Improving Coverage of Internet Outage Detection in Sparse Blocks

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What outages say...

about the Internet, about the world, and how they connect...



Iraq shuts down the internet to stop pupils cheating in exams The Irag government cuts off fixed-line and mobile broadband services to discourage children from smuggling mobile phones into state tests



intentional network interference



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speedy **physical recovery to natural disasters**



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speedy **physical recovery to natural disasters**

Outages are RARE, we need to look EVERYWHERE

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Our Approach

Goal:

- Broad coverage for active outage detection systems
 - Like Trinocular
 - 2 new algorithms

Requirements:

- Polite probers: limit probing to infer state
- Probe (in any order) **all** addresses before repeating

Quantify the results:

• Using 2 calendar quarters of real data





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(blocks: really have 256 addresses, we show 6 here)

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 - In example, up to 2
 - In Trinocular, up to 15



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- We do probe multiple times, but sometimes not enough
 => False outage!



















Blocks with multiple down events are often sparse

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Trinocular Round (TR)

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- If block is sparse, keep probing until:
- Full round (FR), or
- Active host

Trinocular Round (TR)

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If block is sparse, keep probing until:

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Block inferred DOWN

Non-reply

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- If block is sparse, keep probing until:
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- Full round (FR), or
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- 5. FR complete



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- 2. Find **one is up** => set pending TRs **UP**
- 3. a.3 goes down truth
- 4. Max probes hit, not yet FR => wait
- 5. FR complete => set pending TRs **DOWN**



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Challenges to Broad Coverage: Lone Address

Non-replies are ambiguous:

- Packet loss
- Temporarily offline
- Firewall
- Empty address
- Outage

Outages are rare, much rarer than other options!

=> Block state inferred from a lone address is **ambiguous**













Lone Address Block Recovery (LABR)

Solution:

- Accept up events.
- Convert down to unknown
 - when active address are less than 3 (last 3 FRs average)

Note:

- LABR is biased (cannot fail)
 - We tag LABR-marked blocks and allow users to ignore them (if they prefer to)















Block to block comparison for 2017q4 responsive Internet (4M blocks)

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Comparing FBS with Passive Outages (number of events)





Comparing FBS with Passive Outages (number of events)



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FBS Cost: Slightly Lower Temporal Precision

- Shortest detectable outage duration is a FR
 - only sparse blocks (30% of total)
- FR duration depends on:
 - number of ever-active addresses
 - how many are currently active






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Coverage Improvement

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Coverage Improvement



Conclusions

- We increase coverage:
 - 96% of responsive internet is trackable.
 - Up from 67% before.
- Minimal cost: slightly lower temporal precision
 - FBS needed for only 30% of blocks
 - Most of these fixed in 1 TR (11 minutes)
 - Almost all fixed in 2.75h
- more info? <u>https://ant.isi.edu/datasets/outage/</u>



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