SERVICES & FACILITIES ANNUAL REPORT - FY April 2016 to March 2017

SERVICE	FUNDING	AGREEMENT	ESTABLISHED as S&F	TERM
BIGF	BLOCK	R8/H10/59	2002 (Operating since 1998)	N/A

TYPE OF SERVICE PROVIDED:

The British Isles continuous GNSS Facility (BIGF) is a unique and secure repository of archived GNSS* data, dating back as far as 1997. All data are in RINEX** files, which are quality-assured and accompanied by metadata, and also form the basis of derived products. BIGF serves all of these data, metadata and derived products to the complete user-spectrum - nationally and internationally across academia, government, and business - with impact on research and development, policy and the wider societal good. BIGF provides data for reference stations to satisfy positioning improvement needs but also acts as a regional natural environmental laboratory, as demonstrated through facilitated studies - of horizontal and vertical land motion, the ionosphere, and the troposphere - carried out at regional, continental and global scales over the multi-decadal extent of the archive. The data are sourced from a network of around 150 continuously recording GNSS stations, sited throughout the British Isles. The data are provided to BIGF free-of-charge by a number of collaborators, including the three national Ordnance Surveys and the Met Office. The archive currently comprises 1,985 station-years of 30 second (GPS, GPS+GLO*) data, and 827 station-years of 1Hz (GPS+GLO*) data. Users can request data and products using an online form. The service provided can be summarised in a 4-part Facility remit: 1. To provide an assured repository of data and derived products, so that the costs of users setting up an ad-hoc observation network and/or deriving their own products for research are reduced or eliminated; 2. To facilitate improvements in positioning quality for historic or current research, by providing reference station data, protecting researchers from the costs and delays of having to repeat data collection exercises; 3. To facilitate the least time delay in the examination of environmental and other variables, by providing extensive backward tracts of data and/or derived products for research; 4. To inform and stimulate the research community across the spectrum of science using various media.

BIGF station network

ANNUAL TARGETS AND PROGRESS TOWARDS THEM

1. To increase the quantity of data in the archive: hourly and daily RINEX files from around 150 CGNSS stations continue to be uploaded, at a nominal rate of 56k station-days a year.

2. To improve metadata: to support users we provide an interactive network map, station log files and data listing by year and station. The veracity of log files is also monitored, assuring accurate station history.

3. To increase archive usage: 1,483.1k, 10.8k, and 1,629.5k station-days of 30 second data, 1Hz data, and derived products were supplied in 2016/17, with a continuing steady uptake of 1Hz data and derived products. There were 74 scientific-user projects this year (and ~74 a year over the previous 5 years), suggesting a well-founded awareness of the Facility and indicating the effectiveness of our varied activities to promote its utility. There were 41 publications this year, including 3 completed PhD theses.

4. To meet the 'future developments/strategic forward look' from the 2015/16 annual report:

a) 5 of the CGNSS stations have now been upgraded to track GPS+GLO+GAL+BDS, including the 4 at tide gauges funded by NERC S&F capital in 2011/12 and installed in late 2013 and the first new station of several to be installed by the Met Office.

b) A sixth 'releasable' set of 'long term trend (LTT) derived products' at Levels 1, 2 and 3, related to station coordinates, tropospheric parameters and station velocities, based on Bernese GNSS software version 5.2 (BSW5.2) and time series from 1997 to 2016:365 have started to be created, but new 'LTT derived products' at Level 1, related to ionospheric parameters, have yet to be.

c) 'Near real-time (NRT) derived products' at Levels 1 and 3, related to tropospheric parameters, and at Levels 1 and 2, related to ionospheric parameters, have continued to be created based on BSW5.0, and the implementation of BSW5.2 for the creation of enhanced 'NRT derived products' at Levels 1 and 3, related to tropospheric parameters, and at Levels 1 and 2, related to ionospheric parameters, has been completed with testing currently on-going.

d) The creation of enhanced 'LTT derived products' at Level 3, through collaboration with BGS on maps of vertical motions based on station velocities, and the creation of new 'LTT and NRT derived products' at Levels 2 and 3 through the further development of tools for the creation of time series and maps related to tropospheric and ionospheric parameters, has been started but not completed.

* Global Navigation Satellite Systems: GPS, Glonass (GLO), Galileo (GAL), Beidou (BDS). ** Receiver INdependent EXchange format.

SCORES AT LAST REVIEW (each out of 5)				Date of Last Review:	
Need	**Uniqueness**	**Quality of Service**	**Quality of Science & Training**		**Average**

CAPACITY of HOST ENTITY FUNDED by S&F	Staff & Status	Next Review (March)	Contract Ends (31 March)
100%	Dr Richard Bingley, Head of Facility, 40% NERC Dr David Baker, Manager, 40% NERC	TBC	

FINANCIAL DETAILS: CURRENT FY

Total Resource Allocation £k	Unit Cost £k			Capital Expend £k	Income £k	Full Cash Cost £k
	Unit 1 (Products)	Unit 2 (30s data)	Unit 3 (1Hz data)			
108.88	0.000039	0.000039	0.000039			121.19

FINANCIAL COMMITMENT (by year until end of current agreement) £k

2016-17	108.88	2017-18	111.44		

STEERING COMMITTEE	Independent Members	Meetings per annum	Other S&F Overseen
NGGFSC	12	2	GEF and NSGF

APPLICATIONS: DISTRIBUTION OF GRADES (current FY — 2016/17)

	10	9	8	7	6	5	4	3	2	1	0	R*	Pilot
NERC Grant projects*			1										
Other academic			20										
Students			6	1									
TOTAL			27	1									

APPLICATIONS: DISTRIBUTION OF GRADES (per annum average previous 3 financial years —2013/2014, 2014/2015 & 2015/2016)

	10	9	8	7	6	5	4	3	2	1	0	R*	Pilot
NERC Grant projects*			2.67										
Other academic			23.33	0.33									
Students		0.33	5	1									
TOTAL		0.33	31	1.33									

PROJECTS COMPLETED (current FY – 2016/17)

	10 (α5)	9	8 (α4)	7	6 (α3)	5 (α2)	4	3 (α1)	2	1 (β)	0 (Reject)	Pilot
NERC Grant projects*			1									
Other Academic			14									
Students			2	1								

Project Funding Type (current FY – 2016/17) (select one category for each project)

Grand Total	Infrastructure					PAYG				
	Supplement to NERC Grant *	PhD Students NERC	Other	NERC Centre	Other	NERC Grant*	PhD Students NERC	Other	NERC Centre	Other
91	1	1	8	5	76					

Project Funding Type (per annum average previous 3 financial years - 2013/2014, 2014/2015 & 2015/2016)

Grand Total	Infrastructure					PAYG				
	Supplement to NERC Grant *	PhD Students NERC	Other	NERC Centre	Other	NERC Grant*	PhD Student NERC	Other	NERC Centre	Other
95.333	1.333	1	6.667	4.333	82					

User type (current FY – 2016/17) (include each person named on application form)

Academic	NERC Centre	NERC Fellows	PhD Students	Other
26	5	0	9	Non-PhD students 10 Collaborators 6 Central and local Govt 18 OS user 17

User type (per annum average previous 3 financial years - 2013/2014, 2014/2015 & 2015/2016)

Academic	NERC Centre	NERC Fellows	PhD Students	Other
30	4.333	0	7.667	Non-PhD students 10 Collaborators 9.333 Central/local Govt 16 OS user 18

OUTPUT & PERFORMANCE MEASURES (current year)

Publications (by science area & type) (calendar year 2016)*

SBA	ES	MS	AS	TFS	EO	Polar	Grand Total	Refereed	Non-Ref/ Conf Proc	PhD Theses
0	13.5	6	16	7	0.5	0	43	25	14	4

Distribution of Projects (by science areas) (FY 2016/17)

Grand Total	SBA	ES	MS	AS	TFS	EO	Polar
91	1.833	16.167	21.333	13	34.83	3.83	0

OUTPUT & PERFORMANCE MEASURES (per annum average previous 3 years)*

Publications (by science area & type) (Calendar years 2013, 2014 & 2015)

SBA	ES	MS	AS	TFS	EO	Polar	Grand Total	Refereed	Non-Ref/ Conf Proc	PhD Theses
0.167	22.5	2.333	20.417	4.25	0.333	0	50	22.333	22.667	5

Distribution of Projects (by science areas) (FY 2013/2014, 2014/2015 & 2015/2016))

Grand Total	SBA	ES	MS	AS	TFS	EO	Polar
95.333	1	18.222	19.722	13.333	36.667	6.389	0

Distribution of Projects by NERC strategic priority (current FY 2016/17)

Grand Total	Climate System	Biodiversity	Earth System Science	Sustainable Use of Natural Resources	Natural Hazards	Environment, Pollution & Human Health	Technologies	Unclassified
91	7.167	0	14.667	2.5	28.167	1.5	1	36

*Either Discovery Science (Responsive Mode) or Strategic Science (Directed Programme) grants

NOTE: All metrics should be presented as whole or part of whole number NOT as a %

Note: From 1998 to 2016 there were 190 publications in Web of Science, generating 2,701 citations; and a total output of 688 publications, including 65 PhD theses. From 2014 to 2016 there were 56 publications added to Web of Science, generating 231 citations.
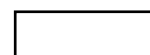
OVERVIEW & ACTIVITIES IN FINANCIAL YEAR (2016/17):

BIGF supported not only frontline UK academic research (32% of projects) and EU/International academic research (23%), but also projects serving UK government and policy (26%) and UK industry (19%). This support impacts on and benefits society as a whole, in terms of e.g. conservation – archaeology; environmental monitoring – mobile scanning systems, remote sensing, sea level change, structural monitoring; increasingly extreme natural hazards - storm driven coastal erosion, landslides, ground deformation, flood risk alert and river management; renewable energy; guidance – integrated transport systems, pedestrian and autonomous vehicle navigation; and regional and global threats – cyclical solar activity, tectonics and seismology, and tsunamis.

Data archival: Hourly and daily data archival continued from 153 CGNSS stations, comprising two data sets: 30 second (GPS, GPS+GLO) with a current volume of about 1,985 station-years, and some stations operating since 1996/7; and 1Hz (GPS+GLO) from 115 CGNSS stations, with a current volume of about 827 station-years and some stations operating since August 2009.

Network development: Minor changes have taken place at many sites, but the Facility station log file monitoring system continues to enable 'clean' metadata to be stored; this is crucial to users interested in the extraction of long-term environmental signatures.

Product development: The creation of derived products has continued to advance. A sixth 'releasable' set of 'long term trend (LTT) derived products' at Levels 1, 2 and 3, related to station coordinates, tropospheric parameters and station velocities, have started to be created based on Bernese GNSS software version 5.2 (BSW5.2) and time series from 1997 to 2016:365. Near real-time (NRT) derived products' at Levels 1 and 3, related to tropospheric parameters available hourly, and at Levels 1 and 2, related to ionospheric parameters available hourly, have continued to be created based on BSW5.0 and have now started to be created based on BSW5.2.

Website development: This continues to adapt to accommodate derived products as they are developed and launched; text and graphic content and FAQs are similarly enhanced to improve the user experience.

Archive access: Access to the archive is via an online request form. The request and delivery process is intentionally maintained as a personalised transaction, with capacity for verbal and e-mail dialogue on all aspects of supply, data processing and field operations, and to enable the easy gathering of user information to support NERC's reporting needs. A number of approved nationally and internationally led major research projects are served an automated continuous data stream.

Archive accounting: This is underpinned by a database designed to fulfil NERC's reporting needs, with user demand summarised as:

Figure1 Archive utility across time

Figure 2 Cumulative data and product demand (FYE)

Figure 3 Projects enabled and number of requests (FYE)

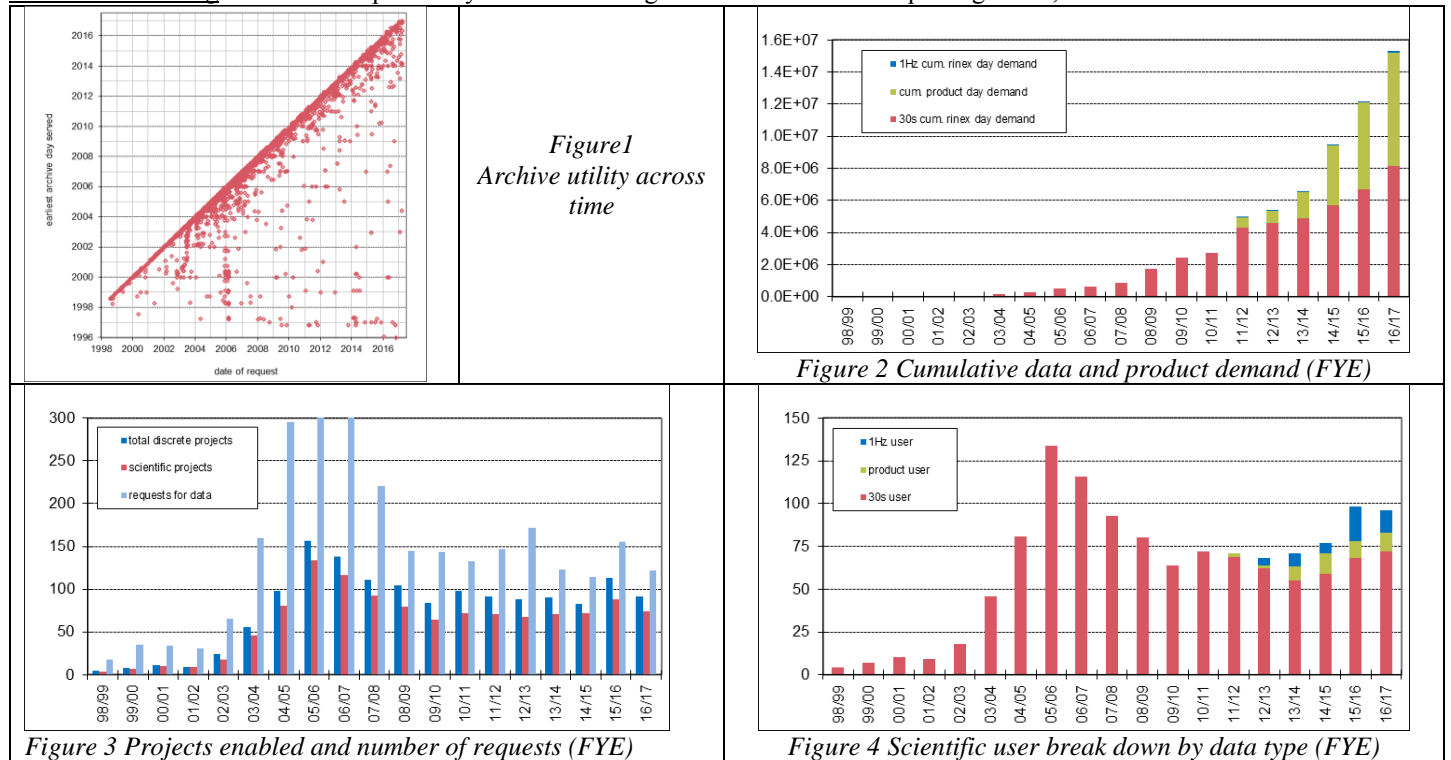*Figure 4 Scientific user break down by data type (FYE)*

Fig. 1 clearly demonstrates a continuous need for the archive through the significant number of users requiring data of several years' vintage, and in a number of cases to its full temporal extent. Fig. 2 shows a continued, year-on-year demand for 30 second data and 1Hz data and a steady demand for derived products since their first availability five years ago. Fig. 3 shows that there has been a consistent level of about 74 scientific-user projects a year over the previous five full years, and Fig. 4 illustrates the arrival and sustained uptake of both 1Hz data and derived products.

SCIENCE HIGHLIGHTS. *To focus on economic and societal impacts and benefits where possible*:

There were 74 scientific-user projects supported in 2016/17, an output of 4 PhD theses (with another 20 in progress), 25 refereed and 14 non-refereed publications, of which the 3 most significant refereed (based on their ISI 2015 JCR impact factors shown in [ ]) were:

1. Wöppelmann, G., Marcos, M. Vertical land motion as a key to understanding sea level change and variability. Reviews of Geophysics, Vol.54(1), pp:64-92, doi:10.1002/2015RG000502, March 2016. [11.444].
2. Pfeffer, J., Allemand, P. The key role of vertical land motions in coastal sea level variations: A global synthesis of multi-satellite altimetry, tide gauge data and GPS measurements. Earth and Planetary Science Letters, Vol.439, pp.39–47, doi:10.1016/j.epsl.2016.01.027, 2016. [4.326].
3. Cherniak, I., Zakharenkova, I. First observations of super plasma bubbles in Europe. Geophysical Research Letters, Vol.43, Issue 21, doi:10.1002/2016GL071421, November 2016. [4.212].

The remainder of this section provides brief summaries of 4 notable research projects supported by BIGF in 2016/17:
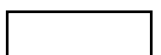
Oxford RobotCar Dataset. University of Oxford. Funded by EPSRC.


(Image credit University of Oxford)

A public dataset for autonomous driving research, acquired during 2014/15, of 1000km of repetitive car routing in all weather conditions, through central Oxford, acquiring LIDAR imagery, GPS and INS data. BIGF 1Hz data for this period were used to establish a corrected GNSS ground truth. This will allow researchers to evaluate their long-term localisation and mapping algorithms against infrastructure-based GNSS measurements.

Yesnaby Art & Archaeology Research Project. Orkney Research Centre for Archaeology.
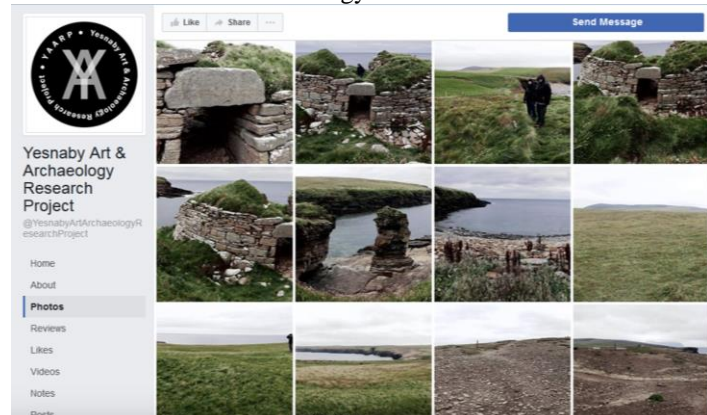
A project designed to explore the archaeological and contemporary landscape of Yesnaby, Sandwick, Orkney, with the objectives of mapping extant archaeological features and locating previously collected geophysical data. BIGF 30s data were used in the improvement of positional accuracy of field records.

Crustal deformation of the European Plate and its boundaries. Istituto Nazionale Geofisica Vulcanologia. Funded by Italian Ministry of Education, Department Civil Protection.
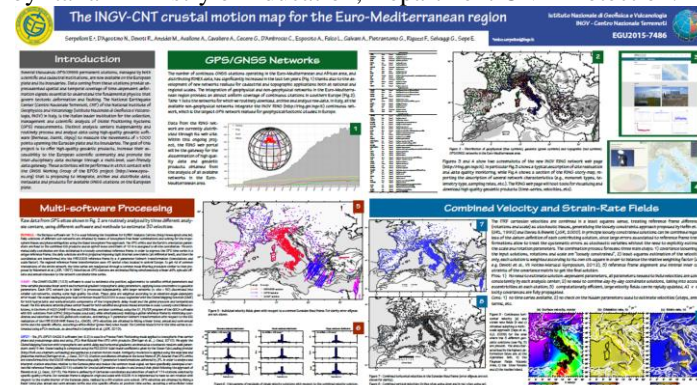
The full temporal and spatial extent of the BIGF 30s data archive were supplied, with the objectives of increasing the density of GNSS stations across the *stable* part of the Eurasian plate, and to determine the horizontal and vertical motion of the British Isles relative to the Eurasian plate.

Hi-Tech Observation of Playground Social Communication Trajectories in Children (Hopscotch). University College London. Funded by ESRC.
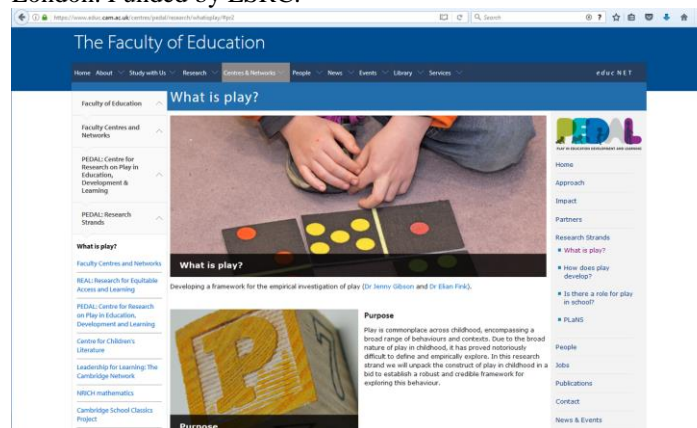
This project aims to create an entirely novel method of using custom built, high-resolution GPS to study social behaviours on the playground, by: developing novel algorithms for the analysis of GPS data collected during free-play; to study the impact of the playground environment on children's social interactions; and to establish whether GPS data could be used to detect and monitor clinically relevant social behavioural problems. BIGF 1Hz and 30s data were supplied for testing purposes.

FUTURE DEVELOPMENTS/STRATEGIC FORWARD LOOK
a) To expand data collection to include more Galileo and Beidou, in addition to GPS and Glonass, whenever possible.
b) To create a sixth 'releasable' set of 'long term trend (LTT) derived products' at Levels 1, 2 and 3, related to station coordinates, tropospheric parameters and station velocities, based on Bernese GNSS software version 5.2 (BSW5.2) and extended time series from 1997 to 2016:365, and to create new 'LTT derived products' at Level 1, related to ionospheric parameters.
c) To continue to create 'near real-time (NRT) derived products' at Levels 1 and 3, related to tropospheric parameters, and at Levels 1 and 2, related to ionospheric parameters, based on BSW5.0, and to continue to test BSW5.2 for the creation of enhanced 'near real-time (NRT) derived products' at Levels 1 and 3, related to tropospheric parameters, and at Levels 1 and 2, related to ionospheric parameters.
d) To create enhanced 'LTT derived products' at Level 3, through collaboration with BGS on maps of vertical motions based on station velocities, and new 'LTT and NRT derived products' at Levels 2 and 3 through the further development of tools for the creation of time series and maps related to tropospheric and ionospheric parameters, with concurrent developments to the website.
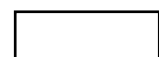
Non-Mandatory Facility-specific OPMs: utilisation, allocation of capacity etc

1. Mission Statement

To provide a unique and secure repository for archived, quality-assured GNSS (Global Navigation Satellite System) data, metadata and derived products dating back to 1997, from a network of continuous GNSS (CGNSS) stations sited throughout the British Isles, and to provide the interface between the archive and archive users, thereby facilitating research into the past, the present and the future, serving the complete user-spectrum - nationally and internationally across academia, government, and business, with impact on research and development, policy and the wider societal good.

2. Steering Committee membership and Terms of Reference

Steering Committee Members:

Dr N Linford (Chair), English Heritage.
Professor Z Li, Newcastle University.
Dr B Kulessa, Swansea University.
Dr J Hammond, Imperial College London.
Professor J Brasington, Queen Mary University of London.
Professor C Hughes (deputy chair), University of Liverpool.
Dr N Penna, Newcastle University.
Professor T van Dam, University of Luxembourg.
Dr A Ferreira, University College London.
Dr J Biggs, University of Bristol.
Prof O Ritter, GeoForschungsZentrum GFZ, Potsdam.

Remit

The NERC Geophysics and Geodesy Facilities Steering Committee oversees the Geophysical Equipment Facility (GEF), British Isles continuous GNSS Facility (BIGF) and Space Geodesy Facility (SGF) and exists to:
- review applications for usage of the Geophysical Equipment Facility (GEF) and monitor the British Isles continuous GNSS Facility (BIGF) peer review process.
- monitor outputs from the three Facilities.
- provide advice to BGS Director and NERC Director of Science on aspects of the operations and development of the Facilities.

BGS Director and NERC Director of Science, in turn, provide advice to the NERC executive and NERC boards on Services and Facilities relevant to their remit.

Terms of Reference

- To review applications and establish priorities for the Heads of the Facilities, for the allocation of the facilities' resources funded from the Services and Facilities Science Budget, taking into account recommendations made through the NERC peer-review mechanisms.
- To review the scientific quality of work undertaken by users of the Facilities, based on reports and publications.
- To monitor the level of user satisfaction with the service and to analyse the user-base.
- To provide guidance to the Heads of the Facilities on improvement of the Facility's equipment and on its service function.
- To receive and comment upon the annual report from the Heads of Facilities, before it is submitted to NERC Swindon Office.
- To advise BGS Director and NERC Director of Science on:
  a. the level and direction of the internal R&D programme for the Facilities;
  b. emerging technical developments within the community;
  c. anticipated changes in requirements from the Facilities and the anticipated levels of future demand.
- To provide advice at other times as appropriate.

Membership constraints

Membership of the Committee, including the chair, will be decided by the Earth Science (ES) Services and Facilities management team at BGS with advice and suggestions from the Committee itself. It will include the Heads of the Facilities/nodes and a representative from the ES Facilities Management Team at BGS.

Members, other than ex-officio members will be invited to serve for a term of up to four years with a maximum extension of a further two years. The Chairperson will serve a maximum of four years.

3. Equipment Inventory

a. In-kind contributions from BIGF collaborators – data from around 150 CGNSS stations, each consisting of: dual-frequency GPS (or GPS+GLO, or GPS+GLO+GAL+BDS) receiver, choke ring antenna, local data storage and communications hardware, with data transfer to BIGF enabled free of charge.

b. Resources at the University of Nottingham:
   a) 2 Linux Network Attached Servers of 23Tb each, serving as primary and secondary archives for 30-second and 1Hz RINEX files of data and derived products (housed in the Nottingham Geospatial Building (NGB), on Jubilee Campus).
   b) 2 Linux Network Attached Servers of 23Tb each, serving as tertiary and quaternary archives for 30-second and 1Hz RINEX files of data and derived products (housed in the Data Centre, on King's Meadow Campus).
   c) 3 Linux workstations, serving to collect 30-second and 1Hz RINEX files of data from collaborators.
   d) 1 Linux workstation with 80Gb of data storage, serving to enable external users to take delivery of data and derived products.
   e) 1 Linux workstation acting as web server.
   f) 7 Linux servers, for product development.

4. Future Developments

The success of the Facility in 2016/17 was based on the following operational tasks:
   a) Maintain the existing archive of data from the BIGF network.
   b) Maintain the on-going memorandums of understanding with collaborators to provide new data to the archive, free of charge.
   c) Develop and maintain mechanisms for the collection of new data for the archive.
   d) Develop and maintain mechanisms to provide data to international networks on European and global scales.
   e) Carry out associated R&D to improve the Facility.
   f) Develop and maintain the website.
   g) Develop and maintain mechanisms to service user requests.
   h) Stimulate increased user demand.

During 2017/18 proposed Facility development will be focussed on enhancements to the Facility related to the above operational tasks as follows:
   a) We will maintain the four 23Tb Linux Network Attached Servers, so that each machine holds a complete copy of the archive: two machines will remain on the Jubilee Campus, and two offsite at the separate King's Meadow Campus. We will also make fully operational the equipment purchased as a non-capital request (£5.6k) in January 2014, as 2 new externally facing servers to replace 4 existing servers that were left over from earlier research projects and have been in use since 2002 to collect data from collaborators and enable external users to take delivery of data and derived products. We will also investigate ways to create offline back-ups of 1Hz data and derived products.
   b) Under existing MOUs all collaborators continue to support and cooperate with BIGF in their supply of new data to the archive, with the continued understanding that 30 second data can be supplied to any user after 30 days, whereas the 1Hz data and derived products can only be supplied to approved scientific users, and in the case of 1Hz data only after 45 days. We will also continue to work with our collaborators in order to encourage the recording of more types of data in the RINEX files and pursue a reduction in the time period after which 1Hz data can be released.
   c) We will expand data collection to include more Galileo (GAL) and Beidou (BDS), in addition to GPS and Glonass (GLO), whenever possible - new satellite signals from GPS (L2C, L5) and new satellite systems such as Galileo and Beidou should be of interest to collaborators who should then upgrade their CGNSS stations, thus providing more GNSS data which will then enable new research and ultimately lead to enhanced derived products. Of the 18 stations currently tracking GPS only and the 130 stations currently tracking GPS+GLO, 113 have the potential to track GPS+GLO+GAL+BDS, but this is mostly subject to OSGB carrying out hardware/firmware upgrades to their receivers.
   d) We will continue to provide user specific access to national and international scientists requesting extensive backward and/or forward tracts of data, as part of international networks on regional or global scales. We will also continue our collaboration with the University of Luxembourg as a joint IGS TIGA Analysis Centre, with the supply of 'long term trend (LTT) derived products' at Level 1, related to station coordinates at tide gauges in the UK, as part of this international research initiative. We will also continue our collaboration with the Satellite Geodetic Observatory (Hungary) as part of the EUREF Permanent Network densification, with the supply of 'long term trend (LTT) derived products' at Level 1, related to station coordinates for the UK and Ireland, as part of this European research initiative.
   e) The creation of derived products has continued to advance. The latest, fifth 'releasable' sets of 'LTT derived products' at Levels 1, 2 and 3, related to station coordinates, tropospheric parameters and station velocities, were created based on Bernese GNSS software version 5.2 (BSW5.2) as time series from 1997 to 2014:180, and then 2014:365, and then 2015:273 (bl08gd11). This followed the implementation and testing of BSW5.2 for the creation of such derived products, and quality assurance against previous 'LTT derived products'. Furthermore, 'near real-time (NRT) derived products' at Levels 1 and 3, related to tropospheric parameters (i.e. zenith total delay, zenith wet delay and integrated water vapour) available hourly (BGF2), and at Levels 1 and 2, related to ionospheric parameters (i.e. vertical total electron content and change in vertical total electron content) available hourly (BGF3), continue to be created. We will create a sixth 'releasable' set of 'LTT derived products' at Levels 1, 2 and 3, related to station coordinates, tropospheric parameters and station velocities, and based on BSW5.2 and extended time series from 1997 to 2016:365. We will also start to create new 'LTT derived products' at Level 1, related to ionospheric parameters. In addition, we will continue to test BSW5.2 for the creation of enhanced 'NRT
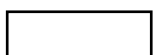
derived products' at Levels 1 and 3, related to tropospheric parameters available hourly, and at Levels 1 and 2, related to ionospheric parameters available hourly. We also aim to create enhanced 'LTT derived products' at Level 3, through collaboration with BGS on maps of vertical motions based on LTT station velocities, and new 'LTT and NRT derived products' at Levels 2 and 3 through the further development of tools for the creation of time series and maps related to tropospheric and ionospheric parameters.

f) We will continue website development, with especial regard to the presentation of sample derived products, and access to their various levels, and particular consideration given to any enhanced and new derived products at Levels 2 and 3, such as time series and maps of LTT tropospheric zenith total delay, zenith wet delay and integrated water vapour (and ionospheric VTEC); and time series and contemporary maps showing the temporal and spatial variations in NRT tropospheric zenith total delay, zenith wet delay and integrated water vapour (and ionospheric VTEC).

g) We will continue to service user requests in line with the approved peer review procedure, offer advice and support when services are requested, provide capacity to handle very large user requests, and provide regulated high level access to some users.

h) We will continue to disseminate information to demonstrate BIGF's utility as widely as possible, at least cost to the Facility and NERC, capitalising on any free marketing opportunities, and targeting the widest range of relevant scientific workshops, fora and conferences, and identifying and targeting scientists who could potentially use BIGF derived products in enabling their research.

5. Summary of Performance Information

Academic (26, 21 peer-reviewed)
1. GNSS Wave Glider: A new tool for sea level and sea state measurement; Penna, Dr, N; Newcastle University. [8, MS, NERC].
2. 1 Year, 1000km: The Oxford RobotCar Dataset (GNSS Ground Truth); Newman, Prof, P; University of Oxford; Funded by EPSRC. [8, TFS].
3. Crustal Deformation of the European Plate and its boundaries; D'Agostino, Dr, N; Istituto Nazionale Geofisica Vulcanologia (INGV); Funded by the Italian Ministry of Education, Department Civil Protection. [8, ES].
4. Densification of European Permanent GNSS Network for ionospheric studies; Pottiaux, Dr, E; Royal Observatory of Belgium. [8, AS].
5. E-GVAP near real-time atmospheric water vapour (formerly COST Action 716/CSIP); Pacione, Dr, R; Agenzia Spaziale Italiana. [8, AS].
6. E-GVAP near real-time atmospheric water vapour (formerly COST Action 716/CSIP); Dousa, Dr, J; Geodetic Observatory Pecny. [8, AS].
7. E-GVAP near real-time atmospheric water vapour (formerly COST Action 716/CSIP); Dick, Dr, G; GFZ Potsdam (German Research Centre for Geosciences). [8, AS].
8. E-GVAP near real-time atmospheric water vapour (formerly COST Action 716/CSIP); de Haan, Dr, S; Royal Meteorological Institute of the Netherlands. [8, AS].
9. Evaluate peatland sensitivity to global change (BIGF product suitability testing); Bonenberg, Dr, L; University of Nottingham. [TFS].
10. GNSS-multipath reflectometry; Tabibi, Dr, S; University of Luxembourg. [8, MS].
11. GPS/GLONASS precise point positioning and undifferenced ambiguity resolution; Geng, Prof, J; Wuhan University, China; Funded by the National Science Foundation of China. [8, TFS]
12. Hi-Tech Observation of Playground Social Communication Trajectories in Children (Hopscotch); Hailes, Prof, S; UCL; Funded by ESRC. [8, TFS].
13. International GNSS Service GPS tide gauge benchmark monitoring - pilot project; Woppelmann, Dr, G; University of La Rochelle; Funded by IGS. [8, ES].
14. International GNSS Service GPS tide gauge benchmark monitoring - pilot project; Teferle, Dr, N; University of Luxembourg; Funded by IGS. [8, ES].
15. International GNSS Service GPS tide gauge benchmark monitoring - pilot project; Schoene, Dr, T; GFZ Potsdam (German Research Centre for Geosciences); Funded by IGS. [8, ES].
16. Ionospheric research using total electron content over Europe; Tsugawa, Prof, T; National Institute of Information and Communications Technology. [8, AS].
17. Supply of Newlyn to the EUREF Permanent Network; Habrich, Dr, H; Bundesamt für Kartographie und Geodäsie; Funded by EC. [8, ES].
18. Supply of Newlyn to the EUREF Permanent Network; Duquesnoy, Dr, T; Institut Geographique National; Funded by EC. [8, ES].
19. Supply of Newlyn to the EUREF Permanent Network; Villaverde, Dr, M; Instituto Geografico Nacional de Espana; Funded by EC. [8, ES].
20. Supply of Newlyn to the EUREF Permanent Network; Bruyninx, Dr, C; Royal Observatory of Belgium; Funded by EC. [8, ES].
21. The potential of precipitable water vapour measurements from GNSS in Luxembourg; Teferle, Prof, N; University of Luxembourg. [ES]
22. To test the functionality of a multi-beam sonar head; Rowlands, Mr, S; University of Wales, Bangor; Funded by SEACAMS. [MS].
23. Towards a global ambiguity resolved precise point solution and time series; Kreemer, Dr, C; University of Nevada, Reno; Nevada Bureau of Mines and Geology; Funded by JPL and NASA. [8, ES].
24. Validation and implementation of direct tropospheric slant delay estimation for precise real-time positioning; Hill, Dr, C; University of Nottingham; Funded by ESA. [8, AS].
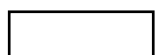
25. Wind turbine effects on the marine habitat; Rowlands, Mr, S; University of Wales, Bangor; Funded by SEACAMS. [MS].
26. Yesnaby Art & Archaeology Research Project; Moore, Dr, J; Orkney Research Centre for Archaeology. [TFS].

NERC centres, surveys and facilities (5)
1. Assessing the feasibility of a National InSAR ground deformation map of Great Britain with Sentinel-1 data; BGS [ES/EO].
2. Environmental baseline monitoring project; BGS. [ES/EO].
3. Geophysical tomography to monitor landslide at Hollin Hill; BGS. [ES].
4. Proof of concept: use of GPS reflection measurements for tide gauge levelling; NERC National Oceanography Centre, Liverpool. [TFS].
5. South baseline comparison at the NERC Space Geodesy Facility, and of other baselines; Wilkinson, Mr, M; NSGF. [ES].

PhD (9, 7 peer-reviewed)
1. A novel GNSS-based positioning system to support railway operations; Damy, Ms, S; Imperial College. PhD to be completed in 2017. [7, TFS, Lloyd's Register Foundation].
2. Application of satellite InSAR data in the assessment of ground motion in areas of historic mining to aid environmental and resource management; University of Nottingham. PhD to be completed in 2019. [8, ES, GERC].
3. Assessment of the accuracy and the contribution of multi-GNSS in structural monitoring; Msaewe, Mr, H; University of Nottingham. PhD to be completed in 2018. [8, TFS].
4. Development of 4D Chirp. Faggetter, Mr, M; University of Southampton/National Oceanography Centre, Southampton; PhD to be completed in 2019. [8, ES/MS/SBA].
5. Integrity and reliability analysis of PPP ambiguity resolution; Pearson, Mr, C; Newcastle University. PhD to be completed in 2017. [8, MS, EPSRC and Fugro Intersite]
6. Monitoring ground deformation patterns at London and Thames Estuary area from 2002 to 2009 by using ISBAS DInSAR results; Al-Shammari, Ms, L; University of Nottingham. PhD to be completed in 2017. [ES/EO, University of Nottingham].
7. Multipath mitigation for GPS and GLONASS with application in earthquake and tsunami early warning; Cowles, Ms, P; Newcastle University. PhD to be completed in 2017. [8, ES, NERC].
8. Soil erosion control using cover crops in maize; Mancini, Ms, A, Cranfield University. PhD to be completed in 2017. [TFS, Douglas Bomford Trust, Wye and Usk Foundation].
9. Terrestrial water storage anomalies as estimated using GPS and GRACE observations; Adusumili, Mr, S; Scripps Institution of Oceanography (USA). PhD to be completed in 2021. [8, ES/TFS/EO, Regents Fellowship (UCSD)].

Ongoing PhDs with no data taken in 2016/17 (11, 8 peer reviewed)
1. Acoustic Doppler current profiler positioning near river engineering structures; Kriechbaumer, Mr, T; Cranfield University. Funded by EPSRC. PhD to be completed in 2017. [8, TFS, EPSRC].
2. Advanced assistance services of high performance in harsh environments, part of Marie Curie Initial Training Network MULTI-POS; Pasnikowski, Mr, M.J; Universitat Autonoma de Barcelona (Spain). PhD to be completed in 2017. [8, TFS, EC].
3. Geophysical methods for identifying streambed structural heterogeneity and implications for groundwater - surface water exchange flow; Dara, Mr, R; University of Birmingham. PhD to be completed in 2018. [ES/TFS, Iraqi Government].
4. High accuracy GNSS processing for a road vehicle; Feng, Mr, S; Imperial College London. PhD to be completed in 2016. [7, TFS, Imperial College London].
5. Investigating the effect of constellation geometry on precise point positioning; Mohammed, Mr, J; University of Nottingham. PhD to be completed in 2017. [8, TFS, Iraqi Government].
6. Is Glacial Isostatic Adjustment continuing in Scotland? Stockamp, Ms, J; University of Glasgow. PhD to be completed in 2017. [9, ES/EO, University of Glasgow / Scottish National Heritage].
7. Multi-sensor fusion for driverless car technologies; Lu, Mr, L; University of Wales, Aberystwyth, Computer Science. PhD to be completed in 2016. [7, TFS].
8. Space weather effects; Alsaleh, Ms, H; University of Bath. PhD to be completed in 2016. [7, AS, Self-funded].
9. The effects of storminess on coastal ecosystem services and wellbeing; Holmes, Mr, T; University of York. PhD to be completed in 2017. [8, MS/TFS, NERC].
10. Sub-surface feature detection using the Sub-SAR technique; Athab, Mr, A; University of Nottingham. PhD to be completed in 2016. [ES/EO, Iraqi Government]
11. Validation of interferometric synthetic aperture radar (InSAR) results using GNSS time series; Che Amat, Mr A; University of Nottingham. PhD to be completed in 2016. [ES/EO].

Non-PhD students (10)
1. An assessment of real time RTK corrected motion data vs post processed RTK corrected motion data; University of Plymouth.
2. Accuracy of static GPS-derived relative position vector; Newcastle University.
3. Cliff erosion rates at Withensea; University of Hull.
4. Evaluation and comparison of Morpeth GNSS reference stations; Newcastle University.
5. Evaluation of the Ordnance Survey active network base stations; Newcastle University.
6. GNSS Meteorology in Support of Severe Weather Forecasting; Technical University of Ostrava, Czech Republic.
7. Impact of antenna changes on GNSS measurements; Newcastle University.
8. Laser scanning of river banks; University of Glasgow.
9. The impact of ocean tide loading on high precision geodetic positioning techniques in Ireland; Dublin Institute of
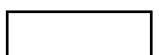
Technology.
    10. Troposphere correction methods comparison via PPP; University of Nottingham.

Collaborators (6)
    1. Aerosol and Clouds Consortium - cirrus climatology from ground-based remote sensing; University of Hertfordshire.
    2. Cell 1 Regional Monitoring Strategy (CERMS) EA/Scarborough CC.
    3. Control for Marsh & Corinthian Dyke channel survey; EA.
    4. Heighting of river gauge stations; EA.
    5. Near real-time atmospheric water vapour for numeric weather prediction in the UK; Met Office.
    6. North East Coastal Monitoring, wave and tide analysis report, EA.

Government / .org (18)
    1. Multibeam calibration; Marine Scotland.
    2. Maritime and Coastguard Agency routine re-survey project.
    3. Assessment of dune erosion at Merthyr Mawr dunes SSSI/NNR South Wales; Natural Resources Wales.
    4. GBAS Ionospheric model study; NATS (National Air Traffic Services).
    5. Control for railway survey; Network Rail.
    6. Control for Carstairs Junction Renewal; Network Rail.
    7. Ferriby to Gilberdyke Resignalling - Topographical surveys; Network Rail.
    8. WIT & Waterloo renovation works for approach structures, outer stations and WIT terminal; Network Rail.
    9. Railway survey; Network Rail.
    10. Pre-electrification surveys; Network Rail.
    11. Ely station survey alignment to OS grid and level; Network Rail.
    12. Control for rail track renewals and tunnel surveys; Network Rail.
    13. Hydrographic surveying in the Thames Estuary; Port of London Authority.
    14. Bridge laser scan geo-referencing; Port of London Authority.
    15. To identify differences in the coordinates and particularly the elevation between the OSTN02/OSGM02 and the OSTN15/OSGM15; Scottish Environment Protection Agency.
    16. Hydrographic survey of UK waters to IHO special order standard; United Kingdom Hydrographic Office.
    17. Processing multibeam data for UKHO chart updates; United Kingdom Hydrographic Office.
    18. Forensic consultancy related to stability of GPS data at specific time and location; UK Police Forces.

Ordnance Survey user (17)
    1. Coupling between GPS and INS (post-processing); Oxford Technical Solutions.
    2. Aerial surveys of land ecosystems; 2Excel Aviation Ltd.
    3. Creating 3D BIM model of Wheaton Aston Sewage treatment works; Elephant Environmental.
    4. Post process POSPac data; EGS International.
    5. Orthophoto production; Bluesky International.
    6. QC of post-processed GNSS data; EGS International.
    7. Tide reduction; Spectrum Geosurvey.
    8. Assessing the performance of two Inertial Navigation System collected simultaneously on a road vehicle; Zetica.
    9. Bathymetric survey corrections; Port of Tyne.
    10. Sonar scanning of underwater structures and seabed; VRT inland.
    11. Precise aircraft relative positioning using carrier phase methods; Qinetiq.
    12. Test and implement a virtual base station and compare the performance with real ones; SBG Systems.
    13. Nab Channel data processing; ABP Hydrographic Survey Department.
    14. Post processing with Stornoway station; Reseau Teria.
    15. Archaeological excavations at Hurn Court Farm, Dorset; Thames Valley Archaeological Services.
    16. To ascertain the relative serviceability of navigational systems (GPS) in the Hitchin area on 21/11/16 used with tagging technologies; Evidence matters.
    17. To obtain highly accurate heights for numerous summits in Britain; Pedantic Surveys.

6. Publication details for the calendar year (2016)

Refereed (25, with, where available, their ISI 2015 JCR impact factors shown in [ ])
    1. Altamimi, Z., Rebischung, P., Metivier, L., Collilieux, X. ITRF2014: A new release of the International Terrestrial Reference Frame modeling non-linear station motions. Journal of Geophysical Research - Solid Earth, Vol.121 (8), pp.6109-6131, doi:10.1002/2016JB013098, August 2016. [3.318].
    2. Araszkiewicz, A., Volksen, C. The impact of the antenna phase center models on the coordinates in the EUREF Permanent Network. GPS Solutions, pp.1-11, doi:10.1007/s10291-016-0564-7, September 2016. [2.991]
    3. Bradshaw, E., Woodworth, P.L., Hibbert, A., Bradley, L.J., Pugh, D.T., Fane, C., Bingley, R.M. A century of sea level measurements at Newlyn, SW England. Marine Geodesy, Vol.39, No.2, pp.115-140, doi:10.1080/01490419.2015.1121175, 2016. [0.979]
    4. Brzezinski, A., Barlik, M., Andrasik, E., Izdebski, W., et al. Geodetic and geodynamic studies at Department of Geodesy and Geodetic Astronomy Unit. Reports on Geodesy and Geoinformatics, Vol.100/2016, pp.165-200, doi:10.1515/rgg-2016-0013, June 2016.
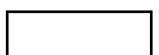
5. Cannavo, F; Palano, M. Defining geodetic reference frame using Matlab(A (R)): PlatEMotion 2.0. Pure and Applied Geophysics, Vol.173 (3), pp.937-944, doi:10.1007/s00024-015-1112-z, March 2016. [1.667].

6. Cherniak, I., Zakharenkova, I. First observations of super plasma bubbles in Europe. Geophysical Research Letters, Vol.43, Issue 21, doi:10.1002/2016GL071421, November 2016. [4.212].

7. Cherniak, I., Zakharenkova. High-latitude ionospheric irregularities: differences between ground-and space-based GPS measurements during the 2015 St. Patrick's Day storm. Earth, Planets and Space, Vol.68, No.136, doi:10.1186/s40623-016-0506-1, July 2016. [1.871].

8. Fernandes, J.M., Lazaro, C. GPD+wet tropospheric corrections for CryoSat-2 and GFO altimetry missions. Remote Sensing, Vol.8(10), doi:10.3390/rs8100851, 2016. [3.036]

9. Geng, J., Zhao, Q., Shi, C. et al. A review on the inter-frequency biases of GLONASS carrier-phase data. Journal of Geodesy, doi:10.1007/s00190-016-0967-9, October 2016. [2.486].

10. Hamlington, B.D., Thompson, P., Hammond, W.C., Blewitt, G., Ray, R.D. Assessing the impact of vertical land motion on twentieth century global mean sea level estimates. Journal of Geophysical Research, V.121, Issue 7, pp.4980-4993, doi:10.1002/2016JC011747, July 2016. [3.318].

11. Honkavaara, E., Hakala, T., Nevalainen, O., Viljanen, N., Rosnell, T., et al. Geometric and reflectance signature characterization of complex canopies using hyperspectral stereoscopic images from UAV and terrestrial platforms. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLI-B7, 2016 XXIII ISPRS Congress, Prague, Czech Republic,doi:10.5194/isprs-archives-XLI-B7-77-2016, 12–19 July 2016.

12. Kagan, Y.Y., Jackson, D.D. Earthquake rate and magnitude distributions of great earthquakes for use in global forecasts. Geophysical Journal International, Vol.206 (1), pp.630-643, doi:10.1093/gji/ggw161, July 2016. [2.484].

13. Mohammed, J., Moore, T., Hill, C., Bingley, R.M., Hansen, D.N. An assessment of static precise point positioning using GPS only, GLONASS only, and GPS plus GLONASS. Measurement, Vol.88, pp.121-130, doi:10.1016/j.measurement.2016.03.048, 2016. [1.742]

14. Parker, A., Ollier, C.D. Coastal planning should be based on proven sea level data. Ocean & Coastal Management, Vol.124, pp.1-9, doi:10.1016/j.ocecoaman.2016.02.005, May 2016. [1.696].

15. Pfeffer, J., Allemand, P. The key role of vertical land motions in coastal sea level variations: A global synthesis of multi-satellite altimetry, tide gauge data and GPS measurements. Earth and Planetary Science Letters, Vol.439, pp.39–47, doi:10.1016/j.epsl.2016.01.027, 2016. [4.326].

16. Rebischung, P., Altamimi, Z., Ray, J., Garayt, B. The IGS contribution to ITRF2014. Journal of Geodesy, Vol.90, Issue 7, pp.611-630, doi:10.1007/s00190-016-0897-6, July 2016. [2.486].

17. Rong, Y., Bird, P., Jackson, D.D. Earthquake potential and magnitude limits inferred from a geodetic strain-rate model for southern Europe. Geophysical Journal International, Vol.205 (1), pp.509-522, doi: 10.1093/gji/ggw018, April 2016. [2.484].

18. Scott, T., Masselink, G., O'Hare, T., Saulter, A., Poate, T., Russell, P., Davidson, M., Conley, D. The extreme 2013/2014 winter storms: Beach recovery along the southwest coast of England. Marine Geology, Vol.382, pp.224-241, doi:10.1016/j.margeo.2016.10.011, December 2016. [2.503].

19. Sidorov, D., Teferle, F.N. Impact of antenna phase centre calibrations on position time series: preliminary results. IAG Symposia, Vol.143, pp.117-123, doi:10.1007/1345_2015_216, February 2016.

20. Stockamp, J., Bishop, P., Li, Z., Petrie, E., Hansom, J., Rennie, A. State-of-the-art in studies of glacial isostatic adjustment for the British Isles: a literature review. Earth and Environmental Science Transactions of the Royal Society of Edinburgh, Vol.106, Issue 3, pp.145-170, doi:10.1017/S1755691016000074, November 2016. [2.333].

21. Watson, P.J. Acceleration in European mean sea level? A new Insight using improved tools. Journal of Coastal Research, doi:10.2112/JCOASTRES-D-16-00134.1 (online) 2016. [0.852].

22. Webb, S.R., Penna, N.T., Clarke, P.J., Webster, S., Martin, I., Bennitt, G.V. Kinematic GNSS estimation of zenith wet delay over a range of altitudes. Journal of Atmospheric Oceanic Technology, Vol.33, Issue 1, pp.3–15, doi:10.1175/JTECH-D-14-00111.1, 2016. [2.159].

23. Wöppelmann, G., Marcos, M. Vertical land motion as a key to understanding sea level change and variability. Reviews of Geophysics, Vol.54(1), pp:64-92, doi:10.1002/2015RG000502, March 2016. [11.444].

24. Yao, Y., Lei, L., Jian, K., Changzhi, Z. Analysis of the global ionospheric disturbances of the March 2015 great storm. Journal of Geophysical Research, Vol.121, Issue 12, pp.12157-12170, doi:10.1002/2016JA023352, December 2016. [3.318].

25. Zakharenkova, I., Astayeva, E., Cherniak, I. GPS and GLONASS observations of large-scale traveling ionospheric disturbances during the 2015 St. Patrick's Day storm. Journal of Geophysical Research, Vol.121, Issue 12, doi:10.1002/2016JA023332, December 2016. [3.318]

Non-Refereed/Conference Proceedings (14)

1. Geng, J., Li, X. Undifferenced GLONASS ambiguity resolution over inhomogeneous stations: Introducing ionosphere corrections or resolving ionosphere free ambiguities? Proceedings of the 29th International Technical Meeting of The Satellite Division of the Institute of Navigation (ION GNSS+ 2016), Portland, oregon, USA, September 2016.

2. Geng, J., Bock, Y. GLONASS inter-frequency bias and PPP ambiguity resolution across inhomogeneous receivers. IGS Workshop. Sydney, Australia, 8-12 February, 2016.

3. Greaves, M., Bingley, R.M., Baker, D.F., Hansen, D., et al. National Report of Great Britain 2016. EUREF Symposium, San Sebastian, Spain, 2016.

4. Hibbert, A., Williams, S.D.P., Cipollini, P., Calafat, F., Cotton, D. Sea and land level trends around the UK from tide gauge, coastal altimeter and GPS time series. Challenger Society Conference, Liverpool, 2016.

5. Hunegnaw, A., Klos, A., Hansen, D., Teferle, N., Abraha, K., Bingley, R.M., Bogusz, J. A new vertical land movements data set from a reprocessing of GNSS at tide gauge stations. IAG/CPGPS International Conference on GNSS+ (ICG+ 2016)
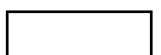
Advances, Opportunities and Challenges, Shanghai, China, July 27-30, 2016.

6. Hunegnaw, A., Teferle, F.N. Combination of Tide Gauge Benchmark Monitoring (TIGA) Analysis Centre from repro2 solutions. EGU General Assembly, 16981-X2-315, Vienna, Austria, 17-22 April 2016.
7. Hunegnaw, A., Teferle, F.N. Quality assessment of BLT Tide Gauge Benchmark Monitoring (TIGA) repro2 solutions. IGS Workshop, Sydney, NSW, Australia, 8-12 February, 2016.
8. Klos, A., Teferle, F.N., Hunegnaw, A., Ahmed, F., Abraha, K.E., Bogusz, J. On the Properties of Zenith Total Delay Time Series from Reprocessed GPS Solutions. IAG/CPGPS International Conference on GNSS+ (ICG+ 2016) - Advances, Opportunities and Challenges, Shanghai, China, July 2016.
9. Lyubushin, A. Hierarchically Fourier-aggregated signals and generalized coherence of the noise in the GPS time series. General Assembly of the European Geosciences Union, Vienna, Austria, 17–22 April 2016.
10. Pacione, R., Di Tomaso, S. A reference GNSS tropospheric dataset over Europe. EGU General Assembly 2016, Vienna, Austria, April 2016.
11. Rodríguez-Bouza, M., Miguel Herraiz, M., Rodríguez-Caderot, G., Radicella, S.M. Ionospheric TEC disturbance during the Mediterranean tropical-like cyclone occurred on November 2014. International Beacon Satellite Symposium BSS-2016, Trieste, Italy, 2016.
12. Rodríguez-Bouza, M., Miguel Herraiz, M., Rodríguez-Caderot, G., Paparini, C., Otero, X., Radicella, S.M. Comparison between the effect of two geomagnetic storms with the same seasonal and daily characteristics and different intensity on the European ionosphere. European Geosciences Union General Assembly, doi:10.13140/RG.2.1.2779.1768, 2016.
13. Williams, S. D. P., Hughes, C.W. GNSS at tide gauges for mean dynamic topography: conventional measurements and multipath reflectometry. Ocean Surface Topography Science Team Meeting, La Rochelle, France, 2016.
14. Yu, C., Li, Z., Penn, N.T. Generation of high resolution water vapour fields from GPS and integration with ECMWF and MODIS, AGU Fall Meeting, 2016.

PhD Theses (4)
1. Cirrus occurrence and properties determined from ground-based remote sensing. Dandini, Mr, P. University of Hertfordshire. [AS].
2. Investigations of GNSS antenna effects on high-precision GNSS positioning at GeoNet and two UK scientific GNSS stations. Sidorov, Mr, D. Funded by University of Luxembourg. [8, ES].
3. Ionospheric scintillation effects on GNSS: monitoring and data treatment development. Romano, Mr, V. University of Nottingham. Funded by University of Nottingham. [8, AS].
4. Soil and land form sensitivity to erosion in the machair landscape of the southern Outer Hebrides, Scotland. Young, Ms, E. University of Dundee. Funded by University of Dundee and the James Hutton Institute. [7, ES/MS/EO].

Appendix 2: Optional Annexes

1. Projects completed

Academic (25)
1. Bathymetric data processing to assess the impact of extreme storm conditions in 2013/2014 on the southwest coast of England; Masselink, Dr, G; University of Plymouth. [8, MS, NERC].
2. 3D spectral reflectance measurement of forest canopies by UAV imaging and passive and active terrestrial measurements for the purposes of improving the estimation of essential climate variables (ECVs); Honkevaara, Dr, E; Finnish Geospatial Research Institute (Finland), [8, TFS/EO, EC (EMRP and EURAMET].
3. Assessing the rate of coastal erosion along an exposed, northwest facing glacially derived cliff-line using terrestrial laser scanning; Roberts, Dr, M; University of Wales, Bangor. [8, ES/MS, Welsh European Funding Office].
4. CARDyAL (Cooperative Aerodynamics and Radio-based DYnamic Animal Localisation); Hailes, Prof, S; UCL [8, TFS, EPSRC].
5. Design, develop and implement an advanced mobile scanning system to monitor railway, road and mining infrastructure; Meng, Dr, X; University of Nottingham. [8, TFS, Innovate UK KTP].
6. Earthquake analysis feasibility study: analysing long term time series to identify changes in patterns due to earthquake events; Bonenberg, Dr, L; University of Nottingham. [ES].
7. EUROPA2 - European Robotic Pedestrian Assistant 2.0; University of Oxford. [8, TFS, EU FP-7].
8. Evolution of the Menai Strait; Walker-Springett, Mr, G; University of Wales, Bangor. [8, ES/MS, Welsh European Funding Office].
9. Exploring the potential for precision nutrient management in China; Li, Prof, Z; Newcastle University. [8, TFS, STFC].
10. GNSS high precision data processing; Geng, Dr, J; University of California, San Diego (USA). [TFS].
11. GNSS seismology: investigate how GNSS can contribute to an early warning system; Bock, Prof, Y; University of California, San Diego (USA). [8, ES, National Science Foundation of America].
12. Investigation of remote Viking sites in Shetland for a BBC television program; Littlewood, Mr, M; UHI Millenium Institute. [8, TFS, BBC].
13. Marine studies undergraduate teaching; Kingston, Dr, K; University of Plymouth. [MS].
14. Monitoring surface deformation in Europe; Houlie, Dr, N; ETH Zurich. [8, ES].
15. Monitoring the effects of storms on a lagoon backed shingle barrier system using terrestrial laser scanning; Roberts, Dr, M; University of Wales, Bangor. [8, ES/MS, Welsh European Funding Office].
16. Piloting a cost effective framework for monitoring soil erosion in England and Wales using terrestrial laser scanning, close range photography, and UAV aerial photography; Quinton, Prof, J; Lancaster University. [8, TFS/EO, Defra].
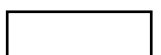
17. Severn Bridge deformation project; Roberts, Dr, G; University of Nottingham. [TFS].
18. Strain-rates of crustal deformation in the Betics-Rif ranges (Gibraltar arc); Gonzalez, Dr, P; University of Leeds. [ES].
19. Study on the effects of solar activity on ECAC (European Civil Aviation Conference) zone; Yaya, Dr, P; Collecte Localisation Satellites (France). [8, AS, Eurocontrol].
20. Understanding atmospheric and ionospheric response to hypersonic objects in the atmosphere; Lay, Dr, E; Los Alamos National Laboratory (USA). [AS].
21. Validation and implementation of direct tropospheric slant delay estimation for precise real-time positioning; Hill, Dr, C; University of Nottingham. [8, AS, ESA].
22. Geophysical tomography to monitor landslide movement; BGS. [ES].
23. Inter-technique comparison of coordinate time series as Herstmonceaux examining thermal expansion effects; NSGF. [ES].
24. Mapping landslide movement using a GPS smart rover; BGS. [ES].
25. Proof of concept: use of GPS reflection measurements for tide gauge levelling; Proudman Oceanographic Laboratory. [TFS].

PhD (3)
1. Investigations of GNSS antenna effects on high-precision GNSS positioning at GeoNet and two UK scientific GNSS stations. Sidorov, Mr, D. Funded by University of Luxembourg. [8, ES].
2. Ionospheric scintillation effects on GNSS: monitoring and data treatment development. Romano, Mr, V. University of Nottingham. Funded by University of Nottingham. [8, AS].
3. Soil and land form sensitivity to erosion in the machair landscape of the southern Outer Hebrides, Scotland. Young, Ms, E. University of Dundee. Funded by University of Dundee and the James Hutton Institute. [7, ES/MS/EO].

7. Targets and Milestones

No further comments to add to the information given in the ANNUAL TARGETS AND PROGRESS TOWARDS THEM section of the main report.

8. Finance

Spend	£121,190
Revenue	£0
Unit cost	£0.039
Planned capital spend	£0

9. Service Management

Dr Richard Bingley, Head of Facility, 40% NERC
Dr David Baker, Manager, 40% NERC