is installed on a 64-bit machine, the connection fails</li> <li>○ If you install the Oracle Instant Client after AX Server, you must restart the ACL Analytics Exchange Service before you can use the connector</li> <li>○ If you are using Oracle as the database server for AX Server, you must also install Instant Client on the machine that</li> </ul>	<p>N/A</p>

Software requirement	Minimum	Recommendation
	hosts the database server, see "Database server" on page 40	

## Automatically installed prerequisites

The following prerequisites are automatically installed by the AX Server setup wizard if the required software is not detected:

- Amazon Corretto 8 (OpenJDK Platform binary 8.0.2320.9)
- Apache TomEE 7.0.6 (Tomcat version 8.5.41)
- Microsoft .NET Framework 4.6.2

### Note

If your computer already has .NET 4.6.0 or 4.6.1, the application uses the installed version of .NET and does not install version 4.6.2.

- Microsoft Visual C++ 2017 Redistributable Package (x64 and x86)
- Microsoft Visual C++ 2013 Redistributable Package (x64 and x86)
- Microsoft Visual C++ 2012 Redistributable Package (x64)
- Microsoft Access Database Engine 2016 (32-bit)

## Analytics data connectors

The ODBC drivers listed below are installed for use as Analytics data connectors:

<b>Big Data and NoSQL</b>	<ul style="list-style-type: none"> <li>◦ Amazon Athena</li> <li>◦ Azure Data Catalog</li> <li>◦ Azure Data Lake Storage</li> <li>◦ Azure Table</li> <li>◦ Parquet</li> <li>◦ Presto</li> <li>◦ Snowflake</li> </ul>
<b>ERP and CRM systems</b>	<ul style="list-style-type: none"> <li>◦ Dynamics 365 Business Central</li> <li>◦ Dynamics 365 Finance and Operations</li> <li>◦ Dynamics 365 Sales</li> <li>◦ Dynamics CRM</li> <li>◦ Epicor ERP</li> <li>◦ Exact Online</li> <li>◦ NetSuite</li> <li>◦ SAP</li> <li>◦ SAP ByDesign</li> </ul>

	<ul style="list-style-type: none"> <li>◦ ServiceNow</li> <li>◦ SugarCRM</li> </ul>
<b>Accounting tools</b>	<ul style="list-style-type: none"> <li>◦ Dynamics GP</li> <li>◦ Dynamics NAV</li> <li>◦ QuickBooks</li> <li>◦ QuickBooks Online</li> <li>◦ QuickBooks POS</li> <li>◦ Sage 50 UK</li> <li>◦ Sage Cloud Accounting</li> <li>◦ Sage Intacct</li> <li>◦ SAP Concur</li> </ul>
<b>Marketing and analytics</b>	<ul style="list-style-type: none"> <li>◦ Google Analytics</li> <li>◦ LinkedIn</li> <li>◦ Marketo</li> <li>◦ Oracle Eloqua</li> <li>◦ Oracle Sales Cloud</li> <li>◦ Splunk</li> <li>◦ SurveyMonkey</li> <li>◦ Twitter</li> </ul>
<b>Collaboration solutions</b>	<ul style="list-style-type: none"> <li>◦ Active Directory</li> <li>◦ Airtable</li> <li>◦ AWS Data Management</li> <li>◦ Azure Management</li> <li>◦ DocuSign</li> <li>◦ Email</li> <li>◦ Excel</li> <li>◦ Excel Online</li> <li>◦ Exchange</li> <li>◦ Google Contacts</li> <li>◦ Google Sheets</li> <li>◦ Jira</li> <li>◦ SAP SuccessFactors</li> <li>◦ SharePoint</li> <li>◦ Slack</li> <li>◦ Zendesk</li> </ul>
<b>File and API integration</b>	<ul style="list-style-type: none"> <li>◦ Amazon S3</li> <li>◦ Box</li> <li>◦ CSV</li> <li>◦ DigitalOcean</li> <li>◦ Dropbox</li> <li>◦ Google Drive</li> <li>◦ JSON</li> <li>◦ LDAP</li> <li>◦ Microsoft OneDrive</li> <li>◦ OData</li> <li>◦ REST</li> <li>◦ RSS/ATOM</li> <li>◦ SFTP</li> </ul>

<b>E-commerce solutions</b>	<ul style="list-style-type: none"> <li>◦ Edgar Online</li> <li>◦ Open Exchange Rates</li> <li>◦ Square</li> <li>◦ Stripe</li> <li>◦ UPS</li> <li>◦ USPS</li> </ul>
<b>Relational databases</b>	<ul style="list-style-type: none"> <li>◦ Azure Analysis Services</li> <li>◦ Microsoft Access</li> <li>◦ MySQL</li> <li>◦ SAP Hybris Cloud for Customer</li> <li>◦ Sybase</li> <li>◦ Sybase IQ</li> <li>◦ xBase</li> </ul>
<b>Security tools</b>	<ul style="list-style-type: none"> <li>◦ Qualys</li> <li>◦ Tenable.sc</li> </ul>
<b>Other connectors</b>	<ul style="list-style-type: none"> <li>◦ Rsam</li> </ul>

## Prerequisites included in Windows server

The following prerequisites are included in a default Windows server installation. The versions listed are the minimum requirement and most OS installations include later versions:

- Microsoft Core XML Services (MSXML) 6.0
- Microsoft Data Access Components (MDAC) 2.8
- Microsoft Jet 4.0

## Database server

AX Server supports two database platforms, Oracle and PostgreSQL.

If your organization is implementing both AX Server and AX Exception the supported configurations are:

- both application databases using Oracle
- configuring the AX Server to use PostgreSQL as the database and Microsoft SQL Server as the AX Exception database

Software requirement	Minimum	Recommendation
<p>One of the following Oracle versions if Oracle is selected as the Analytics Exchange database platform:</p> <ul style="list-style-type: none"> <li>◦ Oracle 12c</li> <li>◦ Oracle 18c</li> <li>◦ Oracle 19c</li> </ul> <p>(Contact Support before using version 19c. Some features and configurations may not be supported.)</p> <p><b>Note</b></p> <p>The server that Oracle is installed on must meet the hardware requirements specified by the database vendor. You must also install Oracle Instant Client for your database version if you intend to use AX Connector direct database access.</p> <p>Oracle databases running on Amazon RDS are supported.</p> <p>Oracle RAC (Real Application Clusters) is not supported.</p>	Oracle 12c	Oracle 18c
<p>PostgreSQL 9.6 if PostgreSQL is selected as the Analytics Exchange database platform.</p> <p><b>Note</b></p> <p>If PostgreSQL is installed on the same server as AX Server, meeting the AX Server hardware requirements is sufficient. If PostgreSQL is installed on a separate server a 64-bit dual CPU, 64-bit operating system, and 2 GB of memory are recommended for production use.</p>	PostgreSQL 9.6	PostgreSQL 9.6

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# AX Server ports

For the ACL Analytics Exchange Service to start successfully on the AX Server server or AX Engine Node, you must ensure that the ports required by the TomEE application server are not being used by other services or applications.

## Checking ports in use

From a command prompt, use the `NETSTAT` command to display in-use ports:

```
NETSTAT -a
```

If required ports are being used by another service, you must do one of the following:

- reconfigure the service to use a different port
- temporarily disable the service in Windows Services while you install AX Server

If necessary, you can modify some of the ports used by AX Server after the installation process is complete.

### Note

If you are installing AX Server or AX Engine Node for the first time on a server, you should verify that the ports required by the TomEE application server are not in use before you run the installer.

## Ports required by the AX Server

AX Server and AX Engine Node are installed with the default port settings used by the ACL Analytics Exchange Service.

Port	Component	Encryption	Description
80	Tomcat Connector HTTP	Non-SSL	Port used for unencrypted HTTP communication with the server. This is a unidirectional port. It should be opened for outside communication with AX Engine Node.
443	Tomcat	SSL	Port used for encrypted HTTP (HTTPS) communication with

Port	Component	Encryption	Description
	Connector HTTPS		<p>the server.</p> <p>This is a bidirectional port. It must be opened on AX Server for communication with AX Client.</p> <p>If you are upgrading an earlier version of AX Server, the default port is 8443.</p>
5432	PostgreSQL	Supported	<p>You can specify a different port that is not in use in the AX Server installer.</p> <p><b>Note</b></p> <p>If you are configuring a dual-server installation, you must ensure that the PostgreSQL and AX Server and AX Engine Node can communicate on this port.</p>
10000	AX Connector	TwoFish 128 bit	<p>If this port is in use, you can specify a different port that is not in use in the AX Server installer.</p> <p>This service is used primarily to access AX Server tables that have been exported to Analytics projects. It must be opened on AX Server for inbound communication.</p>
4201	AX Engine Node	Non-SSL	<p>Used to connect AX Engine Node to the master AX Server. If the AX Engine Node and AX Server are communicating across a firewall, you must open this port.</p>
1521	Oracle database	Non-SSL	<p>Port used for unencrypted Oracle database communication. It must be opened on AX Server and AX Engine Node for communication with the Oracle database.</p> <p><b>Note</b></p> <p>Your IT team will stipulate which port is required when Oracle is used as the AX Server database server. The port can be changed after the installation is completed, if necessary.</p>
5432	Oracle database	SSL	<p>Port used for encrypted Oracle database communication. It must be opened on AX Server and AX Engine Node for communication with the Oracle database if you are encrypting the connection.</p> <p><b>Note</b></p> <p>Your IT team will stipulate which port is required when Oracle is used as the AX Server database server. The port can be changed after the installation is completed, if necessary.</p>

Port	Component	Encryption	Description
1543	ACL Connector for Analytics Exchange	SSL	Port used for establishing an ODBC connection to analytic results. This port is only required if you install the optional ACL Connector for Analytics Exchange service.  It must be opened for inbound communication on AX Server.

## Firewall configuration

To connect to AX Server from outside your network firewall, you must allow inbound connections on the following ports:

Port	Component	Description
443	Tomcat Connector HTTPS	Used to enable HTTPS connections to the web server for the AX Web Client and AX Server Configuration web applications, and for secure file transfers to and from AX Server.  This port is also required for using aclsript.exe to communicate with HighBond.  <b>Note</b> The default value for servers upgraded from versions prior to 5.0.0 is 8443.
10000	AX Connector	Used to enable access to AX Server tables from client computers through Analytics.
4201	AX Engine Node	Used to connect AX Engine Node to the master AX Server. If the AX Engine Node and AX Server are communicating across a firewall, you must open this port.

Each client computer that connects to AX Server must also have the corresponding ports open for outbound communication.

## Connecting to HighBond

If you intend to transfer data between AX Server and any HighBond, you must allow the following connection:

- **Executable** – aclsript.exe
- **Port** – 443
- **Allowlisted domain** – \*.highbond.com