GENI Survey Results

For public release

October 7, 2020

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Executive Summary

- In June of 2020, the ENTeR team (consisting of UNC RENCI and University of Kentucky) sent a survey to over 4000 experimenters who were known to have used GENI within the past 2 years.

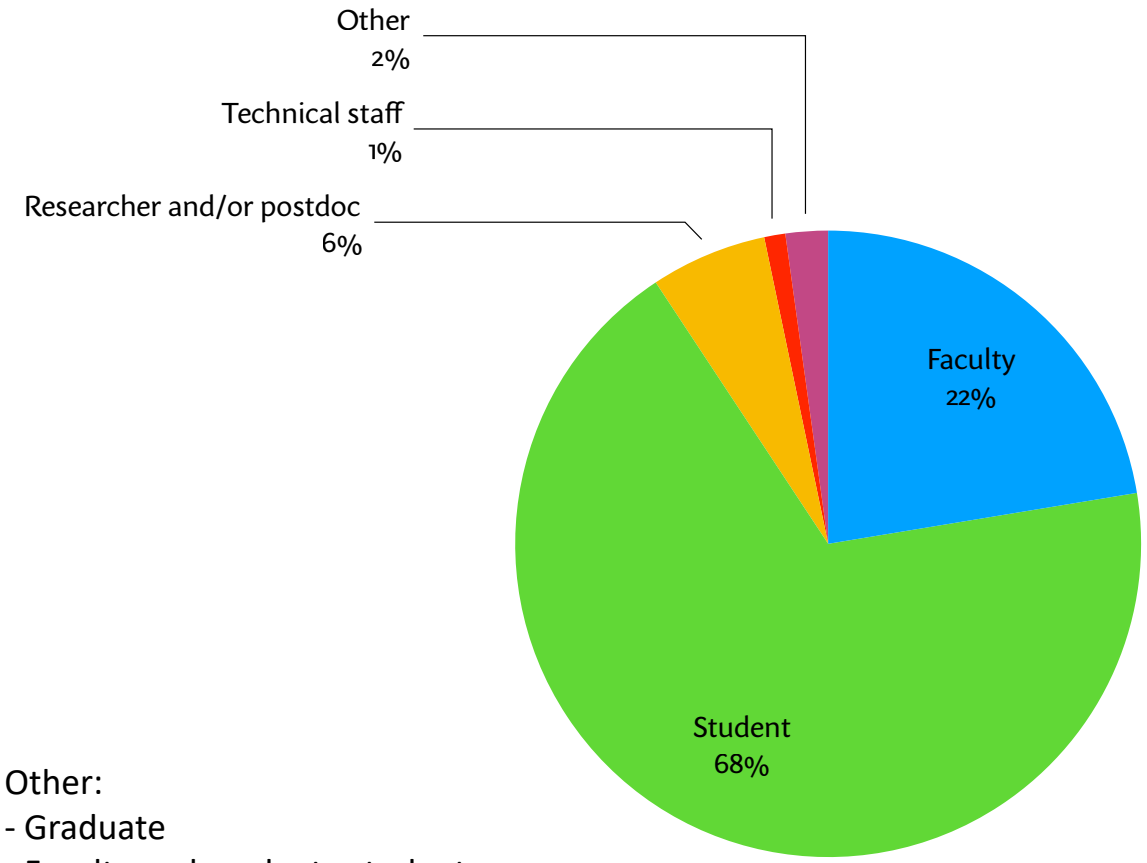
- We received 183 *complete* responses (251 total), of which 22% were from faculty, 68% from students, 10% from professional researchers, postdocs and technical staff.
  - Across those groups, 40% used GENI for research, 80% used it for education (many used GENI for both).
  - Over 40% used it periodically during the semester, and 30% reported using it weekly.
  - Their activities spanned a wide variety of research topics, from network architectures and protocols, to security, virtualization and software-defined networking.

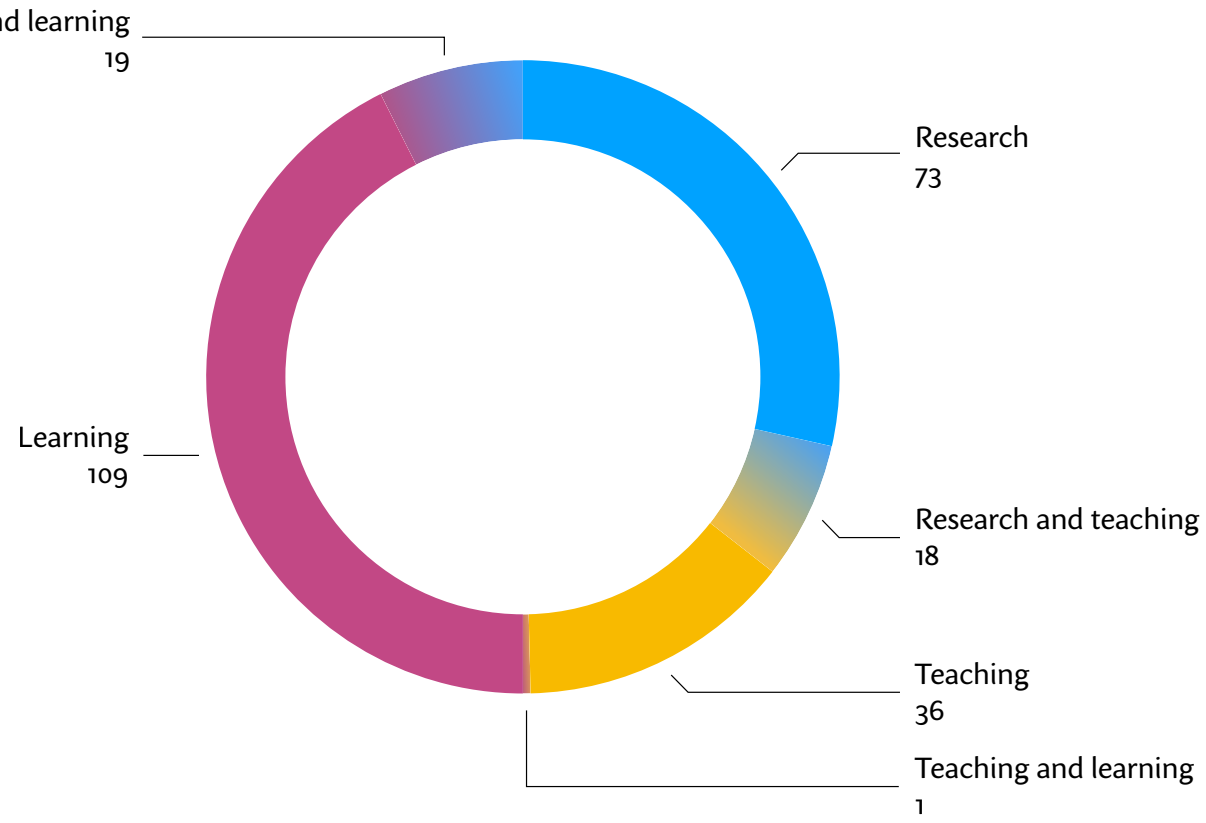
- Overwhelmingly 83% of respondents found GENI to be beneficial or very beneficial to their research or educational activities.

- Faculty using GENI for teaching reported using GENI in classes that had a total over 4000 students.
  - Many taught regularly recurring classes on Computer Communications, Networking, Cybersecurity, and Cloud Computing.

- Respondents collectively reported publishing 245 papers that benefitted from GENI.
  - Respondents provided 31 specific citations of these papers published between 2011 and 2020; 26 of these 31 were not previously listed in the GENI Bibliography.
  - The GENI Bibliography has been updated to include these citations.

Role and Use



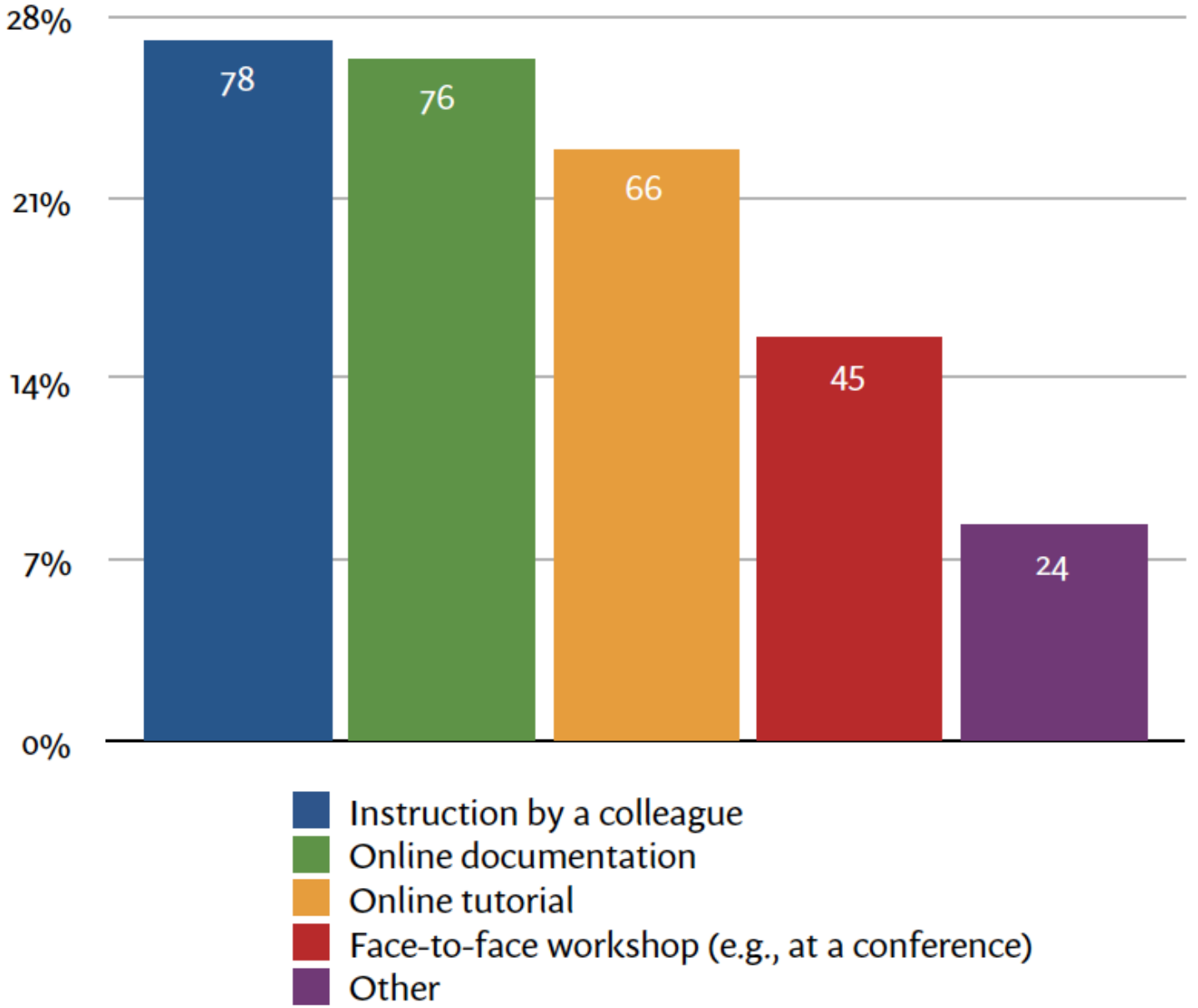


Other:
- Graduate
- Faculty and graduate student
- Graduate teaching assistant
- Senior Researcher / Head of the R&D on Networking and Distributed Systems

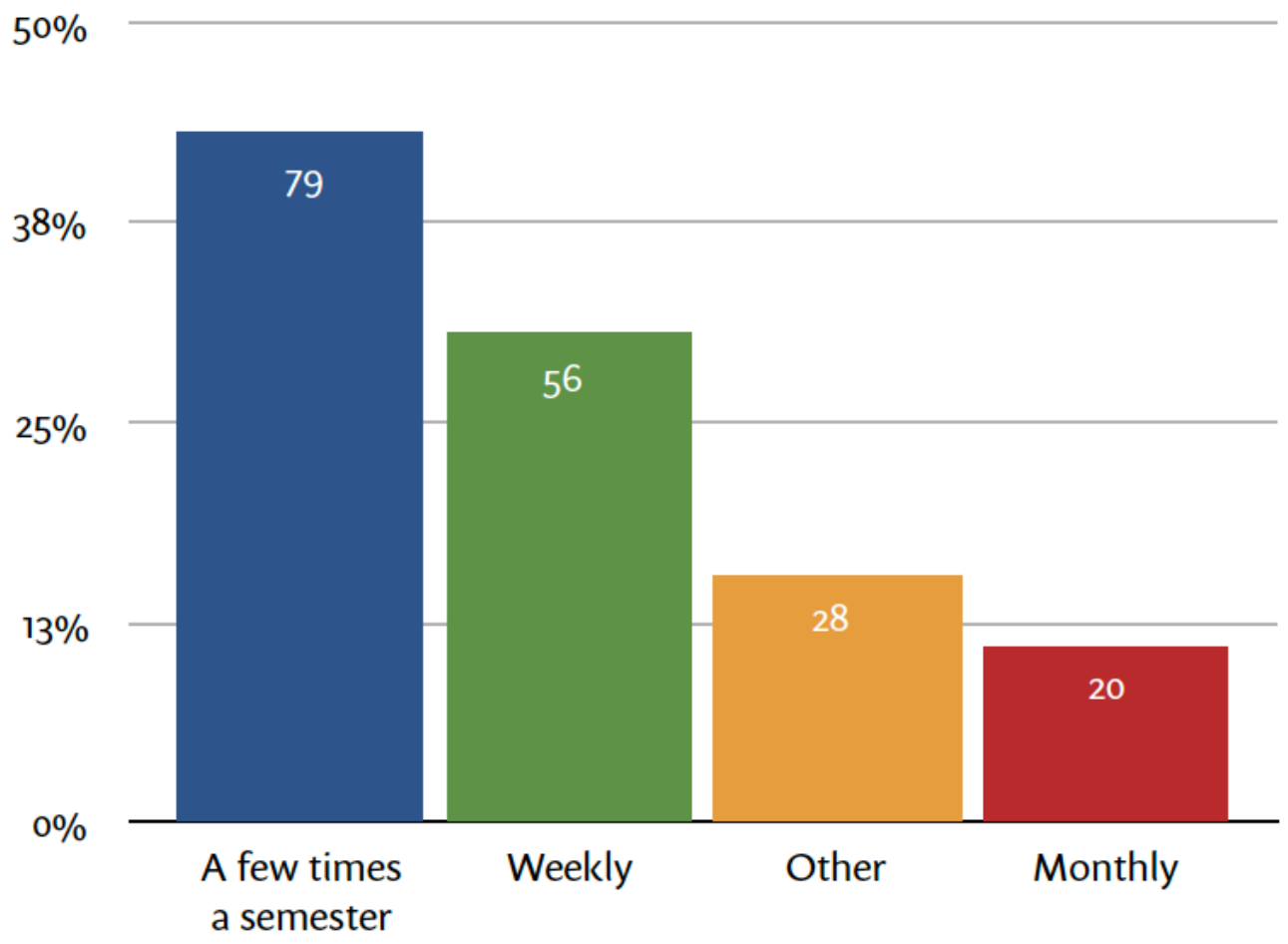
How did you learn to use GENI?

14 of the 24 respondents who selected Other said they learned from an instructor in a class. Two said they were self-taught. The rest included:

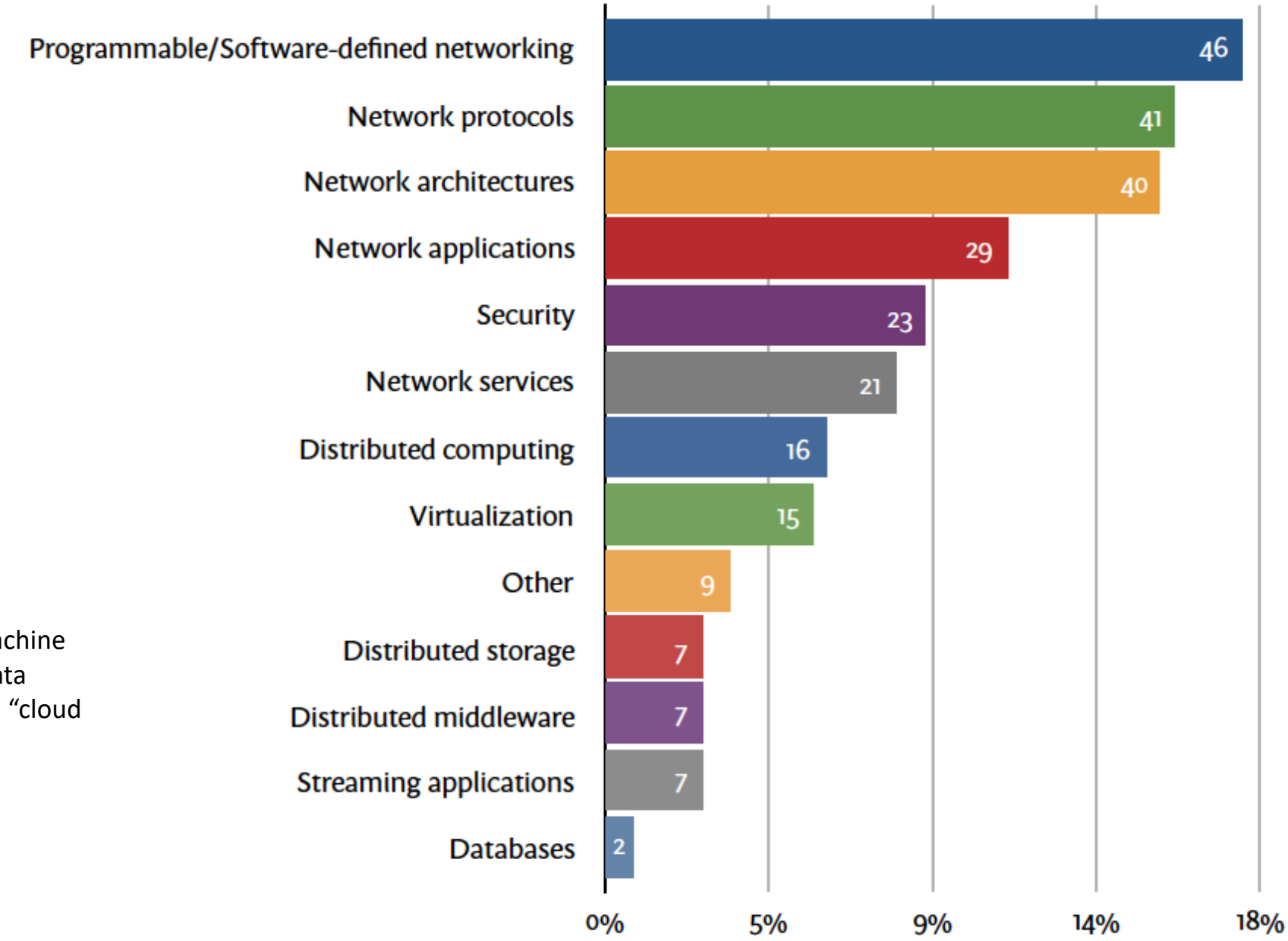
- From emulab.net
- GENI project office member
- Internship with Ciena
- NICE workshop
- Original GENI solicitation
- A webinar



How often do you use GENI?

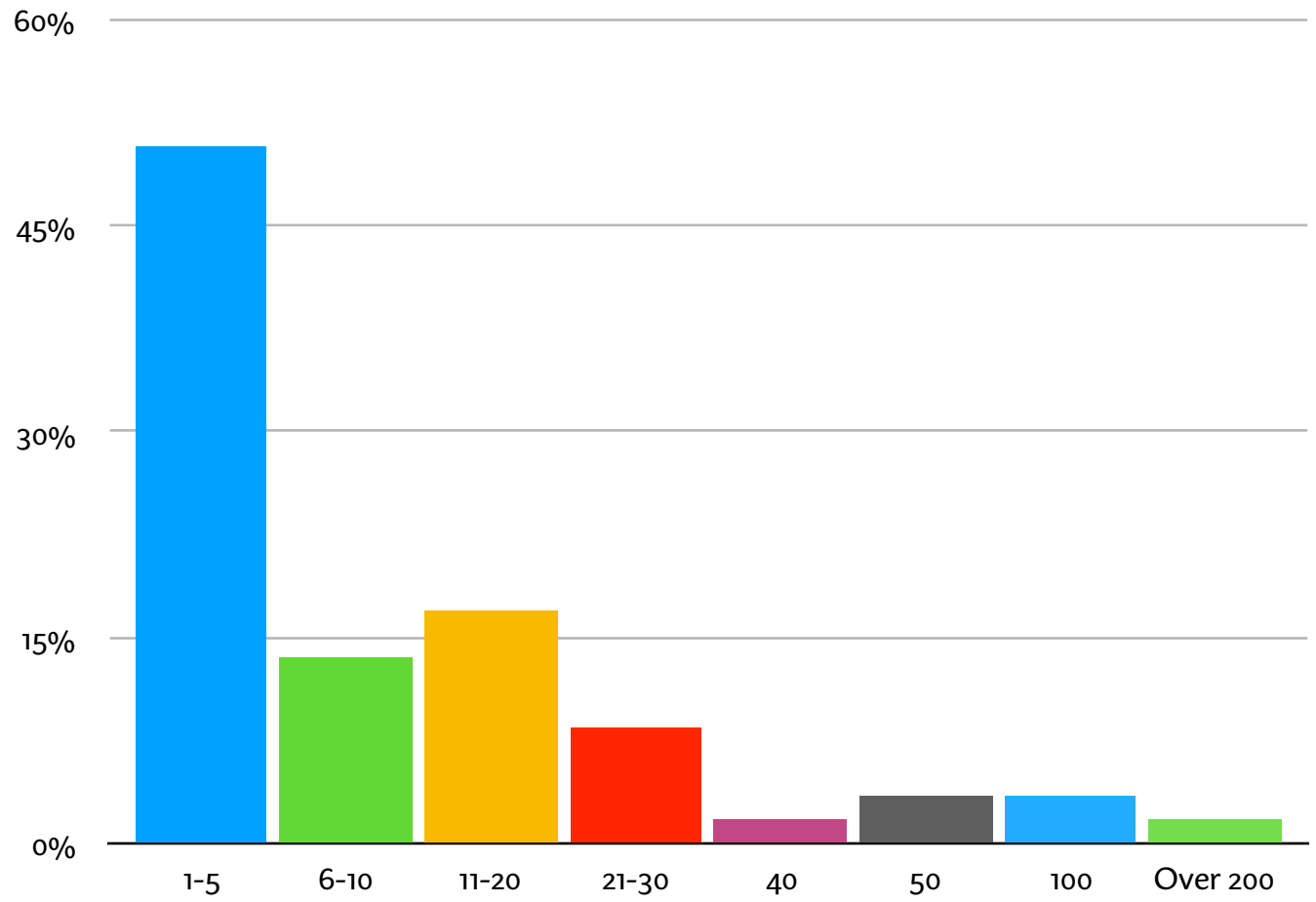


Experiment types

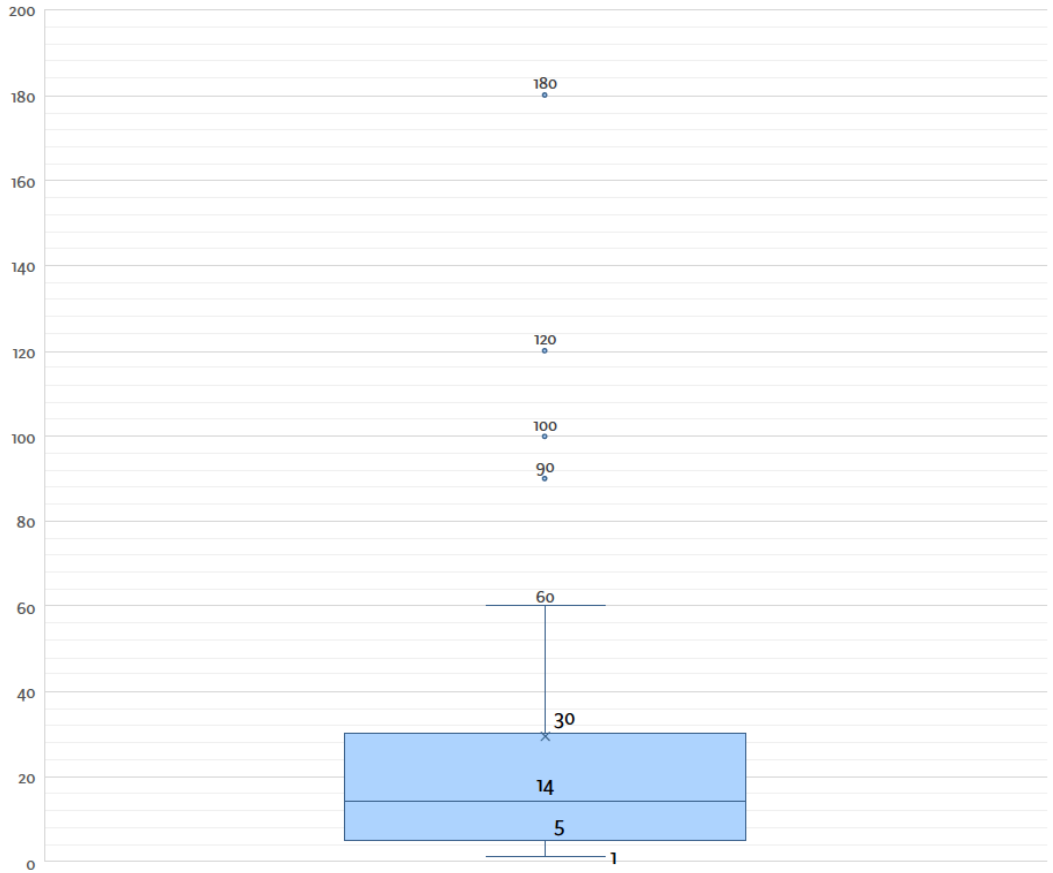


Other included “artificial intelligence,” “machine learning,” “domain science workflows,” “data science,” “applications of GPU computing,” “cloud software,” “blockchain,” and “extended calculations.”

Average number of slices used / semester



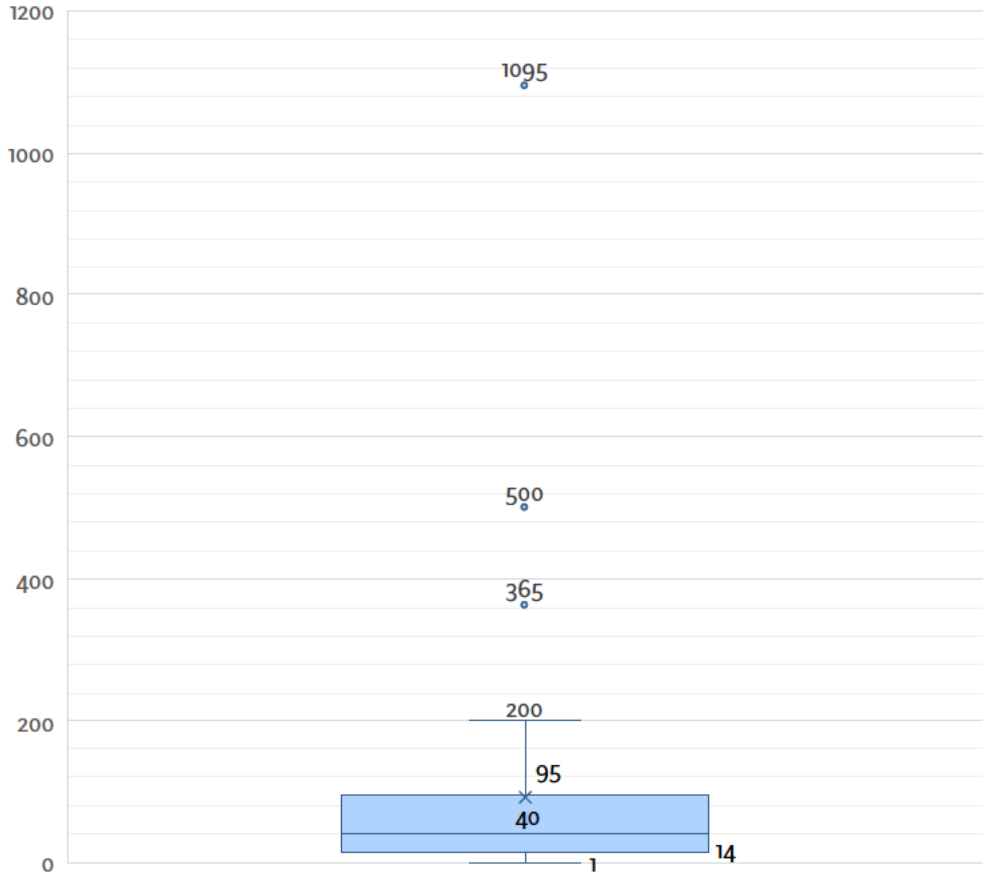
Average slice duration



Median	14
Mode	30
Average	29.51

in days

Longest slice duration



Median	40
Mode	90
Average	93.26

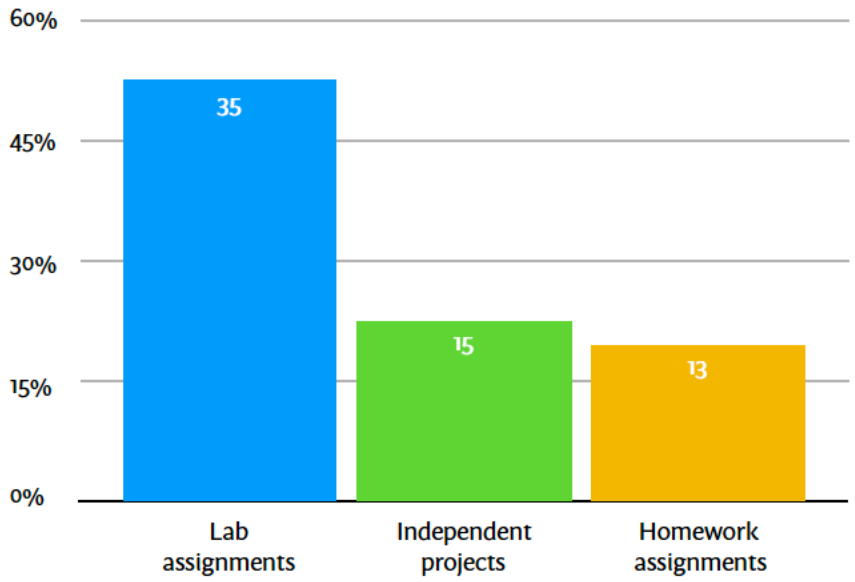
Papers

- Respondents reported 245 papers that benefitted from using GENI; 216 of which cited GENI.
- Some papers have multiple co-authors and so may have been counted more than once.
- Respondents reported 31 specific citations of these papers published between 2011 and 2020. These were cross-referenced against the GENI Bibliography.
  - 26 papers were not previously listed in the GENI bibliography. It has been updated with these 26 new papers.
  - Previously, the GENI Bibliography had 374 papers published between 2006 and 2018.
- Examples of specific citations listed by respondents:
  - Wang, Y., & Hsin, W. J. (2020, February). Improving User Experience for GENI-based Cybersecurity Labs. In Proceedings of the 51st ACM Technical Symposium on Computer Science Education (pp. 1296-1296).
  - Gosain, A., et al. (2016, October). Enabling campus edge computing using GENI racks and mobile resources. In 2016 IEEE/ACM Symposium on Edge Computing (SEC) (pp. 41-50). IEEE.
  - Shenoy, N., Rudroju, S., & Schneider, J. (2018, June). An Emergency Internet Bypass Lane Protocol. In 2018 IEEE 20th International Conference on High Performance Computing and Communications; IEEE 16th International Conference on Smart City; IEEE 4th International Conference on Data Science and Systems (HPCC/SmartCity/DSS) (pp. 533-540). IEEE.
  - Antequera, R. B., Calyam, P., Chandrashekara, A. A., & Mitra, R. (2019). Recommending heterogeneous resources for science gateway applications based on custom templates composition. Future Generation Computer Systems: Special Issue on Science Gateways, 100, 281-297.
  - Izard, R., Deng, J., Wang, Q., Xu, K., & Wang, K. C. (2016). An agent-based framework for production software defined networks. International Journal of Communication Networks and Distributed Systems, 17(3), 254-274.
  - Cecil, J., Gupta, A., Pirela-Cruz, M., & Ramanathan, P. (2018). An IoMT based cyber training framework for orthopedic surgery using Next Generation Internet technologies. Informatics in Medicine Unlocked, 12, 128-137.
  - Kalle, T. (2019). Design and Experimental Evaluation of Ephemeral QUIC for Cyber-Physical Systems (master's thesis). Technische Universität Darmstadt, Germany.
  - Lyons, E., (2020). An On-Demand Weather Avoidance System for Small Aircraft Flight Path Routing, 2020 InfoSymbiotics/DDDAS conference (invited)

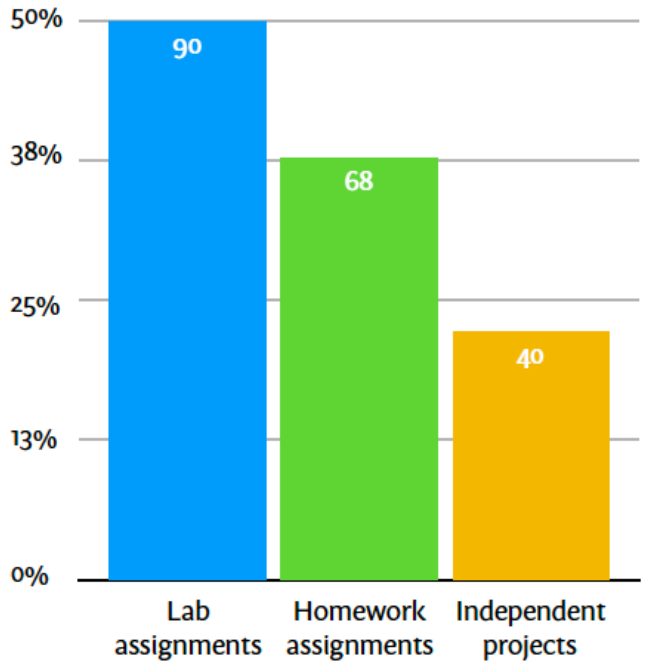
Classes Using GENI

- Faculty claimed to have taught over 4000 students in courses that used GENI.
- Students claimed to have taken over 185 courses that used GENI.
- Classes that use GENI are taught in a variety of subjects, mostly some form of networking, but security, virtualization, cloud computing, and Internet protocols are also taught.

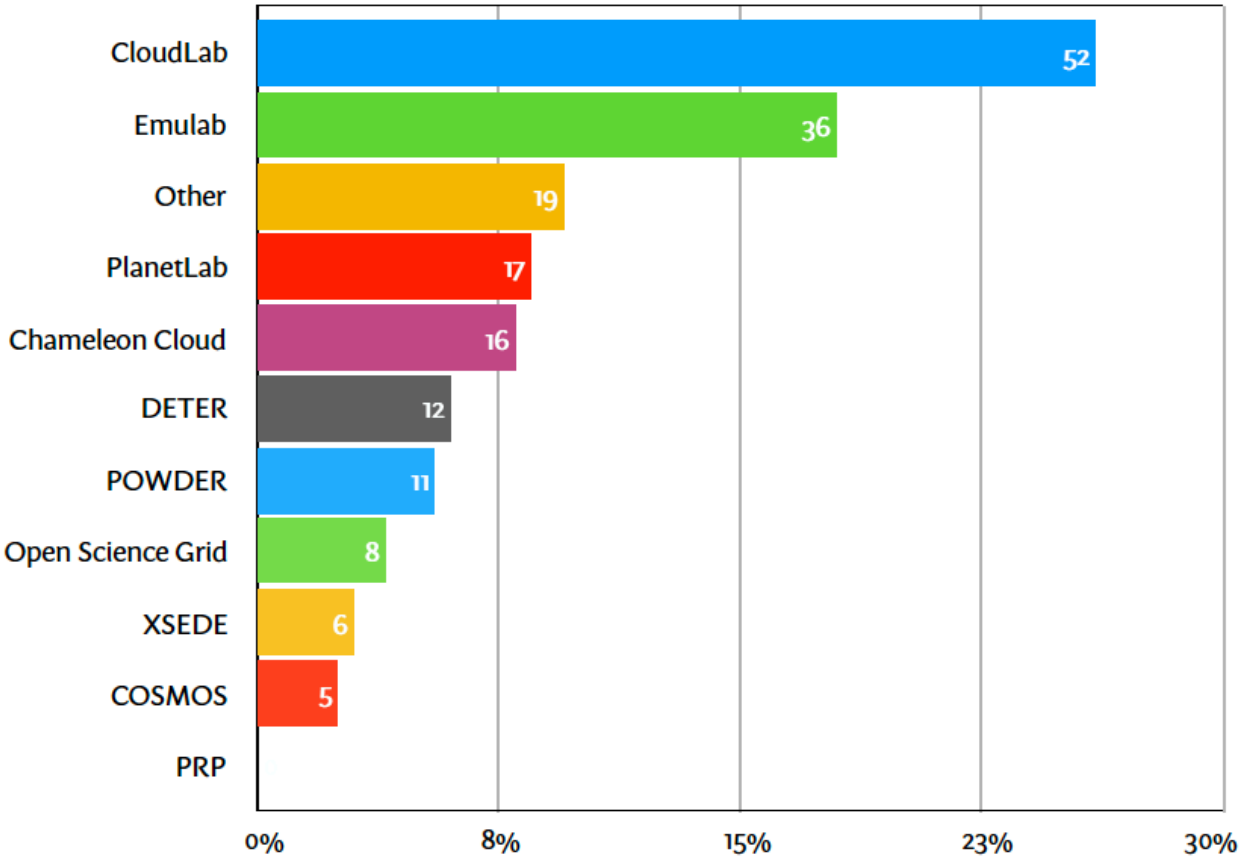
Faculty report giving these kinds of assignments



Students report being given these kinds of assignments

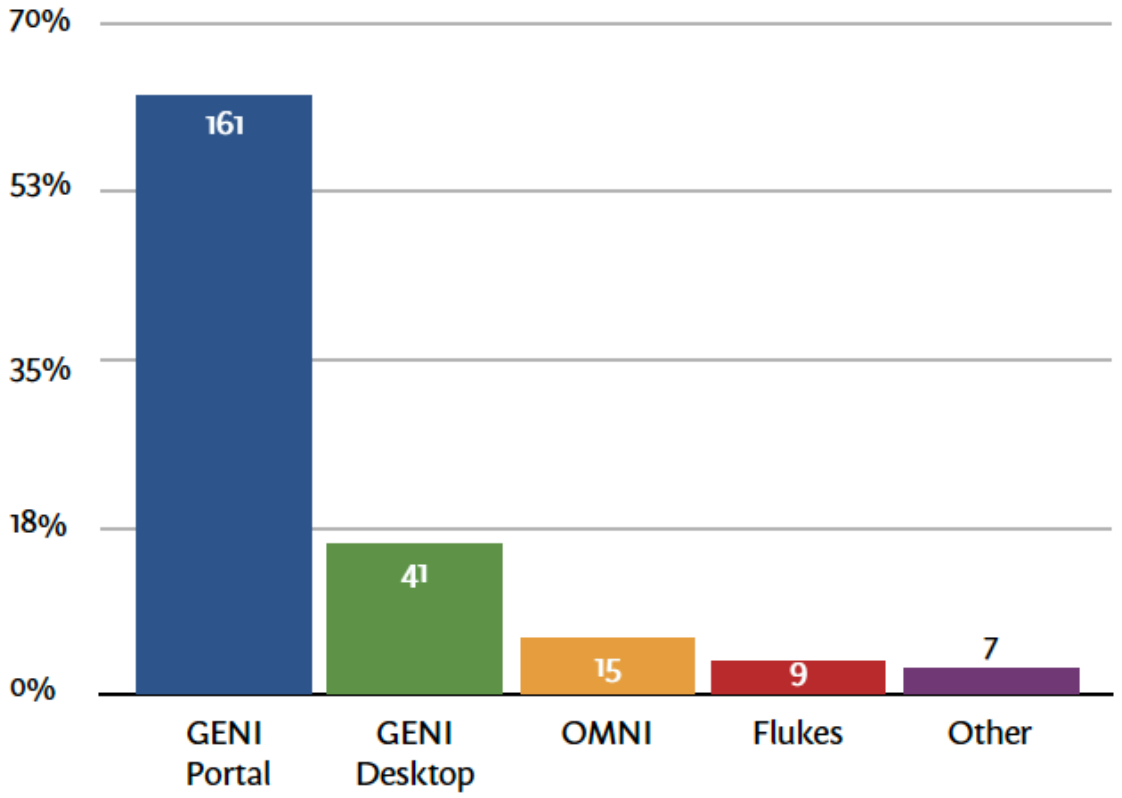


Other testbeds used



8 of the 19 respondents who selected Other said they either didn't use another testbed or couldn't recall which one. Other testbeds mentioned include VirtualWall, university testbeds, EVE nglab, Mininet-Based Testbed, home grown simulators and clusters, ISEAGE ISElab, Mass Open Cloud, Edgenet.

Experimenter tools used



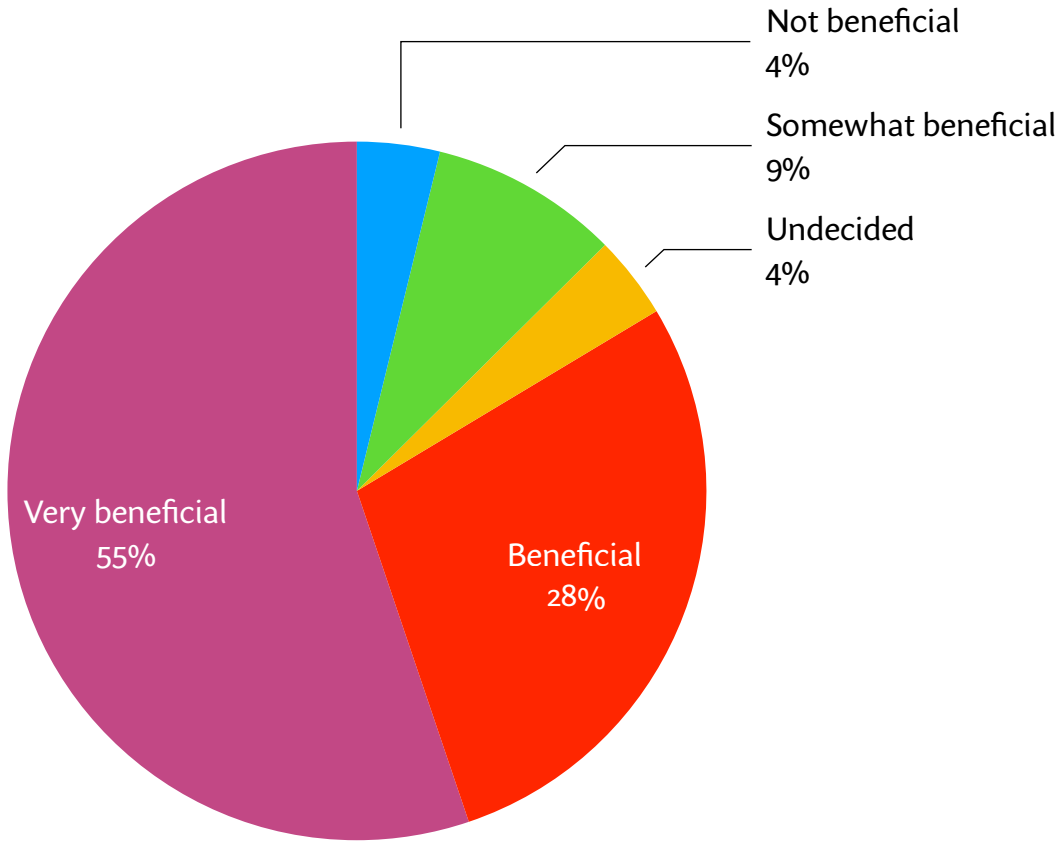
Other experimenter tools mentioned included jFED, vPark, AHAB library, VTS and geni-lib, Mobius, and Jacks. One respondent put N/A in this form field.

GENI’s perceived value

The majority of respondents found GENI to be very beneficial or beneficial.

- 101 Very beneficial
- 52 Beneficial
- 7 Undecided
- 16 Somewhat beneficial
- 7 Not beneficial

Many thanked the GENI team for its work, asked that work on it continue, and requested improvements or discussed problems they would like to see resolved.



Very Beneficial/Beneficial

"Always available, easy to use, broadly applicable to many different research and teaching contexts."

"Tremendous availability of resources and dependability. A+++"

"Being from a small Liberal Arts college, it gave students access to infrastructure we do not have and it made it reasonable for me to manage as a faculty member since we have very limited support from IT."

"The ability to create isolated networks to test programs on. This made learning about networks much more interesting and valuable."

"Being able to simulate a network and see how things connect was useful for my course. GENI in general was just a cool resource to use because it allowed me to play in a sandbox with different techniques."

"Using GENI for my network-related experiments is always easy for me. If I want to do an experiment from my lab, we have to take care of connecting the nodes in the way we want and it needs resources like LAN cables, switches, and servers. When I use GENI, I don't need to worry about the resources."

"It was incredible having access to so many resources to just mess around with. I have a small network of like 5 towers at my house - but GENI give the offering to far more. It is easy to reserve resources and it was easy to design networks."

facilitates learning	28
easy to use	18
resources!	16
open/accessible/available	11
provides distributed experiments/environments	10
realism	9
allows for a variety of experiments	9
provides scale	8
frees you from managing hw/sw and maintenance	8
fosters experimentation, play	8
help (documentation, labs, training) is good	6
flexible/versatile	5
saves money	4
provides resources that are currently lacking for courses	4
provides speed	3
provides automation	3
GENI community	3
various features	3
saves time	2
remote accessibility	2
expertise of GENI team	2

Somewhat beneficial/not beneficial

- Website (portal?) is not easy to use
- Website (portal?) is not aesthetically pleasing
- Difficult to get working
- Portal is unreliable
- Unstable/unreliable (2)
- Clunky
- Difficult to install

General Feedback

Requests	"Bugs"/Problems	Just criticism
need easier login and account creation	some resources have become unstable	unstable (2)
make it faster	harder to setup slices	cumbersome
please make resources more reliable, consistent, and faster	installing a new resource has become difficult	not easy to use
broken tutorials, please fix	sometimes difficult to reserve resources	portal is difficult to use, unreliable
more tutorials/labs needed	some sites' resources are slow and not easy to use	
make more stable for teaching	login through Putty throws errors	
would like the ability to take down an active link	sometimes difficult to reserve resources	
add the ability to remove a slice rather than waiting for it to expire	cloud computer allocation speed is very slow	
	some resources are slow to boot	
	"Verify that the RSPECS are available for use and not just dead links."	
	wouldn't start on occasion	
	inexplicable failures of deployed VMs or Bare metal machines (no log)	
	ssh connection crashed	
	slices have failed	
	reserving resources is buggy	
	often doesn't work, must wait or rebuild system	

General Feedback

“Keep supporting efforts like GENI with ample support and recognition to their leaders. They were truly inspirational.”

“Keep up the great work.”

“Excellent resource and we need more like it.”

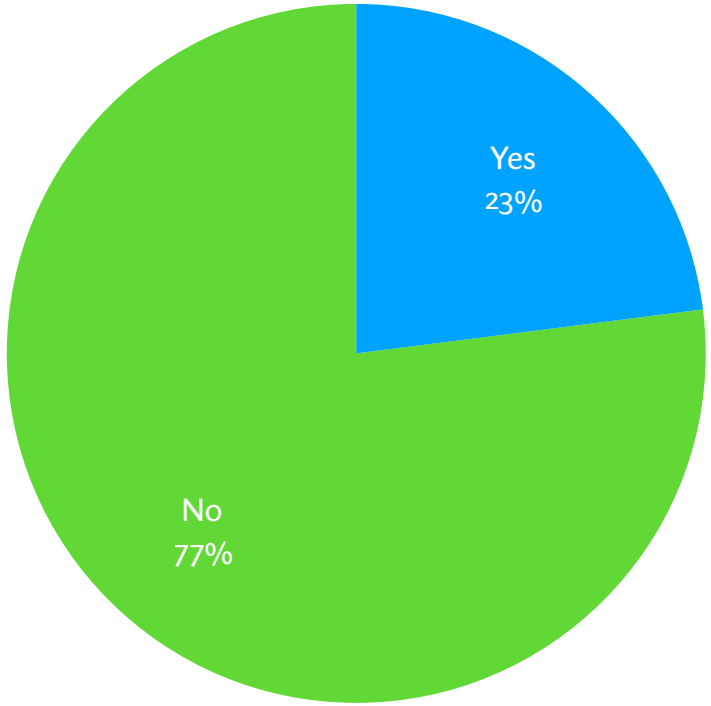
“Please continue developing this service, it's was incredibly useful. (And its nice to set services that exist for more than just making money and extracting every bit of data they can from their users... cough cough AWS)”

“This is a valuable tool - thank you!!!”

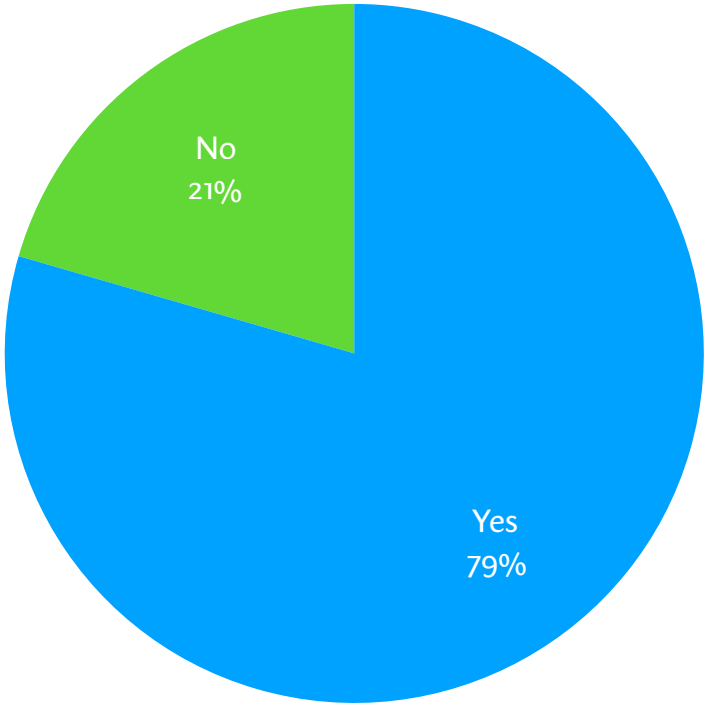
“Like all things GENI must evolve, operationally stabilize, and at least in my opinion move beyond low-level network experimentation, while at the same time continue to provide more granular control of resources. This is much easier said than done.”

“Just an overwhelming gratitude for your time and support. GENI has been extremely useful for our research testbed. Its value is not entirely captured just by our publications... it has enabled many products and services that we otherwise would not have been able to provide. While I'm excited for FABRIC, I must admit I will certainly miss GENI.”

Have you heard of FABRIC?



If yes, do you plan to use FABRIC?



Questions?

- Please write to help@geni.net