

# SEGGER

# SystemView

## User Guide

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A product of SEGGER Microcontroller GmbH & Co. KG

[www.segger.com](http://www.segger.com)

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## Manual versions

This manual describes the current software version. If you find an error in the manual or a problem in the software, please inform us and we will try to assist you as soon as possible. Contact us for further information on topics or functions that are not yet documented.

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Software	Revision	Date	By	Description
2.20	1	151119	JL	<ul style="list-style-type: none"> <li>• Screenshots updated.</li> <li>• Fixed defines in configuration.</li> </ul>
2.20	0	151118	JL	<ul style="list-style-type: none"> <li>• SystemViewer GUI elements restructured.</li> <li>• SystemView Config module added.</li> </ul>
2.10	0	151106	JL	Official Release.
2.09	0	151026	JL	Initial Pre-Release.



# About this document

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## Assumptions

This document assumes that you already have a solid knowledge of the following:

- The software tools used for building your application (assembler, linker, C compiler).
- The C programming language.
- The target processor.
- DOS command line.

If you feel that your knowledge of C is not sufficient, we recommend *The C Programming Language* by Kernighan and Richie (ISBN 0-13-1103628), which describes the standard in C programming and, in newer editions, also covers the ANSI C standard.

## How to use this manual

This manual explains all the functions and macros that the product offers. It assumes you have a working knowledge of the C language. Knowledge of assembly programming is not required.

## Typographic conventions for syntax

This manual uses the following typographic conventions:

Style	Used for
Body	Body text.
Keyword	Text that you enter at the command prompt or that appears on the display (that is system functions, file- or pathnames).
Parameter	Parameters in API functions.
Sample	Sample code in program examples.
Sample comment	Comments in program examples.
Reference	Reference to chapters, sections, tables and figures or other documents.
GUI Element	Buttons, dialog boxes, menu names, menu commands.
Emphasis	Very important sections.



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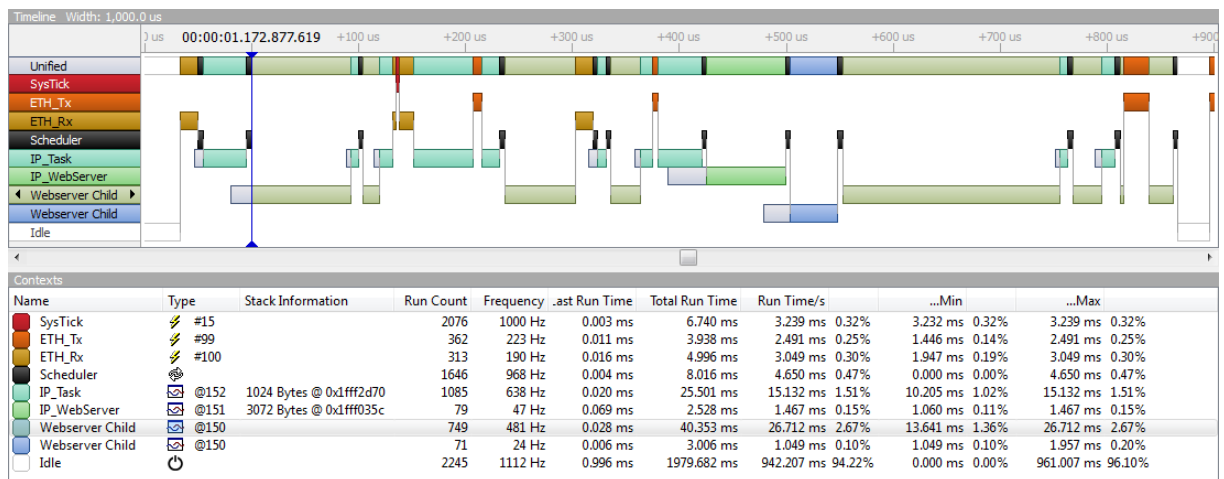
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# Chapter 1

## Overview

This section describes SEGGER SystemView in general.



## 1.1 What is SEGGER SystemView?

SystemView is a toolkit for visual analysis of any embedded system. SystemView gives complete insight into an application, to gain a deep understanding of the runtime behavior, going far beyond what a debugger is offering. This is particularly advantageous when developing and working in complex systems with multiple threads and events.

SystemView consists of two parts:

The PC visualization application *SystemViewer*, and some code, collecting information on the target system.

The SystemViewer host application allows analysis and profiling of the behavior of an embedded system. It records the monitor data which is generated in the embedded system and visualizes the information in different windows. The recording can be saved to a file for analysis at a later time or for documentation of the system.

The monitor data is recorded via the debug interface, meaning that no additional hardware (especially no extra pins) is required to use SystemView. It can be used on any system that allows debug access.

With a SEGGER J-Link and its *Real Time Transfer* (RTT) technology SystemViewer can continuously record data, and analyze and visualize it in real time.

SystemView makes it possible to analyze which interrupts, tasks and software timers have executed, how often, when exactly and how much time they have used. It sheds light on what exactly happened in which order, which interrupt has triggered which task switch, which interrupt and task has called which API function of the underlying RTOS.

Cycle-accurate profiling can be performed and even user functionality can be timed.

SystemView should be used to verify that the embedded system behaves as expected and can be used to find problems and inefficiencies, such as superfluous and spurious interrupts, and unexpected task changes. It can be used with any (RT)OS which is instrumented to call SystemView event functions, but also in systems without an instrumented RTOS or without any RTOS at all, to analyze interrupt execution and to time user functionality like time-critical subroutines.

### How does it work?

On the target side a small software module, containing SYSTEMVIEW and RTT, needs to be included. The SYSTEMVIEW module collects and formats the monitor data and passes it to RTT. The RTT module stores the data in the target buffer, which allows continuous recording with a J-Link on supported systems, as well as single-shot recording on any system.

The target system calls SYSTEMVIEW functions in certain situations, such as interrupt start and interrupt end, to monitor events. SystemView stores these events together with a configurable, high-accuracy timestamp, in the RTT target buffer. Timestamps can be as accurate as 1 CPU cycle, which equates to 5 ns on a 200 MHz CPU.

### What resources are required on the target side?

The combined ROM size of RTT and the SYSTEMVIEW modules is less than 2 KByte. For typical systems, about 600 bytes of RAM are sufficient for continuous recording with J-Link. For system-triggered recording the buffer size is determined by the time to be recorded and the amount of events. No other hardware is required. The CPU needs less than 1 us for typical events (based on a 200 MHz Cortex-M4 CPU), which results in less than 1% overhead in a system with 10,000 events per second. Since the debug interface (JTAG, SWD, FINE, ) is used to transfer the data, no additional pins are required.

### On which CPUs can SystemView be used?

SystemView can be used on any CPU. Continuous real-time recording can be done on any system supported by J-Link RTT technology. RTT requires the ability to read memory via the debug interface during program execution. This especially includes ARM Cortex-M0, M0+, M1, M3, M4 processors as well as all Renesas RX devices. On systems which are not supported by the RTT technology the buffer content can be read manually when the system

is halted, which allows single-shot recording until the buffer is filled. Single-shot recording can be triggered by the system to be able to control when a recording starts.

### **How much work is it to add it to a target system?**

Not very much. A small number of files need to be added to the make file or project. If the operating system supports SystemView, then only one function needs to be called. In a system without RTOS or non-instrumented RTOS, two lines of code need to be added to every interrupt function which should be monitored. That's all and should not take more than a few minutes.

## 1.2 The SEGGER SystemView package

The following sections describe how to install the SEGGER SystemView package and its contents.

### 1.2.1 Download and installation

The SEGGER SystemView package is available as an installer setup and a portable zip.

#### Installer

Download the latest setup from <http://www.segger.com/systemview.html> and execute it. The setup wizard guides through the installation.

After installation the package content can be accessed through the Windows *Start* menu or from the file explorer.

#### Portable zip

Download the latest zip from <http://www.segger.com/systemview.html> and extract it to any directory on the file system.

No installation is required, after extraction the package content can be used directly.

### 1.2.2 Package content

The SEGGER SystemView package includes everything needed for application tracing — the target instrumentation code and the host PC visualization tool.

Additional sources to interface with SEGGER software, such as embOS, and sample trace files are included for a quick and easy start.

The following table lists the important package content.

File	Description
SystemViewer.exe	SystemView analysis and visualization tool.
Doc/UM08027_SystemView.pdf	This documentation.
Doc/ AN08003_SystemViewOSIntegration.pdf	Application note on how to integrate SystemView into any OS.
description/ SYSVIEW_embOS.txt	SystemView API description file for SEGGER embOS.
description/ SYSVIEW_FreeRTOS.txt	SystemView API description file for FreeRTOS.
SampleTraces/ OS_IP_WebServer.SVdat	SystemView sample trace file of a web server application.
SampleTraces/ OS_Start_LEDBlink.SVdat	SystemView sample trace file of a simple embOS application.
TargetSrc/Config/ SEGGER_RTT_Conf.h	SEGGER Real Time Transfer (RTT) configuration file.
TargetSrc/Config/ SEGGER_SYSVIEW_Conf.h	SEGGER SYSTEMVIEW configuration file.
TargetSrc/Sample/Config/ SEGGER_SYSVIEW_Config_embOS.c	Sample initialization of SystemView with embOS.
TargetSrc/Sample/Config/ SEGGER_SYSVIEW_Config_embOS_CM0.c	Sample initialization of SystemView for Cortex-M0 targets with embOS.
TargetSrc/Sample/Config/ SEGGER_SYSVIEW_Config_FreeRTOS.c	Sample initialization of SystemView with FreeRTOS.
TargetSrc/Sample/Config/ SEGGER_SYSVIEW_Config_NoOS.c	Sample initialization of SystemView with no OS.

File	Description
TargetSrc/Sample/OS/ SEGGER_SYSVIEW_embOS.c	Interface between SYSTEMVIEW and embOS.
TargetSrc/Sample/OS/ SEGGER_SYSVIEW_embOS.h	Interface header.
TargetSrc/Sample/OS/ SEGGER_SYSVIEW_FreeRTOS.c	Interface between SYSTEMVIEW and FreeRTOS.
TargetSrc/Sample/OS/ SEGGER_SYSVIEW_FreeRTOS.h	Interface header.
TargetSrc/SEGGER/ SEGGER_RTT.c	SEGGER RTT module source.
TargetSrc/SEGGER/ SEGGER_RTT.h	SEGGER RTT module header.
TargetSrc/SEGGER/ SEGGER_SYSVIEW.c	SEGGER SYSTEMVIEW module source.
TargetSrc/SEGGER/ SEGGER_SYSVIEW.h	SEGGER SYSTEMVIEW module header.
TargetSrc/SEGGER/ SEGGER_SYSVIEW_ConfDefault.h	SEGGER SYSTEMVIEW configuration fallback.
TargetSrc/SEGGER/ SEGGER_SYSVIEW_Int.h	SEGGER SYSTEMVIEW internal header.



# Chapter 2

## Getting started with SEGGER SystemView

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This section describes how to get started with SEGGER SystemView. It explains how to analyze an application based on monitored data.

This chapter refers to the sample data file `OS_IP_WebServer.SVDat` which is part of the SEGGER SystemView package.

The sample data file shows the behavior of a target system running the embOS RTOS, the embOS/IP TCP/IP stack and a web server application.

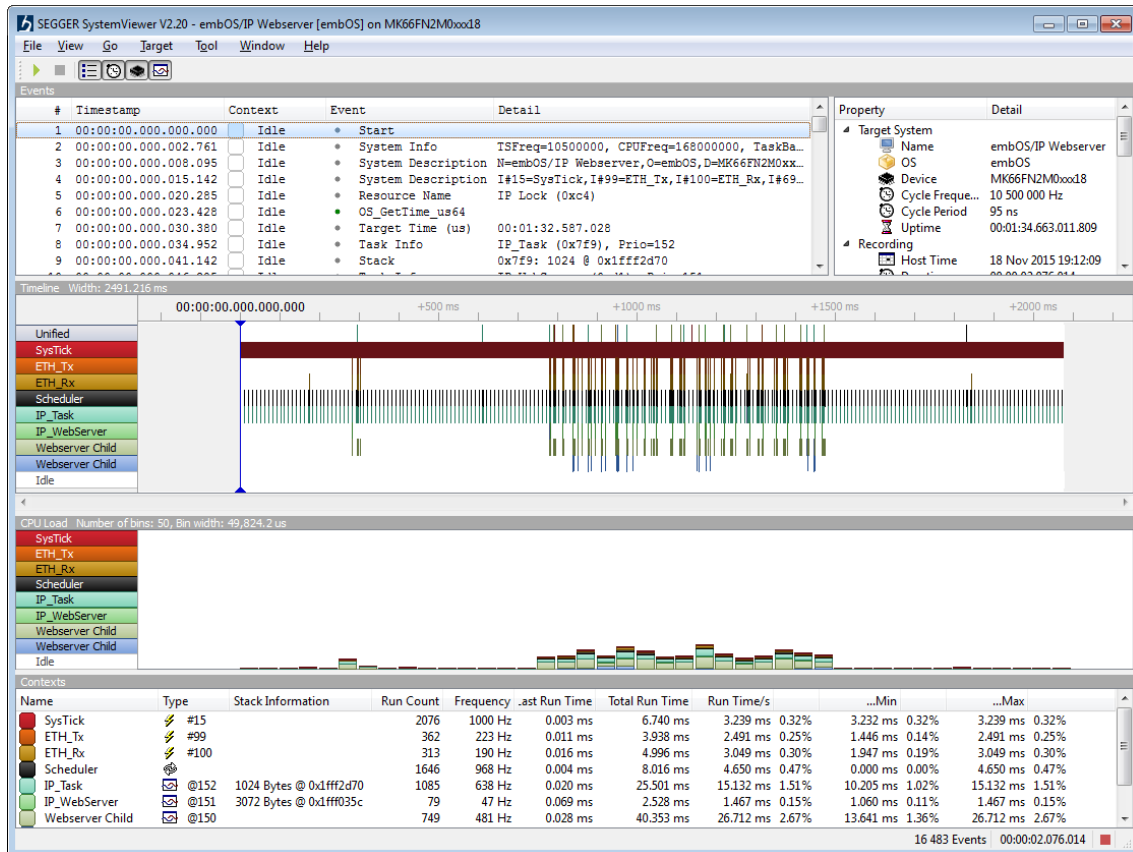
We are going to analyze what the application is doing with the information from SEGGER SystemView.

## 2.1 Starting SystemViewer and loading data

SystemViewer can monitor data live from the target application. The monitored data can be saved to a file for later work with it. Saved data can be analyzed without a J-Link and even without the target hardware or the target application. This allows analysis of the system by developers who do not have physical access to it.

- Start SystemViewer (SystemViewer.exe) from the Windows *Start* menu or the installation directory.
- Select File → Load Data (Keyboard shortcut: F3).
- Choose OS\_IP\_WebServer.SVdat from \$PackageInstallationDir\$/SampleTraces/ and click Open.

SystemViewer loads and analyzes the data and should now look like this:





## 2.2 A first look at the system

We will take a first look at the data to get some information about the monitored system.

The *Timeline* window shows the complete monitored data. In the *Events* list, scroll to the first item to get started.

### System information

The window on the top right displays information about the system. This information has been sent by the application, therefore SystemViewer does not require any setup configuration.

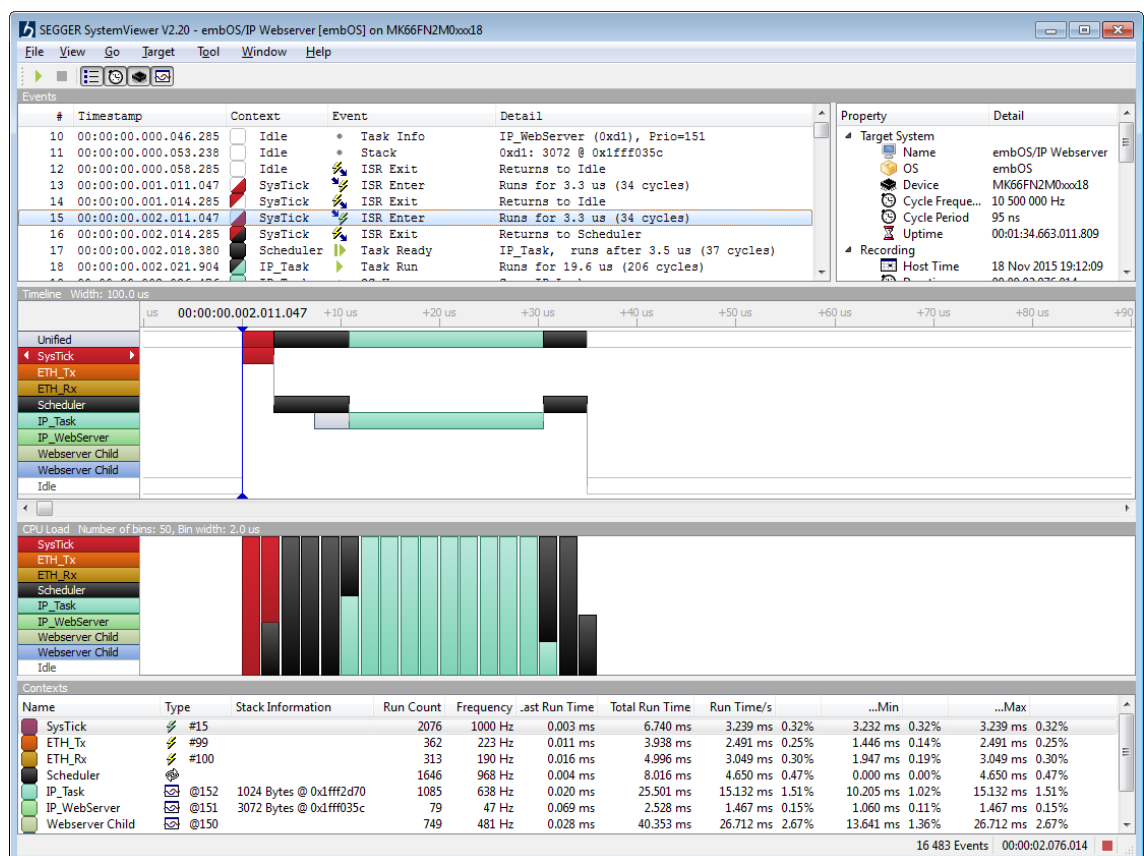
The System information includes the application name, the used OS, the target device, and the timing information. Additional information about task switches and interrupt frequency provide a quick overview of the system.

### Timeline

The *Timeline* window shows the system activity by context (task, interrupt, scheduler and idle) over the system time. Each row refers to one context item and we can see all items which have been used in the application while it has been monitored. In the initial view we can see system activity every millisecond.

Double-click on the vertical line below '+1 ms' to center the item and zoom in to see the active contexts. (Use the mouse wheel, [Ctrl] + [+] / [-] keys or View → Zoom In, View → Zoom Out to zoom.) We see that the activity every millisecond is the 1 kHz SysTick interrupt.

Jump to the next interrupt with View → Forward (Keyboard shortcut: F) until we see more activity than the SysTick interrupt. Zoom in or out to see all activity on the screen. We can see the SysTick interrupt returned to the OS Scheduler, which makes the IP\_Task ready, indicated by the grey bar in the IP\_Task's row, and lets it run. When the IP\_Task has done its current job it goes back to idle.



### Conclusion

We have got some information about the monitored system, the application name, the target device and the system frequency. From the Timeline we know which tasks and

interrupts are used by the application, that it is controlled by the 1 kHz SysTick interrupt, and the IP\_Task is activated at least every 10 ms.

## 2.3 Analysing system activity

After getting some information of the system we will analyze what the system does when it is active.

### Events list

The Events list shows all events as they are sent from the system and displays their information, including timestamp of the event, active context, type of event and event details.

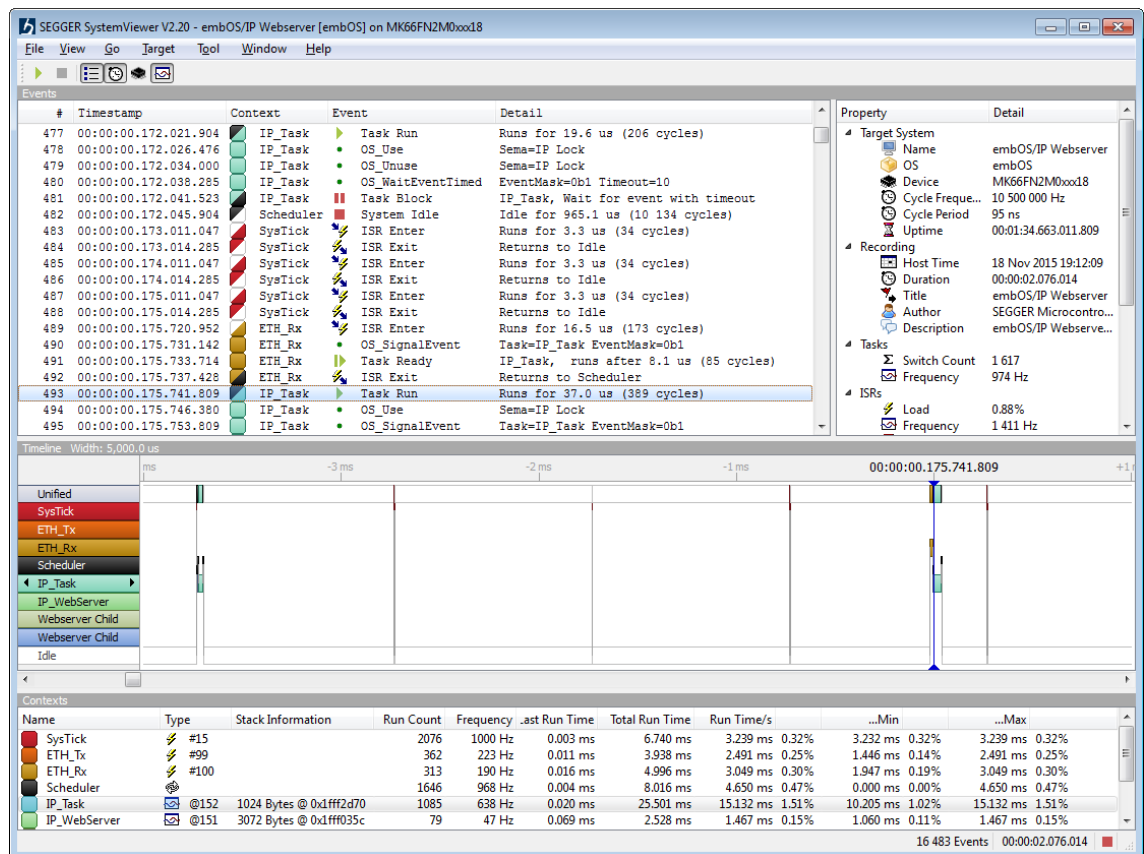
We have seen that every millisecond the SysTick ISR enters and exits and that it activates the IP\_Task every 10 ms because its timeout occurred.

Go to event #480 with View→Go to Event... (Keyboard shortcut: Ctrl+G). It is a call of OS\_WaitEventTimed with a timeout out 10 ms from the IP\_Task at 00:00:00.172.026. The timeout would happen at 00:00:00.172.026.

Set a time reference on the event with View→Events→Toggle Reference (Keyboard shortcut R). All following timestamps in the events list are measured from the latest reference.

To now see whether the IP\_Task runs because of the timeout or because of the event, move the mouse over the label of the IP\_Task row in the timeline and click on the right arrow button to jump to the next activity of IP\_Task. Alternatively select the Task Run event (#477) and select View→Next Task Run in IP\_Task (Keyboard shortcut: Shift+N) to jump to the next Task Run event of IP\_Task.

The timestamp is 00:00:00.003.703, clearly before the timeout, so the task was activated by the event it waited for. We can see the ETH\_Rx interrupt happened before and called OS\_SignalEvent, which marked the task as ready as indicated in the timeline. The ETH\_Rx interrupt returns to the Scheduler and IP\_Task runs. We have received something via Ethernet.



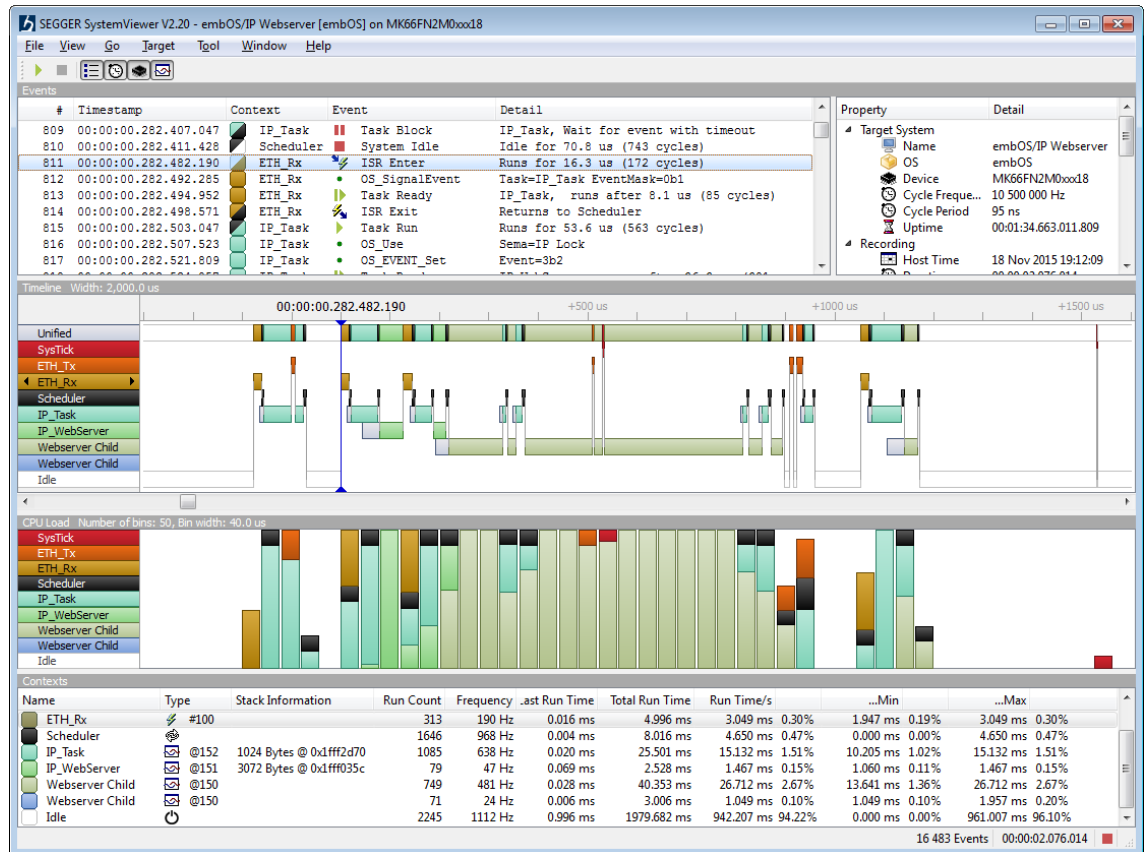
## Conclusion

Going further through the events, we can see that the IP\_Task is activated after the 10 ms timeout occurred or after we received something and the ETH\_Rx interrupt occurred.

## 2.4 Further analysis of the application core

We now know that the system is mainly controlled by the ETH\_Rx interrupt. The next step is to see what the system does when it is active.

The application creates a web server which can be accessed by the browser to view the embOS/IP demo web page. The sample data has been gathered while the web server was running and the browser loaded the web page multiple times.



### Timeline, Events list and Contexts window

The windows of SystemViewer are synchronized and provide the best possibilities for system analysis when used together.

Search through the Events list to find some activity in the system. Go to event #811.

Here we can see that the ETH\_Rx interrupt activates the IP\_Task, calls OS\_EVENT\_Set and makes the Webserver Child task ready. After the IP\_Task has done its work the Scheduler activates Webserver Child.

The Webserver Child is interrupted by another ETH\_Rx interrupt which causes a preemptive task switch to the IP\_Task in the Scheduler, because the IP\_Task has a higher priority than the Webserver Child. After IP\_Task has run, the Scheduler goes back to the Webserver Child task.

**Note:** Tasks are ordered by priority in the Timeline, the exact task priority can be seen in the Contexts window.

The Webserver Child runs and handles the received request. It sends back data, which can be seen by the following ETH\_Tx interrupts. After it has done its work it waits for an event and goes to idle.

While recording this trace we have now seen the web page in the browser.

## 2.4.1 Analysis conclusion

We analyzed what a system does without insight into the application code. With the application source we can check with SEGGER SystemView that the system does what it is supposed to do.

SEGGER SystemView can actively help developing applications, since it not only shows what the system does, but also allows exact time measurement and visualizes the influence of interrupts and events on the application flow. This provides advanced possibilities to find problems and to improve the system.

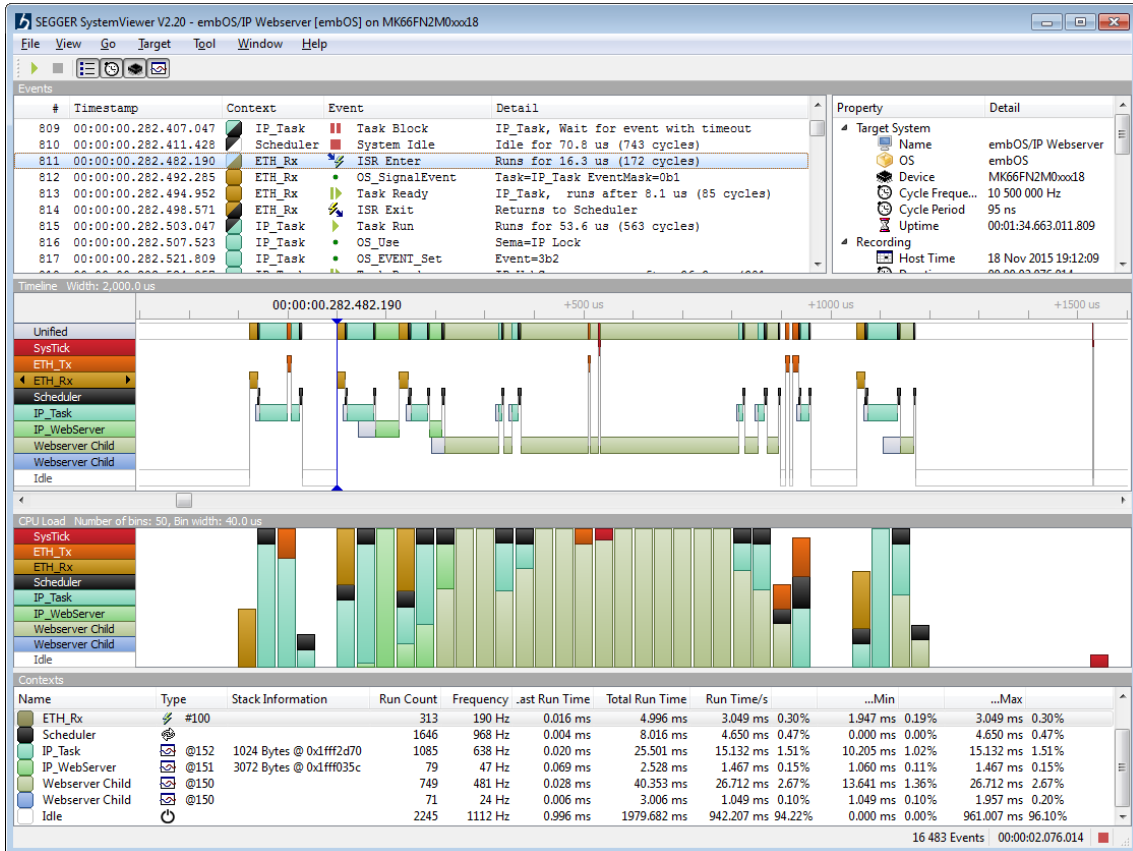
# Chapter 3

## Host application - SystemViewer

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This section describes SystemViewer, the SystemView analysis and visualization tool.

## 3.1 Introduction



SystemViewer is the host PC visualization tool for SEGGER SystemView. It connects via a J-Link to the target application, controls the application tracing and reads its data. The monitored data is analyzed on runtime and visualized in the different windows of SystemViewer. After tracing has stopped, the data can be saved to a file which allows later analysis of the application trace.

To get started with SystemViewer please refer to the previous chapter.

SystemViewer provides different windows to visualize the execution in the system, measure timing and analyze the CPU load. All windows are synchronized to always get all information of the currently selected state.

For a description of the application windows please refer to the following sections.

SystemViewer allows going through the monitored data and keeping track of what happened in the system at any time.



## 3.2 Events window

#	Timestamp	Context	Event	Detail
9635	00:00:01.170.011.047	SysTick	ISR Enter	Runs for 3.3 us (34 cycles)
9636	00:00:01.170.014.285	SysTick	ISR Exit	Returns to Idle
9637	00:00:01.171.011.047	SysTick	ISR Enter	Runs for 3.3 us (34 cycles)
9638	00:00:01.171.014.285	SysTick	ISR Exit	Returns to Idle
9639	** REF **	ETH_Rx	ISR Enter	Runs for 17.8 us (187 cycles)
9640	00:00:00.000.011.523	ETH_Rx	OS_SignalEvent	Task=IP_Task EventMask=0b1
9641	00:00:00.000.014.095	ETH_Rx	Task Ready	IP_Task, runs after 8.1 us (85 cycles)
9642	00:00:00.000.017.809	ETH_Rx	ISR Exit	Returns to Scheduler
9643	** REF **	IP_Task	Task Run	Runs for 40.7 us (428 cycles)
9644	00:00:00.000.004.571	IP_Task	OS_Use	Sema=IP Lock
9645	00:00:00.000.023.619	IP_Task	OS_EVENT_Set	Event=9de

The Events window shows all events as they are sent by the system and displays their information. Every event has the following items:

- A timestamp in target time or recording time, which can be displayed with microsecond or nanosecond resolution.
- A context from which it has been created, i.e. the task which is running.
- An event description, displayed with the type of event (ISR enter and exit, task activity, API call).
- Event details describing the parameters of the event, i.e. the API call parameters.
- An ID to locate events in the list.

The Events window allows going through the list, jumping to the next or previous context, or to the next or previous similar event. The Timeline and CPU Load windows are synchronized to show the currently selected event.

The timestamp in the events list can be relative to the start of recording or the target system time if it has been sent by the system. Events can be set as time reference for following events to allow easy measurement of when an event occurred after another one.

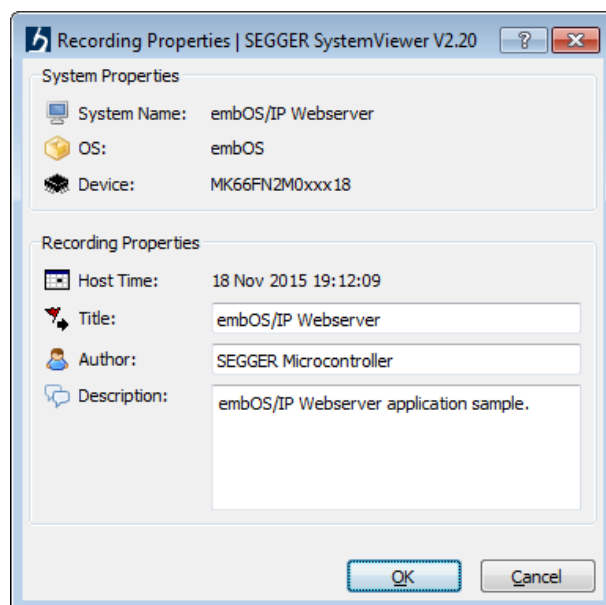
### 3.3 System information

Property	Detail
Target System	
Name	embOS/IP Webserver
OS	embOS
Device	MK66FN2M0xxx18
Cycle Frequency	10 500 000 Hz
Cycle Period	95 ns
Uptime	00:01:34.663.011.809
Recording	
Host Time	18 Nov 2015 19:12:09
Duration	00:00:02.076.014
Title	embOS/IP Webserver
Author	SEGGER Microcontroller
Description	embOS/IP Webserver application sample.
Tasks	
Switch Count	1 617
Frequency	974 Hz
ISRs	
Load	0.88%
Frequency	1 411 Hz
Total Time	15,675.7 us
Interrupt Count	2 748
Events	
Count	16 483
Frequency	9 421/s
Dropped	0
RTT	

The window on the top right displays:

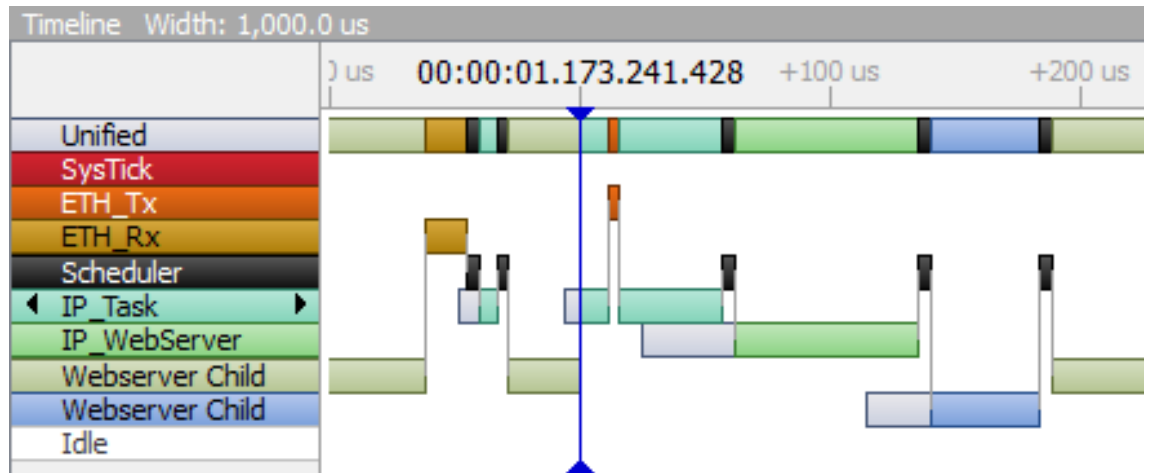
- Information about the system, which has been sent by the application to identify it.
- Recording properties, which can be set by the user.
- Statistics about tasks, interrupts, SystemView events and recording throughput.

The System information includes the application name, the used OS, the target device, and the timing information. Additional information about task switches and interrupt frequency provides a quick overview of the system.



The recording properties can be set by the user to be stored with the record when it is saved and allow identifying a record when it is loaded for later analysis.

## 3.4 Timeline window



The Timeline window shows the system activity by context (task, interrupt, scheduler, timer and idle) over the system time. Each row refers to one context item to show all context items which have been used in the application while it has been monitored.

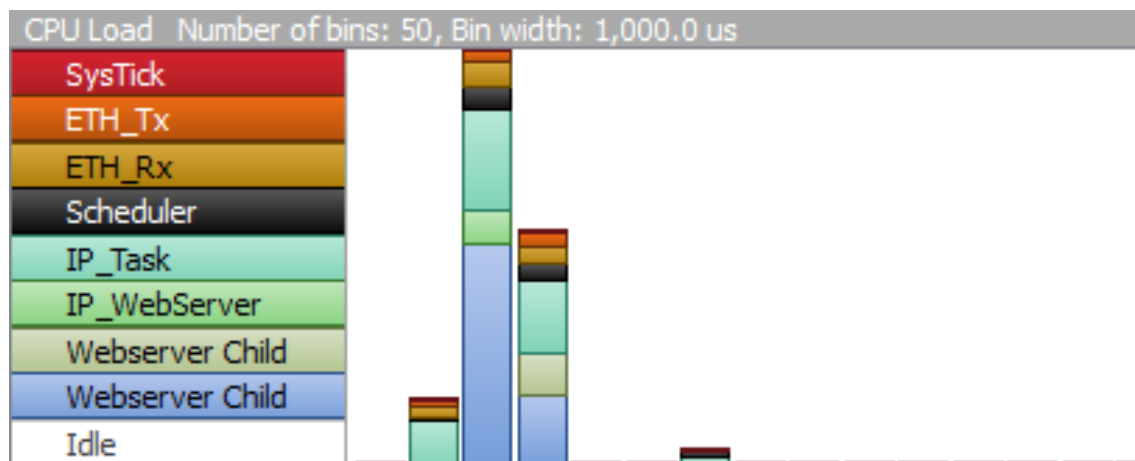
Switches between contexts are displayed as connection lines to easily identify which events cause context switches and when they occurred. It also indicates when tasks are marked ready before they start to run. Contexts are ordered by priority. It starts with interrupts on top ordered by Id. Followed by the Scheduler and software timers, if they are used in the system. Below the Scheduler (and timer) the tasks are ordered from high priority to low priority. The bottom context displays idle time, when no other context is active.

The Timeline is synchronized with the Events list. The event under the cursor (the blue line) is the selected event in the list. The cursor can be fixed at 10% to 90% of the window and update the selection in the list when scrolling through the timeline. An event can be dragged under the cursor to select the corresponding event in the events list and vice-versa.

To get an overview of the whole system or to see the exact duration of an event the Timeline view can be zoomed in or out.

To jump to the next or previous activity of a context, the labels include left and right buttons on mouse-over.










## 3.5 CPU Load window



The CPU Load window displays the used CPU time of contexts for a period. The CPU Load is measured over the width of a bin with the current resolution of the Timeline and is therefore synchronized with the zoom level.

The number of bins can be selected to measure the load over a shorter or longer period. With a single bin the CPU load is measured over the whole visible Timeline.

## 3.6 Contexts window

Contexts											
Name	Type	Stack Information	Run Count	Frequency	Last Run Time	Total Run Time	Run Time/s		...Min	...Max	
 SysTick	#15		2076	1000 Hz	0.003 ms	6.740 ms	3.239 ms 0.32%		3.232 ms 0.32%	3.239 ms 0.32%	
 ETH_Tx	#99		362	223 Hz	0.011 ms	3.938 ms	2.491 ms 0.25%		1.446 ms 0.14%	2.491 ms 0.25%	
 ETH_Rx	#100		313	190 Hz	0.016 ms	4.996 ms	3.049 ms 0.30%		1.947 ms 0.19%	3.049 ms 0.30%	
 Scheduler			1646	968 Hz	0.004 ms	8.016 ms	4.650 ms 0.47%		0.000 ms 0.00%	4.650 ms 0.47%	
 IP_Task	@152	1024 Bytes @ 0x1fff2d70	1085	638 Hz	0.020 ms	25.501 ms	15.132 ms 1.51%		10.205 ms 1.02%	15.132 ms 1.51%	
 IP_WebServer	@151	3072 Bytes @ 0x1fff035c	79	47 Hz	0.069 ms	2.528 ms	1.467 ms 0.15%		1.060 ms 0.11%	1.467 ms 0.15%	
 Webserver Child	@150		749	481 Hz	0.028 ms	40.353 ms	26.712 ms 2.67%		13.641 ms 1.36%	26.712 ms 2.67%	
 Webserver Child	@150		71	24 Hz	0.006 ms	3.006 ms	1.049 ms 0.10%		1.049 ms 0.10%	1.957 ms 0.20%	
 Idle			2245	1112 Hz	0.996 ms	1979.682 ms	942.207 ms 94.22%		0.000 ms 0.00%	961.007 ms 96.10%	

The *Contexts* window shows statistical information of the contexts (Tasks, Interrupts, Scheduler, and Idle). Each context item can be identified by its Name and Type. The Type includes the priority for tasks and the ID for interrupts. (i.e. The Cortex-M SysTick is interrupt ID #15.)

The Contexts window information include following items:

- The context name and type.
- Stack information for tasks, if available.
- Activation count of the context.
- Activation frequency.
- The total and last run-time.
- The current, minimum and maximum run time per second in ms and %.

The Contexts window is updated while the recording, the current context is indicated by selection of the row.

## 3.7 GUI controls

SystemViewer can be controlled with mouse and keyboard, and via menus. The most important controls are also accessible in the toolbar.

The following table describes the controls of SystemViewer.

Action	Menu	Shortcut
Recording data		
Start recording on the target.	Target → Start Recording	F5
Stop recording.	Target → Stop Recording	F9
Save recorded data to a file.	File → Save Data	F2
Load a record file.	File → Load Data	F3
View/Edit recording properties.	File → Recording Properties ...	Ctrl+Shift+R
View		
Set/clear the current event as time reference.	View → Toggle Reference	R
Remove all time references.	View → Clear References	Ctrl+Shift+R
Display timestamps in application target time.	View → Display Target Time	None
Display timestamps in time since start of recording.	View → Display Recording Time	None
Set the timestamp resolution to 1 us.	View → Resolution: 1 us	None
Set the timestamp resolution to 100 ns.	View → Resolution: 100 ns	None
Set the timestamp resolution to 10 ns.	View → Resolution: 10 ns	None
Set the timestamp resolution to 1 ns.	View → Resolution: 1 ns	None
Show/Hide API calls in the events list.	View → Show APIs	Shift+A
Show/Hide ISR Enter/Exit in the events list.	View → Show ISRs	Shift+I
Show/Hide Task activity in events list.	View → Show Tasks	Shift+T
Show/Hide User events in events list.	View → Show User Events	Shift+T
Toggle automatic scroll to last item on new events.	View → Auto Scroll	None
Zoom in.	View → Zoom → Zoom In	Ctrl++, Scroll up
Zoom out.	View → Zoom → Zoom Out	Ctrl+-, Scroll down
Show 10 us across the timeline.	View → Zoom → 10us Window	None
Show 20 us across the timeline.	View → Zoom → 20us Window	None
Show 50 us across the timeline.	View → Zoom → 50us Window	None
Show 100 us across the timeline.	View → Zoom → 100us Window	None
Show 200 us across the timeline.	View → Zoom → 200us Window	None
Show 500 us across the timeline.	View → Zoom → 500us Window	None

Action	Menu	Shortcut
Show 1 ms across the timeline.	View→Zoom→1ms Window	None
Show 2 ms across the timeline.	View→Zoom→2ms Window	None
Show 5 ms across the timeline.	View→Zoom→5ms Window	None
Show 10 ms across the timeline.	View→Zoom→10ms Window	None
Show 20 ms across the timeline.	View→Zoom→20ms Window	None
Show 50 ms across the timeline.	View→Zoom→50ms Window	None
Show 100 ms across the timeline.	View→Zoom→100ms Window	None
Show 200 ms across the timeline.	View→Zoom→200ms Window	None
Show 500 ms across the timeline.	View→Zoom→500ms Window	None
Show 1 s across the timeline.	View→Zoom→1s Window	None
Show 2 s across the timeline.	View→Zoom→2s Window	None
Show 5 s across the timeline.	View→Zoom→5s Window	None
Show 10 s across the timeline.	View→Zoom→10s Window	None
Show 30 s across the timeline.	View→Zoom→30s Window	None
Show 60 s across the timeline.	View→Zoom→60s Window	None
Show the full recording in the timeline.	View→Zoom→Full Recording	None
Set the cursor to 10% of the timeline.	View→Cursor→Cursor at 10%	1
Set the cursor to 20% of the timeline.	View→Cursor→Cursor at 20%	2
Set the cursor to 30% of the timeline.	View→Cursor→Cursor at 30%	3
Set the cursor to 40% of the timeline.	View→Cursor→Cursor at 40%	4
Set the cursor to 50% of the timeline.	View→Cursor→Cursor at 50%	5
Set the cursor to 60% of the timeline.	View→Cursor→Cursor at 60%	6
Set the cursor to 70% of the timeline.	View→Cursor→Cursor at 70%	7
Set the cursor to 80% of the timeline.	View→Cursor→Cursor at 80%	8
Set the cursor to 90% of the timeline.	View→Cursor→Cursor at 90%	9
Measure the visible CPU load in a single bin.	View→CPU Load→Single Bin	None
Measure the visible CPU load in 10 bins.	View→CPU Load→10 Bins	None
Measure the visible CPU load in 50 bins.	View→CPU Load→50 Bins	None
Measure the visible CPU load in 100 bins.	View→CPU Load→100 Bins	None
Measure the visible CPU load in 200 bins.	View→CPU Load→200 Bins	None
<b>Go</b>		
Jump to the next context switch.	Go→Forward	F

Action	Menu	Shortcut
Jump to the previous context switch.	Go →Back	B
Jump to the next similar event.	Go →Next [Event]	N
Jump to the previous similar event.	Go →Previous [Event]	P
Jump to the next similar event with the same context.	Go →Next [Event] in [Context]	Shift+N
Jump to the previous similar event with the same context.	Go →Previous [Event] in [Context]	Shift+P
Open dialog to go to an event by Id.	Go →Go to Event...	Ctrl+G
Open dialog to go to an event by timestamp.	Go →Go to Timestamp...	Ctrl+Shift+G
Scroll forward.	Go →Scroll Forward	Left, Ctrl +Scroll up, Click&Drag
Scroll back.	Go →Scroll Back	Right, Ctrl +Scroll down, Click&Drag
Window		
Show/hide the Events window.	Window →Events View	E
Show/hide the Timeline window.	Window →Time View	T
Show/hide the CPU Load window.	Window →CPU Load View	L
Show/hide the Contexts window.	Window →Context View	C
Show/Hide the Status bar	Window →Show/Hide Status Bar	None
Show/Hide the Tool bar	Window →Show/Hide Tool Bar	None
Open application preferences dialog.	Tool →Preferences	Alt+,
Help		
Open this SystemView Manual.	Help →SystemView Manual	F11
Show SystemViewer information.	Help →About SystemViewer	F12



# Chapter 4

## Target implementation - SYSTEMVIEW modules

---

This section describes the instrumentation of a target application to use SEGGER SystemView.

## 4.1 Prerequisites

To use SEGGER SystemView the target source modules of the SystemView package need to be added to the application make file or project.

The SEGGER SystemView package is available at <https://www.segger.com/systemview.html>.

To use continuous real-time tracing the following additional items are required:

- An ARM Cortex-M or Renesas RX target.
- A J-Link Debug Probe.

For an easy start it is recommended to use SEGGER embOS V4.12 or later, which already includes the SystemView integration.

### 4.1.1 Segger SystemView target implementation modules

The following files are part of the SEGGER SystemView target implementation. We recommend to copy all files into the application project and keep the given directory structure.

File	Description
/Config/SEGGER_RTT_Conf.h	SEGGER Real Time Transfer (RTT) configuration file.
/Config/SEGGER_SYSVIEW_Conf.h	SEGGER SYSTEMVIEW configuration file.
/Config/SEGGER_SYSVIEW_Config_[SYSTEM].c	Initialization of SystemView for [SYSTEM].
/OS/SEGGER_SYSVIEW_[OS].c	Interface between SYSTEMVIEW and [OS].
/OS/SEGGER_SYSVIEW_[OS].h	Interface header.
/SEGGER/SEGGER_RTT.c	SEGGER RTT module source.
/SEGGER/SEGGER_RTT.h	SEGGER RTT module header.
/SEGGER/SEGGER_SYSVIEW.c	SEGGER SYSTEMVIEW module source.
/SEGGER/SEGGER_SYSVIEW.h	SEGGER SYSTEMVIEW module header.
/SEGGER/SEGGER_SYSVIEW_ConfDefault.h	SEGGER SYSTEMVIEW configuration fallback.
/SEGGER/SEGGER_SYSVIEW_Int.h	SEGGER SYSTEMVIEW internal header.

## 4.2 Including SEGGER SystemView in the application

To use SEGGER SystemView, the target implementation modules must be added to the target application. Copy the sources from /Config/ and /SEGGER/, as well as the `SEGGER_SYSVIEW_Config_[SYSTEM].c` and `SEGGER_SYSVIEW_[OS].c/.h` which match your system and OS to the application source and include them in the project.

### Example

For a system with embOS on a Cortex-M3 include `SEGGER_SYSVIEW_Config_embOS.c`, `SEGGER_SYSVIEW_embOS.c` and `SEGGER_SYSVIEW_embOS.h`.

For a system with no OS or no instrumented OS on a Cortex-M3 include `SEGGER_SYSVIEW_Config_NoOS.c` only.

## 4.3 Initializing SystemView

The system information are sent by the application. This information can be configured via defines in `SEGGER_SYSVIEW_Config_[SYSTEM].c`. Add a call to `SEGGER_SYSVIEW_Conf()` in the main function to initialize SystemView.

```
#include "SEGGER_SYSVIEW.h"

/*****
 *
 *      main()
 *
 * Function description
 * Application entry point
 */
int main(void) {
    OS_IncDI();           /* Initially disable interrupts */
    OS_InitKern();        /* Initialize OS */
    OS_InitHW();          /* Initialize Hardware for OS */
    BSP_Init();           /* Initialize BSP module */

    SEGGER_SYSVIEW_Conf(); /* Configure and initialize SystemView */

    /* You need to create at least one task before calling OS_Start() */
    OS_CREATETASK(&TCB0, "MainTask", MainTask, 100, Stack0);
    OS_Start();           /* Start multitasking */
    return 0;
}
```

The generic part of SEGGER SystemView is now ready to monitor the application.

When using embOS V4.12 or later with profiling enabled, SystemView events for ISRs, Task, and API calls are generated. When not using embOS, appropriate events must be generated by the application.

Download the application to the target and let it run. As long as SystemViewer is not connected, and `SEGGER_SYSVIEW_Start()` is not called, the application will not generate SystemView events. When SystemViewer is connected or `SEGGER_SYSVIEW_Start()` is called it will activate recording SystemView events.

## 4.4 The SystemView system information config

The included files `SEGGER_SYSVIEW_Config_[SYSTEM].c` provide the configuration of SystemView and can in most cases be used without modification.

```

/*****
 *
 *      (c) SEGGER Microcontroller GmbH & Co. KG
 *
 *****/
----- END-OF-HEADER -----

File      : SEGGER_SYSVIEW_Config_embOS.c
Purpose   : Sample setup configuration of SystemView with embOS.
*/
#include "RTOS.h"
#include "SEGGER_SYSVIEW.h"
#include "SEGGER_SYSVIEW_embOS.h"

// SystemcoreClock can be used in most CMSIS compatible projects.
// In non-CMSIS projects define SYSVIEW_CPU_FREQ.
extern unsigned int SystemCoreClock;

/*****
 *
 *      Defines, configurable
 *
 *****/
// The application name to be displayed in SystemViewer
#define SYSVIEW_APP_NAME      "Demo Application"

// The target device name
#define SYSVIEW_DEVICE_NAME   "Cortex-M4"

// Frequency of the timestamp. Must match SEGGER_SYSVIEW_Conf.h
#define SYSVIEW_TIMESTAMP_FREQ (SystemCoreClock >> 4)

// System Frequency. SystemcoreClock is used in most CMSIS compatible projects.
#define SYSVIEW_CPU_FREQ      (SystemCoreClock)

// The lowest RAM address used for IDs (pointers)
#define SYSVIEW_RAM_BASE      (0x20000000)

/*****
 *
 *      _cbSendSystemDesc()
 *
 *      Function description
 *      Sends SystemView description strings.
 */
static void _cbSendSystemDesc(void) {
    SEGGER_SYSVIEW_SendSysDesc("N="SYSVIEW_APP_NAME",O=embOS,D="SYSVIEW_DEVICE_NAME);
    SEGGER_SYSVIEW_SendSysDesc("I#15=SysTick");
}

/*****
 *
 *      Global functions
 *
 *****/
void SEGGER_SYSVIEW_Conf(void) {
    SEGGER_SYSVIEW_Init(SYSVIEW_TIMESTAMP_FREQ, SYSVIEW_CPU_FREQ,
        &SYSVIEW_X_OS_TraceAPI, _cbSendSystemDesc);
    SEGGER_SYSVIEW_SetRAMBase(SYSVIEW_RAM_BASE);
    OS_SetTraceAPI(&embOS_TraceAPI_SYSVIEW); // Configure embOS to use SYSVIEW.
}

/***** End of file *****/

```

## 4.5 SEGGER SystemView API functions

The following functions can be used to implement SEGGER SystemView into an application. Any other functions that are exposed through `SEGGER_SYSVIEW.h` are used for integration of SEGGER SystemView into OSes and middleware modules.

Function	Description
<code>SEGGER_SYSVIEW_Init()</code>	Initializes the SYSVIEW module.
<code>SEGGER_SYSVIEW_OnUserStart()</code>	Send a user event start, such as start of a subroutine for profiling.
<code>SEGGER_SYSVIEW_OnUserStop()</code>	Send a user event stop, such as return of a subroutine for profiling.
<code>SEGGER_SYSVIEW_SendSysDesc()</code>	Send the system description string to the host.
<code>SEGGER_SYSVIEW_SetRAMBase()</code>	Sets the RAM base address, which is subtracted from IDs in order to save bandwidth.

# 4.5.1 SEGGER\_SYSVIEW\_Init()

## Description

Initializes the SYSVIEW module. Must be called before SystemViewer attaches to the system.

## Prototype

```
void SEGGER_SYSVIEW_Init(      U32          SysFreq,
                               U32          CPUFreq,
                               const SEGGER_SYSVIEW_OS_API * pOSAPI,
                               SEGGER_SYSVIEW_SEND_SYS_DESC_FUNC pfSendSysDesc);
```

## Parameters

Parameter	Description
<a href="#">SysFreq</a>	Frequency of timestamp, i.e. CPU core clock frequency.
<a href="#">CPUFreq</a>	CPU core clock frequency.
<a href="#">pOSAPI</a>	Pointer to the API structure for OS-specific functions.
<a href="#">pfSendSysDesc</a>	Pointer to SendSysDesc callback function.

## Additional information

This function initializes the RTT channel used to transport SEGGER SystemView packets. The channel is assigned the label "SysView" for client software to identify the SystemView channel.

## 4.5.2 SEGGER\_SYSVIEW\_OnUserStart()

### Description

Send a user event start, such as start of a subroutine for profiling.

### Prototype

```
void SEGGER_SYSVIEW_OnUserStart(unsigned UserId);
```

### Parameters

Parameter	Description
UserId	User defined ID for the event.



### 4.5.3 SEGGER\_SYSVIEW\_OnUserStop()

#### Description

Send a user event stop, such as return of a subroutine for profiling.

#### Prototype

```
void SEGGER_SYSVIEW_OnUserStop(unsigned UserId);
```

#### Parameters

Parameter	Description	
UserId	User defined ID for the event.	

Item	Identifier	Example
Application name	N	"N=Test Application"
Operating system	O	"O=embOS"
Additional module	M	"M=embOS/IP"
Target device	D	"D=MK66FN2M0xxx18"
Target core	C	"C=Cortex-M4"
Interrupt	I#<InterruptID>	"I#15=SysTick"

#### Example strings

- N=Test Application,O=embOS,D=MK66FN2M0xxx18
- I#15=SysTick,I#99=ETH\_Tx,I#100=ETH\_Rx

## 4.5.4 SEGGER\_SYSVIEW\_SetRAMBase()

### Description

Sets the RAM base address, which is subtracted from IDs in order to save bandwidth.

### Prototype

```
void SEGGER_SYSVIEW_SetRAMBase(U32 RAMBaseAddress);
```

### Parameters

Parameter	Description
<a href="#">RAMBaseAddress</a>	Lowest RAM Address. (i.e. 0x20000000 on most Cortex-M)

## 4.5.5 SEGGER\_SYSVIEW\_SendSysDesc()

### Description

Send the system description string to the host. The system description is used by SysViewer to identify the current application and handle events accordingly.

### Prototype

```
void SEGGER_SYSVIEW_SendSysDesc(const char * sSysDesc);
```

### Parameters

Parameter	Description
<code>sSysDesc</code>	Pointer to the 0-terminated system description string.

### Additional information

One system description string may not exceed 128 characters.

The Following items can be described in a system description string. Each item is identified by its identifier, followed by '=' and the value. Items are separated by ','.

## 4.5.6 SEGGER\_SYSVIEW\_Start()

### Description

Start recording SystemView events. This function is triggered by the host application.

### Prototype

```
void SEGGER_SYSVIEW_Start();
```

### Additional information

This function enables transmission of SystemView packets recorded by subsequent trace calls and records a SystemView Start event.

As part of start, a SystemView Init packet is sent, containing the system frequency. The list of current tasks, the current system time and the system description string is sent, too.

## 4.6 Configuring SEGGER SystemView

SEGGER SystemView is configurable to match the target device and application. The default configuration is set to match most cases and normally does not require modification.

To configure SystemView edit the macro defines in `SEGGER_SYSVIEW_Conf.h`:

- Select a timestamp source and the timestamp size, i.e. the Cortex-M cycle counter shifted by four, resulting in 28 bits.
- Define `SEGGER_SYSVIEW_GET_INTERRUPT_ID()`, i.e. read the Cortex-M ICSR bits [8:0].
- Optionally define the base ID and a shift for pointers, i.e. base ID as the lowest RAM address and a shift of 2 if all pointers are 4 byte aligned.
- Define the locking functions used when sending SystemView events, i.e. disable all interrupts.

The following sections describe the configuration defines in detail.

### 4.6.1 SEGGER\_SYSVIEW\_RTT\_BUFFER\_SIZE

Number of bytes that SEGGER SystemView uses for the communication buffer.

*Default:* 1024

### 4.6.2 SEGGER\_SYSVIEW\_RTT\_CHANNEL

The RTT Channel used for SEGGER SystemView communication. 0: Auto selection

*Default:* 0

### 4.6.3 SEGGER\_SYSVIEW\_GET\_TIMESTAMP()

Function macro to retrieve the system timestamp.

*Default on Cortex-M3/4:* `((*(U32 *) (0xE0001004)) >> 4)`

This is the Cortex-M cycle counter with the least significant four bits removed in order to save bandwidth over RTT.

*Default on other cores:* `SEGGER_SYSVIEW_X_GetTimestamp()`

`SEGGER_SYSVIEW_X_GetTimestamp()` has to be provided by the user. For an example, please refer to `SEGGER_SYSVIEW_Config_embOS_CM0.c`

### 4.6.4 SEGGER\_SYSVIEW\_TIMESTAMP\_BITS

Number of valid bits low-order delivered by clock source. I.e. 28 when the 32-bit cycle counter has four low-order bits removed (as above).

*Default on Cortex-M3/4:* 28

*Default on Cortex-M0/1:* 32

### 4.6.5 SEGGER\_SYSVIEW\_ID\_BASE

Base to be subtracted from IDs (pointers) in order to save bandwidth. I.e. the lowest RAM address.

Can be overridden by the application via `SEGGER_SYSVIEW_SetRAMBase()` on initialization.

*Default:* `0x10000000`

### 4.6.6 SEGGER\_SYSVIEW\_ID\_SHIFT

Number of bits to shift IDs (pointers) in order to save bandwidth. I.e. 2 when all IDs are at least 4 byte aligned.

*Default: 2*

### 4.6.7 SEGGER\_SYSVIEW\_GET\_INTERRUPT\_ID()

Function macro to get the currently active interrupt ID: I.e. read the Cortex-M3 ICSR[8:0] = active vector.

*Default on Cortex-M3/4:* ((\*(U32 \*) (0xE000ED04)) & 0x1FF)

*Default on Cortex-M0/1:* ((\*(U32 \*) (0xE000ED04)) & 0x3F)

### 4.6.8 SEGGER\_SYSVIEW\_LOCK()

Function macro to (nestable) lock SystemView transfers from being interrupted. I.e. disable interrupts.

*Default:* SEGGER\_RTT\_LOCK()

### 4.6.9 SEGGER\_SYSVIEW\_UNLOCK()

Function macro to (nestable) unlock SystemView transfers from being interrupted. I.e. restore previous interrupt state.

*Default:* SEGGER\_RTT\_UNLOCK()