Patriot Missile Software Failure

Aly Farahat

Background

- Anti-missile system
- Surface-to-air
- mobile
- air defense system
- Developed by Raytheon

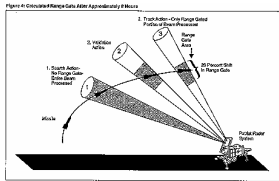# Defends against

- Aircrafts
- Cruise missiles
- Short range ballistic missiles

Failure

- Skud ballistic missile launched on Feb 25th 1991 hits the Dahran American Military base.
- Patriot system failed to track the Skud missile and never launched.

1/28/2009   CS5090   4

Failure Reason

- Software error in the control and tracking radar system of the weapon
- Conversion from integral units of time to floating point representation rounded off the number
- 1/10 in binary has a non-terminating expansion
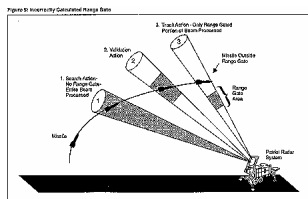- 100 hours of continuous run caused a time shift of 0.43 s

1/28/2009   CS5090   5

Failure Reason (cont'd)

- 0.43 s are sufficient for a Skud Missile to travel 670 m
- This shift caused a significant error in trajectory estimation and hence, failure in tracking

1/28/2009   CS5090   6

Cost of Failure

- 28 Soldiers dead
- >90 injured
- A failure to track after launch costs around $600K

Means of Avoidance

- A bug fix was already available by Feb, 16th.

- Ambiguity of "very long operation time"

- Program verification in simulated real-time

- No requirement for operation time >100 hours… Requirements redefinition

- Correct conversion from integer to float should have avoided this failure

Open Questions

- How could addition of fault tolerance avoided this failure?

- Suggest a representation for time to avoid the shift

Sources

- General Accounting Office Report: http://www.fas.org/spp/starwars/gao/im92026.htm

- "The Patriot Missile Failure in Dhahran: Is Software to Blame?":http://shelley.toich.net/projects/CS201/patriot.html

- MIM-104 Patriot: http://en.wikipedia.org/wiki/MIM-104_Patriot

- Patriot Missile System Problem: http://www.cs.usyd.edu.au/~alum/patriot_bug.html

1/28/2009   CS5090   10

Thank you!

Questions?

1/28/2009   CS5090   11