

# 15、ROS2时间相关API

## 1、时间相关API简介

ros2涉及时间相关的API有Rate, Time, Duration, Time与Duration的运算等，下面分别讲解。

- 首先，创建一个功能包，用来存放相关的程序文件

```
ros2 pkg create learning_time --build-type ament_python --dependencies rclpy
```

## 2、create\_rate

ROS2 中还提供了create\_rate函数，用于**控制循环执行频率**的工具，其核心作用是让一段代码按照**固定频率周期性执行**，`Rate` 通过控制循环的“休眠时间”来保证循环执行频率的稳定性。**切记**，`Rate`一般不能直接用于主线程，否则会永久阻塞回调事件，一般只用于带有多线程回调的程序或子线程中使用。

具体工作原理：

- 记录每次循环开始的时间；
- 执行循环内的代码；
- 计算当前循环实际耗时与“目标间隔时间”的差值；
- 自动休眠对应的差值时间，确保从一次循环开始到下一次循环开始的间隔严格等于“目标间隔”（如 100 毫秒）。

虽然 `Rate` 和 `Timer` 都能实现周期性执行，但适用场景不同：

特性	<code>Rate</code>	<code>Timer</code>
实现方式	基于循环内主动休眠（阻塞当前线程）	基于回调函数（非阻塞，由 ROS 2 事件循环触发）
适用场景	适用于需要在 <b>同一线程</b> 内按固定频率执行的循环（如主控制逻辑）	适用于需要 <b>异步执行</b> 的周期性任务（不阻塞主线程）
灵活性	循环内可直接控制流程（如 break 退出）	需通过标志位等方式控制回调执行

- 以下是 `Rate` 的基本用法，实现一个每秒执行 2 次的循环：

- 功能包中新建一个文件rate\_demo.py

```
import rclpy
from rclpy.node import Node
import threading

class RateExampleNode(Node):
    def __init__(self):
        super().__init__("rate_example_node")
```

```

self.get_logger().info("Rate 示例节点启动")

def run_loop(self):
    # 使用节点的create_rate()创建2Hz的Rate
    rate = self.create_rate(2)

    count = 0
    try:
        while rclpy.ok():
            self.get_logger().info(f"循环执行 {count} 次")
            count += 1
            rate.sleep() # 休眠到下一个周期 (0.5秒)
    except KeyboardInterrupt:
        self.get_logger().info("循环被中断")

def main(args=None):
    rclpy.init(args=args)
    node = RateExampleNode()

    # 创建线程运行循环 (避免阻塞主线程)
    loop_thread = threading.Thread(target=node.run_loop)
    loop_thread.start()

    # 主线程执行spin, 维持ROS 2节点运行
    try:
        rclpy.spin(node)
    except KeyboardInterrupt:
        pass
    finally:
        loop_thread.join() # 等待线程结束
        node.destroy_node()
        rclpy.shutdown()

if __name__ == "__main__":
    main()

```

- 配置对应的setup.py配置文件，在console\_scripts中添加

```
'rate_demo=learning_time.rate_demo:main'
```

```
src > learning_time > setup.py > ...
12 |     ('share/' + package_name, ['package.xml']),
13 | ],
14 |     install_requires=['setuptools'],
15 |     zip_safe=True,
16 |     maintainer='yahboom',
17 |     maintainer_email='1111@example.com',
18 |     description='TODO: Package description',
19 |     license='TODO: License declaration',
20 |     tests_require=['pytest'],
21 |     entry_points={
22 |         'console_scripts': [
23 |             'rate_demo=learning_time.rate_demo:main',
24 |         ],
25 |     },
26 | },
27 |
28 )
```

- 编译功能包

```
colcon build --packages-select learning_time
```

```
'colcon build' successful
/home/yahboom/workspace

yahboom@yahboom-virtual-machine: ~/workspace
yahboom@yahboom-virtual-machine:~/workspace 80x24
yahboom@yahboom-virtual-machine:~$ cd workspace/
yahboom@yahboom-virtual-machine:~/workspace$ colcon build --packages-select learning_time
Starting >>> learning_time
Finished <<< learning_time [0.71s]

Summary: 1 package finished [0.91s]
yahboom@yahboom-virtual-machine:~/workspace$
```

- 刷新工作空间环境并运行节点

```
source ./install/setup.bash
```

```
ros2 run learning_time rate_demo
```

```
yahboom@yahboom-virtual-machine: ~/workspace
yahboom@yahboom-virtual-machine: ~/workspace 80x24
yahboom@yahboom-virtual-machine:~/workspace$ source install/setup.bash
yahboom@yahboom-virtual-machine:~/workspace$ ros2 run learning_time rate_demo
[INFO] [1757059176.053501355] [rate_example_node]: Rate 示例节点启动
[INFO] [1757059176.054427139] [rate_example_node]: 循环执行 0 次
[INFO] [1757059176.555647565] [rate_example_node]: 循环执行 1 次
[INFO] [1757059177.056046927] [rate_example_node]: 循环执行 2 次
[INFO] [1757059177.555834344] [rate_example_node]: 循环执行 3 次
[INFO] [1757059178.055316796] [rate_example_node]: 循环执行 4 次
[INFO] [1757059178.555822847] [rate_example_node]: 循环执行 5 次
[INFO] [1757059179.055854307] [rate_example_node]: 循环执行 6 次
[INFO] [1757059179.556198596] [rate_example_node]: 循环执行 7 次
[INFO] [1757059180.055669535] [rate_example_node]: 循环执行 8 次
[INFO] [1757059180.555035501] [rate_example_node]: 循环执行 9 次
[INFO] [1757059181.054900909] [rate_example_node]: 循环执行 10 次
[INFO] [1757059181.556449990] [rate_example_node]: 循环执行 11 次
[INFO] [1757059182.056311527] [rate_example_node]: 循环执行 12 次
[INFO] [1757059182.555986180] [rate_example_node]: 循环执行 13 次
[INFO] [1757059183.055526793] [rate_example_node]: 循环执行 14 次
[INFO] [1757059183.555156111] [rate_example_node]: 循环执行 15 次
```

### 3、Timer定时器应用

- Timer用于创建一个定时触发的定时器来执行一些周期性任务
- 示例：创建两个定时器一个1秒执行一次打印执行次数，一个0.5秒执行一次打印当前时间
- 新建一个程序文件Timer\_demo.py

```
import rclpy
from rclpy.node import Node

class TimerDemoNode(Node):
    def __init__(self):
        super().__init__('timer_demo_node')

        # 计数器，用于演示定时器执行次数
        self.counter = 0

        # 创建定时器：每1秒执行一次callback函数
        self.timer = self.create_timer(1.0, self.timer_callback)

        # 创建一个更快的定时器：每0.5秒执行一次
        self.fast_timer = self.create_timer(0.5, self.fast_timer_callback)

        self.get_logger().info("定时器节点已启动")

    def timer_callback(self):
        """1秒定时器回调函数"""
        self.counter += 1
        current_time = self.get_clock().now()

        # 打印当前时间和计数器值
        self.get_logger().info(
            f"[1秒定时器] 第 {self.counter} 次执行，当前时间：" +
            f"{current_time.seconds_nanoseconds()}"
        )

    def fast_timer_callback(self):
```

```

"""0.5秒定时器回调函数"""
# 打印当前时间戳（纳秒）
self.get_logger().info(
    f"[0.5秒定时器] 当前时间戳: {self.get_clock().now().nanoseconds}"
)

def main(args=None):
    # 初始化ROS 2
    rclpy.init(args=args)

    # 创建节点
    node = TimerDemoNode()

    # 运行节点
    rclpy.spin(node)

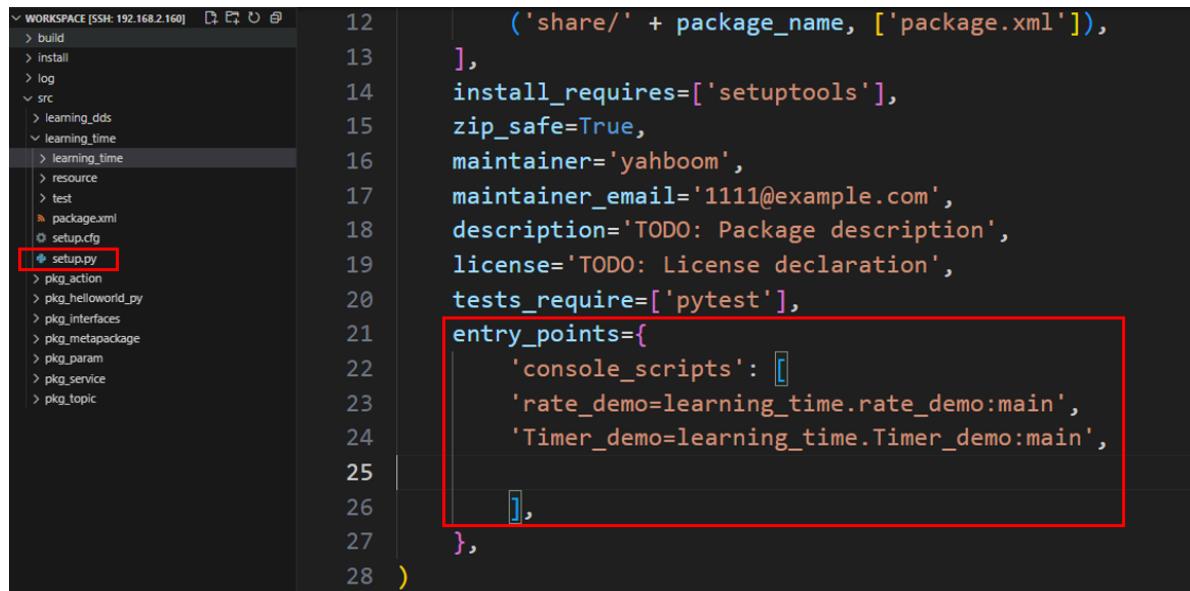
    # 关闭ROS 2
    node.destroy_node()
    rclpy.shutdown()

if __name__ == '__main__':
    main()

```

- 配置对应的setup.py配置文件，在console\_scripts中添加

```
'Timer_demo=learning_time.Timer_demo:main'
```



```

12     ('share/' + package_name, ['package.xml']),
13 ],
14 install_requires=['setuptools'],
15 zip_safe=True,
16 maintainer='yahboom',
17 maintainer_email='1111@example.com',
18 description='TODO: Package description',
19 license='TODO: License declaration',
20 tests_require=['pytest'],
21 entry_points={
22     'console_scripts': [
23         'rate_demo=learning_time.rate_demo:main',
24         'Timer_demo=learning_time.Timer_demo:main',
25     ],
26 },
27 },
28 )

```

- 编译功能包

```
colcon build --packages-select learning_time
```

```
colcon build` successful  
/home/yahboom/workspace
```

```
yahboom@yahboom-virtual-machine: ~/workspace  
yahboom@yahboom-virtual-machine: ~/workspace 80x24  
yahboom@yahboom-virtual-machine:~$ cd workspace/  
yahboom@yahboom-virtual-machine:~/workspace$ colcon build --packages-select learning_time  
Starting >>> learning_time  
Finished <<< learning_time [0.71s]  
Summary: 1 package finished [0.91s]  
yahboom@yahboom-virtual-machine:~/workspace$
```

- 刷新工作空间环境并运行节点

```
source ./install/setup.bash
```

```
ros2 run learning_time Timer_demo
```

```
yahboom@yahboom-virtual-machine: ~/workspace  
yahboom@yahboom-virtual-machine: ~/workspace 80x24  
yahboom@yahboom-virtual-machine:~/workspace$ source install/setup.bash  
yahboom@yahboom-virtual-machine:~/workspace$ ros2 run learning_time Timer_demo  
[INFO] [1757059329.395564545] [timer_demo_node]: 定时器节点已启动  
[INFO] [1757059329.891631857] [timer_demo_node]: [0.5秒定时器] 当前时间戳: 1757059329891008756  
[INFO] [1757059330.391806054] [timer_demo_node]: [1秒定时器] 第 1 次执行, 当前时间: (1757059330, 391143464)  
[INFO] [1757059330.392652648] [timer_demo_node]: [0.5秒定时器] 当前时间戳: 1757059330392110483  
[INFO] [1757059330.891208466] [timer_demo_node]: [0.5秒定时器] 当前时间戳: 1757059330890472233  
[INFO] [1757059331.391747680] [timer_demo_node]: [1秒定时器] 第 2 次执行, 当前时间: (1757059331, 391145049)  
[INFO] [1757059331.392596890] [timer_demo_node]: [0.5秒定时器] 当前时间戳: 1757059331392112596  
[INFO] [1757059331.891140285] [timer_demo_node]: [0.5秒定时器] 当前时间戳: 1757059331890548604  
[INFO] [1757059332.391227028] [timer_demo_node]: [1秒定时器] 第 3 次执行, 当前时
```

- 可以看出定时器按照设定的定时时间触发，在各自的回调函数中打印对应的日志信息

## 4、get\_clock获取当前时刻时间

- get\_clock函数可以用来获取到时钟对象，再通过()方法获取到当前时刻时间
- 新建程序文件get\_clock\_demo.py,填入以下示例程序：

```
import rclpy  
from rclpy.node import Node  
from rclpy.time import Time  
  
class TimeExampleNode(Node):  
    def __init__(self):  
        super().__init__("time_example_node")
```

```
# 获取节点的时钟对象（默认使用系统时钟）
self.clock = self.get_clock()

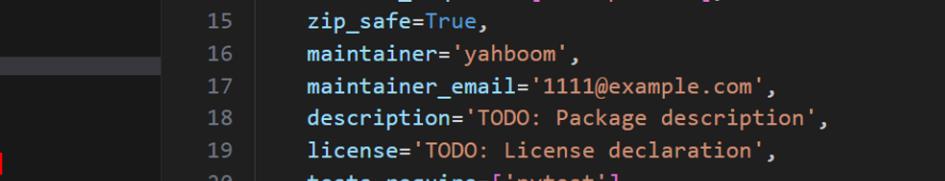
# 获取当前时间（返回Time对象）
current_time = self.clock.now()
self.get_logger().info(f"当前时间: {current_time}")

def main(args=None):
    rclpy.init(args=args)
    node = TimeExampleNode()
    rclpy.spin_once(node)    # 运行一次节点
    node.destroy_node()
    rclpy.shutdown()

if __name__ == "__main__":
    main()
```

- 配置对应的setup.py配置文件，在console\_scripts中添加

'get\_clock\_demo=learning\_time.get\_clock\_demo:main'



```
src > learning_time > setup.py > ... \ shared / package_name, [ package Amit ],  
13     ],  
14     install_requires=['setuptools'],  
15     zip_safe=True,  
16     maintainer='yahboom',  
17     maintainer_email='1111@example.com',  
18     description='TODO: Package description',  
19     license='TODO: License declaration',  
20     tests_require=['pytest'],  
21     entry_points={  
22         'console_scripts': [  
23             'rate_demo=learning_time.rate_demo:main',  
24             'Timer_demo=learning_time.Timer_demo:main',  
25             'get_clock_demo=learning_time.get_clock_demo:main',  
26         ],  
27     },  
28 },  
29 )
```

- 编译功能包

```
colcon build --packages-select learning_time
```

```
yahboom@yahboom-virtual-machine: ~/workspace
[yahboom@yahboom-virtual-machine:~/workspace]$ colcon build --packages-select learning_time
Starting >>> learning_time
Finished <<< learning_time [0.71s]

Summary: 1 package finished [0.91s]
yahboom@yahboom-virtual-machine:~/workspace$
```

- 刷新工作空间环境并运行节点

```
source ./install/setup.bash
```

```
ros2 run learning_time get_clock_demo
```

```
yahboom@yahboom-virtual-machine: ~/workspace
[yahboom@yahboom-virtual-machine:~/workspace]$ ros2 run learning_time get_clock_demo
[INFO] [1757059580.529675470] [time_example_node]: 当前时间：Time(nanoseconds=175705958052233
1199, clock_type=ROS_TIME)
```

## 5、Time 与 Duration

- `Time` 类在ros中用于表示一个具体的时间点（如 "2023-10-01 12:00:00"），通常用于标记事件发生的时刻。
- `Duration` 类表示两个时间点之间的间隔（如 "5 秒"），用于计算时间差或延迟。
- 示例：**Time 以及 Duration 应用
- 创建一个新的程序文件TimeDuration\_demo.py

```
import rclpy
from rclpy.time import Time
from rclpy.duration import Duration

def main():
    rclpy.init()
    node = rclpy.create_node("time_opt_node")

    #time类的使用方法，创建‘时间点、时刻’
    time1 = Time(seconds=10)
    time2 = Time(seconds=4)
    #Duration类使用方法，创建‘持续时间、一段时间’
    duration1 = Duration(seconds=3)
    duration2 = Duration(seconds=5)

    # 时刻可以进行比较
    node.get_logger().info("time1 >= time2 ? %d" % (time1 >= time2))
    node.get_logger().info("time1 < time2 ? %d" % (time1 < time2))

    # 时间段与时刻可以数学运算
```

```

t3 = time1 + duration1
t4 = time1 - time2
t5 = time1 - duration1

node.get_logger().info("t3 = %d" % t3.nanoseconds)
node.get_logger().info("t4 = %d" % t4.nanoseconds)
node.get_logger().info("t5 = %d" % t5.nanoseconds)

# 时间段可以进行比较
node.get_logger().info("-" * 80)
node.get_logger().info("duration1 >= duration2 ? %d" % (duration1 >=
duration2))
node.get_logger().info("duration1 < duration2 ? %d" % (duration1 <
duration2))

rcipy.shutdown()

if __name__ == "__main__":
    main()

```

- 配置对应的setup.py配置文件，在console\_scripts中添加

```
'TimeDuration_demo=learning_time.TimeDuration_demo:main'
```

```

> 打开的编辑器
src > learning_time > setup.py > ...
17     maintainer_email='1111@example.com',
18     description='TODO: Package description',
19     license='TODO: License declaration',
20     tests_require=['pytest'],
21     entry_points={
22         'console_scripts': [
23             'rate_demo=learning_time.rate_demo:main',
24             'Timer_demo=learning_time.Timer_demo:main',
25             'get_clock_demo=learning_time.get_clock_demo:main',
26             'TimeDuration_demo=learning_time.TimeDuration_demo:main',
27         ],
28     },
29 )
30

```

- 编译功能包

```
colcon build --packages-select learning_time
```

```

`colcon build` successful
/home/yahboom/workspace

yahboom@yahboom-virtual-machine:~/workspace
yahboom@yahboom-virtual-machine:~/workspace 80x24
yahboom@yahboom-virtual-machine:~$ cd workspace/
yahboom@yahboom-virtual-machine:~/workspace$ colcon build --packages-select learning_time
Starting >>> learning_time
Finished <<< learning_time [0.71s]

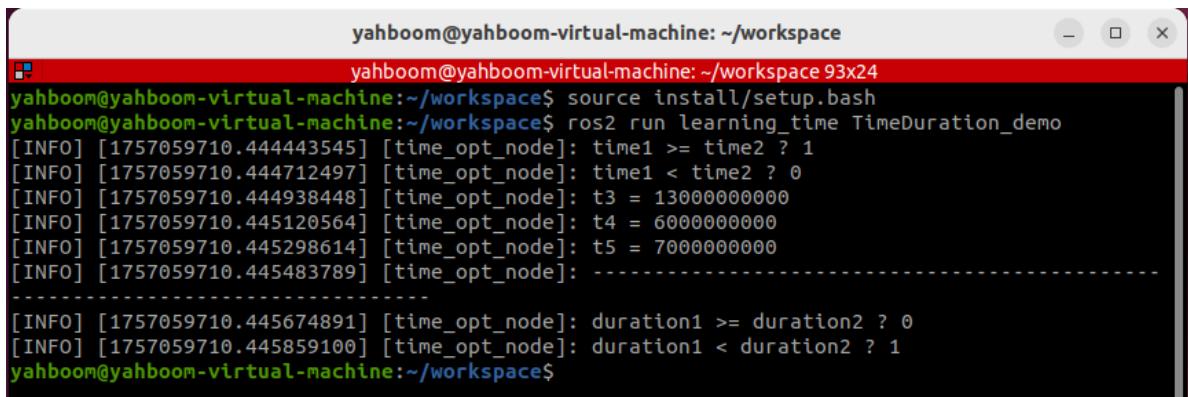
Summary: 1 package finished [0.91s]
yahboom@yahboom-virtual-machine:~/workspace$ 

```

- 刷新工作空间环境并运行节点

```
source ./install/setup.bash
```

```
ros2 run learning_time TimeDuration_demo
```



A terminal window titled "yahboom@yahboom-virtual-machine: ~/workspace". The window shows the command "source install/setup.bash" followed by "ros2 run learning\_time TimeDuration\_demo". The terminal then displays several [INFO] log messages from the "time\_opt\_node" component. These messages include comparisons between time1 and time2, and between duration1 and duration2. It also shows the calculation of t3, t4, and t5. The terminal ends with a prompt "yahboom@yahboom-virtual-machine:~/workspace\$".

```
yahboom@yahboom-virtual-machine: ~/workspace
yahboom@yahboom-virtual-machine: ~/workspace 93x24
yahboom@yahboom-virtual-machine:~/workspace$ source install/setup.bash
yahboom@yahboom-virtual-machine:~/workspace$ ros2 run learning_time TimeDuration_demo
[INFO] [1757059710.444443545] [time_opt_node]: time1 >= time2 ? 1
[INFO] [1757059710.444712497] [time_opt_node]: time1 < time2 ? 0
[INFO] [1757059710.444938448] [time_opt_node]: t3 = 13000000000
[INFO] [1757059710.445120564] [time_opt_node]: t4 = 6000000000
[INFO] [1757059710.445298614] [time_opt_node]: t5 = 7000000000
[INFO] [1757059710.445483789] [time_opt_node]: -----
-----
[INFO] [1757059710.445674891] [time_opt_node]: duration1 >= duration2 ? 0
[INFO] [1757059710.445859100] [time_opt_node]: duration1 < duration2 ? 1
yahboom@yahboom-virtual-machine:~/workspace$
```

- 这个示例证明时间点和时间段可以进行数学运算，可以让我们灵活的对不同时间戳的数据进行查询和操作