



# Interledger

A Payment Protocol Inspired by IP

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# Agenda

1. Project Background
2. Ledgers and the Problem with Payments Today
3. Interledger Packet and Protocol Flow
4. Addressing and Routing

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# Project Background

- Interledger Whitepaper & Implementation Published in October 2015
- Established W3C Community Group (190+ participants)  
**public-interledger@w3.org** mailing list, **#interledger** on **irc.w3.org**
- Community Workshops Held in San Francisco and London
- First Real Money Payment @ London Workshop

# Business Adoption (Early Days)

- Ripple Integrating Into Core Product for Banks
- BigchainDB Integrating Into Blockchain
- Gatehub and Bitstamp Integrating Cryptocurrency Exchanges
- Interest From Central Banks, Banks, Payment Service Providers, Blockchain Companies, Foundations Seeking Payment Interoperability
- Interest From Protocol and Platform Developers Seeking to Incorporate Micropayments

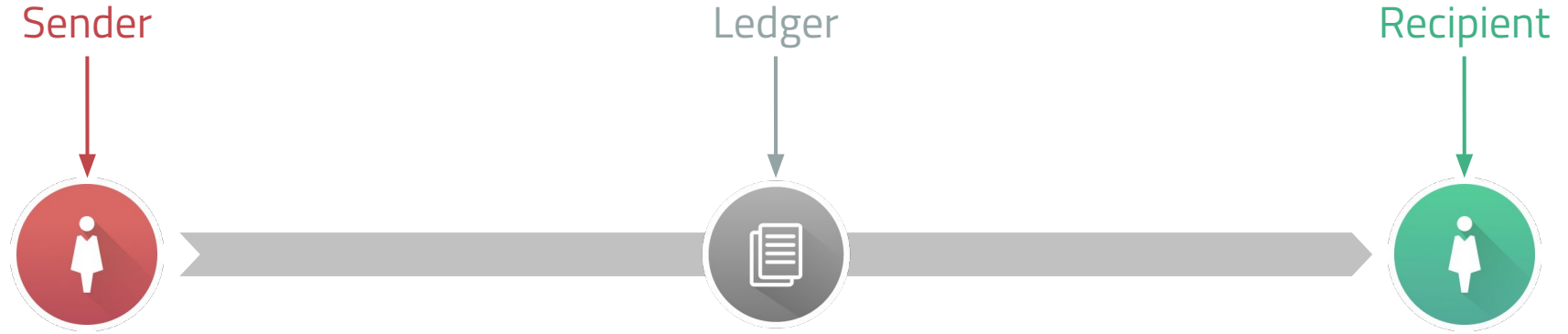
# IP and Project Resources

- Nonprofit Foundation Being Chartered in Luxembourg to Hold IP, Patents on Interledger To Be Used Only For Defensive Purposes
- IP Will Be Available Royalty-Free
- Community Resources Hosted on [interledger.org](https://interledger.org)
- Specs, Code, Issues on GitHub: [github.com/interledger](https://github.com/interledger)  
(Includes Working Reference Implementation)

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# Ledgers Track Accounts and Balances

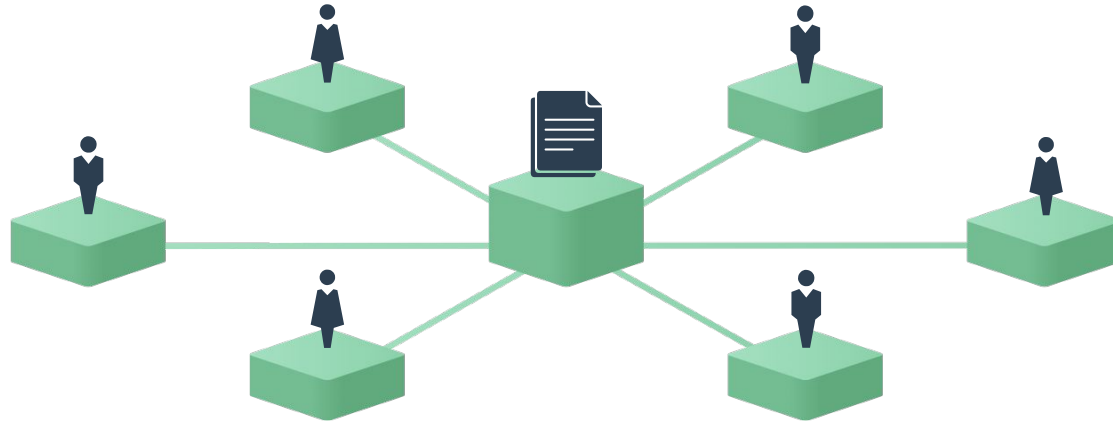




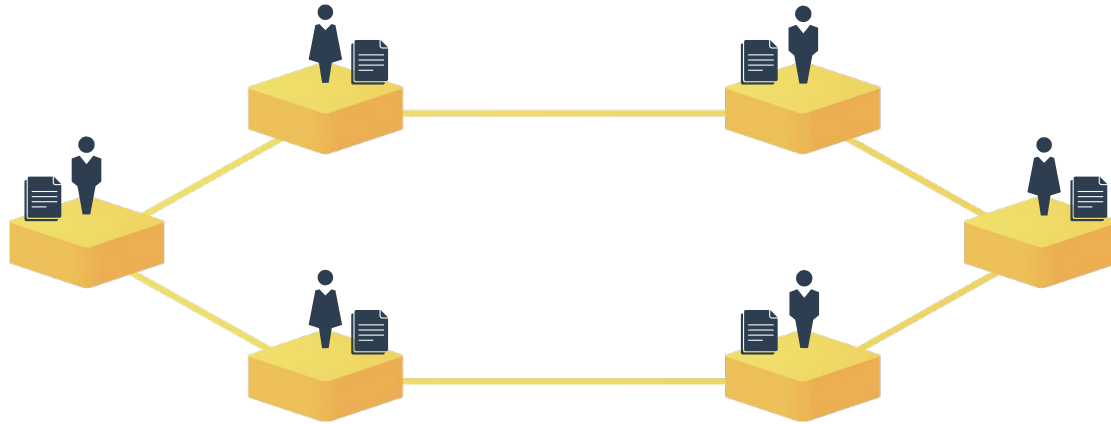
# Payments Are All About **Ledgers**



# Central Ledger Model



# Distributed Ledger Model

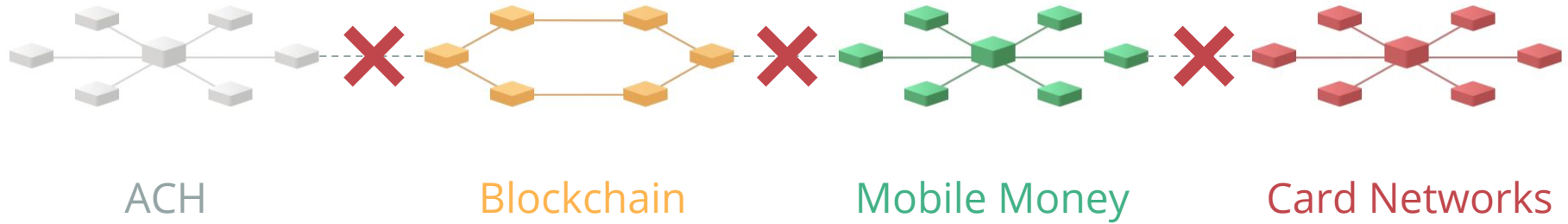






The World Will **Never Agree**  
On One Ledger

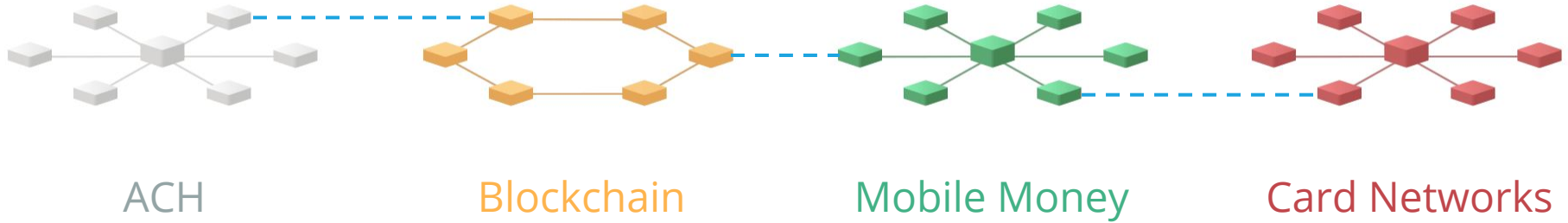
# The Problem: Payment Networks are Disconnected



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# We Need a Protocol for Payments Across Payment Networks



# The Interledger Protocol (ILP)

**Interledger is a suite of protocols for transferring digital assets between accounts on different ledgers.**

Interledger provides:

- A standard for addressing digital asset ledgers and accounts
- A protocol for orchestrating transfers on independent ledgers to facilitate secure multi-hop payments



## Interledger In One Slide

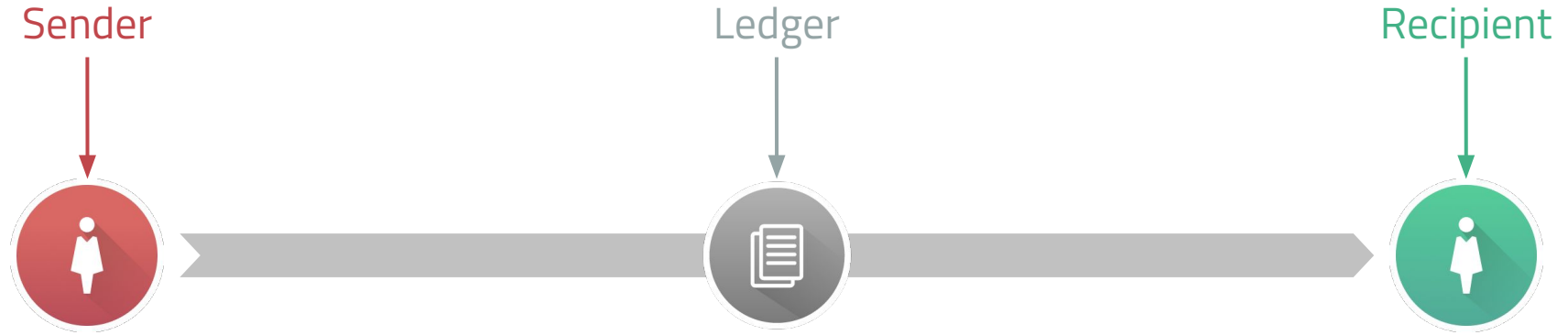
address: "us.wf.bob"

amount: "1023.20"

expiry: "2016-07-06T09:00:10Z"

condition: "cc:0:3:4a7DEpj8f9..."

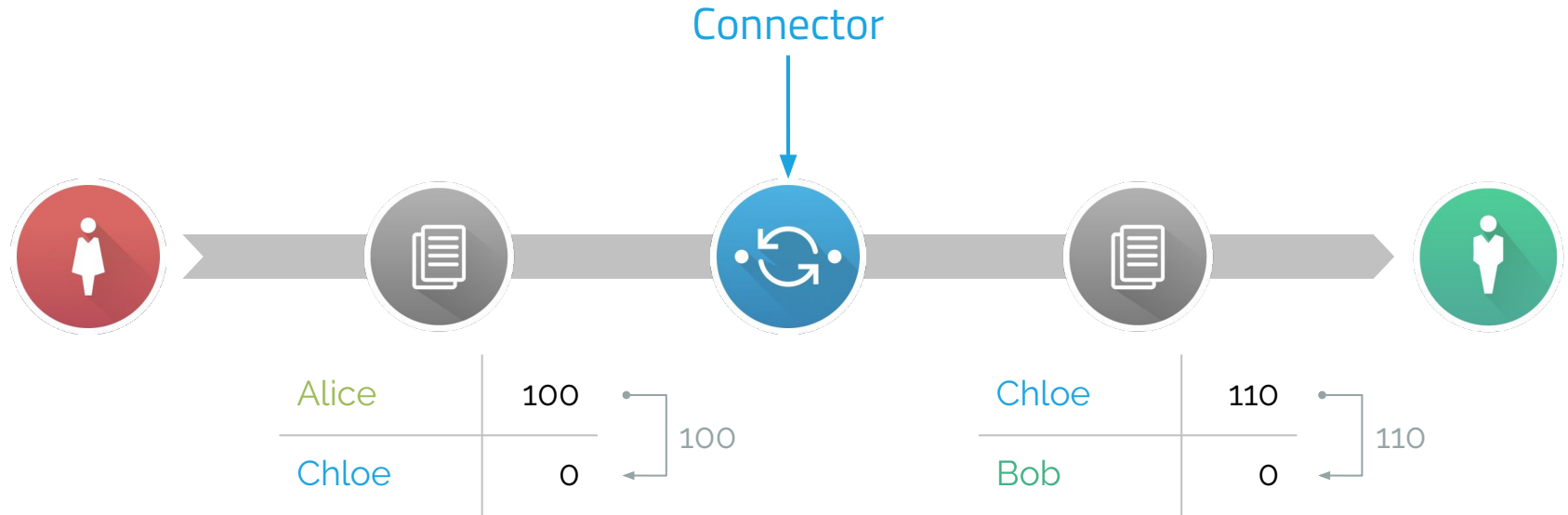
# Ledgers Track Accounts and Balances



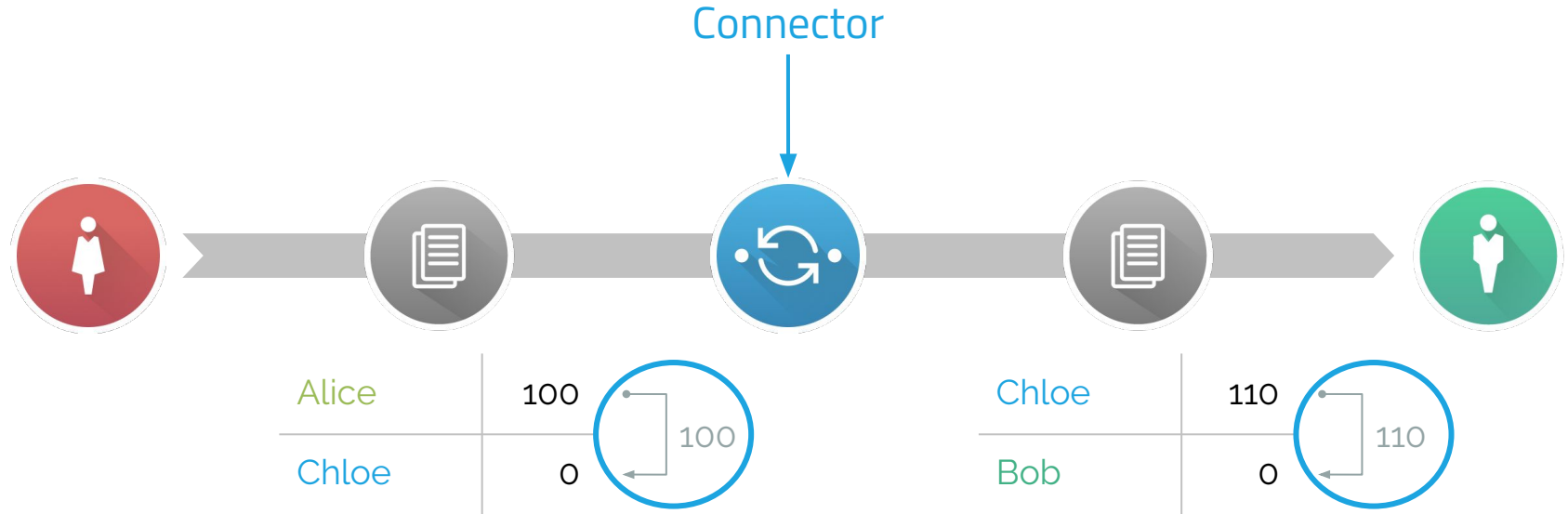
# But Not Everyone Is on the Same Ledger



# Connectors Relay Money



# Connectors Convert Currencies



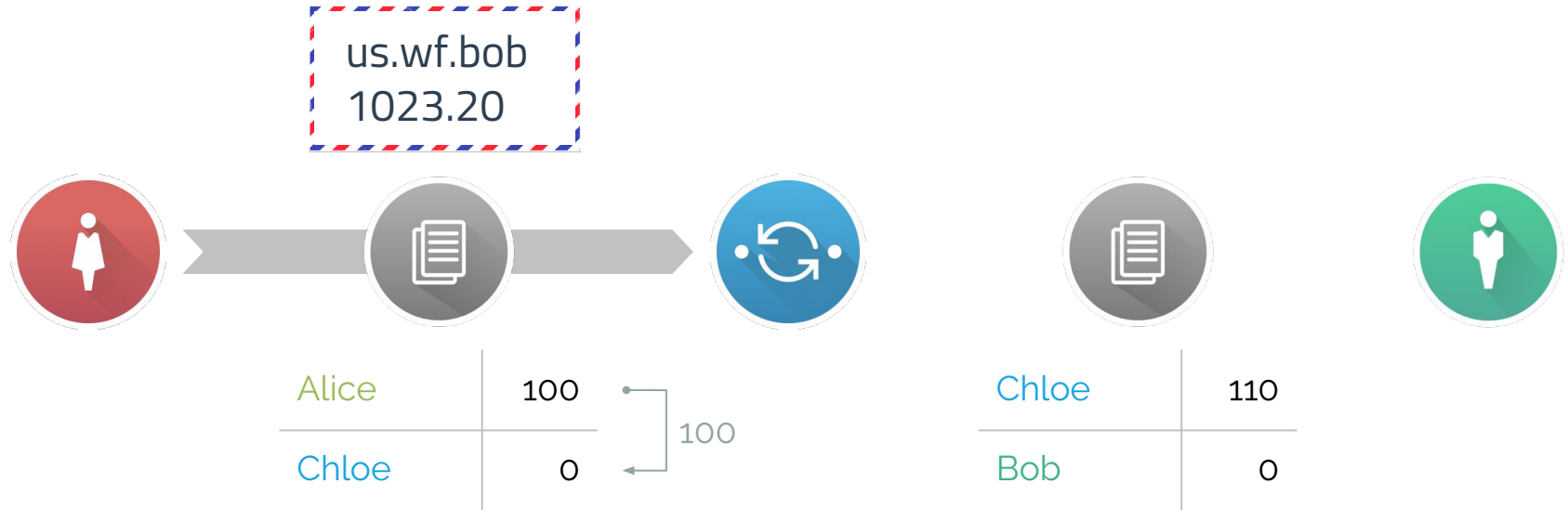
# ILP Packet Instructs Connectors

address: "us.wf.bob" ← Hierarchical identifier

amount: "1023.20" ← Decimal amount

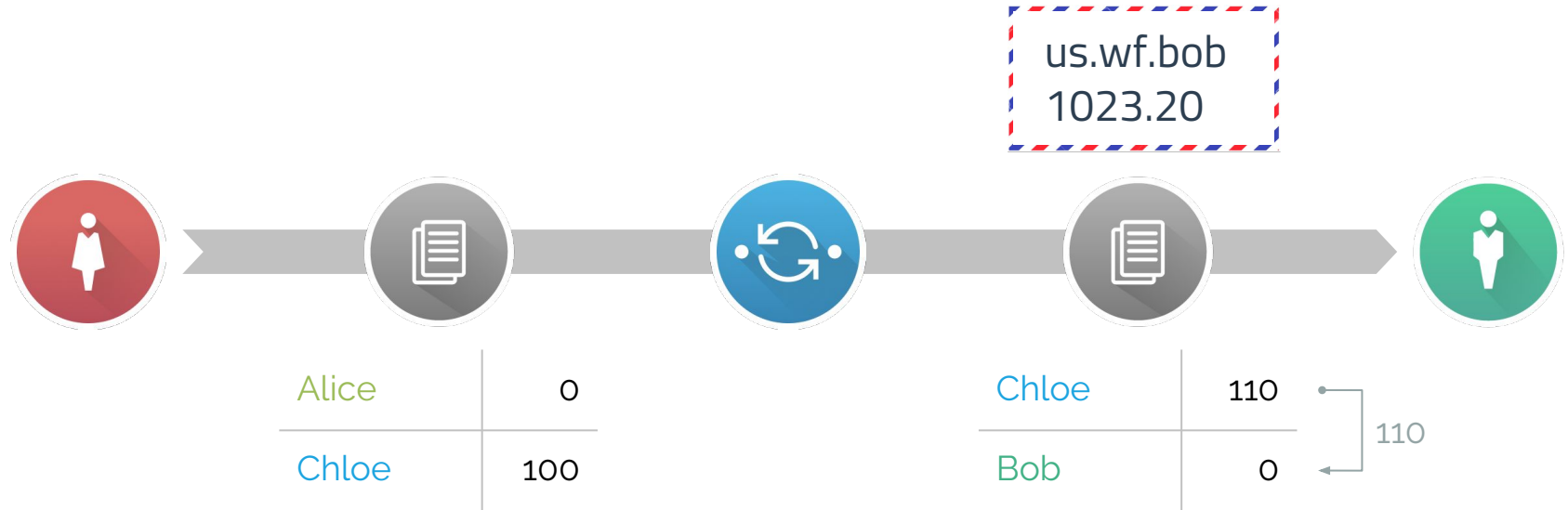


# Sender Attaches Packet to Local Transfer





# Connector Forwards the Packet via Another Transfer



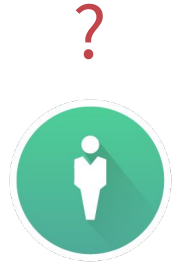
# If Connectors Fail, Would We Lose Money?



Alice	100	100
Chloe	0	

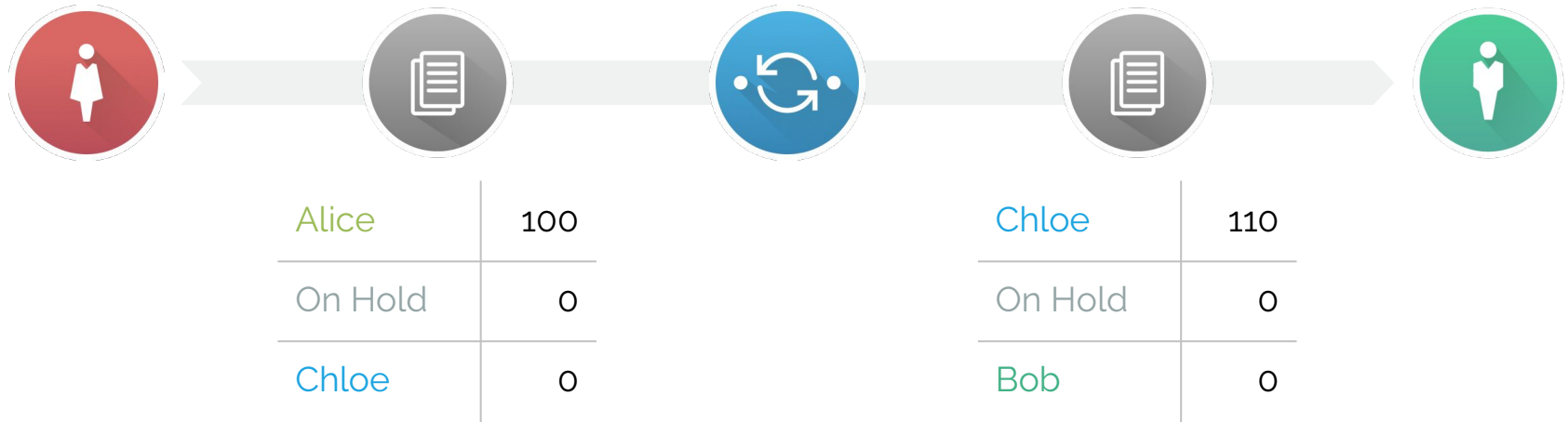


Chloe	110	?
Bob	0	

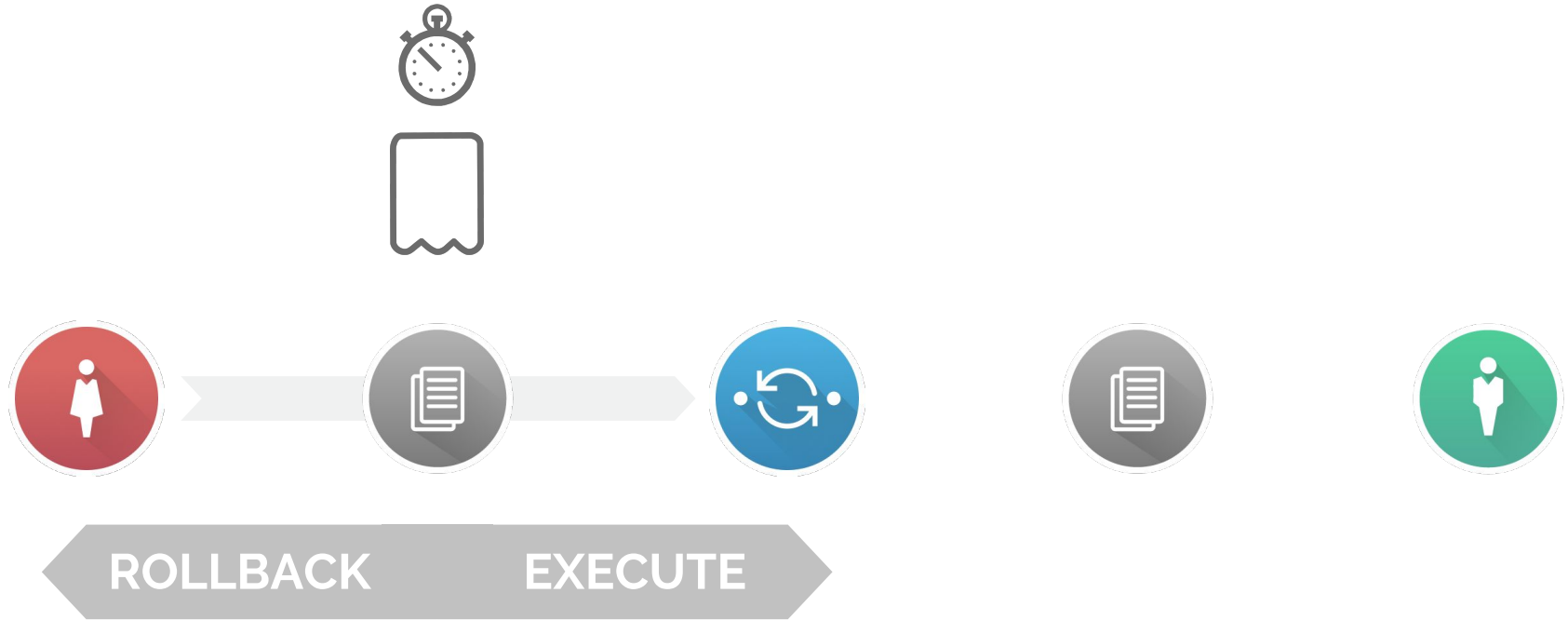


# **Holds** Provide Security

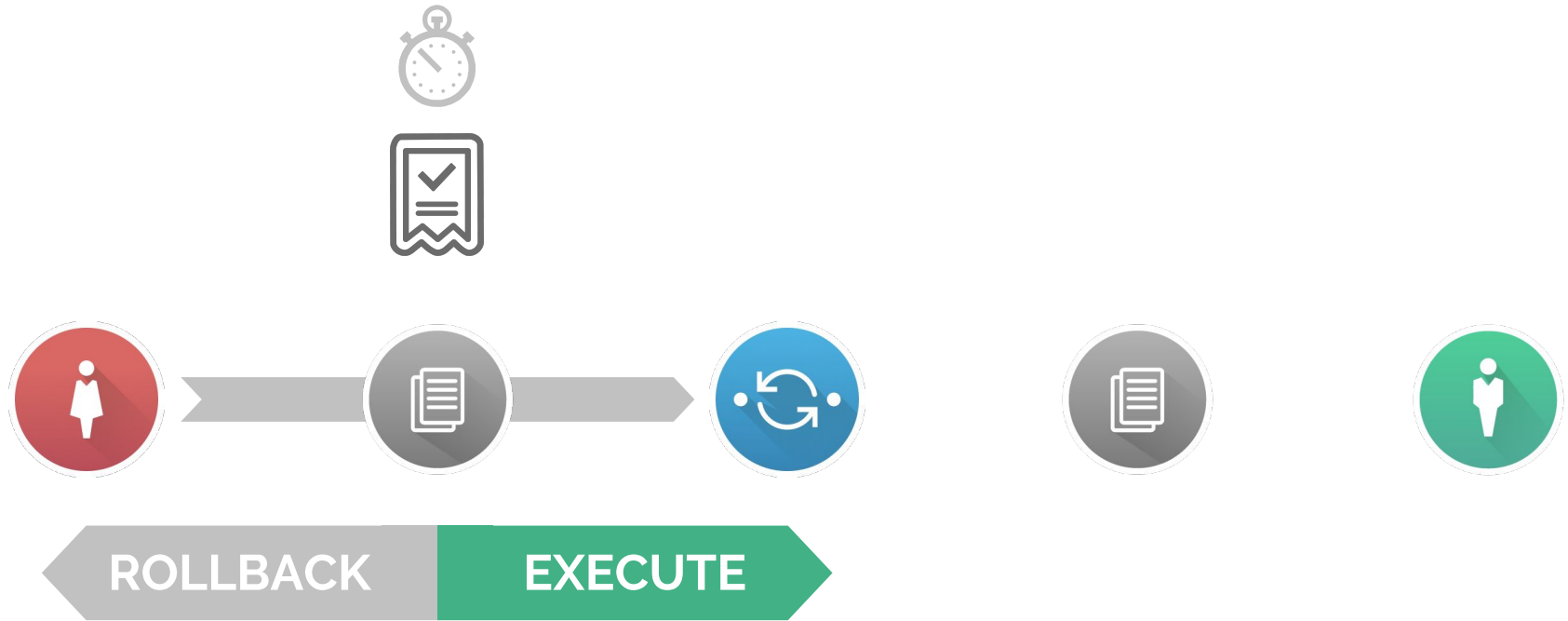
# Ledgers Provide Hold Functionality



# Holds Are Dependent on Conditions + Expiries



# Condition Fulfillment Executes Transfer



# Timeouts Cause Funds to Be Returned



**ROLLBACK**

**EXECUTE**

## The Interledger Packet Includes Details for Holds

address: "us.wf.bob"

amount: "1023.20"  Timestamp (ISO 8601)

expiry: "2016-07-06T09:00:10Z"

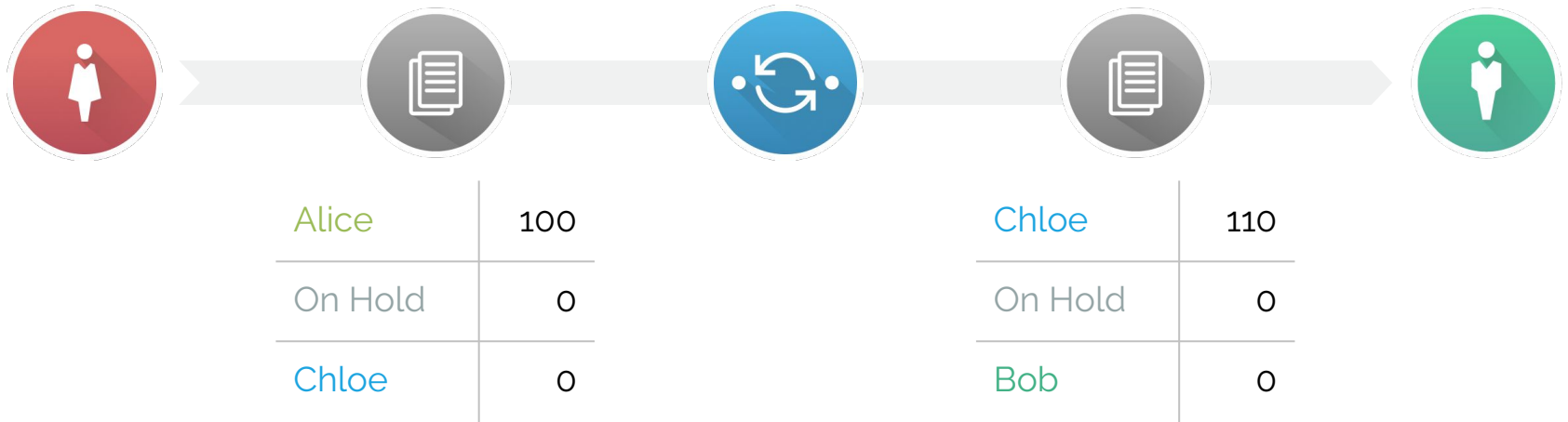
condition: "cc:0:3:4a7DEpj8f9..." 

Crypto Condition

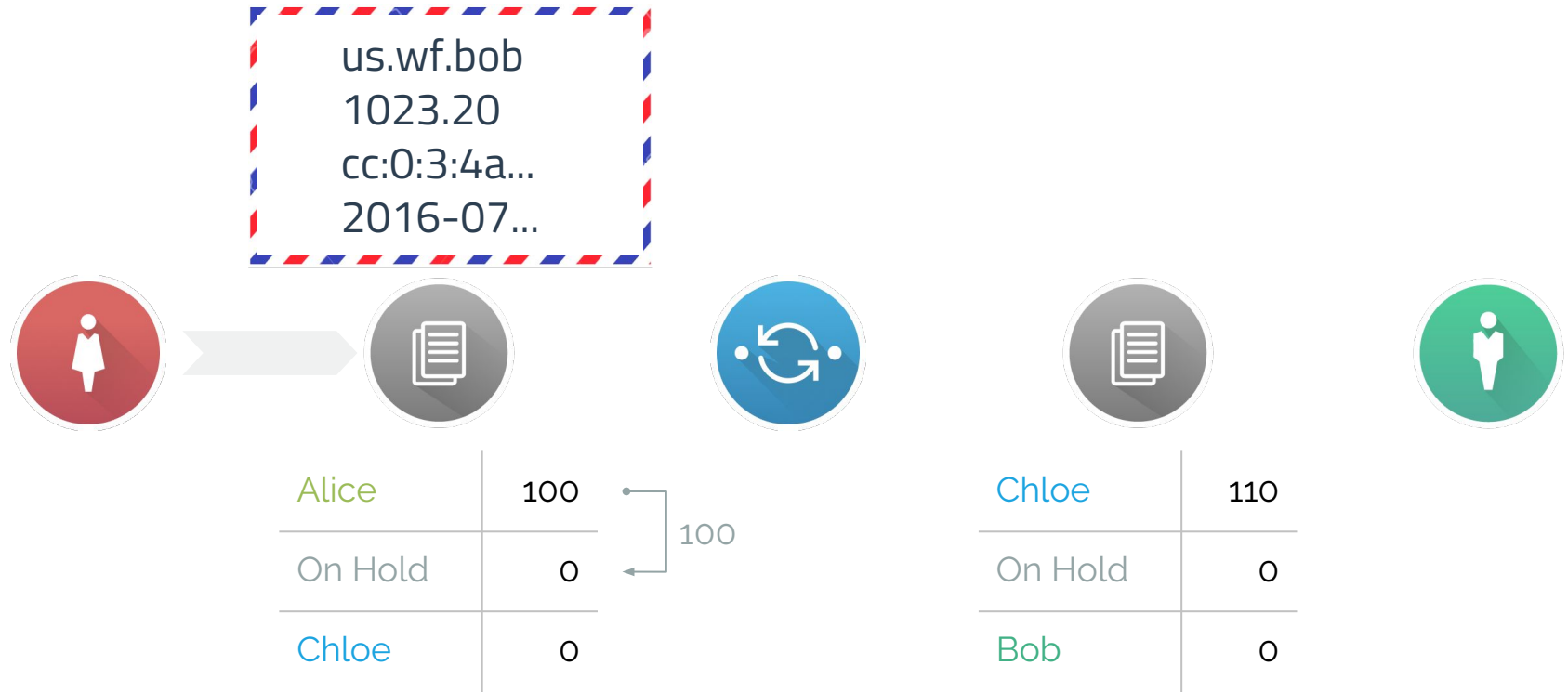


# Funds Are Committed From Left to Right

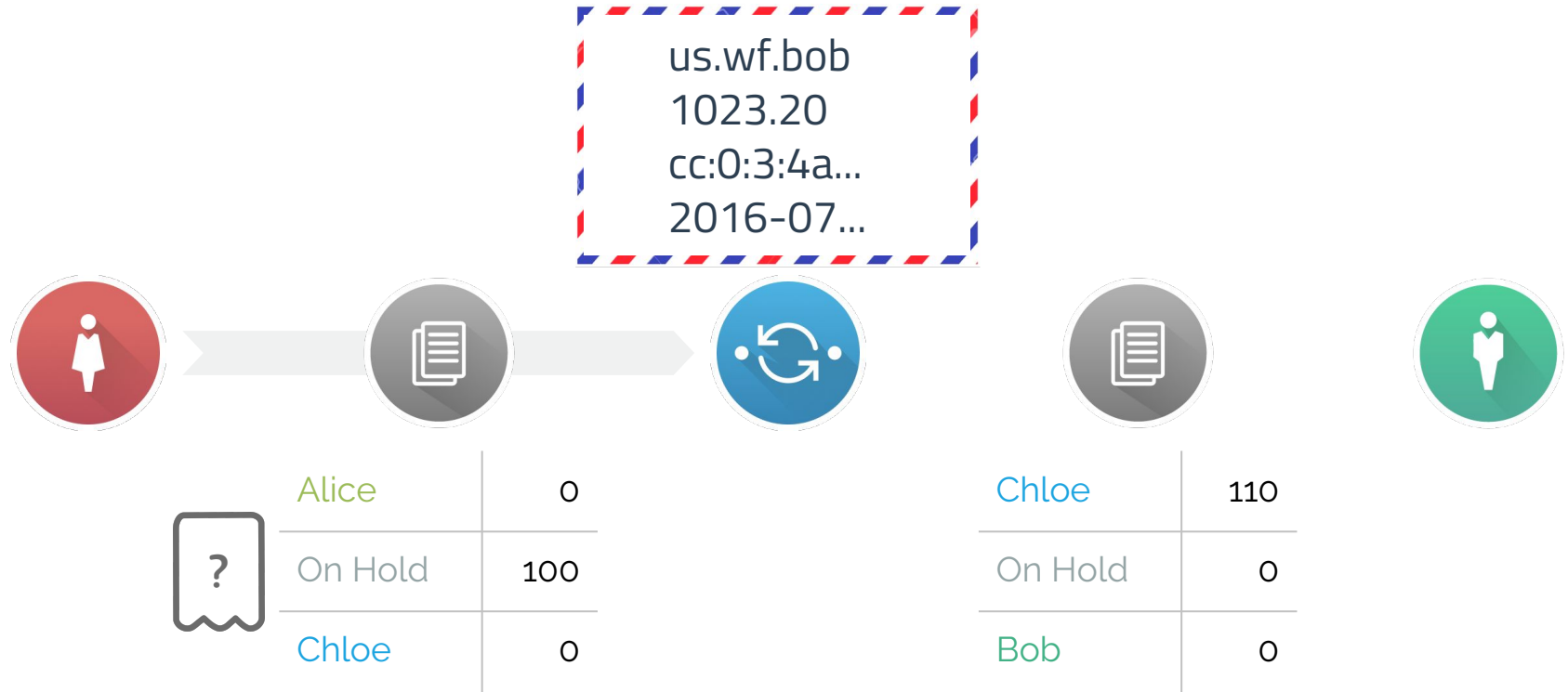
## COMMITMENT



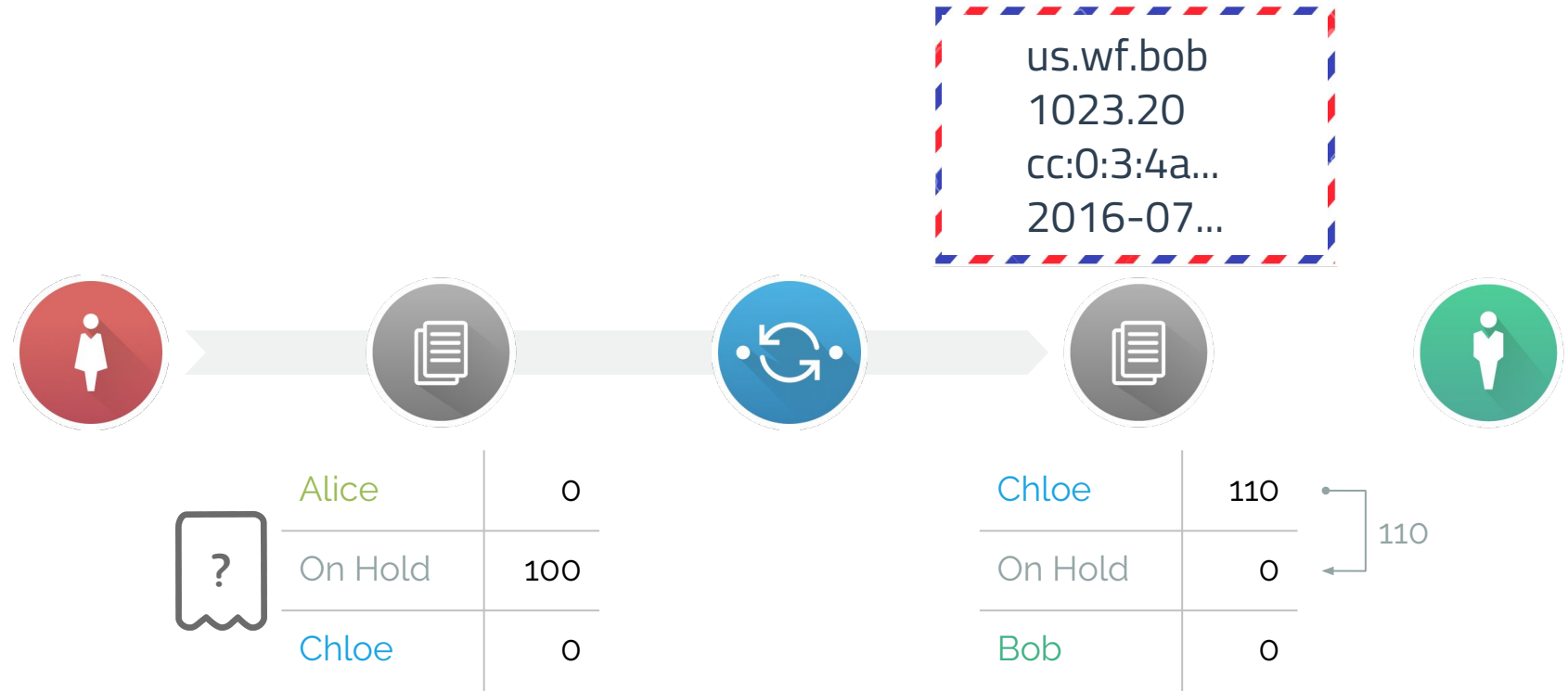
# Sender Puts Funds On Hold



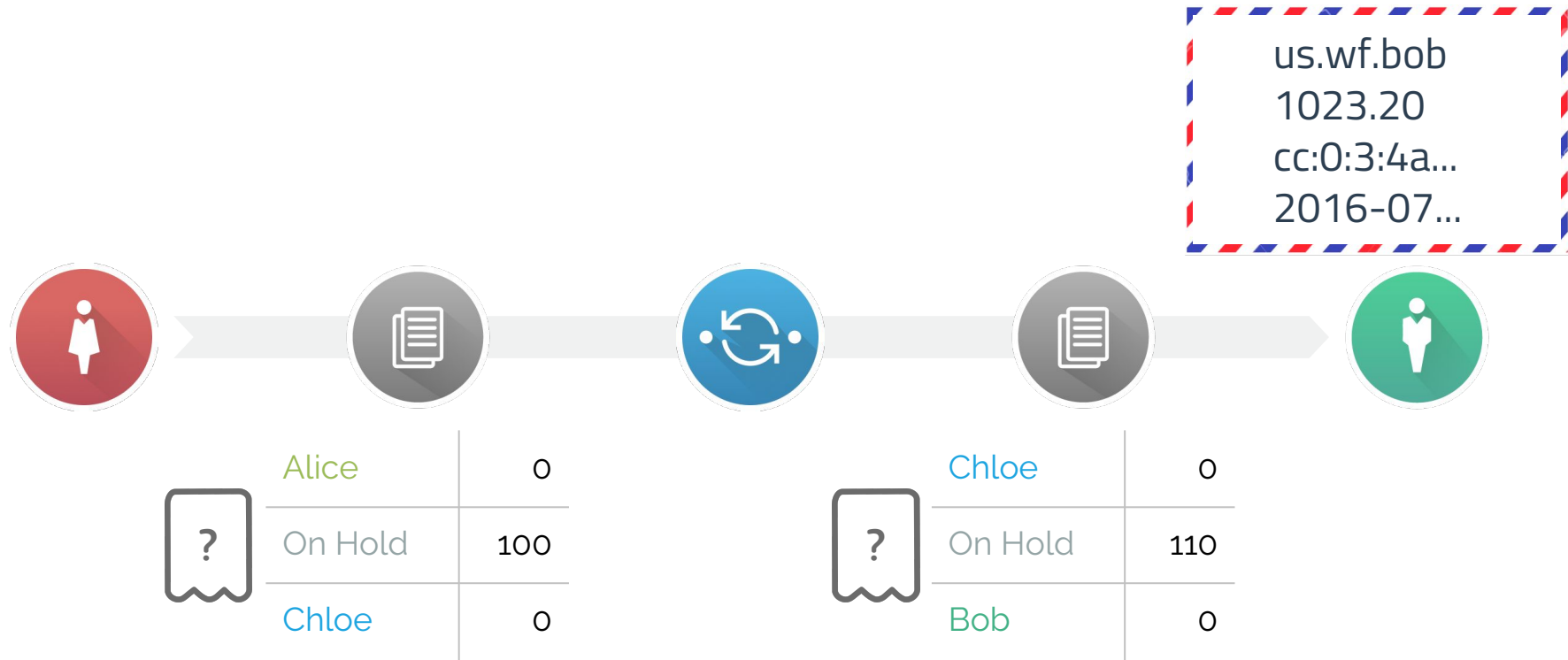
# Connector Gets Notification of Funds on Hold



# Connector Puts Funds on Hold



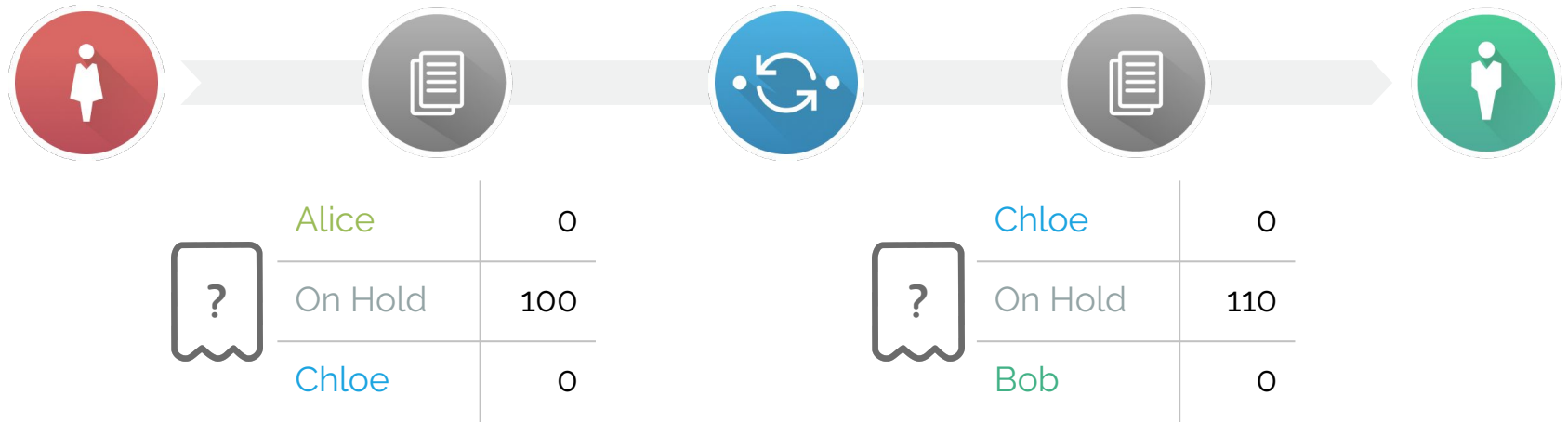
# Recipient Gets Notification of Funds on Hold



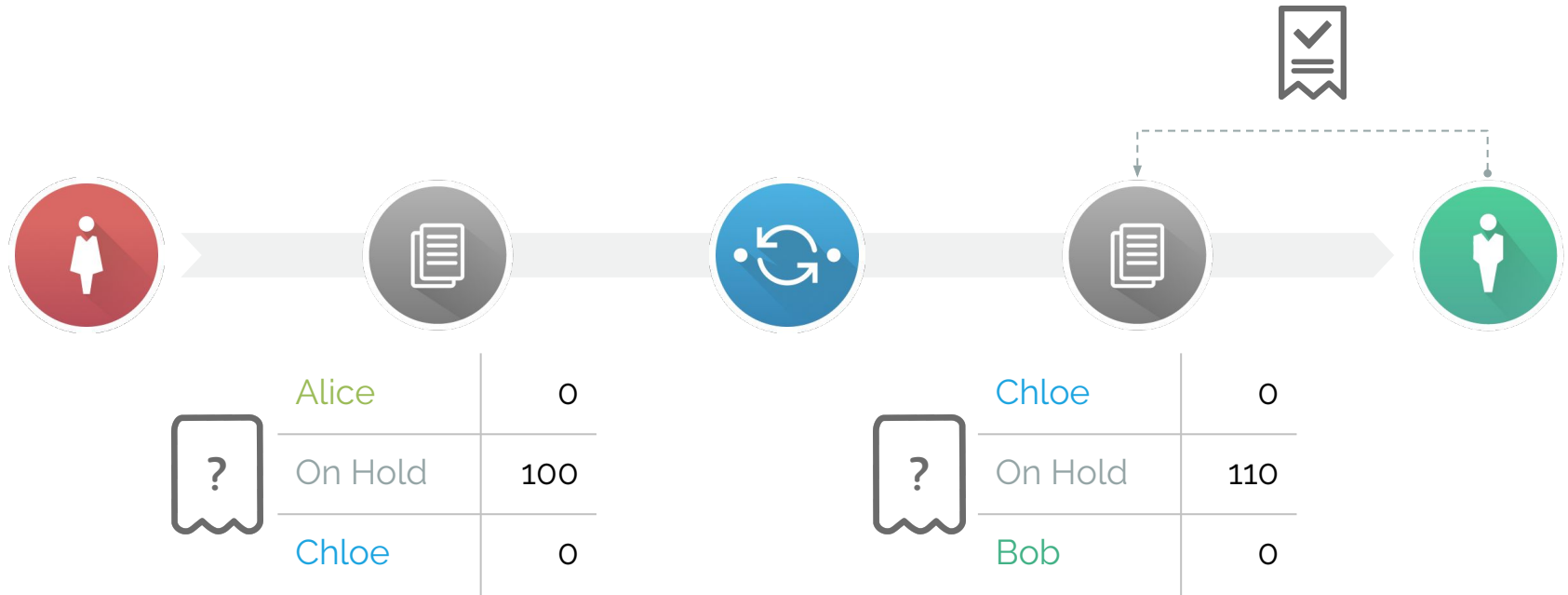
Recipient **Triggers Payment** by  
Fulfilling the Condition

# Transfers Are Executed Right to Left

## EXECUTION

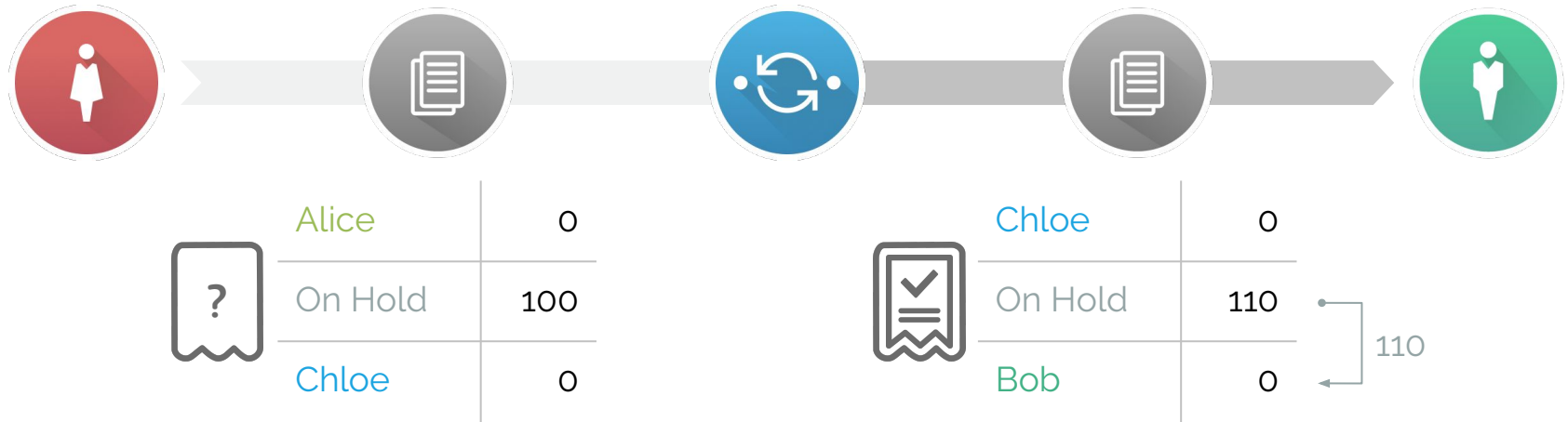


# Recipient Signs Receipt

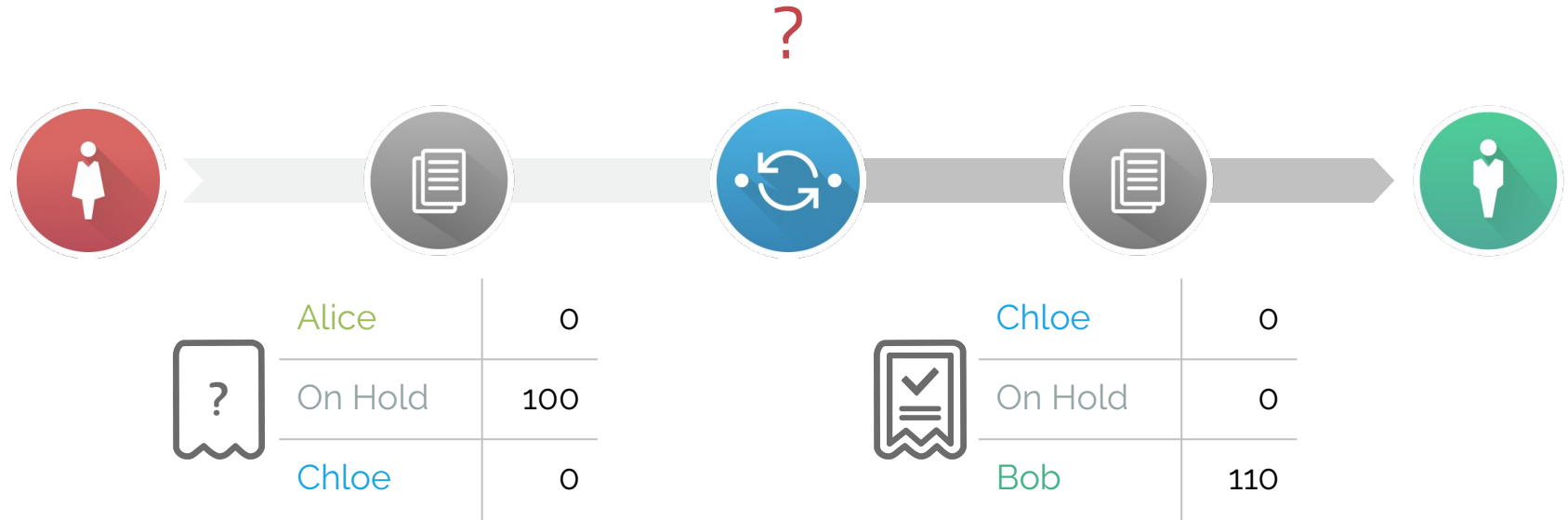




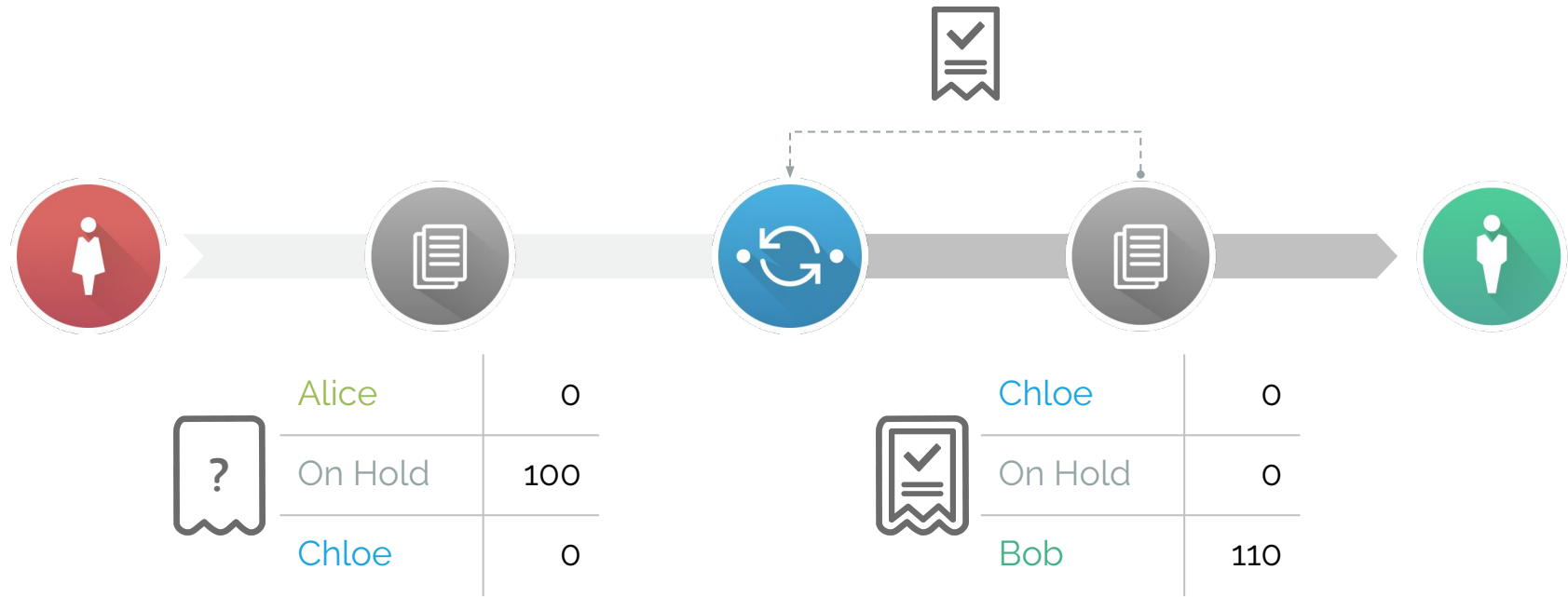
# Signature Fulfills Condition, Ledger Releases Held Funds



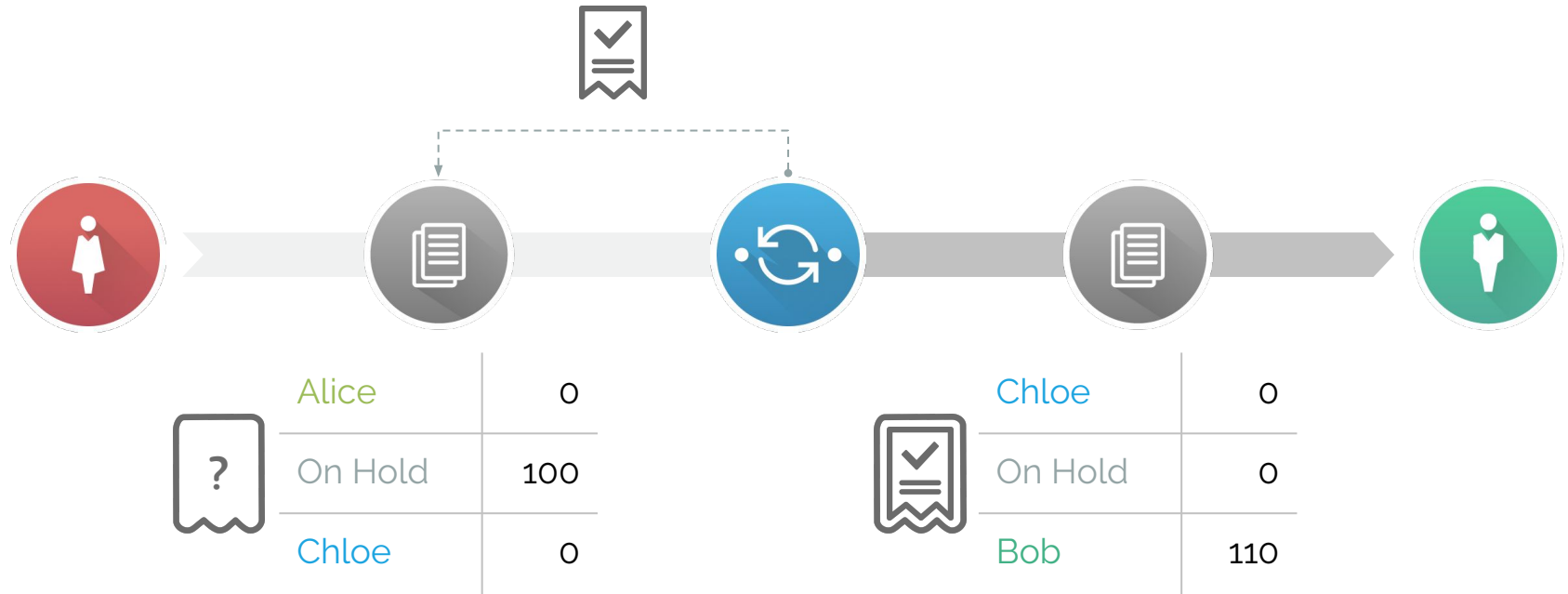
# How Does the Connector Get Reimbursed?



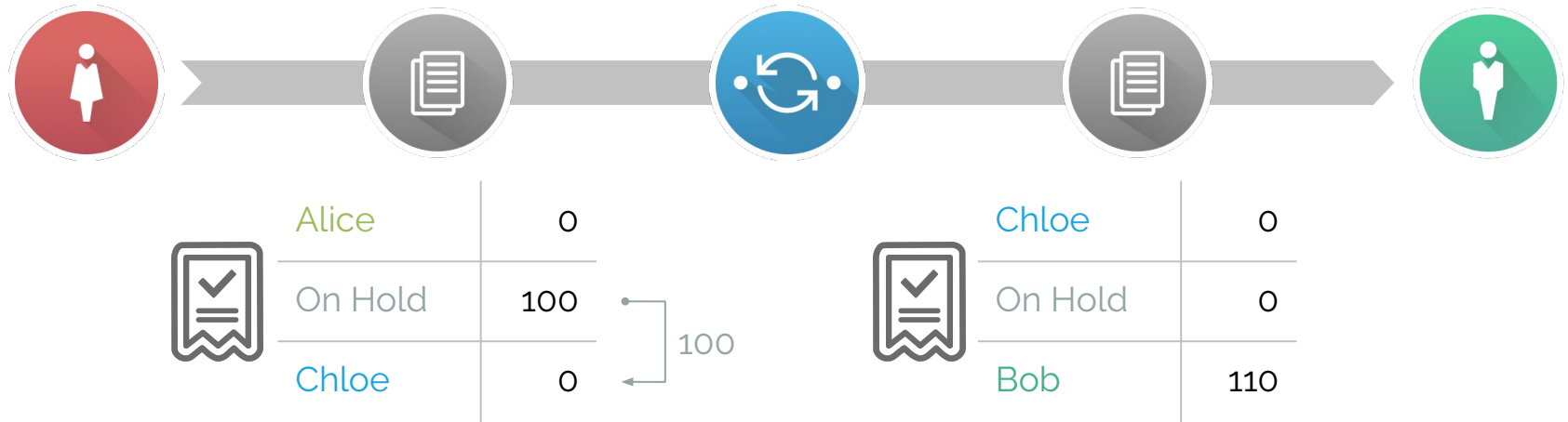
# Connector is Notified That Funds Have Been Released



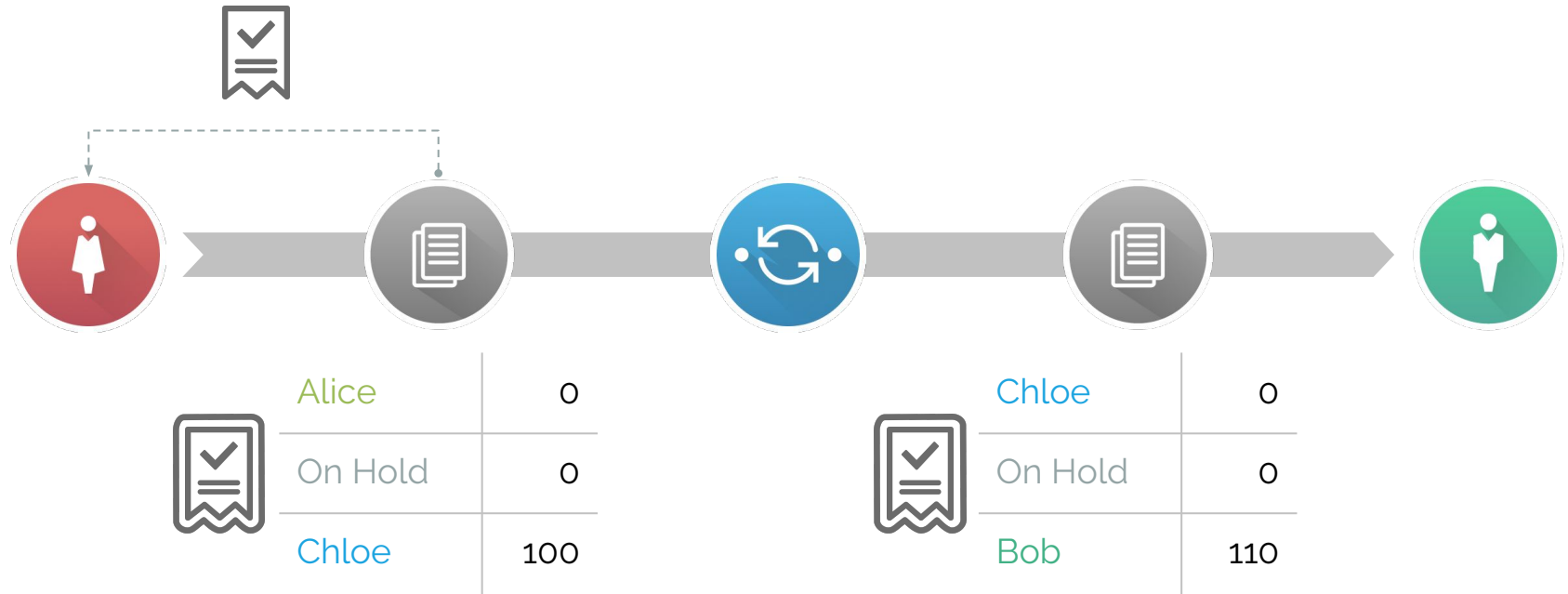
# Connector Passes on the Recipient's Signature



# Receipt Releases Funds from Hold



# Sender Gets Non-Repudiable Proof of Payment



# Transfers Are Committed L2R, Executed R2L

**COMMITMENT**



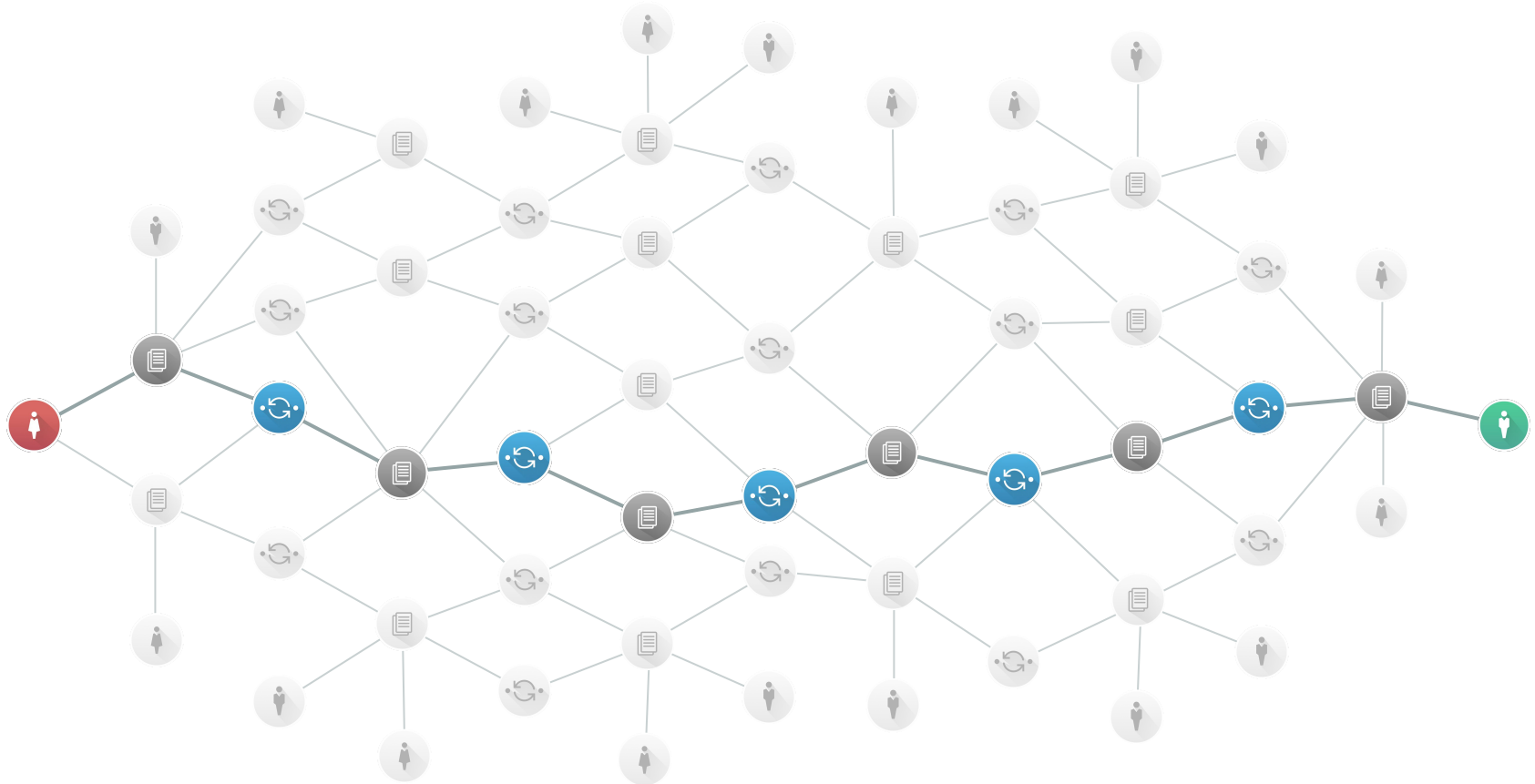
**EXECUTION**

# Simple Primitive Can Be Extended to Longer Paths





# Interledger Enables a Network of Payment Networks



## Based On a Simple Packet Format

address: "us.wf.bob"  
amount: "1023.20"  
expiry: "2016-07-06T09:00:10Z"  
condition: "cc:0:3:4a7DEpj8f9..."

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# Interledger Addresses

address: "us.wf.bob"



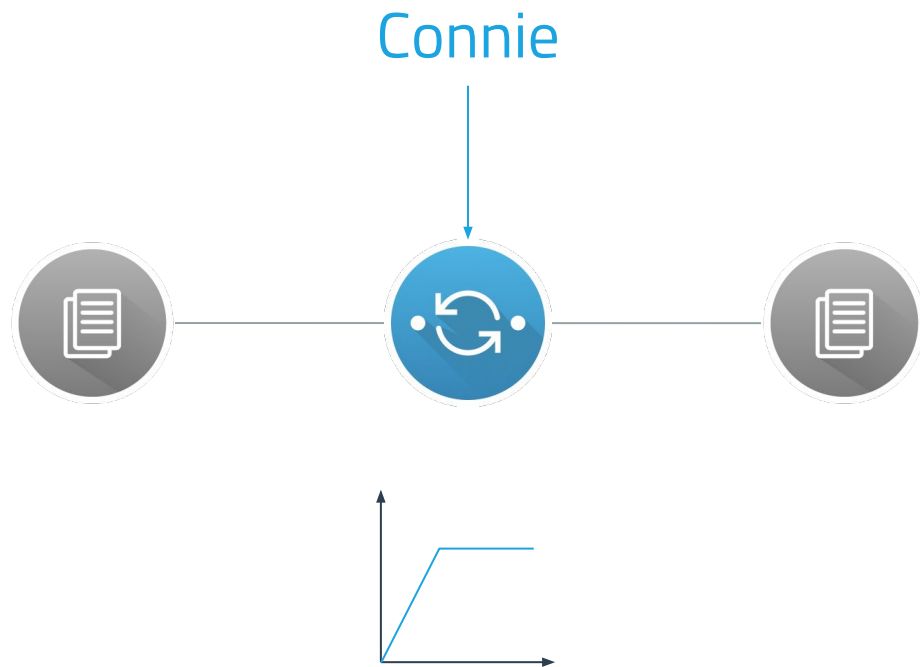
ledger account

# Interledger Addresses

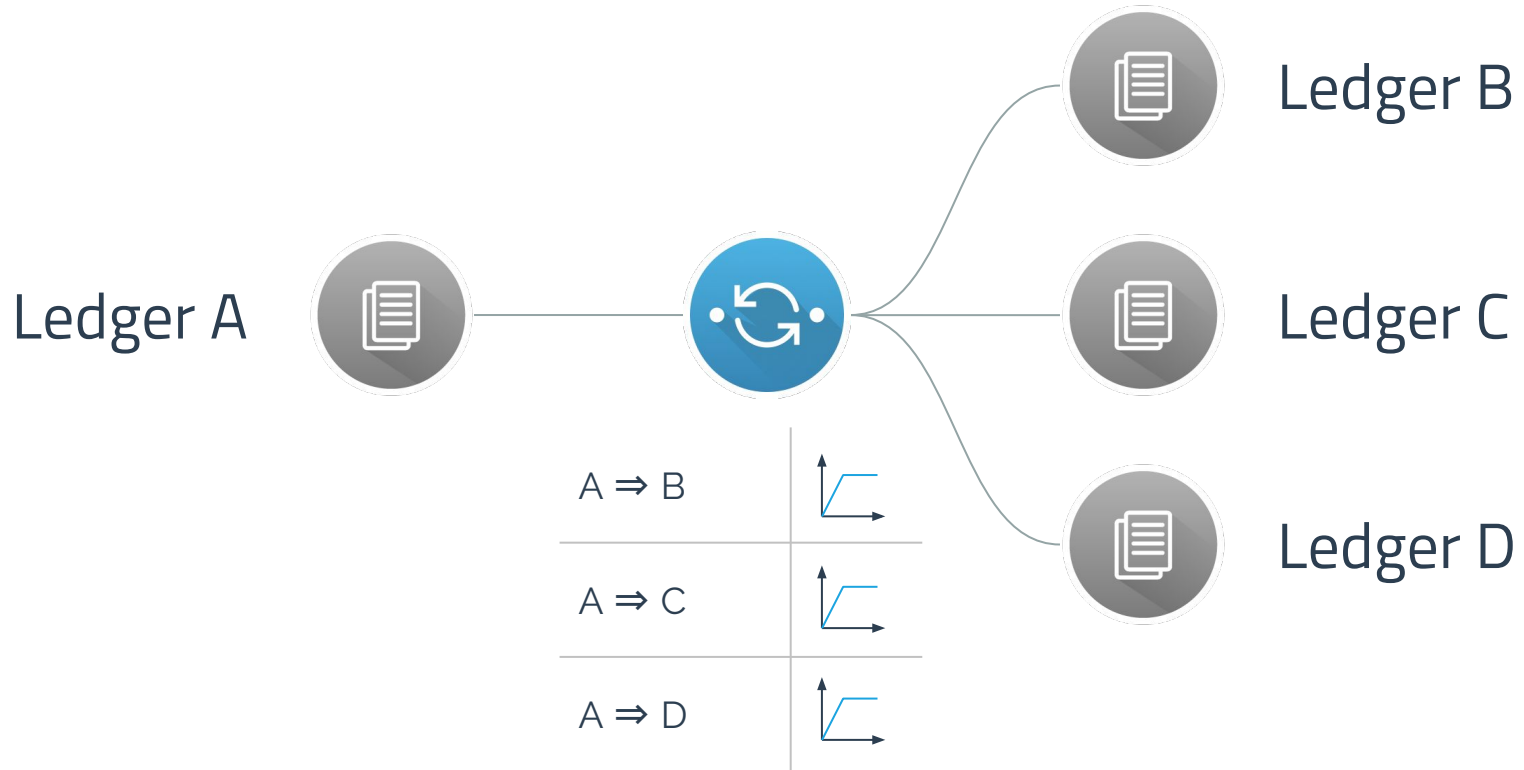
ledger subledger account  
address: "us.wf.bob.mary"

How does the sender know what amount to send?

# Liquidity Curves Determine Exchange Rates

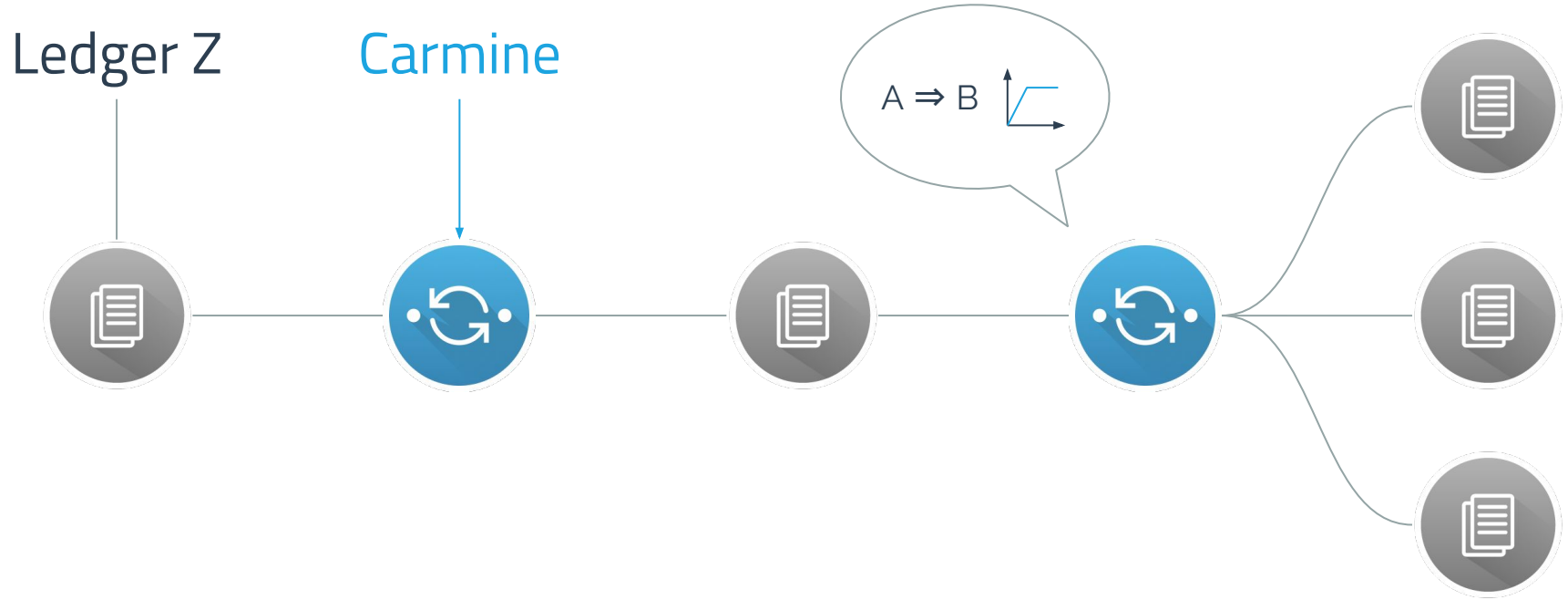


# Connectors Set Rates per Ledger Pair

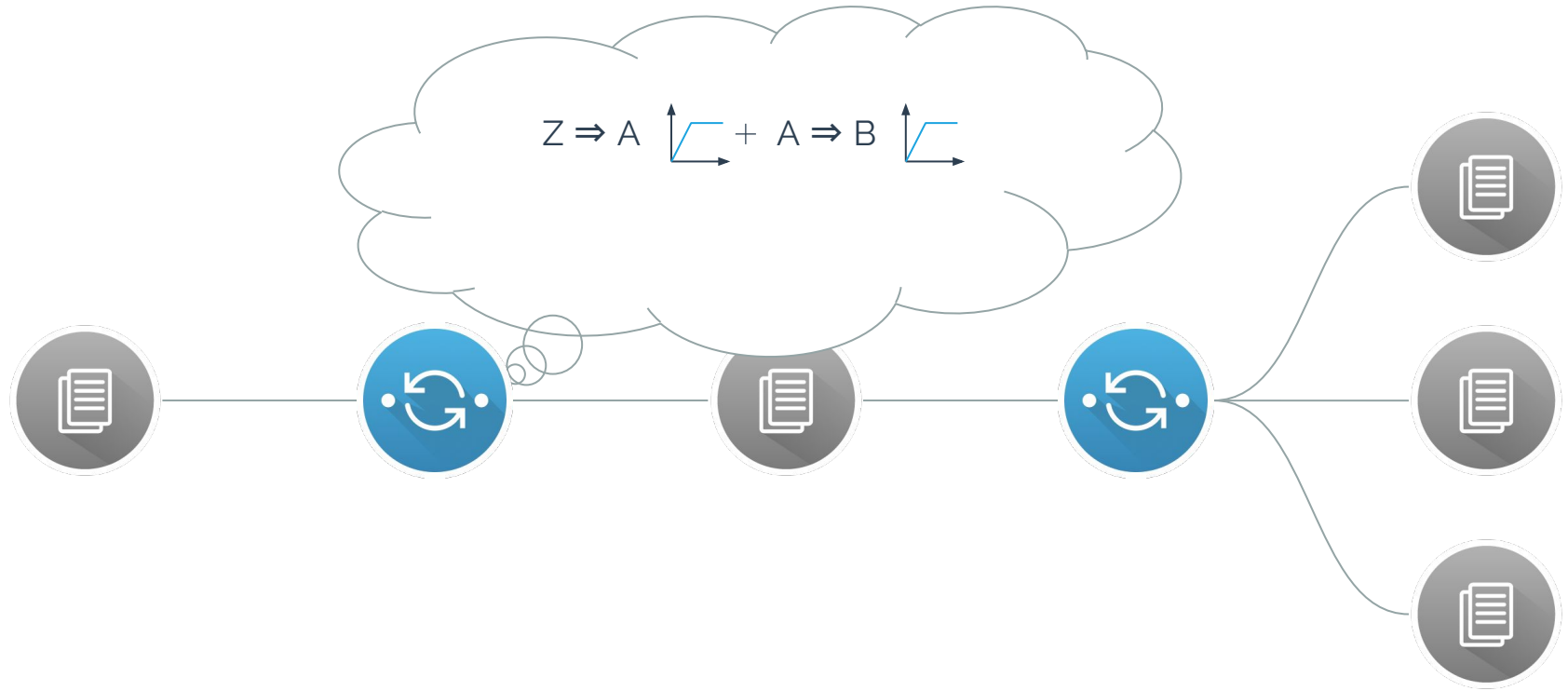




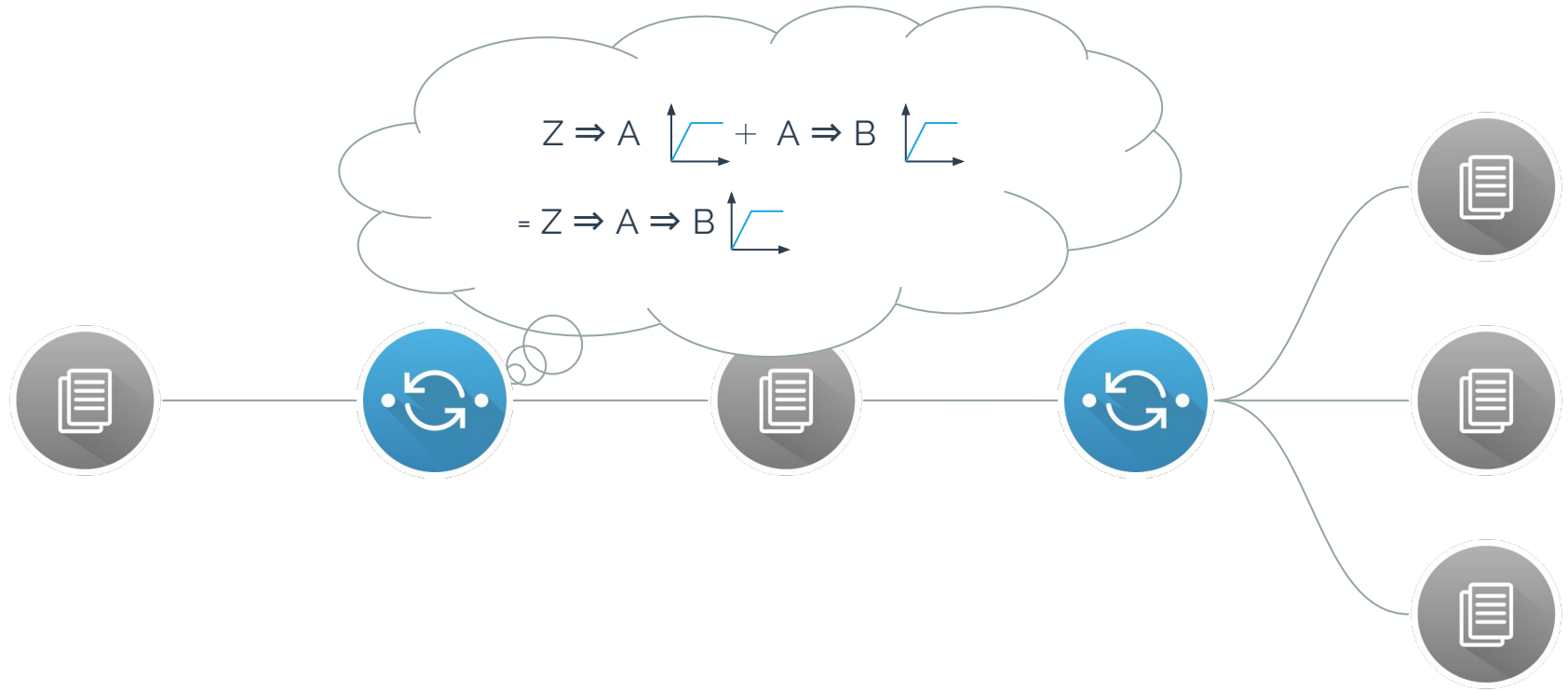
# Connectors Advertise Their Routes



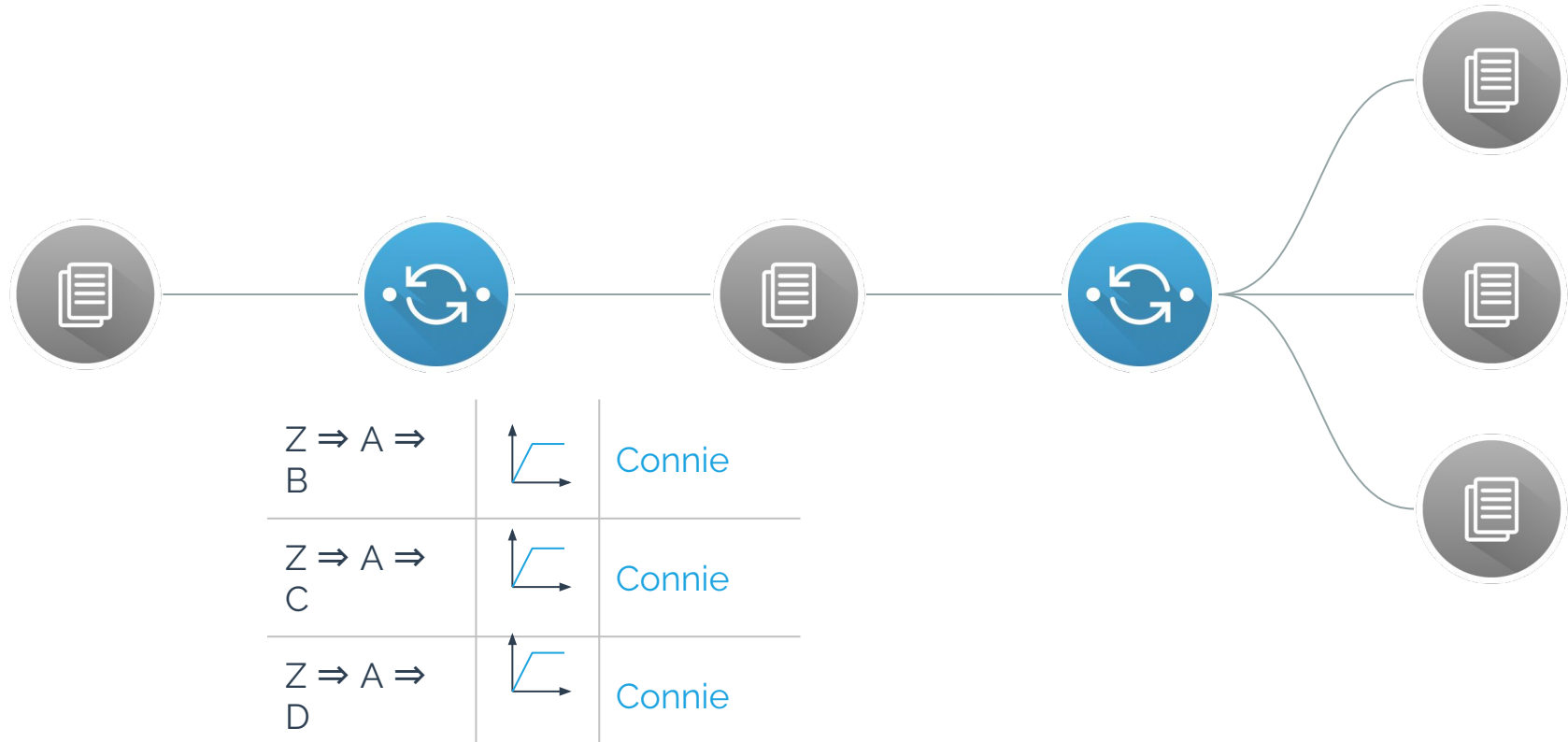
# Synthetic Routes Are Created










# Synthetic Routes Are Created



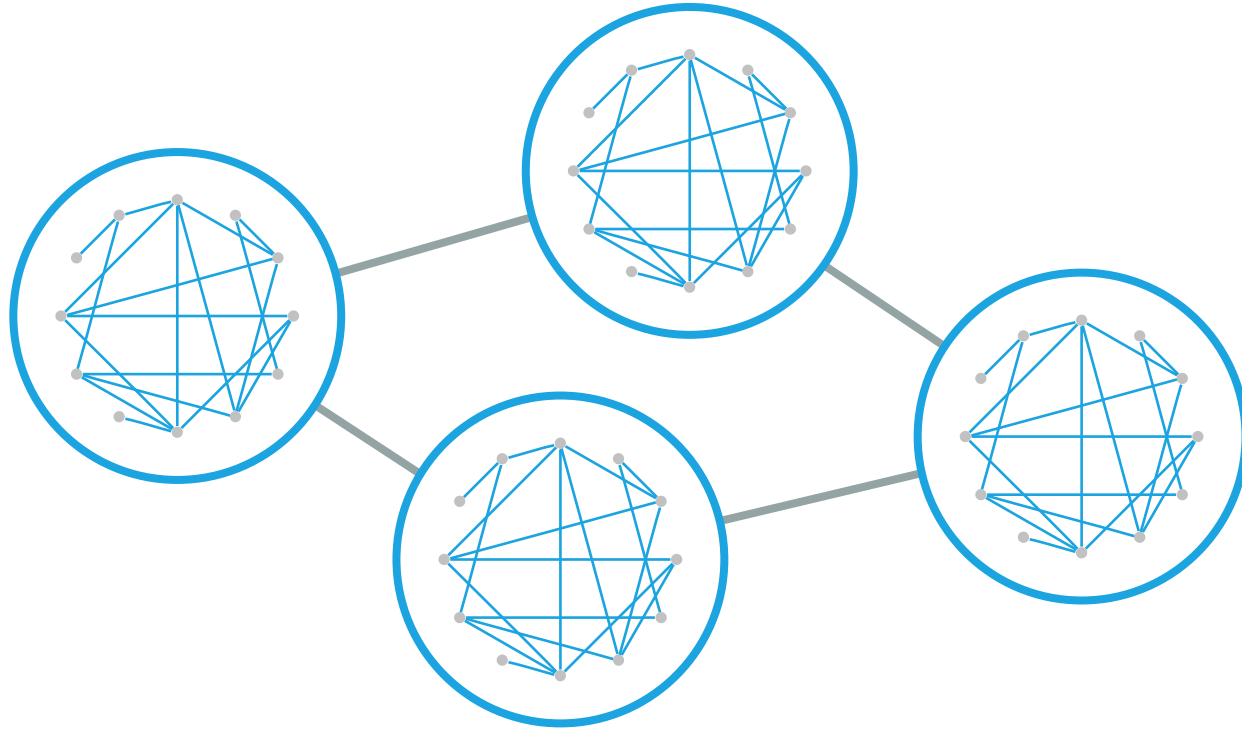
# And Added to the Routing Table



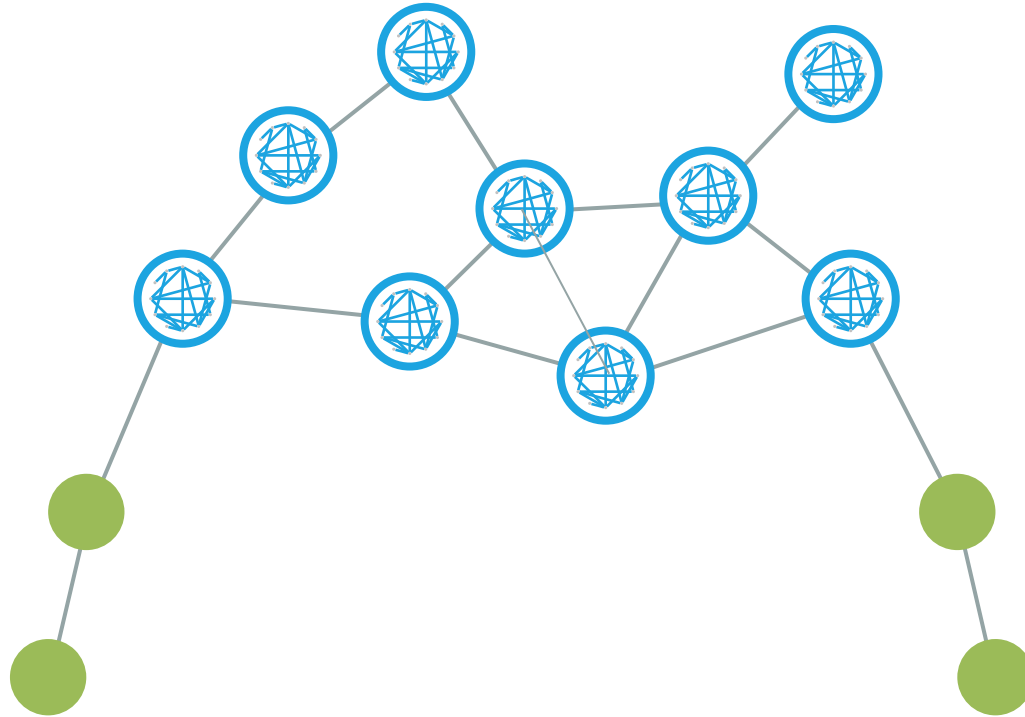
# Routing Tables Grow Quickly

$Z \Rightarrow A$		Local
$Z \Rightarrow A \Rightarrow B$		Connie
$Z \Rightarrow A \Rightarrow C$		Connie
$Z \Rightarrow A \Rightarrow D$		Connie
$Z \Rightarrow C$		Local
$Z \Rightarrow C \Rightarrow E$		Chao
$Z \Rightarrow C \Rightarrow F$		Carl

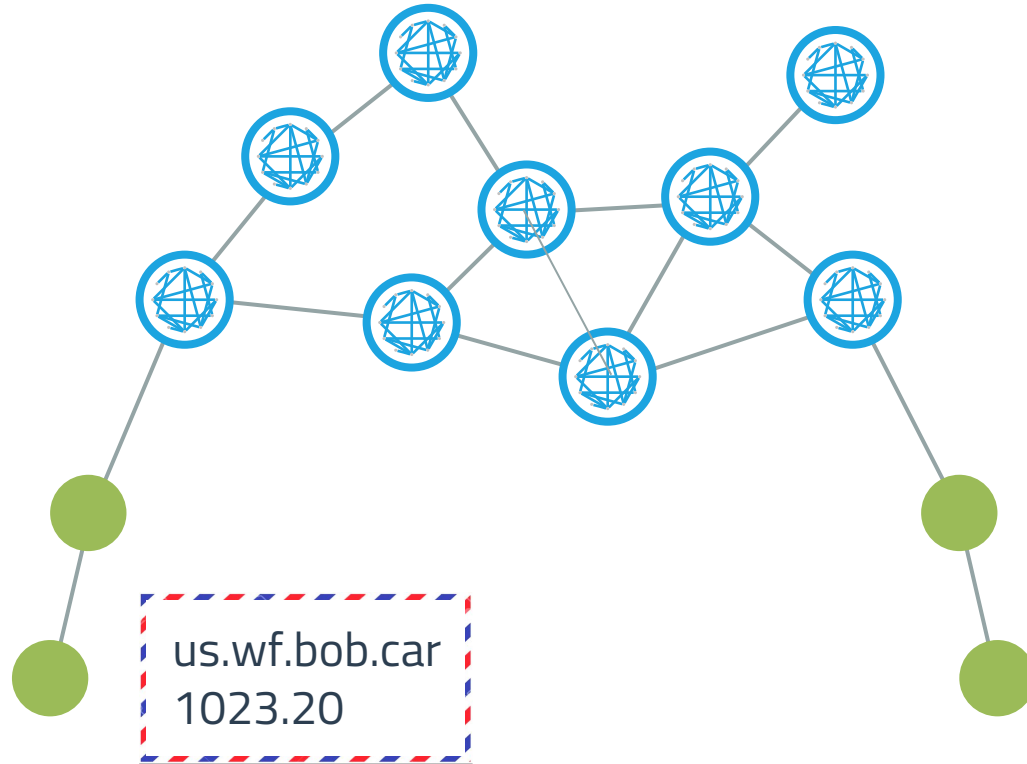
# Autonomous Systems



# Core vs. Periphery

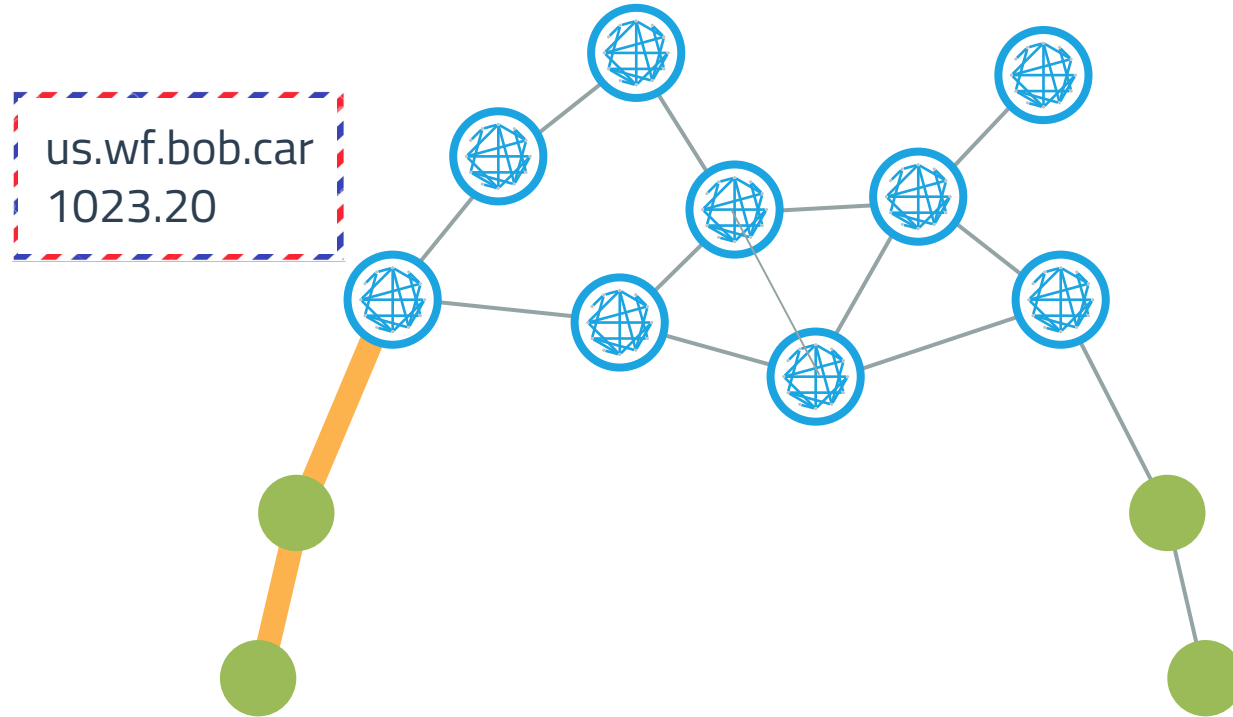


# Routing a Payment

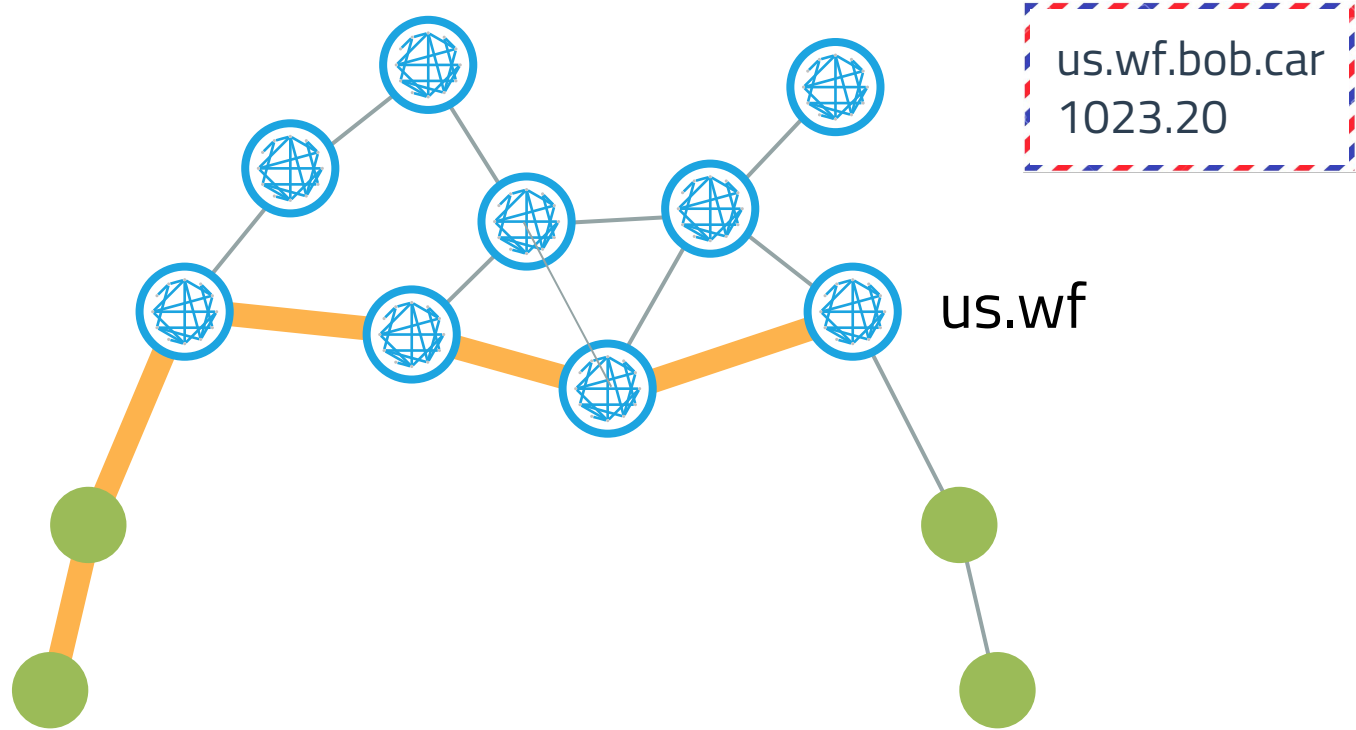




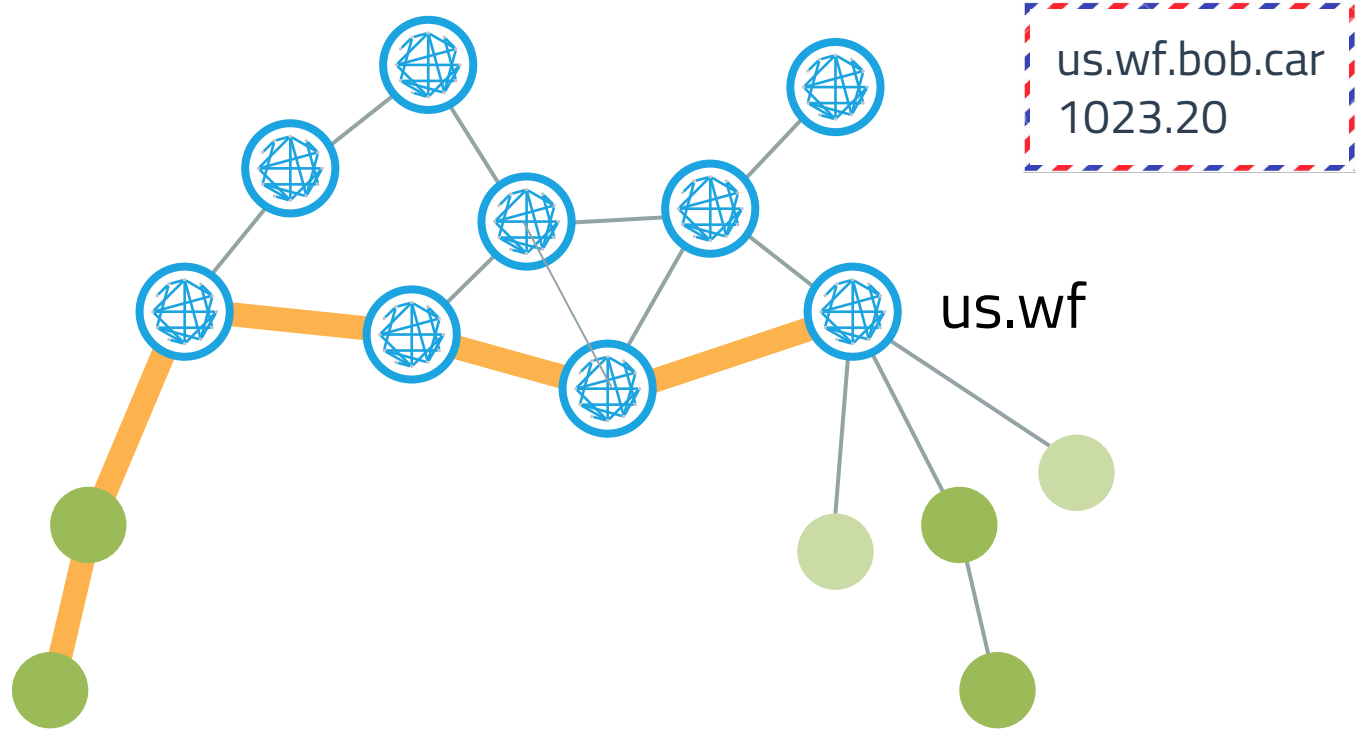
# First We Route Up



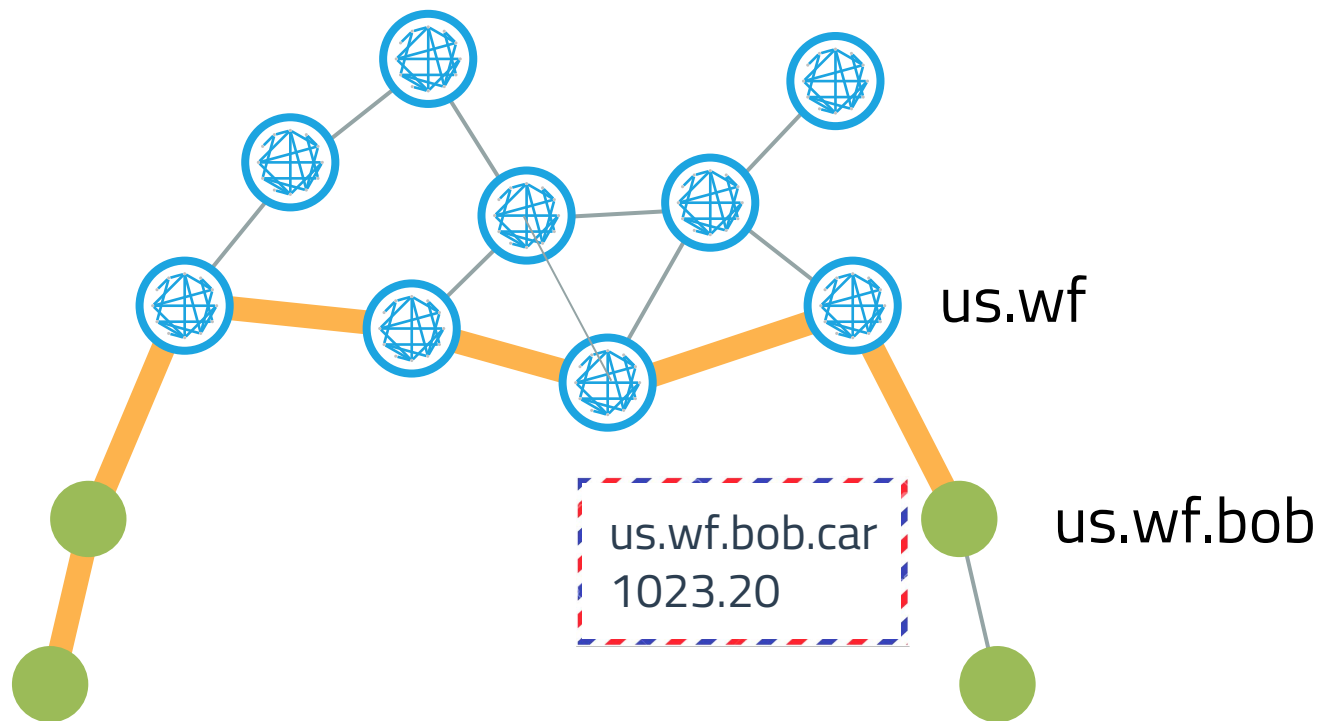
# Then Across



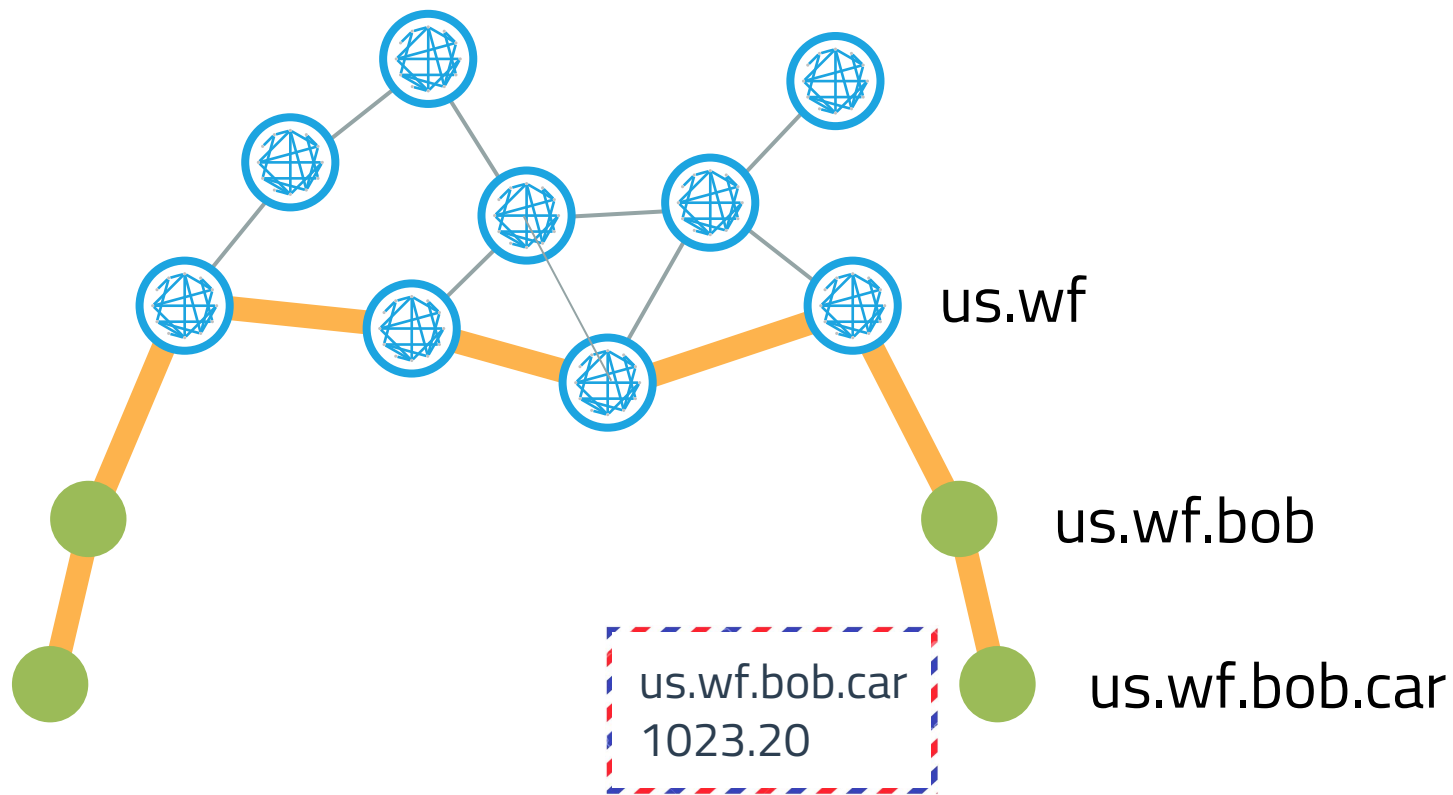
# Then Across



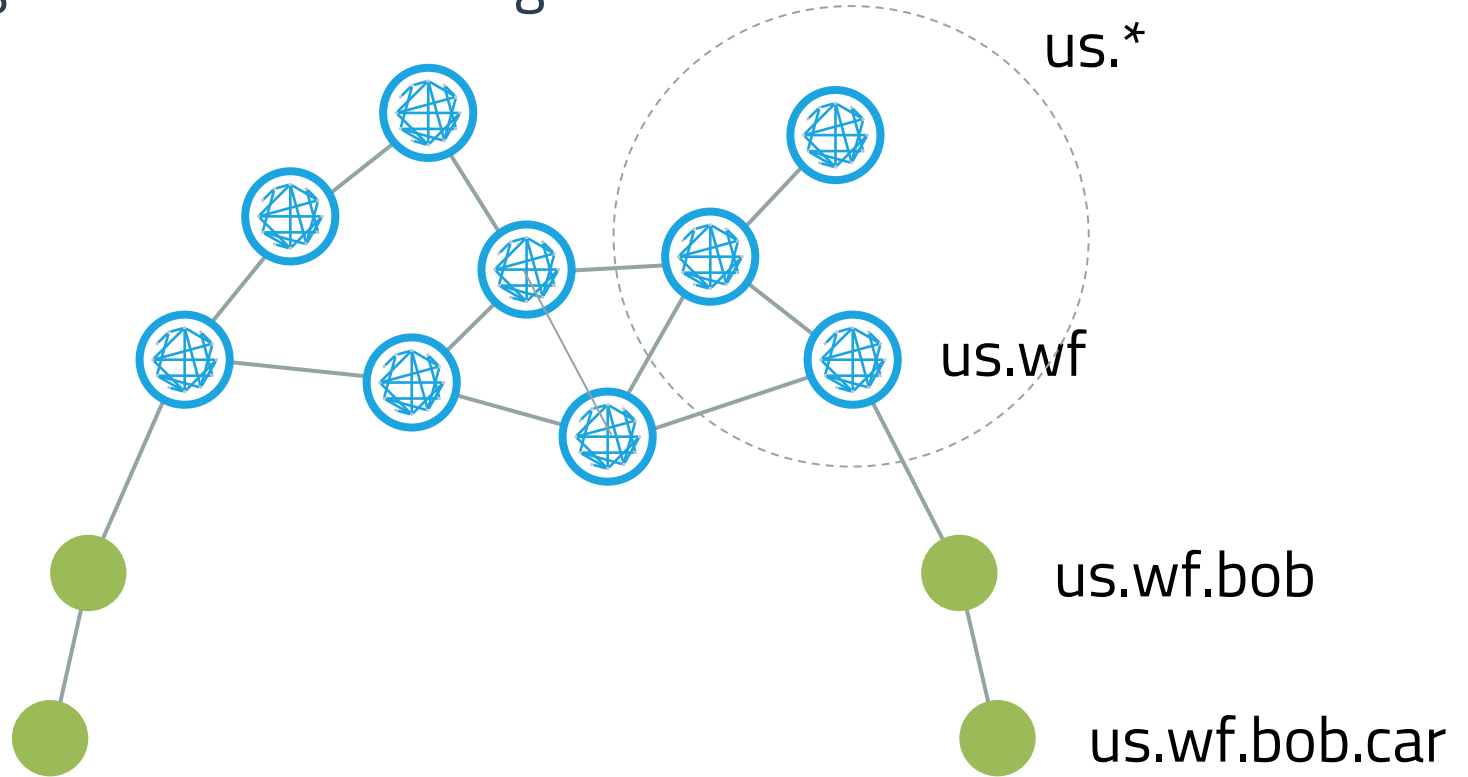
## And Finally Down



## And Finally Down



# Some Ledgers Aren't Real Ledgers



## In Summary...

**Interledger is a suite of protocols for transferring digital assets between accounts on different ledgers.**

Interledger provides:

- A standard for addressing digital asset ledgers and accounts
- A protocol for orchestrating transfers on independent ledgers to facilitate secure multi-hop payments

# Interledger Enables:

- Network-Agnostic, Minimal Standard for Payments Interoperability
- Universal Payments Between Any Accounts on Any Connected Ledger
- Competitive Landscape for Ledgers and Connectors
- Micropayments in Any Currency
- New Payments Use Cases and Business Models
- Neutral Protocol That Can Be Built Into Other Standards





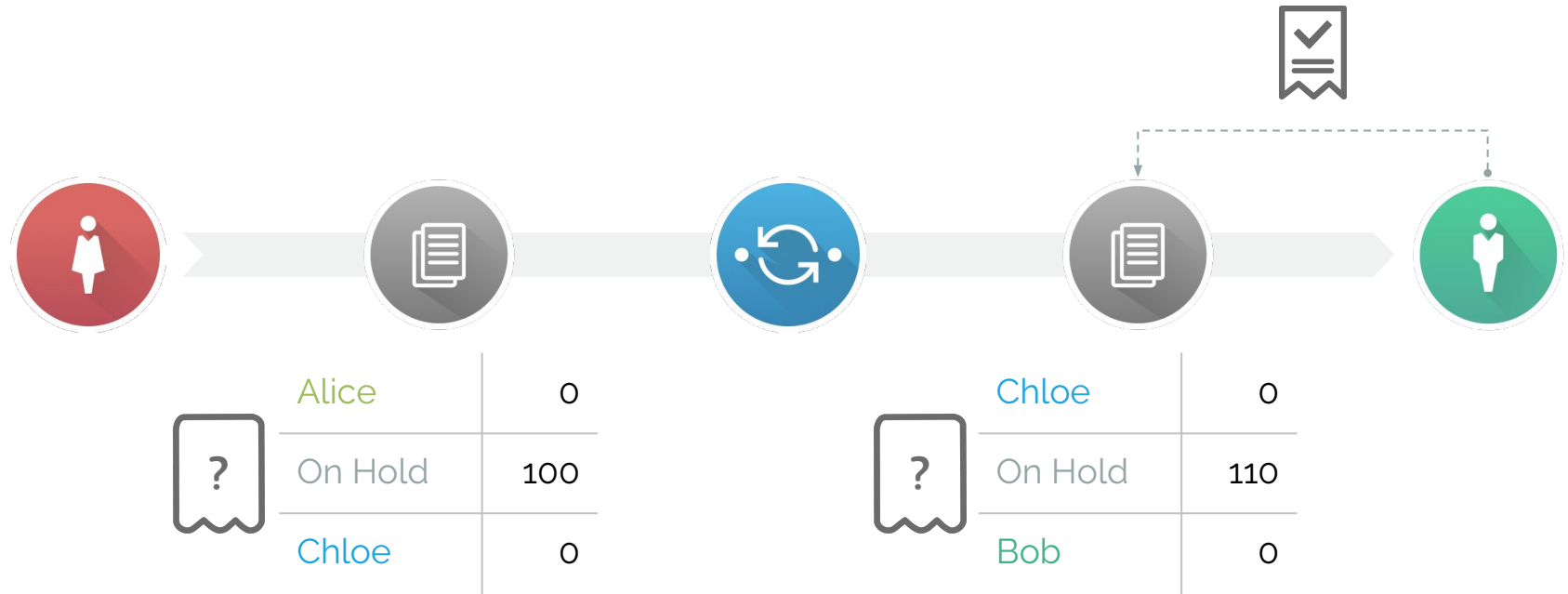
interledger.org

# Appendix: Risks and Mitigations

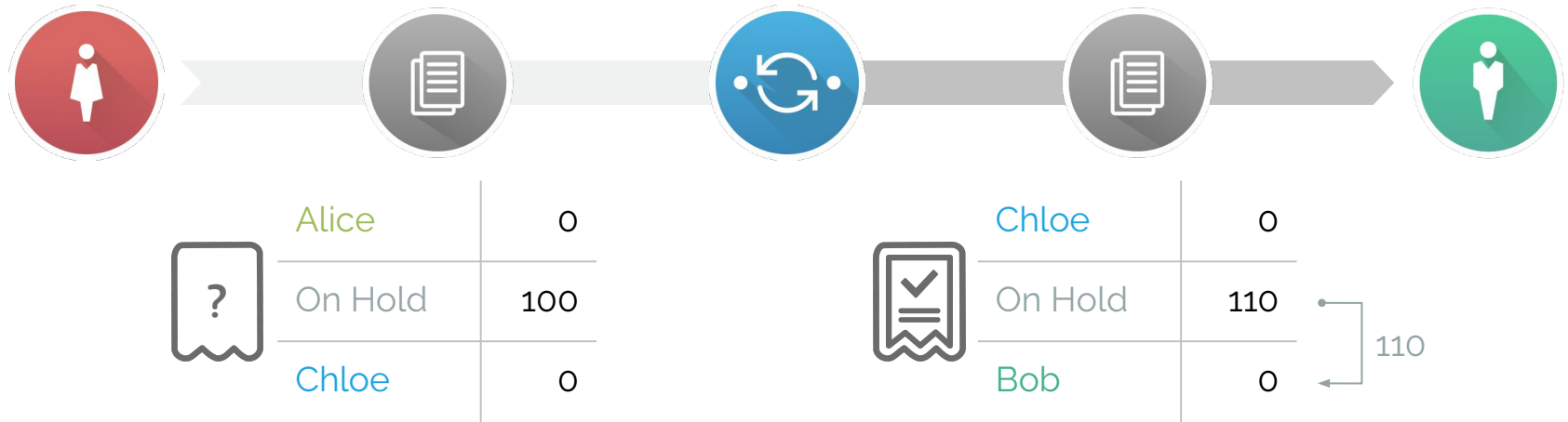
Senders and Receivers are  
**isolated from risk** by ledger-  
enforced holds.

Connectors that fail to pass on  
fulfillments *may lose money*

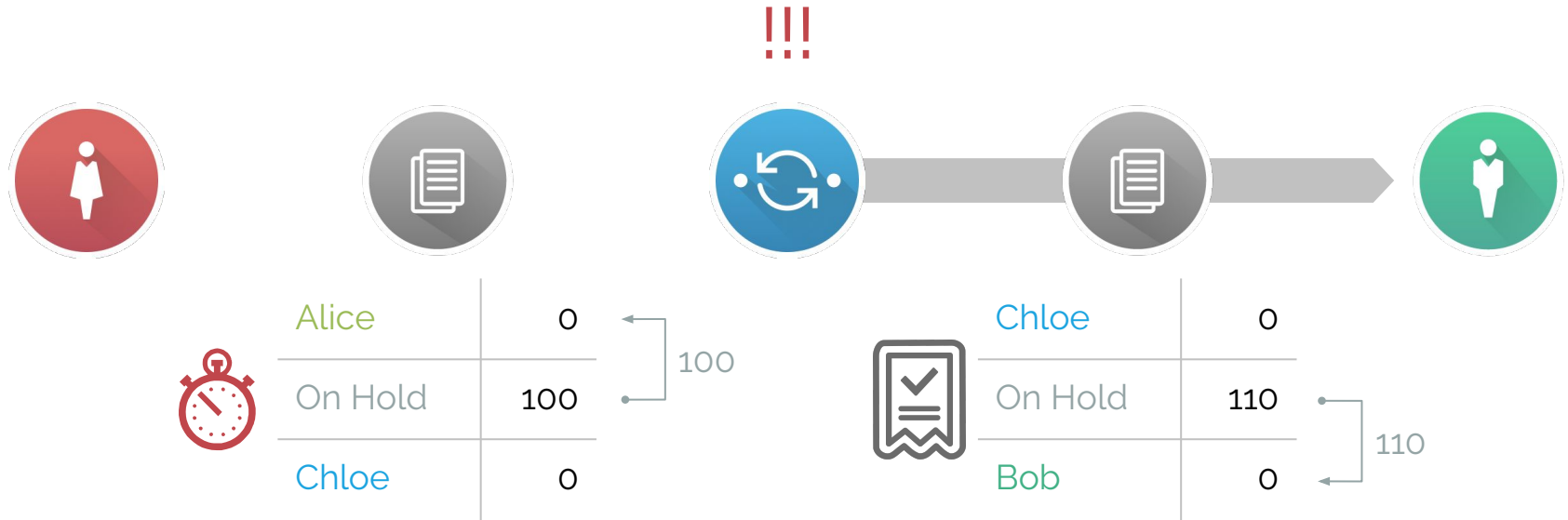
# Recipient Signs Receipt



# Signature Fulfills Condition, Ledger Releases Held Funds



## ...And the First Hold Expires



# Connector That Fails to Pass on Fulfillment Loses Money



Alice	100
On Hold	0
Chloe	0



Chloe	0
On Hold	110
Bob	0

110



# Connector Risk Mitigation Strategies

- Redundant Ledger Connections
- Connect More Reliable Ledgers
- Price Risk Into Spread
- Incentivize Retries

Interledger enables payments  
to be **retried**

# Sender Sees Money Returned, But They Wanted to Pay



Alice	100
On Hold	0
Chloe	0



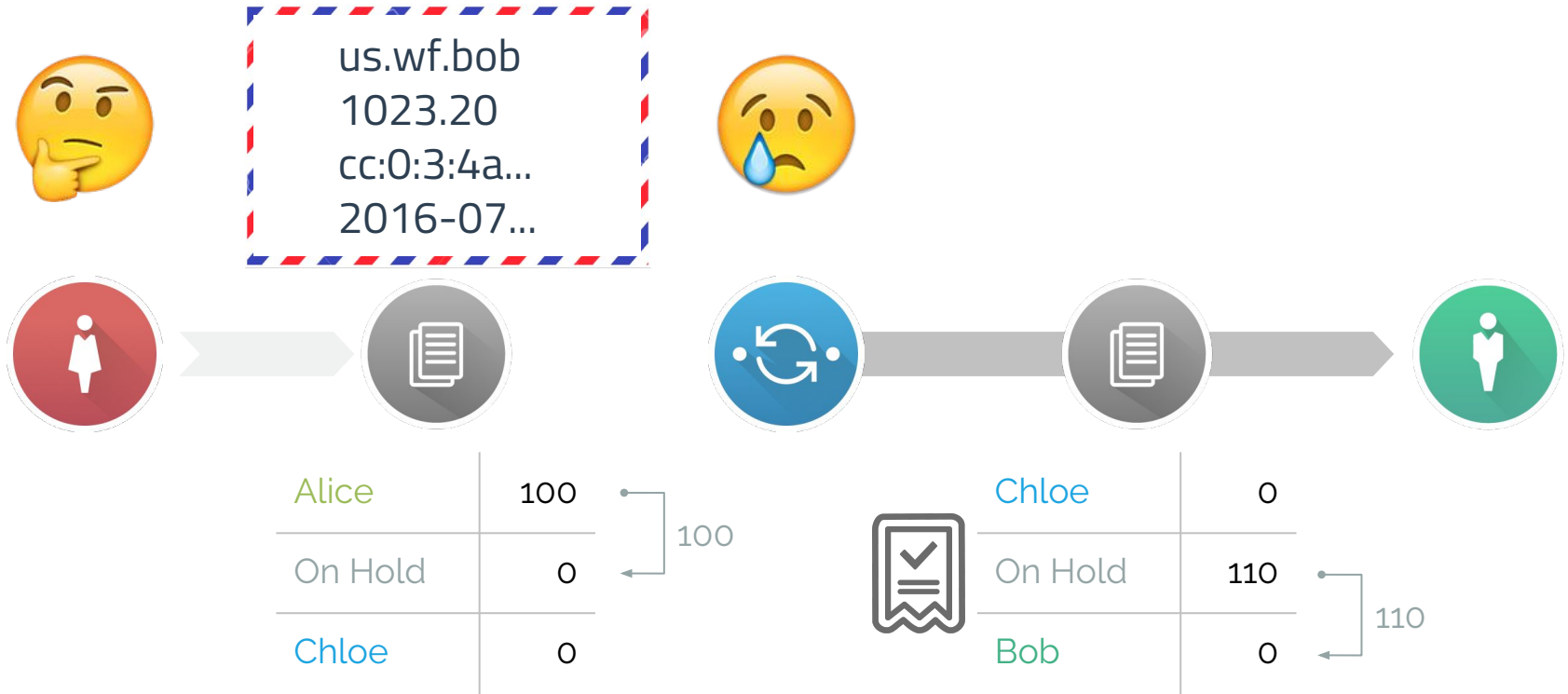
Chloe	0
On Hold	110
Bob	0



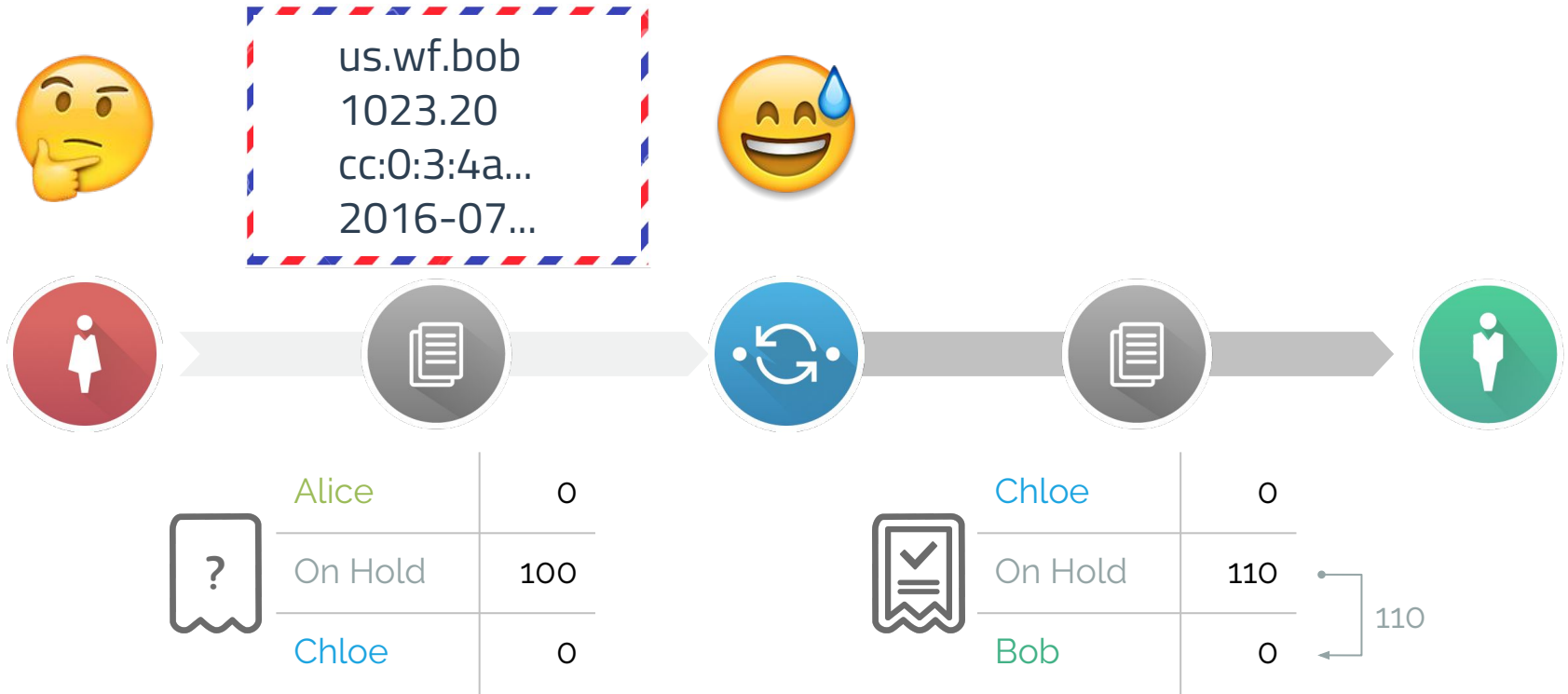
110



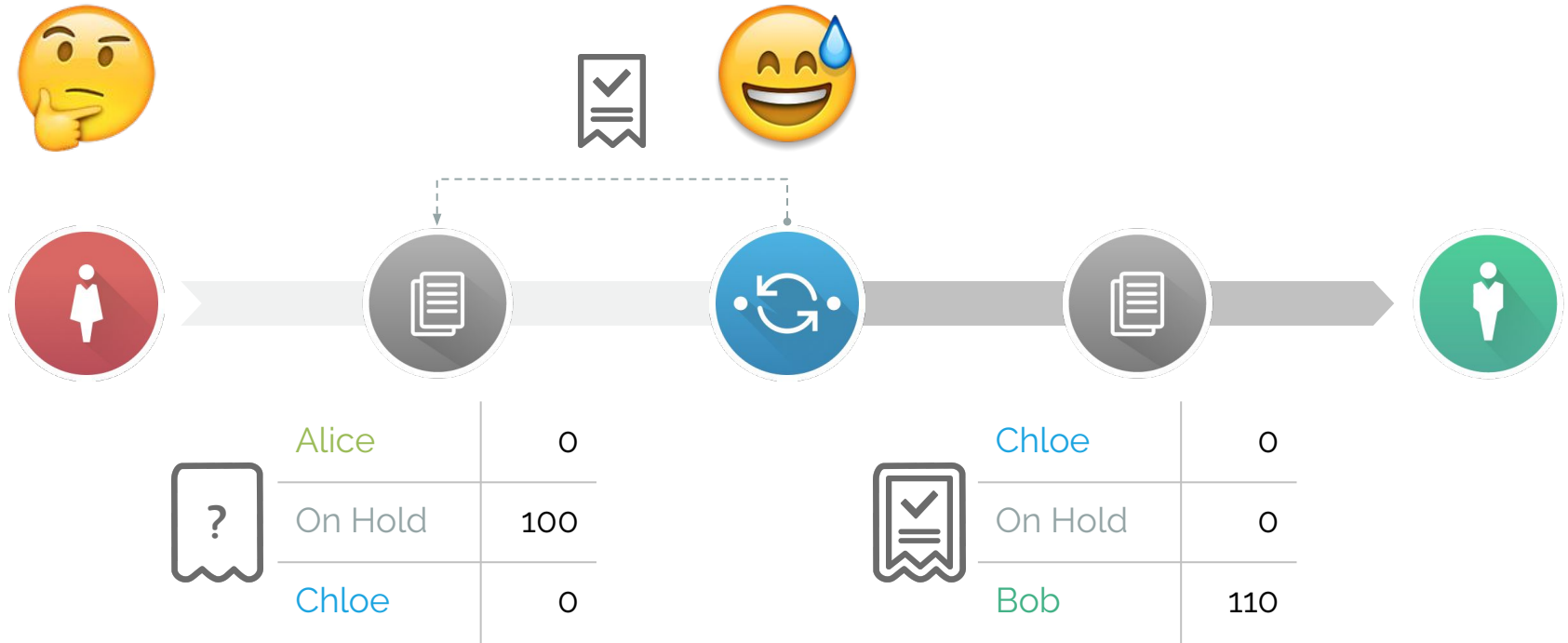
# Sender Can Retry Payment



# Connector Is Notified of New Funds on Hold



# Connector Passes on the Recipient's Signature



# Receipt Releases Funds from Hold



Alice

0

On Hold

100

Chloe

0

100



Chloe

0

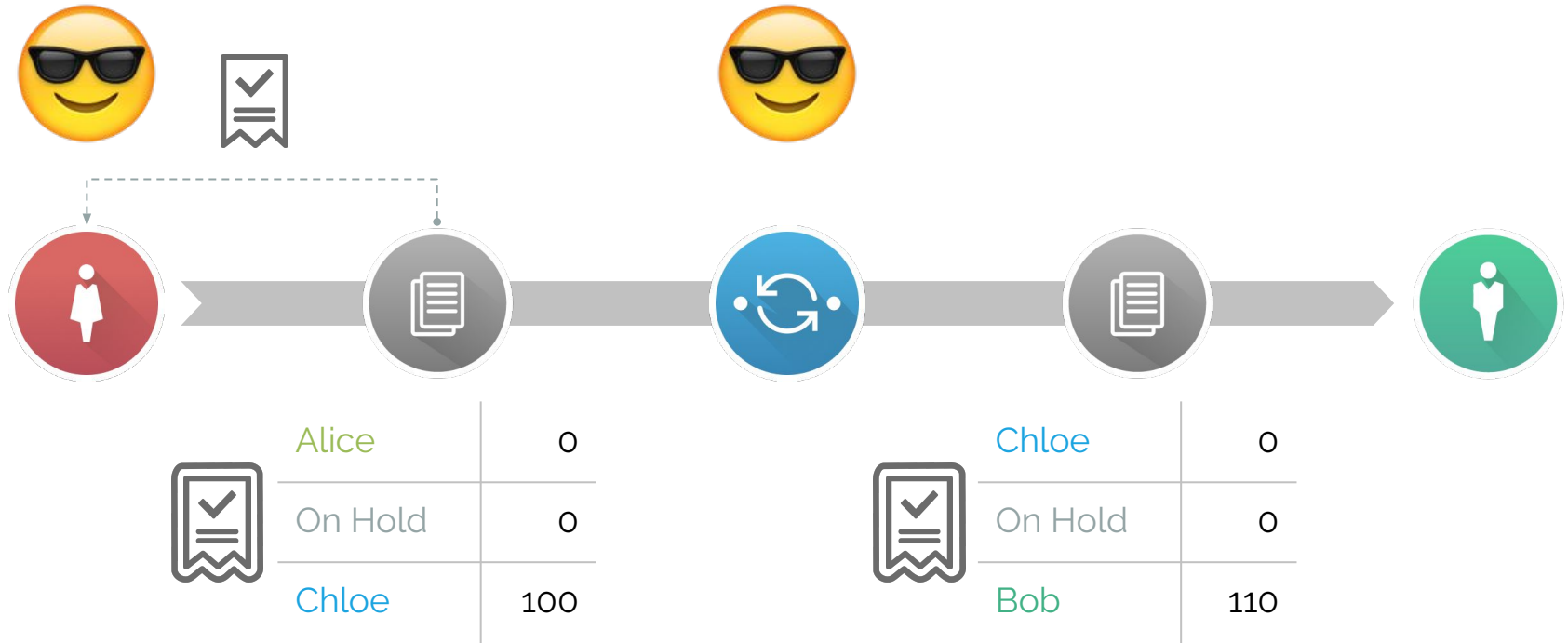
On Hold

0

Bob

110

# Sender Gets the Receipt, Connector Gets the Money





In multi-hop payments,  
connectors are incentivized to  
retry through the same route