



[www.chameleoncloud.org](http://www.chameleoncloud.org)

# NEXT GENERATION CLOUDS, THE CHAMELEON CLOUD TESTBED, AND SOFTWARE DEFINED NETWORKING (SDN)

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# TESTBED TO SUPPORT THE COMMUNITY'S RESEARCH CHALLENGES

*The community builds the testbed,  
and afterwards the testbed will shape the  
community*

## Big Data

Data volume,  
velocity and  
variety

**Big Compute**  
A wide range of  
data analytics

Programmable networks  
cheap, ubiquitous sensors  
and other emergent trends

**Big  
Instruments**  
Cyber-Physical  
Systems,  
Observatories

- **Build the right testbed**
- **Make the environment**

- **Reach the right community**
- **Have the right team**

# CHAMELEON: A POWERFUL AND FLEXIBLE EXPERIMENTAL INSTRUMENT

- ▶ Large-scale
  - ▶ Targeting Big Data, Big Compute, Big Instrument research
  - ▶ Over 650 nodes, 5 PB disk, 100G network
- ▶ Reconfigurable
  - ▶ Bare metal reconfiguration, single instrument, graduated approach for ease-of-use
- ▶ Connected
  - ▶ Workload and Trace Archive, partners with production clouds
- ▶ Complementary
  - ▶ Complementing GENI, Comet, Wrangler, XSEDE
  - ▶ Partnering with GENI, Grid'5000, OCC, OSDC et al (FIRE?)
- ▶ Sustainable
  - ▶ Strong industry connections
- ▶ **Currently - Number of users is 481 Number of projects is 135.**

# RESEARCH COMMUNITIES AND CAPABILITIES

## Users

New models, algorithms, platforms, auto-scaling HA, etc.,  
Application and educational uses

*Persistent, reliable, shared cloud*

## Core Researchers and Users

Repeatable experiments in new models, algorithms,  
platforms, auto-scaling, HA, etc.

*Isolated partition, pre-configured images reconfiguration*

## Core Researchers

Virtualization technology (SR-IOV, accelerators, etc.)  
Infrastructure-level resource management

*Isolated partition, full bare metal reconfiguration*

# SUPPORTED APPLICATIONS

## ▶ CPS

- ▶ Offloading, multi-criteria trade-off analysis (response time vs cost), auto-scaling, high availability, etc.

## ▶ Machine learning, data mining

- ▶ Mix of Big Compute and Big Data simulations and models, design of novel data processing frameworks

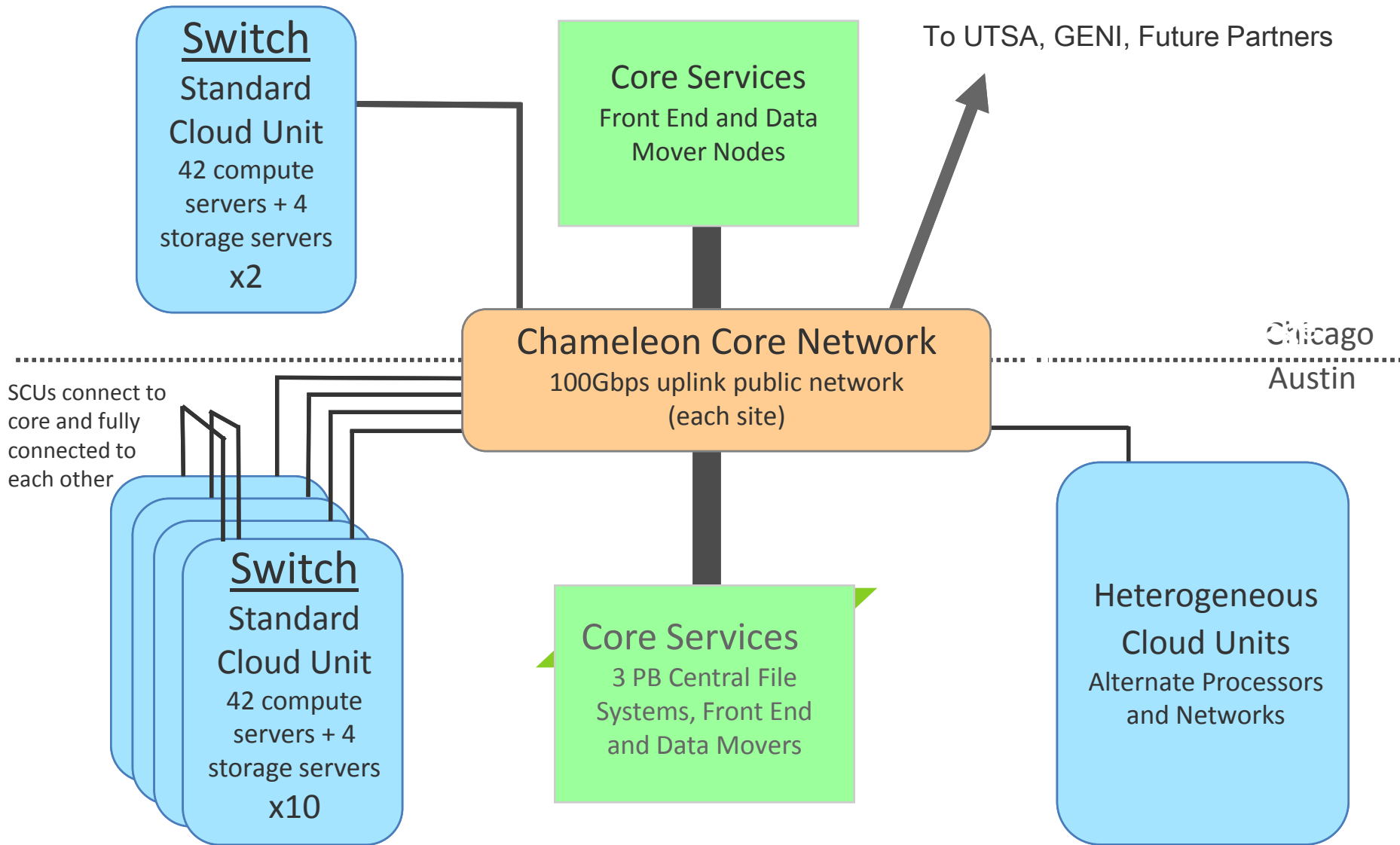
## ▶ System Software/Virtualization

- ▶ Hypervisors optimizing a range of qualities, SR-IOV, virtualizing accelerators, etc.

## ▶ Networking

- ▶ Programmable networks & QoS, refinement and effects of SR-IOV, large dataflows, end-to-end QoS

# ARCHITECTURE



# SYSTEM SOFTWARE: CORE CAPABILITIES



**Users**

**Persistent  
clouds**  
OpenStack

**Pre-configured  
Image Catalog**  
VM images

**Core Researchers  
and Users**

**Pre-configured Image Catalog**  
Bare metal images

**Core Researchers**

**Provisioning**  
LosF (TACC)  
OpenFlow (GENI)

**Scheduling**  
OAR2 (Grid'5000)

**Orchestration**  
Cloudinit.d

# CHAMELEON SERVICES AND FEATURES

- ▶ User Services
  - ▶ Allocation management through reservations, automatic image deployment
  - ▶ Dedicated Web portal for reservations, docs, stats, etc.
- ▶ Experiment Support
  - ▶ Trace and Workload Archive
  - ▶ Experiment enhancement (e.g., load generators)
- ▶ Additional Features
  - ▶ Reconfigurable, connected instrument
  - ▶ Development-focused approach
  - ▶ Ease-of- use: one stop shopping for experimental needs
  - ▶ Distinct from off-the-shelf cloud services
  - ▶ Code ownership and collaboration



# NETWORKING CAPABILITIES

- ▶ Expose SDN, OpenFlow, etc. to users
  - ▶ Isolation
  - ▶ Hybrid Network Capabilities
  - ▶ Programmable Topologies
  - ▶ Integration With Other Resources Within and External to the Testbed
- ▶ Pushing 100G Networks To Their Limit
  - ▶ Using 100G + SDN Optimally
  - ▶ Chameleon appliances and services allow experimenters a highly granulated view into -- and control -- over traffic flows
- ▶ Integration/Federation with GENI (Et Al... \*N Testbeds)
- ▶ Within Common Policy Context

# PARTNERSHIP WITH GENI COMMUNITY

- ▶ Chameleon Enables the GENI Virtual Laboratory For Networking and Distributed Systems Research and Education To Extended Significantly With Many New Types of Resources.
- ▶ This Blending of Resources Will Enable Investigations Of New Types Of Innovative Highly Distributed Environments at Scale.

# GENI-CHAMELEON FEDERATION

- ▶ Federation: ~ Identity Federation (Authentication/Authorization)
- ▶ Goal: Experiments Should Be Able To Log Into Either The GENI or Chameleon Environments Through a Federated Identity Mechanism.
- ▶ After An Experimenter Logs In, Portals Should Be Able To Identify the Groups And Or Projects In Which That Experimenter is a Member To Verify Access To Resources That Belong To Specific Projects.

# GENI AND OPENID: PHASE 1

- ▶ GENI Currently Supports an OpenID Provider (OP) Through Which Identity Can Be Federated to Services.
- ▶ The Phase 1 Implementation is Thanks to Matthew Hanlon of TACC
- ▶ Phase 1: GENI ↔ Chameleon Federation.
  - ▶ Chameleon Has Implemented an OpenID RP To Receive Identity Information From GENI.
  - ▶ However, A Project Association Is Required
  - ▶ Currently, GENI Experimenters Who Would Like To Use Chameleon Need To Be Added As Members Of the “GENI/Chameleon Federation” Project In The GENI Environment.

# GENI AND OPENID: PHASE 1 (CONT.A)

- ▶ Afterward, When They Are Project Members, Chameleon Resources Are Shown As Available.
- ▶ They Can See And Select A “Use-Chameleon” Button That Brings Them To the Chameleon/OpenID Page Where They Will Be Authenticated And Then Automatically Added To The “GENI/Chameleon Federation” Project In the Chameleon Environment.
- ▶ Subsequently, They Have Log-In Access to Chameleon OpenStack interface(s) And Can Log Into Chameleon Using Their GENI OpenID directly from the Chameleon Portal.

# GENI AND OPENID: PHASE 1 (CONT.B)

- ▶ This Project Association Provides A Means To Allow Initial Exploration and Evaluation of the Chameleon Environment By Experimenters
- ▶ If The Environment Proves To Be Useful, The Experimenters Can Establish Their Own Chameleon Projects To Enable Larger Scaling of Resources
- ▶ Reference: Subsequent Slides Depicting This Process, Provided By Matthew Hanlon

# PHASE 2

- ▶ **Phase 2: Chameleon ↔ GENI Federation**
  - ▶ **The GENI Portal Cannot Receive OpenID Federated Identity Information From Another Source (Relaying Party or RP, i.e., Chameleon)**
  - ▶ **This Issue Is Being Addressed Through the G ↔ C Federation Project.**
  - ▶ **Chameleon Will Soon Implement a Process to Transmit Identity Information to GENI Enable Federation from Chameleon -> GENI**
    - ▶ **1. Creating OpenID RP in GENI Portal**
    - ▶ **2. Creating OpenID OP in Chameleon Portal**
    - ▶ **3. Investigating Potential For Chameleon Shibboleth IdP to log In To GENI (Technique Used By SAVI, Which Uses OpenStack & ShibIdP To Send Project Data From Keystone To LDAP)**

# PHASE 3

- ▶ Project Federation Between GENI and Chameleon
- ▶ A Mechanism Is Required To Enable An Experimenter To Bring a GENI Project to Chameleon
- ▶ GENI Designates A “Project Lead” Who Is Manually Approved (e.g., FT Faculty at Accredited Research Institution)



# PHASE 4

- ▶ Plans Are To Enable GENI Experiments To Reserve And Use Chameleon Resources Without Using The CC User Interface
- ▶ This Requires Some Development Activities By The Chameleon Systems Team Addressing Issues At:
  - ▶ API Layer
  - ▶ Control Plane Layer
  - ▶ Orchestration Layer
  - ▶ Data Plane Layer
  - ▶ SDI Infrastructure Federation
  - ▶ Etc

# PHASE 5: FEDERATION-AS-A-SERVICE

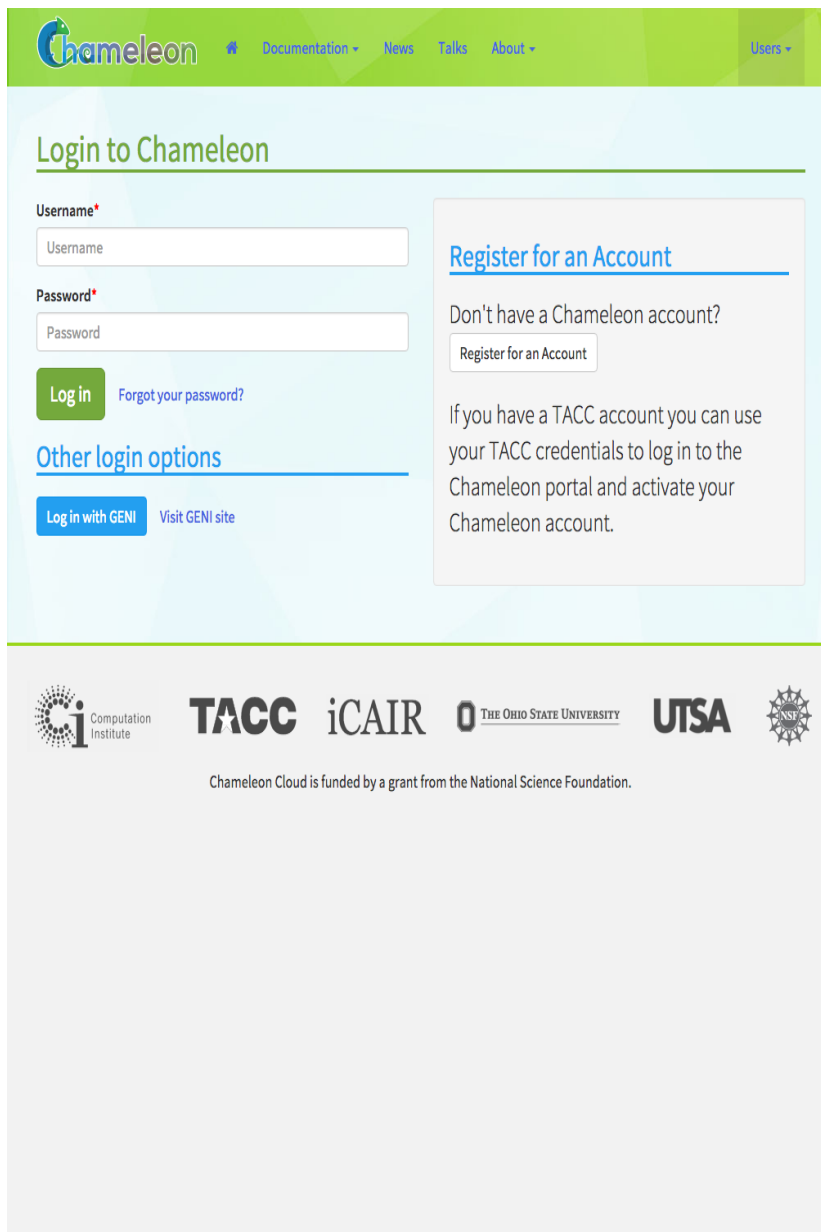
- ▶ Federation-as-a-Service
- ▶ Generalized Architectural Model For Federation With N Testbeds (GENI, FIRE, Chameleon, CloudLab, OSDC, CERN CT, SAVI, OCX, JGN-X, IOFT, NGN, GTS, and Many Others)
- ▶ SDX Implementations (e.g., StarLight SDX) Will Be Key Resources
- ▶ An Open Architecture API Would Be Useful
- ▶ Also, Mechanisms For Policy Implementation
- ▶ Architecture Should Incorporate Options For Policy Based Access to Other SDN Resources
- ▶ Policy Architecture For SDN Is Progressing Through Standardization Processes

# CHAMELEON-GENI FEDERATION

The initial phase of the Chameleon-GENI Federation supports Identity and Project federation between Chameleon and GENI.

GENI users can log in to the Chameleon Portal using their GENI OpenID credentials.

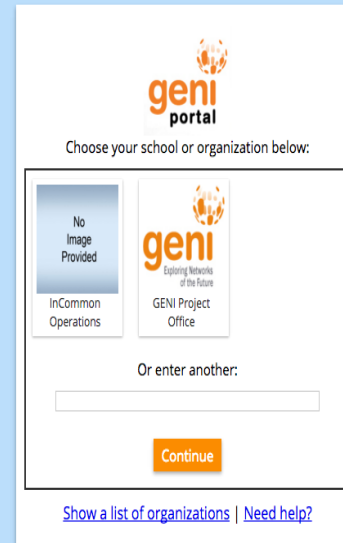
From the Log In screen, select “Log in with GENI” from under “Other login options”.



The screenshot displays the Chameleon login interface. At the top, the Chameleon logo is on the left, and navigation links for Documentation, News, Talks, About, and Users are on the right. The main heading is "Login to Chameleon". Below this, there are input fields for "Username\*" and "Password\*", each with a "Forgot your password?" link. A green "Log in" button is positioned below the password field. Underneath, the "Other login options" section features a blue "Log in with GENI" button and a link to "Visit GENI site". To the right, a registration box titled "Register for an Account" includes the text "Don't have a Chameleon account?" and a "Register for an Account" button. Below this, it states: "If you have a TACC account you can use your TACC credentials to log in to the Chameleon portal and activate your Chameleon account." The footer contains logos for the Computation Institute, TACC, iCAIR, THE OHIO STATE UNIVERSITY, and UTSA, along with the NSF logo. A note at the bottom reads: "Chameleon Cloud is funded by a grant from the National Science Foundation."

## CHAMELEON-GENI FEDERATION


After choosing to Log in with GENI, users are directed to the GENI Portal federated login screen. Users can select their identity provider and log in to GENI as usual.



The screenshot shows the GENI Portal login interface. At the top, the GENI logo is displayed with the text "geni portal" below it. Below the logo, the instruction "Choose your school or organization below:" is shown. There are two selection boxes: the first is labeled "No Image Provided" and "InCommon Operations"; the second is labeled "geni Exploring Networks of the Future" and "GENI Project Office". Below these boxes, the text "Or enter another:" is followed by a text input field. A blue "Continue" button is positioned below the input field. At the bottom of the selection area, there are two links: "Show a list of organizations" and "Need help?".

Can't login via any of the above organizations?  
[Request a login here](#) | [Contact GENI Help](#)

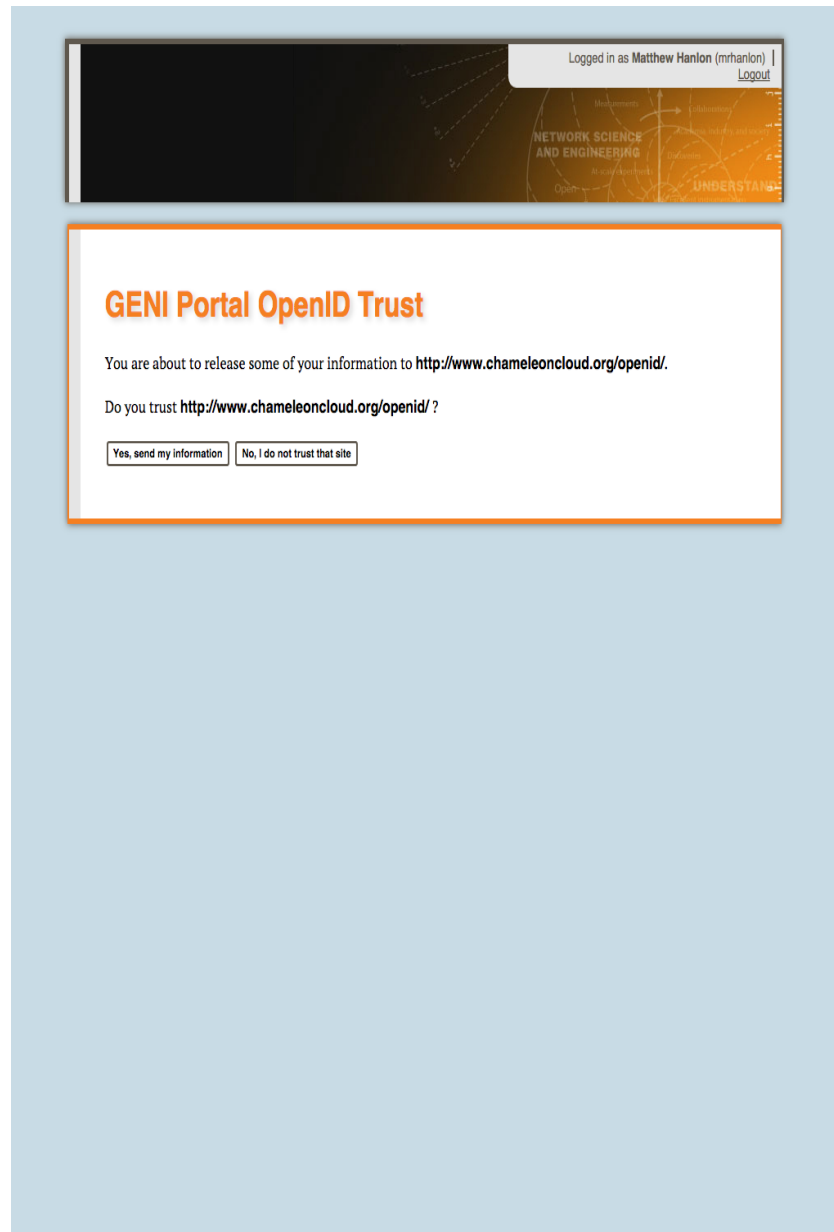
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GENI is sponsored by the  National Science Foundation  
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# CHAMELEON-GENI FEDERATION

After successful login, users are asked to confirm that they consent to GENI releasing some information to Chameleon. This information includes:

- Full name
- Email address
- GENI username
- GENI project membership



The screenshot shows a web interface with a dark header bar. On the right side of the header, it says "Logged in as Matthew Hanlon (mrhanlon) | Logout". The background of the header features a network diagram with nodes and lines, and the text "NETWORK SCIENCE AND ENGINEERING" and "UNDERSTAND" is visible. Below the header is a white box with an orange border containing the following text:

**GENI Portal OpenID Trust**

You are about to release some of your information to <http://www.chameleoncloud.org/openid/>.

Do you trust <http://www.chameleoncloud.org/openid/> ?

# CHAMELEON-GENI FEDERATION

After consenting to information exchange between GENI and Chameleon, users are directed back to the Chameleon Portal.

If this is the first time the user has logged in to the Chameleon Portal using GENI OpenID then the user is prompted to “connect their account”. If the remote GENI user has the same email address as an existing Chameleon user, then the user is prompted to connect their account. If the email does not match then the user can either connect to an existing account to create a new account.

The screenshot shows the Chameleon OpenID Connect interface. At the top, there is a navigation bar with the Chameleon logo, a home icon, and links for Documentation, News, Talks, About, and Users. The main content area has a light blue background with a geometric pattern. The title 'OpenID Connect' is underlined. Below the title, a message reads: 'Hello, Matthew Hanlon! You have successfully authenticated with the remote identity: <https://portal.geni.net/server/server.php/idpage?user=mrhanlon>'. A second message states: 'It looks like you already have a Chameleon account, but this is the first time you've logged in using this OpenID Identity. Please enter your Chameleon credentials below to connect this identity with your existing Chameleon account.' Below this is a section titled 'Connect account' with a green underline. The instructions say: 'Enter your Chameleon username and password to link your Chameleon account with this OpenID identity.' There are two input fields: 'Username\*' and 'Password\*'. A green 'Connect account' button is at the bottom of the form. The footer contains logos for the Computation Institute, TACC, iCAIR, The Ohio State University, and UTSA, along with the text: 'Chameleon Cloud is funded by a grant from the National Science Foundation.'

# CHAMELEON-GENI FEDERATION

Once the identity connection between GENI and Chameleon is established, the user is logged in.

If the **Chameleon-Federation** project is not in the user's list of GENI projects they are prompted to learn more about the federation and join the **Chameleon-Federation** project on GENI.

Chameleon [Documentation](#) [News](#) [Talks](#) [About](#) [Hello, Matthew Harlon](#)

[Dashboard](#) [Projects](#) [Outages](#) [Help Desk](#) [Profile](#)

Login success using OpenID.

## Dashboard

Learn more about Chameleon-GENI Cloud Federation  
Take advantage of the Chameleon-GENI Cloud Federation by joining the **Chameleon-Federation** project on GENI! [Read more about the federation here.](#)

Active Projects [Manage your Projects](#)

Project	Status	Usage/Info
CH-TEST01	Active	

Open tickets [View all Tickets](#) [Open a Ticket](#)

No open tickets.

Ongoing outages

### Scheduled network maintenance at UC

A network maintenance is scheduled at the datacenter hosting the Chameleon UC resources. Connectivity will be disrupted during this maintenance planned for 6:30 AM to 7:30 AM on Monday, July 20, 2015.

Computation Institute TACC iCAIR THE OHIO STATE UNIVERSITY UTSA

Chameleon Cloud is funded by a grant from the National Science Foundation.

# CHAMELEON-GENI FEDERATION

Once the identity connection between GENI and Chameleon is established, the user is logged in.

If the **Chameleon-Federation** project is not in the user's list of GENI projects they are prompted to learn more about the federation and join the **Chameleon-Federation** project on GENI.

If they are on the GENI project, they can activate access to Chameleon.

The screenshot shows the Chameleon user dashboard. At the top, there is a navigation bar with the Chameleon logo, a user profile dropdown for 'Hello, Matthew Hanlon', and links for 'Documentation', 'News', 'Talks', and 'About'. Below the navigation bar, there are tabs for 'Dashboard', 'Projects', 'Outages', 'Help Desk', and 'Profile'. A green notification box at the top indicates 'Login success using OpenID.'. The main content area is titled 'Dashboard' and features a yellow box with the heading 'Activate Chameleon-GENI Federation Access'. This box contains the text 'As a member of the Chameleon-Federation project on the GENI Cloud, you can access resources in the Chameleon Cloud!' and a prominent orange button labeled 'Activate Access to Chameleon Cloud Resources'. Below this, there are three main sections: 'Active Projects', 'Open tickets', and 'Ongoing outages'. The 'Active Projects' section contains a table with one entry: 'CH-TEST01' with a status of 'Active' and a 'Usage/Info' link. The 'Open tickets' section shows 'No open tickets.' with links to 'View all Tickets' and 'Open a Ticket'. The 'Ongoing outages' section features a notification titled 'Scheduled network maintenance at UC' with details about a connectivity disruption on Monday, July 20, 2015. The footer of the dashboard includes logos for the Computation Institute, TACC, iCAIR, The Ohio State University, UTSA, and the National Science Foundation (NSF), along with the text 'Chameleon Cloud is funded by a grant from the National Science Foundation.'



## CHAMELEON-GENI FEDERATION

Once the identity connection between GENI and Chameleon is established, the user is logged in.

If the **Chameleon-Federation** project is not in the user's list of GENI projects they are prompted to learn more about the federation and join the **Chameleon-Federation** project on GENI.

If they are on the GENI project, they can activate access to Chameleon.

The screenshot shows the Chameleon website's navigation bar with the logo and links for Documentation, News, Talks, and About. A user is logged in as Matthew Hanlon. The main content area is titled 'Activate Chameleon-GENI Federation Access' and contains the following text:

As a member of the [Chameleon-Federation](#) project on the GENI Portal, you have access to use Chameleon. Click **Activate Access** below to be automatically added to the GENI-Federation project on Chameleon, through which you will have access to use Chameleon resources.

The GENI-Federation project will give you access to test the capabilities that Chameleon offers. Because the resources available via this project are shared, once you are ready to scale up your project to fully utilize Chameleon we ask that you [submit a project request](#).

I agree to abide by Chameleon Acceptable Use Policies \*

Please review the Chameleon [User Terms of Use](#) before proceeding.

Buttons for **Activate Access** and **Cancel** are visible.

The footer features logos for the Computation Institute, TACC, iCAIR, The Ohio State University, UTSA, and the National Science Foundation (NSF). A note states: 'Chameleon Cloud is funded by a grant from the National Science Foundation.'

# CHAMELEON-GENI FEDERATION

Once active, the project will appear in the users list of Active Projects, and access to launch instances under that project will be available in the OpenStack Dashboard.

After testing out Chameleon using the shared GENI-Federation Project, users who wish to scale up their research experiments on Chameleon should submit a project request in order to acquire more time on the system.

The screenshot shows the Chameleon user interface. At the top, there is a navigation bar with the Chameleon logo, a user profile for Matthew Harlon, and links for Documentation, News, Talks, and About. Below the navigation bar, there are tabs for Dashboard, Projects, Outages, Help Desk, and Profile. A green notification bar at the top states: "Your access to the Chameleon-GENI Federation Project is active." The main content area is titled "Dashboard" and contains three panels. The "Active Projects" panel has a "Manage your Projects" link and a table with two rows: "CH-TEST01" and "CH-817201", both with "Active" status and "Usage/Info" links. The "Open tickets" panel has a "View all Tickets" and "Open a Ticket" link, and displays "No open tickets." The "Ongoing outages" panel has a link for "Scheduled network maintenance at UC" and a text block stating: "A network maintenance is scheduled at the datacenter hosting the Chameleon UC resources. Connectivity will be disrupted during this maintenance planned for 6:30 AM to 7:30 AM on Monday, July 20, 2015." The footer contains logos for the Computation Institute, TACC, iCAIR, The Ohio State University, UTSA, and NSF, along with the text: "Chameleon Cloud is funded by a grant from the National Science Foundation."

# THANKS!



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