



Arm Streamline Tutorial

Revision: NA

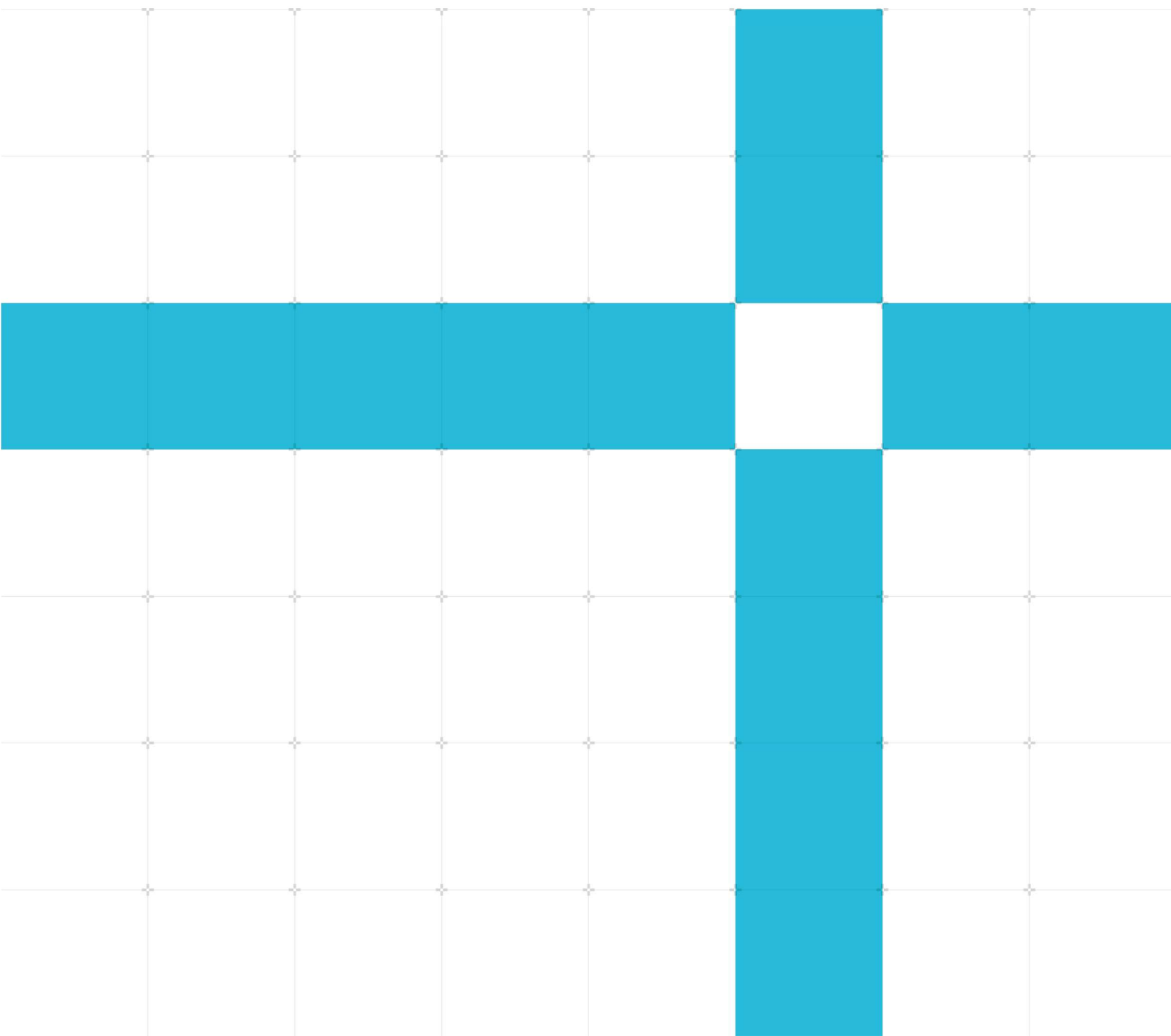
Analyzing an example Streamline report with Arm DS

Non-Confidential

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Issue 0.0

NA



Arm Streamline Tutorial

Analyzing an example Streamline report with Arm DS

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Release information

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Issue	Date	Confidentiality	Change
0.0	30 th of March 2021	Non- Confidential	First version

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110 Fulbourn Road, Cambridge, England CB1 9NJ.

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1 Introduction

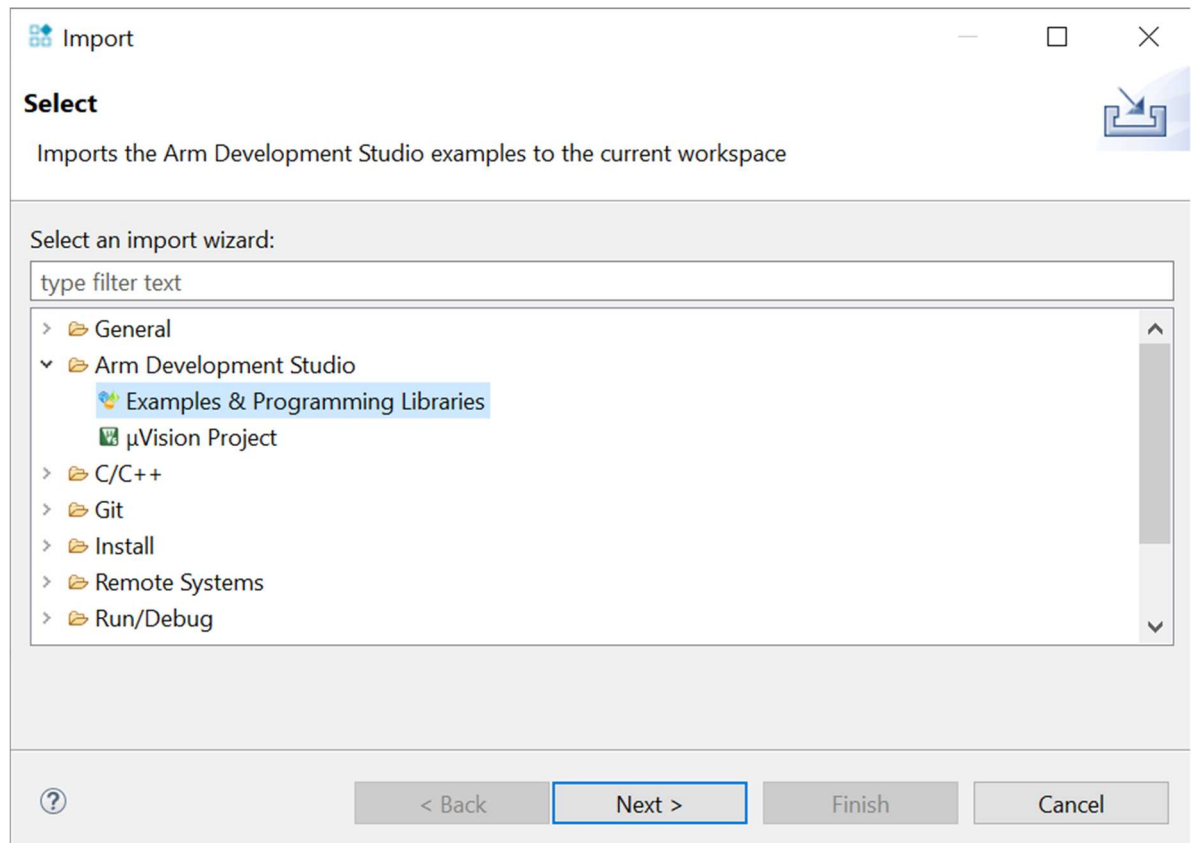
Learn how to import, re-analyze, and then explore the XaoS example report included in Streamline. The report was generated running the XaoS example included in **Arm Development Studio (Arm DS)**.

We use one of the example reports that are included with Streamline. These reports provide a quick way of exploring the features of the **Streamline performance analyzer**. The sample report used in this tutorial was captured by running the XaoS example included in Arm DS on a Cortex-A7 and Cortex-A15 Versatile Express board.

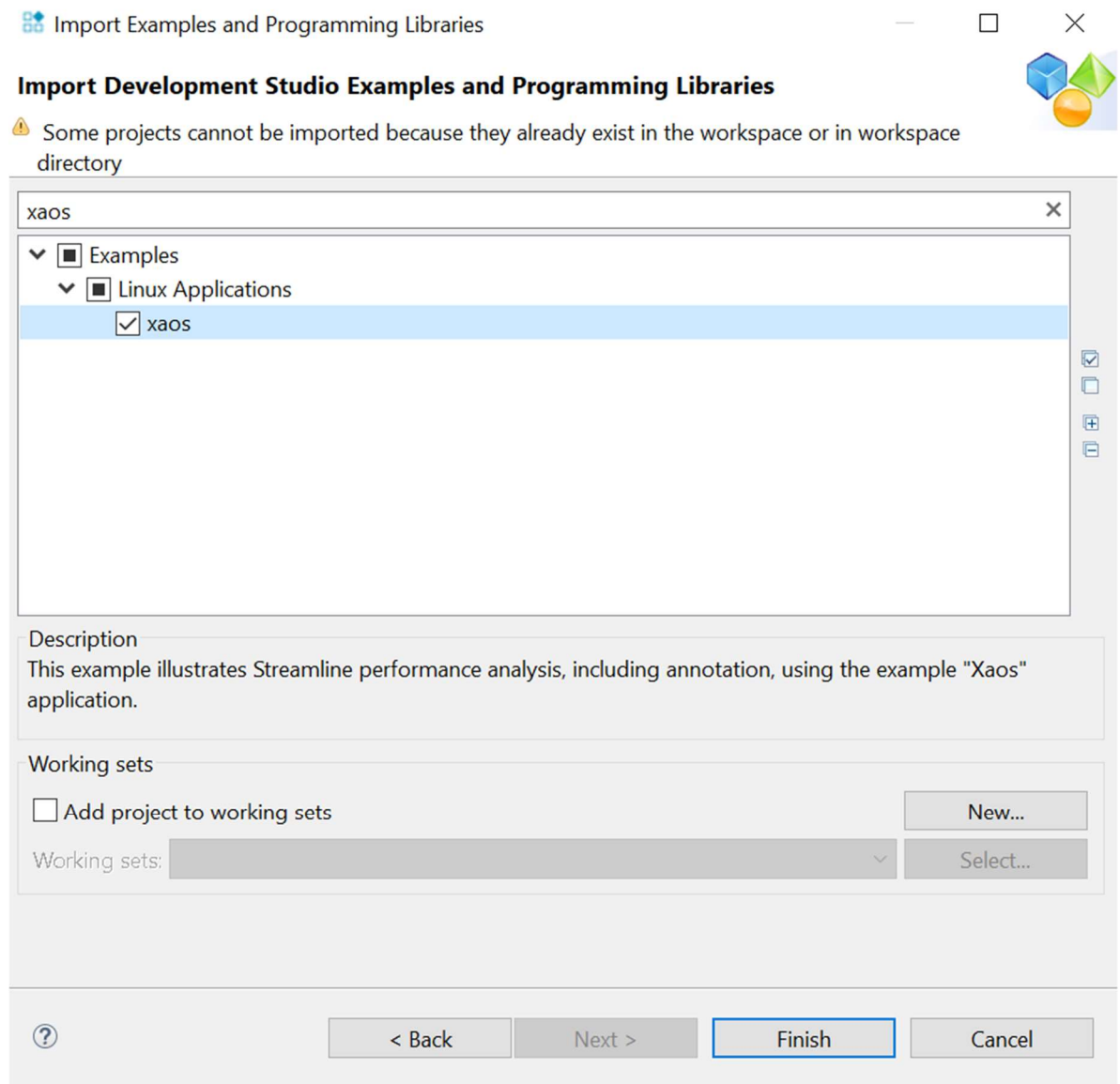
2 Import the Linux example project

The sample Streamline XaoS report was generated using the XaoS example project in Arm DS. Therefore, to work with the report, you must import the Arm DS XaoS example project to your Arm DS Workspace. To import the XaoS example project:

1. Open Arm DS IDE.
2. Click **File > Import**.
3. In the **Import** window, expand **Arm Development Studio** and select **Examples & Programming Libraries**. Click **Next**.



4. In the **Import Examples and Programming Libraries** window, expand **Examples > Linux Applications** and select **xaos**. You can also write "xaos" in the search bar to locate the example project. Click **Finish**.



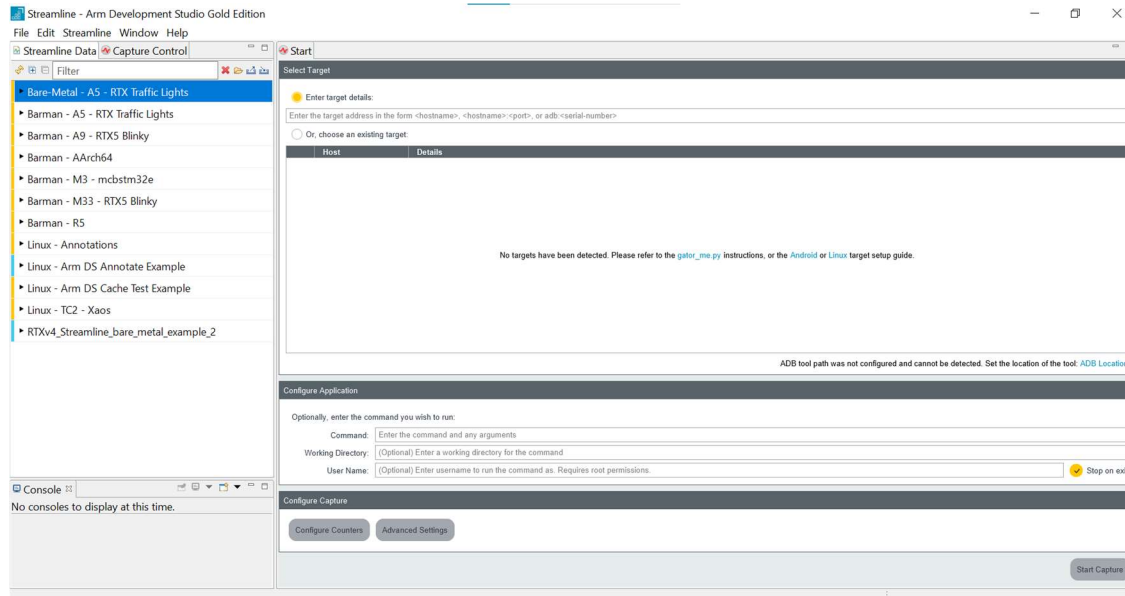
5. The xaos example project now appears in the **Project Explorer** view.

What is XaoS?:

XaoS is an open-source "interactive fractal zoomer" application. In our case, it runs multi-threaded to generate an interesting report.

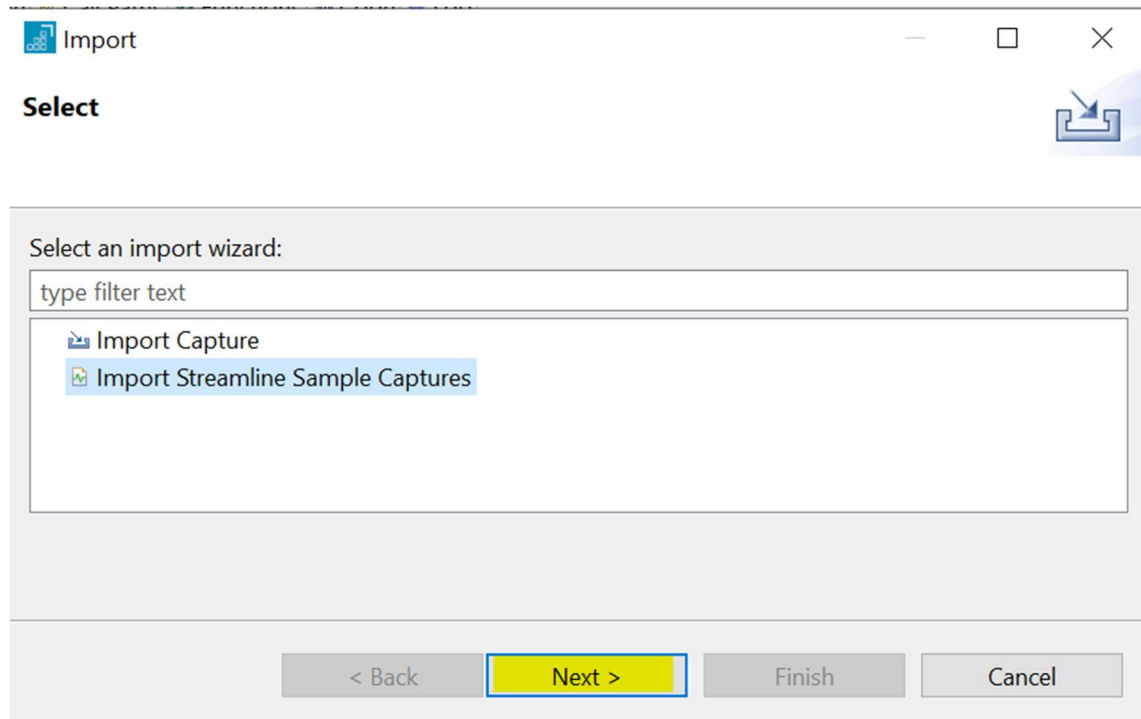
3 Import Streamline example report

Streamline is included with Arm DS installation. Now open Streamline. You will see the following IDE:




Now, you must import the Xaos Streamline example report. To import the example reports:

1. Click **File > Import...**
2. Select **Import Streamline Sample Captures** and click **Next**.



3. You can now select the sample Streamline captures available that you want to import. For this tutorial, select the **Linux > Arm DS Xaos Example**. To import the sample capture, click **Finish**.

—□×

Import Sample Captures

Select the sample captures to import from the list below:

▼ ☒ Linux

☒ Annotations Examples

☒ Arm DS Annotate Example

☒ Arm DS Cache Test Example

☒ Arm DS Xaos Example

▼ ☒ Bare-Metal

☒ Bare-Metal Agent Example running on Armv8 model

☒ RTXv4 Traffic Lights Example running on Cortex-A5

☒ Bare-Metal Agent Example running on Cortex-R5 model

☒ Bare-Metal Agent Example running on Cortex-M3 on MCBSTM32E board

☒ Bare-Metal Agent Example Blinky running on Cortex A9

☒ Bare-Metal Agent Example Blinky running on Cortex-M33

▼ ☒ Instruction Trace

☒ RTXv4 Traffic Lights Example running on Cortex-A5

< Back

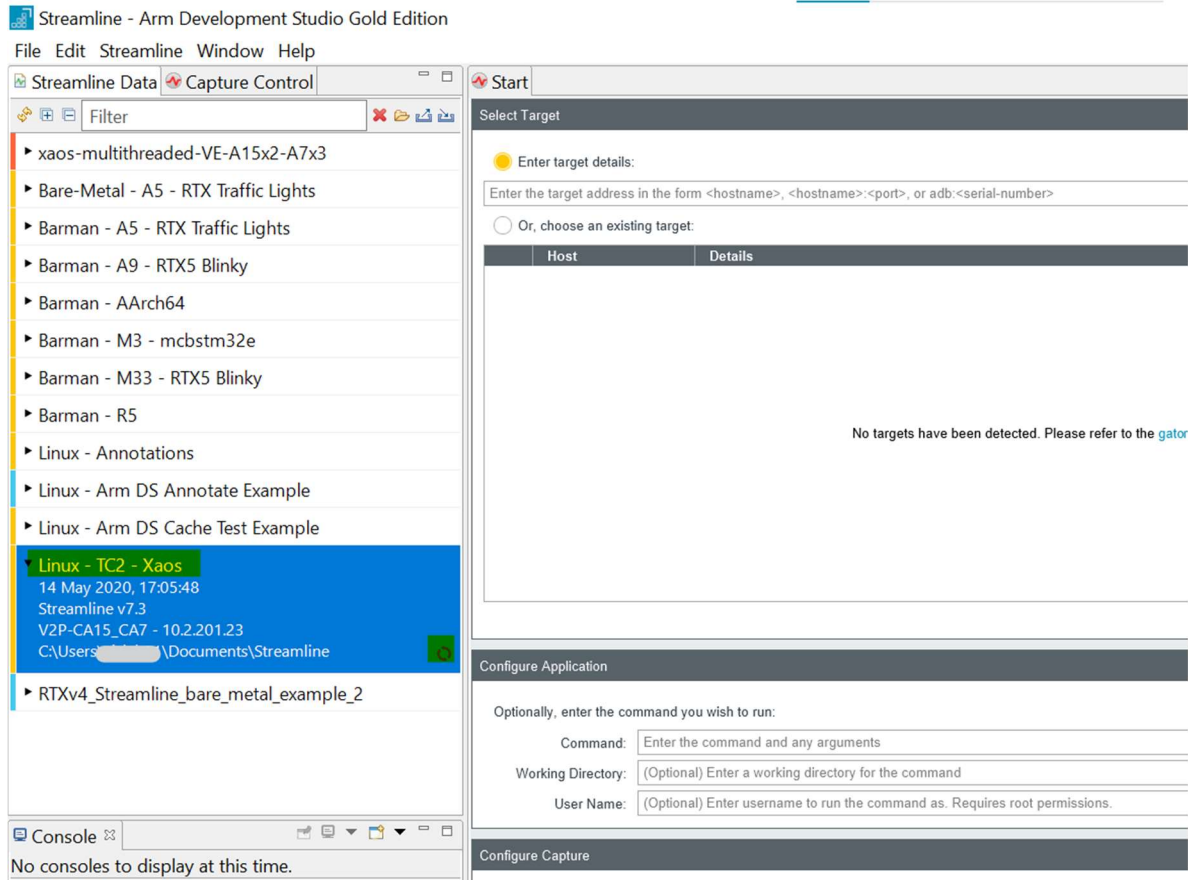
Next >

Finish

Cancel

4 Re-analyze the report

The **Linux - TC2 - Xaos** capture is listed in the **Streamline Data** view. Notice that the vertical bar at the left of the capture (in the list of captures) is yellow, meaning it must be re-analyzed.



Why do I have to re-analyze the report?:

Since the report was generated with a different version of Arm DS, you must re-analyze it in to update it.

In the **Analyze** dialog box, you can load extra program images. These images can be useful for gaining a more comprehensive idea of system execution, or alternatively, for focusing on one particular program. Streamline loads debug symbols if available.

To open the **Analyze** dialog, double-click on the Streamline capture. In the **Program Images** tab, select the ELF images **xaos** and **libpthread-2.17.so**. Then click **Analyze**. Re-analyzing the capture might take some time.

 Linux - TC2 - Xaos



Analyze




Choose the settings to produce a new report.









Analysis

☒ Process Extra Debug Information (when available)

Resolution mode: Normal

Program Images | Script Search Paths

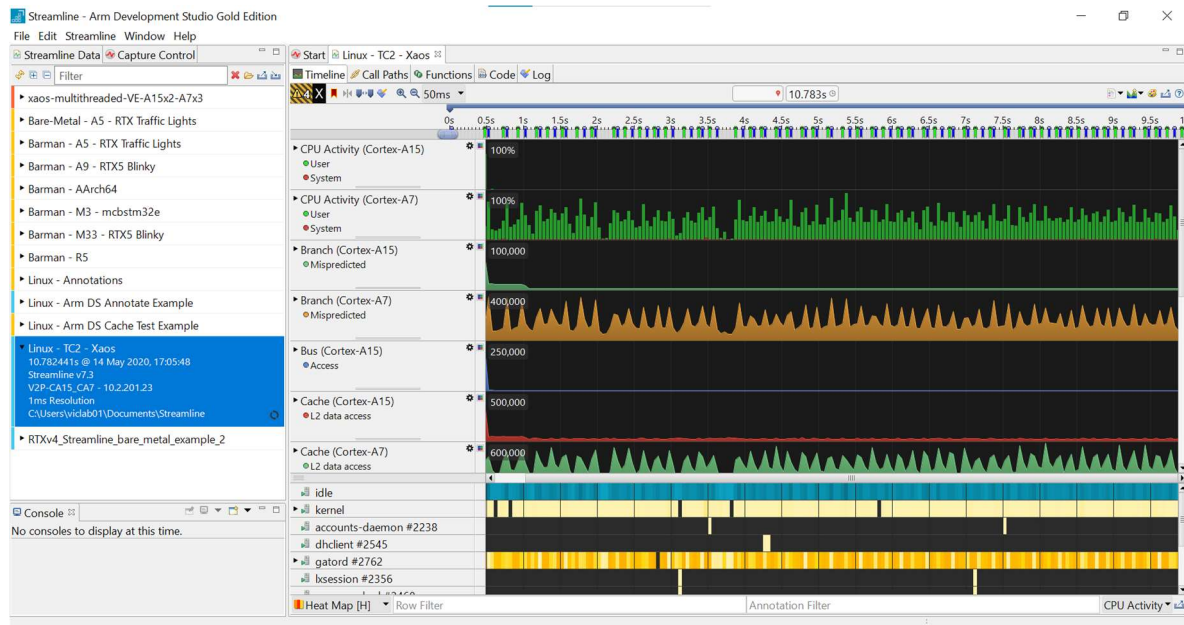
☒  Add ELF image...  Select Separate Debug Image...  Remove

Use	Name	Symbols	Debug Info	CFI	Remarks
<input checked="" type="checkbox"/>	 xaos				
<input checked="" type="checkbox"/>	 libpthread-2.17.so				Debug data in separate files

Analyze Cancel

5 Exploring the sample report

The Xaos report opens in a new tab automatically once you have re-analyzed it. It provides a summary view of CPU performance, branch mispredictions, memory and cache accesses, along with a sample of the frame buffer. Note that the vertical bar of the capture is now colored blue in the **Streamline Data** view, meaning it is up to date.



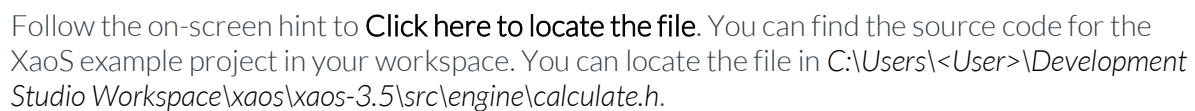
In the panel underneath these charts, there is a heatmap for each process and thread. Click individual processes or threads to reconfigure the charts to reflect them. You can also see annotations on each thread and the frame buffer, which are being passed from the source code. These annotations are a very useful profiling tool when you are working on your own code.

Along the top of the report, there are tabs which break down the data all the way to source code level. When using Streamline to profile your own software, look for areas where the CPU is being pushed hard, or where the cache is being heavily used. Then, try to identify which line of code is causing this.

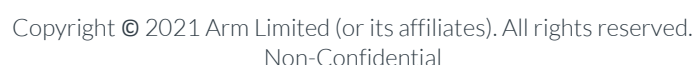
I see numerous **<unknown code in "x">** in the Call Paths and Functions tabs :

This issue relates to the images that you use for analysis in the first place. By default, this capture only includes a couple of images (in this case, the images `xaos` and `libpthread-2.17.so`). So, while Streamline knows that function "x" is taking up a certain percentage of processor time, it does not know what this code is.

In the **Functions** tab, try double-clicking on a function name such as **calculate**. This action takes you to the corresponding line of source code. However, the source file is missing.



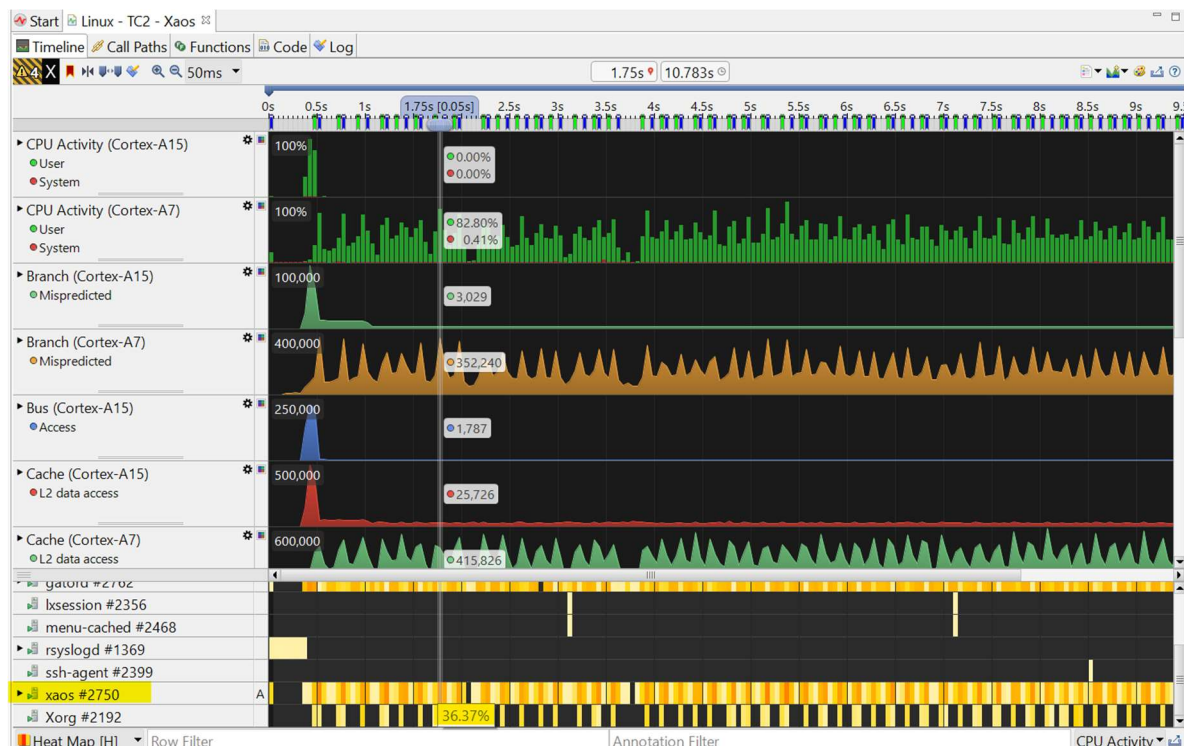
Once you have located the file, the source code appears:



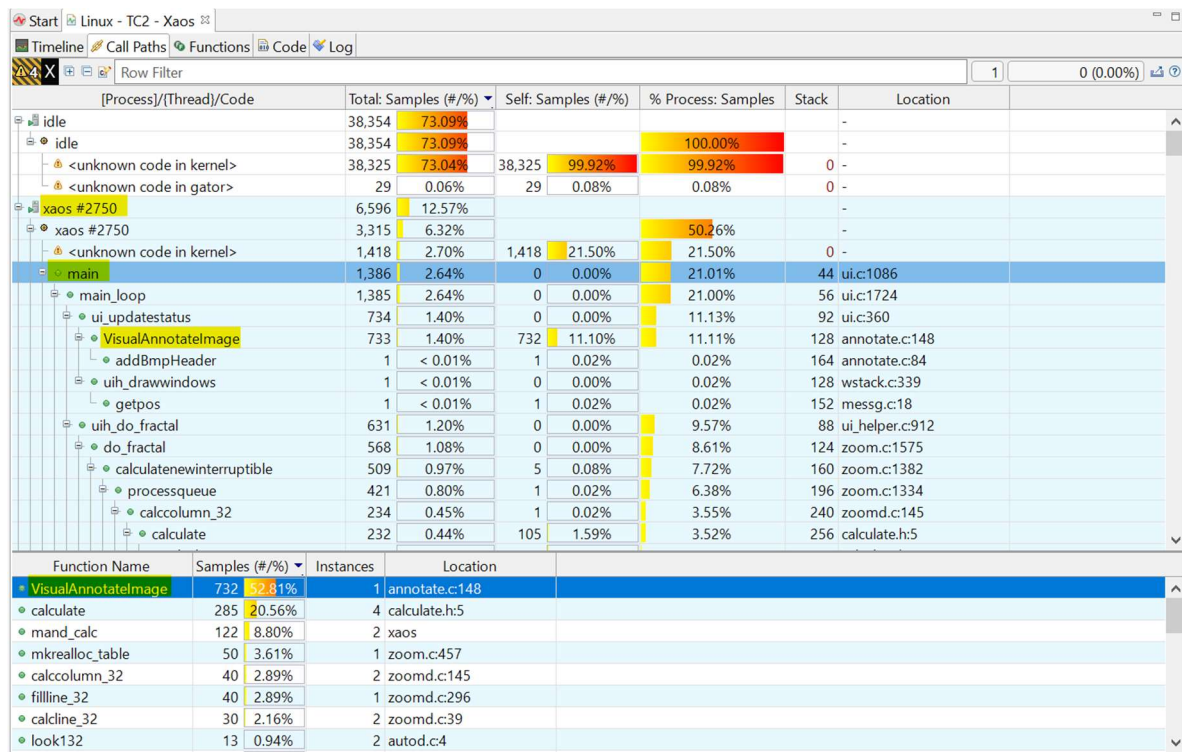
7 Example - How to analyze the sample capture

In the **Timeline** view, you can see a timeline with information such as CPU activity, branch mispredictions, and instructions executed. You can click the timeline to set a cross-section market at 1.75 seconds of execution. That point in the execution time corresponds to one of the activity peaks in the Cortex-A7 core.

In the heat map below, you can see the CPU activity for the different processes. At 1.75s, you notice that the **xaos #2750** process is in orange color, using 36.37% of the **CPU Activity**.



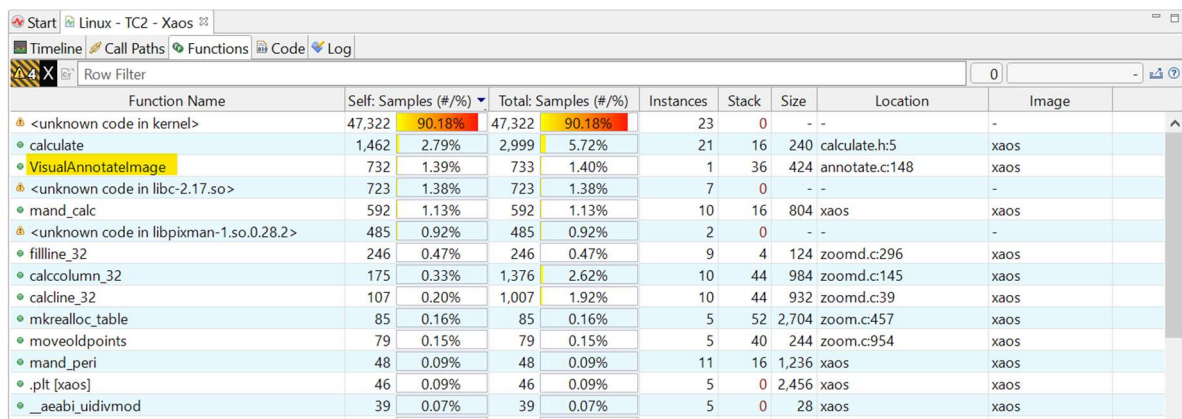
Go to the **Call Paths** view selecting the Call Paths tab. The **main** code is contained within the **xaos #2750** process and thread. We want to see which functions in **main** are using more resources. If you click **main**, you can see that more than half of the samples (52.81%) in **main** correspond to the function **VisualAnnotateImage**. That corresponds to a 11.11% of samples in the **xaos #2750** process.



[Process]/[Thread]/Code	Total: Samples (#/%)	Self: Samples (#/%)	% Process: Samples	Stack	Location
idle	38,354 73.09%			-	
idle	38,354 73.09%		100.00%	-	
<unknown code in kernel>	38,325 73.04%	38,325 99.92%	99.92%	0	-
<unknown code in gator>	29 0.06%	29 0.08%	0.08%	0	-
xaos #2750	6,596 12.57%			-	
xaos #2750	3,315 6.32%		50.26%	-	
<unknown code in kernel>	1,418 2.70%	1,418 21.50%	21.50%	0	-
main	1,386 2.64%	0 0.00%	21.01%	44	ui.c:1086
main_loop	1,385 2.64%	0 0.00%	21.00%	56	ui.c:1724
ui_updatestatus	734 1.40%	0 0.00%	11.13%	92	ui.c:360
VisualAnnotateImage	733 1.40%	732 11.10%	11.11%	128	annotate.c:148
addBmpHeader	1 < 0.01%	1 0.02%	0.02%	164	annotate.c:84
uih_drawwindows	1 < 0.01%	0 0.00%	0.02%	128	wstack.c:339
getpos	1 < 0.01%	1 0.02%	0.02%	152	messg.c:18
uih_do_fractal	631 1.20%	0 0.00%	9.57%	88	ui_helper.c:912
do_fractal	568 1.08%	0 0.00%	8.61%	124	zoom.c:1575
calculatenewinterruptible	509 0.97%	5 0.08%	7.72%	160	zoom.c:1382
processqueue	421 0.80%	1 0.02%	6.38%	196	zoom.c:1334
calcolumn_32	234 0.45%	1 0.02%	3.55%	240	zoomd.c:145
calculate	232 0.44%	105 1.59%	3.52%	256	calculate.h:5

Function Name	Samples (#/%)	Instances	Location
VisualAnnotateImage	732 52.81%	1	annotate.c:148
calculate	285 20.56%	4	calculate.h:5
mand_calc	122 8.80%	2	xaos
mkrealloc_table	50 3.61%	1	zoom.c:457
calcolumn_32	40 2.89%	2	zoomd.c:145
fillline_32	40 2.89%	1	zoomd.c:296
calcline_32	30 2.16%	2	zoomd.c:39
look132	13 0.94%	2	autod.c:4

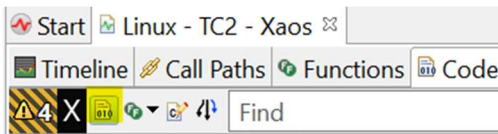
Now, select the **Functions** tab to see the **Functions** view. You can see that the function `VisualAnnotateImage` appears at the top and that it is one of the functions with the highest number of samples. Double-click the function to open the **Code** view for the `VisualAnnotateImage` function.



Function Name	Self: Samples (#/%)	Total: Samples (#/%)	Instances	Stack	Size	Location	Image
<unknown code in kernel>	47,322 90.18%	47,322 90.18%	23	0	-	-	-
calculate	1,462 2.79%	2,999 5.72%	21	16	240	calculate.h:5	xaos
VisualAnnotateImage	732 1.39%	733 1.40%	1	36	424	annotate.c:148	xaos
<unknown code in libc-2.17.so>	723 1.38%	723 1.38%	7	0	-	-	-
mand_calc	592 1.13%	592 1.13%	10	16	804	xaos	xaos
<unknown code in libpixman-1.so.0.28.2>	485 0.92%	485 0.92%	2	0	-	-	-
fillline_32	246 0.47%	246 0.47%	9	4	124	zoomd.c:296	xaos
calcolumn_32	175 0.33%	1,376 2.62%	10	44	984	zoomd.c:145	xaos
calcline_32	107 0.20%	1,007 1.92%	10	44	932	zoomd.c:39	xaos
mkrealloc_table	85 0.16%	85 0.16%	5	52	2,704	zoom.c:457	xaos
moveoldpoints	79 0.15%	79 0.15%	5	40	244	zoom.c:954	xaos
mand_peri	48 0.09%	48 0.09%	11	16	1,236	xaos	xaos
plt [xaos]	46 0.09%	46 0.09%	5	0	2,456	xaos	xaos
_aeabi_uidivmod	39 0.07%	39 0.07%	5	0	28	xaos	xaos

One of the advantages of Streamline is that you can obtain a performance analysis from a high level and general perspective to the lowest level possible. In this example, we began detecting one of the processes with the highest CPU activity. Then, we detected one of the functions with more samples, within the main code that is executed in that process. Now, we can reach the lowest level possible, which is detecting which instructions are executed more frequently.

In the **Code** view, you see the code for the `VisualAnnotateImage` function, which is included in `annotate.c`. Select the highlighted icon in the following image to also show the assembly code:



The code in line 174 (`for` loop) corresponds to the 49.04% of the samples in the function. If you click the line 174, you can see the associated assembly code in green. You have been able to locate the instructions that are constantly executed in your code. This procedure can help you detecting bottlenecks in your code. The instruction `ADD r2, r2, #3` corresponds to the 30.05% of the samples in the `VisualAnnotateImage` function.

Self: Samples (#/%)	Line	Source File	Code
359 49.04%	174	C:/Users/.../Development Studio Workspace/xaos/xaos-3.5/src/ui/ui-drv/gtk/annotate.c	<code>for (col = 0; col < bmp_width; col++) {</code>
93 12.70%	175		<code>buffer[offset++] = screen_data[screen_row_start++]; // b</code>
138 18.85%	176		<code>buffer[offset++] = screen_data[screen_row_start++]; // g</code>
80 10.93%	177		<code>buffer[offset++] = screen_data[screen_row_start++]; // r</code>
62 8.47%	179		<code>// discard unused upper (A) byte, but set to opaque for the Screen Viewer</code>
	180		<code>screen_data[screen_row_start++] = 0xFF;</code>
	181		<code>}</code>
	182		<code>memcpy(&buffer[offset], pad, bmp_pad_bytes);</code>
	183		<code>offset += bmp_pad_bytes;</code>
	184		<code>}</code>
	185		<code>ANNOTATE_VISUAL(buffer, bmp_file_size, "Xaos");</code>
	186		<code>free(buffer);</code>
	187		<code>}</code>

Self: Samples (#/%)	Address	Opcode	Disassembly
45 6.15%	0x00066974	E0852004	<code>ADD r2, r5, r4</code>
1 0.14%	0x00066978	E3A01000	<code>MOV r1, #0</code>
220 30.05%	0x0006697C	E5D30000	<code>LDRB r0, [r3, #0]</code>
	0x00066980	E2811001	<code>ADD r1, r1, #1</code>
	0x00066984	E2822003	<code>ADD r2, r2, #3</code>
	0x00066988	E2833004	<code>ADD r3, r3, #4</code>
48 6.56%	0x0006698C	E7C50004	<code>STRB r0, [r5, r4]</code>
	0x00066990	E2844003	<code>ADD r4, r4, #3</code>
92 12.57%	0x00066994	E5530003	<code>LDRB r0, [r3, #-3]</code>
46 6.28%	0x00066998	E5420002	<code>STRB r0, [r2, #-2]</code>
41 5.60%	0x0006699C	E5530002	<code>LDRB r0, [r3, #-2]</code>
39 5.33%	0x000669A0	E5420001	<code>STRB r0, [r2, #-1]</code>
62 8.47%	0x000669A4	E5437001	<code>STRB r7, [r3, #-1]</code>
41 5.60%	0x000669A8	E5960000	<code>LDR r0, [r6, #0]</code>
97 13.25%	0x000669AC	E1500001	<code>CMP r0, r1</code>
	0x000669B0	CAFFFFFF	<code>BGT {pc}-0x34 ; 0x6697c</code>

8 Add the project path to Streamline locations

If you generate and save your own Streamline reports in a project, you must include the location of the reports. You must indicate the path to the folders with the captures you want to analyze, so Streamline can find the captures in your file system.

As an example, in case you created and saved reports in your Xaos project:

1. In Streamline, click **Window > Preferences**.
2. To add or remove locations where Streamline analysis data can be found, select **Data Locations**.
3. Click **New** and select the *Streamline* folder with captures within the *xaos* project folder in your workspace. Then click **Apply and close**.
4. Your captures are now listed in the **Streamline Data** view.