e-VLBI Status in CVN

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Outline

- CVN e-VLBI Network
- CVN e-VLBI Application
- Conclusion

e-VLBI

❖ e-VLBI

- electronic-VLBI

  - High-speed network connecting stations & data center
  - Digital backend System
  - Data Recording & Transmitting System

- Modes

  - Real-time: memory buffering
  - Near Real-time: huge memory or disk buffering
  - e-Transfer: Disk recording(buffering) then post transfer

- Advantages

  - Real-time: Short turn around time
  - ‘WYSIWYG’ : Correlator output, Station devices status, …
  - High data rate: network evolving faster than hard disk
  - automation, distributing processing, software correlator

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CVN e-VLBI Network

❖ Stations

Sh – Shanghai Sheshan, 25m, 1987

Ur – Xinjiang Urumuqi, 25m, 1993

Bj – Beijing Miyun, 50m, 2006

Km – Yunnan Kunming, 40m, 2006

Tm – Shanghai Tianma, 65m, 2013

❖ Data Center

- Shanghai VLBI data center

  - C&C center of VLBI tracking system for CLEP, 2007

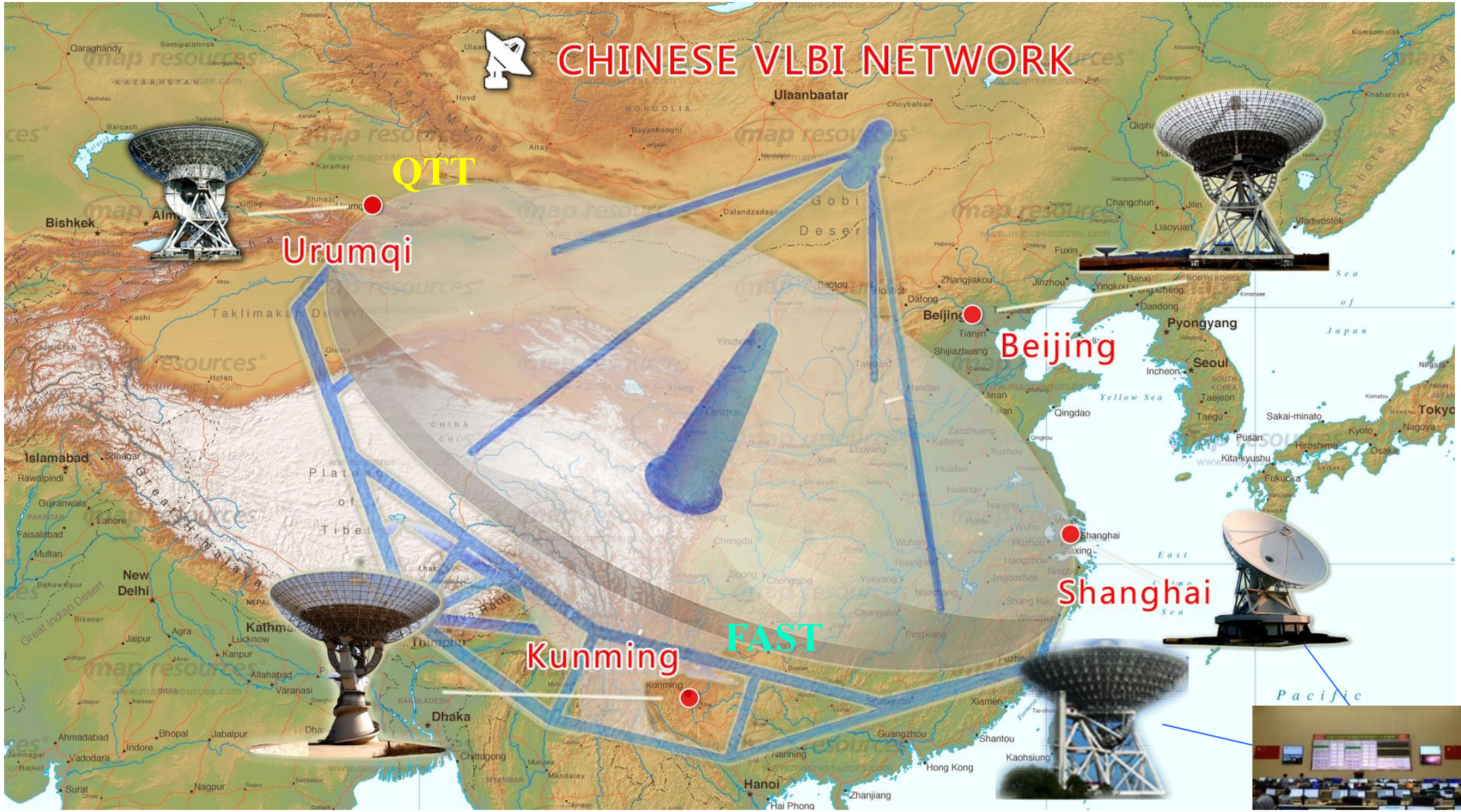
  - IVS Correlator Center, 2012

  - Scientific: astrophysics, pulsar, …

❖ History

- Started: 2006
- Supported by CLEP Project

CVN e-VLBI Map



CVN e-VLBI Sites

Ur, XAO

VLBI C&C Hall
ShAO

Bj, NAOC

Sh, ShAO

Km, NAOC

VLBI Center
Server Room

Tm, ShAO

Outline

- ❖ CVN e-VLBI Network
- ❖ e-VLBI Applications
  - CLEP Phase I/II/III
  - Shanghai IVS Correlator
- ❖ Conclusion

e-VLBI for CLEP

❖ VLBI Tracking and Measurement System

- **Service for M&C system**
- **Phase I(CE-1), Phase II(CE-2/3/4), Phase III(CE-5T1/CE-5/6)**
- **Real-time Requirement**
- **Additional Function**
  - Receiving & recording & distributing data to HW/SW Correlators in data center

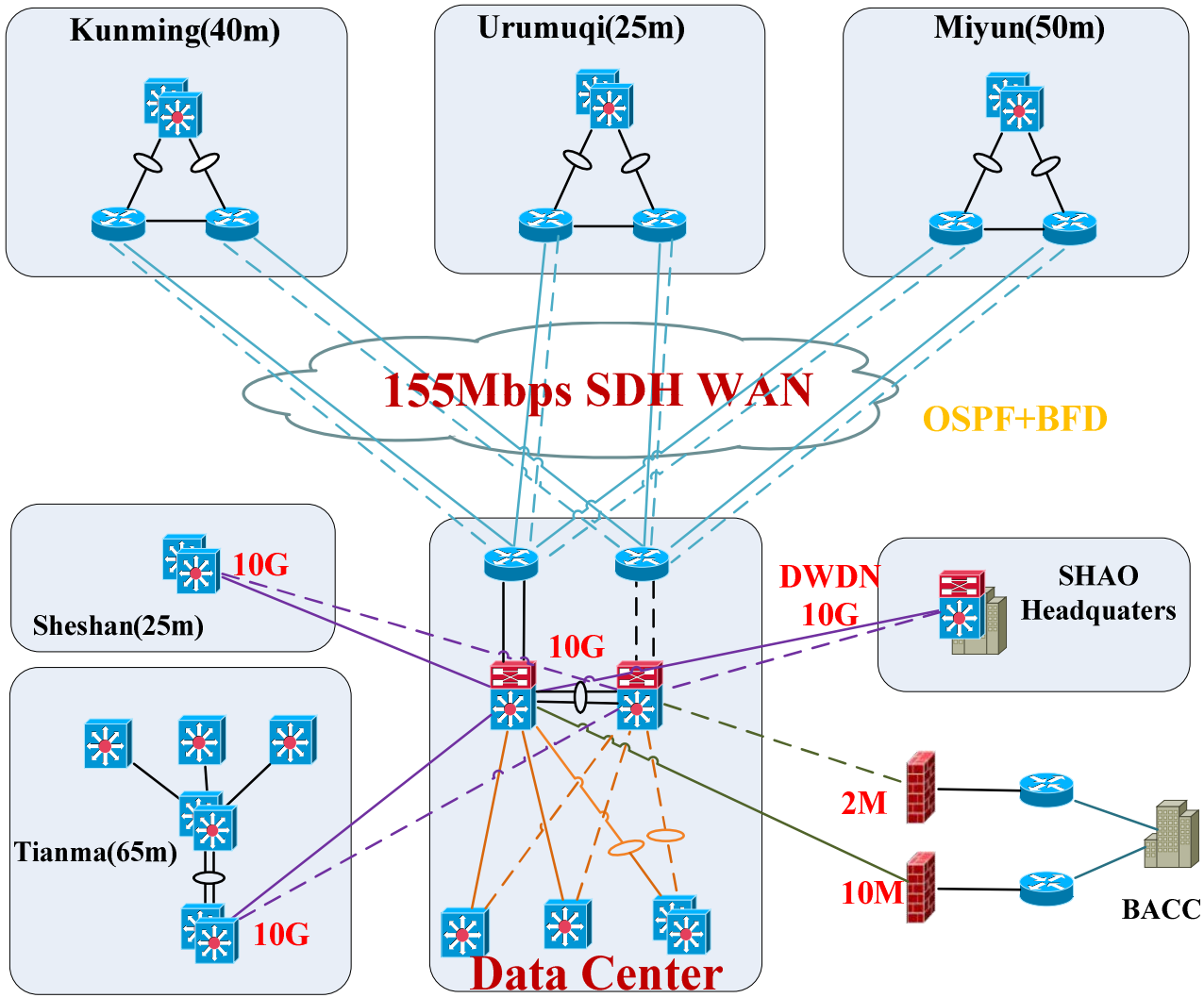
CLEP e-VLBI Statistics

Mission	Mode	Network Line	Raw Data rate	Network Failover	Realtime Requirement	Performance
CE-1	Near realtime	Telecom/CNC (SDH 34Mb/s)、CSTNET IP-VPN (100Mb/s)	16Mb/s	Manually, >30m	<10m	<6m
CE-2	Near realtime	Telecom/CNC MSTP(100Mb/s)	32Mb/s	Manually, >15m	<10m	<4m
CE-3	Realtime	Telecom/Unicom (SDH 155Mb/s)	64Mb/s	Automatically, <3s	<1m	<40s
CE-5T1	Realtime	Telecom/Unicom MSTP(100Mb/s)	64Mb/s	Automatically, <3s	<1m	<40s
CE-5	Realtime	Telecom/Unicom (SDH 155Mb/s)	128Mb/s	Automatically, <3s	<1m	2017

CE-3 e-VLBI High Availability Network

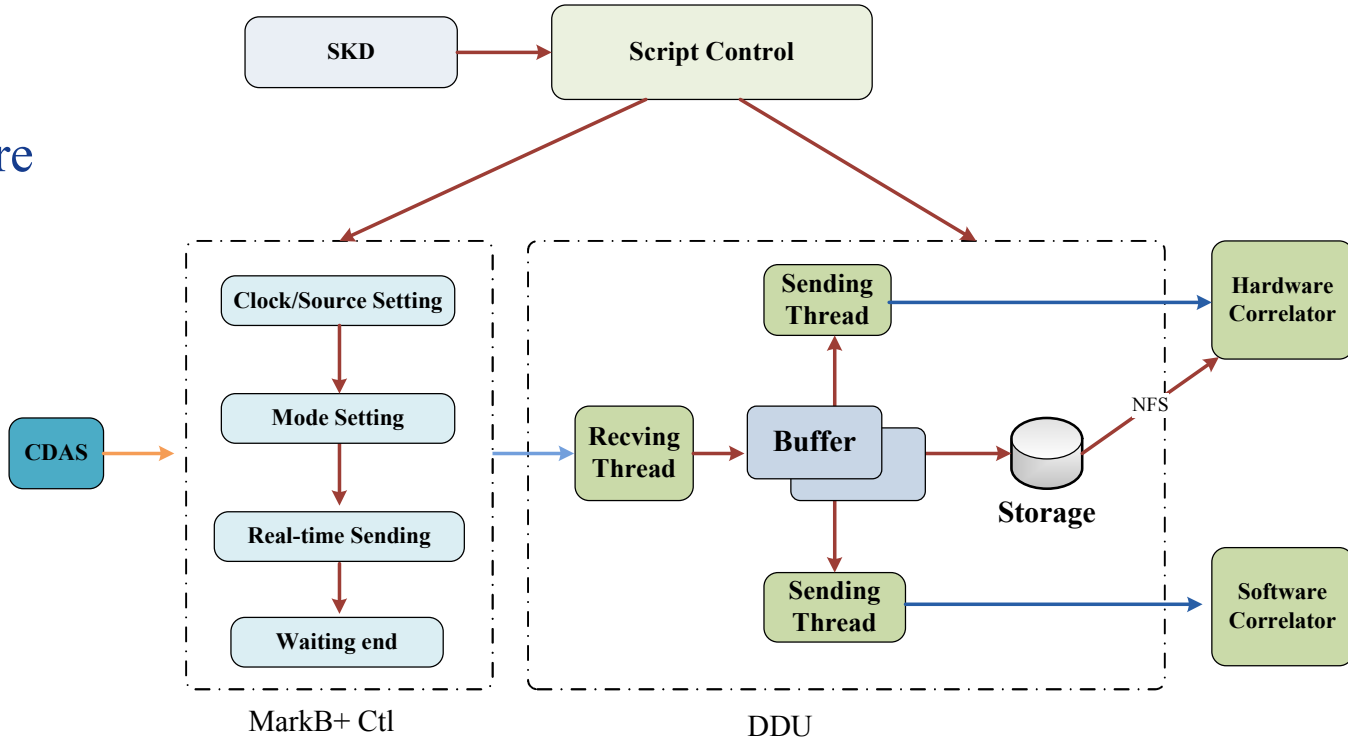
❖ Km, Ur, Bj, Sh, Tm

- Long Range Network Backbone not so reliable
- OSPF+BFD protocol to detecting and switching backbone network link when unscheduled fail: switch time < 3s
- Backbone failovers > 20
- Buffer data for short time, when switching, retransmit after link recover
- TCP Protocol Performance Tuning



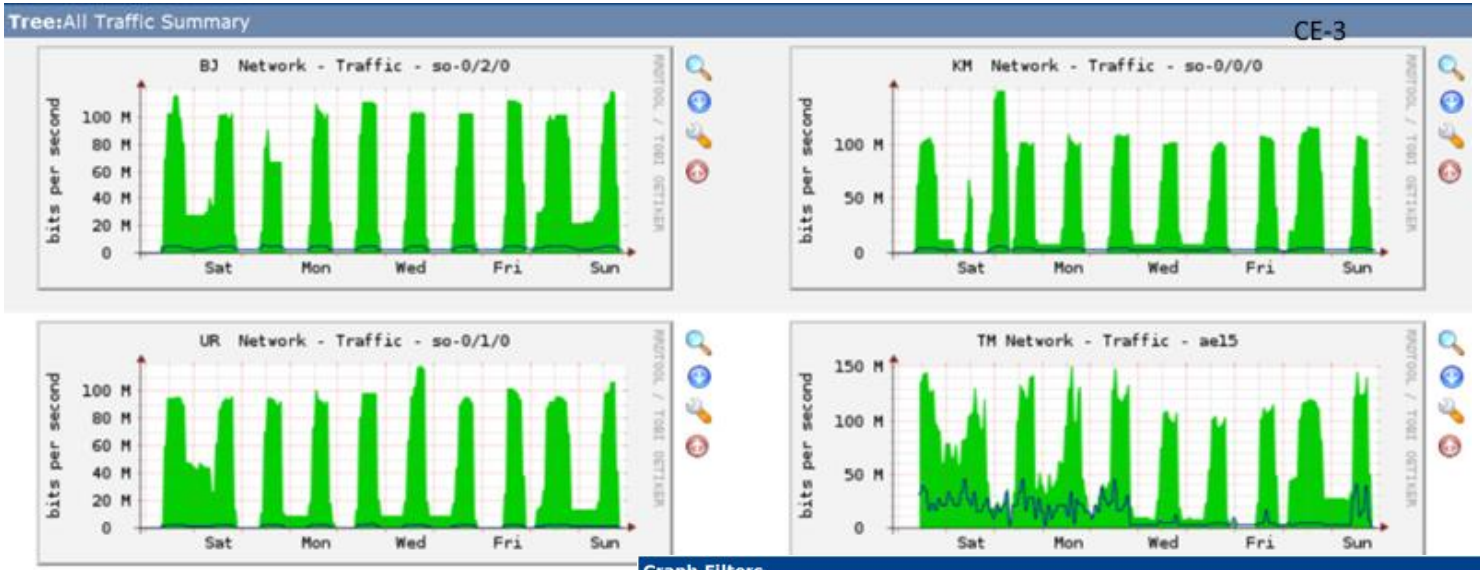
e-VLBI Transfer System

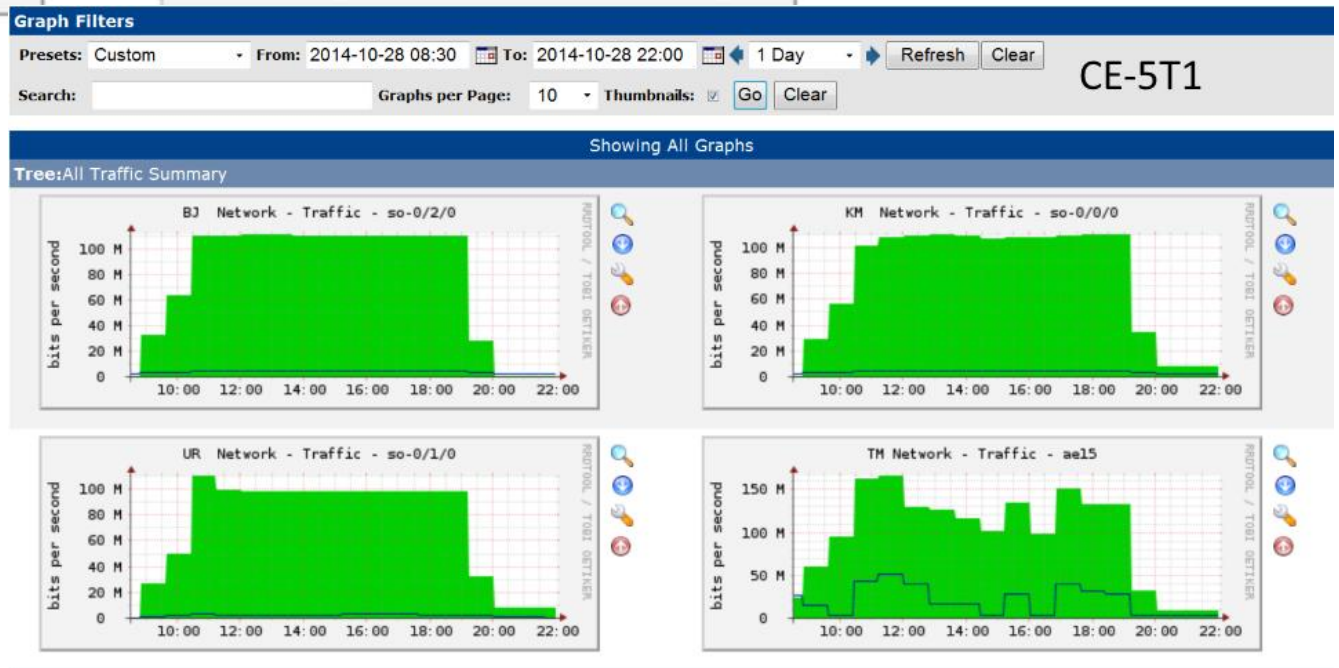
- **Stations**
  - CDAS
  - Mark5B+ (2/station)
  - Modified Mark5B+ software
  - Two level buffer: HW/SW
- **Data center**
  - Data Distribute Unit
  - COST Servers (5+1)+DAS
  - Data Receiving
  - Data Distribution
  - Ring Buffer
- **Protocol: TCP (*UDP*，*IPv6*)**
- **Control**
  - Script Control



e-VLBI Network flow

❖ e-VLBI





Outline

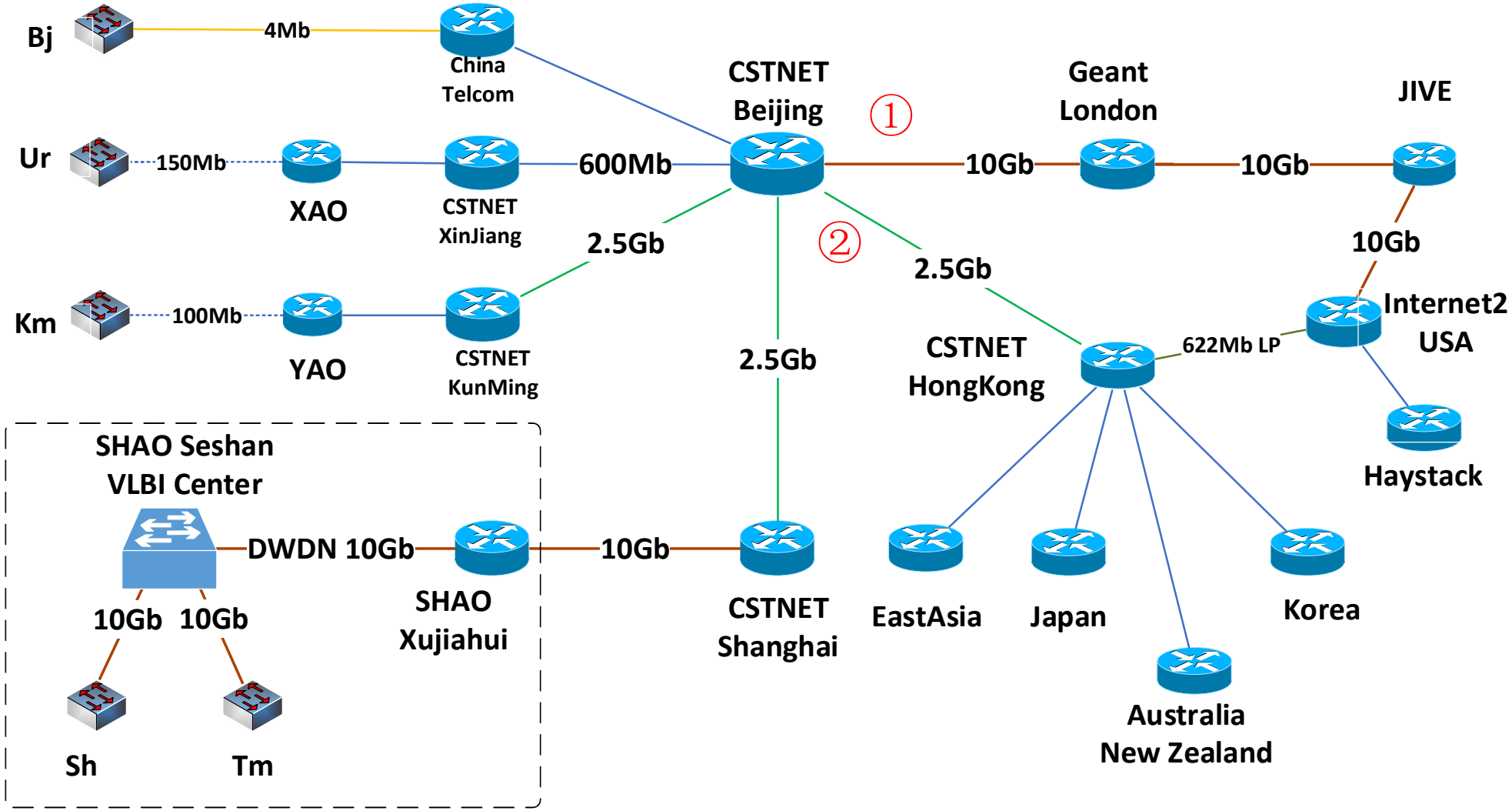
- ❖ CVN e-VLBI Network
- ❖ e-VLBI Applications
  - CLEP
  - Shanghai Correlator for IVS
- ❖ Conclusion

Shanghai Correlator for IVS

- **IVS Correlator Center**
  - Bonn, Haystack, IAA, Kashima, Tsukuba, Washington, Shanghai (2012, Madrid, IVS GM Meeting)
- **Data Processing**
  - DiFX
  - CVN Software correlator
- **Data Transfer**
  - Internet based e-Transfer: from most stations & correlators
  - Disk Shipping: Kokee, …

CVN Internet B/W

- Via CSTNET(Chinese Science&Technology Network, CAS)
- IPv6 supported in CVN



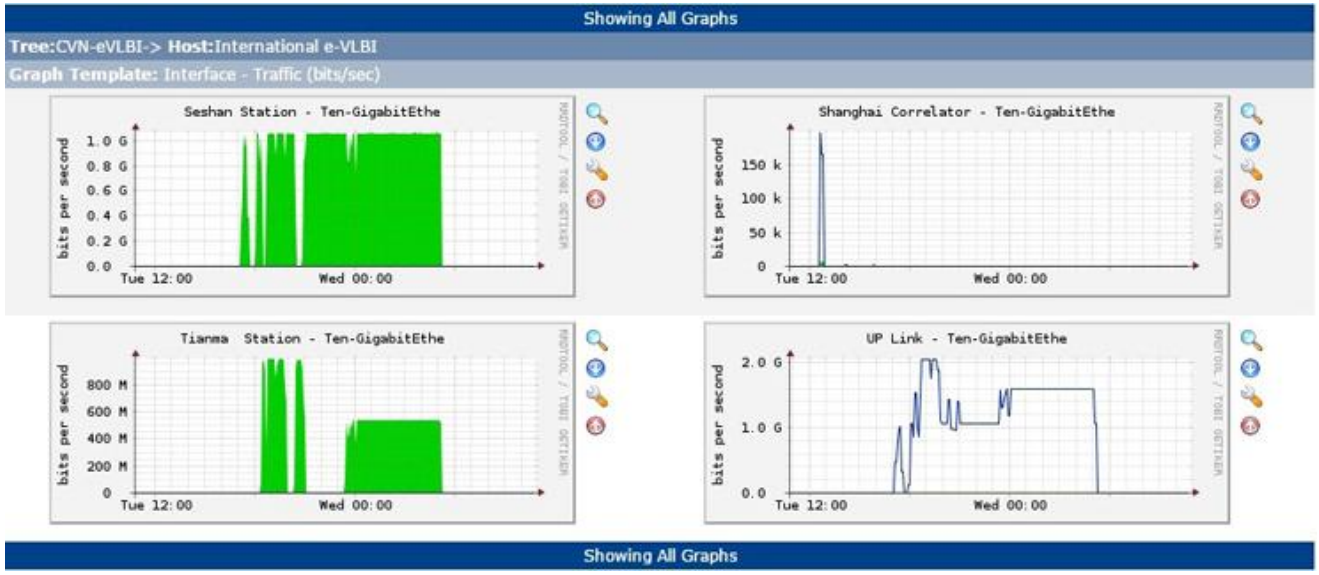
Shanghai Correlator e-Transfer data rate

Country	Institutes	Network B/W	To/From Shanghai
Germany	Bonn MPRiFR	900Mb/s	800Mb/s
Japan	NICT	10Gb/s	1Gb/s
Japan	GSI	10Gb/s	1Gb/s
South Korea	NGII	1Gb/s	800Mb/s
Italy	IRA	10Gb/s	800Mb/s
South Africa	Hartebeesthoek	10Gb/s	550Mb/s
Australia	University of Tasmania	10Gb/s	800Mb/s
New Zealand	Auckland University of Technology	10Gb/s	800Mb/s
Brazil	IPNE	1Gb/s	200Mb/s
Netherlands	JIVE	10Gb/s	1Gb+/s
Russia	IAA	1Gb/s	500Mb/s
USA	Haystack	1Gb/s	600Mb/s
Malaysia	University of Malaya	100Mb/s	90Mb/s

International e-VLBI Testing/Transfer

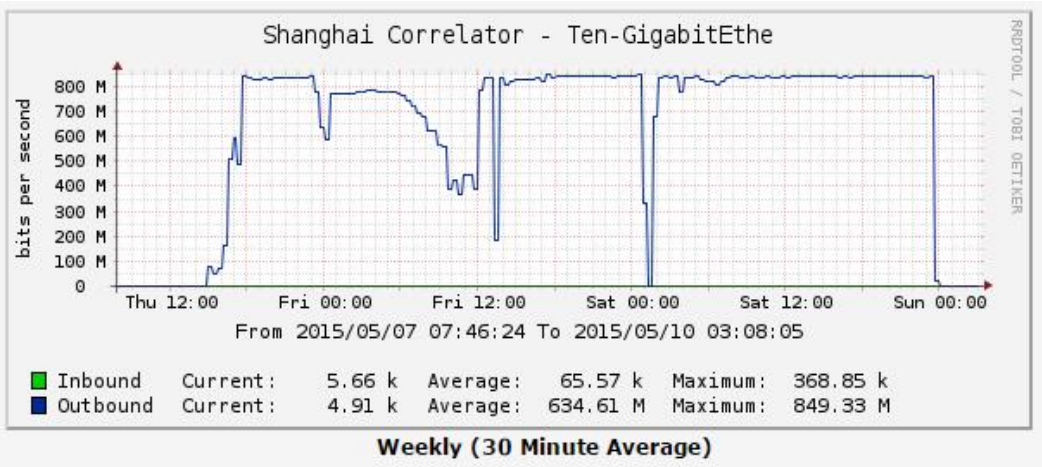
❖ Sheshan/Tinama->JIVE

- 2015.4.17
- e-EVN
- Sh:1Gb/s
- Tm:500Mb/s



❖ Sejong->Sh

- 2015.05
- e-Transfer



Conclusion

- **Deep space exploration e-VLBI**
  - High reliability, Low data rate
- **Science observation e-VLBI**
  - High data rate, Distributed Processing
- **Applications**
  - CVN e-VLBI for CLEP is very successful, continuous services
  - IVS Shanghai Correlator connecting more worldwide stations&centers, providing geodesic data processing service officially, as well as astrophysics
- **Challenges**
  - Future technical requirement: VGOS, SKA
  - CVN
    - R&E backbone network bandwidth limitation: CSTNET, Km, Ur
    - Last mile to stations: Bj, FAST, QTT

Thanks !