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Bandwidth and Quality on Demand for Multimedia Services: A Reality?

Emerging multimedia services are often bandwidth-demanding, delay-sensitive and mission-critical. Supporting such services in an IP network presents a challenge to connectivity and service providers for providing users with reliable bandwidth and end-to-end guaranteed service levels in an environment of finite resources. This challenge can hardly be met with existing QoS technologies since deployment requires a consistent configuration of a large number of widely distributed devices. Policy Based Networking (PBN), intended for allocating network resources based on centrally defined policies, has emerged as a technology to reach such goals. We show how PBN deals with provisioning network devices using easy-to-understand policy rules, while enabling connectivity and service providers to offer tailored services with bandwidth and QoS on demand.

The programme "Future Network Services" explores future network technologies enabling wired and wireless, fix and mobile broadband services. Novel broadband wireless technologies, such as WLAN, will strongly affect mobile and fixed network operators. Moreover, new wireless access technologies will support voice services, leading to threats for traditional, and opportunities for new voice services. Supporting such services requires a very flexible, economically operated, IP-based backbone network.
With its Innovation Programmes, Swisscom Innovations follows the objective of recognising the impact of technological developments early on, finding new business opportunities, promoting technical synergies, and developing concrete innovation proposals. Further, the expertise built up enables active engineering support of business innovation projects.

Residential broadband customers as well as corporate customers are asking more and more for multimedia services. For such services to work properly, access and core networks should be tuned to deliver reliable band-

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width and end-to-end guaranteed service levels (delay, packet loss and jitter). To keep the right level of QoS, core networks are generally over-dimensioned. Moreover, no specific intelligence is needed. However, a limiting factor exists in the access network where bandwidth is scarce. Over-designing access connections is neither viable nor scalable. This means that the scarce access bandwidth resource should be tuned per customer and per service.

In an environment of limited access resources and highly demanding services, intelligent resource allocation is a must. Policy Based Networking easily deals with this need. In addition, it enables bandwidth and QoS on demand. A customisation request, based on service type or allocated budget, is either issued from the customer or the service provider.

The purpose of this article is to investigate the ability of Policy Based Networking (PBN) technology for tuning and automating access resource allocation for residential broadband and corporate customers.

For corporate customers, PBN implements a set of policies that promote an organisation's business objectives by dictating how users, applications, and units can access and use network resources. This makes the network automatically aware of who is trying to do what. It correlates information about each user and the running application, taking into account three major aspects: security, business priorities and network characteristics. PBN can be implemented for Swisscom business customers and offered as an enhancement of the existing VPN services (LAN-I). The enhanced LAN-I service allows corporate customers to dynamically differentiate services, to personalise service profiles and to outsource policying.
Residential broadband customers should be able to choose various types of services, each one with its own bandwidth requirements. PBN ensures a proper bandwidth distribution between customers using different types of services. This is done through an automated and tailored configuration of broadband access links, based on service and customer budget.

Policy Based Networking: State of the Art

The IETF/Distributed Management Task Force (DMTF) policy framework has developed a Policy Based Networking (PBN) architecture [1] shown in figure 1. It consists of four elements:
- A Policy Management Tool (PMT)
- A Policy Information Base (PIB)
- A Policy Decision Point (PDP)
- A Policy Enforcement Point (PEP)

An administrator uses the PMT to define the policies to be enforced within the network. The PIB is used to store the policies generated by the PMT. In order to ensure interoperability across products from different vendors, information stored in the PIB must correspond to an information model specified by the IETF [2]. A PIB could be a network directory server accessed using the LDAP protocol [3]. The PDP is responsible for interpreting the policies stored in the PIB and communicating them to the PEP. The PEP can apply and execute the different policies. It uses the PDP to communicate with the repository. PEP and PDP may be in a single device or in different physical devices. Different protocols are to be

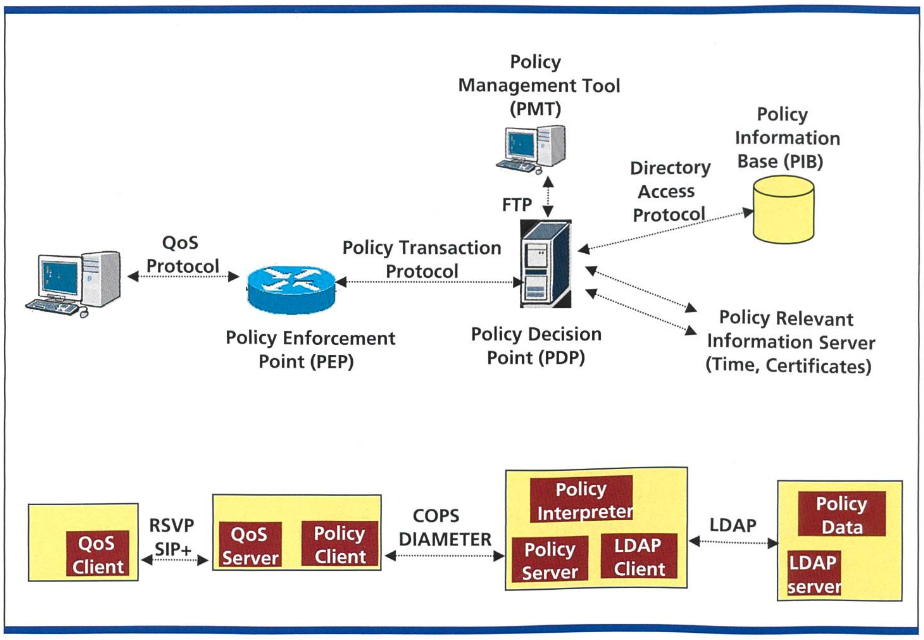

Fig. 1. Policy Based Networking Architecture.

used for various parts of the architecture, such as COPS [4] or SNMP for PDP–PEP communication.

PBN Service Opportunities

Opportunities in the Business Segment

In order to assist corporate customers in deploying applications, an intelligent network infrastructure is used to bind business policies to the allocation of network resources. As new applications emerge, generated traffic flows will compete for network resources. The relative resource priority of these applications should be defined. PBN implements a set of policies that fulfil business objectives by dictating how users, applications and units access and use network resources. Examples of policies can be seen in figure 2.

PBN can be implemented and offered to Swisscom business customers as an enhancement of the existing VPN services (LAN-I) as follows:

- Dynamic service differentiation: several application flows with different requirements in terms of bandwidth and QoS are sharing the link connecting LAN-I customers to the IPSS backbone. DiffServ is generally used to differentiate these flows, thus requiring a consistent and manual configuration of a large number of widely distributed devices. This is quite complex and error-prone. However, PBN can solve this issue with an automated, dynamic and centralised service configuration.
- Personalised service profiles: LAN-I customers use a service selection centre (e.g. a simple web site), part of the PBN framework, to subscribe to new services or to upgrade the existing one according to their present needs (e.g. bandwidth on-demand, service levels configuration for multimedia applications, etc). This corresponds to a self-controlled LAN-I service.
- Outsourced policing: As organisations implement new applications, the number of administration systems in the network increases. Network managers are faced with the increasingly difficult task of administering the network to manage user needs and the differing priority requirements of the applications. LAN-I customers can outsource policing functions to Swisscom in order to enforce its business policies for network resource usage and security rules (e.g. content filtering).

Rule 1: ERP and Sales applications receive highest priority
if (Application = ERP) or (Application = Sales)
then Priority = 4

Rule 2: VoIP
if (Application = VoIP) and
((User = executive) or (User = Sales))
then
One-Way-Delay < 400ms
MAX_BW < 64Kbps ; per call
MAX_AGGR_BW < 512Kbps ; for all calls

Rule 3: HTTP traffic from office
if (Application = HTTP)
and (User = Executive)
then
Up to 256Kbps: Priority = 3
Up to 0.5Mbps: Priority = 2
Else : Priority = 1

Rule 4: Other is basically best effort
if (Application = Other)
then Priority = 0

Fig. 2. Example of Business-Level Policies.

Opportunities in the Residential Segment

Currently, broadband wholesalers own the complete DSL access network equipment and focus on bit transport. On the other hand, ISPs own customers and are content and service aware. For complete service fulfilment with quality and prioritisation, both entities need to co-operate in order to define policies. These policies take effect on traffic prioritisation in the transport network.

Multimedia services generally require a 1Mbit/s pipe. Statically providing this amount of bandwidth per customer is neither scalable nor future-proof. Further, this approach is expensive for the wholesaler in terms of access capacity and results in high network upgrade cost compared to the potential revenues. Consequently, it will be expensive for the ISPs as well as for end customers.

Several potential interactive and bandwidth-demanding services are emerging on the broadband market, such as:

- Audio/Video on demand
- Gaming
- Recording/Archiving

Once the above-mentioned multimedia services have taken off, over-designing access pipes will no longer work. We recommend to implement a PBN framework which enables statistical multiplexing as well as *automated and tailored configuration of broadband access* links. PBN should be implemented in the broadband network as follows (figure 3):

1 The customer accesses a personalised web page to choose a service.

2 Once the customer has chosen a service, the PDP retrieves the policies associated with the customer and the service profiles. Since the wholesaler is responsible for allocating the suitable amount of

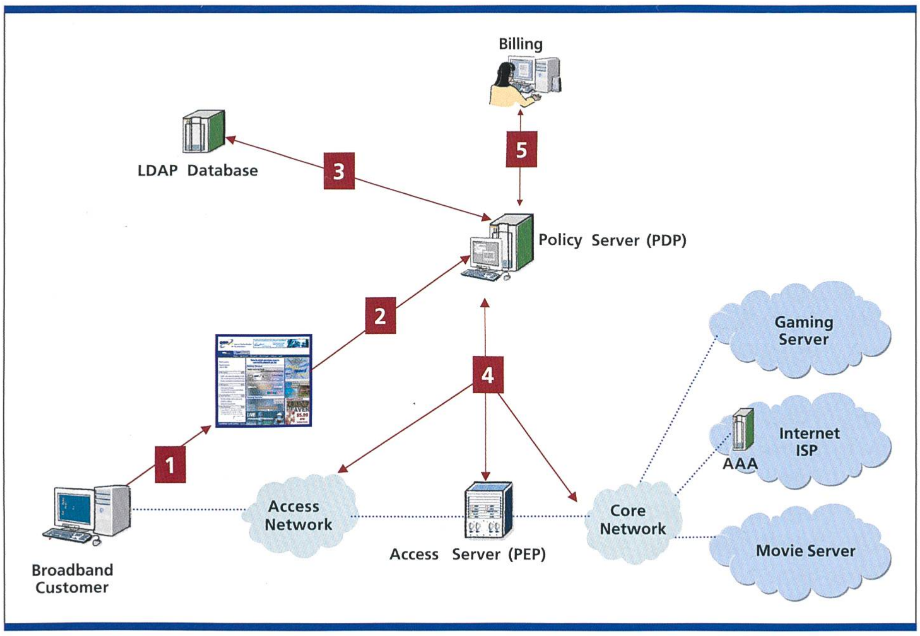

Fig. 3. Implementing PBN for Broadband Customers.

resources to the service flows and is aware of the network infrastructure, he should implement the PDP.

3 The PDP accesses the LDAP repository which stores all the service policies. An SLA has to be signed between the wholesaler and the ISP in order to define the resource allocation policies per service. The wholesaler knows the traffic characteristics of each service and the resources needed (bandwidth and QoS), so he can manage the policies on his own. This means that the PMT is located at the wholesaler side.

4 Once the policies are retrieved, the PDP downloads them on the different PEPs on the service path. The PEPs have to enforce the policies. The PBN architecture contains multiple PEPs.

5 The PDP gathers accounting data and sends them to the billing server.

Conclusions

A common attitude in networking is: "If it works, don't change it". This is due to the fact that a single change on an element may disrupt the whole network. However, this practice leads to static networks that can not fulfil the flexibility requirements of today's customers. A PBN approach could be an alternative that enables the support of new services in the evolving IP networks.

PBN components such as policy servers can automatically identify the various devices in the network and determine which QoS capabilities they support. Several protocols have been developed, such as COPS, to send the appropriate configuration information to the network devices, allowing them to efficiently provide feedback to the policy server regarding the state of the network. Feedback of this nature is an essential component for dealing with dynamic changes in the network since policy rules may need to be altered or added.

In this article, we briefly described the PBN architecture. Then, we introduced a short list of new service opportunities enabled by PBN, either in the business or in the residential market segment. Such opportunities could be enabled for the following reasons:

- Cost reduction: by increasing operational efficiency and reducing network management costs, operational resources are available to support new services.
- Dynamic provisioning: Network operators are able to automatically carve out and then tear down bandwidth as needed without disrupting other services.
- Router optimisation: SLAs which give priority to certain types of delay-sensitive traffic are needed. For instance, "Gold" service might cost more because network routers give priority to a customer's VoIP traffic. PBN supports business rules to allocate this service to those customers who have paid for the service. The network configuration policies then ensure that the Gold service does not adversely affect other deployed services that have higher priorities.

Outlook

An interesting model defining interactions between different players in the service chain has been introduced by the European project CADENUS [5]. The objective of this project is to define an integrated solution for the creation, configuration, and provisioning of end user services with QoS guarantees in Premium IP networks. The project defined a logical architecture which partitions the functionalities needed to realise such a framework in a few major packages: an Access Mediator (AM), a Service Mediator (SM), and a Resource Mediator (RM).

The AM allows unique access to customers independently of the technology involved at the transfer layer and to offer services to end customers. The SM provides the presentation of the service and the subscriptions, the contracts, client profile, and the access to the unitary service which has been chosen. The RM allows choosing the appropriate resources to support the service requests.

Through the use of the PBN technology, the proposed architecture enables service creation and configuration in a dynamic way by the appropriate linking of user-related service components to network-related service components.

As a next step, it would be interesting to map the existing structure of the Swisscom Group into the CADENUS framework and identify missing functionalities. As a result, recommendations could be given to satisfy the business and functional requirements for succeeding in the future premium IP services business. 6

Abbreviations

AM	Access Mediator
COPS	Common Open Policy Service protocol
DMTF	Distributed Management Task Force
LAN-I	Local Area Network Interconnect
LDAP	Lightweight Directory Access Protocol
PBN	Policy Based Networking
PDP	Policy Decision Point
PEP	Policy Enforcement Point
PIB	Policy Information Base
PMT	Policy Management Tool
RM	Resource Mediator
QoS	Quality of Service
SLA	Service Level Agreement
SM	Service Mediator
VoIP	Voice over IP
VPN	Virtual Private Network

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Zusammenfassung

Bandbreite und Qualität «on-Demand» für Multimediadienste – eine Realität?

Privatkunden mit Breitbandanschluss und Geschäftskunden sind zunehmend an Multimediadiensten interessiert. Damit diese Dienste zufriedenstellend funktionieren, müssen Zugangs- und Übertragungsnetze in der Lage sein, Bandbreite und definierte End-zu-End-Qualität zu garantieren.
Um eine bestimmte Dienstqualität sicherstellen zu können, wird das Fernnetz normalerweise überdimensioniert. Zudem wird keine spezifische Intelligenz benötigt. Dagegen stellt das Zugangsnetz mit seiner limitierten Bandbreite einen limitierenden Faktor dar. Überdimensionieren stellt hier keine Lösung dar und wäre auch nicht skalierbar. Vielmehr muss die Bandbreite hier als Ressource pro Kunde und Dienst optimiert werden.
Eine neue Technologie, «Policy Based Networking» (PBN), kann diese Aufgabe lösen. PBN erlaubt es, Netzressourcen gemäss zentral implementierten Regeln zu vergeben. Dieser Artikel zeigt, wie mittels der PBN-Technologie Netzwerkeinheiten durch leicht zu verstehende Grundsatzregeln versorgt werden. Dadurch erhalten Netzzugangs- und Dienstanbieter die Möglichkeit, Dienste mit angepasster Bandbreite und einer vom Kunden georderten Dienstqualität anzubieten.

FORSCHUNG UND ENTWICKLUNG

Ernüchternde US-Energiebilanz

Eine Studie der Cornell-Universität (Ithaka, NY) kommt zum Schluss, dass unter Nutzung aller bekannten erneuerbaren Energien weniger als 50% des amerikanischen Energiebedarfs ersetzt werden könnte. Und das zu einem hohen Preis: 17% des Territoriums müsste dafür aufgewendet werden. Weitere Ergebnisse der Untersuchung: Die Amerikaner stellen zwar nur 4% der Erdbevölkerung, emittieren aber 22% des Kohlendioxids weltweit. Der äquivalente Ölverbrauch in den USA beträgt rund 8000 Liter pro Jahr und Kopf. Kritisch wird in dieser Studie die Nutzung von Biomasse als erneuerbare Energiequelle gesehen. Die Forscher kommen zu der Ansicht, dass Biomasse nicht so umweltfreundlich ist, wie sie dargestellt wird. Rund 200 verschiedene chemische Stoffe entweichen dabei, von denen 14 sogar als Krebs erregend bekannt sind. Als einzigen Ausweg für eine langfristige Lösung der Energiefrage sehen die Autoren eine drastische Reduktion des Energieverbrauchs und argumentieren: «Andere hoch entwickelte Länder haben gezeigt, dass ein hoher Lebensstandard auch mit dem halben Energieverbrauch pro Kopf erreicht werden kann.»

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Die Comdex Fall verliert rapide an Bedeutung

Während sich die Münchner «Electronica» trotz der Krise in der Branche gut geschlagen hat, musste die traditionelle amerikanische Herbstmesse «Comdex Fall» in Las Vegas empfindliche Einbussen hinnehmen. Die alle zwei Jahre stattfindende Fachmesse «Electronica» hatte gegenüber dem Boomjahr 2000 einen nur leichten Rückgang bei der Ausstellerzahl und bei den Besuchern (76 000) hinnehmen müssen. Die populäre «Comdex Fall» kam ebenfalls auf nur noch 75 000 Besucher (im Jahr 2000 waren es aber noch 225 000). 2003 wird sie überhaupt nicht mehr in Las Vegas abgehalten. Bill Gates wird seine «Key Note» wohl in Houston, Texas, halten müssen.