

Touch Screen Technologies

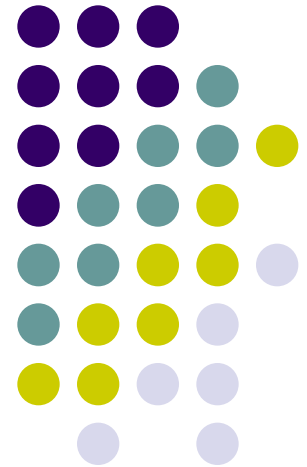
ECE 317

By: John Broz

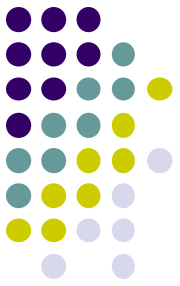
Ted Dimiropoulos

Alex Schallmo

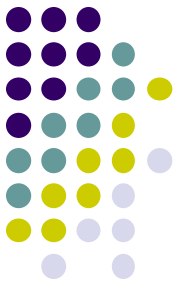
Mahreen Younus



Agenda



- History of Touch Screen Technology
- Overview of current Touch Screen Technologies
- Touch Screen Technologies
- Commercial Applications
- Future Applications
- Q & A



History of Touch Screen Technology

History

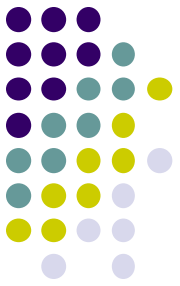


- Touch screens emerged from academic and corporate research labs in the second half of the 1960s.
- One of the first places where they gained some visibility was in the terminal of a computer-assisted learning terminal that came out in 1972 as part of the PLATO project.

History

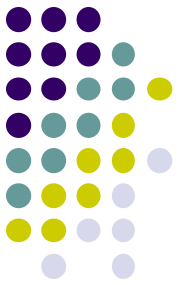


- Touch screens became widely used in kiosk and point of sale systems in banks and stores.
 - In 1983, the first touch screen computer, the HP-150, reached the market.
 - Introduction of advanced touch screen technologies leading to the commercialization of tablet PCs, PDAs, and touch-screen phones.



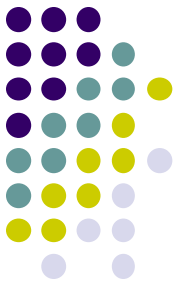
Touch Screen Technologies

Touch Screen Technologies

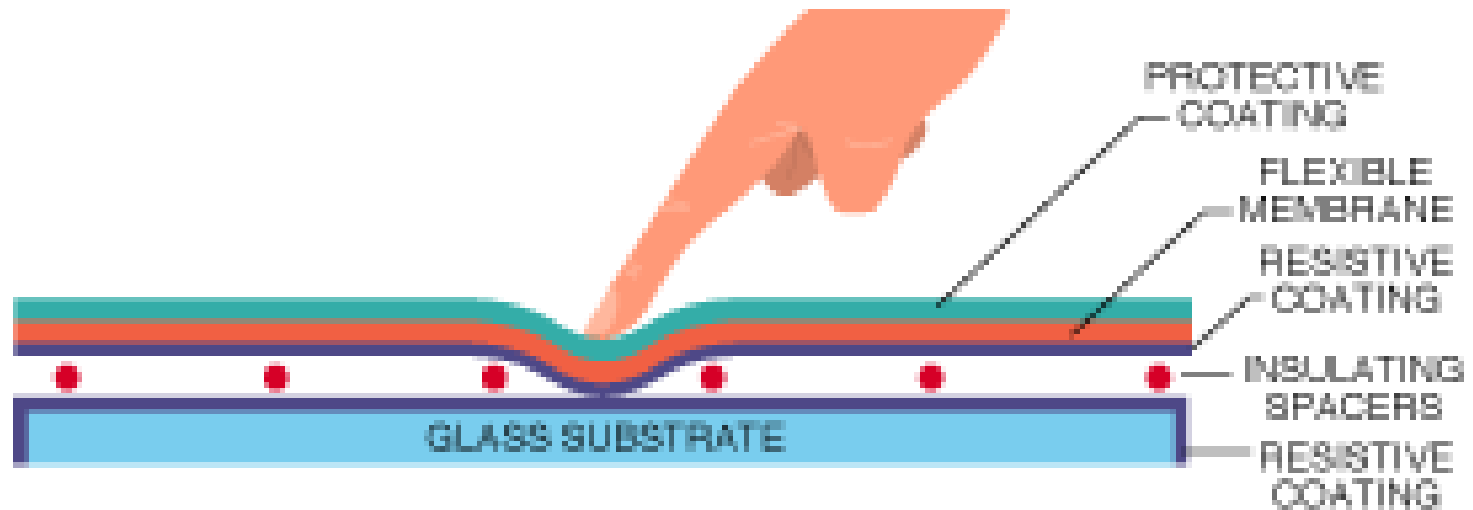


- Resistive
- Capacitive
- Surface Acoustic

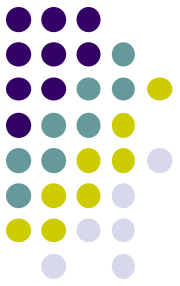
Resistive



- 2 Resistive Surfaces (Indium-Tin-Oxide)
- Metallic-coated
- Insulating Space
- Touch compresses and forms closed circuit

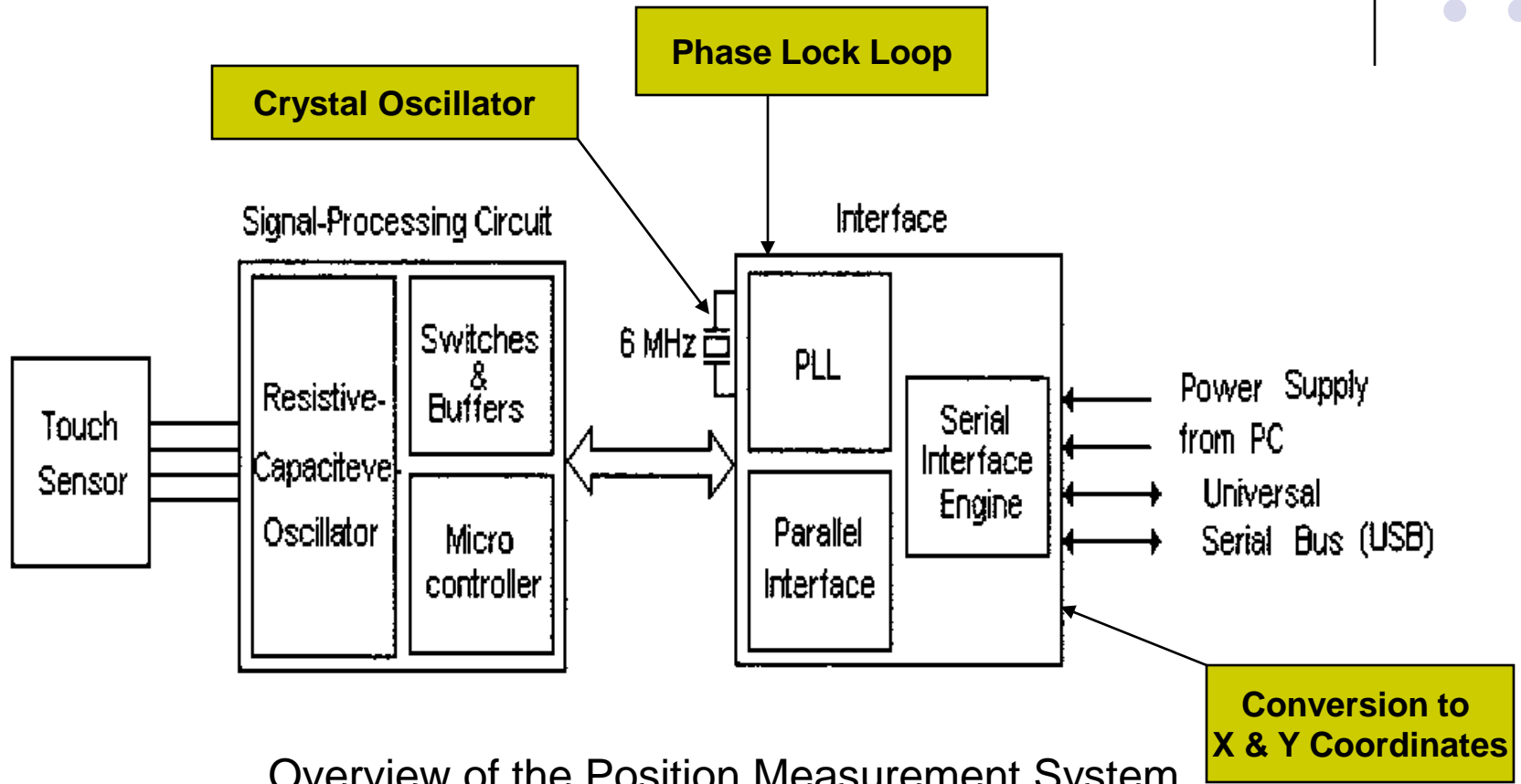
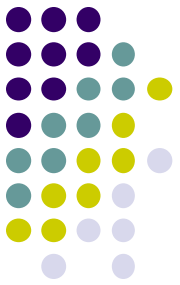


Resistive

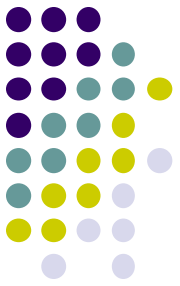


- Most widely used due to its simple structure
- 2 Types
 - 1. **Matrix (digital)**
 - Striped electrodes on substrates such as glass or plastic face each other
 - 2. **Analogue**
 - Transparent electrodes without any patterning facing each other
 - Low production costs

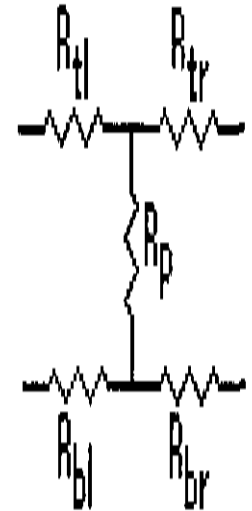
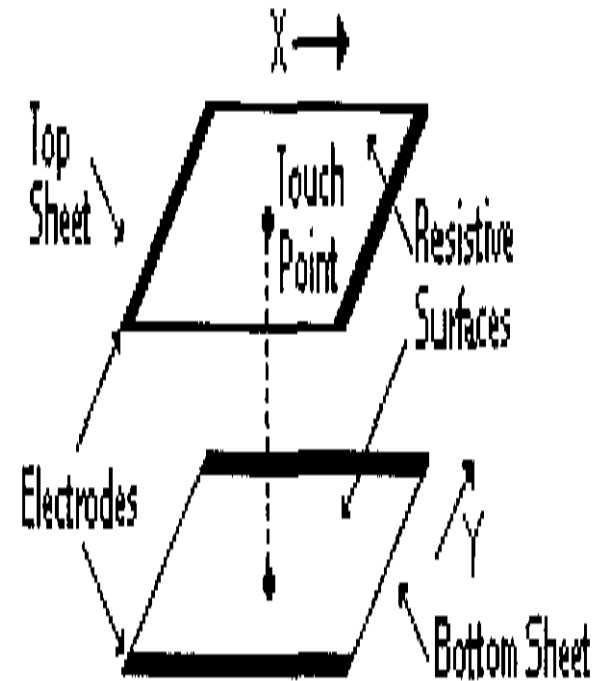
Resistive

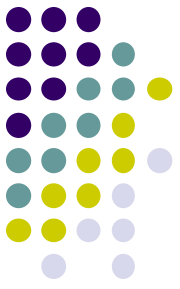


Resistive



- 2 Parallel Sheets
 - If there is no pressure applied – electronically separated
 - Applied pressure – impedance between the 2 sheets is lowered at the touch point.



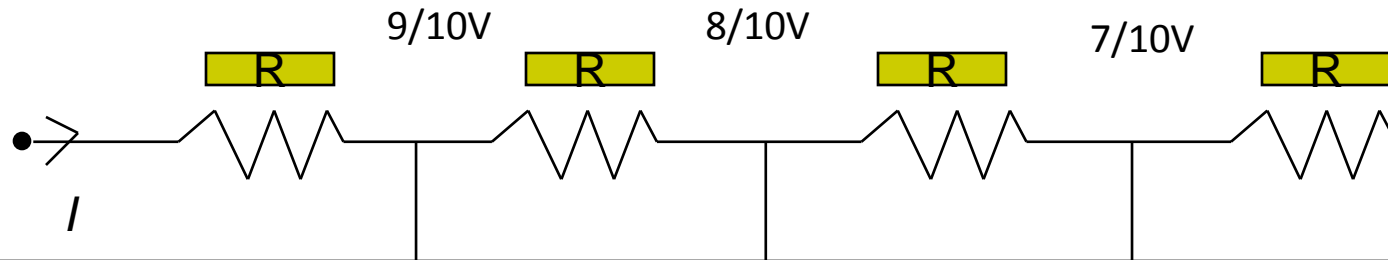
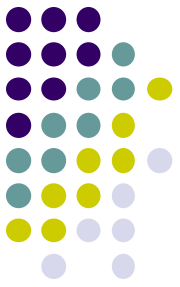


Resistive

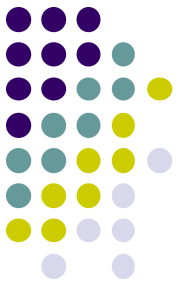
- Measurement of X & Y Coordinates:
 - Top sheet carries a voltage gradient by applying a voltage between the electrodes of top sheet
 - Bottom sheet serves as a slide in a ***linear potentiometer.***

Resistive

Voltage Gradient



- Equal voltage drop across each resistor in voltage gradient
- Dependent upon resistance value

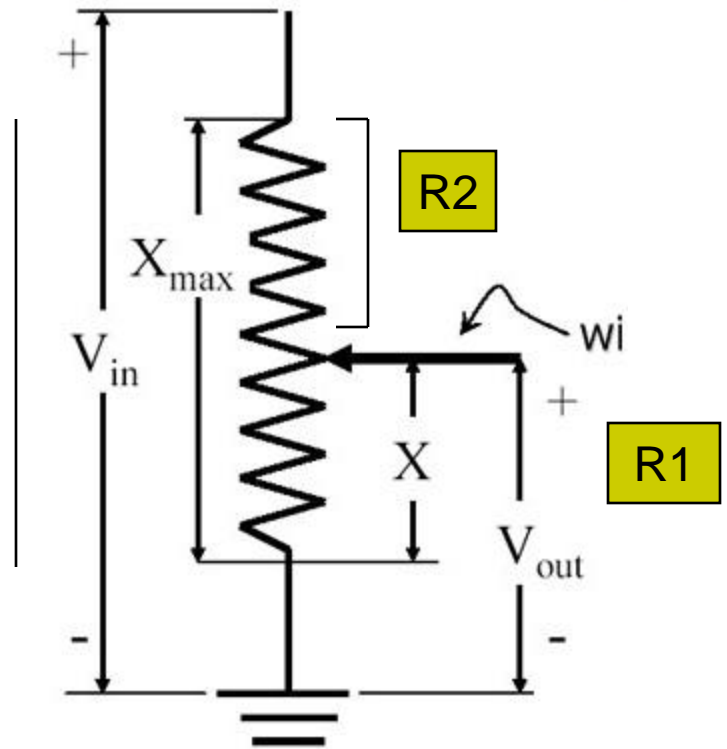


Resistive

Linear Potentiometers

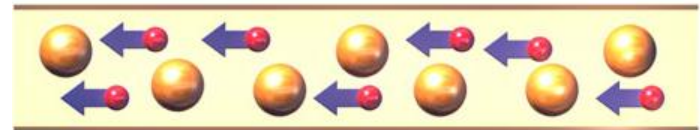
- Linear potentiometers are sensors that produce a resistance output proportional to the displacement or position
- Resistance value changes with rotation of screw

R_{total}

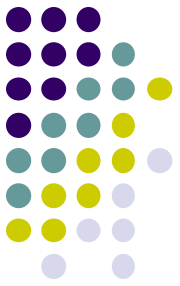
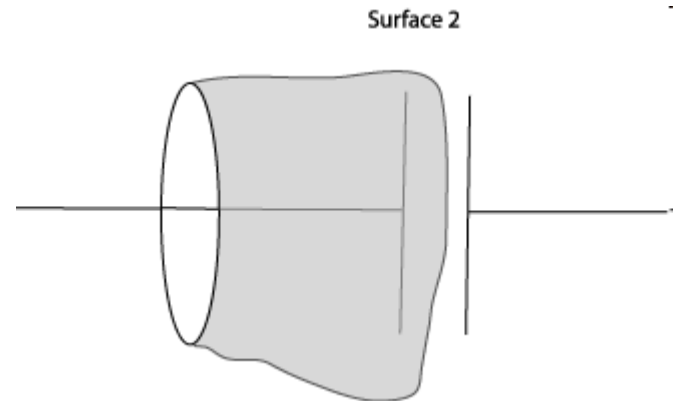


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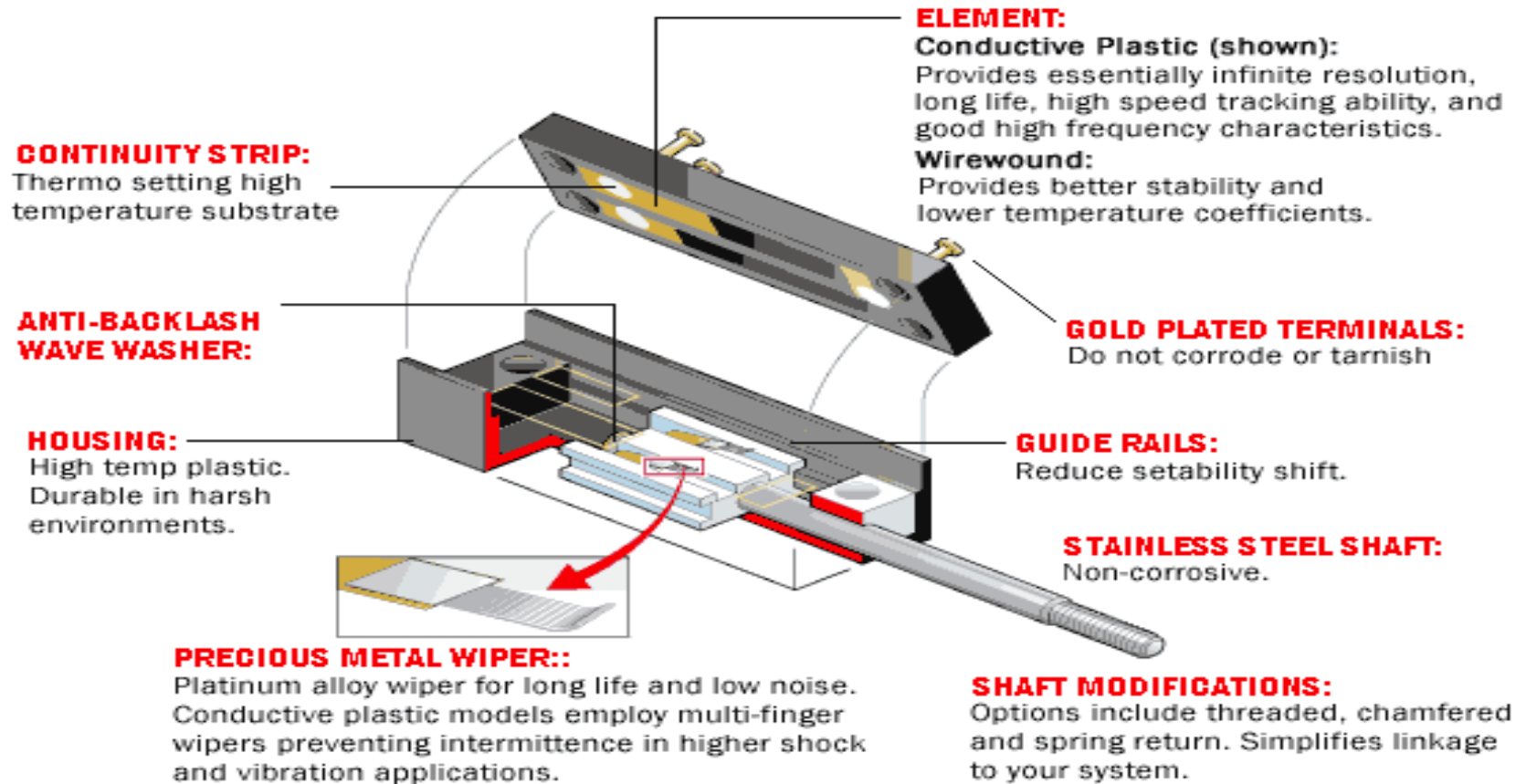
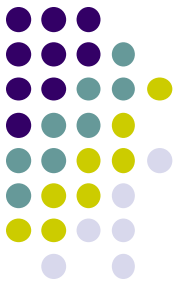
- Conduction Current
 - Electrons move along

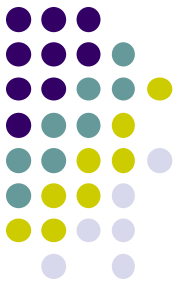


- Displacement Current
 - Electrons are completely displaced



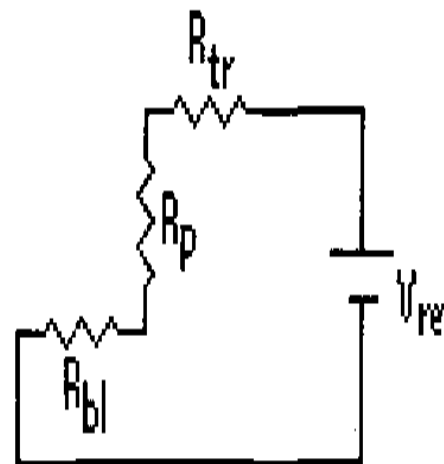
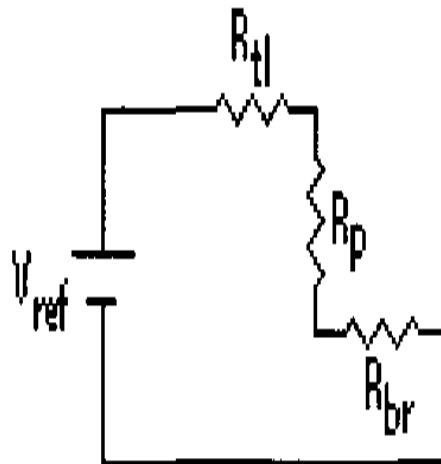
Resistive



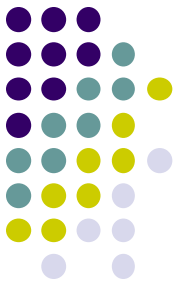


Resistive

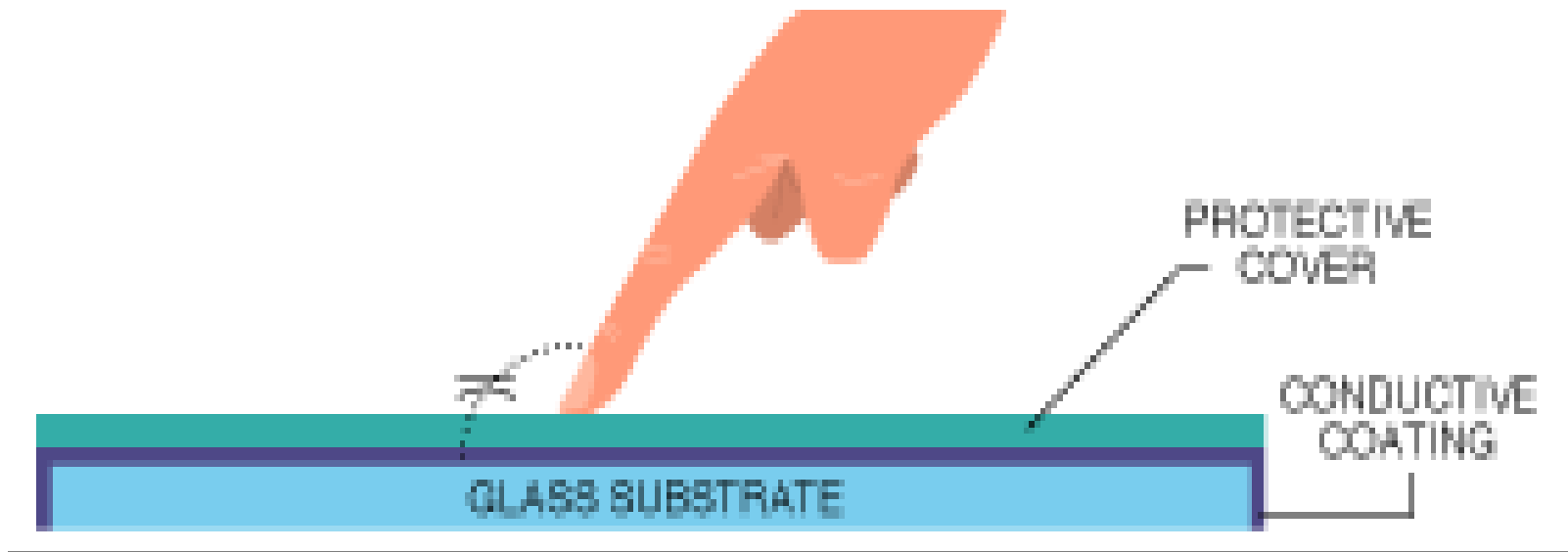
- Measurement of the touch point resistance is valuable
- Value varies depending upon force applied



Capacitive



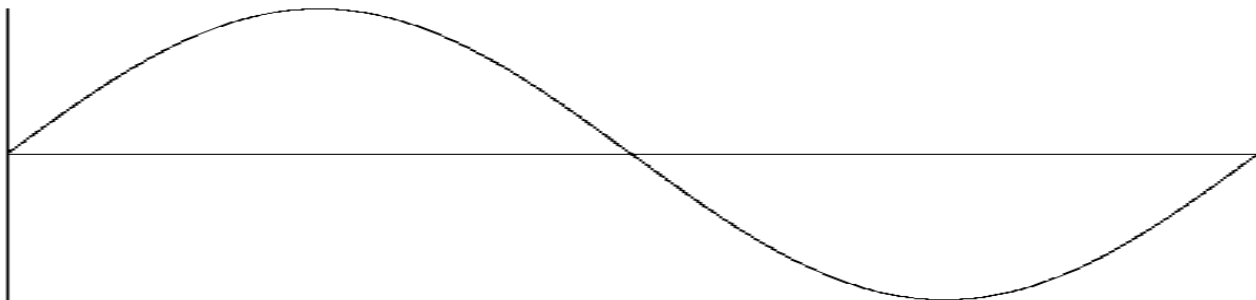
- Conductive lower coating (Indium-Tin-Oxide)
- No top coating, only rigid protective cover
- Finger serves as second conducting layer





Capacitive

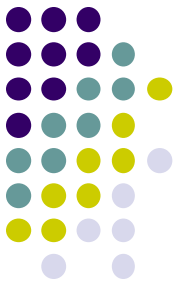
- Ohm's Law relates current to voltage in DC circuit in the form of $V = iR$
- Capacitive touch screen uses Alternating Current (AC).
- The current is continuous across the ITO surface → Remember Sinusoid waves from lab



Capacitive

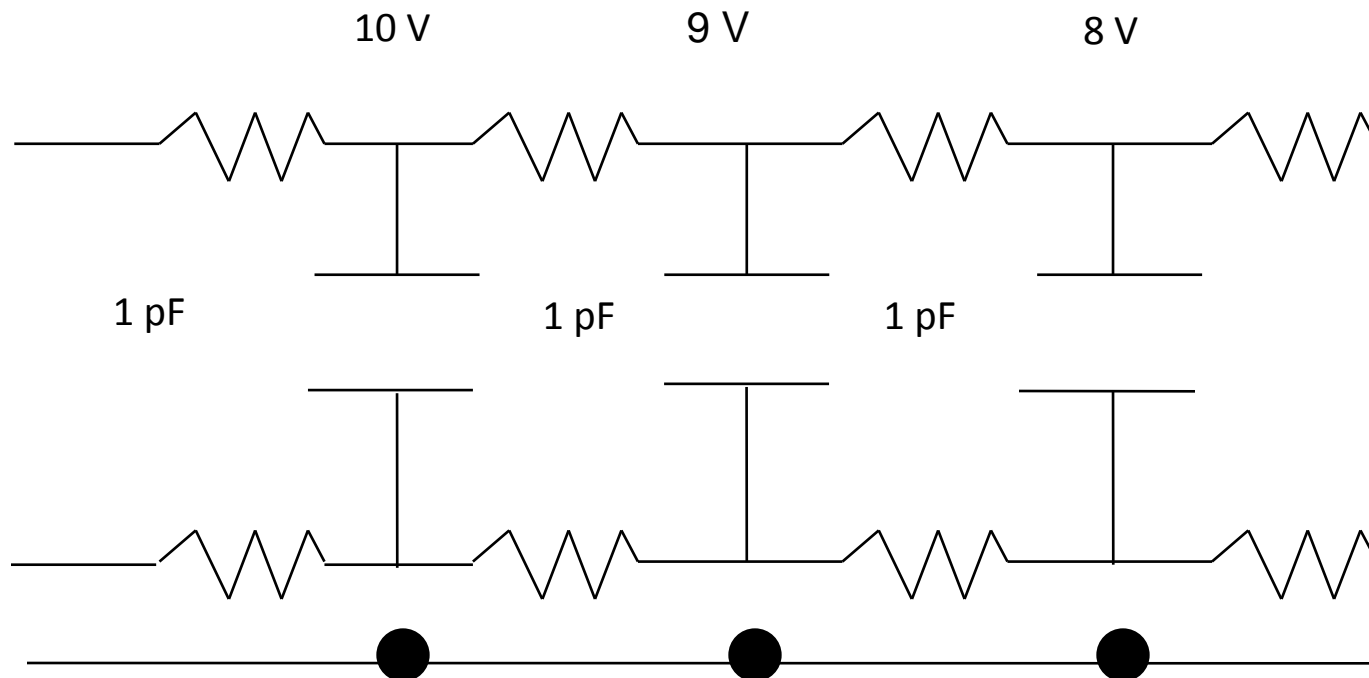


- Impedance is equivalent to resistor in AC circuit $\rightarrow V = iZ$; where $Z = (1/j\omega C)$
- $J = \text{sqrt}(-1)$ $\omega = 2\pi F$ where $F = \text{Freq.}$
- $C = \text{Capacitance} = (e_r A)/d$
- Human body achieves capacitance and conducts current
- Touch Event \rightarrow Voltage drop at the point of touching
- Affects strength of current across ITO surface

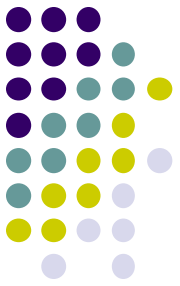


Capacitive

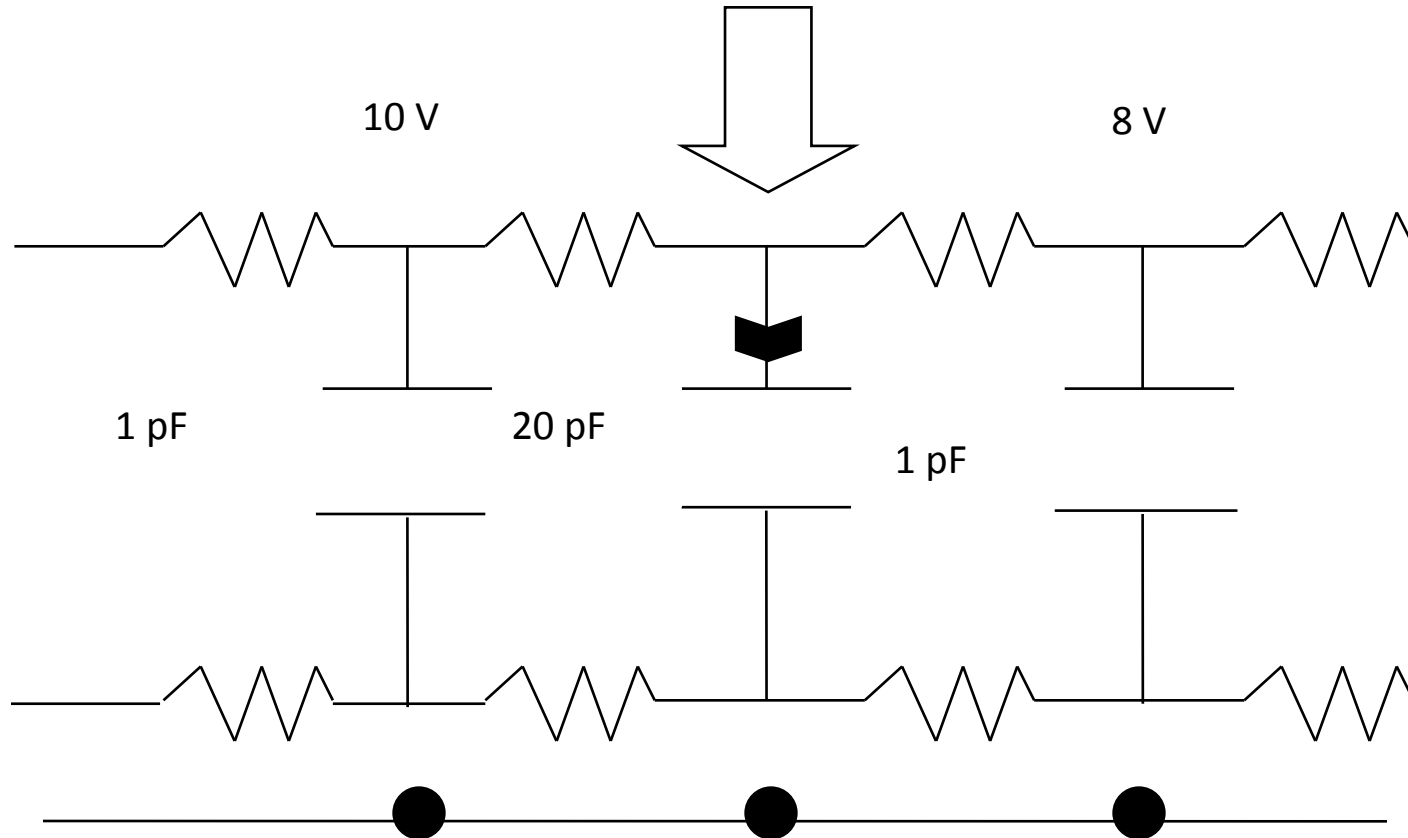
- Voltage gradient across surface
- Conductive ITO surface allows for continuous current across the surface



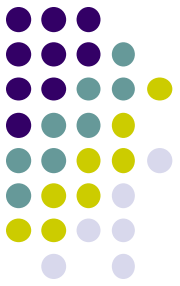
Capacitive



Touch Event



Capacitive

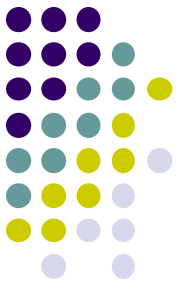


- Electronic circuits located underneath ITO surface measure the resulting distortion in the sine waves produced by voltage drop as a result of the touch event.

Surface Acoustic Wave

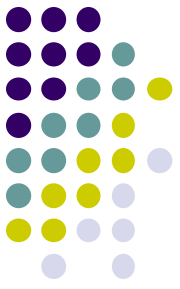


- Based upon emission and absorption of sound waves
- Materials used:
 - Transducers
 - One glass screen
 - Reflectors
 - Sensors
- Two transducers are placed along the X and Y axes and generate sound waves.



Surface Acoustic Wave

- The waves propagate across the glass and are reflected back to the sensors.
- When screen touched, a portion of the wave is reflected back to the sensors immediately.
- The sensor is able to tell if the wave has been disturbed by a touch event at any instant, and can locate it accordingly.



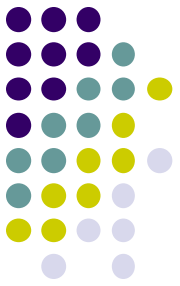
Surface Acoustic Wave

- How can the sensors tell?
 - Waves travel at the speed of sound
 - Speed of Sound = 343 m/s
 - Based on the time it takes for the wave to return to the source, the sensor can tell if it was disturbed or not.
 - If it was, based on the time it takes to get back to the source, the sensor can calculate the distance.
 - These calculations will generate (X,Y) coordinates



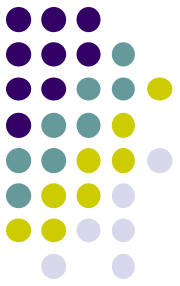
Surface Acoustic Wave

- Benefits
 - 100% clarity because of the lack of metallic layers in the screen
 - Able to interact with the use of multiple mediums
 - Stylus, finger, glove ...
- Negatives
 - Screen can become contaminated and cease to operate correctly.



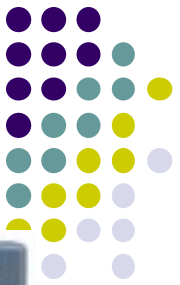
Commercial Applications

Current Uses



- Kiosks
 - ATMs, Self Checkout Counters, Airport Check-in, etc.
- PDAs
- Tablet PCs
- Mobile Phones
- Handheld Gaming Consoles

PDAs and Tablet PCs



- Apple Newton and Palm Pilot
 - First PDAs to use touch screens
 - Apple Newton introduced in 1993
 - Palm Pilot introduced in 1997
- IBM ThinkPad 750P and 360P
 - Introduced in 1993
- PDAs and Tablet PCs were the first consumer devices to utilize touch screen technology



Mobile Phones



- Apple iPhone
 - Introduced in 2007
 - Uses multi-touch technology
 - Widely popularized the use of touch screen technology
- Touch Screen Cell Phones
 - Every major carrier now has a touch screen phone available
 - Touch screen market for mobile phones is projected to reach \$5 Billion by 2009

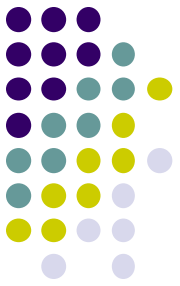


Where Is Technology Heading?



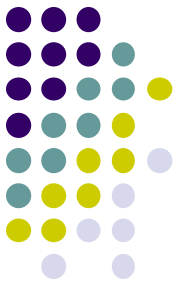
- According to USA Today:
 - Advanced touch screen phones expected to increase from 200,000 shipped in 2006 to 21 million units by 2012.
 - Regular touch technology has already been incorporated into 38 million phones as of 2006, and is estimated to be in nearly 90 million phones by 2012.

Uses of Multi-Touch

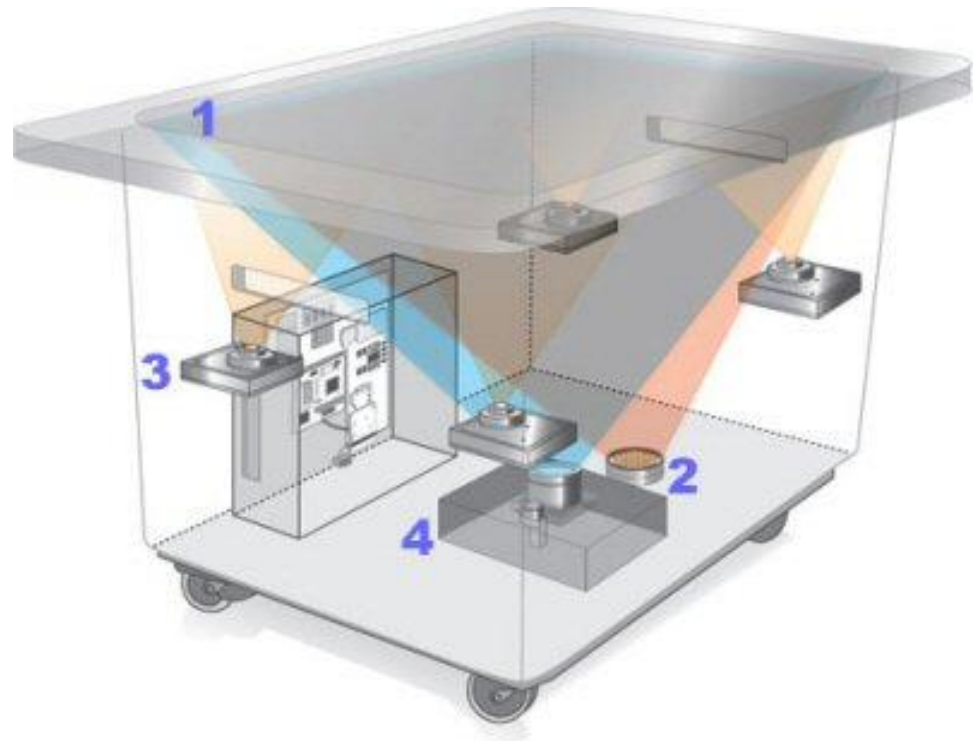


- Enhanced dining experience at restaurant
- Concierge service at hotels
- Concept mapping
- Use as interactive Whiteboards
- Better multi-media experience

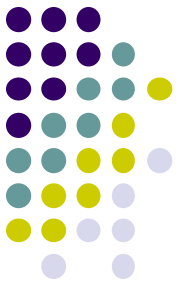
Microsoft Surface



- 1) Screen
- 2) Infrared Cameras
- 3) CPU
- 4) Projector



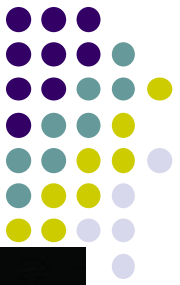
Microsoft Surface (cont.)



- No mouse or keyboard
- Multiple contact points
- Several simultaneous users
- Non-digital objects used as input
- Not limited by traditional touch



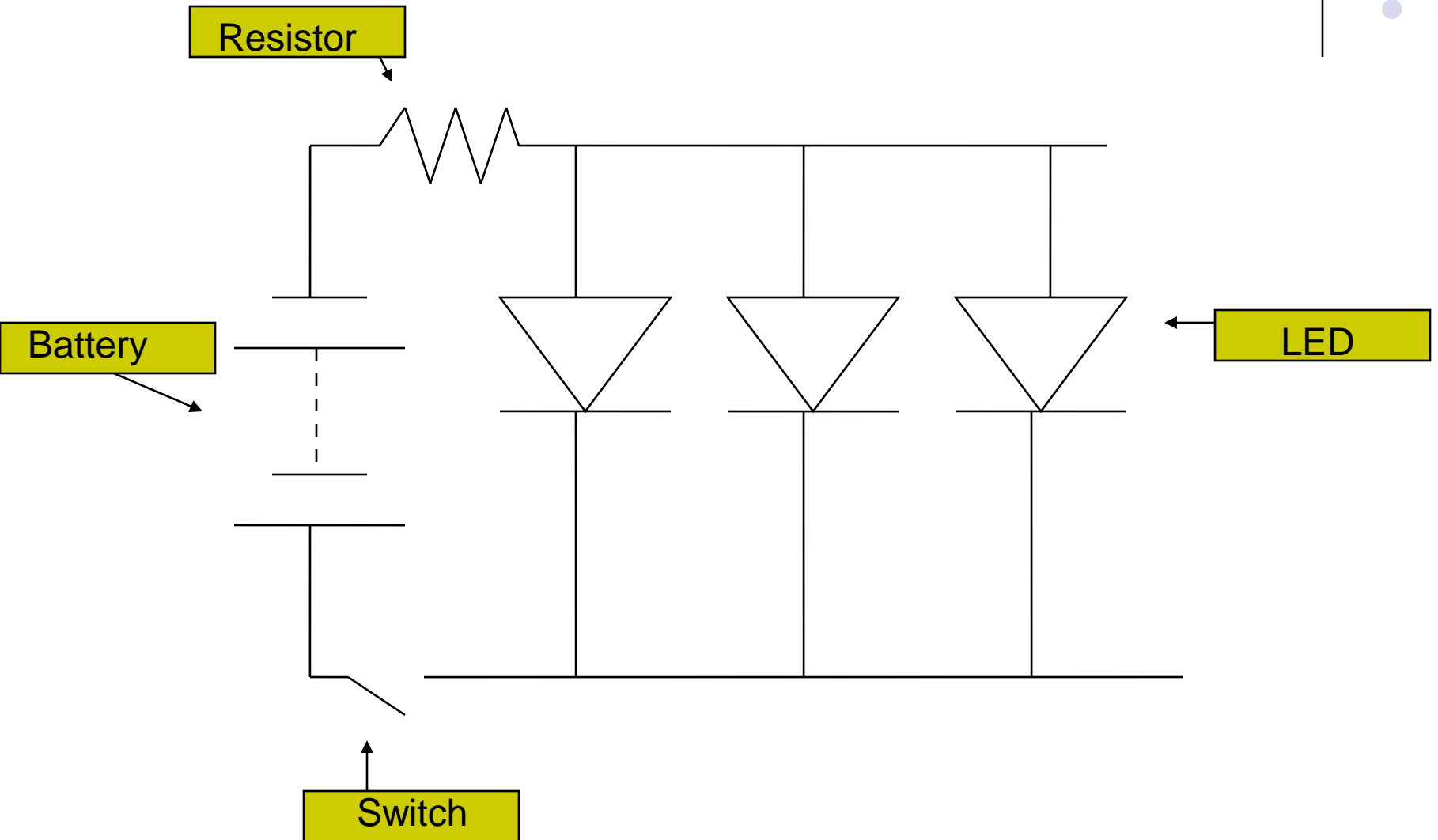
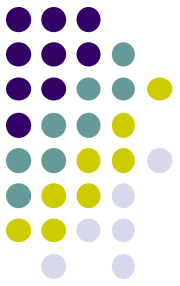
Multi-Touch Collaboration Wall

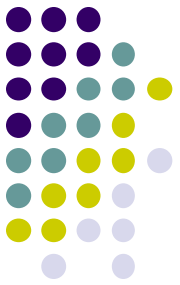


- Invented by Jeffrey Han
- Made by Perceptive Pixel
- Original for military use
- Currently used by CNN
- Available at Neiman Marcus



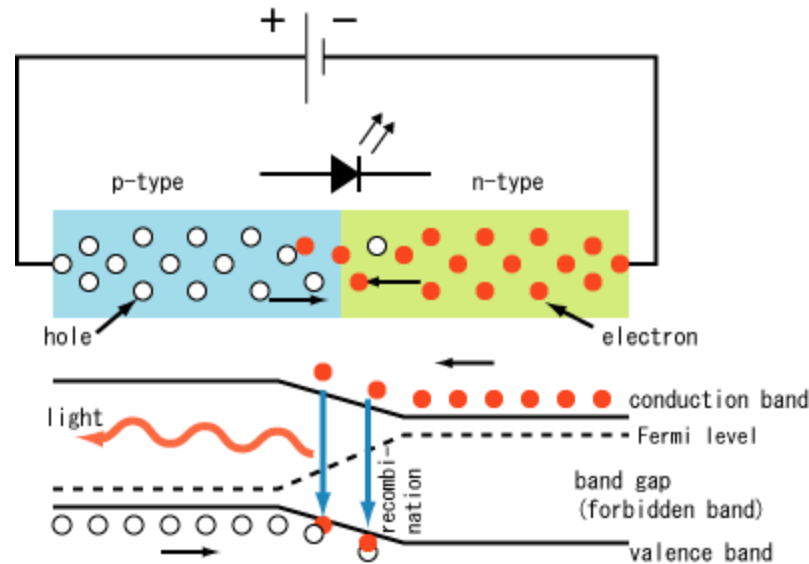
LED: DC Circuit

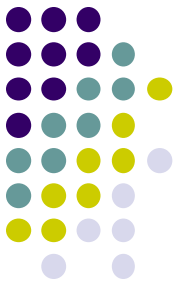




LED

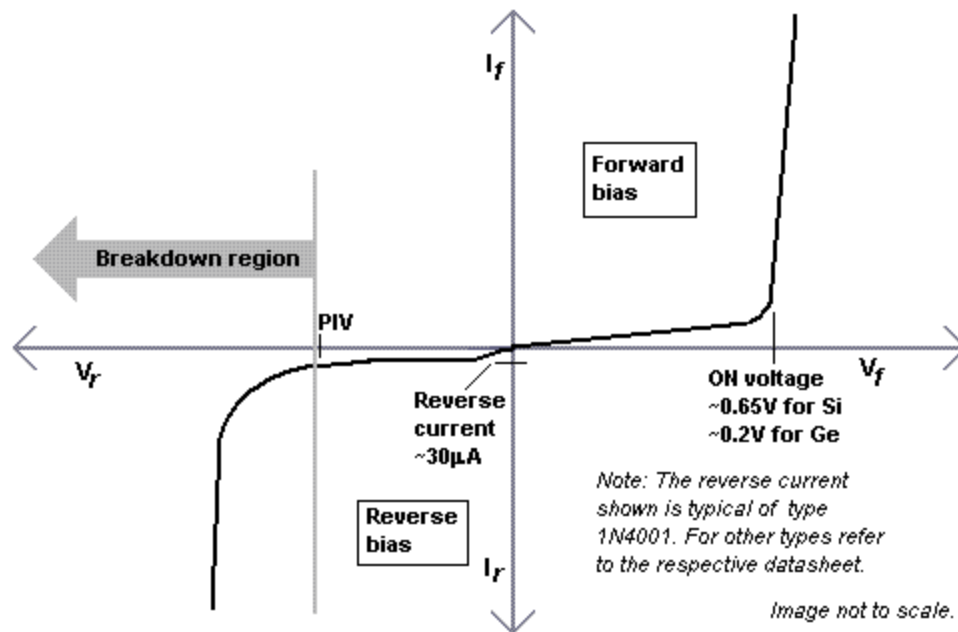
- A semi-conductor diode
- Emits light when current moves in forward direction (p-n junction)





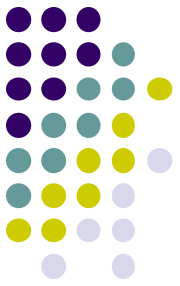
LED cont.

- As DC circuit, when switch closes, the LED light up

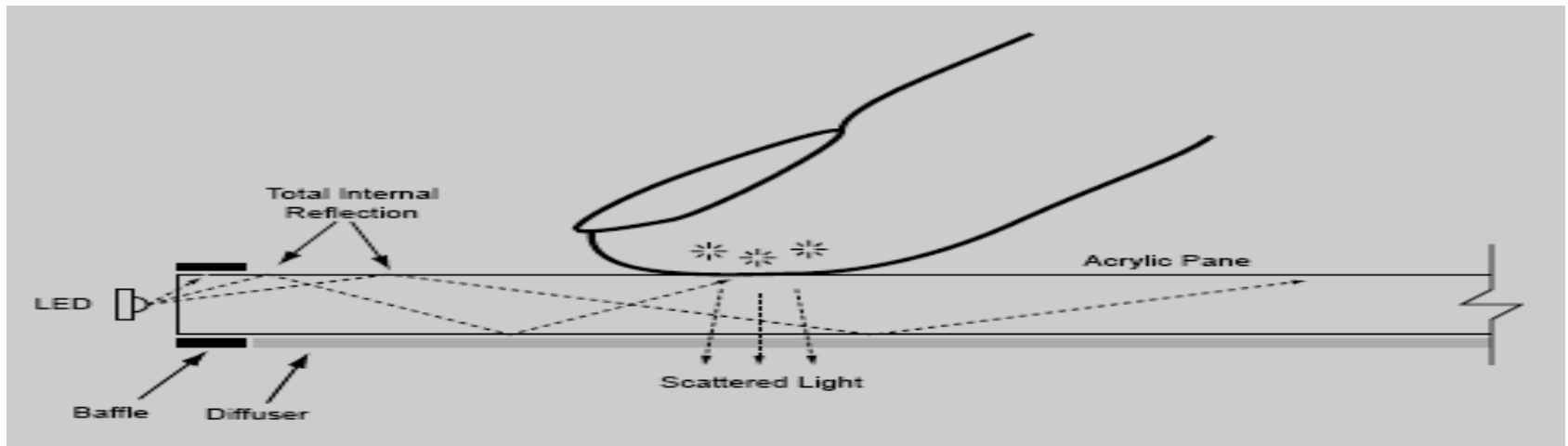


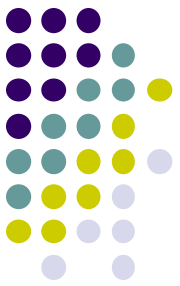
- As DC circuit, when switch closes, the LED light up

How Does it Work?



- Utilizes Frustrated Total Internal Reflection
- The surface of the table is a thin diffuser, which has infrared light and a projector reflected on its underside.
- Infrared cameras pick up on any objects such as fingers, paintbrushes over the surface, when touching the display.

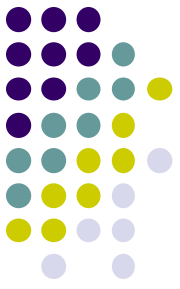




Frustrated Total Internal Reflection

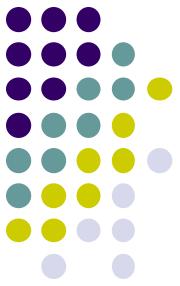
- Light encounters an interface (boundary) with lower index of refraction, light becomes refracted (bent).
- Refraction depends on the angle of incidence
- After a certain angle it undergoes TIR
- A finger, with a lower index of refraction, when it comes in contact with that surface can cause the light to escape

Image Processing

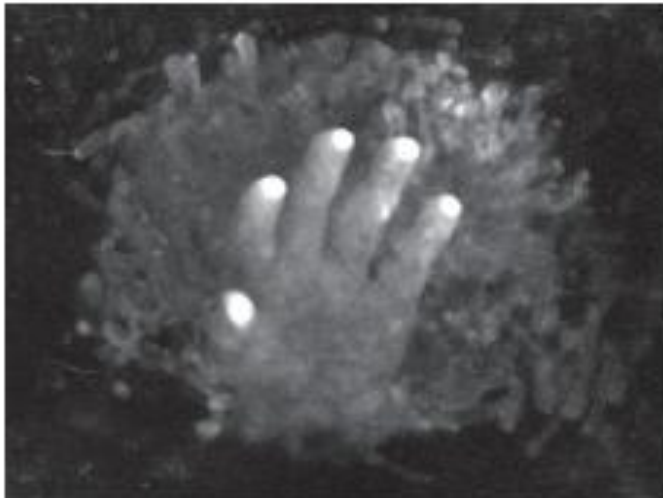


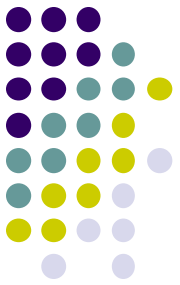
- Infrared camera captures image on the screen
- The image processing subtracts background image to reduce noise
- It uses a Gaussian smoothing filter to reduce noise
- Introduced a cutoff filter to make the image black and white
- Grouped the white pixels together
- Then the program finds the center and relative size of the pixel groups to drive the applications.

Image Capture



If the boundary changes the index of refraction (like our hands) the light is frustrated, bounces down to the camera, creating images below.





Questions?