Evaluating the Impact of NASA's Strategic and Competed Planetary Missions

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Topics

- Study Goal
- Approach
- Results
- Conclusions

Study Goal

Simply stated:

Evaluate the impact of competed and strategic planetary missions to inform discussion of the roles of these two types of missions in the context of a balanced program comprised of both.

Ground Rules

- The approach must be quantitative.
- It must be based on publicly available information.
- The information sources and methodology must be clearly identifiable.
- The study should be conducted by a group of people with diverse viewpoints from across the spectrum of competed and strategic planetary missions.

Approach

- **Scientific impact:** utilize publications, citations and *h-index* assessment using the Web of Science (WOS)
- **Impact on number of scientists directly supported:** assess the total number of scientists directly supported by each named mission
- **Impact on number of mission instruments:** assess the number of science instruments

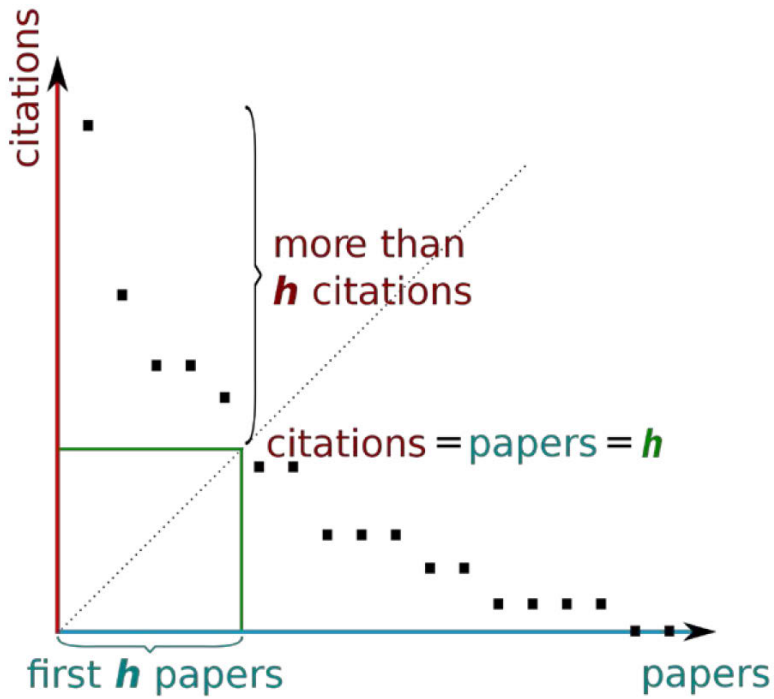
Results: Scientific Impact

The key elements of our approach

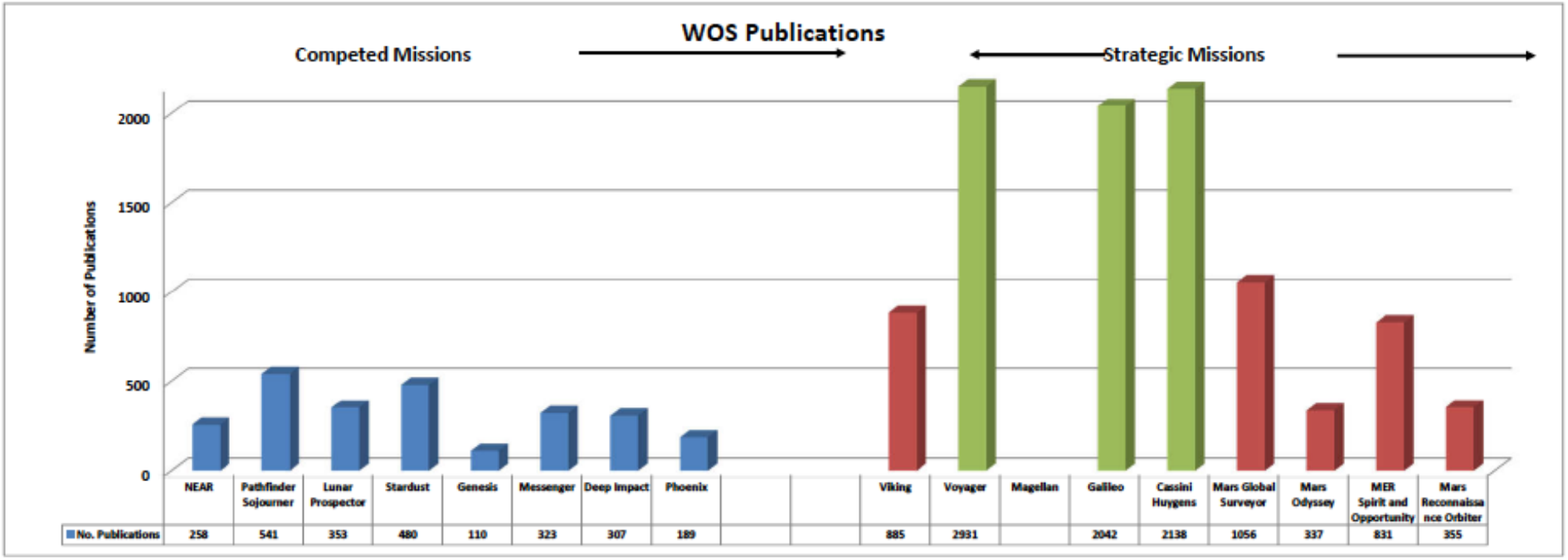
- We utilized publications, citations, and *h-index* as drawn from the Web of Science on a mission by mission basis for an objective evaluation of scientific impact.
- We included all NASA planetary missions that have completed at least their prime mission phase.
- The approach was blind to the type of mission; it was applied uniformly.

h-index Defined

- *h index* is defined as the number of papers cited at least *h* times each.
- It was created by UCSD physicist Jorge E. Hirsch to evaluate both the productivity and impact of a scientist or group of scientists (*PNAS, 2005).*



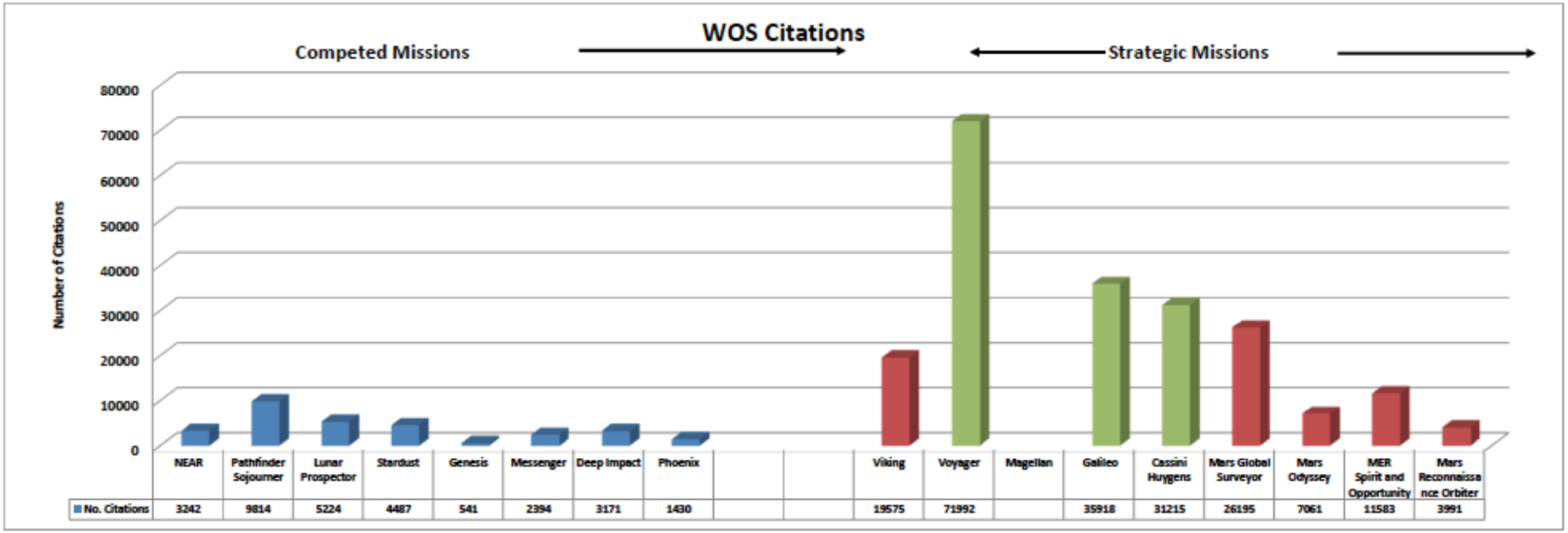
Web of Science number of publications



Mission order is from earliest to latest launch date within each mission family class

- Add NOTE: Magellan evaluation pending
- MESSENGER (all caps)
- Add commas on the big numbers
- Make mission names and numbers more legible

Web of Science number of citations



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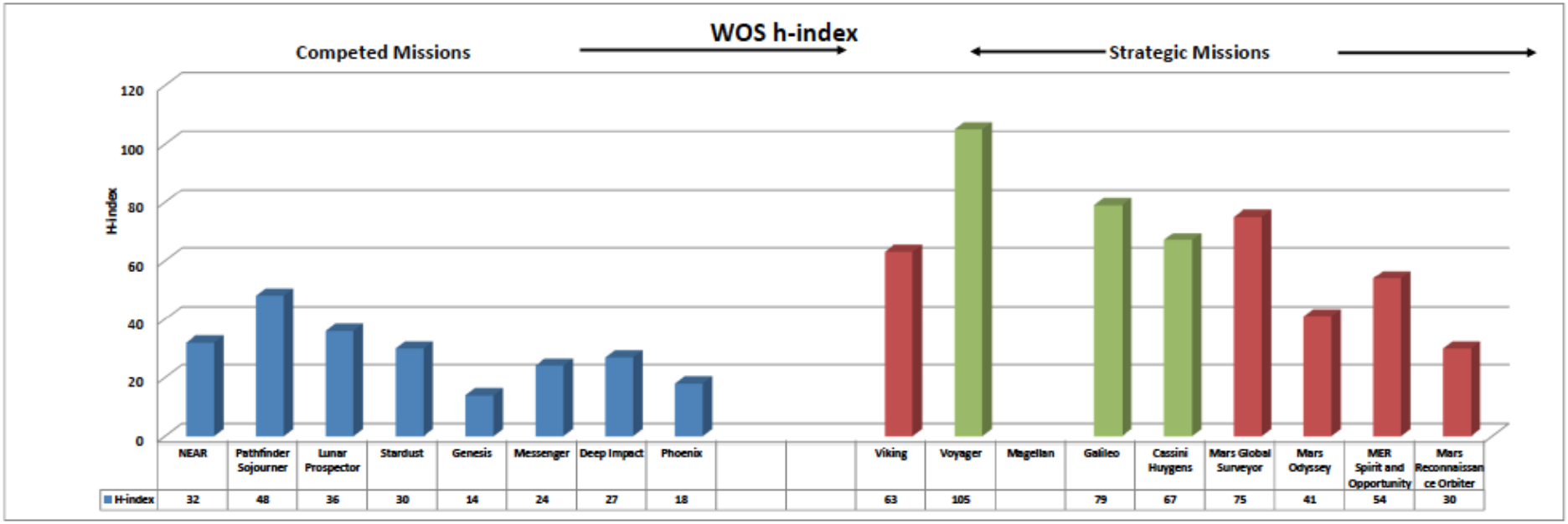
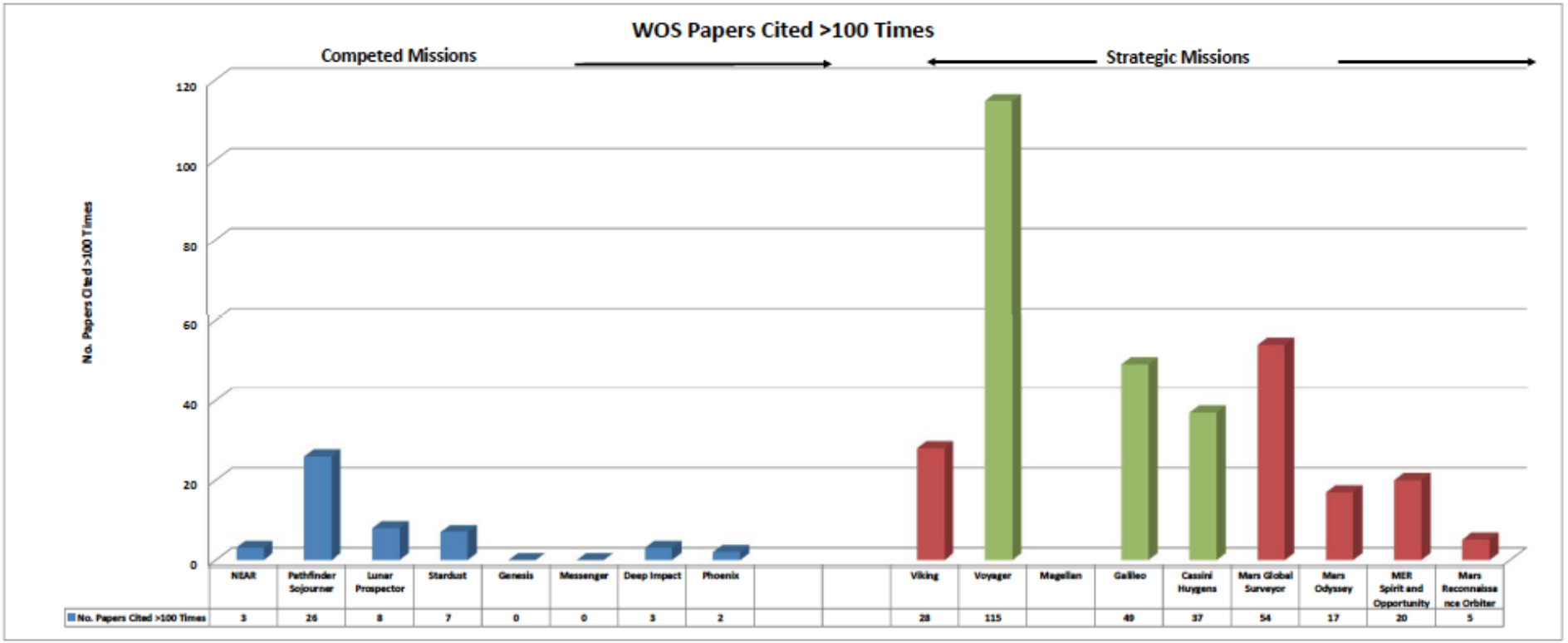
Web of Science *h-index*



- Based on *h-index,* competed and strategic missions both have substantial impact.
- Note that in general, *h-index* grows with time so that older missions tend to have a higher *h-index.*

  - MESSENGER (all caps)
  - Add commas on the big numbers
  - Make mission names and numbers more legible

Web of Science number of papers cited >100



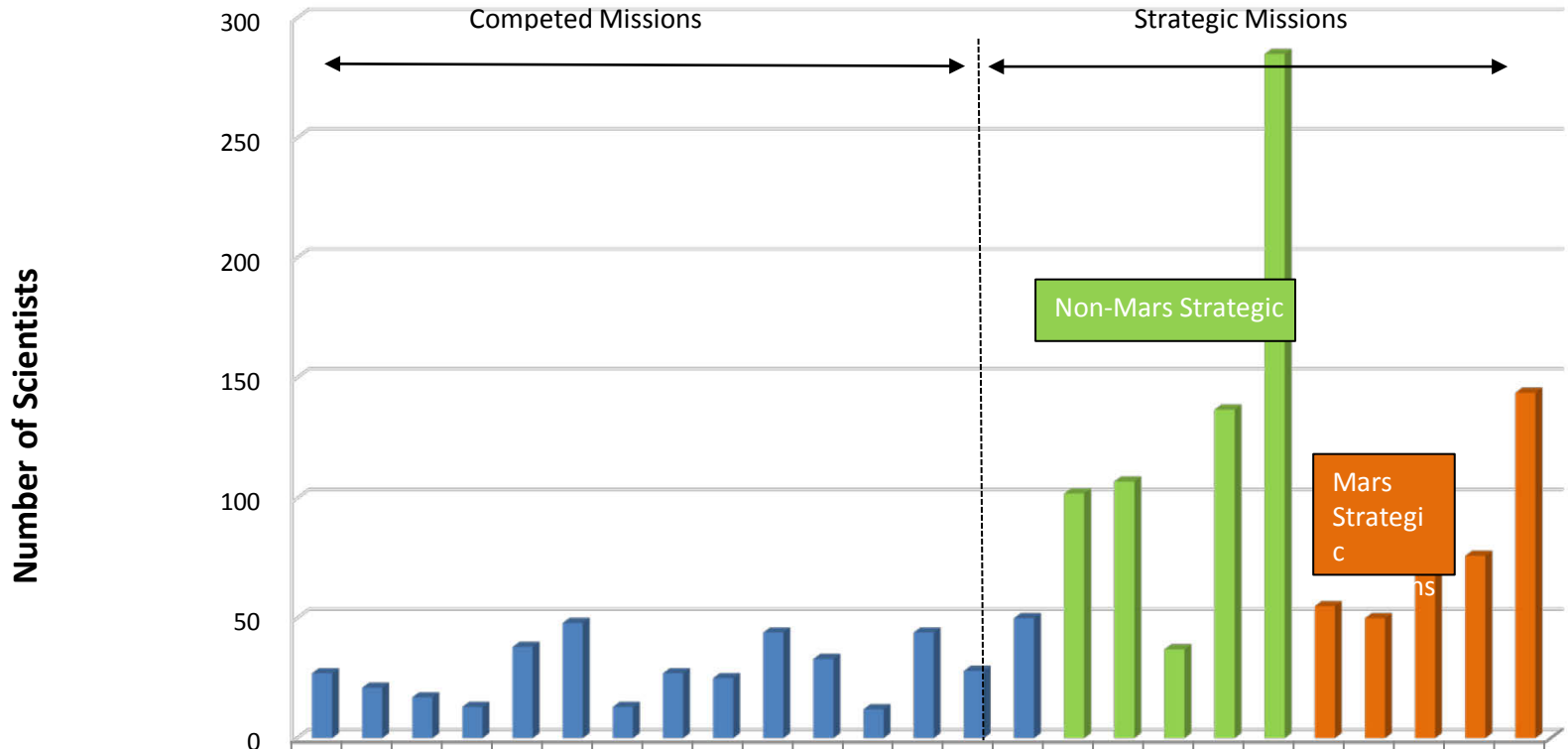
- Papers cited >100 can be used as one of several *rough* surrogates for "paradigm changing."
- We note that since citation numbers grow with time, up to a point, some of the more recent missions should be expected to show an increase in this parameter with time.

Results: Number of scientists directly supported

Approach and data sources:

- We included all NASA planetary missions that (a) have completed their full mission, beginning with Viking; that (b) are currently in flight; or that (c) are formally approved and funded for full development (i.e., in Phase B, C or D). Magellan is under evaluation as of the date of DPS.
- The number of directly supported scientists was limited to those named in competed mission CSRs, and those named as strategic mission co-investigators. Named IDS scientists are included in both cases.
  - We did not include collaborators as these numbers are harder to find and verify.
  - In the four cases where we have such data, the number of collaborators doubles the number scientists who are directly supported.

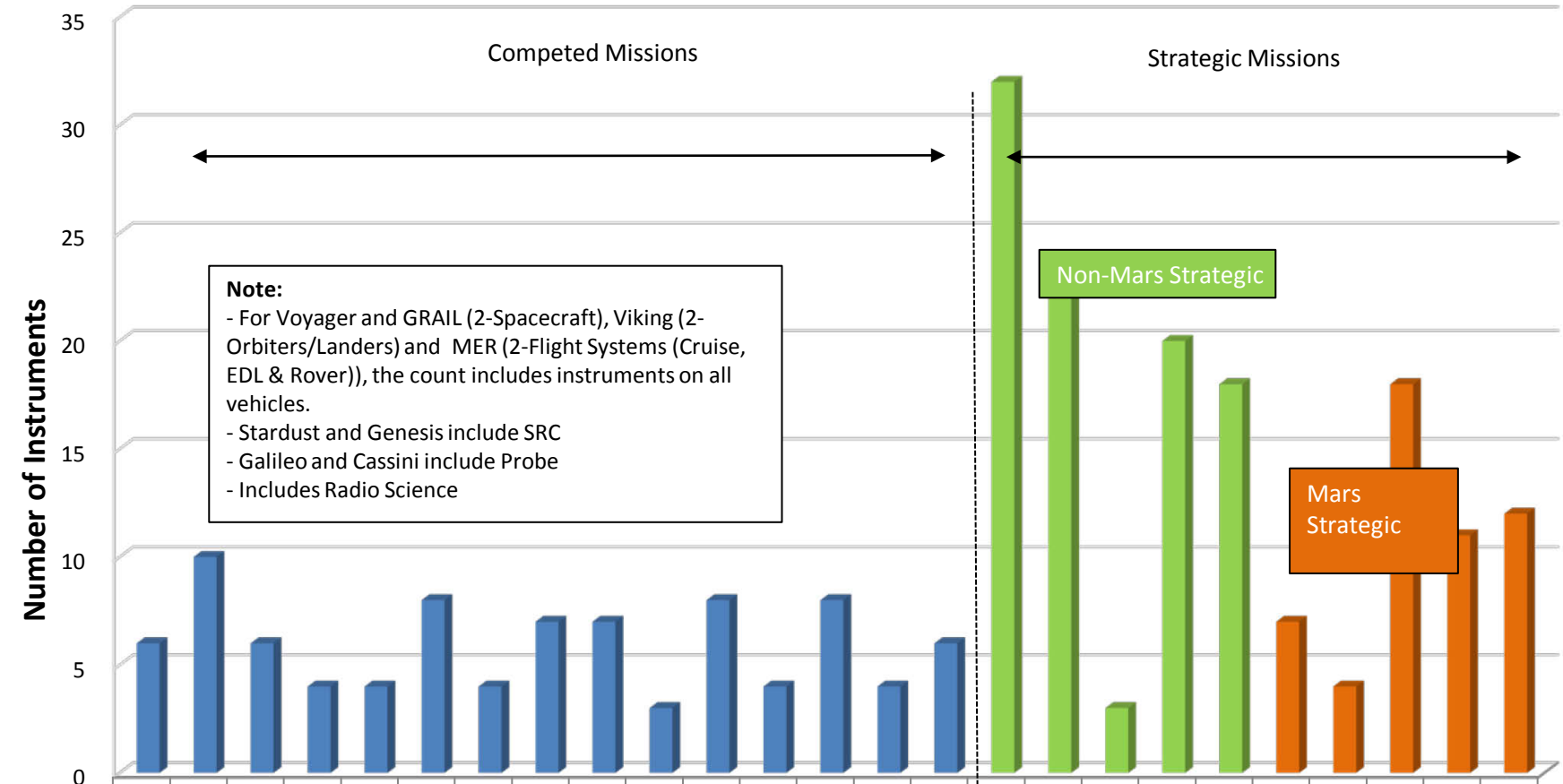
Results: Total number of directly supported, named scientists including US and international scientists



	NEAR	Mars Pathfinder	Lunar Prospector	Stardust w/ SRC	Genesis w/ SRC	MESSENGER	Deep Impact	New Horizons	Phoenix	Dawn	JUNO	GRAIL 2 Spacecraft	MAVEN	InSight	OSIRIS-Rex	Viking 1 & 2	Voyager 1 & 2	Magellan	Galileo w/ Probe	Cassini w/ Probe	Mars Global Surveyor	Mars Odyssey	MER Spirit & Oppor.	MRO	MSL
Total Number of Named Scientists	27	21	17	13	38	48	13	27	25	44	33	12	44	28	50	102	107	37	137	285	55	50	68	76	144

Were collaborators to be included, the total number of scientists supported by each mission would roughly double.

Results: Number of mission instruments



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Number of Instruments	6	10	6	4	4	8	4	7	7	3	8	4	8	4	6	32	22	3	20	18	7	4	18	11	12

Conclusions 1

- *The composite results of our study show clearly that both classes of NASA planetary mission have high impact and are essential to continued progress in our search for answers to the big questions: Is there or has there been life elsewhere in our solar system, and how did the solar system come to be?*
- Loss of either class of mission would have major negative impacts to US planetary science:
  1. Loss of direct support to a major fragment of the US planetary science and instrument communities who enable high-impact scientific discoveries.
  2. Loss of key engineering skills peculiar to each class of mission which enable access to key destinations required to make the next set of major scientific advances.

Conclusions 2

- While competed missions are funded at lower levels than strategic missions, they occur more frequently, about three per decade on average since 1994, and this balances the disparity in science impact and direct support compared when compared individually with strategic missions.
  - Implications: The loss of competed missions or a degradation in their cadence would have a large impact on the science and instrument builder communities.
- While the number of papers from competed missions that are cited >100 times is less than those from strategic missions, the *h-index* clearly shows that competed missions as a family are impactful.
  - Implication: Competed missions lead to important advances in our understanding of our solar system that would be lost were this class of mission to end.

Conclusions 3

- Inasmuch as strategic missions generally are considerably larger than competed missions, they result in a higher science impact as well as directly support more scientists and instrument builders.
  - Implication: The loss of the strategic mission element of the NASA planetary program would have a very large impact on the science and instrument builder communities.
- Strategic missions generate larger numbers of papers cited >100 times.
  - Implication: They lead to more paradigm-changing science than competed missions do, in general.

Conclusions 4

- *Vision and Voyages* had it right:
  - *"NASA's suite of planetary missions for…2013-2022 should consist of a balanced mix of Discovery [and] New Frontiers [competed] and flagship [strategic] missions [to enable] a steady stream of new discoveries and the ability to address larger challenges…"*

** Emphasis added*

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