# No Right to Remain Silent: Isolating Malicious Mixes

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[1]Bar-Ilan University, IL [2]University College London, UK [3]University of Connecticut, US

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| System | Efficiency | Security |
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**“Anonymity loves company”**

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**From "Tor: The Second-Generation Onion Router":**

"Tor does not claim to completely solve end-to-end timing or intersection attacks."

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| **Miranda's mixnet (this work)** | Efficient, higher latency | Secure against global eavesdropper and **malicious servers (mixes)** |
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**Senders**

**Receivers**

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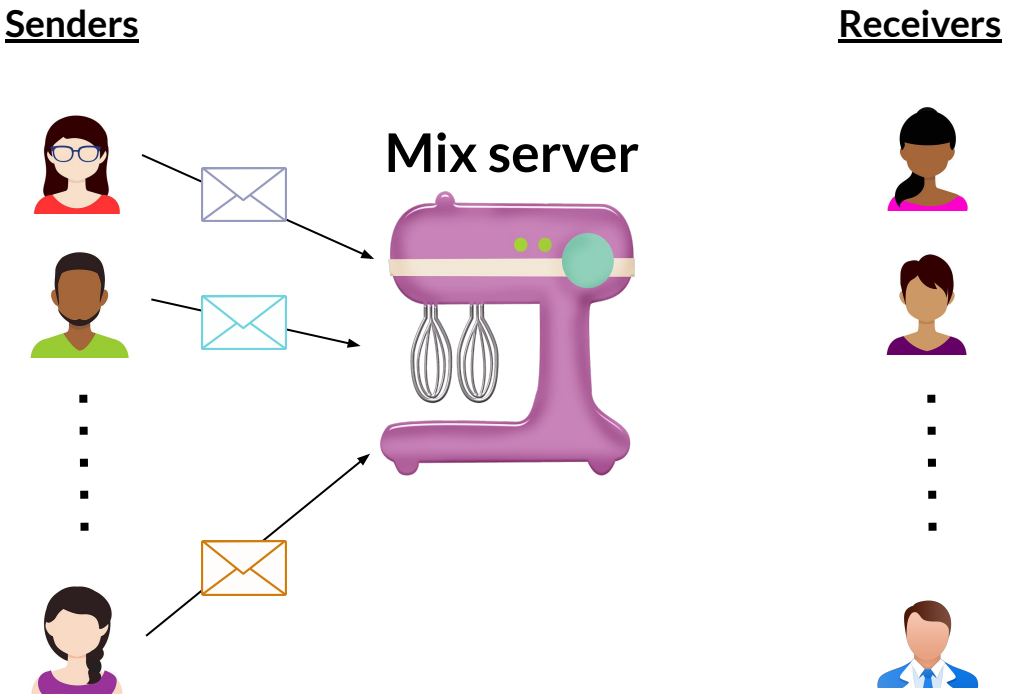

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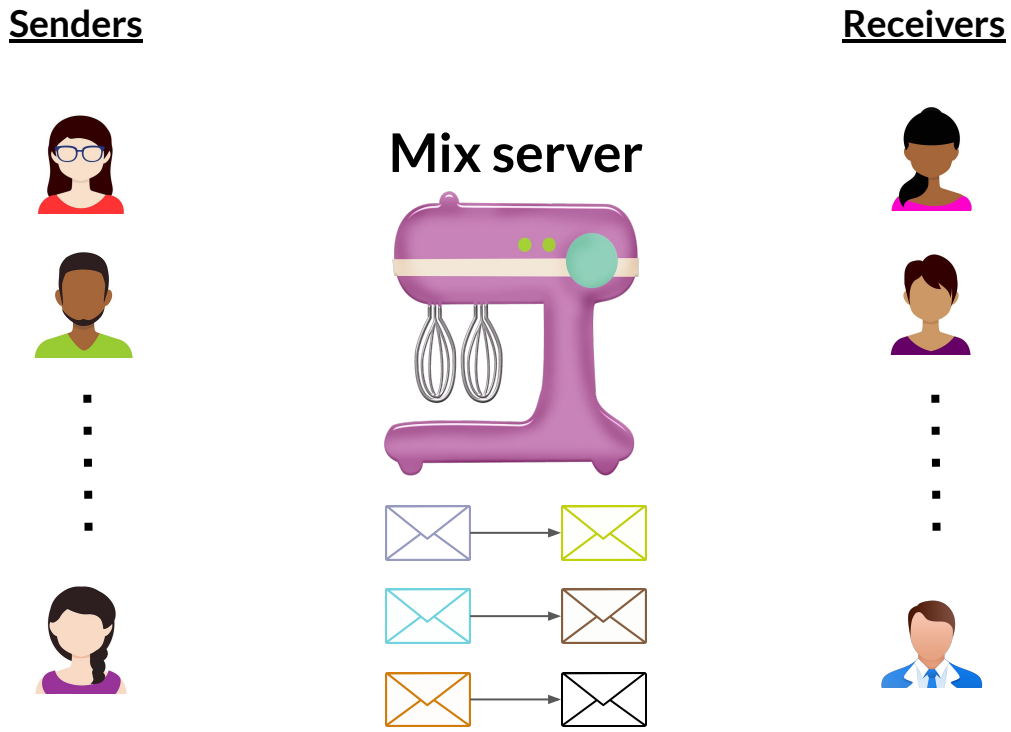

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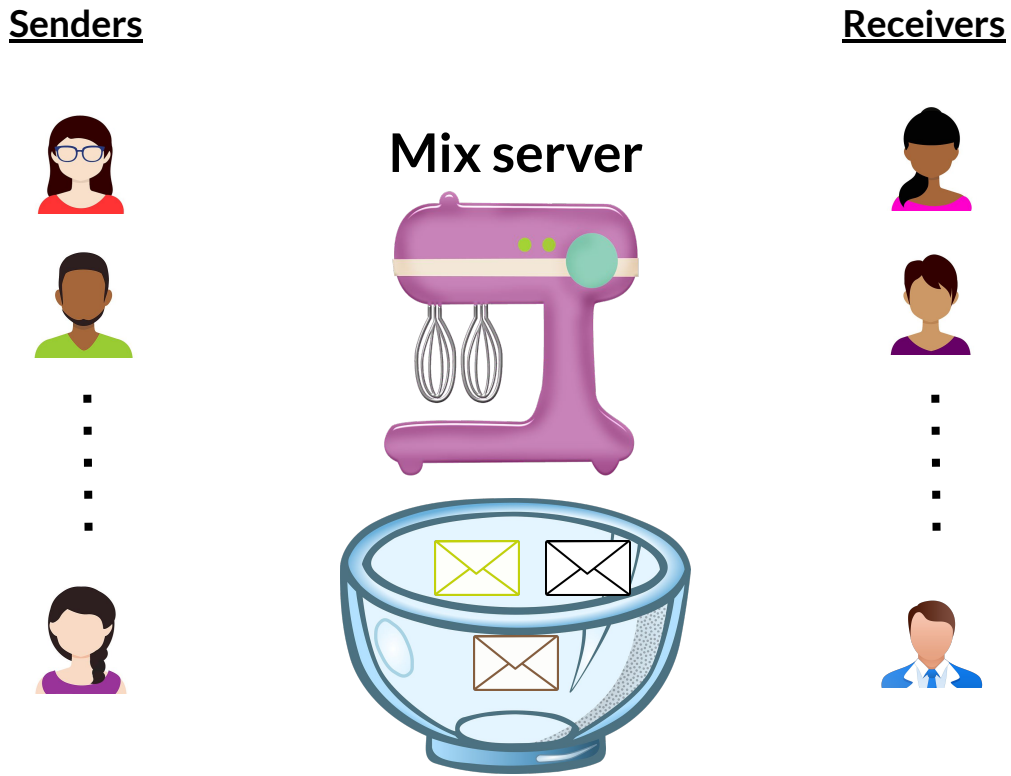

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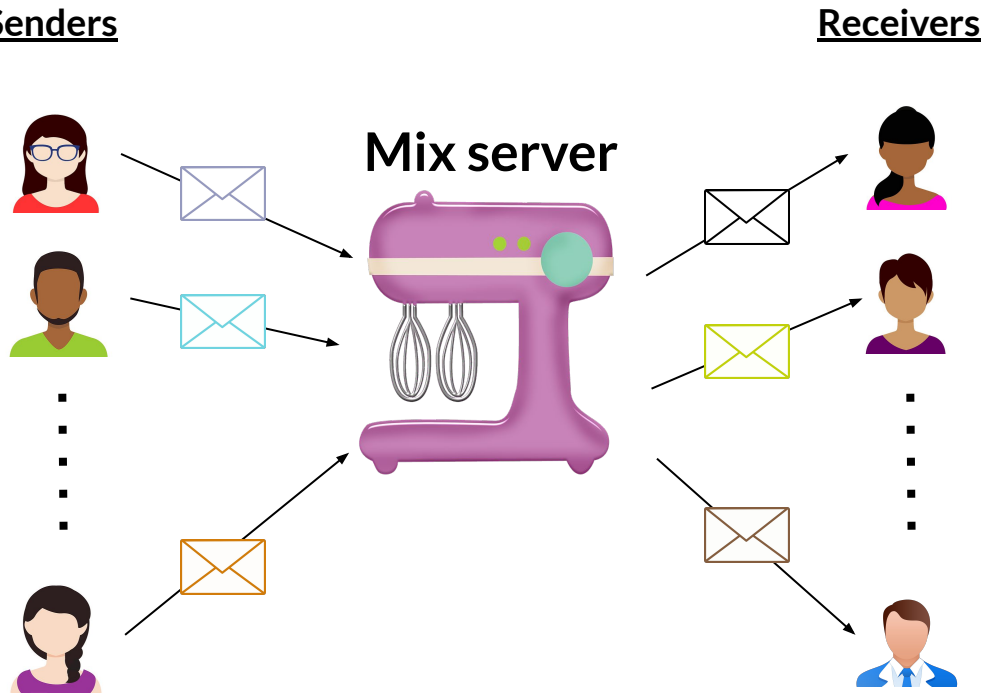
**Incoming and outgoing messages are unlinkable,**
**to an outside observer**



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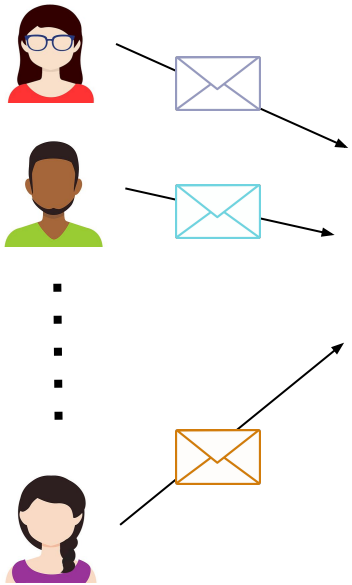
## Mix cascade



**Chaining mixes in a cascade prevents any single mix from tracking messages end-to-end.**

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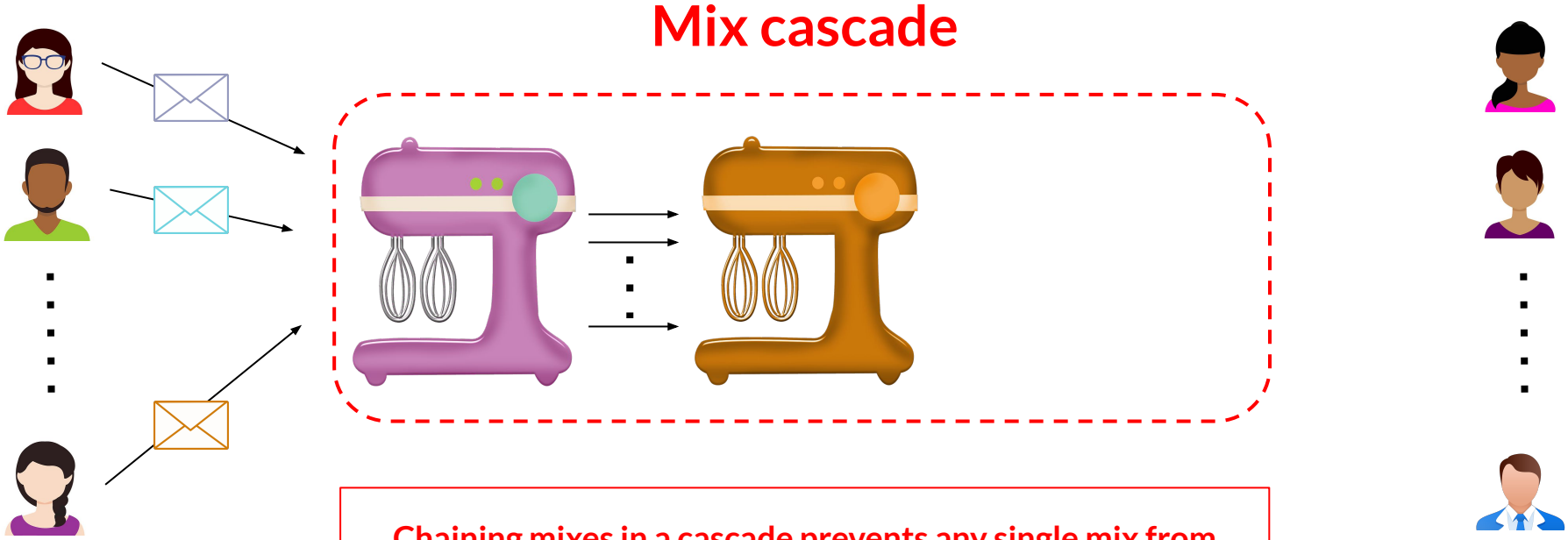


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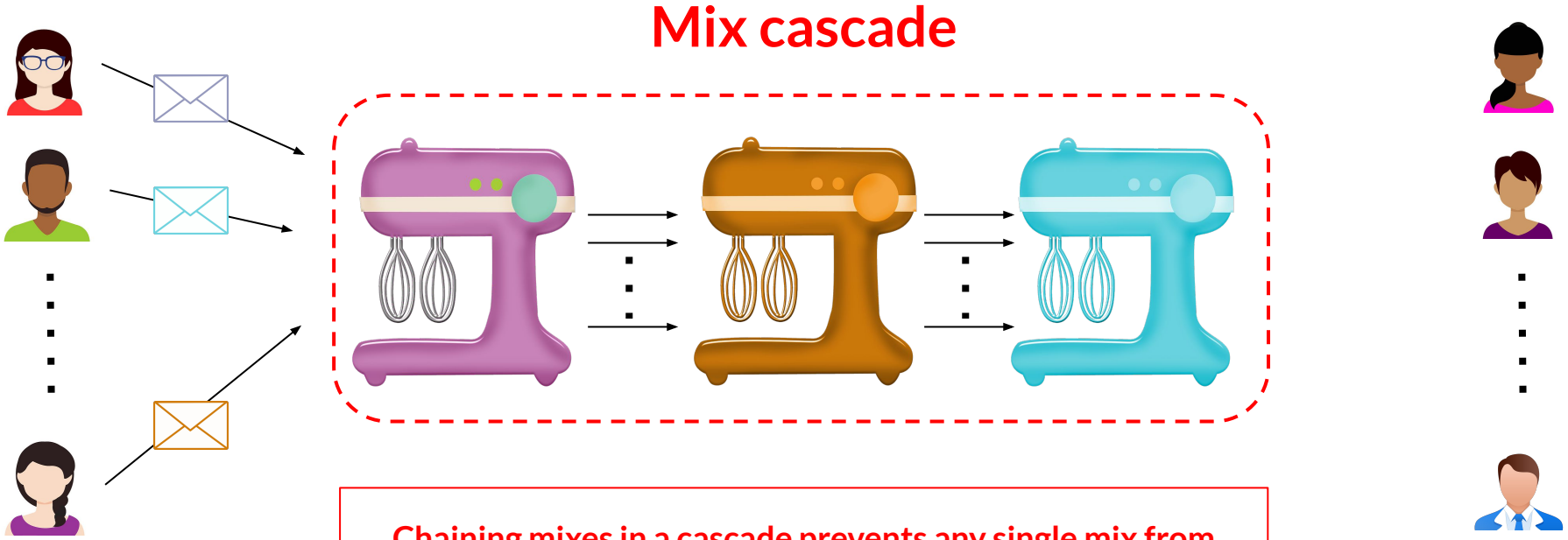


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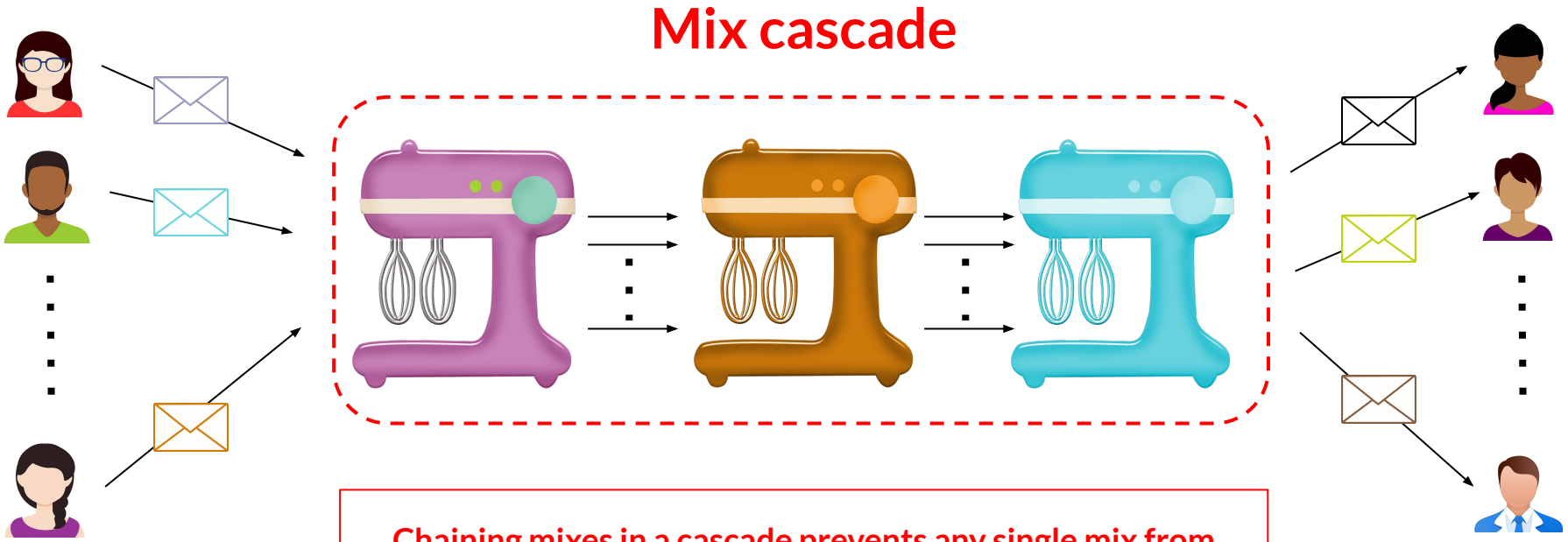


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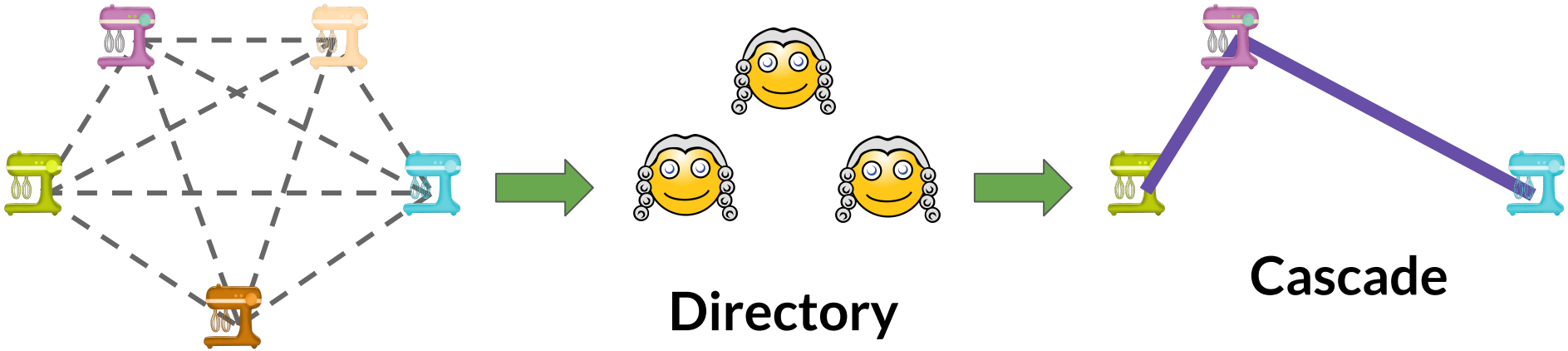

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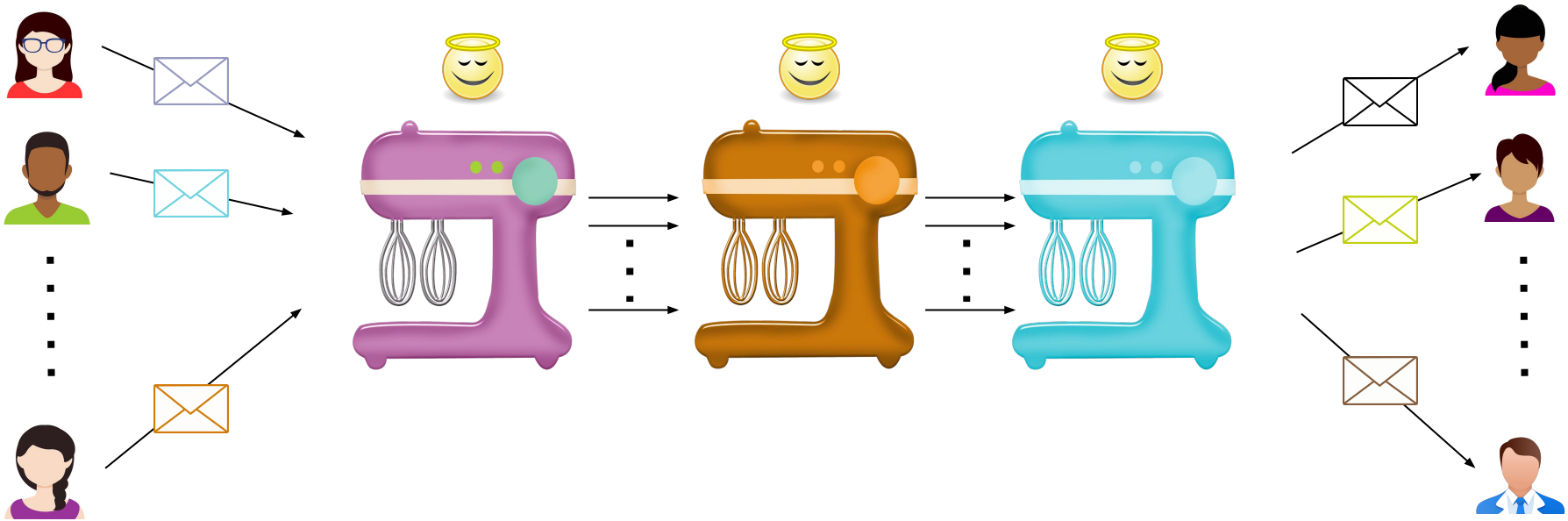

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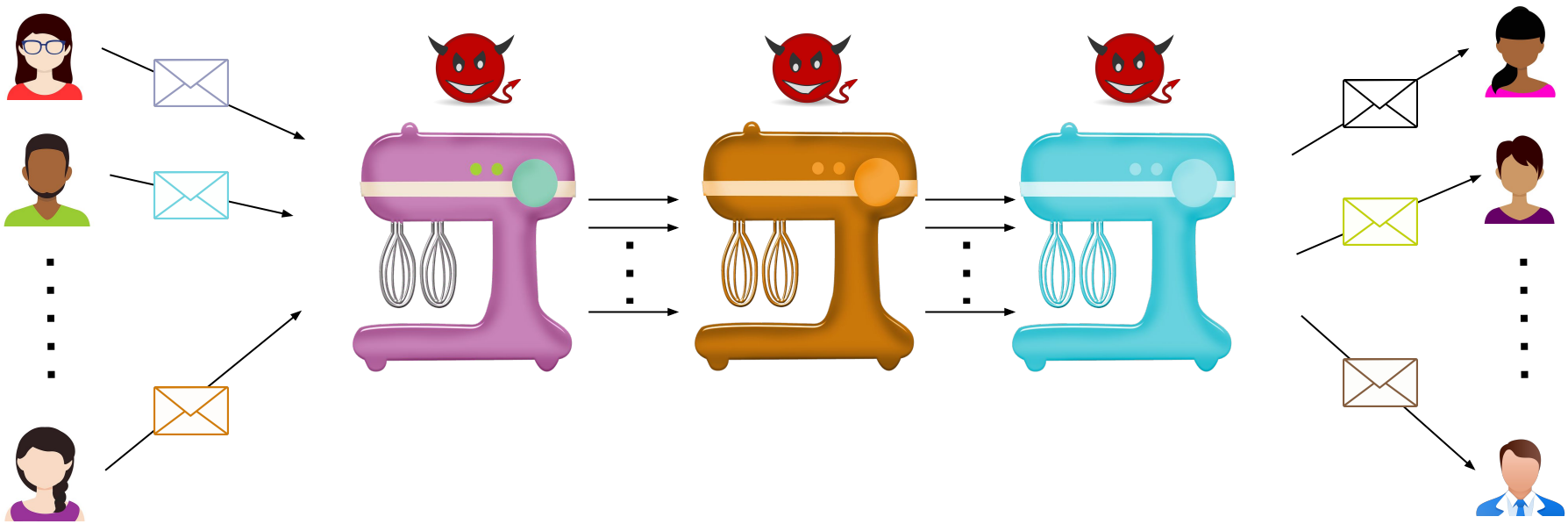

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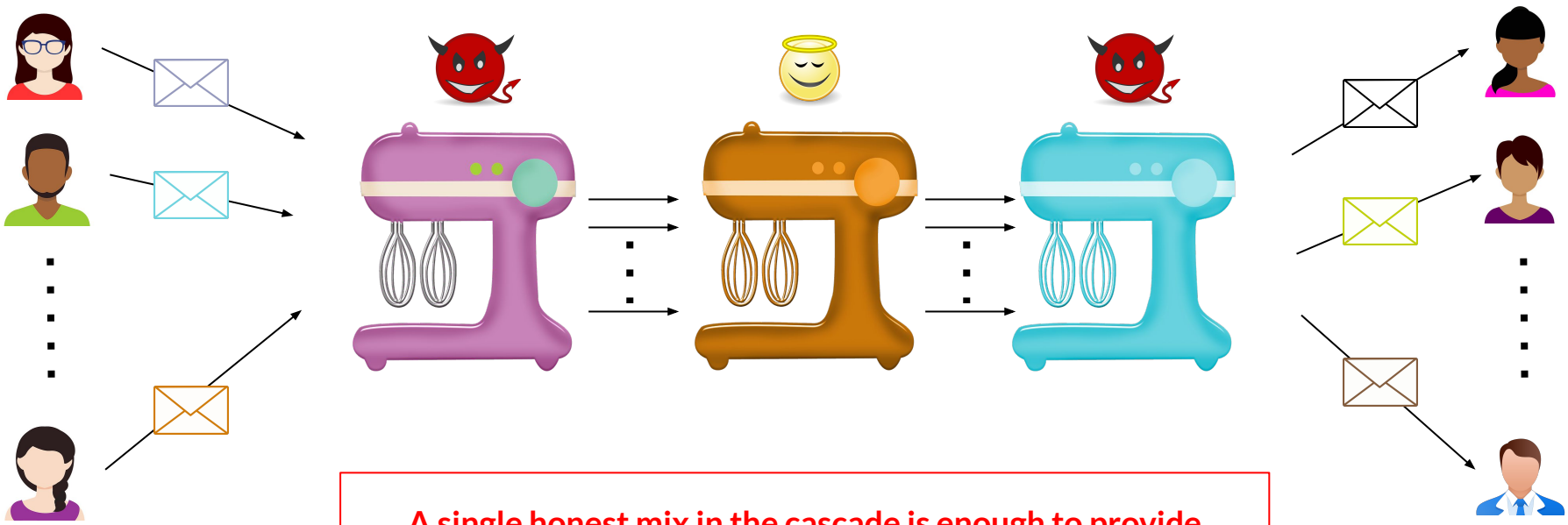
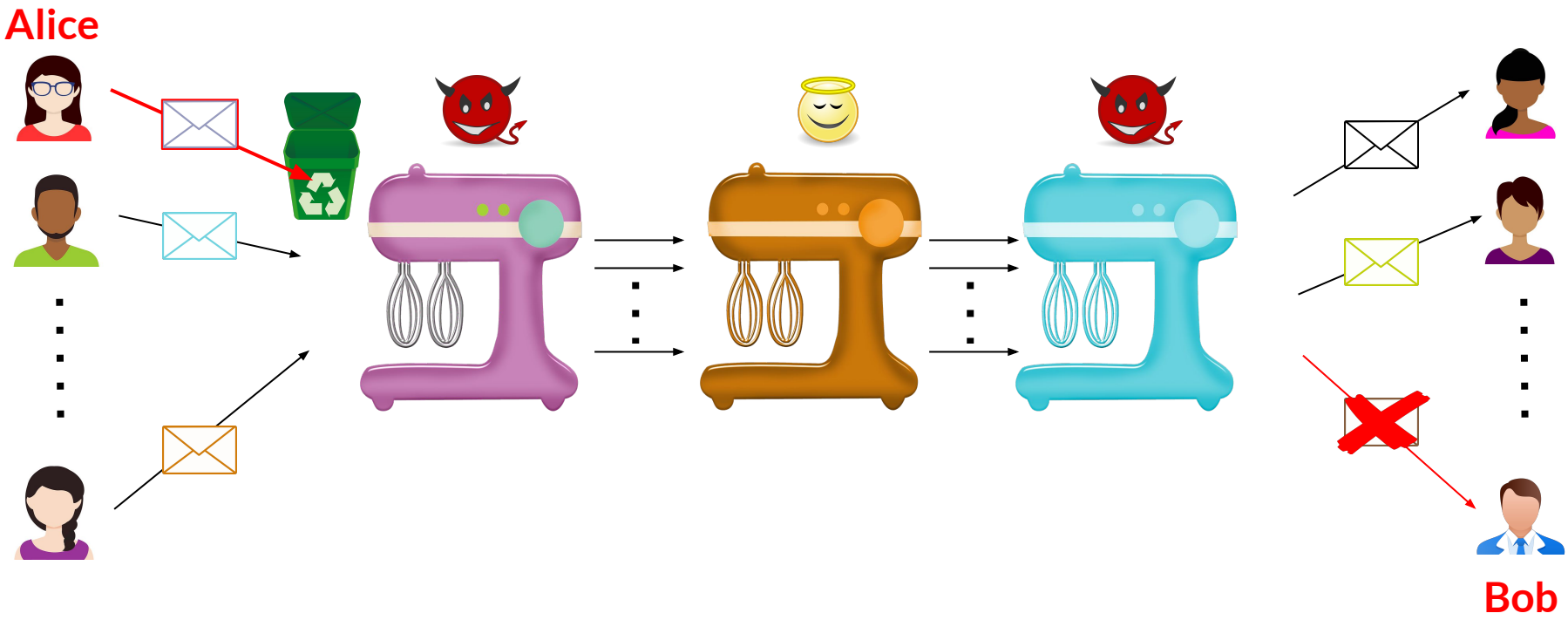


A single honest mix in the cascade is enough to provide protection against passive global observer

# MOTIVATION (why malicious mixes are a threat to mixnets)



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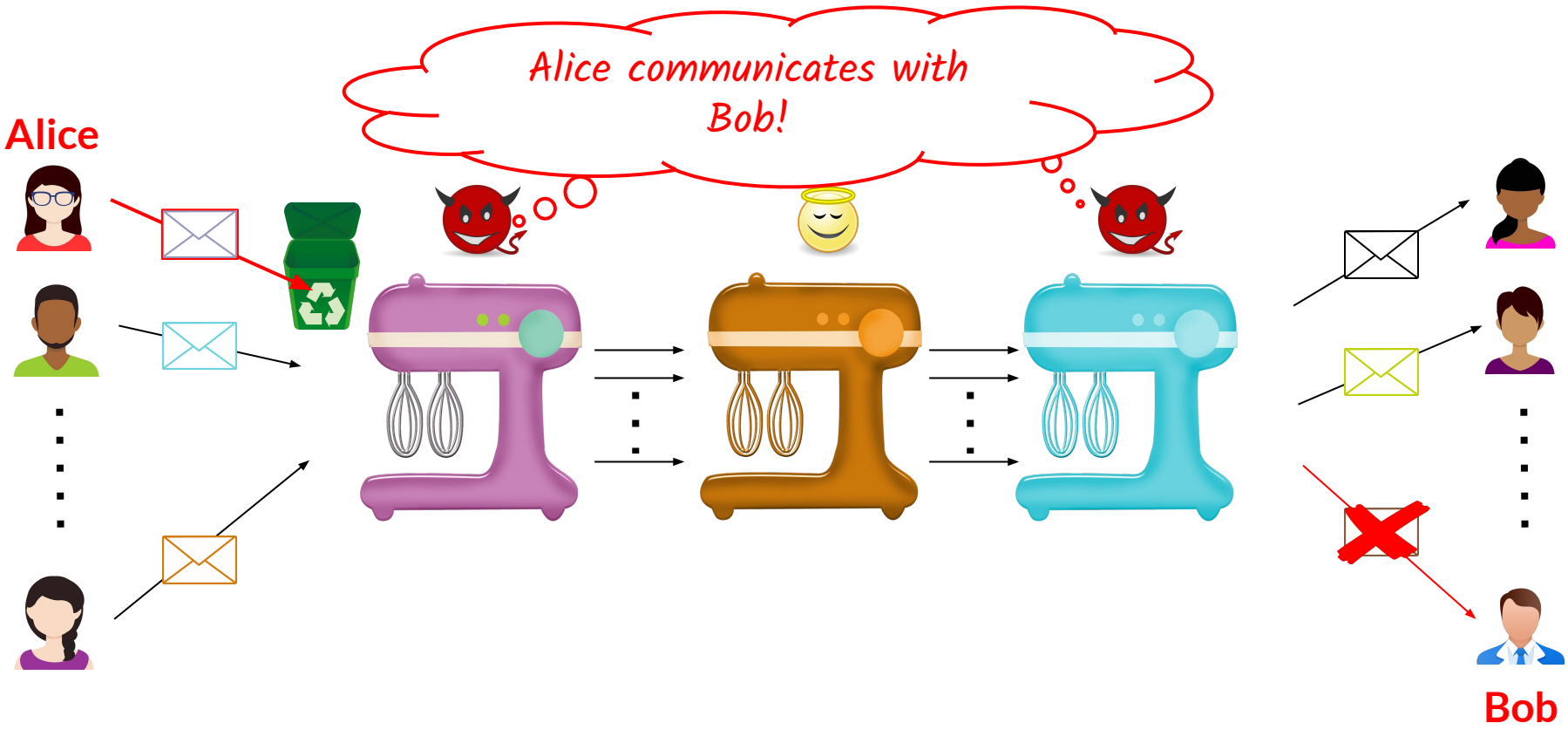

# MIRANDA'S DESIGN (assumptions)

- A fixed set of mixes (no churn)
- More honest mixes than malicious mixes (no Sybil)
- Reliable communication and processing
- Synchronized clocks

# MIRANDA'S DESIGN (challenges)

- Detect attacks by malicious mixes
- Penalize the malicious mix
- Identify the malicious mix

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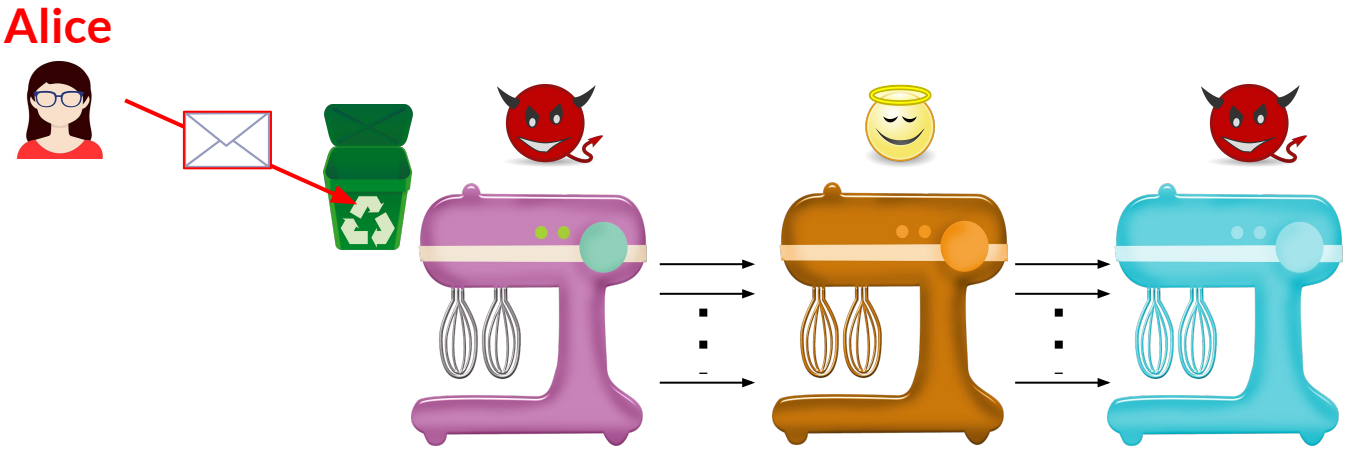
✔ Detect attacks by malicious mixes

- **Penalize the malicious mix**
- Identify the malicious mix

# IDENTIFYING THE MALICIOUS MIX IS CHALLENGING



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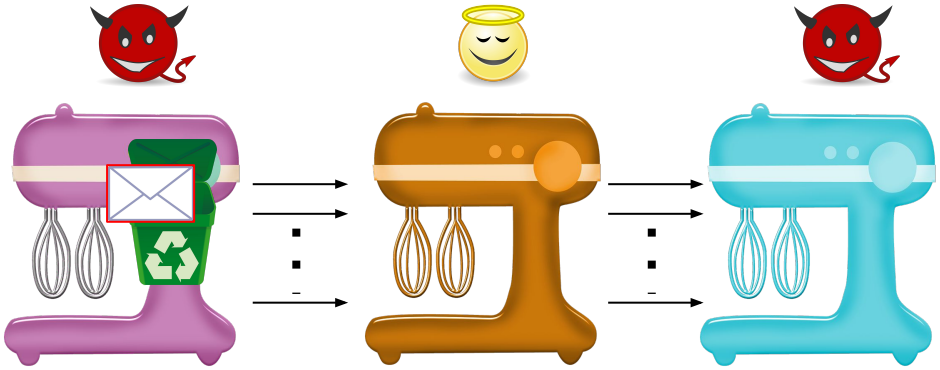
**Alice**

My message never arrived to its destination. Did you forward it?!



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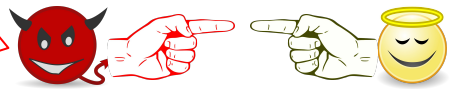

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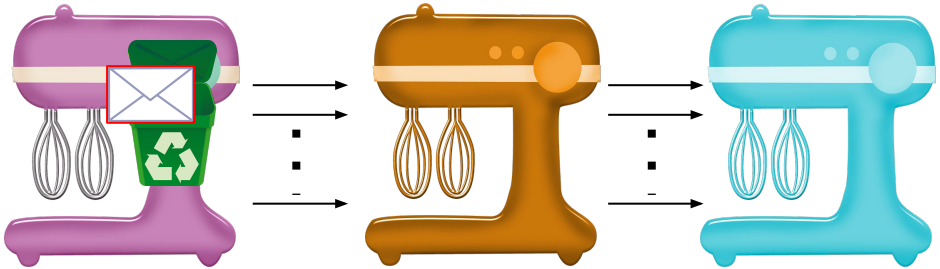

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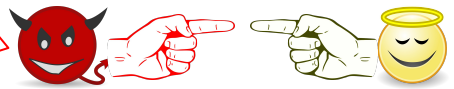

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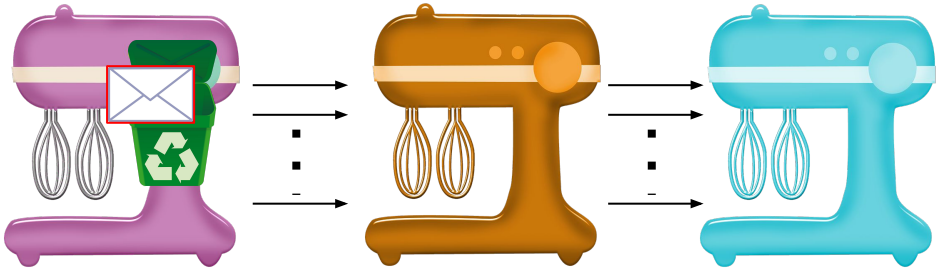

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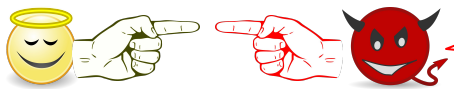

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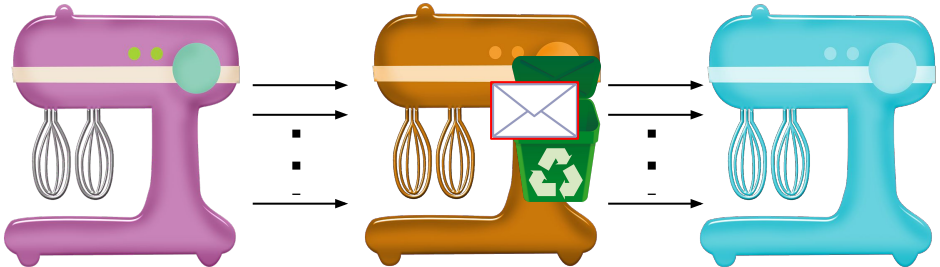

# MIRANDA *(focus on problematic pair of mixes)*

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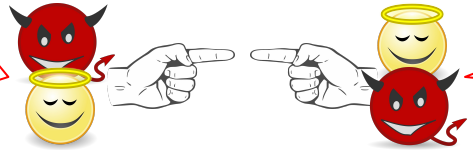

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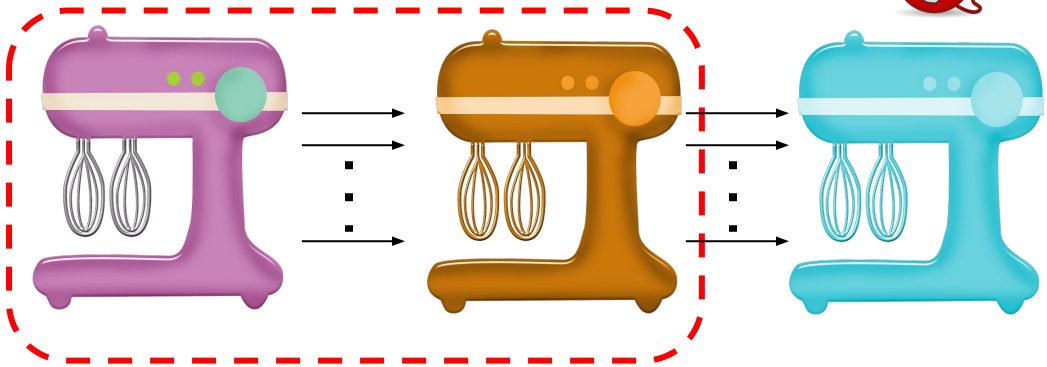

**A problematic pair of mixes ⇒**

**don't use the link between them**

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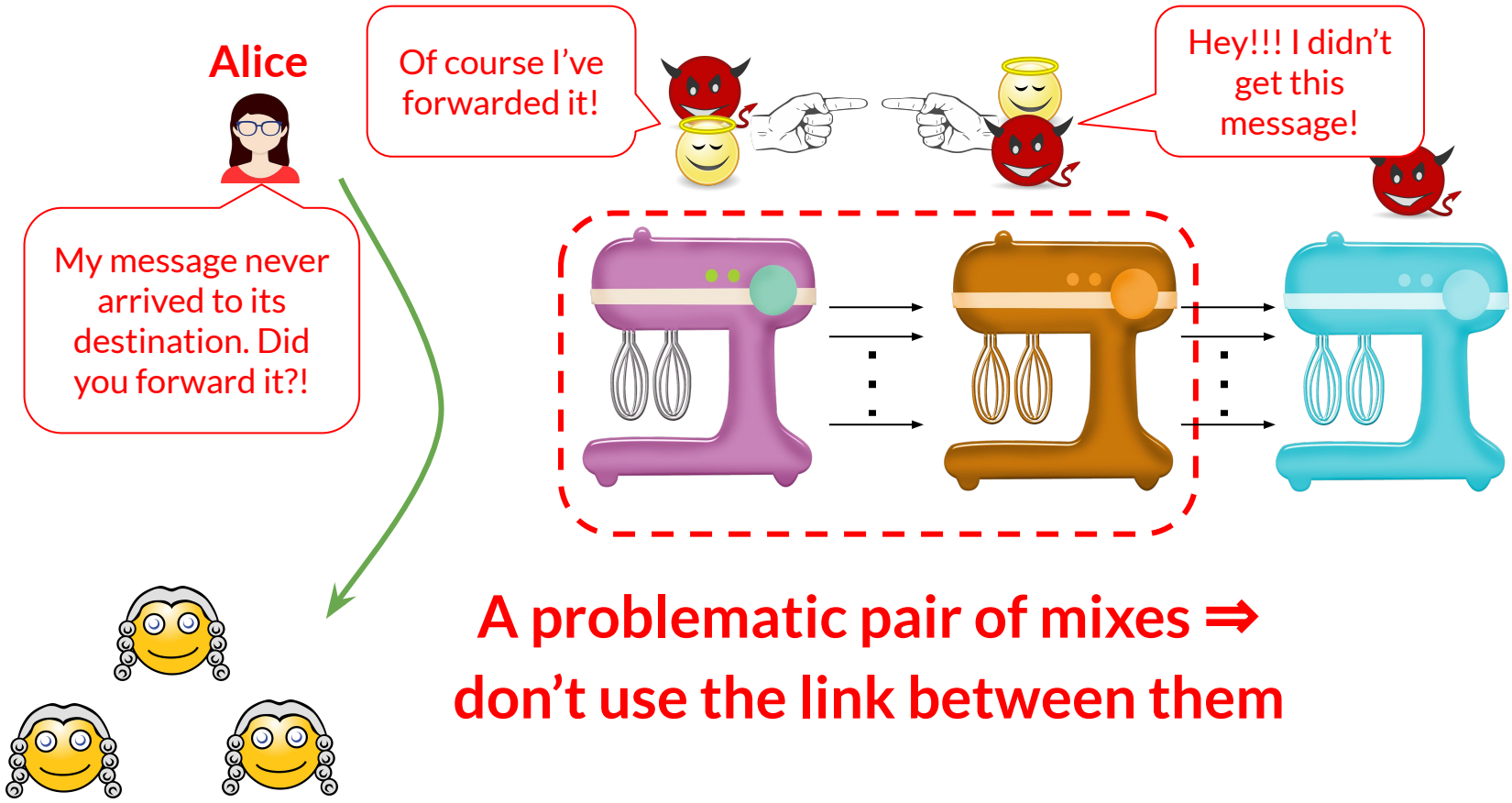
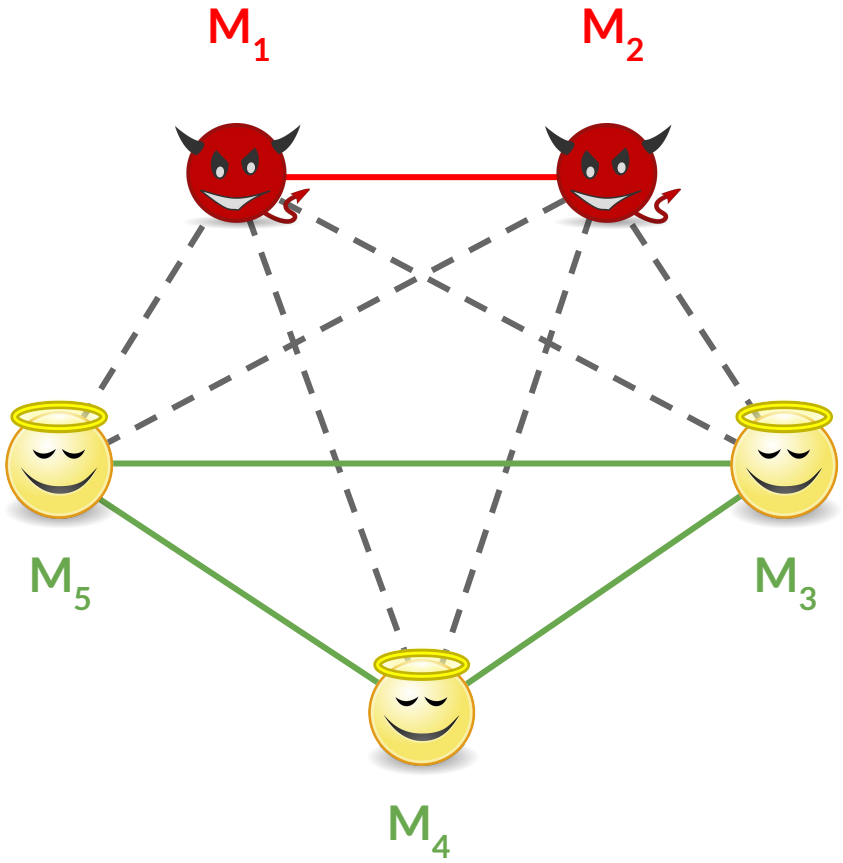



**A problematic pair of mixes ⇒ don't use the link between them**

# MIRANDA FROM 10,000 FEET (removing problematic links is a good idea)

In the beginning,
everyone are willing to communicate with each other



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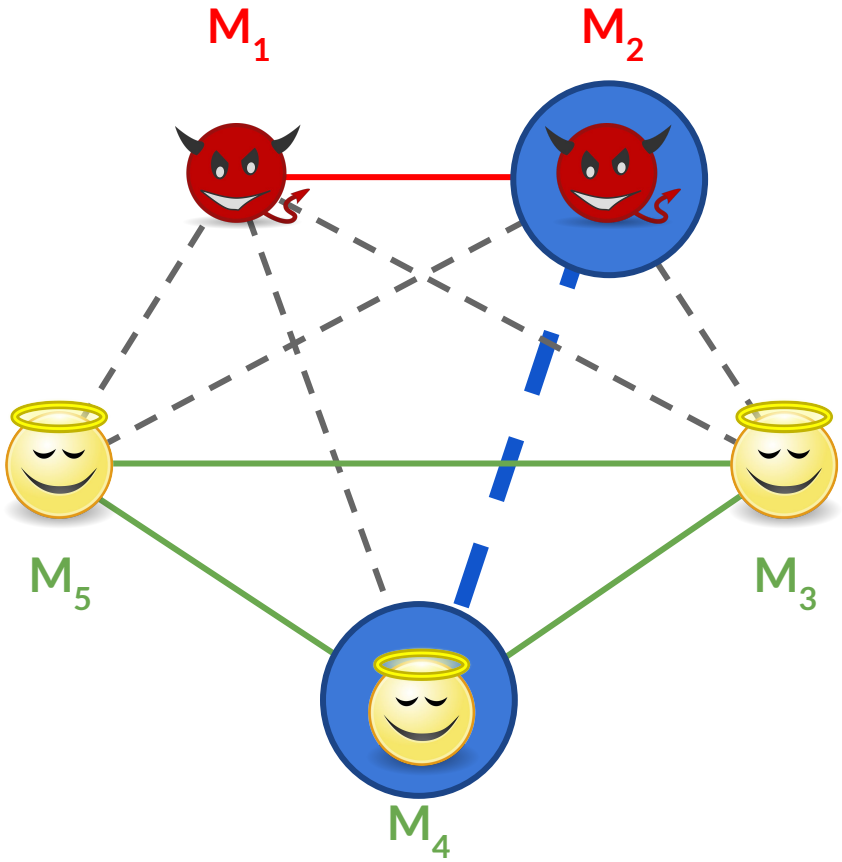
Miranda detects problematic pairs involved in active attacks, and removes their shared links, eliminating these attack vectors



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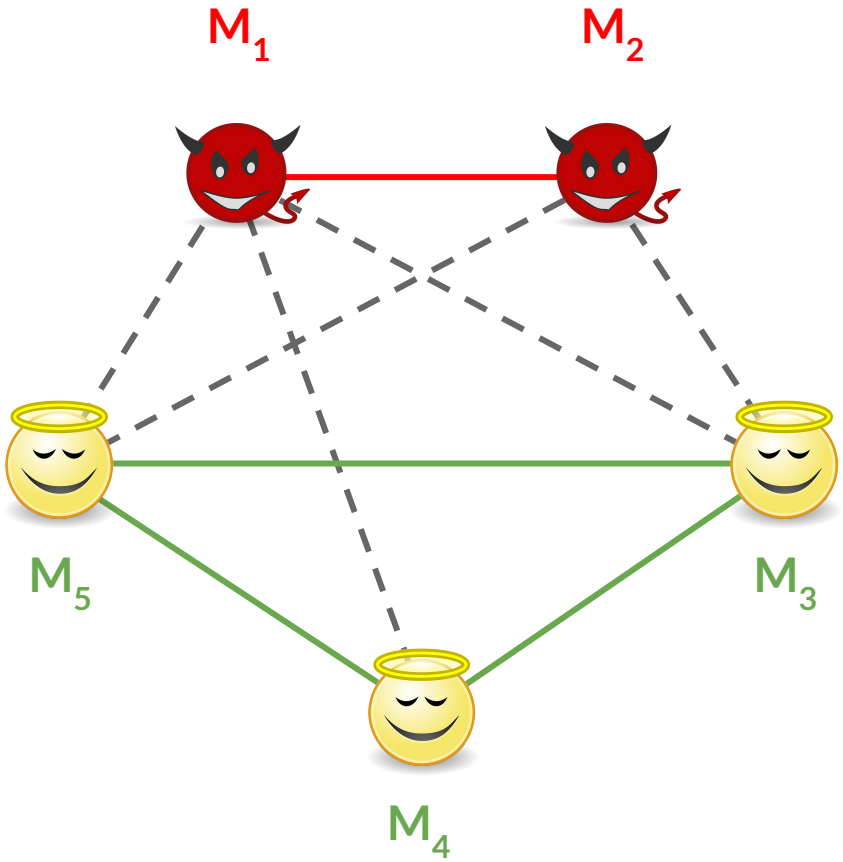

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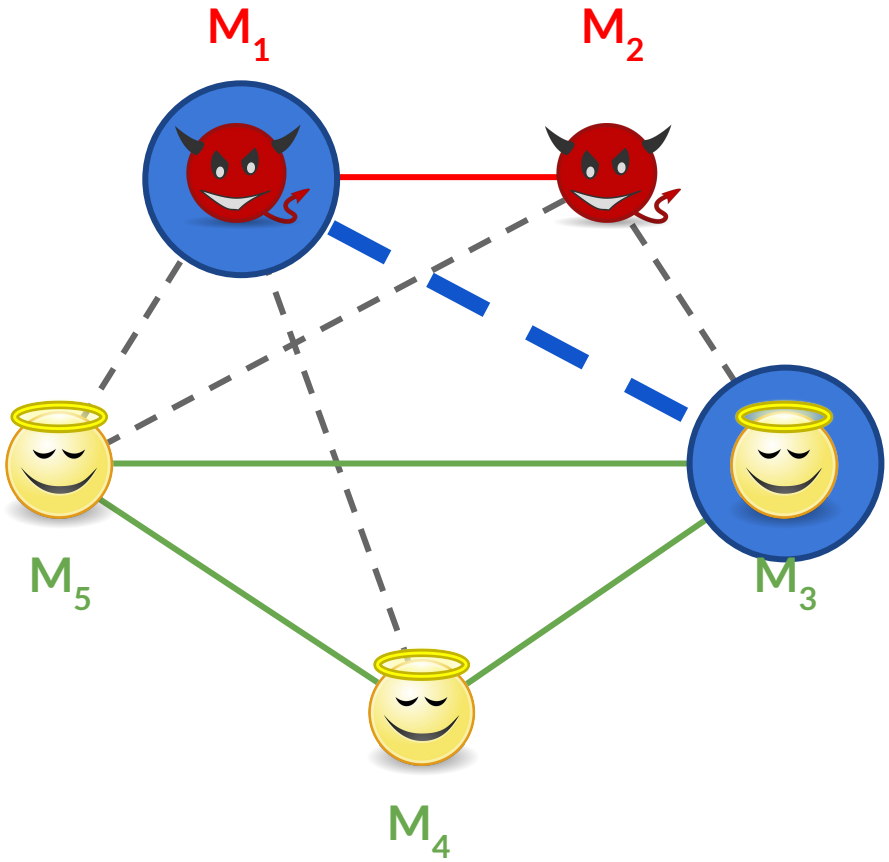

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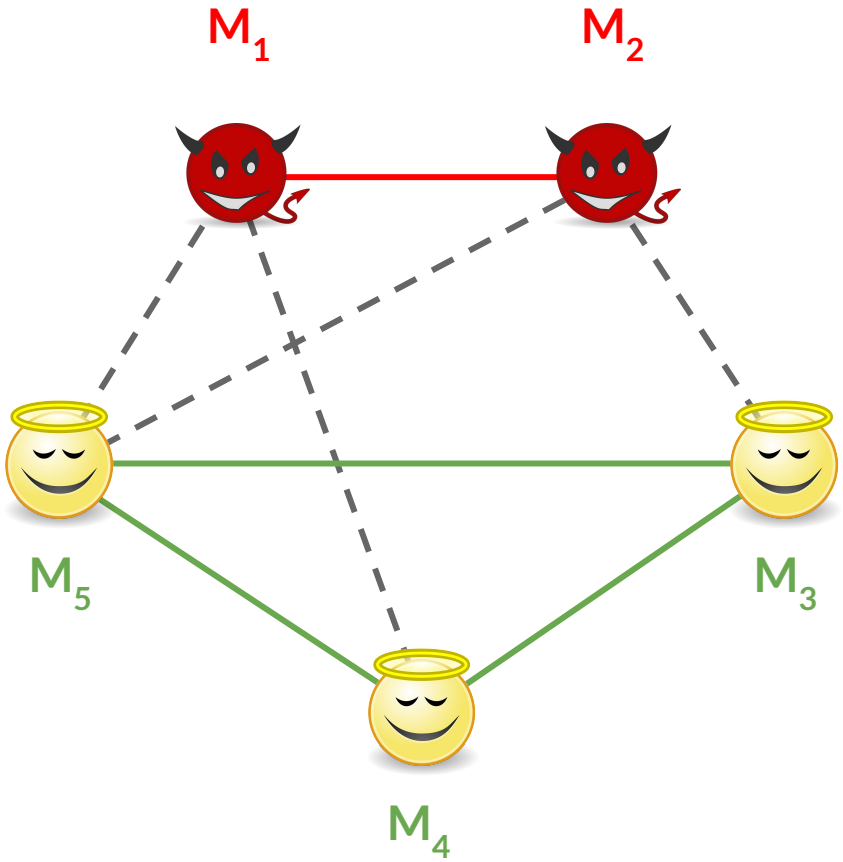

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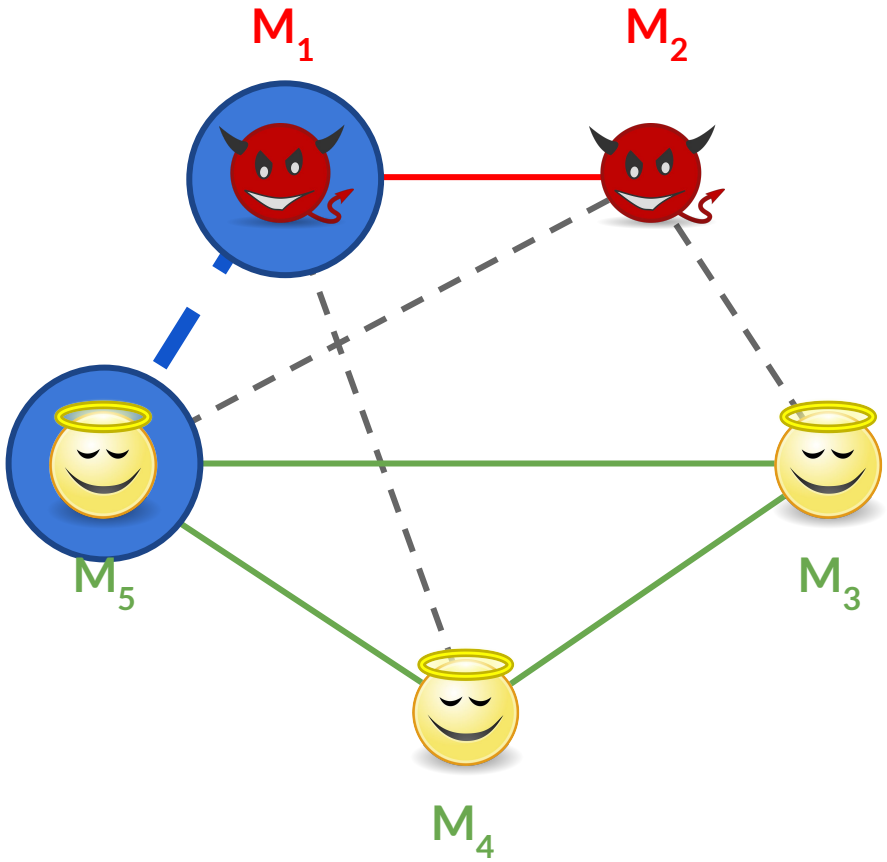

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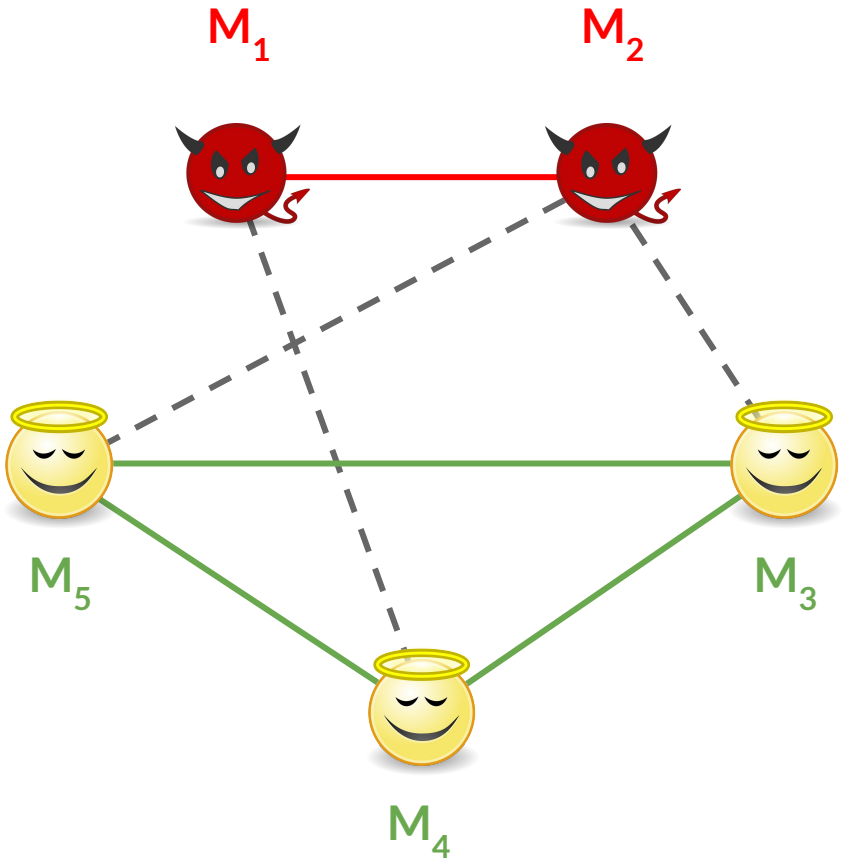

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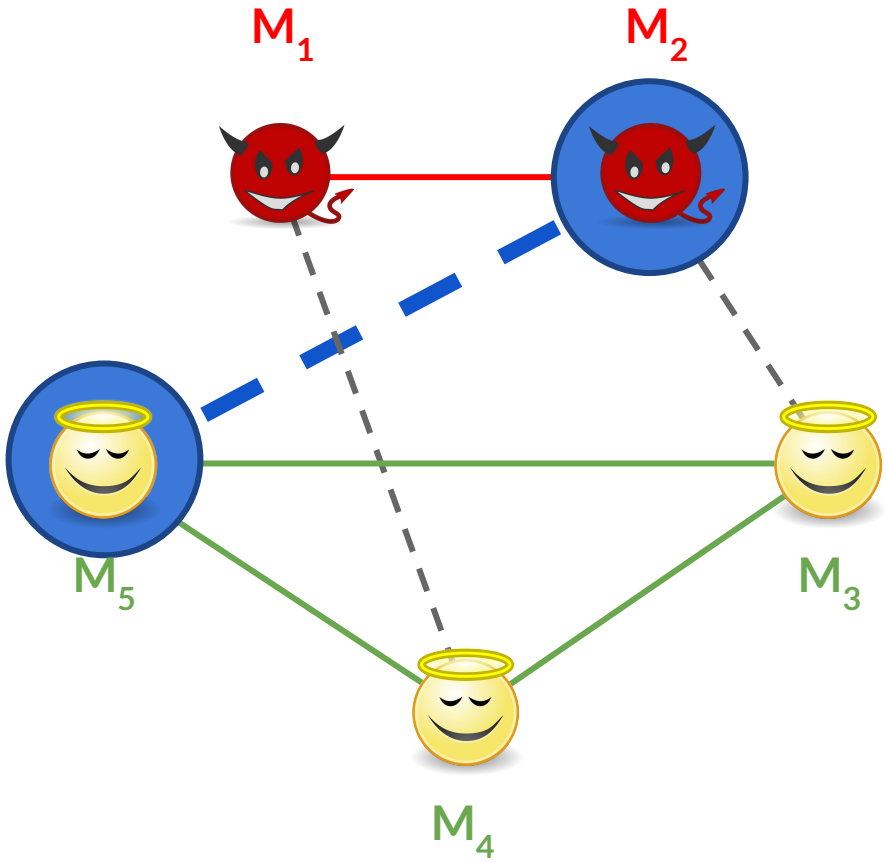

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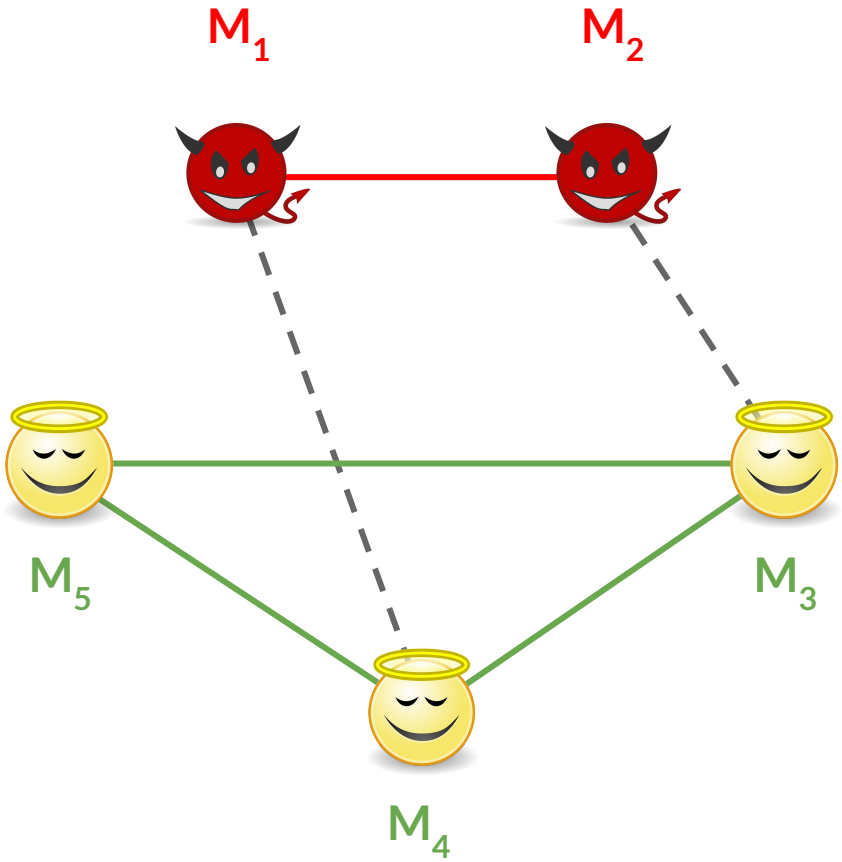

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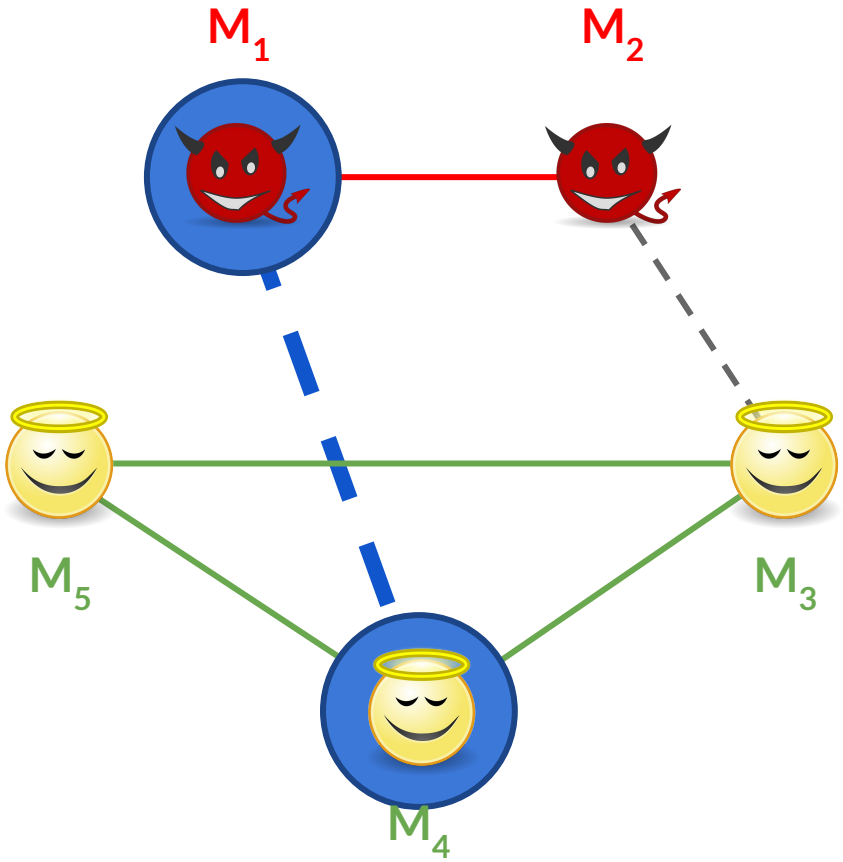

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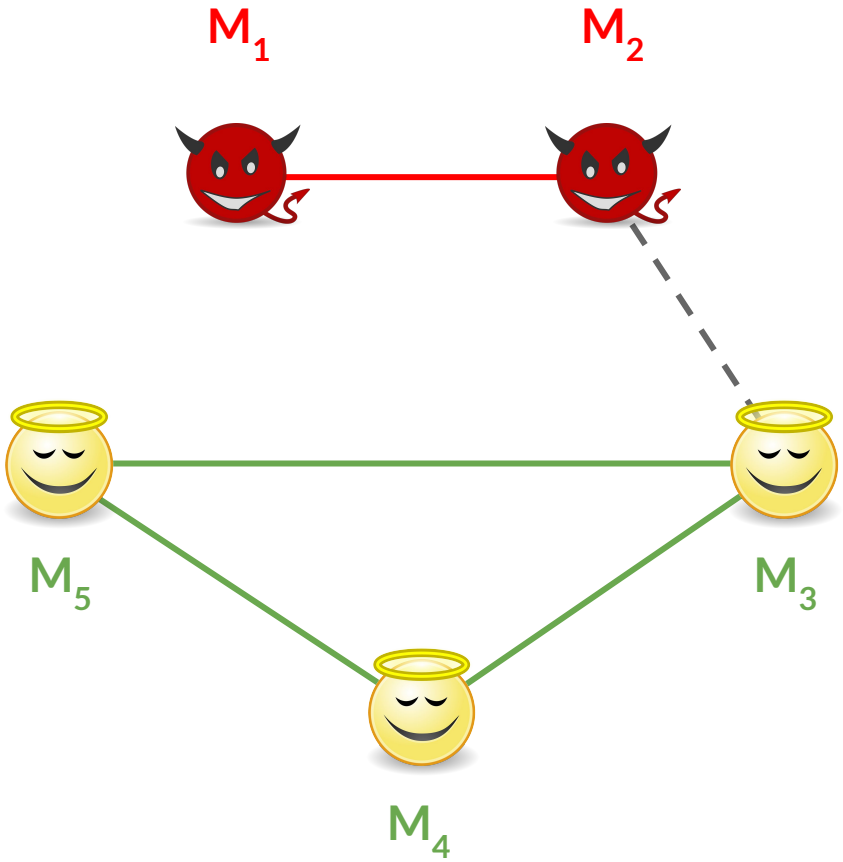
The result:

malicious mixes are removed from the system



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✔ Penalize the malicious mix

➔ **Identify the malicious mix**

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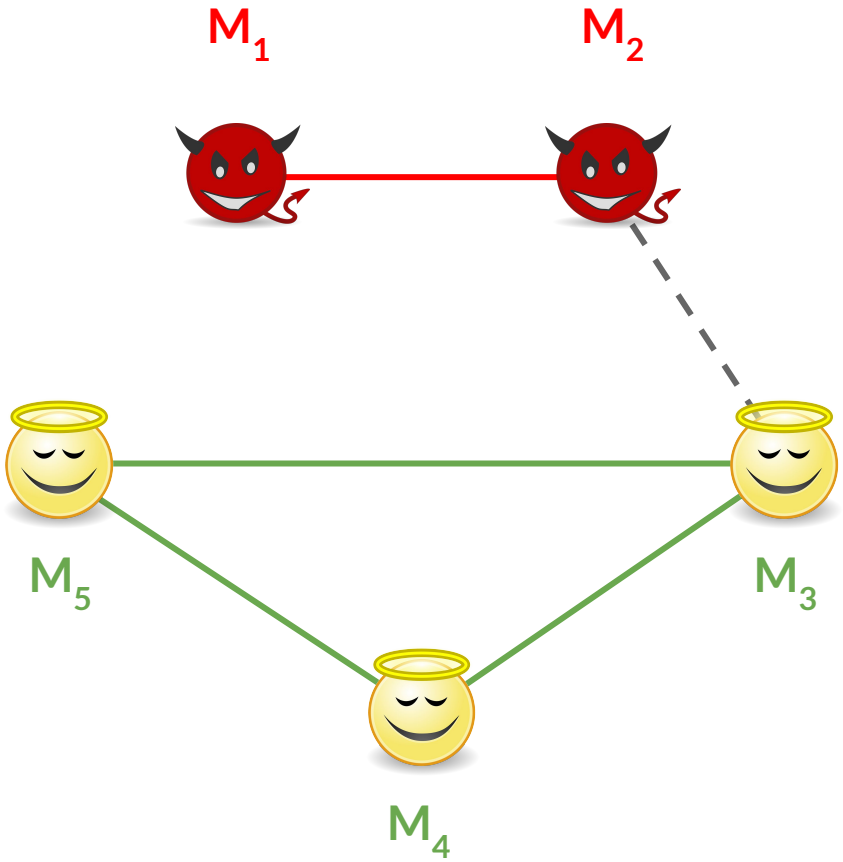

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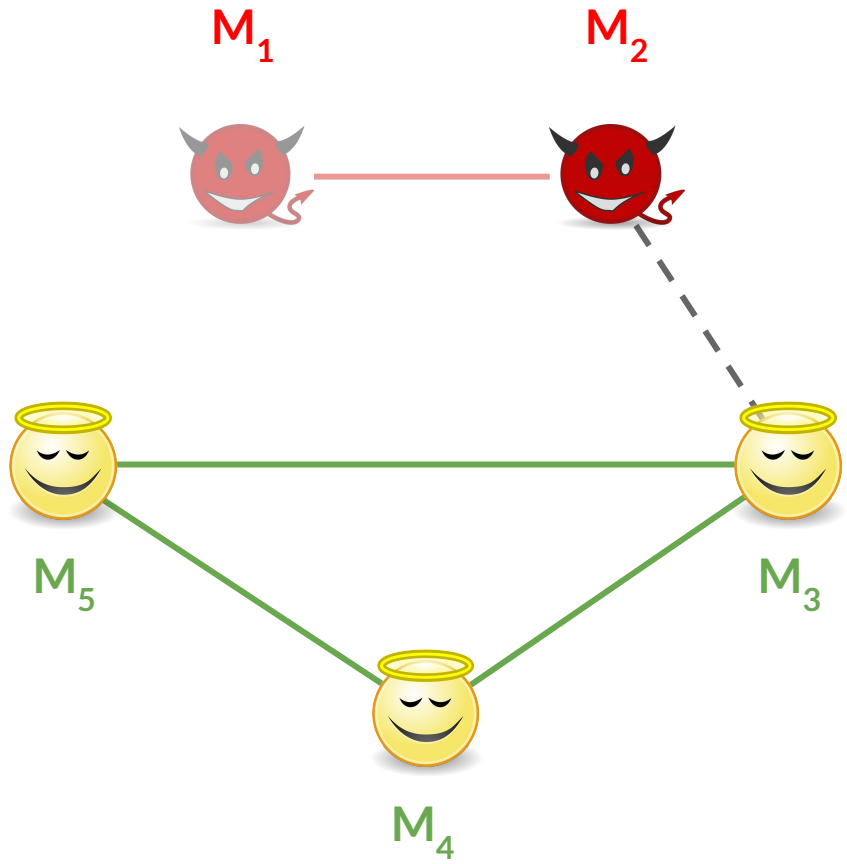

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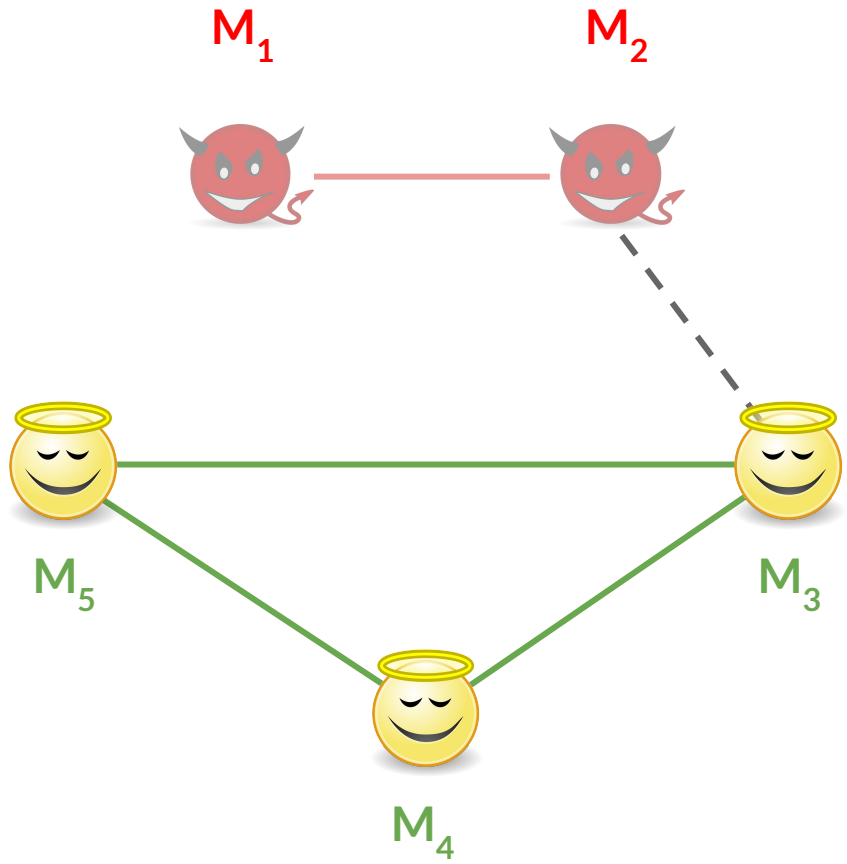

# MIRANDA'S DESIGN (challenges)

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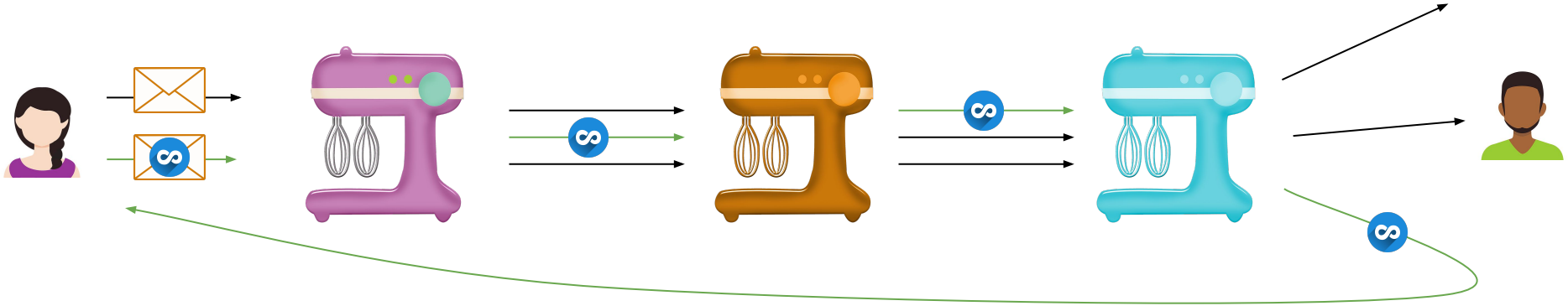
# DETECTING AN ATTACK (using loop messages)



# A LOT MORE IN THE PAPER

- More details
- Community detection techniques: enhanced detection
- Mitigating protocol abuse
- Cascade compilation strategies
- Experimental results

# CONCLUSION

- Miranda is a step in the right direction, but we have not reached the promised land yet
- Future work
  - Complete (provable) security analysis
  - Relax assumptions towards practicality (e.g., churn)
  - Further reduce latency

# THANK YOU

# Questions?

(for example, why the name Miranda?)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