The University of Kansas

Information and Telecommunication Technology Center

Technical Report

User-Perceived Interoperability of Bluetooth Devices

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ITTC-FY2004-TR-35580-01

June 2004

Project Sponsor:
Bluetooth Special Interest Group

Executive Summary

This reports describes the result of a study we performed to assess the state of interoperability of Bluetooth devices currently on the market. This document summarizes the results of that test.

We performed tests on 37 devices. This report describes our experiences with testing 30 devices, consisting of 5 handhelds, 8 mobile phones, 11 headsets, and 6 PCs (2 integrated and 4 adapters). Given 30 devices, ideally there are 559 device-device pairs possible, and given our test suite, there are 2991 potential test cases. Of this potential, we performed tests on 325 device-device pairs and 1745 test cases, a completion rate of 58.34%. Of the 1745 performed test cases we found 750 failures, or a failure rate of approximately 43%. There is some question about whether some test cases should apply to certain device type pairs, but we anticipate addressing this issue with future work.

In general, we found the interoperability of Bluetooth devices to be mixed. Some devices and device groups interoperated well, while others were particularly troublesome.

We found a number of trends in our testing. The simpler the interface, the less likely the device was to fail. Hands Free and Headset devices (with very simple interfaces), for example, worked well with Mobile Phones. In general, we found PCs with integrated Bluetooth and PC (USB and PCMCIA) devices particularly troublesome. The installation process was often tedious, and unintuitive.

Some of the features we found were possible, but very difficult. In particular, dialup networking by a Mobile Phone providing service to another device, such as a PC or a Handheld, was eventually made to work, but only after many hours of effort. More results are given in the conclusion of this document.

What follows is a report that describes in more detail the results of our tests.

Contents

Introduction

This reports describes the result of a study we performed to assess the state of interoperability of Bluetooth devices. We began by developing an approach and test plan, including a number of procedures and measurements. This document summarizes the results of those tests.

This document is divided into four sections. Section 1 summarizes the Test Plan document, specifically the approach and methodology used. Section 2 describes the different test cases that were applied and describes how to interpret the actual results. Section 3 represents the bulk of the report and contains the results from the testing and more importantly a summary and implications section for each portion of testing. We conclude with Section 4, which gives some conclusions to our findings, and just as importantly, the limitations to our approach.

1   Test Plan Overview

This section briefly describes the test plan.

1.1 Approach

The purpose of the interoperability tests is to identify the state of interoperability between Bluetooth devices. Interoperability is a necessary feature for Bluetooth to be successful as a technology, and early product interoperability testing can provide key feedback for the SIG and manufacturers.

1.2 Interoperability

An interoperability test determines the how well two devices that support the same profiles or gateway/client version of the same profiles, as defined by the Bluetooth specification, are able to interoperate for those portions of the profiles supported by both devices. Although as many as 8 Bluetooth devices can be networked together, the methodology, as describe in the Test Plan Document, only tests devices in pairs.

There are several definitions for interoperability. The standard IEEE/ISO definition is given as:

> The ability of two or more systems or components to exchange information and use the information that has been exchanged.

Note that this definition is defined from an engineering perspective; the devices must simply be able to use the information that has been exchanged. Whether useful or desired information, is exchanged, or whether the information can be used in some meaningful way, is not defined. There is no notion of a user in this definition.

The Bluetooth SIG has used a more meaningful definition for interoperability given below.

> The ability for an end-user to make two or more devices to perform their desired Bluetooth functions, independent of the producers of the device.

This is a significant improvement because it emphasizes the end user of the devices, and interoperability is only achieved if the devices can perform their desired functions. An important feature of this definition is that the user chooses whether the requirement is met. It is this "user-oriented interoperability" that describes the purpose of this work.

To further emphasize the user, we adopt a definition of interoperability that has been promoted by the American Association of Publishers in their work on electronic books. The definition is as follows:

> The condition achieved when two or more technical systems exchange
> information directly in a way that is satisfactory to the users of the systems

What we like about this definition is interoperability is entirely at the discretion of the user. It is not presuppose what is a valid "Bluetooth function." It simply examines whether users are satisfied with the exchange of information.

It is important to keep this definition in mind when we discuss interoperability. Within the Bluetooth community, there seems to be a conception that interoperability problems are primarily low-level protocol issues. With our definition of interoperability, we will show in this report that low-level protocols are not the primary cause of interoperability problems. We conclude that application software and/or managing user expectations are the primary causes of interoperability failures.

All testing is from the user's perspective. For example, all testing involves user input to the devices using applications and user interfaces on those devices. No special software or hardware is used in the testing, except as specifically noted in the Test Plan. The tests are devised to exercise as much of the Bluetooth profiles supported by the devices as is practical through the user interface. An aspect of this testing perspective is that test steps describe, in general, application operations to perform on the devices. The operator may use the user manual of the devices to determine how to carry out the application operations or any other material the user may have available.

1.3 Categorization

Devices are classified into *device types*. (Section 2.1 gives a list of the device types used in this test campaign.) For example, all cellular phones are grouped together in the "Mobile Phone" group. The testing strategy has been to develop tests for each *device type-pairs*, e.g., Mobile Phone – Mobile Phone, or PC – Handheld, etc., and then, as necessary, refine the test strategy for individual devices. For example, a test plan was developed for Mobile Phones to be tested with other Mobile Phones, which included sending a business card and a meeting request. Part of the general test plan called for resetting the device before each test. Since resetting a phone is not a measure of Bluetooth interoperability, specific instructions for how to reset the device were developed for each Mobile Phone. For tests that include Bluetooth interoperability, more specific instructions were omitted, and the difficulty of determining how to perform those actions was evaluated by the tester and measured by the *subjective scale*. The *subjective scale* is defined in detail in the Test Plan document, but will not be presented since the quality of the results has not been quantified.

1.4 Methodology

For each device pair, we assign a set of tests from the test suite. This assignment is done primarily on the types of the devices, but can be "overridden" based on a number of factors. The test mapping is described in Section 2.2.3. Each test case contains a purpose, description, test procedure, and expected outcome.

A number of different things were measured within the test process, including: the time to perform a pairing (if necessary), the time to complete the test, the success or failure of the test, if a success then the *subjective scale* (see Test Plan document), if a failure the *operator code* (see Test Plan document), the number of transient error (number of connection errors, unable to pair errors, failed sending error, etc.), and any comments by the tester.

This report presents the results from the testing. We organize the test results as follows. For each device-device pair, we present the results for each test case. After the individual test cases are presented, we summarize all the data for each device-device pair. After presenting all device-device pairs, we present aggregate information for each test case. Finally, we present aggregate information for all test cases.

The information contained in this document attempts to summarize and categorize this data. Primarily, we examine three measures: failure data and failure breakdown, transient error data, and completion data. A *failure breakdown* classifies failures into different 'bins' so that a more exact determination can be made as to the cause of the failure, or if the failure cannot be deduced, at least describe the user perception of the failure. During the course of our testing we found that many devices failed in similar fashion, e.g. a file was transferred in a format unsupported by the other device; the devices were not able to detect each other during a Bluetooth search, etc. Each of these failures was then assigned an operator code which was later used in the data extraction for the *failure breakdown.* A *transient error* is a non-permanent Bluetooth related error that occurs, but can be eliminated by retrying one or more times. The completion data is simply a representation of what test cases and device type pairs were tested. We believe that these measurements will provide the best summary of the interoperability of a device or device group.

2 Testing

2.1 Device Groups and Devices

There were a total of 37 devices tested in this study. Those 37 devices were distributed (unevenly) among the following device groups:

- HID – Human Interface Device, e.g., keyboard, mouse, etc.

- HH – Handheld devices, such as PDAs.

- HS – Headset

- MP – Mobile Phone, e.g., cellular phone.

- PC – Personal Computer. This includes desktop or laptop/portable PC running some version of Windows or Mac OS, a Bluetooth adapter, either integrated, or connected by USB or PCMCIA.

- PR – Printer

- IMG – Imaging Device

- GPS – Global Positioning System Bluetooth device

- AP – Access Points

The following Human Interface Devices (HID) were tested. For confidentiality reasons, we do not give the manufacturer, model, or serial number of each device. In parenthesis is the label (a sort of abbreviation) we use for the remainder of this report. In order to give the reader a better understanding of what each device is capable a list of supported profiles each device has according to the service discovery profile (SDP) is listed following the device listing.

The following Human Interface Devices (HID) were tested.

- Bluetooth Wireless Mouse/Pointer (HID1)

    Service Discovery not successfully performed.

The following Handheld (HH) devices were tested.

- Handheld device #1 (HH1)

    Network Access "PAN user", "OBEX Object Push", "OBEX File Transfer", "Headset", and Audio Gateway "Headset Audio Gateway"

- Handheld device #2 (HH2)

    "Serial Port", Network Access "PAN group network", Network Access "PAN user", "OBEX Object Push", and "OBEX File Transfer"

- Handheld device #3 (HH3)

    Service Discovery not successfully performed.

- Handheld device #4 (HH4)

"Serial Port", "OBEX Object Push", and "OBEX File Transfer"

- Handheld device #5 (HH5)

    Service Discovery not performed.

The following Headset (HS) devices were tested. The service discovery profile (SDP) is not successfully performed on any of the Headset devices.

- Headset device #1 (HS1)

- Headset device #2 (H22)

- Headset device #3 (HS3)

- Headset device #4 (HS4)

- Headset device #5 (HS5)

- Headset device #6 (HS6)

- Headset device #7 (HS7)

- Headset device #8 (HS8)

- Headset device #9 (HS9)

- Headset device #10 (HS10)

- Headset device #11 (HS11)

The following Mobile Phones (MP) were tested

- Mobile Phone device #1 (MP1)

    "Serial Port", "Dialup networking", "OBEX Object Push", "OBEX File Transfer", and "Headset"

- Mobile Phone device #2 (MP2)

    "Serial Port", "Dialup networking", "OBEX Object Push", "OBEX File Transfer", "FAX", PIM Synchronization "IrMCSync", "Headset", Handsfree Audio Gateway

- Mobile Phone device #3 (MP3)

    "Serial Port", "Serial Port 2", "Dialup networking", "OBEX Object Push", "OBEX File Transfer", PIM Synchronization "IrMCSync", Handsfree Audio Gateway, HF Voice gateway, and "OBEX Basic Imaging"

- Mobile Phone device #4 (MP4)

    "Serial Port", "Dialup networking", "OBEX Object Push", "OBEX File Transfer", "FAX", and Handsfree Audio Gateway

- Mobile Phone device #5 (MP5)

    "Serial Port", "Dialup networking", "OBEX Object Push", "OBEX File Transfer", and "FAX"

- Mobile Phone device #6 (MP6)

"Serial Port", "Serial Port #2", "Dialup networking", "OBEX Object Push", "OBEX File Transfer", "FAX", PIM Synchronization "IrMCSync", Sync Command Service "IrMCSync", "Headset", Audio Gateway "Headset Audio Gateway", HF Voice Gateway, "OBEX Basic Imaging", IrMC synchronization, PIM item transfer "OBEX Object Push", Voice gateway "Headset", and OBEX File Transfer "Dialup Networking"

- Mobile Phone device #7 (MP7)

    "Serial Port", "Dialup networking", "OBEX Object Push", "OBEX File Transfer", "FAX", and Handsfree Audio Gateway

- Mobile Phone device #8 (MP8)

    "Serial Port", "Dialup networking", "OBEX Object Push", "OBEX File Transfer", "FAX", and Handsfree Audio Gateway

The following Personal Computers (PC) and Adapters were tested.

- PC with integrated Bluetooth device #1 (PC1)

    "Serial Port", Network Access "PAN group network", Network Access "PAN user", "Dialup Networking", "OBEX Object Push", "OBEX File Transfer", "Fax", PIM Synchronization "IrMCSync", Sync Command Service "IrMCSync", "Headset", and Audio Gateway "Headset Audio Gateway"

- PC with integrated Bluetooth device #2 (PC2)

    "Serial Port", "OBEX Object Push", and "OBEX File Transfer"

- PC with Bluetooth adapter device #3 (PC3)

    Service Discovery not successfully performed.

- PC with Bluetooth adapter device #4 (PC4)

    "OBEX Object Push"

- PC with Bluetooth adapter device #5 (PC5)

    Service Discovery not successfully performed

- PC with Bluetooth adapter device #6 (PC6)

    Service Discovery not successfully performed

The following Printers (PR) were tested.

- Bluetooth Printer #1 (PR1)

The following Imaging devices (IMG) were tested.

- Imaging Device #1 (IMG1)

The following GPS devices (GPS) were tested.

- Imaging Device #1 (GPS1)

- Imaging Device #2 (GPS2)

The following Access Points (AP) were tested.

- Access Point #1 (AP1)

- Access Point #2 (AP2)

2.2 Test Plan and Results

This section briefly overviews the test plan and results. The Test Plan document contains much more detail, and is only summarized here. We describe the interoperability matrix of device groups (what groups were tested with each other), describe the possible and applied test cases, detail what tests were applied to certain device type pairings, and describe how to read the data collected and summarized in the results (Section 3) of this document. Due to time limitations, we were not able to test every device-device pair possible, so we present those device-device pairings that were tested.

2.2.1 Interoperability Test Matrix

The following table (Table 2.2.2.1-1) provides a summary of the device group interoperability tests. If a device group in the left hand column was tested to interoperate with a device in the top row, then an "X" is placed in the box. The matrix generally follows the order of information presented in Section 3. The pairing are read such that the row represents the initiating device or the source of information, and the column represents the receiving device. Note that many – but not all – tests are symmetric. For example, exchanging business cards between Mobile Phones and Handhelds is a symmetric test, so an X will appear in the MP → HH field and the HH → MP field, but printing from a PC to a Printer is not, so only the PC → PR field has an X.

Table 2.2.2.1-1

	HID	HH	HS	MP	PC	PR	IMG	GPS
HID		X			X			
HH		X	X	X	X		X	X
HS								
MP		X	X	X	X		X	
PC		X	X	X	X	X	X	X
PR								
IMG								
GPS								

2.2.2 Description of Test Cases

This section is split into two subsections: 2.2.2.1 Performed Test Cases and 2.2.2.2 Possible/Future Test Cases. Each section gives the full name of a test case, the purpose of the test case, and criteria that must be meant in order for the performed test to be considered successful. The description given here is only an abstract; the full description is described in the Test Suite document. Section 2.2.2.1 describes the test cases that have been completed and whose results are reported in this document. Section 2.2.2.2 describes the test cases that have been developed and in some cases performed, but due to some limitations, the analysis has not been completed in order to present these in the results section of this document.

2.2.2.1 Performed Test Cases

Business Card Exchange
Purpose: To test the ability of two devices to exchange business cards.
Pass Criteria: Device A initiates the exchange between device B, device A must receive device B's business card with all the original information unaltered, and device B must receive device A's business card with all the original information unaltered.

Transfer Contact
Purpose: To test the ability of a device pair to send/receive a contact.
Pass Criteria: Device A sends device B a contact that has been created on device A, and device B must receive this contact with all the original information unaltered from device A.

Transfer Calendar Entry
Purpose: To test the ability of a device pair to send/receive a calendar entry.
Pass Criteria: Device A sends device B a calendar entry that has been created on device A, and device B must receive this calendar entry with all the original information unaltered from device A.

Transfer a Picture
Purpose: To test the ability of a device pair to send/receive a picture.
Pass Criteria: Device A sends device B a picture file, and device B must receive this picture file and be able to display the picture unaltered from its original form.

Dial-up Networking
Purpose: To test the ability of a device A to provide dial-up networking access to device B.
Pass Criteria: Device A provides the dial-up networking service and device B must be able to use this service to connect to the internet and display content from the World Wide Web.

Send/Receive FAX
Purpose: To test the ability of a device pair to send/receive a FAX.
Pass Criteria: Device A sends a FAX to device B, and the FAX must be received by device B uncorrupted from its original format.

Synchronize Data
Purpose: To test the ability of a device pair to synchronize selected data.
Pass Criteria: Device A initiates synchronization, and all data selected for the synchronization process must be synchronized between device A and device B.

Call from MP, talk with HS
Purpose: To test the ability to use a headset when a call is initiated from a mobile phone.
Pass Criteria: The ability to talk through the headset and be heard as well as the ability to listen through the headset must be maintained during a call that has been initiated from the mobile phone under test.

Call from HS, talk with HS
Purpose: To test the ability to use a headset when a call is initiated using voice dialing from the headset.
Pass Criteria: The ability to talk through the headset and be heard as well as the ability to listen through the headset must be maintained during a call that has been initiated using voice dialing from the headset under test.

Receive Call with MP, talk with HS
Purpose: To test the ability to use a headset when a call has been received by a mobile phone.
Pass Criteria: The ability to talk through the headset and be heard as well as the ability to listen through the headset must be maintained during a call that has been received by the mobile phone under test.

Receive Call with HS, talk with HS
Purpose: To test the ability to use a headset when a call has been received by a headset.
Pass Criteria: The ability to talk through the headset and be heard as well as the ability to listen through the headset must be maintained during a call that has been received by the headset under test.

Transfer Call between MP and HS
Purpose: To test the ability to transfer audio control between the mobile phone and the headset.
Pass Criteria: The ability to talk through the headset and be heard as well as the ability to listen through the headset must be maintained when audio control is given to the headset, and the ability to talk through the mobile phone and be heard as well as the ability to listen through the mobile phone must be maintained when audio control is given to the mobile phone.

LAN access to the Internet
Purpose: To test the ability of device A connected to broadband internet to provide internet access to device B.
Pass Criteria: Device A provides LAN access for device B, and device B must be able to use this service to connect to the internet and display content from the World Wide Web.

Play music
Purpose: To test the ability of a HS to play music (or some other type of audio) provided to it by another Bluetooth compatible device.
Pass Criteria: The audio file being used by the device under test must be audible through the headset under test.

File Sharing
Purpose: To test the ability of a device pair to share selected files.

Pass Criteria: Device A must provide a shared folder with device B, and device B must be able to see the files listed in the shared folder by device A and they must be accessible by device B.

2.2.2.2 Possible/Future Test Cases

Print Test
Purpose: To ensure the ability of the device A to print a document from the participating device B.
Pass Criteria: Device A must produce a printed document unaltered from device B.

Remote Image Viewing: Single Image
Purpose: To ensure the ability of device A (Bluetooth enabled image viewing device) to display a picture file sent from device B.
Pass Criteria: Device A must produce an image on a compatible television or screen unaltered from device B.

Remote Image Viewing: Slide Show
Purpose: To ensure the ability of device A (Bluetooth enabled image viewing device) to display multiple picture files sent from device B.
Pass Criteria: Device A must produce a slide show of multiple images on a compatible television or screen unaltered from device B.

Mobile Phone – Headset Test Suite
Accept Call and Close First Call (MP-HS)
Purpose: To ensure the ability of device A (Bluetooth enabled Headset/Handsfree device) to work with device B to accept a new incoming call while a call is in progress and terminate the original ongoing call.
 Pass Criteria: Device A must initiate all actions. With a call ongoing through device A (headset) a new incoming call must be accepted and the old call terminated. The user/tester must be able to talk/listen using headset.

Accept Call without Closing First Call (MP-HS)
Purpose: To ensure the ability of device A (Bluetooth enabled Headset/Handsfree device) to work with device B to accept a new incoming call while a call is in progress and put the original ongoing call on hold.
Pass Criteria: Device A must initiate all actions. With a call ongoing through device A (headset) a new incoming call must be accepted and the old call must be put on hold. Using device A the user/tester must be able to transfer between calls and talk/listen using the headset.

Initiate Call, First Call on Hold (MP-HS)
Purpose: To ensure the ability of device A (Bluetooth enabled Headset/Handsfree device) to work with device B to initiate a new outgoing call from after putting the previous ongoing call on hold.
Pass Criteria: Device A must initiate all actions. With a call ongoing through device A (headset) a new call is initiated from device A after putting the ongoing call on hold. Using device A the user/tester must be able to transfer between calls and talk/listen using the headset.

Play Network Game
Purpose: To ensure the ability of device A and device B to provide network gaming.
Pass Criteria: A network game must be established and tested between device A and device B.

Dial Number from Contact List
Purpose: To ensure the ability of device A (PDA/PC) to dial a number directly from its list of contacts using the services of device B (mobile phone).
Pass Criteria: Device A must initiate all actions. Device A must initiate the dialing of a number from its list of contacts using the wireless services of device B. If possible talk/listen through device A, if not talk/listen through device B.

2.2.3 Applicability of Test Cases by Device Type Pairs

This section breaks down what test cases were performed for certain device type pairs (see Test Plan document). For example MP – MP may contain the test case, "transfer a contact," but it will not contain the test case, "LAN access to the internet."

The following test cases represent our best judgment on what users expect device type pairs to be capable of performing. Since this is a judgment call, there is room for disagreement, and we recognize that. We discuss this shortcoming and potential future efforts at making this applicability more empirical in Section 4.

Although the following list what we believe are expectations, these can be "overridden" by product labeling and documentation. For example, a mobile phone may explicitly state in the manual that it does not interoperate with headset or hands free devices. In that case, those test cases will not be applied.

Handheld – Handheld
- Business Card Exchange
- Transfer Contact
- Transfer a Calendar entry
- Transfer a Picture
- Transfer Audio recording
- File Sharing

Handheld – Mobile Phone
- Business Card Exchange

- Transfer Contact
- Transfer a Calendar entry
- Transfer a Picture
- Dial-up Networking
- Transfer of Recorded Audio
- FAX
- File Sharing

Handheld – Headset
- Play Audio File

Handheld – PC
- Business Card Exchange
- Transfer Contact
- Transfer a Calendar entry
- Transfer a Picture
- Transfer of Recorded Audio
- Synchronize
- LAN Access
- File Sharing

Mobile Phone – Mobile Phone
- Business Card Exchange
- Transfer Contact
- Transfer a Calendar entry
- Transfer a Picture
- Transfer of Recorded Audio
- File Sharing

Mobile Phone – Headset
- Call from Mobile Phone
- Call from Headset
- Receive Call with Mobile Phone
- Receive Call with Headset
- Transfer Call

Mobile Phone – PC
- Business Card Exchange
- Transfer Contact
- Transfer a Calendar entry
- Transfer a Picture
- Dial-up Networking
- Transfer of Recorded Audio
- FAX
- Synchronize
- File Sharing

PC – Headset
- Play Audio

PC – PC
- Business Card Exchange
- Transfer Contact
- Transfer a Calendar entry
- Transfer a Picture
- Transfer of Recorded Audio
- Synchronize
- File Sharing

2.2.4 Description of Data

Section 3, Results, is split into several subsections. Each of these subsections will be organized into three sections of data, failure data, error data, and completion data, followed by a Summary/Implications section. This portion of the document is meant to act as a guide on how to read and interpret the results.

2.2.4.1 Description of Failure Data

The failure data section represents the bulk of the data presented. Each of these subsections gives a brief explanation on how to read the data in form it is presented.

2.2.4.1.1 Failure Code Explanation

The table below (Table 2-2) gives the abbreviation and description of the different types of failures we found in our testing. It was determined during testing that it would be useful to further breakdown failures into "bins", or by the different ways in which device type pairs failed. The abbreviations seen here will be used for the remainder of this document when classifying failures.

Table 2-2: Chart of Failure Types

Failure abbreviations	Failure Descriptions
UC	"Unable to Connect…" Permanent Error
MBC	"Max number of Bluetooth Connection…" Permanent Error
InB	"Internal Bluetooth…" Permanent Error
PNS	"Profile not Supported…" Permanent Error
UDB	"Unable to detect device during Bluetooth search…" Permanent Error
PE	Pairing Error, "Unable to Pair…" Permanent
USF	Device pair does not support feature under test
t&d	Transferred calendar times and dates are incorrect
DL	Data lost while transferring
FS	"Failed sending…" Permanent Error
UFF	Unsupported file format
PNI	Pairing cannot be initiated from device

2.2.4.1.2 Failure Matrix

Table 2.2.4.1-2 consists of a matrix. The table is a summary of the data that can be found by reading the matrix. This example is actually taken from the Handheld – Handheld test case "Transfer a Contact." *Potential* is the total number of pairs that this test case could have potentially been performed for the Handheld – Handheld. Note that since we had only one item of each device that the diagonal entries will always be untested. *Tested* represents the number of pairs tested under this test case. *Passed* is the number of pairs which passed the test case, and *Failed* is the number of pairs that did not pass the test case. The *Pass Rate* and *Completion Rate* are self-explanatory. All matrices in this document are read as the "row to column", e.g., if you want to see how HH1 interoperated with HH5 (with HH1 initiating), then you would follow the row labeled by HH1 to the column labeled by HH5 and find the failure code abbreviation UDB. (See Table 2-2 for the interpretation of the failure code abbreviations.) This means that when HH1 initiates a transfer of contact to HH5 then this test case fails because HH1 is unable to detect HH5 during a Bluetooth search. Light blue boxes with a zero indicate successes, and dark blue boxes with an 'X' represent device pairs not tested.

Table 2.2.4.1-2: Example Data

	HH1	HH2	HH3	HH4	HH5	MP1
HH1	x	0	x	0	UDB	UDB
HH2	0	x	0	0	0	0
HH3	x	0	x	0	x	x
HH4	0	0	0	x	0	0
HH5	0	0	x	0	x	x
MP1	0	0	x	0	x	x

Along with each Figure is a table such as Table 2.2.4.1-3, which provides statistical summary information.

Table 2.2.4.1-3: Example Stats

Potential	36
Tested	22
Passed	20
Failed	2
Pass Rate	90.91%
Completion Rate	61.11%

2.2.4.1.3 Aggregates

The Aggregates section of the failure data, shown in Table 2.2.4.1-4, contains two matrices. One matrix, the "Passes" matrix, shows the total number of successfully performed test cases for each device pair, and the "Failures" matrix shows the total number of unsuccessfully performed test cases for each device pair.

Table 2.2.4.1-4: Example Aggregates

	HH1	HH2	HH3	HH4	HH5	MP1
HH1		3		3	3	2
HH2	4		1	4	1	4
HH3		3		2		
HH4	3	5	1		1	4
HH5	3	4		4		
MP1	3	4		4		

	HH1	HH2	HH3	HH4	HH5	MP1
HH1		2		2	4	5
HH2	1		4	1	4	3
HH3		2		3		
HH4	2		4		4	3
HH5	3	1		1		
MP1	3	2		2		

Passes   Failures

2.2.4.1.4 Failure Rates

Table 2.2.4.1-5 gives the failure rates (as a percentage) of certain device pairs over all their applicable test cases. Looking at HH1 → HH2 with a failure rate of 40%; this is derived from the fact that from 5 HH1 → HH2 test cases, 2 were failures.

Table 2.2.4.1-5: Example Failure Rates

	HH1	HH2	HH3	HH4	HH5	MP1
HH1		40%		40%	57%	71%
HH2	20%		80%	20%	80%	43%
HH3		40%		60%		
HH4	40%	0%	80%		80%	43%
HH5	50%	20%		20%		
MP1	50%	33%		33%		

2.2.4.1.5 Failure Rates 3D

Figure 2.2.4.1-1 represents a three dimensional representation of Table 2.2.4.1-5. In this case the percentages become volumetric pairs in a bar graph.
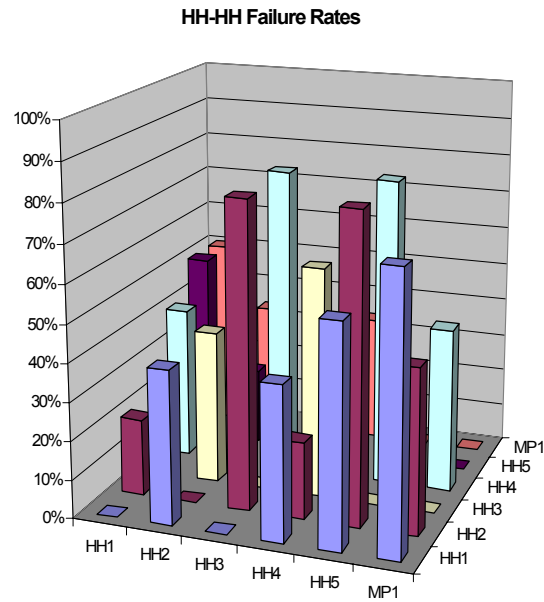
HH-HH Failure Rates

Figure 2.2.4.1-1

2.2.4.1.6 Failure Distribution

Figure 2.2.4.1-2 represents a graph of a discrete probability density function for the failure rates for all Handheld – Handheld pairs. The X-axis represents the failure rates and the Y-axis represents the number of pairs. One can see that there was only one device pair of the HH – HH device type pair that had a zero percent failure rate.
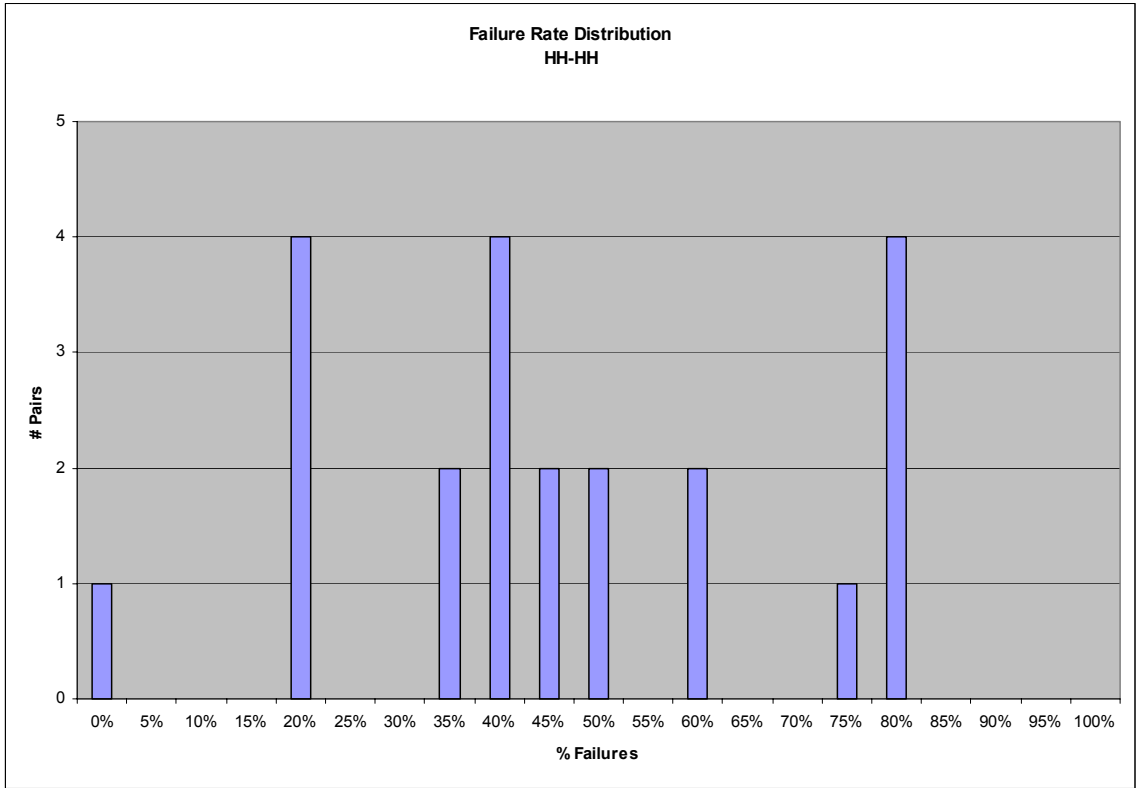
Figure 2.2.4.1-2

2.2.4.1.7 Distribution by Test Cases

Figure 2.2.4.1-3 gives the failure, pass, and completion distribution by test cases for all HH – HH test cases. The X-axis is represented by the different test cases and follows the same order as Section 2.2.2.1. The Y-axis is a metric for measuring percentages. For example, examining the first bar one would find for HH – HH and the test case "Business Card Exchange" that 14 pairs have not been performed, 20 pairs failed this test case, and 2 pairs passed this test case.
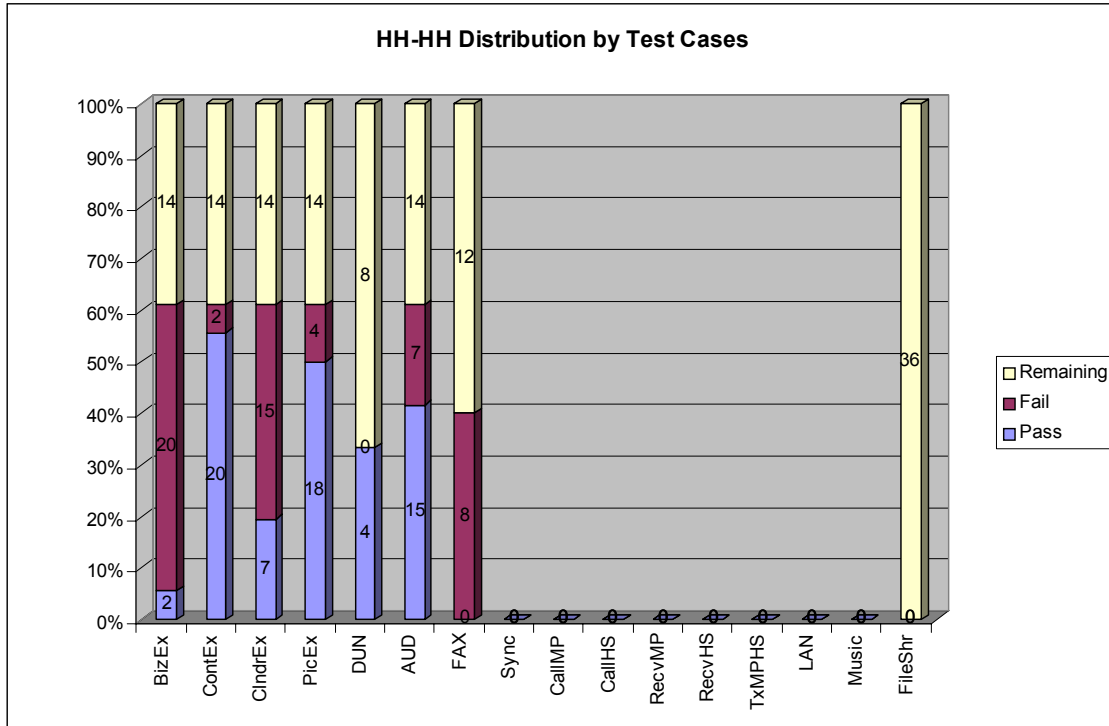
Figure 2.2.4.1-3: HH-HH Distribution by Test Case

2.2.4.1.8 Failure Breakdown

Table 2.2.4.1-6: Example Breakdown (below) is used to quantify the types of failures encountered. From this table it is apparent that 37 of the 56 failures are due to, "Device pair does not support feature under test."

Table 2.2.4.1-6: Example Breakdown

Total	Failure Description
0	"Unable to connect…" error
0	"Max number of Bluetooth connections…" error
0	"Internal Bluetooth…" error
0	"Profile not supported…" error
7	Unable to detect device during Bluetooth Search
0	Pairing Error: "Unable to Pair…"
37	Device pair does not support feature under test.
6	Transferred calendar times/dates are incorrect
0	Data lost while transferring
3	"Failed sending" error
5	Unsupported file format
1	Pairing cannot be initiated from device
56	Total number of failures

2.2.4.1.9 Failure Breakdown Pie Chart

Figure 2.2.4.1-4 shows a pie chart of the different failures encountered. From the figure we can see that of all the failures for the test case 'Transfer of Recorded Audio' that 55% of the failures were due to unsupported file formats.

Failure Breakdown for Transfering an Audio Recording
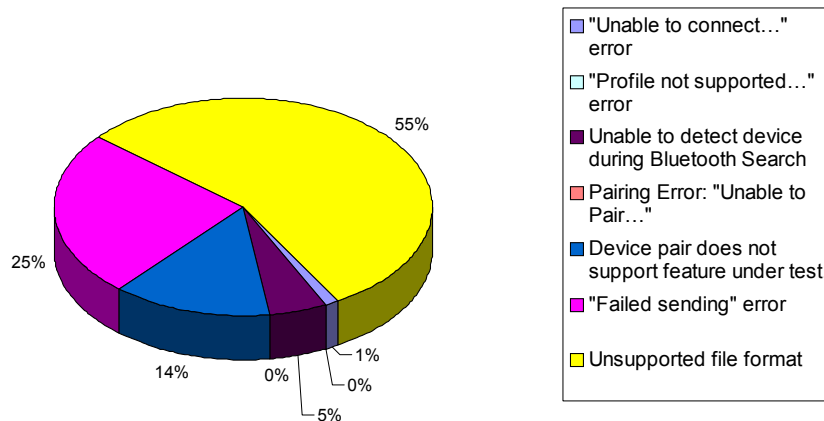
Figure 2.2.4.1-4: Audio Recording Breakdowns

2.2.4.2 Description of Error Data

The presentation of error is represented by an error matrix data (Table 2.2.4.2-1) and summary information (Table 2.2.4.2-2). The terms *Error Rate* and *Average Errors* are defined below.

Error Rate: The number of test cases in which at least one error is encountered divided by the number of test cases.

> E.g., if test case A had 2 transient errors and test case B had 0, then its error rate would be 1/2 or 50%.

Average Errors: The number of errors divided by the number of test cases.

> E.g., using the same example from above this would yield an average error of 2/2 or 100%.

The error matrix represents the total number of errors encountered for each device pair over all the applicable test cases. This means that the matrix may not be fair to use in comparing devices because some device pairs have not been tested or do not contain as many test cases, but it does give some insight into the nature of the transient errors encountered, especially in the aggregate.

Table 2.2.4.2-1: HH-HH Errors

	HH1	HH2	HH3	HH4	HH5	MP1
HH1	0	0	0	0	2	1
HH2	8	0	0	4	0	3
HH3	0	0	0	0	0	0
HH4	0	0	0	0	0	4
HH5	0	5	0	0	0	0
MP1	0	0	0	0	0	0

Table 2.2.4.2-2: HH-HH Error Aggregates

TC w/ Errors	7
Total Errors	27
Error Rates	5.74%
Average Errors	22.13%

2.2.4.3 Description of Completion Data

The representation of completion data is presented in the same format as much of the error data. The completion rates are presented in a matrix similar to the failure rate matrix in **Error! Reference source not found.**, except the percentages are the number of test cases performed divided by the total number of test cases. The three dimensional representation of the matrix usually follows.

One important thing to note is that the completion rate matrix does not always distinguish between 0% completion and those cases in which tests were not applicable. This is one of the known limitations of our evaluation methods.

3   Results

3.1 Overview of Results

The remainder of this report will consist mostly of the results that have been collected, aggregates, and analysis. One can imagine the data collected as a three dimensional array of information where the X and Y axes would be the devices and the Z axis the test case.

- Device × Device × Test Case
    - 3D array of information
    - Each point contains multiple data items: success or failure, subjective scale, time for completion, operator notes, and comments.

For simplicity sake we have split up the results into subgroups that will be presented in this order:

- Device × Device
    - Test Case – Failure Results
        - Test Case – Failure data
        - Summary/Implications of Test Case – Failure data
    - Aggregate – Failure data
    - Summary/Implications of Aggregate – Failure data
    - Aggregate – Error data
    - Aggregate – Completion rates
- Test Case (All applicable devices)
    - Test Case – Failure Results
        - Failure data
        - Summary/Implications of Test Case – Failure Date
    - Aggregate – Failure data
    - Summary/Implications of Aggregate – Failure data
    - Aggregate – Error data
    - Aggregate – Completion rates
- All tests
    - Pass/Fail statistics
    - Failure breakdown
        - Graphs
        - Table
        - Pie chart
    - Summary/Implications
    - Error statistics
    - Completion Data

3.2 Device – Device

3.2.1 Handheld ─ Handheld

3.2.1.1 Test Case – Business Card Exchange: Failure Results

3.2.1.1.1 **Failure Data**

Table 3.2.1.1-1: HH-HH Transfer Calendar Entry Data

	HH1	HH2	HH3	HH4	HH5	MP1
HH1	x	USF	x	UFF	UDB	UFF
HH2	UFF	x	t&d	0	t&d	t&d
HH3	x	0	x	FS	x	x
HH4	FS	0	t&d	x	t&d	t&d
HH5	PNI	0	x	0	x	x
MP1	UDB	0	x	0	x	x

Table 3.2.1.1-2: HH-HH Transfer Calendar Entry Stats

Potential	36
Tested	22
Passed	2
Failed	20
Pass Rate	9.09%
Completion Rate	61.11%

- 100% of the failures are due to the device pair not supporting this feature, so either one or none of the two devices supported this feature in all recorded failures.
- Of the six devices tested only two could initiate a business card exchange.
- Interesting to note that HH2 and HH4 could initiate business card exchange, but HH2 was not able to successfully initiate and complete a business card exchange with HH4.

3.2.1.1.2 Summary/Implications

- Summary
  - Only 2 out of 22 test cases were successful; a pass rate of ~9%
  - Only 2 out of 6 devices tested included a user interface making it possible to initiate a business card exchange.
  - Most devices supported the business card profile, but did not accommodate it into the software

- Implications
  - Integrating business card exchange in the application software would raise success from 9% to 100%.

3.2.1.2 Test Case – Transfer Contact: Failure Results

3.2.1.2.1 Failure Data

Table 3.2.1.2-1: HH-HH Transfer Contact Data

	HH1	HH2	HH3	HH4	HH5	MP1
HH1	x	0	x	0	UDB	UDB
HH2	0	x	0	0	0	0
HH3	x	0	x	0	x	x
HH4	0	0	0	x	0	0
HH5	0	0	x	0	x	x
MP1	0	0	x	0	x	x

Table 3.2.1.2-2: HH-HH Transfer Contact Stats

Potential	36
Tested	22
Passed	20

Failed   2
Pass Rate   90.91%
Completion Rate   61.11%

- Only 2 out of 22 failed.
- Both failures were from sending a contact from HH1
- The two failures were because HH1 was not able to detect the other devices to send the contact to.

3.2.1.2.2 **Summary/Implications**

- Summary
  - The pass rate for "HH-HH: transfer contact," was very high; 20 out of 22 or ~91%.
  - The two failures came from same device, HH1, when sending a contact from this device.
- Implications
  - If problems with HH1 could be solved the pass rate could have easily been 100% or 22 out of 22 successes.

3.2.1.3 Test Case – Transfer Calendar Entry: Failure Results

3.2.1.3.1 Failure Data

Table 3.2.1.3-1: HH-HH Transfer Calendar Entry Data

	HH1	HH2	HH3	HH4	HH5	MP1
HH1	x	USF	x	UFF	UDB	UFF
HH2	UFF	x	t&d	0	t&d	t&d
HH3	x	0	x	FS	x	x
HH4	FS	0	t&d	x	t&d	t&d
HH5	PNI	0	x	0	x	x
MP1	UDB	0	x	0	x	x

Table 3.2.1.3-2: HH-HH Transfer Calendar Entry Stats

Potential   36
Tested   22
Passed   7
Failed   15
Pass Rate   31.82%

Completion Rate   61.11%

- Low Pass rate ~32%.
- 6 out of 15 failures due to incorrect time/date (t&d) when transferred, and 3 out of 15 failures due to unsupported file format (UFF).
- This means file format issues account for 9 out of the 15 failures (60%) and could be fairly easy to fix.
- Note: asymmetry in the data; indicates it makes a difference which device is initiating the transfer.

3.2.1.3.2 **Summary/Implications**

- Summary
    - Low pass rate for this test case, ~32%
    - 6 out of the 15 failures due to incorrect time/date when calendar entry transferred.
    - 3 out of the 15 failures due to incompatible file formats not recognized by other device; all three have to do with HH1.
    - Combined file format issues account for 60% of all failures
- Implications
    - By enforcing or adapting a standard calendar form when sending calendar entries 6 of the 15 failures could be corrected raising the pass rate to 13 of 22, or a 60% pass rate.
    - Also if all handheld devices supported the same calendar file format then 3 out the 15 failures could be corrected further raising the pass rate to 16 of 22, or a 73% pass rate

3.2.1.4 Test Case – Transfer Picture: Failure Results

3.2.1.4.1 Failure Data

Table 3.2.1.4-1: HH-HH Transfer Picture Data

	HH1	HH2	HH3	HH4	HH5	MP1
HH1	x	0	x	0	0	0
HH2	0	x	USF	0	USF	0
HH3	x	0	x	0	x	x
HH4	0	0	USF	x	USF	0
HH5	0	0	x	0	x	x
MP1	0	0	x	0	x	x

Table 3.2.1.4-2: HH-HH Transfer Picture Stats

Potential	36
Tested	22
Passed	18
Failed	4
Pass Rate	81.82%
Completion Rate	61.11%

- Note: asymmetry in the data;
- Indicates HH3 and HH5 were bad receivers while having no problem sending a picture.
- Also indicates that HH2 and HH4 were bad senders while having no problem receiving a picture.

3.2.1.4.2 Summary/Implications

- Summary
    - A total of 4 failures out of 22 tests
    - Asymmetry indicates HH3 and HH5 were poor receivers while HH2 and HH4 were poor senders.
    - All failures are because HH2 and HH4 offered no option to send a file to HH3 and HH5.
    - The reason HH2 and HH4 could send files to the other handheld devices is because the other devices supported a file browsing option that allowed for them to retrieve file from other handhelds and also send files to other handhelds, while HH3 and HH5 offered no such service.
- Implications
    - All 4 failures are solved relatively easily by implementing a user interface to send files from a browser on HH2 and HH4 much like the other handhelds.
    - This could give a 100% pass rate.

3.2.1.5 Test Case – Transfer Audio Recording: Failure Results

3.2.1.5.1 Failure Data

Table 3.2.1.5-1: HH-HH Transfer Recorded Audio Data

	HH1	HH2	HH3	HH4	HH5	MP1
HH1	x	0	x	0	0	FS
HH2	0	x	USF	0	USF	0
HH3	x	UFF	x	UFF	x	x
HH4	0	0	USF	x	USF	0
HH5	0	0	x	0	x	x
MP1	0	0	x	0	x	x

Table 3.2.1.5-2: HH-HH Transfer Recorded Audio Stats

Potential	36
Tested	22
Passed	18
Failed	4
Pass Rate	81.82%
Completion Rate	61.11%

- 4 out of the 7 failures are due to the same reasons as with transferring a picture: HH2 and HH4 are not able to initiate a transfer of an audio file with HH3 or HH5.
- 2 out of the 7 failures are due to unsupported file formats

3.2.1.5.2 Summary/Implications

- Summary
    - A total of 7 failures out of 22 tests
    - 4 out of the 7 failures are due to the same reasons as with transferring a picture: HH2 and HH4 are not able to initiate a transfer of an audio file with HH3 or HH5.
    - 2 out of the 7 failures are due to unsupported file format issues, HH2 and HH4 do not recognize the audio file from HH3.
- Implications
    - 4 out of 7 failures (57%) are solved relatively easily by implementing a user interface to send files from a browser on HH2 and HH4 similar to the other handhelds.
    - 2 of the 7 failures (29%) could be solved if other handhelds had the capability to recognize files from HH3, or if HH3 adopted the file format used by HH2 and HH4 for recorded audio.
    - Correcting these six failures would result in 21 of 22 successful tests which is a ~95% pass rate.

3.2.1.6 Handheld – Handheld: Failure Results

3.2.1.6.1 Failure Data

3.2.1.6.1.1 Aggregates

Table 3.2.1.6-1: HH-HH Aggregates

Passes

	HH1	HH2	HH3	HH4	HH5	MP1
HH1		3		3	3	2
HH2	4		1	4	1	4
HH3		3		2		
HH4	3	5	1		1	4
HH5	3	4		4		
MP1	3	4		4		

Failures

	HH1	HH2	HH3	HH4	HH5	MP1
HH1		2		2	4	5
HH2	1		4	1	4	3
HH3		2		3		
HH4	2		4		4	3
HH5	3	1		1		
MP1	3	2		2		

Table 3.2.1.6-2: HH-HH Aggregate Stats

Potential Pairs	36
Tested Pairs	22
Potential TC	248
Tested TC	122
Passed TC	66
Failed TC	56
Pass Rate	54.10%

3.2.1.6.1.2 Failure Rates

Table 3.2.1.6-3: HH-HH Failure Rates

	HH1	HH2	HH3	HH4	HH5	MP1
HH1		40%		40%	57%	71%
HH2	20%		80%	20%	80%	43%
HH3		40%		60%		
HH4	40%	0%	80%		80%	43%
HH5	50%	20%		20%		
MP1	50%	33%		33%		

3.2.1.6.1.3 Failure Rates 3D
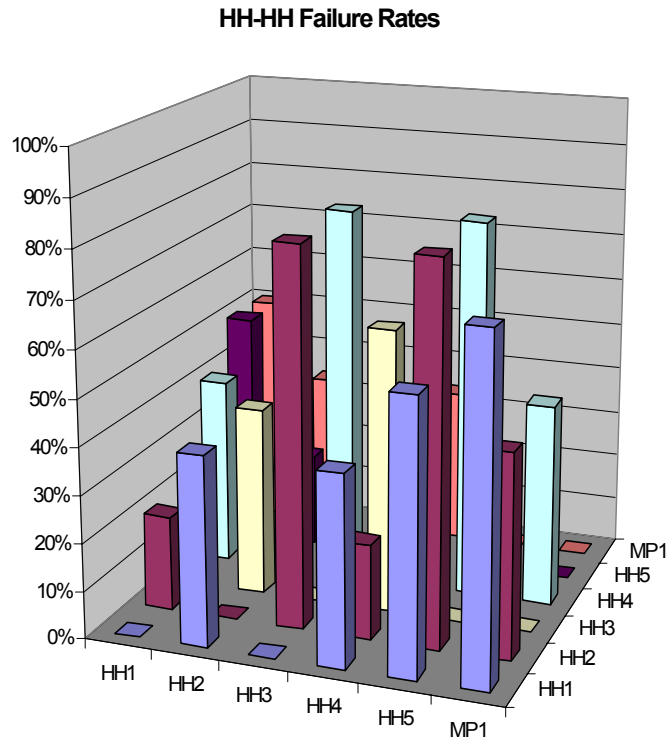
HH-HH Failure Rates

Figure 3.2.1.6-1: HH-HH Failure Rates

3.2.1.6.1.4 Failure Rate Distribution

Figure 3.2.1.6-2: HH-HH Failure Rate Distribution

3.2.1.6.1.5Distribution by Test Cases

Figure 3.2.1.6-3: HH-HH Distribution by Test Cases

3.2.1.6.1.6 Failure Breakdowns

Table 3.2.1.6-4: HH-HH Breakdowns

Total	Failure Description
0	"Unable to connect…" error
0	"Max number of Bluetooth connections…" error
0	"Internal Bluetooth…" error
0	"Profile not supported…" error
7	Unable to detect device during Bluetooth Search
0	Pairing Error: "Unable to Pair…"
37	Device pair does not support feature under test.
6	Transferred calendar times/dates are incorrect
0	Data lost while transferring
3	"Failed sending" error
5	Unsupported file format
1	Pairing cannot be initiated from device
56	Total number of failures

3.2.1.6.2 Summary

- Overall Pass rate of 66 of 122 or 54%
- 37 of 56 failures due to unsupported feature for a particular device pair and test case.
- 6 of 56 come from one test case (transferring a calendar entry) where the times and dates are transferred incorrectly.
- 5 of 56 come from an unsupported file format issue.
- Recognized that on 4 of 5 test cases represented HH3 and HH5 were poor receivers, while HH2 and HH4 were poor transmitters.

3.2.1.6.3 Implications

- Using the "Summary/Implications" sections from the previous breakdowns the amount of improvement (failures that could be corrected) can be tracked if these modifications are made.
    - 12 if all six handhelds could initiate a business card exchange.
    - 8 if all devices had software supporting a business card exchange.
    - 8 if HH2 and HH4 implemented a user interface to send files similar to other handhelds.
    - 6 by enforcing or adapting a standard calendar form when sending calendar entries.
    - 3 if all handheld devices supported the same calendar file format.
    - 2 if all handhelds used the same file format for transferring recorded audio.
- These account for 39 of 56 failures (70%)
- 86% pass rate (105 out of 122) if all these failures corrected
- 93% pass rate (113 out of 122) if FAX test was not included or worked
- Compare this to the actual pass rate of 54%.

3.2.1.7 Handheld – Handheld: Error Data

3.2.1.7.1 Error Definitions

Error Rate: The number of test cases in which at least one error is encountered divided by the number of test cases.

> E.g., If test case A had 2 transient errors and test case B had 0, then its error rate would be 1/2 or 50%.

Average Errors: The number of errors divided by the number of test cases.

> E.g., Using the same example from above this would yield Average Errors of 2/2 or 100%.

3.2.1.7.2 Error Data

Table 3.2.1.7-1: HH-HH Error Data

	HH1	HH2	HH3	HH4	HH5	MP1
HH1	0	0	0	0	2	1
HH2	8	0	0	4	0	3
HH3	0	0	0	0	0	0
HH4	0	0	0	0	0	4
HH5	0	5	0	0	0	0
MP1	0	0	0	0	0	0

Table 3.2.1.7-2: HH-HH Error Summary

Tested TC	122
TC w/ Errors	7
Total Errors	27
Error Rates	5.74%
Average Errors	22.13%

3.2.1.8 Handheld – Handheld: Completion Rates

Table 3.2.1.8-1: HH-HH Completion Rates

	HH1	HH2	HH3	HH4	HH5	MP1
HH1		83%		83%	88%	88%
HH2	83%		83%	83%	63%	88%
HH3		83%		83%		
HH4	83%	83%	83%		63%	88%
HH5	86%	71%		71%		
MP1	86%	86%		86%		

Table 3.2.1.8-2: HH-HH Completion Summary

Potential Pairs	36
Tested Pairs	22
Potential TC	248
Tested TC	122
Completion Rate	49.19%

HH-HH Completion Rates
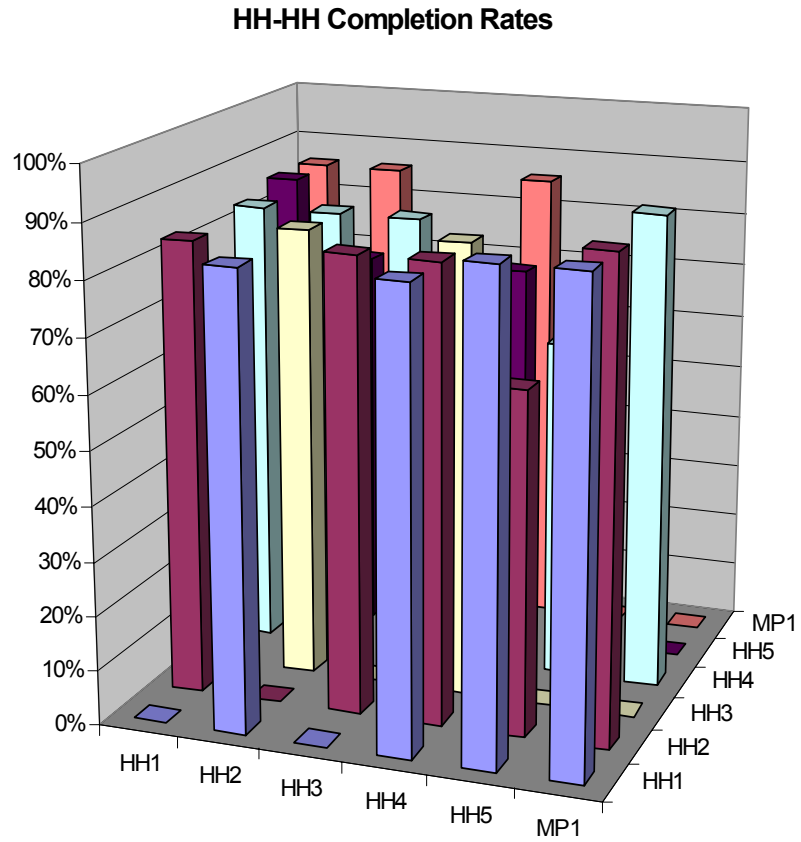
Figure 3.2.1.8-1: HH-HH Completion Rates
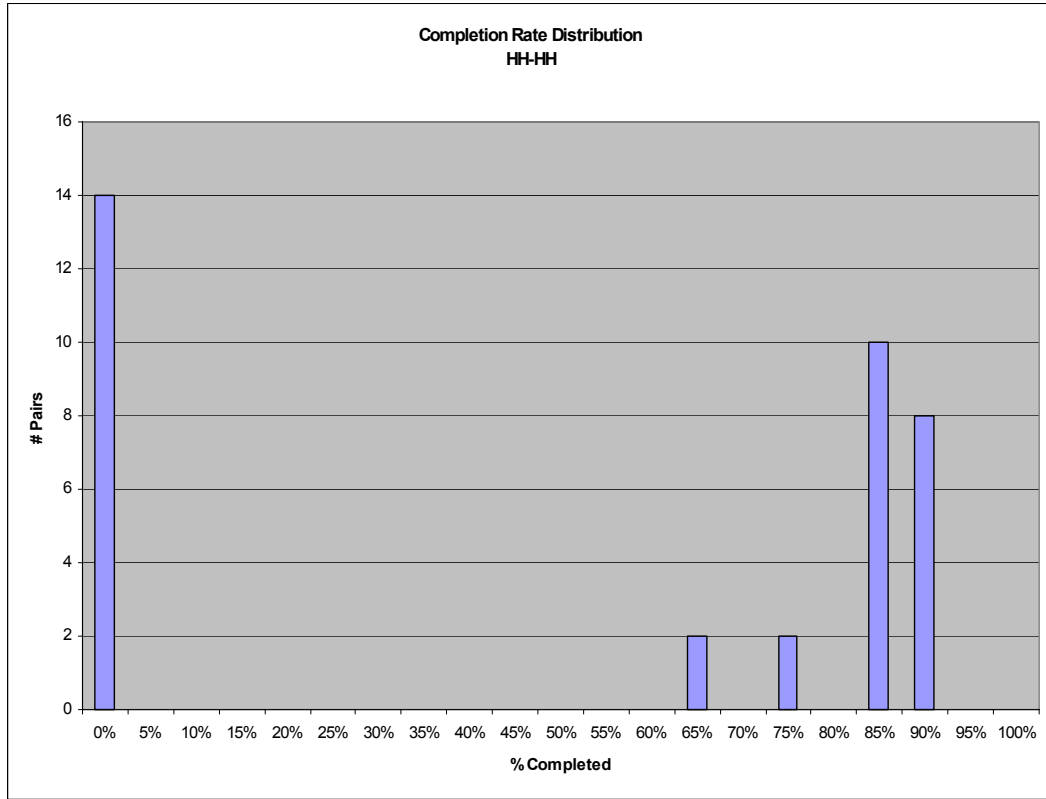
Figure 3.2.1.8-2: HH-HH Completion Rate Distribution

3.2.2 Handheld – Mobile Phone

3.2.2.1 Test Case – Business Card Exchange: Failure Results

3.2.2.1.1 Failure Data

Table 3.2.2.1-1: HH-MP Business Card Exchange Data

	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH1					USF	USF	USF	USF	USF	x	USF	USF	x
HH2					USF	USF	USF	USF	USF	USF	USF	USF	USF
HH3					x	x	x	x	x	x	x	x	x
HH4					USF	USF	USF	USF	USF	USF	USF	USF	USF
HH5	USF	USF	x	USF	x	x	USF	USF	USF	USF	USF	USF	USF
MP1	USF	USF	x	USF	x	x	USF	USF	USF	USF	USF	x	x
MP2	USF	USF	x	USF	USF	USF							
MP3	USF	USF	x	USF	USF	USF							
MP4	USF	USF	x	USF	USF	USF							
MP5	x	USF	x	USF	USF	USF							
MP6	USF	USF	x	USF	USF	USF							
MP7	USF	USF	x	USF	USF	x							
MP8	x	USF	x	USF	USF	x							

Table 3.2.2.1-2: HH-HH Business Card Exchange Stats

Potential Pairs	104
Tested Pairs	74
Passed	0
Failed	74
Pass Rate	0%
Completion Rate	71.5%

- All 74 failures are due to the devices' inability to initiate and/or support a business card exchange

3.2.2.1.2 Summary/Implications

- Summary
  - Pass rate of 0% (0 out of 74 tested)
  - No devices could initiate a business card exchange

- Implications
  - All 74 failures could be corrected if all devices could initiate a business card exchange, and the software implementing the business card profile was present.

3.2.2.2 Test Case – Transfer Contact: Failure Results

3.2.2.2.1 Failure Data

Table 3.2.2.2-1: HH-MP Transfer Contact Data

	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH1					UDB	UDB	UDB	UDB	UDB	x	0	0	x
HH2					0	0	0	0	0	0	0	0	0
HH3						x	x	x	x	x	x	x	x
HH4					0	0	0	0	0	0	0	0	0
HH5	0	0	x	0	x	x	0	FS	0	0	FS	0	0
MP1	0	0	x	0	x	x	0	0	0	0	0	x	x
MP2	0	0	x	0	0	0							
MP3	UDB	0	x	0	0	0							
MP4	0	0	x	0	0	0							
MP5	x	0	x	0	0	0							
MP6	0	0	x	0	0	0							
MP7	FS	0	x	0	0	x							
MP8	x	0	x	0	0	x							

Table 3.2.2.2-2: HH-MP Transfer Contact Stats

Potential Pairs	104
Tested Pairs	74
Passed	65
Failed	9
Pass Rate	87.8%
Completion Rate	71.2%

- Tests involving HH1 constituted 7 of the 9 failures
- 5 of the 7 were due to HH1 not being able to detect the other Bluetooth device

3.2.2.2.2 Summary/Implications

- Summary
  - Pass rate of 87.8% (65 of 74)
  - 7 of the 9 failures involved HH1

- 5 of the 7 failures involving HH1 were because HH1 was not able to detect other Bluetooth devices.
- Implications
    - If the 5 failures due to HH1 being unable to detect other Bluetooth devices was corrected would bring the pass rate up to 94.6% (70 of 74).

3.2.2.3 Test Case – Transfer Calendar Entry: Failure Results

3.2.2.3.1 Failure Data

Table 3.2.2.3-1: HH-MP Transfer Calendar Entry Data

	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH1					UDB	UFF	UDB	UDB	UFF	x	UFF	FS	x
HH2					t&d	t&d	0	0	0	0	0	0	t&d
HH3					x	x	x	x	x	x	x	x	x
HH4					t&d	t&d	0	t&d	t&d	t&d	0	0	t&d
HH5	PNI	0	x	0	x	x	0	FS	UFF	UFF	FS	UFF	0
MP1	UDB	0	x	0	x	x	0	0	0	0	0	x	x
MP2	UFF	0	x	t&d	0	0							
MP3	UDB	0	x	t&d	t&d	0							
MP4	UDB	0	x	t&d	0	0							
MP5	x	t&d	x	0	0	0							
MP6	USF	0	x	0	0	0							
MP7	MBC	0	x	0	0	x							
MP8	x	0	x	0	0	x							

Table 3.2.2.3-2: HH-MP Transfer Calendar Entry Stats

Potential Pairs	104
Tested Pairs	74
Passed	41
Failed	33
Pass Rate	55.4%
Completion Rate	71.2%

- 14 of 33 failures due to incorrect time/date when transferring
- 8 of 33 failures due a calendar entry transferred in a format not supported by the receiving device
- 3 of 33 failures due to HH1 not being able to detect the other Bluetooth device to send Calendar Entry to.

3.2.2.3.2 **Summary/Implications**
- Summary
    - Pass rate of 55.4% (41 of 74)

- 14 of 33 failures due to incorrect time/date when transferring
- 8 of 33 failures due a calendar entry transferred in a format not supported by the receiving device
- 3 of 33 failures due to HH1 not being able to detect the other Bluetooth device to send Calendar Entry to.
- Implications
  - Many improvements can be made to increase the pass rate.
  - 14 of the 33 failures could be corrected raising the pass rate to 55 of 74, or a 74% pass rate by enforcing the standard calendar form when sending calendar entries.
  - 8 of the 33 failures could be corrected further raising the pass rate to 63 of 74, or an 85% pass rate if all handheld devices supported the calendar file format.
  - Finally, if the 3 failures due to HH1 were corrected the pass rate would be 66 of 74 or a pass rate of 89%.

3.2.2.4 Test Case – Transfer Picture: Failure Results

3.2.2.4.1 Failure Data

Table 3.2.2.4-1: HH-MP Transfer Picture Data

	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH1					0	0	0	0	0	x	0	0	x
HH2					USF	0	0	0	0	0	0	0	0
HH3					x	x	x	x	x	x	x	x	x
HH4					USF	0	0	0	0	0	0	0	0
HH5	0	0	x	0	x	x	0	FS	0	0	FS	0	0
MP1	0	0	x	0	x	x	0	0	0	0	0	x	x
MP2	0	0	x	0	0	0							
MP3	0	0	x	0	0	0							
MP4	0	0	x	0	0	0							
MP5	x	0	x	0	x	0							
MP6	0	0	x	0	0	0							
MP7	UC	0	x	0	0	x							
MP8	x	0	x	0	0	x							

Table 3.2.2.4-2: HH-MP Transfer Picture Stats

Potential Pairs	104
Tested Pairs	73
Passed	68
Failed	5
Pass Rate	93.2%
Completion Rate	70.2%

- High pass rate of 93.2%
- 2 of 5 failures due to HH2, and HH4 not being able to send a file to HH5 which was seen in Section 3.2.1.4.
- Only other notable trend is that HH5 had two permanent, "failed sending," errors.

3.2.2.4.2 Summary/Implications

- Summary
    - Pass rate of 93.2% (68 of 73); high pass rate indicates a relatively good state of interoperability.
    - 2 of 5 failures due to HH2, and HH4 not being able to send a file to HH5 which was seen in Section 3.2.1.4.

- Implications
    - Handhelds and mobile phones seem to perform fairly well when transferring a picture.
    - 2 out of 5 failures are solved relatively easily by implementing a user interface to send files from a browser on HH2 and HH4 similar to the other handhelds; this would raise the pass rate to 95.9% (70 of 73).

3.2.2.5 Test Case – Dialup Networking: Failure Results

3.2.2.5.1 Failure Data

Note that dialup networking can only be provided by mobile phones, so this test case is not symmetric.

Table 3.2.2.5-1: HH-MP Dialup Networking Data

	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH1					0	0	0	0	0		UC	0	x
HH2					x	0	0	0	0		0	0	0
HH3					x	x	x	x	x		x	x	x
HH4					x	0	0	0	0		0	0	0
HH5					x	x	0	0	0		0	0	0
MP1					x	x	USF	USF	USF		USF	x	x
MP2													
MP3													
MP4													
MP5													
MP6													
MP7													
MP8													

Table 3.2.2.5-2: HH-MP Dialup Networking Stats

Potential Pairs	48
Tested Pairs	31
Passed	26
Failed	5
Pass Rate	83.9%
Completion Rate	64.6%

- Note: There is some question for the applicability of MP1, but HH5 (also a dual device) does support DUN.
- MP1 does not have a user interface allowing for initialization of dial-up networking.

3.2.2.5.2 Summary/Implications

- Summary
    - Pass rate of 83.9% (26 of 31); high pass rate indicates good interoperability.
    - 4 of 5 failures are because MP1 does not have a user-interface allowing the initialization of this feature.
- Implications
    - If MP5 was not included for this test case because of its questionable applicability, or a user-interface was implemented allowing the device use dial-up networking from another phone, then the pass rate would rise to 96.3% (26 of 27).

3.2.2.6 Test Case – Transfer of Recorded Audio: Failure Results

3.2.2.6.1 Failure Data

Table 3.2.2.6-1: HH-MP Transfer Recorded Audio Data

	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH1					0	FS	UFF	UFF	0	x	USF	0	x
HH2					USF	0	UFF	UFF	0	0	UFF	0	0
HH3					x	x	x	x	x	x	x	x	x
HH4					USF	0	UFF	UFF	0	0	UFF	0	0
HH5	0	0	x	0	x	x	UFF	0	0	0	0	0	0
MP1	0	0	x	0	x	x	UFF	FS	0	0	FS	x	x
MP2	UFF	UFF	x	UFF	UFF	UFF							
MP3	FS	FS	x	UFF	UFF	0							
MP4	UFF	UFF	x	UFF	UFF	0							
MP5	x	UFF	x	UFF	UFF	0							
MP6	0	UFF	x	FS	UFF	0							
MP7	UC	UFF	x	UFF	UFF	x							
MP8	x	UFF	x	UFF	UFF	x							

Table 3.2.2.6-2: HH-MP Transfer Recorded Audio Stats

Potential Pairs   104
Tested Pairs   74
Passed   32
Failed   42
Pass Rate   43.2%
Completion Rate   71.2%

- 22 of 42 failures, the majority, came from MP → HH because most mobile phones use an `.amr` file format which is not recognized by most handhelds.
- 12 of 42 failures came from mobile phones not being able to recognize the `.wav` format that most handheld devices use.
- As seen before HH2 and HH4 were not able to send a file to HH5.

3.2.2.6.2 Summary/Implications

- Summary
  - Pass rate of 43.2% (32 of 74); Poor interoperability for this device type pair and test case.
  - 22 of 42 failures, the majority, came from MP → HH because mobile phones use an `.amr` file format which is not recognized by most handhelds.
  - 12 of 42 failures came from mobile phones not being able to recognize the .wav format that most handheld devices use.
  - As seen before, HH2 and HH4 were not able to send a file to HH5
- Implications
  - 34 of 42 failures could be corrected if both mobile phones and handhelds adopted the same format for recorded audio files, or had the ability to recognize both `.amr` and `.wav` formats.
  - That would raise the pass rate to 89.1% (66 of 74).

3.2.2.7 Test Case – Send FAX: Failure Results

3.2.2.7.1 Failure Data

Table 3.2.2.7-1: HH-MP FAX Data

	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH1					USF	USF	USF	USF	USF	x	USF	USF	x
HH2					x	USF	USF	USF	USF	USF	USF	USF	USF
HH3					x	x	x	x	x	x	x	x	x
HH4					x	USF	USF	USF	USF	USF	USF	USF	USF
HH5	USF	x	x	x	x	x	USF	USF	USF	USF	USF	USF	USF
MP1	USF	USF	x	USF	x	x	USF	USF	USF	x	USF	x	x
MP2	USF	USF	x	USF	USF	USF							
MP3	USF	USF	x	USF	USF	USF							
MP4	USF	USF	x	USF	USF	USF							
MP5	x	USF	x	USF	USF	x							
MP6	USF	USF	x	USF	USF	USF							
MP7	USF	USF	x	USF	USF	x							
MP8	x	USF	x	USF	USF	x							

Table 3.2.2.7-2: HH-MP FAX Stats

Potential Pairs	104
Tested Pairs	68
Passed	0
Failed	68
Pass Rate	0%
Completion Rate	65.4%

- Note: Handhelds lack the software or interface to attempt this test case.
- Is it a valid test case?
    - Word, PDF viewers on HH are really no different from PCs.
    - Remains an open question

3.2.2.8 Handheld – Mobile Phone: Failure Results

3.2.2.8.1 Failure Data

3.2.2.8.1.1 Aggregates

Table 3.2.2.8-1: HH-MP Aggregates

Passes

	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH1					3	2	2	2	3		2	4	
HH2					1	4	4	4	5	4	4	5	4
HH3													
HH4					1	4	4	3	4	3	4	5	4
HH5	3	4		4		4	4	2	4	3	2	4	5
MP1	3	4		4			3	3	4	4	3		
MP2	2	3		2	3	3							
MP3	1	3		2	2	4							
MP4	2	3		2	3	4							
MP5		2		3	2	4							
MP6	3	3		3	3	4							
MP7		3		3	3								
MP8		3		3	3								

Failures

	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH1					4	5	5	5	4		5	3	
HH2					4	3	3	3	2	3	3	2	3
HH3													
HH4					4	3	3	4	3	4	3	2	3
HH5	3	1		1		3	5	3	4	5	3	2	
MP1	3	2		2			4	4	3	1	4		
MP2	4	3		4	3	3							
MP3	5	3		4	4	2							
MP4	4	3		4	3	2							
MP5		4		3	3	1							
MP6	3	3		3	3	2							
MP7	6	3		3	3								
MP8		3		3	3								

Table 3.2.2.8-2: HH-MP Aggregate Stats

Potential Pairs	104
Tested Pairs	74
Potential TC	698
Tested TC	468
Passed TC	232
Failed TC	236
Pass Rate	49.57%

3.2.2.8.1.2 Failure Rates

Table 3.2.2.8-3: HH-MP Failure Rate Data

	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH1					57%	71%	71%	71%	57%		71%	43%	
HH2					80%	43%	43%	43%	29%	43%	43%	29%	43%
HH3													
HH4					80%	43%	43%	57%	43%	57%	43%	29%	43%
HH5	50%	20%		20%			43%	71%	43%	57%	71%	43%	29%
MP1	50%	33%		33%			57%	57%	43%	20%	57%		
MP2	67%	50%		67%	50%	50%							
MP3	83%	50%		67%	67%	33%							
MP4	67%	50%		67%	50%	33%							
MP5		67%		50%	60%	20%							
MP6	50%	50%		50%	50%	33%							
MP7	100%	50%		50%	50%								
MP8		50%		50%	50%								

3.2.2.8.1.3 Failure Rates 3D
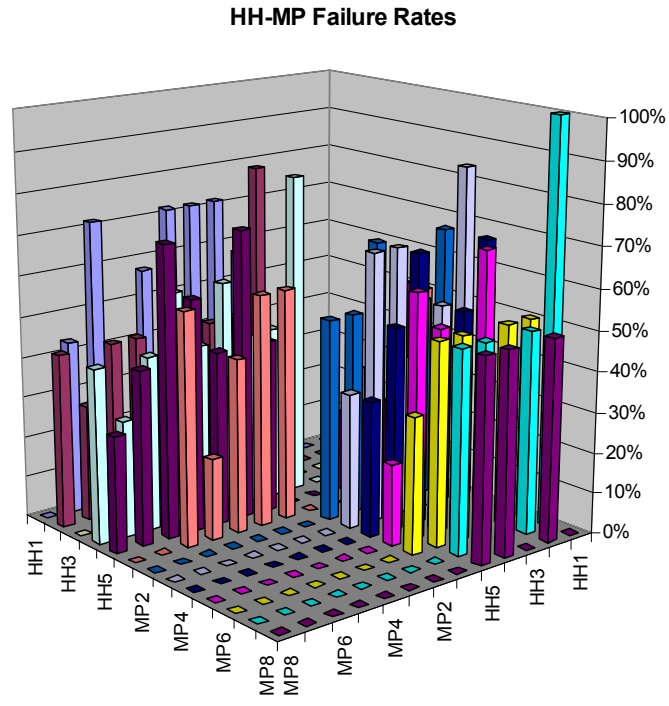
HH-MP Failure Rates

Figure 3.2.2.8-1: MP-HH Failure Rates
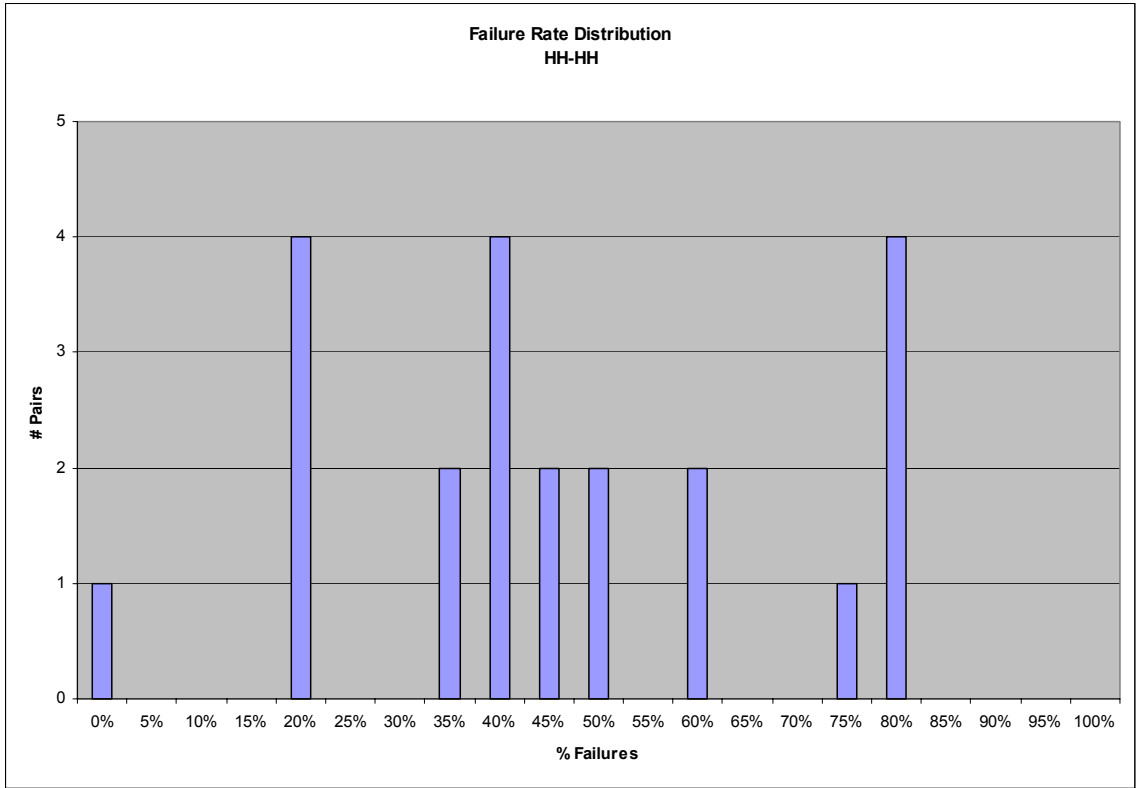
3.2.2.8.1.4 Failure Rate Distribution
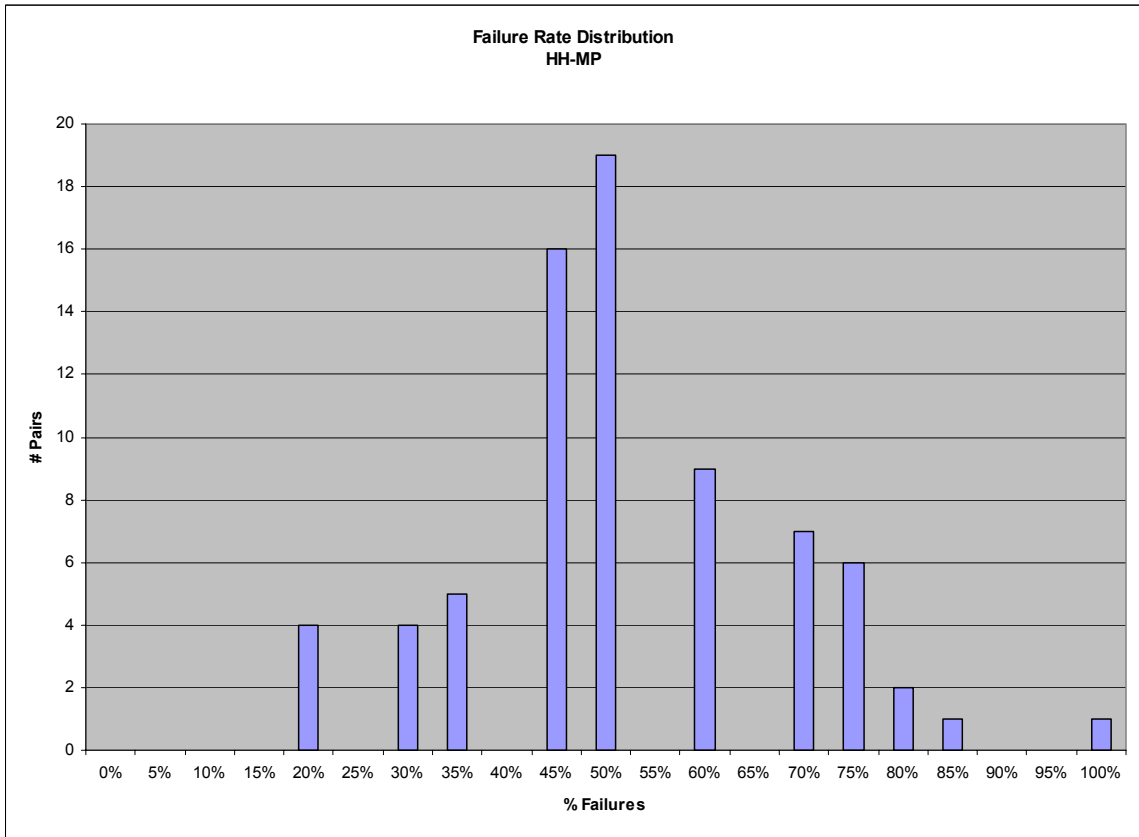
Figure 3.2.2.8-2: HH-MP Failure Rate Distribution
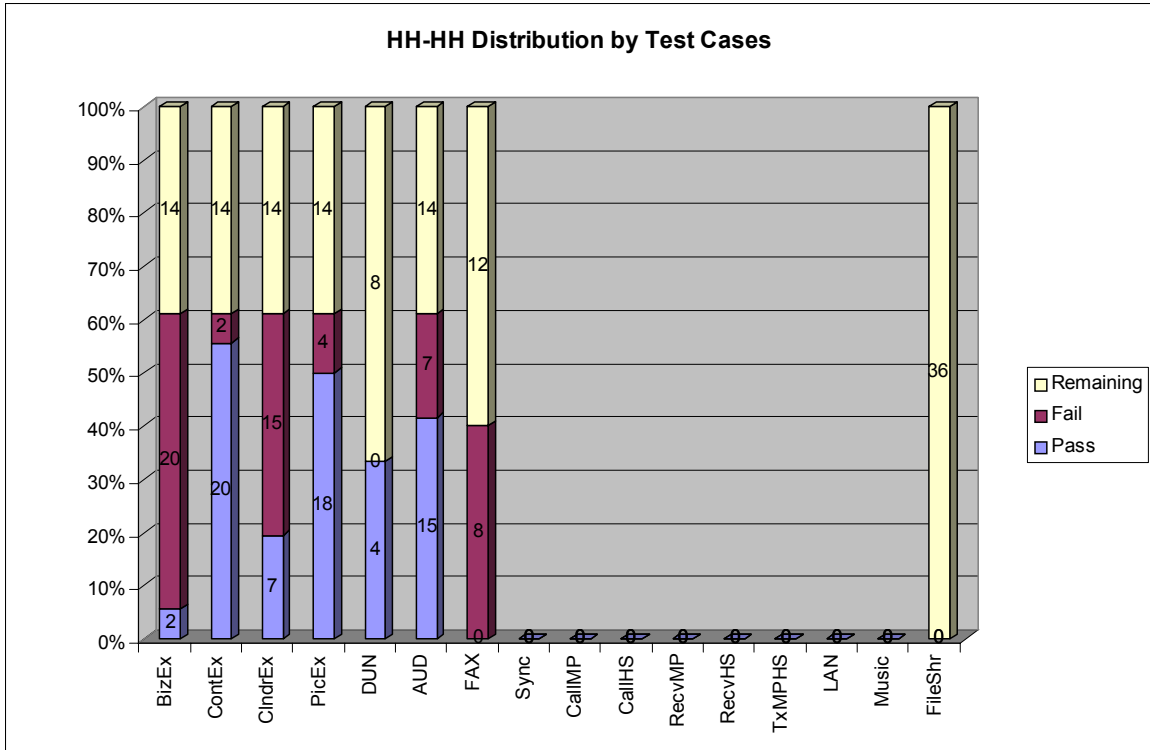
3.2.2.8.1.5 Distribution by Test Cases
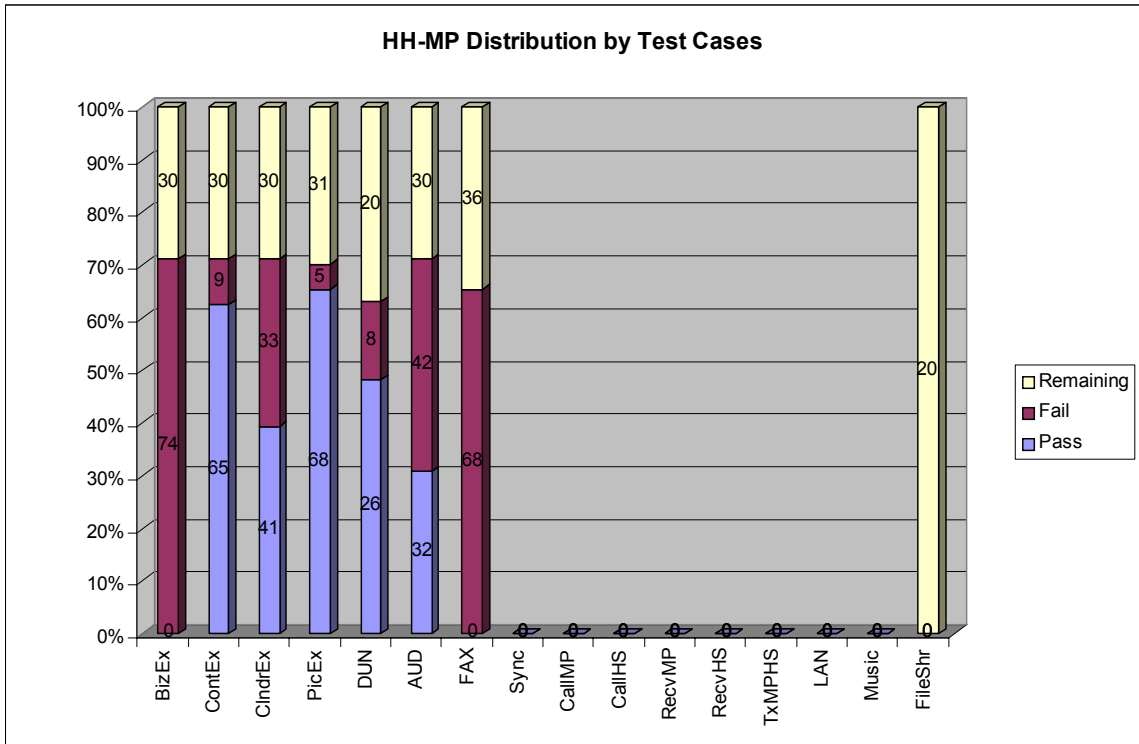
Figure 3.2.2.8-3: HH-MP Distribution by Test Cases

3.2.2.8.1.6 Failure Breakdowns

Table 3.2.2.8-4: HH-MP Breakdowns

Total	Failure Description
5	"Unable to connect…" error
1	"Max number of Bluetooth connections…" error
0	"Internal Bluetooth…" error
0	"Profile not supported…" error
12	Unable to detect device during Bluetooth Search
0	Pairing Error: "Unable to Pair…"
153	Device pair does not support feature under test.
14	Transferred calendar times/dates are incorrect
0	Data lost while transferring
14	"Failed sending" error
39	Unsupported file format
1	Pairing cannot be initiated from device
239	Total number of failures

3.2.2.8.2 Summary

- Overall Pass rate of 232 of 471 or 49.26%
- 153 of 236 failures due to unsupported feature for a particular device pair and test case.
- 39 of 236 due to unsupported file format.
- 14 of 236 come from one test case where the transferred calendar times/dates were incorrect.
- Recognized that on 3 test cases represented HH2 and HH4 were unable to transfer files to HH5.

3.2.2.8.3 Implications

- Using the "Summary/Implications" sections from the previous breakdowns the amount of improvement (failures that could be corrected) can be tracked if these modifications are made.
  - 74 if all devices could initiate a business card exchange, and software implementing the business card profile was present.
  - 34 if both mobile phones and handhelds adopted the same format for recorded audio files, or had the ability to recognize both `.amr` and `.wav` formats.
  - 14 by enforcing or adapting a standard calendar form when sending calendar entries.
  - 8 if all handheld devices supported the same calendar file format.

- 4 if HH2 and HH4 implemented a user interface to send files similar to other handhelds.
- 2 if all handhelds used the same file format for transferring recorded audio.
- These account for136 of 236 failures (60%)
- 78.6% pass rate (368 out of 468) if all these failures corrected
- 93.1% pass rate (436 out of 468) if FAX test was not included.
- Compare this to the actual pass rate of 49.57%

3.2.2.9 Handheld – Mobile Phone: Error Data

Information in Table 3.2.2.9-1 and Table 3.2.2.9-2 shows the failure data for all HH-MP test data. Note that this data should not be used for comparison purposes.

Table 3.2.2.9-1: HH-MP Error Data

	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH1					2	1	2	1	2	0	2	15	0
HH2					0	3	2	7	3	0	8	0	0
HH3					0	0	0	0	0	0	0	0	0
HH4					0	4	9	7	7	0	9	0	0
HH5	0	5	0	0	0	0	1	0	0	0	3	0	2
MP1	0	0	0	0	0	0	6	2	0	0	12	0	0
MP2	0	0	0	0	0	0							
MP3	0	0	0	0	0	0							
MP4	0	0	0	0	0	0							
MP5	0	0	0	0	0	0							
MP6	0	0	0	0	0	0							
MP7	0	0	0	0	0	0							
MP8	0	0	0	0	0	0							

Table 3.2.2.9-2: HH-MP Error Stats

Tested TC	471
TC w/ Errors	24
Total Errors	115
Error Rates	5.10%
Average Errors	24.42%

.

3.2.2.10   Handheld – Mobile Phone: Completion Results

Table 3.2.2.10-1: HH-MP Completion Rates

	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH1					88%	88%	100%	100%	100%		100%	100%	
HH2					63%	88%	100%	100%	100%	100%	100%	100%	100%
HH3													
HH4					63%	88%	100%	100%	100%	100%	100%	100%	100%
HH5	86%	71%		71%			100%	100%	100%	100%	100%	100%	100%
MP1	86%	86%		86%			100%	100%	100%	71%	100%		
MP2	100%	100%		100%	100%	100%							
MP3	100%	100%		100%	100%	100%							
MP4	100%	100%		100%	100%	100%							
MP5		100%		100%	83%	83%							
MP6	100%	100%		100%	100%	100%							
MP7	100%	100%		100%	100%								
MP8		100%		100%	100%								

Table 3.2.2.10-2: HH-MP Completion Statistics

Potential Pairs	104
Tested Pairs	74
Potential Test Cases	698
Tested Test Cases	471
Completion	67.48%

HH-MP Completion Rates
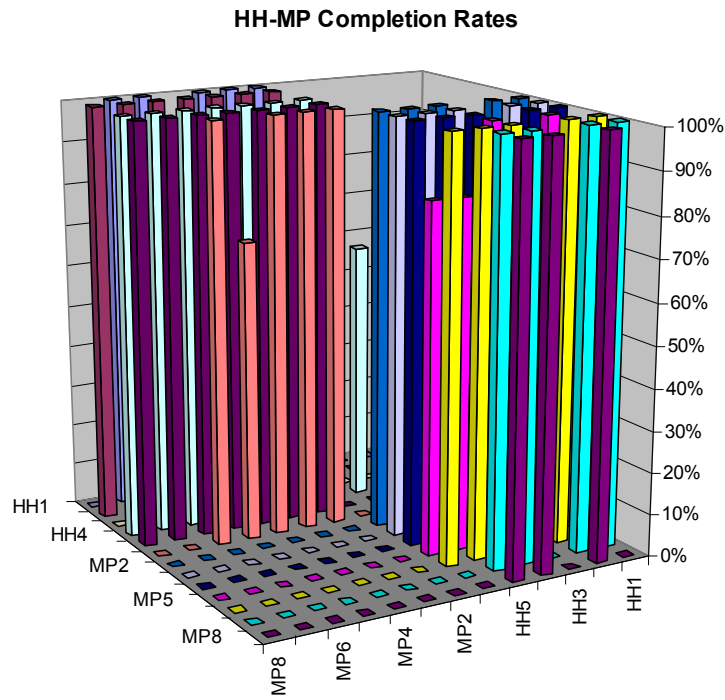
Figure 3.2.2.10-1: HH-MP Completion Rates
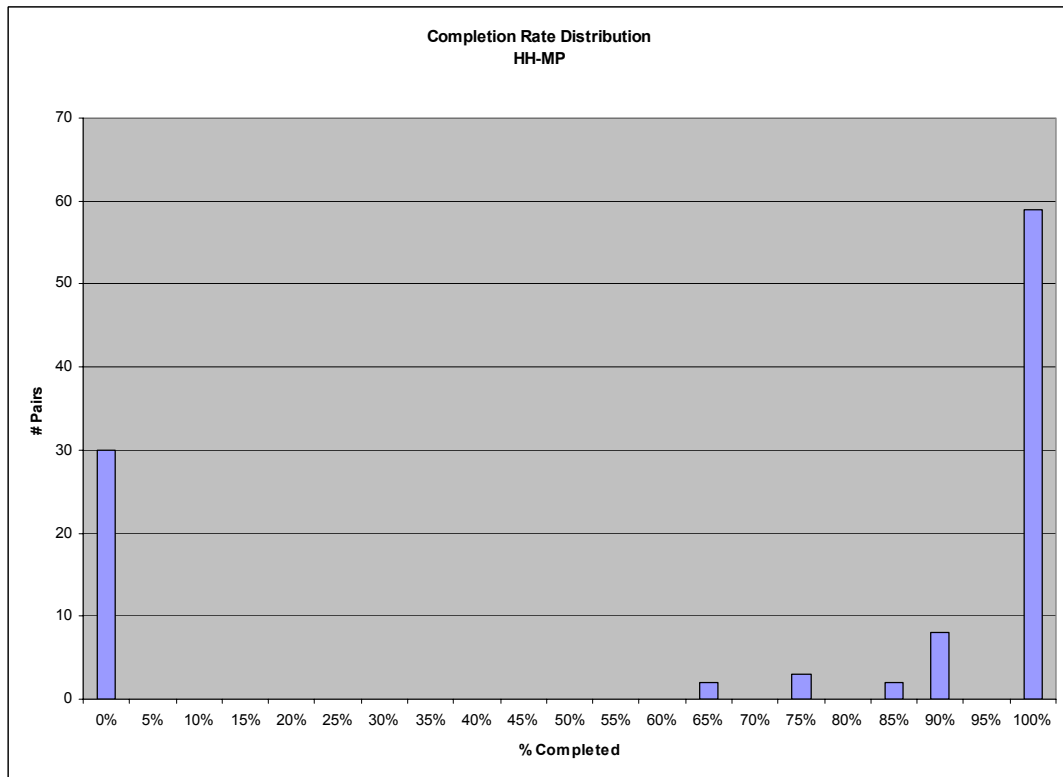
Figure 3.2.2.10-2: HH-MP Copmletion Distribution

3.2.3 Handheld – Headset

3.2.3.1 Test Case – Play Audio File: Failure Results

3.2.3.1.1 Failure Data

Table 3.2.3.1-1: HH-HS Play Audio File Data

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH1	x	x	x	x	x	x	x	x	x	x	x
HH2	UC	UC	UC	UC	UC	UC	UC	UC	UC	UC	x
HH3	x	x	x	x	x	x	x	x	x	x	x
HH4	UC	x	x	x	x	UC	x	x	x	x	x
HH5	UC	UC	UC	UC	UC	UC	UC	UC	UC	UC	UC
MP1	UC	UC	UC	UC	UC	UC	UC	UC	UC	UC	UC

Table 3.2.3.1-2: HH-HS Play Audio File Stats

Potential Pairs	66
Tested Pairs	34
Passed	0
Failed	34
Pass Rate	0%
Completion Rate	51.5%

- Handhelds are not able to connect to headsets to perform this task
- Is this a valid test case?

3.2.3.2 Handheld – Headset: Failure Results

3.2.3.2.1 Failure Data

3.2.3.2.1.1 Aggregates

Note that HH5 and MP1 are dual devices, so the data included here also include MP→HS tests.

Table 3.2.3.2-1: HH-HS Aggregates

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH1											
HH2											
HH3											
HH4											
HH5	4	4	1	4	4	4	4	4	4	4	4
MP1	5	5	5	5	5	5	5	5	5	5	5

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH1											
HH2	1	1	1	1	1	1	1	1	1	1	
HH3											
HH4	1					1					
HH5	2	2	5	2	2	2	2	2	2	2	2
MP1	1	1	1	1	1	1	1	1	1	1	1

Passes　　　　　　　　　　　　Failures

Table 3.2.3.2-2: HH-HS Aggregates

Potential Pairs	54
Tested Pairs	34
Potential TC	176
Tested TC	144
Passed TC	96
Failed TC	48
Pass Rate	66.7%

3.2.3.2.1.2 Failure Rates

The results are obvious.

Table 3.2.3.2-3: HH-HS Failure Rates

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH1											
HH2	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
HH3											
HH4	100%					100%					
HH5	33%	33%	83%	33%	33%	33%	33%	33%	33%	33%	33%
MP1	17%	17%	17%	17%	17%	17%	17%	17%	17%	17%	17%

3.2.3.2.1.3 Failure Rates 3D
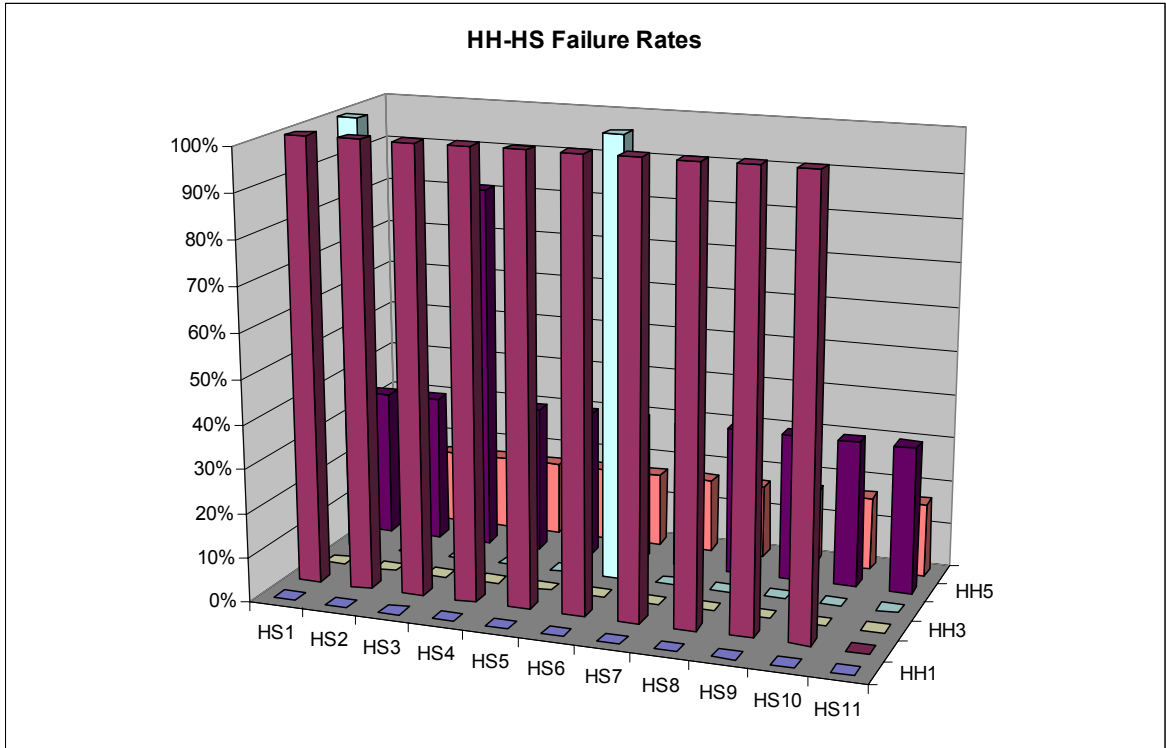
Figure 3.2.3.2-1: HH-HS Failure Rates

3.2.3.2.1.4 Failure Rate Distribution
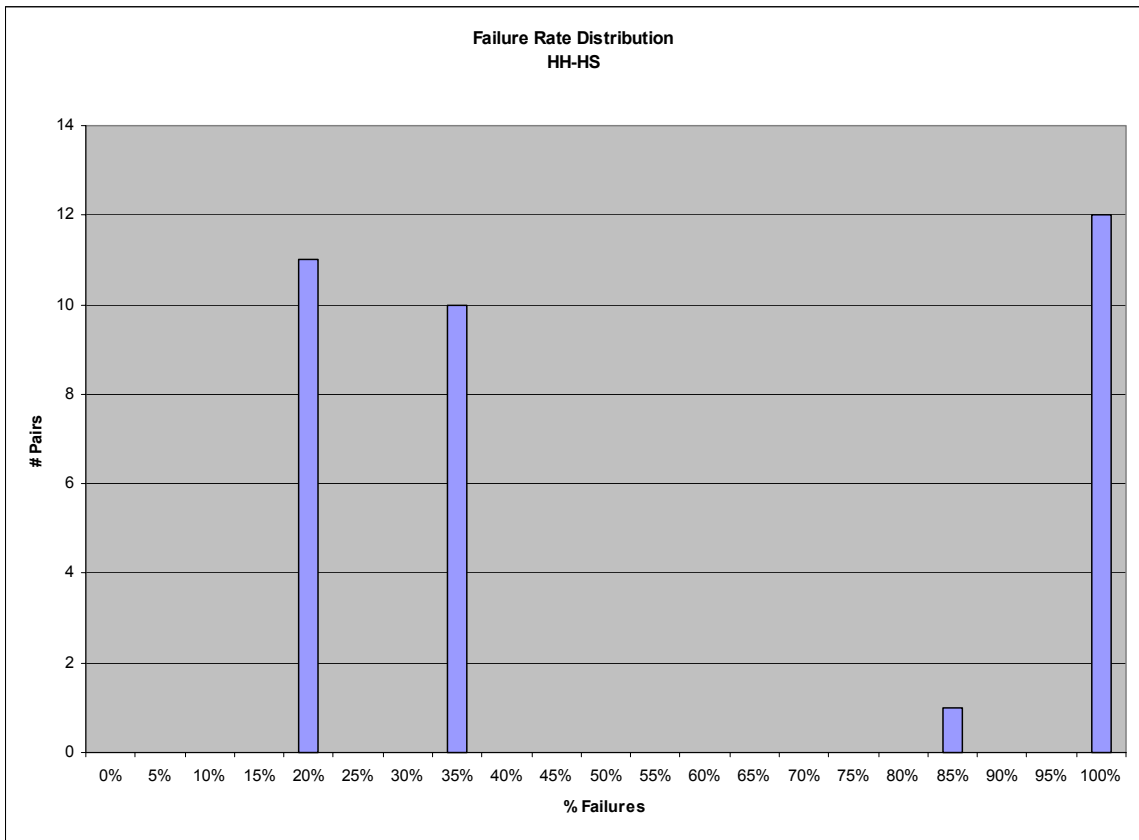
Figure 3.2.3.2-2: HH-HS Failure Rate Distribution

3.2.3.2.1.5 Distribution by Test Cases

Figure 3.2.3.2-3: HH-HS Distribution by Test Cases

Only Music test case is unique to this device type. Other test cases apply because HH5 and MP1 are also mobile phones.

3.2.3.2.1.6 Failure Breakdowns

Table 3.2.3.2-4: HH-HS Breakdowns

Total	Failure Description
34	"Unable to connect…" error
0	"Max number of Bluetooth connections…" error
0	"Internal Bluetooth…" error
0	"Profile not supported…" error
0	Unable to detect device during Bluetooth Search
0	Pairing Error: "Unable to Pair…"
14	Device pair does not support feature under test.
14	Transferred calendar times/dates are incorrect
0	Data lost while transferring
0	"Failed sending" error
0	Unsupported file format
0	Pairing cannot be initiated from device
48	Total number of failures

3.2.3.3 Handheld – Headset: Error Data

No errors were observed.

3.2.3.4 Handheld – Headset: Completion Results

Table 3.2.3.4-1: HH-HS Completion Rates

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH1											
HH2	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
HH3											
HH4	100%					100%					
HH5	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MP1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 3.2.3.4-2: HH-HS Completion Statistics

Potential Pairs	54
Tested Pairs	34
Potential TC	176
Tested TC	144
Completed	81.82%

3.2.4 Handheld – PC

Note: One of the deficiencies of our work was in tracking and enforcing the failure declaration process. This was particularly deficient in PC-related tests, since PC testing was the most difficult and time consuming. Thus, we believe some of the failures that we declare may be declared prematurely, and we may give a pessimistic view of PCs.

3.2.4.1 Test Case – Business Card Exchange: Failure Results

3.2.4.1.1 Failure Data

Table 3.2.4.1-1: HH-PC Business Card Exchange Data

	HH1	HH2	HH3	HH4	HH5	MP1	PC1	PC2	PC3	PC4	PC5	PC6
HH1							x	x	x	UDB	0	USF
HH2							x	x	x	x	0	FS
HH3							x	x	x	x	x	x
HH4							x	USF	x	x	x	x
HH5							x	USF	x	x	x	x
MP1							x	USF	x	x	x	x
PC1	x	x	x	x	x	x						
PC2	x	x	x	USF	USF	USF						
PC3	x	x	x	x	x	x						
PC4	FS	x	x	x	x	x						
PC5	0	0	x	x	x	x						
PC6	USF	FS	x	x	x	x						

Table 3.2.4.1-2: HH-PC Business Card Exchange Stats

Potential Pairs	72
Tested Pairs	16
Passed	4
Failed	12
Pass Rate	25%
Completion Rate	22.2%

- PC2 is not able to initialize or support a business card exchange

3.2.4.1.2 Summary/Implications
- Summary
    - Pass rate of 25% (4 of 16); poor interoperability for PC – PC Business Card Exchange.

- 6 of 12 failures are from PC2 not being able to initialize or support a business card exchange.
- Implications
    - 6 of 12 failures can be corrected is PC2, HH5, and MP1are able to initiate and support a business card exchange.
    - This would raise the pass rate to 62.5% (10 of 16).

3.2.4.2 Test Case – Transfer Contact: Failure Results

3.2.4.2.1 Failure Data

Table 3.2.4.2-1: HH-PC Transfer Contact Data

	HH1	HH2	HH3	HH4	HH5	MP1	PC1	PC2	PC3	PC4	PC5	PC6
HH1							x	x	x	UDB	0	0
HH2							x	x	x	x	0	FS
HH3							x	x	x	x	x	x
HH4							x	0	x	x	x	x
HH5							x	0	x	x	x	x
MP1							x	0	x	x	x	x
PC1	x	x	x	x	x	x						
PC2	x	x	x	FS	0	0						
PC3	x	x	x	x	x	x						
PC4	FS	x	x	x	x	x						
PC5	0	0	x	x	x	x						
PC6	0	0	x	x	x	x						

Table 3.2.4.2-2: HH-PC Transfer Contact Stats

Potential Pairs	72
Tested Pairs	16
Passed	12
Failed	4
Pass Rate	75%
Completion Rate	22.2%

- 3 of 4 failures from "Failed Sending," error

3.2.4.2.2 Summary/Implications

- Summary
    - Pass rate of 75% (12 of 16); indicates a moderate level of interoperability.

- 3 of 4 failures due to "Failed Sending" permanent error; this signifies that the operation was able to be initiated, but the contact was never finished sending and was never received.
  – Possible low-level Bluetooth problems
- 1 of 4 failures came from a device not being able to detect the other Bluetooth enabled device in order to send a contact
  – Again this could indicate low-level Bluetooth problems
- Implications
  - No simple solutions exist because the root of the problem is indiscernible at this point.

3.2.4.3 Test Case – Transfer Calendar Entry: Failure Results

3.2.4.3.1 Failure Data

Table 3.2.4.3-1: HH-PC Transfer Calendar Entry Data

	HH1	HH2	HH3	HH4	HH5	MP1	PC1	PC2	PC3	PC4	PC5	PC6
HH1							x	x	x	UDB	UFF	UFF
HH2							x	x	x	x	0	USF
HH3							x	x	x	x	x	x
HH4							x	0	x	x	x	x
HH5							x	0	x	x	x	x
MP1							x	0	x	x	x	x
PC1	x	x	x	x	x	x						
PC2	x	x	x	FS	0	UFF						
PC3	x	x	x	x	x	x						
PC4	FS	x	x	x	x	x						
PC5	UFF	0	x	x	x	x						
PC6	FS	0	x	x	x	x						

Table 3.2.4.3-2: HH-PC Transfer Calendar Entry Stats

Potential Pairs	72
Tested Pairs	16
Passed	7
Failed	9
Pass Rate	43.8%
Completion Rate	22.2%

3.2.4.3.2 Summary/Implications

- Summary
    - Pass rate of 43.8% (7 of 16); poor interoperability.
    - 4 of 9 failures from unsupported file formats
    - 3 of 9 failures due to "Failed Sending" error; this signifies that the operation was able to be initiated, but the calendar entry was never finished sending and was never received.
        – Possible low-level Bluetooth problems.
- Implications
    - 4 of the 9 failures could be corrected if PCs and handhelds adapted the same file format for calendar entries.
    - This could raise the pass rate to 68.75% (11 of 16).

3.2.4.4 Test Case – Transfer Picture: Failure Results

3.2.4.4.1 Failure Data

Table 3.2.4.4-1: HH-PC Transfer Picture Data

	HH1	HH2	HH3	HH4	HH5	MP1	PC1	PC2	PC3	PC4	PC5	PC6
HH1							x	x	x	UDB	0	0
HH2							x	x	x	x	0	0
HH3							x	x	x	x	x	x
HH4							x	0	x	x	x	x
HH5							x	0	x	x	x	x
MP1							x	0	x	x	x	x
PC1	x	x	x	x	x	x						
PC2	x	x	x	0	0	0						
PC3	x	x	x	x	x	x						
PC4	FS	x	x	x	x	x						
PC5	0	0	x	x	x	x						
PC6	0	0	x	x	x	x						

Table 3.2.4.4-2: HH-PC Transfer Picture Stats

Potential Pairs	72
Tested Pairs	16
Passed	14
Failed	2
Pass Rate	87.5%
Completion Rate	22.2%

3.2.4.4.2 Summary/Implications

- Summary
    - Pass rate of 87.5%; indicates good interoperability.
    - Only trend is that HH1 and PC4 do not interoperate for this test case which has been the case throughout.
    - 2 of 2 failures are between HH1 and PC4; this has been the trend for all handheld – PC test cases.
- Implications
    - If PC4 and HH1 are corrected to interoperate, then there would be a perfect pass rate, 100%.

3.2.4.5 Test Case – Transfer of Recorded Audio: Failure Results

3.2.4.5.1 Failure Data

Table 3.2.4.5-1: HH-PC Transfer Recorded Audio Data

	HH1	HH2	HH3	HH4	HH5	MP1	PC1	PC2	PC3	PC4	PC5	PC6
HH1							x	x	x	UDB	0	0
HH2							x	x	x	x	0	0
HH3							x	x	x	x	x	x
HH4							x	UFF	x	x	x	x
HH5							x	0	x	x	x	x
MP1							x	0	x	x	x	x
PC1	x	x	x	x	x	x						
PC2	x	x	x	USF	0	0						
PC3	x	x	x	x	x	x						
PC4	FS	x	x	x	x	x						
PC5	0	0	x	x	x	x						
PC6	0	0	x	x	x	x						

Table 3.2.4.5-2: HH-PC Transfer Recorded Audio Stats

Potential Pairs	72
Tested Pairs	16
Passed	12
Failed	4
Pass Rate	75%
Completion Rate	22.2%

3.2.4.5.2 Summary/Implications

- Summary

- Pass rate of 75% (12 of 16); indicates moderate interoperability for this device type pair and test case.
  - 1 of 4 failures due to, "Unsupported file format" permanent error.
  - HH1 and PC4 again do not interoperate
- Implications
  - 1 of the 4 failures could be corrected if PCs and handhelds adapted the same file format for recorded audio files.
  - 2 of 4 failures from HH1 and PC4. For all test cases HH1 has been unable to detect PC4, and PC4 has been able to initiate a file transfer to HH1, but this has never been received or sent completely.
  - Without these failures the pass rate would be 93.75% (15 of 16).

3.2.4.6 Test Case – Synchronize: Failure Results

3.2.4.6.1 Failure Data

Table 3.2.4.6-1: HH-PC Synchronize Data

	HH1	HH2	HH3	HH4	HH5	MP1	PC1	PC2	PC3	PC4	PC5	PC6
HH1							x	x	x	USF	USF	USF
HH2							x	x	x	x	USF	USF
HH3							x	x	x	x	x	x
HH4							x	USF	x	x	x	x
HH5							x	USF	x	x	x	x
MP1							x	USF	x	x	x	x
PC1												
PC2												
PC3												
PC4												
PC5												
PC6												

Table 3.2.4.6-2: HH-PC Synchronize Stats

Potential Pairs	38
Tested Pairs	8
Passed	0
Failed	8
Pass Rate	0%
Completion Rate	22.2%

- Handhelds and PCs were not able to synchronize using Bluetooth.
- Other evidence suggests that this is possible, and we declared failures prematurely.

3.2.4.7 Test Case – LAN Access: Failure Results

3.2.4.7.1 Failure Data

Table 3.2.4.7-1: HH-PC LAN Access Data

	HH1	HH2	HH3	HH4	HH5	MP1	PC1	PC2	PC3	PC4	PC5	PC6
HH1							x	x	x	UC	UC	UC
HH2							x	x	x	x	UC	UC
HH3							x	x	x	x	x	x
HH4							x	USF	x	x	x	x
HH5							x	USF	x	x	x	x
MP1							x	USF	x	x	x	x
PC1												
PC2												
PC3												
PC4												
PC5												
PC6												

Table 3.2.4.7-2: HH-PC LAN Access Stats

Potential Pairs	38
Tested Pairs	8
Passed	0
Failed	8
Pass Rate	0%
Completion Rate	22.2%

- Other evidence suggests that HH-PC LAN Access is possible, and we may have declared failures prematurely.

3.2.4.7.2 Summary/Implications

- Summary
  - Pass rate of 0%
  - 5 of 8 failures due to "Unable to Connect" permanent error; this signifies that the action can be initiated, but LAN access was never acquired.
    - Possible low-level Bluetooth problems
- Implications
  - No simple solutions exist because the root of the problem is indiscernible at this point.

3.2.4.8 Handheld – PC: Failure Results

3.2.4.8.1 Failure Data

3.2.4.8.1.1 Aggregates

Table 3.2.4.8-1: HH-PC Aggregates

Passes

	HH1	HH2	HH3	HH4	HH5	MP1	PC1	PC2	PC3	PC4	PC5	PC6
HH1											4	3
HH2											5	2
HH3												
HH4								3				
HH5								4				
MP1								4				
PC1												
PC2			1	4	4							
PC3												
PC4												
PC5	4	5										
PC6	3	4										

Failures

	HH1	HH2	HH3	HH4	HH5	MP1	PC1	PC2	PC3	PC4	PC5	PC6
HH1										7	3	4
HH2											2	5
HH3												
HH4										4		
HH5										3		
MP1										4		
PC1												
PC2				4	1	3						
PC3												
PC4	5											
PC5	1											
PC6	2	1										

Potential Pairs	72
Tested Pairs	16
Potential TC	540
Tested TC	99
Passed TC	50
Failed TC	49
Pass Rate	50.51%

3.2.4.8.1.2 Failure Rates

Table 3.2.4.8-2: HH-PC Failure Rates

	HH1	HH2	HH3	HH4	HH5	MP1	PC1	PC2	PC3	PC4	PC5	PC6
HH1										100%	43%	57%
HH2											29%	71%
HH3												
HH4								57%				
HH5								43%				
MP1								50%				
PC1												
PC2				80%	20%	43%						
PC3												
PC4	100%											
PC5	20%	0%										
PC6	40%	20%										

3.2.4.8.1.3 Failure Rates 3D
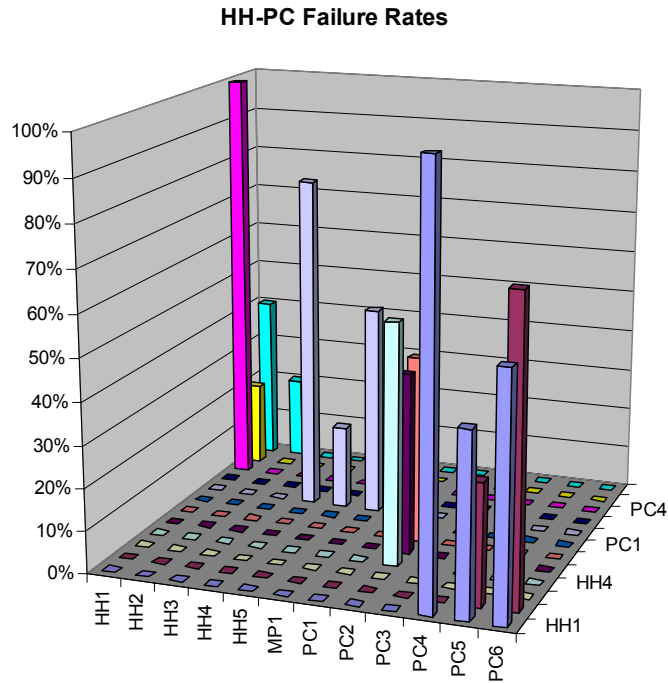
Figure 3.2.4.8-1: HH-PC Failure Rates

3.2.4.8.1.4 Failure Rate Distribution
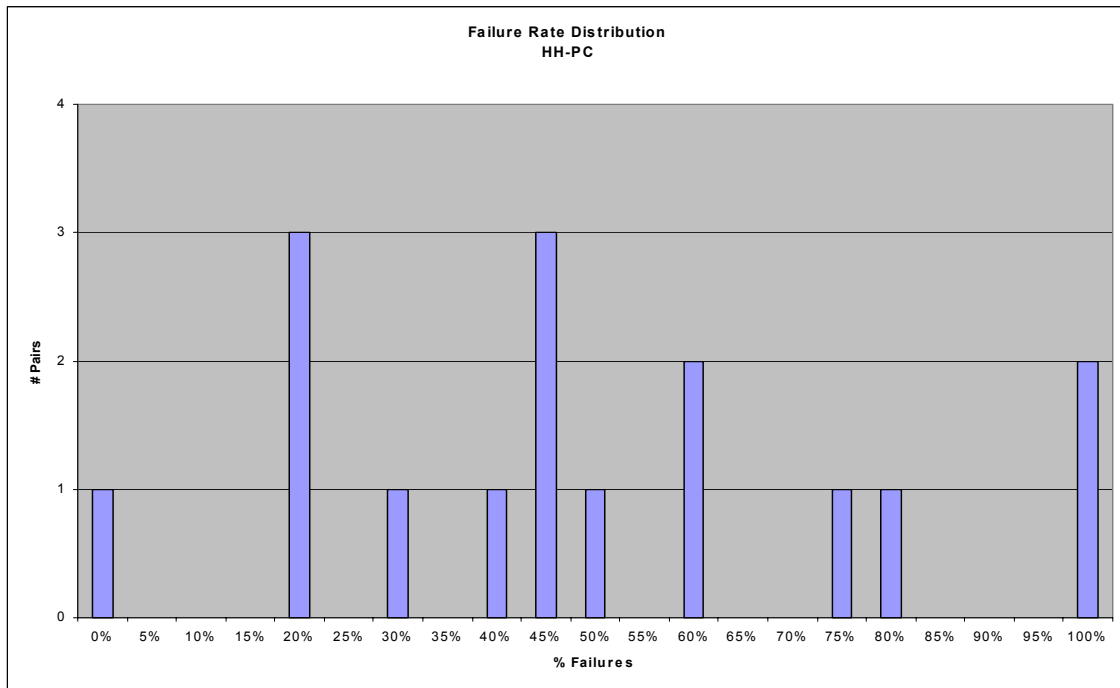
Figure 3.2.4.8-2: HH-PC Failure Rate Distribution
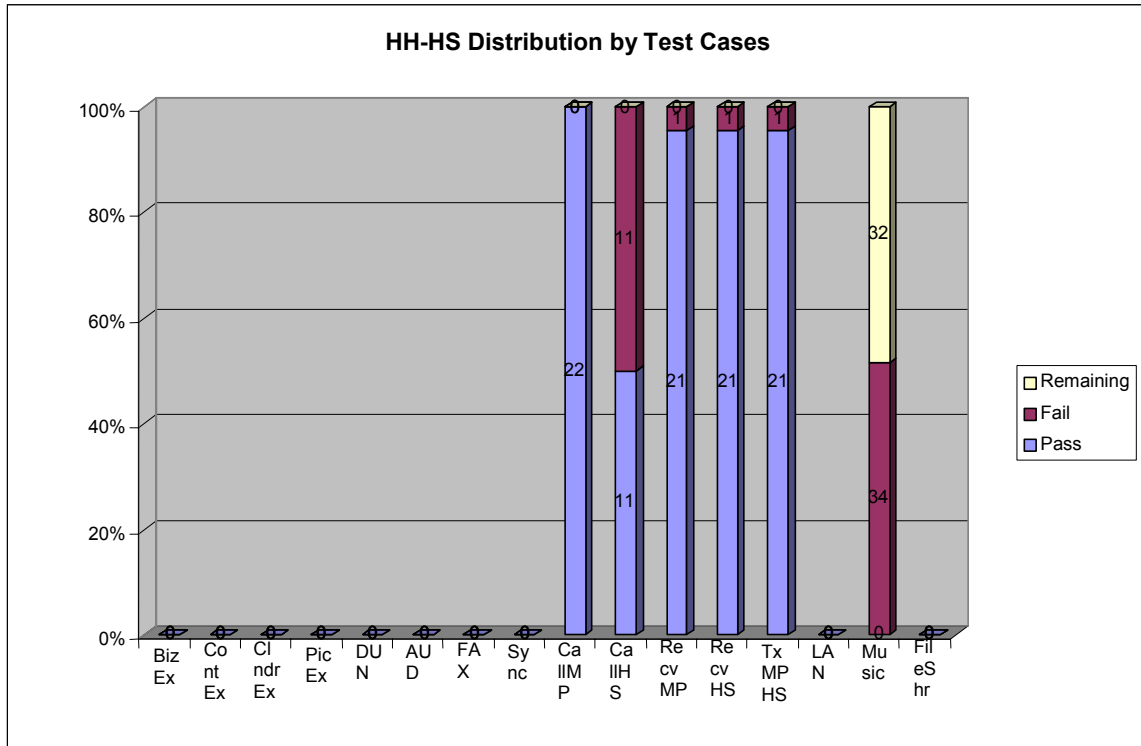
3.2.4.8.1.5 Distribution by Test Cases
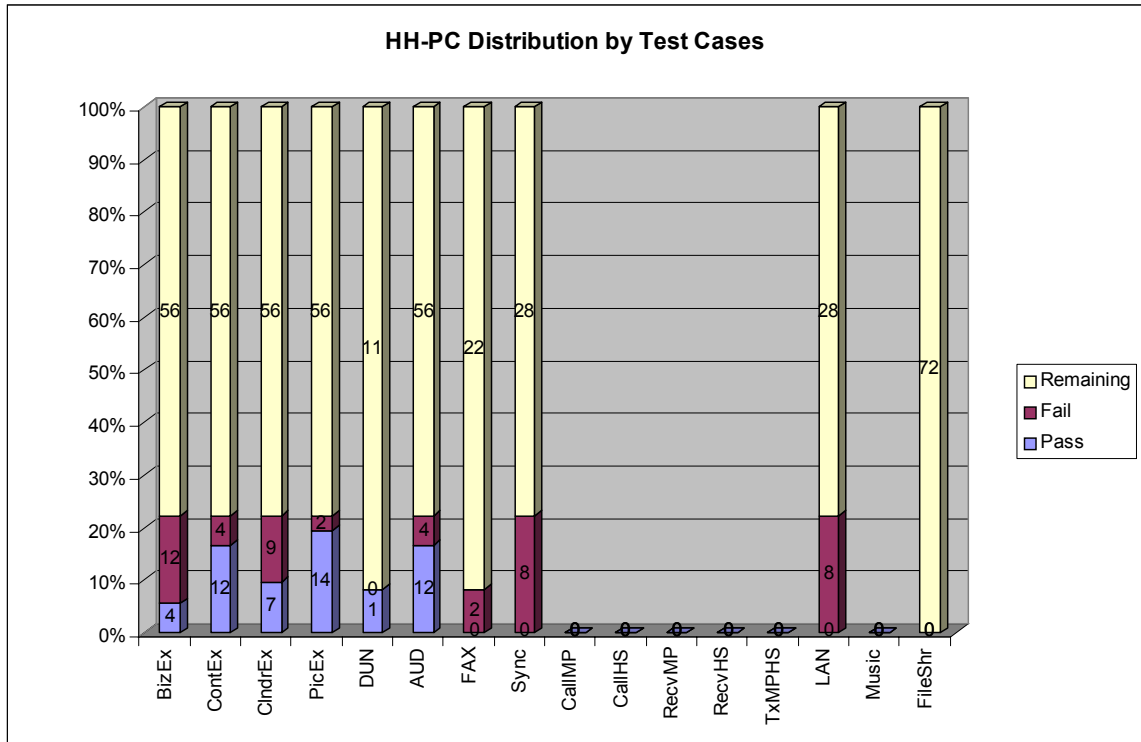
Figure 3.2.4.8-3: HH-PC Failure Distribution by Test Case

3.2.4.8.1.6 Failure Breakdowns

Table 3.2.4.8-3: HH-PC Breakdowns

Total	Failure Description
5	"Unable to connect…" error
0	"Max number of Bluetooth connections…" error
0	"Internal Bluetooth…" error
0	"Profile not supported…" error
5	Unable to detect device during Bluetooth Search
0	Pairing Error: "Unable to Pair…"
23	Device pair does not support feature under test.
0	Transferred calendar times/dates are incorrect
0	Data lost while transferring
11	"Failed sending" error
5	Unsupported file format
0	Pairing cannot be initiated from device
49	Total number of failures

3.2.4.8.2 Summary

- Overall Pass rate of 50 of 99 or 50.51%
- 23 of 49 failures due to unsupported feature for a particular device pair and test case.
- 11 of 49 due to "Failed Sending" permanent error.
- 5 of 49 due to unsupported file format issues.

3.2.4.8.3 Implications

- Using the "Summary/Implications" sections from the previous breakdowns the amount of improvement (failures that could be corrected) can be tracked if these modifications are made.
    - 12 if interoperability problems could be solved between PC4 and HH1
    - 6 if PC2 is able to initialize and support a business card exchange.
    - 4 if PCs and handhelds adapted the same file format for calendar entries.
    - 1 if PCs and handhelds adapted the same file format for recorded audio files.
- These account for 23 of 49 failures (47%)
- 73.7% pass rate (73 out of 99) if all these failures corrected
- Compare these to the actual pass rate of 50.51%.

3.2.4.9 Handheld – PC: Error Data

Table 3.2.4.9-1: HH-PC Error Data

	HH1	HH2	HH3	HH4	HH5	MP1	PC1	PC2	PC3	PC4	PC5	PC6
HH1							0	0	0	0	0	0
HH2							0	0	0	0	0	0
HH3							0	0	0	0	0	0
HH4							0	1	0	0	0	0
HH5							0	0	0	0	0	0
MP1							0	1	0	0	0	0
PC1	0	0	0	0	0	0						
PC2	0	0	0	0	0	5						
PC3	0	0	0	0	0	0						
PC4	0	0	0	0	0	0						
PC5	0	0	0	0	0	0						
PC6	0	0	0	0	0	0						

Table 3.2.4.9-2: HH-PC Error Stats

Potential TC	540
Tested TC	99
TC w/ Errors	3
Total Errors	7
Error Rates	3.03%

Note that errors are fairly correlated, implying that errors are being caused by Bluetooth-related problems.

3.2.4.10   Handheld – PC: Completion Results

Table 3.2.4.10-1: HH-PC Completion Rates

	HH1	HH2	HH3	HH4	HH5	MP1	PC1	PC2	PC3	PC4	PC5	PC6
HH1							0%	0%	0%	88%	88%	88%
HH2							0%	0%	0%	0%	88%	88%
HH3							0%	0%	0%	0%	0%	0%
HH4							0%	88%	0%	0%	0%	0%
HH5							0%	70%	0%	0%	0%	0%
MP1							0%	90%	0%	0%	0%	0%
PC1	0%	0%	0%	0%	0%	0%						
PC2	0%	0%	0%	83%	71%	86%						
PC3	0%	0%	0%	0%	0%	0%						
PC4	83%	0%	0%	0%	0%	0%						
PC5	83%	83%	0%	0%	0%	0%						
PC6	83%	83%	0%	0%	0%	0%						

Table 3.2.4.10-2: HH-PC Completion Summary

Potential Pairs	54
Tested Pairs	34
Potential TC	176
Tested TC	144
Completed	81.82%

HH-PC Completion Rates
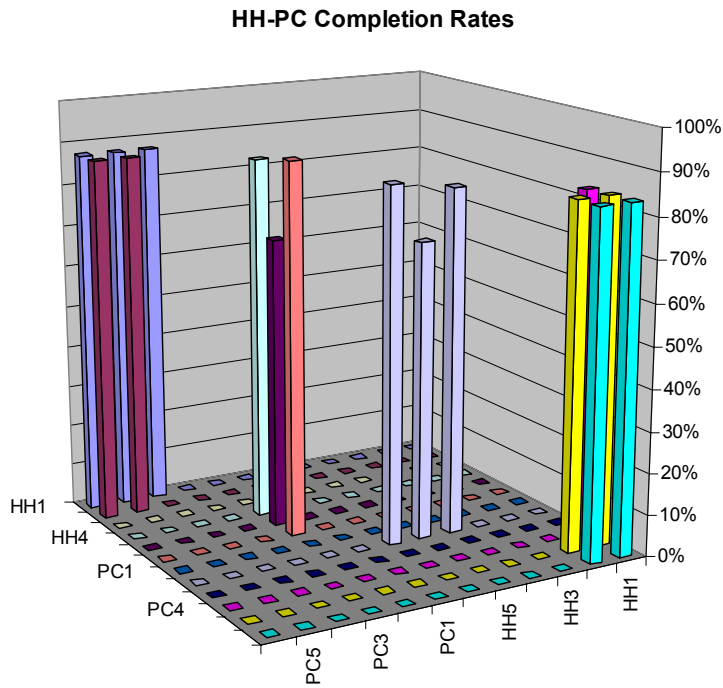
Figure 3.2.4.10-1: HH-PC Completion Rates
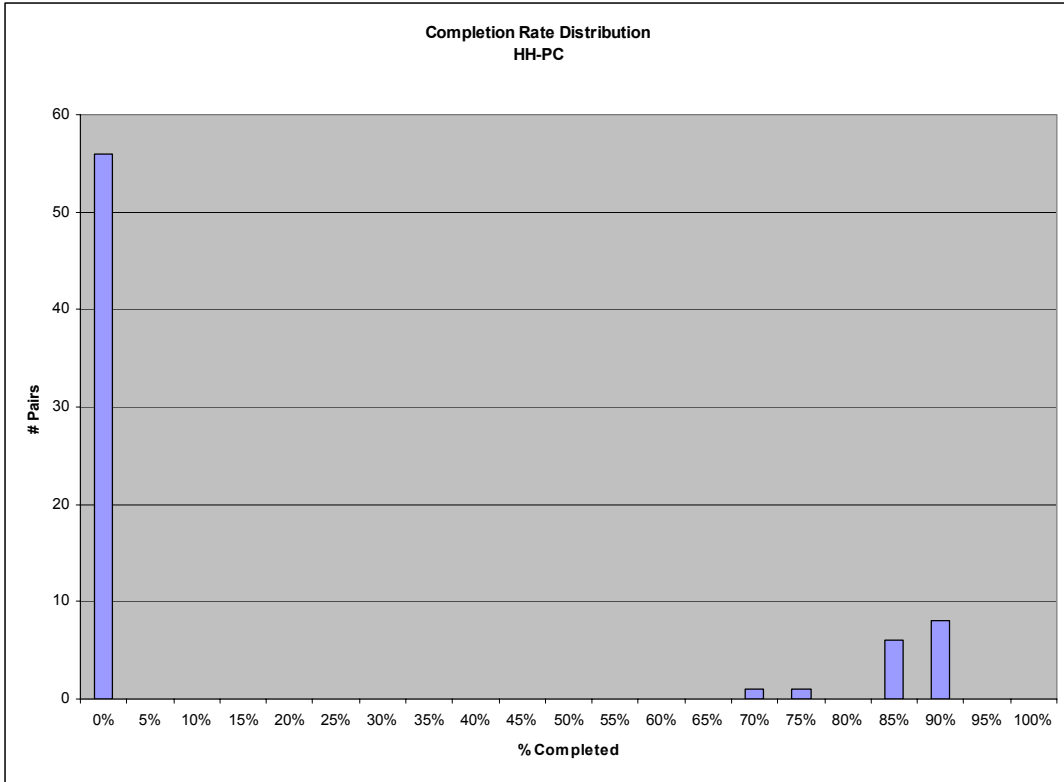
Figure 3.2.4.10-2: HH-PC Completion Rate Distribution

3.2.5 Mobile Phone – Mobile Phone

3.2.5.1 Test Case – Business Card Exchange: Failure Results

3.2.5.1.1 Failure Data

Table 3.2.5.1-1: MP-MP Business Card Exchange Data

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH5	x	x	USF	USF	USF	USF	USF	USF	USF
MP1	x	x	USF	USF	USF	USF	USF	x	x
MP2	USF	USF	x	USF	USF	USF	USF	USF	USF
MP3	USF	USF	USF	x	USF	USF	USF	USF	USF
MP4	USF	USF	USF	USF	x	USF	USF	USF	USF
MP5	USF	USF	USF	USF	USF	x	USF	USF	USF
MP6	USF	USF	USF	USF	USF	USF	x	USF	USF
MP7	USF	x	USF	USF	USF	USF	USF	x	USF
MP8	USF	x	USF	USF	USF	USF	USF	USF	x

Table 3.2.5.1-2: MP-MP Business Card Exchange Stats

Potential Pairs	81
Tested Pairs	66
Passed	0
Failed	66
Pass Rate	0%
Completion Rate	81.5%

Note: Mobile phones lack the user interface to initiate a business card exchange

3.2.5.1.2 Summary/Implications
- Summary
  - Pass rate of 0% (0 of 66)
  - 66 of 66 failures are because mobile phones lack the user interface to initialize a business card exchange and the software to support a business card exchange.
- Implications
  - All 66 failures could be corrected if mobile phones were able to initiate and support a business card exchange.

3.2.5.2 Test Case – Transfer Contact: Failure Results

3.2.5.2.1 Failure Data

Table 3.2.5.2-1: MP-MP Transfer Contact Data

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH5	x	x	0	FS	0	0	FS	0	0
MP1	x	x	0	0	0	0	0	x	x
MP2	0	0	x	0	0	0	0	0	0
MP3	0	0	0	x	0	0	0	0	0
MP4	0	0	0	0	x	0	0	0	0
MP5	0	0	0	0	0	x	0	0	0
MP6	0	0	0	0	0	0	x	0	0
MP7	0	x	0	0	0	0	0	x	0
MP8	0	x	0	0	0	0	0	0	x

Table 3.2.5.2-2: MP-MP Transfer Contact Stats

Potential Pairs	81
Tested Pairs	66
Passed	64
Failed	2
Pass Rate	96.9%
Completion Rate	81.5%

3.2.5.2.2 Summary/Implications
- Summary
  - Pass rate of 96.9% (64 of 66); indicates high level of interoperability.
  - 2 of the 2 failures due to "Failed Sending," permanent error; this signifies that the operation could be initiated, but the contact was never finished sending and was never received.
    – Possible low-level Bluetooth problems.
- Implications
  - No simple solutions exist because the root of the problem is indiscernible at this point.

3.2.5.3 Test Case – Transfer Calendar Entry: Failure Results

3.2.5.3.1 Failure Data

Table 3.2.5.3-1: MP-MP Transfer Calendar Entry Data

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH5	x	x	0	FS	UFF	UFF	FS	UFF	0
MP1	x	x	0	0	0	0	0	x	x
MP2	0	0	x	0	0	0	0	0	0
MP3	t&d	0	0	x	0	0	0	0	0
MP4	0	0	0	0	x	0	0	0	0
MP5	0	0	UFF	0	0	x	0	0	0
MP6	0	0	0	0	0	0	x	0	0
MP7	0	x	0	0	0	0	0	x	0
MP8	0	x	0	0	0	0	0	0	x

Table 3.2.5.3-2: MP-MP Transfer Calendar Entry Stats

Potential Pairs	81
Tested Pairs	66
Passed	59
Failed	7
Pass Rate	89.4%
Completion Rate	81.5%

3.2.5.3.2 Summary/Implications

- Summary
  - Pass rate of 89.4% (59 of 66); indicates good level of interoperability.
  - 4 of 7 failures are due to incompatible file format.
  - 1 of 7 failure due to time/date incorrectly received.
  - 2 of the 7 failures due to "Failed Sending," permanent error on the same HH and MP pairs as before (HH1→MP3 & MP6); this signifies that the operation was able to be initiated, but the calendar entry was never finished sending and was never received.
    - Possible low-level Bluetooth problems.
- Implications
  - 1 of the 7 failures could be corrected raising the pass rate to 60 of 66, or a 91% pass rate by enforcing or adapting a standard calendar form when sending calendar entries.
  - 4 of the 7 failures could be corrected further raising the pass rate to 64 of 66, or a 96.9% pass rate if all handheld devices supported the same calendar file format.

3.2.5.4 Test Case – Transfer Picture: Failure Results

3.2.5.4.1 Failure Data

Table 3.2.5.4-1: MP-MP Transfer Picture Data

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH5	x	x	0	FS	0	0	FS	0	0
MP1	x	x	0	0	0	0	0	x	x
MP2	0	0	x	0	0	0	0	0	0
MP3	0	0	0	x	0	0	0	0	0
MP4	0	0	0	0	x	0	0	0	0
MP5	x	0	0	0	0	x	0	0	0
MP6	0	0	0	0	0	0	x	0	0
MP7	0	x	0	0	0	0	0	x	0
MP8	0	x	0	0	0	0	0	0	x

Table 3.2.5.4-2: MP-MP Transfer Picture Stats

Potential Pairs	81
Tested Pairs	66
Passed	63
Failed	2
Pass Rate	96.9%
Completion Rate	81.5%

3.2.5.4.2 Summary/Implications
- Summary
    - 2 of the 7 failures due to "Failed Sending" permanent error on the same HH and MP pairs as before (HH1→MP3 & MP6); this signifies that the operation was able to be initiated, but the picture file was never finished sending and was never received.
        - Possible low-level Bluetooth problems.
- Implications
    - No simple solutions exist because the root of the problem is indiscernible at this point.

3.2.5.5 Test Case – Transfer of Recorded Audio: Failure Results

3.2.5.5.1 Failure Data

Table 3.2.5.5-1: MP-MP Transfer Recorded Audio Data

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH5	x	x	UFF	0	0	0	0	0	0
MP1	x	x	UFF	FS	0	0	FS	x	x
MP2	UFF	UFF	x	FS	UFF	UFF	FS	UFF	UFF
MP3	UFF	0	0	x	0	0	0	0	0
MP4	UFF	0	0	0	x	0	0	0	0
MP5	UFF	0	0	0	0	x	0	0	0
MP6	UFF	0	0	0	0	0	x	0	0
MP7	UFF	x	0	0	0	0	0	x	0
MP8	UFF	x	0	0	0	0	0	0	x

Table 3.2.5.5-2: MP-MP Transfer Recorded Audio Stats

Potential Pairs	81
Tested Pairs	66
Passed	48
Failed	18
Pass Rate	72.7%
Completion Rate	81.5%

3.2.5.5.2 Summary/Implications

- Summary
  - Pass rate of 72.7% (48 of 66); indicates a moderate level of interoperability for this device type pair and test case.
  - 6 of 18 failures came from mobile phones not being able to recognize recorded audio file sent from MP2
  - 7 of 18 failures came from mobile phones not being able to recognize the `.wav` format used by HH5.
  - 4 of the 18 failures due to "Failed Sending" permanent error; this signifies that the operation was able to be initiated, but the audio file was never finished sending and was never received.
    - Possible low-level Bluetooth problems.
- Implications
  - 14 of 18 failures could be corrected if both mobile phones and mobile phone enabled handhelds adopted the same format for recorded audio files, or had the ability to recognize both .amr and .wav formats.
  - This would raise the pass rate to 93.9% (62 of 66).

3.2.5.6 Mobile Phone – Mobile Phone: Failure Results

3.2.5.6.1 Failure Data

3.2.5.6.1.1 Aggregates

Table 3.2.5.6-1: MP-MP Aggregate Data

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH5			4	2	4	3	2	4	5
MP1			3	3	4	4	3		
MP2	3	3		3	3	3	3	3	3
MP3	2	4	4		4	4	4	4	4
MP4	3	4	4	4		4	4	4	4
MP5	2	4	3	4	4		4	4	4
MP6	3	4	4	4	4	4		4	4
MP7	3		4	4	4	4	4		4
MP8	3		4	4	4	4	4		

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH5			3	5	3	4	5	3	2
MP1			4	4	3	1	4		
MP2	3	3		2	2	2	2	2	2
MP3	4	2	1		1	1	1	1	1
MP4	3	2	1	1		1	1	1	1
MP5	3	1	2	1	1		1	1	1
MP6	3	2	1	1	1	1		1	1
MP7	3		1	1	1	1	1		1
MP8	3		1	1	1	1	1		

Passes   Failures

Table 3.2.5.6-2: MP-MP Aggregate Data

Potential Pairs	81
Tested Pairs	66
Potential TC	459
Tested TC	362
Passed TC	240
Failed TC	122
Pass Rate	66.60%

3.2.5.6.1.2 Failure Rates

Table 3.2.5.6-3: MP-MP Failure Rates

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH5			43%	71%	43%	57%	71%	43%	29%
MP1			57%	57%	43%	20%	57%		
MP2	50%	50%		40%	40%	40%	40%	40%	40%
MP3	67%	33%	20%		20%	20%	20%	20%	20%
MP4	50%	33%	20%	20%		20%	20%	20%	20%
MP5	60%	20%	40%	20%	20%		20%	20%	20%
MP6	50%	33%	20%	20%	20%	20%		20%	20%
MP7	50%		20%	20%	20%	20%	20%		20%
MP8	50%		20%	20%	20%	20%	20%	20%	

3.2.5.6.1.3 Failure Rates 3D
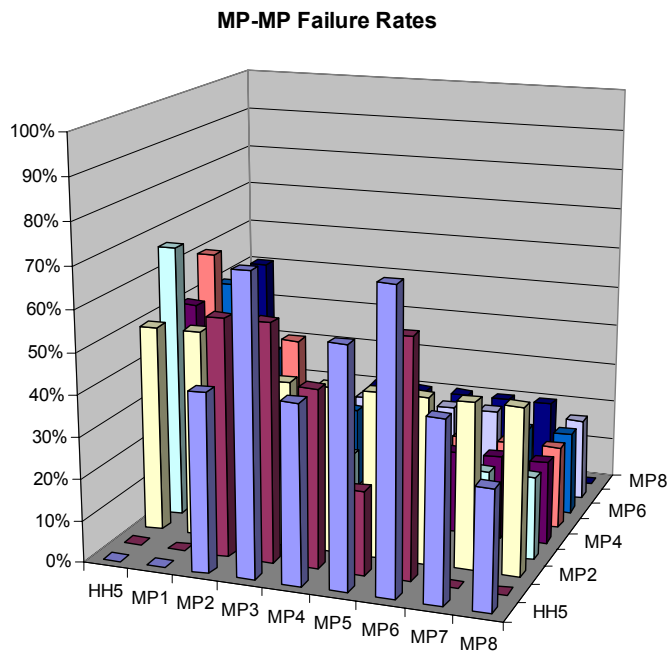
Figure 3.2.5.6-1: MP-MP Failure Rates

3.2.5.6.1.4 Failure Rate Distribution
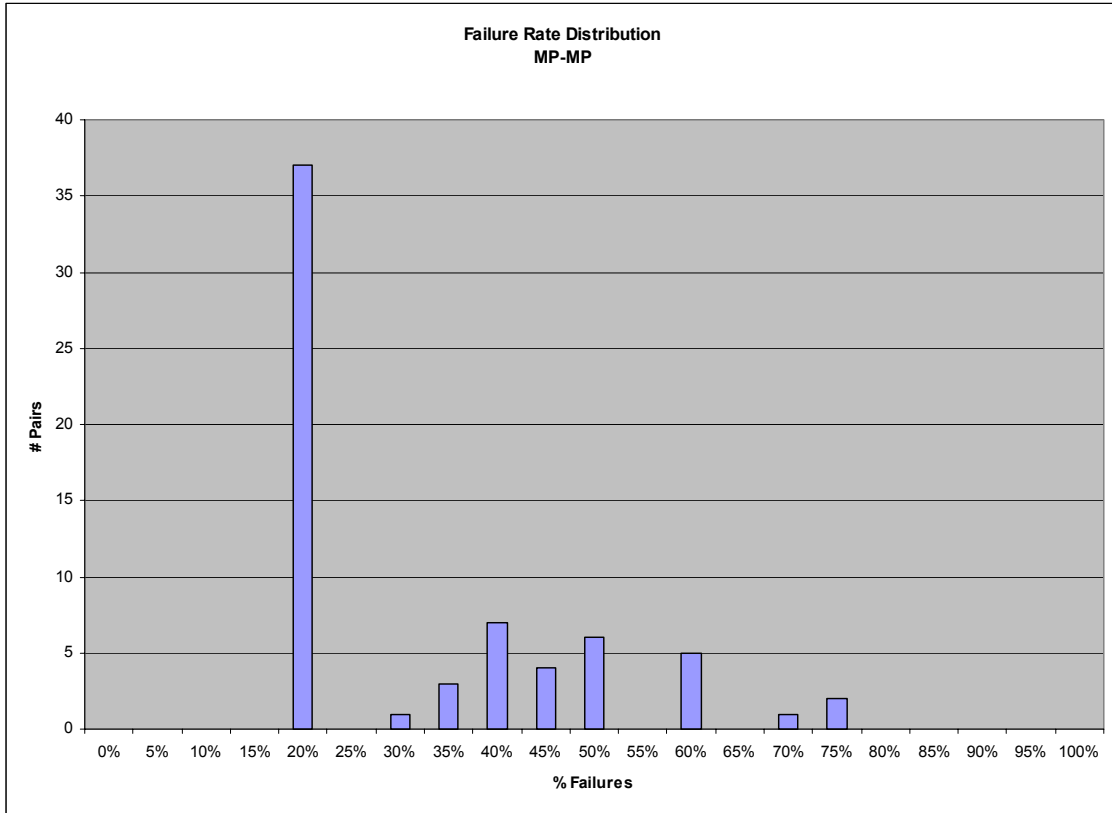
Figure 3.2.5.6-2: MP-MP Failure Rate Distribution

3.2.5.6.1.5Distribution by Test Cases

Figure 3.2.5.6-3: MP-MP Failure Distribution by Test Case

3.2.5.6.1.6 Failure Breakdowns

Table 3.2.5.6-4: MP-MP Failure Breakdowns

Total	Failure Description
0	"Unable to connect…" error
0	"Max number of Bluetooth connections…" error
0	"Internal Bluetooth…" error
0	"Profile not supported…" error
5	Unable to detect device during Bluetooth Search
0	Pairing Error: "Unable to Pair…"
93	Device pair does not support feature under test.
1	Transferred calendar times/dates are incorrect
0	Data lost while transferring
10	"Failed sending" error
18	Unsupported file format
0	Pairing cannot be initiated from device
122	Total number of failures

3.2.5.6.2 Summary

- Overall Pass rate of 240 of 362 or 66.60%.
- 93 of 122 failures due to unsupported feature for a particular device pair and test case.
- 18 of 122 due to unsupported file format issues.
- 10 of 122 due to "Failed Sending," permanent error.

- 6 of 10 "Failed Sending" permanent errors come from HH5 → MP3 & MP6.

3.2.5.6.3 Implications

- Using the "Summary/Implications" sections from the previous breakdowns the amount of improvement (failures that could be corrected) can be tracked if these modifications are made.
    - 66 if mobile phones were able to initiate and support a business card exchange.
    - 14 if both mobile phones and mobile phone enabled handhelds adopted the same format for recorded audio files, or had the ability to recognize both `.amr` and `.wav` formats.
    - 6 due to interoperability issues ("Failed Sending") for HH5 → MP3 & MP6
    - 4 if all handheld devices supported the same calendar file format.
    - 1 by enforcing or adapting a standard calendar form when sending calendar entries.
- These account for 91 of 122 failures (74.6%)
- 91.4% pass rate (331 out of 362) if all these failures corrected
- Compare this to the actual pass rate of 66.60%.

3.2.5.7 Mobile Phone: Error Data

Table 3.2.5.7-1: MP-MP Error Data

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH5	0	0	1	0	0	0	3	0	2
MP1	0	0	6	2	0	0	12	0	0
MP2	0	0	0	1	0	8	0	0	0
MP3	0	0	0	0	0	0	1	0	0
MP4	0	0	0	0	0	0	0	0	0
MP5	0	0	0	3	0	0	0	2	0
MP6	0	0	0	0	1	0	0	0	0
MP7	0	0	0	0	0	0	2	0	0
MP8	0	0	0	0	1	0	0	0	0

Table 3.2.5.7-2: MP-MP Error Stats

Potential TC　459

Tested TC　362

TC w/ Errors   14

Total Errors   45

Error Rates   3.87%

Average Errors   12.43%

3.2.5.8 Mobile Phone: Completion Results

Table 3.2.5.8-1: Completion Rates

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH5	0%	0%	100%	100%	100%	100%	100%	100%	100%
MP1	0%	0%	100%	100%	100%	71%	100%	0%	0%
MP2	100%	100%	0%	100%	100%	100%	100%	100%	100%
MP3	100%	100%	100%	0%	100%	100%	100%	100%	100%
MP4	100%	100%	100%	100%	0%	100%	100%	100%	100%
MP5	83%	83%	100%	100%	100%	0%	100%	100%	100%
MP6	100%	100%	100%	100%	100%	100%	0%	100%	100%
MP7	100%	0%	100%	100%	100%	100%	100%	0%	100%
MP8	100%	0%	100%	100%	100%	100%	100%	100%	0%

Table 3.2.5.8-2: MP-MP Completion Data

Potential Pairs   54

Tested Pairs   34

Potential TC   176

Tested TC   144

Completion   78.87%

MP-MP Completion Rates
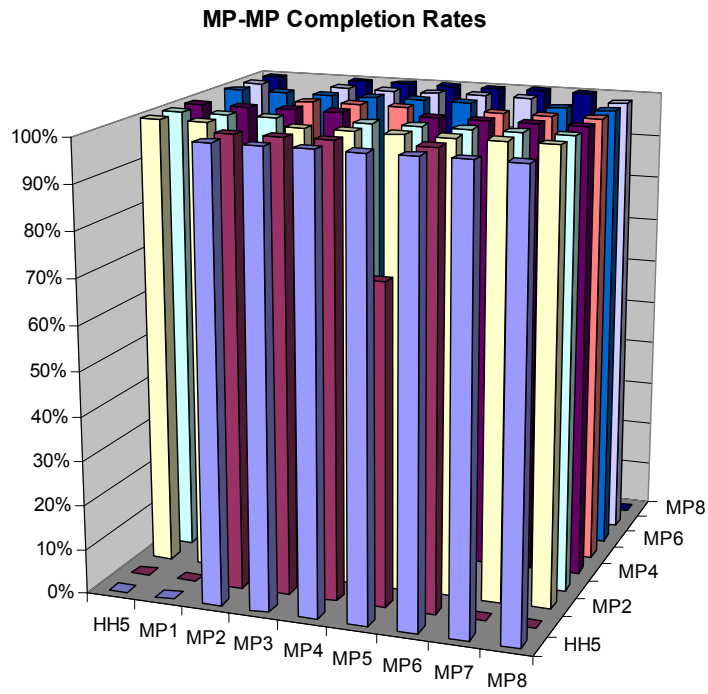
Figure 3.2.5.8-1: MP-MP Completion Rates
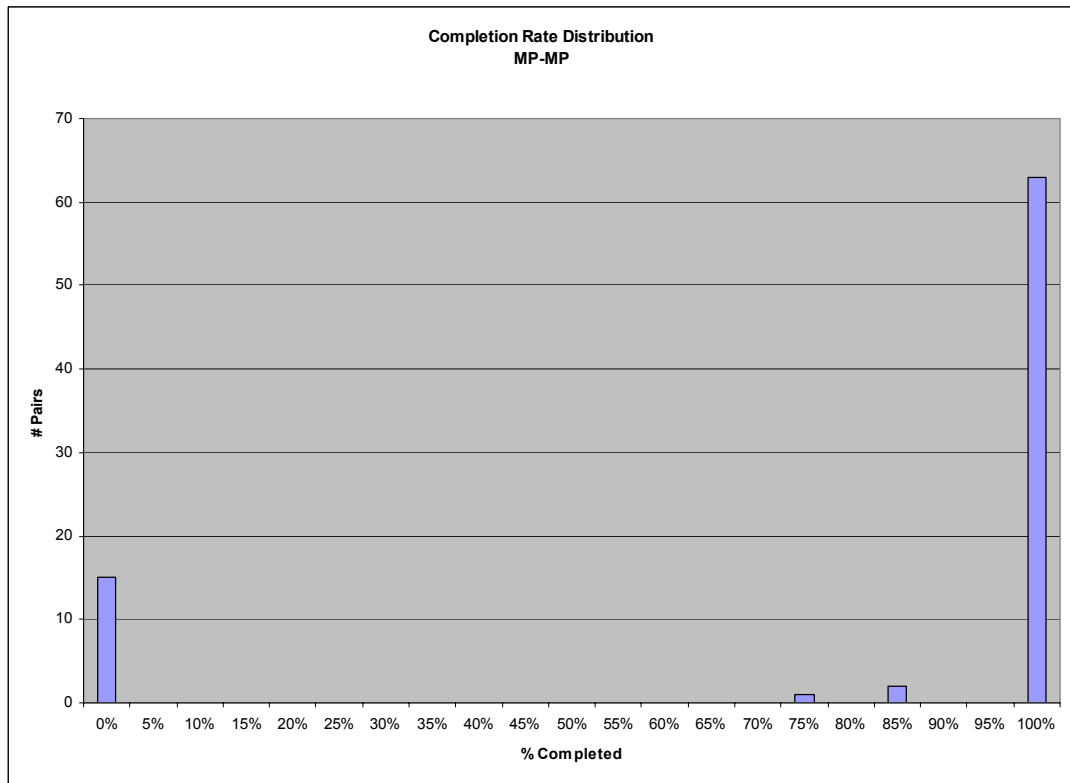
Figure 3.2.5.8-2: MP-MP Completion Rate Distribution

3.2.6 Mobile Phone x Headset

3.2.6.1 Test Case – Call from Mobile Phone: Failure Results

3.2.6.1.1 Failure Data

Table 3.2.6.1-1: MP-HS Call from MP Data

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH5	0	0	0	0	0	0	0	0	0	0	0
MP1	0	0	0	0	0	0	0	0	0	0	0
MP2	0	0	0	0	0	0	0	0	0	0	0
MP3	0	0	0	0	0	0	0	0	0	0	0
MP4	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0
MP5											
MP6	0	0	0	0	0	0	0	0	0	0	0
MP7	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0
MP8	0	UC	UC	UC	UC	UC	UC	0	0	0	0

Table 3.2.6.1-2: MP-HS Call from MP Stats

Potential Pairs	88
Tested Pairs	88
Passed	70
Failed	18
Pass Rate	79.6%
Completion Rate	100%

Note: all failures come from headsets implementing the headset profile and mobile phones implementing the handsfree profile.

3.2.6.1.2 Summary/Implications
- Summary
    - Pass rate of 79.6% (70 of 88); indicates moderate level of interoperability.
    - All failures come from headsets implementing the headset profile and mobile phones implementing the handsfree profile.
- Implications
    - 18 of 18 failures could be corrected raising the pass rate to 100% if headsets and mobile phones adapted the same profile.

3.2.6.2 Test Case – Call from Headset: Failure Results

3.2.6.2.1 Failure Data

Table 3.2.6.2-1: MP-HS Call from HS Data

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH5	USF	USF	USF	USF	USF	USF	USF	USF	USF	USF	USF
MP1	0	0	0	0	0	0	0	0	0	0	0
MP2	0	0	0	0	0	0	0	0	0	0	0
MP3	0	0	0	0	0	0	0	0	0	0	0
MP4	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0
MP5											
MP6	0	0	0	0	0	0	0	0	0	0	0
MP7	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0
MP8	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0

Table 3.2.6.2-2: MP-HS Call from HS Stats

Potential Pairs	88
Tested Pairs	88
Passed	59
Failed	29
Pass Rate	67.1%
Completion Rate	100%

3.2.6.2.2 Summary/Implications

- Summary
  - Pass rate of 67.1% (59 of 88); indicates low-level of interoperability that could easily be raised.
  - 18 of 29 failures come from headsets implementing the headset profile and mobile phones implementing the handsfree profile.
  - 11 of 29 failures are because HH5 does not support voice tags.
- Implications
  - 18 of 29 failures could be corrected raising the pass rate to 87.5% if headsets and mobile phones adapted the same profile.
  - 11 of 29 failures could also be corrected if HH5 supported voice tags.
  - These account for 100% of the observed failures.

3.2.6.3 Test Case – Receive Call with Mobile Phone: Failure Results

3.2.6.3.1 Failure Data

Table 3.2.6.3-1: MP-HS Receive with MP Data

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH5	0	0	USF	0	0	0	0	0	0	0	0
MP1	0	0	0	0	0	0	0	0	0	0	0
MP2	0	0	0	0	0	0	0	0	0	0	0
MP3	0	0	0	0	0	0	0	0	0	0	0
MP4	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0
MP5											
MP6	0	0	0	0	0	0	0	0	0	0	0
MP7	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0
MP8	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0

Table 3.2.6.3-2: MP-HS Receive with MP Stats

Potential Pairs	88
Tested Pairs	88
Passed	69
Failed	19
Pass Rate	78.4%
Completion Rate	100%

3.2.6.3.2 Summary/Implications

- Summary
    - Pass rate of 78.4% (69 of 88); indicates moderate level of interoperability.
    - 18 of 19 failures come from headsets implementing the headset profile and mobile phones implementing the handsfree profile.
- Implications
    - 18 of 19 failures could be corrected raising the pass rate to 98.9% if headsets and mobile phones adapted the same profile.

3.2.6.4 Test Case – Receive Call with Headset: Failure Results

3.2.6.4.1 Failure Data

Table 3.2.6.4-1: MP-HS Receive from HS

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH5	0	0	USF	0	0	0	0	0	0	0	0
MP1	0	0	0	0	0	0	0	0	0	0	0
MP2	0	0	0	0	0	0	0	0	0	0	0
MP3	0	0	0	0	0	0	0	0	0	0	0
MP4	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0
MP5											
MP6	0	0	0	0	0	0	0	0	0	0	0
MP7	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0
MP8	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0

Table 3.2.6.4-2: MP-HS Receive from HS

Potential Pairs	88
Tested Pairs	88
Passed	69
Failed	19
Pass Rate	78.4%
Completion Rate	100%

3.2.6.4.2 **Summary/Implications**

- Summary
    - Pass rate of 78.4% (69 of 88); indicates moderate level of interoperability.
    - 18 of 19 failures come from headsets implementing the headset profile and mobile phones implementing the handsfree profile.
- Implications
    - 18 of 19 failures could be eliminated, raising the pass rate to 98.9% if headsets and mobile phones adapted the same profile.

3.2.6.5 Test Case – Transfer Call: Failure Results

3.2.6.5.1 Failure Data

Table 3.2.6.5-1: MP-HS Transfer Call Data

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH5	0	0	USF	0	0	0	0	0	0	0	0
MP1	0	0	0	0	0	0	0	0	0	0	0
MP2	0	0	0	0	0	0	0	0	0	0	0
MP3	0	0	0	0	0	0	0	0	0	0	0
MP4	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0
MP5											
MP6	0	0	0	0	0	0	0	0	0	0	0
MP7	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0
MP8	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	USF

Table 3.2.6.5-2: MP-HS Transfer Call Stats

Potential Pairs	88
Tested Pairs	88
Passed	68
Failed	20
Pass Rate	77.3%
Completion Rate	100%

3.2.6.5.2 Summary/Implications

- Summary
  - Pass rate of 77.3% (68 of 88); indicates moderate level of interoperability.
  - 18 of 20 failures come from headsets implementing the headset profile and mobile phones implementing the handsfree profile.
- Implications
  - 18 of 20 failures could be corrected raising the pass rate to 97.7% if headsets and mobile phones adapted the same profile.

3.2.6.6 Mobile Phone – Mobile Phone: Failure Results

3.2.6.6.1 Failure Data

3.2.6.6.1.1 Aggregates

Table 3.2.6.6-1: MP-HS Aggregates

Passes

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH5	4	4	1	4	4	4	4	4	4	4	4
MP1	5	5	5	5	5	5	5	5	5	5	5
MP2	5	5	5	5	5	5	5	5	5	5	5
MP3	5	5	5	5	5	5	5	5	5	5	5
MP4	5							5	5	5	5
MP5											
MP6	5	5	5	5	5	5	5	5	5	5	5
MP7	5							5	5	5	5
MP8	5							5	5	5	4

Failures

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH5	2	2	5	2	2	2	2	2	2	2	2
MP1	1	1	1	1	1	1	1	1	1	1	1
MP2											
MP3											
MP4		5	5	5	5	5	5				
MP5											
MP6											
MP7		5	5	5	5	5	5				
MP8		5	5	5	5	5	5				1

Table 3.2.6.6-2: MP-HS Aggregates

Potential Pairs	88
Tested Pairs	88
Potential TC	462
Tested TC	462
Passed TC	335
Failed TC	127
Pass Rate	72.51%

3.2.6.6.1.2 Failure Rates

Table 3.2.6.6-3: MP-HS Failure Rates

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH5	33%	33%	83%	33%	33%	33%	33%	33%	33%	33%	33%
MP1	17%	17%	17%	17%	17%	17%	17%	17%	17%	17%	17%
MP2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MP3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MP4	0%	100%	100%	100%	100%	100%	100%	0%	0%	0%	0%
MP5											
MP6	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MP7	0%	100%	100%	100%	100%	100%	100%	0%	0%	0%	0%
MP8	0%	100%	100%	100%	100%	100%	100%	0%	0%	0%	20%

3.2.6.6.1.3 Failure Rates 3D
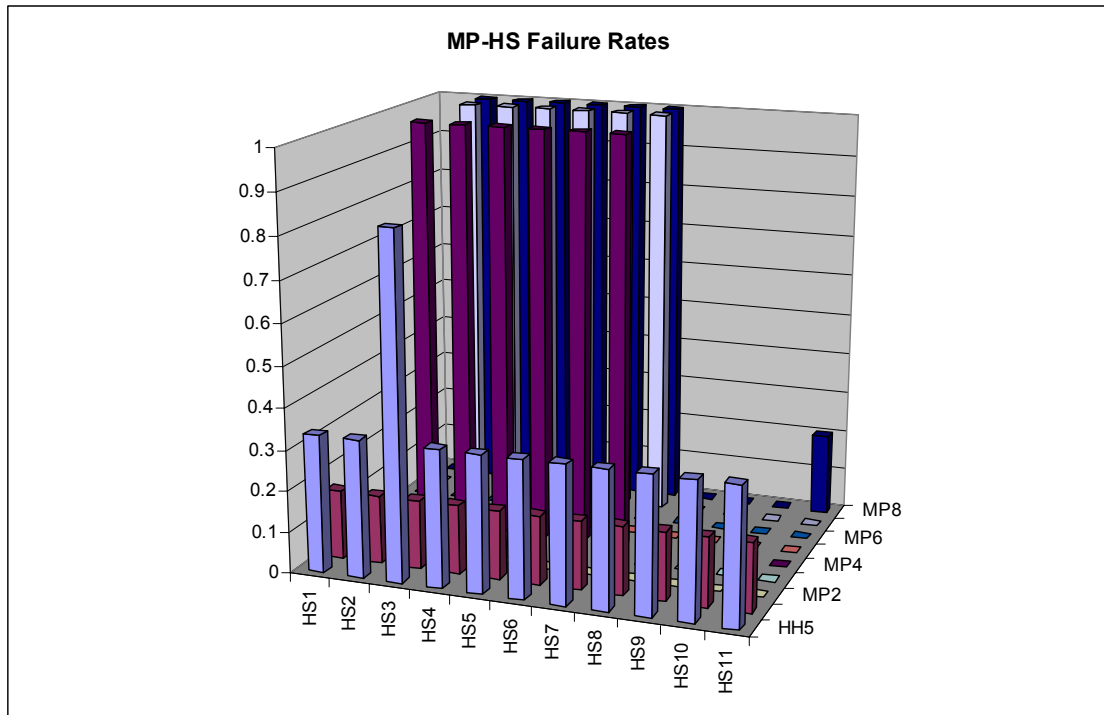
Figure 3.2.6.6-1: MP-HS Failure Rates

3.2.6.6.1.4 Failure Rate Distribution
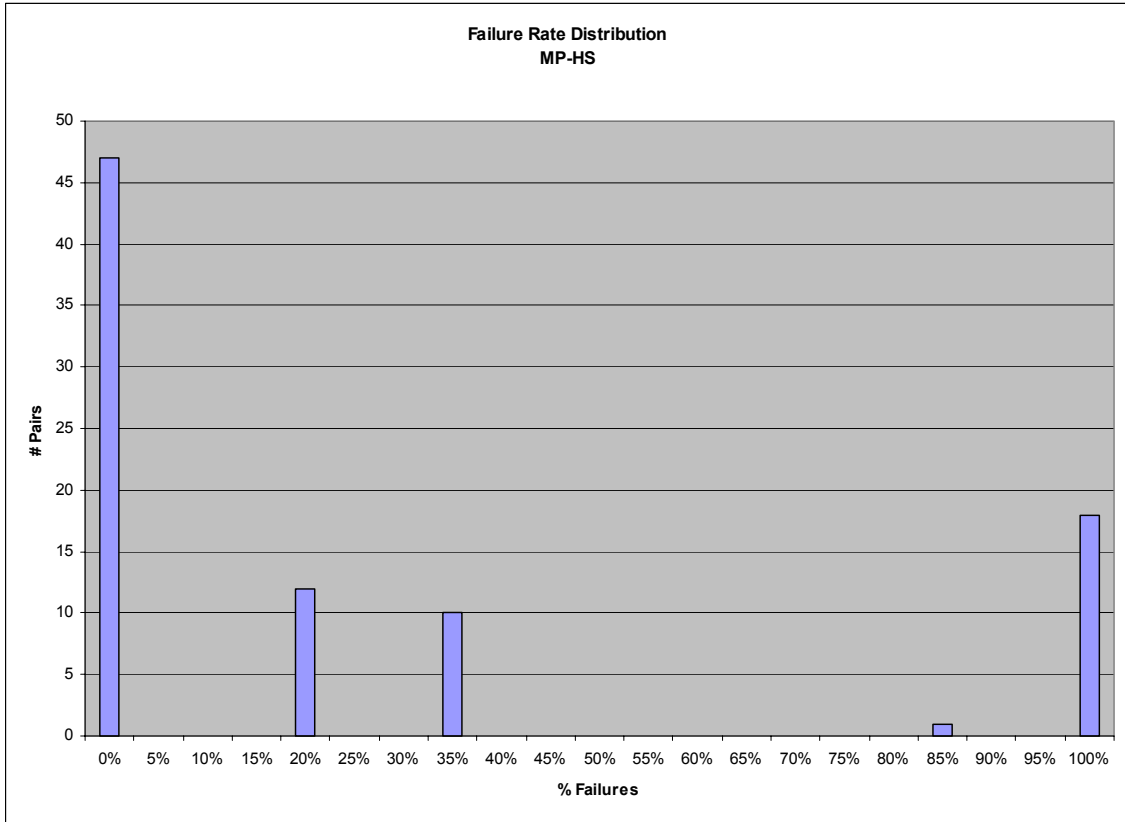
Figure 3.2.6.6-2: MP-HS Failure Rate Distribution
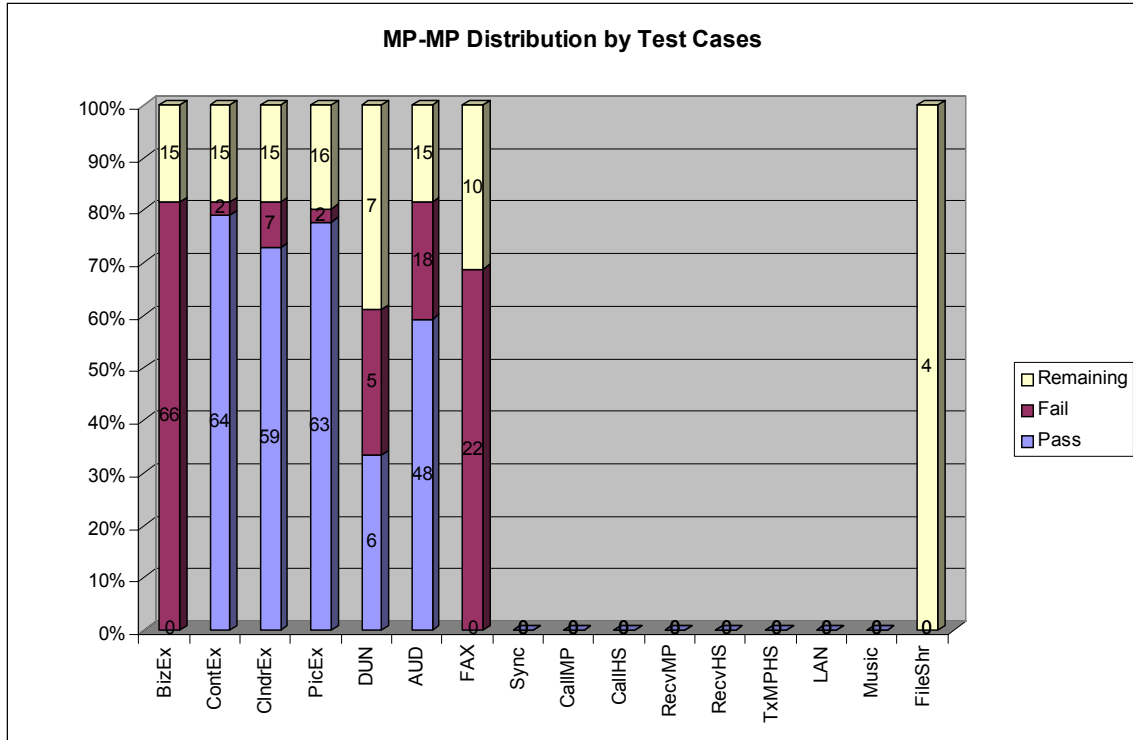
3.2.6.6.1.5Distribution by Test Cases

MP-HS Distribution by Test Cases
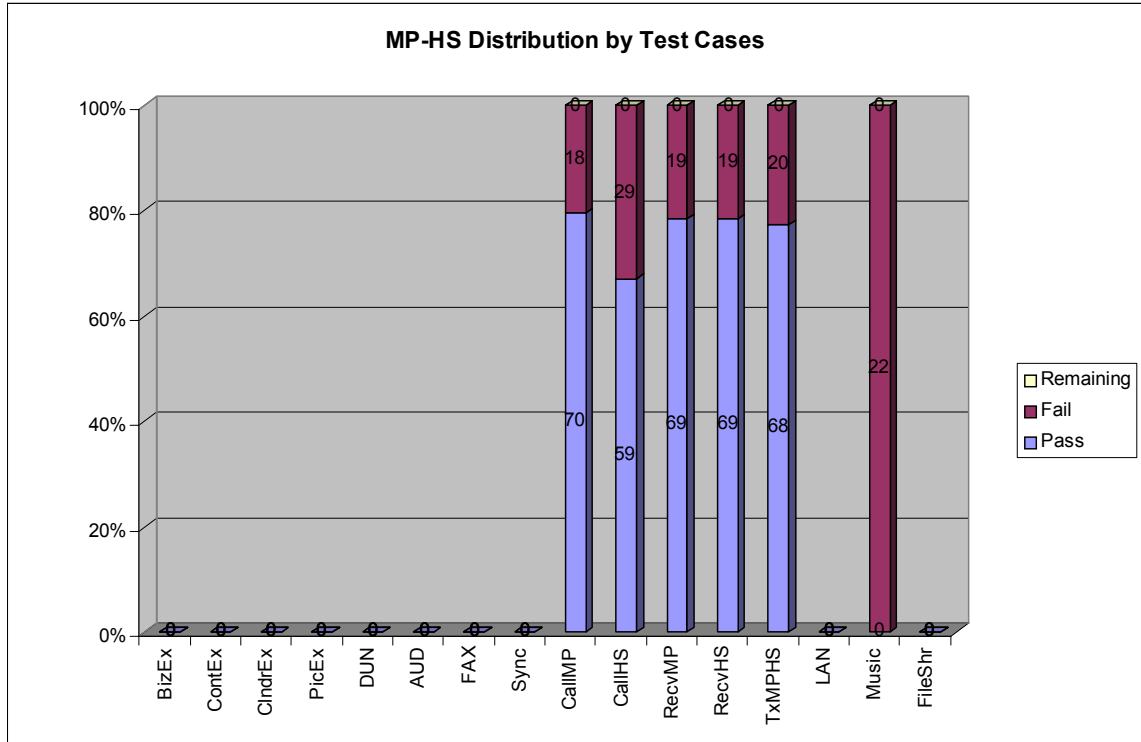
Figure 3.2.6.6-3: MP-HS Failure Distribution by Test Cases

3.2.6.6.1.6 Failure Breakdowns

Table 3.2.6.6-4: MP-HS Failure Breakdowns

Total	Failure Description
28	"Unable to connect…" error
0	"Max number of Bluetooth connections…" error
0	"Internal Bluetooth…" error
84	"Profile not supported…" error
0	Unable to detect device during Bluetooth Search
0	Pairing Error: "Unable to Pair…"
15	Device pair does not support feature under test.
0	Transferred calendar times/dates are incorrect
0	Data lost while transferring
0	"Failed sending" error
0	Unsupported file format
0	Pairing cannot be initiated from device
127	Total number of failures

3.2.6.6.2 Summary

- Overall Pass rate of 335 of 462 or 72.51%

- 84 of 127 "Profile not supported" permanent error.
- 11 of 127 due to HH5 not supporting voice tags.

3.2.6.6.3 Implications

- Using the "Summary/Implications" sections from the previous breakdowns the amount of improvement (failures that could be corrected) can be tracked if these modifications are made.
  - 84 if headsets and mobile phones adapted the same profile.
  - 11 if HH5 supported voice tags and voice dialing.
- These account for 95 of 127 failures (74.8%)
- 93.1% pass rate (430 out of 462) if above failures was corrected.
- 97.8% pass rate (452 out of 462) if handheld test, "Play music," is also not included for HH5 and MP1.

3.2.6.7 Mobile Phone – Headset: Error Data

Table 3.2.6.7-1: MP-HS Error Data

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH5	0	0	2	0	0	0	0	0	0	0	6
MP1	1	1	0	7	0	4	2	1	0	2	0
MP2	0	0	0	0	1	0	0	0	0	0	0
MP3	0	0	2	0	5	1	0	0	1	1	0
MP4	0	0	0	0	0	0	0	7	3	3	0
MP5											
MP6	1	0	0	0	1	0	3	0	1	0	1
MP7	3	0	0	1	0	0	0	2	5	1	3
MP8	0	0	0	0	0	0	0	4	3	0	1

Table 3.2.6.7-2: MP-HS Error Stats

Potential TC	462
Tested TC	462
TC w/ Errors	32
Total Errors	80
Error Rates	6.93%
Average Errors	17.32%

3.2.6.8 Mobile Phone – Headset: Completion Results

Table 3.2.6.8-1: MP-HS Completion Rates

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH5	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MP1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MP2	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MP3	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MP4	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MP5											
MP6	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MP7	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MP8	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 3.2.6.8-2: MP-HS Completion Statistics

Potential Pairs	88
Tested Pairs	88
Potential TC	462
Tested TC	462
Completd	100%

3.2.7 Mobile Phone – PC

3.2.7.1 Test Case – Business Card Exchange: Failure Results

3.2.7.1.1 Failure Data

Table 3.2.7.1-1: MP-PC Business Card Exchange Data

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH5										x	USF	x	x	x	x
MP1										x	USF	x	x	x	x
MP2										USF	USF	x	x	x	x
MP3										USF	USF	x	x	x	x
MP4										USF	USF	x	x	x	x
MP5										x	x	x	USF	FS	USF
MP6										USF	USF	x	x	x	x
MP7										x	x	x	USF	FS	USF
MP8										x	x	x	USF	FS	USF
PC1	x	x	FS	USF	USF	x	USF	x	x						
PC2	USF	USF	x	USF	x	x	USF	x	x						
PC3	x	x	x	x	x	x	x	x	x						
PC4	x	x	x	x	x	USF	x	USF	USF						
PC5	x	x	x	x	x	x	x	x	x						
PC6	x	x	x	x	x	x	x	PNS	x						

Table 3.2.7.1-2: MP-PC Business Card Exchange Stats

Potential Pairs	108
Tested Pairs	31
Passed	0
Failed	31
Pass Rate	0%
Completion Rate	28.7%

3.2.7.1.2 Summary/Implications
- Summary
  - Pass rate of 0% (0 of 31)
  - 16 of 31 failures because mobile phones lack the user interface to initialize a business card exchange.
  - 15 of 31 failures because mobile phones lack the software supporting a business card exchange.
- Implications

- 31 of 31 failures could possibly be eliminated raising the pass rate to 100% if mobile phones were able to initialize and support a business card exchange.

3.2.7.2 Test Case – Transfer Contact: Failure Results

3.2.7.2.1 Failure Data

Table 3.2.7.2-1: MP-PC Transfer Contact Data

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH5										x	0	x	x	x	x
MP1										x	0	x	x	x	x
MP2										0	UFF	x	x	x	x
MP3										0	0	x	x	x	x
MP4										0	0	x	x	x	x
MP5										x	x	x	0	0	0
MP6										0	0	x	x	x	x
MP7										x	x	x	0	0	0
MP8										x	x	x	0	0	0
PC1	x	x	0	0	0	x	0	x	x						
PC2	0	0	0	0	0	x	0	x	x						
PC3	x	x	x	x	x	x	x	x	x						
PC4	x	x	x	x	x	0	x	0	0						
PC5	x	x	x	x	x	0	x	0	0						
PC6	x	x	x	x	x	x	x	0	0						

Table 3.2.7.2-2: MP-PC Transfer Contact Stats

Potential Pairs	108
Tested Pairs	37
Passed	36
Failed	1
Pass Rate	97.3%
Completion Rate	34.3%

3.2.7.2.2 Summary/Implications
- Summary
  - Pass rate of 97.3% (36 of 37); indicates a high level of interoperability.
  - Only failure is due to unsupported file format
- Implications
  - 100% pass rate if file format issue is corrected between MP2→PC2

3.2.7.3 Test Case – Transfer Calendar Entry: Failure Results

3.2.7.3.1 Failure Data

Table 3.2.7.3-1: MP-PC Transfer Calendar Entry Data

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH5										x	0	x	x	x	x
MP1										x	0	x	x	x	x
MP2										FS	UFF	x	x	x	x
MP3										FS	0	x	x	x	x
MP4										FS	0	x	x	x	x
MP5										x	x	x	0	0	FS
MP6										FS	0	x	x	x	x
MP7										x	x	x	0	0	DL
MP8										x	x	x	0	0	FS
PC1	x	x	0	0	t&d	x	0	x	x						
PC2	0	UFF	UFF	FS	UFF	x	FS	x	x						
PC3	x	x	x	x	x	x	x	x	x						
PC4	x	x	x	x	x	0	x	0	t&d						
PC5	x	x	x	x	x	0	x	0	0						
PC6	x	x	x	x	x	0	x	t&d	0						

Table 3.2.7.3-2: MP-PC Transfer Calendar Entry Stats

Potential Pairs	108
Tested Pairs	38
Passed	22
Failed	16
Pass Rate	57.9%
Completion Rate	35.2%

3.2.7.3.2 Summary/Implications

- Summary
    - Pass rate of 57.9% (22 of 38)
    - 8 of the 16 failures due to "Failed Sending" permanent error; this signifies that the operation was able to be initiated, but the calendar entry was never finished sending and was never received.
        - Possible low-level Bluetooth problems.
    - 4 of 16 failures due a calendar entry transferred in a format not supported by the receiving device.
    - 3 of 16 failures due to incorrect time/date when transferring.
- Implications
    - 3 of the 16 failures could be corrected raising the pass rate to 25 of 38, or a 65.8% pass rate by enforcing or adapting a standard calendar form when sending calendar entries.

- 4 of the 16 failures could be corrected further raising the pass rate to 29 of 38, or a 76.3% pass rate if all handheld devices supported the same calendar file format.

3.2.7.4 Test Case – Transfer Picture: Failure Results

3.2.7.4.1 Failure Data

Table 3.2.7.4-1: MP-PC Transfer Picture Data

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH5										x	0	x	x	x	x
MP1										x	0	x	x	x	x
MP2										0	UFF	x	x	x	x
MP3										0	0	x	x	x	x
MP4										0	0	x	x	x	x
MP5										x	x	x	0	FS	0
MP6										0	0	x	x	x	x
MP7										x	x	x	0	FS	0
MP8										x	x	x	0	FS	0
PC1	x	x	0	0	0	x	0	x	x						
PC2	0	0	0	0	0	x	0	x	x						
PC3	x	x	x	x	x	x	x	x	x						
PC4	x	x	x	x	x	0	x	0	0						
PC5	x	x	x	x	x	0	x	0	0						
PC6	x	x	x	x	x	0	x	0	0						

Table 3.2.7.4-2: MP-PC Transfer Picture Stats

Potential Pairs	108
Tested Pairs	38
Passed	34
Failed	4
Pass Rate	89.5%
Completion Rate	35.2%

3.2.7.4.2 Summary/Implications

- Summary
    - Pass rate of 89.5% (34 of 38)
    - 1 of 4 failures due to unsupported file format; same pair as transferring a contact.
    - 3 of the 4 failures due to "Failed Sending," permanent error; this signifies that the operation was able to be initiated, but the picture file never finished sending or was never received.
        – Possible low-level Bluetooth problems

- Implications
    - If file format issues were corrected this would raise the pass rate slightly to 92.1% (35 of 38).

3.2.7.5 Test Case – Dialup Networking: Failure Results

3.2.7.5.1 Failure Data

Table 3.2.7.5-1: MP-PC DUN Data

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH5															
MP1															
MP2															
MP3															
MP4															
MP5															
MP6															
MP7															
MP8															
PC1	x	x	UC	UC	UC		UC	x	x						
PC2	x	0	FS	0	0		0	x	x						
PC3	x	x	x	x	x		x	x	x						
PC4	x	x	x	x	x		x	UC	UC						
PC5	x	x	x	x	x		x	0	0						
PC6	x	x	x	x	x		x	0	0						

Table 3.2.7.5-2: MP-PC DUN Stats

Potential Pairs	48
Tested Pairs	15
Passed	8
Failed	7
Completion Rate	31.3%

3.2.7.5.2 Summary/Implications

- Summary
    - Pass rate of 53.3% (8 of 15)
    - 6 of 7 failures due to "Unable to connect…" permanent error.
    - PC1 does not seem to be able to support dial-up networking through Bluetooth enabled phones
- Implications
    - No simple solutions exist because the root of the problem is indiscernible at this point.

3.2.7.6 Test Case – Transfer of Recorded Audio: Failure Results

3.2.7.6.1 Failure Data

Table 3.2.7.6-1: MP-PC Transfer Recorded Audio Data

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH5										x	0	x	x	x	x
MP1										x	0	x	x	x	x
MP2										UFF	FS	x	x	x	x
MP3										0	0	x	x	x	x
MP4										0	0	x	x	x	x
MP5										x	x	x	0	FS	0
MP6										0	0	x	x	x	x
MP7										x	x	x	0	FS	0
MP8										x	x	x	0	FS	UFF
PC1	x	x	UFF	UFF	0	x	UFF	x	x						
PC2	0	0	0	0	0	x	0	x	x						
PC3	x	x	x	x	x	x	x	x	x						
PC4	x	x	x	x	x	0	x	0	0						
PC5	x	x	x	x	x	0	x	0	0						
PC6	x	x	x	x	x	0	x	0	UFF						

Table 3.2.7.6-2: MP-PC Transfer Recorded Audio Stats

Potential Pairs	108
Tested Pairs	38
Passed	28
Failed	10
Pass Rate	73.7%
Completion Rate	35.2%

3.2.7.6.2 Summary/Implications

- Summary
  - Pass rate of 73.7% (28 of 38)
  - 6 of 10 failures because the audio file is not recognizable by the receiving device.
  - 4 of the 10 failures due to "Failed Sending," permanent error; this signifies that the operation was able to be initiated, but the audio file never finished sending or was never received.
    - Possible low-level Bluetooth problems.
- Implications
  - 6 of 10 failures could be corrected raising the pass rate to 89.5% (34 of 38) if mobile phones and PCs adopt the same file format for all recorded audio files.

3.2.7.7 Test Case – Send FAX: Failure Results

3.2.7.7.1 Failure Data

Table 3.2.7.7-1: MP-PC FAX Data

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH5										x	x	x	x	x	x
MP1										x	USF	x	x	x	x
MP2										FS	USF	x	x	x	x
MP3										USF	USF	x	x	x	x
MP4										FS	USF	x	x	x	x
MP5										x	x	x	USF	FS	USF
MP6										USF	USF	x	x	x	x
MP7										x	x	x	USF	FS	FS
MP8										x	x	x	USF	USF	FS
PC1	x	x	FS	USF	FS	x	USF	x	x						
PC2	x	USF	USF	USF	USF	x	USF	x	x						
PC3	x	x	x	x	x	x	x	x	x						
PC4	x	x	x	x	x	USF	x	USF	USF						
PC5	x	x	x	x	x	UC	x	FS	USF						
PC6	x	x	x	x	x	USF	x	UC	FS						

Table 3.2.7.7-2: MP-PC FAX Stats

Potential Pairs	108
Tested Pairs	36
Passed	0
Failed	36
Pass Rate	0%
Completion Rate	33.3%

Note that the failure declaration process was not tracked, and there may be premature failures declared.

3.2.7.7.2 Summary/Implications
- Summary
    - Pass rate of 0% (0 of 36)
    - Mobile phones could not initiate a FAX.
- Implications
    - No simple solutions exist because the root of the problem is indiscernible at this point.

3.2.7.8 Test Case – Synchronize: Failure Results

3.2.7.8.1 Failure Data

Table 3.2.7.8-1: MP-PC Synchronize Data

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH5										x	USF	x	x	x	x
MP1										x	USF	x	x	x	x
MP2										0	USF	x	x	x	x
MP3										0	DL	x	x	x	x
MP4										USF	0	x	x	x	x
MP5										x	x	x	USF	USF	USF
MP6										0	FS	x	x	x	x
MP7										x	x	x	USF	USF	USF
MP8										x	x	x	USF	USF	USF
PC1															
PC2															
PC3															
PC4															
PC5															
PC6															

Table 3.2.7.8-2: MP-PC Synchronize Stats

Potential Pairs	54
Tested Pairs	19
Passed	4
Failed	15
Pass Rate	21.1%
Completion Rate	35.2%

Currently, synchronization is initiated from the Mobile Phone. An open question is whether it is reasonable to initiate synchronization from the PC.

3.2.7.8.2 Summary/Implications

- Summary
  - Pass rate of 21.1% (4 of 19)
  - One "Failed sending" permanent error, and one "Data lost while transferring."
  - 13 of 15 failures due to unsupported feature.
- Implications
  - No simple solutions exist because the root of the problem is indiscernible at this point.

3.2.7.9 Mobile Phone – PC: Failure Results

3.2.7.9.1 Failure Data

3.2.7.9.1.1 Aggregates

Table 3.2.7.9-1: MP-PC Aggregate Data

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH5											4				
MP1											5				
MP2										3					
MP3										4	5				
MP4										3	6				
MP5													4	2	3
MP6										4	5				
MP7													4	3	4
MP8													4	3	3
PC1			3	3	3		3								
PC2	4	3	3	3	3		3								
PC3															
PC4						4		4	3						
PC5						4		4	4						
PC6						3		3	3						

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH5											3				
MP1											4				
MP2										5	8				
MP3										4	3				
MP4										5	2				
MP5													4	6	5
MP6										4	3				
MP7													4	5	4
MP8													4	5	5
PC1			3	3	3		3								
PC2	1	3	2	3	2		3								
PC3															
PC4						2		2	3						
PC5						1		1	1						
PC6						1		3	2						

Passes   Failures

Table 3.2.7.9-2: MP-PC Aggregate Stats

Potential Pairs	108
Tested Pairs	38
Potential TC	792
Tested TC	257
Passed TC	132
Failed TC	125
Pass Rate	51.4%

3.2.7.9.1.2 Failure Rates

Table 3.2.7.9-3: MP-PC Failure Rate Data

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH5											43%				
MP1											50%				
MP2										57%	100%				
MP3										43%	43%				
MP4										57%	29%				
MP5													43%	71%	57%
MP6										43%	43%				
MP7													43%	71%	57%
MP8													43%	71%	71%
PC1			57%	57%	57%		57%								
PC2	20%	43%	50%	43%	33%		43%								
PC3															
PC4						43%		43%	57%						
PC5						33%		17%	17%						
PC6						40%		43%	33%						

3.2.7.9.1.3 Failure Rates 3D
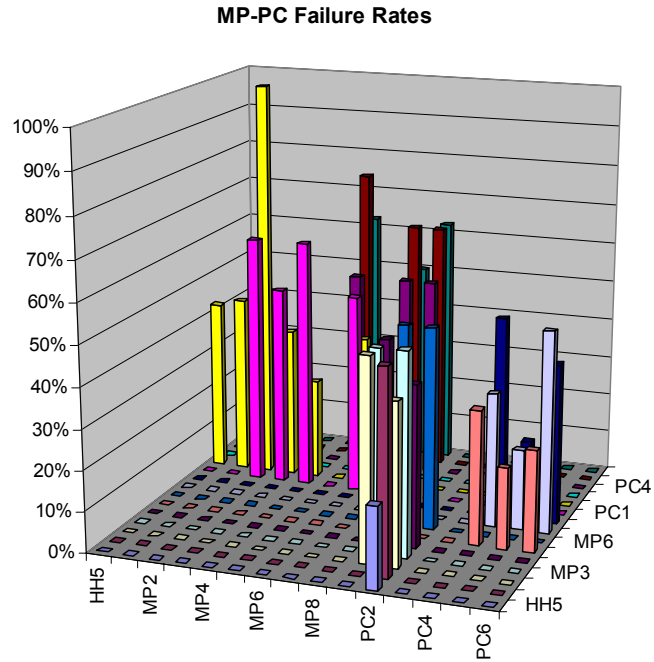
MP-PC Failure Rates

Figure 3.2.7.9-1: MP-PC Failure Rates Plot

3.2.7.9.1.4 Failure Rate Distribution
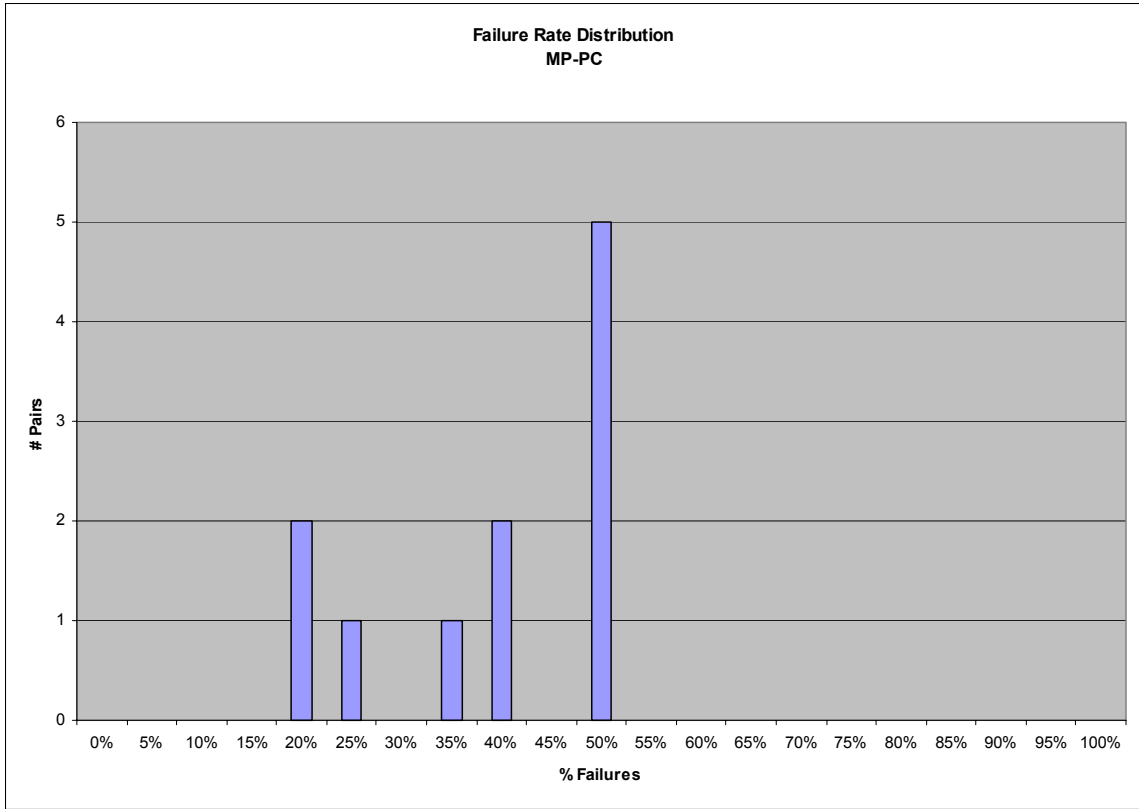
Figure 3.2.7.9-2: MP-PC Failure Rate Distribution

3.2.7.9.1.5Distribution by Test Cases

MP-PC Distribution by Test Cases
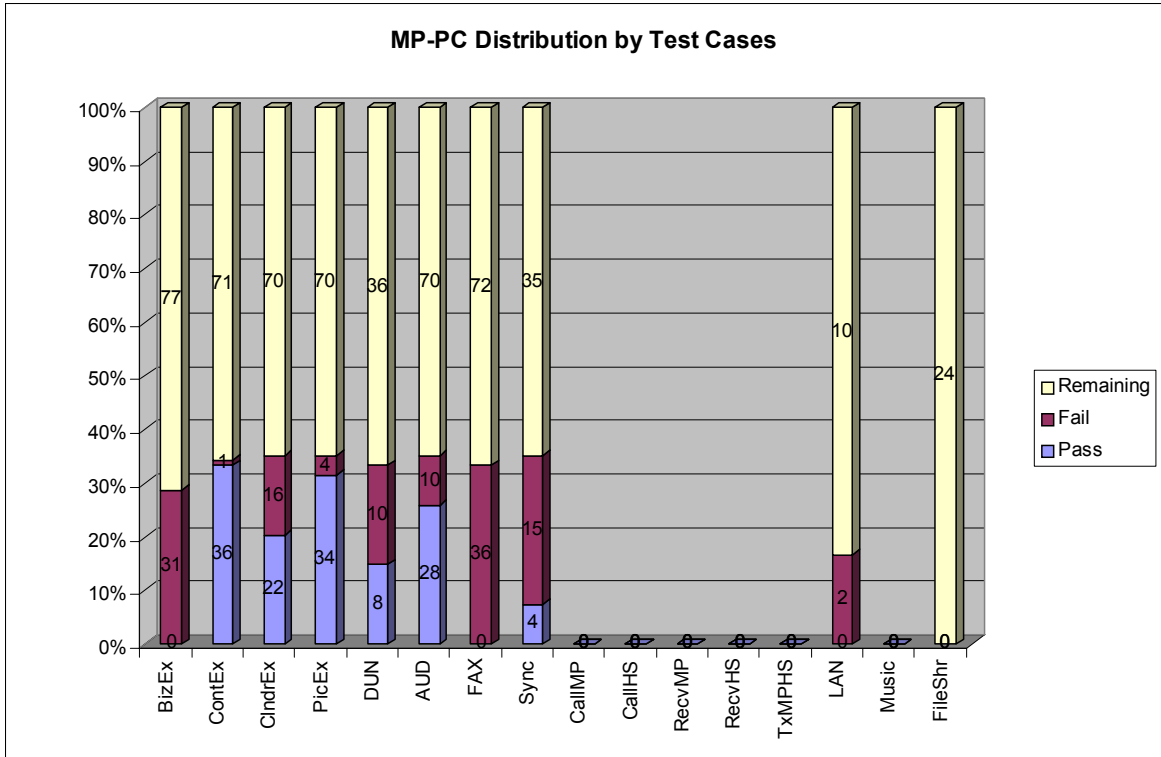
Figure 3.2.7.9-3: MP-PC Failure Distribution by Test Case

3.2.7.9.1.6 Failure Breakdowns

Table 3.2.7.9-4: MP-PC Failure Breakdowns

Total	Failure Description
8	"Unable to connect…" error
0	"Max number of Bluetooth connections…" error
0	"Internal Bluetooth…" error
1	"Profile not supported…" error
0	Unable to detect device during Bluetooth Search
0	Pairing Error: "Unable to Pair…"
65	Device pair does not support feature under test.
3	Transferred calendar times/dates are incorrect
2	Data lost while transferring
31	"Failed sending" error
12	Unsupported file format
0	Pairing cannot be initiated from device
122	Total number of failures

3.2.7.9.2 Summary

- Overall pass rate of 51.4% (132 of 257)
- 16 of 125 failures because mobile phones lack the user interface to initialize a business card exchange.
- 15 of 125 failures because mobile phones lack the software supporting a business card exchange.
- 6 of 125 failures because the audio file is not recognizable by the receiving device.
- 4 of 125 failures due a calendar entry transferred in a format not supported by the receiving device.
- 3 of 125 failures due to incorrect time/date when transferring.

3.2.7.9.3 Implications

- Using the "Summary/Implications" sections from the previous breakdowns the amount of improvement (failures that could be corrected) can be tracked if these modifications are made.
    - 31 if mobile phones were able to initialize and support a business card exchange.
    - 6 if mobile phones and PCs adopt the same file format for all recorded audio files.
    - 4 if all handheld devices supported the same calendar file format.
    - 3 by enforcing or adapting a standard calendar form when sending calendar entries.
- These account for 44 of 125 failures (35.2%)
- 68.5% pass rate (176 out of 257) if all these failures corrected
- 82.5% pass rate (212 out of 257) if FAX test is not included in aggregate.

3.2.7.10   Mobile Phone – PC: Error Data

Table 3.2.7.10-1: MP-PC Error Data

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH5										0	0	0	0	0	0
MP1										0	1	0	0	0	0
MP2										0	0	0	0	0	0
MP3										0	0	0	0	0	0
MP4										0	0	0	0	0	0
MP5										0	0	0	1	0	0
MP6										1	0	0	0	0	0
MP7										0	0	0	0	0	8
MP8										0	0	0	0	0	1
PC1	0	0	1	0	0	0	0	0	0						
PC2	0	5	0	0	0	0	0	0	0						
PC3	0	0	0	0	0	0	0	0	0						
PC4	0	0	0	0	0	0	0	0	0						
PC5	0	0	0	0	0	0	0	0	0						
PC6	0	0	0	0	0	0	0	0	0						

Table 3.2.7.10-2: MP-PC Error Stats

Potential TC	792
Tested TC	257
TC w/ Errors	7
Total Errors	18
Error Rates	2.72%
Average Errors	7.00%

3.2.7.11 Mobile Phone – PC: Completion Results

Table 3.2.7.11-1: MP-PC Completion Rates

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH5										0%	70%	0%	0%	0%	0%
MP1										0%	90%	0%	0%	0%	0%
MP2										100%	100%	0%	0%	0%	0%
MP3										100%	100%	0%	0%	0%	0%
MP4										100%	100%	0%	0%	0%	0%
MP5										0%	0%	0%	100%	100%	100%
MP6										100%	100%	0%	0%	0%	0%
MP7										0%	0%	0%	100%	100%	100%
MP8										0%	0%	0%	100%	100%	100%
PC1	0%	0%	100%	100%	100%	0%	100%	0%	0%						
PC2	71%	86%	83%	100%	83%	0%	100%	0%	0%						
PC3	0%	0%	0%	0%	0%	0%	0%	0%	0%						
PC4	0%	0%	0%	0%	0%	100%	0%	100%	100%						
PC5	0%	0%	0%	0%	0%	83%	0%	83%	83%						
PC6	0%	0%	0%	0%	0%	67%	0%	100%	83%						

Table 3.2.7.11-2: MP-PC Completion Stats

Potential Pairs	108
Tested Pairs	38
Potential Test Cases	792
Tested Test Cases	257
Completion	32.5%

MP-PC Completion Rates
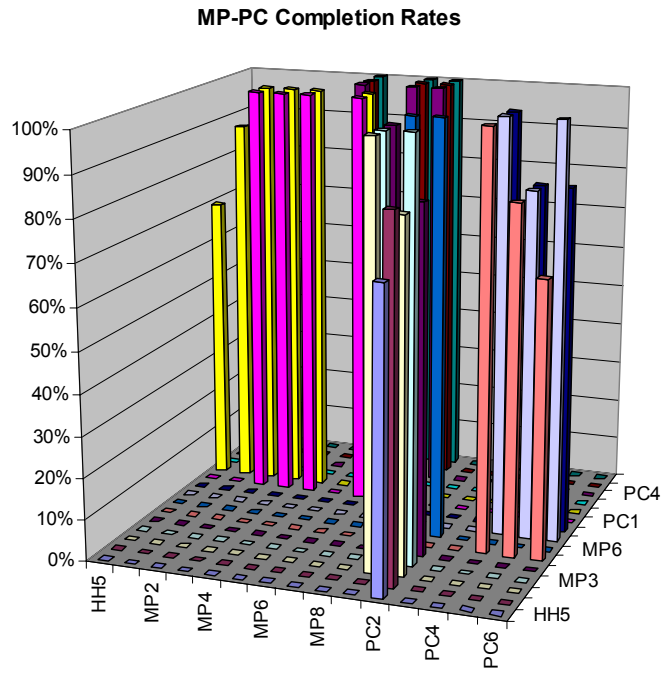
Figure 3.2.7.11-1: MP-PC Completion Rate Plot
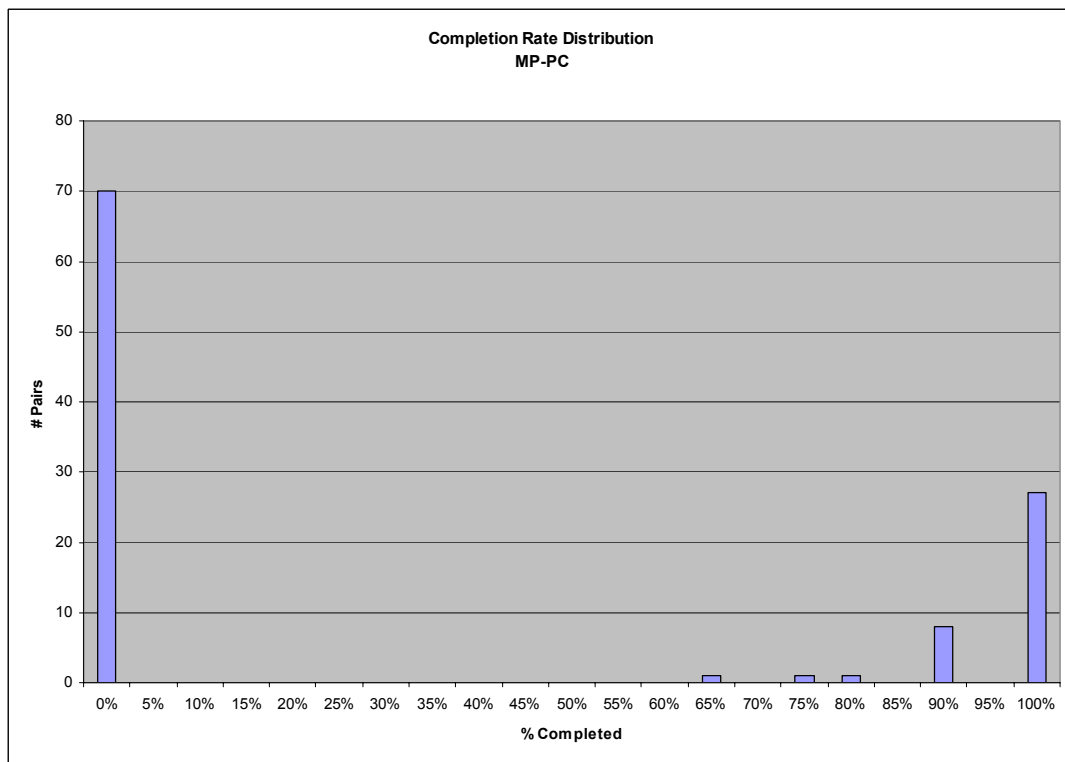
Figure 3.2.7.11-2: MP-PC Completion Rate Distribution

3.2.8 PC – Headset

3.2.8.1 Test Case – Play Audio File: Failure Results

3.2.8.1.1 Failure Data

Table 3.2.8.1-1: PC-HS Play Audio File Data

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
PC1	0	x	x	x	x	UC	x	x	x	x	x
PC2	PNS	x	x	x	x	x	x	x	x	x	x
PC3	x	x	x	x	x	x	x	x	x	x	x
PC4	x	PE	PE	PE	PE	PE	PE	PE	PE	PE	x
PC5	x	x	x	x	x	x	x	x	x	x	x
PC6	0	0	x	0	0	0	x	x	0	0	x

Table 3.2.8.1-2: PC-HS Play Audio File Summary

Potential Pairs	66
Tested Pairs	19
Passed	8
Failed	11
Pass Rate	42.11
Completion Rate	28.8%

3.2.8.2 PC – Headset: Failure Results

3.2.8.2.1 Failure Data

Table 3.2.8.2-1: PC-HS Failure Breakdown

Total	Failure Description
1	"Unable to connect…" error
0	"Max number of Bluetooth connections…" error
0	"Internal Bluetooth…" error
1	"Profile not supported…" error
0	Unable to detect device during Bluetooth Search
9	Pairing Error: "Unable to Pair…"
0	Device pair does not support feature under test.
0	Transferred calendar times/dates are incorrect
0	Data lost while transferring
0	"Failed sending" error
0	Unsupported file format
0	Pairing cannot be initiated from device
11	Total number of failures

3.2.8.2.2 Summary/Implications

- Summary
  - Pass rate of 42.1% (8 of 19)
  - 9 of 11 failures are from "Unable to Pair" permanent error.
  - 1 of 11 failures is from "Profile not supported" permanent error.
- Implications
  - 1 of 11 failures can be corrected raising the pass rate to 47.4% (9of 19) if PC2 implements the audio profile.
  - Majority of failures are likely due to Bluetooth-related problems.

3.2.8.3 PC – Headset: Error Data

Table 3.2.8.3-1: PC-HS Error Data

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
PC1	1	0	0	0	0	0	0	0	0	0	0
PC2	0	0	0	0	0	0	0	0	0	0	0
PC3	0	0	0	0	0	0	0	0	0	0	0
PC4	0	0	0	0	0	0	0	0	0	0	0
PC5	0	0	0	0	0	0	0	0	0	0	0
PC6	0	0	0	1	3	0	0	0	0	0	0

Table 3.2.8.3-2: PC-HS Error Stats

Potential TC   66

Tested TC   19

TC w/ Errors   3

Total Errors   5

Error Rates   15.79%

Average Errors   26.32%

3.2.8.4 PC - Headset: Completion Results

Table 3.2.8.4-1: PC-HS Completion Stats

Potential Pairs   54

Tested Pairs   34

Potential TC   176

Tested TC   144

Completed   81.82%
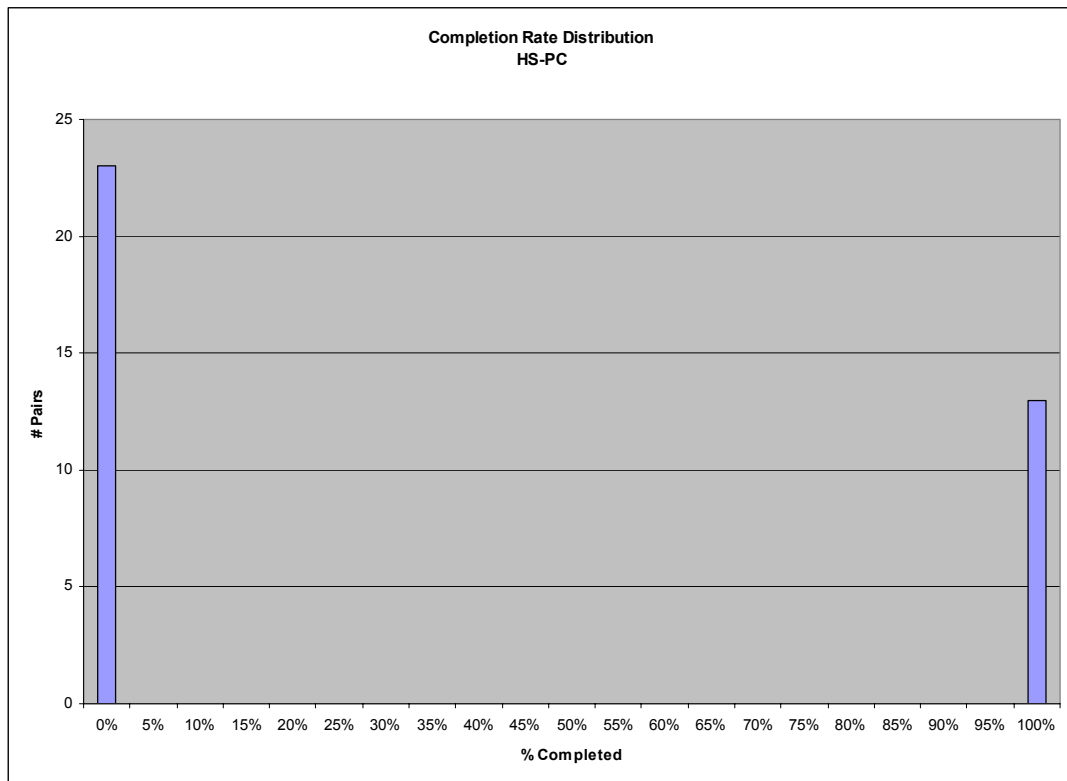
Figure 3.2.8.4-1: PC-HS Completion Rate Distribution

3.2.9 PC – PC

3.2.9.1 Test Case – Business Card Exchange: Failure Results

3.2.9.1.1 Failure Data

Table 3.2.9.1-1: PC-PC Business Card Exchange Data

	PC1	PC2	PC3	PC4	PC5	PC6
PC1	x	FS	USF	0	0	0
PC2	USF	x	USF	USF	USF	USF
PC3	USF	USF	x	USF	USF	USF
PC4	0	FS	FS	x	FS	FS
PC5	0	USF	USF	FS	x	FS
PC6	0	USF	USF	FS	0	x

Table 3.2.9.1-2: PC-PC Business Card Exchange Stats

Potential Pairs	36
Tested Pairs	30
Passed	7
Failed	23
Pass Rate	23.3%
Completion Rate	83.3%

Highlights of the failure breakdowns
- 15 of 23 failures due to unsupported feature
- 8 of 23 failures due to "Failed sending…" permanent error

Note that the failure declaration process was not tracked, and there may be some failures that were prematurely declared.

3.2.9.1.2 Summary/Implications
- Summary
    - Pass rate of 23.3% (7 of 30).
    - 15 of 23 failures due to unsupported feature.

- 8 of the 23 failures due to "Failed Sending," permanent error; this signifies that the operation was able to be initiated, but the business card exchange never finished.
  - Indicates possible low-level Bluetooth problems
- Implications
  - 15 of 23 failures may be eliminated raising the pass rate to 73.3% if all PCs were able to support a business card exchange.

3.2.9.2 Test Case – Transfer Contact: Failure Results

3.2.9.2.1 Failure Data

Table 3.2.9.2-1: PC-PC Transfer Contact Data

	PC1	PC2	PC3	PC4	PC5	PC6
PC1	x	0	UDB	0	0	0
PC2	FS	x	USF	FS	FS	FS
PC3	USF	USF	x	UDB	USF	USF
PC4	0	FS	FS	x	0	0
PC5	0	0	UDB	0	x	0
PC6	0	0	0	0	0	x

Table 3.2.9.2-2: PC-PC Transfer Contact Stats

Potential Pairs	36
Tested Pairs	30
Passed	16
Failed	14
Pass Rate	53.3%
Completion Rate	83.3%

3.2.9.2.2 Summary/Implications

- Summary
  - Pass rate of 53.3% (16 of 30)
  - 6 of 14 failures due to "Failed Sending," error; this signifies that the operation was able to be initiated, but the contact never finished sending or was never received.
    - Possible low-level Bluetooth problems.
  - 3 of 14 failures came from a device not being able to detect the other Bluetooth enabled device in order to send a contact.

– Again this could indicate low-level Bluetooth problems
- For PC3 this seems to be an unsupported feature.
- Implications
  - 5 of 14 failures could be corrected raising the pass rate to 70% if PC3 supported this feature.

3.2.9.3 Test Case – Transfer Calendar Entry: Failure Results

3.2.9.3.1 Failure Data

Table 3.2.9.3-1: PC-PC Transfer Calendar Entry Data

	PC1	PC2	PC3	PC4	PC5	PC6
PC1	x	0	UDB	UDB	0	0
PC2	FS	x	USF	FS	FS	FS
PC3	USF	USF	x	UDB	USF	USF
PC4	0	FS	FS	x	0	0
PC5	FS	FS	UDB	0	x	0
PC6	FS	0	USF	0	0	x

Table 3.2.9.3-2: PC-PC Transfer Calendar Entry Stats

Potential Pairs	36
Tested Pairs	30
Passed	11
Failed	19
Pass Rate	36.7%
Completion Rate	83.3%

3.2.9.3.2 Summary/Implications
- Summary
  - Pass rate of 36.7% (11 of 30)
  - 9 of 19 failures due to "Failed Sending" error; this signifies that the operation was able to be initiated, but the calendar entry never finished sending or was never received.
    - Indicates possible low-level Bluetooth problems.
  - 4 of 19 failures came from a device not being able to detect the other Bluetooth enabled device in order to send a calendar entry.
    - Again, this could indicate low-level Bluetooth problems.

- PC3 again does not support this feature.
- Implications
    - 6 of 19 failures could be corrected, raising the pass rate to 56.7% (17 of 30), if PC3 supported sending and receiving a calendar entry.

3.2.9.4 Test Case – Transfer Picture: Failure Results

3.2.9.4.1 Failure Data

Table 3.2.9.4-1: PC-PC Transfer Picture Data

	PC1	PC2	PC3	PC4	PC5	PC6
PC1	x	0	UDB	UDB	0	0
PC2	FS	x	USF	FS	FS	FS
PC3	USF	USF	x	UDB	USF	USF
PC4	0	FS	FS	x	0	0
PC5	0	0	UDB	0	x	0
PC6	0	FS	USF	0	0	x

Potential Pairs	36
Tested Pairs	30
Passed	13
Failed	17
Pass Rate	43.3%
Completion Rate	83.3%

3.2.9.4.2 Summary/Implications

- Summary
    - Pass rate of 43.3% (13 of 30)
    - 7 of 17 failures from "Failed sending" permanent error.
    - 4 of 17 failures were due to "Unable to detect device during Bluetooth search" permanent error.
    - PC3 again does not support this feature.
- Implications
    - 6 of 17 failures could be corrected raising the pass rate to 63.3% (19 of 30) if PC3 supported sending and receiving a picture.

3.2.9.5 Test Case – Transfer of Recorded Audio: Failure Results

3.2.9.5.1 Failure Data

Table 3.2.9.5-1: PC-PC Transfer Recorded Audio Data

	PC1	PC2	PC3	PC4	PC5	PC6
PC1	x	0	UDB	0	0	0
PC2	FS	x	USF	FS	FS	FS
PC3	USF	USF	x	UDB	USF	USF
PC4	0	FS	FS	x	0	0
PC5	0	0	UDB	0	x	0
PC6	0	0	FS	0	0	x

Table 3.2.9.5-2: PC-PC Transfer Recorded Audio Stats

Potential Pairs	36
Tested Pairs	30
Passed	15
Failed	15
Pass Rate	50%
Completion Rate	83.3%

3.2.9.5.2 Summary/Implications

- Summary
  - Pass rate of 50% (15 of 30)
  - 7 of 15 failures due to "Failed Sending" error; this signifies that the operation was able to be initiated, but the audio file never finished sending and/or was never received.
    – Implies possible low-level Bluetooth problems.
  - 3 of 15 failures came from a device not being able to detect the other Bluetooth enabled device in order to send an audio file.
    – Again this could indicate low-level Bluetooth problems.
  - PC3 again does not support this feature.
- Implications
  - 6 of 15 failures could be corrected raising the pass rate to 70% (21 of 30) if PC3 supported sending and receiving an audio file.

3.2.9.6 Test Case – Synchronize: Failure Results

3.2.9.6.1 Failure Data

Table 3.2.9.6-1: PC-PC Synchronize Data

	PC1	PC2	PC3	PC4	PC5	PC6
PC1	x	USF	USF	USF	USF	0
PC2	USF	x	USF	USF	USF	USF
PC3	USF	USF	x	USF	USF	USF
PC4	USF	USF	USF	x	USF	USF
PC5	USF	USF	USF	USF	x	FS
PC6	0	USF	USF	USF	USF	x

Table 3.2.9.6-2: PC-PC Synchronize Data

Potential Pairs	36
Tested Pairs	30
Passed	2
Failed	28
Pass Rate	6.7%
Completion Rate	83.3%

3.2.9.6.2 Summary/Implications
- Summary
    - Pass rate is poor, only 6.7% (2 of 30).
    - Only two successes.
    - 27 of 28 failures due to synchronization being an unsupported feature.
- Implications
    - 27 of 28 failures could be corrected raising the pass rate to 96.7% (28 of 30) if all PCs could initialize and support synchronization through Bluetooth.

3.2.9.7 Test Case – File Sharing: Failure Results

3.2.9.7.1 Failure Data

Table 3.2.9.7-1: PC-PC File Sharing Data

	PC1	PC2	PC3	PC4	PC5	PC6
PC1	x	USF	USF	x	x	x
PC2	USF	x	USF	USF	x	x
PC3	USF	USF	x	USF	USF	x
PC4	x	USF	USF	x	x	x
PC5	x	x	USF	x	x	x
PC6	x	x	x	x	x	x

Table 3.2.9.7-2: PC-PC File Sharing Stats

Potential Pairs	36
Tested Pairs	12
Passed	0
Failed	12
Pass Rate	0%
Completion Rate	33.3%

Note that the file declaration process was not well tracked, hence some of the failures may have been prematurely declared.

3.2.9.7.2 Summary/Implications

- Summary
  - Pass rate of 0% (0 of 12)
  - This test needs to be more intensively tested.
- Implications
  - No simple solutions exist because the root of the problem is indiscernible at this point.

3.2.9.8 PC – PC: Failure Results

3.2.9.8.1 Failure Data

3.2.9.8.1.1 Aggregates

Table 3.2.9.8-1: PC-PC Aggregate Data

	PC1	PC2	PC3	PC4	PC5	PC6
PC1		4		3	5	6
PC2						
PC3						
PC4	5				4	4
PC5	4	3		4		4
PC6	5	3	1	4	5	

Passes

	PC1	PC2	PC3	PC4	PC5	PC6
PC1		3	7	3	1	
PC2	7		7	7	6	6
PC3	7	7		7	7	6
PC4	1	7	7		2	2
PC5	2	3	7	2		2
PC6	1	3	5	2	1	

Failures

Table 3.2.9.8-2: PC-PC Aggregate Stats

Potential Pairs	36
Tested Pairs	30
Potential TC	252
Tested TC	192
Passed TC	64
Failed TC	128
Pass Rate	33.3%

3.2.9.8.1.2 Failure Rates

Table 3.2.9.8-3: PC-PC Failure Rates

	PC1	PC2	PC3	PC4	PC5	PC6
PC1		43%	100%	50%	17%	0%
PC2	100%		100%	100%	100%	100%
PC3	100%	100%		100%	100%	100%
PC4	17%	100%	100%		33%	33%
PC5	33%	50%	100%	33%		33%
PC6	17%	50%	83%	33%	17%	

Error! Objects cannot be created from editing field codes.

3.2.9.8.1.3 Failure Rates 3D
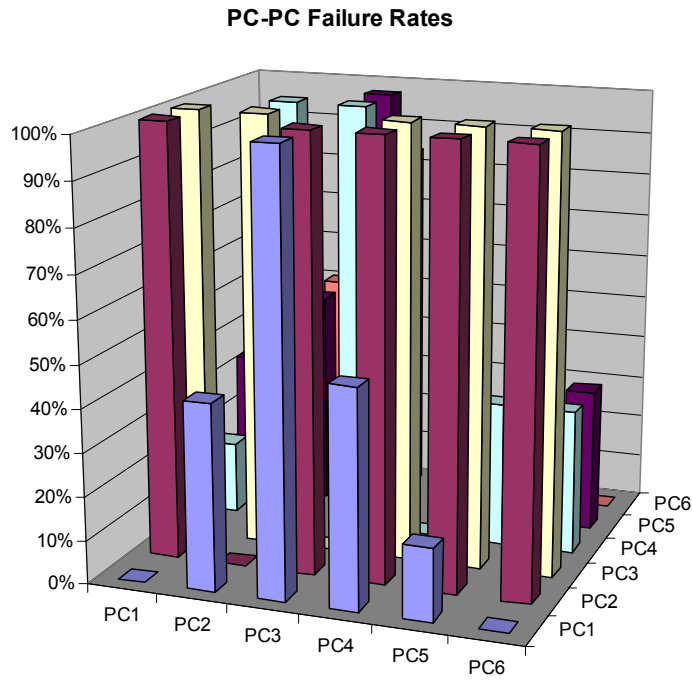
PC-PC Failure Rates

Figure 3.2.9.8-1: PC-PC Failure Rate Plot

3.2.9.8.1.4Failure Rate Distribution
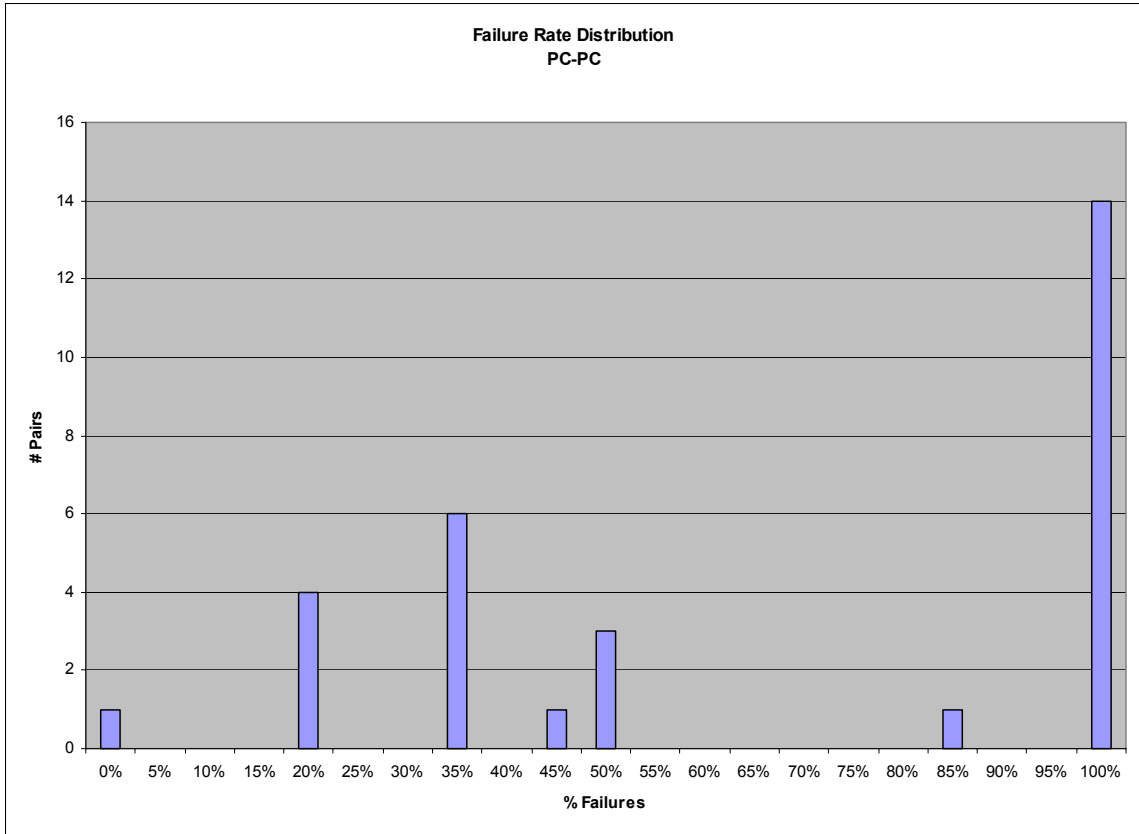
Figure 3.2.9.8-2: PC-PC Failure Rate Distribution

3.2.9.8.1.5 Distribution by Test Cases
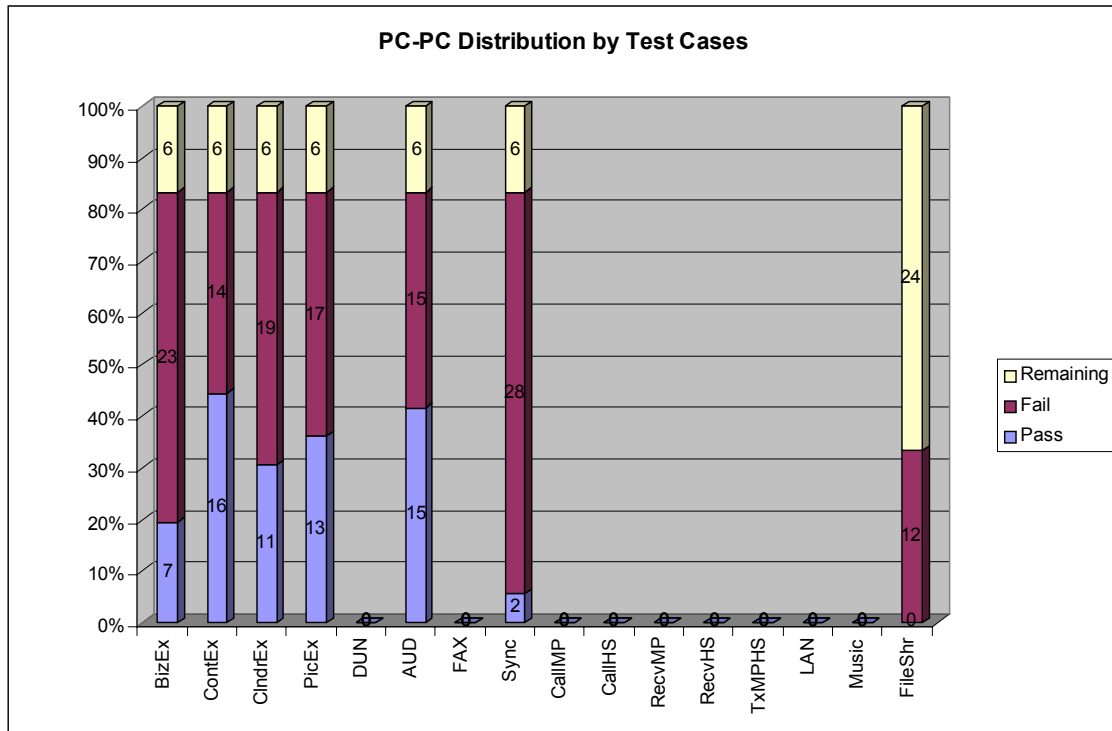
Figure 3.2.9.8-3: PC-PC Distribution by Test Cases

3.2.9.8.1.6 Failure Breakdowns

Table 3.2.9.8-4: PC-PC Failure Breakdowns

Total	Failure Description
0	"Unable to connect…" error
0	"Max number of Bluetooth connections…" error
0	"Internal Bluetooth…" error
0	"Profile not supported…" error
14	Unable to detect device during Bluetooth Search
0	Pairing Error: "Unable to Pair…"
76	Device pair does not support feature under test.
0	Transferred calendar times/dates are incorrect
0	Data lost while transferring
38	"Failed sending" error
0	Unsupported file format
0	Pairing cannot be initiated from device
128	Total number of failures

3.2.9.8.2 Summary

- Overall pass rate of 33.3% (64 of 192).
- 15 of 128 failures are because PCs did not support a business card exchange.
- 27 of 128 failures are because PCs could not initialize and support synchronization through Bluetooth.
- 24 of 128 are due to PC3's recurring interoperability problems.
- 38 of 128 failures due to "Failed Sending" error; this signifies that the operation was able to initiate, but the file never finished sending and was never received. PC's had the highest proportion of failures from this problem.
    - Possible low-level Bluetooth problems.
- 14 of 128 failures came from a device not being able to detect the other Bluetooth enabled device in order to send a file.
    - Again, this could indicate low-level Bluetooth problems.

3.2.9.8.3 Implications

- Using the "Summary/Implications" sections from the previous breakdowns the amount of improvement (failures that could be corrected) can be tracked if these modifications are made.
    - 27 if PCs could initialize and support synchronization through Bluetooth.
    - 24 if PC3's interoperability problems are corrected.
    - 15 if all PCs supported a business card exchange.
- These account for 66 of 128 failures (51.6%)
- 67.8% pass rate (130 out of 192) if all these failures corrected.

3.2.9.9 PC – PC: Error Data

Table 3.2.9.9-1: PC-PC Error Data

	PC1	PC2	PC3	PC4	PC5	PC6
PC1	0	0	0	0	0	0
PC2	0	0	0	0	1	1
PC3	0	0	0	0	0	0
PC4	0	0	0	0	0	0
PC5	0	0	0	0	0	0
PC6	0	0	0	0	0	0

Table 3.2.9.9-2: PC-PC Error Stats

Potential TC	252
Tested TC	192
TC w/ Errors	2
Total Errors	2
Error Rates	1.04%
Average Errors	1.04%

3.2.9.10   PC – PC: Completion Results

Table 3.2.9.10-1: PC-PC Completion Rate Data

	PC1	PC2	PC3	PC4	PC5	PC6
PC1	0%	100%	100%	86%	86%	86%
PC2	100%	0%	100%	100%	86%	86%
PC3	100%	100%	0%	100%	100%	86%
PC4	86%	100%	100%	0%	86%	86%
PC5	86%	86%	100%	86%	0%	86%
PC6	86%	86%	86%	86%	86%	0%

PC-PC Completion Rates
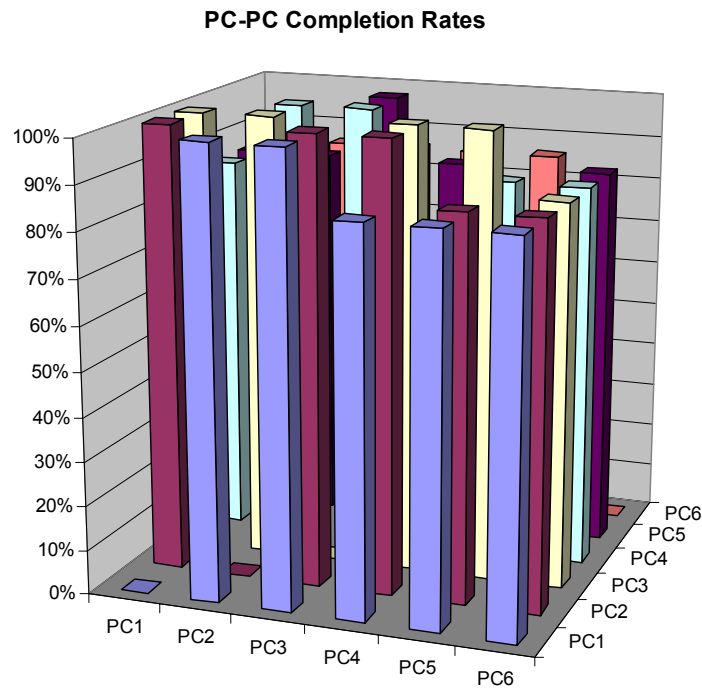
Figure 3.2.9.10-1: PC-PC Completion Rate Plot

Table 3.2.9.10-2: PC-PC Completion Stats

Potential Pairs	36
Tested Pairs	30
Potential TC	252
Tested TC	192

Completion   76.2%

3.3 Breakdown by Test Cases

3.3.1 Test Case: Business Card Exchange

3.3.1.1 Failure Data

Table 3.3.1.1-1: Business Card Exchange Data

0	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH1	x	USF	x	USF	USF	USF	USF	USF	USF	x	USF	USF	x	x	x	x	UDB	0	USF
HH2	0	x	USF	USF	USF	USF	USF	USF	USF	USF	USF	USF	USF	x	x	x	x	0	FS
HH3	x	USF	x	USF	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
HH4	USF	0	USF	x	USF	USF	USF	USF	USF	USF	USF	USF	USF	x	USF	x	x	x	x
HH5	USF	USF	x	USF	x	x	USF	USF	USF	USF	USF	USF	USF	x	USF	x	x	x	x
MP1	USF	USF	x	USF	x	x	USF	USF	USF	USF	USF	x	x	x	USF	x	x	x	x
MP2	USF	USF	x	USF	USF	USF	x	USF	USF	USF	USF	USF	USF	USF	USF	x	x	x	x
MP3	USF	USF	x	USF	USF	USF	USF	x	USF	USF	USF	USF	USF	USF	USF	x	x	x	x
MP4	USF	USF	x	USF	USF	USF	USF	USF	x	USF	USF	USF	USF	USF	USF	x	x	x	x
MP5	x	USF	x	USF	USF	USF	USF	USF	USF	x	USF	USF	USF	x	x	x	USF	FS	USF
MP6	USF	USF	x	USF	USF	USF	USF	USF	USF	USF	x	USF	USF	USF	USF	x	x	x	x
MP7	USF	USF	x	USF	USF	x	USF	USF	USF	USF	USF	x	USF	x	x	x	USF	FS	USF
MP8	x	USF	x	USF	USF	x	USF	USF	USF	USF	USF	USF	x	x	x	x	USF	FS	USF
PC1	x	x	x	x	x	x	FS	USF	USF	x	USF	x	x	x	FS	USF	0	0	0
PC2	x	x	x	USF	USF	USF	x	USF	x	x	USF	x	x	USF	x	USF	USF	USF	USF
PC3	x	x	x	x	x	x	x	x	x	x	x	x	USF	USF	x	x	USF	USF	USF
PC4	FS	x	x	x	x	x	x	x	USF	x	USF	USF	x	0	FS	FS	x	FS	FS
PC5	0	0	x	x	x	x	x	x	x	x	x	x	x	0	USF	USF	FS	x	FS
PC6	USF	FS	x	x	x	x	x	x	x	x	x	PNS	x	0	USF	USF	FS	0	x

Table 3.3.1.1-2: Business Card Exchange Stats

Potential Pairs	361
Tested Pairs	199
Passed	13
Failed	186
Pass Rate	6.5%
Completion Rate	55.1%

3.3.1.2 Failure Breakdown

3.3.1.2.1 Failure Breakdown Table

Table 3.3.1.2-1: Business Card Exchange Breakdown

Failure Type	Total	Failure Description
UC	0	"Unable to connect…" error
MBC	0	"Max number of Bluetooth connections…" error
InB	0	"Internal Bluetooth…" error
PNS	1	"Profile not supported…" error
UDB	1	Unable to detect device during Bluetooth Search
PE	0	Pairing Error: "Unable to Pair…"
USF	169	Device pair does not support feature under test.
t&d	0	Transferred calendar times/dates are incorrect
DL	0	Data lost while transferring
FS	15	"Failed sending" error
UFF	0	Unsupported file format
PNI	0	Pairing cannot be initiated from device
All	186	Total number of failures

3.3.1.2.2 Failure Breakdown Pie Chart

Breakdown for Bussiness Card Exchange
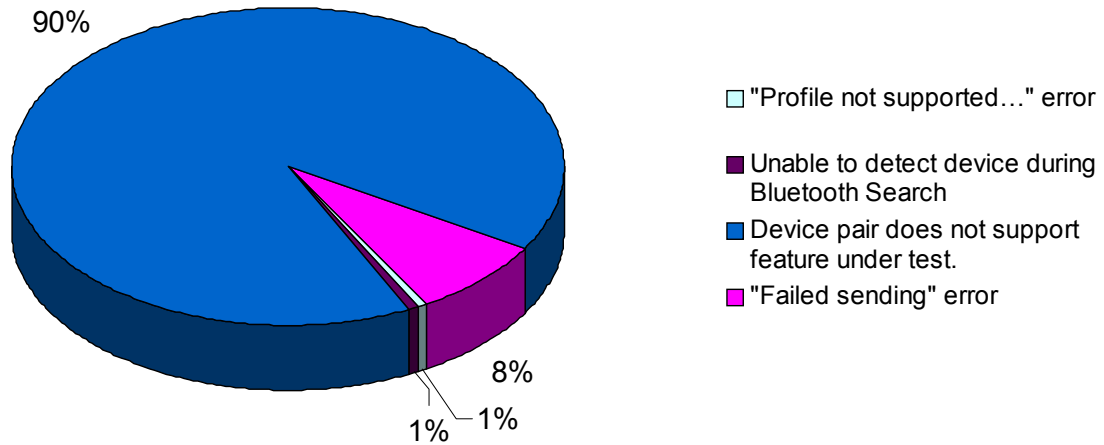
Figure 3.3.1.2-1: Business Card Exchange Breakdown

3.3.1.3 Summary/Implications

- Summary
  - Low pass rate of 6.5% (13 of 199)
  - 169 of 199 failures due to device pair not supporting this feature.
    - Should this be supported? Is this an important feature?
  - 15 of 199 failures due to "Failed Sending" error; this signifies that the operation was able to be initiated, but the business cards never finished sending and/or never received.
    - Possible low-level Bluetooth problems
- Implications
  - A possible 169 failures could be corrected raising the pass rate to 91.5% (182 of 199) if all devices were able to support and initiate a business card exchange.

3.3.1.4 Error data

Table 3.3.1.4-1: Business Card Exchange Error Data

0	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH1	x	0	x	0	0	0	0	0	0	x	0	3	x	x	x	x	0	0	0
HH2	0	x	0	0	0	0	0	0	0	0	0	0	0	x	x	x	x	0	0
HH3	x	0	x	0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
HH4	0	0	0	x	0	0	1	0	0	0	0	0	0	x	0	x	x	x	x
HH5	0	0	x	0	x	x	0	0	0	0	0	0	0	x	0	x	x	x	x
MP1	0	0	x	0	x	x	2	0	0	0	0	x	x	x	0	x	x	x	x
MP2	0	0	x	0	0	0	x	0	0	0	0	0	0	0	0	x	x	x	x
MP3	0	0	x	0	0	0	0	x	0	0	0	0	0	0	0	x	x	x	x
MP4	0	0	x	0	0	0	0	0	x	0	0	0	0	0	0	x	x	x	x
MP5	x	0	x	0	0	0	0	0	0	x	0	0	0	x	x	x	0	0	0
MP6	0	0	x	0	0	0	0	0	0	0	x	0	0	0	0	x	x	x	x
MP7	0	0	x	0	0	x	0	0	0	0	0	x	0	x	x	x	0	0	0
MP8	x	0	x	0	0	x	0	0	0	0	0	0	x	x	x	x	0	0	0
PC1	x	x	x	x	x	x	0	0	0	x	0	x	x	x	0	0	0	0	0
PC2	x	x	x	0	0	0	x	0	x	x	0	x	x	0	x	0	0	1	1
PC3	x	x	x	x	x	x	x	x	x	x	x	x	x	0	0	x	0	0	0
PC4	0	x	x	x	x	x	x	x	x	0	x	0	0	0	0	0	x	0	0
PC5	0	0	x	x	x	x	x	x	x	x	x	x	x	0	0	0	0	x	0
PC6	0	0	x	x	x	x	x	x	x	x	x	0	x	0	0	0	0	0	x

Table 3.3.1.4-2: Business Card Exchange Error Stats

Tested Pairs	199
TC w/ Errors	5
Errors	8
Error Rate	2.51%
Avg. Errors	4.02%

Tested Pairs   199

3.3.2 Test Case: Transfer Contact

3.3.2.1 Failure Data

Table 3.3.2.1-1: Transfer Contact Data

0	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH1	x	0	x	0	UDB	UDB	UDB	UDB	UDB	x	0	0	x	x	x	x	UDB	0	0
HH2	0	x	0	0	0	0	0	0	0	0	0	0	0	x	x	x	x	0	FS
HH3	x	0	x	0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
HH4	0	0	0	x	0	0	0	0	0	0	0	0	0	x	0	x	x	x	x
HH5	0	0	x	0	x	x	0	FS	0	0	FS	0	0	x	0	x	x	x	x
MP1	0	0	x	0	x	x	0	0	0	0	0	x	x	x	0	x	x	x	x
MP2	0	0	x	0	0	0	x	0	0	0	0	0	0	0	UFF	x	x	x	x
MP3	UDB	0	x	0	0	0	0	x	0	0	0	0	0	0	0	x	x	x	x
MP4	0	0	x	0	0	0	0	0	x	0	0	0	0	0	0	x	x	x	x
MP5	x	0	x	0	0	0	0	0	0	x	0	0	0	x	x	x	0	0	0
MP6	0	0	x	0	0	0	0	0	0	0	x	0	0	0	0	x	x	x	x
MP7	FS	0	x	0	0	x	0	0	0	0	0	x	0	x	x	x	0	0	0
MP8	x	0	x	0	0	x	0	0	0	0	0	0	x	x	x	x	0	0	0
PC1	x	x	x	x	x	x	0	0	0	x	0	x	x	x	0	UDB	0	0	0
PC2	x	x	x	FS	0	0	0	0	0	x	0	x	x	FS	x	USF	FS	FS	FS
PC3	x	x	x	x	x	x	x	x	x	x	x	x	x	USF	USF	x	UDB	USF	USF
PC4	FS	x	x	x	x	x	x	x	x	0	x	0	0	0	FS	FS	x	0	0
PC5	0	0	x	x	x	x	x	x	x	0	x	0	0	0	0	UDB	0	x	0
PC6	0	0	x	x	x	x	x	x	x	x	x	0	0	0	0	0	0	0	x

Table 3.3.2.1-2: Transfer Contact Stats

Potential Pairs	361
Tested Pairs	205
Passed	177
Failed	28
Pass Rate	86.3%
Completion Rate	56.8%

3.3.2.2 Failure Breakdown

3.3.2.2.1 Failure Breakdown Table

Table 3.3.2.2-1: Transfer Contact Breakdown

Failure Type	Total	Failure Description
UC	0	"Unable to connect…" error
MBC	0	"Max number of Bluetooth connections…" error
InB	0	"Internal Bluetooth…" error
PNS	0	"Profile not supported…" error
UDB	10	Unable to detect device during Bluetooth Search
PE	0	Pairing Error: "Unable to Pair…"
USF	5	Device pair does not support feature under test.
t&d	0	Transferred calendar times/dates are incorrect
DL	0	Data lost while transferring
FS	12	"Failed sending" error
UFF	1	Unsupported file format
PNI	0	Pairing cannot be initiated from device
All	28	Total number of failures

## 3.3.2.2.2 Failure Breakdown Pie Chart

Breakdown for Transfering a Contact
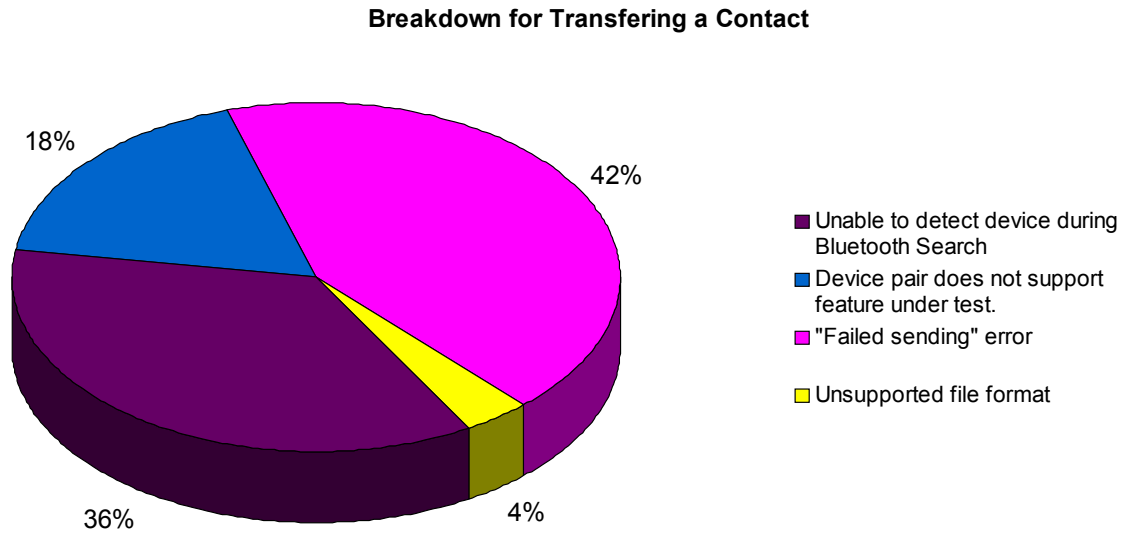
Figure 3.3.2.2-1: Transfer Picture Breakdown

3.3.2.3 Summary/Implications

- Summary
  - Pass rate high, 86.3% (177 of 205).

- 12 of 28 failures due to "Failed Sending," error; this signifies that the operation was able to be initiated, but the file never finished sending and was never received.
  - Possible low-level Bluetooth problems.
- 10 of 28 failures came from a device not being able to detect the other Bluetooth enabled device in order to send a contact.
  - Again, this could indicate low-level Bluetooth problems.
- 5 of 28 failures from recurring interoperability problems with PC3.
- 1 of 28 failures from an unsupported file format.
- Implications
  - A possible 5 failures could be eliminated raising the pass rate to 88.7% (182 of 205) if PC3's interoperability problems are corrected.
  - This represents a slight raise over the original pass rate of 86.3%.

3.3.2.4 Error data

Table 3.3.2.4-1: Transfer Contact Error Data

0	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH1	x	0	x	0	0	0	0	0	0	x	2	1	x	x	x	x	0	0	0
HH2	2	x	0	3	0	0	0	1	1	0	1	0	0	x	x	x	x	0	0
HH3	x	0	x	0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
HH4	0	0	0	x	0	0	4	0	5	0	4	0	0	x	0	x	x	x	x
HH5	0	3	x	0	x	x	0	0	0	0	1	0	0	x	0	x	x	x	x
MP1	0	0	x	0	x	x	4	1	0	0	5	x	x	x	0	x	x	x	x
MP2	0	0	x	0	0	0	x	0	0	8	0	0	0	0	0	x	x	x	x
MP3	0	0	x	0	0	0	0	x	0	0	0	0	0	0	0	x	x	x	x
MP4	0	0	x	0	0	0	0	0	x	0	0	0	0	0	0	x	x	x	x
MP5	x	0	x	0	0	0	0	1	0	x	0	0	0	x	x	x	1	0	0
MP6	0	0	x	0	0	0	0	0	0	0	x	0	0	1	0	x	x	x	x
MP7	0	0	x	0	0	x	0	0	0	0	0	x	0	x	x	x	0	0	0
MP8	x	0	x	0	0	x	0	0	1	0	0	0	x	x	x	x	0	0	0
PC1	x	x	x	x	x	x	0	0	0	x	0	x	x	x	0	0	0	0	0
PC2	x	x	x	0	0	0	0	0	0	x	0	x	x	0	x	0	0	0	0
PC3	x	x	x	x	x	x	x	x	x	x	x	x	x	0	0	x	0	0	0
PC4	0	x	x	x	x	x	x	x	x	0	x	0	0	0	0	0	x	0	0
PC5	0	0	x	x	x	x	x	x	x	0	x	0	0	0	0	0	0	x	0
PC6	0	0	x	x	x	x	x	x	x	x	x	0	0	0	0	0	0	0	x

Table 3.3.2.4-2: Transfer Contact Error Stats

Tested Pairs	205
TC w/ Errors	50
Errors	20
Error Rate	9.76%
Avg. Errors	24.4%
Tested Pairs	205

3.3.3 Test Case: Transfer Calendar Entry

3.3.3.1 Failure Data

Table 3.3.3.1-1: Transfer Calendar Entry Data

0	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH1	x	USF	x	UFF	UDB	UFF	UDB	UDB	UFF	x	UFF	FS	x	x	x	x	UDB	UFF	UFF
HH2	UFF	x	t&d	0	t&d	t&d	0	0	0	0	0	0	t&d	x	x	x	x	0	USF
HH3	x	0	x	FS	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
HH4	FS	0	t&d	x	t&d	t&d	0	t&d	t&d	t&d	0	0	t&d	x	0	x	x	x	x
HH5	PNI	0	x	0	x	x	0	FS	UFF	UFF	FS	UFF	0	x	0	x	x	x	x
MP1	UDB	0	x	0	x	x	0	0	0	0	0	x	x	x	0	x	x	x	x
MP2	UFF	0	x	t&d	0	0	x	0	0	0	0	0	0	FS	UFF	x	x	x	x
MP3	UDB	0	x	t&d	t&d	0	0	x	0	0	0	0	0	FS	0	x	x	x	x
MP4	UDB	0	x	t&d	0	0	0	0	x	0	0	0	0	FS	0	x	x	x	x
MP5	x	t&d	x	0	0	0	UFF	0	0	x	0	0	0	x	x	x	0	0	FS
MP6	USF	0	x	0	0	0	0	0	0	0	x	0	0	FS	0	x	x	x	x
MP7	MBC	0	x	0	0	x	0	0	0	0	0	x	0	x	x	x	0	0	DL
MP8	x	0	x	0	0	x	0	0	0	0	0	0	x	x	x	x	0	0	FS
PC1	x	x	x	x	x	x	0	0	t&d	x	0	x	x	x	0	UDB	UDB	0	0
PC2	x	x	x	FS	0	UFF	UFF	FS	UFF	x	FS	x	x	FS	x	USF	FS	FS	FS
PC3	x	x	x	x	x	x	x	x	x	x	x	x	x	USF	USF	x	UDB	USF	USF
PC4	FS	x	x	x	x	x	x	x	x	0	x	0	t&d	0	FS	FS	x	0	0
PC5	UFF	0	x	x	x	x	x	x	x	0	x	0	0	FS	FS	UDB	0	x	0
PC6	FS	0	x	x	x	x	x	x	x	0	x	t&d	0	FS	0	USF	0	0	x

Table 3.3.3.1-2: Transfer Calendar Entry Stats

Potential Pairs	361
Tested Pairs	206
Passed	122
Failed	84
Pass Rate	59.2%
Completion Rate	57.1%

3.3.3.2 Failure Breakdown

3.3.3.2.1 Failure Breakdown Table

Table 3.3.3.2-1: Transfer Calendar Entry Breakdown

Failure Type	Total	Failure Description
UC	0	"Unable to connect…" error
MBC	1	"Max number of Bluetooth connections…" error
InB	0	"Internal Bluetooth…" error
PNS	0	"Profile not supported…" error
UDB	11	Unable to detect device during Bluetooth Search
PE	0	Pairing Error: "Unable to Pair…"
USF	9	Device pair does not support feature under test.
t&d	19	Transferred calendar times/dates are incorrect
DL	1	Data lost while transferring
FS	25	"Failed sending" error
UFF	17	Unsupported file format
PNI	1	Pairing cannot be initiated from device
All	84	Total number of failures

3.3.3.2.2 Failure Breakdown Pie Chart

Breakdown for Transfering a Calender Entry
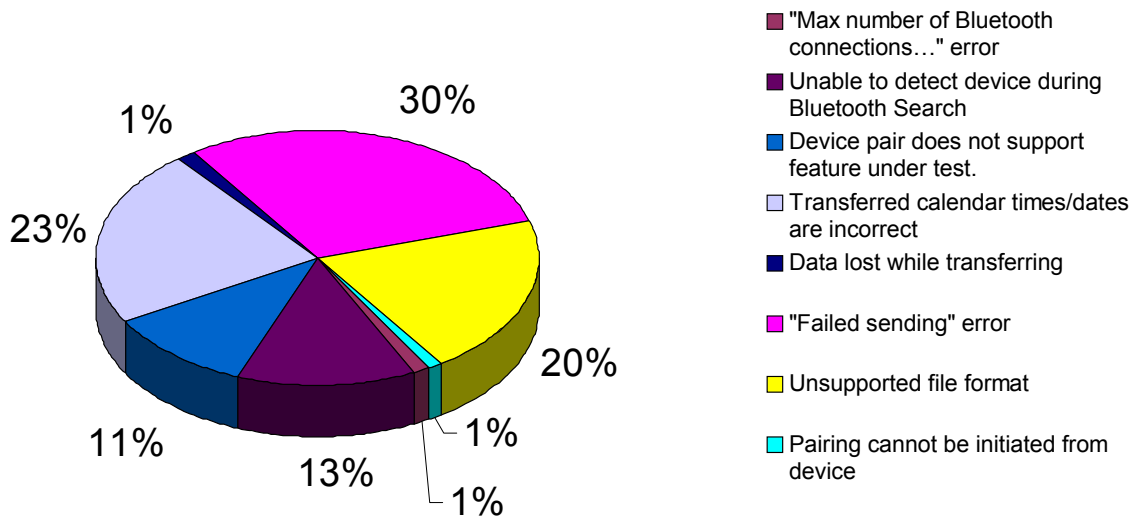
Figure 3.3.3.2-1: Transfer Calendar Entry Breakdown

3.3.3.3 Summary/Implications

- Summary
    - Pass rate of 59.2% (122 of 206).
    - 25 of 84 failures due to "Failed Sending" error; this signifies that the operation could be initiated, but the file never finished sending and was never received.
        – Possible low-level Bluetooth problems.
    - 19 of 84 failures due to incorrect time/date when calendar entry transferred.
    - 17 of 84 failures due to incompatible file formats not recognized by other device.
    - 11 of 84 failures came from a device not being able to detect the other Bluetooth enabled device in order to send a calendar entry.
        – Again this could indicate low-level Bluetooth problems
    - 6 of 84 failures due to PC3's recurring interoperability problems.

- Implications
    - Using the "Summary/Implications" sections from the previous breakdowns, the amount of improvement possible if these modifications are made:
        - 19 by enforcing or adapting a standard calendar form when sending calendar entries
        - 17 if all devices supported the same calendar file format.
        - 6 if recurring interoperability problems solved for PC3.
    - These account for 42 of 84 failures (50%)
    - 79.6% pass rate (164 out of 206) if all these failures corrected.

3.3.3.4 Error data

Table 3.3.3.4-1: Transfer Calendar Entry Error Data

0	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH1	x	0	x	0	0	0	0	0	0	x	0	4	x	x	x	x	0	0	0
HH2	0	x	0	0	0	1	1	6	0	0	1	0	0	x	x	x	x	0	0
HH3	x	0	x	0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
HH4	0	0	0	x	0	3	3	0	2	0	0	0	0	x	0	x	x	x	x
HH5	0	0	x	0	x	x	0	0	0	0	2	0	0	x	0	x	x	x	x
MP1	0	0	x	0	x	x	0	1	0	0	7	x	x	x	0	x	x	x	x
MP2	0	0	x	0	0	0	x	0	0	0	0	0	0	0	x	x	x	x	x
MP3	0	0	x	0	0	0	0	x	0	0	0	0	0	0	x	x	x	x	x
MP4	0	0	x	0	0	0	0	0	x	0	0	0	0	0	0	x	x	x	x
MP5	x	0	x	0	0	0	0	0	0	x	0	1	0	x	x	x	0	0	0
MP6	0	0	x	0	0	0	0	0	0	0	x	0	0	0	0	x	x	x	x
MP7	0	0	x	0	0	x	0	0	0	0	0	x	0	x	x	x	0	0	2
MP8	x	0	x	0	0	x	0	0	0	0	0	0	x	x	x	x	0	0	1
PC1	x	x	x	x	x	x	0	0	0	x	0	x	x	x	0	0	0	0	0
PC2	x	x	x	0	0	0	0	0	0	x	0	x	x	0	x	0	0	0	0
PC3	x	x	x	x	x	x	x	x	x	x	x	x	x	0	0	x	0	0	0
PC4	0	x	x	x	x	x	x	x	x	0	x	0	0	0	0	0	x	0	0
PC5	0	0	x	x	x	x	x	x	x	0	x	0	0	0	0	0	0	x	0
PC6	0	0	x	x	x	x	x	x	x	0	x	0	0	0	0	0	0	0	x

Table 3.3.3.4-2: Transfer Calendar Entry Error Stats

Tested Pairs	206
TC w/ Errors	14
Errors	35
Error Rate	6.8%
Avg. Errors	17.0%
Tested Pairs	206

3.3.4 Test Case: Transfer a Picture

3.3.4.1 Failure Data

Table 3.3.4.1-1: Transfer Picture Data

0	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH1	x	0	x	0	0	0	0	0	0	x	0	0	x	x	x	x	UDB	0	0
HH2	0	x	USF	0	USF	0	0	0	0	0	0	0	0	x	x	x	x	0	0
HH3	x	0	x	0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
HH4	0	0	USF	x	USF	0	0	0	0	0	0	0	0	x	0	x	x	x	x
HH5	0	0	x	0	x	x	0	FS	0	0	FS	0	0	x	0	x	x	x	x
MP1	0	0	x	0	x	x	0	0	0	0	0	x	x	x	0	x	x	x	x
MP2	0	0	x	0	0	0	x	0	0	0	0	0	0	0	UFF	x	x	x	x
MP3	0	0	x	0	0	0	0	x	0	0	0	0	0	0	0	x	x	x	x
MP4	0	0	x	0	0	0	0	0	x	0	0	0	0	0	0	x	x	x	x
MP5	x	0	x	0	x	0	0	0	0	x	0	0	0	x	x	x	0	FS	0
MP6	0	0	x	0	0	0	0	0	0	0	x	0	0	0	0	x	x	x	x
MP7	UC	0	x	0	0	x	0	0	0	0	0	x	0	x	x	x	0	FS	0
MP8	x	0	x	0	0	x	0	0	0	0	0	0	x	x	x	x	0	FS	0
PC1	x	x	x	x	x	x	0	0	0	x	0	x	x	x	0	UDB	UDB	0	0
PC2	x	x	x	0	0	0	0	0	0	x	0	x	x	FS	x	USF	FS	FS	FS
PC3	x	x	x	x	x	x	x	x	x	x	x	x	x	USF	USF	x	UDB	USF	USF
PC4	FS	x	x	x	x	x	x	x	x	0	x	0	0	0	FS	FS	x	0	0
PC5	0	0	x	x	x	x	x	x	x	0	x	0	0	0	0	UDB	0	x	0
PC6	0	0	x	x	x	x	x	x	x	0	x	0	0	0	FS	USF	0	0	x

Table 3.3.4.1-2: Transfer Picture Stats

Potential Pairs	361
Tested Pairs	205
Passed	175
Potential Pairs	361
Tested Pairs	205
Passed	175

3.3.4.2 Failure Breakdown

3.3.4.2.1 Failure Breakdown Table

Table 3.3.4.2-1: Transfer Picture Breakdown

Failure Type	Total	Failure Description
UC	1	"Unable to connect…" error
MBC	0	"Max number of Bluetooth connections…" error
InB	0	"Internal Bluetooth…" error
PNS	0	"Profile not supported…" error
UDB	5	Unable to detect device during Bluetooth Search
PE	0	Pairing Error: "Unable to Pair…"
USF	10	Device pair does not support feature under test.
t&d	0	Transferred calendar times/dates are incorrect
DL	0	Data lost while transferring
FS	13	"Failed sending" error
UFF	1	Unsupported file format
PNI	0	Pairing cannot be initiated from device
All	30	Total number of failures

### 3.3.4.2.2 Failure Breakdown Pie Chart

Breakdown for Transfering a Picture
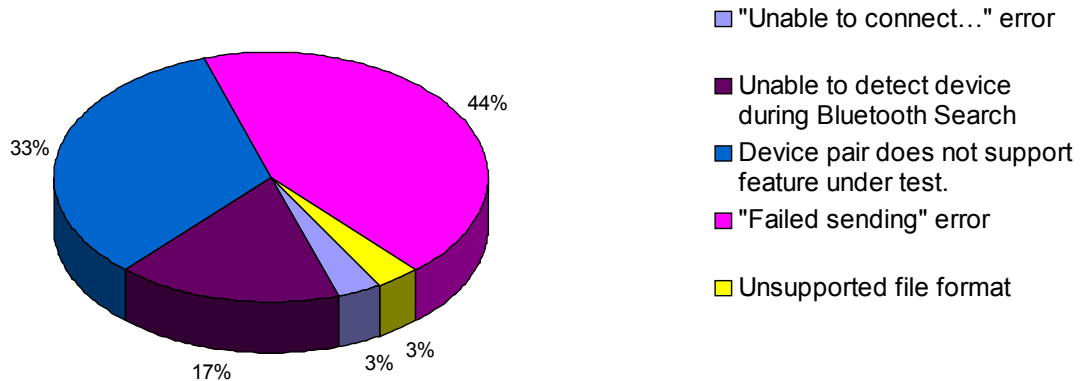
Figure 3.3.4.2-1: Transfer Picture Breakdown

3.3.4.3 Summary/Implications

- Summary
  - Pass rate of 85.4% (175 of 205).
  - 13 of 30 failures due to "Failed Sending" error; this signifies that the operation was able to be initiated, but the file never finished sending and was never received.
    - Possible low-level Bluetooth problems.
  - 6 of 30 failures due to recurring interoperability problems with PC3.
  - 4 of 30 failures are due to trend with HH2 and HH4 being bad senders and HH3 and HH5 being bad receivers.
  - 5 of 30 failures came from a device not being able to detect the other Bluetooth enabled device in order to send a picture file.
    - Again, this could indicate low-level Bluetooth problems.
- Implications
  - Using the "Summary/Implications" sections from the previous breakdowns the amount of improvement (failures that could be corrected) can be tracked if these modifications are made.
    - 6 if recurring problems with PC3 were eliminated.
    - 4 if HH2 and HH4 implement file browsers allowing you to send picture files like those of other handhelds.
  - These account for 10 of 30 failures (33.3%)
  - 90.2% pass rate (185 out of 205) if all these failures corrected.

3.3.4.4 Error data

Table 3.3.4.4-1: Transfer Picture Error Data

0	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH1	x	0	x	0	1	0	1	0	1	x	0	0	x	x	x	x	0	0	0
HH2	4	x	0	1	0	1	1	0	0	0	2	0	0	x	x	x	x	0	0
HH3	x	0	x	0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
HH4	0	0	0	x	0	1	0	2	0	0	5	0	0	x	1	x	x	x	x
HH5	0	0	x	0	x	x	0	0	0	0	0	0	2	x	0	x	x	x	x
MP1	0	0	x	0	x	x	0	0	0	0	0	x	x	x	1	x	x	x	x
MP2	0	0	x	0	0	0	x	0	0	0	0	0	0	0	0	x	x	x	x
MP3	0	0	x	0	0	0	0	x	0	0	1	0	0	0	0	x	x	x	x
MP4	0	0	x	0	0	0	0	0	x	0	0	0	0	0	0	x	x	x	x
MP5	x	0	x	0	x	0	0	0	0	x	0	1	0	x	x	x	0	0	0
MP6	0	0	x	0	0	0	0	0	0	0	x	0	0	0	0	x	x	x	x
MP7	0	0	x	0	0	x	0	0	0	0	1	x	0	x	x	x	0	0	0
MP8	x	0	x	0	0	x	0	0	0	0	0	0	x	x	x	x	0	0	0
PC1	x	x	x	x	x	x	0	0	0	x	0	x	x	x	0	0	0	0	0
PC2	x	x	x	0	0	0	0	0	0	x	0	x	x	0	x	0	0	0	0
PC3	x	x	x	x	x	x	x	x	x	x	x	x	x	0	0	x	0	0	0
PC4	0	x	x	x	x	x	x	x	x	0	x	0	0	0	0	0	x	0	0
PC5	0	0	x	x	x	x	x	x	x	0	x	0	0	0	0	0	0	x	0
PC6	0	0	x	x	x	x	x	x	x	0	x	0	0	0	0	0	0	0	x

Table 3.3.4.4-2: Transfer Picture Error Stats

Tested Pairs	205
TC w/ Errors	17
Errors	27
Error Rate	8.29%
Avg. Errors	13.2%
Tested Pairs	205

Note that error correlation is only modest.

3.3.5 Test Case: Dialup Networking

3.3.5.1 Failure Data

Table 3.3.5.1-1: DUN Data

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH1	0	0	0	0	0		UC	0	x
HH2	x	0	0	0	0		0	0	0
HH3	x	x	x	x	x		x	x	x
HH4	x	0	0	0	0		0	0	0
HH5	x	x	0	0	0		0	0	0
MP1	x	x	USF	USF	USF		USF	x	x
PC1	x	x	UC	UC	UC		UC	x	x
PC2	x	0	FS	0	0		0	x	x
PC3	x	x	x	x	x		x	x	x
PC4	x	x	x	x	x		x	UC	UC
PC5	x	x	x	x	x		x	0	0
PC6	x	x	x	x	x		x	0	0

Table 3.3.5.1-2: DUN Stats

Potential Pairs	96
Tested Pairs	46
Passed	34
Failed	12
Pass Rate	73.9%
Completion Rate	47.9%

3.3.5.2 Failure Breakdown

3.3.5.2.1 Failure Breakdown Table

Table 3.3.5.2-1: DUN Breakdown

Failure Type	Total	Failure Description
UC	7	"Unable to connect…" error
MBC	0	"Max number of Bluetooth connections…" error
InB	0	"Internal Bluetooth…" error
PNS	0	"Profile not supported…" error
UDB	0	Unable to detect device during Bluetooth Search
PE	0	Pairing Error: "Unable to Pair…"
USF	4	Device pair does not support feature under test.
t&d	0	Transferred calendar times/dates are incorrect
DL	0	Data lost while transferring
FS	1	"Failed sending" error
UFF	0	Unsupported file format
PNI	0	Pairing cannot be initiated from device
All	12	Total number of failures

3.3.5.2.2 Failure Breakdown Pie Chart

Failure Breakdown for Dial-up Networking
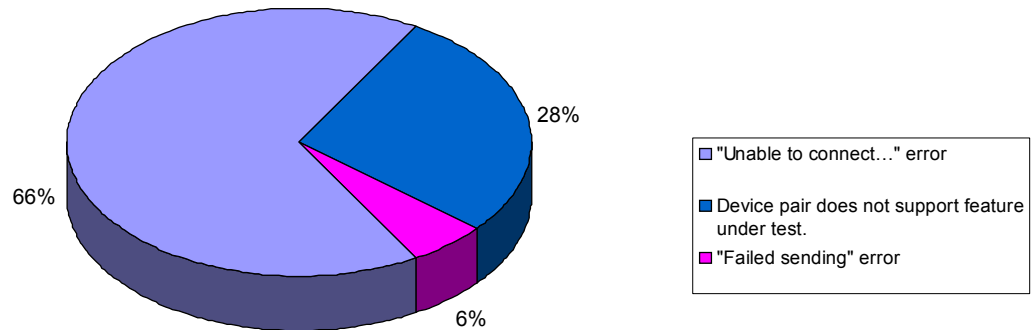
Figure 3.3.5.2-1: DUN Breakdown

3.3.5.3 Summary/Implications

- Summary
    - Pass rate of 73.9% (34 of 46)
    - 4 of 12 failures are due to MP1 (a dual device) not supporting dialup networking through Bluetooth.
    - 4 of 12 failures come from PC1 "Unable to connect" permanent errors.
- Implications
    - 4 failures could be corrected raising the pass rate to 82.6% (38 of 46) if this test case was not applied to MP1 because of the uncertainty pertaining to it applicability or if MP1 was able to initiate and support dialup networking through Bluetooth.
    - 4 failures if interoperability problems with PC1 are corrected. This would raise the pass rate to 91.3% (42 of 46).

3.3.5.4 Error data

Table 3.3.5.4-1: DUN Error Data

	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8
HH1	0	0	0	0	0		0	0	x
HH2	x	0	0	0	1		4	0	0
HH3	x	x	x	x	x		x	x	x
HH4	x	0	1	0	0		0	0	0
HH5	x	x	0	0	0		0	0	0
MP1	x	x	0	0	0		0	x	x
PC1	x	x	1	0	0		0	x	x
PC2	x	5	0	0	0		0	x	x
PC3	x	x	x	x	x		x	x	x
PC4	x	x	x	x	x		x	0	0
PC5	x	x	x	x	x		x	0	0
PC6	x	x	x	x	x		x	0	0

Table 3.3.5.4-2: DUN Error Stats

Tested Pairs	52
TC w/ Errors	5
Errors	12
Error Rate	9.62%
Avg. Errors	23.1%
Tested Pairs	52

3.3.6 Test Case: Transfer of Recorded Audio

3.3.6.1 Failure Data

Table 3.3.6.1-1: Transfer Recorded Audio Data

0	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH1	x	0	x	0	0	FS	UFF	UFF	0	x	USF	0	x	x	x	x	UDB	0	0
HH2	0	x	USF	0	USF	0	UFF	UFF	0	0	UFF	0	0	x	x	x	x	0	0
HH3	x	UFF	x	UFF	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
HH4	0	0	USF	x	USF	0	UFF	UFF	0	0	UFF	0	0	x	UFF	x	x	x	x
HH5	0	0	x	0	x	x	UFF	0	0	0	0	0	0	x	0	x	x	x	x
MP1	0	0	x	0	x	x	UFF	FS	0	0	FS	x	x	x	0	x	x	x	x
MP2	UFF	UFF	x	UFF	UFF	UFF	x	FS	UFF	UFF	FS	UFF	UFF	UFF	FS	x	x	x	x
MP3	FS	FS	x	UFF	UFF	0	0	x	0	0	0	0	0	0	0	x	x	x	x
MP4	UFF	UFF	x	UFF	UFF	0	0	0	x	0	0	0	0	0	0	x	x	x	x
MP5	x	UFF	x	UFF	UFF	0	0	0	0	x	0	0	0	x	x	x	0	FS	0
MP6	0	UFF	x	FS	UFF	0	0	0	0	0	x	0	0	0	0	x	x	x	x
MP7	UC	UFF	x	UFF	UFF	x	0	0	0	0	0	x	0	x	x	x	0	FS	0
MP8	x	UFF	x	UFF	UFF	x	0	0	0	0	0	0	x	x	x	x	0	FS	UFF
PC1	x	x	x	x	x	x	UFF	UFF	0	x	UFF	x	x	x	0	UDB	0	0	0
PC2	x	x	x	USF	0	0	0	0	0	x	0	x	x	FS	x	USF	FS	FS	FS
PC3	x	x	x	x	x	x	x	x	x	x	x	x	USF	USF	x	UDB	USF	USF	
PC4	FS	x	x	x	x	x	x	x	x	0	x	0	0	0	FS	FS	x	0	0
PC5	0	0	x	x	x	x	x	x	x	0	x	0	0	0	0	UDB	0	x	0
PC6	0	0	x	x	x	x	x	x	x	0	x	0	UFF	0	0	FS	0	0	x

Table 3.3.6.1-2: Transfer Recorded Audio Stats

Potential Pairs	361
Tested Pairs	206
Passed	125
Failed	81
Pass Rate	60.7%
Completion Rate	57.1%

3.3.6.2 Failure Breakdown

3.3.6.2.1 Failure Breakdown Table

Table 3.3.6.2-1: Transfer Recorded Audio Breakdown

Failure Type	Total	Failure Description
UC	1	"Unable to connect…" error
MBC	0	"Max number of Bluetooth connections…" error
InB	0	"Internal Bluetooth…" error
PNS	0	"Profile not supported…" error
UDB	4	Unable to detect device during Bluetooth Search
PE	0	Pairing Error: "Unable to Pair…"
USF	11	Device pair does not support feature under test.
t&d	0	Transferred calendar times/dates are incorrect
DL	0	Data lost while transferring
FS	20	"Failed sending" error
UFF	45	Unsupported file format
PNI	0	Pairing cannot be initiated from device
All	81	Total number of failures

## 3.3.6.2.2 Failure Breakdown Pie Chart

Failure Breakdown for Transfering an Audio Recording
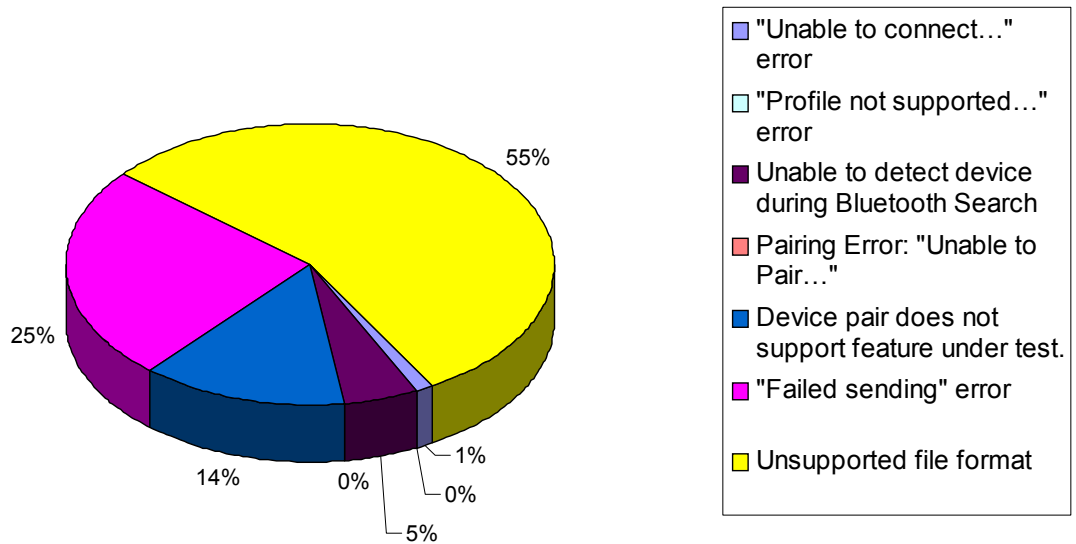
Figure 3.3.6.2-1: Transfer Recorded Audio Breakdown

3.3.6.3 Summary/Implications

- Summary
    - Pass rate of 60.7% (125 of 206).
    - 45 of 81 failures due to unsupported file formats.
    - 20 of 81 failures due to "Failed Sending" error; this signifies that the operation was able to be initiated, but the file never finished sending and/or was never received.
        - Possible low-level Bluetooth problems.
    - 11 of 81 failures due to unsupported feature.
        - 6 of these 11 failures due to recurring interoperability problems with PC3.
        - 4 of these 11 failures are due to trend with HH2 and HH4 being bad senders and HH3 and HH5 being bad receivers.
- Implications
    - Using the "Summary/Implications" sections from the previous breakdowns the amount of improvement (failures that could be corrected) can be tracked if these modifications are made.
        - 45 if all devices supported the same audio file format.
        - 6 if recurring interoperability problems with PC3 are corrected.
        - 4 if HH2 and HH4 implement file browsers allowing you to recorded audio files like those of other handhelds.
    - These account for 55 of 81 failures (67.9%)
    - 87.4% pass rate (180 out of 206) if all these failures corrected.

3.3.6.4 Error data

Table 3.3.6.4-1: Transfer Recorded Audio Error Data

0	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH1	x	0	x	0	1	1	1	1	1	x	0	7	x	x	x	x	0	0	0
HH2	2	x	0	0	0	1	0	0	1	0	0	0	0	x	x	x	x	0	0
HH3	x	0	x	0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
HH4	0	0	0	x	0	0	0	5	0	0	0	0	0	x	0	x	x	x	x
HH5	0	2	x	0	x	x	1	0	0	0	0	0	0	x	0	x	x	x	x
MP1	0	0	x	0	x	x	0	0	0	0	0	x	x	x	0	x	x	x	x
MP2	0	0	x	0	0	0	x	1	0	0	0	0	0	0	0	x	x	x	x
MP3	0	0	x	0	0	0	0	x	0	0	0	0	0	0	0	x	x	x	x
MP4	0	0	x	0	0	0	0	0	x	0	0	0	0	0	0	x	x	x	x
MP5	x	0	x	0	0	0	0	2	0	x	0	0	0	x	x	x	0	0	0
MP6	0	0	x	0	0	0	0	0	1	0	x	0	0	0	0	x	x	x	x
MP7	0	0	x	0	0	x	0	0	0	0	1	x	0	x	x	x	0	0	1
MP8	x	0	x	0	0	x	0	0	0	0	0	0	x	x	x	x	0	0	0
PC1	x	x	x	x	x	x	0	0	0	x	0	x	x	x	0	0	0	0	0
PC2	x	x	x	0	0	0	0	0	0	x	0	x	x	0	x	0	0	0	0
PC3	x	x	x	x	x	x	x	x	x	x	x	x	x	0	0	x	0	0	0
PC4	0	x	x	x	x	x	x	x	x	0	x	0	0	0	0	0	x	0	0
PC5	0	0	x	x	x	x	x	x	x	0	x	0	0	0	0	0	0	x	0
PC6	0	0	x	x	x	x	x	x	x	0	x	0	0	0	0	0	0	0	x

Table 3.3.6.4-2: Transfer Recorded Audio Error Stats

Tested Pairs	206
TC w/ Errors	17
Errors	30
Error Rate	8.25%
Avg. Errors	14.6%
Tested Pairs	206

3.3.7 Test Case: FAX test

3.3.7.1 Failure Data

Table 3.3.7.1-1: FAX Data

0	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH1					USF	USF	USF	USF	USF	x	USF	USF	x						
HH2					x	USF	USF	USF	USF	USF	USF	USF	USF						
HH3					x	x	x	x	x	x	x	x	x						
HH4					x	USF	USF	USF	USF	USF	USF	USF	USF						
HH5	USF	x	x	x	x	x	USF	USF	USF	USF	USF	USF	USF	x	x	x	x	x	x
MP1	USF	USF	x	USF	x	x	USF	USF	USF	x	USF	x	x	x	USF	x	x	x	x
MP2	USF	USF	x	USF	USF	USF								FS	USF	x	x	x	x
MP3	USF	USF	x	USF	USF	USF								USF	USF	x	x	x	x
MP4	USF	USF	x	USF	USF	USF								FS	USF	x	x	x	x
MP5	x	USF	x	USF	USF	x								x	x	x	USF	FS	USF
MP6	USF	USF	x	USF	USF	USF								USF	USF	x	x	x	x
MP7	USF	USF	x	USF	USF	x								x	x	x	USF	FS	FS
MP8	x	USF	x	USF	USF	x								x	x	x	USF	USF	FS
PC1					x	x	FS	USF	FS	x	USF	x	x						
PC2					x	USF	USF	USF	USF	x	USF	x	x						
PC3					x	x	x	x	x	x	x	x	x						
PC4					x	x	x	x	x	USF	x	USF	USF						
PC5					x	x	x	x	x	UC	x	FS	USF						
PC6					x	x	x	x	x	USF	x	UC	FS						

Table 3.3.7.1-2: FAX Stats

Potential Pairs	212
Tested Pairs	104
Passed	0
Failed	104
Pass Rate	0%
Completion Rate	49.1%

3.3.7.2 Failure Breakdown

3.3.7.2.1 Failure Breakdown Table

Table 3.3.7.2-1: FAX Breakdown

Failure Type	Total	Failure Description
UC	2	"Unable to connect…" error
MBC	0	"Max number of Bluetooth connections…" error
InB	0	"Internal Bluetooth…" error
PNS	0	"Profile not supported…" error
UDB	0	Unable to detect device during Bluetooth Search
PE	0	Pairing Error: "Unable to Pair…"
USF	92	Device pair does not support feature under test.
t&d	0	Transferred calendar times/dates are incorrect
DL	0	Data lost while transferring
FS	10	"Failed sending" error
UFF	0	Unsupported file format
PNI	0	Pairing cannot be initiated from device
All	104	Total number of failures

3.3.7.2.2 <u>Failure Breakdown Pie Chart</u>

Breakdown for Sending a FAX
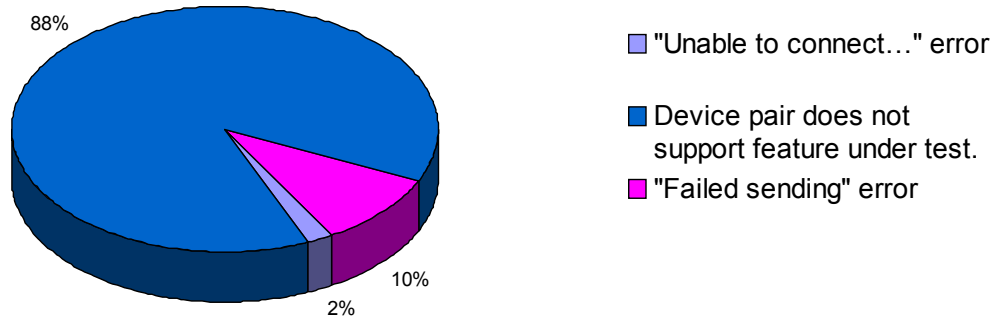
Figure 3.3.7.2-1: FAX Breakdown

3.3.7.3 Summary/Implications

- Summary
    - Pass rate of 0% (0 of 104)
    - 86 of 104 failures are because mobile phones and handhelds are not did not provide a user-interface to initialize a FAX.
    - More extensive testing need to be done in this area.
    - Should FAX be a test case? How important and useful is it?
- Implications
    - If mobile phones and handhelds are able to initiate and support a FAX and the FAX profile then a possible 86 failures could be corrected raising the pass rate to 82.7% (86 of 104).

3.3.7.4 Error data

Table 3.3.7.4-1: FAX Error Data

0	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	PC1	PC2	PC3	PC4	PC5	PC6
HH1					0	0	0	0	0	x	0	0	x						
HH2					x	0	0	0	0	0	0	0	0						
HH3					x	x	x	x	x	x	x	x	x						
HH4					x	0	0	0	0	0	0	0	0						
HH5	0	x	x	x	x	x	0	0	0	0	0	0	0	x	x	x	x	x	x
MP1	0	0	x	0	x	x	0	0	0	x	0	x	x	x	0	x	x	x	x
MP2	0	0	x	0	0	0								0	0	x	x	x	x
MP3	0	0	x	0	0	0								0	0	x	x	x	x
MP4	0	0	x	0	0	0								0	0	x	x	x	x
MP5	x	0	x	0	0	x								x	x	x	0	0	0
MP6	0	0	x	0	0	0								0	0	x	x	x	x
MP7	0	0	x	0	0	x								x	x	x	0	0	5
MP8	x	0	x	0	0	x								x	x	x	0	0	0
PC1					x	x	0	0	0	x	0	x	x						
PC2					x	0	0	0	0	x	0	x	x						
PC3					x	x	x	x	x	x	x	x	x						
PC4					x	x	x	x	x	0	x	0	0						
PC5					x	x	x	x	x	0	x	0	0						
PC6					x	x	x	x	x	0	x	0	0						

Table 3.3.7.4-2: FAX Error Stats

Tested Pairs	104
TC w/ Errors	1
Errors	5
Error Rate	0.96%
Avg. Errors	4.81%
Tested Pairs	104

3.3.8 Test Case: Synchronization

3.3.8.1 Failure Data

Table 3.3.8.1-1: Synchronization Data

	PC1	PC2	PC3	PC4	PC5	PC6
HH1	x	x	x	USF	USF	USF
HH2	x	x	x	x	USF	USF
HH3	x	x	x	x	x	x
HH4	x	USF	x	x	x	x
HH5	x	USF	x	x	x	x
MP1	x	USF	x	x	x	x
MP2	0	USF	x	x	x	x
MP3	0	DL	x	x	x	x
MP4	USF	0	x	x	x	x
MP5	x	x	x	USF	USF	USF
MP6	0	FS	x	x	x	x
MP7	x	x	x	USF	USF	USF
MP8	x	x	x	USF	USF	USF
PC1	x	USF	USF	USF	USF	0
PC2	USF	x	USF	USF	USF	USF
PC3	USF	USF	x	USF	USF	USF
PC4	USF	USF	USF	x	USF	USF
PC5	USF	USF	USF	USF	x	FS
PC6	0	USF	USF	USF	USF	x

Table 3.3.8.1-2: Synchronization Stats

Potential Pairs	114
Tested Pairs	55
Passed	6
Failed	49
Pass Rate	10.9%
Completion Rate	48.3%

3.3.8.2 Failure Breakdown

3.3.8.2.1 Failure Breakdown Table

Table 3.3.8.2-1: Synchronization Breakdown

Failure Type	Total	Failure Description
UC	0	"Unable to connect…" error
MBC	0	"Max number of Bluetooth connections…" error
InB	0	"Internal Bluetooth…" error
PNS	0	"Profile not supported…" error
UDB	0	Unable to detect device during Bluetooth Search
PE	0	Pairing Error: "Unable to Pair…"
USF	46	Device pair does not support feature under test.
t&d	0	Transferred calendar times/dates are incorrect
DL	1	Data lost while transferring
FS	2	"Failed sending" error
UFF	0	Unsupported file format
PNI	0	Pairing cannot be initiated from device
All	49	Total number of failures

3.3.8.2.2 Failure Breakdown Pie Chart

Failure Breakdown for Synchronization Test Case
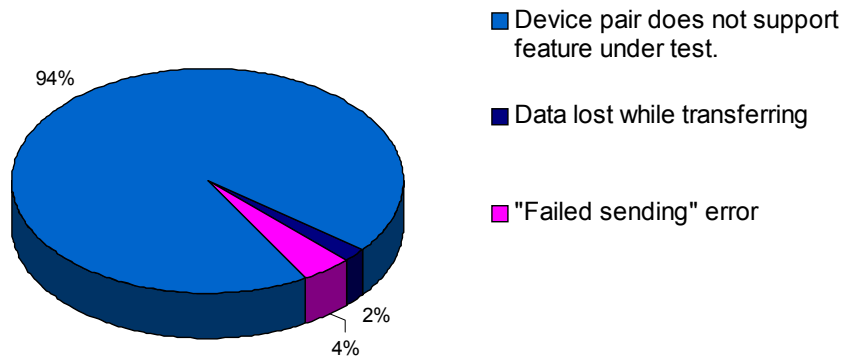
Figure 3.3.8.2-1: Synchronization Breakdown

3.3.8.3 Summary/Implications

- Summary
  - Pass rate of 10.9% (6 of 55)
  - More extensive testing needs to be done in this area.
  - 46 of 49 failures are from device pair does not support feature under test.
- Implications
  - 46 of 49 failures may be able to be corrected raising the pass rate to 94.5% if all devices (MP, HH, and PC) could initialize and support the synchronization process through Bluetooth.

3.3.8.4 Error data

No errors were observed with this test case.

3.3.9 Mobile Phone – Headset Test Suite

3.3.9.1 Test Case: Call from Mobile Phone

3.3.9.1.1 <u>Failure Data</u>

Table 3.3.9.1-1: Call from MP Data

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH5	0	0	0	0	0	0	0	0	0	0	0
MP1	0	0	0	0	0	0	0	0	0	0	0
MP2	0	0	0	0	0	0	0	0	0	0	0
MP3	0	0	0	0	0	0	0	0	0	0	0
MP4	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0
MP5											
MP6	0	0	0	0	0	0	0	0	0	0	0
MP7	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0
MP8	0	UC	UC	UC	UC	UC	UC	0	0	0	0

Table 3.3.9.1-2: Call from MP Stats

Potential Pairs	88
Tested Pairs	88
Passed	70
Failed	18
Pass Rate	79.6%
Completion Rate	100%

Note that all failures are due to some headsets implementing only the headset profile and mobile phones implementing only the handsfree profile.

3.3.9.1.2 Failure Breakdown

3.3.9.1.2.1 Failure Breakdown Table

Table 3.3.9.1-3: Call from MP Breakdown

Failure Type	Total	Failure Description
UC	6	"Unable to connect…" error
MBC	0	"Max number of Bluetooth connections…" error
InB	0	"Internal Bluetooth…" error
PNS	12	"Profile not supported…" error
UDB	0	Unable to detect device during Bluetooth Search
PE	0	Pairing Error: "Unable to Pair…"
USF	0	Device pair does not support feature under test.
t&d	0	Transferred calendar times/dates are incorrect
DL	0	Data lost while transferring
FS	0	"Failed sending" error
UFF	0	Unsupported file format
PNI	0	Pairing cannot be initiated from device
All	18	Total number of failures

3.3.9.1.2.2 Failure Breakdown Pie Chart

Breakdown for: Initiate Call from Mobile Phone and Talk through Headset

67%

■ "Unable to connect…" error

□ "Profile not supported…" error

33%
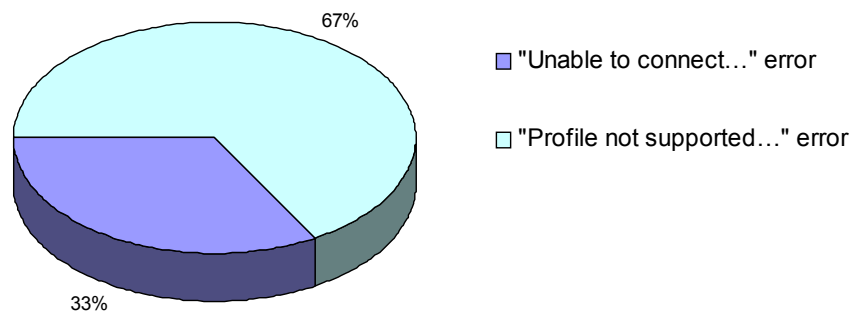
Figure 3.3.9.1-1: Call from MP Breakdown

3.3.9.1.3 Error data

Table 3.3.9.1-4: Call from MP Error Data

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH5	0	0	0	0	0	0	0	0	0	0	0
MP1	0	1	0	1	0	1	2	0	0	1	0
MP2	0	0	0	0	0	0	0	0	0	0	0
MP3	0	0	0	0	3	0	0	0	0	0	0
MP4	0	0	0	0	0	0	0	0	0	1	0
MP5											
MP6	0	0	0	0	0	0	0	0	0	0	1
MP7	0	0	0	1	0	0	0	1	0	1	1
MP8	0	0	0	0	0	0	0	0	1	0	1

Table 3.3.9.1-5: Call from MP Error Stats

Tested Pairs	88
TC w/ Errors	14
Errors	17
Error Rate	15.9%
Avg. Errors	19.3%
Tested Pairs	88

3.3.9.2 Test Case: Call from Headset

3.3.9.2.1 Failure Data

Table 3.3.9.2-1: Call from HS Data

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH5	USF	USF	USF	USF	USF	USF	USF	USF	USF	USF	USF
MP1	0	0	0	0	0	0	0	0	0	0	0
MP2	0	0	0	0	0	0	0	0	0	0	0
MP3	0	0	0	0	0	0	0	0	0	0	0
MP4	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0
MP5											
MP6	0	0	0	0	0	0	0	0	0	0	0
MP7	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0
MP8	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0

Note:
- HH5 does not support voice tags
- All failures come from some headsets implementing only the headset profile and some mobile phones implementing only the handsfree profile.

3.3.9.2.2 Failure Breakdown

3.3.9.2.2.1 Failure Breakdown Table

Table 3.3.9.2-2: Call from HS Breakdown

Failure Type	Total	Failure Description
UC	0	"Unable to connect…" error
MBC	0	"Max number of Bluetooth connections…" error
InB	0	"Internal Bluetooth…" error
PNS	18	"Profile not supported…" error
UDB	0	Unable to detect device during Bluetooth Search
PE	0	Pairing Error: "Unable to Pair…"
USF	11	Device pair does not support feature under test.
t&d	0	Transferred calendar times/dates are incorrect
DL	0	Data lost while transferring
FS	0	"Failed sending" error
UFF	0	Unsupported file format
PNI	0	Pairing cannot be initiated from device
All	29	Total number of failures

3.3.9.2.2.2 Failure Breakdown Pie Chart

Breakdown for: Initiate Call with Headset and Talk through Headset
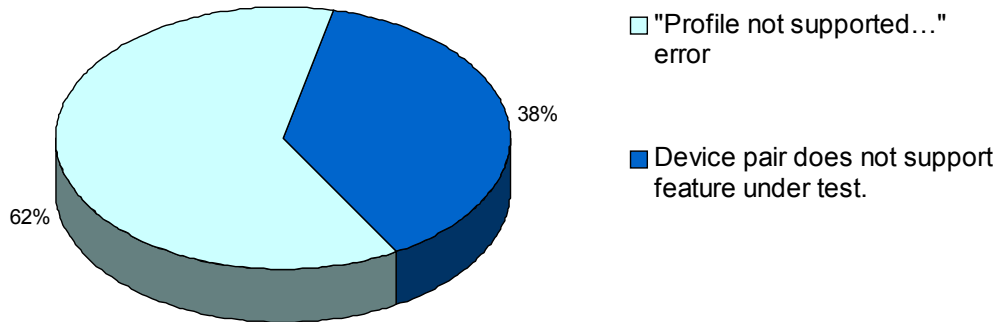
Figure 3.3.9.2-1: Call from HS Breakdown

3.3.9.2.3 Error data

Table 3.3.9.2-3: Call from HS Error Data

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH5	0	0	1	0	0	0	0	0	0	0	0
MP1	1	0	0	5	0	1	0	0	0	0	0
MP2	0	0	0	0	0	0	0	0	0	0	0
MP3	0	0	0	0	1	0	0	0	0	0	0
MP4	0	0	0	0	0	0	0	6	0	0	0
MP5											
MP6	1	0	0	0	1	0	0	0	0	0	0
MP7	1	0	0	0	0	0	0	0	2	0	1
MP8	0	0	0	0	0	0	0	0	1	0	0

Table 3.3.9.2-4: Call from HS Error Stats

Tested Pairs	88
TC w/ Errors	12
Errors	22
Error Rate	13.6%

Avg. Errors   25%

Tested Pairs   88

3.3.9.3 Test Case: Receive Call with Mobile Phone

3.3.9.3.1 Failure Data

Table 3.3.9.3-1: Receive from MP Data

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH5	0	0	USF	0	0	0	0	0	0	0	0
MP1	0	0	0	0	0	0	0	0	0	0	0
MP2	0	0	0	0	0	0	0	0	0	0	0
MP3	0	0	0	0	0	0	0	0	0	0	0
MP4	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0
MP5											
MP6	0	0	0	0	0	0	0	0	0	0	0
MP7	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0
MP8	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0

Table 3.3.9.3-2: Receive from MP Stats

Potential Pairs	88
Tested Pairs	88
Passed	69
Failed	19
Pass Rate	78.4%
Completion Rate	100%

Note that 18 of 19 failures come from some headsets implementing only the headset profile and some mobile phones implementing only the handsfree profile.

3.3.9.3.2 Failure Breakdown

3.3.9.3.2.1 Failure Breakdown Table

Table 3.3.9.3-3: Receive from MP Breakdown

Failure Type	Total	Failure Description
UC	0	"Unable to connect…" error
MBC	0	"Max number of Bluetooth connections…" error
InB	0	"Internal Bluetooth…" error
PNS	18	"Profile not supported…" error
UDB	0	Unable to detect device during Bluetooth Search
PE	0	Pairing Error: "Unable to Pair…"
USF	1	Device pair does not support feature under test.
t&d	0	Transferred calendar times/dates are incorrect
DL	0	Data lost while transferring
FS	0	"Failed sending" error
UFF	0	Unsupported file format
PNI	0	Pairing cannot be initiated from device
All	19	Total number of failures

3.3.9.3.2.2 Failure Breakdown Pie Chart

Breakdown for: Receive Call with Mobile Phone and Talk through Headset
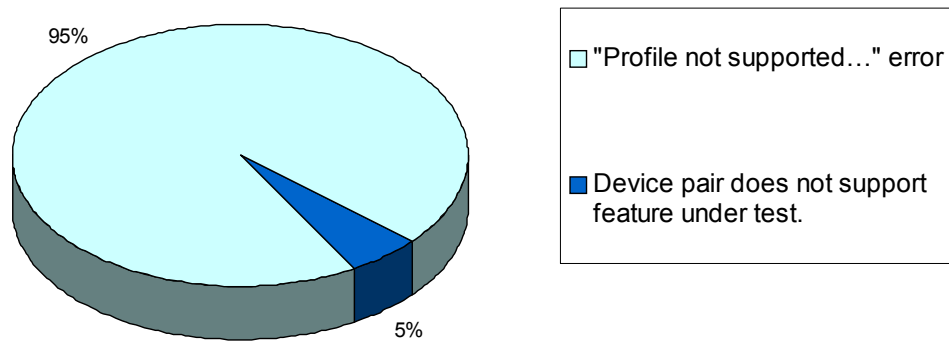
Figure 3.3.9.3-1: Receive from MP Breakdown

3.3.9.3.3 Error data

Table 3.3.9.3-4: Receive from MP Error Data

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH5	0	0	0	0	0	0	0	0	0	0	3
MP1	0	0	0	0	0	2	0	1	0	1	0
MP2	0	0	0	0	0	0	0	0	0	0	0
MP3	0	0	0	0	0	0	0	0	0	0	0
MP4	0	0	0	0	0	0	0	1	2	1	0
MP5											
MP6	0	0	0	0	0	0	0	0	0	0	0
MP7	1	0	0	0	0	0	0	0	1	0	0
MP8	0	0	0	0	0	0	0	2	0	0	0

Table 3.3.9.3-5: Receive from MP Error Stats

Tested Pairs	88
TC w/ Errors	10
Errors	15
Error Rate	11.4%
Avg. Errors	17.1%
Tested Pairs	88

3.3.9.4 Test Case: Receive Call with Headset

3.3.9.4.1 Failure Data

Table 3.3.9.4-1: Receive with HS Data

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH5	0	0	USF	0	0	0	0	0	0	0	0
MP1	0	0	0	0	0	0	0	0	0	0	0
MP2	0	0	0	0	0	0	0	0	0	0	0
MP3	0	0	0	0	0	0	0	0	0	0	0
MP4	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0
MP5											
MP6	0	0	0	0	0	0	0	0	0	0	0
MP7	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0
MP8	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0

Table 3.3.9.4-2: Receive with HS Stats

Potential Pairs	88
Tested Pairs	88
Passed	69
Failed	19
Pass Rate	78.4%
Completion Rate	100%

Note that 18 of 19 failures come from some headsets implementing only the headset profile and some mobile phones implementing only the handsfree profile.

3.3.9.4.2 Failure Breakdown

3.3.9.4.2.1 Failure Breakdown Table

Table 3.3.9.4-3: Receive with HS Breakdown

Failure Type	Total	Failure Description
UC	0	"Unable to connect…" error
MBC	0	"Max number of Bluetooth connections…" error
InB	0	"Internal Bluetooth…" error
PNS	18	"Profile not supported…" error
UDB	0	Unable to detect device during Bluetooth Search
PE	0	Pairing Error: "Unable to Pair…"
USF	1	Device pair does not support feature under test.
t&d	0	Transferred calendar times/dates are incorrect
DL	0	Data lost while transferring
FS	0	"Failed sending" error
UFF	0	Unsupported file format
PNI	0	Pairing cannot be initiated from device
All	19	Total number of failures

3.3.9.4.2.2 Failure Breakdown Pie Chart

**Breakdown for: Receive Call with Headset and Talk through Headset**

95%

☐ "Profile not supported…" error

■ Device pair does not support feature under test.

5%
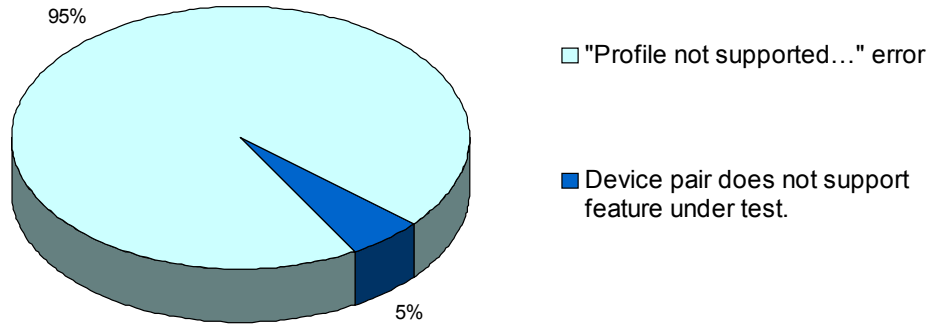
Figure 3.3.9.4-1: Receive with HS Breakdown

3.3.9.4.3 Error data

Table 3.3.9.4-4: Receive with HS Error Data

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH5	0	0	1	0	0	0	0	0	0	0	3
MP1	0	0	0	1	0	0	0	0	0	0	0
MP2	0	0	0	0	0	0	0	0	0	0	0
MP3	0	0	2	0	1	0	0	0	0	0	0
MP4	0	0	0	0	0	0	0	0	1	0	0
MP5											
MP6	0	0	0	0	0	0	2	0	1	0	0
MP7	0	0	0	0	0	0	0	0	1	0	0
MP8	0	0	0	0	0	0	0	1	0	0	0

Table 3.3.9.4-5: Receive with HS Error Stats

Tested Pairs　88

TC w/ Errors　10

Errors　14

Error Rate   11.4%

Avg. Errors   15.9%

Tested Pairs   88

3.3.9.5 Test Case: Transfer Call

3.3.9.5.1 Failure Data

Table 3.3.9.5-1: Transfer Call Data

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH5	0	0	USF	0	0	0	0	0	0	0	0
MP1	0	0	0	0	0	0	0	0	0	0	0
MP2	0	0	0	0	0	0	0	0	0	0	0
MP3	0	0	0	0	0	0	0	0	0	0	0
MP4	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0
MP5											
MP6	0	0	0	0	0	0	0	0	0	0	0
MP7	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	0
MP8	0	PNS	PNS	PNS	PNS	PNS	PNS	0	0	0	USF

Table 3.3.9.5-2: Transfer Call Stats

Potential Pairs   88

Tested Pairs   88

Passed   68

Failed   20

Pass Rate   77.3%

Completion Rate   100%

Note that 18 of 20 failures come from some headsets implementing only the headset profile and some mobile phones implementing only the handsfree profile.

3.3.9.5.2 Failure Breakdown

3.3.9.5.2.1 Failure Breakdown Table

Table 3.3.9.5-3: Transfer Call Breakdown

Failure Type	Total	Failure Description
UC	0	"Unable to connect…" error
MBC	0	"Max number of Bluetooth connections…" error
InB	0	"Internal Bluetooth…" error
PNS	18	"Profile not supported…" error
UDB	0	Unable to detect device during Bluetooth Search
PE	0	Pairing Error: "Unable to Pair…"
USF	2	Device pair does not support feature under test.
t&d	0	Transferred calendar times/dates are incorrect
DL	0	Data lost while transferring
FS	0	"Failed sending" error
UFF	0	Unsupported file format
PNI	0	Pairing cannot be initiated from device
All	20	Total number of failures

3.3.9.5.2.2 Failure Breakdown Pie Chart

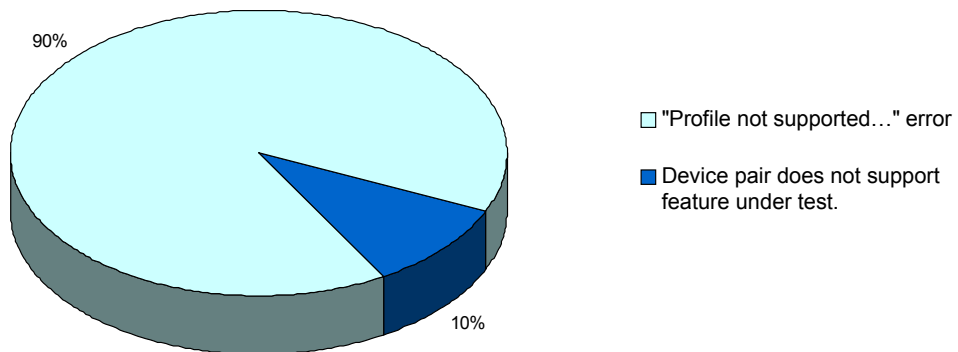**Breakdown for: Transfering Audio from a Call between Mobile Phone and Headset**

90%

10%

☐ "Profile not supported…" error

■ Device pair does not support feature under test.

Figure 3.3.9.5-1: Transfer Call Breakdown

3.3.9.5.3 Error data

Table 3.3.9.5-4: Transfer Picture Error Data

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH5	0	0	0	0	0	0	0	0	0	0	0
MP1	0	0	0	0	0	0	0	0	0	0	0
MP2	0	0	0	0	1	0	0	0	0	0	0
MP3	0	0	0	0	0	1	0	0	1	1	0
MP4	0	0	0	0	0	0	0	0	0	1	0
MP5											
MP6	0	0	0	0	0	0	1	0	0	0	0
MP7	1	0	0	0	0	0	0	1	1	0	1
MP8	0	0	0	0	0	0	0	1	1	0	0

Table 3.3.9.5-5: Transfer Picture Error Stats

Tested Pairs	88
TC w/ Errors	12
Errors	12
Error Rate	13.6%
Avg. Errors	13.6%
Tested Pairs	88

3.3.9.6 Mobile Phone – Headset Test Suite: Summary/Implications

- Summary
    - Overall Pass rate of 335 of 462 or 72.51%
    - 84 of 127 "Profile not supported" permanent error.
    - 11 of 127 due to HH5 not supporting voice tags.
- Implications
    - Using the "Summary/Implications" sections from the previous breakdowns the amount of improvement (failures that could be corrected) can be tracked if these modifications are made.
        - 84 if headsets and mobile phones adapted the same profile.
        - 11 if HH5 supported voice tags and voice dialing.
        - These account for 95 of 127 failures (74.8%).
    - 93.1% pass rate (430 out of 462) if all these failures corrected.
    - 97.8% pass rate (452 out of 462) if handheld test, "Play music," is not included for HH5 and MP1.

3.3.10 Test Case: LAN access

3.3.10.1 Failure Data

Table 3.3.10.1-1: LAN Access Data

	PC1	PC2	PC3	PC4	PC5	PC6
HH1	x	x	x	UC	UC	UC
HH2	x	x	x	x	UC	UC
HH3	x	x	x	x	x	x
HH4	x	USF	x	x	x	x
HH5	x	USF	x	x	x	x
MP1	x	USF	x	x	x	x

Table 3.3.10.1-2: LAN Access Stats

Potential Pairs	38
Tested Pairs	8
Passed	0
Failed	8
Pass Rate	0%
Completion Rate	22.2%

Note that the failure declaration process was not carefully tracked, so it is possible that some of the failures were prematurely declared.

3.3.10.2 Failure Breakdown

3.3.10.2.1 Failure Breakdown Table

Table 3.3.10.2-1: LAN Access Breakdown

Failure Type	Total	Failure Description
UC	5	"Unable to connect…" error
MBC	0	"Max number of Bluetooth connections…" error
InB	0	"Internal Bluetooth…" error
PNS	0	"Profile not supported…" error
UDB	0	Unable to detect device during Bluetooth Search
PE	0	Pairing Error: "Unable to Pair…"
USF	3	Device pair does not support feature under test.
t&d	0	Transferred calendar times/dates are incorrect
DL	0	Data lost while transferring
FS	0	"Failed sending" error
UFF	0	Unsupported file format
PNI	0	Pairing cannot be initiated from device
All	8	Total number of failures

3.3.10.2.2   Failure Breakdown Pie Chart

Breakdown for: LAN Access to the Internet
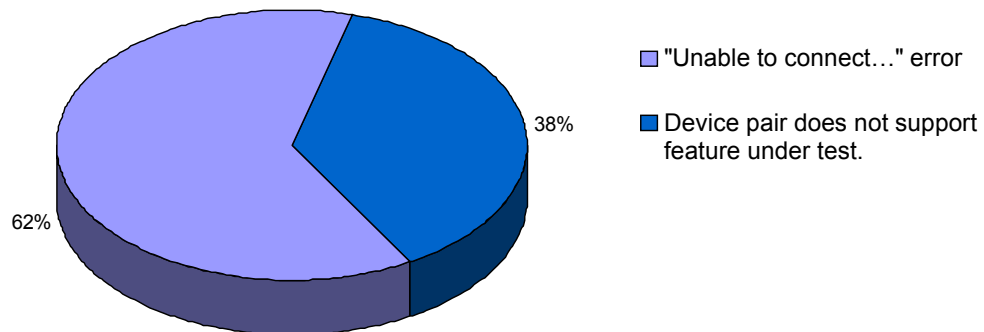
Figure 3.3.10.2-1: LAN Access Breakdown

3.3.10.3   Summary/Implications

- Summary
    - Pass rate of 0%
    - 5 of 8 failures due to "Unable to Connect," permanent error; this signifies that the action was able to be initiated, but LAN access was never acquired.
        – Possible low-level Bluetooth problems
- Implications
    - No simple solutions exist because the root of the problem is indiscernible at this point.

3.3.10.4   Error data

There were no errors observed for this test case.

3.3.11   Test Case: Play Audio File

3.3.11.1   Failure Data

Table 3.3.11.1-1: Play Audio File Data

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH1	x	x	x	x	x	x	x	x	x	x	x
HH2	UC	UC	UC	UC	UC	UC	UC	UC	UC	UC	x
HH3	x	x	x	x	x	x	x	x	x	x	x
HH4	UC	x	x	x	x	UC	x	x	x	x	x
HH5	UC	UC	UC	UC	UC	UC	UC	UC	UC	UC	UC
MP1	UC	UC	UC	UC	UC	UC	UC	UC	UC	UC	UC
PC1	0	x	x	x	x	UC	x	x	x	x	x
PC2	PNS	x	x	x	x	x	x	x	x	x	x
PC3	x	x	x	x	x	x	x	x	x	x	x
PC4	x	PE	PE	PE	PE	PE	PE	PE	PE	PE	x
PC5	x	x	x	x	x	x	x	x	x	x	x
PC6	0	0	x	0	0	0	x	x	0	0	x

Table 3.3.11.1-2: Play Audio File Stats

Potential Pairs	132
Tested Pairs	53
Passed	8
Failed	45
Pass Rate	15.1%
Completion Rate	40.2%

3.3.11.2 Failure Breakdown

3.3.11.2.1 Failure Breakdown Table

Table 3.3.11.2-1: Play Audio File Breakdown

Failure Type	Total	Failure Description
UC	35	"Unable to connect…" error
MBC	0	"Max number of Bluetooth connections…" error
InB	0	"Internal Bluetooth…" error
PNS	1	"Profile not supported…" error
UDB	0	Unable to detect device during Bluetooth Search
PE	9	Pairing Error: "Unable to Pair…"
USF	0	Device pair does not support feature under test.
t&d	0	Transferred calendar times/dates are incorrect
DL	0	Data lost while transferring
FS	0	"Failed sending" error
UFF	0	Unsupported file format
PNI	0	Pairing cannot be initiated from device
All	45	Total number of failures

3.3.11.2.2 Failure Breakdown Pie Chart

Failure Breakdown for Ability to Play Music
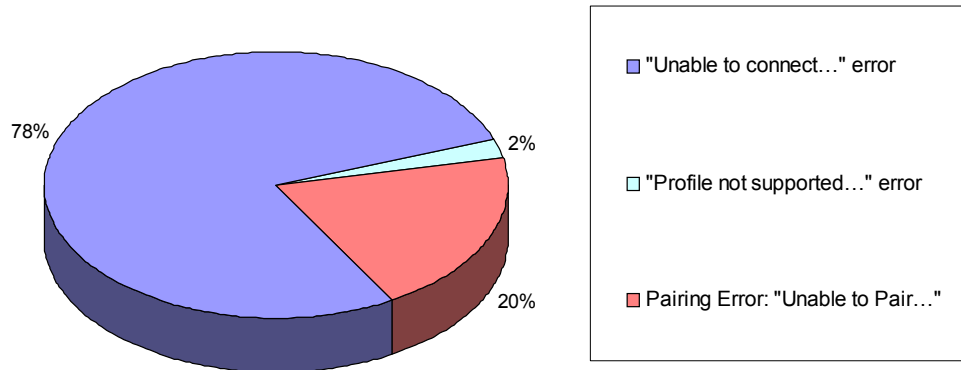
Figure 3.3.11.2-1: Play Audio File Breakdown

3.3.11.3   Summary/Implications

- Summary
  - Pass rate of 15.1% (8 of 53).
  - Handhelds are not able to connect to headsets to perform this task.
  - PC4 is also unable to initiate this task.
- Implications
  - No simple solutions exist because the root of the problem is indiscernible at this point.

3.3.11.4   Error data

This section shows the error data for the Play Audio File test case.

Table 3.3.11.4-1: Play Audio File Error Data

	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11
HH1	x	x	x	x	x	x	x	x	x	x	x
HH2	0	0	0	0	0	0	0	0	0	0	x
HH3	x	x	x	x	x	x	x	x	x	x	x
HH4	0	x	x	x	x	0	x	x	x	x	x
HH5	0	0	0	0	0	0	0	0	0	0	0
MP1	0	0	0	0	0	0	0	0	0	0	0
PC1	1	x	x	x	x	0	x	x	x	x	x
PC2	0	x	x	x	x	x	x	x	x	x	x
PC3	x	x	x	x	x	x	x	x	x	x	x
PC4	x	0	0	0	0	0	0	0	0	0	x
PC5	x	x	x	x	x	x	x	x	x	x	x
PC6	0	0	x	1	3	0	x	x	0	0	x

Table 3.3.11.4-2: Play Audio File Error Stats

Tested Pairs	53
TC w/ Errors	3
Errors	5
Error Rate	5.66%
Avg. Errors	9.43%
Tested Pairs	53

3.3.12　　　Test Case: File Sharing

3.3.12.1　　　Failure Data

Table 3.3.12.1-1: File Sharing Data

0	HH1	HH2	HH3	HH4	HH5	MP1	PC1	PC2	PC3	PC4	PC5	PC6
HH1	x	x	x	x	x	x	x	x	x	x	x	x
HH2	x	x	x	x	x	x	x	x	x	x	x	x
HH3	x	x	x	x	x	x	x	x	x	x	x	x
HH4	x	x	x	x	x	x	x	x	x	x	x	x
HH5	x	x	x	x	x	x	x	x	x	x	x	x
MP1	x	x	x	x	x	x	x	x	x	x	x	x
PC1	x	x	x	x	x	x	x	USF	USF	x	x	x
PC2	x	x	x	x	x	x	USF	x	USF	USF	x	x
PC3	x	x	x	x	x	x	USF	USF	x	USF	USF	x
PC4	x	x	x	x	x	x	x	USF	USF	x	x	x
PC5	x	x	x	x	x	x	x	x	USF	x	x	x
PC6	x	x	x	x	x	x	x	x	x	x	x	x

Table 3.3.12.1-2: File Sharing Stats

Potential Pairs	144
Tested Pairs	12
Passed	0
Failed	12
Pass Rate	0%
Completion Rate	8.3%

Note that the failure declaration process was not carefully tracked, so it is possible that some of the failures were prematurely declared.

3.3.12.2   Failure Breakdown

3.3.12.2.1   Failure Breakdown Table

Table 3.3.12.2-1: File Share Breakdown

Failure Type	Total	Failure Description
UC	0	"Unable to connect…" error
MBC	0	"Max number of Bluetooth connections…" error
InB	0	"Internal Bluetooth…" error
PNS	0	"Profile not supported…" error
UDB	0	Unable to detect device during Bluetooth Search
PE	0	Pairing Error: "Unable to Pair…"
USF	12	Device pair does not support feature under test.
t&d	0	Transferred calendar times/dates are incorrect
DL	0	Data lost while transferring
FS	0	"Failed sending" error
UFF	0	Unsupported file format
PNI	0	Pairing cannot be initiated from device
All	12	Total number of failures

3.3.12.2.2   Failure Breakdown Pie Chart

Failure Breakdown for: File Sharing

100%

Device pair does not support feature under test.
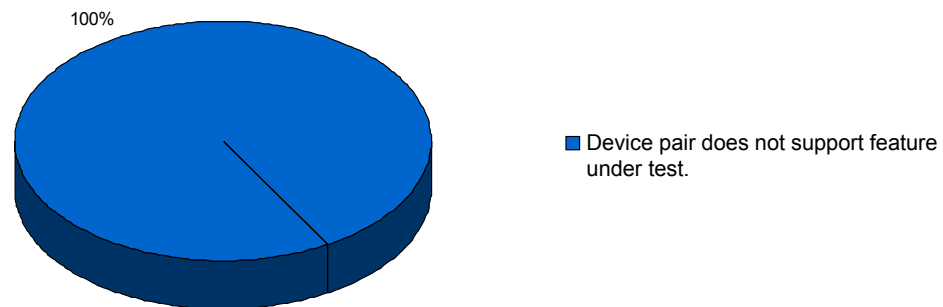
Figure 3.3.12.2-1: File Share Breakdown

3.3.12.3   Summary/Implications

- Summary
  - Pass rate of 0% (0 of 12).
  - This test needs to be more intensively tested.
- Implications
  - No simple solutions exist because the root of the problem is indiscernible at this point.

3.3.12.4   Error data

No errors were observed for this test case.

3.4 Summary of All Test Cases

3.4.1 Failure Data

3.4.1.1 Pass/Fail Statistics

Table 3.4.1.1-1: Summary Statistics

Potential Pairs	559
Tested Pairs	325
Potential TC	2979
Tested TC	1745
Passed TC	995
Failed TC	750
Pass Rate	57.02%

3.4.1.2 Totals

Table 3.4.1.2-1: Sum of Passed, Failed Tests

	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11	PC1	PC2	PC3	PC4	PC5	PC6
HH1		3		3	3	2	2	2	3		2	4																	4	3
HH2	4		1	4	1	4	4	4	5	4	4	5	4																5	2
HH3		3		2																										
HH4	3	5	1		1	4	4	3	4	3	4	5	4															3		
HH5	3	4				4		4	2	4	3	2	4	5	4	4	1	4	4	4	4	4	4	4		4				
MP1	3	4		4					3	3	4	4	3	5	5	5	5	5	5	5	5	5	5	5		4				
MP2	2	3		2	3	3		3	3	3	3	3	3	5	5	5	5	5	5	5	5	5	5	5	3					
MP3	1	3		2	2	4	4		4	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	4	4				
MP4	2	3		2	3	4	4	4		4	4	4	5	5							5	5	5	5	3	5				
MP5		2		3	2	4	3	4	4		4	4	4															4	2	3
MP6	3	3		3	3	4	4	4	4	4		4	4	5	5	5	5	5	5	5	5	5	5	5	4	4				
MP7		3		3	3		4	4	4	4	4		4	5							5	5	5	5				4	2	3
MP8		3		3	3		4	4	4	4	4	4		5							5	5	5	4				4	2	2
HS1																														
HS2																														
HS3																														
HS4																														
HS5																														
HS6																														
HS7																														
HS8																														
HS9																														
HS10																														
HS11																														
PC1							3	3	3		3			1												4		3	5	6
PC2				1	4	4	3	4	4		4																			
PC3																														
PC4										4		4	3												5				4	4
PC5	4	5								4		5	5												4	3		4		4
PC6	3	4								3		4	4	1	1		1	1	1			1	1		5	3	1	4	5	

	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11	PC1	PC2	PC3	PC4	PC5	PC6
HH1		2		2	4	5	5	5	4		5	3																7	3	4
HH2	1		4	1	4	3	3	3	2	3	3	2	3	1	1	1	1	1	1	1	1	1	1	1					2	5
HH3		2		3																										
HH4	2		4		4	3	3	4	3	4	3	2	3	1				1								4				
HH5	3	1		1		3	5	3	4	5	3	2	2	2	5	2	2	2	2	2	2	2	2	2		3				
MP1	3	2		2			4	4	3	1	4			1	1	1	1	1	1	1	1	1	1	1		4				
MP2	4	3		4	3	3		2	2	2	2	2	2												4	7				
MP3	5	3		4	4	2	1		1	1	1	1	1												3	3				
MP4	4	3		4	3	2	1	1		1	1	1	1		5	5	5	5	5	5					4	2				
MP5		4		3	3	1	2	1	1		1	1	1															3	5	4
MP6	3	3		3	3	2	1	1	1	1		1	1												3	3				
MP7	6	3		3	3		1	1	1	1	1		1		5	5	5	5	5	5								3	5	4
MP8		3		3	3		1	1	1	1	1	1			5	5	5	5	5	5			1					3	5	5
HS1																														
HS2																														
HS3																														
HS4																														
HS5																														
HS6																														
HS7																														
HS8																														
HS9																														
HS10																														
HS11																														
PC1							4	4	4		4								1							3	7	3	1	
PC2				4	1	3	3	3	2		3			1											7		7	7	6	6
PC3																									7	7		7	7	6
PC4	5									3		3	4	1	1	1	1	1	1	1	1				1	7	7		2	2
PC5	1									2		1	1												2	3	7	2		2
PC6	2	1								2		3	2												1	3	5	2	1	

3.4.1.3 Failure Rates

3.4.1.3.1 Failure Rate Matrix

Table 3.4.1.3-1: Failure Rates

	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11	PC1	PC2	PC3	PC4	PC5	PC6
HH1		40%		40%	57%	71%	71%	71%	57%		71%	43%																100%	43%	57%
HH2	20%		80%	20%	80%	43%	43%	43%	29%	43%	43%	29%	43%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%						29%	71%
HH3		40%		60%																										
HH4	40%	0%	80%		80%	43%	43%	57%	43%	57%	43%	29%	43%	100%					100%							57%				
HH5	50%	20%		20%			43%	71%	43%	57%	71%	43%	29%	33%	33%	83%	33%	33%	33%	33%	33%	33%	33%	33%		43%				
MP1	50%		33%		33%			57%	57%	43%	20%	57%		17%	17%	17%	17%	17%	17%	17%	17%	17%	17%	17%		50%				
MP2	67%	50%		67%	50%	50%		40%	40%	40%	40%	40%	40%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	57%	100%				
MP3	83%	50%		67%	67%	33%	20%		20%	20%	20%	20%	20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	43%	43%				
MP4	67%	50%		67%	50%	33%	20%	20%		20%	20%	20%	20%	0%	100%	100%	100%	100%	100%	100%	0%	0%	0%	0%	57%	29%				
MP5		67%		50%	60%	20%	40%	20%	20%		20%	20%	20%															43%	71%	57%
MP6	50%	50%		50%	50%	33%	20%	20%	20%	20%		20%	20%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	43%	43%				
MP7	100%	50%		50%	50%		20%	20%	20%	20%	20%		20%	0%	100%	100%	100%	100%	100%	100%	0%	0%	0%						43%	71%	57%
MP8		50%		50%	50%	20%	20%	20%	20%	20%	20%	20%		0%	100%	100%	100%	100%	100%	100%	0%	0%	0%	20%				43%	71%	71%
HS1																														
HS2																														
HS3																														
HS4																														
HS5																														
HS6																														
HS7																														
HS8																														
HS9																														
HS10																														
HS11																														
PC1						57%	57%	57%			57%			0%					100%							43%	100%	50%	17%	0%
PC2				80%	20%	43%	50%	43%	33%		43%			100%											100%		100%	100%	100%	100%
PC3																									100%	100%		100%	100%	100%
PC4	100%								43%		43%	57%		100%	100%	100%	100%	100%	100%	100%	100%	100%			17%	100%	100%		33%	33%
PC5	20%	0%							33%		17%	17%													33%	50%	100%	33%		33%
PC6	40%	20%				40%			43%	33%	0%	0%			0%		0%	0%			0%	0%			17%	50%	83%	33%	17%	

3.4.1.3.2 Failure Rate 3D Graph
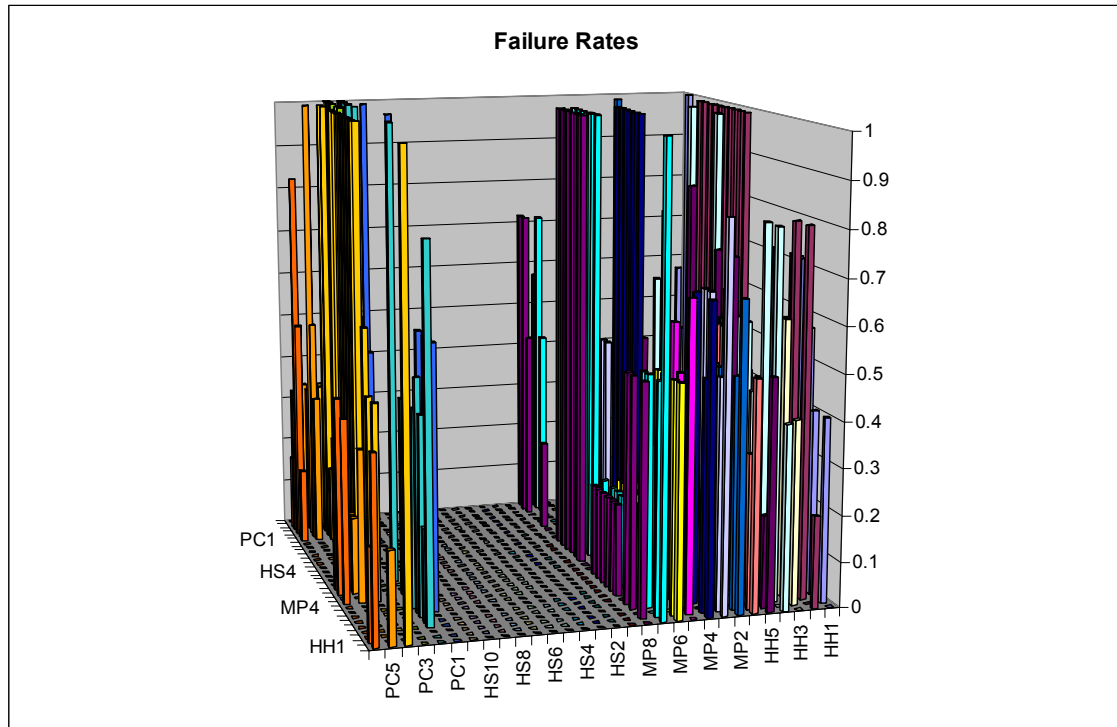
Figure 3.4.1.3-1: Failure Rates

3.4.1.3.3 Failure Rate Distribution Graph
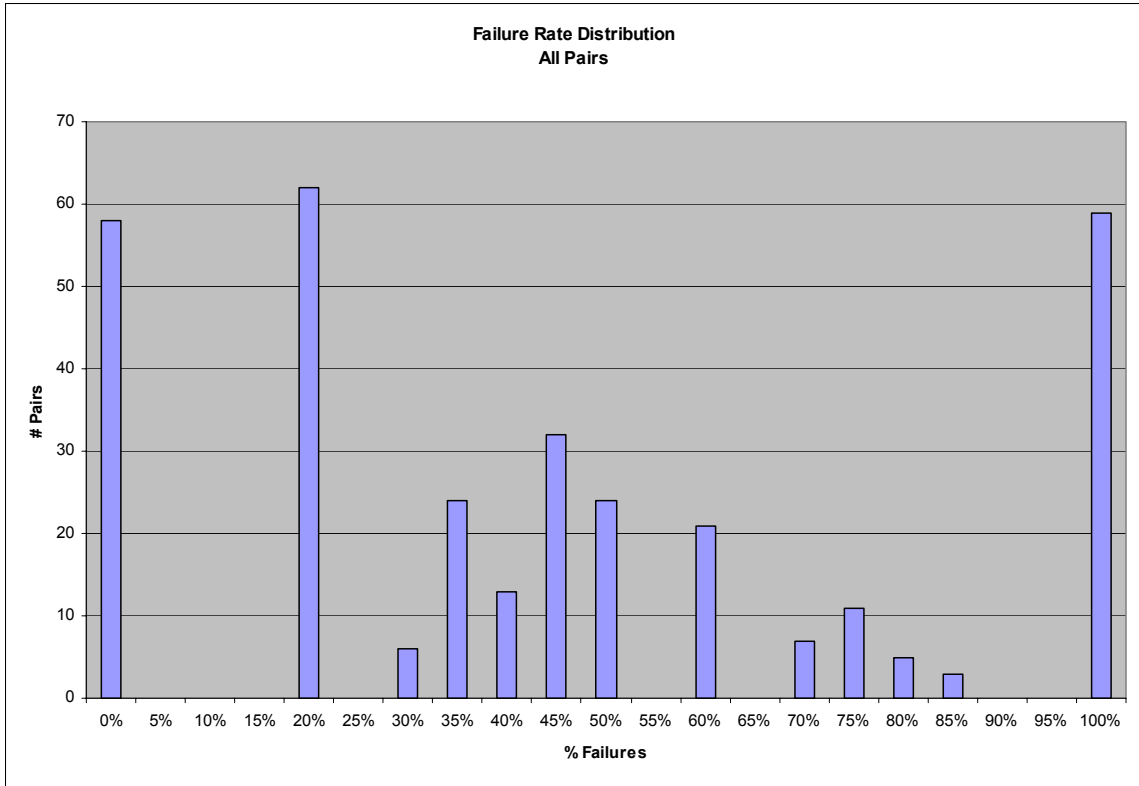
Figure 3.4.1.3-2: Failure Rate Distribution

3.4.1.3.4 Distribution by Test Cases

Distribution by Test Cases
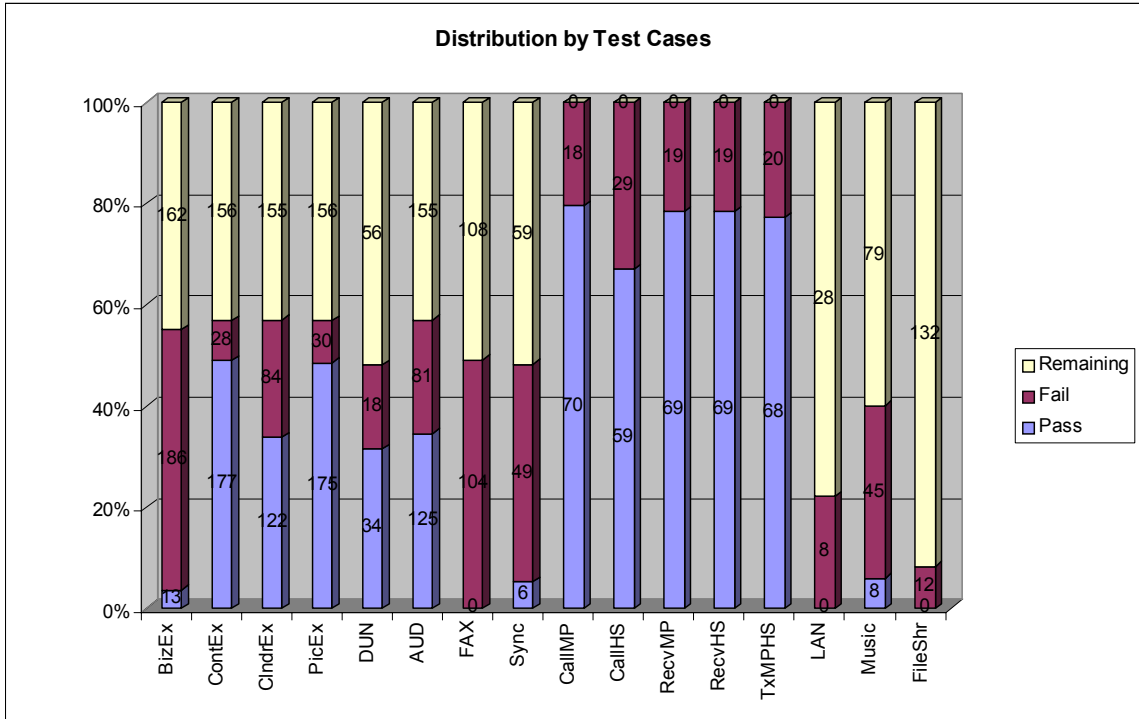
Figure 3.4.1.3-3: Distribution by Test Case

3.4.1.4 Failure Breakdown

3.4.1.4.1 Failure Breakdown Table

Table 3.4.1.4-1: Failure Breakdown

Failure Type	Total	%	Failure Description
UC	62	8.27	"Unable to connect…" error
MBC	1	0.13	"Max number of Bluetooth connections…" error
InB	0	0	"Internal Bluetooth…" error
PNS	86	11.47	"Profile not supported…" error
UDB	31	4.13	Unable to detect device during Bluetooth Search
PE	9	1.2	Pairing Error: "Unable to Pair…"
USF	377	50.27	Device pair does not support feature under test.
t&d	19	2.53	Transferred calendar times/dates are incorrect
DL	2	0.27	Data lost while transferring
FS	98	13.07	"Failed sending" error
UFF	64	8.53	Unsupported file format
PNI	1	0.13	Pairing cannot be initiated from device
All	750		Total number of failures

3.4.1.4.2 <u>Failure Breakdown Pie Chart</u>

Failure Breakdown over all Test Cases
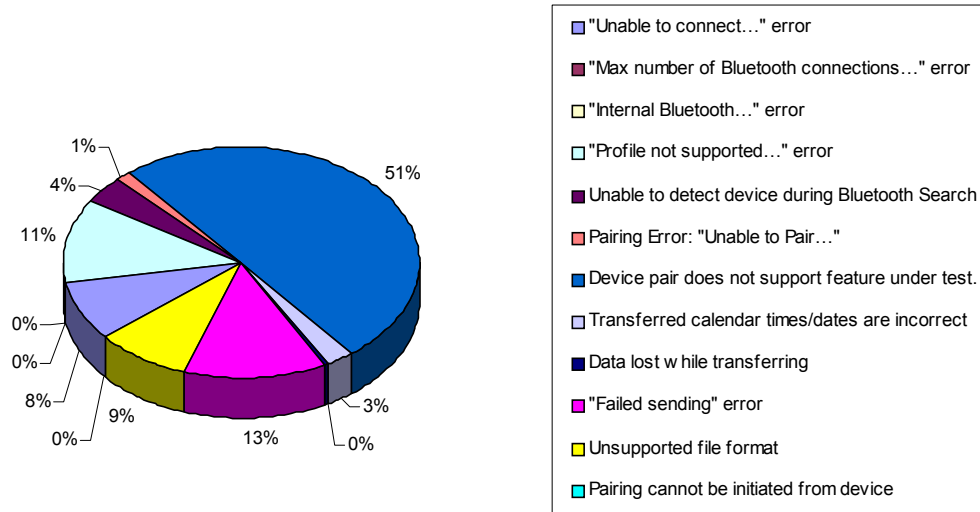
Figure 3.4.1.4-1: Failure Breakdown

3.4.2 Summary

- Overall pass rate of 57.02% (995 of 1745).
- 86 of 750 failures (11.5%) are observed, "Profile not supported" permanent errors.
- 64 of 750 failures (8.5%) are due to data format incapability.
- 377 of 750 failures (50.3%) of failures are due to unsupported features
    - Some might be solved by managing expectations
    - Some might be solved by providing capability to the user interface
- 98 of 750 failures (13.1%) due to "Failed Sending" error; this signifies that the operation was able to be initiated, but the file never finished sending and was never received.
    - Possible low-level Bluetooth problems.
- Several failure trends
    - HH2 and HH4 as senders to HH3 and HH5
    - PC3 high failure rates

3.4.3 Implications

- Using the "Summary/Implications" sections from the previous breakdowns the amount of improvement (failures that could be corrected) can be tracked if these modifications are made.
    - 169 if all devices were able to support and initiate a business card exchange.

- • 84 if headsets and mobile phones used the same profiles.
- • 64 if all devices supported the same audio, picture, calendar, and contact file format.
- • 46 if mobile phones, handhelds, and PCs could all initiate and support synchronization.
- • 23 if recurring interoperability problems with PC3 are corrected.
- • 19 handhelds, mobile phones, and PCs adapted the same format when sending calendar entries.
- • 8 if HH2 and HH4 implement file browsers allowing you to send files like those of other handhelds.
- • These account for 413 of 750 failures (55.1%)
- • 80.7% pass rate (1408 out of 1745) if all these failures corrected.
- • 86.6% pass rate (1512 out of 1745) if the FAX test was not included.

3.4.4 Future Implications

- • It can be seen that many of the interoperability problems are solved on the application software level.
- • Most failures come from unsupported file formats or because a test case to be performed has not been implemented in the user-interface.
- • Indicates most failures are corrected relatively easily.
- • A little less than 20% of all failures may be due to actual low-level Bluetooth issues
    - • "Failed sending" permanent error
    - • "Unable to detect device during Bluetooth search" permanent error

3.4.5 Error Data

Table 3.4.1.4-1: Error Data

Tested Pairs	1745
TC w/ Errors	140
Errors	252
Error Rate	8.02%
Avg. Errors	14.4%
Tested Pairs	1745

Table 3.4.1.4-2: Average Errors

	HH1	HH2	HH3	HH4	HH5	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8	HS9	HS10	HS11	PC1	PC2	PC3	PC4	PC5	PC6
HH1		0%		0%	29%	14%	29%	14%	29%		29%	214%																0%	0%	0%
HH2	160%		0%	80%	0%	43%	29%	100%	43%	0%	114%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%							0%	0%
HH3		0%		0%																										
HH4	0%	0%	0%		0%	57%	129%	100%	100%	0%	129%	0%	0%	0%		0%	33%	0%	0%		0%	0%	0%	100%				14%		
HH5	0%	100%		0%		14%	0%	0%	0%	29%		0%	17%	17%	0%	117%	0%	67%	33%	17%	0%	33%	0%			13%				
MP1	0%	0%		0%		86%	29%	0%	0%	171%			0%	17%	17%	0%	117%	0%	67%	33%	17%	0%	33%	0%		13%				
MP2	0%	0%		0%	0%	0%		20%	0%	160%	0%	0%	0%	0%	0%	0%	0%	20%	0%	0%	0%	0%	0%	0%	0%	0%				
MP3	0%	0%		0%	0%	0%	0%		0%		20%	0%	0%	0%	0%	40%	0%	100%	20%	0%	0%	20%	20%	0%	0%	0%				
MP4	0%	0%		0%	0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	140%	60%	60%	0%	0%	0%				
MP5		0%		0%	0%	0%	60%	0%		0%	40%	0%																14%	0%	0%
MP6	0%	0%		0%	0%	0%	0%	20%	0%		0%		20%	0%	0%	0%	20%	0%	60%	0%	20%	0%	20%	14%	0%					
MP7	0%	0%		0%	0%	0%	0%	0%	0%	40%		0%	60%	0%	0%	20%	0%	0%	0%	40%	100%	20%	60%					0%	0%	114%
MP8		0%		0%	0%		0%	0%	20%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	80%	60%	0%	20%				0%	0%	14%
HS1																														
HS2																														
HS3																														
HS4																														
HS5																														
HS6																														
HS7																														
HS8																														
HS9																														
HS10																														
HS11																														
PC1						14%	0%	0%		0%		100%				0%											0%	0%	0%	0%
PC2				0%	0%	71%	0%	0%	0%	0%		0%												0%			0%	0%	17%	17%
PC3																									0%	0%		0%	0%	0%
PC4	0%						0%		0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%	0%		0%	0%		0%
PC5	0%	0%					0%		0%	0%														0%	0%	0%	0%	0%		0%
PC6	0%	0%					0%		0%	0%	0%	0%			100%	300%		0%			0%	0%		0%	0%	0%	0%		

Note that average Errors >> Error Rates, implying that errors are highly correlated.

3.4.6 Completion Data

Completion Rates
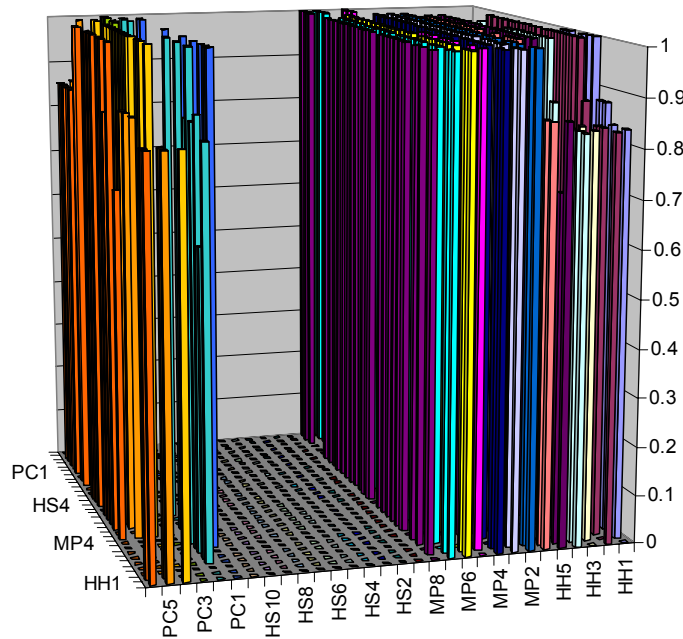
Figure 3.4.1.4-1: Completion Rates

**Completion Rate Distribution
All Pairs**
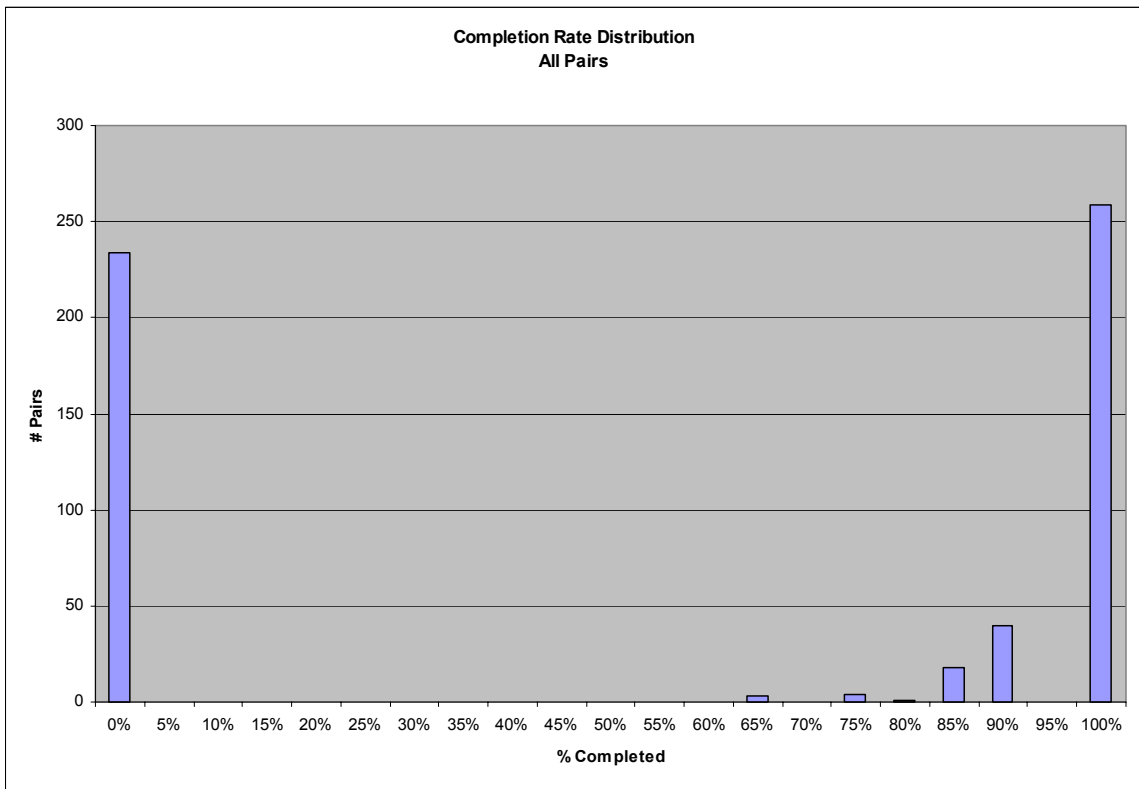
Figure 3.4.1.4-2: Completion Rate Distribution

Table 3.4.1.4-1: Completion Stats

Potential Pairs	559
Tested Pairs	325
Potential Test Cases	2991
Tested Test Cases	1745
Completion	58.34%
Potential Pairs	559

4 Conclusion

4.1 Summary of Results

There are several conclusions that we can draw from the tests we were able to perform. The results gathered from our tests were mixed. We found that the simpler the interface (headsets) the more likely the device is to pass a particular test case. Conversely, we found the more complicated a device's user interface then it is less likely to pass a particular test case. In general we found that these device type pairs worked well together: mobile phones and headsets, and mobile phones and mobile phone; while the other device type pairs performed less well. The overall pass rate for all devices was 57.02%, which we found to be surprisingly low. However, after removing some possibly controversial test cases, the pass rate increases substantially. The pass rate for each device type pair can be seen below in Table 4.1.

Table 4.1: Pass Rate by Device Type

Device Type Pair	Overall Pass Rate
Handheld – Handheld	54.10%
Handheld – Mobile Phone	49.57%
Handheld – Headset	0.0%
Handheld – PC	50.51%
Mobile Phone – Mobile Phones	66.60%
Mobile Phone – Headset	72.51%
Mobile Phone – PC	51.40%
PC – Headset	42.10%
PC – PC	33.33%

4.2 Critique of Approach

We are aware that the approach we have taken has certain limitations and is not purely scientific. There are many aspects of our testing that have vast room for improvement. Performing tests and mapping out plans for test procedures is a learning process. Through the course of gathering, results we made many refinements in our testing procedures and measurements. This document represents data from various points in our learning process, and this section points out some of the critiques we have our own current processes that have produced the data found in this report. The following section describes what we believe are potential remedies for most of these identified problems.

The results we have gathered are subject to differences in points of view. There were several testers working together with similar approaches to the problem (see the Test Plan document), but ultimate the results are from that testers perspective. The subjective scale and timing results are the two measurements most affected by the individuality of a tester. Also it should be noted that a certain test case was applied to a pair only once meaning that there is really little statistical significance to the subjective scale and timing

measurements. These results should not be viewed as scientific (even though we tried to make the test plan as scientific as possible). For reliable results, one would have to perform multiple experiments with a number of different testers in order to gain confidence intervals for the results. Because we did not verify the validity of the time and subjective scale measures, we did not include the data in this report.

As was noted in many of our results, we did not track the failure declaration process that was drawn up in our test plan document. This was due to a number of trivial but practical factors. As a result, some of the devices and tests were tested more rigorously than others. We suspect that most tests involving PCs, for example, were not tested as thoroughly, and hence may have a negative bias in the results. Consequently, the success of a test sometimes relied more on the tester's time, effort, and cleverness in performing tests. Consequently, we have less than perfect confidence in all of our data.

The method for storing our results became a major issue. During the course of our data collection, we acquired more results/measurements from each test case than we originally estimated. This problem was originally going to be solved by software from a third party, but after thorough examination and attempted application of the software, it became evident that it was not adequate for our needs. The end result was to fall back to using Microsoft Excel, which proved to be sufficient for storing our results and extracting them for data analysis, but cost us an unforeseeable amount of time. We also failed to design forms to help in tracking the failure declaration process. The data generation and analysis failed to scale well with the problem, and hence we spent more time trying to manage the data than to provide more in depth analysis fo the data. It is also interesting to point out that approximately 100 test cases have been performed (these include test cases for the imaging device, GPS devices, and the printer adapter), which have not been included in this document because of the time required to incorporate the analysis.

Another critique is the manner in which failures were classified. We were able to break down the failures, but in hindsight a more thorough breakdown would have been useful. One particular example is the failure code, "Device pair does not support feature under test." Over 50% of our failures fell under that code making it hard to determine how those were determined, what the user experienced, and the root causes of failures. Many times when a device did not provide a user interface to initiate such an action this code would be used to classify the failure. A more constructive code could have been, "Initiating device does not provide the interface to complete this action."

Another issue that became apparent is choosing what test cases are applicable for certain devices and device pairs. It can be seen from our results that two test cases, Business Card Exchange and FAX test, combined for a large portion of the reported failures. It is quite reasonable to question the applicability of these test cases for many devices that this test was performed on. We simply used our best judgment in guessing what users would expect which features Bluetooth devices would be capable of performing. Our goal is to report on the overall interoperability of Bluetooth, and if users do not expect a device to do something and the device does not provide the means to initiate such a task, then the results of that test should not be included.

A related issue is that we do not know the relative importance of some test cases versus other test cases. Thus, we considered all test cases as equal. This does not accurately reflect interoperability from the users' perspective. Users may not buy a Bluetooth mobile phone that does not send a picture, but exchanging business cards may be considered a novelty, and hence the two test cases should be given different weight.

Finally, to represent what the overall interoperability of Bluetooth it would be necessary to have a group of devices representative of what is on the market. While we believe we have a good sample, including a mix of device types and a mix of popular and less popular devices, there was no effort to validate that we have a representative sample, or that the results are weighted according to the proportion of Bluetooth devices on the market.

4.3 Future Directions

In the future, we propose a number of changes that we believe will enhance the quality of the results of future interoperability tests.

First, and likely the most important, is the development of a software tool to help us store, track, and analyze the data we collect. Ideally we would prefer a web based front end to a data base. This would allow different testers to input data into the data base and help guide them through the data entry process. Another important feature that would be included is the ability of the data base to track a testers' progress through the failure declaration process. The tracking of this process was not always done during our testing so we can not determine to what extent a device pair was tested before a failure was declared. Also, whenever a new device is to be added to the data base, a series of information should be entered that would be used to automatically generate a test campaign. The data base would also store the results of the tests, including (currently) the subjective scale, operator codes for failures or transient errors, time to perform the test, operator notes on how to perform certain tasks, operator notes corresponding to the operator codes, pass/fail information, and the test has been unsuccessful how far the failure declaration process has been followed. Finally, this tool would be able to perform queries on the data base. For example we could use this software tool to generate a pie chart of the failure breakdown for all mobile phones to all handhelds and transferring a picture file. Ultimately, this tool would address many of the critiques sited in the previous section: it would solve the problem of how the results would be stored, the time for analysis and data generation could be reduced drastically, it would track the failure declaration process, and it would be able to guide testers through the data entry process.

Another improvement that can be made is we could enhance the data reporting by applying more statistical measures rather than just average (mean). For example, we could provide standard deviations and confidence intervals. This could be applied to transient errors and subjective scale measures, but could also be applied to any measure in general.

Something that must be addressed is how to report on how well this devices interoperate with Bluetooth overall. This report gives every device pair and test case the same weighting as any other device pair and test case. This is obviously not the case in the marketplace. Consumers have priorities for the things they buy to accomplish certain tasks they feel are important. We are currently investigating how to incorporate experts in usability and human-computer interaction on developing empirical ways of measuring what users/consumers expect certain device pairs to accomplish. By acquiring this information, it will be possible to assign certain weightings to device pair test cases. For example, this could mean that the picture exchange test case for mobile phones will be given a much higher weighting than the business card exchange. By doing this we, would be able to report on the overall interoperability of Bluetooth in a more empirical and meaningful manner.

An improvement that may be potentially of great value is the development of a failure diagnosis process. We have a failure declaration process, but a detailed diagnosis process would be very helpful in narrowing down the root cause of many failures. This process would have different steps to follow that detail what a tester must do in order to analyze the failure. This would detail using the protocol analyzer to find if the failure was something in the packet exchange or if it was with the application software. Another portion of this will be to further narrow down our failure causes. This will give us more insight as to the manner of failures, and identify trends of technical failures.

Finally, we would like to increase the volume of testing. The testing represented in this report shows a considerable amount of effort by a team of 6 testers over several months. Even so, the testing was incomplete, relatively few test cases were performed, the failure declaration process was sometimes not followed to completion (a time consuming process), and no failure diagnostics were performed.