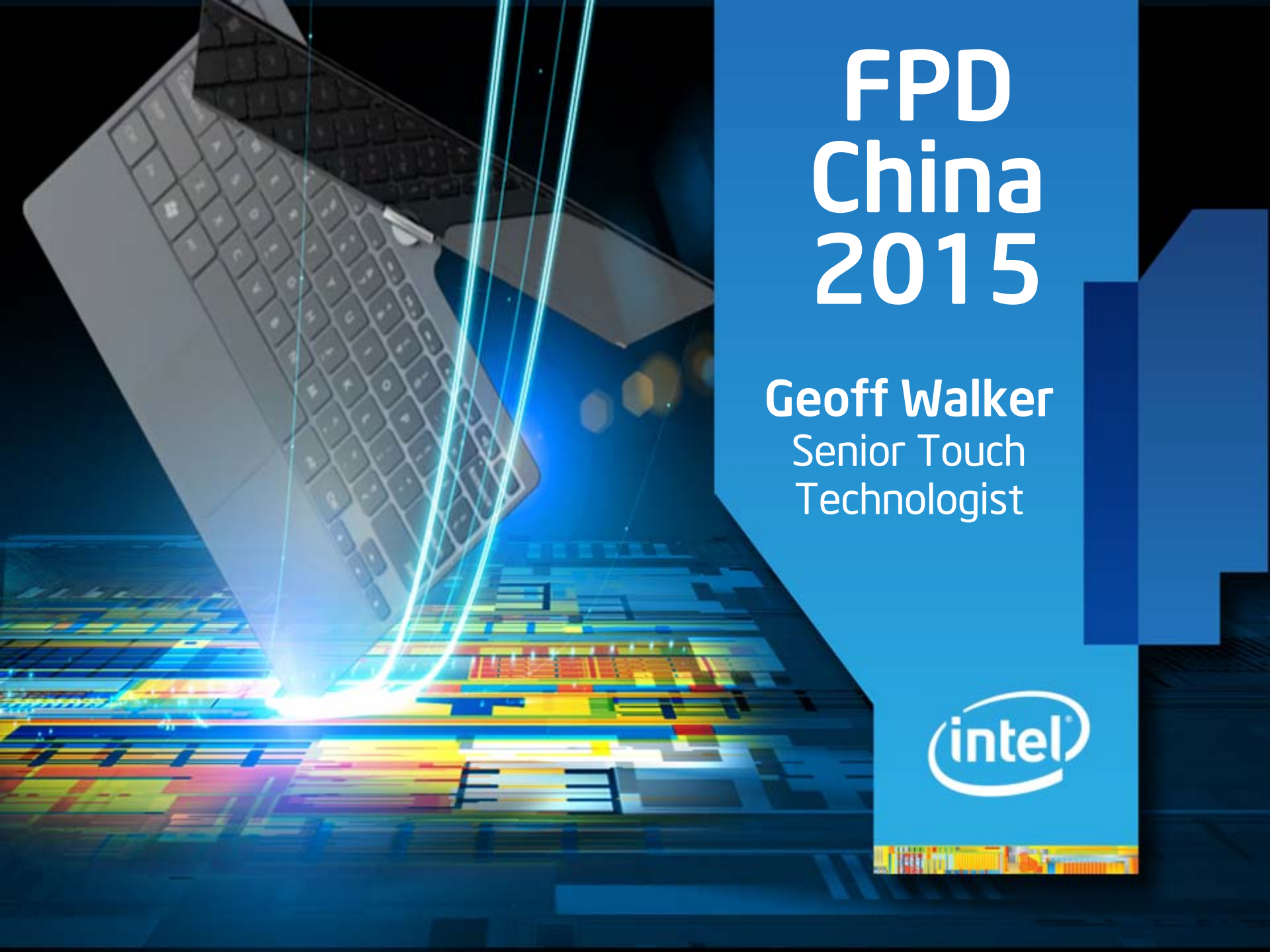

FPD China 2015

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intel

The Role of Force-Sensing in Touch

***Download file from*:** www.walkermobile.com/PublishedMaterial.htm

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Agenda

- Basics
- Increasing use
- History
- The problem
- The solution
- Force-sensing applications
- Adding force-sensing to p-cap
- What's needed to make it happen
- Summary

Basics

- **What is force-sensing?**
  - Measuring the force exerted by something on something
- **Examples of use**
  - Many consumer and industrial devices (but not displays!) have incorporated force-sensing for many years
    - Musical instrument, car-occupancy sensor, joint tensile-load sensor, digital weighing scale, pressure-sensing for pumps, force-sensitive smartphone camera button, breast-cancer detection, self-serve foot scanning, eyelid pressure, etc.
    - Force-sensing resistors (FSR) and capacitive sensors are the most common methods of implementation
    - Most interesting company in commercial applications
      - www.pressureprofile.com

Increasing Use…1

- **Consumer electronic devices are making increasing use of force-sensing**
  - Apple watch
    - Top surface is force-sensitive

Apple Website:
"[Force-sensing] is the most significant new sensing capability since multi-touch"

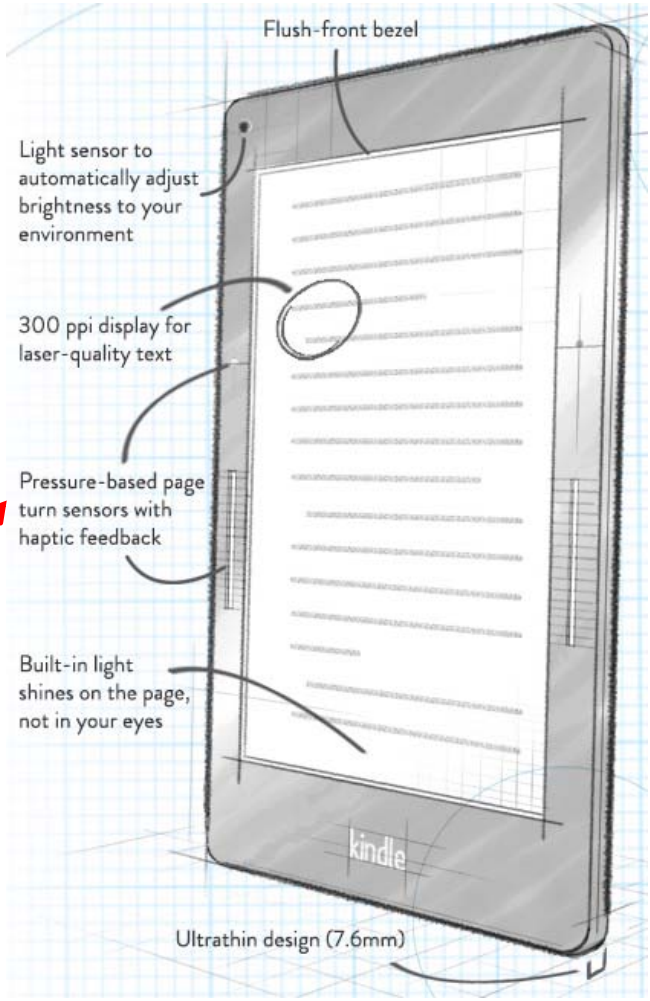
Source: Apple

Increasing Use…2

- **Continued…**
  - Apple MacBook Pro touchpad
    - Force-sensor under each corner
    - A light click can perform one action; a harder click another

Source: Apple

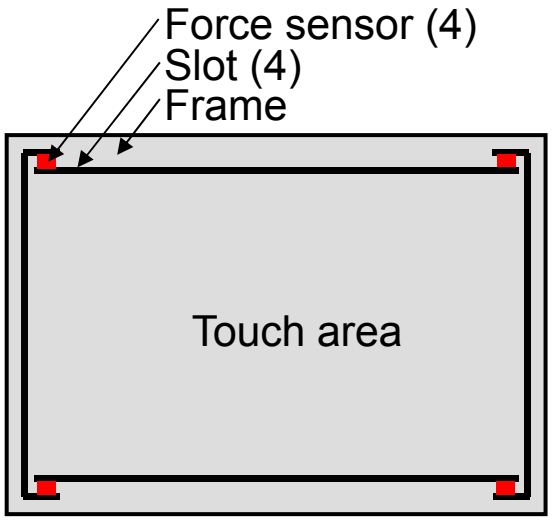
  - Latest Kindle e-book reader
    - Press bezel to turn page instead of touching screen



Source: Amazon

History…1

- **There have been many attempts to use force-sensing to *determine touch location***
  - IBM "TouchSelect" CRT touch-panel supported on strain gauges
    - Early 1990s, unsuccessful
  - Vissumo: LCD touch-panel on beam-mounted sensors
    - Ran out of money in 2009, but their technology was very cool



Drawing by Author

Demo box

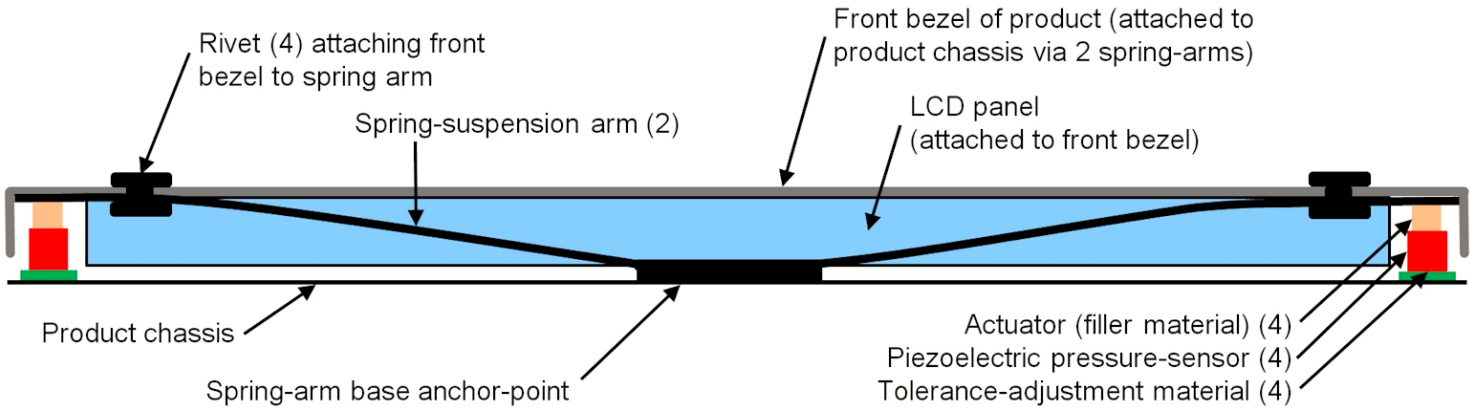
Photo by Author

Elevator control panel

Photo by Author

History…2

- **Continued…**
  - F-Origin: LCD & touch-panel on spring-arm mounted sensors (originally used monofilament on pulleys!)
    - Down to one person; effectively out of business

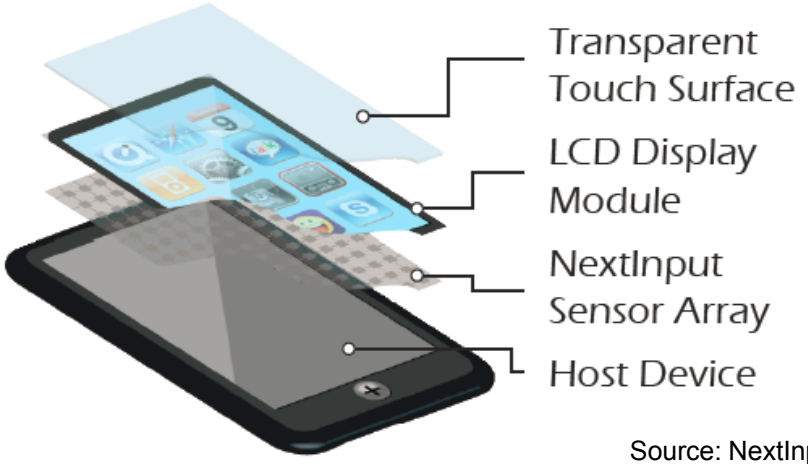


Drawing by Author

  - FloatingTouch: Flexible adhesive pads forming variable capacitors between the LCD and the system
    - Insufficient start-up funding

History…3

- **Continued…**
  - Peratech + Nissha + Stantum: Force-sensitive digital multi-touch resistive (DMR)
    - DMR couldn't compete with p-cap for determining touch-location
  - NextInput: Started with an array of force-sensitive organic transistors under the LCD ("touch skin" developed for robotics)
    - Now using just a cover-glass mounted on four MEMS force-sensors
    - Still in business, but focused on single-touch commercial, not consumer



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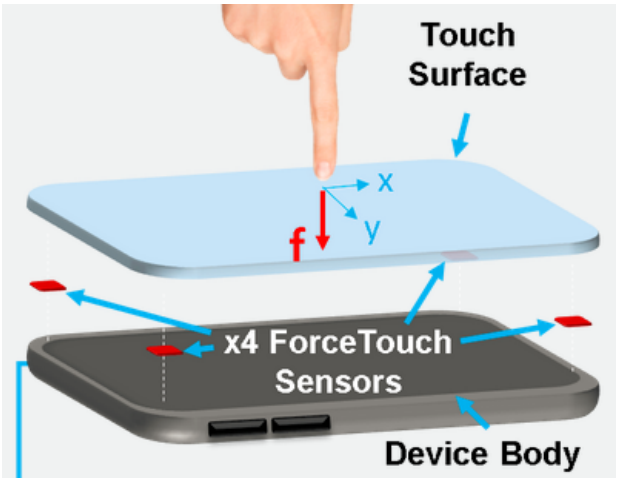


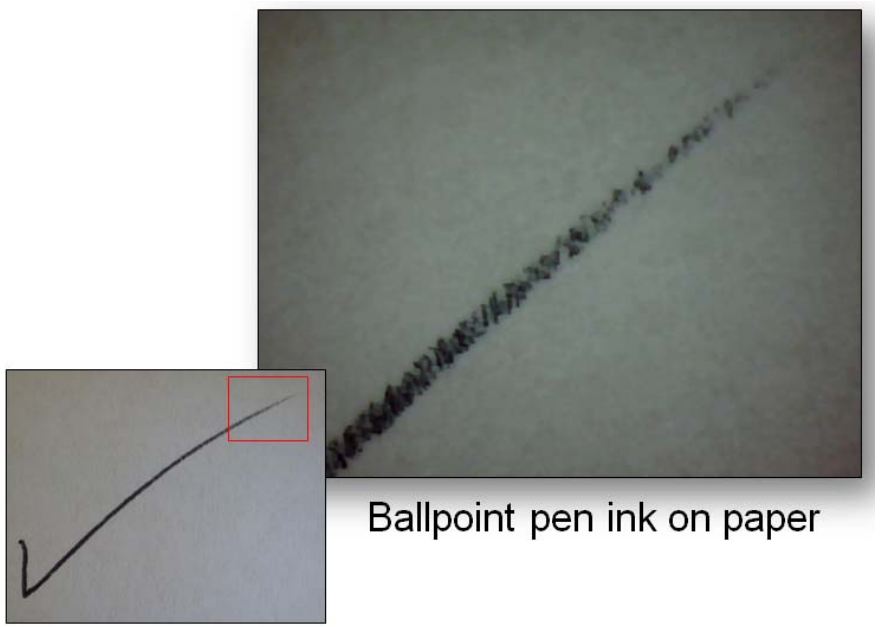
The Problem with Force-Sensing

- **Using force-sensing as a method to *determine touch location* can't compete with p-cap**
  - Force-sensing has problems with…
    - More than one touch
    - Vibration
    - LCD & touchscreen mounting (ODMs don't like "floating" LCDs)

- **But p-cap today can only detect relative force**
  - P-cap uses the touch area as a proxy for force
    - But my little finger pressed hard has the same touch area as my thumb pressed lightly…

The Solution

- **Detect the touch-location and touch-force separately**
  - Active stylus has been doing this for 25 years!
    - Location methods:
      - (1) EMR
      - (2) Receive touch-panel drive signal and retransmit it
      - (3) Transmit signal from stylus to touch-panel electrodes
    - Force-sensing methods:
      - (1) Variable capacitor
      - (2) Variable inductor
      - (3) Variable resistor
      - (4) Variable light-blocker
  - Force-sensing in active stylus makes "digital ink" look REAL
    - Also simulates the reality of drawing with a pencil (shading vs. dark lines)



Source: N-Trig

Touch Force-Sensing Applications…1

- **Why combine force-sensing and touch?**
  - "Preview" (equivalent to "mouseover") is the main reason
    - This is something that p-cap touch can't do today
  - "Hover" is an attempt to accomplish the same thing, but it's not well-accepted by the market
    - Non-intuitive
    - Muscle tremor reduces accuracy
    - Hard to stay within 10 mm range without touching
    - Users don't like it!
  - The lack of mouseover in p-cap touch has changed the way mobile-website apps work
    - Full websites: Hover mouse over menu name; choices appear under
    - Mobile website: Touch menu name; choices are listed separately
  - Providing mouseover is the best way to start adding force-sensing
    - Everybody already knows how to use mouseover!

Touch Force-Sensing Applications…2

- **Force-sensing can also be used to create new UI functionality, but wide adoption is difficult to achieve**
  - Zoom or vary scroll rate with one finger by pressing harder
  - Copy by pressing harder and swipe-selecting
  - True touch-typing with on-screen keyboard
  - Add value to passive stylus (more realistic digital ink)
  - Reduce unintended touches by requiring a minimum touch force
  - And more…
- **It's very difficult to make new UI functionality intuitive**

Adding Force-Sensing to P-Cap

- **UK startup Cambridge Touch Technologies (CTT) has the best, most practical solution that I've seen**
  - Slightly modifies the standard p-cap stackup, without changing the p-cap user-experience in any way, and without changing the electrodes or adding more I/O
  - Can be used with any p-cap stackup, discrete or embedded

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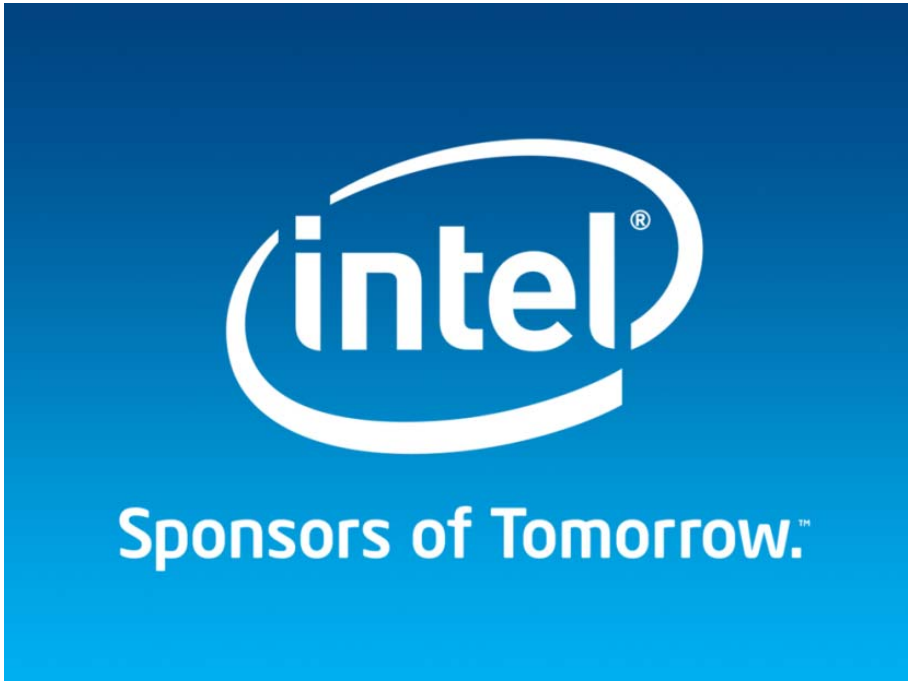
What's Needed to Make It Happen

- **Force-sensing material**
  - Multiple high-volume ($B) chemical suppliers exist today
- **Modified touch controller**
  - Under development
- **Android & Windows must insert force-data into existing touch data-structures**
  - They already do it for active stylus; it's a simple change for touch
- **Apps must make use of force data; mouseover is the easiest starting point**
  - Press lightly to preview
  - Press harder to select

Summary

- **Force-sensing in touch is best for creating touch characterization data rather than as a primary method of determining touch location**
- **The use of force-sensing is increasing in both opaque and transparent applications in consumer electronics**
- **The best, most practical method of adding force-sensing to p-cap that I've seen is from Cambridge Touch Technologies**



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