In HybridsID player formware pulplay2-2.0 subplay2-5 ID HVSC 55-all of them sip minut

SS-all of themaip Toller sid Dulcedo, Constations and Eliminator sid EARAF Lood

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CAWindows/system3.5, and exe - "server v2.Hybrid510

FPGAs

spanned OOL

65 DECEND ODD

Cybernoid aid

Cybermond II and

Detender of the Convension

Dan Ellis <u>dpwe@ee.columbia.edu</u> 2014-04-17

#### Field-Programmable Gate Arrays

- Large collection

   of logic gates
   + connection logic
- "Field-programmable" i.e., in the field



Alternative to custom-design
 "Application Specific Integrated Circuit" (ASIC)

# How Big?

- Xilinx Spartan 6 LX9 (\$14)
  - 9,152 logic blocks
  - 64 KB RAM
  - 144 pins
  - Able to simulate e.g. two simultaneous ATMEGA108s





#### Advantages

- Reconfigurable
- Fast (100 MHz +)
- Parallel
- Lots of IO
- Good for dedicated processing pipeline (DSP filters, Bitcoin mining)



## Disadvantages

- Hardware & parallel not software & sequential
- Awful 1990s-era design language & tools (PC-centric)
- Expensive (dev board ~\$100)



• Esoteric - small community

## Example: Sine Oscillator

 <u>http://hamsterworks.co.nz/mediawiki/index.php/FPGA\_course</u> chapter 16



## 1 Bit DAC

 Increment counter by the desired value output whether you "overflow"



