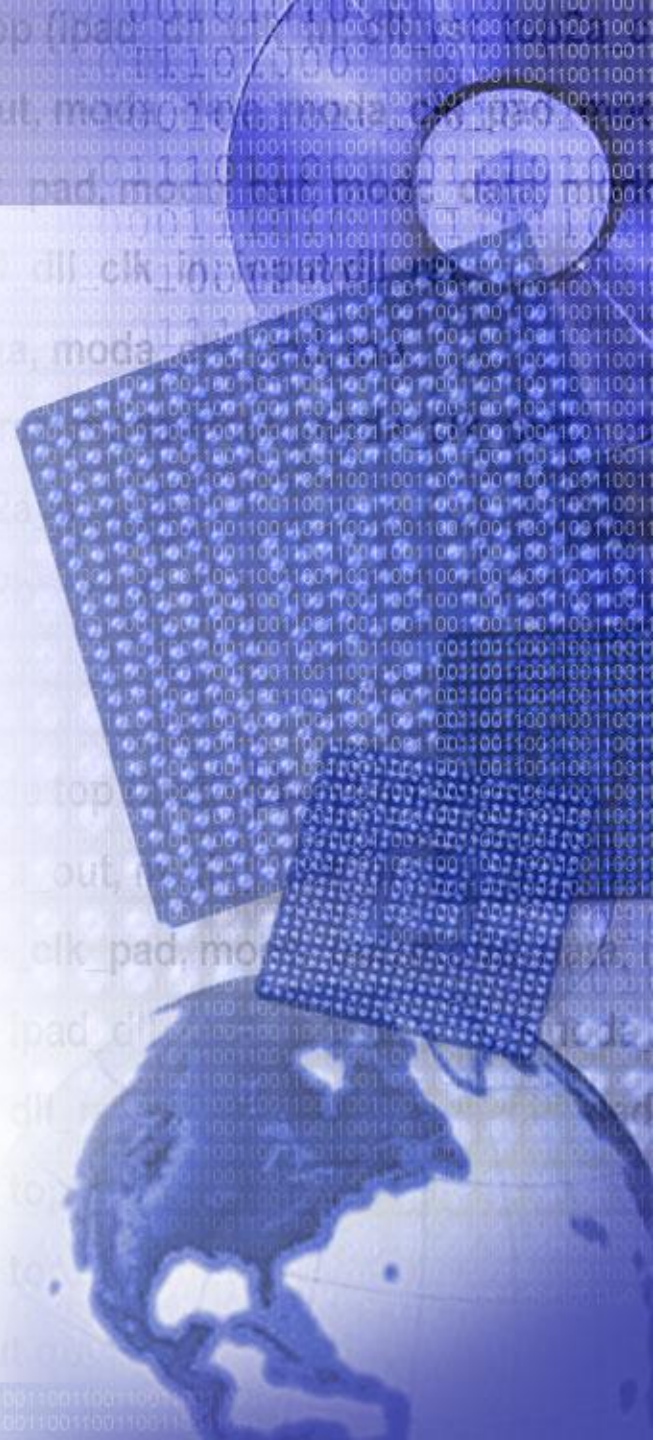
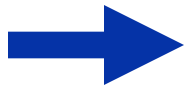




# Spartan™-3E FPGAs for Lowest Total Cost: *Configuration Options*



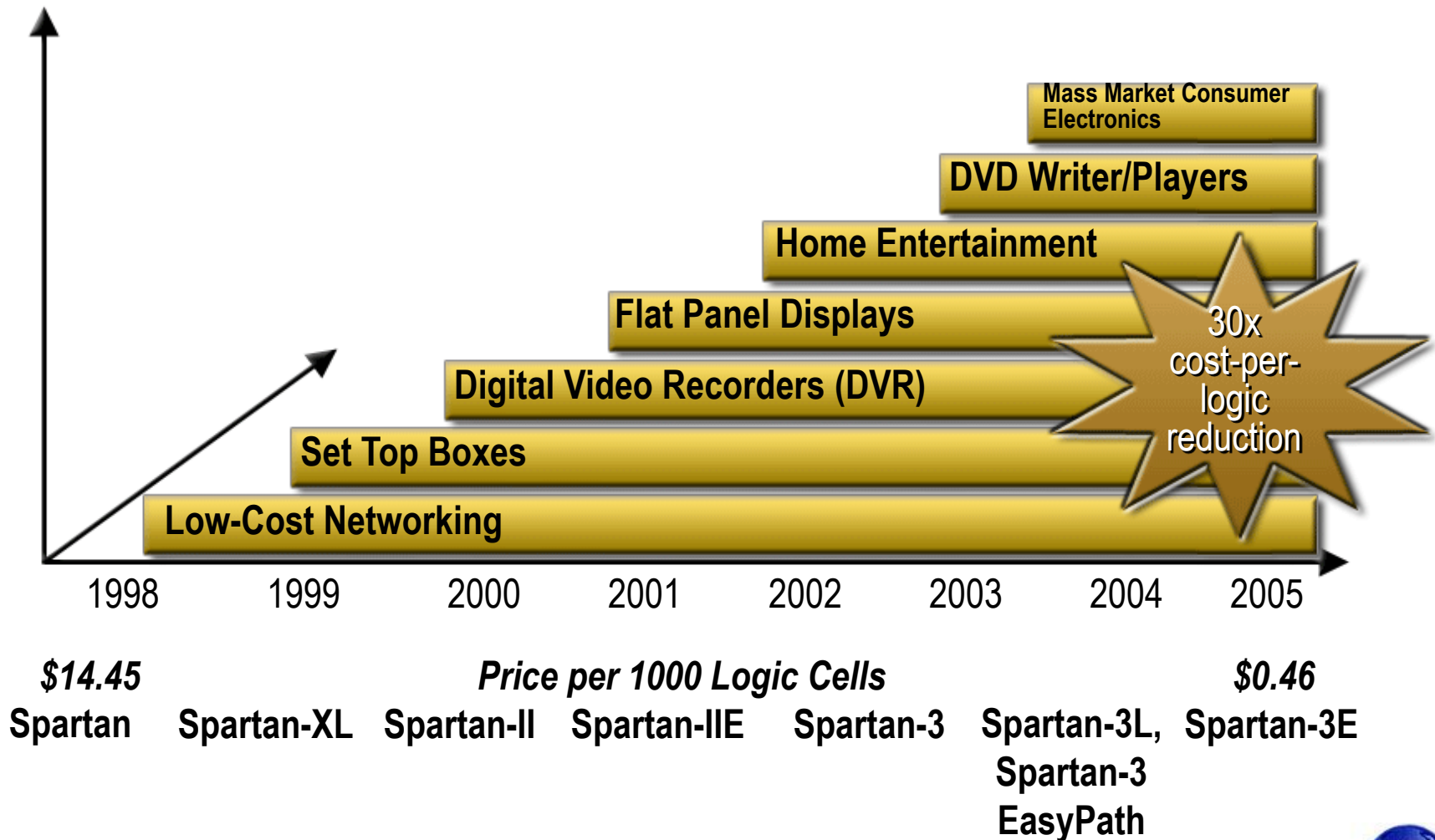
# Agenda



## Introduction to the low-cost Spartan-3E FPGA family

- Low-cost configuration options with Spartan-3E FPGAs
- Choosing the optimal configuration solution for your system
- Configuration solutions using SPI and parallel flash memory

# Spartan Series: The World's Lowest Cost FPGAs



# The Spartan-3 Generation

## Easy, Inexpensive, Complete FPGA Solutions

- The leader in low-cost programmable logic
  - For implementing custom circuitry
  - For integrating system functions into a single device
- Three families in the 90nm Spartan-3 Generation
  - Spartan-3 (introduced in 2003)
  - Spartan-3L (introduced in 2004)
  - Spartan-3E (introduced in 2005)
- All built on Xilinx mainstream 90nm technology
- Supported by a broad portfolio of IP, reference designs, hardware evaluation kits, design tools, training and support

# The Newest Family: Spartan-3E

- 7th Family in the Spartan Series of low-cost FPGAs
  - Five devices from 100K gates to 1.6M gates
  - Up to 47% cost reduction from Spartan-3
- World's Lowest Cost FPGAs
  - 100K system gate FPGA for under \$2\*
  - 1.2M system gate FPGA for under \$9\*
- Ready for Production
  - Utilizes 90nm process technology and 300mm wafers
  - Full design tool support in ISE and WebPack
  - Broad portfolio of Spartan-3 IP

\*Pricing is for 500K units, 2H06



# Spartan-3E Family Members



Device	3S100E	3S250E	3S500E	3S1200E	3S1600E
System Gates	100K	250K	500K	1.2M	1.6M
Logic Cells	2160	5508	10476	19512	33192
Maximum I/O	108	172	232	304	376
Block RAM bits	72K	216K	360K	504K	648K
Distributed RAM bits	15K	38K	73K	136K	231K
18x18 Multipliers	4	12	20	28	36
DCMs	2	4	4	8	8



# Spartan-3E Family: Key New Features



- **Support for configuration by SPI/Parallel commodity flash memory**
  - Low/zero cost configuration for systems with existing flash memory

- **Enhancements for Digital Consumer Electronics markets**
  - Consumer I/O standards: Mini-LVDS, PCI-64/66, DDR 333
  - Expanded DCM input frequency down to 5MHz



- **Enhancements for Embedded Designers**
  - SPI/Parallel Flash useable post-configuration for code & data storage
  - 32-bit MicroBlaze soft processor in XC3S1200E: \$0.48 (~5% of FPGA)

- **Enhancements for Low-Cost Digital Signal Processing**
  - Multiplier performance increased to 325MHz
  - 9.1 GMAC/s in XC3S1200E ( less than \$1/GMAC/s)



\*Pricing is for 500K units, 2H06

# Spartan-3E FPGAs for Lowest Total Cost

- Lowest Device Cost
  - 100K system gate FPGA for under \$2\*
  - 1.2M system gate FPGA for under \$9\*
- Lowest System Cost
  - Platform architecture enables complex functions within FPGA
    - Digital signal processing
    - Embedded processing
  - Complex interfaces built into Spartan-3E I/O
    - Support for 18 common I/O standards
    - Support for numerous low-cost configuration options

\*Pricing is for 500K units, 2H06





# Agenda

- Introduction to the low-cost Spartan-3E FPGA family
- **Low-cost configuration options with Spartan-3E FPGAs**
- Choosing the optimal configuration solution for your system
- Configuration solutions using SPI and parallel flash memory

# Spartan-3E Configuration Options

- Configuration memory with direct FPGA-to-memory interface
  - Xilinx Platform Flash
    - Complete family of feature-rich configuration memory
    - Low-power, small-form-factor packaging
  - New!* – **Commodity flash memory**
    - **Serial Peripheral Interface (SPI)** *New!*
    - **Parallel interface**
- Configuration storage with separate controller
  - Configuration data may be stored in local storage and directed to the Spartan FPGA by an intelligent host
  - A CoolRunner-II CPLD can manage the configuration interface between the Spartan FPGA and nearly any form of external semiconductor memory
- In-System Programming (ISP)
  - JTAG serial and parallel-IV programming
  - Parallel and USB configuration cables
  - Third party tools available for ISP of commodity Flash memory

# Configuration with Commodity Serial *New!* (SPI) & Parallel Flash Memory

- Feature Details
  - Embedded control logic enables configuration from low-cost commodity memory: Serial Peripheral Interface (SPI) & Parallel Flash
  - Complete SPI support: Spartan-3E can address the memory after configuration through the configuration port (competing low-cost FPGAs cannot)
- Application Examples
  - Many systems already have SPI or parallel flash memory – simply use an incrementally larger memory for the FPGA configuration data
  - Implement a MicroBlaze soft processor in the FPGA and store embedded processing code & data externally in the SPI or Flash memory device
  - Multiboot configuration enables two independent applications to be loaded from parallel flash memory

# Agenda

- Introduction to the low-cost Spartan-3E FPGA family
- Low-cost configuration options with Spartan-3E FPGAs
- ➔ **Choosing the optimal configuration solution for your system**
- Configuration solutions using SPI and parallel flash memory

# Choosing the Optimal Configuration Solution for Spartan-3E

- Factors to consider to choose your optimal configuration solution
  - Using existing on-board memory or controller
    - “Extra bits” on memory chips
    - Microcontroller
  - Calculating the lowest *total* cost
    - Component cost
    - PCB and system costs
    - Development cost
    - Programming and other costs
  - Technical and sales support
    - Single vs. multiple source
    - Supply guarantee

# Choosing the Optimal Configuration Solution for Spartan-3E

- More factors to consider...
  - Exclusive Xilinx Platform Flash features
    - JTAG programming
    - Revisioning
    - Compression
    - High speed parallel configuration
    - Integrated software and programming hardware support from Xilinx
  - Parallel NOR flash features
    - Multiboot configuration with parallel NOR flash
    - Embedded processing applications
  - Packaging
    - Footprint
    - Upgradeability without PCB changes

# Xilinx Platform Flash: Pros and Cons

## Advantages

- Single supplier for FPGA and PROM
- One contact for sales and support
- In system programmability with Xilinx tools
- JTAG programming
- Revisioning
- Compression
- High speed parallel configuration
- Power-on, brown-out protection
- Up to 85% lower price than previous XC18V Family and under \$1/Mbit in volume

## Limitations

- Using “extra memory bits” (that are not required for configuration) as a general purpose data store requires additional logic in FPGA
- Single supplier (but Xilinx is the supplier!)



# SPI Flash: Pros and Cons

## Advantages

- Lowest unit cost
- High density
- Multiple suppliers, most pin compatible
- Random accessible, byte addressable
- Readable/writable by FPGA user application
- Low power
- High write endurance (100K+ cycles)
- Long data retention

## Limitations

- No JTAG interface
- Slower data transfer
- Not sold by Xilinx
  - May require separate vendor qualification
- Not supported by Xilinx
  - No low cost Xilinx programming hardware support for ISP
- No power-on, brown-out protection

# Parallel NOR Flash: Pros and Cons

## Advantages

- Uses existing onboard memory (commonly used for embedded processing apps)
- Multiboot capability
- Lowest unit cost
- High density
- Multiple suppliers, most pin compatible
- Random accessible, byte addressable
- Readable/writable by FPGA user application
- Low power
- High write endurance (100K+ cycles)
- Long data retention

## Limitations

- Requires numerous I/O connections
- No JTAG interface
- Slower data transfer
- Not sold by Xilinx
  - May require separate vendor qualification
- Not supported by Xilinx
  - No low cost Xilinx programming hardware support for ISP
- No power-on, brown-out protection

# Choosing the Optimal Configuration Solution for Spartan-3E

- Decide which factors are most important to you
- Review the advantages and limitations of each option
- Develop a comparison chart...

# Example: Comparing Platform Flash & SPI Flash

**Platform *Flash*** *SPI Flash PROM*

Absolute lowest unit cost  
Multi-sourced  
Smallest form factor  
Read/Write, random-access

**COMPETITIVE!**



Xilinx sold and supported  
Xilinx In-System Programming  
Built-in power monitoring  
Long-term supply security



\* Using JTAG and additional control logic in a CPLD, FPGA, or microcontroller

# Agenda

- Introduction to the low-cost Spartan-3E FPGA family
  - Low-cost configuration options with Spartan-3E FPGAs
  - Choosing the optimal configuration solution for your system
- ➔ Configuration solutions using SPI and parallel flash memory



# Spartan-3E Configuration with Commodity SPI Flash Memory

- SPI flash memory with direct FPGA-to-memory interface
  - Uses standard, commodity SPI memory types
  - Standard, easy-to-design 4-pin interface
  - Only three dedicated configuration pins, all other configuration pins can be re-used as general I/O
  - Single memory can configure multiple FPGAs (daisy-chain)

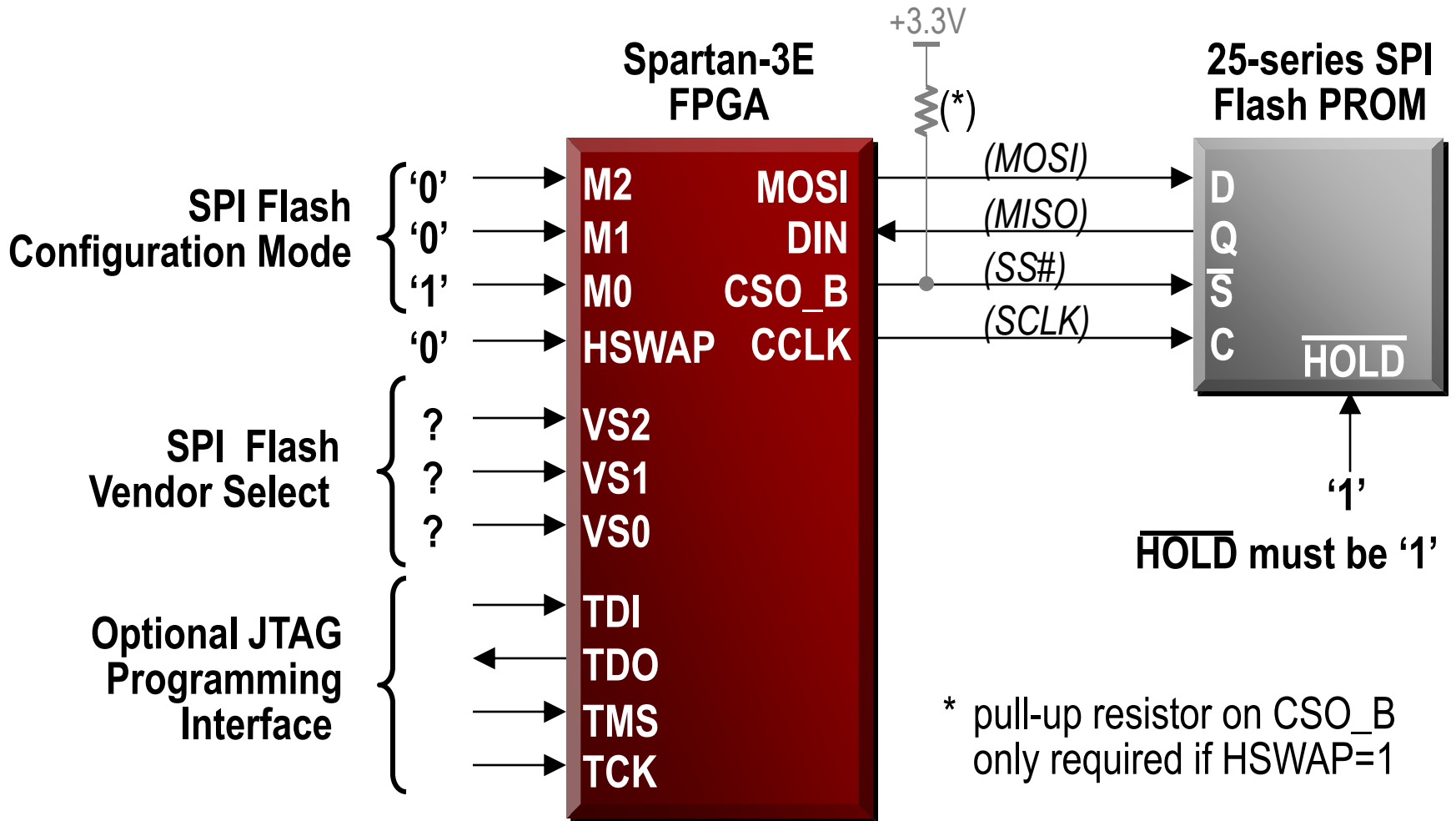


# How Many Bits are Required?

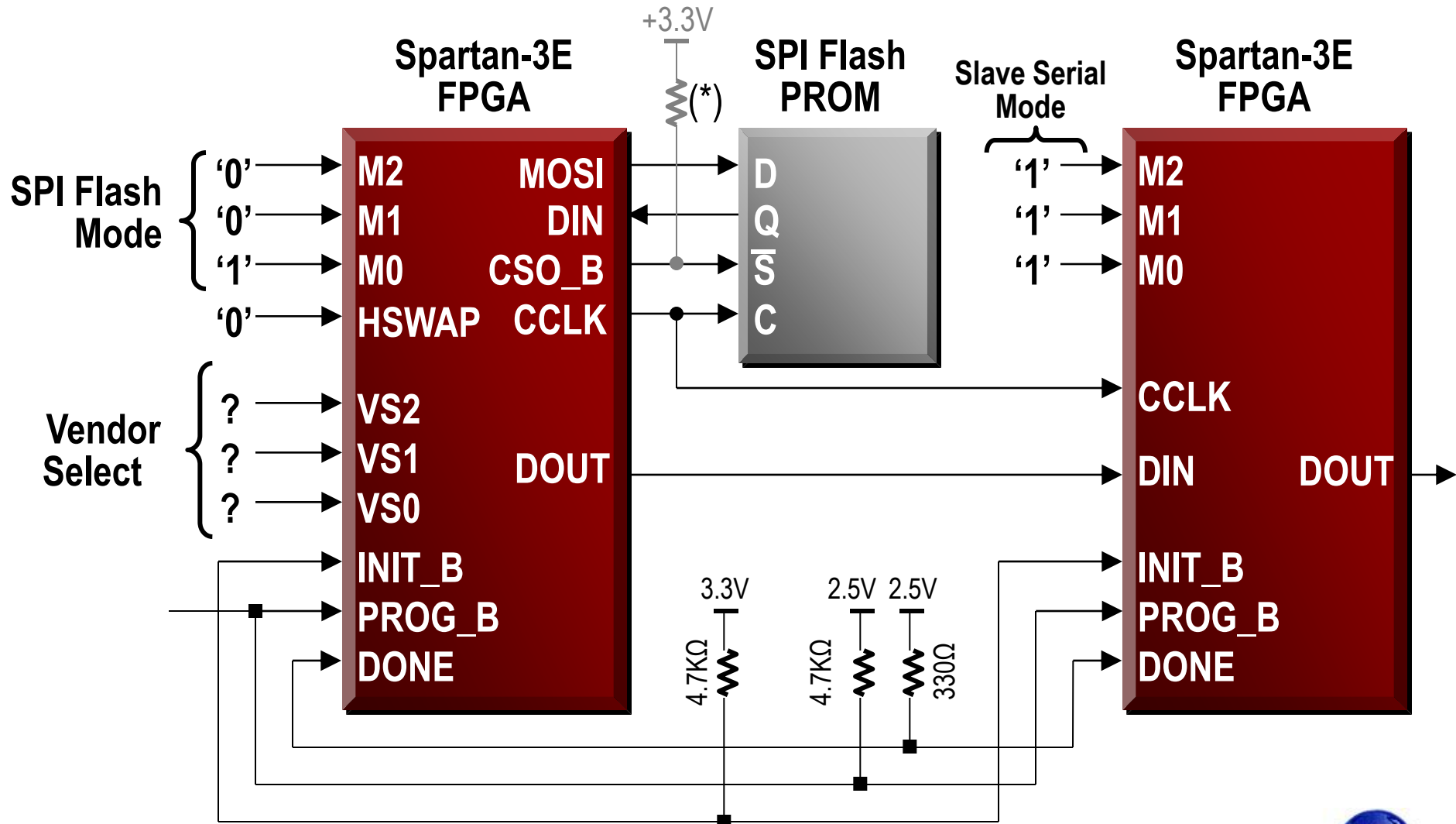
Device	Configuration Bits (per)	Smallest SPI Flash Required	Remaining Space
XC3S100E	581,344	1,024Kb (1Mb)	456Kb
XC3S250E	1,353,728	2,048Kb (2Mb)	726Kb
XC3S500E	2,270,208	4,096Kb (4Mb)	1.83Mb
XC3S1200E	3,837,184	4,096Kb (4Mb)	348Kb
XC3S1600E	5,964,672	8,192Kb (8Mb)	2.31Mb

- SPI Flash PROMs are specified in bits
- Assumes no bitstream compression used (`BitGen -g compress`)
- Larger SPI Flash devices provide additional storage to user applications (MicroBlaze code, ID codes, etc.)

# Spartan-3E SPI Flash Interface



# Spartan-3E SPI Daisy-Chain



\* pull-up resistor on CSO\_B only required if HSWAP=1



# Spartan-3E Configuration with Commodity Parallel Flash

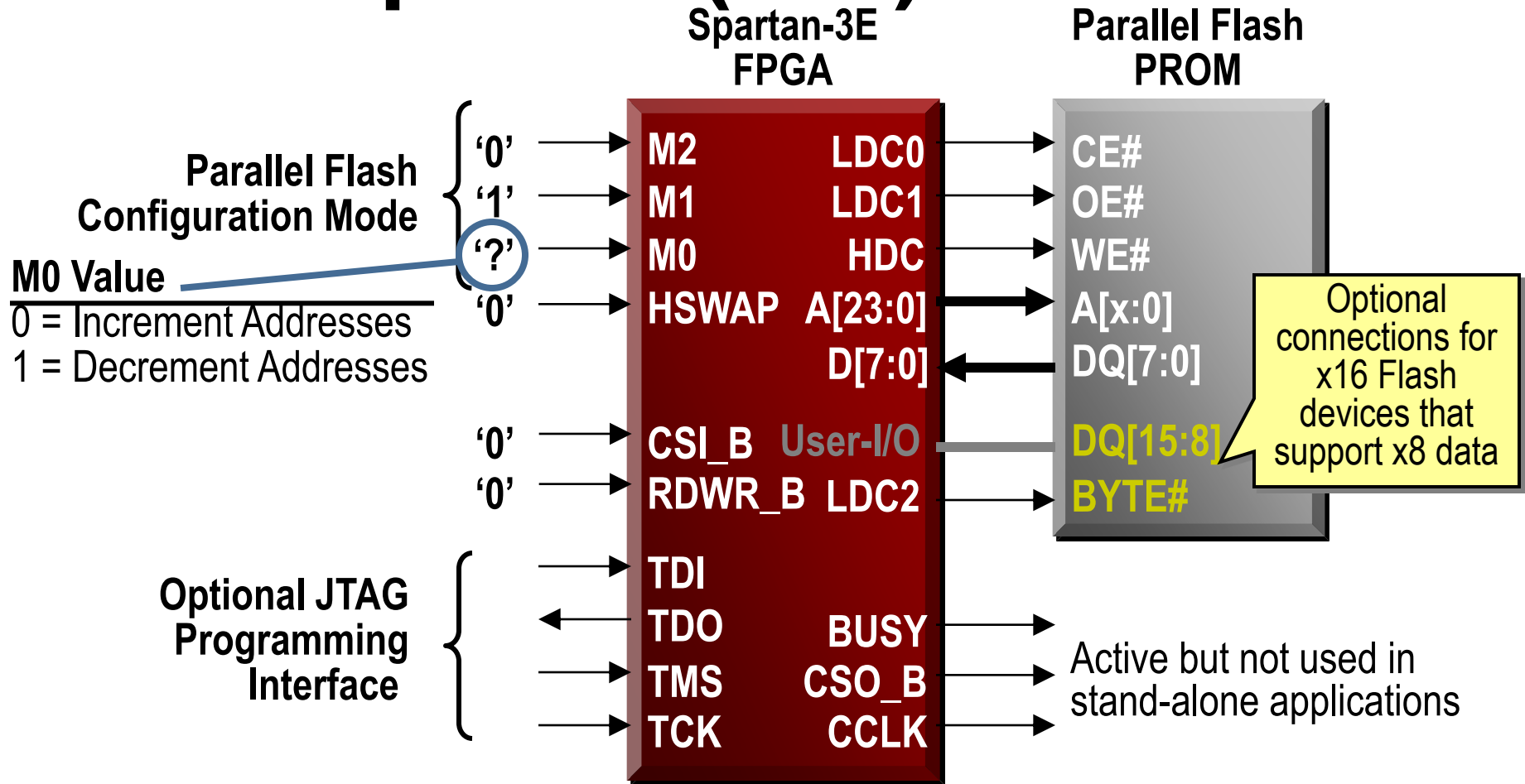
- Parallel flash memory with direct FPGA-to-memory interface
  - Uses standard, commodity parallel NOR flash memory types
  - Standard, easy-to-design interface
  - Few dedicated configuration pins, most configuration pins can be re-used as general I/O
  - Single memory can configure multiple FPGAs (daisy-chain)

# How Many Bits are Required?

Device	Configuration Bits (per)	Smallest Flash Required	Minimum Address Lines
XC3S100E	581,344	1,024Kb (1Mb)	17
XC3S250E	1,353,728	2,048Kb (2Mb)	18
XC3S500E	2,270,208	4,096Kb (4Mb)	19
XC3S1200E	3,837,184	4,096Kb (4Mb)	19
XC3S1600E	5,964,672	8,192Kb (8Mb)	20

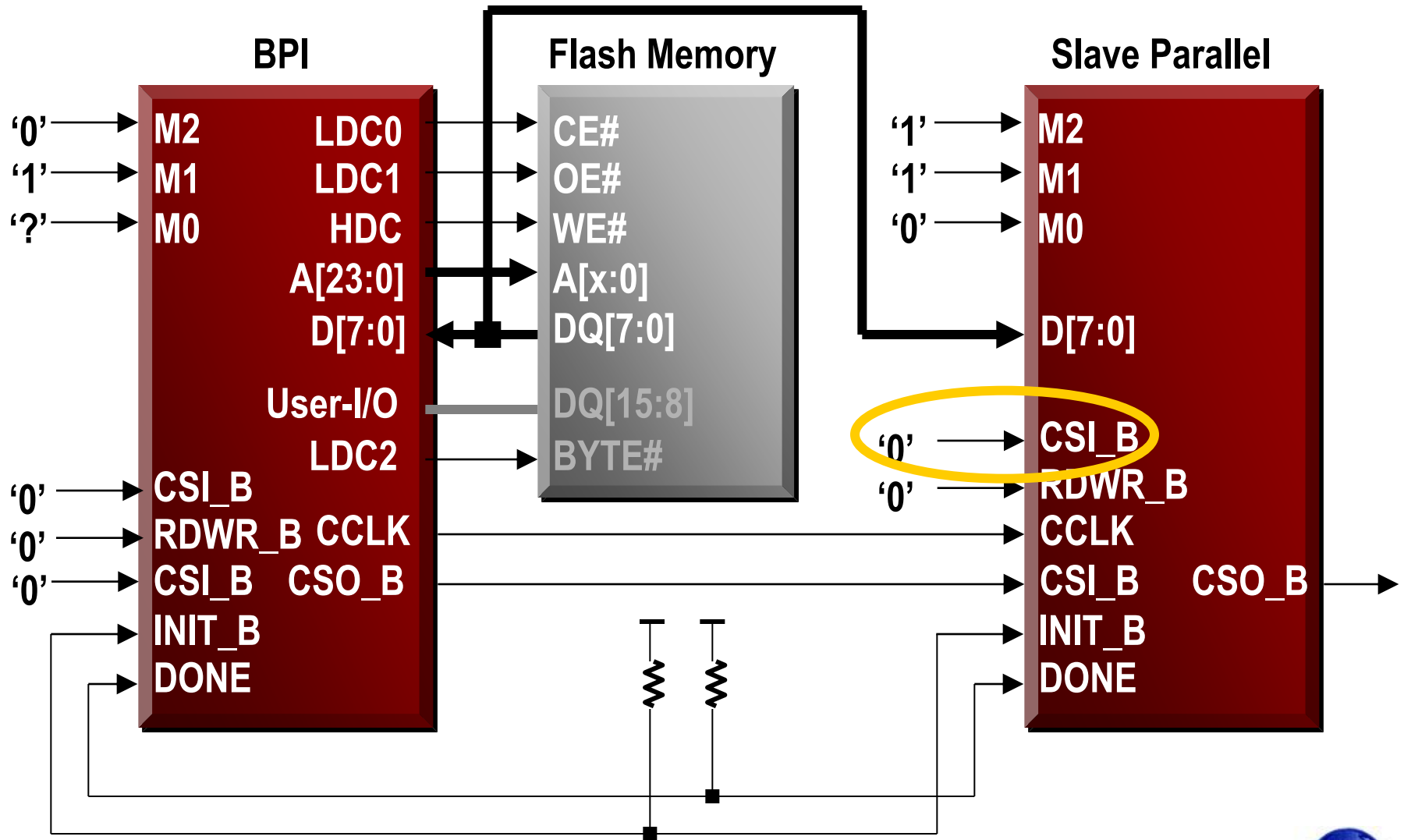
- Assumes no bitstream compression used (`bitgen -g compress`)
- Parallel Flash size is specified in bits, addressed as bytes
- FPGA drives 24 address lines but Flash PROM may have fewer
- Larger parallel Flash devices provide additional storage to user applications (MicroBlaze code, ID codes, etc.)

# Spartan-3E Byte-Wide Peripheral (BPI) Interface



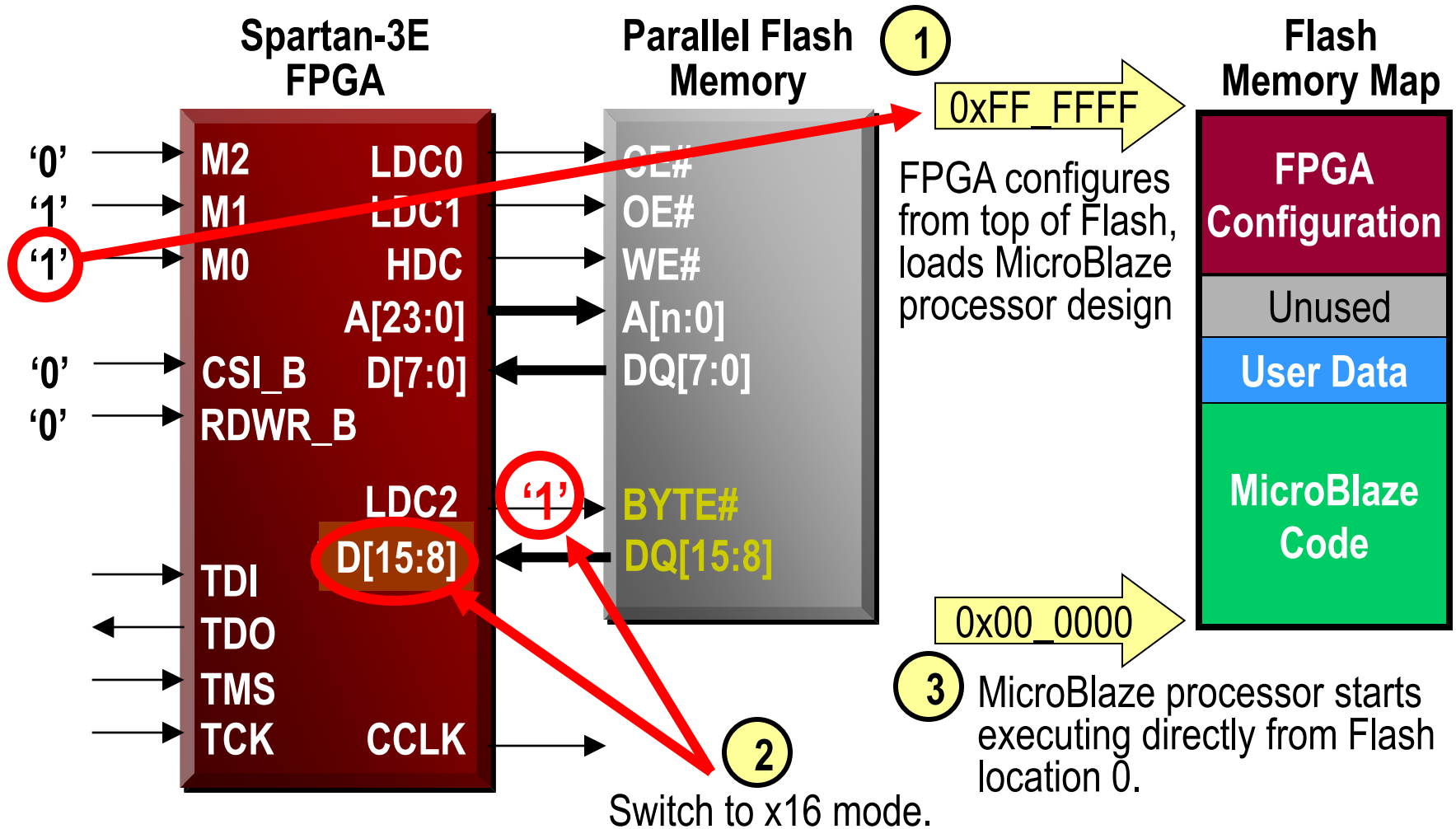
- Not supported in VQ100 package

# Daisy-Chain Flash Interface





# Embedded MicroBlaze Processor

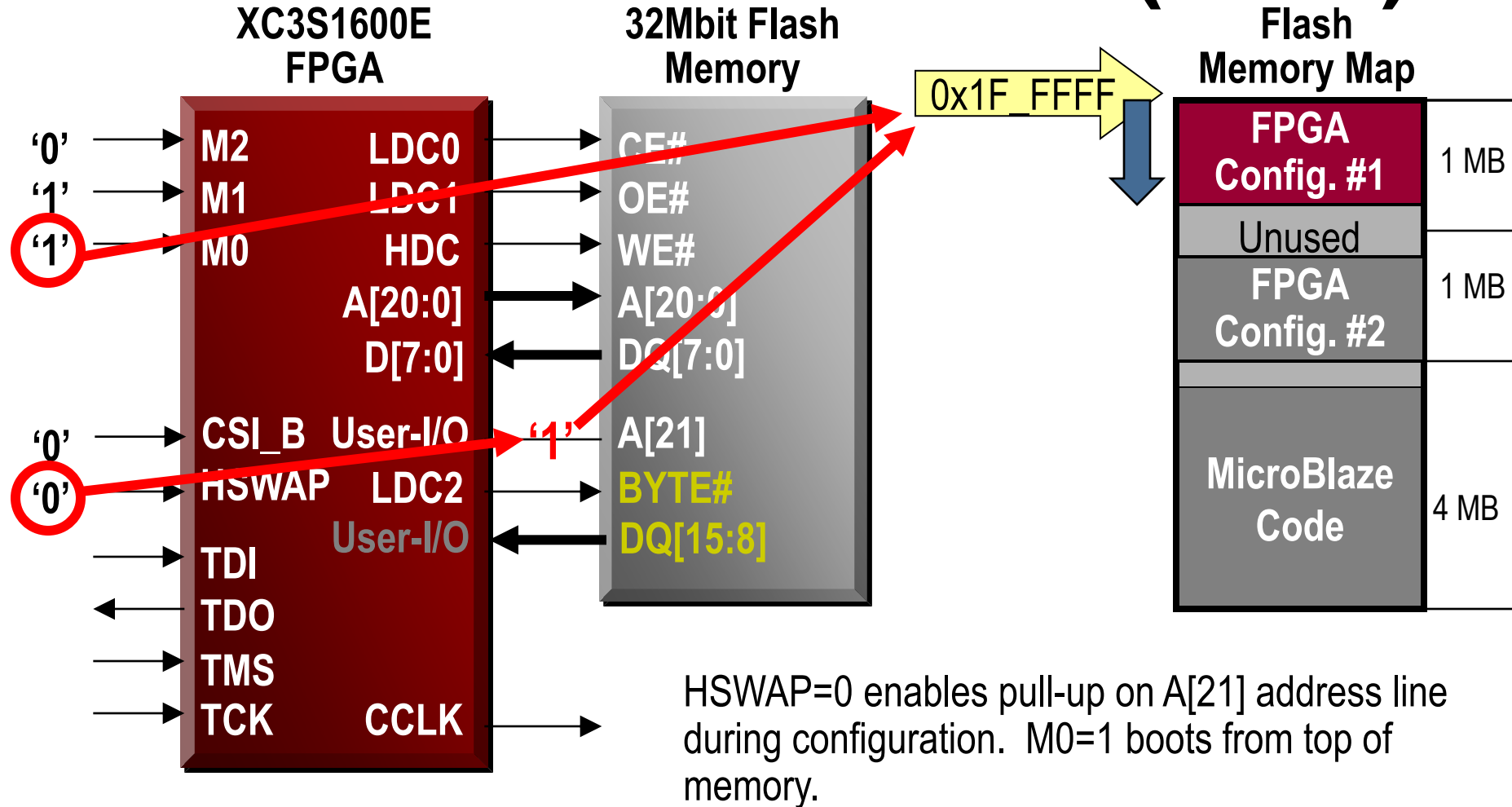


# Multi-Boot Mode Applications

- New mode based on customer requests
  - Diagnostics then Operation configurations
  - “Golden” vs “Enhanced” configurations
  - Spartan-3E provides both solutions
- Any two mutually-exclusive FPGA designs
- Only supported with BPI Up or Down modes
- See alternative Platform Flash/CPLD solution

[XAPP693: A CPLD-Based Configuration and Revision Manager for Xilinx Platform Flash PROMs and FPGAs](#)

# Using MultiBoot with Embedded MicroBlaze Processor (Boot)

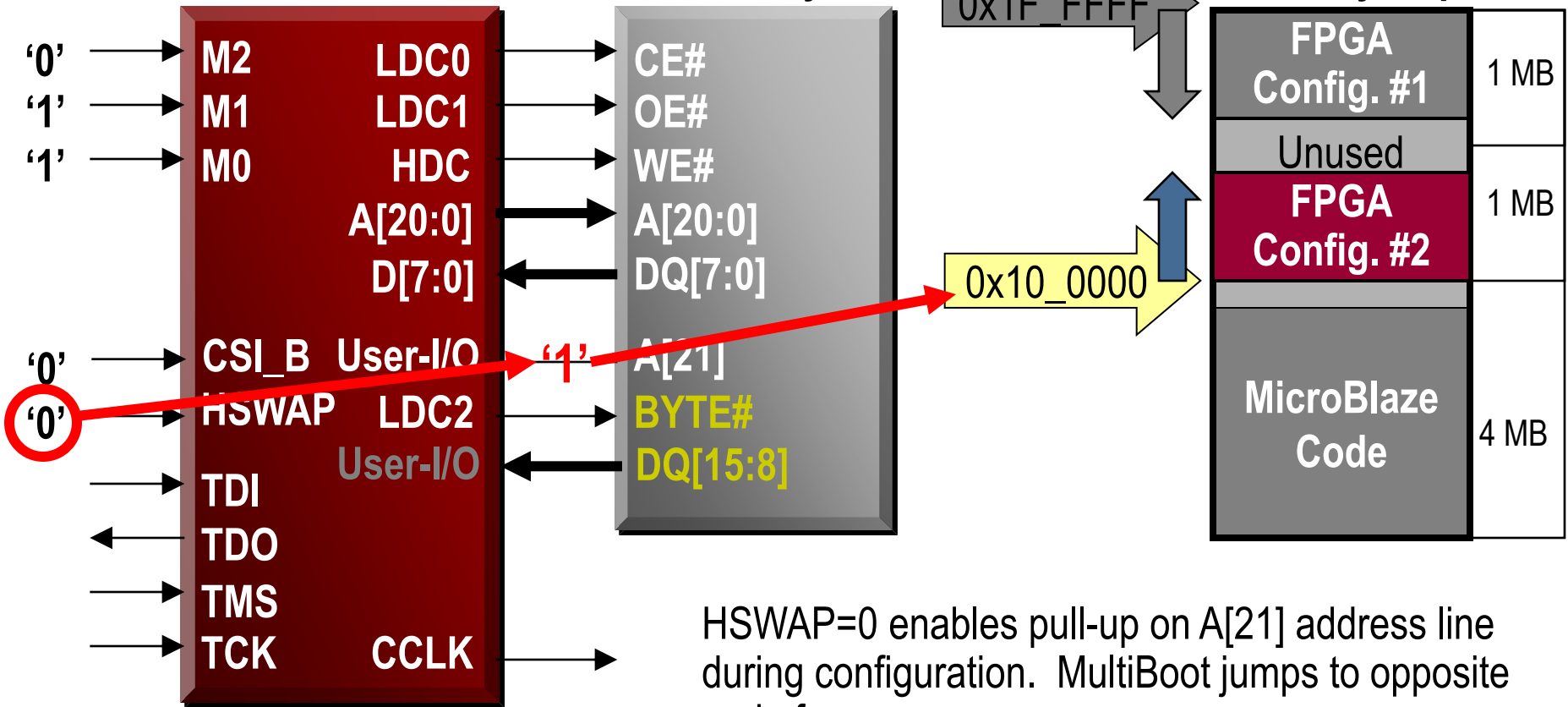


# Using MultiBoot with Embedded MicroBlaze Processor (MultiBoot)

XC3S1600E  
FPGA

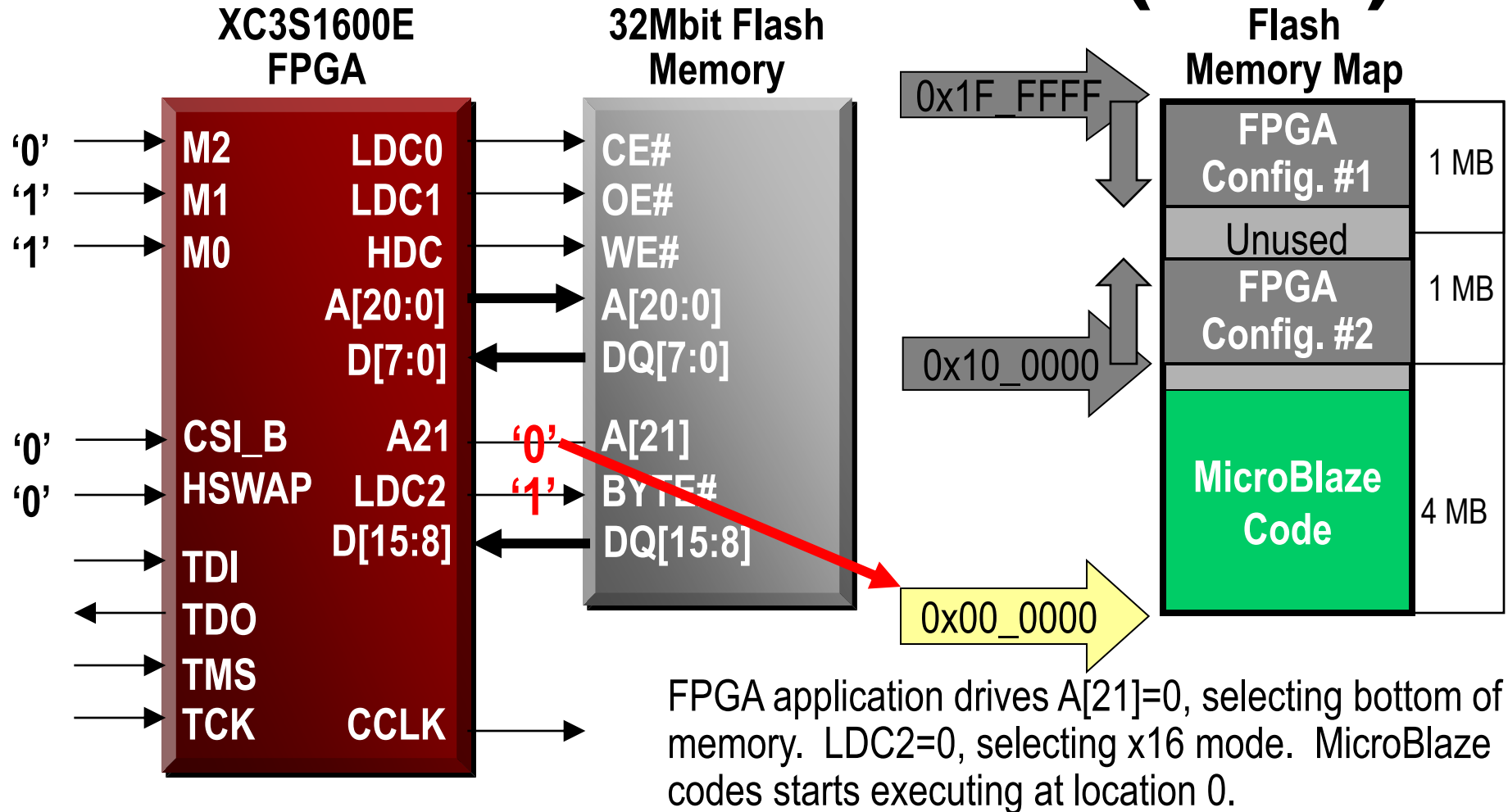
32Mbit Flash  
Memory

Flash  
Memory Map



HSWAP=0 enables pull-up on A[21] address line during configuration. MultiBoot jumps to opposite end of memory.

# Using MultiBoot with Embedded MicroBlaze Processor (User)



# Resources for the Next Step...

- Download Spartan-3E information at [www.xilinx.com/spartan3e](http://www.xilinx.com/spartan3e)
  - For Spartan-3E data sheet, click “Data Sheets” link under “Documentation”
  - For Spartan-3E application notes, click “Application Notes and Reference Designs” link under “Documentation”
- Download Platform Flash information at [www.xilinx.com/platformflash](http://www.xilinx.com/platformflash)
- Purchase Prototype Devices – [www.xilinx.com/store](http://www.xilinx.com/store)
- Purchase Hardware Kits - [www.xilinx.com/xob](http://www.xilinx.com/xob)
- Download & Purchase Design Tools - [www.xilinx.com/ise](http://www.xilinx.com/ise)

# Spartan Low-Cost Starter Kits

## Spartan-3E Starter Kit Features

- Spartan-3E 500Kgate XC3S500E FPGA
- Multiple Memory Types
  - 32 Mbit Parallel Flash
  - 8 Mbit SPI Flash
  - 32MByte DDR SDRAM
- Expansion & I/O Interfaces
  - Ethernet 10/100 PHY
  - USB 2.0 PHY+Controller
  - 3-bit, 8-color VGA display port
  - 9-pin RS-232 Serial Port, PS/2 port
- Design & Support Tools
  - Power Supply
  - JTAG Programming Cable
  - Evaluation software
  - Reference Designs



**\$149 Spartan-3E Kit available Q4CY05**

**\$99 Spartan-3 Kit available now**