

**Reliving 24 Years
in the Next 12 Minutes:**
*A Statistical and Personal History
of University-Class Satellites*

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32nd Conference on Small Satellites
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Gotta Catch 'Em All

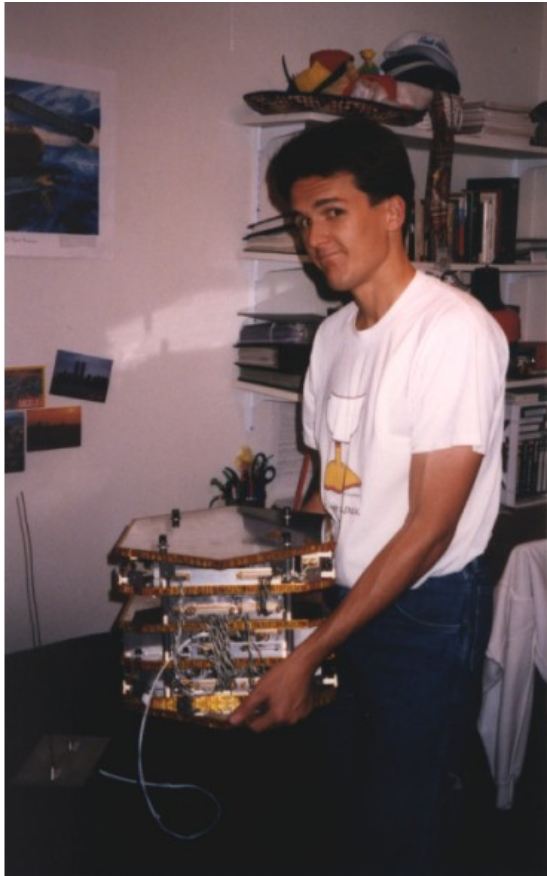
- These charts, plus live & downloadable versions of all plots and the table are available **right now** at:

<https://sites.google.com/a/slu.edu/swartwout/smallsat2018>

- Please read the paper; there's no time to cover it in 12 minutes
- This is not my CubeSat talk (though that data is on my website, too)
- ***University class mission***: student training is at least as important as any other mission objective



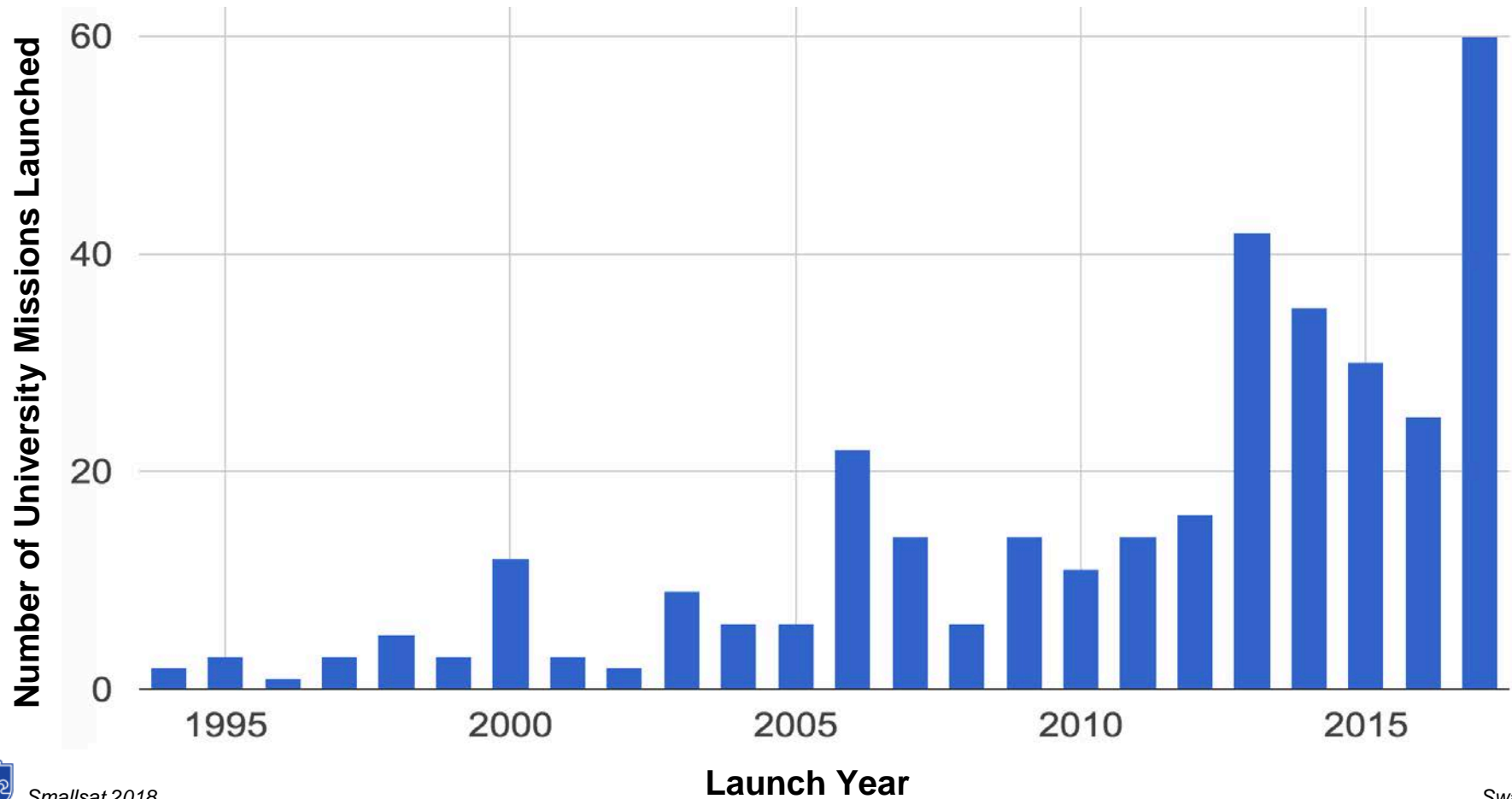
Some Make History, Some Merely Observe (and write snarky titles)



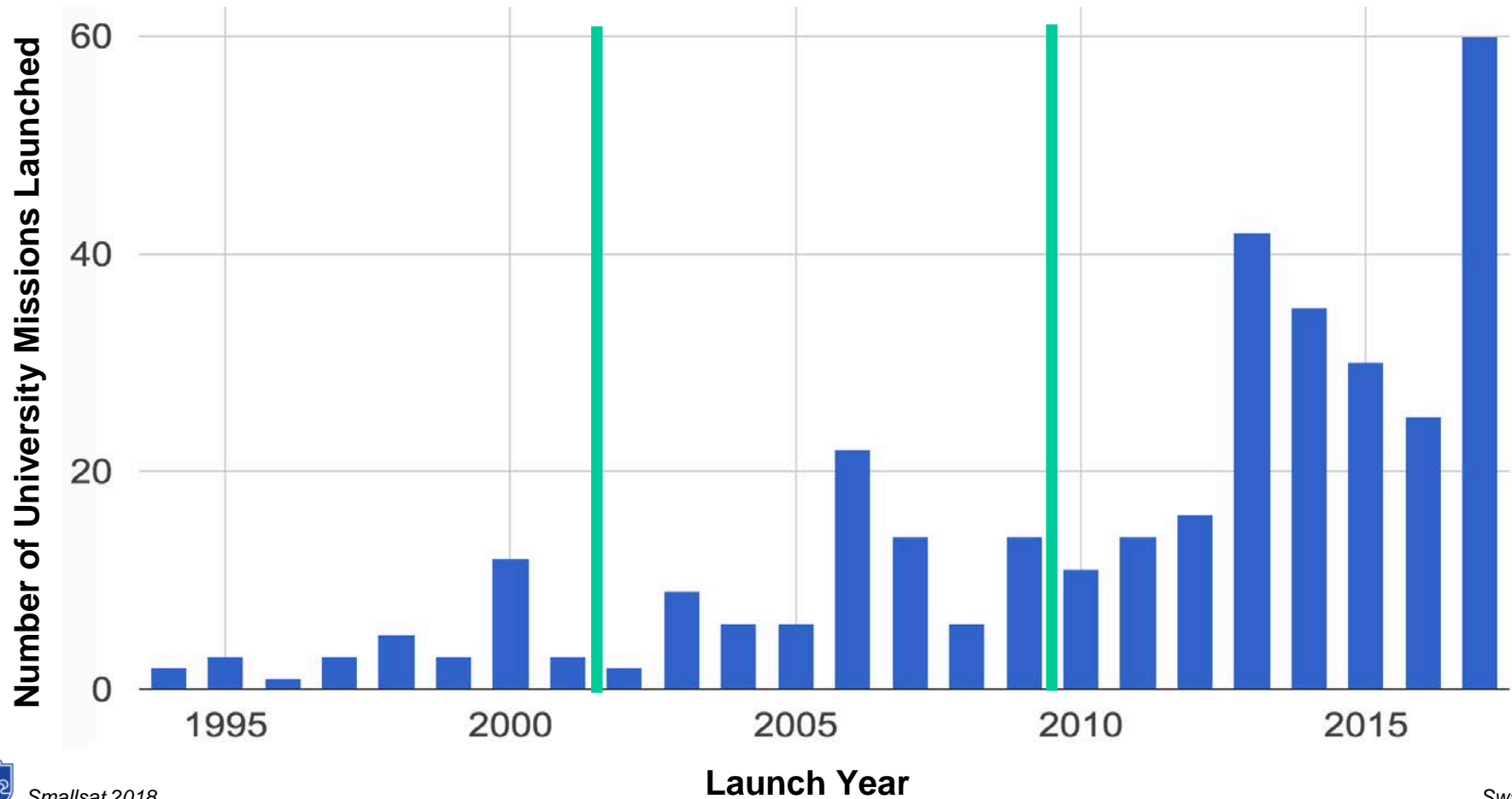
- Three eras of ***university-class*** missions
- Three types of university developers
- Three recurring questions
 - *What do we fly?*
(What should we fly?)
 - How well do they work?
 - Is this good or bad?



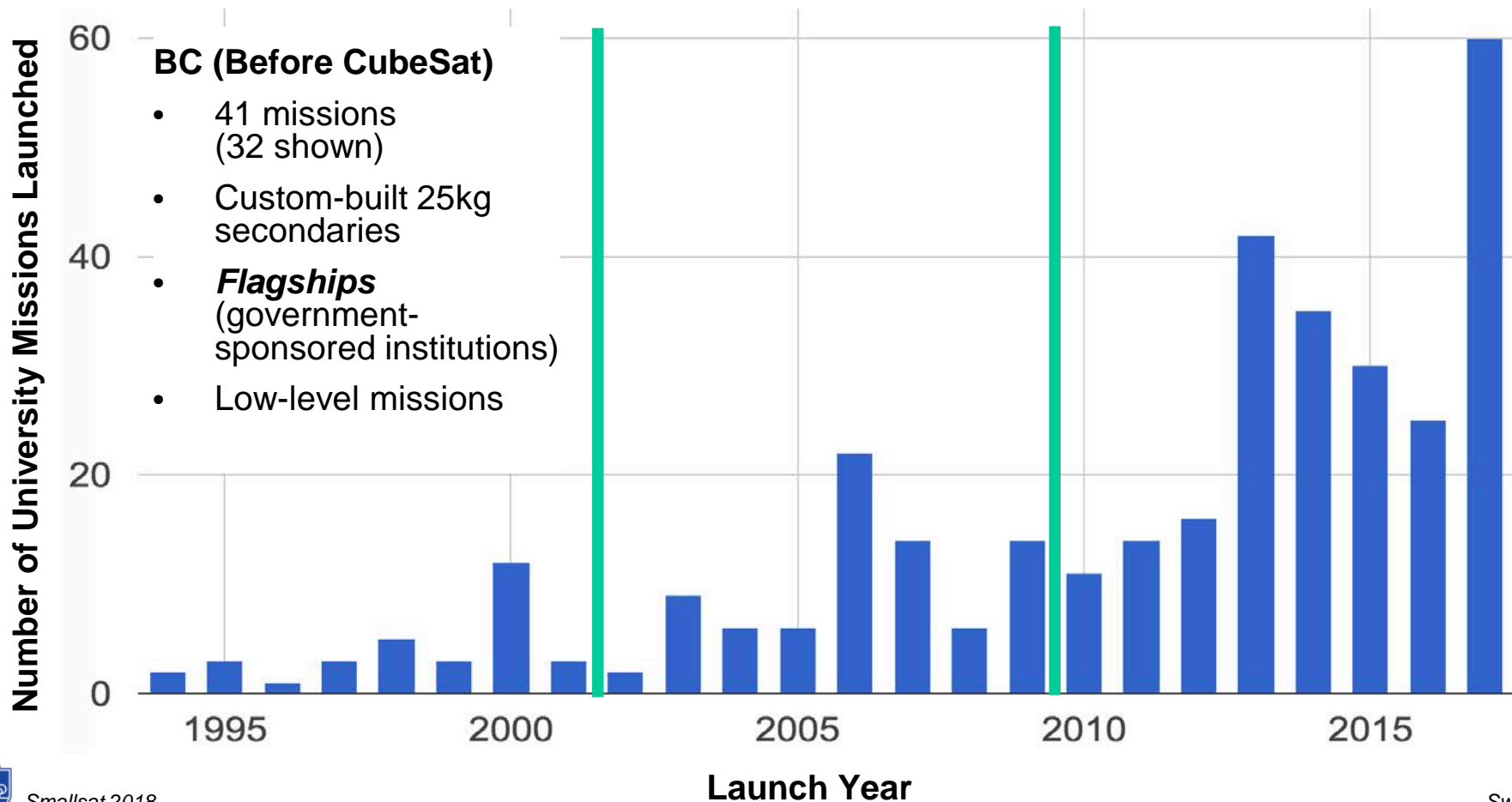
24 Years, 166 Schools, 344 Spacecraft



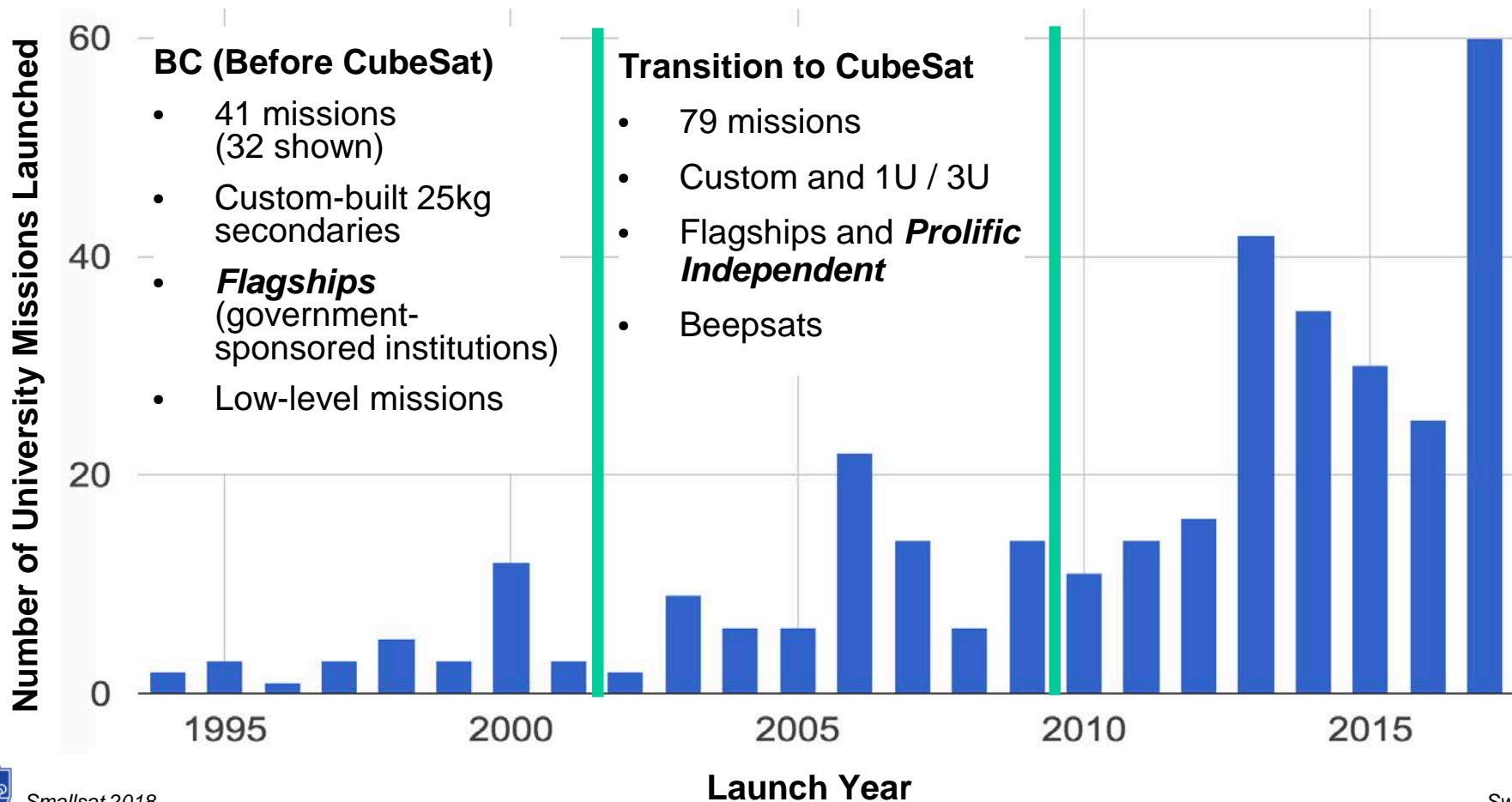
Three Eras: Arbitrary, and Yet Instructive



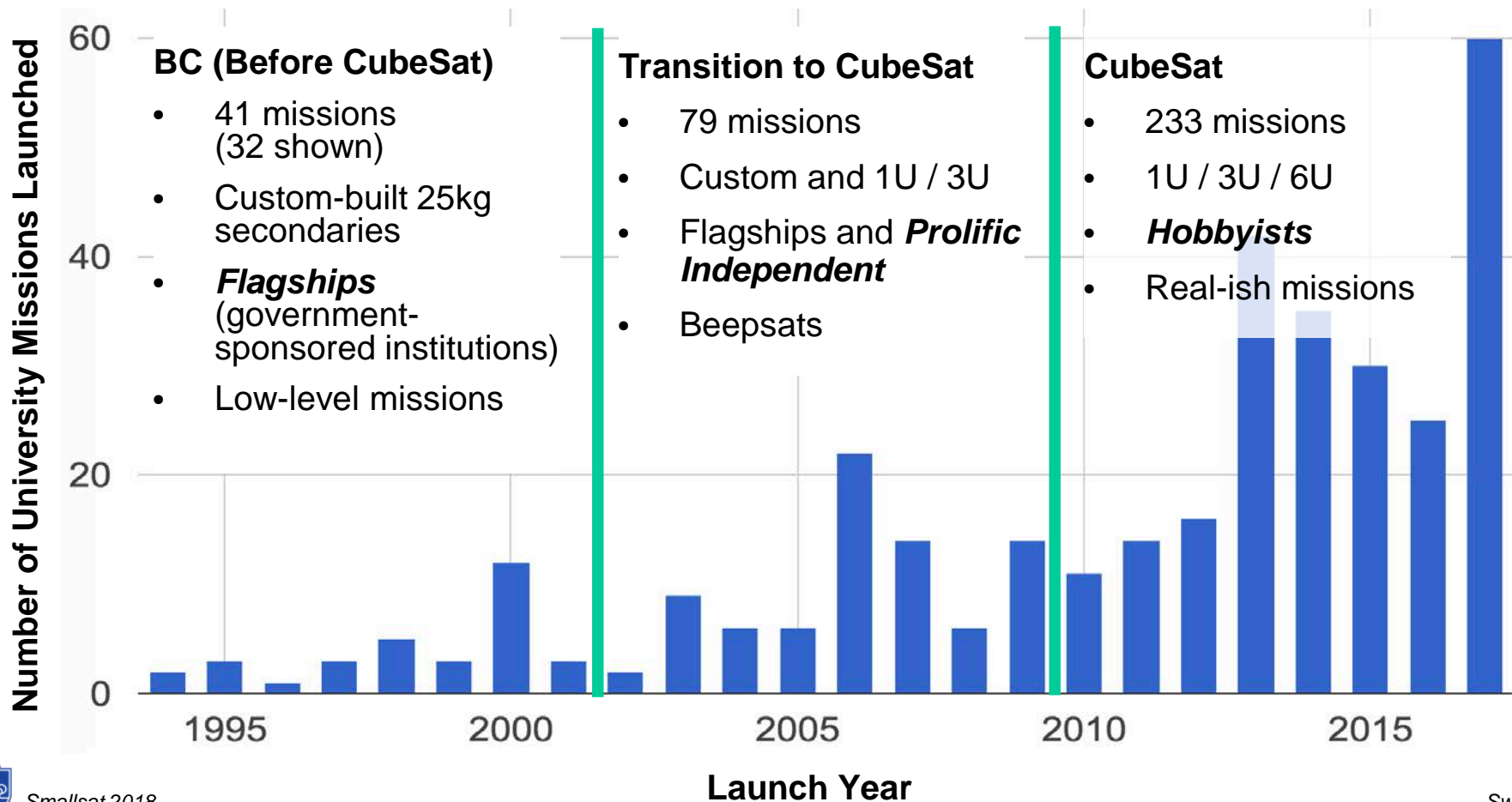
History Did Not Begin Yesterday *(Also: Get Off My Lawn)*



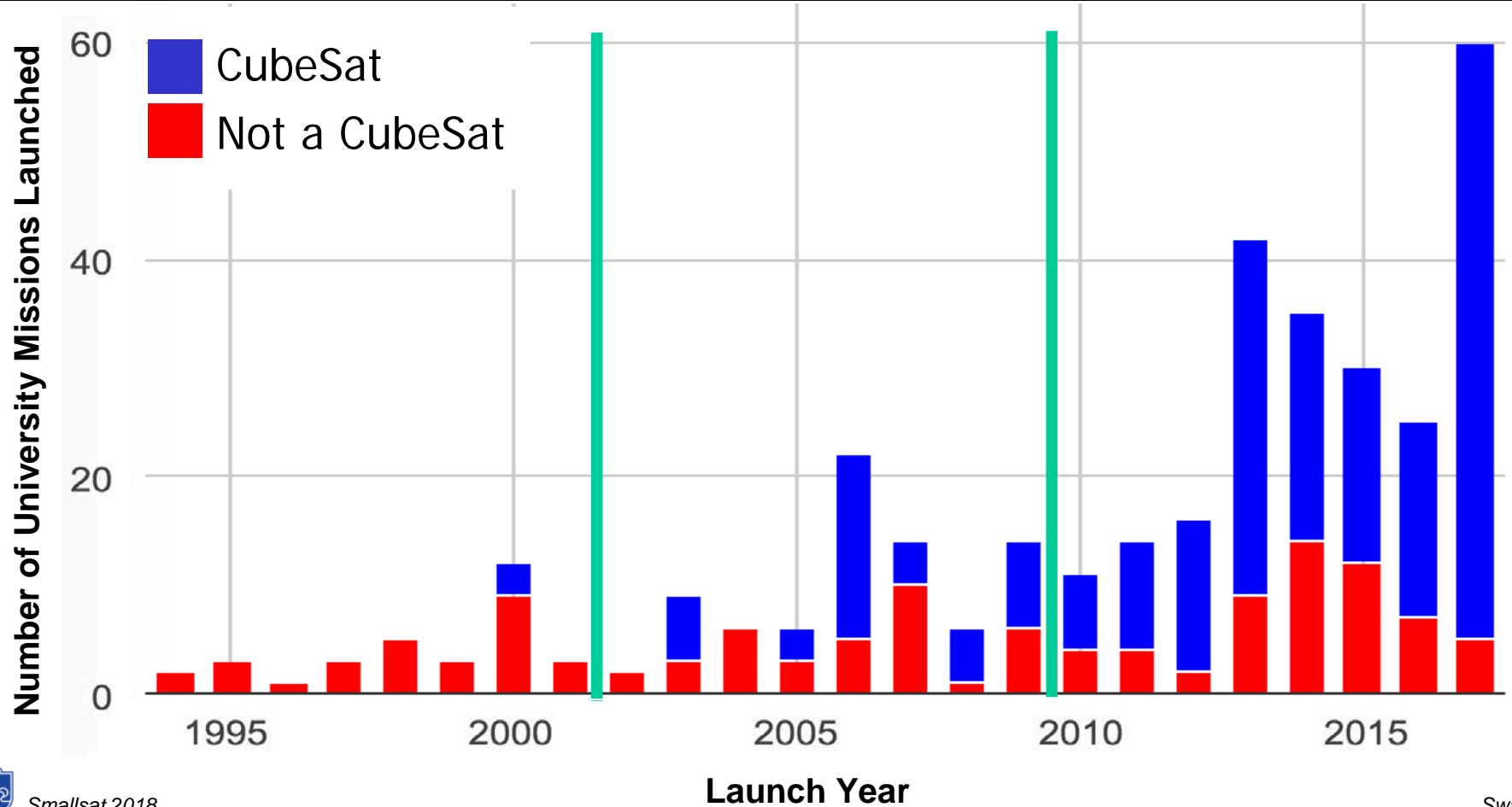
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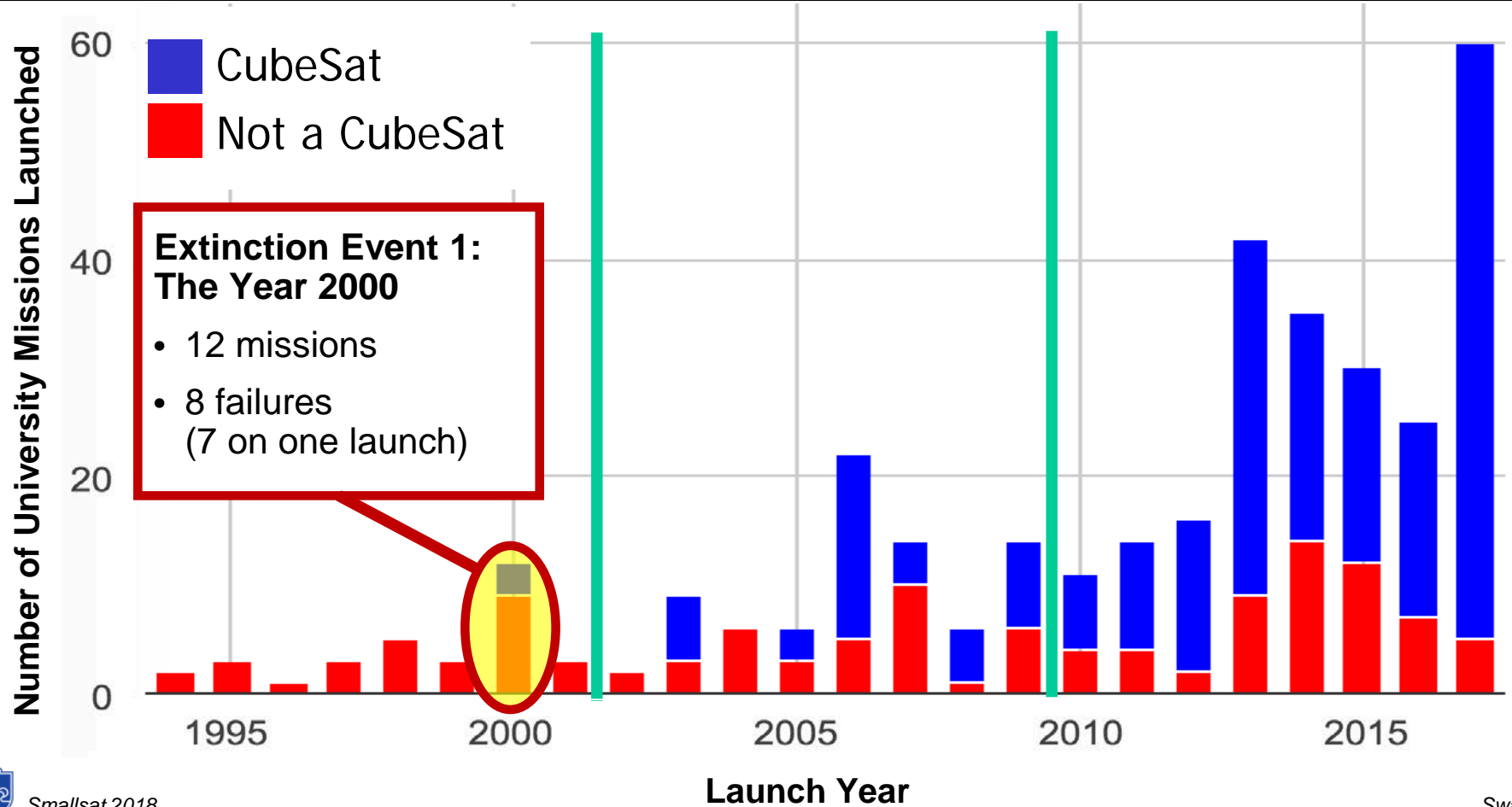
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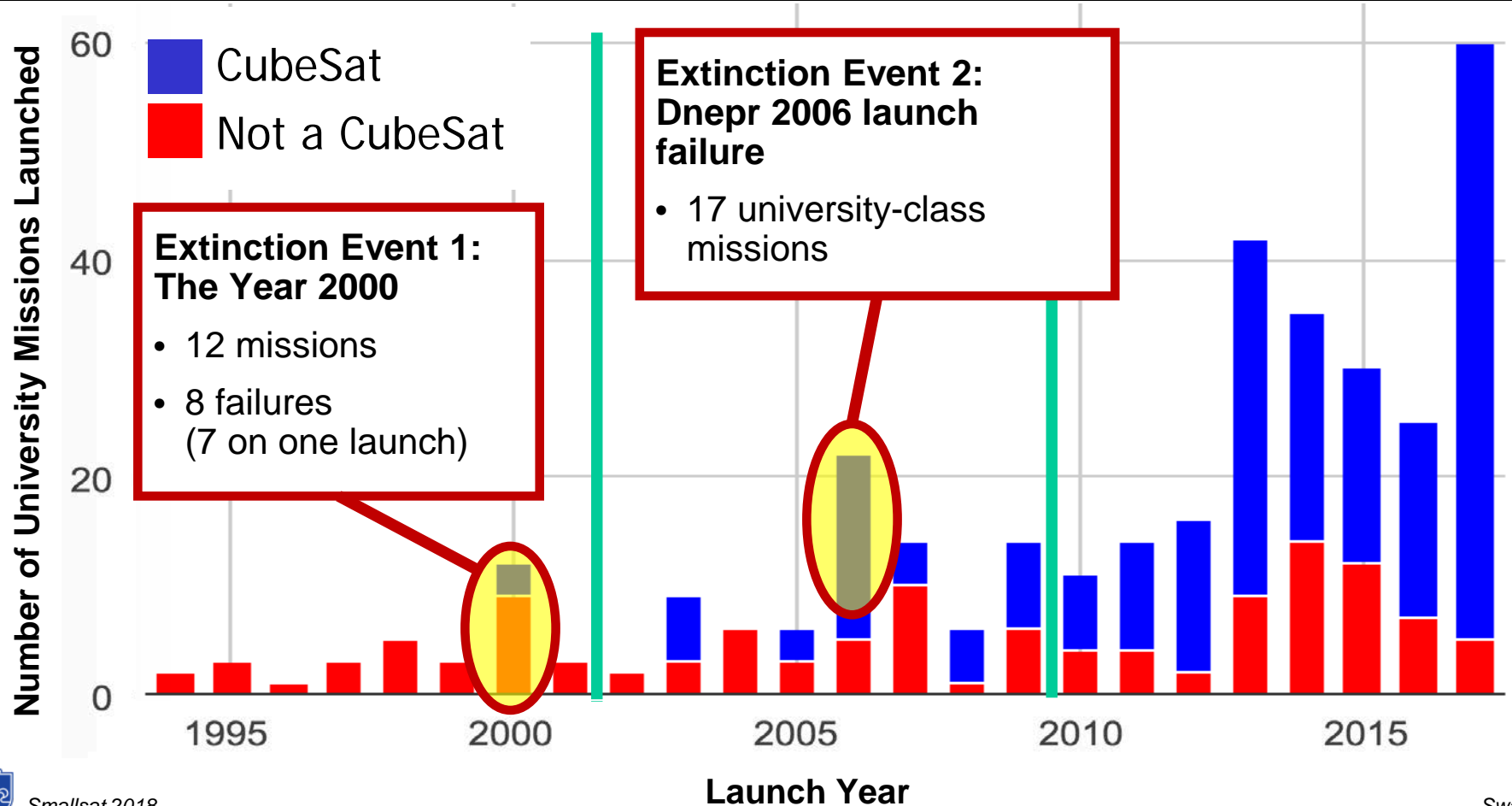
What is now Ubiquitous was once Precarious



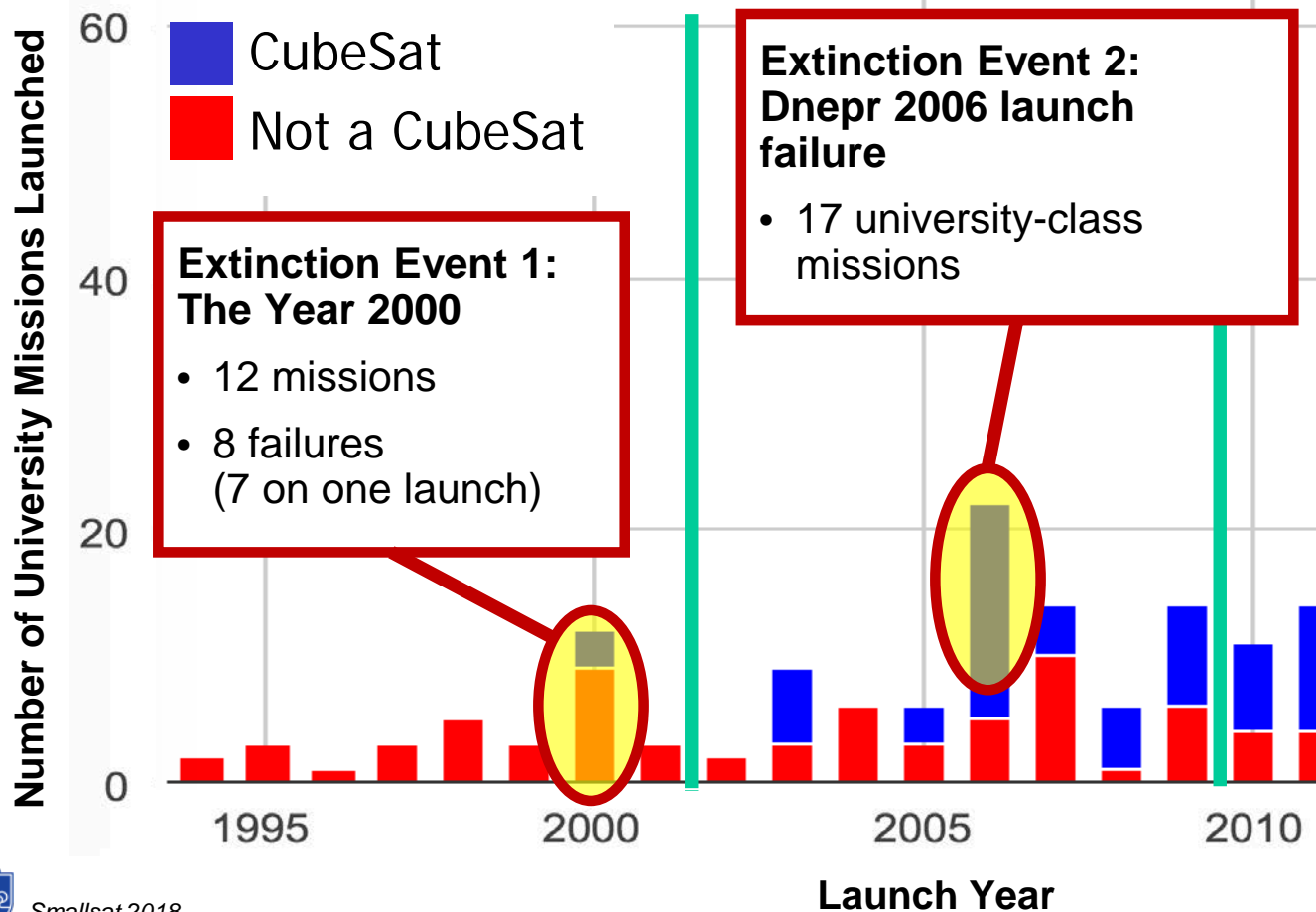
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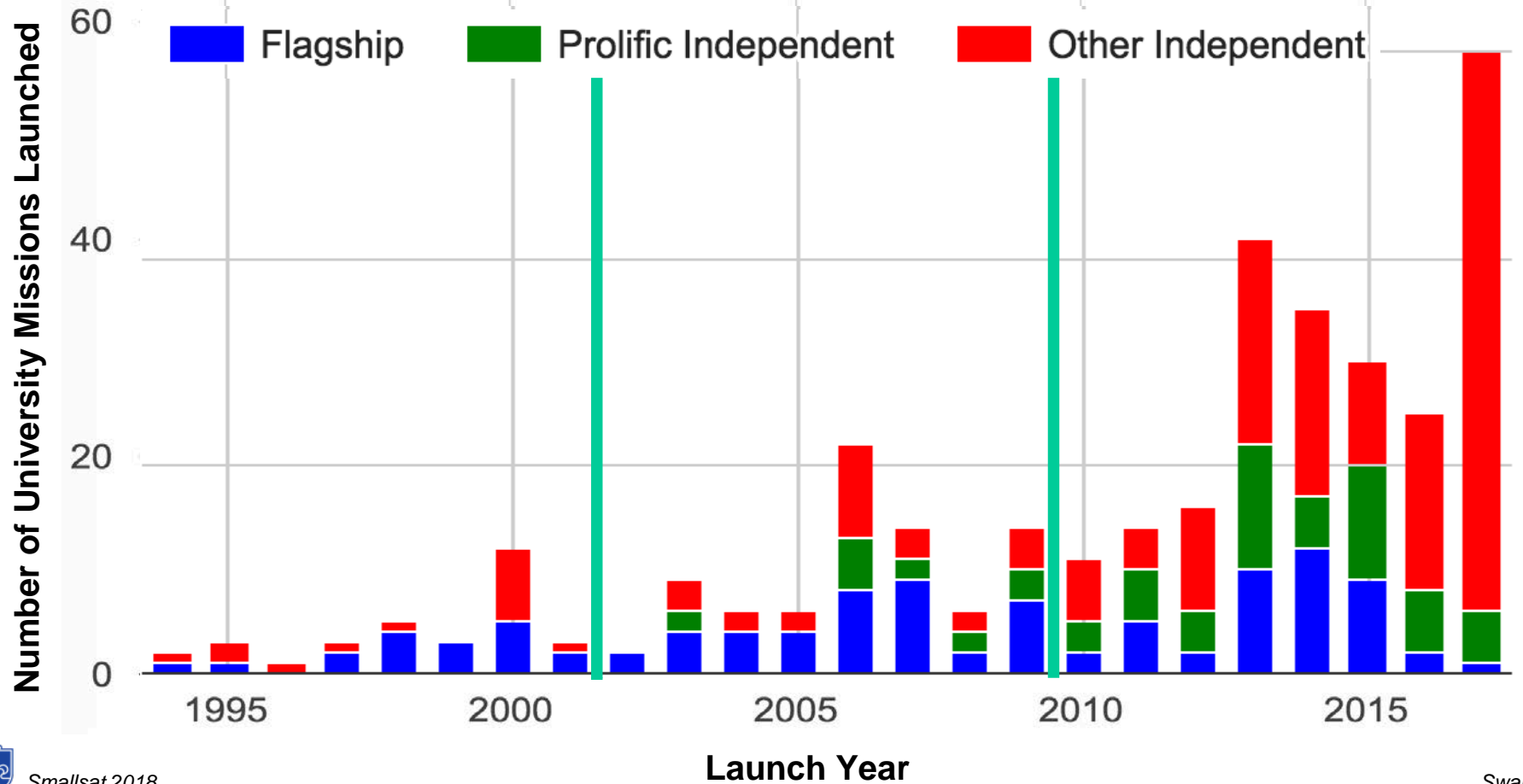


What is now Ubiquitous was once Precarious

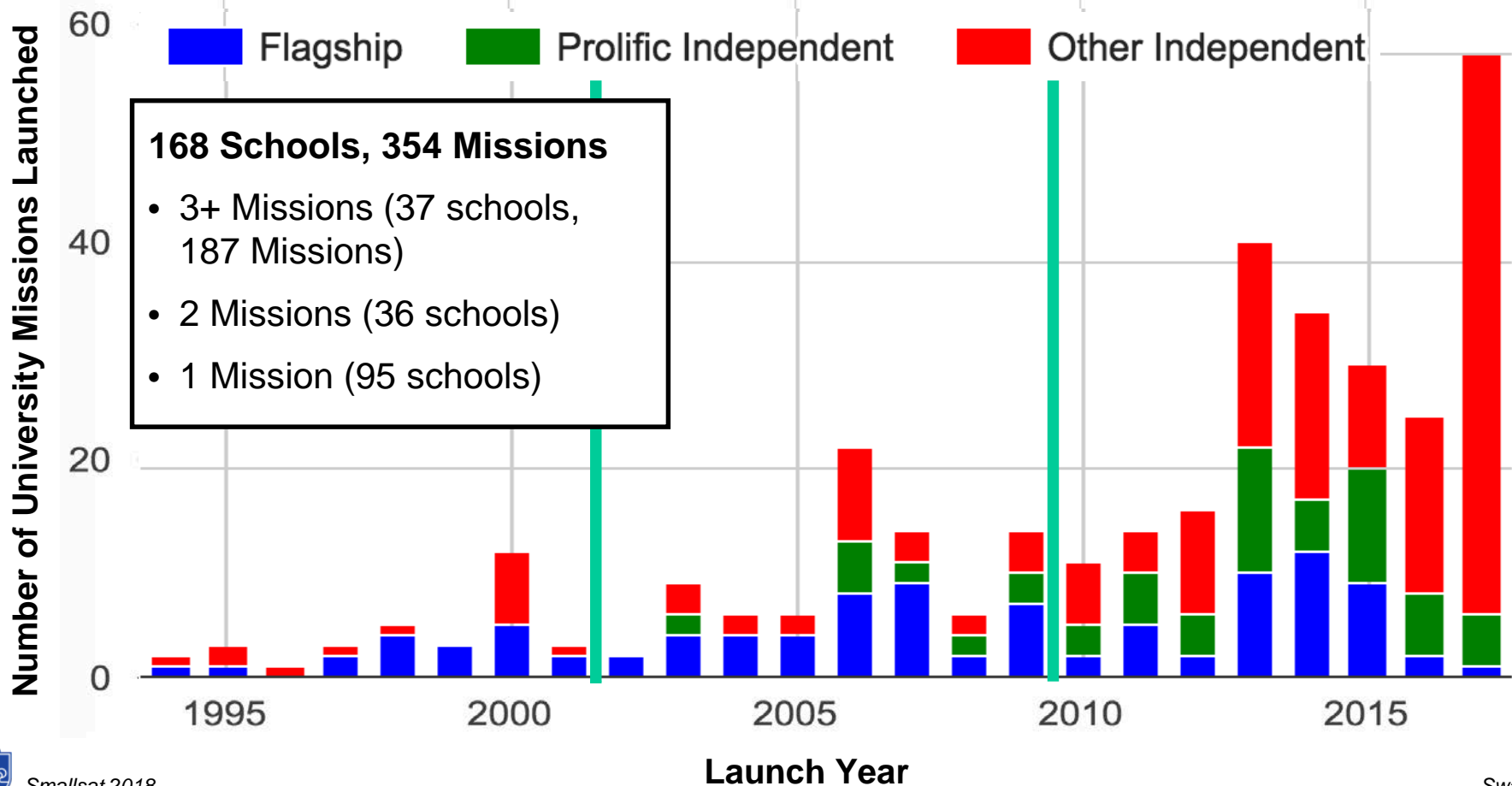


- ### Many Angels
- National Science Foundation (2008-present)
 - AFRL / AFOSR (1999-present)
 - NASA CubeSat Launch Initiative (2009-present)
 - Parallel International Development (e.g., Japan)
 - Many others that I don't know about!

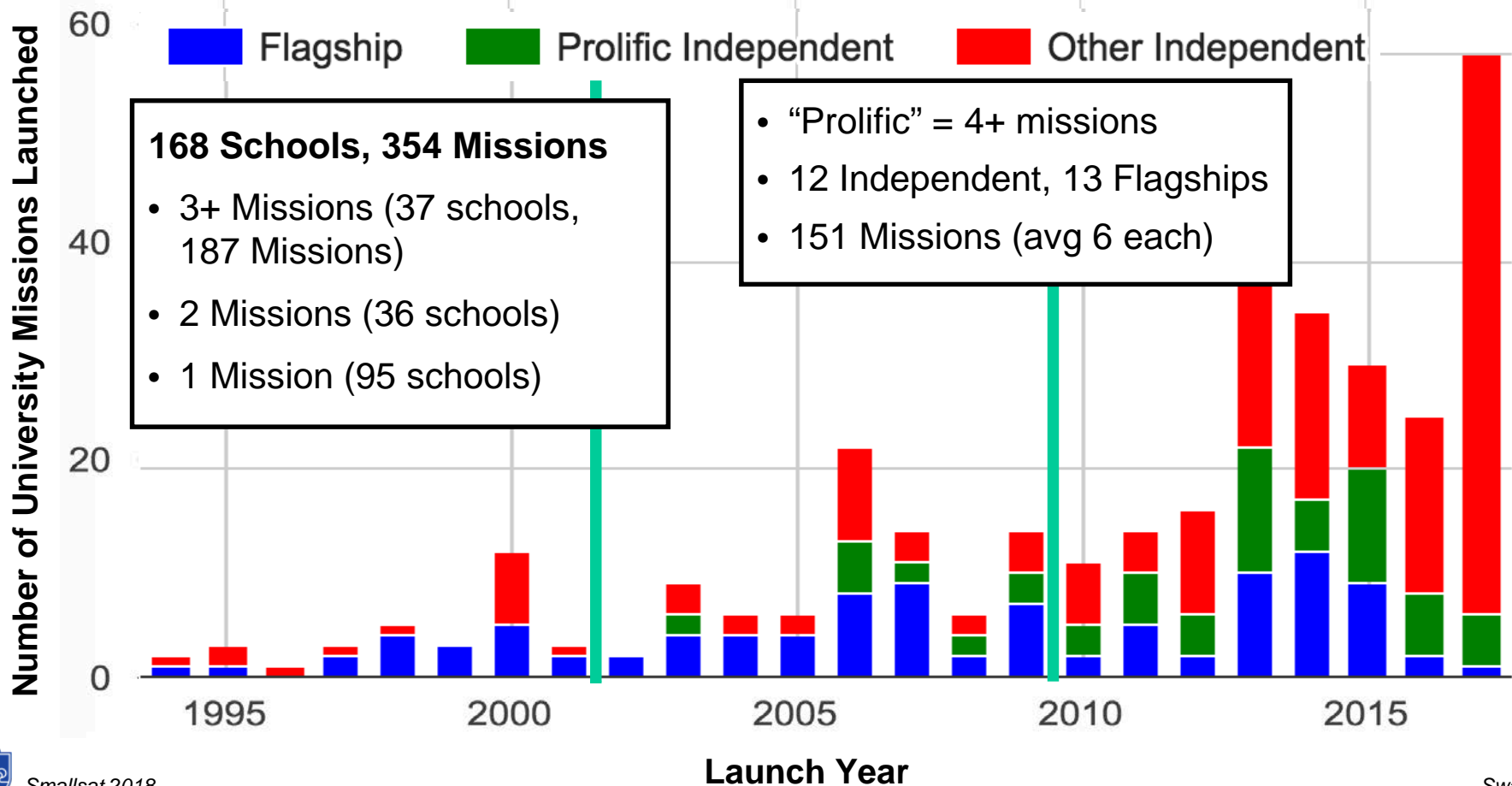
Chicken, Meet Egg



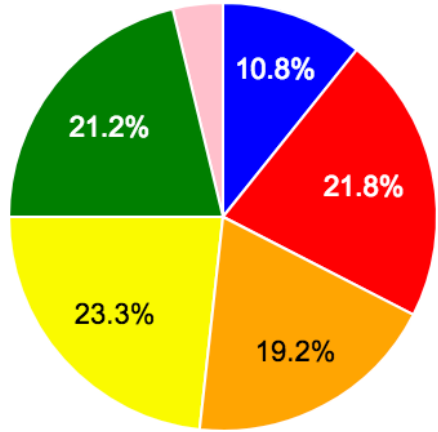
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Chicken, Meet Egg

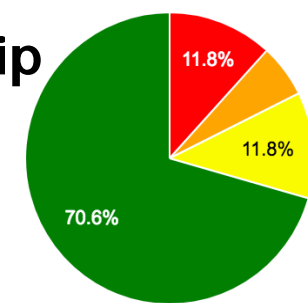


What Are We Learning? Are We Learning?

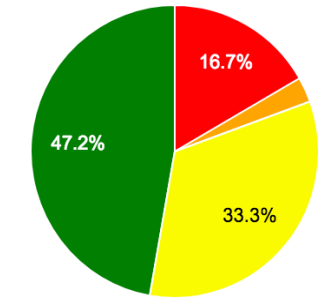


- DOA
- Early Loss
- Partial Mission
- Full Mission
- Unknown

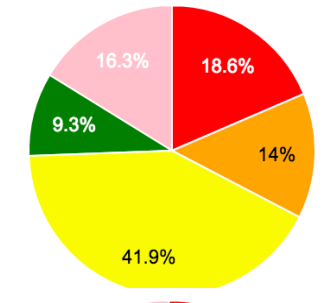
1994-2001
Flagship



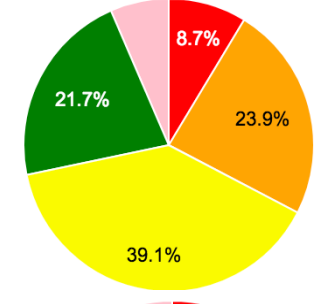
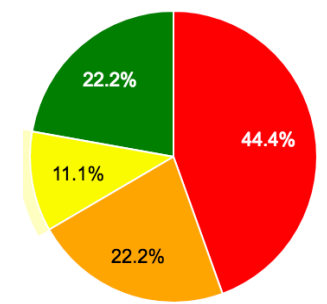
2002-2009



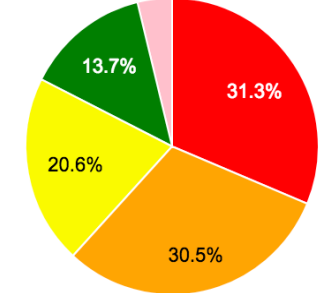
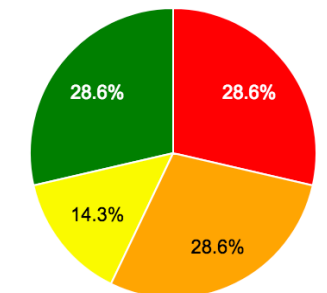
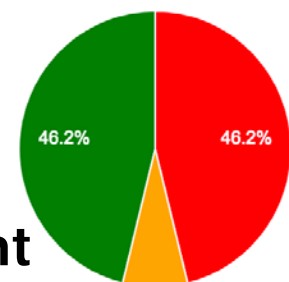
2010-2017



Prolific
Independent



Other
Independent



Don't Shoot the Messenger *(but you can buy him lunch)*

- **Three eras**
 - Before 2001: Heterogenous spacecraft, few launches by a few flagships
 - 2001-2009: Transition to CubeSats (surviving two Extinction-level Events)
 - 2010-????: CubeSats for everyone!
- **Three developers, three experiences**
 - Flagships
 - Prolific Independents
 - Independents
- **Three questions**
 - **What should we fly?** *(Read my Smallsat bibliography)*
 - **How well do they work?** *(Not as well as we'd like)*
 - **Why don't they work?** *(I'd need another speaker slot to cover this)*



Acknowledgements

- Data Sources
 - Public: Gunter's Space Page (*international launch log*)
 - Public: Jonathan's Space Report (*orbital elements*)
 - Public: DK3WN Satblog (*university/amateur operations*)
 - Public: Union of Concerned Scientists (*operational status*)
 - Public: Program websites, conference presentations
 - Public: Bryan Klofas (*communications/operational status*)
 - Private: Personal communications with mission developers
- Search for **2-Minute CubeSat Survey**
- Support
 - AFOSR / UNP (original work)
 - NASA NEPP (NNX17AJ46G and 80NSSC18K0637)



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