GSFC Info for 11Mar04 Meeting with Level(3)

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Presentation/Discussion Topics

- GSFC overall interest: Using new IT (e.g. optical networks, SAN's, compute/data grid software to improve collaborative research among Earth scientists
- GSFC FY04 IRAD proposal recently approved for funding by GSFC's Director
- Current Issues and How Level(3) can help
  - » Transcontinental Backbone Network
  - » Regional Access Network for GSFC

GSFC FY04 IRAD Proposal "Preparing Goddard for Large Scale Team Science in the 21st Century: Enabling an All Optical Goddard Network Cyberinfrastructure"

Objectives Summary

- "…establish a "Lambda Network" (in this case using optical wavelength technology and 10 Gbps Ethernet per wavelength) from GSFC's Earth science Greenbelt facility in MD to the Scripps Institute of Oceanography (SIO) through the University of California, San Diego (UCSD) facility over the National Lambda Rail (NLR), a new national dark optical fiber infrastructure."
- "…make data residing on Goddard's high speed computer disks available to SIO with access speeds as if the data were on their own desktop servers or PC's."
- "…enable scientists at both institutions to share and use compute intensive community models, complex data base mining and multi-dimensional streaming visualization over this highly distributed, virtual working environment."

GSFC FY04 IRAD Proposal "Preparing Goddard for Large Scale Team Science in the 21st Century: Enabling an All Optical Goddard Network Cyberinfrastructure"

Examples of Initial Primary Users/Applications (1 of 2)

- Drs. Paul Houser and Mike Bosilovich of Code 970 are collaborating with Dr. John Roads of SIO on the Coordinated Earth Observing Program under GEWEX
- Dr. Roads with Dr. Max Suarez of Code 900.3, Mike Seablom of Code 560, and a UMBC graduate student working with Dr. Milton Halem, GSFC Emeritus, plan to run interactive distributed regional model forecasts using boundary forcing conditions from the Global Modeling and Assimilation Office (GMAO) global climate model
- Dr. Yoram Kaufman of Code 910 is collaborating with Dr. Ramanathan of SIO on an Aerosol project
- Dr. J. Herman of Code 910 is the Co–I with Dr. Francisco Valero of SIO who is the PI on the Triana mission

GSFC FY04 IRAD Proposal "Preparing Goddard for Large Scale Team Science in the 21st Century: Enabling an All Optical Goddard Network Cyberinfrastructure"

Examples of Initial Primary Users/Applications (2 of 2)

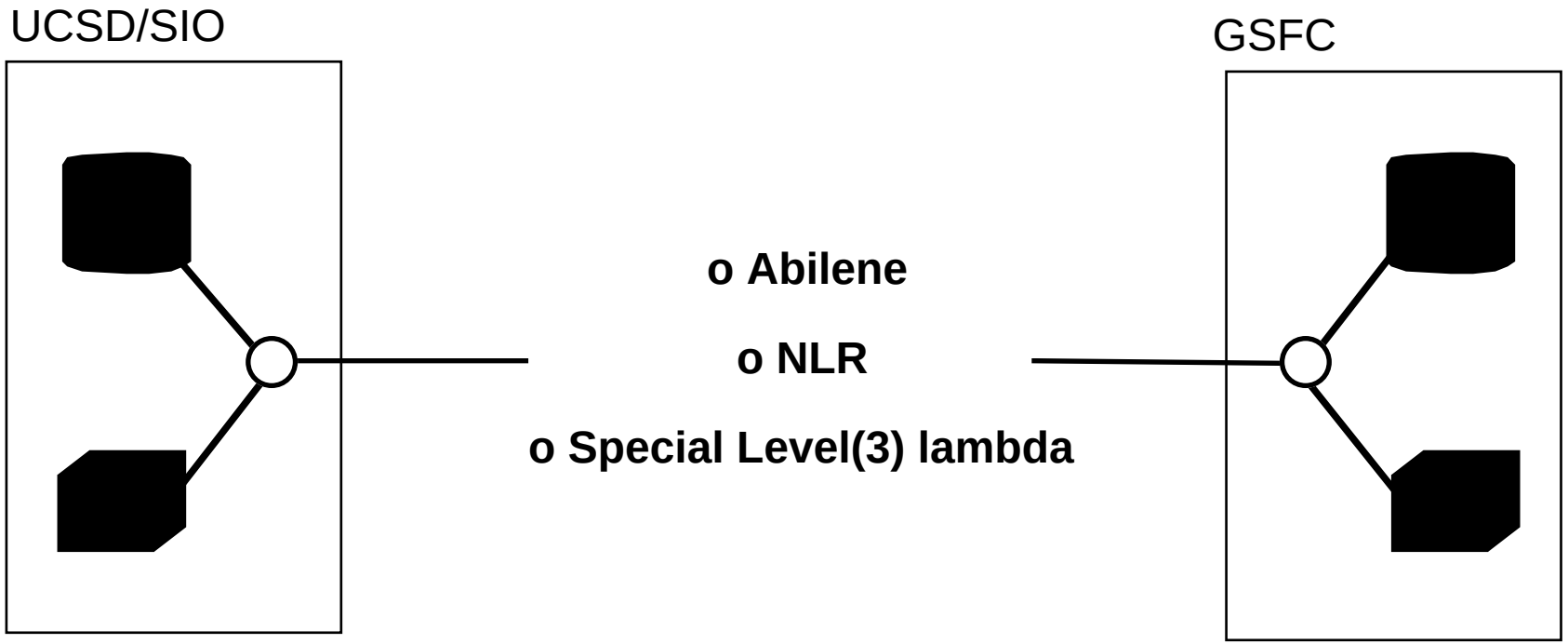
- Dr. Michelle Rienecker of Code 900.3 is collaborating with Dr. Tim Barnett of SIO on the assimilation of global sea height data from TOPEX and GRACE
- SIO's Prof. Richard Sommerville has one of his modelers remotely providing computational science support to the NCCS of Code 930
- Code 920 has collocated one of its geophysical scientists at SIO
- UCSD's Geosciences Network PI Dr. Dogan Seber has identified some of GSFC's solid earth research data sets and models for developing collaborative research efforts with Dr. Weijia Kuang and others from Code 920

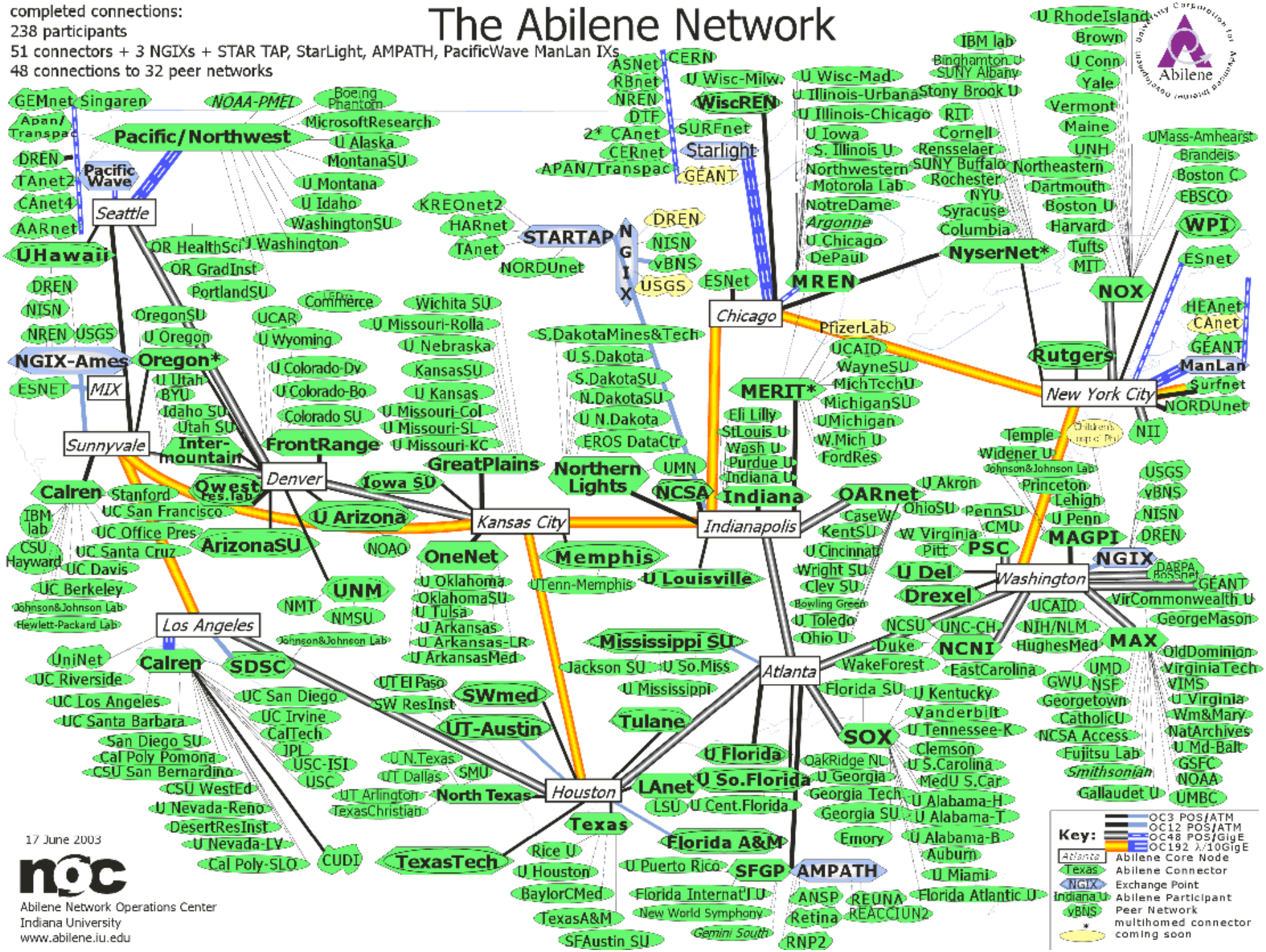
GSFC FY04 IRAD Proposal "Preparing Goddard for Large Scale Team Science in the 21st Century: Enabling an All Optical Goddard Network Cyberinfrastructure"

Technical Approach

- Transcontinental, Regional, and Local Networking
  - » Become a member of the NLR in partnership with the NREN Project, or directly through a Mid-Atlantic Terascale Partnership membership arrangement
  - » Provision a lambda between GSFC and UCSD/SIO
  - » Deploy Optical Add Drop Muxs at GSFC
  - » Interconnect GSFC's *Thunderhead* cluster in building 28 to UCSD/SIO's OptIPuter network via this Lambda Network first at 1GigE, then 10GigE
- Application Development
  - » Integrate Earth System Modeling Framework software with GRID middleware by constructing prototype interfaces between the components
  - » Identify requirements for new methods and/or messages that would be desirable for supporting GSFC models and data assimilation

Considerations for Transcontinental Backbone Network




completed connections:
238 participants
51 connectors + 3 NGIXs + STAR TAP, StarLight, AMPATH, PacificWave ManLan IXs
48 connections to 32 peer networks
The Abilene Network
Abilene
GEMnet
Singaren
Apan/ Transpac
DREN
TAnet2
CAnet4
AARnet
Pacific Wave
Pacific/Northwest
NOAA-PMEL
Boeing Phantom
MicrosoftResearch
U Alaska
MontanaSU
U Montana
U Idaho
WashingtonSU
U Washington
OR HealthSci
OR GradInst
PortlandSU
Seattle
UHawaii
DREN
NISN
NREN
USGS
NGIX-Ames
ESNET
MIX
OregonSU
U Oregon
Oregon*
U Utah
BYU
Idaho SU
Utah SU
Inter-mountain
Sunnyvale
Commerce
UCAR
U Wyoming
U Colorado-Dv
U Colorado-Bo
Colorado SU
FrontRange
Denver
Wichita SU
U Missouri-Rolla
U Nebraska
KansasSU
U Kansas
U Missouri-Col
U Missouri-SL
U Missouri-KC
GreatPlains
Iowa SU
Kansas City
KREQnet2
HARnet
TAnet
NORDUnet
STARTAP
NGIX
DREN
NISN
vBNS
USGS
ESNet
CERN
ASNet
RBnet
NREN
DTF
2* CAnet
CERnet
APAN/Transpac
U Wisc-Milw
WiscREN
SURFnet
Starlight
GÉANT
Chicago
S.DakotaMines&Tech
U.S.Dakota
S.DakotaSU
N.DakotaSU
U N.Dakota
EROS DataCtr
Northern Lights
UMN
NCSA
Eli Lilly
StLouis U
Wash U
Purdue U
Indiana U
Indiana
Indianapolis
MERIT*
U Wisc-Mad
U Illinois-Urbana
U Illinois-Chicago
U Iowa
S. Illinois U
Northwestern
Motorola Lab
NotreDame
Argonne
U Chicago
DePaul
MREN
PfizerLab
UCAID
WayneSU
MichTechU
MichiganSU
UMichigan
W.Mich U
FordRes
IBM lab
Binghamton U
SUNY Albany
Stony Brook U
RIT
Cornell
Rensselaer
SUNY Buffalo
Rochester
NYU
Syracuse
Columbia
NyserNet*
U RhodeIsland
Brown
U Conn
Yale
Vermont
Maine
UNH
Northeastern
Dartmouth
Boston U
Harvard
Tufts
MIT
NOX
UMass-Amhearst
Brandeis
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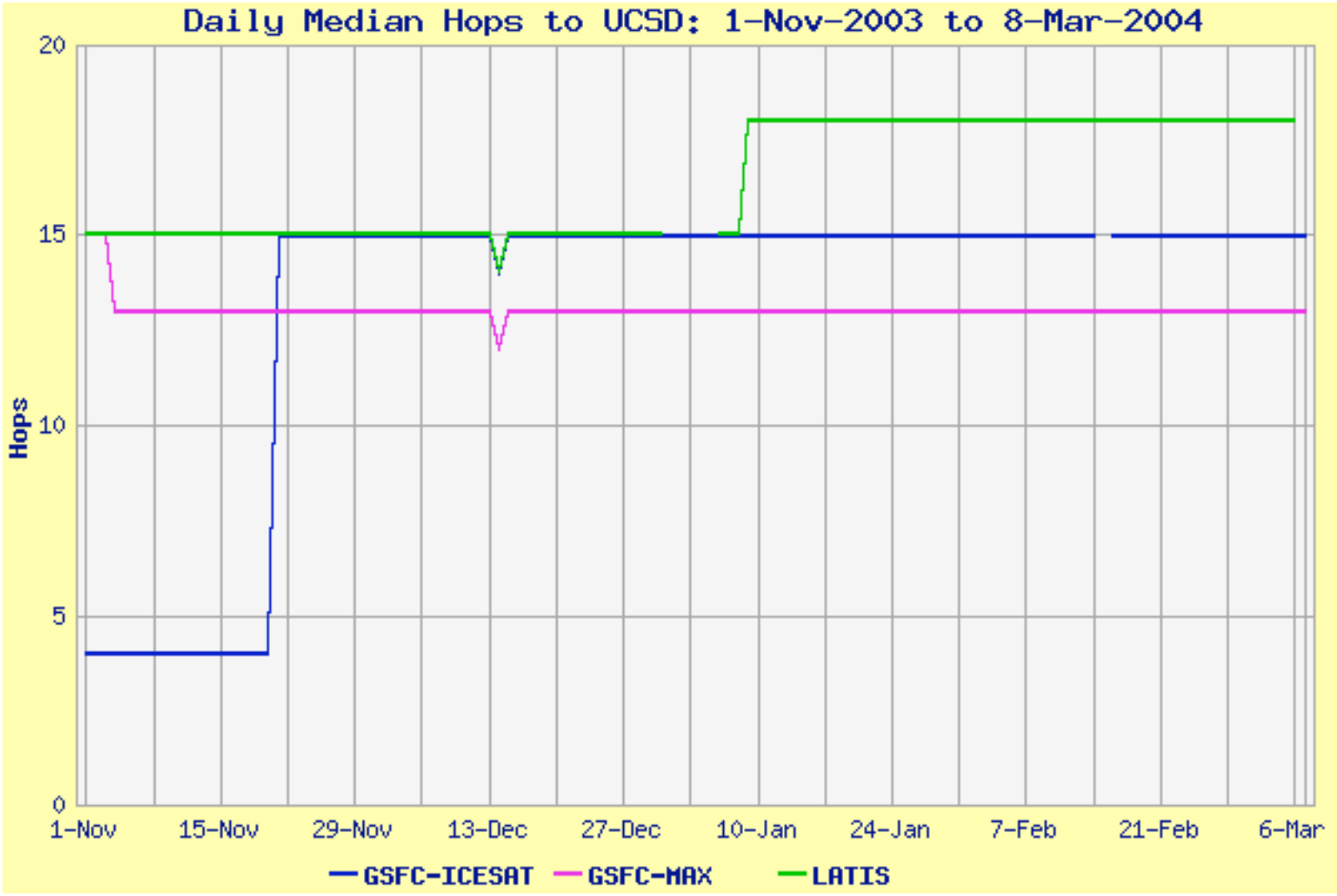
ESnet
HEAnet
CAnet
GÉANT
ManLan
Surfnet
NORDUnet
NII
Rutgers
New York City
Temple
Widener U
Johnson&Johnson Lab
Princeton
Lehigh
U Penn
OARnet
U Akron
OhioSU
CaseW
KentSU
U Cincinnati
Wright SU
Clev SU
Bowling Green
U Toledo
Ohio U
PennSU
CMU
W Virginia
Pitt
PSC
MAGPI
USGS
vBNS
NISN
DREN
NGIX
DARPA BoSSnet
GÉANT
VirCommonwealth U
GeorgeMason
MAX
OldDominion
VirginiaTech
VIMS
U Virginia
Wm&Mary
NatArchives
U Md-Balt
GSFC
NOAA
UMBC
Gallaudet U
Washington
U Del
Drexel
UCAID
NIH/NLM
HughesMed
NCSU
UNC-CH
Duke
WakeForest
Florida SU
NCNI
EastCarolina
U Kentucky
Vanderbilt
U Tennessee-K
Clemson
U S.Carolina
MedU S.Car
U Alabama-H
U Alabama-T
U Alabama-B
Auburn
U Miami
Florida Atlantic U
SOX
OakRidge NL
U Georgia
Georgia Tech
Georgia SU
Emory
Atlanta
Mississippi SU
Jackson SU
U So.Miss
U Mississippi
Tulane
U Florida
U So.Florida
LAnet
LSU
U Cent.Florida
Florida A&M
SFGP
AMPATH
Florida Internat'l U
New World Symphony
Gemini South
ANSP
REUNA
REACCIUN2
Retina
RNP2
Houston
Texas
Rice U
U Houston
BaylorCMed
TexasA&M
SFAustin SU
TexasTech
U Puerto Rico
North Texas
U N.Texas
UT Dallas
SMU
UT Arlington
TexasChristian
SWmed
UT El Paso
SW ResInst
UT-Austin
Los Angeles
Calren
SDSC
UniNet
UC Riverside
UC Los Angeles
UC Santa Barbara
San Diego SU
Cal Poly Pomona
CSU San Bernardino
CSU WestEd
U Nevada-Reno
DesertResInst
U Nevada-LV
Cal Poly-SLO
CUDI
UC San Diego
UC Irvine
CalTech
JPL
USC-ISI
USC
Calren
Stanford
UC San Francisco
UC Office Pres
UC Santa Cruz
UC Davis
UC Berkeley
Johnson&Johnson Lab
Hewlett-Packard Lab
IBM lab
CSU Hayward
Qwest Res.lab
ArizonaSU
U Arizona
NOAO
UNM
NMT
NMSU
Johnson&Johnson Lab
OneNet
U Oklahoma
OklahomaSU
U Tulsa
U Arkansas
U Arkansas-LR
U ArkansasMed
Memphis
UTenn-Memphis
U Louisville
17 June 2003
noc
Abilene Network Operations Center
Indiana University
www.abilene.iu.edu
Key:
OC3 POS/ATM
OC12 POS/ATM
OC48 POS/GigE
OC192 λ/10GigE
Atlanta Abilene Core Node
Texas Abilene Connector
NGIX Exchange Point
Indiana U Abilene Participant
vBNS Peer Network
multihomed connector
coming soon

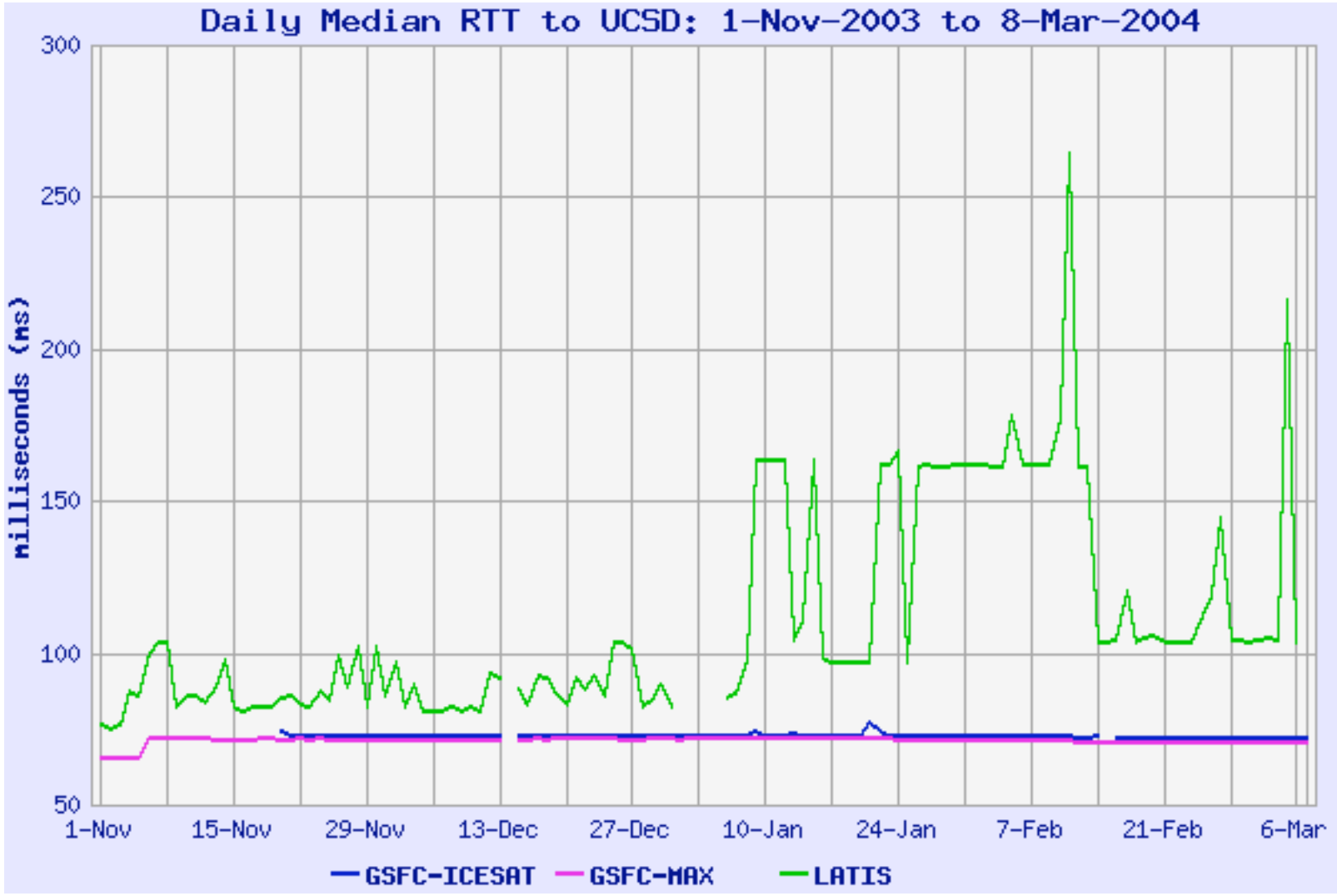
National LambdaRail (http://www.nationallambdarail.org/)

- **Provide an enabling network infrastructure for new forms and methods for research in science, engineering, health care, and education as well as for research and development of new Internet technologies, protocols, applications and services.**
- **Provide the research community with direct control over a nationwide optical fiber infrastructure, enabling a wide range of facilities, capabilities and services in support of both application level and networking level experiments and serving diverse communities of computational scientists, distributed systems researchers and networking researchers.**

Network-based Limitations of Abilene Removed with NLR

- Applications traffic must be IP-based
- 1 GE present limits at access POP's
- Shared 10 GE backbone
- Typically 13 store-and-forward router hops between GSFC and SIO; ~75 msec RTT
- Private addresses of UCSD's OptIPuter not advertised via Abilene


Daily Median Hops to UCSD: 1-Nov-2003 to 8-Mar-2004
Hops
20
15
10
5
0
1-Nov
15-Nov
29-Nov
13-Dec
27-Dec
10-Jan
24-Jan
7-Feb
21-Feb
6-Mar
GSFC-ICESAT
GSFC-MAX
LATIS


Daily Median RTT to UCSD: 1-Nov-2003 to 8-Mar-2004
milliseconds (ms)
300
250
200
150
100
50
1-Nov
15-Nov
29-Nov
13-Dec
27-Dec
10-Jan
24-Jan
7-Feb
21-Feb
6-Mar
GSFC-ICESAT
GSFC-MAX
LATIS

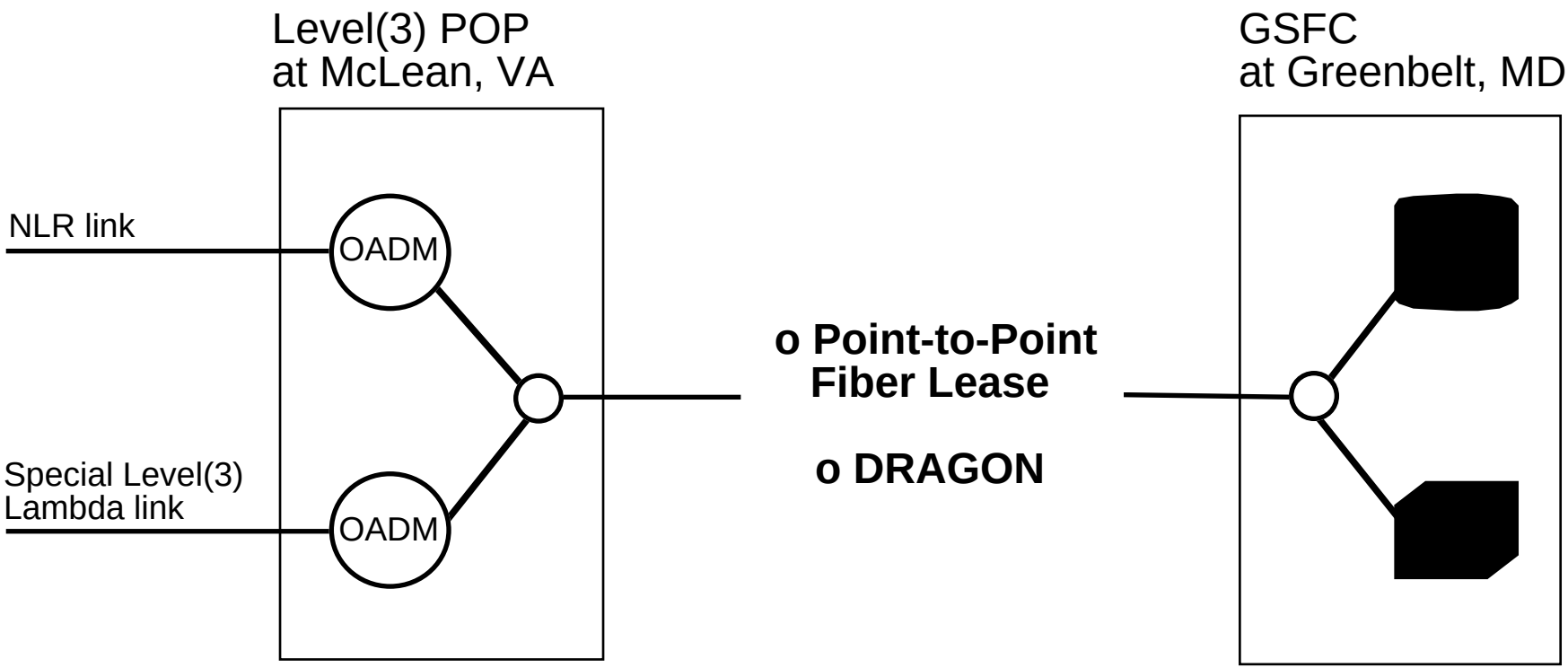
Additional Benefits of Having a Special Level(3) Lambda (vs Abilene or NLR)

- Starting Before September
  - » Early end-to-end proof-of-concept tests affect direction of EOSDIS Evolution Tiger Team
  - » Usage demos affect positive support for GSFC FY05 budget requests
- Continuing After September
  - » Enables performance comparisons with Abilene and NLR transcontinental network approaches
  - » Permits part of GSFC's FY04 funding for NLR membership and dedicated lambda implementation to be deferred and reallocated to implementing remaining network infrastructure, I.e. GSFC regional access and campus networks

Considerations for Regional Access Network for GSFC

- Via Point-to-Point Fiber Lease Approach
- Via DRAGON-based Approach
  - » For an overview to the entire DRAGON project, see http://hpn.east.isi.edu/nsf-sci/presentations/sobieski_jerry_nsf_feb_2004.pdf

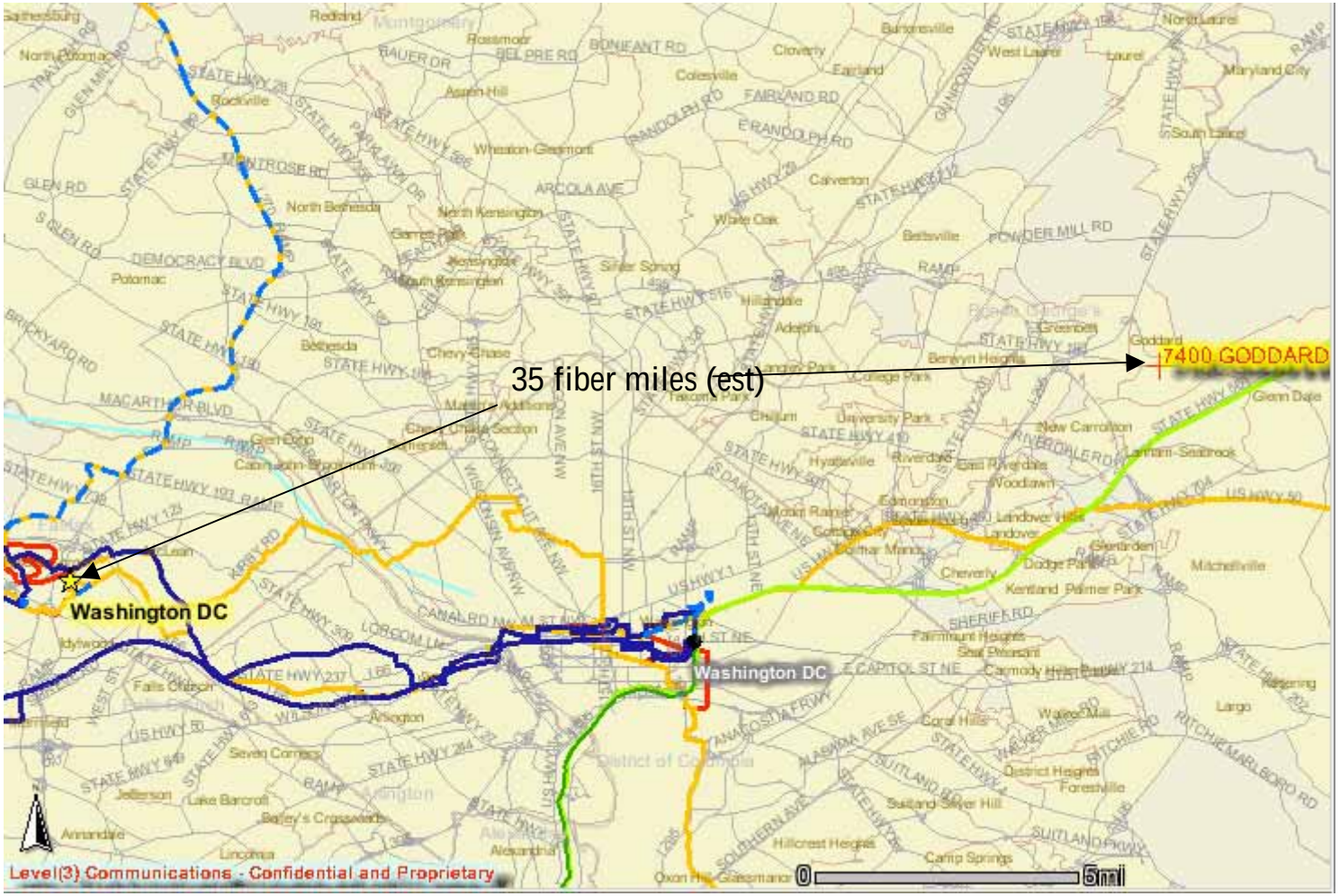
Considerations for Regional Access Network for GSFC



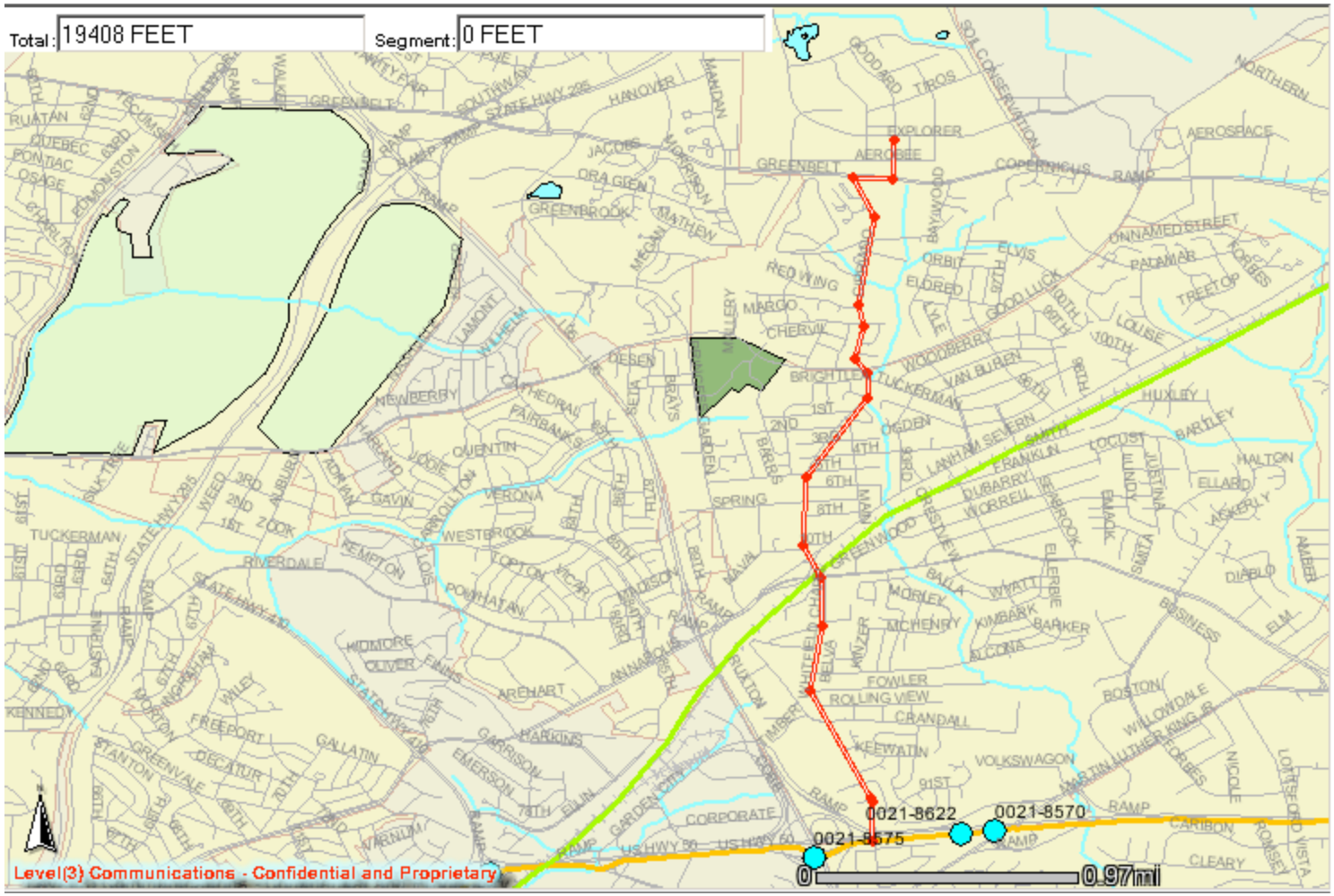
Fibers Considered in Point-to-Point Fiber Lease Approach

- **9Sep03 quotes obtained by GSFC's Jeff Smith from:**
  - Michael C. Ross
  - Account Executive
  - Level (3) Communications
  - (410) 490-1410
  - mike.ross@level3.com

GSFC – Greenbelt, MD



Goddard Space Flight Center
Lateral off of Level 3 Network

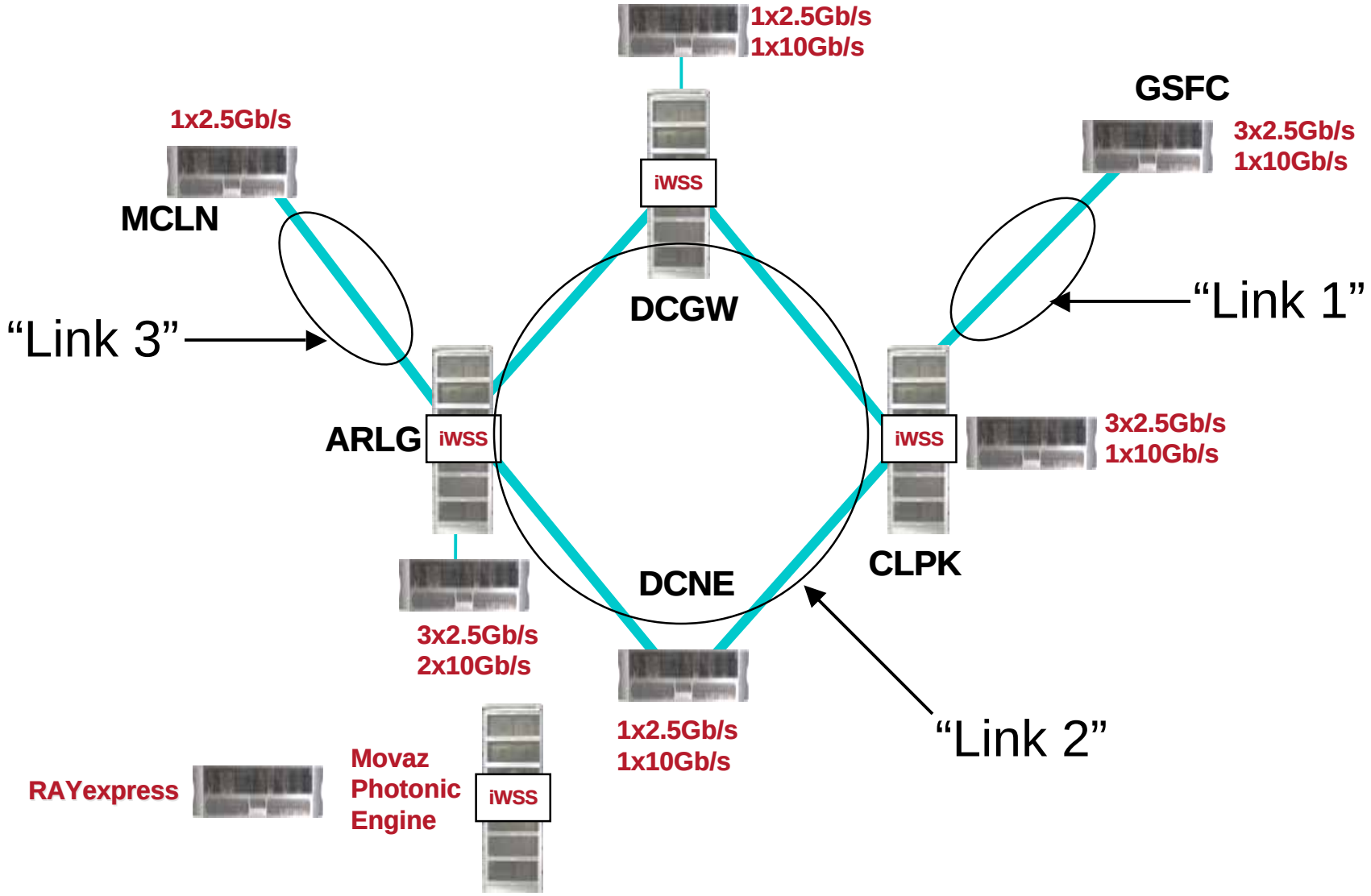


High Level Build Estimate

Fibers Considered in DRAGON-based Approach

- Fibers already “deployed” for all needed DRAGON links; and usage contracts in various states of progress
  - » “Link 1” GSFC -- UMD at College Park (UMCP): Order placed with FiberGate; expect available use in ~1 month
  - » “Link 2” UMCP -- ISI/E at Arlington & GWU in DC: In contract negotiations with Qwest; expect available use in ~2 months
  - » “Link 3” ISI/E (& GWU) -- Level(3) POP in McLean: Have quote for 20 year Indefeasible Right to Use (IRU)

DRAGON - Complete Network by Year 3



Present Issues with Plans for Regional Access Network for GSFC

- Via Point-to-Point Fiber Lease
  - » Likely facing multi-month installation schedule to close air gap
  - » Yet highly desirable as a future diverse route
- Via DRAGON
  - » For “Link 3” only, all-up-front payment for Level(3) IRU requires more planning effort and possibly multi-agency consortium support to assemble funding
  - » Rest of DRAGON-based approach is “good-to-go”

Help Level(3) Can Provide wrt DRAGON-related “Link 3” Fibers between ISI/E and McLean POP

- Enable temporary early use while funding consortium is assembled
- Permit multi-year 1/n payments for IRU rather than requiring all-up-front