Simulators and Software

Simulators and software systems

- Smart Home framework using WoT and Social Electricity

- UMTS: Enhanced UMTS ns-2 based simulator, and MBMS OPNET based simulator
ns-2 based congestion control:

1. A universal estimator for internet congestion control,

2. Fuzzy Active Queue Management,

3. Flock-based Congestion Control in Wireless Sensor Networks,

Smart Home framework using Web of Things (WoT)

HomeWeb is an application framework for smart homes, built using Web principles and designed following REST architectural style. By integrating request queues for communicating with home devices, reliability and time efficiency are ensured while prioritized requests can be easily included to the system and multiple simultaneous family members may be supported. By combining sensor devices with smart power outlets, the foundational pillars are built, towards energy-aware smart homes that operate with Web technologies.

Access to the software is available here or through Andreas Kamilaris web site here. You can find a manual for the application here, and a report here.

SocialElectricity is a Facebook application that aims to demonstrate whether energy awareness can be reinforced by social comparisons. It allows people to compare their electricity footprint with their online friends and their neighborhood/village/city in a country-wide scale.

Recently, SocialElectricity has been awarded the winner of the 2nd ITU Green ICT Application Challenge.

PachuRadar is a mobile application that discovers, locates and interacts with services provided by Internet-enabled sensors that are registered to the online sensor directory Cosm and are deployed in the proximity of the mobile user. These services help the mobile user be aware of the local environmental conditions. Location is a potential dimension that facilitates the filtering of enormous amounts of data, collected by Web-enabled sensors that will flood the cities of the future.
1. Enhanced UMTS ns-2 based system level simulator

The developed system level simulator captures the dynamic end-to-end behavior of the overall network. Dynamic end-to-end behavior includes the dynamic user behavior (e.g. mobility and variable traffic demands), radio interface, Radio Access Network, and Core Network, at an appropriate level of abstraction. The simulator is based on ns-2 using a discrete event based (DES) approach and was developed within the IST funded SEACORN (Simulation of Enhanced UMTS Access and Core Network) project.

Access to the simulator is by request only, through this web site. http://seacorn.cs.ucy.ac.cy/eumtssim/

2. MBMS (Multicast/Broadcast Multimedia System) OPNET based simulator

Within the C-MOBILE IST funded project an MBMS (Multicast/Broadcast Multimedia System) simulator has been implemented using OPNET, extending the existing R99 based OPNET UMTS simulator. This extension supports the most important functionalities of the MBMS, both at the CN and UTRAN side. Thus, it is now possible to set mobile users to join in a MBMS Service provided by the BMSC and receive traffic by either Dedicated or Common channels. Additional enhancements on the proposed UMTS specifications were included, that cover either Core Network issues (Diameter and Multiple Content Variants) and Radio Network issues (Enhanced Handover algorithm, UE Power Counting, Diversity and MIMO). It is also possible to evaluate this system and compare it with the Release 99 UMTS in cases of multicast data delivery.

Access to the simulator is through this web site.

MBMS System Level Simulator http://b-bone.ptinovacao.pt/docs/BBONE-Reference-Model.rar

Also http://seacorn.cs.ucy.ac.cy/bbonesim/

Software - ns-2 extensions
1. A universal estimator for internet congestion control

We propose a novel estimation algorithm which is based on online parameter identification techniques and is shown through analysis and simulations to converge to the effective number of users utilizing each link. The algorithm does not require maintenance of per flow states within the network or additional fields in the packet header, and is shown to outperform previous proposals which were based on pointwise division in time. The estimation scheme is designed independently from the control functions of the protocols and is thus universal in the sense that it operates effectively in a number of congestion control protocols.

It can thus be successfully used in the design of new congestion control protocols. To illustrate its universality, we use the proposed estimation scheme to design three representative set of Internet congestion control protocols: ACP, QLA and DMM. The main objective of ACP is to match the input data rate to the link capacity and at the same time maintain small queue sizes, QLA tracks a reference queue size at equilibrium and DMM attempts direct calculation of the max-min fair rate at each link. We demonstrate using simulations that these protocols satisfy key design requirements. They guide the network to a stable equilibrium which is characterized by high network utilization, small queue sizes and max-min fairness. In addition they are scalable with respect to changing bandwidths, delays and number of users, and they generate smooth responses which converge fast to the desired equilibrium. Apart from its practical significance, this work also demonstrates the effectiveness of formal control theory techniques in general and adaptive control techniques in particular in delivering efficient solutions in a highly complex networked system such as the Internet.

Comprehensive results are available here, and the simulation code implemented in NS-2 Simulator is available here.

2. Fuzzy Active Queue Management

A generic AQM (Active Queue Management) control methodology in TCP/IP networks, based on fuzzy logic control principles is designed. A simple, effective and efficient nonlinear control law is built, using a linguistic model of the system, rather than a traditional mathematical model, which is easily adapted in different network environments (e.g. Best-Effort and Differentiated-Services architectures). We demonstrate, via extensive simulative evaluation, that the proposed fuzzy control methodology offers inherent robustness with effective control of the system under widely differing operating conditions, without the need to (re)tune any parameters. As demonstrated, this is in contrast with its well-known conventional counterparts A-RED, REM, PI, AVQ for Best-Effort, and two-level PI, RIO for Differentiated-Services based networks, where the proposed approach outperforms all of them both in Best-Effort and Differentiated-Services architecture application scenarios. Furthermore, the proposed approach is applied without any retuning for the two architectures using the same fuzzy logic controller for both, with the only difference being in the setting of the target queue lengths for different precedence levels in Differentiated-Services. Comprehensive results are available here, and the simulation code implemented in NS-2 Simulator is available here.

3. Flock-based Congestion Control in Wireless Sensor Networks

Our work proposes that the flocking behavior of birds can guide the design of a robust, scalable and self-adaptive congestion control protocol in the context of wireless sensor networks (WSNs). The proposed approach adopts a swarm intelligence paradigm inspired by the collective behavior of bird flocks. The main idea is to guide packets (birds) to form flocks and flow towards the sink (global attractor), whilst trying to avoid congestion regions (obstacles). The direction of motion of a packet flock is influenced by repulsion and attraction forces between packets, as well as the field of view and the artificial magnetic field in the direction of the artificial magnetic pole (sink). The proposed approach is simple to implement at the individual node, involving minimal information exchange. In addition, it displays global self-* properties and emergent behavior, achieved collectively without explicitly programming these properties into individual packets. Performance evaluations show the effectiveness of the proposed Flock-based Congestion Control (Flock-CC) mechanism in dynamically balancing the...
offered load by effectively exploiting available network resources and moving packets to the sink. Furthermore, Flock-CC provides graceful performance degradation in terms of packet delivery ratio, packet loss, delay and energy tax under low, high and extreme traffic loads. In addition, the proposed approach achieves robustness against failing nodes, scalability in different network sizes and outperforms typical conventional approaches. Comprehensive results are available here, and the simulation code implemented in the NS-2 Simulator is available here.

Pavlos Antoniou Phd Thesis is available here.

Link for flockcc.tar.gz is available here.


The LVCC approach targets streaming applications and focuses on how congestion can be prevented, or if not gracefully controlled, in small-scale, decentralized networks by regulating the rate of each traffic flow based on the Lotka-Volterra population model of mathematical biology.

The Lotka-Volterra based congestion control (LVCC) strategy involves minimal exchange of information and computation burden and is simple to implement at the individual node. Performance evaluations reveal that the LVCC approach achieves adaptability to changing traffic loads, scalability and fairness among competing traffic flows, while providing graceful performance degradation, in terms of throughput and delay of individual streams, as the offered load increases. However, its scalability is questionable, and further work is required here, as for example the adaptive setting of its control parameters. Comprehensive results are available here, and the simulation code implemented in the NS-2 Simulator is available here.

Link for the journal is available here.

Link for lvcc.tar.gz is available here.