Internet2
and the
Cyberinfrastructure Ecosystem
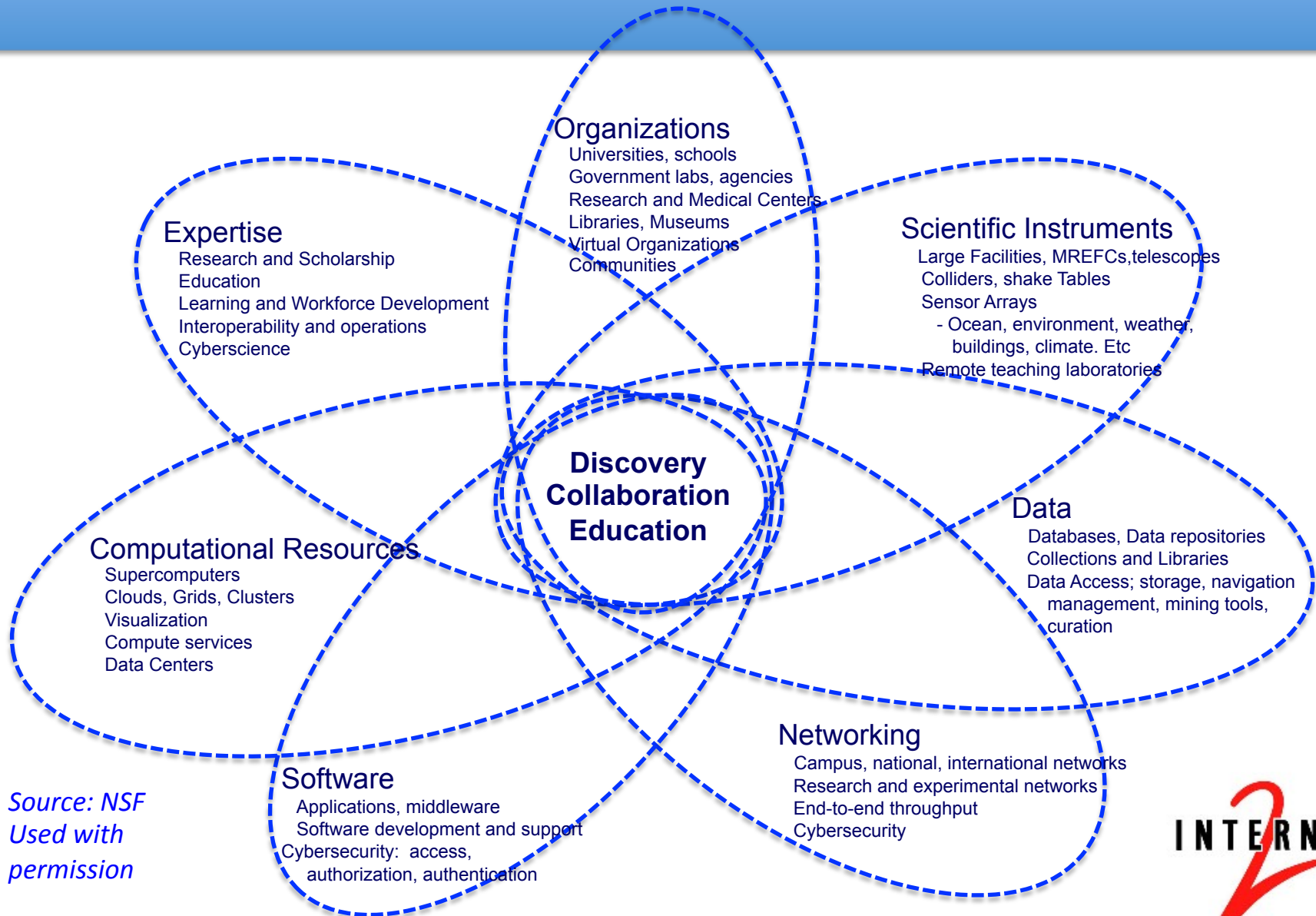
Stephen Wolff
Internet2

INTERNET
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An ecosystem is

a community

of living and non-living things

that work together

-- Natureworks,
New Hampshire Public Television

Cyberinfrastructure Ecosystem

Organizations
Universities, schools
Government labs, agencies
Research and Medical Centers
Libraries, Museums
Virtual Organizations
Communities

Expertise
Research and Scholarship
Education
Learning and Workforce Development
Interoperability and operations
Cyberscience

Scientific Instruments
Large Facilities, MREFCs, telescopes
Colliders, shake Tables
Sensor Arrays
 - Ocean, environment, weather,
   buildings, climate. Etc
Remote teaching laboratories

Discovery Collaboration Education

Computational Resources
Supercomputers
Clouds, Grids, Clusters
Visualization
Compute services
Data Centers

Data
Databases, Data repositories
Collections and Libraries
Data Access; storage, navigation
   management, mining tools,
   curation

Software
Applications, middleware
Software development and support
Cybersecurity: access,
   authorization, authentication

Networking
Campus, national, international networks
Research and experimental networks
End-to-end throughput
Cybersecurity

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Internet2 membership

- The primary purpose of Internet2 is to support the research, education, and service missions of its <u>research university members</u> by providing advanced network and technology services and by assuring the continuation of that community's long-standing legacy of advancing the capabilities of the global Internet.

- Internet2 has
  - Higher education members
  - Affiliate members
  - R&E network members
  - Industrial members

- University presidents hold a majority on the Internet2 Board of Trustees

- Interactions between Internet2 and its disparate membership are complex

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Key issues for the future (courtesy e-IRG)

- The position of dedicated research networks vs. commercial services
- Ongoing innovation vs. operational service provision
- ~~Central planning vs. organic growth~~
- The changing environment
- The role of the users
- The ʻdigital divideʼ between users, regions and countries

- Stay ~~ahead~~ *outside the envelope* of commercial offerings
  - E.g., DCN, GLIF, …
- Employ commercial services when mutually beneficial
  - Technical/market tests
  - As aggregator

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Innovation vs. operational services

- Services are paid by users; innovation is supported by public funding
- *however…*
- Public funds are limited, and Internet2 must not compete with its members for them
- ∴ innovation projects must *always* be collaborations with members

Changing environment

- Energy consumption
- Data-intensive networking and THE FOURTH PARADIGM
  - LHCONE
  - XSEDE
  - the Altacama
  - Genome sequencers
  - …
- Planning for when data are immobile
  - Gray's third law
  - Research has been global for some time; now *research instruments* are becoming global
- Virtual organizations
  - Tools & processes
  - "Public/private partnerships"

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Role of users

- Internet2 must respond to its most demanding and difficult users

- Users need to have "some skin in the game"
  - The NSF program CIF21 is a good start

Further challenges

- "Bye-bye Backbone"
  - RONs may choose to stitch themselves together with "cross-border fiber" (European term) and avoid Backbone fees
  - ∴ connectivity cannot be the *only* benefit of membership
  - May render fault isolation & repair more difficult
  - Performance of the interconnected set of local optimizations may suffer
- Loss of focus
  - 200,000 CAIs vs. ≅500 research universities

Thank you!