Network Traffic Engineering

Lecturer: Andrea Baiocchi

Academic Year 2020/2021 – Graduate degree, spring period
Time table: Wed, 1 pm–3 pm; Thu, 2 pm–5 pm – Classroom A4 (Via Ariosto, 25)

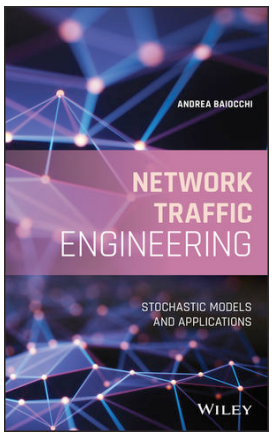
Week 01	Wed	24.02.21	L01	Outline of the course. Introduction to network traffic engineering: what is all about. Structure of a service system. Arrival and service processes. Traffic process. Performance metrics.
	Thu	25.02.21	L02	The Poisson process: relationship with the negative exponential PDF, memory-less property. Fitting of Poisson process to real traffic traces. Queues in equilibrium. Little's law. Lindley's recursion.
Week 02	Wed	03.03.21	Lab01	Stochastic discrete simulation: event-driven and time-stepped approaches.. Example of simulation of a single server queue.
	Thu	04.03.21	L03	Response time of a pooled resource system versus a partitioned resource system. Priority queuing: general definition and classification. Single server scheduling: conservation law. HOL priorities, SJF.
Week 03	Wed	10.03.21	Lab02	Generation of random variables.. Script of Poisson r.v. generator. Script of Lindley's recursion.
	Thu	11.03.21	L04	Processor sharing. Generalized processor sharing. Credit-based scheduling. Least Attained Service (LAS). Resource pooling revisited. Load Balancing: push and pull policies, delay optimality, classification of load balancing policies.
Week 04	Wed	17.03.21	E01	Exercises on Little's law. Optimal load balancing between two network paths with background traffic.
	Thu	18.03.21	L05	Overview of load balancing policies: JSQ. Pod, JIQ, JBT(r). Adaptive JBT. Open queuing networks: Jackson's networks. Steady-state probability distribution. Special case of single-server queues.
Week 05	Wed	24.03.21	Lab03	Elementary point and interval statistical estimators. Simulation of a discrete-time single server queue and comparison of time-averages with ensemble averages.
	Thu	25.03.21	L06	Open queuing networks: Mean delay through the network. Example of application to an IP packet network. Optimization of link capacities. Braess' paradox.
.Week 06	Wed	31.03.21	E02	Exercises on single server queueing systems, priority queueing and open queuing networks.
	Thu	01.04.21	-	Easter vacation
Week 07	Wed	07.04.21	L07	Birth-death processes. Application to Erlang's queueing model. Erlang B formula.
	Thu	08.04.21	L08	Models of cellular coverage. Application of Erlang's queueing model to the dimensioning of the cellular coverage under quality of service constraints.
Week 08	Wed	14.04.21	Lab04	Fixed versus Dynamic Channel Allocation. Simulation of DCA in 1-D models of cellular networks.
	Thu	15.04.21	L09	Slotted ALOHA: protocol, model, analysis, stability issues and stabilization algorithm.
Week 09	Wed	21.04.21	Lab05	Simulation of stabilized Slotted ALOHA.
	Thu	22.04.21	L10	Non-persistent CSMA and WiFi CSMA/CA: : back-off model, saturation throughput analysis. Performance anomaly.
Week 10	Wed	28.04.21	Lab06	Simulation of stabilized non-persistent CSMA.
	Thu	29.04.21	L11	Overview of congestion control. TCP refresher: congestion control of classic TCP. DCTCP.
Week 11	Wed	05.05.21	L12	Fluid approximation for queueing systems. Fluid analysis of classic TCP.
	Thu	06.05.21	L13	Fluid analysis of DCTCP. Fairness: general definition and possible approaches. Max-min fairness, Proportional Fairness.
Week 12	Wed	12.05.21	E03	Exercises on fluid models and TCP.
	Thu	13.05.21	L14	Network Utility Maximization (NUM). Utility functions, statement of social tulity maximization problem. Interpretation of TCP congestion control as an adaptive, distributed controller solving NUM.

Week 13	Wed	19.05.21		
	Thu	20.05.21	Lab07	Tutoring of lab project.
Week 14	Wed	26.05.21		
	Thu	27.05.21		
Class time	39 L + 6 Exe + 15 Lab = 60			1° exam call – xx/06/2021 – at 10 am – Classroom TBD 2° exam call – xx/07/2021 – at 10 am – Classroom TBD 3° exam call – xx/09/2021 – at 10 am – Classroom TBD

Reference textbook

A. Baiocchi, *Network Traffic Engineering – Stochastic models and applications*, Wiley, 2020.

https://www.wiley.com/en-us/Network+Traffic+Engineering%3A+Stochastic+Models+and+Applications-p-9781119632436
(available to students at the library of DIET and NetLab, Room 106, DIET, 1st floor)



Course web site:
https://web.uniroma1.it/netlab/network-traffic-engineering