ivtrace: Tracing Across Host OS and Guest OSs

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HITACHI
Inspire the Next

Introduce myself

- I’m working at Linux Technology Center of Yokohama Research Lab in Hitachi Ltd.,

- I’m interested in
  - Tracing Technology
  - Automated software testing
  - Performance analysis
  - Development toolchains ...etc

Agenda

1. Background
2. Requirements of Tracing for Virtualized System
3. ivring System Overview
4. Evaluation
5. Conclusion

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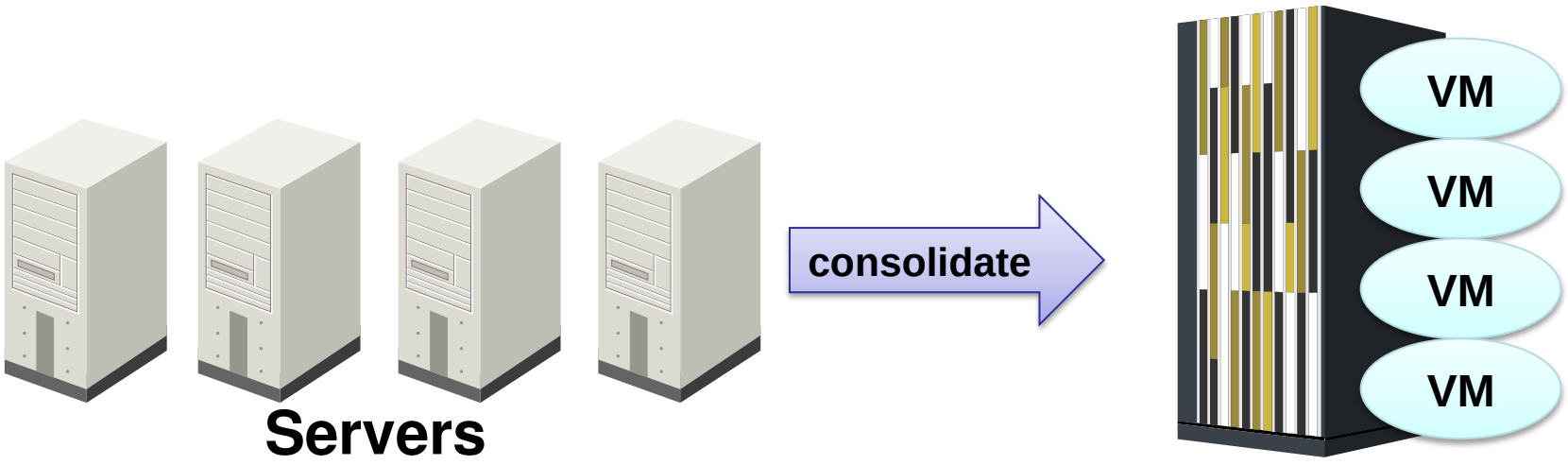
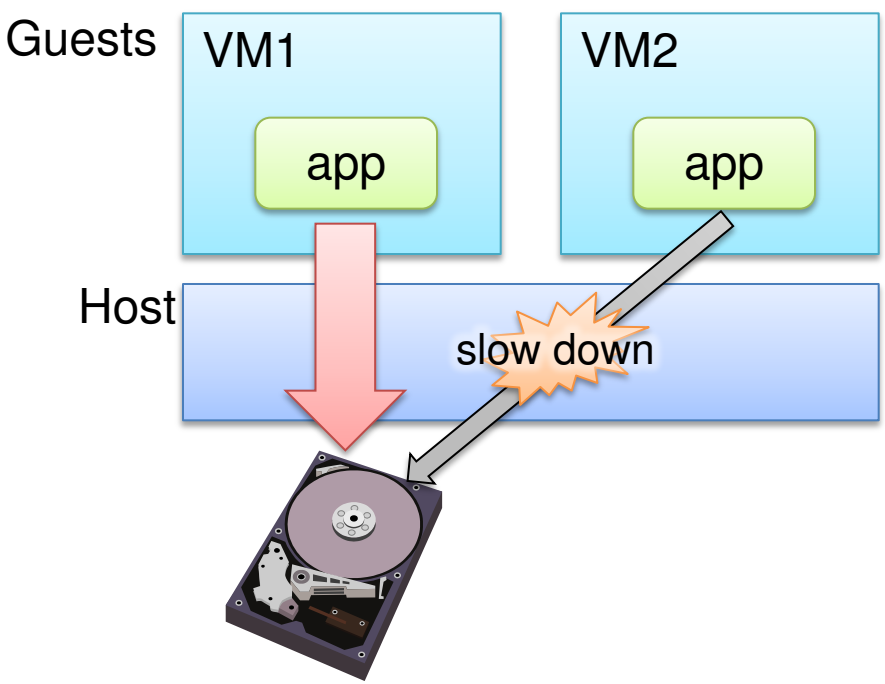
1 Background

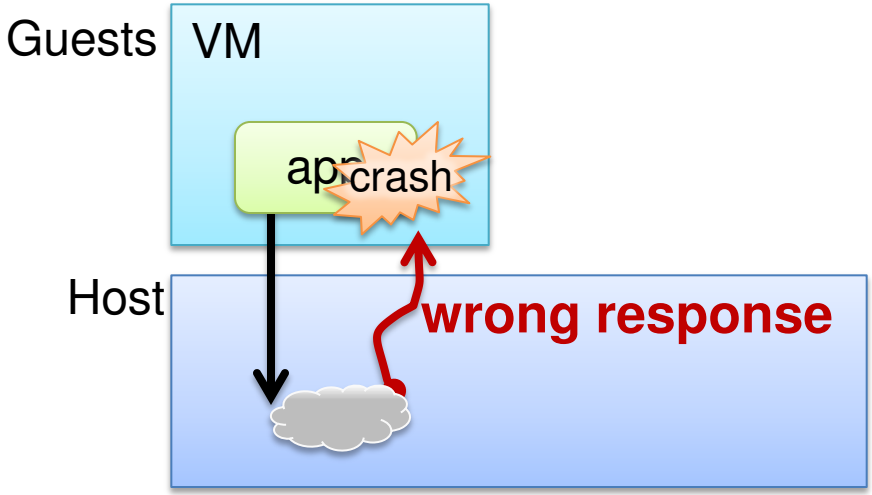
- Recently, enterprise systems are often built on cloud systems that use virtualization technology and aim for system consolidation.



1.1 Problems in Virtualized System

- A VM's behavior can affect other VMs' behavior
- A VM can die by host OS or hypervisor's bug





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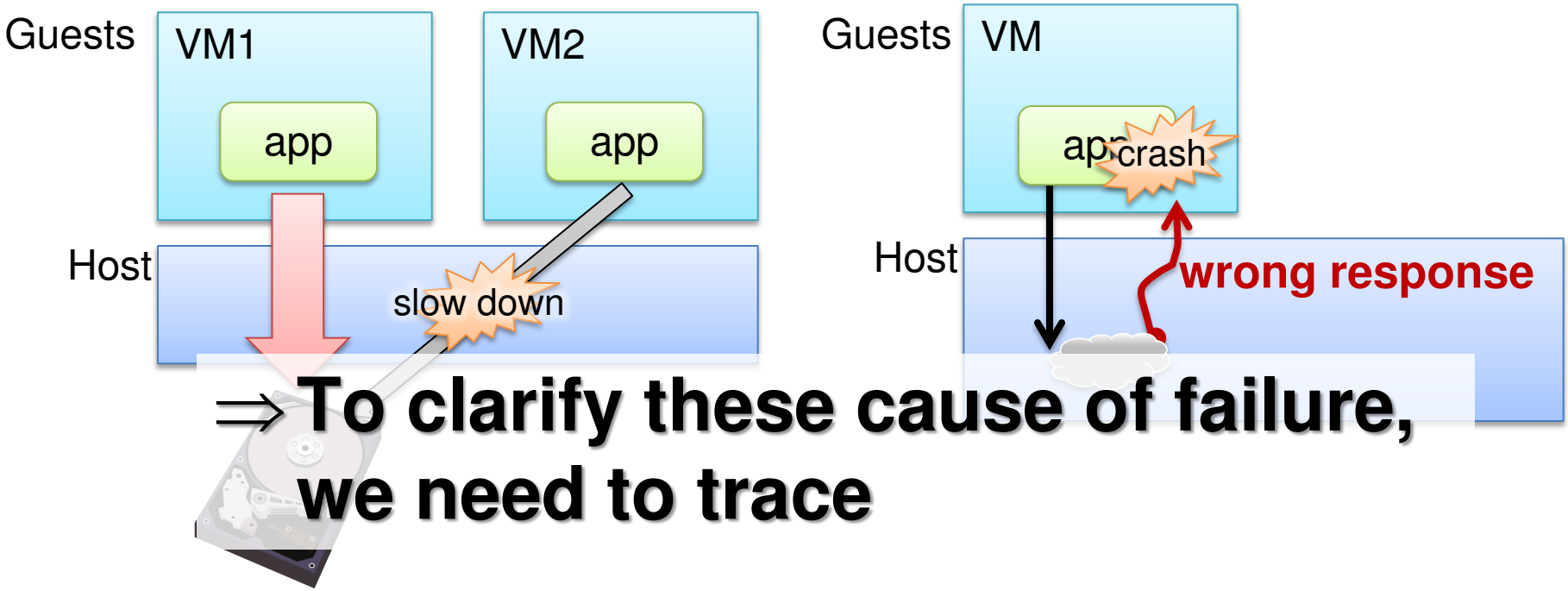
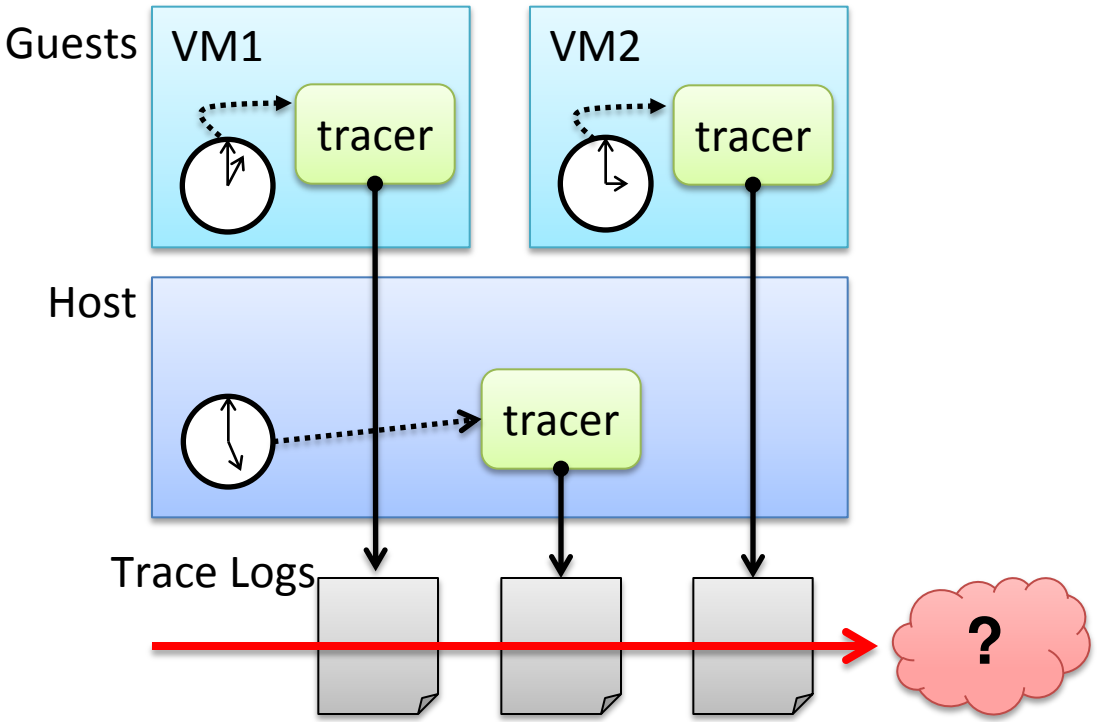


⇒ **To clarify these cause of failure, we need to trace**

1.2 Problems in Tracing

- Get trace logs to find out the cause of failures, it has following problems
  - Each VM has own time-stamp-counter
  - Too huge trace logs (x VMs) to analyze them



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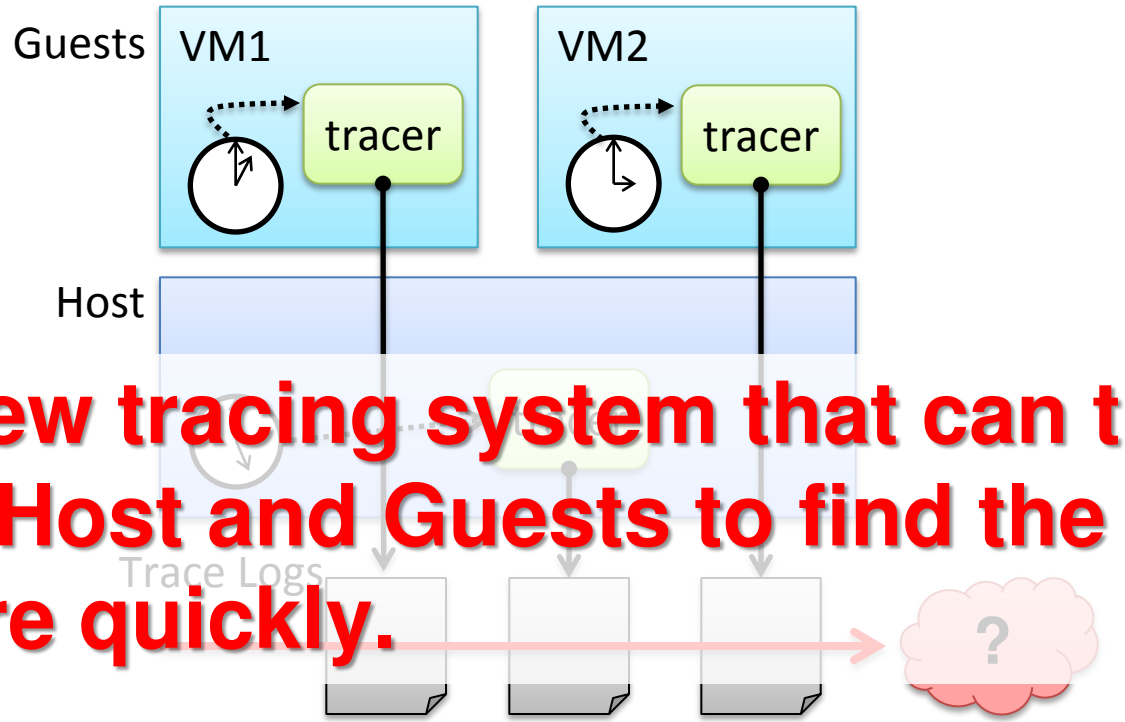

Need new tracing system that can trace across Host and Guests to find the cause of failure quickly.

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2 Requirements

- Adjusting host OS's time-stamp-counter and Guests' one
  - Need it to merge trace logs
- Visualization
  - Find out the cause of failure from huge trace logs quickly

2.1 What we use

- Use **systemtap** as a tracer
  - Trace both of kernel and user applications
- Adjusting guests' time-stamp-counter(tsc) in host OS using **tsc_offset**
- Use **IVRing** to pass the trace logs from guests to host
  - IVRing is an implementation of Inter-VM Ring buffer using IVShmem
- Use **TimeDoctor** to visualize trace data

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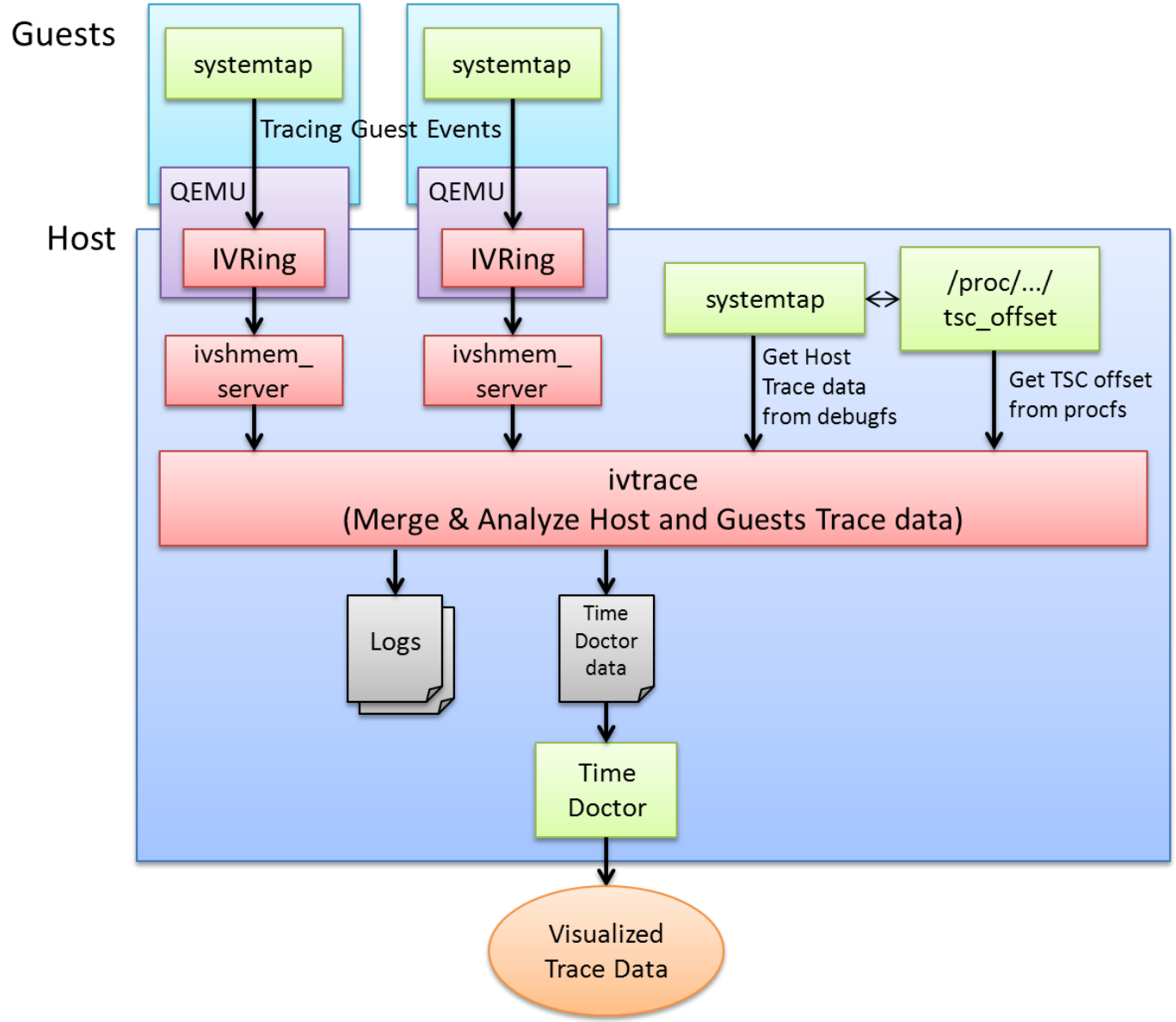
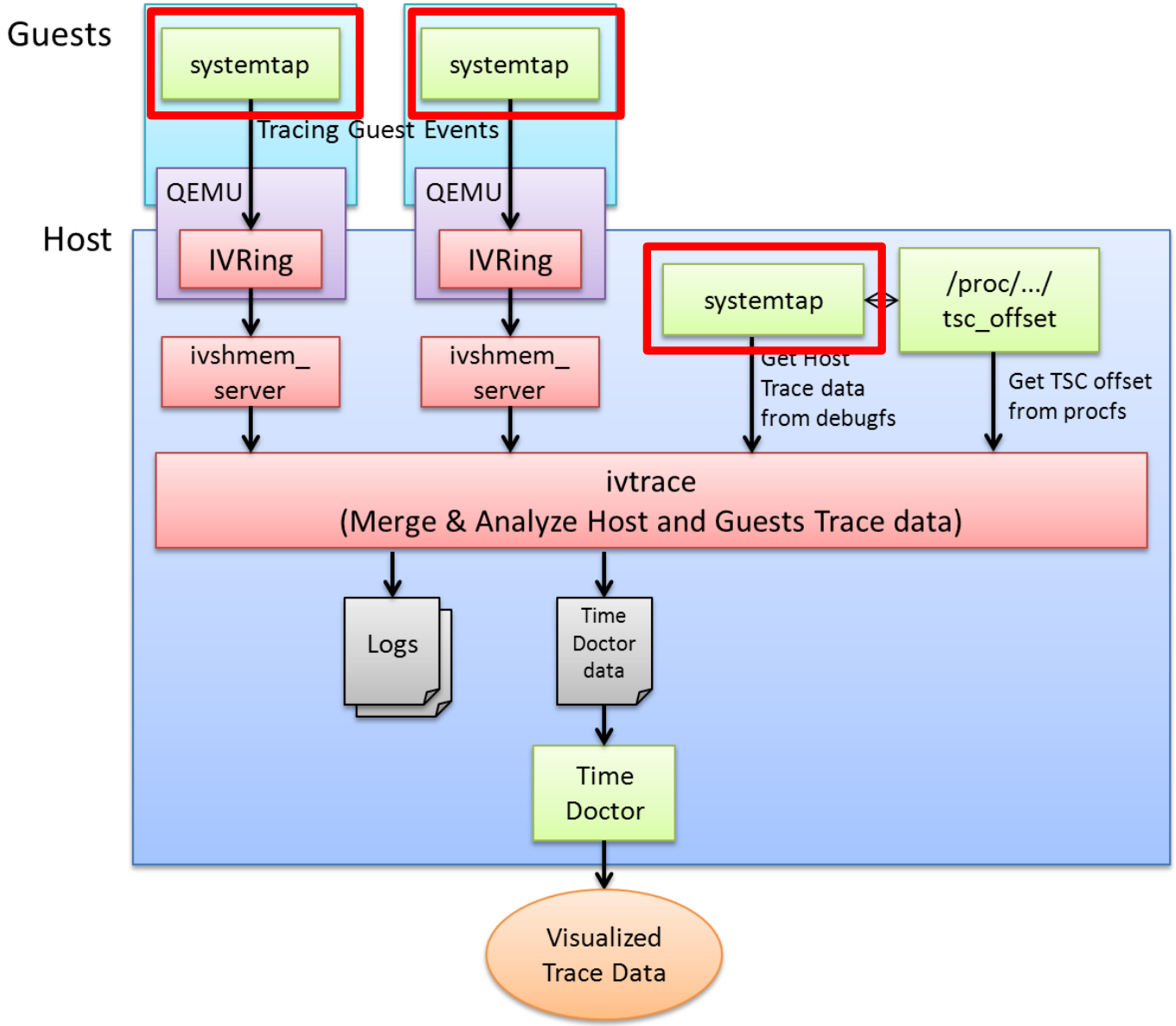
3 System Overview



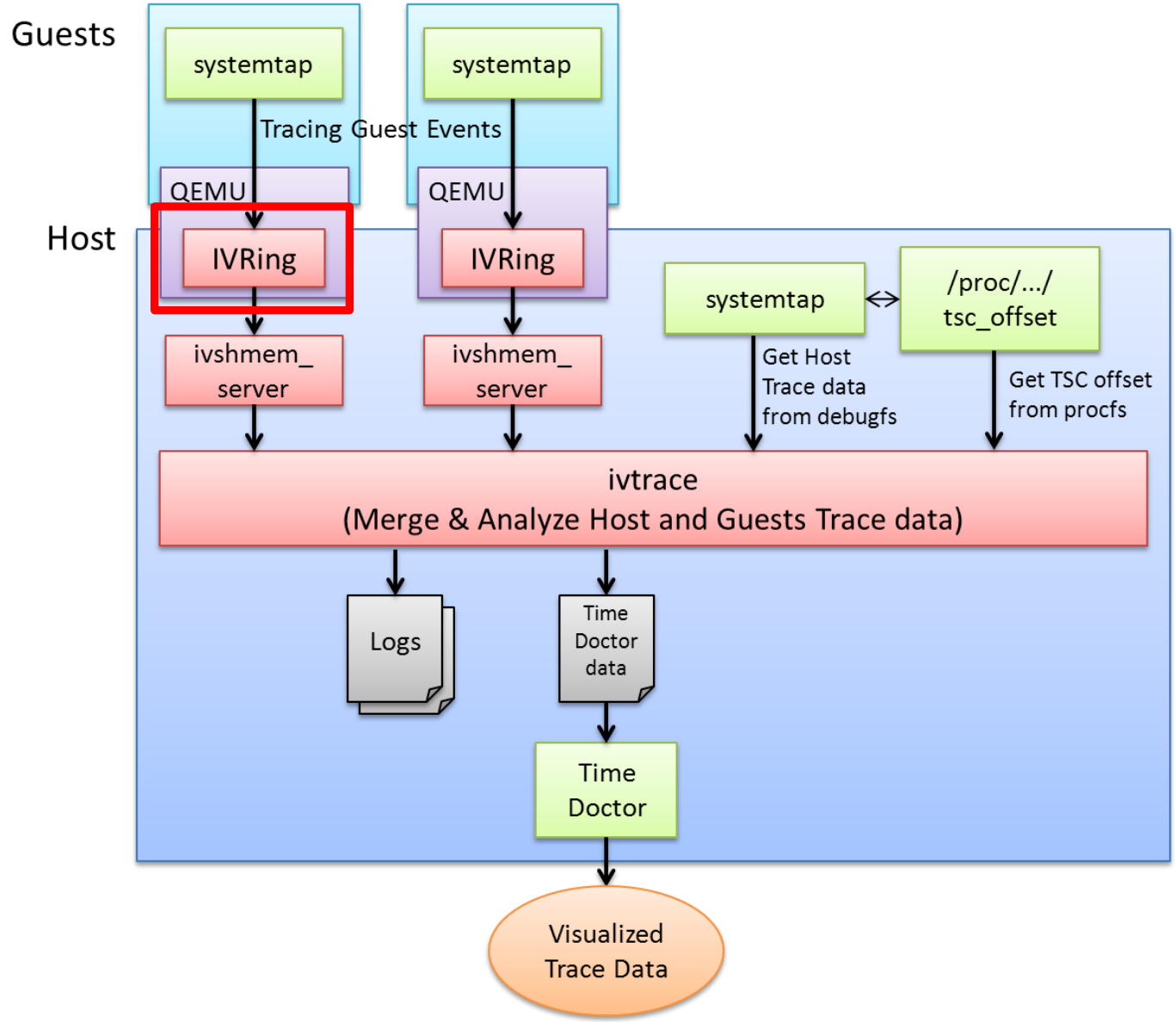
3.1 Systemtap



3.1 Systemtap

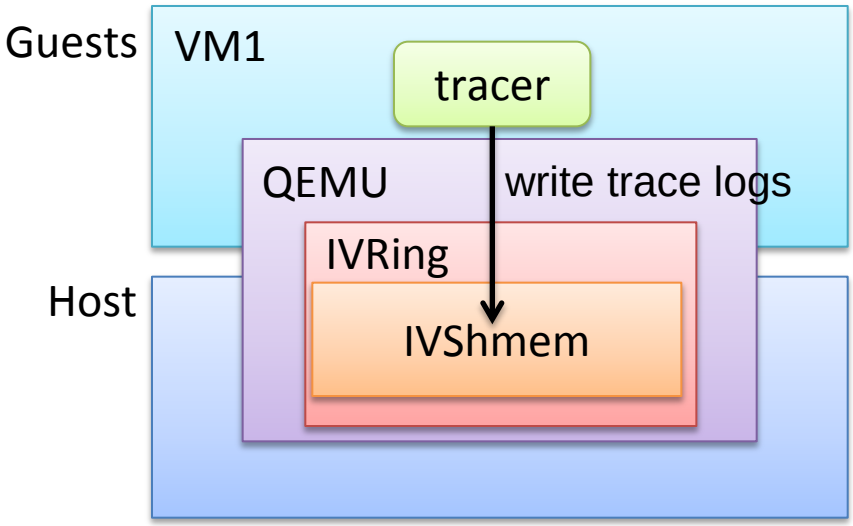
- Systemtap is a Tracer
- Possible to trace both of kernel and user-space applications
- Programmable tracing by stap-script
- Dynamic probing
- Easy to install in Fedora/Cent/RHEL

3.2 IVRing



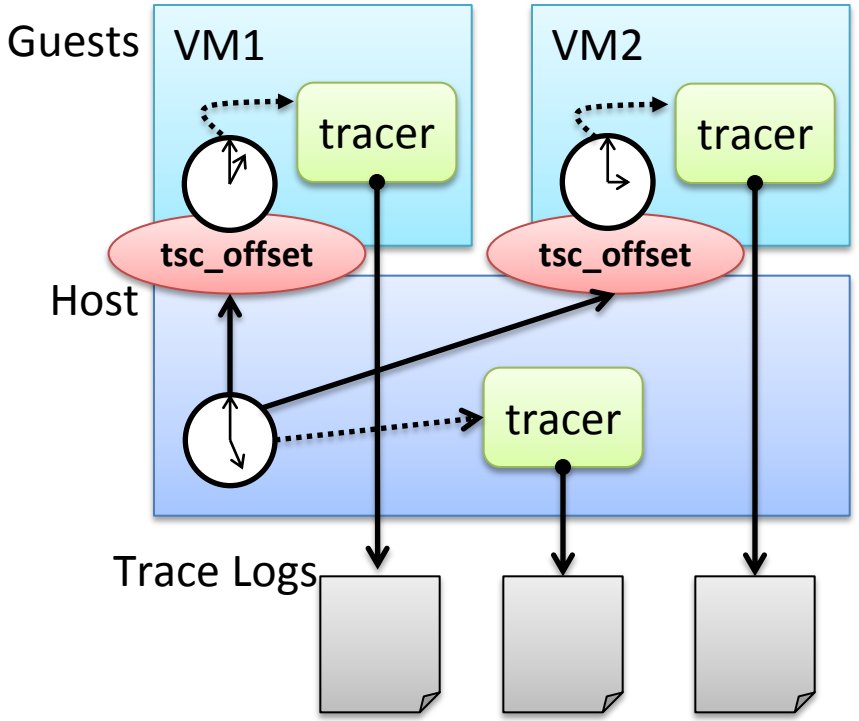
3.2 IVRing

- IVRing is a Ring Buffer based on QEMU's IVShmem (Inter-VM Shared memory)
- Copyless & Low overhead data communication between VMs and host
- ivtrace uses it to pass the trace logs from guests to host
- Implementation details are presented in the next session



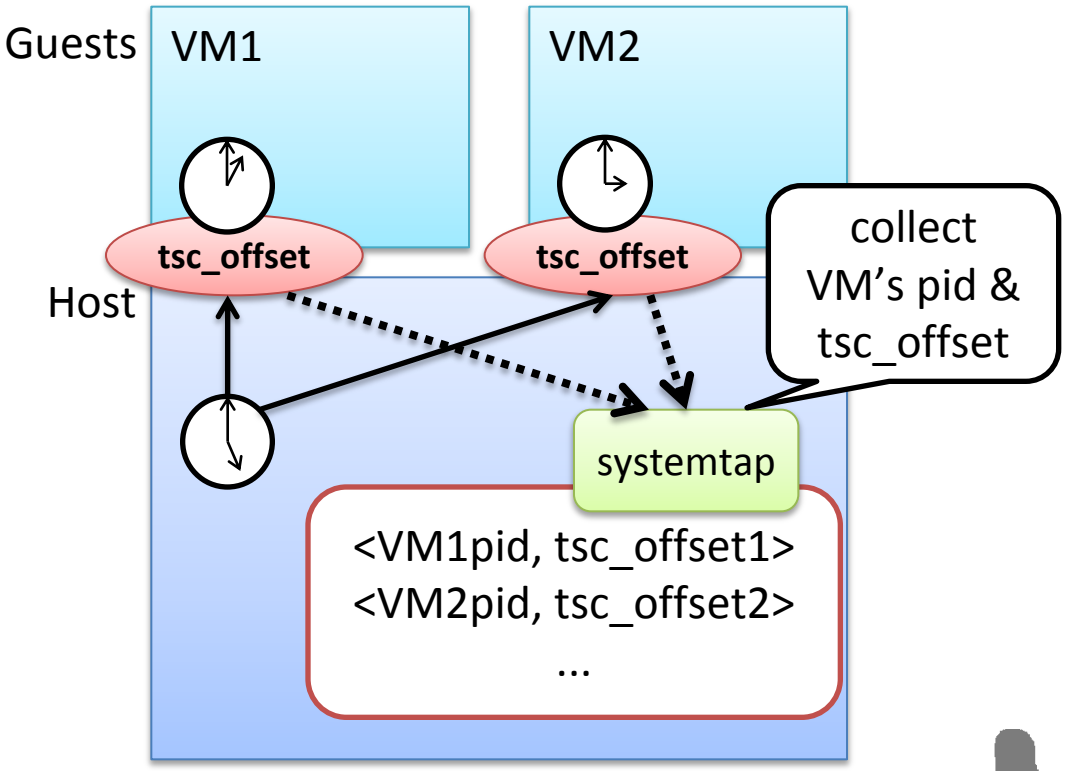
3.3 Adjusting tsc (1/3)

- Each guests has virtualized independent tsc
- The substitution of host's tsc and guests' one is called **tsc_offset**
- Each tracers in guests uses own tsc, so we need to fix it using **tsc_offset** to merge logs.

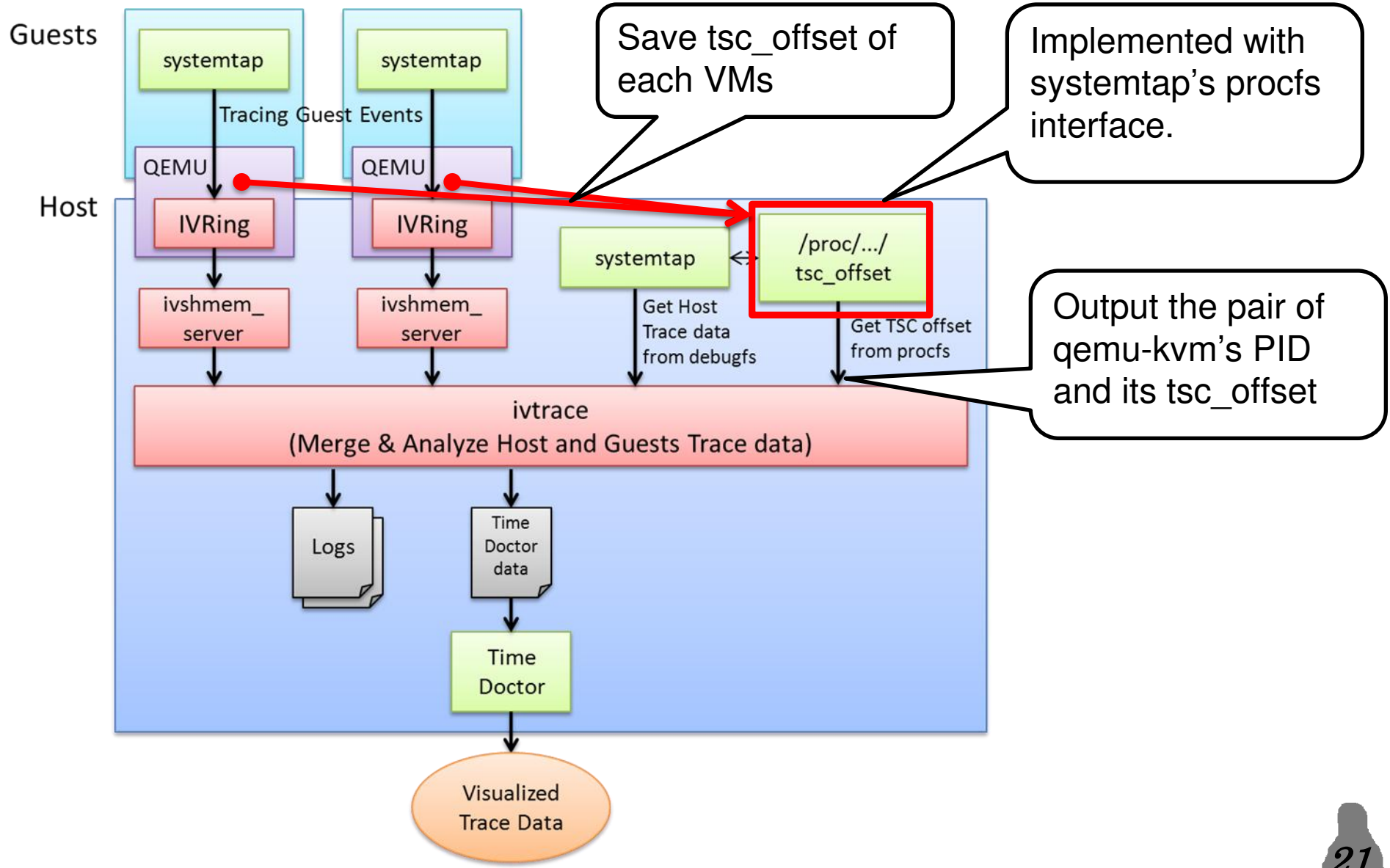


3.3 Adjusting tsc (2/3)

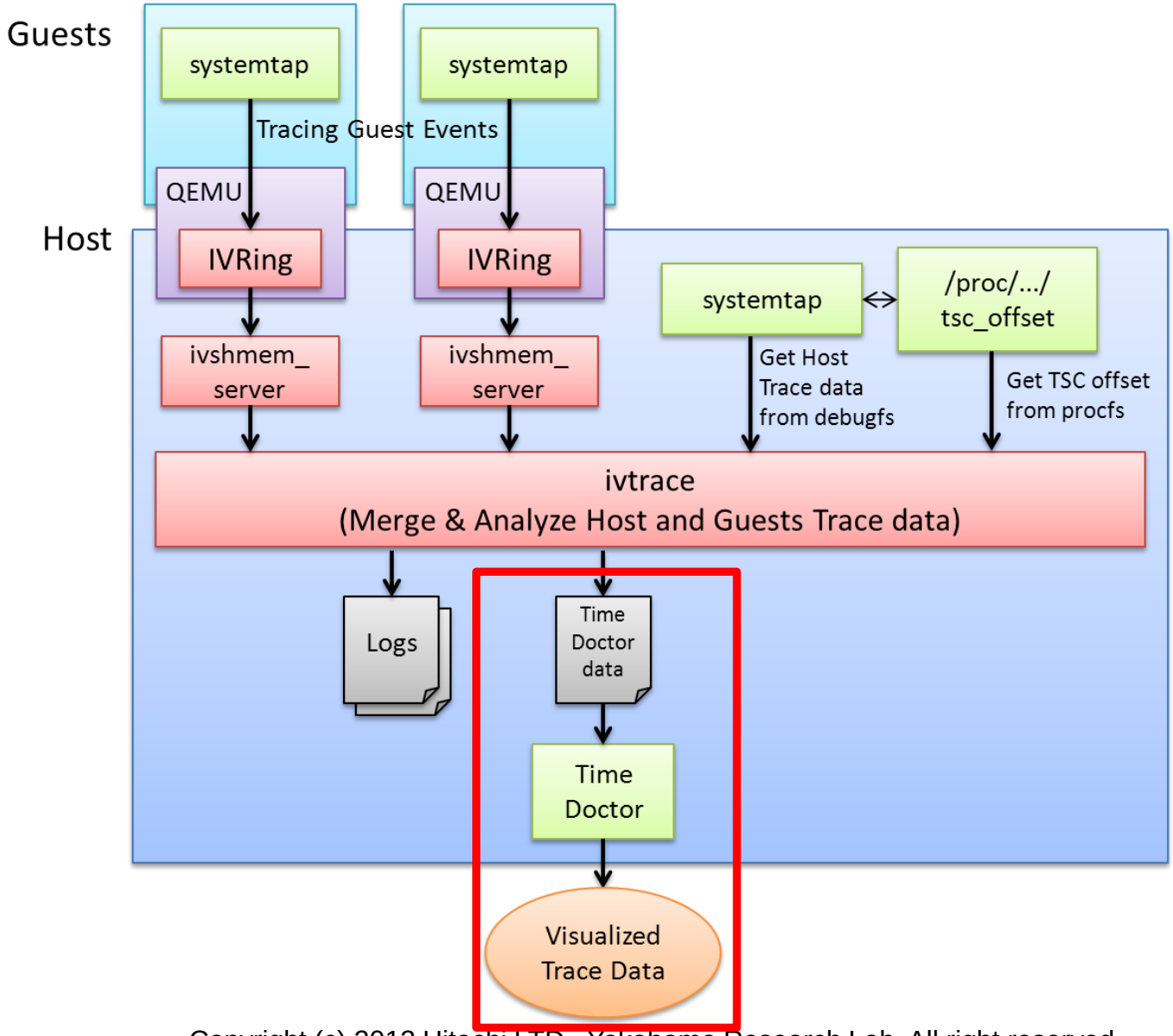
- **tsc_offset** are available with kernel function **`vmcs_read()`** in host.
- ivtrace records the tsc_offset as the pair of <qemuPID, tsc_offset>
  - Each qemu-kvm has one tsc_offset
- At vm_exit, ivtrace gets tsc_offset using systemtap probing.



3.3 Adjusting tsc (3/3)

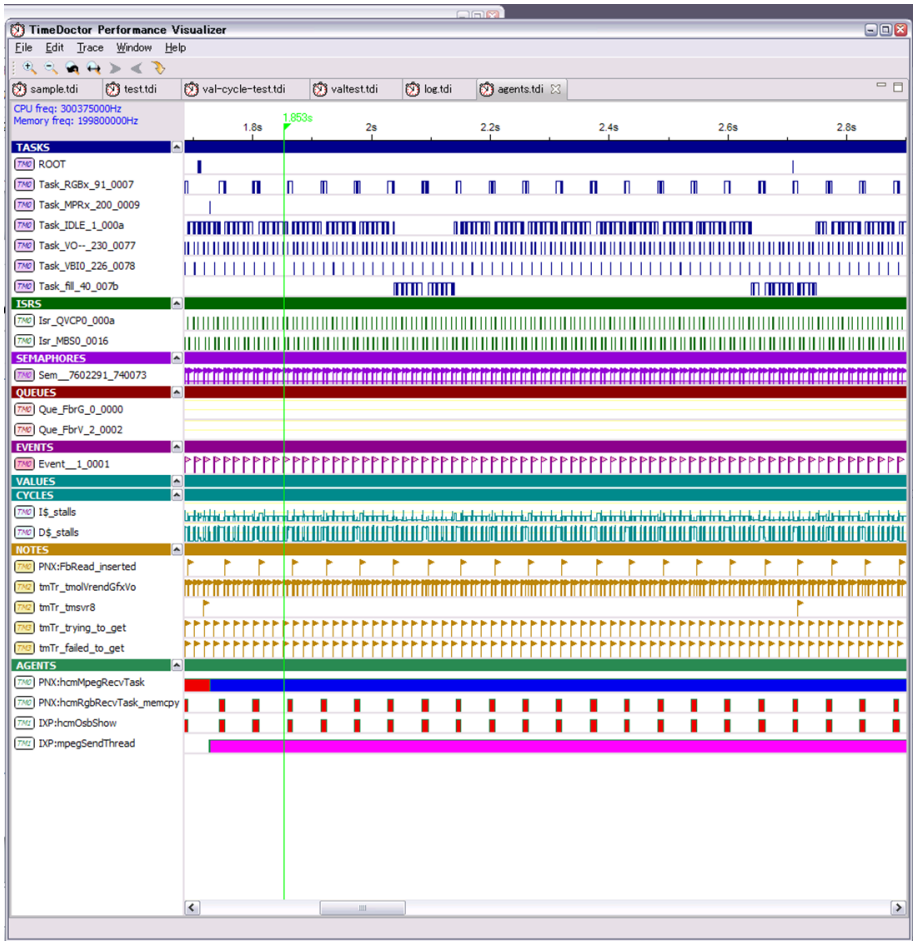


3.4 Visualization



3.4 Visualization

- Use TimeDoctor
  - Visualizing tool specialized for trace data
- Input text file with simple syntax
- Multi Platform
  - Eclipse plugin



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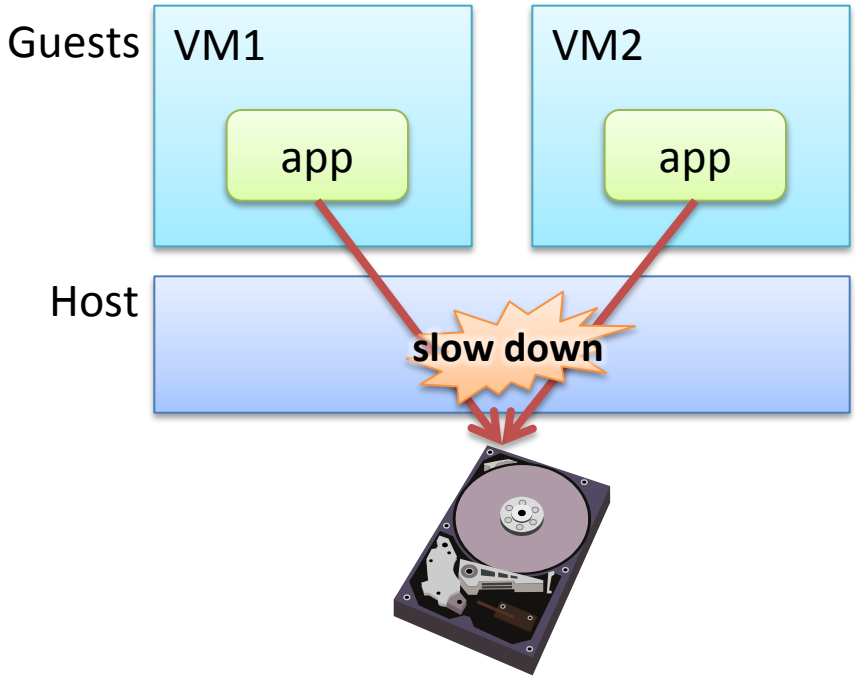
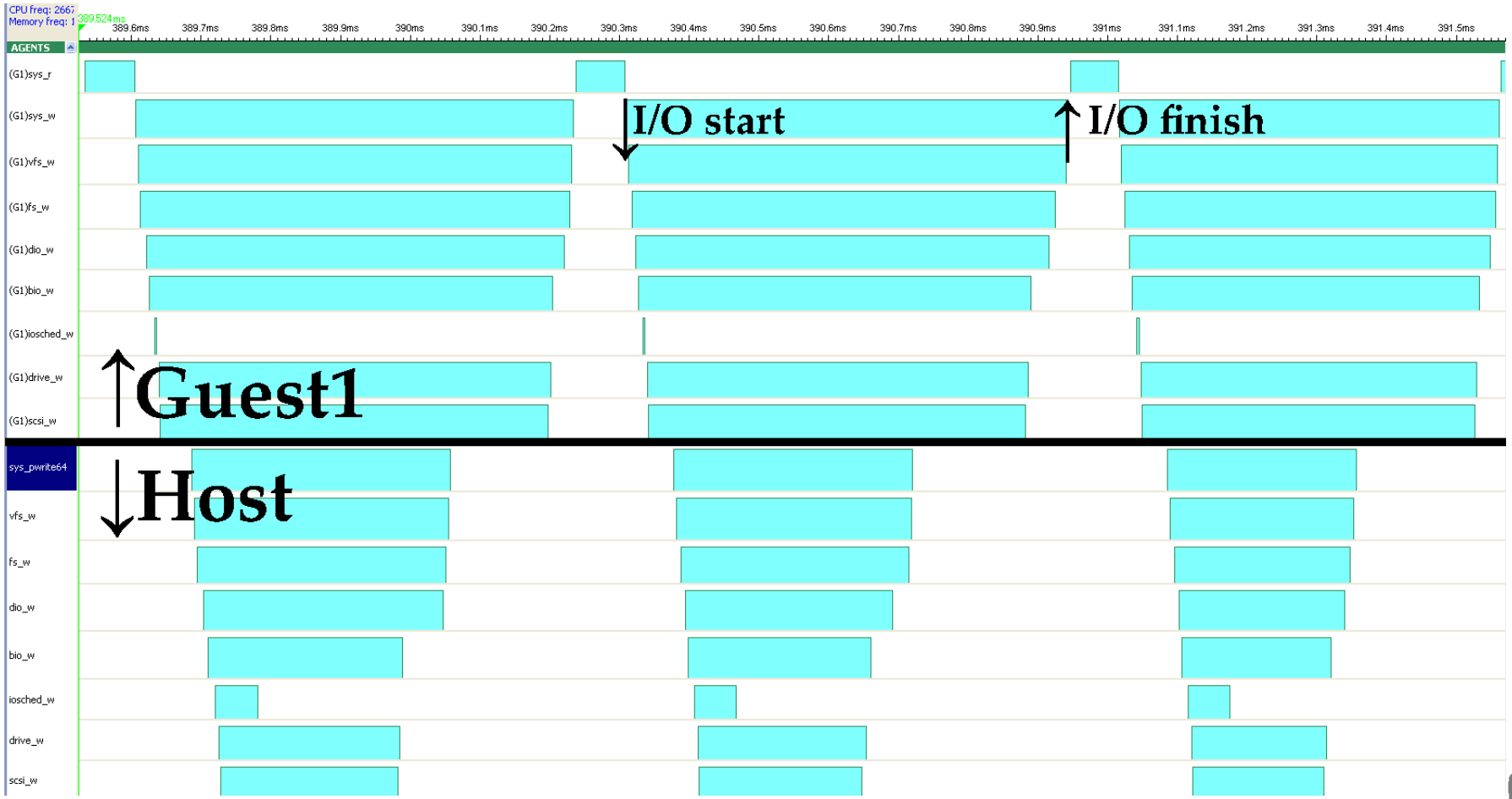
4 Evaluation

- Clarify the cause of performance degradation by disk access contentions using ivtrace



4.1 Result

- The case of no contentions



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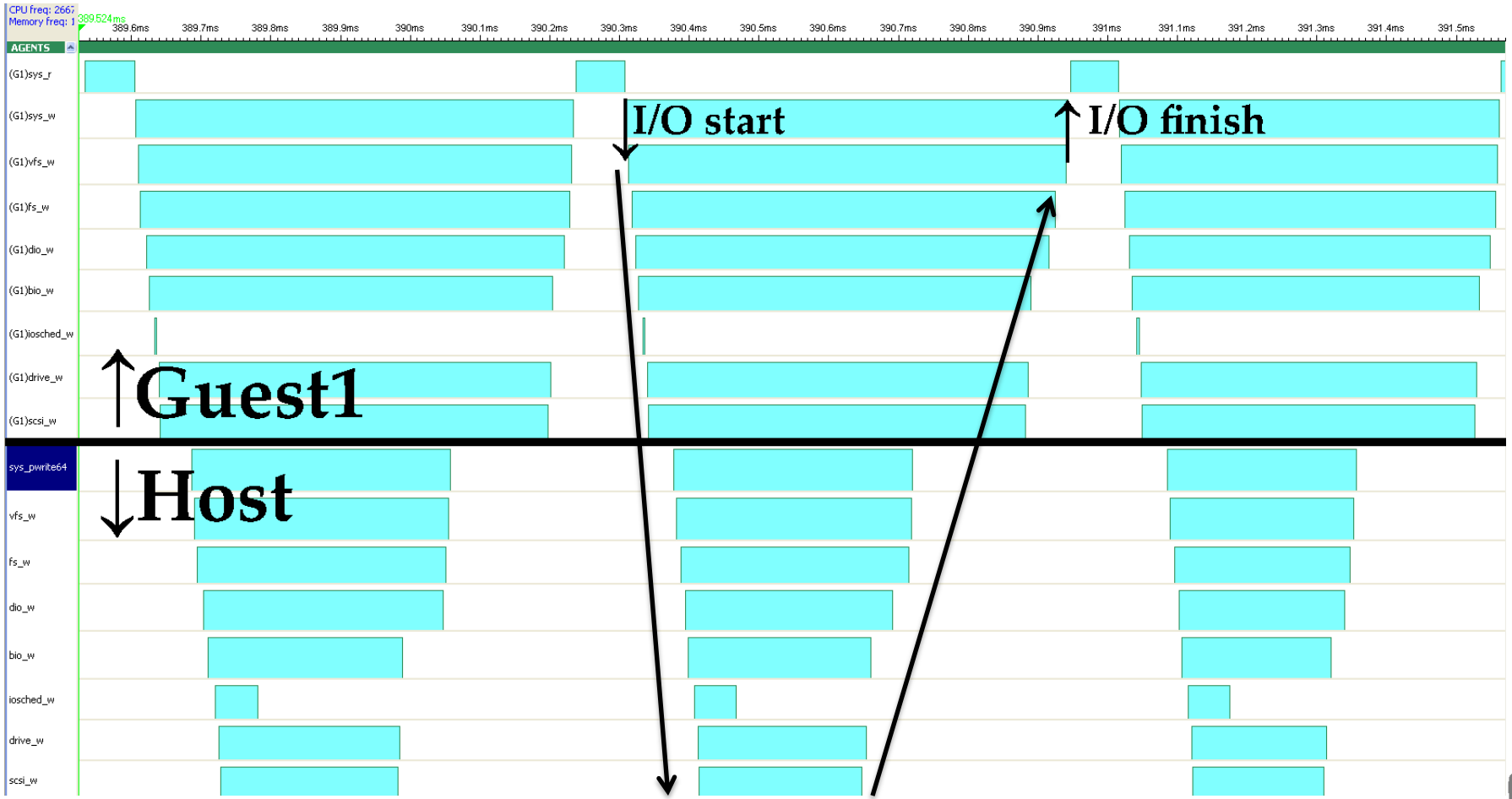
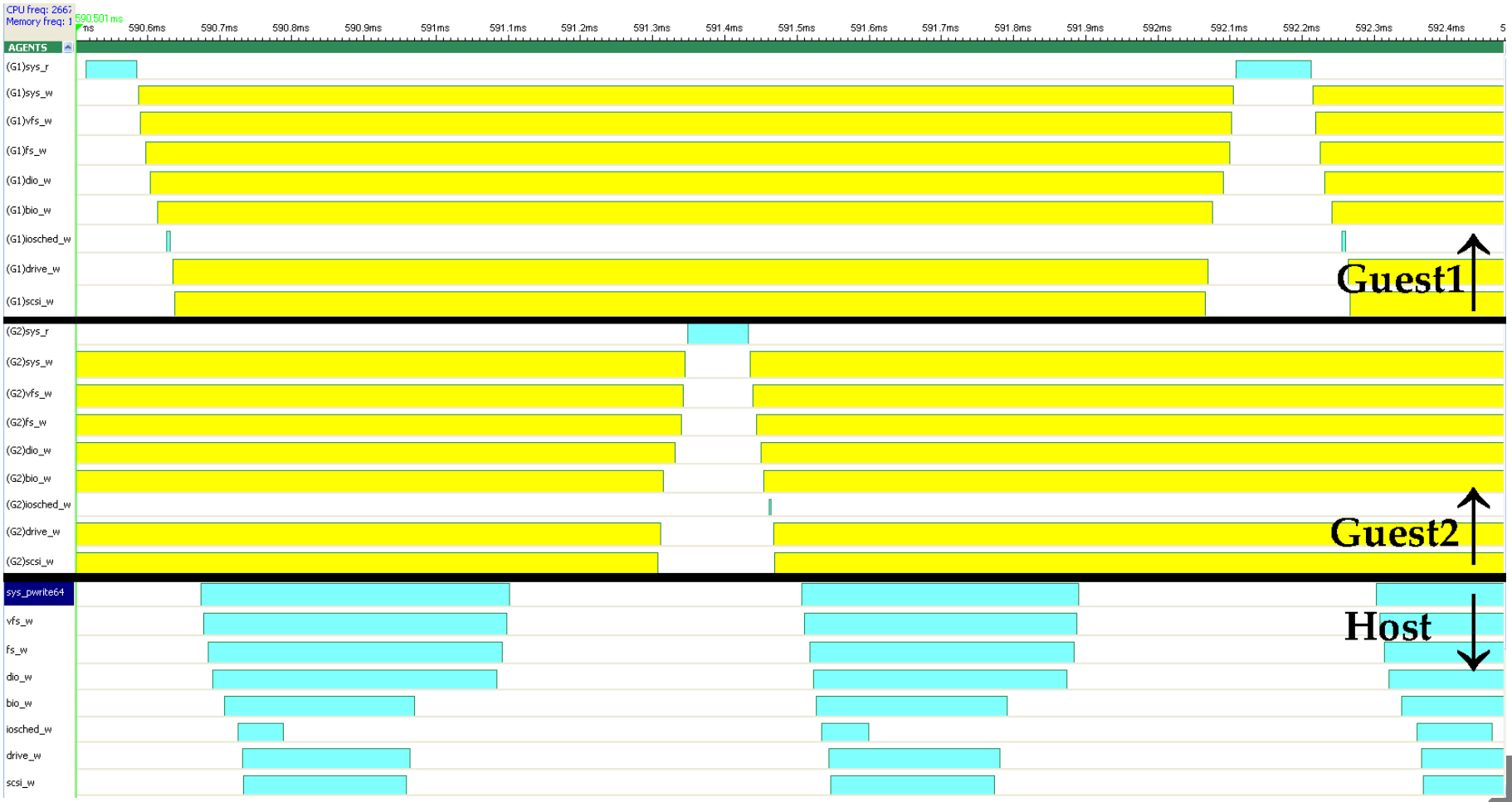


4.2 Result2

- The case of contentions. I/O slowdown



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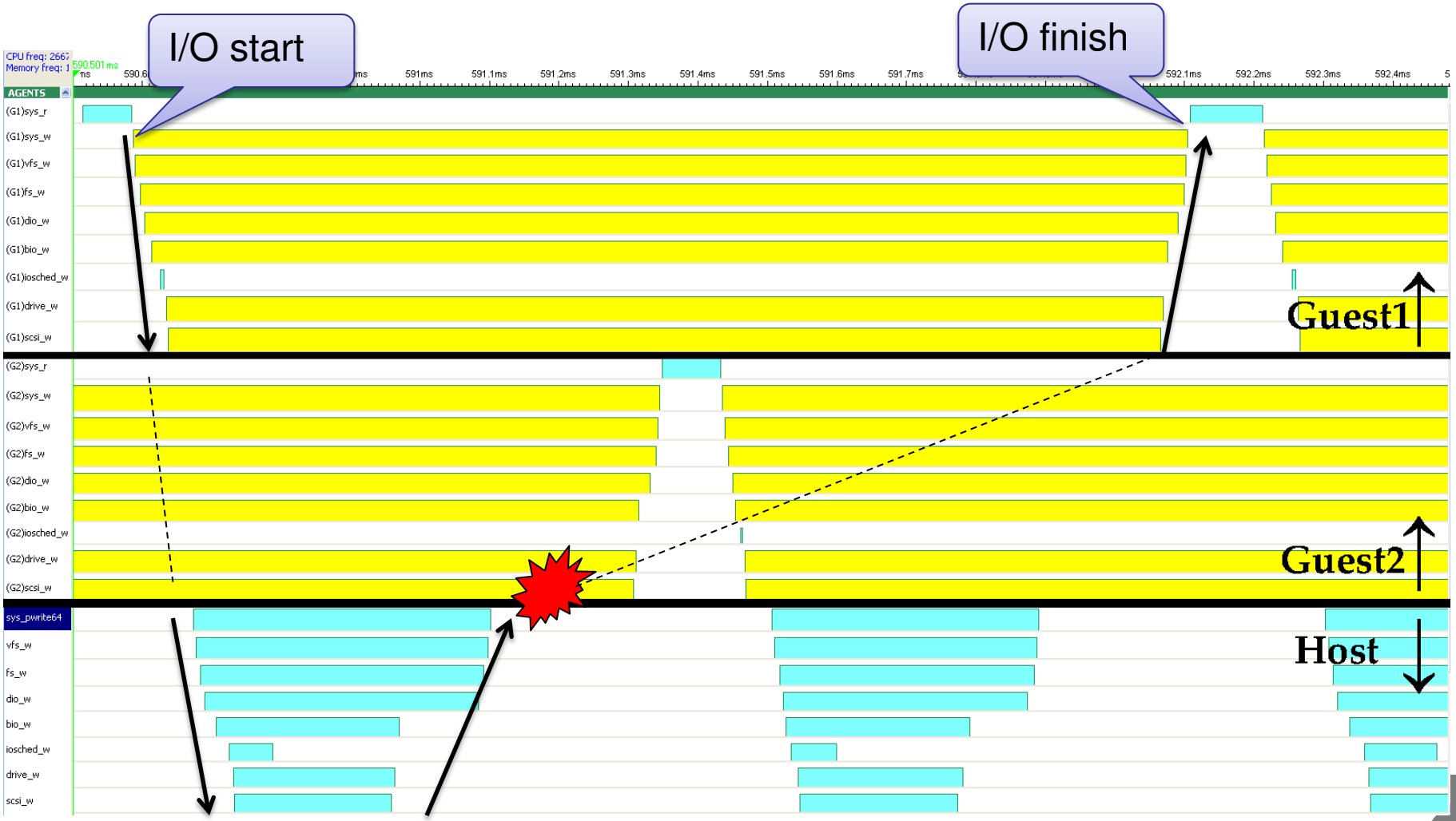

4.2 Result2

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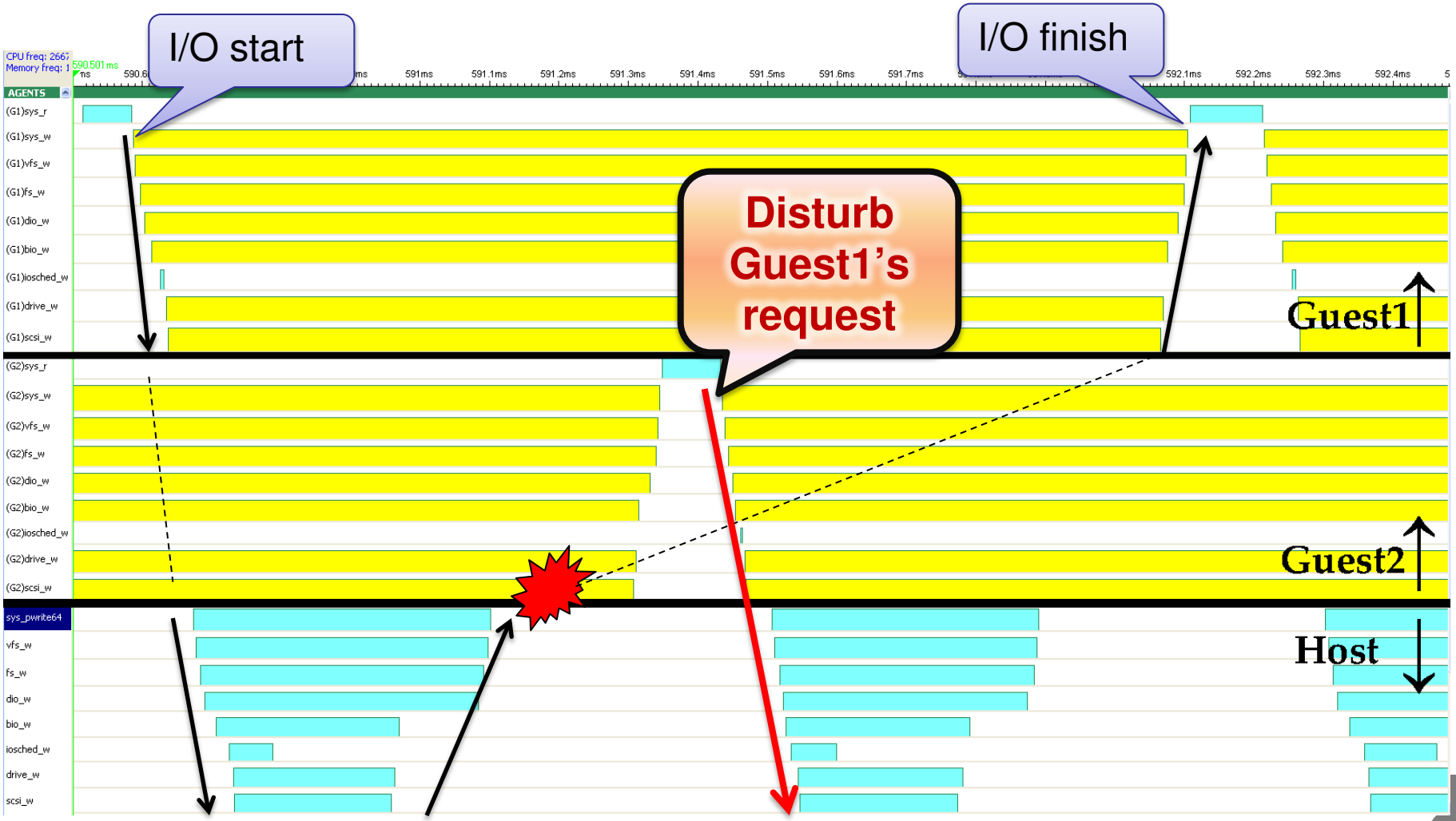

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5 Conclusion

- The cause of system failure are getting difficult to find by using virtualization technology. e.g. cloud system.
- Need new tracing system which is possible to trace across host and guests.
- This session suggests new tracing system “ivtrace”: using systemtap, IVRing and TimeDoctor
- “ivtrace” can clarify the delay of disk I/O requests

5.1 Future Works

- Support other failure patterns
  - Need the framework to add new patterns
- Support live migration
  - Need to apply to real cloud systems
- Support CPU hot-plug

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