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Technology Administration, U.S. Department of Commerce

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Control-Based Mobile Ad-Hoc Networking: Achieving High-Level Objectives through Pricing

Vladimir Marbukh
marbukh@nist.gov

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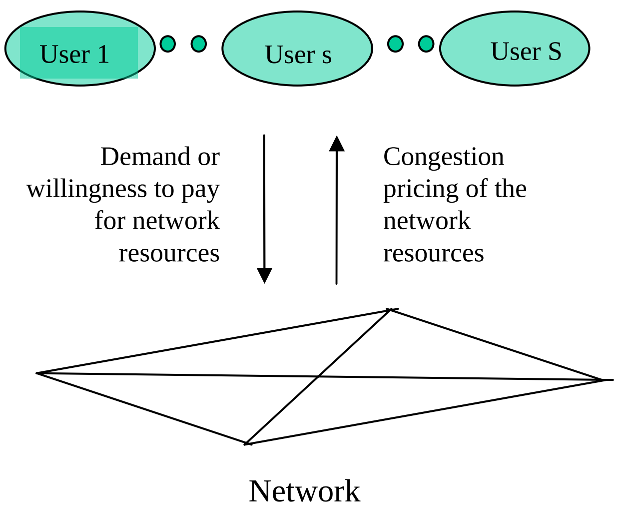
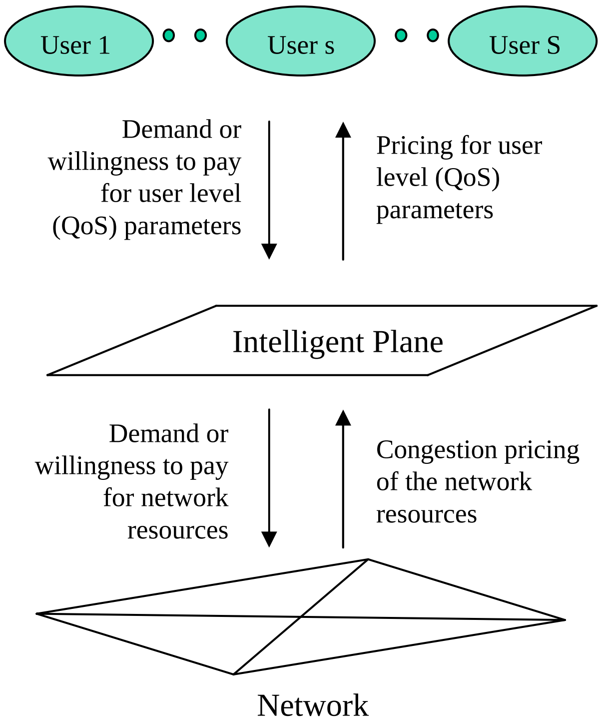
Aggregate Utility Maximization subject to Operational Constraints: Price-Based Approach

Prices are minimal sufficient statistics required to control a distributed system
- Frederick Hayek

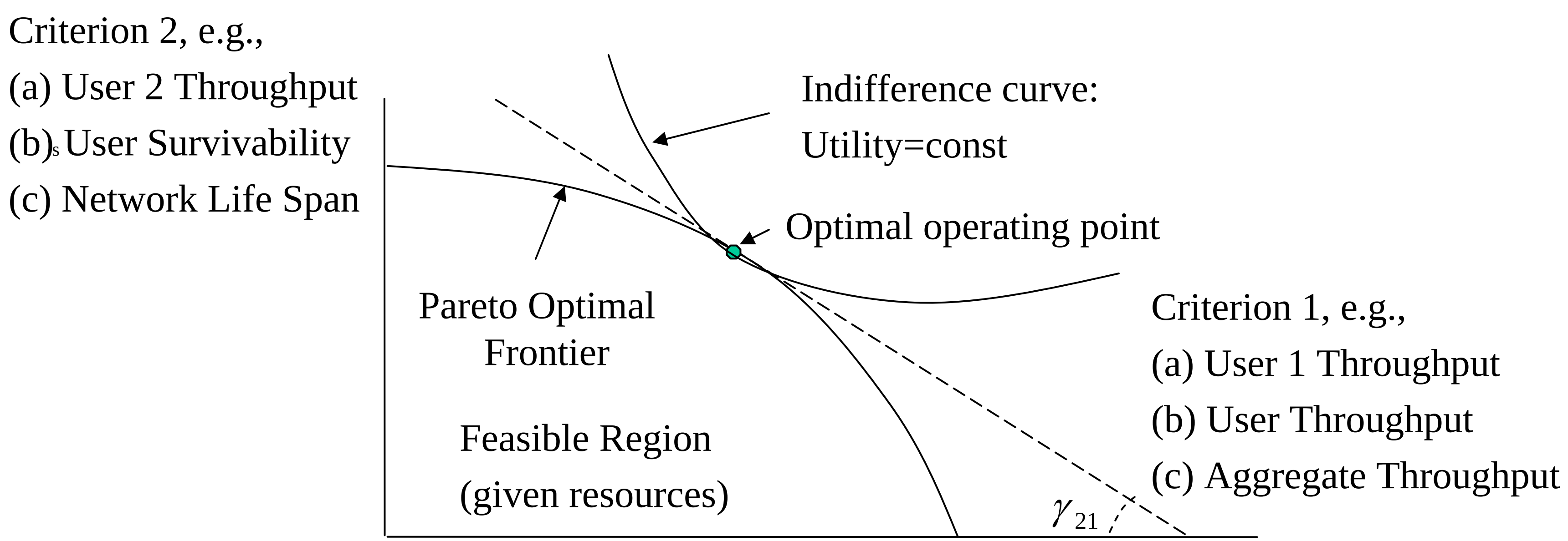


Pricing resources



Pricing user level requirements

Optimal Operating Point: Marginal Utility = Price

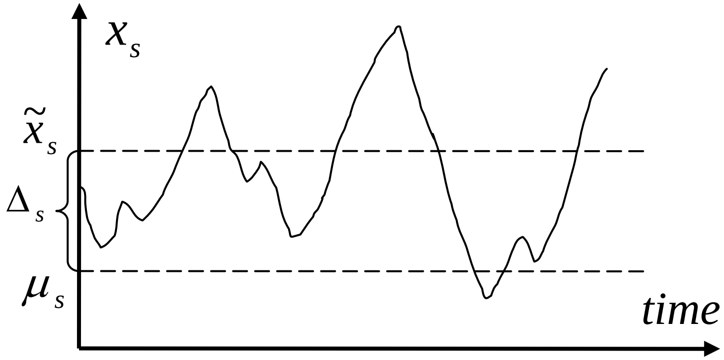


Cost of criterion 1 with respect to criterion 2: $\gamma_{21} = -\dfrac{\delta(Criterion\ \ 2)}{\delta(Criterion\ \ 1)}$

Criterion cost in terms of the resource j costs p_j (Lagrange multipliers) is as follows:

$$\delta(criterion_i) = \sum_j p_j \frac{\partial(criterion_i)}{\partial(resource_j)}$$

Example: Managing Throughput/Survivability trade-offs through Route Diversity Coding



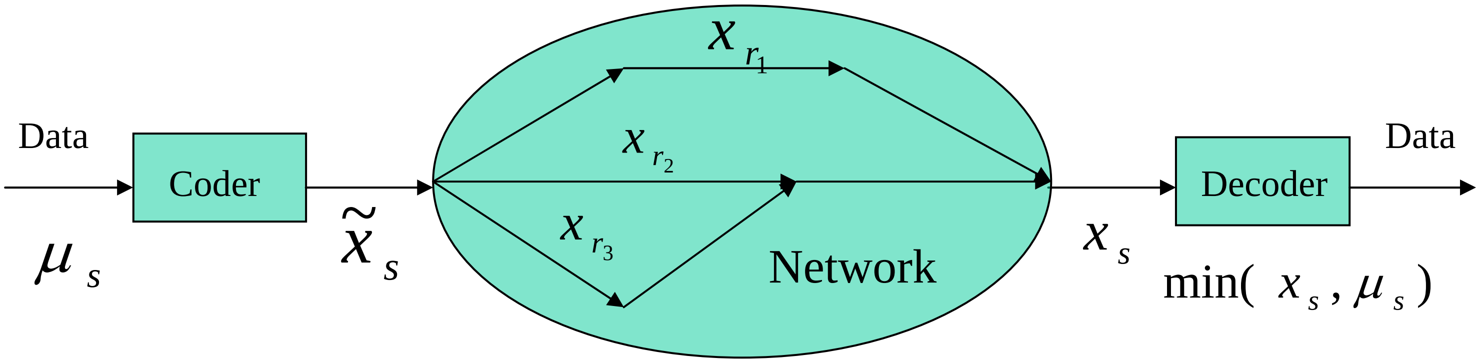
$\tilde{x}_s$ - User expected aggregate bandwidth

x_s - User available instantaneous aggregate bandwidth

μ_s - User data rate

Δ_s - User safety margin (for error correction)

Allowing for "safety margin" by providing extra aggregate bandwidth creates a trade-off between reliability and throughput for each user as well as across different users.



Route diversity coding mitigates effect of variations in network connectivity at the expense of utilizing multiple and typically more "expensive" routes.

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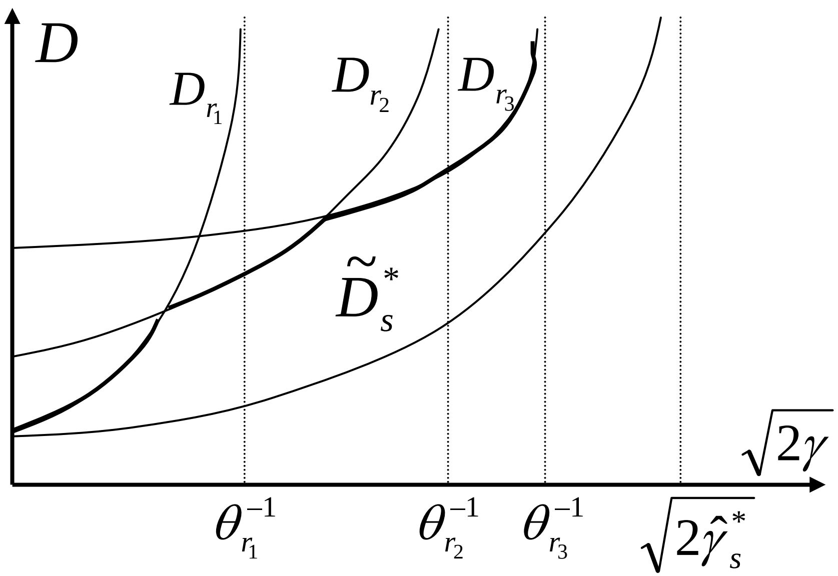
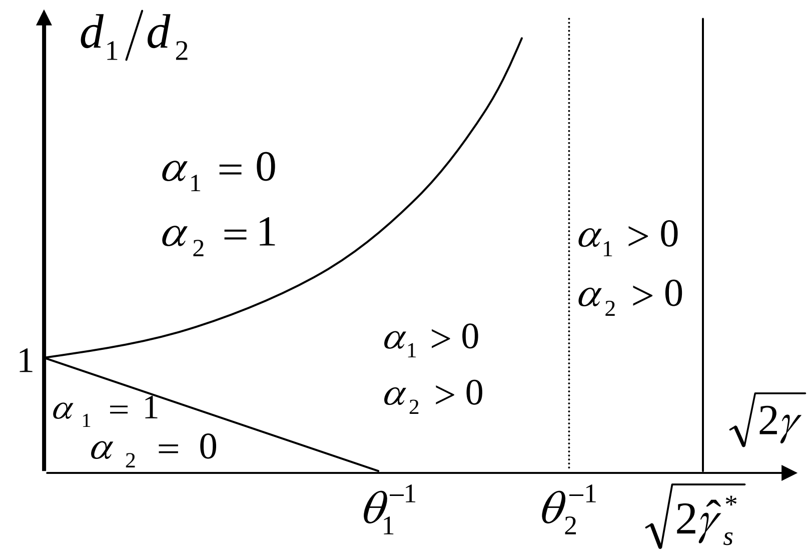
Distributed Route Diversity Coding Optimization through Pricing of the Reliable Throughput

Cross-layer optimization includes routing, flow control, and coding.



Congestion cost D of a unit of reliable throughput for a single-path (D_r) and multi-path ($\tilde{D}_s^*$) routing as a function of the reliability exponent γ.
Result: higher quality routes are more congested.



Individual net utility maximization: routing decisions depend on the route congestion costs d_1/d_2 and user reliability requirements γ, where α_i is a portion of user load to be carried on route r_i.

Thank you!!!