A Survey of Current & Emerging Touch-Screen Technologies

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Agenda

- Introduction
- Six current touch technologies
- Two emerging touch technologies
- Two “under-development” touch technologies
- Selecting a touch screen

Introduction…1

- Geoff Walker
- Opaque touch vs. transparent touch
- Overall touch business

Touch is HOT

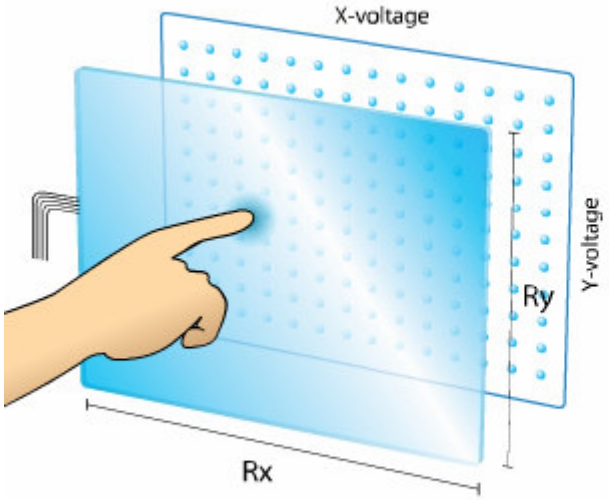
TIME

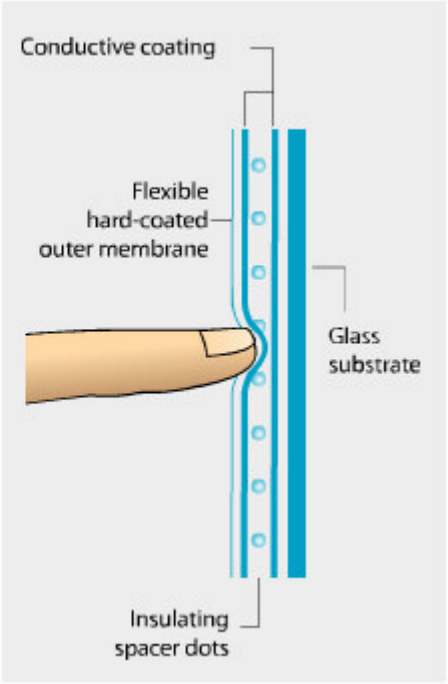
"Touch Screens Take Over“, Time Magazine, 6/14/07

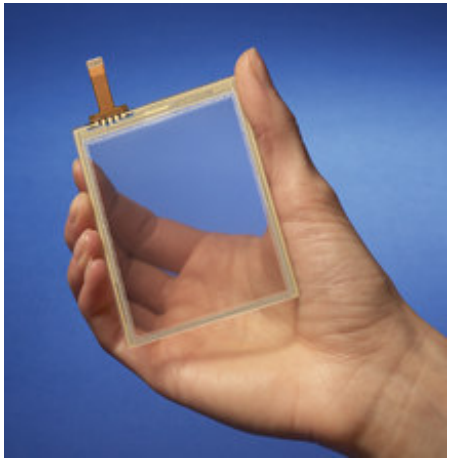
Six Current Touch Technologies

- Analog resistive
- Surface capacitive
- Projected capacitive
- Surface acoustic wave (SAW)
- Infrared (IR)
- Optical

Analog Resistive…1







Illustrations courtesy of Elo TouchSystems and Bergquist

Analog Resistive…2

- **Types:** 4-wire = low cost
  5-wire = long life
  8-wire = low drift
- **Constructions:** Film-glass, film-film, film-plastic, glass-glass, film-film-glass, film-film-plastic

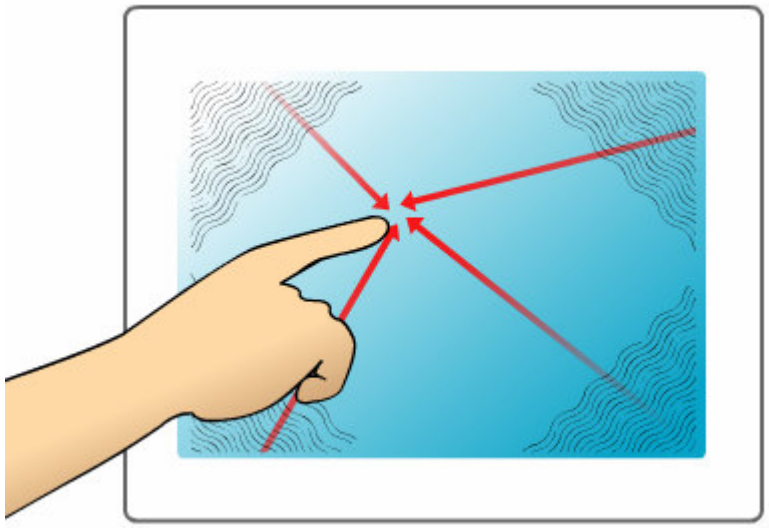
- **Options:** Surface armoring, dual-force touch, low-reflectivity/high transmissivity, rugged substrate, etc.
- **Advantage:** Low cost
- **Disadvantages:** Durability, transmissivity, reflectivity
- **Applications:** Mobile, POS
- **Market Share:** ~70%

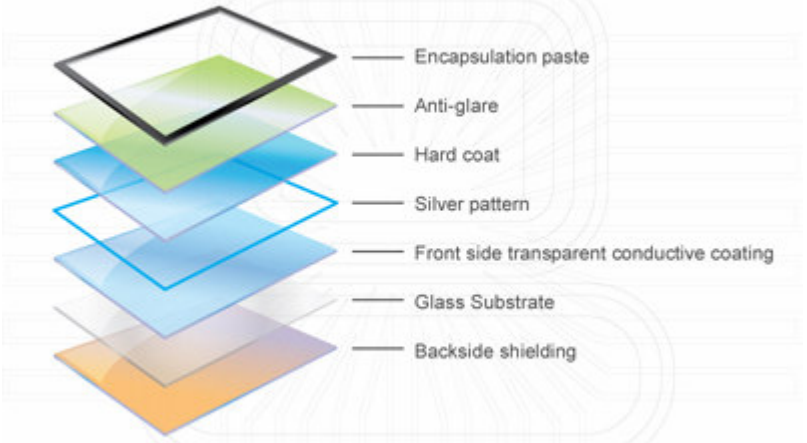
Illustration courtesy of Schott

Analog Resistive…3

- **Market Leaders:** Elo, Fujitsu, Nissha, Gunze, PED, Young Fast, J-Touch, Liyitec…
- **Number of Suppliers:** 50+
- **Market Event:** 3M exited resistive business in 2006
- **Market Trends:** Quantity growth continuing; revenue growth slowing (10% price reduction per year); Japanese resistive suppliers looking hard at projected capacitive because of iPhone; glass-glass slowly becoming more popular

Surface Capacitive…1





Illustrations courtesy of Elo TouchSystems & DanoTech

Surface Capacitive…2

- **Advantage:** High durability compared with resistive
- **Disadvantages:** Finger-only, integration, drift
- **Applications:** Casino gaming, kiosks
- **Market Share:** ~15%
- **Market Leaders:** 3M, DanoTech
- **Number of Suppliers:** 16+
- **Market Event:** 3M patent expired, ending 3M monopoly
- **Market Trends:** Price dropping as Taiwanese manufacturers jump in; 3M expected to eventually abandon the business

Projected Capacitive…1

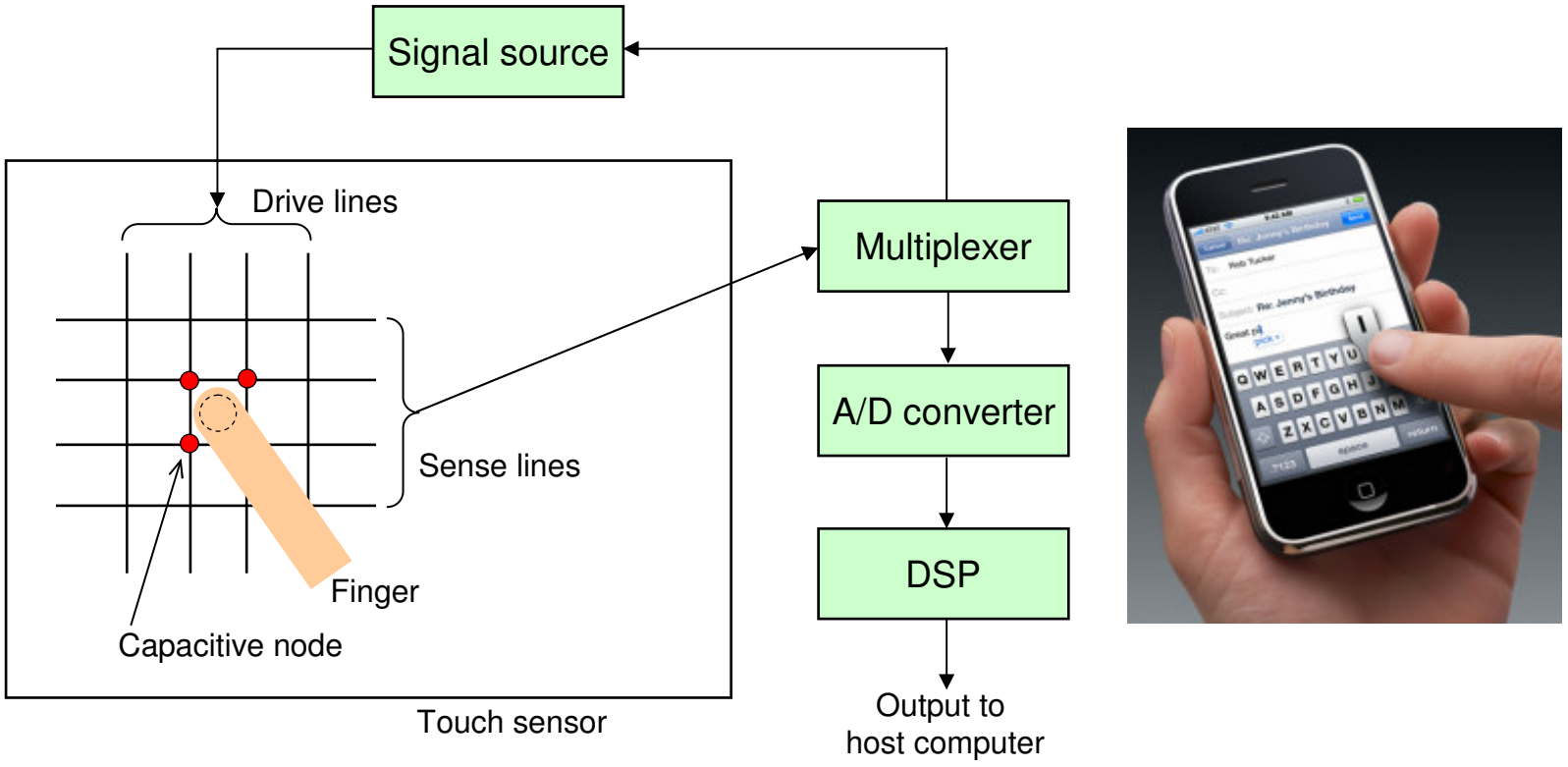
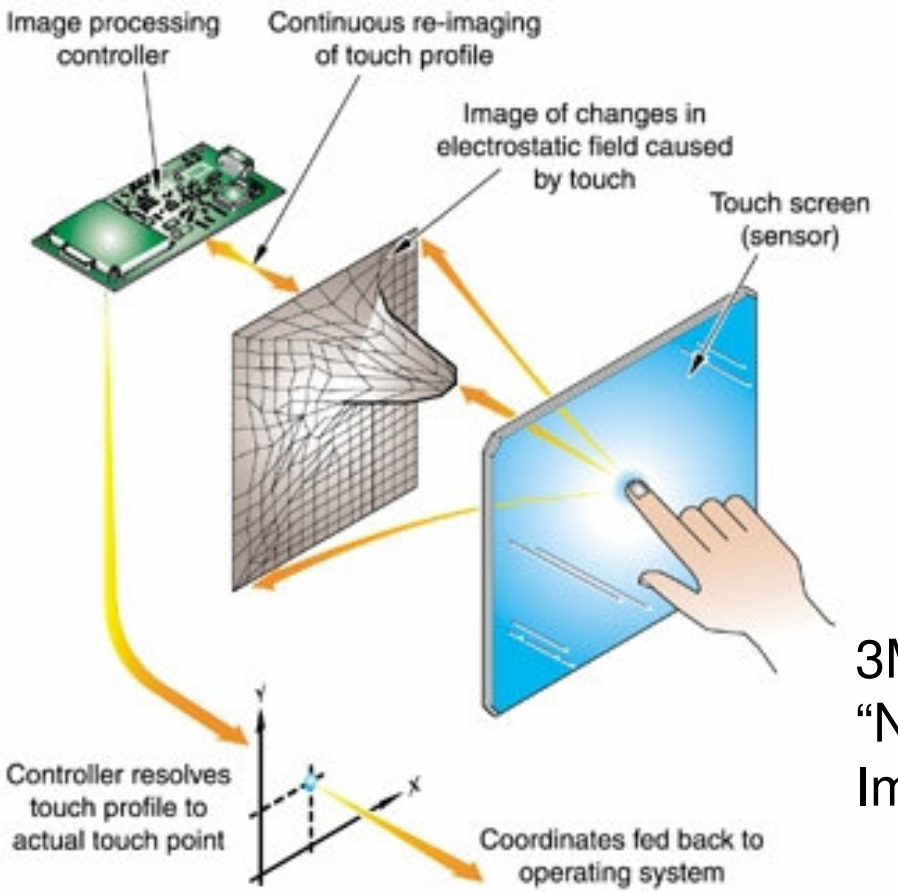


Photo courtesy of Apple

Projected Capacitive…2



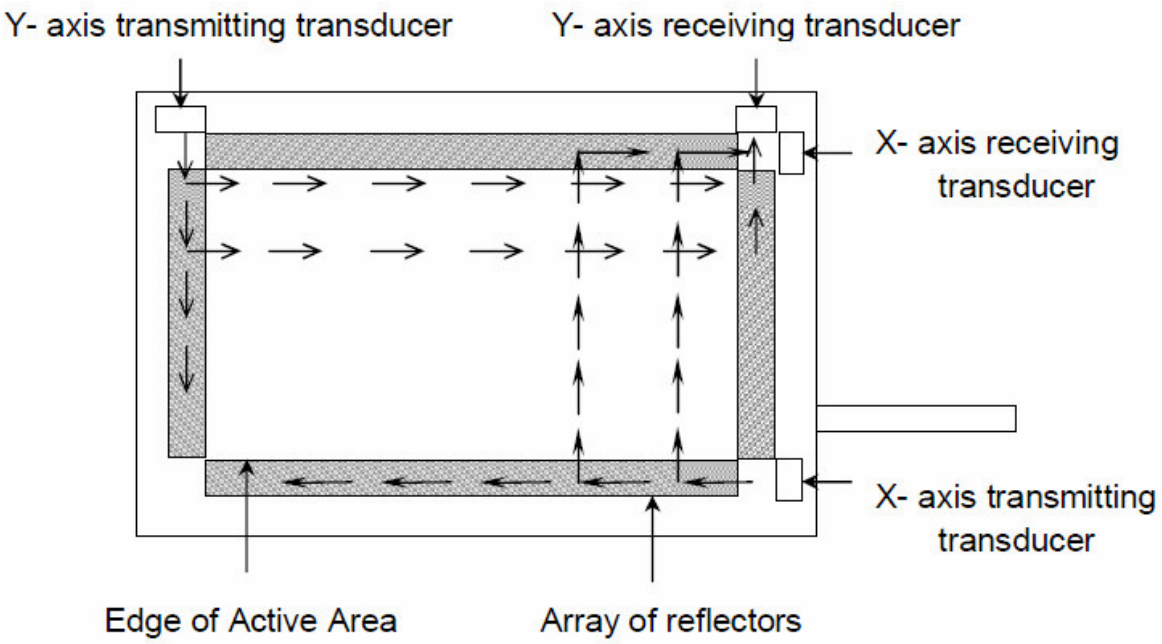
3M's obsoleted "Near Field Imaging" (NFI)

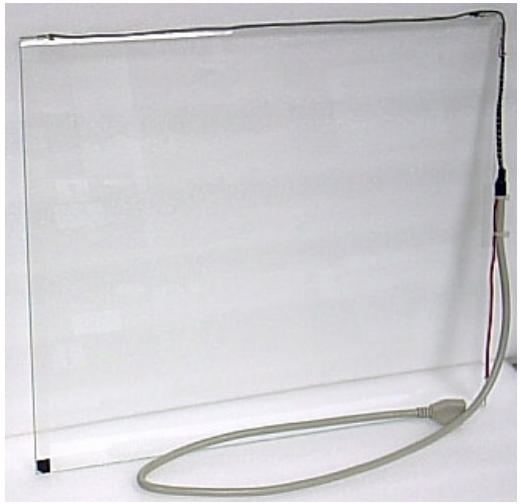
Illustration courtesy of 3M

Projected Capacitive…3

- **Advantages:** Sensor completely protected; multi-touch
- **Disadvantages:** Cost
- **Applications:** Apple iPhone, POS, ATMs
- **Market Share:** ~2% (without iPhone)
- **Market Leaders:** Balda/TPK/Optera JV, Zytronic, Touch International
- **Number of Suppliers:** 5+
- **Market Events:** Apple iPhone; 3M's "Flex Capacitive"; Garmin switching from resistive; Wacom's purchase of TouchKO
- **Market Trends:** Increasing widespread interest

Surface Acoustic Wave…1





Illustrations courtesy of Onetouch and A-Touch

Surface Acoustic Wave…2

Illustration courtesy of Fujitsu Labs

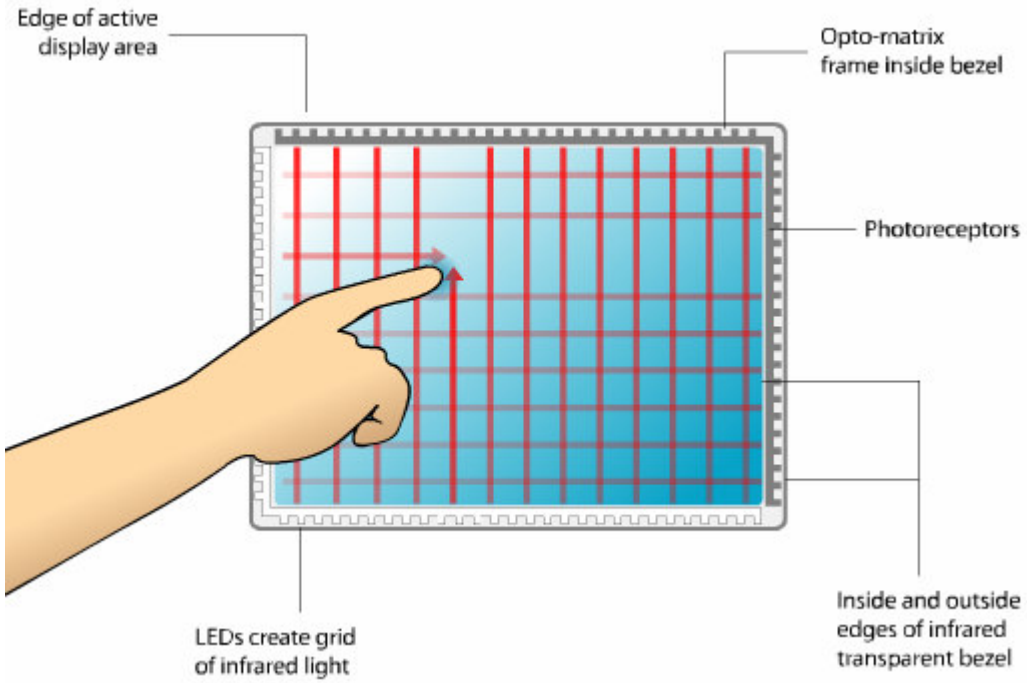
Key Development

Thin-film piezo transducer that's only 2 microns thick. The transducer is sandwiched in an electrode structure consisting of an array of V-shaped electrodes.

Surface Acoustic Wave…3

- **Advantage:** Clear substrate
- **Disadvantages:** Contamination, sound-absorbing stylus
- **Application:** Kiosks
- **Market Share:** ~7%
- **Market Leaders:** Elo, General Touch
- **Number of Suppliers:** 10+
- **Market Event:** Elo patent expired, ending Elo monopoly
- **Market Trends:** Price dropping as Taiwanese & Chinese manufacturers jump into the market

Infrared…1



Illustrations courtesy of Elo TouchSystems

Infrared (RPO Waveguide)…2

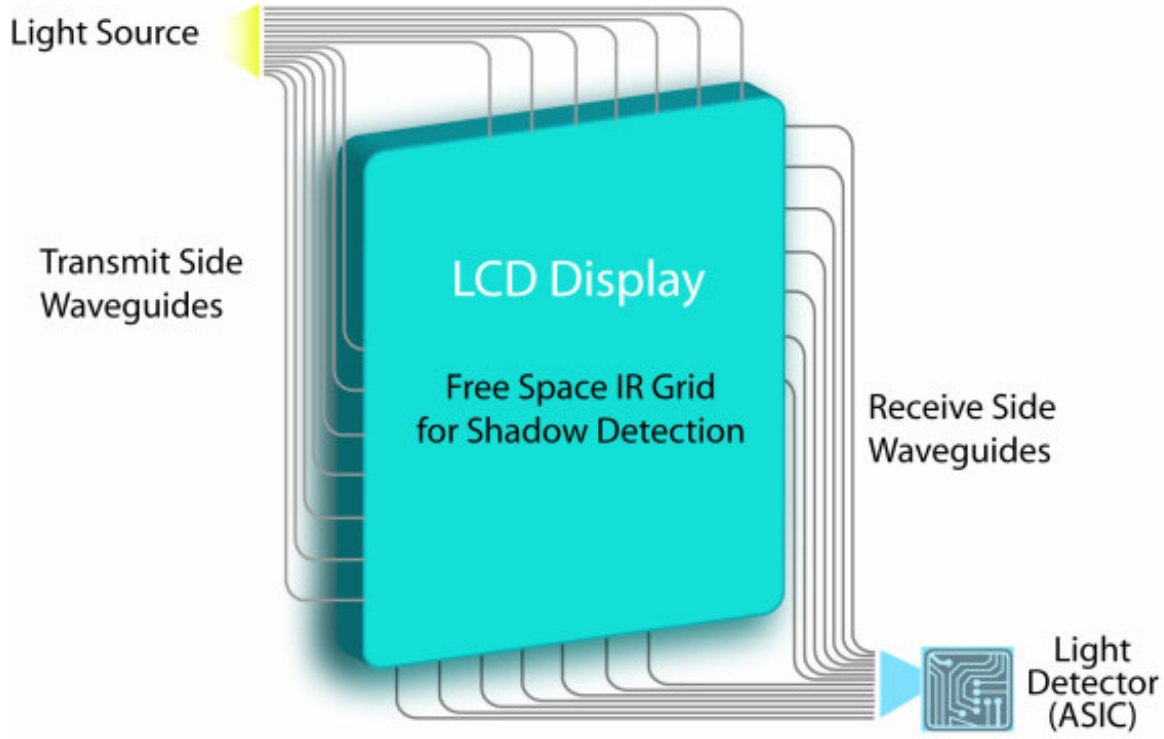
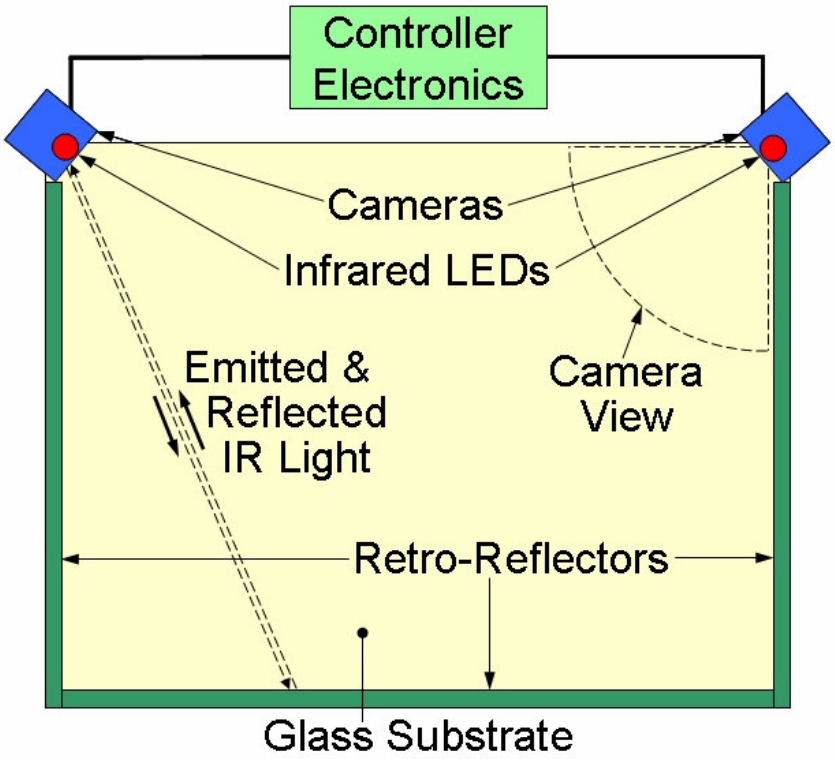


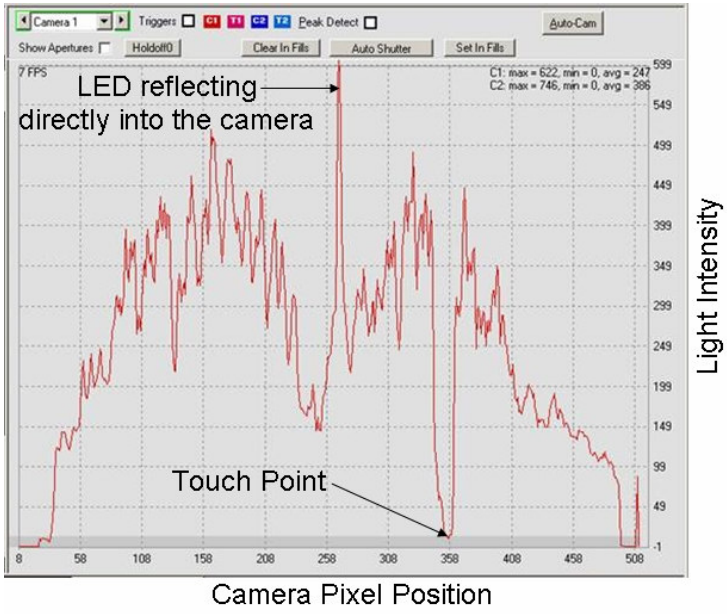
Illustration courtesy of RPO

Infrared…3

- **Advantages:** No substrate required; multi-touch; scaleable to large sizes (150”)
- **Disadvantages:** Cost, pre-touch
- **Applications:** Kiosks, large displays
- **Market Share:** ~5%
- **Market Leaders:** Elo, IR Touch
- **Number of Suppliers:** 16+
- **Market Event:** RPO announced optical waveguide 5/07
- **Market Trends:** Interest in IR is increasing again as displays get larger

Optical…1





Illustrations courtesy of NextWindow

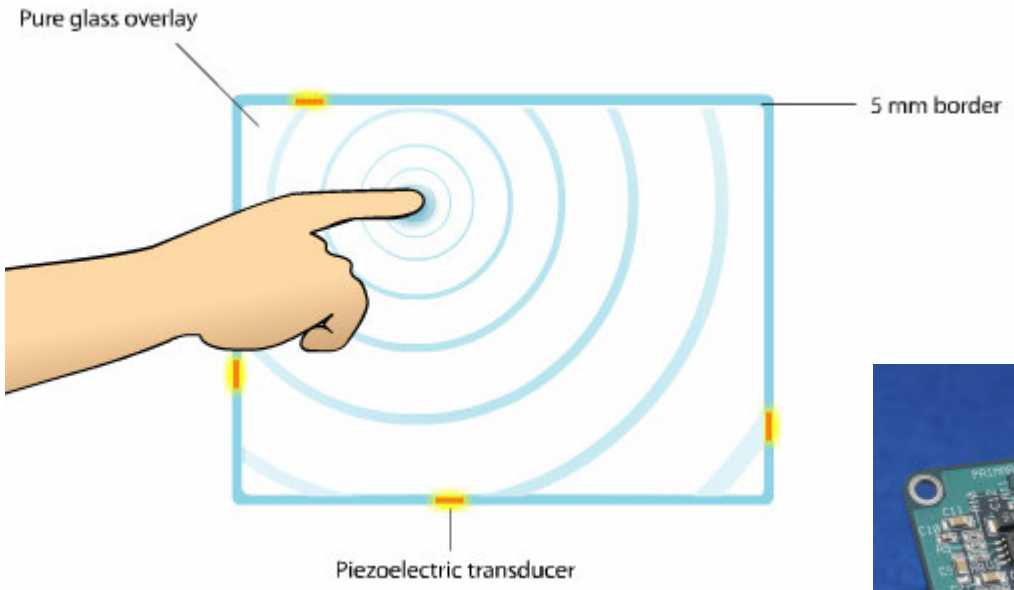
Optical…2

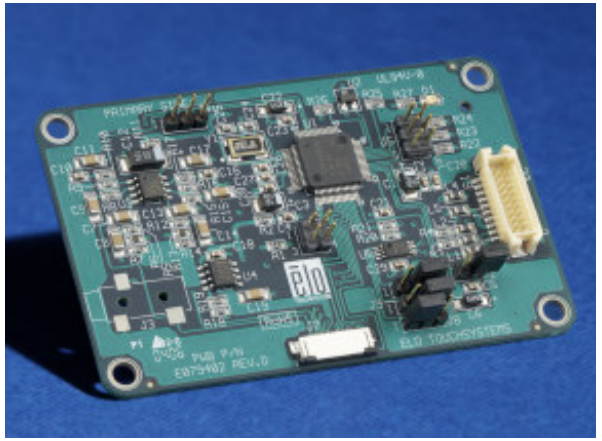
- **Advantages:** Scalability, multi-touch, drag performance
- **Disadvantages:** Profile height; contamination
- **Applications:** Large displays; HP TouchSmart (19”)
- **Market Share:** ~1%
- **Market Leaders:** NextWindow, Smart Technologies
- **Number of Suppliers:** 2+
- **Market Event:** HP selected optical touch for 19” TouchSmart all-in-one “family” computer (first use of optical in mainstream consumer product)
- **Market Trend:** Will there be a consumer touch-monitor market? Application software that makes touch desirable is the driver, and there isn’t any yet…

Two Emerging Technologies

- Bending wave (APR from Elo; DST from 3M)
- Force sensing

Bending Wave (APR)…1



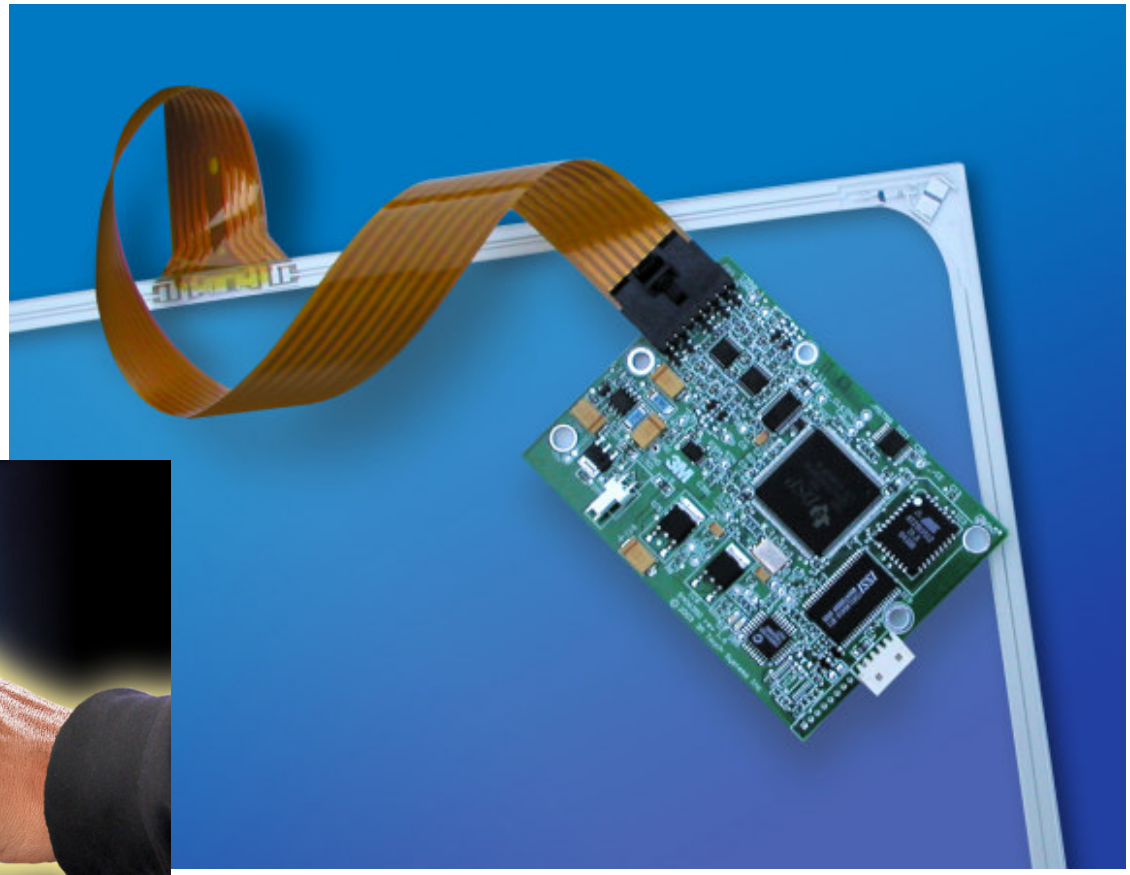


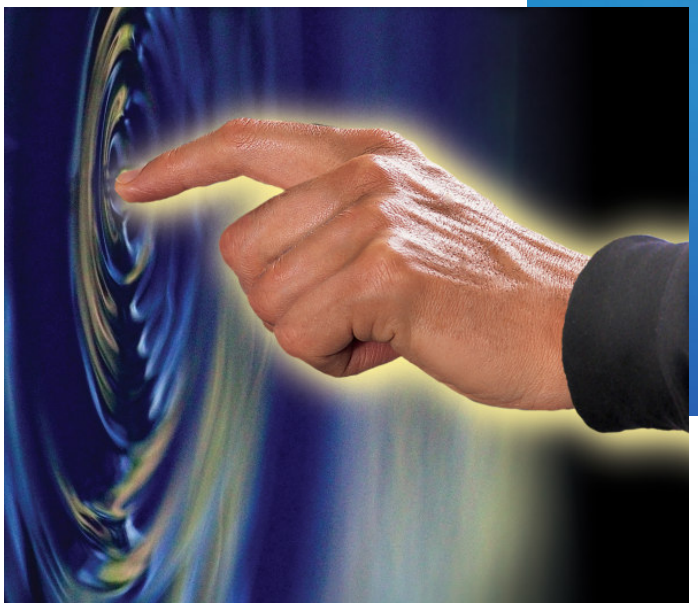
Method: Table look-up
of 10ms touch “signatures”

Illustrations courtesy of Elo TouchSystems

Bending Wave (DST)…2

Method: Real-time analysis of bending waves (“time of flight”)





Illustrations courtesy of 3M

Bending Wave…3

- **Advantages:** Very simple sensor; performs like an improved version of analog resistive
- **Disadvantages:** Integration; no “hold”; Elo = not available (yet) as a component; 3M = only 32” and up
- **Applications:** POS (Elo), large displays (3M)
- **Market Share:** <1%
- **Market Leaders:** Elo, 3M
- **Number of Suppliers:** 2
- **Market Event:** 3M re-launched DST 4/07 after 16-month redesign following initial false start
- **Market Trend:** Elo has no motivation to replace existing touch technologies other than 5-wire resistive with APR, and no motivation to license it – another monopoly!

Force-Sensing…1

QSI Demo Box from SID 2007

Illustration courtesy of QSI

Force-Sensing…2

- **Advantage:** Substrate can be any 3D semi-rigid material with anything embedded in it, even a pile of rocks
- **Disadvantages:** Vibration sensitivity, edge-margin
- **Application:** “Architectural” touch
- **Market Share:** None
- **Market Leader:** QSI
- **Number of Suppliers:** 1
- **Market Event:** QSI launched “Force Panel Technology” (FPT) 5/07 but hasn’t announced any products yet
- **Market Trends:** None

Two “Under Development” Technologies

- Pixel-integrated photo-sensitive elements
- Frustrated Total Internal Reflection (FTIR)

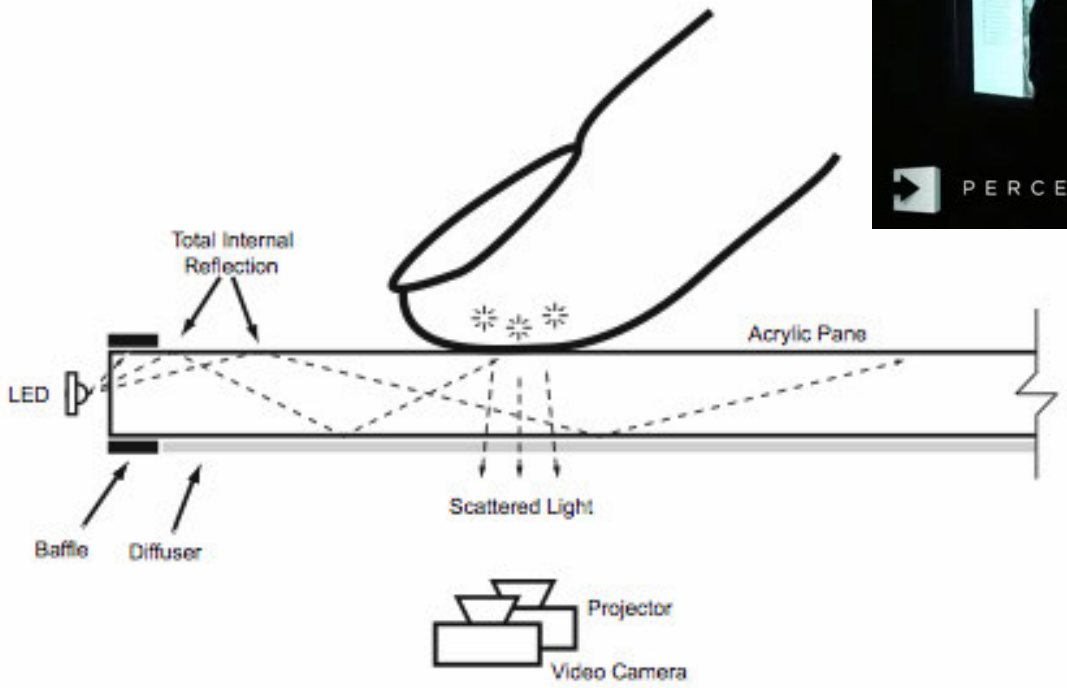
Pixel-Integrated Photo-Sensitive Elements…1

Illustrations courtesy of TMD

Pixel-Integrated Photo-Sensitive Elements…2

- **Advantages:** Low cost; no additional top layers
- **Disadvantages:** LCD backplane change, which is a chicken-and-egg problem for LCD manufacturers
- **Application:** TBD
- **Market Share:** None
- **Market Leaders:** TMD, Sharp
- **Number of Suppliers:** None
- **Market Event:** TMD announced on 3/07 the ability to automatically switch between finger-shadow and finger-reflection modes, allowing usage from 0-100K Lux
- **Market Trends:** None

Frustrated Total Internal Reflection…1



Illustrations courtesy of Jeffrey Han, NYU

Frustrated Total Internal Reflection…2

- **Advantages:** Multi-touch; alternative to IR and projected capacitive for rear-projection touch
- **Disadvantages:** Rear-projection only; finger-only (?)
- **Application:** TBD
- **Market Share:** None
- **Market Leader:** Perceptive Pixel (Jeffrey Han at NYU)
- **Number of Suppliers:** 1
- **Market Event:** None
- **Market Trends:** Interest in FTIR is increasing, driven by Jeffrey Han's showmanship and the multi-touch capability of the Apple iPhone

Selecting A Touch Technology…1

- Focus on existing technologies and ignore the emerging technologies
- Focus on functionality rather than specifications
- Select the key functionalities from the following tables and rank the technologies
- If there are no dominant functionality requirements, then the technology choice is typically determined by vendor relationships and local availability

Selecting A Touch Technology…2

Characteristic	Resistive (4-wire)	Resistive (5-wire)	Surface Capacitive	Projected Capacitive	Surface Acoustic Wave	Infrared	Optical
Ambient Light Sensitivity	5	5	5	5	5	3	5
Calibration Stabilty	2	4	2	5	4	5	5
Controller Chip	5	5	5	0	0	5	0
Cost	5	5	3	2	4	1	3
Curved Substrate	0	0	0	5	0	0	0
Debris/Contamination	5	5	4	5	1	2	2
Drag Performance	2	2	4	3	2	3	5
Durability	1	3	4	5	4	5	5
Ease of Integration	5	5	1	4	3	3	4
Flush Surface	4	4	4	5	3	1	2
Handwriting Recognition	4	4	1	1	1	1	3
HID Interface	0	0	0	0	0	0	5
Hover	0	0	0	4	0	0	4
Lifetime/MTBF	2	3	4	5	5	3	5
Mobile/Handheld	5	5	0	5	0	0	0

Selecting A Touch Technology…3

Characteristic	Resistive (4-wire)	Resistive (5-wire)	Surface Capacitive	Projected Capacitive	Surface Acoustic Wave	Infrared	Optical
Multi-Touch	0	0	0	5	0	5	5
Non-Glass Substrate	2	2	0	5	0	5	5
Object Size Recognition	0	0	0	3	0	0	5
Optical Clarity	1	1	3	4	5	5	5
Reliable Light Touch	3	3	2	4	2	1	5
Scratch Resistance	1	3	2	5	4	5	5
Sealability	4	4	4	5	2	4	1
Size >42"	0	0	0	3	0	3	5
Size 12" - 26"	4	4	5	3	5	5	5
Size 2" - 10"	5	3	1	5	0	0	0
Size 26" - 42"	0	0	0	3	3	4	5
Stylus Independence	4	4	1	2	3	4	5
Vandal Resistance	1	3	4	5	4	3	3
Weather Resistance	2	2	3	5	2	2	1
Z-Axis Measurement	0	0	0	3	3	0	3

Thank You!

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