Mobile Display Types

In this reading, you will learn about several types of displays used in modern mobile devices and monitors. As an IT Support professional, you may need to troubleshoot various types of displays. This might involve repairing damaged mobile device screens. You may even be responsible for selecting and ordering mobile devices for the employees of an organization. In your IT job role, you should have a basic understanding of the technology behind modern displays, as well as their common uses, positive features, and negative flaws. The top two technologies used in mobile system displays are Liquid Crystal Displays (LCD) and Light Emitting Diodes (LED).

Liquid Crystal Display (LCD)

LCDs use liquid crystal technology. Liquid crystals have the properties of both a liquid and a solid. The crystals can be aligned in a variety of patterns and manipulated with electricity. How the liquid crystals are arranged and manipulated inside display panels affects refresh rates, image quality, and display performance. LCDs require backlighting, often provided by LEDs. Displays that need backlighting are also called non-emissive or passive displays. The backlighting unit (BLU) requires extra space, which makes LCD panels thicker and less flexible than other displays. Polarizers on either side of the liquid crystal layer control the path of the backlight to ensure the light is aimed toward the user.

The following are common LCD display types used for mobile devices:

In-Plane Switching (IPS)

- **How it works:** In IPS displays, the liquid crystals are aligned horizontally to the screen. Electricity is passed between the ends of the crystals to control their behavior.

- **Uses:** IPS technology is used in touch screen displays and high-end monitors. They are often used for design, photography, video/film editing, animation, movies, and other media. They can also be used for games that rely on color accuracy and wide viewing

angles, as opposed to speed.

- **Positives:** IPS displays provide vibrant colors, high quality graphics, and wide viewing areas. Additionally, they offer excellent color reproduction, accuracy, and contrast.

- **Negatives:** IPS displays are expensive. They have low refresh rates and slow response times. However, response times have been improving as the IPS technology evolves. IPS displays can be affected by “IPS Glow”, where the backlight is visible from side viewing angles.

Twisted Nematic (TN)

Twisted Nematic (TN) is the earliest LCD technology that is still in use today. The term nematic, which means “threadlike,” is used to describe the appearance of the molecules inside the liquid.

- **How it works:** In TN displays, the liquid crystals are twisted. When voltage is applied, the crystals will untwist to change the angle of the light they transmit.

- **Uses:** TN displays are appropriate for basic business use (e.g., email, document, and spreadsheet applications). They are also used for games that need rapid display response times.

- **Positives:** TN displays are low cost, easy to produce, have excellent refresh rates, response times, and resolutions. They are versatile and can be manufactured for any size and/or shape.

- **Negatives:** TN displays have narrow viewing angles, low image quality, color distortion, and poor color accuracy and contrast.

VA-Vertical Alignment

- **How it works:** In VA displays, the liquid crystal molecules are vertically aligned. They tilt when electricity passes through them.

- **Uses:** VA displays are intended for general purpose. Provides mid-range performance for graphic work, movies, and TV.

- **Positives:** VA displays offergreat contrast, deep black shades, and fast response times. They are mid-range quality for refresh rates, image quality, viewing angle, and color reproduction.

- **Negatives:** On VA displays, motion blur and ghosting occurs with fast-motion visuals.

Organic Light Emitting Diodes (OLED)

OLEDs are diodes that emit light using organic (carbon-based) materials when electricity is passed through the diodes. Displays that are able to convert electricity into light are called emissive or active displays.

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How it works: The basic structure of an OLED display consists of an emissive layer placed between a cathode (which injects electrons) and an anode (which removes electrons). Electricity enters through the cathode layer, passes into the emissive layer and conductive layer to create light, then out through the anode layer.

- **Uses:** OLED display technology can be used in foldable smartphones, rollable TVs, as backlighting in LCD TVs, for gaming, and inside VR headsets.

- **Positives:** OLED displays deliver excellent picture quality, wide viewing angles, infinite contrast, fast response rate, and brilliant colors with true blacks. They are energy efficient, simpler to make, and much thinner than LCDs. OLED panels can be built to be flexible and even rollable.

- **Negatives**: OLED displays are sensitive to light and moisture. Blue LEDs degrade faster than other LED colors causing color distortion over time. They are also prone to image retention and burn-in.

Active Matrix Organic Light Emitting Diode (AMOLED)

Active Matrix Organic Light Emitting Diode (AMOLED) and Super AMOLED are recent technologies used in smartphone displays.

- **How it works:** AMOLED displays are a type of OLED panel that uses active matrix technology. Active-matrix displays have active capacitors arranged in a matrix with thin film transistors (TFTs). This technology enables the control of each individual pixel for rapid state changes, including changing brightness and color. AMOLEDs have touchscreen functions integrated into the screen.

- **Uses:** AMOLED and Super AMOLED panels are used in high-end mobile devices, flat screen monitors, curved screens, and touchscreens.

- **Positives:** AMOLED displays offer a high picture quality and fast response time. Color and brightness are consistent across the screen. Fast-moving images and motion are displayed clearly without blurring or ghosting. Super AMOLED panels can display a wider range of colors with enhanced contrast, which makes them easy to view in a wider variety of lighting conditions.

- **Negatives:** AMOLED displays have the same problems as OLED displays (listed above) plus AMOLED panels can be difficult and expensive to manufacture.

Inorganic mini-LEDs (mLEDs)

Inorganic mini-LEDs (mLEDs) are a next-generation, emissive display technology.

- **How it works:** Mini-LED displays work the same way that OLED displays work, but the individual LED size is much smaller at approximately 50-60 micrometers.

- **Uses:** Mini-LED displays are used for LCD backlighting in smartphones, public information displays, signage, electronics, vehicle displays, and more. Mini-LEDs are also the tech behind “Liquid Retina XDR” screens.

- **Positives:** Mini-LED displays offer ultra high luminance, superior HDR fineness, long lifetimes, thin panels, and are readable in sunlight. They are also less expensive than

micro-LED displays.

- **Negatives:** Mini-LED displays, when used as LCD backlighting, are limited by the properties of LCD technology. Mini-LED displays for mobile devices are more expensive than OLED displays.

Inorganic micro-LEDs (µLEDs)

Micro-LEDs (?LEDs) are also emissive, next-generation displays.

- **How it works:** Micro-LED displays work the same way that OLED displays work, but the individual LED size is extremely small at 15 micrometers.

- **Uses:** Micro-LED displays can be used in smartphones, AR/VR headsets, wearables, public information displays, wall-sized TVs, vehicle displays, and more.

- **Positives:** Micro-LED displaysoffer superior performances across virtually all common display features, such as brightness, reaction speeds, power consumption, durability, color gamut, stability, viewing angles, HDR, contrast, refresh rates, transparency, seamless connectivity, and more. Micro-LED displays are readable in sunlight and have sensor integration capability.

- **Negatives:** Micro-LED displaysare expensive to manufacture and are not yet ready for mass production.

Key takeaways

The two main technologies used in mobile displays are Liquid Crystal Display (LCD) and Organic Light Emitting Diodes (OLED). Each technology has its own benefits and drawbacks when used in mobile device displays, among other consumer goods.

- Common LCDs include:
  - In-Plane Switching (IPS) displays
  - Twisted Nematic (TN) displays
  - VA-Vertical Alignment displays
- Common and upcoming OLED displays include:
  - Active Matrix Organic Light Emitting Diode (AMOLED) displays
  - Inorganic mini-LEDs (mLEDs) displays
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Inorganic micro-LEDs (?LEDs) displays

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