DUNE Networking from FNAL Perspective and Comp. Consortium Perspective

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Two different perspectives

- DUNE Computing Consortium – data management, offline computing processing, data delivery, integration of computing resources into a coherent computing model (sites, networking, etc)
    - Working with ESNet to define use cases and establish requirements, coordinate timelines, secure funding/effort
    - I Have a good understanding of these issues
- FNAL CCD Networking Group – the experts that actually build the networks and make sure that they work, configured properly, and monitor the low-level performance
    - Working as consultants for Computing Consortium, DAQSC, and working with SURF IT experts on projects there
    - I have secondhand knowledge from presentations and discussions

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Networking slides at Sep DUNE CM

- Most of these slides were prepared for the Sep 2020 DUNE Collaboration Meeting

- Prepared by CCD Networking group and presented by Ramon Pasetes

- https://indico.fnal.gov/event/22617/timetable/#b-19090-computing-surf-sitenet

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DUNE Network

CS/CCD/NCS/Network Services

September 2020

Elements of DUNE Networking (from 39,000 ft)

Three distinct components:

1. WAN connection between FNAL & SURF (FD)

2. General purpose FD LAN

3. DAQ network at FD

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This is outside of the scope of the Comp Consortium, but CCD Networking is consulting on these designs

This is what the Comp Consortium is concerned with describing with use cases

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Component 1:
WAN Connection between FNAL & SURF

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Use Cases for DUNE Computing

DUNE Table

User/Collaborator and Location Here we list the source of data..	Do they store a primary or secondary copy of the data?	Data access method, such as data portal, data transfer, portable hard drive, or other? (please describe "other")	Avg. size of dataset? (report in bytes, e.g. 125GB)	Frequency of data transfer or download? (e.g. ad-hoc, daily, weekly, monthly)	Is data sent back to the source? (y/n) If so, how?	Any known issues with data sharing (e.g. difficult tools, slow network)?
1) FD Underground (DAQ[1])	no	create/transfer to Fermilab	30 PB/year	continuous	no	one 2GB readout every 10-100 seconds
1.5) FD Underground (temporary DAQ data[2])	no	create/transfer to Fermilab	<5 PB/year	ad-hoc	no	raw data that may be transferred temporarily for processing without long term storage.
2) FD Control[3] (DAQ, detector, cryogenics, …)	no	create/transfer to and from Fermilab	???	continuous	yes	control/DB needs very high availability
3) FD Supernova and calibrations.	no	create/transfer to Fermilab	200 TB at once	4 hrs once per month	no	needs to be very fast
4) Near Detector	no	create/transfer	1-2 PB/year	continuous	no	

5) FNAL data center	yes	ingest from 1-4 and streaming transfer out for processing on OSG/WLCG	30 PB/year	continuous	yes	ingest
6) FNAL data center	yes	transfer out to secondary tape/disk archives in Europe/Asia	30 PB/year	continuous	no	egress from FNAL
7) FNAL data center	no	transfer to HPC facilities	200 TB at once	4 hrs once per month	no	needs to be very fast
8) OSG sites	partial	transfer output back to storage at DUNE sites	12 PB/year	continuous	yes	
9) US HPC sites	no	transfer back to storage at DUNE sites	12 PB/year	continuous	yes	staged transfer and not streaming
10) CERN data center	partial	transfer to FNAL primary store and European sites	5 PB/year	continuous	yes	protoDUNE
11) European sites	partial	provide data via streaming to DUNE compute sites and collaborating institutions	12 PB/year	continuous	yes	
12) Rest of World	small	provide data via streaming/transfer	6 PB/year	continuous	yes	

- These use cases cover most everything that Comp Consortium can think of right now
- Goal is to define the requirements, work with ESNet to schedule timeline – 10 year perspective
- Good news – ESNet should be able to find funding for upgraded network
- Other news – Use cases need to be comprehensive

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WAN Connection between FNAL & SURF

- DUNE FD → FNAL network service target is 100Gb/s:
  - Dedicated circuit providing guaranteed bandwidth
  - Expectation is bandwidth demand to remain relatively constant
  - Backup/failover network service target is (currently...) 10Gb/s

- Support model is ESnet-managed end-to-end circuit to FNAL
  - ESnet router(s) deployed at SURF

- Two options currently being investigated:
  - South Dakota's higher education network (REED)
    - 100GE wave to ESnet PoP in Kansas City
  - 100GE wave from a commercial service provider

- Full end-to-end geographic diversity is objective:
 - But will be challenging to do

WAN Connection between FNAL & SURF: Option #1 – REED

- 100GE service via REED from SURF to Kansas City
  - REED = South Dakota's higher education network
    - Currently, REED only has 10GE service to SURF
    - However, upgrade to 100GE in progress (completed in Q1 CY21)
  - Waiting on cost estimates for service
 - Still investigating backup path options
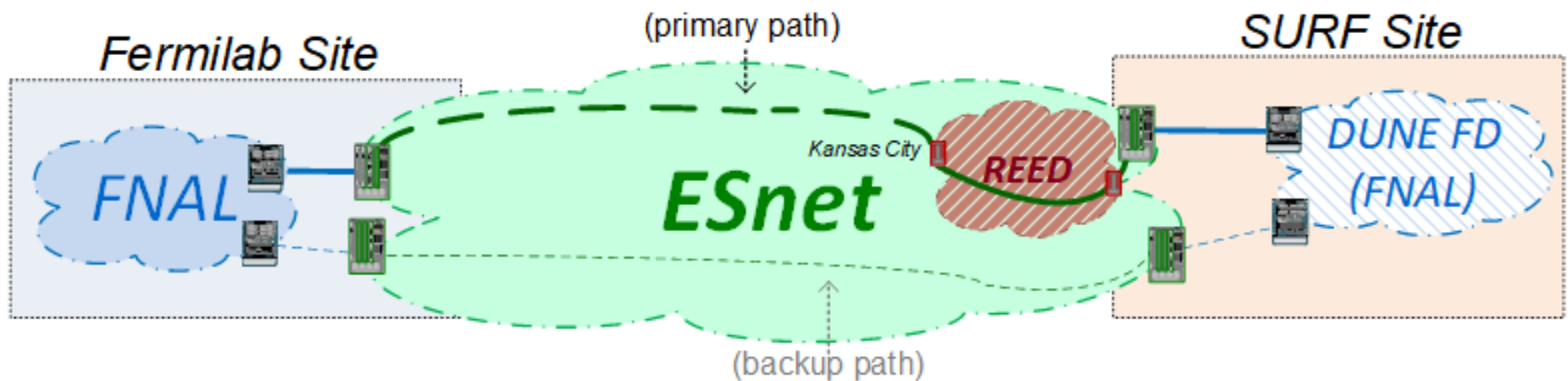
WAN Connection between FNAL & SURF:
Option #2 – Commercial Provider

- MidCom 100GE service directly to Chicago from SURF
  - Protected service available from Whitewood, SD (at higher cost)
  - Cost estimates appear to be reasonable
  - Still investigating backup/failover path options here as well

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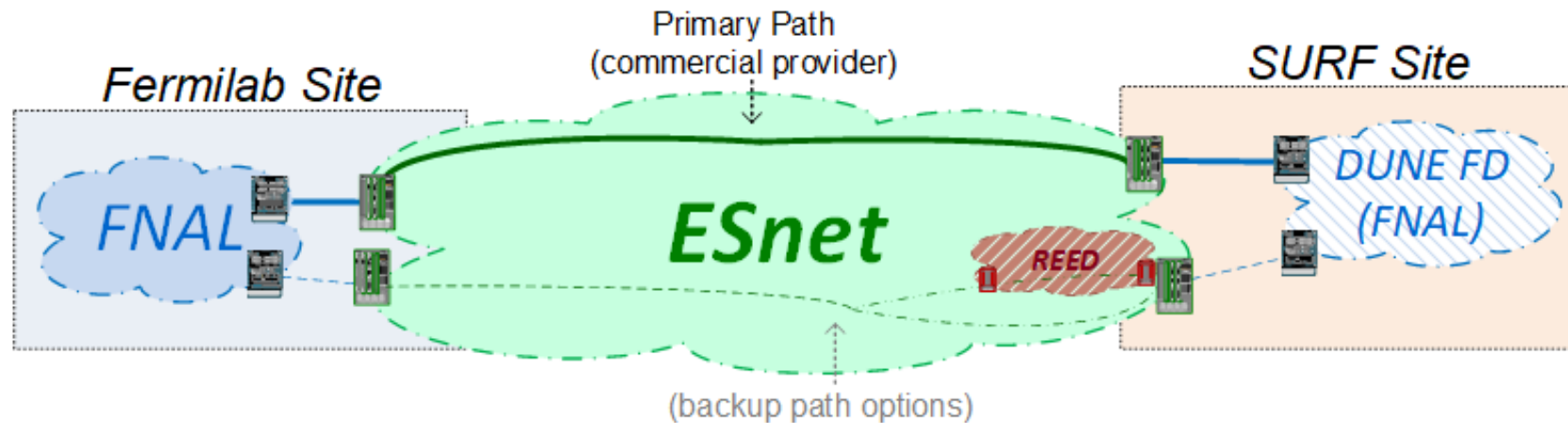
Computing Consortium - other data paths
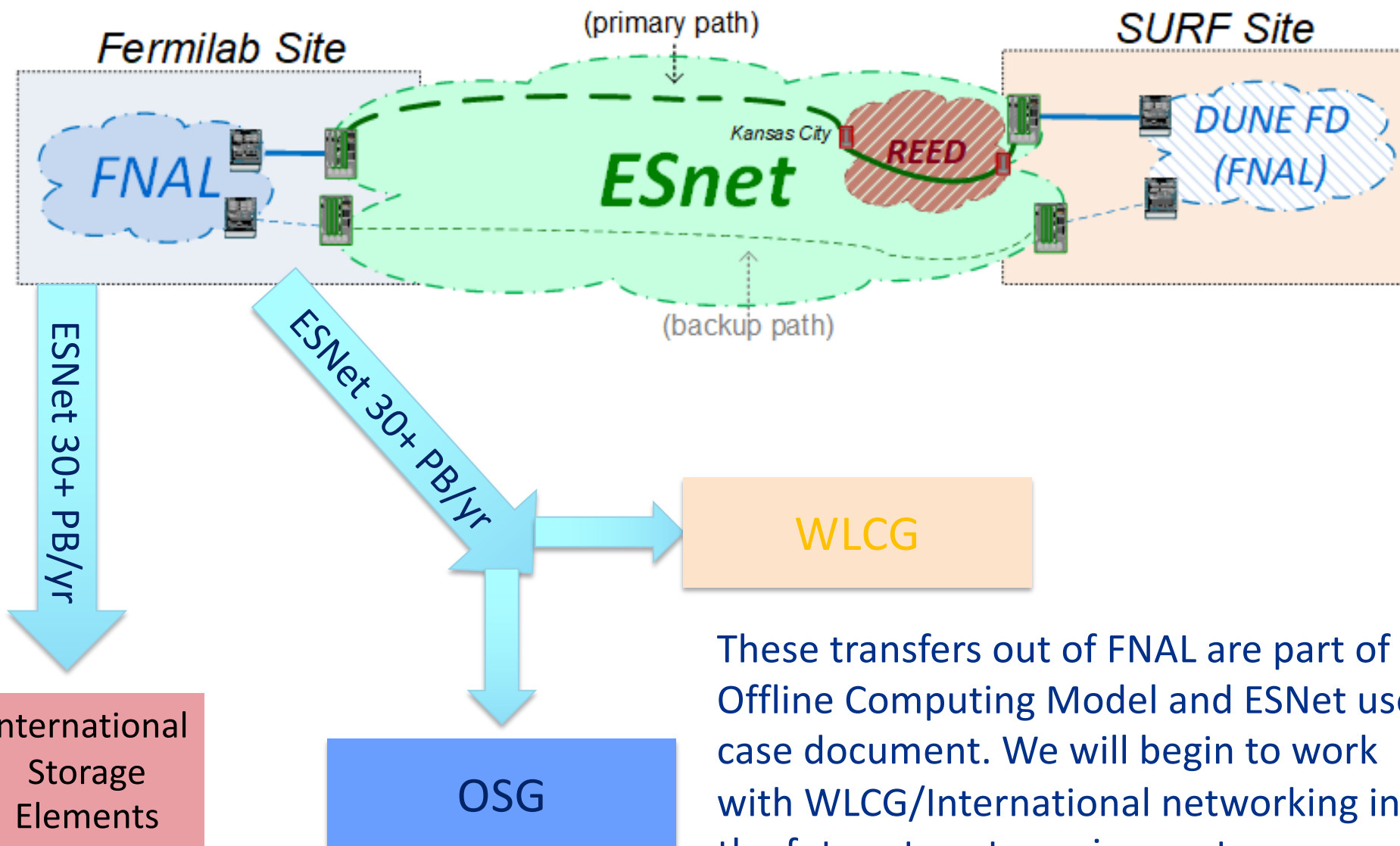
These transfers out of FNAL are part of the Offline Computing Model and ESNet use case document. We will begin to work with WLCG/International networking in the future to set requirements

WAN Connection between FNAL & SURF: Timelines & Backup Path Issues

- Current timeline plans for network service:

Timeline Summary:

Date	Stage of the experiment	Primary Path Capacity	B/W Needs Guarantee	Backup Path Capacity	B/W Needs Guarantee
2020	Cavern evacuation	VPN via SURF	<none>	n/a	n/a
2022-23	Detector construction	10-100GE	10-100Gb/s	n/a	n/a
2025	Computing/DAQ deployment	100GE	10-100Gb/s	n/a	n/a
2027	Commissioning/Ramp-up	100GE	100Gb/s	10Gb/s+	<tbd>
2028	Start of production run	100GE	100Gb/s	10Gb/s+	<tbd>

- Backup/failover path issues:
  - Geographically-diverse WAN paths appear to be available eastward from the Spearfish/Whitewood area
  - Still seeking geographically-diverse fiber into Lead
  - Diverse fiber paths within Lead & at SURF remain open issues
  - Cellular fallback has been configured for NOvA FD, but CCD networking prefer for this to be network maintenance only
  - CCD Networking available consult/acquire hardware & config

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Extra Reference Slides

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Fermilab Network Architecture & DUNE

- FNAL's network is based on a modular architecture

- DUNE network at SURF will be an extension of FNAL network facility via WAN

- Compliant with Fermilab's Cyber Security model:
  - Multiple security zones, with differing requirements for each zone

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How DUNE fits into Fermilab Network
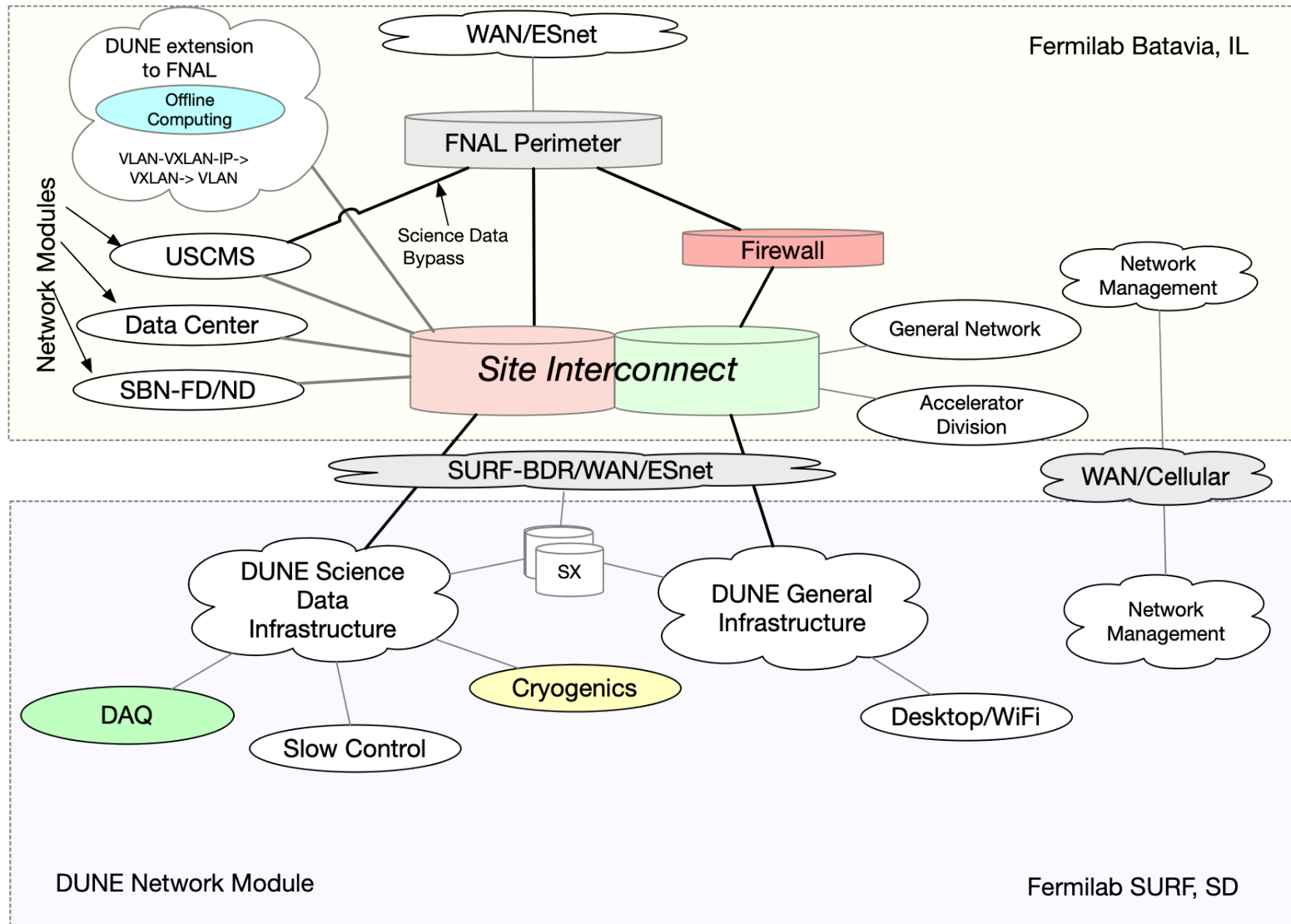
Component 2:
General Purpose FD LAN

General Purpose FD LAN:
Far Detector Local Network Status Update

- Initial Network presence in the ROSS Dry Building
  - Extension of FNAL's network via VPN tunnel
    - fgz, eduroam, guest, and printer networks extended
  - Using SURF LAN that is connected to REED at 10G
    - REED = South Dakota's Research Education & Economic Development network
  - Not to be used for data movement

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Component 3:
DAQ Network at FD

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DAQ Network at FD: Fermilab-SURF Science Data Network Status

- A draft design of 1Tbps resilient Science Data Network has been developed, assuming presence at 3 locations:
  - Detector area underground CDR/Cryo Mezz
  - Ross Dry building
  - Yates building (networking and core computing services only)

DAQ Network at FD :
Experiment's View on Network Architecture

Diagram from Dave Newbold.
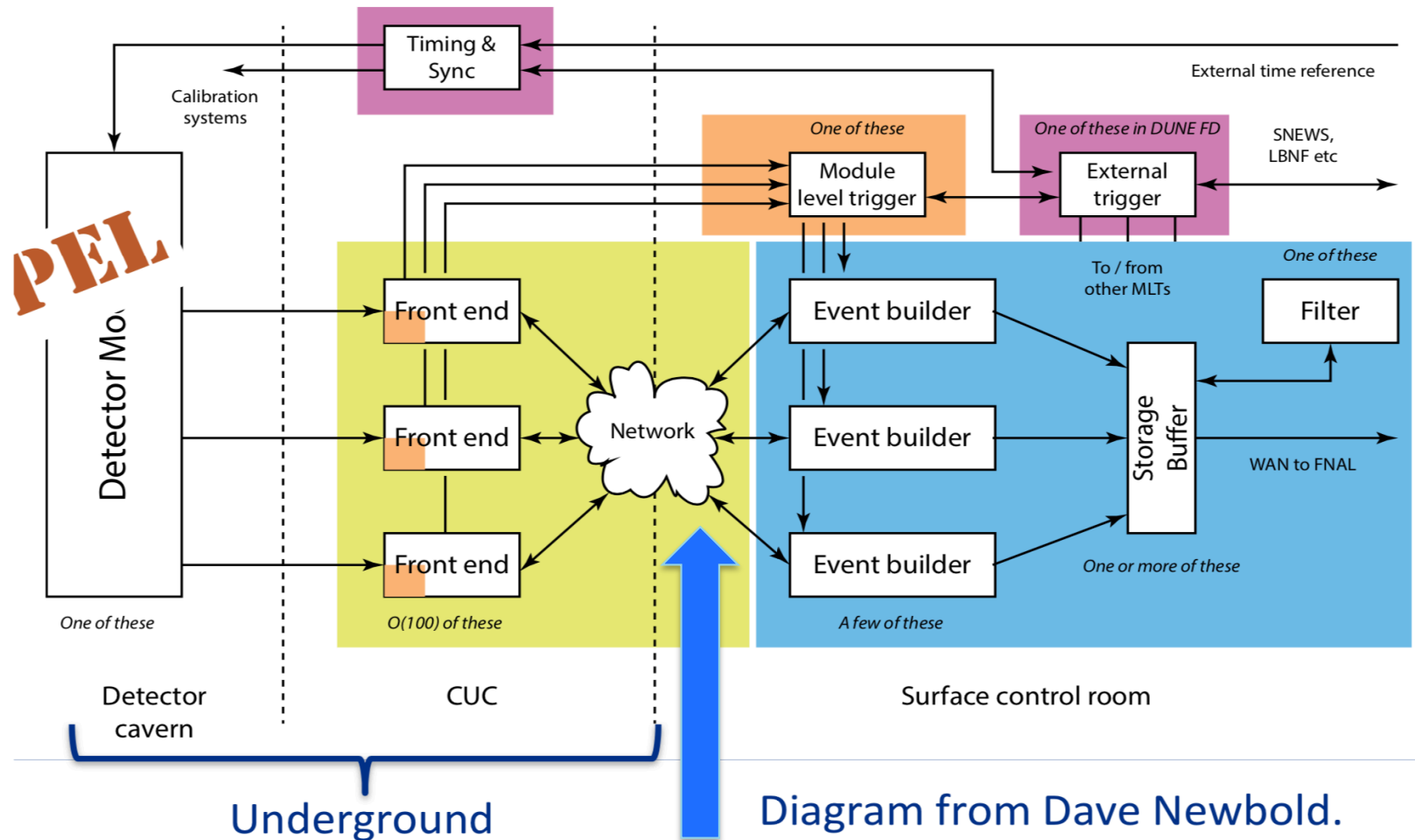
FNAL's Network Services Group will design that portion of DUNE Network

DAQ Network at FD:
Draft Design of Science Data Network at SURF

- Redundant aggregation hubs:
  - High-performance 100/400G L2/L3 switches

- Interconnected full-mesh topology by multiple 100G uplinks:
  - Upgradable to 400G in the future

- DAQ VLANs available in all locations as needed:
  - Potentially extensible to Fermilab site via VXLAN technology

- Top-of-Rack access switches with Nx100G redundant uplinks

Fermilab's Networking roles as of 09.2020
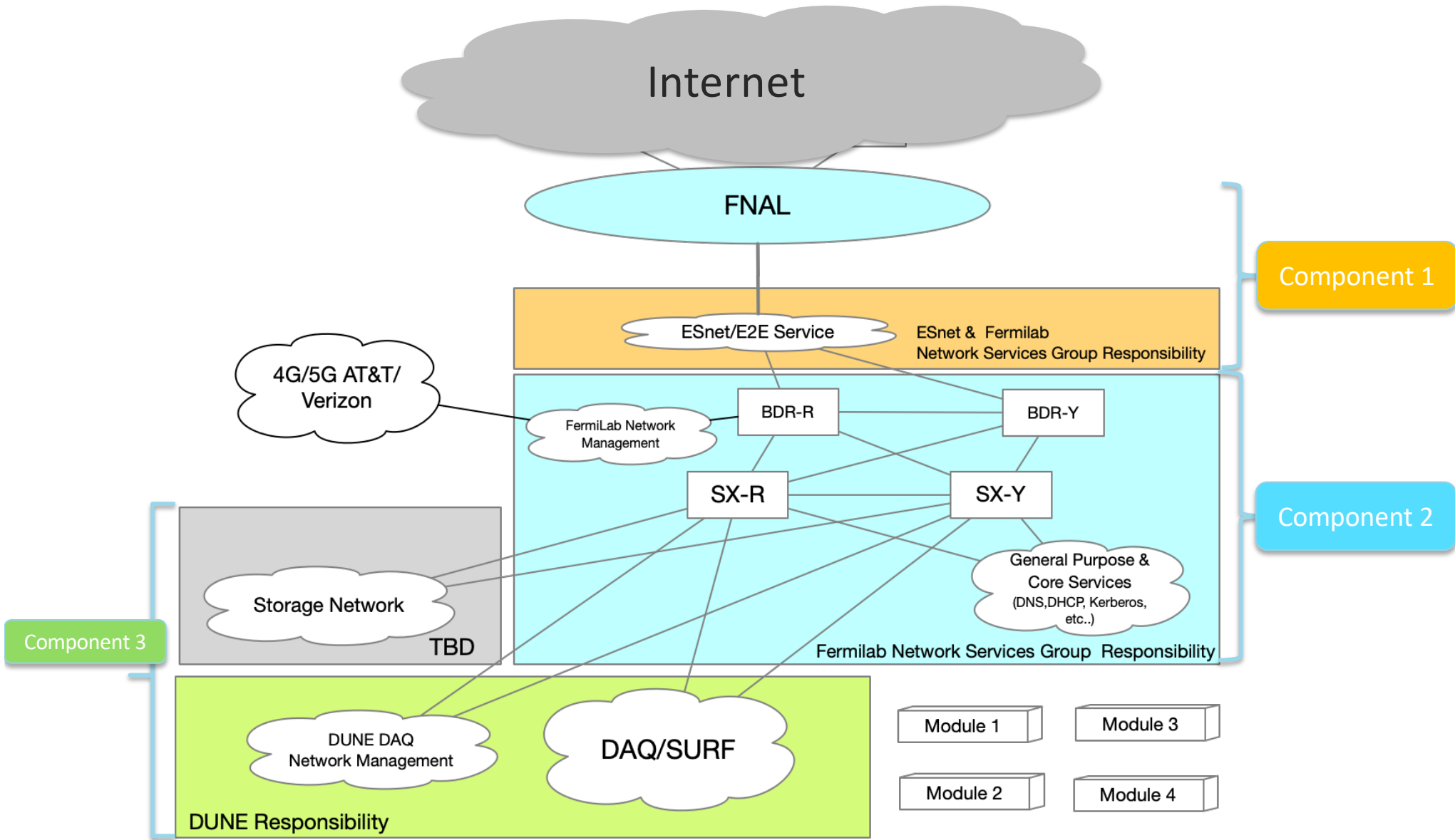
Fermilab's Networking roles as of 09.2020

From Fermilab LBNF/DUNE Memorandum of Agreement (DUNE-Doc#19276:

- General campus wired and wireless networking
  - Private network and General Purpose Network.
- Essential services to allow DUNE to collect and share scientific data from the Far Site.
- ESNET connectivity to support the transfer of DUNE data from SURF
- LBNF/DUNE-US will utilize SCD servers and services for MARS and other physics simulations
- The LBNF/DUNE-US Project will be reliant on the Fermilab CCD for maintenance and operations of the TeamCenter, Docdb and Indico systems

South Dakota's Research Education & Economic Development (REED) network {Q3 CY20}

Legend:
- `100` 100GE today
- `100` 100GE in progress (10GE today...)
- (Possible alternate path to ESnet at Denver)

Line types:
- SDN Fiber
- SDN – BU
- NDSU –MidCo Fiber
- UNL – L3 Fiber

Locations / Nodes:
- Fargo NDSU
- Northern Lights at UMN
- Aberdeen NSU 2x10G Upgrade to 100G In Budget
- Spearfish BHSU 2x10G Upgrade to be determined
- Pierre BIT 2x10G + 100G In October
- Brookings SDSU 2x10G Upgrade to 100G in October
- Madison DSU 2x10G Upgrade to 100G in budget
- Sioux Falls EROS 1x10G
- SURF (DUNE)
- Lead SURF 1x10G
- Rapid City SDN core SDSMT 2x10G Upgrade to be determined
- Sioux Falls SDN core USD – 3x100G In October
- Vermillion USD 2x10G Upgrade to 100G in budget
- Omaha – Carrier hotel 2x100G In October
- Univ. of Neb. fiber
- GPN – Level3 Kansas City 2x100G In October
- ESnet (Kansas City)

Notes:
REED upgrade to 100G from GPN in Kansas City along the North-South path to NDSU in Fargo continuing to UMN in Minneapolis in current budget

SDN loop through Pierre will also be upgrade to 100G as a backup

Path from Aberdeen to Kansas City scheduled for completion during October and Novermber

Path from Aberdeen to Minneapolis technology requirements have been defined. Scheduling of upgrade from Aberdeen to UMN likely in December-January timeframe

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