

Resource Brokerage in future wired and wireless Networks - WHYLESS.COM

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Abstract: This paper describes the concepts developed in the IST-project whyless.com. Leaving the traditional approach of network development, a novel approach has been chosen to support both operator and user needs in a more efficient way. One of the basic requirements of the whyless.com approach is the separation of infrastructure and content, which leads to the necessity of a network resource coordinating entity, the resource broker.

The developed open platform logical architecture with new introduced network entities is described as well as the resource brokerage process and implications of the status of the resource broker entity.

1 Introduction

Whyless.com investigates, within the frame of a feasibility study, in how far available and emerging technologies can be used to restructure mobile communications systems and the involved operational entities such, that an open platform for electronically conducted business and work is achieved. It is an underlying assumption that an open business platform is to be disassociated from the business itself, i.e. that an open platform is purely an enabler for users and businesses which require network infrastructure to fulfil their (business) objectives. Disassociation of network infrastructure and digital content is a necessary consequence. A so released infrastructure is expected to be populated by businesses of various size which provide mass- or tailored services and applications, from plain telephony through Internet services to highly specialised, end-to-end configurable services.

Based on above scenario, whyless.com has developed a network resource brokerage concept which employs an algorithm which synthesizes a route through multiple, heterogeneous networks (wired and wireless) resulting in lowest cost at a given grade of service for the user. New network entities have been introduced to establish the network resource brokerage mechanism, which are the Resource Broker, the Network Resource Manager and the businesses in demand of network resources, i.e. service providers. The conception and evaluation of this open platform are main tasks of the whyless.com project and it is expected to prove the feasibility of such a system as well as giving innovative impulses for the development of the next generation networks.

2 Open Platform Logical Architecture

The technical realization of resource brokerage on the basis of present-day network-structures is a difficult task. An expansion of the network functions as well as an improvement of the network management is necessary in order to create a basis for a possible implementation. Particularly the improvement of the network management is very

important. Procedures existing today for IP-networks are not sufficient and therefore new procedures have to be developed and examined. Another important aspect of resource brokerage is security. Mechanisms must be implemented, to prevent network misuse and fraud.

The architecture depicted in fig. 1, with the introduced functional entities, is the currently considered solution to support the brokerage process. New network entities have been defined, the Network Resource Manager (NRM), the Resource Broker (RB) and the Server. The Clearing House (CH) is indicated as an administrative entity which will be dealing with security issues. Effectively the CH is considered a distributed entity.

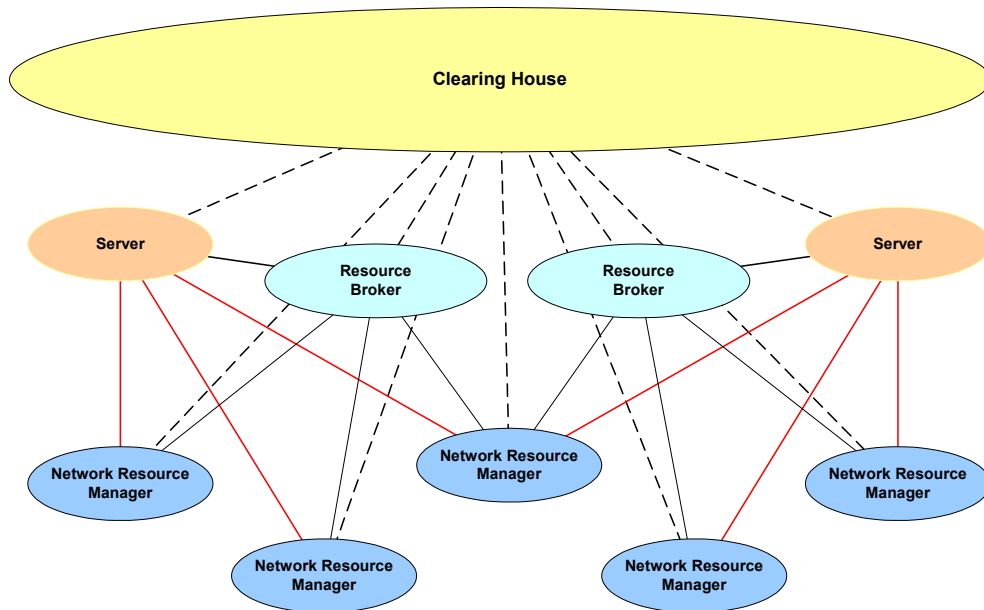


Fig. 1: Logical Architecture

The open mobile access network is populated by numerous Resource Managers, Resource Brokers and Server. Server require network infrastructure on their own behalf in order to satisfy a client's (or a group of clients') needs. They turn to one of many Resource Brokers who determines the cheapest path through the network providing a desired QoS, which requires that he contacts prospective Resource Managers as to their current offer. Once the cheapest path satisfying the desired QoS has been found, the details of this cheapest path are communicated to the Server. The Server then secures, via contract, the offered path elements which each NRM through which domain the path has been routed by the Resource Broker.

3 Entities

3.1 Client

The mobile user may or may not have a subscription with a Server providing Internet connectivity, as he may or may not have a subscription with other Servers offering general or specific services. Particularly he has no subscription with network elements. In the whyless.com world it is sufficient a client, pre-registered with the Clearing House, buys a mobile terminal and switches it on. When switched on, irrespective of the client wanting to become active (i.e. receive a service), the terminal will broadcast the clients pseudo identity, such that radio nodes (radio base stations) in the vicinity can detect the presence of a potential customer. Via a defined mechanism the client will contact a Server, which

business model is the collection of actual tariffs of other Servers providing Internet connectivity. This information is obviously not free of charge. The client hence needs to be accredited with a body which handles charges. Many of the activities concerned with resource brokerage are subject to charges which are assumed to be covered by a warranty. The risk that payments will not be effected by the involved parties (e.g. client) is assumed to be carried by the Clearing House or an associated body.

3.2 *Server*

Servers (Application & Service Providers) are any kind of individuals or businesses, requiring telecommunications infrastructure in fulfilment of their objectives. The Server is the link between outer and inner business model and it is important to understand the role of servers in the context of resource brokerage. Servers usually do not possess infrastructure themselves, the open market model however does not generally rule out the possibility. The palette of potential services can be grouped in three major categories:

- generic connectivity services
- administrative services
- content provision

The first category comprises services which support wireless mobility, i.e. provide IP connectivity. These services may be compared to today's Internet Service Providers (ISPs). The second category of services administers the client (and/or server) as regards security, accounting, billing, verification of the client received QoS versus the contractually agreed one, or customer care/support in any other respect. Finally, the third category provides content of whatever kind. A server may represent one, some or all of the mentioned categories. Of extremely high interest is however the possibility of service integration, i.e. the creation of business models making use of the offer of a number of specialized services. The business model of such a service integrator is hence the creation of 'hyper' services, without requiring him to develop the constituting elements. Such a scenario however depends on the existence of two things: i) fast and compact electronic negotiation and contract schemes and ii) a 'language by means of which the server can configure the physical network according to the 'hyper' service needs, without being an expert in networks.

According to above, the role of a server is extremely versatile and the assumed possibility of hyper-services enables a huge variety of context sensitive and spontaneous business models. This is enabled by the fact that the hyper-server needs neither infrastructure nor base-services.

3.3 *The Internet Service Provider*

The ISP in principal is a server, i.e. provides a service making use of network infrastructure. The service provided by the ISP is however fundamental in that it is required for all other services. The ISP provides mobile Internet connectivity. When a mobile user switches on the terminal, the first contact is made to his/her ISP. Knowing the location of the user in the network, the ISP can route incoming calls to the mobile user. This information is continuously updated, which is equivalent to tracking the roaming user. Since location is a major trait of privacy and anonymous tracking is difficult to conceive, confidence in the ISP is a major issue. Hence the role of the ISP is rather intimate and possibly comes closest to today's network operators in the sense of customer care.

3.4 Resource Broker

The Resource Broker is an entity mediating between parties in demand and in possession of network resources, respectively. Depending on the status of the RB different scenarios have been evaluated.

As a major requirement one might set that the RB must ensure that its clients (Server) receive the cheapest network service which satisfies the demanded QoS. The requirement implies that all RBs, upon a certain request by a Server would produce identical results regarding the path through the network and the associated price, which leads to a neutral and hence regulated status of Resource Brokers. Under such conditions the Resource Broker would act according to set of obliging rules, which comprise the algorithm which determines the cheapest path through the network. The obvious advantage for parties in demand of network resources is the neutral response of RBs, i.e. the absolute minimum-price-path is found by employing a single RB, reason being that Network Resource Managers, representing network resources, would have no reason to offer different prices (for identical services) to different RBs, since the latter are mere copies of themselves. The disadvantage however is that there is no competition between path finding algorithms and hence no incentive for RBs to employ the most recent and efficient ones.

In another scenario RBs act according to a set of proprietary, i.e. unregulated rules. There are no restrictions in setting up a Resource Broker business, which gives everyone, inclusive of other network entities, access to this network function. It is obvious that network resource owners being also RBs would try to direct data traffic to their own network infrastructure whenever possible. The path-finding-algorithm hence would be biased such that own infrastructure is favoured. From a Resource Manager point of view the situation would change in that there are RBs of different colour, possibly acting on own behalf, which prevents NRMs from providing neutral offers. The situation is not unlikely that certain NRMs would not make any offer to certain RBs (e.g. to the one's known to represent a competitor's network), which would make it difficult, or even impossible, for any RB to compose an end-to-end network path. However, since many RBs would suffer such an experience, strategic alliances between 'selfish' RBs might cure the problem to some extent - the total number of possibilities to compose an end-to-end network path however remains reduced. The only way forward for the latter scenario appears to be a guaranteed anonymity of RBs. In case this can be achieved there is a clear incentive for RBs to optimise their path-finding-algorithms in order to attract many customers and hence maximise revenues. This scenario is attractive as far as the competition scenario and the possibility of 'derivatives' is concerned, but creates a new problem: how can Server identify the best RB? Anonymity inevitably leads to a hierarchy of RBs with a regulated RB at the top level. These concepts need to be discussed beyond the current state of analysis.

For further discussion the concept of regulated RBs is followed, without however precluding further work on the unregulated scenario. Resource Brokers are trusted (regulated) entities and require accreditation with an administrative body, e.g. the Clearing House. Otherwise there is no essential restriction in setting up an RB office, except for an explicit commitment to the rules of 'conduct'. The objectives of the RB are purely administrative, particularly he is not involved in the business case beyond obtaining a fee for his services. In its current shape the RB can hence not assume the role of a market maker or hedger, nor can he influence the market by any other means. The services of the RB are defined as being:

- End-to-end path synthesis according to QoS requirements
- End-to-end path price analysis
- Authentication of parties involved in the (potential) service contract (Server, NRMs)
- Risk assessment (financial credibility of parties and limits of liability)
- Network services contract verification
- Technical assessment of NRMs

The RB has the function of mediation of network resources between Server(s) and NRMs. Based on ITR offer and demand, supported by knowledge of global network topology, he can build end-to-end network paths with certain QoS characteristics and price. In case an adequate path is found, a service contract is installed between the Server and all NRMs contributing to the chosen path.

The end-to-end path synthesis is the fundamental operation of the RB. Upon technical specification of the end-to-end QoS by the Server, the RB will contact NRMs which offer infrastructure suitable for integration into the end-to-end path (see Fig. 2, two different RBs evaluating two different paths passing through more than one domain). By means of QoS related network parameters and associated price coefficients the RB can evaluate the technical suitability and the cost of passing the information flow through a specific administrative domain, i.e. the RB integrates sub-paths into end-to-end (server to user) network models under consideration of the technical QoS specification. The synthesis process ends with the RB passing the set of data specifying the cheapest route to the Server.

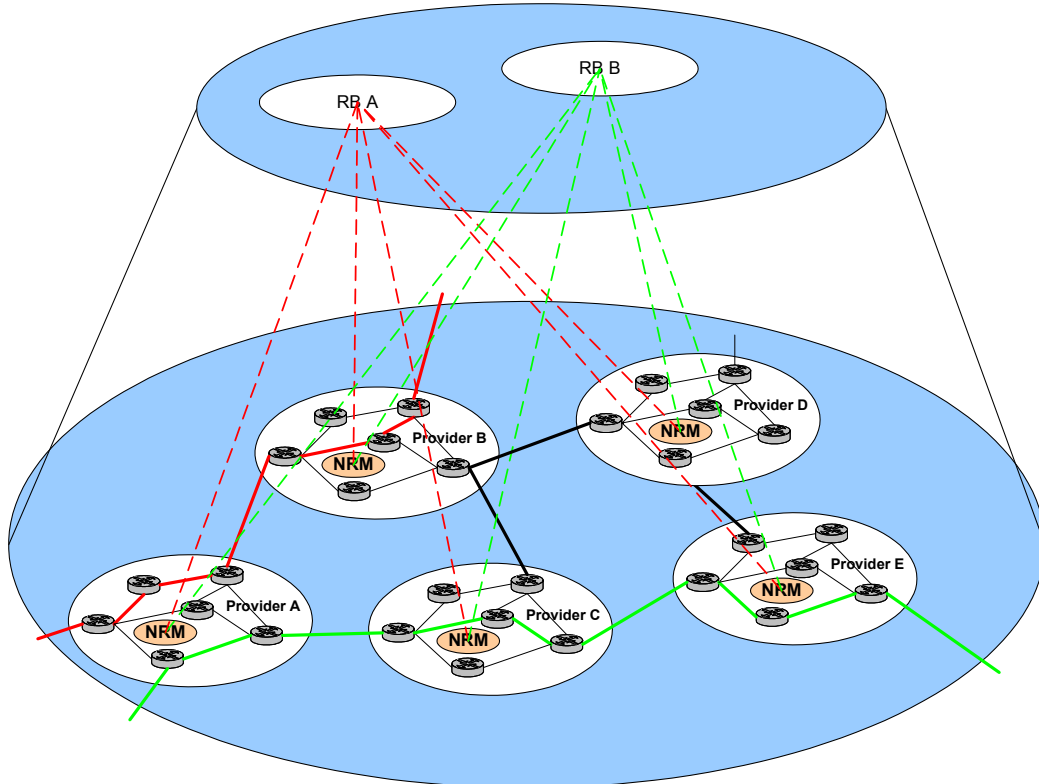


Fig. 2: Inter-domain connections

3.5 The Network Resource Manager (NRM)

The Network Resource Manager (NRM) controls the Information Transport Resources (ITR) within an administrative domain. His task is defined as being the management of the domain such that revenues from network operation are maximised while providing differentiated, inclusive of guaranteed QoS to network users. Provision and guarantee of services are restricted to the network the NRM is in control of. Administrative domains consists of various network-components, which are administered by one Network Resource Manager. Routers with connections to networks administered by other NRMs, are called Edge-Routers and the connections between routers are referred to as links. The NRM collects traffic information from routers within the domain with the general goal to distribute traffic such that the domain load is balanced over all links and hence the total transfer capacity maximised under certain QoS conditions. The activity of the NRM is very much comparable with (actually is a scaled copy of) the activity of the Resource Broker, difference being the optimisation criteria. While the RB is minimising the price of a connection passing through a number of domains, the NRM will minimise the technical 'cost' of traversing a single domain. The algorithms used by the NRM are clearly proprietary and partly represent the business model of the NRM. The basic NRM architecture at domain level is shown in fig. 3.

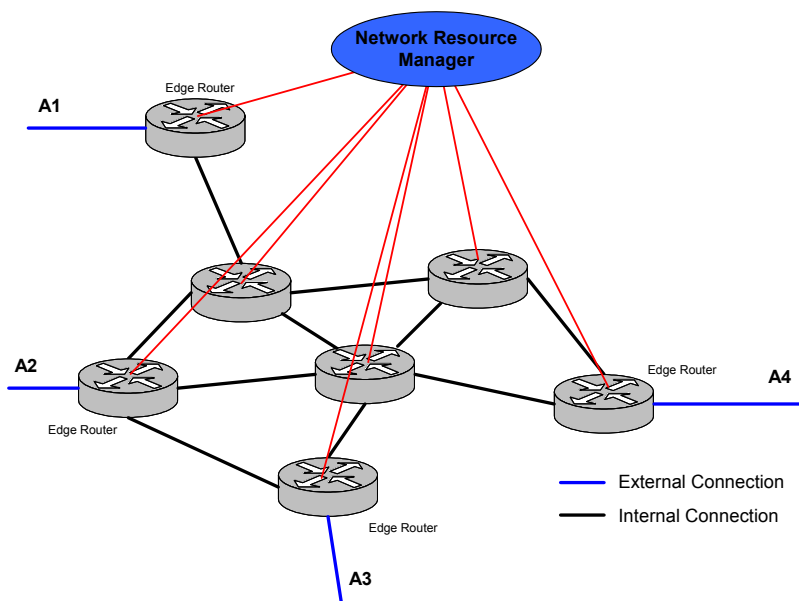


Fig. 3: Domain Architecture

Either upon request by the RB or 'a priori' any intervention, the NRM will evaluate the possibilities of adding traffic to the already existing one without violating any QoS guarantees. The result of the evaluation will have substantial impact on the type, class and price of transport services which can be offered beyond the current load. One of the major problems encountered is the definition of the request and/or offer parameters. On the one hand they should describe the desired services as precisely as possible, whereas on the other hand data volumes need to be restricted to the absolute minimum, since the network load caused by the negotiation procedure must be kept low and comparability be maintained. Actually the executive part of the NRM is a distributed and based in edge routers. Informed via network status broadcasts (current technology) the ingress router (router receiving data from other administrative domains) can employ certain techniques to evaluate the technical cost of adding a data streams to the current flows. The technical specification of a desired

service (provided by the server) is the basis on which the NRM analyses the technical cost of accepting the data stream. The technical cost and other parameters (investment, operations cost, competition status, marketing) eventually define the monetary offer made to the server. Currently two different service specifications are investigated. The first one tries to compress the description of the desired service into a single parameter and is earmarked by extreme compactness, simple processing and a certain range of business models which can be mapped. The second specification is generic, allows the description of services in fine detail and hence a sophisticated evaluation of technical cost by the NRM.

4 The brokerage process

The Resource Broker is approached by parties (servers) requiring network infrastructure in execution of their business objectives. In accord with the application/service to be provided to the client, the server will make available a technical specification (service descriptor) of end-to-end QoS parameters to the Resource Broker.

the brokerage process is defined as being the synthesis of a network connection (route) between server and client, fulfilling the end-to-end technical specification of the server at minimum cost.

More specifically, the Resource Broker will, via access to global network topology and interconnection data bases, actively interrogate appropriate NSPs' offers and integrate their individual offers into an end-to-end (server to client) network model. The details of a route, which complies with the descriptor at lowest cost, is then returned to the network services requesting party (server). For a specified period of tbd duration, the requested resources of the involved NRMs (administrative domains) are then (statistically) barred from otherwise allocations. If within this period the proposed route is not secured by contracts between server and NRMs, the barred resources will be released for general availability.

It is important to see, that irrespective of the type of descriptor used, the brokerage process is a creative process. The broker not merely mediates between parties in possession, respectively demand of network resources, but rather composes a new product - the end-to-end QoS connection. The creative element is the distribution of e.g. delay, jitter, etc. across a number of domains such that desired end-to-end quality is achieved at the lowest price. The Resource Broker is hence adding to the value chain, which suggests an implementation as a business entity. However, the disadvantages and problems of an unregulated RB have already been discussed in whyless.com and will be the subject of further dedicated analysis by the expert partner in the whyless.com consortium.

5 Conclusion

Operations of mobile communications networks have been analysed and mapped to a novel structure which has been derived from the disassociation of content and infrastructure. Regarding the resource brokerage entities have been defined (Server, Resource Broker and Network Service Provider) and rules of interaction have been developed. If compared to other attempts to improve network efficient use and QoS, the key difference of the whyless.com approach is easily identified as being the centralized control by the Resource Brokers, which on one hand is earmarked by considerable advantages in the user-friendly selection of adequate information routes and the provision of guaranteed QoS, whereas on the other hand the openness of the platform requires security measures far more advanced than the ones used in traditional network. Further and despite simplistic 'protocols' the scalability of the whyless.com approach remains to be verified.

Beyond technical improvements, the open platform offers novel business constructions and in particular the integration of the 'user' into the business process, enabled by the disassociation of content and infrastructure. As far as it can be seen, this approach is unique and represents severe cuts into current MCN structures, which is reason enough to secure the models and assumptions in every respect before embarking on the next level of detail. However, once the models and scenarios have been completed, simulations will have to demonstrate the fundamental feasibility and stability of the open platform for e-work and e-commerce.

The described network model is currently prepared for simulation and performance analysis.

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