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On-The-Go

USB On-The-Go Overview

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Today's Agenda

- 0900 Introduction – Eric Huang, Synopsys
- 0930 OTG Overview – Mark Saunders, Mentor
- 1015 OTG Compliance – Chris Wang, TDI
- 1100 Break
- 1115 System Software – Joe Meza, TDI
- 1200 Lunch
- 1330 Embedded Host / Multiple Receptacles – Bill McInerney, TDI
- 1415 PHY interfaces
  - Ian Parr, Mentor
  - Shaun Reemeyer, Philips
  - Hyun Lee, TDI
- 1500 Adjourn

Overview Outline

- A brief history of USB OTG
- Why USB OTG?
- What is USB OTG – how is it different from USB?
- Focus group results and proper messaging
- Feature Tradeoffs – Real life application example
- Market adoption

New USB OTG Logos

USB 2.0 On-The-Go Certification Available at Labs & Plugfests

Hi-Speed USB 2.0 On-The-Go Certification Available Early 2005

A Brief History of USB OTG Specifications

- USB OTG Design and Compliance Specifications authored by ACON, Cypress, Ericsson, Hewlett-Packard, Intel, MCCI, Mentor, Microsoft, Motorola, NEC, Nokia, Onspec, Palm, Philips, PMTC, Qualcomm, SoftConnex, Synopsys, Texas Instruments, TransDimension
- USB On-The-Go Supplement 1.0 released in 2001
  - Revision 1.0a released July 9, 2003
- USB OTG compliance specification released February 22, 2003
- Full-Speed USB OTG silicon and IP Certified
  - Began October 2003
  - Plugfests
  - Independent Labs

A Brief History of USB OTG Building Block Announcements

- Multiple USB OTG controller chips announced by Cypress, Epson, Philips and TransDimension
- Multiple USB OTG IP Core designs announced by ChipIdea, Mentor, Synopsys, TransDimension (ARC)
- System on a Chip (SOCs) implementations including USB OTG announced by ATI, NEC, Portal Player, Qualcomm ST and Texas Instruments

Why USB On-The-Go?

- Clear need for connectivity in mobile devices
- However, connectivity is in a state of disarray with literally dozens of proprietary connection methods
- Current disarray leads to higher costs
  - proprietary cables and cradles
  - product variants for each proprietary interface
  - even USB has been used in non standard ways!

Models for each Interface

Example: Stowaway Portable Keyboards (Actual Products)

…for Palm / Handspring

…for Sony CLIE Handhelds

…for Compaq IPAQ

Proprietary cradles

- Proprietary expansion ports, cradles
  - Examples - iPaq & Jornada sleds, cradles for just about every cellular phone

Various proprietary and "standard" cables

Sync Cable for IPAQ

Sync Cable for Palm

Sync Cable for Casio

Sync Cable for Motorola phone

Sync Cable for HP Jornada

USB On-The-Go defines a new connection paradigm

Existing PC with USB host

Cellular Phone

Connects to PC as a device

Existing digital camera with USB device capability

New functionality via USB OTG

Connects to camera as host

Application Examples

Host	Peripheral	Application
Mobile Phone	Mobile Phone	Exchange contact information
	Still Image Camera	Email pictures, upload pictures to web
	MP3 Player	Upload/download/broadcast music
	Mass Storage	Upload/download files
	Scanner	Scan business cards
Still Image Camera	Still Image Camera	Exchange pictures
	Mobile Phone	Email pictures, upload pictures to web
	Printer	Print pictures
	Mass Storage	Store pictures
Printer	Still Image Camera	Print pictures
	Scanner	Print scanned image
	Mass Storage	Print files stored on device
MP3 Player	MP3 Player	Exchange songs
	Mass Storage	Upload/download songs

Application Examples - more

Host	Peripheral	Application
AutoPC	MP3 player	Play audio in car
	Mobile Phone	Hands free over stereo
PDA	PDA	Exchange files
	Printer	Print files
	Mobile Phone	Upload/download files
	MP3 Player	Upload/download songs
	Scanner	Scan pictures
	Mass Storage	Upload/download files
	GPS	Obtain directions, mapping information
	Still Image Camera	Upload pictures

A Day in Life with USB OTG

All with one $10, “low profile” cable…

Purchase MP3 & store on cell phone

MP3 playback

Download digital photo into cell phone

Email

Photo printing

What is USB On-The-Go?

- Supplement to USB 2.0 specification
- Extends device only products to include host (master) capability
- Gives dual role (host & peripheral) capability to increasingly intelligent platforms, on same port
  - Examples: PDAs, Set top boxes and Home gateways
- Result is “point-point” USB from a users perspective
- Supports 12 Mbits/sec and 1.5 Mbit/sec transfer rates
  - 480 Mbits/sec optional

What changes does USB On-The-Go require?

- Defines a reduced connector size
- Reduces power consumption
  - 8 ma <= Current supplied <= 500 ma
  - Many designs are battery-powered devices
  - Non-portables can be USB OTG too – may even supply 500 mA
- Adds protocol for dynamic switching between host and device (HNP)
- Session request protocol (SRP)
  - USB bus power can be turned off/on at the discretion of the A-Device
- Targeted peripheral list

Device Capability Comparison

- USB OTG Products
  - Must act as a standard Certified USB Peripheral
- USB Peripherals
  - Passes USB 2.0 Certification for peripherals.

A peripheral
is a peripheral
is a peripheral

Host Capability Comparison

- USB OTG Products
  - Must source 8mA minimum on Vbus
  - Targeted Peripheral List
  - Generally a limited number of drivers made available because of variations in OS and Hardware
  - May or may not be able to load more drivers
  - May or may not have a display for messaging
  - PCI is typically not present
- USB Host in Standard PCs
  - Sources 500mA on Vbus
  - Supports devices for which it has drivers
  - Always has a mechanism to load more drivers
  - Standardized PCI host interfaces

Device Types

- A-Devices (Host or Master)
  - mini-A plug inserted (ID pin shorted)
  - Supplies power on VBUS
  - Default master
  - Must source at least 8 mA (can be more)
- B-Device (Device or Slave)
  - mini-B plug inserted (ID pin floating)
  - Default slave
  - May consume up to 8 mA if bus powered

Software Considerations

- USB-IF has approved ~16 Device Classes
- Some classes are not generic
  - e.g. printer, CDC
  - Need for conformity in device classes
- Allows manufacturers to specify exactly which peripherals are supported
  - e.g. own products

USB OTG Application Example – Smart Phone

- Smart Phone manufacturer wants to support Active Sync capability when operating as a peripheral and connected to a PC
  - Smart Phone acts as a USB peripheral to connect to a PC
- Smart Phone manufacturer wants to support connection to existing USB cameras, keyboards and flash card readers when operating as a host
  - Smart Phone to act as a USB OTG host to a camera, keyboard, and flash card drivers
- Assume that previous version of the smart phone already has support for USB peripheral only

USB OTG Application Example – Smart Phone New Requirements

- Hardware – New Hardware Controller
- Software
  - USB OTG Host Stack
    - For OS and Hardware Platform
  - USB OTG Host Class Driver
  - USB OTG Application

USB OTG Application Example – Smart Phone

- Hardware Controller Requirements
  - Existing device-only controller must be upgraded to a USB OTG dual-role controller
  - Controller Options
    - Discrete controller
    - IP core with a discrete transceiver
    - IP core with an integrated transceiver

USB OTG Application Example – Smart Phone

- Power Requirements
  - DSC – typically 0-10mA (self-powered peripheral)
  - Keyboard – typically 30-45mA with all LEDs turned on (bus powered peripheral)
  - Flash reader – typically 40-50mA (bus powered peripheral)
  - Implementation would require a 50mA 5V source for Vbus

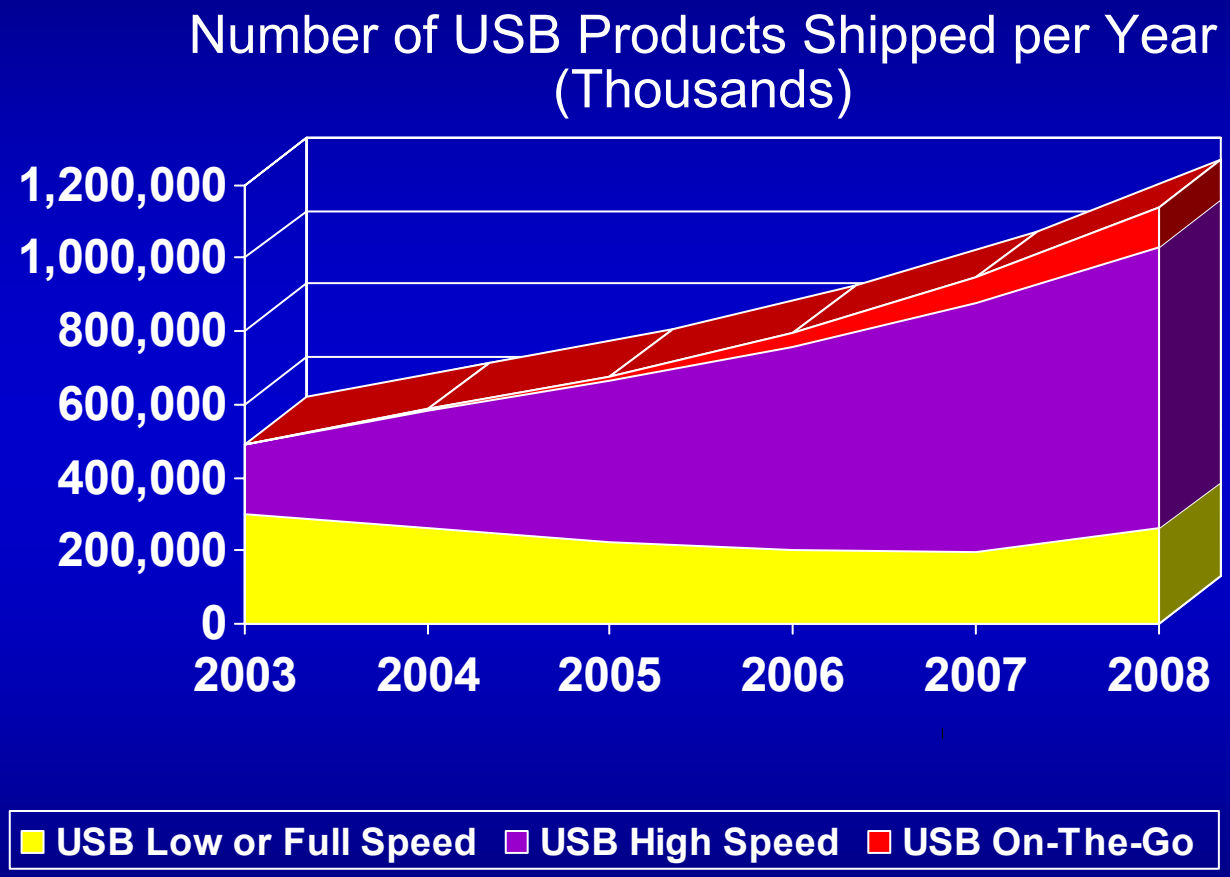
USB OTG Application Example – Smart Phone

- Software Requirements
  - Host Stack is required because of the multiple driver requirement
  - Class Drivers for attached peripherals
    - Full HID class driver for keyboards
    - Mass Storage class driver for flash reader
    - Class and device drivers for digital still camera support
      - Mass Storage
      - PIMA
      - Proprietary
      - Depends on which cameras the manufacturer decides to support
  - ActiveSync software – device stack optional
  - Transceiver driver to perform USB OTG functions

Major Developments in the USB OTG Market

- USB ports predicted to grow to 4.3 Billion by 2007 – In-Stat.
- USB OTG in cellular handset chipsets
  - Announcements by Qualcomm, TI, NEC, and Motorola
  - Potential widespread adoption
- PDAs - rapid adoption
  - ATI Imageon 2300 chipset features USB OTG
  - Sony Clie' USB OTG announcement using Philips Chip
- Significant design activity in Digital Still Cameras (DSCs), Printers, MP3 Players and other mass storage devices
- USB plugfests
  - Full-Speed USB OTG Compliance program is complete
  - Hi-Speed USB OTG Compliance targeted for the end of 2004

Increasing annual USB Shipments



Source: In-Stat/MDR February 2004

500+million units shipped in 2003

Over 1.1 billion units shipped annually by 2008

USB OTG Market Update

- There are over 1.4 Billion USB products in the marketplace today
- USB OTG is being rapidly adopted now
- All of the building blocks are in place today
  - Specifications and Compliance Program
  - Controllers, IP Blocks, Software
  - Testing Tools
  - Logos

For More Information

Visit the USB-IF OTG Web Site:

- http://www.usb.org/developers/onthego/
- USB OTG Working Group Chair
  - Eric Huang, Ehuang@Synopsys.com
- Face-To-Face Meetings every 2 months

- Sources:
  - USB 2004: The Bus Rolls On, March 2004, Brian O'Roarke, InStat MDR, www.instat.com
  - USB On-The-Go Technology and Report, October 2003, John W. Koon et al., Tech Idea International, www.techidea.net
  - www.usb.org