

BitTorrent Experiments on Testbeds: A Study of the Impact of Network Latencies

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Outline

Introduction

Methodology

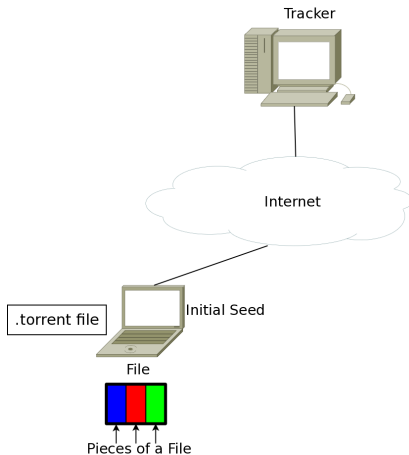
Experimental Results

Homogeneous Latency

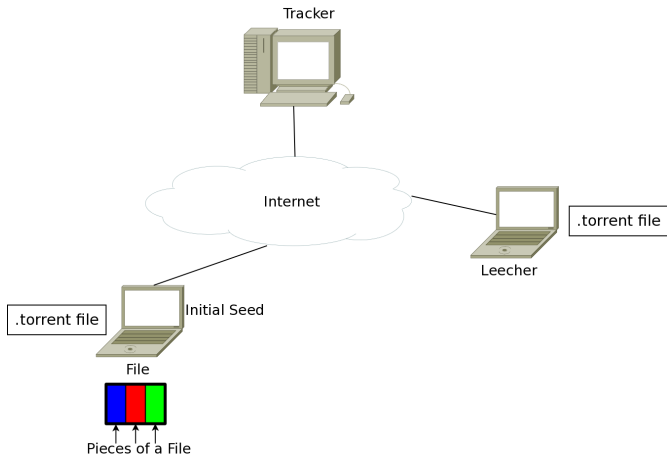
Heterogeneous Latency

Conclusion

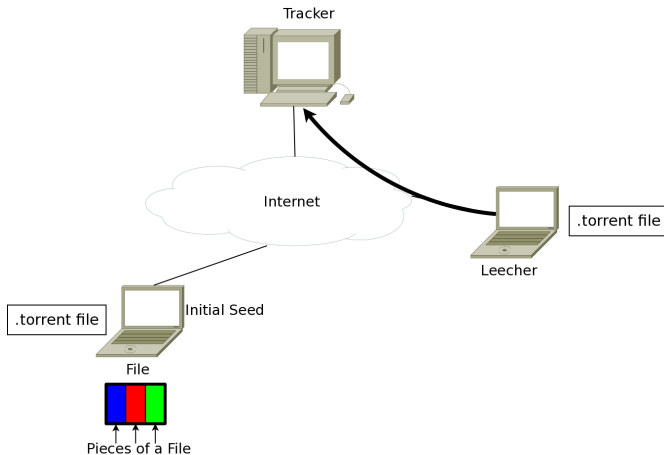
Overview of BitTorrent



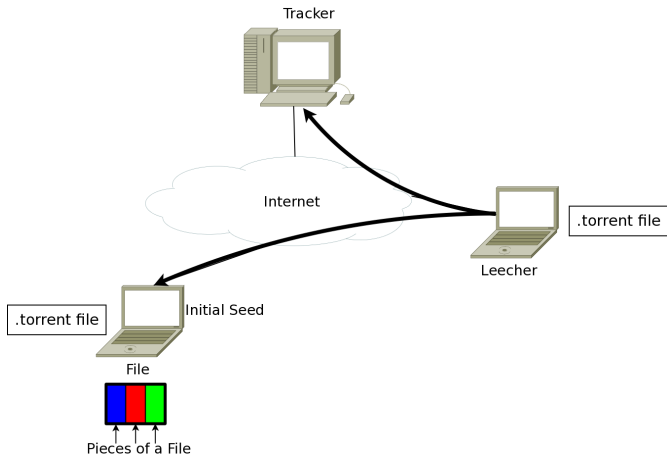
Overview of BitTorrent



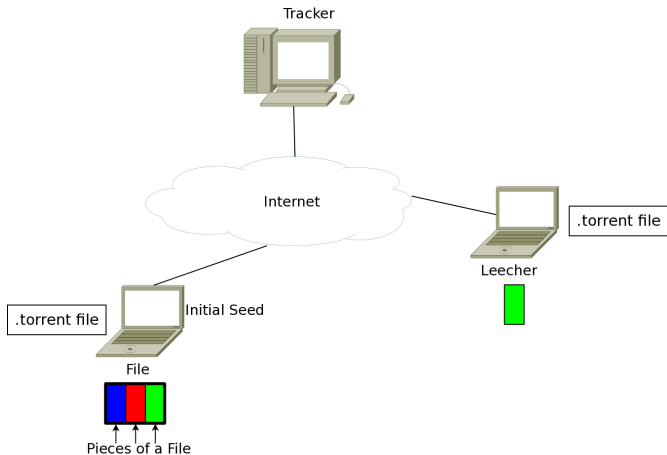
Overview of BitTorrent



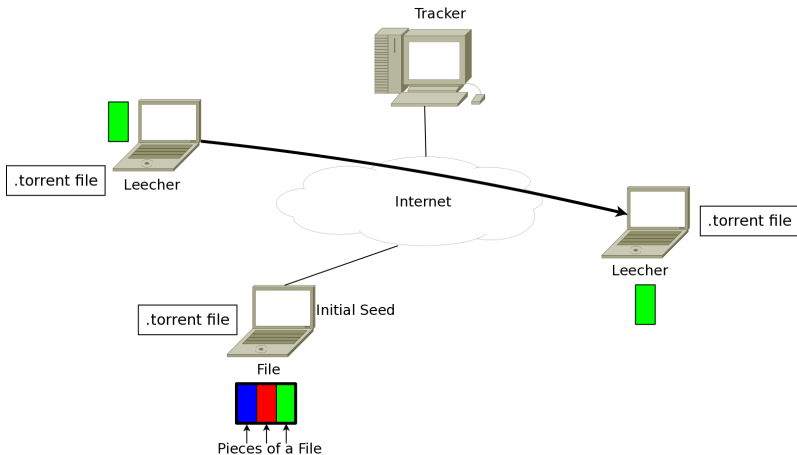
Overview of BitTorrent



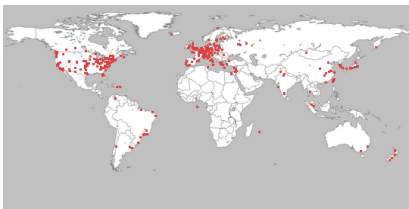
Overview of BitTorrent



Overview of BitTorrent



Evaluation of BitTorrent Performance



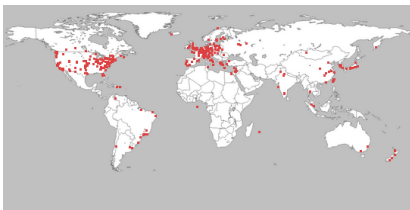
Planetlab sites [planet-lab.org]



Grid5000 sites
[grid5000.fr]

- Grid5000 and PlaneteLab Testbeds

Evaluation of BitTorrent Performance



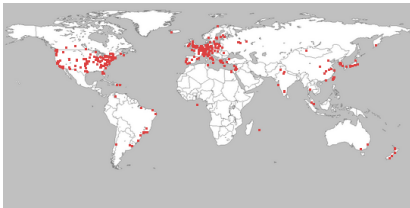
Planetlab sites [planet-lab.org]



Grid5000 sites
[grid5000.fr]

- Grid5000 and PlaneteLab Testbeds
- Absence of network latency between
 - Instances of application running on same machine
 - Machines in the same LAN

Evaluation of BitTorrent Performance



Planetlab sites [planet-lab.org]

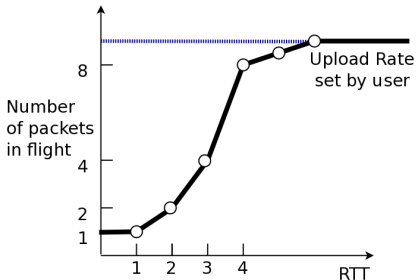


Grid5000 sites
[grid5000.fr]

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- Absence of network latency between
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 - Machines in the same LAN

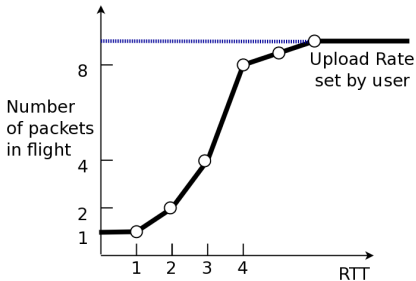
Does network latency affect the outcome of BitTorrent experiments performed on testbeds

Can Latency Impact BitTorrent Performance?

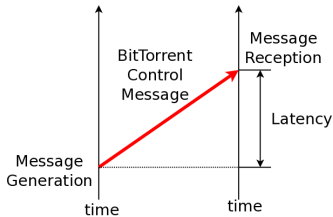


TCP Ramp-up and Impact of Upload Rates

Can Latency Impact BitTorrent Performance?

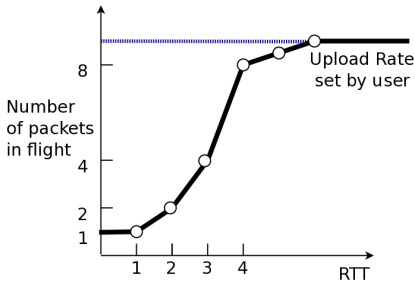


TCP Ramp-up and Impact of Upload Rates

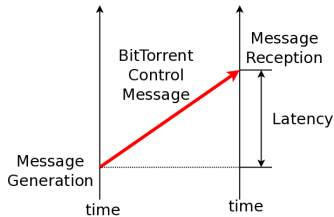


Delays in receiving BitTorrent control messages

Can Latency Impact BitTorrent Performance?



TCP Ramp-up and Impact of Upload Rates



Delays in receiving BitTorrent control messages

Can testbeds such as Grid5000 be used for experimental evaluation of BitTorrent?

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Introduction

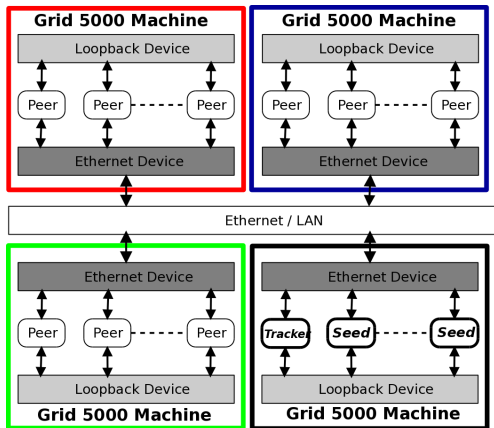
Methodology

Experimental Results

Homogeneous Latency
Heterogeneous Latency

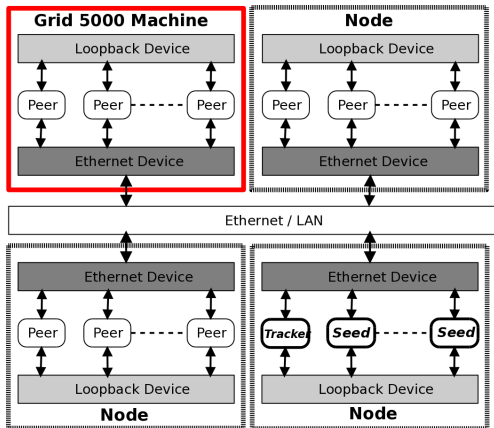
Conclusion

Testbed Setup



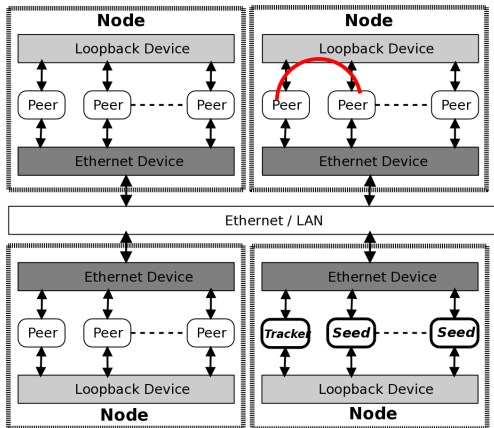
4 Machines of Grid5000 Experimental Testbed

Testbed Setup



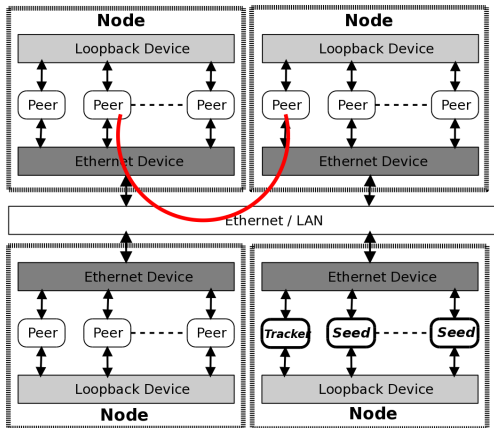
Machines capable of running 100 instances of BitTorrent Client

Testbed Setup



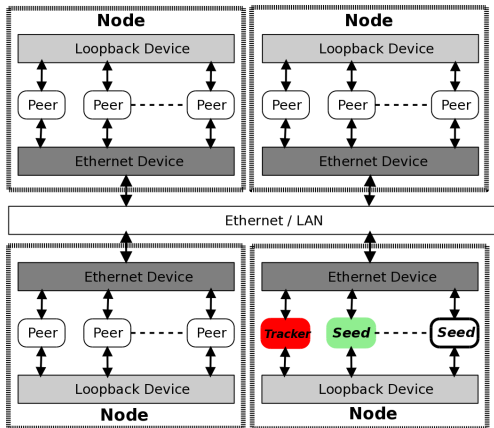
Peers on same machine communicate using Loopback device

Testbed Setup



Peers on different machines communicate using Ethernet device

Testbed Setup



Tracker and Seed placed on same machine

Experiment Setup

- Experiment Parameters
 - 50 MB file
 - 1 Tracker, 1 Seed, and 300 Leechers
 - Upload rates - 10 KiB/s to 100 KiB/s
 - Emulate RTT - 1000 ms
- Metric
 - Download completion time

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Methodology

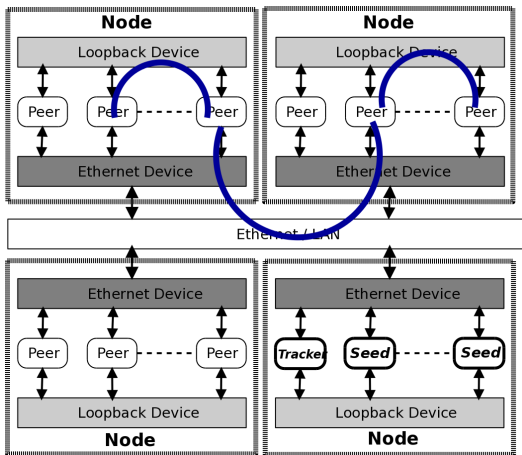
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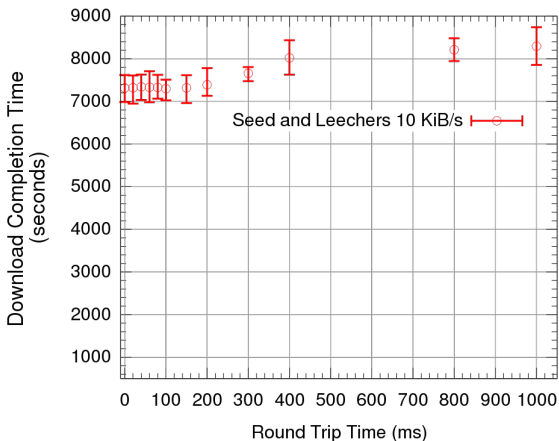
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Homogeneous Latency - Setup



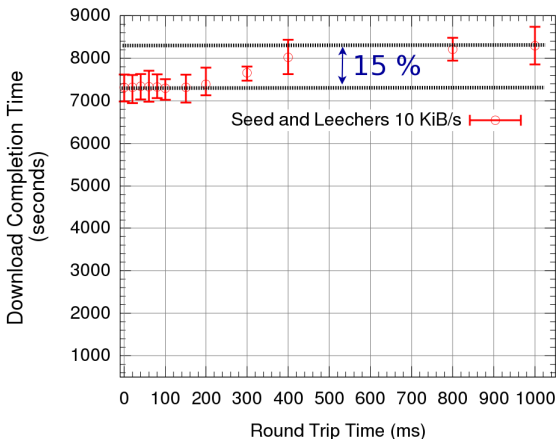
Same delay on Loopback and Ethernet Device

Homogeneous Latency - Experiment Results



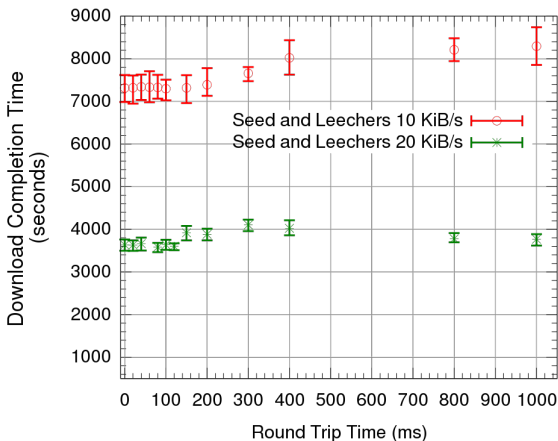
Download Completion Time vs RTT

Homogeneous Latency - Experiment Results



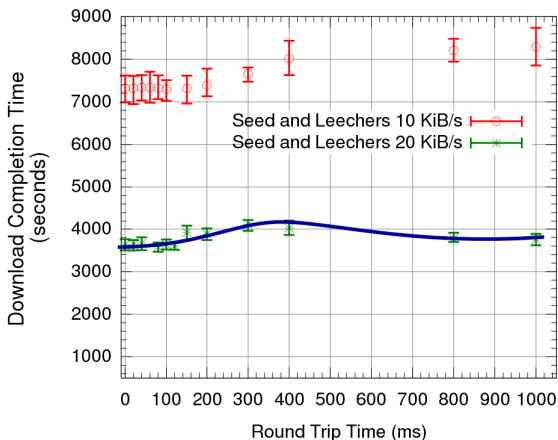
1000 ms RTT does not increase Average Download Completion Time by more than 15%

Homogeneous Latency - Experiment Results



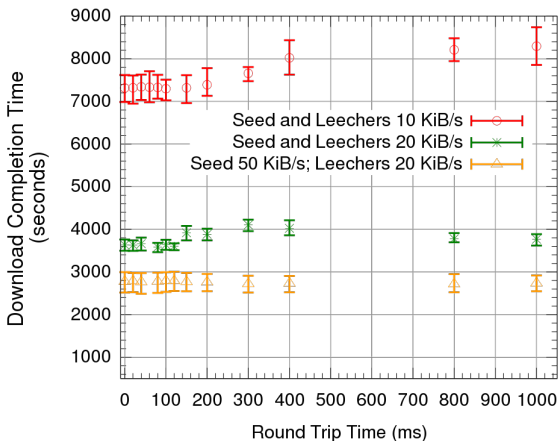
Download Completion Time not a monotonously increasing function of RTT

Homogeneous Latency - Experiment Results



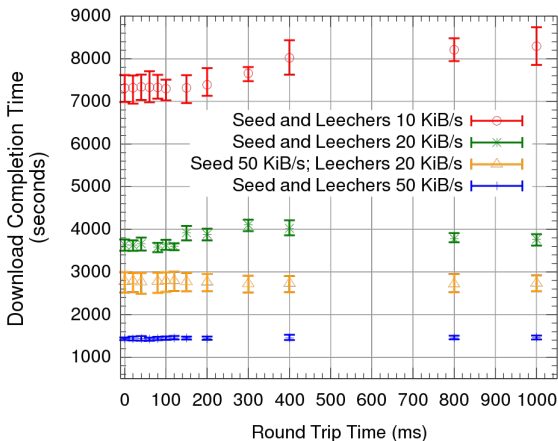
Download Completion Time not a monotonously increasing function of RTT

Homogeneous Latency - Experiment Results



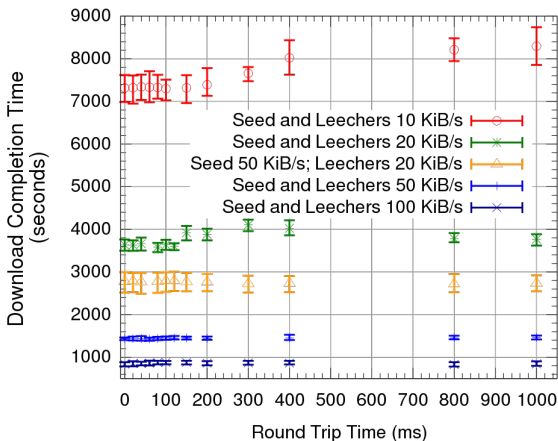
Impact of latency not observed when seed is fast

Homogeneous Latency - Experiment Results



Marginal impact of RTT

Homogeneous Latency - Experiment Results



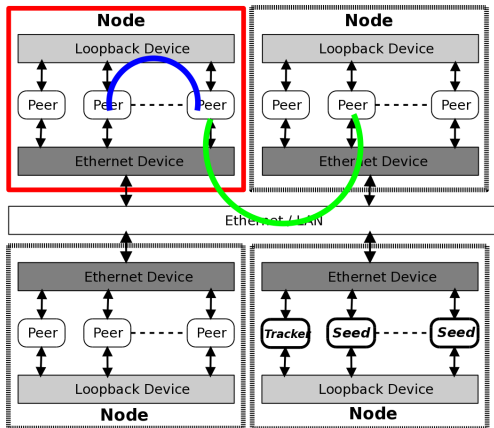
Marginal impact of RTT

Heterogeneous Latency



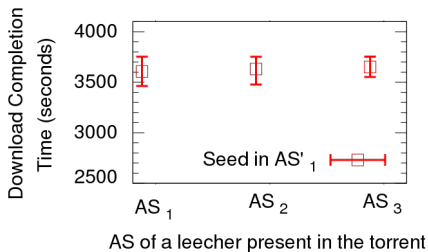
Each machine used to abstract an AS

Heterogeneous Latency

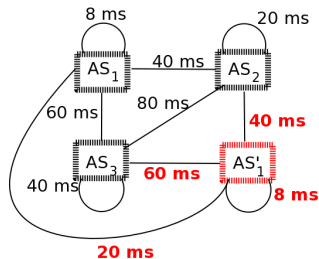


Different latency on loopback and ethernet device

Results - Small RTT Between Peers



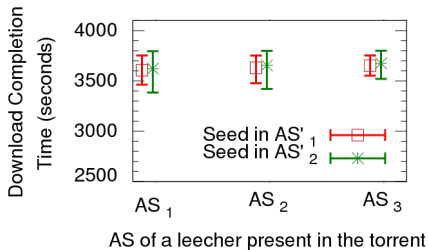
Upload Rate limited to
20 kB/s.



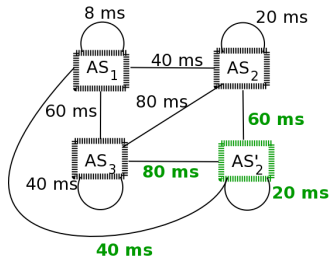
RTT between a pair of
leechers.

RTT between any two peers is less than 100 ms

Results - Small RTT Between Peers



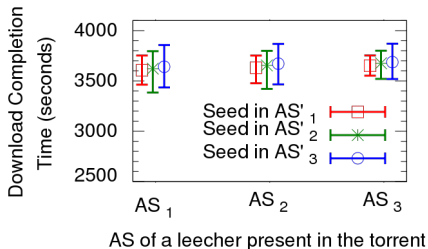
Upload Rate limited to
20 kB/s.



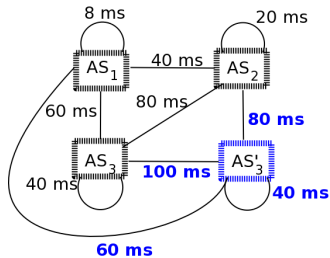
RTT between any two peers is less than 100 ms

Marginal Impact of Latency

Results - Small RTT Between Peers



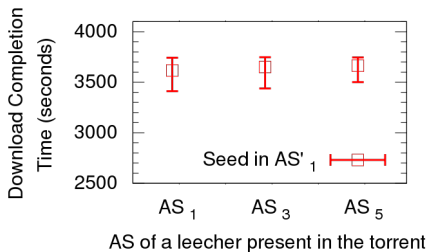
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20 kB/s.



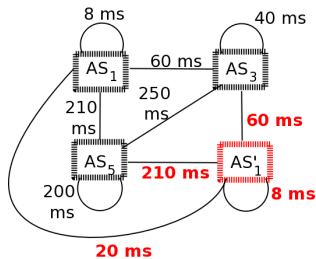
RTT between any two peers is less than 100 ms

Marginal Impact of Latency

Results - Large RTT Between Some Peers



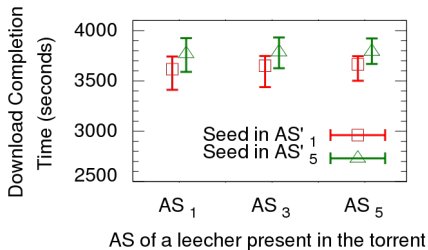
Upload Rate limited to
20 kB/s.



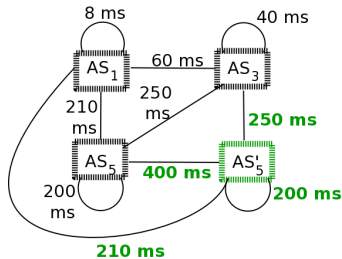
RTT between a pair of
leechers.

RTT between some of the peers is greater than 200 ms

Results - Large RTT Between Some Peers



Upload Rate limited to
20 kB/s.



RTT between some of the peers is greater than 200 ms

Marginal Impact of Latency

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- Latency has a marginal impact on the outcome of BitTorrent experiments

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BitTorrent experiments can be performed on testbeds without explicitly emulating latency.

BitTorrent Experiments on Testbeds: A Study of the Impact of Network Latencies

Ashwin Rao (ashwin.rao@inria.fr)

TCP Segmentation Offloading

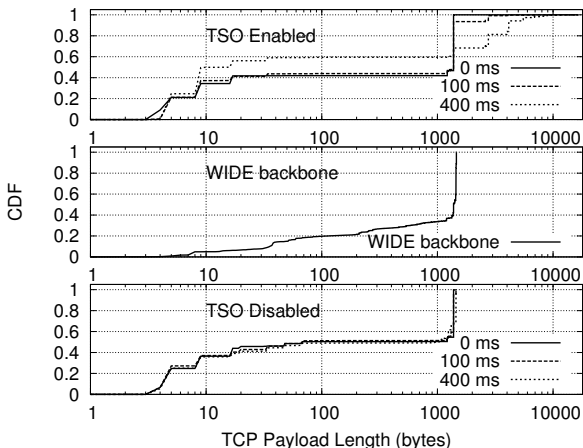


Figure: Impact of Segmentation Offloading

Number of Nodes on a Machine

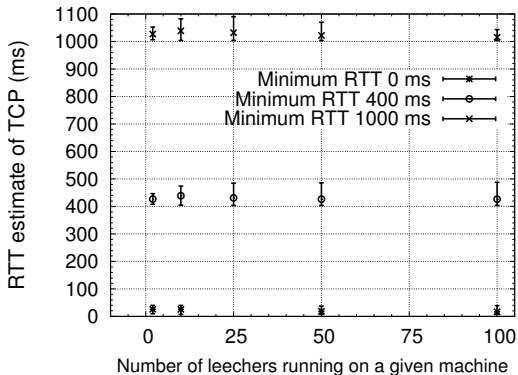
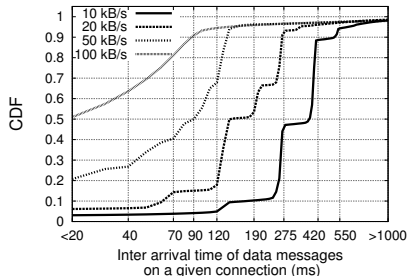
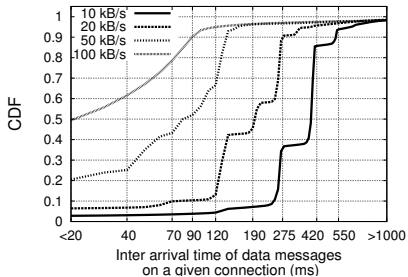


Figure: Impact of Number of Nodes on a Machine

Machines support up to 100 instances of a leecher

Send Call Inter-arrival Time



RTT between pair of peers

	AS_1	AS_2	AS_3	AS_4	AS_5
AS_1	8 ms	40 ms	60 ms	210 ms	210 ms
AS_2	40 ms	20 ms	80 ms	230 ms	230 ms
AS_3	60 ms	80 ms	40 ms	250 ms	250 ms
AS_4	210 ms	230 ms	250 ms	100 ms	400 ms
AS_5	210 ms	230 ms	250 ms	400 ms	200 ms

Table: RTT between a pair of leechers.

	AS_1	AS_2	AS_3	AS_4	AS_5
AS'_1	20 ms	40 ms	60 ms	210 ms	210 ms
AS'_2	40 ms	60 ms	80 ms	230 ms	230 ms
AS'_3	60 ms	80 ms	100 ms	250 ms	250 ms
AS'_4	210 ms	230 ms	250 ms	400 ms	400 ms
AS'_5	210 ms	230 ms	250 ms	400 ms	400 ms

Table: RTT between the initial seed and the leechers.

Results - Large RTT Between Some Peers

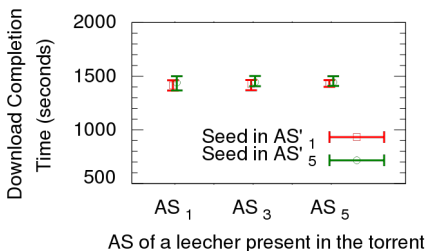


Figure: Upload rate limited to 50 KiB/s. RTT between some peers more than 100 ms.

RTT of even
400 ms has
marginal impact on
download
completion time

	AS_1	AS_3	AS_5
AS_1	8 ms	60 ms	210 ms
AS_3	60 ms	40 ms	250 ms
AS_5	210 ms	250 ms	200 ms
AS'_1	20 ms	60 ms	210 ms
AS'_5	210 ms	250 ms	400 ms

Table: RTT between a pair of leechers.

Results - Large RTT Between Some Peers

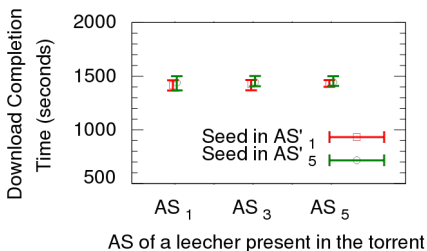


Figure: Upload rate limited to 50 KiB/s. RTT between some peers more than 100 ms.

RTT of even
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	AS ₁	AS ₃	AS ₅
AS ₁	8 ms	60 ms	210 ms
AS ₃	60 ms	40 ms	250 ms
AS ₅	210 ms	250 ms	200 ms
AS' ₁	20 ms	60 ms	210 ms
AS' ₅	210 ms	250 ms	400 ms

Table: RTT between a pair of leechers.