UNIVERSITY
OF AMSTERDAM

docker

Docker Overlay Networks

Performance analysis in high-latency environments

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Research Project 1

System and Network Engineering

Research question

> *“What is the performance of various Docker overlay solutions when implemented in high latency environments and more specifically in the GÉANT Testbeds Services (GTS)?”*

Related Work

Internal

- Claassen, J. (2015, July). Container Network Solutions. Retrieved January 31, 2016, from http://rp.delaat.net/2014-2015/p45/report.pdf.
- Rohprimardho, A. (2015, August). Measuring The Impact of Docker on Network I/O Performance. Retrieved January 31, 2016, from http://rp.delaat.net/2014-2015/p92/report.pdf.

External

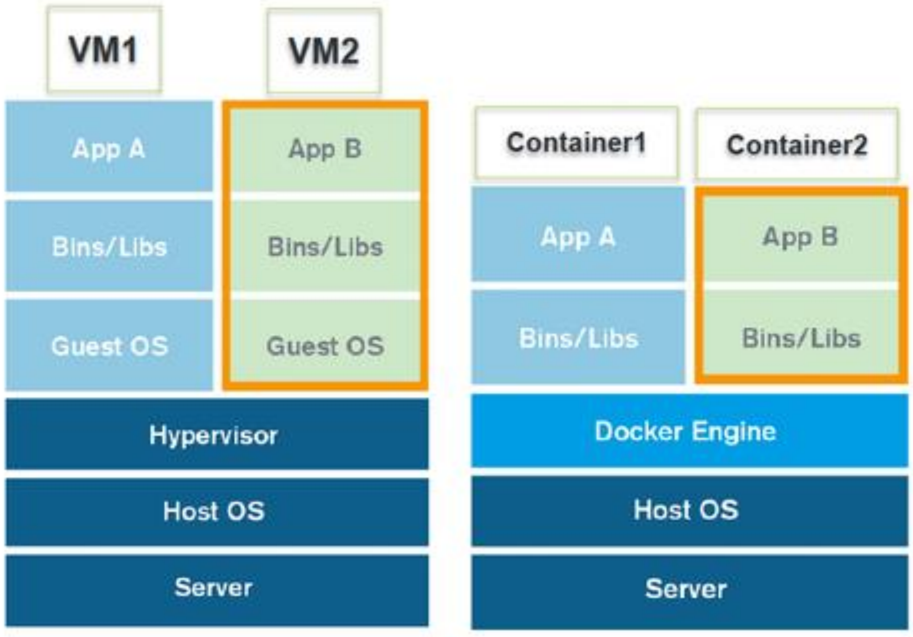
- Kratzke, N. (2015). About Microservices, Containers and their Underestimated Impact on Network Performance. CLOUD COMPUTING 2015, 180.
- Barker, S. K., & Shenoy, P. (2010, February). Empirical evaluation of latency-sensitive application performance in the cloud. In Proceedings of the first annual ACM SIGMM conference on Multimedia systems (pp. 35-46). ACM.

Docker - Concepts

Basics

- Containerization
- Gaining traction
- Performance increases

- Role of Docker

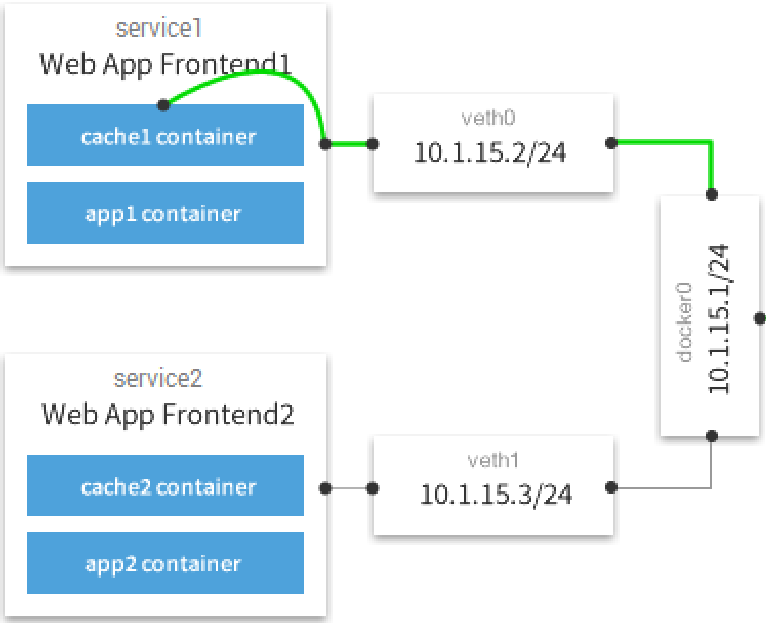


Virtual Machine

Container

Multi-host networking

- Virtual networks that span underlying hosts
- Powered by `libnetwork`



Overlay solutions

Libnetwork

(Native overlay driver)

- Based on SocketPlane
- Integrating OVS APIs in Docker
- VXLAN based forwarding

Weave Net

- Previously routing based on `pcap`. Now uses OVS.
- Libnetwork plugin
- VXLAN based forwarding

Flannel

- Flanneld agent
- No integration with `libnetwork`
- Subnet per host
- UDP or VXLAN forwarding

Project Calico

- Technically not an overlay
- Routing via BGP
- Segmentation via iptables
- State distribution via BGP route reflectors
- No tunneling

Kratzke, N. (2015).

GÉANT - Introduction

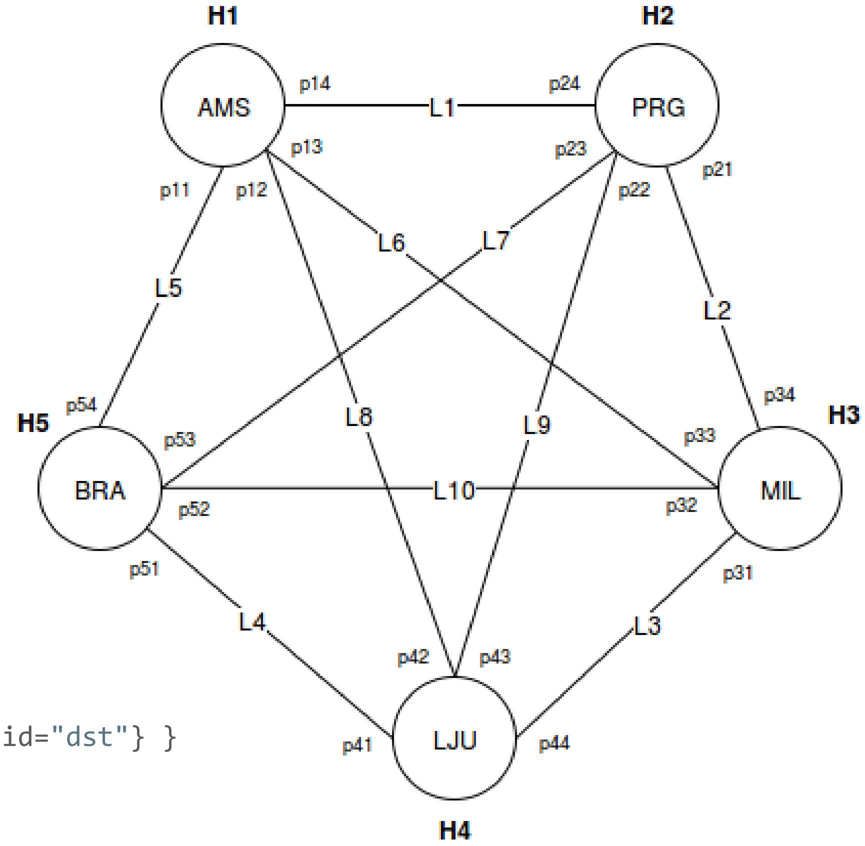
- European research community
  - Amsterdam
  - Bratislava
  - Ljubljana
  - Milan
  - Prague
- GÉANT Testbeds Service (GTS)
- OpenStack platform, interconnected by MPLS
- KVM for compute nodes
- Resembles IaaS providers; *Shared infrastructure*

Topologies (1)

- Four full mesh instances
    - DSL 2.0 grammar (JSON)
- Local site; Feasibility evaluation

DSL

```
FullMesh {
            id="FullMesh_Dispersed"
            host { id= "h1" location= "AMS"
            port { id="port11"}
            port { id="port12"} }
            link { id="l1" port {id="src"} port {id="dst"} }
            adjacency h1.port14, l1.src
            adjacency h2.port24, l1.dst
} {...}
```

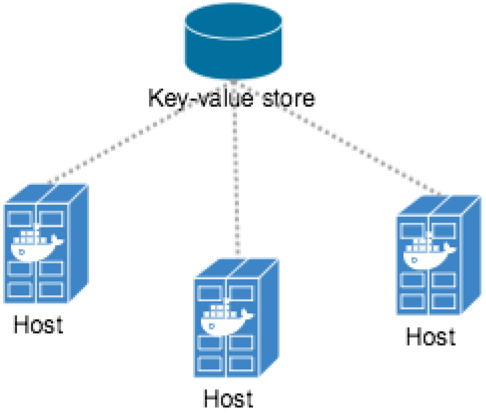


Topologies (2)

- Scaling up from single-site feasibility check
  - **Calico dropped**
- Full mesh divided in:
  1. **Point-to-point**, synthetic benchmarks
  2. **Star topology**, real-world scenario

Setup

- Flannel VXLAN tunneling
- Key-value store placement
  - Storing network state
  - Separate distributed system



Methodology - Performance

Synthetic benchmark (PtP)

- Placement of nodes

Netperf

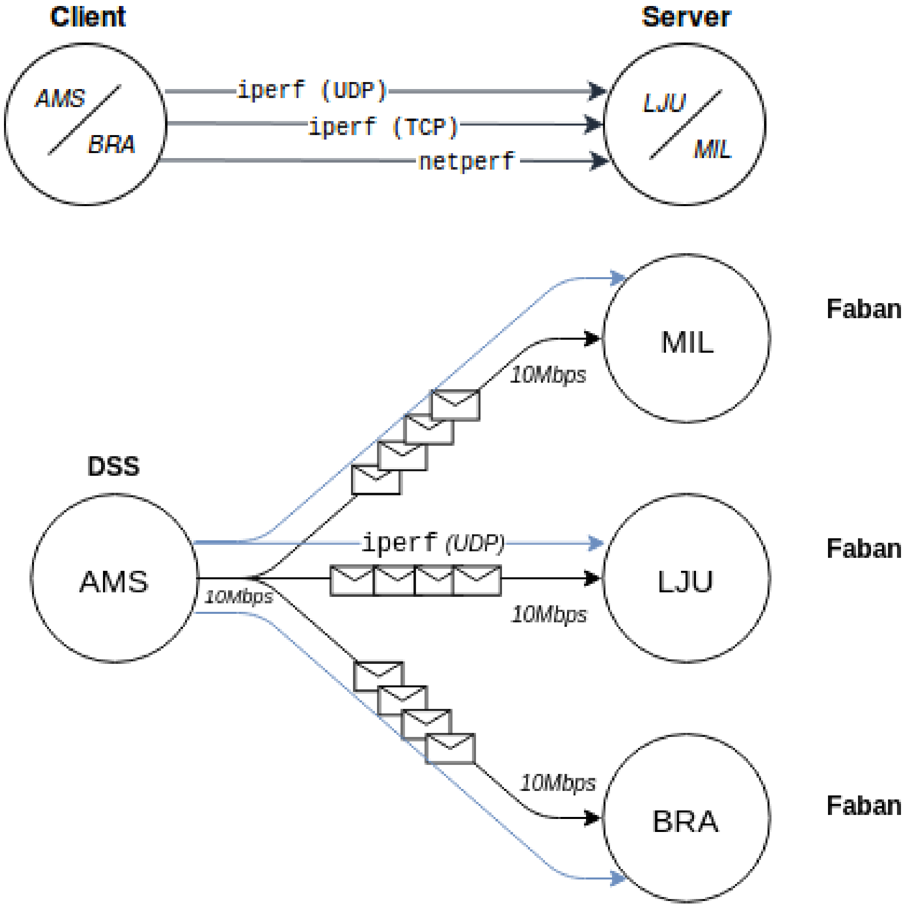
- Latency
- Jitter

Iperf

- TCP/UDP throughput
- Jitter

Latency sensitive application (Media streaming)

- Darwin Streaming Server, Faban RTSP clients
  - Jitter (with netperf)
  - Bitrate



Barker, S. K., & Shenoy, P. (2010, February).

Results - GÉANT

Documentation

Provisioning

Access

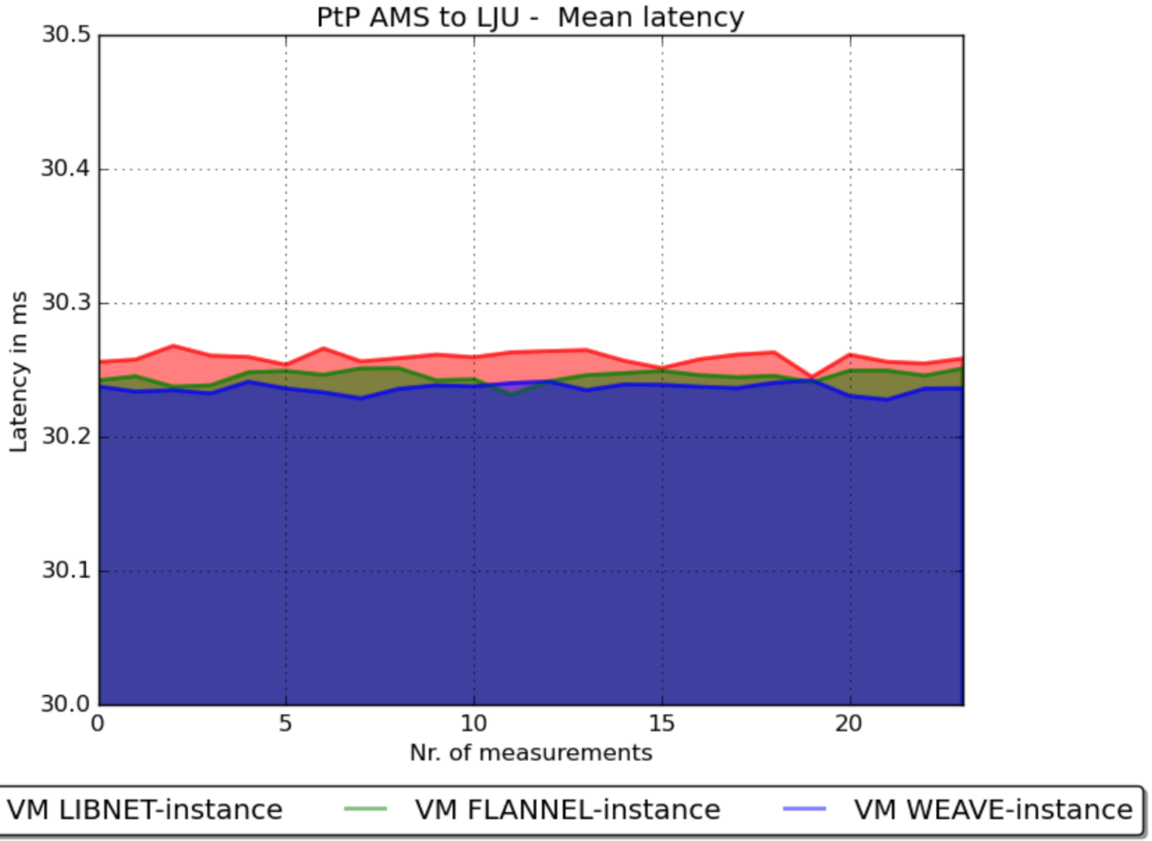
Setup

VPN

Resources

Support

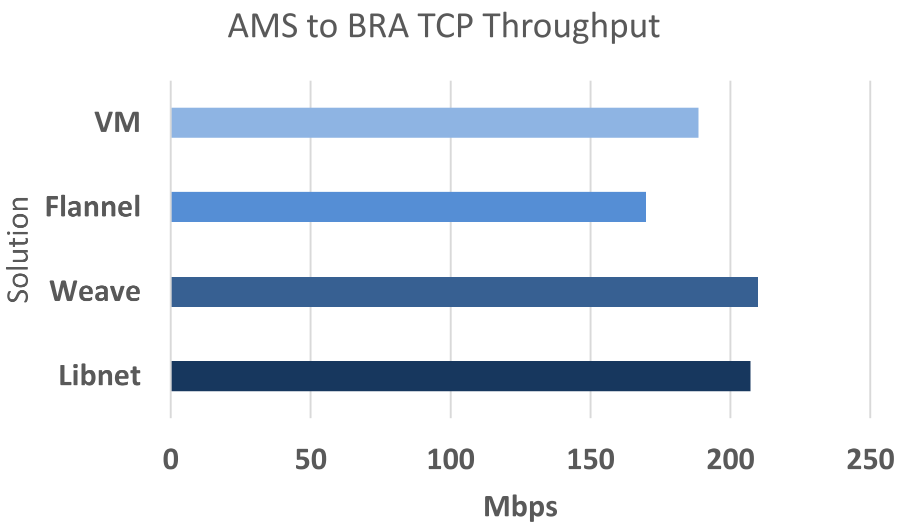
Results - PtP VM to VM Latency

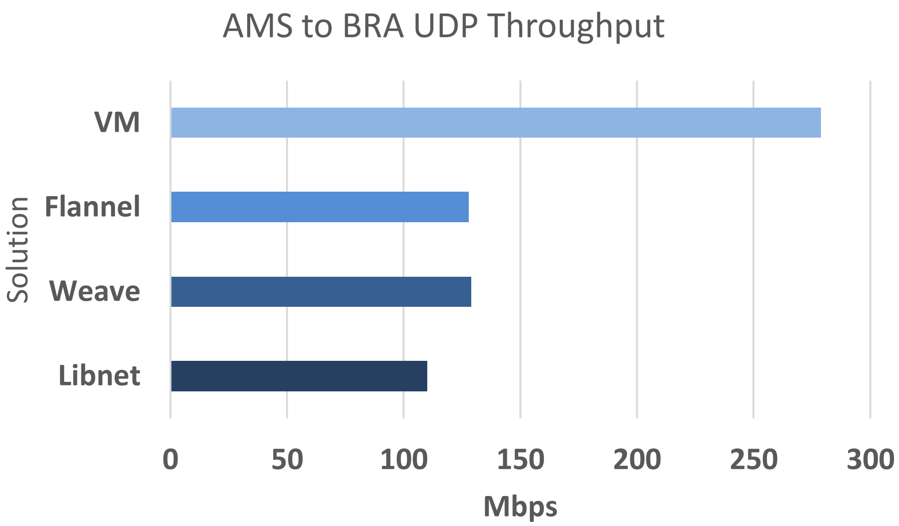


Results - PtP Docker to Docker Latency

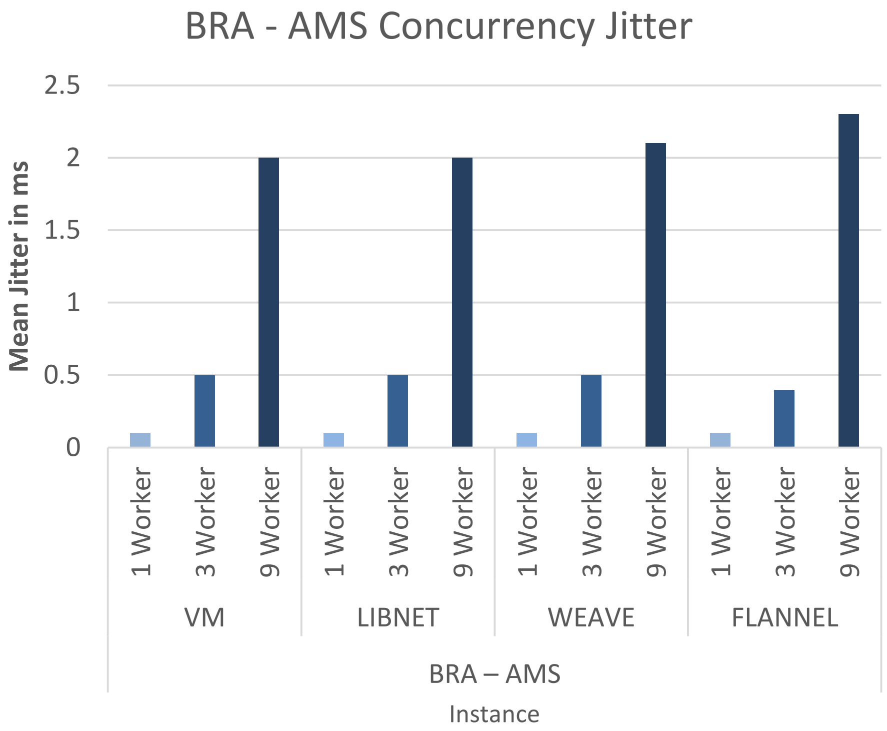
		In Milliseconds (ms)		
Circuit	Topology	Min. Latency	**Mean Latency**	99th % Latency
AMS – MIL	LIBNET	36.3	**36.5**	37.0
	WEAVE	36.2	**36.5**	37.0
	FLANNEL	42.5	**42.9**	43.0
AMS – LJU	LIBNET	30.1	**30.3**	31.0
	WEAVE	29.8	**30.3**	31.0
	FLANNEL	29.8	**30.3**	31.0
AMS – BRA	LIBNET	17.6	**17.7**	18.0
	WEAVE	17.4	**17.7**	18.0
	FLANNEL	17.4	**17.7**	18.0
MIL – LJU	LIBNET	61.8	**62.1**	62.4
	WEAVE	59.6	**59.8**	60.0
	FLANNEL	55.6	**55.8**	56.0
MIL – BRA	LIBNET	12.7	**13.0**	14.0
	WEAVE	12.9	**13.1**	14.0
	FLANNEL	12.9	**13.1**	14.0
BRA – LJU	LIBNET	47.1	**47.4**	48.0
	WEAVE	43.1	**59.5**	130.0
	FLANNEL	43.1	**43.4**	44.0

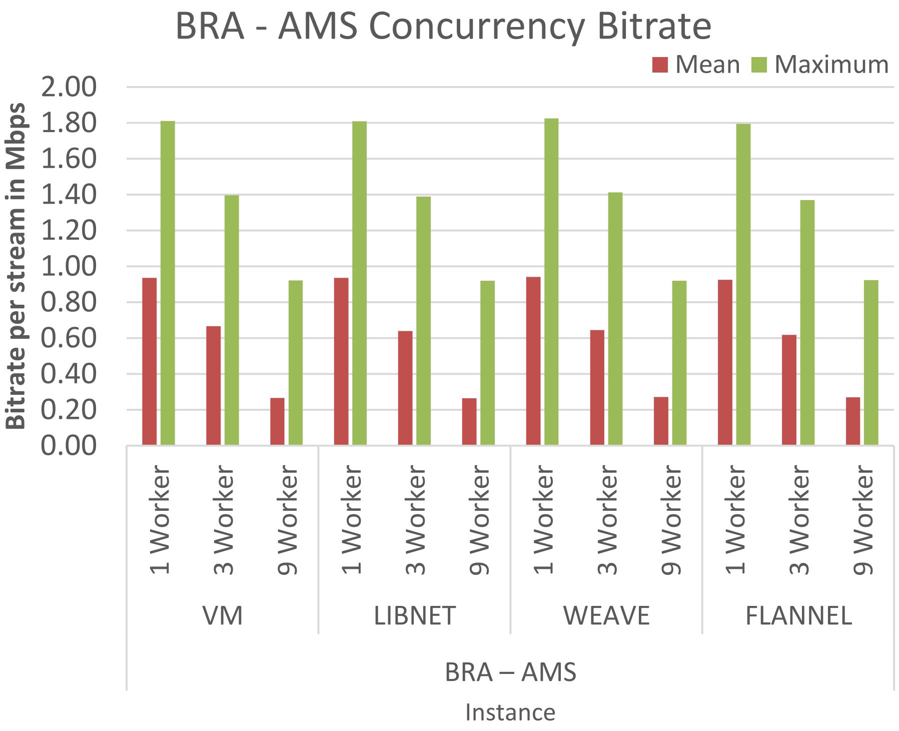
Results - PtP Throughput





Results - Streaming Experiment





Conclusion & Future Work

- Measurements currently only valid within GTS environment;
  - Reconduct performance analysis in heavily shared environment *(e.g. Amazon EC2)*
  - Perform experiments with more compute resources *(CPU capping)*
- Anomalies in throughput performance not identified *(UDP, TCP)*
  - Similar behavior discovered in the work of J. Claassen
- Ideally more measurements to increase accuracy
- No significant performance degradations by implementing Docker overlays within GTS
- Use Weave ideally within the GTS environment

Questions ?

Thank you

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github.com/siemhermans/gtsperf

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