

TRUE NORTH FLOATING POINT (/)

HIDDEN DANGER

# The Problem

<https://www.truenorthfloatingpoint.com/problem>

## WHY FLOATING POINT?

Floating point was created because computers needed to represent real numbers in a fixed number of digits and to perform operations on them. The very first computer, the Zuse Z3, employed floating point in 1941.

**First standardized in 1985, floating point, and operations with floating point numbers, are defined by an international standard**

([http://en.wikipedia.org/wiki/IEEE\\_754](http://en.wikipedia.org/wiki/IEEE_754)).

## WHAT IS FLOATING POINT REPRESENTATION?

Computers represent real numbers (numbers with a decimal point) with a scheme similar to scientific notation. Floating point numbers are represented with a fixed number of digits, and just as  $1/3$  (0.33333...) cannot be represented without error, real numbers with fractions in a computer usually have some error.

[https://en.wikipedia.org/wiki/IEEE\\_754](https://en.wikipedia.org/wiki/IEEE_754)



Photo from [www.army.mil](http://www.army.mil)

## **PATRIOT MISSILE FAILURE**

The most notorious floating point error catastrophe was the Patriot Missile Failure

([https://en.wikipedia.org/wiki/MIM-104\\_Patriot#Failure\\_at\\_Dhahran](https://en.wikipedia.org/wiki/MIM-104_Patriot#Failure_at_Dhahran)) at Dhahran, Saudi Arabia, February 25, 1991, when a Patriot missile failed to

destroy a SCUD missile and 128 U.S. military soldiers were killed or wounded as a result. This was the greatest combat loss in an Army unit since Vietnam. **The conversion of 100 hours in tenths of a second (3600000) to floating point introduced an undetectable error resulting in the missile guidance software incorrectly locating the SCUD missile** (<http://www.gao.gov/assets/220/215614.pdf>).

# ARIANE 5 ROCKET, FLIGHT 501

On June 4th, 1996, 40 seconds into flight and at an altitude of 3.7 kilometers, the initial launch of the Ariane 5 rocket, flight 501 (<http://sunnyday.mit.edu/nasa-class/Ariane5-report.html>), ended in RUD (colloquially, Rapid Unplanned Disassembly). Estimates of the loss of the rocket and cargo are as high as \$500M. **Cause of the failure was an inappropriate floating point conversion.** (Photo from Deadpan ([https://commons.wikimedia.org/wiki/File:Ariane\\_501\\_Fragment.jpg](https://commons.wikimedia.org/wiki/File:Ariane_501_Fragment.jpg)))



Recovered piece of Ariane 5 after RUD

**RUD - GOOD EUPHEMISM**



## VANCOUVER STOCK EXCHANGE

In January of 1982 the Vancouver Stock Exchange

(<https://www5.in.tum.de/~huckle/Vancouver.pdf>) started a stock index

accumulating total stock value for all

1,400 stocks listed on the exchange. but

<https://web.ma.utexas.edu/users/arbogast/misc/disasters.html>

truncating (rounding down) that sum up to 3000 times per day resulting in a loss of index value of about \$25 per month for about 23 months **indicating an index value of \$524.811 when the actual value was \$1098.892.**

(Image by Mafue

(<https://www.flickr.com/photos/mafue/4810200633/>))

<https://slate.com/technology/2019/10/round-floor-software-errors-stock-market-battlefield.html>