# Interoperability in E2EE Messaging


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Real World Crypto 2023
March 28, 2023

# End-to-End Encrypted Messaging Today

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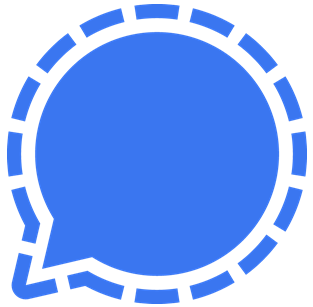
Telegram


WhatsApp


Signal


iMessage


Google Messages

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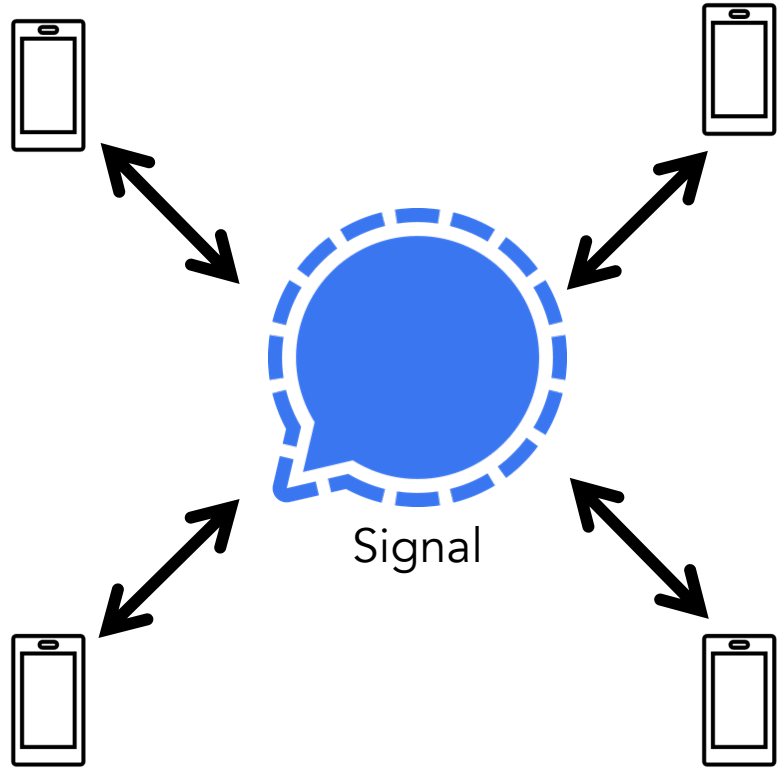

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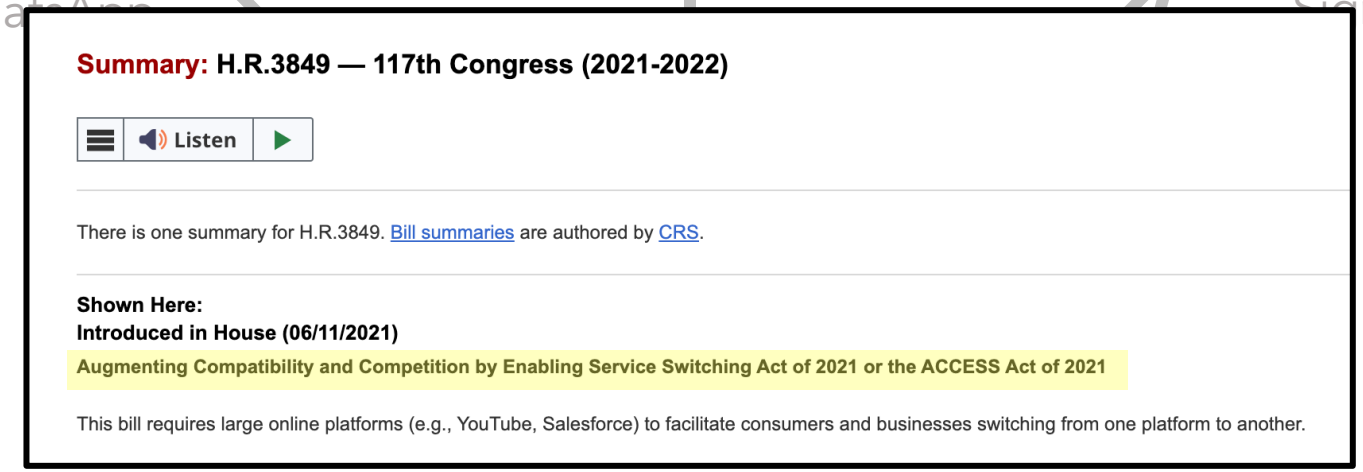

**Summary:** H.R.3849 — 117th Congress (2021-2022)

Listen

There is one summary for H.R.3849. Bill summaries are authored by CRS.

**Shown Here:**
**Introduced in House (06/11/2021)**

**Augmenting Compatibility and Competition by Enabling Service Switching Act of 2021 or the ACCESS Act of 2021**

This bill requires large online platforms (e.g., YouTube, Salesforce) to facilitate consumers and businesses switching from one platform to another.

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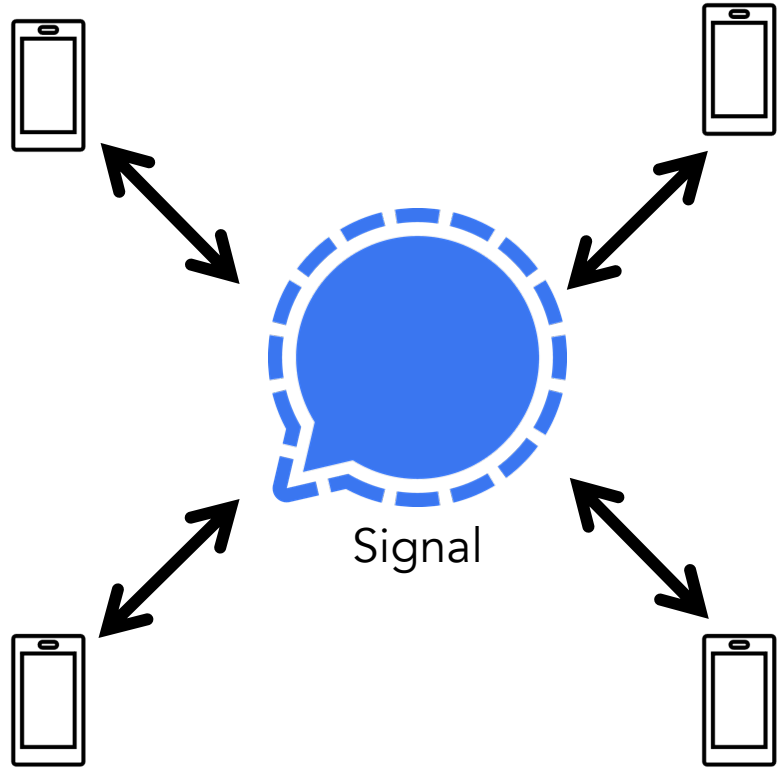

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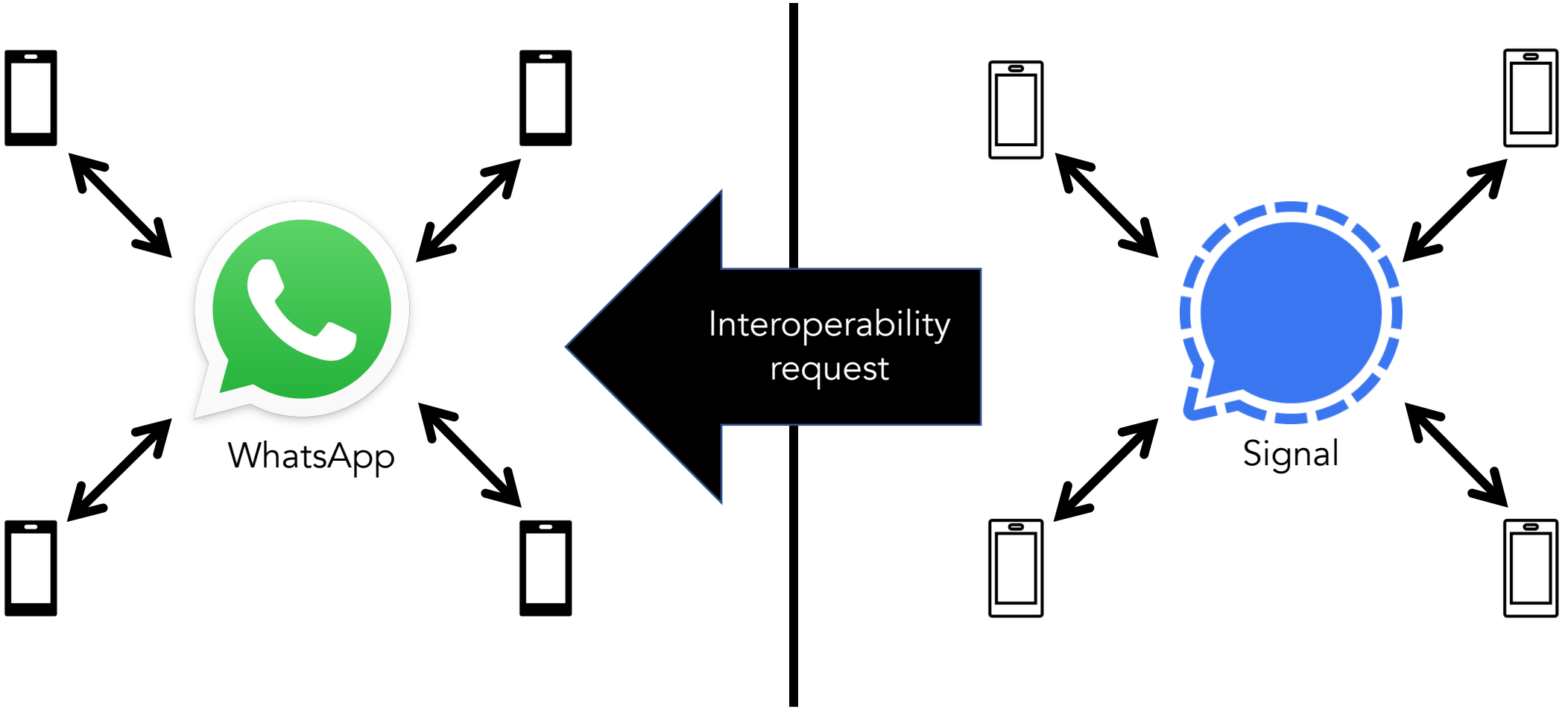

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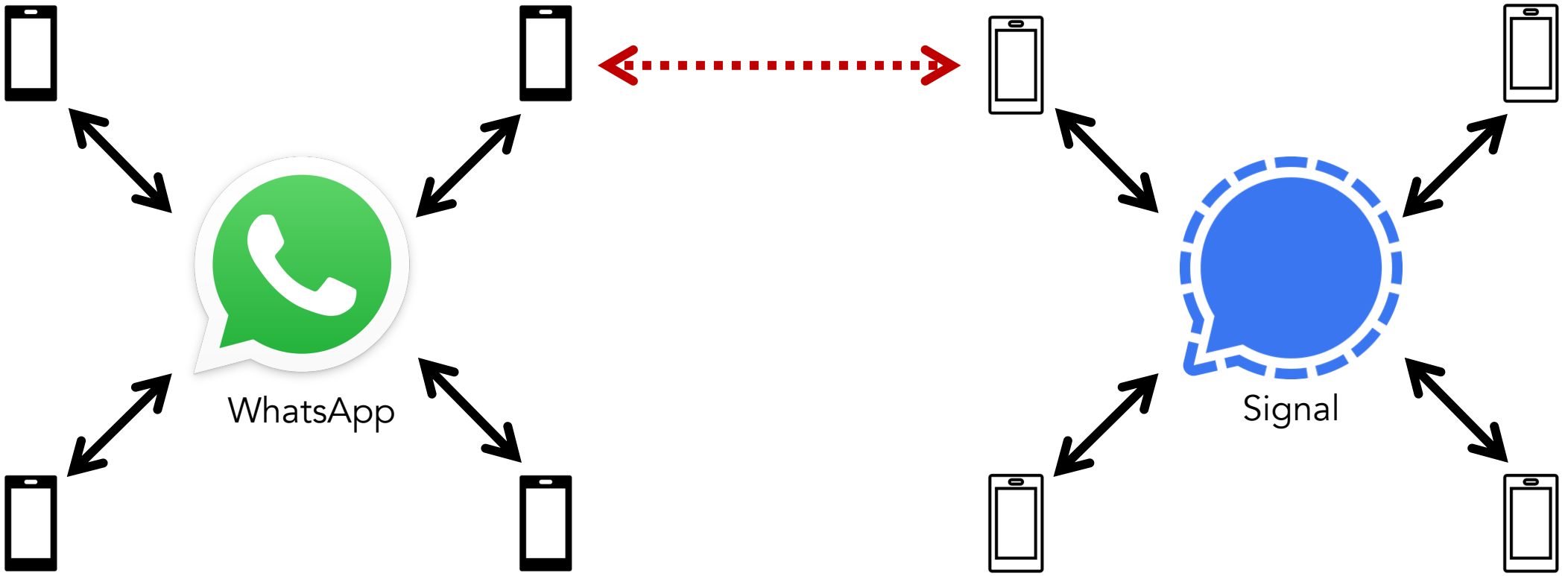
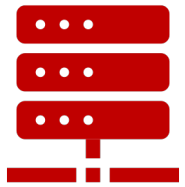
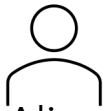


# End-to-End Encrypted Messaging Today

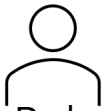
# New Challenges



Service Provider 1

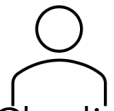


Alice

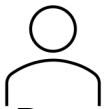


Bob

Service Provider 2

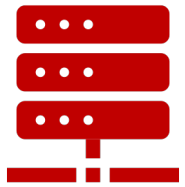


Charlie



Dan

# New Challenges



Service Provider 1

Alice

(111)111-1111

Bob

(222)222-2222

Phone numbers as user identifiers

Service Provider 2

Charlie

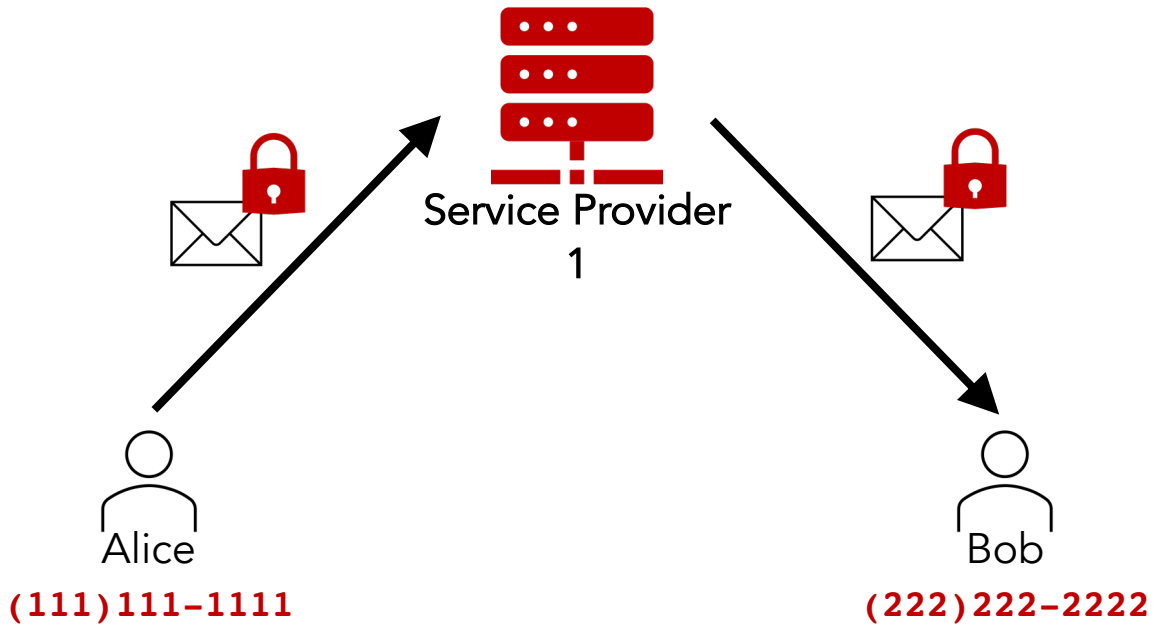
charlie@email.com

Dan

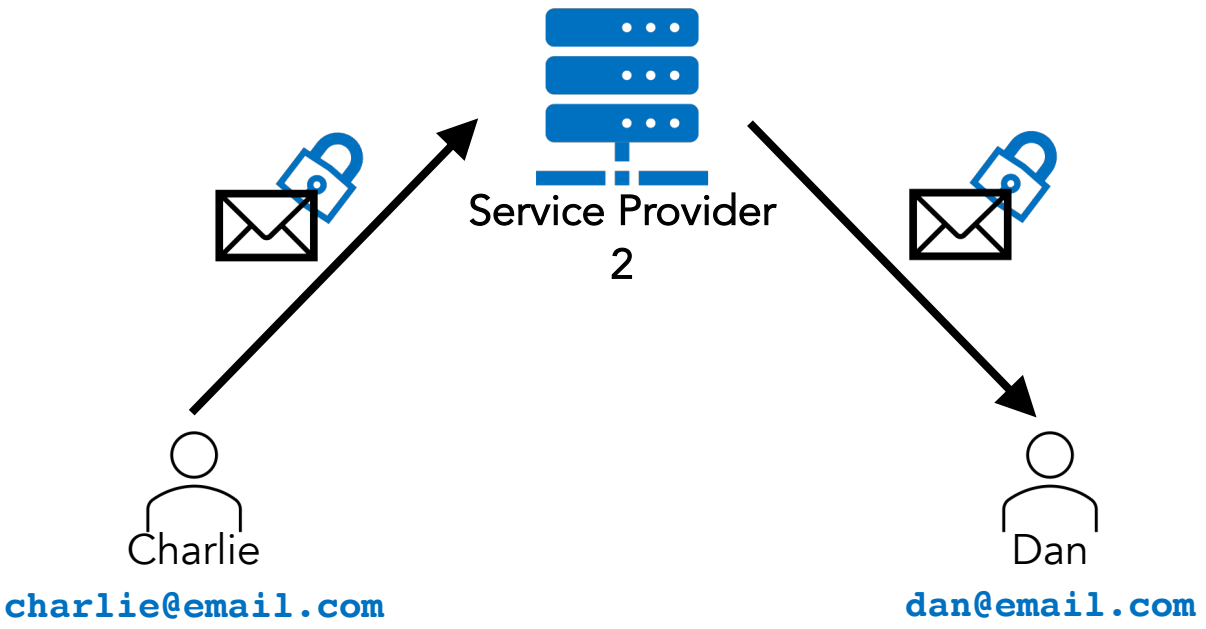
dan@email.com

Email as user identifiers

# New Challenges




Uses Signal's Double Ratchet algorithm for E2EE protocol




Uses MTProto algorithm for E2EE protocol

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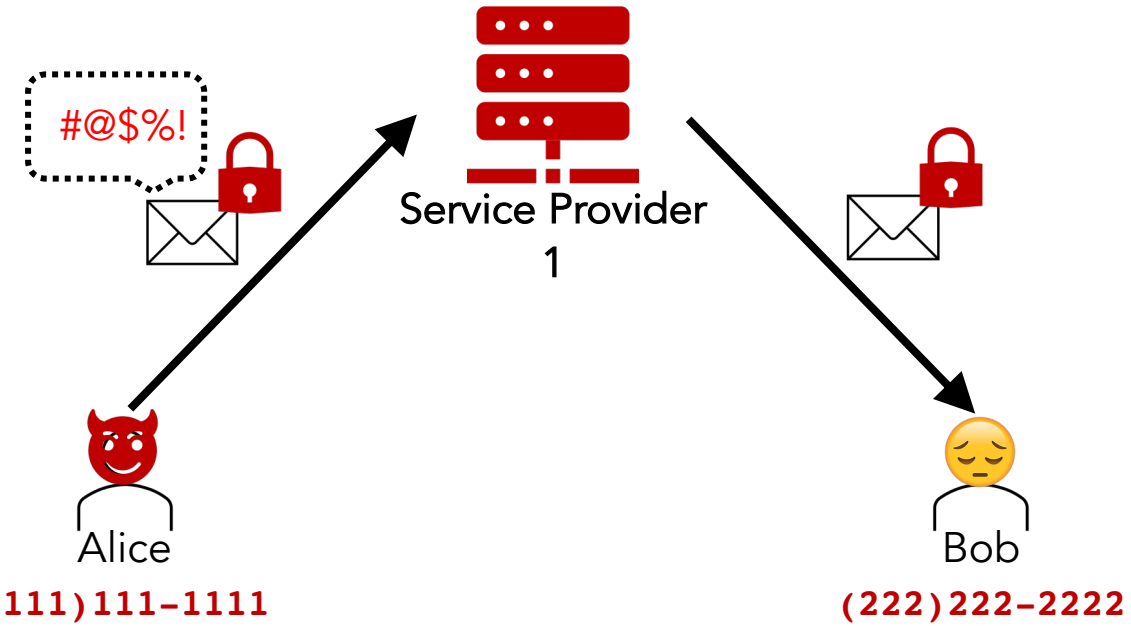
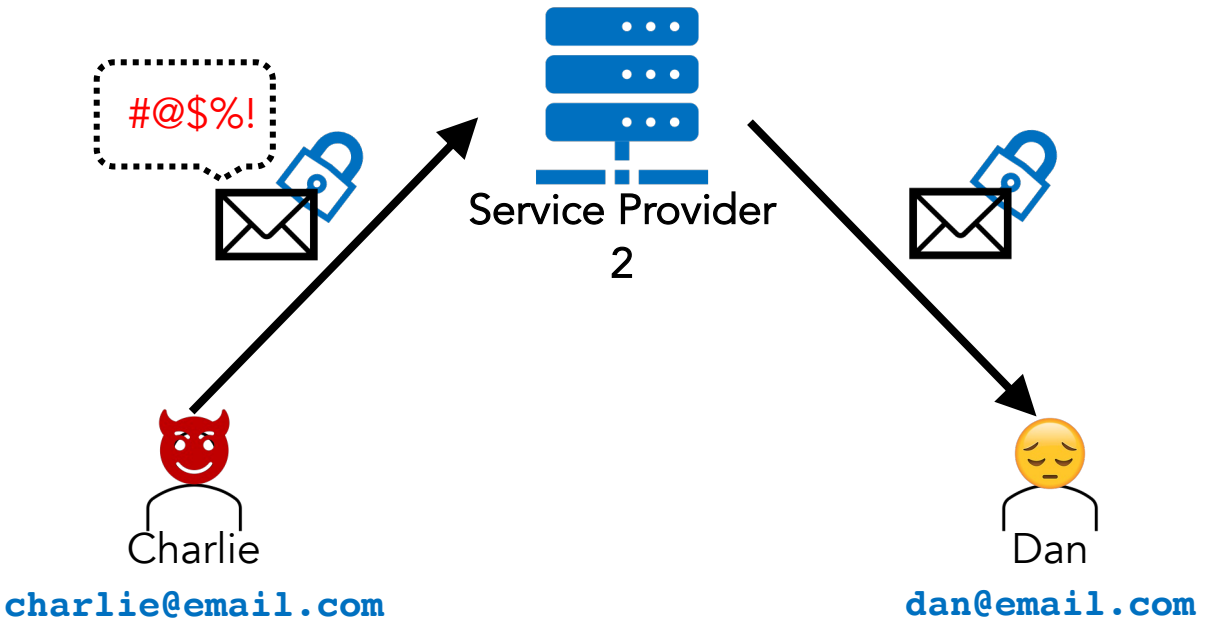
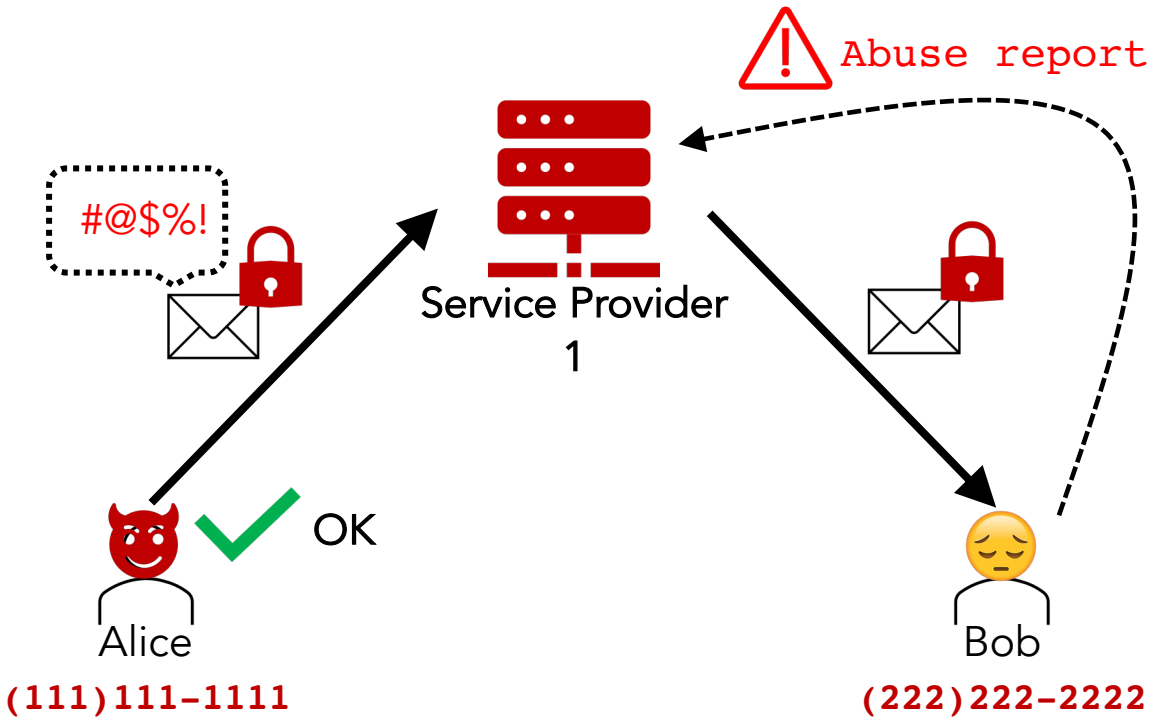



Alice's behavior *does not* violate Terms of Service for Provider 1




Charlie's behavior *does* violate Terms of Service for Provider 2

# New Challenges

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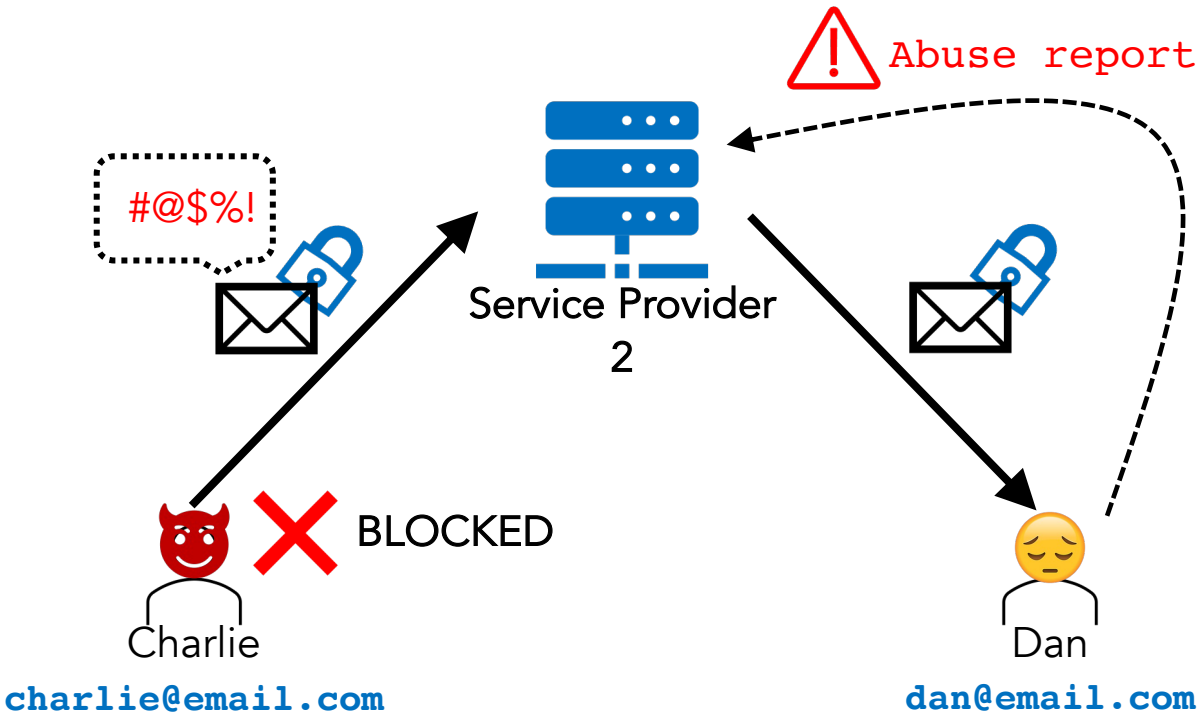
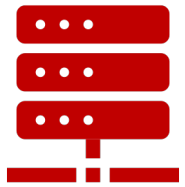



Charlie's behavior *does* violate Terms of Service for Provider 2

# New Challenges



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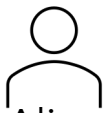

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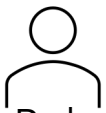
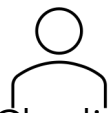


Bob

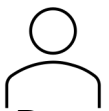
(222)222-2222

Service Provider 2



Charlie

charlie@email.com



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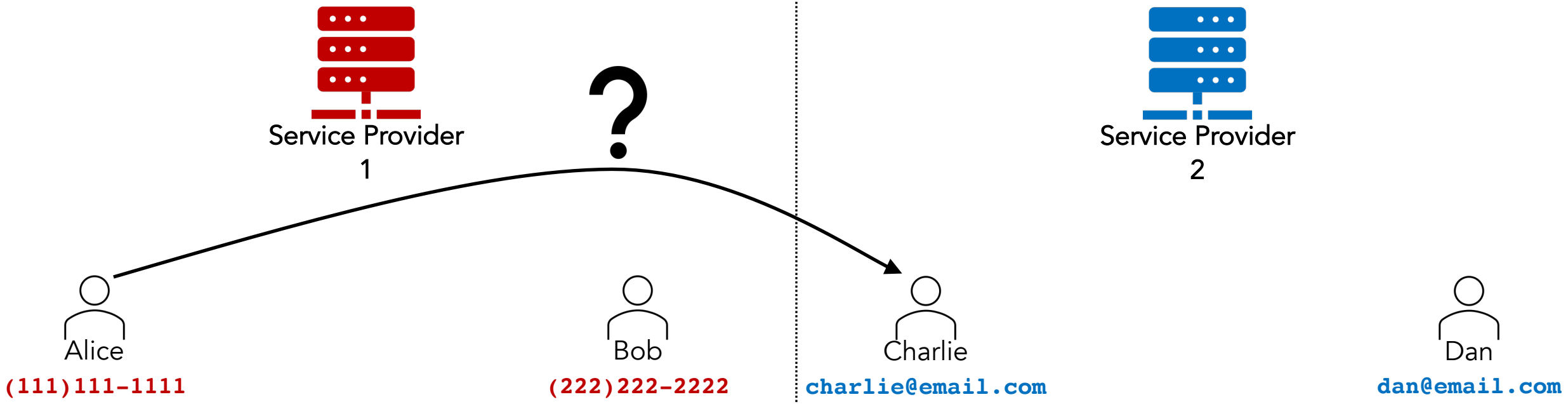

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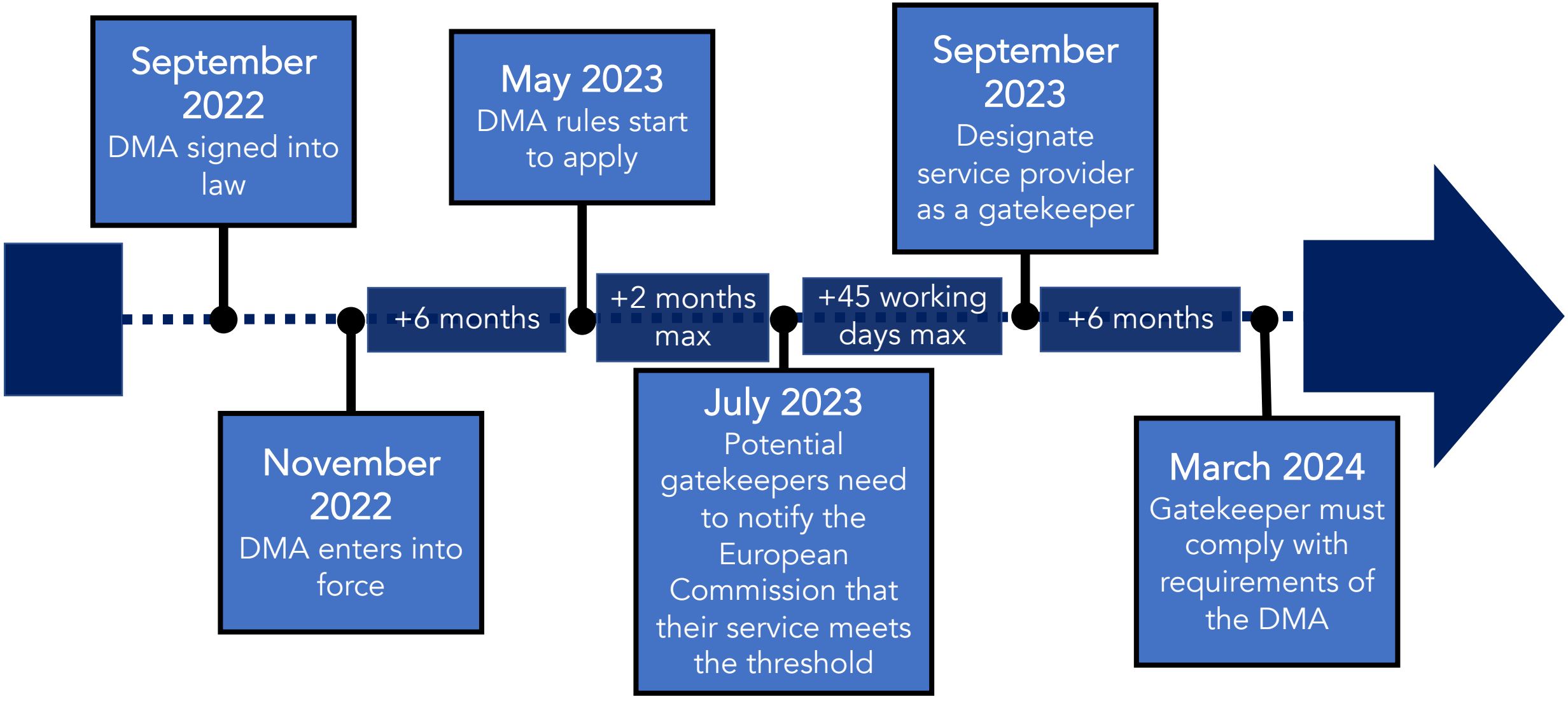


European Commission. https://ec.europa.eu/commission/presscorner/detail/en/ip_22_6423

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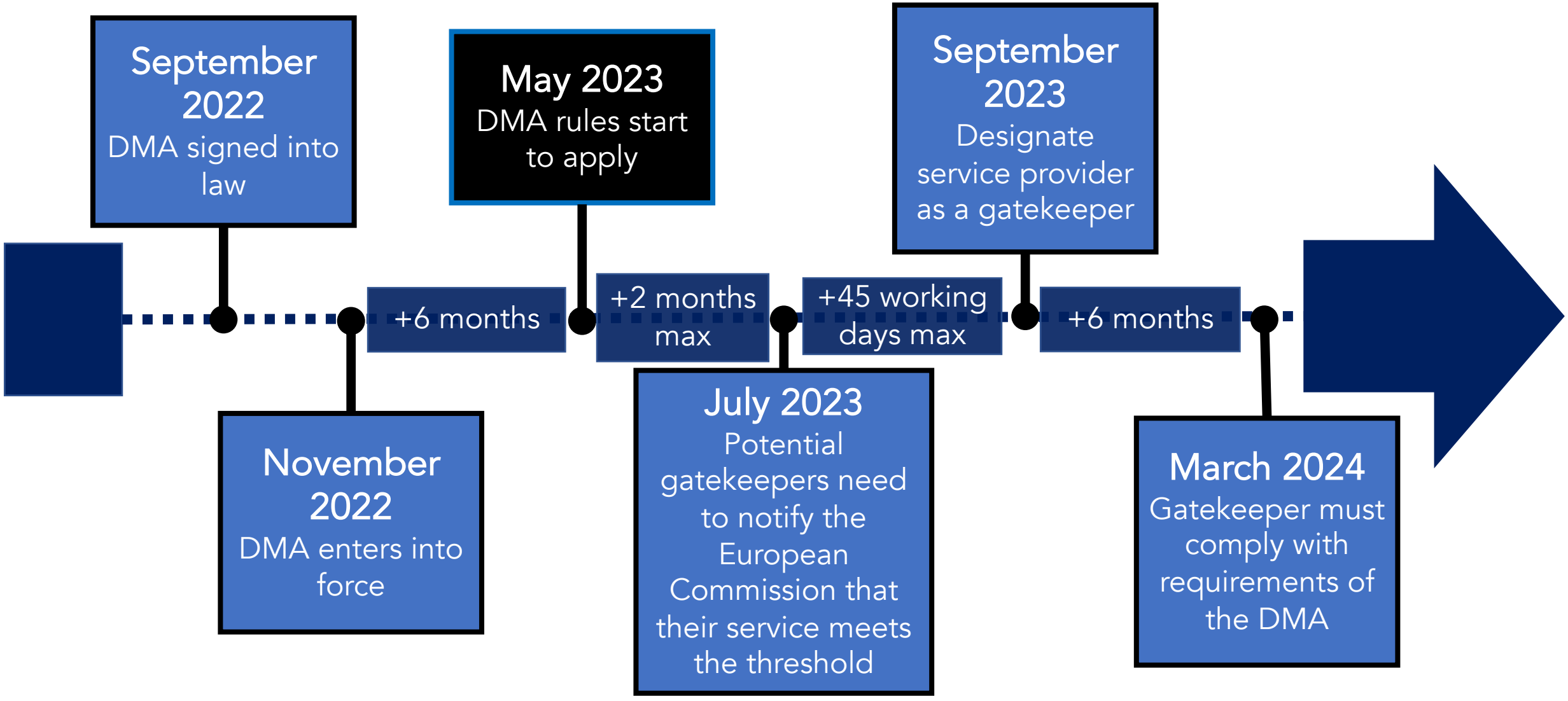


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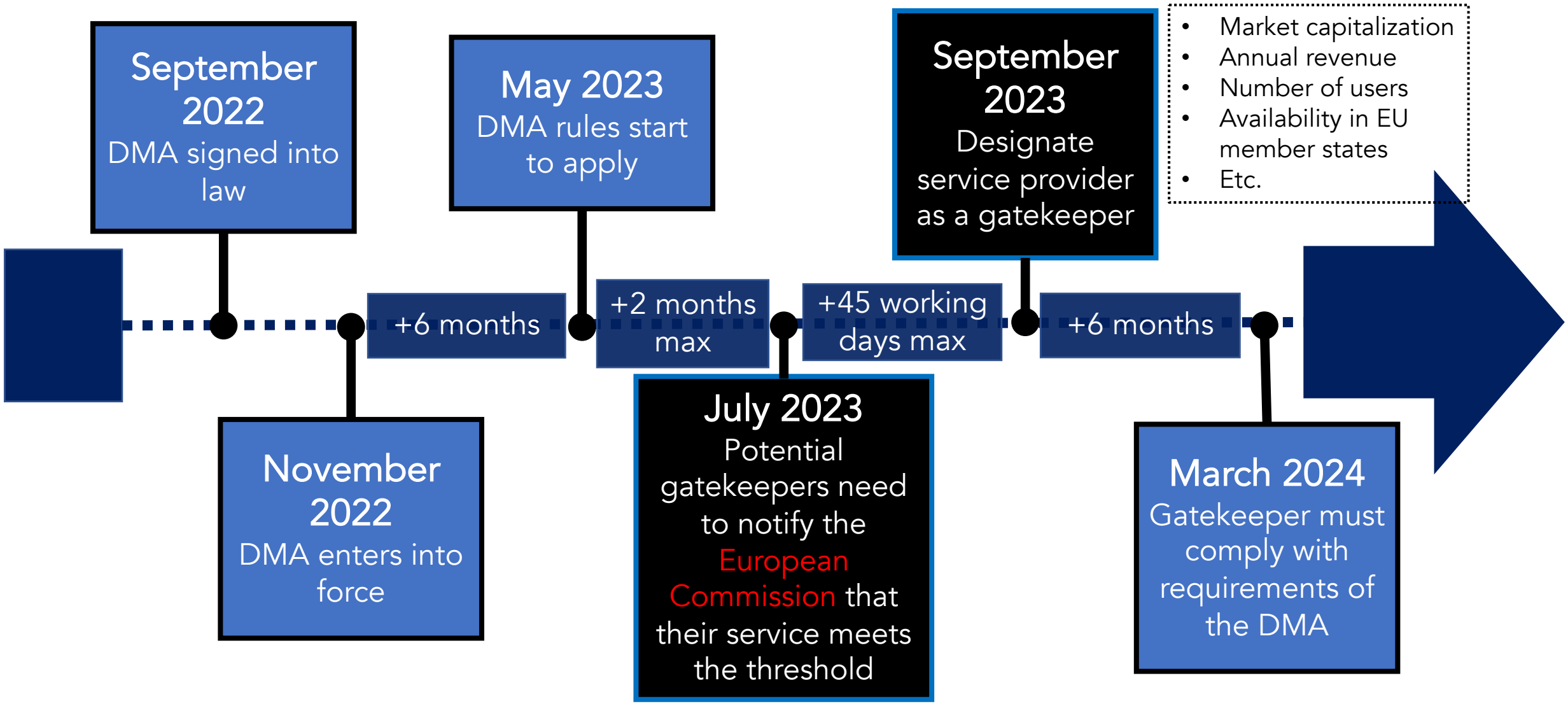


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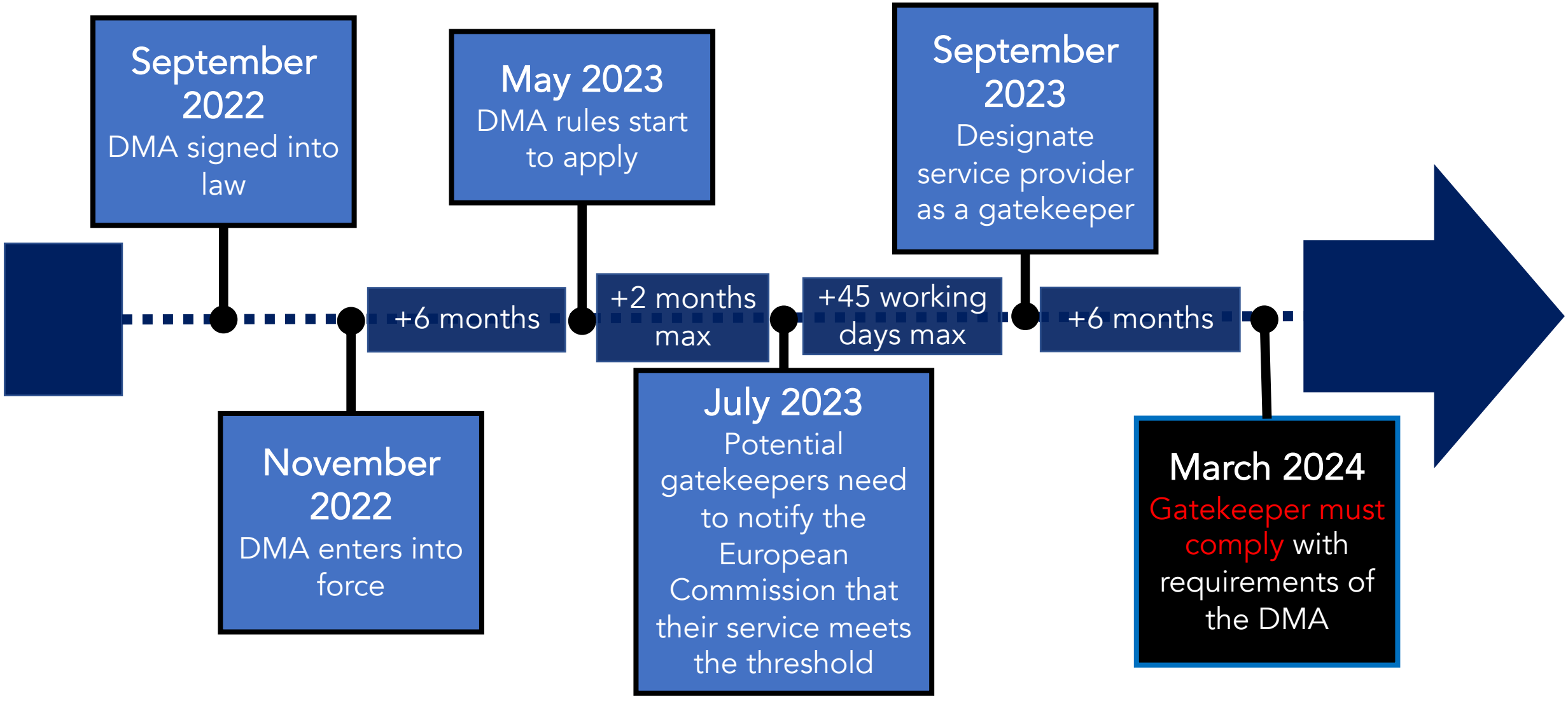


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*2 years after designation:*

Extend functionality to group messaging

*4 years after designation:*

Voice and video calls for both 1-1 and group communication

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## Paragraph 9 *(abuse prevention)*

The gatekeeper is allowed to take measures to stop risk to “integrity, security, and privacy” of its services, as long as they are “strictly necessary”

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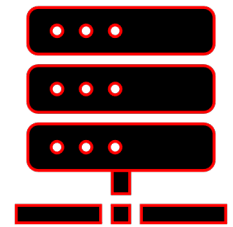
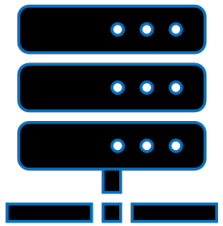
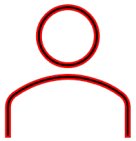


AliceChat



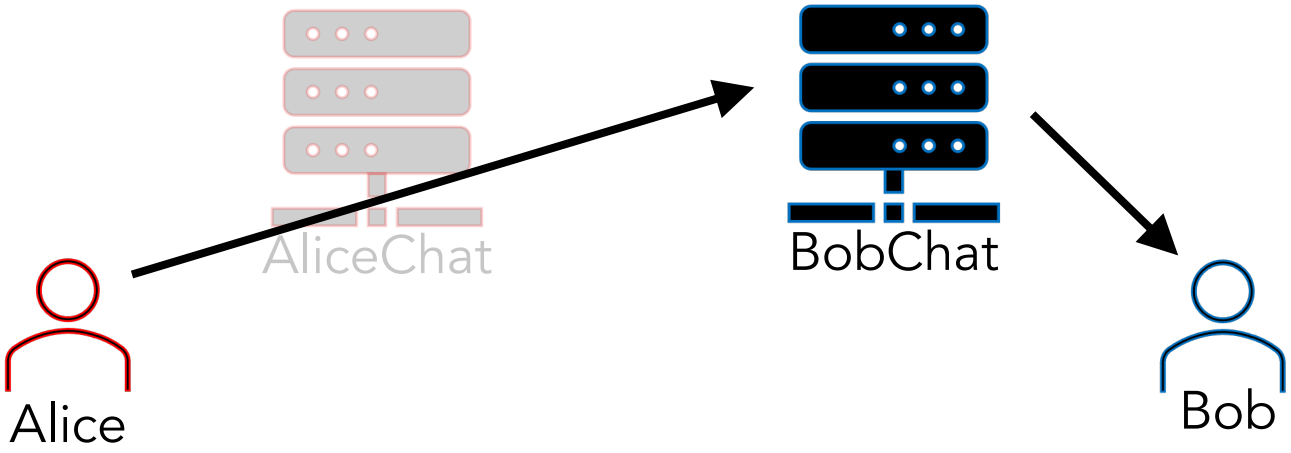
BobChat



Alice

Bob

# Architecture




## Client-to-server

- \+ AliceChat does not learn that Alice is communicating with somebody on BobChat
- − Alice would need a way to authenticate herself to BobChat as an authorized user
- − Abuse prevention techniques like server-side spam filtering might be more challenging

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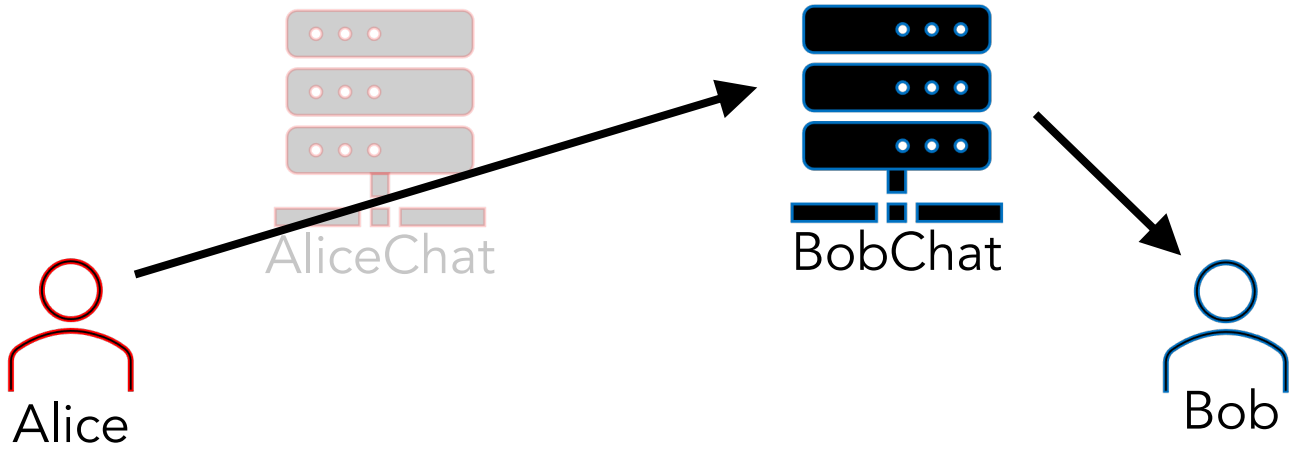


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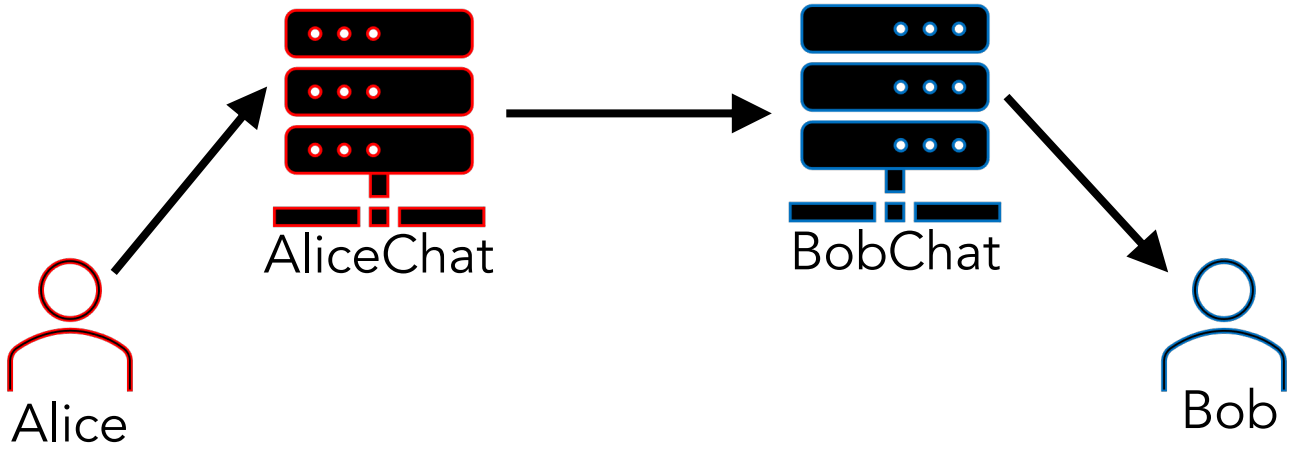
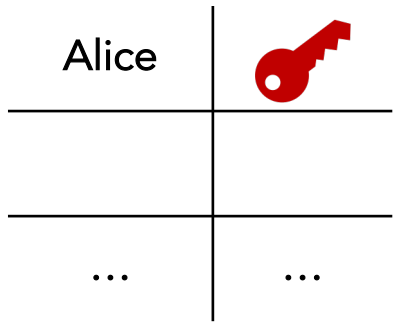
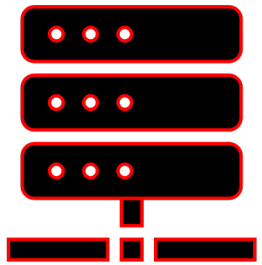


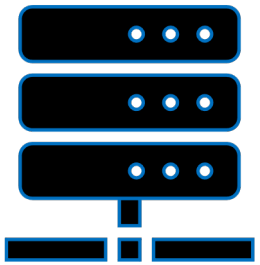

## Server-to-server (our design)

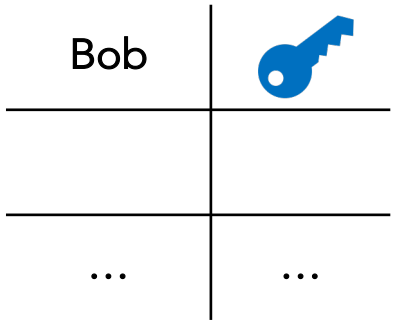
- — Leaks to AliceChat that Alice is talking to someone on BobChat and to BobChat that Bob is talking to someone on AliceChat
- ✚ Network-level metadata like IP addresses of users is not leaked in cross-provider communication to other providers
- ✚ Makes implementing some abuse prevention measures easier

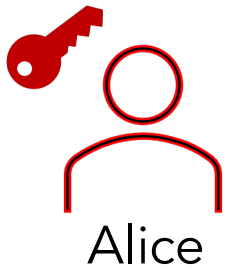
# Identity Discovery and Interoperability

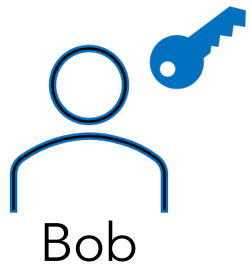


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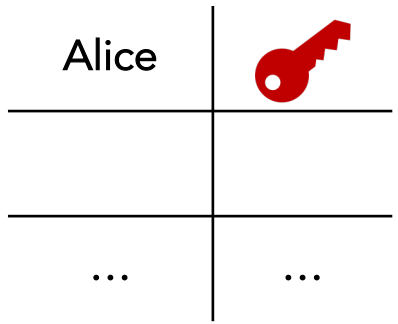


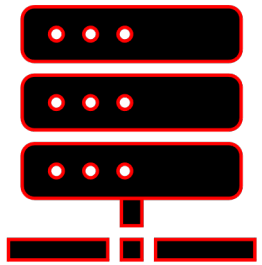

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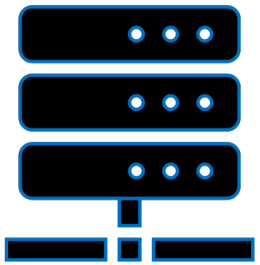
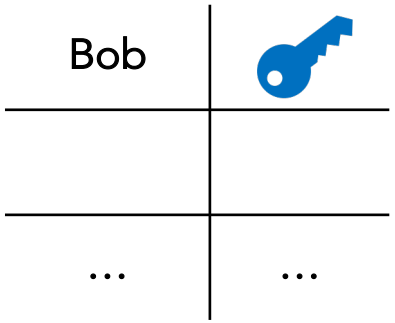
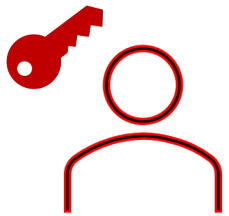


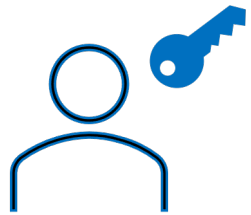
BobChat



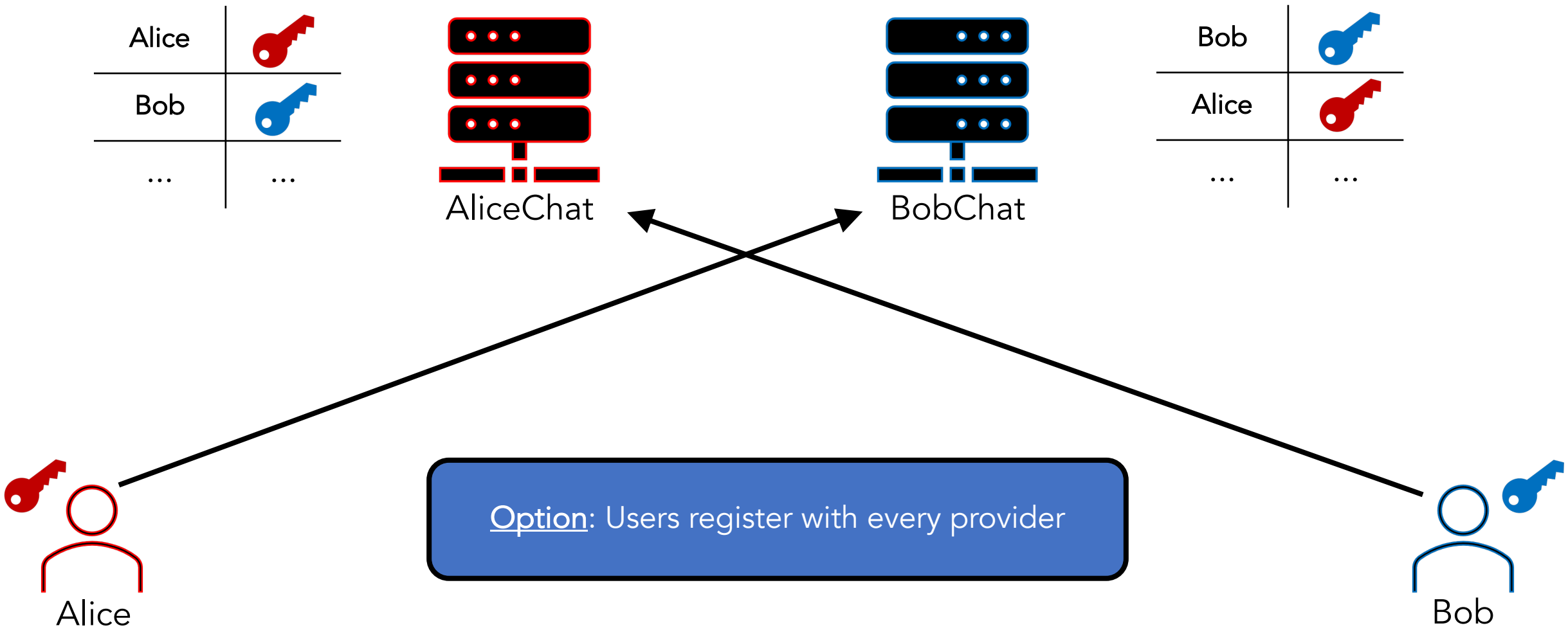
Alice

Option: Users register with every provider

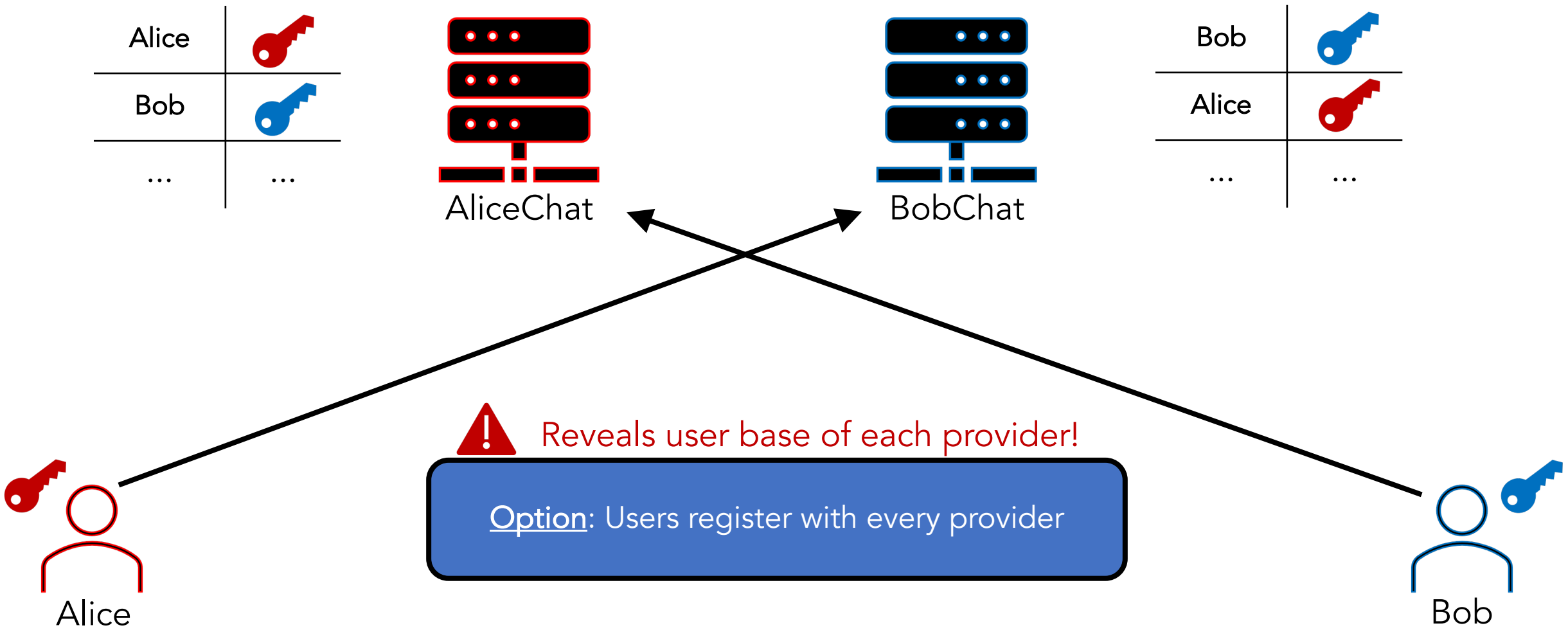


Bob

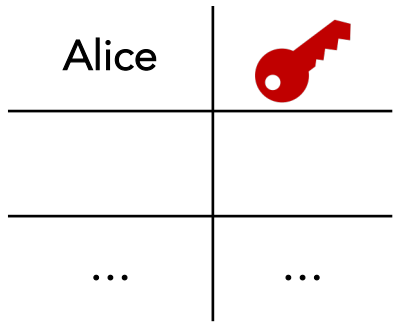
# Identity Discovery and Interoperability

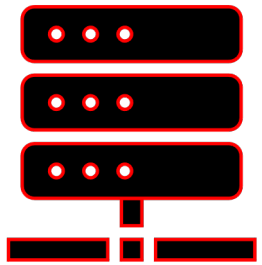


# Identity Discovery and Interoperability

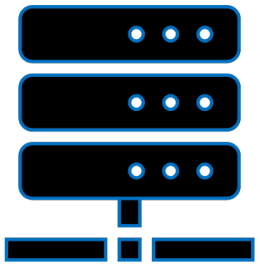


# Identity Discovery and Interoperability

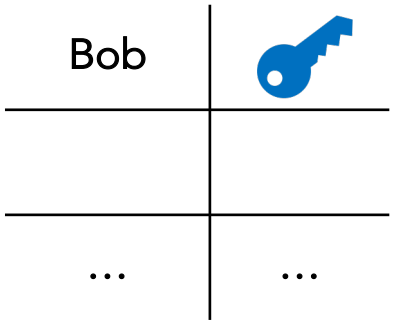


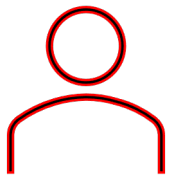



AliceChat



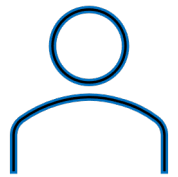
BobChat



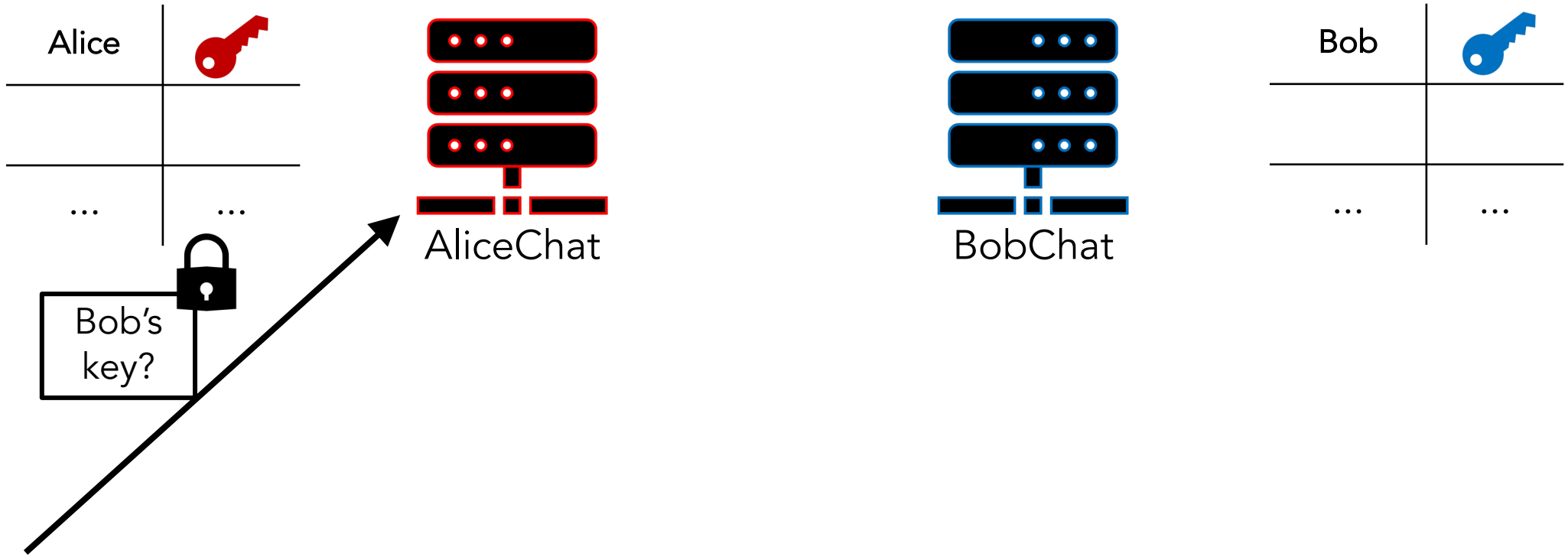
Alice

Our design: Encrypted queries to other provider's identity system

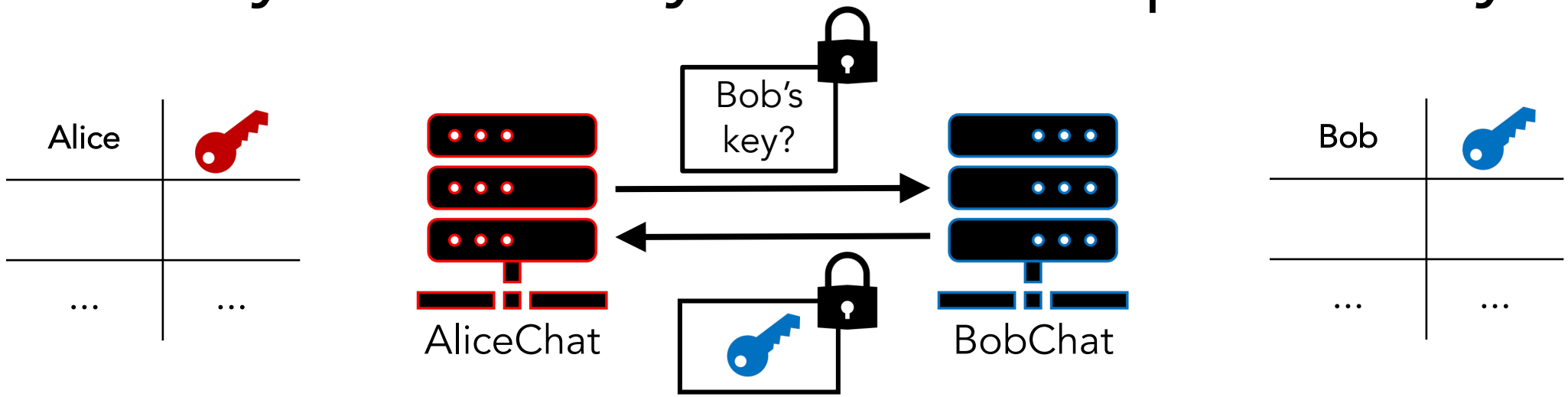


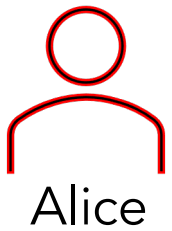
Bob

# Identity Discovery and Interoperability

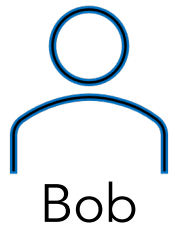


# Identity Discovery and Interoperability

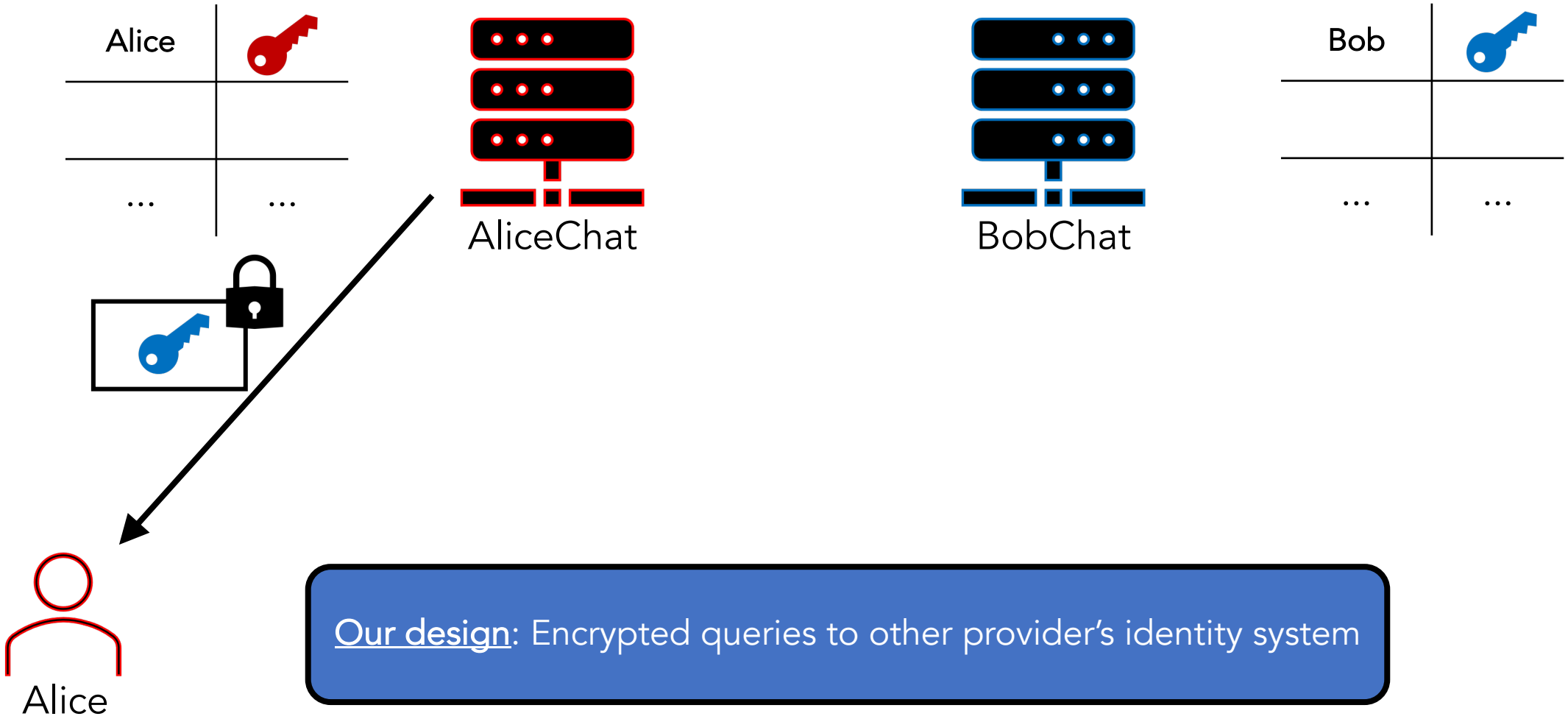


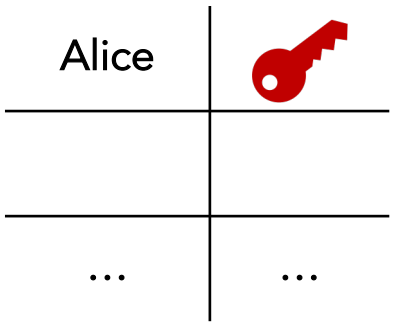

Our design: Encrypted queries to other provider's identity system

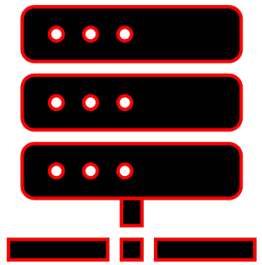


# Identity Discovery and Interoperability

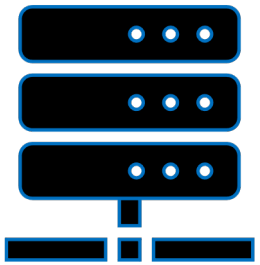


# Identity Discovery and Interoperability

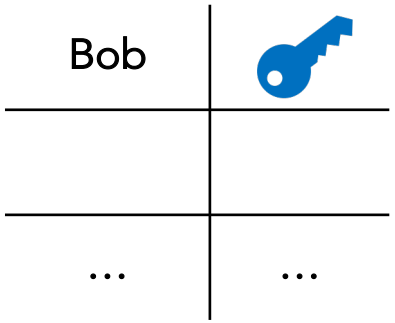


AliceChat

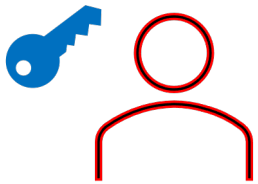


BobChat




**Security Goals**

- AliceChat should not learn Alice is querying for Bob
- BobChat should not learn Alice is the one querying

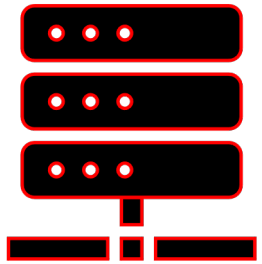


Alice

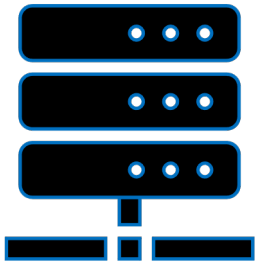
Our design: Encrypted queries to other provider's identity system

Bob

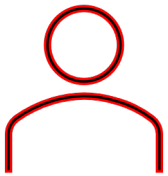
# Protocol-Layer Interoperability (PRO)



AliceChat



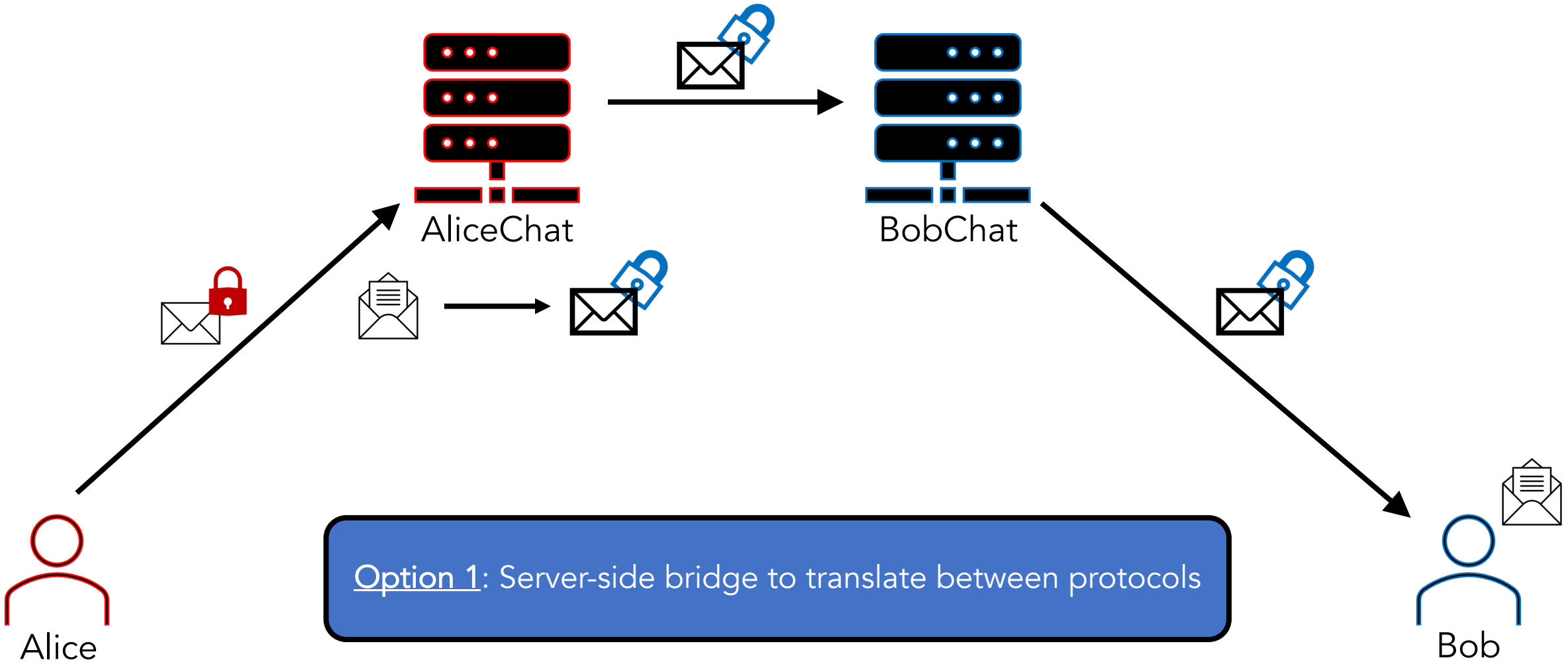
BobChat



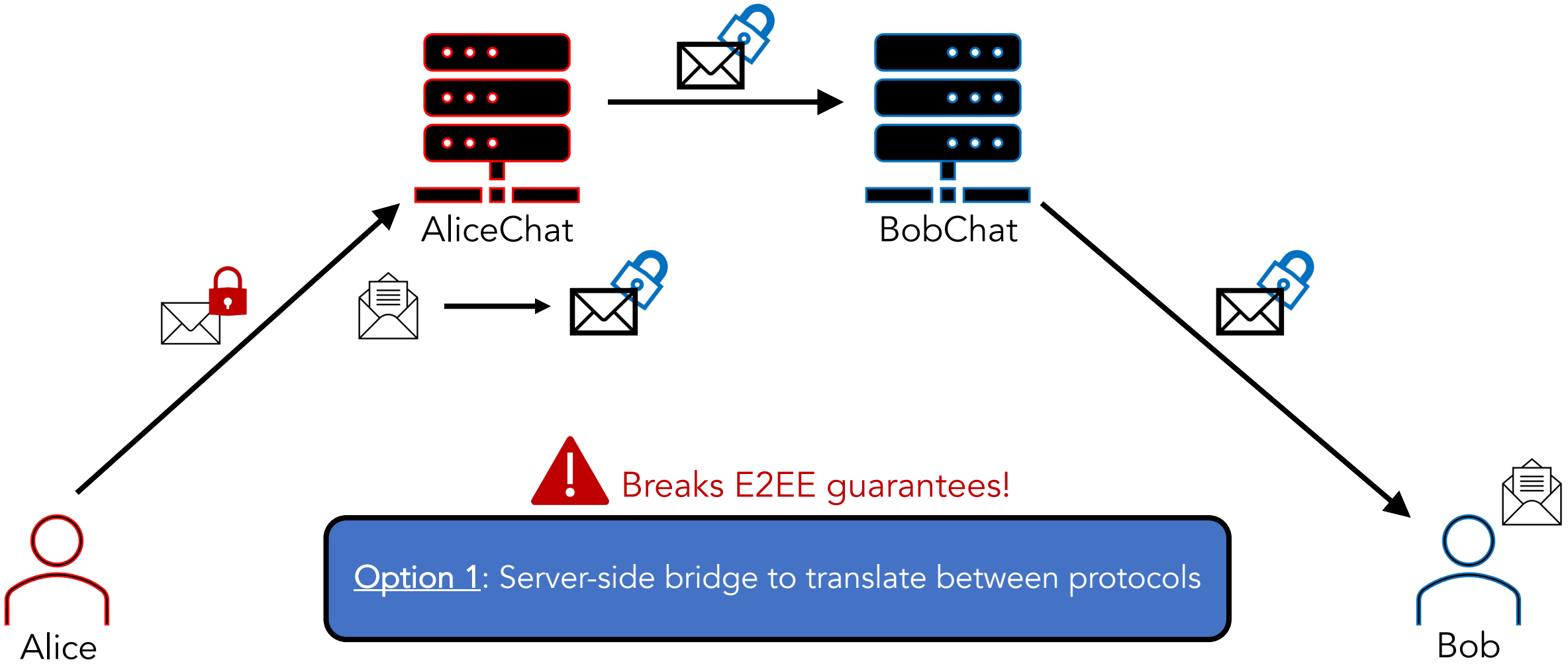
Alice

Bob

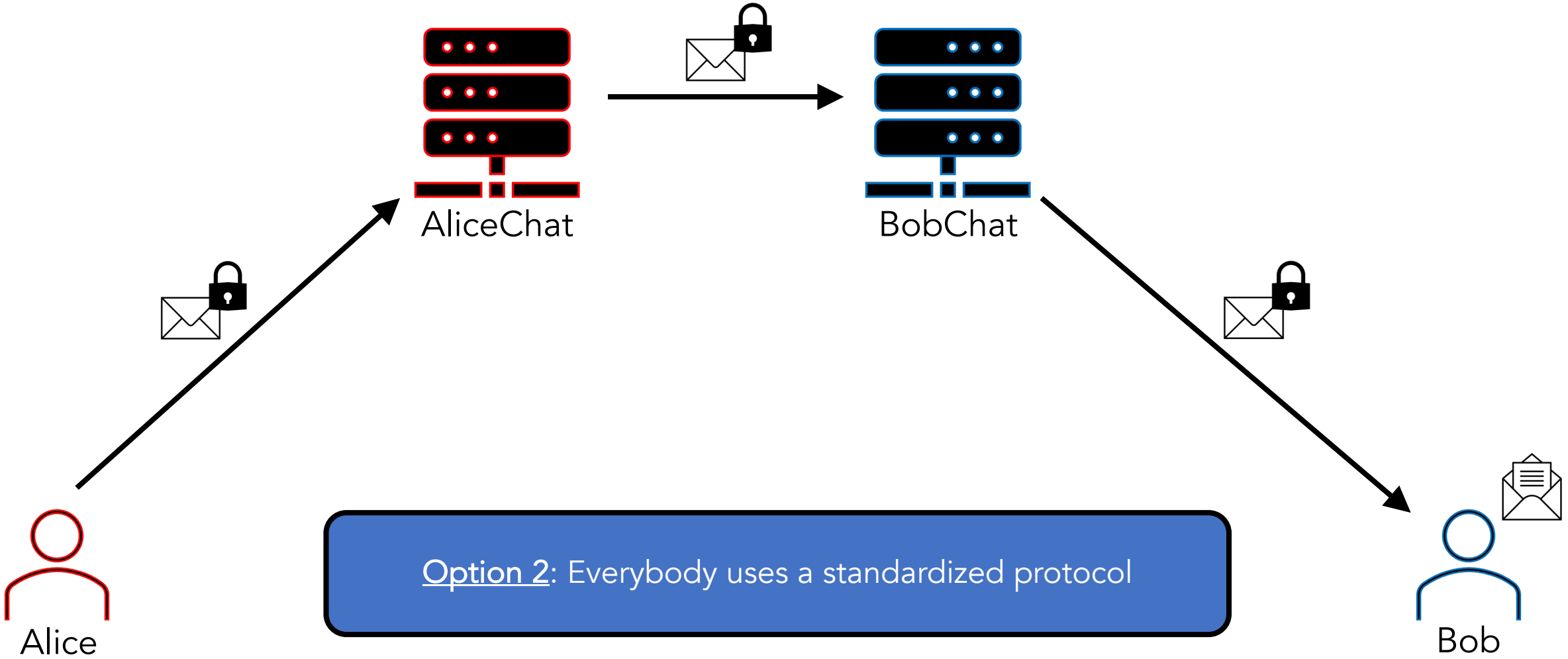
# Protocol-Layer Interoperability (PRO)



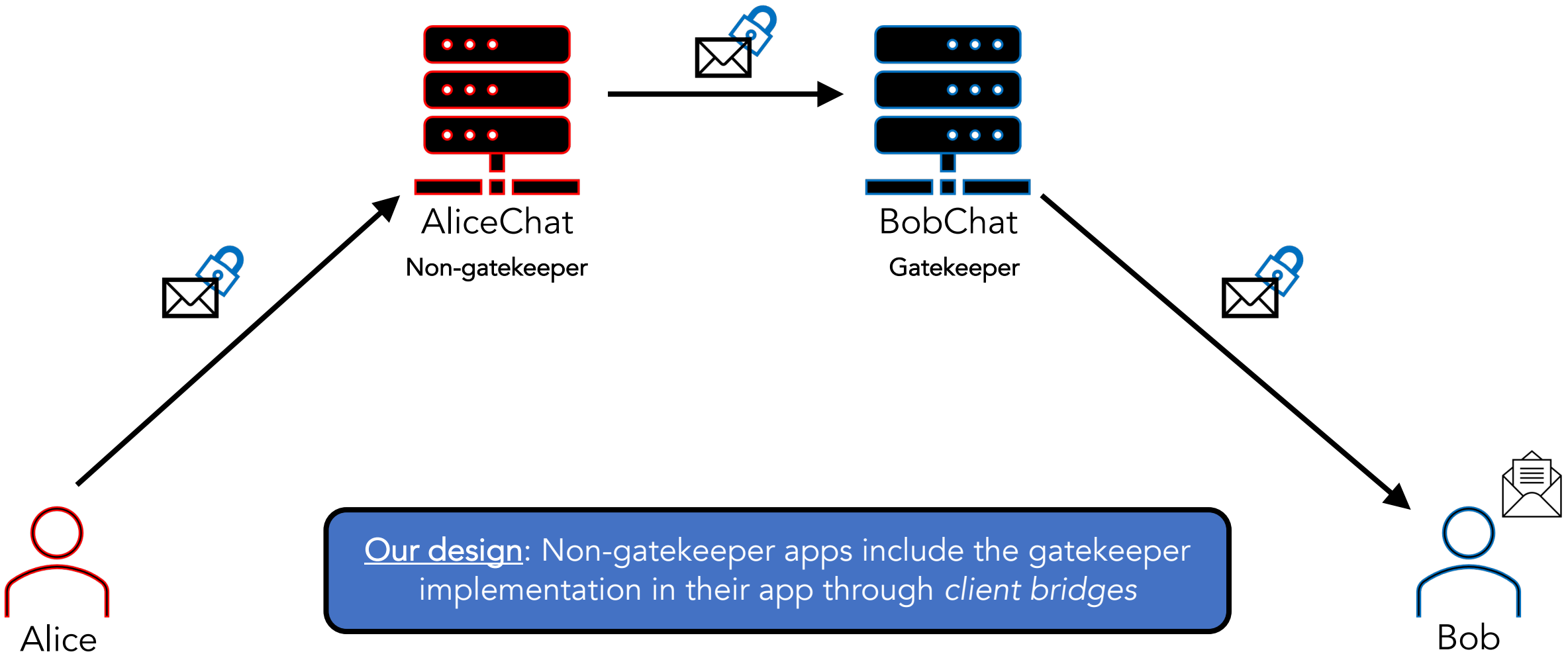
# Protocol-Layer Interoperability (PRO)



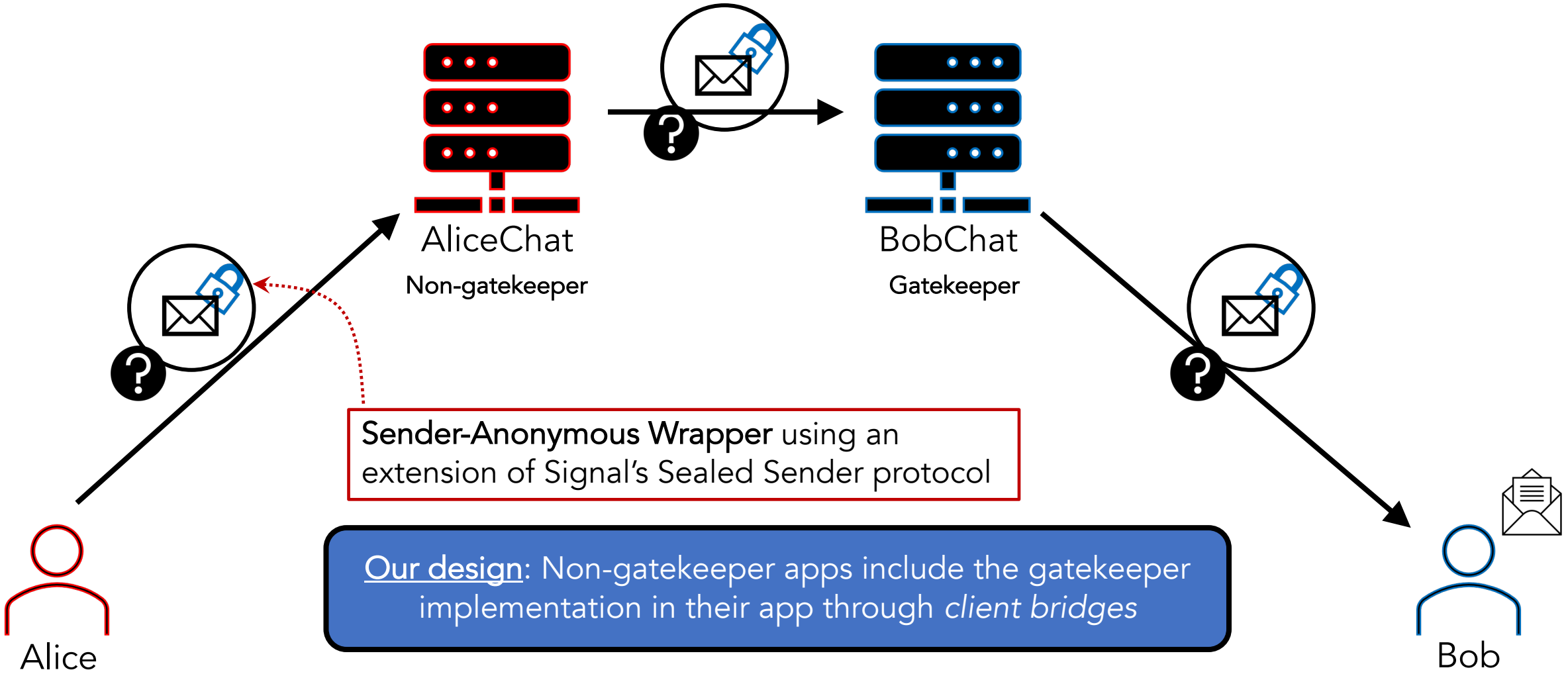
# Protocol-Layer Interoperability (PRO)



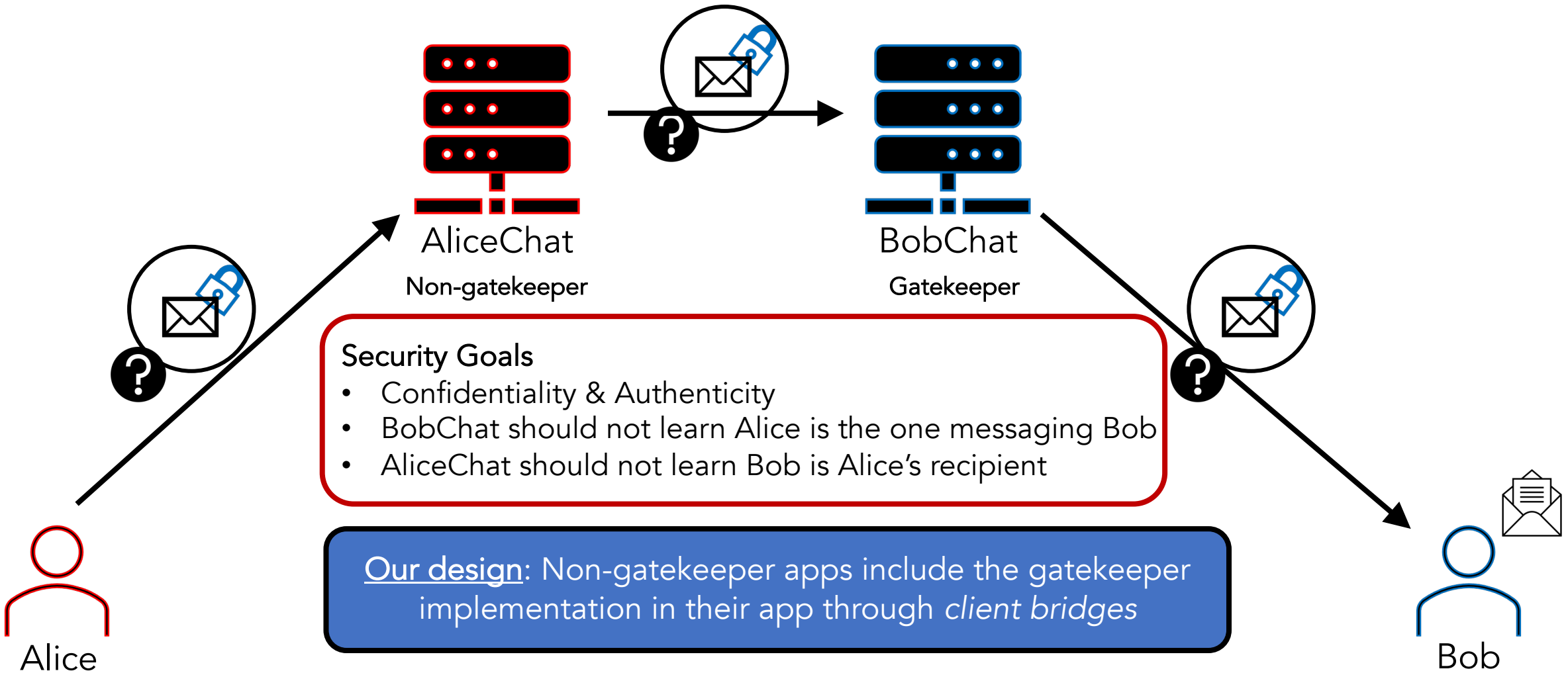
# Protocol-Layer Interoperability (PRO)



# Protocol-Layer Interoperability (PRO)



# Protocol-Layer Interoperability (PRO)

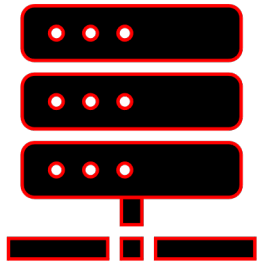



**Security Goals**

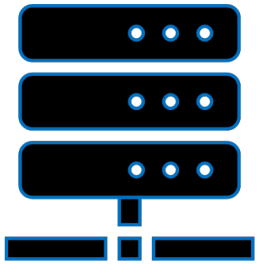
- Confidentiality & Authenticity
- BobChat should not learn Alice is the one messaging Bob
- AliceChat should not learn Bob is Alice's recipient

<u>Our design</u>: Non-gatekeeper apps include the gatekeeper implementation in their app through *client bridges*

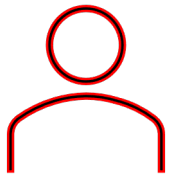
# Abuse Prevention (ABP)



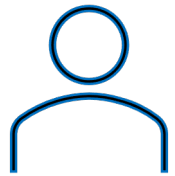
AliceChat



BobChat

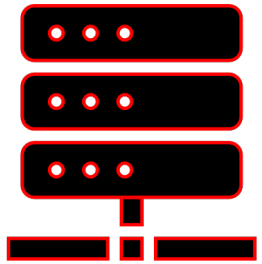


Alice

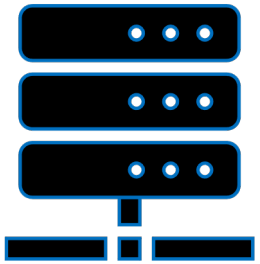


Bob

# Abuse Prevention (ABP)

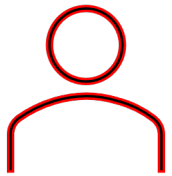


AliceChat



BobChat

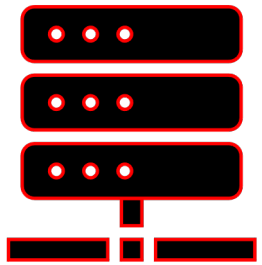
<u>Option 1</u>: Don’t address it



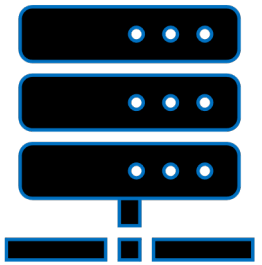
Alice

Bob

# Abuse Prevention (ABP)



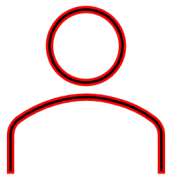
AliceChat



BobChat

Bad for privacy!

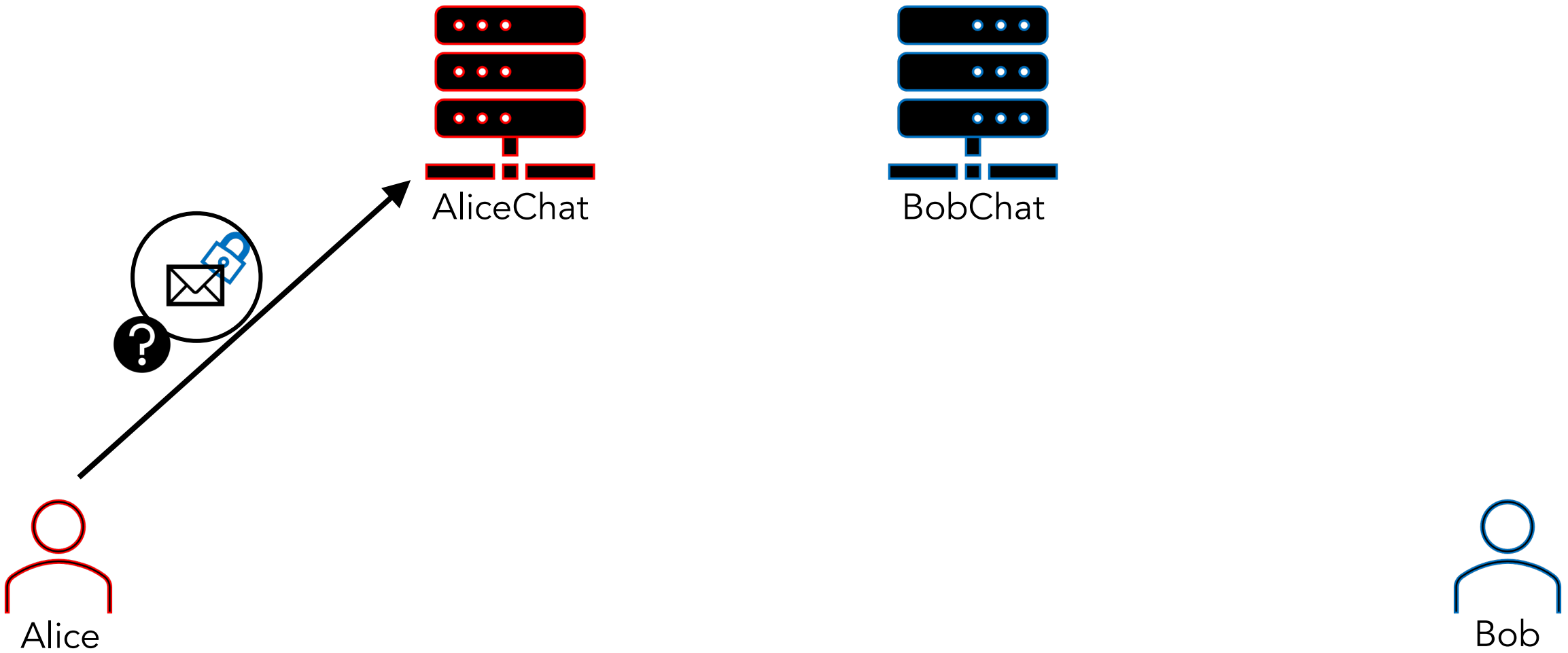
<u>Option 2</u>: Give BobChat all the metadata about senders from AliceChat.



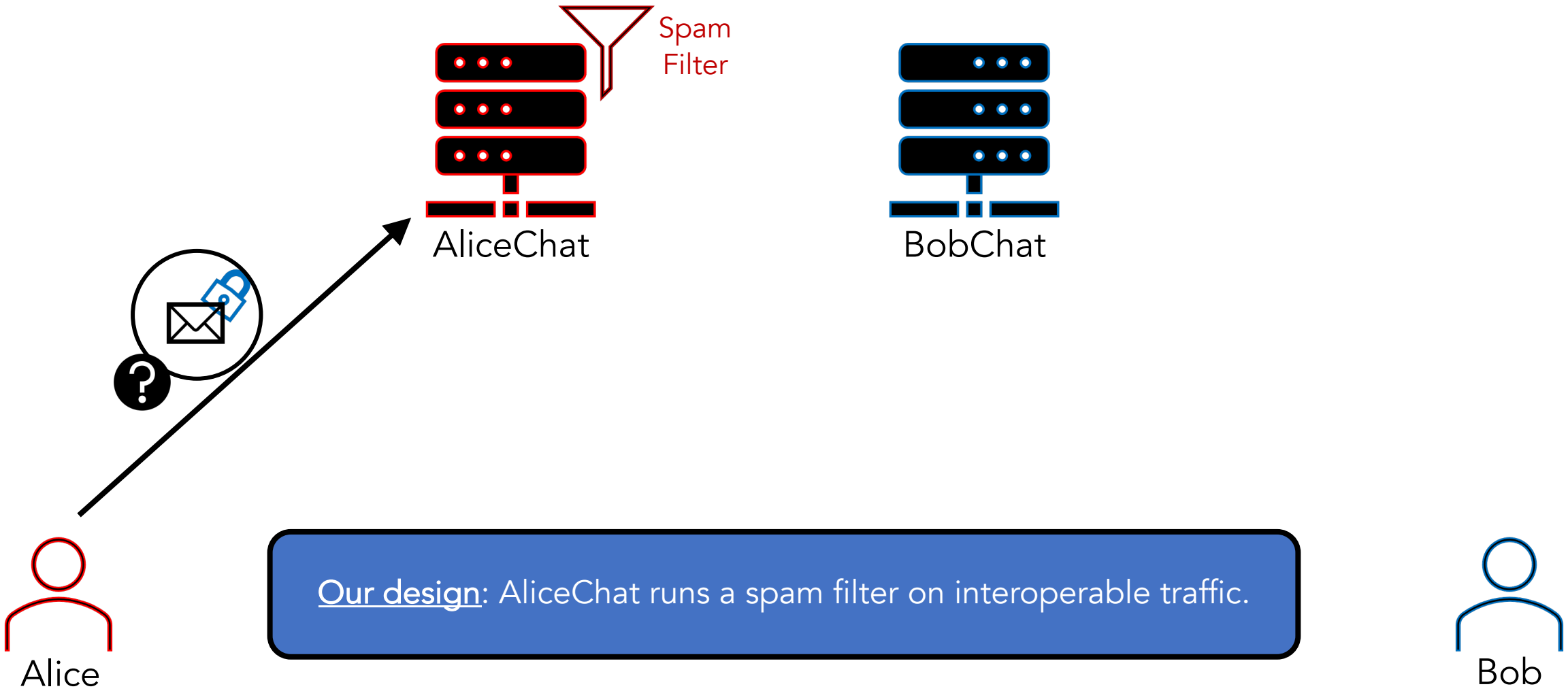
Alice

Bob

# Abuse Prevention (ABP): Spam Filtering

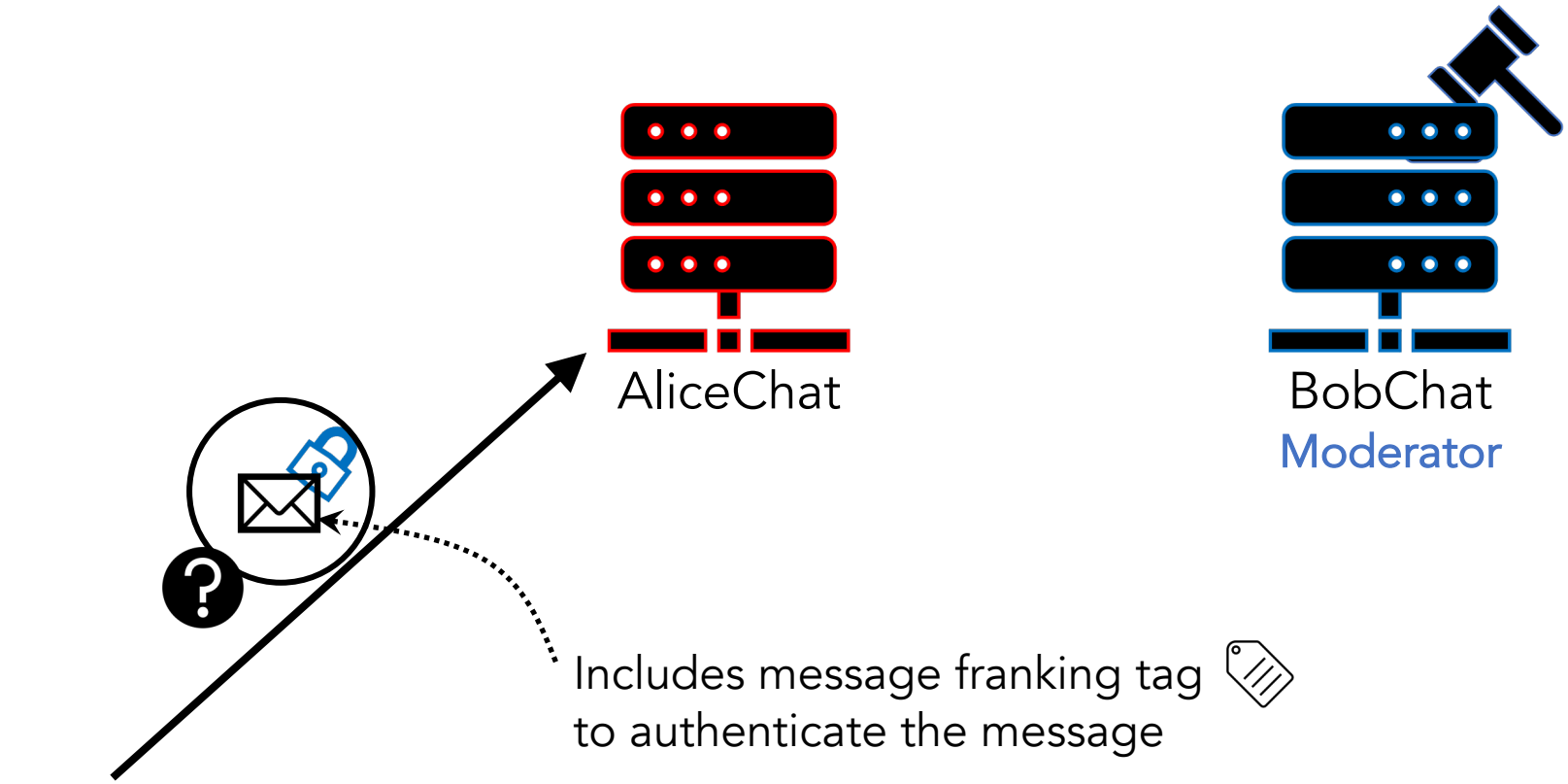


# Abuse Prevention (ABP): Spam Filtering




Our design: AliceChat runs a spam filter on interoperable traffic.

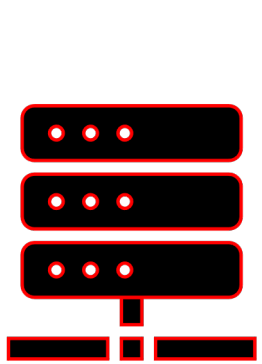
# Abuse Prevention (ABP): User Reporting



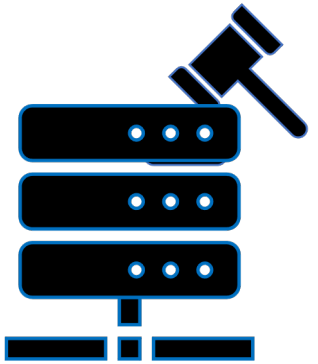

Our design: Use an *Asymmetric Message Franking* [TGLMR19] scheme to enable secure metadata-private moderation.

Nirvan Tyagi, Paul Grubbs, Julia Len, Ian Miers, and Thomas Ristenpart. Asymmetric Message Franking: Content Moderation for Metadata-Private End-to-End Encryption. CRYPTO 2019.

# Abuse Prevention (ABP): User Reporting

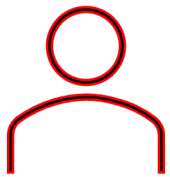


AliceChat



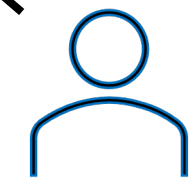
BobChat
Moderator


Sent by Alice



Alice

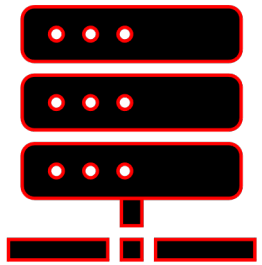
**Our design**: Use an *Asymmetric Message Franking* [TGLMR19] scheme to enable secure metadata-private moderation.



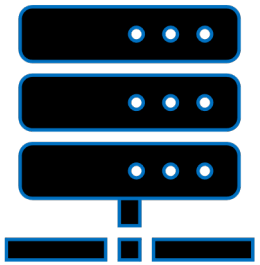
Bob

Nirvan Tyagi, Paul Grubbs, Julia Len, Ian Miers, and Thomas Ristenpart. Asymmetric Message Franking: Content Moderation for Metadata-Private End-to-End Encryption. CRYPTO 2019.

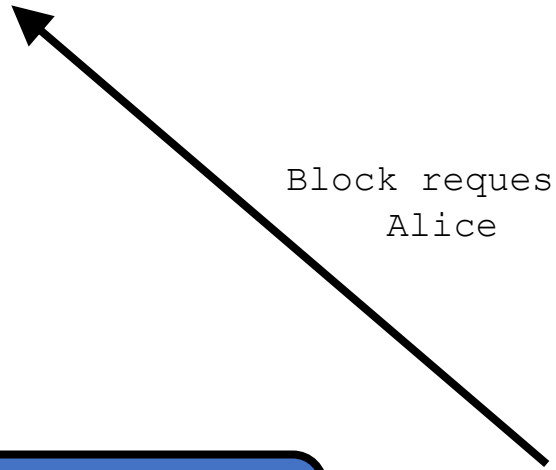
# Abuse Prevention (ABP): Blocklisting

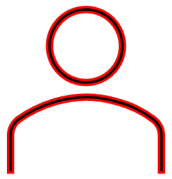


AliceChat



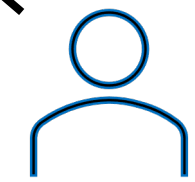
BobChat



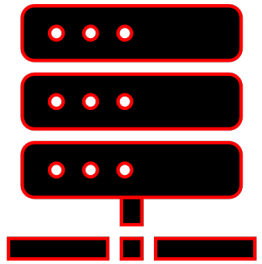
Alice

<u>Our design</u>: Bob reveals Alice's user id to BobChat and BobChat knows the identity of those wanting to initiate communication.

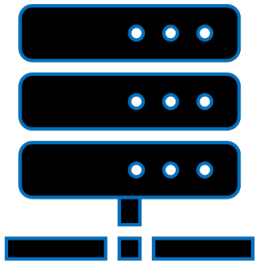


Bob

# Abuse Prevention (ABP)



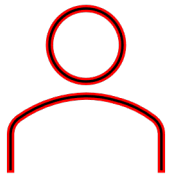
AliceChat



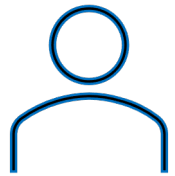
BobChat

**Security Goals**

- Verifiable user reporting
- Minimize metadata leakage



Alice



Bob

# Our Goals

*Given the DMA and its timeline, how can the existing components of widely used E2EE apps be extended to be interoperable?*

Overview of the Digital Markets Act (DMA) interoperability requirements

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1) Identity systems
2) E2EE protocols
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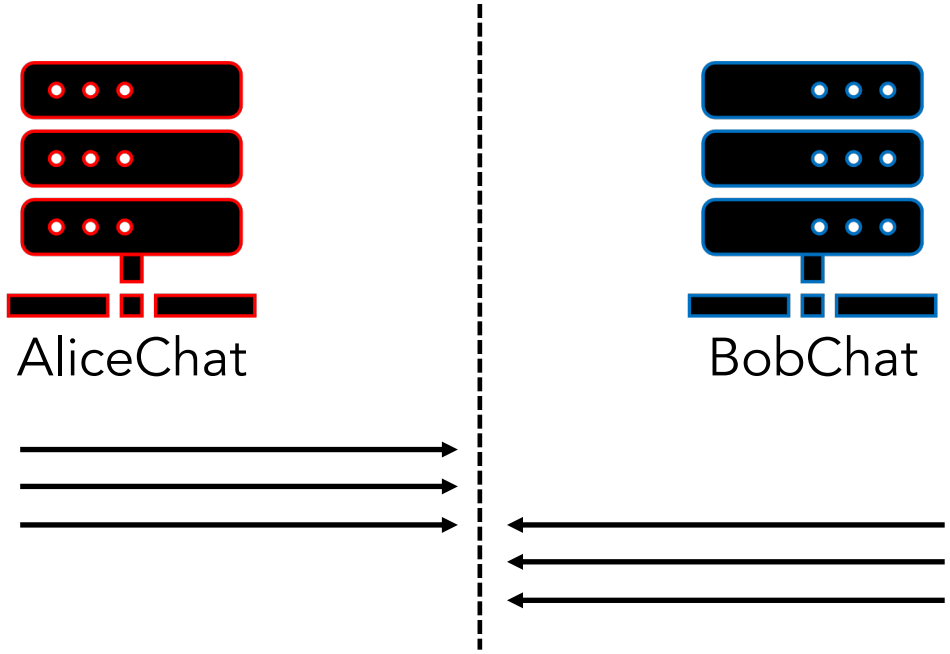
# Open Problems in Interoperable E2EE

- How do we improve the privacy of interoperable E2EE by reducing metadata leakage?
- How do we extend other protocols used in E2EE messaging, like key transparency, into the interoperability setting?
- How do we extend our framework and analyses to group chats and encrypted calls?

# Conclusion: This is an Opportunity

https://ia.cr/2023/386




**Free privacy win from our server-to-server architecture!**

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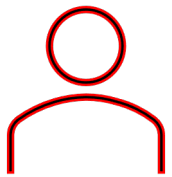
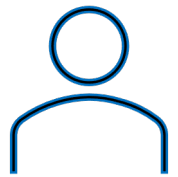
- Better privacy than in Signal's Sealed Sender (which does not hide network-level metadata)



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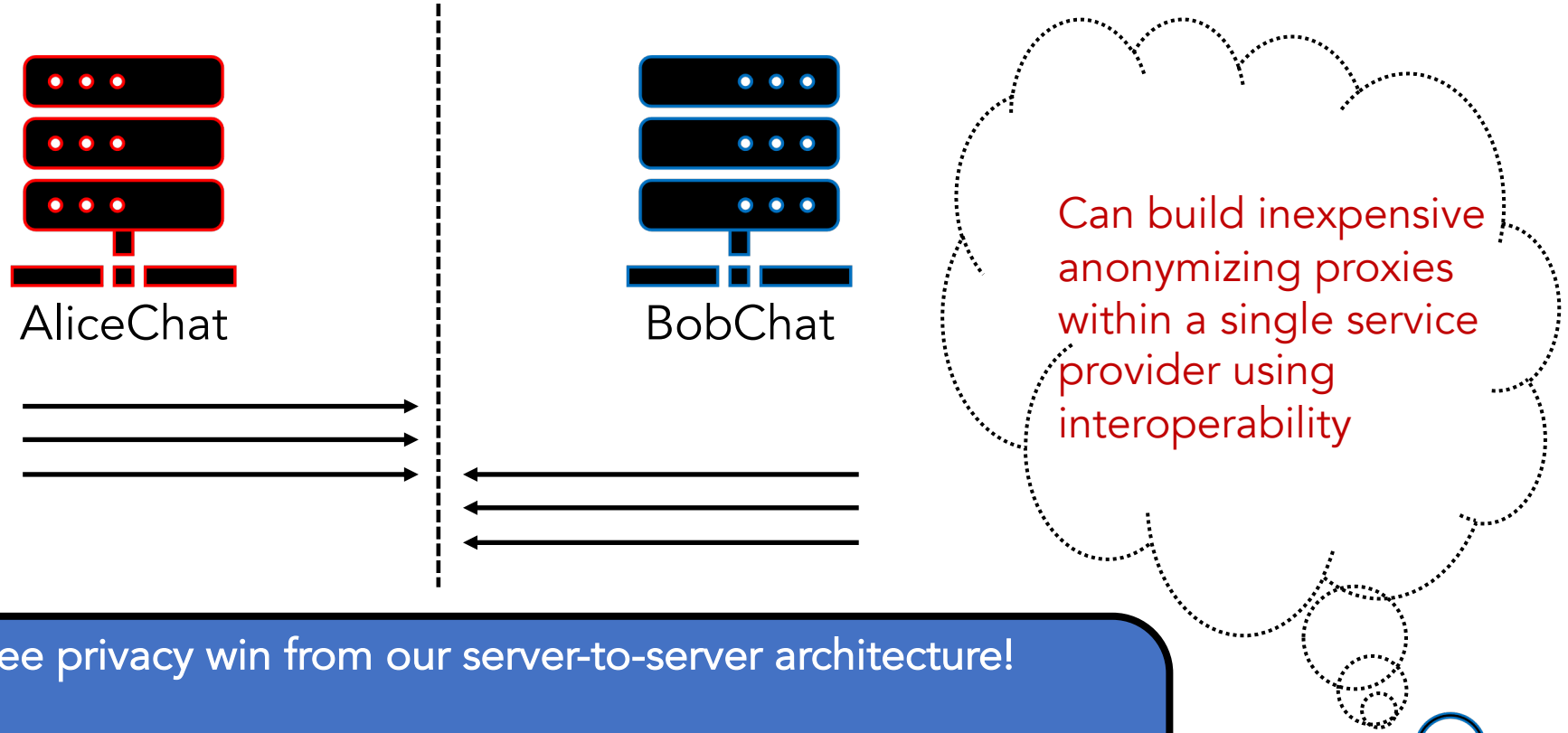


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