
# 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.

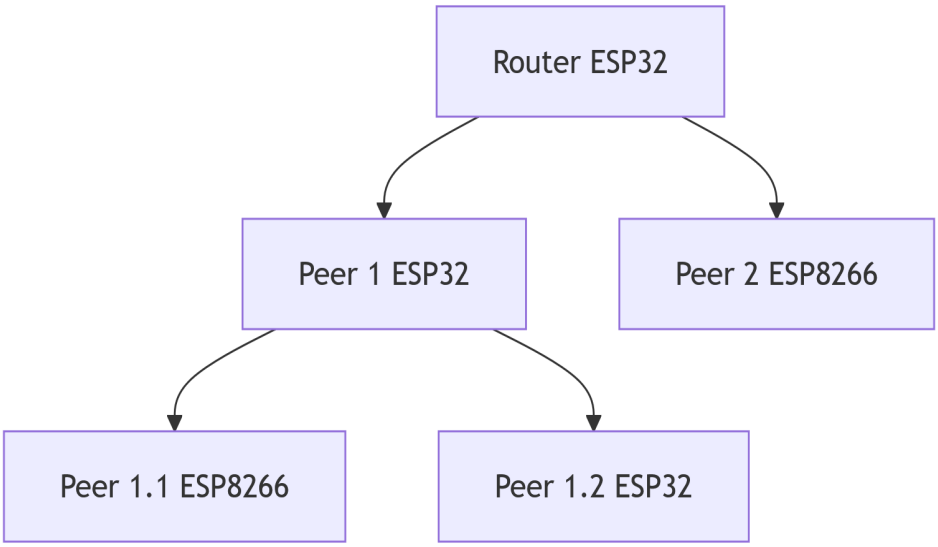
**Full Abstraction**: Developers interact with a single API while the library automatically chooses between:

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

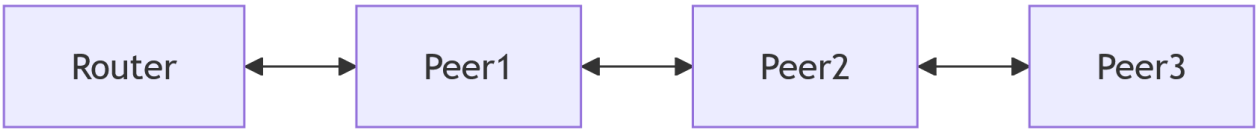
**MQTT**: For cloud/remote connectivity (ESP32 Router only)

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);
}
```

## 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 |

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