



清華大學

Tsinghua University

TSINGHUA UNIVERSITY

# Updates of CERNET and FITI

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**Tsinghua University**

# Contents

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- **CERNET**
- **FITI**

# Contents

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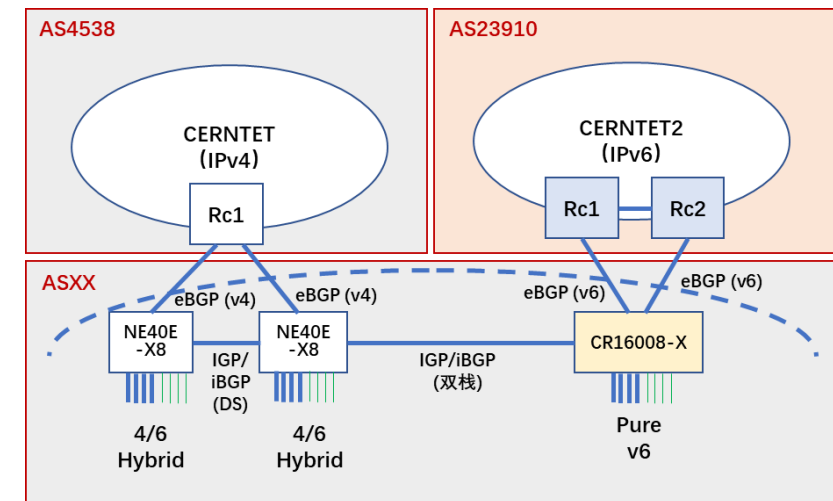
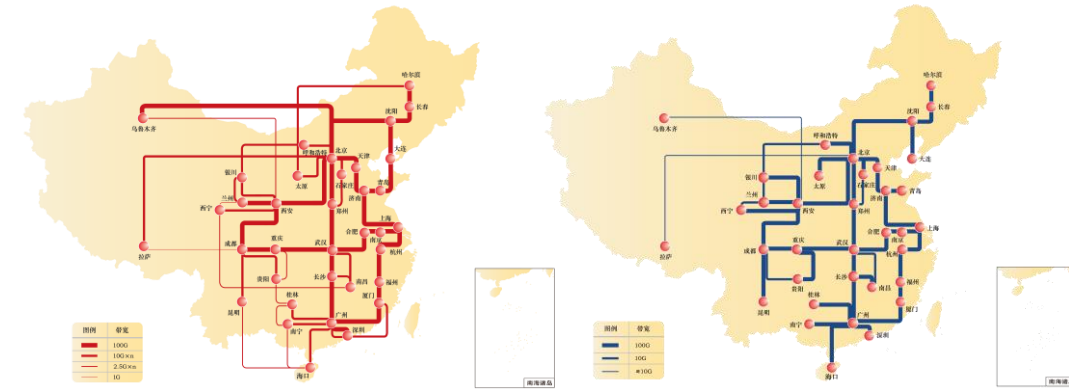


- **CERNET**
- **FITI**

# Backbone



- **Optical transmission backbone**
  - 32,000km dark fiber
- **Two IP backbones**
  - CERNET (AS4538): Pure IPv4 (since 1994)
  - CERNET2 (AS23910): Pure IPv6 (since 2004)
- **41 PoPs with unified access node**
  - One AS for each PoP
- **100G/400G backbone links**
- **2000+ Universities & Research Institutes**
- **20M end users**



# Upgrade project

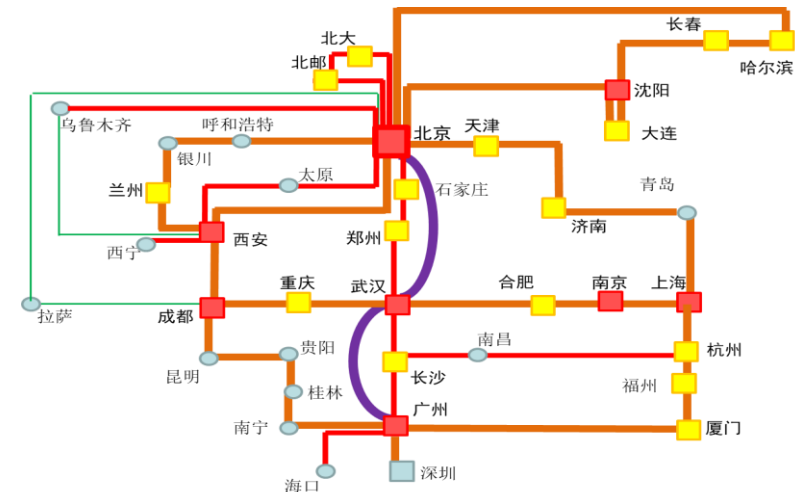


- **Optical transmission backbone**

- 2023: 17,000km
- 2024: 15,000km

- **IP backbone**

- Upgrade for CERNET is underway, which is supposed to be all ready for Terabit connection in the near future
- Upgrade for CERNET2 is under preparation

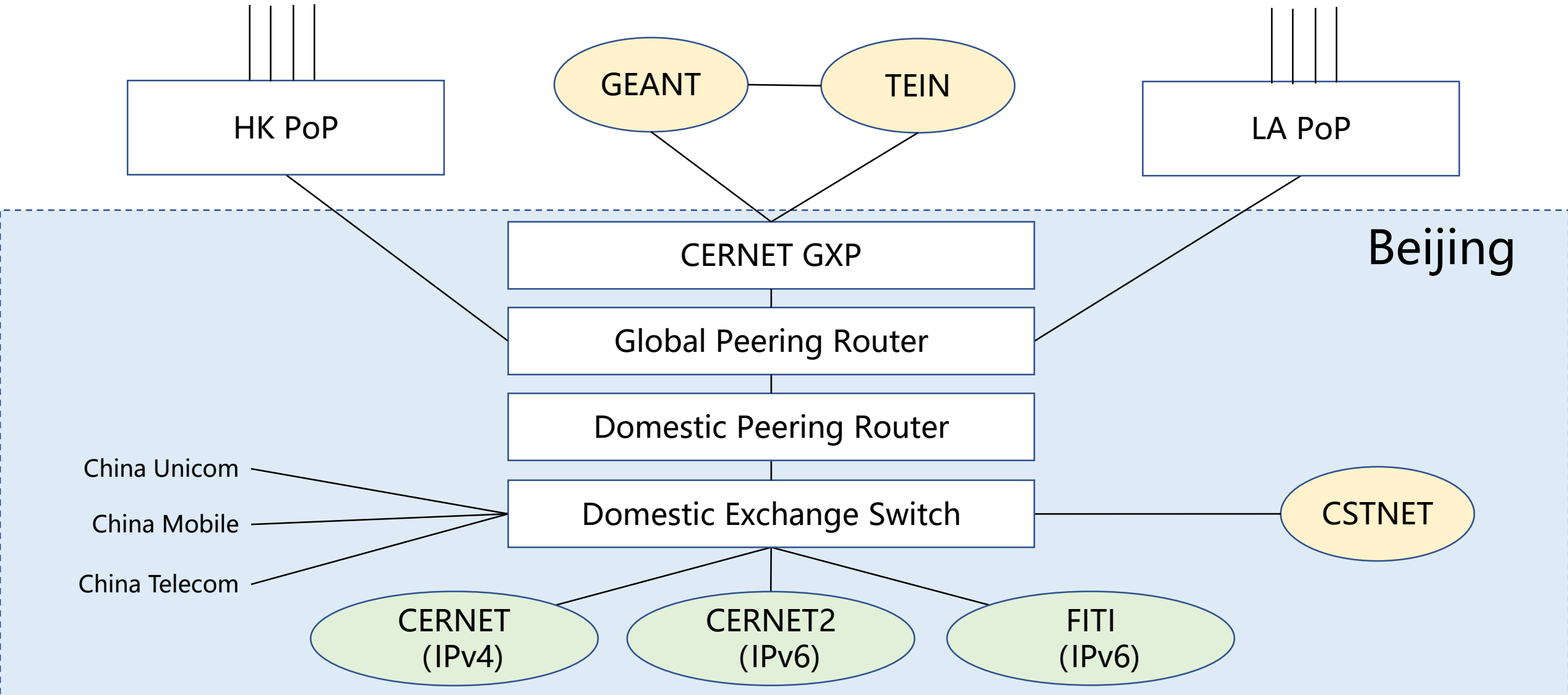


# Global & domestic peering



APAN-JP, KREONET, HARNET, HKIX

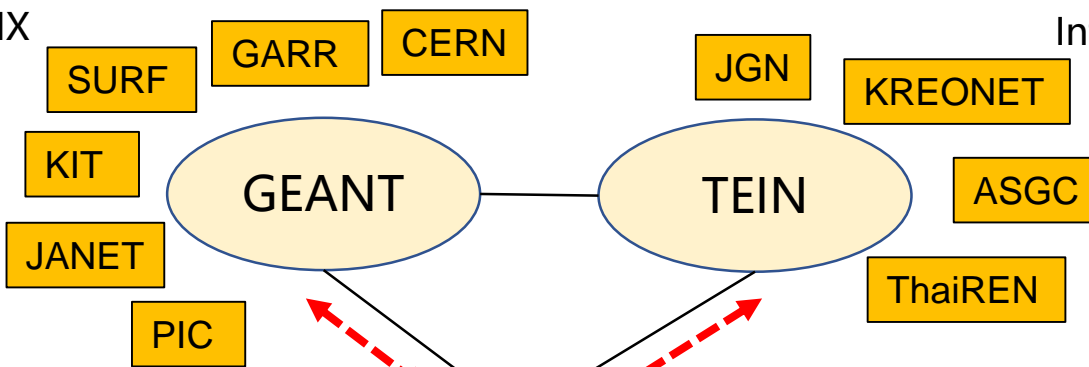
Internet2, ESnet, TransPAC, PacWave



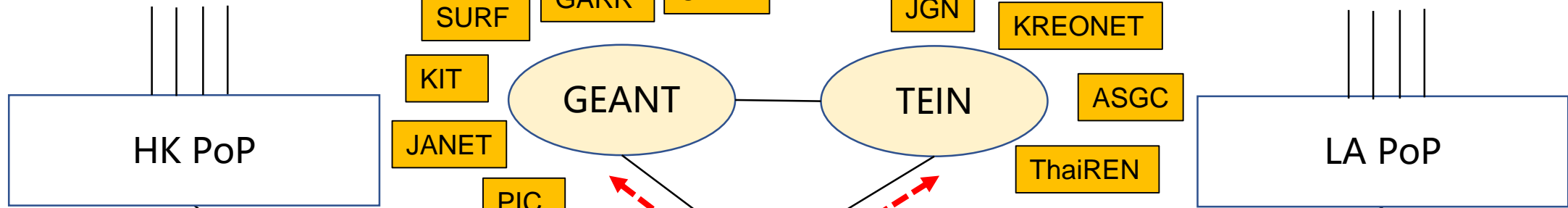
# LHCONE L3VPN peering



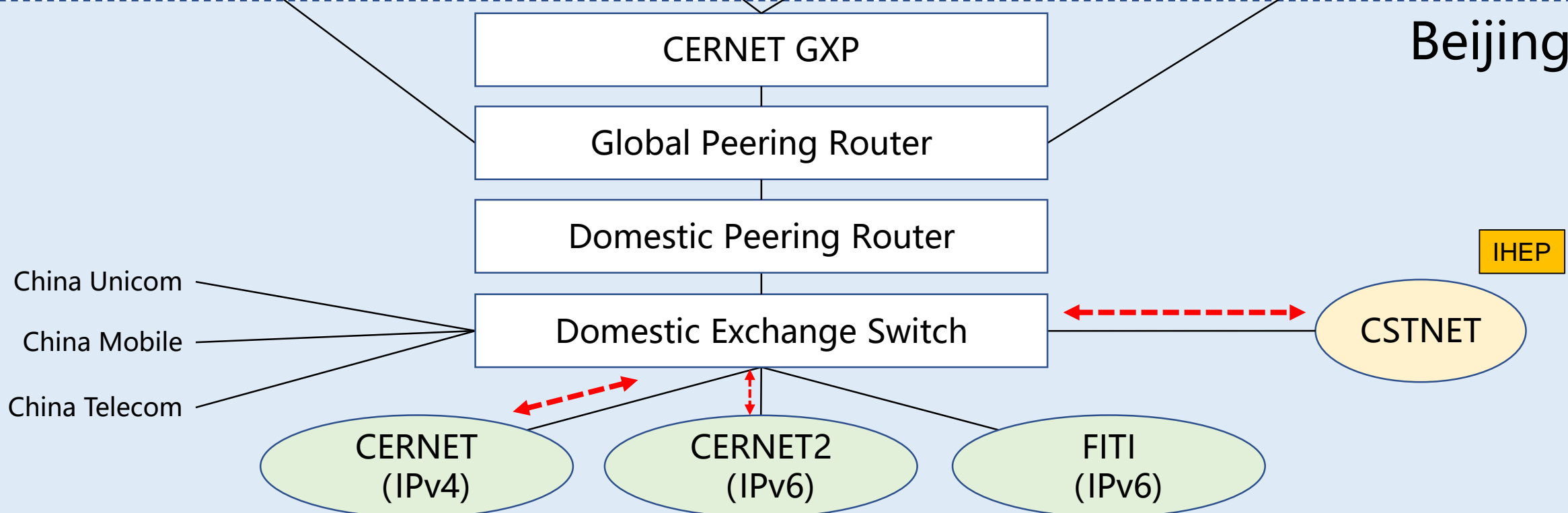
APAN-JP, KREONET, HARNET, HKIX



Internet2, ESnet, TransPAC, PacWave



Beijing



# LHCONE traffic Top 10 over CERNET-GEANT link

(*GEANT → CERNET*, 1 Mar 2024 – 31 Aug 2024)

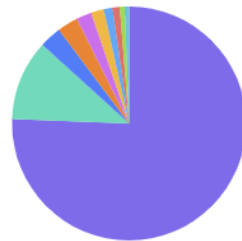


Top 10 As on Router [redacted] by octs src

As	PKTS SRC	PKTS DST	OCTS SRC	OCTS DST
513	628.9M	1	818.2G	74
137	88.5M	1	120.3G	74
58069	37.1M	7	33.0G	4.0K
43115	26.7M	1	31.1G	74
786	29.9M	1	22.8G	1.2K
1162	75.0M	15	19.3G	9.4K
20965	1.5M	0	12.8G	0
789	8.5M	4	11.0G	1.5K
1754	5.5M	4	7.3G	3.8K
39590	1.4M	0	6.4G	0

CERN  
GARR  
KIT  
PIC  
JANET  
SURF

- 513
- 137
- 58069
- 43115
- 786
- 1162
- 20965
- 789
- 1754
- 39590



Top 10 As on Router [redacted] by octs dst

As	PKTS SRC	PKTS DST	OCTS SRC	OCTS DST
3460	0	911.7M	0	1.1T
38272	12	41	968	49.0K
0	13.0K	168	13.9M	15.9K
1162	75.0M	15	19.3G	9.4K
35296	205.2K	9	298.2M	4.1K
58069	37.1M	7	33.0G	4.0K
1754	5.5M	4	7.3G	3.8K
2091	1.9M	3	1.7G	2.5K
789	8.5M	4	11.0G	1.5K
142801	0	1	0	1.3K

IHEP

- 3460
- 38272
- 0
- 1162
- 35296
- 58069
- 1754
- 2091
- 789
- 142801



Top 10 AS sorted by src address

Top 10 AS sorted by dest address



# LHCONE traffic Top 10 over CERNET-GEANT link

(*CERNET* → *GEANT*, 1 Mar 2024 – 31 Aug 2024)



Top 10 As on Router [redacted] by octs src

IHEP

As	PKTS SRC	PKTS DST	OCTS SRC	OCTS DST
3460	1.4G	0	1.9T	0
0	7.4M	164	10.2G	15.6K
23911	1.6K	0	156.3K	0
13335	4	0	5.5K	0
38272	12	11	956	6.2K
23910	3	5	376	576
4837	2	0	192	0
142799	2	0	144	0
9425	1	0	136	0
4812	1	0	96	0

Top 10 As on Router [redacted] by octs dst

PIC  
JANET  
SURF  
KIT  
GARR  
IN2P3

As	PKTS SRC	PKTS DST	OCTS SRC	OCTS DST
43115	0	314.5M	0	475.0G
786	0	322.4M	0	442.4G
1162	0	316.2M	0	427.7G
58069	0	308.1M	0	418.2G
137	0	99.8M	0	127.7G
789	0	12.3M	0	16.4G
2135	0	10.4M	0	14.4G
1754	0	10.8M	0	13.8G
2852	0	8.2M	0	11.5G
2091	0	6.2M	0	8.5G

Top 10 AS sorted by src address

Top 10 AS sorted by dest address

# LHCONE traffic Top 10 over CERNET-TEIN link

(TEIN → CERNET, 1 Mar 2024 – 31 Aug 2024)



Top 10 As on Router [redacted] by octs src

FNAL  
UCSD  
WISC  
UltraLight  
BNL  
KEK

As	PKTS SRC	PKTS DST	OCTS SRC	OCTS DST
3152	39.0M	21	49.4G	3.0K
26397	15.1M	49	21.0G	60.6K
59	18.4M	52	21.0G	64.3K
32361	16.5M	0	17.3G	0
43	17.3M	81	14.5G	76.1K
2505	8.4M	63	11.3G	32.5K
7896	7.7M	0	10.9G	0
3	5.6M	52	7.6G	64.3K
7212	5.5M	63	7.1G	77.9K
2501	5.9M	75	6.0G	53.1K

- 3152
- 26397
- 59
- 32361
- 43
- 2505
- 7896
- 3
- 7212
- 2501



Top 10 AS sorted by src address

Top 10 As on Router [redacted] by octs dst

IHEP

As	PKTS SRC	PKTS DST	OCTS SRC	OCTS DST
3460	0	150.7M	0	177.9G
0	818.8K	3.9K	1.0G	385.7K
7212	5.5M	63	7.1G	77.9K
43	17.3M	81	14.5G	76.1K
59	18.4M	52	21.0G	64.3K
3	5.6M	52	7.6G	64.3K
26397	15.1M	49	21.0G	60.6K
2501	5.9M	75	6.0G	53.1K
2505	8.4M	63	11.3G	32.5K
160	2.7M	26	2.8G	32.1K

- 3460
- 0
- 7212
- 43
- 59
- 3
- 26397
- 2501
- 2505
- 160



Top 10 AS sorted by dest address

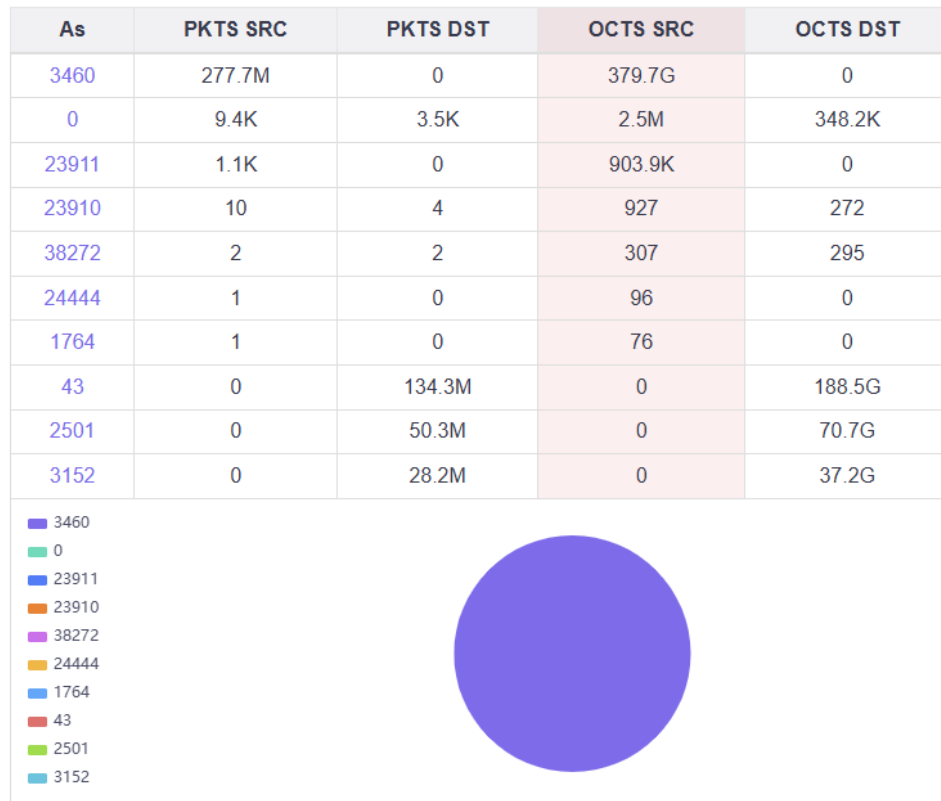
# LHCONE traffic Top 10 over CERNET-TEIN link

(*CERNET* → *TEIN*, 1 Mar 2024 – 31 Aug 2024)



Top 10 As on Router [redacted] by octs src

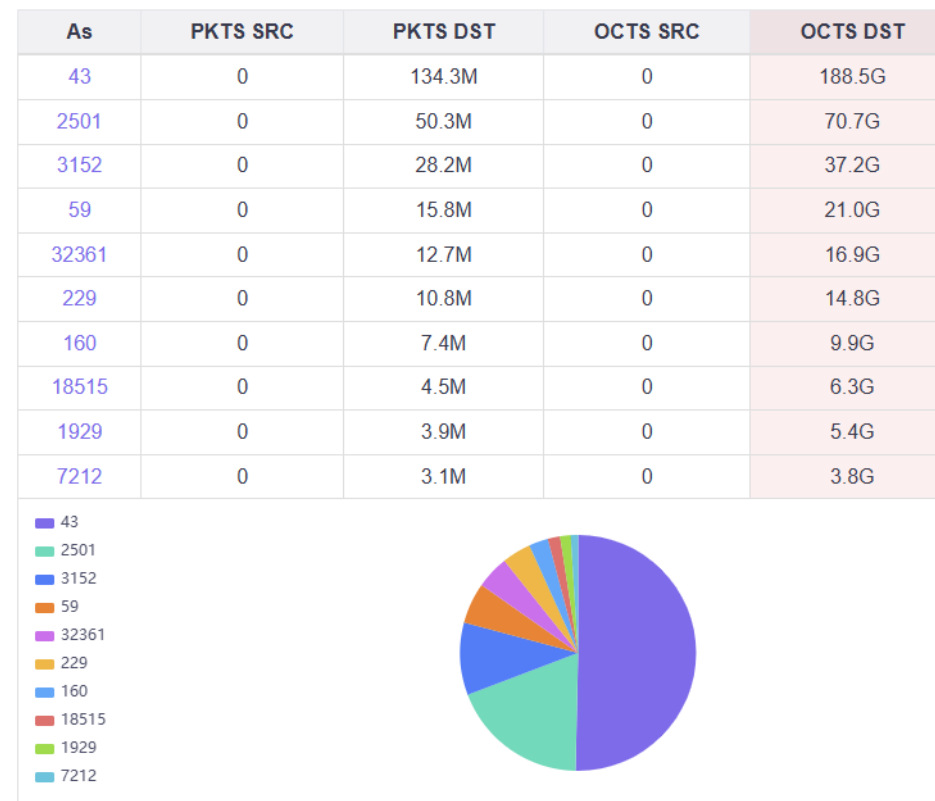
IHEP



Top 10 AS sorted by src address

Top 10 As on Router [redacted] by octs dst

BNL  
University of Tokyo  
FNAL  
WISC  
UltraLight  
MERIT



Top 10 AS sorted by dest address

# Future plan for LHCONE



- **Extending LHCONE L3VPN to LHCONE participants in CERNET, e.g. faculty or lab in university**
- User research by Jennifer An
  - Tsinghua University, Peking University, Lanzhou University, Central China Normal University etc.
- Challenge
  - Policy of campus network: L3VPN deployment (dedicated link from LHCONE participant to CERNET backbone?)
  - Bandwidth: LHCONE burst traffic vs. campus customer traffic
- **Extending LHCONE peering with international partners**
  - E.g. ESnet at LA PoP?

# Contents

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- CERNET
- FITI

# Project background

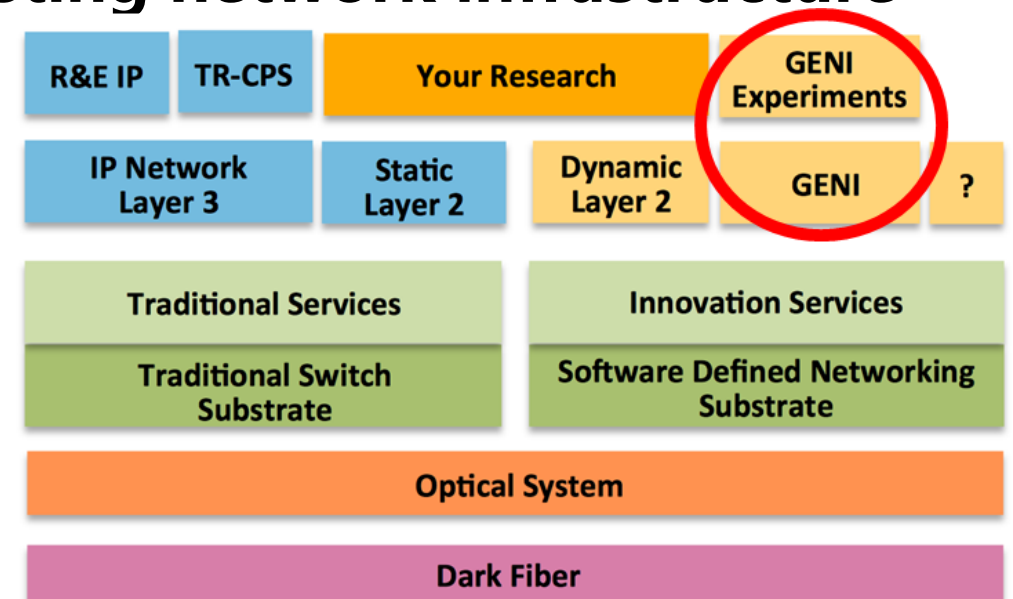


- **Future Internet Technology Infrastructure (FITI) is co-funded by government and 40 universities in China**
- Led by Tsinghua University, together with Peking University, Shanghai Jiao Tong University etc.
- The major purpose of FITI Project is to build a large-scale experimental verification infrastructure to support
  - Research on major computer network science subject
  - Innovation on Internet architecture
  - Experimental verification for future Internet technology

# Learn experience from global R&E partners



- As an example, the helpful experience and case from Internet2 and GENI
  - Stable core + SDN Overlay
- Fully take advantage of current network infrastructure, based on existing academic network backbone like Internet2 and GEANT, avoid potential risk, lower capital cost
- Promote innovative development of existing network infrastructure
- Layered (differentiated) service for different function and different scale of network experiment
- Build experimental infrastructure by making the best use of advanced and mature technology



# Overview of FITI



Network management & security monitoring system

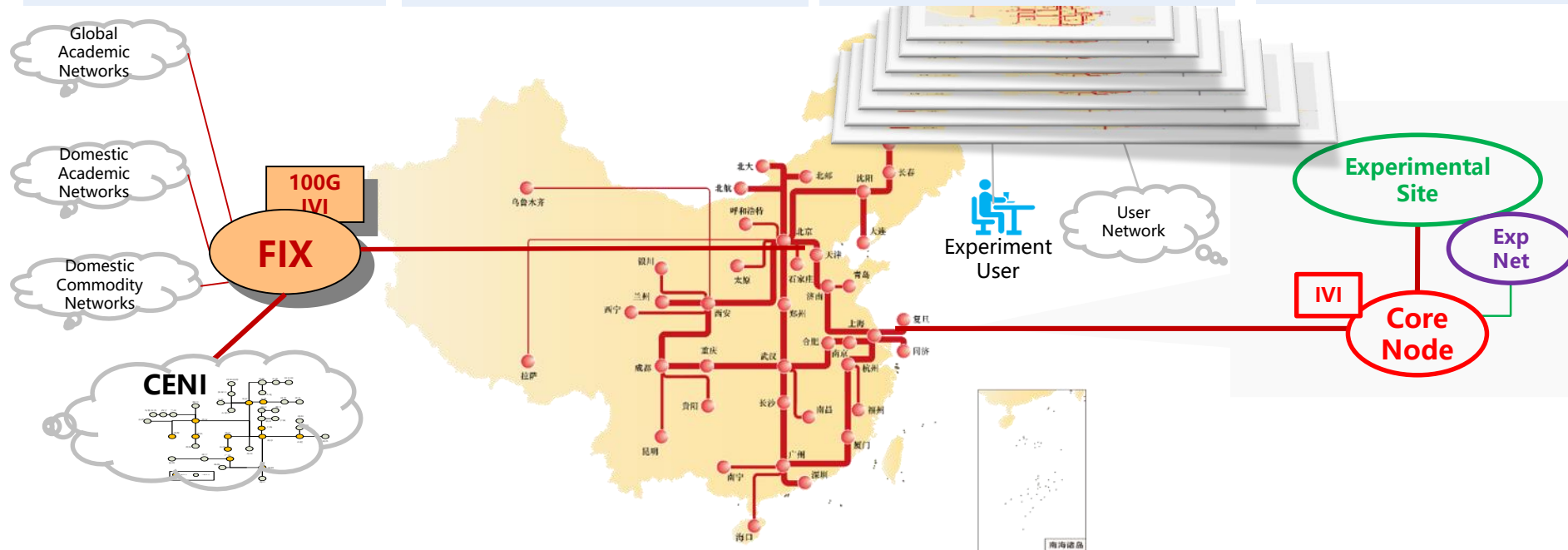
Resource scheduling & experiment support system

Intl' & domestic exchange center

2-plane IP backbone  
Optical backbone

4096 heterogeneous experiment networks

40 experimental nodes





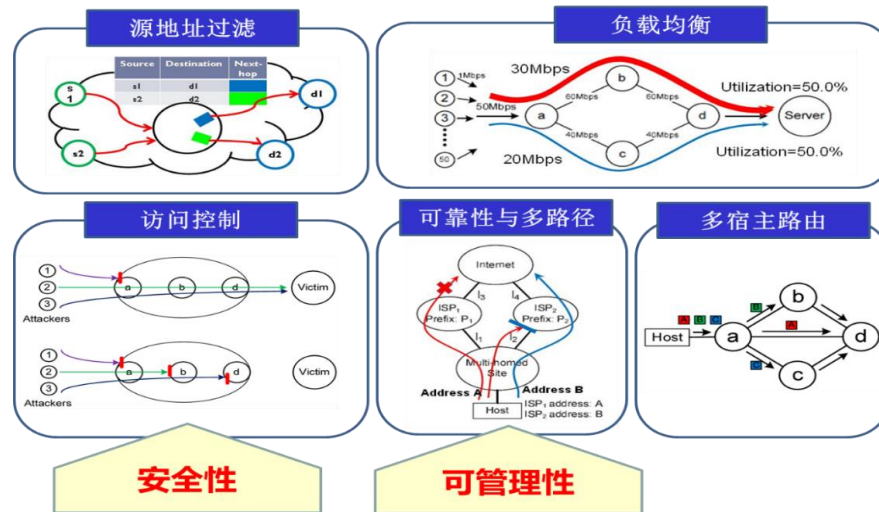
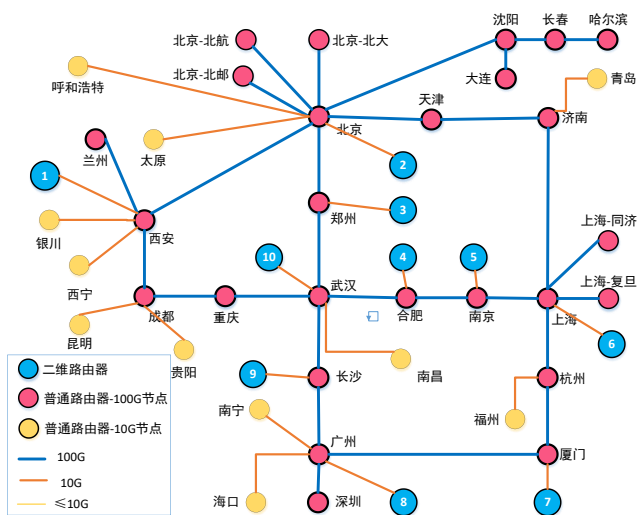


# Typical experiments supported by FITI

- Address-Driven Network (ADN)
- Space-earth integration network
- Counter-measure study for Internet infrastructure cyber attack

# Address-Driven Network (ADN)

- Two-dimension routing
  - Two-dimension routing extension for OSPF
    - Intra-Area-Prefix-LSA extension etc.
    - Two-dimension advertisement mechanism
- 13 experimental nodes with ADN router deployed



0										1										2										3									
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
LS Age										LS Type																													
Link State ID																																							
Advertising Router																																							
LS Sequence Number																																							
LS Checksum																				Length																			
Type																				Length																			
PrefixLength										Reserved										PrefixNumbers																			
Address Prefix1																																							
...																																							
Address Prefix2																																							
...																																							
Address Prefix3																																							
...																																							
...																																							

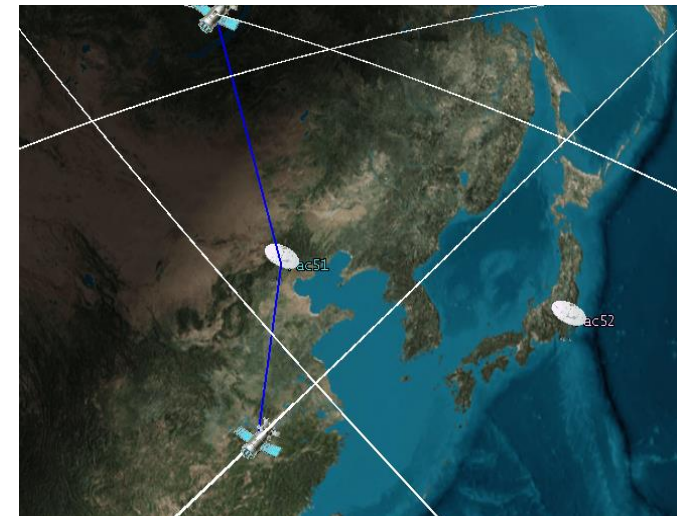
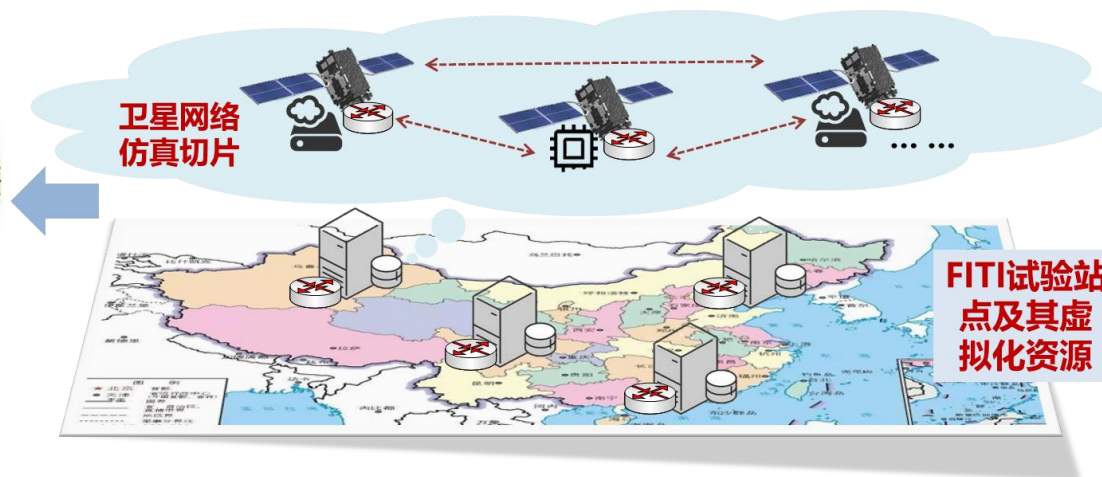
# Space-earth integration network



- Integration of satellite communication networks and ground Internet
  - Global coverage, everywhere access, on-demand service, secure and trusted
- L2 overlay network across 10 experimental nodes



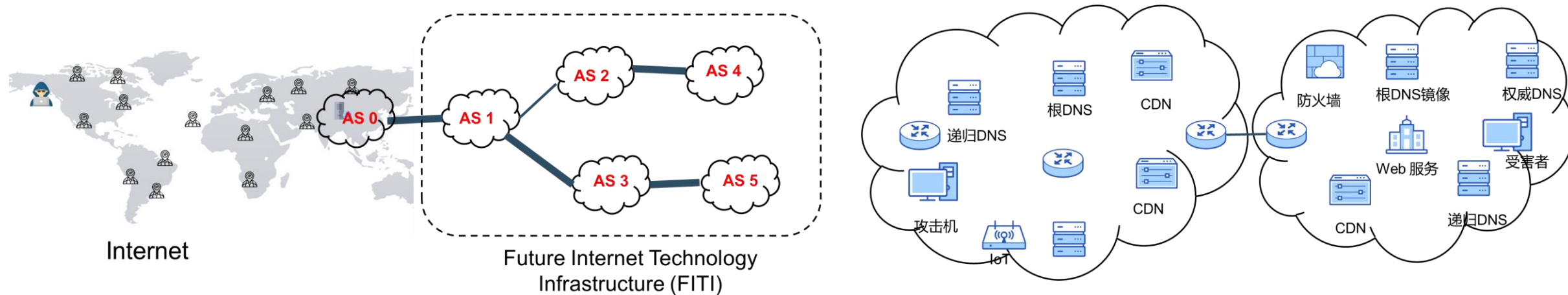
模拟真实巨型卫星星座



# Counter-measure study for Internet infrastructure cyber attack



- Evaluation for effectiveness of counter-measures for cyber attack against Internet core infrastructure
  - Core network (router & link), DNS, Web, FW, CDN, IoT etc.
- 5 individual AS domains over 5 experimental nodes with global Internet interconnection



1

The background features a large, faint watermark of the Tsinghua University seal. The seal is circular with a rope-like border. Inside, there is a five-pointed star in the center. The Chinese characters "清華大學" (Tsinghua University) are written in the upper half, and "TSINGHUA UNIVERSITY" is written in the lower half.

**Thanks!**

*Looking forward to collaboration with  
domestic and global partners on future  
Internet technology*