Product Requirements Document (PRD): Detection of U.S. Surface Ships by Chinese UAVs and Fishing Boats

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1 Purpose

This program calculates the likelihood and timing of Chinese UAVs and fishing boats detecting U.S. surface ships operating between 3,500–4,000 km from the coast of China. The simulation uses agent-based modeling and Monte Carlo methods, with outputs summarized in a detection time matrix for various force compositions and patrol densities.

2 Scope

- Simulate detection of U.S. ships by Chinese UAVs/fishing boats in a large maritime area.
- Model three U.S. formations: single destroyer, multiple destroyers, and multiple destroyers with an aircraft carrier.
- Vary Chinese patrol density: 10%, 25%, 50%, 75% of available UAVs/fishing boats.
- Output: Median time to detection for each scenario, summarized in a matrix.
- No combat; only detection/observation events.

3 Area of Interest

The area is defined by a baseline of 600 km, extending outwards at 120 degrees on both sides, forming a wide sector that reaches up to 4,500 km from the baseline. U.S. ships enter from the far edge (3,500–4,000 km) and head towards the baseline until they are 2,000 km away.

3.1 Diagram: Area of Interest

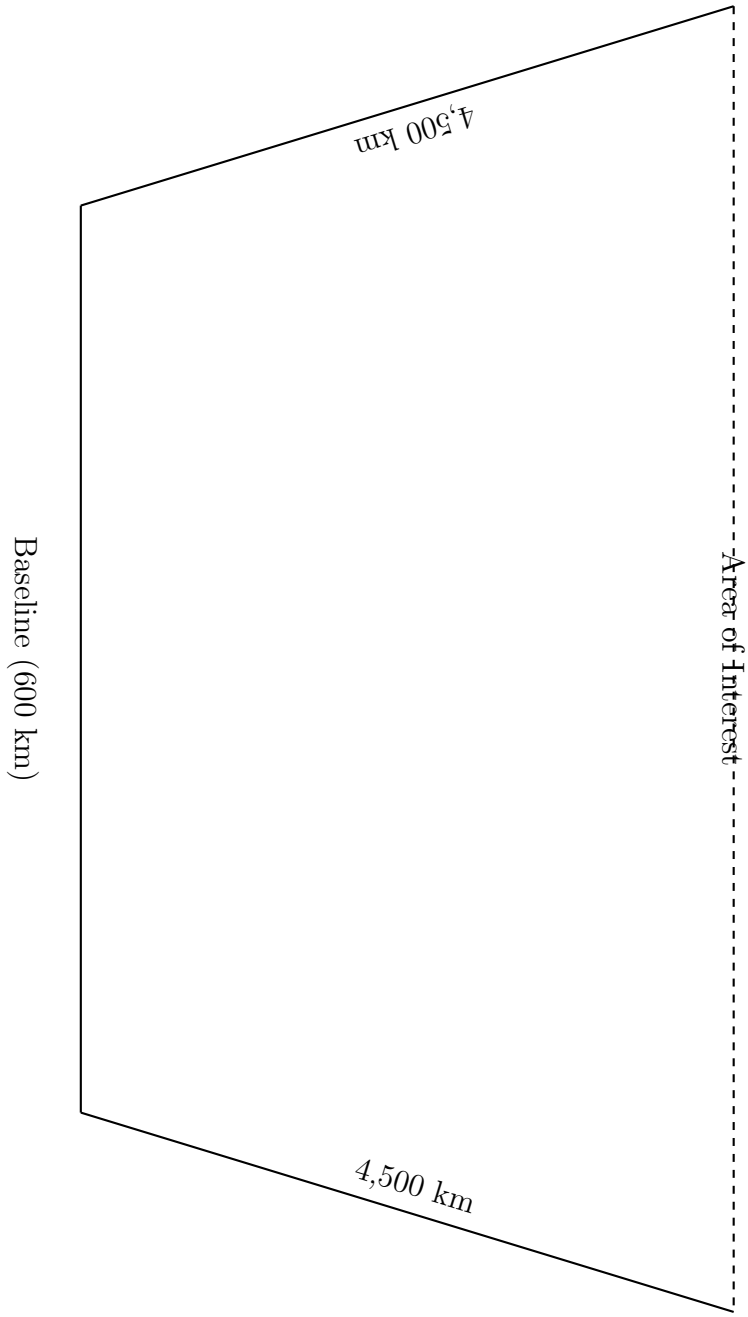

Figure 1: Area of Interest: Baseline and sector out to 4,500 km (not to scale)

3.2 Diagram: U.S. Ship Entry and Movement

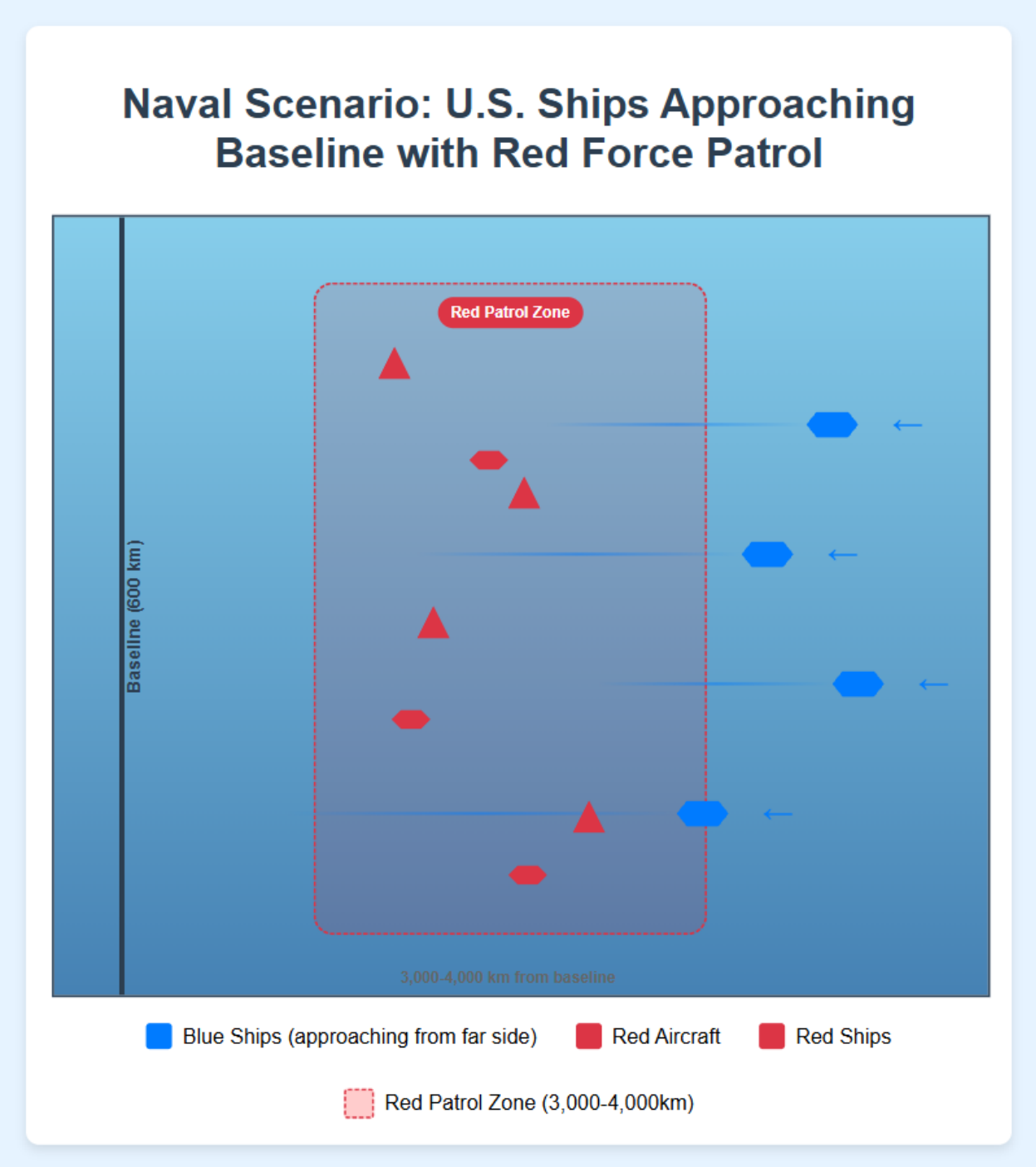

Figure 2: U.S. ships enter from far side and move towards baseline

4 Agent Model

The simulation uses an agent-based model as described in the Program Description (see Overleaf.tex):

- **U.S. Ships:** Destroyers and aircraft carriers, modeled in three formations.
- **Chinese UAVs and Fishing Boats:** Patrol agents assigned missions and detection algorithms per Overleaf.tex.
- **Detection:** Based on sensor effectiveness, patrol patterns, and agent interactions. No combat occurs.

5 Simulation Methodology

- Monte Carlo simulation: Randomized agent placement, movement, and detection events.
- Each run simulates U.S. ships entering the area and Chinese agents patrolling.
- Detection events are logged; time to first detection is recorded for each scenario.
- Repeat for all combinations of patrol density and U.S. force composition.

6 Output Requirements

6.1 Detection Time Matrix

The output is a table showing the median time to detection (in hours) for each combination of Chinese patrol density and U.S. force composition.

Chinese Patrol Density	**U.S. Force Composition**		
	Single Destroyer	**Multiple Destroyers**	**Destroyers + Carrier**
10%	95%	85%	75%
25%	80%	70%	60%
50%	65%	55%	45%
75%	50%	35%	20%

Table 1: Median Time to Detection (Monte Carlo Results)

7 References

- Agent-based model and mission assignment: See Overleaf.tex
- Paper structure and analysis: See DraftManuscript.tex