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IPsphere Forum – A Summary

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Abstract and Keywords

Driven by the need of Quality of Service and the provision of existing services and newly upcoming services through a packet based infrastructure – namely the Internet –, the need for new network provider services and a new network architecture came up. The IPsphere Forum tries to solve these challenges by the introduction of a three strata model, which means basically going along the widely discussed three overlay model for the Internet – this is not part of this document but will be briefly explained. The upper stratum or overlay, which is responsible for the service provisioning, is in the clear focus of IPsphere. This document describes the vision, the architecture, and the mechanisms.

Index Terms:

IPsphere Forum, specification, architecture, Service Structuring Stratum.

Status	Participants

Public	**Not restricted.**

Disclaimer: The report is a summary of the current state of IPsphere Forum and does not claim to be exhaustive. The IPsphere Forum is still under construction. The decision regarding a service delivery platform to support the Next Generation Networks is not done widely by the network operators.

"It is not enough to have a good mind. The main thing is to use it well." - Rene Descartes (1596-1650)

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1 Introduction

The current infrastructures built with fibre, Ethernet and other IP-driven technologies provide a high flexible and cost effective transport and connection across the Internet. However, the important task nowadays is bringing these benefits up to the level where the service providers operate. Furthermore, the operation, administration and human tasks related to service creation and marketing have become important cost points of the providers. Due to that, service providers are facing markets conditions demanding sophisticated trade-offs between opportunity optimisation and cost management, flexibility and efficiency.

This last trade-off is particularly difficult to deal with when assembling services that must use capabilities provided by multiple stakeholders. Flexibility became and becomes more and more a key issue for network operators. That flexibility has always been obtained at the expense of either efficiency of capital investment or efficiency of operational expenditure or both.

Furthermore, the current business model of the telecommunication providers is not feasible anymore. Traditional telecommunication services are insufficient to sustain the current infrastructure, so there is a big need of new services to come up. Some of these new services need a network performance of higher quality than the best-effort, highly extended compare to the current Internet. But providers want to keep the costs low while achieving the previous goal.

Therefore, to provide those new services it is needed to have a service differentiation mechanism. A flexible framework applicable to any service and allowing service composition delivering them in a converged infrastructure needs to be built. Furthermore, a high degree of automation, and the ability of supporting the transition through many networks and technologies as possible, is needed.

2 Objectives

The addressing of the mentioned topics leads to more dynamic business models in an evolving communication and service networks.

The IPsphere Forum is creating a service abstraction and composition framework addressing these challenges and alleviating the trade-offs mentioned previously. It will allow providers to optimise flexibility and efficiency by means of translating a generalised service offering into a set of generalised resource commitments in a “meet in the middle” approach. This service management approach focuses on extending the existing frameworks to handle inter-provider and other multi-stakeholder interactions [1].

It will be able to operate independently of the underlying transport or access technology thanks to an abstraction and breaking down to certain functional blocks in a generic infrastructure. It tries to give the system enough flexibility making the communication between the main functional blocks of the infrastructure (Administrative Owners and Element Owners) flowing through a message bus and allowing any kind of federation or service composition.

3 IPsphere actors, history, and agenda

The IPsphere forum is an international non-profit consortium of network equipment manufacturers, IT companies and communications service providers. Currently, the following companies are involved in the IPsphere forum: Alcatel-Lucent, British Telecom, CISCO, The CNIA GROUP, ERICSSON, etisalat, France Telecom, HP, HUAWEI, i2cat, Juniper, KT, NEC, Net One Systems, Nokia Siemens Networks, NTT, Red Zinc, Soapstone, T-COM, TATA Communications, Telefonica, Telenor, Tellabs, Telstra, TELUS, TrueBaseline, and Verizon as full members and Telarix as a associative member.

In addition, the IPsphere Forum has some related organisations like standardisation organisations and more like: ATIS, ETSI, HGI, IETF, IPDR, ITU-T, MFA, MSF, OASIS, OGSA, TMF, and VSF. Recently, it will join the TMF.

It was established in 2005 with the goal of developing an open multi-stakeholder Web-services framework for the rapid creation and automated deployment of IP-based services.

4 IPsphere technology

4.1 Three Strata Model

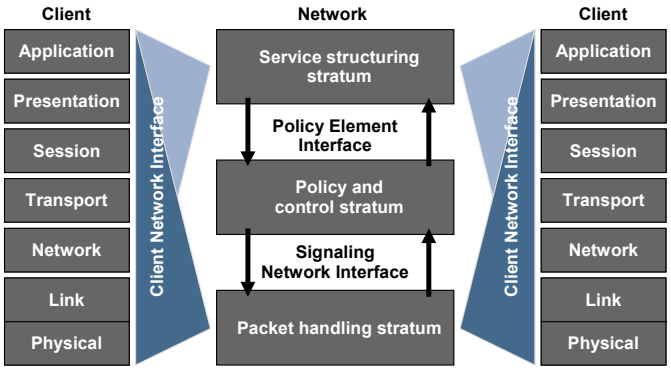

Figure 1: Three strata model

The scope of IPsphere Framework is based on the service abstraction, service decomposition and in the three strata model. The strata model is a model of three overlays. The Packet Handling Stratum (PHS) is responsible for handling incoming and outgoing packets (routing, switching, forwarding queuing, etc). The Policy and Control Stratum (PCS) is in charge of aspects related to resource allocation and tracking ensuring the reliability, security and availability in the network. The focus of IPsphere is on the Service Structuring Stratum (SSS) (Note: The SSS is called in [3] Service Signalling Stratum). In this stratum, the service abstraction and decomposition will take place [1].

The SSS acts as a control and management overlay for the PCS – a kind of control plane – and PHS – a kind of data plane. It is in charge of providing a way to exchange business information in a group of service providers. The information is used to create services and service modules in the service provisioning areas of the network and service providers' domains. The interface to exchange the data is called Network-Network Interfaces (NNI). It contains information about the principle customer request/contract, the provider service offer, the requested service, peak and average data rate information, packet loss rate, cost metrics, etc. Therefore the SSS interconnection is a kind of Virtual Private Network (VPN) between carriers and service providers where they exchange business information. It is important to remark that the SSS only controls the business relationships; it does not influence and interact with the network – overlay principles.

The communications in this overlay is based on eXtensible Markup Language (XML) and/or the Web services Simple Object Access Protocol (SOAP). The members of this VPN are the Service Management System (SMS) Childs [3] and the SMS Parents. These are functional blocks in the architecture SMS Childs are the representations of the service Elements, which are provided by a service provider. The SMS parents provide order analysis and dissection of services. They create templates and drive the SMS Clients in the process of service creation. These templates are used to describe services and the Elements of these services, so it will carry the business information and are based on XML and/or Service Oriented Architecture (SOA) principles.

The service management behaviour of the SSS is translated to the network via the SMS Child. SMS Child translates templates to network policies or provisioning commands to control the network elements. They use existing standards. This relationship between the SSS and the control plane of the network is a key concept of IPsphere. It allows the separation of business exchanges and technical network control. The SMS Parent is managed by the Administrative Owner (AO) and is responsible for the control of the coordination of all the involved providers. It is also responsible for the collection of fees from the involved actors. On the other hand, the SMS Child is part of the Element Owners (EO) and supports service composition and service bundling.

The service delivery has three stages [3]: Setup, Execute and Assure. At the Setup stage the AO looks for a contractual agreement with all the partners, which participate in the service delivery and in the negotiation of the parameters. At the Execute phase, the AO signals each partner to create the service in the network. The message includes the request to allocate resources, and to change policies and management settings. Afterwards the actual service creation is performed. In the last stage – Assure – the partners monitor their agreements and report problems to the AO via an "Alert" signal. The finishing message is created when the service is cancelled or is expired.

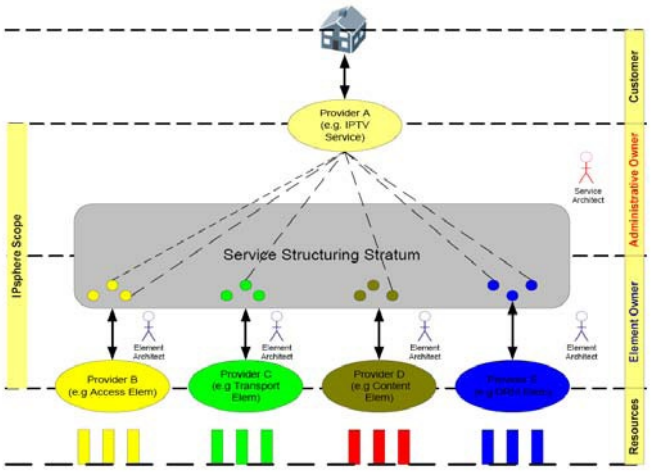

Figure 2: Meet in the middle approach

The primary goal of the IPsphere framework is to define interfaces for the currently existing systems participating in the "meet in the middle" interaction (Figure 2) between service based views and resource based views. In addition, it looks for specifying how vendors' management, billing, and publishing systems can participate in the framework. It is responsible for defining the interfaces needed to facilitate the participation of these systems in the SSS.

From a non-technical point of view, IPsphere is a collaboration space where the stakeholders for services are able to orchestra, structure, and offer services to other service providers or to do it together in an alliance.

The framework has to be seen in two perspectives. In the "top-down" perspective the Administrative Owner starts a relationship with a customer to provide a service, which will be broken down into a certain number of resource types. Each of those could be offered by a different provider. For each resource type the optimum provider will be found and bounded into a service contract with the other contributors. In the "bottom-up" perspective, the network operators define specific offerings called "Elements", which are a piece of functionality and assembled with others by the Administrative Owner to create a new service. Elements can be offered to all Administrative Owners or to a subset of them. So there are two types of offers:

- Service offers (commercial offer to provide a service by the Administrative Owner) and
- Element offers (offer to create a specific set of service features as a part of one or more service offers).

The framework will not take care of the particular way of managing the resources of a certain PCS, which is interfacing its correspondent Management System (xMS). It will abstract all those particular features using the SMS Child functional block [1].

4.2 Architecture

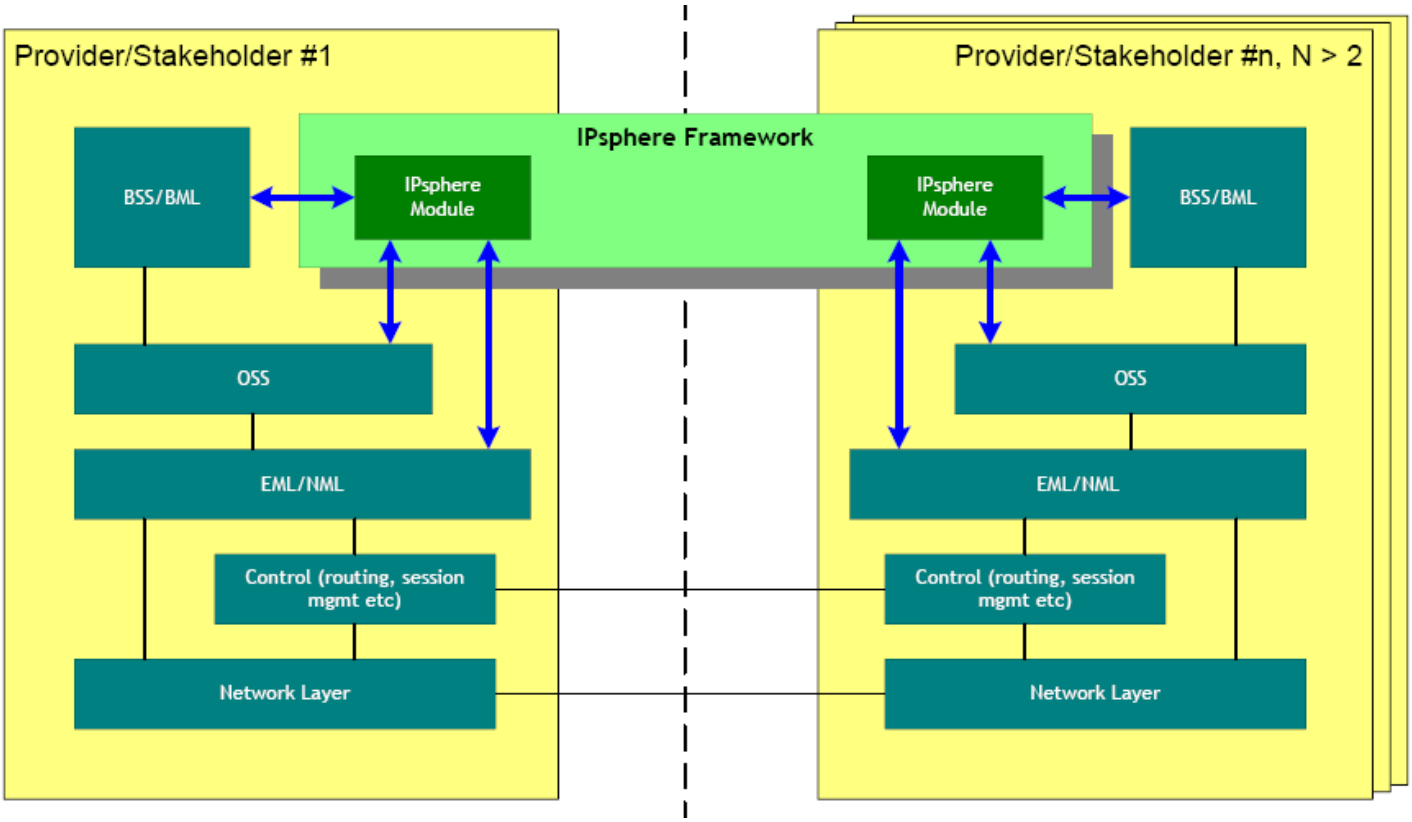

Figure 3: IPsphere in the context of a typical Network Provider's environment

The figure above shows the exact location of the IPsphere framework module in a network provider's environment and the functional blocks. It shows also the context of a bilateral relationship between providers and stakeholders. IPsphere is fully extensible to any configuration of multilateral relationships.

At the highest level the AOs communicate with the EOs through the bidirectional SSS Message Bus [1]. This bus will be used by the AO to manage the provisioning and activation of a service sending messages to EOs. EOs will use the bus to communicate faults, alerts, Quality of Service (QoS), and other Service Level Agreements (SLAs) related data to the correspondent AO. Messages exchanged across the SSS Message bus will be based on SOA/Web Services principles.

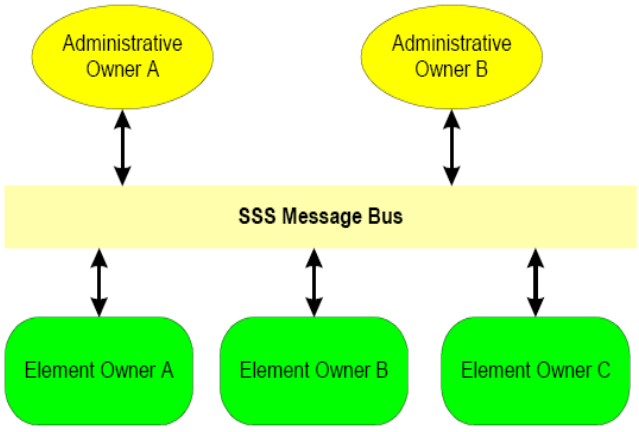

Figure 4: SSS Message Bus implemented as a VPN connection between the participants

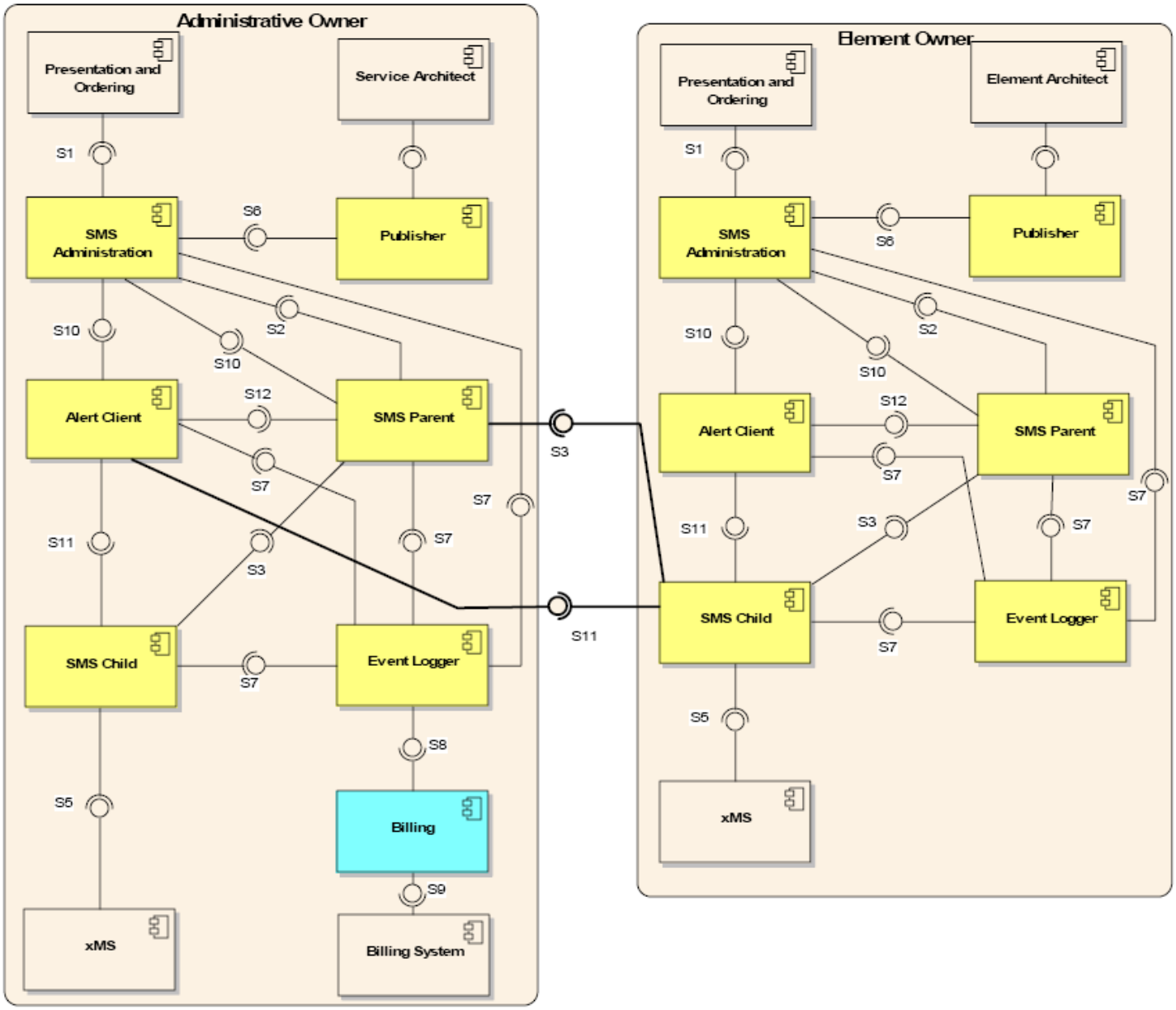

Figure 5: Administrative Owner – Element Owner component design

In the following the functional components are explained deeper:

The Administrative Owner (AO) is in charge of the contractual obligations of the service offering, broking the relationship between the customer, and one or more Element Owners (EO – see next paragraph). It may also play the role of an Element Owner and even provide all the elements to build a Service Offer. It must provide the SMS parent and Service Architect functions.

Element Owners (EO) contributes Services Elements (these could be simple or complex, composed by several other services elements) abstracting resources and capabilities into the IPsphere framework. Therefore, it must provide the SMS Child and Element Architect functions.

The Service Architect is responsible for creating Service Templates, which defines how an Element Offer can be selected and combined with others, using XML Schema models. Meanwhile, Element Architect is in charge of developing an Element Template describing an Element Offer, also with XML Schema, including policies used in the provisioning of resources to the element.

The Service Presentation and Ordering component is external to IPsphere. It represents the AO service provider order entry and management processes usually considered as a part of the OSS component. It interfaces with the SMS administration to manage service instances.

The Publisher interfaces with one or more registries, repositories or data stores to be able to publish and discover Service

Templates, Element Templates, and more information abstracting the interaction between IPsphere and external information systems.

SMS Administration component carries out the element selection process, decomposing a Service Instance into elements based in the constraints of the Service Template created by the AO Architect to generate the Service Script to be passed to the SMS Parent. It interfaces with the publisher to get Element Template and policy information and with the SMS Parent to send to it the Service Scrip needed to obtain the constituent partner Elements.

SMS Parent manages the orchestration of the elements in the service order to provide a specified service using the script provided by the SMS Administration component with all the Elements to be commissioned, modified or deactivated. It must create a series of messages to the EO's SMS Child to perform the functions stated before. It interfaces with the Event Logger to record all the coming up events and with the Alert Client to manage Element alerts. Finally the SMS Child is connected with the SMS Parent.

The SMS Child is basically an abstraction of an xMS and the resources. It translates the messages from the SMS Parent into the corresponding vendor, network, or device commands. It also must generate and distribute alert messages if the resources fail or violate the specified SLA. It interfaces with the correspondent xMS and with the Event Logger. It also interfaces with the Alert Client to send possible alerts to it. It is in charge of collaborating with the SMS Parent in the service creation process activating, modifying, and deactivating elements.

An Event Logger records all the transactions to provide support for auditing, billing, settlement, and recovery. It also performs a transaction monitoring between the rest of the functional blocks during the service provisioning and the recovery of the current state of a Service Instance (improves performance and reliability).

The Alert Client component is responsible for intercepting alert messages sent by the SMS Child and the SMS Parent and applying filtering, queuing, or other processing to those alerts before forwarding them to the SMS Administration. Therefore it interfaces with the SMS Administration to forward alerts and with the Event Logger to record important events. An alert must contain the Globally Unique Identifier GUID of the Service Instance, Element Order/the element template, and the associated error code.

5 Different types of interconnections

5.1 Inter-working Session Services and Resource Management

One of the main objectives of IPsphere is to guarantee end-to-end QoS for session-based services even over cross service-provider boundaries. In order to achieve this goal, the IPsphere framework is able to negotiate and assure SLAs between service providers.

The reference architecture defined for this purpose is shown in

Figure 6, which is an adaptation of Figure 3. It illustrates the inter-working between IPsphere, Service Control Functions (SCF) and Resource Admission Control Functions (RACF).

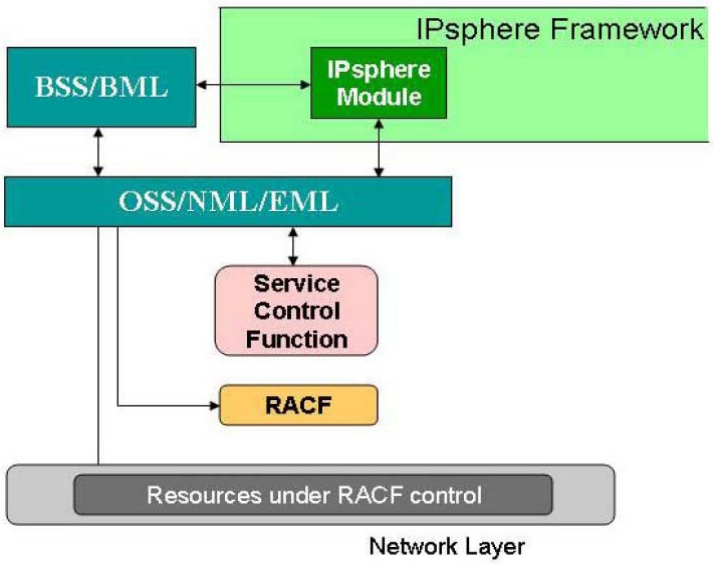

Figure 6: Provisioning of resources for session-based services basic architecture

As it has been already mentioned above, IPsphere has to deal with negotiation between partner service providers, which may result in specific policies that should be used by SCF and RACF. It has to handle the allocation of aggregate resources. The admission of individual sessions is controlled by the RACF.

Such a hierarchical model works as follows. IPsphere controls resource allocation through the appropriate management systems (xMS). It typically interfaces with a network management system to provision end-to-end resources within a domain.

When the resources required by the service are allocated, IPsphere will interface with RACF's management system through the appropriate xMS to indicate which resources are under control of the RACF. In order to ensure that there is no inconsistency in the decisions made by IPsphere (based on certain business objectives) and the decisions made independently by RACF, the RACF may not admit any sessions onto a certain slice of resources except for those explicitly identified by IPsphere.

From that moment, session initiation is under control of SCF and RACF without further intervention by IPsphere. SCF performs session management (initiation procedure, exchange of session parameters such as codecs, transactions, teardown procedure) and resource control. Before the session is established, SCF asks RACF for the required resources. RACF evaluates the subscriber and network-related policies, checks for bandwidth availability and decides whether or not the request can be granted. If RACF responds positively, SCF will continue with the session establishment. Otherwise, the RACF instance (also called Admission Control Instance, ACI) that handles this slide of resources may alert SSS through the appropriate xMS (via SMS child) of such a situation. E.g. if the ACI is running out of resources, the AO of the service would have to negotiate with the appropriate EO the reallocation of aggregate resources. If such a feedback loop does not exist, it may be necessary to determine resource state through other means.

To a large extent, the tasks associated to SCF are performed by IP Multimedia Subsystem (IMS, [5]), which is not part of the IPsphere framework. However, IPsphere not only is able to work over IMS, but also over any other SSRM-compliant service and it enables the creation of different infrastructures for pan-provider session-based services.

Next, session and resource control across service provider boundaries will be studied in three different situations that model different ways in which operators can interoperate.

5.2 Resource Admission Control Across Service Provider Boundaries

1. Both domains are involved in Service Signalling Processing (SSP)

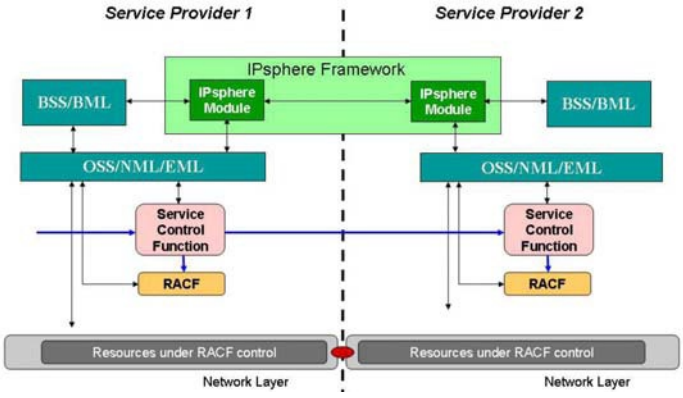

Figure 7: Both domains involved in SSP

This model occurs when both service providers use a SCF, such as IMS, and a RACF function. In that case, the SCF in each domain requests resources from RACF in the same domain. Each RACF is responsible for resource control in its own domain only.

2. One domain is involved in SSP, but both domains are involved in Per-Session Resource Admission Control (P-SRAC)

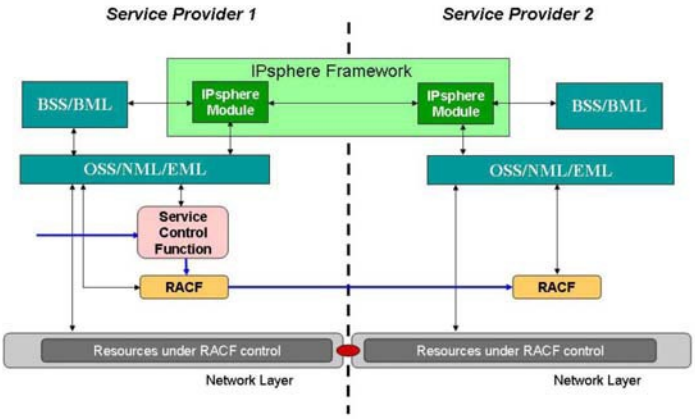

Figure 8: Both domains perform P-SRAC

This situation occurs, for instance, in the case of roaming to an operator without the same service platform. In such a scenario, SCF in the home network interfaces with RACF in its own network which makes a decision based on policies that may include subscriber profile information. Subsequently, RACF in the home network requests resources from RACF in the visited network, which makes a per-session basis decision based on its own network policies. Such a policy interface between service providers could be based on Diameter [4]

3. Resource Admission Contro l in the case a Transit Network is not involved in SSP nor P-SRAC

This model occurs when two service providers are connected through a transit network. The service providers are responsible for resource admission control within their own domains and they are jointly responsible for resource admission control with respect to the transport capacity leased from the transit provider – most probably by over-provisioning.

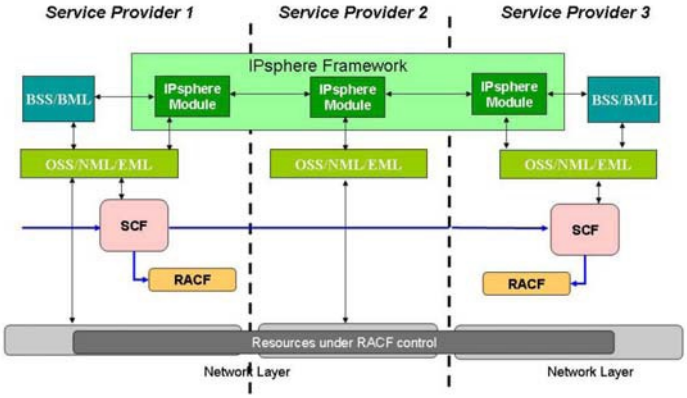

Figure 9: The Transit Network is not involved in per-session operations

Note: An EO can work as a Service Provider, Transit Provider or Access Provider.

For more details with respect to resource admission control on peering interfaces see [2].

5.3 Data Steering

In order to guarantee that traffic is mapped correctly onto the allocated resources, IPsphere proposes some mechanisms that enable operators to steer session-based traffic through selected peering interfaces and transit networks.

1. Route Manipulation: e.g. a network provider can associate certain session-based services with specific IP subnets (IP prefixes) and then advertise these IP prefixes using BGP (Border Gateway Protocol, [6]). As a result, the flows related to these services will be routed through one or more selected peering points.
2. Tunnelling: e.g. in MPLS (Multi Protocol Label Switching), the FEC (Forwarding Equivalence Class) associated with the tunnel can be used to determine which flows are mapped onto the tunnel.
3. Source Routing: the source includes the nodes the traffic has to go through.
4. Anchoring: used together with SIP (Session Initiation Protocol) and SDP (Session Description Protocol). The path of the flow is split by anchors (e.g. Interconnection Border Gateway Function, I-BGF) that perform NAT (Network Address Translation) and control each chunk of the path [2].The above mechanisms can be used together with this one.

5.4 Resource Allocation

As it was remarked in section 5.1, an infrastructure for pan-provider session-based services can be created by using IPsphere. The so-called “meet in the middle” approach must be applied. IPsphere must enable an AO that has decided to launch a session-based service to contact different EOs. This EOs do not have necessarily all the functions implemented in their network. By using service composition, it is possible to use functions from other EOs or the AO – which offer some capabilities and such as system that can process signalling information (e.g. IMS) or systems that perform policy enforcement and traffic anchoring (e.g. I-BGF), see Figure 2.

IPsphere also takes into consideration using Path Computation Elements (PCE) to calculate a path based on bandwidth availability when creating a pipe across domain boundaries.

Regarding resource re-allocation, IPsphere or RACF may detect that there is a need to change the amount of resources previously allocated by RACF. In these cases, the RACF will alert IPsphere about such a situation. This results in a Threshold Alert that triggers the AO to determine to re-allocate resources.

Finally, IPsphere also deals with failures on resource allocation. EOs will generate an Alert on any Element instances that fails to meet the service level agreement identified in the Element Order. This process is designed to allow the AO the reconfiguration of the service and to take any other needed actions following the procedure of a SLA violation (Figure 5). However, this high-level procedure seems to provide little chance to preserve session integrity. Therefore, a structured mechanism for resource fault handling is defined.

- Automatic recovery: If possible, the Element should recover the path automatically at the network level, below any EMS/NMS/OSS layer, and in a period less than any SLA-defined service interruption. In this case, there would be neither a resource alert nor an AO Alert.
- Element-level recovery: If the EMS/NMS/OSS does “see” a fault or if one is detected by a monitoring process, the SMS Child should initiate local recovery – if possible. If the period of interruption is within the SLA period, there would be a resource alert, but not an AO Alert.
- Service-level recovery: If the network or the SMS Child cannot recover the Element within the SLA period, the AO must receive an Alert. The Alert would then signal AO a remediation is required.

6 Above and below the line – a kind of Conclusion

The IPsphere story is still under construction. A lot of things have to be defined and discussed. Hence, a full conclusion can not be performed at this time. In the following, there is a summary and a collection of the described facts.

6.1 Control and management framework

The control and management framework is defined in the SSS – the IPsphere framework. In the context of IPsphere a service is a temporary offer to one or more customers provided by more than one service provider (content, facility, or network provider). During this time, one of the participating service providers will become the Administrative Owner (AO) and the others the Element Owner(s). It might be the case, that afterwards – without changing the set-up of the infrastructure – another service provider will become the AO of another service offering. The role of the AO is virtually. The service provider does not necessarily have to own all service components for the service offering. It might be able to “rent” service components for the period of the service offering from another service provider. The business transactions are defined in the SSS.

The control of the infrastructure is still in the responsibility of the service provider. The service provider will not give the infrastructure control and management to the AO away for the time of an active running service. The AO can ask for a change of the setting(s) or for an update of a SLA(s). In the case that a service provider can not provide the requested service, the service provider will not any more participate in the service offering.

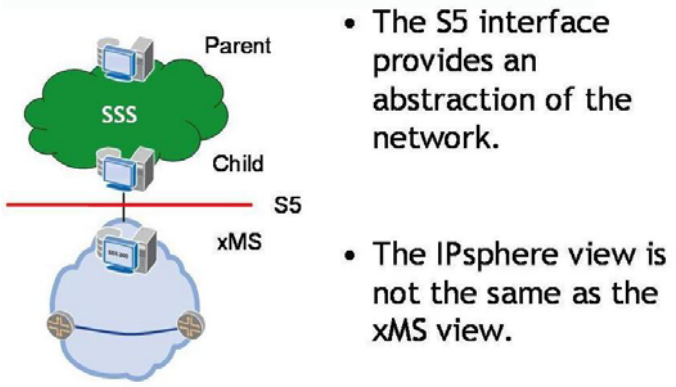

Figure 10: Control and management area

The interface between the virtual world of the SSS and service provider infrastructure is done by the S5 interface – see Figure 10.

6.2 Easy example of a service change

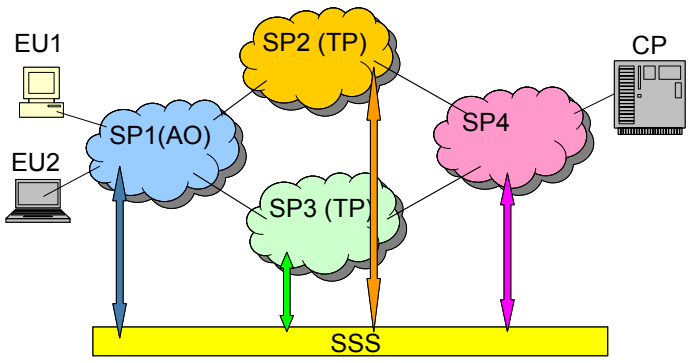

Figure 11: Example scenario of a provider set-up

End-user EU1 and EU2 are connected to Service (network) provider SP1. Service provider SP2 and SP3 act as transit provider, whereas Service provider SP4 is connected to a Content provider (CP). In a given scenario, following SLAs could be negotiated:

Service provider inter-connection	Link bandwidth	Reserved bandwidth for QoS	Utilisation
SP1 – SP2	10 Mbit/s	6 Mbit/s	2 Mbit/s
SP1 – SP3	5 Mbit/s	3 Mbit/s	0 Mbit/s
SP2 – SP4	5 Mbit/s	3 Mbit/s	2 Mbit/s
SP3 – SP4	5 Mbit/s	3 Mbit/s	0 Mbit/s

Since EU1 and EU2 are connected through the same Service provider – namely SP1. This Service provider acts as the Administrative Owner (AO). EU1 has an active QoS flow from CP with the peak bandwidth of 2 Mbit/s. In the case that EU2 requests also a QoS flow with peak bandwidth of 2 Mbit/s, the link between SP2 and SP4 becomes problematic. The SLA between SP2 and SP4 does not cover this additional request.

The AO can now either request a change of the SLA between SP2 and SP4 (if both Service providers are willing to negotiate a new SLA) or the establishment of a new route either for all flows from SP1 to SP4 or for the specific newly requested flow through SP3 (since resources and a valid SLA exist, which can be seen in the table).

Please note: The AO has no control. The AO can only request changes in the network.

6.3 Outlook

The story will continue … □

7 Acknowledgement

We want to thank the members and document contributors from the IPsphere Forum, since we have copied some pictures from their documents for this document. Of course, the copyright is still with the IPsphere Forum. Authors' company is a member of the IPsphere Forum.

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9 Table of figures

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