

Utility-based Optimisation of Resource Allocation for Wireless Networks

by

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Abstract

From providing only voice communications, wireless networks aim to provide a wide range of services in which soft real-time, high priority critical data, and best effort connections seamlessly integrate. Some of these applications and services have firm resource requirements in order to function properly (e.g. videoconferences), others are flexible enough to adapt to whatever is available (e.g. FTP). Providing differentiation and resource assurance is often referred to as providing quality of service (QoS). In this thesis we study how novel resource allocation algorithms can improve the offered QoS of dynamic, unpredictable, and resource constrained distributed systems, such as a wireless network, during periods of overload.

We propose and evaluate several bandwidth allocation schemes in the context of cellular, hybrid and pure ad hoc networks. Acceptable quality levels for a connection are specified using resource-utility functions, and our allocation aims to maximise accumulated system-wide utility. To keep allocation optimal in this changing environment, we need to periodically reallocate resources. The novelty of our approach is that we have augmented the utility function model by identifying and classifying the way reallocations affect the utility of different application classes. We modify the initial utility functions at runtime, such that connections become comparable regardless of their flexibility to reallocations or age-related importance.

Another contribution is a combined utility/price-based bandwidth allocation and routing scheme for ad hoc networks. First we cast the problem of utility maximisation in a linear programming form. Then we propose a novel distributed allocation algorithm, where every flow bids for resources on the end-to-end path depending on the resource "shadow price", and the flow's "utility efficiency". Our periodic (re)allocation algorithms represent an iterative process that both adapts to changes in the network, and recalculates and improves the estimation of resource shadow prices.

Finally, problems connected to allocation optimisation, such as modelling non-critical resources as costs, or using feedback to adapt to uncertainties in resource usage and availability, are addressed.

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