Research Activities

Simulation has always been a valuable tool for experimentation and validation of models, architectures and mechanisms in the field of networking. In order to study and validate Quality of Service and wireless architecture issues we used the ns-2 simulator.

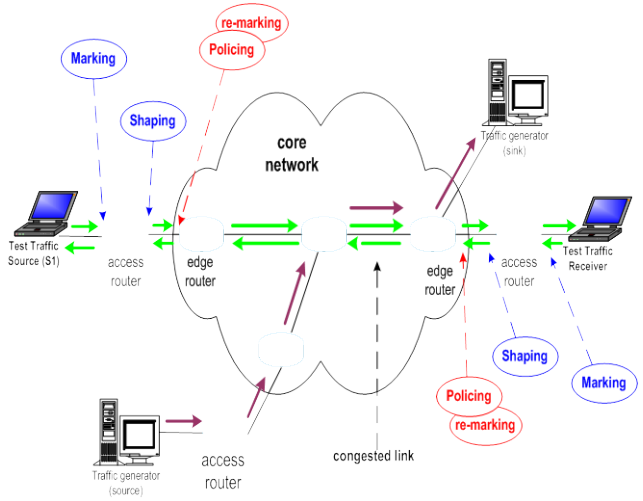
Ns-2 is a powerful simulation tool that can simulate many kinds of networks, like mobile and satellite networks and provide useful low-level insight in the operation of the networks. A user can define arbitrary network topologies consisting of nodes and links and attach applications and queues on each node. A researcher using ns-2 can design new protocols, test their functionality and performance and compare them.

In the case of the DiffServ framework, simulation is valuable due to the fact that an analytical approach of mechanisms and services is infeasible because of the aggregation and multiplexing of flows. We extended the ns-2 functionality towards the direction of realistic traffic generation and a series of mechanisms defined by the DiffServ architecture. We have also extended ns-2 with the functionality of Bandwidth Brokers, which are entities for managing the resources and negotiating end to end resource reservations between domains. The implementation and deployment complexity of such solutions makes it useful to be able to inexpensively study related research issues in a simulation environment.

Finally, we have extended ns-2 functionality by implementing modules for third generation cellular networks and in particular aspects of the Universal Mobile Telecommunications System (UMTS). These modules include functionality such as adaptive multimedia transmission, multicast routing, user mobility etc.

Diffserv

The DiffServ framework proposes the provision of service differentiation to traffic in a scalable manner, by suggesting the aggregation of individual application flows with similar quality needs.



The Diffserv architecture works by:

- Defining service classes to which aggregates of application flows are appointed
- Packets are entitled to a certain service or belonging to a specific aggregate. These packets are marked with a distinctive value (DSCP)

We designed modules which were implemented within the environment of the ns-2 simulator. This implementation can be used for:

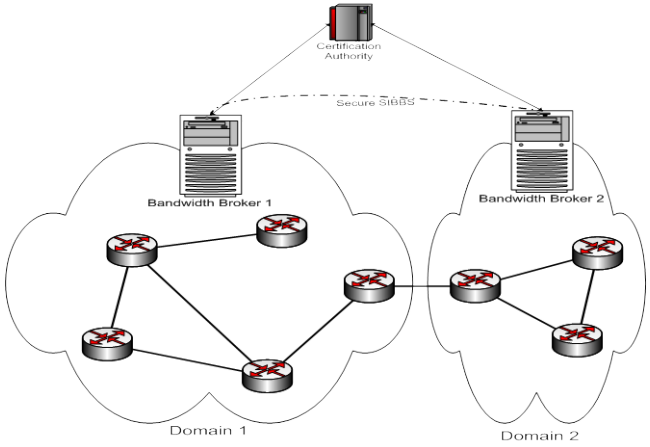
- An additional traffic generator or DiffServ mechanism functionality.
- Efficient simulation of DiffServ mechanisms and DiffServ-based services in realistic scenarios.

Also we implemented modules for the simulation of:

- Background traffic
- Foreground traffic
- Leaky Bucket Shaping
- DiffServ-based tracing
- Scheduling at the ingress interface
- MDRR scheduling (strict and alternate priority)

Bandwidth Brokers

In order to facilitate negotiations for automatic end to end QoS provisioning between domains, an additional mechanism has to be used. The Bandwidth Broker is an entity that manages the resources within a specific DiffServ domain by controlling the network load and by accepting or rejecting bandwidth requests.



Requests for resources are sent to the Bandwidth Broker.

- For requests that span multiple domains (inter-domain requests), the Bandwidth Broker communicates with Bandwidth Brokers in the adjacent domains
- The Bandwidth Broker architecture makes it possible to keep state on an administrative domain basis, and the DiffServ architecture makes it possible to confine per flow state to just the leaf routers.

Four architectural models that have been developed, implemented and tested in the ns-2 simulator environment:

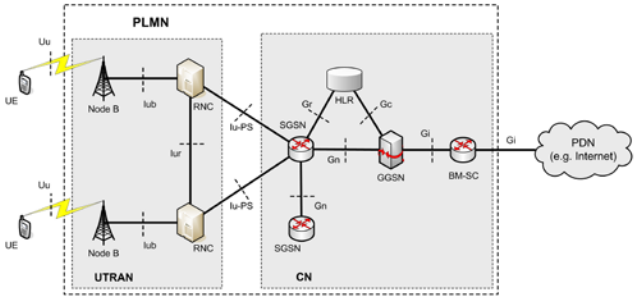
- Serial Distributed Bandwidth Broker model
- Parallel Distributed Bandwidth Broker model
- Centralized Bandwidth Broker model
- Centralized Fault-tolerant Bandwidth Broker model

Several admission control algorithms have been implemented and tested:

- Simple admission control
- Price-based admission control trying to maximize network utilization
- Adaptive admission control
- Adaptive admission control utilizing resubmissions

UMTS

Universal Mobile Telecommunications System (UMTS) constitutes the third generation of cellular wireless networks which aims to provide high-speed data access along with real time voice calls. Wireless data is one of the major boosters of wireless communications and one of the main motivations of the next generation standards. The topology of a UMTS network is presented in the folloeing figure



The current version of ns-2 does not support the functionality of UMTS network. However, there is an extension for ns-2, named EURANE (Enhanced UMTS Radio Access Network Extensions for ns-2) developed within the European Commission 5th framework project SEACORN

EURANE comprises of three additional nodes, namely the Radio Network Controller (RNC), Base station (BS) and the User Equipment (UE), whose functionality allow for the support of the transport channels FACH, RACH, DCH, HS-DSCH. We have to mention that the EURANE platform was used for our extensions of the ns-2 functionality concerning the UMTS network.

As part of our extensions to the ns-2 simulator, we implemented modules for the simulation of major aspects of the third generation cellular networks and in particular aspects of the UMTS:

- Multicast data transmission over UMTS
- User mobility and relocation support
- Adaptive data transmission

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NETWORKS, TELEMATICS AND NEW SERVICES

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