

# Belle II DC24

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WLCG/HSF Workshop 2024  
Hamburg - Germany  
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# Belle II Data Challenge 2024

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## What should be exercised during DC24:

Technology that can be stressed: Network, DDM, FTS, Storages, Monitoring System, Protocols.

## Main goal: Emulate data transfer conditions in a Belle II high-lumi scenario

Our current estimation for such scenario is 40 TB per day.

Transfers from KEK to RAW Data Centers according to our distribution schema (30%BNL, 20%CNAF, 15%IN2P3CC, 15%UVic, 10%DESY, 10%KIT)

Considering that the average speed needed to transfer 40TB/day is 3.7Gbit/s in outbound at KEK vs all the Raw Data Centers.

- Min - The target speed to achieve is  $3 \times 3.7 \text{ Gbit/s} = \mathbf{11.1 \text{ Gbit/s}}$
- Max - The target speed to achieve is  $5 \times 3.7 \text{ Gbit/s} = \mathbf{18.5 \text{ Gbit/s}}$

# Belle II Data Challenge 2024

Storage Name	Site	Country	#5G Files	Minimal x3		Maximal x5	
				Ingress (Gbps)	Egress (Gbps)	Ingress (Gbps)	Egress (Gbps)
KEK-TMP-SE	KEK	JP	8000	0,0	11,1	0,0	18,5
BNL-TMP-SE	BNL	US	2400	3,3	0	5,6	0
CNAF-TMP-SE	CNAF	IT	1600	2,2	0	3,7	0
DESY-TMP-SE	DESY	DE	800	1,1	0	1,9	0
KIT-TMP-SE	KIT	DE	800	1,1	0	1,9	0
IN2P3CC-TMP-SE	IN2P3CC	FR	1200	1,7	0	2,8	0
UIVc-RAWTMP-SE	UIVc	CA	1200	1,7	0	2,8	0
Napoli-TMP-SE	Napoli	IT	TBD	TBD	TBD	TBD	TBD
SIGNET-TMP-SE	SIGNET	SL	TBD	TBD	TBD	TBD	TBD



# Testing script

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We started by a predefined dataset stored at KEK and reused multiple times for transfers.

All transfers have been done using DAVS protocol and the RUCIO+FTS production infrastructure.

Test automation done via a Python script that it operates on a cyclical base as follow:

At each cycle, the script checks for existing replication rules associated with specific datasets.

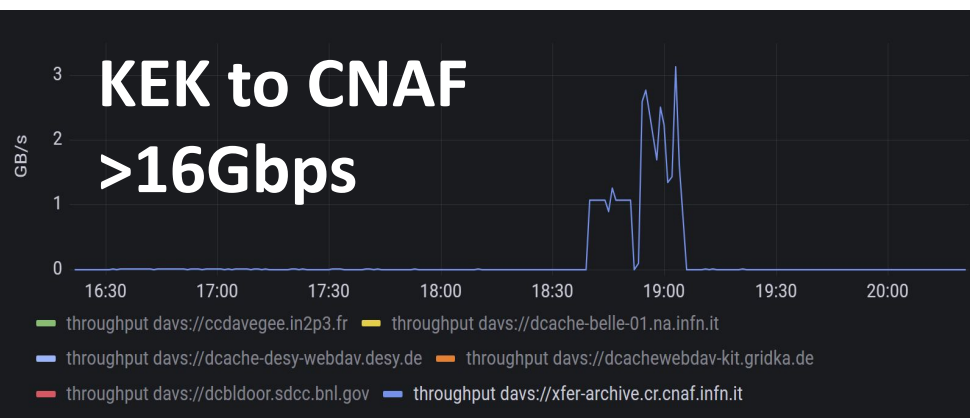
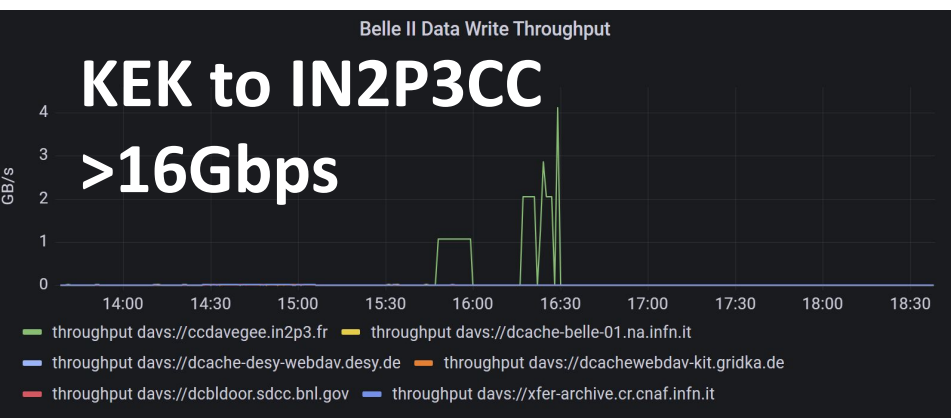
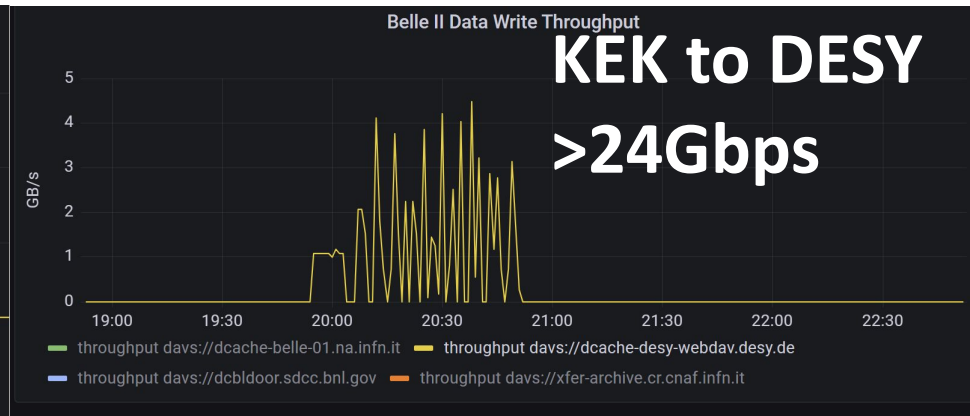
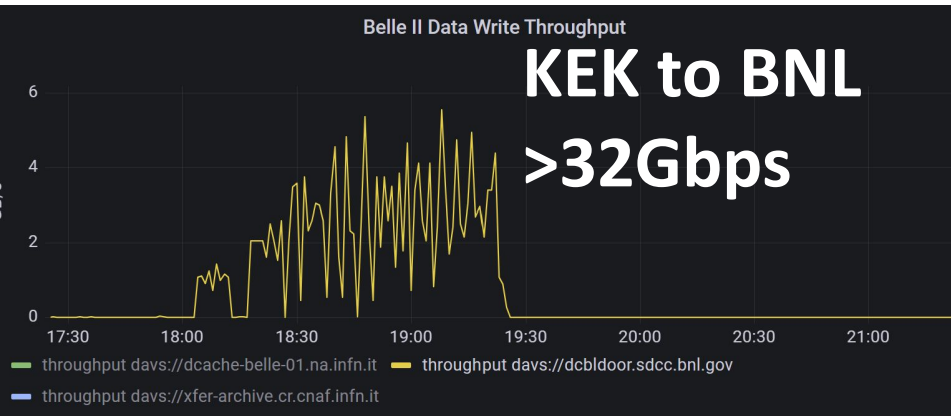
If no rule is found for a particular site, it verifies the presence of data replicas at that site.

If replicas are absent, a new replication rule is created.

When a replication rule exists but the replication is completed, the script triggers a deletion instruction.

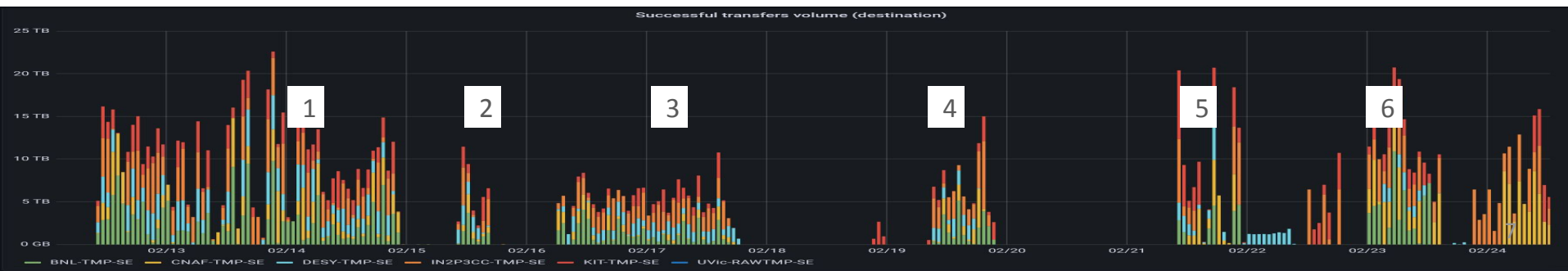
**N.B. Only GSI authentication has been used**

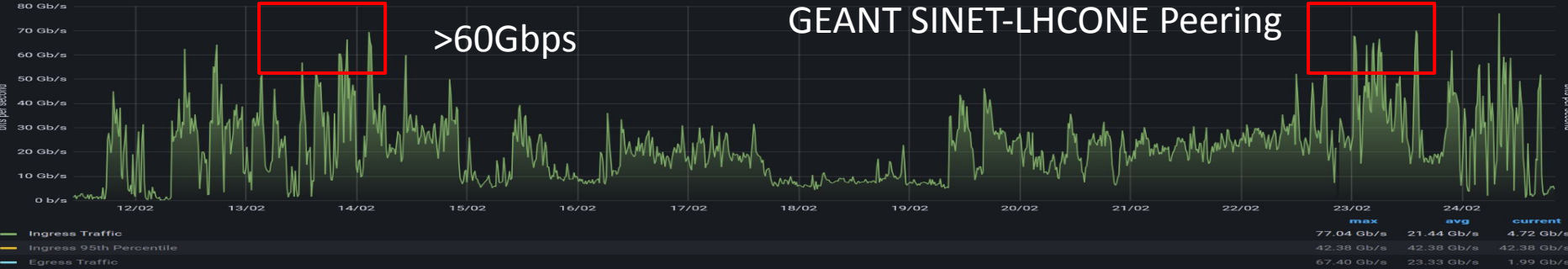
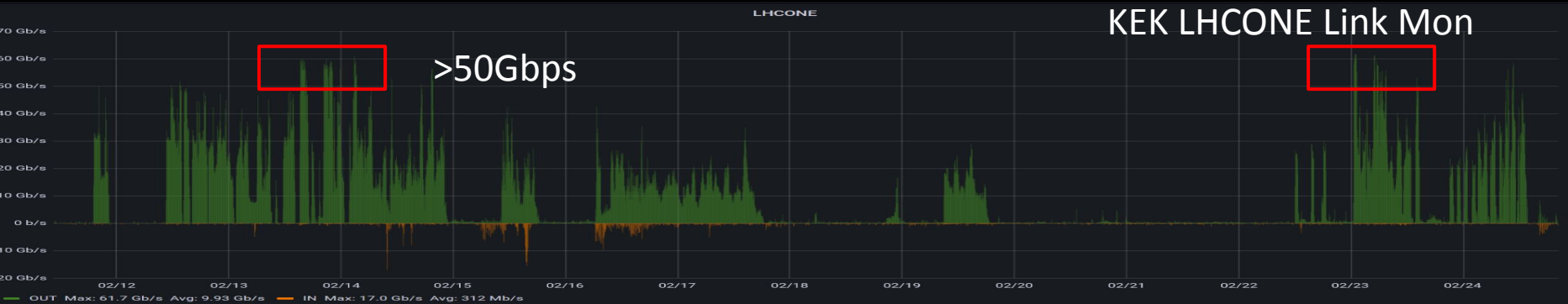
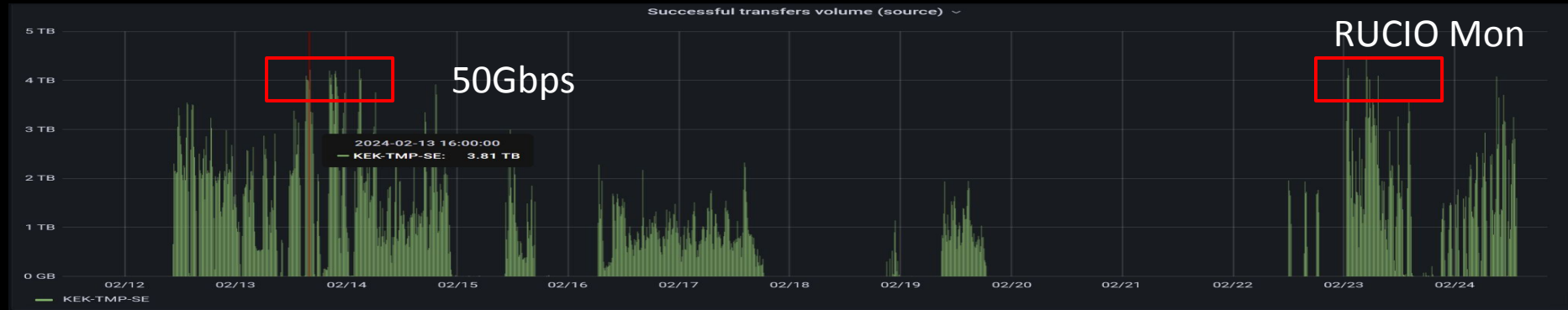
# FTS pre-test in January



# Belle II DC24 Activities

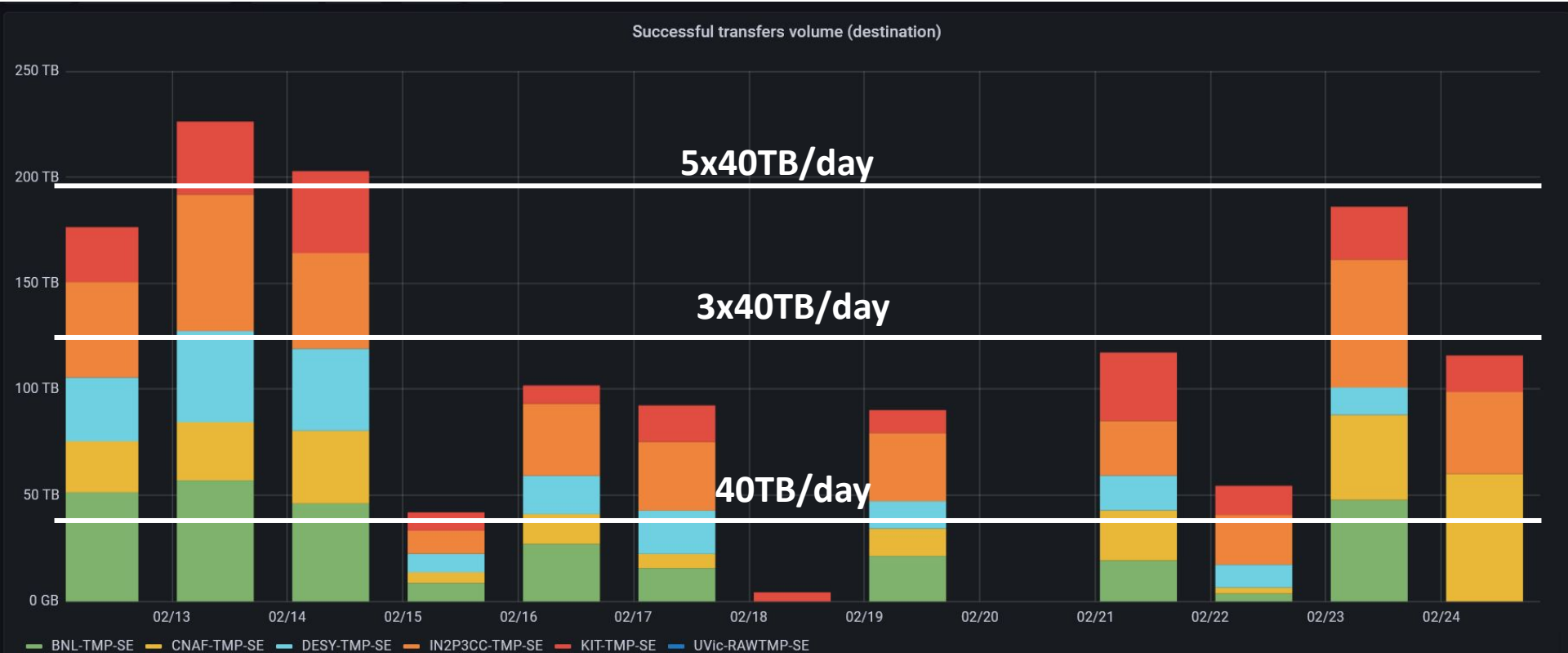
	DATE	Test	TOT	Peak (1h)	Average
1	12/02/2024 9:00 to 14/02/2004 23:00	KEK vs RAW DC (kek2-fts03 - v3.12.1)	606 TB/61h	50 Gbps	22,0 Gbps - Reached Max goal
2	15/02/2024 9:00 to 15/02/2024 16:00	KEK vs RAW DC (kek2-fts01 older)	39,9 TB/7h	25 Gbps	12,6 Gbps - Reached Min goal
3	16/02/2024 6:00 to 17/02/2024 19:00	KEK vs RAW DC (kek2-fts01)	194 TB/38h	24 Gbps	11,3 Gbps - Reached Min goal
4	19/02/2024 8:30 to 19/02/2024 21:30	KEK vs RAW DC + RAW DCs vs RAW DCs	80 TB/13h	27 Gbps	13,7 Gbps - Mixed traffic
5	21/02/2024 10:00 to 22/02/2024 9:00	RAW DCs vs RAW DCs (kek2-fts03)	141 TB/23h	46 Gbps	13,6 Gbps - Mixed traffic
6	23/02/2024 0:00 to 23/02/2024 14:00	KEK vs RAW DCs (kek2-fts03)	178 TB/15h	46 Gbps	26 Gbps - Reached Max goal





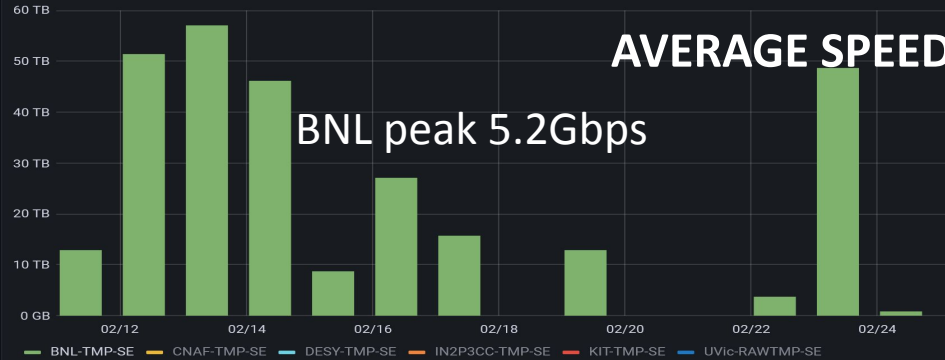


# Traffic per Day View vs Goals

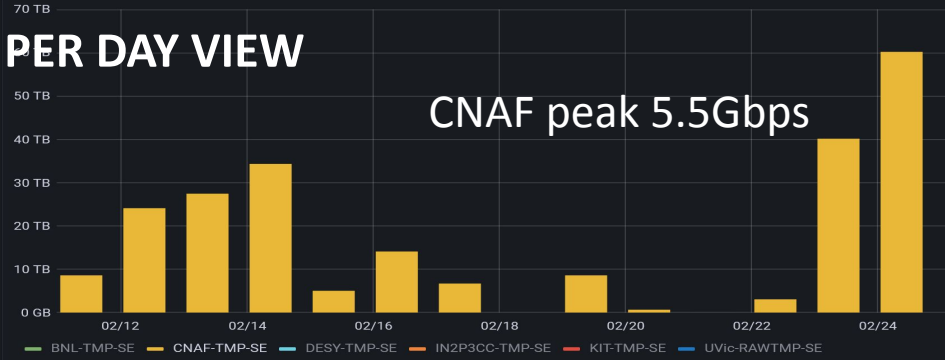


# AVERAGE SPEED PER DAY VIEW

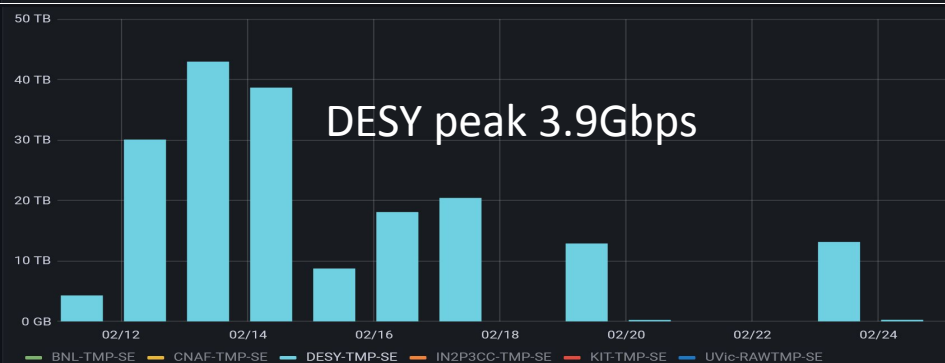
BNL peak 5.2Gbps



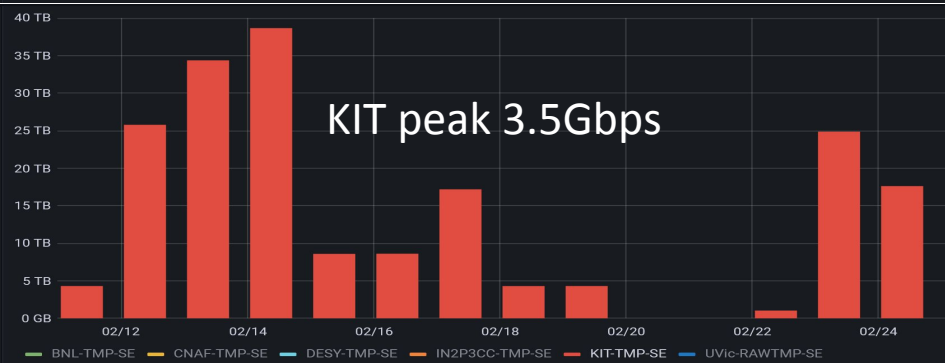
CNAF peak 5.5Gbps



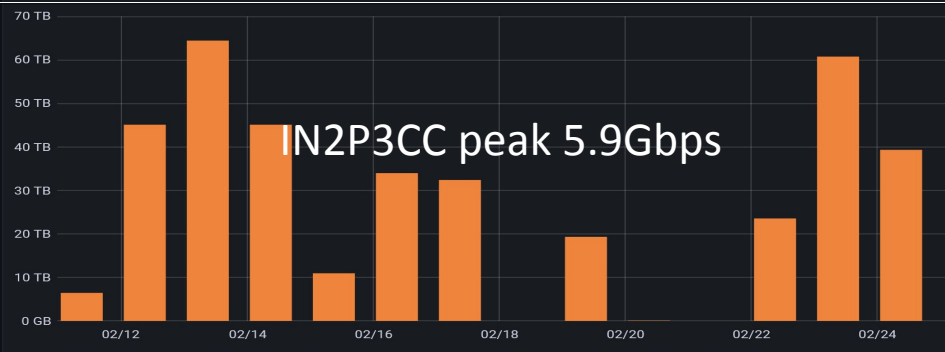
DESY peak 3.9Gbps



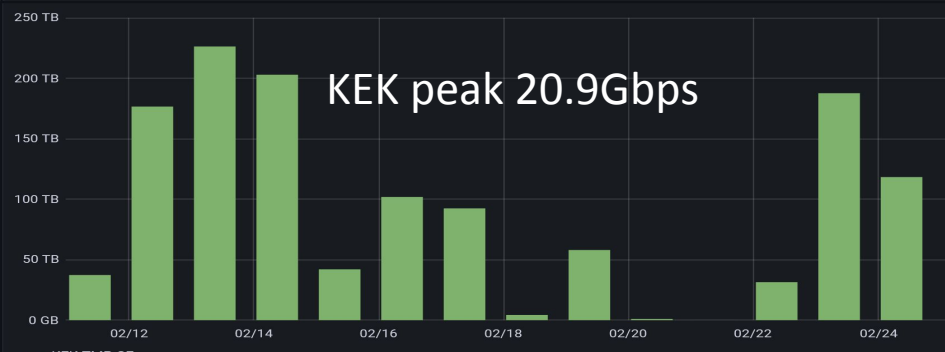
KIT peak 3.5Gbps



IN2P3CC peak 5.9Gbps

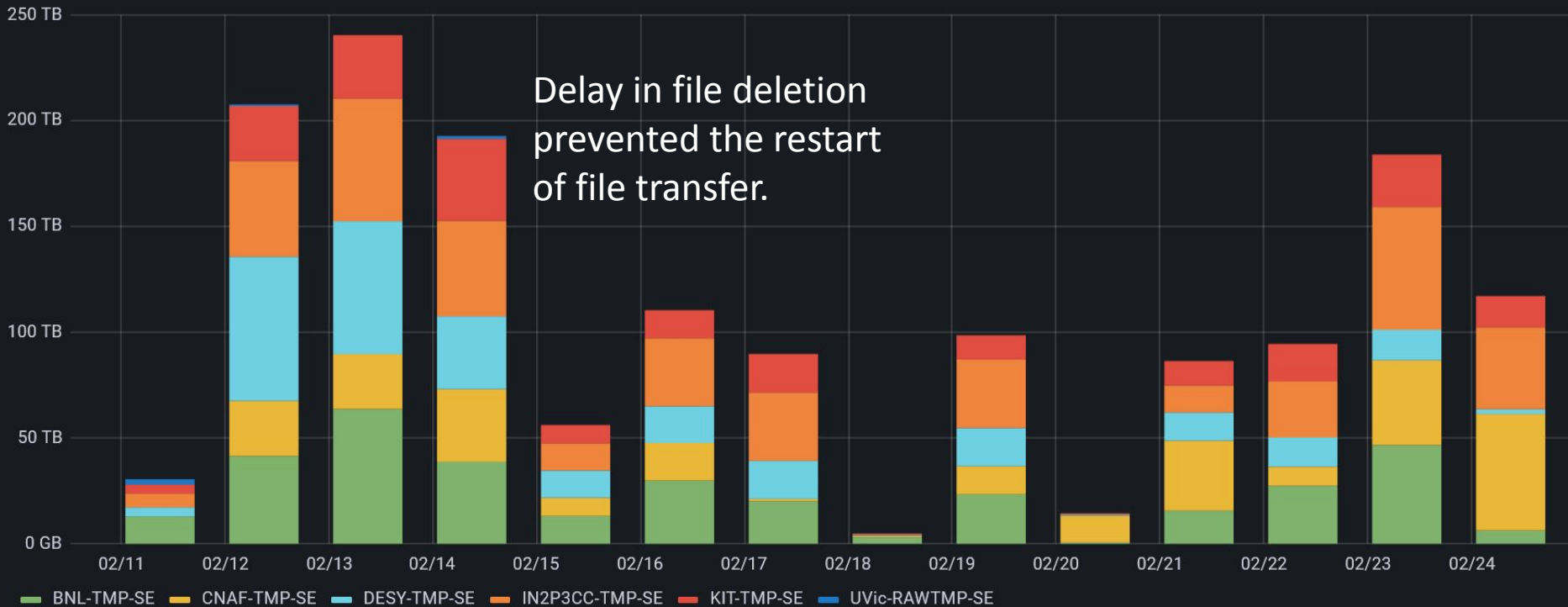


KEK peak 20.9Gbps



# Deleted Volume

Successful deletion volume

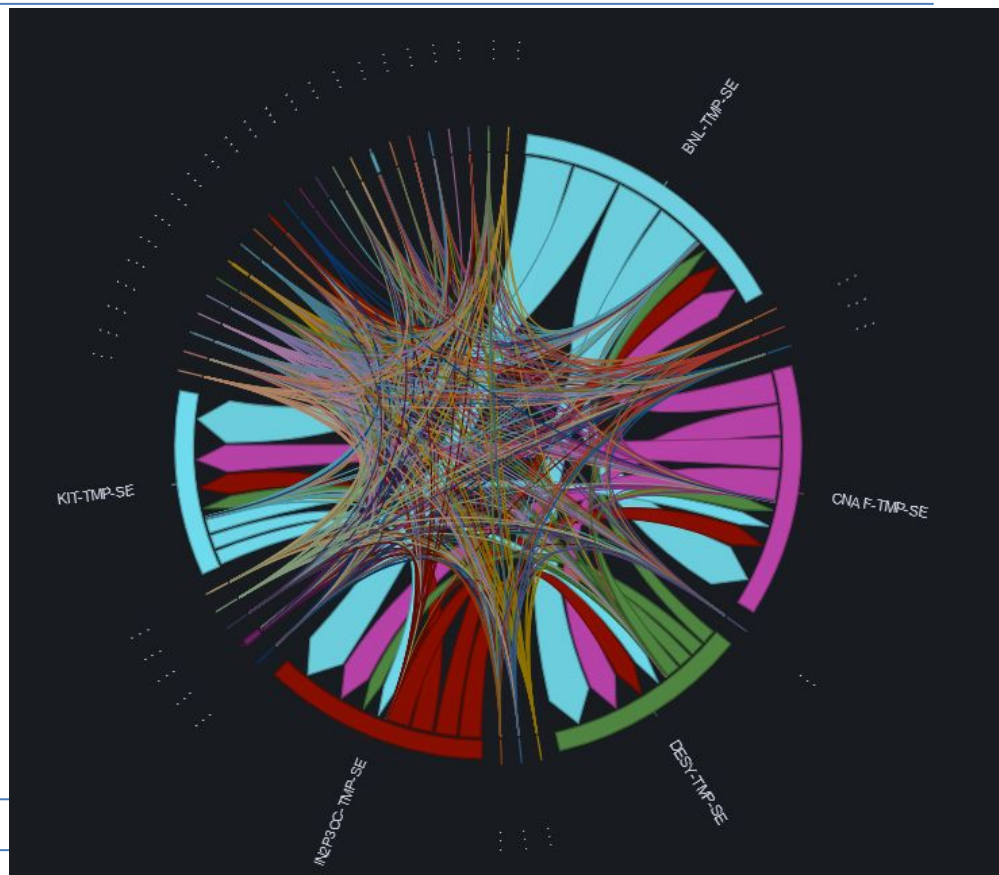


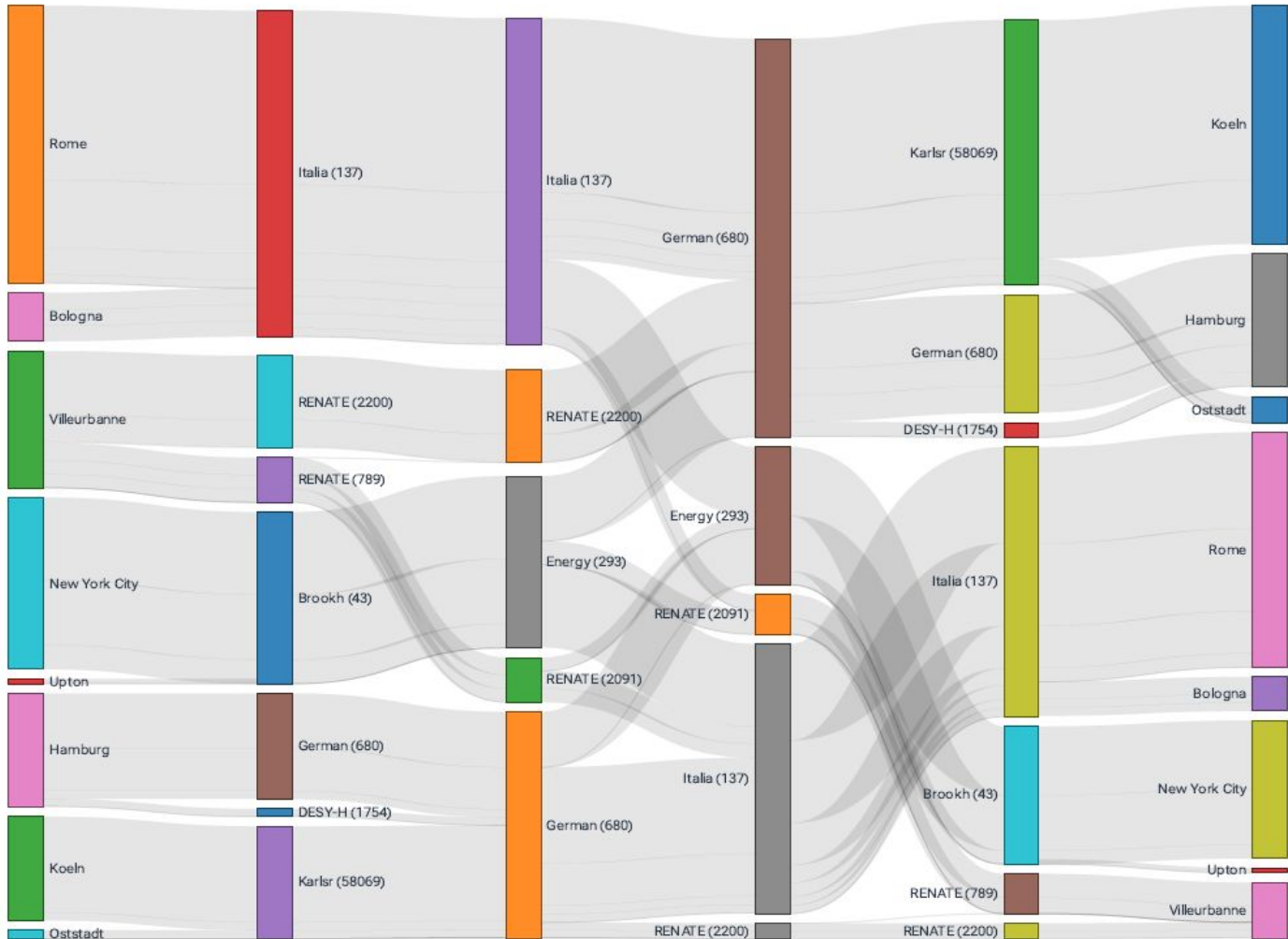
# Traffic among RAW Data Centres 21/02/2024 9:00 to 22/02/2024 9:00



Expected routing table. Tentative of flow analysis ongoing.

	BNL	KIT	CNAF	DESY	IN2P3CC	Uvic
BNL		LHCOPN	LHCOPN	LHCONE	LHCONE	GeneralIP
KIT	LHCOPN		LHCONE	LHCONE	LHCONE	GeneralIP
CNAF	LHCOPN	LHCONE		LHCONE	LHCONE	GeneralIP
DESY	LHCONE	LHCONE	LHCONE		LHCONE	GeneralIP
IN2P3CC	LHCONE	LHCONE	LHCONE	LHCONE		GeneralIP
Uvic	GeneralIP	GeneralIP	GeneralIP	GeneralIP	GeneralIP	





# Lessons learnt and next steps

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The bandwidth appears to be sufficient for RAW transfer even in conjunction with the traffic generated by the LHC experiment.

Different monitoring tools can show slightly different values, so it is important to define the bin and the time window for monitoring in advance.

For the next tests, we should improve the deletion process to avoid periods with unused storages. Additionally, we should inject extra traffic other than the RAW Data Export to simulate a more realistic scenario of bandwidth utilization.

Other technologies not yet exercised:

- Token authentication
- Packet marking

# Personal considerations

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The Data Challenge has proven to be a potent tool for gaining a comprehensive understanding of network usage and to be a powerful technology deployment accelerator. This initiative has also fostered stronger collaboration among various experiment groups and teams.

The effort looks to be appreciated by NRENs. I've had high support from GARR. Additionally, other communities have expressed interest in participating, with the Data Challenge being incorporated into the proposal of the European project JENNIFER3, in collaboration with T2K and HyperK.

Thank you so much to all individuals involved, including Belle II members, network administrators, and site administrators, for their support. Special acknowledgment goes to the WLCG-DOMA working group for their efforts in organizing the challenge.

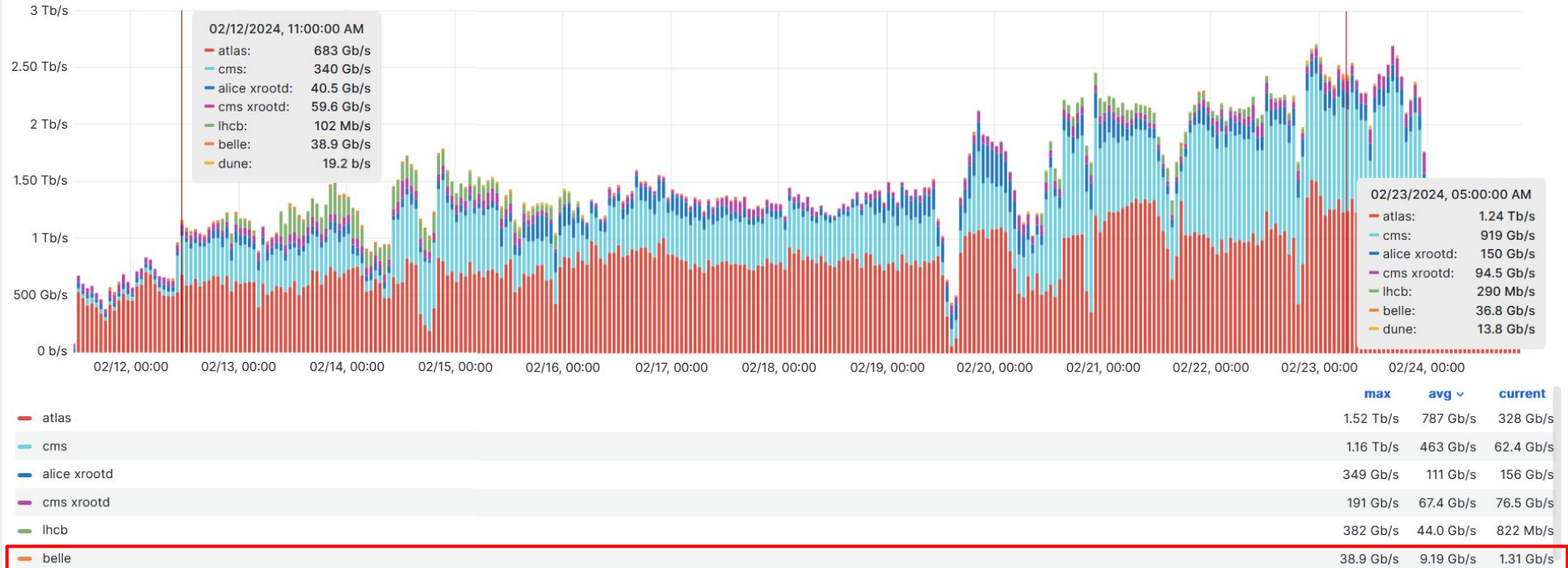
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# BACKUP



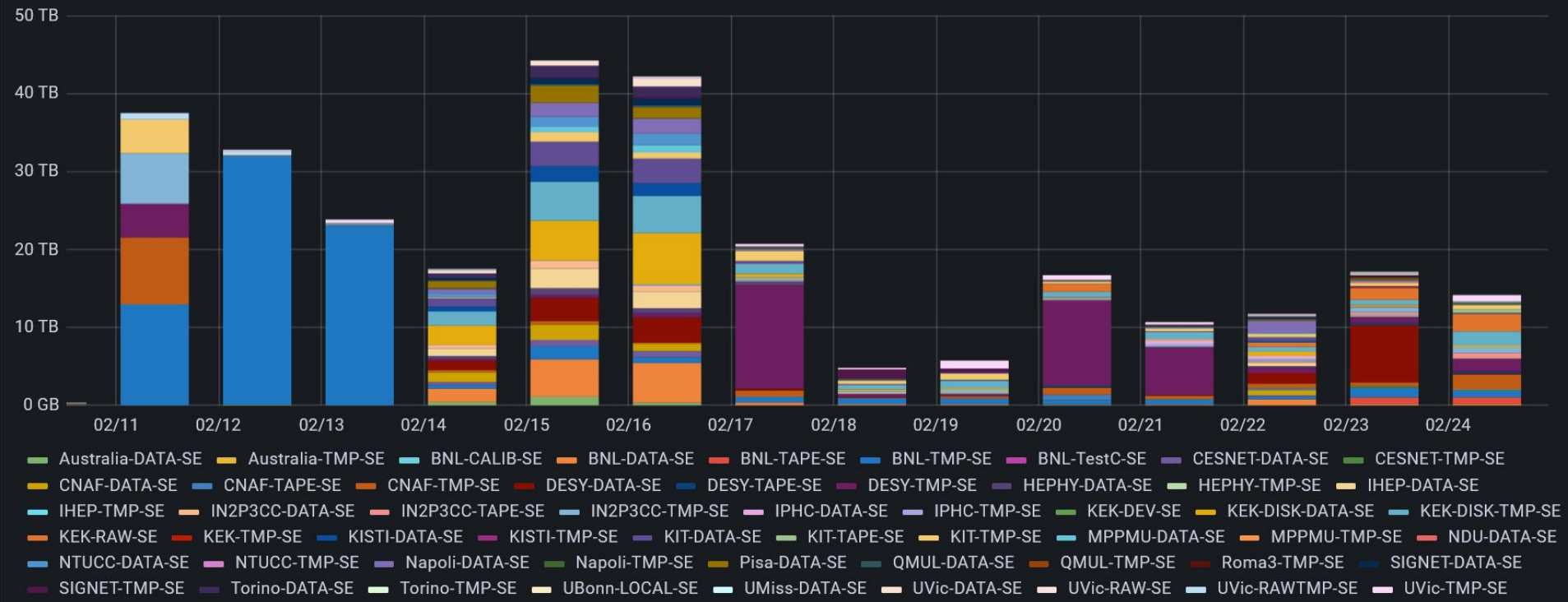
# Belle II on the WLCG Dashboard for DC24

Transfers Throughput (Per VO - No DC traffic highlighted) ⓘ

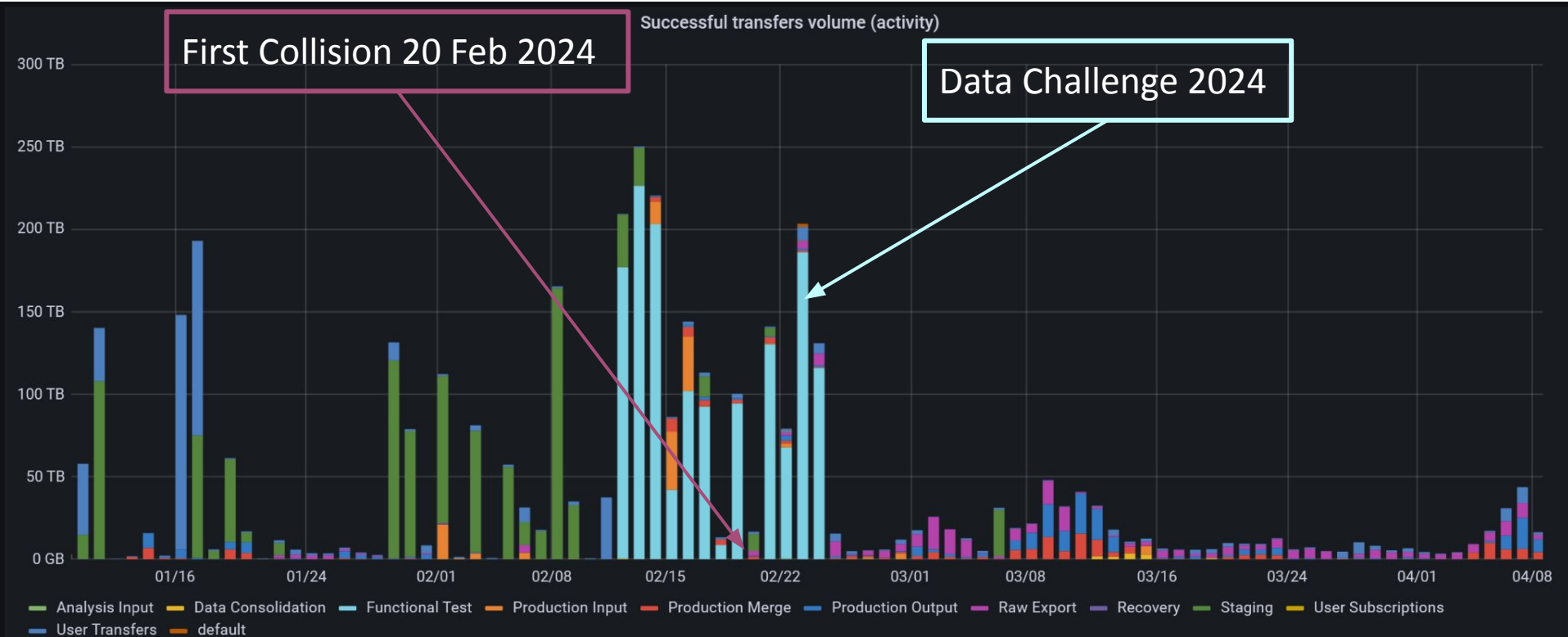


# Traffic during DC24 excluding Functional test

Successful transfers volume (destination)



# Successful Transfer Volume since January 2024

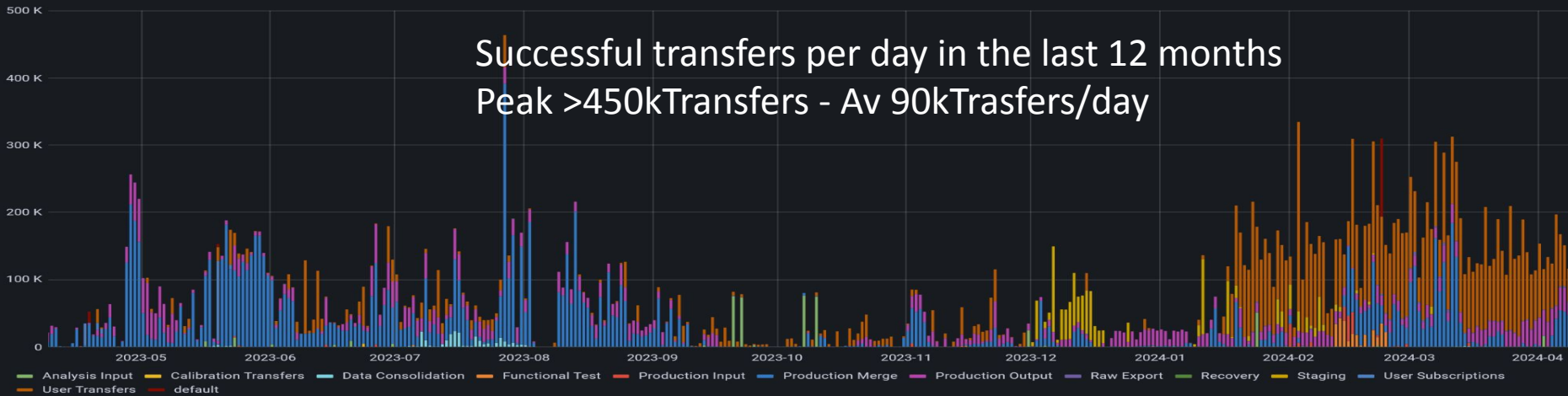


# From Rucio Monitoring



Successful transfers (activity)

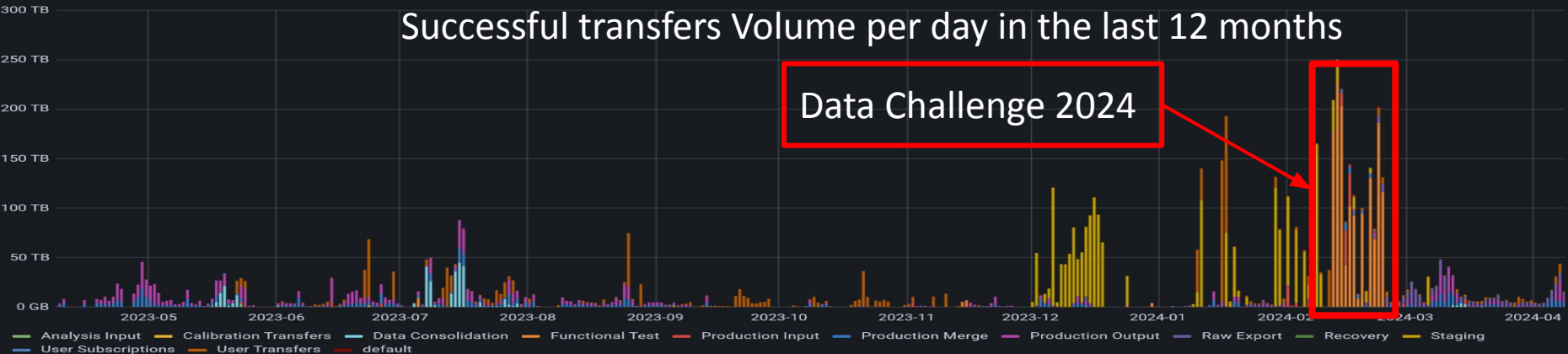
Successful transfers per day in the last 12 months  
Peak >450k Transfers - Av 90k Transfers/day



Successful transfers volume (activity)

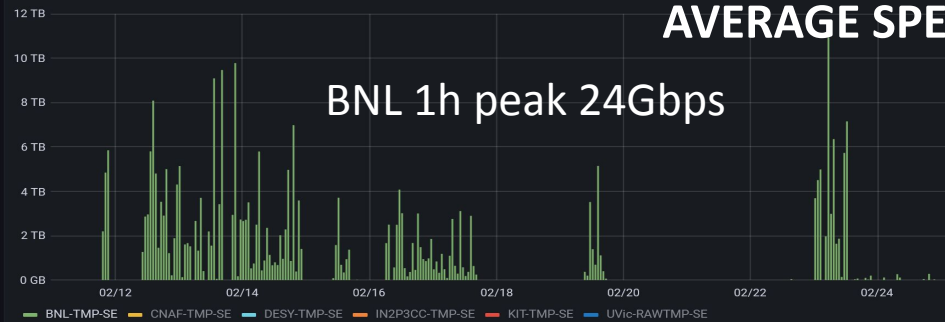
Successful transfers Volume per day in the last 12 months

Data Challenge 2024

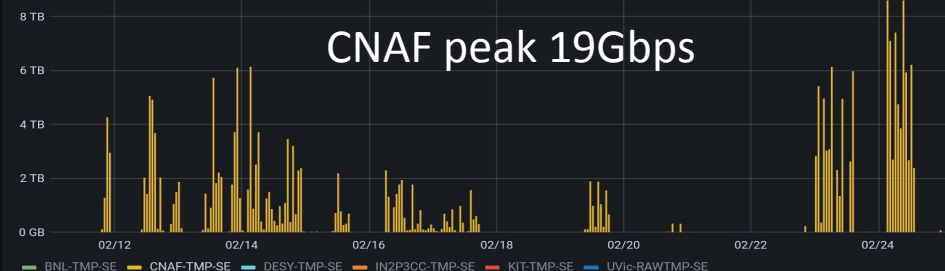


# AVERAGE SPEED IN 1h BIN

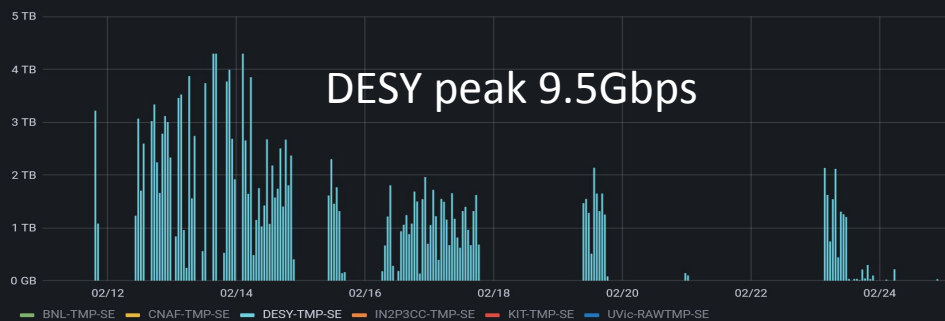
## BNL 1h peak 24Gbps



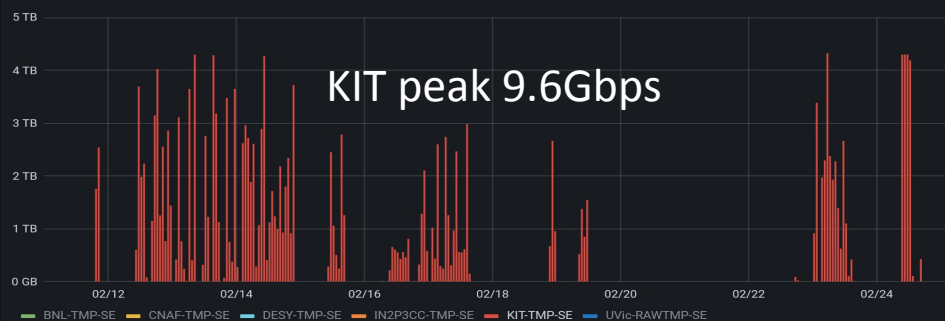
## CNAF peak 19Gbps



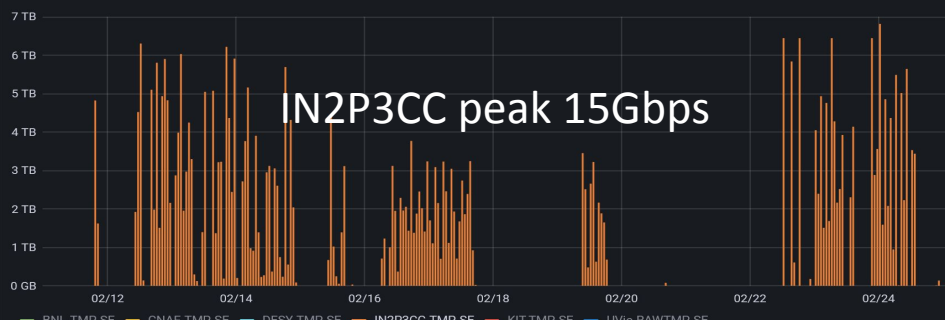
## DESY peak 9.5Gbps

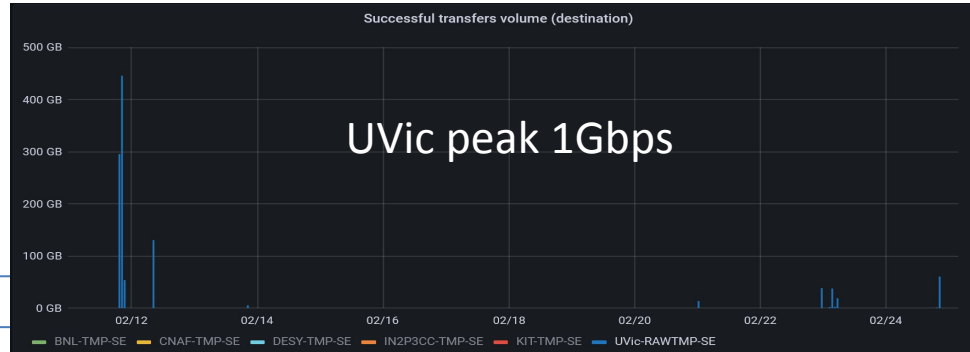
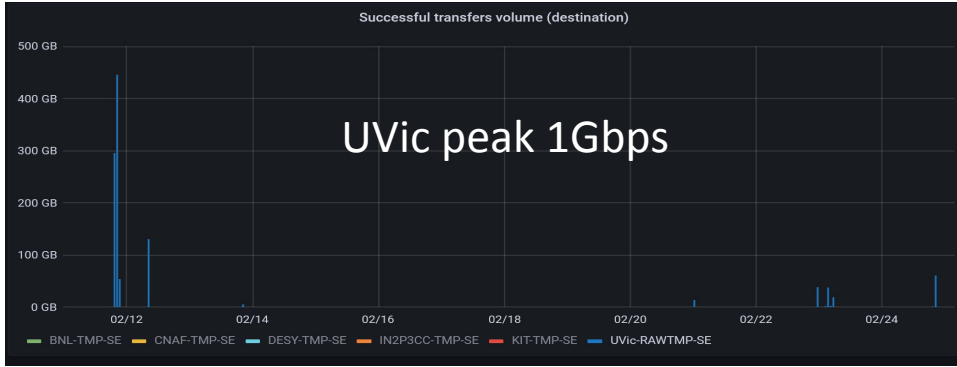


## KIT peak 9.6Gbps



## IN2P3CC peak 15Gbps

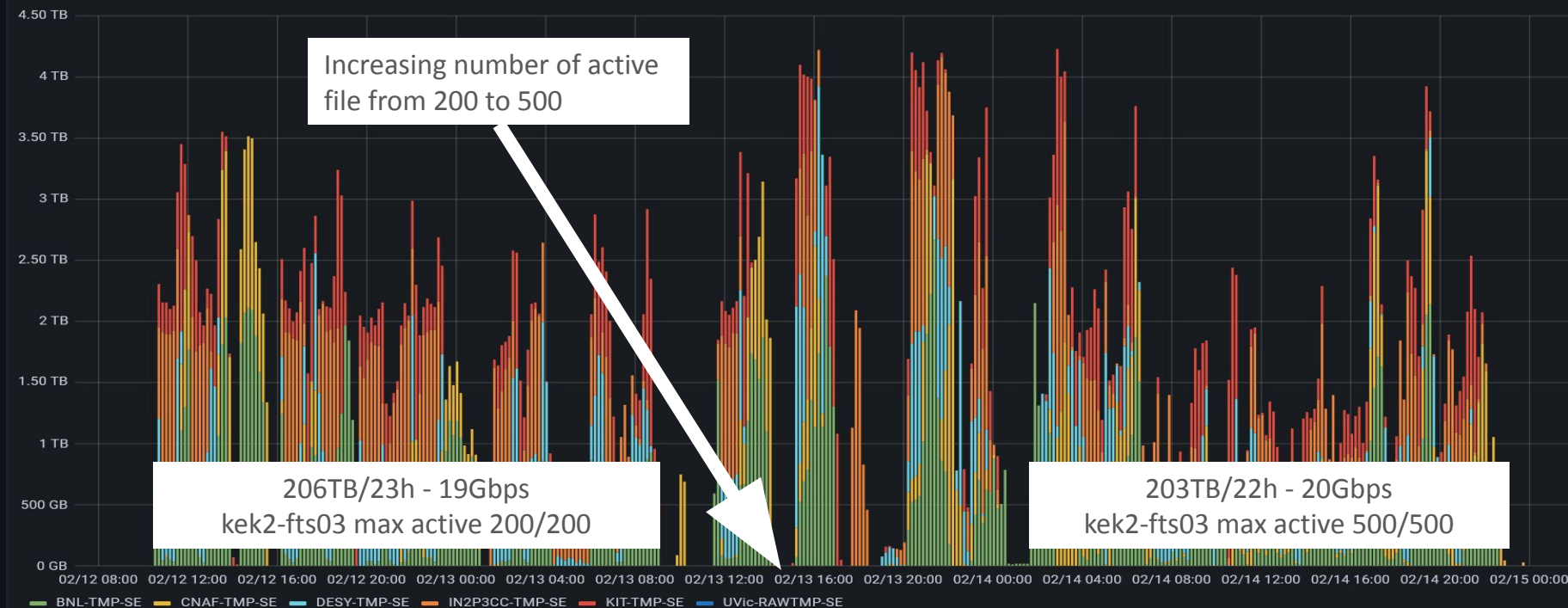




# Zoom on 12/02/2024 9:00 to 14/02/2004 23:00



Successful transfers volume (destination)

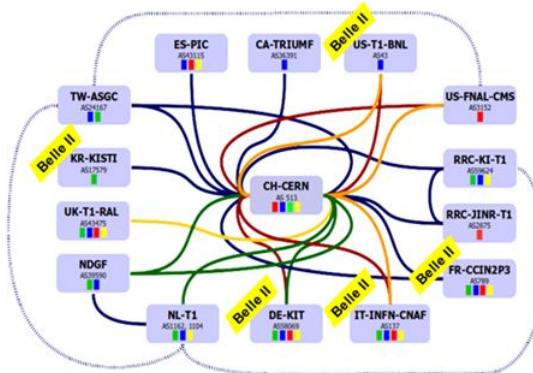


# Belle II Network

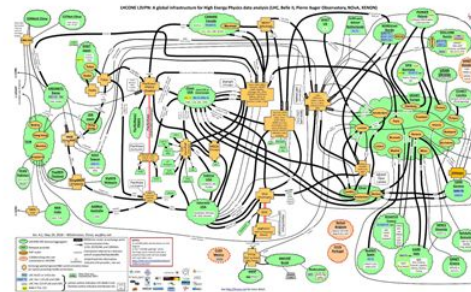
## 100G Global Ring via SINET



## LHCOPN Optical infrastructure that can be used without jeopardizing resources



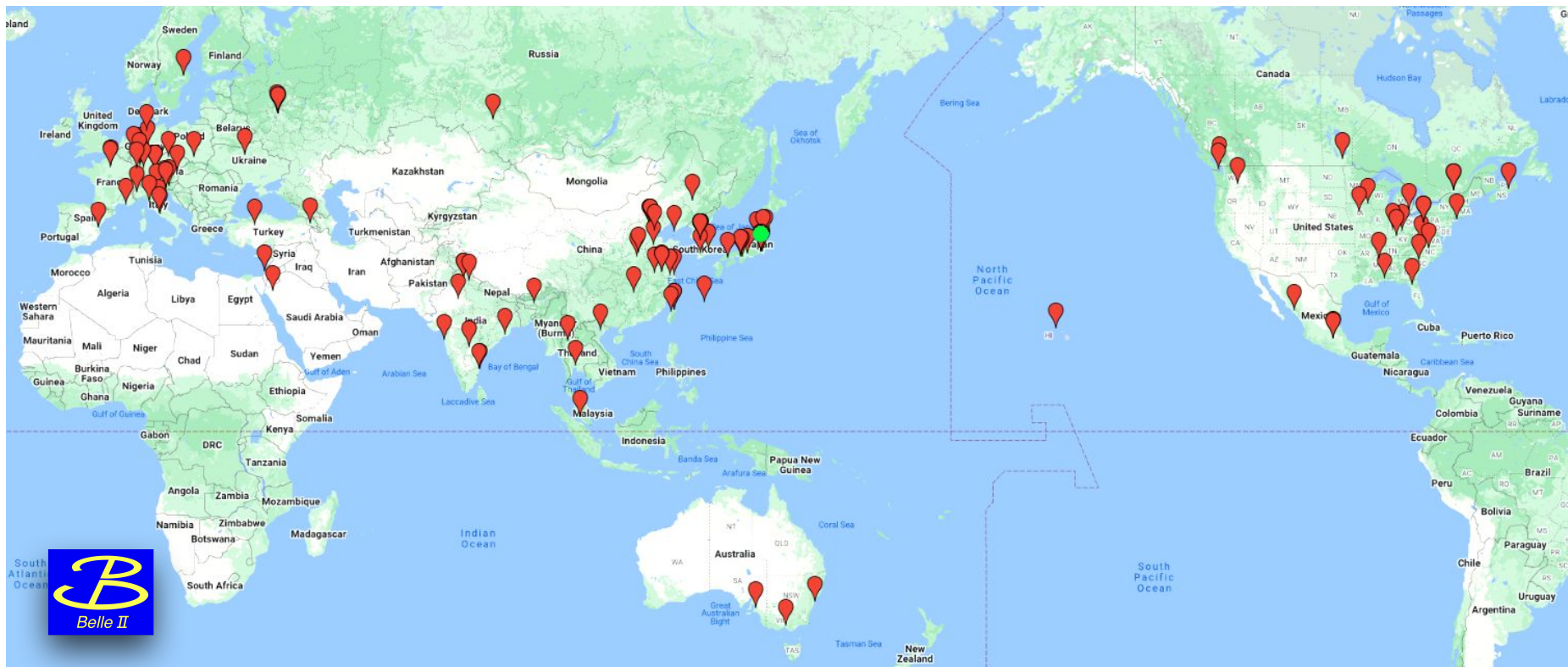
## LHCONE L3 VPN Connecting all the major Data Centres





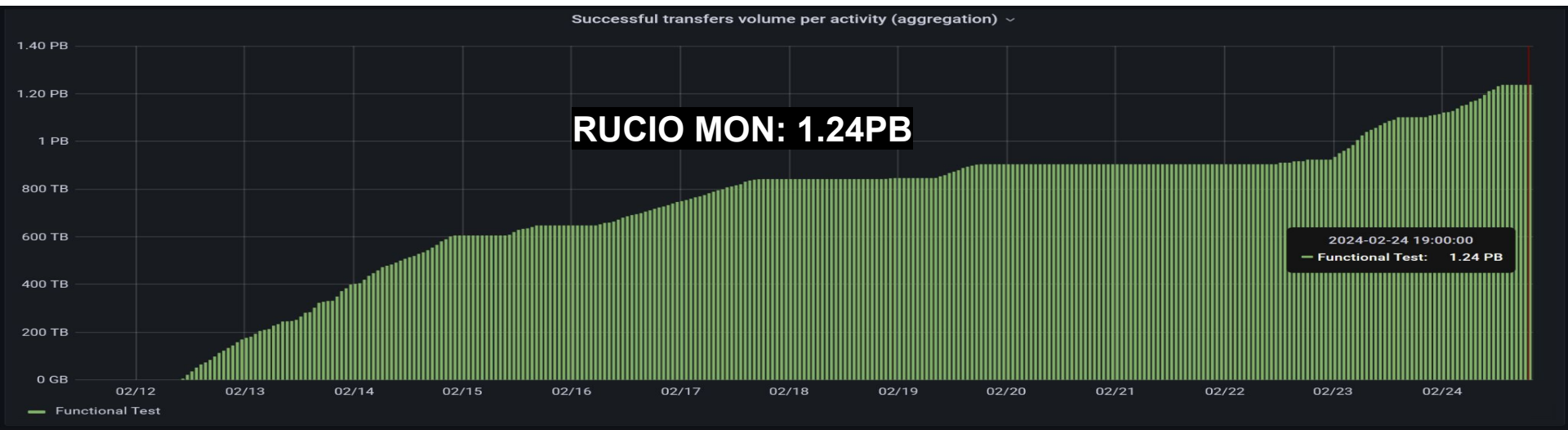
# The Belle II Experiment

Around 1200 members, 131 institutions, 28 countries



# Total Data transferred.

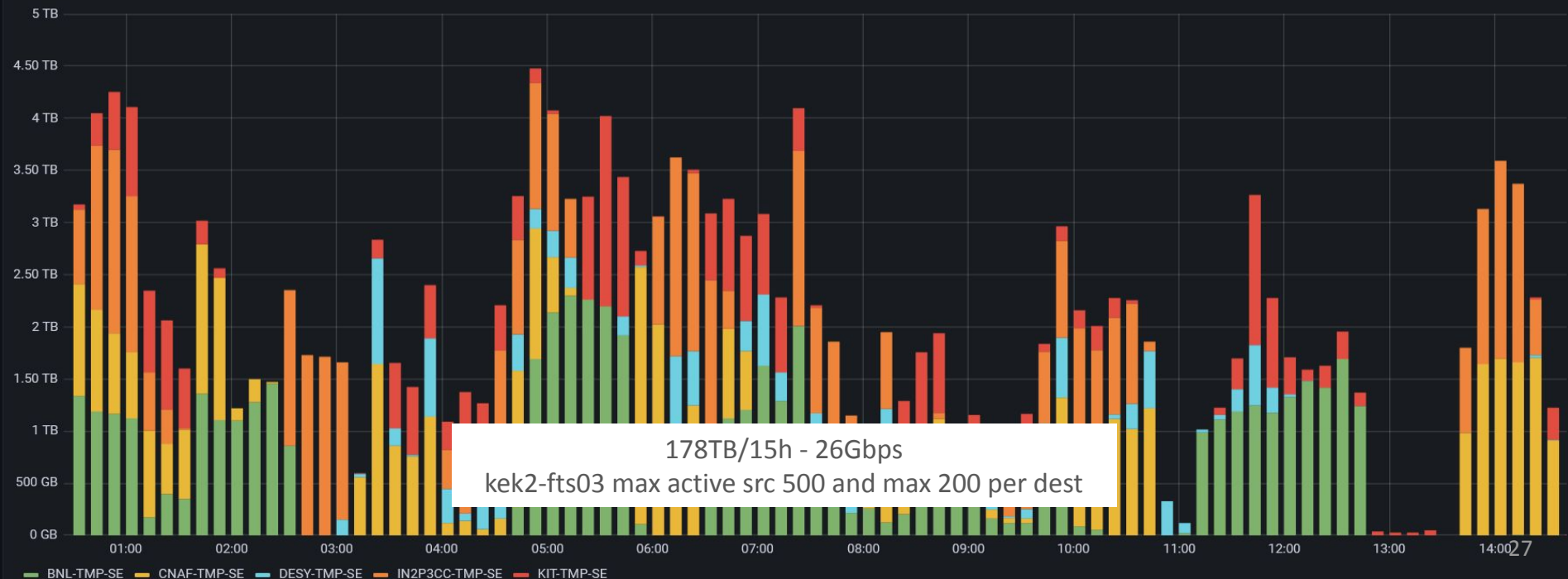
1.24 PB of synthetic data copied from KEK to RAW DC in 12 days of tests performed in burst. Average of 103TB per day, more than 2 times the needed throughput from KEK to RAW DC at maximum luminosity. This demonstrate how the capability to reach 5x40TB/day may protect from unwanted stop or service unavailability.



# Zoom on 23/02/2024 0:00 to 23/02/2024 14:00



Successful transfers volume (destination)



# Failed Transfers

