

Electric Paper at PARC

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Outline

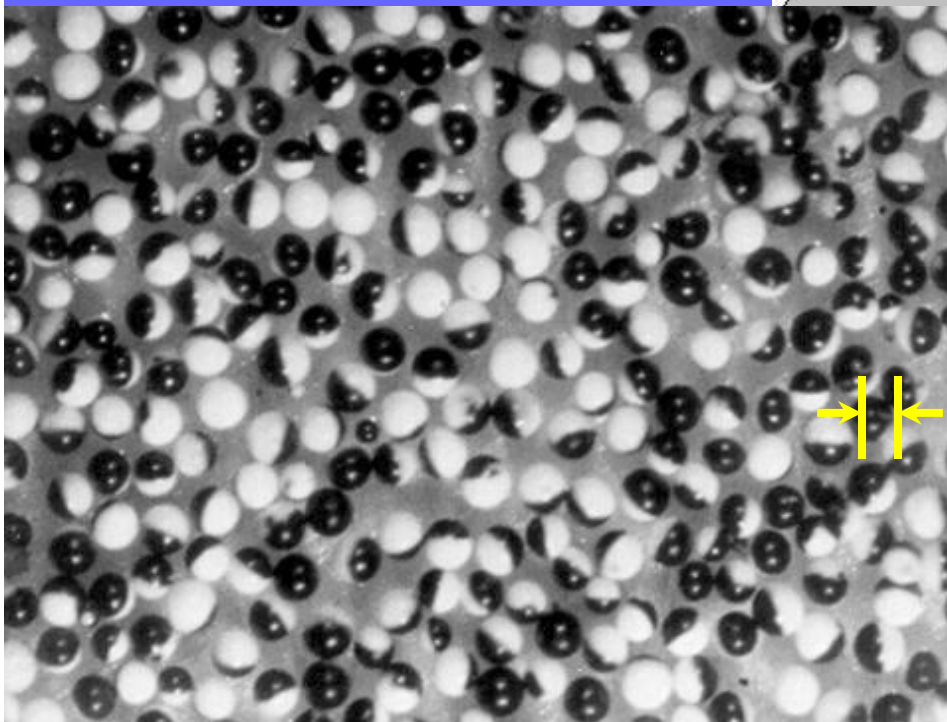
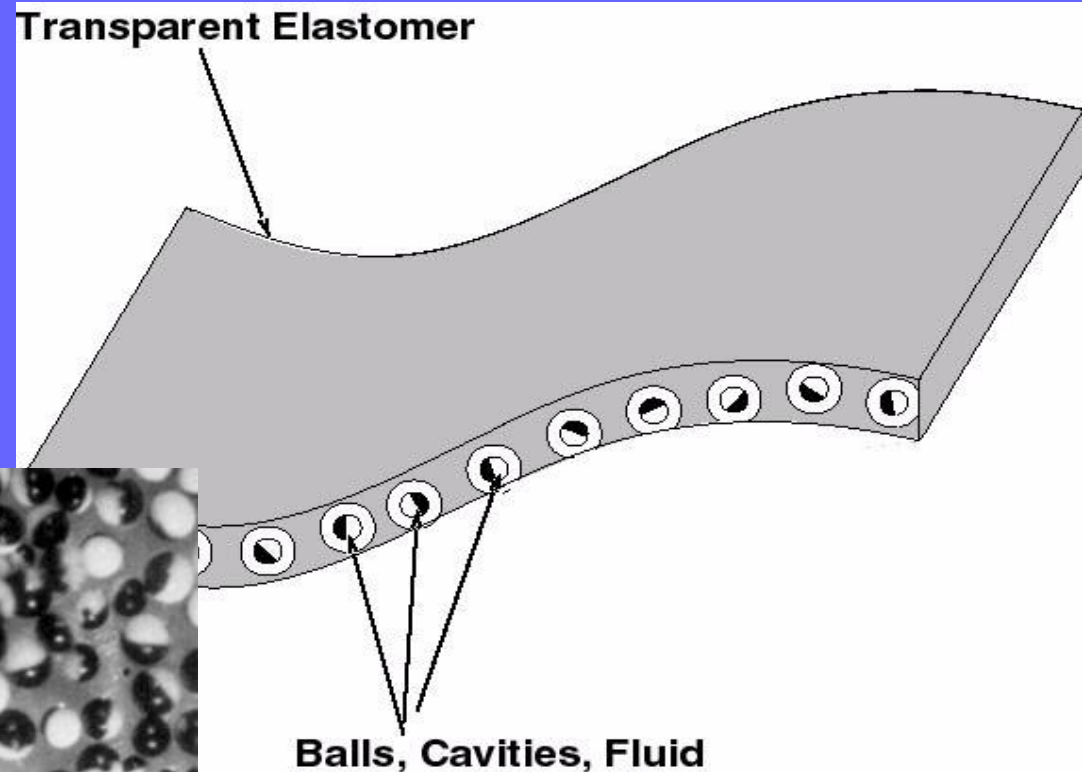
- Electric paper concepts
- Interesting electric paper systems
 - Explore application space
 - Some products

Gyricon Electric Paper Concepts

Cost of materials:

~ \$2 / sq ft

μJ to change display

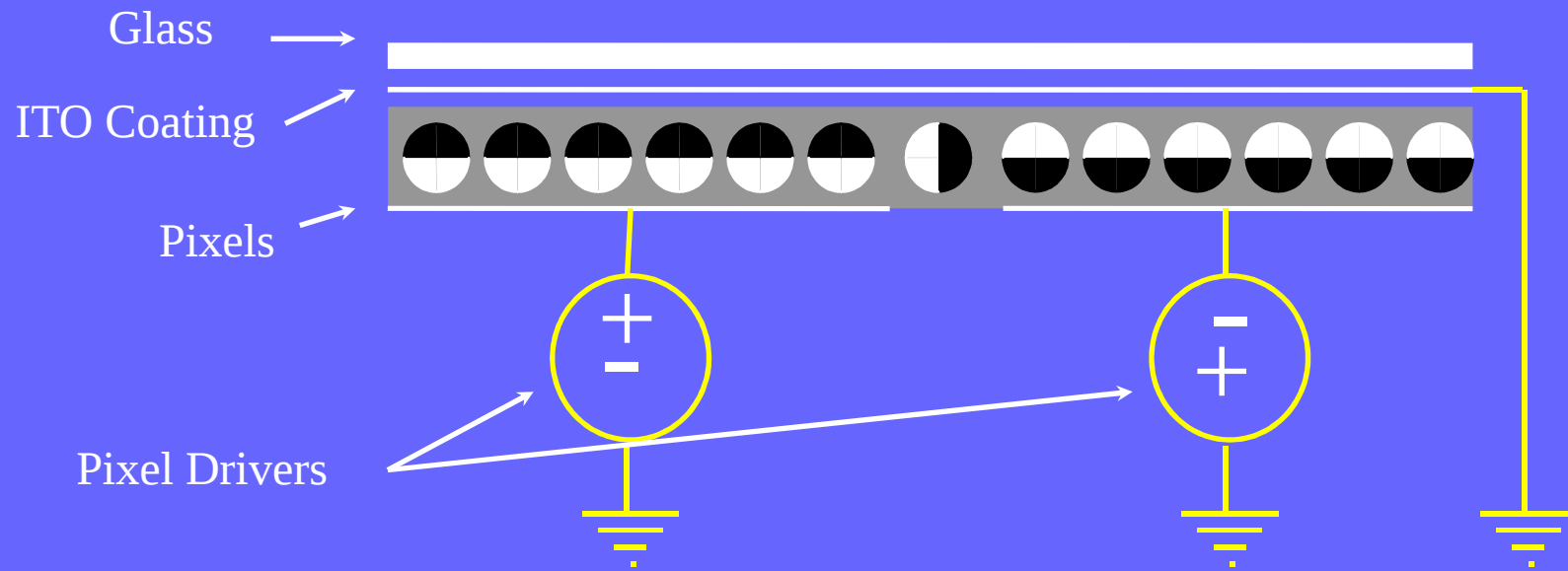


100 μm

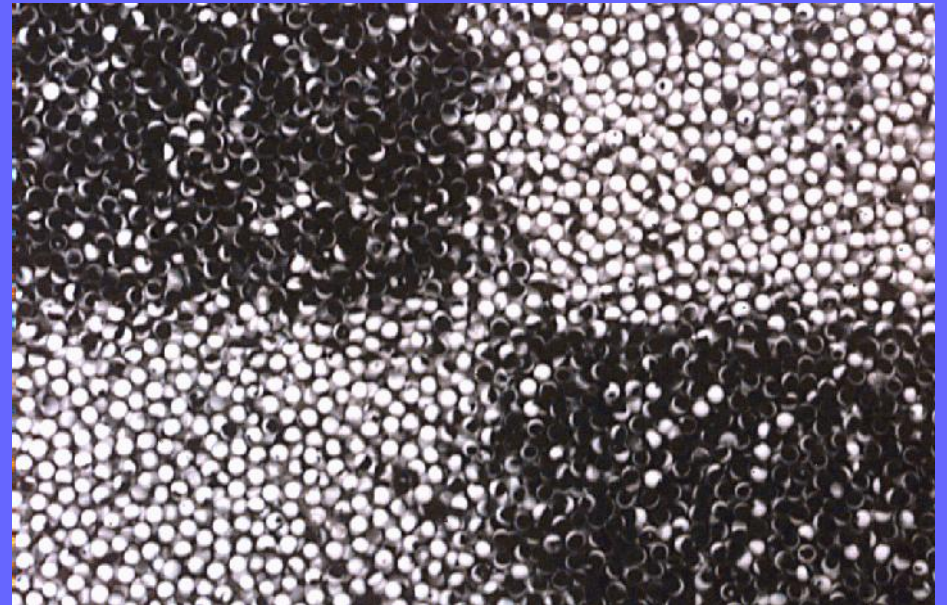
Dipole:

Black side +, white side -

Gyricon Sign Concepts



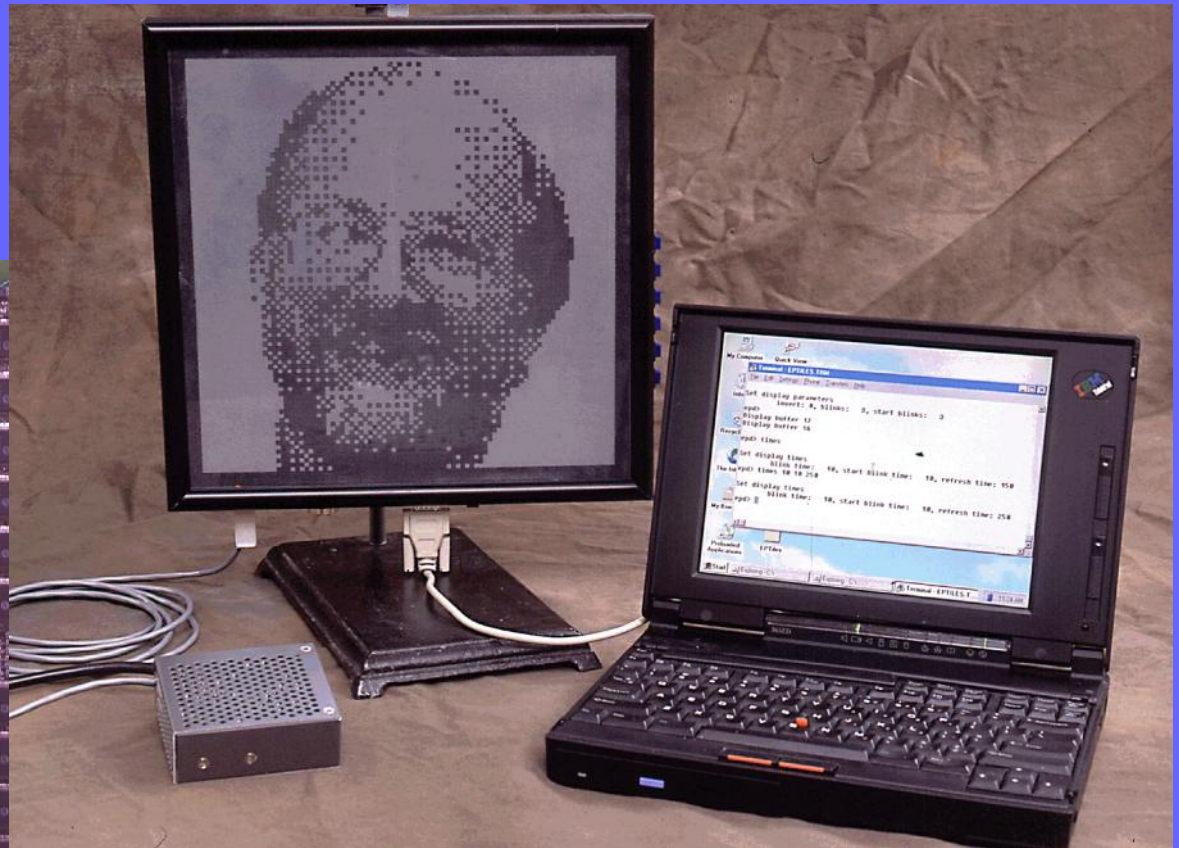
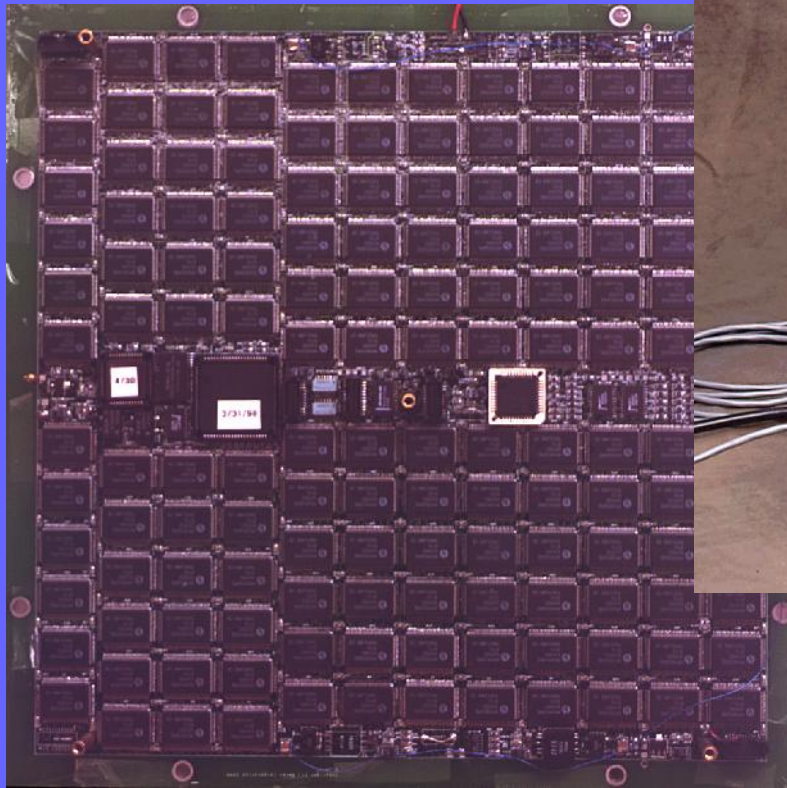
Low power, bistable,
low cost, inherently large
area, flexible



EPTiles: A Pixel-based Display

Goal: Wall sized display

Cheap electric paper,
expensive system

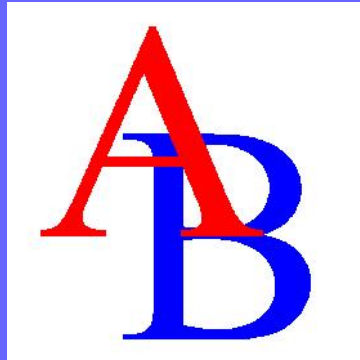


1/8 in sq pixels, 96 x 96, 180 volt drive,
on board: HV PS, 8052 uC display controller,
64 HV drivers / chip., 144 HV driver chips
serial interface

Multi-fixed Image Basics

Two complex images
controlled by 4 drivers

High resolution info
embedded in PCB metal



Two Images: A, B

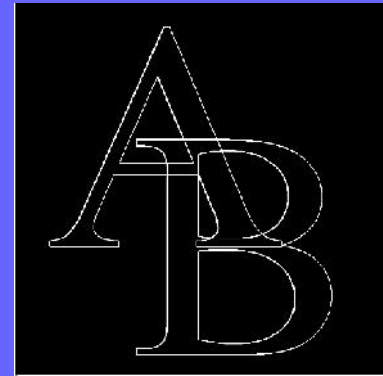
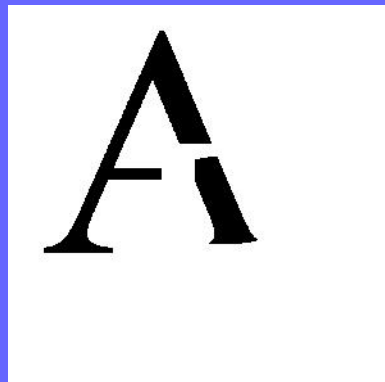


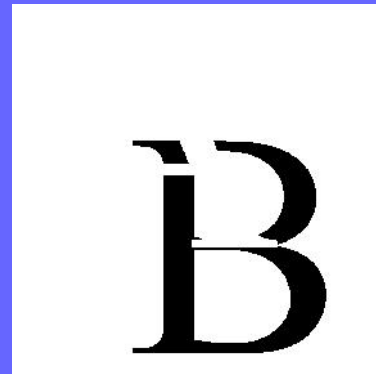
Image Artwork



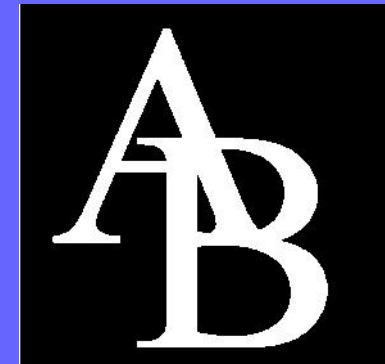
A and B



A and not B



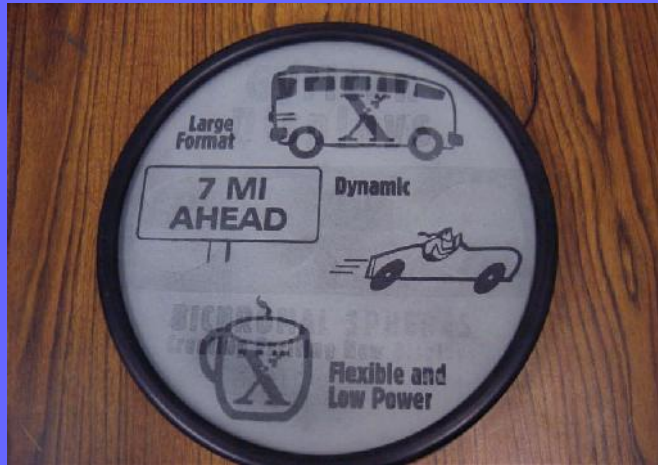
not A and B



not A and not B

High resolution, few drivers, low cost, electronics cost independent
of size or resolution, automated design process

First MFI Sign – Truly Low Cost



8 bit PIC uC, 1 k byte program memory, 128 bytes RAM, 1 MIPS,
11 images, 64 HV drivers, SW controlled HV power supply.
Miniaturization not necessary

Round Sign with Red Paper



Eleven images, table driven sequence,
image update in three seconds,
four button user interface

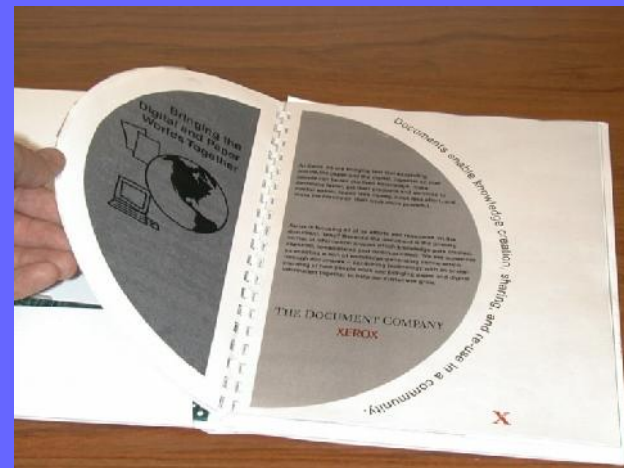
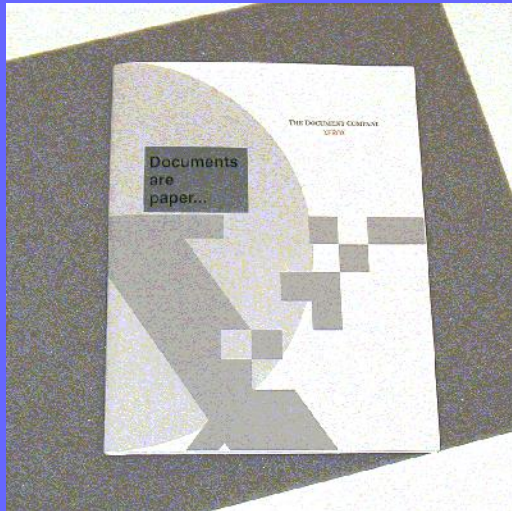
Large Flexible, MFI Sign



18 in x 26 in, 150 spi, polyester substrate, carbon electrodes, one layer of silver interconnection, path to very large area signs.

Same controller as round sign.

An Active Brochure



Low cost: ~ \$15 in high volume

Low power: Operates for months on coin cell

Macy's – High Water Mark

~ 25 signs in Women's Dept.
RF distribution system,
5 base stations
Windows print server



Any Message Sign
Expensive, but a big hit

Pricer Signs

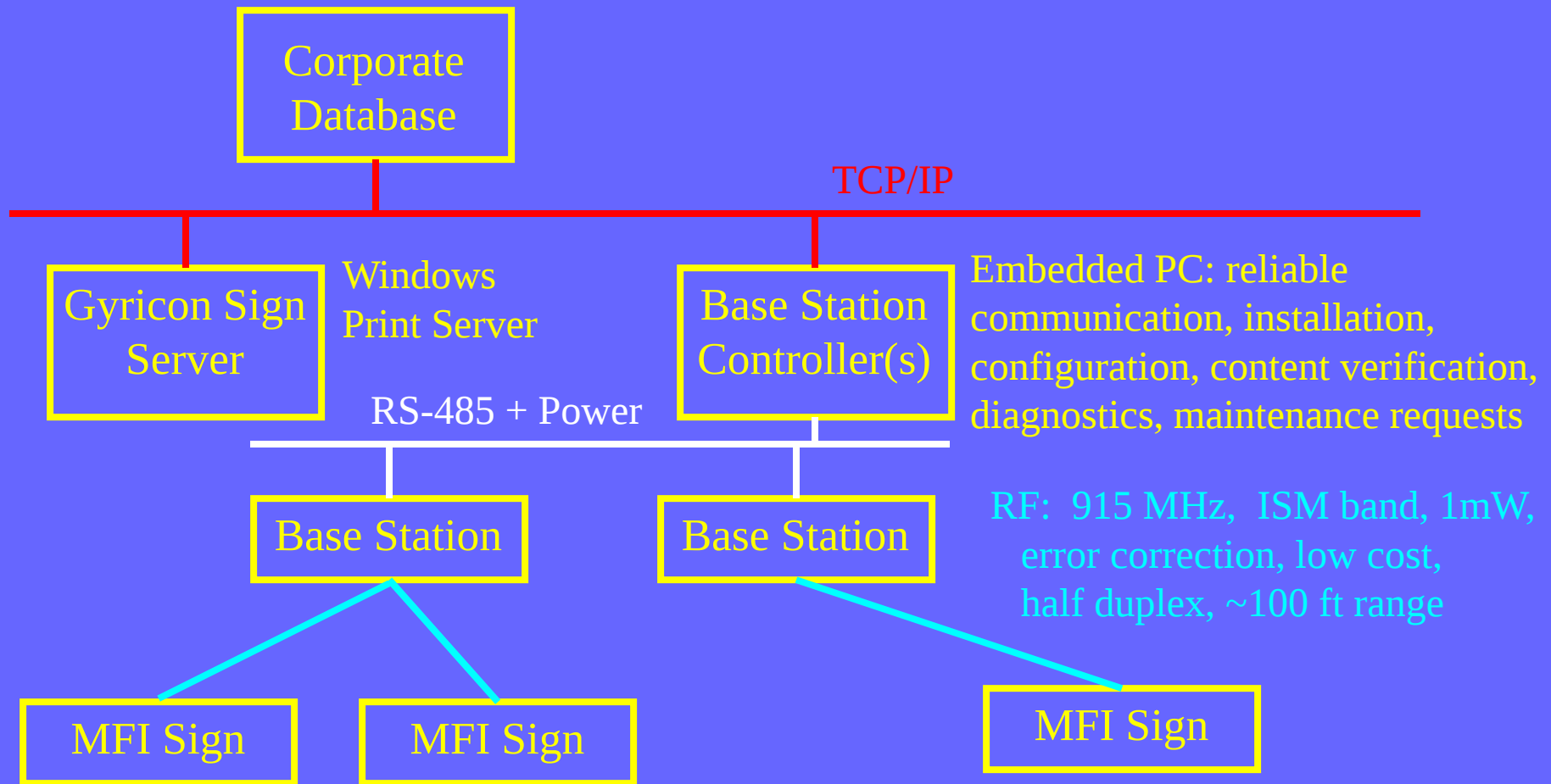
Less Capable,
More Cost Effective



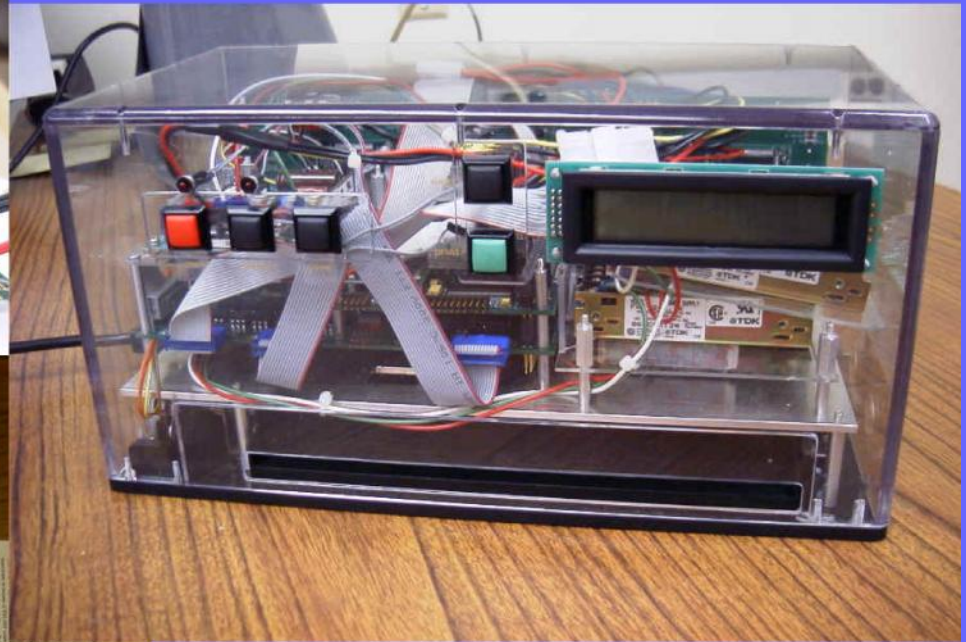
Can display \$ price or % off

Sign Services Architecture

Users print to signs



Desk Top Printer



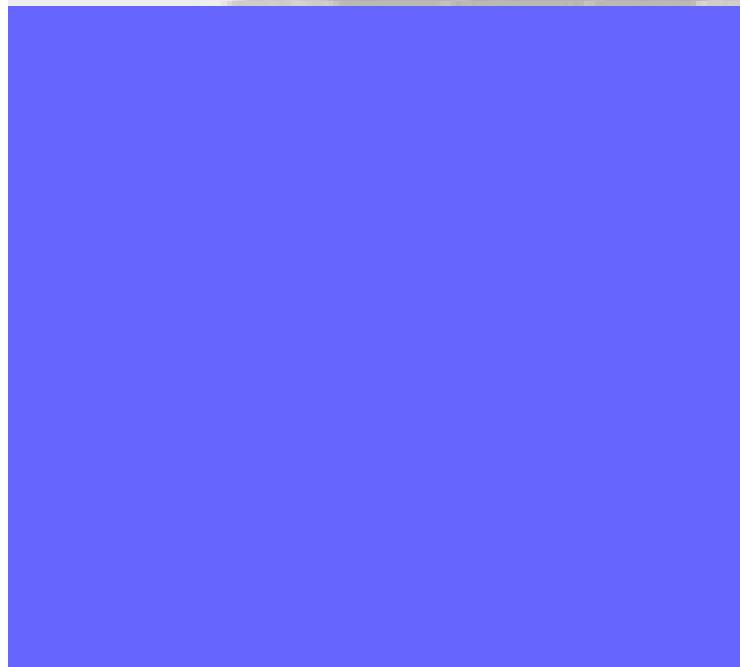
8.5 in x 11, 50 x 150 spi, 3 in/sec write, PC104 platform
Intel 486 controller, Windows print server, USB interconnection

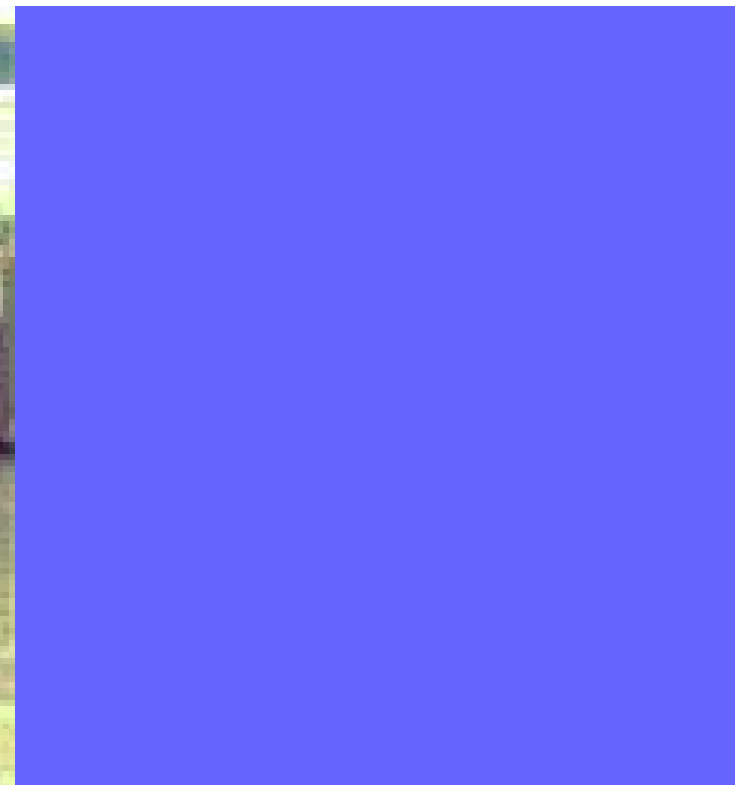
Large Format Plotter: Printer with Large Print Head



Print head and travelers are on the back side. Front side only sees image.

22 in x 28.5 active area, 50 x 150 spi, 3 in/sec write, 5 in/sec erase, Intel 486 controller, Windows print server, TCP/IP interconnection





MFI Test System



High volume manufacturing required automated testing. Different ball lots required waveform tweaking.

Test: manufacturing, lifetime, environmental, refresh, driving waveforms, ...

Electric Paper Manufacturing



Bichromal Ball Manufacturing

Capacity for 500 ft²/Hr



Electric Paper Coating Apparatus

Capacity for 500-5000 ft²/Hr

Summary

- ◆ Overview of electric paper
- ◆ Examples of the systems that we built
- ◆ Interesting way to spend four years

