



TGM 2014

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P-Cap: *Is That All There Is?*

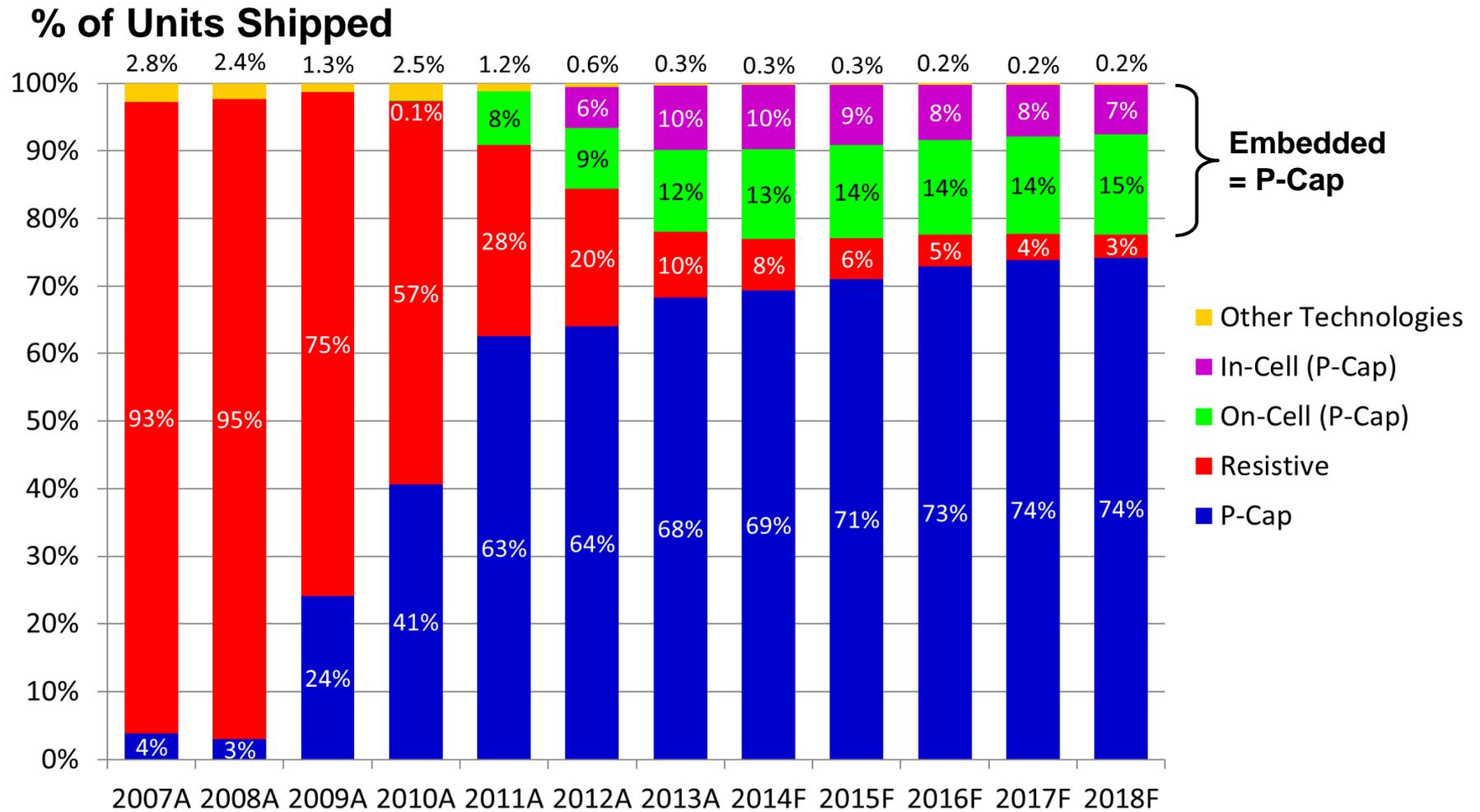
Geoff Walker – Intel
June 4, 2014

File Download: www.walkermobile.com/SID_2014_TGM.pdf

Agenda

- ❖ **Penetration**
- ❖ **State-of-the-art**
- ❖ **What's missing**
- ❖ **Conclusions**

P-Cap Penetration 2007-2018

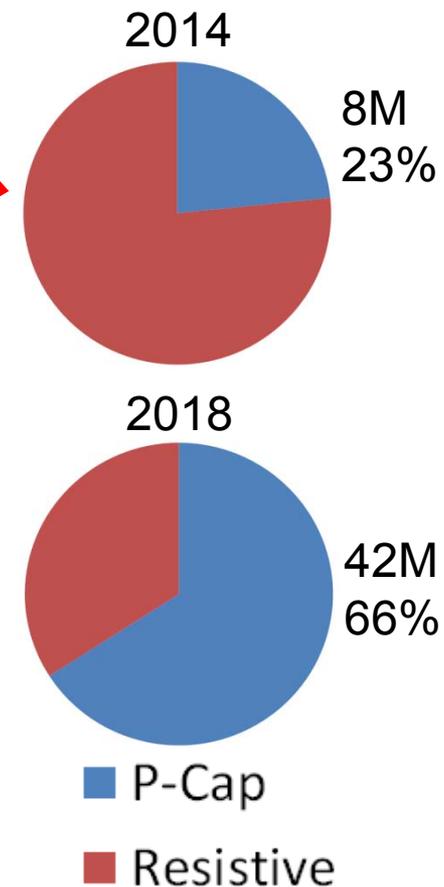


Source: DisplaySearch Touch-Panel Market Analysis Reports 2008-2014

P-Cap Penetration In Small-Medium Commercial Applications

❖ Prediction for p-cap penetration into commercial applications

- Automotive – high
- Healthcare – high
- Casino gaming – high
- Point-of-information (POI) – medium
- Self-check-in, ticketing, & ATM – medium
- Industrial & factory automation – medium
- Military & aerospace – medium
- Point-of-sale (POS) – low



Source of other predictions: The author

Source: DisplaySearch

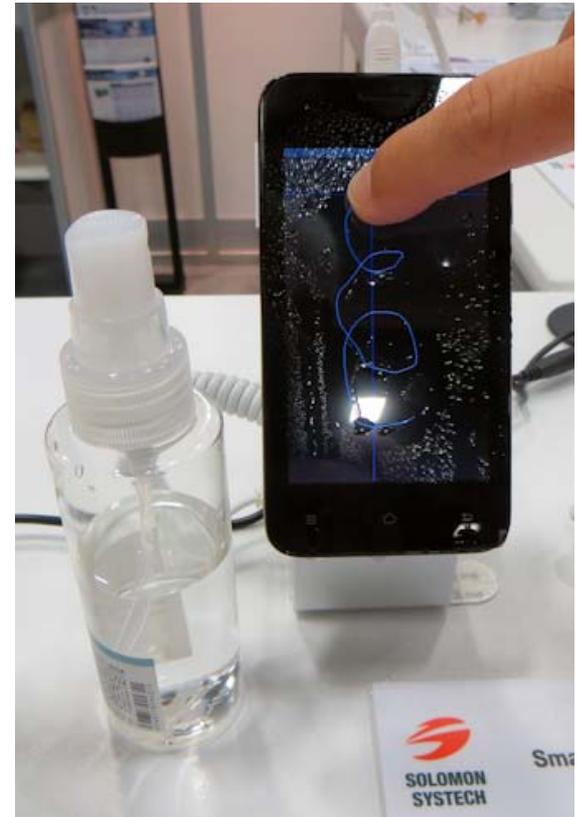
P-Cap Penetration In Large-Format Applications

- ❖ **Prediction: Metal-mesh p-cap will replace most current forms of large-format touch up to ~65" (IR, optical, waveguide, bending-wave, etc.) within 5 years**
 - ◆ Many suppliers are working on this, with low public visibility
 - The technical challenges (large number of electrode connections, longer sensing time, slower sensing speed, sensor printing & touchscreen assembly process, etc.) are all being solved
 - ◆ **Consistency of user experience** will be the driving force
 - ◆ Interactive video walls (tiled 42" – 55" displays) will probably be an exception
 - **Vision-based touch** (primarily from MultiTaction) has already gone well beyond what p-cap can do
 - ◆ Touchscreens over 65" (e.g., education & training) are likely to continue using various forms of optical technology

State-of-the-Art In P-Cap...1

❖ Many p-cap enhancements have been developed but not widely rolled out yet

- ◆ Finger-hover
- ◆ Touch with a 1 – 2 mm-tip passive stylus, a #2 pencil, a ballpoint pen, or long fingernails
- ◆ Active stylus (using p-cap sensor)
- ◆ “Palm” (unintended touch) rejection
- ◆ Touch with gloves (even thick ski-gloves)
- ◆ Water resistance (including running water)
- ◆ Resistance to interference from \$2 USB chargers, desktop fluorescent desk lamps, and other external sources
- ◆ Higher frame rates
- ◆ Curved touchscreens



Source: The author

What's Missing...1

❖ True absolute pressure-sensing

- ◆ Depending on implementation, might be able to replace one of the key characteristics of analog-resistive: **“Touch with Anything”**
- ◆ Alternative **mouseover** solution
 - Versus hover, which is a rolling express-train
- ◆ Necessary for good handwriting (Western or Kanji) with a passive stylus
- ◆ Essential for art with a passive stylus
- ◆ Startups working on pressure-sensing
 - NextInput
 - FloatingTouch
 - NanoMade
 - And some development work by current p-cap suppliers...

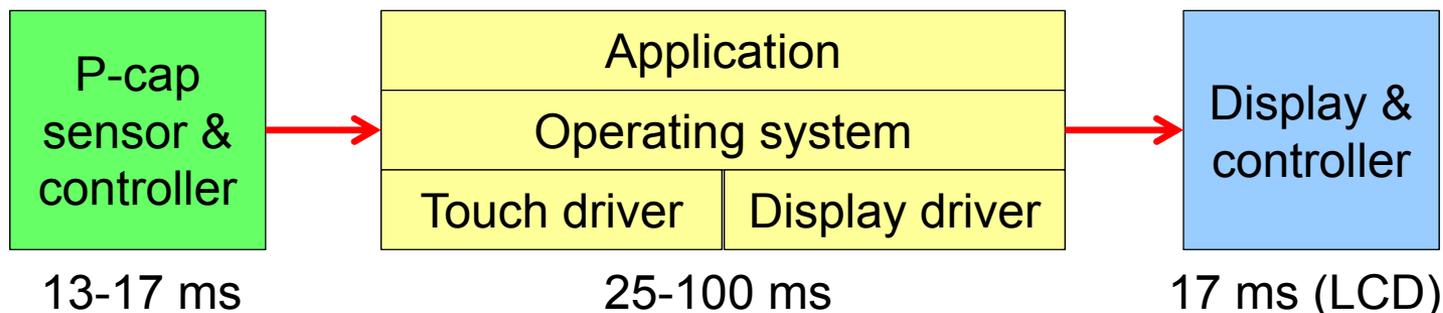


Source: N-Trig

What's Missing...2

❖ Lower latency

- ◆ Typically 75-125 ms; 10 ms required to feel “real”
- ◆ Startups working on latency
 - Tactual Labs (mostly on Android)
 - And Microsoft may be doing something...



Source: Tactual Labs

What's Missing...3

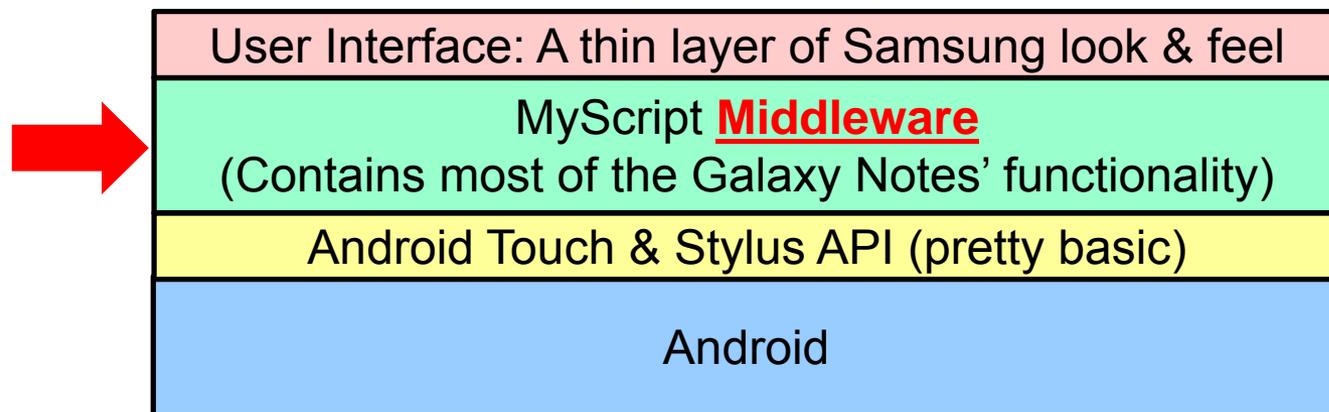
❖ **More adaptive controller-behavior** **(“context awareness”)**

- ◆ Handling an even wider range of environmental conditions
- ◆ Adapting to changes in user characteristics
- ◆ “Software integration” (running some touch-controller algorithms on the host GPU) can significantly aid this by providing powerful on-demand resources

What's Missing...4

❖ Touch application-development support

- ◆ More & better touch **middleware** to (a) make touch applications easier to develop, and (b) add functionality
 - **MyScript** is currently the best Android middleware



Samsung Galaxy Notes' software stack

Source:
The author

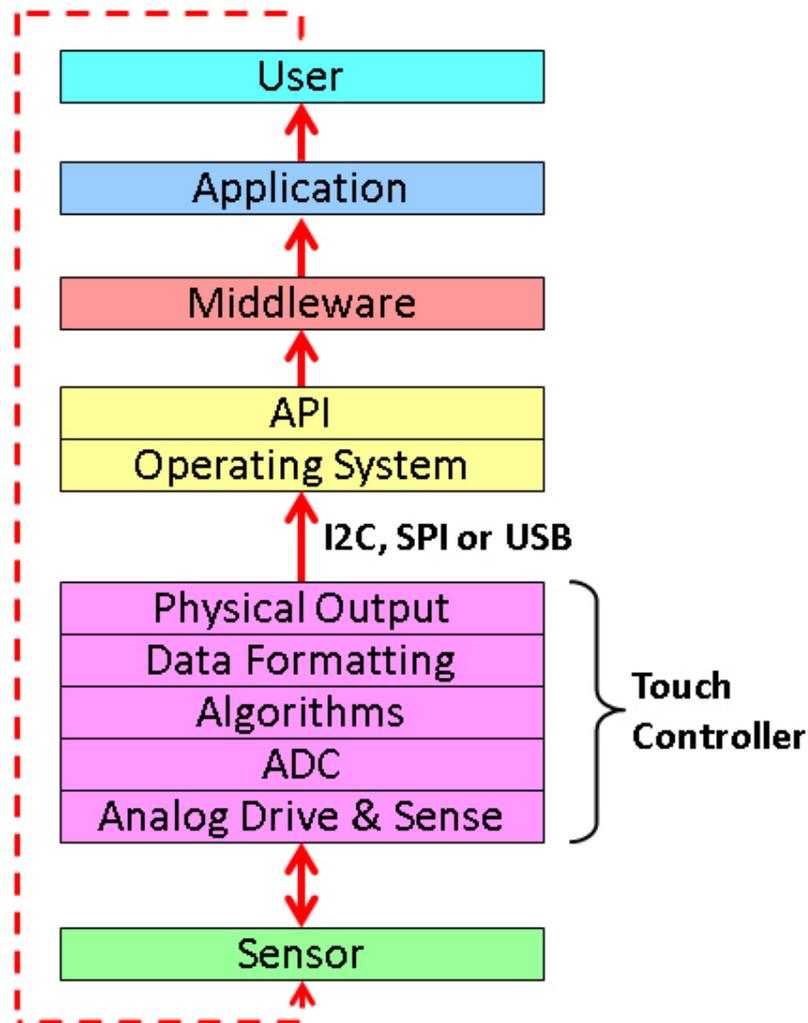
What's Missing...5

- ❖ **Touch application-development support (continued)**
 - ◆ Application programming books written from the user perspective instead of from the API perspective
 - ◆ The goal is to fix the #1 source of touch user-experience problems and get to the point where **“it just works!”**
 - ◆ If you don't believe that application software is the #1 source of touch user-experience problems, download **“Touch Explorer”** by Synaptics from Google Play and see if you can make your touchscreen hardware & firmware fail to respond properly

What's Missing...6

❖ A more systems-level approach to touch

- ◆ P-cap is much more affected by and dependent on the rest of the system than analog-resistive touch technology



What's Missing...7

❖ Interoperability with other HMI technologies

- ◆ Simple in-air gestures
- ◆ Sophisticated 3D-tracking of in-air hand & body movements
- ◆ Eye-tracking
- ◆ Voice

What's Missing...8

❖ Better accessibility to p-cap for use in low-volume applications

- ◆ The amount of “tuning” necessary is a significant impediment to implementing p-cap in a low-volume new product
 - Synaptics “Design Studio 5” automated tuning tools are a good step in the right direction, but not enough
- ◆ Accessibility is improving, but it's still very far from the “buy it from distribution, slap it on, and go” capability of analog resistive

Conclusions...1

- ❖ **P-cap is totally dominant in consumer electronics and eventually will be in commercial applications**
- ❖ **Many p-cap enhancement have been developed, so many more user needs will be met**
- ❖ **Continued innovation will address many of the missing capabilities**
- ❖ **There is NO viable replacement technology visible on the horizon**
 - ◆ *However, just when we feel that nothing can displace an entrenched technology, that's usually when innovation or commercialization of an existing idea disrupts everything*
 - *Analog resistive was dominant from 1980 to 2010 (30 years!)*
 - *P-cap has only been in the mainstream since 2007*

Conclusions...2



***“Is that all there is, is that all there is
If that's all there is my friends, then let's keep dancing
Let's break out the booze and have a ball
If that's all there is”***

“Is That All There Is” was
written by Jerry Leiber &
Mike Stoller during the
1960s and performed by
Peggy Lee

***Yes, p-cap is all there is,
at least as far as I can see today***

As motivation to download this file I have included a special
appendix on why I believe that optical in-cell will never make it



Thank You!

File Download: www.walkermobile.com/SID_2014_TGM.pdf

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Appendix A...1

❖ Why optical in-cell is never going to make it...1

- ◆ The three commercial attempts so far have all failed
 - Sharp PC-NJ70A netbook in 2009
 - Samsung SUR-40 (Microsoft PixelSense)
 - iDTI 21.5-inch touch monitor
- ◆ Processing optical-sensor data with minimal latency requires the resources of a powerful CPU/GPU, not an ordinary touch controller
- ◆ Optical in-cell reduces display performance excessively
 - Lower LCD aperture ratio due to light-sensors using up pixel space
 - Lower OLED light output due to IR emitters using up pixel space
- ◆ Optical in-cell has relatively low signal-to-noise ratio (SNR), which results in poor touch sensitivity under some conditions
 - The contrast ratio between the touch object and the surrounding area is lowest at the crossover point where the backlight IR reflected from the touch-object is equal to the ambient IR falling on the display

Appendix A...2

❖ Why optical in-cell is never going to make it (continued)

- ◆ The low signal levels from optical sensors make touch-sensing more sensitive to internal interference (e.g., stray current from adjacent photo-sensors)
- ◆ Touch sensitivity decreases as the touch surface moves further away from display (i.e., due to air-gap touchscreens, the thicker cover-glass required for larger displays, etc.)
- ◆ Optical-sensor density isn't high enough to enable using the display as a scanner, which has always been a holy grail
 - One sensor per 8 pixels on a 40" FHD display is 8 dpi resolution!
- ◆ If the light-sensors are standard amorphous-silicon, high-power IR emitters are required in the backlight; if the light-sensors are made more sensitive (e.g., aSiGe), the touchscreen becomes much more sensitive to ambient IR (ref: SUR-40)
- ◆ Off-screen icons can't be supported without additional hardware