

NOKIA
PureMotion Technology

PureMotion Technology White Paper

PureMotion is the latest innovation of Nokia to radically improve the display capabilities. A set of new technologies ensures that the PureMotion HD+ display of the [Lumia 920 smartphones](#) is the fastest and brightest display and has the most sensitive touch on top of the high resolution.

Fastest display

All display technologies currently used in modern smartphones, i.e. liquid crystal displays (LCDs) and organic light-emitting diode (OLED) displays, suffer from inadequate [smartphone video](#) quality. While hardware (HW) and operating systems (OS) are capable of delivering smooth rendering at a steady rate of 60 frames per second (FPS) for most of the displayed content, display technologies are still designed for the era of lower rendering rates when fast-response time displays were not necessary. For consumers this means blurred display while scrolling, navigating, playing games, using the viewfinder etc.

Nokia's PureMotion technology is addressing the inadequate moving image quality in mobile displays, thus leveraging on the high-speed rendering capabilities of the graphics engine.

Fast liquid crystal response and panel overdrive

With the typical [in-plane switching](#) (IPS)-type liquid crystal display in mobile devices, the pixel transition time is longer than the period of one rendered frame i.e. 16.7 milliseconds (ms). In practice the time it takes a pixel to change its state from one level to another is spanning over several frames, thus creating blur.

In most LCDs white-to-black and black-to-white transitions are faster than transitions involving grey-to-grey level changes. Especially this is the case for twisted nematic (TN) and vertically aligned (VA) liquid crystals (LCs). IPS-type of LCDs, on the other hand, show a much smaller visible variation in transition times across grey levels. With grey-to-grey transitions, the crystal driving voltage difference between original and target state is smaller leading to slower turning of the liquid crystal molecules, which get even slower at lower temperatures

The way to overcome this problem is to use a temporary higher voltage difference for driving each LC pixel i.e. to overdrive the panel. This leads to the PureMotionHD having the [best video quality](#).

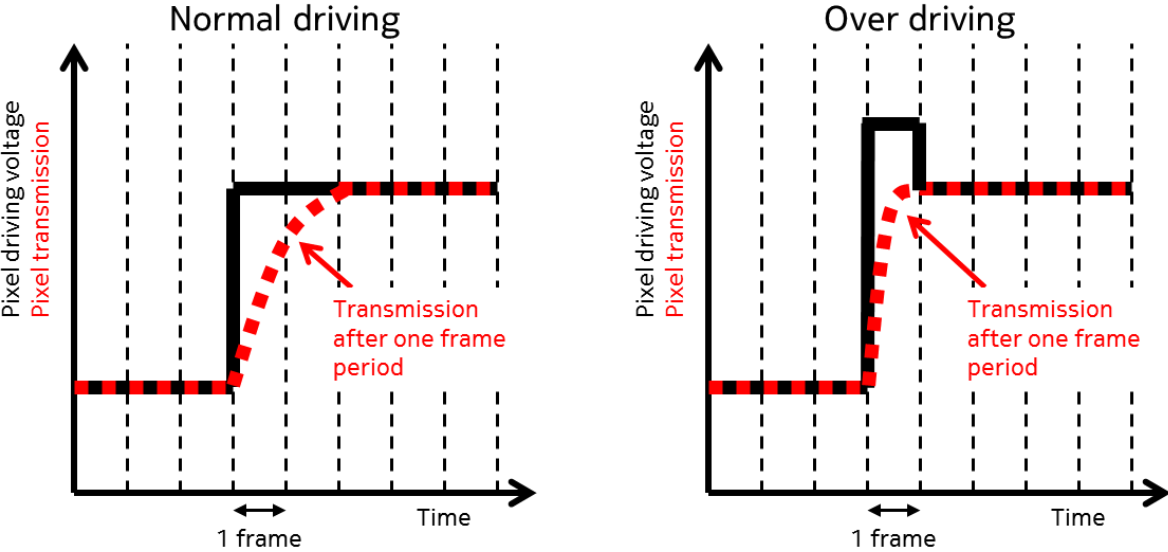


Figure 1. Illustration of the overdrive principle

In the end overdrive contributes to both reducing the liquid crystal rise time and also improving the consistency of the transitions as can be seen in the following measurement data. In the charts height of the bar indicates transition time.

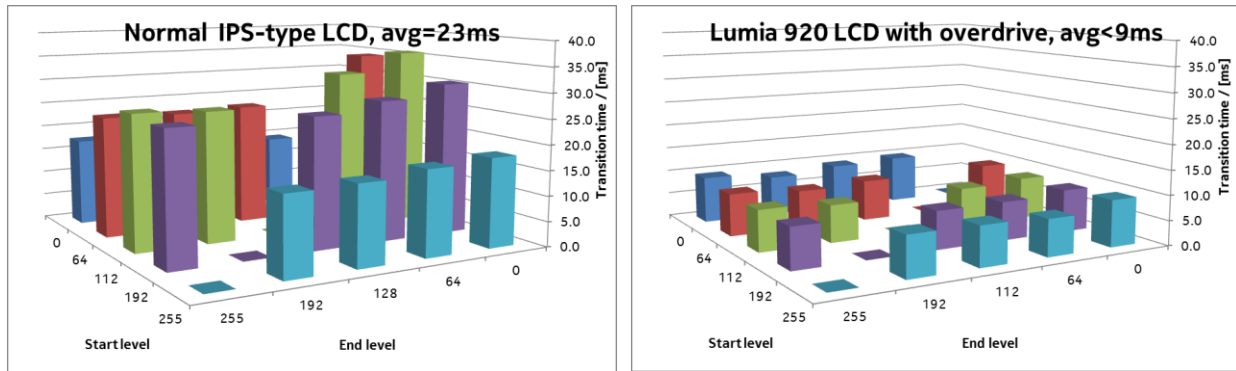


Figure 2. Transition times for normal (left) and overdriven (right) IPS-like LCDs.

In order to be able to show any image at good motion quality with 60fps, liquid crystals need to complete their transition from the previous frame before transition starts for the next frame. In practice this means that LC transition time needs to be below one frame time for any transition, because it also takes some time to write the image to the display (panel addressing time).

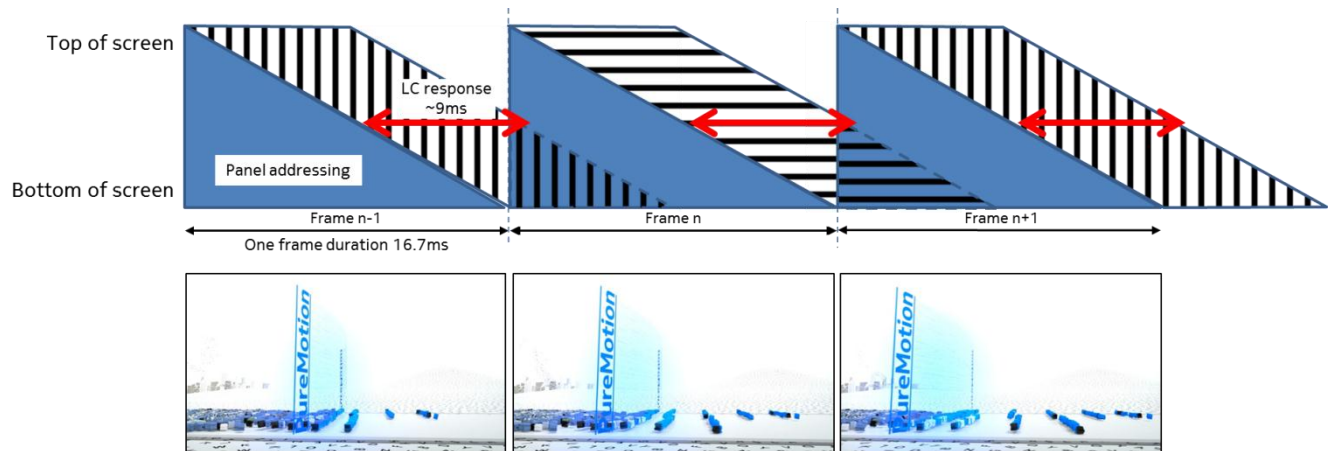


Figure 3. PureMotion HD+ display panel update in the top image and panel data after update in the bottom image

With overdrive-enhanced LC response, PureMotion display pixels finish their transition well before the update of the next frame for any pixel needs to start, resulting in a less blurry image.

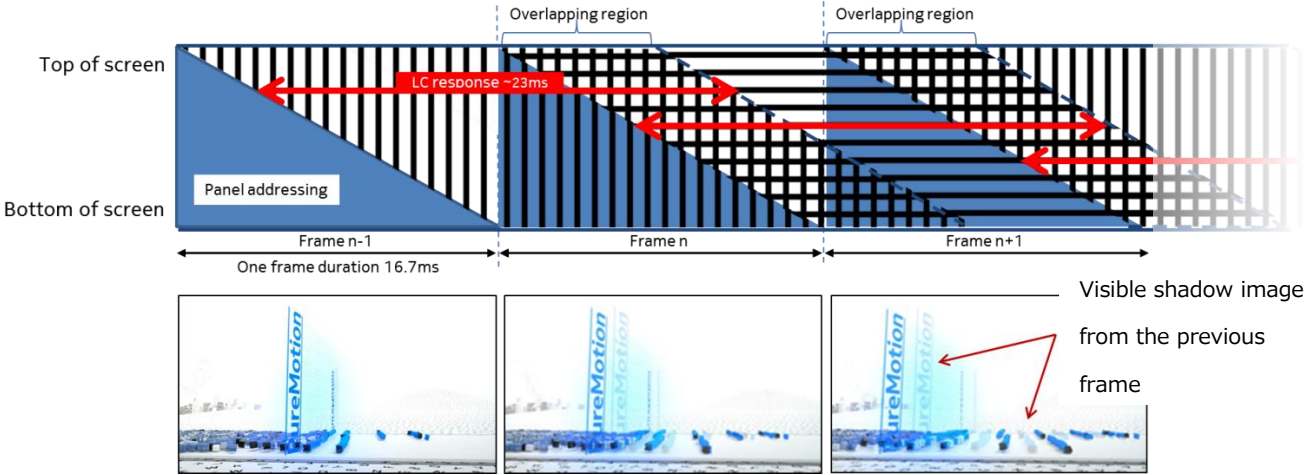


Figure 4. Conventional IPS-like display update where slow pixel response time leads to shadow images

In a normal IPS-like LCD having longer ~23ms LC response time, previous frame has not yet been fully updated when the pixels already needs to be updated again. In practice this means that during image motion, some of the pixels never reach the intended value, resulting in a more blurry image and even miscoloured edges (color bleeding).

Brightest

[Smartphones](#) rely completely on touch screen operation. In bright sunlight most displays turn non-readable and non-usable. It is close to impossible to read text messages or browse, even making a call becomes very difficult. For consumers this is a major usability problem. With PureMotion technology, we are introducing innovation solving these problems.



Building on top of innovations in the [ClearBlack technology](#), PureMotion introduces new innovation on outdoor viewing experience in mobile displays. In addition to the very low reflectance, which largely improves dark tone rendering in ambient light, PureMotion adds high luminance mode for backlight LED-driving and image contrast enhancement, on top of superb optical stack design. Together they improve the overall contrast and thus brightness and sunlight readability.

In an extremely bright environment the [Lumia 920 PureMotion](#) display its backlight luminance reserve and becomes the smartphone WXGA (1280x768) display with highest peak luminance. For user high luminance mode is fully automatic, working based on the data coming from ambient light sensor.

The adaptive image contrast enhancement compensates the loss of contrast caused by the unavoidable ambient light reflections inside the display-touch-window optical stack. It enhances the display readability by altering the user interface graphics color and contrast mathematically and optimizes it dynamically for any ambient light viewing condition. These sunlight readability enhancements are fully automatic for the user.

Details are visible with Lumia 920



Figure 5: Original photo



Figure 6: Phones under direct sunlight: Lumia 900 (which has been praised having very good outdoor visibility) on the left and Lumia 920 on the right demonstrating the effect sunlight readability enhancement improving greatly the visibility of dark shades in high illuminance.

Highest pixel count: HD+

To achieve the best smartphone video on the market, the first PureMotion display has a pixel count of 1280x768, also called WXGA. HD+ refers to the fact that WXGA has 7% more pixels than regular 720p (1280x720) and 15:9 aspect ratio. Also it has 60% more pixels than DVGA (960x640) and response fast enough to show content rendered at 60fps in a blur free fashion.

HD+ provides the best balance for content viewing and UI usability of touch screen. When browsing, looking at photos, watching videos etc. you get more content in one go. 15:9 aspect ratio gives better usability compared to 16:9. User interface elements, which are at top edge of the screen, are closer to the users fingers, thus being more reachable also with thumbs.



Figure 7: Comparison between the amount of content visible in WXGA HD+ display vs. DVGA and 720p

Most sensitive touch

People with long fingernails haven't been able to use touch screen by the most natural way - with nails. They have needed to learn a new way to touch the screen by bending their fingers into all kinds of positions. This makes the use of a smartphone more cumbersome and not that easy as it could be. There are also moments when you want to use gloves. For example in cold weather you would rather keep the gloves on than pulling them off to make a call. As funny as it may appear, many people have even learned to answer their phone by their nose, not taking their gloves off.

Super sensitive touch in Lumia 920 sets a new bar in touch display experience since the introduction of capacitive touch in smartphone mass market 2007. So far it's been about [multitouch](#) and usage of the device with bare fingers or stylus but now there will finally be a radical user experience improvement. Nokia is the first smartphone manufacturer to bring super sensitive and [best touchscreens](#) to the market. The touch in Lumia 920 is more sensitive than in any other touch display enabling interaction not only with your bare fingers but also with gloves, long finger nails and even some regular pens. This technology adapts its sensitivity according to user input method, making touch usage faster, more natural and accurate.



Figure 8: Comparison between conventional and super sensitive touch

Lumia Lumia 920 display specification

Diagonal size: 4.5"

Resolution: 332 pixels per inch (PPI)

Pixel count: 1280x768 (WXGA HD+)

Luminance control levels: 8bit i.e. 256 levels

Grey-to-grey pixel transition time: average <9ms

Display architecture:

- In-Plane-Switching
- Overdrive
- Backlight LED driving with high luminance mode
- Sunlight readability enhancement algorithms
- ClearBlack technology

Capacitive super sensitive touch

Additional Resources:

[Nokia Beta Labs](#)

- Nokia Beta Labs brings together developers and consumers keen on improving products and accelerating innovation.

[Nokia Conversations](#)

- Conversations by Nokia is a site that tells compelling stories about the global cultures, technology and people shaping mobile, and [smartphone](#) innovation.

[Nokia Lumia Smartphones](#)

- See the range of award winning [smartphones](#) that have the latest smartphone technology such as the Nokia Lumia 920