Grids at Indiana University

Scott McCaulay
IU TeraGrid Site Lead

INDIANA UNIVERSITY

Grid Activities at IU

- TeraGrid Resource Partner
- Open Science Grid – Atlas Tier 2 Site
- Hydra Portal/Condor Pool
- IVDGL Grid Operations Center (iGOC)
- Indianapolis/Bloomington intercampus grid
- Environmental, political factors that shaped the development of grid activities at IU?

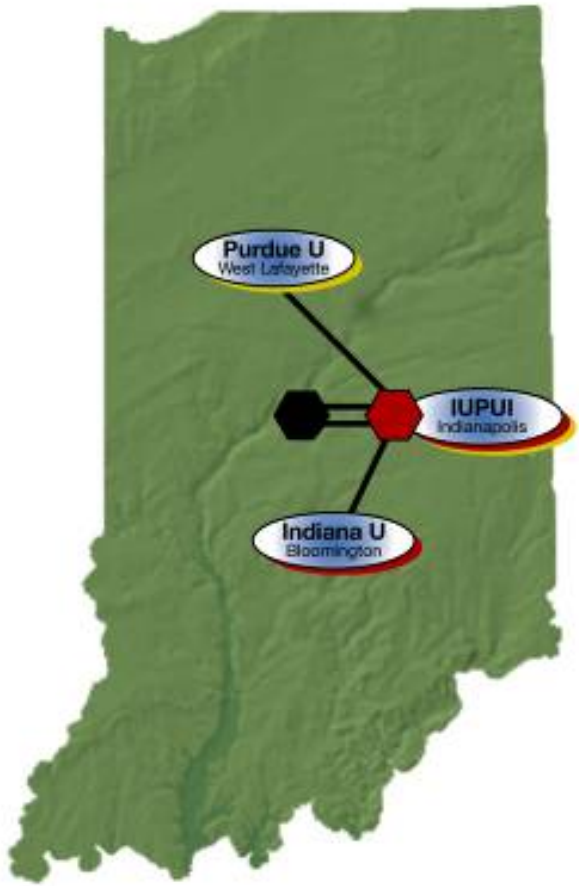
One IT Department Serving Two Research Communities

- Bloomington campus
  - Astronomy, Biology, Computer Science, Chemistry, Physics…

- Indianapolis campus
  - IU School of Medicine
  - Indiana University-Purdue University Indianapolis (IUPUI)

The I-Light Network

- $5.3 million appropriation from the state of Indiana in 1999, operational in 2001
- Indiana became the first state to deploy its own high-performance data network
- Connects IU Bloomington, IUPUI Indianapolis and Purdue West Lafayette campuses
- Opened up a host of new opportunities…



AVIDD Cluster

(Analysis and Visualization of Instrument-Driven Data)

- First geographically distributed Linux cluster to top 1 TFLOPS on Linpack
- Nodes communicate through a Force 10 gigabit Ethernet network
- Indianapolis and Bloomington clusters connected via dual 10-gigabit pipeline through I-Light
- Funded in part by a $1.8 million grant from the NSF
- Aggregate peak computing power of 2.2 TFLOPS

IBM Research SP

- IBM Scalable POWERparallel system geographically distributed between Bloomington and Indianapolis
- Provided a computing capacity of approximately 1 teraFLOP
- Funding for the SP system and its expansions came from Lilly Endowment, Inc. and from IBM SUR grants
- Supported over 900 researchers on both campuses, partially retired as of September 30,2005

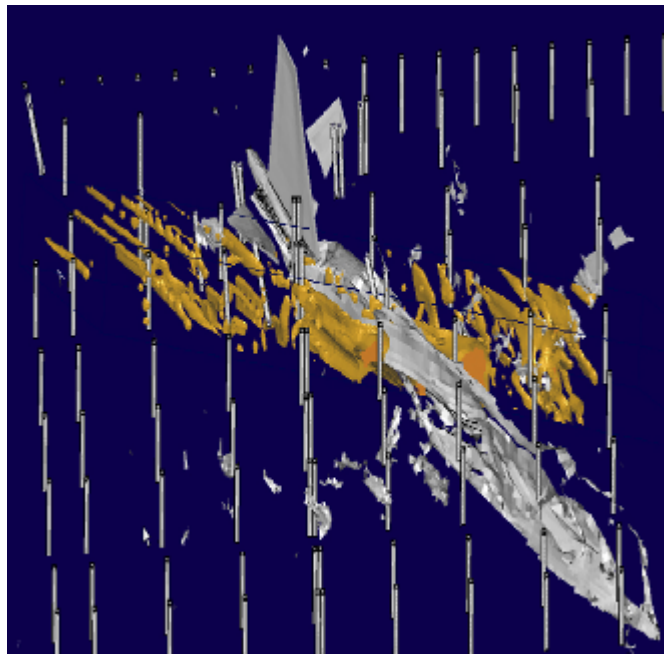
Massive Data Storage System

- HPSS (High Performance Storage System)
- Automatic data replication between Indianapolis and Bloomington, via I-Light
- 720 TB current tape capacity, total capacity of 2.2 PB
- >250 TB currently in use; >5 TB for biomedical data
- Will be available to TeraGrid users via HSI, eventually vid gridFTP

Photo by Tyagen Miller, © Trustees of Indiana University

Uses of Linked Computational Resources

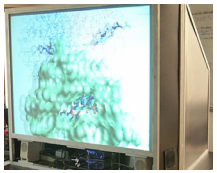
- The I-Light network has been used in a Purdue-led simulation of the Sept 11 crash of a jet into the Pentagon
- Global Grid - HPC Challenge award at the SuperComputing 2003 conference
- Support for Center for Computational Homeland Security
- Ongoing cycle sharing agreement, IU-Purdue



Distribution of Systems Across Two Campuses

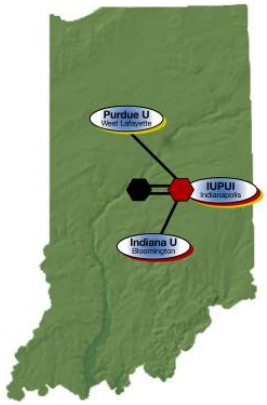
- A potential weakness becomes a strength for grid computing at Indiana University
- Disaster resiliency, AVIDD & SP users on both campuses can still be supported if one machine room goes out
- Automated data replication between Indianapolis and Bloomington
- Spread machine room load, some relief from power and cooling headaches
- Additional opportunities at regional campuses with I-Light 2

Chicago

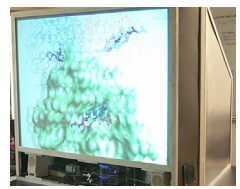


Gary

Purdue
West Lafayette



Indianapolis

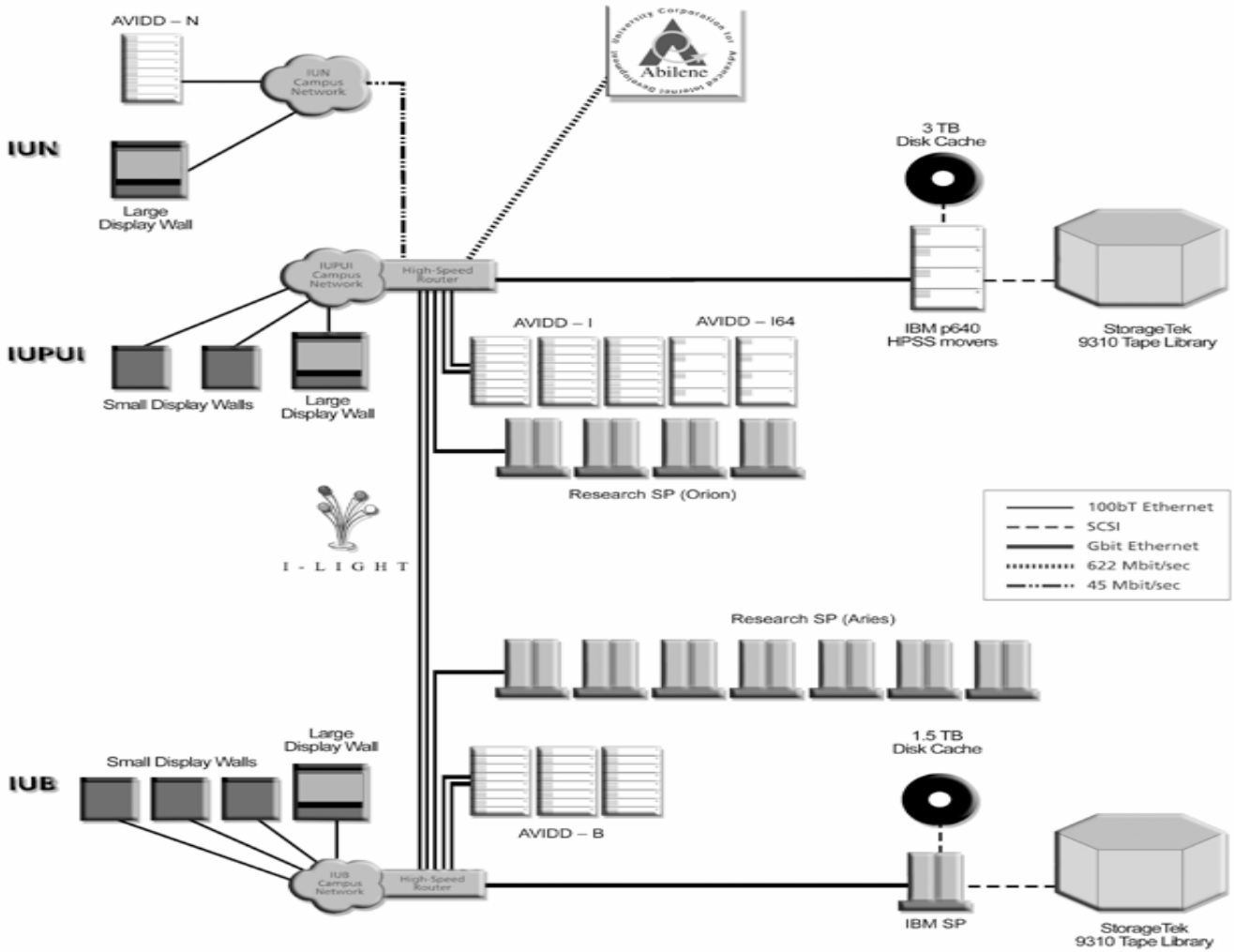


Richmond

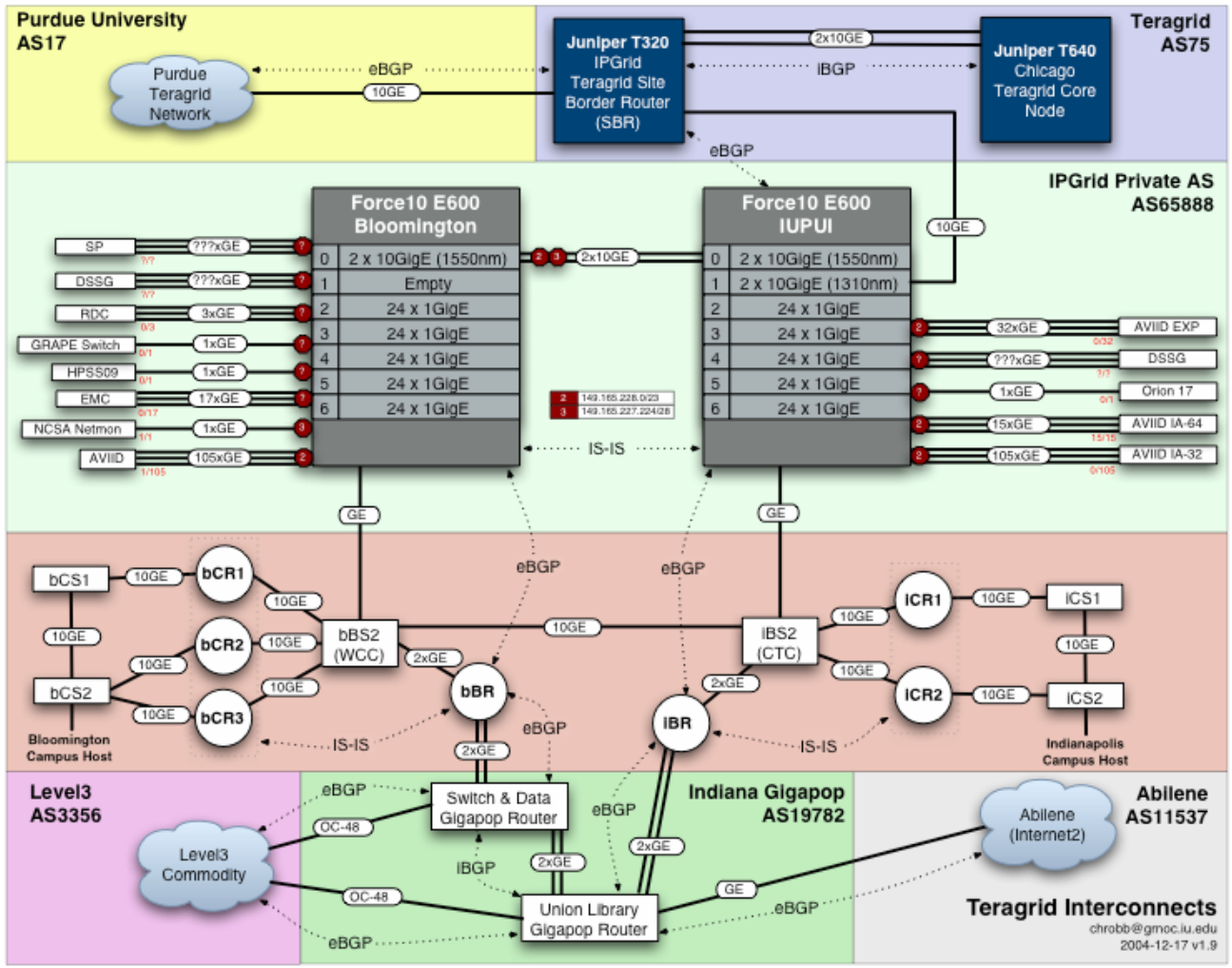
1 TFLOPS SP – INGEN, IBM
2 TFLOPS AVIDD – NSF, IBM
2.2 PB Storage – STK, NSF, INGEN

Bloomington

One view of the IU System

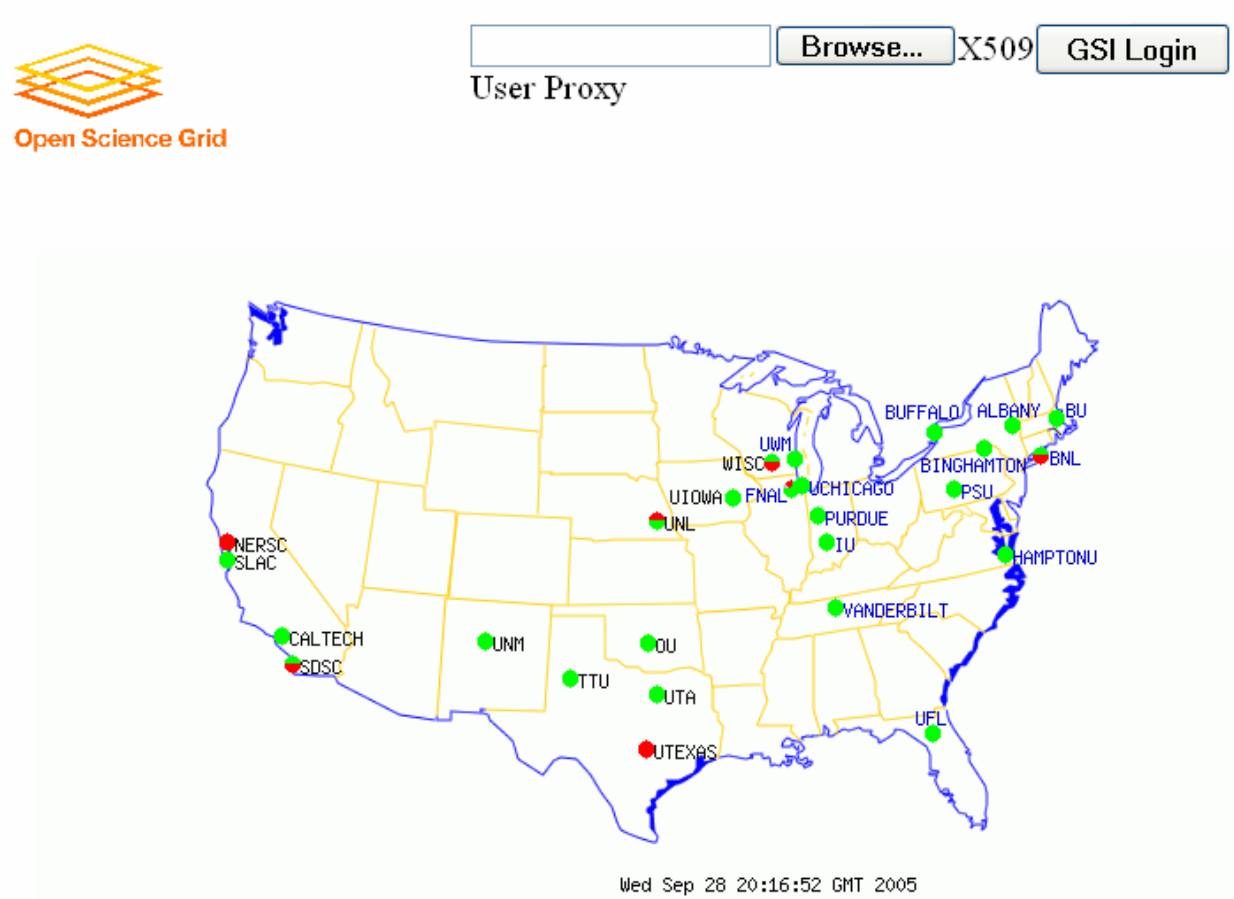


Network


Purdue University
AS17
Purdue Teragrid Network
eBGP
10GE
Juniper T320
IPGrid Teragrid Site Border Router (SBR)
2x10GE
IBGP
Juniper T640
Chicago Teragrid Core Node
Teragrid
AS75
eBGP
IPGrid Private AS
AS65888
Force10 E600
Bloomington
0 2 x 10GigE (1550nm)
1 Empty
2 24 x 1GigE
3 24 x 1GigE
4 24 x 1GigE
5 24 x 1GigE
6 24 x 1GigE
2x10GE
Force10 E600
IUPUI
0 2 x 10GigE (1550nm)
1 2 x 10GigE (1310nm)
2 24 x 1GigE
3 24 x 1GigE
4 24 x 1GigE
5 24 x 1GigE
6 24 x 1GigE
10GE
IS-IS
SP ???xGE
DSSG ???xGE
RDC 3xGE
GRAPE Switch 1xGE
HPSS09 1xGE
EMC 17xGE
NCSA Netmon 1xGE
AVIID 105xGE
32xGE AVIID EXP
???xGE DSSG
1xGE Orion 17
15xGE AVIID IA-64
105xGE AVIID IA-32
GE
GE
eBGP
eBGP
bCS1
bCS2
bCR1
bCR2
bCR3
10GE
bBS2 (WCC)
2xGE
bBR
IS-IS
eBGP
2xGE
Bloomington Campus Host
iBS2 (CTC)
iBR
ICR1
ICR2
ICS1
ICS2
IS-IS
Indianapolis Campus Host
Level3
AS3356
Level3 Commodity
OC-48
OC-48
eBGP
eBGP
Switch & Data Gigapop Router
IBGP
2xGE
Union Library Gigapop Router
Indiana Gigapop
AS19782
eBGP
2xGE
GE
eBGP
Abilene
AS11537
Abilene (Internet2)
Teragrid Interconnects
chrobb@gmoc.iu.edu
2004-12-17 v1.9

Open Science Grid

IVDGL Tier 2 Operations for Atlas

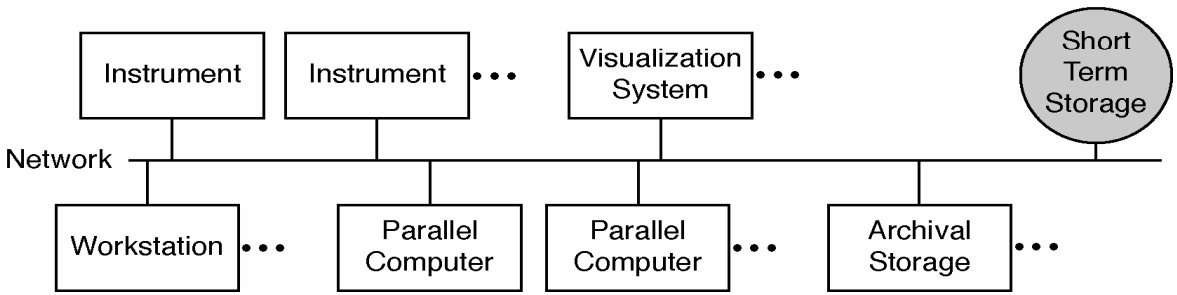


TeraGrid

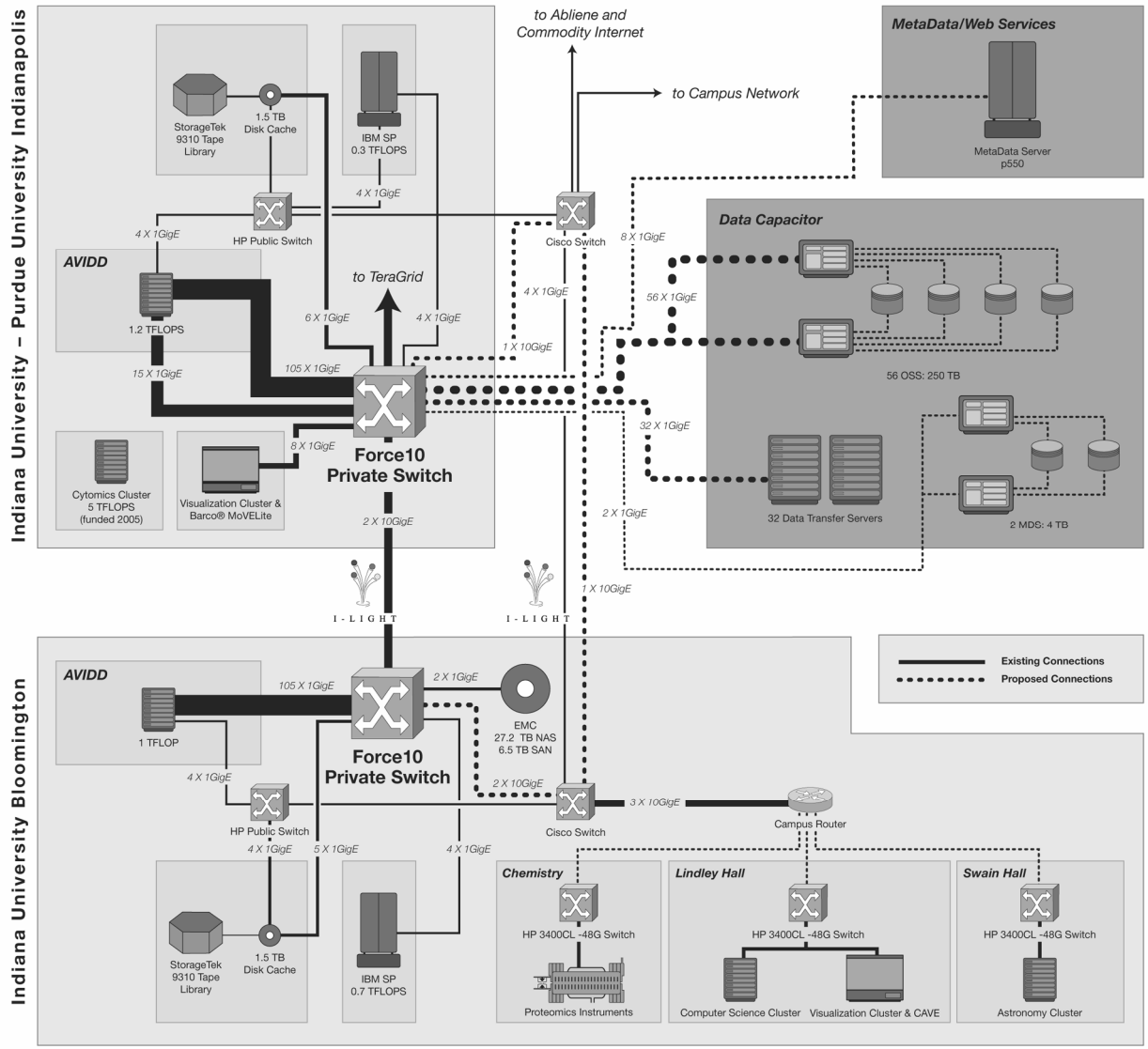
- Received $4.4 million NSF grant to participate as a resource partner in the TeraGrid
- Plan to provide computing resources, storage, data sources, “unique” resources

Data Capacitor

- Announced September 27,2005, $1.72 million NSF grant to build a massive short-term data storage system
- Data acts (sort of) as an incompressible fluid
- Catching the data deluge
- Parallel high speed I/O of files transported in serial
- Temporary storage between different parts of a work flow



	Production rate (TB/year)		Disk use per job (TB)		Local archive or remote data source (TB)		Published to Web (TB)	
Project	Current	2008	Current	2008	Current	2008	Current	2008
Chemistry	3.5	12,900	1	100				
Biology								
Protein structure searching			1	10	0.26	10	1	10-100
Text mining for protein sites			1	10	0.1	1		
Functional genomics	2	6	4	4-10	3*	12*	4	10
Genome assembly			10	100	2.5	10		
Genome comparisons			10	100s	0.26	10		
Bio knowledge warehousing	0.1	0.3	0.2	0.5	1-2	10s to 100s	0.5	~1
Astronomy								
WIYN 3.5M & 0.9M	3.5	3.5	1-2	≥2	7*	10-20	2	
WIYN 3.5-m+ODI		120	-	120	-	50		
High energy physics		1.5	20	100	2.5*	**		
Informatics								
Complex network analysis			10	100	1	1000		10
Linguistic analysis					1			
Computer Science								
NEXRAD Level II data management	1	5	5	5	68*	88*	4	100s
Network traffic analysis		13	1	13	12.8*	100s*		
TOTALS	**10.1**	**13049**	**-**	**-**	**≥99**	**≥1300**	**>10**	**≥100**


Indiana University – Purdue University Indianapolis
to Abilene and Commodity Internet
to Campus Network
MetaData/Web Services
MetaData Server p550
StorageTek 9310 Tape Library
1.5 TB Disk Cache
IBM SP 0.3 TFLOPS
4 X 1GigE
HP Public Switch
Cisco Switch
8 X 1GigE
Data Capacitor
AVIDD
1.2 TFLOPS
to TeraGrid
6 X 1GigE
4 X 1GigE
4 X 1GigE
1 X 10GigE
56 X 1GigE
56 OSS: 250 TB
15 X 1GigE
105 X 1GigE
32 X 1GigE
8 X 1GigE
Force10 Private Switch
Cytomics Cluster 5 TFLOPS (funded 2005)
Visualization Cluster & Barco® MoVELite
2 X 10GigE
32 Data Transfer Servers
2 MDS: 4 TB
2 X 1GigE
1 X 10GigE
I - L I G H T
I - L I G H T
Existing Connections
Proposed Connections
Indiana University Bloomington
AVIDD
105 X 1GigE
2 X 1GigE
1 TFLOP
EMC 27.2 TB NAS 6.5 TB SAN
Force10 Private Switch
4 X 1GigE
2 X 10GigE
3 X 10GigE
HP Public Switch
Cisco Switch
Campus Router
4 X 1GigE
5 X 1GigE
4 X 1GigE
Chemistry
Lindley Hall
Swain Hall
StorageTek 9310 Tape Library
1.5 TB Disk Cache
IBM SP 0.7 TFLOPS
HP 3400CL -48G Switch
HP 3400CL -48G Switch
HP 3400CL -48G Switch
Proteomics Instruments
Computer Science Cluster
Visualization Cluster & CAVE
Astronomy Cluster

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For additional info

- www.purdue.teragrid.org/
- www.itap.purdue.edu/
- www.rcac.purdue.edu/
- rac.uits.indiana.edu/
- www.iu.teragrid.org/
- uits.iu.edu/
- email: smccaula@indiana.edu
- Send email to Scott McCaulay if you are interested in getting a starter (DAC) account on the TeraGrid