Testing WAN access to storage over IPv4 and IPv6 using multiple transfer protocols

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Introduction

In the lead up to Run 2 of the LHC the WLCG grid middleware, storage access protocols and LHC computing models are in a state of flux. The LCG utilities and SRM middleware are being phased out, IPv6 is being rolled out across the WLCG and LHC experiments are making increasing use of xrootd federated access to storage elements over the WAN. However, both client and server software and WLCG sites vary in their readiness for IPv6. Sites will soon need to enable IPv6, support it on relevant software and ensure everything is working correctly. Comprehensive monitoring will help and we report on work to extend existing monitoring of WAN transfer capability that GridPP has been doing for a number of years. WAN access from storage elements to worker nodes over both IPv4 and IPv6 is systematically checked.

Method

This work is an extension of a pre-existing IPv4-based worker node to storage element testing framework. The new work extends the testing to include IPv6 and an increased number of protocols. Tests were carried out at a pre-determined set of sites. Sites were chosen based on availability of at least one IPv6-enabled worker node and/or storage element. Each site consists of a compute element and storage element pair. Test files of size 100MB, 500MB and 1000MB were uploaded to the site storage elements and registered in an LFC. The use of IPv6-only SEs necessitated the use of the IPv6-enabled UI at CERN together with a dual-stack LFC at Imperial College. Similarly, in order to submit jobs to an IPv6-only CE a dual-stack WMS, again at Imperial College, was used. Jobs were submitted hourly to each site from a UI at Queen Mary University of London (QMUL) and tested transfer rates using the following client and protocol combinations. The gsiftp protocol was tested with the, now deprecated, lcg-cp command. This defaults to using IPv4 unless environment variables specifying IPv6 are set. The gfal-copy client was also used to test gsiftp transfers, specifying the use of IPv6 with the –D "GRIDFTP PLUGIN:IPV6=true" option. The https protocol was tested with the curl client. Curl has the option to direct the use of either IPv4 or IPv6 with -4 and -6 flags respectively. Finally the xrootd protocol was tested, selection of IPv6 was made with the -DSNetworkStackIPv6 option. Transfer rate was calculated from the slope of a linear fit of the transfer times of the three files sizes. Results are uploaded to the website every hour.

Results

The figures show mean transfer rates (in MB/s) for each testing set up. The QMUL worker node has only IPv4 connectivity and so jobs were killed off from running there. Similarly, at the time of writing jobs were failing at the Oxford University CE. Otherwise as would be expected most sites were able to copy using the lcg-cp command. Only two sites (Brunel University and the Imperial College IPv6 testbed) have installed the gfal-copy client on the worker nodes. Interestingly, we were unable to read files stored on DPM storage elements with curl, the problem seems to be related to the state of the proxy after having travelled through the WMS. The Imperial College dCache storage element was unaffected by this issue however. Only the IPv6-only WN at Imperial College had the recently released xrootd4 client required in order to read over IPv6.

Protocol: lcg
Ordered by sites

CE	Brun	Imp	Imp_V6	QMUL	Ox	Ave	CE
Brun	30.2	21.2	19.2	100.2	27.4	35.7	Brun
Imp	42.6	82.7	70.7	59.9	48.1	61.0	Imp
Imp_V6	58.1	56.9	53.4	59.4	43.8	54.0	Imp_V6
QMUL							QMUL
Ox							Ox
Ave	43.9	53.3	47.6	72.3	39.7	50.2	Ave
	Brun	Imp	Imp_V6	QMUL	Ox	Ave	

Protocol: gfal
Ordered by sites

CE	Brun	Imp	Imp_V6	QMUL	Ox	Ave	CE
Brun	26.6	17.5	16.6	14.9	27.5	21.0	Brun
Imp							Imp
Imp_V6	41.9	41.4	41.8	50.3	37.3	42.3	Imp_V6
QMUL							QMUL
Ox							Ox
Ave	34.4	29.9	30.0	35.0	32.6	32.3	Ave
	Brun	Imp	Imp_V6	QMUL	Ox	Ave	

Protocol: http_ipv4
Ordered by sites

CE	Brun	Imp	Imp_V6	QMUL	Ox	Ave	CE
Brun	23.4					23.4	Brun
Imp	92.7					92.7	Imp
Imp_V6							Imp_V6
QMUL							QMUL
Ox							Ox
Ave	57.2					57.2	Ave
	Brun	Imp	Imp_V6	QMUL	Ox	Ave	

Protocol: http_ipv6
Ordered by sites

CE	Brun	Imp	Imp_V6	QMUL	Ox	Ave	CE
Brun	19.1					19.1	Brun
Imp	95.4					95.4	Imp
Imp_V6	48.9					48.9	Imp_V6
QMUL							QMUL
Ox							Ox
Ave	54.7					54.7	Ave
	Brun	Imp	Imp_V6	QMUL	Ox	Ave	

Protocol: xrootd_ipv4
Ordered by sites

CE	Brun	Imp	Imp_V6	QMUL	Ox	Ave	CE
Brun							Brun
Imp							Imp
Imp_V6							Imp_V6
QMUL							QMUL
Ox							Ox
Ave							Ave
	Brun	Imp	Imp_V6	QMUL	Ox	Ave	

Protocol: xrootd_ipv6
Ordered by sites

CE	Brun	Imp	Imp_V6	QMUL	Ox	Ave	CE
Brun							Brun
Imp							Imp
Imp_V6	53.5	31.3				42.2	Imp_V6
QMUL							QMUL
Ox							Ox
Ave	53.5	31.3				42.2	Ave
	Brun	Imp	Imp_V6	QMUL	Ox	Ave	

Discussion and Conclusion

The lcg-util package is now deprecated and the fact that its replacement (gfal-util) has only recently been added to the EMI-WN, may explain why the gfal-copy client was unavailable at some of the sites. https access to data using both IPv4 and IPv6 only worked at the site using dCache.

In conclusion, we have created a testing framework which can easily be extended to all UK sites. Future work will include migration of job submission and data handling tests to the GridPP DIRAC service.