

測地VLBIの国際的な技術動向

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Contents

- 国際測地 VLBI 観測の現状
- 国際 e-VLBI の現状
- VLBI2010: IVS (国際VLBI事業) における検討
- 提案・要望

国際測地VLBI観測の現状

- IVS (International VLBI Service for Geodesy and Astrometry : 国際VLBI事業) のもとに実施



2004 Observing Plan Summary

Session purpose	Session code	Total sessions	Average # participating stations	Total station days	Average GB recorded per station	Mb/s for transfer in 1 day	Total TB per year
Rapid turnaround EOP (Monday)	IVS-R1	52	6.8	356	1200	111	427
TRF, all stations 3-4 times per year	IVS-T2	12	7.8	94	400	37	38
EOP, TRF using S2	IVS-E3	12	5.3	64	600	56	38
Rapid turnaround EOP (Thursday)	IVS-R4	52	6.9	357	500	46	179
CRF, emphasis on south	IVS-CRF	13	2.7	35	400	37	14
20-station EOP/TRF/CRF sessions	RDV	6	20.0	120	1000	93	120
R&D Gigabit/s investigations	IVS-R&D	10	6.1	61	3000	278	183
Regional - Antarctica	IVS-OHIG	6	6.0	36	300	28	11
Regional - Europe	EURO	4	8.8	35	300	28	11
Regional - Antarctica	SYOWA	4	3.0	12	300	28	4
Regional - Asia/Pacific	APSG	2	6.0	12	300	28	4
	Totals	173		1182			1027

Mark5/K5 Usage Plan

NRV last updated 040208

	2003					2004								
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Correlator														
Bonn	4	8	8	8	8	8	8	8	8	8	8	8	8	8
Haystack	2	2	2	4	4	4	4	6	6	6	6	6	6	6
Washington	2	2	2	4	4	6	6	8	8	8	8	8	8	8

	2003					2004								
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Station														
Algonquin	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	Mk5 partial	Mk5 partial	Mk5 partial	Mk5 only	Mk5 only	Mk5 only
Fortaleza	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
Gilmore Creek	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
GGAO	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
HartRAO	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
Hobart	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
Kashima34	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
Kokee Park	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
Matera	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
Medicina	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
Noto	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
Ny Alesund	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
O'Higgins	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
Onsala	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
Seshan	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
Simeiz	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
Svetloe	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
TIGO	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
Tsukuba	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
Urumqi	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
Westford	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
Wettzell	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
Yebeis	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape
Yellowknife	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape	thin tape

- Mk5 only
- Mk5 partial
- K5 partial
- thin tape
- thick tape

国際測地VLBI観測の現状

- IVS-R1, IVS-R4 週2回の24時間実験 (EOP)
- IVS-T2 月1回の24時間実験 (ITRF)
- IVS-CRF 月1回の24時間実験 (ICRF)
- Intensive 1~2時間の1基線観測 (UT1)
 - Kooke-Wetzell (週5回)
 - Tsukub32-Wetzell (週2回)
- 観測局時間がボトルネック

国内の IVS 観測局

- 2004年における国際VLBI実験参加状況
 - つくば 32m: 110回
(R1+T2+R&D+APSG+JADE+IN2)
 - 鹿島 34m: 12回 (T2 + CRF)
 - 昭和基地 11m: 9回 (SYOWA+OHIG)
 - 水沢 10m: 0回

国際 e-VLBI の現状

- 一部で徐々に導入されつつある状況。USNO 相関局と Bonn 相関局をネットワークにつなげることが現在の課題。
- 鹿島 JIVE 400Mbps (tsunami UDP/IP)
- JGN2 Symposium 2005 in Osaka e-VLBI デモ
 - ヘイスタック 大阪 700Mbps
 - 鹿島 大阪 900Mbps
 - 伝送 + リアルタイム分散相関処理 : 240Mbps
- 上海 鹿島 30Mbps (TCP/IP bbftp)

VSI-E

● Goals:

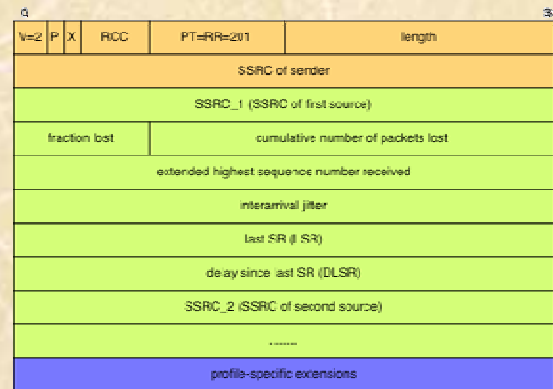
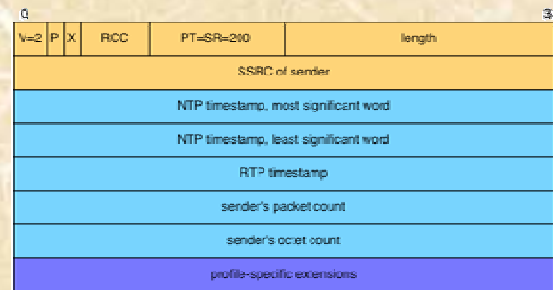
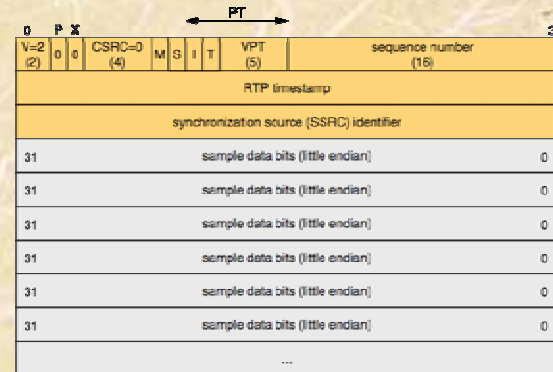
- Efficient transport mechanism
- Standard protocols
- Internet-friendly transport
- Scalable Implementation
- Ability to transport individual data-channel streams as individual packet streams
- Ability to make use of multicasting to transport data and/or control information in an efficient manner
 - *could be used in the future for support of distributed correlation*

VSI-E History

- e-VLBI Workshop Dwingeloo 2003, first discussion on VSI-E:
 - RTP proposed for transport of VSI-E data:
 - *RTP has wealth of implementation and operational experience*
 - *RTP seen as internet-friendly by the network community:*
 - attention to efficiency, attention to resource constraints, attention to scaling issues
- Draft release 2.7, January 30, 2004
- Reference implementation library and application release 1.0, October 5th, 2004.

e-VLBI RTP/RTCP Packets

- RTP Data packet
 - used to transport data
- RTCP Sender Report
 - Timestamp
 - allows sources to distribute transmission statistics and relationship between sender RTP timestamp and sampling time reference
- RTCP Receiver Report
 - used by receivers (e.g. correlator) to distribute quality of reception statistics:
 - E.g. fractional packet losses, cumulative number of packets lost, interarrival jitter etc.



VSI-E

- 現在のドラフトに準拠したMark-5データを伝送するサーバー・クライアントの開発 by David Lapsley
- K5データを読み込む部分のインターフェースを開発すれば、K5-Mark5のVSI-E伝送が可能
- キーパーソン (David Lapsley 氏) がヘイスタック観測所からいなくなる IETFへの標準提案は不透明

国際測地VLBI観測の今後

- 目標：連続観測（7日 / 週）
- 現実問題
 - 観測局老朽化
 - 予算状況、スタッフ
 - Sバンドの混信

VLBI2010

VLBI2010 : 国際測地VLBI観測の将来検討

- WG 発足 : Sep. 28, 2003 @ IVS 評議会
- Discussions : Feb., 2004 @ IVS 総会
- 1st. Draft : April, 2004
- Final Report : Fall, 2004 遅れ気味 . . .

VLBI2010 Working Group : Members

Brian Corey (antennas, RF/IF systems, calibration)

Hayo Hase (antenna systems)

Ed Himwich (control, data management)

Hans Hinteregger (digital backend systems, correlators)

Tetsuro Kondo (data systems, data transport, real-time)

Yasuhiro Koyama (data systems, data transport)

Chopo Ma (post-correlation analysis; data management)

Zinovy Malkin (post-correlation analysis)

Arthur Niell (atmospheric calibration, analysis)

Bill Petrachenko (antenna arrays, multi-beam VLBI, frequency standards)

Wolfgang Schlüter (antennas, observing strategies, frequency standards)

Harald Schuh (post-correlation analysis, cross-technique use)

Dave Shaffer (observing strategies, systems, analysis)

Gino Tuccari (digital backend systems)

Nancy Vandenberg (scheduling, observing strategies)

Alan Whitney (data systems, data transport, correlators)

VLBI2010 : Sub-groups

- Observing strategies (Chair : Bill Petrachenko)
- RF/IF, frequency and time (Chair : Hayo Hase)
- Backend systems (Chair : Gino Tuccari)
- Data acquisition and transport (Chair : Alan Whitney)
- Correlation and fringe-finding (Chair : Yasuhiro Koyama)
- Data analysis (Chair : Harald Schuh)
- Data archiving and management (Chair : Chopo Ma)

Science-based VLBI Accuracy Targets

from NGO proposal

<u>Parameter</u>	<u>VLBI now</u>	<u>Future Science Requirement</u>	
Scale (ppb)	0.2	0.1	(important)
Coords (NEU,mm)	2, 2, 5	1, 1, 1	
Nutation (mas)	0.2, 3/wk	0.05, daily	(unique)

from NASA's SESWG report

“...accuracy of global geodetic networks advances by about a factor of 10 per decade, with submillimeter-scale reference-frame accuracy likely in the near future. Continued improvements in accuracy are critical to a number of the recommendations of this report...”

Primary VLBI Targets for 2010 and Beyond

- Achieve significantly **better long-term accuracy** for scale and orientation of **reference frames**.
- Do it in a manner such that **daily operations** can be **sustained indefinitely**.
- **Reduce latency** between the taking of data and delivery of products.

検討中の課題

● 観測システム

- 小口径のアンテナ (6m or 12m)、同一デザイン
- 2000km ごとに1局 40局
- 大口径アンテナ (ICRF+R&D用) と小口径アンテナ (e-VLBI, EOP用) の組み合わせ

● 周波数

- X+22GHz or X+32GHz?
- S+X & 多ビットサンプリング, on the fly freq. selection

提案・要望

- VERA 観測局の IVS への参加
 - K5/VSSP システムの配備
 - P-cal などの改善
 - IVS 参加機関としての責任の履行
- VERA 測地観測データの IVS への提供
 - Mark-III Database or PIVEX

国内の IVS 参加機関

- IVS Annual Report for 2003 の執筆状況
 - NICT : 6 編、23 ページ
 - GSI : 2 編、8 ページ
 - NIPR : 0 編、0 ページ
 - NAO : 0 編、0 ページ
- Configuration File が提出されていないのは水沢局のみ