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Informatik VIII
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Masterkurs Rechnernetze / Master Lecture on Computer Networks (IN2907) — Tutorial

Class Assignment No. 2, WS 2009/2010

Abgabedatum / To be handed in by: 2009-12-14, 14h

To get a basic understanding of the topics to be discussed within this assignment, please read the following paper: `http://www.cc.gatech.edu/~dovrolis/Papers/NetDov0248.pdf`. In particular, section III.A and III.B provide essential background knowledge.

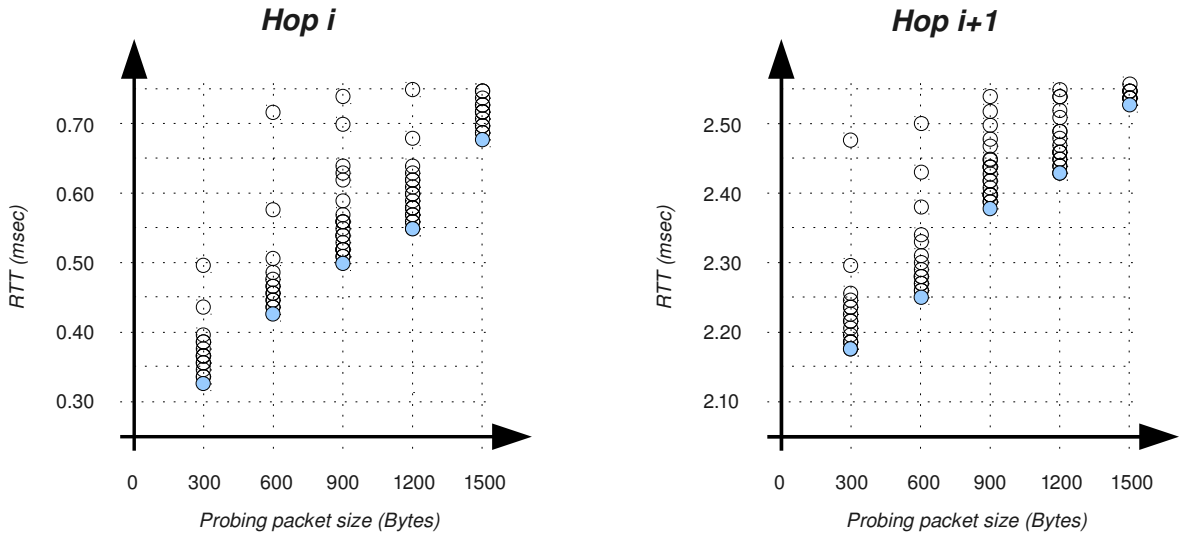
Exercise 5 — Variable packet size probing (VPS)

Goal: bandwidth measurement, hop-by-hop link capacities, theoretical approach

a) Make yourself familiar with the formula for calculating the minimum round trip time (RTT) $T_i(L)$ up to hop i for a given packet size L.

- *Explain in your own words how the VPS technique works, what values have to be measured and how the capacity estimation makes use of variable packet sizes.*
- *Explain at least two general problems with this approach.*
  (Hints: linear RTT increase, signal-to-noise, multiple paths, hidden hops)
- *Give a deduction of the per-hop-capacity formula* $C_i = \frac{1}{\beta_i - \beta_{i-1}}$.
- *Find out the formula for the 2D least-squares linear fit, i.e. how can* a *be computed in* $y(t) = a \cdot t + c$ *for discrete input data* t *and* $y(t)$ *(of length* n*)?*

b) Consider the following diagrams, showing the RTT measurements for two different hops.



Extract all relevant values from the diagrams, and answer the following questions:

- *What is your estimation for the link capacity from hop i to hop $i+1$? Use the already discussed VPS formula for the calculation.*
  (Hints: least-squares linear fit of minimum RTTs, per-hop-capacity formula)
- *What kind of underlying topology can be assumed?*

Exercise 6 — Packet pair probing (PP)

Goal: bandwidth measurement, end-to-end link capacity, theoretical approach

a) The PP formula for calculating end-to-end capacities is given by $C = \frac{L}{\Delta_R}$, where L is the packet size and Δ_R the packet dispersion at the receiver R.

- *What is the main (unrealistic but necessary) assumption of this approach for obtaining accurate bandwidth estimations?*
- *Are there measures to compensate this disadvantage? Explain briefly.*

b) Consider the following table providing local packet dispersion information for different link pairs (packet size 1500 Byte).

$A \to B$	$B \to C$	$C \to D$	$D \to E$	$E \to F$
190.18 msec	13.11 msec	2.35 msec	67.26 msec	3.75 msec

- *What is your estimation for the end-to-end link capacity $A \to F$?*
- *What underlying connection could be assumed?*