Software Systems
Brian Demsky

Electrical & Computer Engineering

At the most basic level, we implement computation in matter

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The Early Days

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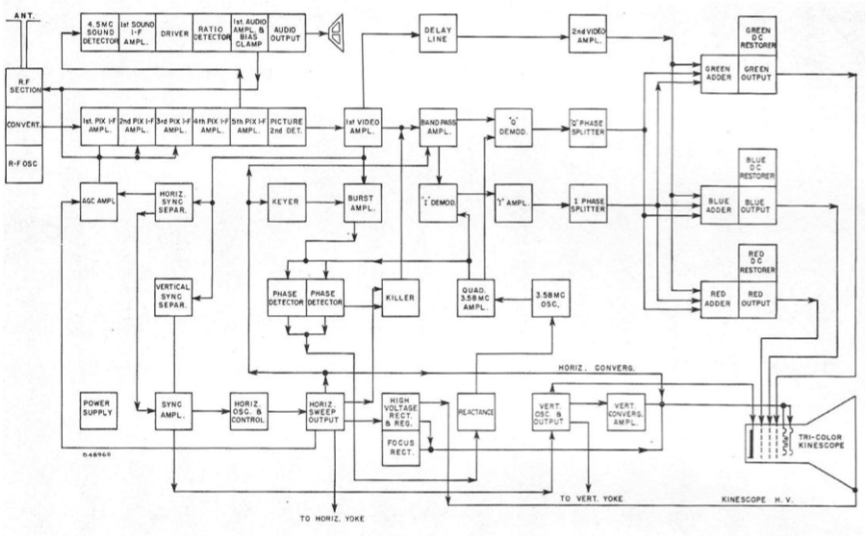

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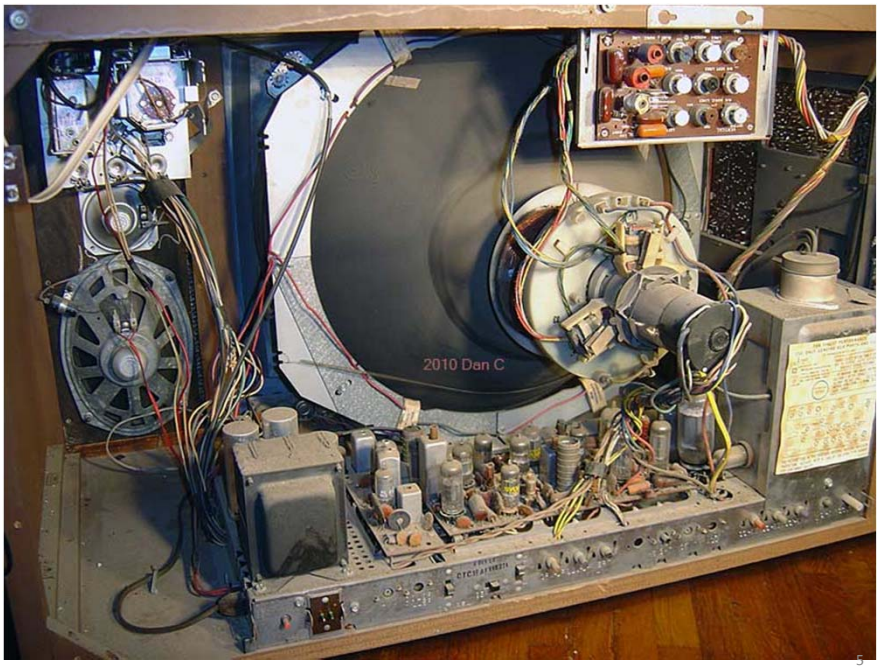

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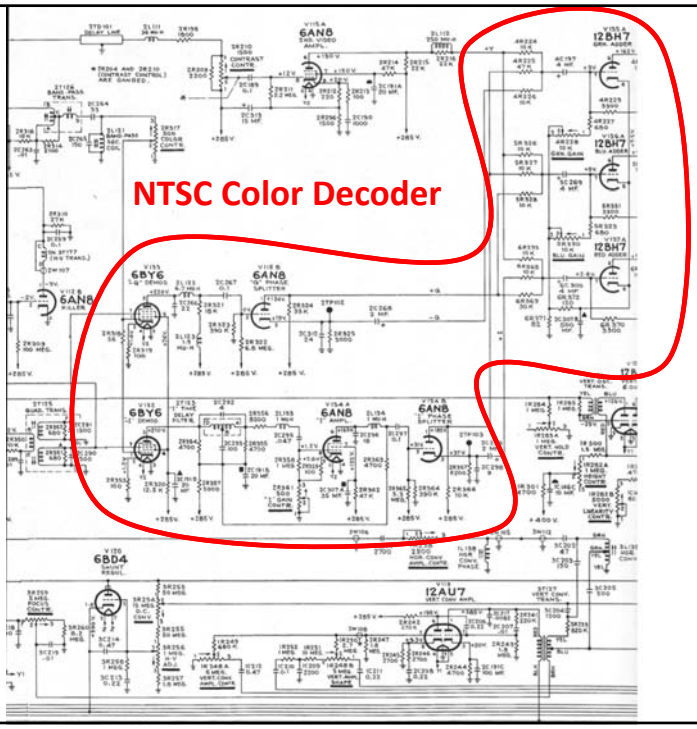

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Summary

Expensive, big, power-hungry components

Slow computation

Computation hardwired

Cheap to change layout

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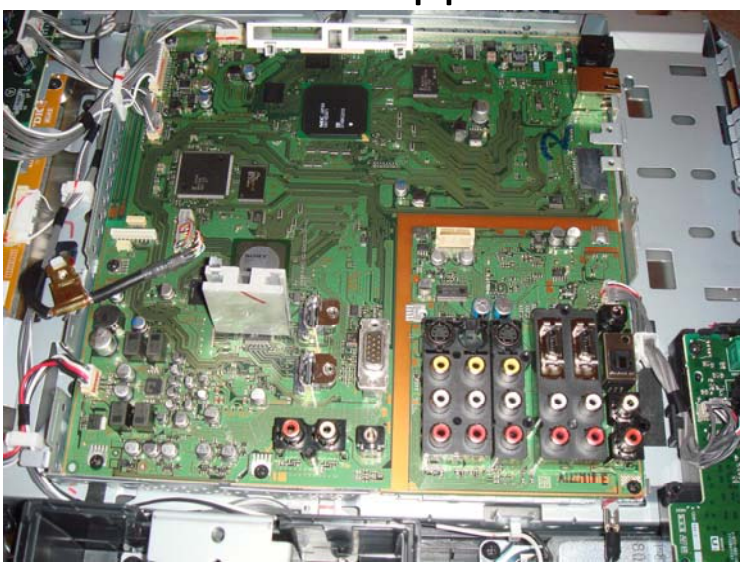
A Modern Approach



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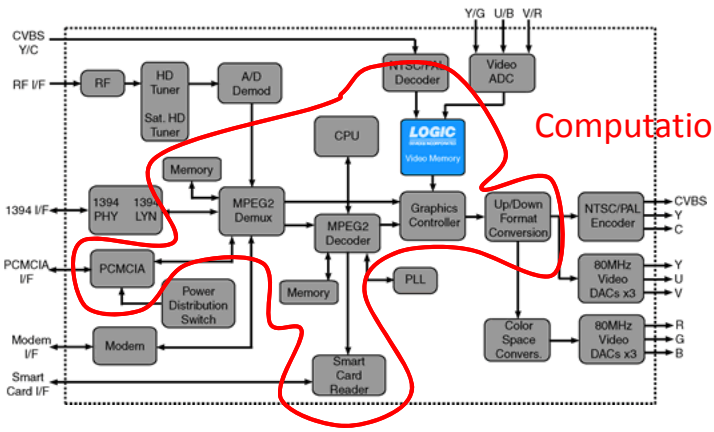
A Modern Approach



Computation


```
float signal_levels[256*8] = {...}; // Eight signal levels for each pixel, normalized to 0..1 range.
Calculated as above.

  unsigned Width; // Input: Screen width. Can be not only 256, but anything up to 2048.
  float phase;    // Input: This should the value that was PPU_cycle_counter * 8 + 3.9
                  // at the BEGINNING of this scanline. It should be modulo 12.
                  // It can additionally include a floating-point hue offset.
  for(unsigned x = 0; x < Width; ++x)
  {
    // Determine the region of scanline signal to sample. Take 12 samples.
    int center = x * (256*8) / Width + 0;
    int begin = center - 6; if(begin < 0)    begin = 0;
    int end   = center + 6; if(end   > 256*8) end   = 256*8;
    float y = 0.f, i = 0.f, q = 0.f; // Calculate the color in YIQ.
    for(int p = begin; p < end; ++p) // Collect and accumulate samples
    {
      float level = signal_levels[p] / 12.f;
      y  =  y + level;
      i  =  i + level * cos( M_PI * (phase+p) / 6 );
      q  =  q + level * sin( M_PI * (phase+p) / 6 );
    }
    render_pixel(y,i,q); // Send the YIQ color for rendering.
  }
```

NTSC Color Decoder

Changes

- Transistors are extremely cheap
- Costs to fabricate new chip designs are huge
- Designs are mostly a handful of analog devices around edges with nearly all computation done digitally

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Programming Hardware vs. Software

- Computation implemented by both
- Computation for both specified by code
- Differences:
  - Hardware costs more to build
  - Hardware is expensive to change
  - Hardware has limits on complexity and expressiveness
  - Hardware has better performance
  - Software is cheaper to build, cheaper to change, lower performance

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Future trends

As both hardware design and fabrication costs increases and performance increases

- More computation moves to software
- Less diversity of hardware designs
- Shift from thinking of transistors as components to processors as components
- Most of design complexity in software
- Nearly at the end of scaling for fabrication

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Software in Embedded Systems

- Control car engines
- Control nearly every device in a home (Ovens, thermostats, refrigerator, …)
- Control factories
- Stop lights

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Mobile

From Apple

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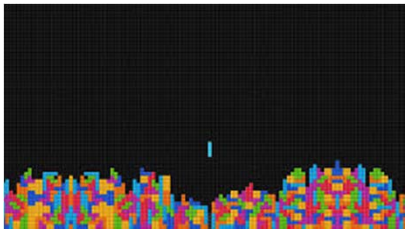
Desktop Software



From Internet

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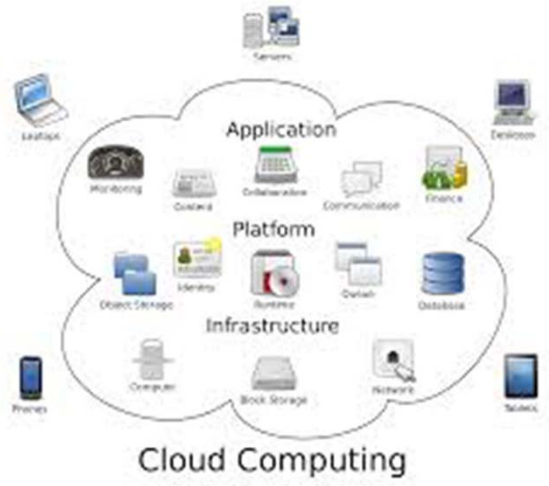
Cloud



From wikipedia

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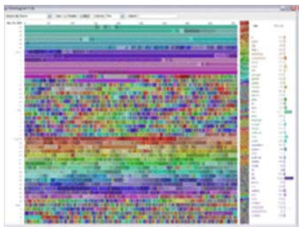
Big Data



Visualization of daily Wikipedia edits created by IBM. At multiple terabytes in size, the text and images of Wikipedia are an example of big data.

From wikipedia

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Proliferation of Web/Mobile Applications

- Google
- Uber
- Netflix
- Airbnb
- SnapChat
- Hulu
- Facebook
- Github
- Amazon
- Lyft
- Nest
- Ebay
- Pinterest
- Waze

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Internet of Things?

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Software Classes

- Recommend all students learn programming
  - EECS 10/12 C/Python (required)
  - EECS 22/22L C
  - EECS 40 Java
  - EECS 111 OS
  - EECS 114 Algorithms
  - EECS 118 Software Engineering

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Software Faculty

Mohammad A. Al Faruque

- Embedded systems

Pai Chou

- Embedded systems/ wireless sensors

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Software Faculty

Brian Demsky
- Compilers
- Programming Languages
- Parallel Software

Rainer Doemer
- Embedded systems

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Software Faculty

Kwei-Jay Lin
- Service Oriented Computing

Chen-Yu Phillip Sheu
- Semantic Computing

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Software Faculty

Aparna Chandramowlishwaran

- High-Performance Computing

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