



Certified Wireless USB Compliance

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Agenda

- Compliance Program Goals
- Compliance Process
- Compliance Devices
- Test Areas
 - WiMedia
 - WiMedia Mac
 - WiMedia Coexistence (Mac Convergence Architecture)
 - Wireless USBCV
 - HWA
 - DWA
 - Physical Layer
- Summary

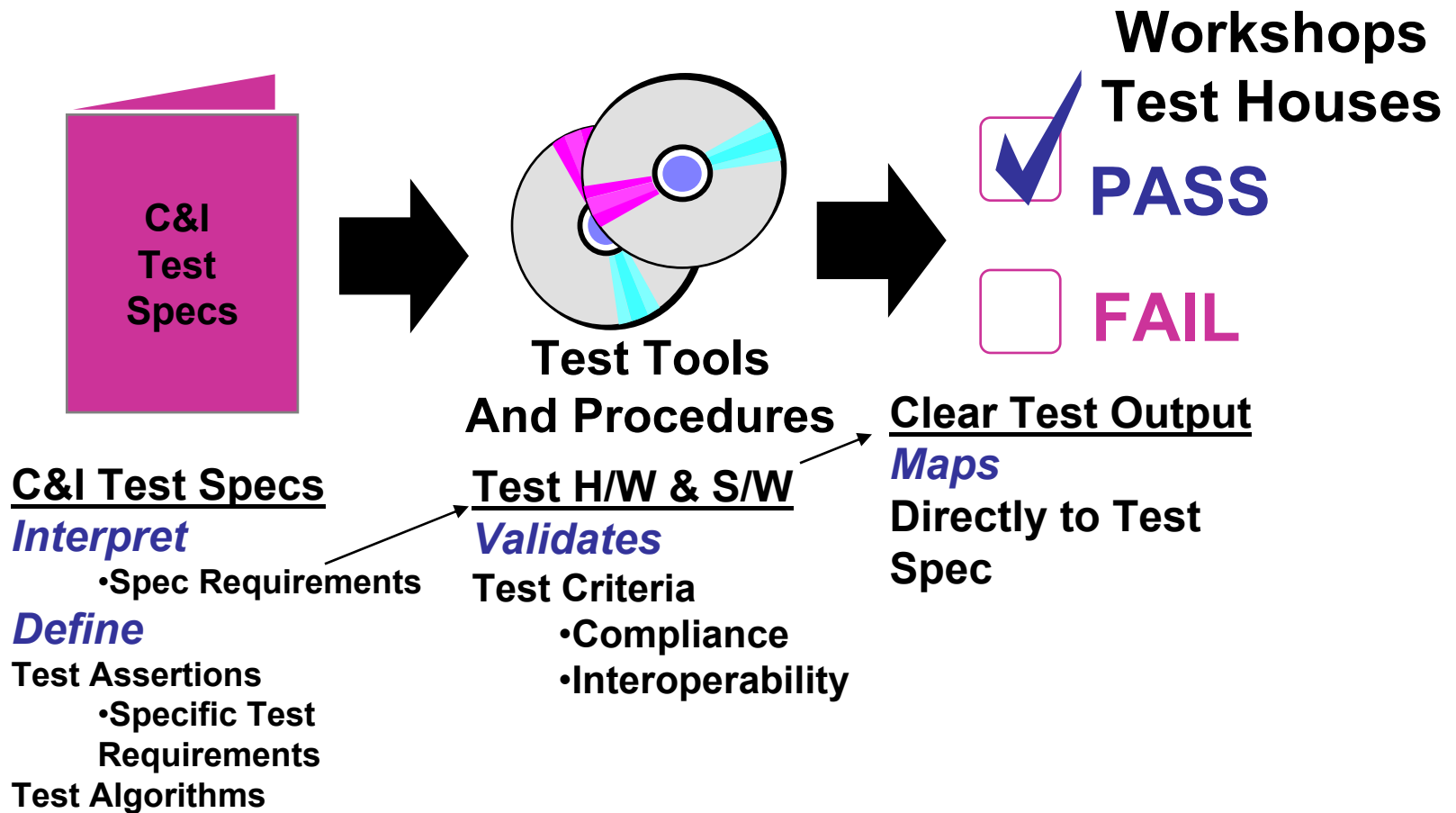
Compliance Program Goals



- **High Quality Certified Wireless USB Products**
- **Stable, Repeatable, Well Documented Tests**
 - Documented Test Procedures
 - Documented Test Assertions and Descriptions
- **Instantly Available Testing (Qualified Test Houses)**
- **Reuse USB 2.0 Compliance Program Infrastructure**
 - Extend and Reuse USBCV
 - Reuse Existing Compliance Devices (DWA testing)
 - Extend Compliance Device Infrastructure (HWA testing)
 - Extend and Reuse Test Services Infrastructure
- **Minimize Test Equipment Costs**
 - Use Over the Air Test Methods
 - Avoid Expensive Equipment As Possible
- **Full End Product Test Coverage Provided at Workshops**
 - USB Workshops Provide WiMedia Compliance Tests

Repeat Success Of USB 2.0 Compliance Program

Certified Wireless USB Compliance Process



Predictable Path To Compliance
Same Model as USB 2.0 Compliance Program

Certified Wireless USB Logo



Passing Compliance Enables Use Of Logo

Test Spec – Test Assertions



- Test assertions provide specific test requirements with spec references
- Simple set of 'yes/no' questions
- Test specs will be available on USB-IF website

7.3.1.8#6	A device must support Loopback_Data_Read() for any data length less than or equal to the largest max packet size of all of the devices endpoints.	
7.3#2	All devices must use the base rate for all standard requests (except for data loopback requests).	

Test Spec – Test Descriptions



- Test descriptions provide detailed algorithmic level descriptions of how test suites test specific test assertions
- Example test description (Summary)
- Explicit host initiated disconnect test
 - Place device in desired starting state
 - Send 3 consecutive MMCs with WDEV_DISCONNECT_IEs.
 - Vary MMC Size
 - Vary MMC Spacing
 - Verify device does not respond to standard requests after disconnect

Test Categories And Specs



- Device Tests
 - WUSBCV – Device tests that can be performed with a standard host
 - WUSBCV+ - Device tests that require a test device or analyzer listening to traffic with standard host
 - WUSBCV++ - Device tests that require a custom host with full timing control, etc. (and a test device listening)
 - Physical Layer (For End Products) – End product tests that can be done with simple test device.
 - WiMedia MAC(Self Beaconsing Devices) – Tests for WiMedia MAC beacon and coexistence requirements
- DWA
 - Standard Certified Wireless USB Device Tests – Device tests listed above
 - USBCV Functional Hub Tests – Functional USBCV Hub Tests adapted as necessary to run on DWA
 - Physical Layer (For End Products) - End product tests that can be done with simple test device.
 - WiMedia MAC (Self Beaconsing DWAs) - Tests for WiMedia MAC beacon and coexistence requirements
 - DWA descriptor tests – Tests of DWA specific descriptor features (part of WUSBCV)
 - DWA functional tests – Tests that use a wired test device to perform transfers of all supported types with various protocol boundary conditions. (Most tests will be silicon only)

Test Categories And Specs



- HWA –
 - Standard USB 2.0 wired device tests
 - Physical Layer (For End Products) - End product tests that can be done with simple test device.
 - WiMedia MAC - Tests for WiMedia MAC beacon and coexistence requirements
 - HWA descriptor tests – Tests of HWA specific descriptor features (part of WUSBCV)
 - HWA functional tests – Tests that use a wireless test device to perform transfers of all supported types with various protocol boundary conditions. (Most tests will be silicon only)
- Generic (embedded) Host
 - WiMedia MAC - Tests for WiMedia MAC beacon and coexistence requirements
 - TBD



Test Spec Status

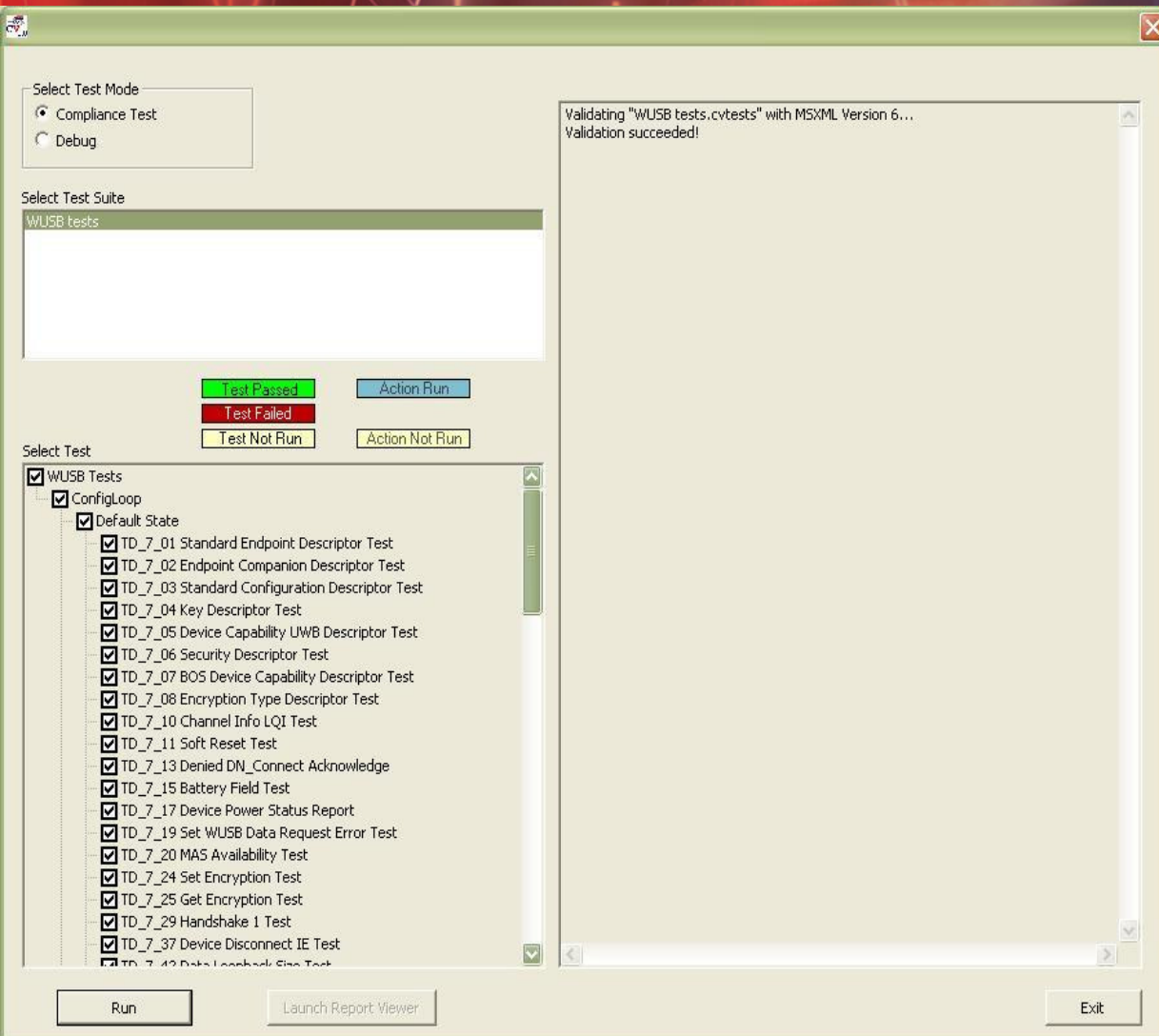
- WUSBCV (Device) Test Spec
 - 1.0 RC released for member review.
 - <http://www.usb.org/members/wusb/>
- DWA Test Spec
 - 1.0 RC released for member review
 - <http://www.usb.org/members/wusb/>
- HWA Test Spec (non Radio Control)
 - 1.0 RC Release in early Q3
- HWA Radio Control
 - 1.0 RC Mid Q3
- Association Model Test Spec
 - 1.0 RC Mid Q3

Compliance Devices



- Transmit Capabilities
 - All specified data rates.
 - All required transmit power control states
 - Transmit time control
 - Transmit packets at specified microsecond
 - Queue multiple packets and transmit times to allow full superframe control
 - Full control of transmitted data (except PHY headers)
 - Inject errors
- Receive Capabilities
 - Full receive at speed.
 - All data (except PHY headers) available to software.
 - LQI measurement (and reporting)
- Framework
 - USB 2.0 Compliance device framework
 - Extensions for Wireless specific testing

Wireless USB Extends USBCV



- New Test Execution App For All Test Suites
- Adds Chapter 7 Tests For Wireless USB Specification
 - Security Framework
 - Directed Beaconing Commands
 - Wireless USB Specific Descriptors
 - Information Element Processing
 - Device Notifications

Wireless USBCV Extends Existing USBCV Tool

WUSBCV Sample Test



- Data loopback
 - Read device configuration descriptor
 - Calculate largest maximum packet size across all endpoints
 - Perform Data Loopback Write and Read sequences across all repeating byte patterns and packet sizes up to maximum
 - Repeat with all supported data rates
 - May enforce a minimum retry rate per data rate for set distance in compliance environment

**WUSBCV is not just descriptor tests.
Everything you can do with a standard host.**

Wireless USBCV – Running Tests



Real Time Test Results Real Time Text Log

The screenshot displays the USB Command Verifier software interface. On the left, the 'Select Test' list includes various tests such as 'WUSB Tests', 'ConfigLoop', and 'Default State'. A legend indicates 'Test Passed' (green), 'Test Failed' (red), and 'Test Not Run' (yellow). The 'Real Time Test Results' section shows a list of tests, with several highlighted in green, indicating they have passed. The 'Real Time Text Log' on the right displays the output of the tests, including details about UWB descriptors and test results. An 'Interactive Prompts' dialog box is overlaid on the interface, displaying the message 'Reconnect the Device. Click OK when done.' and an 'OK' button.

Select Test Mode
 Compliance Test
 Debug

Select Test Suite

Select Test

- WUSB Tests
 - ConfigLoop
 - Default State
 - TD_7_01 Standard Endpoint Descriptor Test
 - TD_7_02 Endpoint Companion Descriptor Test
 - TD_7_03 Standard Configuration Descriptor Test
 - TD_7_04 Key Descriptor Test
 - TD_7_05 Device Capability UWB Descriptor Test
 - TD_7_06 Security Descriptor Test
 - TD_7_07 BOS Device Capability Descriptor Test
 - TD_7_08 Encryption Type Descriptor Test
 - TD_7_10 Channel Info LQI Test
 - TD_7_11 Soft Reset Test
 - TD_7_13 Denied DN_Connect Acknowledge
 - TD_7_15 Battery Field Test
 - TD_7_17 Device Power Status Report
 - TD_7_19 Set WUSB Data Request Error Test
 - TD_7_20 MAS Availability Test
 - TD_7_24 Set Encryption Test
 - TD_7_25 Get Encryption Test
 - TD_7_29 Handshake 1 Test
 - TD_7_37 Device Disconnect IE Test
 - Addressed State

Test Passed
Test Failed
Test Not Run

USB Command Verifier

Reconnect the Device. Click OK when done.

OK

UWB Descriptor field bmAttributes bits 7:4 : 0x0
UWB Descriptor field bmAttributes bits 3:2 : 0x2
UWB Descriptor field PHYRates bits 15:8 : 0x0
UWB Descriptor field bmBandGroup bit 0 : 0x1
UWB Descriptor field bmBandGroup bits 15:5 : 0x1
UWB Descriptor field bReserved : 0x0
Stopping Test [TD_7_05 Device Capabilities On UWB Descriptor Test (Configuration Index 0) : Number of: Fails (0); Aborts (0); Warnings (0)]

Now Starting Test: TD_7_06 Security Descriptor Test (Configuration Index 0)

bLength : 0x5 .
wTotalLength : 0xa .
bNumEncryptionTypes : 0x1

or Test (Configuration Index 0) ings (0)]

ound : 0x1
Number of: Fails (0); Aborts (0); Warnings (0)]

ypes Descriptor Test (Configuration Index 0)

Encryption Types Descriptor Test (Configuration Index 0)

Stopping Test [TD_7_08 Encryption Types Descriptor Test (Configuration Index 0) : Number of: Fails (0); Aborts (0); Warnings (0)]

Now Starting Test: TD_7_10 Channel Info and LQI Get-Status Test

Retrieving Device Power information.
Setting transmit power to full strength.
Setting transmit power to lower setting.
Stopping Test [TD_7_10 Channel Info and LQI Get-Status Test : Number of: Fails (0); Aborts (0); Warnings (0)]

Abort Launch Report Viewer Exit

Interactive Prompts

Wireless USBCV Tests Finished



Full Pass/Fail Summary

Select Test Mode
 Compliance Test
 Debug

Validate Test Suite only

Select Test Suite

Test Passed (green)
Test Failed (red)
Test Not Run (yellow)
Action Run (blue)
Action Not Run (yellow)

- Select Test
- WUSB Tests
 - ConfigLoop
 - Default State
 - TD_7_01 Standard Endpoint Descriptor Test
 - TD_7_02 Endpoint Companion Descriptor Test
 - TD_7_03 Standard Configuration Descriptor Test
 - TD_7_04 Key Descriptor Test
 - TD_7_05 Device Capability LWB Descriptor Test
 - TD_7_06 Security Descriptor Test
 - TD_7_07 BOS Device Capability Descriptor Test
 - TD_7_08 Encryption Type Descriptor Test
 - TD_7_10 Channel Info LQI Test
 - TD_7_11 Soft Reset Test
 - TD_7_13 Denied DN_Connect Acknowledge
 - TD_7_15 Battery Field Test
 - TD_7_17 Device Power Status Report
 - TD_7_19 Set WUSB Data Request Error Test
 - TD_7_20 MAS Availability Test
 - TD_7_24 Set Encryption Test
 - TD_7_25 Get Encryption Test
 - TD_7_29 Handshake 1 Test
 - Addressed State

Now Starting Test: TD_7_24 Set_Encryption Test
(7.3.2.2.1#0) A device must respond to Set_Encryption() with a Request Error if Encryp Device did not Request Error when sent Set Encryption with an invalid EncryptionValue.
(7.3.2.2.4#0) A device must respond to Set_Encryption() with Request Error if wIndex i Device did not Request Error when sent Set Encryption with a wIndex of 0x4.
Stopping Test [TD_7_24 Set_Encryption Test
: Number of: Fails (2); Aborts (0); Warnings (0)]

Now Starting Test: TD_7_25 Get_Encryption Test
Get Encryption returned an unexpected error.
(7.3.2.3.4#0) A device must return WIRED from Get_Encryption() with Request Error if
Stopping Test [TD_7_25 Get_Encryption Test
: Number of: Fails (1); Aborts (0); Warnings (0)]

Test Results
Test suite Failed
OK

Test: TD_7_29 Handshake 1 Test
Handshake 1..
succeeded
Handshake 1..
succeeded after device responded to Handshake 1
Handshake 2..
Handshake2 succeeded
Attempting Handshake 1..
Handshake1 succeeded after device responded to Handshake 2
Attempting Handshake 2..
Handshake2 succeeded
Attempting Handshake 3..
Handshake3 succeeded
Attempting Handshake 1..
Handshake1 succeeded after device responded to Handshake 3
Attempting Handshake 1 with illegal values..
Handshake1 with illegal wValue(127) failed (correct behavior).
Handshake1 with illegal wIndex(127) failed (correct behavior).
Stopping Test [TD_7_29 Handshake 1 Test
: Number of: Fails (0); Aborts (0); Warnings (0)]

Summary Log Counts [Fails (13); Aborts (0); Warnings (0)]

Detailed HTM Log



Wireless USBCV – HTML Log

WORKSTATION: HAWK-3000-HT
DATE: Friday, June 16, 2006
TIME: 09:21:30 AM
OPERATOR: gtomlms
NUMBER OF TESTS: 18
RESULT: [failed](#)

Time Stamp, Machine Info, Test Summary

Initialize TestSuite

```
INFO Microsoft Windows XP (Build 2600)
INFO Service Pack 2.0
INFO Initialize TestSuite Succeeded.
INFO Initializing Device!
```

TD_7_01 Standard Endpoint Descriptor Test

```
INFO Now Starting Test: TD_7_01 Standard Endpoint Descriptor Test (Configuration Index 0)
INFO Testing Interface number : 0 Alternate setting : 0
INFO Endpoint Type : Bulk, Number : 1, Direction : IN
INFO bEndpointAddress.EndpointNumber set to : 0x1
INFO Endpoint size : 0x7
INFO Endpoint Interval : 0x0
INFO Endpoint bmAttributes field : 0x2
INFO Endpoint Type : Bulk, Number : 1, Direction : OUT
INFO bEndpointAddress.EndpointNumber set to : 0x1
INFO Endpoint size : 0x7
INFO Endpoint Interval : 0x0
INFO Endpoint bmAttributes field : 0x2
INFO Stopping Test [ TD_7_01 Standard Endpoint Descriptor Test (Configuration Index 0)
: Number of: Fails (0); Aborts (0); Warnings (0) ]
```

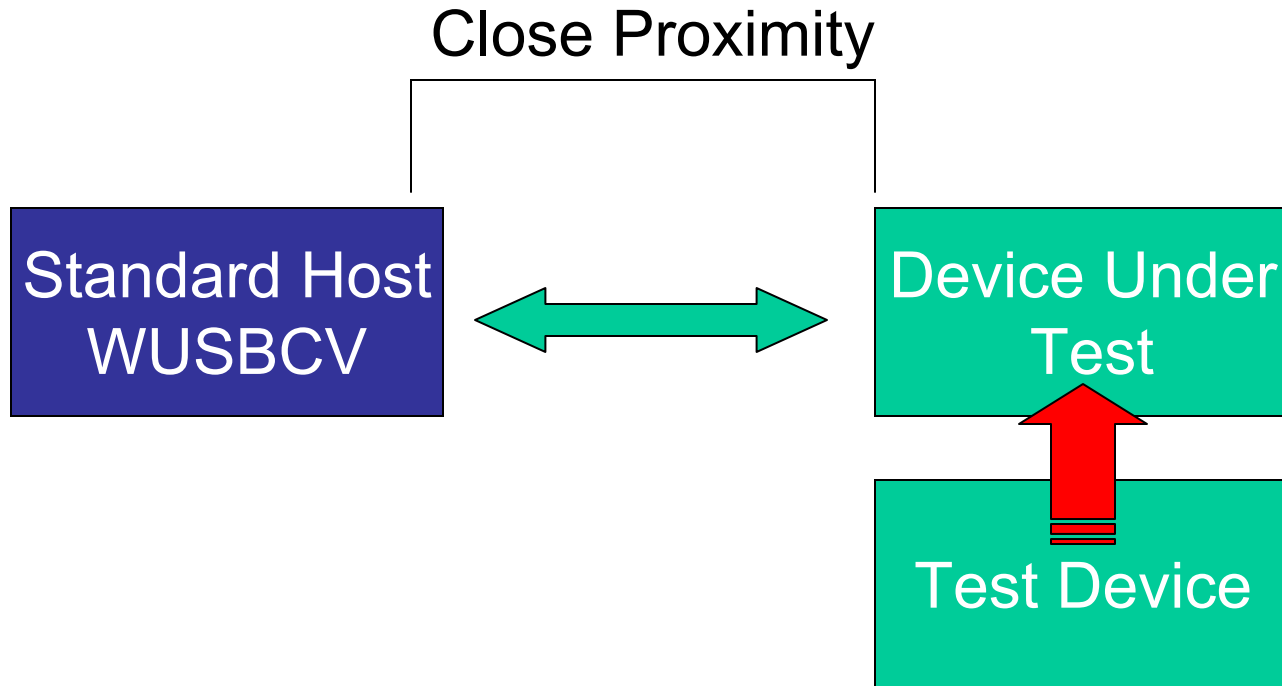
TD_7_02 Endpoint Companion Descriptor Test

```
INFO Now Starting Test: TD_7_02 Endpoint Companion Descriptor Test (Configuration Index 0)
INFO Testing Interface number : 0 Alternate setting : 0
INFO Endpoint Type : Bulk, Number : 1, Direction : IN
INFO Max Burst Size : 0x10
INFO Max Sequence Number : 0x20
INFO Testing Endpoint Companion :
INFO bLength : 0xa
INFO bDescriptorType : 0x11
INFO bMaxBurst : 0x10
INFO bCompAttributes bits 1:0 : 0x0
INFO Endpoint Type : Bulk, Number : 1, Direction : OUT
INFO Max Burst Size : 0x10
INFO Max Sequence Number : 0x20
INFO Testing Endpoint Companion :
INFO bLength : 0xa
INFO bDescriptorType : 0x11
INFO bMaxBurst : 0x10
INFO bCompAttributes bits 1:0 : 0x0
INFO Stopping Test [ TD_7_02 Endpoint Companion Descriptor Test (Configuration Index 0)
: Number of: Fails (0); Aborts (0); Warnings (0) ]
```

TD_7_03 Standard Configuration Descriptor Test

Detailed Test Behavior. Pointers To Test Spec For Failures

WUSBCV Stress Test Setup

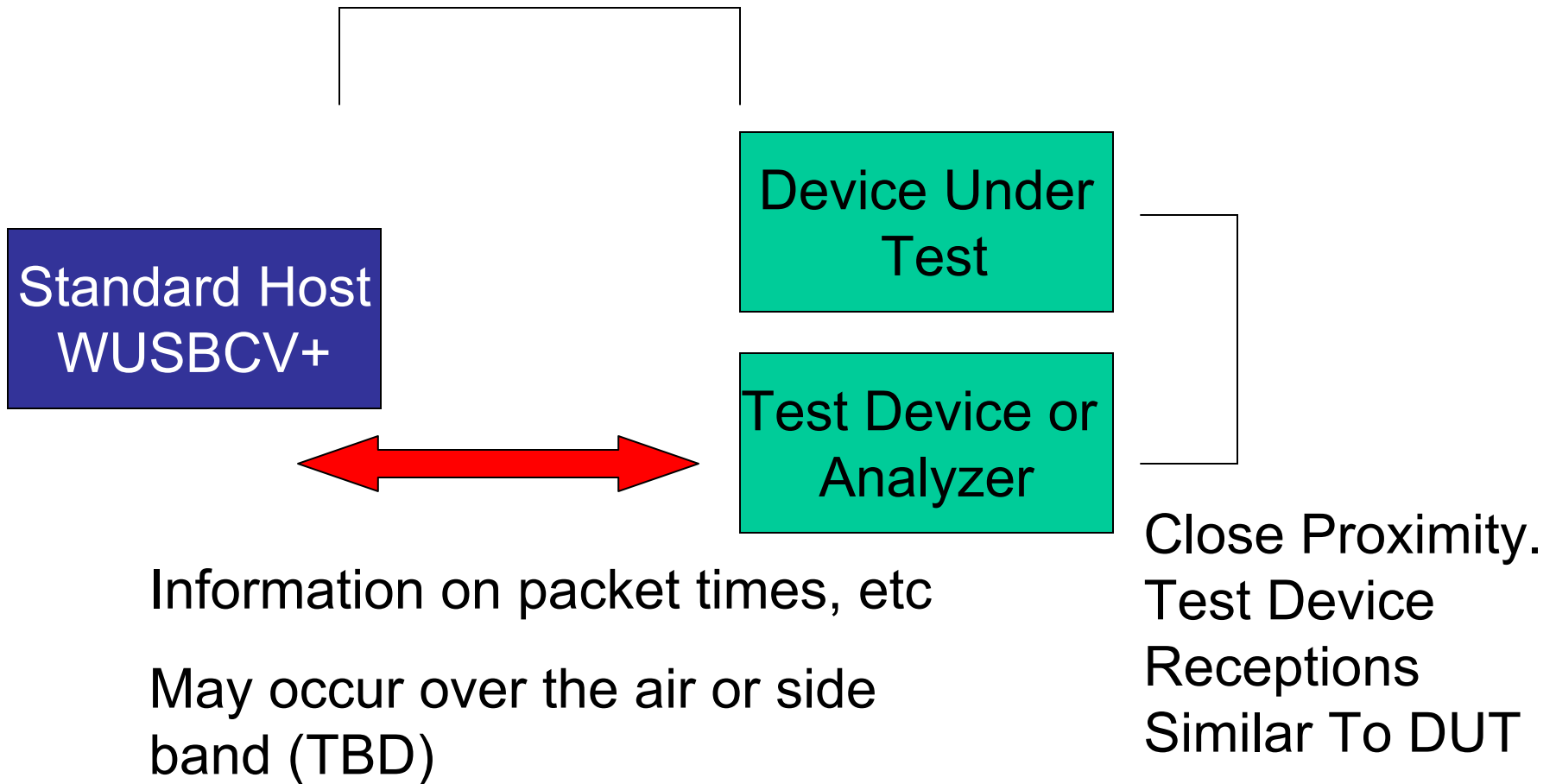


Test device blasts interference during standard WUSBCV descriptor tests, etc. Verify that tests still complete properly under high error rates

WUSBCV+ Test Setup



Close Proximity - Clean Environment



WUSBCV + Test Summary



- Verify data rate of packets
 - Notifications
 - Control traffic
 - Handshakes
 - Beacons or directed beacon transmissions
 - Loopback traffic
- Transmit power level
- Timeslot boundaries
 - Boundaries are not crossed
 - Device start transmitting at beginning of timeslots (within tolerance)
- Random selection of DNTS slots
- Protocol format details
 - Secure packet encryption offsets are correct per spec

WUSBBCV+ Test Example 1



- Random Selection of DNTS Slots
 - Device under test connected to test host.
 - Host sends Device KeepAlive IE
 - Test software setup to not respond to Device DN_ALIVE notifications
 - Host varies DNTS frequency and number slots.
 - Test device listens and notes slots used for DNTS.
 - Possible “Random” slot use verified over small time period.

WUSBCV ++ Test Summary



- Vary MMC spacing
 - Up to 65535 microseconds.
 - WUSBCV will approximate by varying host reservation and traffic load with standard host
 - Vary frequency of MMCs used for control traffic (every, every other, etc).
 - Vary MMC size and location of device under test information.
- Vary transmit bit rate within a burst to device.
- IE Parameters
 - Varied MMC size and IE location within MMC
 - Varied IE frequency for repeated IEs (every MMC, every other, etc)
 - Maximum size of IEs and location of DUT information.
- Vary fields device must ignore
 - Example - When a device receives a WDTCTA addressed to one of its endpoints with the `bmTXAttributes.ControlStatusStage` field set it must ignore `bmAttributes.Direction`.
- MISC
 - A device must start listening `tGuardTime` before scheduled slot.
 - A device must disconnect if its computed MIC does not match host.



Test Coverage

- Compliance is not a replacement for validation
- WUSBCV will attempt to approximate variations that could occur across all hosts (MMC spacing, frequency of MMC use, etc) - but full coverage will not be possible with standard host
- For example - It is unlikely WUSBCV++ will be developed for compliance program



WiMedia Testing

- WiMedia Mac
 - Beacon Protocol
 - Synchronization
 - Interference Mitigation
 - Transmit Power Control
 - Channel Selection
 - Bandwidth Sharing
 - Allocation limits
 - Reservation form
- WiMedia PHY
 - Certified Wireless USB Products Must Use Registered PHYs

**USB-IF will include WiMedia test suites at USB-IF events
WiMedia level tests apply directly only to host controllers
and self beaconing devices**

HWA Testing



- WiMedia Tests
 - Beacon protocol
 - Coexistence policy
- Device Class Framework
 - USBCV Extensions
- Protocol Tests
 - Wireless USB compliance devices
 - Loopback tests, bursting, etc.
 - Protocol test suite will use USB 2.0 hub TT test model
 - Silicon only requirement

DWA Testing



- Standard device WUSBCV tests
- DWA Device Class Framework
 - USBCV Extensions
- USBCV Functional Hub Tests (Adapted for DWA)
- Protocol Tests
 - USB 2.0 compliance devices
 - Loopback tests, etc.
 - Protocol test suite will use USB 2.0 hub TT test model
 - Silicon only requirement

DWA Test Setup

DWA Functional Protocol Tests

Adapted USBCV Hub Tests



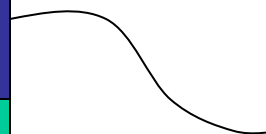
Close Proximity - Clean Environment



Standard
WUSB
Host

DWA Under
Test

Test Device
LS, FS, or HS



DWA Protocol Test Examples



- Downstream frame numbers match WUSB Channel time
- Periodic downstream service interval.
- Loopback
 - Use all RPIPES for all supported traffic types and sizes
 - Test maximum queued requests per RPIPE
 - Test wRPipeMaxBlocks can be allocated and used (as possible)

Physical Layer - Approach



- All end product testing will be performed over the air using the products shipping antenna (if possible)
 - Measures real end product behavior
 - Testing to looser requirements with the real product is more valuable than controlled tests (without antenna, etc) that may not predict actual end product behavior
- Test equipment will be evaluated to see if significant interop problem can be predicted through spectrum analysis, Evm etc
 - Initial testing will require oscilloscope for signal analysis

Physical Layer Tests



- Signal Quality (EVM)
- Required Data Rates
- Advertised Data Rates
- Bit Error Rate
 - Test bit error rate at various rates and distances with reference host(s)
 - Verify transmitter/receiver performance meet minimum requirements
- Transmit Power Control
 - Required level support
 - Level accuracy
- LQI Support

EVM Algorithm Overview



- Sample data at 20 Gs/s with RT Scope
- Packet Detection (Energy)
- Mix Per Packet
 - Remove Carrier
 - Filter Above 528 and Resample to 528 Mhz
- Find TFC (Match Filter) and Precise Packet Start
- Find Channel Estimation Symbols/Factor
- Compute EVM
 - FFT Each Symbol
 - Apply Channel Estimation Correction
 - Track Phase Below 300 Khz

Electrical Test Tool



The screenshot shows the "WiMedia Electrical Compliance Test" application window. The title bar includes the application name and standard window controls. The menu bar contains "File", "Edit", and "Help".

Scope Capture File (indicated by an arrow pointing to the "Input File Name" field)

Tests To Run (indicated by an arrow pointing to the "Preamble Symbol Count" checkbox)

Alternate Views (indicated by an arrow pointing to the "Status" field)

Input File Name: A text field with a "Browse" button below it.

Lines to Skip: A spinner control set to 7.

Sample Rate: A spinner control set to 20.00 GHz.

Transmit Data Rate: A dropdown menu set to 53.3 Mb/s.

Packet Count: A spinner control set to 0.

Status: A text field displaying "Ready".

Select Tests:

- Burst Packet Timing
- Preamble Symbol Count
- Power Spectral Density (PSD)
- Transmitter Power Control (TPC)
- Error Vector Magnitude (EVM)
- Test All

Packet Index: A spinner control set to 0.

Buttons: "Test" and "Exit".

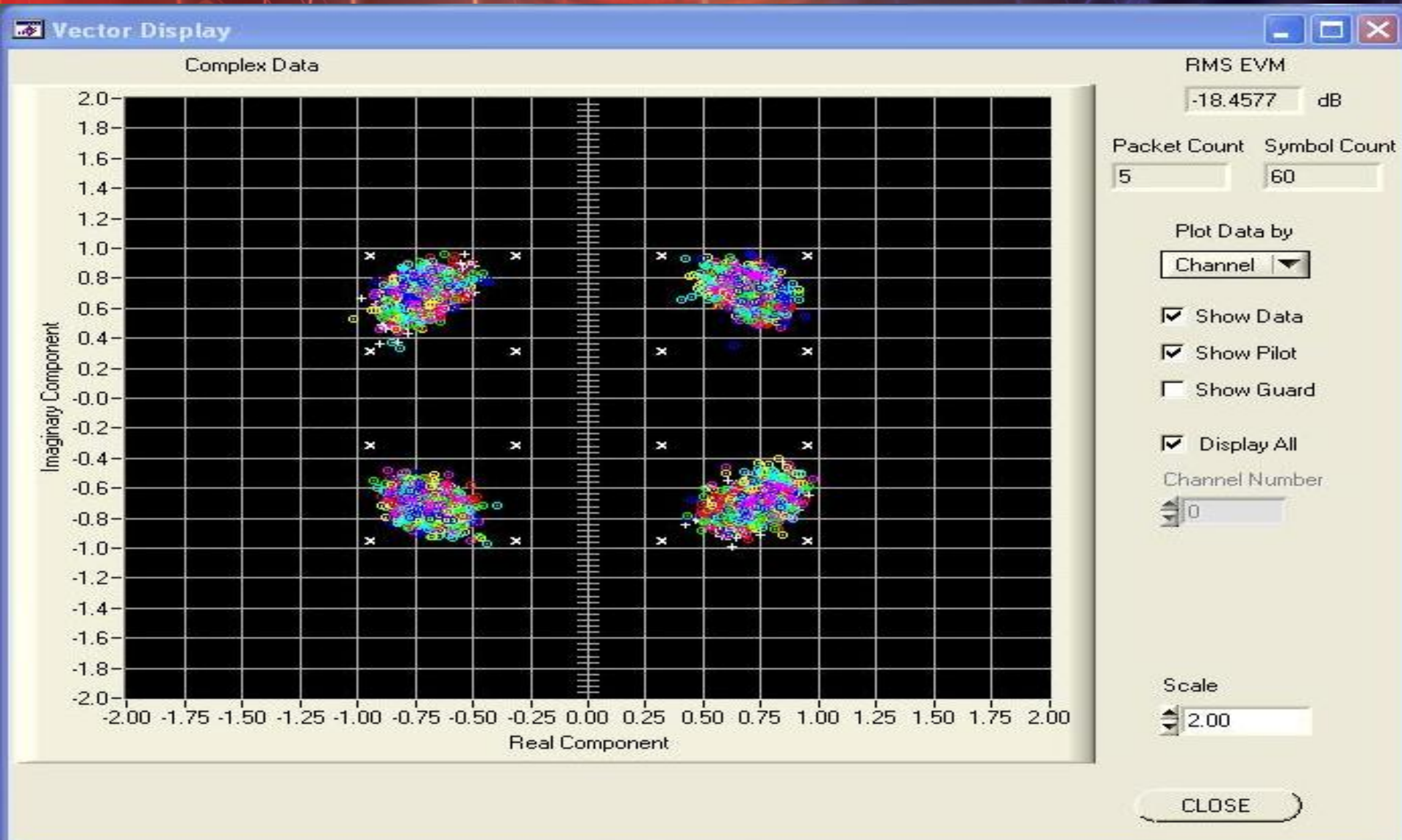
Footer Buttons: "Show Results", "Show Constellation Plot", "Show PSD Plot", "Show ACPR Plot".

Electrical Test Tool File Selection

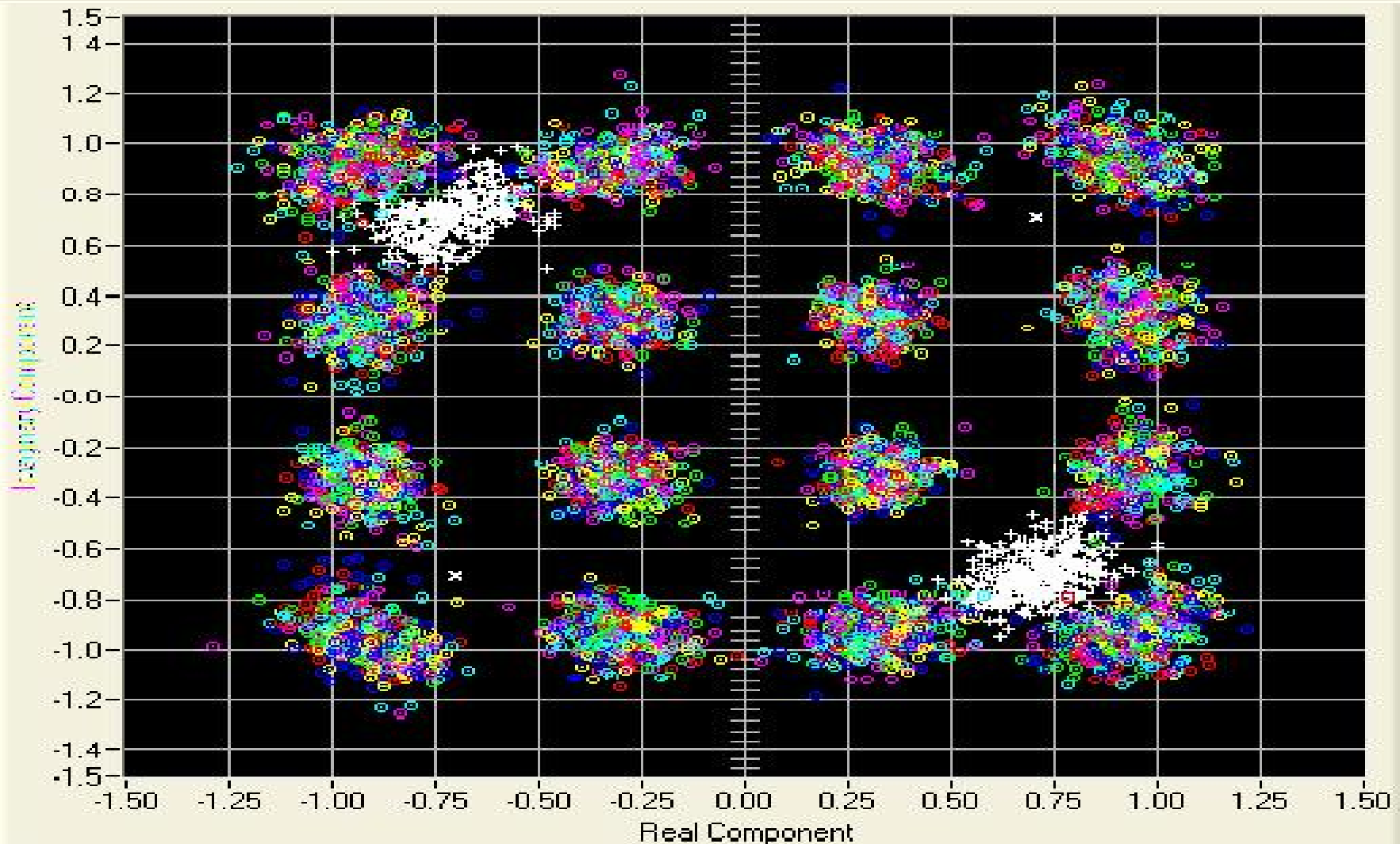


- Most Common Scope Formats Supported
 - Tab Delimited
 - Comma Delimited
 - With/Without Timestamps
 - Tek .wfm (binary)

Electrical Tool – EVM Plot



Electrical Tool – EVM. Signaling Above 200 Mb/s



Electrical Tool - Results



Compliance Test Results

Burst Packet Timing				
	Number of Intervals	Minimum MIFS	Maximum MIFS	Mean MIFS
Pass	4	6.635 us	6.635 us	6.635 us

Preamble Symbol Count				
	Number of Packets	Standard Preamble	Short Preamble	Non-Compliant Preamble
Pass	5	5	0	0

Power Spectral Density (PSD)	
	Number of Packets
Pass	0

Transmitter Power Control (TPC)	
	Number of Packets
Pass	0

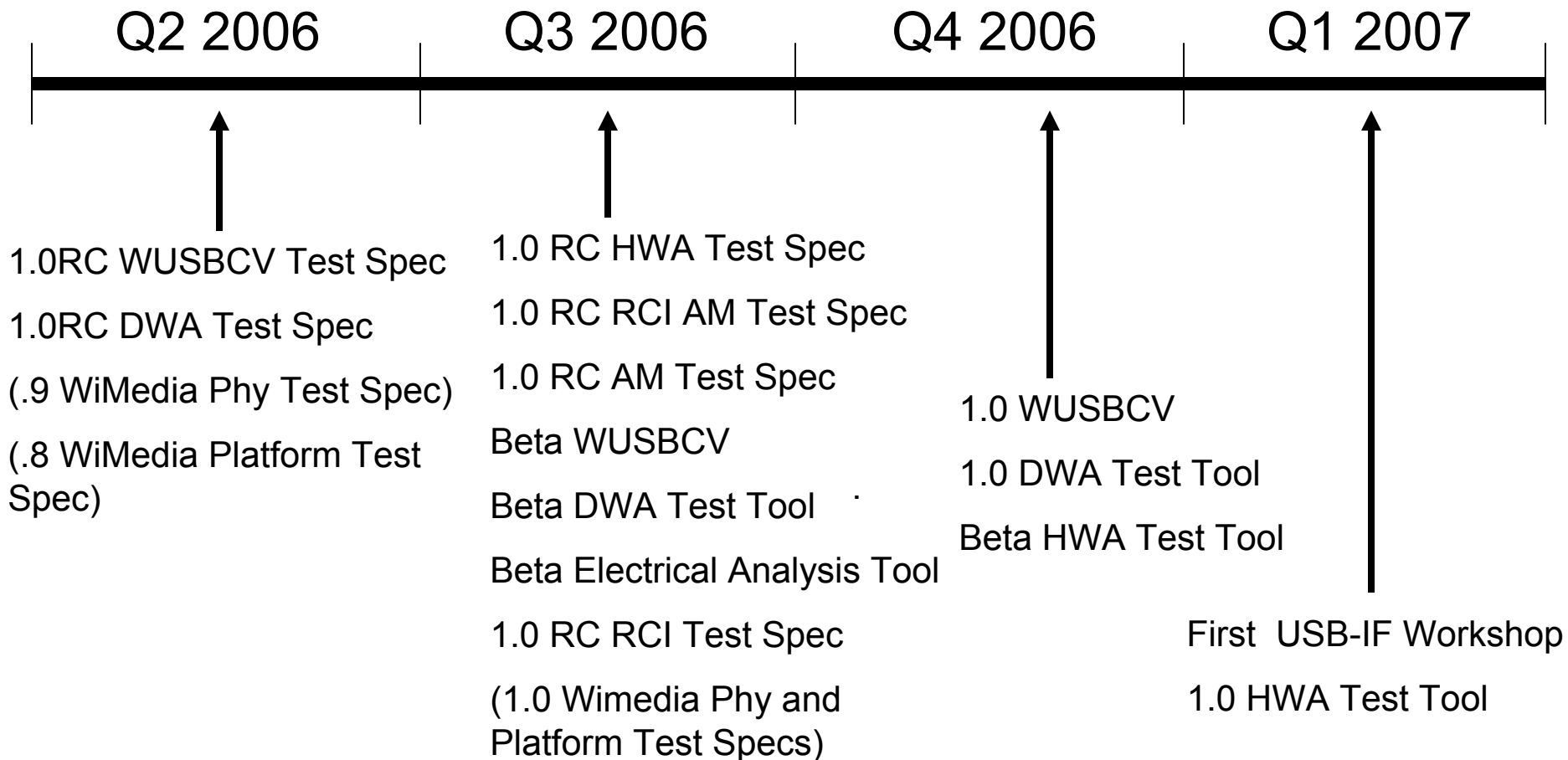
Error Vector Magnitude (EVM)			
	Number of Packets	Number of Symbols	EVM
Pass	5	60	-18.46 dB

Physical Layer Example – Transmit Power Control



- Test device is programmed to listen to all packets and report LQI values
- Standard host enumerates device under test.
- Standard host issues loopback read requests specifying power level X.
- Standard host issues loopback read requests specifying power level Y.
- The difference between LQI readings for power levels X and Y is computed and checked against transmit power control accuracy requirements.

Certified Wireless USB Compliance Timeline*



* All dates are tentative and subject to change

Summary and Call to Action



- Certified Wireless USB Compliance Program Will Follow USB 2.0 Model
 - Trademarked Logo For Compliance
 - High level of testing with initial product rollout
 - Repeatable tests and procedures
- USB-IF will provide all required testing at USB-IF workshops
- Review Test Specs and Provide Feedback
 - Available on USB-IF website now!
- Download WUSBCV when available
- Attend Compliance Workshops



Developers Conference 2006

Taipei, Taiwan