

ROBOT-TO-ROBOT COMMUNICATION PROTOCOL v2.0

PROPRIETARY AND CONFIDENTIAL

Polar Dynamics Robotics, Inc.

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1. PURPOSE AND SCOPE

1. This Robot-to-Robot Communication Protocol ("Protocol") establishes the mandatory technical and operational requirements for all inter-robot communications within Polar Dynamics Robotics, Inc.'s ("PDR") IceNav(TM)-enabled Autonomous Mobile Robot ("AMR") systems operating in temperature-controlled environments.

2. This Protocol applies to all PDR AMR units utilizing PDR's proprietary ColdMesh(TM) network architecture and supersedes Protocol v1.5 (PDR-RTRC-2023-02).

2. DEFINITIONS

1. "AMR Unit" means any PDR-manufactured autonomous mobile robot operating under IceNav(TM) control systems.

2. "ColdMesh(TM)" means PDR's proprietary mesh networking protocol designed for sub-zero environments.

3. "Critical Communication" means any data exchange affecting safety systems, collision avoidance, or emergency protocols.

4. "Operating Environment" means any controlled temperature space between +25 C and -40 C.

3. TECHNICAL SPECIFICATIONS

1. Communication Architecture

a) All AMR Units shall utilize PDR's ColdMesh(TM) protocol operating on IEEE 802.15.4e channels

b) Maximum latency for Critical Communications: 50ms

c) Minimum signal strength: -85 dBm at maximum operating range

d) Frequency hopping pattern: PDR Proprietary Sequence #PDR-FH-2024

2. Data Encryption

- a) All transmissions must employ AES-256 encryption
- b) Key rotation interval: 4 hours
- c) Certificate validation: Required for all endpoints
- d) Hardware security module integration mandatory

4. OPERATIONAL REQUIREMENTS

1. Communication Hierarchy

- a) Priority 1: Safety-critical messages
- b) Priority 2: Navigation and positioning data
- c) Priority 3: Task coordination messages
- d) Priority 4: Status updates and diagnostics

2. Fault Tolerance

- a) Minimum packet delivery success rate: 99.99%
- b) Automatic failover timing: <100ms
- c) Required redundancy paths: Minimum of 3
- d) Local cache duration: 30 minutes

5. SAFETY PROTOCOLS

1. Emergency Communications

- a) Dedicated emergency channel must remain open
- b) Maximum emergency broadcast delay: 10ms
- c) Acknowledgment required from all units within range
- d) Automatic safety stop if acknowledgment fails

2. Interference Management

- a) Active RF monitoring required
- b) Automatic channel switching on interference detection
- c) Minimum signal-to-noise ratio: 20dB
- d) Maximum retry attempts: 3

6. COMPLIANCE AND TESTING

1. Each AMR Unit must pass the following tests before deployment:

- a) Protocol compliance verification
- b) Stress testing under maximum load
- c) Cold environment performance validation
- d) Interference resistance certification

2. Documentation Requirements

- a) Test results logged to secure PDR cloud
- b) Monthly performance metrics
- c) Incident reports within 24 hours
- d) Quarterly compliance audits

7. INTELLECTUAL PROPERTY

1. All aspects of this Protocol, including but not limited to the ColdMesh(TM) architecture, encryption methods, and frequency hopping patterns, are proprietary to PDR and protected under U.S. Patent Nos. 11,XXX,XXX and 11,XXX,XXX.

8. MODIFICATIONS AND UPDATES

- 1. PDR reserves the right to modify this Protocol with 30 days' notice to licensed operators.
- 2. Emergency security updates may be deployed immediately as needed.

9. CERTIFICATION

The undersigned hereby certifies that this Protocol has been reviewed and approved for implementation.

APPROVED BY:

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Date: _

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