TGM SID 2013

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intel

Where P-Cap Is Going

***File Download*:** www.walkermobile.com/SID_2013_TGM.pdf

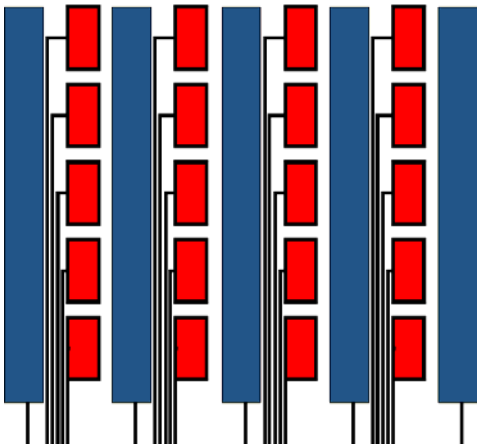
15 P-Cap Directions

- Cost Reduction
- Finger-Hover
- Glove-Touch
- Noise Management
- Water-Touch
- Pressing Very Hard
- Other Touch-Objects
- Touch Feedback
- Faster Response
- Longer Battery-Life
- Pressure Sensing
- Active Stylus Support
- Software Integration
- Embedded Touch
- Hardware Integration

Source: DigitalTrends.com

Cost Reduction

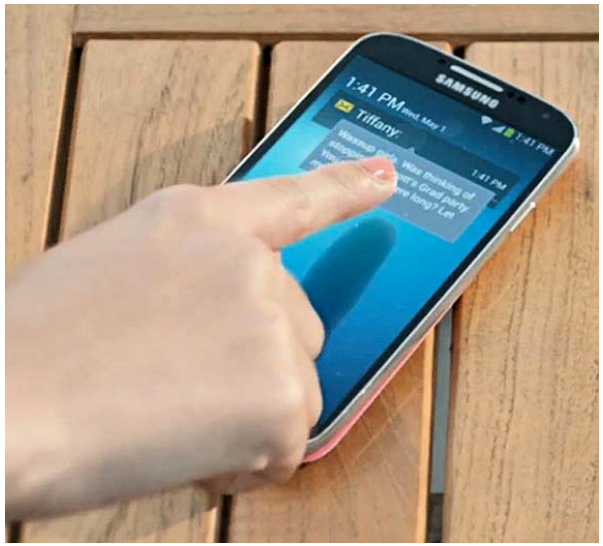
- **Intel is focused on reducing the cost of p-cap**
  - ITO-replacement materials have the largest potential cost impact
    - Top 3: metal mesh, silver nanowires, carbon nanotubes
    - It's not really about the **material**; it's about the **process**
  - Other focus areas:
    - Easier/simpler/higher-yield direct bonding (lamination to LCD)
    - "True" single-layer electrodes with acceptable performance
    - Plastic (non-glass) cover-glass
    - Supply-chain improvements
    - Alternative touch-technology for larger screens
  - Intel wants to cut the cost of a 13.3" p-cap touchscreen by 50% in 18 months



Source: Synaptics

Finger-Hover & Glove-Touch

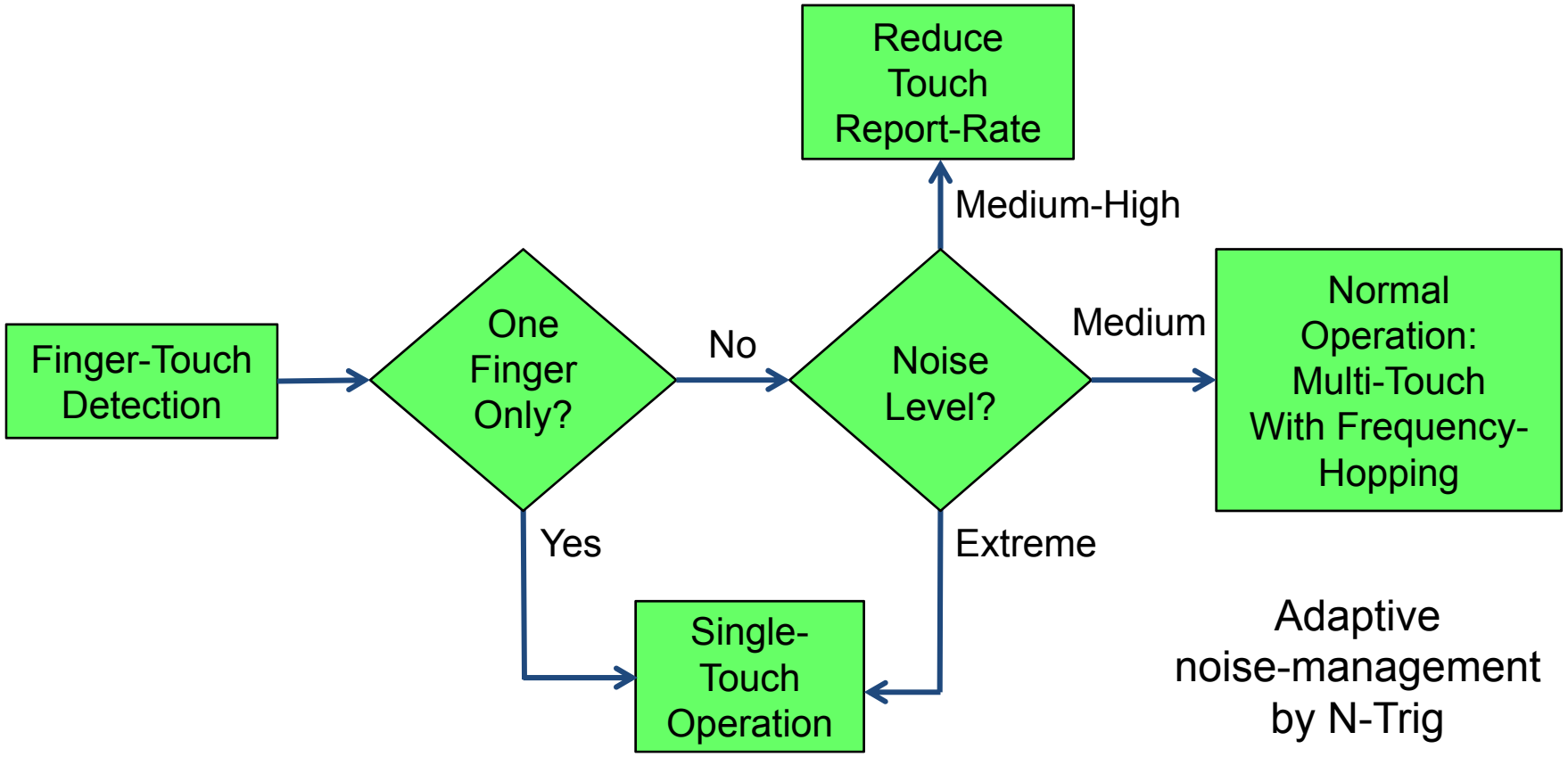
- **Addition of self-capacitance (proximity-sensing) to existing mutual-capacitance (touch location)**
  - Provides finger-hover
    - Hover to view choices, touch to select
    - Available today in the Samsung Galaxy S4
  - Provides glove-touch
    - Glove causes finger to remain a constant distance above screen; proximity-sensing recognizes that
  - Provides more information for "adaptive configuration"
    - Improved palm-rejection
    - Adaptive noise-management



Source: TheTechBlock.com

Noise Management

- **Touch Should Always "Just Work"**



Water-Touch

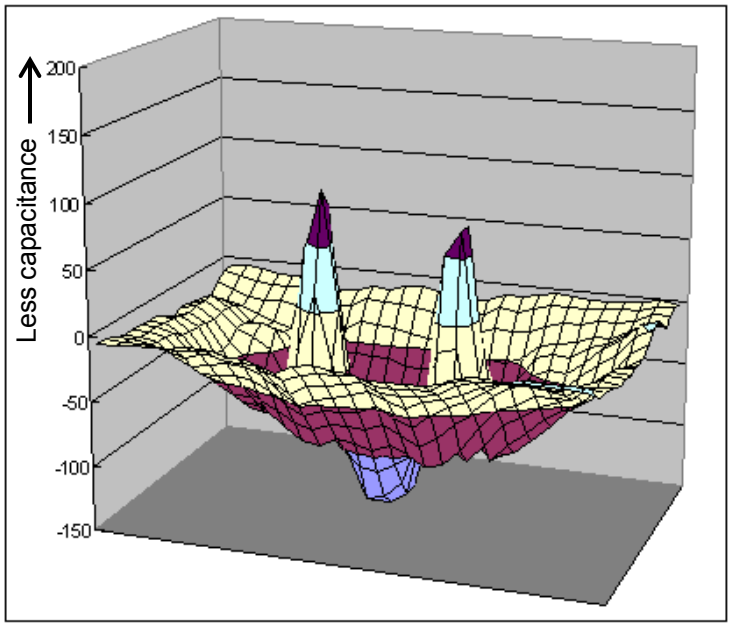
- **It's all about the shape of the e-field**
  - Water affects the shape of the e-field between the electrodes
  - Adaptive algorithms can adjust for the difference in field shape

WaterSENSE® from UICO *(handheld shower spray)*

  - P-cap touchscreens <u>already exist</u> that can operate with running water on the surface
    - Common commercial market-requirement
  - The REAL issue may be lack of sufficient demand from consumers for water-immunity

Pressing Very Hard

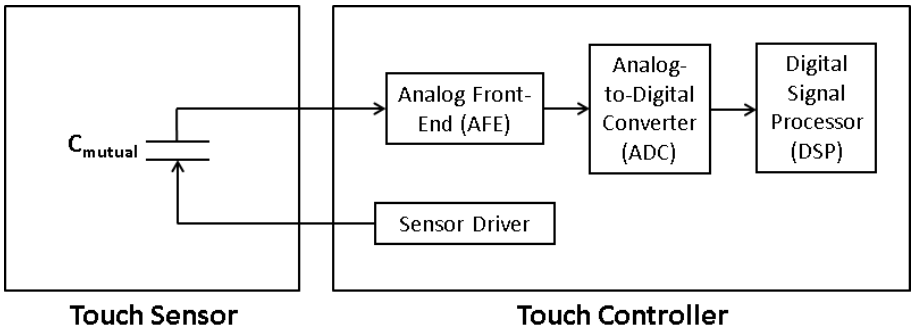
- **"Cover-glass bending" algorithms**
  - Air-bonding is getting more popular due to the high cost of direct-bonding
  - Cover-glass is getting thinner (currently 0.55 mm; next step is 0.4 mm)
  - When an air-bonded cover-glass is pressed hard enough, it contacts the LCD surface
    - This adds capacitance at the contact point, but the finger-touches reduce capacitance
    - Sophisticated algorithms can detect and handle this complex situation



Source: Solomon Systech

Other Touch-Objects

- **Much higher signal-to-noise (SNR) ratios**
  - Today's best SNR is around 50 dB, which supports a passive stylus with a 2-mm tip (still too large)
  - What's in the lab now is ~65 dB, which allows using a **#2 pencil as a stylus** (or just your fingernail)
    - The author has seen several companies demonstrate this
    - This will be the end of "finger-only touch"
  - Much of this improvement comes from enhancing the controller analog front-end in addition to focusing on the digital algorithms



Source: The Author

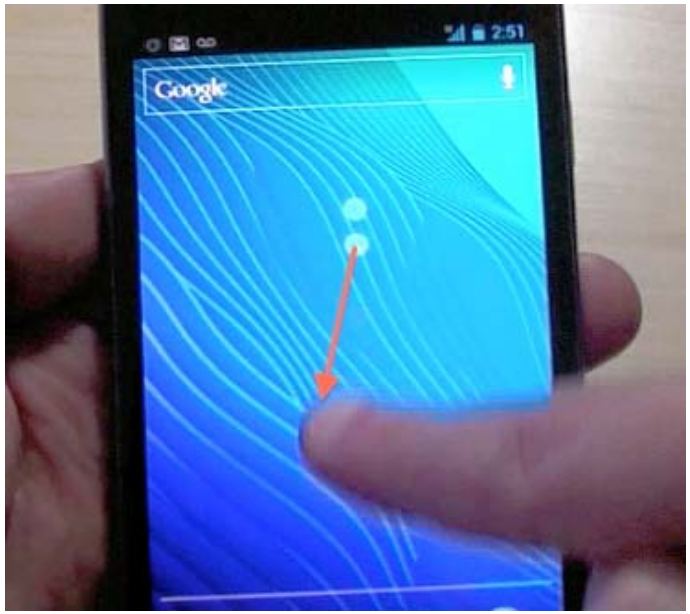
Touch Feedback

- **Haptics support**
  - A few touch controllers already supply signals to drive haptics transducers (e.g., Synaptics); doing so is relatively easy
  - The REAL problem is that haptic feedback in touch-displays larger than mobile-phone size has progressed very little
    - Most of the current market for haptic feedback is in non-display devices such as headsets, game controllers, capacitive buttons, touchpads, medical simulators, robotics, etc.
  - Progress has been limited because nobody has a clear vision of what to do with haptic feedback in larger mobile-device screens, other than on-screen keyboards

Source: Concept Hunter.com

Faster Response

- **Reduced touch latency**
  - Latency is the time between a touch and the response
    - Best examples are an object lagging behind your finger when you drag it, and ink lagging behind the stylus when you're drawing
  - Minor improvements
    - Optimize the software path
    - Increase the scan & data-report rates
  - Major improvements
    - Create a direct path between the touch controller and the display controller (Synaptics)



Source: Gigaom.com

Longer Battery-Life

- **Reduced power consumption**
  - Touch power-consumption is already small compared to display power-consumption (< 3%)
  - Even so, it should drop to < 1.5% in the next two years

Software Integration

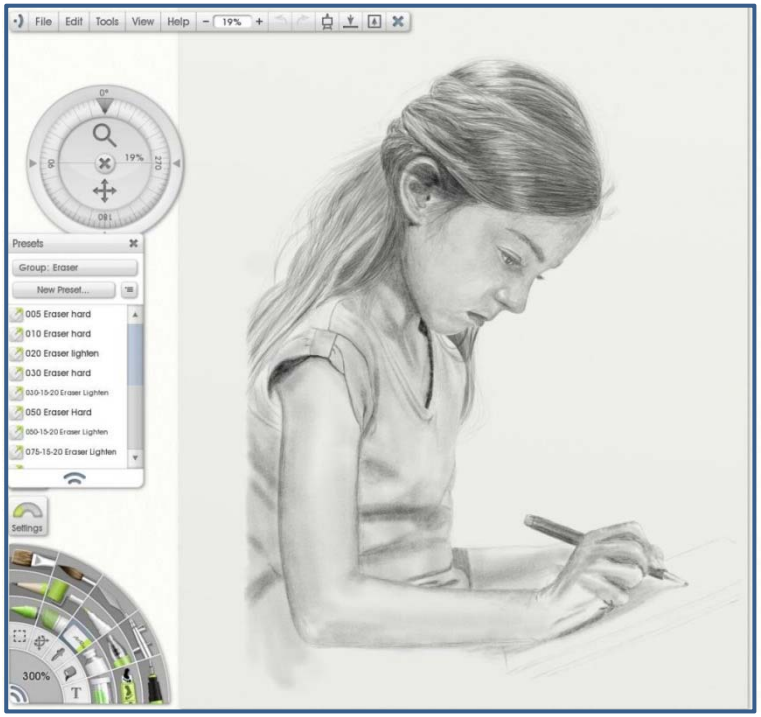
- **Integration of the digital portion of the touch controller as software running on the device GPU**
  - This has already happened in NVIDIA's "Direct Touch", but it wasn't widely used in actual devices
  - Benefits
    - Algorithm-writers can take advantage of much larger resources on the host device (MIPS and memory)
      - This can support higher frame-rate, reduced latency, reduced power consumption, easier support of different sensor designs, etc.
    - Algorithmic code is easier and faster to change when it's in a "driver" than when it's in firmware in an ASIC
      - Most touch-controller suppliers never change the firmware in the touch controller once it ships in a device; N-Trig is the exception
    - Cost-reduction by elimination of one micro
      - Even more cost reduction for large screens by elimination of slave chips

Pressure Sensing

- **"True" pressure-sensing is still an unrealized dream**
  - Blackberry Storm (2 models!) failed with "press harder to select"
  - Nissha/Peratech (QTC) collaboration never hit mass-production
  - Multiple startups are working on smartphone pressure-sensing
    - NextInput
      - Uses an array of pressure-sensing piezo-capacitors under the LCD
    - FloatingTouch
      - Mounts the LCD on pressure-sensing capacitors made using a 3M material
  - Synaptics may be able to get some traction applying their opaque touchpad pressure-sensing technology to transparent touchscreens
  - In the meantime, finger-hover may take over!

Active Stylus Support…1

- **Stylus is coming back into the consumer space**
  - The “finger-only” focus of 2007-2013 is ending
  - All the major p-cap controller suppliers support active & passive
  - PC OEMs want to differentiate their products from Apple’s
  - Legacy Windows software on a Win-8 tablet needs a stylus
  - Samsung has shipped >15M Galaxy Notes I & II
  - Consumption isn’t enough; a stylus is great for creation



Created with an N-Trig stylus on a Fujitsu Lifebook using ArtRage software

Active Stylus Support…2

- **Intel's user-testing of stylus on clamshells produced some surprising results**
  - 60 people tested for 2 hours each in USA, UK, & PRC
    - Everybody owned a laptop and a smartphone; 50% owned 1+ tablet
    - Tracked 82 specific actions for each user in 4 desktop apps and 2 Modern apps
  - Ideal laptop (after testing)
    - 56% touch laptop with stylus; 22% touch laptop with stylus and no touchpad; 20% touch laptop; 2% standard laptop
  - 66% expressed moderate or high likelihood of purchasing an Ultrabook with a stylus in the next year, even with a premium

http://ultrabooknews.com/2013/01/28/digitizers-and-ultrabooks-what-people-want-design-recommendations-and-developer-tips-video-series/
Daria Loi – User Experience Innovation Manager at Intel Corporation
Study released to the public on January 28, 2013 (30 minutes of video)

Embedded Touch…1

- **Touch provided by the display manufacturer ("in-cell")**
  - It's shipping today in high-volume smartphones
    - Sony Xperia P, HTC EVO Design 4G, iPhone-5, Huawei Ascend P2…
  - Hybrid in-cell, "true" in-cell, and on-cell
    - All other forms of embedded touch should be considered "dead"
  - Embedded is limited today to smartphone display-sizes
    - JDI paper in this year's Symposium describes 12.2" automotive display with embedded touch
  - Embedded could win a significant share of high-volume displays (several million units/product)
    - Smartphones have already started
    - Tablets will start by the end of 2014
    - Ultrabooks may start by the end of 2015
    - Everything else (lower volume) will remain discrete

Source: CNET

Embedded Touch…2

- **Why is embedded-touch happening?**
  - Touch in 2007 was $1.3B; in 2013 it will be $21.4B
    - The display industry (~$100B) wants a piece of this action
- **What might prevent it from happening?**
  - According to DisplaySearch, mobile phones & tablets will be 74% of total touch-revenue in 2018
    - If the display industry takes all of this revenue, the touch-module business will shrink to <40% of its current size
  - Touch-on-cover-glass (OGS) is only 0.1 mm thicker than in-cell
    - Thickness difference in today's newest embedded phones is 0.8 mm
  - Embedded touch isn't free
    - Cover-glass, bonding, FPC (hybrid), controller, amortized NRE, margin…
  - Cover-glass variations may create a supply-chain problem
  - Touch-module suppliers may increase their level of innovation

Controller Integration

- **Touch controller + display controller (TCON) in a single chip**
  - Synaptics is the leader in doing this; they acquired a TCON company in order to be able to do it right
  - First generation of embedded touch in smartphones (by JDI & Synaptics) uses a communication link between the touch controller and the TCON to coordinate the display and touch timing
  - Next generation (from Synaptics) uses an integrated chip
    - BUT, the chip is display-specific (resolution, pixel structure, etc.), so it's not really a general-purpose solution
  - Even so, integration is probably the optimum solution for embedded (hybrid and true in-cell) touch in high-volume displays

P-Cap Conclusions

- **Conclusion 1:** *P-cap innovation continues unabated*
- **Conclusion 2:** *P-cap commoditization seems to be a long way off*

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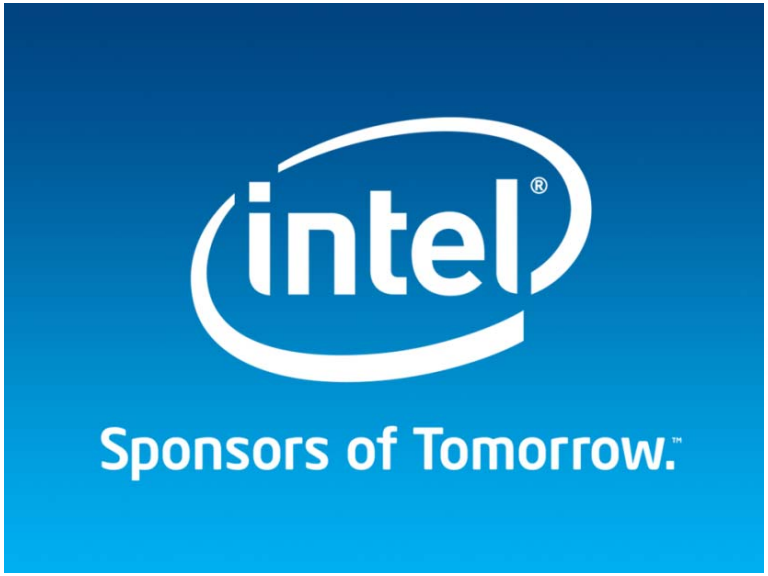

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