

Detecting Unhealthy Kernels at Scale

Sam Crossley (Meta)



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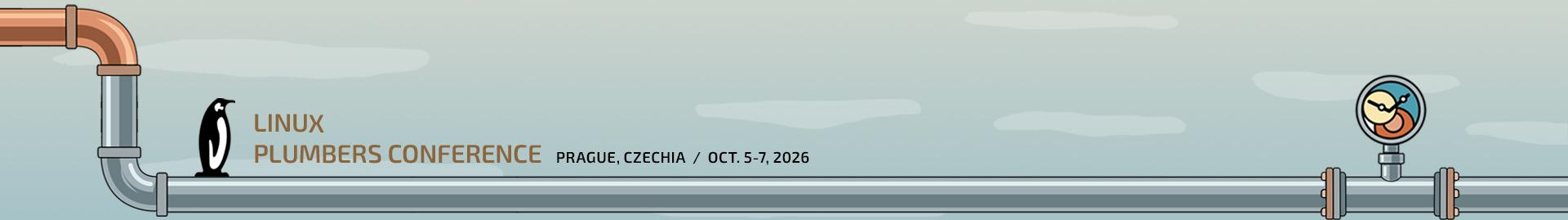
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Layers of Observability

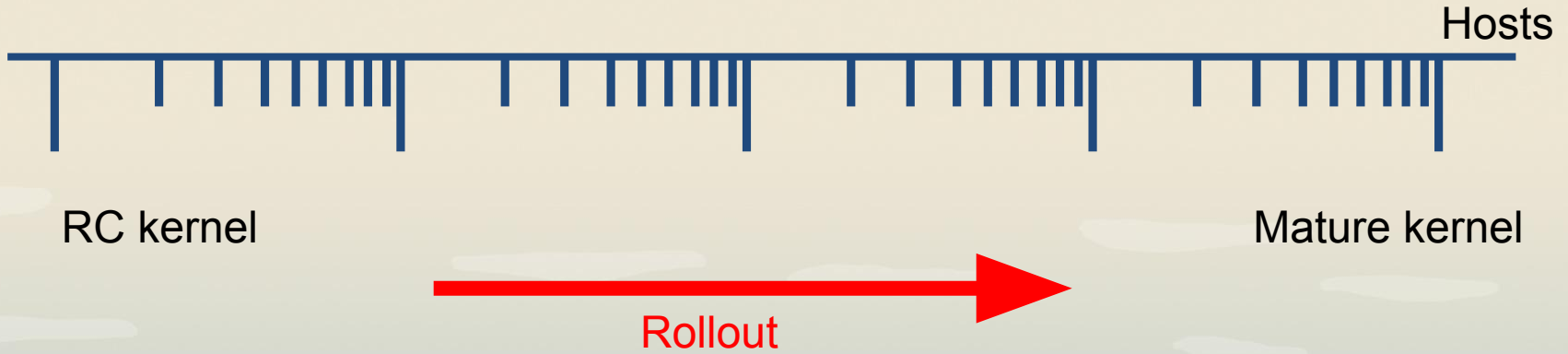
Detection: is there a problem?

Correlation: where is the problem?

Debugging: what is the nature, cause, remediation
of the problem?



Alerts and Health Checks

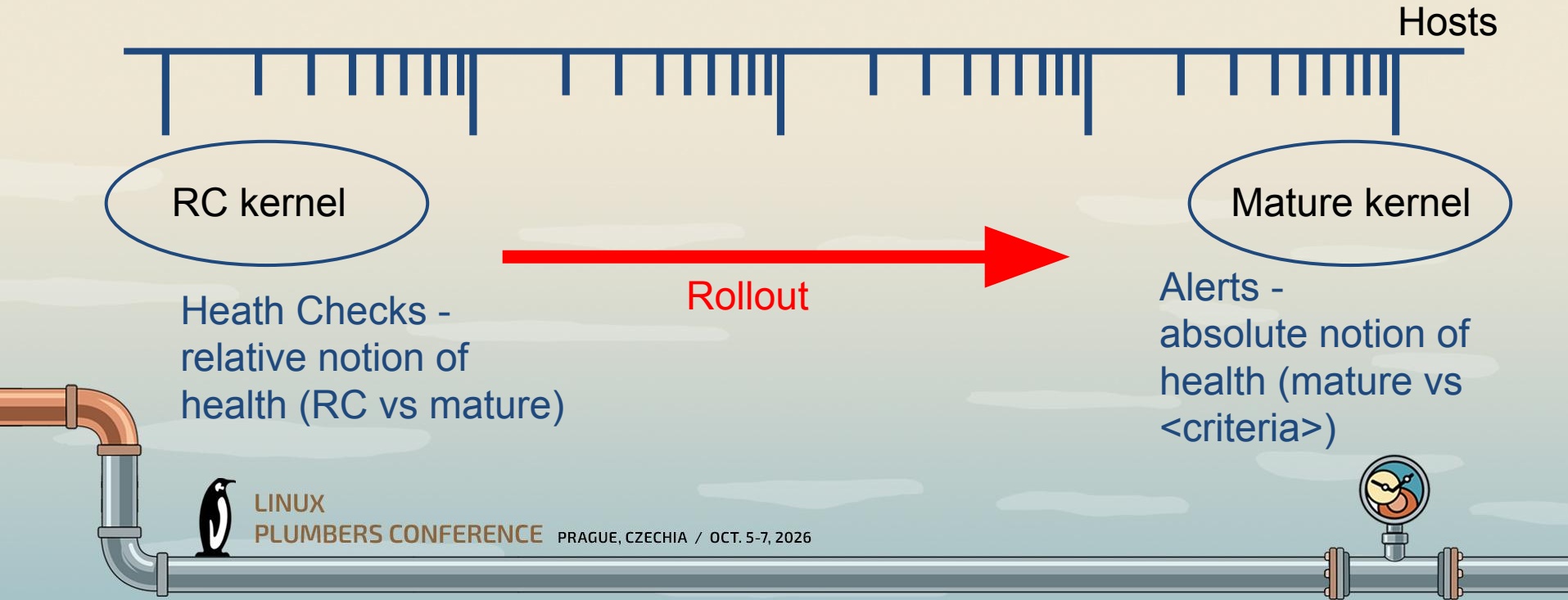


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Alerts and Health Checks



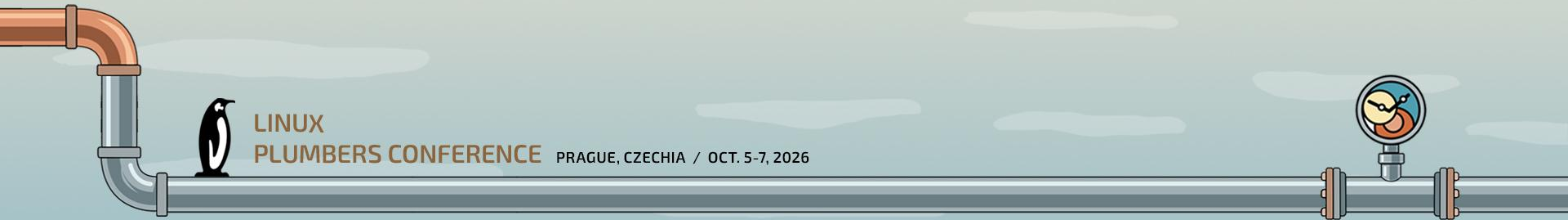
Instrumentation

Gauges (Metrics)

- Something that can always be measured at a point in time
- E.g. Memory Footprint

Counters (Events)

- Something that either happened or it didn't
- Example: Panics
- If expressed as a rate over a time interval, ~gauge.



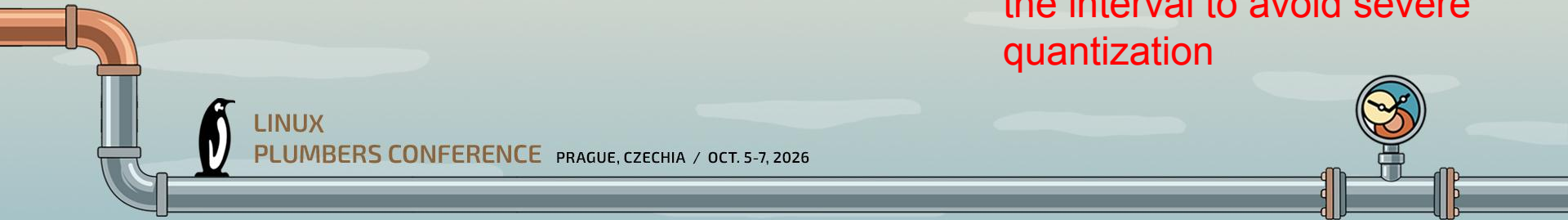
Instrumentation

Gauges (Metrics)

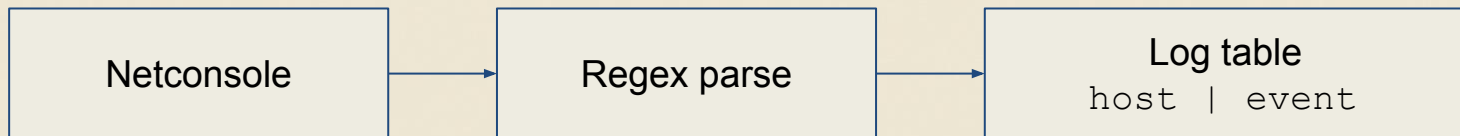
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Counters (Events)

- Something that either happened or it didn't
- Example: Panics
- If expressed as a rate over a time interval, ~gauge.
 - **Caveat! must be $\gg 1$ event in the interval to avoid severe quantization**



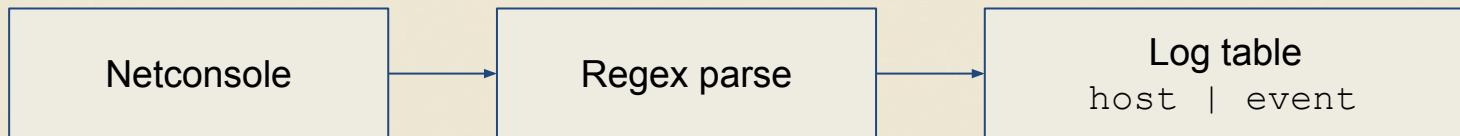
Instrumentation: Events



- Crashes
- Stalls
- Lockups
- Subsystem stuff
- Hardware errors
- ...

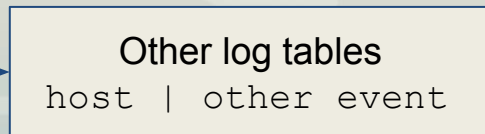


Instrumentation: Events



- Crashes
- Stalls
- Lockups
- Subsystem stuff
- Hardware errors
- ...

Other 'events'

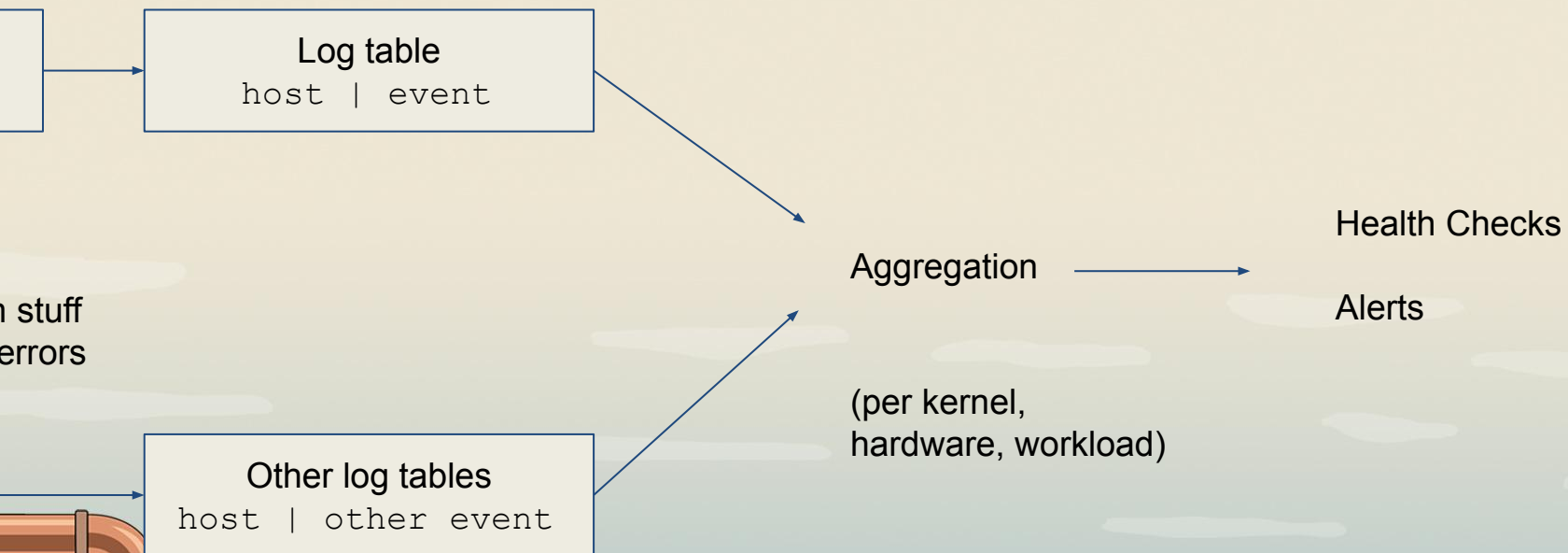


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Instrumentation: Events

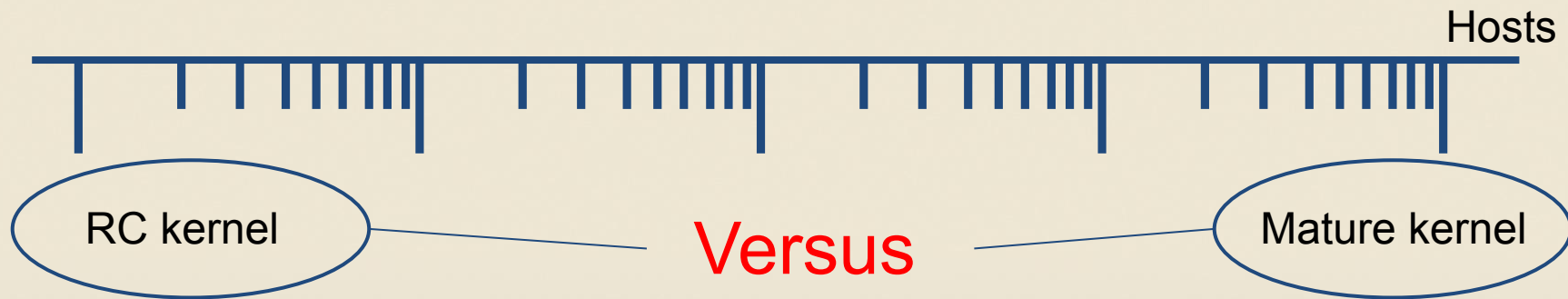


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Health Checks

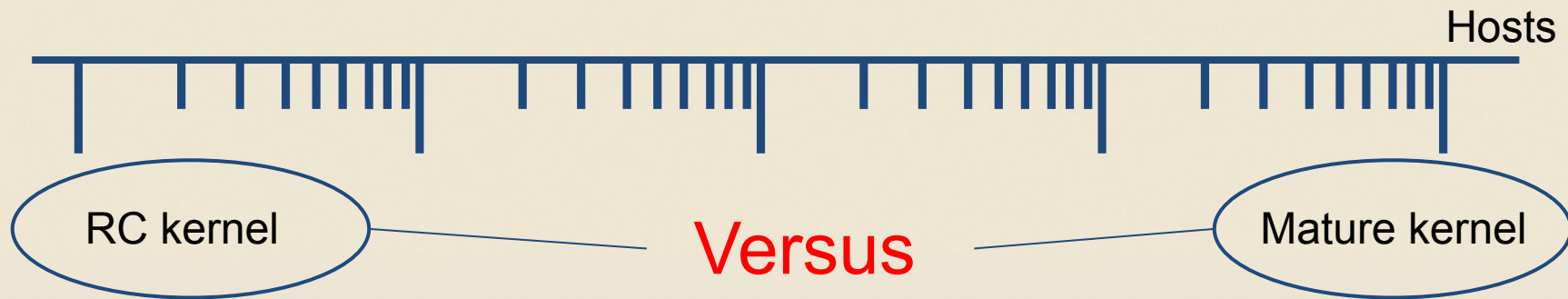


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Health Checks



'Is the health of the new kernel statistically worse than the health of the mature kernel it is replacing?'

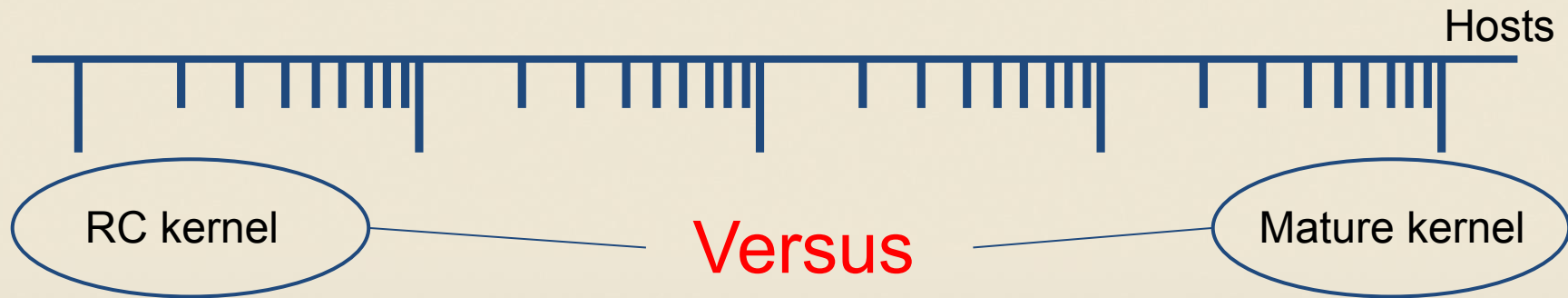


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Health Checks



'Is the health of the new kernel statistically worse than the health of the mature kernel it is replacing?'

Problems:

- The populations of the new and old kernels differ by orders of magnitude
- Rare 'events' do not behave like a 'gauge' - need to properly handle the quantization



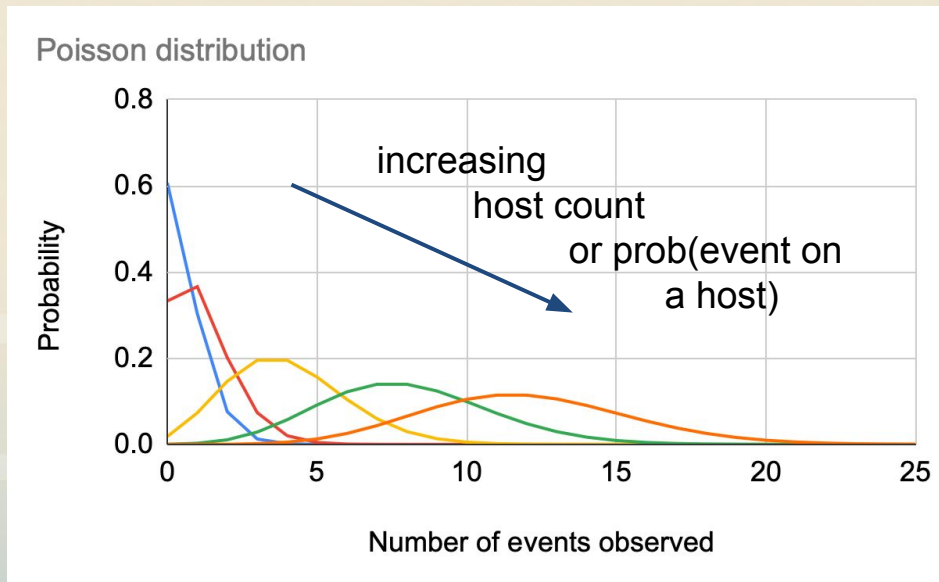
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Handling rare events

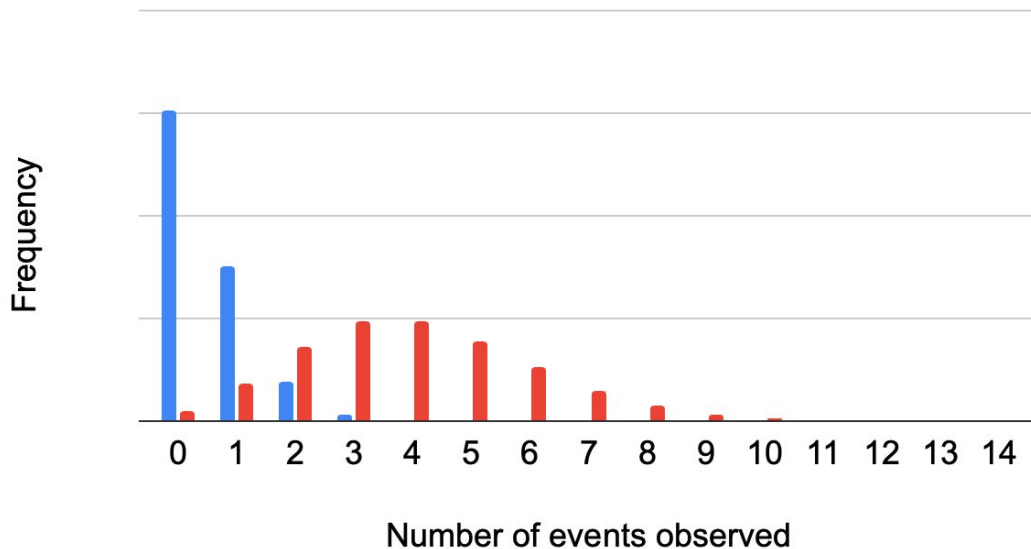


- Each host in a time interval represents a Bernoulli trial
- Many hosts, but low probability of an event, such that probability of an event on *some host* is moderate
- Cannot conveniently compute the binomial distribution, but Poisson provides good approximation



Handling rare events

RC vs Mature (illustration)



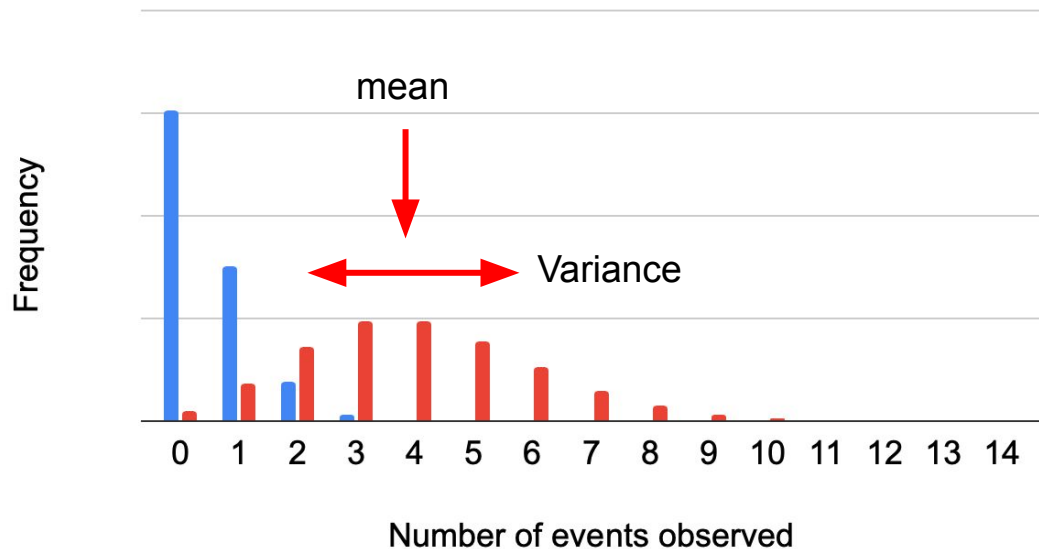
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Handling rare events

RC vs Mature (illustration)



Bucketization

'Time'
'Space' (hosts)
or both



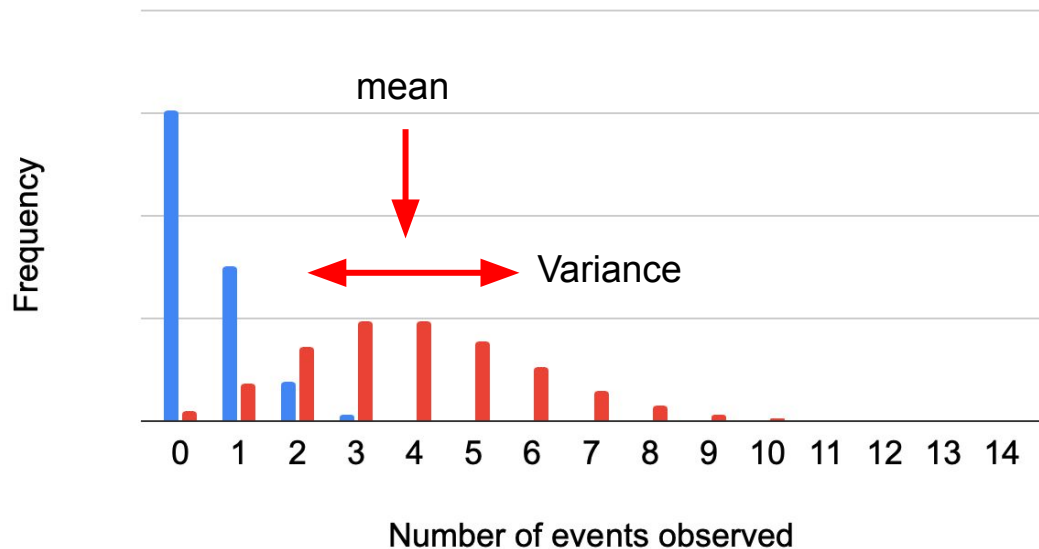
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Poisson Distribution Property

Mean == Variance

Real Observation

Variance / Mean = ϕ



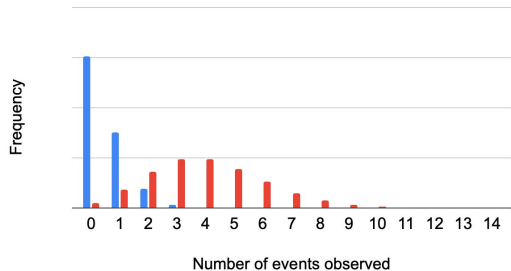
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Process

RC vs Mature (illustration)



Poisson Distribution Property

Mean == Variance

Real Observation

Variance / Mean = ϕ

- Is ϕ 'reasonable' ?
- Fit the mature kernel data
- 'Translate' the mature kernel distribution to reflect the new kernel's population size
 - 'Imagine we had N_x fewer hosts, corresponding to the new kernel. What distribution would we expect?



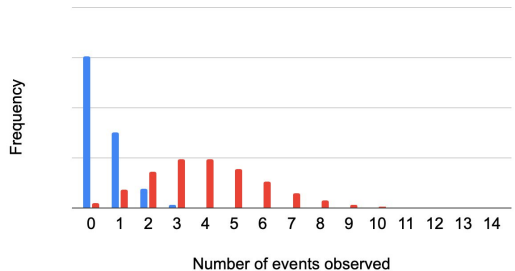
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Limitations

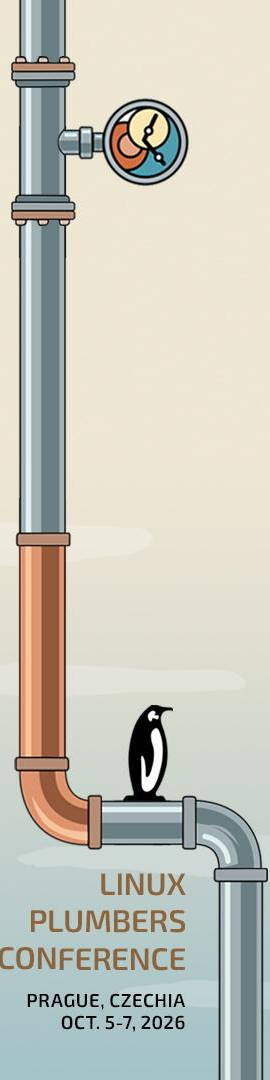
RC vs Mature (illustration)



- Assumes each 'bucket' is statistically equivalent
 - This can be violated e.g. if we bucketize over time and there is workload variability over the day
 - Can be handled by small modification
- Assumes that there is no extrinsic effect (other than kernel) that makes the probability of observing an event different for the new kernel vs the mature kernel
 - Example: events whose probability depends on system uptime, new kernel is being rolled out, so uptime will be lower



Thank you!

A vertical pipe with a pressure gauge and a penguin on a horizontal section. The pipe is grey with orange-brown joints. A circular pressure gauge with a yellow face and blue needle is attached to the upper part. A penguin is perched on a horizontal section of the pipe near the bottom.

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