Networks Research Lab (NetRL)

http://www.NetRL.cs.ucy.ac.cy
Adaptive non-linear control (IDCC)

- **robust and adaptive non-linear control theory** to tackle
  - difficulties due to large bandwidth-delay product
  - dynamic non-linear aspects
  - lack of (accurate) dynamic models

- derived simple **non-linear dynamic model** using fluid flow consideration
  - *robust adaptive* control to cope with uncertainties in model accuracy
  - features small set of design parameters
  - no maintenance of per flow states within the network

- derived **strong analytical results**
- verified by extensive discrete event OPNET based simulations
  - fairness – achieves max-min fairness
  - good steady state and transient behaviour
  - high utilisation

- since 1995 successfully employed these ideas to address a number of open problems
Adaptive non-linear control (IDCC)

Fluid Flow Model:
\[ \frac{dx(t)}{dt} + C \frac{x(t)}{1 + x(t)} = \lambda(t) \quad x(0) = x_0. \]  

**Premium Traffic Controller:**
Control Objective: Choose \( C_p(t) \) such that \( \lim_{t \to \infty} x_p(t) = x_p^{ref} \).

\[ C_p(t) = \max \left[ 0, \min \left( C_{server}, \rho(t) \left( \frac{1 + x_p(t)}{x_p(t)} \right) \left( a_p x_p(t) + k_p(t) \right) \right) \right] \]  

- \( C_{server} \) is the physical capacity of the server.
- \( a_p > 0 \) is a design parameter.
- \( x_p(t) = x_p(t) - x_p^{ref} \)
- \( k_p(t), \rho(t) \) are signals which improve the robustness of the algorithm and take into account the maximum rate allocated to the incoming traffic.

**A1. Proof of stability of Premium Traffic control strategy**
Theorem A1. The control strategy described by the equations (8), (9), and (10) guarantees that \( x_p(t) \) is bounded, and \( C_p(t) \leq C_{server} \) and \( x_p(t) \) converges close to \( x_p^{ref} \) with time, with an error that depends on the rate of change of \( \lambda_p(t) \).