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Monitoring in Disadvantaged Grids

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Monitoring dynamic networks

- Best effort handling of network traffic is not good enough when resources are scarce
- Efficient automatic adaptation of the traffic injected into the network is only possible if the resource situation is known
- In dynamic networks, resource availability varies
  - The total capacity of the network is deployment specific, and should be measured for planning purposes
  - Knowledge about the current resource situation can enable better resource usage efficiency

Monitoring tool categories

- Active
  - Measures by probing, which means inserting traffic into the network
  - Can measure any part of the network independent of whether the network is being used
  - Increases the load on the network

- Passive
  - Measures by observation of already existing traffic
  - Often piggy-backs information on ongoing traffic

- Hybrid
  - Combines elements from passive and active techniques in different ways

Measuring “Bandwidth”

- Different tools measure different things
  - Capacity
  - Available bandwidth
  - TCP throughput

  - Per-hop vs path

Capacity	The maximum rate at which packets can be transmitted by a link
Narrow link	The link with the smallest capacity along a path
Available bandwidth	A link’s unused capacity
Tight link	The link with minimum available bandwidth along a path
Cross traffic	Traffic other than the traffic created by the probing

Factors to consider

- Intrusiveness
  - The intrusiveness of a monitoring technique describes which impact the monitoring tool has on other traffic in network being measured
  - Flooding
    - Simple to implement and understand
    - Highly intrusive
  - Packet Pair
    - Sends a pair of probes and calculates performance factors based on the observed behavior of these
    - Less intrusive
    - Higher calculation overhead
  - and many others…

Factors to consider

- Responsiveness
  - Measurements are always “outdated”
    - Predicting the future based on past events
  - Disadvantaged grids are often dynamic
    - The future can be very different from even the near past
  - ➢ Indicates that a short look back window should be used

  - Basing results on one (or a few) measurements can give large variations in the results
    - One lost packet can cause a large shift in measured performance
    - Temporary interference can cause connections to drop briefly
  - ➢ Indicates that a longer look back window should be used

Monitoring tool tests

- Requirement analysis based on the properties of dynamic, low capacity networks
  - Low intrusiveness
  - Short response time
  - End-to-end measurement (due to our intended use for the results)
  - Generic software solution
  - Ability to measure both capacity and available bandwidth
  - And for practical reasons: limited to openly available tools

Monitoring tool tests

- We did a theoretical evaluation of a number of monitoring tools
  - Identified key properties of each tool
  - Table showing the full list in the paper

- Based on the theoretical evaluation we tested two promising tools
  - Low capacity emulated network

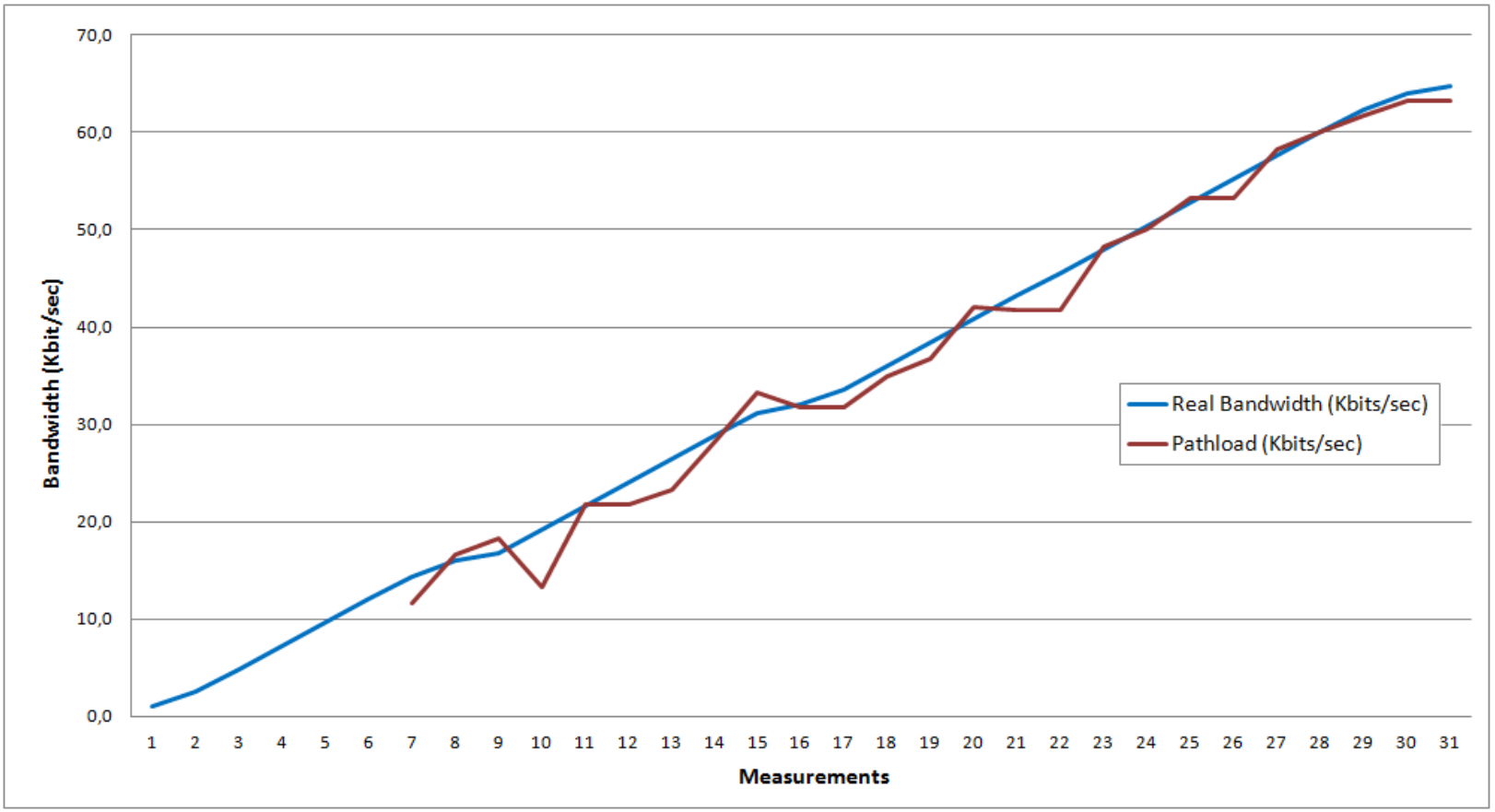
Pathload

One-way delay of periodic packet streams will increase if the sending rate is higher than the available bandwidth.

- Iterative process, so multiple streams are required to get a result.
- Based on one-way delay
  - Requires support at both the sender and receiver side

- Chosen because
  - It can measure most the network parameters we are interested in
  - Fairly low intrusiveness
  - Generates results fast

Pathload

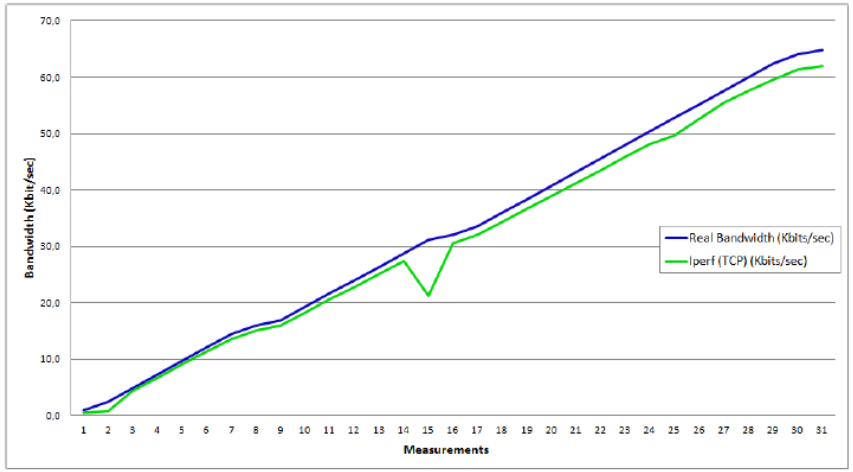

70,0
60,0
50,0
40,0
30,0
20,0
10,0
0,0
Bandwidth (Kbit/sec)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Measurements
Real Bandwidth (Kbits/sec)
Pathload (Kbits/sec)

Iperf

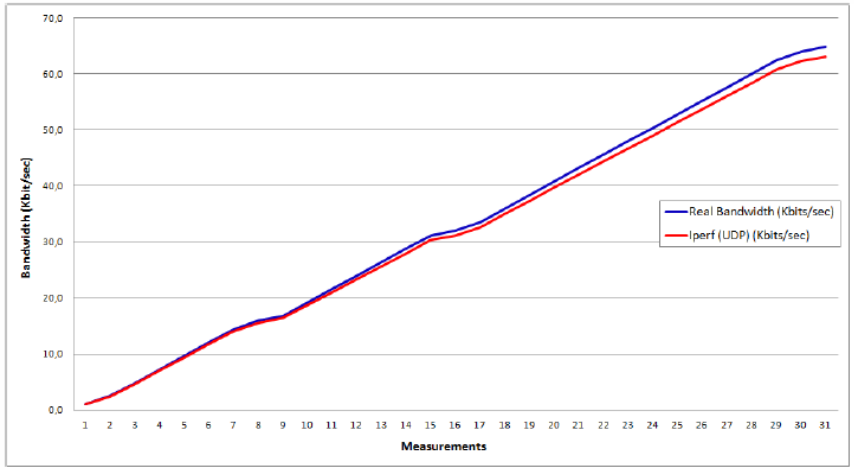
Floods the network path that is being measured with either TCP or UDP streams to determine the path capacity.

- Two modes: TCP and UDP
  - UDP measurement gives throughput and packet loss rate
  - TCP measurement gives TCP throughput
- Chosen because:
  - Most promising tool for measuring capacity
  - Can measure either one-way of round trip
- However, flooding makes it intrusive

Iperf



(a) Iperf measurements - TCP protocol.



(b) Iperf measurements - the UDP protocol.

Tool Comparison

Pathload

- Measures available bandwidth
- Fleet of streams approach
  - low intrusiveness
  - streams discarded if results are inconclusive
- Difficult to get results at very low capacities
  - In our experiment, the lower limit was at 14.4 kbps

Iperf

- Measures capacity (UPD)
  - less than 3% difference between actual and measured capacity
  - flooding
- Measures TCP throughput (TCP)
  - ~4-5% delta
  - packet loss can affect accuracy
  - less intrusive than the UDP mode

Summary

- Knowledge about networking conditions
  - An enabler for automatic adaptation of information flows and more advanced network and system management
  - Useful both in the network setup/configuration phase and at runtime

- Monitoring dynamic networks is challenging, but freely available tools can give reasonable results
  - Pathload gives fairly accurate measurements for available bandwidth
    - But only over a certain threshold
  - Iperf can be used to find the maximum capacity of the current network configuration
    - Should not be used during operation as it influences other traffic