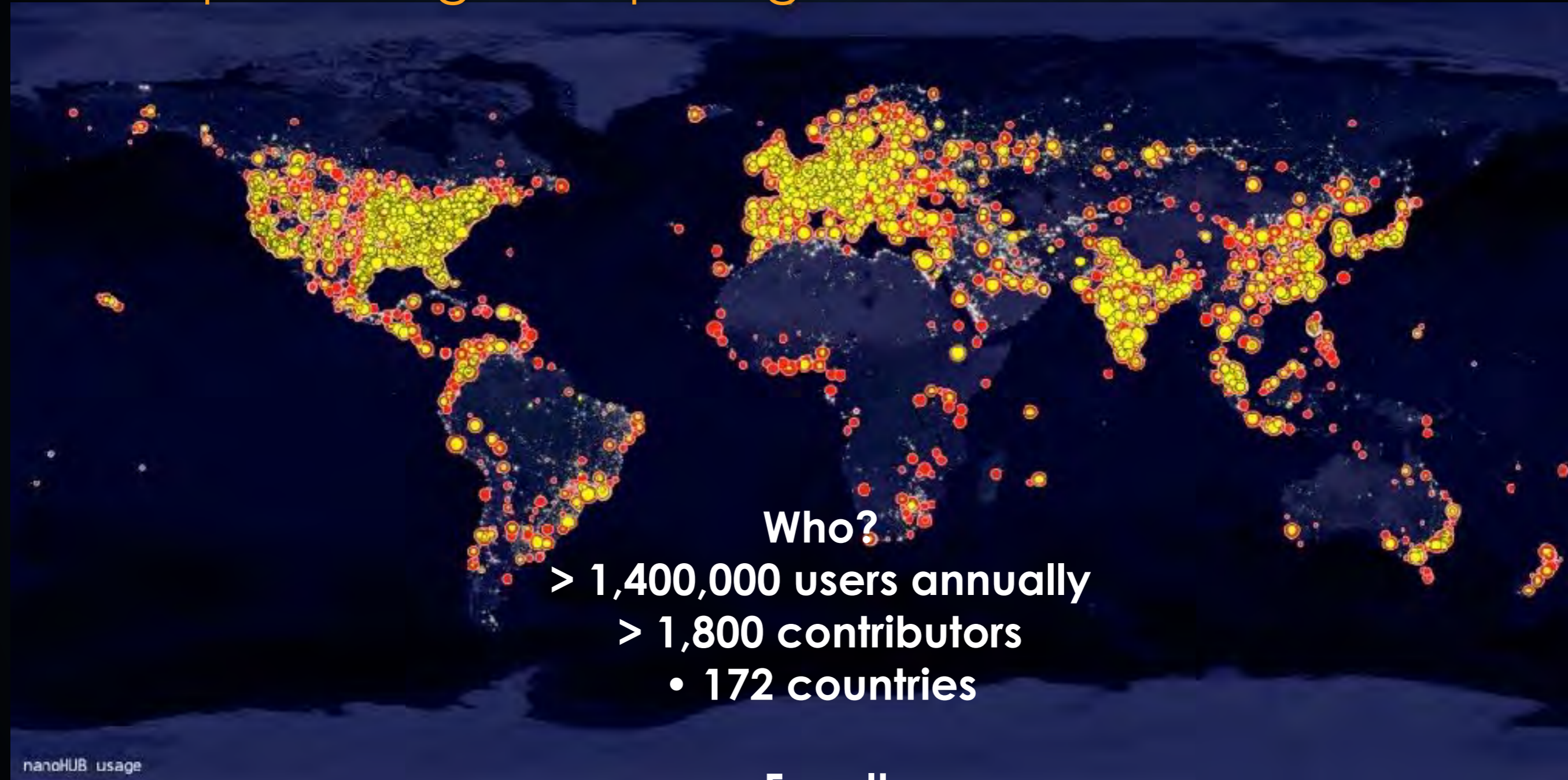


nanoHUB:

translating traditional research to new paradigms
in publishing, computing, research, & education



Who?

- > 1,400,000 users annually
- > 1,800 contributors
- 172 countries

- Faculty
- Students
- Industry practitioners



nanoHUB:

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in publishing, computing, research, & education

What ?

- > 440 nano-Apps in the cloud
- > 4,000 lectures and tutorials
- > 100 courses => MOOC

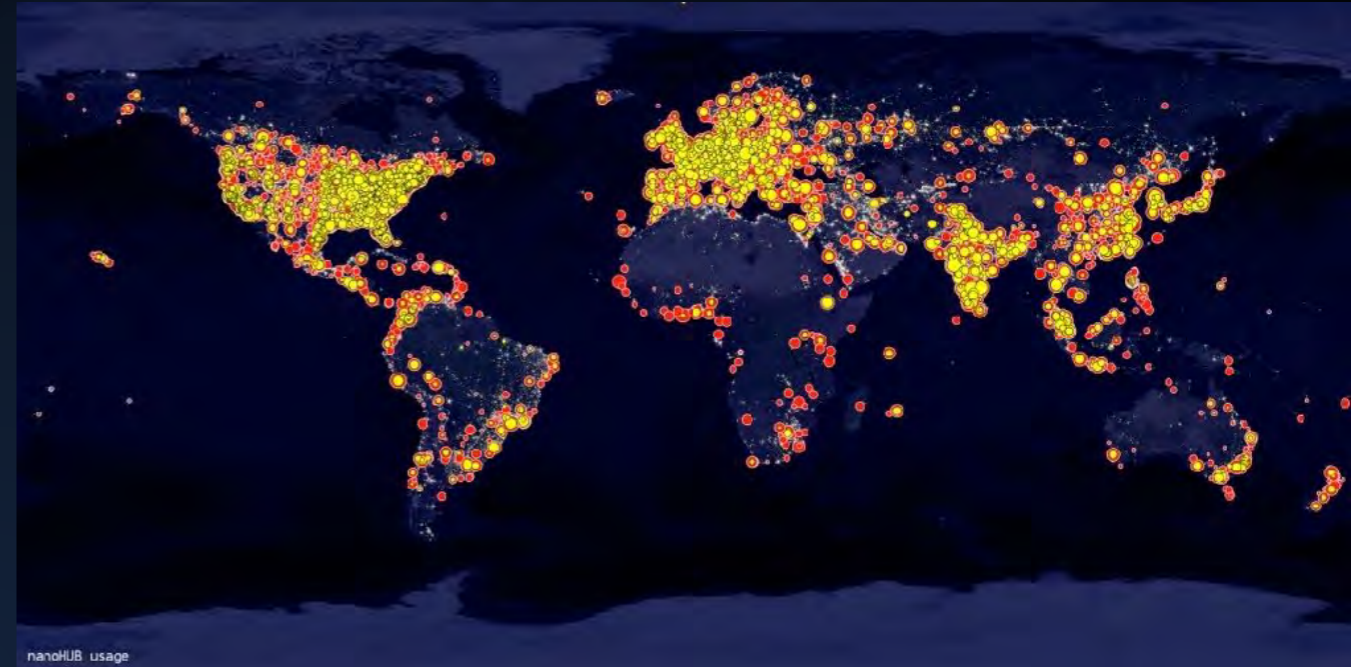
Cyberinfrastructure

- 24/7 operation with 99.9% uptime
- 35 professionals
- 70+ servers, 4,000+ compute cores


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Research Impact:

- nanoHUB tools now listed in
- 
- > 1,700 papers cite nanoHUB
 - > 26,700 secondary citations
 - h-index of 75

Educational Impact

- Rapid curriculum change
- >35,000 students use tools in classrooms



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- Industry practitioners

NOT about compute cycles!
NOT computational scientists!

Different users!
Access, Usability, Cycles!

Research Impact:

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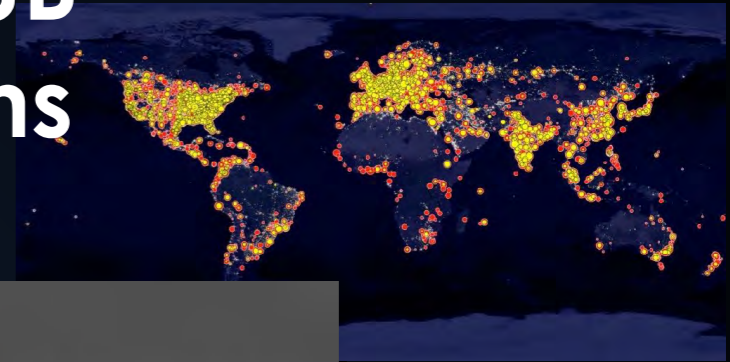
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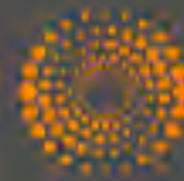


Research Impact

- > 1,700 papers cite nanoHUB
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THOMSON REUTERS™



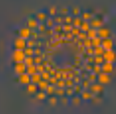
new paradigms

a fundamental change in approach
or underlying assumptions



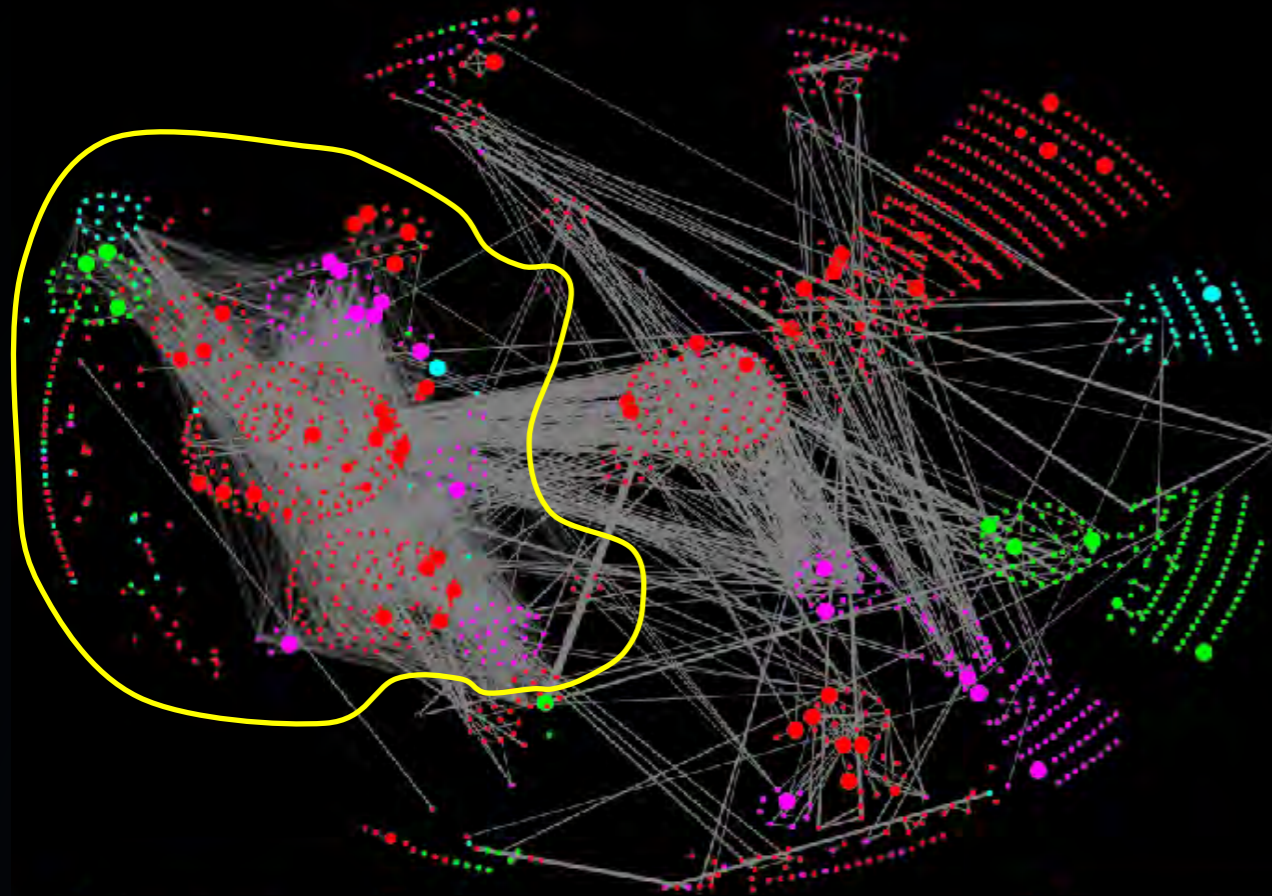
Research Impact

WEB OF SCIENCE™



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Reference Types (2000–2016)



new paradigms

a fundamental change in approach
or underlying assumptions

**translational
research => research**

38% Experimental Data

17% Experimentalists

65% outside NCN

7% Industry

nano researchers

computer
science

educators



Research Impact

**translational
research => research**

Education Impact ?

**translational
research => education
?**

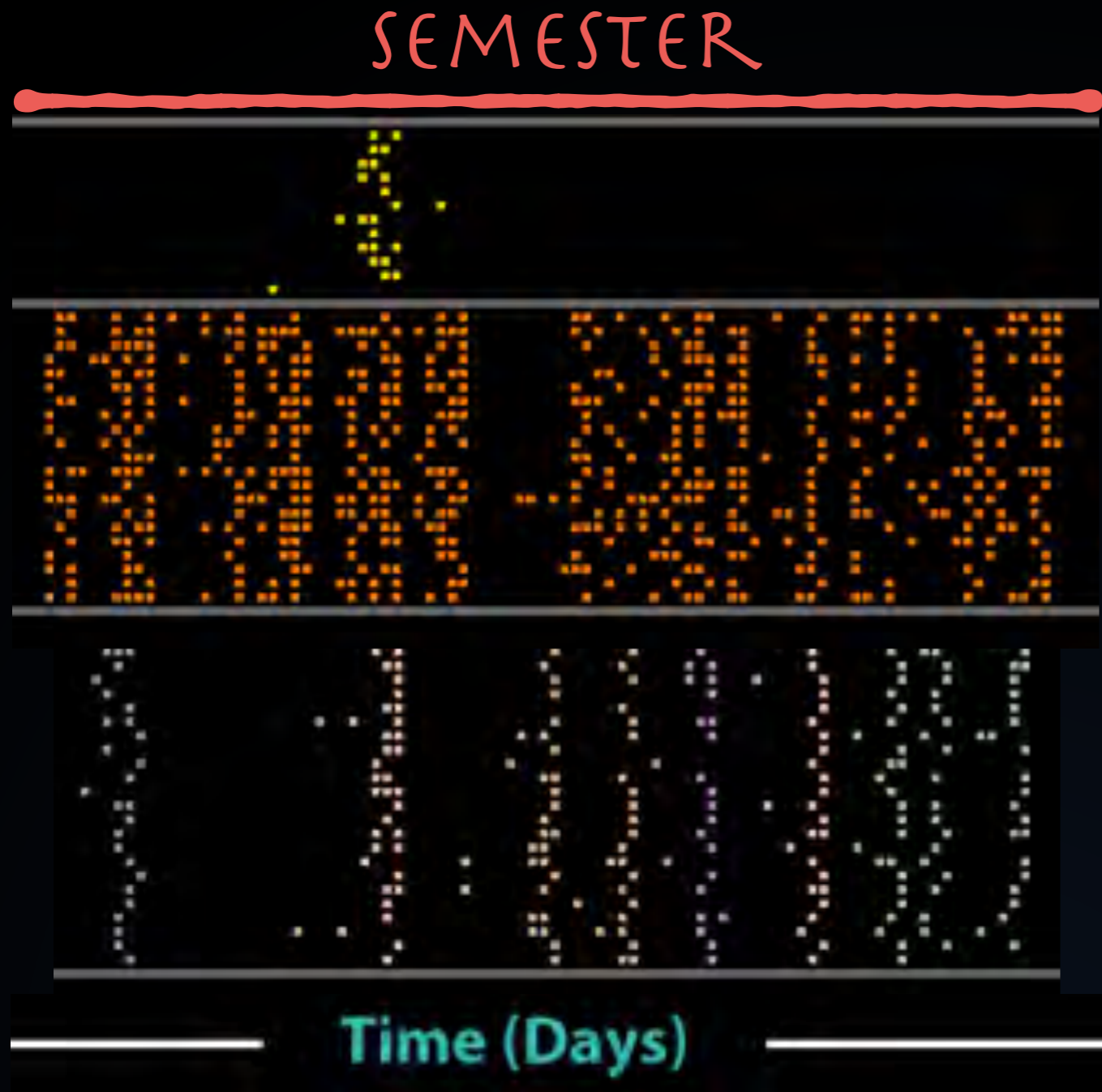
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Education Impact

**translational
research => education**



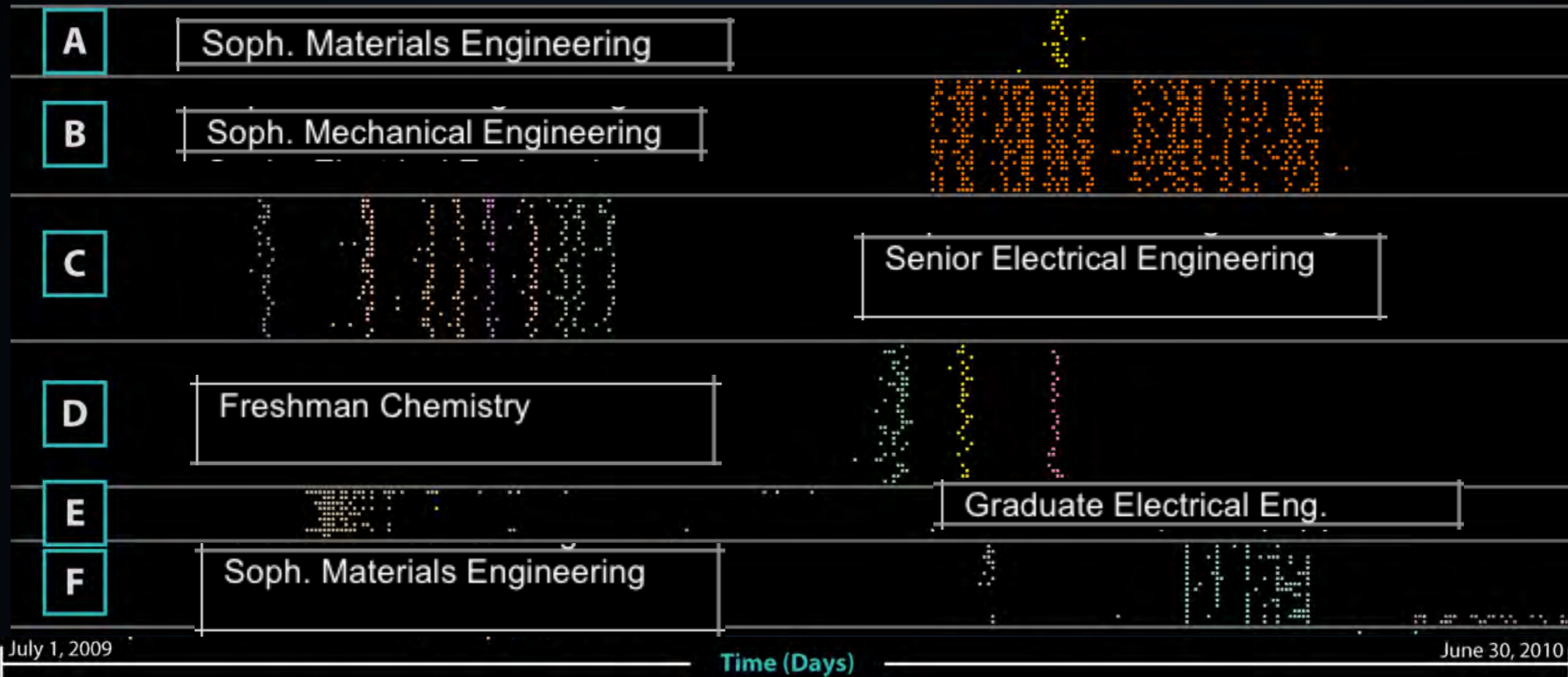
**Approach:
user behavior analysis
NOT surveys!
=> scalable**

new paradigms

a fundamental change in approach
or underlying assumptions



New Assessment Approach!



35,100+ students,
1,780+ courses,
185 institutions

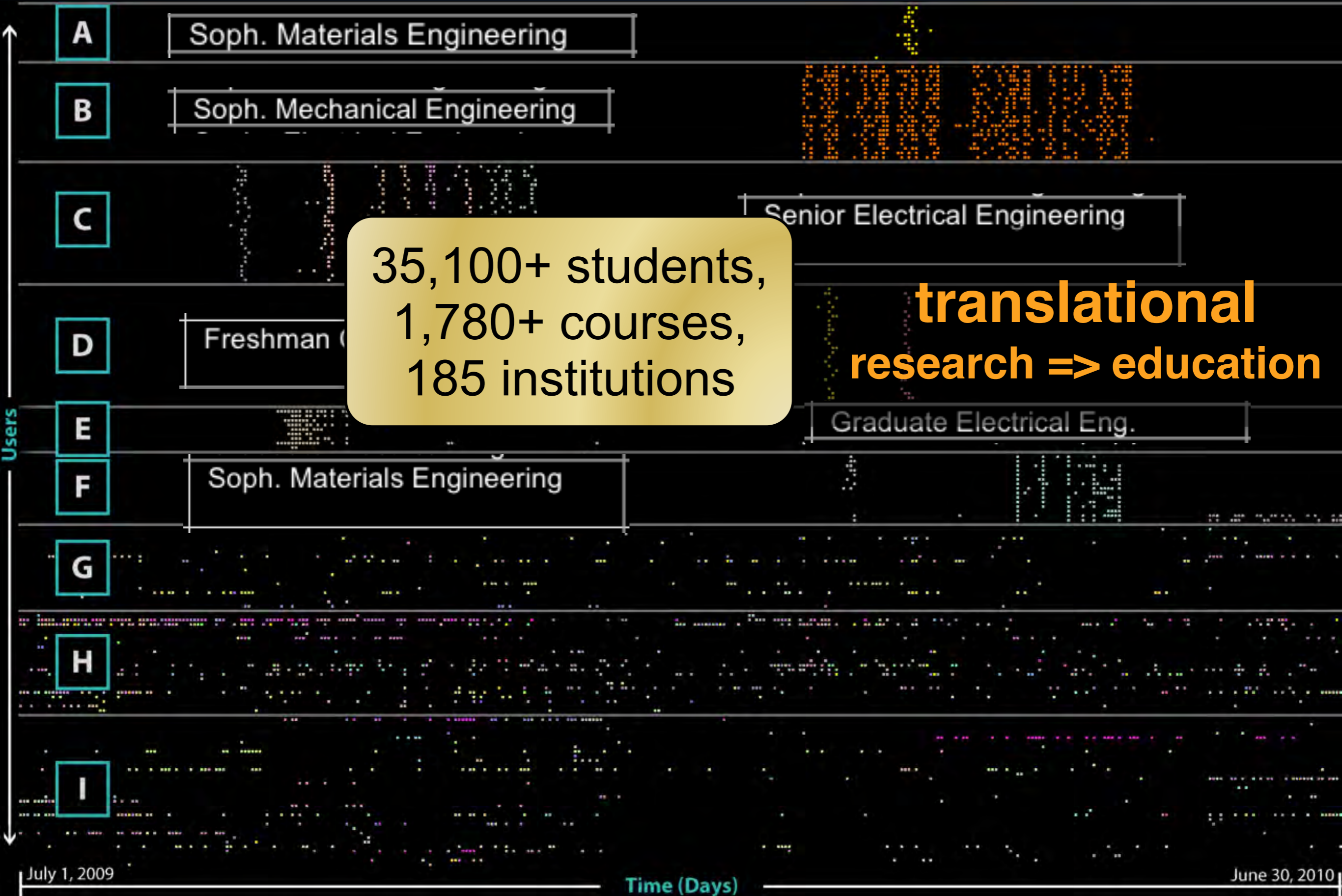
**translational
research => education**

new paradigm

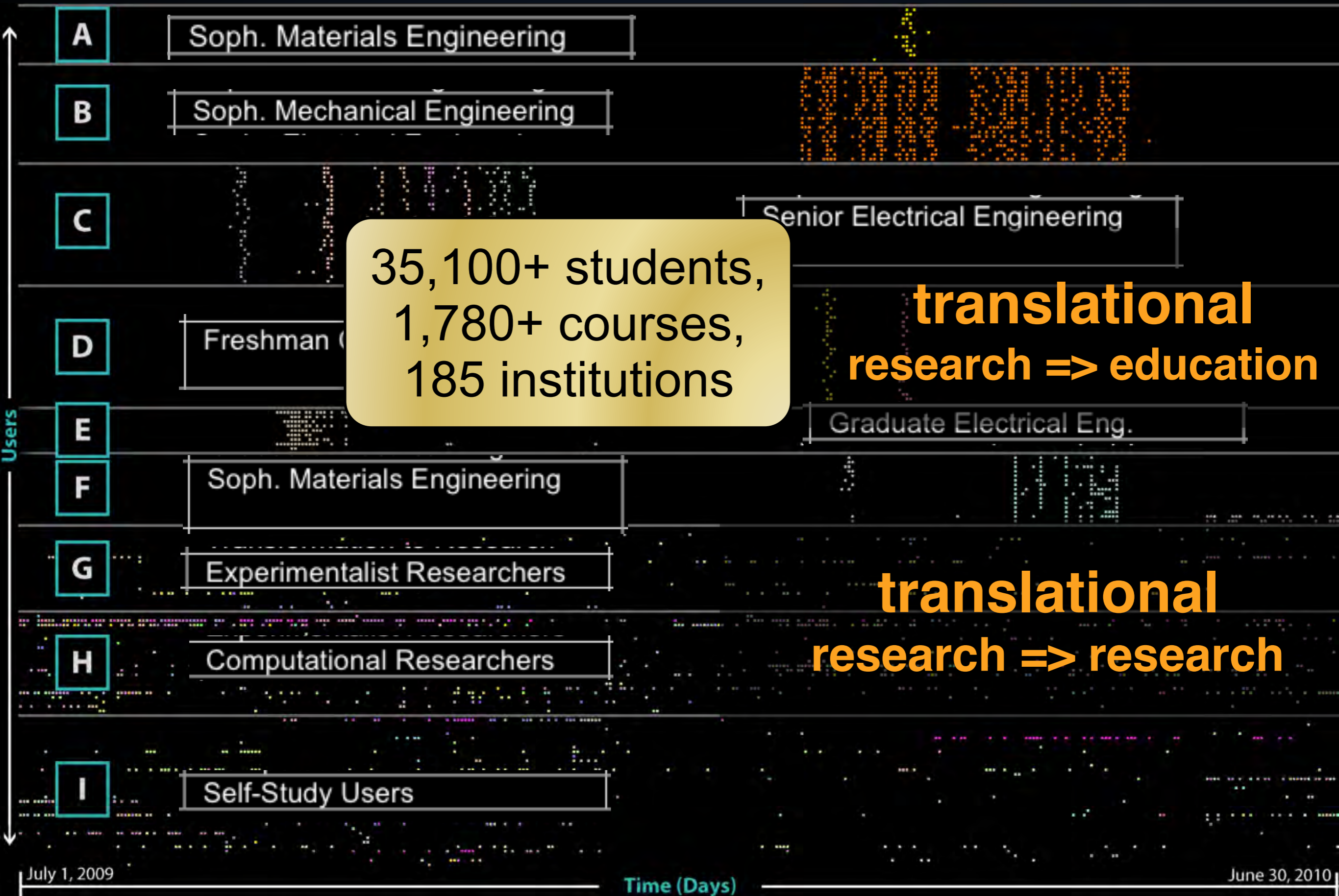
a fundamental change in approach
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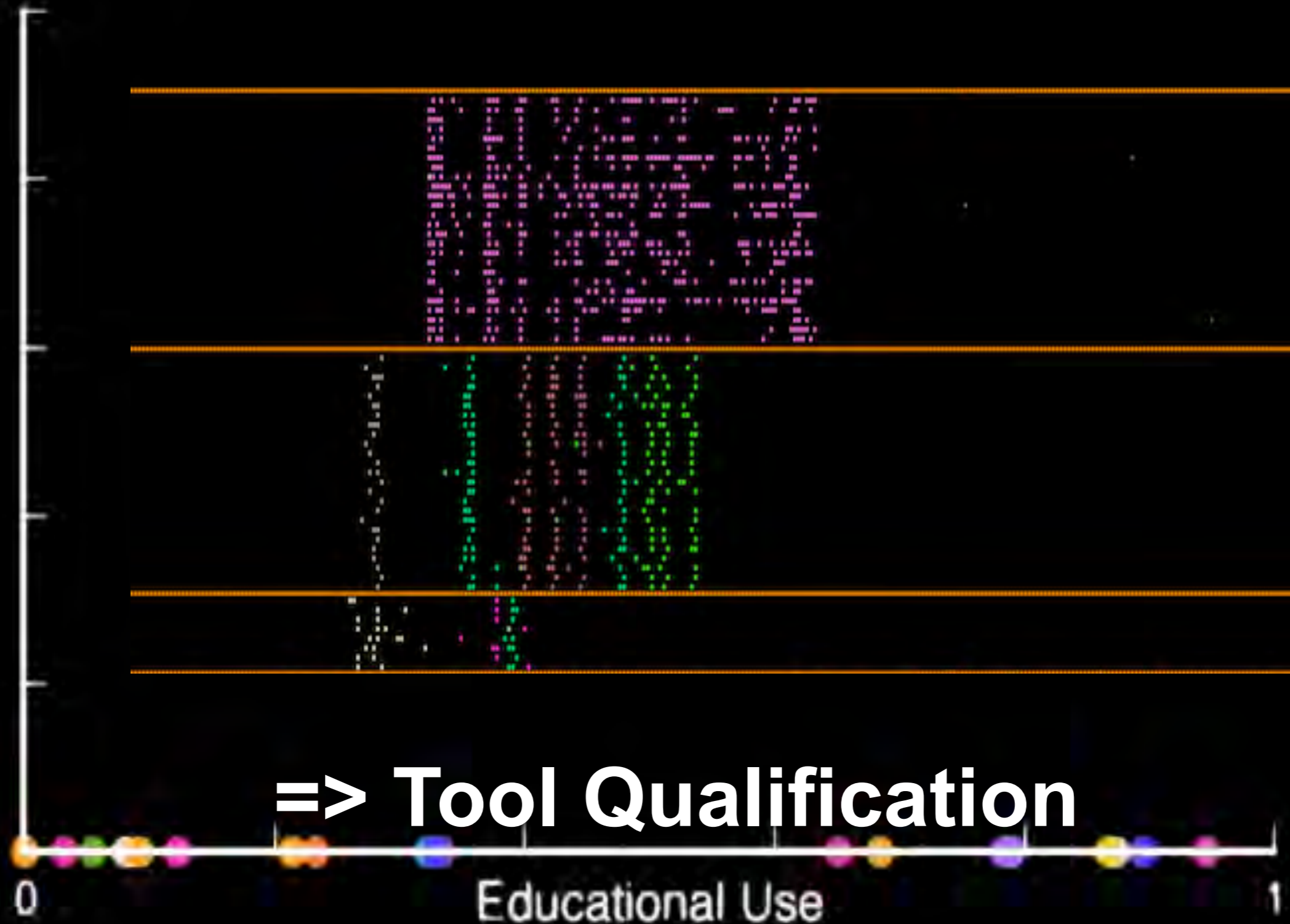
New Assessment Approach!



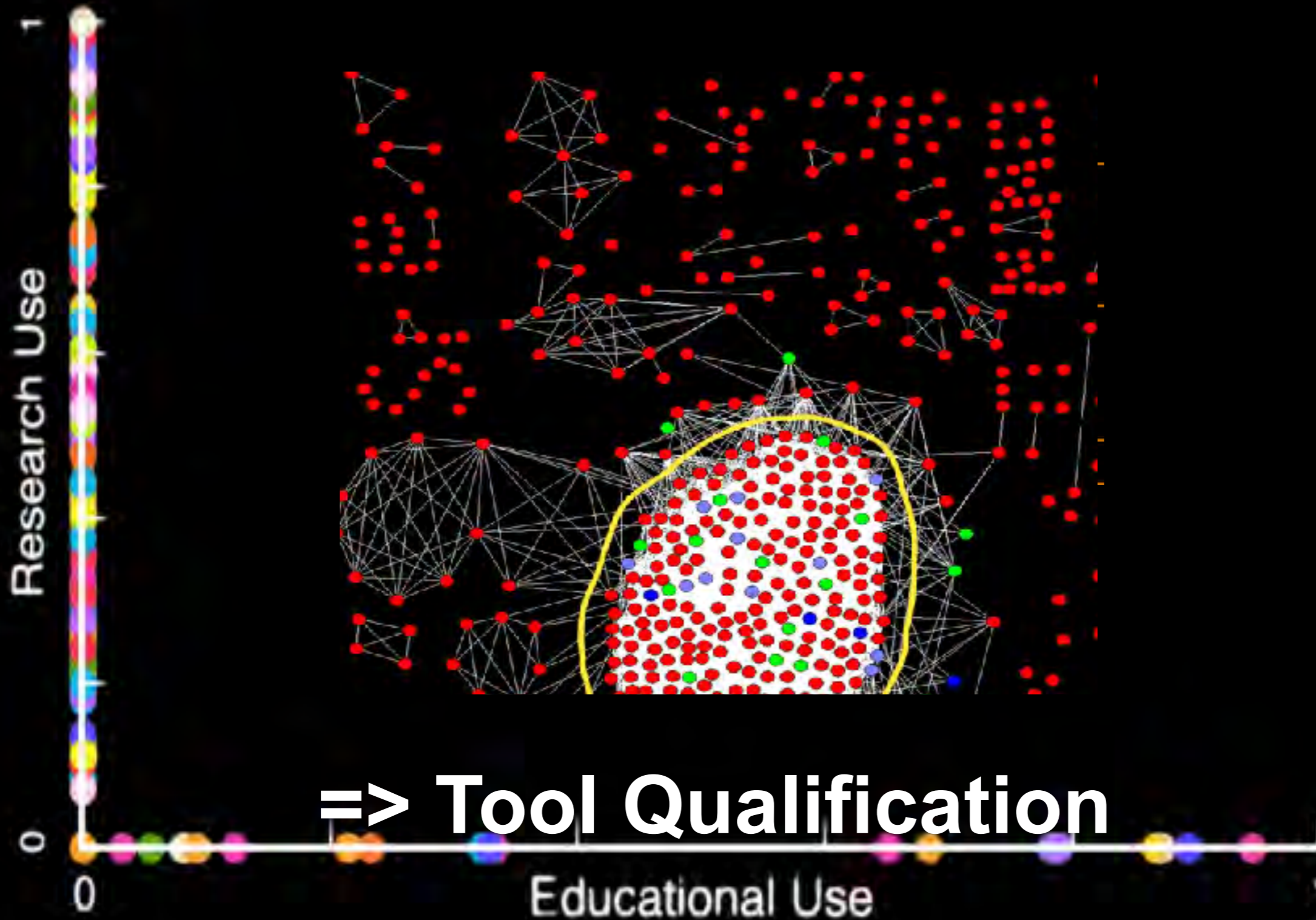
New Assessment Approach!



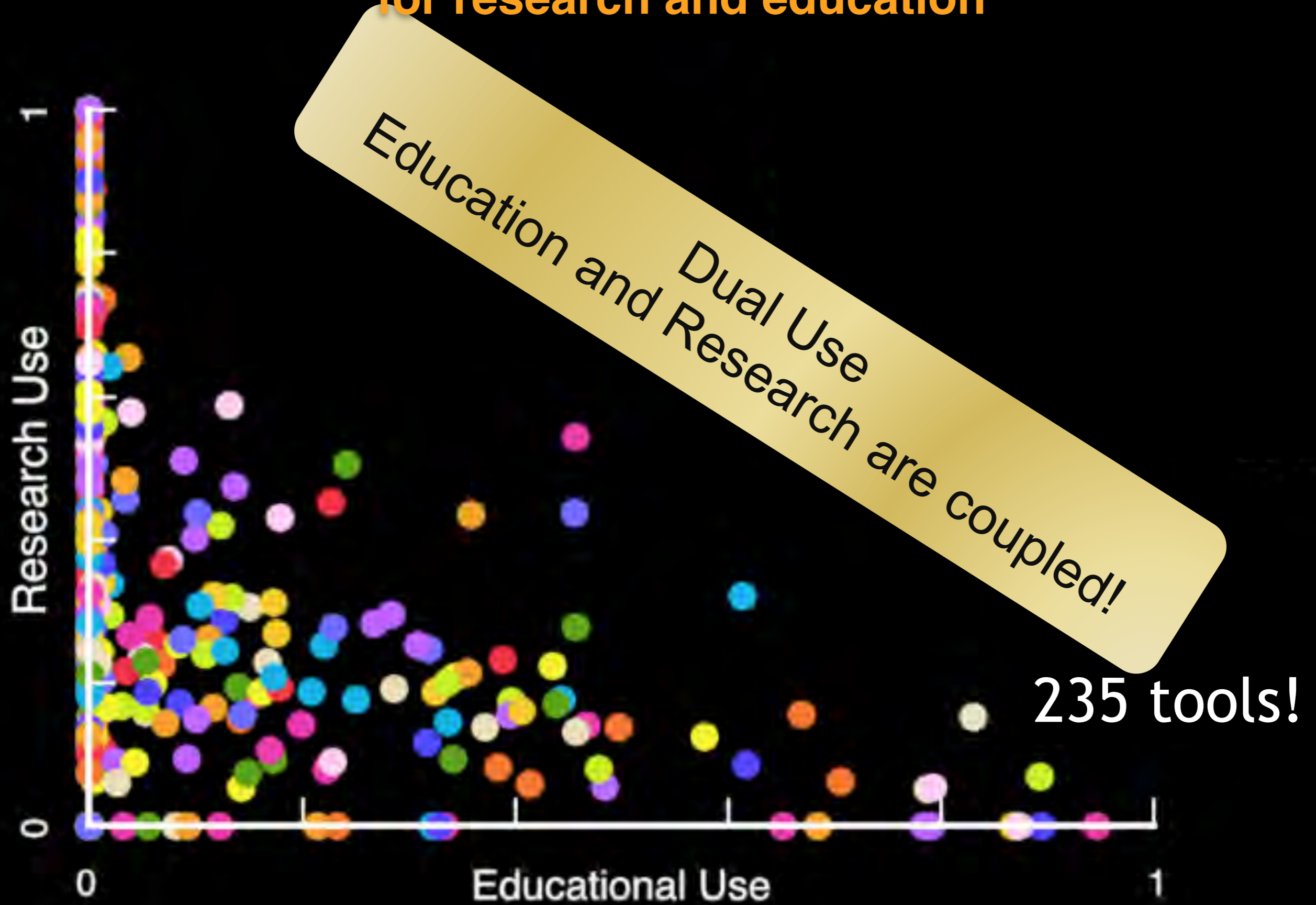
New nanoHUB Paradigm: The first science / engineering computing cloud for research and education Usage Patterns



New nanoHUB Paradigm:
The first science / engineering computing cloud
for research and education
Literature Citations



New nanoHUB Paradigm: The first science / engineering computing cloud for research and education



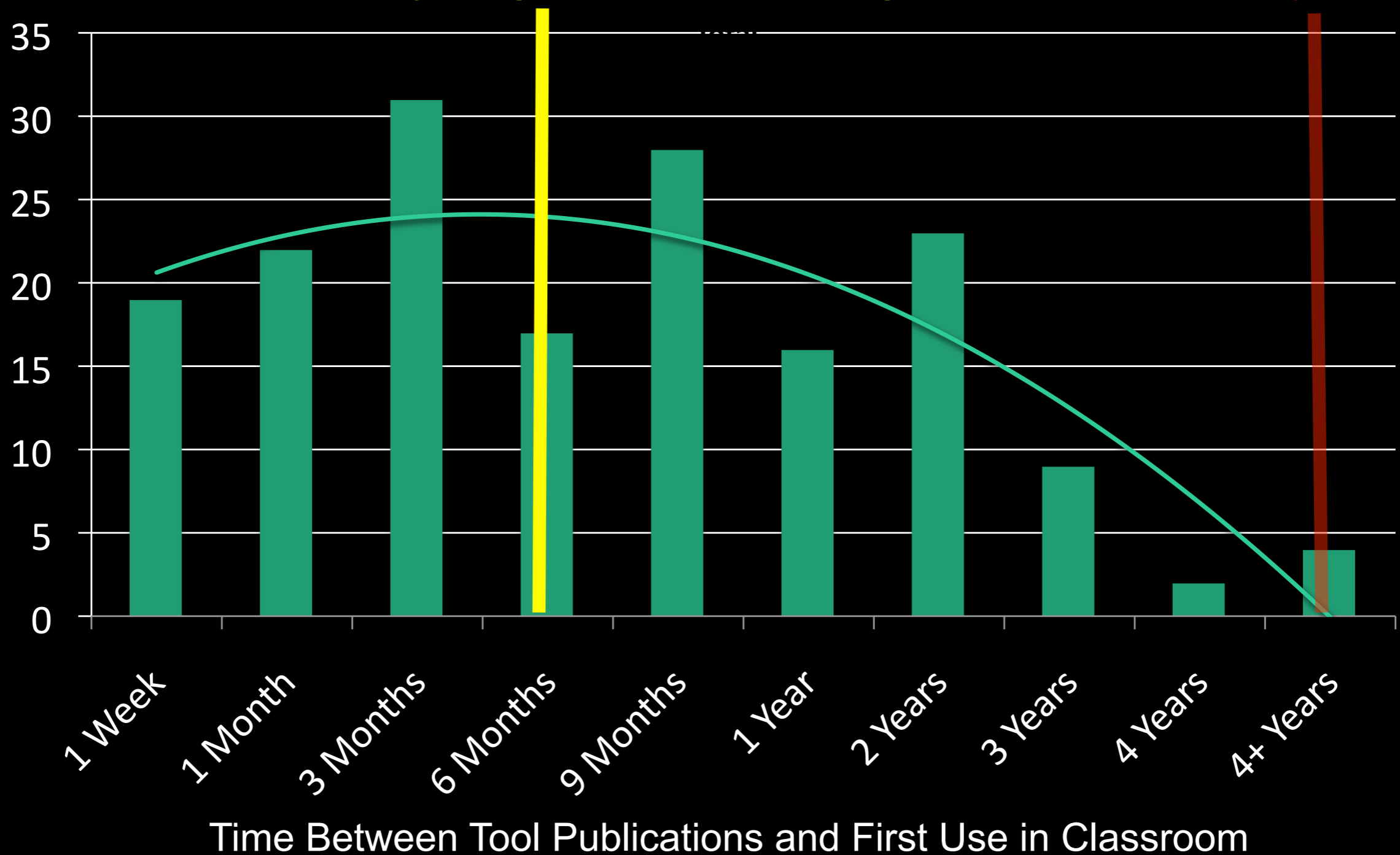
Rapid Adoption of Research

Median adoption time:

174 days (5.7 months)

Typical textbook update:

3.8 years



Hubs 'R Us

hubzero.org



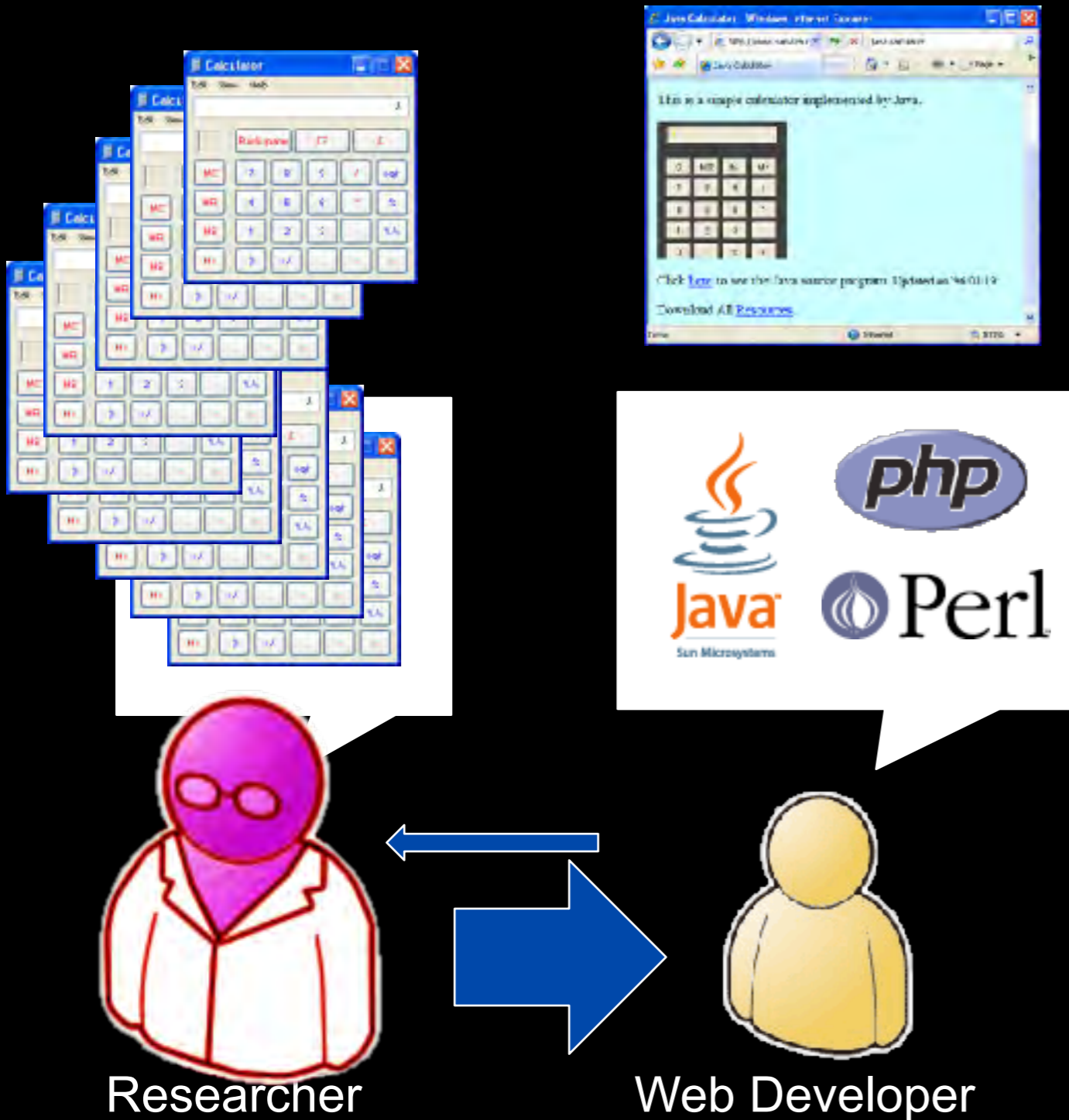
- Feb 2007: 1 hub
- Feb 2008: 5 hubs
- Feb 2009: 8 hubs
- Feb 2010: 21 hubs
- Sept 2010: >30 hubs
- Sept 2012: >40 hubs

Each hub has its own funding stream

Outside institutions:
EPA, NYSTAR, Rice



Usual Science Gateway Process



- ~~175 tools / 4 years:~~
=> ~~\$8.8M~~
- \$500k/tool
- NO new research!
- Not validated by researcher (disowned)
- Researcher has much better version
- Code rewrite takes 2-3 years



Many Proposals read alike



Usual Science Gateway Process



- ~~175 tools / 4 years:~~
=> ~~\$88M~~
- \$500k/tool



Customers / Users

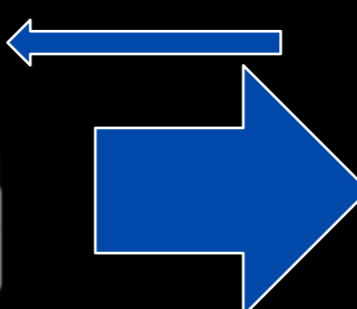
- Scale back expectations
- Not research codes
- Toy applications
- Not deep research
- Maybe for education?



Researcher



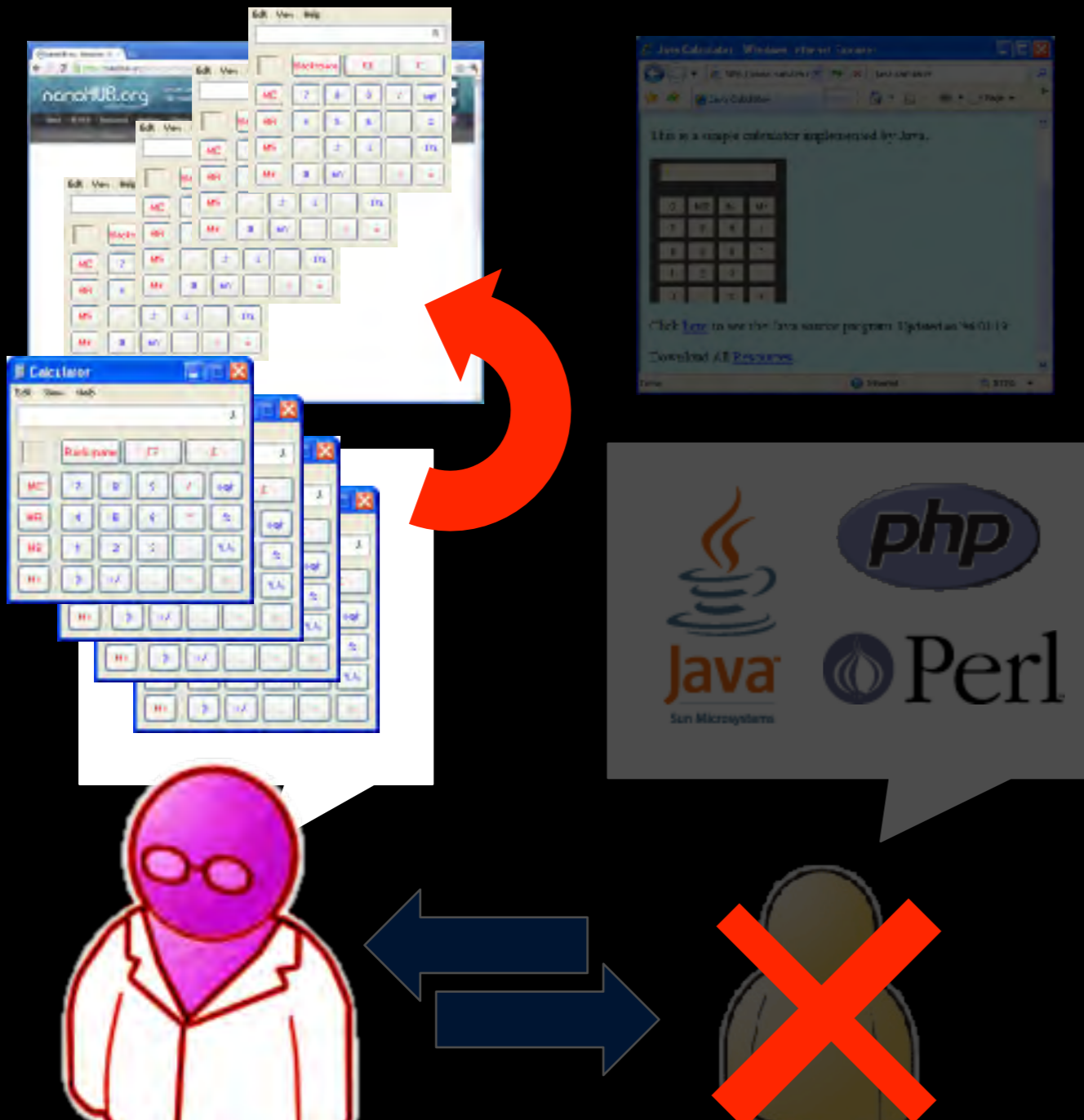
Web Developer



Generating a Bad Reputation



nanoHUB Process

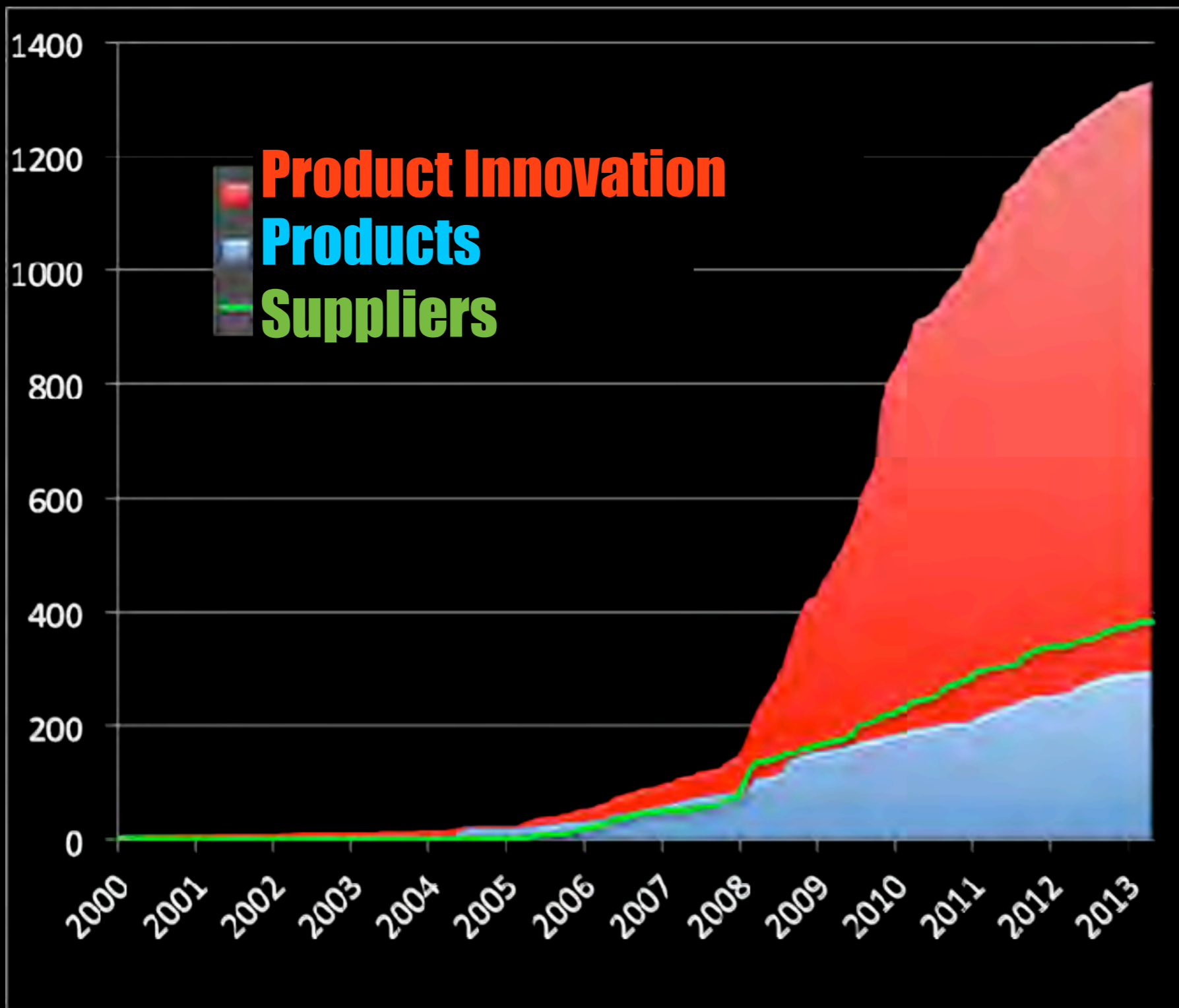


- **175 tools / 4 years without \$88M**
- Eliminate bottlenecks
 - No Middleman
 - No Rewrite
 - Retain ownership
- Rapid Deployment: 2-3 years → 1-2 weeks
- **Rappture** toolkit
- **HUBzero** Ecosystem

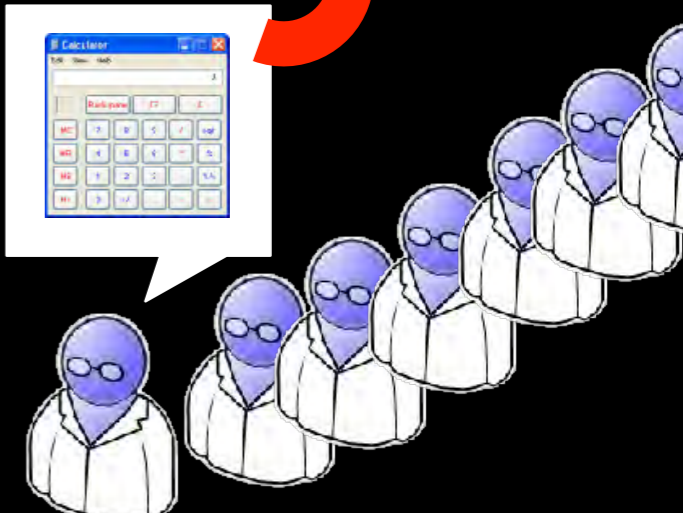
Supplier

**Sub-Contractor
Consultant**

nanoHUB is different



v3



Continual Engagement

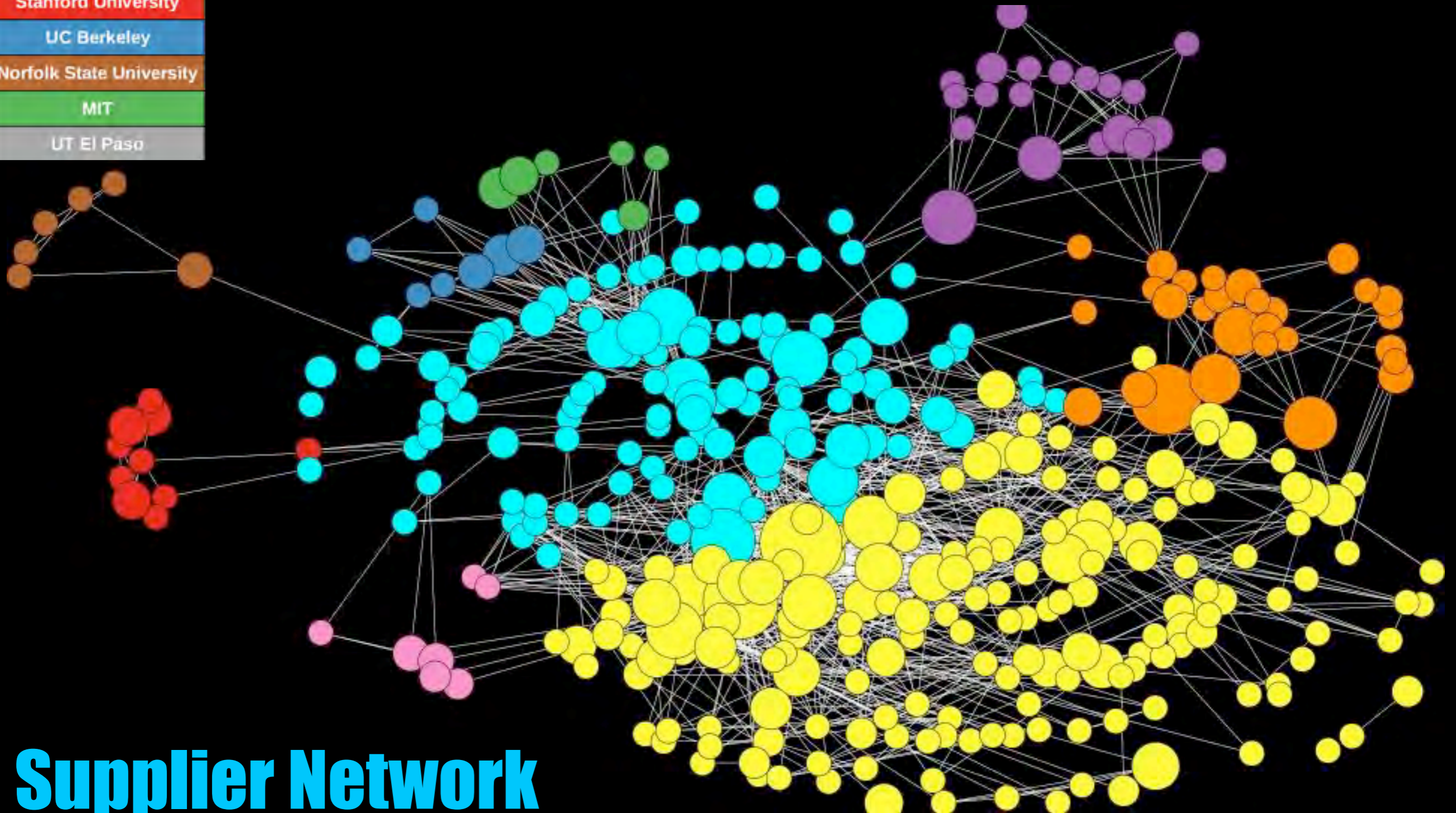
380+ Developers
NOT PAID by NCN

nanoHUB can prove it

Developer Collaboration Network

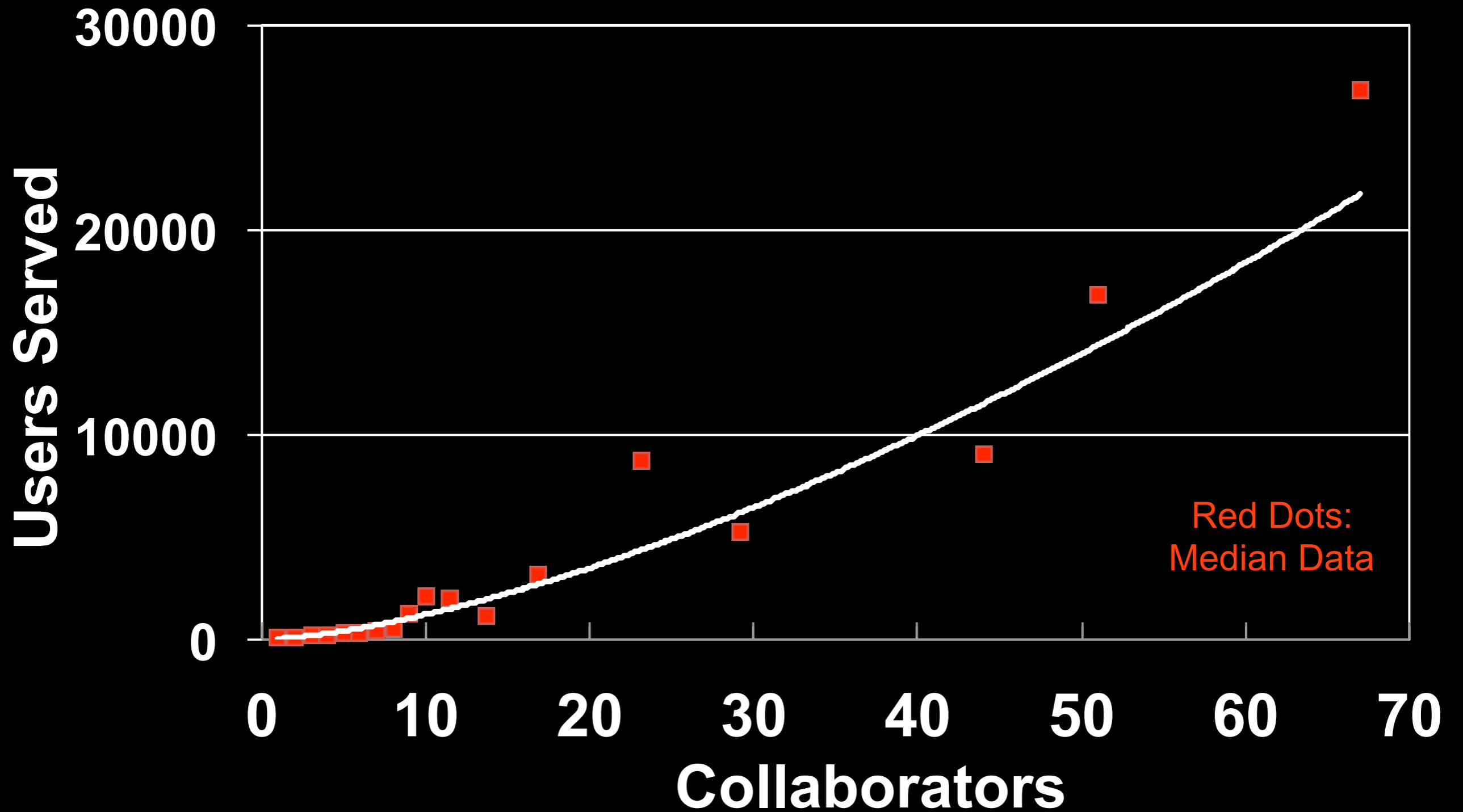
Purdue University
Northwestern University
University of Illinois
University of Florida
Stanford University
UC Berkeley
Norfolk State University
MIT
UT El Paso

Each dot is a Developer **suppliers**
Links are tools **product**

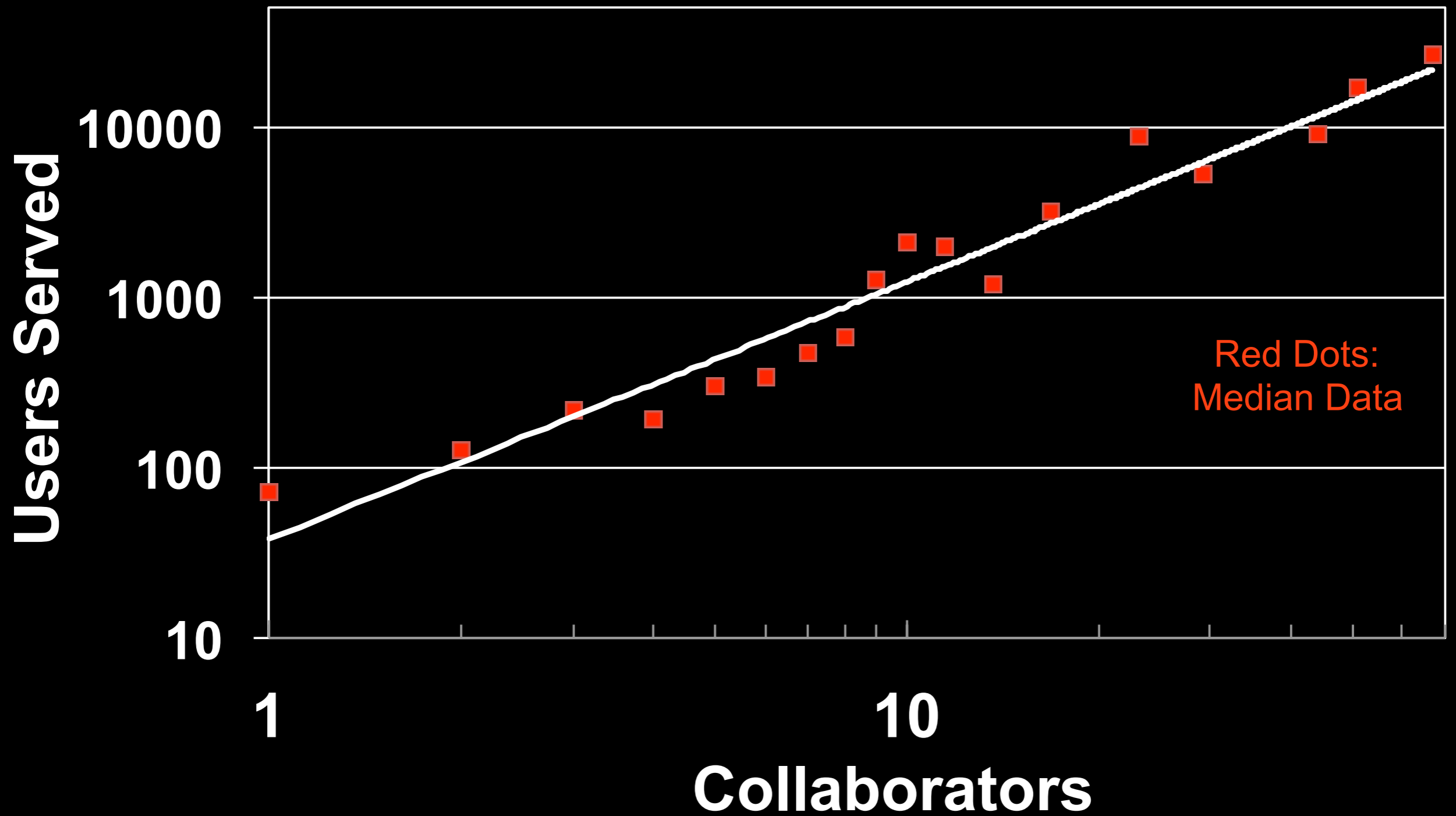


Supplier Network

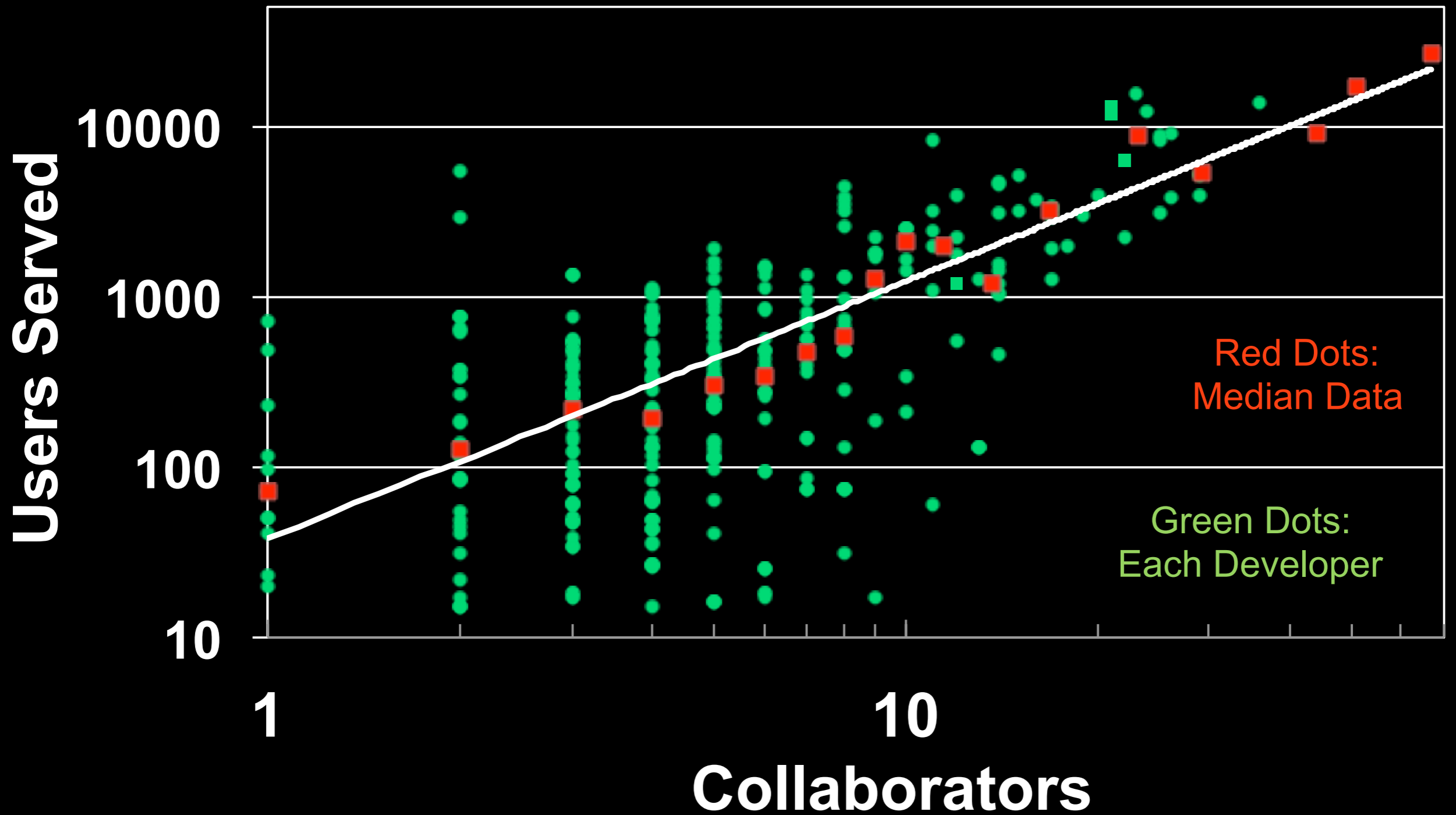
Developer Collaboration Impact



Developer Collaboration Impact

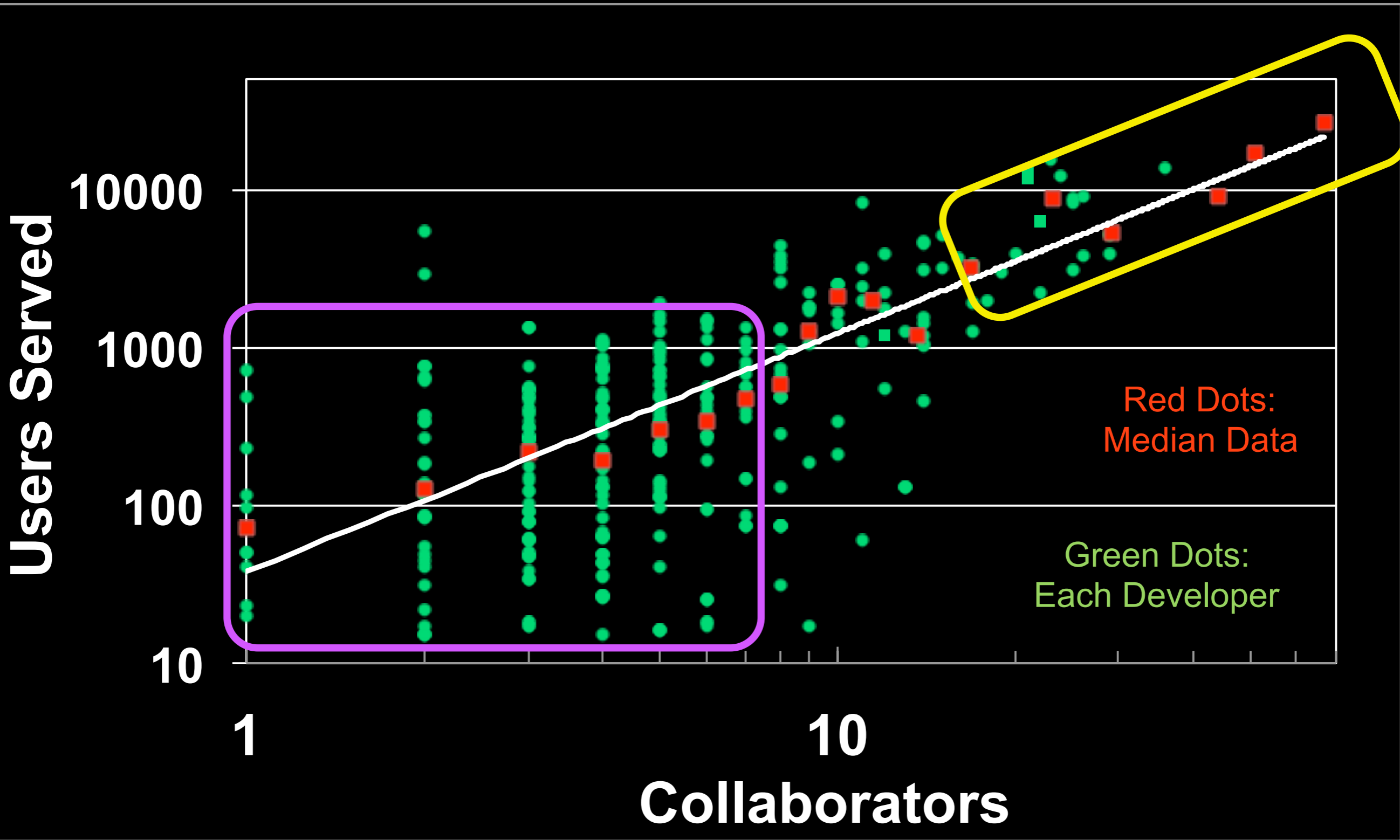


Developer Collaboration Impact



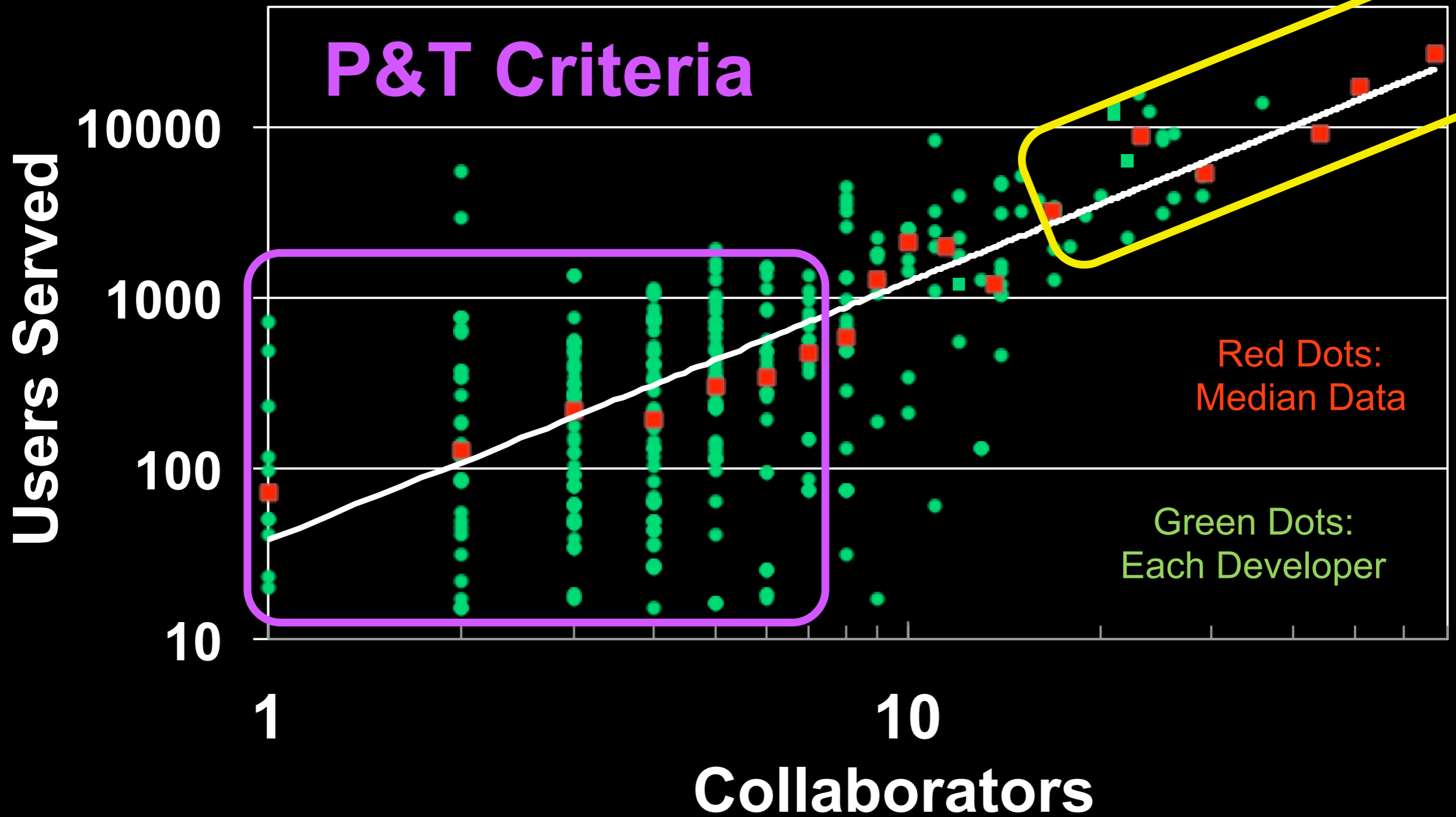
**Small Collaborations:
Scattered Success**

**Large Collaborations
Predictable Success**



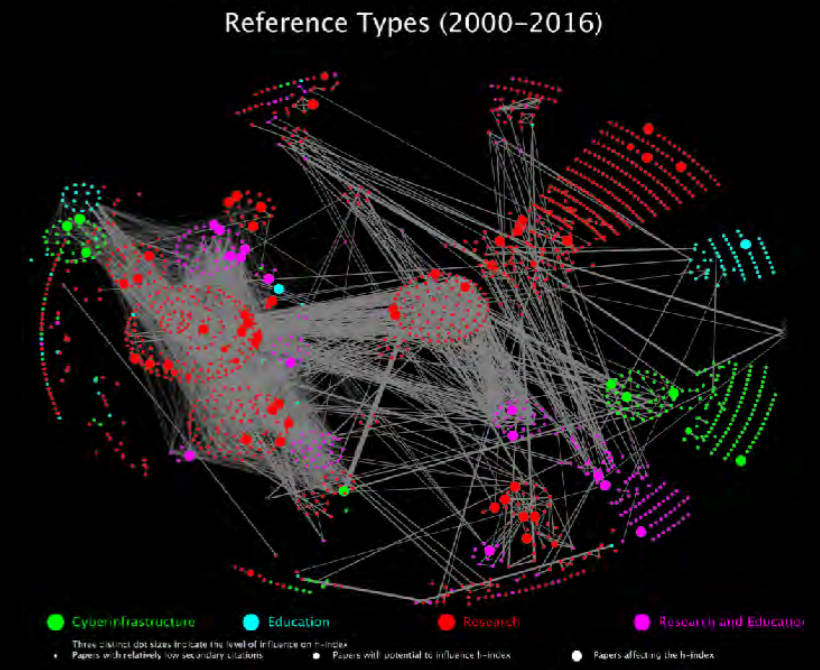
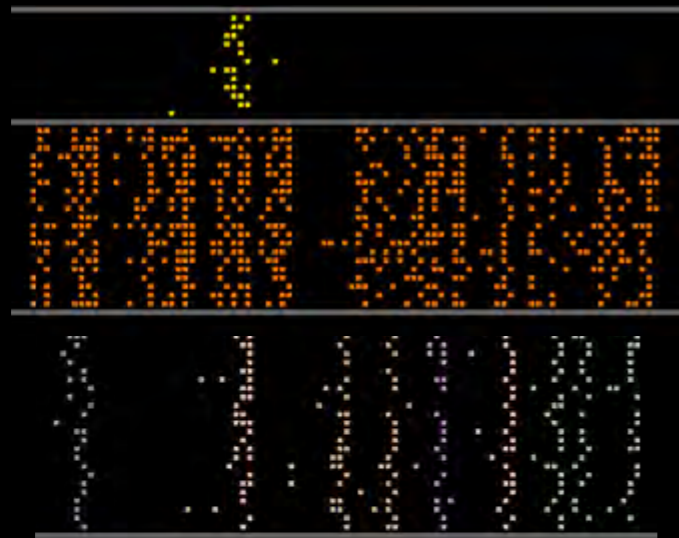
Old Approach

Surviving Universities



Retrospective and longitudinal data => nanoHUB has demonstrated several paradigm shifts

a fundamental change in approach or underlying assumptions



**translational
research => education**

**translational
research => research**

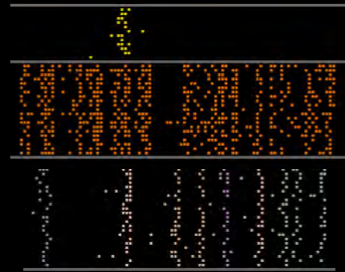
Operational 24/7
99.9% uptime

computational services:
simple => HPC



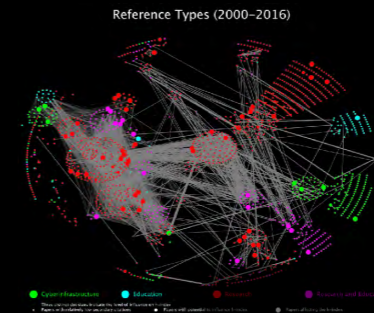
Retrospective and longitudinal data => nanoHUB has demonstrated several paradigm shifts

a fundamental change in approach or underlying assumptions



**translational
research => education**

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**translational
research => research**

These are demonstrators! Existence proofs!

What is the next BIG thing?



Retrospective and longitudinal data =>
nanoHUB has demonstrated several paradigm shifts
a fundamental change in approach or underlying assumptions

These are demonstrators!
Existence proofs!

What is the next BIG thing?

Vision

to accelerate innovation through
user-centric science and engineering



Vision

**to accelerate innovation through
user-centric science and engineering**

Mission

**to make science and engineering products
usable, discoverable, reproducible, and
easy to create
for learners, educators, researchers,
and business professionals**



Challenges / Opportunities

- US STEM User Growth Growth

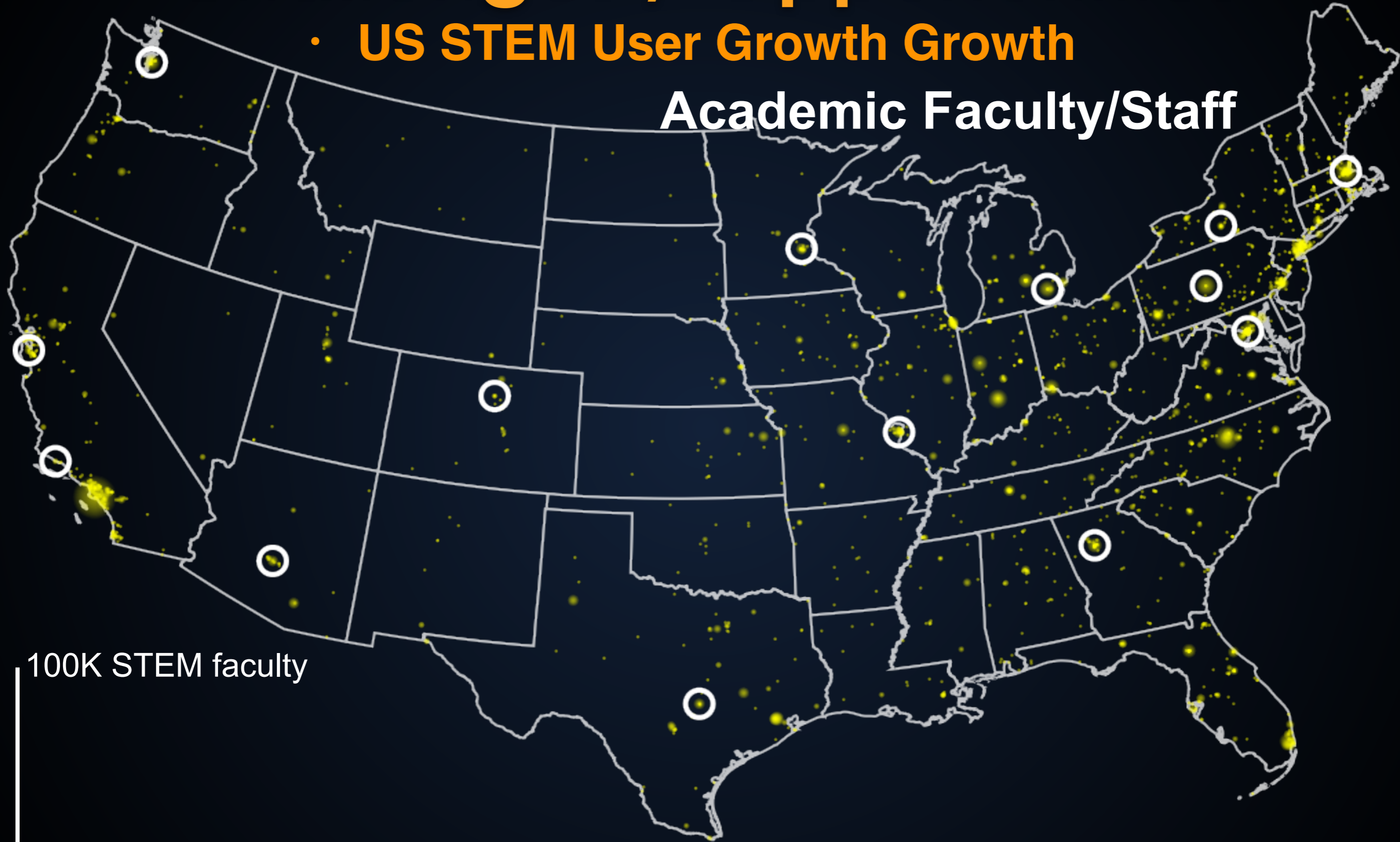
NNIN => NNCI



Challenges / Opportunities

- US STEM User Growth Growth

Academic Faculty/Staff



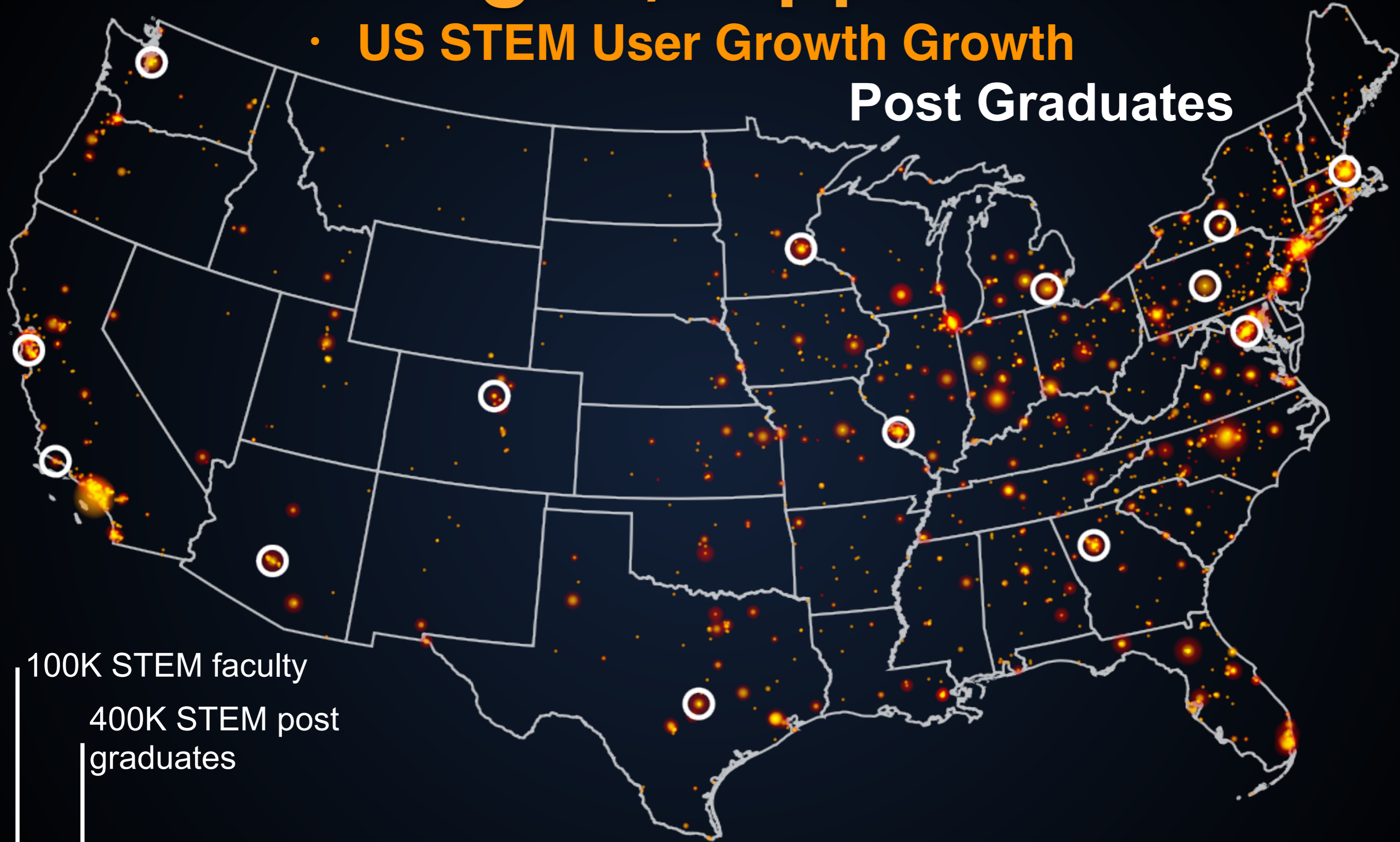
100K STEM faculty



Challenges / Opportunities

• US STEM User Growth Growth

Post Graduates



100K STEM faculty

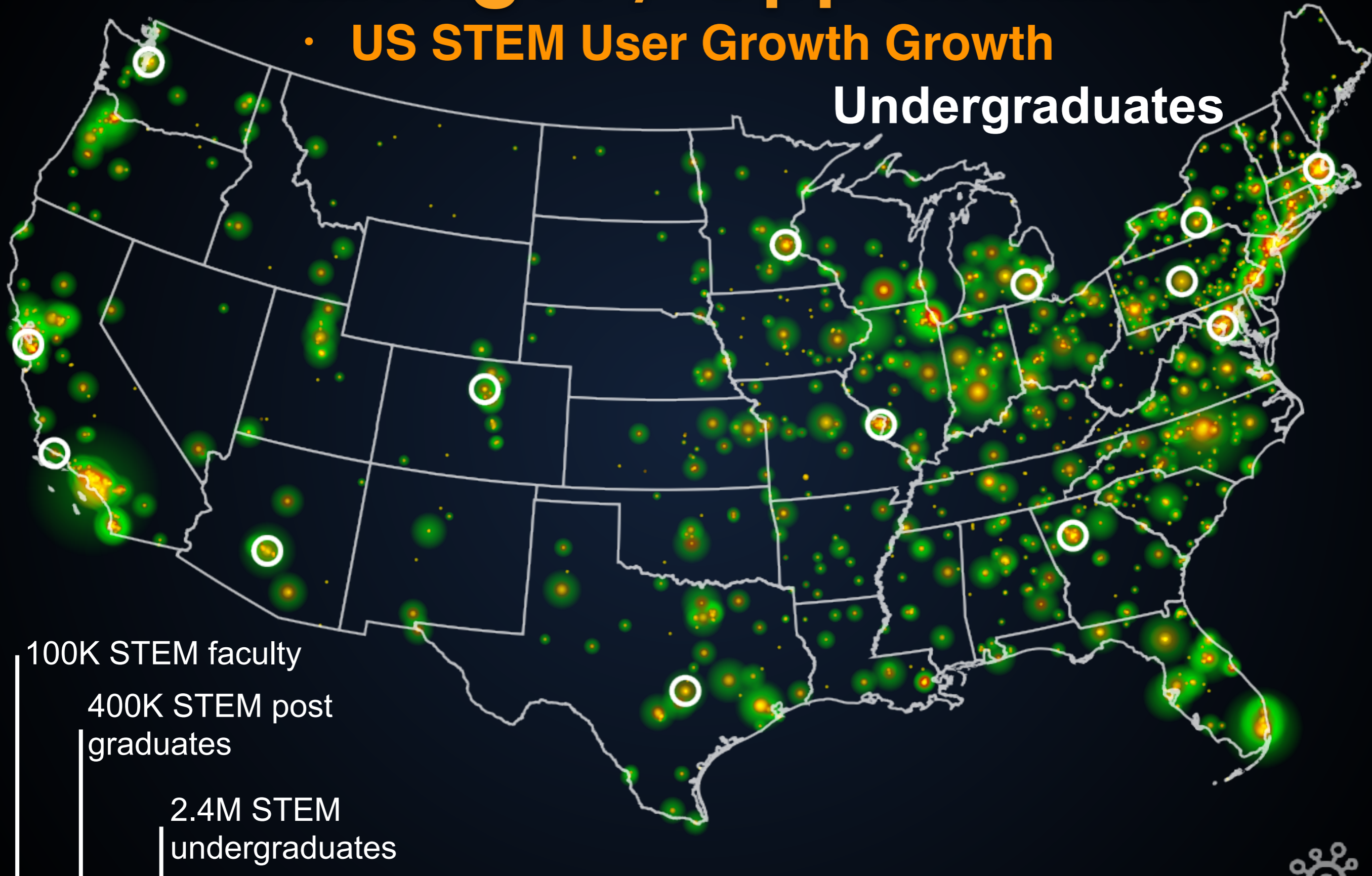
400K STEM post graduates



Challenges / Opportunities

- US STEM User Growth Growth

Undergraduates



100K STEM faculty

400K STEM post
graduates

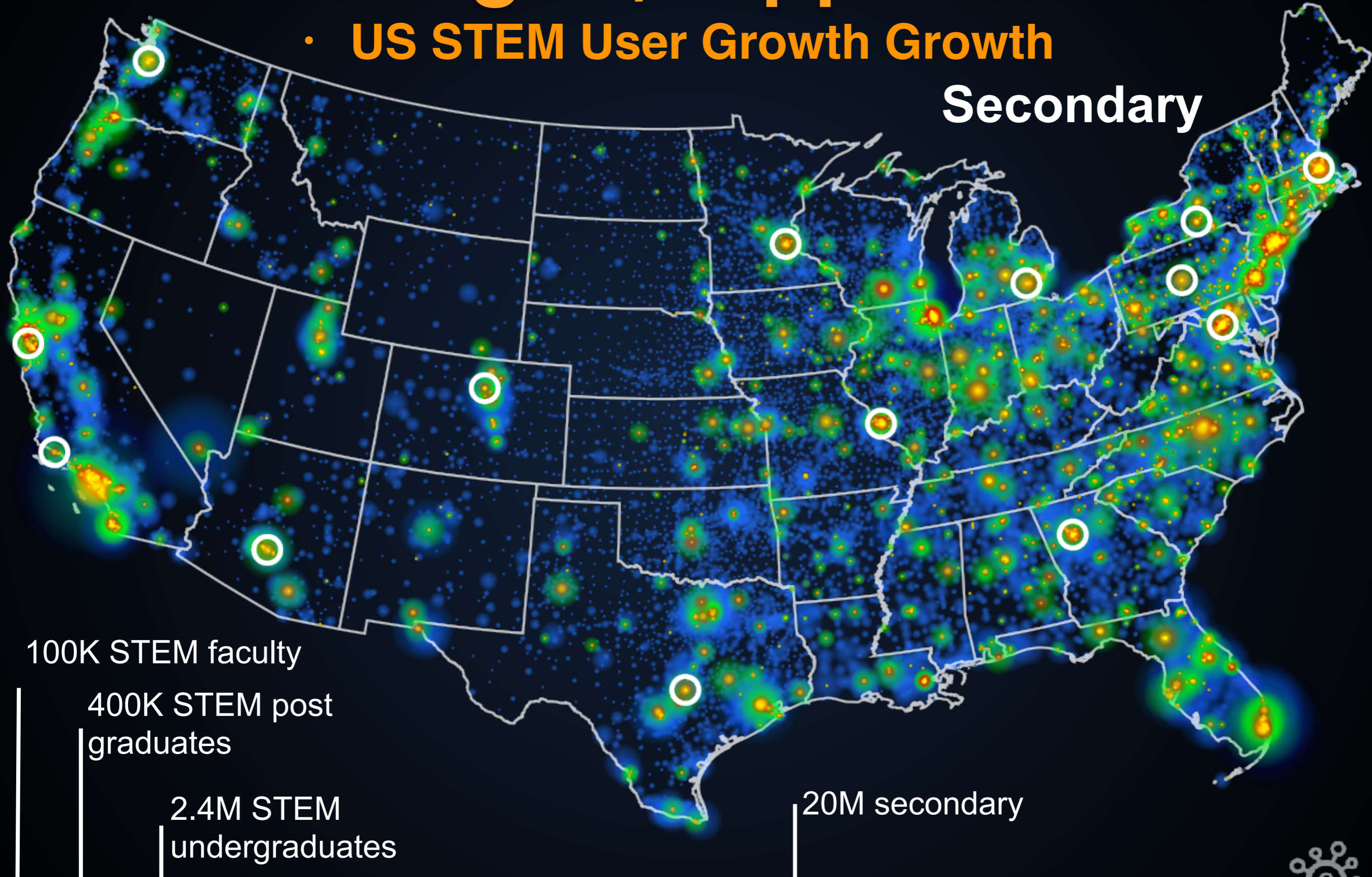
2.4M STEM
undergraduates



Challenges / Opportunities

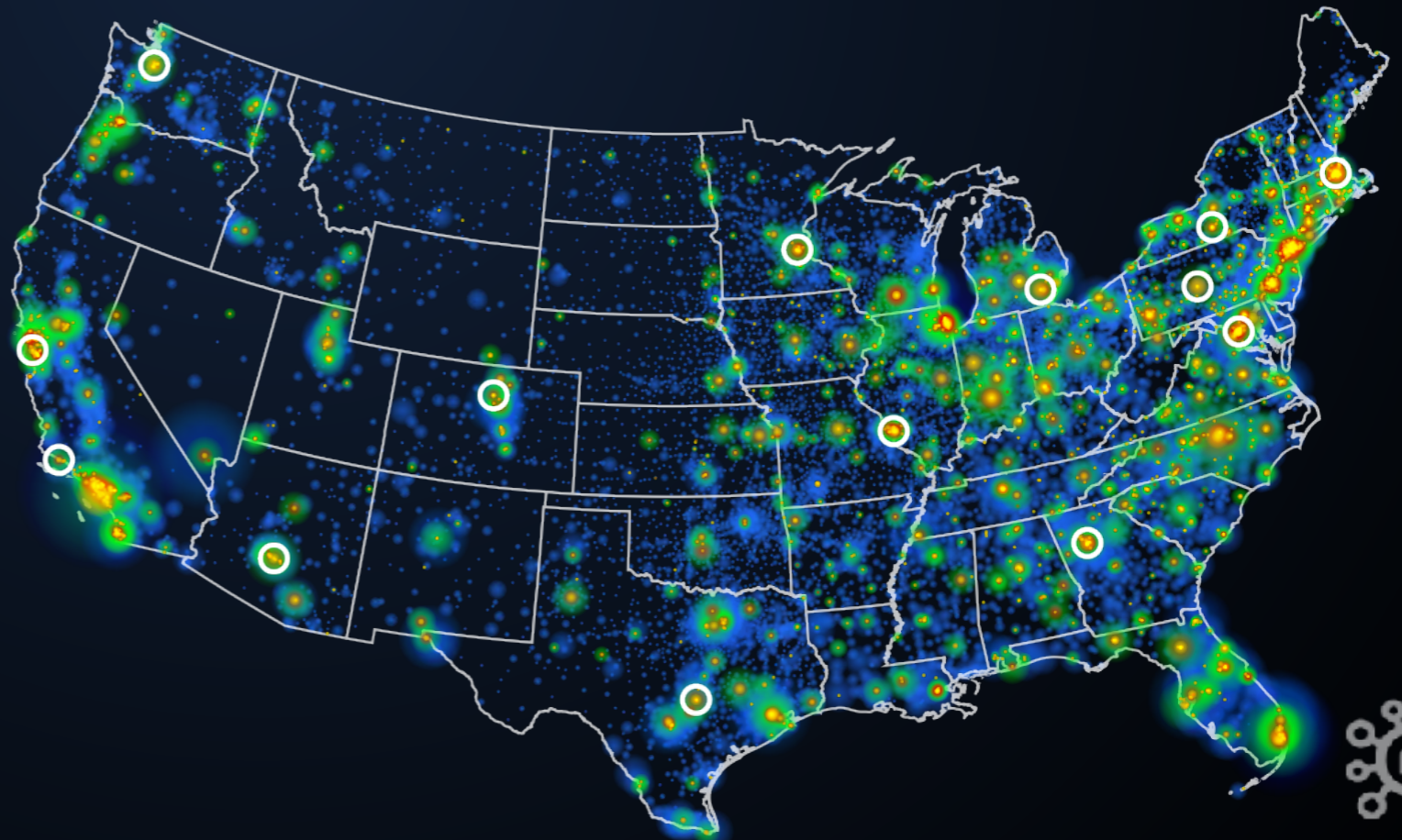
- US STEM User Growth Growth

Secondary



Challenges / Opportunities

- **US STEM User Growth Growth**
 - 100k faculty
 - 400k grad students
 - 2.4M undergrads
 - 20M secondary ed

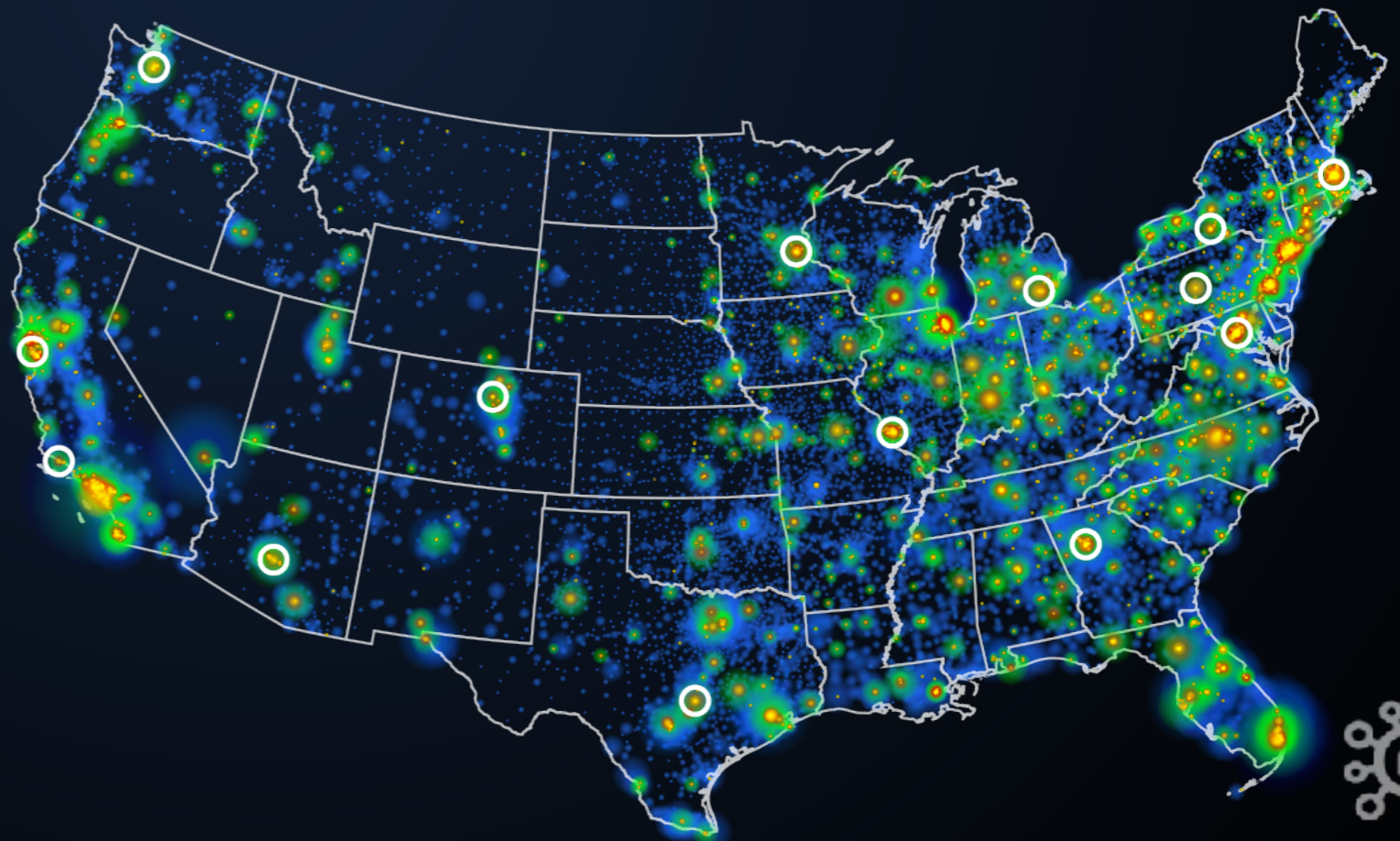


Challenges / Opportunities

- **US STEM User Growth Growth**
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 - 400k grad students
 - 2.4M undergrads
 - 20M secondary ed
- **US Content Contribution Growth**

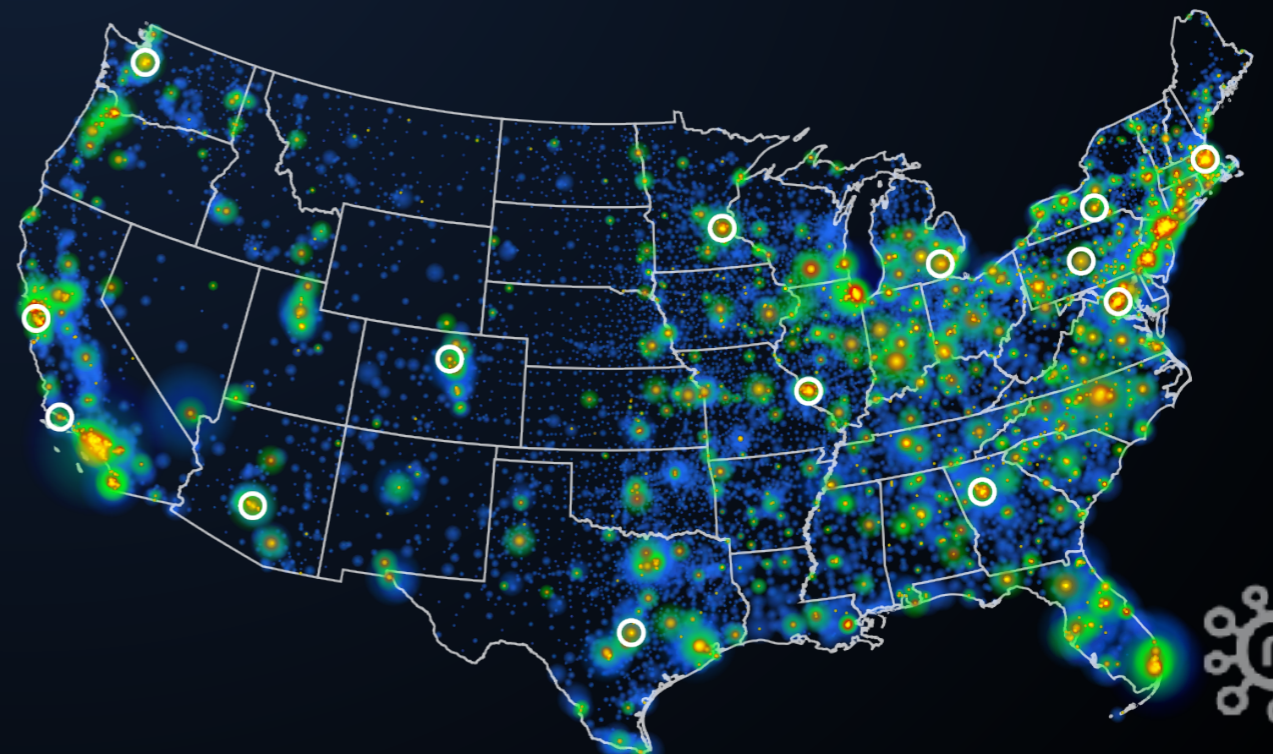


\$5M
|
■



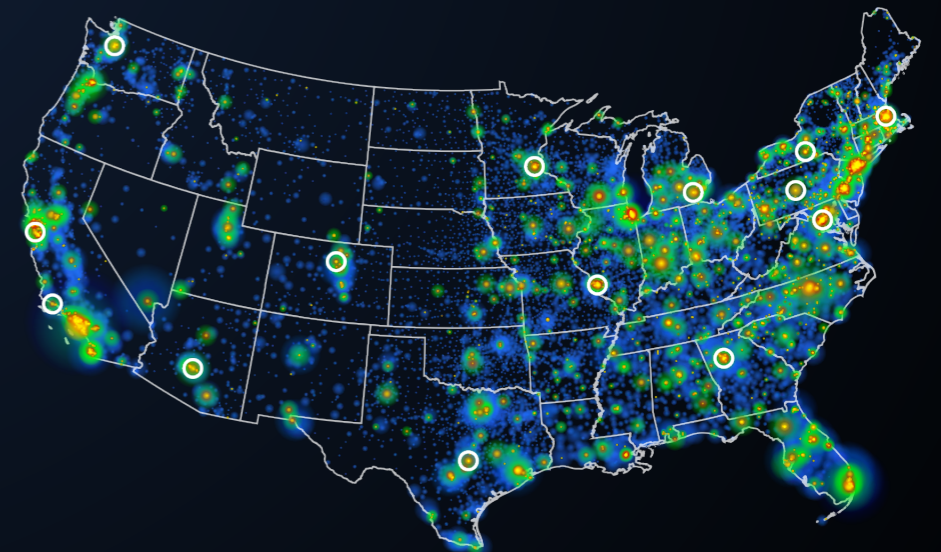
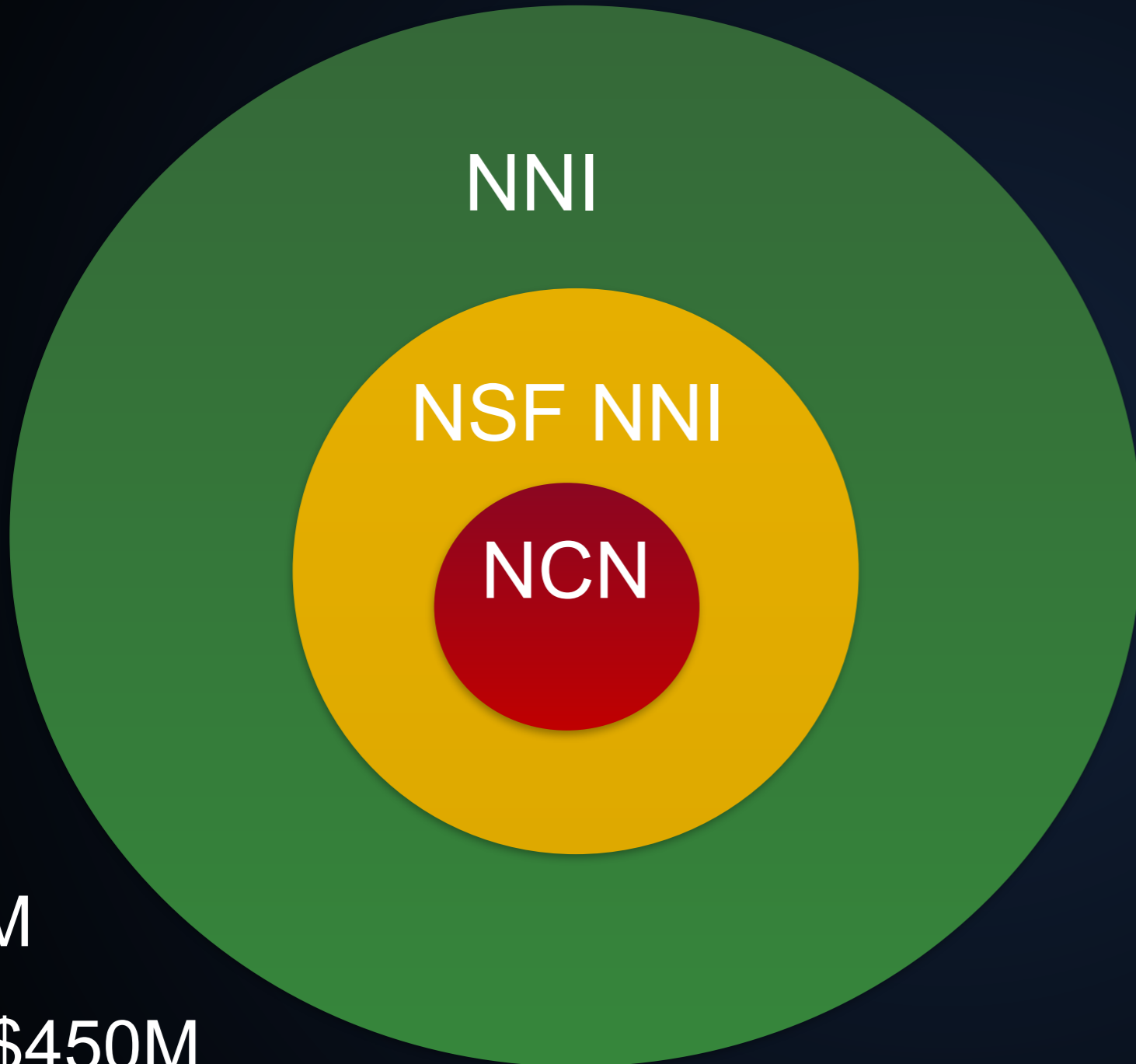
Challenges / Opportunities

- US Content Contribution Growth



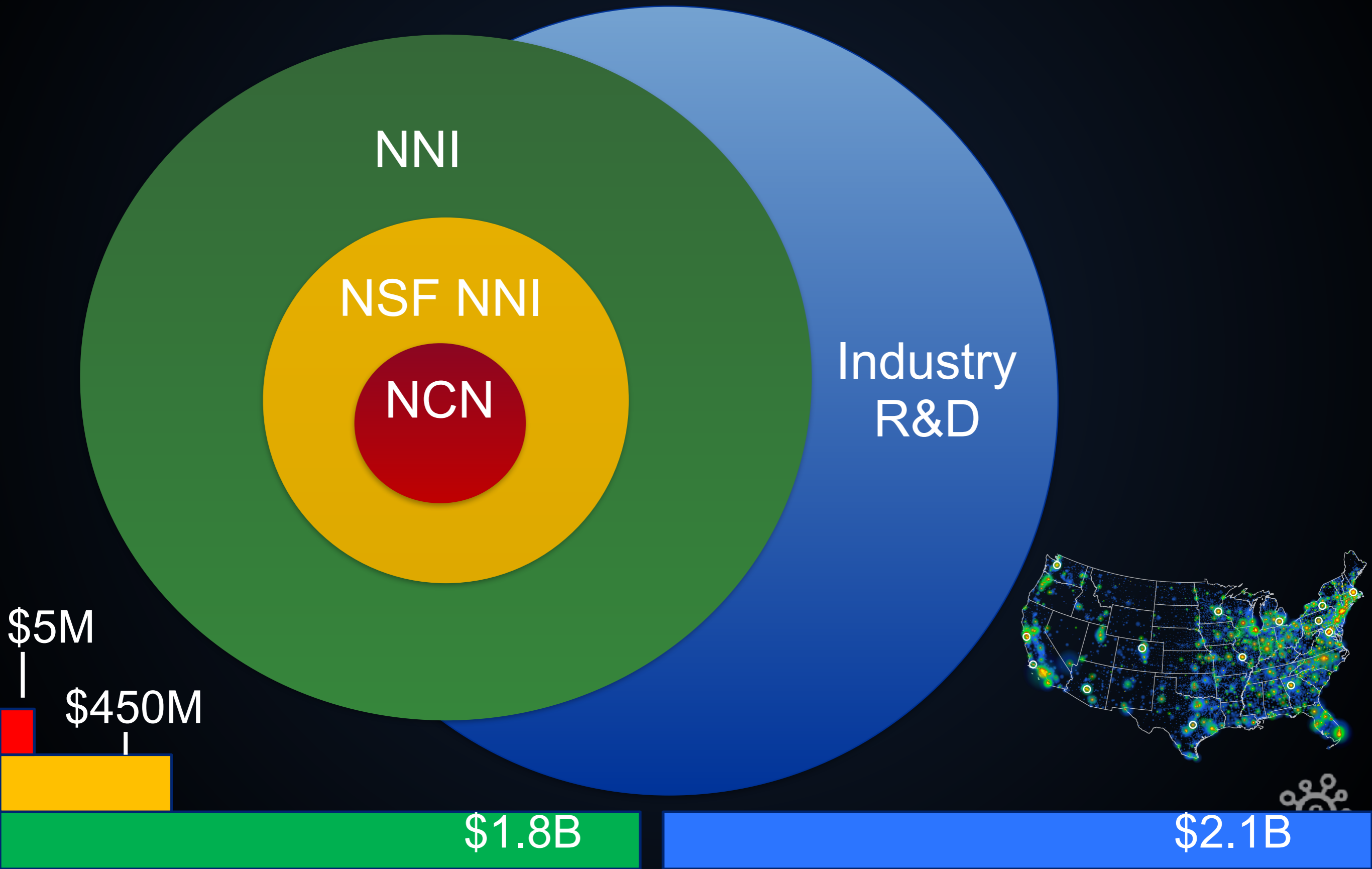
Challenges / Opportunities

- US Content Contribution Growth



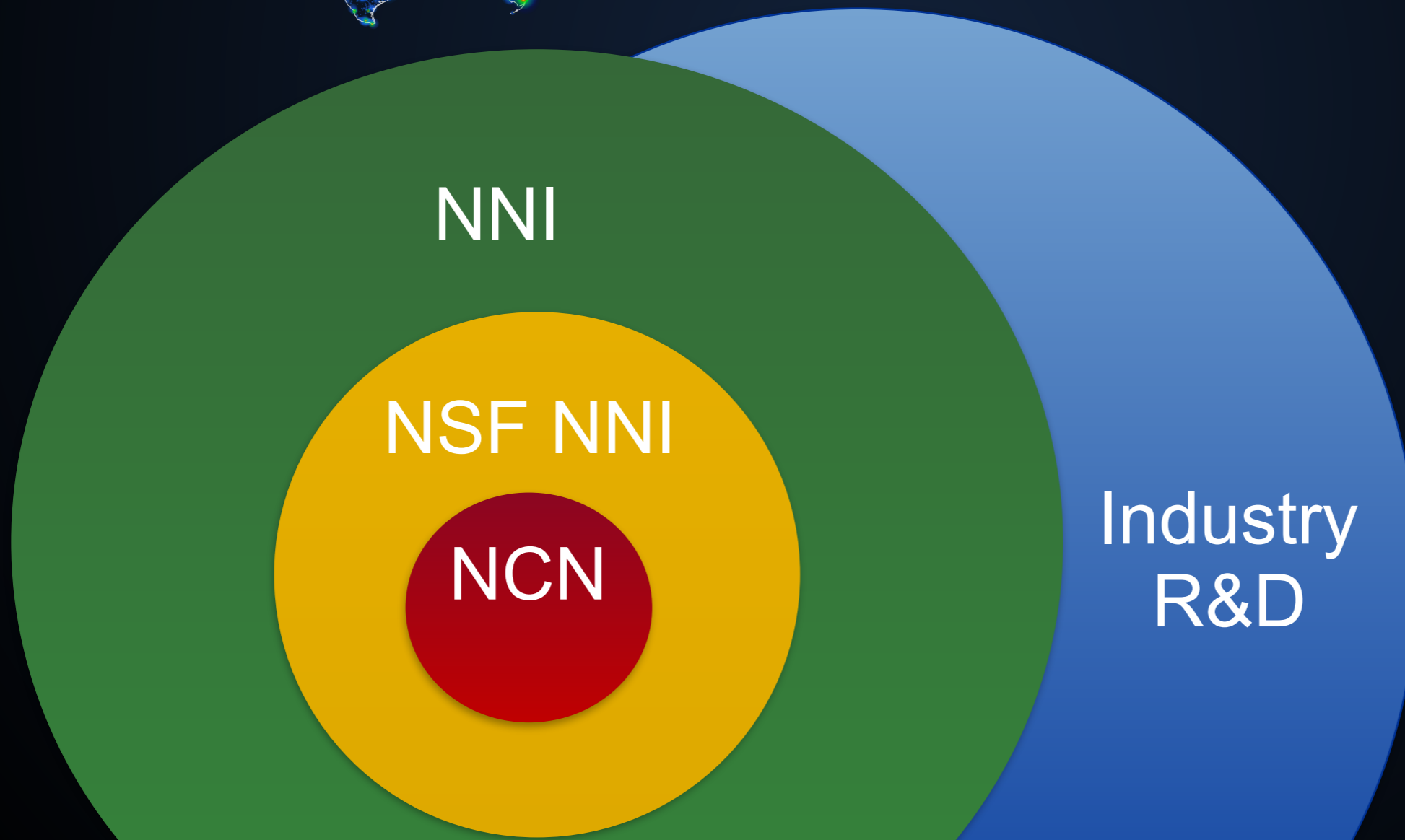
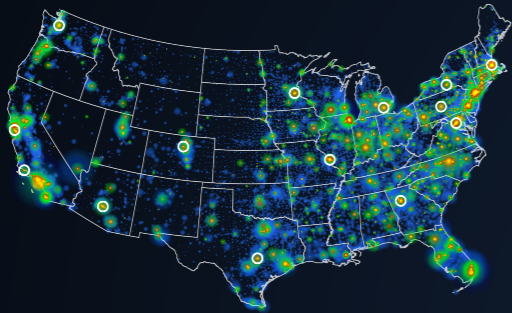
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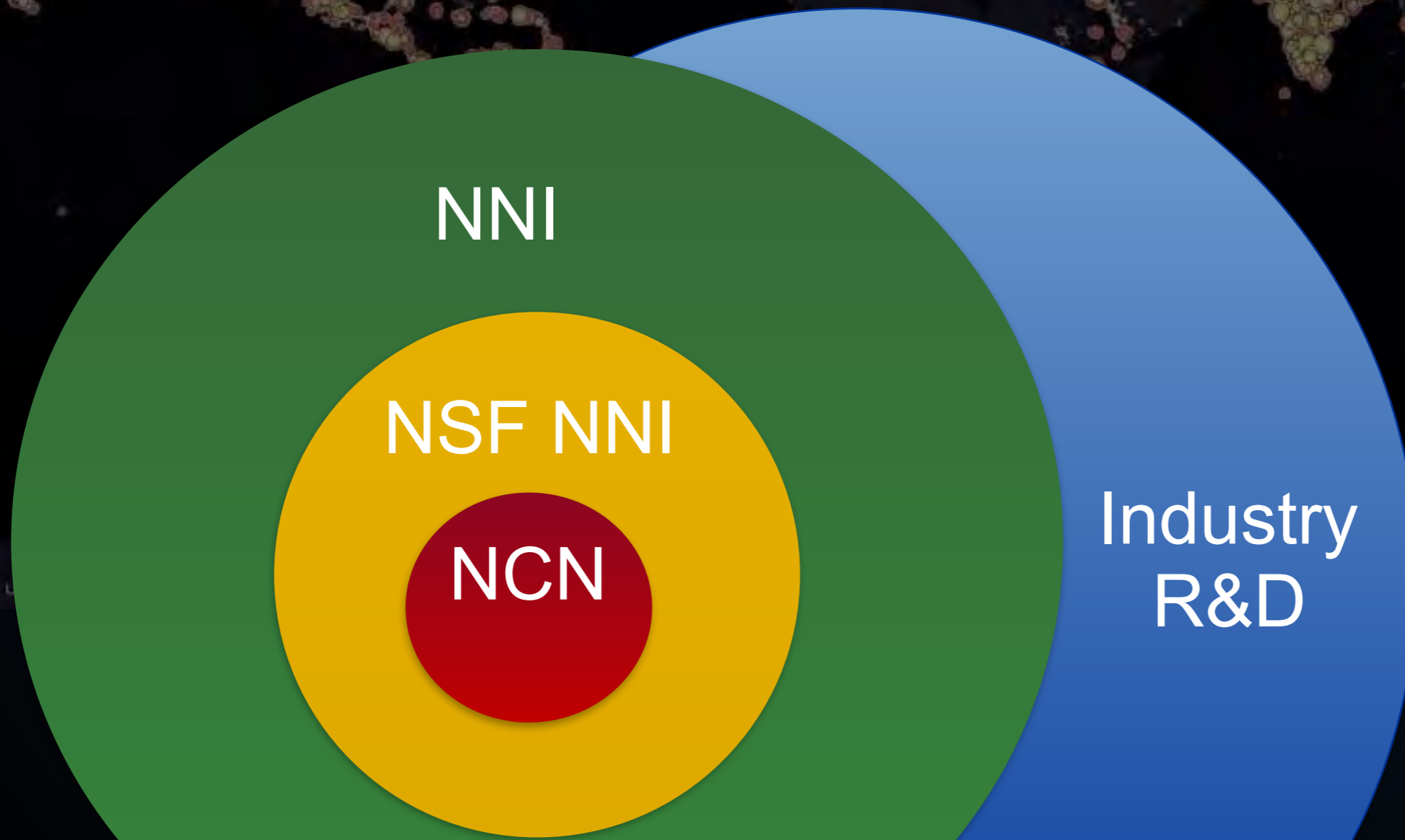
Challenges / Opportunities

- US Content Contribution Growth
 - \$1.8B federal investments
 - \$2.1B industrial investments



Challenges / Opportunities

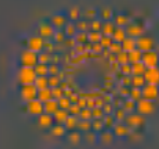
- US Content Contribution Growth
 - \$1.8B federal investments
 - \$2.1B industrial investments
- Sustainability



Challenges / Opportunities

- US Content Contribution Growth
 - \$1.8B federal investments
 - \$2.1B industrial investments
- Sustainability
 - Freemium models
 - Publishing models

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NNI

NSF NNI

NCN

Industry
R&D



nanoHUB 2022

VISION

Aspiration

Vision

Where we want to go

**to accelerate innovation through
user-centric science and engineering**

MISSION

Definition

Why we exist
& how we behave

Mission

**to make science and engineering products
usable, discoverable, reproducible, and
easy to create
for learners, educators, researchers,
and business professionals**