5.1.2 Graphical User Interfaces Facts

This lesson covers the following topics:

- Display servers
- X11 systems
- Wayland systems
- Desktops

Display Servers

In a Linux system, a display server is the program responsible for coordinating the input and output of the programs and applications running the GUI interface to and from the rest of the operating system, the hardware, and each other. In other words, the display server sits between the graphical interface and the kernel and determines how your program and applications will be displayed based on your actions. This program is called a display server because it is capable of displaying (or serving) its output on a remote system that is also running the display server software.

Display servers communicate with the clients (such as Google Chrome) using a display server protocol. The two most popular display server protocols are X11 and Wayland. X11is implemented by the X Windows System and, as such, is sometimes referred to as X Windows or just X. The Wayland protocol is used by the Wayland Compositor.

X11 Systems

X11 (X Window System or simply X) is one method of providing the graphical user interface (GUI) on Linux systems. It is a modular system that gives administrators control over each component.

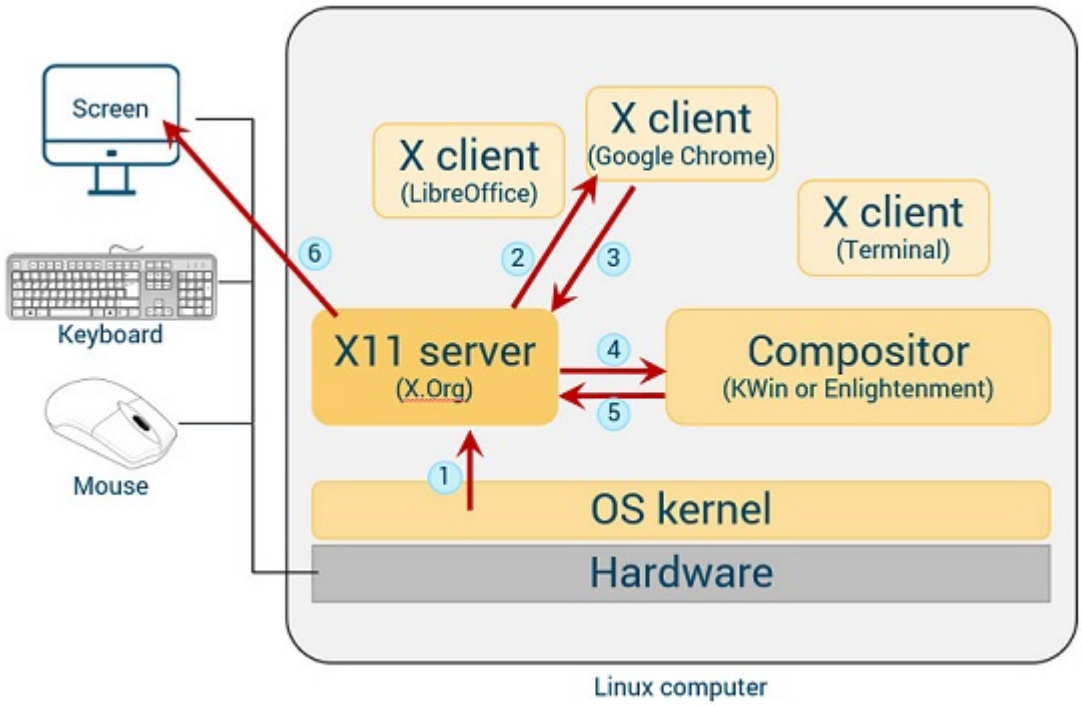
The X11 system includes the following components:

Component	Description
X11 Server	The X11 server is the main component of the X Window System. The X11 server: • Manages input devices, such as the mouse and keyboard and controls output to monitors and printers. • Is networked, which means its output can be displayed locally or sent over the network to other computers.

	• Uses the DISPLAY environment variable to control where the output is sent. Setting DISPLAY to **0:0** will send the X11 server output to the monitor on the local system.
	• Has two common implementations.
	  ◦ X.Org is the most commonly used by X11 Windows systems.
	  ◦ XFree86 is an earlier X11 server implementation that was used by default in most Linux distributions up until 2004.

Window manager	A window manager controls the placement and appearance of windows on a Linux computer (such as moving, hiding, resizing, or closing), as well as controlling what they display. Most Linux distributions come with multiple window managers. A few window manager examples for X11 include: • Enlightenment • Sawfish • KDE Window Manager (KWin)
X client	X clients are the graphical applications (such as Firefox) requesting the display of pixel buffers on the screen.
Desktop environment	A desktop environment controls the desktop features, including desktop menus, screensavers, wallpapers, desktop icons, and taskbars. The two most common desktop environments are GNU Network Object Model Environment (GNOME) and Kool Desktop Environment (KDE).

An X11 system functions as follows:



1. The kernel gets an event from an input device, such as the keyboard, and then sends that event to the X11 server.

2. The X11 server determines which window is affected and sends the information to the correct X client program, such as Google Chrome.
3. The X client looks at the event and decides what to do. For example, the user interface may need to be changed in some way. Since the client doesn't know how to render the change, it sends the required information back to the X11 server.
4. To render, the X11 server sends the information to the compositor (or window manager).
5. The compositor returns its information back to X11 to re-composite the part of the screen where the change is being made.
6. The X11 server makes the required change on the display.

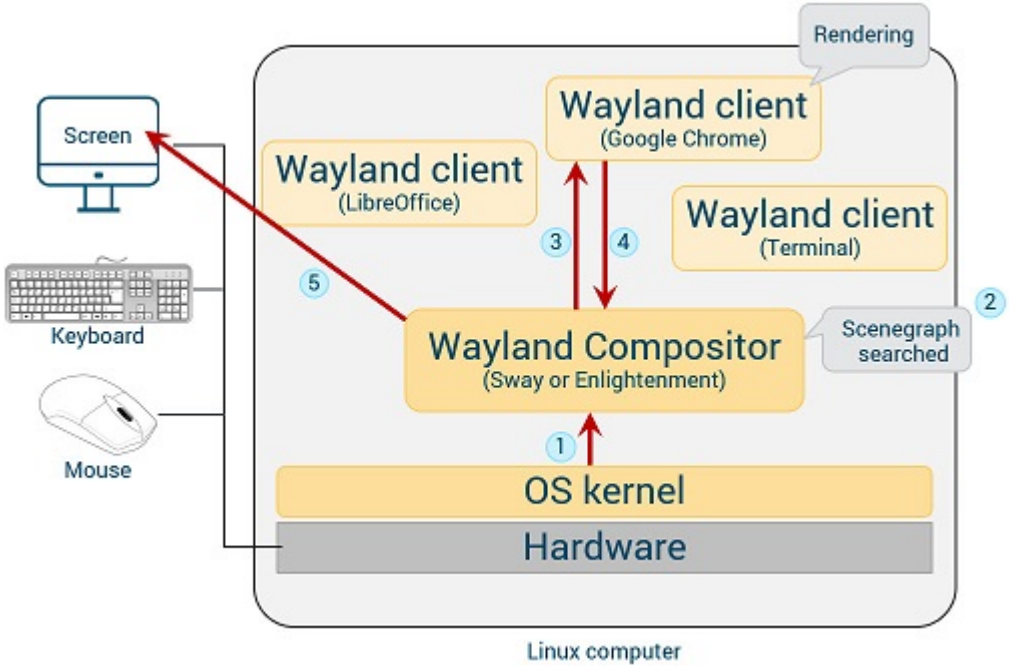
Wayland

The Wayland compositor (display server) is one method of providing the graphical user interface (GUI) on Linux systems. It is a modular system that gives administrators control over each component.

The Wayland system includes the following components:

Component	Description
Wayland compositor	The Wayland compositor is the main component of the Wayland system. In a Wayland system, the display server and the compositor (window manager) are one component, simplifying the process of updating the GUI. The Wayland compositor: • Manages input devices, such as the mouse and keyboard, and controls output to monitors and printers. • Is networked, which means its output can be displayed locally or sent over the network to other computers. • Controls the placement and appearance of windows (such as moving, hiding, resizing, or closing). • Controls what is displayed.
Wayland client	Clients are the graphical applications (such as Firefox) requesting the display of pixel buffers on the screen. In a Wayland system, the client also performs the rendering by itself and then shares that information with the compositor.
Desktop environment	A desktop environment controls the desktop features, including desktop menus, screensavers, wallpapers, desktop icons, and taskbars. The two most common desktop environments are GNU Network Object Model Environment (GNOME) and Kool Desktop Environment (KDE)

A Wayland system functions in the following way:



1. The kernel gets the event from the input device and sends it to the Wayland compositor, which is considered the display server in this environment.
2. The Wayland compositor keeps track of what's on the screens in something called a scenegraph and can search through the scenegraph to determine which Wayland client (like Google Chrome) needs the information.
3. The Wayland client receives the event and updates what the user interface should look like and performs the rendering.
4. The Wayland client sends a request to the compositor to indicate the region that was updated, and the compositor updates it scenegraph information to reflect the change.
5. The compositor then redraws the screen.

Desktops

The desktop environment leverages the information created by the window manager or compositor and then adds a series of tools and utilities to make the graphical user interface useful. It ties all of your GUI components together into one cohesive environment. In most cases, the desktop gives the end-user the look and feel of Windows, although each version of desktop will vary in what is shown and how that information is accessed.

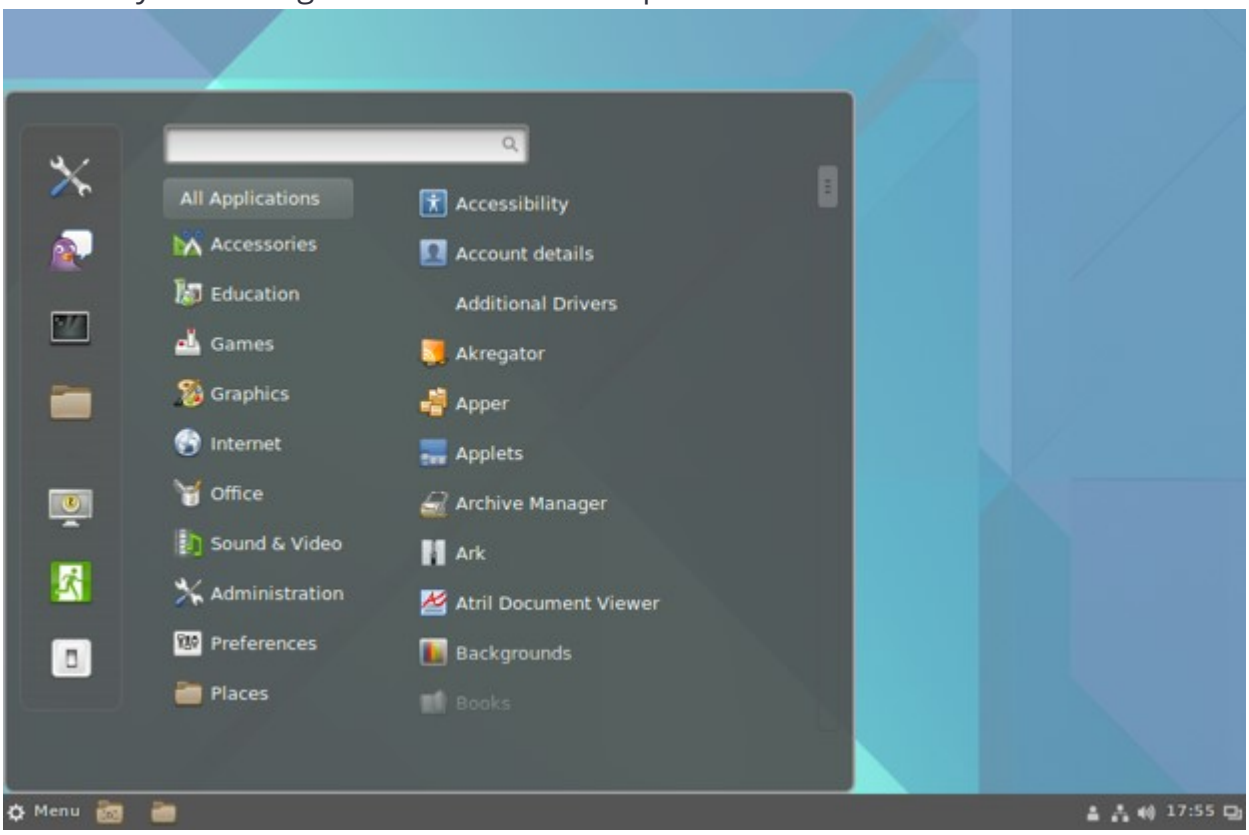
A few of the common desktop environments currently used with Linux systems include:

- GNOME
- Unity
- Cinnamon
- MATE

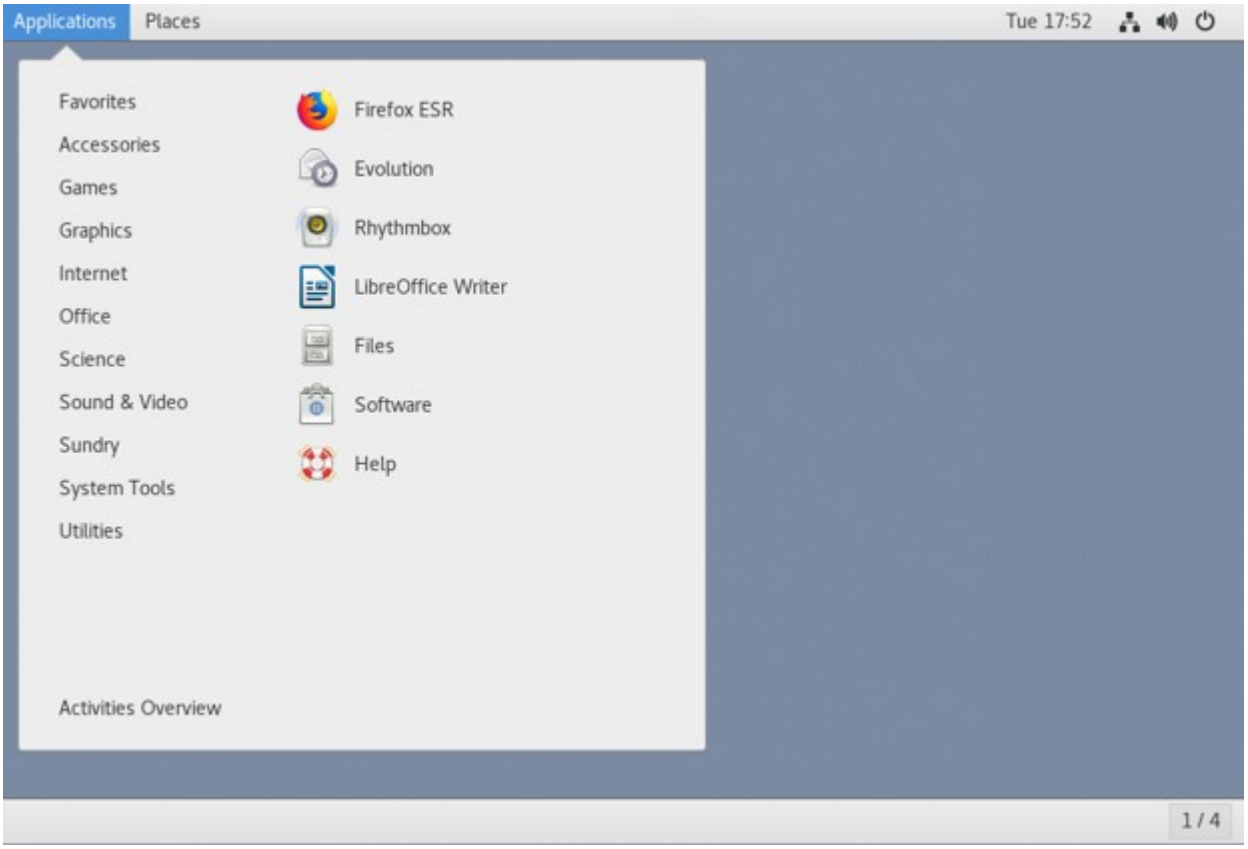
- KDE

Due to the modularity of the GUI environment, a single system can have several desktops installed at the same time, giving the users the ability to select which they will use. In many cases, this choice is made while logging onto the system.

Examples:
A Linux system using the Cinnamon desktop.



The same Linux system using the MATE desktop.



While the desktop environment is optional, although highly recommended for end-user systems, there are some Linux distributions, such as those designed for security or those that are only functioning as a server, that either don't have a GUI installed at all or have a very limited GUI.