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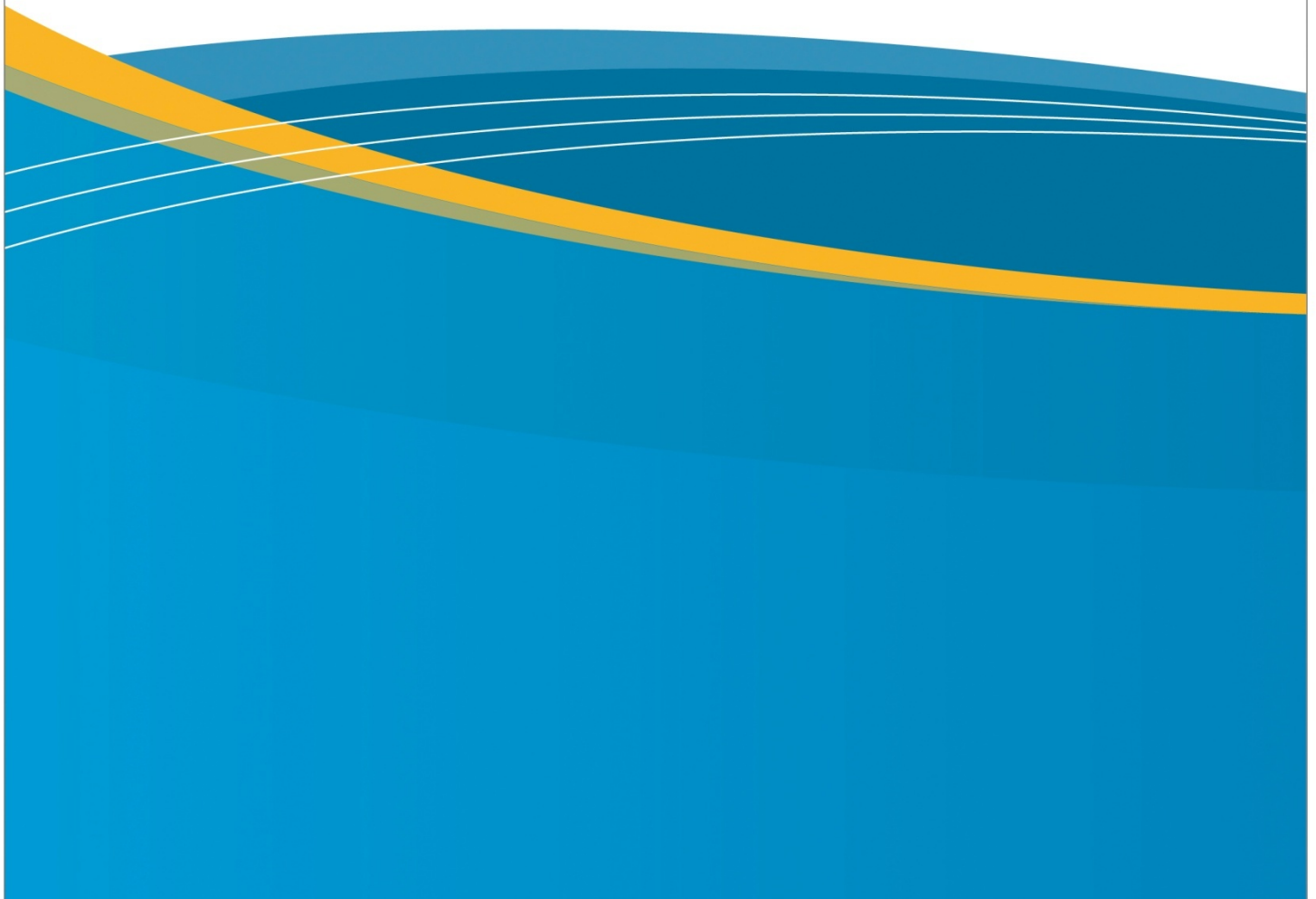
The Content Experts™

■ The Architecture Overview

Exceed onDemand and Exceed Freedom

Remote X Window Application Delivery Solutions

Published: February 2009



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Overview

In a quick paced modern business world, most business decisions are made on the road instead of boardrooms or offices; product designs and technology breakthrough are often the result of collaborative efforts of a body of international scientists and experts. The opposing forces of decentralization and consolidation are now working in a new found harmony, where technology resources are being centralized by the likes of virtualization technology, meanwhile labor resources are dispersed throughout the world.

The trick is, and has always been, how to allow users to effectively access technologies without the burden of the physical distance that separates them.

Exceed onDemand and Exceed Freedom are solutions designed to keep the global work force in touch with their business X window applications. These solutions are designed for modern business server and desktop platforms, and are built on a sophisticated architecture that gives them the power, flexibility, and security to meet business needs.

This whitepaper will provide a quick overview of the architecture of Exceed onDemand and Exceed Freedom, and then it will delve into the technical aspects of each major building block of each solutions and the interplay between components.

This document is part of the Open Text Remote X Window Application Delivery Solutions Whitepaper series. For other technical topics, please visit www.opentext.com/connectivity.

The Architecture

Both Exceed onDemand and Exceed Freedom, collectively known as the Remote X application delivery solutions, employs a 3-tier architecture in their design. It requires a small client residing on users desktop, and middle-tier server acting as a mediator between end users and business applications. The simple diagram below depicts the relationship of all active components.

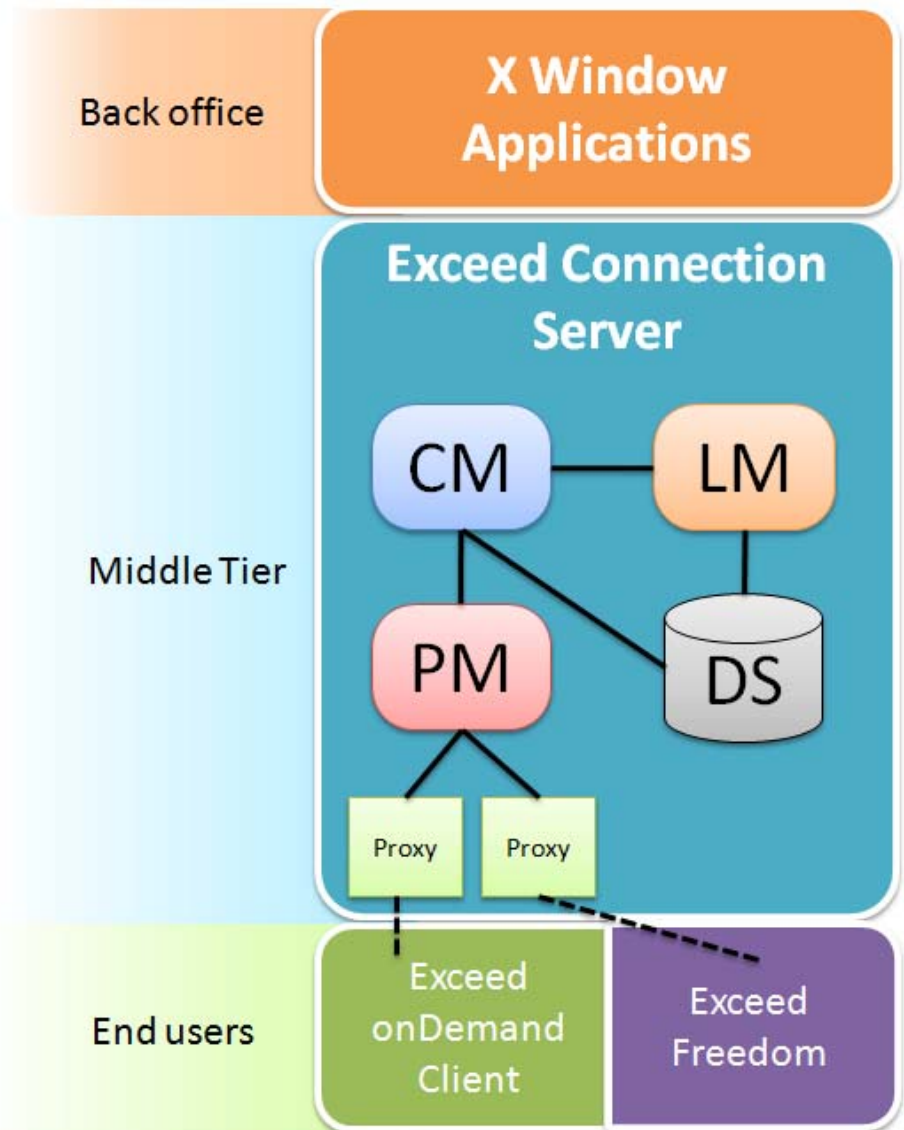


Figure 1
Architectural diagram of the
Open Text Remote X
Window Access Solution

The Components

This section describes in detail the functionalities of all components that are involved in the process of establishing an active connection.

ECS

Exceed Connection Server

The middle-tier server is called Exceed Connection Server (ECS). It comprises many modules, including Cluster Manager (CM), License Manager (LM), DataStore (DS), and Proxy Manager (PM), which can spawn and manage Proxies - the X servers that interact with the Client software running on end user desktops. Each component is instrumental in bringing X applications to user's displays.

ECS must be installed on a UNIX, Linux, or Microsoft Windows platform. It can run as standalone server or it can be grouped to form a cluster:

Standalone configuration: An ECS is configured as a complete and independent entity capable of performing its core functions.

Cluster configuration: Multiple ECS are programmatically linked together to form a large, single, and logical computing unit. Each ECS within a Cluster is called a *Node*.

For more information on how to configure ECS, please read our whitepaper titled "*Configuration and Usage*".

CM

Cluster Manager (CM)

The Cluster Manager is one of the components found in ECS and it is at the top of the chain of command. Although the name may suggest that the component handles cluster related activities, but if one may consider that a standalone Exceed Connection Server is a cluster with just 1 node, then it is logical to see why a Cluster Manager component is present and needed in both Standalone and Cluster configuration.

A CM handles the following tasks:

- Authenticates users
- Governs license usage
- Manages all X Proxy Managers (see below) that are present in the cluster
- Manages all types of user configuration files (in the case of working with Exceed onDemand Clients)
- Balances and distribute the work load (in a Cluster configuration)
- Keeps track of shared and suspended sessions



X Proxy Manager (PM)

X Proxy Manager is the middleman between CM and a Proxy (see below). The PM's job is to start and stop Proxies on demand, manage and monitor their status at all time. Since there can be many Proxies running in an ECS, a PM will act as a traffic director and make sure that the Client software can reach the right Proxy. A PM also reports to the CM and keeps it informed of the status of each Proxy.



Proxy

A Proxy is a fully functional X server that supports all X protocol requests. While the CM and PM handle mostly administrative tasks, Proxy is the one that does the “real” work. As an X server, it communicates with both the X applications and the Exceed onDemand Client or Exceed Freedom (see below), and it is spawned on demand by a PM. In a typical ECS, it will have one PM and it manages multiple Proxies. Each Proxy is uniquely identified by a display number that X applications use to display output to and receive input from.

Although a Proxy supports all X protocol requests, it does not natively handle screen drawing and keyboard and mouse inputs. Instead, it translates the standard X drawing commands and input requests to equivalent Thin X Protocol commands before transmitting them to the Client. The Thin X Protocol will be covered in more detail in a later chapter.

A Proxy can communicate with X applications securely using the Secure Shell protocol (SSH), which will be covered in “*Configuration and Usage*”.



Data Store (DS)

A Data Store is a central location where vital server settings and other resources are stored. In the case of Exceed onDemand, DS also contains user settings and connection profiles. A DS can be either local or remote to ECS, however, one can significantly improve service reliability by moving the Data Store to an enterprise network storage device and take advantage of data redundancy and high availability offered by the storage solution.



License Manager (LM)

The License Management functionality is only applicable to the Exceed onDemand solution. It manages and monitors the license usage of the ECS, it knows when to allocate a license for a new session and when to take the license back from a user and return it to the license pool.

Exceed onDemand Client

Exceed onDemand Client

Exceed onDemand Client is the client portion of the Exceed onDemand solution that each user must install on a PC running either Microsoft Windows, Linux or IBM AIX operating system.

The main function of Exceed onDemand Client is to render the image on the display and interact with users through the input devices. Connections between the Client and the Proxy can be secured using Secure Sockets Layer (SSL), which will be covered in “*Configuration and Usage*”.

For administrators who need to deploy Exceed onDemand Clients to business users running Microsoft Windows operating systems, they have the option of deploying it through a Web browser. The “*Configuration and Usage*” whitepaper will discuss the Hummingbird Deployment Wizard in more detail.

Exceed Freedom

Exceed Freedom

Exceed Freedom is an add-on software solution to the latest version of Exceed® and Exceed PowerSuite™.

Similar to the Exceed onDemand solution, Exceed Freedom is designed to offer the same performance and productivity gain to Exceed and Exceed PowerSuite customers. Exceed Freedom reuses existing Exceed configuration files, which may have been created over the years to satisfy many users X application demands. For organizations that have heavily invested in Exceed and have accumulated a large amount of configuration files, Exceed Freedom is a no-risk choice for improving Exceed user’s productivity and security, and reducing downtime.

Exceed Freedom supports the same platforms as Exceed and Exceed PowerSuite do.

Exceed Connection Server Manager

Exceed Connection Server Manager is a Windows-based management tool that is essential to ECS administrators. It allows them to configure the ECS and the ECS Cluster, to manage licenses and user settings, and to view and manage Client sessions that are currently running or suspended. Further discussion on the functionalities of the Exceed Connection Server Manager can be found in “*Configuration and Usage*”.

Exceed License Server

Exceed License Server is a component that is only available to the Exceed onDemand solution. It provides a centralized license pool that any number of Exceed Connection Server, whether it is standalone or clustered, can connect to and

share licenses in that pool. Exceed License Server (ELS) is designed to help medium to large organizations, which may have many Exceed Connection Servers or Clusters spread over multiple cities or countries in order to serve various groups of users in different geographical locations. For those organizations, it is administratively expensive to determine a fixed number of licenses for each Server or Cluster in order to maintain optimal license coverage. With ELS, organizations can streamline the license distribution process and reduce the number of license pockets.

ELS will provide the following services:

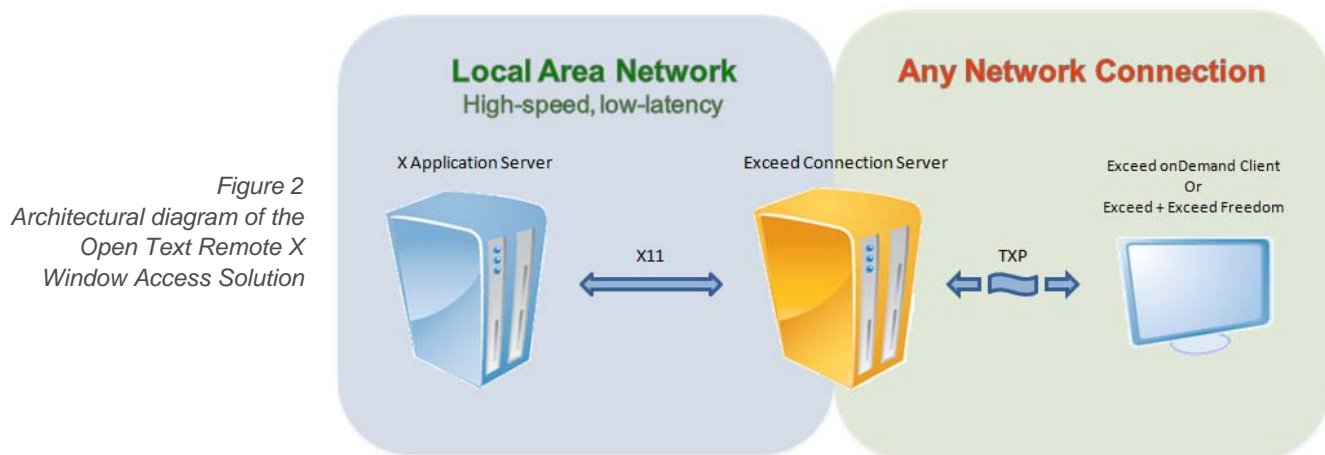
- Keep common corporate wide license pool
- Monitor license usage
- Allocate predefined number of license for each server or cluster (optional)

However, it is not ELS responsibility to manage the actual usage of licenses on the ECS – it is still the job of the individual License Manager present in each ECS or cluster. ELS will only support shared/server-based licenses type. Also, please note that an ECS can either use locally installed licenses or licenses from ELS, but not both.

Exceed License Server will be covered in details in the coming chapter.

Thin X Protocol

If ECS is the heart of the Open Text's remote X window access solutions, then Thin X Protocol (TXP) is the blood that is coursing throughout the solution. TXP is one of the main reasons why Exceed onDemand and Exceed Freedom have such exceptional performance over limited bandwidth connection, which is commonly associated with increased geographical distance. Results of an in-house analysis have shown the amount of network traffic generated by TXP is less than 1 percent of the traditional X protocol.



TXP is designed to accomplish the following:

- Split functionalities between the Proxy and Client.

The X functionalities are split between Proxy and the Client because the Proxy does not have the native ability to handle drawing requests and keyboard and mouse inputs. These requests are mapped to the TXP-equivalent requests and passed to Clients.

- Reduce bandwidth requirements.

TXP has the ability to compress, cache, and optimize requests. The goal is to minimize the amount of data that has to travel across the high-latency, low-bandwidth network. The trade off for the compression is higher CPU overhead; additional CPU cycles and computer resources are required to compress and decompress the requests. However, the abundant computing power that PCs and servers now harness allows Exceed onDemand to achieve a higher compression rate without sacrificing overall performance.

- Adapt to the network bandwidth.

The level of compression and optimization can change automatically depending on the network bandwidth availability. As the available bandwidth decreases, the

compression rate increases and special optimization of TXP is activated. The shift between CPU overhead and bandwidth usage is done automatically during startup without demanding user inputs.

- Reduce roundtrip requests.

X applications normally communicate with a Proxy over a LAN connection where network bandwidth is abundant. The Proxy, acting as a fully functional X server, is capable of handling all X protocol commands with the exceptions that have already been mentioned. As a result, many of the roundtrip requests are taking place over a LAN connection with little latency, while fewer roundtrip requests take place over WAN or Internet connections. Comparing this to having a traditional X server running on a WAN or the Internet, where all X protocol commands have to travel on low-bandwidth connections, the reduction in the number of roundtrip requests over the WAN or Internet connection is significant, thus giving our solution an unparalleled performance advantage.

- Strengthen X security over WAN and Internet.

TXP can be easily encrypted using Secure Sockets Layer (SSL) protocol for heightened security.

Authentication

A user has to complete the authentication process before they are allowed to access ECS resources and services. An ECS support different authentication types.

- **Kerberos** – This option is available if the system on which ECS is installed supports Kerberos. This option allows ECS to authenticate users by assigning a Kerberos ticket to each user that logs on to the network. With this option enabled, we offer out-of-the-box single-sign-on experience to Exceed onDemand and Exceed Freedom users.

At the time of the creation of this Whitepaper ECS support the following Kerberos solutions on each platform.

	ECS Platform				
	Windows	Linux	Sun	IBM	HP
Hummingbird Kerberos	X				
MIT Kerberos	X				
OS Native Kerberos		X		X	X
Quest Authentication Services		X	X	X	X
Centrify DirectAuthorize			X		

- **User Credential** – Administrators can configure ECS to authenticate users based on user credentials. The ECS can authenticate user based on the authentication type used by the operating system on which ECS is installed, or Pluggable Authentication Module or LDAP server as configured by the administrators.

For more information on how to configure the authentication type in ECS, please refer to the “*Configuration and Usage*” whitepaper.

Licensing

The licensing model apply to Exceed onDemand is very different than the one found in Exceed Freedom. In the case of Exceed Freedom, it uses a standard desktop-type licensing model, where each license of the software purchased grants a user the right to install and use the software on one desktop. Any computer with both Exceed and Exceed Freedom installed can use the software to connect to ECS and launch a session.

Exceed onDemand, on the other hand, employs a far more complicated mechanism to control the access to the software and measure the license usage. This mechanism comprise of a License Manager, Activation Keys, and an optional Exceed License Server.

An Activation Key is a sequence of alphanumeric characters which represents the fixed number of licenses that a company is entitled to, based on the purchase agreement. An Activation key also reflects the license type.

License Types

Exceed onDemand offers two types of licenses:

Shared or Server-Based License – This type of license allows a large amount of users to share a pool of licenses. For example, if you buy 10 server-based licenses, it means that 10 people at a time can be logged into ECS. If the 11th person tries to log in, the connection will be refused.

Assigned or Named License – This type of license restricts who can log into ECS. For example, if you buy 10 named licenses, it means that 10 individual that are defined in the ECS user database can be logged into ECS. Others who are not defined in this database will not be allowed.

The license type has a direct effect on determining who can access the Exceed onDemand solution, and the choice of license type must be decided at the time of purchase because it is reflected in the Activation Keys that are subsequently issued. An ECS can accept multiple Activation Keys but they must be of the same license type in order for ECS to report the cumulative license count.

Rules of License Usage

The purpose of having different license types is to give the software the ability to impose different logon restrictions. But once users are logged on to ECS, it will assign licenses to those users based on the following the rules, regardless of which type of license is installed on the server.

- The first time when a user creates a new session or joins a shared session, one license is deducted from the license pool, provided the pool has at least one license available.
- If this user launches another session on the same Exceed Connection Server from the same PC, then the user will be reusing the same license that was issued to him/her previously. No additional license will be deducted from the license pool.
- If this user connects to the same ECS from another PC, or connects to another ECS either from the same PC or a different one, one license will be deducted from that ECS's license pool.
- When a user terminates or suspends the last session from an ECS, the license is then returned to the pool for circulation.

Centralized License Pool

Exceed License Server is an optional component that is only needed if common license pool is to be shared among different ECS or Clusters. The following diagram shows the architecture with ELS incorporated in the infrastructure.

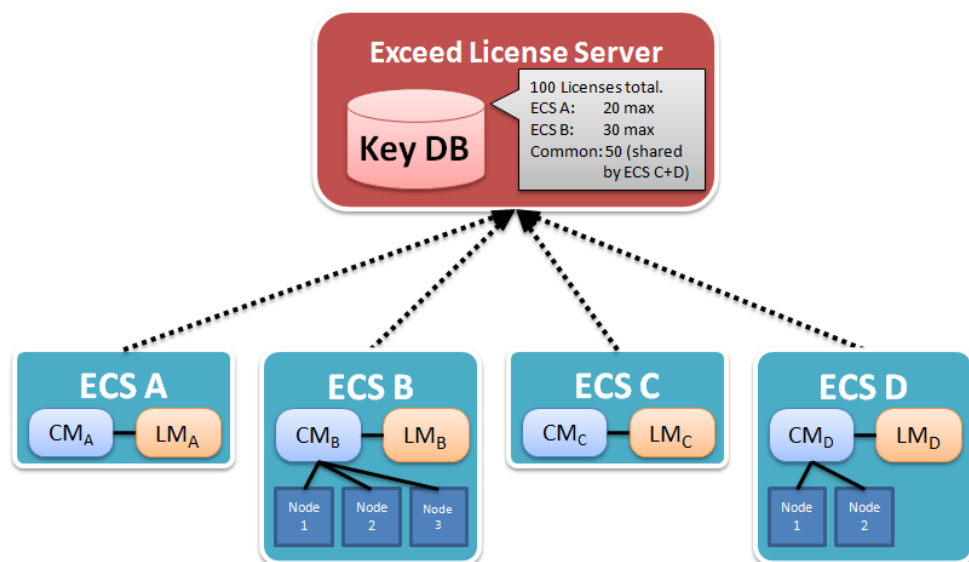


Figure 3
Exceed License Server

Administrators can use the Exceed Connection Server to configure and manage ELS. As part of the configuration, administrators have an option to allocate a fixed number of licenses from the pool to selective or all ECS. For example, if there are 100 licenses in the ELS license pool, an administrator can allocate 20 licenses to ECS A and 30 licenses to ECS B, the remaining 50 licenses can be shared by ECS C and D on a first-come-first-serve basis.

If an ECS is configured to use a license server, it will try to connect to the server during startup. Upon successful connection, ECS will discover whether a fixed number of licenses are allocated to it from the ELS. ECS will store this number internally and it will use it as if those licenses are installed locally. ECS will frequently update ELS on its license usage. If the ECS is not assigned with a fixed number of licenses then it will request ELS to allocate a license on demand from the common license pool.

In the event that the connection between an ELS and an ECS is broken, one of two things will happen.

- **For an ECS with license limitation**

Upon disconnection from ELS, the ECS will continue to manage the allotted licenses as if they are locally installed. When the connection to ELS is restored, the ECS will report current license usage. Impact to the ECS and its users are minimal.

- **For an ECS that has no license limits**

Upon disconnection from the ELS, the ECS will assume all available licenses in the common license pool are allocated to it. When the connection to ELS is restored, ELS will recalculate the total number of licenses in use. Users who have active sessions will not be penalized if the total number of licenses in use after restoring connection is greater than the number of installed licenses. In this case, this event will be logged and new sessions will not be available until the total number of licenses in use is less than the number of licenses installed.

Cluster Computing

What Is a Cluster?

In a computer system, a Cluster is defined as the use of a group of machines to form a single logical system that enables high availability and load balancing.

Active and Passive Cluster Managers

As mentioned before, the CM component is found in every installation of ECS, but not all instances of those CM components are active at all time. In a cluster configuration, only one ECS will still have the CM component activated, and the machine where this ECS is physically installed on will be called the Master Node. The CM component in all other ECS will be switched to a passive mode. A passive CM has only the following two functions:

1. to monitor the status of the active CM, and
2. to be ready to assume the role of the active CM should the Master Node become unavailable

PMs on every Node will be reporting to the active CM.

Also, all incoming connection requests will be processed by the active CM as well, and the work will be distributed to the Node based on the Load Balancing preference set up by the administrators, which can be the Node with the lowest CPU load or the one with the least number of active sessions.

How Does Clustering Work?

In a Cluster configuration, multiple ECS are programmatically linked to form a single, logical computing unit, and each ECS within a Cluster is called a *Node*. An ECS in Standalone configuration can be considered as a cluster with only one Node.

In a typical scenario, a user will use the client-side software to initiate a session by specifying an Xstart and Xconfig profiles, which contain parameters of an X server, and the X application that a Proxy should launch on behalf of the user. The first task that the CM performs after receiving the connection request is to authenticate the user. Once the user's identity is confirmed, the CM will have to determine whether a new Proxy is required to handle the new connection, and if so, which Node and the corresponding PM will be handling it. The decision will be based on the Proxy Reuse Rules (see below) and the work load of each Node. Once the decision is made, the CM will reply to the Client with the redirection information: the Node ID, the port on that Node, and an authentication token. While possessing this token, the Client can

directly communicate with the Node. If the Master Node itself has the most available resources, the PM on this Node will accept the Client connection.

As instructed, the Client will contact the PM on the designated Node, and provide it with launch parameters as specified in the Xstart and Xconfig profiles. The PM on the Node will then start a Proxy to manage the X session, assign it with a unique display ID, and send the startup information back to the Client so it can directly communicate with the Proxy.

All communication between the Client and X applications is mediated by the Proxy. X applications communicate with the Proxy using the traditional X protocol, and the Proxy communicates with the Client using the Thin X Protocol (TXP).

Data Storage

In cluster configuration, all Nodes must have full access rights to the DS because any Node can be promoted to a Cluster Manager Node in the case of a fail-over scenario, and it needs unrestricted access to the content in the DS.

Also, in order to maintain consistency and integrity, there can be only one DS in each ECS Cluster. Before multiple ECS can be grouped together to form a cluster, administrators will need to create a remote DS which is accessible to all node.

License

When a standalone ECS joins a Cluster, the administrators are required to manually transfer the license from the newly added Node to the license pool by re-entering the Activation Key in the Exceed Connection Server Manager.

Fail-Over Scenarios

There are the following three types of failure:

- Failure of a Node
- Failure of the Cluster Manager Node
- Failure of the Data Store

Failure of a Node

Any node in a Cluster, except for the Master Node, is called a Node. Should a Node fail, there are built-in sensors in the software that will alert the active CM of its failure. The CM will stop allocating workload to that Node until it receives another notification from the sensors that the Node is restored. This process is completely automated, and it does not require input from administrators. Such failure does not have a prolonged impact on the rest of the Cluster.

If the system on which the failed Node is located is restarted, then all sessions on that Node will be lost and cannot be recovered. Users will have to reconnect and restart their X applications on other Nodes. However, if the failure is caused by communication errors, such as faulty network connections, the built-in auto-suspend feature may safeguard those sessions automatically by suspending all active session. Users can wait until all network problems are resolved and attempt to resume those suspended sessions.

Failure of the Master Node

The CM in the Master Node handles all cluster-related administrative tasks, such as authenticating users, managing licenses, and monitoring the health of all Nodes and PMs present in the Cluster. However, it will not interfere with the operation of the PMs or Proxies. In the event that the Master Node is offline, the role of the Master Node will automatically be delegated to one of the remaining active Nodes. The election of the new Master Node is timely and automated. Since the Master Node does not interfere with the operation of the Proxies, its failure will not have any impact on existing sessions, except for the ones that it was managing. In this case, users may restart those sessions, or wait to resume.

Failure of the Data Store

Although it is one of the main components of an ECS, the Data Store can exist outside of a Cluster. In fact, it is recommended that the DS to be housed in an enterprise network storage device and take advantage of redundancy and high-availability features that are offered, so the DS less susceptible to failure.

Should a failure occur which renders the DS unreachable it will prevent users from launching any new session. But it will not have any effect on existing sessions. As soon as the Data Store is back online, users can continue to create new sessions.

Limitations

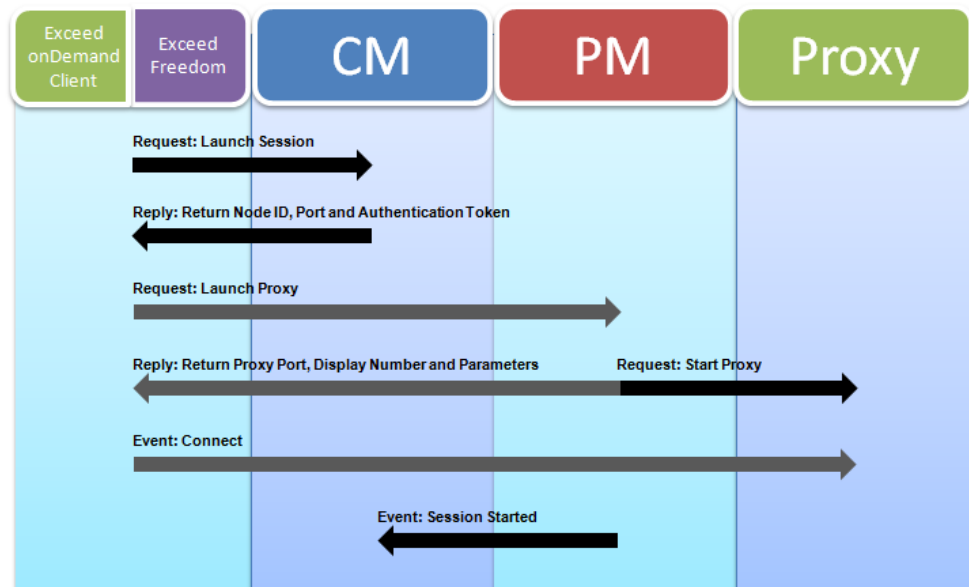
There are a few restrictions in setting up a Cluster.

- All Nodes in an ECS Cluster must be connected to the same Data Store.
- All Nodes in an ECS Cluster must share the same authentication process.
- Font Database on all Nodes must be identical.
- System clocks on all Nodes must be synchronized.
- All Nodes must have the same SSL keys and certificates.

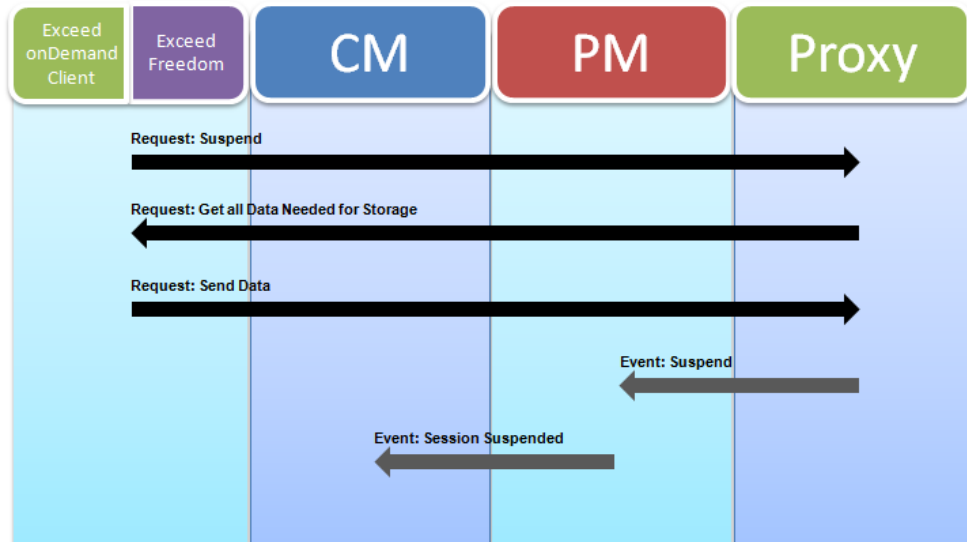
The Sequence of Events

The following diagrams depict different connection events:

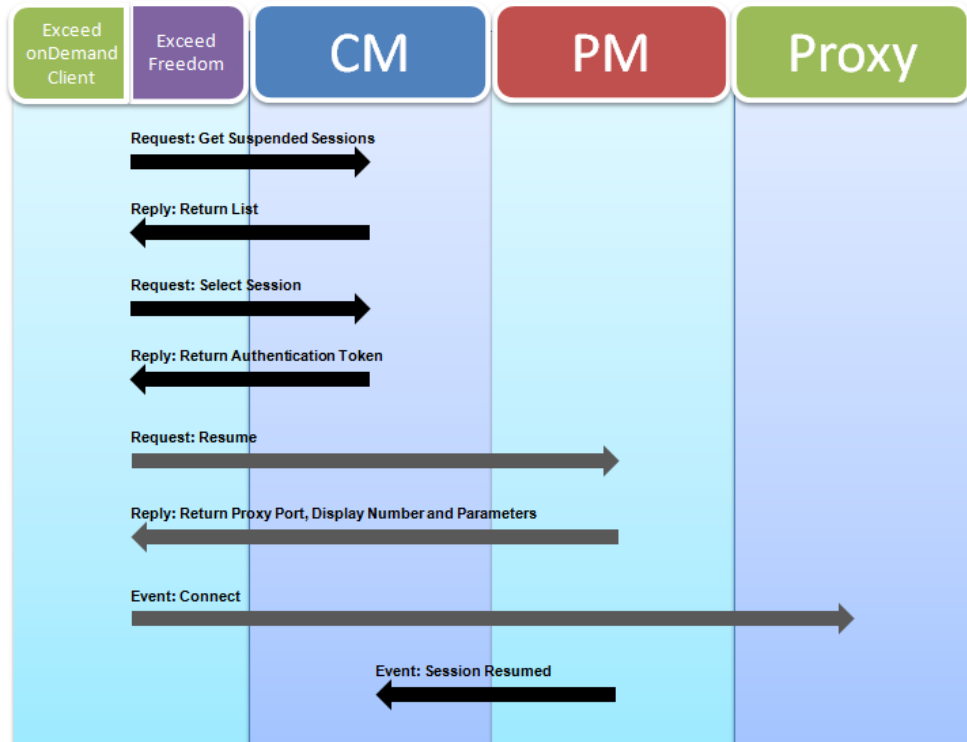
Launch a Session



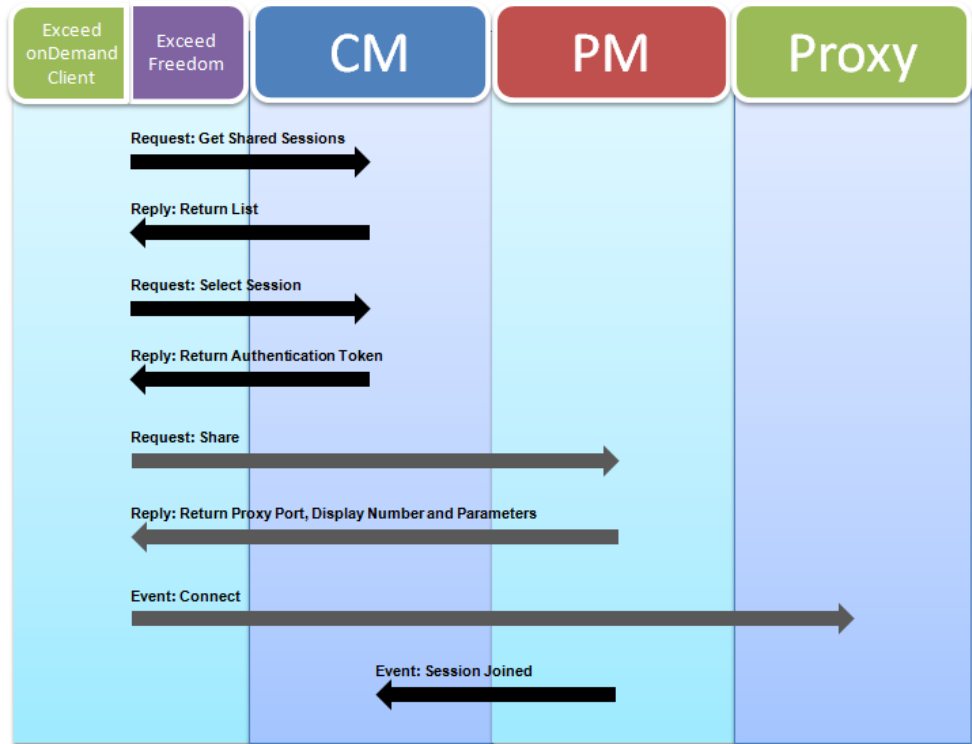
Suspend a Session



Resume a Session



Join a Session





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