



New Developments In Touch Technologies

Geoff Walker – NextWindow
FPD China Conference
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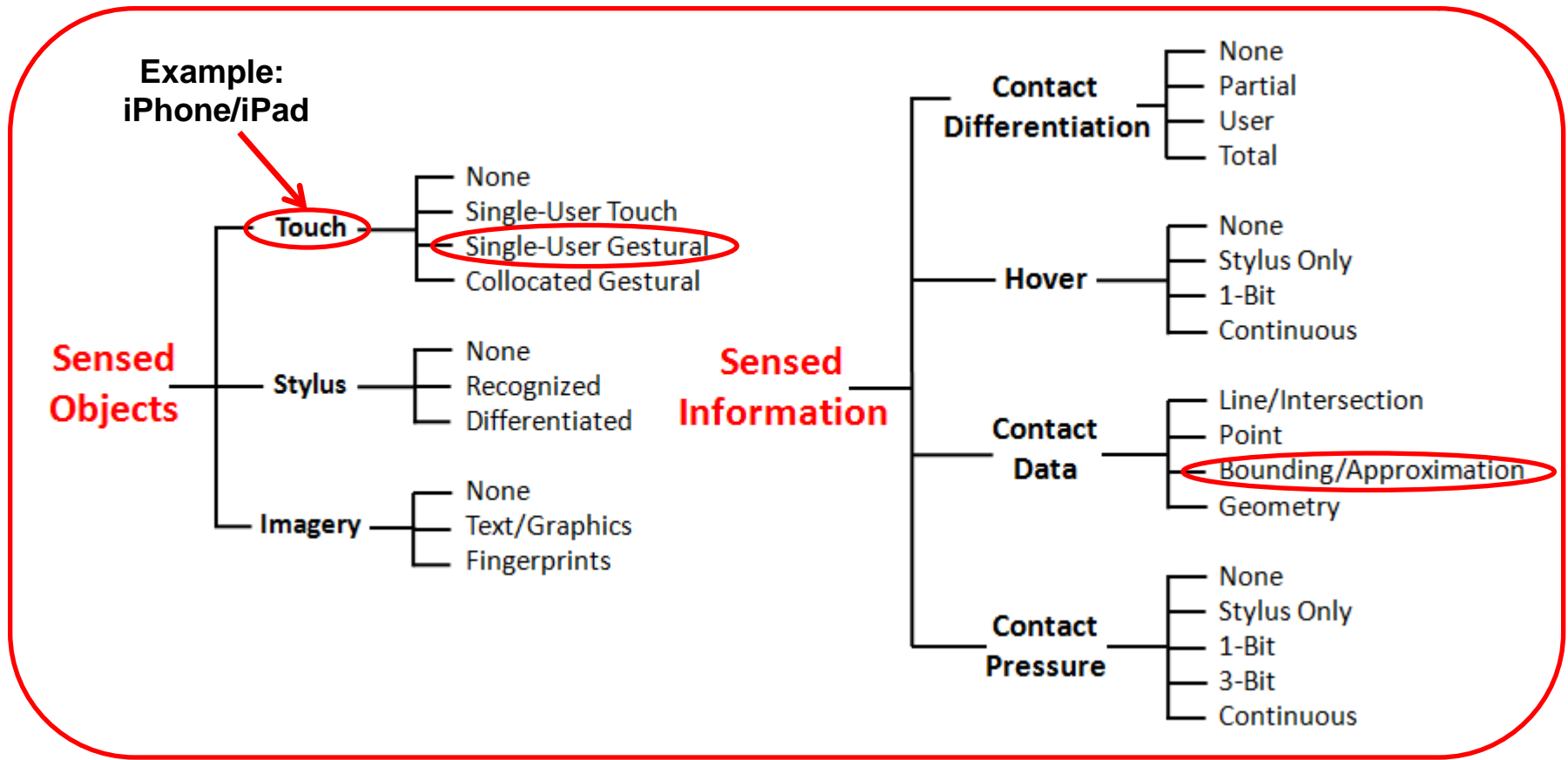
Agenda

❖ Introduction

- ① Projected Capacitive
- ② Vision-Based
- ③ Camera-Based Optical
- ④ In-Cell, On-Cell & Out-Cell
- ⑤ Infrared
- ⑥ Analog & Digital Multi-Touch Resistive (AMR & DMR)
- ⑦ Surface Acoustic Wave (SAW)

A Simple Touch Isn't Simple...1

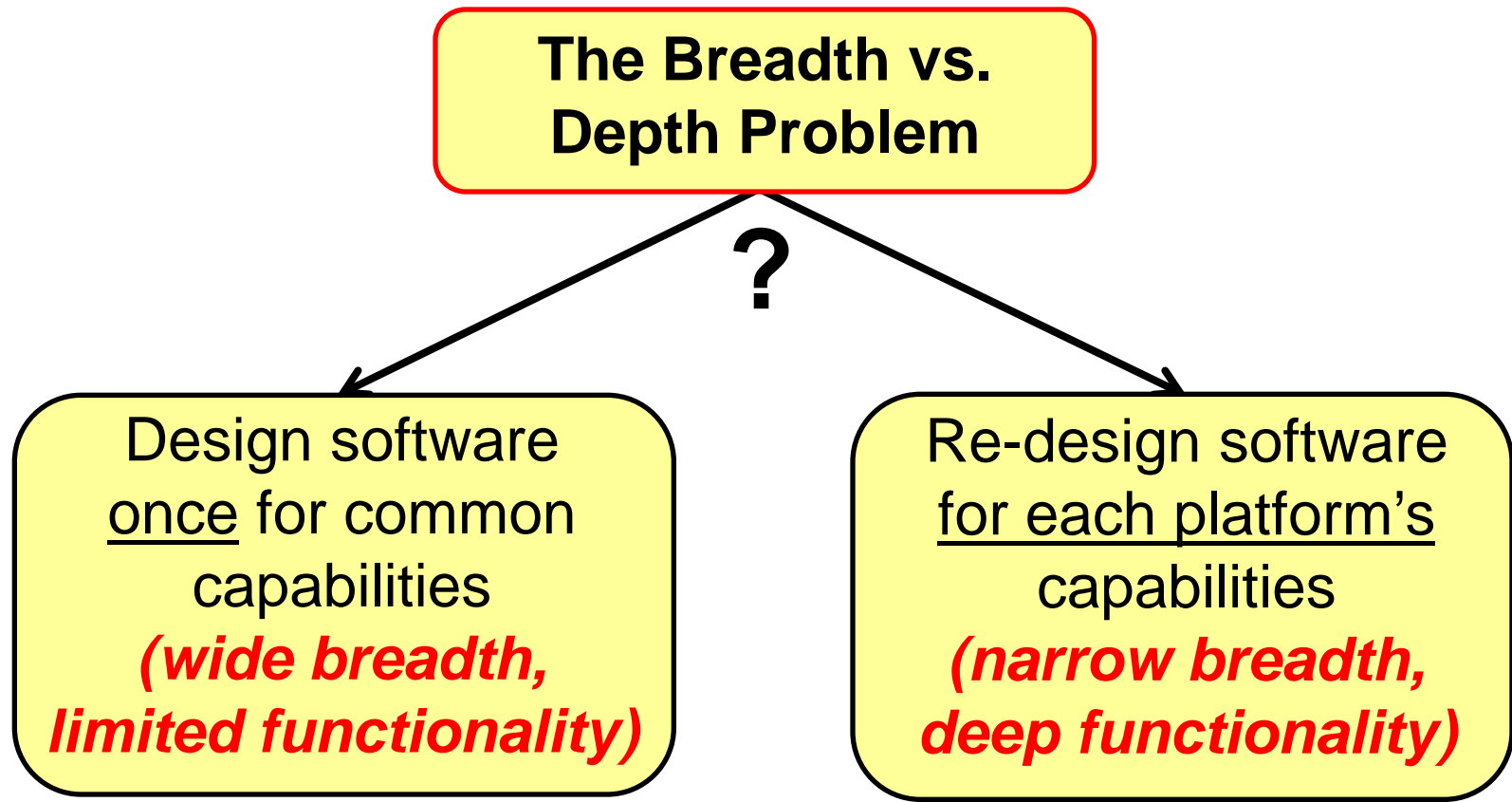
❖ Touch classification from the University of Toronto



Source: Daniel Wigdor

A Simple Touch Isn't Simple...2

- ❖ It's far more complex than just “how many touches?”



Projected Capacitive...1

1

❖ Projected capacitive has become mainstream

- ◆ In 2006 (pre-iPhone), total worldwide sales of pro-cap were approximately **\$20M**
- ◆ According to DisplaySearch, pro-cap is estimated to be **\$2.8B** in 2010 (CAGR = 244%)
 - According to DigiTimes, the largest single supplier in 2010 (TPK Touch Solutions) was over \$1B

❖ Mobile phones & tablets are driving the market

- ◆ **50%** of the \$2.8B in 2010 was mobile phones (DisplaySearch)
- ◆ **30%** was Mini-Note PC/Tablet
- ◆ 14% was MP3(music) / PMP(media) / PND (navigation)

Projected Capacitive...2

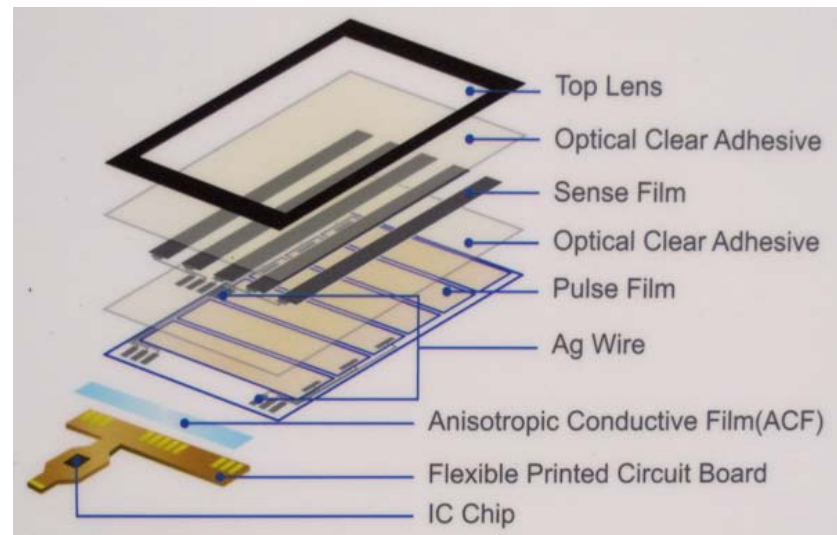
1

❖ Capacity is expanding extremely rapidly

- ◆ TPK, Wintek, CMI, Cando, Sintek, Young Fast, AUO, CPT, etc. are all adding glass-type pro-cap capacity (mostly 2.5G – 5.3G)

❖ Construction is stabilizing

- ◆ Film-type for mobile phones
- ◆ Glass-type for larger products (e.g., iPad)
 - **“One-glass”** (touch on underside of cover lens) is the current industry trend



Source: Sony Chemical

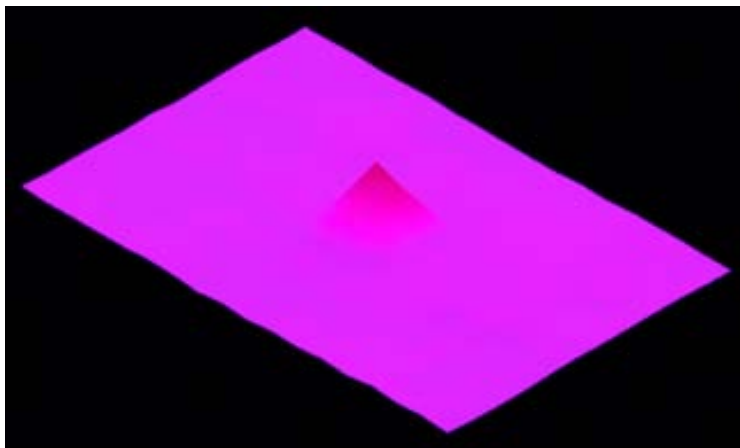
Projected Capacitive...3

1

❖ Usable stylus is almost here

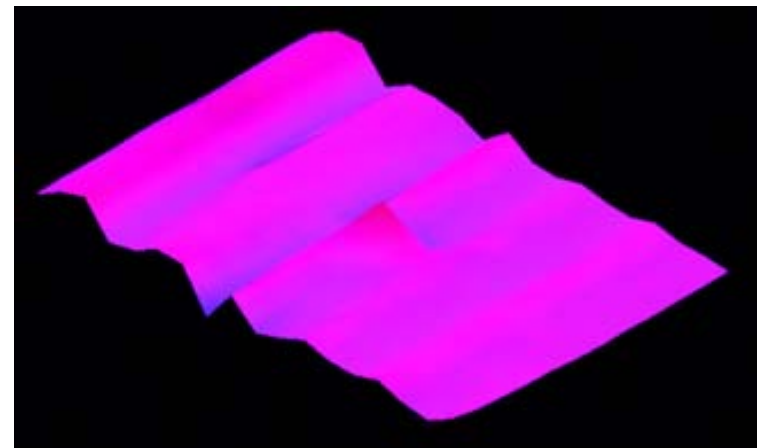
- ◆ Atmel, Cypress, Maxim (controller-IC suppliers) are all saying they can support a conductive stylus with **1-mm tip**
- ◆ Higher signal-to-noise-ratio (SNR) controllers are enabling this

Capacitance Profiles



2-mm stylus on 4" screen
with high-SNR controller

Source: Maxim



Same stylus and screen
with low-SNR controller

Projected Capacitive...4

1

❖ Hitachi's claimed "non-conductive pro-cap stylus"

- ◆ Shown at FPD International in Japan (November 2010)
- ◆ Probably is a combination of pro-cap and voltage-sensing in-cell (pressure-sensitive) touch, **NOT** just pro-cap



Source: Photo by author

Projected Capacitive...5

1

❖ The maximum size has expanded to 32"

- ◆ 3M & TPK/MasTouch have 32" pro-cap monitors
- ◆ Asus has a 27" pro-cap all-in-one touch computer (ET2700)



Asus
10-touch
27" AiO

Source: TheTechJournal.com



3M 10-touch
32" monitor

Source: 3M

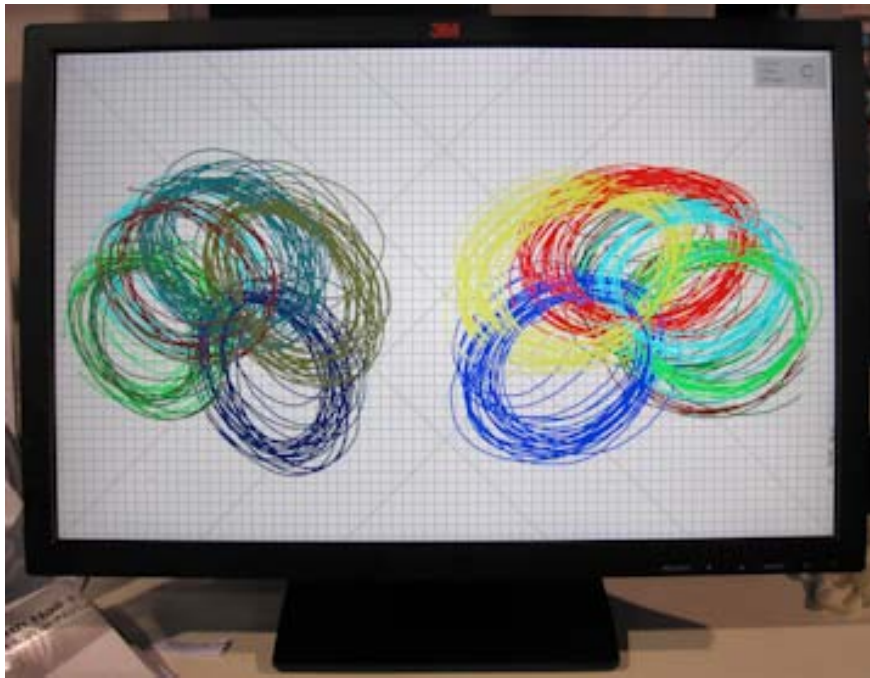
- ◆ High-volume cost is \$3/inch

Projected Capacitive...6

1

❖ Performance is increasing

- ◆ **Consumers don't want to wait for the touch system!**
- ◆ 3M is the current champion with 40+ touches on 22" pro-cap monitor at 200 samples/second/touch (5 ms)



3M 22" pro-cap monitor
with 10 fingers moving
as fast as possible

Source: Photo by author

Vision-Based...1

2

❖ Microsoft/Samsung announced **Surface v2** at CES 2011



Document
on surface



Source: Microsoft

Source: TechCrunch.com

❖ What is Surface v2?

- ◆ **“Connects people to information and each other” (Microsoft)**
- ◆ 40” full-HD (1920x1080) Samsung LCD (55 ppi)
 - 4” thickness includes 2.9 GHz PC with embedded 64-bit Win-7
- ◆ Corning Gorilla Glass bonded to LCD
 - Display still has some bezel height (not a flush surface)
- ◆ **In-cell touch:** 1 light-sensor per pixel = 2M sensors
 - By far the most sophisticated in-cell light-sensing so far
 - Half of sensors are IR; other half are visible-light (unclear why)
 - RGB pixels may be modified to reduce effect on aperture ratio
 - IR light source is probably added to backlight (uncertain)
- ◆ 50+ simultaneous touch points
 - Surface image-processing software is primary Microsoft value-add
- ◆ \$7,600 – targeted at enterprise

Vision-Based...3

2

❖ The number of “touch tables” is rapidly increasing



❖ Why does vision-based touch matter?

- ◆ It's the only touch technology that can do true **object-recognition**
which...
- ◆ Enables integrating the **physical world** and the **virtual (digital) world** more closely
which...
- ◆ Makes **digital information** more easily accessible when users interact with a **physical object**

***Which has more potential to change the world,
projected capacitive or vision-based touch?***

Camera-Based Optical...1

3

❖ Camera-based optical is starting to mature

❖ Windows 7 on all-in-one (AiO) desktops is #1 volume

- Optical hits the sweet spot of price and performance compared with other touch technologies for all-in-ones
- Almost all desktop PC OEMs & ODMs are using optical



❖ Large-format (> 30") camera-based optical is growing

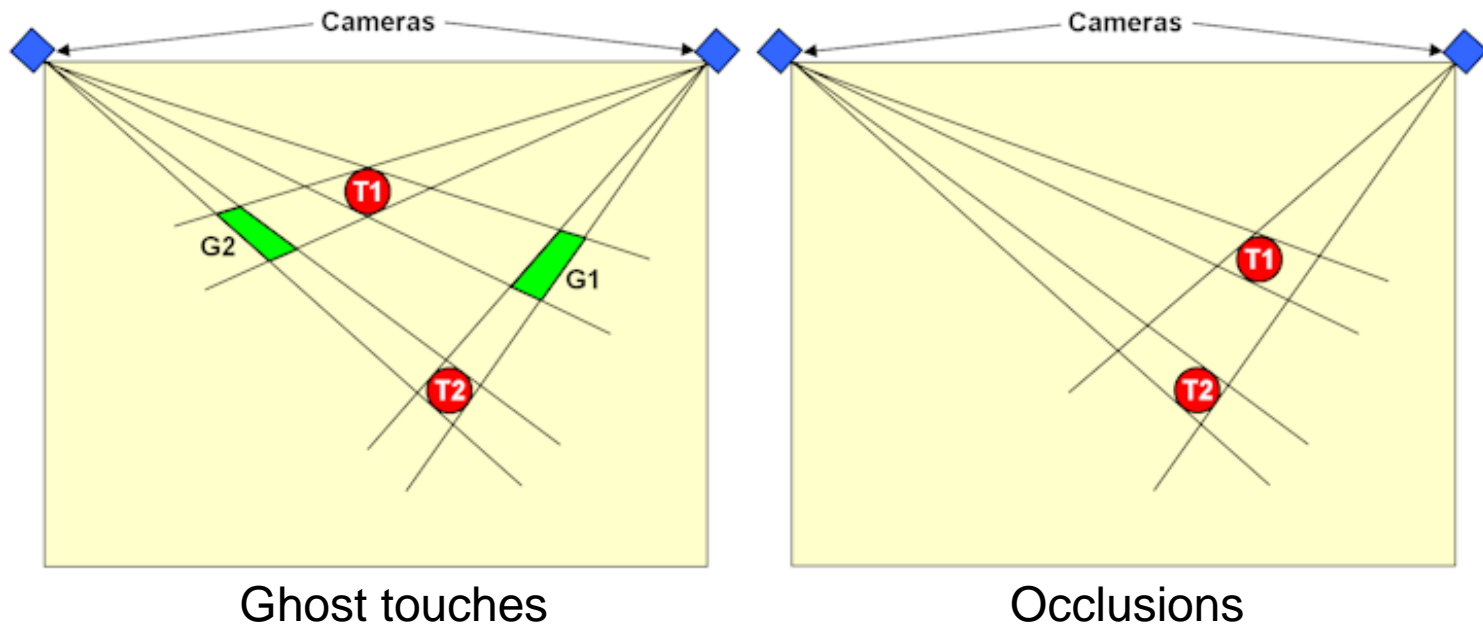
❖ Key applications

- Interactive information
- Interactive digital signage
- Education (including opaque & LCD interactive whiteboards)

Camera-Based Optical...2

3

- ❖ Two touches with two cameras (current market focus) has two main limitations



The quality of the touch experience depends on the sophistication of the algorithms that handle ghost touches and occlusions

❖ Products with 3 cameras

- ◆ Adding a third camera doesn't actually improve the touch quality very much because there are still ghost touches and occlusions
- ◆ Using four cameras eliminates essentially all of these problems, but most PC OEMs perceive that two-camera performance is “good enough” and aren't willing to pay for four cameras



Dell ST2220T
Touch Monitor
with 3 cameras

In-Cell, On-Cell & Out-Cell...1

❖ Definitions

- ❖ **In-cell:** Touch sensor is inside the LCD cell, between the two sheets of glass
- ❖ **On-cell:** Touch sensor is on top of the color filter glass, underneath the polarizer
- ❖ **Out-cell:** Touch sensor is on top of the LCD (normal)

❖ Technologies

Touch Technology	Location	Status
Light-sensing	In-cell	Difficult technical problems; see Surface v2
Voltage-sensing	In-cell	Used only in hybrid combinations
Charge-sensing (projected capacitive)	In-cell & on-cell	Limited success in-cell; strong success on-cell (products in the pipeline)
Hybrid voltage-sensing & charge-sensing	In-cell	A few products on the market (e.g., digital cameras)
All other technologies	Out-cell	Business as usual

In-Cell, On-Cell & Out-Cell...2

4



First product with in-cell (hybrid) touch (April 2009)



First product with optical in-cell touch (May 2009)



2nd-gen camera with hybrid in-cell touch (August 2009)



First OLED product with on-cell touch (Feb 2010)



Largest (13.3") on-cell finger-touch (charge-sensing) product so far (Feb 2010)

In-Cell, On-Cell & Out-Cell...3

4

❖ Special case: Integrated Digital Technologies, Inc.



Source: IDTI



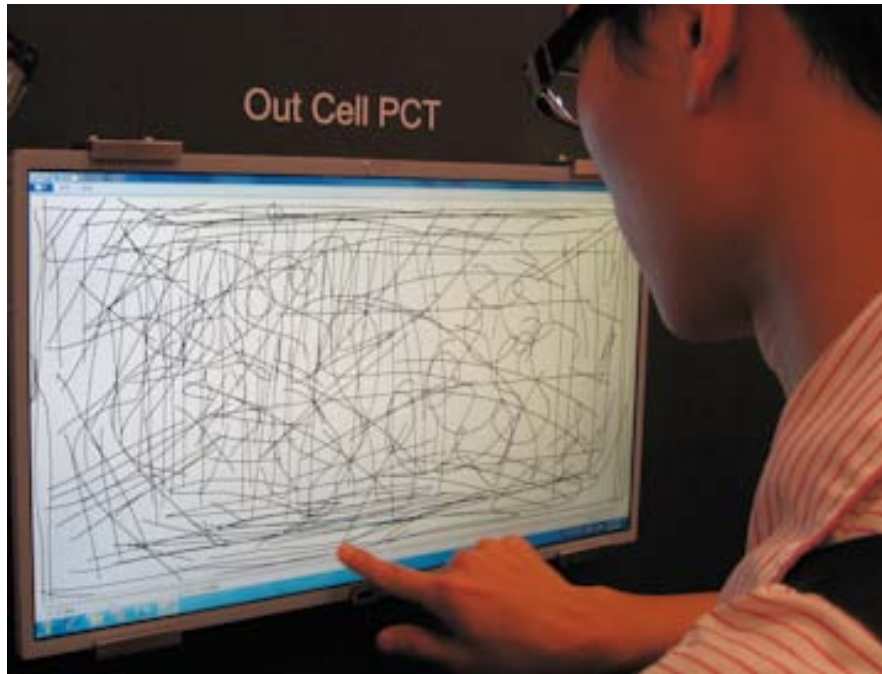
Source: Photo by author

- ❖ 21.5" light-sensing in-cell monitor with **IR light-pen**
- ❖ Supports two-touch with two pens

In-Cell, On-Cell & Out-Cell...4

4

❖ Out-Cell Projected Capacitive



CPT 21.5"
2 touches

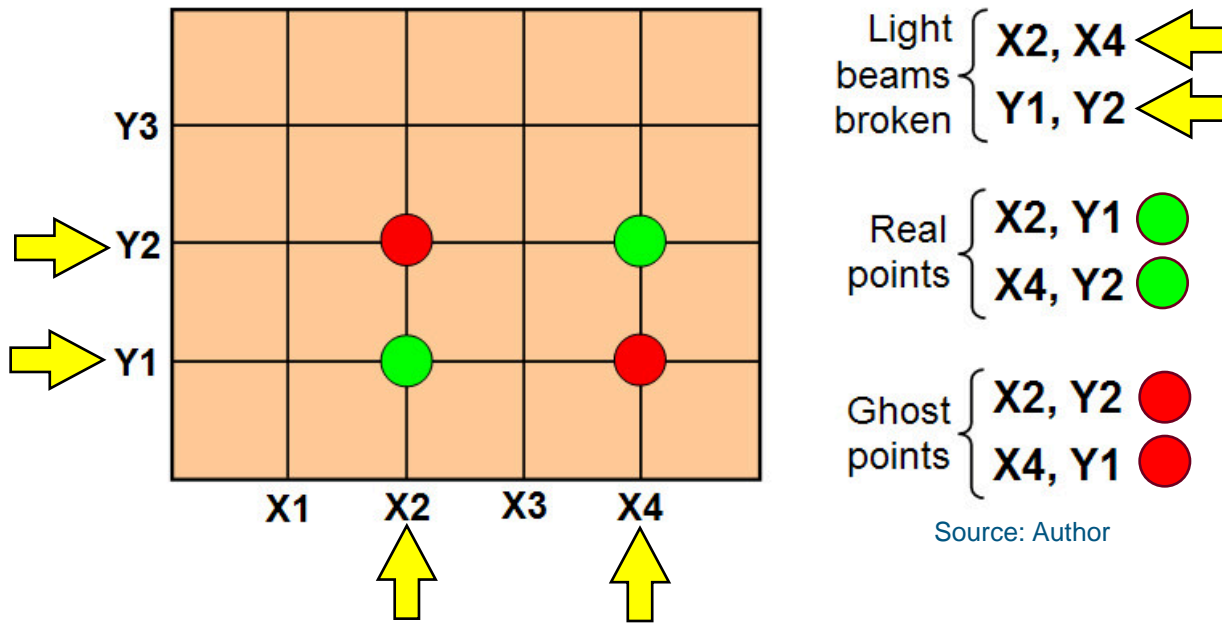
Source: Photos by author



AUO 32"
10 touches

❖ Multi-touch in traditional infrared

- ◆ 2+ touches
- ◆ Suppliers: IRTouch, Groovy Touch, Leading Touch, etc.
- ◆ “Ghost” points are the problem, and **there’s no good solution**

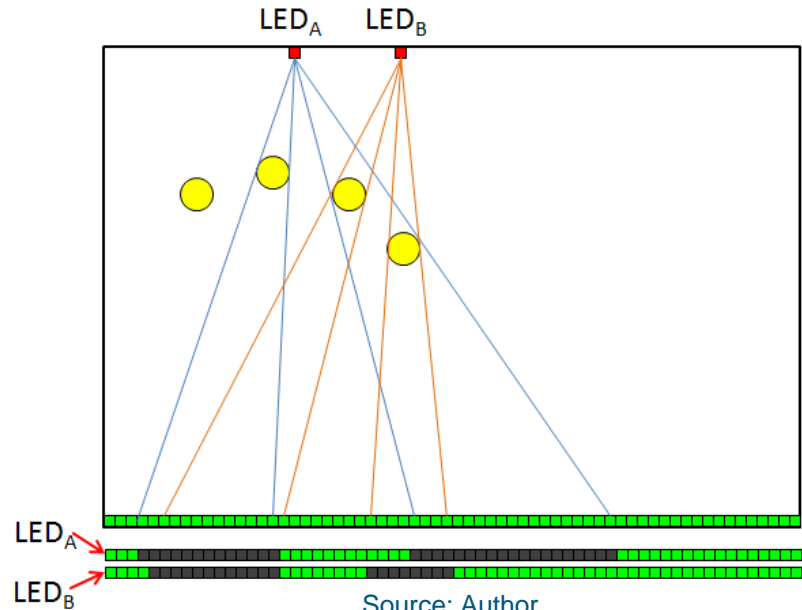


❖ Multi-touch in “LED Cell Imaging” infrared

- ◆ 20-30 touches
- ◆ Suppliers: PQ Labs, Citron



Source: PQ Labs



Source: Author

- ◆ Issues: Relatively low resolution and slow response time

❖ Infrared in mobile devices



Neonode
cellphone
(2009)

Source: Pen Computing



RPO **waveguide infrared**
in prototype 13.3" notebook
from LG Displays (2010)

Source: Photos by author



Sony e-book
readers (2010)

Source: PC World

RPO in
Mirasol
screen
(2010)



Analog & Digital Multi-Touch Resistive (AMR & DMR)...1

6

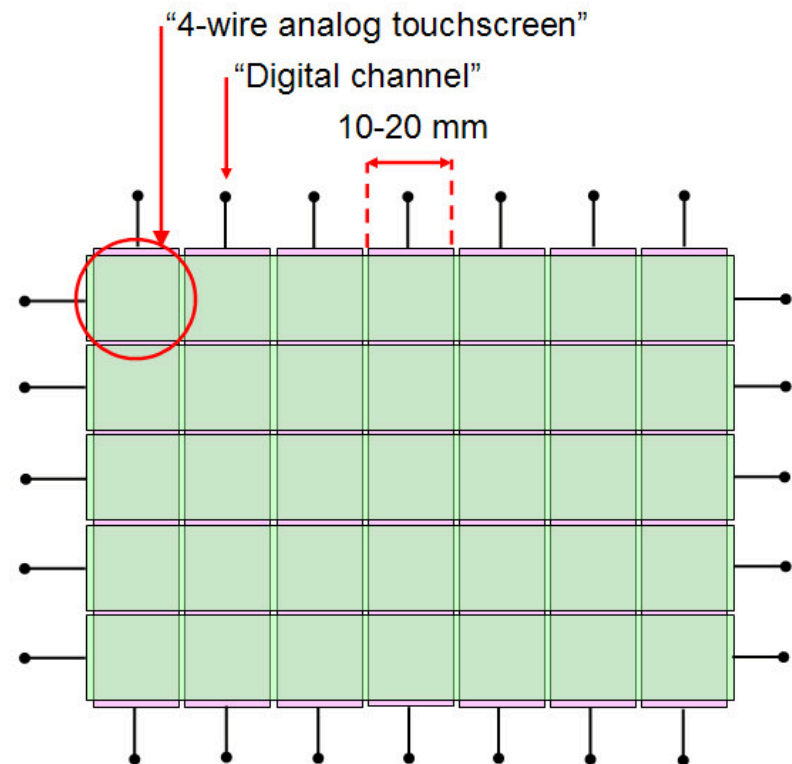
- ❖ **Both are alternatives to projected capacitive**
 - ◆ Familiar resistive technology
 - ◆ Patterned ITO (like pro-cap) instead of single-touch resistive's continuous ITO
 - ◆ Lower cost
- ❖ **But, both have standard resistive shortcomings**
 - ◆ Low durability (PET top surface)
 - ◆ Low transmissivity
 - ◆ Non-zero touch force

Analog & Digital Multi-Touch Resistive (AMR & DMR)...2

6

❖ AMR (also called “hybrid analog-digital”)

- ◆ Suppliers: eTurboTouch, Mildex, Mutto, EETI, ATouch...
- ◆ Limited IP on concept
- ◆ Number of touch points is controller-dependent (2-10)
- ◆ Offered in 3” – 23”, but not actually in production in all sizes
- ◆ **Can't touch with two fingers on the same square**



Source: Author

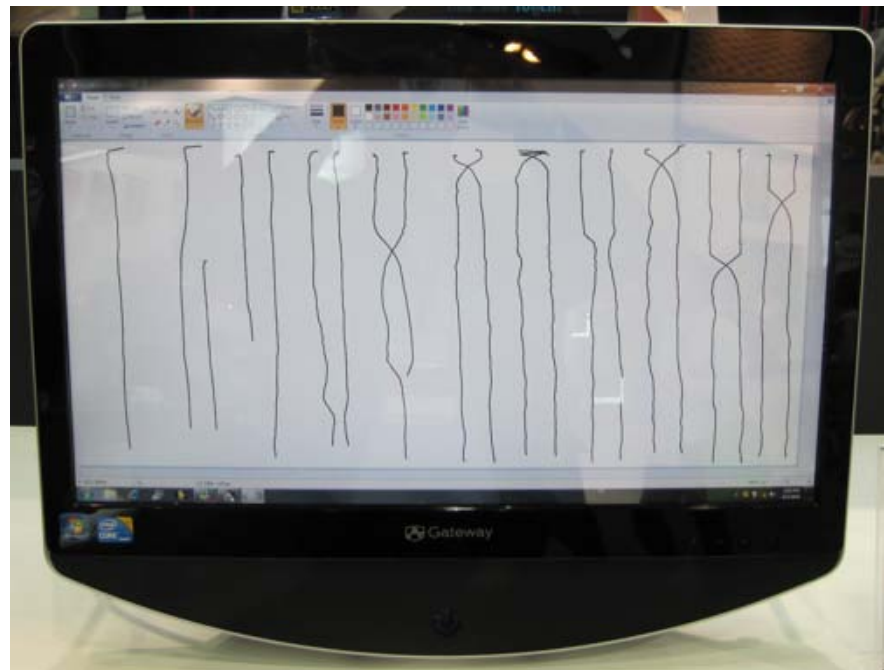
Analog & Digital Multi-Touch Resistive (AMR & DMR)...3

6

Gateway ZX6910 AiO with 23" AMR touchscreen from eTurboTouch



Source: Photos by author



Drawing parallel lines with two closely held fingers (squares are 13 x 15 mm)

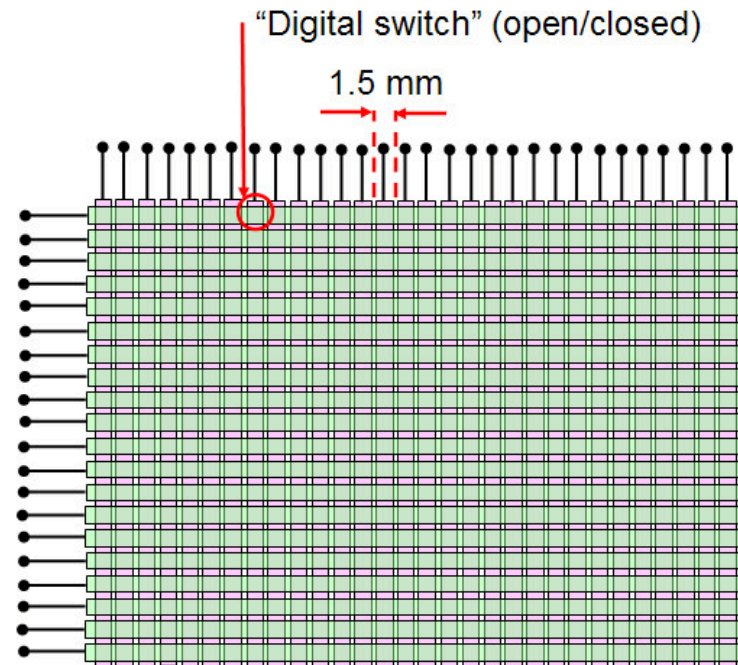
“There is no perfect touch technology”

Analog & Digital Multi-Touch Resistive (AMR & DMR)...4

6

❖ DMR (also called “digital matrix resistive”)

- ❖ Stantum (in France) is primary IP holder
- ❖ Stantum’s strategy is to license controller IP to IC manufacturers
 - Sitronix
 - ST Micro
- ❖ Unlimited number of touch points
- ❖ Aimed at phones and netbooks
- ❖ **Fine pitch results in much higher number of connections than AMR**
 - $64 \times 36 = 100$ on 4.3” screen



Source: Author

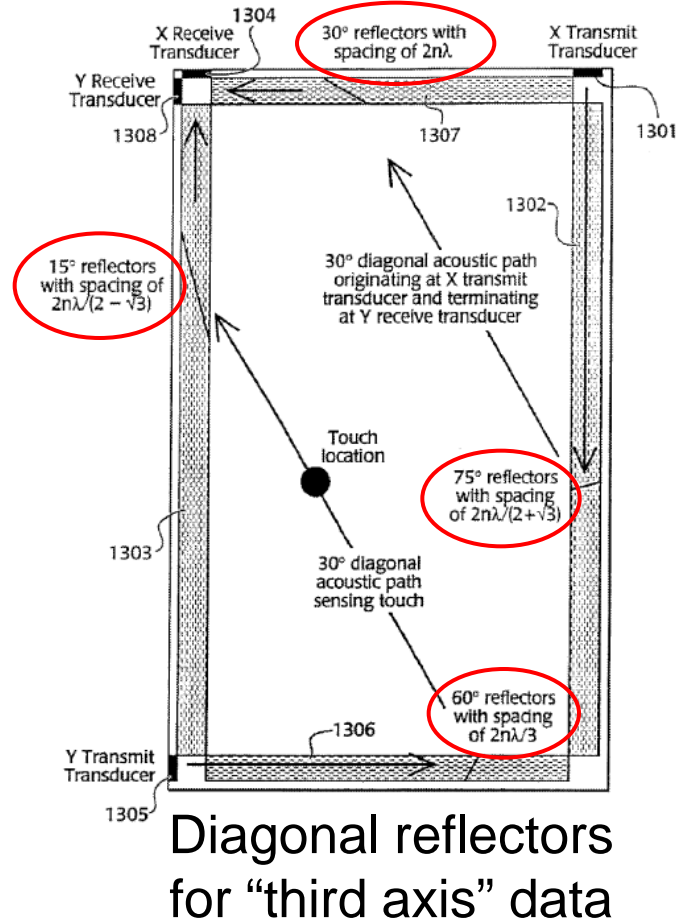
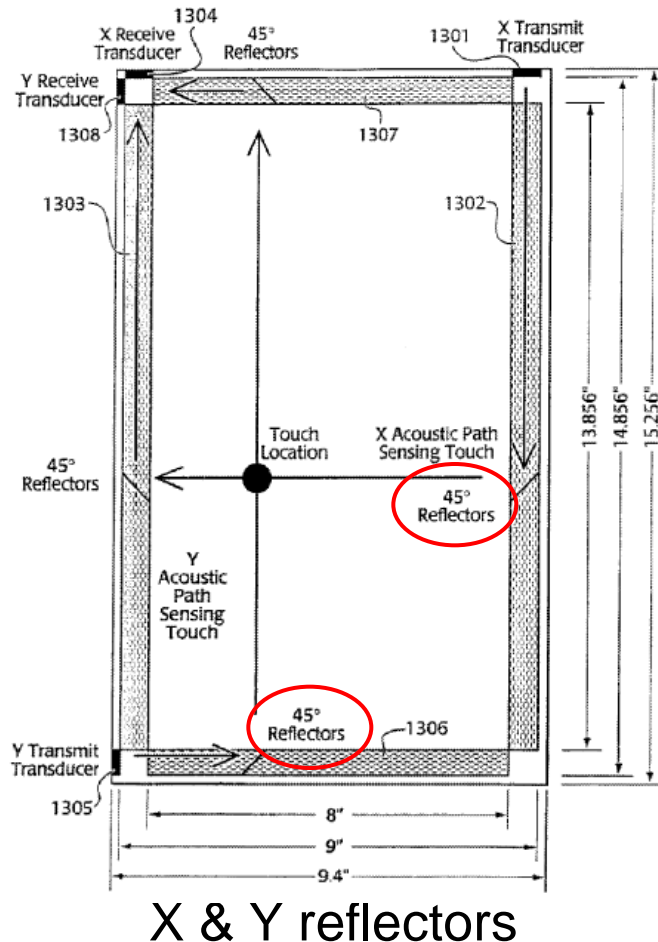
Intel-Quanta
“Redvale”
Tablet

Source: Stantum

Surface Acoustic Wave (SAW)...1

7

❖ How two touches are supported by SAW



Surface Acoustic Wave (SAW)...2

7

❖ Multi-touch SAW from Elo/Tyco Electronics

- ◆ Shipping in the 23" Lenovo A700 all-in-one desktop



Source: Lenovo



2-finger
vertical
lines



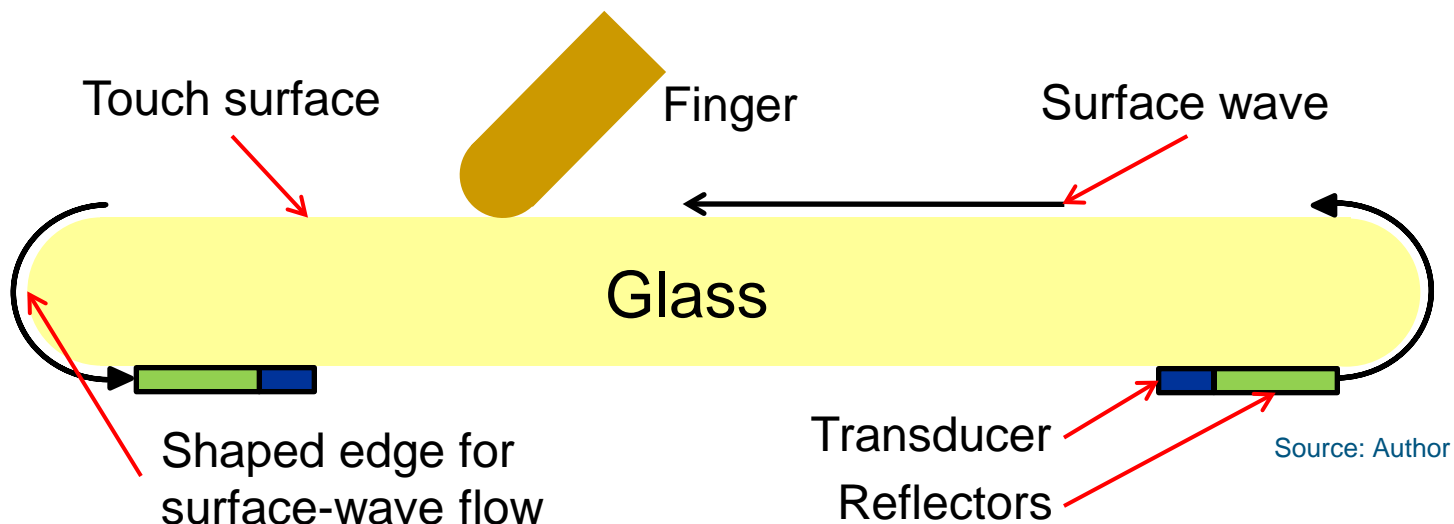
2-finger
diagonal
lines

Source: Photos by author

Surface Acoustic Wave (SAW)...3

7

❖ Elo/Tyco Electronics' "zero-bezel" (flush) SAW



Conclusions

**1: “Change is the only constant”
(especially in touch!)**

**2: “There is no perfect touch
technology”**



Thank You!

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