

# Technological Innovation In the 21st Century

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The National Academies

Washington, DC

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# Technological Innovation

1. *Why is everyone in a hurry?*
2. *Where are we?*
3. *What do we see?*
4. *Where have we been?*
5. *Where do we need to go?*
6. *How are we going to get there?*

# Technological Innovation\*

1. *Why is everyone in a hurry?*

2. *Where are we?*

\*Well, it's not just  
Technological.

3. *What do we see?*

4. *Where have we been?*

5. *Where do we need to go?*

6. *How are we going to get there?*

# *Why is everyone in a hurry?*

Sound bites

Poetry

Facts

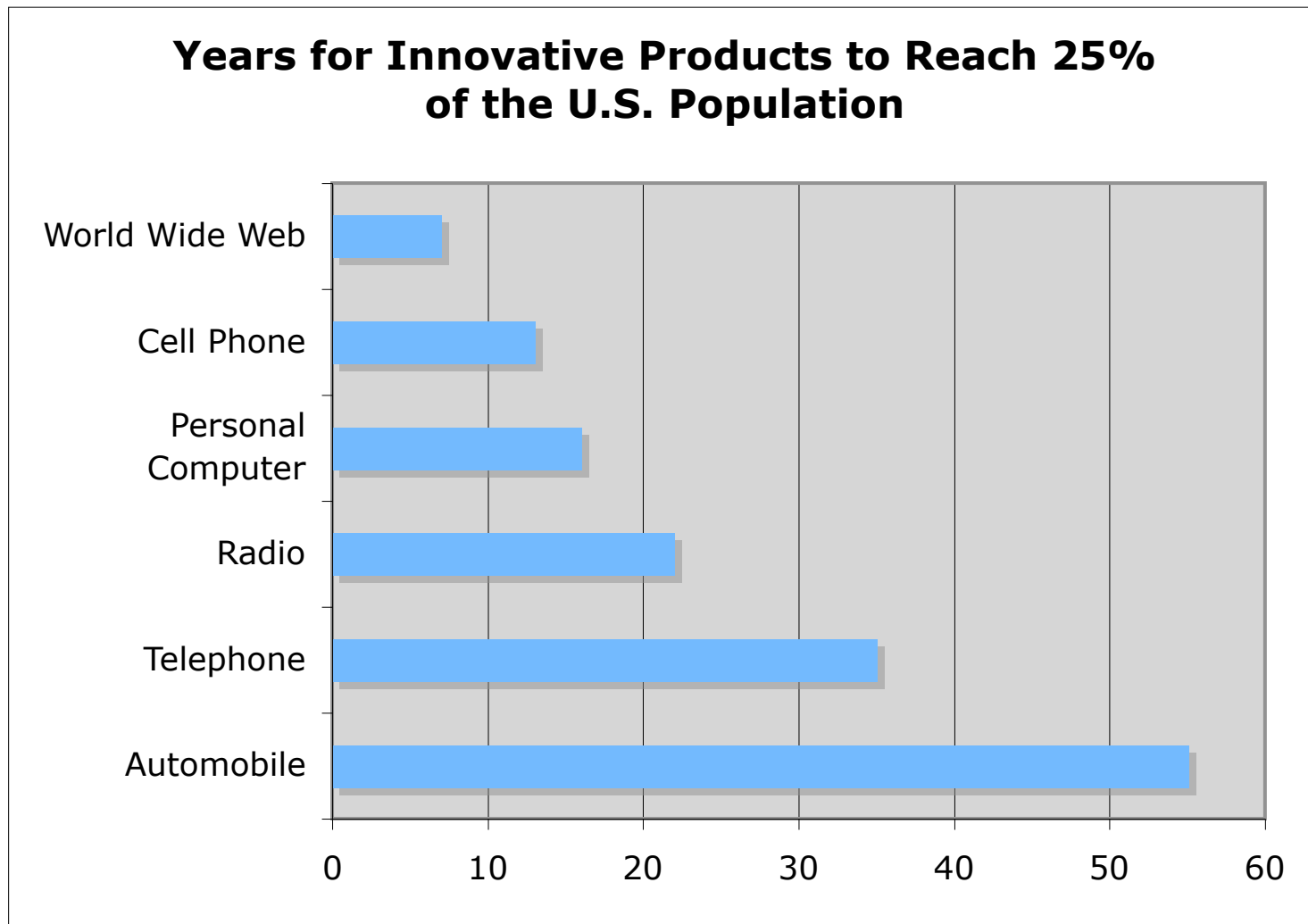
*“Innovate or Abdicade”*

-Sam Palmisano, CEO, IBM

*It doesn't matter whether you're a lion or a gazelle- when the sun comes up, you'd better be running.*

*-Richard Hodgetts*

# Why Everyone is in a Hurry.



# *Where are we?*

Four Facts

Three Consequences

One Principle

And an Irony



# Four Facts

- People everywhere are smart and capable.
- Science and Technology advance relentlessly.
- Globalization is a dominating reality.
- The Internet and World Wide Web are democratizing forces.

# Three Consequences

- Individuals must innovate.
- Companies must innovate.
- Nations and regions must innovate

# One Principle

## Competition drives Excellence and Innovation

- Competition among universities
  - For the best students, faculty, research, and scholarship
  - Merit-based awarding of research grants
- Competition among companies
  - To create new markets
  - To get to market first
  - To gain market share

# An Irony

In the 21st century Cooperation and Competition reinforce each other.

# *What do we see?*

Research

People

R&D Funding

# R&D is increasingly performed in “Pasteur’s Quadrant”

Research is inspired by:

Consideration of use?

No

Yes

Quest for  
Fundamental  
Understanding?

Yes

Pure Basic  
Research  
(Bohr)

No

Pure Applied  
Research  
(Edison)

Adapted from *Pasteur’s Quadrant: Basic Science and Technological Innovation*, Donald E. Stokes 1997

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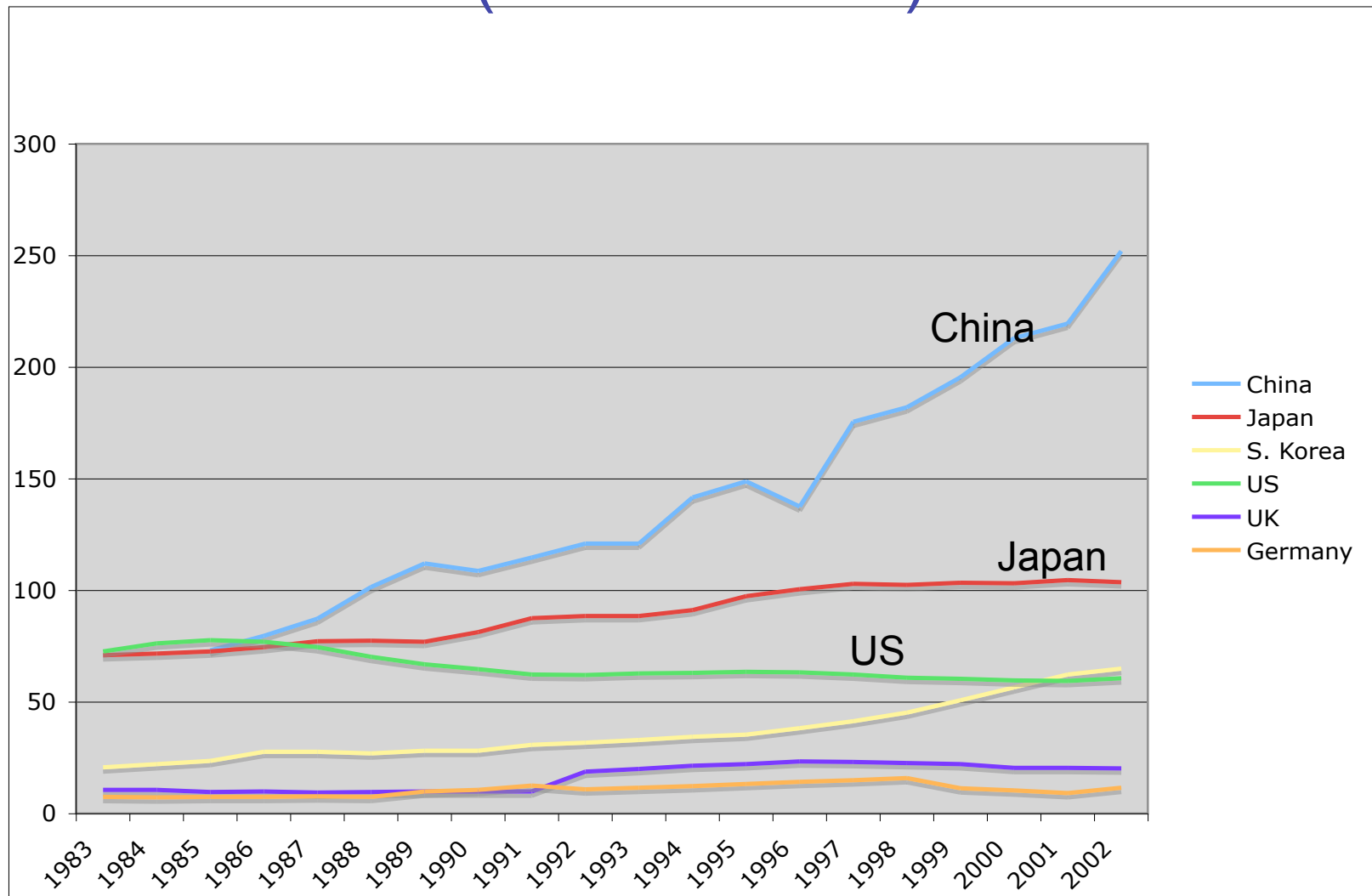
**Former  
University  
Presidents  
(Vest)**

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Research  
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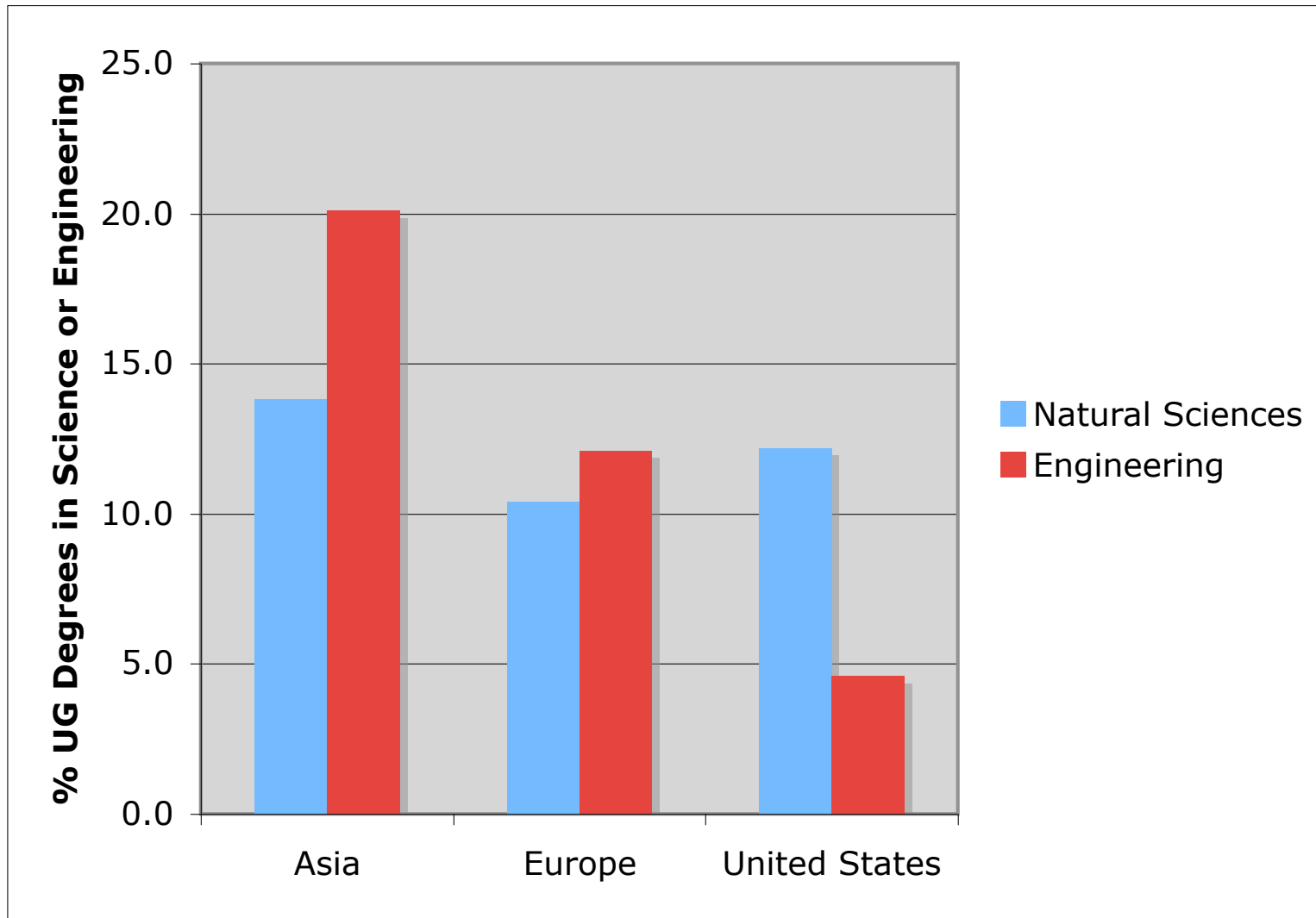


# First Engineering Degrees (China Rises.)



Source: Science and Engineering Indicators 2006, National Science Foundation, Washington, DC

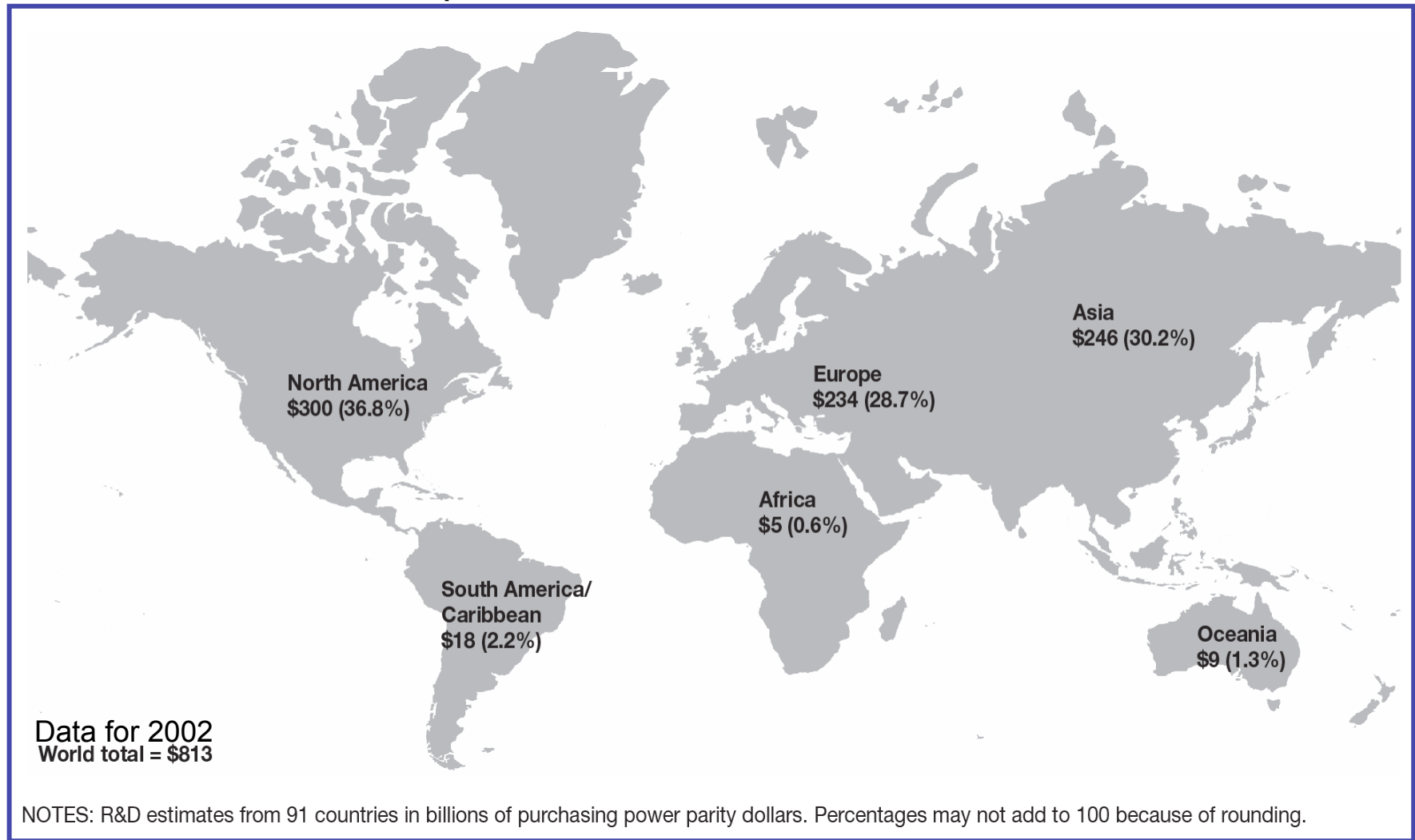
# S&E UG Degrees



Source: NSF Science and Engineering Indicators 2008

# Global R&D Investments

## R&D Expenditures and Share of World Total



Source: *Science and Engineering Indicators*, NSF 2008

*Where have we been?*

America's Innovation System from  
1945-2005

*A Brief history*

# The Vannevar Bush Report, 1945

## Primary Recommendations

- Universities should be the primary national Basic Research Infrastructure.
- Federal dollars do double duty:
  - Procure research results
  - Educate the next generation
- Award research grants based on competitive merit.
- Establish a National Science Foundation.

# The Bush Report's Economic Development Assumptions

- Linear

Basic Research --> Applied Research -->  
Product Development --> Market Products and Services

- Laissez-faire

Do basic research in universities and leave its commercialization to chance and market forces.

# From 1945 - 1985

- American research universities grew to excel.
- American companies dominated.
- Large corporations dominated.
- Corporations developed massive central research laboratories
  - Attracted outstanding university graduates
  - Conducted outstanding pure and applied research
  - Contributed to the S&T Commons

# Two Tectonic Shifts in the 1980s and 1990s

- **Japanese companies suddenly dominated manufacturing.**
- **American entrepreneurship expanded explosively.**



## Comment

The Japanese Total Quality Movement was the Major Innovation of the 1980s.

It changed everything.

# Evolution of U.S. Corporate Innovation and R&D

- 1970s: Central Corporate Research Labs
- 1980s: R&D Absorbed and Transformed into Product Development
- 1990s: Purchase High-Tech Startups to acquire Innovation
- 2000s: Open Innovation Systems

# Evolution of U.S. University Research

- 1970s: The Engineering Science Revolution
- 1980s: Design, Manufacturing, Computer Science, Joint Management/Engineering
- 1990s: Life Science, Interdisciplinary, More “Use-Inspired”
- 2000s: These trends accelerating; more global cooperation

# *Where do we need to go?*

- Henry Chesbrough
- Clayton Christensen
- Michael Piore and Richard Lester
- John Hagel and John Seeley-Brown
- Judy Estrin
- Charles Weiss and William Bonvillian

***How are we going to get there?***

Life Sciences  
and  
Information Technology

21st century  
Innovation

21st century  
Innovation

Disruptive Technologies  
For  
Grand Challenges

21st century  
Innovation

The diagram consists of a central blue circle with a black outline. A black line extends from the right side of the circle to a yellow rounded rectangular callout box with a black outline. The entire diagram is enclosed within a thick red rectangular border.

Macro Systems  
especially Energy



A new  
Enabling Technology?

21st century  
Innovation



```
graph LR; A[A new Enabling Technology?] --- B((21st century Innovation))
```

21st century  
Innovation

Future of  
Venture Capital?

```
graph LR; A[Globalization of R&D Education Workforce] --- B((21st century Innovation))
```

Globalization of  
R&D  
Education  
Workforce

21st century  
Innovation

Life Sciences  
and  
Information Technology

Globalization of  
R&D  
Education  
Workforce

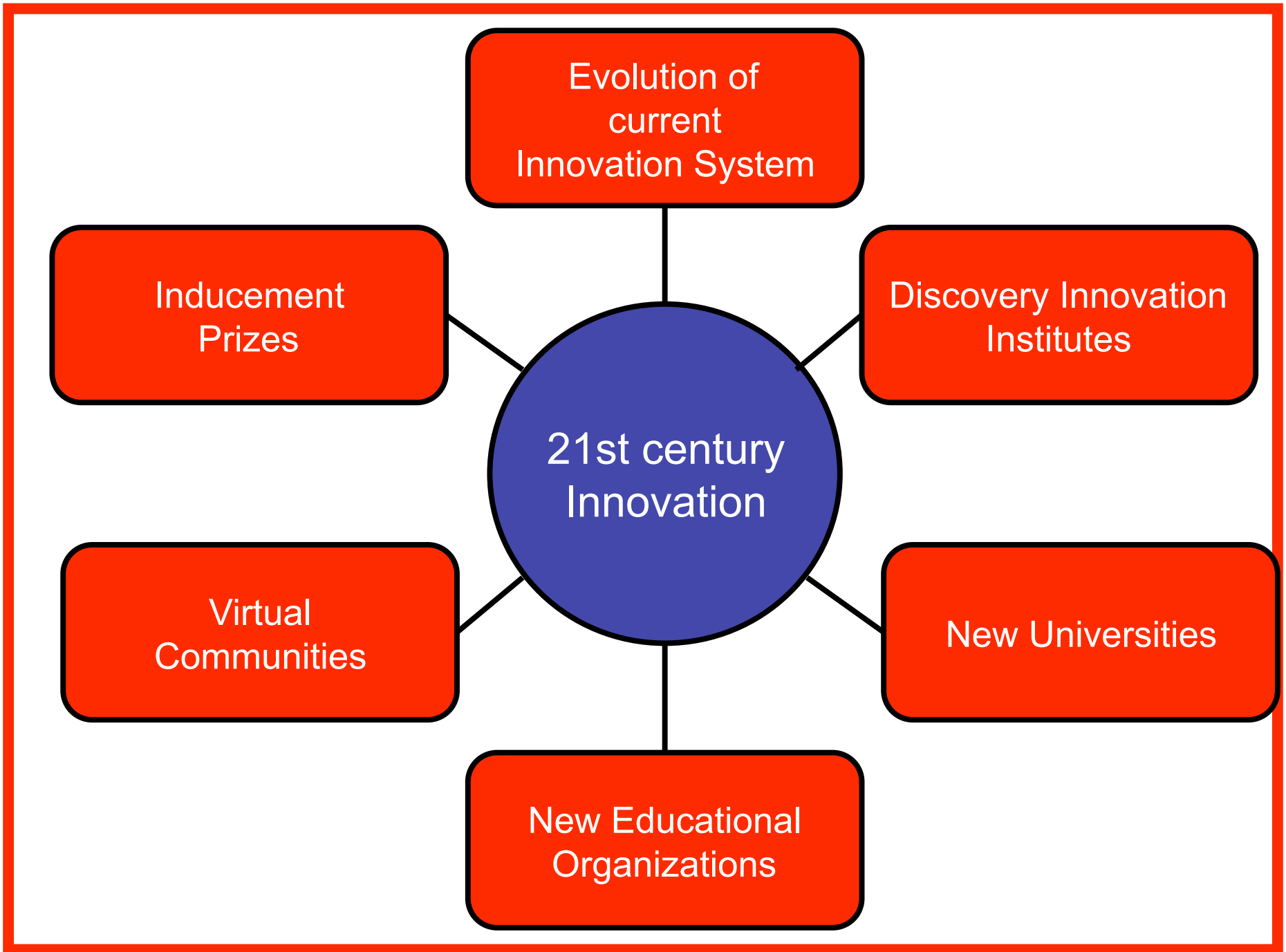
Macro Systems  
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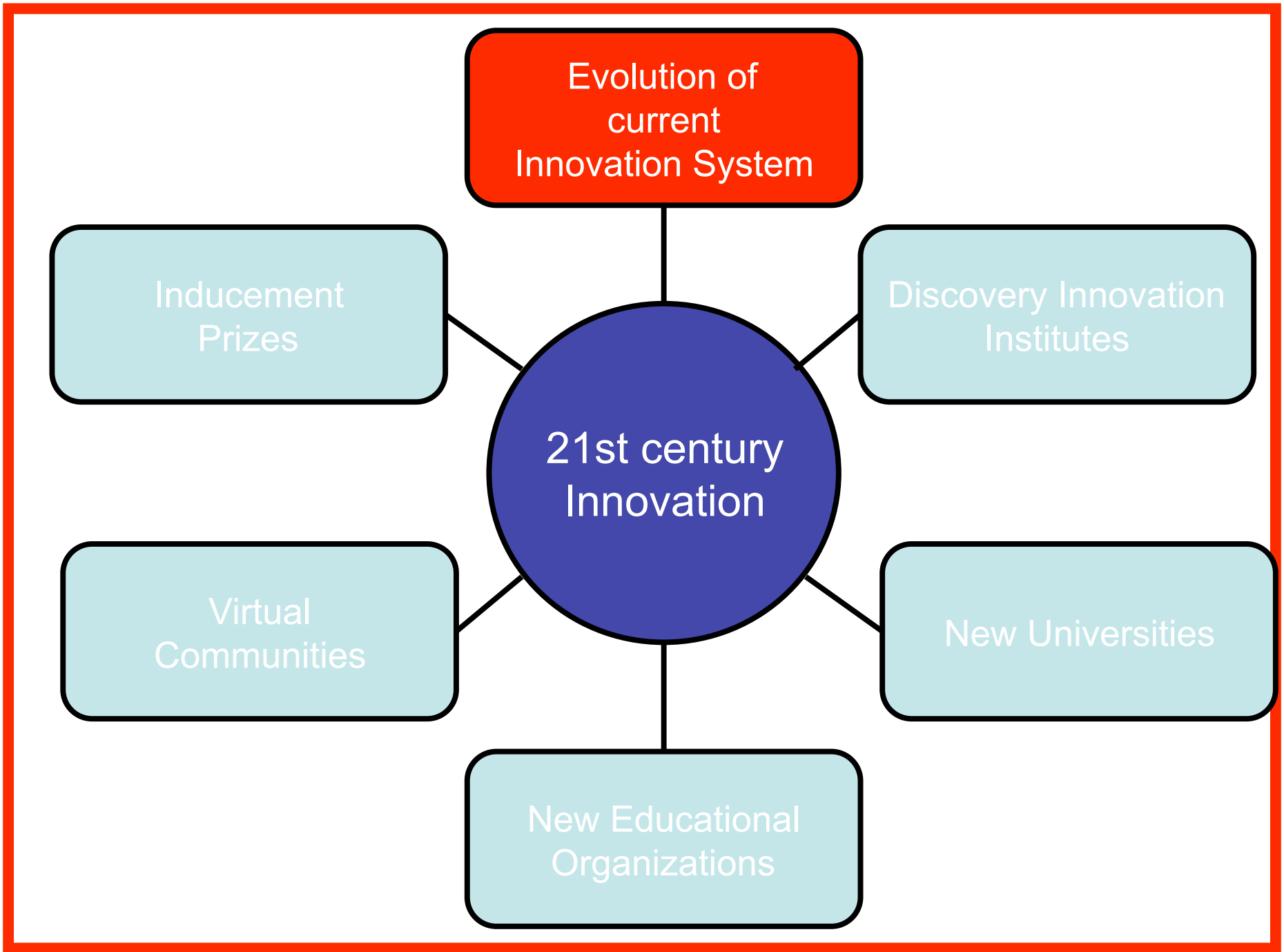
21st century  
Innovation

A new  
Enabling Technology?

Future of  
Venture Capital?

Disruptive Technologies  
For  
Grand Challenges





Evolution of  
current  
Innovation System

Inducement  
Prizes

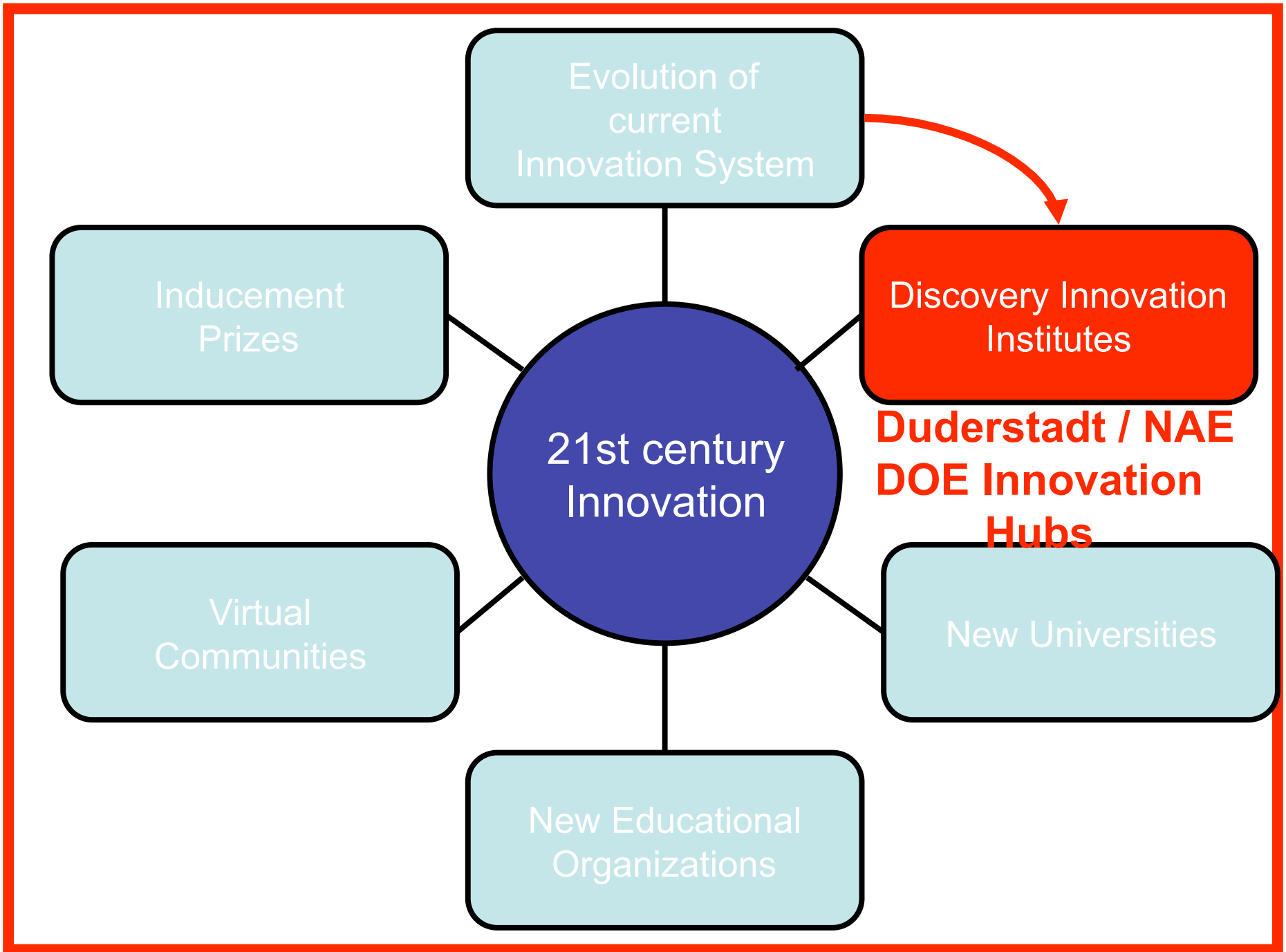
Discovery Innovation  
Institutes

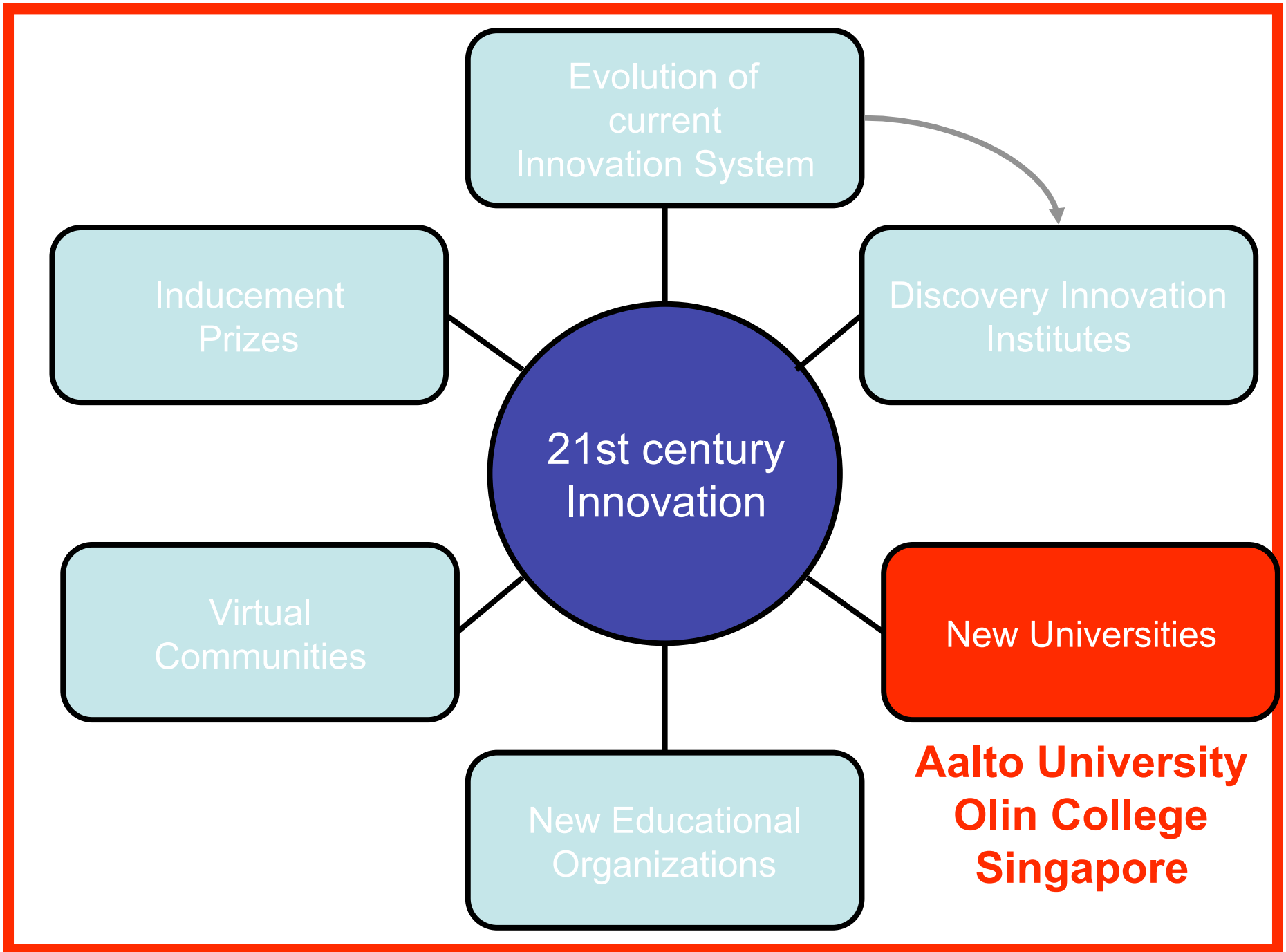
21st century  
Innovation

Virtual  
Communities

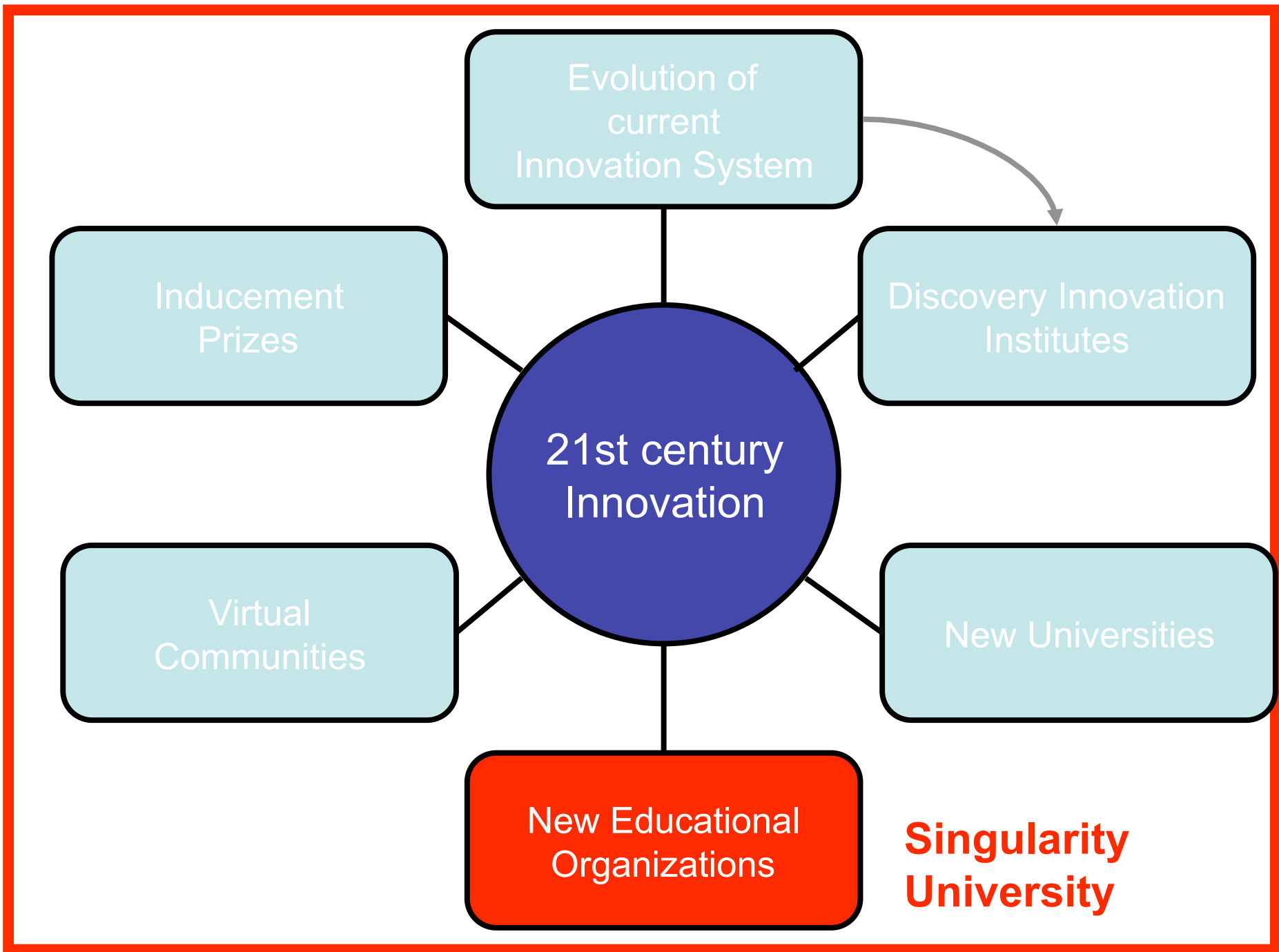
New Universities

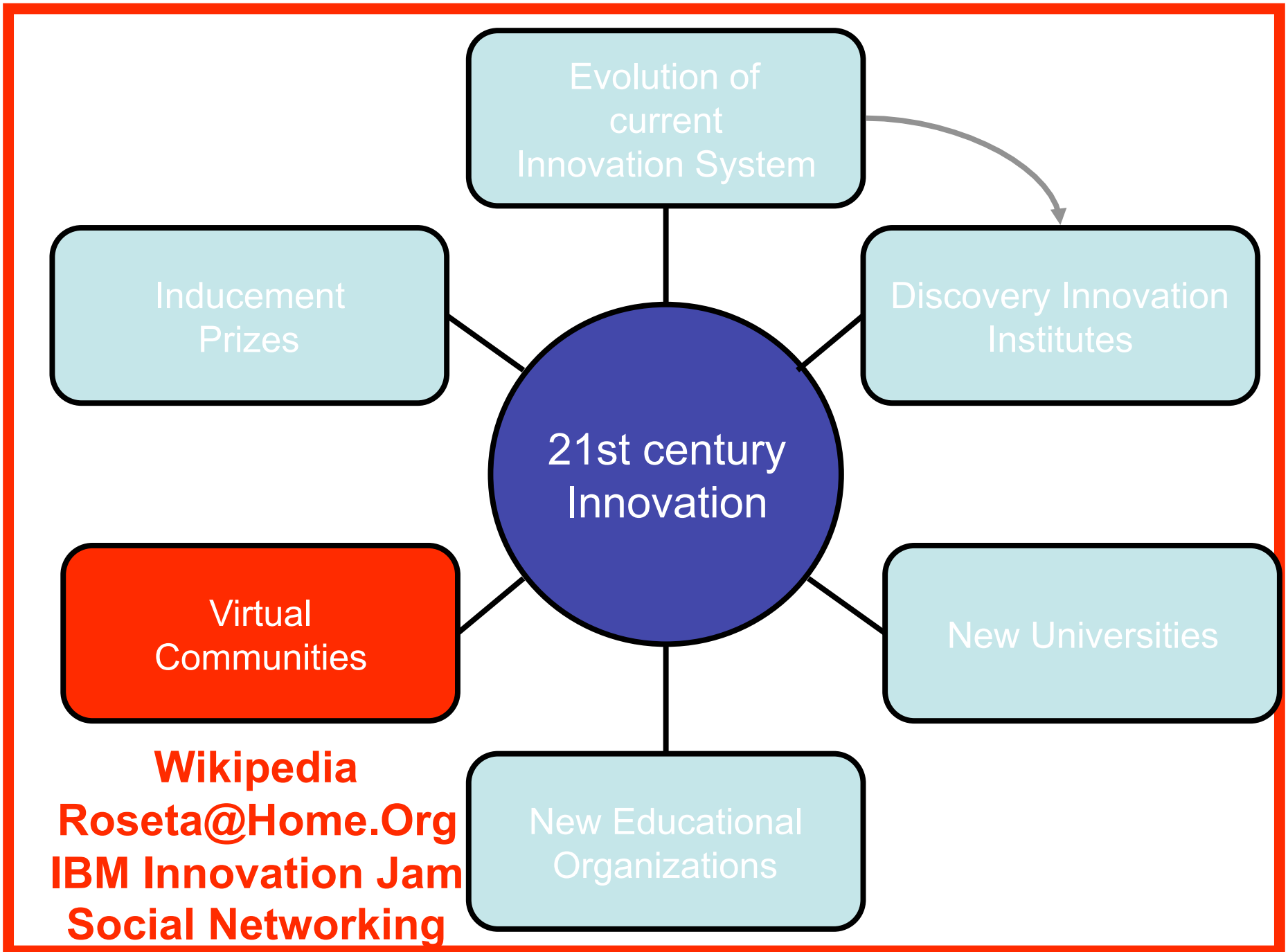
New Educational  
Organizations



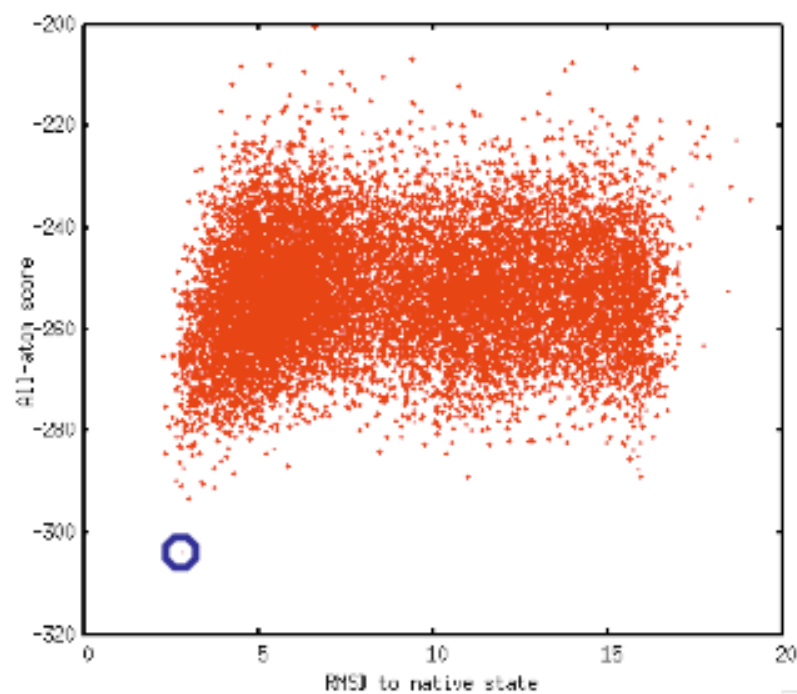








# Extensive conformational sampling with Rosetta@Home



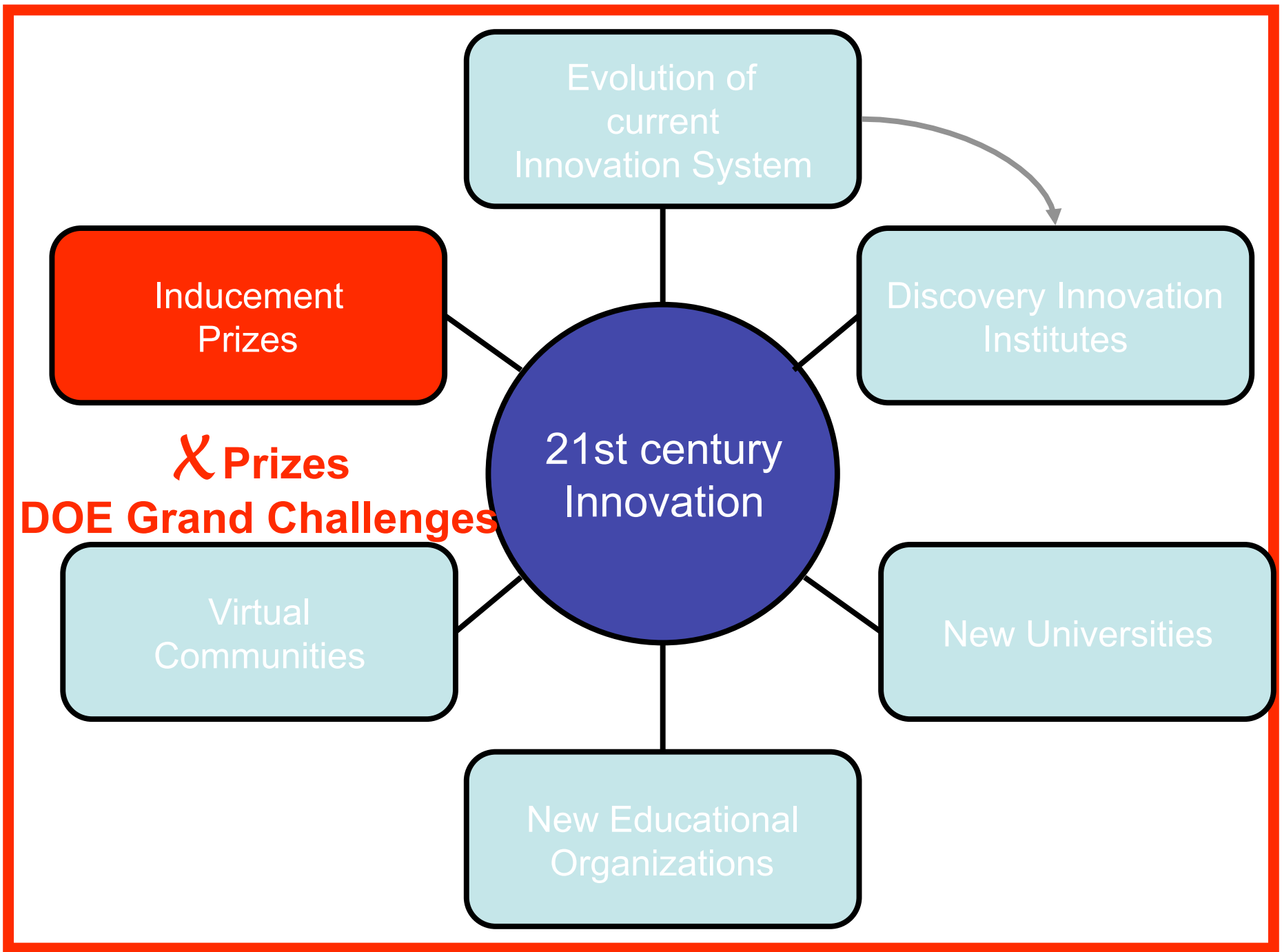
Native (CheY)

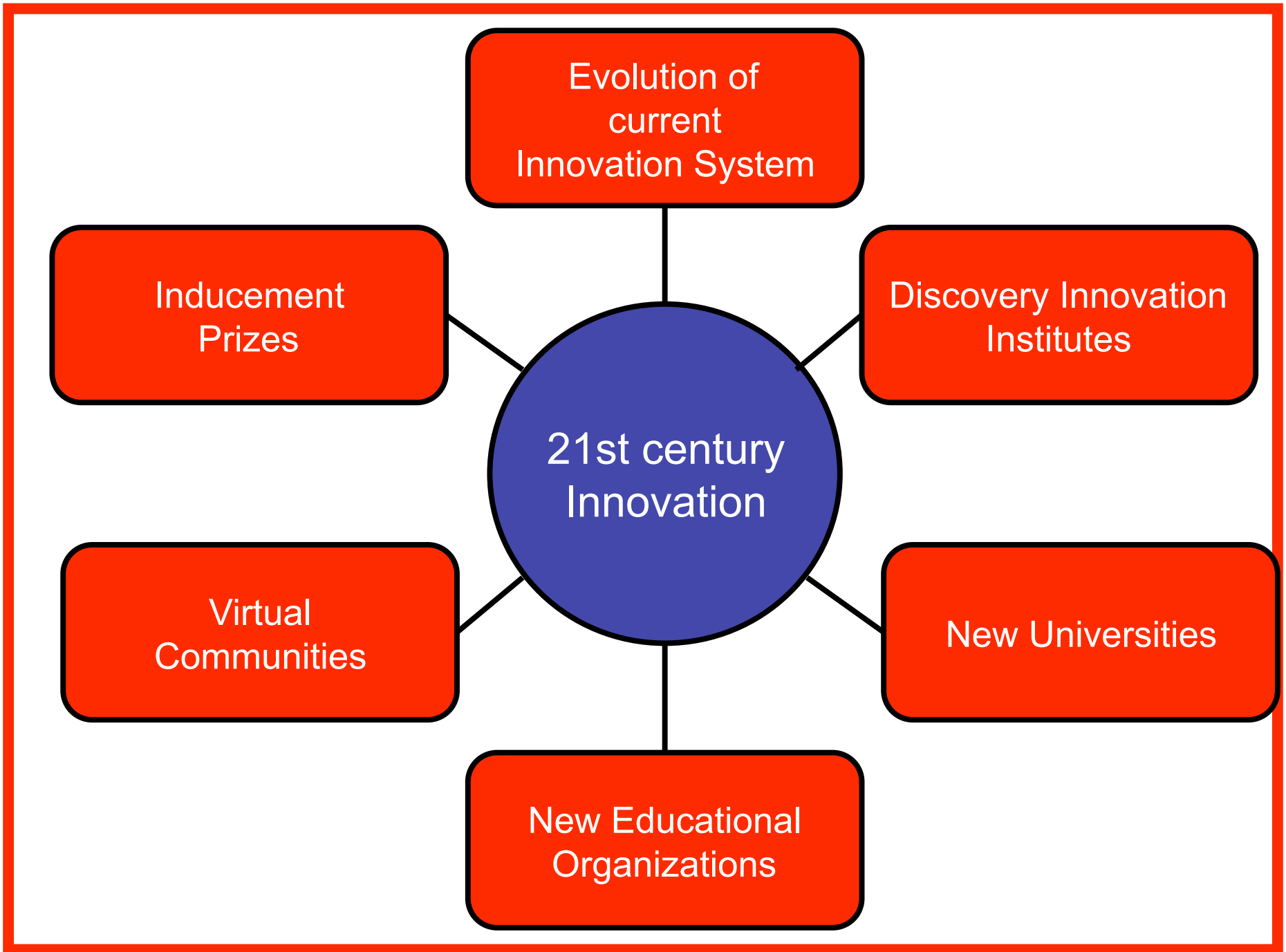


Lowest energy  
Rosetta  
structure



source: Prof. David Baker, University of Washington

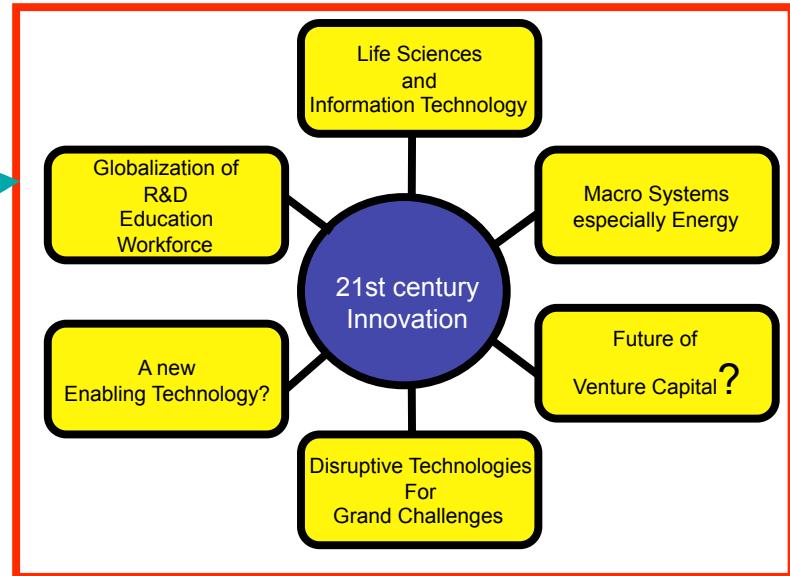




In closing ...

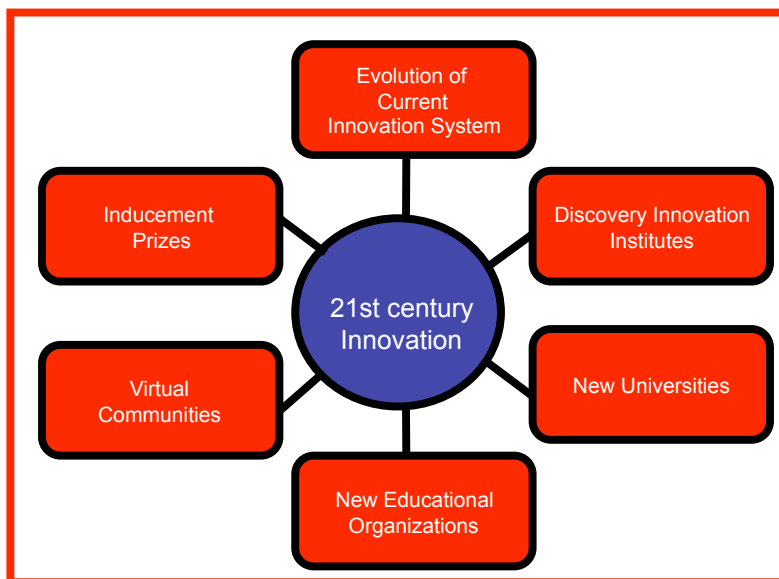
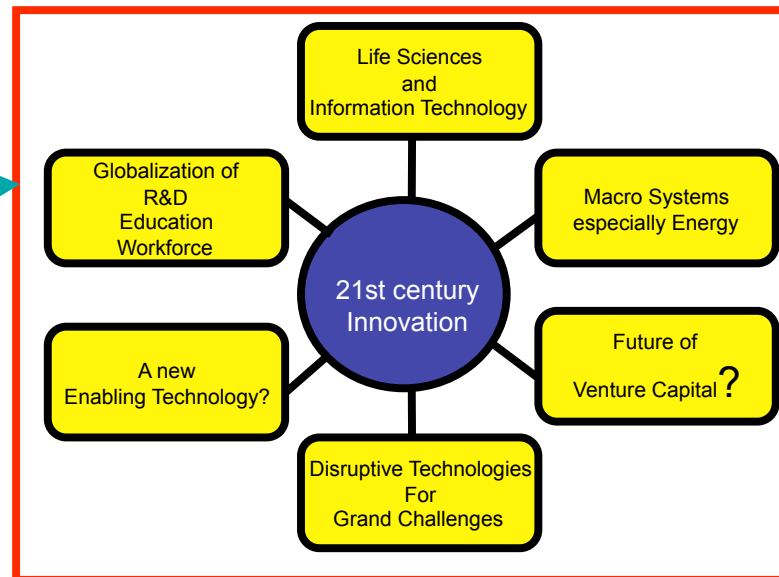
Relentless Change  
Grand Challenges  
Distributed Intelligence  
S&T Acceleration  
Globalization  
Internet Democracy

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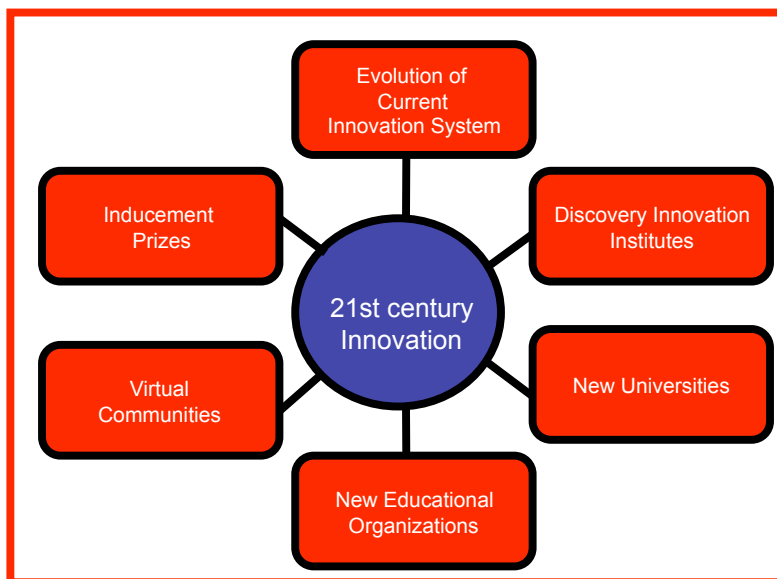
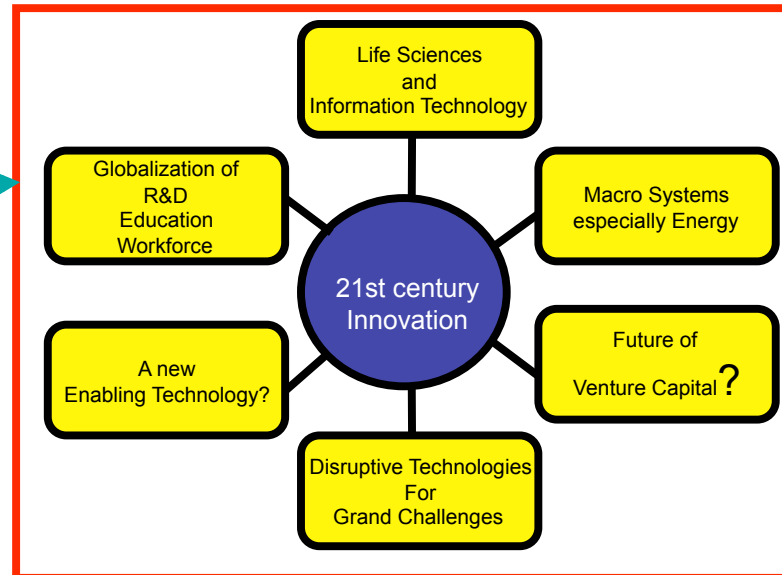




Relentless Change  
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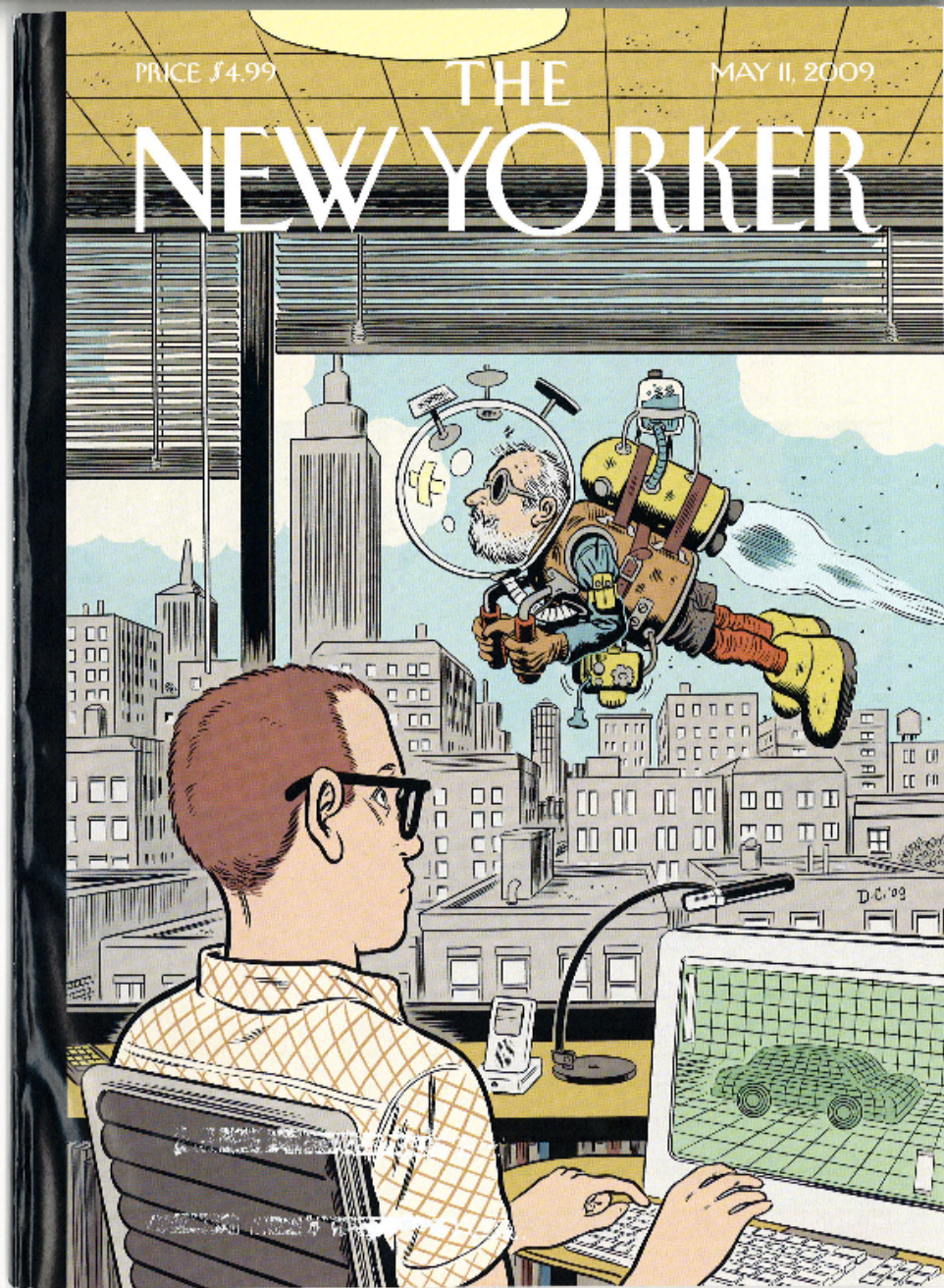


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Thank you.