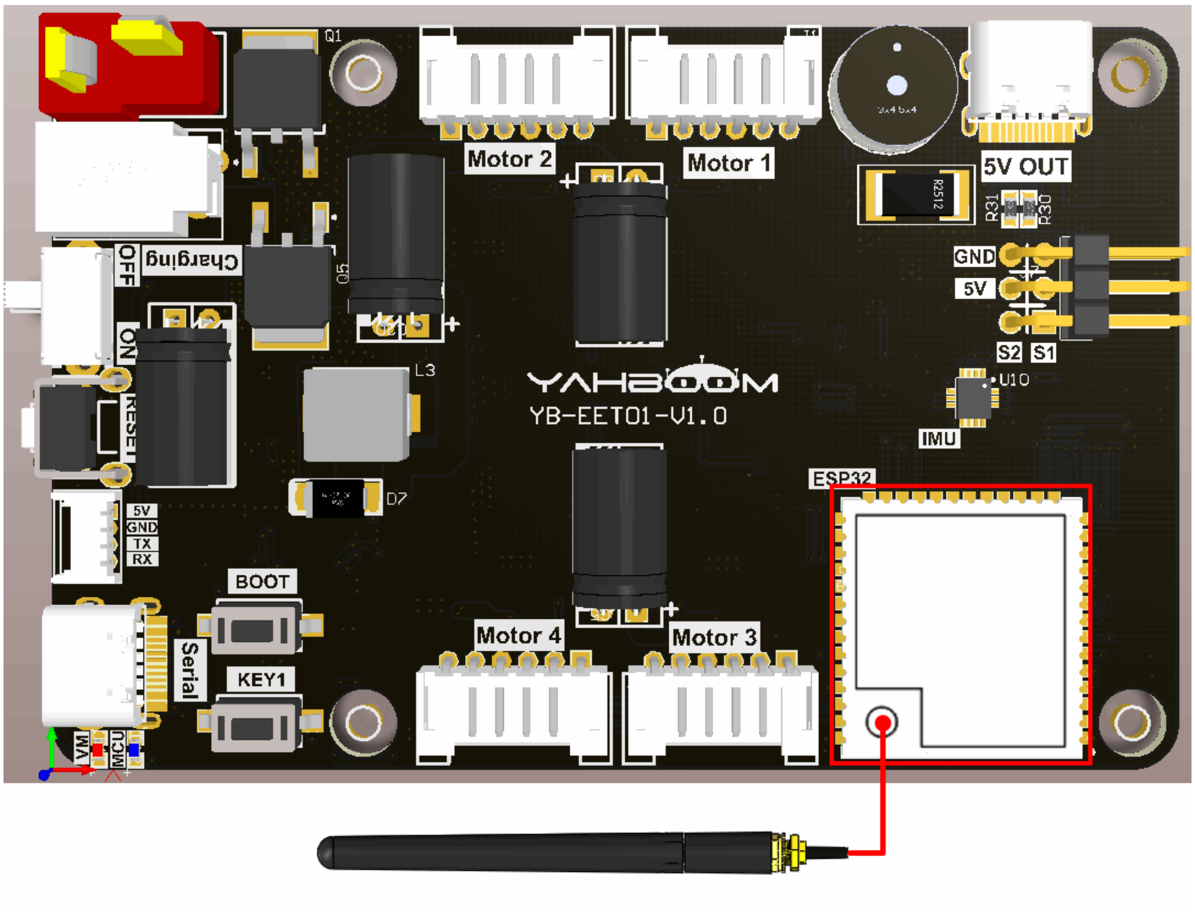
Customized transmission method

1. Experimental purpose

Learn the ESP32-microROS component and use a custom transmission method (serial port transmission) to connect to the agent.

2. Hardware connection

As shown in the figure below, the microROS control board integrates the ESP32-S3-WROOM core module, which has its own wireless WiFi function. The ESP32-S3 core module needs to be connected to an antenna, and a type-C data cable needs to be connected to the computer and the microROS control board as The functions of burning firmware and serial communication.



3. Core code analysis

The virtual machine path corresponding to the program source code is as follows:

```
~/esp/Samples/microros_samples/custom_transport
```

Since the custom transmission method needs to be recompiled to generate the libmicroros.a static library, this project does not import extra_components as the external component library. You need to reinstall the micro_ros_espidf_component component to the custom_components directory, and then import custom_components as the external component library.

The factory virtual machine system has already installed custom_components components.

The operation process of compiling and generating the custom version libmicroros.a static library is similar to the operation process of compiling the libmicroros.a static library in the extra_components directory. You just need to modify the "rmw_microxrcedds" parameter in the colcon.meta file and pay attention to replacing the compilation path.

```
        "rmw_microxrcedds": {
            "cmake-args": [
                "-DRMW_UXRCE_XML_BUFFER_LENGTH=400",
                "-DRMW_UXRCE_TRANSPORT=custom",
                "-DRMW_UXRCE_MAX_NODES=1",
                "-DRMW_UXRCE_MAX_PUBLISHERS=3",
                "-DRMW_UXRCE_MAX_SUBSCRIPTIONS=3",
                "-DRMW_UXRCE_MAX_SERVICES=1",
                "-DRMW_UXRCE_MAX_CLIENTS=1",
                "-DRMW_UXRCE_MAX_HISTORY=3"
            ]
        },
```

Obtain relevant configuration parameters from the IDF configuration tool. By default, serial port 2 is used, the baud rate is 921600, the TX pin is GPIO43, the RX pin is GPIO44, the namespace is empty, and the domain ID is 20.

```
#define ROS_NAMESPACE      CONFIG_MICRO_ROS_NAMESPACE
#define ROS_DOMAIN_ID      CONFIG_MICRO_ROS_DOMAIN_ID

#define ROS_UART_NUM       CONFIG_MICRO_ROS_UART_NUM
#define ROS_UART_BAUD      CONFIG_MICRO_ROS_UART_BAUD
#define UART_TXD           CONFIG_MICRO_ROS_UART_TXD
#define UART_RXD           CONFIG_MICRO_ROS_UART_RXD
#define UART_RTS           CONFIG_MICRO_ROS_UART_RTS
#define UART_CTS           CONFIG_MICRO_ROS_UART_CTS
```

Initialize the configuration of microROS, in which ROS_DOMAIN_ID, ROS_AGENT_IP and ROS_AGENT_PORT are modified in the IDF configuration tool according to actual needs.

```
    rcl_allocator_t allocator = rcl_get_default_allocator();
    rclc_support_t support;

    // 创建rcl初始化选项
    // Create init_options.
    rcl_init_options_t init_options = rcl_get_zero_initialized_init_options();
    RCCHECK(rcl_init_options_init(&init_options, allocator));
    // 修改ROS域ID
    // change ros domain id
    RCCHECK(rcl_init_options_set_domain_id(&init_options, ROS_DOMAIN_ID));

    // 初始化rmw选项
    // Initialize the rmw options
    rmw_init_options_t *rmw_options =
rcl_init_options_get_rmw_init_options(&init_options);
```

Set the microROS custom transmission mode to serial port transmission mode.

```
RCCHECK(set_microros_serial_transports_with_options(rmw_options));
```

set_microros_serial_transports_with_options function as long as the function is to specify the transmission method

```
rmw_ret_t set_microros_serial_transports_with_options(rmw_init_options_t *
rmw_options)
{
    rmw_ret_t ret = RMW_RET_OK;
    static size_t uart_port = ROS_UART_NUM;
    uart_driver_delete(UART_NUM_0);
    ret = rmw_uros_options_set_custom_transport(
        true,
        (void *) &uart_port,
        transport_serial_open,
        transport_serial_close,
        transport_serial_write,
        transport_serial_read,
        rmw_options
    );
    return ret;
}
```

Open serial port

```
static bool transport_serial_open(struct uxrCustomTransport *transport)
{
    size_t *uart_port = (size_t *)transport->args;

    uart_config_t uart_config = {
        .baud_rate = serial_baudrate,
        .data_bits = UART_DATA_8_BITS,
        .parity = UART_PARITY_DISABLE,
        .stop_bits = UART_STOP_BITS_1,
        .flow_ctrl = UART_HW_FLOWCTRL_DISABLE,
    };

    if (uart_param_config(*uart_port, &uart_config) == ESP_FAIL)
    {
        return false;
    }
    if (uart_set_pin(*uart_port, UART_TXD, UART_RXD, UART_RTS, UART_CTS) ==
ESP_FAIL)
    {
        return false;
    }
    if (uart_driver_install(*uart_port, UART_BUFFER_SIZE * 2, 0, 0, NULL, 0) ==
ESP_FAIL)
    {
        return false;
    }
    return true;
}
```

Close serial port

```
static bool transport_serial_close(struct uxrCustomTransport *transport)
{
    size_t *uart_port = (size_t *)transport->args;
    return uart_driver_delete(*uart_port) == ESP_OK;
}
```

Write data to serial port

```
static size_t transport_serial_write(struct uxrCustomTransport *transport, const
uint8_t *buf, size_t len, uint8_t *err)
{
    size_t *uart_port = (size_t *)transport->args;
    const int txBytes = uart_write_bytes(*uart_port, (const char *)buf, len);
    return txBytes;
}
```

Read data from serial port

```
static size_t transport_serial_read(struct uxrCustomTransport *transport, uint8_t
*buf, size_t len, int timeout, uint8_t *err)
{
    size_t *uart_port = (size_t *)transport->args;
    const int rxBytes = uart_read_bytes(*uart_port, buf, len, timeout /
portTICK_PERIOD_MS);
    return rxBytes;
}
```

Try to connect to the proxy. If the connection is successful, go to the next step. If the connection to the proxy is unsuccessful, you will always be in the connected state.

```
    while (1)
    {
        state_agent = rclc_support_init_with_options(&support, 0, NULL,
&init_options, &allocator);
        if (state_agent == ESP_OK)
        {
            break;
        }
        vTaskDelay(pdMS_TO_TICKS(500));
    }
```

Create the node "custom_transport", in which ROS_NAMESPACE is empty by default and can be modified in the IDF configuration tool according to actual conditions.

```
    rcl_node_t node;
    RCCHECK(rclc_node_init_default(&node, "custom_transport", ROS_NAMESPACE,
&support));
```

Create the publisher "custom_publisher" and specify the ROS topic information as std_msgs/msg/Int32 type.

```
    RCCHECK(rclc_publisher_init_default(
        &publisher,
        &node,
        ROSIDL_GET_MSG_TYPE_SUPPORT(std_msgs, msg, Int32),
        "custom_publisher"));
```

4. Compile and download the burning firmware

Use a Type-C data cable to connect the virtual machine/computer and the microROS control board. If the system pops up, choose to connect to the virtual machine.

Activate the ESP-IDF development environment. Note that every time you open a new terminal, you need to activate the ESP-IDF development environment before compiling the firmware.

```
source ~/esp/esp-idf/export.sh
```

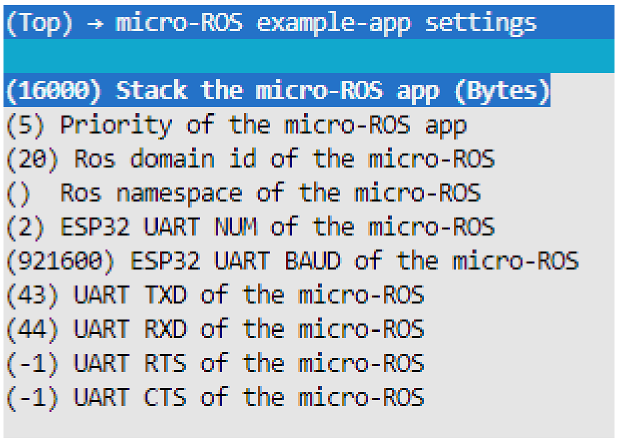
Enter the project directory

```
cd ~/esp/Samples/microros_samples/custom_transport
```

Open the ESP-IDF configuration tool.

```
idf.py menuconfig
```

Open micro-ROS example-app settings and keep the default configuration if there are no special requirements.



```
(Top) → micro-ROS example-app settings

(16000) Stack the micro-ROS app (Bytes)
(5) Priority of the micro-ROS app
(20) Ros domain id of the micro-ROS
()  Ros namespace of the micro-ROS
(2) ESP32 UART NUM of the micro-ROS
(921600) ESP32 UART BAUD of the micro-ROS
(43) UART TXD of the micro-ROS
(44) UART RXD of the micro-ROS
(-1) UART RTS of the micro-ROS
(-1) UART CTS of the micro-ROS
```

If there are any changes, please press S to save, and then press Q to exit the configuration tool.

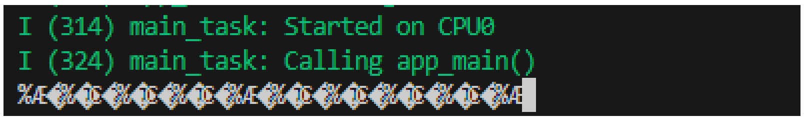
Compile, burn, and open the serial port simulator.

```
idf.py build flash monitor
```

If you need to exit the serial port simulator, press **Ctrl+]**.

5. Experimental results

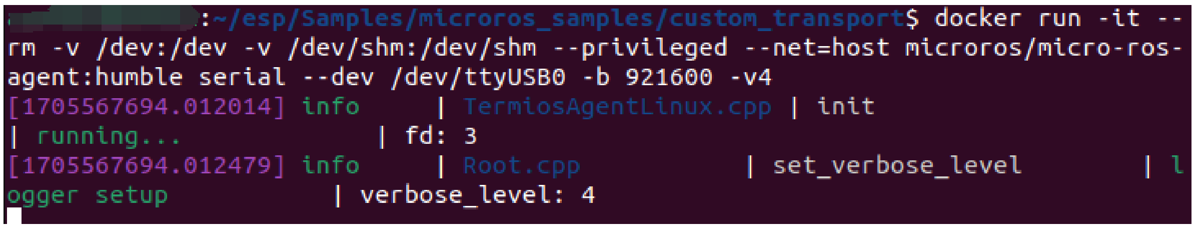
After starting up, the serial port simulator will print a string of garbled characters. The reason is that the connection request sent by Microros using the serial port is not all characters, and the default baud rate is not suitable, so it looks like garbled characters.



```
I (314) main_task: Started on CPU0
I (324) main_task: Calling app_main()
%Ä�%�C�%�C�%�C�%�C%Ä�%�C�%�C�%�C�%�C�%Ä
```

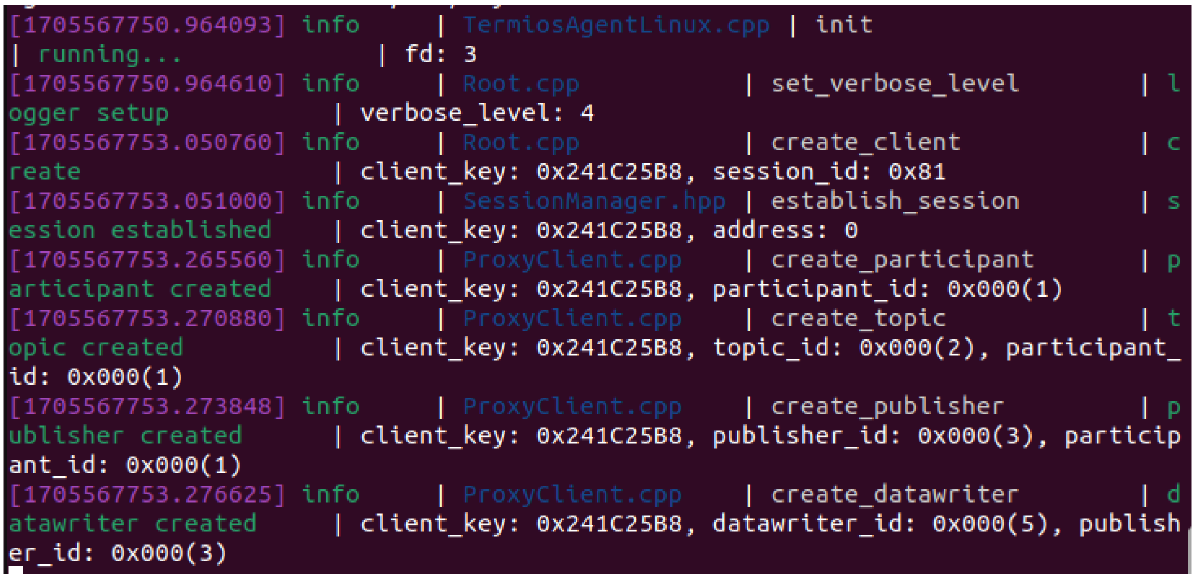
At this time, press Ctrl+] to exit the simulator, and then enter the following content to open the serial port proxy.

```
docker run -it --rm -v /dev:/dev -v /dev/shm:/dev/shm --privileged --net=host
microros/micro-ros-agent:humble serial --dev /dev/ttyUSB0 -b 921600 -v4
```



```
[redacted]:~/esp/Samples/microros_samples/custom_transport$ docker run -it --
rm -v /dev:/dev -v /dev/shm:/dev/shm --privileged --net=host microros/micro-ros-
agent:humble serial --dev /dev/ttyUSB0 -b 921600 -v4
[1705567694.012014] info     | TermiosAgentLinux.cpp | init                   
| running...             | fd: 3
[1705567694.012479] info     | Root.cpp              | set_verbose_level      | l
ogger setup            | verbose_level: 4
```

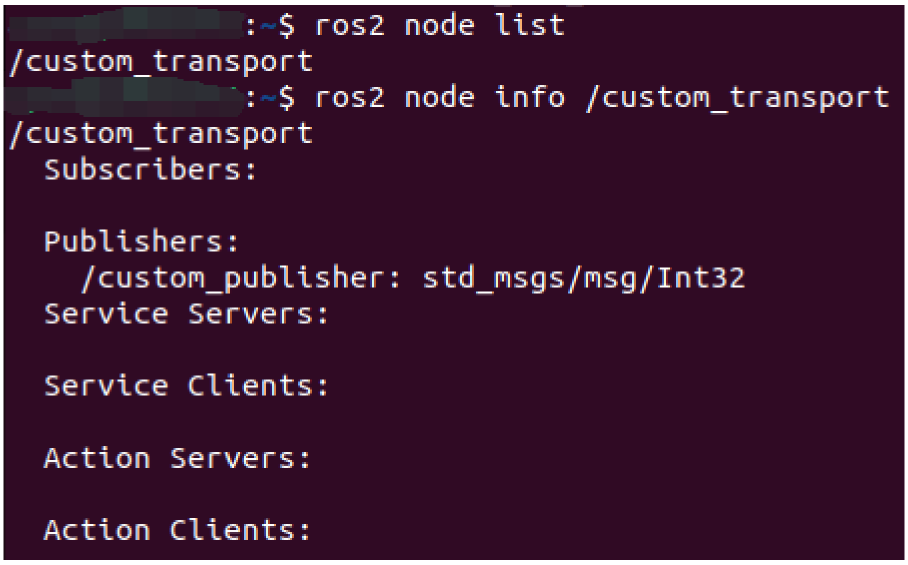
If the connection is successful, information about the relevant nodes and topics will be printed.



```
[1705567750.964093] info     | TermiosAgentLinux.cpp | init
| running...             | fd: 3
[1705567750.964610] info     | Root.cpp              | set_verbose_level      | l
ogger setup            | verbose_level: 4
[1705567753.050760] info     | Root.cpp              | create_client          | c
reate                  | client_key: 0x241C25B8, session_id: 0x81
[1705567753.051000] info     | SessionManager.hpp | establish_session         | s
ession established     | client_key: 0x241C25B8, address: 0
[1705567753.265560] info     | ProxyClient.cpp       | create_participant     | p
articipant created     | client_key: 0x241C25B8, participant_id: 0x000(1)
[1705567753.270880] info     | ProxyClient.cpp       | create_topic           | t
opic created           | client_key: 0x241C25B8, topic_id: 0x000(2), participant_
id: 0x000(1)
[1705567753.273848] info     | ProxyClient.cpp       | create_publisher       | p
ublisher created       | client_key: 0x241C25B8, publisher_id: 0x000(3), particip
ant_id: 0x000(1)
[1705567753.276625] info     | ProxyClient.cpp       | create_datawriter      | d
atawriter created      | client_key: 0x241C25B8, datawriter_id: 0x000(5), publish
er_id: 0x000(3)
```

At this time, open another terminal to view the current node signal.

```
ros2 node list
ros2 node info /custom_transport
```

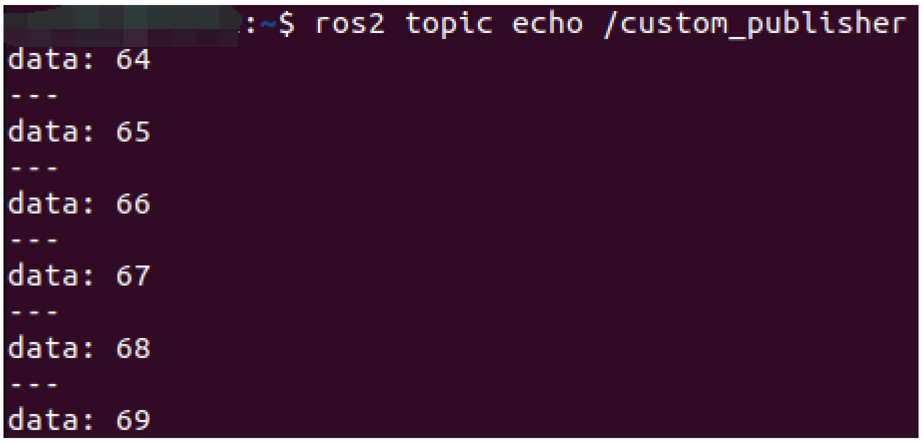


```
[redacted]:~$ ros2 node list
/custom_transport
[redacted]:~$ ros2 node info /custom_transport
/custom_transport
  Subscribers:

  Publishers:
    /custom_publisher: std_msgs/msg/Int32
  Service Servers:

  Service Clients:

  Action Servers:

  Action Clients:
```

Subscribe to the data content of the /custom_transport topic

```
ros2 topic echo /custom_publisher
```

Press Ctrl+C to exit the topic content.



```
[redacted]:~$ ros2 topic echo /custom_publisher
data: 64
---
data: 65
---
data: 66
---
data: 67
---
data: 68
---
data: 69
```

Note: Since the microros serial port agent will occupy the serial port and cannot be burned, you need to press Ctrl+C to close the serial port agent before burning the program next time, and then burn the program.