EspnowMqttPeer2Peer

ESP-NOW/MQTT Hybrid Communication Protocol
Technical Documentation – v2.1.0
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1. Introduction

1.1 Protocol Overview

Inspiration and Core Concept

This system was designed to **unify MQTT and ESP-NOW paradigms**, creating a transparent communication layer where:

ESP-NOW acts as "Wireless MQTT": Messages are routed using topic patterns (source/destination/action), simulating MQTT's publish/subscribe model without requiring a central broker.

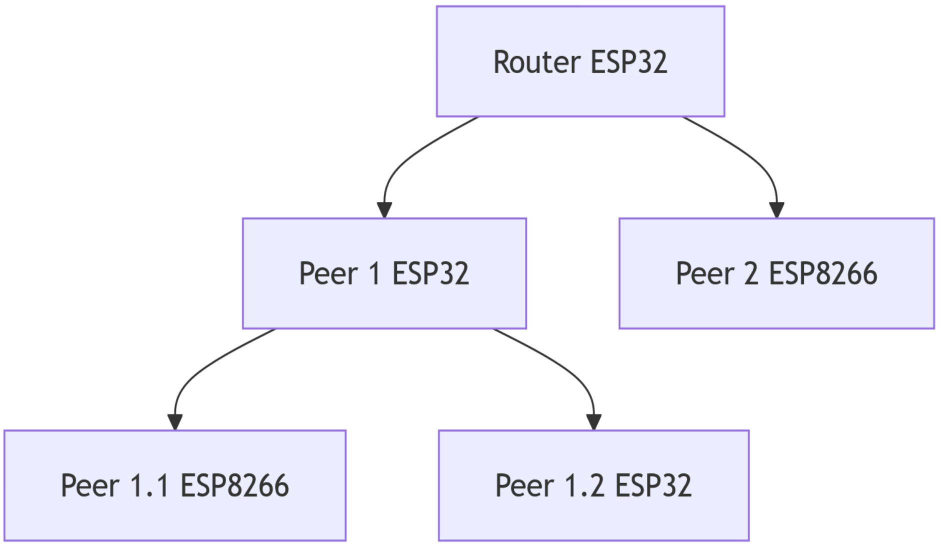
Full Abstraction: Developers interact with a single API while the library automatically chooses between:

ESP-NOW: For local peer-to-peer communication (ESP32/ESP8266)

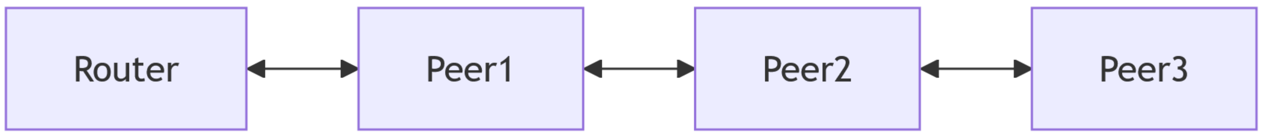
MQTT: For cloud/remote connectivity (ESP32 Router only)

A hybrid communication system combining:

- ESP-NOW for direct device-to-device messaging
- MQTT for cloud/remote communication
- Unified API for seamless protocol switching
- **Hierarchical Tree**:



- **Linear Chain**:



1.2 Key Features

Feature	Description
Dual-Mode Operation	Automatic ESP-NOW/MQTT selection
Event-Driven Architecture	Critical network event callbacks
Multi-Hop Routing	Message forwarding through peers
Cross-Platform Support	ESP32 (Router/Peer), ESP8266 (Peer)

1.3 Use Cases

- Industrial sensor networks
- Smart home automation
- Agricultural monitoring systems

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2. API Reference

2.1 Core Classes

MqttEspNowRouter (ESP32 Only)

cpp

```
class MqttEspNowRouter {
public:
  void begin(uint8_t wifiChan, uint8_t espnowChan, const char* name,
           const uint8_t* mac, const char* mqttName,
           std::vector<DeviceInfo>& peers, const char* mqttSrv,
           uint16_t port, const char* user = "", const char* pwd = "");

  void subscribe(const String& src, const String& dest,
              const String& action, LocalHandler h, RouteType t);

  void publishMqtt(const String& src, const String& dest,
               const String& action, const String& msg);
};
```

EspNowPeer

cpp

```
class EspNowPeer {
public:
  void begin(uint8_t channel, const char* name,
           std::vector<DeviceInfo>& routers,
           std::vector<DeviceInfo>& peers);

  void subscribe(const String& src, const String& dest,
              const String& action, LocalHandler h);
};
```

2.2 Data Structures

cpp

```
struct DeviceInfo {
  String name;
  uint8_t mac[6];  // MAC address in byte array format
  bool online = false;
  unsigned long lastPing = 0;
};
```

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3. Code Examples

3.1 Router Initialization

cpp

```
/* File: examples/Router/RouterBasic.ino */

#include <MqttEspNowRouter.h>

// Network configuration
const uint8_t routerMac[] = {0x12,0x34,0x56,0x78,0x9A,0xBC};
std::vector<DeviceInfo> peers = {{"Sensor1", {0xAA,0xBB,0xCC,0xDD,0xEE,0xFF}}};

MqttEspNowRouter router;
wifiConnManager wifi;

void setup() {
  wifi.onWifiReady([]() {
    wifi.onEspNowReady([]() {
      router.begin(6, 6, "MainRouter", routerMac,
                  "CloudBroker", peers, "mqtt.server.com", 1883);

      router.subscribe("CloudBroker", "Sensor1", "LED",
                      [](String msg) { /* Handler */ }, ROUTE_MQTT);
    });
  });
  wifi.begin(/* ... parameters ... */);
}
```

3.2 Peer Implementation

cpp

```
/* File: examples/Peer/PeerBasic.ino */

#include <EspNowPeer.h>

EspNowPeer peer;
std::vector<DeviceInfo> routers = {{"MainRouter",
{0x12,0x34,0x56,0x78,0x9A,0xBC}}};

void setup() {
  peer.begin(6, "TempSensor1", routers, {});

  peer.subscribe("MainRouter", "TempSensor1", "REPORT",
                [](String msg) { /* Handle command */ });
}

void loop() {
  peer.publishENow("TempSensor1", "MainRouter", "TEMP", readTemp());
  delay(10000);
}
```

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4. Project Structure

Directory Layout

```
ESPNow-MQTT-Hybrid/
├── src/                 # Core library
│   ├── EspNowPeer.cpp     # Peer implementation
│   └── MqttEspNowRouter.h # Router class
│
├── examples/            # Sample implementations
│   ├── Router/          # ESP32 router examples
│   └── Peer/            # ESP32/ESP8266 peer examples
│
├── docs/                # Documentation
│   ├── ESPNowMqttProtocol.pdf
│   └── wiring_diagrams/   # Hardware schematics
│
└── library.json         # PlatformIO metadata
```

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5. Platform Compatibility

Hardware Support

Feature	ESP32 Router	ESP32 Peer	ESP8266 Peer
MQTT Client	✓	✗	✗
ESP-NOW Transmitter	✓	✓	✓
Dual Protocol Routing	✓	✓	Limited

Software Requirements

- PlatformIO Core 6.1+
- Arduino Framework 3.0+
- ESP32 Arduino Core 2.0.9+

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6. Key Event Sequence

Initialization Flow

1. WiFi Connection Establishment
2. ESP-NOW Protocol Initialization
3. MQTT Broker Connection (Router Only)
4. Peer/Router Registration

5. Message Handler Setup

Event Timeline

```
[0ms] WiFi.begin()
[1200ms] onWifiReady()
[1500ms] esp_now_init()
[1600ms] onEspNowReady()
[1700ms] MQTT.connect()
[2000ms] Ready for Operation
```

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7. Troubleshooting

Common Issues

Error Code	Description	Solution
0x3001	ESP-NOW Not Initialized	Check WiFi channel
0x102	MQTT Connection Failed	Verify broker credentials
N/A	Message Loss	Verify MAC addresses

Debugging Tips

cpp

```
// Enable verbose logging
#define COMM_DEBUG 1 // 0-Disable, 1-Basic, 2-Verbose

// In setup():
Serial.setDebugOutput(true);
```

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8. Revision History

Version	Date	Changes
2.1.0	2024-03-15	Added event API
2.0.2	2024-02-28	ESP8266 fixes
1.4.1	2023-12-10	Initial release
