**Illinois Business Consulting**

The Nation’s Largest Fee-Based, Student-Run Consulting Firm

<table>
<thead>
<tr>
<th>Student Run</th>
<th>Project Based</th>
<th>Company Focused</th>
<th>University Sponsored</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 250 students per year from 9 colleges</td>
<td>• 50 projects per year</td>
<td>• Over 500 clients since 1996</td>
<td>• Operates under Gies College of Business</td>
</tr>
<tr>
<td>• Students are peer-selected</td>
<td>• 1,200+ projects since 1996</td>
<td>• Fortune 500 multinationals</td>
<td>• Access to the research and expertise the university</td>
</tr>
<tr>
<td>• 14% acceptance rate</td>
<td>• 12 to 14 week semester-long engagements</td>
<td>• Government agencies</td>
<td>• Professional guidance and oversight</td>
</tr>
<tr>
<td>• The university’s top talent</td>
<td>• 600+ student work hours per project</td>
<td>• Non-profit organizations</td>
<td>• Client owns all intellectual property and deliverables</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Start-ups</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Team Introduction

Fan Yang
SENIOR MANAGER
PhD, Aerospace Engineering

Amol Rairikar
PROJECT MANAGER
Mechanical Engineering

Sneha Mathew
SENIOR CONSULTANT
Finance

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Masters, Accounting

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Accounting

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CONSULTANT
Chemical Engineering

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Lishen He
CONSULTANT
PhD, Civil Engineering

Sneha Mathew
SENIOR CONSULTANT
Finance
# Agenda

<table>
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<th>Topic</th>
<th>Page</th>
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</thead>
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<tr>
<td>Appendix</td>
<td>21</td>
</tr>
</tbody>
</table>
Problem statement and recommendation
IBC final recommendation for pricing, marketing, and product strategies

Apply value-based pricing strategy

- Tiered pricing plans for customers segmented by demand for the product
- Maximize revenue by creating most value for customers

Start active marketing strategy

- Introduce the product through different channels: existing clients, conference, growth hacking
- Provide trial version and real-life demonstrations
- Offer project protection and subsidies

Build up product competence

- Be the most comprehensive product for HPC in the market
- Separate PI and student account interfaces
- Offer professional, timely, and efficient user support

Based on primary/secondary research and a comprehensive market analysis, IBC recommends that XSEDE utilize the above strategies to best enter the market with XRAS.
XRAS, SSOH Background
XRAS and SSOH are tools that can be used for many applications

**XRAS: Resource allocation management system**

- **Process**
  - Submit proposals
  - Review of proposals
  - Decision on allocation
  - Allocation

**SSOH: Add-on component to XRAS**

- **Features**
  - Multifactor authentication
  - Remote access
  - Endpoint control
  - Bundled service

**XRAS use cases, competitors**

| NCAR, EOL, CADENS | XRAS allocates time on aircraft, instruments, and reviews allocation requests |
| Competitors | EasyChair, Cold Front, Request Tracker, Google Forms |

XRAS and SSOH are services which can be used for supercomputers and other research purposes; combined, they are a flexible tool and can be customized for different clients.
Pricing Research
Target customers are segmented in value-based pricing strategy

<table>
<thead>
<tr>
<th>Support plan</th>
<th>Trial</th>
<th>Basic</th>
<th>Standard</th>
<th>Advanced</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target customer</strong></td>
<td>Small HPC</td>
<td>Small HPC (nodes &lt; 1,000)</td>
<td>Medium HPC (1,000-2,000 nodes)</td>
<td>Large HPC (nodes &gt; 2,000)</td>
</tr>
<tr>
<td><strong>Annual base fee</strong></td>
<td>$0</td>
<td>$2,000</td>
<td>$10,000</td>
<td>$50,000</td>
</tr>
<tr>
<td><strong>Number of accounts</strong></td>
<td>25</td>
<td>50</td>
<td>200</td>
<td>Unlimited</td>
</tr>
<tr>
<td><strong>Customization &amp; installation</strong></td>
<td>$500</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
</tr>
<tr>
<td><strong>Support limit</strong></td>
<td>$100/h</td>
<td>5 requests/year, extra support @ $100/h</td>
<td>20 requests/year, extra support @ $100/h</td>
<td>Unlimited</td>
</tr>
<tr>
<td><strong>SSOH</strong></td>
<td>Not Supported</td>
<td>Supported</td>
<td>Supported</td>
<td>Supported</td>
</tr>
</tbody>
</table>

The amount of technology support, number of supported accounts, and customization & installment are key variables for different customer segments in the Value-based Pricing Strategy.
HPCs of different sizes have different levels of demands of XRAS

According to the graph above, the willingness to pay of HPC’s in universities or national labs has a positive correlation to the number of nodes they have.
xras’ pricing model incorporates key features present in competitors’ pricing models

<table>
<thead>
<tr>
<th></th>
<th>Price driver</th>
<th>Number of tiers</th>
<th>Key features</th>
<th>Customers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xras</td>
<td>Features included</td>
<td>3+1 (trial version)</td>
<td>Customizability, number of accounts, support type, review</td>
<td>Universities, national laboratories</td>
</tr>
<tr>
<td>Request Tracker</td>
<td>Features included</td>
<td>3</td>
<td>Request limit, support type, customizability</td>
<td>Universities, businesses</td>
</tr>
<tr>
<td>EasyChair</td>
<td>Number of submissions</td>
<td>3</td>
<td>Review, hosting, event management</td>
<td>Academic conferences, universities</td>
</tr>
</tbody>
</table>

By including features from pricing models of successful competitors, XSEDE can ensure that their pricing model for Xras is in line with market expectations.
The break-even point for XRAS can be reached at 22 customers per year, or slightly after 2 years with 10 customers per year based on IBC’s recommended pricing model.
Research from industry experts validates three tiered pricing plan

Sample willingness to pay figures

- **UCLA:** $10,000-$20,000 (1,000-2,000 nodes)
- **UC Santa-Barbara:** $10,000 (1,000-2,000 nodes)
- **Sandia National Laboratory:** $10,000-$100,000 (>2,000 nodes)
- **University of Wyoming:** $2,500 (<1,000 nodes)
- **University of Illinois CADENS Project:** $10,000-$20,000 (>2,000 nodes)

XRAS pricing ranges from:

- **$50,000/year**
  - Experts find these features most valuable
  - “There will be a big use”
  - “Can more efficiently manage the resource moving forward”
- **$2,000/year**
  - Customization
  - “This will make the product much more valuable”
  - Compatibility to job schedulers
  - “It’s important to communicate the capabilities of the resource management system”

The willingness-to-pay from various HPC centers falls into three distinct tiers that XRAS’ pricing structure incorporates, each with a varying level of the features experts find valuable.
Marketing Research
XRAS can be marketed to customers based on the savings it can present them

Assumptions

- It takes 40 seconds to send an email and 0 seconds to send an XRAS notification
- It takes at most 1 week and at least 5 work hours to collaborate in allocating a request; XRAS does this in minutes
- It takes a maximum of 2 minutes to transfer allocation request data to HPC systems without XRAS
- Software engineers are required to process allocation requests as they have to review the researcher’s code
- Medium-sized universities (our ideal target customer) process 60 allocation requests a year

\[
\frac{(40 \text{ seconds} + 5 \text{ hours} + 2 \text{ minutes})}{\text{allocation}} \times ($100/\text{hr}) = $504/\text{allocation}
\]

\[
$504/\text{allocation} \times 60 \text{ allocations/year} - $10,000/\text{year (XRAS cost)} = $20,267/\text{year in savings}
\]

After making certain valid assumptions and calculating the difference in labor costs between using XRAS and Google Forms, the savings to the customer is $20,267 per year.
XSEDE should promote XRAS and SSOH through various market-entry strategies

**Demonstration**

- **Online video**
  - Produce *simulation videos* about specific functions of XRAS and SSOH

- **Real-life demonstration**
  - Remote or *in-person* demonstrations
  - Give short-length demonstration at conferences to show the increased efficiency of XRAS

**Protection and subsidy**

- **Protection plans**
  - Promises in *future R&D, maintenance* and future *price guarantee*

- **Subsidies**
  - First-time customers
  - Current affiliated partners
  - Customers with a large number of users or units of HPC

The market-entry strategies for XRAS and SSOH can be specifically focused on the needs of customers, who will need substantial information about the specific function of the products.
**XSEDE can introduce XRAS and SSOH through clientele and growth hacking**

<table>
<thead>
<tr>
<th>E-Blasts</th>
<th>Growth hacking</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Reach out to <strong>existing clients and current platform</strong></td>
<td>• Leverage <strong>social media</strong>, viral marketing, and low cost alternatives to traditional media</td>
</tr>
<tr>
<td>• Include <strong>informational videos</strong> such as case studies detailing customers</td>
<td>• Generates <strong>10% more</strong> leads than traditional marketing</td>
</tr>
<tr>
<td>• 25-40% of all traffic and lead generation comes from earned media</td>
<td></td>
</tr>
</tbody>
</table>

**Associated costs**

- Hiring of a third-party **video production** company
- **Staff time** utilized towards making presentations and supporting materials

Traditional methods of marketing prove to be expensive and ineffective; by leveraging low cost media outlets and existing platforms, XRAS and SSOH can successfully enter the market.
XSEDE Action Plan
XSEDE should follow steps from the action plan within the next 3 years

- Develop protection, subsidies plan
- Find conferences of interest
- Begin video production
- Reach out to existing clientele

Year 1

- Plan market entry, expand customer base

Year 2

- Continue to expand customer base

Year 3

- Review XRAS progress
- Verify discounts are fiscally reasonable
- Update existing videos
- Continuously improve software, notify customers to changes
- As customer base expands, readjust protection and subsidies plan
Appendix
## Assumptions for the Revenue Projection

Projection of revenue and total labor hour consumption for every 10 customers

<table>
<thead>
<tr>
<th>Willingness to pay</th>
<th># of customers</th>
<th>Plan used</th>
<th>Base Fee</th>
<th>Installation</th>
<th>$ from support</th>
<th>Labor hours per customer</th>
<th>Total Labor Hours (h)</th>
<th>Revenue ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>2</td>
<td>Trial</td>
<td>0</td>
<td>500</td>
<td>500</td>
<td>10</td>
<td>20</td>
<td>2,000</td>
</tr>
<tr>
<td>Low</td>
<td>4</td>
<td>Basic</td>
<td>2,000</td>
<td>0</td>
<td>1,000</td>
<td>20</td>
<td>80</td>
<td>12,000</td>
</tr>
<tr>
<td>Medium</td>
<td>3</td>
<td>Standard</td>
<td>10,000</td>
<td>0</td>
<td>1,000</td>
<td>40</td>
<td>120</td>
<td>33,000</td>
</tr>
<tr>
<td>High</td>
<td>1</td>
<td>Advanced</td>
<td>50,000</td>
<td>0</td>
<td>0</td>
<td>150</td>
<td>150</td>
<td>50,000</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>370 h</td>
<td>$ 97,000</td>
</tr>
</tbody>
</table>

One engineer can support \[ \frac{52 \text{ weeks} \times 40 \text{ hours/week}}{360 \text{ hours/10 customers}} \approx 56 \text{ customers} \], XSEDE adds 10 new customers per year.

Cost components are software engineer ($200,000), AWS ($300)
Top universities and colleges with a large emphasis on STEM programs are promising users

Universities with promising research and innovation labs are a promising market for XRAS and SSOH

Top STEM Colleges of 2018

- Massachusetts Institute of Technology
- California Institute of Technology
- John Hopkins University
- United States Naval Academy
- United States Air Force Academy
- Carnegie Mellon University
- United States Coast Guard Academy
- Harvard Mudd College
- Cooper Union for the Advancement of Science and Art
- Lehigh University
- University of Rochester
- Georgia Institute of Technology
- Case Western Reserve University
- Rensselaer Polytechnic Institute of Technology

Potential Barriers to Entry

- 21 of the most competitive research programs already have a form of resource allocation or system for finding resources
- Top 5 Supercomputers
  1. Stampede at University of Texas
  2. Amos at Rensselaer Polytechnic Institute of Technology
  3. Big Red II at Indiana University
  4. HPCC at University of Southern California
  5. Palmetto2 at Clemson University

In order to successfully launch XRAS and SSOH, a strong marketing campaign must be established in order to persuade universities to adopt XSEDE’s software systems
XRAS is a resources allocation tool with unique features

The most valuable feature of XRAS is that it can be customized to the client’s needs and can be integrated into the website’s infrastructure.
There are six major features for Single Sign On Hub applications in the market

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote Access</td>
<td>Controls access to applications and resources when employees are outside of the local network</td>
</tr>
<tr>
<td>Supports Bring-Your-Own-Device Users</td>
<td>Enables users to access applications and resources with their own device</td>
</tr>
<tr>
<td>Supports 3rd Party Authentication System</td>
<td>Supports required 3rd party authentication such as biometric, key cards and token based system</td>
</tr>
<tr>
<td>Multi-factor Authentication</td>
<td>Supports the authentication, so users are required to provide multiple factors to authenticate, such as password + token</td>
</tr>
<tr>
<td>Supports Required Authentication Methods</td>
<td>Supports SSOH via Web agents, proxy agents, agent-less, SAML or OAuth and WS-Federation authentication and authorization Web services</td>
</tr>
<tr>
<td>Endpoint Access</td>
<td>Provides ability to control access to PC's, Mobile devices, and other endpoint devices</td>
</tr>
</tbody>
</table>

XSEDE should consider adding these features to SSOH to meet the needs of future clients and be more competitive in the SSOH market
**SSOH competitors have several features and a set pricing model**

<table>
<thead>
<tr>
<th>Feature</th>
<th>XSEDE</th>
<th>RSA</th>
<th>Active Directory</th>
<th>Centrify</th>
<th>Bitium</th>
<th>One</th>
<th>Okta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote Access</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Supports BYOD Users</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Supports 3rd Party Authentication System</td>
<td>?</td>
<td>X</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>X</td>
</tr>
<tr>
<td>Multi-factor Authentication</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>X</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Supports Required Authentication Methods</td>
<td>?</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>X</td>
</tr>
<tr>
<td>Endpoint Access</td>
<td>?</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>X</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Starting Pricing (per user per month)</td>
<td>-</td>
<td>Quoted</td>
<td>$2</td>
<td>$2</td>
<td>$3</td>
<td>$2</td>
<td>$2</td>
</tr>
</tbody>
</table>

Most competitors in the SSOH market have developed the six features and they have similar pricing strategies based on the number of users.
Research labs will benefit from the use of XRAS and SSOH in their supercomputing practices.

To ensure the market for XRAS and SSOH exists we must evaluate what other research laboratories seek in an allocation resource system.
Clients are looking for different requirements to successfully complete their HPC requests

<table>
<thead>
<tr>
<th>Potential customers of XRAS/SSOH</th>
<th>Industry experts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theoretical and computational biophysics group (UIUC)</td>
<td>IEEE Computer Society: Tom Conte (UIUC alum), Georgia Institute of Technology David Ebert, Purdue</td>
</tr>
<tr>
<td></td>
<td>Keynote speaker of the supercomputing conference 18: Erik Brynjolfsson, MIT</td>
</tr>
</tbody>
</table>

**Compute:** Some algorithms are more compute-centric and require very little inter/intranode data movement (e.g., genome sequencing applications).

**Memory:** Some applications might require frequent data fetches from main memory to perform computations (e.g., computational fluid dynamics and computer-aided engineering applications).

**Network:** Some algorithms might require extensive communication across nodes (e.g., multiphysics simulations and deep learning).

**Storage:** Some algorithms are more data-intensive and require high-throughput input/output operations per second (IOPS; e.g., financial simulations with market data and genome sequencing).

Industry experts can give insights into client’s needs and help to design an effective HPC infrastructure strategy.
XSEDE has customers and competitors in Southwestern US

Washington State University Center For Institutional Research Computing Kamiak HPC
- Resources allocated by SLURM
- Collaborate with Colfax Research to provide external trainings
- Have Secure Socket Shell (for security remote log in)

University of Washington Shared Scalable Compute Cluster for Research (Hyak)
- Resources allocated by SLURM
- Have Secure Socket Shell
- Use Lolo Archive for file storage
- All services are monitored internally by UW-IT

University of Oregon ACISS High Performance Computing at Oregon
- Resource allocated by TORQUE
- Received $1.97 million NSF grant in 2009
- No backup or snapshot option
- Have Secure Socket Shell

Oregon State University The College of Engineering HPC Cluster
- Resources allocated by the Redhat Enterprise Linux 6 WS and the Linux 2.6.32 kernel
- Have Secure Socket Shell using MobaXterm

These 4 supercomputers are academia-based and only used internally, since they have not collaborated with XSEDE, they may be developed as potential customers for XSEDE
There are multiple supercomputers located in California that are currently not working with XSEDE, and California should be considered as a target location where XSEDE focuses its marketing.
FFRDCs are either nonprofit institutions other than universities or industrial firms to conduct special long-term research that match NSF and XSEDE’s mission statement.
XRAS is competing with submission management systems instead of HPC job schedulers

<table>
<thead>
<tr>
<th>Major Job Schedulers</th>
<th>Differences between Job Scheduling &amp; Submission Management System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Companies</td>
<td>Products</td>
</tr>
<tr>
<td>SchedMD</td>
<td>Torque</td>
</tr>
<tr>
<td>Adaptive Computing</td>
<td>Portable Batch System (PBS)</td>
</tr>
<tr>
<td>grid engine</td>
<td>Univa Grid Engine (UGE)</td>
</tr>
<tr>
<td>IBM</td>
<td>Platform LSF</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Job Scheduling</th>
<th>Submission Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose</td>
<td>Operate the HPC</td>
</tr>
<tr>
<td>Input</td>
<td>Scripts and commands to execute applications</td>
</tr>
<tr>
<td>Methodology</td>
<td>Automated</td>
</tr>
<tr>
<td>Output</td>
<td>Identify hardware to complete the job</td>
</tr>
<tr>
<td>Market</td>
<td>HPC</td>
</tr>
</tbody>
</table>

The players in the Job Scheduling Market are NOT direct competitors if XRAS targets on HPC resource owners; XRAS has a much wider market than job schedulers.

Company website, Dave Hart
EasyChair is a similar online submission management system like XRAS

<table>
<thead>
<tr>
<th>EasyChair</th>
<th>XRAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event Organizer</td>
<td>University, company, etc.</td>
</tr>
<tr>
<td>EasyChair Staff</td>
<td>XRAS staff</td>
</tr>
<tr>
<td>Reviewer/Author</td>
<td>End user who submit requests</td>
</tr>
</tbody>
</table>

**EasyChair has very similar functions compared to XRAS; however, EasyChair is only focused on conference management yet XRAS can be used for different purposes in various industries**

**Event will appear on EasyChair homepage after staff approval**
- Then, researchers can submit papers on specific conferences for reviewers to go through

**Setup Conference Draft**
i.e. dates, requirement, agenda, etc.

**Review Newly Published Conferences**

**Conference Call for Paper**
Author and reviewer log on to the same portal and submit to Conference
XRAS and TORQUE/SLURM are completely different products

- XRAS collects user requests for resources
- Panel review requests every quarter
- Users access decisions are decided by the panel
- Feedback given to each user

- Decisions given to tech people
- Tech people modify parameters in the system to fulfil decisions

- Users submit a number of job requests using PBS files to the head node
- Jobs are managed by the TORQUE/SLURM, queued and given physical computing nodes and CPU time

---

As "resource allocation" can refer to both XRAS and SLURM, we should be aware of their difference and avoid the confusion when using "resource allocation"
Primary research highlighted the market, important features, costs, and pricing of XRAS

### Broad market for XRAS

ANYTHING that need to be allocated can use XRAS:

- HPC
- Experimental aircraft of NCAR
- Telescope
- Machinery
- Conference Time (EasyChair)

### Unique features

- Adequate historical data for the panel to make decisions
- Effective user interface
- Review system
- Multiple review panels

### Cost and pricing concerns

**Cost**

“engineers are expensive”

**Service of customization**

**Pricing**

“don’t limit the number of users”

**Supporting group**

Charge by number of resources to allocate, not by number of users

Many features of XRAS can be used for anyone who needs to allocate resources; the cost may increase significantly as the market grows and the pricing should be on a resource-basis.
The main worry that RIT has is that third-party allocation systems act like black boxes.

The University of Rochester's main concern is that third-party allocation systems function like black boxes, making it difficult for RIT's supercomputer administrators to understand how the resources are allocated. This perception of mystery in the functioning of these systems can lead to significant setbacks in case of problems, which can take weeks to resolve. The university may only consider employing such systems if they offer great transparency and work at a 100% success rate.

University supercomputer administrators are worried about employing third-party tools due to larger debugging costs in the long-run and a lack of control over their own systems.
University of Chicago is using Request Tracker to manage HPC allocation requests

Allocation Process at U Chicago

Requested submitted on university website
Request reviewed by one engineer
Status granted for Principal Investigator (PI)
Other users added for the HPC resource by the PI
HPC resource allocated

There is a demand for request management system for daily processing capacity of 15~20 requests; the pricing of XRAS should vary by the availability of support and customization

Request Tracker (RT)

<table>
<thead>
<tr>
<th>Support Plan</th>
<th>Basic</th>
<th>Enterprise</th>
<th>Premier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support type</td>
<td>Email support</td>
<td>Chat support</td>
<td>Chat + 24/7 emergency support</td>
</tr>
<tr>
<td>Support request limit per quarter</td>
<td>2</td>
<td>4</td>
<td>Unlimited</td>
</tr>
<tr>
<td>Response time</td>
<td>2 business days</td>
<td>1 business days</td>
<td>0.5 business days</td>
</tr>
<tr>
<td>Customization</td>
<td>X</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Annual cost</td>
<td>$4,995</td>
<td>$19,995</td>
<td>$59,995</td>
</tr>
</tbody>
</table>

There are about 450 PI and 3,000 users.

One engineer a day to process 15~20 requests.
The feature of tagging requests.

SLURM
**Cost-based Pricing strategies for XRAS and SSOH**

| Direct Labor [Engineer salary] | $10,000 |
| Direct Material [Amazon Web Services] | $300 |
| Indirect Labor | ??? |

### Cost Structure based on per customer per year

<table>
<thead>
<tr>
<th>Services</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>XRAS</td>
<td>$10,000</td>
</tr>
<tr>
<td>SSOH</td>
<td>$300</td>
</tr>
<tr>
<td>XRAS + SSOH</td>
<td>$10,300</td>
</tr>
</tbody>
</table>

### Pricing Strategies

- **Pros and Cons**
  - Flexible, can change and add new costs
  - Fails to match up with competitors
  - Lack of information about exact costs

---

Cost-based Pricing is one possible pricing strategy, but due to lack of information, this model is difficult to be set up accurately.
Differentiated worth is an important tool to assess value-based pricing for XRAS services

Differentiated worth is looking at the extra features or lack of features that XRAS has compared to its competitors and assessing the value of those extra/lost features.

Ex: Samsung’s Plasma TV is 5 inches larger than its competitor (who prices their TV at $700) and the monetary valuation of 5 extra inches for a TV is $150, making the value-based pricing for Samsung's Plasma TV $700 + $150 = $850.

In the case of XRAS specifically, product differentiation between XRAS and competitors such as EasyChair’s conference management system and OpenConf will become important tools for gauging a value-based pricing model.

Once differentiated worth of XRAS can be uncovered through primary research, all that needs to be done is combine this data with competitor pricing data to obtain full value-based pricing.

Value Based Pricing Visualized

Features that differentiate XRAS from EasyChair
- Some aspects of the panel tasked with allocating supercomputer resources

The same underlying features concerning XRAS and EasyChair and OpenConf
- Human-based submission assessment system
- Strong basis in academic institutions
- Et cetera
Value-based pricing can maximize the price but requires more resources to implement

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Charge the maximum price that customers will pay</strong></td>
<td>Different segments of customers require separate research</td>
</tr>
<tr>
<td>Avoid pricing higher than what customers are prepared to pay or lower than what they will pay</td>
<td>XSEDE needs to research on different segments of customers (HPC, conference) because they have different values</td>
</tr>
<tr>
<td><strong>Understand the customer better</strong></td>
<td>Competitors may charge an inappropriate price</td>
</tr>
<tr>
<td>The research to determine the customers’ value also improves the understanding of the customers</td>
<td>If competitors are charging too high or too low, XSEDE’s pricing will be negatively affected</td>
</tr>
<tr>
<td><strong>Reduce costs of creating the product or service</strong></td>
<td>Require, re-assess, and adjust</td>
</tr>
<tr>
<td>XSEDE can improve XRAS and SSOH according to customers’ values, thus avoiding unnecessary improvements</td>
<td>The value customers place on XRAS and SSOH can change when their needs change</td>
</tr>
<tr>
<td><strong>More effective when conjugated with marketing</strong></td>
<td></td>
</tr>
<tr>
<td>XSEDE can influence how much customers believe the product is worth, and therefore how much they will pay for it</td>
<td></td>
</tr>
</tbody>
</table>

XSEDE may blend with other pricing strategies to avoid the disadvantages of value-based pricing while benefit from the maximized price and a deep understanding of customers’ value.
Value based pricing results in the highest possible price that can be charged

**Advantages**
- Increases profits
- Customer loyalty

**Disadvantages**
- Niche market
- Not scalable
- Competition
- Labor costs

Due to the unique features X-RAS and SSOH can provide for users, value based pricing will ensure that customization will be accounted for in a revenue perspective.

1. Identify customer’s “second best option” and the pricing
2. Identify unique offerings of X-RAS and account for added value
3. Identify unique offerings of X-RAS and account for added value

Take price of second best option, add the value of X-RAS advantages and subtract the value of the second best option advantages.

Value based pricing will provide the greatest returns but will be challenging because there is no efficient way to gauge customer perception on the value of X-RAS and SSOH.
Opportunity cost will be an effective last-resort method to gauge value-based pricing

Cost of Using Google Forms

In order to research the cost of using Google Forms to allocate supercomputer resources, many things will be necessary.

- Understanding the technical components of allocating with Google Sheets and determining the time spent to do 100 or 1000 allocations.
- Once the time spent handling allocations is obtained, this can be multiplied by $96 / hour (assumed labor cost of software engineer) to obtain the labor costs of using Google Sheets for allocations.

Cost of Using XRAS

The same procedure of calculating the labor costs of using Google Forms will be applied to calculating the cost of using XRAS.

From here, value-based pricing can be easily obtained by subtracting the two costs.

\[ \text{Price} = \text{CPT}_{\text{Google Forms}} - \text{CPT}_{\text{XRAS}} \]

\[ \text{CPT} = \text{Cost to Allocate 1,000 Requests} \]

In case primary research contacts fail in delivering value-based pricing, knowing how much more efficient XRAS is in the form of lower labor costs will be useful in determining value-based pricing.
XRAS helps the people at Blue Waters at the back end for supercomputing

**Pricing**
- Not willing to pay a monthly fee (too expensive), but per allocation process
- $500/allocation process $\Sigma$ $1000$/year

**XRAS**
- Jay Roloff puts supercomputing request into XRAS; doesn’t really make a difference for him what program he uses for that (XRAS vs spreadsheet)

**Illinois allocation process**
- 2x per year
- $\Sigma$ 60 awards per year

**Proposal submission and review**

**Request input into XRAS**

**Allocation supercomputer**

**EasyChair**
- Review committee members then bid on which proposals they want to review according to their expertise
- After bidding, EasyChair sends out proposals to the respective committee members
- 1. proposal 5. proposal
- 2. proposal 6. proposal
- 3. proposal 7. proposal
- 4. proposal 8. proposal

Blue Waters uses EasyChair at the front end because it is fully automated and therefore keeps track of the submission and review processes
Supercomputer centers (SC) in central US do not all have resource allocation systems (RAS)

Supercomputer RAS’s market in central US

Customer segmentation by # of nodes

- Competitor’s customer (>2000)
  - Have RAS: 3
  - Don’t have RAS: 0

- Immediate customer (1000~2000)
  - Have RAS: 1
  - Don’t have RAS: 2

- Potential customer (<1000)
  - Have RAS: 0
  - Don’t have RAS: 11

XSEDE should adapt XRAS to meet different needs; consider adding advanced features for competitor’s customer segmentation and downsize XRAS for potential customers
Sandia has representatives to manage the user requests

Requests submitted to the representative via phone/email/verbal → Documented on the internal contract by the representative → Supercomputing job conducted by the Capability Group → Computation result sent back to the representative → End-user get the result from the representative

Features & Pricing

- Historical Data
  - "There will be a big use"
  - "Can more efficiently manage the resource moving forward"
- Customization
  - "This will make the product much more valuable"
- Compatibility to Job Schedulers
  - "It's important to communicate the capabilities of the resource management system"

Sandia is willing to pay

- $100,000/year
  - Depending on if these features are provided
  - $10,000/year

The willingness-to-pay of Sandia varies based on whether key features are provided; Customization is the biggest drive its willingness to pay
UCLA developed Great Identity Manager to manage HPC allocation requests

**Allocation Process at UCLA**
(Almost same as U Chicago’s)

1. **Requested submitted on university website**
2. **Request reviewed by the committee**
3. **Status granted for Principal Investigator (PI)**
4. **Other users added for the HPC resource by the PI**
5. **HPC resource allocated to the end-user**

Features & Pricing

- **Historical Data**: "This is not as necessary as the other two features, but should be helpful"
- **Customization**: "Every cluster is very unique and needs to be customized; and we want to have control on it"
- **Compatibility to Job Schedulers**: "This is definitely essential"

UCLA is willing to pay

- **$20,000/year** Depending on the # of users & clusters
- **$10,000/year**

"The system won’t work without these three features"

UCLA currently has its in-house system that is highly customized to meet its needs; they would buy the software only if it is customized and can be compatible to job schedulers
### Mountain region universities use internal resource allocation system for HPC, requests reviewed by staffs

<table>
<thead>
<tr>
<th>University Name</th>
<th>Internal System Login</th>
<th>Number of Nodes</th>
<th>Allocation Method</th>
<th>Reviewed by staff?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Montana State University</td>
<td>○</td>
<td>77</td>
<td>Online form</td>
<td>X</td>
</tr>
<tr>
<td>University of Wyoming (NCAR Alliance)</td>
<td>○</td>
<td>4500+</td>
<td>Online form, Email</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Special committee review for large requests</td>
<td></td>
</tr>
<tr>
<td>University of Colorado</td>
<td>○</td>
<td>415</td>
<td>Written request</td>
<td></td>
</tr>
<tr>
<td>University of Utah</td>
<td>○</td>
<td>538 (7 clusters)</td>
<td>Online form</td>
<td></td>
</tr>
<tr>
<td>New Mexico Computing Application Center</td>
<td>X*</td>
<td>1792</td>
<td>Email staffs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Not disclosed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Contact internal staffs</td>
<td></td>
</tr>
<tr>
<td>University of New Mexico</td>
<td>○</td>
<td>280</td>
<td>Online form</td>
<td></td>
</tr>
</tbody>
</table>

Most universities have small number of nodes, this means their internal submission systems, staff reviews and approvals are sufficient for their HPC resource allocation.
According to primary research, although customization would be more efficient for universities’ request allocation processes, they are mostly self-sufficient due to the small request volume/nodes.

Universities with HPCs that have less than 1,000 nodes will not be XRAS’s target client

### Allocation Processes at Universities

<table>
<thead>
<tr>
<th>University of North Dakota</th>
<th>University of Utah</th>
<th>University of Nebraska</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-house built submission and allocation system</td>
<td>In-house built submission and allocation system (Service Now)</td>
<td>PI/faculty request for access for group/project and researchers request under group</td>
</tr>
<tr>
<td>Limited data storage</td>
<td>Only interview PI of new research groups</td>
<td>End user send form and email to advisor to access HPC</td>
</tr>
<tr>
<td><strong>No limit to nodes usage for researchers</strong></td>
<td><strong>Fairshare system:</strong> automatically allocate HPC based on scoring of project/group usage</td>
<td><strong>HPC always operating on full capacity</strong></td>
</tr>
<tr>
<td>Desired feature: <strong>analytics insight</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 20 new users in the past 3 months | takes few days to process a request

#### 15-30 requests per 3 months (request window open 4 times/yr) | few days to process a request

#### 1 individual small request per day (more requests at beginning of semester) | few minutes to process

All universities we reached out to with HPC ~1,000 nodes indicate a specific system (like XRAS) to help them with HPC request submission management to boost efficiency is not necessary.

University of Nebraska | 1178 Nodes
University of North Dakota | 75 Nodes
University of Utah | 538 Nodes
University of North Dakota | 75 Nodes
University of Utah | 538 Nodes
University of Nebraska | 1178 Nodes
Coldfront very similar to XRAS in the sense that it is a resource allocation management tool that has been developed by the school itself and is compatible with various back-ends.

Coldfront is the resource allocation management system of the University at Buffalo.

- Project includes description of research, users, grants, publications
- PI can have more than one project to keep accounts separate

- Subscriptions = what resources your account has access to
- All resources require a subscription and they expire

- 200 resources (clusters, storage, cloud)
- Track attributes on resources: private vs public, extra payment required
- LakeEffect: UB’s research cloud
  - Allows access to virtual servers and storage on demand

Coldfront allows users to request and manage the access they or collaborators have to the resources in UB’s data center.
XRAS is capable of doing all the things EasyChair can do

**General**

- Blue Waters is not using XRAS because when they developed it, XRAS wasn’t at the stage they needed it to be, so they went with EasyChair/spreadsheet (and because of politics)
- Ester Soriano, NY, new XRAS project manager (development etc.)
- XRAS can do bidding (like EasyChair) → possible to customize it to automate the process. As of right now, administrator in the middle

**Pricing**

- Depends on customization
- Depends on whether XSEDE/NSF is sponsoring it → without more expensive
  - XRAS ready-to-use version: $10,000
  - not connected to XSEDE/NSF: $50,000

XRAS should be priced differently depending on the level of customization and whether it is supported by XSEDE and the NSF
XRAS has advantages over in-house system used currently in Massachusetts’ HPC

The Massachusetts Green High Performance Computing Center (MGHPCC), MA

- Use **in-house system** to request for accounts
- A **simple web page** to fill basic information into the forms
- These requests will be reviewed by human for **2-4 school days** or longer
- After getting approval of accounts, users can log into accounts to request for HPC resources

Advantages of XRAS

- Skip the extra steps
- The average human review time can be shortened

XRAS can speed up the average review time, this is especially helpful when the HPC has a large number of users
UC Santa Barbara (UCSB) expects to use a Submission Management System in the future.

Currently, UCSB does not require a system like XRAS, but believes that the system would be valuable if the size of the HPC system expands in the future.

**Allocation Process at UCSB**

- Requests submitted to the allocation manager on a Google Sheet
- HPC account granted, if UCSB student/faculty
- Account information sent to the requester via email
- Requesters log on to use HPC resources

**Willingness-to-pay**

- 10,000/year, if the size of HPC at UCSB expands

**Number of nodes**

- 400~500 (<1,000)

**Needed features**

- Compatibility to job schedulers
- Track users’ usage
Our analysis confirms the value-based pricing for large HPC (>1,000 nodes) agrees well with their willingness to pay in previous research ($10,000-$100,000 per year).

<table>
<thead>
<tr>
<th>Institution</th>
<th># Nodes</th>
<th>RAS Cost Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purdue</td>
<td>2,020</td>
<td>$20,200/yr</td>
</tr>
<tr>
<td>University of Nebraska</td>
<td>1,178</td>
<td>$11,780/yr</td>
</tr>
<tr>
<td>University of North Dakota</td>
<td>75</td>
<td>$750/yr</td>
</tr>
</tbody>
</table>

Primary research shows that the number of new users per node per year is 0.67. It takes 15 min or $15 for IT staff to finish allocation.

Opportunity cost = $1,728 per 1000 idle nodes per day

Most allocation requests concentrate in the beginning of the semester so the actual labor cost might be higher.
XRAS can be marketed to university HPCs that have a large number of nodes, however, there are only a few universities in the US that have large HPCs.

XSEDE can gauge the sizes of the university HPCs by looking at the number of nodes in the HPC.

<table>
<thead>
<tr>
<th>Schools</th>
<th># Nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Texas-Austin</td>
<td>20728</td>
</tr>
<tr>
<td>Rensselaer Polytechnic Institute</td>
<td>5160</td>
</tr>
<tr>
<td>University of Southern California</td>
<td>2688</td>
</tr>
<tr>
<td>Harvard University</td>
<td>2000+</td>
</tr>
<tr>
<td>Purdue University</td>
<td>1997</td>
</tr>
<tr>
<td>Clemson University</td>
<td>1988</td>
</tr>
<tr>
<td>University of Minnesota</td>
<td>1832</td>
</tr>
<tr>
<td>Indiana University</td>
<td>1372</td>
</tr>
<tr>
<td>University of Chicago</td>
<td>1174</td>
</tr>
</tbody>
</table>

Percentage of Universities‘ HPC that Have More than 1,000 Nodes

- Nodes > 1000
- Nodes < 1000

* This is out of the top 100 universities in the US, ranking obtained from US News National Universities Rankings.
The CADENS project uses XRAS to review proposals and are willing to pay for it

What is CADENS?
- CADENS: the centrality of advanced digitally enabled science
- NSF supported project
- To inform the general public about computational and data-enabled discovery
- In the process of producing ad distributing documentaries

Importance of XRAS
- Would have cost a lot of more time without XRAS
- Even though customization took a while
- Easy to use interface

Pricing (willingness to pay)
- $10,000-20,000 per year depending on project (how many requests/proposals they have to handle)

XRAS is a valuable tool for the members of the CADENS team and has helped save a lot of time for the proposal collection and review process.
There are two major pricing strategies that can be pursued for XRAS:

**Value-based Pricing**
- Prices determined by HPCs’ willingness-to-pay
- XRAS HPC
- U of Nebraska: $0
- U of Chicago: $10K
- U of Nebraska: $10K
- UCSB: $10K
- Sandia: $10K
- and so on

**Cost-based Pricing**
- Prices determined by XSEDE’s expenses
- XRAS XSEDE
- One Engineer (Annual wage): $200,000
- AWS: $6,000
- Est. # of customers: 20
- $10,300

Cost-based Pricing Strategy establishes the minimum price of XRAS to break even and Value-based Pricing Strategy finds higher prices at market potential for XRAS.