Node Test: Lifecycle node + manager

Node test set up and prerequisites:

Rclcpp, sensor_msgs, rclcpp_lifecycle, colcon, gtest

Lifecycle node

Test1 : NodeCanBeCreated
Tester : Melissa van Leeuwen
date : 06/11/2025

Short description test: - Verify that the Subscriber node (LifecycleNodeSubscriber) can be instantiated successfully within the ROS 2 test framework.
Input test: No input data required; only instantiate the node.
Expected result : - The pointer to the created node is not nullptr. - No exceptions or runtime errors occur during instantiation.
Result test: Node created successfully. Test passes if ASSERT_NE(node, nullptr) returns true.

Test2 : PublishesImuDataInWiredMode
Tester : Melissa van Leeuwen
date : 06/11/2025

Short description test: - Verify that in wired mode, the IMULifecycleNode correctly processes incoming IMU data received on the imu_data_esp topic and republishes it to imu_data when the node is active.
Input test: - A mock sensor_msgs::msg::Imu message published to imu_data_esp with the following fields: linear_acceleration = (1.0550, 3.2444, 2.8768) angular_velocity = (-0.3, 0.6, 0.5) timestamp = now()

Expected result : - The node, when configured and activated, republishes a corresponding sensor_msgs::msg::Imu message on the /imu_data topic. - The received message values match the published ones (within a tolerance of 1e-6). - No exceptions, crashes, or warnings occur during execution.
Result test: - The received data matches the input message within tolerance. - No exception or crash.

Test3 : PublishesImuDataInWirelessMode
Tester : Melissa van Leeuwen
date : 06/11/2025

Short description test: - Verify that in wireless mode, the IMULifecycleNode correctly processes incoming UDP IMU data and republishes it on the imu_data topic when the node is active.
Input test: - A simulated UDP packet containing comma-separated IMU values: angular_velocity: 0.1, 0.2, 0.3 linear_acceleration: 9.81, 0.0, 0.0
Expected result : - Node republishes a sensor_msgs::msg::Imu message on imu_data. - The received message contains the same IMU values as in the test UDP packet. - Node processes the UDP packet without errors or warnings.
Result test: - The received data matches the injected UDP data within a tolerance of 1e-6. - No exception or crash.

Test4 : DoesNotPublishWhenDeactivated
Tester : Melissa van Leeuwen
date : 06/11/2025

Short description test: - Verify that the IMULifecycleNode does not publish IMU data when it is in the deactivated state, regardless of whether it is in wired or wireless mode. This ensures lifecycle state enforcement is correctly implemented.
Input test: - Node lifecycle manually transitioned: - Configured - Activated - Deactivated
Expected result : - No message is published to imu_data while the node is deactivated. - received_msg remains nullptr throughout the 2-second test window.
Result test: - received_msg == nullptr after attempting to publish while the node is deactivated. - No exceptions or crashes observed.

```
melissa@ubuntu:~/Documents/GitHub/rmb_ws$ ./build/g425_assign3_pkg/utest_imu_lifecycle_node
[==========] Running 4 tests from 1 test suite.
[----------] Global test environment set-up.
[----------] 4 tests from TestIMULifecycleNode
[ RUN      ] TestIMULifecycleNode.NodeCanBeCreated
[INFO] [1762513047.652361920] [imu_lifecycle_node]: Lifecycle node started in state: unconfigured
[       OK ] TestIMULifecycleNode.NodeCanBeCreated (39 ms)
[ RUN      ] TestIMULifecycleNode.PublishesImuDataInWiredMode
[INFO] [1762513047.671616314] [imu_lifecycle_node]: Lifecycle node started in state: unconfigured
[INFO] [1762513047.678192498] [imu_lifecycle_node]: Configuring IMU lifecycle node...
[INFO] [1762513047.678255243] [imu_lifecycle_node]: Wired connection selected.
[INFO] [1762513047.679358555] [imu_lifecycle_node]: Node activated, ready to receive and publish IMU data.
[INFO] [1762513047.730010663] [imu_lifecycle_node]: Reveiced IMU data:
Linear Acceleration: x=1.055, y=3.244, z=2.877
Angular Velocity: x=-0.300, y=0.600, z=0.500
Time: sec=1762513047, nanosec=679414091
[INFO] [1762513047.730093096] [imu_lifecycle_node]: Publish data to database subscriber...
[       OK ] TestIMULifecycleNode.PublishesImuDataInWiredMode (178 ms)
[ RUN      ] TestIMULifecycleNode.PublishesImuDataInWirelessMode
[INFO] [1762513047.848539562] [imu_lifecycle_node]: Lifecycle node started in state: unconfigured
[INFO] [1762513047.849106452] [imu_lifecycle_node]: Configuring IMU lifecycle node...
[INFO] [1762513047.849138098] [imu_lifecycle_node]: Wireless connection selected.
[INFO] [1762513047.849241987] [imu_lifecycle_node]: Listening for UDP packets on port 5005...
[INFO] [1762513047.849664547] [imu_lifecycle_node]: Node activated, ready to receive and publish IMU data.
[INFO] [1762513047.849722079] [imu_lifecycle_node]: Reveiced IMU data:
Linear Acceleration: x=9.810, y=0.000, z=0.000
Angular Velocity: x=0.100, y=0.200, z=0.300
Time: sec=1762513047, nanosec=849718863
[INFO] [1762513047.849758294] [imu_lifecycle_node]: Publish data to database subscriber...
[       OK ] TestIMULifecycleNode.PublishesImuDataInWirelessMode (118 ms)
[ RUN      ] TestIMULifecycleNode.DoesNotPublishWhenDeactivated
[INFO] [1762513047.967289123] [imu_lifecycle_node]: Lifecycle node started in state: unconfigured
[INFO] [1762513047.967900109] [imu_lifecycle_node]: Configuring IMU lifecycle node...
[INFO] [1762513047.967930255] [imu_lifecycle_node]: Wired connection selected.
[INFO] [1762513047.968562333] [imu_lifecycle_node]: Node activated, ready to receive and publish IMU data.
[INFO] [1762513047.968603053] [imu_lifecycle_node]: Node deactivated.
[WARN] [1762513047.968926255] [LifecyclePublisher]: Trying to publish message on the topic '/imu_data_esp', but the publisher is not activated
[       OK ] TestIMULifecycleNode.DoesNotPublishWhenDeactivated (2028 ms)
[----------] 4 tests from TestIMULifecycleNode (2366 ms total)

[----------] Global test environment tear-down
[==========] 4 tests from 1 test suite ran. (2384 ms total)
[  PASSED  ] 4 tests.
```

Test5 : Wireless connection check
Tester : Rik van Velzen
date : 07/11/2025

Short description test: - We observe if the IMU ESP32 is wireless connected to our ROS system (computer).
Input test: - Settings for connection: Connection_type_ = 1 Port = 5005 Timer_period_ms = 200
Expected result : - There is a wireless connection through which data can be sent.
Result test: - Wireless connection is established and data is received.

```
rik@IdeaPad-5-Pro:~/rmb_ws$ ros2 launch g425_assign3_pkg assign3_wireless.launch.
xml
[INFO] [launch]: All log files can be found below /home/rik/.ros/log/2025-11-07-1
4-42-18-114689-IdeaPad-5-Pro-32934
[INFO] [launch]: Default logging verbosity is set to INFO
[INFO] [LifecycleNodeSubscriber-1]: process started with pid [32937]
[INFO] [ImuLifecycleNode-2]: process started with pid [32938]
[INFO] [LifecycleManager-3]: process started with pid [32939]
[ImuLifecycleNode-2] [INFO] [1762522938.340526350] [imu_lifecycle_node]: Lifecycl
e node started in state: unconfigured
[LifecycleNodeSubscriber-1] [INFO] [1762522938.342405640] [lifecycle_node_subscri
ber]: Lifecycle node subscriber started, waiting for messages...
[LifecycleManager-3] [INFO] [1762522938.343562964] [lifecycle_manager]: Waiting f
or lifecycle node 'imu_lifecycle_node'...
[LifecycleManager-3] [INFO] [1762522938.343640361] [lifecycle_manager]: Connected
 to lifecycle node 'imu_lifecycle_node'!
[ImuLifecycleNode-2] [INFO] [1762522938.344023160] [imu_lifecycle_node]: Configur
ing IMU lifecycle node...
[ImuLifecycleNode-2] [INFO] [1762522938.344053869] [imu_lifecycle_node]: Wireless
 connection selected.
[ImuLifecycleNode-2] [INFO] [1762522938.344211619] [imu_lifecycle_node]: Listenin
g for UDP packets on port 5005...
[LifecycleManager-3] [INFO] [1762522938.347106572] [lifecycle_manager]: Transitio
n 1 completed successfully.
[LifecycleManager-3] [INFO] [1762522938.347316903] [lifecycle_manager]: State cha
nge of node'imu_lifecycle_node': inactive
[ImuLifecycleNode-2] [INFO] [1762522938.347384612] [imu_lifecycle_node]: Node act
ivated, ready to receive and publish IMU data.
[LifecycleManager-3] [INFO] [1762522938.347453744] [lifecycle_manager]: Transitio
n 3 completed successfully.
[LifecycleManager-3] [INFO] [1762522938.347558854] [lifecycle_manager]: State cha
nge of node'imu_lifecycle_node': active
[INFO] [LifecycleManager-3]: process has finished cleanly [pid 32939]
[ImuLifecycleNode-2] [INFO] [1762522938.544756975] [imu_lifecycle_node]: Reveiced
 IMU data:
[ImuLifecycleNode-2] Linear Acceleration: x=0.000, y=0.000, z=-0.330
[ImuLifecycleNode-2] Angular Velocity: x=-0.001, y=0.002, z=0.001
[ImuLifecycleNode-2] Time: sec=1762522938, nanosec=544752176
[ImuLifecycleNode-2] [INFO] [1762522938.544816358] [imu_lifecycle_node]: Publish
data to database subscriber...
```

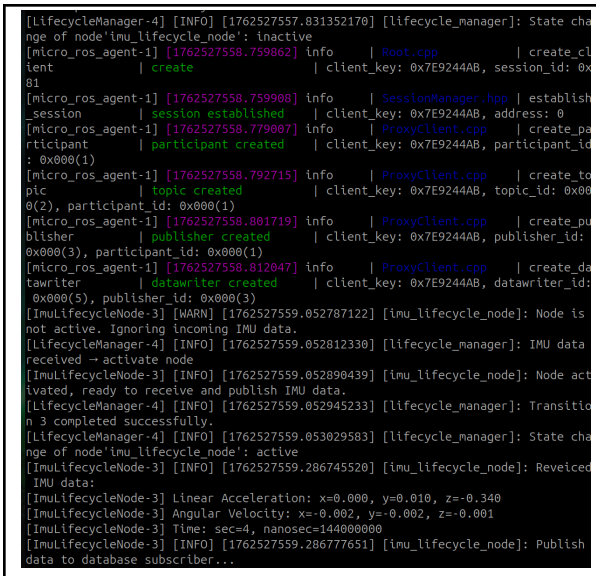
Test6 : Wired connection check
Tester : Rik van Velzen
date : 07/11/2025

Short description test:
- We observe if the IMU ESP32 is connected to our ROS system (computer).

Input test:
- Settings for connection:
  Baudrate = 115200
  Serial port: /dev/ttyusb0
  Publisher: /imu_data_esp

Expected result :
- There is a wired connection through which data can be sent.

Result test:
- A wired connection is established and data is received.



Lifecycle manager

Test1 : NodeCanBeCreated
Tester : Melissa van Leeuwen
date : 06/11/2025

Short description test: - Verify that the Subscriber node (LifecycleNodeSubscriber) can be instantiated successfully within the ROS 2 test framework.
Input test: No input data required; only instantiate the node.
Expected result : - The pointer to the created node is not nullptr. - No exceptions or runtime errors occur during instantiation.
Result test: Node created successfully. Test passes if ASSERT_NE(node, nullptr) returns true.

Test2 : EspCallbackUpdatesData
Tester : Melissa van Leeuwen
date : 06/11/2025

Short description test:

- Verify that the LifecycleManager properly updates its internal state (data_received_ and last_msg_time_) when a new IMU message is received through the esp_callback. This ensures that the node can correctly track incoming data and determine connection health.
Input test: - A sensor_msgs::msg::Imu test message containing: linear_acceleration = (1.0, 2.0, 3.0) angular_velocity = (0.1, 0.2, 0.3)
Expected result : - data_received_ is set to true. - last_msg_time_ is updated to a timestamp between before and after. - is_connection_alive(1.0) returns true, indicating the node considers the connection alive within a 1-second timeout.
Result test: - Node correctly reports the connection as alive.

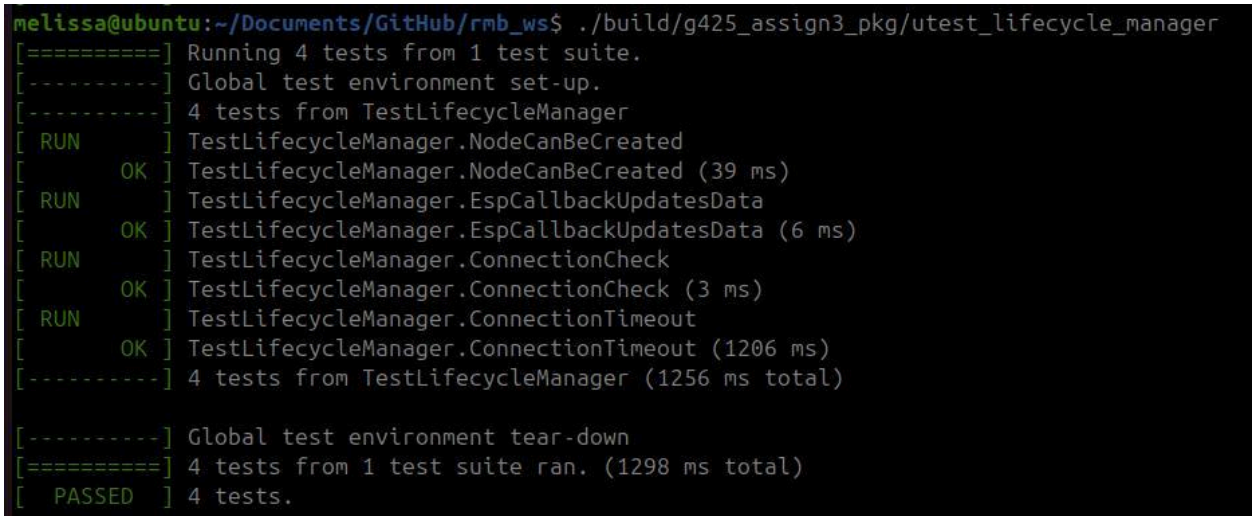
Test3 : ConnectionCheck
Tester : Melissa van Leeuwen
date : 06/11/2025

Short description test: - Verify that the LifecycleManager correctly reports the connection status based on recent IMU message reception. This test ensures that the is_connection_alive(timeout) function properly distinguishes between active and inactive connections.
Input test: - A small timeout value (0.1s) to check connection status without any message received. - A test sensor_msgs::msg::Imu message used to mark the connection as active. - A larger timeout (1.0s) to verify the connection is considered alive after receiving a message.
Expected result : - is_connection_alive(0.1) returns false, indicating no data has been received and the connection is inactive. - is_connection_alive(1.0) returns true, indicating the node considers the connection alive after receiving a message.

Result test: - The node correctly identifies a lack of data as a disconnected state. - The node correctly updates its internal timestamp and reports the connection as alive after receiving a message.

Test4 : ConnectionTimeout
Tester : Melissa van Leeuwen
date : 06/11/2025

Short description test: - Verify that the LifecycleManager correctly detects a connection timeout when no new IMU data is received. This test ensures that is_connection_alive(timeout) returns false after the specified inactivity period.
Input test: - A test sensor_msgs::msg::Imu message used to simulate incoming data. - Timeout value: 1.0 second. - Sleep period: 1.2 seconds to simulate inactivity longer than the timeout.
Expected result : - The connection is alive immediately after receiving a message. - The connection is considered inactive after the timeout period (no new messages received).
Result test: - is_connection_alive(timeout) properly reflects connection activity and timeout behavior. - LifecycleManager can reliably detect stale or lost IMU connections.


melissa@ubuntu:~/Documents/GitHub/rmb_ws$ ./build/g425_assign3_pkg/utest_lifecycle_manager
[==========] Running 4 tests from 1 test suite.
[----------] Global test environment set-up.
[----------] 4 tests from TestLifecycleManager
[RUN   ] TestLifecycleManager.NodeCanBeCreated
[OK] TestLifecycleManager.NodeCanBeCreated (39 ms)
[RUN   ] TestLifecycleManager.EspCallbackUpdatesData
[OK] TestLifecycleManager.EspCallbackUpdatesData (6 ms)
[RUN   ] TestLifecycleManager.ConnectionCheck
[OK] TestLifecycleManager.ConnectionCheck (3 ms)
[RUN   ] TestLifecycleManager.ConnectionTimeout
[OK] TestLifecycleManager.ConnectionTimeout (1206 ms)
[----------] 4 tests from TestLifecycleManager (1256 ms total)
[----------] Global test environment tear-down
[==========] 4 tests from 1 test suite ran. (1298 ms total)
[PASSED] 4 tests.