SST Core Python Module Manual

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Chapter 1

Introduction

SST provides a python module to allow interaction with the simulation build system. This python module is used in the input python script for the purpose of building the graph that represents the simulation to be performed. This is done by providing class and functions to define the elements of the simulation, their parameters, and how they are interconnected. The user can also optionally enable statistics and create a user specified partitioning for the described model. Behind the scenes, these classes will build the c++ data structure that is used by SST to construct the simulation model.

The SST core python module is defined in cpython and is only available in the python interpreter launched within a running SST executable. The module is accessed by importing the sst module. This can be done in a number of ways. The two most common being:

```
# Import SST python module using sst. prefix
import sst
# Import SST python module members into current namespace
from sst import *
```

Within this module, there are a number of available classes and global functions. The available classes are: Component, SubComponent, Link, StatisticOutput and StatisticGroup. The global functions are divided between general functions and functions operating on or returning one of the available objects. This document will first discuss the available classes in the SST python module and will then document the global functions.

Chapter 2

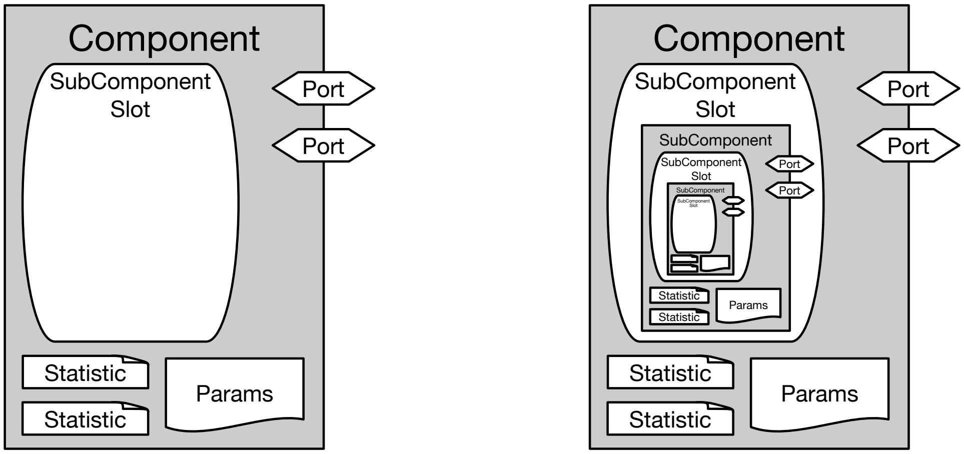
SST Python Classes

There are 5 classes available in SST: Component, SubComponent, Link, StatisticGroup and StatisticOutput. The Component and SubComponent classes share many of the same functions and will be covered together.

2.1 Component/SubComponent Classes

The Component and SubComponent python classes represent the Component and SubComponent C++ classes that are used to implement the simulation models used in SST. They are similar, and have similar APIs, but SubComponents can only exist inside of Components. Subsequently, Components are instanced directly, but SubComponents are only instanced through a Component or another SubComponent.

Figure 2.1 shows the main pieces of the Component/SubComponent.



(a) Main structures of the Component and SubComponent objects

(b) Component with SubComponents loaded, showing that SubComponents can be arbitrarily nested

Figure 2.1: Structure of a Component

An instance of Component is created using:

Component

Component(name, element_type)

Creates a new Component object.

Parameters:

> **name** (type: string) name of the Component specified as string. The name can be used to get a handle to the Component later in the python code. The name is also available to the c++ implementation of the Component
>
> **element_type** (type: string) type of the Component in the lib.element format (for example, merlin.hr_router) specified as a string
>
> **returns** Component object

A SubComponent is created by calling setSubComponent() on either a Component or SubComponent object. Instancing a SubComponent in this way creates a User SubComponent and allows the user to specify the parameters and statistics directly on the SubComponent. The name of the SubComponent is automatically generated using the name of the parent Component and the slot_name(s) in which SubComponents are loaded. If more than one SubComponent is loaded into a slot, the slot_name is also indexed using square brackets (e.g. [0]). This name can be used to get a handle to the SubComponent later in the python code. See setSubComponent function description below.

setSubComponent

setSubComponent(slot_name, element_type, slot_index = 0)

Inserts a SubComponent of the specified type into the indicated slot name and index and creates a new SubComponent object

Parameters:

> **slot_name** (type: string) name of the slot in which the SubComponent should be loaded.
>
> **element_type** type of the SubComponent in the lib.element format (for example, merlin.linkcontrol)
>
> **slot_index** (type: string) slot index in which the SubComponent should be inserted. This defaults to 0 and is not required if only one SubComponent is being loaded into the specified slot. Each SubComponent must be loaded into a unique slot_index and some (Sub)Components will require the indexes to be linear with no gaps.
>
> **returns** SubComponent object

2.1.1 Functions Common to Component and SubComponent

The following functions are available to both Component and SubComponent classes.

addParam

addParam(key, value)

Adds a parameter to the Params object for the Component/SubComponent.

Parameters:

key (type: string) name of the parameter

value (type: varies) value of the parameter. This can be almost any python object and the `__str__` method will be called to get a string representation. A list can be passed to this call when the find_array function is used in the class to retrieve the parameters.

returns no return value

addParams

addParams(params)

Adds multiple parameters to the Params object for the Component/SubComponent.

Parameters:

params (type: dict) a python dict of key, value pairs. `See addParam()` description for information about how key and value are used.

returns no return value

addLink

addLink(link, port, latency=link_default)

Connects a link to the specified port with the specified latency on the link. You can also connect a link by using Link.connect().

Parameters:

link (type: sst.Link) sst.Link object that will be connected to the port

port (type: string) name of the port to connect the link to

latency (type: string) latency of the link from the perspective of this Component/SubComponent sending an event. This parameter is optional and the call will use the default latency set on the link if it's not specified in the call.

returns no return value

getFullName

getFullName()

Returns the full name of the Component/SubComponent. For Components, the name is the one supplied by the user at the time the Component was created. For SubComponents, the name is automatically generated from the parent Component and slot name. At each level, the name is generated as the parent's name plus the slot name, separated by a colon. The slot number is appended in square brackets:

Parent:slot[index]

This holds true for SubComponents of SubComponents, the slotname and index are just appended to the parent name:

Parent:slot[index]:slot[index]

Parameters:

> **returns** full name of Component/SubComponent as a string

getType

getType()

Returns the type of the component in lib.element format. This is simply the type supplied to either the Component constructor or setSubComponent() call.

Parameters:

> **returns** type of Component/SubComponent

setStatistic

setStatistic(stat_name, stat_obj=None)

Sets the statistic object to use in the specified statistic slot.

Parameters:

> **stat_name** Name of the statistic that will be set
>
> **stat_obj** Statistic object that will be used for the named statistic slot. If no stat object is specified, a new one will be created and returned.
>
> **returns** Statistic object loaded into the specified statistic slot.

setStatisticLoadLevel

setStatisticLoadLevel(level, apply_to_children=False)

Sets the load level for this statistic. This overrides the default load level. Load levels are not used for statistics that are explicitly enabled (i.e. does not use one of the "All" variants for enabling statistics). See "General Notes on Statistics" below for more information.

Parameters:

> **level** (type: int) statistic load level for the component

include_children (type: bool) If set to True, will recursively enable specified statistics on all currently instanced SubComponent descendants. SubComponents created after this call will not have their load level set

returns no return value

enableAllStatistics

enableAllStatistics(stat_params_dict, apply_to_children=False)

Enables all statistics for the Component/SubComponent on which the call is made. See "General Notes on Statistics" below for more information.

Parameters:

stat_params_dict (type: dict) Python dictionary that specified the statistic parameters. All statistics will get the same set of parameters

include_children If set to True, will recursively enable specified statistics on all currently instanced SubComponent descendants. SubComponents created after this call will not have their statistics enabled.

returns no return value

Example:

```
class foo
comp.enableAllStatistics({
    "type":"sst.AccumulatorStatistic",
    "rate":"0ns"
})
```

enableStatistics

enableStatistics(stat_list, stat_params_dict, apply_to_children=False)

Enables a list of statistics for the component on which the call is made. See "General Notes on Statistics" below for more information.

Parameters:

stat_list (type: string or list of strings) list of statistics to be enabled. If only one stat is to be enabled, you may pass a single string instead of a list.

stat_params_dict (type: dict) Python dictionary that specified the statistic parameters. All statistics will get the same set of parameters

include_children (type: bool) If set to True, will recursively enable specified statistics on all currently instanced SubComponent descendants. SubComponents created after this call will not have their statistics enabled.

returns no return value

setCoordinates

setCoordinates(x, y=0.0, z=0.0)

Sets the x, y, z coordinates for this element. This is for use with visualization.

Parameters:

x (type: float) sets the x position of the element

y (type: float) sets the y position of the element

z (type: float) sets the z position of the element

returns no return value

2.1.2 Functions Unique to Component

The following functions are unique to Components, and, therefore, are not available to SubComponents.

setRank

setRank(mpi_rank, thread = 0)

Sets the rank the Component should be assigned to. This information is only used if the partitioner is set to sst.self.

Parameters:

mpi_rank (type: int) MPI rank the Component should be assigned to

thread (type: int) thread the Component should be assigned to

returns no return value

setWeight

setWeight(weight)

Sets the weight of the Component. The weight is used by some partitioners to help balance Components across ranks.

Parameters:

weight (type: float) weight of the Component specified as a float. Weights can have any value, but should be meaningful in the context of the overall simulation.

returns no return value

2.2 Link Class

The Link object is used to connect Component/SubComponents together to form the simulation. The Link is created using:

Link

Link(name, latency=None)

Creats a new Link object

Parameters:

name (type: string) Name of the link

latency (type: string) default latency for the link, optional. This will be used if no latency is specified in calls to Link.connect() or (Sub)Component.addLink().

returns Link object

connect

connect((comp1, port1, latency1=default), (comp2, port2, latency2=default))

Connects two ports using the link object.

Actual parameters are two tuples representing the information for the ports to be connected. The fields in the tuple are (comp, port, latency) as describe below.

Parameters:

comp (type: Component or SubComponent) Component/SubComponent object that the port is a part of

port (type: string) port to connect to

latency (type: string) latency of link from the perspective of the corresponding Component/SubComponent sending an event. This is optional, and if not specified, the default latency of the link will be used. If no latency is set, either in the call or as a default, the call will fatal.

returns no return value

setNoCut

setNoCut()

Tell the simulator that this link should not be “cut” by a partition boundary. In effect, it will guarantee that the two Components connected by this link will be on the same rank when using an autotmatic partitioning scheme (this attribute is ignored if the self partitioner is used). This must be used with care, as you can easily get into a situation where too many components are on the same rank.

Parameters:

returns no return value

2.3 Statistic

A Statistic object is created using the `setStatistic()` function in a Component or SubComponent.

The following functions are also available to configure the statistics object.

addParam

addParam(key, value)

Adds a parameter to the statistics Params

Parameters:

key (type: string) name of the parameter

value (type: varies) value of the parameter. This can be almost any python object and the `__str__` method will be called to get a string representation. A list can be passed to this call when the find_array function is used in the class to retrieve the parameters.

returns no return value

addParams

addParams(params)

Adds multiple parameters to the Params object for the Statistic.

Parameters:

params (type: dict) a python dict of key, value pairs.

See `addParam()` description for information about how key and value are used.

returns no return value

2.4 StatisticOutput

The StatisticOutput object is used to configure the output type and options for statistics and is for use with StatisticGroup. For the global statistics output, see the global functions: `setStatisticOutput()`. `setStatisticOutputOption()` and `setStatisticOutputOptions()`.

The StatisticOutput object is created using:

StatisticOutput

StatisticOutput(type, params=None)

Constructor for StatisticOutput

Parameters:

type (type: string) type of Statistic output to use

params (type:dict) Diction of key value pairs to be added to the StatisticOutput's parameters

returns created StatisticOutput object

addParam

addParam(key, value)

Adds a parameter to the Params object for the StatisticOutput.

Parameters:

key (type: string) name of the parameter

value (type: varies) value of the parameter. This can be almost any python object and the `__str__` method will be called to get a string representation. A list can be passed to this call when the find_array function is used in the class to retrieve the parameters.

returns no return value

addParams

addParams(params)

Adds multiple parameters to the Params object for the StatisticOutput.

Parameters:

params (type: dict) a python dict of key, value pairs. `See addParam()` description for information about how key and value are used.

returns no return value

2.5 StatisticGroup

The StatisticsGroup object is used to group Statistics object together to be written to the same StatisticOutput object.

NOTE: The StatisticGroup object had limited use in the past and is evolving to include new functionality. This is the proposed functionality of the class and may not be the final API for the object.

A StatisticGroup is creating using:

StatisticGroup

StatisticGroup(name)

Constructor for StatisticGroup

Parameters:

name name of the group

returns created StatisticGroup object

addStatistic

addStatistic(stat)

Adds a statistic to the group.

Parameters:

stat Statistic to add to the group

returns no return value

addComponent

addComponent(comp)

Add a component to the group

Parameters:

comp Component/SubComponent to add to the group

returns no return value

setOutput

setOutput(output)

Configure how the Statistics in the group should be written

Parameters:

output StatisticOutput object that will record the data

returns no return value

setFrequency

setFrequency(interval)

Set the frequency or rate (e.g.: `"10ms", "25kHz"`) to write out the statistics.

Parameters:

interval Interval at which to write out statistics. A rate of “0ns” will cause the output to be written only at the completion of simulation.”

returns no return value

Chapter 3

Global Functions in SST Python Module

The SST core python module provides a set of global functions not attached to any particular class. These functions generally fall into one of the following categories: general control and informational functions, functions to get handles to existing objects and statistic enable and control functions. These functions are described below. Following those descriptions is a section on general notes on statistics (Section 3.4).

3.1 General Control and Informational Functions

setProgramOption

setProgramOption(option,value)

Sets the specified program option for the simulation. These mirror the options available on the sst command line. Parameters set in the python file will be overwritten by options set on the command line. Use sst –help to get a list of available options.

Parameters:

option (type: string) configuration option to set

value (type: varies by option) value to set option to

returns no return value

getProgramOptions

getProgramOptions()

Returns a dictionary with the current values of the program options. This will include all program options, not just those set in the python file.

Parameters:

returns p

ython dictionary with program options and values

getMPIRankCount

getMPIRankCount()

Returns the number of physical MPI ranks in the simulation

Parameters:

returns n

umber of MPI ranks in the simulation

getSSTThreadCount

getSSTThreadCount()

Returns the threads per rank specified for the simulation

Parameters:

returns n

umber of threads per MPI rank in the simulation

setSSTThreadCount

setSSTThreadCount(threads)

Sets the number of threads per rank for the simulation. These values can be overwritten by using -n on the command line.

Parameters:

threads (type: int) number of threads per MPI rank to use in the simulation

returns no return value

pushNamePrefix

pushNamePrefix(prefix)

Pushes a name prefix onto the name stack. This prefix will be added on the names of all Components and Links. The names in the stack are separated by a period. Example, if pushNamePrefix("base") and pushNamePrefix("next") were called in that order, the prefixed name would be "base.next". Prefixes can be popped from the stack using popNamePrefix().

Parameters:

prefix : (type: string) prefix to add to the name stack

returns no return value

popNamePrefix

popNamePrefix()

Pops a prefix from the name stack. See pushNamePrefix for how name stacks are used.

Parameters:

returns no return value

exit

exit()

Causes the simulation to exit.

Parameters:

returns no return value

3.2 Functions to Get Handles to Existing Objects

findComponentByName

findComponentByName(name)

In many cases, Components and SubComponents will be created using library functions and the user will not have direct access to their handles. In some instances, the provided python modules will have accessor functions that can provide handles to these elements. If this is not provided by the library, the user can call the findComponentByName() function to get a handle to the desired element. The function can find handles for both Components and SubComponents. The use of this function presupposes a knowledge of the naming convention of the elements in the build functions of the library.

Parameters:

name (type: string) name of the Component or SubComponent to find. The name for SubComponents is described above. Slot indexes are optional in cases where only on SubComponent has been added to a slot, but you can also use [0] in all cases, even when the actual name will not display this way.

returns t

he function will return a handle to the Component/SubComponent with the provided name, or None if the name is not found.

3.3 Statistic Enable and Control Functions

The following functions are used to enable statistics on Components and SubComponents using the name or type of the element. See "General Notes on Statistics" (Section 3.4) below for more information.

enableAllStatisticsForAllComponents

enableAllStatisticsForAllComponents(stat_params_dict)

Enables all statistics for all Components in the simulation that have already been instanced.

Parameters:

> **stat_params_dict** (type: dict) Python dictionary that specified the statistic parameters. All statistics will get the same set of parameters.
>
> **returns** no return value

enableAllStatisticsForComponentName

enableAllStatisticsForComponentName(name, stat_params_dict, apply_to_children=False)

Enables all statistics for the Component named in the call. This call works for both Components and SubComponents.

Parameters:

> **name** (type: string) name of the Component or SubComponent on which to enable all statistics. The name for SubComponents is described above. Slot indexes are optional in cases where only one SubComponent has been added to a slot, but you can also use [0] in all cases, even when the actual name will not display this way. If component with the provided name not found, the function will call fatal().
>
> **stat_params_dict** (type: dict) Python dictionary that specified the statistic parameters. All statistics will get the same set of parameters
>
> **include_children** (type: bool) If set to True, will recursively enable all statistics on all SubComponent descendants of named element.
>
> **returns** no return value

enableStatisticForComponentName

enableStatisticForComponentName(name, stat, stat_params_dict, apply_to_children=False)

Enables a statistic for the component on which the call is made.

Parameters:

name (type: string) name of the Component or SubComponent on which to enable the specified statistic. The name for SubComponents is described above. Slot indexes are optional in cases where only on SubComponent has been added to a slot, but you can also use [0] in all cases, even when the actual name will not display this way. If component with the provided name not found, the function will call fatal().

stat (type: string) statistic to be enabled

stat_params_dict (type: dict) Python dictionary that specifies the statistic parameters

include_children (type: bool) If set to True, will recursively enable specified statistic on all SubComponent descendants.

returns no return value

enableStatisticsForComponentName

enableStatisticsForComponentName(name, stat, stat_params_dict, apply_to_children=False)

Enables a list of statistics for the component on which the call is made.

Parameters:

name (type: string) name of the Component or SubComponent on which to enable specified statistics. The name for SubComponents is described above. Slot indexes are optional in cases where only on SubComponent has been added to a slot, but you can also use [0] in all cases, even when the actual name will not display this way. If component with the provided name not found, the function will call fatal().

stat_list (type: list of strings) list of statistics to be enabled. If only one stat is to be enabled, you may pass a single string instead of a list.

stat_params_dict (type: dict) Python dictionary that specified the statistic parameters

include_children (type: bool) If set to True, will recursively enable specified statistic on all SubComponent descendants.

returns no return value

enableAllStatisticsForComponentType

enableAllStatisticsForComponentType(type, stat_params_dict, apply_to_children=False)

Enables all statistics for all previously instanced Components/SubComponents of the type specified in the call. This call works for both Components and SubComponents.

Parameters:

type (type: string) type of the Component or SubComponent on which to enable all statistics. All previously instanced elements of this type will have their statistics enabled.

stat_params_dict (type: dict) Python dictionary that specified the statistic parameters. All statistics will get the same set of parameters.

include_children (type: bool) If set to True, will recursively enable all statistics on all SubComponent descendants.

returns no return value

enableStatisticForComponentType

enableStatisticForComponentType(type, stat, stat_params_dict, apply_to_children=False)

Enables a the specified statistic for all previously instanced Components/SubComponents of the type specified in the call. This call works for both Components and SubComponents.

Parameters:

type (type: name) type of the Component or SubComponent on which to enable the specified statistic. All previously instanced elements of this type will have their statistics enabled.

stat (type: string) statistic to be enabled

stat_params_dict (type: dict) Python dictionary that specified the statistic parameters

include_children (type: bool) If set to True, will recursively enable specified statistic on all SubComponent descendants.

returns no return value

enableStatisticsForComponentType

enableStatisticsForComponentType(type, stat_list, stat_params_dict, apply_to_children=False)

Enables a list of statistics for all previously instanced Components/SubComponents of the type specified in the call. This call works for both Components and SubComponents.

Parameters:

type (type: string) type of the Component or SubComponent on which to enable the specified statistics. All previously instanced elements of this type will have their statistics enabled.

stat_list (type: list of strings) list of statistics to be enabled. If only one stat is to be enabled, you may pass a single string instead of a list.

stat_params_dict (type: dict) Python dictionary that specified the statistic parameters

include_children (type: bool) If set to True, will recursively enable specified statistic on all SubComponent descendants.

returns no return value

setStatisticLoadLevelForComponentName

setStatisticLoadLevelForComponentName(name, level, apply_to_children=False)

Sets the statistic load level for the named component.

Parameters:

name (type: string) name of the Component or SubComponent on which to set the statistic load level. The name for SubComponents is described above. Slot indexes are optional in cases where only on SubComponent has been added to a slot, but you can also use [0] in all cases, even when the actual name will not display this way. If component with the provided name not found, the function will call fatal().

level (type: int) statistic load level for the component

include_children : (type:bool) If set to True, will recursively enable specified statistic on all SubComponent descendants.

returns no return value

setStatisticLoadLevelForComponentType

setStatisticLoadLevelForComponentType(type, level, apply_to_children=False)

Sets the statistic load level for all components of the specified type.

Parameters:

type (type: string) type of the Component or SubComponent on which to set the statistic load level. All previously instanced elements of this type will have their level set.

level (type: int) statistic load level for the components

include_children (type: bool) If set to True, will recursively enable specified statistic on all SubComponent descendants.

returns no return value

setStatisticLoadLevel

setStatisticLoadLevel(level)

Set the global statistic load level. This level is used if individual load levels are not set. Also, the load level is only used for statistics not specifically enabled (i.e., not enabled using one of the enableAllStatistics variants).

Parameters:

level (type: int) value to set global statistic load level to

returns no return value

getStatisticLoadLevel

getStatisticLoadLevel()

Return the global statistic load level

Parameters:

returns value of global statistic load level

setStatisticOutput

setStatisticOutput(stat_output_module)

Sets the global StatisticOutput to be of the module type specified

Parameters:

stat_output_module (type: string) name of the stat output module to load in lib.element format.

returns no return value

setStatisticOutputOption

setStatisticOutputOption(option, value)

Set the specified option for the StatisticOutput object.

Parameters:

option (type: string) option to set

value (type: string) value to set option to

returns no return value

setStatisticOutputOptions

setStatisticOutputOptions(options)

Set the specified options for the StatisticOutput object

Parameters:

options (type: dict) dictionary the contents specify the option as dictionary keys with the options value being specified by the corresponding dictionary value.

returns no return value

3.4 General Notes on Statistics

There are a number of ways to enable statistics on Components and SubComponents. There are a set of functions that can be called directly on Component/SubComponent handles and a set of functions that are provided by the sst python module that use name or type to find the elements on which to enable statistics. There may also be specific methods provided by element library python modules.

Statistic load levels It is possible to set load levels both globally and per Component/SubComponent. Each statistic defined in Components/SubComponents has a load level assigned to it in order to help with finer grained control with using the enableAllStatistics* functions. Load levels only apply to statistics not explicitly enabled. Also, local load levels will override global load levels.

The precedence for enabling statistics is as follows: If a statistic is explicitly enabled (does not use one of the enableAllStatistics* functions), it will be enabled. Else, if the set load level meets the minimum for a statistic and all statistics for the component have been enabled, the statistic will be enabled. The local load level will be used, if set, otherwise the global load level will be used.

Statistic parameters Statistic parameters are used to pass the parameters to the statistics subsystem and to the the statistics themselves and are specified in a python dictionary. In addition to statistic specific parameters, the following parameters are supported:

type type of statistic

rate collection rate of statistic. Stats will be dumped at this interval. A rate of "0ns" will cause the stats to be dumped only at the end of simulation.

startat Time that statistic should start recording statistics

stopat Time that statistic should stop recording statistics

resetOnRead If set to true, statistics will reset when written out. Default is False.