Cross-Site Search (XS-Search) Attacks

Hemi Leibowitz, OWASP AppSec IL 2015

Work By:

Nethanel Gelernter:

Head of the cyber research group at the Michlala LeMinhal.

Professor Amir Herzberg:

Head of the Secure Communication and Computing (`Cyber`) group at Bar-Ilan University

AGENDA

Extraction of private, sensitive data using cross-site vulnerabilities via XS-Search attacks

- ➢ Who, what, how?
- ➢ Demo
- ➢ Conclusions

* All experiments were performed ethically

VULNERABLE SITES AND DATA

Mail content, contacts…

Gmail by Google

YAHOO! MAIL

Outlook.com

Search history

bing

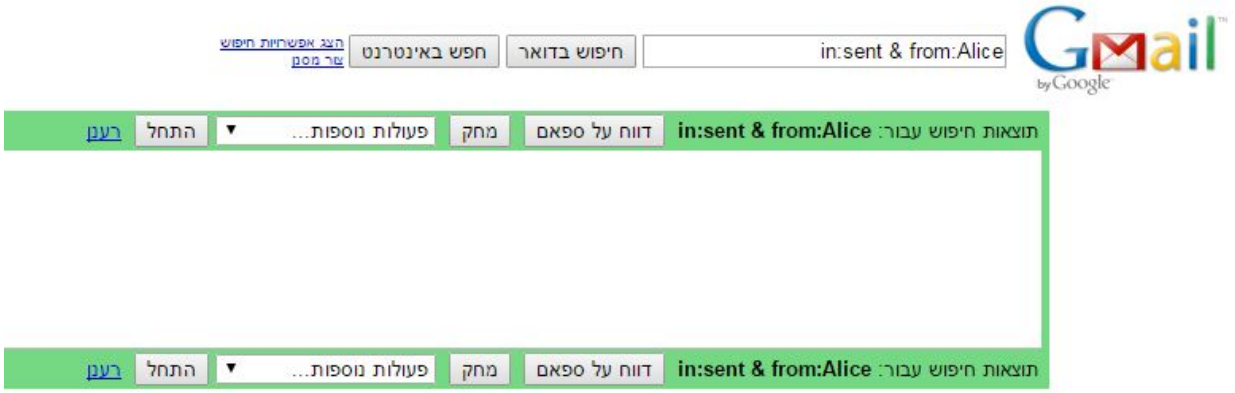
Structured information

Relationships

And a lot more…

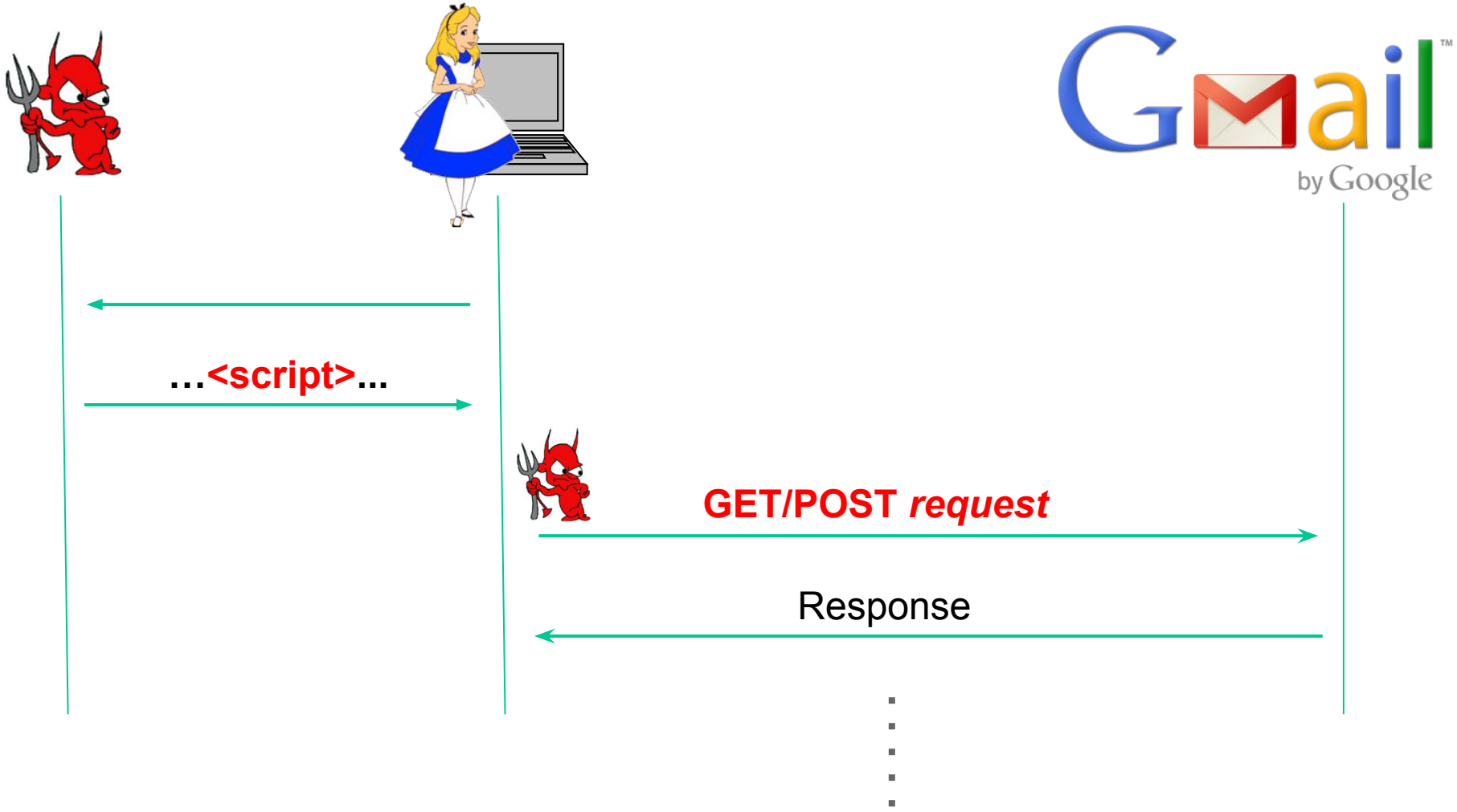
EXAMPLE SCENARIO

GET / POST request to Gmail
Browser receives the response and displays it



Cross-Site Attacks

XS-SEARCH: HIGH LEVEL VIEW



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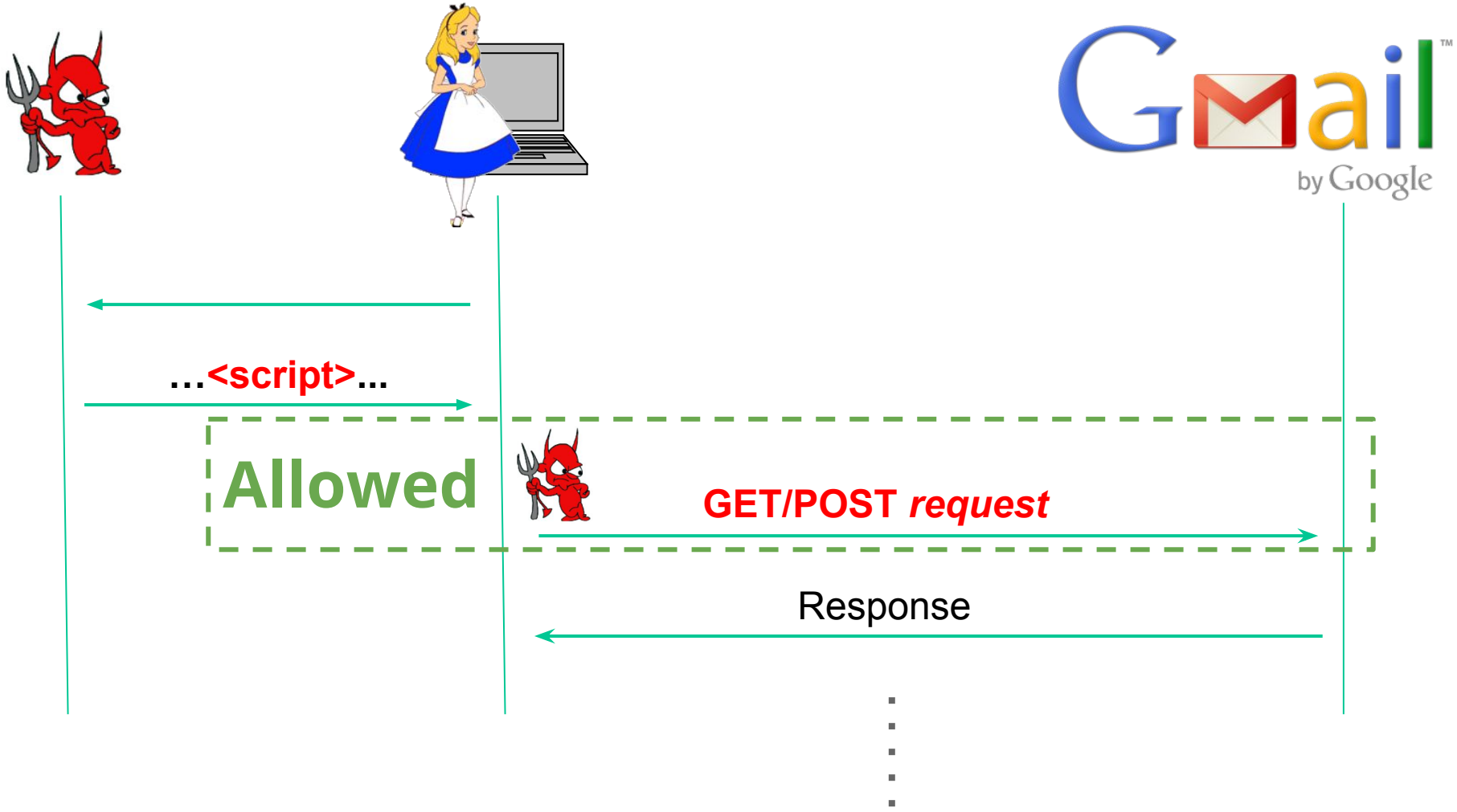
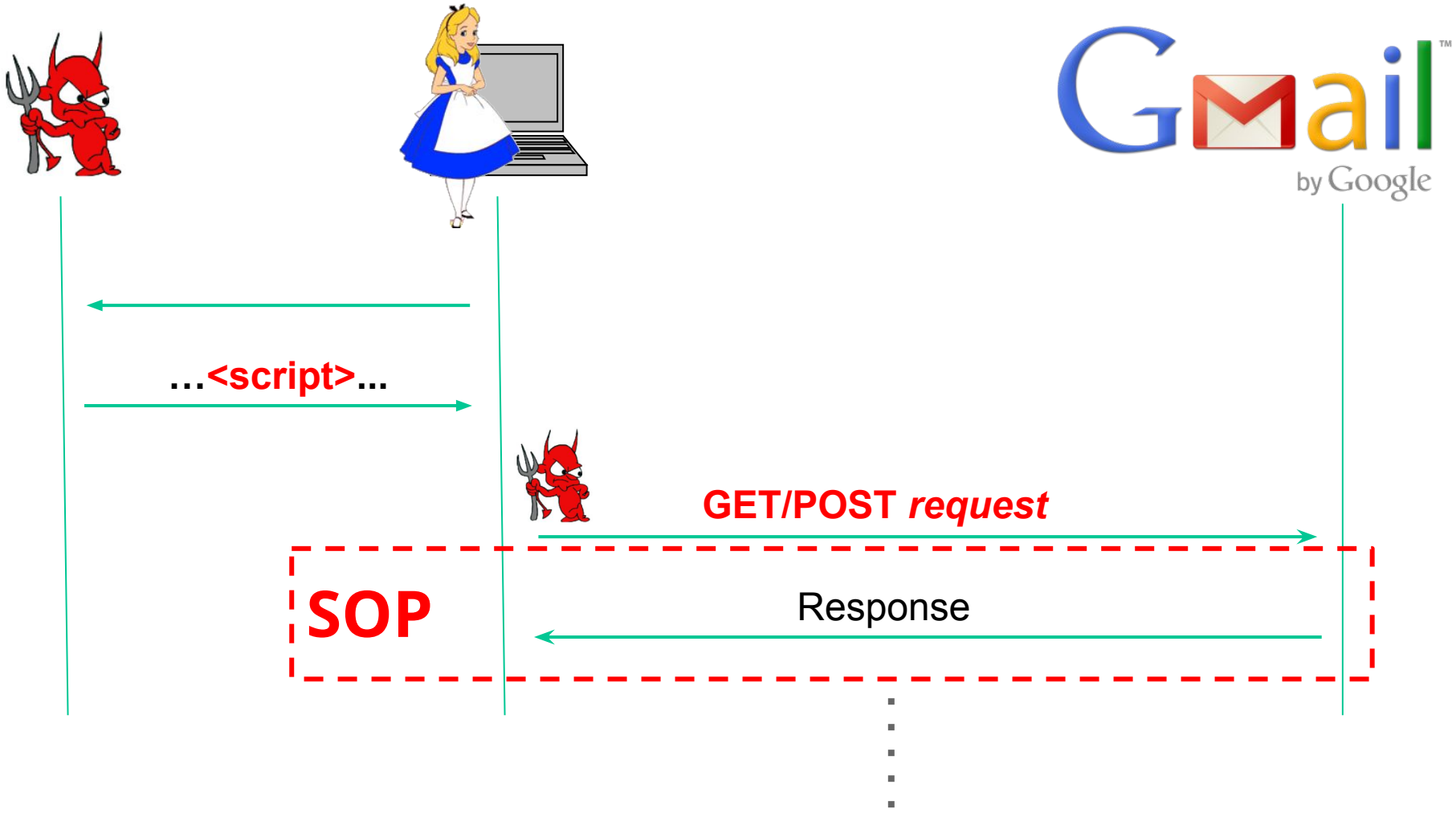


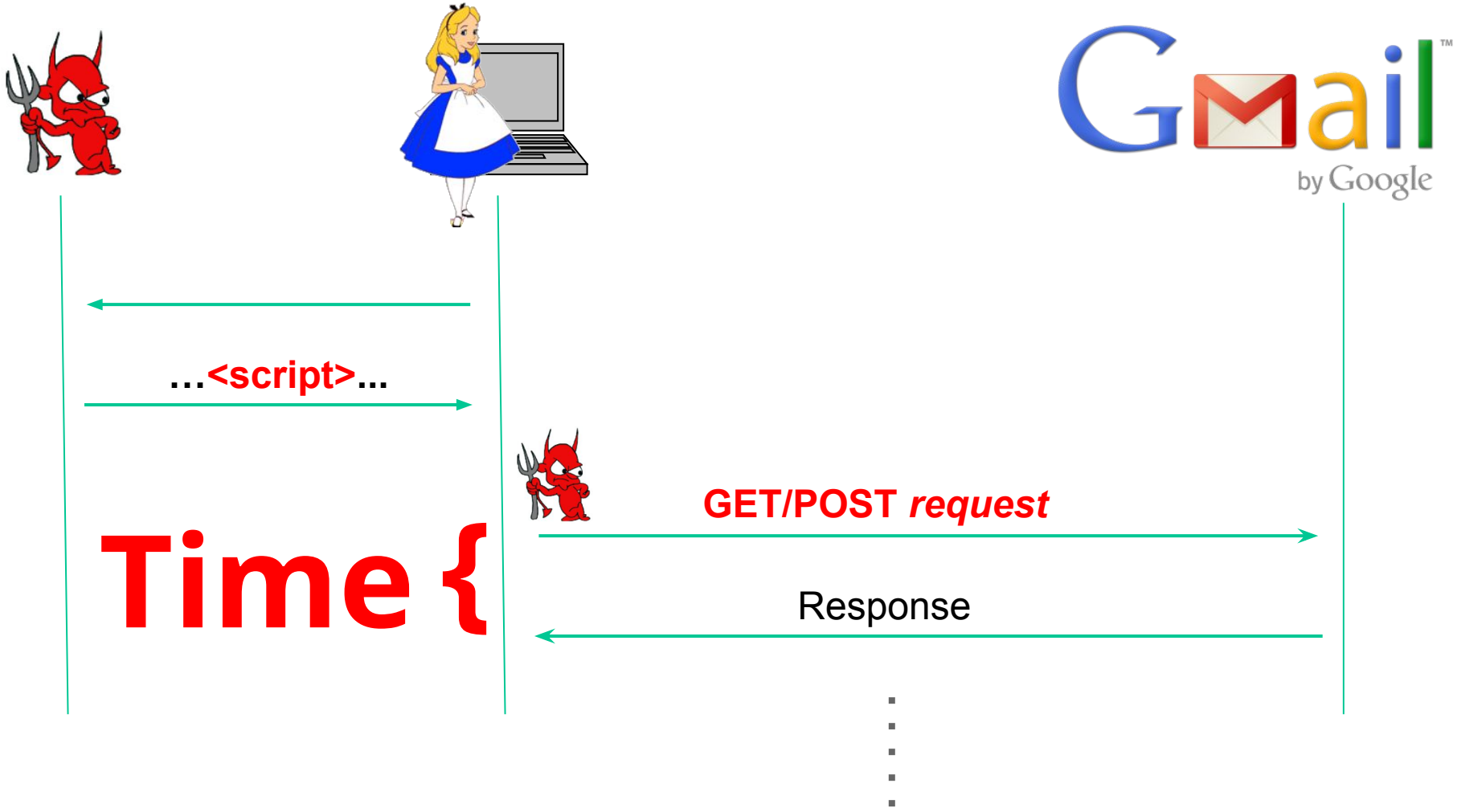
XS-SEARCH: HIGH LEVEL VIEW



Timing Side Channel

We can’t read the response, BUT - we can measure how long it took

XS-SEARCH: HIGH LEVEL VIEW



PROBLEMS

1. ***Noise -***
    a. Timing a response is inaccurate and influenced by many factors (Internet connection, Browser etc.)
    b. Very (very) short time differences between responses (even long ones) - especially when heavily compressed.
2. ***Small window of opportunity -***
    a. User visits the page for a short term only
    b. Avoid detection mechanisms (anti-DoS)

These XS-Search attacks

are **impractical**

XS-SEARCH: BASIC FLOW

Dummy - request that yields a short (fast) response

q=in:sent&from:fdjakdhasd

Challenge - request that yields either long or short response

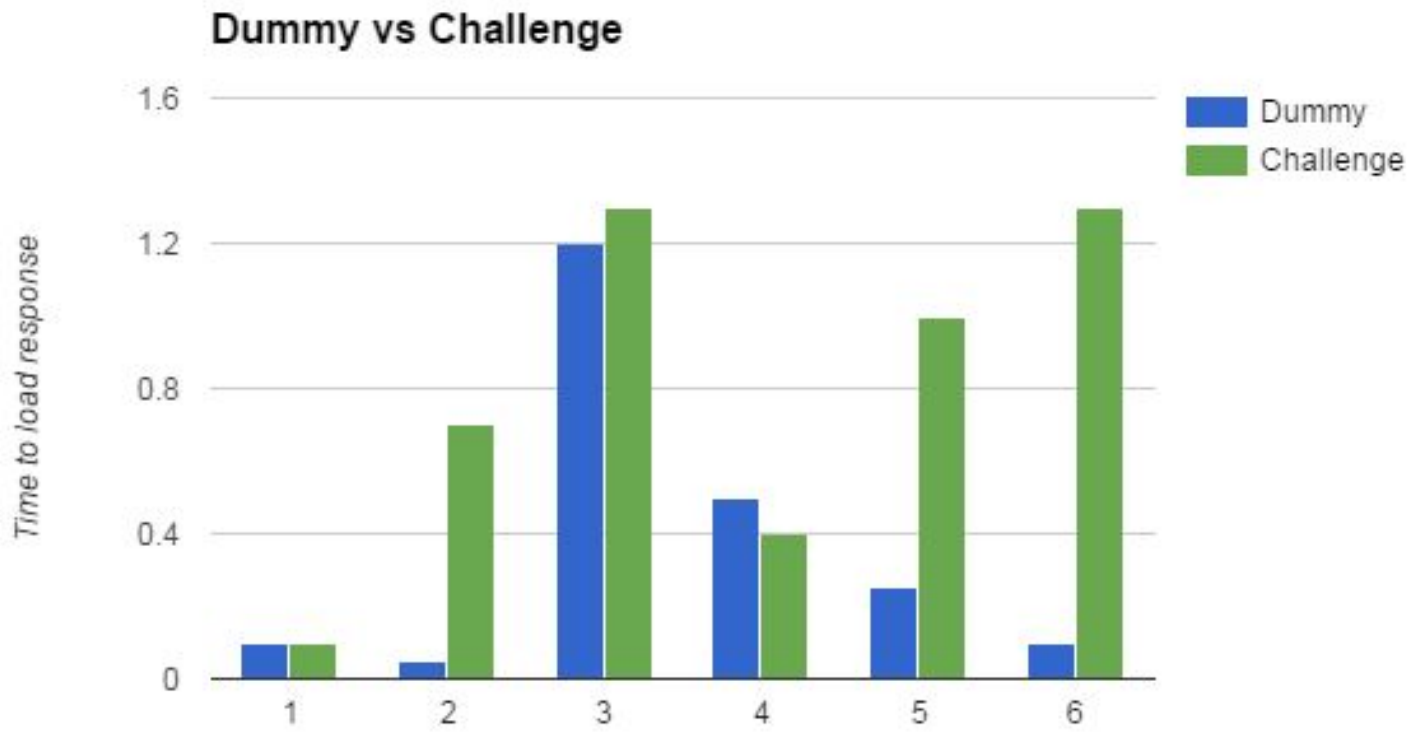
q=in:sent&from:Alice

BASIC FLOW: ANSWER BOOLEAN QUESTIONS

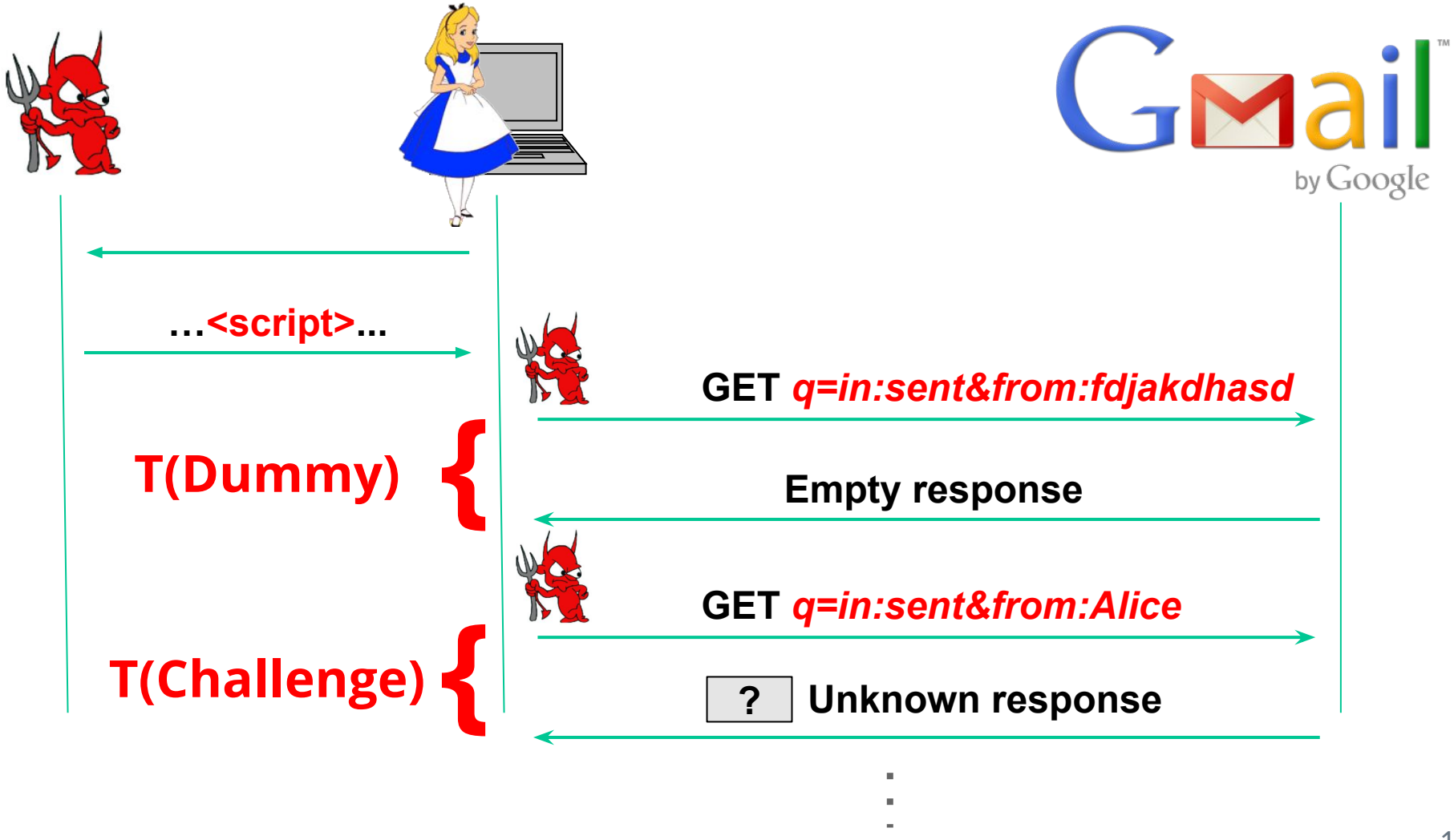
$$T(Dummy) \approx T(Challenge) \Rightarrow \textbf{False}$$

$$T(Dummy) \ll T(Challenge) \Rightarrow \textbf{True}$$

XS-SEARCH: BASIC FLOW



XS-SEARCH: BASIC FLOW



DEALING WITH THE PROBLEMS

- Dummy / Challenge pairs
- Statistical tests
- Inflation techniques
- Divide and Conquer algorithms

STATISTICAL TESTS

Classical statistical hypothesis tests assume large samples.

In order to achieve good results using small samples:

- Ran each Dummy / Challenge pair a few times
- Tested and compared various statistical tests between the distributions

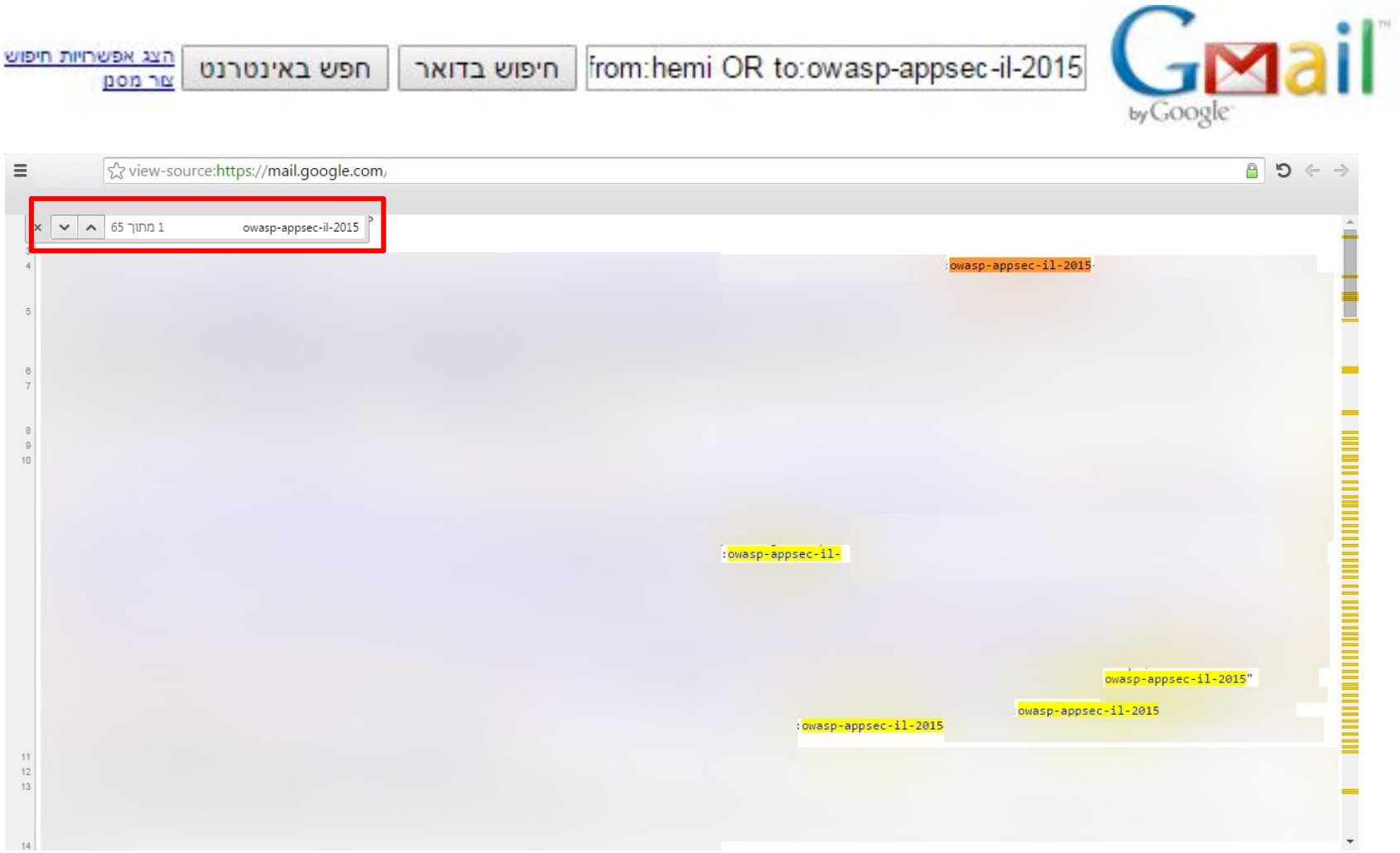
Main observation: lower values give better indication

INFLATION TECHNIQUES

Increase the difference of the response time between empty and full response

- Response-length inflation
  - Query fields are copied to the response
- Compute-time inflation

RESPONSE-LENGTH INFLATION



COMPUTE-TIME INFLATION

- Abuses hard-to-compute ‘has not’ search terms
- Short circuit ‘empty’ queries
- Allows detection of information that appears only once!

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Dummy:

q=in:sent&from:fdjakdhasd&hasnot:{rjew+...+iqejh}

Challenge:

q=in:sent&from:Alice&hasnot:{rjew+...+iqejh}

EFFICIENT TERM IDENTIFICATION

Which of {T1, T2,…} appears in <data>?

Naïve solution: check one by one…

Three efficient divide and conquer algorithms:

- Multiple Terms Identification (MTI)
- Optimized Multiple Terms Identification (OMTI)
- Any Term Identification (ATI)

Each of them sends queries for conjunction of terms

from:michael+OR+dan+OR+.... Up to the URL limit

DEMO

WHAT CAN WE EXPOSE WITH XS-SEARCH?

- Specific terms or from list of candidate terms
- By date, subject, folder, or other properties
- Structured information
  - Credit card numbers (xxxx-xxxx-xxxx-xxxx)
  - Phone numbers (xxx-xxxx-xxx)

WHAT CAN WE EXPOSE WITH XS-SEARCH?

- Does the name of the user is Alice?
  - in:sent&from:alice
- Closely related to bob@gmail.com?
  - bob@gmail.com&st=100
- Is a client of SomeBank?
  - noreply@somebank.com
- Do have Bob as a friend in Google+?
  - from:bob&circle:friends
- Did Bob bcc Charlie ***about an amazing lecture?!***
  - from:bob&bcc:charlie&after:2015/10/12+before:2015/10/14&subject:amazing-xssearch-lecture

WHAT CAN WE EXPOSE WITH XS-SEARCH?

Credit card numbers (xxxx-xxxx-xxxx-xxxx)

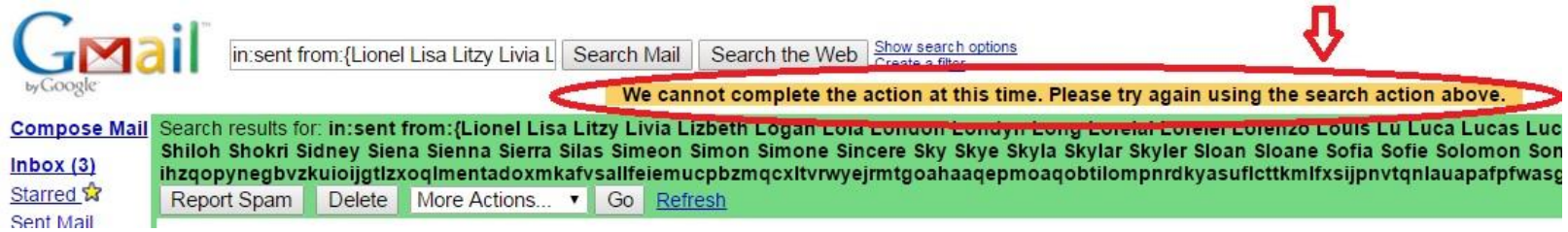
- $x \in \{0,1...9\} \Rightarrow 10^{16} =$

  10,000,000,000,000,000

But, using XS-Search we only need to reveal xxxx

- Only 10^4 (= 10,000) possibilities!

PREVENTING XS-SEARCH?



PREVENTING XS-SEARCH?

Easy - prevent any cross-site request.

BUT…

Many services wish to allow cross-site requests.

These services can ***try*** to:

- Restrict: limit requests rate, inflation …
- Detect: anomalies, heuristics...

Thanks!

Any questions?

You can find me at:

leibo.hemi@gmail.com

Credits

Special thanks to all the people who made and released these awesome resources for free:

- Presentation template by SlidesCarnival
- Photographs by Unsplash