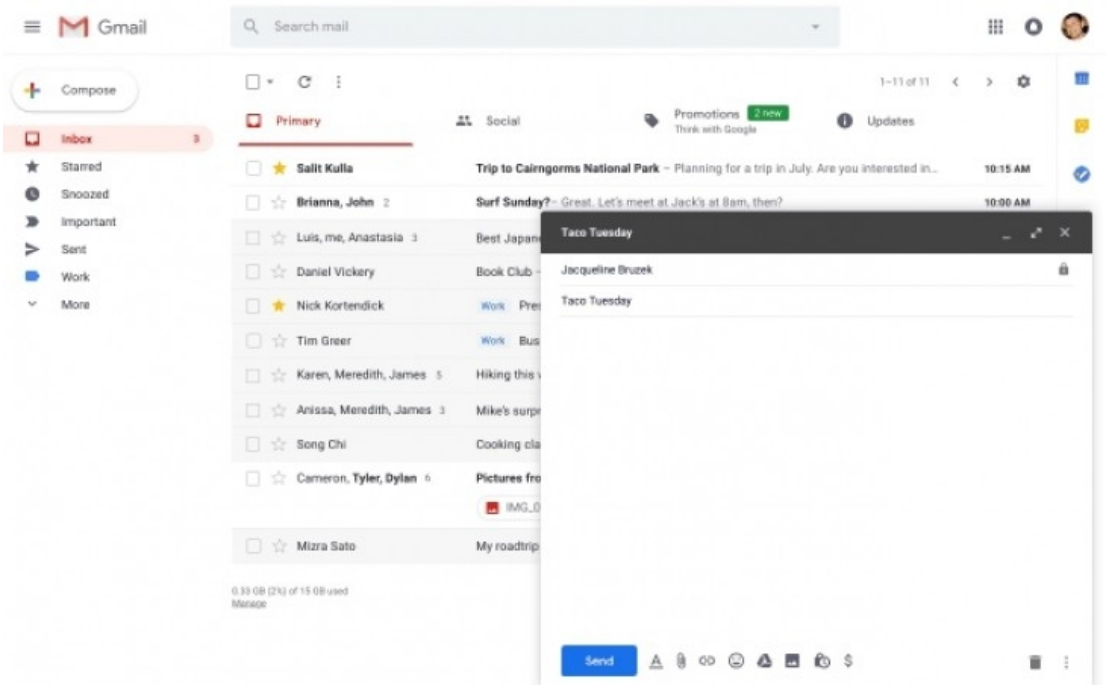
ProtectIOn: Root-of-Trust for IO in Compromised Platforms

A. Dhar, E. Ulqinaku, K. Kostiainen, S. Capkun
ETH Zürich

Motivation

- Communication



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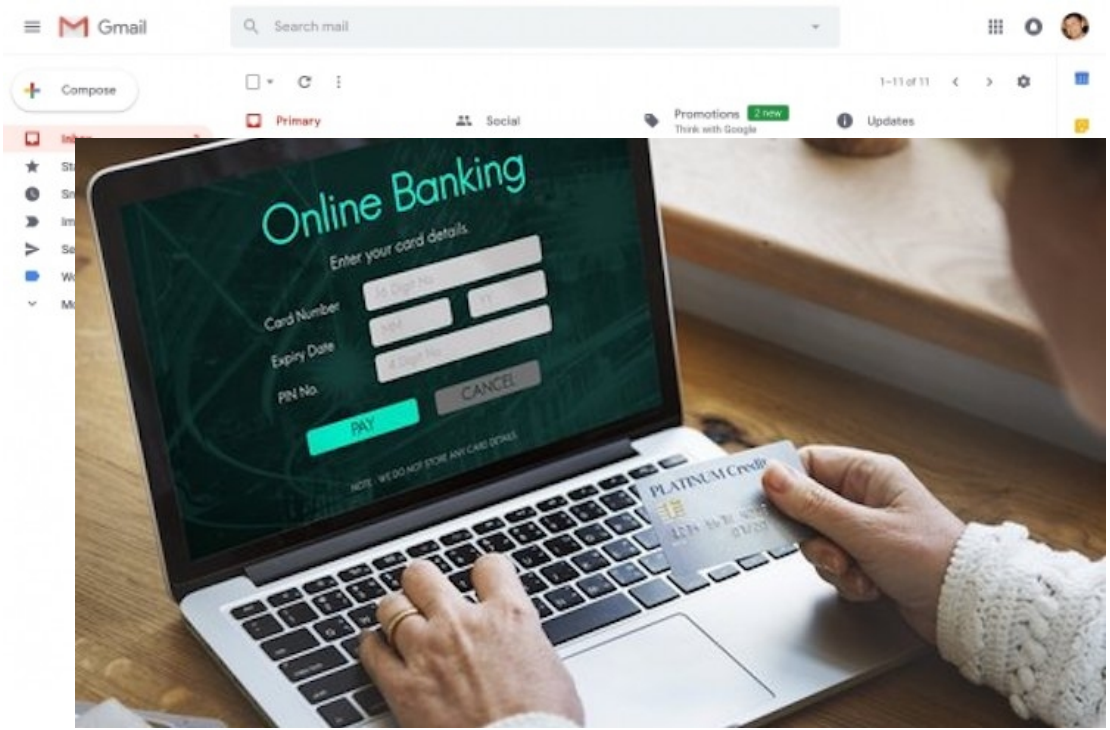

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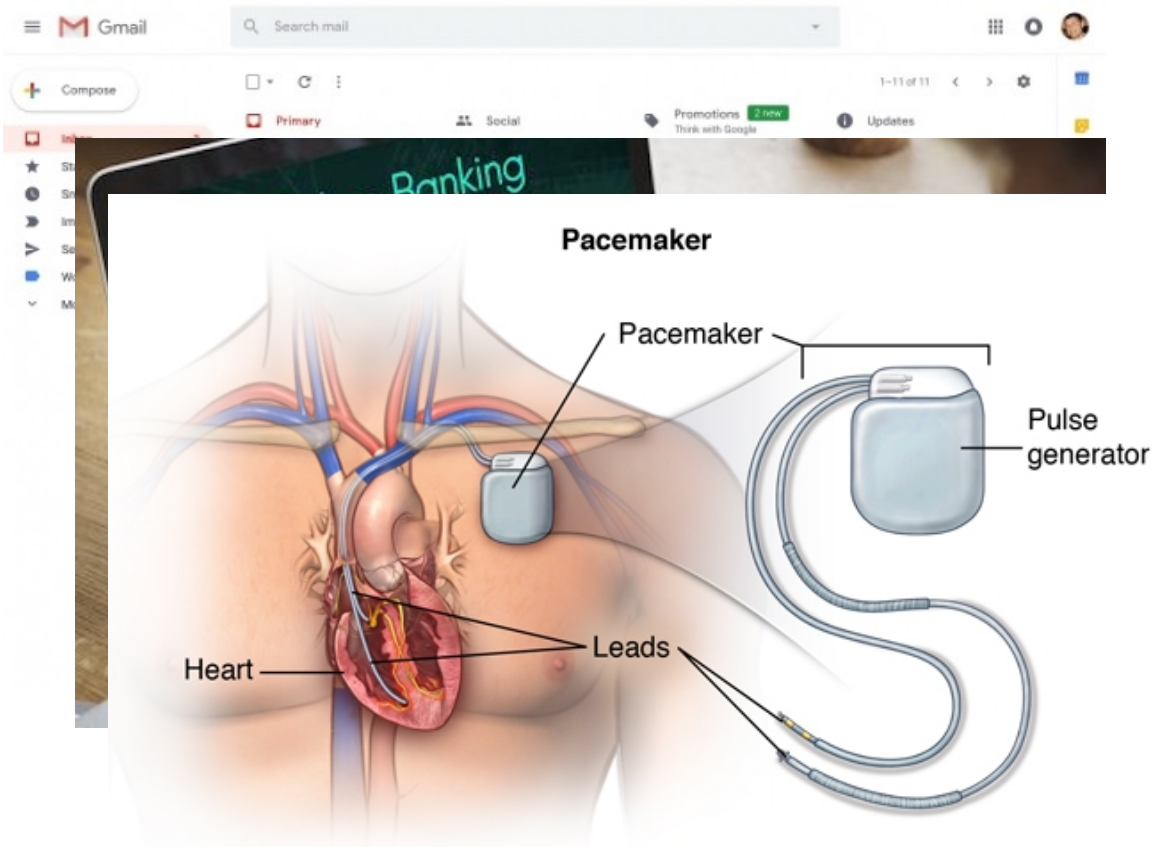

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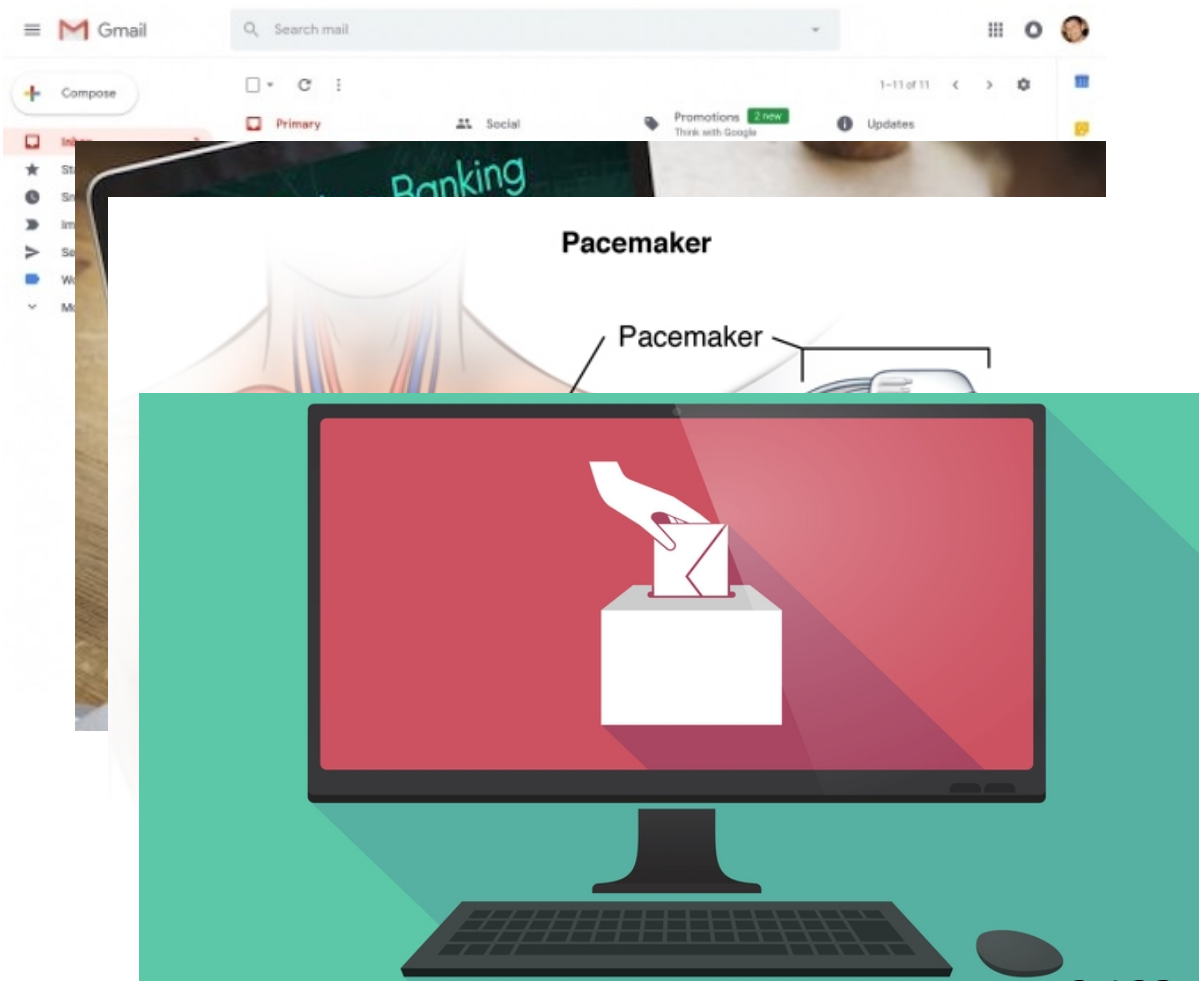
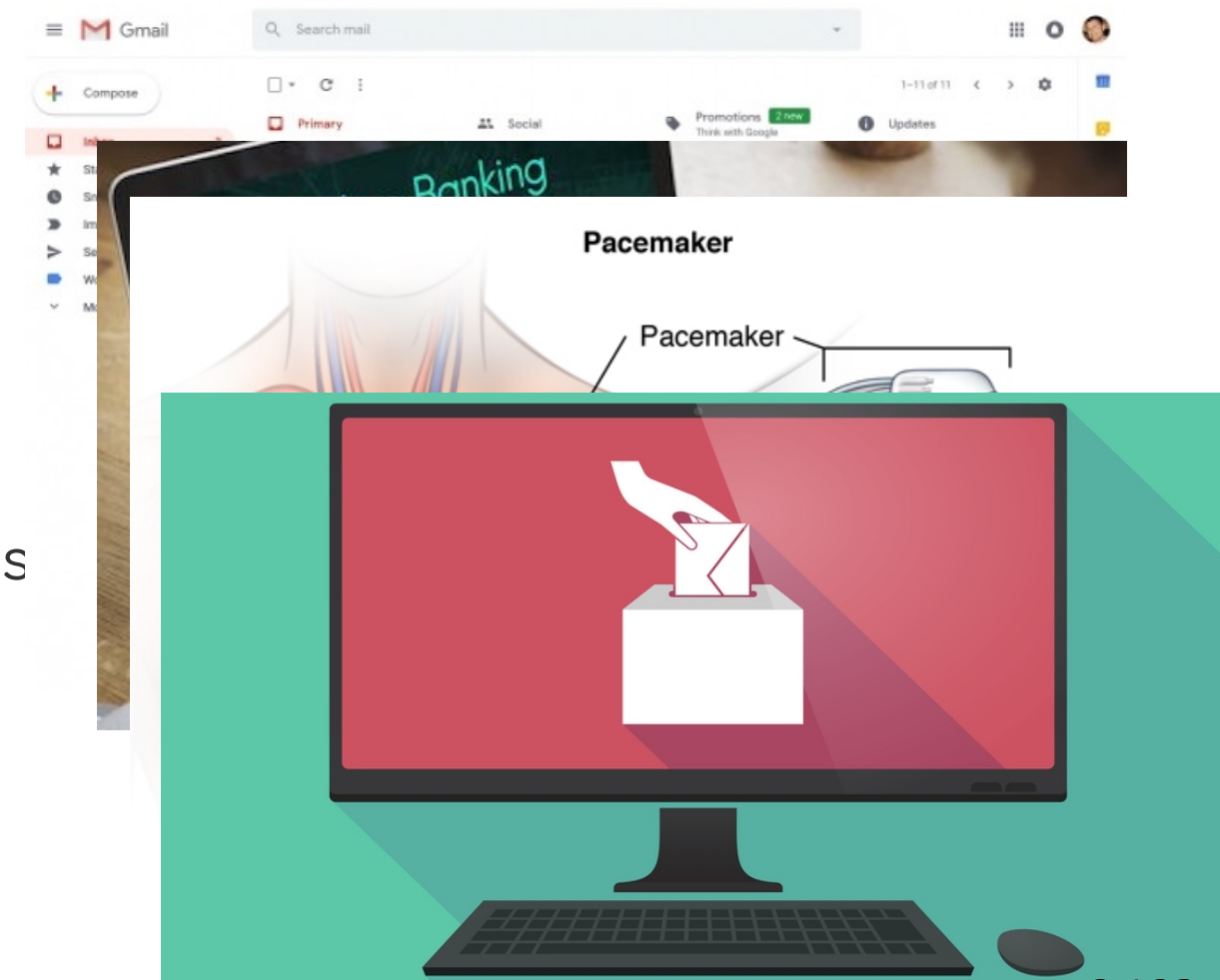
- Financial Transaction
- Configurations
- Voting



Motivation

- Communication
- Financial Transaction
- Configurations
- Voting
- Cyber-Physical Systems
- ...



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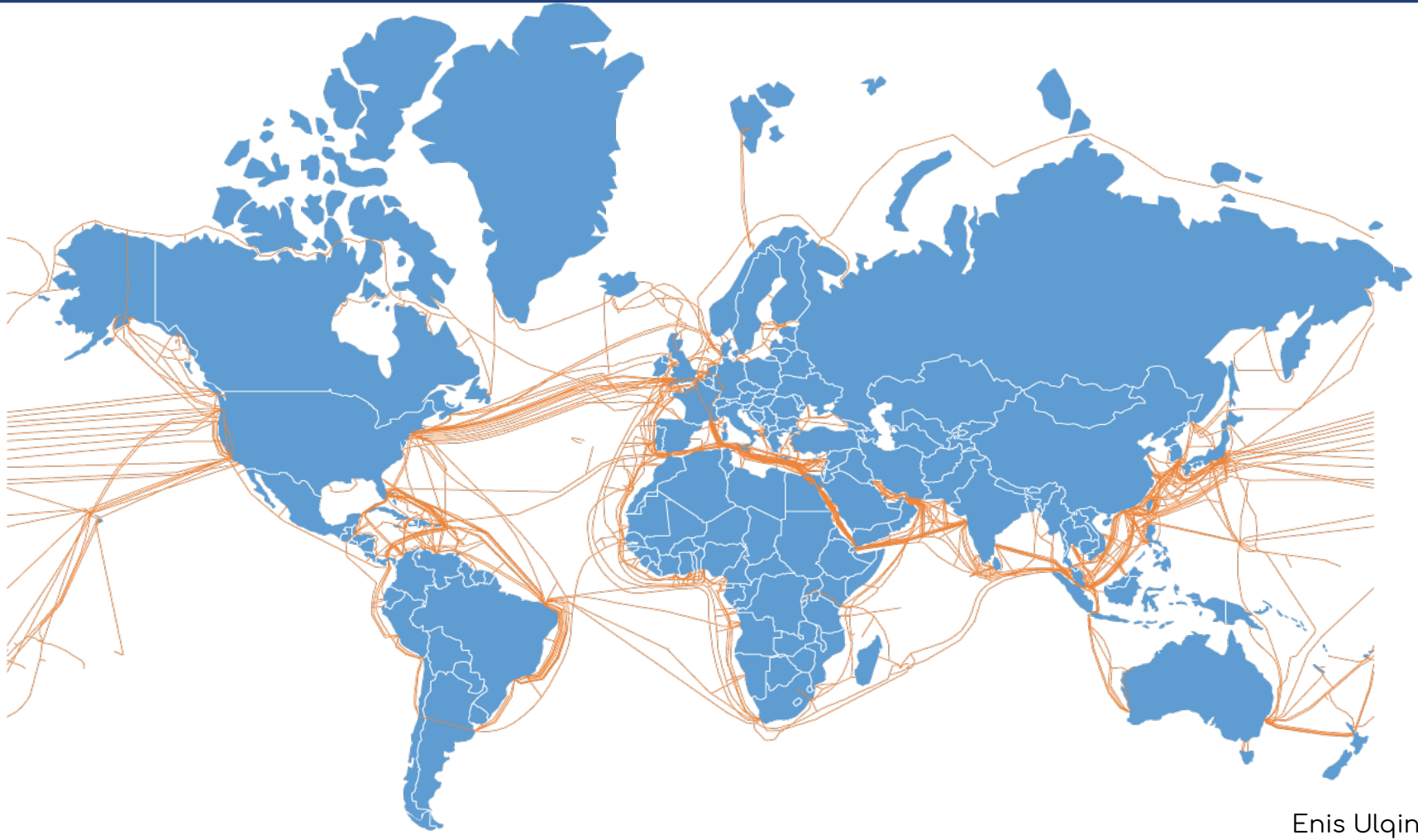

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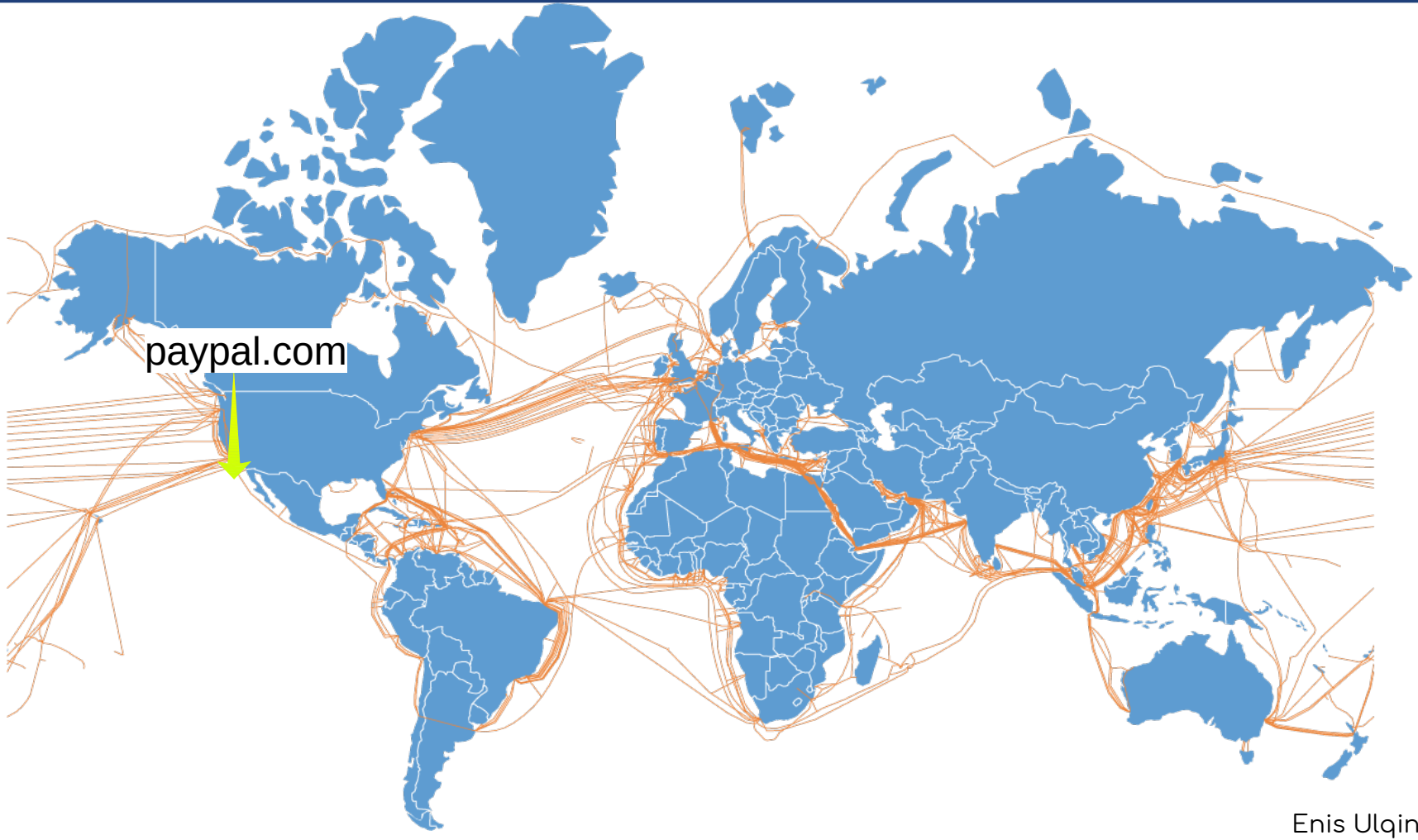

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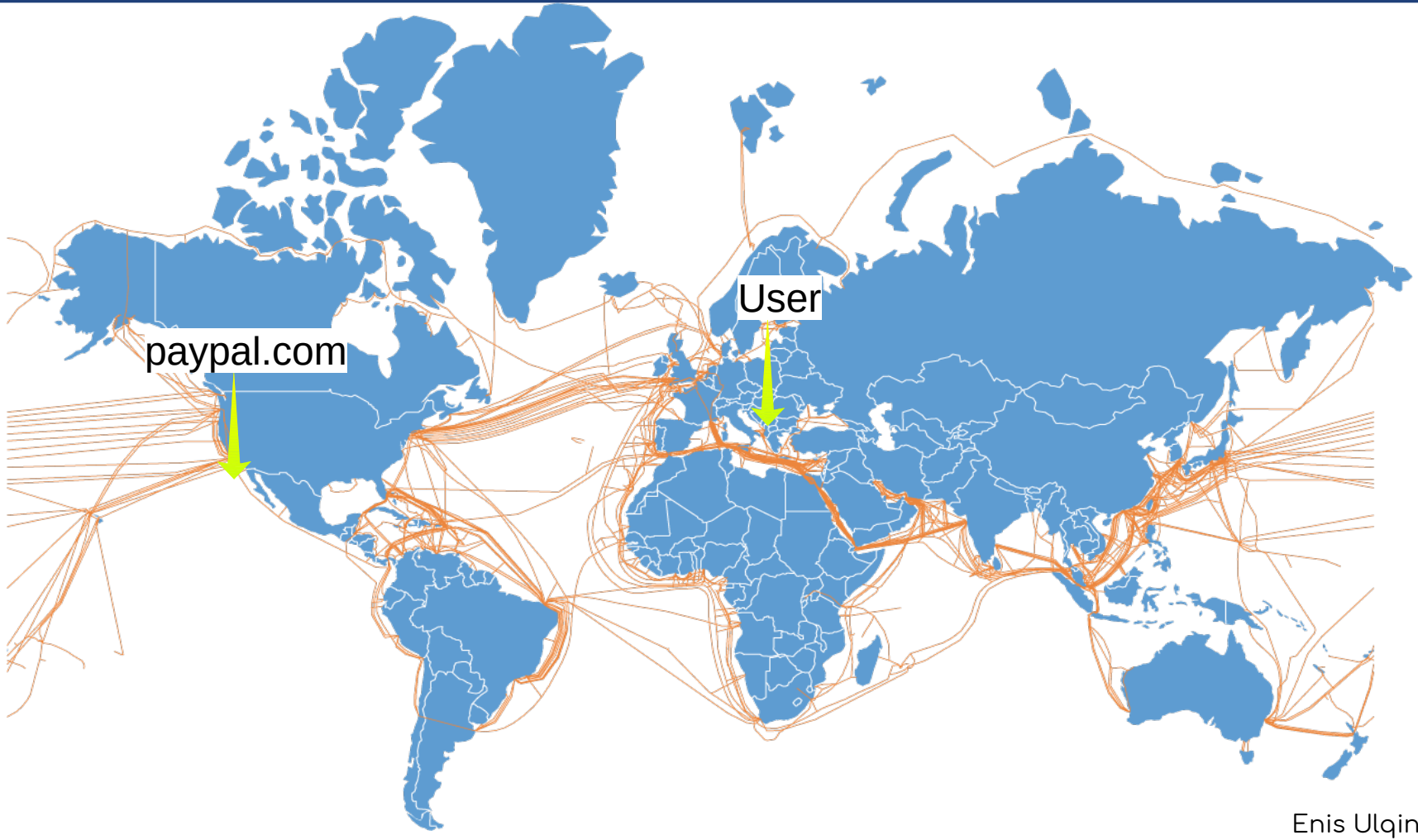

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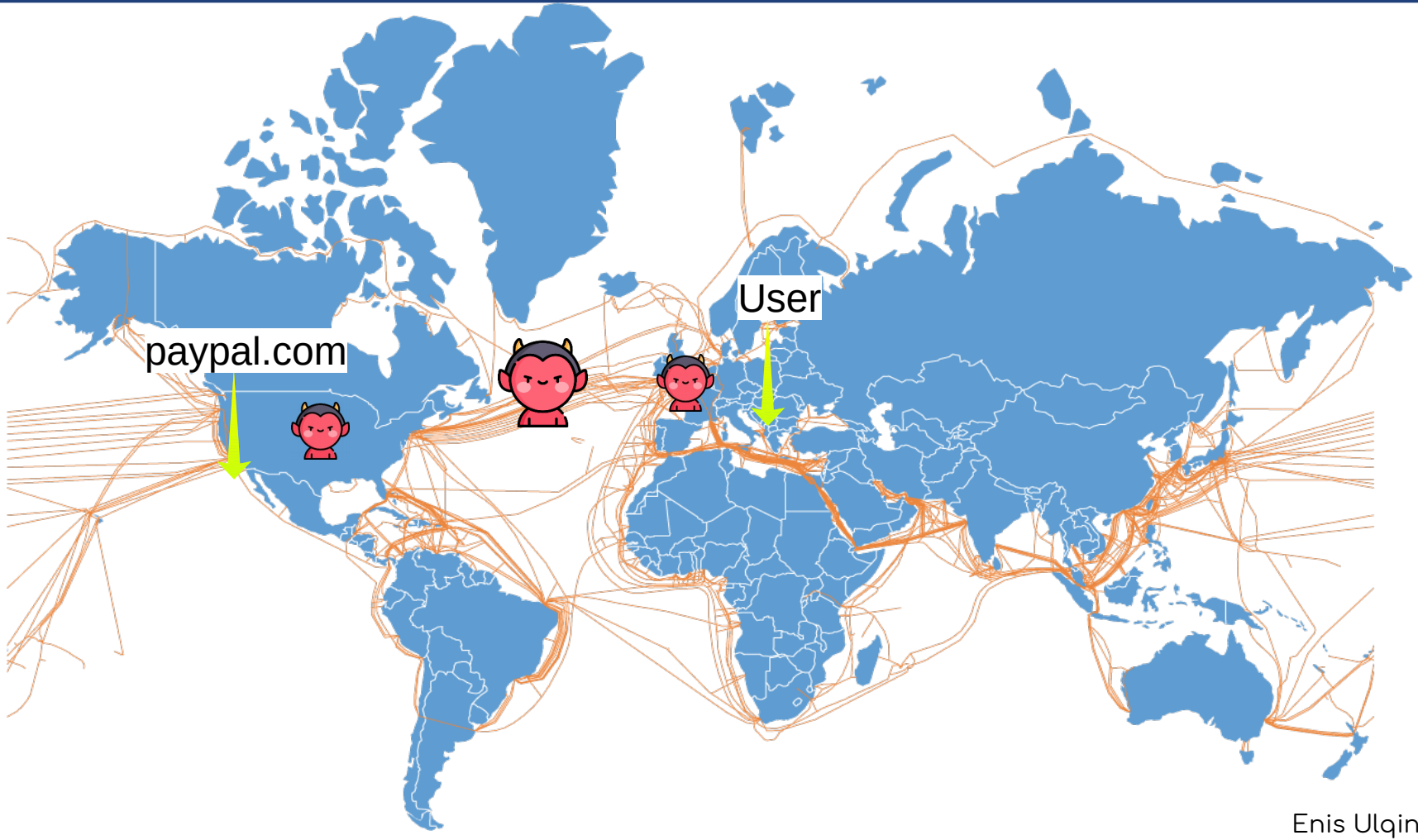

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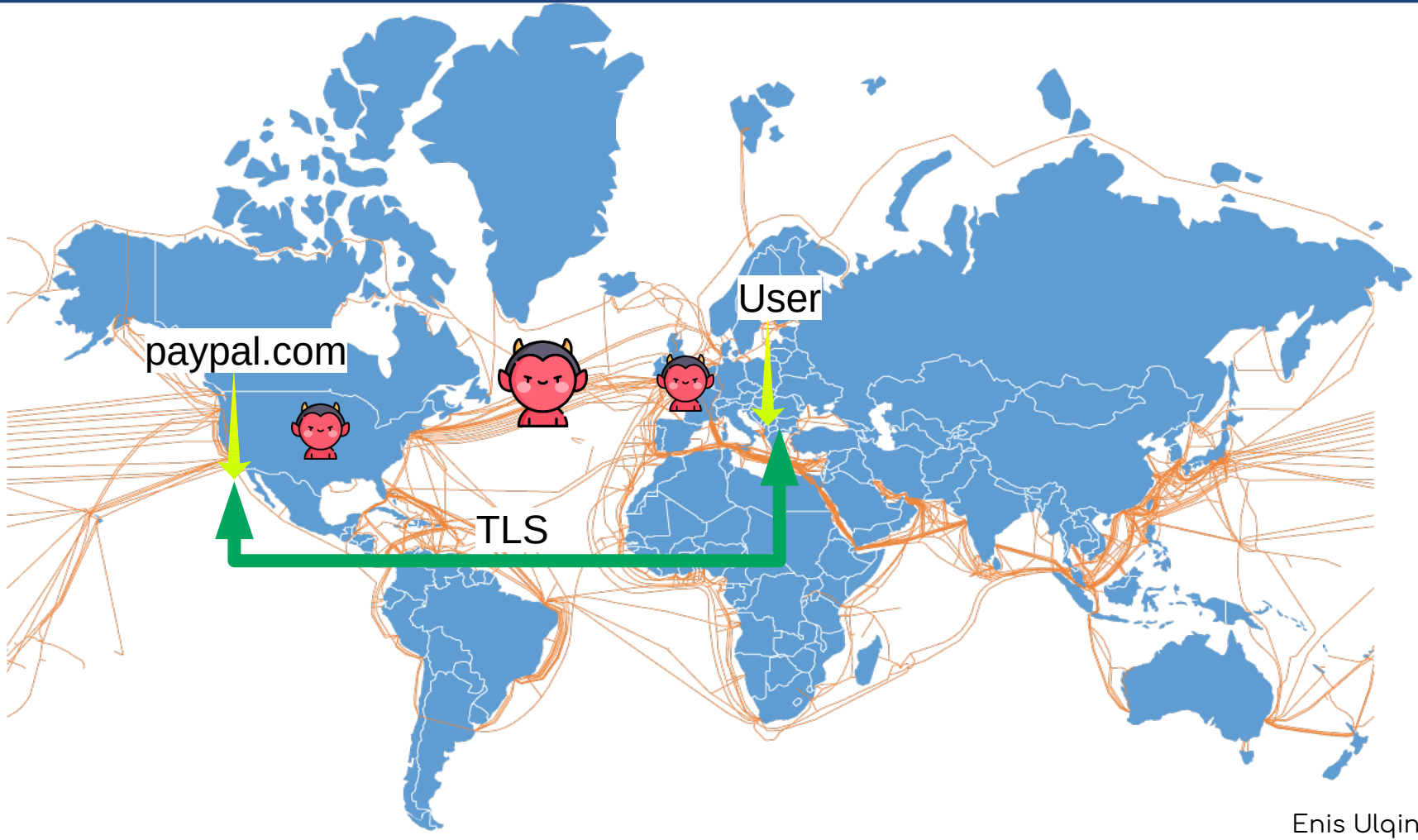

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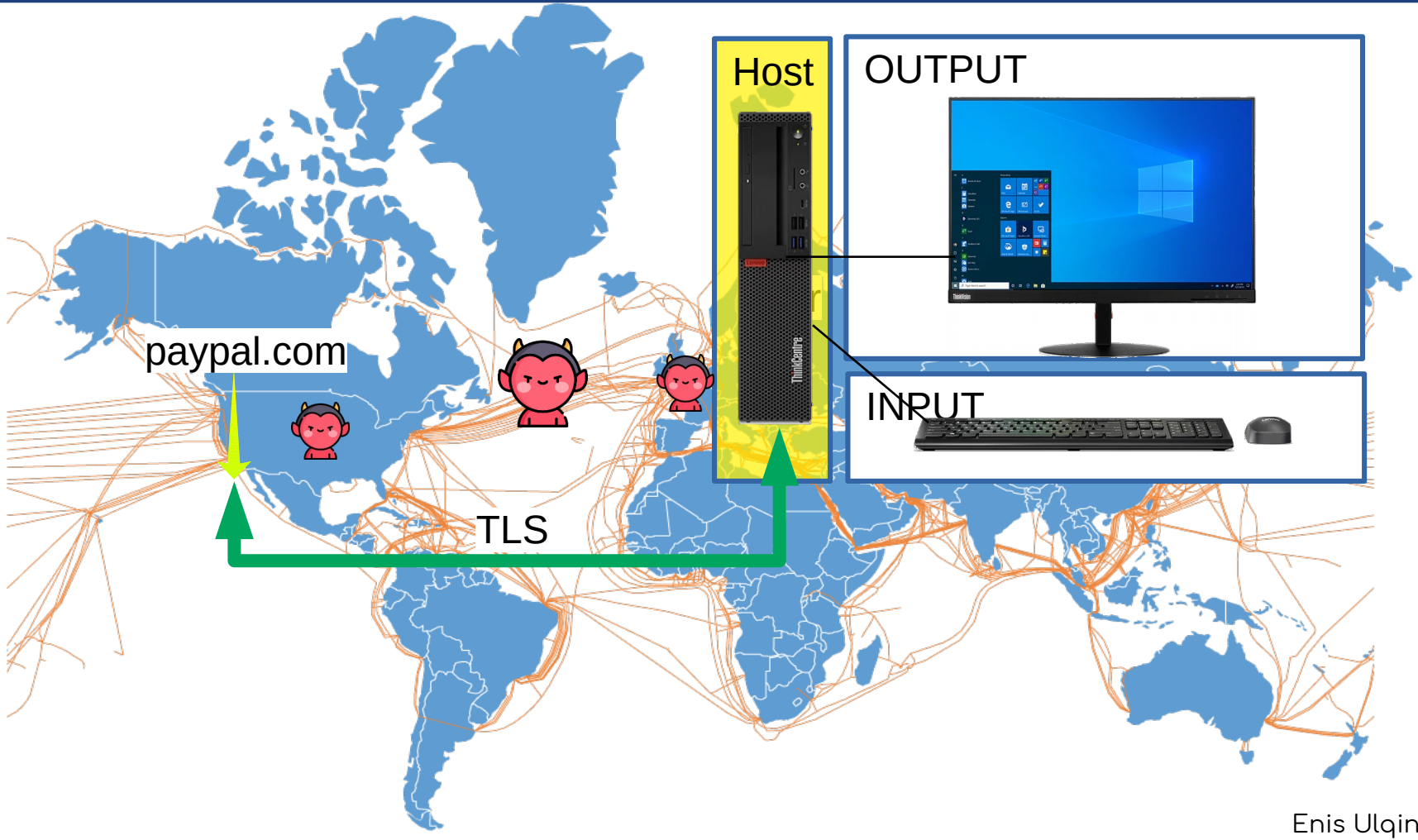
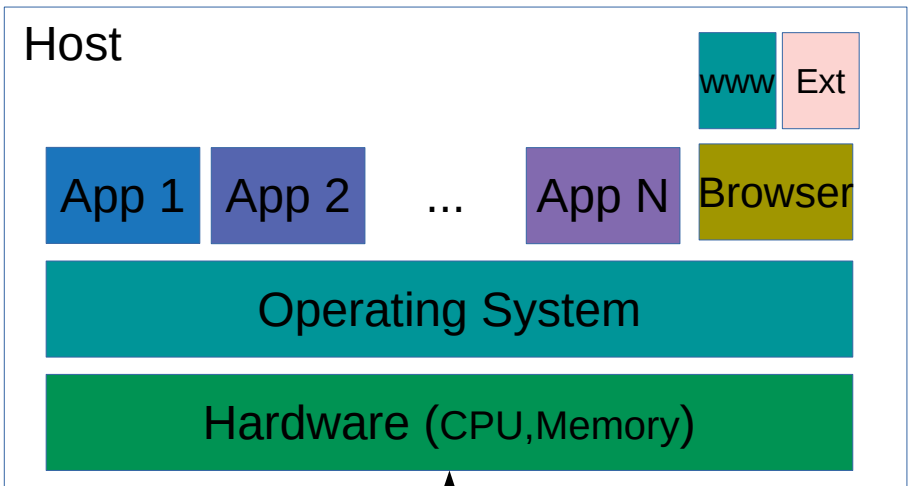


How secure are computers?



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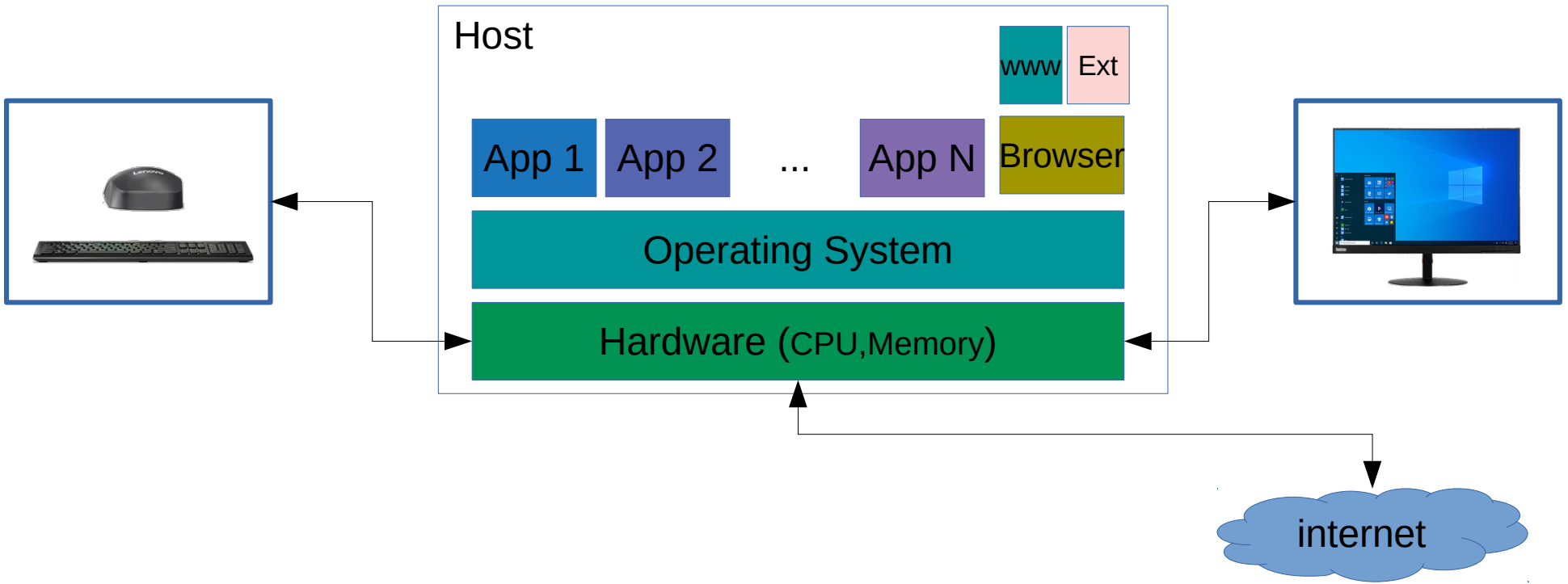

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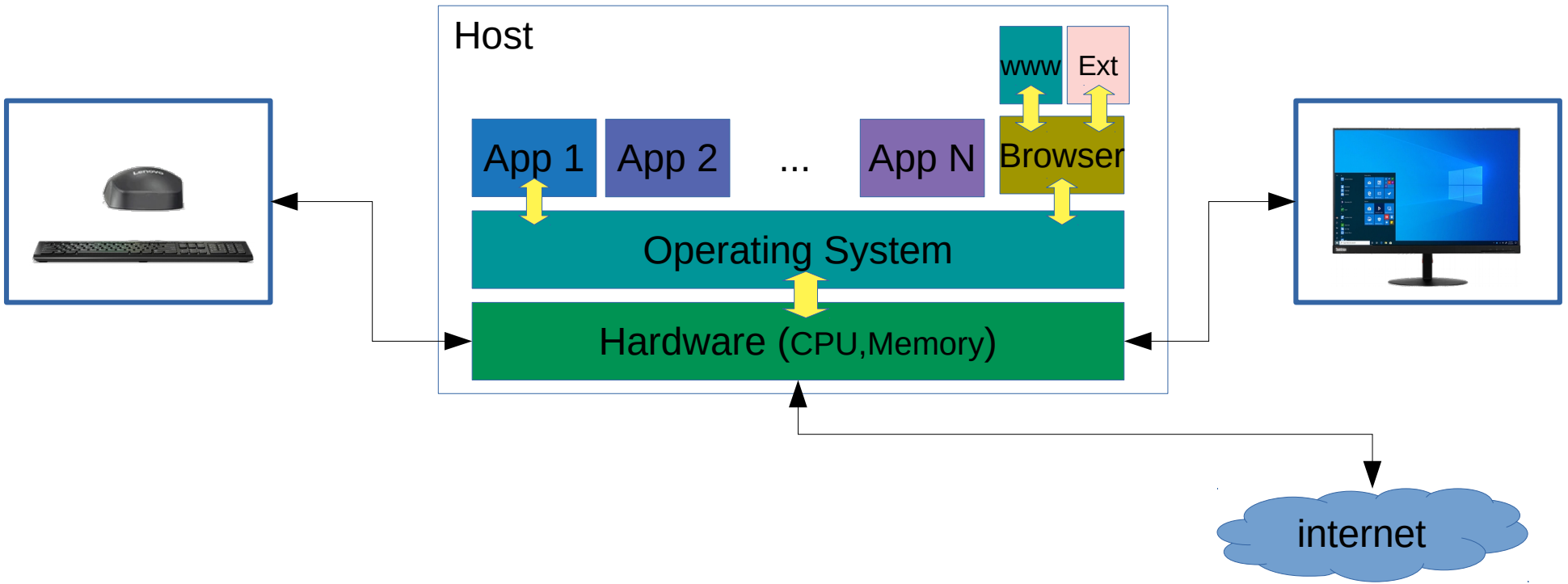

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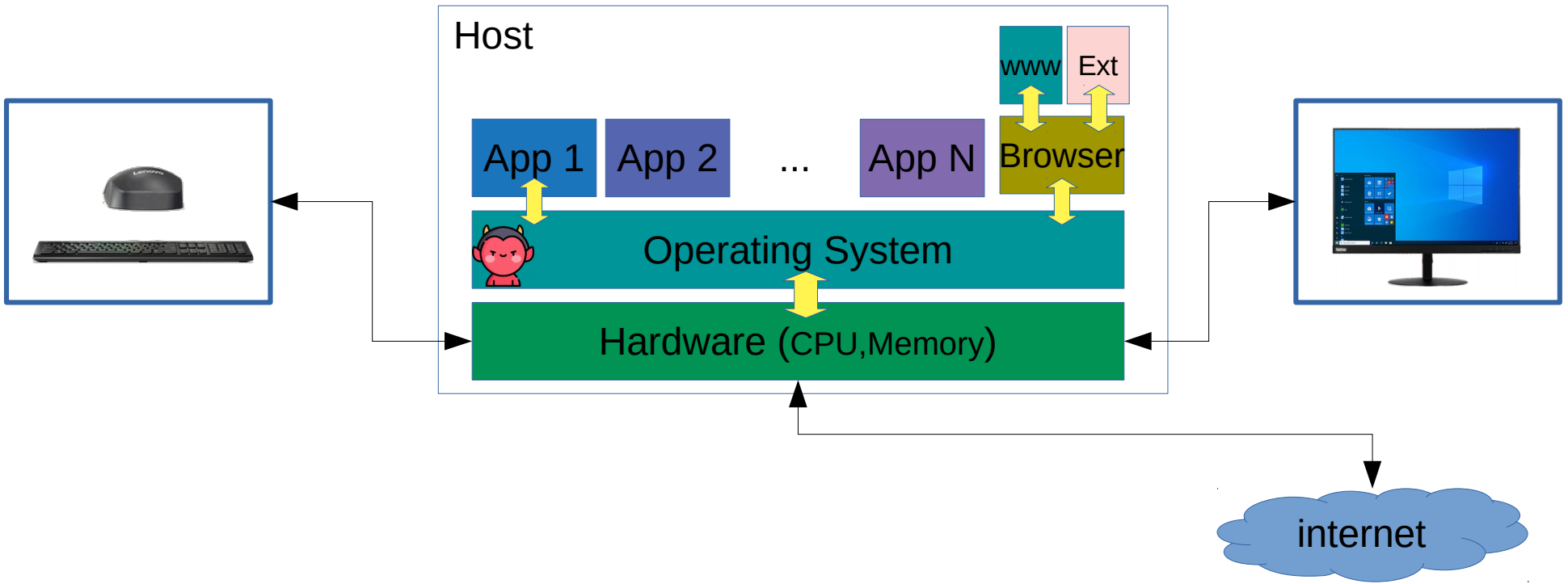

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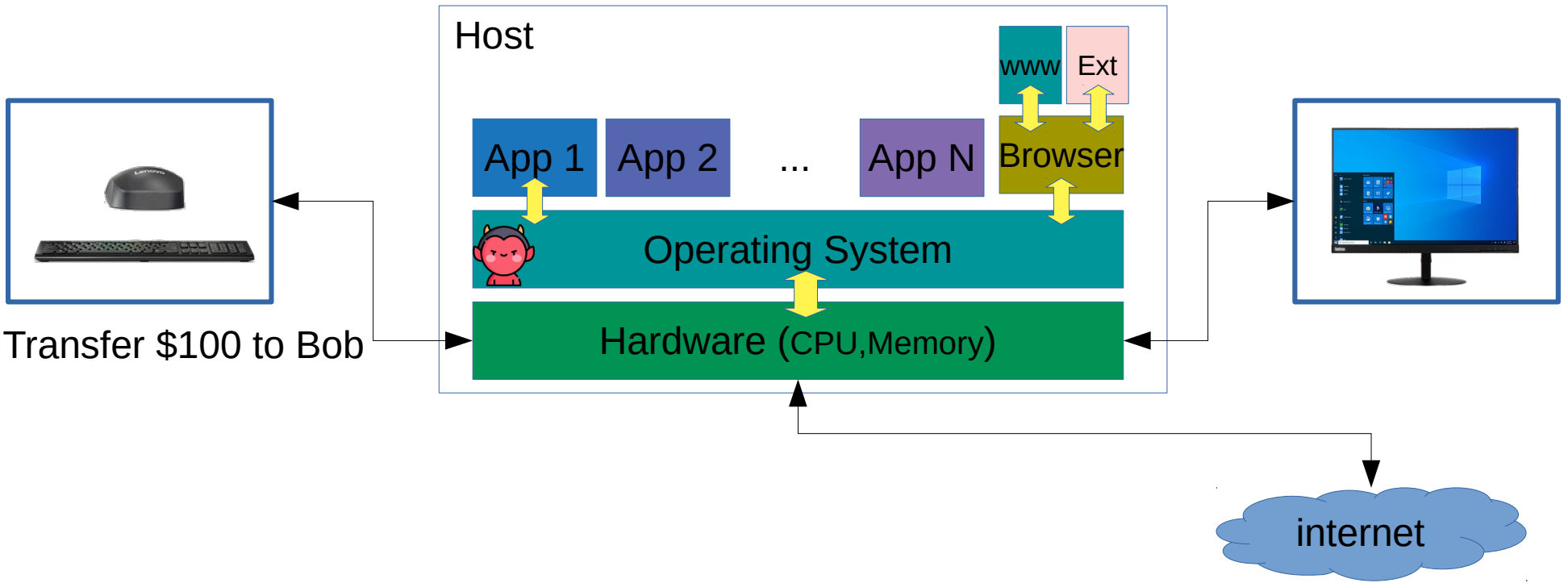

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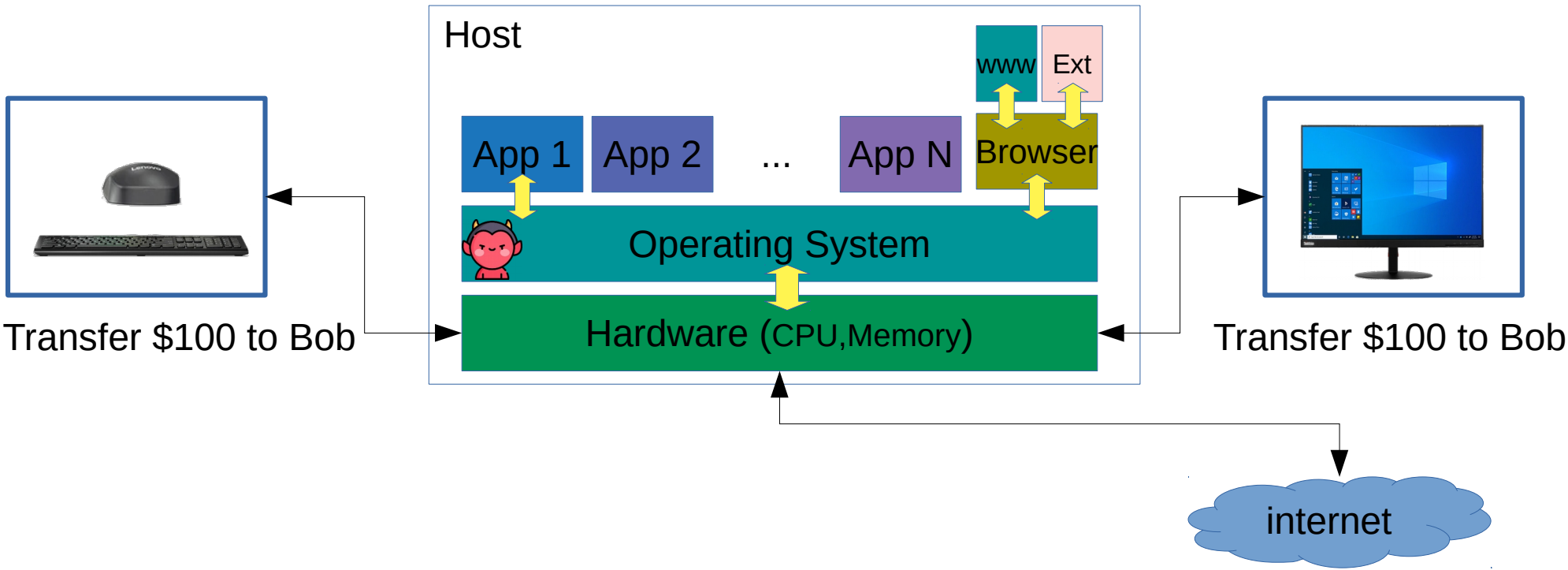

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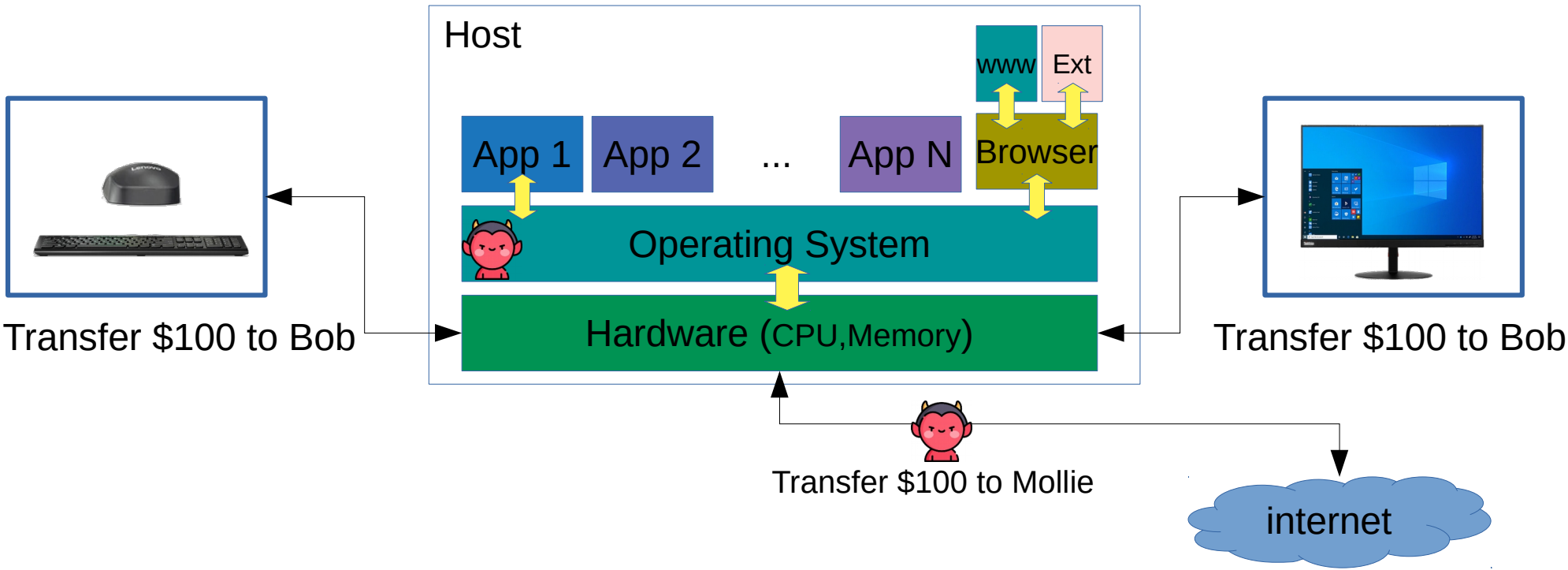

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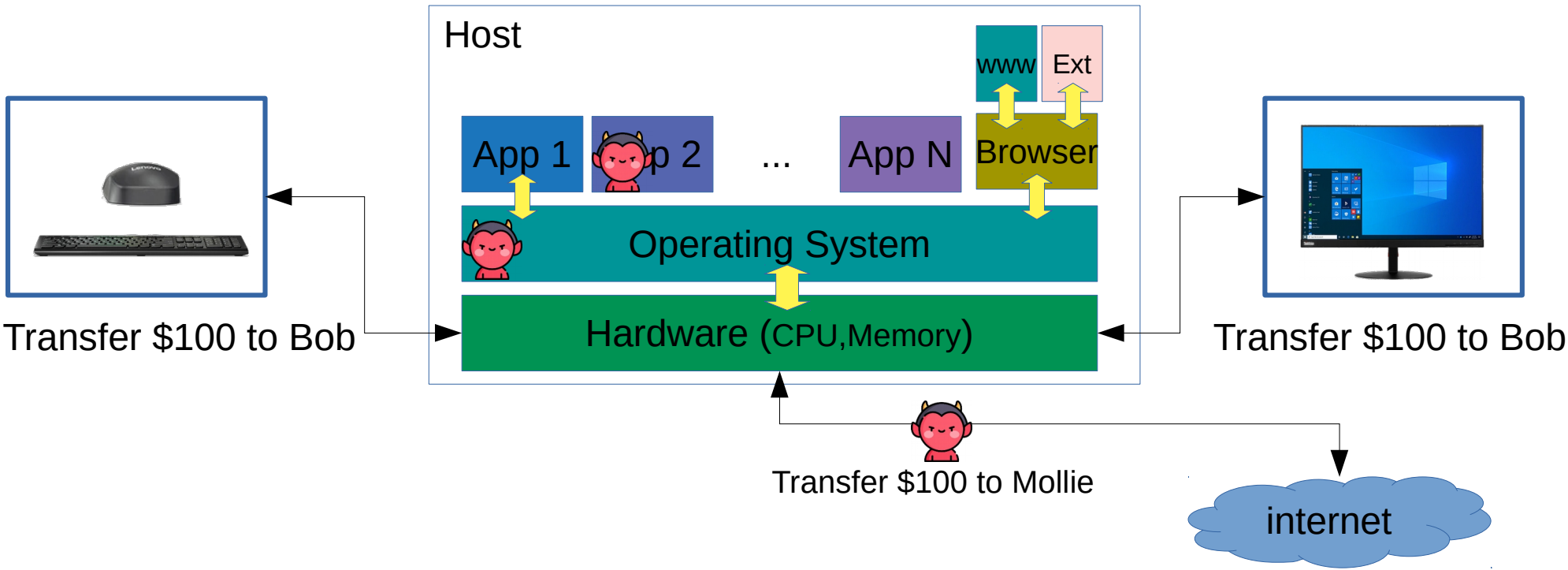

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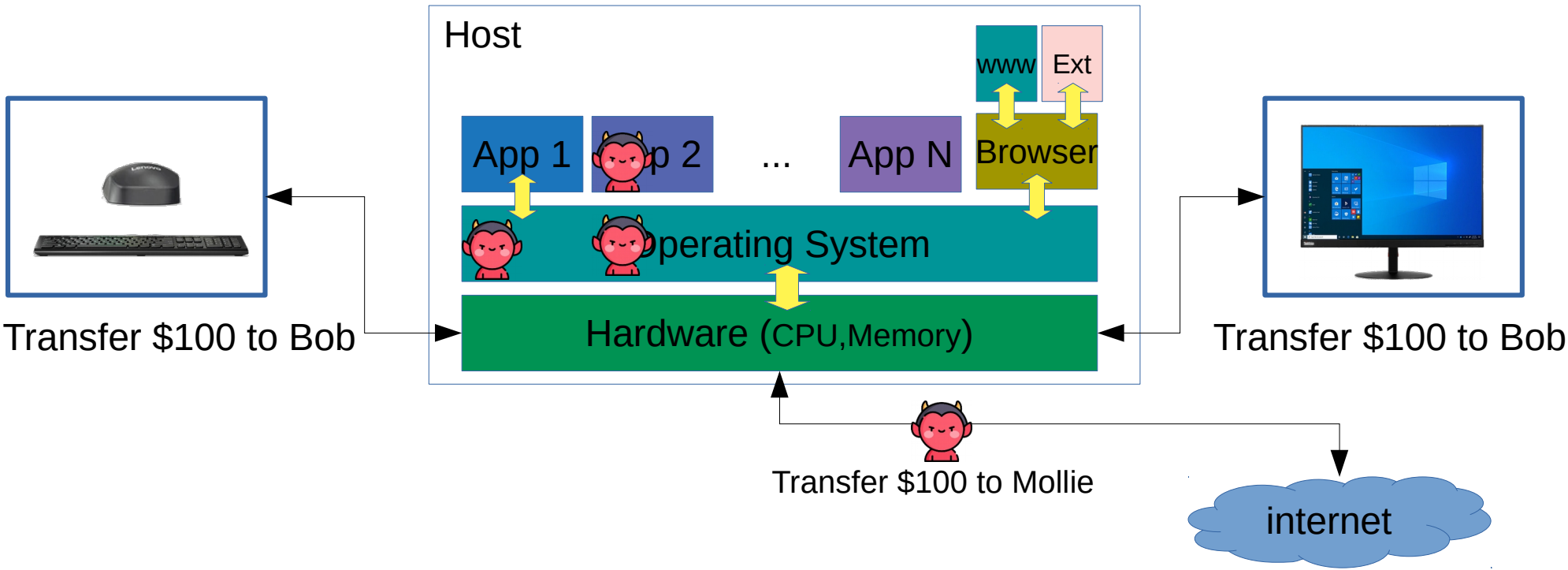

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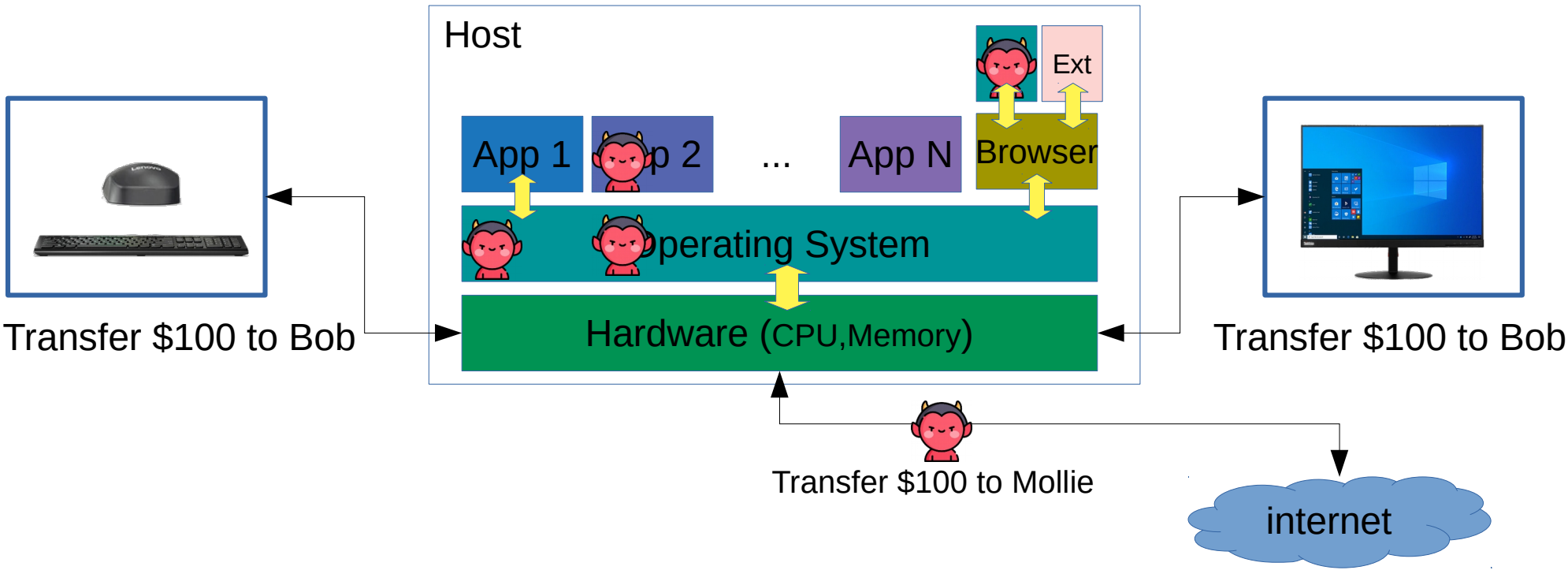

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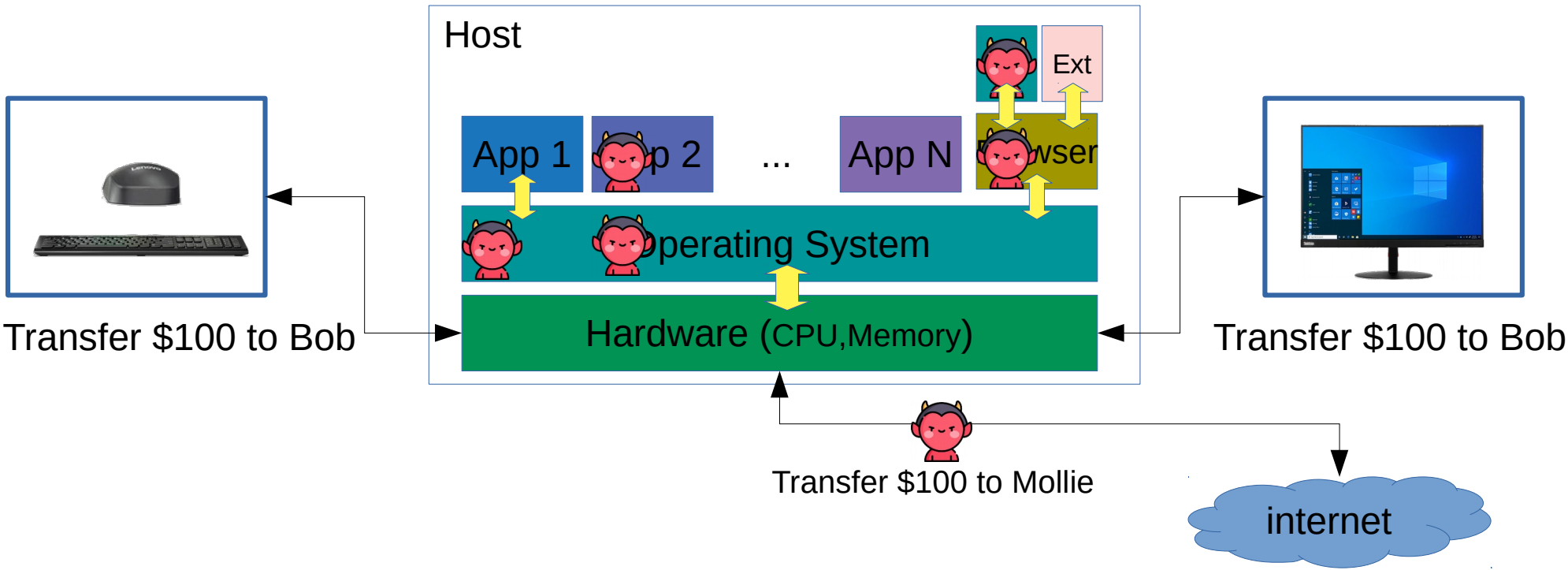

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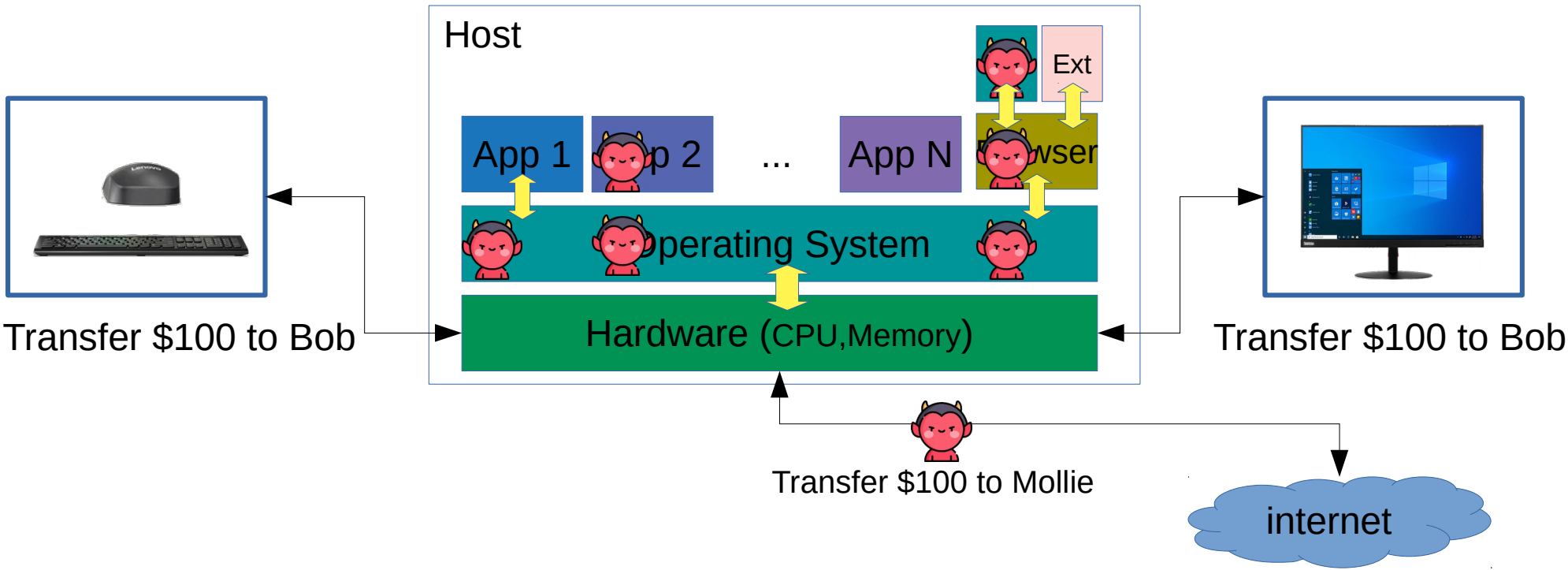

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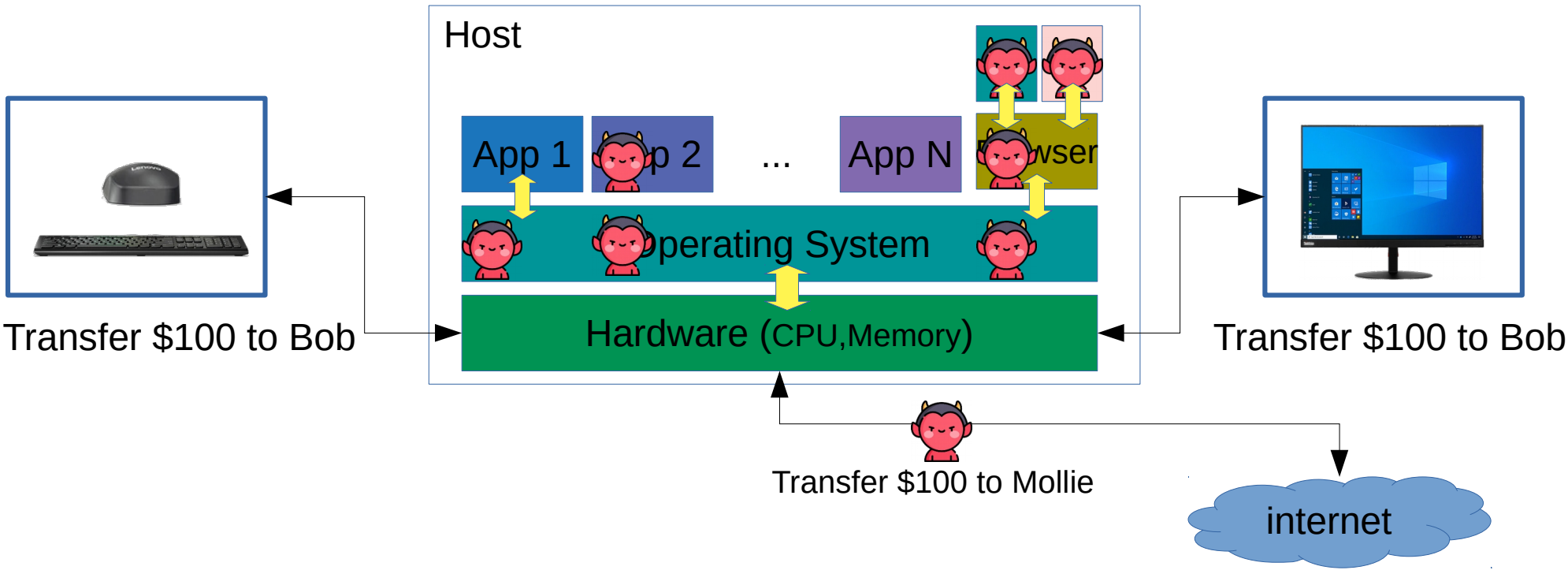

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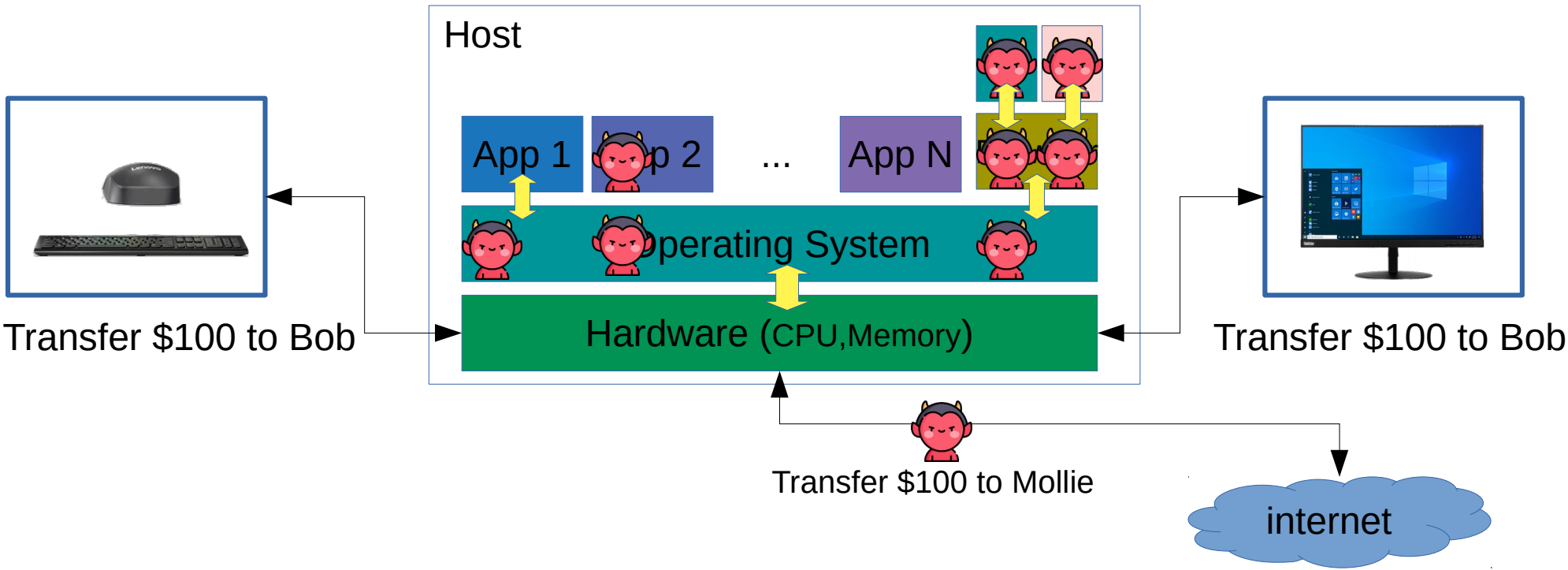

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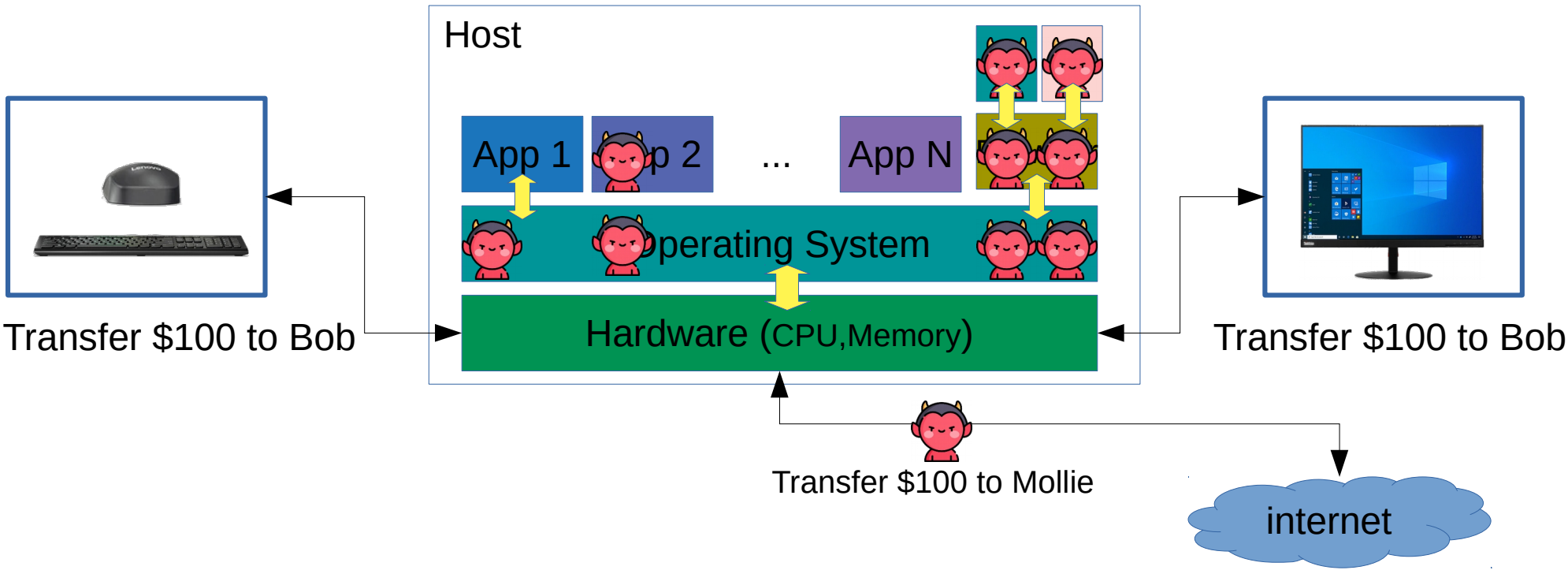
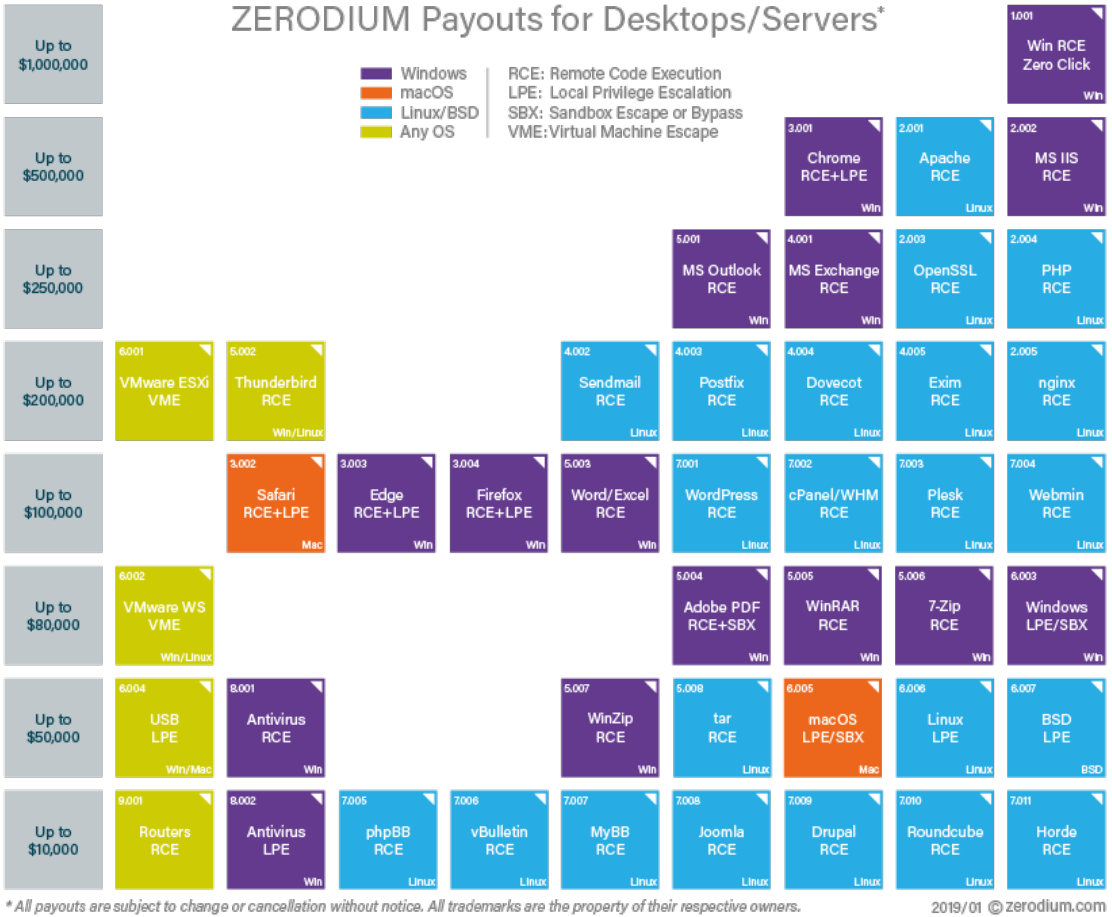


Vulnerabilities Price



Trusted Paths Requirements

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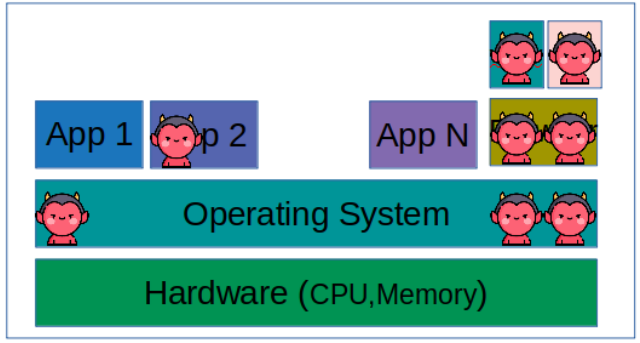
- Observation 2: If the protected output is provided out-of-context, users are more likely not to verify it. Therefore input integrity can be violated.
- Observation 3: If not all the modalities of inputs are secured simultaneously, none of them can be fully secured.

Trusted Paths approaches

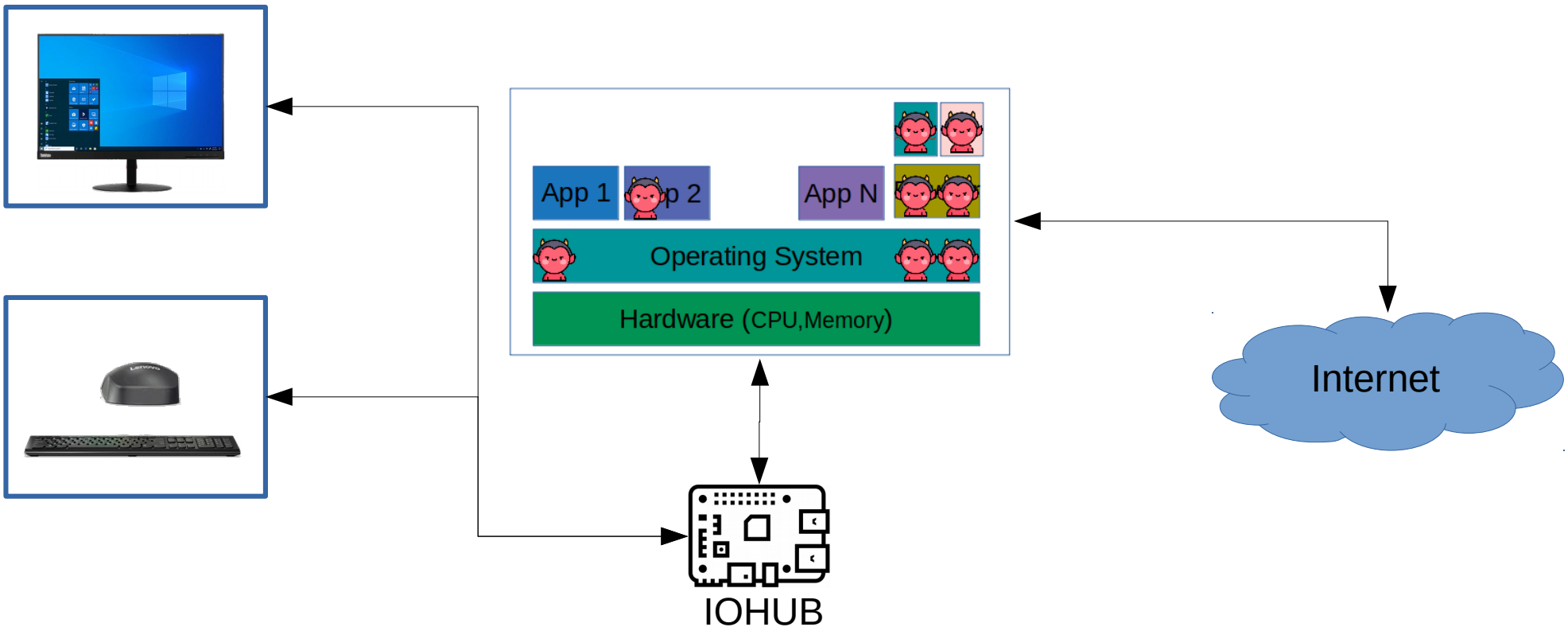
- Trusted path
  - **A.** Transaction confirmation Device
    - Uni-dir [5]
  - **B.** Trusted intermediary
    - **B1.** Hypervisor-based
      - Overshadow [18]
      - SGXIO [4]
    - **B2.** External HW
      - PROTECTION
      - Fidelius [9]
    - **B3.** System TEE
      - VButton [16]
      - TruZ-Droid [17]

ProtectIOn Architecture



Internet

ProtectIOn Architecture



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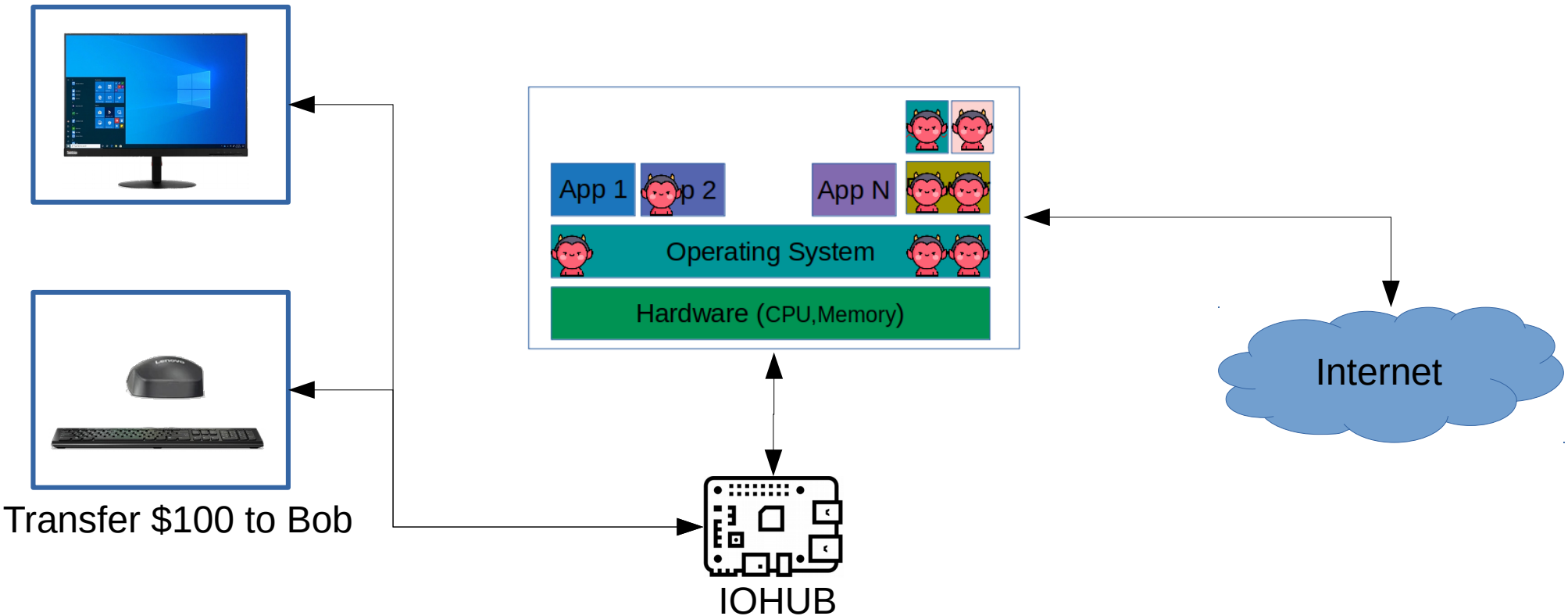

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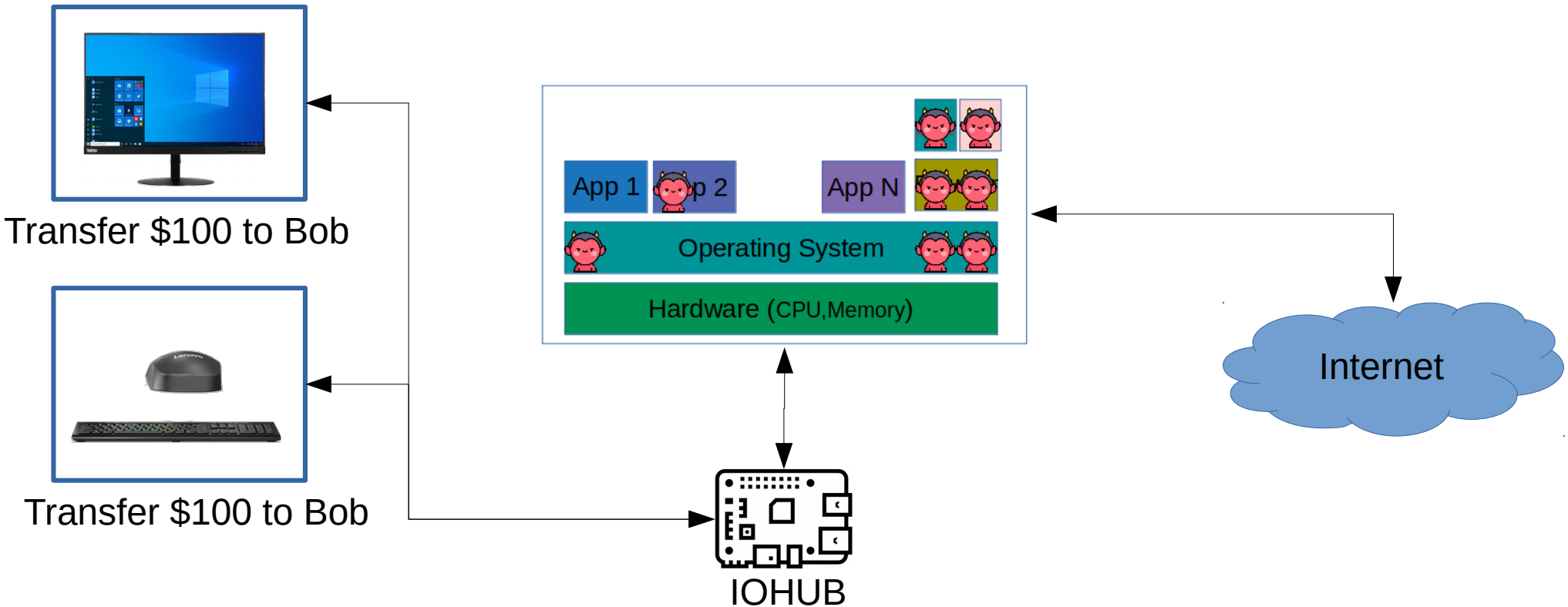

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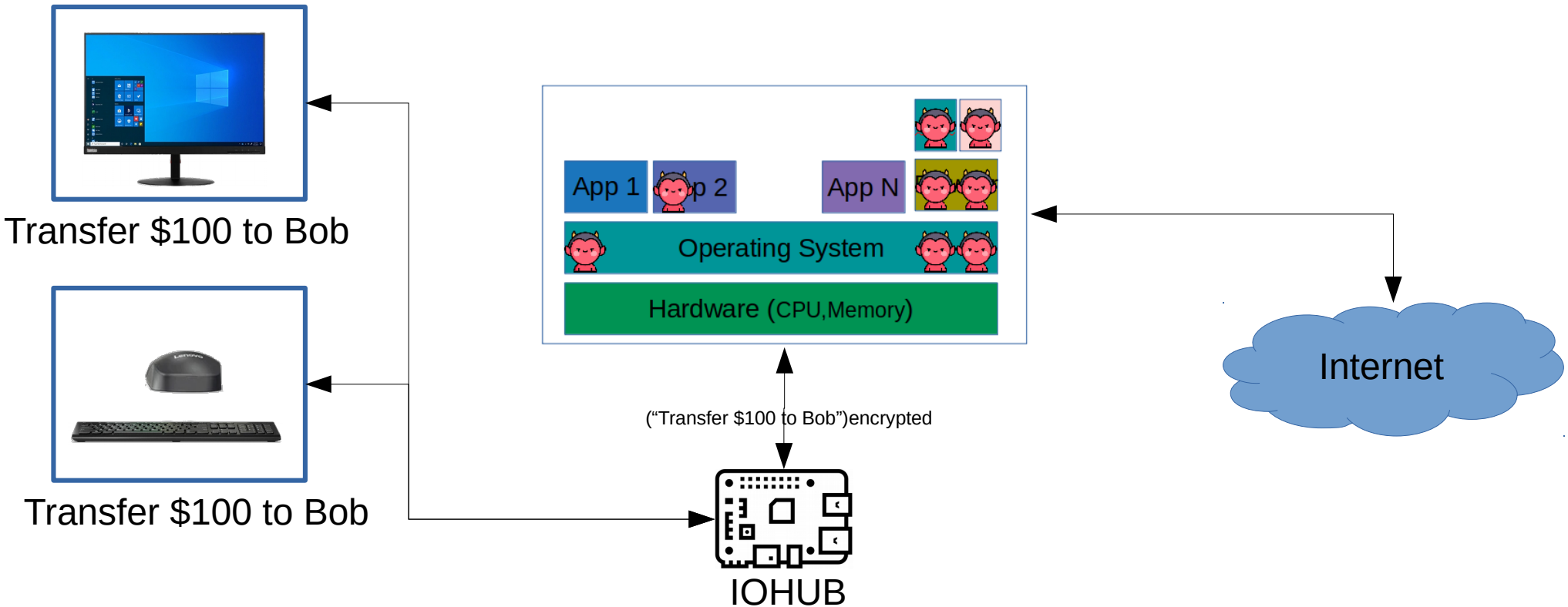

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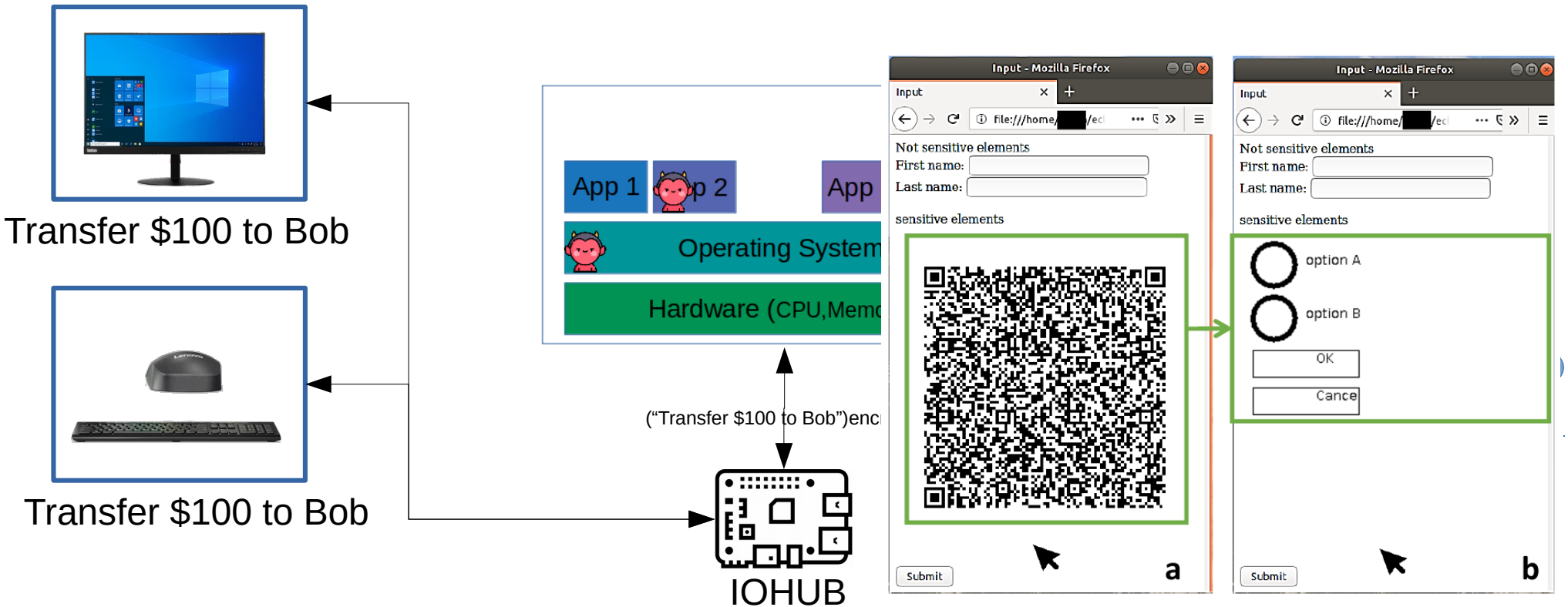
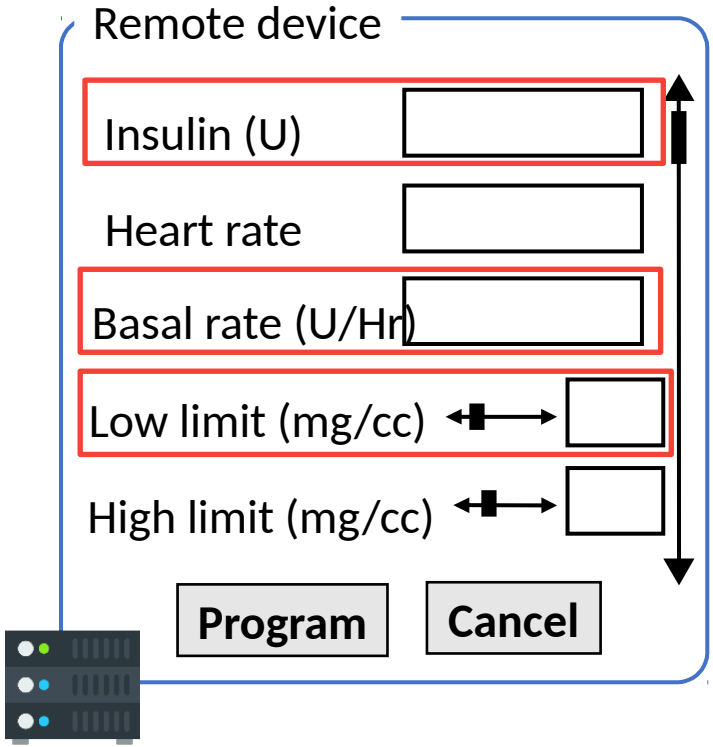


IO Integrity – Configuration

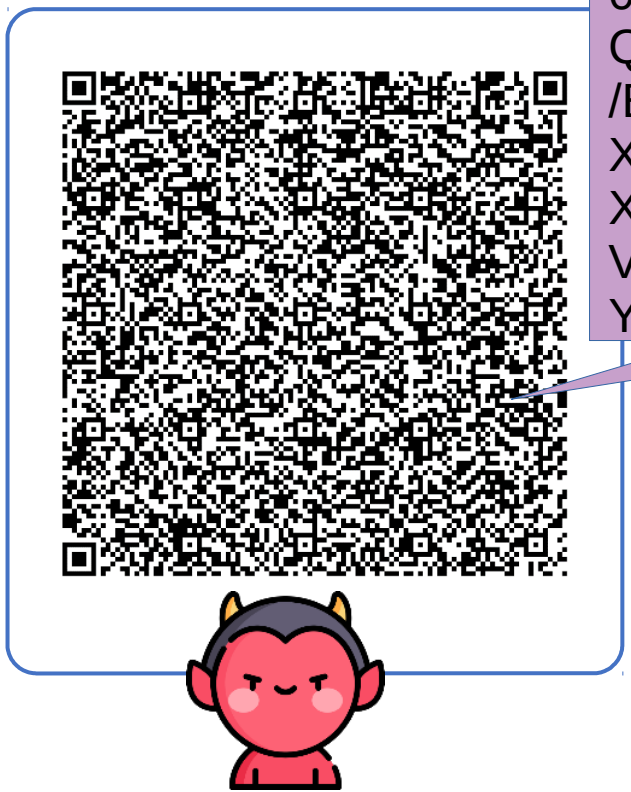
Simultaneous IO



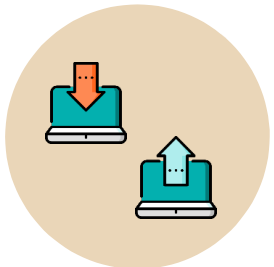

```
<form action="/some_action", signature = "0x45AB…", id
= "0x0ab">
```

IO Integrity – Host's view

Simultaneous IO



IO Integrity – User's view



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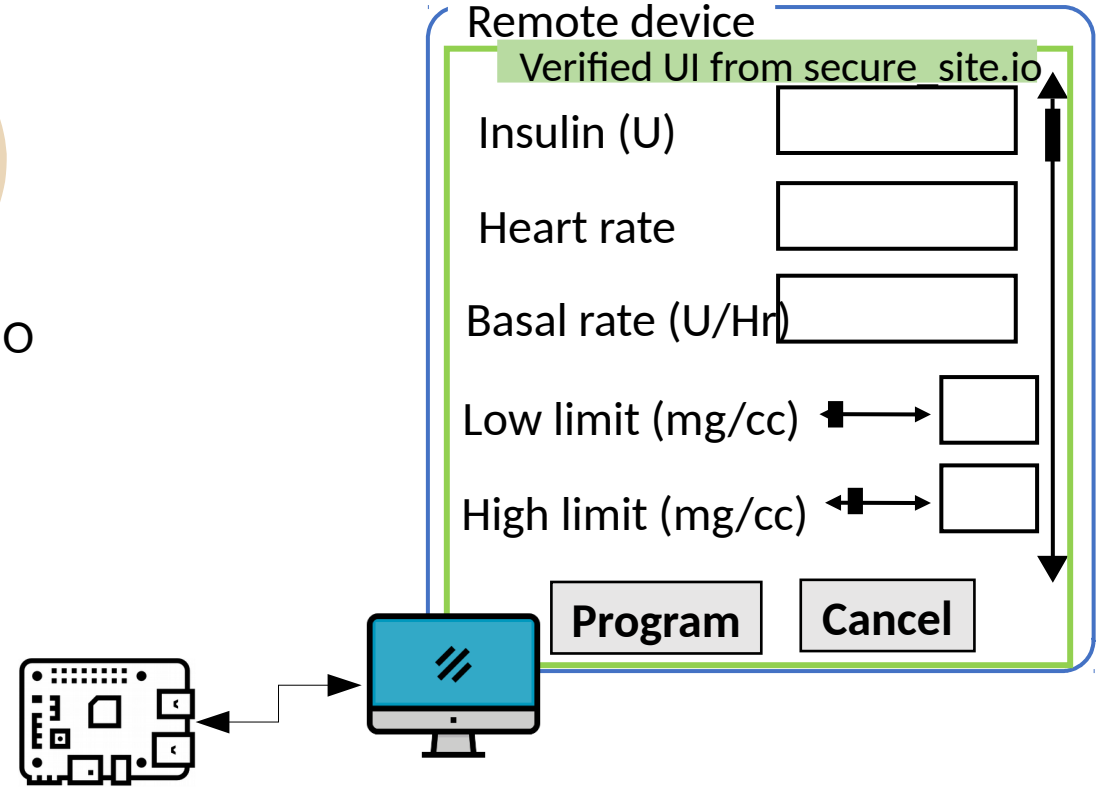

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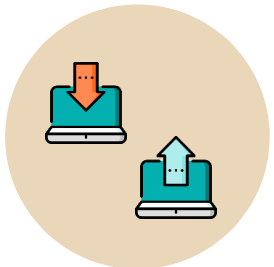

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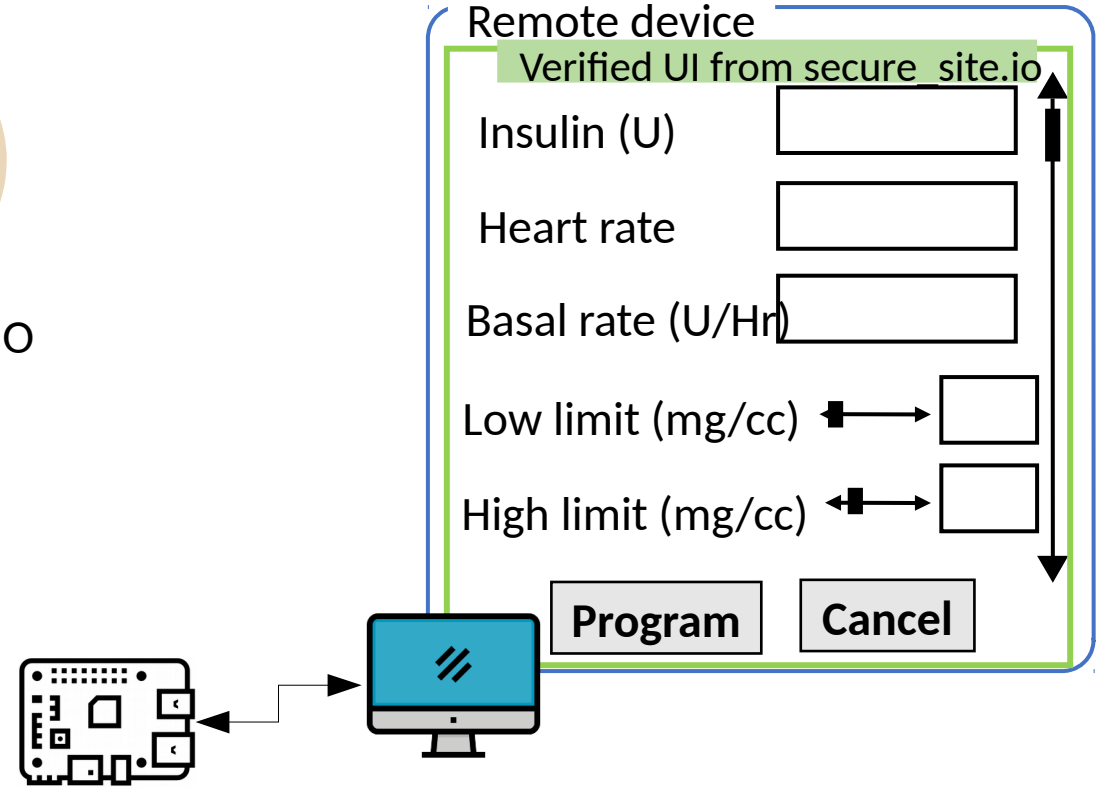

Put 1 in front of all inputs

User Attention

Low cognitive load

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- Output Integrity: Low cognitive load

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Grabbing User Attention

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  - Lightbox

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  - Freezing

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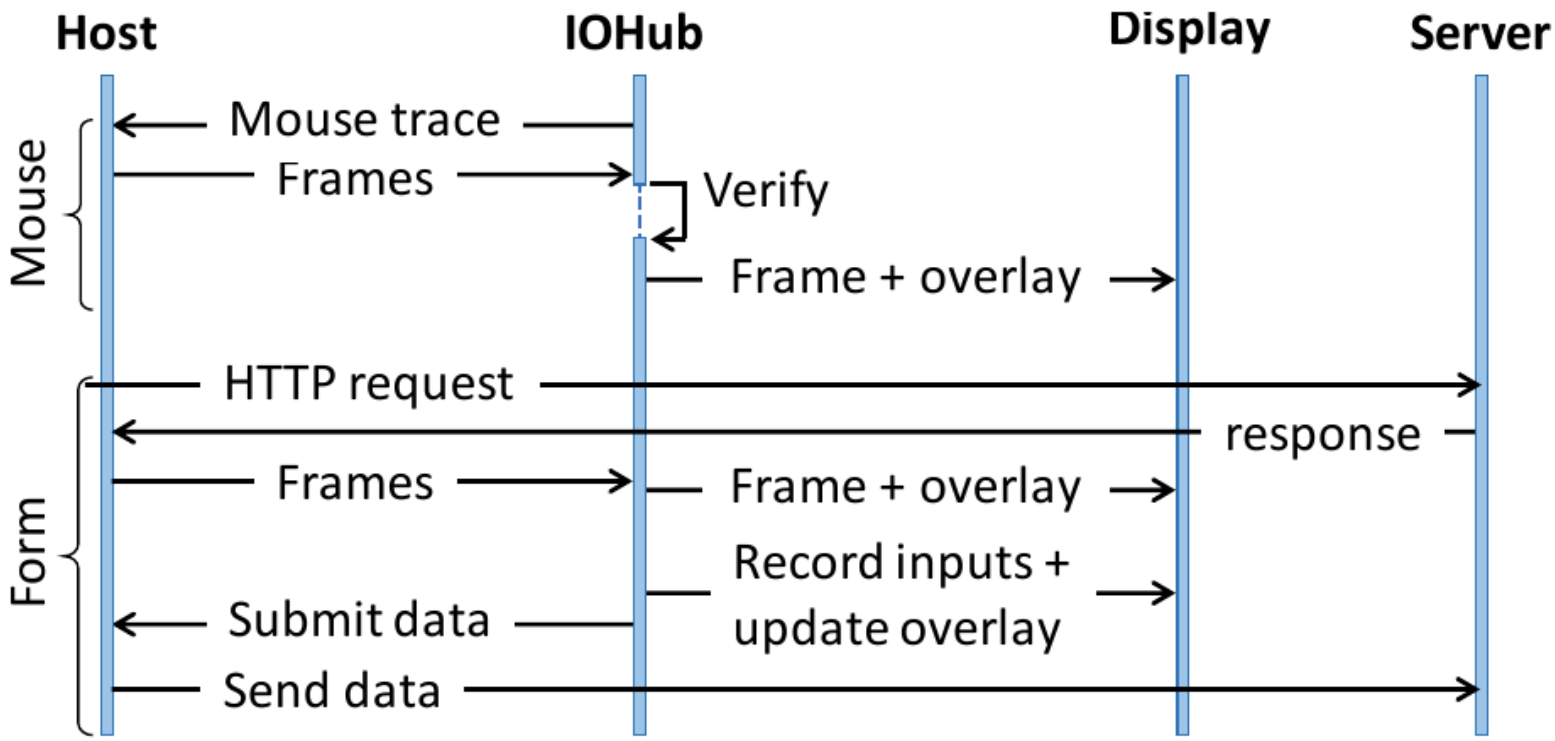
- Output Integrity: Low cognitive load
- Several existing mechanisms
  - Lightbox
  - Highlight
  - Freezing
  - Combination

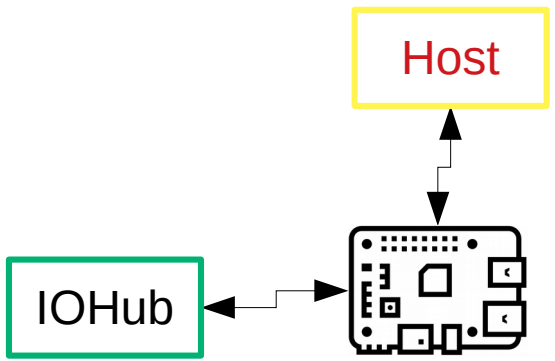
Put 1 in front of all inputs

Protocol flow

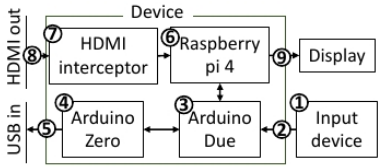


IOHub benefits

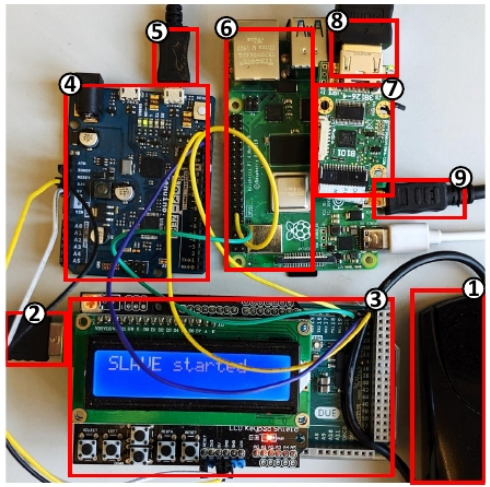
- Low TCB (possible to formally verify)
- Limited interfaces
- Generalization
  - Security guarantees
  - Easy to deploy
  - Scalability
- Low cost



Prototype Implementation



(a) The figure shows the basic components and connections between them in our PROTECTION prototype.



(b) PROTECTION prototype uses Arduino Due and Zero microcontroller board and a Raspberry Pi 4 SBC. The highlighted numbers correspond to the labels in Figure 9a

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Thank You