Clean-slate Internet Reinvention Initiative

CIRI

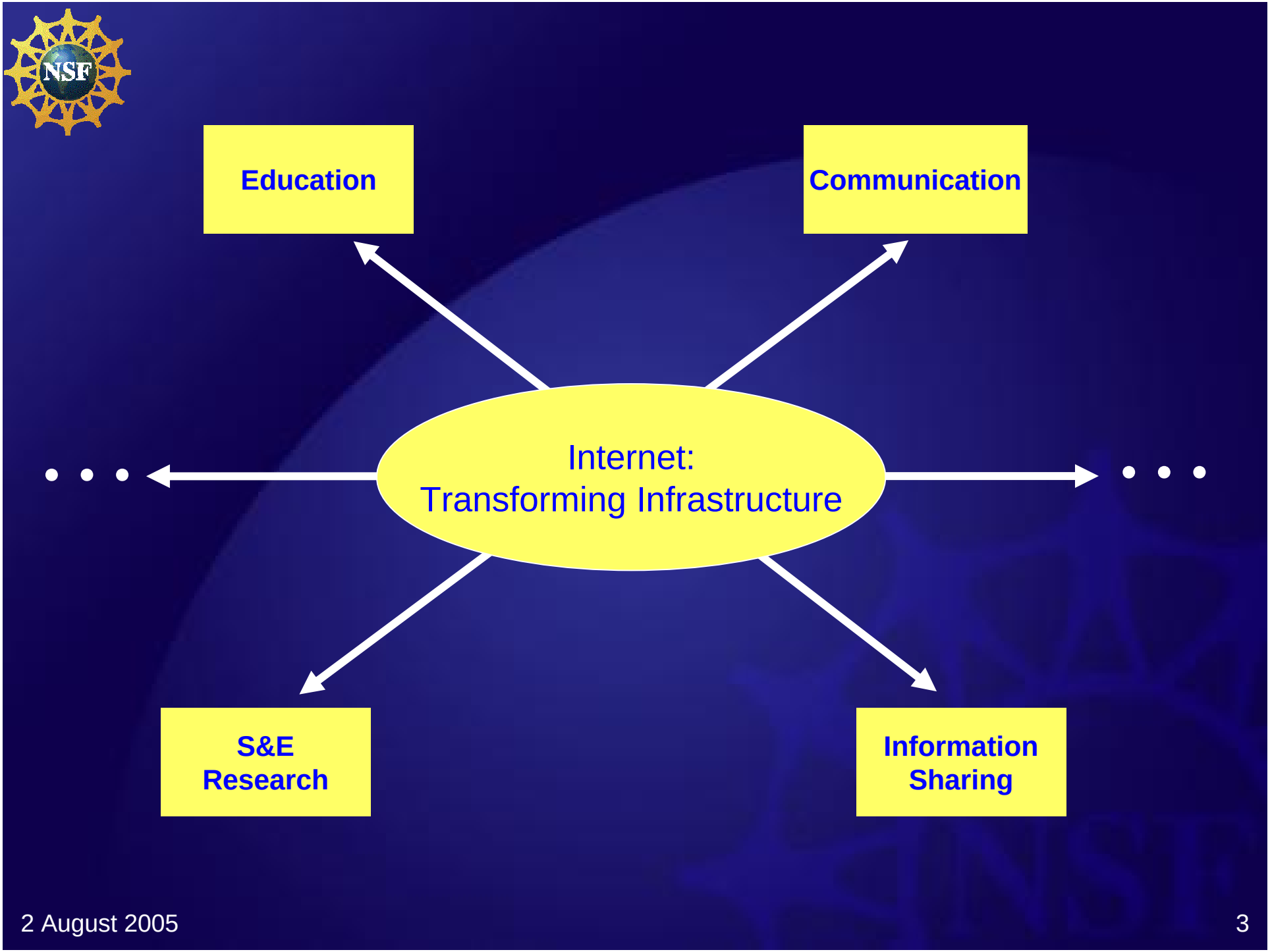
GENI

Global Environment for Network Investigation

Imagine

Global Network Infrastructure that

- Is worthy of our society's trust
  - Even for managing and operating critical infrastructures
- Provides a bridge between physical and virtual worlds
  - Via instrumented and managed sensorized physical environment
- Supports pervasive computing
  - From wireless devices to supercomputers
  - From wireless channels to all optical light-paths
- Enables further innovations in S&E research
  - Seamless access to networked instruments, supercomputers, storage


Education
Communication
Internet:
Transforming Infrastructure
S&E
Research
Information
Sharing

Transportation

Critical Infrastructure

Internet Not Ready for Its Future Roles

Telecommunications
Banking & Finance

Fundamental Limitations

- Security and robustness
  - Built-in assumptions about trust
  - Lack of emphasis on control and management
- Scalability
  - Ability to deal with increasing diversity of everything
- Internet Ossification
  - No incentive for providers to innovate at network level
- This group will identify more…

"… in the thirty-odd years since its invention, new uses and abuses, along with the realities that come with being a fully commercial enterprise, are pushing the Internet into realms that its original design neither anticipated nor easily accommodates."

"Such problems are numerous, and the Internet's emerging centrality has made these flaws all the more evident and urgent. As a result, it is now widely believed that the Internet architecture is in need of substantial change."

"Freezing forevermore the current architecture would be bad enough, but in fact the situation is deteriorating. … These architectural barnacles—unsightly outcroppings that have affixed themselves to an unmoving architecture— may serve a valuable short-term purpose, but significantly impair the long-term flexibility, reliability, security, and manageability of the Internet."

Overcoming Barriers to Disruptive Innovation in Networking, NSF Workshop Report, 2005.

Internet Security Limitations

"Because much of this (IT) infrastructure connects one way or another to the Internet, it embodies the Internet's original structural attributes of openness, inventiveness, and the assumption of goodwill.

These signature attributes have made the US IT infrastructure an irresistible target…"

"A broad consensus among computer scientists is emerging that the approach of patching and retrofitting networks, computing systems, and software to "add" security and reliability may be necessary in the short run but is inadequate for addressing the Nation's cyber security needs."

PITAC Report on CyberSecurity

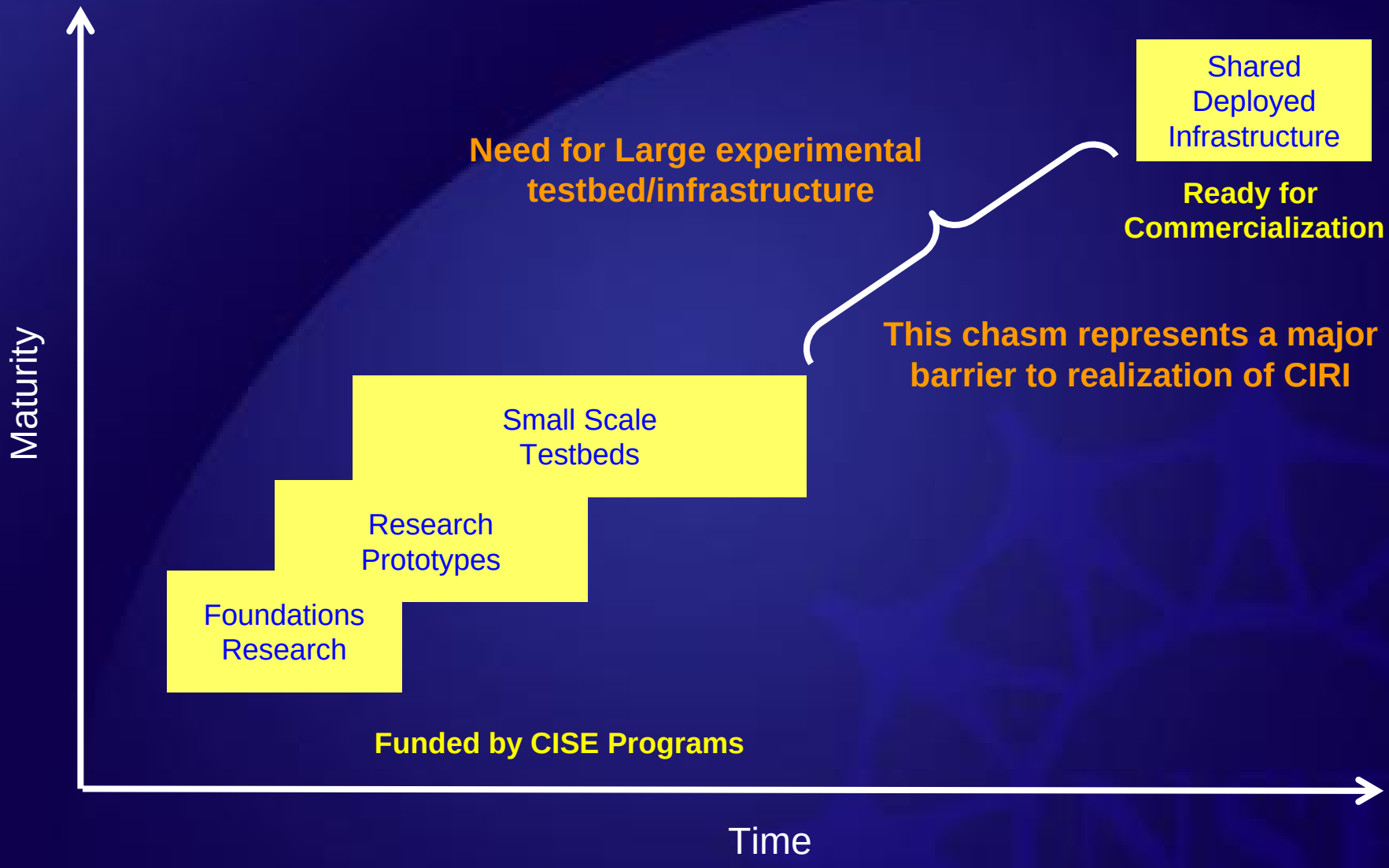
Opportunities

- Technology push
  - Sensors, wireless devices, optical integration, System on a Chip (SoC), …
  - High-end computers and massive databases
  - Networking, data mining, new algorithmic approaches
- Increasing commercial and government interest
  - All industry sectors: telecom, healthcare, entertainment, and others
  - Government agencies: DoD, DoE, DHS, and others
- S&E applications
  - Seamless access to range of online resources
  - Bridge physical and virtual worlds
    - E.g., sensorized environment and large scale simulation
  - Massive data archiving facilities and data mining tools

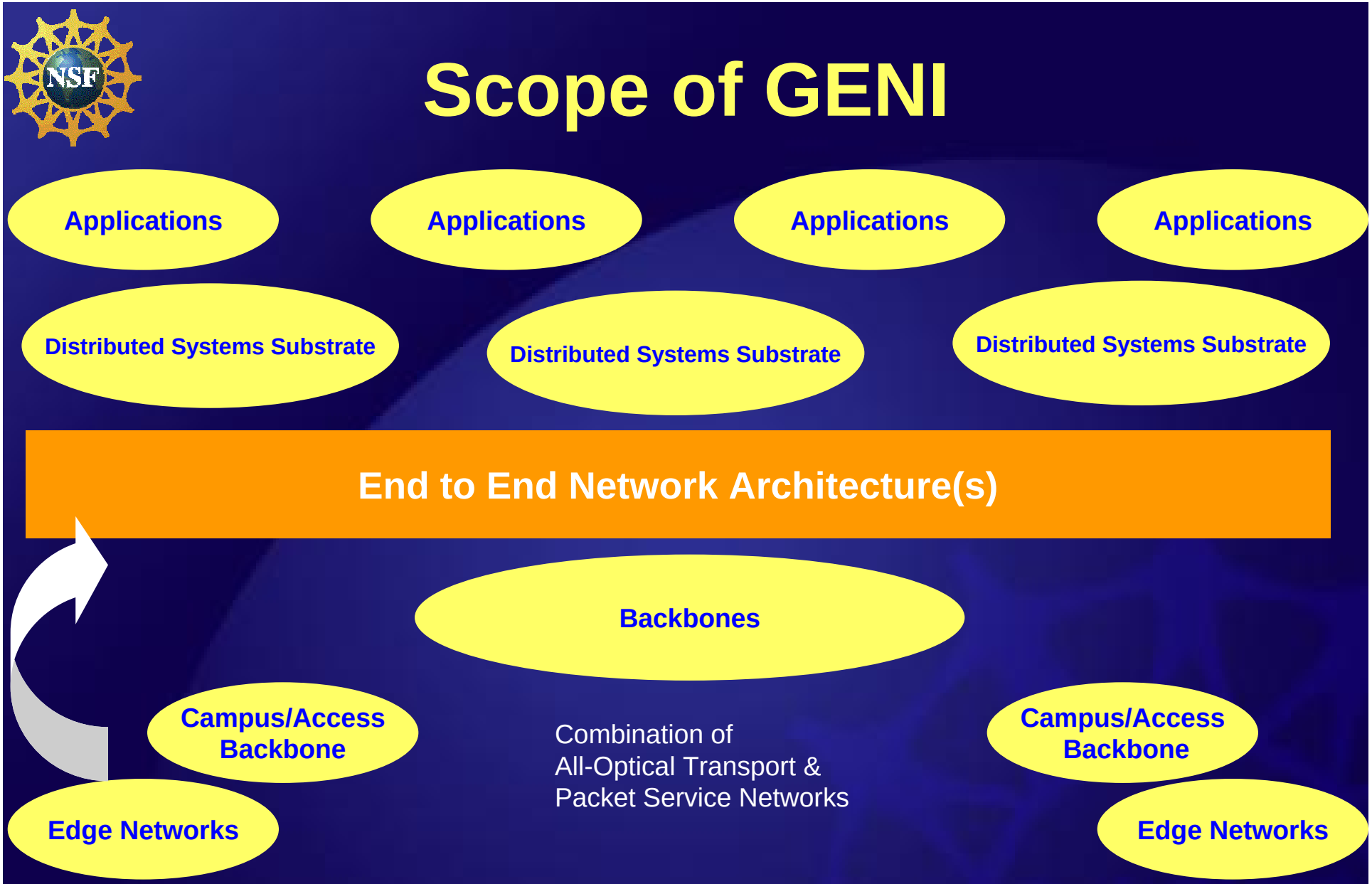
CISE Portfolio: A Perspective

- Good news
  - Many promising projects and solutions
  - Little nudge from NSF led community leaders to respond
- **Need of the hour: explicit re-focus of programs on CIRI goals to**
  - Articulate research agendas
  - Galvanize larger research community
  - Accelerate progress towards CIRI
- Example focus
  - NeTS focus area on new network architectures
    - Resulting from NSF nudge, planning grant, and community participation
  - CyberTrust and CSR need to do something similar
    - Proposed planning grants would help
- **CISE leadership in favor of explicit focus of existing programs**

Case for GENI



Scope of GENI



GENI Not Just Another Testbed

- Overcome testbed dilemma
  - Production testbeds have real users but are incremental
  - Research testbeds allow innovation but have no users
- Meta-testbed (aka virtual testbed)
  - Support many architecture-specific network testbeds
  - Exploit advantages of diverse network technologies
  - Allow users *opt-in* to experimental networks that offer value
- Not necessarily a single connected network
  - Technology and other constraints may dictate that

Expected GENI Deliverables

- A new class of
  - Network platforms: switches/routers/APs/optical systems/?
  - Control and management planes
  - Distributed system infrastructures
  - Embedded measurement and instrumentation infrastructure
  - Optical transport systems and networks
- New and old applications
  - New class of edge devices
- Real users that depend on the infrastructure
- Deep insight about
  - Various proposed architectures
  - Various engineering trade-offs

An operational infrastructure based on a new end-to-end architecture that is secured, robust, scalable, manageable, and evolvable

GENI Funding?

- Going after new funding
  - CI
  - MREFC
- Target: $300M over five years
- Will help fund
  - Systems: prototypes to commercial grade
  - Infrastructure
  - Experimentation
- Timeframe?

Infrastructure funding will support experimental systems work & relieve research programs from this burden


CIRI
GENI

CIRI/GENI Planning

- Planning grants FY04
  - Disruptive network innovations via network virtualization
  - Optical integration and implications on optical networking
- Planning grants FY05
  - Clean-slate network security
  - End to end network architecture
  - Wireless, mobile, and sensor networks
  - Distributed systems
  - Real time networked systems and CIP
- Meta GENI planning grant
  - Builds on the results of other planning grants
  - Facility for experimentation on network distributed systems architectures

Purpose of Planning Grants

- Articulate a compelling research agenda
- Articulate requirements for an experimental infrastructure
- Get communities to work together
  - Wired, mobile, wireless, sensor network architects
  - Network architects and security experts
  - Network architects and optical integration experts
  - …
- Communicate excitement, rationale to broader research community
- Help NSF & other agencies to fund and promote agenda
  - Bring focus of existing research programs to CIRI

GENI Planning Goals

- Build a compelling case for GENI
  - Detailed project plan
  - Initiate smaller scale effort ASAP
- Invent new processes
  - Allow for competition and consensus building
  - Leverage each others work to build infrastructure
- Leverage intellectual capital of the community
- Get broader community involved

Wireless/Mobile/Sensor Architectures and Experimental Evaluation

Some Workshop Topics

- Wireless/Mobile/Sensor Network Requirements
- Emerging/Enabling Technologies
- Future Architecture & Protocols and Integration of Wireless/Mobile/Sensor Networks
- Experimental Infrastructure Concepts

Challenge

Can the Research Community Propose a Compelling Research Agenda?

Compelling Research Agenda?

Agenda needs to

- Go beyond Internet
  - Keep the good, address limitations, and plan for future
- Be comprehensive
  - Be end-to-end including diversity of applications and networks
- Be synergistic
  - Avoid list of loosely related research topics
- Include experimental evaluation & deployment plan
  - Support multiple network architectures on a single testbed
- Include consensus building process
  - Avoid endless exploration of competitive ideas

Agenda Audience and Goals

- Broader research community
  - How they can contribute and participate?
- NSF and other agencies
  - How implementation of the agenda will lead to the next generation network(s) that will be the engine of growth for the next 30-50 years?

Anything short of this will not work

Cost of Status Quo

Network funding *relatively* healthy

- 15% acceptance rate
- Most of HR and R+ projects getting funded

Without a compelling research agenda

- Funding will go down
- Overall flat/reducing NSF budget
  - Implication - people looking to cut other people's programs!!
- Acceptance rates will go down maybe to 5%
  - As in other programs…

Sustaining small non-exciting programs much harder

Exciting Research Agenda

Will help

- Keep existing generous networking budget
- Attract more of discretionary funds to networking
- Win NSF funds for major research infrastructure
- Potentially double total funding for networking

Final Thoughts

- Opportunity and urgency to innovate
  - Innovate beyond Internet
- NSF & community need compelling research agenda leading to
  - Next generation architecture, protocol stack, platforms
  - Deployed infrastructure
- NSF ready to commit serious resources
- Our opportunity to change course of networking
  - Let us use our best creativity to make this happen