AN ENHANCED DYNAMIC REPLICA CREATION AND EVICTION MECHANISM IN DATA GRID FEDERATION ENVIRONMENT

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Abstrak

Sistem Grid Data Bersekutu merupakan satu infrastruktur yang menghubungkan beberapa sistem grid, yang memudahkan perkongsian besar yang data, serta sumber penyimpanan dan pengkomputeran. Mekanisme sedia ada bagi replikasi data hanya tertumpu kepada mencari nilai fail berdasarkan jumlah akses fail dalam menentukan fail mana yang akan direplikasi, dan meletakkan replika baru di lokasi yang menyediakan kos bacaan yang minimum. DRCEM melakukan secara berbeza dengan mempertimbangkan kebergantungan logik fail dalam mencari nilai fail, dan menempatkan replika baru di lokasi dengan beban kerja, jarak rangkaian dan kegagalan tapak yang minimum, dengan itu meminimumkan pemindahan data dan kos penyimpanan. Tesis ini memperkenalkan satu penambahbaikan ke atas mekanisme replikasi data yang dikenali sebagai Mekanisme Penciptaan dan Pengeluaran Replika (DRCEM) yang menggunapakai sumber data grid dengan memperuntukkan tapak replika yang sesuai dalam sistem yang bersekutu. Mekanisme yang dicadangkan menggunakan tiga skim: 1) Skim Penilaian dan Pengeluaran Replika Dinamik, 2) Skim Penempatan Replika Dinamik, dan 3) Skim Pengusiran Replika Dinamik. DRCEM telah dinilai menggunakan simulator rangkaian OptorSim berdasarkan empat metrik prestasi: 1) Tempoh Perlengkapan Pekerjaan, 2) Penggunaan Rangkaian yang Berkesan, 3) Penggunaan Elemen Penyimpanan, dan 4) Penggunaan Elemen Pengkomputeran. DRCEM mengatasi mekanisme ELALW dan DRCM sebanyak 30% dan 26% dari segi Tempoh Perlengkapan Pekerjaan. Di samping itu, DRCEM menggunakan ruang penyimpanan yang sedikit berbanding ELALW dan DRCM sebanyak 42% dan 40%. Walau bagaimanapun, DRCEM menunjukkan prestasi yang lebih rendah berbanding dengan mekanisme sedia ada dalam Penggunaan Elemen Pengkomputeran, disebabkan penambahan dalam pengiraan kebergantungan logik fail. Hasil kajian menunjukkan Tempoh Perlengkapan Pekerjaan yang lebih baik dengan penggunaan sumber yang lebih rendah daripada pendekatan sedia ada. Penyelidikan ini menghasilkan tiga skim replikasi yang terkandung dalam satu mekanisme yang dapat menyumbang kepada peningkatan prestasi persekitaran Grid Data Bersekutu, yang mampu membuat keputusan sama ada untuk mencipta atau mengusir lebih daripada satu fail dalam masa yang sama. Tambahan pula, kebergantungan logik fail telah diintegrasikan ke dalam skim penciptaan replika untuk menilai fail data dengan lebih tepat.

Kata kunci: Replikasi Data, Grid Data Bersekutu, Penciptaan Replika, Penempatan Replika, Penggantian Replika

Abstract

Data Grid Federation system is an infrastructure that connects several grid systems, which facilitates sharing of large amount of data, as well as storage and computing resources. The existing mechanisms on data replication focus on finding file values based on the number of files access in deciding which file to replicate, and place new replicas on locations that provide minimum read cost. DRCEM finds file values based on logical dependencies in deciding which file to replicate, and allocates new replicas on locations that provide minimum replica placement cost. This thesis presents an enhanced data replication strategy known as Dynamic Replica Creation and Eviction Mechanism (DRCEM) that utilizes the usage of data grid resources, by allocating appropriate replica sites around the federation. The proposed mechanism uses three schemes: 1) Dynamic Replica Evaluation and Creation Scheme, 2) Replica Placement Scheme, and 3) Dynamic Replica Eviction Scheme. DRCEM was evaluated using OptorSim network simulator based on four performance metrics: 1) Jobs Completion Times, 2) Effective Network Usage, 3) Storage Element Usage, and 4) Computing Element Usage. DRCEM outperforms ELALW and DRCM mechanisms by 30% and 26%, in terms of Jobs Completion Times. In addition, DRCEM consumes less storage compared to ELALW and DRCM by 42% and 40%. However, DRCEM shows lower performance compared to existing mechanisms regarding Computing Element Usage, due to additional computations of files logical dependencies. Results revealed better jobs completion times with lower resource consumption than existing approaches. This research produces three replication schemes embodied in one mechanism that enhances the performance of Data Grid Federation environment. This has contributed to the enhancement of the existing mechanism, which is capable of deciding to either create or evict more than one file during a particular time. Furthermore, files logical dependencies were integrated into the replica creation scheme to evaluate data files more accurately.

Keywords: Data Replication, Data Grid Federation, Replica Creation, Replica Placement, Replica Eviction

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List of Abbreviations

APACGrid	Australian Partnership for Advanced Computing Grids
APIs	Application Programming Interfaces
BADC	British Atmospheric Data Centre
BeInGrid	Business Experiments in Grid
BIRN	Bioinformatics Research Network
CE	Computing Element
CERN	European Organization for Nuclear Research
CEU	Computing Element Usage
CG	Compute Grid
CPU	Central Processing Unit
DDG	Data Duplication problem on the Grid
DG	Data Grids
DGF	Data Grid Federation
DIF	Directory Interchange Format
DPSO	Discrete Particle Swarm Optimisation
DRA	Data Replication Agent
DRCEM	Dynamic Replica Creation and Eviction
DRCM	Dynamic Replica Creation Mechanism
DRECS	Dynamic Replica Evaluation and Creation Scheme
DRES	Dynamic Replica Eviction Scheme
DRPS	Dynamic Replica Placement Scheme
EDG	European Data Grid
EGEE	Enabling Grids for E-science
ELALW	Enhanced Largest Access Largest Weight
ENU	Effective Network Usage
ERDA	Efficient Dynamic Replication Algorithm
FV	File Value
FW	File Weight
GCMD	NASA Global Change Master Directory
GF	Grid Federation
GFA	Grid-Federation Agent

GMS	Grid Management Software
GridPP	The UK Grid for Particle Physics
GriPhyN	Grid Physics Network
GRIS	Grid Resource Information Services
HCS	Hierarchical Cluster Scheduling
HDD	Hard Disk Drive
HPC	High Power Computing
HRS	Hierarchical Replication Strategy
HTC	High Throughput Computing
IDE	Integrated Development Environment
ILD	Indirect Logical Dependency
LALW	Largest Access Largest Weight
LAN	Local Area Network
LAS	Live Access Server
LDGF	Large Data Grid Federation
LFU	Least Frequently Used
LHC	Large Hadron Collider
LRMS	Local Resource Management Systems
LRU	Least Recently Used
NASA	National Aeronautics and Space Administration
P2P	Peer-to-Peer
PDB	Protein Data Bank
PDCS	Parallel and Distributed Computing Systems
PH-PSO	Parallel Particle Swarm Optimisation
QoS	Quality of Service
ROP	Replica Optimisation Process
SE	Storage Element
SEU	Storage Element Usage
SGFRS	Sub-Grid-Federation Replication Strategy
SGFS	Sub-Grid-Federation Scheduling
SLAs	Service Level Agreements
TeraGrid	Now Extreme Science and Engineering Digital Environment (XSEDE)

TLC	Total Logical Connections
UML	Universal Mark-up Language
UNICORE	Uniform Interface to Computing Resources
WAN	Wide Area Network

CHAPTER ONE

INTRODUCTION

1.1 Research Background

Data Grid Federation (DGF), as a distributed computing infrastructure, is an interesting area of continued research, which emanates from the popular Grid Computing (GC) paradigm that manages diverse resources from different administrative domains [1]. In this chapter, a brief background on the types of Grid Computing and Data Grid Federation is given as well the types of servies offered by these types of Distributed Computing infrastructure. The chapter, in its subsequent secions, explains the problems that motivated this research together with statements of research questions that need to be addressed. Accordingly, the research objectives are articulated to help address the research questions. In its last three sections, the chapter highlights on the significance of the research, research conributions as well as scope of the research, respectively. Lastly, the chapter maps out how the whole thesis is structured, by highlighting on the contributions of each chapter (One to Six) of this thesis.

The fundamental goal of this research is to develop a dynamic replica creation and eviction mechanism (DRCEM) for improving the performance of DGF systems, interms of jobs completion times, storage element usage (SEU), effective network usage (ENU) and computing element usage (CEU). As mentioned earlier, DGF belongs to Grid Computing paradigm [2] and it is formed by joining more than one Data Grids system [3] or computing clusters together [1]. Furthermore, DGF is a large-scale resource management system consisting of data and computing

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Appendix A: Files Access History Sample Workload Data

	Access Intervals (mins)							
	1:00-1:30	1:30-2:00	2:00-2:30	2:30-3:00	3:00-3:30	3:30-4:00	4:00-4:30	4:30-5:00
File_ID	Number of Access							
1	200	150	120	100	200	150	120	100
2	170	200	240	150	170	200	240	150
3	150	130	200	300	150	130	200	300
4	140	180	210	160	140	180	210	160
5	150	190	170	140	150	90	170	140
6	200	160	140	110	200	160	140	110
7	200	170	150	240	200	70	150	240
8	150	130	200	300	150	130	200	300
9	140	180	210	160	140	180	210	160
10	200	160	140	110	200	160	140	110
11	140	180	210	160	140	180	210	160
12	200	120	150	100	200	120	150	100
13	130	150	300	200	130	150	300	200
14	200	170	150	240	200	170	150	240
15	200	150	120	100	200	150	120	100
16	140	180	210	160	140	180	210	160
17	150	190	170	140	150	190	170	140
18	200	160	140	110	200	160	140	110
19	200	170	150	240	200	170	150	240
20	150	130	20	300	150	130	200	300
21	140	180	210	160	140	180	210	160
22	170	200	240	150	170	200	240	150
23	150	130	200	300	150	130	200	300
24	140	180	210	160	140	180	210	160
25	150	190	170	140	150	190	170	140
26	200	160	140	110	200	160	140	110
27	140	180	210	160	140	80	210	160
28	200	120	150	100	200	120	150	100
29	130	150	300	200	130	150	300	200
30	200	170	150	240	200	170	150	240
31	200	150	120	100	200	150	120	100
32	140	180	50	160	140	180	210	160
33	150	190	170	140	150	190	170	140
34	200	160	140	110	200	160	140	110
35	200	170	150	240	30	170	150	240
36	150	130	200	300	150	130	200	300
37	140	180	210	160	140	180	210	160
38	170	200	240	150	170	200	240	150
39	150	130	200	300	150	130	200	300
40	140	180	210	160	140	180	210	160
41	150	190	170	140	150	190	170	140
42	200	170	150	90	200	170	150	240
43	150	130	200	30	150	130	200	30
44	140	180	210	160	140	180	210	160
45	170	200	240	150	170	200	240	150
46	150	130	200	50	150	130	200	30
47	140	180	210	160	140	180	210	160
48	150	190	170	140	150	190	170	140
49	200	150	120	100	200	150	120	100
50	10	200	24	150	17	20	240	15

Appendix B: Site Connectivity Data from Gnutella file sharing Network (2002)

Directed graph (each unordered pair of nodes is saved once): #p2p-#Gnutella04.txt
#Directed Gnutella P2P network from August 4 2002
#Nodes: 10876 Edges: 39994

#From_ NodeId	To_ NodeId	#From_ NodeId	To_ NodeId	#From_ NodeId	To_ NodeId	#From_ NodeId	To_ NodeId
0	1	83	223	89	274	94	306
0	2	83	224	90	89	94	307
0	3	83	225	90	92	94	308
0	4	83	226	90	223	96	333
0	5	83	227	90	259	96	334
0	6	83	228	90	260	96	335
0	7	83	229	90	261	96	336
0	8	83	230	90	262	96	337
0	9	83	231	90	263	96	338
0	10	84	408	90	264	96	339
1	2	84	820	90	265	96	340
1	11	84	2619	91	249	96	341
1	12	84	2952	91	250	96	342
1	13	84	4166	91	251	97	27
1	14	84	4657	91	252	97	142
1	15	84	4754	91	253	97	502
1	16	84	5031	91	254	97	742
1	17	84	6337	91	255	97	871
1	18	84	6338	91	256	97	872
1	19	87	208	91	257	97	873
3	20	87	241	91	258	97	874
3	21	87	242	92	164	97	875
3	22	87	243	92	275	97	876
3	23	87	244	92	276	97	877
3	24	87	245	92	277	97	878
3	25	87	246	92	278	97	879
3	26	87	247	92	279	97	880
3	27	87	248	92	280	97	881
3	28	88	84	92	281	97	882
3	29	88	85	92	282	97	883
8	30	88	86	92	283	97	884
8	31	88	292	93	107	97	885
8	32	88	293	93	284	99	4
8	33	88	294	93	285	99	103
8	34	88	295	93	286	99	105
8	35	88	296	93	287	99	320
8	36	88	297	93	288	99	321
8	37	88	298	93	289	99	322
8	38	89	148	93	290	99	323
8	39	89	266	93	291	99	324
10	41	89	267	94	299	99	325
10	136	89	268	94	300	99	326

#From_ NodeId	To_ NodeId	#From_ NodeId	To_ NodeId	#From_ NodeId	To_ NodeId	#From_ NodeId	To_ NodeId
10	137	89	269	94	301	99	327
10	138	89	270	94	302	99	328
10	139	89	271	94	303	99	329
10	140	89	272	94	304	99	330
10	141	89	273	94	305	99	331
99	332	112	359	120	442	125	478
101	139	113	86	120	443	125	479
101	313	113	360	120	444	126	244
101	314	113	361	120	445	126	957
101	315	113	362	121	480	126	958
101	316	113	363	121	481	127	1475
101	317	113	364	121	482	127	2364
101	318	113	365	121	483	127	2799
101	319	113	366	121	484	127	3641
106	166	113	367	121	485	127	3681
106	171	115	395	121	486	127	3682
106	343	115	396	121	487	127	3683
106	344	115	397	121	488	127	3684
106	345	115	398	121	489	127	3685
106	346	115	399	122	149	127	3686
106	347	115	400	122	415	128	18
106	348	115	401	122	416	128	429
106	349	115	402	122	417	128	430
107	2981	115	403	122	418	128	431
107	3307	115	404	123	405	128	432
107	6479	116	512	123	406	128	433
107	7381	118	368	123	407	128	434
107	8612	118	369	123	408	128	435
107	8842	118	370	123	409	128	436
107	8843	118	371	123	410	128	437
107	8844	118	372	123	411	129	2518
107	8845	118	373	123	412	129	3309
108	350	118	374	123	413	129	3310
109	385	118	375	123	414	129	3311
109	386	118	376	124	419	129	3312
109	387	118	377	124	420	129	3313
109	388	119	102	124	421	129	3314
109	389	119	103	124	422	129	3315
109	390	119	322	124	423	129	3316
109	391	119	378	124	424	129	3317
109	392	119	379	124	425	130	446
109	393	119	380	124	426	130	447
109	394	119	381	124	427	130	448
111	102	119	382	124	428	130	449
112	329	119	383	125	470	130	450
112	351	119	384	125	471	130	451
112	352	120	97	125	472	130	452
112	353	120	408	125	473	130	453
112	354	120	438	125	474	130	454
112	355	120	439	125	475	130	455
112	356	120	440	125	476	131	140

#From_ NodeId	To_ NodeId	#From_ NodeId	To_ NodeId	#From_ NodeId	To_ NodeId	#From_ NodeId	To_ NodeId
112	358	120	441	125	477	131	328
131	456	141	504	153	549	165	594
131	457	141	505	153	550	165	595
131	458	141	506	153	551	165	596
131	459	141	507	153	552	53	548
131	460	141	508	153	553	165	597
131	461	141	509	153	554	165	598
131	462	141	510	153	555	166	205
131	463	141	511	154	167	166	599
132	3	144	260	154	580	166	600
132	52	144	377	154	581	166	601
132	219	144	513	154	582	166	602
132	222	144	514	154	583	166	603
132	464	144	515	154	584	166	604
132	465	144	516	154	585	166	605
132	466	144	517	154	586	166	606
132	467	144	518	154	587	166	607
132	468	144	519	154	588	167	608
132	469	144	520	157	155	167	609
133	570	147	402	157	556	167	610
133	1210	147	521	157	557	167	611
133	1755	147	522	157	558	167	612
133	2002	147	523	157	559	167	613
133	2773	147	524	157	560	167	614
133	3680	147	525	157	561	167	615
133	4229	147	526	157	562	167	616
133	4230	147	527	157	563	167	617
133	4231	147	528	157	564	168	155
133	4232	147	529	158	346	168	157
136	730	148	40	158	495	168	540
136	1116	148	121	158	505	168	618
136	1198	148	530	158	565	168	619
136	1454	148	531	158	566	168	620
136	4191	148	532	158	567	168	621
136	4694	148	533	158	568	168	622
136	5062	148	534	158	569	168	623
136	5626	148	535	162	570	168	624
136	8253	148	536	162	571	170	78
136	8958	148	537	162	572	170	715
137	289	150	538	162	573	170	716
137	493	150	539	162	574	170	717
137	494	150	540	162	575	170	718
137	495	150	541	162	576	170	719
137	496	150	542	162	577	170	720
137	497	150	543	162	578	170	721
137	498	150	544	162	579	170	722
137	499	150	545	165	589	170	723
137	500	150	546	165	590	171	543
137	501	150	547	165	591	171	600
141	502	153	197	165	592	171	616
141	503	153	473	165	593	171	625

#From_ NodeId	To_ NodeId	#From_ NodeId	To_ NodeId	#From_ NodeId	To_ NodeId	#From_ NodeId	To_ NodeId
171	626	184	666	194	9	206	328
171	627	184	667	194	290	206	641
171	628	184	668	194	351	206	753
171	629	184	669	194	581	206	754
171	630	184	670	194	836	206	755
171	631	184	671	194	4391	206	756
175	92	184	672	194	4596	206	757
175	190	184	673	194	4609	206	758
175	421	185	3578	194	4870	206	759
175	632	185	8662	194	6699	206	760
175	633	187	167	195	278	207	743
175	634	187	407	195	399	207	744
175	635	187	568	195	605	207	745
175	636	187	693	195	701	207	746
175	637	187	694	195	702	207	747
175	638	187	695	195	703	207	748
176	180	187	696	195	704	207	749
176	561	187	697	195	705	207	750
176	633	187	698	195	706	207	751
176	639	187	699	195	707	207	752
176	640	189	674	198	165	213	172
176	641	189	675	198	178	213	348
176	642	189	676	198	675	213	410
176	643	189	677	198	708	213	761
176	644	189	678	198	709	213	762
176	645	189	679	198	710	213	763
177	4	189	680	198	711	213	764
180	304	189	681	198	712	213	765
180	639	189	682	198	713	213	766
180	646	189	683	198	714	213	767
180	647	190	1091	200	724	218	69
180	648	190	1579	200	725	218	564
180	649	190	2793	200	726	218	768
180	650	190	3004	200	727	218	769
180	651	190	4496	200	728	218	770
180	652	190	4579	200	729	218	771
180	653	190	5173	200	730	218	772
181	359	190	5355	200	731	218	773
181	655	190	9273	200	732	218	774
181	656	190	9357	200	733	220	108
181	657	192	684	201	359	220	775
181	658	192	685	201	734	220	776
181	659	192	686	201	735	220	777
181	660	192	687	201	736	220	778
181	661	192	688	201	737	220	779
181	662	192	689	201	738	220	780
181	663	192	690	201	739	220	781
183	664	192	691	201	740	220	782
184	564	192	692	201	741	220	783
184	665	193	700	201	742	221	784

Appendix C: Site Availability Sample Workload Data

Site status record for availability workload data extracted from Failure Trace Archives (FTA, 2007)

#event _id	compone nt_id	node _id	platform _id	Node _name	event _type	start_time	stop_time	event_end _reason
0	0	927	10	"tg-login1"	1	1.15E+09	1.17E+09	NULL
0	0	928	10	"tg-login2"	1	1.15E+09	1.17E+09	NULL
0	0	929	10	"tg-login3"	1	1.15E+09	1.17E+09	NULL
0	0	930	10	"tg-login4"	1	1.15E+09	1.17E+09	NULL
0	0	739	10	"tg-c740"	1	1.15E+09	1.17E+09	NULL
0	0	748	10	"tg-c749"	1	1.15E+09	1.17E+09	NULL
0	0	962	10	"tg-s148"	1	1.15E+09	1.17E+09	NULL
0	0	234	10	"tg-c235"	1	1.15E+09	1.17E+09	NULL
1	0	234	10	"tg-c235"	0	1.17E+09	1.17E+09	NULL
2	0	234	10	"tg-c235"	1	1.17E+09	1.17E+09	NULL
0	0	233	10	"tg-c234"	1	1.15E+09	1.17E+09	NULL
1	0	233	10	"tg-c234"	0	1.17E+09	1.17E+09	NULL
2	0	233	10	"tg-c234"	1	1.17E+09	1.17E+09	NULL
0	0	236	10	"tg-c237"	1	1.15E+09	1.17E+09	NULL
1	0	236	10	"tg-c237"	0	1.17E+09	1.17E+09	NULL
2	0	236	10	"tg-c237"	1	1.17E+09	1.17E+09	NULL
0	0	235	10	"tg-c236"	1	1.15E+09	1.17E+09	NULL
1	0	235	10	"tg-c236"	0	1.17E+09	1.17E+09	NULL
2	0	235	10	"tg-c236"	1	1.17E+09	1.17E+09	NULL
0	0	230	10	"tg-c231"	1	1.15E+09	1.17E+09	NULL
1	0	230	10	"tg-c231"	0	1.17E+09	1.17E+09	NULL
2	0	230	10	"tg-c231"	1	1.17E+09	1.17E+09	NULL
0	0	229	10	"tg-c230"	1	1.15E+09	1.17E+09	NULL
1	0	229	10	"tg-c230"	0	1.17E+09	1.17E+09	NULL
2	0	229	10	"tg-c230"	1	1.17E+09	1.17E+09	NULL
0	0	232	10	"tg-c233"	1	1.15E+09	1.17E+09	NULL
1	0	232	10	"tg-c233"	0	1.17E+09	1.17E+09	NULL
2	0	232	10	"tg-c233"	1	1.17E+09	1.17E+09	NULL
0	0	231	10	"tg-c232"	1	1.15E+09	1.17E+09	NULL
1	0	231	10	"tg-c232"	0	1.17E+09	1.17E+09	NULL
2	0	231	10	"tg-c232"	1	1.17E+09	1.17E+09	NULL
0	0	310	10	"tg-c311"	1	1.15E+09	1.17E+09	NULL
0	0	238	10	"tg-c239"	1	1.15E+09	1.17E+09	NULL
1	0	238	10	"tg-c239"	0	1.17E+09	1.17E+09	NULL
2	0	238	10	"tg-c239"	1	1.17E+09	1.17E+09	NULL
0	0	237	10	"tg-c238"	1	1.15E+09	1.17E+09	NULL
1	0	237	10	"tg-c238"	0	1.17E+09	1.17E+09	NULL
2	0	237	10	"tg-c238"	1	1.17E+09	1.17E+09	NULL
0	0	790	10	"tg-c791"	1	1.15E+09	1.17E+09	NULL

#event _id	component _id	node _id	platform _id	Node _name	event _type	start_time	stop_time	event_end _reason
0	0	588	10	"tg-c589"	1	1.15E+09	1.16E+09	NULL
1	0	588	10	"tg-c589"	0	1.16E+09	1.16E+09	NULL
2	0	588	10	"tg-c589"	1	1.16E+09	1.17E+09	NULL
0	0	587	10	"tg-c588"	1	1.15E+09	1.17E+09	NULL
0	0	586	10	"tg-c587"	1	1.15E+09	1.17E+09	NULL
0	0	585	10	"tg-c586"	1	1.15E+09	1.16E+09	NULL
1	0	585	10	"tg-c586"	0	1.16E+09	1.16E+09	NULL
2	0	585	10	"tg-c586"	1	1.16E+09	1.17E+09	NULL
0	0	584	10	"tg-c585"	1	1.15E+09	1.17E+09	NULL
0	0	583	10	"tg-c584"	1	1.15E+09	1.17E+09	NULL
0	0	582	10	"tg-c583"	1	1.15E+09	1.16E+09	NULL
1	0	582	10	"tg-c583"	0	1.16E+09	1.16E+09	NULL
2	0	582	10	"tg-c583"	1	1.16E+09	1.17E+09	NULL
0	0	581	10	"tg-c582"	1	1.15E+09	1.17E+09	NULL
0	0	580	10	"tg-c581"	1	1.15E+09	1.17E+09	NULL
0	0	579	10	"tg-c580"	1	1.15E+09	1.17E+09	NULL
0	0	467	10	"tg-c468"	1	1.15E+09	1.17E+09	NULL
0	0	468	10	"tg-c469"	1	1.15E+09	1.17E+09	NULL
0	0	742	10	"tg-c743"	1	1.15E+09	1.16E+09	NULL
1	0	742	10	"tg-c743"	0	1.16E+09	1.16E+09	NULL
2	0	742	10	"tg-c743"	1	1.16E+09	1.17E+09	NULL
0	0	741	10	"tg-c742"	1	1.15E+09	1.16E+09	NULL
1	0	741	10	"tg-c742"	0	1.16E+09	1.16E+09	NULL
2	0	741	10	"tg-c742"	1	1.16E+09	1.17E+09	NULL
0	0	744	10	"tg-c745"	1	1.15E+09	1.17E+09	NULL
0	0	743	10	"tg-c744"	1	1.15E+09	1.17E+09	NULL
0	0	746	10	"tg-c747"	1	1.15E+09	1.17E+09	NULL
0	0	745	10	"tg-c746"	1	1.15E+09	1.17E+09	NULL
0	0	459	10	"tg-c460"	1	1.15E+09	1.17E+09	NULL
0	0	460	10	"tg-c461"	1	1.15E+09	1.15E+09	NULL
1	0	460	10	"tg-c461"	0	1.15E+09	1.15E+09	NULL
2	0	460	10	"tg-c461"	1	1.15E+09	1.17E+09	NULL
0	0	461	10	"tg-c462"	1	1.15E+09	1.17E+09	NULL
0	0	462	10	"tg-c463"	1	1.15E+09	1.17E+09	NULL
0	0	463	10	"tg-c464"	1	1.15E+09	1.17E+09	NULL
0	0	464	10	"tg-c465"	1	1.15E+09	1.17E+09	NULL
1	0	464	10	"tg-c465"	0	1.17E+09	1.17E+09	NULL
0	0	465	10	"tg-c466"	1	1.15E+09	1.17E+09	NULL
0	0	466	10	"tg-c467"	1	1.15E+09	1.16E+09	NULL
1	0	466	10	"tg-c467"	0	1.16E+09	1.16E+09	NULL
2	0	466	10	"tg-c467"	1	1.16E+09	1.17E+09	NULL
3	0	466	10	"tg-c467"	0	1.17E+09	1.17E+09	NULL

#event _id	component _id	node _id	platform _id	Node _name	event _type	start_time	stop_time	event_end _reason
4	0	466	10	"tg-c467"	1	1.17E+09	1.17E+09	NULL
0	0	574	10	"tg-c575"	1	1.15E+09	1.15E+09	NULL
1	0	574	10	"tg-c575"	0	1.15E+09	1.15E+09	NULL
2	0	574	10	"tg-c575"	1	1.15E+09	1.17E+09	NULL
0	0	992	10	"tg-s178"	1	1.15E+09	1.17E+09	NULL
0	0	157	10	"tg-c158"	1	1.15E+09	1.15E+09	NULL
0	0	89	10	"tg-c090"	1	1.15E+09	1.17E+09	NULL
1	0	89	10	"tg-c090"	0	1.17E+09	1.17E+09	NULL
2	0	89	10	"tg-c090"	1	1.17E+09	1.17E+09	NULL
0	0	300	10	"tg-c301"	1	1.15E+09	1.17E+09	NULL
0	0	299	10	"tg-c300"	1	1.15E+09	1.17E+09	NULL
0	0	302	10	"tg-c303"	1	1.15E+09	1.17E+09	NULL
0	0	301	10	"tg-c302"	1	1.15E+09	1.17E+09	NULL
0	0	304	10	"tg-c305"	1	1.15E+09	1.16E+09	NULL
1	0	304	10	"tg-c305"	0	1.16E+09	1.16E+09	NULL
2	0	304	10	"tg-c305"	1	1.16E+09	1.17E+09	NULL
0	0	303	10	"tg-c304"	1	1.15E+09	1.17E+09	NULL
0	0	306	10	"tg-c307"	1	1.15E+09	1.17E+09	NULL
0	0	305	10	"tg-c306"	1	1.15E+09	1.17E+09	NULL
0	0	308	10	"tg-c309"	1	1.15E+09	1.17E+09	NULL
0	0	307	10	"tg-c308"	1	1.15E+09	1.17E+09	NULL
0	0	912	10	"tg-c909"	0	1.15E+09	1.15E+09	NULL
1	0	912	10	"tg-c909"	1	1.15E+09	1.17E+09	NULL
0	0	667	10	"tg-c668"	1	1.15E+09	1.17E+09	NULL
0	0	513	10	"tg-c514"	1	1.15E+09	1.15E+09	NULL
1	0	513	10	"tg-c514"	0	1.15E+09	1.15E+09	NULL
2	0	513	10	"tg-c514"	1	1.15E+09	1.17E+09	NULL
0	0	514	10	"tg-c515"	1	1.15E+09	1.15E+09	NULL
1	0	514	10	"tg-c515"	0	1.15E+09	1.15E+09	NULL
2	0	514	10	"tg-c515"	1	1.15E+09	1.17E+09	NULL
0	0	515	10	"tg-c516"	1	1.15E+09	1.17E+09	NULL
0	0	516	10	"tg-c517"	1	1.15E+09	1.17E+09	NULL
0	0	509	10	"tg-c510"	1	1.15E+09	1.17E+09	NULL
0	0	510	10	"tg-c511"	1	1.15E+09	1.17E+09	NULL
0	0	511	10	"tg-c512"	1	1.15E+09	1.17E+09	NULL
0	0	512	10	"tg-c513"	1	1.15E+09	1.17E+09	NULL
0	0	517	10	"tg-c518"	1	1.15E+09	1.15E+09	NULL
1	0	517	10	"tg-c518"	0	1.15E+09	1.16E+09	NULL
2	0	517	10	"tg-c518"	1	1.16E+09	1.17E+09	NULL
0	0	518	10	"tg-c519"	1	1.15E+09	1.17E+09	NULL
0	0	997	10	"tg-s183"	1	1.15E+09	1.17E+09	NULL
0	0	941	10	"tg-s047"	1	1.15E+09	1.17E+09	NULL

#event_id	component_id	node_id	platform_id	Node_name	event_type	start_time	stop_time	event_end_reason
0	0	98	10	"tg-c099"	1	1.15E+09	1.17E+09	NULL
1	0	98	10	"tg-c099"	0	1.17E+09	1.17E+09	NULL
2	0	98	10	"tg-c099"	1	1.17E+09	1.17E+09	NULL
0	0	97	10	"tg-c098"	1	1.15E+09	1.17E+09	NULL
1	0	97	10	"tg-c098"	0	1.17E+09	1.17E+09	NULL
2	0	97	10	"tg-c098"	1	1.17E+09	1.17E+09	NULL
0	0	45	10	"tg-c046"	1	1.15E+09	1.16E+09	NULL
1	0	45	10	"tg-c046"	0	1.16E+09	1.17E+09	NULL
2	0	45	10	"tg-c046"	1	1.17E+09	1.17E+09	NULL
0	0	46	10	"tg-c047"	1	1.15E+09	1.15E+09	NULL
1	0	46	10	"tg-c047"	0	1.15E+09	1.15E+09	NULL
2	0	46	10	"tg-c047"	1	1.15E+09	1.16E+09	NULL
3	0	46	10	"tg-c047"	0	1.16E+09	1.17E+09	NULL
4	0	46	10	"tg-c047"	1	1.17E+09	1.17E+09	NULL
0	0	43	10	"tg-c044"	1	1.15E+09	1.16E+09	NULL
1	0	43	10	"tg-c044"	0	1.16E+09	1.17E+09	NULL
2	0	43	10	"tg-c044"	1	1.17E+09	1.17E+09	NULL
0	0	44	10	"tg-c045"	1	1.15E+09	1.16E+09	NULL
1	0	44	10	"tg-c045"	0	1.16E+09	1.17E+09	NULL
2	0	44	10	"tg-c045"	1	1.17E+09	1.17E+09	NULL
0	0	41	10	"tg-c042"	1	1.15E+09	1.16E+09	NULL
1	0	41	10	"tg-c042"	0	1.16E+09	1.17E+09	NULL
2	0	41	10	"tg-c042"	1	1.17E+09	1.17E+09	NULL
0	0	42	10	"tg-c043"	1	1.15E+09	1.15E+09	NULL
1	0	42	10	"tg-c043"	0	1.15E+09	1.16E+09	NULL
2	0	42	10	"tg-c043"	1	1.16E+09	1.16E+09	NULL
3	0	42	10	"tg-c043"	0	1.16E+09	1.16E+09	NULL
4	0	42	10	"tg-c043"	1	1.16E+09	1.16E+09	NULL
5	0	42	10	"tg-c043"	0	1.16E+09	1.17E+09	NULL
6	0	42	10	"tg-c043"	1	1.17E+09	1.17E+09	NULL
0	0	39	10	"tg-c040"	1	1.15E+09	1.16E+09	NULL
1	0	39	10	"tg-c040"	0	1.16E+09	1.16E+09	NULL
2	0	39	10	"tg-c040"	1	1.16E+09	1.17E+09	NULL
0	0	40	10	"tg-c041"	1	1.15E+09	1.16E+09	NULL
1	0	40	10	"tg-c041"	0	1.16E+09	1.17E+09	NULL
2	0	40	10	"tg-c041"	1	1.17E+09	1.17E+09	NULL
0	0	124	10	"tg-c125"	1	1.15E+09	1.16E+09	NULL
1	0	124	10	"tg-c125"	0	1.16E+09	1.16E+09	NULL
2	0	124	10	"tg-c125"	1	1.16E+09	1.17E+09	NULL
0	0	123	10	"tg-c124"	1	1.15E+09	1.16E+09	NULL
1	0	123	10	"tg-c124"	0	1.16E+09	1.16E+09	NULL
2	0	123	10	"tg-c124"	1	1.16E+09	1.17E+09	NULL
0	0	126	10	"tg-c127"	1	1.15E+09	1.16E+09	NULL