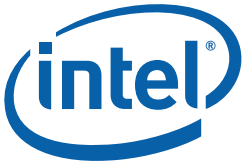

Profiling Runtime Generated and Interpreted Code using the VTune™ Performance Analyzer

User Guide

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Revision History

Document Number	Revision Number	Description	Revision Date
319806-001US	0.6	Initial Release	04 2008
319806-001US	0.74	• Tables are added in API descriptions • Intel Copyright notice added to the sample source code	06 2008
319806-003US	0.75	• Updated the API section • Intel Copyright notice added to the sample source code	06 2008

Contents

1 Introduction

The VTune™ Performance Analyzer's JIT (Just-In-Time) Profiling API provides functionality to profile runtime generated code. This API allows analysis of runtime generated code with both sampling and call graph profilers which are already available with VTune™ Performance Analyzer.

JIT Profiling API can also be used to analyze the virtual machines (VM) which interpret code. Analyzing a VM with sampling or call graph methods provides valuable performance data on how the VM functions and performs.

The VM (or any code that is generating code during runtime) can communicate with a profiler object through a statically linked library (Figure 1). The static library and the profiler object is part of the standard VTune™ analyzer installation. During runtime, the VM notifies the static library of specific events and provides the static library with the necessary data. The static library dynamically loads the profiler object (dll) and sends the data to the VTune analyzer, via the profiler object, to be formatted and displayed. If the VTune analyzer is not installed, profiling is disabled.

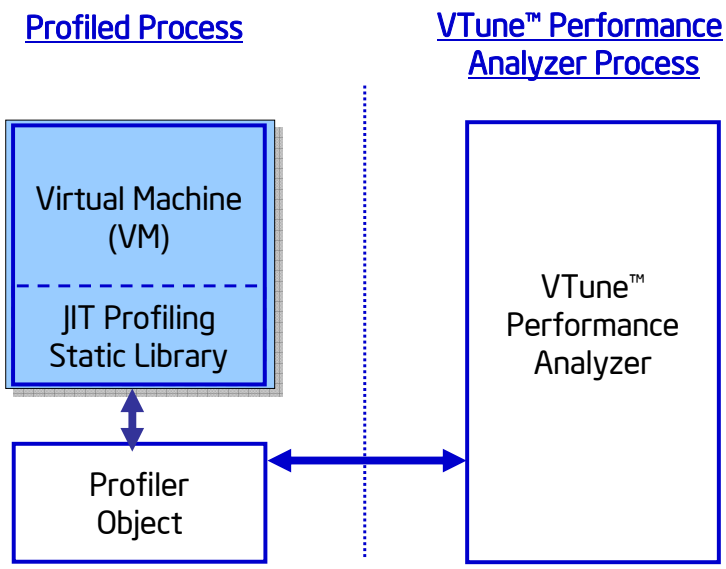


Figure 1: JIT Profiling Components

2 Adding VTune™ Performance Analyzer JIT Profiling Support

2.1 Instructions to include JIT Profiling Support

1. Include **JITProfiling.h** file located under *"C:\Program Files\Intel\VTune\Analyzer\include"* directory for Microsoft* operating systems and under /opt/intel/vtune/analyzer/include for Linux* operating systems. This header file provides all API function prototypes and type definitions.
2. Link the Virtual Machine (or any code using these APIs) with **JITProfiling.lib** located under *"C:\Program Files\Intel\VTune\Analyzer\lib"* on Windows*, and with **JITProfiling.a** located under *"/opt/intel/vtune/analyzer/bin"* on Linux* operating systems. On Linux* please link with the standard libraries **libdl.so** and **libpthread.so**. **Note**: **JITProfiling.a** which comes with VTune analyzer is compiled with g++ and not with gcc, therefore either compile your code with g++ or compile with gcc and link with **-lstdc++** library.

In order to function properly, a VM that uses the JITProfiling API should implement a mode-change callback function and register it using **iJIT_RegisterCallbackEx**. The callback function is executed every time the profiling mode changes. This ensures that the VM issues appropriate notifications when mode changes happen.

To enable JIT profiling support, set the environment variable **ENABLE_JITPROFILING=1**.

On Windows:

```
set ENABLE_JITPROFILING=1
```

On Linux:

```
export ENABLE_JITPROFILING=1
```

On Linux JIT profiling can only be used with the command line interface (vtl) and *jitprofiling* option needs to be used.

For call graph analysis:

```
        vtl activity jitcg -c callgraph -o jitprofiling -app
./jitprof run
```

For sampling analysis:

```
        vtl activity jitsamp -c sampling -o jitprofiling -app
./jitprof run
```

If you wish to perform JIT profiling on a remote Linux OS system, define the **BISTRO_COLLECTORS_DO_JIT_PROFILING** environment variable in the shell where **vtserver** executes.

```
export BISTRO_COLLECTORS_DO_JIT_PROFILING=1
```

2.2 Time and Event Based Sampling

In order to profile run-time generated code with the sampling profiler, **iJIT_NotifyEvent** API function needs to be used in order to send the **iJVM_EVENT_TYPE_METHOD_LOAD_FINISHED** notification. This function needs to be called after JIT compilation and before the first entry into the JIT compiled method.

2.3 Call Graph Analysis

To profile run-time generated code with the call graph profiler, use:

- **iJVM_EVENT_TYPE_ENTER_NIDS** notification upon function entry,
- **iJVM_EVENT_TYPE_LEAVE_NIDS** notification upon function exit,
- **iJVM_EVENT_TYPE_METHOD_LOAD_FINISHED** notification upon function JIT compilation.

When an exception occurs, the VTune analyzer expects method leave events for each method that is unwound. When an exception occurs in the VM-code, the VTune analyzer expects the VM to issue the LEAVE callback when it “unwinds” the stack frame of the executing method. Otherwise, the generated call-graph will be incorrect.

Call **FinalizeThread** when a thread you are profiling exits. Call **FinalizeProcess** when a process you are profiling is about to exit. The JIT Profiling API automatically identifies new threads and handles thread related initialization.

Note: mixed mode call graph of VM functions and native IA-32, IA-32 with Intel® 64, or IA-64 architecture functions is not supported.

2.4 Special Virtual Machine Events

Use the **iJVM_EVENT_TYPE_SHUTDOWN** to terminate profiling, both for sampling and for call graph.

3 API Description

This section describes JIT Profiling API functions, their prototypes, and the data types associated with them.

iJIT_NotifyEvent

Sends an event notification to the VTune analyzer.

```
int iJIT_NotifyEvent(
iJIT_JVM_EVENT event_type,
void *EventSpecificData
);
```

Description:

The iJIT_NotifyEvent function sends a notification of event_type with the data pointed by EventSpecificData to the VTune analyzer.

Parameters:

Parameter	Description
`iJIT_JVM_EVENT event_type`	Notification code to send to the VTune analyzer. See a complete list of event types below.
`void *EventSpecificData`	Pointer to event specific data.

Return Values:

The return values are dependent on the particular **iJIT_JVM_EVENT**.

Event Types

The following values are allowed for event_type:

Event	Description
`iJVM_EVENT_TYPE_METHOD_LOAD_FINISHED`	Send this notification after a JITted method has been loaded into memory, and possibly JIT compiled. Use the iJIT_Method_Load structure for EventSpecificData. The return value of iJIT_NotifyEvent is undefined.
`iJVM_EVENT_TYPE_ENTER_NIDS`	Send this notification at the entry point of a method, JITted or not. This notification

	is only used for call graph profiling. Use the iJIT_Method_NIDS structure for EventSpecificData. iJIT_NotifyEvent returns 0 on failure.
`iJVM_EVENT_TYPE_LEAVE_NIDS`	Send this notificaton at the exit point of a method, JITted or not. This notification is only used for call graph profiling. Use the iJIT_Method_NIDS structure for EventSpecificData. iJIT_NotifyEvent returns 0 on failure.
`iJVM_EVENT_TYPE_SHUTDOWN`	Send this notification to terminate profiling. Use NULL for EventSpecificData. iJIT_NotifyEvent returns 1 on success.

iJIT_Method_Load Structure

The **iJIT_Method_Load** structure has the following fields:

Field	Description
`unsigned int method_id`	Unique method ID. Method ID's may not be smaller than 0x100000. Either you use the API function iJIT_GetNewMethodID to get a valid and unique method ID, or you take care of ID uniqueness and correct range by yourself.
`char *method_name`	The name of the method, optionally prefixed with its class name and appended with its complete signature. This argument cannot be set to NULL.
`void *method_load_address`	The base address of the method code. Can be NULL if the method is not JITted.
`unsigned int method_size`	The code size of the method. Can be 0 if the method is not JITted.
`unsigned int line_number_size`	The number of entries in the line number table.
`pLineNumberInfo line_number_table`	Pointer to the line numbers info array. Can be NULL if line_number_size is 0. See LineNumberInfo Structure for a description of a single entry in the line number info array.
`unsigned int class_id`	Unique class ID. Can be 0.
`char *class_name`	Class name. Can be NULL.
`char *source_file_name`	Source file name. Can be NULL.
`void *user_data`	This field is obsolete.
`unsigned int user_data_size`	This field is obsolete.
`iJDEnvironmentType env`	This field is obsolete.

LineNumberInfo Structure

The **LineNumberInfo** structure has the following fields:

Field	Description
`unsigned int  Offset`	Opcode byte offset from the beginning of the method.
`unsigned int LineNumber`	Matching source line number offset (from beginning of source file).

iJIT_Method_NIDS Structure

The **iJIT_Method_NIDS** structure has the following fields:

Field	Description
`unsigned int method_id`	The method ID.
`unsigned int stack_id`	This field is ignored and filled automatically.
`char *method_name`	The name of the method, optionally prefixed with its class name and appended with its complete signature (see Method Signature section below for details). This field can be NULL

Method Signature

The signature of a method is composed of its return value and the arguments it accepts in the following structure:

```
(<return value>(<param 1>, <param 2> ...))
```

The complete method_name argument structure is:

```
<class-name>.<method-name><signature>.
```

iJIT_ GetNewMethodID

Generates new method ID upon each call.

```
unsigned int iJIT_GetNewMethodID(void);
```

Description:

The **iJIT_ GetNewMethodID** function generates new method ID upon each call. You must use this function to assign unique and valid method IDs to methods reported to the VTune analyzer.

Parameters

None

Return Value:

A new unique method ID. When out of unique method IDs, this API function returns 0.

iJIT_RegisterCallbackEx

Registers a call back function.

```
void iJIT_RegisterCallbackEx(
        void *userdata,
        iJIT_ModeChangedEx  NewModeCallBackFuncEx
);
```

Description:

The **iJIT_RegisterCallbackEx** function registers NewModeCallBackFuncEx as a call back function. When the profiling mode changes, the callback function is called.

Parameters:

Parameter	Description
`void *userdata`	Pointer to user data to be passed to callback function
`iJIT ModeChangedEX NewModeCallBackFuncEx`	Pointer to callback function (see iJIT_ModeChangedEx prototype).

Return Values:

None

iJIT_ModeChangedEx Prototype

iJIT_ModeChangedEx has the following prototype:

```
void  (void *UserData, iJIT_ModeFlags Flags)
void *UserData
```

The user data pointer passed to **iJIT_RegisterCallbackEx**

```
iJIT_ModeFlags  Flags
```

Indicates what mode the VTune analyzer is in. It can have any of the following values OR'd together:

Value	Description
`iJIT_NO_NOTIFICATIONS`	The VTune analyzer is not running.
`iJIT_BE_NOTIFY_ON_LOAD`	Call iJIT_NotifyEvent with iJVM_EVENT_TYPE_METHOD_LOAD_FINISHED for every method that is loaded.
`iJIT_BE_NOTIFY_ON_METHOD_ENTRY`	Call iJIT_NotifyEvent with iJVM_EVENT_TYPE_ENTER_NIDS on entry of every

	method.
`iJIT_BE_NOTIFY_ON_METHOD_EXIT`	Call iJIT_NotifyEvent with iJVM_EVENT_TYPE_LEAVE_NIDS on exit of every method.

iJIT_IsProfilingActive

Returns the current mode of the profiler.

```
iJIT_IsProfilingActiveFlags  iJIT_IsProfilingActive(
void
);
```

Description:

Returns the current mode of the profiler: off, sampling, or call graph using the **iJIT_IsProfilingActiveFlags** enumeration.

Parameters:

None

Return Values:

Value	Description
`iJIT_NOTHING_RUNNING`	No profiler is running. Currently not used.
`iJIT_SAMPLING_ON`	Sampling is running. This is the default return value.
`iJIT_CALLGRAPH_ON`	Call graph is running.

FinalizeThread

Call this when the thread exits. Required for call graph only.

```
void FinalizeThread(
       void
);
```

Parameters:

None

Return Values:

None

FinalizeProcess

Call this after the process ends. Use this function only under call graph profiling.

```
void FinalizeProcess(
       void
);
```

Parameters:

None

Return Values:

None

Remarks:

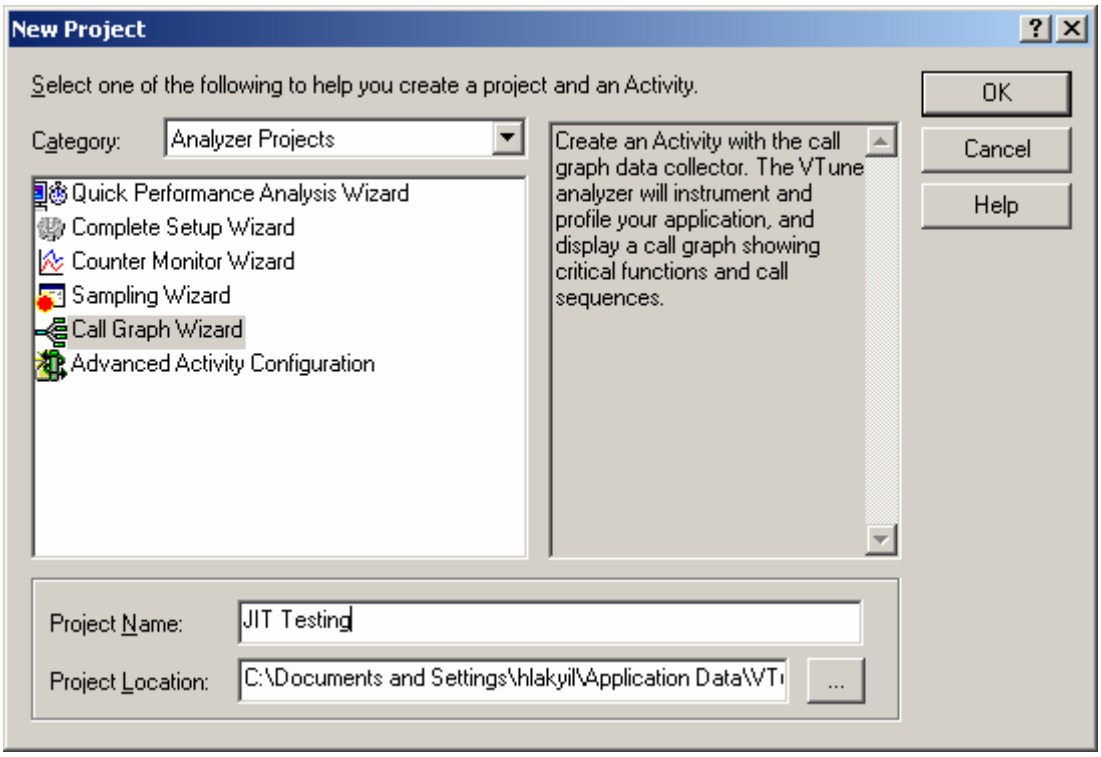
4 Usage Example

4.1 Sample Code

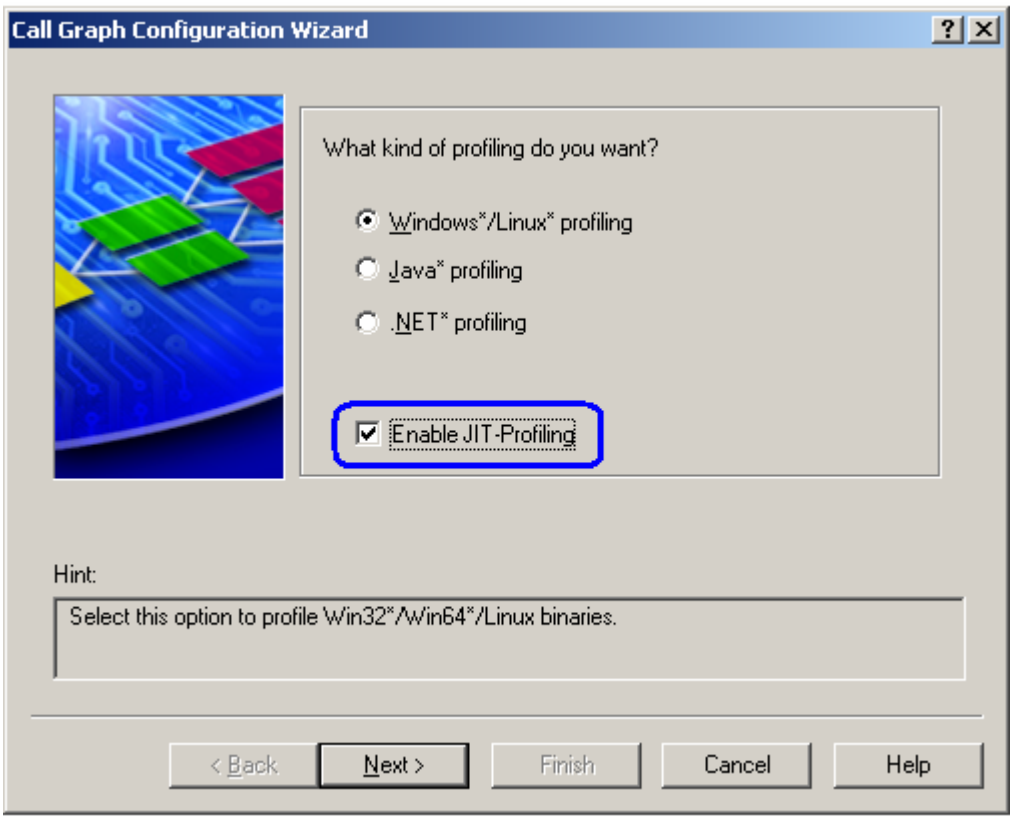
The sample code can be found under the *C:\Program Files\Intel\VTune*Examples directory for Windows and under /opt/intel/vtune/samples directory for Linux*.

4.2 Call Graph Analysis of the Sample Code

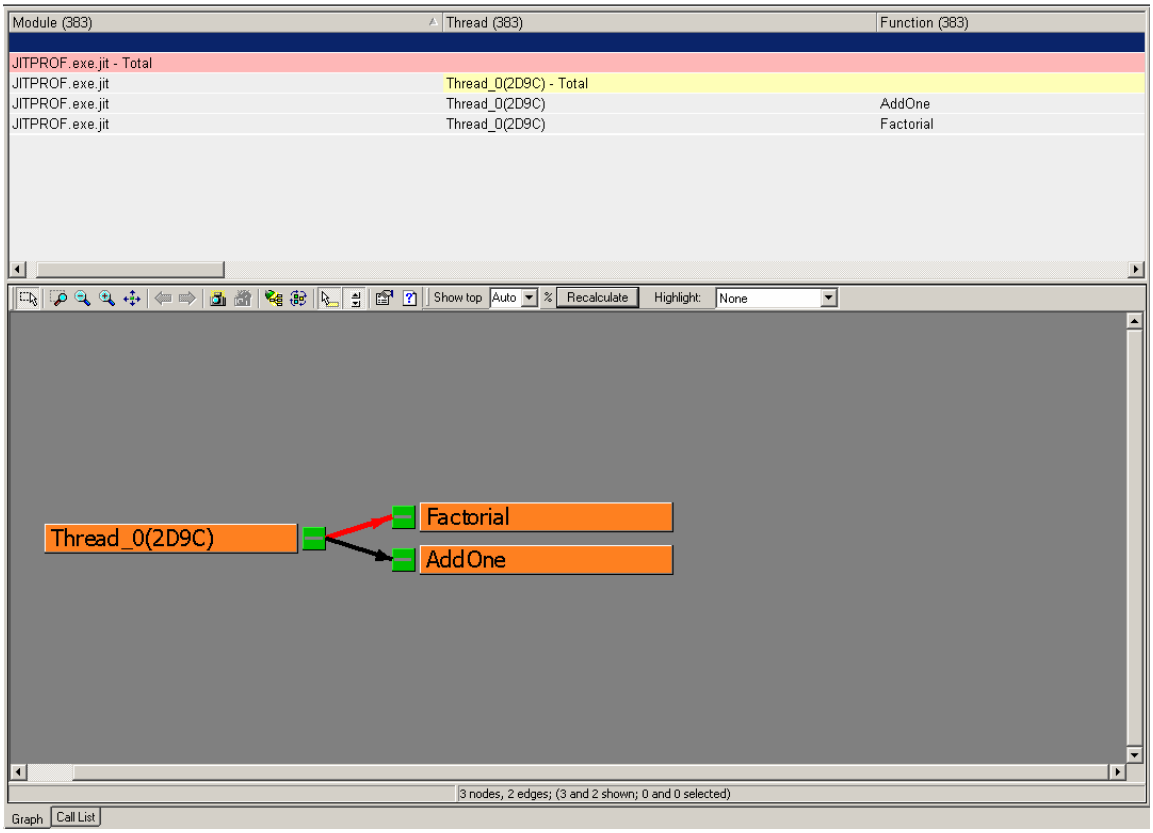
Create a new VTune analyzer project.



Select what kind of profiling you want to do and check “Enable JIT Profiling” option. Please note that “Enable JIT-Profiling” option won't appear unless **ENABLE_JITPROFILING** environment variable is enabled.



After following the wizard, the sample test code generates the following results.


Module (383)
Thread (383)
Function (383)
JITPROF.exe.jit - Total
JITPROF.exe.jit
Thread_0(2D9C) - Total
JITPROF.exe.jit
Thread_0(2D9C)
AddOne
JITPROF.exe.jit
Thread_0(2D9C)
Factorial
Show top
Auto
Recalculate
Highlight:
None
Thread_0(2D9C)
Factorial
AddOne
3 nodes, 2 edges; (3 and 2 shown; 0 and 0 selected)
Graph
Call List