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	QoS signaling requirements, interfaces and	architecture
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Abstract

This draft gives evidence for the existence of different QoS signaling interfaces based on a reference architecture that

derived from two use cases. The main purpose is to refine the requirements for the signaling interface that is being considered in scope of NSIS. The two use cases are the interconnection of PSTN trunking gateways over an IP core network and the connection of an UMTS access network to an IP core network. From these use cases a QoS reference architecture is derived containing QoS Initiator (QI) and QoS Controller (QC) entities, as defined in draft-brunner-nsisreq-<u>00.txt</u>. The architecture encompasses the inter-connection of any type of access networks over an IP DiffServ core network and does not require any upgrade of the existing (and deployed) DiffServ routers. The proposed architecture identifies four relevant signaling interfaces between functional entities. We believe the interface between QI and QC to be of particular interest in the context of Buchli et al. Informational - Expires August 2002 1 QoS signaling architecture, interfaces February 2002 and requirements NSIS. Based on our architecture, the signaling protocol over this interface can be kept simple. Conventions used in this document The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC-2119 [1].

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<u>1</u> .	Introduction
	The task of the NSIS working group is to specify general QoS signaling requirements and possibly propose a new protocol or modifications to existing ones.
	Two use cases are presented in this draft to explore such QoS signaling requirements. The first case is a PSTN trunking
interconnection	interconnection scenario. The second case is the
THEFCOMPECTON	between a UMTS access network and an IP core network.
the two	In addition to the NSIS requirements draft [8], and based on
architecture and	use cases, we introduce a QoS signaling reference
An	identify the different protocol interfaces that are in place.
interfaces may	important observation is that several QoS signaling
We	exist and that their requirements are of a different nature.
involved	identify four relevant signaling interfaces, which may be
between	in QoS provisioning. The most important being the interface
described	the QoS Initiator (QI) and the QoS Controller (QC) as also
	in [8].
described and	The basic requirements of the QI-to-QC interface are
particular it	compared with the requirements as expressed in [8]. In
ton of	must be possible to gradually deploy the NSIS QoS solution on
concrete	existing networks. This high-level requirement yields
	consequences for the QoS signaling in as well access as core networks.
ADSL	First it is noted that access networks (UMTS, Packet cable,

access, etc) may use their own specific QoS signaling protocols for quite some time. Moreover, in current networks, QoS signaling in access may be very technology dependent, while for IP core networks we need definitely a technology independent protocol. This may involve mapping requirements and the draft discusses particular features of this mapping and the actual place in the network where this mapping can take place.

Thus, in a first phase, access networks may still use their own QoS entity at the edge of the network. However, in a second phase the NSIS protocol may also be supported by the end-host and used in the access networks to setup QoS reservations. Hence, this provides an evolution scenario for gradual deployment of the NSIS protocol in

Second the QoS technology used by most operators in IP core networks is Differentiated Services (DiffServ). It should be possible to deploy the QoS solution onto these networks without upgrading the routers. This may require the compatibility of in-band and out-ofband signaling because, for pure DiffServ networks, the QoS signaling can not be done on the data-path. This draft presents one way of doing this for scenarios involving one IP core and several access networks. It presents a two-step approach in order to support Buchli et al. Informational - Expires August 2002 3 QoS signaling architecture, interfaces February 2002

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end-user Quality of Service (QoS). First step is to pre-

provision	
	bandwidth pipes in the transport network defined by means of
e.g.	
	DiffServ Service Level Specifications (SLS). These are e.g.
IP VLLS	with statistical OoS quarantees, such as edge-to-edge delay
and	nich otatiotioai (oo gaalantooo, oach ao oago to oago aoia)
	packet loss bounds, for traffic aggregates. The second step
is then	
ucor Occ	to admit (micro)-flows in the bandwidth pipes based on the
user yos	request As a consequence of this two-step approach the
dynamic	
	per-flow QoS signaling can be simplified and kept out of the
	(DiffServ) routers.
	The outline of the draft is as follows
	The terminology is defined in section 2. Section 3 summarizes
the	
	main signaling requirements for the QI-to-QC interface and
makes the	companies with [0]. Conting 4 presents the two was speed
while	comparison with [8]. <u>Section 4</u> presents the two use cases
WILLE	section 5 draws conclusions and proposes a more general
signaling	
	architecture. The requirements on the signaling protocol and
the	
are	parameter groups are discussed in <u>section 6</u> . The Conclusions
ui o	presented in the final section.

# Terminology

DiffServ	The terminology used in this draft is in line with the
	terminology [10] and the NSIS requirements draft from Brunner
et al.	[8]. The relevant terminology is repeated here and some new
terms	are introduced. See e.g. figure 3 for a position of the
relevant	functional entities in the network.
	Host: end-user entity where the application is running that
requires	QoS to another host or server. The end-user service, which
should be	supported end-to-end by the network, is supposed to be a
dynamic QoS	demanding service such as voice, video, etc.

bv	Access Gate (AG): functional entity that enforces QoS policy
	policing and traffic conditioning per microflow. In this context, a microflow is understood as the IP packet
flow	carrying the payload of the actual service to be supported in
the	network (e.g. voice) and may be formally defined as e.g. the
IntServ	E tuple A microfley is always understand to be and to and
i.e.	5-tupie. A microriow is always understood to be end-to-end,
	host-to-host.
Services	Edge router (ER): router at the edge of a Differentiated
router	(DiffServ) capable network. It is a common DiffServ edge
	enforcing QoS policy by policing and traffic conditioning
LTATILC	aggregates and DiffServ Service Level Specifications SLS, see
e.g.	[8][9].
parameters and	According to DiffServ an SLS is "a set of technical
	their values, which together define the service, offered to a traffic stream by a (DiffServ) transport network". In this
context,	an SLS is the technical specification of a long-lived QoS
service	such as an IP VLL or an assured rate bandwidth pipe. The geographical scope of an SLS is single domain, i.e. edge-to-
edge.	The edge-to-edge statistical QoS guarantees, such as maximum
delay,	
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	are provided to the in-profile packets of the traffic
aggregate	stream defined by the SLS. For a detailed description of
SLSs, see	[9]. For its support and implementation in a DiffServ network
by	mann of Dor Hon Pohaviora (DUD) and Dor Domain Dehaviora
(PDB), see	means of Per Hop Benaviors (PHB) and Per Domain Benaviors
	[8].

	Network Management System (NMS): common network and element management platform, configuring the edge and core routers of
a	single IP network by e.g. the SNMP or COPS protocol. In this
context	
configuration	the NMS is the functional entity responsible for the
technically	and provisioning of long-lived QoS services, which are
connicarry	described by SLSs.
ôresponsible for	QoS Controller (QC): the functional entity that is
	interpreting the signaling carrying the end-user service QoS parameters, optionally inserting/modifying the parameters
according	to local network QoS management policy, and invoking local
QoS	provisioning mechanismsö [8]. More specifically in this
context the	OC performs per-microflow admission control for a single TP
domain.	The OC manages or "owne" (part of) the pre provisioned
network	The QC manages of owns (part of) the pre-provisioned
	resources, which are described by a set of Service Level Specifications. These SLSs provide statistical edge-to-edge
QoS	guarantees.
	QoS Initiator (QI): the functional entity ôgenerating the QoS request for traffic flow(s) based on user or application requirements and signaling them to the network as well as
invoking	local OoS provisioning mechanisms. This can be located in
the end	iocai dos provisioning mechanisms. This can be iocated in
takes	system, but may reside elsewhere in networko [8]. This draft
locations	the same viewpoint and discusses use cases for different
	of the QI. The QI is in any case an ôNSIS-speakerö, i.e. it implements the (to-be-defined) NSIS protocol and signals a
QoS	request to the OC. In case the OI is situated at the network
edge	
(access	(access-core), the vi should perform a mapping from the
towards	technology dependent) user QoS request to the QoS request
	the QC.

# <u>3</u>. Overview of signaling requirements

for NCTC	The main purpose of this document is to derive requirements
TOP NSIS	protocol interfaces that are identified from use cases. In
this	
h	section, we give an overview of the requirement list. The requirements are primarily derived for the QI-QC interface
but it	seems advantageous that they be reused (partly) for the QC-QC
clarified	interface. Each requirement will be put into context and
	in subsequent sections.
be fast	Apart from the generic requirements that the protocol should
	and lightweight, it
	- must support both in-band and out-of-band signaling - must support priority
	- must allow notification of (QoS) failure
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	- must decouple the messaging mechanism from the information
being	signaled
	- should be independent of core transport technology - should avoid extra complexity due to (optional) multicast
support	- should be optimized for interactive multimedia services
	- should support different service levels for a service class - the mobility aspects should have no impact on the NSIS
protocol	
	Two considerations are left as open issues:
	<ul> <li>the protocol may be stateful or stateless</li> <li>it should consider allowing grouping of microflows</li> </ul>
	<ul> <li>the protocol may be stateful or stateless</li> <li>it should consider allowing grouping of microflows</li> <li>Related work in the NSIS group [8] states that:</li> <li>"Specific mechanisms for OoS provisioning within a domain/</li> </ul>
subdomain	<ul> <li>the protocol may be stateful or stateless</li> <li>it should consider allowing grouping of microflows</li> <li>Related work in the NSIS group [8] states that:</li> <li>"Specific mechanisms for QoS provisioning within a domain/</li> </ul>
subdomain	<ul> <li>the protocol may be stateful or stateless</li> <li>it should consider allowing grouping of microflows</li> <li>Related work in the NSIS group [8] states that:</li> <li>"Specific mechanisms for QoS provisioning within a domain/</li> <li>are not considered. It should be possible to exploit these mechanisms optimally within the end to end context.</li> </ul>
subdomain Consideration of	<ul> <li>the protocol may be stateful or stateless</li> <li>it should consider allowing grouping of microflows</li> <li>Related work in the NSIS group [8] states that:</li> <li>"Specific mechanisms for QoS provisioning within a domain/</li> <li>are not considered. It should be possible to exploit these mechanisms optimally within the end to end context.</li> <li>how to do this might generate new requirements for NSTS</li> </ul>

in thic	The two-step approach for which requirements are documented
	draft achieves this goal of exploiting the QoS intra-domain provisioning solution. In this way, it inherently addresses
some of	the requirements in [8]: - it avoids duplication of sub-domain signaling - it provides independence of the underlying technology - it reuses existing QoS technologies and does not impact
existing mobility	infrastructure during deployment - it decomposes the path which is essential to provide
to be in	It also emphasizes some other requirements in [8]: - QoS signaling and QoS Controllers must not be constrained
flow	the data path - the network is expected to handle 2 QoS granularities: per- and per-trunk or per-class
amount	Note, however, that an important difference is that per-flow signaling can be considered in the core because the required
	of signaling information is strongly reduced by the two-step approach.
requirements in	Finally, it allows to relax some of the signaling
to be	- the info that is passed as signaling content does not have
domain in	the appropriate local QoS.
(e.g.	- communication between QoS administration functionality traffic engineering) and QI is not needed.
function and	- it is not necessary to map opaque application-dependent information in the message. The QI provides a mapping
	the end-host to end-host alignment can be obtained at the application layer.
<u>4</u> .	Use cases
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	In [8] the concepts of QoS Initiator (QI) and QoS Controller
(QC)	
	were introduced. Here we analyze these functions for two
concrete	
	use cases. In 3.1 a scenario of interconnecting PSTN trunking gateways is discussed. In this case the OI and OC are
integrated in	gaconajo io aisoacooar in chio caco cho qi ana qo aro
integrated in	one entity. In 3.2 a possible scenario is shown for providing
end-	
	to-end QoS with UMTS access networks. In this case the QI and
QC are	
	two separate entities. In both cases the QI function is not
part of	
	the end-host.

## **4.1** PSTN trunking gateway scenario

DCTN	This section discusses an example scenario where a number of
FSTN	trunking gateways are interconnected by a QoS enabled IP
transport	notwork. The DCTN concists of a notwork corruing (4 kb/c
circuits.	network. The PSIN consists of a network carrying 64 kb/s
	It is connected to the Edge Router (ER) of the IP network by
a Media	GateWay (MG). The PSTN call signaling is transported over a
separate	
a	SS7 signaling network. This signaling network is connected to
u	Media GateWay Controller (MGC). In the IP network the SS7
signaling	is carried with the ISUR/SIGTRAN protocol [11] The MGC
controls the	is carried with the isorystonan protocol [ii]. The Moc
	MG with the Megaco protocol [5].
	In figure 1 the example scenario is shown for two media
gateways,	is a trupling gate ways. The Network Menagement System (NMC)
is the	1.e. trunking galeways. The Network Management System (NMS)
	entity that is able to provision bandwidth pipes in the
transport	network.
++	++ ISUP/SIGIKAN ++

| SS7 network |------| MGC |------|



Figure 1: PSTN trunking gateway scenario

Resources should be pre-provisioned between the media is done by establishing a mesh of bandwidth pipes, with guarantees, between the trunking gateways. The capacity of the pipes of e.g. Erlang calculations in order to provision for a small call blocking

Buchli et al. Informational - Expires August 2002 7 QoS signaling architecture, interfaces February 2002 and requirements The MGC receives the call setup signaling and should perform permicroflow admission control onto the pre-provisioned resources. The MGC determines the rate of the microflow from the type of codec that is used in the MG. The resource request is a number of 64kb

channels	and hence, a simple counter to keep track of the used
capacity of	the bandwidth pipe could be sufficient to perform admission
control.	
canacity is	The MGC should have the information about the capacity of all bandwidth pipes and should block call setups when the
capacity is	completely used. The capacity of the bandwidth pipe may be negotiated by an off-line process via paper contracts or by
an	automated process with an SLS negotiation protocol.
MGC acts	In this scenario the MG has the role of Access Gate and the
nre-	as the QoS Controller, performing admission control in the
may	provisioned bandwidth pipes. The QoS Initiator functionality
information by	reside in as well the MG as in the MGC, exchanging
implementation of	the MEGACO protocol. This depends on the concrete
traffic	MG and MGC. In any case the codec type must be mapped onto a
trattic	descriptor, which is then used for the admission control of
LIIE .	micro-flow into the bandwidth pipe.
(owning	In this scenario there may be a separate network provider
(owning	the transport network and NMS) and voice service provider
	the MGs and the MGC). Both legal entities have a service
describes the	agreement (SLA) and the technical part, i.e. the SLS,
describes the	mesh of bandwidth pipes between the MGs. The existence of
that	is shown as a line between MGC and NMS in figure 1. For more details, see <u>section 5.2</u> ôQC-to-NMS interfaceö. Remark also
that	multiple service providers may be active on the same physical network through SLAs with the network provider.

# **<u>4.2</u>** UMTS access scenario

The UMTS access scenario is shown in figure 2. The  $\ensuremath{\mathsf{Proxy-Call}}$ 

State

Control Function/Policy Control Function (P-CSCF/PCF) is the outbound SIP proxy of the visited domain, i.e. the domain where the mobile user wants to set-up a call. The Gateway GPRS Support Node (GGSN) is the egress router of the UMTS domain and connects the UMTS access network to the Edge Router (ER) of the core IP network. The P-CSCF/PCF communicates with the GGSN via the COPS protocol [4]. The User Equipment (UE) consists of a Mobile Terminal (MT) and Terminal Equipment (TE), e.g. a laptop.

+----+ +-----+ P-CSCF |-----> SIP signaling / +----+ / SIP : : +----+ NSIS +-----+ : | PCF |------| QoS Controller | : +----+ +---+

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:	:	
:	: COPS	
:	:	
++	++	++
UE	GGSN	ER
++	++	++

Figure 2: UMTS access scenario

	In this scenario the GGSN has the role of Access Gate.
According to	
	3GPP standardization, the PCF is responsible for the policy-
based	
	control of the end-user service in the UMTS access network
(i.e.	
	from UE to GGSN). In the current UMTS release R.5, the PCF is
part	
	of the P-CSCF, but in UMTS R.6 the interface between P-CSCF
and PCF	
	may evolve to an open standardized interface. In any case the
PCF	

has all required QoS information for per-flow admission control in the UMTS access network (which it gets from the P-CSCF and/or GGSN). Thus the PCF would be the appropriate entity to host the functionality of QI, initiating the "NSIS" QoS signaling towards the core IP network. The PCF/P-CSCF has to do the mapping from codec type (derived from SIP/SDP signaling) to IP traffic descriptor. SDP extensions to explicitly signal QoS information [7] are useful to avoid the need to store codec information in the PCF and to allow for more flexibility and accurate description of the QoS traffic parameters. The PCF also controls the GGSN to open and close the gates and to configure per-flow policers, i.e. to authorize or forbid user traffic. The QC is (of course) not part of the standard UMTS architecture. However, to achieve end-to-end QoS a QC is needed such that the PCF can request a QoS connection to the IP network. As in the previous example, the QC could manage a set of pre-provisioned resources in the IP network, i.e. bandwidth pipes, and the QC performs per-flow admission control into these pipes. In this way, a connection can be made between two UMTS access networks, and hence, end-to-end QoS can be achieved. In this case the QI and QC are clearly two separate entities. This use case clearly illustrates the need for an "NSIS" QoS signaling protocol between QI and QC. An important application of such a protocol may be its use in the inter-connection of UMTS networks over an IP backbone.

#### 5. General architecture

This section proposes a QoS reference architecture

generalizing the	examples discussed above. The architecture encompasses the
inter-	connection of any type of (layer two) access networks with an
IP	connection of any type of (layer two) access networks with an
	backbone and provides QoS to any type of (uni-cast) end-user services (i.e. not only telephony services). The extension of
the	architecture to multiple IP backbones, with multiple OCs on
the end-	to ond signaling nath is for further study
	to-end signating path, is for further study.
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	In 4.1 the architecture is presented. The different signaling
NSIS	interfaces are identified and discussed in 4.2. In 4.3 an
networks.	evolution scenario is discussed with regard to access
<u>5.</u>	<u>1</u> Signaling architecture
	The reference architecture is shown in figure 3. In this architecture the host requests QoS to the QoS Initiator,
which in	
	turn contacts the OoS Controller. The functional entities are
shown	turn contacts the QoS Controller. The functional entities are
shown For the	turn contacts the QoS Controller. The functional entities are separately but they may be located in the same physical box.
shown For the single lines	turn contacts the QoS Controller. The functional entities are separately but they may be located in the same physical box. sake of simplicity the access networks are presented as
shown For the single lines	turn contacts the QoS Controller. The functional entities are separately but they may be located in the same physical box. sake of simplicity the access networks are presented as between host and Access Gates.
shown For the single lines	<pre>turn contacts the QoS Controller. The functional entities are separately but they may be located in the same physical box. sake of simplicity the access networks are presented as between host and Access Gates. ++ 3 NSIS ++ NSIS ++ +-  QI    QC    QI  -+ / ++ ++ ++ \</pre>
shown For the single lines	<pre>turn contacts the QoS Controller. The functional entities are separately but they may be located in the same physical box. sake of simplicity the access networks are presented as between host and Access Gates. ++ 3 NSIS ++ NSIS ++ +-  QI    QC    QI  -+ / ++ ++ ++ ++ \ / : : : \ 1 / : : 4 : SLS IF : \</pre>
shown For the single lines	<pre>turn contacts the QoS Controller. The functional entities are separately but they may be located in the same physical box. sake of simplicity the access networks are presented as between host and Access Gates. ++ 3 NSIS ++ NSIS ++ +-  QI    QC    QI  -+ / ++ ++ ++ ++ \ / : : : \ 1/ : 4 : SLS IF : \ / : ++ :</pre>
shown For the single lines	<pre>turn contacts the QoS Controller. The functional entities are separately but they may be located in the same physical box. sake of simplicity the access networks are presented as between host and Access Gates.</pre>



Figure 3: QoS signaling interfaces and functional

entities

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The architecture identifies at least three roles, i.e. the end-user, the service provider (SP) and the network provider (NP). The NP is the owner of the IP transport equipment. The SP naturally provides end-user services and may or may not be the same entity as the NP. For example the SP could be an UMTS mobile operator, leasing transport capacity from an IP Network Provider. The leased capacity inter-connects the Access Gates of the SP and is formalized by a SLSs, which are part of a Service Level Agreement between NP and SP (see section 5.2 ôQC-to-NMS interfaceö for more details). The IP network is DiffServ enabled and therefore capable of providing e.g. IP virtual leased line services. These IP VLLs are specified by DiffServ Service Level Specifications (SLSs), which are the technical part of the SLA. QoS provisioning for individual flows is done by a two-step approach. First step is to provision the capacity in the network by provisioning bandwidth pipes between the ingress and egress points of the IP network by means of SLSs. The second step is to perform Buchli et al. Informational - Expires August

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admission control for microflows, i.e. checking whether they still fit in the bandwidth pipe. This admission control function is done by the QoS Controller.

The end-user QoS provisioning is described in detail below. Steps 1) and 2) are the pre-provisioning steps for aggregate bandwidth pipes (SLS). Steps 3) and 4) are the per-microflow signaling and admission control steps.

1) The QoS Controller requests one or more bandwidth pipes
(i.e.
 virtual leased lines) to the NMS. These bandwidth pipe IP
services
 are specified as SLSs and are requested over an SLS interface
or
 they are negotiated off-line, resulting in a paper contract
SLA (in
 case NP and SP are distinct legal entities). The capacity of
the
 bandwidth pipes is based on some kind of traffic prediction
process.
 The SLSs are stored in databases in the QoS Controller and

2) The NMS triggers a traffic management process in order to provision the required resources (SLSs) in the network. This may involve reconfiguring one or more network elements. The traffic conditioning block in the edge routers are configured to police the bandwidth pipes. Thus, the traffic is policed on an aggregate base.

3) The application (e.g. VoIP) at the end-host, requiring a connection with QoS guarantees to another host or server, signals the QoS request to the QoS Initiator. This signaling may be access technology dependent. The QoS initiator performs the mapping to a technology independent format and signals the QoS request to

the QoS

Controller by the NSIS protocol.

	4) The QoS Controller performs admission control for the QoS request. It determines whether sufficient capacity is
available in	the bandwidth pipes that are defined by the SLSs. The QC will
return	an admit or reject message. Note, that this step does not
involve admitted police	any configuration of network elements. If the flow has been
	the QoS Initiator will configure the Access Gate in order to
	the microflow.
distinction	This end-user QoS provisioning approach provides a clear
	between the provisioning of resources in the transport
network and	the admission of per-microflow QoS requests. The per-flow QoS signaling can therefore be kept simple since the complexity
resides	mainly in the resource provisioning in the network and
specification	of the bandwidth pipes (i.e. SLSs). The provisioning may be
static	or semi-dynamic. The provisioning is anyhow already in place
when	the per-flow QoS request arrive.
	This two-step approach is also visible in the way the traffic
15	policed. The edge router polices per SLS (bandwidth pipe),
and	hence, on aggregated traffic. The Access Gate polices per-
microflow.	The main point here is that the DiffServ network is not
(required to	be) per micro-flow aware. The DiffServ network operator only
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	provides QoS guarantees to the (SLA/SLS contracted) long-term aggregate IP services such as IP virtual leased lines.

Above we made abstraction of the QoS class and QoS parameters

to be signaled. This is discussed in more detail below, but it is instructive to make the following key observation at this point. The main objective is to keep the NSIS signaling protocol between QI and QC as simple as possible, certainly if it should be extended to QC-to-QC inter-domain scenarios. Basically, the information to be signaled is an indication of the QoS class plus a required throughput R (peak rate, token rate, etc) for this particular QoS class. Indeed, provided the QoS class is determined by other means, the required throughput is the main parameter needed by the QC to be able to perform per-flow admission control (i.e. answering the question whether there is still enough capacity in the QoS pipe SLS for admitting e.g. R bandwidth units). We argue that there is no need to signal delay values in the NSIS protocol (interface 3), because the statistical delay bounds are already known and provided by the SLSs. If the QC admits the request for R bandwidth units, then the service will enjoy the delay bounds guaranteed by the SLS. The remaining question is whether this approach can deal with several service (QoS) classes. Suppose for example that there are two QoS classes ôGoldö and ôSilverö. This could e.g. be used for the offering of voice services with different quality. Another example is to use the Gold QoS class for real-time, delay-sensitive services and the Silver QoS class for elastic, non-delay sensitive services. The latter only require a throughput guarantee. How is this handled in the two-step approach described above? First step: the pre-provisioning. The SLSs describing the

bandwidth pipes between the AGs may or may not contain edge-to-edge delaybound guarantees, corresponding respectively with gold and silver type of services. The Gold and Silver SLSs are realized by respectively the DiffServ Virtual Wire PDB and Assured Rate PDB. Second step: per-flow signaling. Clearly the signaling between host and QI (interface 1) must indicate whether the requested service is gold or silver. The QoS class could also be implicitly derived from the type of service (e.g. voice). Besides the QoS class the user must at minimum also signal the required throughput. In any case, the QI knows the appropriate QoS class and the required throughput. What remains to be decided is what information is signaled between QI and QC. If the same QC is allowed to manage as well Gold as Silver SLSs, then the QI needs to signal the required QoS Class. If a QC only manages one type of SLSs, corresponding with one 00S class, then the QI decides (based on QoS class information) which QC Buchli et al. Informational - Expires August 2002 12 QoS signaling architecture, interfaces February 2002 and requirements he has to request resources and signals (only) the required throughput. It is for further study to decide whether both approaches should be possible and able to inter work.

#### **5.2** Protocol interfaces

5.2.1 Host to QoS Initiator

The host to QoS Initiator protocol interface will in most

cases

depend on the access technology that is used. Due to the variety of access QoS technologies it is to be expected that there will not be one single protocol used over this protocol interface. The QoS Initiator is the entity that triggers the actual QoS setup in the core network. There are several possibilities how the host can trigger the QoS Initiator.

1) The QoS Initiator may be integrated in a web-host or an outbound SIP proxy. In the first case the end-user may e.g. use a webpage in order to specify the service he/she would like to use. The web host may then initiate a QoS connection. In the latter case, the host may piggyback the QoS information on the session setup signaling. More precisely, QoS information may be carried in SDP [7] and may be interpreted by the SIP proxy, which will trigger the QoS setup in the network.

2) The host uses an access specific layer 2 or 3 protocol. This is e.g. an RSVP-derived protocol for PacketCable networks and the Packet Data Protocol (PDP) for UMTS networks. For xDSL broadband access a mechanism based on ATM Virtual Connections (VC) maybe used. The AG intercepts this QoS signaling and forwards it to the QoS Initiator. In this way the access specific QoS signaling is coupled to the generic QoS setup in the core.

This protocol interface is within the scope of NSIS in the sense that existing access signaling protocols should be assessed whether they contain the minimum set of parameters that are required at the QoS Initiator in order to map them to the generic signaling protocol between the QoS Initiator and the QoS Controller. Of course,

the parameters	first step should be to specify this minimum set of required for the generic signaling protocol.
policers. required marking	<pre>5.2.2 QoS Initiator to Access Gate The protocol interface between the QI and the AG is used to configure the AG such that it correctly installs per-flow In order to configure the policer a flow identifier is (e.g. five-tuple) and a traffic descriptor (e.g. token bucket parameters). Optionally an indication for DiffServ packet may be signaled (i.e. the DiffServ Code Point value).</pre>
2002 February 2002 MIDCOM [13] of	Buchli et al. Informational - Expires August 13 QoS signaling architecture, interfaces and requirements This protocol interface may be e.g. COPS [4] or a future protocol. Hence, this protocol interface is outside the scope NSIS.
generic in responsible for this NSIS.	5.2.3 QoS Initiator to QoS Controller (NSIS) The protocol interface between the QoS Initiator and the QoS Controller is discussed in <u>section 6</u> . This protocol is the sense that is technology independent. The QI is mapping the access technology dependent user QoS request on protocol. This protocol interface is certainly within the scope of
a	5.2.4 QoS Controller to Network Management System (NMS) A Service Level Agreement (SLA) is a legal agreement between customer and a provider. The technical part of the SLA is

called a	
and	Service Level Specification (SLS). The SLS specifies capacity
anu	QoS guarantees between one or more ingress and egress points
of a	
reliability of	network. The SLS also specifies the availability and
	the bandwidth service. The services specified in an SLS
usually stay	in place for a long duration (e.g. days or months) and their
setup	in place for a long duration (e.g. days of months) and their
and the	(time between the request of the service from the customer
and the	availability) will not be real-time. The resources needed to
fulfill	
In case	the SLS may be provisioned by means of traffic engineering.
	the IP network is a DiffServ domain, the SLS may be
implemented with	a PDB [6] e g a virtual wire or assured rate PDB
automate this	Remark that it is not required for the architecture to
	interface. Indeed the SLA may be negotiated off-line yielding
full	static SIS nines between the Access Gates. It may however
evolve to	static sis pipes between the Access dates. It may nowever
	an automated, (to-be-standardized) interface.
	It is argued that automation and standardization of this SLS
First	interface may yield two key advantages for QoS provisioning.
FIISL,	it may be used to semi-dynamically negotiate SLSs. For
example, if	
AGs, the	the QoS controller has to block too many calls between two
	QC may trigger the NMS for more resources on a dynamic basis.
	Second, the interface may be used to exchange monitoring information. In other words, the NMS may send information
about e.g.	· · · · · · · · · · · · · · · · · · ·
specified by	the current traffic load in the bandwidth pipe that is
Spectried by	the SLS. The monitoring information applies to the traffic
aggregate	SISS The OC may use this monitoring information to cross
check	SESS. The QC may use this monitoring information to cross
	whether the currently admitted flows (and their throughput)
pipe SLSs.	Corresponds with the actual training road in the bandwidth
	An SLS template has been specified by the European IST-
project	

Tequila [9] in order to facilitate for both functions. Finally note that in figure 3 the SLS interface is shown as a line between the QC and NMS. This is a somewhat simplified view because Buchli et al. Informational - Expires August 2002 14 QoS signaling architecture, interfaces February 2002 and requirements in practice, the service provider owning the QC will also dispose of an NMS for managing his equipment (e.g. Access Gates). Thus an SLS interface will rather be implemented between two NMSÆs of providers. These NMSÆs each have their SLS-database and the QC has access to the NMS of the service provider for executing the policybased admission control decision. This protocol interface may be in scope of NSIS. 5.3 Evolution scenario In the previous section it was assumed that the end-host and QI were two separate entities. This is because each type of access network has its own QoS signaling protocol. The QI couples the access dependent QoS signaling with the generic NSIS signaling in the core (i.e. between QI and QC). Hence, in the short/medium-term the NSIS protocol will be used between the QI and QC and an access technology dependent protocol will be used between the host and the QI. However, once an NSIS protocol has been specified and deployed between QI and QC the access networks may gradually start to adopt NSIS signaling. This implies that the QoS Initiator becomes integrated in the end-host and that the NSIS protocol is also used to setup QoS in the access. Of course, this is an evolution scenario

access	since there is a large installed base of cable, UMTS, xDSL
	networks only supporting their own QoS signaling methods.
	Hence, in the long-term the NSIS signaling protocol may be
supported	by the end-host (acting as QoS Initiator) and may also be
used for	QoS signaling in the access network, realizing effectively
end-to-	end (NSIS) QoS signaling.

6. Requirements on the QoS Initiatorûto-QoS Controller interface Per-flow QoS requests are mapped onto an SLS. Hence, most of the complexity resides in the specification and provisioning of SLSS. This results in a small set of requirements for the end-user QoS signaling.

The QoS Initiator must map the parameters from the host-to-QI interface on the QoS Initiator-to-QoS Controller (NSIS) protocol.

•

This section discusses the signaling requirements and parameter groups that need to be signaled.

### <u>6.1</u> Signaling requirements

	1) The protocol should be lightweight.
	The required processing power and memory consumption per $\ensuremath{\mathtt{QoS}}$
request	
	should be very small at the QoS Controller such that large
amounts	
	of reservation requests can be processed per time unit. The
protocol	
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	can be lightweight since the complexity resides in the pre- provisioning of resources by means of SLSs.

2) The time to setup a QoS connection should be constrained

to one or a few round trip times. This may be necessary for a telephony application because this requires a small call setup delay. Short set up times can be achieved by the two-step approach discussed earlier in this draft, i.e. pre-provision bandwidth pipes by means of SLSs and map flow in these bandwidth pipes. 3) Support of priority A minimal support of priority and preemption in case of congestion may be needed in the signaling or in the class description. 4) Immediate notification of QoS failure The signaling must allow the users to be notified in case of QoS failure or violation. This notification must be immediate if no local recovery action is taken. The notification should occur when local recovery actions are taken. This requirement is due to the high reliability of the service that needs at least to make the user know in case the QoS is no more guaranteed. 5) Both in-band and out-of-band signaling should be supported. This implies that the QoS Initiator and QoS Controller may not be located on the data path of the media flow. See e.g. the UMTS use case. The main advantage of out-of-band signaling is that it avoids the need to upgrade (edge) routers with e.g. the NSIS protocol. Indeed the QCs can be deployed on existing (DiffServ) IP networks. In other words, the network needs only to provision bandwidth pipes (e.g. by means of DiffServ PDBs) while the QoS Controller performs per-flow admission control into these pipes and processes the per-flow (NSIS) signaling. Therefore, the NSIS protocol MUST allow for interworking between both in-band and out-of-band signaling approaches for (gradual) deployment reasons.

6) The protocol should be independent of core transport technology as opposed to the access part where the transport and QoS are technology specific. Because of this there is a need for interworking between the QoS in the access network with the QoS in the core network in order to offer end-to-end QoS (i.e. from host to host). 7) The signaling information should be independent from the protocol that carries it. Different protocols may be used but the semantics should be the same. The information semantics of the host-to-QI protocol must be mapped on a QI-to-QC protocol. This mapping should take place in the QoS Initiator. This couples the technology dependent signaling protocols in the access with a generic protocol in the core. Τn order to do this a minimal set of protocol parameters that need to be mapped should be specified. Buchli et al. Informational - Expires August 2002 16 QoS signaling architecture, interfaces February 2002 and requirements 8) Multicast consideration should not impact the protocol complexity for unicast flows. Multicast support is not considered as a priority, because the targeted interactive multimedia services are mainly unicast. For this reason, if considered in the solution, multicast should not bring complexity in the unicast scenario. 9) Effective support of unidirectional reservations Bidirectional reservations are considered as almost impossible in a multidomain configuration due to the unidirectional nature of IP. So

not out	bidirectionnal reservations are considered as exceptional if
	of the scope of the protocol.
	10) the mobility aspects should have no impact on the NSIS
In UMTS does	A QoS controller should not be affected by mobility issues.
	networks, the users has an anchor point in the GGSN, and thus
	not require mobility support.
	11) Optimization for interactive multimedia services The SIP/H.323 applications are foreseen as the main drivers
for end	to end QoS solutions. NSIS protocols should be designed in
order to	be optimised for such traffics.
	12) Support for different service levels The protocol should be able to support different service
levels for	a service class. This may, for instance, be used in relation
to	olympic service classes ("gold", "silver" and "bronze")
<u>6.2</u>	2 Requirements on protocol content
	The per-flow QoS requests are mapped onto the bandwidth pipe,
which	is specified by an SLS. These pipes may provide statistical
the	guarantees such as delay and packet loss bounds (depending on
	QoS class). In order to invoke per-flow QoS services the only parameter needed is a required rate, a means to identify the
data	path (mapping on SLS) and eventually a reservation
identifier.	
· ci	1) Microflow/reservation description The signaling should allow the request to describe the
and	whose QoS would be guaranteed by giving at least the source
and	destination IP addresses of the media flow. In case the QC is stateful (per microflow) there may be a need to include a
unique	
	reservation identifier (e.g. QI identifier+counter) such that

easily	identified in the QC.
traffic parameters	2) Traffic descriptor The required peak rate must be signaled. Optionally the
	parameters may be expressed in terms of token bucket
	(similar to the TSpec in RSVP).
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	and requirements
<u>!</u>	<u>6.3</u> Open issues
	Two points are left as open issues:
	1) The protocol may be stateful or stateless. Because of the two-level approach, statefulness needs to be considered both for the pre-provisioned pipes and for the microflows.
the NMS	Clearly, per QoS-class state will need to be maintained by
always	and the QC; so the (long-term) bandwidth pipe reservations
aiways	should be stateful.
maintained	It is not clear yet whether per microflow state should be
	A stateful approach allows simple implementation of per-flow notification of QoS violation and priority/preemption. This
may be	feasible in some parts of the network because the two-step
approach	strongly reduces the state information that needs to be kent
Still,	in core networks the number of recorrections may be too large
to use	In core networks the number of reservations may be too large
or	a stateful approach. A stateful approach can keep hard-state
soft_state	soft-state. Regardless of the fact whether hard-state or
Sort-State	is used, we see a possible need for explicit refresh/feedback messages that may be used for teardown and/or performance notification (performance level and/or violation). Note that

these messages may be per-flow or per-class. A stateless approach may simply decrement/increment capacity on preprovisioned bandwidth pipes without keeping per-flow state. In this case, the information required for priority support and/or QoS failure notification may be implemented on a per-class basis. Note that in this case, only one setup message should be sent in order to avoid duplicate reservation. Notification messages should be clearly distinguishable as such in order to avoid unnecessary or unwanted allocation or deallocation of resources. 2) Grouping of microflows As a consequence of the optimization for the interactive multimedia services, the signaling should allow one unique request for several micro flows having the same origination and destination IP addresses. This is usually the case for multimedia SIP calls where the voice and video micro flows follow the same path. This grouping of requests allows optimization of the QoS processing. Note that this may be detrimental for the call setup time. The use of grouping for microflows may be restricted to teardown and/or notification messages when call setup time is a concern. 7. Security Considerations This draft does not identify other security aspects than those described in [8].

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and requirements

## 8. Conclusions

	Based on the use cases of an interconnection scenario of PSIN
	trunking gateways and an interconnection scenario between a
UMTS	
	access network and an IP core network, a general architecture
is	
	proposed and the different protocol interfaces where
identified.	
	These are between the:
	1) host and the Oos Initiator
	2) OoS Initiator and the Access Gate
	3) OoS Initiator and the OoS Controller
	4) OoS Controller and the Network Management System.
dependent	The QoS signaling in the access is usually technology
dependent.	However the OoS signaling in the core should be technology
	independent The signaling protocol requirements and the
narameter	independent. The signating protocol requirements and the
paramocor	groups to be signaled between the OoS Initiator and the OoS
	Controller where discussed in this draft.
	The proposed architecture involves two steps in QoS
provisioning:	
	1) Provisioning of bandwidth pipes between the ingress and
egress	nainte of the TD core network by means of CLCs. This involves
	points of the IP core network by means of SLSS. This involves
Sustem	configuration of network exements by a network Management
System:	
	2) Admission control of per-flow QoS request in the pre-
provisioned	2) Admission control of per-flow QoS request in the pre-
provisioned	2) Admission control of per-flow QoS request in the pre- bandwidth pipes. In other words, a functional entity in the
provisioned network	2) Admission control of per-flow QoS request in the pre- bandwidth pipes. In other words, a functional entity in the
provisioned network	2) Admission control of per-flow QoS request in the pre- bandwidth pipes. In other words, a functional entity in the checks if the usage of the bandwidth pipe between the ingress
provisioned network and	2) Admission control of per-flow QoS request in the pre- bandwidth pipes. In other words, a functional entity in the checks if the usage of the bandwidth pipe between the ingress
provisioned network and	2) Admission control of per-flow QoS request in the pre- bandwidth pipes. In other words, a functional entity in the checks if the usage of the bandwidth pipe between the ingress egress points of the network does not exceed the capacity
provisioned network and specified	2) Admission control of per-flow QoS request in the pre- bandwidth pipes. In other words, a functional entity in the checks if the usage of the bandwidth pipe between the ingress egress points of the network does not exceed the capacity
provisioned network and specified	2) Admission control of per-flow QoS request in the pre- bandwidth pipes. In other words, a functional entity in the checks if the usage of the bandwidth pipe between the ingress egress points of the network does not exceed the capacity in the SLS. Hence, this step does not involve any
provisioned network and specified configuration of	2) Admission control of per-flow QoS request in the pre- bandwidth pipes. In other words, a functional entity in the checks if the usage of the bandwidth pipe between the ingress egress points of the network does not exceed the capacity in the SLS. Hence, this step does not involve any
provisioned network and specified configuration of	2) Admission control of per-flow QoS request in the pre- bandwidth pipes. In other words, a functional entity in the checks if the usage of the bandwidth pipe between the ingress egress points of the network does not exceed the capacity in the SLS. Hence, this step does not involve any network elements.
provisioned network and specified configuration of	2) Admission control of per-flow QoS request in the pre- bandwidth pipes. In other words, a functional entity in the checks if the usage of the bandwidth pipe between the ingress egress points of the network does not exceed the capacity in the SLS. Hence, this step does not involve any network elements. The following recommendations are made towards the NSTS
provisioned network and specified configuration of	<pre>2) Admission control of per-flow QoS request in the pre- bandwidth pipes. In other words, a functional entity in the checks if the usage of the bandwidth pipe between the ingress egress points of the network does not exceed the capacity in the SLS. Hence, this step does not involve any network elements. The following recommendations are made towards the NSIS</pre>
provisioned network and specified configuration of working	2) Admission control of per-flow QoS request in the pre- bandwidth pipes. In other words, a functional entity in the checks if the usage of the bandwidth pipe between the ingress egress points of the network does not exceed the capacity in the SLS. Hence, this step does not involve any network elements. The following recommendations are made towards the NSIS group:
provisioned network and specified configuration of working	<pre>2) Admission control of per-flow QoS request in the pre- bandwidth pipes. In other words, a functional entity in the checks if the usage of the bandwidth pipe between the ingress egress points of the network does not exceed the capacity in the SLS. Hence, this step does not involve any network elements. The following recommendations are made towards the NSIS group:</pre>
provisioned network and specified configuration of working	<ul> <li>2) Admission control of per-flow QoS request in the pre- bandwidth pipes. In other words, a functional entity in the checks if the usage of the bandwidth pipe between the ingress egress points of the network does not exceed the capacity in the SLS. Hence, this step does not involve any network elements.</li> <li>The following recommendations are made towards the NSIS group:</li> <li>1) A first priority for NSIS should be the signaling</li> </ul>

	between the QoS Initiator and the QoS Controller. This is
completely	in line with the recommendation in [8].
200855	2) The protocol between the host and the QoS Initiator is
different	technology dependent. Therefore, NSIS should study the
	access signaling protocol and assess whether they contain the minimal set of protocol parameter groups (that have to be
defined in	step 1) If not changes may be proposed for these access
signaling	protocols.
ic used	3) The SLS interface between the QoS Controller and the NMS
is used	for SLS negotiation and for the exchange of SLS monitoring information. The SLS negotiation may be off-line by means of
a paper	contract or may be semi-dynamically signaled. The monitoring
aspect	Somerade of may be semi-aynamicarly signated. The monitoring
between the	of SLSs is very important and requires that the protocol
Thoroforo NSIS	NMS and the QC is able to exchange such information.
Ineretore, NSIS	may consider adding this signaling interface to their scope.
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