NETWORK SLS AND DRAFT SLA

BALTIC GRID NETWORK SERVICE LEVEL SPECIFICATIONS AND DRAFT SLA WITH INVOLVED NRENs

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Abstract: BalticGrid network infrastructure is being built upon services provided by the National Research and Education Networks and pan-European GÉANT2 research network. This document outlines network Service Level Specifications required for efficient Resource Centre interconnection within the BalticGrid and for provision of production level Grid services within the Baltics. The document also includes a draft SLA to be concluded with the involved NRENs as a mechanism for implementing the mentioned network SLS within the Baltic Grid.

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1. INTRODUCTION

1.1. PURPOSE

The purpose of this document is to map the BalticGrid application requirements described in the DSA2.1 with the services currently available in the networks (the NRENs and GÉANT) as well as to provide an SLS + SLA based mechanism for activation and maintenance of such services.

This document is developed based on the relevant EGEE documents [1], [2], [3] to ensure maximum functional compatibility with the rest of EGEE network and its main international network service provider – GÉANT2. Meanwhile the draft Service Level Agreement (SLA) to be concluded with the involved NRENs providing connectivity for the BalticGrid resource centres, is tailored towards local conditions and network infrastructures available, which were described in detail in the deliverable DSA2.1.

1.2. APPLICATION AREA

This document forms the basis for the actual SLAs to be concluded with the involved NRENs, and thus provides an interface for operational contact between the BalticGrid infrastructure and the infrastructure of the involved NRENs.

The network Service Level Specification (SLS) described in this document is a precondition for other activities of the BalticGrid project – namely, it is integral to JRA1 effort to establish the BalticGrid computing services QoS SLA as well as to SA1 effort to establish BalticGrid monitoring and operational support system.

1.3. REFERENCES

[1] EGEE deliverable "Institution of SLAs and appropriate policies"	https://edms.cern.ch/document/565447/4
[2] EGEE deliverable "Initial requirements aggregation model, specification of services as SLSs on the networks"	https://edms.cern.ch/document/509455/1.9
[3] EGEE deliverable "Operational interface between EGEE and GEANT/NRENs"	https://edms.cern.ch/document/565449/3

1.4. TERMINOLOGY

ACRONYMS	EXPLANATION
ART	Amber, Rock, Timber – QoS levels
BE	Best Effort
CERN	European Organisation for Nuclear Research
CMS	LHC physic experiment
diffserv	Differentiated services
EGEE	Enabling Grids for E-sciencE
EU	European Union

GE	Gigabit Ethernet
GEANT	European Academic Network
GN2	Codename for GEANT-2 (the successor to the GEANT network)
HEP	High Energy Physics
JRA	Joint Research Activity
LBE	Less Than Best Effort
LHC	Large Hadron Collider
MTU	Maximum Transfer Unit
MPI	Message Passing Interface software
NPM	Network Performance Monitoring
NREN	National Research and Education Network
PoP	Point of Presence
QoS	Quality Of Services
SA	Specific Service Activity
SLA	Service Level Agreement
SLR	Service Level Request
SLS	Service Level Specification

2. THE NEED FOR SERVICE LEVEL AGREEMENTS

2.1. DETAILED ANALYSIS OF BALTICGRID APPLICATIONS REQUIREMENTS

In the first deliverable DSA2.1 an overview of BalticGrid applications and their requirements relating to the network resources was given in order to mark out possible network load and thus foreshadow network requirements for the project. To specify network requirements the need for more detailed application analysis was recognised and closer study of applications summarised by NA3 activity was carried out (see Table 2-1). Please note that the analysis was based on those applications that provided extended description of their needs. Also not all applications have provided all the necessary data (shadowed cells), therefore reasonable estimated values based on the understanding of the application descriptions were given and taken into account.

The most important conclusion drawn from the BalticGrid applications summary is that currently identified application requirements are negligible compared to the available network bandwidth.

Even when extrapolating the required network capacity, presuming that there are three times as many applications, the applications are run only in working hours (8 hours a day, 20 days a month), the resulting network bandwidth needed to ensure acceptable network usage is estimated at about 15Mbps.

Table 2-1 Application provided data

	size (MB)		usage (times/month)		Bandwidth requested (Mbps)	Required bandwidth (calculated MB per month)	
	input	output	min	max		min	max
SimHEP	5	1000	1	4	10	1005	4020
SYMPLECTIC1	5	5	20	50	1	200	500
LOAD	0.01	0.1	10	30		1.1	3.3
MCIsing	0.001	0.1	20	50	5	2.02	5.05
NSBGT	0.001	1	10	20	5	10.01	20.02
mpiBLAST	100	10	20	60		2200	6600
SemTi-Kamols	0.01	0.1	1000	100000		110	11000
SYNTSPEC	100	500	10	10		6000	6000
SMEFLUX	100	500	10	10		6000	6000
StatHEP	0.01	1	1500	10000		1515	10100
DOUG	300	30	20	50		6600	16500
abinit	0	0	5	10		0	0
CCP4	100	100	20	500		4000	100000
CNS	100	100	20	500		4000	100000
DEMPAR	30	5	30	30	20	1050	1050
G03	0.01	1	20	20		20.2	20.2
Opt	0.01	1	20	20		20.2	20.2
SHYFEM	500	1000	20	50	5	30000	75000
SWAN	1	2	20	50		60	150
					Month	62793.53	336988.77
					Day	2093.12	11232.96
					Hour	87.21	468.04
					Mbps	**0.19**	**1.04**

In our view the above "systematic" evaluation of the BalticGrid network capacities requirements is giving unrealistically low results, most likely due to incomplete list of potential applications and their network requirements. This effect might have been caused by the low awareness about the available Grid applications and their requirements at the time when the survey was completed by the NA3 in the first months of the BalticGrid project.

Another reason for underestimating is that the NA3 survey has not taken into consideration the applications, which other EGEE members will be running on the EGEE certified BalticGrid computing clusters, such as HEP experiments originating from CERN and others. The recently conducted tests with HEP CMS application in the BalticGrid show that it has major influence on the traffic and generates between 400Mbps – 1Gbps traffic for the duration of several weeks.

It is also necessary to take into account future development of the BalticGrid: most probably there will be more applications with higher requirements. There might even be applications requiring real-time network traffic delivery.

In the light of these considerations, for the initial planning purposes our best estimate is that the EGEE certified resource centres of the BalticGrid must have at least 1Gbps capacity available between each other and towards the GEANT pan-European network. This seems to be a realistic estimate based on the fact that present BalticGrid resource centres typically utilize 1Gbps Ethernet interconnect technology, and this capacity already today can be fully consumed by the HEP CMS application running in the BalticGrid. This estimate can be revised at the later stages of the project, if needed.

2.2. DETAILED ANALYSIS OF THE AVAILABLE NETWORK CONNECTIVITY

Since the beginning of the BalticGrid project the situation in the region concerning the available network bandwidth has become clearer and preferences in the area of bandwidth acquisition are outlined. When the project proposal was drafted, the best option to guarantee the needed bandwidth for the Grid users seemed to be to specify SLS and to sign SLAs with the respective NRENs. At that stage the GEANT2 project was just started and the new network topology was not outlined in details yet.

In the framework of GEANT2 a 2.5Gbit fiber optic lines are installed from Copenhagen to Tallinn, then to Riga, to Vilnius and to Poland. From this capacity 1Gbps will be made available for EENet, 655Mbps to LITNET and 155 Mbps for LATNET.

Estonian and Lithuania NRENs have already announced that they could increase the available bandwidth in these lines, if that would be needed for the Grid infrastructure. They would prefer over-provisioning rather than extensive traffic engineering, which would be otherwise required for the implementing of the SLAs. Their argument was that traffic engineering at speeds of 622Mbps would require very powerful hardware but they rather invest these funds in additional bandwidth.

Latvian NREN at present is in a different situation. Latvia is one of the few countries in the EU where government is not fully supporting GEANT project and the national part of the payment (about 50%) for the GEANT connection is mostly financed by the institutions using this connection. Therefore the Latvian NREN is tighter bound to the needs of the users and can not easily increase payments towards GEANT to provide extra bandwidth required only for the Grid users. The discussions between the Latvian universities and Ministry of Science and Education are ongoing to cure the situation, but no definite decision is in sight yet.

The issue of traffic engineering vs. over-provisioning has been discussed among the BalticGrid project partners and external advisors. The external advisor for the SA2 activity has strongly suggested focusing on acquiring larger capacity instead of traffic engineering. His opinion was that DANTE should also be more understanding and perhaps make larger fraction of the capacity available for the Baltic NRENs when it is required for the Grid traffic. He also promised to raise this question with

DANTE as well as to influence the national decision-makers to provide more support locally for the academic networking.

The existing GEANT link load is up to 50 % for Estonia with around ~400Mbps traffic (this includes CMS experiment running on BalticGrid, discussed below) at peak hours (Fig. 1), 30-40% for Latvia with ~60Mbps traffic at peak hours (Fig. 2) and up to 50% for Lithuania with ~400Mbps traffic at peak hours (Fig. 3). Note that the blue line depicts traffic from GEANT and the green line depicts traffic towards GEANT.

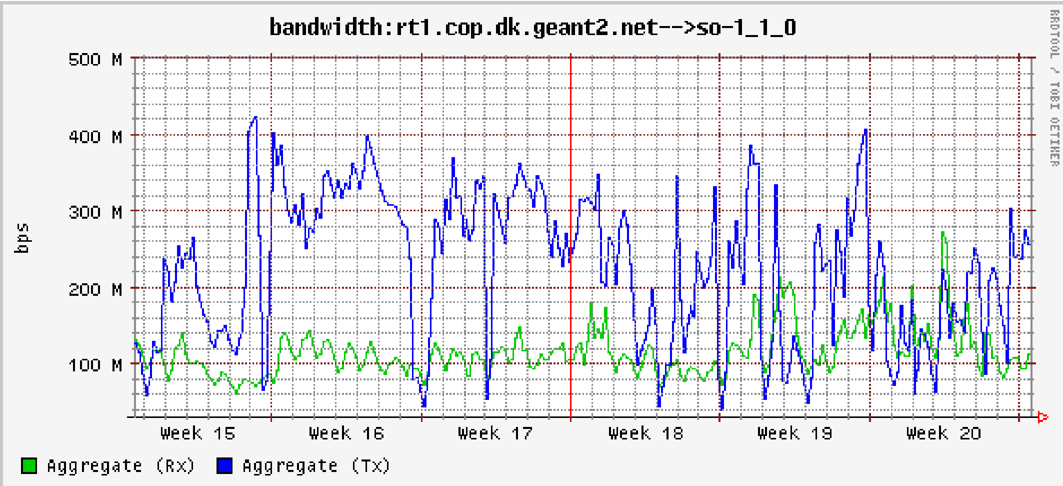

Fig. 1 EEnet-GEANT traffic before BalticGrid

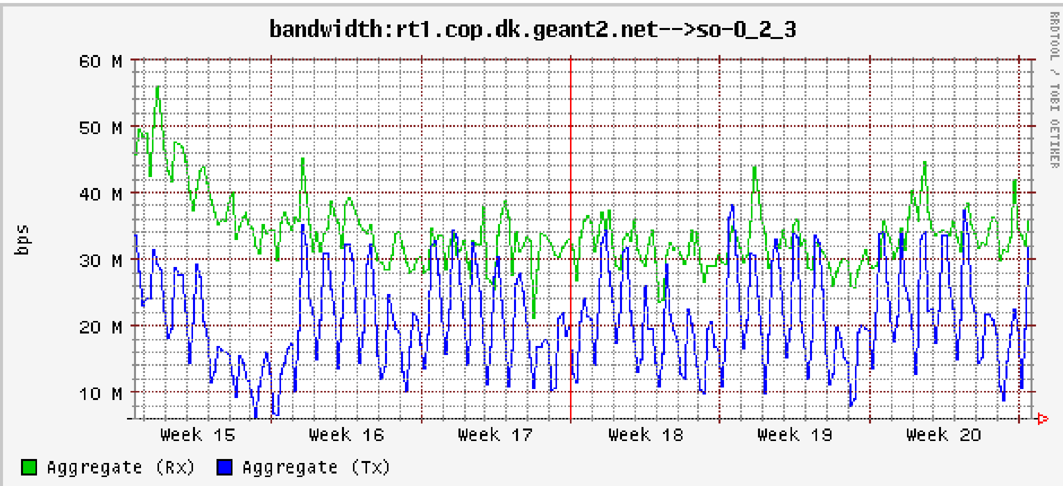

Fig. 2 LATNET-GEANT traffic before BalticGrid

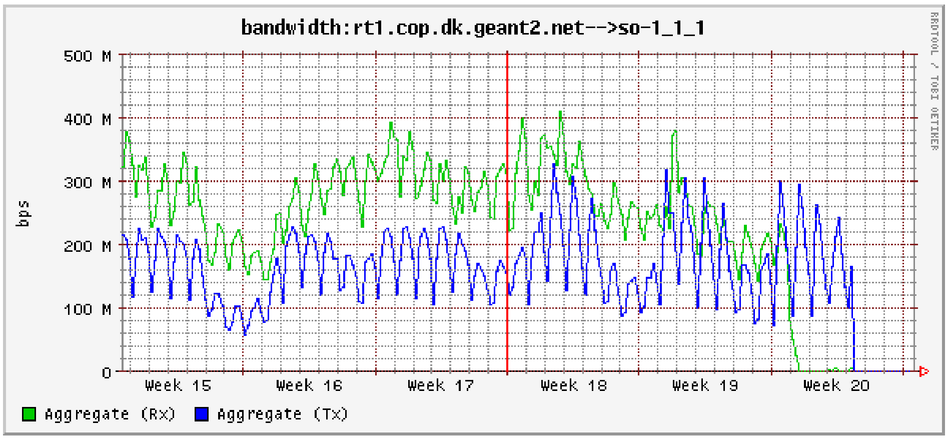

Fig. 3 LITNET-GEANT traffic before BalticGrid

As shown by CMS experiments conducted by BalticGrid SA1 in Estonia, BalticGrid resource centers in each country might be able to generate around 1Gbps Grid traffic towards each other and towards CERN, if running at full load. The EENet traffic load (Fig. 4) shows difference of the Estonian GEANT link load with and without the Grid traffic.

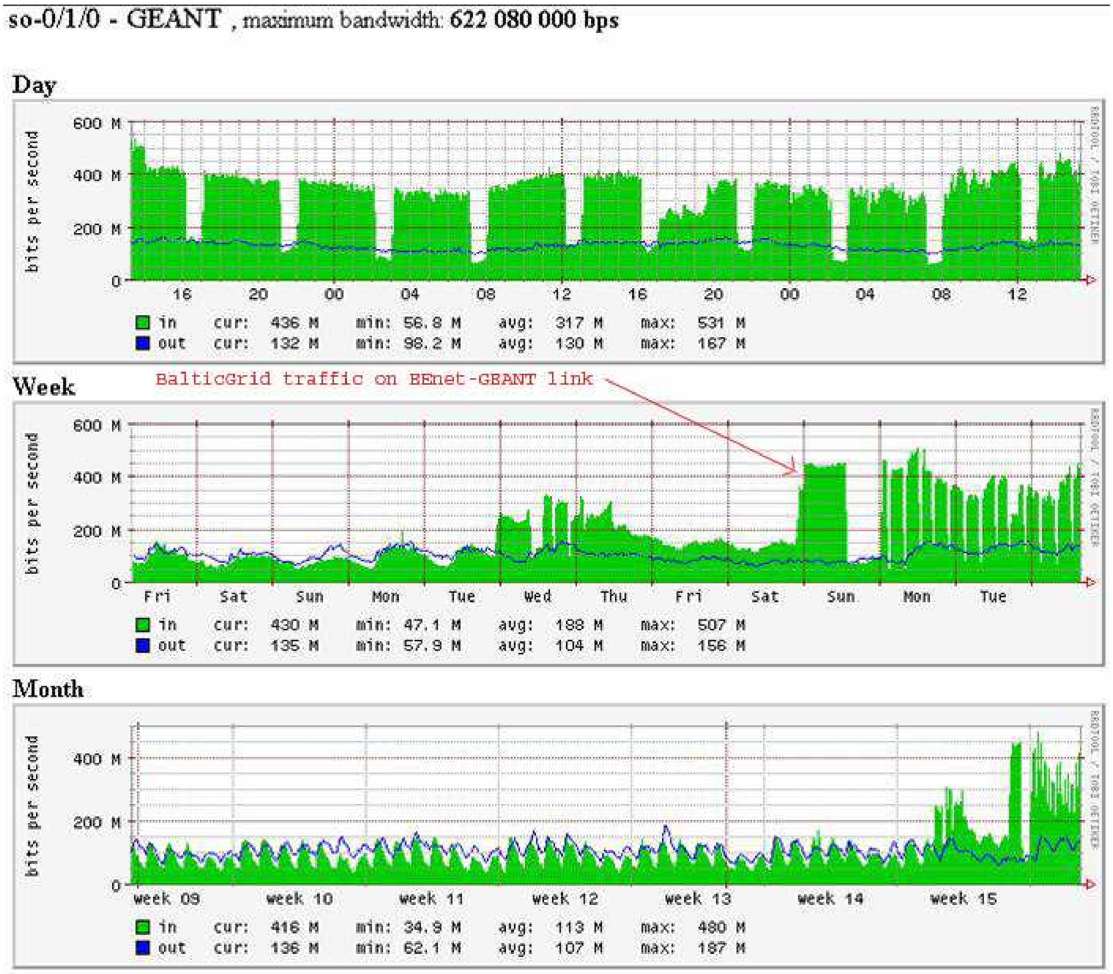

Fig. 4 EEnet-GEANT link traffic load with Grid traffic peaks.

If not managed, the Grid traffic can use all the available bandwidth and significantly disturb other GEANT users. In the same way other GEANT users might generate excessive amounts of traffic and disrupt normal Grid operation (at present time this is a less likely scenario, as generating traffic at Gigabit scale requires clustered computers and unrestricted Gigagabit network access lines; such event more likely could occur only as a result of massive virus or worm infection of numerous networked computers). Such unwanted traffic pattern can and should be avoided with appropriate traffic engineering and limiting the Grid and other users traffic to the max throughput, which is not yet causing GEANT line overload, in other words, with implementing the SLAs, as described in the chapter 3.2. Note that small available capacity variations are not considered critical for the "best-effort" Grid traffic, as long as they do not exceed ~50% of the average available capacity.

Considering all options, EENet has announced preparations to fund larger capacity to accommodate the Grid user needs even if the capacity would not be used/needed by other ordinary network users. Situation in Lithuania is similar. For these NRENs BalticGrid SA2 would have to design a special form of SLA that describes parameters of sufficient over-provisioning for the Grid traffic (see chapter 3.1).

For the reasons described above Latvian NREN is not able to fund significantly larger capacity unless extra support and funding would become available from the national government or external sources. Many parties have agreed to work towards raising funds for larger GEANT capacity in Latvia, but even if this process will be successful, the bandwidth upgrades could be expected not earlier than year 2007. Therefore BalticGrid SA2 would have to use different type of SLA with LATNET agreeing about different service classes for the Grid users. When larger bandwidth would become available, the SLA might be changed to focus on over-provisioning.

To conclude, in the present situation the BalticGrid SA2 would have to accommodate both approaches, i.e., bandwidth over-provisioning and traffic engineering. The long-term goal would be to acquire enough GEANT bandwidth to be able to over-provide even for the Grid users as it has been done in the Central and Western Europe. But as long as sufficient bandwidth is lacking for some of the Baltic countries, the BalticGrid SA2 should provide also a mechanism for traffic engineering to serve the needs of the Grid user.

3. SPECIFICATION OF SLS TYPES SUPPORTED IN BALTICGRID

The purpose of this chapter is to describe the different types of SLS, which need to be supported in the BalticGrid, as derived from the requirements of various applications expected to run on the BalticGrid.

For BalticGird purposes two main strategies for traffic management are proposed:

I – over-provisioning of network resources;

II – Quality of Service (QoS) classes.

Generally, over-provisioning is preferred strategy because it is easy to implement and it requires less administrative efforts. On the other hand, QoS maintains flexibility even at limited available total bandwidth and allows high level of network performance fine-tuning for application-specific needs.

3.1. OVER-PROVISIONING

Over-provisioning means that service provider guarantees available bandwidth capacity that exceeds the actual user needs. When user applications become more demanding, service provider adds network resources in order to increase available bandwidth and meet new requirements. Main difficulty in defining SLS for over-provisioning is finding out or estimating total bandwidth requirements for Grid applications. Also it is difficult to specify criteria when channel capacity has to be increased and by what amount.

As a specific case it is necessary to take care of situations when some future applications require significantly more bandwidth than it is needed for usual day-to-day Grid operation.

The BalticGrid NA3 activity carried out the questionnaire about the user applications requirements. Current estimate is that for day-to-day operations BalticGrid requires not more than 15 Mbps available bandwidth (see 2.1). In order to keep Grid performance optimal it is still required that packet loss does not exceed 0.1% and one-way delay between the BalticGrid resource centres is in the range of 20-50ms, but does not exceed 150 ms under any conditions. In order to speed up traffic flow between GÉANT2 nodes and sites it is worth to increase MTU (Maximum Transfer Unit). It would be recommended to negotiate MTU size as big as possible. If not - MTU of 1500 bytes all along the traffic path must be the minimum requirement. Since there is no QoS mechanisms used with over-provisioning the jitter should be kept minimal by avoiding extra routing/buffering hops on the path..

If traffic load is more than 75% of available bandwidth for more than 10% of agreed measurement time, then total amount of available bandwidth should be increased so that traffic load does not exceed 50%.

In order to detect conditions when bandwidth increase is needed it is crucial to constantly and regularly measure network usage and quality. Moreover, both sides have to agree on the methodology how these measurements are carried out. SLA should also contain a timeframe in which additional resources will be provided after request has been accepted.

If possible, SLA should contain mechanisms to request additional bandwidth for future applications in case their demands exceed current bandwidth allocation. This feature will allow short term high bandwidth applications to run on Baltic Grid.

3.2. QUALITY OF SERVICE

Though over-provisioning is by far the easiest way to ensure BG operations, unfortunately it might not be available everywhere. Also when no additional bandwidth resources are left, QoS procedures have to be implemented using existing channels.

In this form of SLS it is proposed to specify the following three QoS levels:

- Amber.
    - Corresponds to GÈANT Premium IP.
    - Does not exceed 10% of total GÈANT connection capacity.
    - One-way delay does not exceed 100ms (distance delay + 50ms).
    - Jitter does not exceed 25ms.
    - No packet loss.
- Rock
    - Corresponds to GÈANT BE traffic class.
    - Traffic is rate-limited to Grid traffic + other GÈANT traffic < 85% of total GÈANT capacity.
    - One-way delay does not exceed 200ms.
    - Packet loss < 1%.
- Timber
    - Corresponds to LBE traffic in GÈANT.
    - Uses capacity unused by Amber and Rock traffic classes.
    - Might be rate-limited.
    - Packet loss: unspecified

The implementation of these QoS levels must follow the GEANT recommendations for implementing the corresponding traffic classes.

Since several users might be competing for the limited network QoS resources, the SLS requests will be Authorized or rejected on the case-by-case basis by the NREN. Some Quota mechanisms shall be considered.

3.3. SLA MANAGEMENT

Analysis given at the beginning of this document shows that in the initial stage of the BalticGrid project no network overload is foreseen, i.e, the over-provisioning of network resources takes place. But taking into account recent high-bandwidth experiments with CMS performed by the SA1 activity and anticipating further development of applications, the need for Service Level Agreements concluded with respective NRENs is observed.

The process of SLA management could be divided into three phases:

1. Negotiations and SLA conclusion;
2. Implementation of SLA;
3. SLA adherence monitoring.

The main objective of the first phase is to determine the suitable type of agreement for each involved NREN, i.e., over-provisioning on the one hand or management of QoS on the other hand. Basically, each NREN has to answer the question if it is able to provide enough capacity for BalticGrid users (approximate estimate is 1Gbps for BalticGrid in each country) and other GEANT users. If the reply is affirmative, SLA on over-provisioning is concluded. If the network resources are not sufficient, SLA on QoS is concluded. QoS is divided into three levels – Amber, Rock, and Timber (see chapter 3.2) or ART for short.

During the second phase SLA requirements are implemented and afterwards, in the third phase, exercised whenever it is needed. It refers especially to ART-management: BalticGrid users send a request indicating the necessary QoS level. If the request is enforceable the required network resources are supplied. The process (for both over-provisioning and ART-management) will be constantly monitored in order to ensure the quality of network connectivity.

Types of agreements might be periodically reviewed in the third phase when analysis of monitoring data takes place, and SLAs re-concluded accordingly in response to the change of situation.

The whole SLA management schema is shown in Fig. 5.

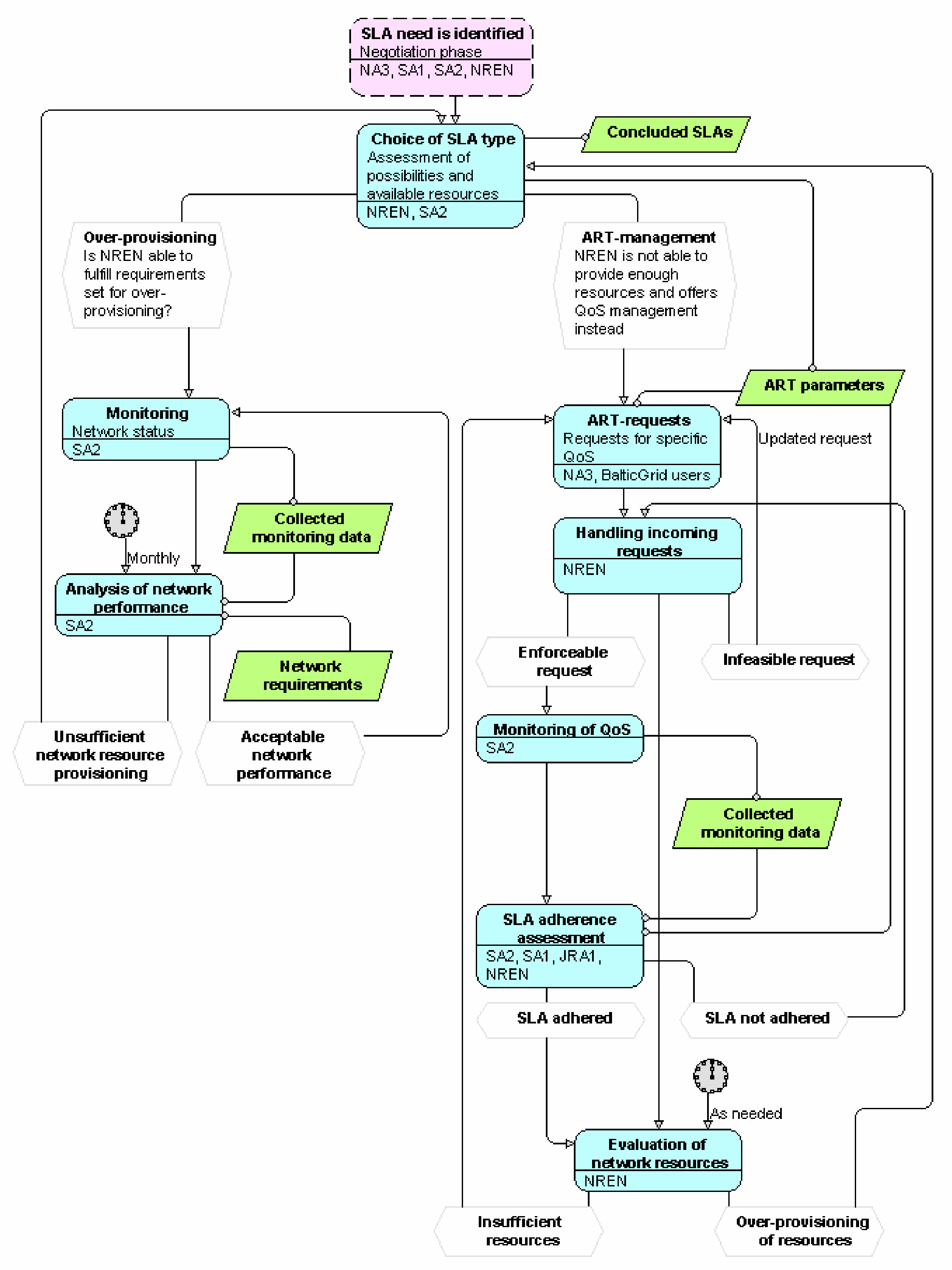

Fig. 5 Implementation and monitoring of SLA adherence

4. THE STRUCTURE OF SLA

SLA consists of two parts:

1) General provisions – this part sets out the substantive clauses setting out the legal basis for the cooperation between NREN and the BalticGrid project. These provisions also serve as guidelines to the interpretation of the specific provisions of the Agreement;
2) Specific provisions - technical service parameters which can be offered and/or ordered.

4.1. GENERAL PROVISIONS

General provisions of the SLA contain Administrative Level Objects (ALO) that include general information related to parties and the agreement itself:

- requisites of the Parties;
- purpose of the Agreement (includes the clause about the chosen SLA type);
- responsibilities of the parties: who is responsible for what, who are the contact persons, what are the expected reaction times of helpdesks etc.
- modification and termination of the Agreement.

This part serves as a legal basis of the cooperation.

As operation of the BalticGrid network depends on the services provided by NRENs in the partnering countries and on GEANT2 international connectivity, failure or under-performance in any of numerous parts of the network might cause an interruption of services for a part of BalticGrid users. Therefore it is essential set explicitly the demarcation point where network provisioning responsibility between the NREN and specific BalticGrid resource centre is. In general, NREN should be responsible for the network path (including transmission lines and network equipment) up to the 1Gbps Ethernet port located directly at the BalticGrid resource centre, if not specified otherwise.

It is also essential to set response time for various levels of failures. For the purposes of BalticGrid the following levels of failures are identified:

1. Breakdown: more than 90% BalticGrid users in the respective country are not able to use the infrastructure of NREN. Response time proposed: 2 hours;
2. Broken international connection: BalticGrid users in the respective country are not able to exchange data via international link. This failure will heavily affect the BalticGrid users in the countries that use brokers and/or VOMS in the other countries. Response time proposed: 4 hours;
3. Broken link: BalticGrid users at the specific organisation are not able to use the infrastructure of NREN. Response time proposed: 8 hours.

The response time on the specific requests of network resources (RONR) in the case of ART-management is proposed to 3 working days.

4.2. SPECIFIC PROVISIONS

Specific provisions of the SLA contain Service Level Objects (SLO), i.e., regarding of the SAL type chosen Specific provisions list the actual technical service parameters which can be offered and/or ordered. This part is closely related to SLS as described in chapter 3.

In the case of over-provisioning of network resources it is necessary to define the very notion of over-provisioning to clearly state what conditions of the network could be considered as over-provided.

In the case of ART-management this part of the SLA contains definitions of parameters that could be ordered by BalticGrid users.

5. INTEGRATION WITH OTHER ACTIVITIES

Current deliverable DSA2.2 is a report on network Service Level Specifications for Baltic Grid as the main objective of SA2 is to deal with network resources provisioning and communicate with network providers. In the description of work for JRA1 the deliverable DJRA1.2 is supposed to identify Grid services SLA – a prototype version of the SLA including quality of service functionality. There is an obvious need for coordinated actions between the two activities.

Network monitoring planned and carried out by SA2 will use Service Level Specifications identified by SA2 and Service Level Agreements developed and concluded by SA2 and JRA1 to establish a reference point for monitoring and troubleshooting.

ANNEX A – DRAFT SLA

SERVICE LEVEL AGREEMENT Nr.

GENERAL PROVISIONS

_____, ___August 2006

BalticGrid

Full name	
Represented by	
Position	

and

NREN

Full name	
Represented by	
Position	

hereinafter referred to as Parties define the service level agreed to be provided by NREN to BalticGrid users.

ARTICLE 1- PURPOSE AND GOALS OF THE SLA

The purpose of this SLA is twofold. First, it is to establish a partnership between BalticGrid project and NREN in order to provide high quality services to BalticGrid users in the respective country. Second, to ensure that future development of resource demanding Grid applications within the BalticGrid project will not affect other academic users of the NREN.

The goals of this Agreement are as following:

- to express mutual understanding of the principles of cooperation between parties;
- to define responsibilities of each party;
- to set procedures for monitoring activities;
- to define network requirements;
- to establish problem reporting procedure and problem response procedures and time.

ARTICLE 2-DEFINITIONS

- Network requirements – collection of parameters that have to be implemented in order to guarantee successful operation of the applications within this network;

- Fair and Reasonable use – the use of the network that corresponds to the goals of the BalticGrid project, policies defined in this Agreement, netiquette, and acceptable practice in the respective country;
- ART-management – Quality of Service according to Amber, Rock and Timber levels;
- BalticGrid resource centres – a collection of nodes supported by an organisation in the BalticGrid;
- BalticGrid users – researchers that run their applications on the BalticGrid resource centres;
- NRR – Network Resources Request;
- Monitoring activities – activities performed by NREN and BalticGrid project participants that measure the actual status of the networking processes and their correspondence to the network requirements defined in this Agreement.

ARTICLE 3 - TERM OF AGREEMENT

The period for the agreement shall be effective by 30 April, 2008. Periodically, according to clauses in the ARTICLES 6 and 7, both Parties will review the benefits of continuing the SLA and take one of the following actions:

1. Terminate the SLA,
2. Modify the General provisions of the SLA, or
3. Modify the Specific Provisions of the SLA.

ARTICLE 4 – DUTIES AND RESPONSIBILITIES OF PARTIES

<u>BALTICGRID: CHARACTERISTIC DUTIES AND RESPONSIBILITIES</u>

1. Provides all necessary help to NREN in order to ensure service availability to BalticGrid users. Gives to NREN a full list of BalticGrid resource centres in the respective country.
2. Informs NREN about new resource centres within 3 (three) working days;
3. Responds to NREN information requests necessary for accomplishment of this Agreement in due time but not later than 5 (five) working days. Urgent requests (specified so by NREN) shall be answered as soon as possible but not later than in 2 (two) working days.
4. Ensures that BalticGrid resource centres make the necessary instalments and configuration of their clusters and local network..
5. BalticGrid contact persons:

   Administrative contact person: _________________________

   Technical contact person: _____________________________

<u>NREN: CHARACTERISTIC DUTIES AND RESPONSIBILITIES</u>

1. Ensures service availability and best possible network performance for the BalticGrid resource centres identified by BalticGrid and BalticGrid users.

2. Does not provide configuration and instalment of a local network for BalticGrid resource centres.

3. Is not responsible for the service availability in the local network of the organisation maintaining resource centre.

4. Responds to and resolves problems reported by BalticGrid Tehcnical contact person by e-mail in due time:

    a. **Breakdown**: more than 90% BalticGrid users in the respective country are not able to use the infrastructure of NREN or are not able to connect to more than 50% of BalticGrid clusters in this country. Response time (high priority): 2 hours;
    b. **Broken international connection**: BalticGrid users/clusters in the respective country are not able to exchange data via international link. Response time (Medium priority): 4 hours;
    c. **Broken link**: BalticGrid users at the specific organisation are not able to use the infrastructure of NREN. Response time (Medium-Low priority): 8 hours.

5. NREN contact persons:

    Administrative contact person: ________________________

    Technical contact person: ___________________________

<u>DEMARCATION POINTS</u>

1. Name of Demarcation point ____

Address, Floor, Room, Rack number ____

Type of interface ____

Planned capacity of the connection ____

(e.g. 1Gbps interface might have been planned for use up to 622Mbps due to uplink restrictions, other users etc.)

2. Name of Demarcation point ____

Address, Floor, Room, Rack number ____

Type of interface ____

Planned capacity of the connection ____

...

ARTICLE 5 – MONITORING SLA ADHERENCE

Both NREN and BalticGrid monitor the compliance of actual network resources to the network requirements defined in the Specific provisions of this Agreement.
Results are collected and analysed on a monthly basis. Results might serve as a proof to the need to modify the SLA.

ARTICLE 6 – TERMINATION OF THE SLA

Either party may terminate this agreement provided that the terminating party first notifies the other party in writing of the exact nature of such decision giving the other party ten (10) days in which to cure the cause for such an action if it is caused by its actions. Agreement is considered terminated if other party does not reply or expresses an acceptance of the termination.

If a party which receives a termination notice from the other party does not agree to terminate the agreement, it notifies the other party and proposes amendments or modifications of the agreement or a new agreement.

If a consensus between parties is not reached in 2 (two) months, the agreement is considered to be terminated.

ARTICLE 7 – MODIFICATION OF THE SLA

Modification of the agreement might be initiated if NREN considers changing Specific provisions of the Agreement from ART-management to Over-provisioning.

Modification of the agreement is to be made if NREN does not meet network requirements defined in Specific provisions of the Agreement for Over-provisioning. In this case Specific provisions must be changed to ART-management.

Either party may invoke modification procedure by sending fully phrased amendment of a clause in writing to the other party. The party receiving a written proposal of modification, within 10 (ten) days accepts, alters or rejects modifications notifying the other party in written.

Modifications are in force when both parties sign an amendment to the Agreement.

ARTICLE 8 – DISPUTE RESOLUTION

All disputes arising under this Agreement shall be discussed the Parties within 30 working days after the issue has arisen or been identified.

If the dispute cannot be resolved within the said period, the Agreement shall be terminated or modified.

SPECIFIC PROVISIONS (Over-provisioning)

1. Under this Agreement NREN will provide the following International connectivity to GEANT network:

- Packet loss: $< 0.1\%$
- One-way delay between the BalticGrid resource centres is in the range of 20-50ms, but does not exceed 150 ms under any conditions.
- MTU of at least 1500 bytes all along the traffic path.
- Minimal jitter by avoiding extra routing/buffering hops on the path.
- Traffic load does not exceed 75% of available bandwidth for more than 10% a month.
- Available bandwidth should be increased so that traffic load does not exceed 50%.

2. In the case of non-compliance to the specified network requirements, NREN shall increase the capacity of their international connection or support ART-management.

SPECIFIC PROVISIONS (ART-management)

1. Under this Agreement NREN will provide Quality of Service management for the following levels:

- Amber.
  - Corresponds to GÈANT Premium IP.
  - Does not exceed 10% of total GÈANT connection capacity.
  - One-way delay does not exceed 100ms (distance delay + 50ms).
  - Jitter does not exceed 25ms.
  - No packet loss.
- Rock
  - Corresponds to GÈANT BE traffic class.
  - Traffic is rate-limited to Grid traffic + other GÈANT traffic < 85% of total GÈANT capacity.
  - One-way delay does not exceed 200ms.
  - Packet loss < 1%.
- Timber
  - Corresponds to LBE traffic in GÈANT.
  - Uses capacity unused by Amber and Rock traffic classes.
  - Might be rate-limited.
  - Packet loss: unspecified

2. The request for the specific level is to be submitted by BalticGrid not later that 3 (three) working days before the level has to be implemented.

3. NREN may propose to change the Specific provisions to Over-provisioning if monitoring results provide enough evidence.