Developer Outreach Program

Application Resource Optimizer (ARO)

User Guide

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Application Resource Optimizer (ARO)

User's Guide

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1. Overview

The *AT&T Application Resource Optimizer (ARO)* is a diagnostic tool for analyzing mobile web application performance. AT&T ARO allows you to automatically profile your prototype applications to optimize their performance, make battery utilization more efficient, and reduce the network impact.

2. About AT&T ARO

The AT&T ARO was initially developed by the AT&T Labs. They were studying the network efficiency of mobile applications, and they discovered that simple application design approaches could greatly influence the efficiency of the applications. They built AT&T ARO as a tool by which they could diagnose inefficiencies and provide advice on how to optimize mobile applications.

AT&T ARO is comprised of two parts, the AT&T ARO Data Collector and the AT&T ARO Data Analyzer.

When using AT&T ARO, the traces run against your application by the AT&T ARO Data Collector are benchmarked against 12 common best practices in the AT&T ARO Data Analyzer. The Data Analyzer looks at how your application (and your server) is handling caching, and how you are managing the network connections for your application. By optimizing against these best practices, your application will run faster, use the network less (saving valuable battery life for your users), and improve the experience of customers using your application.

3. Using the AT&T ARO Data Collector

The AT&T ARO Data Collector is an application that runs certain mobile devices as described below to capture the data traffic of the device and store that information in trace files that can be analyzed using the AT&T ARO Data Analyzer.

You can get access to the AT&T ARO Data Collector in one of the following ways:

- The AT&T ARO Data Analyzer has a built-in Data Collector feature that can capture trace data on an Android Emulator.
- The AT&T ARO Data Collector is pre-installed on various device models that have been provided and are available via the Keynote DeviceAnywhere™ program: http://developer.att.com/ARO/deviceanywhere.

The AT&T ARO Data Collector collects data from the Android Emulator (a virtual device), or from a physical device via the Keynote DeviceAnywhere program. The following sections describe how to collect and save trace data from both of these sources.

3.1.1 Collecting Data Using Android Emulator

3.1.1.1 Introduction

The Android Emulator allows you to test your Android application in an emulated environment on your computer. The AT&T ARO Data Analyzer can interface directly with the Emulator and collect traces from it, just like it does from an AT&T ARO device on Keynote DeviceAnywhere. The advantage is that you can test anytime (no waiting for a device), but the disadvantage is that you are not really running on a wireless network. You also lose some functions like the camera, Bluetooth, and changeable GPS.

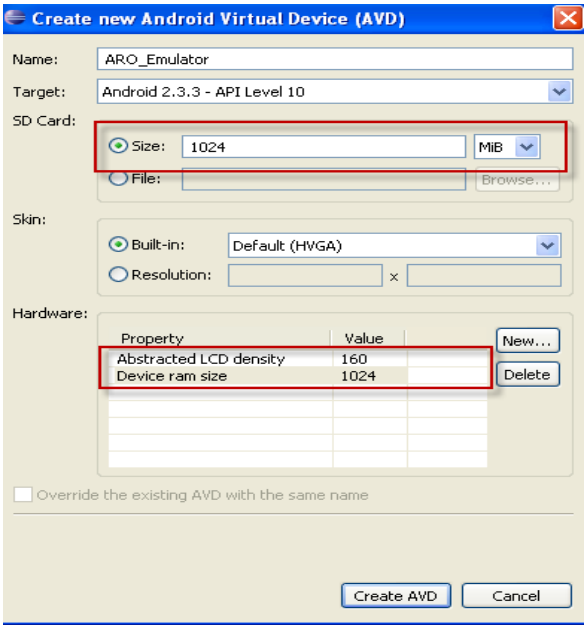
3.1.1.2 Prerequisites

To install and configure the Android Emulator for use with the AT&T ARO Data Collector, do the following:

- Download the latest version of the Android SDK package based on your operating system type from http://developer.android.com/sdk/index.html.
- Add the latest Android Platform to your Android SDK. AT&T recommends version 2.2 or above. Install the Android Platform by following the steps on the Android website at http://developer.android.com/sdk/installing.html.
  Note: The steps used on the Android website describe how to set up an Emulator using Eclipse (http://www.eclipse.org/) and the ADT plug-in for Eclipse.
- Make the following settings to optimize the speed of the Emulator:

- Enable a 1 GB (1024 MB) Secure Digital (SD) card. Please note that this will take away a section of your PC hard drive for use as the Emulator's SD card.
- Maximize the amount of RAM that the Emulator is allowed to use. You will notice an improvement in the speed of the Emulator when you allocate 500 MB of RAM or greater to the device.

The following example shows how to optimize the speed of the Android Emulator by setting an SD card size and a RAM allocation size of 1 GB (1024 MB).



3.1.1.3 Launching Android Emulator

Once you have installed and configured the Android Emulator for use with the AT&T ARO Data Collector, you can launch it in one of the following ways:

1.) From the command line.

The command to launch the Emulator uses the following syntax:

```
emulator -avd <YourEmulatorName>
```

In the following example, an Emulator named *NexusOne* is launched from the command line:

```
emulator -avd NexusOne
```

2.) From the Eclipse Integrated Developer Environment (IDE).

To launch the Emulator from the Eclipse IDE, open the Android SDK Manager window, select your Emulator, and click start.

Note: Once the Android Emulator is launched, and before launching the the AT&T ARO Data Collector, you should confirm that the application you are testing is installed on the Emulator and running properly. This will ensure that when you run the application during the AT&T Data Collector session, you will be collecting useful trace data.

3.1.1.4 Launching AT&T ARO Data Collector

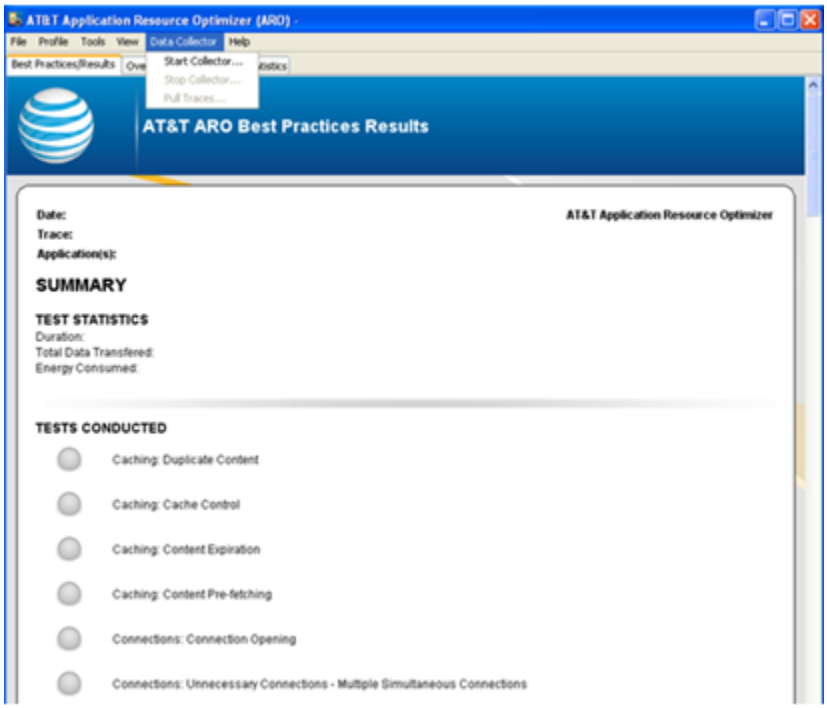
To collect data on the Android Emulator, launch the AT&T ARO Data Collector through the commands on the Data Collector menu in the AT&T ARO Data Analyzer.

Ensure that your computer meets the system requirements in section 4.1 and that you have installed the Data Analyzer as described in section 4.2.

Launch the AT&T ARO Data Collector by following these steps:

Step 1: Launch the AT&T ARO Data Analyzer application.

Step 2: Open the “Data Collector” menu on the AT&T ARO Data Analyzer as in the following image.



The “Data Collector” menu has the following options for collecting data on the Android Emulator:

Menu Option	Description
Start Collector	Starts data collection on the Android Emulator.
Stop Collector	Stops data collection on the Android Emulator.
Pull Traces	Pulls the trace files from the Android Emulator to the hard drive.

Step 3: Click the “Start Collector” option on the “Data Collector” menu.

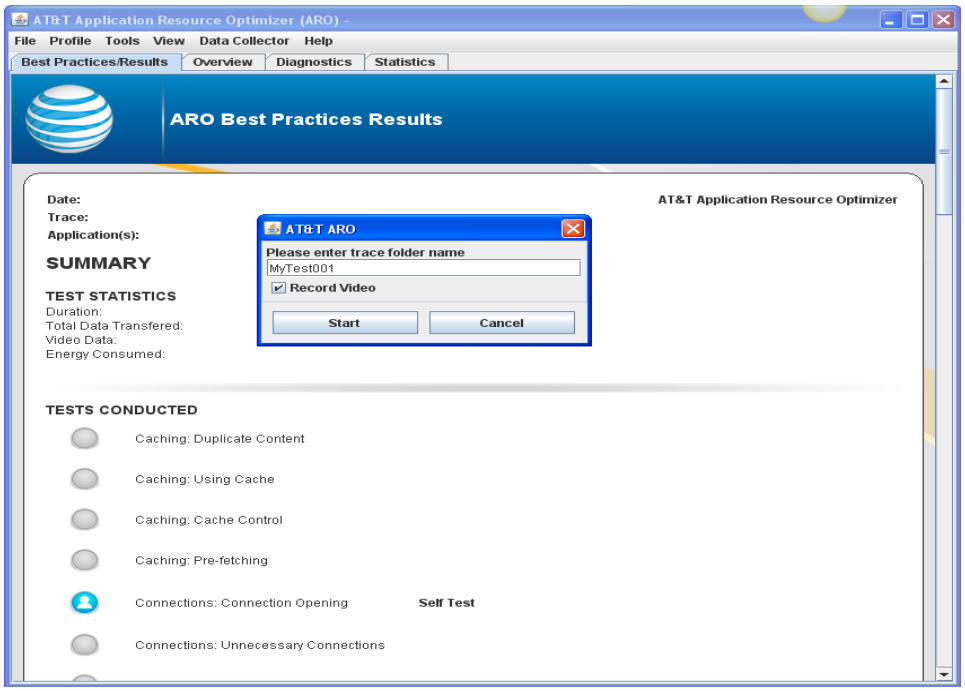
Note: If the Android Emulator is not started when the “Start Collector” option is clicked, you will see the following error message indicating that the AT&T ARO Data Analyzer could not find an

active Android Emulator connecton.

Step 4: Enter the trace folder name.

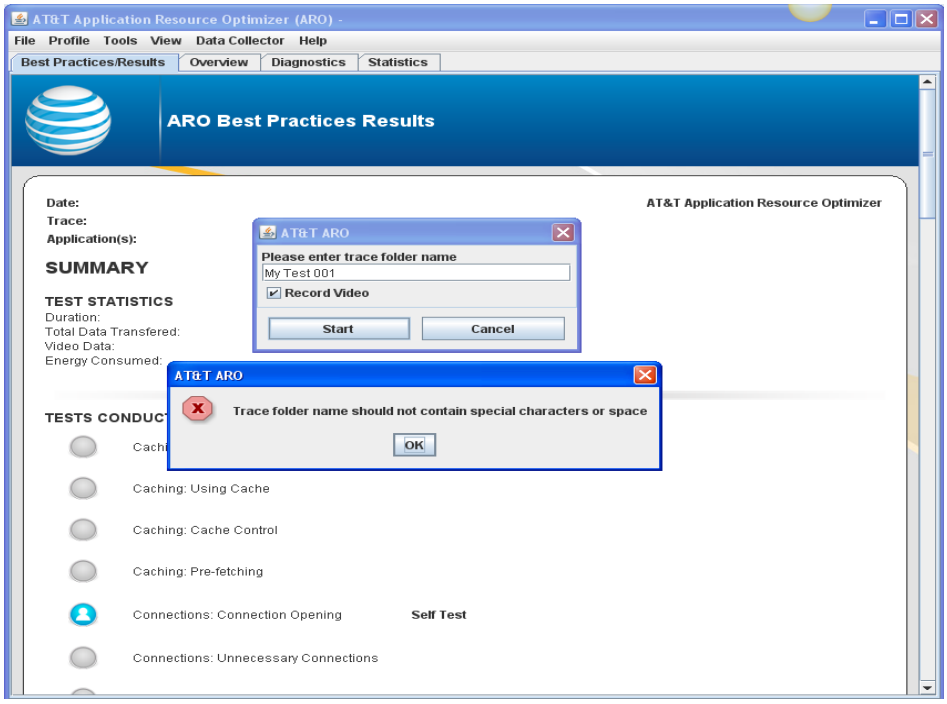
When you click the “Start Collector” option on the “Data Collector” menu with the Android Emulator started, you will see the following dialog box prompting you for a trace folder name on the Emulator.

Note: The “Record Video” check box in this dialog indicates whether a video will be recorded of the activities carried out on the device while the trace data is being collected. This option is checked by default.

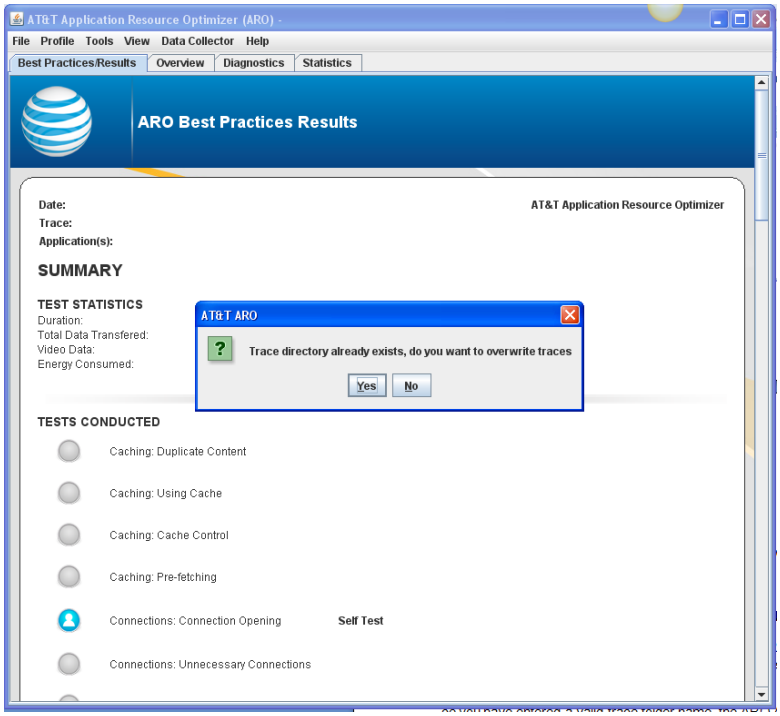


The trace folder name must not contain special characters or spaces. For instance, the folder name “MyTest001” is valid, but the folder name “My Test 001” or “My!Test” is not valid. Limit the folder name to alphanumeric characters.

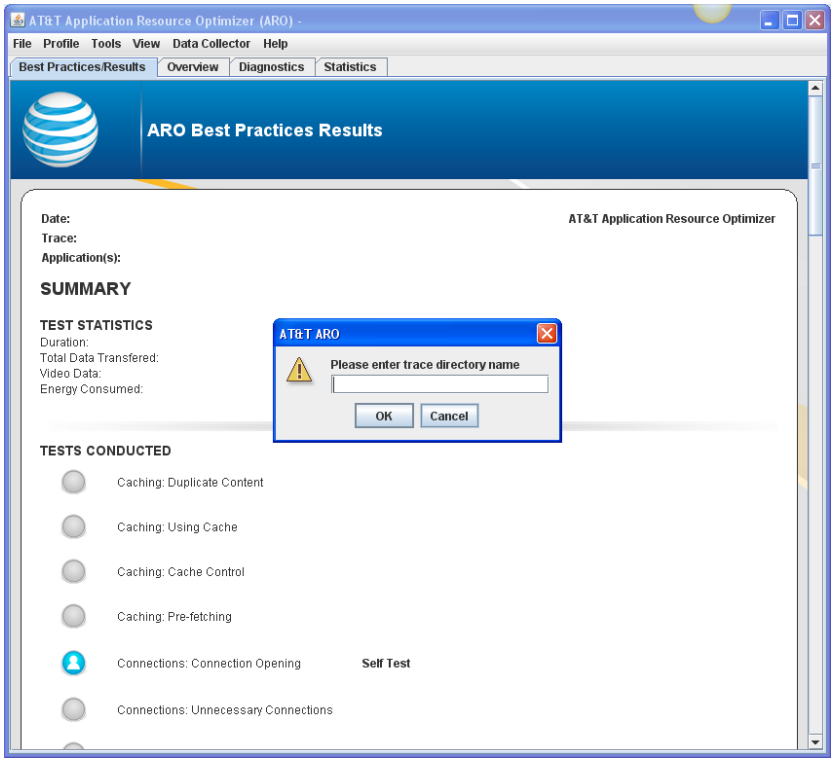
The following image shows the error for an invalid folder name.



If the trace folder name already exists on the Emulator, you will see the following prompt asking if you want to overwrite the existing trace folder.



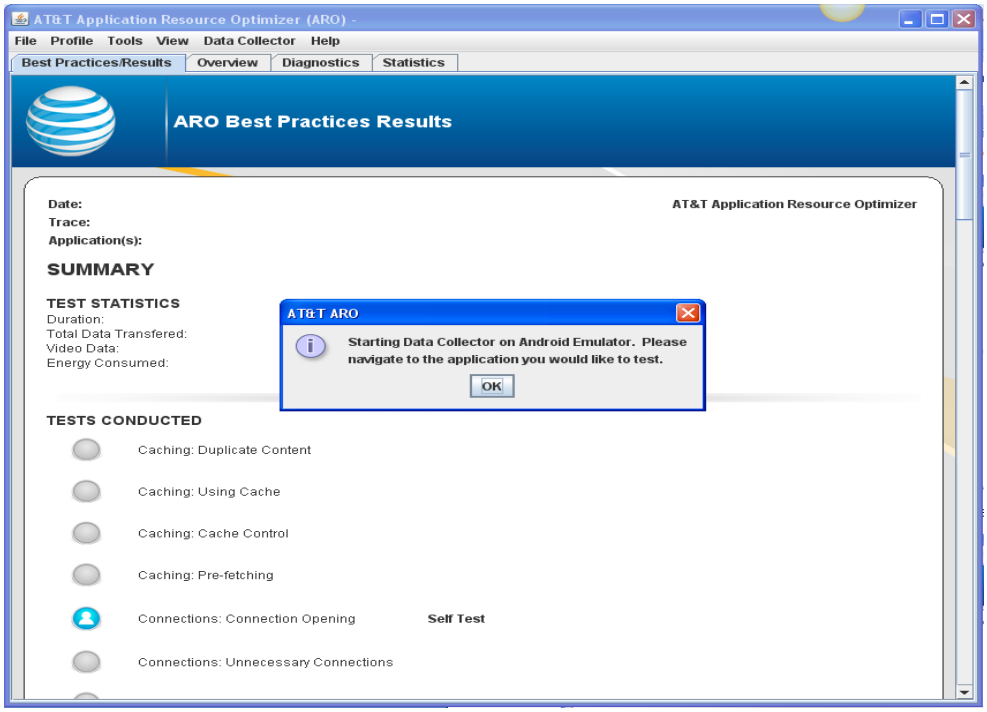
If you choose “No”, you will see the following dialog giving you the option to choose a different folder name.



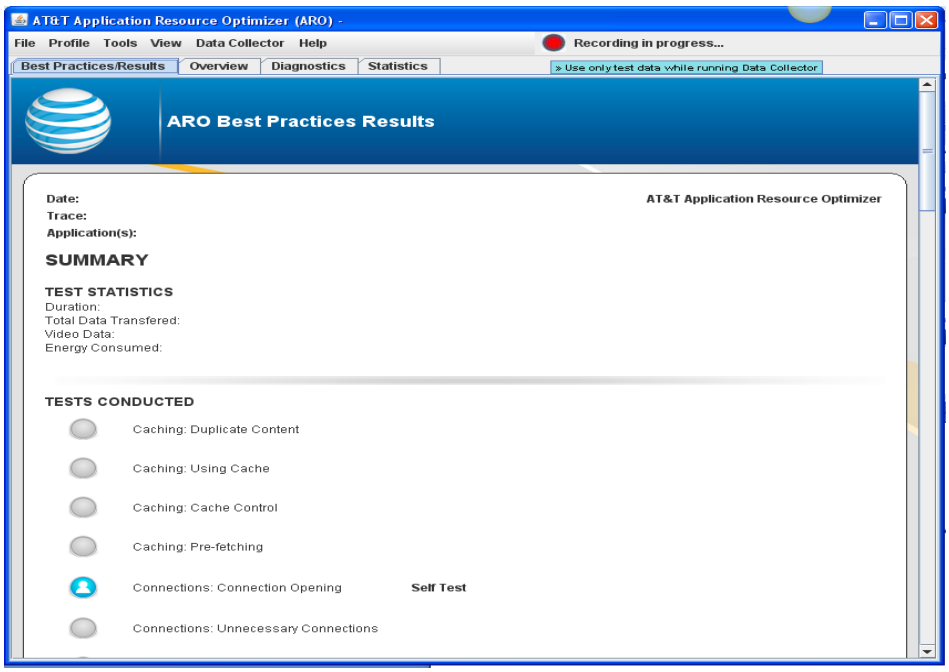
3.1.1.5 Running a Trace on Android Emulator

Once you have entered a valid trace folder name, the AT&T ARO Data Analyzer starts the Data Collector on the Android Emulator.

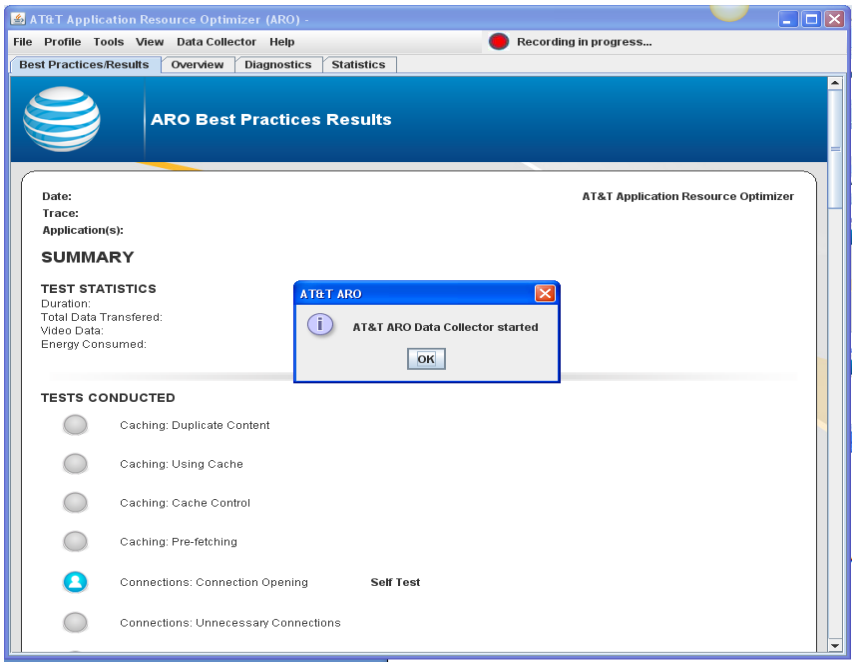
First, you will see the following message box indicating that the Data Collector is starting on the Android Emulator.



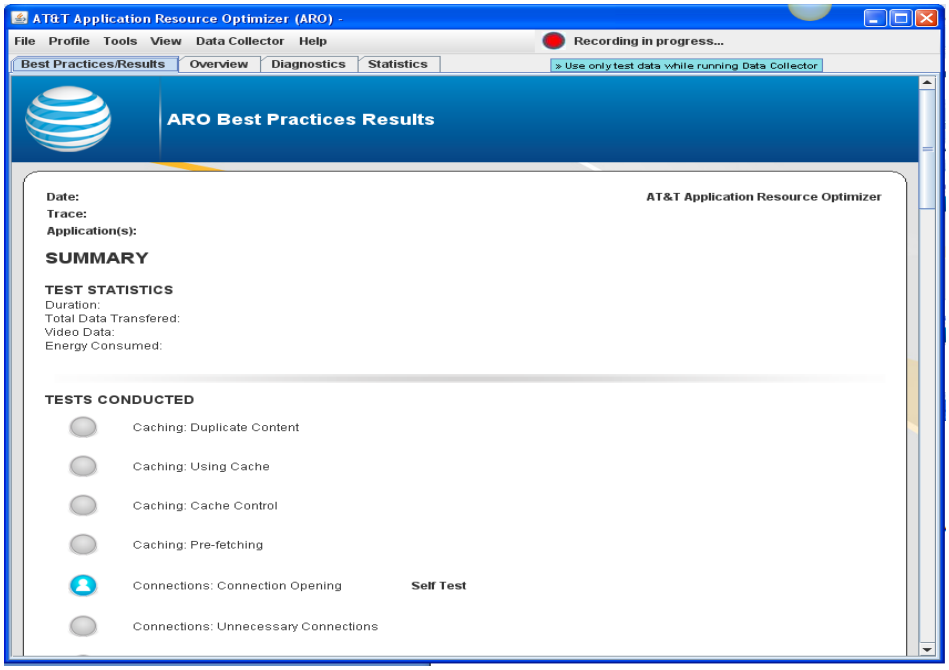
Next, you will see the “Recording in Progress…” message on the right hand side of the menu bar indicating that a recording of the Emulator is ongoing.



When the Data Collector is fully engaged on the emulator, you will see the following message indicating that the Data Collector has started. After you receive this message, you can move to the Emulator and start testing your application.

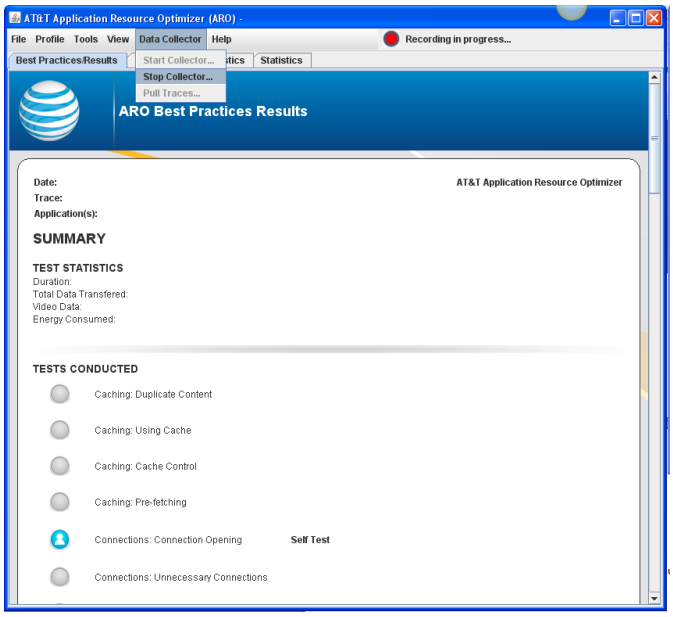


The red “Recording in Progress…” notification will continue to display as long as the Data Collector is running on the Emulator. If you hold the mouse cursor over the “Recording in Progress” icon, the following tooltip will appear:

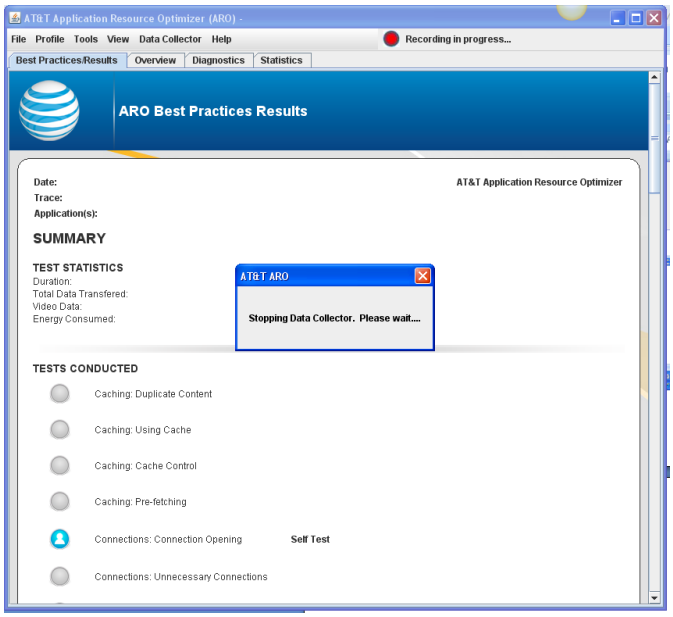


When the Data Collector is fully engaged, move to the Emulator and start testing your application. For information on how to develop a testing strategy for your application, refer to the Testing Guide.

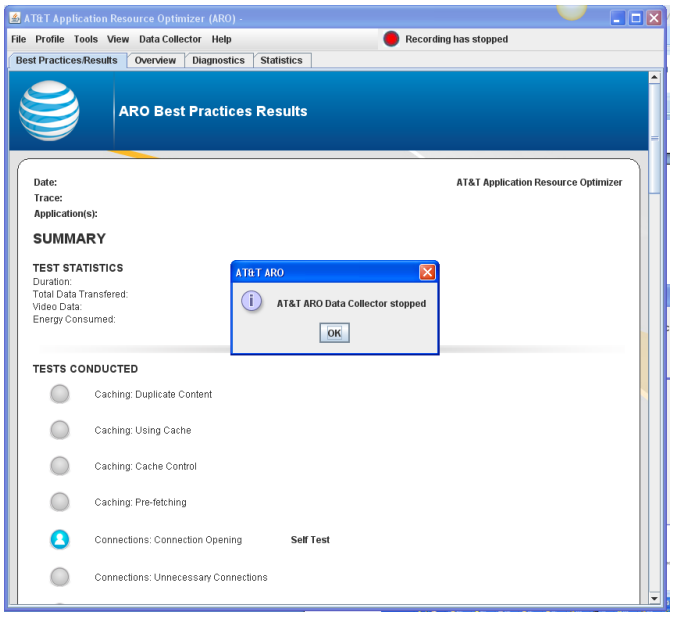
When you have completed testing your application on the Android Emulator, open the “Data Collector” menu on the AT&T ARO Data Analyzer and select the “Stop Collector” menu item.



The AT&T ARO Data Analyzer will display the following message when the “Stop Collector” menu item has been selected.



When data collection has completely stopped, you will see the following message.



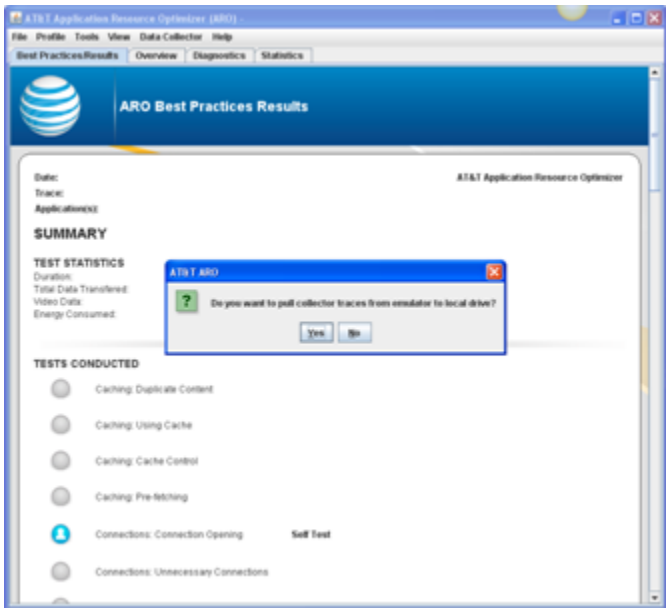
3.1.1.6 Pulling the Trace

When the AT&T ARO Data Collector has stopped, pull the trace data to your computer so that it can be analyzed.

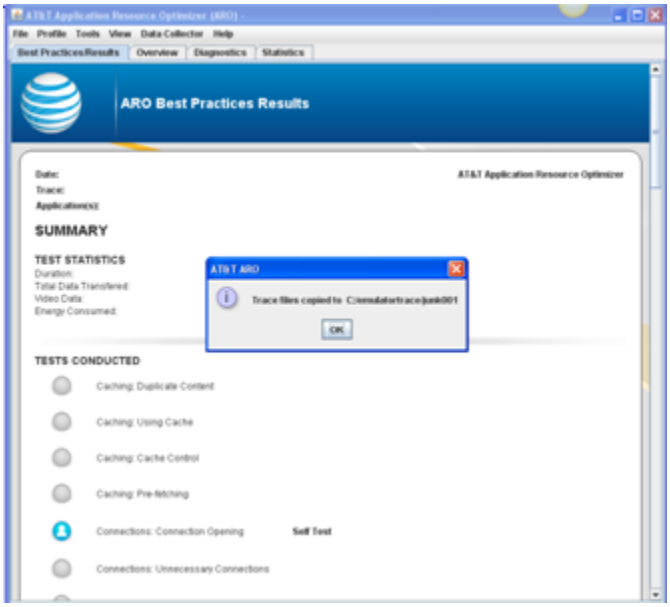
To pull the trace data, open the Data Collector menu on the AT&T ARO Data Analyzer and select the “Pull Traces” menu item. Notice that this menu item is only enabled after the Data Collector has been stopped.

The following image shows the “Pull Traces” menu item enabled on the Data Collector menu.

When you select “Pull Traces”, a confirmation dialog appears (as in the following image) asking whether you want to pull the trace files from the Emulator to the hard drive. If you select “No”, the trace folder will not be copied to the computer’s hard drive.



If you select “Yes”, The AT&T ARO application will copy the files to the computer’s hard drive and confirm the location as the following image.



3.1.2 Collecting Data Using Keynote DeviceAnywhere™

3.1.2.1 Introduction

Keynote DeviceAnywhere is a platform that allows you to remotely connect to mobile devices from your computer to test applications on a device. Keynote DeviceAnywhere supports an AT&T ARO package that includes AT&T ARO specific devices to test Android applications.

3.1.2.2 Prerequisites

To use Keynote DeviceAnywhere with the AT&T ARO Data Collector, you need the following:

- Login credentials to Keynote DeviceAnywhere.
- Keynote DeviceAnywhere Studio installed on your computer.
- A File Transfer Protocol (FTP) client. AT&T recommends installing SmartFTP from http://www.smartftp.com/download/.

3.1.2.3 Launching Keynote DeviceAnywhere Studio

The following steps describe how to launch Keynote DeviceAnywhere and select an AT&T ARO device:

Step 1: Create a Keynote DeviceAnywhere account. **Note:** Only first time users without an account need to complete this step. If you already have an account with Keynote DeviceAnywhere proceed to Step 2.

Step 2: Launch Keynote DeviceAnywhere Studio from the computer using the same login credentials that were provided to you at login to Keynote DeviceAnywhere at http://developer.att.com/ARO/deviceanywhere.

3.1.2.4 Acquiring an AT&T ARO Device

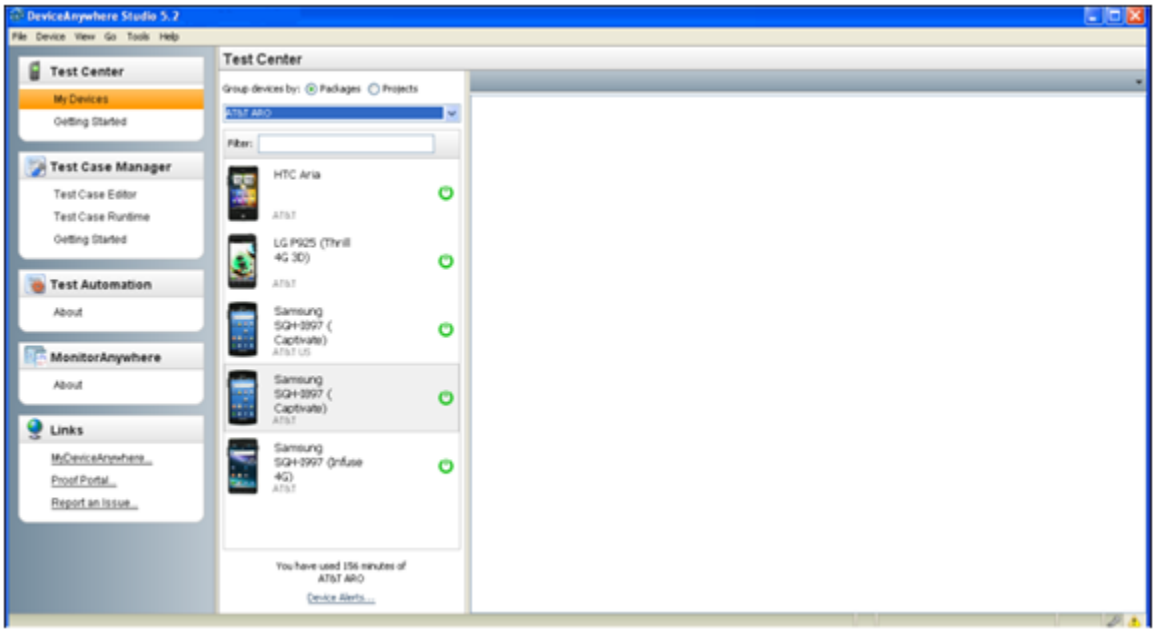
Once the Keynote DeviceAnywhere Studio is launched, acquire an AT&T ARO device by doing the following:

Step 1: Select “My Devices” from the group of options under “Test Center” on the left side of the screen.

Step 2: Click the radio button to select “Group devices by: Packages”.

Step 3: Select “AT&T ARO” from the drop down list of device packages. This selection will display all of the AT&T ARO specific devices in the device package installed by the AT&T ARO Data Collector application.

In the following example, the AT&T ARO device package is selected and one AT&T ARO device is displayed.



Step 4: Right click on the green ON Power icon button next to the device and select Acquire device. It will take a few seconds to display the device on the right hand side of the screen.

The following image shows the Keynote DeviceAnywhere Studio with an AT&T ARO device acquired.

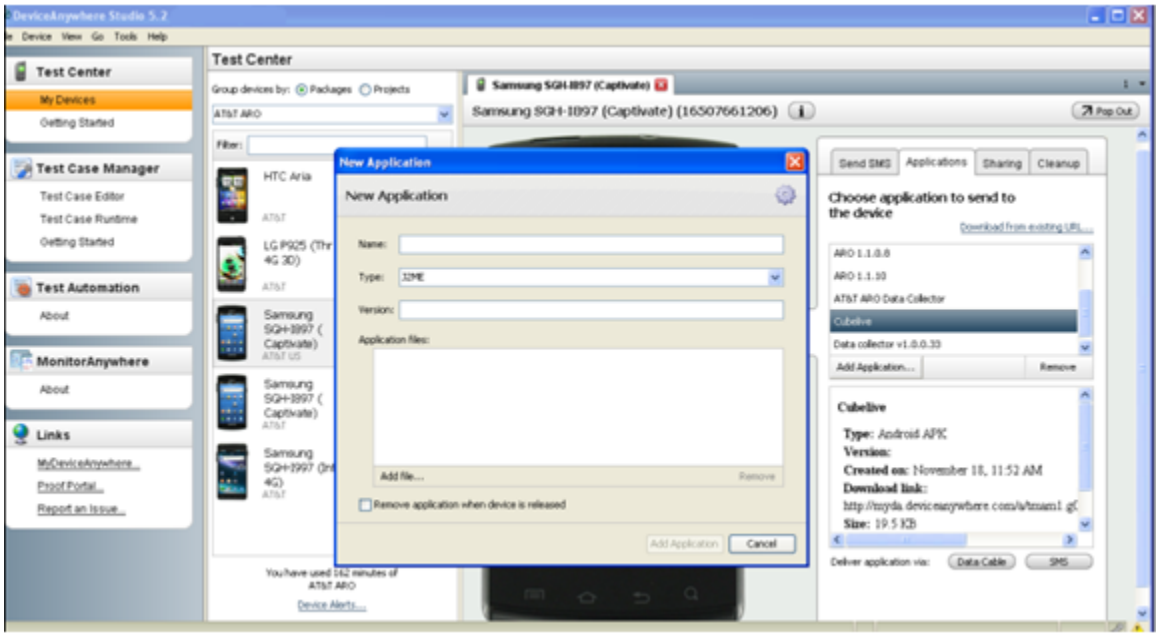
3.1.2.5 Running a Trace on an AT&T ARO Device

Once you have acquired an AT&T ARO device in the Keynote DeviceAnywhere Studio, you can test an application on the device and run a trace on it using the AT&T ARO Data Collector.

The following steps describe how to add your own application to the device, launch the Data Collector, stop other applications from running on the device, and run a trace on your application.

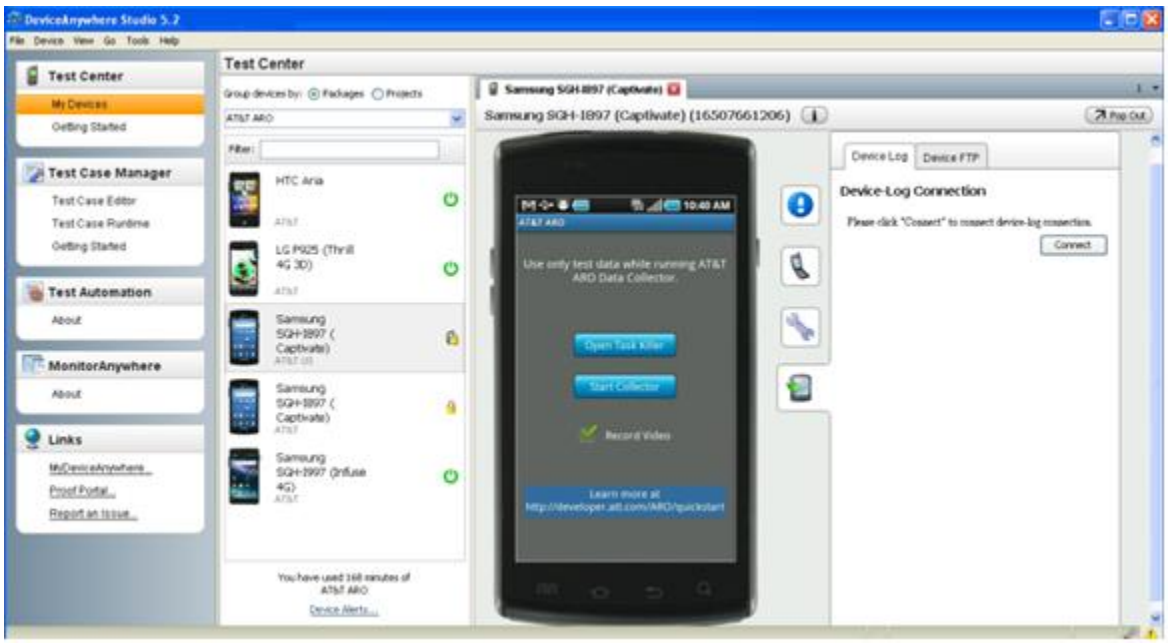
Step 1: To test your own application, the application must be added to the device before starting the AT&T ARO Data Collector. To add an application to the device, select the tool icon tab “Additional tool to work with the device” on the right hand side of the device, and choose an application to upload.

The following image shows the “New Application” dialog for adding your application to the device.



Step 2: On the device, navigate to Applications and launch the application AT&T ARO Data Collector.

The following image shows the opening screen of the AT&T ARO Data Collector.



Step 3: Click the “Open Task Killer” button on the opening screen of the Data Collector. This will allow you to kill the other applications that are running other than the one that you want to test. This ensures that the trace is captured only for the application that you are testing. You can tap on the select all button or select individual applications that you would like to end and click the “Kill Selected Tasks” button.

The following image shows how the device appears after the “Open Task Killer” button has been clicked:

Step 4: After you have stopped all of the applications except the one you are testing, return to the main AT&T ARO Data Collector screen and click the “Start Collector” button. After clicking this button, you will be prompted to enter a folder name in which to save the trace.

The following image shows the “Create Folder” dialog after the “Start Collector” button has been clicked.

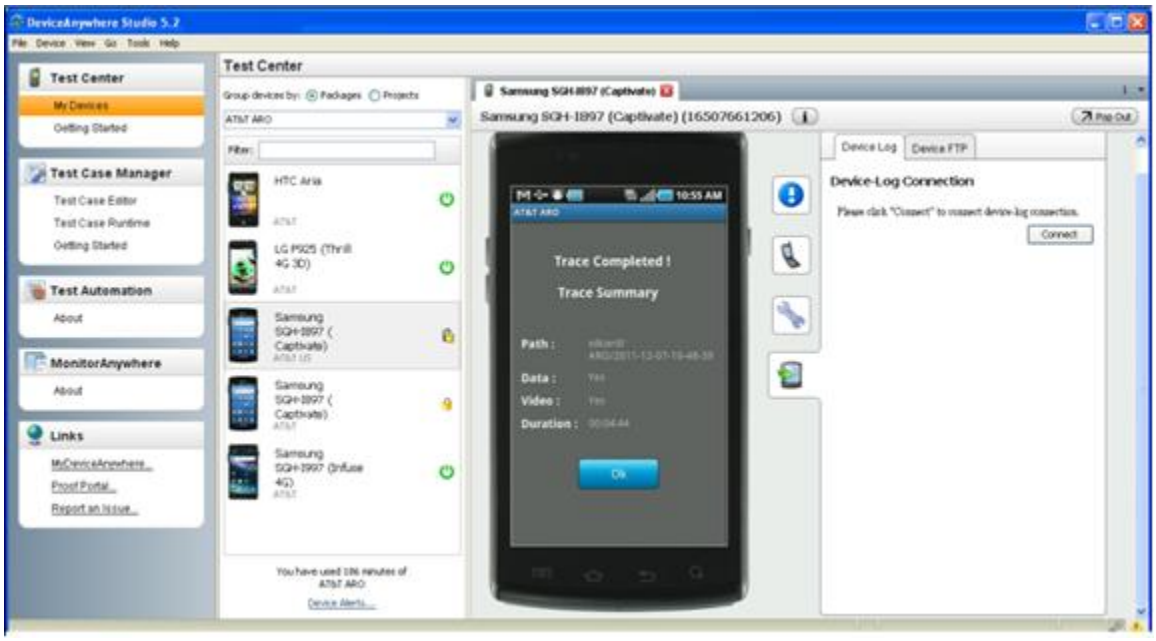
Step 5: After you click the OK button to accept the folder name, the Data Collector will be started in few seconds.

The following image shows the AT&T ARO Data Collector when it has started recording:

Step 6: Once the Data Collector started recording, click the “Hide Collector” button and navigate to the application that was uploaded to the device. Start the application and test its features.

Step 7: After testing the application, click the “Stop Collector” button. When the Data Collector is stopped, the trace summary will be displayed.

The following image shows the Trace Summary screen on the device after the “Stop Collector” button has been clicked.



3.1.2.6 Pulling the Trace

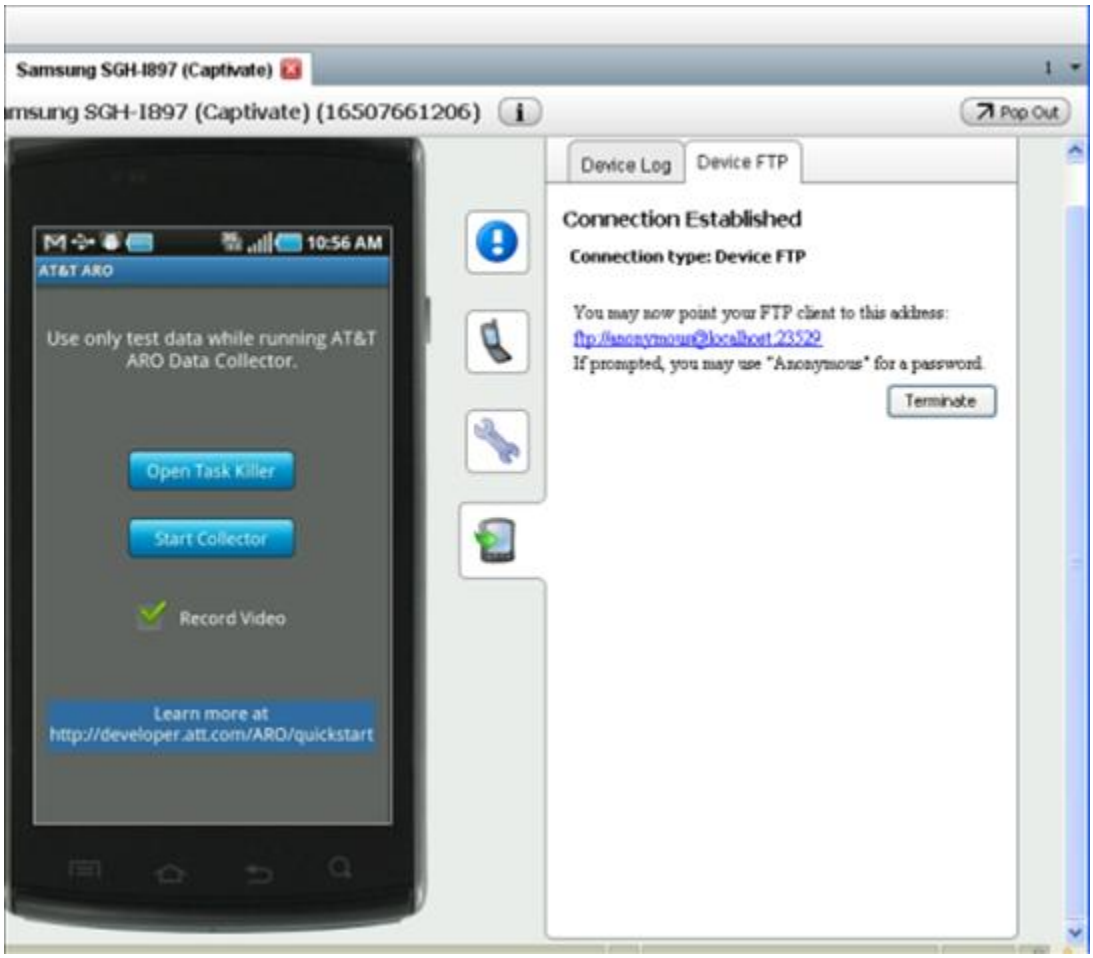
When the AT&T ARO Data Collector has stopped, pull the trace data from Keynote DeviceAnywhere to your computer so that it can be analyzed using the AT&T ARO Data Analyzer.

To pull the trace, an FTP client must be installed on your computer in order to establish a connection with the AT&T ARO device. As specified in the prerequisites (section 3.1.2.2), AT&T recommends installing the SmartFTP client from http://www.smartftp.com/download/.

The following steps describe how to pull the trace data to your computer.

Step 1: In Keynote DeviceAnywhere Studio, on the right hand side of the device image, click on the “Connect the device to Local computer” icon and select the “Device FTP” tab.

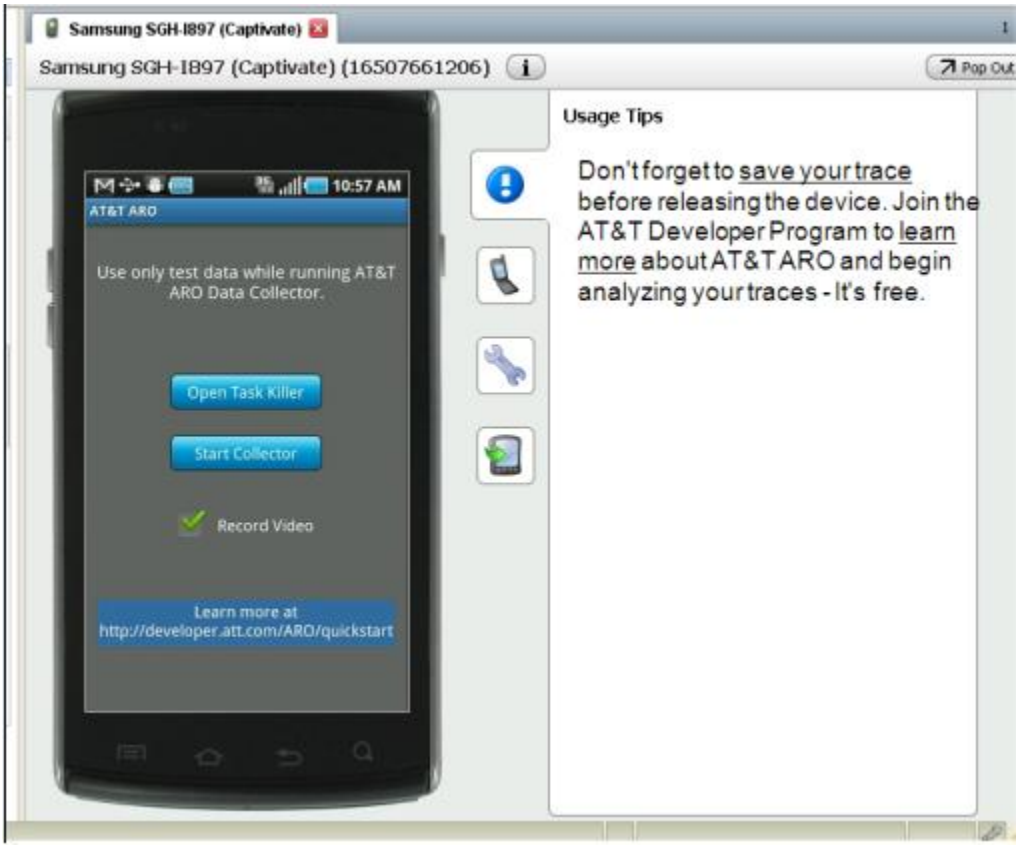
The following image shows that an FTP connection has been established after you have clicked “Connect the device to Local computer” and selected “Device FTP”.



Step 2: Point your FTP client to the address provided in the “Device FTP” tab. You will see this address in the tab below the “Connection Established” message (as in the preceding image).

Note: Ensure that the trace folder is downloaded successfully on your computer before you release the device. Once the device is released, it will clean up all traces and history.

This message, and other important messages, are displayed when you click the “Usage Tips” icon as shown in the following image.



With the trace folder saved to your computer, you are ready to use the AT&T ARO Data Analyzer to perform analysis on the trace. This process is described in section 4 “Using the AT&T ARO Data Analyzer”.

4. Using the AT&T ARO Data Analyzer

The AT&T ARO Data Analyzer is a tool for measuring and analyzing the energy usage of applications running on a device or on the Android Emulator. The Data Analyzer works from application traces gathered through the AT&T ARO Data Collector to do its analysis.

The AT&T ARO Data Analyzer provides the following:

- Visibility into radio resource and energy utilization.
- Benchmarking of resource efficiencies.
- Automatic diagnosis of application inefficiencies.

To use the AT&T ARO Data Analyzer, you must meet the system requirements and follow the installation instructions in the following sections.

4.1 System Requirements

The AT&T ARO Data Analyzer application is a Java Web Start application that can be accessed from the AT&T Developer Program web site http://developer.att.com/ARO. You can launch the application from any web browser that has set the MIME-type association for JNLP files. This association is automatically set when you install Java on your computer.

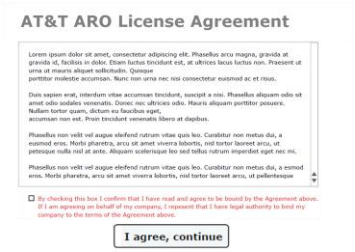
The system requirements to run the AT&T ARO Data Analyzer are:

- A computer running 32-bit Windows XP, Windows Vista, or Windows Seven.
- At least 1GB of RAM.
- The Java Runtime Environment (JRE™).
- WinPcap, the “industry-standard windows packet capture library”.

4.2 Installing AT&T ARO Data Analyzer

The AT&T ARO Data Analyzer can be accessed from the AT&T Developer Program web site at http://developer.att.com/ARO.

First, sign in, then read and accept the Terms and Conditions.



Next, click on the “Download the AT&T ARO Data Analyzer” link to download the AT&T ARO Data Analyzer for single-session use.

4.3 Launching the AT&T ARO Data Analyzer

Launch the AT&T ARO Data Analyzer application by opening your web browser and navigating to the AT&T Developer Program web site at http://developer.att.com/ARO.

The AT&T ARO Data Analyzer can be used offline as long as the session is not closed. Once you exit the Data Analyzer, you will need to go to the AT&T Developer Program web site, accept the terms and conditions, and download the Data Analyzer again (as described in section 4.2) in order to use it again.

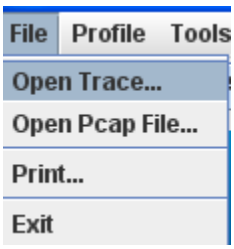
This is to ensure that the latest version of the AT&T ARO Data Analyzer is immediately available.

4.4 Opening a Trace File

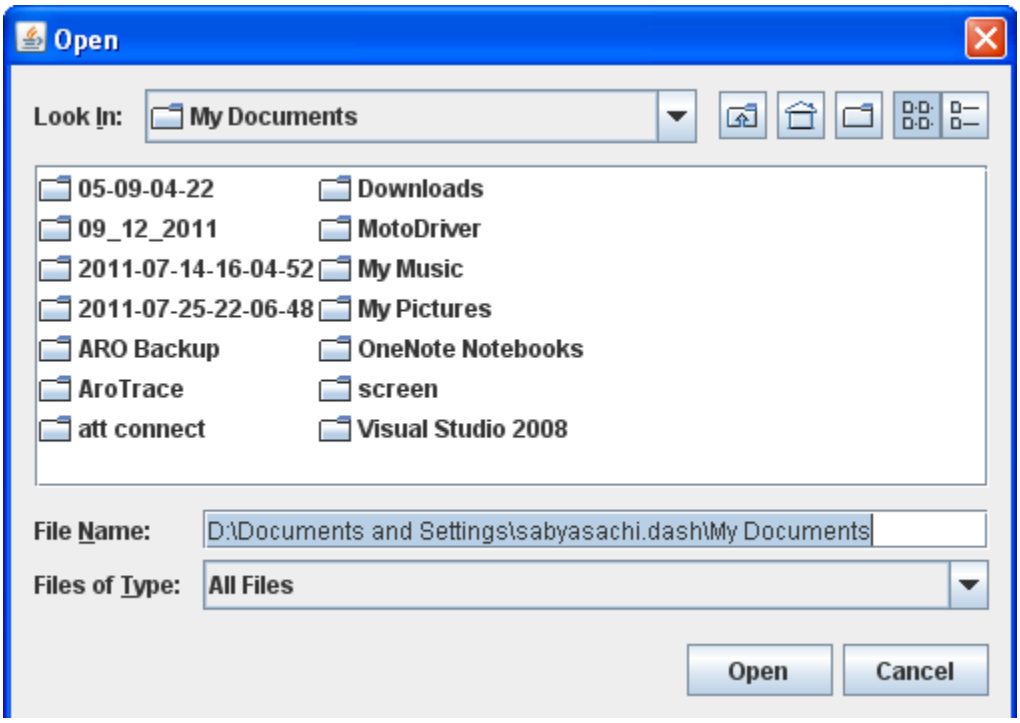
When you open a trace file in the AT&T ARO Data Analyzer, the data is evaluated against 12 common best practices. The Data Analyzer looks at how your application (and your server) is handling caching, and how you are managing the network connections for your application.

To open a trace file, do the following:

Step 1: From the “File” menu in the AT&T ARO Data Analyzer, select the “Open Trace” menu item as in the following image.



Step 2: After selecting the “Open Trace” menu item, a dialog box is displayed that prompts you to select the location of the trace folder. The following image shows the dialog box that is displayed when you select “Open Trace”.



Step 3: When you click the “Open” button, the trace files are loaded, and the AT&T ARO Data Analyzer begins analyzing the data. The time it takes the Data Analyzer to complete the analysis depends on the size of the trace file. As soon as the analysis is complete, all of the content tabs in the Data Analyzer are updated with the analysis results.

For a complete reference of the Command Menus and Content Tabs in the AT&T ARO Data Analyzer see the AT&T ARO Data Analyzer Reference in section 5 of this document.

5. AT&T ARO Data Analyzer Reference

The following sections are a complete reference of the Command Menus and Content Tabs in the AT&T ARO Data Analyzer.

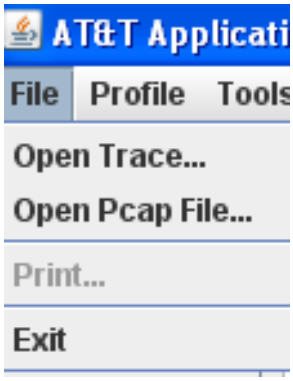
5.1 Command Menus

The AT&T ARO menu bar has the following command menus.

Menu	Description
File	Contains options for opening Trace files, Pcap files, printing results and exiting the application.
Profile	Contains options for loading and customizing device profiles.
Tools	Contains options that allows you to run a Time Range Analysis, and a Pcap file analysis.
View	Contains options for displaying video, selecting applications, and configuring which items appear in the analysis and diagnostics.
Data Collector	Contains options for accessing the AT&T ARO Data Collector from the AT&T ARO Data Analyzer.
Help	Contains options for displaying the application version, the FAQ page, the User Forum, the User Guide, the Analysis Guide, and other Help documentation.

5.1.1 File

The File menu, pictured below, contains the following options.

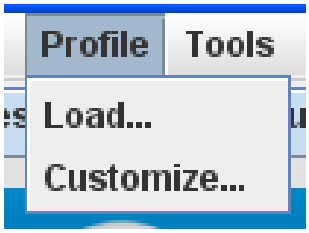


Menu Option	Description
Open Trace	Opens the Trace file for trace analysis. When this menu item is selected, a dialog box is displayed that prompts you to select the location of the trace folder containing the trace files. You must select a trace file in order to do trace analysis.

Open Pcap file	Opens a Pcap file for packet data analysis. When this menu item is selected, a dialog box is displayed that prompts you to select the location of the Pcap file. You must select a Pcap file in order to do packet data analysis.
Print	Prints the results that are displayed when the Best Practices or Statistics tab is selected. This menu option is only enabled when the Best Practices or Statistics tab is selected.
Exit	Exits the AT&T ARO application.

5.1.2 Profile

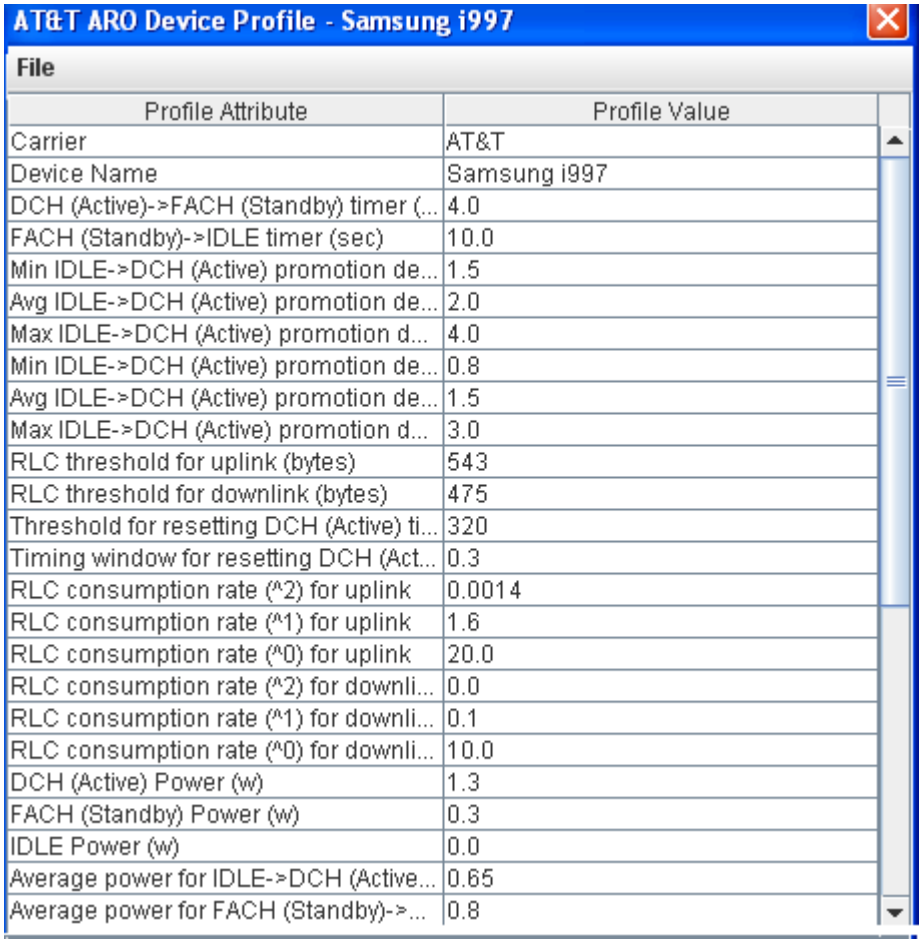
The Profile menu, pictured below, contains the following options.



Menu Option	Description

Load	Loads the selected Device Profile. When this menu option is selected, the following dialog box is displayed that prompts you to select one of the listed Device Profiles. When a Device Profile is selected, the profile values are updated accordingly. To edit individual profile values, select the Customize menu option. 

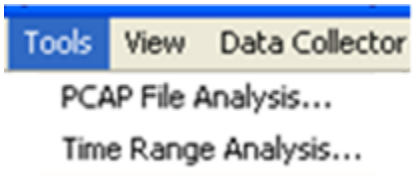
Customize	Displays the values of the selected Device Profile and allows you to edit them. The following dialog is displayed when you select the Customize menu option.

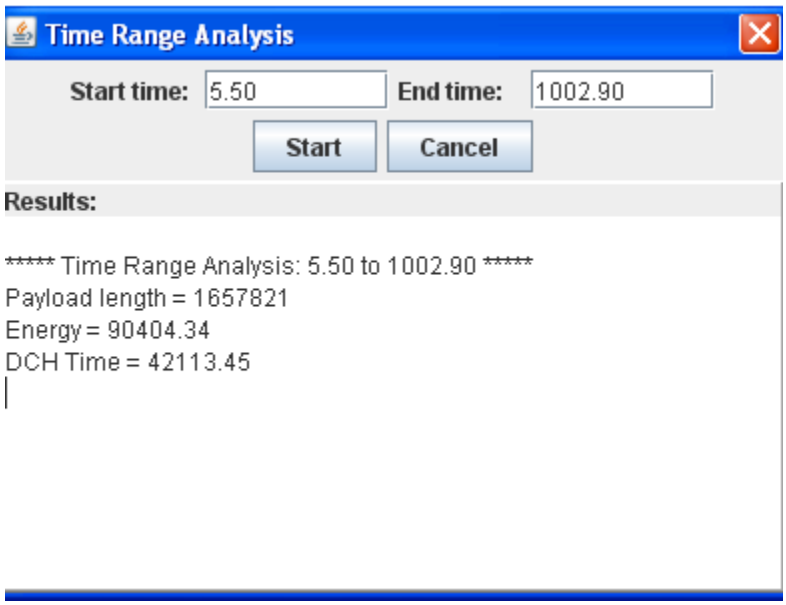


Profile Attribute	Profile Value
Carrier	AT&T
Device Name	Samsung i997
DCH (Active)->FACH (Standby) timer (...	4.0
FACH (Standby)->IDLE timer (sec)	10.0
Min IDLE->DCH (Active) promotion de...	1.5
Avg IDLE->DCH (Active) promotion de...	2.0
Max IDLE->DCH (Active) promotion d...	4.0
Min IDLE->DCH (Active) promotion de...	0.8
Avg IDLE->DCH (Active) promotion de...	1.5
Max IDLE->DCH (Active) promotion d...	3.0
RLC threshold for uplink (bytes)	543
RLC threshold for downlink (bytes)	475
Threshold for resetting DCH (Active) ti...	320
Timing window for resetting DCH (Act...	0.3
RLC consumption rate (^2) for uplink	0.0014
RLC consumption rate (^1) for uplink	1.6
RLC consumption rate (^0) for uplink	20.0
RLC consumption rate (^2) for downli...	0.0
RLC consumption rate (^1) for downli...	0.1
RLC consumption rate (^0) for downli...	10.0
DCH (Active) Power (w)	1.3
FACH (Standby) Power (w)	0.3
IDLE Power (w)	0.0
Average power for IDLE->DCH (Active...	0.65
Average power for FACH (Standby)->...	0.8

5.1.3 Tools

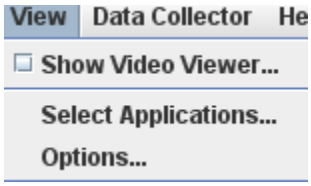
The Tools menu, pictured below, contains the following menu options.



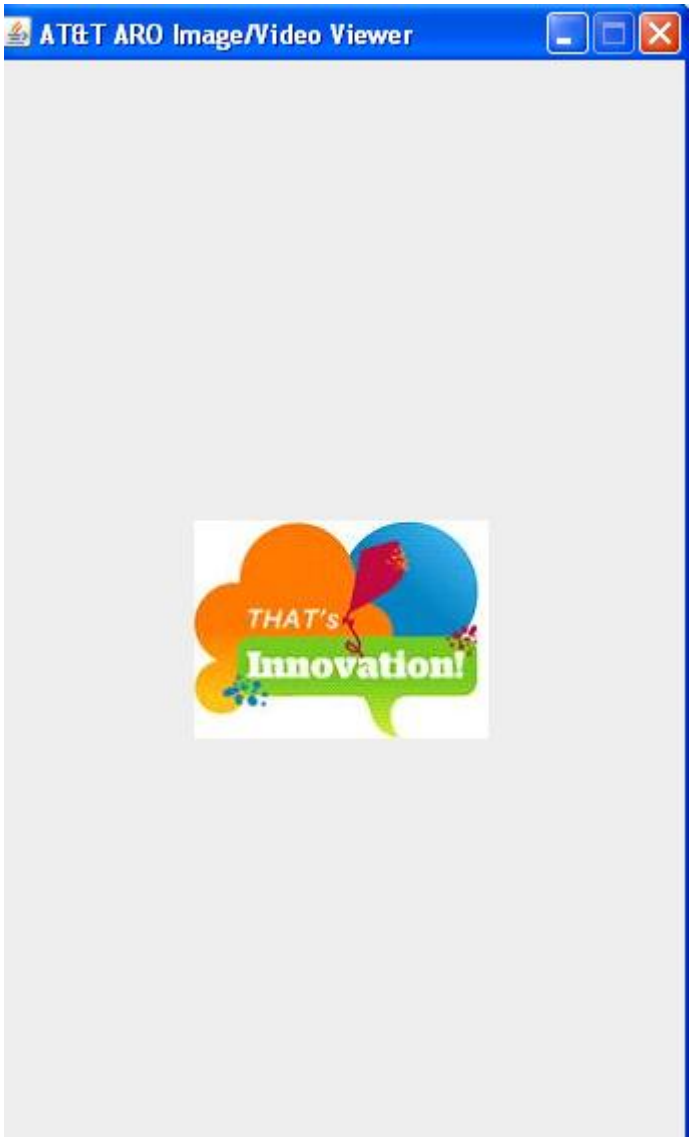
<table>
<tr><th>Menu Option</th><th>Description</th></tr>
<tr><td>PCAP File Analysis</td><td>Displays the start and end times of the Pcap file analysis.</td></tr>
<tr><td>Time Range Analysis...</td><td>Displays the Time Range Analysis dialog that allows you to set a time range, start or cancel the analysis, and displays the analysis results. When the start and end time are entered and the Start button is clicked, the following results are displayed:
<table>
<tr><th>Result</th><th>Description</th></tr>
<tr><td>Payload length</td><td>The length of the payload in bytes.</td></tr>
<tr><td>Energy</td><td>The amount of energy used in joules.</td></tr>
<tr><td>DCH Time</td><td>The amount of time, in seconds, that the application was in the DCH state.</td></tr>
</table>

</td></tr>
</table>

5.1.4 View

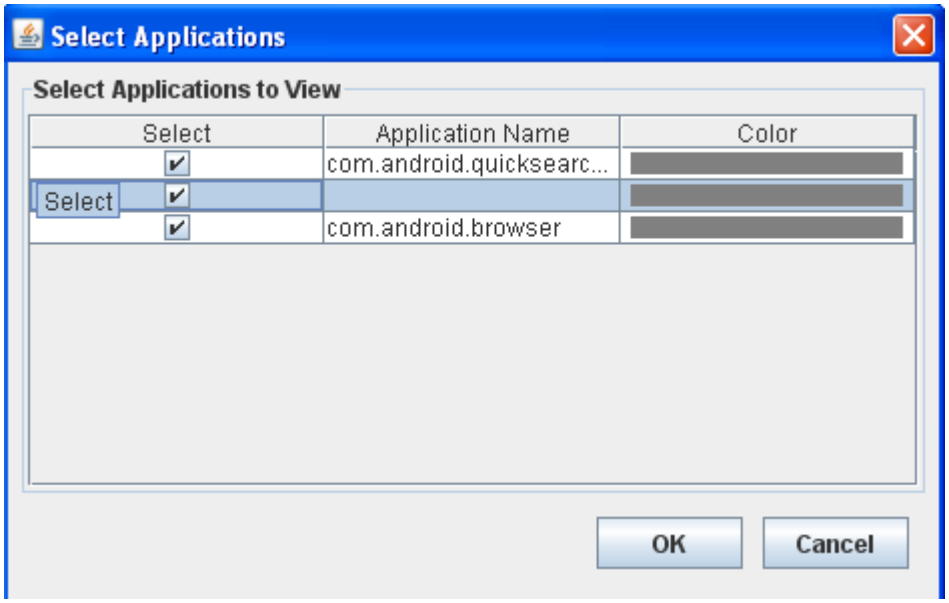
The View menu, pictured below, contains the following menu options.



Menu Option	Description

Show Video Viewer	Opens a window that displays the video of the activities carried out on the device while the trace data was being collected. The following image shows the video viewer window. 

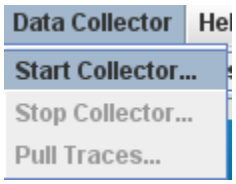
Select Applications	Opens a dialog box that allows you to select individual applications from the list of applications that were captured in the trace. The data from each selected application will be included in the analysis. The following image shows the Select Applications dialog box.



Options	Displays a dialog box of View Options that allows you to select the events and states that will be plotted in the Diagnostics View chart. 

5.1.5 Data Collector

The Data Collector menu, pictured below, contains the following options for accessing the AT&T ARO Data Collector from the AT&T ARO Data Analyzer that are only available when an Android Emulator is running.



Menu Option	Description

Start Collector	Starts the AT&T ARO Data Collector in the Android Emulator from the AT&T ARO Data Analyzer.
Stop Collector	Stops the AT&T ARO Data Collector in the Android Emulator from the AT&T ARO Data Analyzer.
Pull Traces	Retrieves the trace files from the Android Emulator.

5.1.6 Help

The Help menu, pictured below, contains the following options.

Menu Option	Description
About	Displays a dialog box containing information about the AT&T ARO application including its version.
	When you choose one of the following options, the default web browser is opened to display the selected page.
FAQ	*Displays the AT&T ARO FAQ* web page (http://developer.att.com/ARO/FAQ).
Forum	*Displays the AT&T ARO User Forum* web page (http://developer.att.com/ARO/forum).
User Guide	*Displays the AT&T ARO User's Guide* web page (http://developer.att.com/ARO/userguide).
Learn More	*Displays the Learn More about AT&T ARO* web page (http://developer.att.com/ARO).
Analysis Guide	*Displays the Analysis Guide* web page (http://developer.att.com/ARO/analysisguide).

5.2 Content Tabs

The AT&T ARO user interface is divided into four tabbed sections.

Tab	Description
Best Practices / Results	Displays the results of the Best Practices tests that are conducted on the trace data.
Overview	Displays charts and tables that present an overview of key statistical data from the trace.
Diagnostics	Displays charts and tables that present key diagnostic data from the trace.
Statistics	Displays charts and tables that present key statistical data from the trace.

5.2.1 Best Practices / Results Tab

The Best Practices / Results tab, pictured below, displays the results for all of the Best Practices tests that are conducted on the data captured in the trace files.

This tab displays the following details when the trace files are loaded into the Data Analyzer:

- The date on which the trace was captured, the trace folder name and the list of application names captured in the trace.
- The duration for which the trace data collection has run, the total data transferred, the total video data (if video was collected during the trace), and the total energy consumed during this time interval.
- The tests conducted for the best practices. The test results are updated when the trace files are loaded.

The Best Practices / Results tab consists of four pages that are populated with data from the best practices tests. These pages also show the results summary in the form of icons for all of the available best practices tests that were conducted. There is a common panel in all four pages of the tab which shows the following information for the loaded trace files:

Label	Description
Date	The date when the trace files were generated.

Label	Description
Trace	The name of the folder containing the trace files.
Application(s)	The names of the applications that were running when the trace data was collected.

5.2.1.1 Icons

Icon	Description
Green	Indicates that the test was passed.
Red	Indicates that the test was failed.
Blue	Indicates a self-evaluation test (a manual test).

5.2.1.2 Best Practices Tests

The following Best Practices tests, excluding the ones marked (Self-Test), are conducted on the trace data.

Test	Description
Duplicate Content	Tests if more than three files are downloaded in a duplicate manner in the loaded trace files.
Cache Control	Tests if the amount of “not expired duplicate data” is greater than the amount of “not changed data” in the loaded trace files.
Content Expiration	Tests if there is more than 10% of non-cacheable data available in the loaded trace files.
Content Pre-fetching	Tests if there are five or more user input bursts in a row in the loaded trace files.
Connection Opening (Self Test)	The Connection Opening test is a self-test and is not conducted automatically. Static information about connection opening is displayed for the test results.
Unnecessary Connections - Multiple Simultaneous Connections	Tests if there are several bursts in a row that are not user initiated in the loaded trace files.
Inefficient Connections - Periodic Transfers	Tests if a periodic connection is detected in the loaded trace files.
Inefficient Connections - Screen Rotation (Self Test)	The Screen Rotation test is a self-test and is not conducted automatically. Static information about screen rotation is displayed for the test results.
Inefficient Connections - Connection Closing Problems	Tests if 5% of the energy is used for TCP control in the loaded trace files.

Test	Description
Inefficient Connections - Offloading to WiFi when Possible	Tests if there are more than 5 large bursts in the loaded trace files.
Accessing Peripheral Applications	Tests if any peripheral applications are seen to be ON for more than 5% of the total duration recorded in the loaded trace files. The peripheral applications checked during this test are: GPS, Wi-Fi, Bluetooth, and camera.
Http 1.0 Usage	Tests if HTTP 1.0 is seen in the header of the loaded trace files.

5.2.1.3 Test Results

The Best practices detailed results are categorized into three sections.

Category	Description
Cache Related	Tests related to the cache.
Connections Related	Tests related to connections.
Others	All other tests.

Note: When any of the best practices tests in a category fails the header for that category turns red. The category header remains green if all of the tests in that category have passed.

5.2.1.4 AT&T ARO Best Practices Results Page-1:

This page shows the summary of results for all of the best practices tests conducted on the loaded trace files. Page 1 contains the following two sections:

5.2.1.4.1 Test Statistics

This section shows the following information about the loaded trace files:

Label	Description
Duration	The total time, in minutes, for which the trace data is collected on the device or Emulator.

Label	Description
Total Data Transferred	The total size, in bytes, of all data packets that are transferred for the entire duration of the trace data collection. This total includes the size of the packet and the packet header.
Video Data	The total size, in bytes, of the video data that is recorded during the trace data collection. This total includes the data size of the video MIME type (i.e. mpeg, mp4, ogg, QuickTime, webm or wmv).
Energy Consumed	The total energy, in Joules, that is consumed during the entire duration of the trace data collection. This total includes the energy of RRC, GPS, Wi-Fi, Bluetooth, Camera and Screen.

5.2.1.4.2 Tests Conducted

This section displays a list of all the best practices tests that were conducted on the loaded trace files. The result status of each test is indicated by an icon. Some best practices tests are self tests which are not conducted. These tests have the caption “Self test”.

The tests are categorized into the following three types:

Label	Description
Caching	Duplicate Content, Using Cache, Cache Control, Prefetching
Connections	Connection Opening (This is a self test and is not conducted.), Unnecessary Connections, Periodic Transfers, Screen Rotation (This is a self test and is not conducted.), Connection Closing, Wi-Fi Offloading
Other:	Accessing Peripherals, HTTP 1.0 Usage

To the left of each test name are icons that indicate the result status of that test. The test result status that these icons represent is as follows:

Symbol	Color	Description
	Green	The best practice test has succeeded.
	Red	The best practice test has failed.
	Blue	The best practice test is a self test and was not conducted.

5.2.1.5 AT&T ARO Best Practices Results Page-2:

This page shows detailed information for all caching tests conducted for best practices on the loaded trace files. It includes the results of the Duplicate Content, Prefetching, Using Cache and Cache Control tests. The following sections describe the details that are displayed for each of the best practices caching tests.

5.2.1.5.1 Duplicate Content

Field	Description
Test	The Duplicate Content test is conducted by checking to see if more than three files are downloaded in a duplicate manner in the loaded trace files. Detailed information about the Duplicate Content test is displayed as follows.
About	The following information is displayed in this field about the Duplicate Content test: Duplicating content leads to slower applications and wasted bandwidth.
Results	If this test passes, the results field will be blank, but you will see a highlighted green icon on the left side indicating success. When the Duplicate Content test passes, It means that more than three files were NOT downloaded in a duplicate manner in the loaded trace files. If this test fails, you will see a highlighted red icon on the left side and failure information will be displayed including a description of the cause. When the Duplicate Content test fails, it means that more than three files were downloaded in a duplicate manner in the loaded trace files. The failure information will typically show the following message: "Your trace had x% duplicated content. By reducing the duplicate content (y items, z M), your application will appear faster to your customers." When you click on this information, you will be directed to the Duplicate Content table of the "Overview" tab for further details.
Learn More	This label appears on the right side of the results section. When you click on it, you will be directed to the ATT help website where additional information about duplicate content is provided.

5.2.1.5.2 Pre-fetching

Field	Description
Test	The Prefetching test is conducted by checking to see if there are five or more user input bursts in a row in the loaded trace files.
About	The following information is displayed in this field about the Pre-fetching test: Downloading files "as needed" can slow the user experience. If a user scrolls through the main screen of the application and has to wait for images to load, the application appears slow.

Field	Description
Results	If this test passes, the results field will be blank, but you will see a highlighted green icon on the left side indicating success. When the Pre-fetching test passes, It means that there are NOT five or more user input bursts in a row in the loaded trace files. If this test fails, you will see a highlighted red icon on the left side and failure information will be displayed including a description of the cause. When the Pre-fetching test fails, it means that there are five or more user input bursts in a row in the loaded trace files. The failure information will typically show the following message: "ARO detected x user input bursts in a row. Consider pre-fetching your data (downloading all at once) to reduce the time your application is connected to the network." When you click on this information, you will be directed to the burst chart in the "Diagnostics" tab for further details.
Learn More	This label appears on the right side of the results section. When you click on it, you will be directed to the ATT help website where additional information about pre-fetching is provided.

5.2.1.5.3 Using Cache

Field	Description
Test	The Using Cache test is conducted by checking to see if there is more than 10% of non-cacheable data available in the loaded trace files.
About	The following information is displayed in this field about the Using Cache test: For all content that should be stored in the cache - make sure that the server is adding the appropriate cache headers.
Results	If this test passes, the results field will be blank, but you will see a highlighted green icon on the left side indicating success. When the Using Cache test passes, it means that there is NOT more than 10% of non-cacheable data available in the loaded trace files. If this test fails, you will see a highlighted red icon on the left side and failure information will be displayed including a description of the cause. When the Using Cache test fails, it means that there is more than 10% of non-cacheable data available in the loaded trace files. The failure information will typically show the following message: "ARO detected cache headers present x% of the time." When you click on this information, you will be directed to the Duplicate Content table of the "Overview" tab for further details.
Learn More	This label appears on the right side of the results section. When you click on it, you will be directed to the ATT help website where additional information about using cache is provided.

5.2.1.5.4 Cache Control

Field	Description

Field	Description
Test	The Cache Control test is conducted by checking to see if the amount of “not expired duplicate data” is greater than the amount of “not changed data” in the loaded trace files. “Not changed data” is data for which a 304 response is received, indicating that the data has not been modified since it was last requested.
About	The following information is displayed in this field about the Cache Control test: This test compares the number of 304 (Not Modified) requests versus files that should be cached that were downloaded multiple times.
Results	If this test passes, the results field will be blank, but you will see a highlighted green icon on the left side indicating success. When the Cache Control test passes, it means that the amount of “not expired duplicate data” is NOT more than the amount of “not changed data” in the loaded trace files. If this test fails you will see a highlighted red icon on the left side and failure information will be displayed including a description of the cause. When the Cache Control test fails, it means that the amount of “not expired duplicate data” is greater than the amount of “not changed data” in the loaded trace files. The failure information will typically show the following message: Your trace contained x duplicate files with "not expired" cache headers and y received 304 responses. When you click on this information, you will be directed to the “HTTP Cache Statistics” section of the “Statistics” tab for further details.
Learn More	This label appears on the right side of the results section. When you click on it, you will be directed to the ATT help website where additional information about cache control is provided.

5.2.1.6 AT&T ARO Best Practices Results Page-3:

This page shows detailed information of all connection related tests conducted for best practices on the loaded trace files. It includes the results of the Connection Opening, Unnecessary Connections, Periodic Transfers, Screen Rotation, Connection Closing, and Wi-Fi Offloading tests. The following sections describe the details that are displayed for each of the best practices connections tests.

5.2.1.6.1 Connection Opening

Field	Description
Test	The Connection Opening test is a self-test and is not conducted automatically.
About	The following information is displayed in this field about the Connection Opening test: A typical startup consists of an input burst, followed by a series of bursts spread out over time which can dramatically slow down the application's response time and waste energy on the device.

Field	Description
Self Evaluation	As this test is a self test and not conducted, static information about connection opening is shown in this section. It is accompanied by showing a highlighted gray icon on left side. Self Evaluation typically shows the following message: If you see many "App" initiated bursts, consider a transaction manager to group these more closely together.
Learn More	This label appears on the right side of the results section. When you click on it, you will be directed to the ATT help website where additional information about connection opening is provided.

5.2.1.6.2 Unnecessary Connections

Field	Description
Test	The Unnecessary Connections test is conducted by checking if there are several bursts in a row that are not user initiated in the loaded trace files. For example: 3 bursts in 15 seconds or 4 bursts in 1 minute.
About	The following information is displayed in this field about the Unnecessary Connections test: By syncing all of the data connections, the user reduces the amount of time an application is on the network, which reduces battery drain and makes content appear to load faster.
Results	If this test passes, the results field will be blank, but you will see a highlighted green icon on the left side indicating success. When the Unnecessary Connections test passes, it means that there are NOT several bursts in a row that are not user initiated in the loaded trace files. If this test fails then, you will see a highlighted red icon on the left side and failure information will be displayed including a description of the cause. When the Unnecessary Connections test fails, it means that there are several bursts in a row that are not user initiated in the loaded trace files. The failure information will typically show the following message: "x sets of bursts that could be more tightly grouped." When you click on this information, you will be directed to the burst chart in the "Diagnostics" tab which will show the burst group with the highest number of bursts.
Learn More	This label appears on the right side of the results section. When you click on it, you will be directed to the ATT help website where additional information about unnecessary connections is provided.

5.2.1.6.3 Periodic Transfers

Field	Description
Test	The Periodic Transfer test is conducted by checking to see if a periodic connection is detected in the loaded trace files.
About	The following information is displayed in this field about the Unnecessary Connections test: You should ensure that the periodic connections are truly needed, as these could cause excessive power drain.

Field	Description
Results	If this test passes, the results field will be blank, but you will see a highlighted green icon on the left side indicating success. When the Periodic Transfer test passes, it means that a periodic connection is NOT detected in the loaded trace files. If this test fails, you will see a highlighted red icon on the left side and failure information will be displayed including a description of the cause. When the Periodic Transfer test fails, it means that a periodic connection is detected in the loaded trace files. The failure information will typically show the following message: "There were x different connections which were repeated a total of y times with a minimum repeat time of z seconds." When you click on this information, you will be directed to the TCP flow table in the "Diagnostics" tab which highlights the TCP connection for the first periodic connection of the shortest period.
Learn More	This label appears on the right side of the results section. When you click on it, you will be directed to the ATT help website where additional information about period transfers is provided.

5.2.1.6.4 Screen Rotation

Field	Description
Test	The Screen Rotation test is a self-test and is not conducted automatically.
About	The following information is displayed in this field about the Screen Rotation test: Some applications must have pinged the server on orientation changes, or completely retransmitted content. If you see this in your trace - consider a new layout for existing content (rather than re-download) or sending the orientation change later as a part of a larger data transmission.
Self Evaluation	As this test is a self test and not conducted, static information about screen rotation is shown in this section. It is accompanied by showing a highlighted gray icon on the left side. Self Evaluation typically shows the following message: In your trace, did you rotate the screen? Look for server pings or duplicate content. Consider a new layout for existing content (rather than re-download) or sending the orientation change later as a part of a larger data transmission.
Learn More	This label appears on the right side of the results section. When you click on it, you will be directed to the ATT help website where additional information about screen rotation is provided.

5.2.1.6.5 Connection Closing

Field	Description
Test	The Connection Closing test is conducted by checking if 5% of the energy is used for TCP control in the loaded trace files. These are wasted bursts.

Field	Description
About	The following information is displayed in this field about the Connection Closing test: When the connections are not closed promptly, the radio remains at high power to close user connections.
Results	If this test passes, the results field will be blank, but you will see a highlighted green icon on the left side indicating success. When the Connection Closing test passes, it means that 5% of the energy is NOT TCP control in the loaded trace files. If this test fails, you will see a highlighted red icon on the left side and failure information will be displayed including a description of the cause. When the Connection Closing test fails, it means that 5% of the energy is TCP control in the loaded trace files. The failure information will typically show the following message: "ARO detected that x Joules (y% of the total energy) was used to control these connections. By closing promptly, you will reduce battery drain." When you click on this information, you will be directed to the burst chart in the "Diagnostics" tab which will show the largest TCP control burst.
Learn More	This label appears on the right side of the results section. When you click on it, you will be directed to the ATT help website where additional information about connection closing is provided.

5.2.1.6.6 Wi-Fi Offloading

Field	Description
Test	The Wi-Fi Offloading test is conducted by checking if there are more than 5 large bursts in the loaded trace files.
About	The following information is displayed in this field about the Wi-Fi Offloading test: "If you are transmitting large chunks of data, consider connecting to Wi-Fi.
Results	If this test passes, the results field will be blank, but you will see a highlighted green icon on the left side indicating success. When the Wi-Fi Offloading test passes, it means that there are NOT more than 5 large bursts in the loaded trace files. If this test fails, you will see a highlighted red icon on the left side and failure information will be displayed including a description of the cause. When the Wi-Fi Offloading test fails, it means that there are more than 5 large bursts in the loaded trace files. The failure information will typically show the following message: "ARO saw x large bursts of heavy data in your trace." When you click on this information, you will be directed to the burst chart in the "Diagnostics" tab which will show the largest burst.
Learn More	This label appears on the right side of the results section. When you click on it, you will be directed to the ATT help website where additional information about Wi-Fi offloading is provided.

5.2.1.7 ARO Best Practices Results Page-4:

This page shows detailed information of all other tests conducted for best practices which are not related to caching and connection for the loaded trace files. It includes the results of Accessing Peripherals and HTTP 1.0 usage tests. The following sections describe the details that are displayed for these best practices tests.

5.2.1.7.1 Accessing Peripherals

Field	Description
Test	The Accessing Peripherals test is conducted by checking if any of the peripherals is seen to be ON for more than 5% of the total duration recorded in the loaded trace files. The peripherals checked during this test are: GPS, Wi-Fi, Bluetooth, and camera.
About	The following information is displayed in this field about the Accessing Peripherals test: Accessing device hardware features like cameras, GPS, Bluetooth, speakers, and Wi-Fi can drain the battery. That's not a problem if the application is utilizing those peripherals, but many apps access peripherals they never utilize.
Results	If this test passes, the results field will be blank, but you will see a highlighted green icon on the left side indicating success. When the Accessing Peripherals test passes, it means that any of the peripherals is NOT seen to be ON for more than 5% of the total duration recorded in the loaded trace files. If this test fails, you will see a highlighted red icon on the left side and failure information will be displayed including a description of the cause. When the Accessing Peripherals test fails, it means that any of the peripherals is ON for more than 5% of the total duration recorded in the loaded trace files. The failure information will typically show the following message: "During your trace, GPS was active and not in use for 8% of the time. Wi-Fi was active and not in use for 17% of the time. Bluetooth was active and not in use for 12% of the time. Camera was active and not in use for 23% of the time." When you click on this information, you will be directed to the peripheral chart in the "Diagnostics" tab for further details.
Learn More	This label appears on the right side of the results section. When you click on it, you will be directed to the ATT help website where additional information about Accessing Peripherals is provided.

5.2.1.7.2 HTTP 1.0 Usage

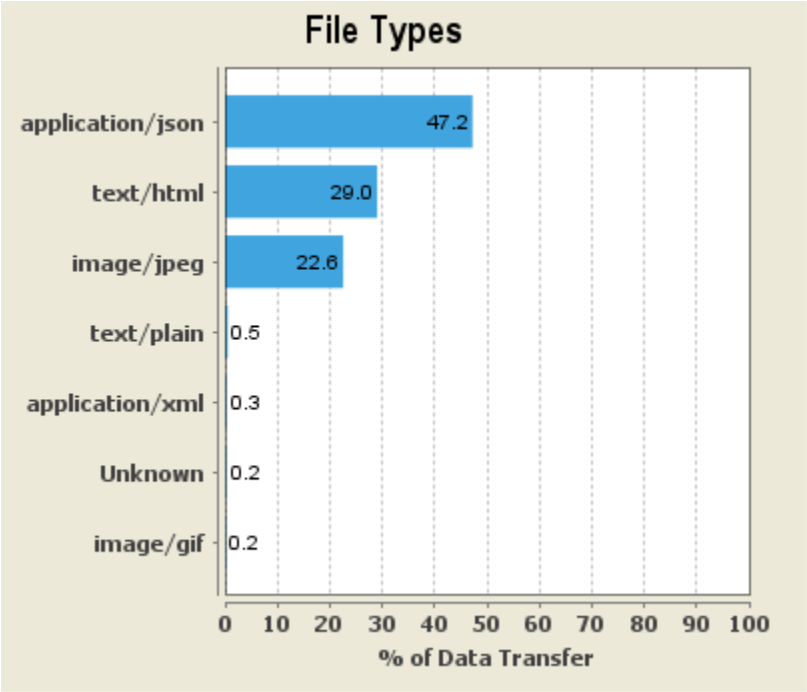
Field	Description
Test	The HTTP 1.0 Usage test is conducted by checking if HTTP 1.0 is seen in the header of the loaded trace files.
About	The following information is displayed in this field about the HTTP 1.0 Usage test: HTTP 1.1 allows multiple items to be downloaded per connection, which is more efficient for the application.

Field	Description
Results	If this test passes, the results field will be blank, but you will see a highlighted green icon on the left side indicating success. When the HTTP 1.0 Usage test passes, it means that HTTP 1.0 is NOT seen in the header of the loaded trace files. If this test fails, you will see a highlighted red icon on the left side and failure information will be displayed including a description of the cause. When the HTTP 1.0 Usage test fails, it means that HTTP 1.0 is seen in the header of the loaded trace files. The failure information will typically show the following message: "ARO detected x HTTP 1.0 headers." When you click on this information, you will be directed to the TCP sessions table in the "Diagnostics" tab for further details.
Learn More	This label appears on the right side of the results section. When you click on it, you will be directed to the ATT help website where additional information about HTTP 1.0 usage is provided.

5.2.2 Overview Tab

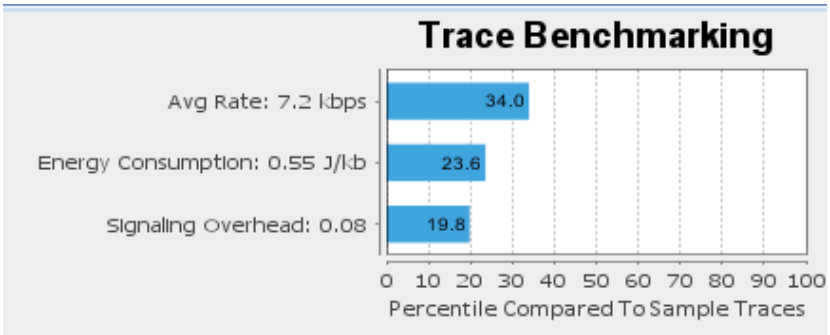
The Overview Tab displays the following charts and tables that are updated when the trace files are loaded.

5.2.2.1 File Types



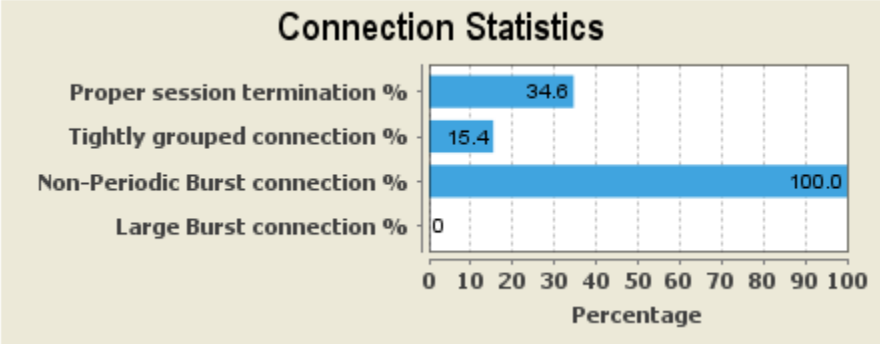
This chart plots the percentage of the various file types found in the responses captured in the trace file.

5.2.2.2 Trace Benchmarking



This chart plots the trace details such as average data rate, total energy consumption, and signaling overhead that are calculated based on the trace data.

5.2.2.3 Connection statistics

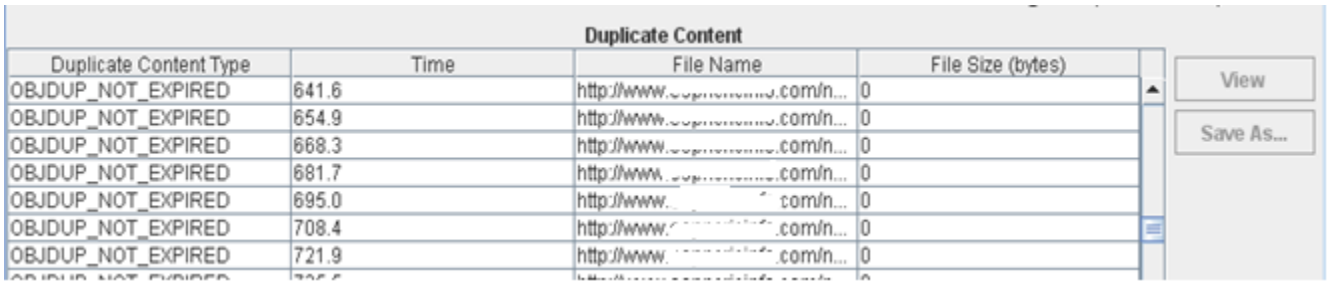


This chart plots the percentage of the various types of session terminations. The type of the session termination is determined based on the data captured in the trace. There are four types of session terminations: proper session termination, tightly grouped connection, periodic bursts connection, and long burst connection.

The following tables are displayed in the Overview tab.

5.2.2.4 Duplicate Content

This table contains the details of the various duplicate content types. The details include the names of the files that have duplicate contents, the sizes of those files, and the timestamps at which they occur. The user is provided with the option to either view or save the content of these files using the “View” and “Save As” buttons on the right side of the table.



5.2.2.5 Accessed Domains Table

This table contains details about the accessed domains. The details include the names of the accessed domains, the number of TCP sessions, the average TCP session length, and the number of files downloaded for the loaded trace files.

Accessed Domains			
Domain name	TCP sessions	Avg. session length (sec)	Files downloaded
www. .com	61	10.5	89
om	1	15.4	6
com	2	13.6	4
	2	8.4	2
	4	0.7	0
www. com	6	9.0	10
om	7	10.0	16
ww	5	9.2	15

5.2.2.6 Domain TCP Sessions

This table contains the details about the various TCP sessions. The details include the session time, the remote IP address, the local port, the session length, and the session close details.

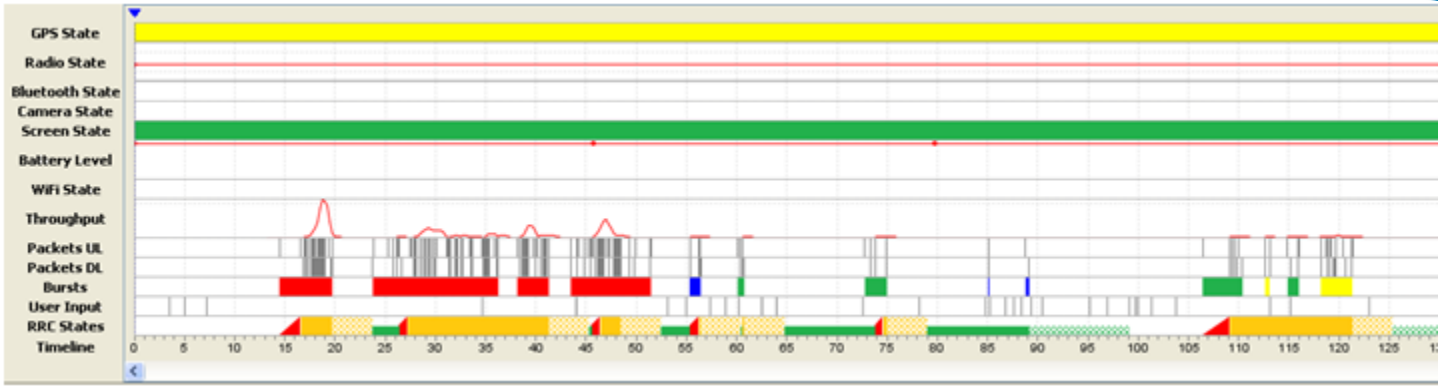
Domain TCP Sessions						
Time	Remote IP A...	Local Port	Session Leng...	Bytes Transm...	Session Close...	Closed By
17.0	74.125.53.188	39274	101.2	4,789		

5.2.3 Diagnostics View Tab

This Diagnostics View tab displays the following charts and tables that are updated when the trace files are loaded.

5.2.3.1 Trace

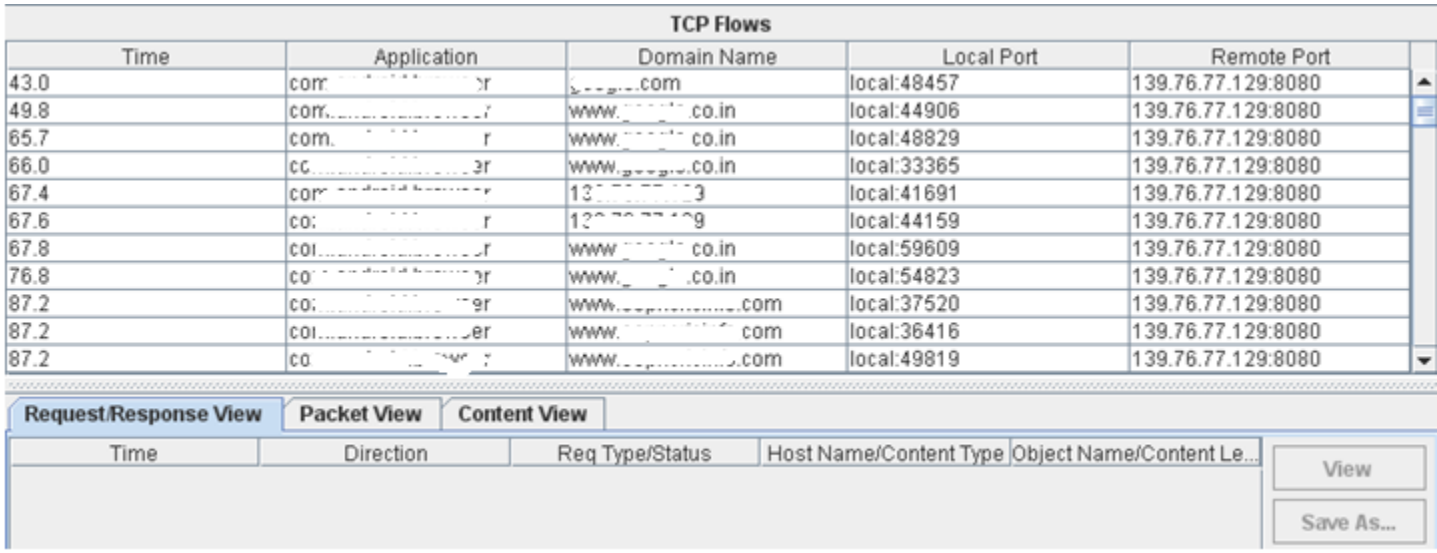
This chart plots GPS State, Radio State, Bluetooth state, Camera state, Screen state, Wi-Fi state, Battery level, Packets DL and UL, Bursts, RRC states, User Events, and Throughput.



Note: The user is provided with an option to zoom-in and zoom-out the graph, and with an option to save a snapshot of the graph.

5.2.3.2 TCP flows, Request Response View, Packet View and Content View Tables

The TCP Flows table displays information in three different views that can be accessed by clicking the Request/Response View, Packet View, and Content View tabs. The Content View tab allows you to view the raw content. Each view allows you to view or save the data by clicking the “View” or “Save As” buttons.



5.2.4 Statistics Tab

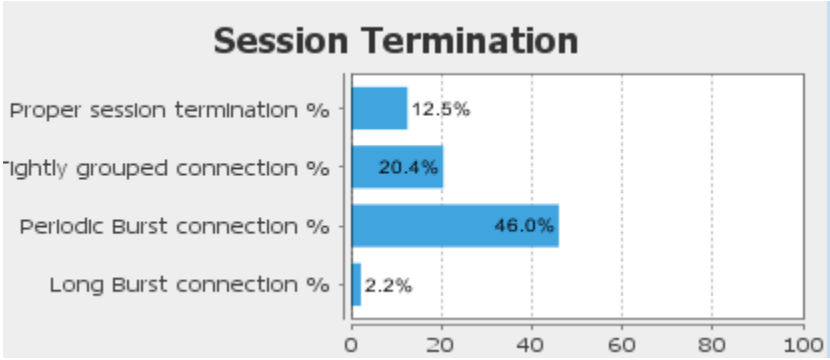
This tab displays statistical details about TCP, RRC, Bursts, Http Cache, and Energy Consumption. The information is displayed in the following sections.

Section	Description
TCP	Displays packet details such as, the duration of packets analyzed, the total bytes transferred, the number of packets, and the average rate of data transferred.
RRC	Displays the details of the occurrence of various RRC states.
Burst Table	Displays the details of the various types of bursts found in the trace analysis.
Http Cache Statistics	Displays the details of cacheable responses.
Energy consumption	Displays the amount of energy consumed by various events, by HTTP1.0 usage, and by access to peripherals such as GPS, Wi-Fi, Radio, RRC, Bursts, and Camera.

5.2.4.1 Percentage of Data Transfers by File Type

5.2.4.2 Session Termination

This graph displays information about various types of session terminations. Each one is represented as the percentage of the total number of sessions / bursts.



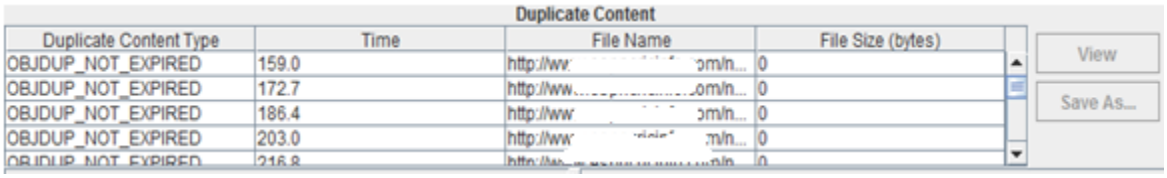
The Session Termination Graph contains the following fields:

Field	Description

Field	Description
Proper session termination	If the amount of time between the last data packet and the data packet that signaled the TCP session termination is less than or equal to 1 sec , then the session termination is represented as *proper session termination*. In the session termination plot, the sessions are displayed as a percentage of the total number of TCP sessions.
Tightly grouped connection	If 3 bursts occur in less than 15 seconds or 4 bursts occur in less than 60 seconds then those sets of bursts are referred to a *tightly grouped connection*. In the session termination plot, these bursts are displayed as a percentage of the total number of bursts.
Periodic Burst connection	If the Internet Addresses, host names, or object names are the same for the packets in a set burst over a period of time, then those bursts are considered *periodic bursts*. In the session termination plot, these bursts are displayed as a percentage of the total number of bursts.
Long Burst connection	If the burst duration is more than 5 seconds then that burst is considered a *long burst*. In the session termination plot, these bursts are displayed as a percentage of the total number of bursts.

5.2.4.3 Duplicate Content Table

The Duplicate Content Table contains the details of the various duplicate content types. You can view this table in the Overview tab. The details in the table include the names of the files that have duplicate contents, the sizes of those files, and the timestamps at which they occur. The user is provided with the option to either view or save the content of these files using the "View" and "Save As" buttons on the right side of the table.



The Duplicate Content Table contains the following fields:

Field	Description
Duplicate Content Type	The duplicate content type. One of the following types: ORIGINAL_FILE, OBJDUP_NOT_EXPIRED. **The types of the duplicate content types are two** **ORIGINAL_FILE** **OBJDUP_NOT_EXPIRED**

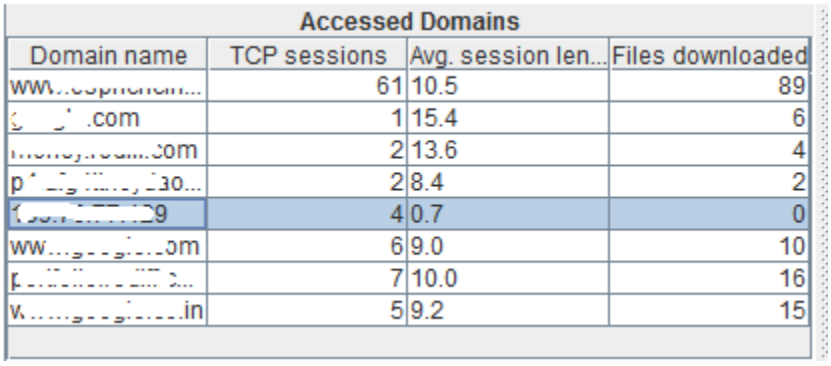
Field	Description
Time	The timestamp for this occurrence of the duplicate content.
File Name	The name of the duplicate file.
File Size (bytes)	The size of the duplicate file in bytes.

The Duplicate Content Table supports the following mouse actions:

Mouse Action	Description
Right-click	Allows you to export the Duplicate Content Table data in the CSV format.
Double-click	Navigates to the TCP Flows Table in the "Diagnostics" tab where you can view the TCP information for the selected duplicate content. The selected duplicate content will be indicated by highlighted type.

5.2.4.4 Accessed Domains Table

The Accessed Domains Table contains details about the accessed domains. The details include the names of the accessed domains, the number of TCP sessions, the average TCP session length, and the number of files downloaded for the loaded trace files. You can view this table in the Overview tab.



Accessed Domains

Domain name	TCP sessions	Avg. session len...	Files downloaded
ww...com	61	10.5	89
.com	1	15.4	6
com	2	13.6	4
30...	2	8.4	2
9	4	0.7	0
ww...om	6	9.0	10
...	7	10.0	16
...in	5	9.2	15

The Accessed Domains Table contains the following fields:

Field	Description
Domain Name	The list of domain names that are captured in the loaded trace files. These domain names are application independent, and may have occurred in the browser app or any other application.

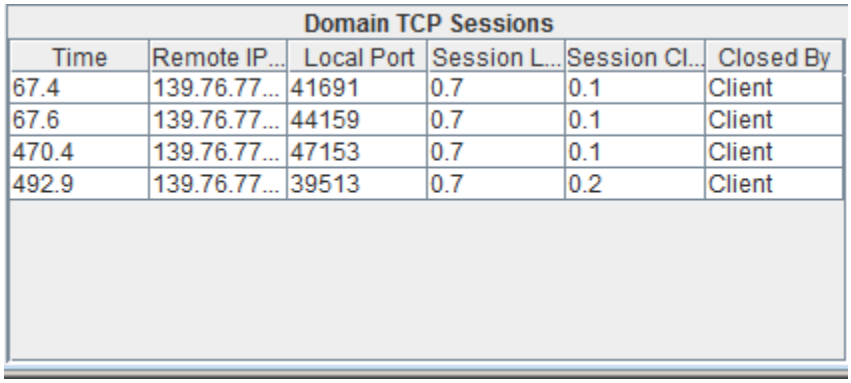
Field	Description
TCP sessions	The count of TCP sessions for the corresponding domain name.
Average session length	The average session length. This average is calculated by dividing the total TCP session time (the difference between the session end time and the session start time) by the size of the session for this particular domain name.
Files Downloaded	The number of files downloaded for the domain name session.

The Accessed Domains Table supports the following mouse actions:

Mouse Action	Description
Left-click	Refreshes the Domain TCP Session Table with the appropriate TCP session information for the row that is clicked.
Right-click	Allows you to export the Accessed Domains Table data in the CSV format.

5.2.4.5 Domain TCP Sessions Table

The Domain TCP Sessions Table contains the collection of TCP Session information for the currently selected domain name in the Accessed Domains table and refreshes each time a new domain name is selected in that table. The Domain TCP Sessions Table contains details about the selected Domain TCP session, including the session time, the remote IP address, the local port, the session length, and the session close details.



The Domain TCP Sessions Table contains the following fields:

Field	Description
Time	The time stamp of the Domain TCP Session.

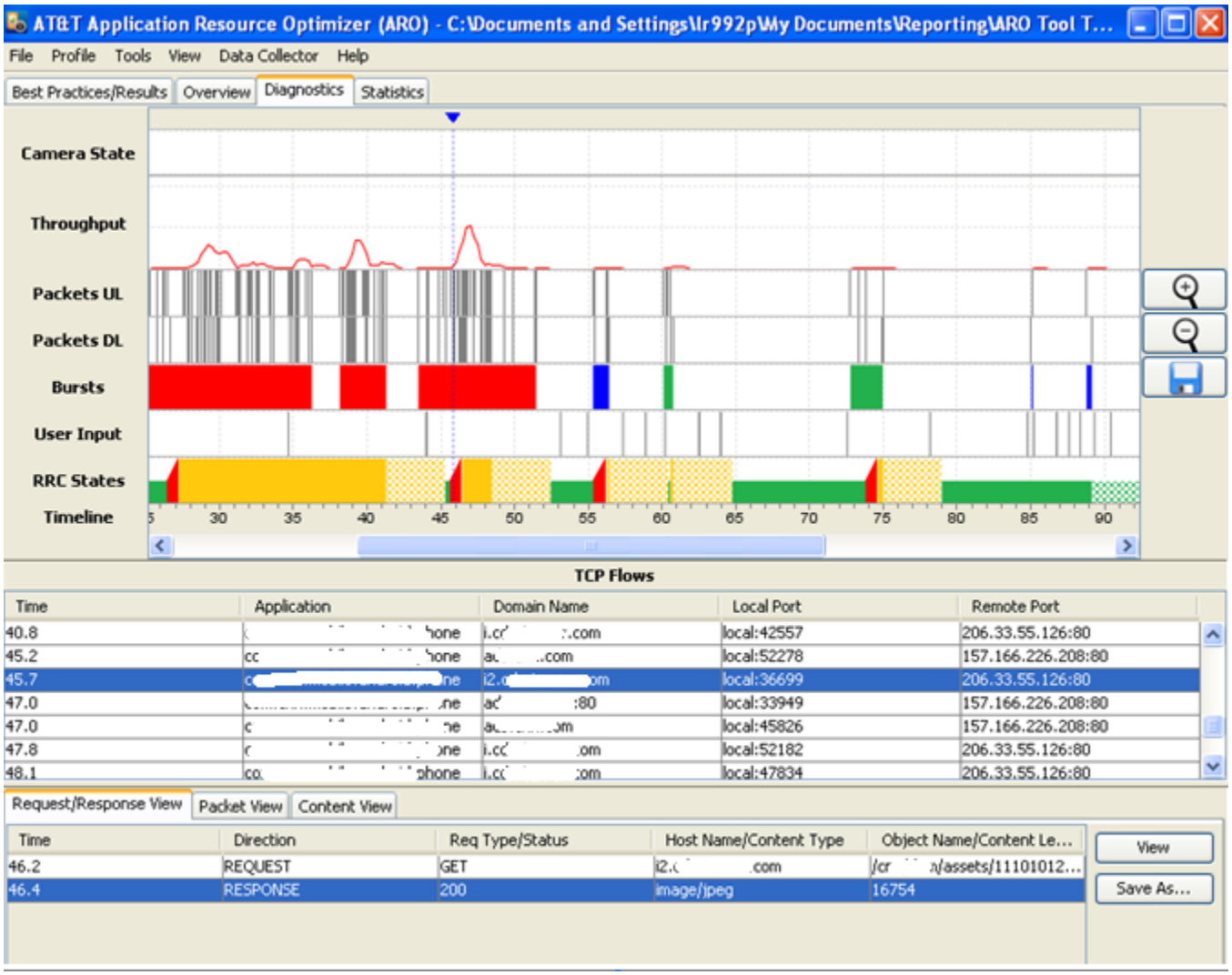
Field	Description
Remote IP Address	The Remote IP Address of the Domain TCP Session.
Local Port	The Local port value of the Domain TCP Session.
Session Length (sec)	The session length, in seconds, of the Domain TCP Session. The session length is the difference between the starting time stamp and the ending time stamp for the session.
Session Close Delay (sec)	The session termination delay, in seconds, of the Domain TCP Session.
Closed By	Indicates whether the Client or the Server closed the Domain TCP Session. The Closed By value can only be Client or Server, and is determined by the session packet direction.

The Domain TCP Sessions Table supports the following mouse actions:

Field	Description
Right-click	Allows you to export the Accessed Domain Name Table data in the CSV format.
Double-click	Navigates to the TCP Flows Table in the "Diagnostics" tab where you can view the TCP flow information for the selected Domain TCP session. The selected TCP information will be indicated by highlighted type.

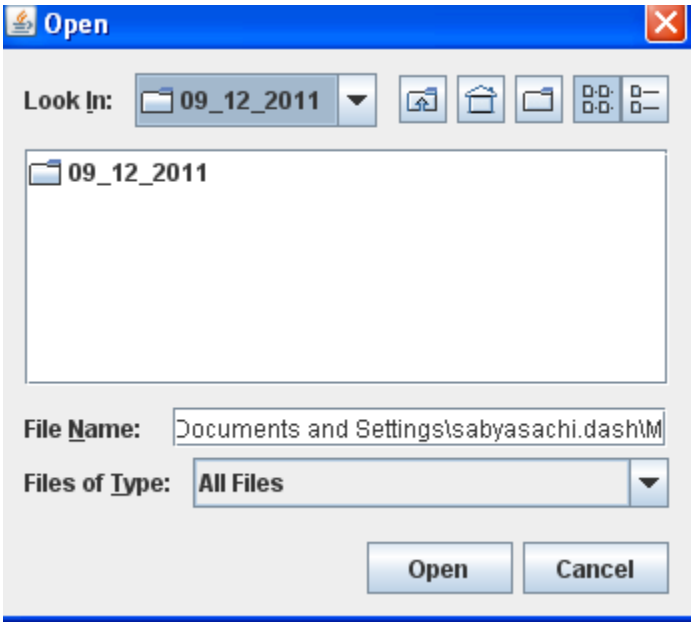
5.2.5 Diagnostics Tab

The following section describes the diagnostic graphs that are available in the Diagnostics View Tab. These graphs are plotted and displayed when you load the trace files created by the AT&T ARO Data Collector. The following image shows what a typical instance of the Diagnostics View Tab looks like when trace data is loaded.



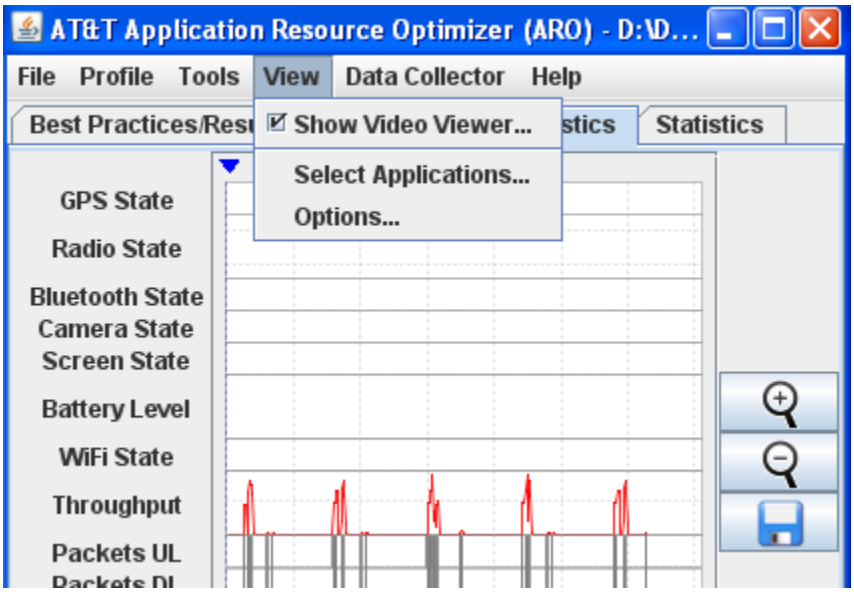
The following sections describe how to load the trace data, select the diagnostic information that you want to plot, and how to read that information.

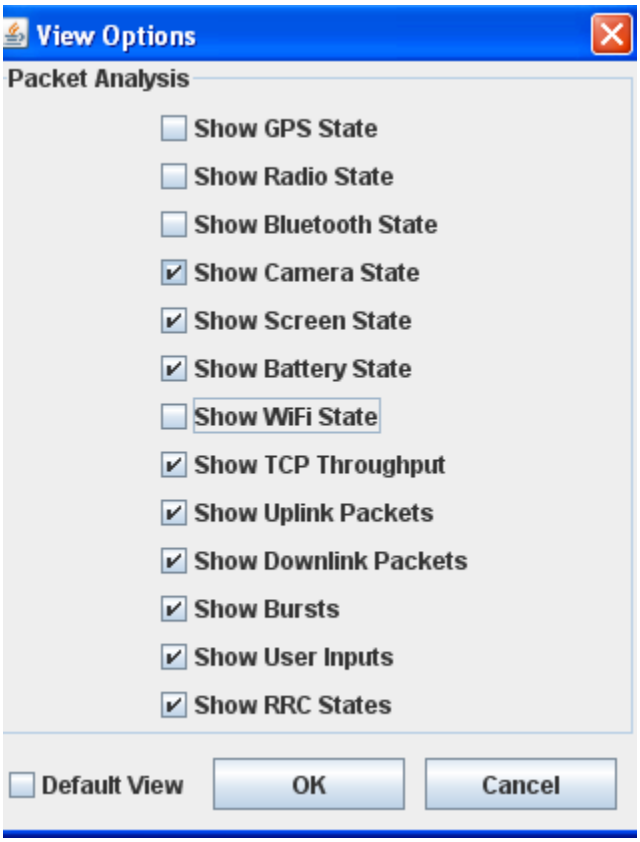
To load the trace data for analysis, click on the Open Trace option in the File menu, select a trace directory in the dialog box, and click the Open button.



The trace directory consists of the trace files that contain the information about the events and peripherals which are used to plot the graphs on the chart. The chart displays the graph data with an X-axis that shows the time stamp, and a Y-axis that varies from 0 to 1. As you view the graphs, you can use the buttons on the right side of the chart to Zoom In and Zoom Out the graph, and to Save a snapshot of the chart.

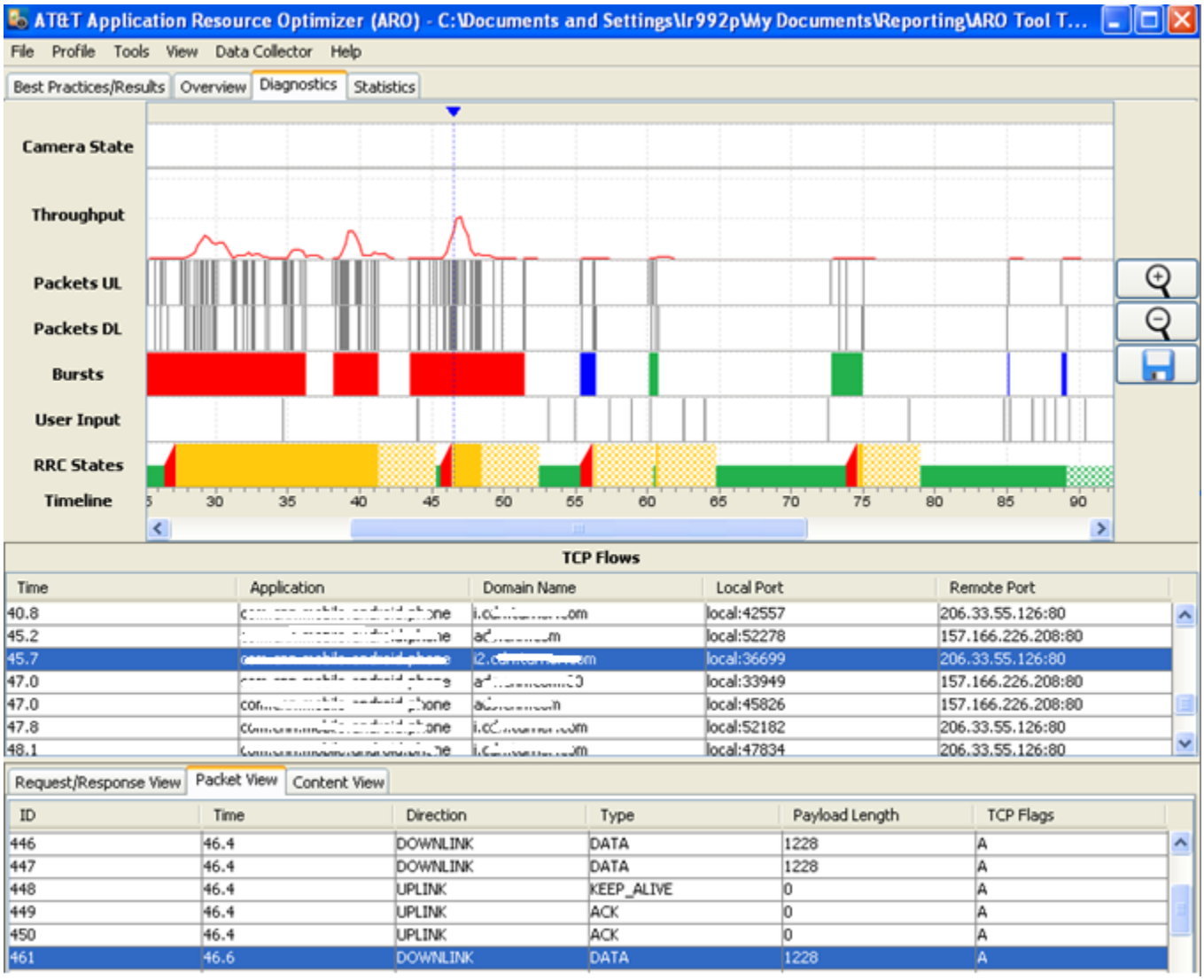
You can specify the items that you want to graph by selecting Options in the View menu and selecting them in the dialog box. The following images show an example of this.





5.2.5.1 Diagnostics View Chart

The Diagnostics View Chart shows the graphs for various events which are plotted using the information contained in the trace files. The following sections describe the graphs that are plotted in the Diagnostics View Chart.



5.2.5.1.1 GPS State

The GPS State plot shows the variation in GPS states over the time stamp interval captured in the trace file. When you place the tool tip over the plot, the GPS state at that time stamp is displayed along with the begin time of the state.

The following table describes the GPS states and how they appear in the graph plot.

State	Description
ACTIVE	The GPS receiver is turned on and is fixing the location. Energy consumption during this state is high. This state colored green in the plot.
STANDBY	The GPS receiver is turned on but is in standby mode. Energy consumption during this state is low. This state is colored yellow in the plot.
DISABLED	The GPS receiver is turned off.

5.2.5.1.2 Radio State

The Radio State plot shows the variation in radio signal strength (expressed in Dbm) over the time stamp interval captured in the trace file. When you place the tooltip over the junction points in the plot, the signal strength at that time stamp is displayed.

5.2.5.1.3 Bluetooth State

The Bluetooth State plot shows the variation in Bluetooth states over the time stamp interval captured in the trace file. When you place the tooltip over the plot, the Bluetooth state at that time stamp is displayed along with the begin time of the state.

The following table describes the Bluetooth states and how they appear in the graph plot.

State	Description
CONNECTED	The Bluetooth in the device is turned on and the device is paired with another device for data transfer. Energy consumption during this state is high. This state is colored green in the plot.
DISCONNECTED	The Bluetooth in the device is turned on but the device is not paired with another device. Energy consumption during this state is low. This state is colored yellow in the plot.
OFF	The Bluetooth is turned off.

5.2.5.1.4 Camera State

The Camera State plot shows the variation in camera states over the time stamp interval captured in the trace file. When you place the tooltip over the plot, the Camera state at that time stamp is displayed along with the begin time of the state.

The following table describes the Camera States and how they appear in the graph plot.

State	Description
ON	The Camera is turned on. Energy consumption during this state is high. This state is colored green in the plot.
OFF	The Camera is turned off.

5.2.5.1.5 Screen State

The Screen State plot shows the variation in screen states over the time stamp interval captured in the trace file.

The following table describes the Screen States and how they appear in the graph plot.

State	Description
ON	The Screen is active. Energy consumption during this state is high. This state is colored green in the plot. When you place the tooltip over this state in the plot, the screen time out value (in seconds) and the brightness (in %) are displayed.
OFF	The device is in sleep mode.

5.2.5.1.6 Battery Level

The Battery Level plot shows the variation in battery level over the time stamp interval captured in the trace file. When you place the tooltip over the plot, the battery level, battery temperature, and battery status are displayed.

5.2.5.1.7 Wi-Fi State

The Wi-Fi State plot shows the variation in Wi-Fi states over the time stamp interval captured in the trace file.

The following table describes the Wi-Fi states and how they appear in the graph plot.

State	Description
CONNECTING	The device is trying to connect to a Wi-Fi network. Energy consumption during this state is high. This state is colored green in the plot.
CONNECTED	The device is connected to a Wi-Fi network. Energy consumption during this state is high. This state is colored green in the plot.
DISCONNECTING	The device is disconnecting from a Wi-Fi network. Energy consumption during this state is high. This state is colored green in the plot.

State	Description
DISCONNECTED	The device is disconnected from Wi-Fi network. Energy consumption during this state is low. This state is colored yellow in the plot.
SUSPENDED	A Wi-Fi network was disconnected unexpectedly. Energy consumption during this state is low. This state is colored yellow in the plot.
DISABLED	Wi-Fi is disabled in the device.

For all states except the Connected state, you placing the tooltip over the plot displays the Wi-Fi state at that time stamp along with the begin time of the state. For the Connected State, the tool tip also shows Mac Address, Radio Received Signal Strength Indication (RSSI) and Service set identifier (SSID) along with the state detail.

5.2.5.1.8 Throughput

The Throughput plot shows the variation in network traffic (expressed in kbps) over the time stamp interval captured in the trace file. When you place the tooltip over the plot, the throughput kbps at that time stamp is displayed. Note that the Higher the throughput, the higher the energy consumption.

5.2.5.1.9 Packets Uplink

The Packets UL plot shows the packets uploaded in various TCP sessions across the time stamp intervals captured in the trace file. When you place the tooltip over the plot, the packet details such as packet id, packet timestamp and application along with the TCP session details such as begin time; end time, remote IP, local port, and remote port are displayed.

5.2.5.1.10 Packets Downlink

The Packets DL plot shows the packets downloaded in various TCP sessions across the time stamp intervals captured in the trace file. When you place the tooltip over the plot, the packet details such as packet id, packet timestamp and application along with TCP session details such as begin time; end time, remote IP, local port, and remote port are displayed.

5.2.5.1.11 Bursts

A burst consists of consecutive packets transferred in a batch. The Burst plot shows the various types of bursts that occurred over the time stamp interval captured in the trace file. When you place the tooltip over the plot, the category of burst and the begin time stamp are displayed.

The following table describes the categories of bursts and how they appear in the graph plot.

State	Description
PROCTOCOL	This category of burst consists of the unwanted packets that are being transferred. It is colored blue in the plot.
LOSS	This category of burst consists of the packets that are lost while getting transferred. It is colored black in the plot.
USER INITIATED	This category of burst consists of the packets that are transferred on user initiation. It is colored green in the plot.
CLIENT	This category of burst consists of the packets that are transferred on client initiation. It is colored red in the plot.
SERVER	This category of burst consists of the packets that are transferred on server initiation. It is colored yellow in the plot.
LONG	If a burst duration is more than 5 seconds, then that burst is considered to be a long burst. This category of burst is colored gray in the plot.
PERIODICAL	If the Internet Addresses, or the host names, or object names are the same for the packets in a set burst over a period of time, then those bursts are considered periodic bursts. This category of burst is colored purple/pink in the plot.
USER DEFINED	These are user defined bursts. This category of burst is colored magenta in the plot.

5.2.5.1.12 User Input

The User Input plot shows the various user input events that have occurred over the time stamp interval captured in the trace file. The user events include screen touch, and various key presses. When you place the tooltip over the plot, the user event that occurred at that time tamp is displayed.

5.2.5.1.13 RRC States

The RRC States plot shows the variation in RRC states over the time stamp interval captured in the trace file. The states are determined by calculating the battery usage when network packets are received. When you place the tooltip over the plot, the RRC state at that time stamp and the begin time of the state are displayed.

The following table describes the RRC states and how they appear in the graph plot.

State	Description
IDLE	No packets are received.
DCH ACTIVE	This state is colored yellow in the plot. Energy consumption during this state is high.

State	Description
DCH TAIL	This state is colored with a yellow cross hatch pattern in the plot. Energy consumption during this state is high.
FACH ACTIVE	This state is colored green in the plot. Energy consumption during this state is low.
FACH TAIL	This state is colored with a green cross hatch pattern in the plot. Energy consumption during this state is low.
PROMOTION IDLE->DCH	Transition from idle to DCH state. This state is represented by a red triangle in the plot.
PROMOTION FACH->DCH	Transition from FACH to DCH state. This state is represented by a red polygon in the plot.

Note: DCH stands for dedicated channel and FACH stands for forward access channel.

5.2.5.1.13.1 TCP Flows Data Grid

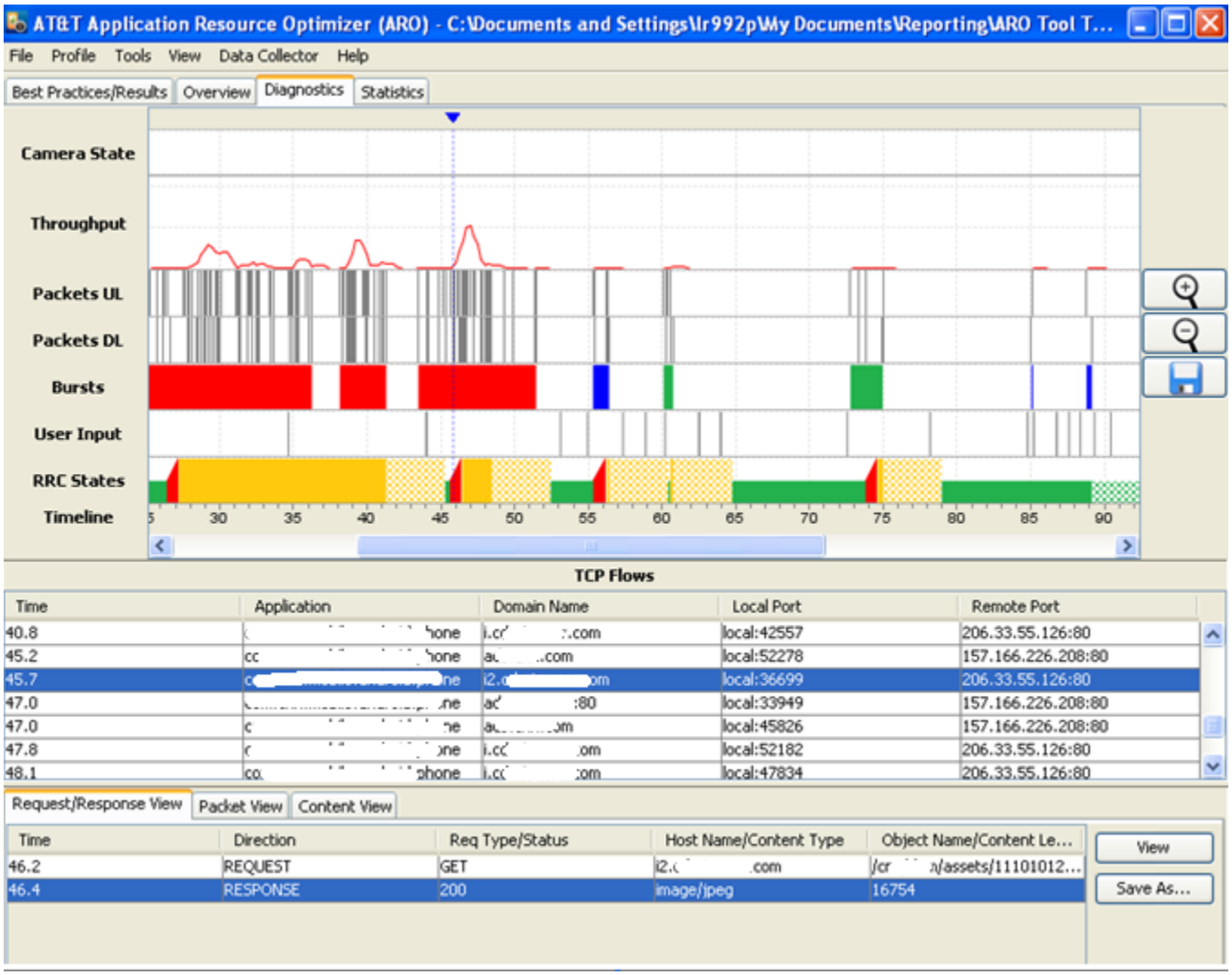
The Content Tabs appears below the main Diagnostics View chart. It contains the following fields.

Field	Description
Time	The initial time of the request in seconds from the beginning of the trace
Application	The name of the client application that is making the request.
Domain Name	The name of the domain to which the request is being made.
Local port	The local port through which the request is being made
Remote port	The remote port (on the domain) through which the request is being received. This consists of the IP address of the domain and the port on which these requests are being listened for.

5.2.5.1.13.2 View Grids

5.2.5.1.13.2.1 Request/Response View Data Grid

The Request/Response View Data Grid displays the request/responses associated with the TCP flow highlighted in the TCP Flows Data Grid as in the following example.



5.2.5.1.13.2.1.1 Request View Fields

The Content Tabs have different meanings depending on whether the row represents a request or a response. The following table describes the fields when the row represents a request.

Field	Description
Time	The time of the request, in seconds, from the beginning of the trace.
Direction	The direction of the TCP flow. The value of this field will be REQUEST when the row represents a request.
Request Type	One of the following HTTP Request Types: GET, PUT, POST, or DELETE.

Field	Description
Host Name	The host name for the HTTP Request.
Object Name	The name of the object requested from the host.

5.2.5.1.13.2.1.2 Responses View Fields

The following table describes the fields in the Request/Response View when the row represents a response.

Field	Description
Time:	The time of the response, in seconds, from the beginning of the trace.
Direction	The direction of the TCP flow: The value of this field will be RESPONSE when the row represents a response.
Status	The status of the response. One of the following values: **Code** / **Description** **200** OK **201** Created **202** Accepted **204** No Content **400** Bad Request **401** Unauthorized **402:** Payment Required **403** Forbidden **404** Not found
Content Type	The content type of the response which consists of a pair of values (type/subtype) representing the internet media type Some examples of content types (and their meanings) are: text/plain (simple text messages), text/html (html document), text/CSS (cascading style sheet), image/gif (GIF Image), image/jpeg (JPEG Image), application/JSON (JSON data object).
Length	The length in bytes of the response

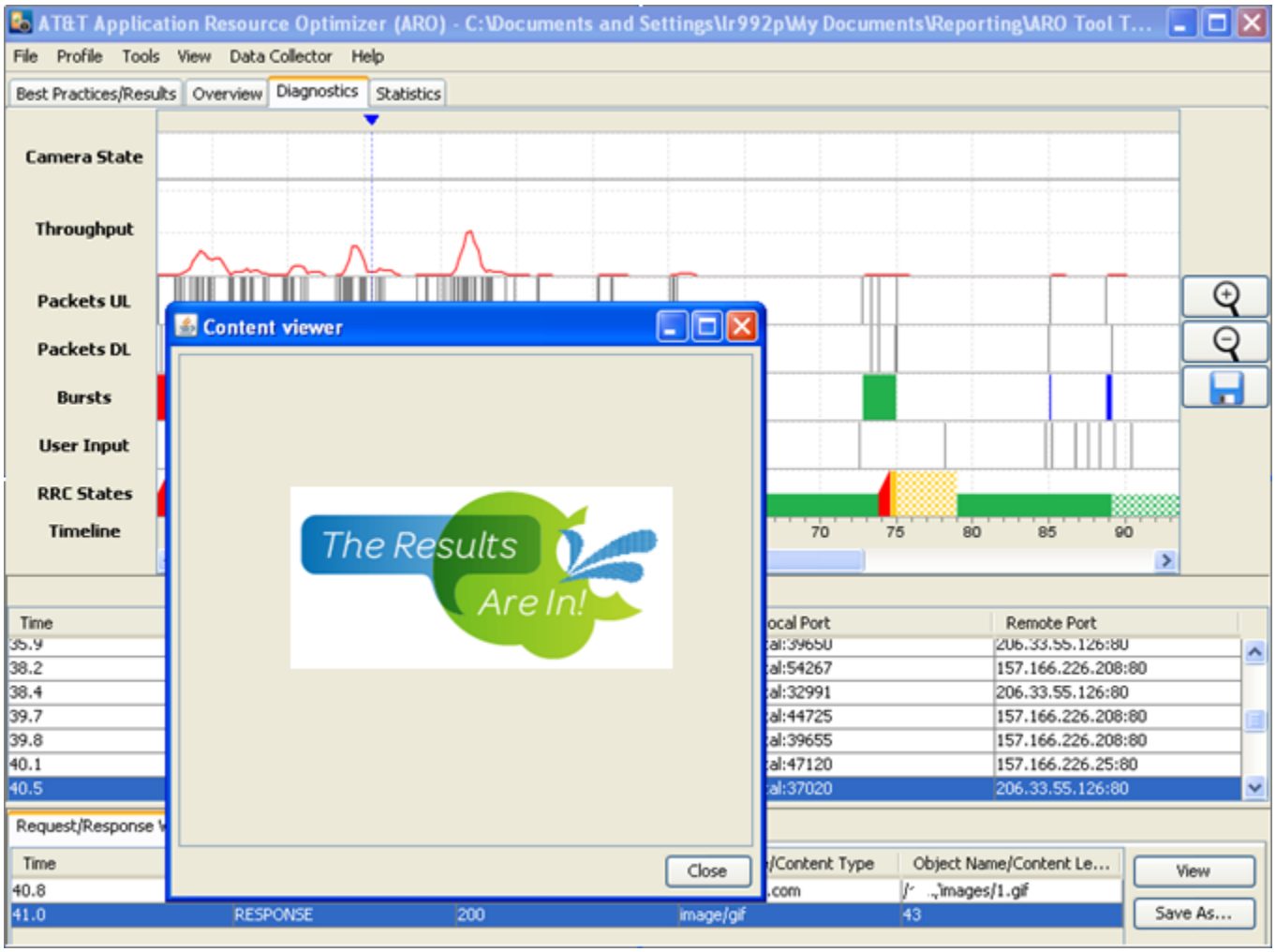
5.2.5.1.13.2.1.3 Command Buttons

In the Request/Response View, the following buttons are available. Note that for requests, the buttons are grayed out, and for responses, the buttons are enabled.

Field	Description
View	Allows the user to view the response object: For an image, the image will be displayed. For text/html, the html will be displayed. For application/JSON, the JSON object will be displayed.
Save As	Allows the user to save the object as a file in a selected directory.

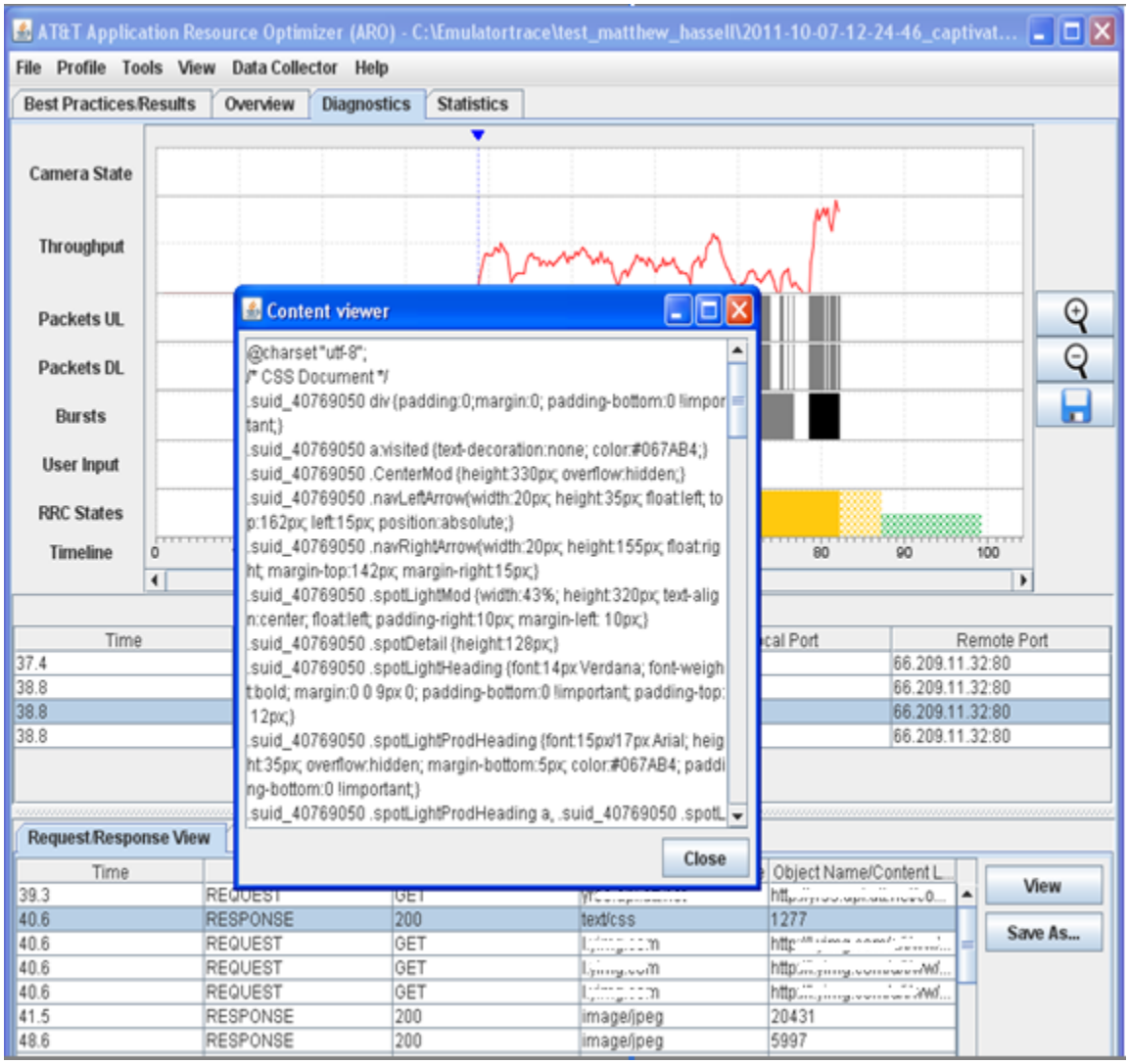
5.2.5.1.13.2.1.3.1 View an Image

Clicking on the View button displays the data object in the response. If the data object is an image, it will be displayed in the Content viewer like the following example:



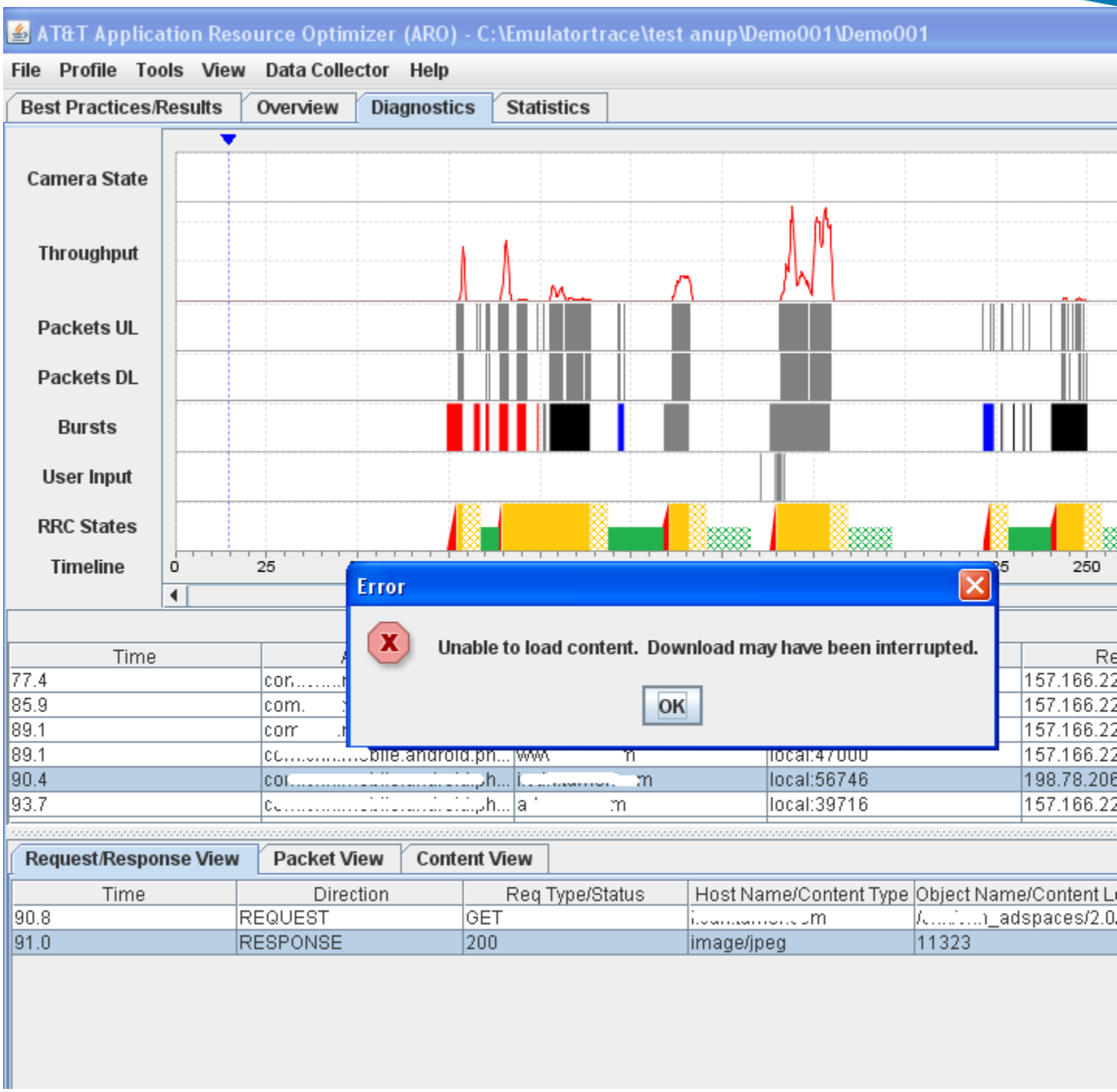
5.2.5.1.13.2.1.3.2 View a Text Object.

If the data object is a text, HTML, or JSON it will be displayed in the Content viewer like the following example:



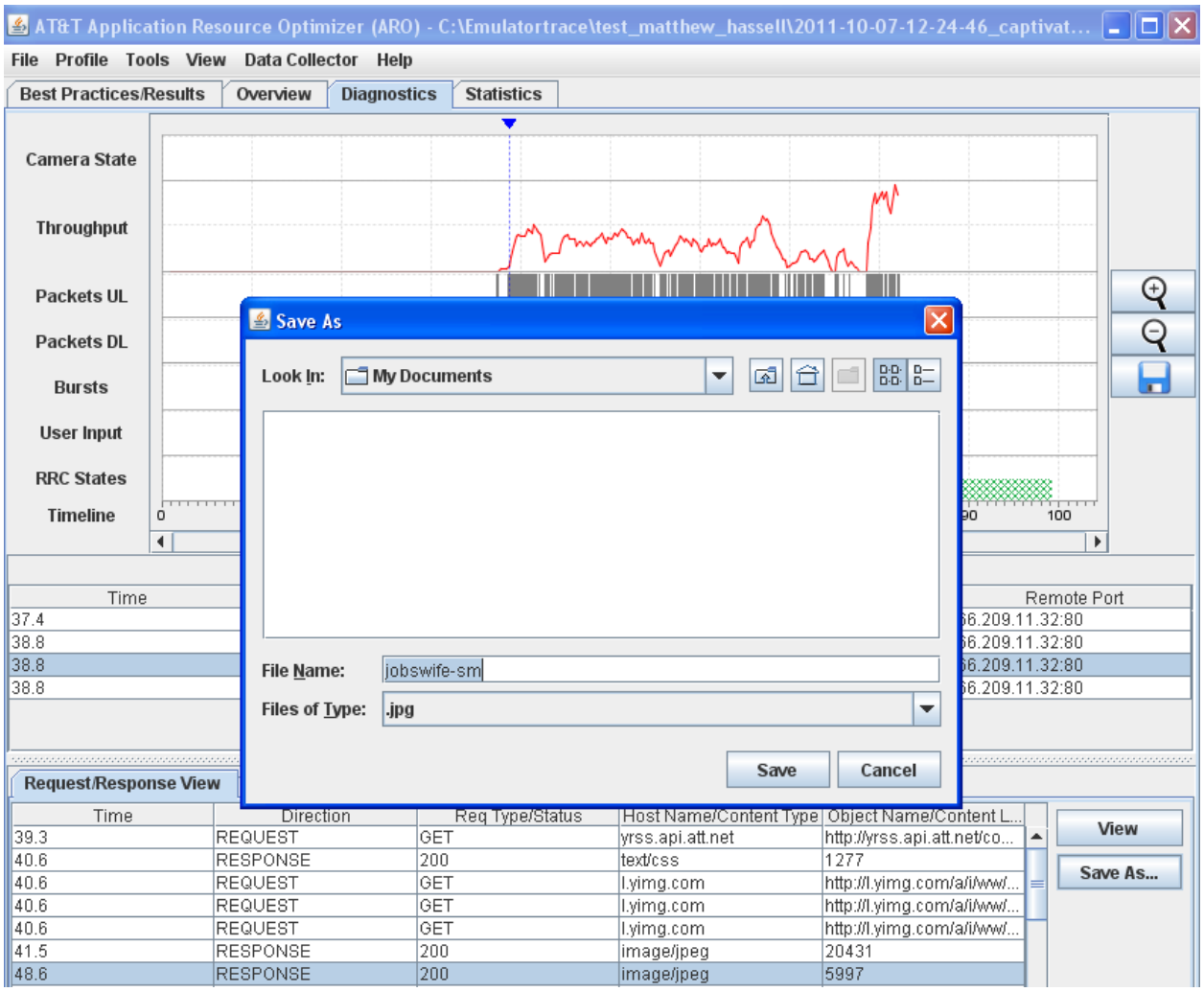
5.2.5.1.13.2.1.3.3 View an object that has not been downloaded properly

If the object cannot be displayed, an error message (like the one in the following example) will indicate that the content was unable to load and that the download may have been interrupted.



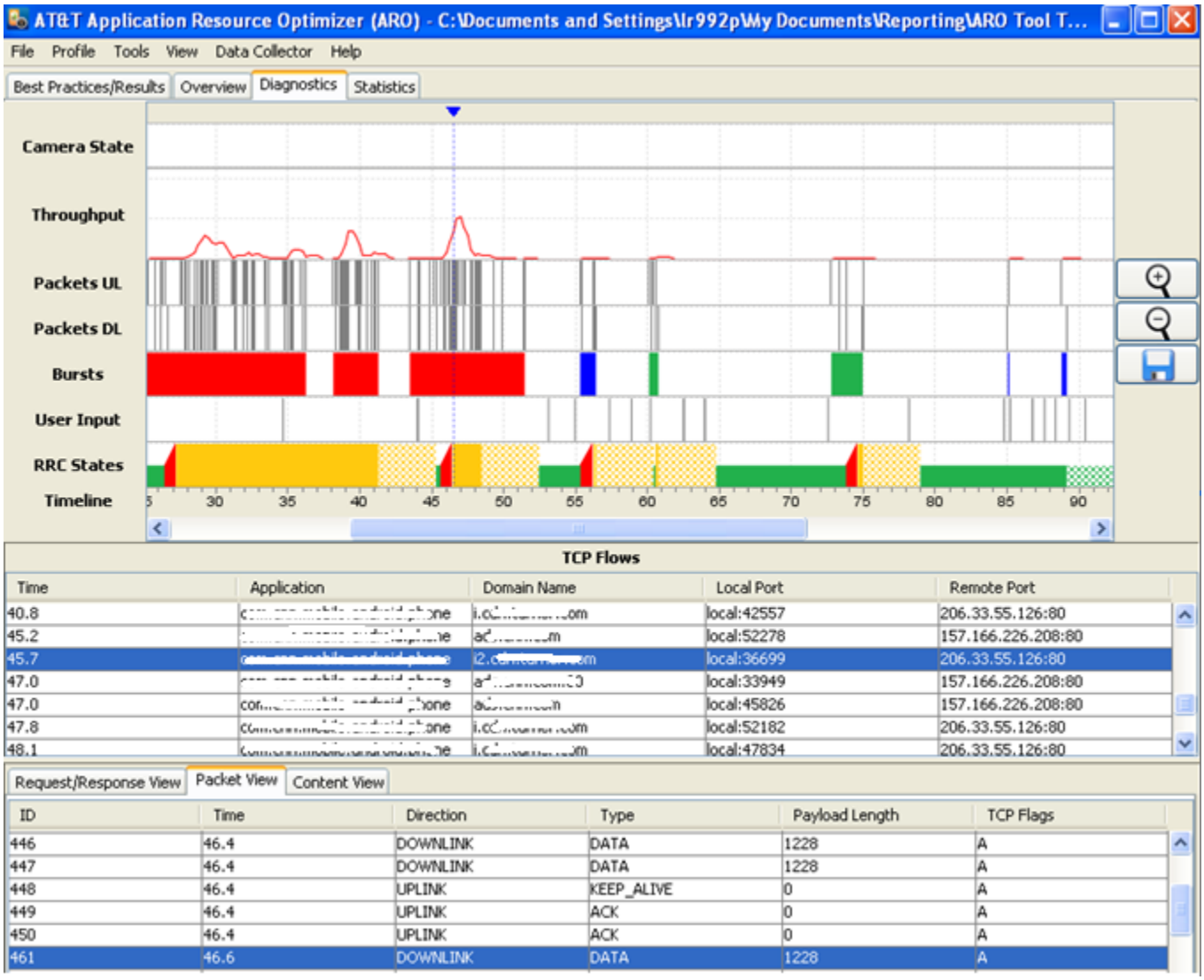
5.2.5.1.13.2.1.3.4 Save As

Clicking on the Content Tabs button will display a dialog allowing you to save the object to a different location.



5.2.5.1.13.2.2 Packet View Data Grid

The AT&T ARO Data Analyzer Reference Data Grid gives you a view of the packets associated with the TCP flow highlighted in the TCP Flows Data Grid as in the following example.



5.2.5.1.13.2.2.1 Packet View Fields

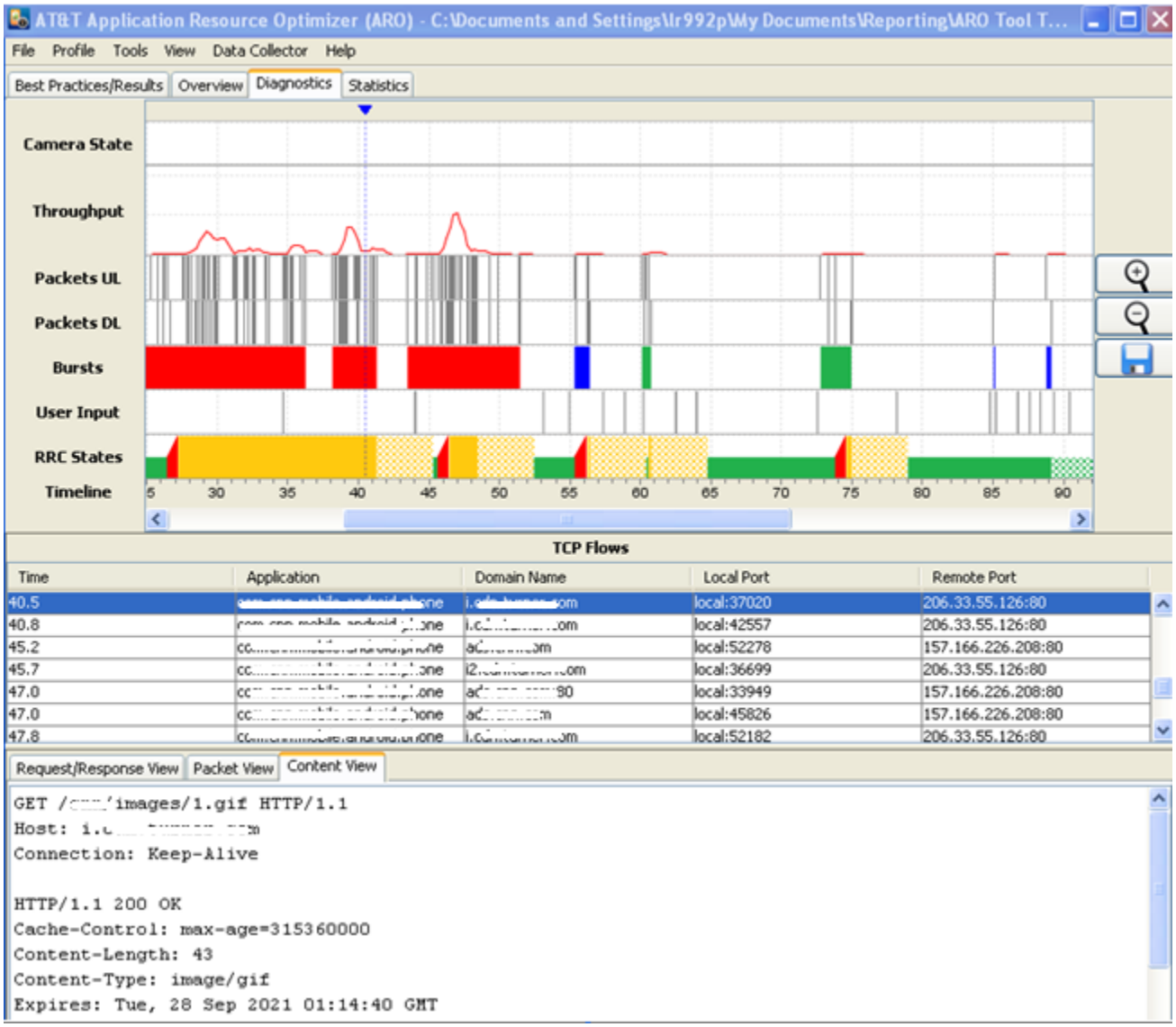
The following table describes the Content Tabs.

Field	Description
ID	An integer value that uniquely identifies each packet within the trace.
Time	The time, in seconds, from the beginning of the trace

Field	Description
Direction	The packet direction. One of the following values: UPLINK (The packet is sent up to the server), DOWNLINK (The packet is sent down from the server/host), UNKNOWN (The packet direction cannot be determined).
Type	Indicates the type of packet. One of the following values: OPEN_CONN (A packet that opens a connection), ACK (An acknowledgement packet), DATA (A data packet).
Payload Length	The length of the payload (the data being sent in the packet) in bytes.
TCP Flags	Each letter in this field represents a different TCP flag associated with the packet. More than one flag can be associated with a packet. The possible flags are: A - Ack; P - Push; R - Reset, S - Synchronize, F - Finish/End, E - Echo, U - Urgent, C - Congestion Windows Reduced.

5.2.5.1.13.2.3 Content View

The AT&T ARO Data Analyzer Reference displays the content of the http request and response for the TCP flow highlighted in the TCP Flows Data Grid as in the following example.



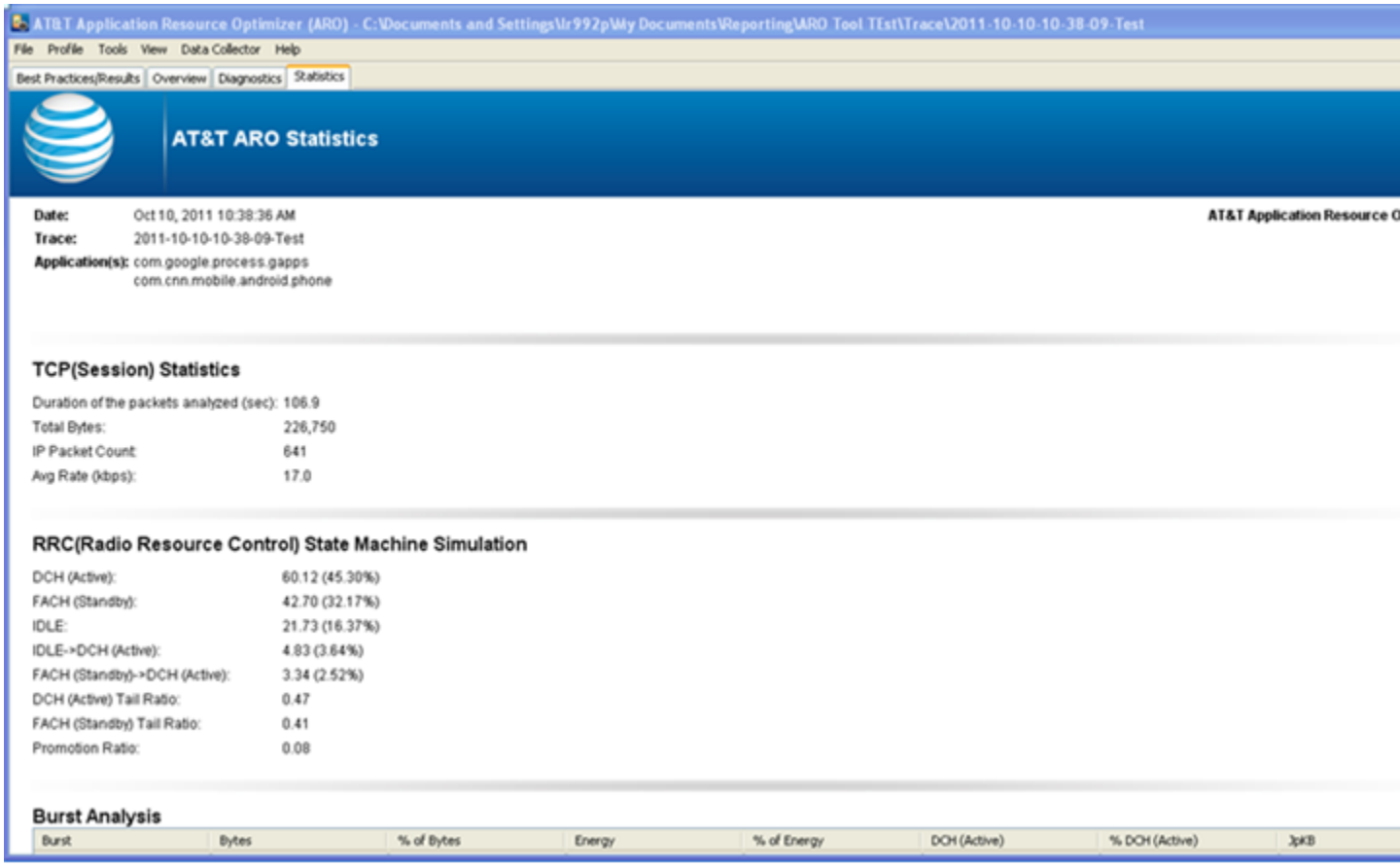
5.2.6 Statistics Tab

The purpose of the Statistics tab is to provide the information to the AT&T ARO Data Analyzer application users about the trace files which are loaded to analyze. This AT&T ARO Statistics Tab information page is mainly divided in below mentioned five panels.

The following section describes the information that is available in the Statistics Tab. This information is displayed when you load the trace files created by the AT&T ARO Data Collector. The Statistics Tab information page is divided into the following five panels:

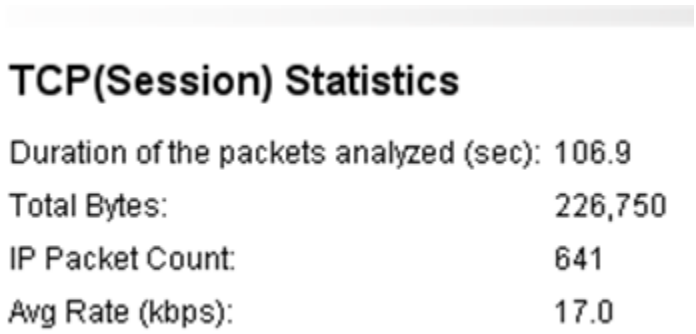
- TCP Statistics
- Energy Consumption Simulation
- RRC State Machine Simulation
- Burst Analysis
- HTTP Cache Statistics

The following is an example of the Statistics Tab information page after it is has been selected in the AT&T ARO Data Analyzer home page.



5.2.6.1 TCP Statistics

The TCP Statistics panel of the Statistics Tab information page provides the overall TCP Packet information captured in the loaded trace files. It contains the following information about the captured TCP.



Field	Description
Total Bytes	The sum of the packet length values from the loaded trace. The packet length value includes both the header length and the data length.
Trace Duration (sec)	The time difference, in seconds, between the last packet time stamp and the first packet time stamp in the loaded trace.
Packet Count	The total number of packets in the loaded trace.
Average Rate (kbps)	The average transfer rate of data in kilobytes per second. This value is derived from the total number of transferred bytes and the trace duration.

5.2.6.2 Energy Consumption Simulation

The Energy Consumption Simulation panel of the Statistics Tab information page displays the overall energy consumption from the loaded trace. The panel lists the amount of energy used for each of the different types of energy consumption that can affect the performance of the application or the energy level of the particular device. The Energy Consumption Simulation panel is pictured as follows and contains the following information:

Energy Consumption Simulation

DCH (Active):	78.15 J
FACH (Standby):	12.81 J
IDLE:	0.00 J
IDLE->DCH (Active):	3.14 J
FACH (Standby)->DCH (Active):	2.68 J
DCH (Active) Tail:	36.40 J
FACH (Standby) Tail:	5.22 J
Total RRC Energy:	96.78 J
Joules per Kilobytes:	0.43
GPS Active:	0.00 J
GPS Standby:	2.65 J
Total GPS Energy:	2.65 J
Total Camera Energy:	0.00 J
Wi-Fi Connected:	0.00 J
Wi-Fi Standby:	0.00 J
Total Wi-Fi Energy:	0.00 J
Bluetooth Active:	0.00 J
Bluetooth Standby:	0.00 J
Total Bluetooth Energy:	0.00 J

Field	Description
CELL_DCH (Active)	The total DCH time energy expended in the loaded traces. This is calculated from the RRC DCH time value and the power DCH value.
CELL_FACH (Standby)	The total FACH energy expended in the loaded trace. This is calculated from the RRC FACH time value and the power FACH value.
IDLE	The total idle time energy from the loaded trace. The idle energy should always be 0.
IDLE→DCH (Active)	The amount of RRC IDLE to DCH (Active) state time energy consumption.
FACH (Standby) →DCH (Active)	The amount of RRC FACH (Standby) to DCH (Active) time energy consumption.
DCH (Active) Tail	The amount of energy consumed during the RRC DCH (Active) Tail state period.
FACH (Standby) Tail	The amount of energy consumed during the RRC FACH Tail state period.
Total RRC Energy	The sum of the CELL_DEH (Active), CELL_FACH (Standby), FACH (Standby) →DCH (Active), IDLE→DCH (Active), and IDLE energy consumption amounts.

Field	Description
Joules per Kilobytes	The amount of Joules per Kilobytes from the loaded trace, calculated from the amount of total energy and total bytes.
GPS Active	The total energy consumed during the GPS Active state. In GPS Active state, the energy consumption will be equal to the time multiplied by the energy draw for Active GPS.
GPS Standby	The total energy consumed during GPS Standby mode.
Total GPS Energy	The sum of the energy consumption amounts for GPS Active and GPS Standby.
Total Camera Energy	The amount of energy consumed while the Camera state is ON.
Wi-Fi Connected	The amount of energy consumed while the Wi-Fi state is Active. The active state includes the Wi-Fi Connected, Wi-Fi Connecting, and Wi-Fi Disconnecting states.
Wi-Fi Inactive	The amount of energy consumed while the Wi-Fi state is Inactive. The inactive state includes the Disconnected and Wi-Fi Suspended states.
Total Wi-Fi Energy	The sum of the energy consumption values for Wi-Fi Connected and Wi-Fi Inactive.
Bluetooth Active	The amount of energy consumed while Bluetooth is in the connected state.
Bluetooth Standby	The amount of energy consumed while Bluetooth is in the disconnected state.
Total Bluetooth Energy	The sum of the energy consumption values for Bluetooth Active and Bluetooth Standby.
Total Screen Energy	The amount of energy consumed while the device screen is in the ON state.

5.2.6.3 RRC State Machine Simulation

The RRC State Machine Simulation panel of the Statistics Tab information page displays the Radio Resource Control analysis of the loaded trace. The panel is pictured as follows and contains the following information:

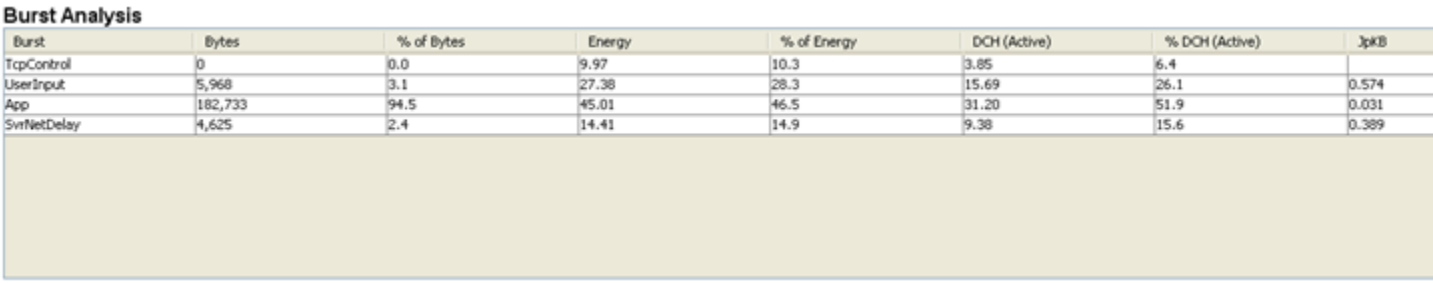
RRC(Radio Resource Control) State Machine Simulation

DCH (Active):	60.12 (45.30%)
FACH (Standby):	42.70 (32.17%)
IDLE:	21.73 (16.37%)
IDLE->DCH (Active):	4.83 (3.64%)
FACH (Standby)->DCH (Active):	3.34 (2.52%)
DCH (Active) Tail Ratio:	0.47
FACH (Standby) Tail Ratio:	0.41
Promotion Ratio:	0.08

Field	Description
CELL_DCH (Active)	The amount of RRC Active state time, in seconds, and its percentage of overall packet duration.
CELL_FACH (Standby)	The amount of FACH Active state time, in seconds, and its percentage of overall packet duration.
IDLE	The amount of RRC IDLE state time, in seconds, and its percentage of overall packet duration.
IDLE→DCH (Active)	The amount of IDLE to DCH (Active) state time, in seconds, and its percentage of overall packet duration.
FACH (Standby) → DCH (Active)	The amount of FACH (Standby) to DCH (Active) state time, in seconds, and its percentage of overall packet duration.
DCH (Active) Tail Ratio	The ratio between the DCH Active Tail state time and the DCH Active state time.
FACH (Standby) Tail Ratio	The ratio between the FACH Standby Tail state time and the FACH Standby state time.
Promotion Ratio	The ratio between the sum of the total promoted RRC states time and the total packet duration. The promoted RRC states are IDLE→DCH (Active) and FACH (Standby) →DCH (Active).

5.2.6.4 Burst Analysis

The Burst Analysis panel of the Statistics Tab information page contains a table that provides information about the collected bursts from the loaded trace. You can export the contents of this table in the CSV format by right-clicking on the table. The Burst Analysis panel is pictured as follows and contains the following information:



Burst Analysis

Burst	Bytes	% of Bytes	Energy	% of Energy	DCH (Active)	% DCH (Active)	JpKB
TcpControl	0	0.0	9.97	10.3	3.85	6.4	
UserInput	5,968	3.1	27.38	28.3	15.69	26.1	0.574
App	182,733	94.5	45.01	46.5	31.20	51.9	0.031
SvrNetDelay	4,625	2.4	14.41	14.9	9.38	15.6	0.389

Field	Description
Burst	One of the following Burst categories according to the request/response types in the loaded trace. **Burst Categories.** **TCP Control** **TCP Loss Recover** **User Input** **App** **Server Network Delay** **Non Target** **Large Burst** **Periodical** **Unknown** **Userdef 1** **Userdef 2** **Userdef 3**
Bytes	The payload length, in bytes, for the corresponding Burst Category. The payload length considers only the data length of packets which occurred during the burst.
% of Bytes	The percentage of total payload used by the individual burst payload. The total payload is the sum of all burst payloads.
Energy	The amount of Energy, in Joules, for the corresponding Burst Category.
% of Energy	The percentage of total burst energy used by the individual burst. Total burst energy is the sum of all individual burst Energy amounts.
DCH (Active)	The amount of DCH Active time for the corresponding Burst Category.

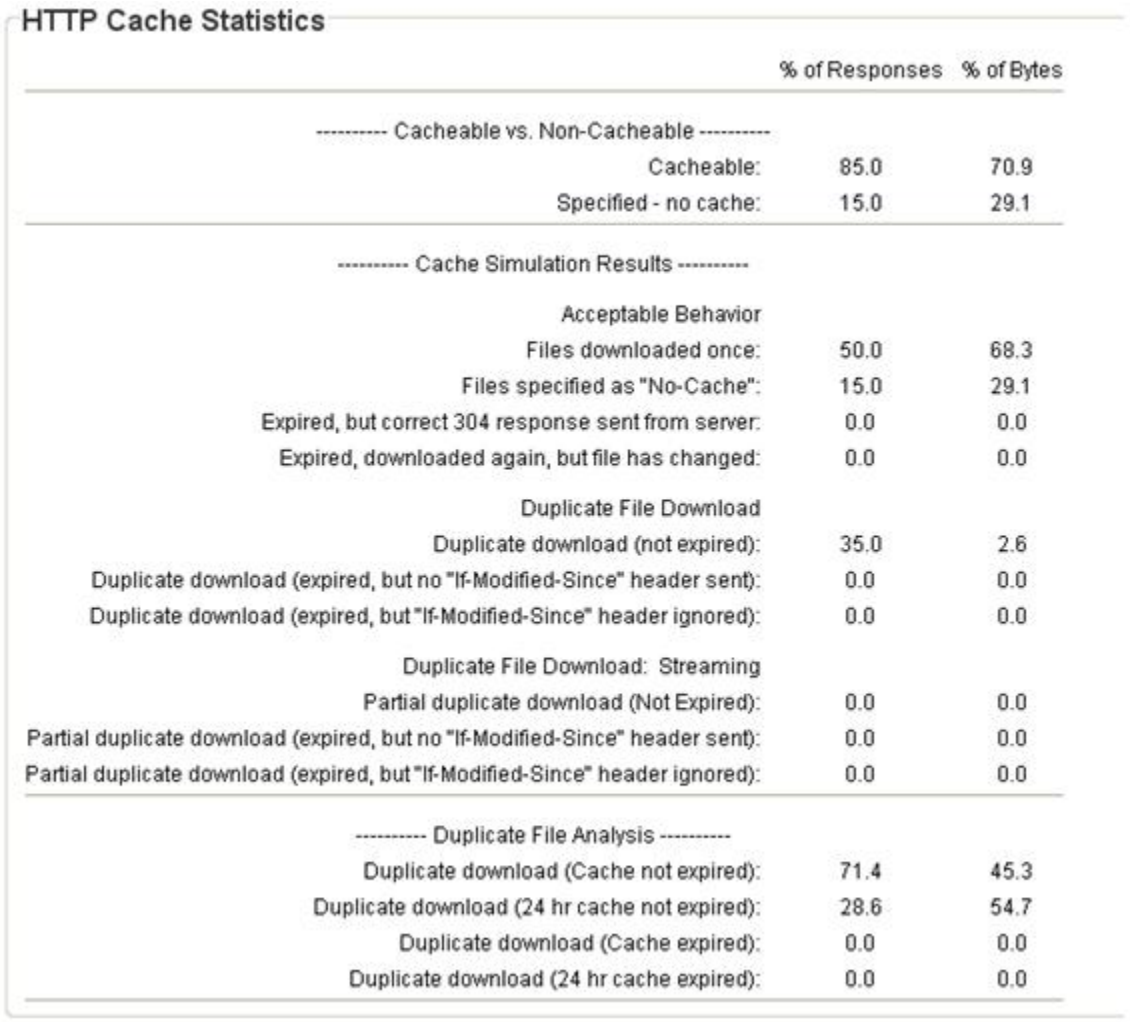
Field	Description
%DCH (Active)	The percentage of total DCH Time used by the individual burst. The total DCH Time is the sum of all individual burst DCH Times.
JpKB	The amount of Joules per Kilobytes for the corresponding Burst Category calculated from the amount of burst category energy and burst category payload.

5.2.6.5 HTTP Cache Statistics

The HTTP Cache Statistics panel of the Statistics Tab information page displays statistical information about the Cache based on the data in the loaded trace. This panel contains the following sub-categories:

- Cacheable vs. non-cacheable
- Cache simulation results
- Duplicate File Analysis

The following is an example of the HTTP Cache Statistics panel showing its columns and sub-categories.



HTTP Cache Statistics

	% of Responses	% of Bytes
---------- Cacheable vs. Non-Cacheable ----------		
Cacheable:	85.0	70.9
Specified - no cache:	15.0	29.1
---------- Cache Simulation Results ----------		
Acceptable Behavior		
Files downloaded once:	50.0	68.3
Files specified as "No-Cache":	15.0	29.1
Expired, but correct 304 response sent from server:	0.0	0.0
Expired, downloaded again, but file has changed:	0.0	0.0
Duplicate File Download		
Duplicate download (not expired):	35.0	2.6
Duplicate download (expired, but no "If-Modified-Since" header sent):	0.0	0.0
Duplicate download (expired, but "If-Modified-Since" header ignored):	0.0	0.0
Duplicate File Download: Streaming		
Partial duplicate download (Not Expired):	0.0	0.0
Partial duplicate download (expired, but no "If-Modified-Since" header sent):	0.0	0.0
Partial duplicate download (expired, but "If-Modified-Since" header ignored):	0.0	0.0
---------- Duplicate File Analysis ----------		
Duplicate download (Cache not expired):	71.4	45.3
Duplicate download (24 hr cache not expired):	28.6	54.7
Duplicate download (Cache expired):	0.0	0.0
Duplicate download (24 hr cache expired):	0.0	0.0

The HTTP Cache Statistics panel contains the following columns:

Field	Description
% of Response	Displays the amount of responses for this row item expressed as a percentage of the total number of responses.
of Bytes	Displays the amount of bytes for this row item expressed as a percentage of the total number of bytes.

5.2.6.5.1 Cacheable vs. non-cacheable

The Cacheable vs. non-cacheable section of the HTTP Cache Statistics panel contains the following rows of information:

Field	Description
Cacheable	Caching is the process of storing data on the client side to avoid the repeated download of data from the server. This increases the amount of bandwidth available for common requests/responses. This field analyzes the cacheable contents from the loaded trace. The percentage of Cacheable Responses is calculated from the amount of Cacheable content and the amount of total cache content. The percentage of Cacheable Bytes is calculated from the number of Cacheable bytes and total number of cache bytes.
Specified - no cache	This field analyzes the non-cache data from the loaded trace. The percentage of Non - Cacheable Responses is calculated from the amount of Non Cacheable content and the amount of Total Cache content. The percentage of Non Cacheable Bytes is calculated from the number of Non Cacheable bytes and the total number of cache bytes.

5.2.6.5.2 Cache simulation results

The Cache simulation results section of the HTTP Cache Statistics panel contains the Acceptable behavior, Duplicate file download, and Duplicate file download: Streaming sub-sections. The following describes the rows of information in those subsections.

5.2.6.5.2.1 Acceptable behavior

Field	Description
Files downloaded once	The percentage of total responses and total bytes for files that were downloaded only once. This content is populated from the caching missed contents.
Files specified as "No-Cache"	This content is calculated from the not cacheable HTTP responses. The percentages are calculated from the cache diagnosis total and the number of total bytes.
Expired, but correct 304 response sent from server	The percentage of total responses and total bytes for content with the HTTP response code 304.
Expired, downloaded again, but file has changed	The percentage of total responses and total bytes for content where the HTTP response has changed from the expired response.

5.2.6.5.2.2 Duplicate File Download

Field	Description
Duplicate download (not expired)	The percentage of total responses and total bytes for content which is a duplicate download but has not expired.

Field	Description
Duplicate download (expired, but no "If-Modified-Since" header sent)	The percentage of total responses and total bytes for content which is a duplicate download that has expired and for which an “If-Modified-Since” header was not sent.
Duplicate download (expired, but "If-Modified-Since" header ignored)	The percentage of total responses and total bytes for content which is a duplicate download that has expired and contains an “If-Modified-Since” header that was ignored.

5.2.6.5.2.3 Duplicate File Download Streaming

Field	Description
Partial duplicate download (Not Expired)	The percentage of total responses and total bytes for content which is a partial duplicate download that has not expired.
Partial duplicate download (expired, but no "If-Modified-Since" header sent)	The percentage of total responses and total bytes for content which is a partial duplicate download that has expired and for which an “If-Modified-Since” header was not sent.
Partial duplicate download (expired, but "If-Modified-Since" header ignored)	The percentage of total responses and total bytes for content which is a partial duplicate download that has expired and for which an “If-Modified-Since” header was ignored.

5.2.6.6 Duplicate File Analysis

Field	Description
Duplicate download (Cache not expired)	The percentage of total responses and total bytes for content which is a duplicate download and for which the cache has not expired. These values are calculated with the total cache expiration count and cache expiration ratios.
Duplicate download (24 hr. cache not expired)	The percentage of total responses and total bytes for content which is a duplicate download and for which the 24 hour cache has not expired.
Duplicate download (Cache expired)	The percentage of total responses and total bytes for content which is a duplicate download and for which the cache has expired.

Field	Description
Duplicate download (24 hr. cache expired)	The percentage of total responses and total bytes for content which is a duplicate download and for which the 24 hour cache has expired.

6. APPENDIX

6.1 AT&T ARO Data Collector Error Messages

The following table lists the error messages that can appear in the AT&T ARO Data Collector user interface, along with their descriptions.

Error Message	Condition
SD card mounted. Please unmount the SD card, and restart the Data Collector.	When the Data Collector finishes collecting data, it writes the data files to the device's onboard SD card—but the SD card must not be mounted during data collection. This error occurs when you start data collection, and the SD card is mounted.
The data folder name should not contain special characters or spaces.	When the Data Collector finishes collecting data, it writes the data files to a folder on the device's onboard SD card. This error occurs when you start data collection, and you provide a folder name that contains either non-alphanumeric characters, or spaces.
Error. Data Collector failed to start!	This error occurs when you click Start Collector. TBD.
Confirmation. The trace folder already exists. Do you want to overwrite it?	This error occurs when you start data collection, and you provide a folder name that already exists. Click Ok to proceed and overwrite the folder contents, or press Cancel to provide another name.
Error. Data collection terminated.	This error occurs during data collection, when the data collection process terminates unexpectedly.
Error. Data collection terminated because the SD card is full.	This error occurs during data collection, when the data collection process terminates because the SD card is full.
Error. Data collection terminated because the network type changed unexpectedly.	This error occurs during data collection, when the data collection process terminates because the network type changed automatically.

6.2 AT&T ARO Data Analyzer Error Messages

The following table lists the error messages that can appear in the AT&T ARO Data Analyzer user interface, along with their descriptions.

Error Message	Condition

AT & T ARO requires WinPcap. Please install WinPcap which can be found at http://www.winpcap.org.	This error occurs while launching the AT&T ARO Data Analyzer application. As the AT&T ARO Data Analyzer application is dependent on WinPcap software, it looks for the WinPcap installation during every launch. If the software is missing AT&T ARO Data Analyzer throws the error.
An error occurred when trying to save the chart.	After loading the trace file in AT&T ARO Data Analyzer user can be able to save the diagnosis tab chart in image format. During this save operation any error occurs then below mentioned error message appears on AT&T ARO Data Analyzer application.
No trace loaded. Please load trace files before selecting this option.	When user is trying to access the Time Range Analysis tool from Tools menu → Time Range Analysis without loading any trace file.
No trace loaded. Please load trace files before selecting this option.	When user is trying to access the PCAP File Analysis tool from Tools menu → PCAP File Analysis without loading any trace file.
No trace loaded. Please load trace files before selecting this option.	When user is trying to access Select Applications wizard from View menu → Select Applications without loading any trace file.
Start time must be less than End Time.	Time Range Analysis error message occurs when the user enters greater Start Time value than End Time.
Start Time and End Time must be between 0.00 and 1005.00.	Time Range Analysis error message occur when the user enters improper time in Time Range Analysis tool. This error message displays the time range of 0 to trace time length.
Unexpected Exception: Type of the exception and Localized message of that particular exception. (Need to check as it should not show null).	After loading the trace file in AT&T ARO Data Analyzer, user is able to export the tables presented in Overview, Diagnosis and Statistics tab in .CSV format. During this save operation, if any error occurs then below mentioned error message appears on AT&T ARO Data Analyzer application.
Invalid trace in directory: trace folder path and Localized message of that particular exception. (Need to check as it should not show null).	Once the trace files are loaded by the user, AT&T ARO Data Analyzer starts reading the trace files. While doing this operation if any error happens because of wrong data in traces then below mentioned error messages will be displayed.
More than one device or emulator is connected to PC.	If the user is connected to multiple device or Emulator before clicking the Data Collector → Start Collector menu option then the below mentioned error message appears.
Could not find emulator connection. Please verify emulator connection.	If the user is not connected to any device or Emulator before clicking the Data Collector → Start Collector menu option then the below mentioned error message appears.

Trace directory already exists, do you want to overwrite traces.	When user clicks "Start Collector" from Data Collector → Start Collector menu option. AT&T ARO Data Analyzer application displays the Enter folder name window. In that window if the user provides the existing directory name then the below mentioned alert will be displayed.
Failed to start Data Collector on emulator.	When user clicks start collector from Data Collector → Start Collector menu option. AT&T ARO Data Analyzer application tries to start the AT&T ARO Data Collector application in the connected Emulator. If this operation fails then it displays the below mentioned error message.
Error stopping Data Collector.	After starting the AT&T ARO Data Collector application in Emulator from Data Analyzer, the user is able to stop the collector application from the AT&T ARO Data Analyzer itself. Once user clicks stop collector from Data Collector → Stop Collector menu option. AT&T ARO Data Analyzer application tries to stop the AT&T ARO Data Collector application in the connected Emulator. If this operation fails then it displays the below mentioned error message.
Emulator SD card is full, please free some space to start Data Collector	After starting the AT&T ARO Data Collector application in Emulator from Data Analyzer. The AT&T ARO Data Collector application runs in background on connected Emulator and it collects the trace files. If there is no space to save the collected trace file then the below mentioned error message will be displayed.
Trace folder name should not contain special characters or space.	When user clicks start collector from Data Collector → Start Collector menu option. AT&T ARO Data Analyzer application displays the Enter folder name window. In this window user can enter alpha numeric folder name with only one special character (-). If the user enters any other character other than specified then this error message will be displayed.
Trace folder name should not be more than 50 characters.	When user clicks start collector from Data Collector → Start Collector menu option. AT&T ARO Data Analyzer application displays the Enter folder name window. In this window user can enter name of 50 character length. If the entered name character length is more than 50 then it displays the below mentioned error.

Emulator error with tcpdump push.	When user stops the ARO Collector in connected Emulator or device by AT&T ARO Data Analyzer, he is able to pull the collected data from the connected Emulator or device using Data Collector → Pull Traces… menu option. Once the Pull Traces is selected, the AT&T ARO Data Analyzer application tries to retrieve the collected trace file from connected device or Emulator to local system. If this operation fails then the below mentioned error message will be displayed.
Emulator IO exception caused data collector failure.	While starting ARO Collector application from the AT&T ARO Data Analyzer, if the opened Emulator or devices is not able to connect due to Input / Output exception then the below mentioned error message will be displayed.
Emulator script execution exception caused data collector failure.	While starting ARO Collector application from the AT&T ARO Data Analyzer, If the opened Emulator or device is not able to connect due to any exception apart from Input / Output exception then the below mentioned error message will be displayed.
Emulator retrieving of SD card info exception caused data collector failure.	When the user clicks the Start Collector menu option then ARO Collector tries to retrieve SD card information of the connected device or Emulator if this operation throws the Input / Output exception then the below mentioned error message will be displayed.
Emulator request rejected; wait 10 to 20 seconds and try again.	When the user clicks the Start Collector menu option then ARO Collector tries to retrieve SD card information of the connected device or Emulator if this operation throws the exception apart from Input / Output exception then the below mentioned error message will be displayed.
Stopping data collector causes unknown exception.	When the user clicks the Stop Collector menu option then AT&T ARO Data Analyzer tries to stop the TCP dump operation from ARO Collector in the connected Emulator or device. During this operation if the AT&T ARO Data Analyzer receives the Unknown host exception then the below mentioned error message will be displayed.
Stopping data collector causes an I/O exception.	When the user clicks the Stop Collector menu option then AT&T ARO Data Analyzer tries to stop the TCP dump operation from ARO Collector in the connected Emulator or device. During this operation if the AT&T ARO Data Analyzer receives the Input / Output exception then the below mentioned error message will be displayed.

Stopping data collector causes other exception.	When the user clicks the Stop Collector menu option then AT&T ARO Data Analyzer tries to stop the TCP dump operation from ARO Collector in the connected Emulator or device. During this operation if the AT&T ARO Data Analyzer receives any exception apart from Unknown host and Input / Output exception then the below mentioned error message will be displayed.
Stopping video trace time causes exception.	If the record video option is enabled during the Start Collector operation. While doing the Stop Collector operation in the ARO Collector tries to stop the recording video. If this operation fails because of any exception then the below mentioned error will be displayed.
Writing video trace time causes exception.	If the record video option is enabled during the Start Collector operation. While doing the Stop Collector operation in the ARO Collector tries to write the recorded video in to the SD card using. If this operation fails because of any exception then the below mentioned error will be displayed.
Closing video trace time file causes exception.	If the record video option is enabled during the Start Collector operation. While doing the Stop Collector operation in the ARO Collector tries to close the video file. If this operation fails because of any exception then the below mentioned error will be displayed.
No application found to open PCAP trace. Please install an application like WireShark for PCAP analysis.	After loading the trace files, user can analyze the same Pcap file with other external tool like WireShark via AT&T ARO Data Analyzer by clicking menu option Tools → PCAP File Analysis. During this step, if analyzer finds that external tool like WireShark is missing then below mentioned message will be displayed:
No traffic.cap file found in trace.	After loading the trace files, user can analyze the same Pcap file with other external tool like WireShark via AT&T ARO Data Analyzer by clicking menu option Tools → PCAP File Analysis. During this step, if analyzer finds that there is no traffic.cap file in the loaded trace folder then below mentioned message will be displayed.
Error loading last device profile. Default profile is being used.	When user is trying to load the last user profile from properties file and gets any profile exception or input output exception then below mentioned message will be displayed:
Error reading profile attributes: Exception message.	When user is trying to read/load/save the profile from properties file and gets any profile exception then below mentioned message will be displayed:

Error writing to file:	When user is trying to save the file from Content Viewer table in Diagnosis View or trying to save image from graph panel in Diagnosis View and gets any input output exception then below mentioned message will be displayed.
Unable to load content. Download may have been interrupted.	When user is trying to save/view the content from Content Viewer table in Diagnosis View and gets any content related exception then below mentioned message will be displayed.
Video file is not valid.	This error message appears in the AT&T ARO Image/Video Viewer, and it appears when you load a trace that contains an invalid video file.
Unable to read file.	This error message appears in the AT&T ARO Image/Video Viewer, and it appears when you load a trace that contains a video file that ARO is unable to read.
Video display conversion of video.mp4 to video.mov file failed.	If AT&T ARO Data Analyzer fails to do the video file conversion from .MP4 to .MOV then below mentioned message will be displayed.

6.3 Glossary

This following table contains a list of Mobile Web-associated terms, with their associated definitions. For a more comprehensive list, see the World Wide Web Consortium (W3C).

Term	Definition
Age	A property of a Response Entity. The length of the elapsed time since the Entity was either: Served by the Origin Server, or Successfully validated.
ARO	The Mobile Application Resource Optimizer. An application used for analyzing Radio Resource usage.
Average Rate	This simply calculates the amount of data in KB over the time the trace was run. Apps that stream content should score high here, apps with few connections should score lower.
Burst	The term used to describe
Cache	A local process implemented in the client that creates copies of Response Messages, and serves them to the client on the Server's behalf, as long as it

	remains identical to the Origin Server's copy. When used properly, the use of Response Caches significantly reduces both application response time, and bandwidth consumption.
Cacheable	A Response is deemed Cacheable if the requirements of the Request Method, Request Header Fields, and the Response Status indicate that it is cacheable.
Client	A program that establishes connections for the purpose of sending Requests.
Connection	A virtual circuit, established at the Transport Layer. Used to connect two programs so they can communicate using TCP.
Content Negotiation	The mechanism for selecting the appropriate Representation for servicing a request. The Representation of Entities in any response can be negotiated (including Error Responses).
Core Network	The Internet backbone. The network that the Radio Access Network is connected to.
Energy Consumption	As your application becomes more efficient, the J/KB should decrease. This means you are consuming less battery energy per kilobyte.
Entity	The requested content. Delivered as the payload of Response/Request messages. Request and Response messages don't always carry a payload. An Entity consists of entity-header fields and an entity-body, although some responses will only include the entity-headers. Entities have two parts. The Entity Header contains meta-information. The Entity Body contains web content.
Explicit Expiration Time	The expiration time associated with an Entity—when specified by the Origin Server.

	Beyond that point in time, the Cache can continue serving the local copy of the Entity, but only if it passes a Validation test.
File Types	A breakdown of all files seen during the trace (in bytes). Files sent through HTTPs are listed as Encrypted.
First-Hand	A property of a Response. A Response that is received directly from the Origin Server. Cached Responses are copies of First-Hand Responses.
Fresh	A property of a Response Entity. Indicates that a Cached Response is still implicitly valid. A Fresh Response is a Response that has not exceeded its Freshness Lifetime.
Freshness Lifetime	A property of a Response Entity. The period in which a Cacheable Response remains implicitly valid. How long it takes for a Cacheable Response to reach its Expiration Time.
Gateway	A Server that acts as an intermediary for another server. Unlike proxies, gateways behave like Origin Servers, receiving resource Requests. The requesting client cannot be aware that it is communicating with a gateway.
GPRS	General Packet Radio Services. Single GSM error-corrected circuit-switched data channel.
Heuristic Expiration Time	The expiration time associated with an Entity—determined programmatically by Cache management logic. A Cache management strategy used whenever the Origin Server doesn't specify an Explicit Expiration Time.
HSDPA	High-speed Downlink Packet Access. In the same way that EDGE uses techniques to increase speeds over GPRS, HSDPA employs these same techniques, as well as others, to increase the speed of UMTS data channels. Also known as UMTS/HSDPA. UMTS/HSDPA is a wide-area wireless data service

HTTP	Application level, stateless, communication protocol. Client/server communication consists solely of independent pairs of Requests and Responses.
Inbound/Outbound	Terms that indicate the path of Request and Response messages. Inbound messages travel toward the Origin Server. Outbound messages travel toward the User Agent.
Joules	The SI unit of energy. The work required to produce one watt of power for one second (think of Kilowatt Hours).
Long Burst Connection	A long burst is one that sends a large amount of data in a short period of time. As long as most of the data is consumed, this is a good way to send data (see tightly grouped above).
Message	The basic unit of HTTP communication.
MIME	Multipurpose Internet Mail Extensions.
Non-Periodic Connections	Connections that recur periodically can cause rapid battery drainage. Consider if your periodic pings are required, if the timing could be lengthened, or if other alternatives exist (Pushing alerts is more efficient than regular polling).
Origin Server	The server on which a given Resource either resides or is created.
Pcap	Packet Capture An API for capturing network traffic. Unix-like systems implement Pcap in the libpcap library; Windows uses a port of libpcap known as WinPcap.
Proper Session Termination	The percentage of connections that close immediately with no delay. Connections that close in a delayed fashion, keep the RRC state Machine on longer - needlessly draining the battery.
Proxy	A program that acts as both a server and a client for the purpose of making requests on behalf of other clients. Requests are either serviced internally, or are passed on with possible

	translation, to other servers. A proxy MUST implement both the client and server HTTP requirements. A transparent proxy is a proxy that does not modify the request or response beyond what is required for authentication and identification. A non-transparent proxy is a proxy that modifies the request or response to provide some added service to the user agent, such as group annotation services, media type transformation, protocol reduction, or anonymity filtering. Except where either transparent or non-transparent behavior is explicitly stated, the HTTP proxy requirements apply to both types of proxies.
Radio Access Network (RAN)	The UMTS wireless network, connecting mobile devices to the Core Network.
Representation	A Response Entity that is subject to Content Negotiation. Multiple representations can be associated with a particular Response Status.
Request	A request message from a client to a server includes, within the first line of that message, the method to be applied to the resource, the identifier of the resource, and the protocol version in use.
Resource	Any network Data Object or Service that can be identified by a URI. Resources can be made available in multiple representations (e.g. multiple languages, data formats, size, and resolutions) or vary in other ways.
Response	After receiving and interpreting a Request Message, a web server fulfills the request by sending back an HTTP Response Message, which contains the requested content as the payload.
Semantically Transparent	A property that describes the way a Cache behaves. In terms of content quality, content served from a Cache that is Semantically Transparent matches that served from the Origin Server. Except for the addition of hop-by-hop headers, the client receives Responses that are identical to First-Hand Responses.
Server	A program that accepts connections to service requests, and sends back

	responses. Any given program can be capable of being both a client and a server; our use of these terms refers only to the role being performed by the program for a particular connection, rather than to the program's capabilities in general. Likewise, any server can act as an origin server, proxy, gateway, or tunnel, switching behavior based on the nature of each request.
Session	HTTP Session. The conversation that takes place, between a client and a server. Initiated by the client, but concluded by either the client or the server. Consists of a series of network Request-Response transactions. Lasts for the duration of the conversation, usually minutes.
Session Termination	This graph is scoring the types and actions of the TCP connections found in this trace.
Signaling Overhead	
Signaling overhead	The higher the percentile, better the performance of your application. Signaling overhead indicates the time spent in RRC state transitions. The lower the signaling overhead number, lower the count of state transitions, and the higher your percentile rank.
Simulation	Based on device profile.
Stale	A property of a Response Entity. Indicates that a Cached Response is no longer implicitly valid. A Stale Response is a Response that has exceeded its Freshness Lifetime.
Stateful	In a session, at least one of the communicating parties needs to save information about the session history to be able to communicate.
Stateless	The communication consists of independent requests and responses.
Tightly Grouped Connections	Connections that are grouped together efficiently use the radio while it is turned on. Connections that are spread out keep the radio on for a longer period, adding to the battery drain.
Trace	
Trace Benchmark	This graph benchmarks your trace to the results of traces run on top mobile applications. This gives you an idea of where your application stands in

	comparison to other applications. The rankings here do not signify anything specific other than a ranking.
Tunnel	An intermediary program that acts as a blind relay in the Client/Server connection. Once active, a Tunnel is not considered a party to the HTTP communication. Tunnels are initiated by an HTTP Request. A tunnel ceases to exist when the connections terminates.
UMTS	Universal Mobile Telecommunications System. The 3G version of the GPRS technology. Based on GSM. UMTS radio link.
UMTS Data Channel	The link established between the mobile device and the cell tower.
Upstream/Downstream	Terms that describe the direction in which messages flow. Messages travel from Upstream, to Downstream.
User Agent	The client that initiates a Request. Clients are usually End-user programs, such as Web Browsers, but they can also be Service programs such as Spiders (web-traversing robots).
User Agent	A client application. Usually implements HTTP 1.1, to communicate with a web server.
Validator	Timestamp information that accompanies Response Entities. Stored a Response Entity header field. Used to validate Stale cache entries. When an Origin Server sends a Full Response, it includes a Validator in the Entity-header, which along with the Entity-body, becomes a local cache entry. A Client (user agent or proxy cache) makes a Conditional Request for a cached copy a Resource when it must guarantee the Resource's validity. The Server evaluates the condition based on the result of comparing the value of its local copy of the requested resource's validator (the current version of the Resource), against that of the value of one in the Request. If

	they match, it responds with a special status code (usually, 304 (Not Modified)) and no entity-body. Otherwise, it returns a Full Response. Thus, we avoid transmitting the full response if the validator matches, and we avoid an extra round trip if it does not match. A protocol element (e.g., an entity tag or a Last-Modified time) that is used to determine whether a Cache Entry is usable (i.e., an equivalent copy of an entity.
Variant	At a given instant, Resources can have multiple Representation(s). Each Representation is referred to as Variant. Use of the term Variant does not necessarily imply that the resource is subject to Content Negotiation.