The e-VLBI Progress in Chinese VLBI Network

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Outline:

1. About VLBI
2. e-VLBI progress
3. The e-VLBI test in CVN
4. The near future plan of e-VLBI for CVN
Traditional VLBI
The Very-Long Baseline Interferometry (VLBI) Technique
(with traditional data recording)

The Global VLBI Array
(up to ~20 stations can be used simultaneously)
**VLBI Science**

**ASTRONOMY**
- Highest resolution technique available to astronomers – tens of microarcseconds
- Allows detailed studies of the most distant objects

**GEOODESY**
- Highest precision (few mm) technique available for global tectonic measurements
- Highest spatial and time resolution of Earth’s motion in space for the study of Earth’s interior
  - Earth-rotation measurements important for military/civilian navigation
  - Fundamental calibration for GPS constellation within Celestial Ref Frame
Some VLBI statistics

- VLBI is inherently an international, global activity
- ~50 radio telescopes worldwide from more than 20 countries participate in global VLBI observations on a regular basis
- VLBI data are recorded on magnetic disk or tape now and physically transported to one of the few VLBI correlator sites (3 in U.S., 2 in Europe, 2 in Japan, 1 in China); expect this data volume to increase rapidly in coming years.
- e-VLBI has been developing rapidly in past 3-4 years, with increasing amounts of data transferred electronically
- The existing global grid of research and education networks continues to rapidly improve in speed. This global grid may, with suitable agreements, be available for transmitting geodetic and astronomical VLBI data.
VLBI Stations in China
Seshan (Shanghai)

Nanshan (Urumqi) at sunrise
Beijing & Kunming station in construction
Advantages of e-VLBI

- Bandwidth growth potential for higher sensitivity
  - VLBI sensitivity (SNR) proportional to square root of Bandwidth resulting in a large increase in number of observable objects (only alternative is bigger antennas – hugely expensive)
  - e-VLBI bandwidth potential growth far exceeds recording capability (practical recordable data rate limited to a few Gbps)

- Rapid processing turnaround
  - Astronomy
    - Ability to study transient phenomena with feedback to steer observations
  - Geodesy
    - Higher-precision measurements for geophysical investigations
    - Better Earth-orientation predictions, particularly UT1, important for military and civilian navigation
Advantages of e-VLBI

• Space craft orbit tracking
  – Highest angle resolution and fast responsive

• Other benefits
  – Elimination of expensive disk/tape media and shipping costs
  – Increased reliability
  – Full station automation
e-VLBI status

- e-VLBI activity is expanding rapidly, particularly in U.S., Europe, Japan and Australia.
- Real-time e-VLBI over public networks has been demonstrated at 512 Mbps.
- All international e-VLBI data are transported over public high-speed R&E networks hosted by various countries and international organizations.
- International standardization of e-VLBI data formats and data-transport protocol has been developed.
- Biggest problem for e-VLBI is ‘last mile’ high-speed connection to telescopes, though increasing number are being connected.
- The Chinese astronomer started e-VLBI experiment since year 2003.
e-VLBI experiment for launch tracking of GEO satellite

Correlator (Shanghai)

Seshan

Car

Nanshan

Car

Urumqi

Network 500Kb/s

ISDN
e – VLBI results: single baseline orbiting for GEO satellite launch tracking
e-VLBI events in Chinese VLBI Network

First e-VLBI test in year 2003, for space craft tracking

- System checking with e-VLBI Technique
- Fast responsive for astronomical events
- Space craft tracking experiments: TC -1, Huygens Descent, Smart-1
- All of these experiments, the max. data rate was 2Mbps only
- The e-VLBI data rate requirement of CVN is several Gbps
- End 2005, 1 Gbps fiber connect between Seshan and city Shanghai (with the support from CNIC, CAS)
- In 2006, 1 Gbps fiber connect between Nanshan and city Urumuqi
- In 2006, 10 Mbps data rate connect for Beijing and Kunming stations
- In 2006, a real time, 4 stations VLBI network should be build in china,
TC-1 e-VLBI tracking results
Fringe results of Smart-1
VLBI Stations for Chinese Lunar Project

Fiber in place – upgradeable to 1 Gbps

New station - 2006

Fiber in end-2005 – plan 1 Gbps

3 M mobile station now, New station - 2006
Thank you!