A Vegas-based Approach for MPTCP Congestion Control

MPTCP – 84. IETF Vancouver – July 31, 2012

Mirja Kühlewind, Régel González Usach
mirja.kuehlewind@ikr.uni-stuttgart.de

Semi-coupled Reno-Based Congestion Control

RFC6356

Increase	$cwnd_i$	by	$min(\alpha/cwnd_{total}, 1/cwnd_i)$	for each ACK on subflow i
Decrease	$cwnd_i$	to	$max(cwnd_i - cwnd_i/2, 1)$	for each loss event on subflow i

- Increase of $cwnd_i$ of each subflow i coupled by a factor α (same for all subflows)
- Sum throughput of all subflows at least as much as a single TCP would get on the best path
- Always slower increase rate on each subflow than single TCP ($\alpha < 1$)

  → Each subflow gets a smaller share than one TCP Reno flow would get on the same link

→ To change the increase in TCP Vegas would not lead to a different share

→ TCP Vegas always aims to share the available capacity equally

→ A smaller increase rate will only take longer to converge

Vegas-based MPTCP Congestion Control

Principle of TCP Vegas

- Compare an expected sending rate with the actual sending rate
- Calculate increase/decrease (once per RTT) if threshold is reached

  if $cwnd / RTT_{min} - cwnd / RTT < \alpha$ then increase *cwnd* by 1

  if $cwnd / RTT_{min} - cwnd / RTT > \beta$ then decrease *cwnd* by 1

- Halve congestion window on loss: cwnd = $max(cwnd - cwnd_i/2, 1)$

Vegas-based Approach for MPTCP congestion control (MPVegas)

- Adjust thresholds to achieve different shares of capacity on one link
- Calculate increase/decrease (once per RTT) with thresholds scaled by k_i on subflow *i*

  if $cwnd / RTT_{min} - cwnd / RTT < \boldsymbol{k_i} * \alpha$ then increase *cwnd* by 1

  if $cwnd / RTT_{min} - cwnd / RTT > \boldsymbol{k_i} * \beta$ then decrease *cwnd* by 1

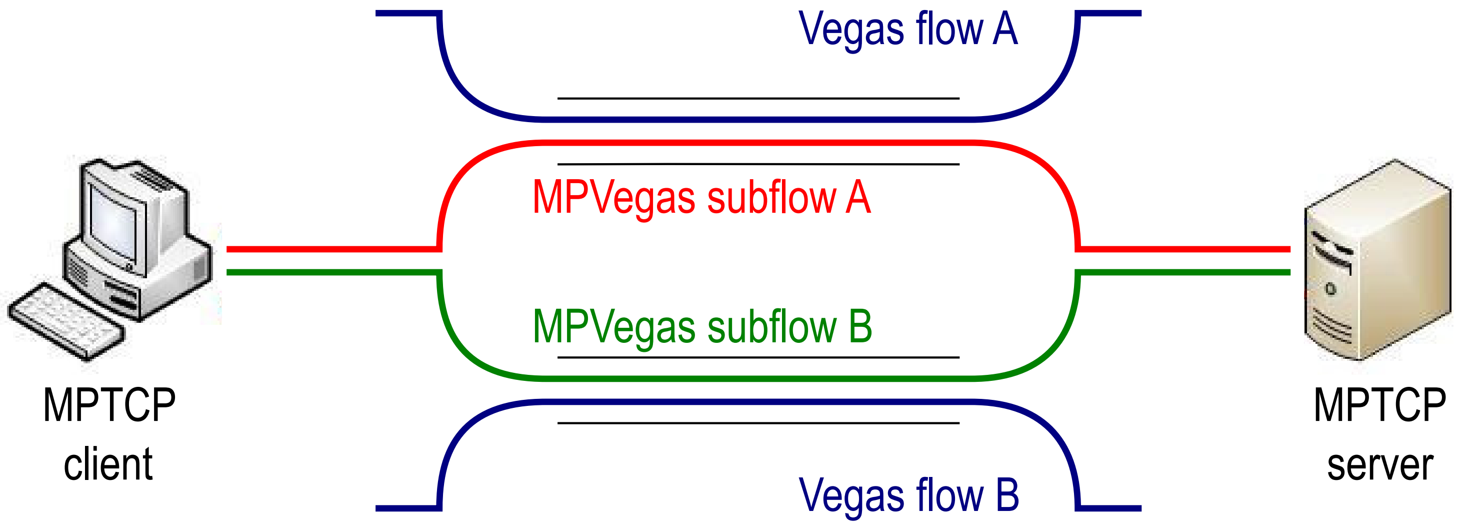
  with $k_i = expected\_throughput_i / sum\_throughput$

Implementation

- MPTCP protocol extension not implemented
- Only congestion control algorithm
  - Linux kernel module
  - Small number of state variable that can be accessed by all congestion control procedures of all subflows
  - Approximation when calculating the maximum rate from all subflow to simplify implementation

$\rightarrow$ In simulations all TCP connections initiated by one network stack are regarded as subflows of one MPTCP connection

Simulation Scenario

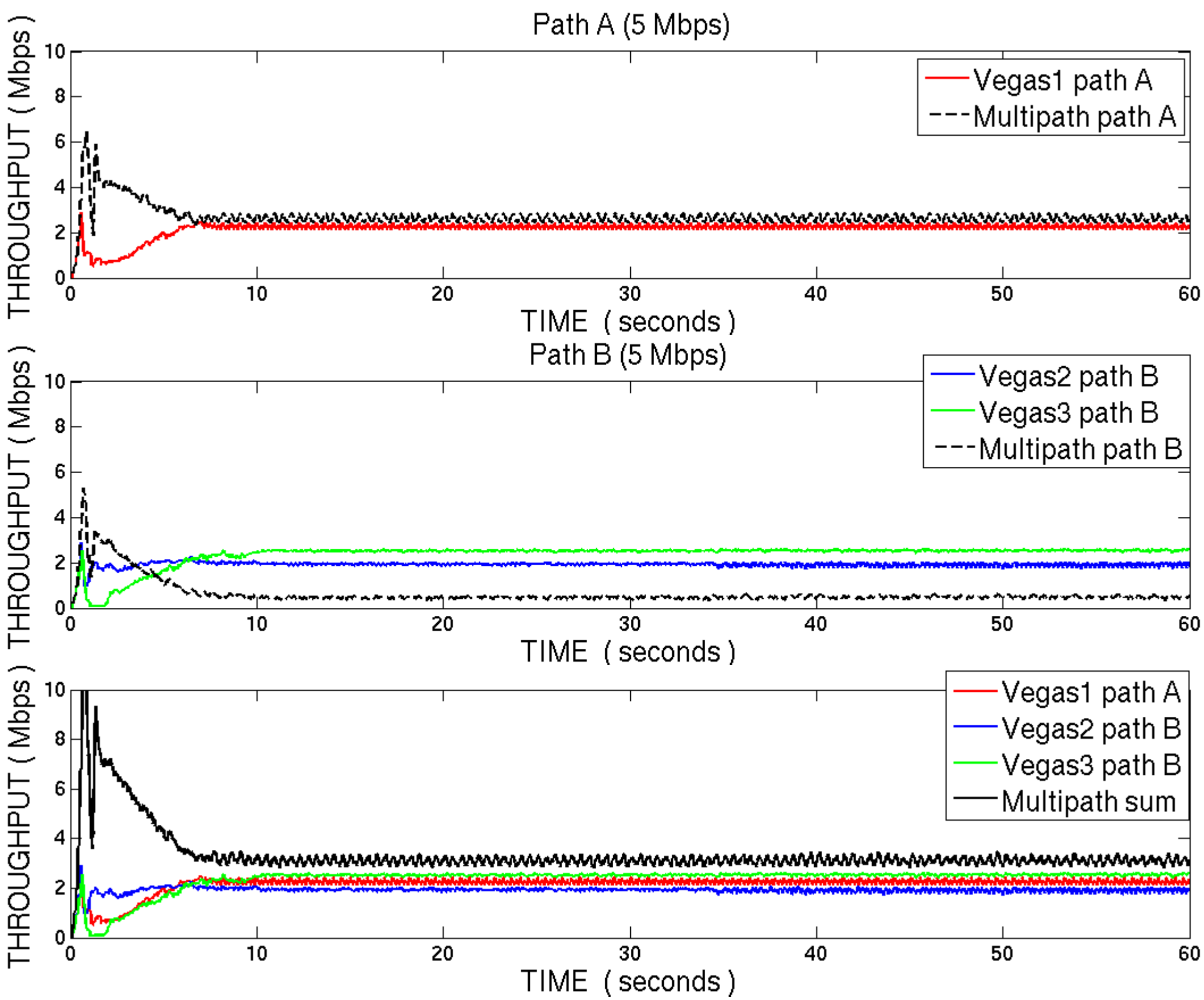


- **Scenario 1:** Two paths with same capacity and TCP Vegas Cross Traffic
  Path A **5 Mbps**, path B **5 Mbps**, **50 ms** One-Way-Delay (OWD) for all subflows
  One TCP Vegas flow on path A and twoTCP Vegas flows on path B
- **Scenario 2:** Three paths with different capacity and TCP Vegas Cross Traffic
  Path A **10 Mbps**, path B **5 Mbps**, path C **2.5 Mbps**, **50 ms** OWD for all subflows
  One TCP Vegas flow on each path

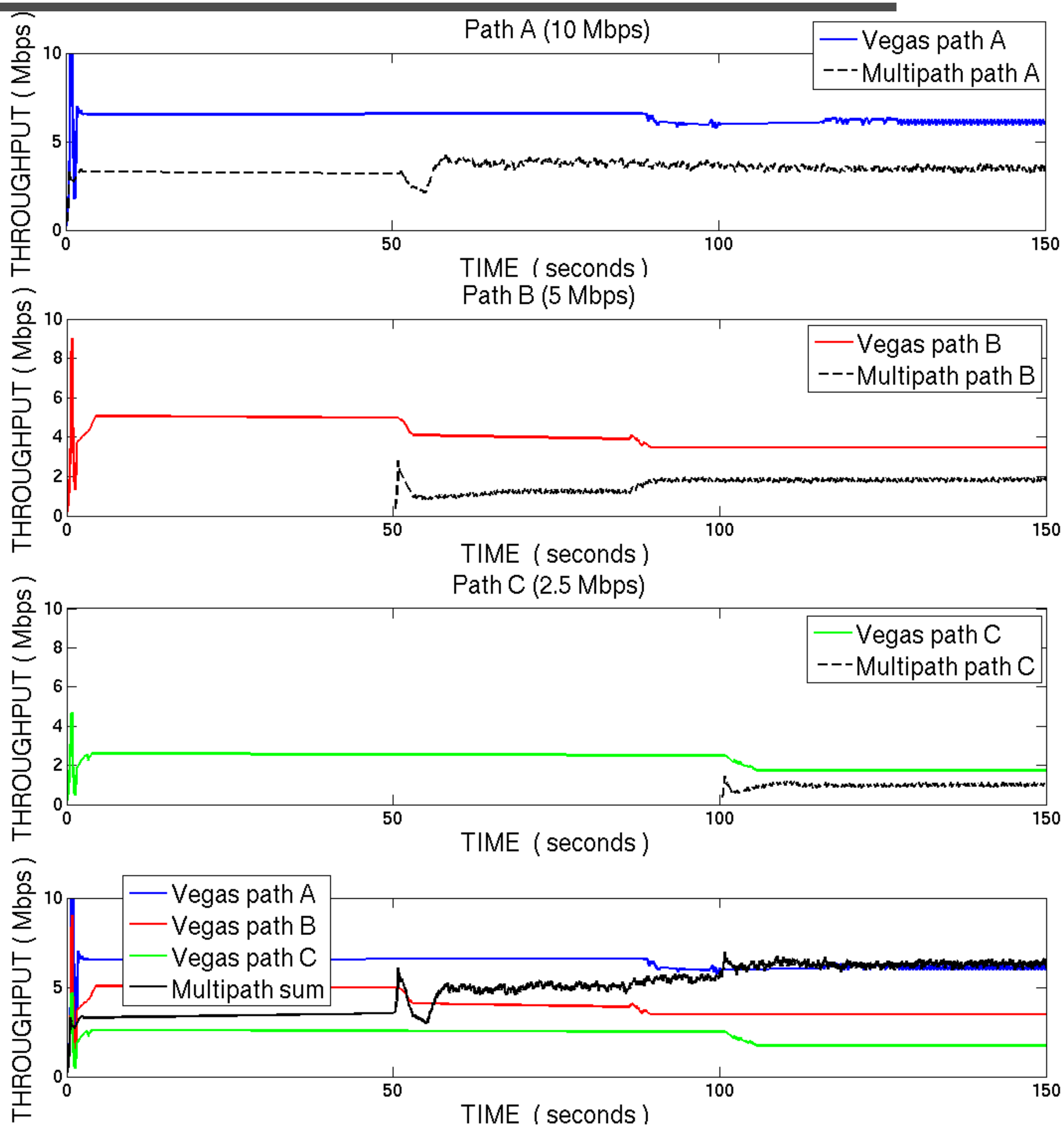
→ We measure the cwnd and throughput at sender side

First Look on MPVegas Congestion Control

Scenario 1: Two Path with Same Capacity and TCP Vegas Traffic



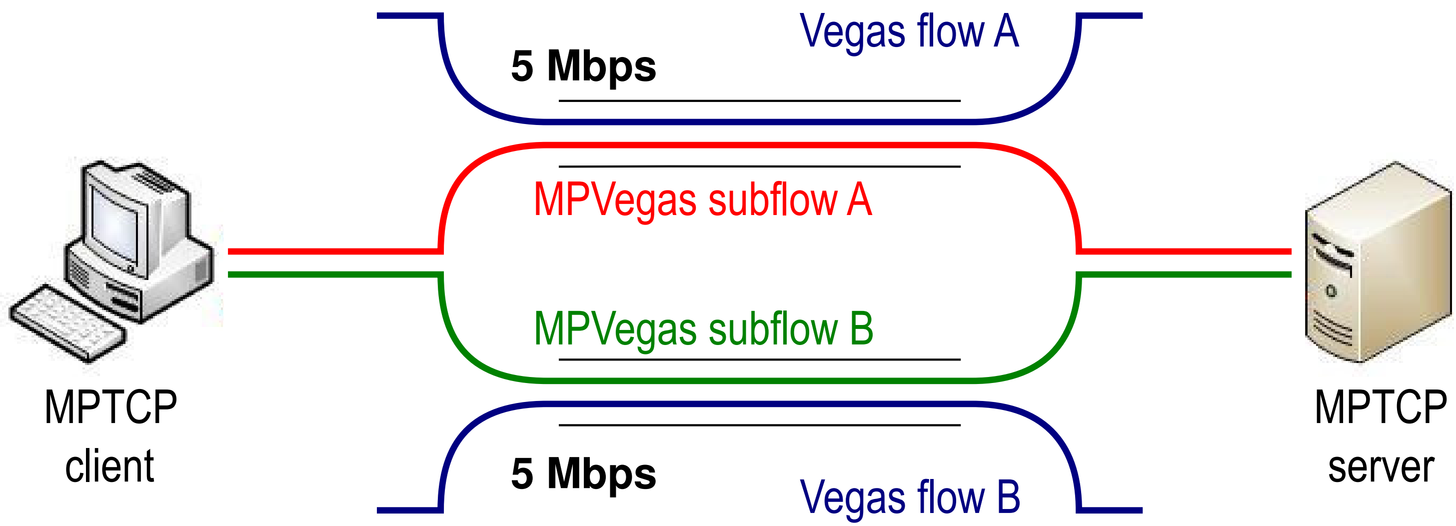
First Look on MPVegas Congestion Control



Questions?

Backup

Example on the Resource Pooling Principle



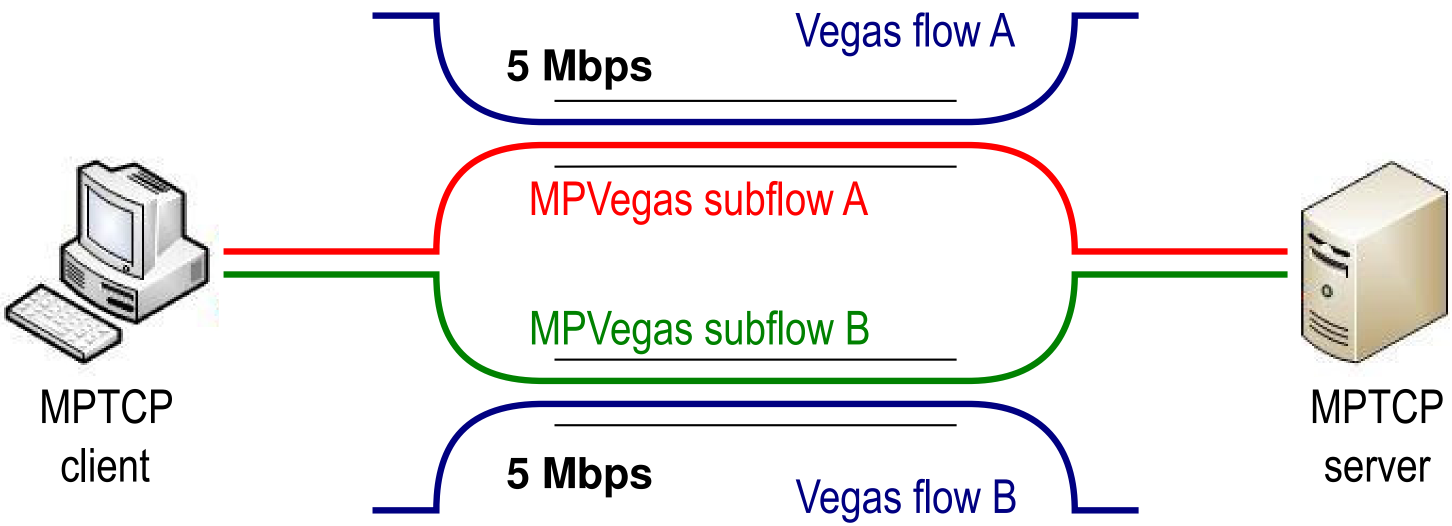
Sum capacity (5 Mbps + 5 Mbps): **10 Mbps**

Each flow should get 1/3 of sum capacity (10 Mbps / 3): **3.33 Mbps**

→ Reno flow A gets **2/3 of path A**
→ Reno flow B gets **2/3 of path B**
→ Each MPTCP subflow gets **1/3 of each path (A and B)**

→ Equal share over all resources

Example on the Resource Pooling Principle



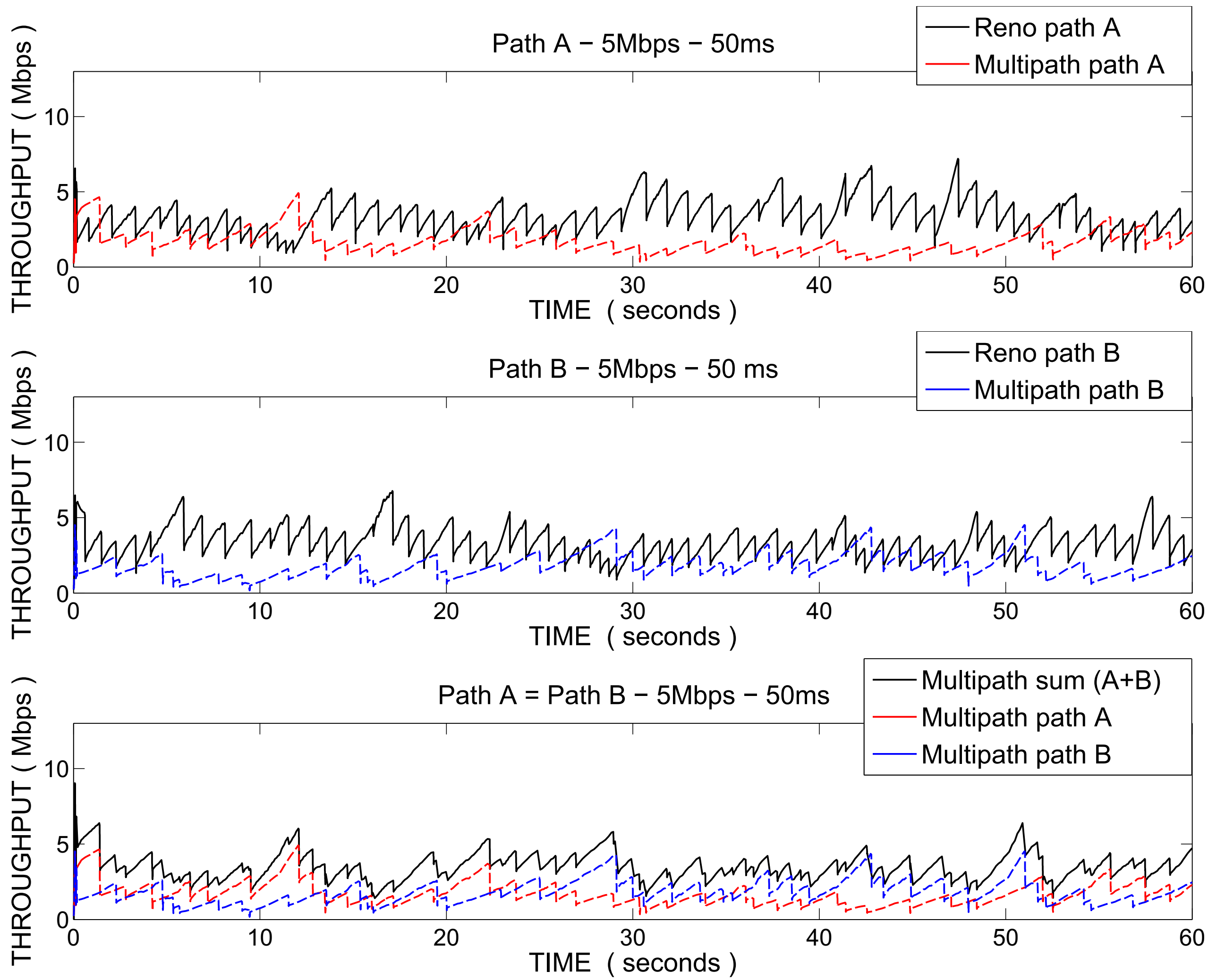
Sum capacity (5 Mbps + 5 Mbps):	**10 Mbps**
Each flow should get 1/3 of sum capacity (10 Mbps / 3):	**3.33 Mbps**

→ Reno flow A gets **2/3 of path A**
→ Reno flow B gets **2/3 of path B**
→ Each MPTCP subflow gets **1/3 of each path (A and B)**

→ Equal share over all resources

Evaluation of Reno-based MPTCP

Scenario: Same Capacity and Same Base Delay for All Flows



MPTCP sum: 3.54 Mbps   Reno path A: 3.13 Mbps   Reno path B: 3.24 Mbps