8 Analyzing the Results

Once a suitable amount of data has been collected, use the **Stop**

button to terminate data collection. If the current test has been set to end after a specific number of cycles or calls, data collection will stop automatically at the conclusion of the test sequence.

When a Voice Quality test is stopped, the **End Active Calls** dialog will appear. It is critical to hang up all active Voice Quality calls before clicking **OK** to close this dialog. Failure to disconnect the calls prior to closing this dialog will result in data missing from the merged output report.

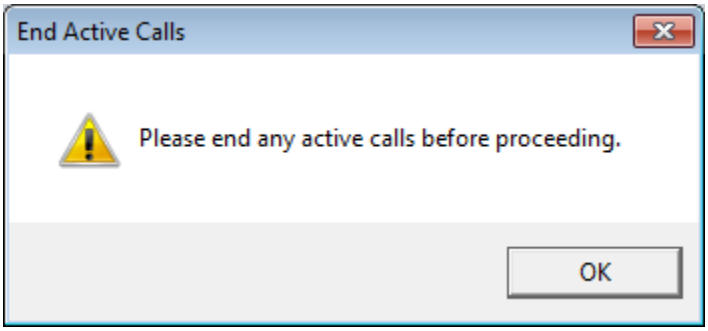

Figure 8-1 - End Active Calls Dialog

When data collection stops, the Nomad **Data** tab will appear for report generation and additional analysis.

8.1 Generating a Report

In most cases, Nomad will automatically merge the downlink data collected at the test PC with the uplink data collected at the Audio or Call Server provided that an internet connection is available at merge time. The merged file will be listed on the **Data → Complete** tab and will be available for report generation. In addition to the **File Name**, the **UTC Start Time** and **End Time** and the task type performed at each channel is listed for identification purposes. The listed reports may be sorted using the column headers (If the session file appears on the **Data → Incomplete** tab, see Section 8.8 for troubleshooting tips).

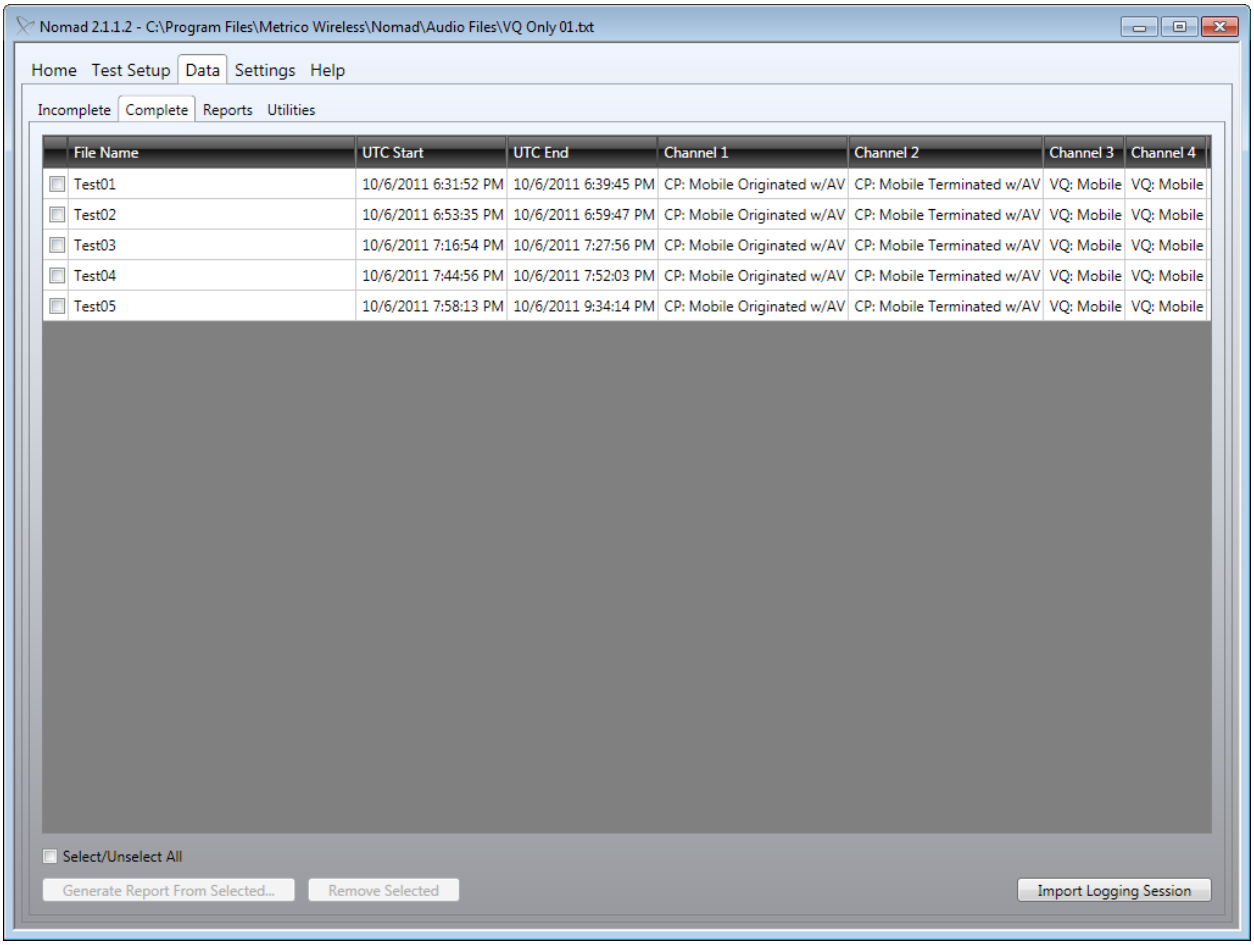

Figure 8-2 – Merged Session Files on the Complete Tab

To generate a report using merged session files:

- Select one or more files to be included in the output report.
- Click the **Generate Report From Selected** Generate Report From Selected... button.
- If multiple session files have been selected, choose whether to **Merge multiple logging sessions into one report** or to **Produce one report for each logging session**.

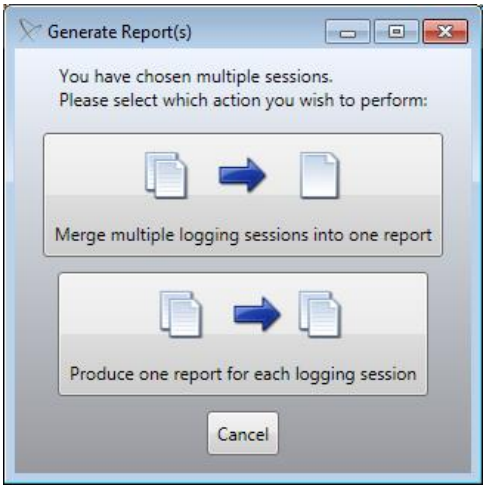

Figure 8-3 - Output File Type Selection

- The **Review Merged Session Report Header Data** dialog will appear. Channels with inconsistent header data will be highlighted yellow. This dialog may also be used to move data among channels for reporting purposes.
    - Examine the data for any marked inconsistencies. Remove any unwanted data from the merge or use the **Move Selected** button to move data to a different channel. Moving data may be necessary if the same device was used on different channels during different test sessions.
    - The **Move Selected** button may also be used to move data among channels for reporting purposes. Use this option to aggregate data collected across multiple channels in the report output.
    - Provide a unified **Name** for the channel data in the report.
    - Click **Generate Report** when all data has been aligned as desired.
- If multiple test session files have been selected, the **Save As** dialog will appear. Name the Nomad report source file, or text file containing all data for the unified output report.

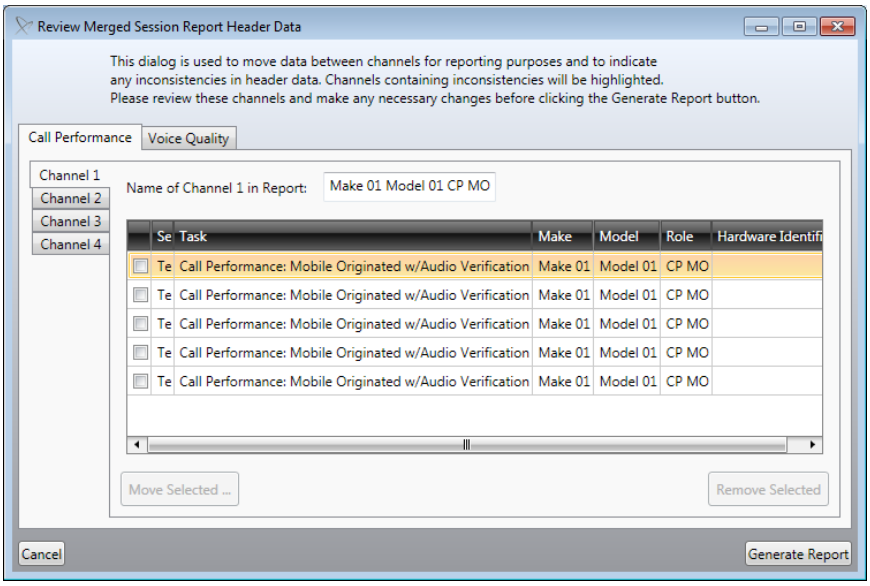

Figure 8-4 - Review Merged Session Report Header Data Dialog

- The source files used to generate the formatted output report and KML file for geographic visualization of MOS data will be listed on the **Data → Reports** tab. A report file created from a single test file will take the name of that file. A report file created from multiple test files will take the name assigned by the user during the report generation process.

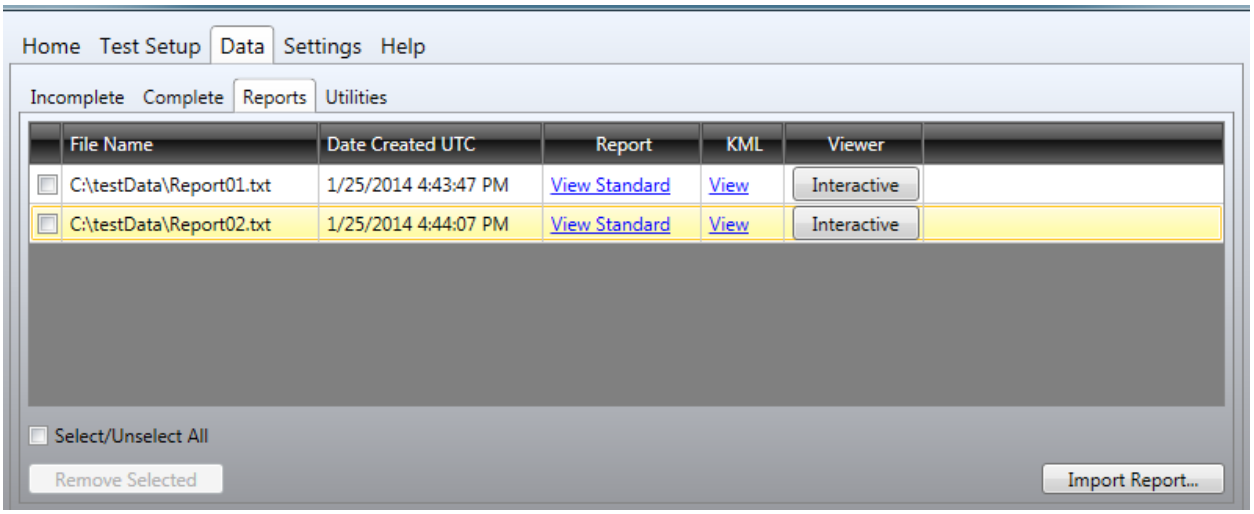

Figure 8-5 - List of Generated Reports on the Reports Tab

8.2 Displaying a Formatted Report

To display the formatted report output:

- On the **Data → Reports** tab, click the **View Standard** link for the data of interest.

- **Note:** If the **View Standard** link is not present, reports must be generated by a team member with access to this functionality. Contact Spirent Support if you believe this capability has been omitted in error.
- In the **Save As** dialog, provide a name for the formatted Excel report.
- **Note:** Formatted output reports are displayed in **.XLSX** format. Microsoft Excel 2007 or newer is required to open files in this format. If you are running an older version of Excel, you must download the Microsoft Excel Viewer to view the **.XLSX** output reports.

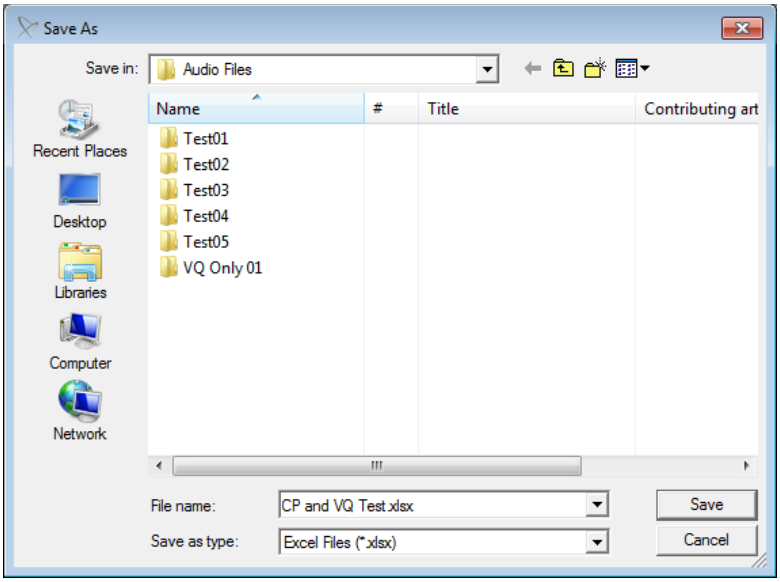

Figure 8-6 - Naming the Formatted Excel Report

- Nomad supports report template customization. If multiple customized report templates are available, the **Report Template Selection** dialog will appear. Select the desired template to use. See Section 8.3 for details on customizing report templates.

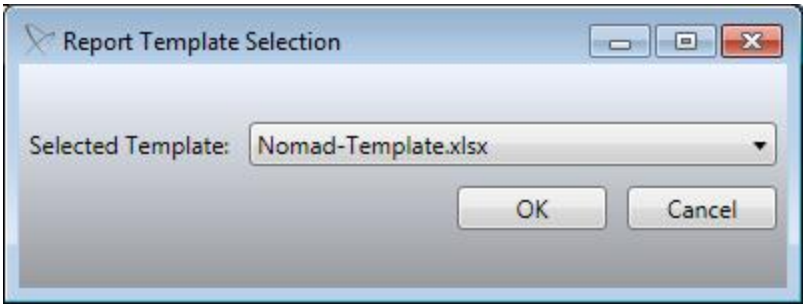

Figure 8-7 - Report Template Selection Dialog

The report will open to the **Device Overview** tab. This page lists the metadata entered for each test device, and provides links to each of the Voice Quality and Call Performance reports. Click on any report **Name** to go directly to that report.

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Device Overview and Report Index

	Channel 1	Channel 2	Channel 3	Channel 4
Make	Make 1	Make 2	Make 3	Make 04
Model	Model 1	Model 2	Model 3	Model 04
Role	CP - MO	CP - MO	VQ	VQ DUT
Hardware Identifier	001C1326C445	001B5258AFA8	00264A860SA7	00249FEE1FFF
Adapter	N/A	N/A	N/A	N/A
Number to Dial	8882087217	8882087219	6172742057	6172742049
Number Dialing From	6033189022	6033181227	6038817575	4438786157
End Input Level	N/A	N/A	255	225
End Output Level	N/A	N/A	155	165

Click any report **Name** below to view the report:

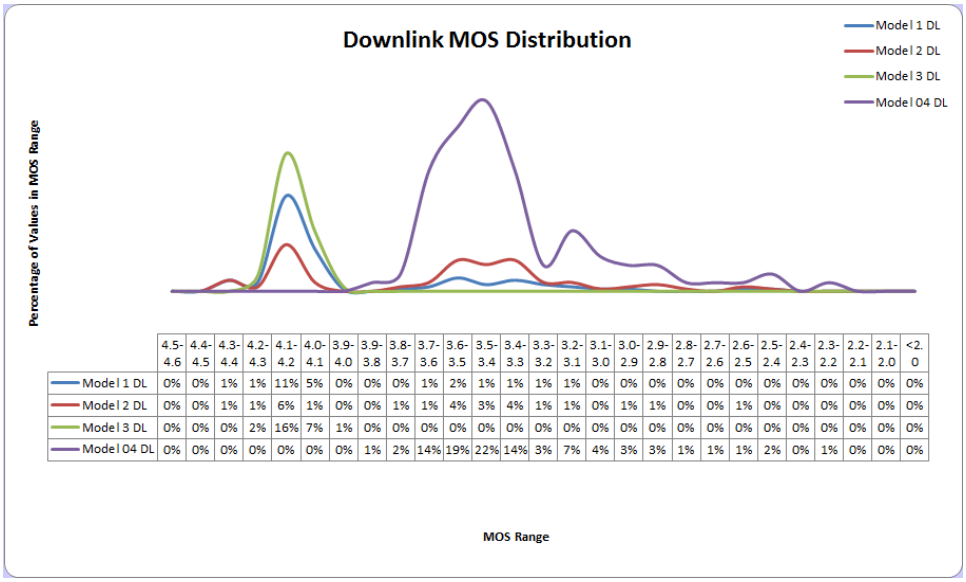
Name	Test Type	Description
Voice Quality Summary	Voice Quality	Statistical and distribution information for uplink and downlink MOS results
Detailed MOS Data	Voice Quality	Detailed MOS result data for each channel ordered by time
Delay Performance Summary	Delay	Statistical information for Delay Task results
Detailed Delay Data	Delay	Detailed Delay result data
Call Performance Summary	Call Performance	Provides a snapshot of the Failed Initiation and Dropped Call Rate
Call Initiation Performance Report	Call Performance	Provides a breakdown of Call Initiation Failure events by failure type
Call Retention Performance Report	Call Performance	Displays the Dropped Call Rate for each device as the % of successful initiations that result in a dropped call
Audio Verification Performance Report	Call Performance	Displays the Audio Verification Failure Rate based on the number of calls where audio was not detected
Device Performance Report	Call Performance	Summarizes signal strength and battery reports from the device as well as Bluetooth errors.

Figure 8-8 - Device Overview Report Landing Page

Formatted **Voice Quality** data can be found on the **Voice Quality Summary** tab of the output and includes statistical and distribution information for **Voice Quality** session results.

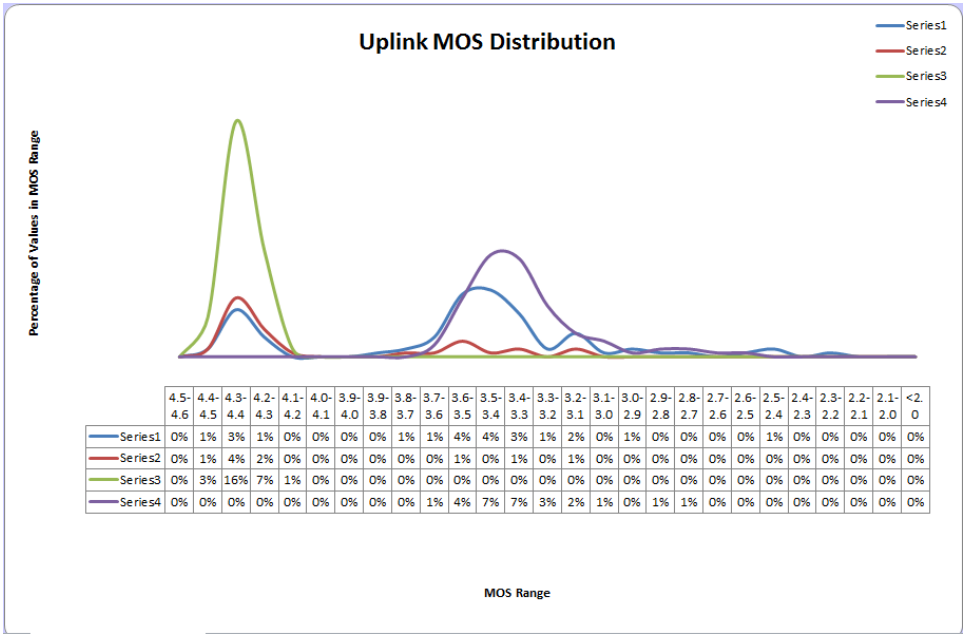
	Downlink MOS				Uplink MOS			
	Model 1 DL	Model 2 DL	Model 3 DL	Model 04 DL	Model 1 UL	Model 2 UL	Model 3 UL	Model 04 UL
Average	3.09	3.62	4.12	3.36	3.57	4.06	4.33	3.34
Standard Deviation	0.42	0.45	0.05	0.30	0.48	0.42	0.05	0.21
Maximum Score	3.56	4.39	4.23	3.80	4.41	4.42	4.44	3.69
Count	381	381	381	98	381	381	381	381
% MOS greater than or equal to 3.2	24.15%	21.52%	25.72%	76.53%	19.16%	8.92%	25.98%	21.52%
% MOS less than 3.0	0.79%	2.36%	0.00%	12.24%	2.10%	0.00%	0.00%	1.84%
% MOS less than 2.0	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
% MOS less than or equal to 1.8	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Scoring Algorithm	POLQA	POLQA	POLQA	POLQA	POLQA	POLQA	POLQA	POLQA

Figure 8-9 - MOS Statistical Summary



	4.5-4.6	4.4-4.5	4.3-4.4	4.2-4.3	4.1-4.2	4.0-4.1	3.9-4.0	3.9-3.8	3.8-3.7	3.7-3.6	3.6-3.5	3.5-3.4	3.4-3.3	3.3-3.2	3.2-3.1	3.1-3.0	3.0-2.9	2.9-2.8	2.8-2.7	2.7-2.6	2.6-2.5	2.5-2.4	2.4-2.3	2.3-2.2	2.2-2.1	2.1-2.0	<2.0
Model 1 DL	0%	0%	1%	1%	11%	5%	0%	0%	0%	1%	2%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Model 2 DL	0%	0%	1%	1%	6%	1%	0%	0%	1%	1%	4%	3%	4%	1%	1%	0%	1%	1%	0%	0%	1%	0%	0%	0%	0%	0%	0%
Model 3 DL	0%	0%	0%	2%	16%	7%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Model 04 DL	0%	0%	0%	0%	0%	0%	0%	1%	2%	14%	19%	22%	14%	3%	7%	4%	3%	3%	1%	1%	1%	2%	0%	1%	0%	0%	0%

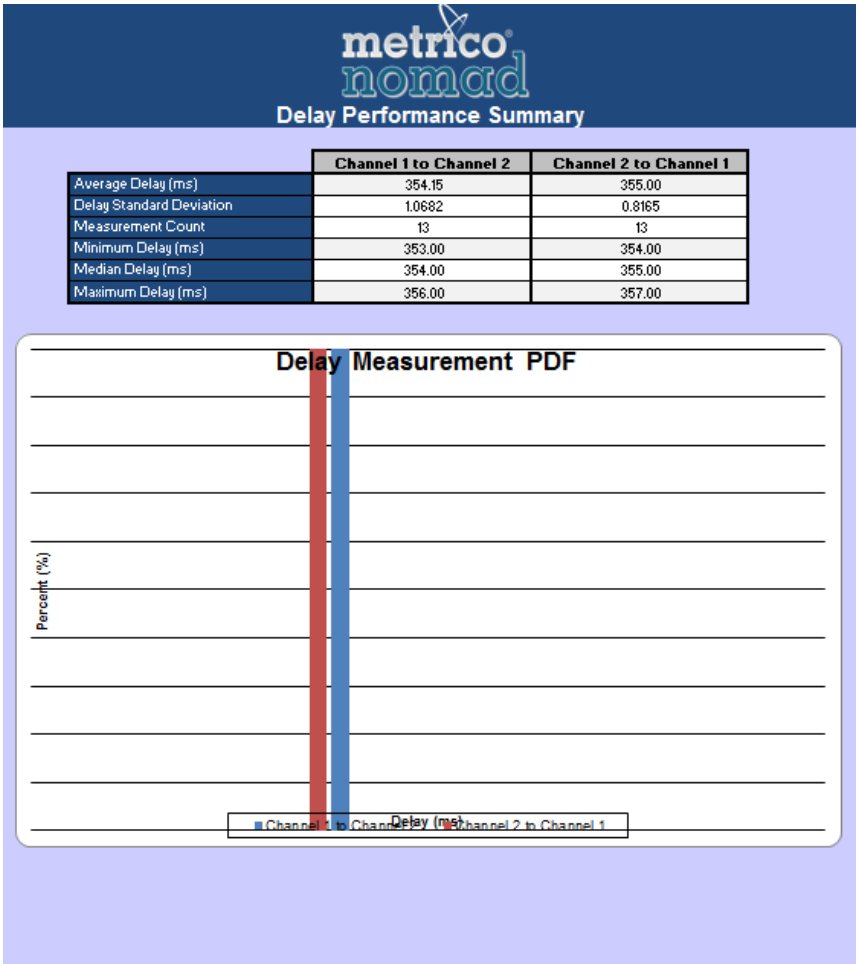
Figure 8-10 - Downlink MOS Distribution



	4.5-4.6	4.4-4.5	4.3-4.4	4.2-4.3	4.1-4.2	4.0-4.1	3.9-4.0	3.9-3.8	3.8-3.7	3.7-3.6	3.6-3.5	3.5-3.4	3.4-3.3	3.3-3.2	3.2-3.1	3.1-3.0	3.0-2.9	2.9-2.8	2.8-2.7	2.7-2.6	2.6-2.5	2.5-2.4	2.4-2.3	2.3-2.2	2.2-2.1	2.1-2.0	<2.0
Series1	0%	1%	3%	1%	0%	0%	0%	0%	1%	1%	4%	4%	3%	1%	2%	0%	1%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%
Series2	0%	1%	4%	2%	0%	0%	0%	0%	0%	0%	1%	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Series3	0%	3%	16%	7%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Series4	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	4%	7%	7%	3%	2%	1%	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%

Figure 8-11 - Uplink MOS Distribution

Formatted Delay Performance data can be found on the **Delay Performance Summary** tab.



	Channel 1 to Channel 2	Channel 2 to Channel 1
Average Delay (ms)	354.15	355.00
Delay Standard Deviation	1.0682	0.8165
Measurement Count	13	13
Minimum Delay (ms)	353.00	354.00
Median Delay (ms)	354.00	355.00
Maximum Delay (ms)	356.00	357.00

Figure 8-12 - Delay Performance Summary Report

Formatted **Call Performance** data can be found on these tabs:

- Call Performance Summary
- Call Initiation
- Call Retention
- Audio Verification
- Device Performance

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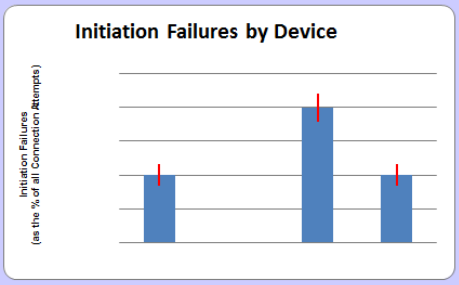
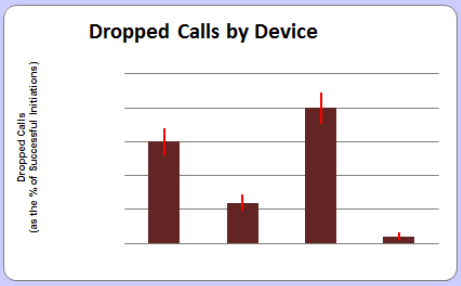
Call Performance Summary

					Call Initiation Performance		Call Retention Performance	
Device Tested	Hardware Identifier	Connection Attempts	Mean Setup Time (s)	Total Call Duration (s)	Successful Initiations	Failed Initiations	Successful Calls	Dropped Calls
Make 1 Model 1	001C1326C445	1000	3.00	4754.00	90.00%	10.00%	85.00%	15.00%
Make 2 Model 2	001B5258AFA8	1000	4.00	4361.00	100.00%	0.00%	94.00%	6.00%
Make 3 Model 3	00264AE605A7	1000	5.00	4457.00	80.00%	20.00%	80.00%	20.00%
Make 4 Model 4	00249FEE1FFF	1000	3.00	4632.00	90.00%	10.00%	99.00%	1.00%





Terminology
Successful Initiation - A successfully established call.
Failed Initiation - Any call not successfully established. The **Call Initiation** report presents **Failed Initiations** by outcome.
Successful Call - A call that is successfully established and which lasts for the expected duration
Dropped Call - A call that is successfully established but which ends before the duration has elapsed.
The red line on each chart bar indicates the 90% Confidence Interval. This allows us to report, with 90% confidence that the event rate for a given device will fall within the calculated range above and below the measured value.

Figure 8-13 - Call Performance Summary Report

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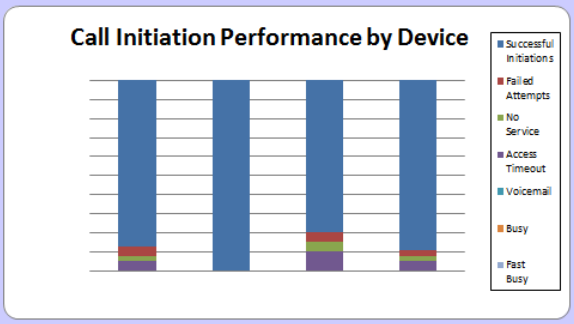
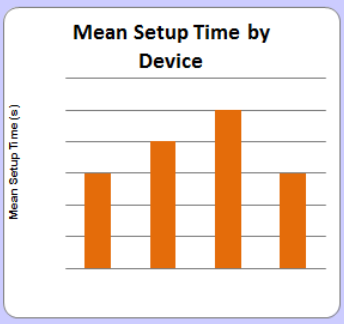
Call Initiation Performance

					Initiation Failures					
Test Device	Hardware Identifier	Mean Setup Time (s)	Connection Attempts	Successful Initiations	Failed Attempts	No Service	Access Timeout	Voicemail	Busy	Fast Busy
Make 1 Model 1	001C1326C445	3.00	1000	90.00%	5.00%	3.00%	5.00%	0.00%	0.00%	0.00%
Make 2 Model 2	001B5258AFA8	4.00	1000	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Make 3 Model 3	00264AE605A7	5.00	1000	80.00%	5.00%	5.00%	10.00%	0.00%	0.00%	0.00%
Make 4 Model 4	00249FEE1FFF	3.00	1000	90.00%	3.00%	3.00%	5.00%	0.00%	0.00%	0.00%





Terminology
Failed Attempt - A *MO* call was placed and an outgoing call was established followed by the phone's return to the call placement state.
No Service - There was no service available when the call was attempted.
Access Timeout - A *MO* call was placed but no state change before Access Timeout ***or*** *MT* connection did not take place before Access Timeout.
Voicemail - A *MT* call was placed and the nonstandard *voicemail* response was received from the mobile.
Busy - A *MT* call was placed and the nonstandard *busy* response was received from the mobile.
Fast Busy - A *MT* call was placed and the nonstandard *fast busy* response was received from the mobile.

Figure 8-14 - Call Initiation Performance Report

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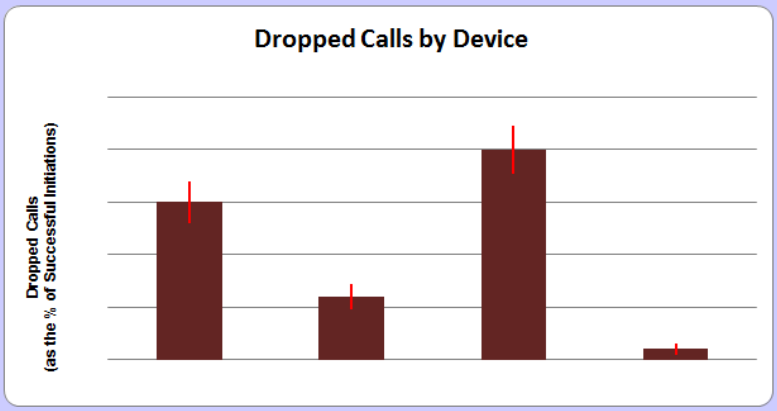
Call Retention Performance

Test Device	Hardware Identifier	Connection Attempts	Successful Initiations	Dropped Calls	Dropped Call Rate (%)	Confidence Interval
Make 1 Model 1	001C1326C445	1000	900	135	15.00%	1.9%
Make 2 Model 2	001B5258AFA8	1000	1000	60	6.00%	1.2%
Make 3 Model 3	00264AE605A7	1000	800	160	20.00%	2.1%
Make 4 Model 4	00249FEE1FFF	1000	900	9	1.00%	0.5%



Terminology
Dropped Call - A call that is successfully established but which ends before the duration has elapsed.
Dropped Call Rate - The percent of all successful initiations which result in a dropped call.
Confidence Interval = +/- z(a) * s(p) = 1.645 * s(p) where
n = connection attempts
p = percentage of drops
s(p) = SQRT[(p(1 - p) / (n - 1)]
z(a) = z(90th percentile) = 1.645

Figure 8-15 - Call Retention Performance Report

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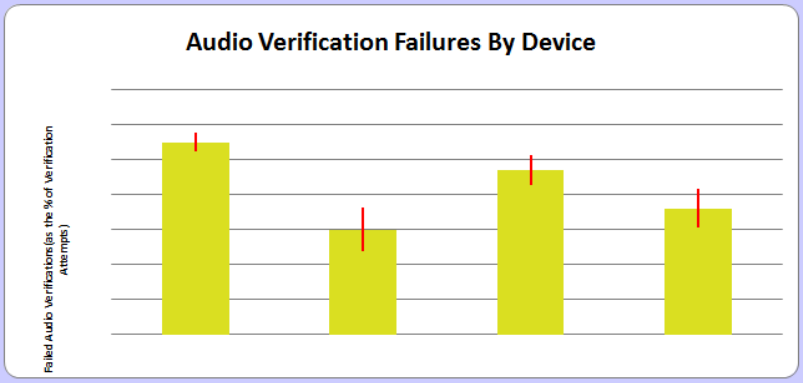
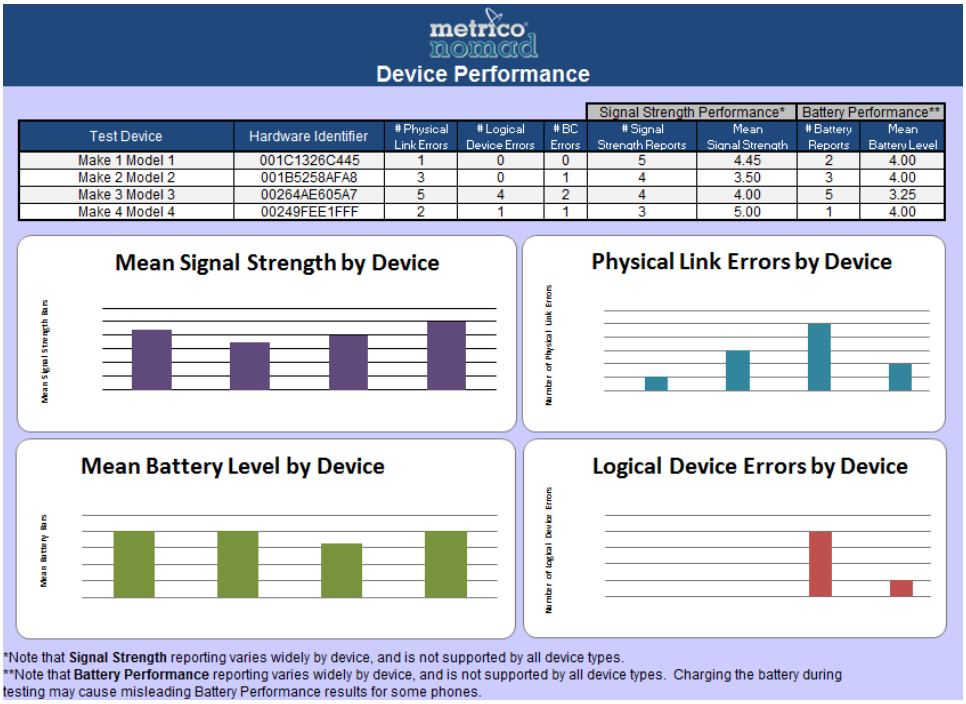
Audio Verification Performance

Test Device	Hardware Identifier	Verification Attempts	Passed Audio Verification Count	Failed Audio Verification Count	Failed Audio Verification (%)	Confidence Interval
Make 1 Model 1	001C1326C445	1000	990	10	99.00%	0.5%
Make 2 Model 2	001B5258AFA8	1000	940	60	94.00%	1.2%
Make 3 Model 3	00264AE605A7	1000	974	26	97.40%	0.8%
Make 4 Model 4	00249FEE1FFF	1000	952	48	95.20%	1.1%



Terminology
Passed Audio Verification Count - A count of calls where the presence of audio was detected successfully
Failed Audio Verification Count - A count of calls where the presence of audio was not detected successfully
Confidence Interval = +/- z(a) * s(p) = 1.282 * s(p) where
n = connection attempts
p = percentage of failed audio verification calls
s(p) = SQRT[(p(1 - p) / (n - 1)]
z(a) = z(90th percentile) = 1.645

Figure 8-16 - Audio Verification Performance Report



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Device Performance

Test Device	Hardware Identifier	# Physical Link Errors	# Logical Device Errors	# BC Errors	Signal Strength Performance* # Signal Strength Reports	Signal Strength Performance* Mean Signal Strength	Battery Performance** # Battery Reports	Battery Performance** Mean Battery Level
Make 1 Model 1	001C1326C445	1	0	0	5	4.45	2	4.00
Make 2 Model 2	001B5258AFA8	3	0	1	4	3.50	3	4.00
Make 3 Model 3	00264AE605A7	5	4	2	4	4.00	5	3.25
Make 4 Model 4	00249FEE1FFF	2	1	1	3	5.00	1	4.00

*Note that **Signal Strength** reporting varies widely by device, and is not supported by all device types.
Note that **Battery Performance reporting varies widely by device, and is not supported by all device types. Charging the battery during testing may cause misleading Battery Performance results for some phones.

Figure 8-17 - Device Performance Report

8.3 Report Template Customization

Nomad supports report template customization. To customize a report template:

- Find the default Nomad report template in the **Templates** directory of the Nomad installation location (typically **C:\Program Files\Spirent Communications\Nomad**). The name of the file is **Nomad-Template.xlsx**.
- Make a copy of the **Nomad-Template.xlsx** template file in the same directory. Rename the copy with a meaningful name.
- Open the new file and edit the formatted report pages using Excel 2007 (.XLSX format). Note that existing worksheet names must remain the same but new sheets may be added.
- When the changes are complete, save the Excel file.
- When more than one report template is available in the **Templates** folder, Nomad will present the **Report Template Selection** dialog during the report generation process. At that time, any custom template may be selected for data population.

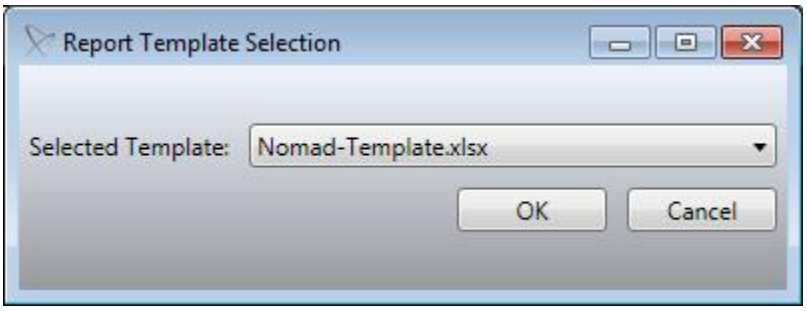


Figure 8-18 - Report Template Selection Dialog

8.4 Interactive Viewer

To display the Interactive Viewer:

- On the **Data** → **Reports** tab, click the **Interactive** button for the data of interest.

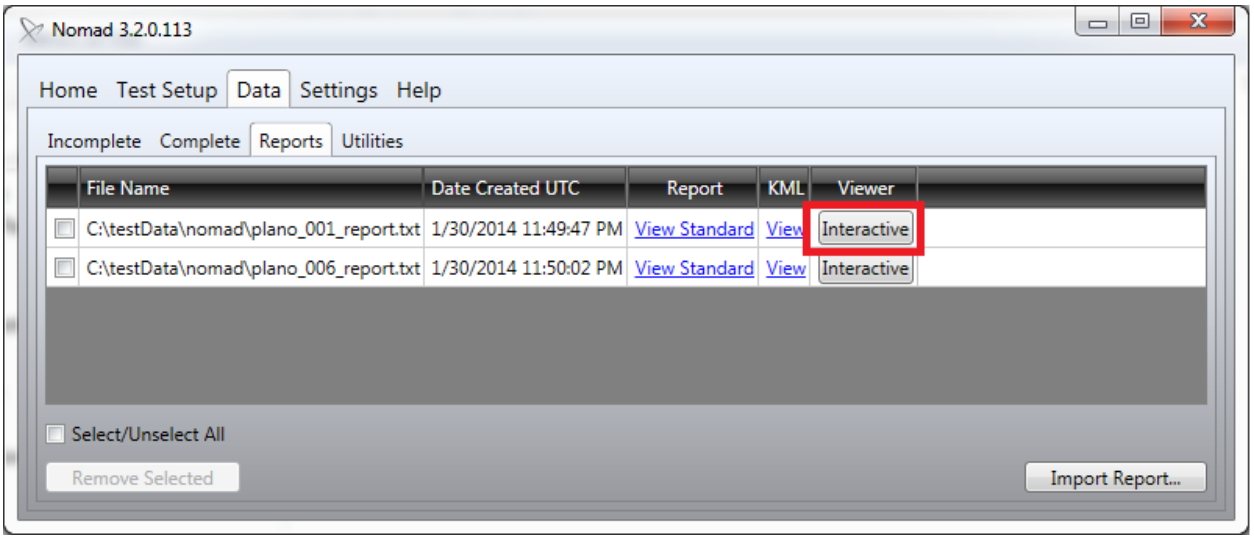


Figure 8-19 – Interactive button on Reports tab

This will display the Interactive Viewer, which will represent cycle level data from each channel in the session report. For **Voice Quality** data, a graph will be shown displaying the MOS scores over time. Hovering over a point on the graph will display the MOS score for that cycle. Clicking on a point in the graph will display information at the bottom of the window relative to that cycle.

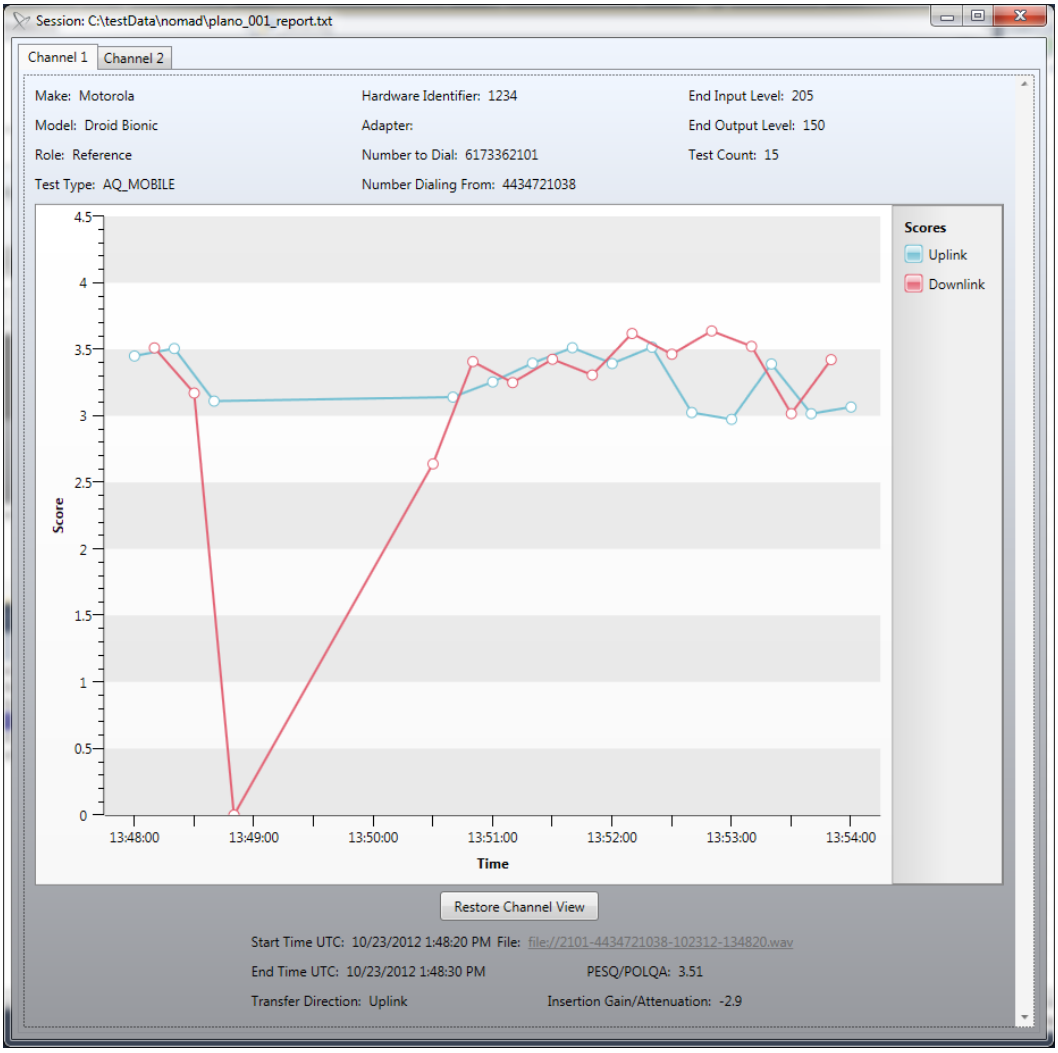
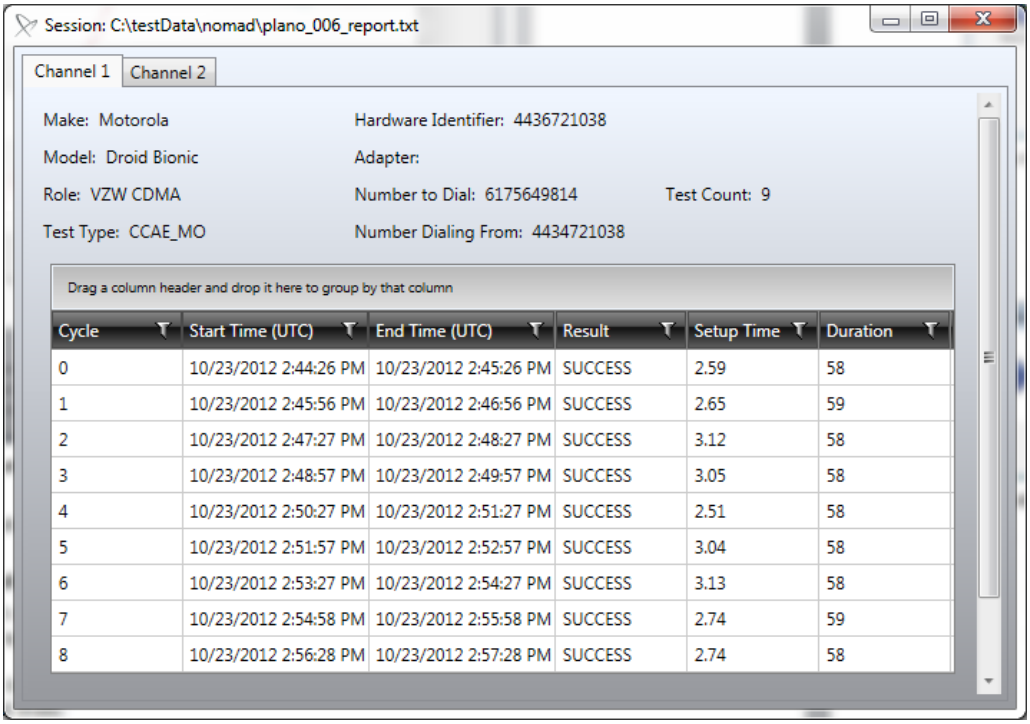


Figure 8-20 – Interactive Viewer Voice Quality data

For Call Performance data, a table will be shown displaying the results of each call:



Cycle	Start Time (UTC)	End Time (UTC)	Result	Setup Time	Duration
0	10/23/2012 2:44:26 PM	10/23/2012 2:45:26 PM	SUCCESS	2.59	58
1	10/23/2012 2:45:56 PM	10/23/2012 2:46:56 PM	SUCCESS	2.65	59
2	10/23/2012 2:47:27 PM	10/23/2012 2:48:27 PM	SUCCESS	3.12	58
3	10/23/2012 2:48:57 PM	10/23/2012 2:49:57 PM	SUCCESS	3.05	58
4	10/23/2012 2:50:27 PM	10/23/2012 2:51:27 PM	SUCCESS	2.51	58
5	10/23/2012 2:51:57 PM	10/23/2012 2:52:57 PM	SUCCESS	3.04	58
6	10/23/2012 2:53:27 PM	10/23/2012 2:54:27 PM	SUCCESS	3.13	58
7	10/23/2012 2:54:58 PM	10/23/2012 2:55:58 PM	SUCCESS	2.74	59
8	10/23/2012 2:56:28 PM	10/23/2012 2:57:28 PM	SUCCESS	2.74	58

Figure 8-21 – Interactive Viewer Call Performance data

8.5 Visualizing Data Geographically

The Nomad KML output capability provides a simple method of visualizing MOS and Call Performance data geographically.

Google Earth™ must be installed in order to take advantage of geographic visualization. Google Earth™ may be obtained from:

http://earth.google.com

An internet connection is required for map access while running the program. To visualize data in Google Earth™:

- On the **Data** → **Reports** tab, click the **View** link in the KML column for the data of interest.
- In the **Save As** dialog, provide a name for the KML map file.

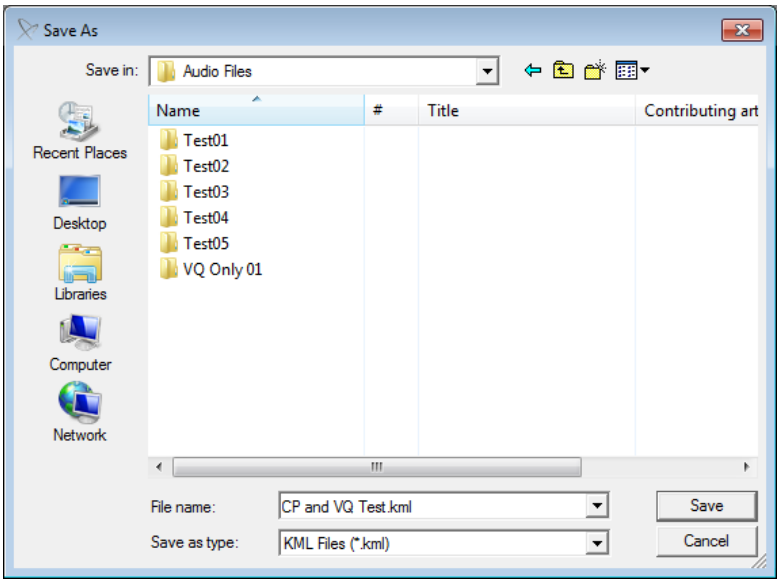


Figure 8-22 - Naming the KML Map File

- The **KML Generation Complete** dialog will appear. Choose whether to view the data now. The data can be viewed at any time by opening the .KML file using the **File → Open** command from the main menu in Google Earth™.

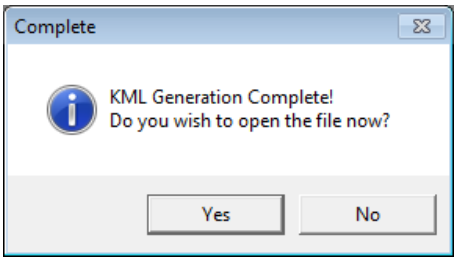


Figure 8-23 - KML Generation Complete Dialog

- Google Earth™ will open and zoom to the map location. MOS measurements or Call Performance events will be shown as color-coded points along the drive route. The color thresholds for each MOS range are determined by the thresholds set on the **Settings → Voice Quality** tab (see Section 4.4.1). Colors for Call Performance events are determined by the system.

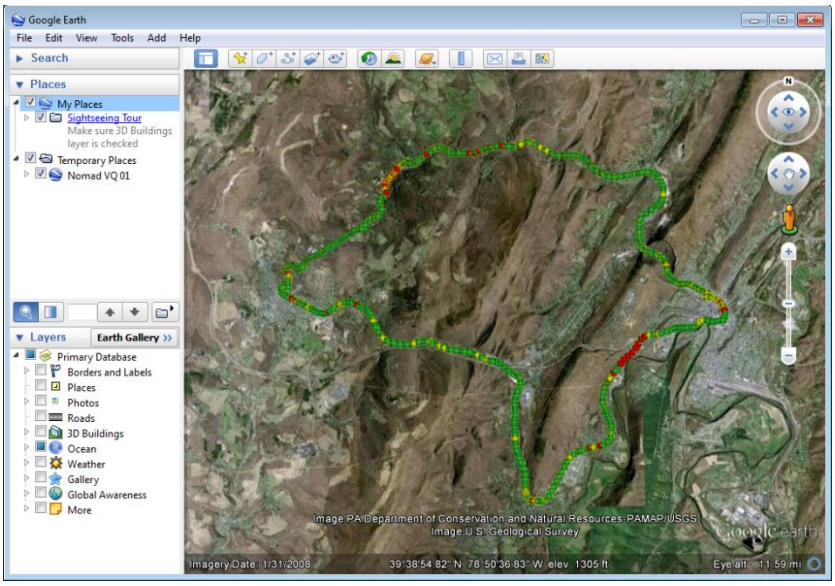


Figure 8-24 - Geographic Display of MOS Data in Google Earth™

- In the **Places** window in the left-hand panel, use the selection boxes to isolate the data by channel and link. For example, this map has been customized to include only Downlink data for Channel 1.

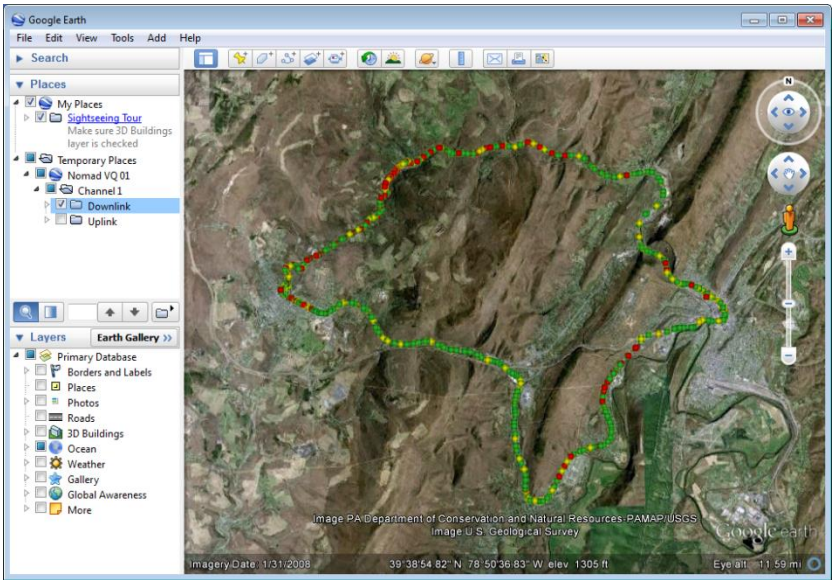


Figure 8-25 - Isolating the Data of Interest

- The map image may be saved as a .JPG file by selecting **File → Save → Save Image**.

8.6 Reporting IP Analytics

If the IP Analytics right is present, collected IP data can be correlated and reported with the session results from Nomad. To correlate IP data:

- On the **Data → Complete** tab, select one or more files with which you wish to associate data in a pcap file.
- Click the **Import IP Analytics File** button.
- Navigate to a pcap file that was collected on the device or server side during the session(s) selected. The data from the pcap file will be analyzed and correlated with the time period of the selected session(s).

To generate a report displaying the IP Analytics data correlated with Nomad results:

- On the **Data → Complete** tab, select one or more files that you wish to generate the report on.
- Click the **Generate Report From Selected** Generate Report From Selected... button.
- The **Review Merged Session Report Header Data** window will appear (for more information on the general functionality of this window, see section 8.1)
- The streams of imported IP data will be listed in the IP Analytics table at the bottom of the window. For each channel applicable (the tabs on the left), select the **Downlink** or **Uplink** radio button in the **IP Analytics** table for the corresponding streams.

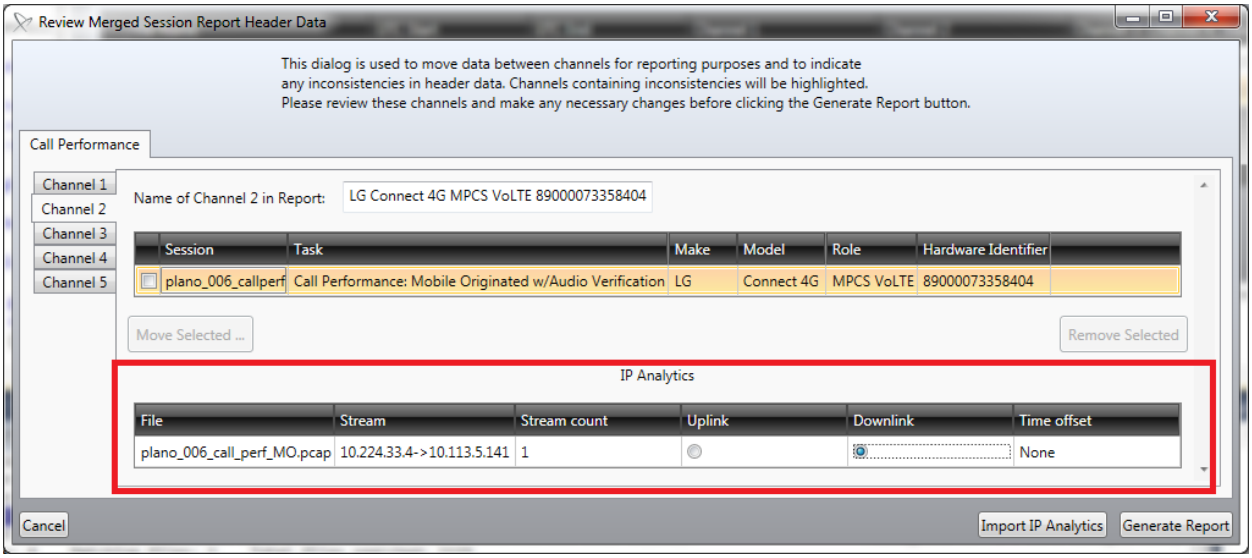


Figure 8-26 – Associating IP Analytics data

- Press the **Generate Report** button.
- On the **Save As** window, provide a location and name for the report to be generated, and then click the **Save** button.
- A report with the provided name will be displayed on the **Data → Reports** tab.
- Click the **View IP link** to view an excel report containing the IP Analytics data and associated Nomad results. Click on the **Interactive** button to view an interactive representation of the IP Analytics data and associated Nomad results.

The generated Excel file will display graphs of Nomad results, and graphs of corresponding Jitter, Delay, and Throughput statistics for the corresponding time period. At the top of the excel report, you can select the starting cycle, and amount of cycles to be represented in the graphs.

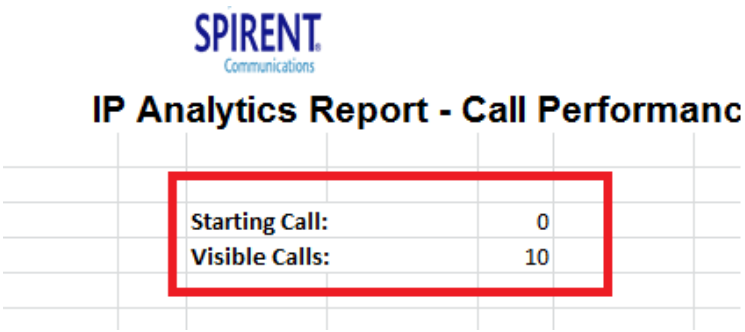


Figure 8-27 – Selecting Displayed data.

The IP Analytics data can also be viewed in the Interactive Viewer. To view the data in the Interactive Viewer, click the Interactive button for the corresponding report on the **Data → Reports** tab. For Call Performance tests, a table will be displayed for each call result. To display the associated stream data, click on a call result within the table. Data on any associate Uplink and Downlink streams for the selected result will be displayed beneath the table.

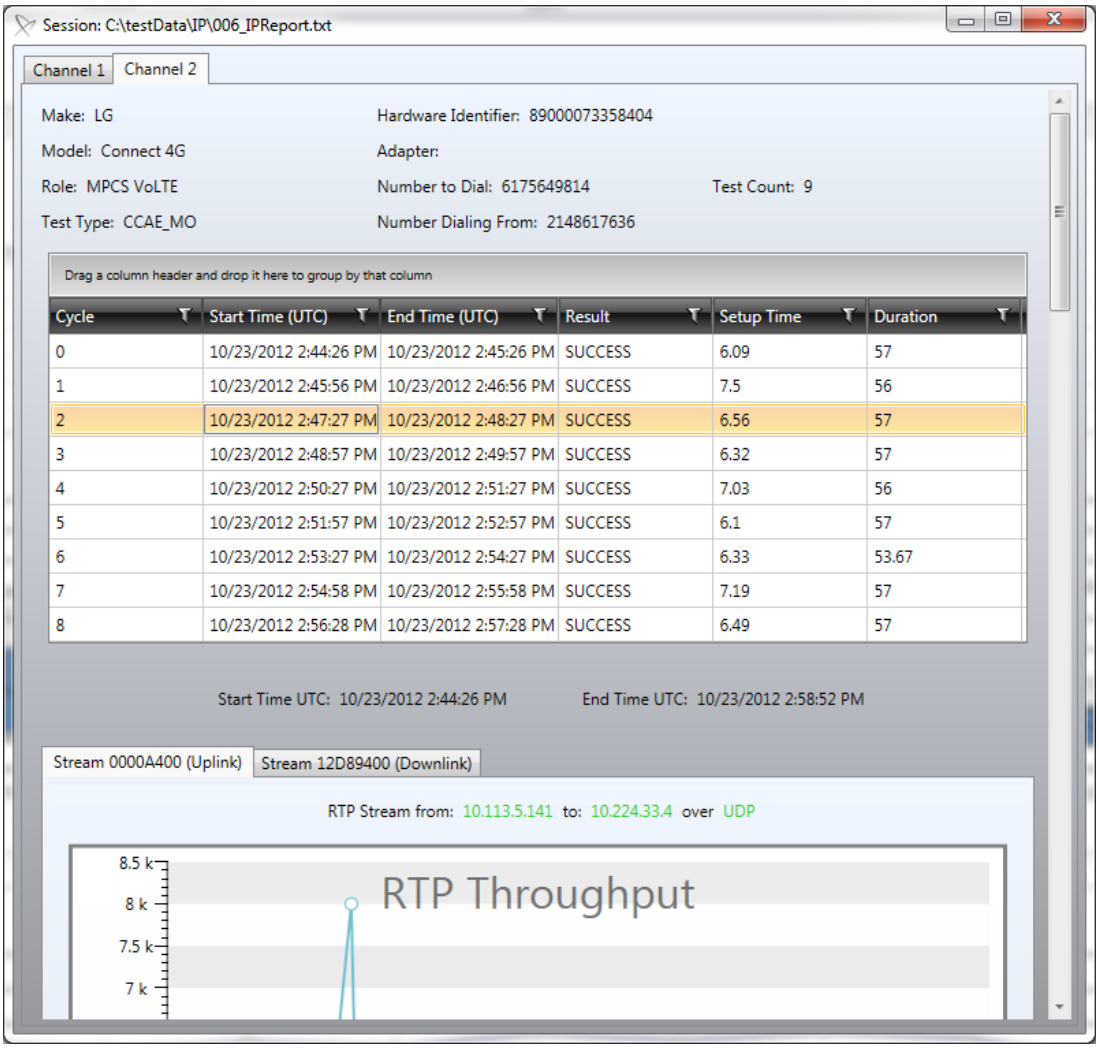


Figure 8-28 – Interactive Viewer – Call Performance data

These charts include RTP Throughput, RTP Jitter, and RTP Relative Delay over time, as well as charts of the distribution of RTP Relative Delay and Distribution of RTP Jitter.

For Voice Quality tasks, a graph will be displayed displaying the MOS scores for the task. Beneath the graph will be displayed the above mentioned charts for the duration of the task for all associated streams (Uplink and Downlink). Clicking on any MOS score in the top graph will filter the remaining charts to the data corresponding the cycle. You may restore the charts to represent the entire task by clicking the Restore Channel View button.

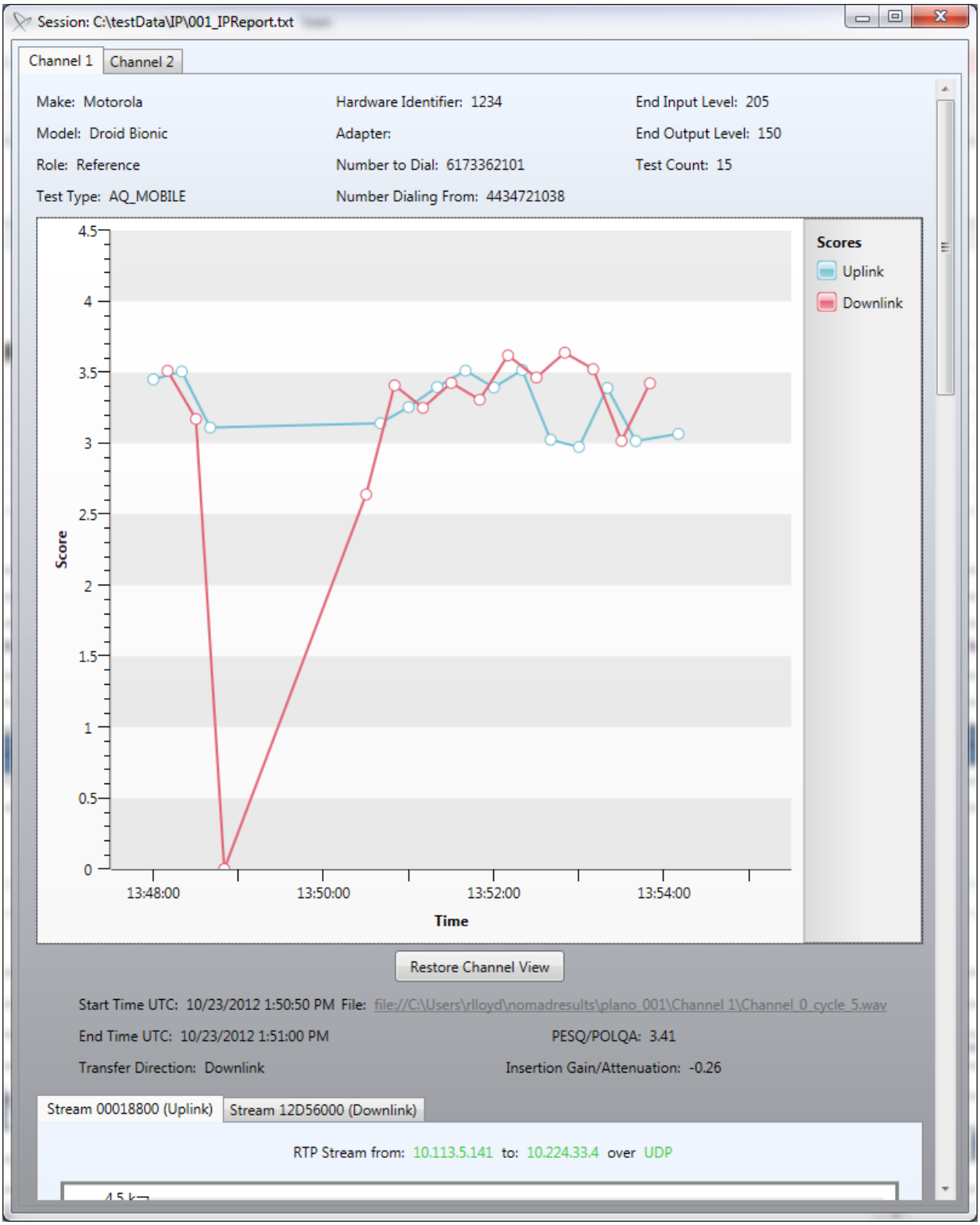


Figure 8-29 – Interactive Viewer – Voice Quality data

8.7 Collecting Random Audio Sample Files (Voice Quality Testing)

Nomad has the ability to set aside a random sample of audio files from a **Voice Quality** test within each MOS performance range. This allows users to audibly verify the performance of **Great**, **Good** and **Bad** audio samples.

Random audio file sampling must be enabled prior to data collection on the **Settings** → **Voice Quality** tab in order to capture this data (see Section 4.4.1).

Start and run the test normally. After the uplink and downlink data for the test has been merged and the session file appears on the **Data** → **Complete** tab, a ZIP containing the sample uplink and downlink audio files will be available in the file's details directory. This folder resides in the log file storage location specified in the **Start Logging Session Wizard** (see Section 6.4) and takes the same name as the session log file. The ZIP file contains a directory structure that organizes the audio samples by channel and by performance threshold. The .WAV audio samples reside within the directory structure.

Some notes about the directory structure containing the audio samples:

- If the specified number of files does not exist for a range, Nomad will include all available .WAV files for that range.
- If no samples fall within a range, no folder will be present for that range.
- The files can be played with any media player that supports .WAV files.

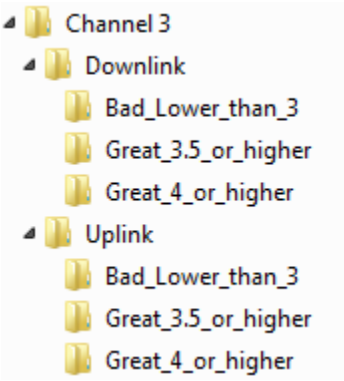
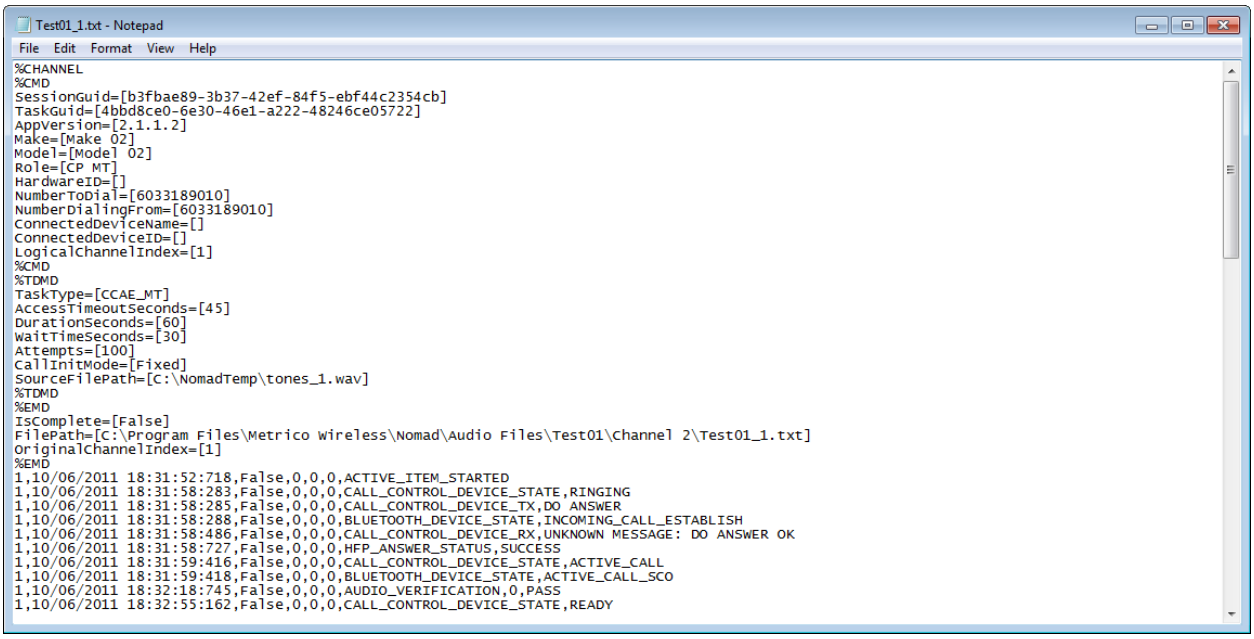


Figure 8-30 - Random Audio Sample Directory Structure

8.8 Viewing the Logs

The log file containing the messaging for each test is stored in the **Log File Storage Location** specified in the **Start Logging Session Wizard** (see Section 6.4). The log files are maintained in an open-format, comma-delimited file for direct access to the information.



```
Test01_1.txt - Notepad
File Edit Format View Help
%CHANNEL
%CMD
SessionGuid=[b3fbae89-3b37-42ef-84f5-ebf44c2354cb]
TaskGuid=[4bbd8ce0-6e30-46e1-a222-48246ce05722]
AppVersion=[2.1.1.2]
Make=[Make 02]
Model=[Model 02]
Role=[CP MT]
HardwareID=[]
NumberToDial=[6033189010]
NumberDialingFrom=[6033189010]
ConnectedDeviceName=[]
ConnectedDeviceID=[]
LogicalChannelIndex=[1]
%CMD
%TDMD
TaskType=[CCAE_MT]
AccessTimeoutSeconds=[45]
DurationSeconds=[60]
WaitTimeSeconds=[30]
Attempts=[100]
CallInitMode=[Fixed]
SourceFilePath=[C:\NomadTemp\tones_1.wav]
%TDMD
%EMD
IsComplete=[False]
FilePath=[C:\Program Files\Metrico Wireless\Nomad\Audio Files\Test01\Channel 2\Test01_1.txt]
OriginalChannelIndex=[1]
%EMD
1,10/06/2011 18:31:52:718,False,0,0,0,ACTIVE_ITEM_STARTED
1,10/06/2011 18:31:58:283,False,0,0,0,CALL_CONTROL_DEVICE_STATE,RINGING
1,10/06/2011 18:31:58:285,False,0,0,0,CALL_CONTROL_DEVICE_TX,DO ANSWER
1,10/06/2011 18:31:58:288,False,0,0,0,BLUETOOTH_DEVICE_STATE,INCOMING_CALL_ESTABLISH
1,10/06/2011 18:31:58:486,False,0,0,0,CALL_CONTROL_DEVICE_RX,UNKNOWN MESSAGE: DO ANSWER OK
1,10/06/2011 18:31:58:727,False,0,0,0,HFP_ANSWER_STATUS,SUCCESS
1,10/06/2011 18:31:59:416,False,0,0,0,CALL_CONTROL_DEVICE_STATE,ACTIVE_CALL
1,10/06/2011 18:31:59:418,False,0,0,0,BLUETOOTH_DEVICE_STATE,ACTIVE_CALL_SCO
1,10/06/2011 18:32:18:745,False,0,0,0,AUDIO_VERIFICATION,0,PASS
1,10/06/2011 18:32:55:162,False,0,0,0,CALL_CONTROL_DEVICE_STATE,READY
```

Figure 8-31 - Nomad Test Log

8.9 Waveform Analysis with the PESQ Tools GUI (Voice Quality Testing)

The **Psytechnics PESQ Tools GUI** is available for Nomad users wishing to perform detailed analysis of any waveform captured during **Voice Quality** testing. PESQ takes into account signal degradation caused by coding distortions, error, packet loss delay and filtering in analog network components. The **PESQ Tools GUI** can be useful in understanding why a sample was scored the way that it was. This section describes the operation of the GUI and the most relevant analyses that can be performed with the tool.

Note: This tool is only applicable to the PESQ scoring method. At this time, there is no comparable tool for POLQA.

Note: At this time, the **PESQ Tools GUI** is not being packaged within Nomad. Please contact Spirent Product Support to obtain the **PESQ Tools GUI** installation.

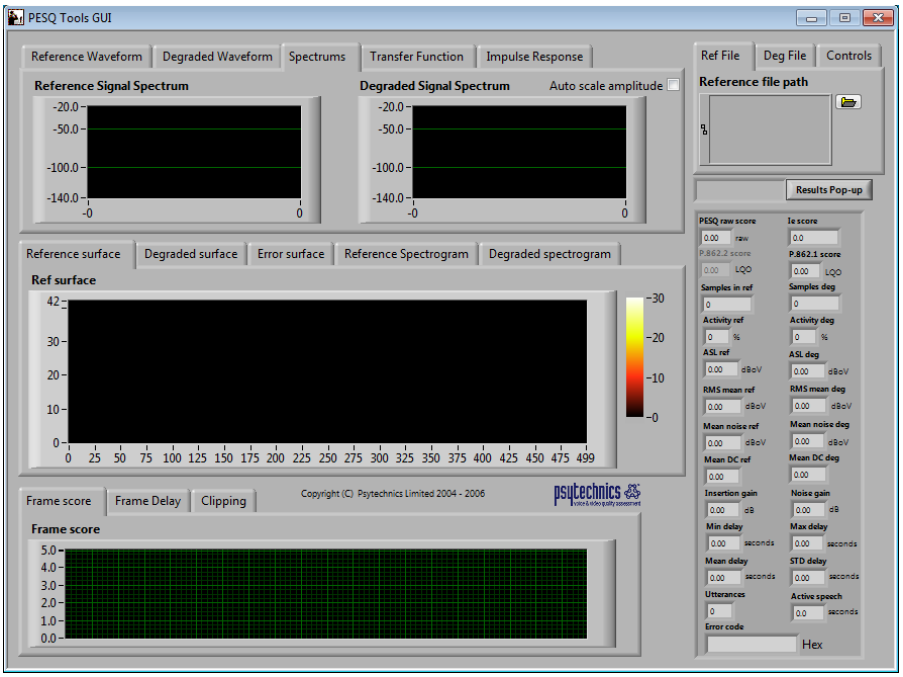


Figure 8-32 - PESQ Tools GUI

The PESQ algorithm calculates MOS by comparing audio samples degraded by the communication channel to the original source sample. Therefore, the PESQ Tools GUI requires both the original and the degraded samples as inputs. To analyze a degraded sample:

1. Open the Reference File
    - From the **Ref File** tab of the control panel, click on the **Open** button in the **Reference file path** area.
    - The standard audio scoring files are stored in the **C:\Program Files\Spirent Communications\Nomad\Audio Files** directory. Select **narr_usasts_107dB.wav** for narrowband handsets (8 kHz) or **wide_usasts_107dB.wav** for wideband handsets (16 kHz).
    - The **Hardware Sample Rate** (8 kHz or 16 kHz) can be confirmed on the Nomad **Settings → Voice Quality** tab.

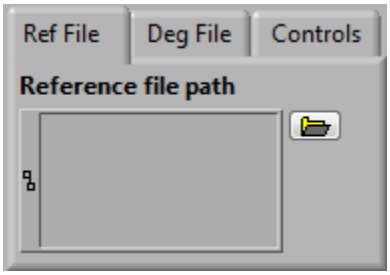


Figure 8-33 - Ref File Tab

2. Open the Degraded File
    - From the **Deg File** tab of the control panel, click on the **Open** button in the **Degraded file path** area.
    - Browse to the storage location for the degraded log file and open the file. Degraded session log files are stored in the **Log File Storage Location** specified in the **Start Logging Session Wizard** (see Section 6.4).

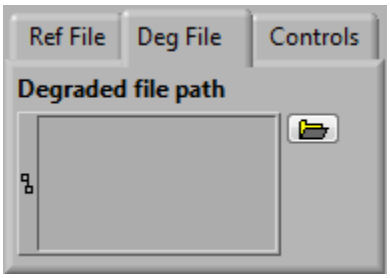


Figure 8-34 - Deg File Tab

3. Run the Analysis
    - On the **Controls** tab of the PESQ Tools GUI control panel click **Run** to run the analysis.

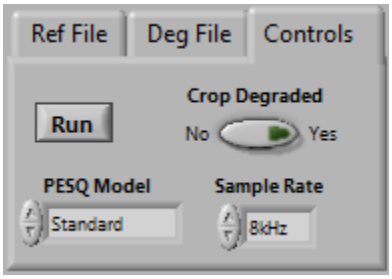


Figure 8-35 - Controls Tab

The **PESQ Tools GUI** can assist in the identification of issues that contribute to low MOS such as background noise and speech clipping. The case study in Appendix D illustrates how the PESQ Tools GUI can be used to identify these types of issues in a test file exhibiting low MOS results.

8.10 Troubleshooting Incomplete Data

On occasion, Nomad may be unsuccessful in merging the uplink and downlink data from a test session into a unified log file for report generation. Such files will appear on the **Data → Incomplete** tab at the conclusion of a test (successfully merged files appear on the **Data → Complete** tab).

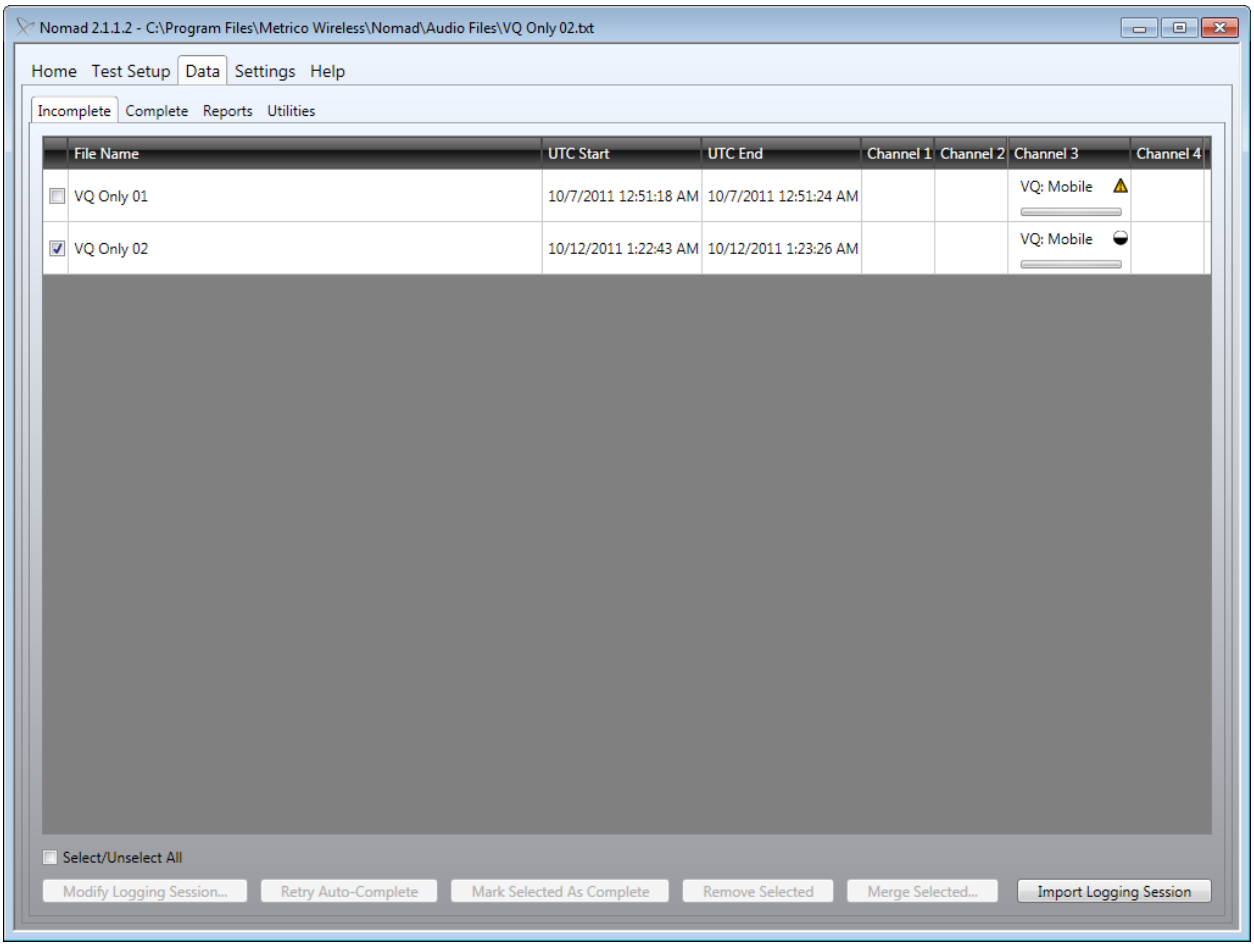


Figure 8-36 - Incomplete Session Files

Files on the **Incomplete** tab contain an icon signifying each problematic channel:

- The **half-circle** icon indicates that Nomad does not have access to all of the data required to merge this file. This might appear if no calls were started for a channel during a test. This might also appear in the case of a **Remote Unit** test where Nomad can access the locally collected data but not the remotely collected data.
- The **yellow triangle** icon indicates that an error has occurred during data collection preventing Nomad from merging the uplink and downlink data associated with this test case. The most common reason for this error is lack of internet connectivity at merge time. Another likely cause is the incorrect entry of the **Phone Number Settings** in the **Session** dialog on the **Test Setup Tab** (see Section 5.2.2).

Nomad provides several options to modify an incomplete logging session to render it suitable for report generation. Click on the ⚫ or ⚠ indicator icon to invoke the **Modify Incomplete Logging Session** dialog.

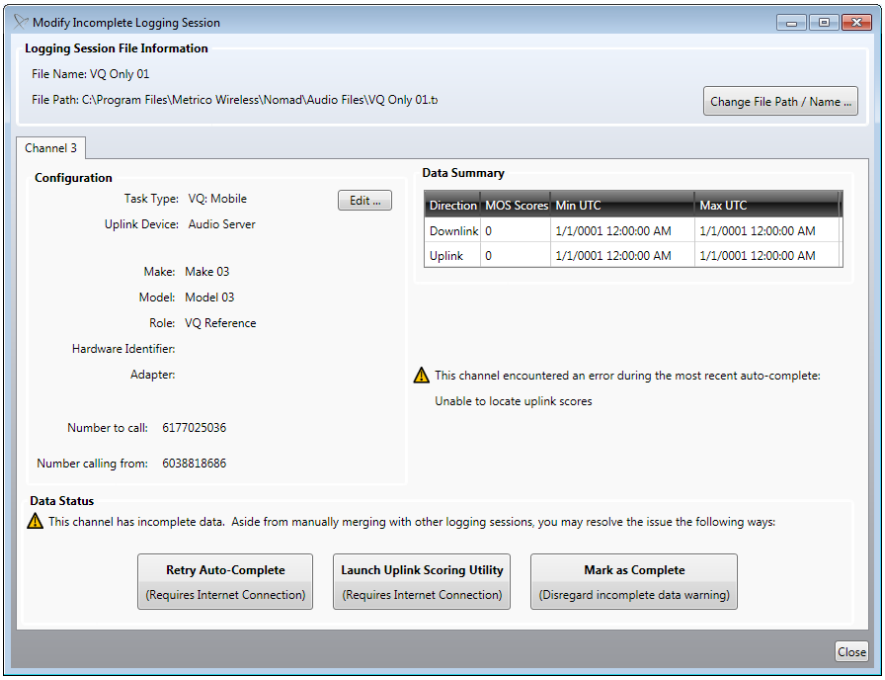


Figure 8-37 - Modify Incomplete Logging Session Dialog

To troubleshoot issues signified by the **yellow triangle** ⚠:

- If lack of internet connectivity is believed to be the reason for the ⚠ error, re-establish the internet connection and then use the **Retry Auto-Complete** button to merge the data and move to the **Complete** tab.
- If the ⚠ icon indicates **Unable to download uplink scores**, the **Phone Number Settings** for the session are likely incorrect. In this case, select the **Edit** button to **Edit Channel Configuration**. Enter the correct values for **Number to call** and **Number calling from** and then **Close** the dialog. Click **Retry Auto-Complete** to merge the data.

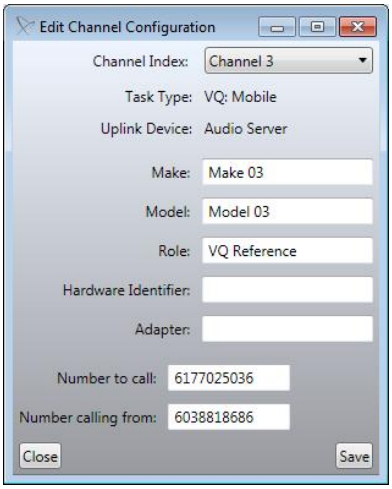


Figure 8-38 - Edit Channel Configuration Dialog

To troubleshoot other incomplete data issues:

- Data collected on a Remote Unit must be copied to the local machine for merging and report generation. Once these files are available locally:
  - Use the **Import Logging Session** button to display the data on the **Incomplete** tab.
  - Select both the local and remote data and choose **Merge Selected**.
  - The merged data will appear on the **Complete** tab and the report may be generated as described in Section 8.1.
- Some files that are unable to be merged automatically can still be merged using the **Uplink Scoring Utility**. See Section 8.9 for more information about using the **Uplink Scoring Utility**.
- If you believe that a channel has been flagged as incomplete in error, use the **Mark As Complete** option to disregard the incomplete data warning. Any report created using this button will be missing data. In this case, Voice Quality tests will be missing uplink scores or CDR data, while Mobile Terminated Call Performance tasks will be missing call server results. The **Mark As Complete** option should only be used if downlink data will be sufficient for analysis.

The **Retry Auto-Complete** and **Mark Selected As Complete** options are also available at the bottom of the **Data → Incomplete** tab. In general, incomplete data should be fixed before generating reports to ensure the integrity of the data.

8.11 Offline Scoring (Voice Quality Testing)

The ability to generate MOS outputs for .WAV files outside of an active test session is called **Offline Scoring**. Use **Offline Scoring** to retrieve .WAV files stored on the Audio Server when uplink results are not available during data collection and data must be retrieved after test completion. Uplink .WAV files are stored on the Audio Server for three weeks after collection.

To perform **Offline Scoring** for files located on the Audio Server, start by accessing the **Uplink Scoring Utility**:

- From the **Data → Utilities** tab, highlight **Uplink Offline Scoring** and click **Launch Utility**.
- Alternatively, access the **Uplink Scoring Utility** from the **Modify Incomplete Logging Session** dialog on the **Data → Incomplete** tab.

On the **Settings** screen of the **Uplink Scoring Utility**:

- Confirm that the Audio Server settings are correct using the **Validate Settings** button.
- Select the **Sample Rate** as either **8 kHz** (narrowband) or **16 kHz** (wideband).
- Select the **Scoring Model** as either **PESQ** or **POLQA**.
- Select the appropriate narrowband or wideband reference audio file from the Audio Files directory within the Nomad installation (likely **C:\Program Files\Spirent Communications\Nomad\Audio Files**)
- Select a **Logging Session** option:
    - **Create a new logging session using offline scoring**
        - This option creates a local uplink file based on data stored on the Audio Server for the selected call session and date / time range.
        - The uplink .WAV files are also downloaded to the local machine.
        - This option is to be used when the downlink file is not readily available, but the collection times are known.
        - This option might be selected when testing has been performed in the field, but an office-based engineer requires access to the uplink results and / or .WAV files.
        - See Section 8.9.1 to create a merged uplink file using this method.
    - **Retrieve complementary uplink data for an existing Logging Session**
        - This option creates a local merged uplink-downlink file based on data stored on the Audio server which corresponds to a locally stored downlink file.
        - The uplink .WAV files are also downloaded to the local machine.
        - This option is to be used when the downlink file corresponding to the desired uplink file is readily available.
        - This option might be selected when local access to the .WAV files is required.
        - See Section 8.9.2 to create a merged uplink file using this method.
- Click **Next** to continue.

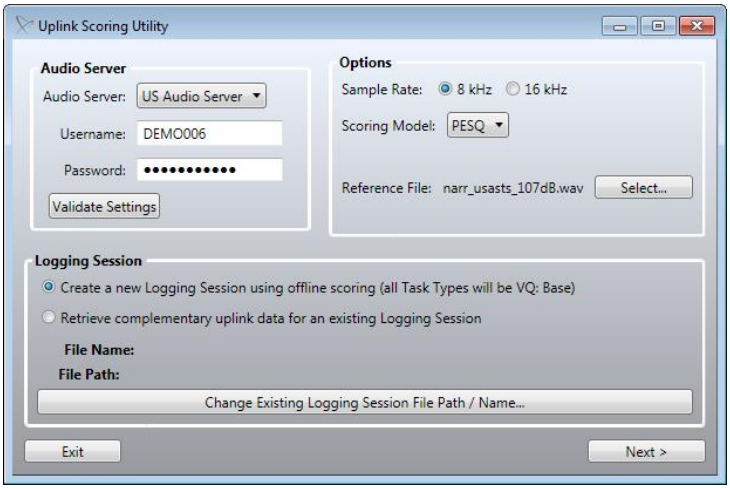


Figure 8-39 - Uplink Scoring Utility Settings Screen

8.11.1 Creating a New Logging Session Using Offline Scoring

On the **Session Selection Screen** of the **Uplink Scoring Utility**:

- Select the start and end date/time values in UTC. These can be found by opening the corresponding downlink log file and noting the timestamps of the first and last entries.
- **Enable** the channels for which to retrieve data.
- Specify the session(s) for which to retrieve the audio files. Each handset can be identified using the **{4 Digit DNIS}-{10 Digit ANI}-{MMDD}** convention with:
    - **{4 Digit DNIS}** – Last four digits of the Audio Server phone number called by the mobile.
    - **{10 Digit ANI}** – The phone number of the mobile phone being tested.
    - **{MMDD}** – The two digit month and two digit date.
- Click **Begin Scoring**.
- When the Offline Scoring process is complete, access the output file from the specified location. The file will also appear on the **Incomplete** tab where it can be marked as **Complete** for report generation.

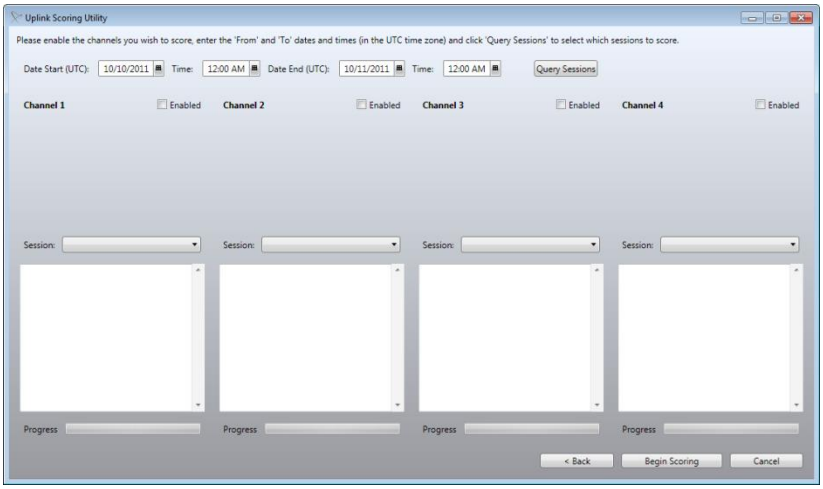


Figure 8-40 – Creating a New Logging Session Using Offline Scoring

8.11.2 Retrieving Complementary Uplink Data for an Existing Logging Session

On the **Session Selection Screen** of the **Uplink Scoring Utility**:

- **Enable** the channels for which to retrieve data.
- The details of the downlink voice quality task will appear for each channel, including start and end time of data collection.
- Specify the session(s) for which to retrieve the audio files. Each handset can be identified using the **{4 Digit DNIS}-{10 Digit ANI}-{MMDD}** convention with:
    - **{4 Digit DNIS}** – Last four digits of the Audio Server phone number called by the mobile.
    - **{10 Digit ANI}** – The phone number of the mobile phone being tested.
    - **{MMDD}** – The two digit month and two digit date.
- Click **Begin Scoring**.
- When the Offline Scoring process is complete, access the output file from the specified location. The file will also appear on the **Incomplete** tab where it can be marked as **Complete** for report generation.

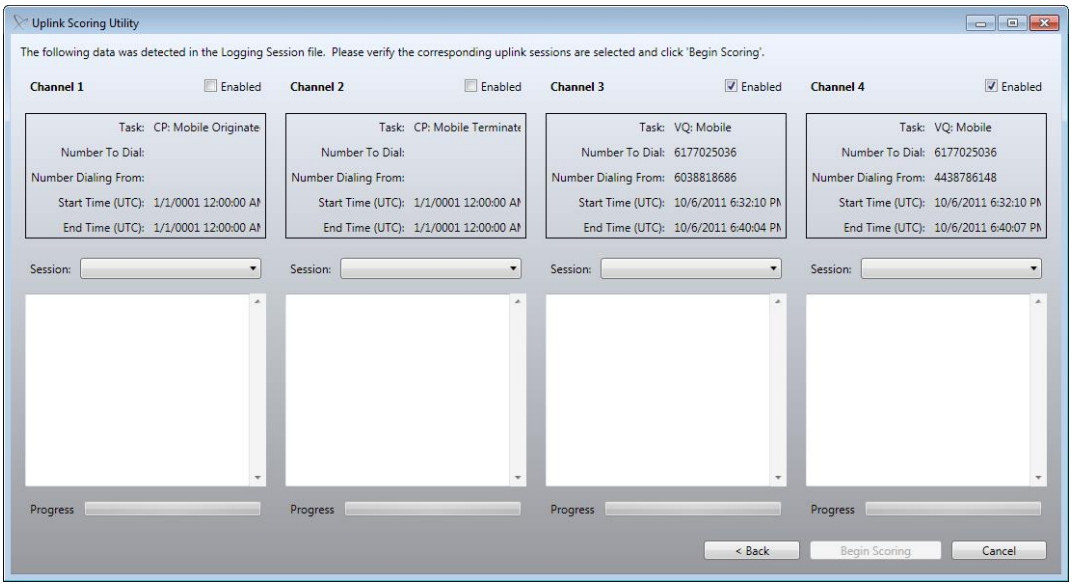


Figure 8-41 - Retrieving Complementary Uplink Data for an Existing Logging Session

8.12 Scoring PESQ and POLQA

It may be desirable to score Voice Quality test results using both the PESQ and POLQA scoring models. On the first pass, the data will always be scored using the **Scoring Model** specified in the test definition. These options exist to score the same data using the other **Scoring Model**:

- Re-Score Files
- Batch Scoring
- Uplink Offline Scoring

8.12.1 Re-Score Files

The **Re-score Files** option will re-process any file using the **Scoring Model** (PESQ or POLQA) not previously used. To re-score a file:

- On the **Data → Complete** tab, right-click on the file to re-score and select **Re-score Files**. Click **Next** to accept the files to re-score.

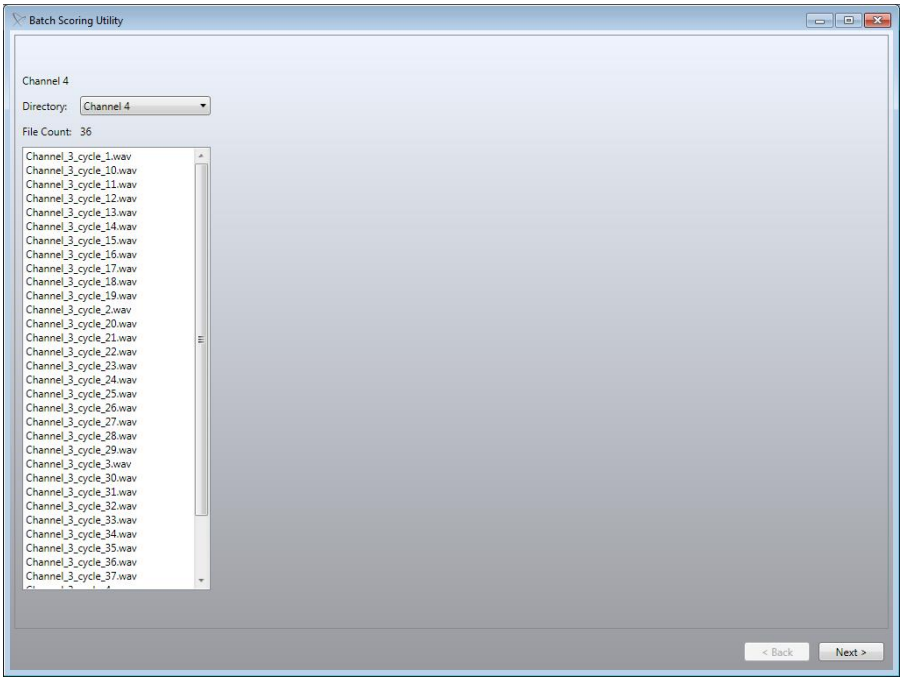


Figure 8-42 - Files to Re-score

- Click **Start Scoring** to begin processing the data.

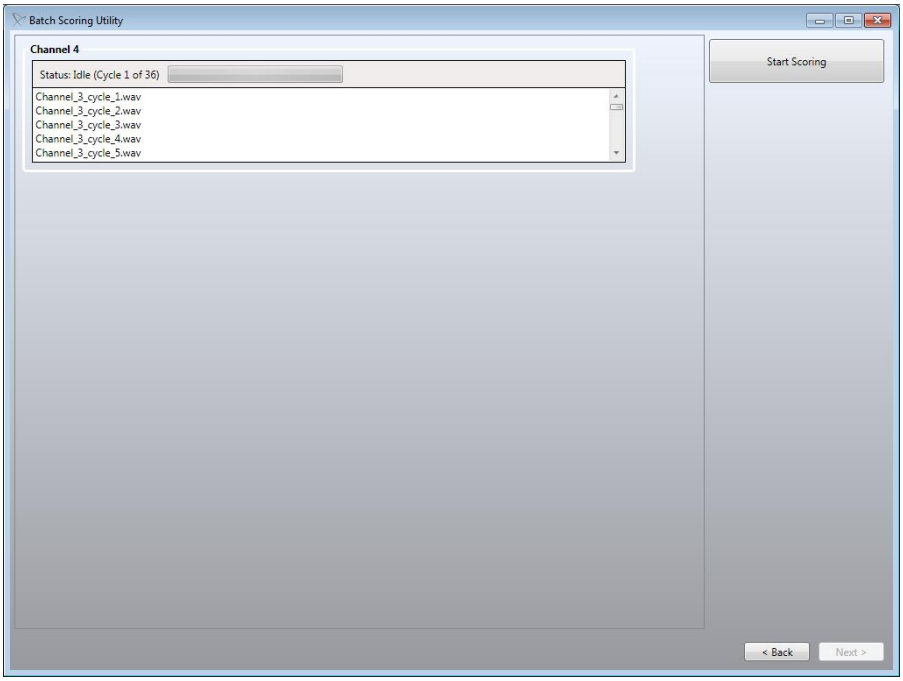


Figure 8-43 - Start Re-scoring

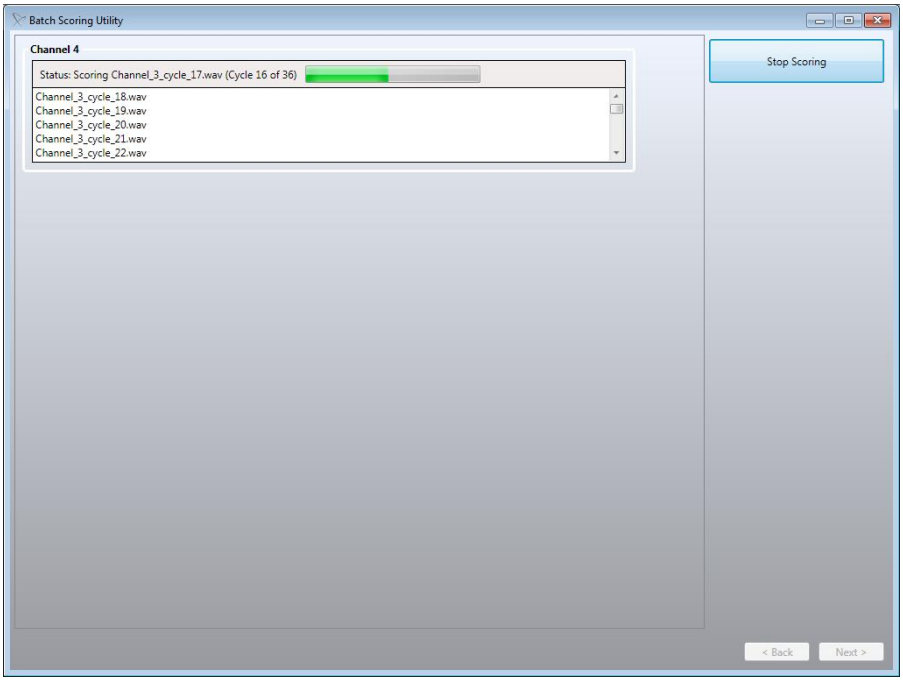


Figure 8-44 - Re-scoring in Progress

- Find the re-scored file on the **Data → Incomplete** tab. The file name will contain the word "rescored" for identification purposes.
- Use the **Retry Auto-Complete** button to move the re-scored file to the **Complete** tab.
- Generate a report from the re-scored file.

Nomad automatically detects and uses the **Scoring Model** not used to score the original file. For example, if POLQA was used to score the original file, PESQ will be used when re-scoring. The **Scoring Algorithm** in use can be verified on the **Voice Quality Summary** tab of the output report.

Note: Although the PESQ and POLQA results for the same file cannot be output to the same report, two output reports may be viewed side-by-side (or data copied from one to another) in order to compare results.

8.12.2 Batch Scoring

Nomad provides a **Batch Scoring Utility** to score multiple .WAV files using PESQ, POLQA or both. The output of this utility is a delimited text file that may be viewed in raw form, opened in Excel or parsed with a script. The **Batch Scoring Utility** may be used to score previously unprocessed files or for re-scoring.

Note: The Spirent ME hardware unit must be attached in order for the **POLQA** and **PESQ & POLQA** scoring options to be available in the **Batch Scoring Utility**.

To batch process with this utility:

- On the **Nomad Data → Utilities** tab, select **Batch Scoring** and click the **Launch Utility** button.
- Select the appropriate narrowband or wideband reference audio file from the Audio Files directory within the Nomad installation (likely **C:\Program Files\Spirent Communications\Nomad\Audio Files**).
- Select the **Scoring Algorithm** as **PESQ**, **POLQA** or **PESQ & POLQA**.
- Use the **Add Files** or **Add Directory** button to browse for and open the .WAV files to score.
- Click **Next** to accept the settings and proceed.

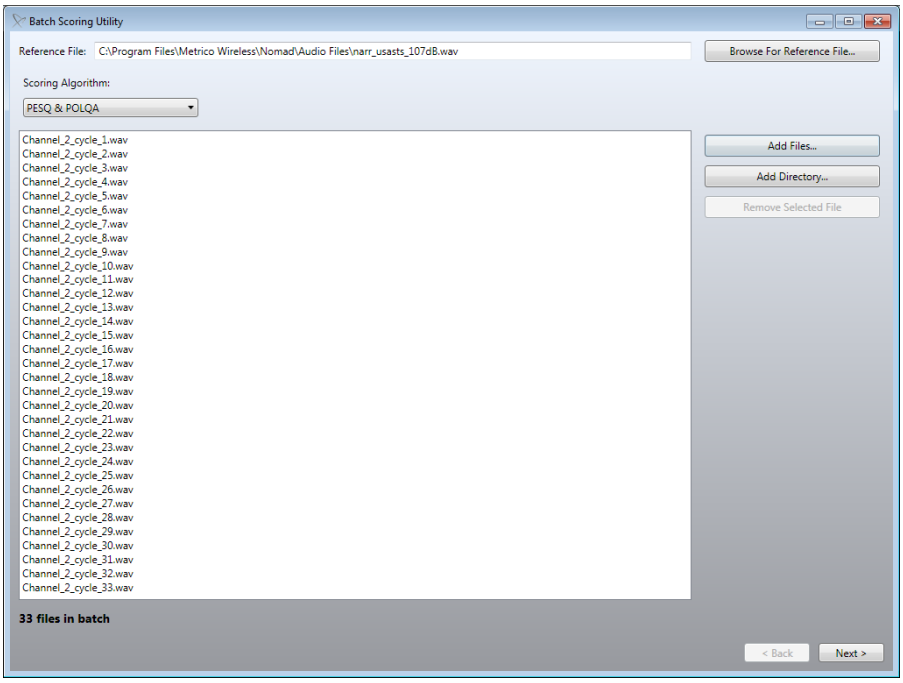


Figure 8-45 - Batch Scoring Configuration

- Click **Start Scoring** to accept the settings and proceed.

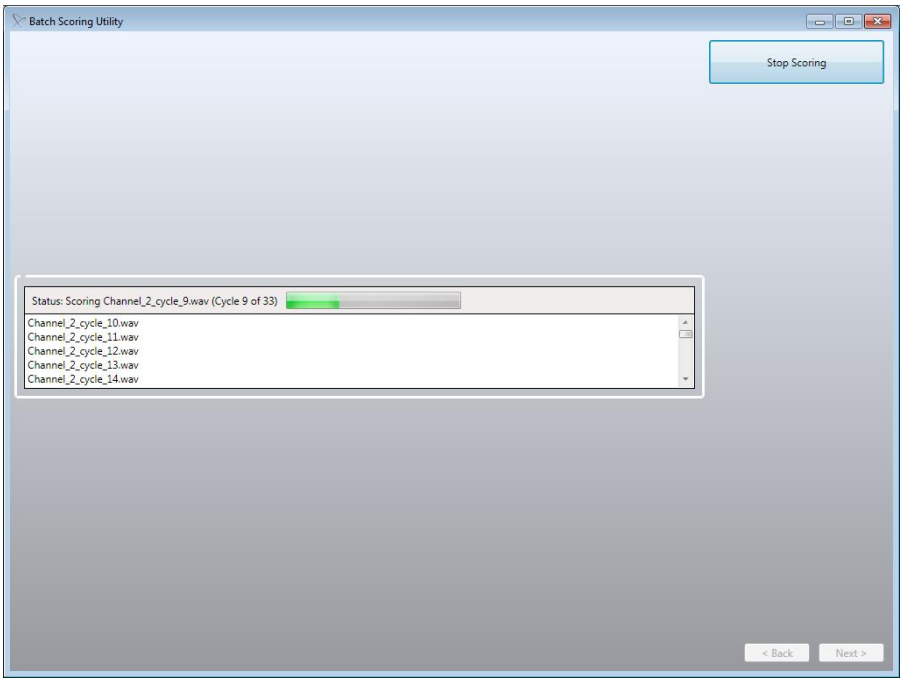


Figure 8-46 - Batch Scoring in Progress

- When scoring is complete, processing and MOS statistics will be presented for the selected scoring algorithm(s).

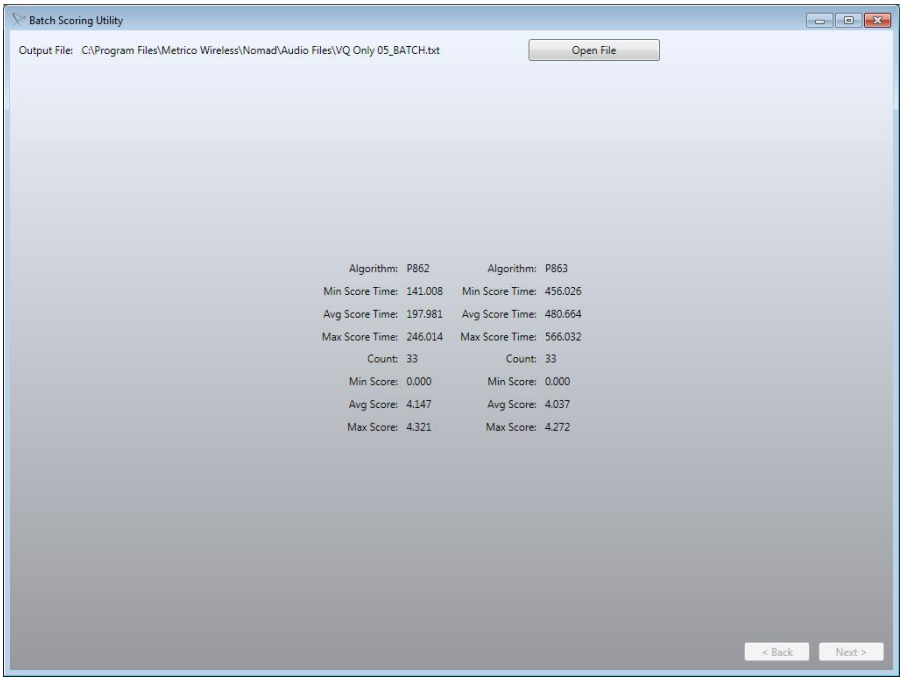
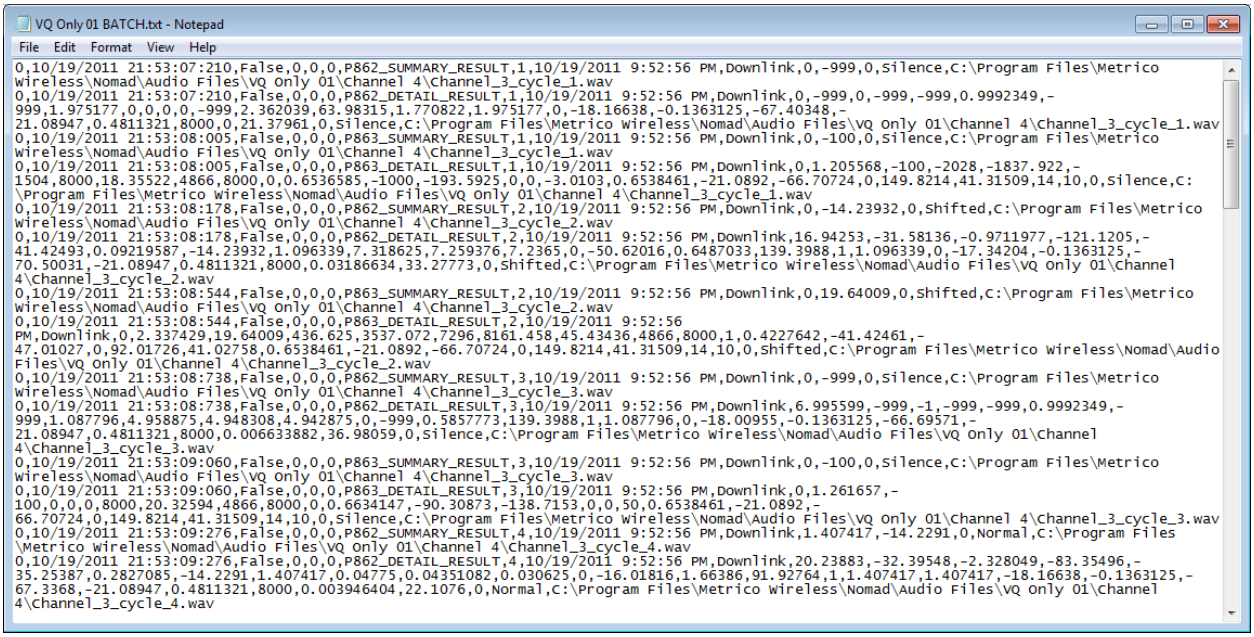


Figure 8-47 - Batch Scoring Complete

Use the **Open File** button to view the processed data. This delimited text file can be analyzed in its raw form, opened in Excel or used as the basis of a custom processing script.



VQ Only 01 BATCH.txt - Notepad

File Edit Format View Help

```
0,10/19/2011 21:53:07:210,False,0,0,0,P862_SUMMARY_RESULT,1,10/19/2011 9:52:56 PM,Downlink,0,-999,0,Silence,C:\Program Files\Metrico
Wireless\Nomad\Audio Files\VQ Only 01\Channel 4\Channel_3_cycle_1.wav
0,10/19/2011 21:53:07:210,False,0,0,0,P862_DETAIL_RESULT,1,10/19/2011 9:52:56 PM,Downlink,0,-999,0,-999,-999,0.9992349,-
999,1.975177,0,0,0,0,-999,2.362039,63.98315,1.770822,1.975177,0,-18.16638,-0.1363125,-67.40348,-
21.08947,0.4811321,8000,0,21.37961,0,Silence,C:\Program Files\Metrico Wireless\Nomad\Audio Files\VQ Only 01\Channel 4\Channel_3_cycle_1.wav
0,10/19/2011 21:53:08:005,False,0,0,0,P863_SUMMARY_RESULT,1,10/19/2011 9:52:56 PM,Downlink,0,-100,0,Silence,C:\Program Files\Metrico
Wireless\Nomad\Audio Files\VQ Only 01\Channel 4\Channel_3_cycle_1.wav
0,10/19/2011 21:53:08:005,False,0,0,0,P863_DETAIL_RESULT,1,10/19/2011 9:52:56 PM,Downlink,0,1.205568,-100,-2028,-1837.922,-
1504,8000,18.35522,4866,8000,0,0.6536585,-1000,-193.5925,0,0,-3.0103,0.6538461,-21.0892,-66.70724,0,149.8214,41.31509,14,10,0,Silence,C:
\Program Files\Metrico Wireless\Nomad\Audio Files\VQ Only 01\Channel 4\Channel_3_cycle_1.wav
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Wireless\Nomad\Audio Files\VQ Only 01\Channel 4\Channel_3_cycle_2.wav
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70.50031,-21.08947,0.4811321,8000,0.03186634,33.27773,0,Shifted,C:\Program Files\Metrico Wireless\Nomad\Audio Files\VQ Only 01\Channel
4\Channel_3_cycle_2.wav
0,10/19/2011 21:53:08:544,False,0,0,0,P863_SUMMARY_RESULT,2,10/19/2011 9:52:56 PM,Downlink,0,19.64009,0,Shifted,C:\Program Files\Metrico
Wireless\Nomad\Audio Files\VQ Only 01\Channel 4\Channel_3_cycle_2.wav
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PM,Downlink,0,2.337429,19.64009,436.625,3537.072,7296,8161.458,45.43436,4866,8000,1,0.4227642,-41.42461,-
47.01027,0,92.01726,41.02758,0.6538461,-21.0892,-66.70724,0,149.8214,41.31509,14,10,0,Shifted,C:\Program Files\Metrico Wireless\Nomad\Audio
Files\VQ Only 01\Channel 4\Channel_3_cycle_2.wav
0,10/19/2011 21:53:08:738,False,0,0,0,P862_SUMMARY_RESULT,3,10/19/2011 9:52:56 PM,Downlink,0,-999,0,Silence,C:\Program Files\Metrico
Wireless\Nomad\Audio Files\VQ Only 01\Channel 4\Channel_3_cycle_3.wav
0,10/19/2011 21:53:08:738,False,0,0,0,P862_DETAIL_RESULT,3,10/19/2011 9:52:56 PM,Downlink,6.995599,-999,-1,-999,-999,0.9992349,-
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21.08947,0.4811321,8000,0.006633882,36.98059,0,Silence,C:\Program Files\Metrico Wireless\Nomad\Audio Files\VQ Only 01\Channel
4\Channel_3_cycle_3.wav
0,10/19/2011 21:53:09:060,False,0,0,0,P863_SUMMARY_RESULT,3,10/19/2011 9:52:56 PM,Downlink,0,-100,0,Silence,C:\Program Files\Metrico
Wireless\Nomad\Audio Files\VQ Only 01\Channel 4\Channel_3_cycle_3.wav
0,10/19/2011 21:53:09:060,False,0,0,0,P863_DETAIL_RESULT,3,10/19/2011 9:52:56 PM,Downlink,0,1.261657,-
100,0,0,0,8000,20.32594,4866,8000,0,0.6634147,-90.30873,-138.7153,0,0,50,0.6538461,-21.0892,-
66.70724,0,149.8214,41.31509,14,10,0,Silence,C:\Program Files\Metrico Wireless\Nomad\Audio Files\VQ Only 01\Channel 4\Channel_3_cycle_3.wav
0,10/19/2011 21:53:09:276,False,0,0,0,P862_SUMMARY_RESULT,4,10/19/2011 9:52:56 PM,Downlink,1.407417,-14.2291,0,Normal,C:\Program Files
\Metrico Wireless\Nomad\Audio Files\VQ Only 01\Channel 4\Channel_3_cycle_4.wav
0,10/19/2011 21:53:09:276,False,0,0,0,P862_DETAIL_RESULT,4,10/19/2011 9:52:56 PM,Downlink,20.23883,-32.39548,-2.328049,-83.35496,-
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67.3368,-21.08947,0.4811321,8000,0.003946404,22.1076,0,Normal,C:\Program Files\Metrico Wireless\Nomad\Audio Files\VQ Only 01\Channel
4\Channel_3_cycle_4.wav
```

Figure 8-48 - Batch Scoring Output

8.12.3 Offline Scoring

The Nomad **Offline Scoring** utility provides a method of retrieving and scoring uplink .WAV files from the Audio Server outside of an active test session. Files processed using Offline Scoring may be scored using either PESQ or POLQA.

Note: The Spirent ME hardware unit must be attached in order for the POLQA scoring option to be available in the **Offline Scoring Utility**.

Offline scoring can be used to score previously unprocessed files or for re-scoring. Select the **Scoring Model** on the **Uplink Scoring Utility Settings Screen** to choose between PESQ and POLQA.

See Section 8.9 for detailed information about the Uplink Offline Scoring utility.

9 Voice Quality Configuration Options

Nomad provides numerous configuration options for voice quality testing. These options include:

- Voice Quality Test Calibration
- Audio Server Testing
- Mobile-to-Mobile Testing
- Remote Unit Testing
- Landline Module Testing
- Base Station Simulator Testing
- Head and Torso Simulator Testing
- Wideband Testing
- Multi-RAB Testing
- Voice Delay Testing
- Adapter Kit

This section contains detailed instructions for each voice quality configuration option.

9.1 Voice Quality Test Calibration

Spirent Communications recommends calibrating the Spirent ME or Spirent HD ME hardware used with the Nomad system prior to testing for the first time to verify proper operation. To calibrate the system:

- Connect the provided **Calibration Cable** between **Channel 1** and **Channel 2** on the Spirent ME unit or between **NB1** and **NB2** (narrowband) on the Spirent HD ME unit or between **HD1** and **HD2** (high definition) on the Spirent HD ME unit.
- On the Nomad **Test Setup** screen, configure **Channel 1** as a **Mobile** task with the following settings:
    - **Session → Uplink Device:** Base task on channel 2
    - **Channel Settings → Audio interface for this channel:** Analog Interface for Nomad ME Units, Narrowband or High Definition for Nomad HD ME units.
    - **Channel Settings → Input Level:** 225
    - **Channel Settings → Output Level:** 180
    - **Channel Settings → Microphone Detect Mode:** Confirm that this option is unchecked
- On the Nomad Test Setup screen, configure **Channel 2** as a **Base** task with the following settings:
    - **Session → Downlink Device:** Base task on channel 1
    - **Channel Settings → Audio interface for this channel:** Analog Interface for Nomad ME Units, Narrowband or High Definition for Nomad HD ME units.
    - **Channel Settings → Input Level:** 225
    - **Channel Settings → Output Level:** 180
    - **Channel Settings → Microphone Detect Mode:** Confirm that this option is unchecked
- Start a new test. The resulting **MOS** values for **Channel 1** and **Channel 2** should be **4.542** or higher, representing perfect audio. If this is the case, the unit has passed.
- Connect the **Calibration Cable** between **Channel 3** and **Channel 4** on the Spirent ME unit and repeat the test.

In the formatted Nomad output report generated with calibration test data, find results for audio received at **Channel 1** in the **Channel 1 – DL** area. Find results for audio received at **Channel 2** in the **Channel 1 – UL** area.

Figure 9-1 – Hardware Configuration for Voice Quality Test Calibration on a Nomad ME unit

9.2 Audio Server Testing

Spirent Communications provides access to a centralized call server that sources downlink data and records uplink data in the audio server testing configuration. The mobile handset will source speech while the audio server will record and score the uplink speech sample for ten seconds. In the next ten second cycle, the audio server will source speech while the mobile handset records and scores the downlink speech sample.

To perform Audio Server testing:

- Connect the test handset to any active channel on the Spirent ME hardware unit via audio cable or Bluetooth.
- On the Nomad **Test Setup** screen, configure that channel as a **Mobile** task with the following settings:
  - **Session → Uplink Device**: Audio Server
  - **Channel Settings → Audio interface for this channel**: Analog Interface(ME), Narrowband (ME HD), High Definition (ME HD) or Bluetooth Interface as desired. Note that a maximum of two Bluetooth devices is permitted for Voice Quality testing at one time.
- If the test mobile is connected via analog audio cable, volume settings may be optimized using **Auto-Level Assist**.
- Click the **Start Logging Session** button and proceed through the **Start Logging Session Wizard**.
- At the conclusion of the **Start Logging Session Wizard**, Nomad will automatically place test calls for devices which are connected via Bluetooth and which have been configured for auto-dial on the **Settings → Voice Quality** tab. All other calls must be manually placed to the Audio Server.
- The test sequence starts with the mobile handset sourcing data to the Audio Server.
- In the second half of the cycle, the Audio Server will source data to the mobile handset. Downlink data collected at the handset is displayed in the **Voice Quality Task Status Window** during the following cycle.

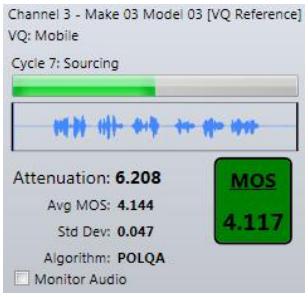


Figure 9-2 - Voice Quality Task Status Window

- During testing, adjust the downlink volume using the **Settings → Levels** dialog such that the **Insertion Gain** (PESQ) or **Attenuation** (POLQA) falls as close to 0 as possible. The **Input** slider should sit within the **Normal Operating Range** values displayed.
- End the test when desired.

Test results can be found on the **Voice Quality Summary** tab of the output report.

9.3 IMS Client Testing

Nomad provides the option for Utilizing a local IMS Client as the Uplink Device. The mobile handset will source speech while the IMS Client will record the uplink speech sample for ten seconds, acting in the traditional role as the voice server. In the next ten second cycle, the IMS client will source speech while the mobile handset records the downlink speech sample. The uplink and downlink speech sample recordings are scored by Nomad.

To perform testing utilizing the local IMS Client as Uplink Device:

- Connect the test handset to any active channel on the Spirent ME hardware unit via audio cable or Bluetooth.
- On the Nomad **Test Setup** screen, configure that channel as a **Mobile** task with the following settings:
  - **Session → Uplink Device**: IMS Client
  - **Channel Settings → Audio interface for this channel**: Analog Interface(ME), Narrowband (ME HD), High Definition (ME HD) or Bluetooth Interface as desired. Note that a maximum of two Bluetooth devices is permitted for Voice Quality testing at one time.
- Click the **Start Logging Session** button and proceed through the **Start Logging Session Wizard**.
- The test sequence starts with the mobile handset sourcing data to the IMS Client.
- In the second half of the cycle, the IMS Client will source data to the mobile handset. Downlink data collected at the handset is displayed in the **Voice Quality Task Status Window** during the following cycle.

- During testing, adjust the downlink volume using the **Settings → Levels** dialog such that the **Insertion Gain** (PESQ) or **Attenuation** (POLQA) falls as close to 0 as possible. The **Input** slider should sit within the **Normal Operating Range** values displayed.
- End the test when desired.

Test results can be found on the **Voice Quality Summary** tab of the output report.

9.4 Mobile-to-Mobile Testing

Nomad provides the option for Mobile-to-Mobile testing. One handset will source speech while the other will record speech for ten seconds. The process will alternate in the next ten second cycle. Both the sourcing and recording is handled by a single Nomad installation.

To perform Mobile-to-Mobile testing:

- Connect one handset to **Channel 1** of the Spirent ME hardware unit via audio cable. Connect the second handset to **Channel 2**.

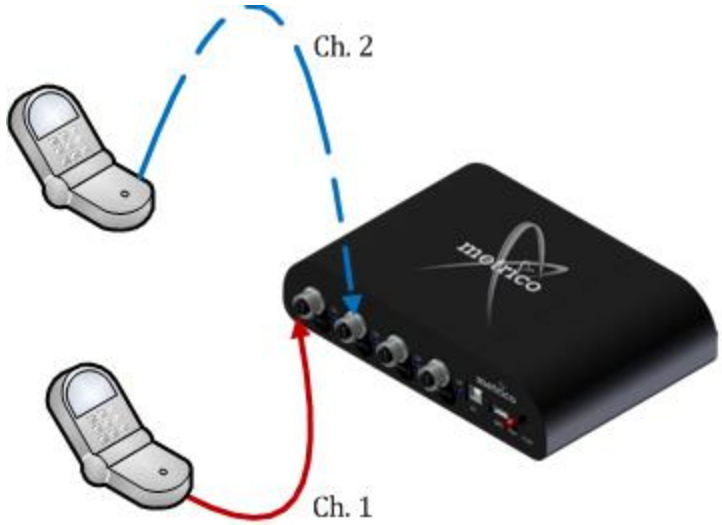


Figure 9-3 - Mobile-to-Mobile Hardware Configuration

- On the Nomad **Test Setup** screen, configure **Channel 1** as a **Mobile** task with the following settings:
  - **Session → Uplink Device:** Base task on channel 2
  - **Channel Settings → Audio interface for this channel:** Analog Interface(ME), Narrowband (ME HD) or High Definition (ME HD)
- On the Nomad **Test Setup** screen, configure **Channel 2** as a **Base** task with the following settings:
  - **Session → Downlink Device:** Mobile task on channel 1
  - **Channel Settings → Audio interface for this channel:** Analog Interface(ME), Narrowband (ME HD) or High Definition (ME HD)
- Confirm that Channel 1 and Channel 2 use the same **Scoring Model**. Both channels must be set for either PESQ or POLQA in the **Session** dialog.
- Place a call from **Handset 1** to **Handset 2**. The incoming call must be manually answered.
- Start a new test.
- The test sequence starts with **Handset 1** sourcing data to **Handset 2**. Data collected at **Handset 2** will be replayed in the **Channel 2** area of the Nomad interface.
- In the next cycle, **Handset 2** will source data to **Handset 1**. Data collected at **Handset 1** will be replayed in the **Channel 1** area of the Nomad interface. This pattern continues throughout the duration of the test.
- During testing, adjust volume using the **Settings → Levels** dialog such that the **Ins Gain** (PESQ) or **Attenuation** (POLQA) reading for each channel falls as close to 0 as possible. The **Input** and **Output** sliders should sit within the **Normal Operating Range** values displayed.
- End the test when desired.

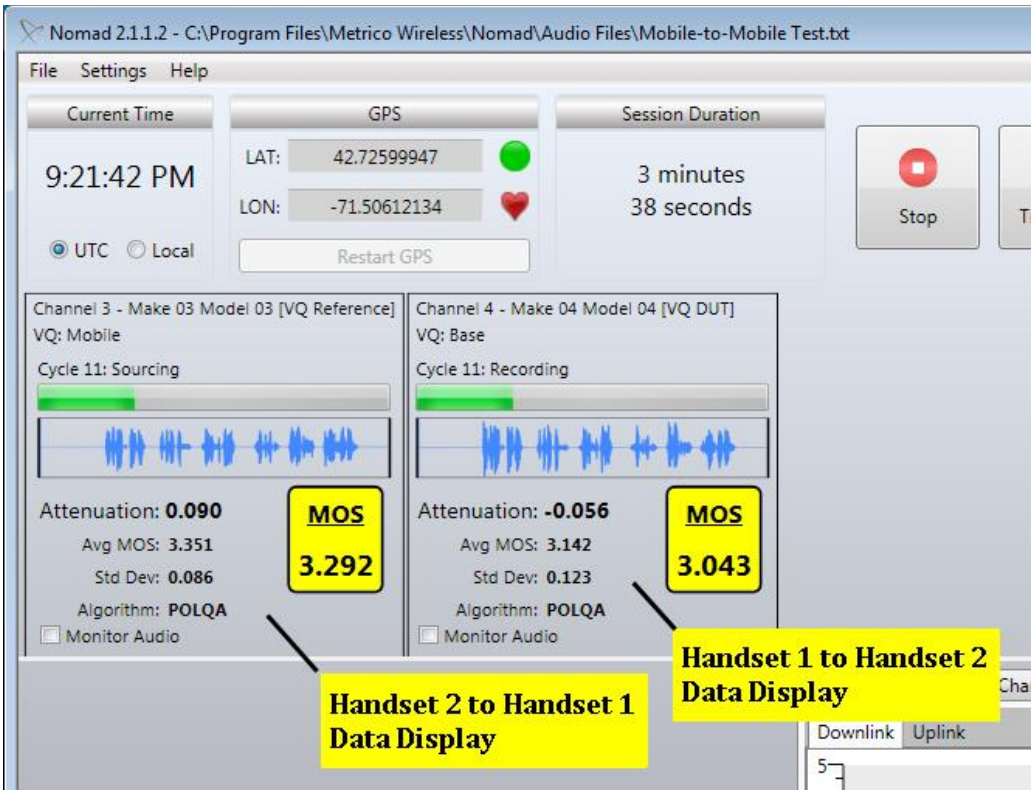


Figure 9-4 - Mobile-to-Mobile Testing

Assuming all four channels are available for testing, a second Mobile-to-Mobile test may be performed simultaneously on **Channel 3** and **Channel 4**. Configure this test following the same instructions as above.

In the Nomad output report generated with Mobile-to-Mobile test data, find results for audio received at **Channel 1** in the **Channel 1 – DL** area. Find results for audio received at **Channel 2** in the **Channel 1 – UL** area.

9.5 Remote Unit Testing

Nomad provides the option for Remote Unit testing. In this configuration, a handset connected to the local Spirent ME hardware unit sources audio to and receives audio from a handset connected to a second hardware unit. In many cases, the second hardware unit is located remotely (i.e. in another office or city). One handset will source speech while the other will record speech for ten seconds. The process will alternate in the next ten second cycle.

To perform Remote Unit hardware testing:

- Connect one handset to **Channel 1**(ME), **NB1** (ME HD) **or HD1** (ME HD) on the local Spirent ME or HD ME hardware unit.
- Connect the second to **Channel 1**(ME), **NB1** (ME HD) **or HD1** (ME HD) on the second Spirent ME or HD ME hardware unit.
- If the second hardware unit is located remotely, ask a colleague for assistance in setting up that unit.

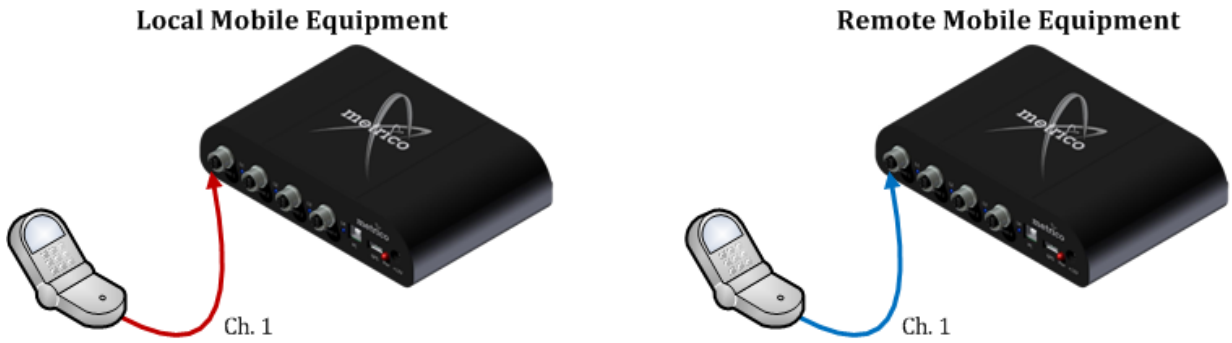


Figure 9-5 - Remote Unit Hardware Configuration for a Spirent ME unit

- In the local Nomad software, configure **Channel 1** as a **Mobile** task with the following setting:
  - **Session → Uplink Device:** Base task on remote unit
- In the remotely located Nomad software, configure **Channel 1** as a **Base** task with the following setting:
  - **Session → Downlink Device:** Mobile task on remote unit
- Confirm that both test channels use the same **Scoring Model**. Both channels must be set for either PESQ or POLQA in the **Session** dialog.
- If testing is performed using Spirent HD ME hardware, make sure the proper Audio interface (High definition or Narrowband) is selected.
- Place a call from **Handset 1** to **Handset 2**. The incoming call must be manually answered.
- Start a new test.
- The test sequence starts with the local handset sourcing data to the remote handset. Data collected at the remote handset will be displayed in **Channel 1** of the remote Nomad installation.
- In the next cycle, the remote handset will source data to the local handset. Data collected at the local handset will be displayed in **Channel 1** of the local Nomad installation.
- During testing, adjust volume using the **Settings → Levels** dialog such that the **Ins Gain** (PESQ) or **Attenuation** (POLQA) reading for each channel falls as close to 0 as possible. The **Input** and **Output** sliders should sit within the **Normal Operating Range** values displayed.

- End the test when desired.

Assuming all four channels are available for testing, up to four Remote Unit test calls may be placed simultaneously. Spirent Communications recommends aligning calling handsets on the local unit with the receiving handsets on the remote unit. For example, **Handset 1** on the local unit should call **Handset 1** on the remote unit; **Handset 2** on the local unit should call **Handset 2** on the remote unit, etc.

To merge the local and remote data into a single file for report generation:

- Obtain the remotely collected log file via email or other file transfer method.
- Because Nomad will have access to only the locally collected data (not the data collected remotely), the locally collected file will appear on the **Data → Incomplete** tab after collection is stopped.
- Use the **Import Logging Session** button to find and open the remotely collected log file.
- On the **Data → Incomplete** tab, select both the locally collected file and the remotely collected file.
- Click the **Merge Selected** button to merge the two files into one file that will appear on the **Data → Complete** tab and which can be used to generate a formatted output report.

In the formatted output report generated with Remote Unit test data, find results for locally received audio in the **Channel 1 – DL** area. Find results for remotely received audio in the **Channel 1 – UL** area.

9.6 Landline Module Testing

The Nomad Landline Module provides an additional option for voice quality testing without needing the Audio Server to handset uplink data collection and downlink audio sourcing. In the Landline Module configuration, the mobile end consists of the standard test handset and Spirent ME unit connected to a laptop which handles downlink data collection and uplink audio sourcing. The landline end consists of the Nomad Landline Module hardware with analog phone connections as the communications links and a computer for handling uplink data collection and downlink audio sourcing.

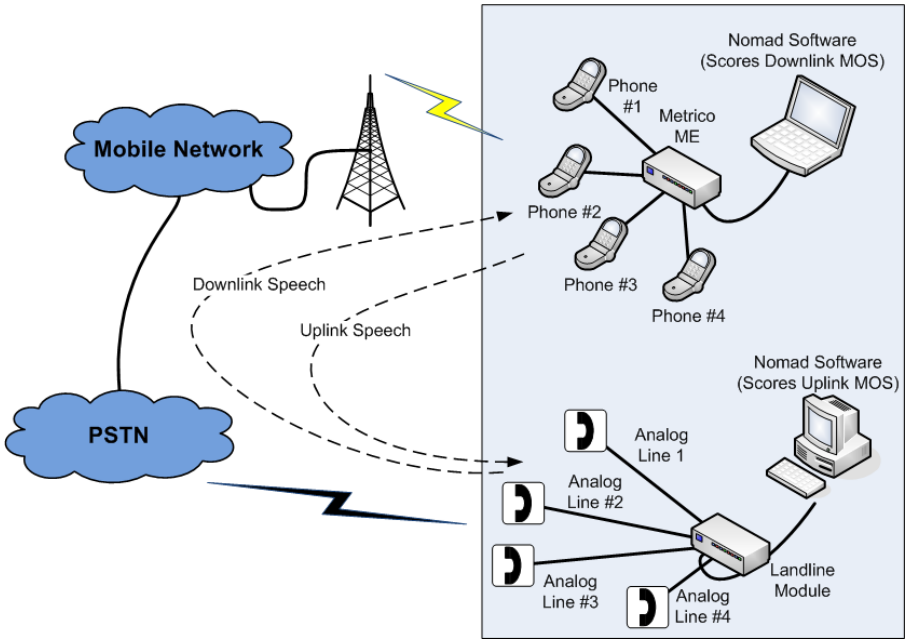


Figure 9-6 - System Configuration for Landline Module Testing

The Nomad setup and configuration for both the mobile and landline end are identical to the Remote Unit testing configuration described in Section 9.3. The only difference is that each test call is made from the handset at the mobile end to the corresponding analog phone line on the Landline Module. For the best results, Spirent Communications recommends dialing **Line 1** using the handset on **Channel 1**, **Line 2** with **Channel 2**, etc. Assuming all four channels are available for testing, up to four Landline Module test calls may be placed simultaneously.

9.7 Base Station Simulator Testing

The Rohde & Schwarz CMU200 and the Agilent 8690 are two commercial base station simulators commonly used to simulate radio conditions in a test lab. An optional Nomad upgrade provides the cables required to interface to these pieces of equipment for degraded channel, noise cancellation and other test scenarios. This interface allows the test handset to perform both sourcing and recording functions, enabling handset testing without a landline voice server. Please contact your Spirent Communications representative for additional information on this option.

To configure Nomad to work with a base station simulator:

- Load the desired test conditions into the simulator. Please see the manufacturer's documentation for simulator configuration details.
- Connect the test handset to **Channel 1** on the Spirent ME hardware unit or **NB1/HB1** on the Spirent HD ME Unit.
- Connect the audio cable provided by Spirent Communications from the base station simulator to **Channel 2** on the Spirent ME hardware unit or **NB2/HB2** on the Spirent HD ME Unit.
-

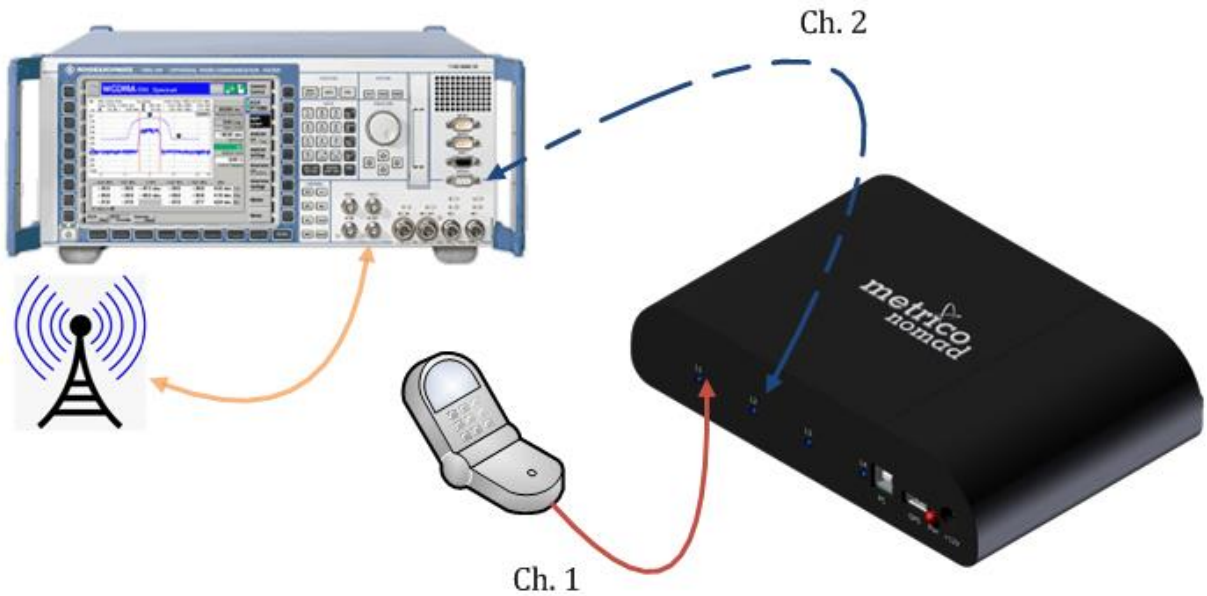


Figure 9-7 - Base Station Simulator Hardware Configuration

- On the Nomad **Test Setup** screen, configure **Channel 1** as a **Mobile** task with the following setting:
  - **Session → Uplink Device:** Base task on channel 2
- On the Nomad **Test Setup** screen, configure **Channel 2** as a **Base** task with the following settings:
  - **Session → Downlink Device:** Mobile task on channel 1
  - **Channel Settings → Input:** 205
  - **Channel Settings → Output:** 195
- Confirm that both test channels use the same **Scoring Model**. Both channels must be set for either PESQ or POLQA in the **Session** dialog.

- If testing is performed using Spirent HD ME hardware, make sure the proper Audio interface (High definition or Narrowband) is selected.
- Establish a call between the handset and the base station simulator.
- Start a new test.
- The test sequence starts with the handset sourcing data to the base station simulator. Data collected at the simulator will be replayed in the **Channel 2** area of the Nomad interface.
- In the next cycle, the simulator will source data to the handset. Data collected by the handset will be replayed in the **Channel 1** area of the Nomad interface. This pattern continues throughout the duration of the test.

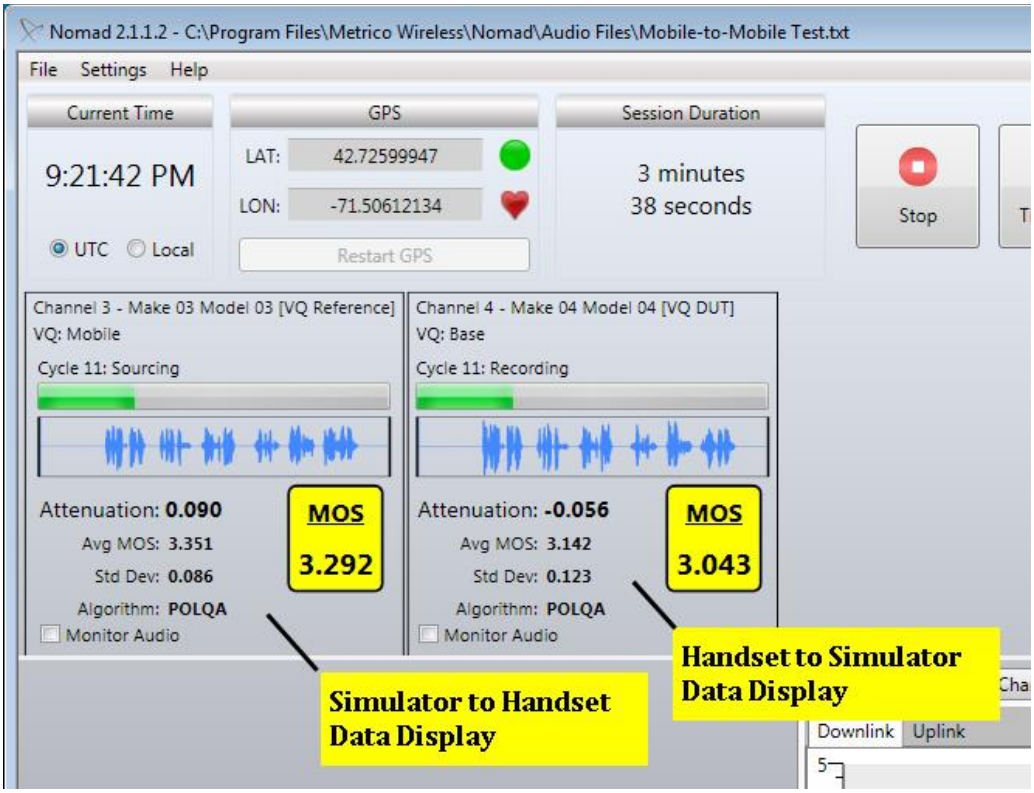


Figure 9-8 - Base Station Simulator Testing

- During testing, adjust **Channel 1** volume using the **Settings** → **Levels** dialog. Adjust the **Channel 1 Input** level for optimal MOS performance of the **Channel 1** (handset) waveform. Adjust the **Channel 1 Output** level for optimal MOS performance of the **Channel 2** (simulator) waveform.
- End the test when desired.

In the formatted Nomad output report generated with base station simulator test data, find results for audio received at the handset in the **Channel 1 – DL** area. Find results for audio received at the simulator in the **Channel 1 – UL** area.

9.8 Head and Torso Simulator

A HATS system may be used in conjunction with the test mobile and base station simulator in Nomad testing to realistically simulate the effect of an adult head and torso on voice quality. The HATS system may be configured with the base station simulator in two different configurations. In each configuration, MOS results at the handset will be displayed in the Nomad **Channel 1** area during testing. Results at the base station simulator will be displayed in the **Channel 2** area. The following sections describe the hardware configuration and volume settings for the HATS configurations. All other test procedures follow the steps described for the base station simulator in Section 9.6.

Note: The **Input** and **Output** settings described in this section represent a general test case that has been performed in the Spirent lab. If you require settings corresponding to specific test cases, please contact your Spirent representative.

9.8.1 HATS Three Channel Configuration

The Spirent ME hardware shall be configured as show below for the HATS three channel configuration:

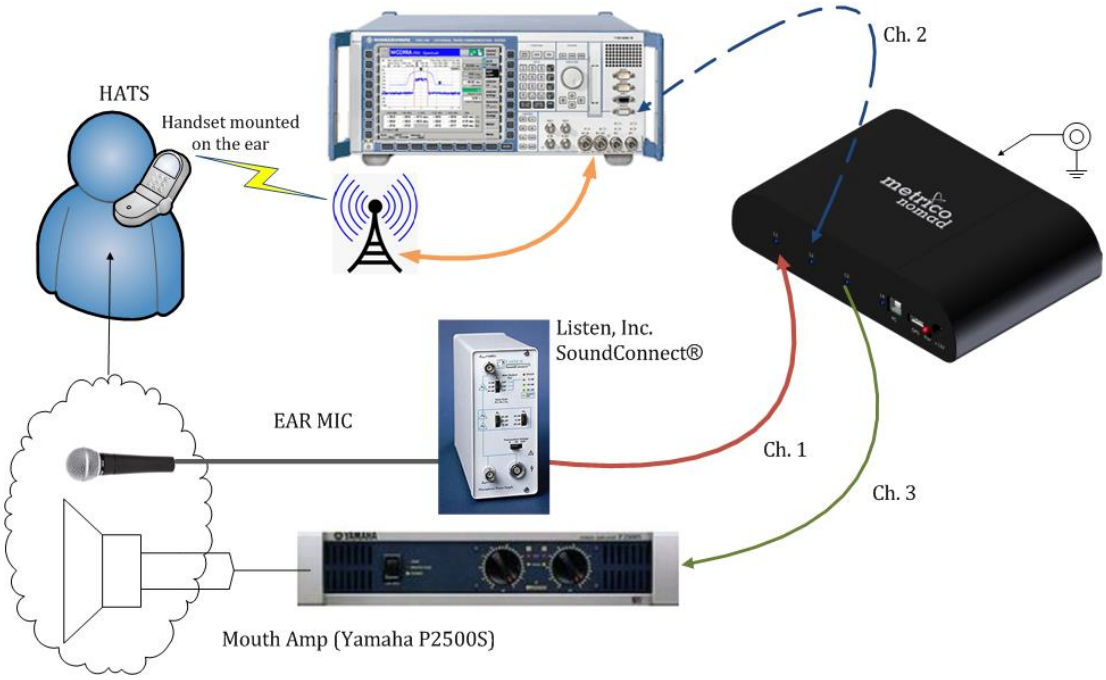


Figure 9-9 - HATS Three Channel Configuration

On the Nomad **Test Setup** tab, configure the channels as follows:

- **Channel 1** – Connects to Ear MIC – "Downlink"
  - **Task Type**: Mobile
  - **Session → Uplink Device:** Base task on channel 2
  - **Channel Settings → Audio interface for this channel:** Analog Interface(ME), Narrowband (ME HD) or High Definition (ME HD)
  - **Channel Settings → Input:** 210

    - **Channel Settings → Output:** 100
- **Channel 2** – Connects to base station simulator – "Uplink"
    - **Task Type**: Base
    - **Session → Downlink Device:** Mobile task on channel 1
    - **Channel Settings → Audio interface for this channel:** Analog Interface(ME), Narrowband (ME HD) or High Definition (ME HD)
    - **Channel Settings → Input:** 180
    - **Channel Settings → Output:** 200
- **Channel 3** – Connects to AMP and HATS mouth speaker – "mouth"
    - **Task Type**: Mobile
    - **Session → Uplink Device:** Base task on channel 4
    - **Channel Settings → Audio interface for this channel:** Analog Interface(ME), Narrowband (ME HD) or High Definition (ME HD)
    - **Channel Settings → Input:** 100
    - **Channel Settings → Output:** 200
- **Channel 4** – No hardware connections
    - **Task Type**: Base
    - **Session → Downlink Device:** Mobile task on channel 3
    - **Channel Settings → Audio interface for this channel:** Analog Interface(ME), Narrowband (ME HD) or High Definition (ME HD)
    - **Channel Settings → Input:** 100
    - **Channel Settings → Output:** 100

Finally, make these additional system adjustments:

- **Handset Volume:**
    - One level below max
- **Yamaha Amp Setting:**
    - 20 dB

9.8.2 HATS Two Channel Configuration

The Spirent ME hardware shall be configured as show below for the HATS two channel configuration:

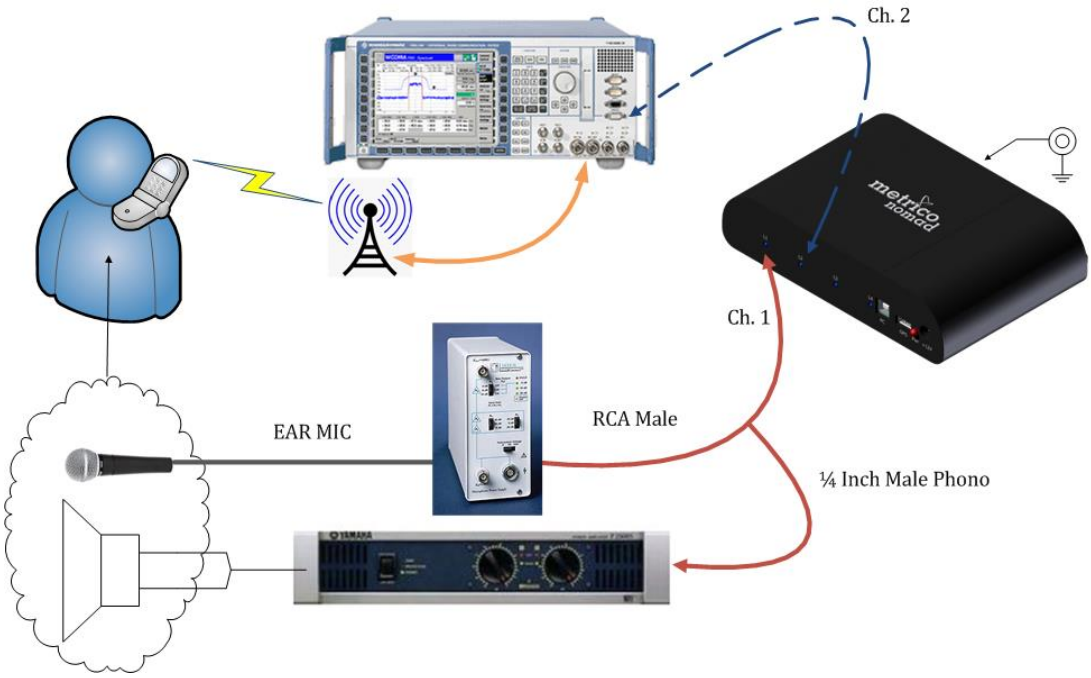


Figure 9-10 - HATS Two Channel Configuration

On the Nomad **Test Setup** tab, configure the channels as follows:

- **Channel 1** – Connects to Ear MIC – "Downlink"
  - **Task Type**: Mobile
  - **Session → Uplink Device:** Base task on channel 2
  - **Channel Settings → Audio interface for this channel:** Analog Interface(ME), Narrowband (ME HD) or High Definition (ME HD)
  - **Channel Settings → Input:** 210
  - **Channel Settings → Output:** 200
- **Channel 2** – Connects to base station simulator – "Uplink"
  - **Task Type**: Base
  - **Session → Downlink Device:** Mobile task on channel 1
  - **Channel Settings → Audio interface for this channel:** Analog Interface(ME), Narrowband (ME HD) or High Definition (ME HD)
  - **Channel Settings → Input:** 180
  - **Channel Settings → Output:** 200

Finally, make these additional system adjustments:

- **Handset Volume:**
  - One level below max
- **Yamaha Amp Setting:**
  - 20 dB

9.9 Wideband Testing

Nomad contains a wideband speech stimulus designed to exercise various wideband AMR codecs enabled on a wideband AMR device under test. Wideband testing works as follows:

- During the audio quality testing process, Nomad injects a wideband speech stimulus into the communication test path.
- The degraded speech at the receiving end is compared to the original wideband reference speech. The MOS calculation is based on this comparison.

Wideband testing is possible in these test configurations:

- Mobile-to-Mobile testing
- Base Station Simulator testing

Wideband testing is not possible in the Audio Server test configuration due to the narrowband limitation on the PSTN connection to the Audio Server. In general, mobile-to-landline testing is unsupported for wideband due to this limitation.

To perform wideband testing:

- Confirm that all test devices (including test mobiles and base station simulator) and the test network support the wideband codec and have been configured for wideband. Some devices must be manually set to the wideband codec.
- (***Nomad ME***) On the Nomad **Settings → Voice Quality** tab, set the **Hardware Sample Rate** to **Wideband (16 kHz)**.
- (***Nomad HD ME***) On the Nomad **Settings → Audio interface** tab, select the **High Definition** option
- Configure the Mobile-to-Mobile or Base Station Simulator test as necessary:
    - See Section 9.3 to configure a Mobile-to-Mobile test.
    - See Section 9.6 to configure a Base Station Simulator test. Note that the simulator should initially be configured with the channels simulating ideal yet realistic conditions (i.e. no degradation introduced). A familiar test device with the appropriate adapter should be selected for confirming the initial setup.
- Set the volume of each test handset to one level below the maximum.
- Start a new test.
- Adjust the **Input Levels** and **Output Levels** using the **Settings → Levels** controls:
    - For a Mobile-to-Mobile test:
        - Keep the **Output** level at a fixed value for both handsets. Spirent recommends an **Output** level of 140.
        - Adjust the **Input** level for both handsets to obtain an **Ins Gain** reading between -7 and 0 dB, or an **Attenuation** reading between 0 and 7 dB.
    - For a Base Station Simulator test:
        - For Channel 1:
            - Adjust the **Input** level to obtain an **Ins Gain** reading between -7 and 0 dB, or an **Attenuation** reading between 0 and 7 dB.
            - Adjust the **Output** level to obtain an **Ins Gain** reading between -12 and 0 dB, or an **Attenuation** reading between 0 and 12 dB.
        - For Channel 2:
            - Set the **Input** level to 205.

- Set the **Output** level to 195.
- End the test when desired.

9.10 Multi-RAB Testing

The objective of Multi-RAB testing with Nomad is to compare the voice quality or call performance of a mobile engaged in data services to a device not transferring data. An Email Campaign may be launched during a Voice Quality or Call Performance task to test Multi-RAB performance. An Email Campaign tests whether e-mail sent to the phone during a call disrupts performance as compared to phones not receiving e-mail.

To configured a Multi-RAB test in Nomad:

- If custom content is desired for the e-mail to be sent to the phone during testing, navigate to **Settings → Email Campaigns**. On this tab, check **Override default email content** and enter the **Custom email body content**. If this option is left unchecked, the default content of the system-generated message reads: "This is an auto-generated e-mail from Spirent Communications, Inc."

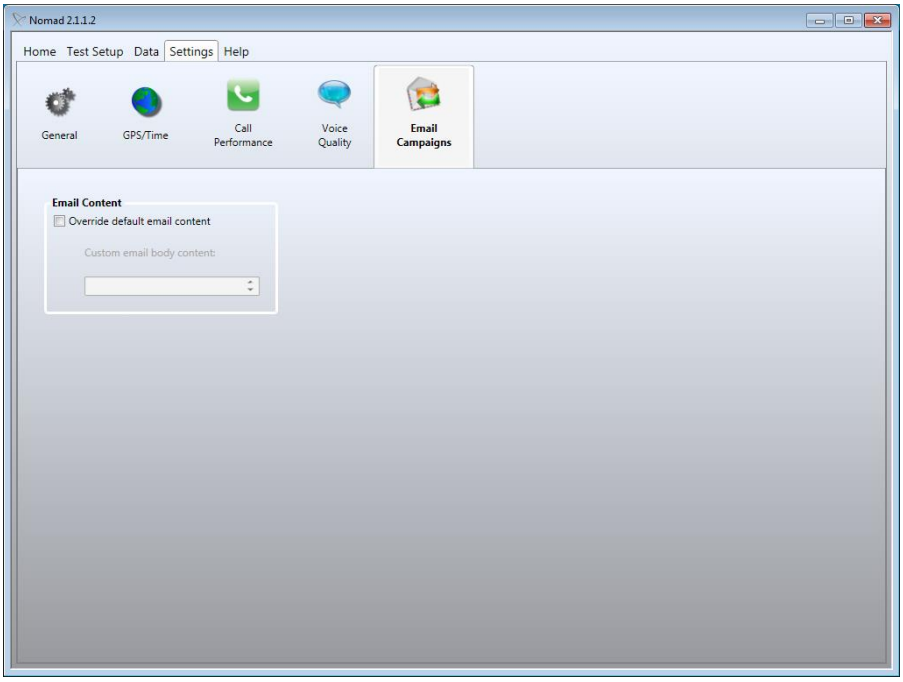


Figure 9-11 - Email Campaign Settings

- On the **Test Setup** tab, configure two Voice Quality or Call Performance tasks as normal.
- Leave one mobile as the "control" with no data traffic.
- Use the **Email Campaign** dialog to configure one mobile to receive periodic e-mails during testing:
    - Select the **Initiate email campaign when logging starts** option.
    - Enter an e-mail address accessible to the test mobile in the **Recipient email address (To:)** field.
    - Enter the **# of emails to send** to the mobile.
    - Enter the **Interval between emails** in seconds.

  - If desired, **Generate Test Email** to be sent to the mobile device.
- **Note:** In the event that Nomad becomes inaccessible during an Email Campaign (i.e. due to PC crash, etc.), it is possible to stop e-mail messages from being sent to the handset(s). Simply reply to any message generated by the Email Campaign to stop unwanted messages from being sent to the phone.

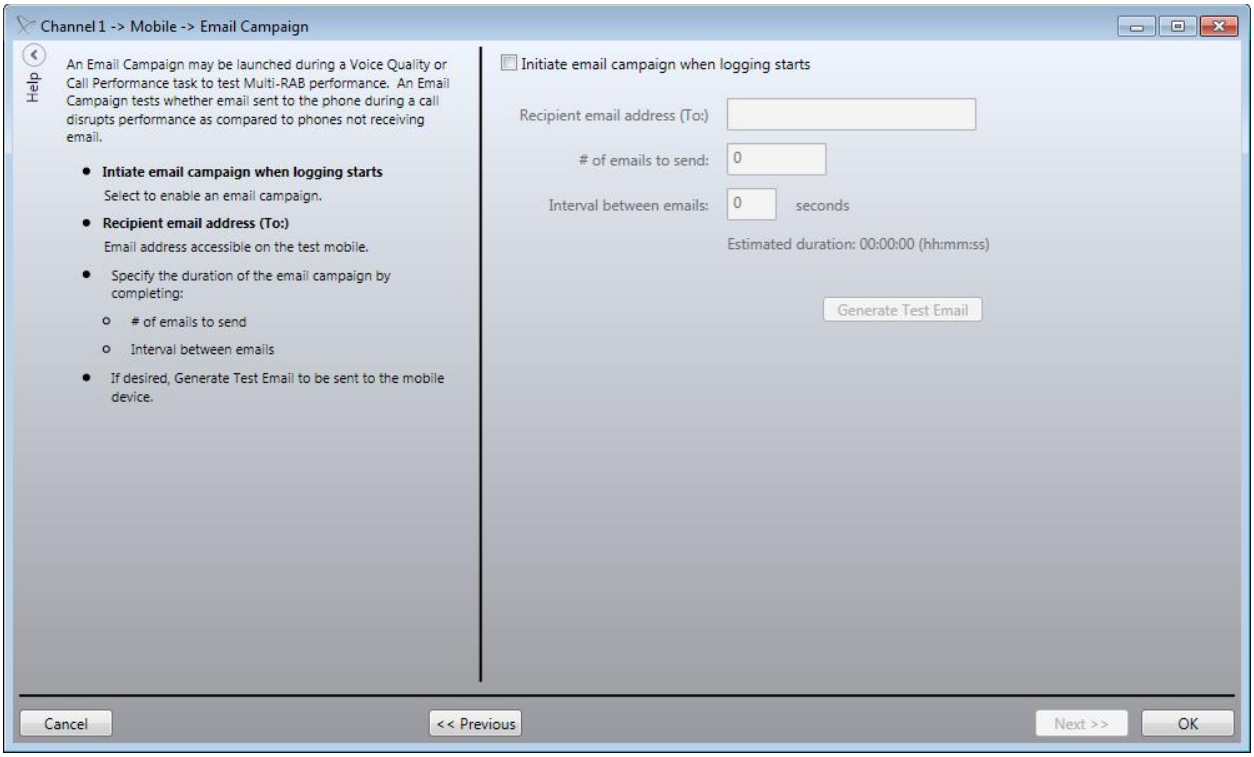


Figure 9-12 - Email Campaign Dialog

- Start a new test.
- During testing and when analyzing results in the output report, watch for performance differences between the multi-RAB and the control device. Remember that the goal of this test is to compare the voice quality or call performance of a mobile engaged in data services to a device not transferring data.

9.11 Voice Delay Testing

Nomad allows the precise measurement of speech delay between two mobile devices connected to the same Spirent ME unit. The measurement includes delay introduced by both handsets and the time it takes to traverse the network.

High levels of delay (generally over 250 milliseconds round-trip) may impact typical conversation. In the presence of high delay levels, normal conversation breaks down, as speakers are likely to interrupt each other and speak over each other during the call. Additionally, delay can exacerbate annoying echo problems.

Note: The Delay Task cannot be run with any other tasks. All other tasks must be removed from the **Test Setup** screen before configuring a **Delay Task**.

To perform Voice Delay testing:

- Connect one handset to **Channel 1**(ME) or **NB1**(HD ME) via audio cable. Connect the second handset to **Channel 2**(ME) or **NB2**(HD ME).

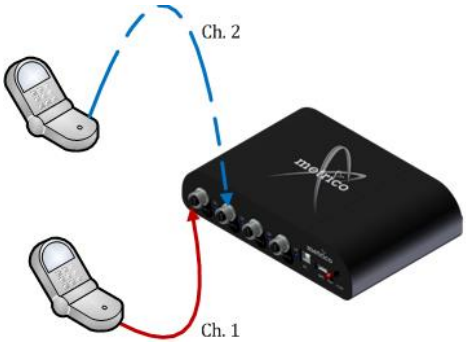


Figure 9-13 - Voice Delay Hardware Configuration

- On the Nomad **Test Setup** screen, configure **Channel 1** as a **Voice Delay** task with the following settings:
  - **Destination Channel:** 2
  - **Cycles:** The desired number of cycles to define the length of the test. The total sample count for a test will be **Cycles** multiplied by **Samples Per Cycle**.

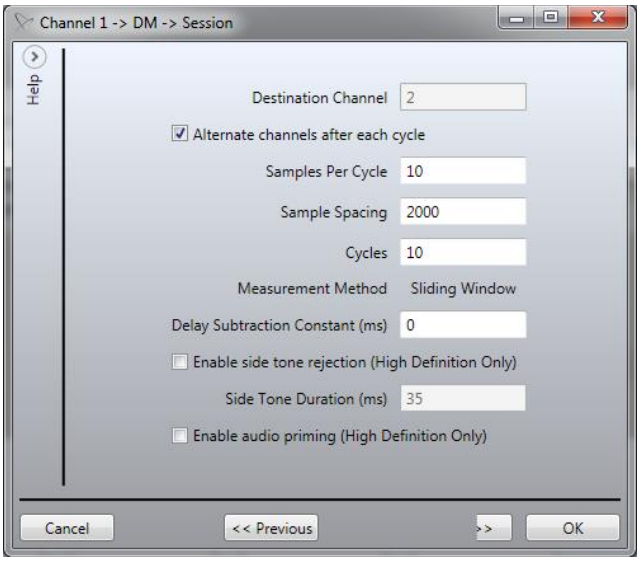


Figure 9-14 - Voice Delay Task Session Dialog

- Spirent recommends leaving the default values for the remaining items in the **Session** dialog. Maintaining the default parameters ensures consistency across tests for benchmarking purposes. Definitions of each parameter are provided here for informational purposes:
    - **Alternate channels after each cycle:** With this option checked, the Nomad channel that is sourcing audio will alternate between each cycle.
    - **Samples Per Cycle:** The number of measurements to take for each Voice Delay Task cycle.
    - **Sample Spacing:** The time in milliseconds between each sample. For example, a test configured for 10 samples per cycle with sample spacing set to 1000 will result in 10 samples collected with 1 second between each sample.
    - **Delay Subtraction Constant:** This value is used to modify the delay results by a fixed number. This would be utilized if testing were being done on a particular test system where it is known that a process on the test server is introducing a known artificial delay that should not be taken into account in the results.
    - **Enable side tone rejection:** In some test configurations, one phone may be used with a special cable to function as both the origination and destination channel by sourcing audio to a server that echoes the audio back. In these cases, some phones echo back audio with a minimal delay directly to the speaker before sending it to the server. This setting, in combination with the Side Tone Duration, will ensure that this side tone will not be measured as the delay. This setting may not be necessary on all phones with side tone present. Side tone rejection is only enabled on the HD interface.
    - **Side Tone Duration:** Duration in ms after start of audio sourcing to ignore received audio as side tone.
    - **Enable audio priming:** With this option enabled, Nomad will source 5 seconds of audio to the channel prior to starting each cycle of delay measurements. This is required in some cases to make sure that the phone is ready to take delay measurements.
- Place a call from **Handset 1** to **Handset 2**. The incoming call must be manually answered.
- Start a new test.

- The test sequence starts with **Handset 1** sourcing audio to **Handset 2**. Assuming **Alternate channels after each cycle** has been selected, in the next cycle **Handset 2** will source audio to **Handset 1**.
- The **Average Delay** and **Median Delay** will be plotted for each direction on the **Delay Times (ms) / Cycle** chart.
- Detailed statistics for each test cycle are available in the **Cycle History** area.

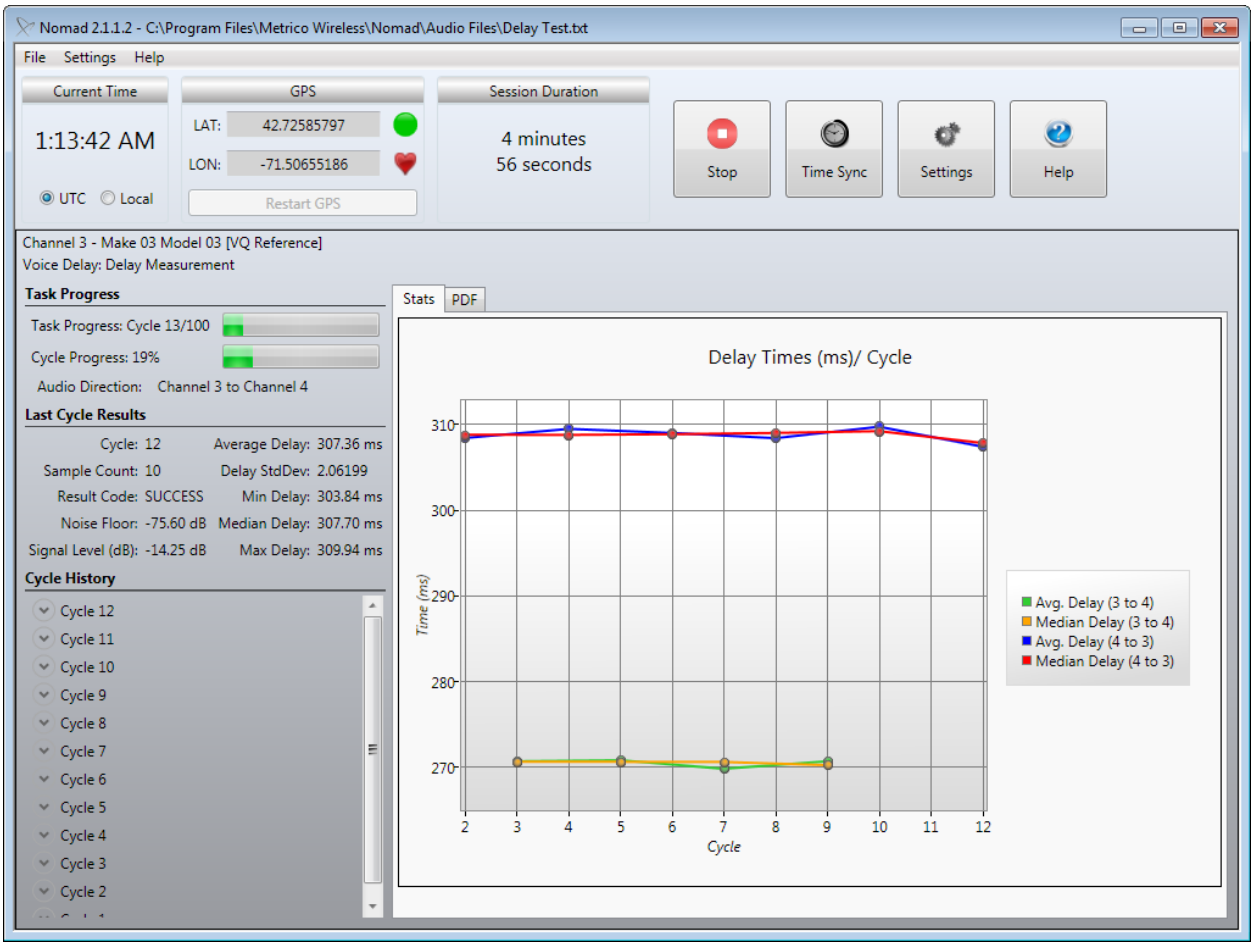


Figure 9-15 - Voice Delay Testing

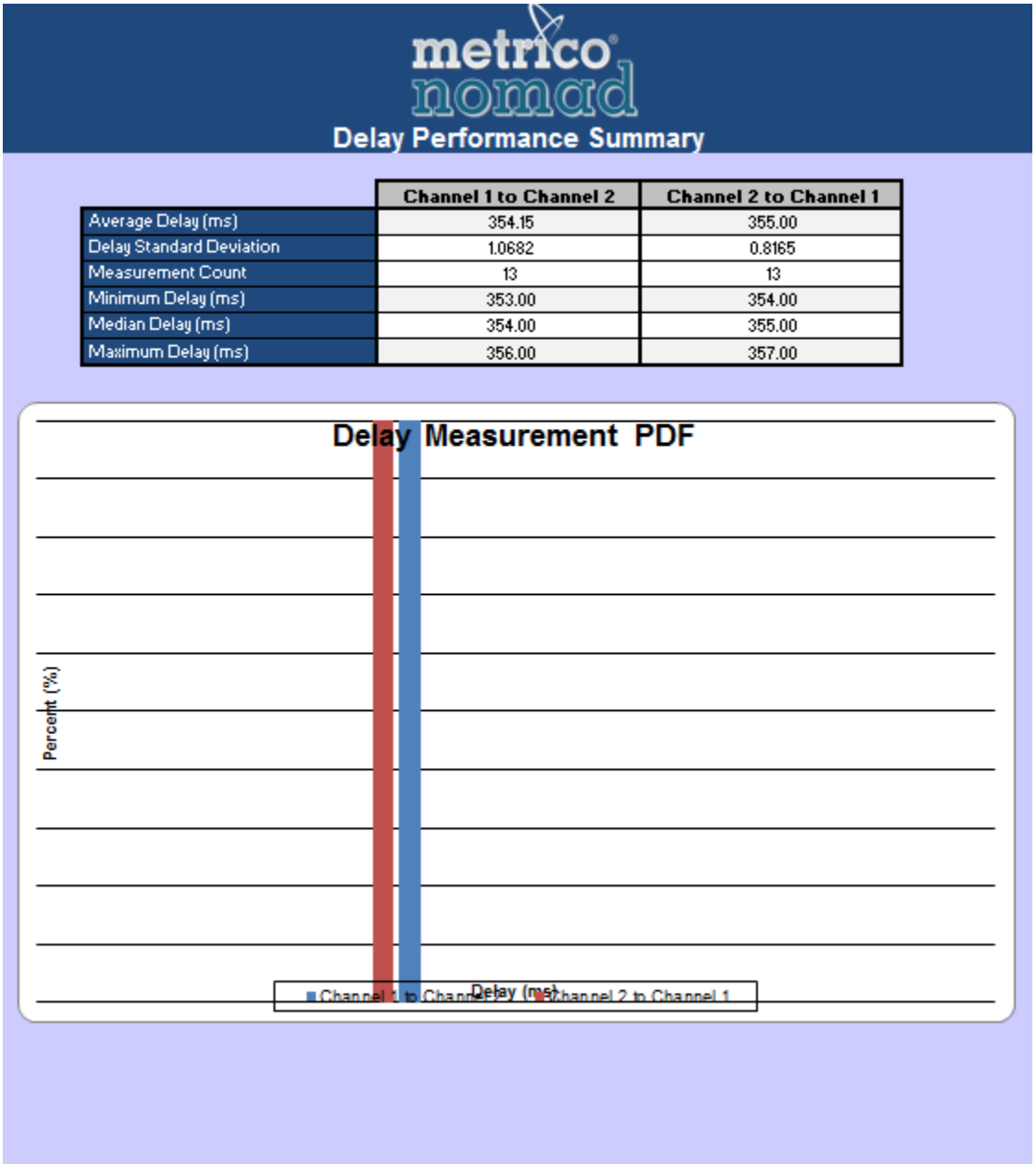
While monitoring the data during testing, be mindful of the following:

- Confirm that each individual cycle has completed and that Nomad has reported data.
- Confirm that the **Delay Times** chart updates for each cycle.

The test will stop after the configured number of **Cycles** has been completed. Alternatively, use the **Stop** button to end the test at any time as desired.

Delay test results can be found on the **Delay Performance Summary** tab of the output report.

Note: Delay measurements greater than 250 milliseconds round-trip are considered "high" and are generally detectable during standard conversation.



	Channel 1 to Channel 2	Channel 2 to Channel 1
Average Delay (ms)	354.15	355.00
Delay Standard Deviation	1.0682	0.8165
Measurement Count	13	13
Minimum Delay (ms)	353.00	354.00
Median Delay (ms)	354.00	355.00
Maximum Delay (ms)	356.00	357.00

Figure 9-16 - Delay Performance Summary Report

10 Call Performance Configuration Options

Nomad provides various configuration options for call performance testing. These options include:

- Mobile Originated Testing
- Mobile Terminated Testing
- Mobile-to-Mobile Testing

This section contains detailed instructions for each call performance configuration option.

10.1 Mobile Originated Testing

In a Mobile Originated test, the mobile test device makes calls to the Call Server for call control testing. To perform Mobile Originated call performance testing:

- Set the volume of the test handset to the maximum volume for optimal Audio Verification results.
- Determine which channel the test will be conducted on. All call performance testing operates via Bluetooth connection.
- On the Nomad **Test Setup** screen, configure that channel as a **Mobile Originated** task with the following settings in the **Call Campaign** dialog:
    - **Dial/Answer Method:** This field will only be visible to customers who have purchased the ability to control devices via a tethered connection. This drop-down allows those customers to choose between controlling via the Bluetooth connection, or the tethered connection.
    - **Phone Number Settings:** Enter the **Number to call** as provided by Spirent and the **Number calling from**.
    - **Call Initiation Mode:**
        - **Synchronous Testing** – Calls start simultaneously on all devices regardless of call outcomes. For example, if one device drops a call, it will remain idle until the next time all mobiles are scheduled to start a new call.
        - **Asynchronous Testing** – Each device follows its own call sequence without regard to other device progress. In this mode, if one device drops a call, it will wait for the specified time and then start a new call, even as the other devices continue their first call.
    - **Access Timeout** – A call attempt that has not connected within this amount of time will be classified as an Access Timeout event.
    - **Duration** – The length of each call in the test sequence.
        - In a **Synchronous** campaign, this refers to the total attempt duration including access time and connected time.
        - In an **Asynchronous** campaign, this refers to the connected time only.
    - **Wait Time** – The amount of idle time between the end of one call in the sequence and the start of the next call.
    - **Attempts** – The number of calls to attempt in this task sequence.

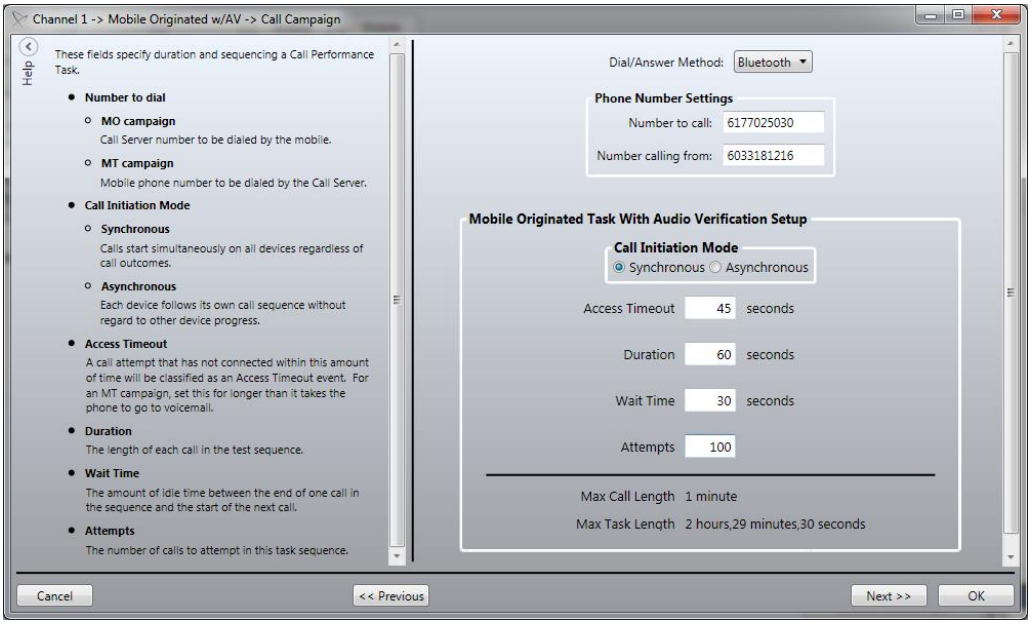


Figure 10-1 - Call Campaign Dialog for a Mobile Originated Task

- Establish the Bluetooth connection for the test device.
- Click the **Start Logging Session** button and proceed through the **Start Logging Session Wizard**.
- Calls will automatically be placed from the test handset to the Call Server.
- During testing, the call status is displayed in the **Call Performance Task Status Window**. Session statistics are displayed in the **Call Performance Statistics Window**. See Section 7.1 for details about the display.

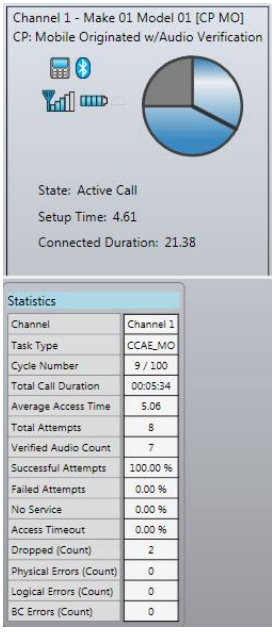


Figure 10-2 - Mobile Originated Call Performance Testing

- The test will stop after the configured number of **Attempts**. Alternatively, use the **Stop** button to end the test at any time as desired.

Test results can be found on the **Call Performance Summary**, **Call Initiation**, **Call Retention**, **Audio Verification** and **Device Performance** tabs of the output report.

10.2 Mobile Terminated Testing

In a Mobile Terminated test, the Call Server makes calls to the mobile test device for call control testing. To perform Mobile Terminated call performance testing:

- Set the volume of the test handset to the maximum volume for optimal Audio Verification results.
- Determine which channel the test will be conducted on. All call performance testing operates via Bluetooth connection.
- On the Nomad **Test Setup** screen, configure that channel as a **Mobile Terminated** task with the following settings:
    - **Dial/Answer Method:** This field will only be visible to customers who have purchased the ability to control devices via a tethered connection. This drop-down allows those customers to choose between controlling via the Bluetooth connection, or the tethered connection.
    - **Number to dial:** The mobile phone number to be dialed by the Call Server.
    - **Call Initiation Mode:**
        - **Synchronous Testing** – Calls start simultaneously on all devices regardless of call outcomes. For example, if one device drops a call, it will remain idle until the next time all mobiles are scheduled to start a new call.
            - **Note: Synchronous Testing** may not be maintained for Mobile Terminated call campaigns.
        - **Asynchronous Testing** – Each device follows its own call sequence without regard to other device progress. In this mode, if one device drops a call, it will wait for the specified time and then start a new call, even as the other devices continue their first call.
    - **Turn off answering** – Turns off automatic answering of incoming calls, to facilitate manual intervention.
    - **Access Timeout** – A call attempt that has not connected within this amount of time will be classified as an Access Timeout event.
    - **Duration** – The length of each call in the test sequence.
        - In a **Synchronous** campaign, this refers to the total attempt duration including access time and connected time.
        - In an **Asynchronous** campaign, this refers to the connected time only.
    - **Wait Time** – The amount of idle time between the end of one call in the sequence and the start of the next call.
    - **Attempts** – The number of calls to attempt in this task sequence.

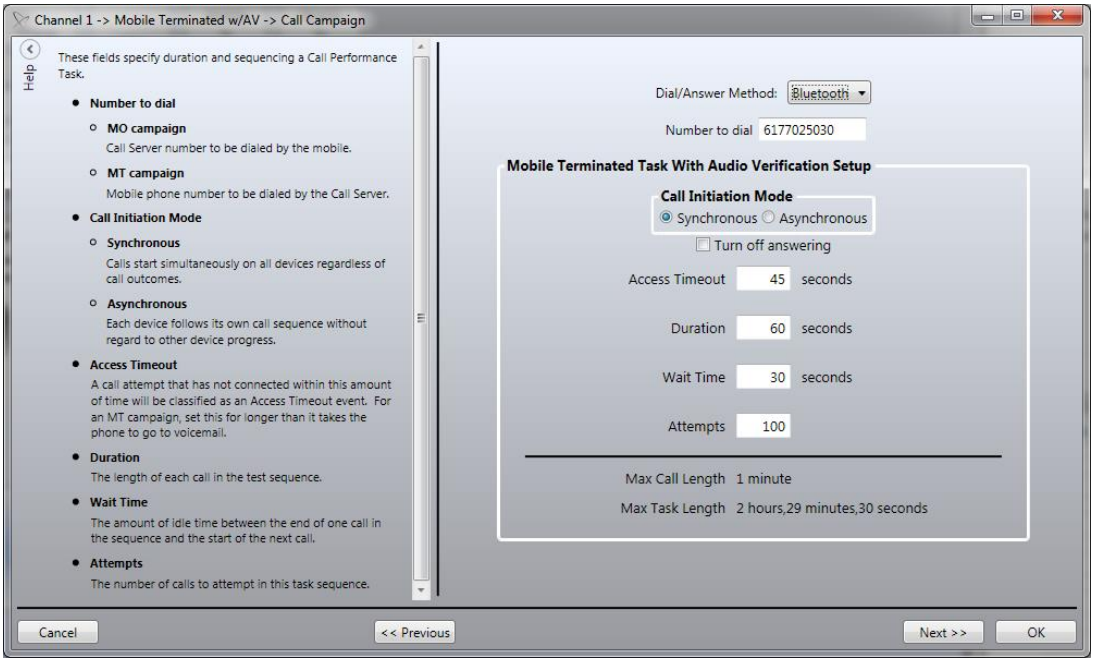


Figure 10-3 - Call Campaign Dialog for a Mobile Terminated Task

- Establish the Bluetooth connection for the test device.
- Click the **Start Logging Session** button and proceed through the **Start Logging Session Wizard**.
- Calls will automatically be placed from the **Call Server** to the test handset.
- During testing, the call status is displayed in the **Call Performance Task Status Window**. Session statistics are displayed in the **Call Performance Statistics Window**. See Section 7.1 for details about the display.
- **Note:** Only those fields for which data is available at the mobile end will be populated in the Call Performance Statistics window during Mobile Terminated testing. The remaining fields will display as PENDING during the test. The statistics for these fields will be compiled in the formatted output report generated at the conclusion of testing. The affected fields are:
    - Average Access Time
    - Failed Attempts
    - No Service
    - Access Timeout
    - Dropped (Count)

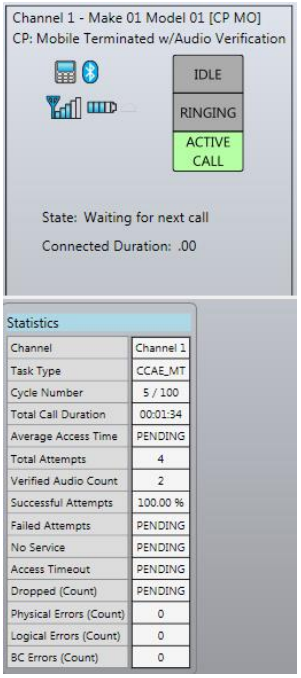


Figure 10-4 - Mobile Terminated Call Performance Testing

- The test will stop after the configured number of **Attempts**. Alternatively, use the **Stop** button to end the test at any time as desired.
- **Note:** Losing internet connectivity during a Mobile Terminated Call Performance campaign may cause the **Stop** button to cease working. In this case, wait for a call to come to the phone, answer the call and dial 9999. This will manually stop the Call Server from repeatedly calling the phone through the scheduled end of the test.

Test results can be found on the **Call Performance Summary**, **Call Initiation**, **Call Retention**, **Audio Verification** and **Device Performance** tabs of the output report.

Spirent recommends following these best practices for the best results with Mobile Terminated testing:

- Confirm that the test handset is properly configured with voicemail. This will ensure that voicemail is properly detected during testing.
- The **Access Timeout** parameter for a Mobile Terminated call campaign must be set to a larger duration than it takes the phone to go to voicemail. If **Access Timeout** is too short, Nomad will fail to recognize a call sent to voicemail. Instead, such a call will be classified as an **Access Timeout** before voicemail picks up. A 45-second **Access Timeout** is generally sufficient for North American carriers.
- Nomad can take up to seven seconds to detect voicemail. In a **Synchronous** campaign it is best practice to set **Duration** at least seven seconds longer than **Access Timeout** to ensure that no Voicemail events are missed.

10.3 Mobile-to-Mobile Testing

In a Mobile-to-Mobile test, one handset makes calls that are received by a second handset attached to a different channel on the same Spirent ME unit. To perform Mobile-to-Mobile call performance testing:

- Determine which handset will be the originating device and which handset will be the receiving device. All call performance testing operates via Bluetooth connection.
- On the Nomad **Test Setup** screen, configure **Channel 1** as a **Mobile-to-Mobile Originate** task with the following **Call Campaign** settings:
    - **Receiving Device:** Receiver on **Channel 2**.
    - **Number to dial:** The phone number of the receiving test device.
    - **Access Timeout:** A call attempt that has not connected within this amount of time will be classified as an **Access Timeout** event.
    - **Duration:** The length of each call in the test sequence.
    - **Wait Time:** The amount of idle time between the end of one call and the start of the next call.
    - **Attempts:** The number of calls to attempt in this call sequence.
- **Note:** All Mobile-to-Mobile call performance tasks are **Synchronous**. Therefore, there is no option to select the **Call Initiation Mode**.

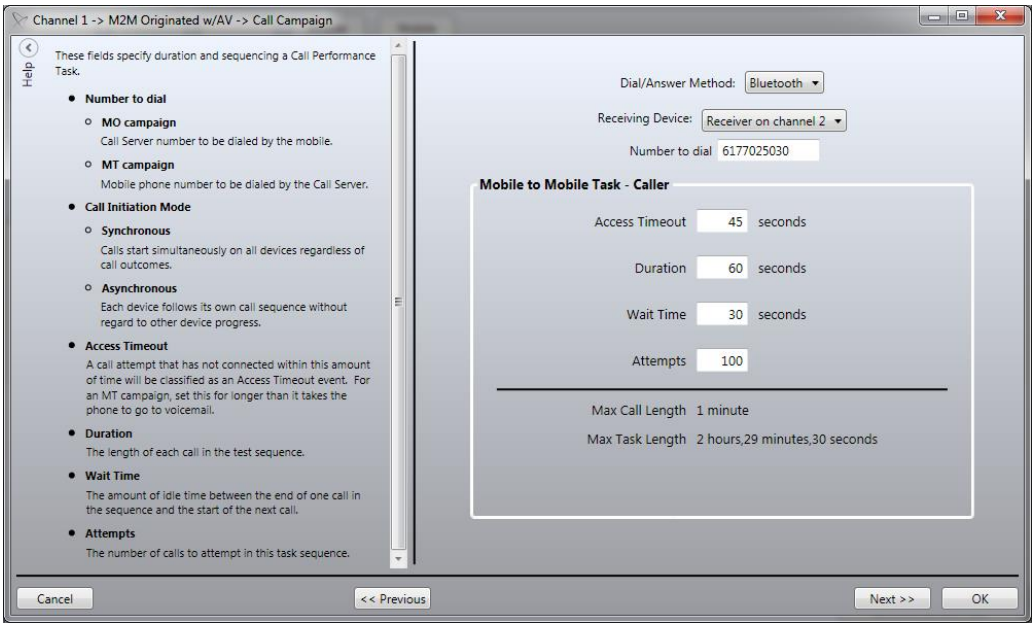


Figure 10-5 - Mobile-to-Mobile Originated Call Campaign Dialog

- **Channel 2** will automatically be configured as a **Mobile-to-Mobile Receive** task. Confirm that the **Incoming number** in the **Call Campaign** dialog matches the phone number of the **Mobile-to-Mobile Originating** device. The settings here are pulled automatically from the **Mobile-to-Mobile Originate** task and are not editable here. These settings will change automatically when changes are made to the **Mobile-to-Mobile Originate** task.

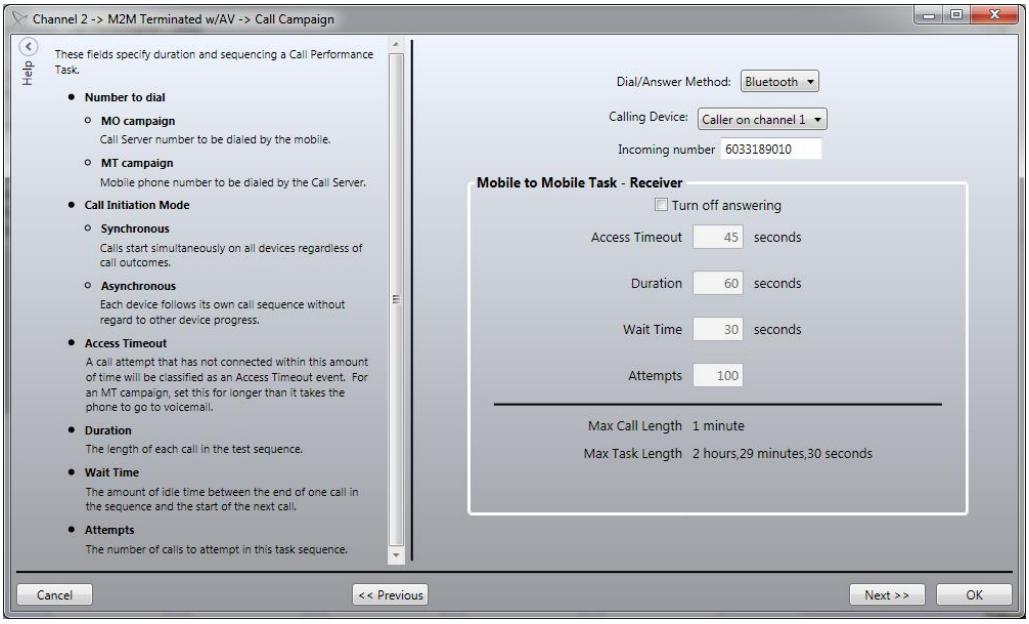


Figure 10-6 - Mobile-to-Mobile Terminated Call Campaign Dialog

- Establish the Bluetooth connection for both test devices.
- Click the **Start Logging Session** button and proceed through the **Start Logging Session Wizard**.
- Calls will automatically be placed from the originating handset to the receiving handset.
- During testing, the call status is displayed in the **Call Performance Task Status Window** for each device. Session statistics for both devices are displayed in the **Call Performance Statistics Window**. See Section 7.1 for details about the display.

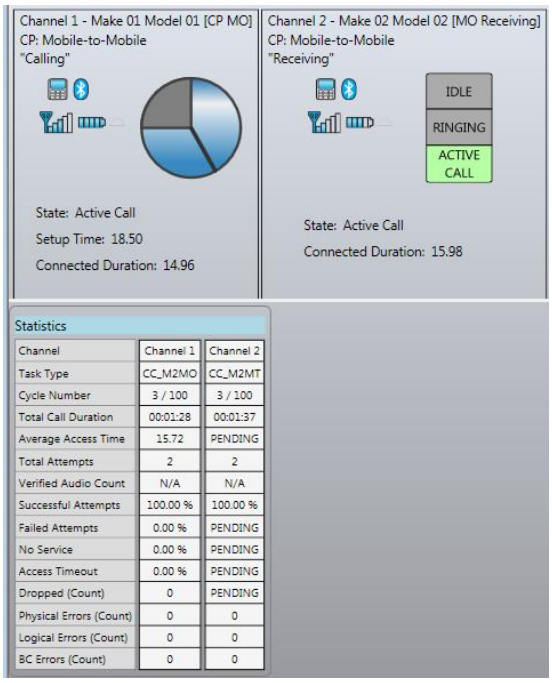


Figure 10-7 - Mobile-to-Mobile Call Performance Testing

When testing is complete, the matching Mobile Originated and Mobile Terminated results are merged together to create a single session file. Generate a report in the standard manner for this merged session file. Test results can be found on the **Call Performance Summary**, **Call Initiation**, **Call Retention**, **Audio Verification** and **Device Performance** tabs of the output report.

In the report, the Mobile to Mobile "Calling" channel is treated as a Mobile Originated task. The Mobile to Mobile "Receiving" channel is treated as a Mobile Terminated task. The statistics reported for the two tasks will likely be similar, with a few key differences:

- **Call Initiation Statistics** – Calls that failed on the MO side will not be represented on the MT side. Specifically, initiations classified as **Failed Attempts**, **No Service** or **Access Timeout** will be counted on the MO channel but not on the MT channel.
- **Setup Time** – The Setup Time is generally larger for MT calls than for MO calls.

Spirent recommends following this best practice for the best results with Mobile-to-Mobile call performance testing:

- The **Access Timeout** parameter for a Mobile-to-Mobile call campaign must be set to a larger duration than it takes the phone to go to voicemail. If **Access Timeout** is too short, Nomad will fail to recognize a call sent to voicemail. Instead, such a call will be classified as an **Access Timeout** before voicemail picks up. A 45-second **Access Timeout** is generally sufficient for North American carriers.

Appendix A – Glossary

General Testing Terms

Term	Definition
Call Performance Task	A task designed to measure how well the device performs with regard to call initiation, call retention, Bluetooth performance, signal strength and battery life.
Configured Task	A Configured Task saves all of the settings for the currently selected task.
Session Profile	A Session Profile defines the tasks and settings for all available test channels.
Task	The type of activity to be performed on an available test channel.
Test	The arrangement of the available Nomad channels based on the task types and settings available for each.
Voice Quality Task	A task designed to measure how speech is perceived by the end user of the test device.

Voice Quality Testing Terms

Term	Definition
Base Task	The test device on a Base channel serves as the uplink device in the mobile communication path. This option should be selected for: • The uplink end of a Landline Module test. • One of the test handsets in a bi-directional Mobile-to-Mobile test scenario (the other handset will be set as a Mobile). • One of the test handsets in a bi-directional Remote Unit test scenario (the other handset will be set as a Mobile).

Term	Definition
Mobile Task	The test device on a Mobile channel serves as the downlink device in the mobile communication path. This option is used for: • Standard bi-directional testing using the Audio Server. • A mobile acting as the downlink device in a test using the Landline Module. • One of the test handsets in a bi-directional Mobile-to-Mobile test scenario (the other handset will be set as a Base). • One of the test handsets in a bi-directional Remote Unit test scenario (the other handset will be set as a Base).
Record Only Task	Select this option to perform downlink testing only. With this setting, Nomad will record speech every ten seconds but will not source speech. This setting can be used to shorten the test cycle time in the event that only downlink data is required.
Source Only Task	Select this option to perform uplink testing only. With this setting, Nomad will send speech every ten seconds but will not record anything. This setting can be used to shorten the test cycle time in the event that only uplink data is required.

Call Performance Testing Terms

Term	Definition
Asynchronous Testing	Each device follows its own call sequence without regard to other device progress. In this mode, if one device drops a call, it will wait for the specified time and then start a new call, even as other devices continue their first call.
Idle Task	The test device makes no calls. This type of task only reports changes in signal strength and battery level.
Mobile Originated Task	Calls are made from the mobile test device to the Call Server.
Mobile Terminated Task	Calls are made from the Call Server to the mobile test device.
Synchronous Testing	Calls start simultaneously on all devices regardless of individual call outcomes. For example, if one device drops a call, it will remain idle until the next time all mobiles are scheduled to start a new call.

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Appendix B – Call Performance Events

Call Outcome Events

Call Outcome	Definition
No Service	• There was no service available when the call was attempted.
Failed Attempt	• A *Mobile Originated Call* was placed and an outgoing call was established followed by the phone's return to the call placement state.
Voicemail	• A *Mobile Terminated* call was placed and the nonstandard *voicemail* response was received from the mobile.
Busy	• A *Mobile Terminated* call was placed and the nonstandard *busy* response was received from the mobile. A *busy* response typically results when the network is unable to place the call.
Fast Busy	• A *Mobile Terminated* call was placed and the nonstandard *fast busy* response was received from the mobile. Both the *fast busy* response and the *no capacity* response typically indicate an issue with the communication path to the server.
No Capacity	• A *Mobile Terminated* call was placed and the nonstandard *no capacity* response was received from the mobile. Both the *fast busy* response and the *no capacity* response typically indicate an issue with the communication path to the server.
Access Timeout	• *Mobile Originated Call* – A call was placed but no state change occurred before the Access Timeout time. • *Mobile Terminated Call* – The connection did not take place before the Access Time.
Drop	• The call was ended before the expected duration had elapsed.
Physical Link Error	• The Bluetooth connection between the test mobile and the Nomad hardware unit was not active at the time a call was supposed to occur.
Logical Device Error	• The test mobile failed to respond properly to a command issued by Nomad via the Bluetooth connection.
BC Error (BlueCore Error)	• The Bluetooth module was not in a nominal state at the time a call was supposed to occur.
User Terminated	• The Stop button on the handset was pressed during a call.
Call Succeeded	• Any call that lasts the expected duration is considered a successful call.

Device State Events

Device State Event	Definition
Device State Value	• The device may change to any of the following: ○ Initializing ○ Ready ○ Discovering ○ Connecting ○ Connected ○ Outgoing Call Established ○ Incoming Call Established ○ Active Call
Signal Strength	• The phone signal strength corresponding to the handset bar display (0 – 5)
Battery Life	• The phone battery life corresponding to the handset bar display (0 – 5)
RSSI	• The RSSI reported by the handset (-113 to -51 dBm); this feature is device-dependent and only available on phones that support RSSI reporting

Appendix C – Confidence Interval Calculation

The Nomad Call Performance output reports employ a 90% Confidence Interval for call initiation failure and dropped call events. The Confidence Interval allows us to report, with 90% confidence, that the event rate for a given device will fall within the calculated range above and below the measured value. The Confidence Interval is calculated as a function of the estimated standard deviation of the sample proportion (% dropped calls or % call initiation failures) and the standard normal distribution function.

$$Confidence\ Interval\ =\ \bar{p}\ \pm\ z(a)\ *\ s(\bar{p})$$

$$\bar{p} =\ sample\ proportion = \%\ dropped\ calls\ or\ \%\ call\ initiation\ failures$$

$$n = total\ connection\ attempts$$

$$z(a) =\ z(90th\ percentile) =\ 1.645\ (based\ on\ standard\ normal\ distribution)$$

$$s(\bar{p}) = \sqrt{\frac{\bar{p}(1-\ \bar{p})}{n-1}} = estimated\ standard\ deviation\ of\ \bar{p}$$

therefore

$$\boldsymbol{Confidence\ Interval =\ \bar{p} \pm 1.645 * \sqrt{\frac{\bar{p}(1-\bar{p})}{n-1}}}$$

Appendix D – PESQ Tools GUI Case Study

The **PESQ Tools GUI** is available for Nomad users wishing to perform advanced analysis of any waveform captured during **Voice Quality** testing and scored using PESQ. Basic operation of the **PESQ Tools GUI** is described in Section 8.7.

The **PESQ Tools GUI** can assist in the identification of issues that contribute to low MOS such as background noise and speech clipping. This appendix presents a case study illustrating how the **PESQ Tools GUI** may be used to identify these types of issues in a test file exhibiting low MOS results.

To start, the **Reference Waveform**, **Reference Surface** and **Reference Spectrogram** tabs display what the test waveform should look like. The **Degraded Waveform**, **Degraded Surface** and **Degraded Spectrogram** tabs display what the waveform actually looks like. Sample waveforms with low MOS results will contain visible differences from the reference images.

In this example, the **Reference Waveform** is free of noise during periods without speech while the **Degraded Waveform** exhibits a constant buzzing during "quiet" periods:

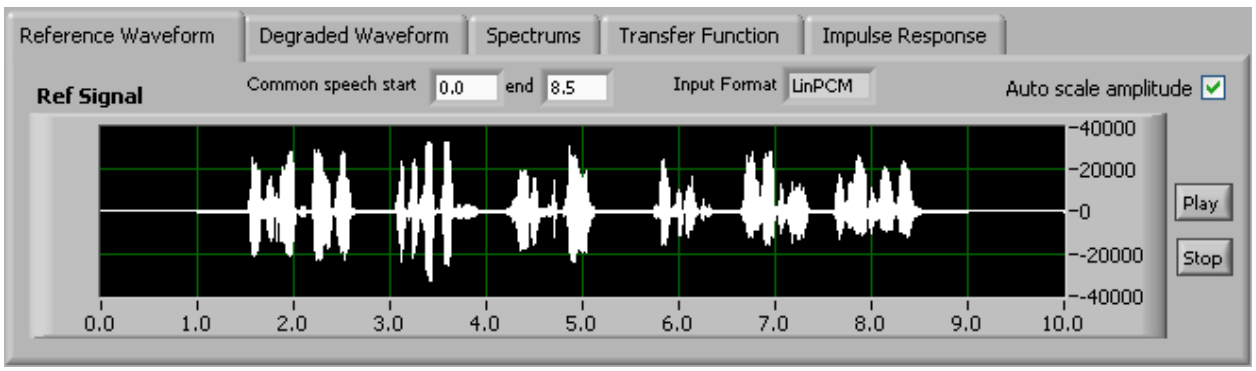

Figure D-1 - Reference Waveform

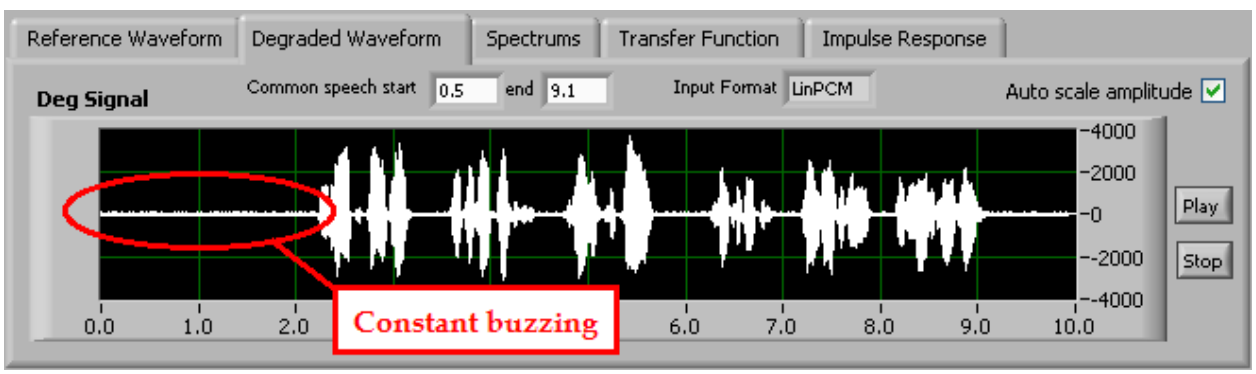

Figure D-2 - Degraded Waveform

Not only is this buzzing visible in the **Degraded Waveform** image, it is audible in the .WAV file. Use the **Play** button to listen to the effect of the buzzing on the speech sample.

The issue of speech clipping is visible when comparing the **Reference Surface** to the **Degraded Surface**:

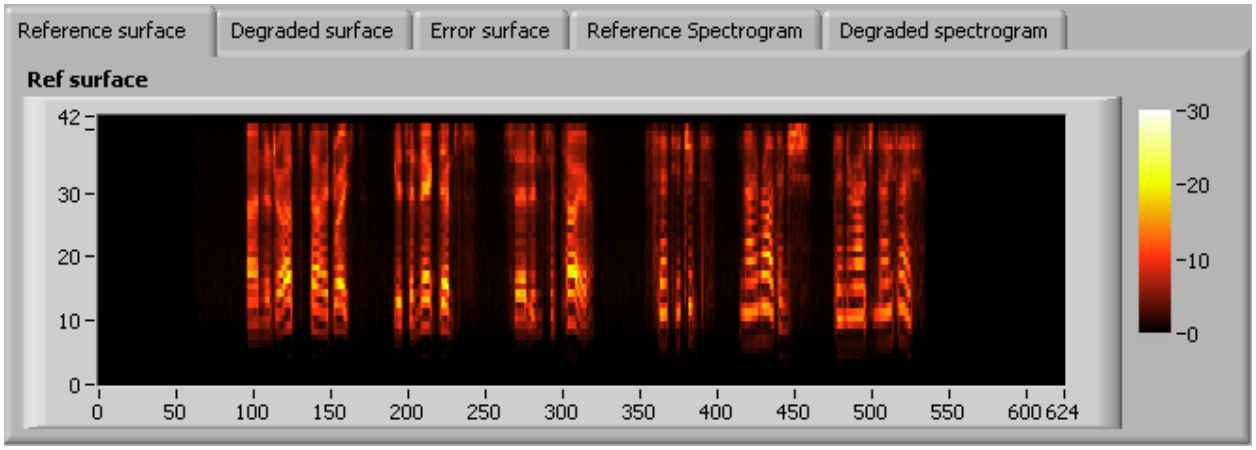

Figure D-3 - Reference Surface

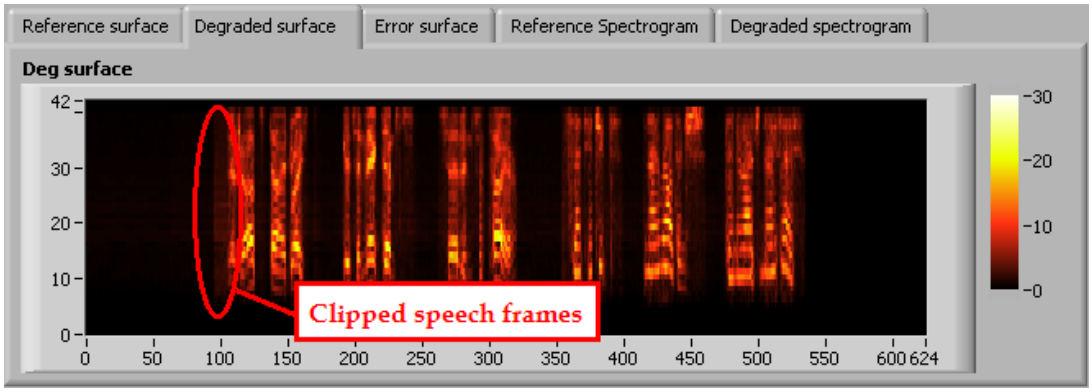

Figure D-4 - Degraded Surface

Speech clipping is also apparent on the **Error Surface** graph. The **Error Surface** represents the **Reference Surface** minus the **Degraded Surface**. Therefore, errors that represent missing signal (i.e. clipping) will have positive values on this chart. Errors that add to the signal (i.e. noise) will have negative values here.

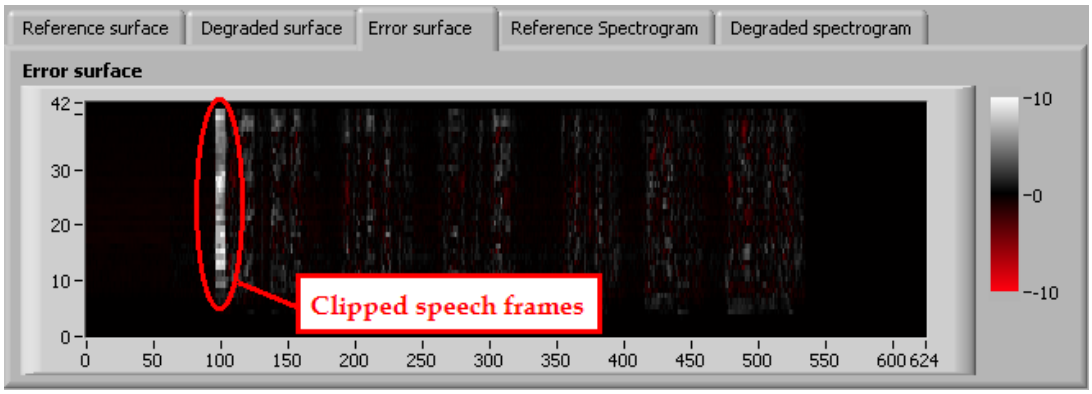

Figure D-5 - Error Surface

The Reference and Degraded Signal spectrums available in the **PESQ Tools GUI** provide another means of analysis. These figures can be used to visually compare the reference to the degraded frequency response. Note that although this example exhibits frequency fade above 3.5 kHz, this is a normal response for mobiles calling the Audio Server and is not expected to affect the MOS outcome.

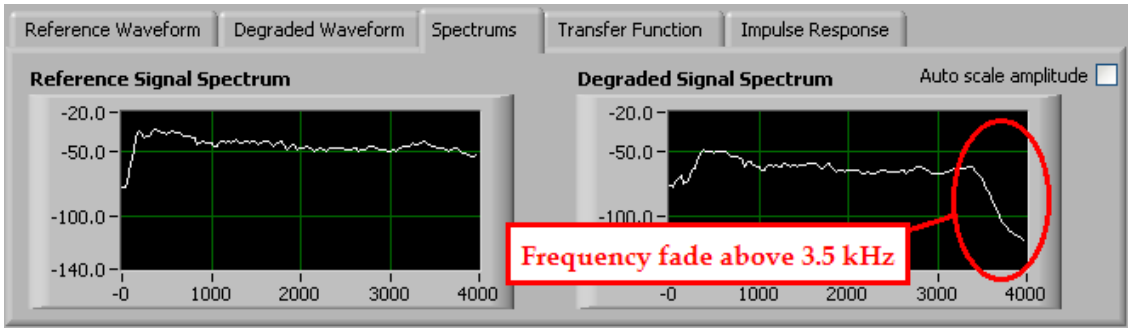

Figure D-6 - Reference and Degraded Signal Spectrums

The buzzing, clipping and frequency response characteristics are all apparent upon comparison of the **Reference Spectrogram** to the **Degraded Spectrogram**. The Spectrogram graphs provide frequency spectra information over the duration of the sample.

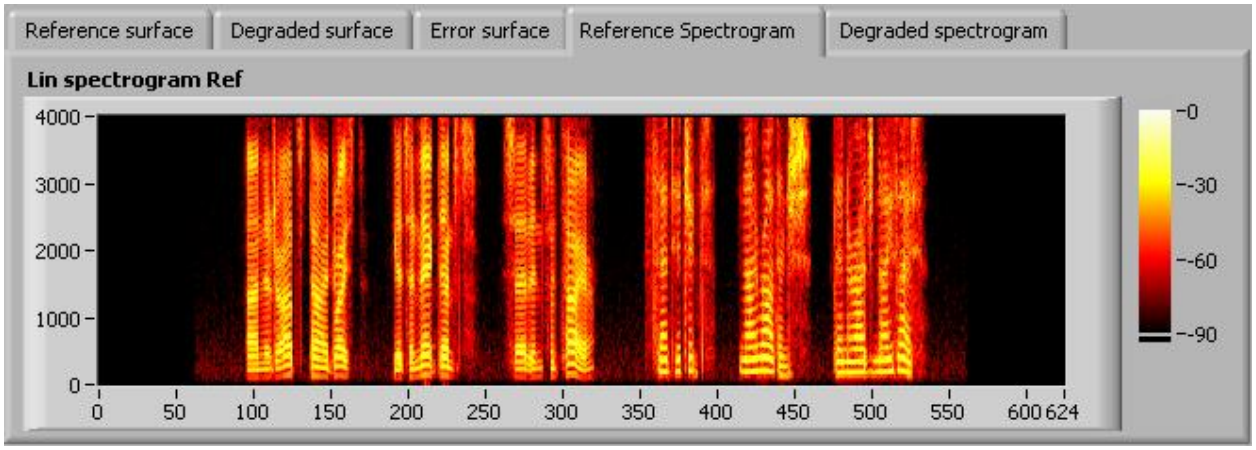

Figure D-7 - Reference Spectrogram

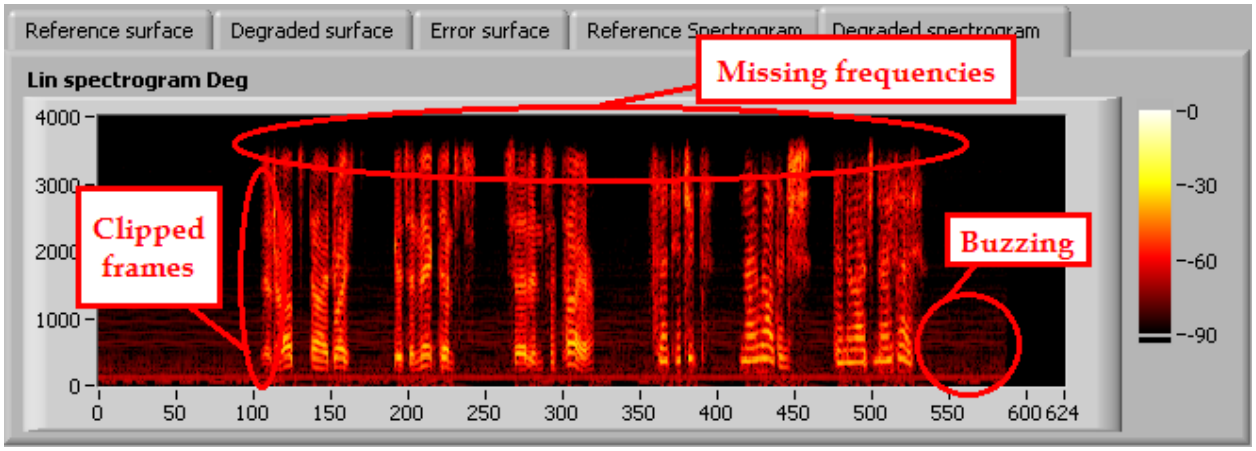

Figure D-8 - Degraded Spectrogram

In conclusion, this example has illustrated how the **PESQ Tools GUI** may be used to identify specific areas of a speech sample contributing to poor MOS results. In this case, multiple factors of background buzzing and speech clipping were identified. Using this information, the source of each issue may now be identified and rectified in order to achieve the desired MOS results.

Appendix E – Introduction to POLQA

The worldwide prevailing standard for mobile voice quality analysis has been ITU-T P.862, known as Perceptual Evaluation of Speech Quality (PESQ). PESQ implements automated testing of telecommunications using actual speech samples, comparison of the reference signal (transmitting side) to the degraded channel (listening side), and generation of mean opinion scores (MOS) to model subjective listening patterns. This technique has been widely adopted due to its capability to automate collections of large sample sets simulating real-world subscriber experience.

As network technologies mature and evolve, the drivers of performance change, and new methodologies for measuring and assuring quality are required. PESQ is logically being succeeded by ITU-T P.863, Perceptual Objective Listening Quality Analysis (POLQA).

Advantages of POLQA include:

- Significantly expanded set of codecs, including AMR-WB, EVRC, EVRC-WB, Skype / SLIK, G.711 and G.729.
- Designed to handle more complex end-to-end network architectures and quality management techniques such as smart loss concealment and time stretching.
- Two operational modes to distinctly address narrowband and super-wideband communication.
- Three-fold increase in evaluation set used compared to PESQ, resulting in considerably smaller residual prediction errors even as the application range has expanded substantially.
- Seamless upgrade path from, and backward compatibility with, PESQ.

POLQA provides more robust quality predictions for:

- Cross-technology quality benchmarking (such as GSM vs. CDMA)
- Noise reduction and voice quality enhancement
- Time scaling, unified communication and VoIP
- Non-optimal presentation levels
- Filtering and spectral shaping
- Recordings made at an ear simulator

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The table below compares PESQ and POLQA at a glance:

	PESQ	POLQA
Codecs	• AMR • EFR	• AMR • AMR-WB • EFR • EVRC • EVRC-WB • iLBC • AMB+ • AAC • Skype / SILK • G.711 • G.729
Reference Speech Material	• 8 kHz	• 8 kHz • 48 kHz
Applications	• POTS • VoIP • 3G	• HD Voice • Voice Enhancement Devices • Skype Calls • Benchmarking CDMA and GSM

POLQA scoring is available as an optional upgrade to Nomad. To configure a POLQA-enabled Nomad installation for POLQA scoring:

- On the **Settings→ Voice Quality** tab, set the **Default Scoring Algorithm** to **POLQA**.
- When creating a new Voice Quality task, confirm that the **Scoring Model** in the **Session** dialog is set to **POLQA**.

During a Voice Quality test using POLQA, the **Voice Quality Task Status Window** displays **Attenuation** as the amplitude of the current waveform. **Attenuation** measures the downlink signal gain reduced by Nomad. For the best results, Spirent Communications recommends maintaining downlink attenuation between 0 and 7 dB, ideally as close to 0 dB as possible. Increase **Input Level** to decrease **Attenuation** toward 0 dB. Note that compared to PESQ, POLQA is more forgiving when it comes to attenuation adjustment.

During a Voice Quality test using POLQA, the **Voice Quality Task Status Window** displays the **Algorithm** as **POLQA**.

Figure E-0-1 - Voice Quality Task Status Window for a POLQA Test

When generating the output report, Nomad always scores the data using the **Scoring Model** specified in the test definition. For example, a test defined with the **POLQA** scoring model will be scored using **POLQA**. Three options exist to score the same data using the other scoring model:

- **Re-score Files** – On the **Data → Complete** tab, right-click on the file of interest and select **Re-score Files**. The scoring method not used on the previous pass will be used.
- **Batch Scoring** – This option scores multiple .WAV files using PESQ, POLQA or both. The output of this utility is a delimited text file that may be viewed in raw form, opened in Excel or parsed with a script. This utility can be used to score previously unprocessed files or for re-scoring. Access the **Batch Scoring** utility from the **Data → Utilities** tab.
- **Offline Scoring** – Retrieve and score uplink .WAV files from the Audio Server using either PESQ or POLQA with this utility. Access the **Offline Scoring** utility from the **Data → Utilities** tab.

Appendix F – Nomad HD Hardware

Figure F-0-1 – Spirent Communications HD ME Hardware Unit

The Nomad HD hardware allows for connection to a mobile device via one of three interfaces: Narrowband, High Definition, or Bluetooth.

Important Safety Note

Any usage of the equipment in a manner not specified by the manufacturer may impair features related to safety and user protection.

Tout usage de cet équipement, qui n'est pas conforme aux spécifications du manufacturier, peut affecter les fonctions relatives à la sécurité et la protection de l'utilisateur

Nomad HD LEDs

Indicator	Function
L1, L2, L3, L4	Indicates the status of the link over the active interface for the given channel. For example, when utilizing the Bluetooth interface, the LED indicates the status of the Bluetooth link. The general behavior is as follows: • **Dark** – Channel is disabled • **Green** – Channel is enabled for Narrowband Analog • **White** – Channel is enabled for Wideband Analog • **Cyan (Flashing)** – Bluetooth initialization • **Cyan (Solid)** – Bluetooth initialized • **Blue (Flashing)** – Bluetooth Pairing "On" • **Blue (Solid)** – Bluetooth is Paired • **Yellow (Flashing)** – Outgoing call setup • **Yellow (Solid)** – Outgoing call in progress • **Magenta (Flashing)** – Incoming call setup • **Magenta (Solid)** – Incoming call in

	progress • **Red** - Overdrive
Pwr	When lit, indicates that power is applied to the unit.

Base Unit Physical Interfaces

Interface	Description
HD1, HD2, HD3, HD4	Interface for High Definition Audio
NB1, NB2, NB3, NB4	Interface for Narrowband Audio
PC	USB interface for communication with the PC
GPS	USB interface for communication with a GPS device. The interface functions as a normal USB port for the PC.
+12V	Power supply interface.

Physical Specifications

Dimensions (H x W X D)	1 5/8 in x 10 ¼ in x 4 7/8 in
Weight	2.2 lbs
Case material	Aluminum
Communication interfaces	Bluetooth, Analog, USB

Power Specifications

AC operations	Requires external AC adapter. Adapter specifications: Input – 100 to 240 V, 50-60 Hz, 0.4 amps Output – 12 V, 1.0 amps
Maximum power usage	10 Watts
Maximum heat dissipation	10 Watts

Environmental Requirements

Operating temperature	0 to 55°C
Storage temperature	-20 to 70°C
Humidity tolerance	5 to 85% RH at 40°C