Figure 1: Distributed Witness Network Architecture
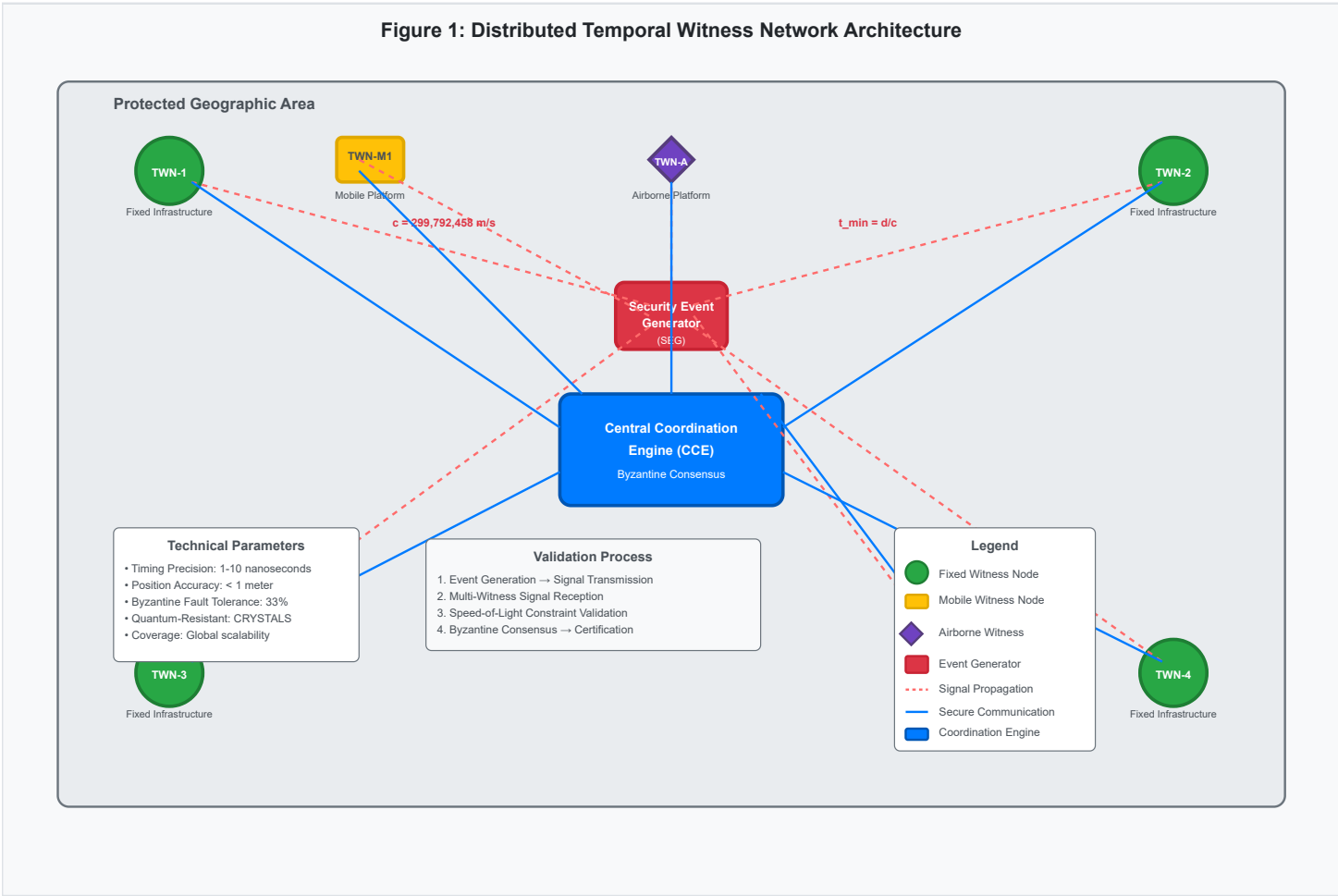

Figure 1: Distributed Temporal Witness Network Architecture

Figure 2: Speed-of-Light Validation Engine

Figure 2: Speed-of-Light Validation Engine Operation

Fundamental Physics Constraint

$$t\_min = t_0 + d/c$$

Any signal arriving before t_min violates physics

Location: (x_0, y_0)

75m

Distance: 90m

TWN-1

t_min = 300 ns

Distance: 180m

TWN-2

t_min = 600 ns

Distance: 75m

TWN-3

t_min = 250 ns

Speed-of-Light Validation Engine

Step 1: Distance Calculation

$d_1 = \sqrt{[(x_1-x_0)^2 + (y_1-y_0)^2]} = 90m$
$d_2 = \sqrt{[(x_2-x_0)^2 + (y_2-y_0)^2]} = 180m$
$d_3 = \sqrt{[(x_3-x_0)^2 + (y_3-y_0)^2]} = 75m$

Step 2: Minimum Time Calculation

$t\_min = t_0 + d/c$ (where c = 299,792,458 m/s)
TWN-1: $t\_min = 0 + 90m/c = 300$ ns
TWN-2: $t\_min = 0 + 180m/c = 600$ ns
TWN-3: $t\_min = 0 + 75m/c = 250$ ns

Step 3: Arrival Time Validation

If $t\_arrival < t\_min \rightarrow$ INVALID (Physics Violation)
If $t\_arrival \geq t\_min \rightarrow$ VALID (Physically Possible)

Step 4: Environmental Compensation

Adjust for temperature, humidity, altitude effects

Validation Results

Witness Node Status:

- TWN-1: VALID (t_arrival = 305ns)
- TWN-2: VALID (t_arrival = 608ns)
- TWN-3: INVALID (t_arrival = 200ns)

Consensus Decision:

2/3 Witnesses Valid → Event ACCEPTED
Attack Detected at TWN-3
Security Alert Generated

Precision Timeline

0 ns (Event)
Invalid Zone
250 ns
TWN-3 Valid
300 ns
TWN-1 Valid
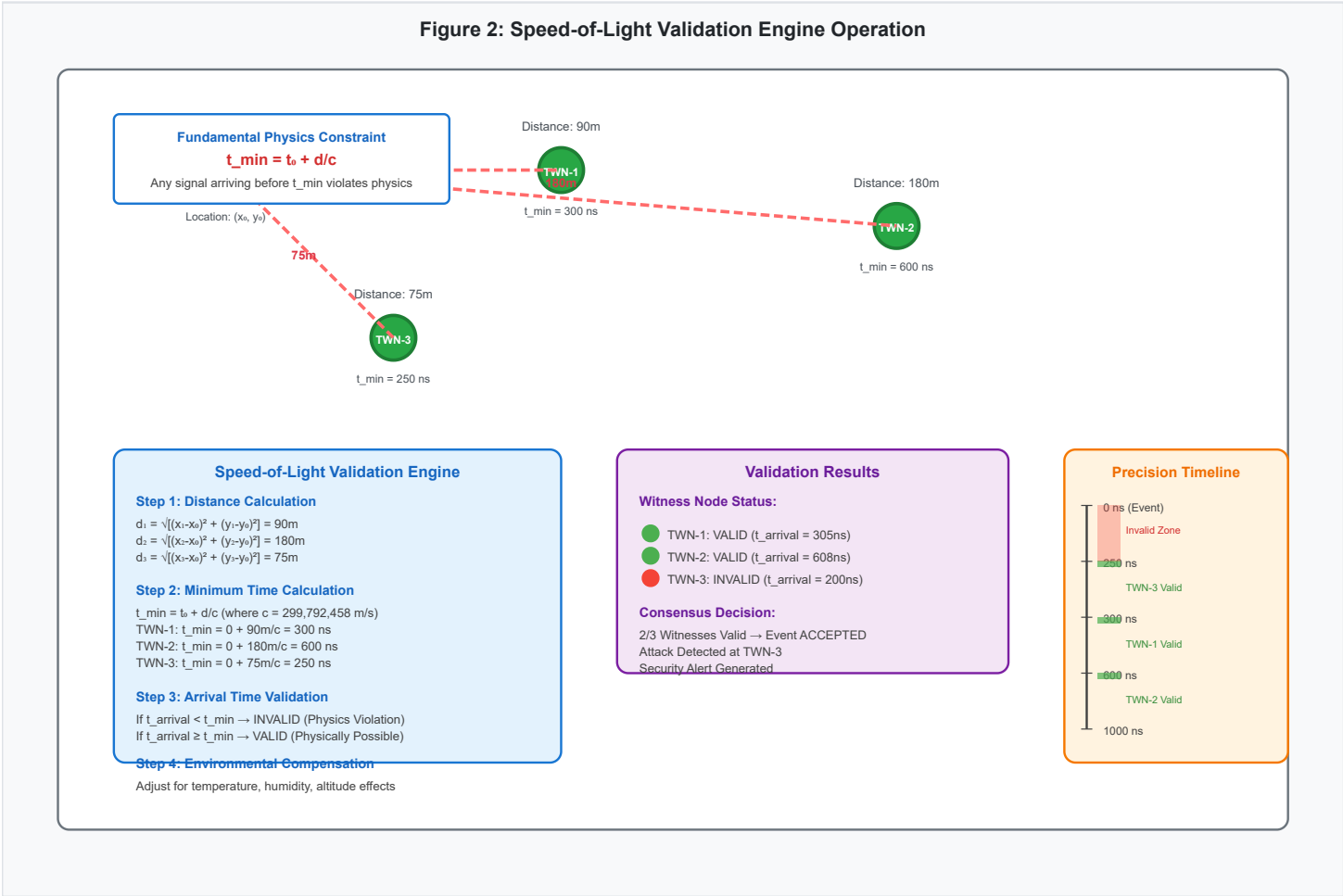600 ns
TWN-2 Valid
1000 ns

Figure 3: Byzantine Consensus Protocol

This page contains the following errors:

error on line 166 at column 25: xmlParseEntityRef: no name

Below is a rendering of the page up to the first error.

Figure 3: Byzantine Fault Tolerant Consensus Protocol

Phase 1: Initial Response

W1 — Valid 305ns
W2 — Valid 608ns
W3 — Invalid 200ns
W4 — Valid 420ns

Each witness independently validates signal timing

Result: 3/4 Valid, 1/4 Invalid

Phase 2: Cross-Correlation

Correlation Matrix

0.95	0.12	0.88
0.18	0.92	0.15
0.93	0.08	0.91

W3 shows anomalous correlation

Phase 3: Consensus

Byzantine Vote

W1 ACCEPT
W2 ACCEPT
W3 REJECT
W4 ACCEPT

Super-majority: 3/4 ≥ 2/3

CONSENSUS: ACCEPT

Phase 4: Final Validation Certificate

✓ Timestamp: 2025-09-04 15:32:07.123456789 UTC
✓ Event Location: (40.7589, -73.9851) ±0.5m
✓ Witness Consensus: 3/4 nodes (75% agreement)
✓ Physics Validation: PASS (all valid times ≥ t_min)
✓ Digital Signature: CRYSTALS-Dilithium verified