Measuring Value and Impact of Science & Engineering Research Enterprises

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Value

Value

The benefit that your enterprise offers a stakeholder

- Solves a problem
- Satisfies a need

Source: Osterwalder & Pigneur 2009

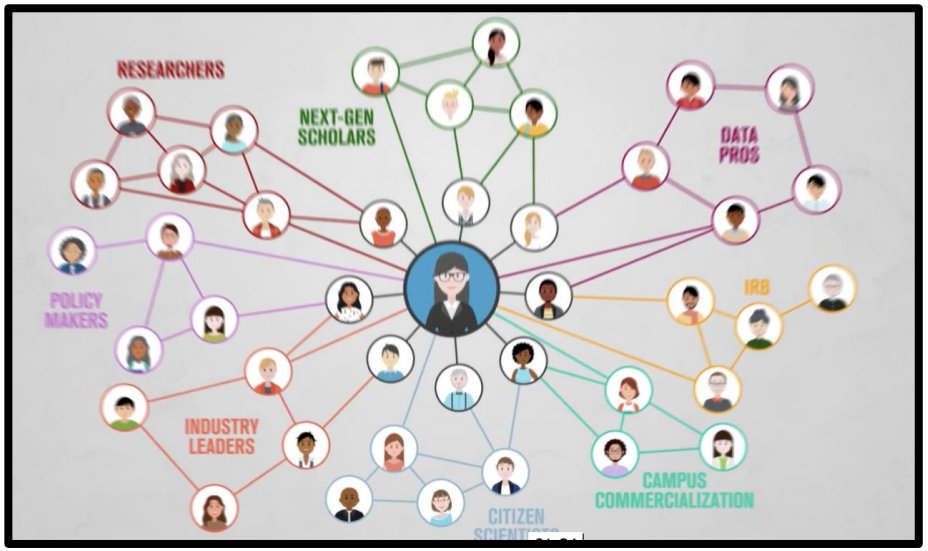
Understanding and Communicating Value

To communicate the value that your enterprise offers a stakeholder, you need to understand the value

Measurement!

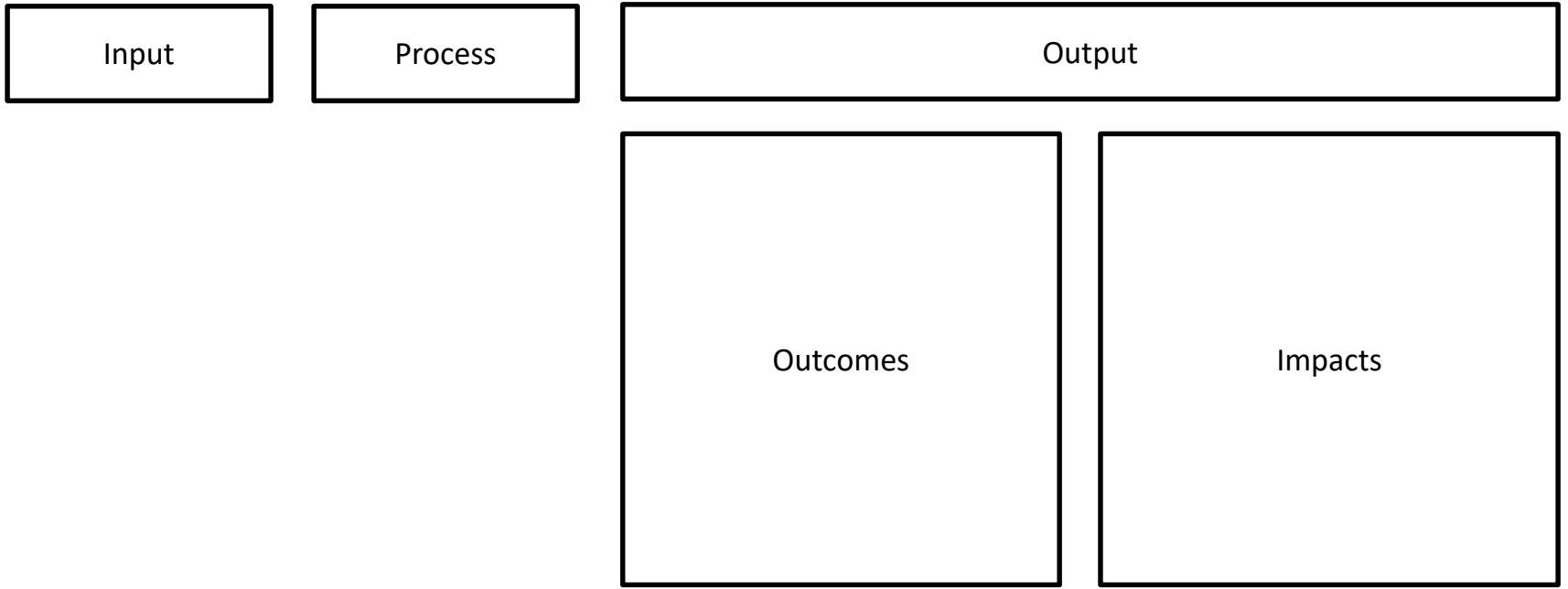
Source: Osterwalder & Pigneur 2009

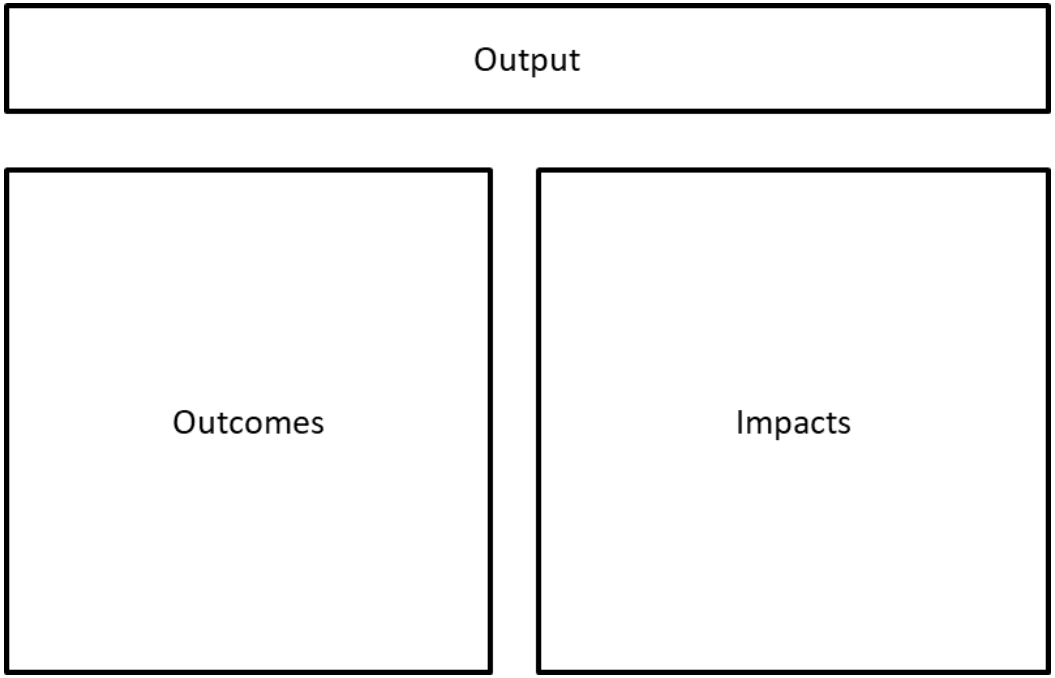
Demonstrating Value & Impact



What you value ≠ **What external stakeholders value**

Logic Model





What you value ≠ **What external stakeholders value**

What HPC centers value:

From Stack & Bielefeld SC 2012:

- Number of CPU / GPU cores?
- How much memory per core?
- Memory allowed per job?
- Which scheduler?
- FTEs for servers?
- Architecture

Also: number of users, number of jobs, size of jobs, etc.

What their external stakeholders value:

Science

NSF:

- *Science advanced (e.g., publications)*

University CFO:

- *ROI (e.g., cost per unit of performance compared with alternative)*

Regional /State Government:

- *Workforce development (# graduates remaining local)*
- *Startups created ($ investment)*

Output

Outcomes

Team – Close Stakeholders

Impacts

Science

External Stakeholders

Four Dimensions of Impact:

SCIENCE & ENGINEERING

- Publications
- Citation metrics
- Funding
- Artifacts

WORKFORCE

- Capacity building and upskilling workforce to industry
- Underrepresented groups

ECONOMIC

- Grant Revenue
- Matching
- Complimentarities & Spillovers
- Multiplier (40-96%)

INNOVATION

- Patents
- Startups (number, funding, revenue)
- New industries
- Technologies & Tech Transfer

Dimensions of Impact

	Science & Engineering 	Workforce 	Economic 	Innovation 
Stakeholder 1	✓	✓	✓	
Stakeholder 2		✓	✓	
Stakeholder 3			✓	✓

Metrics

Metrics

Metric – specific measurement through which we can evaluate performance and demonstrate value

Rules about metrics:
- Must be specific
- Must be measurable

Metrics

Key Principle: Context!

- Target
- Benchmark
- Trend
- Quality

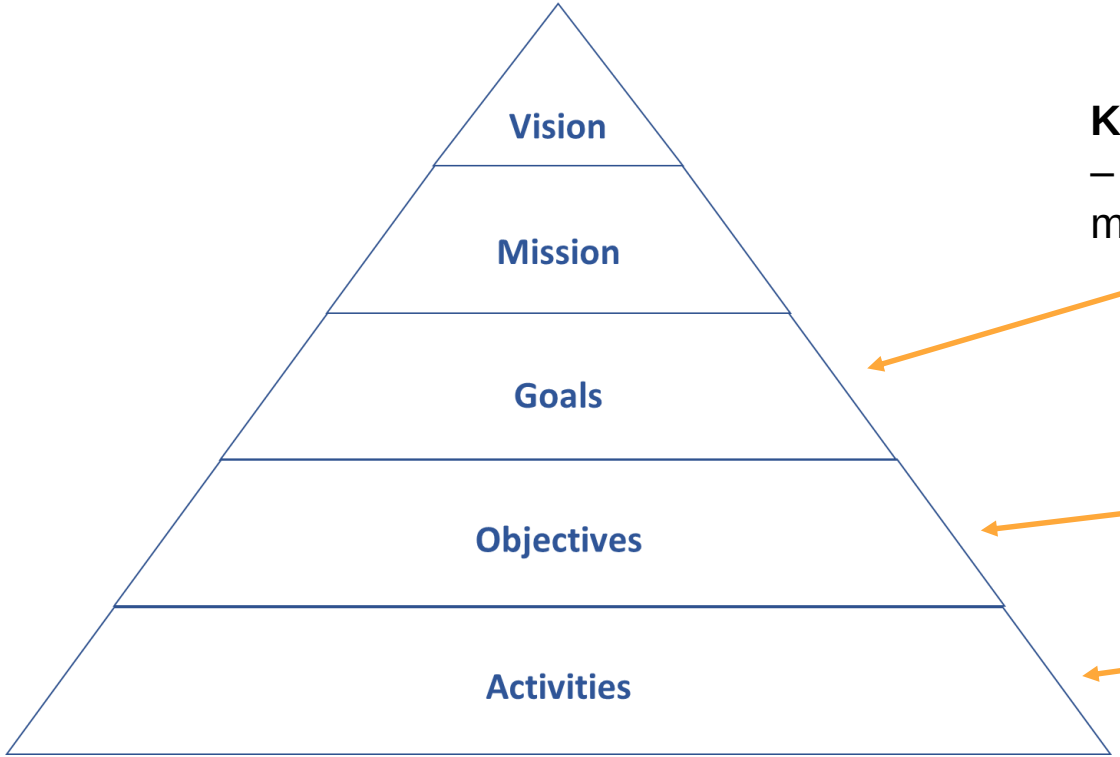
10 Publications

Goal: 8 Pubs

Typical: 6 Pubs

Last year: 5 Pubs

2 in Nature



Key Performance Indicator (KPI) – a metric with a target that you monitor in relation to overall goal

Metrics for each objective

Deliverables and milestones for activities

What Form to Communicate In?

- Quantitative (numbers)
  - # of Publications
  - # of students graduated
- Qualitative (categories)
  - Published where?
  - Student placements
- Visualizations
  - Charts (bar, pie, trend lines)
  - Maps
- Stories/Testimonials
  - Vividness, Connection to Audience

Economic Example: Financial ROI of CI

Stewart et al 2019a

"Assessment of financial returns on investments in cyberinfrastructure facilities: A survey of current methods"

https://dl.acm.org/doi/pdf/10.1145/3332186.3332228

Area of Benefit	Measure of Benefit	Ways to Measure Benefit	Citations
	Financial Returns		
Benefit to end user of CI facilities in research	Financial value of time saved	Cost of the time that would have been spent by end user doing research without use of CI resources	
CI system resources	Value of investment in other CI facilities that would have been made without use of a particular facility	Actual costs, cost avoidance	[18, 40]
Personnel resources	Value of support and consulting from CI resource provider	Evaluate allocated usage as a fraction of total costs for providing support and consulting	[40]
Training	Value of training materials created by organizations operating CI facilities	Perceived value, equivalent cost of commercial training, value of CI skills held by employee entering job market	[25]
Grant income	Monetary income	Measure income attributable to use of the resource	[19, 27]
Products & patents	Monetary income	Allocate part of income attributable to use of the resource	[8]
Economic impact	Regional economic impact as measured by economic models (IMPLAN)	Indirect financial benefits, jobs, & tax income attributable to existence of resource	[5, 27, 34]
	Non-financial impacts and benefits		
Research innovations	Number of papers, citations, impact of resulting innovations	Impact Factors, patents awarded, license fees generated that are attributable to use of the resource	[15, 20, 41]
Grants awarded	Number of grants awarded, number and impact of papers produced resulting from such grant awards	Grants awarded to users of the resource that can be attributed to usage of the resource	[15, 19]

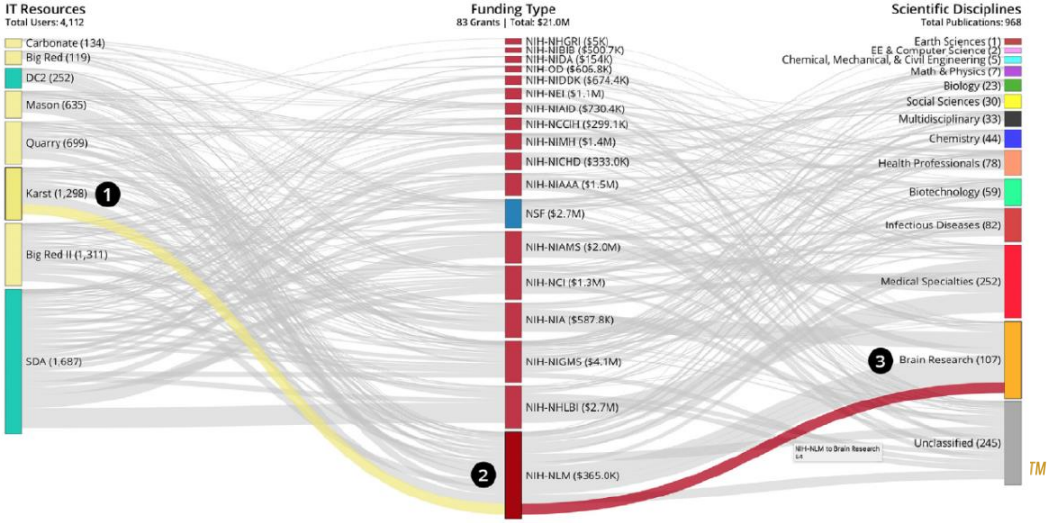
Other Example:

Non-financial Impact of CI

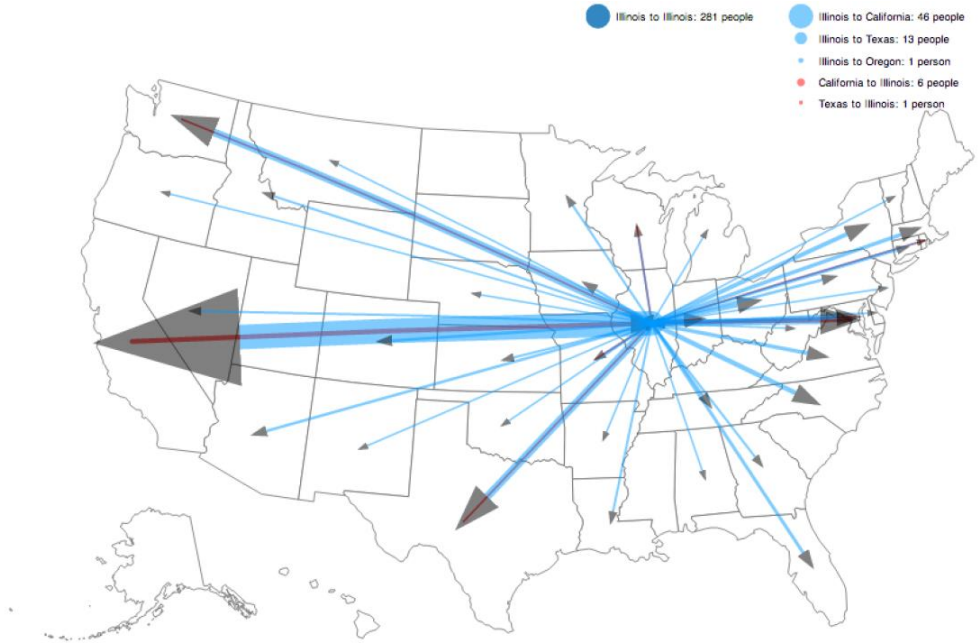
Stewart et al 2019b "Assessment of non-financial returns on cyberinfrastructure: A survey of current methods":

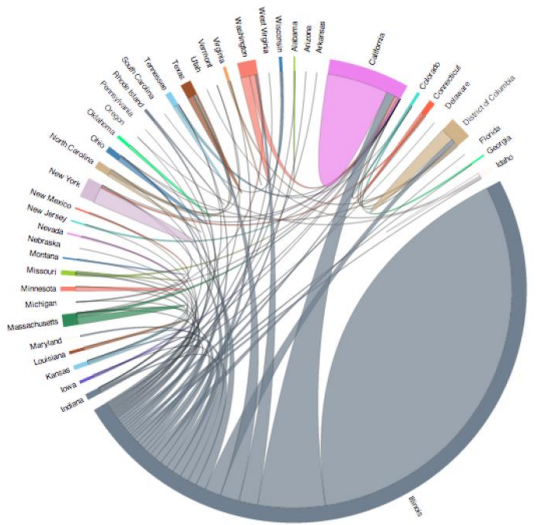
https://dl.acm.org/doi/abs/10.1145/3355738.3355749

Output	Outcome or Impact	Non-financial measures of outcome	Impact
Discoveries, creations, innovations	Publications	Number of publications, number of citations, impact factors of publications	New knowledge, improved quality of life for people
	Acceleration of research	Time	Quicker responsiveness to new science and engineering challenges
Training	Individuals trained as CI experts	Number of people, levels of training	Increased salary, quality of employment for the individual; better-trained workforce; improved global competitiveness for any given country
Awards, press notices	Award, e.g., Nobel Prize, press releases	Number, type of awards; number of press releases, number of reads of same	Recognition of a particular invention's significance; reputational benefits
Patents	Legal protection that facilitates entry of new innovation into commercial market and use	Number of patent filings, patents, income from licensing of patents	Potential for invention to be used in a commercial product that improves people's quality of life



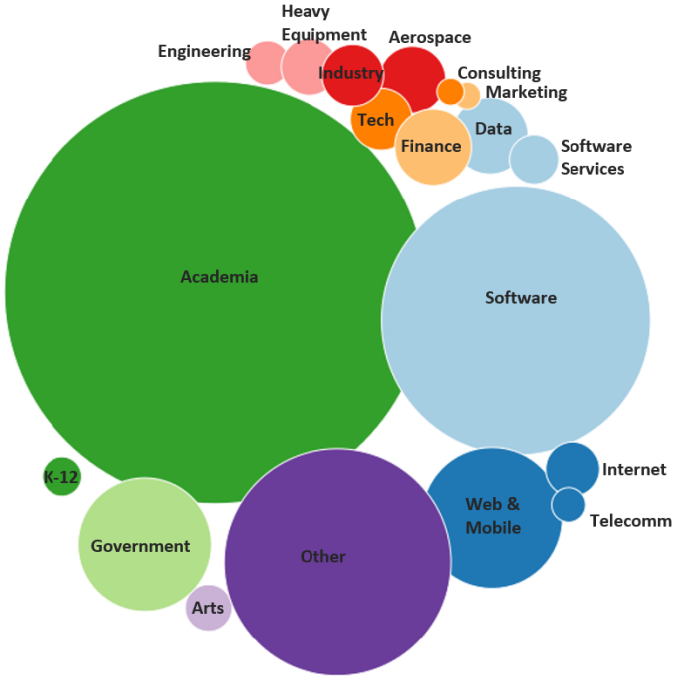
NCSA’s Diaspora

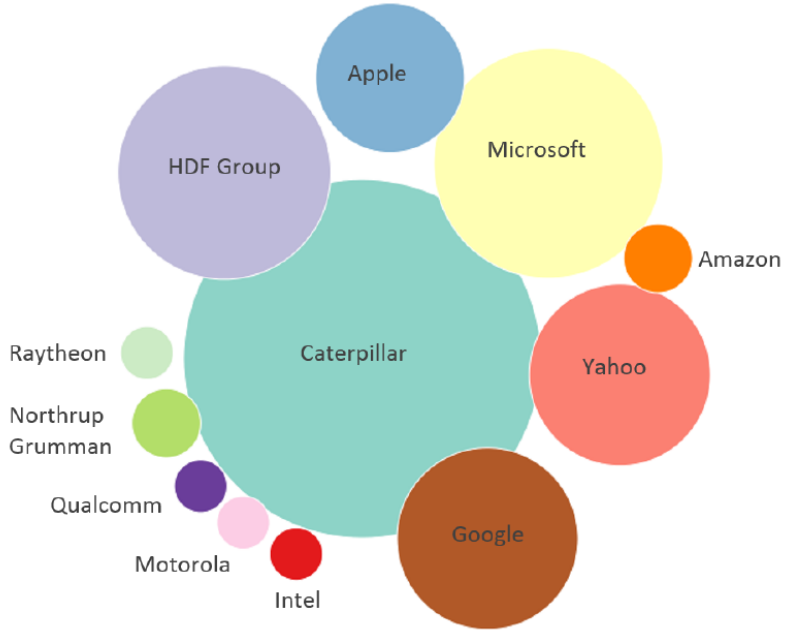




Howison et al , Impact of a Cyberinfrastructure Enterprise on the Nation's Workforce: Visualizations of a Decade of NCSA's Diaspora (August 29, 2017). Available at SSRN: https://ssrn.com/abstract=3028931

NCSA's Diaspora





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Science Stories

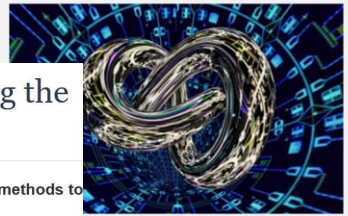
Research News

Researchers develop speedier network analysis for a range of computer hardware

Advance could boost recommendation algorithms and internet searches

Researchers develop advance that could

NSF statement: New development in quantum computing



perconducting processor, in the Oct. 24 issue of the journal Nature, *a team of*

Computers play a crucial role in preserving the Earth

From bears to birds to herders: NSF-funded researchers develop computing methods to cultivate a sustainable environment, economy and society

Kenyan pastoralist use the GrazeIt app to take a picture of vegetation and submit a survey.

YouTube: “Leap to Large” online workshop videos

https://www.youtube.com/channel/UC0f7mQHXsDCQJ9d2ORzdgbA/playlists

Thank you!

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