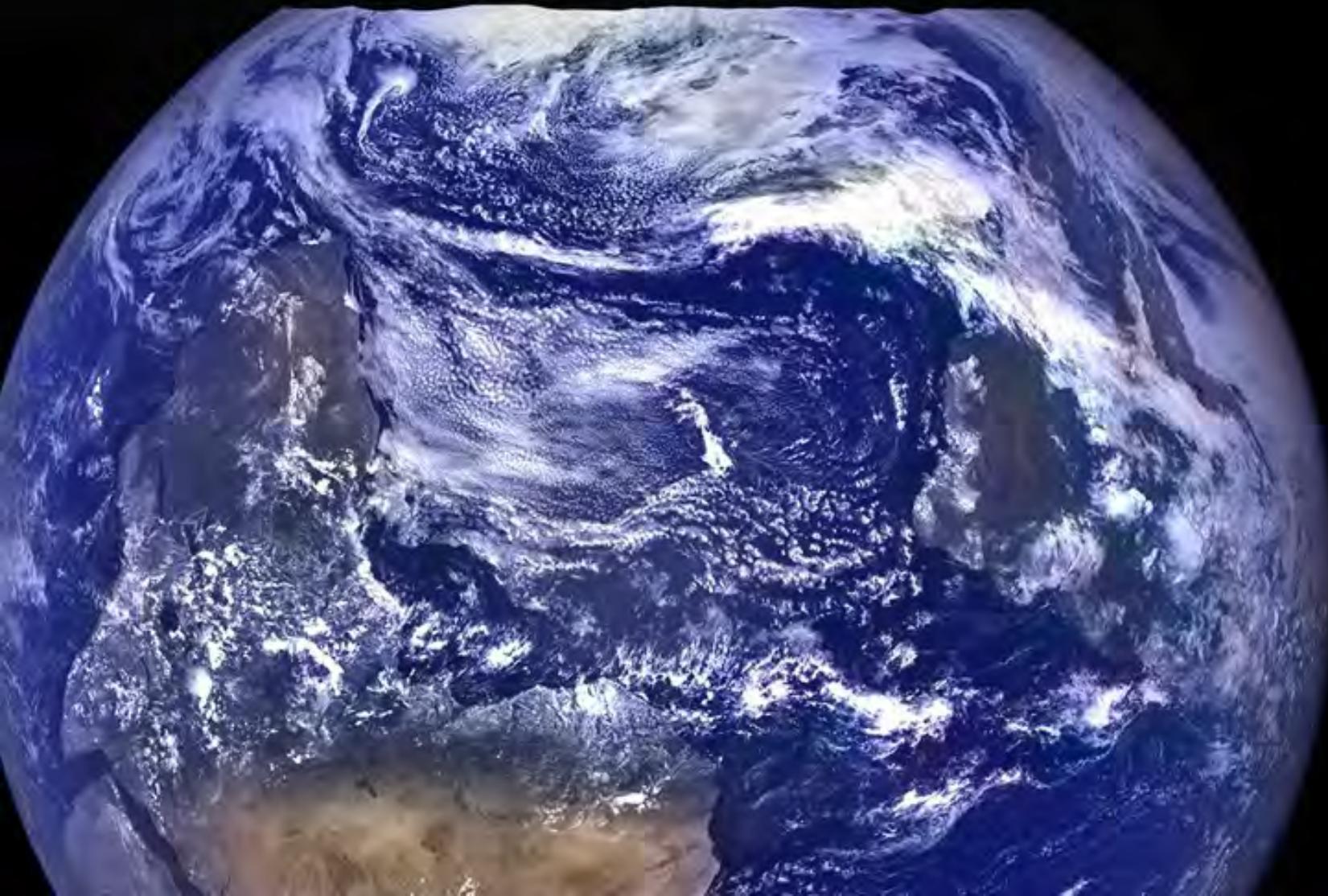


# The Rapidly Evolving Landscape of Human Spaceflight

## Implications from the Economic Revolution on the Final Frontier



**Greg Autry, PhD**  
March, 2024



A unit of the Arizona State University Knowledge Enterprise

**Imperial College  
London**

# Query

Is computing important to your research?

# 1980



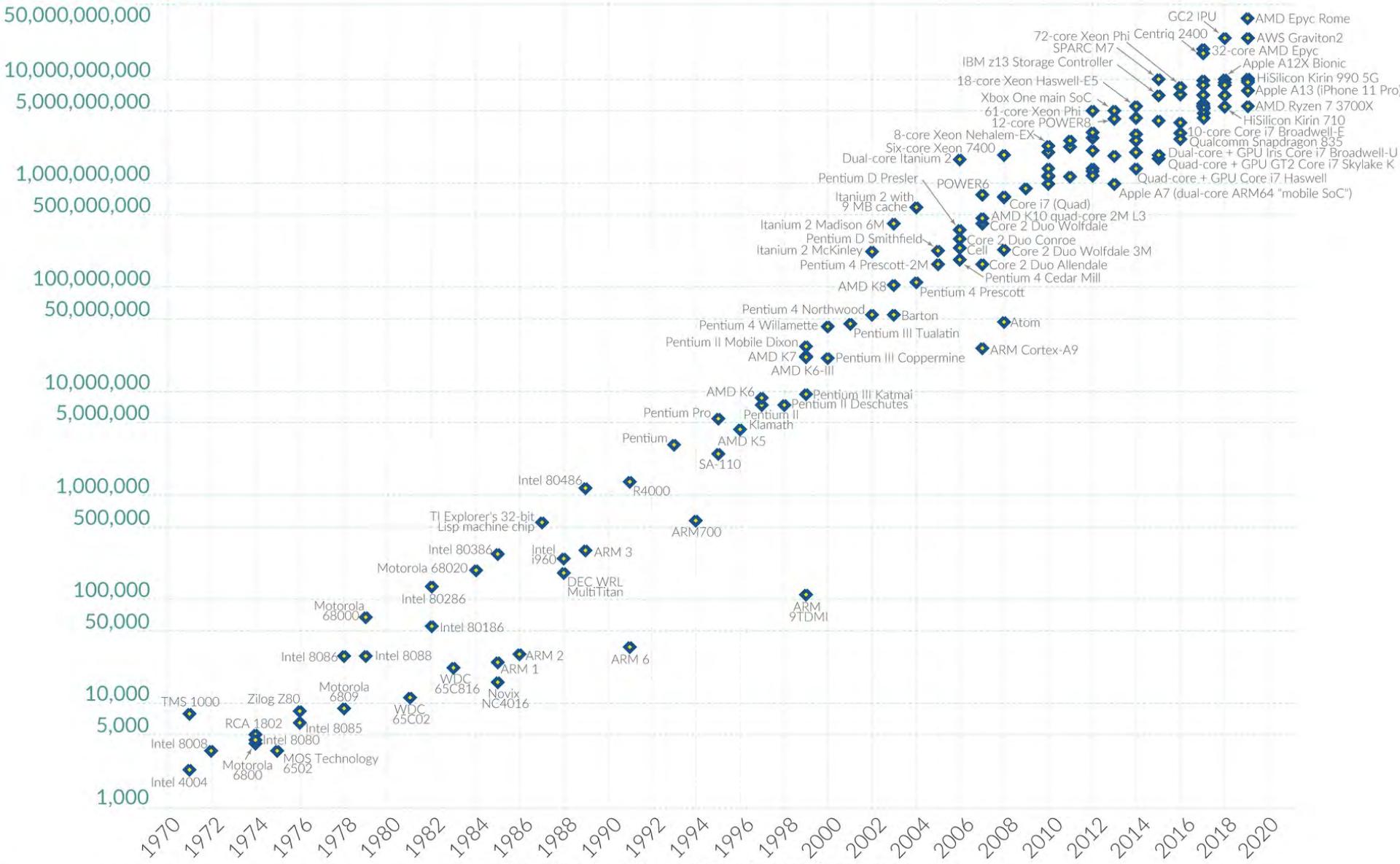
Moore's Law: The number of transistors on microchips doubles every two years

Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years.

This advancement is important for other aspects of technological progress in computing – such as processing speed or the price of computers.

## Our World in Data

## Transistor count



Data source: Wikipedia ([wikipedia.org/wiki/Transistor\\_count](https://en.wikipedia.org/wiki/Transistor_count))

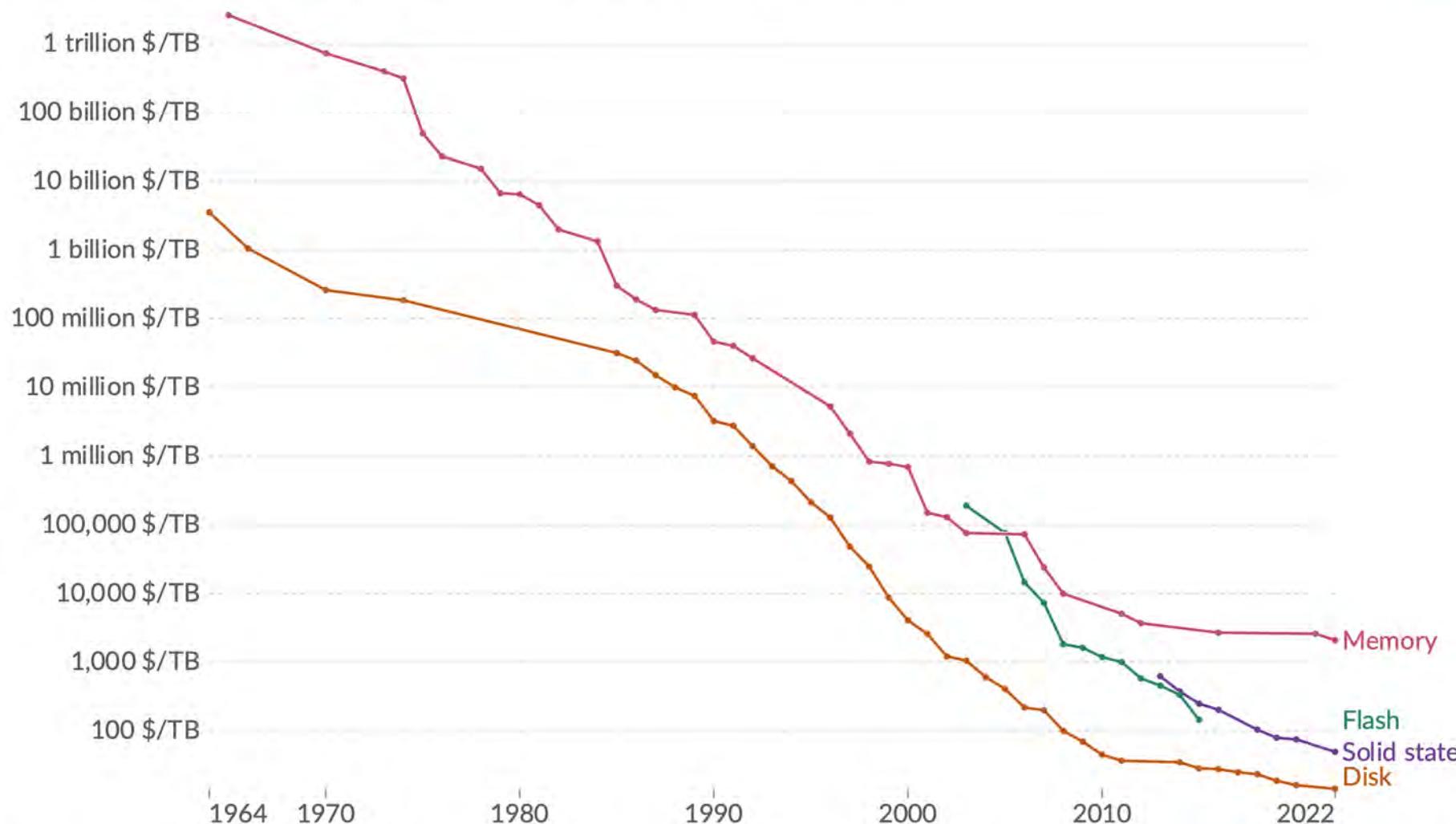
ear in which the microchip was first introduced

OurWorldinData.org – Research and data to make progress against the world's largest problems.

Licensed under CC-BY by the authors Hannah Ritchie and Max Roser.

# Historical cost of computer memory and storage

This data is expressed in US dollars per terabyte (TB). It is not adjusted for inflation.

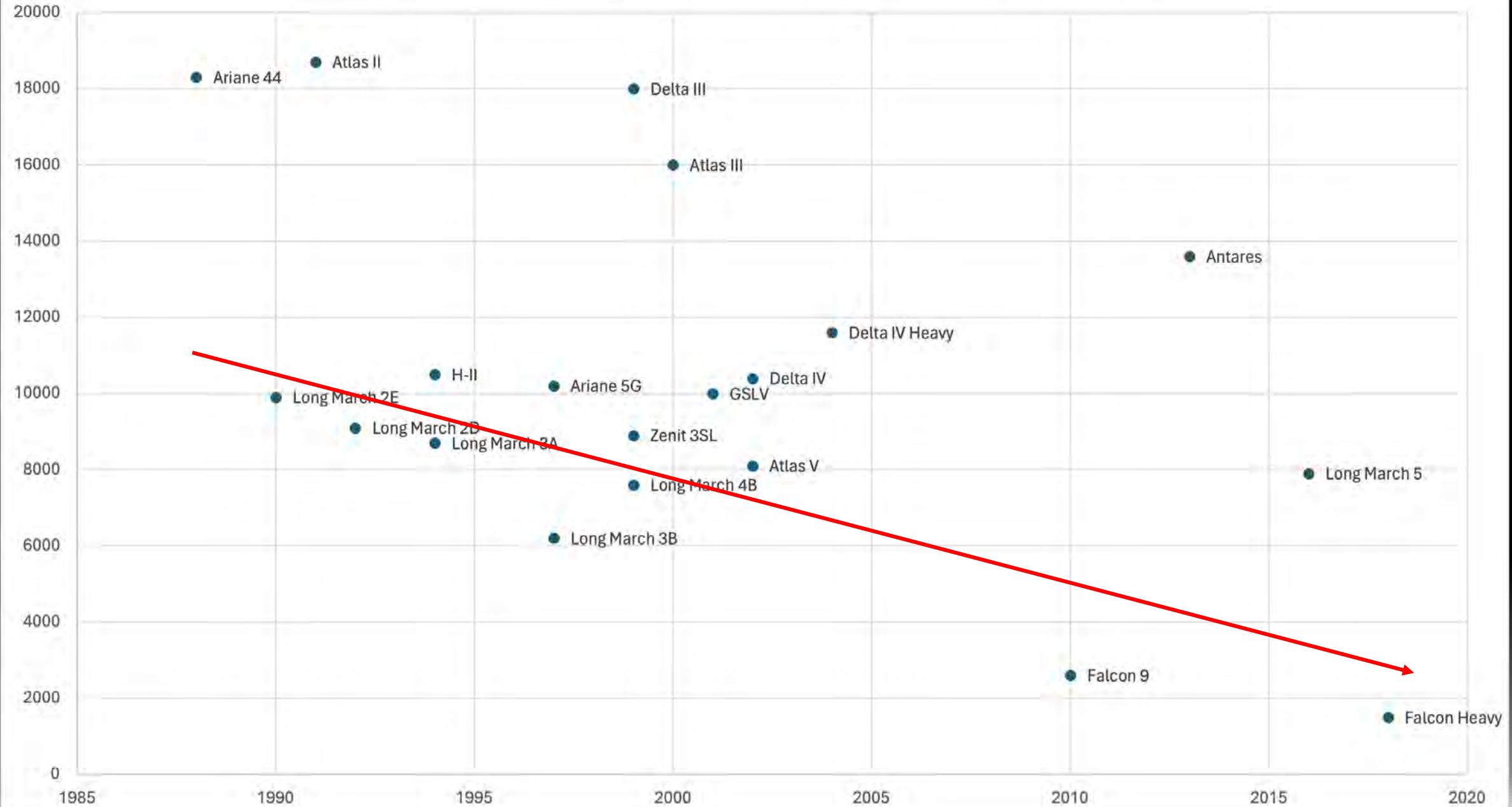


Data source: John C. McCallum (2022)

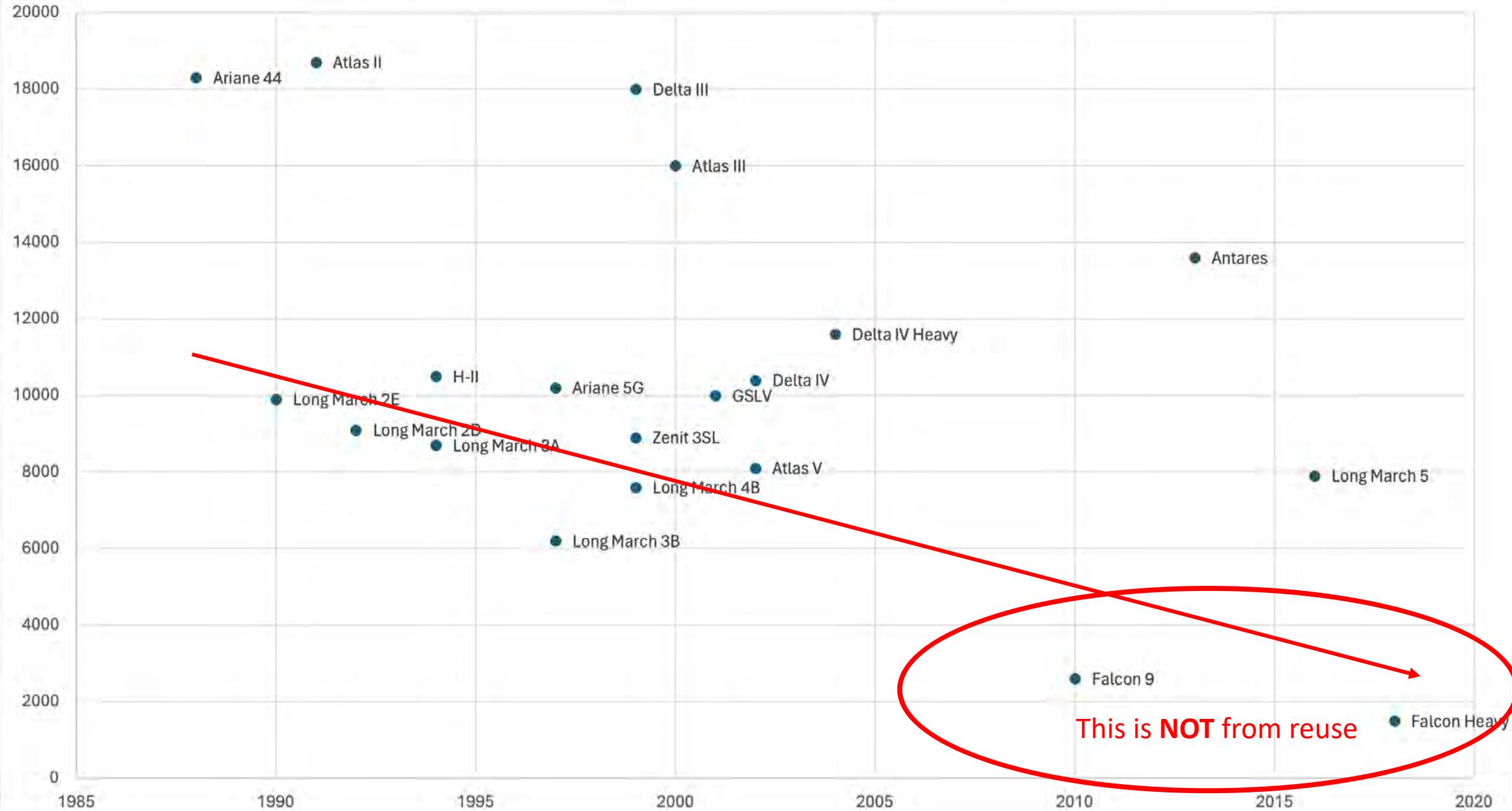
Note: For each year, the time series shows the cheapest historical price recorded until that year.

[OurWorldInData.org/technological-change](https://OurWorldInData.org/technological-change) | CC BY

Competitive Med-Heavy Luanch Cost: \$ per kg 1985-2020 (sans outliers)

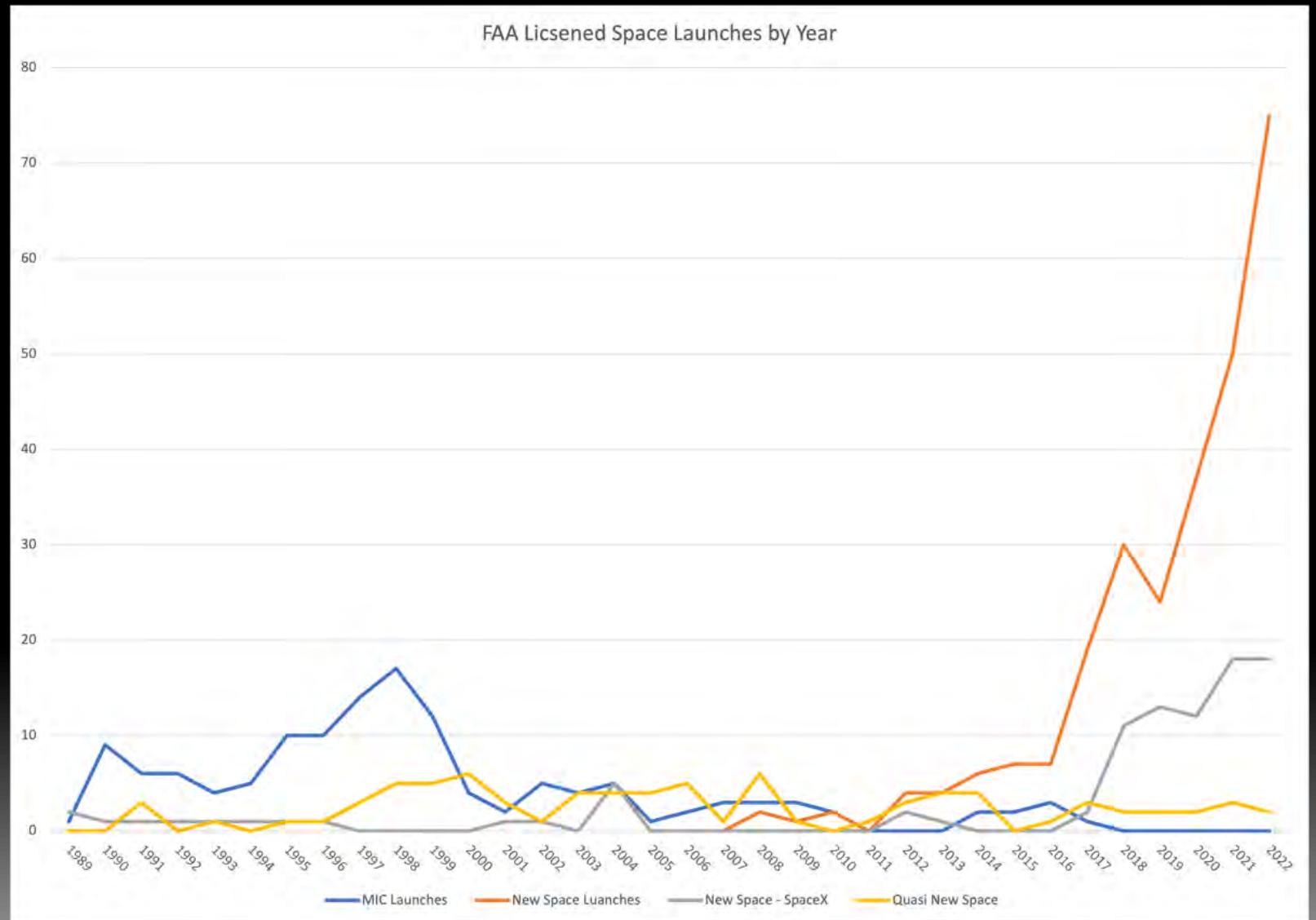


## Competitive Med-Heavy Luanch Cost: \$ per kg 1985-2020 (sans outliers)



# U.S. Space Entrepreneurship is revolutionizing space launch

SpaceX  
Firefly  
Rocket Lab  
Orbital / NG  
Relativity

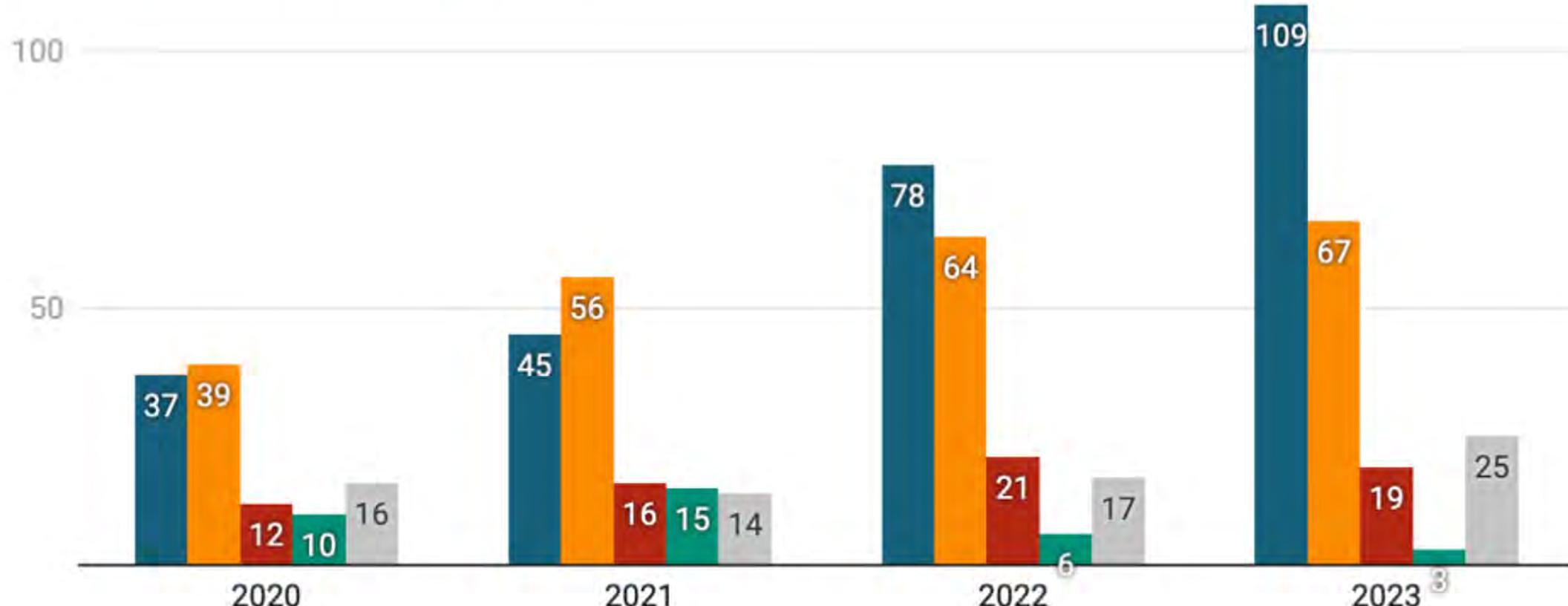


# U.S. recaptures global launch market

## 2023 Orbital Launch Attempts by Country

223 orbital launches were attempted last year. 212 reached orbit.

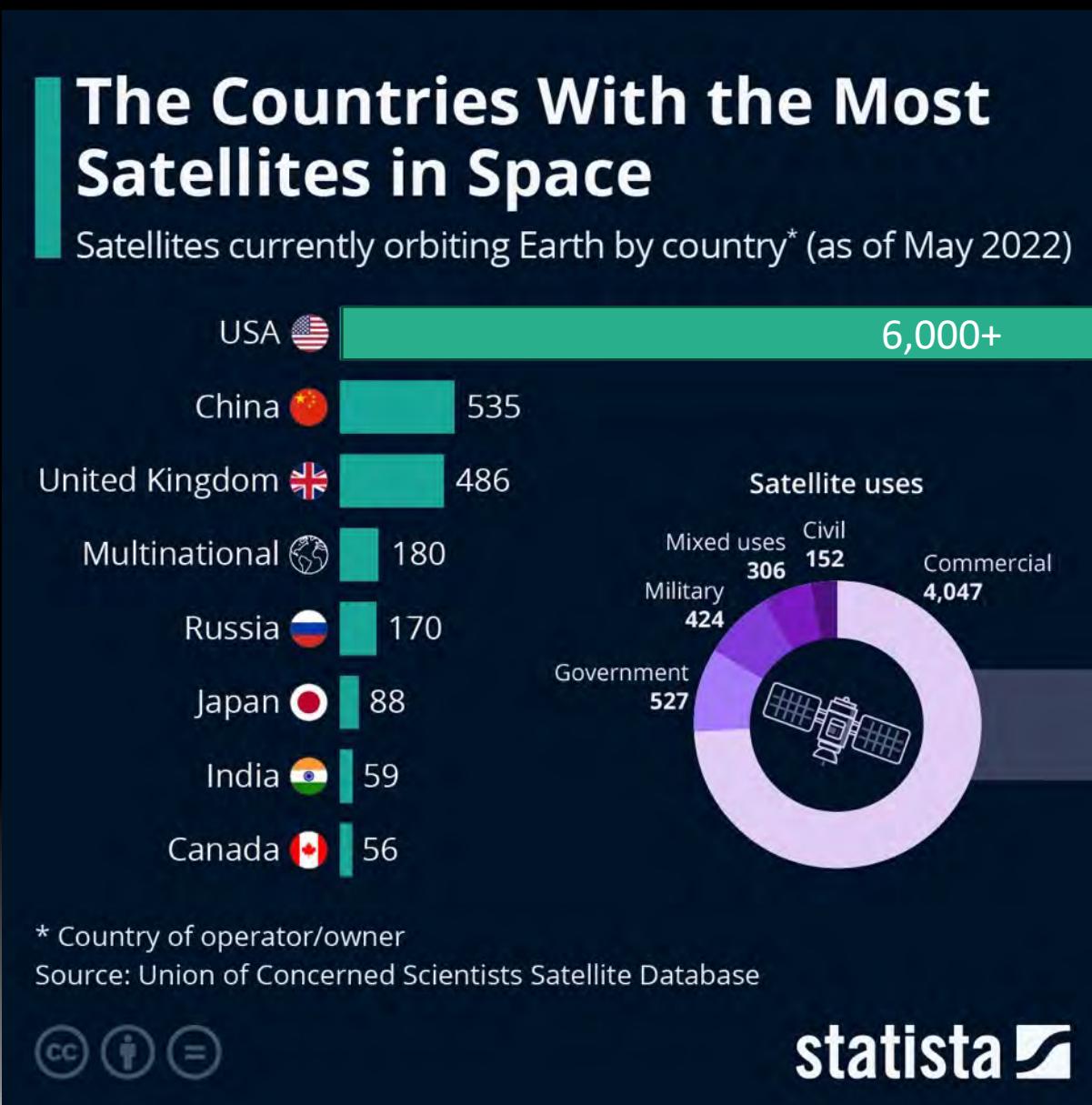
USA China Russia Europe Other



# An Embarrassment of Riches



U.S. entrepreneurial firms recapture global leadership in satellite production and then some...



# US Dominates Human spaceflight

FREEDOM SPLASHES DOWN —

Since Crew Dragon's debut, SpaceX has flown more astronauts than anyone

"Thank you for an incredible ride up to orbit and an incredible ride home."

ERIC BERGER - 10/14/2022, 5:57 PM



[Enlarge](#) / Crew Dragon splashes down in the Atlantic Ocean on Friday afternoon.



Since May 2020

13 Flights

30 Astronauts

Since May 2020

8 Flights

24 Cosmonauts



Since 2003

9 Flights

20 Taikonauts

*Plan for access to space to being  
ubiquitous & affordable,  
like access to computing*

# Competition vs. Cooperation



# Competition vs. Cooperation

