

SPACE GEODESY NETWORK MODEL
Projected Ground Network
as of 01/21/2013 (Rev 19)

Background

- uSimulations show that we will need about 30 globally distributed, new technology, core sites to achieve the required reference frame capability.
- uCore sites will include VLBI, SLR, GNSS, and DORIS (where available).
- uThis network will deploy over time and the quality of the data products will improve as the network evolves.
- uCo-location (sub-core site) sites with two and three technique co-location sites with either VLBI or SLR will
 - play a major role in the data product development while the core capability is building out; and
 - offer added strength to the full network once the core capability is established.

Objective

- Develop a model/tool to help us:
 - uMake intelligent decisions for deploying our resources (whatever they are)
 - uMake persuasive arguments to convince the powers-that-be to give us the resources
 - > All within the context of the activities underway throughout the global space geodesy community

Overview of the Task

- uCharacterize present ITRF contributing sites in the global Space Geodesy Network and project their capability 5 and 10 years ahead
- uTest the characterization of present sites model against the quality of our current data products for a reality check
- uIdentify new sites that are under development and that we see on the horizon, and project their capability 5 and 10 years ahead
- uUse the model to project improvements in data product quality:
 - as the global network evolves, and
 - for different scenarios of NASA site deployment

Task

- Evaluate current NASA and NASA partnership sites as candidate future core sites
 - Site evaluations reports underway
 - Identify some scenarios for deployment of new technology and maintenance of the legacy technology
- Evaluate plans and capabilities of overseas groups
 - Current core and co-location sites
 - Responses to the GGOS CfP
 - Anticipated participation from groups that have not yet responded to the CfP, but we know are planning to do so (Korea, France, etc)
 - Our own collective wisdom to project where we think these groups will be in 5 and 10 years
- Make some assumptions
 - GNSS receivers at any of the accepted network sites will have multi-constellation capability
 - People will be a little smarter as time goes on
- Develop a model that characterizes the sites for use in the simulations

Parameters identified in the Model

- uStation configuration of instruments:
 - Current and future projections
- uGeneral:
 - Ground stability: (based on geology and GPS history);
 - Ease of doing business at the site (infrastructure, logistics, personnel, etc)
 - Evidence of commitment
- uSLR:
 - Cloud cover
 - Current data production
 - Present Equipment Rating
 - Site tie closure based on ITRF closure file (relative to GPS)
- uVLBI:
 - Days per year (current operation)
 - Communications (data rate)
 - RFI conditions
 - Site tie closure based on ITRF closure file (relative to GPS)
- uOther equipment:
 - Gravimeters, seismometers, tiltmeters, etc.
- uNASA participation – What NASA would have to add
- uIssues and comments

Method of Rating

uTechnology

- New Technology - N
- Legacy Technology - L

uRatings

- Index rating: 3 (excellent), 2 (satisfactory), or 1 (poor)
- Value in mm

uGeneral

- Ground stability: (based on geology and GPS history);
- Ease of doing business at the site (infrastructure, logistics, personnel, etc)
- Evidence of Commitment (3 ~ strong, 2 ~ interest, 1 ~ ??)

uSLR:

- Cloud cover: (3 ~ 30%, 2 ~ 50%, 1 ~ 70%);
- Current data production (3 ~100%, 2~ 50%, 1~25% based on LAGEOS/LARES)
- Equipment rating (3 =N, 2 = L, 1 = poor)
- Site tie closure (mm) based on ITRF closure file (Altamimi)

uVLBI

- Days per year (current operation)
- Communication (3= >500 Mbps, 2= 100-499 Mbps, 1= 99-2 Mbps, 0= <Mbps)
- RFI conditions (1= not significant, 0= significant)
- Site Tie closure (mm) based on ITRF closure file (Altamimi)

uOther Systems

- G Gravimeter: A Absolute; S Superconducting

Candidate NASA Space Geodesy Sites

Region/Class	Sites	Current Config.					5 Year Projected Configuration					10 Year Projected Configuration					Partner/ Agency	Other Equipment	Ground Stability	Ease of Business	SLR				VLBI				Sponsor Commitment	Equipment Provider	Issues/Comments
		G	V	S	D	Gr	G	V	S	D	Gr	G	V	S	D	Gr					Production	Eq. Rating	Cloud Cover	Site Tie Closure (mm)	Days / Year	Data Rate	RFI Conditions	Site Tie Closure (mm)			
North America																															
Core	GGAO*	N	L	L	L	N	N	N	N	N	N	N	N	NASA		3	3	3	3	2	7	2	0	3	NGSLR (NASA) VGOS (NASA)						
VLBI	Westford/Haystack	L	L			N	N			N	N			MIT					2		68	2	1	10,11	3	VGOS (NASA)					
Potential Core Options	Monument Peak*	L	L	L		N	N	N		N	N	N		NASA		2	3	3	2	3	7		0	3	NGSLR (NASA) VGOS (NASA)	Locating VLBI requires alternative site about 1 mile away Alternative site belonging to the Forest Service; RF problem with DORIS.					
	McDonald/Ft. Davis	L	L	L		N	L	L		L				UT		3	3	3	1	2	21	6		1	1		Fort Davis is VLBA site				
	Owens Valley		L				L			L				NRAO					3		6		1	0		VLBA - Clear skies almost 80% of the time					
	Goldstone	L	L			L	L	L		L	L	L		NASA		2			3		8					Clear Skies almost 80% of the time					
Potential Core	Gilmore Creek	L												NOAA		2	3			2					9	NGSLR (NASA) VGOS (NASA)	Cold/ cloud cover is overcast or mostly cloudy about 50%...				
South America																															
SLR	Arequipa	L	L	L		N	L			N	L			(UNSA)		1	1.5	3	2	2	7,13					Not appropriate; Ground motion issue Near tota Cloud Cover 3 months a year, otherwise clear					
VLBI	Fortaleza	L	L			N	L			N	L			Mackenzie		3	2			1		100	2	0	5		Mostly/partly cloudy ~70% of time, best period Jul-Oct w/~40% mostly clear sky Mostly dark skies 3 months and mostly daylight 3 months				
Potential Core	NE Colombia					N	N	N		N	N	N		IGAC					2						1	NGSLR (NASA) VGOS (NASA)	Three candidate sites suggested				
Potential Core	Brazilia (tentative)									N	N	N		INPE		2			2						1	NGSLR (NASA) VGOS (NASA)	Only general area identified Stability looks seasonal, http://sideshow.jpl.nasa.gov/post/links/BRAZ.htm				
Central Pacific																															
Potential Core	Haleakala*	L	L	L		N	N	N		N	N	N		U. Hawaii		3	2	3	2	3	4,9,7		0		NGSLR (NASA)	VLBI very difficult and no Navy Support					
	Kokee Park*	L	L	L		N	N	N		N	N	N		USNO		3	2			1		104	2	1	41,42		VGOS(Navy)	Very poor weather, but Navy supports VLBI			
Australia/South Pacific																															
Core	Yarragadee	L	L	L		N	N	N		N	N	N		GA		3	3	3	2	3	15	49	3	0	3	NGSLR (NASA) VGOS (GA)	GA support for VLBI. Nearby transmitter - requires filter				
Potential Core	Papeete	L	L	L		N	N	N	N	N	N	N	N	GRGS/UFP		3	1	1	2	1	10					2	SLR (GRGS) VGOS (NASA)	Needs new location; needs commitment from GRGS and UFP Assumes GRGS SLR			
Africa																															
Core	Harteebeesthoek, SA (Matjiesfontein)	L	L	L		N	N	N	N	N	N	N	N	NRF		3	2	3	2	2	5	58	2	1	4	3	NGSLR (NASA) VGOS (NASA)	Some talk about moving to Matjiesfontein			
New Core	Malindi, Kenya									N	N	N		ASI		2			2						?	NGSLR (NASA) VGOS (NASA)	Talking stage; ASI support of SLR / mostly or partly cloudy about 50% ASI providing data				
New Core	Toro, Nigeria									N	N	N		NASRDA		2			No Data						CfP	NGSLR (NASA) VGOS (NASA)	No Data Available at this time Tough Site				

Foreign/Other Supported Stations

Region/Class	Sites	Current Config.				5 Year Projected Configuration				10 Year Projected Configuration				Partner/ Agency	Other Equipment	Ground Stability	Ease of Business Production	Eq. Rating	Cloud Cover	Site Tie Closure (mm)	Days/Y ear	Data Rate	RFI Conditions	Site Tie Closure (mm)	Sponsor Commitment	Equipment Provider	Issues/Comments	
		G	V	S	D	Gr	G	V	S	D	Gr	G	V															S
North America																												
VLBI	Brewster	L	L			L	L			L	L			NRAO		3			3		6	1	1	3				VLBA
VLBI	Hancock	L				L				L				NRAO				2		6	1	1					VLBA	
VLBI	Kitt Peak	L				L				L				NRAO				3		6	1	1					VLBA	
VLBI	Los Alamos	L				L				L				NRAO				3		6	1	1					VLBA	
VLBI	Mauna Kea	L	L			L	L			L	L			NRAO	2			3		6	2	1					VLBA	
VLBI	North Liberty	L	L			L	L			L	L			NRAO	3			2		6	1	1	7				VLBA	
VLBI	Pie Town	L	L			L	L			L	L			NRAO	1			2		6	2	1	4				VLBA	
VLBI	St. Croix	L	L			L	L			L	L			NRAO				2	3	6	1	1	3				VLBA	
Europe																												
Core	Wetzell, Germany	N	L	L	AS	N	N	N	AS	N	N	N		BKG		3	3	3	2	2	9	133	3	1	4,10	3		Historic Site
VLBI	Grasse, France	L	L			N	L		AS	N	L			GRGS		3	3	3	2	2	2,7					3		Historic Site
VLBI	Effelsberg, Germany	L				L				L				MPIR				1		2	3	1						
Core	Matera, Italy	N	L	L		N	L	L	A	N	N	N	A	ASI		3	3	3	2	2	6	52	0	0	10	3		Historic Site
Core Plan	Yebes, Spain	L	L		AS	N	N		AS	N	N	N	AS	IGN		2			2		35	3	1	7	3			
VLBI	Madrid, Spain	L	L			N	L			N	L			NASA				2		8			9					
VLBI Plan	Canary Islands					N	N			N	N			IGN				2				1			S		very cloudy Nov - June, other time can be very clear...depending on exact location	
VLBI Plan	Azores					N	N			N	N			DRCTC		3		3					1			S	Mostly cloudy at the Terceira Island location. Need better location identification	
SLR (Core Plan)	Herstmonceux, GB	N	L		A	N	N		A	N	N	N	A	NERC		3	3	3	3	2	4					3		Historic Site
SLR	Graz, Austria	N		N		N		N		N		N		OEAW		3	3	3	3	2	6					3		Historic Site
SLR	Zimmerwald, Switzerl	N		N		N		N		N		N		AIUB		3	3	3	3	3	2,6					3		Historic Site
SLR	Potsdam, Germany	L	L			N	L			N	L			GFZ		3	3	2	2	2	7,22					3		Historic Site
SLR	San Fernando, Spain	L	L			N	L			N	L			ROA		3	3	2	2	3	21					3		Historic Site
SLR	Borowiec, Poland	L	L			N	L			N	L			SRC/PAS		3	3			2	3					2		Historic Site
VLBI (Core Plan)	Metsahovi, Finland	L	L		AS	N	N	N	AS	N	N	N	AS	FGI		3	3			2	12,62	10	3	1		3		
VLBI (Core Plan)	Ny Alesund, Norway	N	L			N	N			N	N	N		NMA		3	3			2		133	1	1		3		
VLBI	Medicina, Italy	L	L		S	N	L		S	N	N			IRA		2	3			2		24	3	0	4	3		
VLBI	Noto, Italy	L	L			N	L			N	N			IRA		3				2		12	3		7	2		
VLBI	Onsala, Sweden	L	L		AS	N	N		SA	N	N		AS	OSO		3	3			2		40	3	1	12	3		Historic Site
SLR	Simeiz, Ukraine	L	L	L		N	L	L		N	L	L		CRAO		3	3	2	1	2		12	1	1	8	3		
VLBI																												
Middle East																												
SLR (Core Plan)	Riyadh, Saudi Arabia	L	L			N	N			N	N			KACST		3	1	1	1	3						2		

Foreign/Other Supported Stations (continued)

Region/Class	Sites	Current Config.				5 Year Projected Configuration				10 Year Projected Configuration				Partner / Agency	Other Equipment	Ground Stability	Ease of Business	Production	Eq. Rating	Cloud Cover	Site Tie Closure (mm)	Days / Year	Data Rate	RFI Conditions	Site Tie Closure (mm)	Sponsor Commitment	Equipment Provider	Issues/Comments
		G	V	S	D	Gr	G	V	S	D	Gr	G	V															
Australia/New Zealand																												
Core	Yarragadee, Aust.	L	L	L	L	N	N	L	N	N	N	N	N	GA	3	3	3	2	3	15	49	3	0	3	NASA (NGSLR)			
SLR	Mt Stromlo, Aust	L		N	L	N	N	N		N	N	N		GA	3	3	3	2	2	6,9				3		Excellent May - Sept, Poor Dec - Mar		
VLBI	Katherine, Aust	L	L			N	N			N	N			GA	3	3			3	43	3	1	3					
VLBI	Hobart, Aust.	L	L			N	N			N	N			GA	3	3			1	58+6	3	1	6	3				
VLBI	Warkworth, NZ	L?	L			L	L			N	N			AUT		3			2	36	3	1	3					
Asia																												
Core	Shanghai, China	L	L	L		N	L	N		N	N	N		SHAO		3	2	2	2	21	14	3	1	11	3			
SLR	Changchun, China	L		L		N		N		N		N		SHAO	3	3	3	2	3				3					
SLR	Beijing, China	L	L	L		N	L	L		N	L	L		CASM	2	3	1	2	2	6				3				
Core Plan (VLBI)	Kunming, China	L	L			N	L	N		N	L	L		Yunnan	2				2	6					Extreme seasonal cloud coverage, from about 50% trackable to <30% trackable			
Core Plan (VLBI)	Urumqi, China	L	L			N	L			N	L			CAS	1				2	31	12					Similar but clearer than Kunming		
Core Plan	Sanya, China									N	N	N		CAS					2	12					Still better than Urumqi			
Core Site	Koganei, Japan	L	L	L		N	L	L		N	L	L		NICT	1		2	2	1	35,68	10	3	1			2 SLR systems		
SLR	Tanegashima, Japan	L		L		N		L		N		L		JAXA			1	2	2						No real good data available other than tracking and personal knowledge			
VLBI	Tsukuba, Japan	N	L			N	N			N	N			GSI	1				1	129	3	0	4			Very cloudy with some breaks Nov-Mar		
VLBI	Kashima, Japan	L	L			N	L			N	L			NICT	1				2	75,71	5+10	3	1	99			Very cloudy with some breaks Nov-Mar	
SLR	Simosato, Japan	L		L		N		L		N		L		SHO/JCG	2	2	2	2	2						Historic Site			
Core	Sejong, Korea					N	L	N		N	L	N		KASI NGII	2	3	1	2	2				3		KASI SLR NGII VLBI			
South America																												
Core	Concepcion, Chile (TIGO)	L	L											BKG	1	2	3	2	1	8	120	0	1	9	3		To be relocated, possibly to La Plata, Argentina	
	(La Plata, Argentina) (TIGO)	L	L	L		N	L	L		N	N	N		BKG	3	3			3				1	3				
SLR (Core Plan)	San Juan, Argentina	L?	L			N	L	L		N	L	L		CASM	3	2	3	2	3					3		Chinese Station; Plan to add VLBI		
Russia																												
Core	Svetloe, Russia	L	L	L		N	L	L		N	L	L		IAA/RAS	2		1		2	30	1	1	16	3		SLR just underway		
Core	Zelenchukskaya, Russ	L	L	L		N	L	L		N	N	L		IAA/RAS	2		1		1	30	1	1	29	3		nge03 Worse than GGAO		
Core	Badary, Russia	L	L	L		N	L	L		N	N	L		IAA/RAS	U		1			30	1	1		3		SLR just underway		
SLR	Altay Mountain, Russi	L?	L			N		L		N		L		IPIE	U		1		2					3		similar to GGAO		
SLR	Arkhyz, Russia		L			N		L		N		L		OJC/RPC/PSI	U		1		2					3				
SLR	Balkonur, Kazakhstan		L			N		L		N		L		OJC/RPC/PSI	U		2		2					3		Kazakhstan? Little information available		
SLR	Komsomolsk, Russia	L		L		N		L		N		L		SRI			1		1							Historic Site		
Antarctica																												
VLBI	Syowa	L	L			L	L							NIPR	3					6	0	1	4			Not much good information		
VLBI	O'Higgins	N	L			N	L							BKG	2					8	0	1	9			Historic Site Not much good information...		