Philosophy and Architecture

Miron Livny

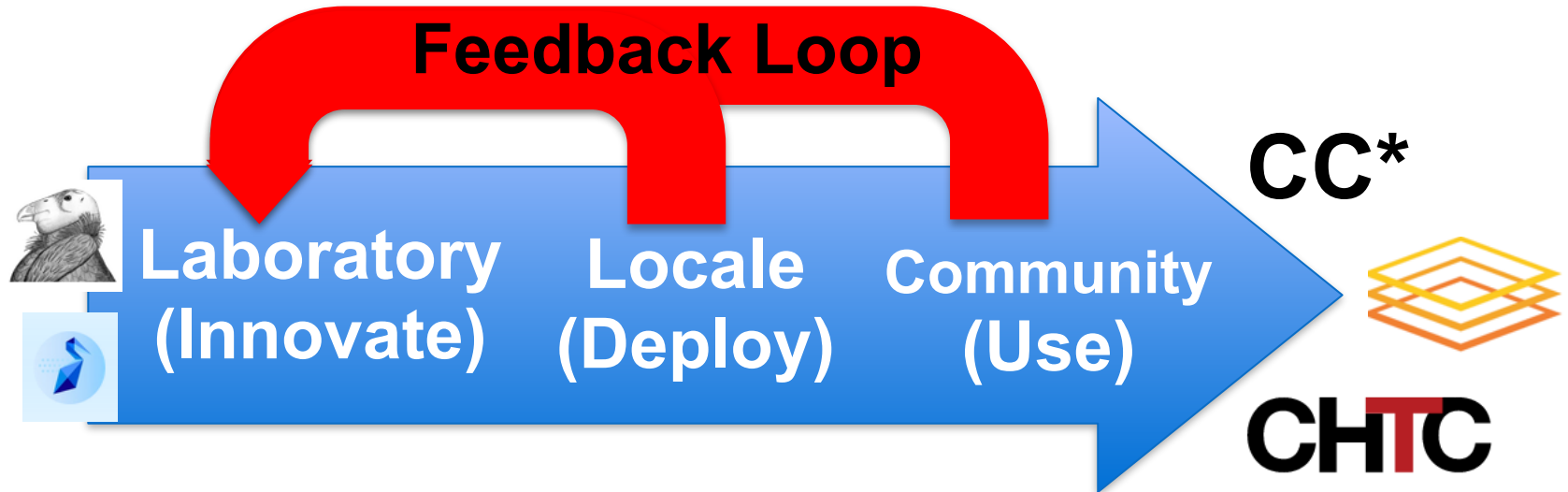John P. Morgridge Professor of Computer Science
Vials Research Professor
Director of CHTC
Technical Director of OSG

I founded The **UW-Madison Center for High Throughput Computing (CHTC)** in 2006 on the principles of Translational Computer Science where **innovation** and **services** that advance scientific discovery feed each other in a reenforcing partnership

Aga Khan Palace

"We should Magnify our own Errors"

"Kasturba trust would have even a bigger place in national service when freedom was there, than it had today. For all would go to the winds, if the women were not properly trained. Every worker in the trust would have a great deal to give to the new government. But we have got to generate that strength within us. We may not be frightened of making mistakes. Man is born to make mistakes, but the great thing is to see out mistakes and learn from them. We should magnify our own errors, so as to be deterred from falling into them again. Those who make imagine that they never make mistakes are to be faked…"

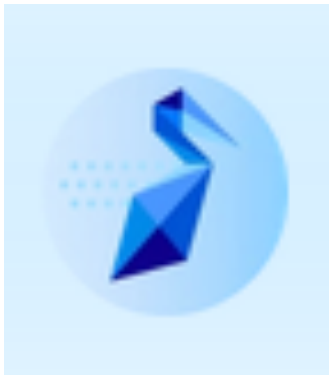- M K Gandhi

Mohandas Karamchand Gandhi (2 October 1869 – 30 January 1948)

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University of Wisconsin–Madison

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CHTC is hiring, view the new position on the jobs page and apply now! | View Job Posting

Last Year Serving UW-Madison

312 Projects Supported

34K HTC Core Years

6K HPC Core Years

1K Facilitator Interactions

College	Projects Supported	HTC Core Years	HPC Core Years	Facilitator Interactions
Agricultural and Life Sciences	62	8,038	54	159
Education	5	216	–	10
Engineering	66	3,342	4,221	316
Law	1	181	–	1
Letters and Sciences	112	11,645	1,244	440
Medicine and Public Health	42	7,172	54	154
Off-Campus Collaborations	14	2,852	138	–
Pharmacy	5	75	258	7
Veterinary Medicine	5	21	–	–
Total	312	33,542	5,969	1,087

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CHTC is home for the **HTCondor Software Suite (HTCSS)** and the **Pelican Platform**

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HTCSS Pool (173)
Updated 9/22/2024, 7:15:11 AM
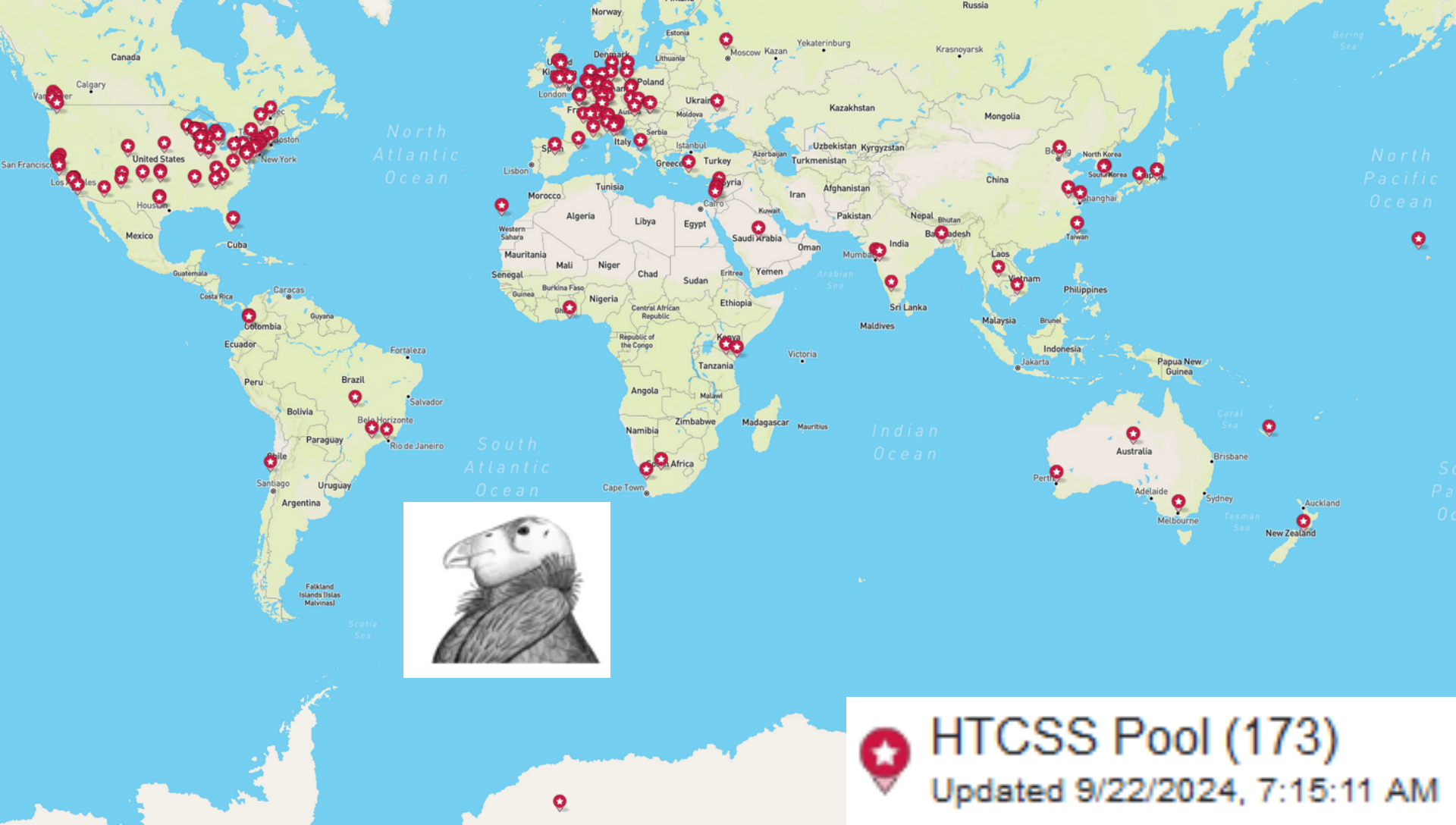
The Open Science Pool (OSPool) is an HTC OSG service powered by the HTCondor Software Suite (HTCSS) that federates **open** computing capacity contributions in support of Throughput Computing **workloads**

OSPool Contributor
86 Sites, 54 Institutions

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OSPool: Serving Open Science throughput computing

On **August 30**

830K jobs completed

Placed by **43 researchers**

Triggering **10M file transfers**

Consuming **673K core hours**

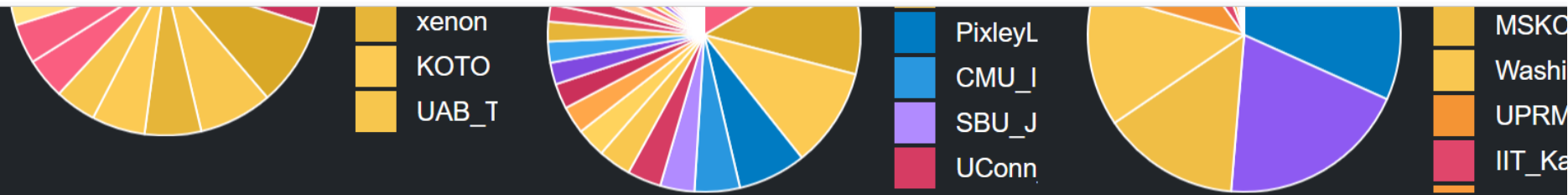On **August 30**

830K jobs completed
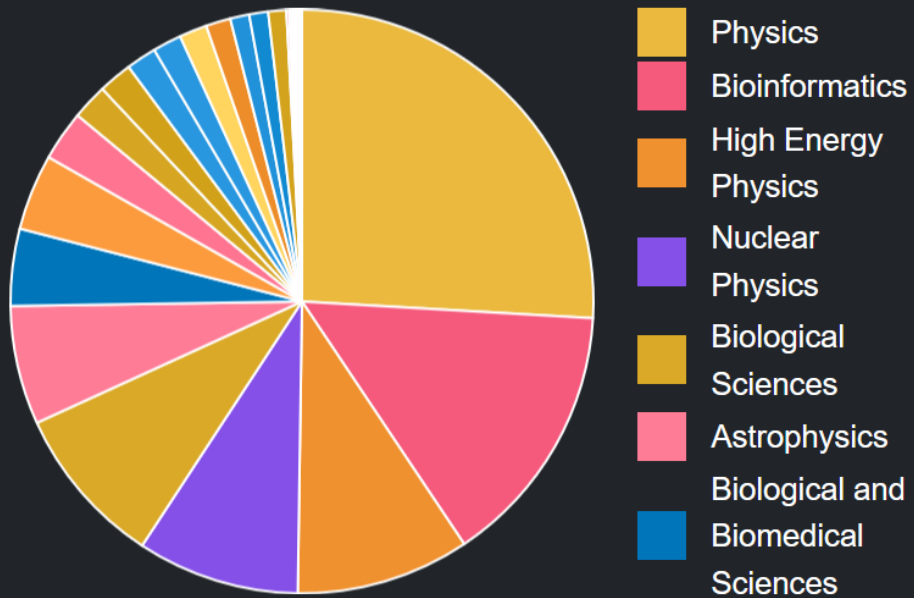
Harnessing capacity from **58 institutions.**

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OSPool
Throughput over the last 12 month

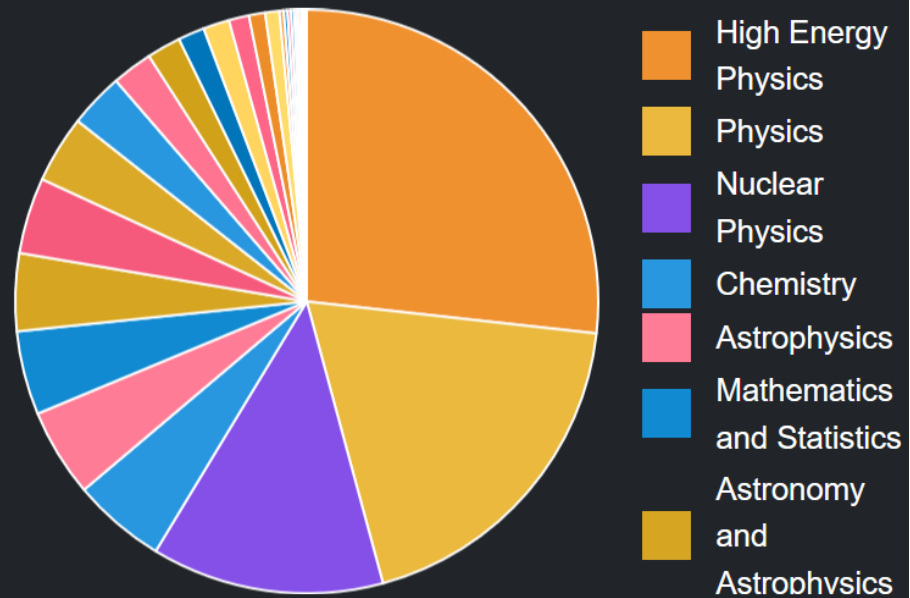| Month Starting	Jobs Completed	Core Hours	Files Transferred	Unique Users	Unique Projects	Unique Institutions Benefiting	Unique Institutions Contributing
TOTAL	192,392,377	293,101,942	4,886,141,481	509	225	101	68

192,392,377/(365*24*60*60) =   6.10 jobs per second
4,886,141,481/(365*24*60*60) = 154.94 file transfers per second

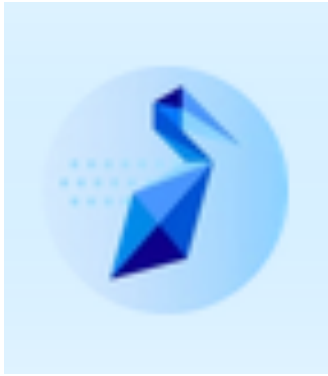## Fields of Science by Jobs ⑦

- Physics
- Bioinformatics
- High Energy Physics
- Nuclear Physics
- Biological Sciences
- Astrophysics
- Biological and Biomedical Sciences

Fields of Science by CPU Hours ⑦

- High Energy Physics
- Physics
- Nuclear Physics
- Chemistry
- Astrophysics
- Mathematics and Statistics
- Astronomy and Astrophysics

Legend entries (top pie charts):
- xenon
- KOTO
- UAB_T
- PixleyL
- CMU_I
- SBU_J
- UConn
- MSKC
- Washi
- UPRM
- IIT_Ka

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Bring data to processing capacity
Store results at Object Stores

Site: California Institute of Technology - Calt ▾
View: Open Science Data Federation ▾

Print as PNG

Origin
12 Sites, 10 Institutions

Cache
29 Sites, 20 Institutions

Cache and Origin
5 Sites, 5 Institutions

Leaflet | Map data © OpenStreetMap contributors, Imagery © Mapbox

US Map featuring the locations of current OSDF architectural components.

Open Science Data Federation

The Open Science Data Federation (OSDF) is an OSG service designed to support the sharing of files staged in autonomous "origins", for efficient access to those files from anywhere in the world via a global namespace and network of caches. The OSDF may be used either standalone - allowing

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- There are 9 namespaces like this, and all 9 belong to international collaborations
  => See Panel Discussion Tuesday Afternoon

name	Read	Unique data
LIGO IGWN	40 PB	203 TB
IceCube	10 PB	66 TB
LIGO users	4 PB	28 TB
IGWN shared	1.7 PB	11 TB
KOTO	8 PB	3.5 TB

name	Read	Unique data
Einstein Telescope	1.5 PB	3.2 TB
Nova	5 PB	3 TB
MicroBoone	12 PB	1.7 TB
IGWN CIT	17 PB	1.2 TB

Gravitational Wave Observatories Community dominates unique data

Next come neutrino physics experiments (IceCube, Nova, MicroBoone)

The words of Leonardo di ser Piero da Vinci

(15 April 1452 – 2 May 1519)

Simplicity is the ultimate sophistication

{ Y[i]=F(X[i]) ,i=1,n }

F and X[i]

Place List of Jobs

Report Status

Access Point

Copy F and X[i]

EXEC F

Move Y[i]

Execution Slot

(Job Log[i],i=1,n)

Y[i]

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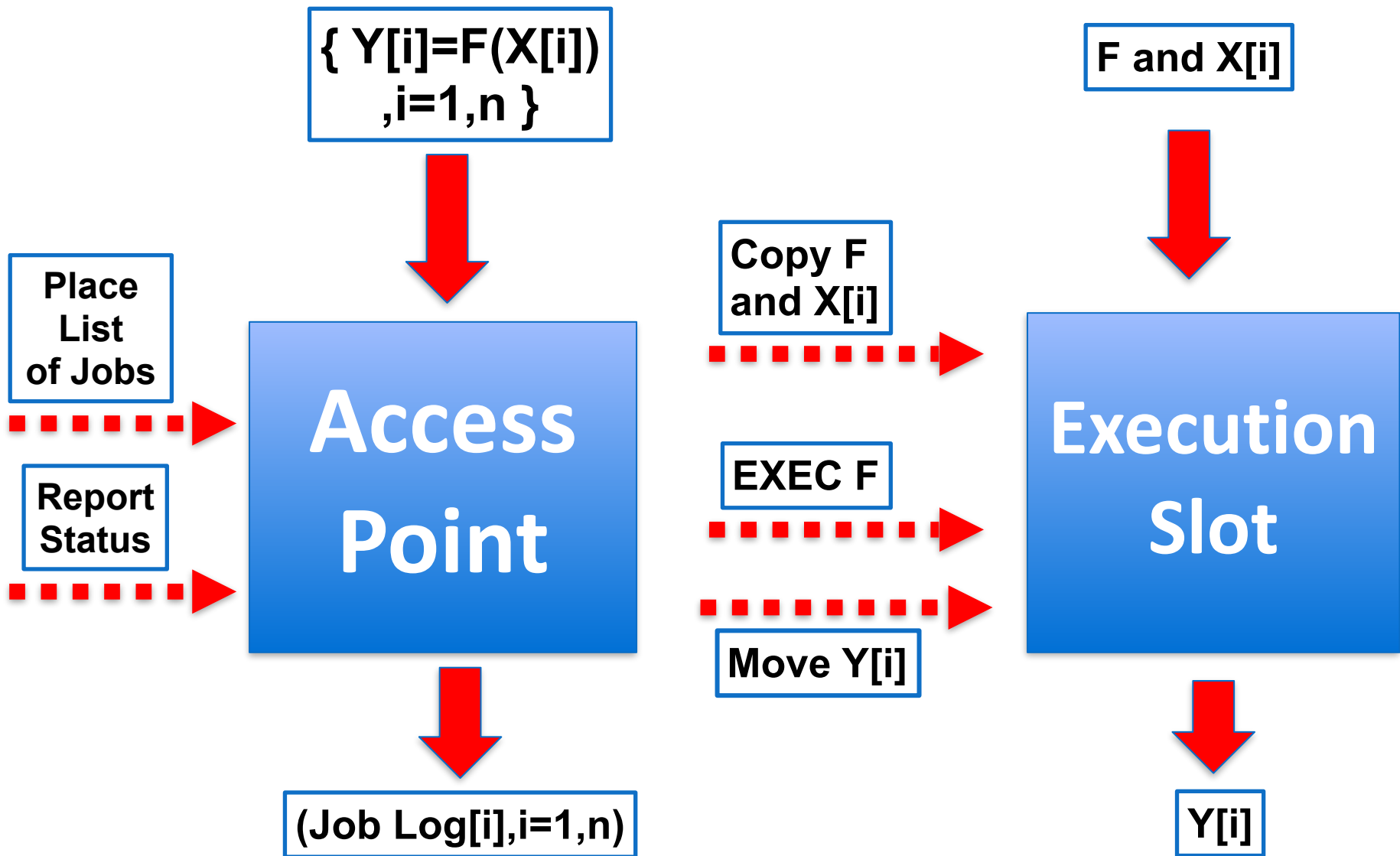
The five years ![PATh] project – is a Partnership between the UW-Madison Center for High Throughput Computing (**CHTC**) – home of the HTCondor Software Suite (HTCSS) and the **OSG** Consortium – provider of the OSG fabric of distributed High Throughput Computing (dHTC) services with a national scale mission

"The Partnership to Advance Throughput Computing (PATh) project will expand Distributed High Throughput Computing (dHTC) technologies and methodologies through innovation, translational effort, and large-scale adoption to advance the Science & Engineering goals of the broader community."

PATh Proposal 04/21/2020

Aligned with NSF Cyberinfrastructure blueprint

"… many fields today rely on **high-throughput computing** for **discovery**."

Committee on Future Directions for NSF Advanced Computing Infrastructure to Support U.S. Science in 2017-2020; Computer Science and Telecommunications Board; Division on Engineering and Physical Sciences; National Academies of Sciences, Engineering, and Medicine

The words of Koheleth son of David, king in Jerusalem ~ 200 A.D.

Only that shall happe
Which has happened,
Only that occur
Which has occurred;
There is nothing new
Beneath the sun!

Ecclesiastes, (קֹהֶלֶת, *Kohelet*, "son of David, and king in Jerusalem" alias Solomon, Wood engraving Gustave Doré (1832–1883)

Claims for "benefits" provided by
Distributed Processing Systems

P.H. Enslow "What is a Distributed Data Processing System?" IEEE Computer, January 1978

– **High Availability and Reliability**

– **High System Performance**

– **Ease of Modular and Incremental Growth**

– **Automatic Load and Resource Sharing**

– **Good Response to Temporary Overloads**

– **Easy Expansion in Capacity and/or Function**

Confucius

(traditionally 28 September 551 B.C.

– 479 B.C.)

- 名不正，則言不順
- If names be not correct, language is not in accordance with the truth of things.

- Paraphrased as a Chinese proverb "**The beginning of wisdom is to call things by their proper name**."

HTCondor Access Points (APs) are capable and dependable handlers of Throughput Computing workloads

- Large job ensembles

- Bring Your Own Capacity (BYOC)

- Support Job-Lists presented as tables

- Job dependencies defined by Directed Acyclic Graphs (DAG)

- Workflows managed by the Pegasus WFMS

- Supports access to remote datasets via HTTP and OSDF

An **HTCondor Execution Point (EP)** is hosted by a server and represents the capacity of the server to HTCondor Access Points through a collection of **HTCondor Execution Slots (ES)**.
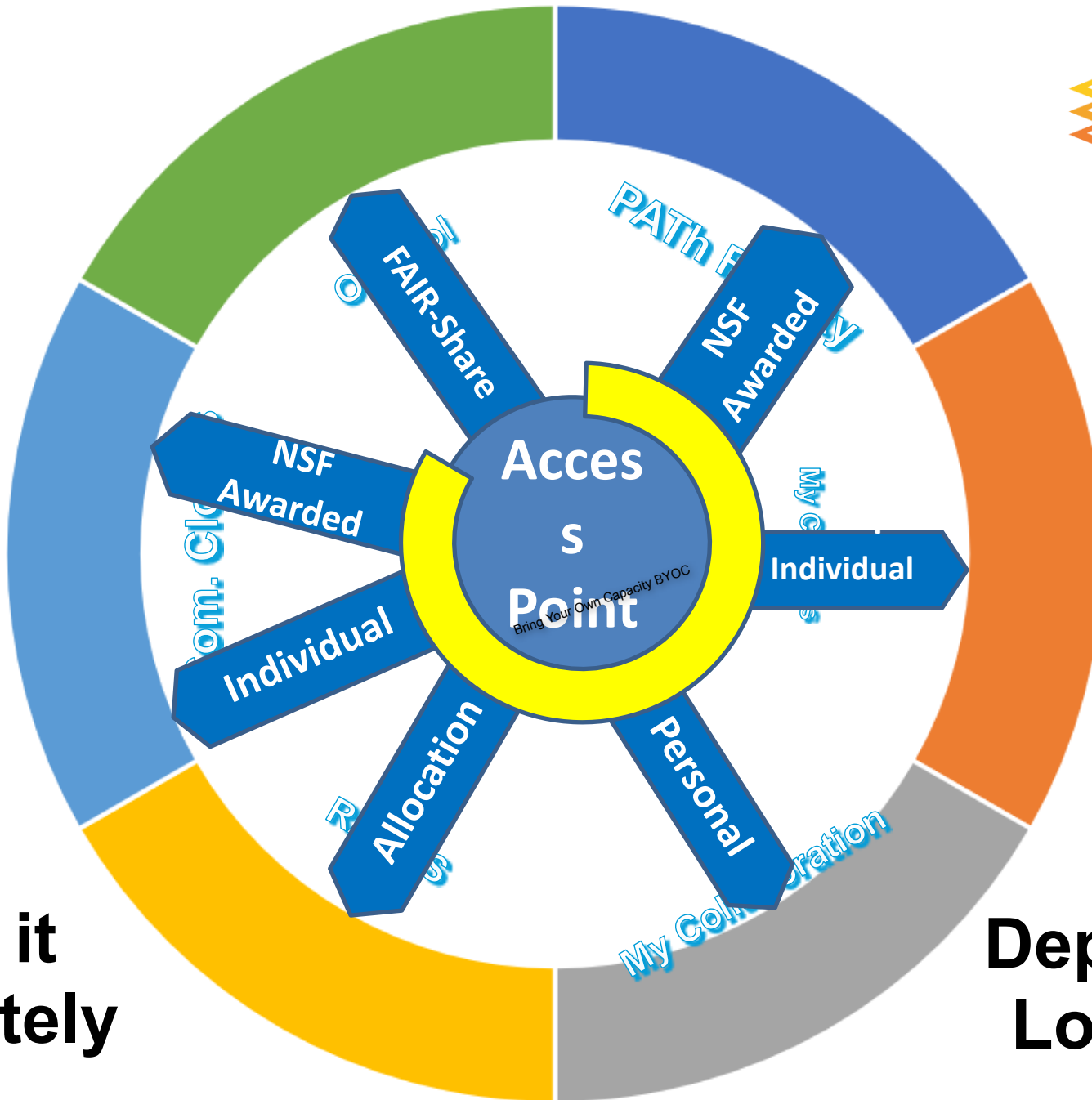
- Number and capacity of Slots is managed by by EP.

- EP is responsible of isolation of ES

A collection of Execution Points forms a HTCondor Pool

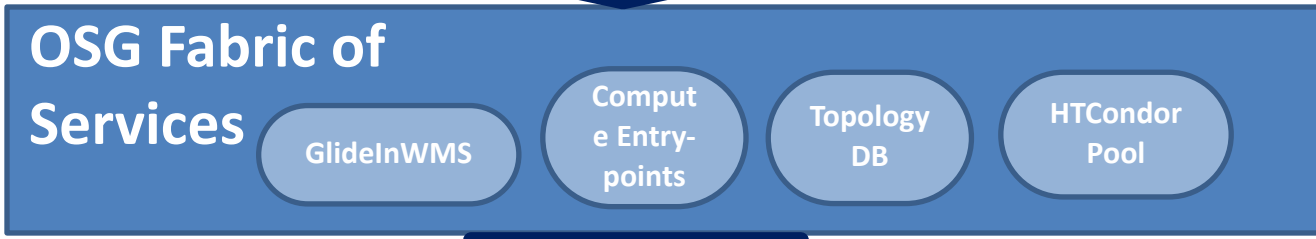# HTCondor Pool + HTCondor AP

= HTCondor System

IGWN HTCondor Pool is deployed and maintained by the PATh operation team using the OSG Fabric of dHTC services

- **IGWN APs** are deployed and operated by CalTech.

- The AP of the IUACC HTCondor System can be configured to "**flock**" to the IGWN HTCondor Pool

PATh

OSG

Access Point

FAIR-Share

NSF Awarded

PATh Facility

NSF Awarded

Individual

Individual

Com. Cloud

Allocation

Personal

My Collaboration

Bring Your Own Capacity BYOC

Use it Remotely

Deploy it Locally

HTCondor

The IGWN Computing Grid is based on top of HTCondor, a specialized workload management system for compute-intensive jobs. HTCondor is used to specify discrete work units (jobs) you want completed that are then distributed across the available resources with sophisticated scheduling, prioritisation, monitoring, and reporting capabilities.

Basic HTCondor Usage

For an excellent introduction to HTCondor usage, please refer to the official HTCondor Users' Manual:

IGWN AP Weekly Usage Report 2024-09-09

	User	Num Uniq Job Ids	All CPU Hours	% Good CPU Hours	Job Unit Hours	% Ckpt Able	% Rm'd Jobs
37	TOTAL	955,907	1,499,007	80.9	3,000,868	1.0	4.0

IGWN AP Weekly Usage Report 2024-08-26

	User	Num Uniq Job Ids	All CPU Hours	% Good CPU Hours	J
24	TOTAL	486,450	942,926	73.3	2

AP Weekly Usage Report 2024-08-19

	User	Num Uniq Job Ids	All CPU Hours	% Good CPU Hours
22	TOTAL	305,268	439,270	86.2

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Collaborations

Scientific collaborations from across the globe rely upon HTCSS to advance their research.

Statistics from these pools generated in the last 365 days.

CMS ⊕	
19,308,785	Jobs
1,257,389,376	CPU Core Hours
62,087	GPU Hours

REDTOP ⊕	
7,538,162	Jobs
42,965,331	CPU Core Hours

IceCube ⊕	
41,916,525	Jobs
69,286,625	CPU Core Hours
1,478,056	GPU Hours

IGWN ⊕	
9,517,636	Jobs
74,648,105	CPU Core Hours
565,549	GPU Hours

South Pole Telescope ⊕	
1,522,901	Jobs
1,267,722	CPU Core Hours

Xenon ⊕	
11,071,788	Jobs
5,380,927	CPU Core Hours

Future Colliders ⊕	
7,160	Jobs
42,588	CPU Core Hours

KOTO ⊕	
9,680,807	Jobs
25,812,590	CPU Core Hours

CLAS12 ⊕	
6,355,967	Jobs
50,507,272	CPU Core Hours

GLUEX ⊕	
1,218	Jobs
715	CPU Core Hours

EIC ⊕	
547	Jobs
37	CPU Core Hours

MOLLER ⊕	
42,515	Jobs
57,441	CPU Core Hours

DUNE ⊕	
20,356,384	Jobs
45,653,147	CPU Core Hours
11	GPU Hours

EHT ⊕	
2,481,012	Jobs
2,801,633	CPU Core Hours

ePIC ⊕	
4,269,301	Jobs
13,050,920	CPU Core Hours

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Contact

PATh is a unique partnership between the Center for High Throughput Computing (CHTC) and the OSG Consortium.

- For enquiries about the *PATh project*, please contact the PATh leadership.
- For help with *CHTC technologies* such as the HTCondor Software Suite (HTCSS), contact chtc@cs.wisc.edu.
- *Campuses* interested in providing resources to the Open Science Pool (OSPool) can contact support@osg-htc.org
- *Users* interested in using an Access Point to leverage resource like the OSPool can contact support@osgconnect.net.
- *PIs* interested in getting credit accounts on PATh-managed hardware should visit the dedicated page.