H3ABioNet

Pan African Bioinformatics Network for H3Africa

Data transfer, storage and security considerations

Background

Example: Havasupai

- Native American tribe in US
  - High incidence of Type 2 diabetes
  - Approached ASU
- Original study done
- Later, more detailed genotyping
  - Standard analyses reported (amongst other results)
    - Inbreeding coefficient
    - Population bottleneck
- Havasupai sued ASU and were awarded damages

Globus email reports

raw data

last updated Mon Feb 15 10:20:05 201

startDate	End date	Source	Destination	Status	Transferred	Speed	from Email
2016-01-29 09:25:04Z	2016-01-29 09:25:29Z	ppanchal#hgsc-xfer	ncsa#BlueWaters	FAILED	0.0B	0.0b/s	Globus Notification <no-reply@globus.org>
2016-01-29 08:49:23Z	2016-02-02 19:30:12Z	ncsa#BlueWaters	grbot#H3ABioNetCentral	SUCCEEDED	3.8TB	84Mb/s	Globus Notification <no-reply@globus.org>
2016-01-27 09:04:39Z	2016-01-27 09:04:49Z	ncsa#BlueWaters	grbot#nautilus2	SUCCEEDED	12kB	9.4kb/s	Globus Notification <no-reply@globus.org>
2016-01-27 09:04:12Z	2016-01-27 09:04:24Z	ncsa#BlueWaters	grbot#nautilus2	SUCCEEDED	8.0kB	6.3kb/s	Globus Notification <no-reply@globus.org>
2016-01-27 09:04:00Z	2016-01-27 09:04:13Z	ncsa#BlueWaters	grbot#nautilus2	SUCCEEDED	11kB	7.3kb/s	Globus Notification <no-reply@globus.org>
2016-01-27 09:03:40Z	2016-01-27 09:03:53Z	ncsa#BlueWaters	grbot#nautilus2	SUCCEEDED	13kB	9.4kb/s	Globus Notification <no-reply@globus.org>
2016-01-27 09:03:22Z	2016-01-27 09:03:37Z	ncsa#BlueWaters	grbot#nautilus2	SUCCEEDED	7.5kB	4.2kb/s	Globus Notification <no-reply@globus.org>
2016-01-26 19:27:07Z	2016-01-27 19:55:29Z	ppanchal#hgsc-xfer	ncsa#BlueWaters	SUCCEEDED	9.9TB	950Mb/s	Globus Notification <no-reply@globus.org>
2016-01-25 08:58:13Z	2016-01-25 09:01:15Z	ncsa#BlueWaters	grbot#H3ABioNetCentral	SUCCEEDED	52kB	2.1kb/s	Globus Notification <no-reply@globus.org>
2016-01-25 08:57:42Z	2016-01-25 09:01:40Z	ncsa#BlueWaters	grbot#H3ABioNetCentral	SUCCEEDED	41kB	1.0kb/s	Globus Notification <no-reply@globus.org>
2016-01-25 08:56:50Z	2016-01-25 09:02:22Z	ncsa#BlueWaters	grbot#H3ABioNetCentral	SUCCEEDED	61kB	1.0kb/s	Globus Notification <no-reply@globus.org>
2016-01-25 08:56:26Z	2016-01-25 09:02:00Z	ncsa#BlueWaters	grbot#H3ABioNetCentral	SUCCEEDED	33kB	1.0kb/s	Globus Notification <no-reply@globus.org>
2016-01-19 17:06:58Z	2016-01-29 08:46:05Z	ncsa#BlueWaters	grbot#H3ABioNetCentral	FAILED	7.2TB	73Mb/s	Globus Notification <no-reply@globus.org>
2016-01-15 14:59:49Z	2016-01-16 10:18:10Z	ncsa#BlueWaters	grbot#H3ABioNetCentral	SUCCEEDED	1.3TB	160Mb/s	Globus Notification <no-reply@globus.org>
2016-01-15 14:41:58Z	2016-01-15 15:23:50Z	shaze#labbook	heinedej#H3ABioNet	SUCCEEDED	110GB	380Mb/s	Scott Hazelhurst <Scott.Hazelhurst@wits.ac.
2016-01-14 18:39:00Z	2016-01-14 23:09:32Z	ncsa#BlueWaters	ncsa#Nearline	SUCCEEDED	21TB	11Gb/s	Globus Notification <no-reply@globus.org>
2016-01-14 18:38:41Z	2016-01-14 20:43:42Z	ncsa#BlueWaters	ncsa#Nearline	SUCCEEDED	3.0TB	3.3Gb/s	Globus Notification <no-reply@globus.org>
2016-01-14 16:53:23Z	2016-01-14 19:50:18Z	ESnet test DTN at LBL	heinedej#H3ABioNet	SUCCEEDED	500GB	400Mb/s	Globus Notification <no-reply@globus.org>
2016-01-14 10:36:57Z	2016-01-14 14:48:56Z	ESnet test DTN at CERN	heinedej#H3ABioNet	SUCCEEDED	500GB	280Mb/s	Globus Notification <no-reply@globus.org>
2016-01-14 06:30:13Z	2016-01-14 06:44:11Z	ppanchal#hgsc-xfer	ncsa#BlueWaters	SUCCEEDED	280GB	2.8Gb/s	Globus Notification <no-reply@globus.org>
2016-01-14 06:24:58Z	2016-01-14 06:25:02Z	ppanchal#hgsc-xfer	ncsa#BlueWaters	SUCCEEDED	5.8kB	16kb/s	Globus Notification <no-reply@globus.org>
2016-01-12 17:31:34Z	2016-01-14 17:27:16Z	ncsa#BlueWaters	heinedej#H3ABioNet	FAILED	1.4TB	70Mb/s	Globus Notification <no-reply@globus.org>
2016-01-11 12:28:34Z	2016-01-11 13:33:22Z	ppanchal#hgsc-xfer	ncsa#BlueWaters	SUCCEEDED	2.7kB	0.0b/s	Globus Notification <no-reply@globus.org>
2016-01-11 08:25:25Z	2016-01-11 20:42:08Z	ncsa#BlueWaters	grbot#H3ABioNetCentral	SUCCEEDED	560GB	110Mb/s	Globus Notification <no-reply@globus.org>
2016-01-11 08:25:04Z	2016-01-11 15:07:26Z	ncsa#BlueWaters	grbot#H3ABioNetCentral	SUCCEEDED	300GB	100Mb/s	Globus Notification <no-reply@globus.org>
2016-01-11 08:23:49Z	2016-01-11 16:03:44Z	ncsa#BlueWaters	grbot#H3ABioNetCentral	SUCCEEDED	520GB	160Mb/s	Globus Notification <no-reply@globus.org>
2016-01-11 08:23:26Z	2016-01-11 18:12:39Z	ncsa#BlueWaters	grbot#H3ABioNetCentral	SUCCEEDED	610GB	140Mb/s	Globus Notification <no-reply@globus.org>

Data transfer

UDP v/s TCP		
Characteristics/ Description	**UDP**	**TCP**
General Description	Simple High speed low functionality "wrapper" that interface applications to the network layer and does little else	Full-featured protocol that allows applications to send data reliably without worrying about network layer issues.
Protocol connection Setup	Connection less data is sent without setup	Connection-oriented; Connection must be Established prior to transmission.
Data interface to application	Message base-based is sent in discrete packages by the application.	Stream-based; data is sent by the application with no particular structure
Reliability and Acknowledgements	Unreliable best-effort delivery without acknowledgements	Reliable delivery of message all data is acknowledged.
Retransmissions	Not performed. Application must detect lost data and retransmit if needed.	Delivery of all data is managed, and lost data is retransmitted automatically.
Features Provided to Manage flow of Data	None	Flow control using sliding windows; window size adjustment heuristics; congestion avoidance algorithms
Overhead	Very Low	Low, but higher than UDP
Transmission speed	Very High	High but not as high as UDP
Data Quantity Suitability	Small to moderate amounts of data.	Small to very large amounts of data.

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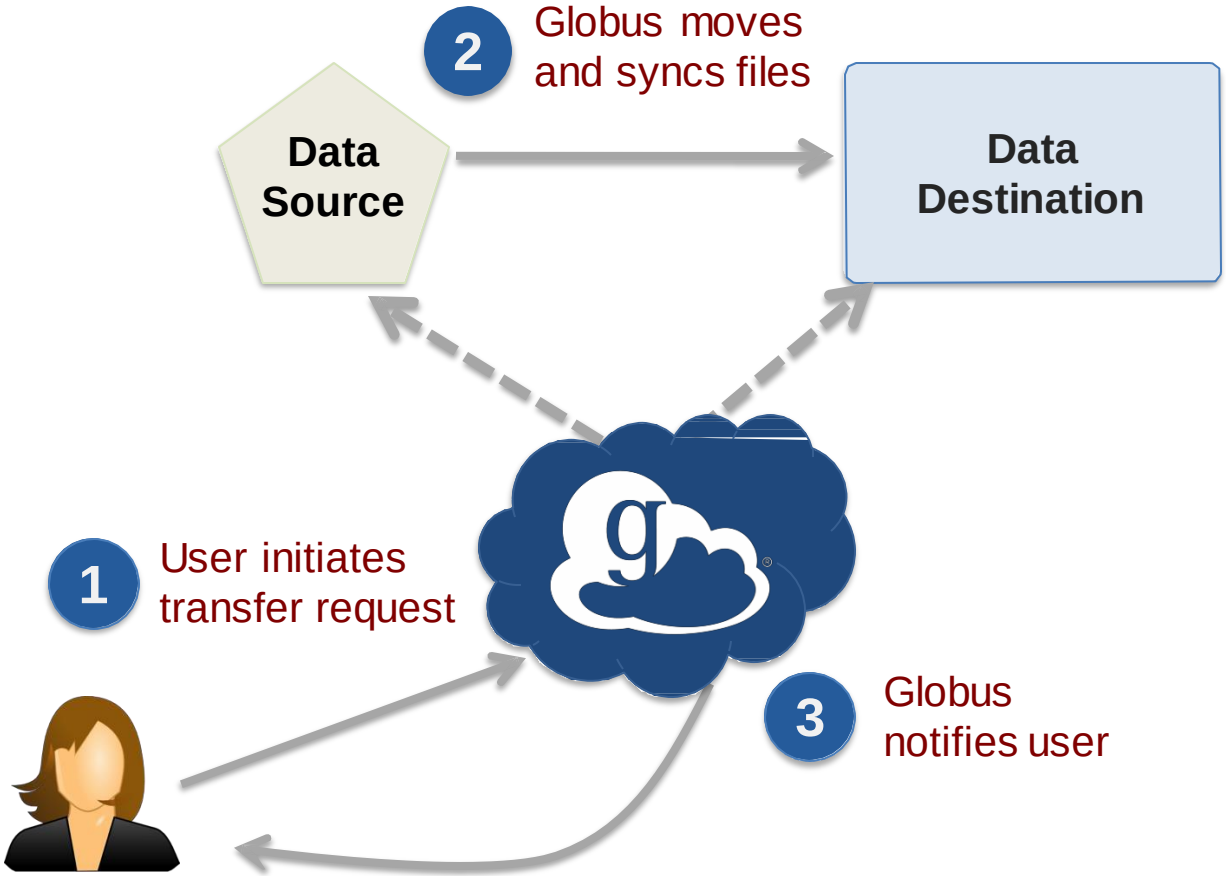
Data transfer – Globus online



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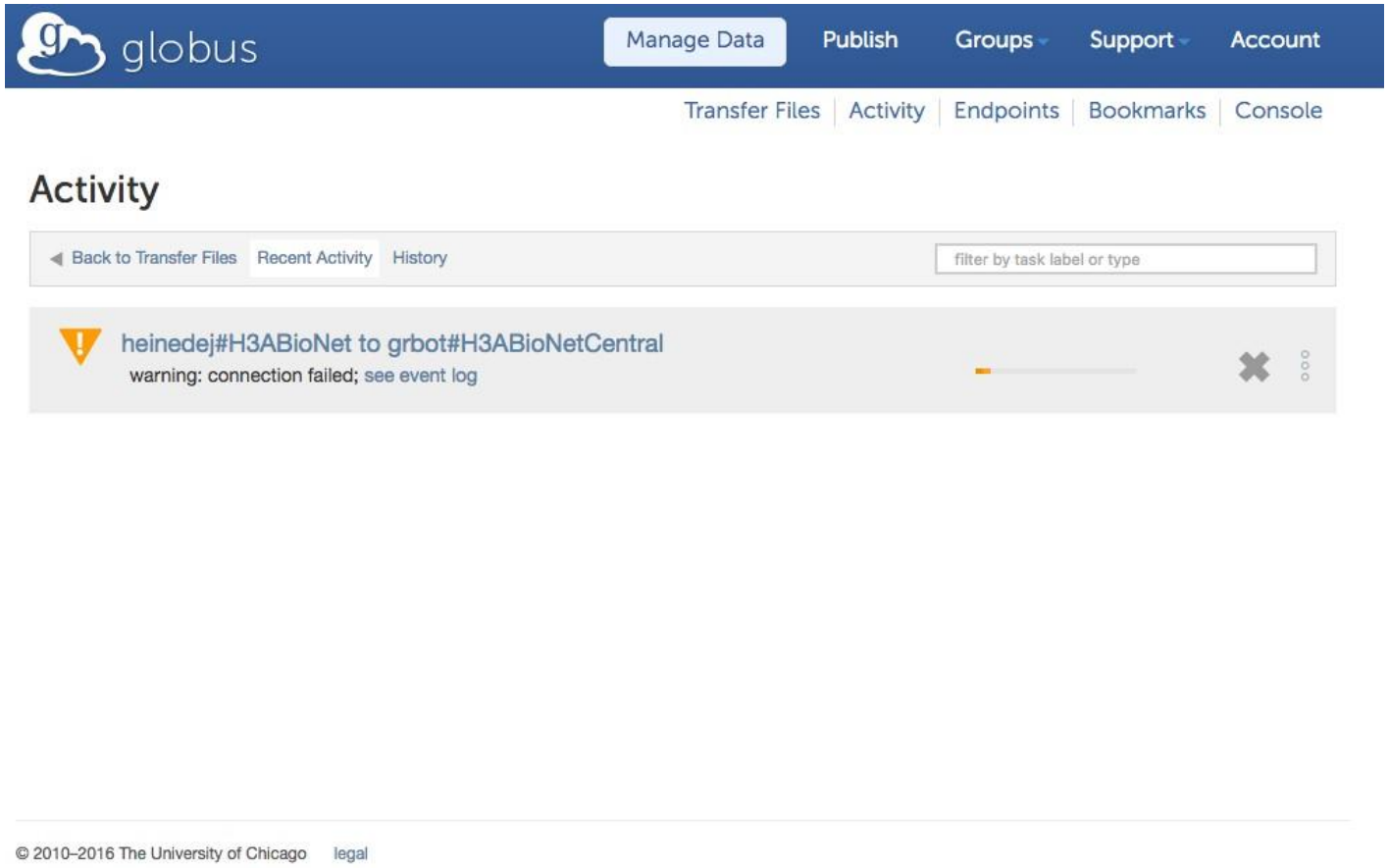
Data transfer – Globus online



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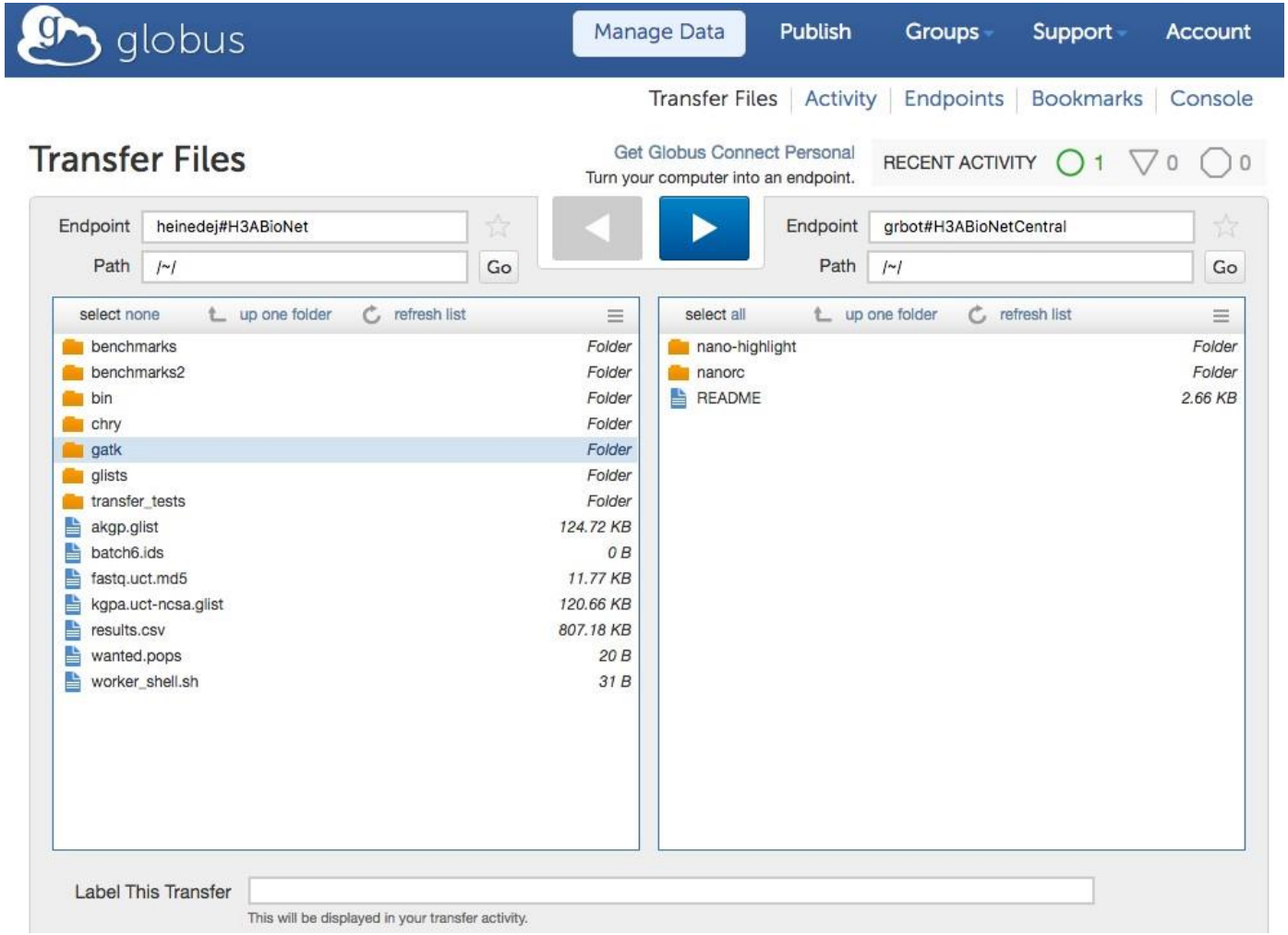
Data transfer – Globus online



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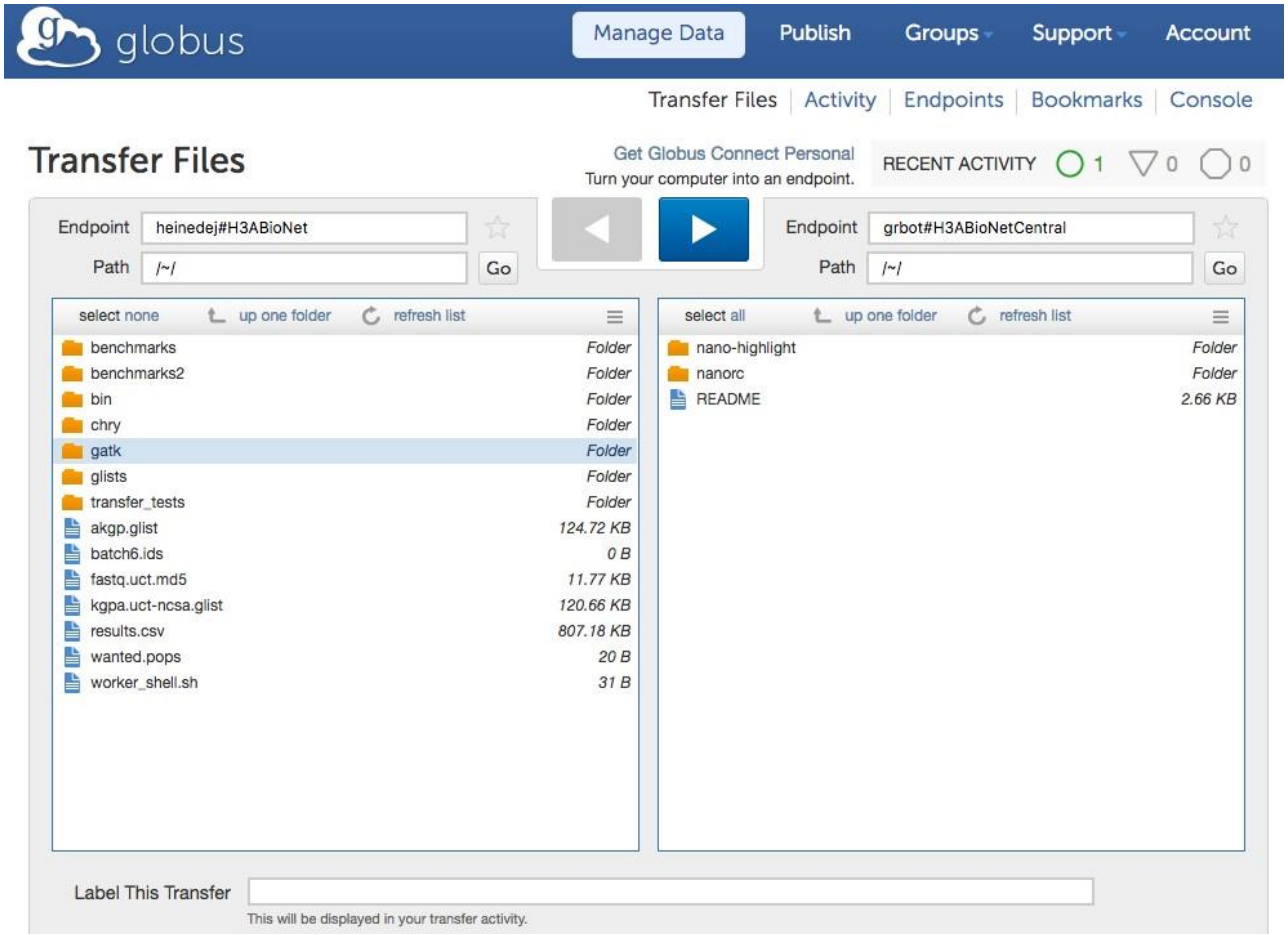
Data transfer – Globus online



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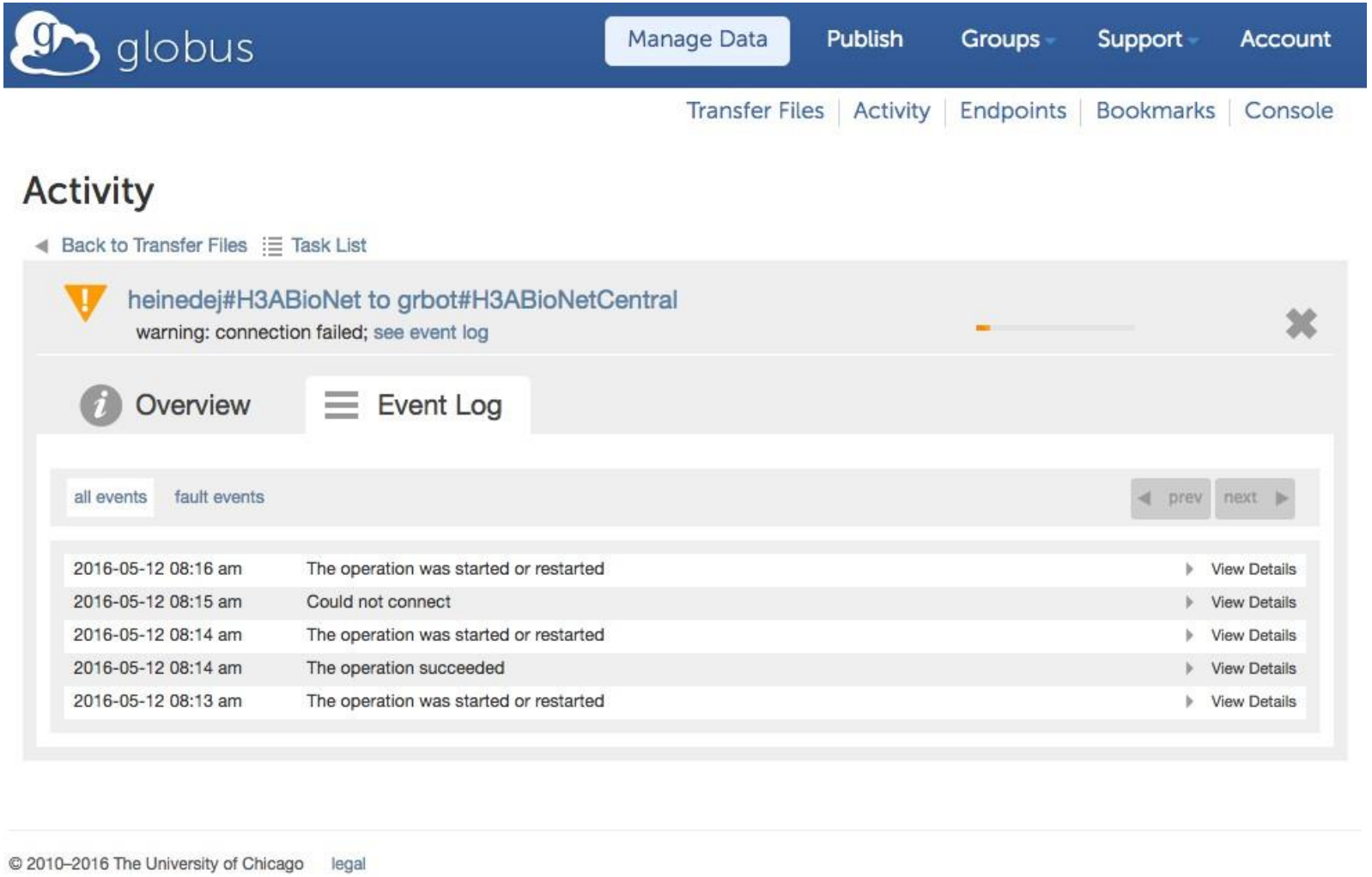
Data transfer – Globus online



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Data transfer – Globus online

Advantages:

- robust
- efficient
- faster

Disadvantages:

- complex setup
- non-standard firewall configuration
- can hog bandwidth

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Storage

- Types of storage
  - Volatile
    - RAM
    - variables
    - cache
  - Persistent
    - disk
    - RAID
    - tape

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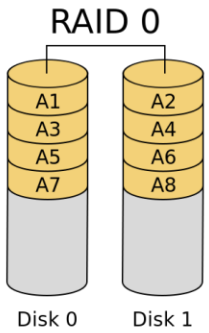
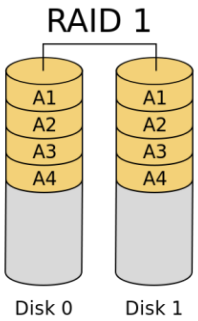
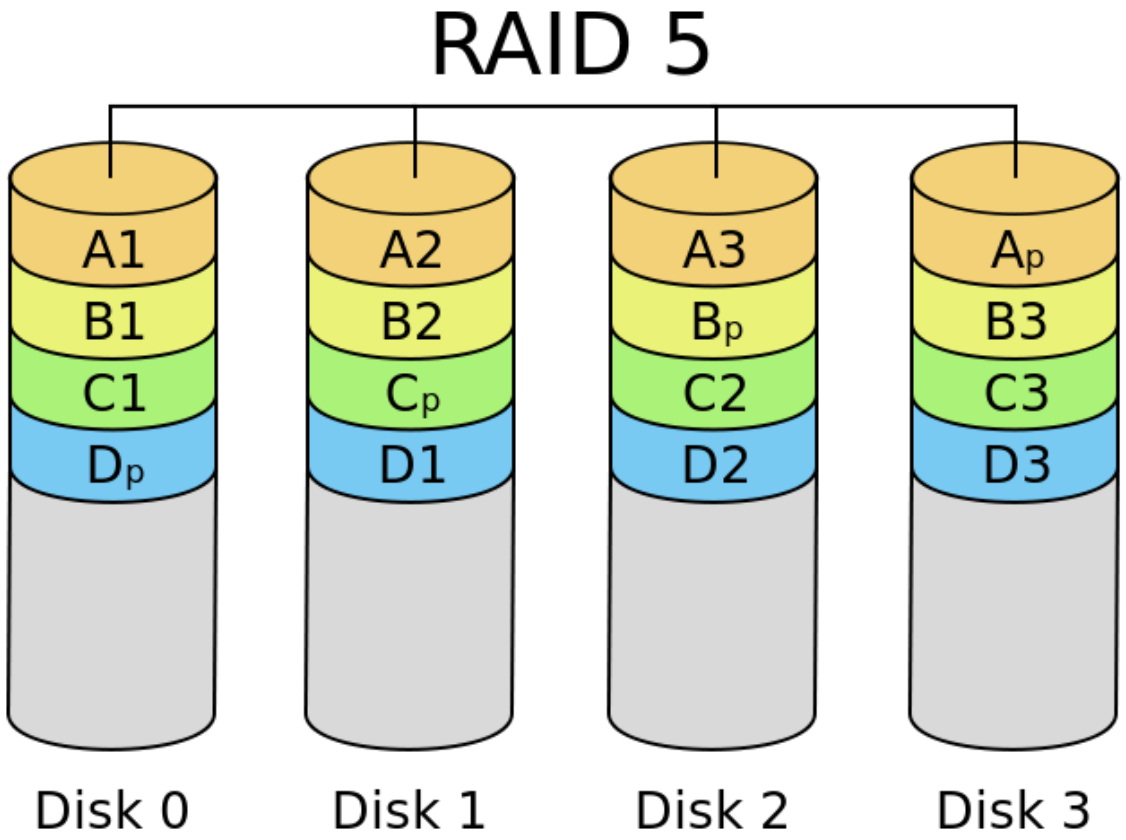
Storage







Source: https://en.wikipedia.org/wiki/Standard_RAID_levels

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Storage - iRODS

- Advantages
  - Associated metadata
  - Rules oriented
  - Built in provenance
- Disadvantages
  - Complex setup
  - Rules infrastructure
  - Integration with existing tools

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Security

- The most secure machine is a disconnected, physically secured machine that is powered off.
- Goals
  - Confidentiality
  - Authentication
  - Integrity
  - Non-repudiation
- Security is a trade-off

Security – threat modelling

- What do you have that is valuable? (assets)
- Why would attackers want to disrupt (motivation)
- Where can they attack (entry points)
- How would they attack (threats)
- Cost to protect? (threat ranking)
- Which threats will you fight and how (mitigation)

Security – motives

- Obtain asset (personal info, genetic data)
- Use resources (e.g. CPU, network)
- Recognition
- Thrill
- Mistakes

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Security – types of attack

- Denial of service
- Exploit configuration errors
- Exploit application bugs
- Social engineering

Security – calculating risk

- Exploitability
  - Likelihood of vulnerability being exploited
- Damage potential
  - Consequences of breach
- Asset value
  - Cost of protecting, recovery

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Security - cryptography

- Terms
  - Cleartext
  - Cipher
  - Ciphertext
- Goals
  - Confidentiality
  - Authentication
  - Integrity
  - Non-repudiation

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Security - principles

- Compartmentalize
- Principle of least privilege
- Defense in depth
- Don’t volunteer information
- Fail safely
- Weakest link
- Simplicity

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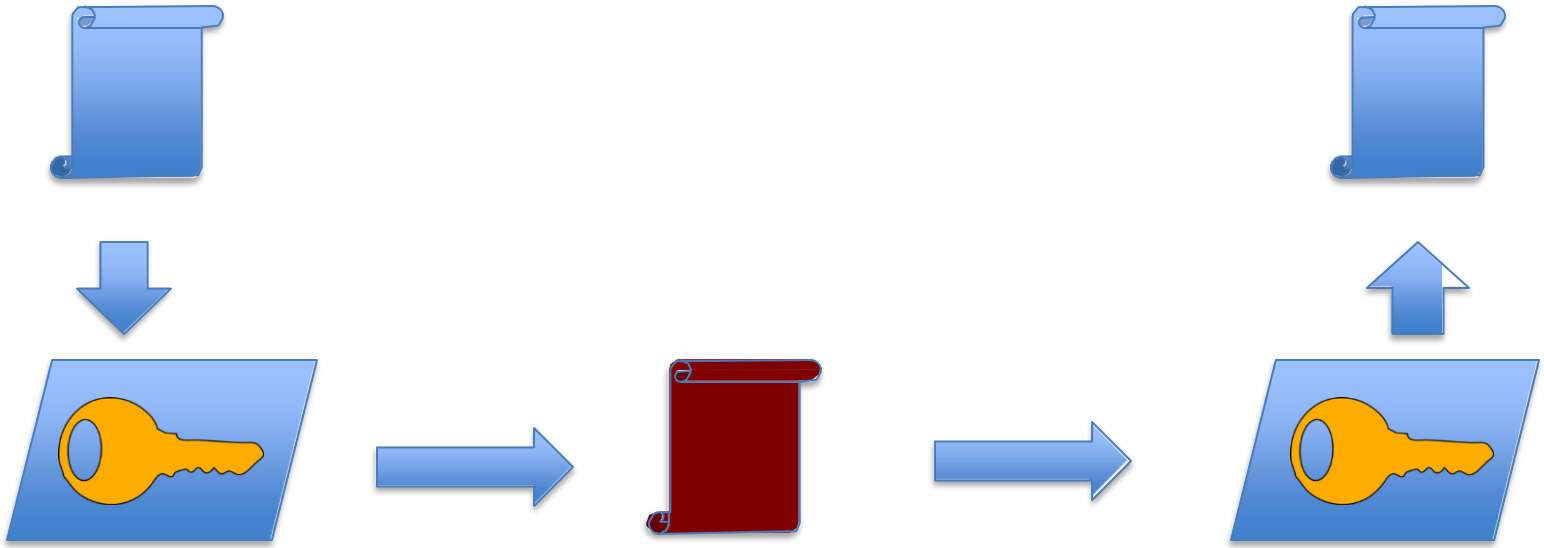
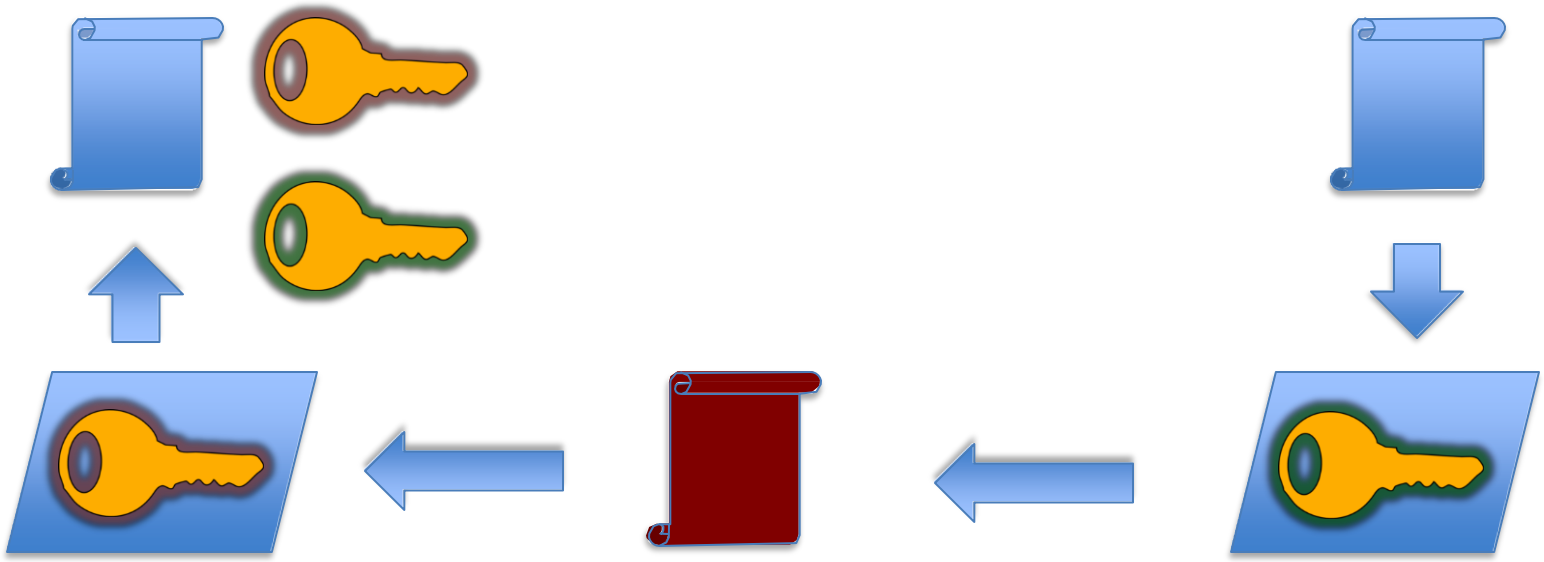
Security - cryptography

- Symmetric encryption
  - requires a shared “secret key”



Security - cryptography

- Asymmetric encryption (public key encryption)
  - Key pairs
  - No shared secret required



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Security - cryptography

- Tools
  - GPG
- Related
  - Public Key infrastructure
  - Digital certificates
  - Certificate authorities

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Conclusion

- Security is hard
- Resources:
  - Bruce Schneier
  - http://security.stackexchange.com
  - https://twitter.com/thegrugq

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