MULTI
TACTION

Migration Guide: SUR40 / Pixelsense to MultiTaction

v1.0

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/// Executive Summary

MultiTouch is one of the forerunners in large format advanced interactive displays for professional use. Market segments such as corporate, retail, education, digital signage and museums are adopting interactive displays to address their specific engagement needs. This market has seen a wide range of technologies and products in use in the above 32” size class. However, in terms of features two products have stood out: MultiTouch’s MultiTaction Cells and Samsung SUR40 with Microsoft Pixelsense technology.

Both MultiTaction Cells and SUR40 work with unique optical imaging technologies of their own. Whereas SUR40 uses a special 40” LCD panel with sensor pixels forming one large imaging sensor, MultiTaction Cells have discrete camera sensors built into the custom backlight panels. Both achieve a perpendicular view of interactions on the screen allowing for a multitude of advanced tracking features such as finger orientation and optical marker based tracking of physical objects which allows tangible user interfaces to be built.

This Migration Guide compares the differences and similarities between MultiTaction Cells and SUR40 for those users of SUR40 wishing to concurrently run or migrate to MultiTaction Cells. The document also explains the benefits of adopting MultiTaction Cells in detail.

In summary, the key points supporting migration from SUR40 include:

- MultiTaction Cells match and exceed the advanced tracking features of SUR40
- Responsiveness and robustness of the touch interaction in different environmental onditions is far superior on the MultiTaction Cells.
- SUR40 applications can run out of the box on MultiTaction Cells or are easily modified to do so.
- MultiTaction Cells open the possibilities for application development by being compatible with any development environment or multi-touch authoring tool available in the market.
- Migration to MultiTouch Cells opens additional opportunities for remote management and control of interactive displays over SUR40.
- MultiTaction Cells offer scalability from single screen applications to multi-screen installations as tables or walls.

In summary, MultiTaction Cells offer a perfect choice for SUR40 users to continue and expand their interactive display installations.

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Taction
Pronounced: \ˈ*tak-shən*\
from Latin: *taction-, tactio*
meaning: *touch*

Source: Merriam Webster

/// Overview

Background

Touch screens have taken over the world in the past five years with growing number of smartphones and tablet computers operated with multi-touch user interfaces. This growing user adoption of touch and multi-touch modalities has increased familiarity of and expectations for touch to be the primary interface method between man and machines in any situation. As a result, larger format displays are increasingly expected to support touch when deployed in public spaces, digital signage, education, retail, museum and corporate environments.

MultiTouch Ltd. has since 2007 developed the world's most advanced multi-touch displays. They are used around the world in over 50 countries for creating exciting applications in retail, corporate, education, museum and other segments. The current generation of MultiTaction Cell displays has found a very positive response from the market with clients making use of the advanced features such as Enriched Reality™ object recognition and IR pen support. Clients are also using the versatility of MultiTaction Cells for multi-screen table or wall installations.

Overall, the market of large format touch screens is being addressed with different technologies such as Infrared frames/overlays, capacitive touch, surface acoustic wave or add-ons such as laser touch. These technologies usually support between 1 and 32 simultaneous touch points depending on the technology but do not have any advanced tracking capability beyond standard touch points. Moreover, they are often add-on technologies to third party displays instead of fully integrated resulting in less than clean installations.

Only Samsung SUR40 with Microsoft Pixelsense has come close to offering the level of advanced tracking features of MultiTaction Cells. This is because Pixelsense employs sensor pixels in its LCD panel which work as one imaging sensor the size of the whole screen area. In MultiTaction Cells, the same is achieved with patented Computer Vision Through Screen (CVTS) technology which has a large number of infrared cameras placed behind the LCD panel in the backlight plane. The images of multiple cameras are stitched together to achieve imaging capability across the whole screen. This underlying technical similarity allows the possibility of migrating from SUR40 to MultiTaction Cells and continuing to use the applications relying on the valuable advanced tracking features of SUR40.

This Migration Guide explains the similarities and differences between SUR40 and MultiTaction Cells and discusses the different migration scenarios in terms of deployment characteristics and application development.

MultiTaction Cells

MultiTouch introduced the first generation MultiTouch Cell interactive displays in 2008. It was followed by a slimmer and a lighter second generation Advanced product line in 2010. In 2011, MultiTouch introduced a completely new way to build interactive displays with its MultiTaction technology.

The first product based on MultiTaction technology, a 55" MultiTaction Cell was introduced in October 2011. With MultiTouch proprietary CVTS technology integrated into the displays, it is possible to recognize user intentions much more accurately than with other touch technologies. Advanced gesture recognition based on identifying finger tips, finger orientation and complete hands allows for natural and intuitive user interfaces to be built.

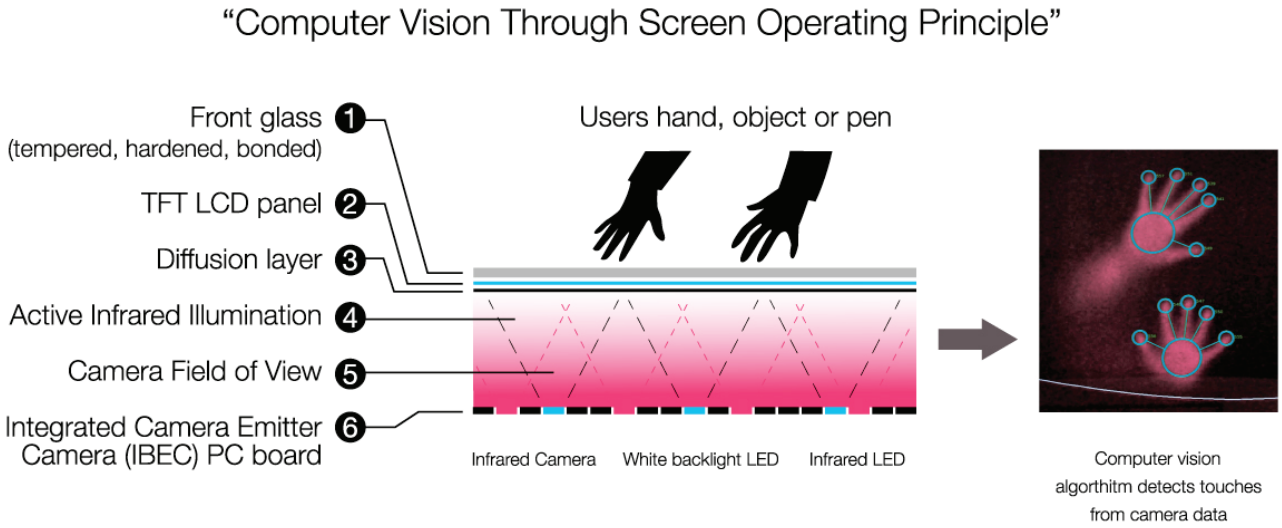


Illustration of Computer Vision Through Screen technology used in MultiTaction Cells

Moreover, the optical tracking which works perpendicularly through the LCD panel allows support for advanced interaction methods. The system is able to see what users were doing in detail. These advanced interaction methods include:

- Object tracking. Physical objects can be tagged with optical 2D markers. There can be billions of different marker codes depending on the marker size. Users can place objects such as ID cards, coupons or product samples on the display and move and rotate them. Application developers can make use of this when designing applications.

- Pen tracking. Active infrared pens are recognized by the computer vision system as separate from fingers or objects. This allows for simultaneous use of pen and touch in the user interfaces.

- Shape (blob) tracking. Simple shapes such as circle, rectangle or triangle shapes can be tracked separately.

Due to these advanced capabilities that go beyond touch, we call MultiTaction Cells interactive displays. As most features are software based, new functionalities are developed and introduced with simple online software updates. A recent example was the industry's first optical Hybrid Tracking technology which eliminates the effects of bright external light sources in touch tracking.

Another major benefit of MultiTaction technology is that it is the only stackable touch display in the market. The front glass is flush from edge to edge and bezels are minimized making it possible to place up to 24 Cells (a single computer video card limitation), together in table or wall installations. MultiTouch's proprietary Cornerstone SDK allows these demanding applications to be implemented.

In 2012, the MultiTaction product line expanded with the launch of 42" models as well as models with embedded application computers with Windows 7, Windows 8 and Linux options. In September 2012, MultiTouch also launched the world's first interactive display with ultra-thin bezel, the 55" MultiTaction Cell Ultra Thin Bezel (UTB). With virtually seamless borders between displays, the UTB model is especially suitable for multi-display installations.

The current range of MultiTaction Cells and some deployment examples are presented below.

42" MultiTaction Cell in optional sofa table

55" MultiTaction Cell in optional table

Two 55" Cells in connected interactive table

Large video wall installation

The applications deployed on the Cells determine the requirements for the technology. The advanced features offered by MultiTaction Cells allow clients and software developers to create applications for an increasing number of versatile environments.

MultiTaction Cells are currently used in these major market segments:

- Corporate market. Workplace productivity solutions, interactive presentation walls, collaboration tables, etc.
- Education. Interactive whiteboards, collaboration tables.
- Retail. Kiosks, point of sale sales promotion tables or walls.
- Real estate. As a replacement for physical 3D building models
- Marketing and Exhibitions. Product showcases.
- Museums. Interactive exhibits.
- Entertainment.
- Command and control
- Digital signage

Some examples of actual client installations are presented below.

Executive Brand Suite at a global IT company in London by engage production

Entel Digital Catalog

Canning Stock Route table at National Museum of Australia by Lightwell

ACME Brick Patina flagship store

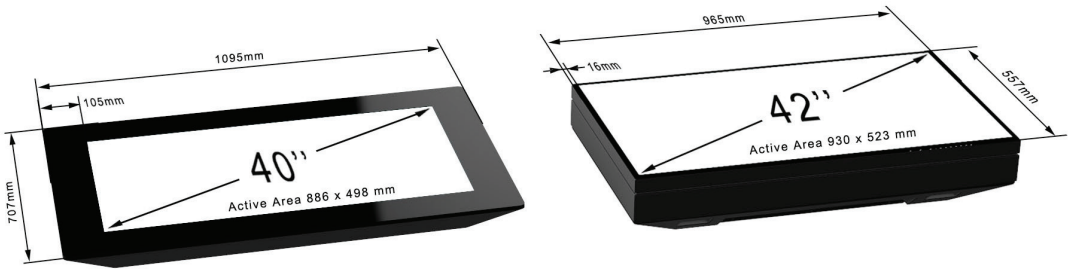
/// Physical Comparison of SUR40 and MultiTaction Cells

The below table compares the various physical specifications of SUR40 to MultiTaction Cell 42” and 55” models.

Display Specifications	**SUR 40**	**MT420W7/W8**	**MT550W7/W8**
Panel Size	40” (Active Area 886 x 498 mm)	42” (Active Area 930 x 523mm)	55” (Active Area 1209 x 680 mm)
Resolution	1920 x 1080 Full HD 16:9	1920 x 1080 Full HD 16:9	1920 x 1080 Full HD 16:9
Contrast Ratio	2000:1	3500:1	4000:1
Brightness	300 cd/m²	400 cd/m²	400 cd/m²
Protection Glass	Gorilla Glass	Tempered 4mm Optiwhite Glass	Tempered 4mm Optiwhite Glass
Interfaces			
Video Input	HDMI DVI-D	DVI-D	
I/O Ports	4 x USB, SD Card Reader	3 x USB	3 x USB
Audio out	RCA/SPDF/3.5mm	RCA	RCA
Communications	1GB Ethernet, Bluetooth	100Mbit Ethernet, USB	100Mbit Ethernet, USB
Embedded Computer			
CPU	AMD Athlon X2 Dual Core	Intel Core i7 Quad Core	Intel Core i7 Quad Core
RAM	4 GB 8 GB	8 GB	8 GB
GPU	AMD Radeon HD 6750 1 GB	NVIDIA GTS450 1GB or similar	NVIDIA GTS450 1GB or similar
Hard Disk	320 GB	120 GB SSD	120 GB SSD
Operating System	Windows 7 64 for Embedded Systems	Windows 7 64 Pro or Windows 8 64 Pro	Windows 7 64 Pro or Windows 8 64 Pro
Touch Sensing			
Touch Technology	IR, PixelSense	IR, Computer Vision Trough Screen	IR, Computer Vision Trough Screen
Tracking Speed	n/a	Up to 200 fps	Up to 200 fps
Software Development			
Environment Support	MS Surface 2 SDK	MS Surface 2 SDK, Multitouch Cornerstone . Any programming environment or tool via standard Windows Touch, TUIO or XML outputs	MS Surface 2 SDK, Multitouch Cornerstone. Any programming environment or tool via standard Windows Touch, TUIO or XML outputs
Dimensions and Weight			
Physical Dimensions	1095 x 707 x 103 mm	965 x 557 x 200 mm	1242 x 715 x 200mm
Bezel Width	15.1mm (Bottom 16.6mm) ???	16mm (Top 17mm)	16mm (Top 17mm)
Weight	36.8 Kg	32 Kg	40 Kg
Environment Specifications			
Operating Temperature	5 - 30 °C (41 - 86 °F)	5 – 35 °C (41 - 95 °F)	5 – 35 °C (41 - 95 °F)
Cooling	??	Active forced air cooling	Active forced air cooling
Ambient Light Limitations	Lot of limitations	Very few limitations	Very few limitations
Electrical Specifications			
Power Supply	100 – 240 VAC 50/60Hz	100 – 240 VAC 50/60Hz	100 – 240 VAC 50/60Hz
Maximum Power Consumption	400W	480W	490W

Highlighted issues

Physical sizes: Users of SUR40 may have designed custom enclosures or tables for SUR40. These designs are typically integrated into a store design or fitting a client brand. Fortunately, MultiTaction Cells are easily adapted in place of SUR40 in typical installations.



Samsung SUR40 and MultiTaction Cell 42

The height and width of a 42” MultiTaction Cell are actually less than that of SUR40’s. The screen size is 2” larger so MultiTaction Cells have far smaller bezels. This is not a problem if the custom enclosure has a hole for SUR40. If the whole SUR40 is visible with bezels then an adapter plate could be fitted around the Cell to fill the whole. If only the screen area is visible then this hole needs to be made larger, there always being enough clearance due to SUR40’s bezel being accommodated under the enclosure.

The depth of the MultiTaction cell is larger, at about 8 inches vs. 4 inches for SUR40. How this depth is accommodated needs to be examined case by case. The tapered edges of the Cell alleviate this need somewhat as the depth is only about 4.5 inches on the sides and tapers to 8 inches at the center.

Computer specifications

One important consideration for SUR40 developers has been the relatively modest performance of the built-in computer. Instead of the AMD Athlon X2 dual core CPU, MultiTaction Cell Embedded models have an Intel Core i7 quad core CPU with double the RAM, a faster graphics processor and an SSD drive instead of standard hard disk.

The better specification of MultiTaction Cell internal computer means that applications written for SUR40 will often run faster and better for this reason alone.

MultiTaction Cells are available with standard Windows 7 or Windows 8 operating systems as well as a Linux model.

Ambient light sensitivity

SUR40 is by design a lot more susceptible to external lighting conditions. The Pixelsense sensor pixels are located in the LCD matrix itself very close to screen surface ensuring that they gather all the light from 180 degree angle. This is bad because Pixelsense will pick up all light coming from external sources and ambient light as well. Pixelsense is therefore easily “flooded” and “blinded” by external IR light. Samsung has addressed this by determining stringent requirements for installation venues in their Venue Readiness Guide. Some SUR40 distributors are even offering optional canopy to shield the SUR40 from external lights.

With MultiTaction Cells, the situation is crucially different due to design. In Computer Vision Through Screen technology, the IR cameras are located in the backlight plane, shielded from external lights by the LCD panel itself. LCD panels typically let only 3-5% of any light through and this helps block ambient IR by equal amount. Moreover, the filtering and image processing algorithms have been optimized to maximize tracking robustness so that MultiTaction Cells perform very well in most installations.

For those rare cases where direct sunlight or very bright halogen spotlights are shining on the screen, MultiTaction Cells employ a new technology called Hybrid Tracking. If normal tracking mode is 200 fps of reflections, Hybrid Tracking uses every other frame to track shadows instead. By combining the reflection and shadow information a robust tracking performance is again achieved. Hybrid Tracking principle is presented in the picture below.

Hybrid Tracking principle illustrated

Hybrid Tracking is included by default with every MultiTaction Cell and can be enabled from the On Screen Display of a MultiTaction Cell at will.

/// Feature Comparison of SUR40 and MultiTaction Cells

SUR40 and MultiTaction Cells are the only interactive display products in the market that employ computer vision technology perpendicular to the screen. The user interactions are therefore seen with as reflections of diffuse infrared from below one's hands instead from the sides as many other IR based technologies do. This means that computer vision algorithms are used to interpret from image data the touch points, finger, markers (tags) or any other user interactions. The differences between SUR40 and MultiTaction can be attributed mostly to the differences in the speed and capability of those algorithms but also differences in the speed and capability of the imaging hardware itself.

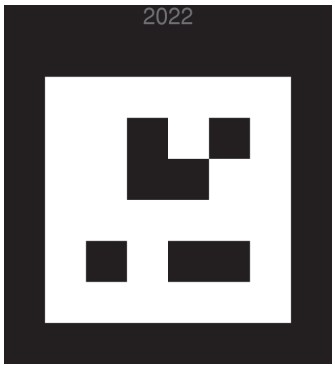
The main differences in the interaction features are presented in the table below.

	MultiTaction Cells	**Sur40 / Pixelsense**
Technology	**Diffusive IR, IR and cameras integrated to backlight (Computer Vision Through Screen)**	**Diffusive IR, integrated to LCD (Pixel Sense)**
Features Tracked	• Fingers • Hands • Objects (blobs) • Optical markers (tags) • IR Pens	• Fingers • Objects (blobs) • Optical Markers (tags)
Number of touch points	Unlimited	Not specified (Quoted as 50)
Tracking speed	200 frames/second = 200 Hz	60 frames/second = 60 Hz
Scalability, stackability and modularity	Scalable and stackable, flush edge to edge with minimal bezels (incl. Ultra Thin)	Large bezel due to electronics. Cannot be used to create larger surfaces.
Environmental Requirements	Technology nearly immune to external lighting conditions	Can be used only in a highly controlled environment for ambient light
Special issues	None	Performance and sensitivity to ambient light

Optical markers (tags)

Optical markers in Surface 2 SD are byte tags which can only be read on SUR40. Surface tags currently support up to 256 different tags and are tracked at maximum 60 fps.

In comparison, MultiTaction Cells use a simpler byte tag which is available in 3x3, 4x4, 5x5 or 6x6 matrices. The tracking speed being over 200 fps and the quality of the algorithms ensure that all markers can be moved very fast across the screen and still be tracked reliably.



MultiTaction 4x4 optical marker, representing code 2022

The number of different codes they provide are as follows:
- 3x3: 32 codes
- 4x4: 4096 codes
- 5x5: Over 2 million codes
- 6x6: Over 4 billion codes.

The number of available codes is so large that it is possible to give individuals their own unique codes. MultiTouch has commercialized this possibility with MultiTaction Codice™ solution which ensures the global uniqueness of 5x5 or 6x6 codes with DRM.

MultiTaction Cells cannot track the printed original SUR40 markers directly. Instead, the physical markers put into product samples or printed on cards or documents must be replaced with the MultiTaction ones. MultiTouch provides a SW utility to generate the marker images.

Fingers and hands

MultiTaction provides data about each fingers location and direction, as does SUR40. This information is already very useful to determine the intentions of the user or to rotate content according to which side of the display user is.

However, MultiTaction also tracks whole hands of the user, as in tying each finger vector with a palm which has a location.

/// Application Development and Migration Scenarios

The Microsoft Surface 2.0 SDK

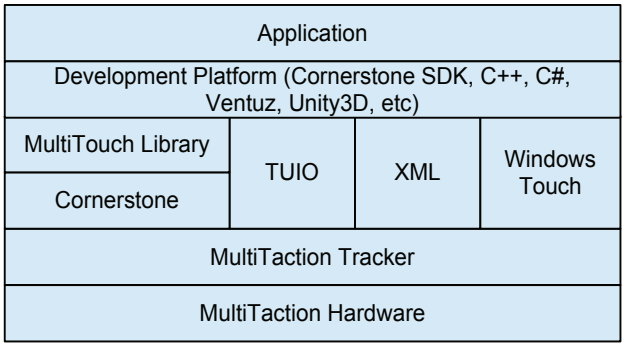
The Microsoft Surface 2.0 SDK enables users to use a large collection of C#/WPF controls in a touch enabled environment. This allows for quick development of media-rich applications with an interface that works on modern touch devices such as tablets and touch-displays.

Using MultiTaction displays: Which protocol to choose?

MultiTaction displays offer different ways of reading the input-data.

- Native Cornerstone protocol (TCP-based binary protocol)
- TUIO (UDP-based binary protocol)
- XML (TCP-based text protocol)
- Windows Touch

Which method is best for the developer depends on the application.



MultiTaction SW stack and output options

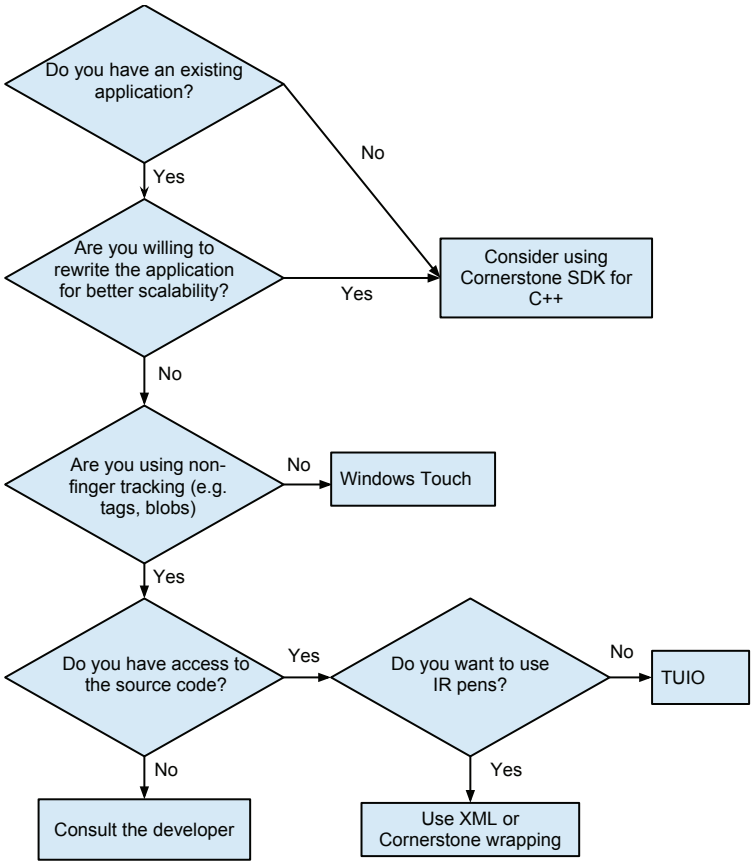
The developer may want to use the Cornerstone protocol when developing an application using MultiTouch's own CornerstoneSDK for C++. This gives full access to all the functionality that is offered by MultiTaction displays, including simultaneous IR pens and hand-tracking. It also has a powerful OpenGL rendering framework that gives the developer the ability to easily scale up to very large multi-screen installations by using multiple graphics cards.

TUIO is an industry standard protocol for transmitting touch- and fiducial marker data. Many 3rd-party tool-kits and environments, such as Ventuz, VVVV, Processing and Unity3D, support the use of TUIO. A lot of other touch-hardware vendors also support TUIO output from their drivers, allowing TUIO applications to run on a variety of hardware platforms.

When the developer wants access to all the functionality in MultiTouch screens, but doesn't want to use Cornerstone (when for example not developing in C++ or already having their own C++ environment), they can use XML. This is a simple to parse human-readable stream containing all the information needed to track fingers, fiducials, hands and pens on the screen.

Tool-kits such as Adobe Flash and the Surface 2.0 SDK use Windows Touch for their touch input. Windows Touch is an extension to the existing Windows input framework and adds messages for touch events.

The decision tree for choosing the application migration is presented below.



Decision tree for migrating SUR40 applications to MultiTaction

Using Windows Touch

The easiest way of getting Surface 2.0 applications to work with MultiTaction is by using Windows Touch. With this the developer can often run Surface 2.0 applications with MultiTaction displays with minimal or no modifications to the application.

Windows Touch uses HID events for its touch input. By reading input-data from the network through the Cornerstone binary protocol and then forwarding the event to a HID driver MultiTaction displays can be made compatible with Windows Touch applications.

Enabling Windows Touch on an external computer (e.g. with MTxxxS and MT553UTB).

1. Install the MultiTouch Win7 HID driver (from C:\Cornerstone\Win7)
2. Configure the screen for input (see https://cornerstone.multitouch.fi/tactionguide/sandutbcells.html#connectingsinglecell. You only need the config.txt since the screen.xml is only for use with Cornerstone applications.)
3. Start MTWin7 (from C:\Cornerstone\bin)

When moving hands across the display you should see white tracers following fingertips. You can now minimize the MTWin7 utility and start Surface 2.0 SDK application.

Enabling Windows Touch on embedded MultiTaction displays (MTxxxW7)

The Windows 7 embedded models support Windows Touch out of the box. You can enable Windows. Touch from the MultiTaction OSD utility in the start menu.

1. Start the MultiTaction OSD
2. In Setup → Win7, enable Windows Touch

After quitting the OSD application you should see white tracers following fingertips when you move your hands across the display. You can now start the Surface 2.0 SDK application.

Windows Touch limitations

Multi-screen installations: Windows Touch does, by design, not support multi-screen installations. Touch events are only sent to the primary display. There are systems (e.g. AMD Eyefinity) where multiple physical screens can be combined into one virtual display, which can then be used as a single primary display.

Windows 8: Windows 8 changes some things about the way how HID events are handled. Unfortunately, this means that Surface 2.0 SDK applications will not work out-of-the-box on Windows 8. There are some workarounds however. You can find more information about this on the Microsoft Surface forum (http://social.msdn.microsoft.com/Forums/en-US/surfaceappdevelopment/thread/82cf4ad7-2b7d-43f8-a93b-4b78199ec9d1/) and at https://blogs.sevensteps.com/Lists/Posts/Post.aspx?ID=10

Fiducial markers ("tags"): Microsoft has not documented the HID data that is required to implement fiducials in MultiTouch's Windows Touch driver. This means that if the developer wants to use these in applications they will have to use alternatives, e.g. TUIO or XML. In these cases many MultiTouch customers have switched to TUIO or combined Windows Touch (for finger interaction) and TUIO (for the fiducials).

Rotated displays: The current version of MultiTaction Windows Touch driver does not automatically detect rotated (e.g. portrait or flipped) displays. When using stackable MultiTaction displays the developer can apply transformations in the input configuration to correct this problem (See for example https://cornerstone.multitouch.fi/taction-guide/exampletwoscreensportrait.html). Embedded models do not currently support rotated displays.

Using TUIO

TUIO is a 3rd-party standard protocol used by a wide variety of touch-application developers. Many SDKs and development environments (e.g. VVVV, Processing, Unity3D, Ventuz) have native support for TUIO or support it via a plugin.

For C#/WPF used in Surface 2 SDK there exist a number of solutions to get TUIO input into the system. For a list of solutions and more information about TUIO and other TUIO-enabled applications and tool-kits, please check http://www.tuio.org/? software . Users wishing to use these solutions should refer to their documentation for details on the implementation.

For details about using TUIO on a MultiTaction display, see:
https://cornerstone.multitouch.fi/taction-guide/tuio.html.

Using the XML-stream

For access to all the options available in MultiTaction devices (touch, fiducials, hand and pen tracking) you can use the XML data stream. All MultiTaction devices have a service that outputs XML-formatted text containing information such as finger, marker and pen locations, rotation angles, marker codes, etc. This service can be approached by connecting a TCP socket to port 5501 at the MultiTaction device's IP.

To use this data you will have to parse the XML and use the information to send touch events to your application UI controls. The implementation for this is beyond the scope of this document.

Using Cornerstone protocol without the SDK

Sometimes you want to use all the functionality of MultiTaction displays in a non-Cornerstone environment, but using the XML-stream is too slow. In this case it's possible to access the MultiTouch library directly from other languages (e.g. C#). An example of how to create a stand-alone MultiTouch touch-device (in C++) can be seen in the MTWin7 source code (included with the Cornerstone SDK). Once we have a touch device we can read input-data directly from there. Wrapping this device in another language such as C# is left as an exercise for the reader.

/// Conclusion

MultiTaction Cells are a perfect alternative for SUR40 display, allowing improved performance, more choice on sizes and installation options and easy migration paths for SUR40 applications to run on MultiTaction Cells.

Please contact MultiTouch for assistance in your particular migration scenario.

/// Contact and Further Information

For further enquiries about MULTITACTION or MultiTouch Ltd products,
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Please visit for further information:
Main Web site: http://www.multitaction.com
Cornerstone developer site: http://cornerstone.multitouch.fi/

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