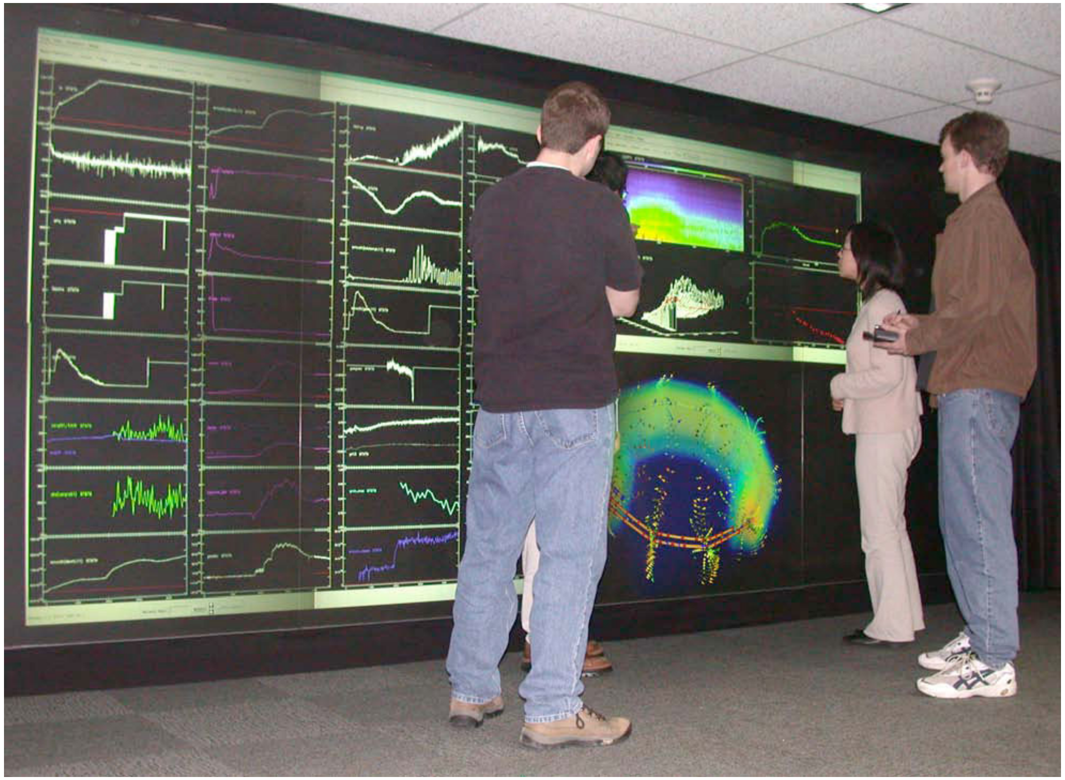

Developments in Remote Collaboration and Computation

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16th ANS TOFE

Madison, WI

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www.fusiongrid.org

V2.1

- **Acknowledgements**
- Motivation
- Key Points
- Collaborative Control Room
- Applicability to Diagnostics and Machines
- Applicability to Next-Generation Experiments
- Concluding Comments

FusionGrid Acknowledgements

- DOE Office of Science, Office of Advanced Scientific Computing Research, SciDAC funded collaboratory project
- A partnership of computer scientists and fusion specialists
- 3 years into a 5 year effort
- http://www.fusiongrid.org

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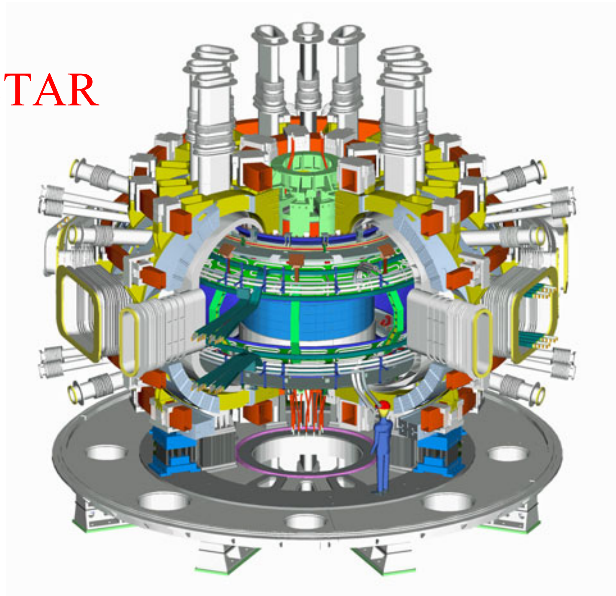
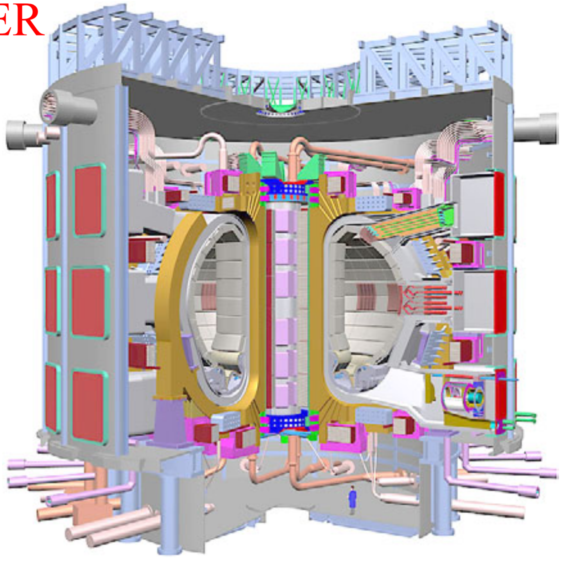
Collaborative technology needed for U.S. success in international next-generation fusion experiments

KSTAR



ITER



- Next-generation fusion experiments will **not** be in United States
  - KSTAR in Korea
  - ITER in France or Japan
- U.S. success requires new remote participation capabilities
- The time to start developing these technologies is now
- Should start prototyping these technologies for design and construction

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FusionGrid is enabling scientific collaboration

- Developing the collaborative control room
- Deploying advanced collaboration and grid computing software to operating U.S. magnetic fusion experiments
- These advances in collaboration are applicable to diagnostics & machines (design, engineering, and construction)
- Technology scales to next generation experiments (KSTAR, ITER) and is critical to their success

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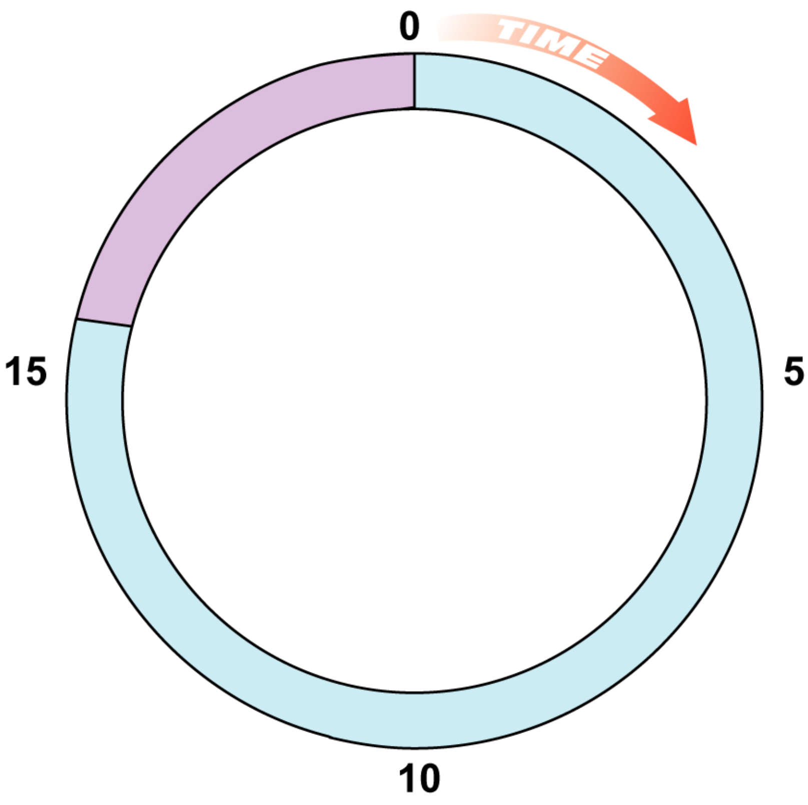
- **Collaborative Control Room**
- Applicability to Diagnostics and Machines
- Applicability to Next-Generation Experiments
- Concluding Comments

The collaborative control room is fundamental to advancing fusion science

- The collaborative control room requires:
  - Fully engaged remote scientists with audio, video, shared displays
  - Share individual results with the group via shared displays
  - Secure computational resources that can be scheduled as required
  - Rapidly compare experimental data to simulation results
- Must function under the high-pressure control room environment
  - Take a shot, analyze results, plan next shot, take next shot…
  - Like doing a space shuttle launch every 20 minutes



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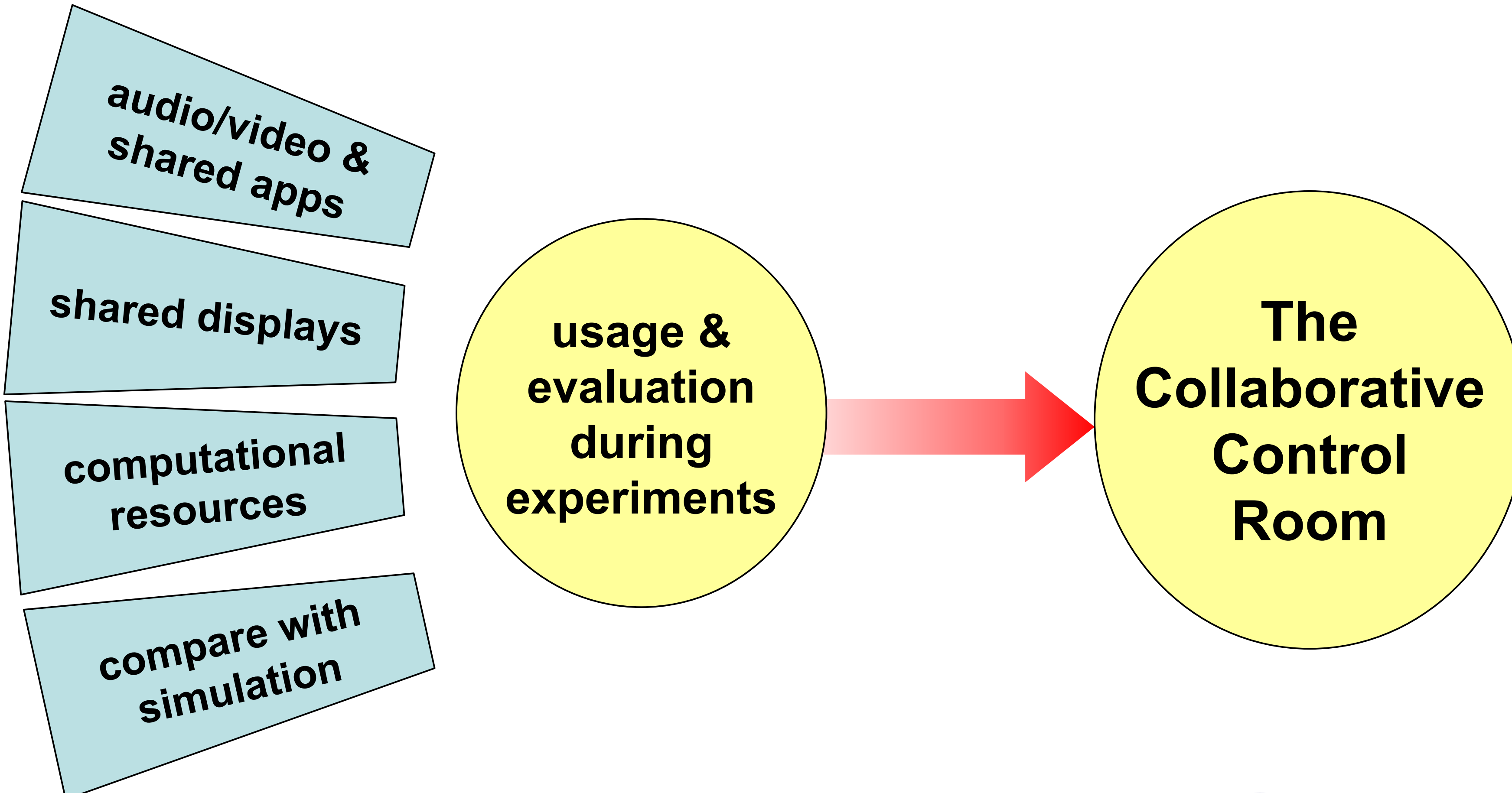
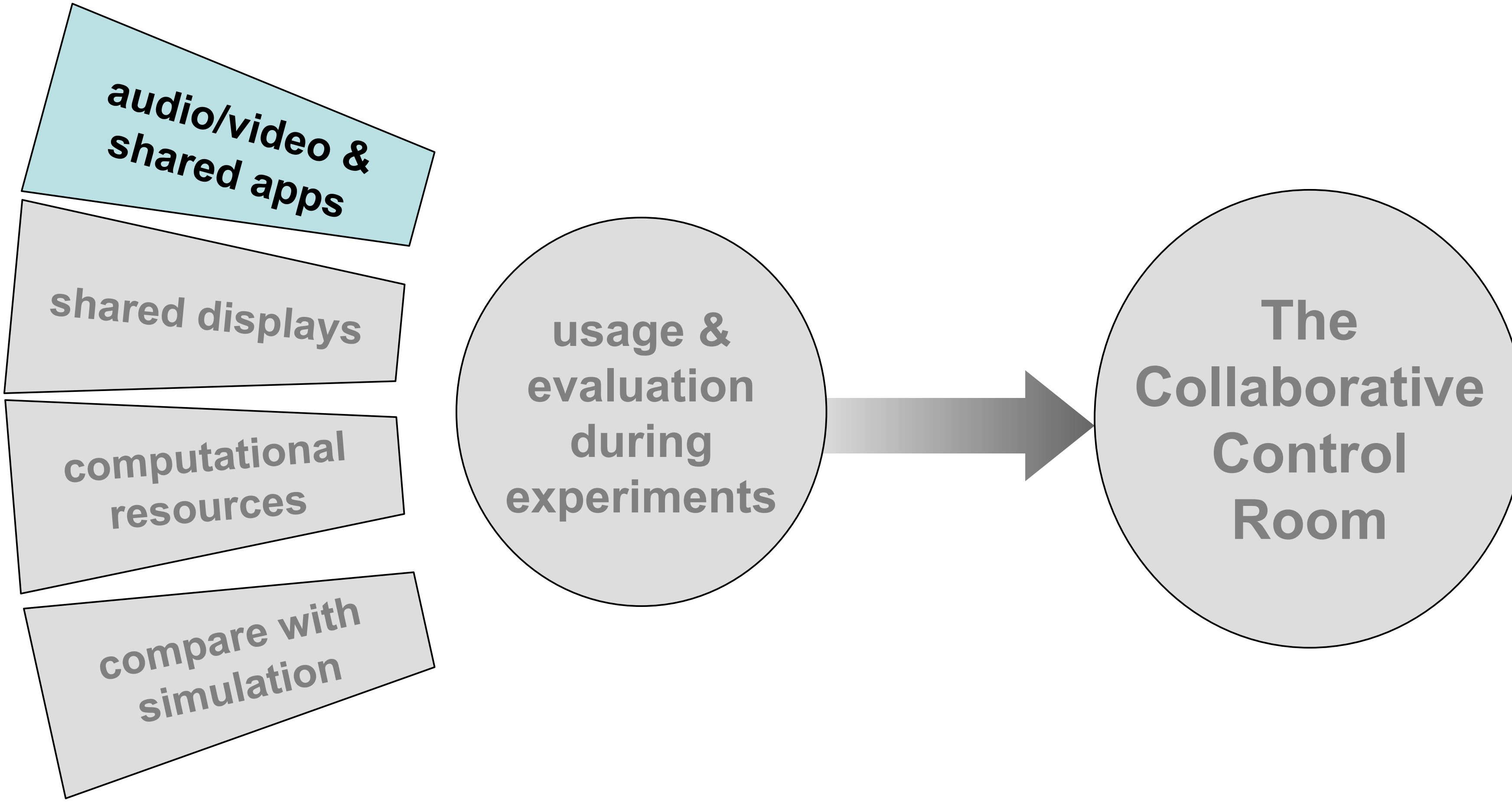
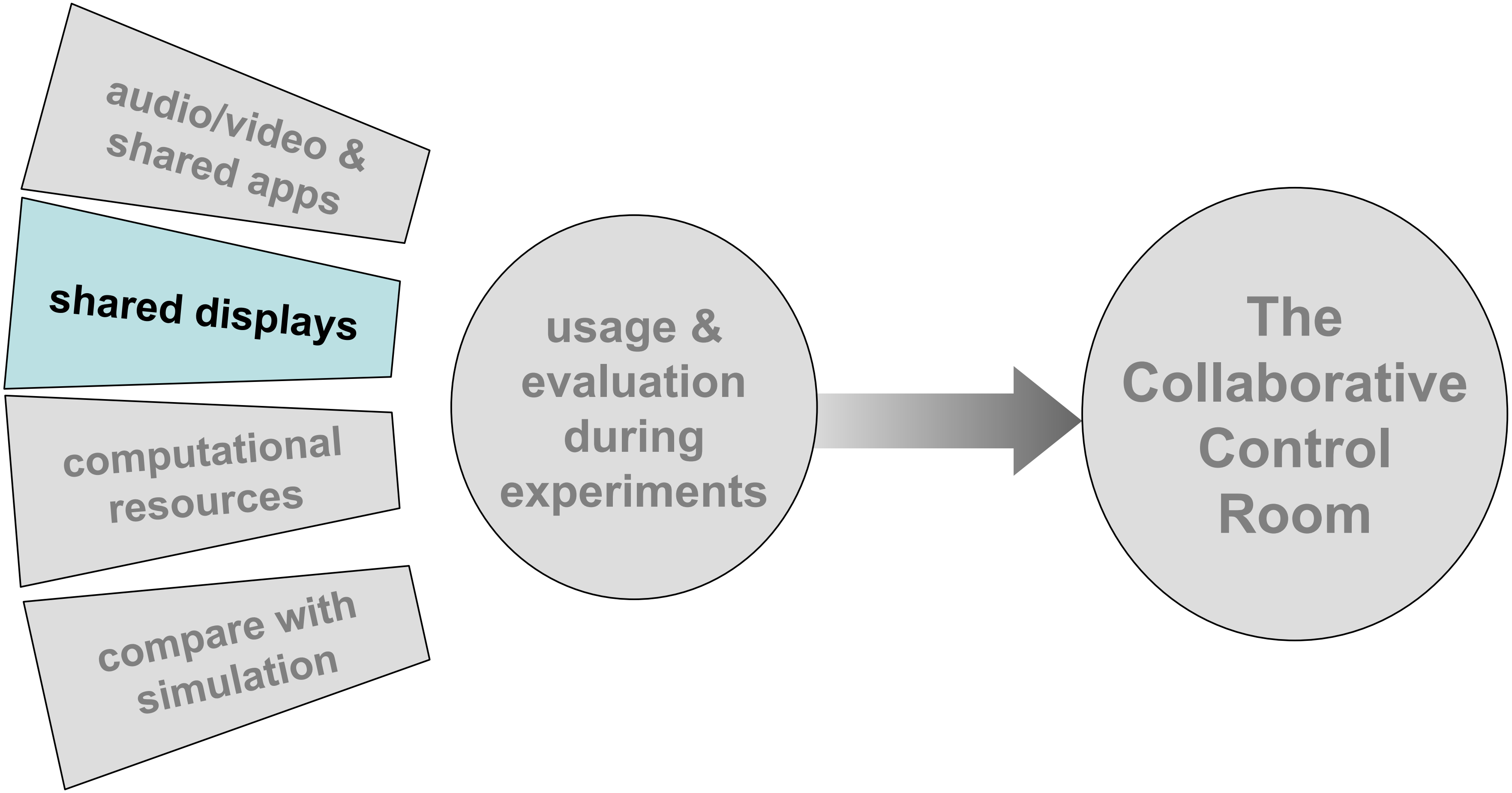
To realize the collaborative control room, we must use and evaluate the enabling technologies




audio/video & shared apps
shared displays
computational resources
compare with simulation
usage & evaluation during experiments
The Collaborative Control Room

Access Grid (AG) connects remote researchers

- Goes beyond simple teleconferencing
- Access Grid software combines video, audio, and application sharing
- Allows for group-to-group scientific collaboration
- Works over the Internet—no special lines required
- Scalable
  - Personal node for $3K
  - Can use same technology to do an entire room


audio/video & shared apps
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The Collaborative Control Room

Share individual results with the group through display walls

DIII-D Tokamak Control Room

NSTX Tokamak Control Room

- Share results with researchers in the same control room
  - "Publish" your data to the display wall
  - An alternative to asking the rest of the control room to gather around your monitor
- Share results with researchers in a remote control room

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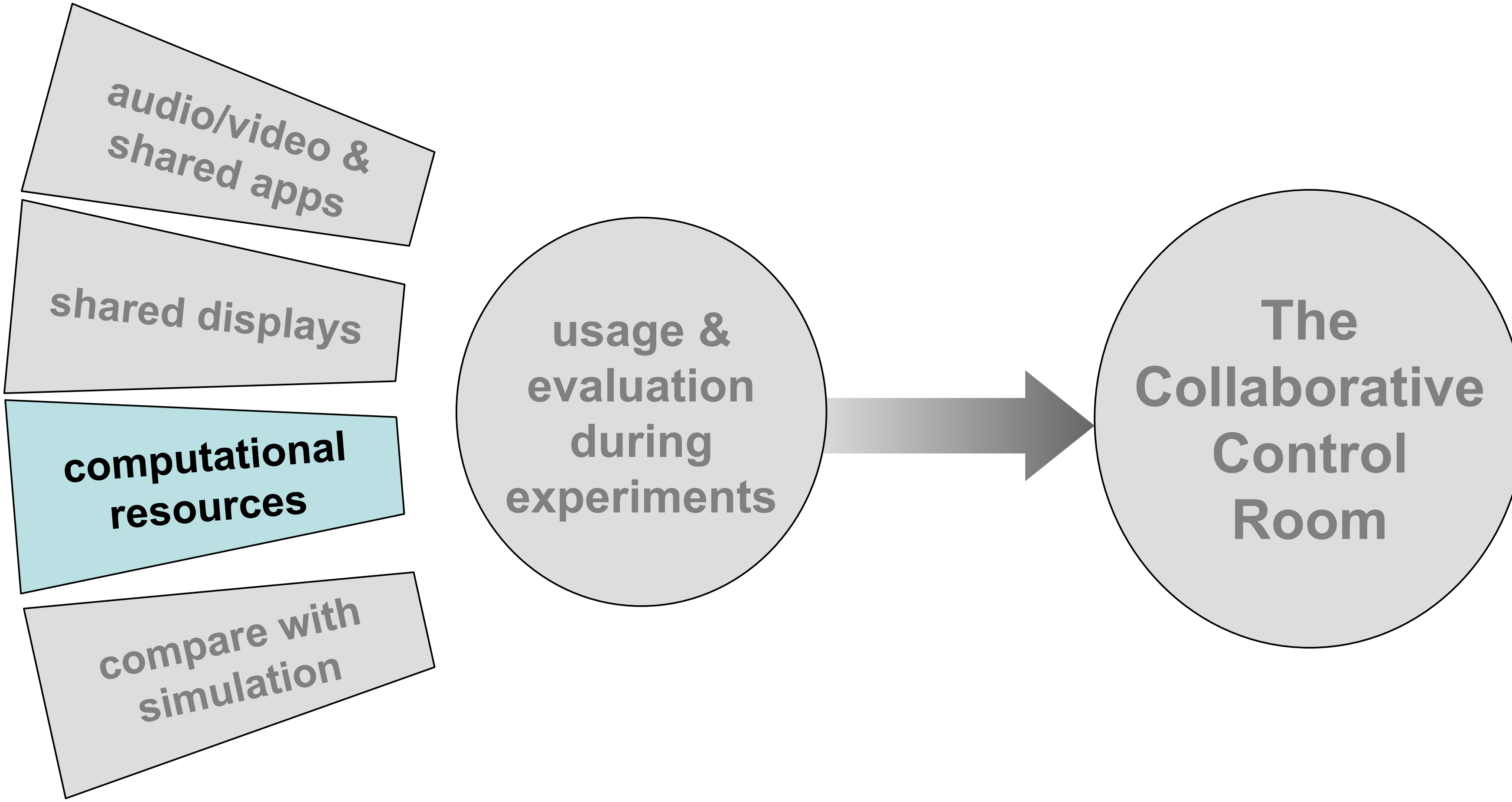

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Grid computing provides secure, remotely accessible computational services

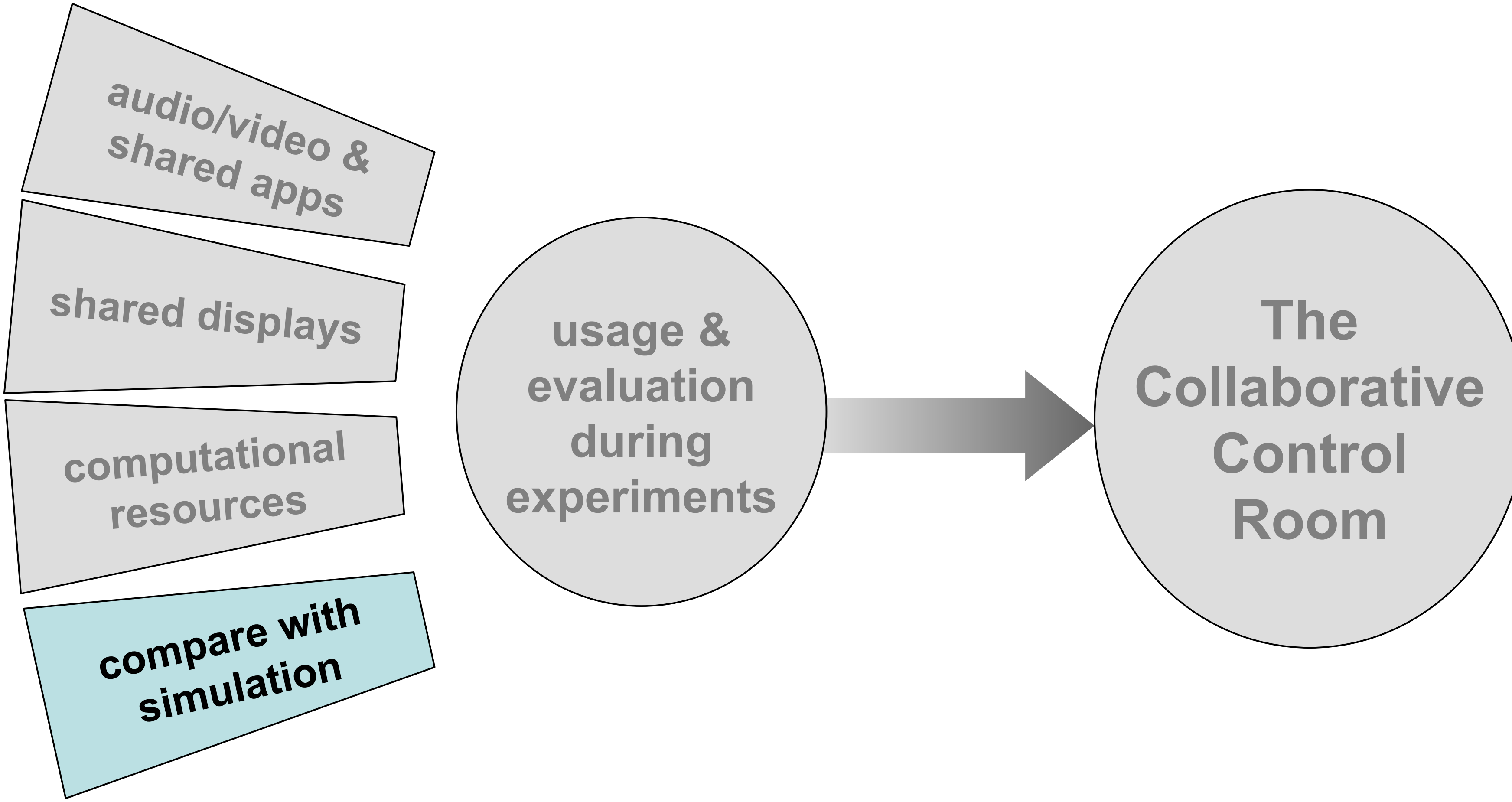
- Applications, systems, and other computing resources are abstracted into grid services
- Users “sign on” to the grid a single time to use grid services
- These computational services may be provided by remote machines
  - e.g. number crunching service on one machine, data storage service on another
- Grid computing standardizes access to remote computing resources

Security is based on certificates

- Each user gets a certificate that uniquely identifies that user on the grid
  - Essentially your public key and name digitally signed by a certificate authority
- Each grid has a certificate authority
- The certificate is used when signing on to the grid
- Modern web browsers fully support the use of certificates
- Other applications can be modified to use certificates
  - Secure MDSplus, for example

TRANSP grid service established grid computing feasibility and has had a positive impact

- The TRANSP transport analysis code was made a FusionGrid service in 2002
- Over 4,200 TRANSP runs completed
- It is now **the** US TRANSP resource
  - Also used by EU researchers
- Code maintenance is centralized at PPPL
  - Those best suited for maintenance—the developers at PPPL—maintain the TRANSP service
  - Economist David Ricardo would call it a comparative advantage
- One installation of TRANSP means researchers are always using the most up-to-date version


audio/video & shared apps
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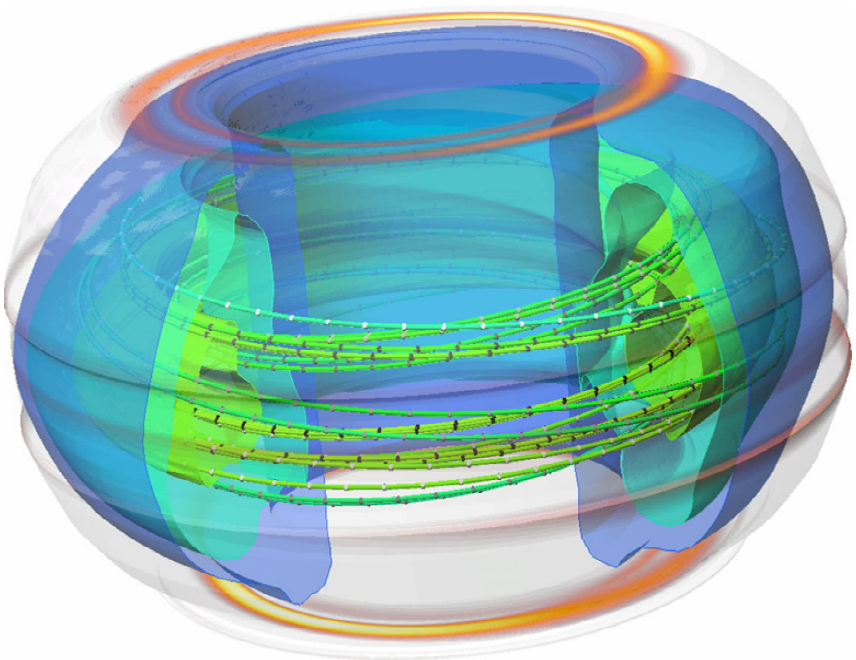
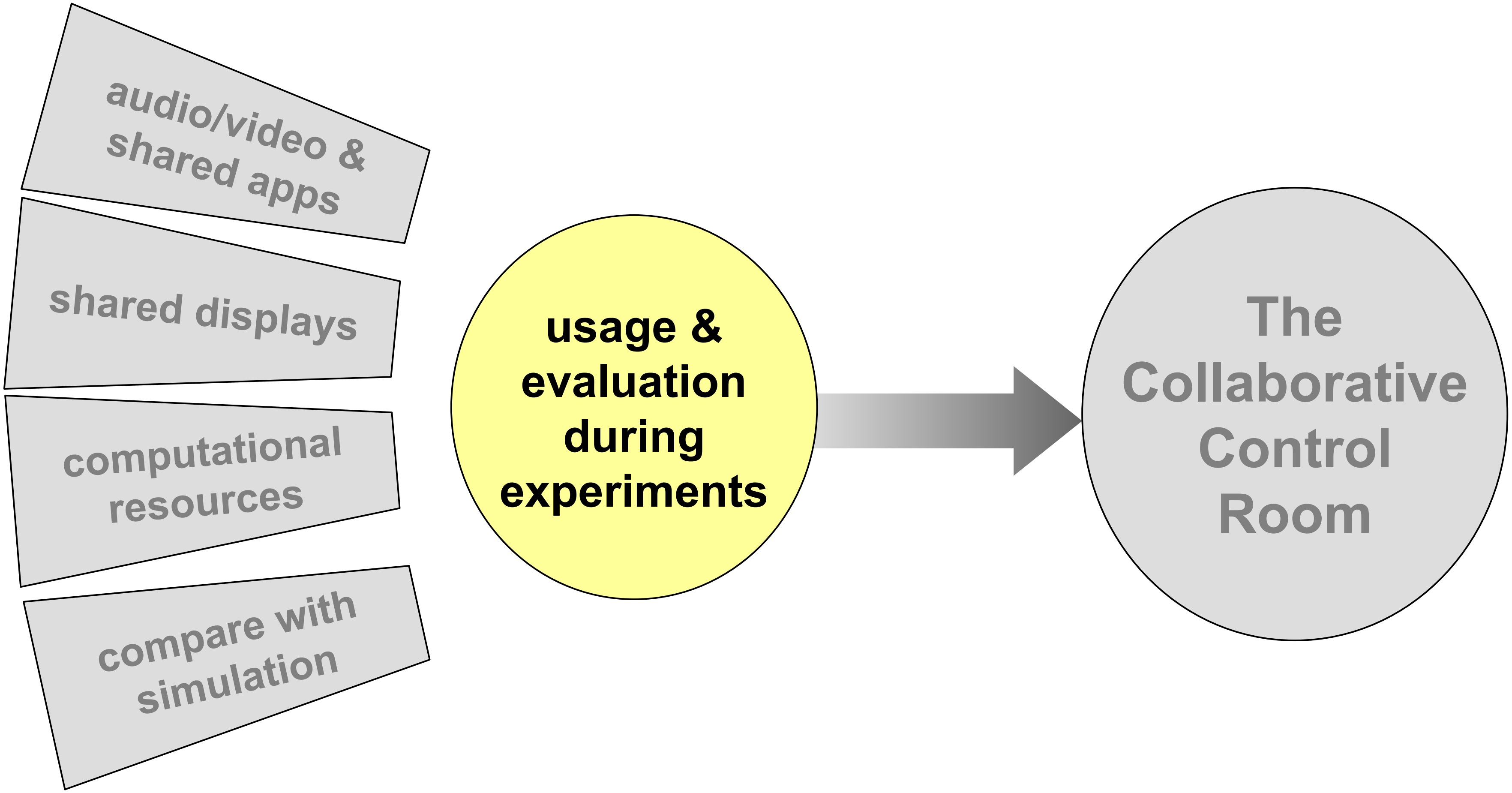
computational resources
compare with simulation
usage & evaluation during experiments
The Collaborative Control Room

Must rapidly compare simulation with experiment

- Requires that you can retrieve simulation results quickly
  - Difficult for large datasets
  - Need to apply the right data transfer technology, e.g. parallel transfer for high-bandwidth, high-latency
- Unified data access makes it easier to compare results



NIMROD simulation of DIII-D



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Live collaborative control room demonstrated at SuperComputing 2003 Conference (SC03)

- The collaborative control room concept was demonstrated at Phoenix (SC03) & DIII-D
- People at SC03 could interact with control room
- Shared displays for data analysis
- Demonstrated advance reservation of computational resources

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Initial usage of collaborative control room was between JET and San Diego in January 2004

- In January, a scientist in San Diego led an experiment located at JET in the UK
- Performed data analysis
- Interacted with researchers located in the JET control room

- Established the feasibility of remote experiment through Access Grid
- Subsequently done between JAERI and ASDEX-U

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Collaborative technology also benefits design, engineering, and construction work

- There are many cases where you want to
  - Interact with (see & hear) other collaborators
  - Share applications and data
  - Show individual results to group
  - Securely access computing resources
- Example: two groups have a remote design meeting
  - See & hear other designers
  - Securely share designs over Internet
- Collaborative technology is beneficial, even if you do not intend to work in a collaborative control room

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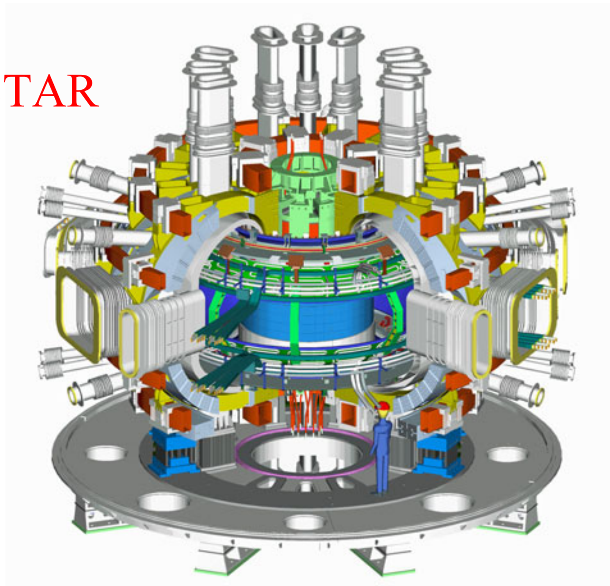
REMOTE PARTICIPATION TECHNOLOGY CRITICAL TO U.S. SUCCESS IN INTERNATIONAL EFFORTS

KSTAR



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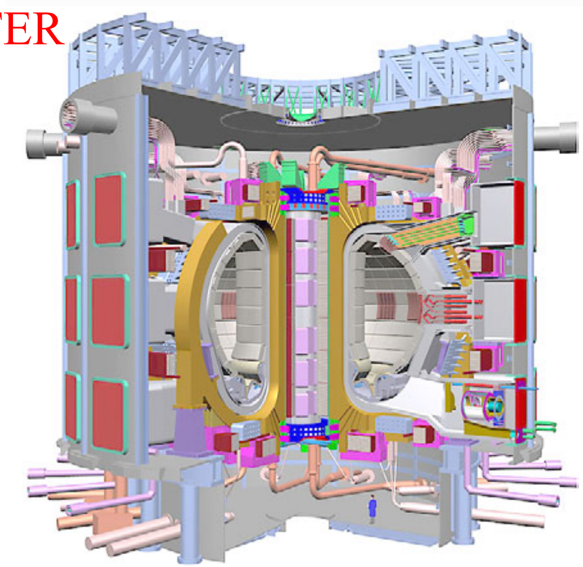

- KSTAR
  - Korea, active U.S. participation
- ITER
  - Located in France or Japan
  - U.S. has rejoined
- Maximize U.S. benefit via collaboration
  - Effective participation or be left behind
- The time to start is now
  - Defining needs & prototyping (FusionGrid)
  - Should be used for design & construction

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CONCLUDING COMMENTS

- The requirements of the collaborative control room encompass in one instantiation the collaborative needs of fusion energy sciences
  - The most demanding since it is time critical and failure intolerant
- The FusionGrid project is implementing and testing new collaborative technologies for fusion research
  - FusionGrid services being used to benefit daily FES research
- Technology has broad applicability beyond tokamak plasma physics
  - Design, engineering, and construction of diagnostics and machines
- Collaborative technology critical to the success of the FES program
  - Experimental: Fewer, larger machines in future (KSTAR, ITER)
  - Computation: Moving toward integrated simulation (FSP)

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