

E-Payment Systems and Cryptocurrency Technologies

Banking, Foreign Exchange
+
Clearing and Settlement Systems

Acknowledgements

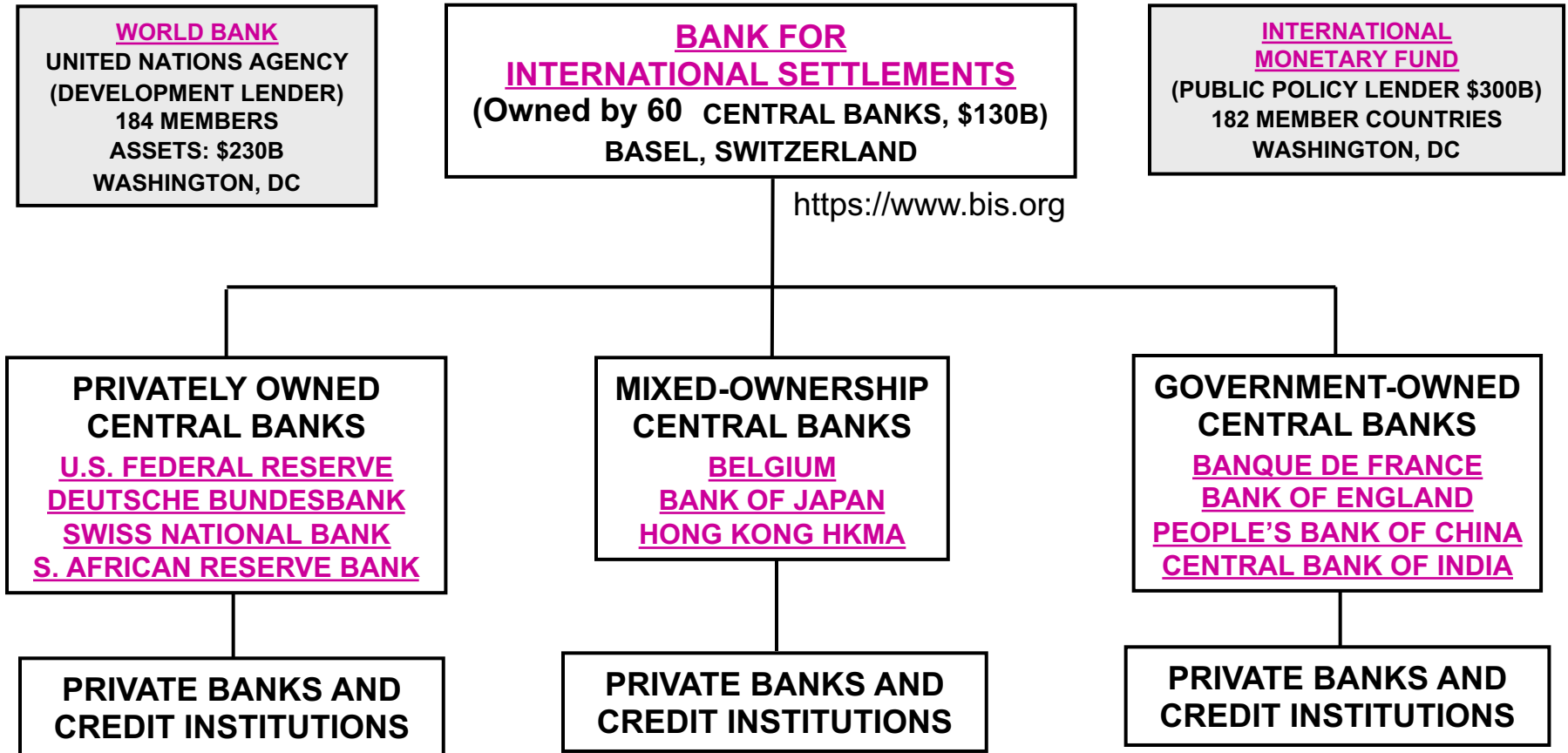
■ The slides used in this lecture are mostly adapted from the following sources. The copyrights and contribution of the original authors are hereby acknowledged and recognized:

- ◆ **The Electronic Payment Systems course by Prof. Michael Shamos, CMU**
- ◆ “Financial Infrastructure in Hong Kong”, HKMA Background Brief No. 4, 2006, <https://www.legco.gov.hk/yr06-07/english/panels/fa/papers/facb1-657-4-e.pdf>
- ◆ Carol Coye Benson, Scott Loftesness, Russ Jones, Payments Systems in the U.S. - Third Edition: A Guide for the Payments Professional 3rd ed. Edition, Glenbrook Partners, 2017.
- ◆ John Hill, Fintech and the Remaking of Financial Institutions, Academic Press 2018
- ◆ Robert E. Litan and Martin Neil Baily, Editors, Moving Money: The Future of Consumer Payments, Brookings Institution Press, 2009.
- ◆ Banking and Electronic Fund Transfer, OCDE, OCED, 1983.
- ◆ Brett King, Breaking Banks -The Innovators, Rogues, and Strategists Rebooting Banking, Wiley, 2014.

Lecture Outline

- World banking system
- Central banks
- Money supply measures
- What banks do
- Foreign exchange
- US Banking and Payment Systems
- More Clearing and Settlement Systems

World Banking System



SOURCE: [TRANSACTION.NET](https://www.transaction.net)

NOTE: Bank for International Settlements (BIS) has published the extremely informative **CMPI Red Book** series, detailing the Payment, Clearing and Settlement systems in various countries ! Freely available at: <https://www.bis.org/list/cpmi/index.htm>

Central Banks

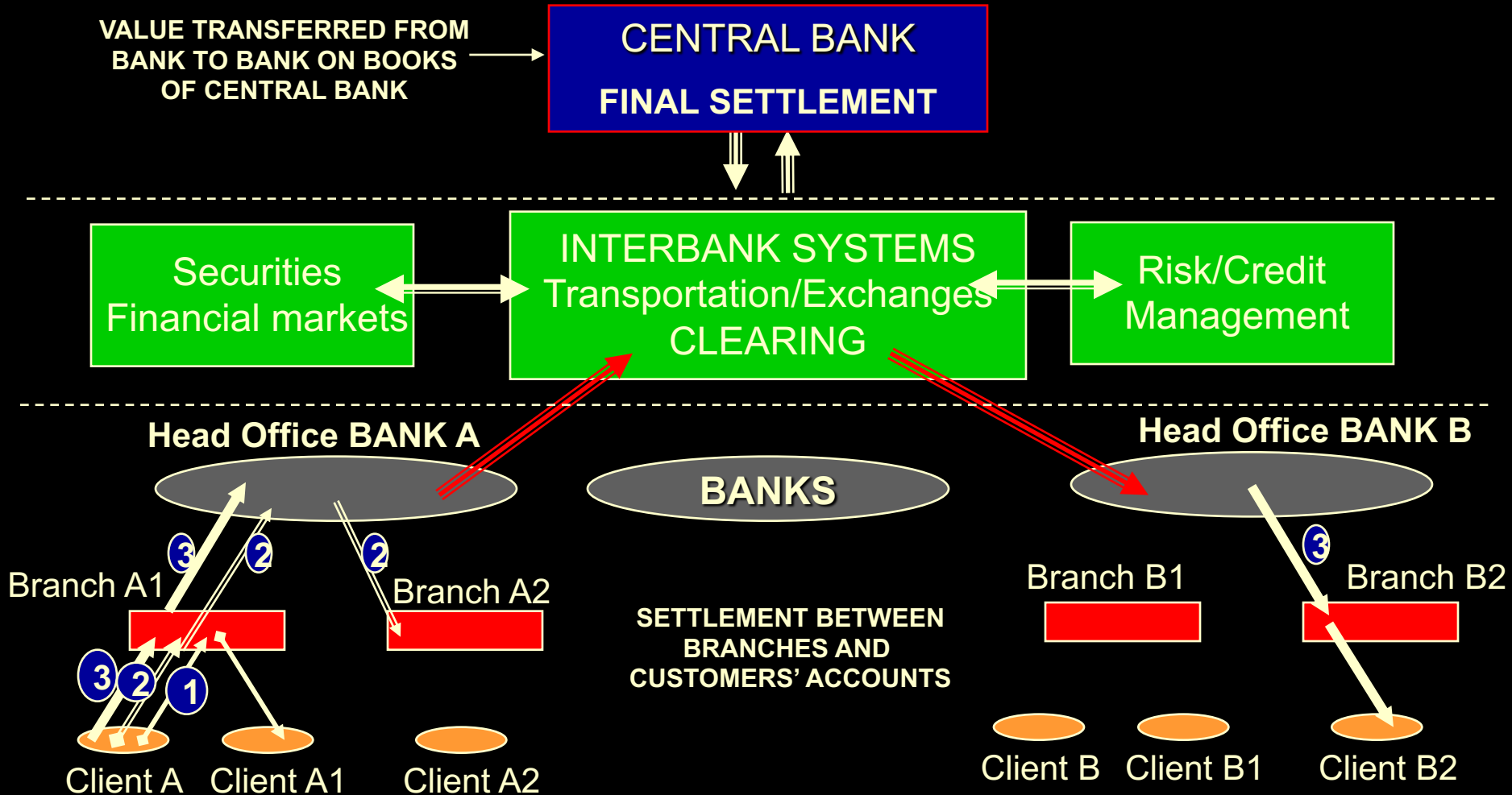
- Legal tender (“real money”) is issued by central banks (and banks operating under their authority)

- ◆ U.S.: Federal Reserve Bank



- Non-central banks cannot hold legal tender (except in cash form). (What form would it take?)
- How do banks pay each other?
 - ◆ Through accounts in the central bank (directly or indirectly)

Payment System Layers

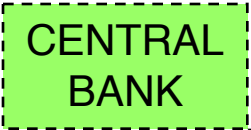


Cash Transaction

1. CENTRAL BANK ISSUES FIDUCIARY MONEY (ANTI-FORGERY) + (SERIAL NUMBERS)

2. CENTRAL BANK SELLS CASH TO BUYER'S BANK

3. BUYER'S BANK ALLOWS BUYER TO DRAW CASH FROM BUYER'S ACCOUNT

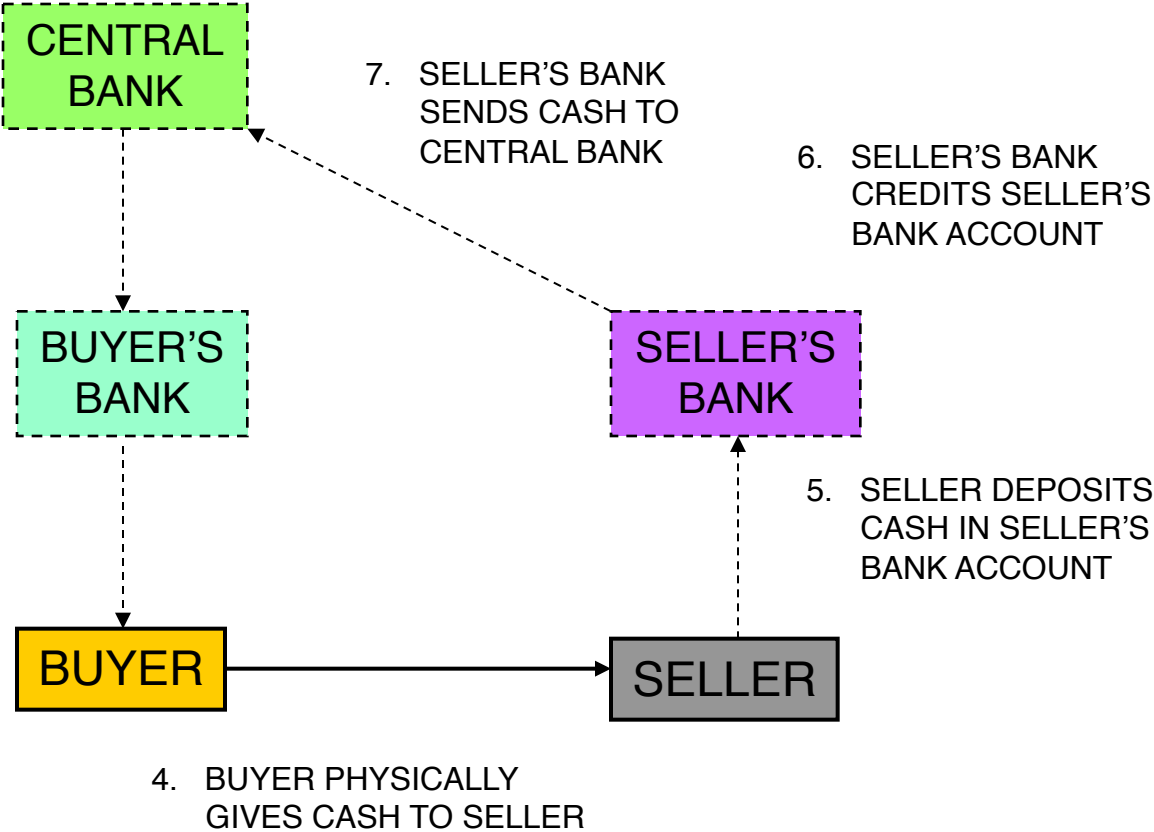


7. SELLER'S BANK SENDS CASH TO CENTRAL BANK

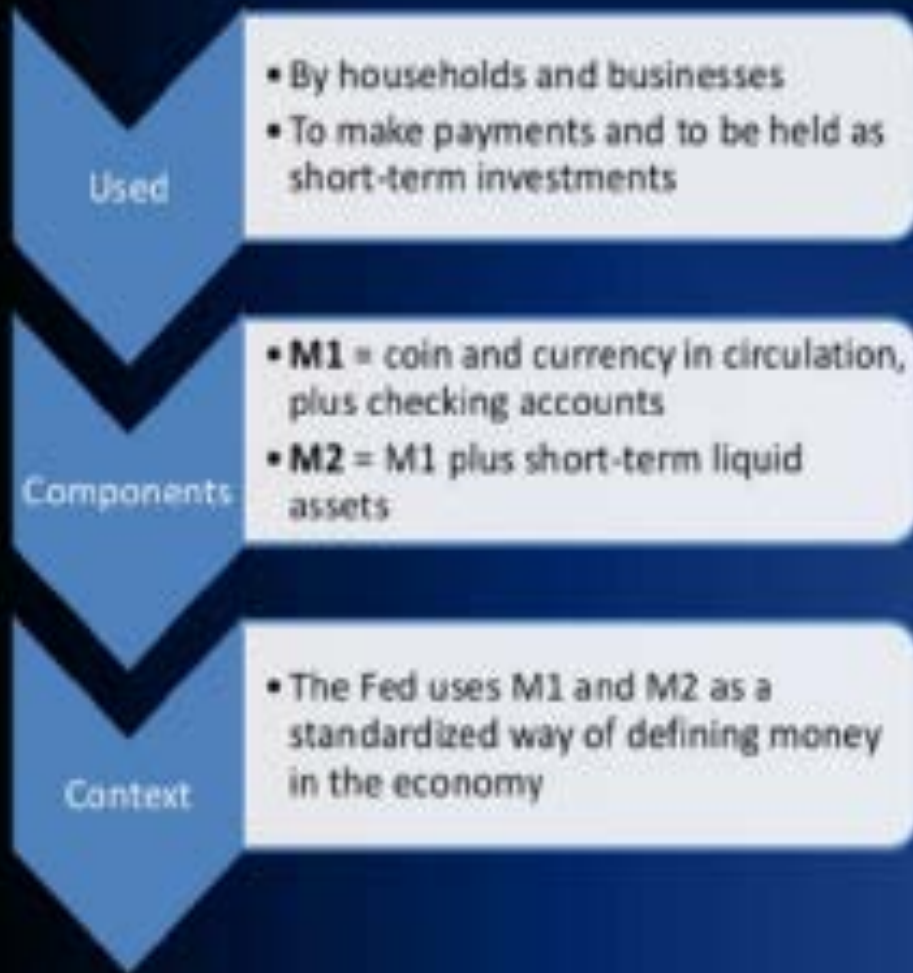
6. SELLER'S BANK CREDITS SELLER'S BANK ACCOUNT

5. SELLER DEPOSITS CASH IN SELLER'S BANK ACCOUNT

4. BUYER PHYSICALLY GIVES CASH TO SELLER



Money Supply in US



M1 and M2
(\$trillions, nonseasonally adjusted)

Source: Federal Reserve Board



As a share of the total values shown above, M1 dropped from 26% in 1980 to 20% in 2010.¹

1. See PowerPoint file for technical note.

Money Supply in US - Components

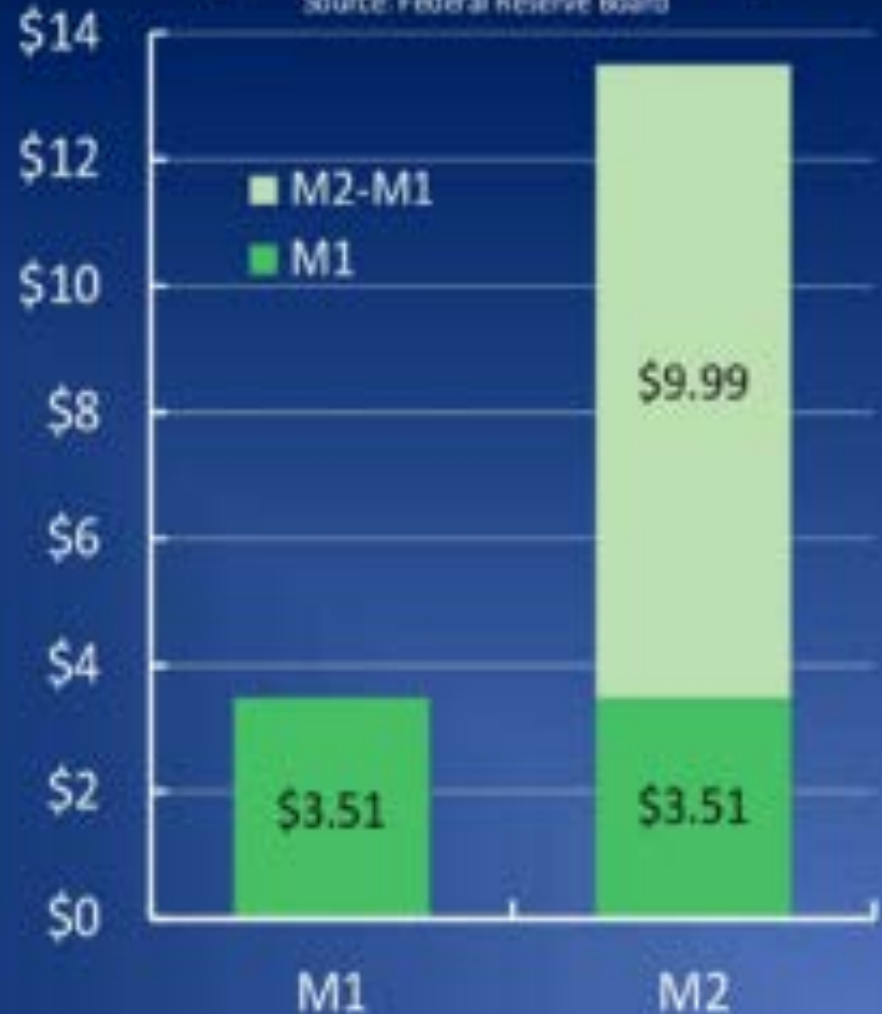
M2

- Savings Deposits
- Time Deposits
- Certain CDs
- Money Market Deposit Accounts
- Money Market Mutual Funds
- Includes M1

M1

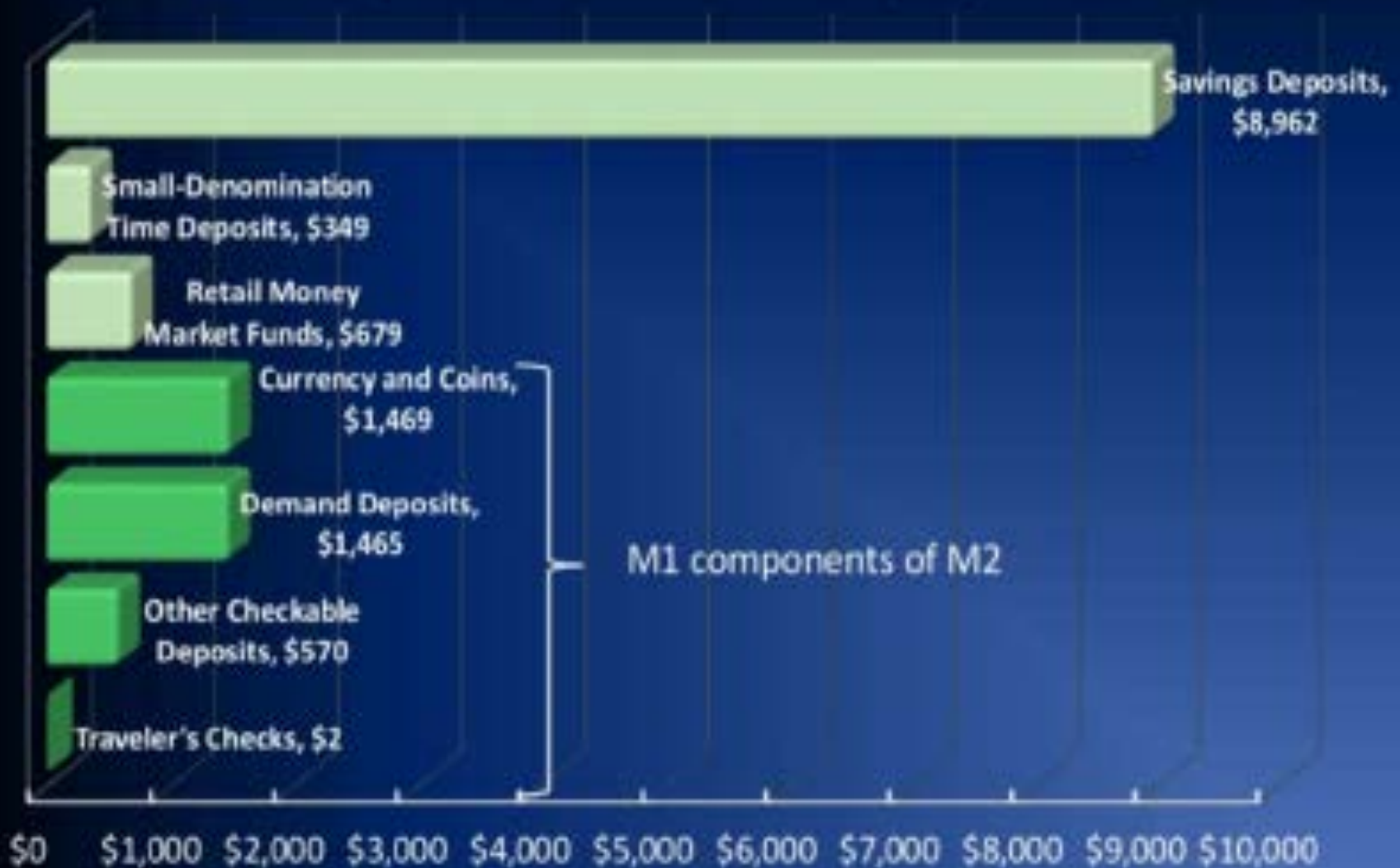
- Coin
- Currency
- Demand Deposits
- Travelers Checks

May 2017
(\$trillions, seasonally adjusted)
Source: Federal Reserve Board



M2 in Details

May 2017 (\$billions, seasonally adjusted)



Source: Federal Reserve Board 7/6/17 data release

Note: Components may not add to totals due to rounding



Money Supply

■ Money supply of US (in USD)

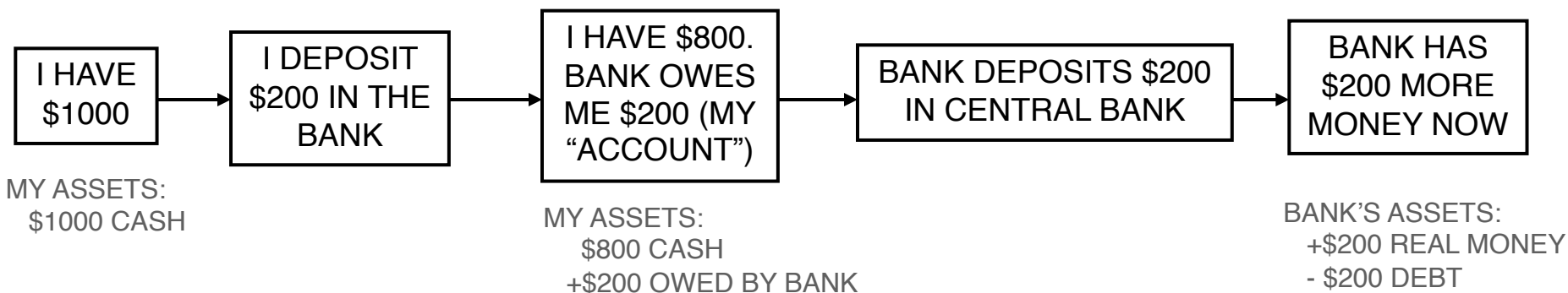
- ◆ M0 (currency = coins & notes) **3.3 Trillion (Nov. 2019) vs. 661B in Nov. 2003.**
- ◆ M1 (spendable now) **4.0 Trillion (Nov. 2019) vs. 1.28T (Nov 2003)** (liquid = M0 + non-interest deposits + travelers checks)
- ◆ **M1 IS MONEY AVAILABLE FOR PAYMENTS**
- ◆ M2 (M1+ time deposits + bank CDs) **15.3T (Nov 2019) vs. 6.07T (Nov 2003)**
- ◆ M3 (M2 + large time deposits + institutional money funds) **8.86T (in Nov 2003) ; US Fedral Reserve no longer uses M3**

Function of Banks

- Central banks:
 - ◆ Issue fiduciary money (both token and notational)
- All other (non-central) banks:
 - ◆ Issue notational scriptural money (bank accounts)
 - ✦ Not fiduciary (“real money”), not token
- Non-central banks
 - ◆ Move notational money
 - ◆ Accept deposits (loans from depositors)
 - ◆ Loan deposits to others (borrowers)

What is a Bank Account?

- Notational representation of a loan to the bank from a depositor
- Once the depositor puts money in his account, it becomes the bank's money, not the depositor's
- When the bank deposits its money in the central bank, it becomes fiduciary (real) money
- The bank then owes the depositor real money
- Effect of deposit: bank ends up with more real money



Benefit of a Bank Deposit

■ Bank can

- ◆ loan the money (more than was deposited!)
- ◆ invest the money
- ◆ move the money, e.g. make payments
- ◆ buy foreign currency with the money

■ Reserve ratio

- ◆ Fraction of deposits the bank must keep in the central bank
- ◆ If the reserve ratio is 25%, then for a \$1000 deposit, the bank can lend out \$3000

Foreign Exchange

- Currency = token fiduciary money of a central bank
- Every bank account is denominated in one currency
- Most banks allow accounts in only one currency
- All currencies have three-letter ISO currency codes:
 - ◆ USD (U.S. dollar) JPY (Japan yen)
 - ◆ GBP (Great Britain pound) CHF (Swiss franc)
 - ◆ HKD (Hong Kong dollar) EUR (Euro)
 - ◆ CNY (Chinese Yuan ; commonly called Renminbi)
- Usually, the first two letters indicate the country; third letter is the first letter of the currency name
- Foreign exchange is a barter transaction
 - ◆ To buy GBP for USD, buyer has to find someone with GBP who wants USD

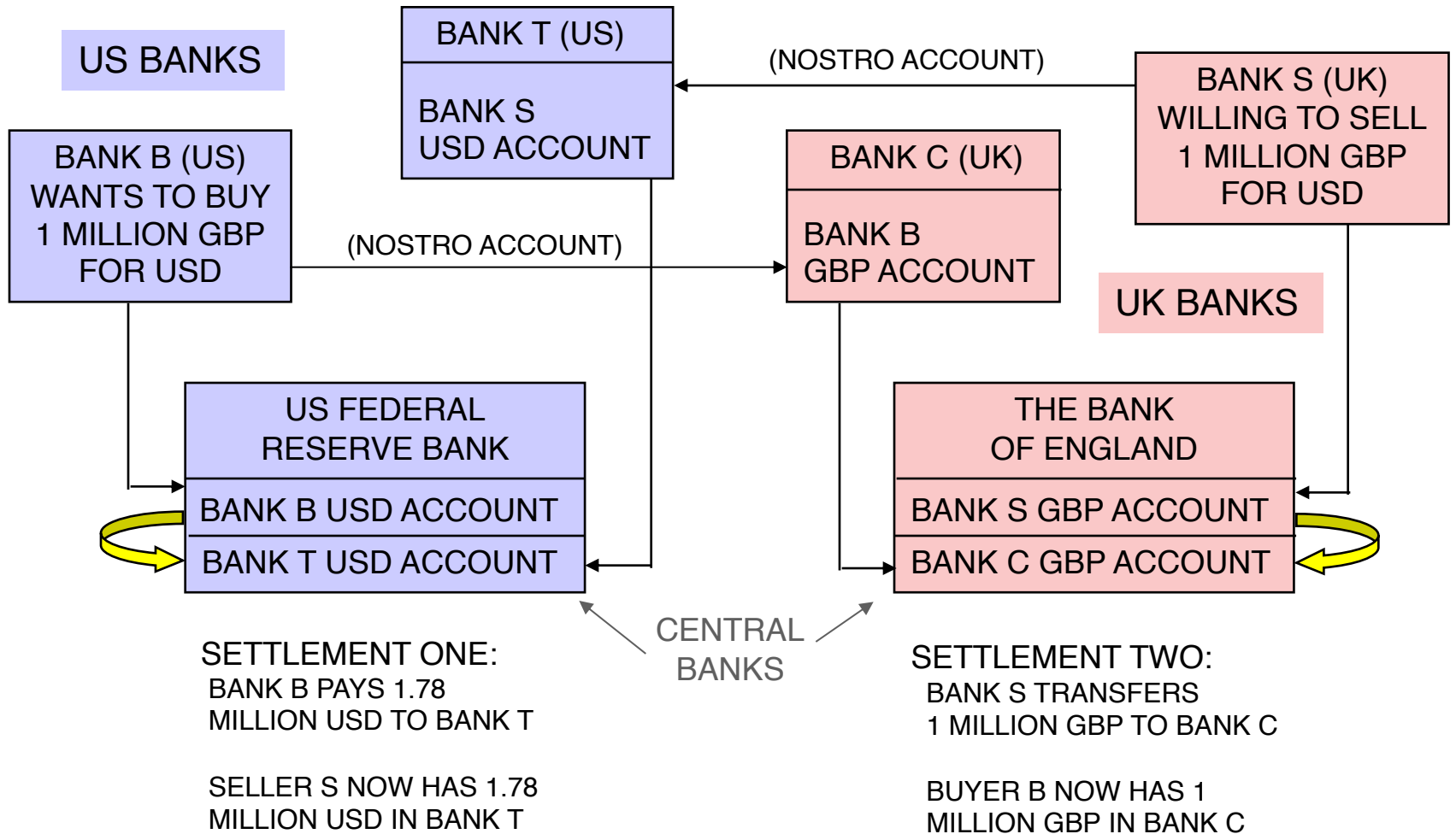
Foreign Exchange

- Every bank must have an account at the central bank (or with another bank that has a central account)
- The account is (usually) denominated in that country's currency and is used to settle obligations in that currency
 - ◆ Hong Kong is an exception. It has 4 systems (RTGS: Real-Time Gross Settlement systems) for transacting in HKD, USD, CNY and EUR.
- A foreign exchange transaction requires two settlements, one in each currency
- Therefore, two countries' central banks (or settlement systems) are involved (except in HK, more later)

Foreign Exchange Example

- Buyer in the US wants to pay an invoice in GBP from Seller in the UK
- Buyer needs GBP. Where does he get them? Where does he put them? This is done through banks.
- Bank B (buyer) in the U.S. buys 1 million GBP for 1.78 million USD from Bank S (seller) in the UK
- Bank B must have an account denominated in GBP somewhere, probably at Bank C in the UK
- Bank S must have an account denominated in USD somewhere, probably at Bank T in the US

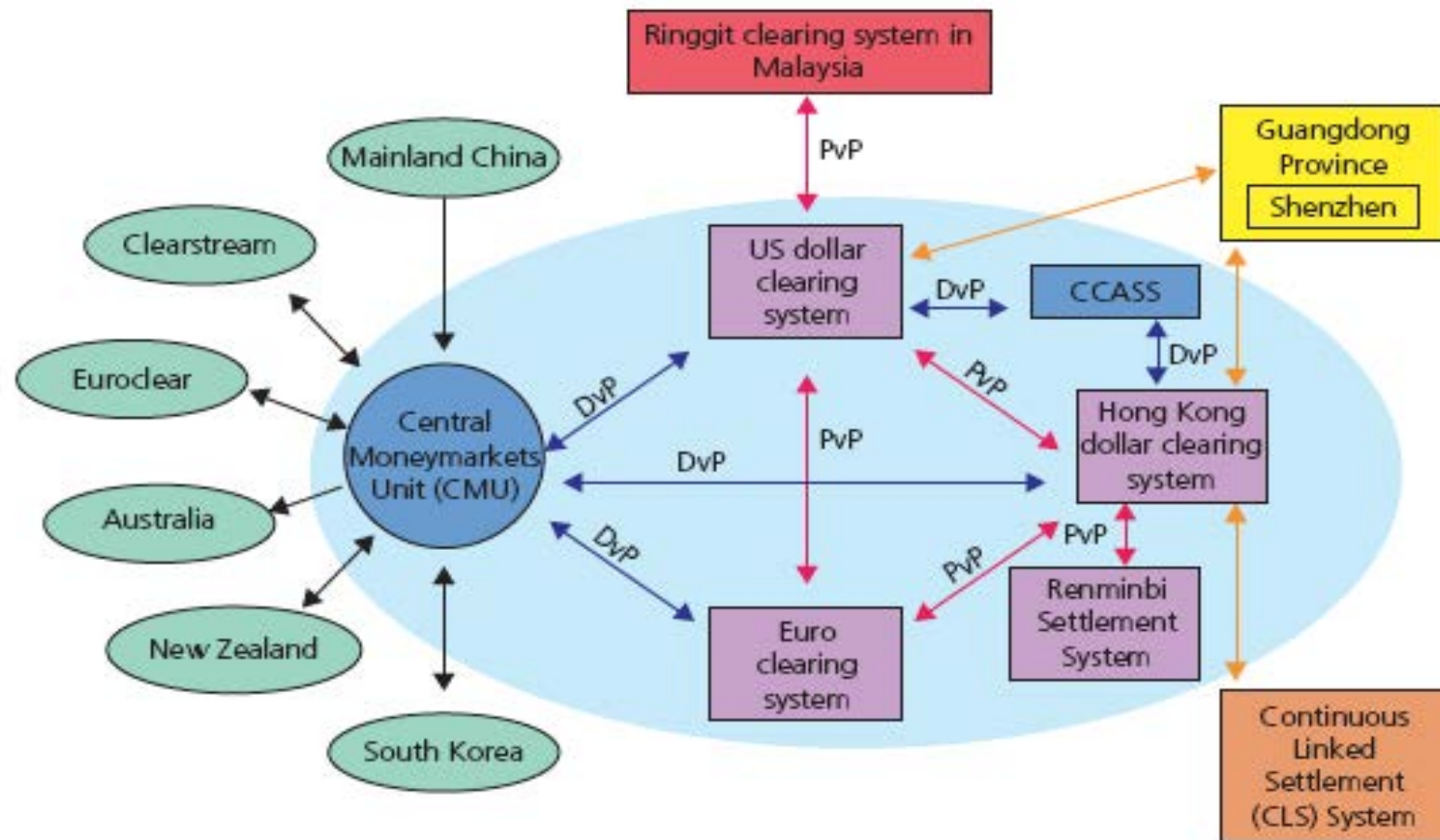
Foreign Exchange Example



Foreign Exchange in Hong Kong

- A bank's sight deposit account is (usually) denominated in that country's currency and is used to settle obligations in that currency
- **Hong Kong is an exception.** HK has 4 systems, namely the 4 Real-Time Gross Settlement systems (RTGS) for transacting in HKD, USD, CNY and EUR.
 - ◆ Interbank HKD settlements via a bank's account with HKMA
 - ◆ HSBC serves as the settlement institution for USD
 - ◆ Standard Chartered Bank as the settlement institution for EUR
 - ◆ Bank of China as the clearing bank for CNY
 - ◆ The RMB RTGS can be considered as an extension of the CNAPS (China's National Advanced Payment System) but governed by Hong Kong laws
- Hong Kong Interbank Clearing Limited (HKICL) is the *operator* of all of these 4 RTGS systems
 - ◆ <https://www.hkma.gov.hk/eng/key-functions/international-financial-centre/financial-market-infrastructure/payment-systems/>
 - ◆ <https://www.hkma.gov.hk/media/eng/publication-and-research/quarterly-bulletin/qb9508/fa01.pdf>

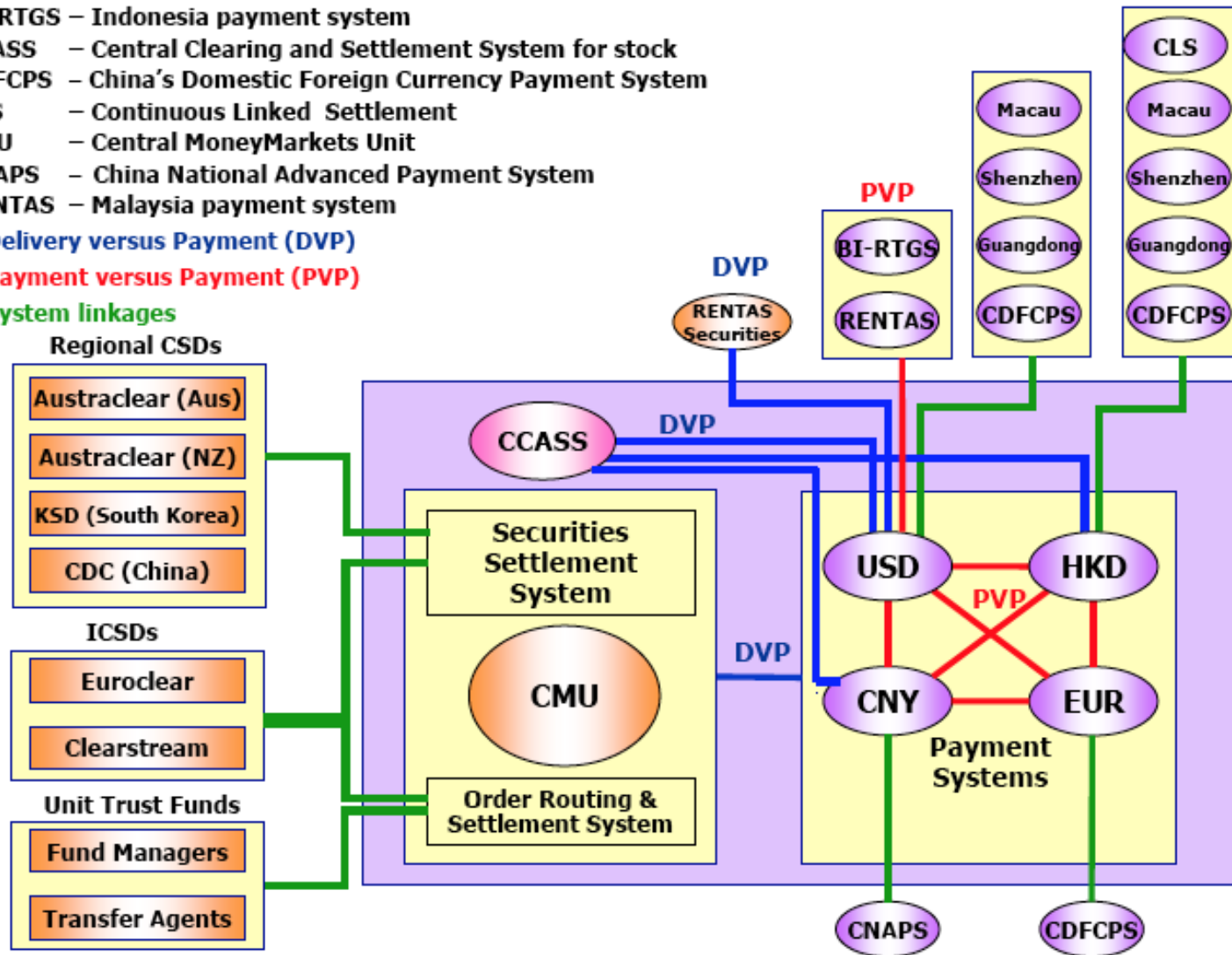
Overview of Financial Infrastructure in Hong Kong (circa 2006)



↔ Cross-border debt settlement system link
 ↔ DvP: Delivery-versus-Payment
 ↔ Cross-border payment and settlement system link
 ↔ PvP: Payment-versus-Payment

Hong Kong's Multi-currency Payment and Settlement Infrastructure (since 2012)

- BI-RTGS – Indonesia payment system
- CCASS – Central Clearing and Settlement System for stock
- CDFCPS – China's Domestic Foreign Currency Payment System
- CLS – Continuous Linked Settlement
- CMU – Central MoneyMarkets Unit
- CNAPS – China National Advanced Payment System
- RENTAS – Malaysia payment system
- Delivery versus Payment (DVP)
- Payment versus Payment (PVP)
- System linkages



Clearance v. Settlement

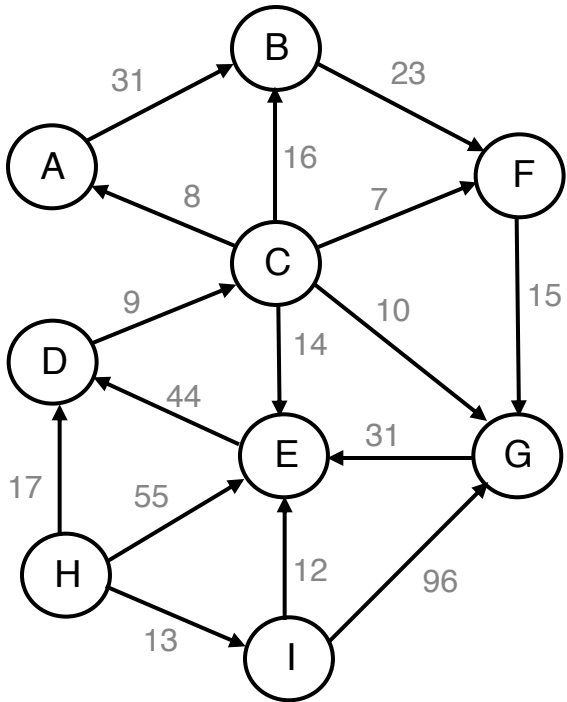
- Messaging
 - ◆ Transmission of payment orders
- Clearance
 - ◆ Determining the net effect of multiple payment orders
 - ◆ How much does each party owe or is owed?
- Settlement
 - ◆ Actual payment, *often (NOT ALWAYS)* involving a central bank
- Foreign exchange requires two settlements
 - ◆ Exchange HKD (HK dollars) to JPY (Japanese ¥) requires settlement in both HKD and JPY

Gross v. Net Settlement Systems

- Gross settlement system: every transaction is processed separately (usually immediately)
Example: cash purchase, large-value bank transfers
- Problem: transaction overhead, network load

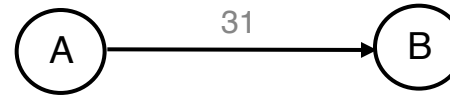
- Net settlement system: transactions are batched
Example: credit cards
 - ◆ Merchant is paid once per day, not for each sale
 - ◆ Customer is billed once per month
- Problem: Delay. Time is the enemy of money.
There is also higher risk of bulk, delayed net settlements !
 - ◆ Alternative (later in the notes): Payment-vs-Payment PVP real-time simultaneous settlements in 2 currencies as in HK to overcome time-zone difference/ delayed settlement risks

Payment Graphs



WITH N PARTIES, NUMBER OF POSSIBLE DEBTS IS $N(N-1)/2$

10,000 BANKS, 50 MILLION PAYMENTS



“A OWES B \$31”

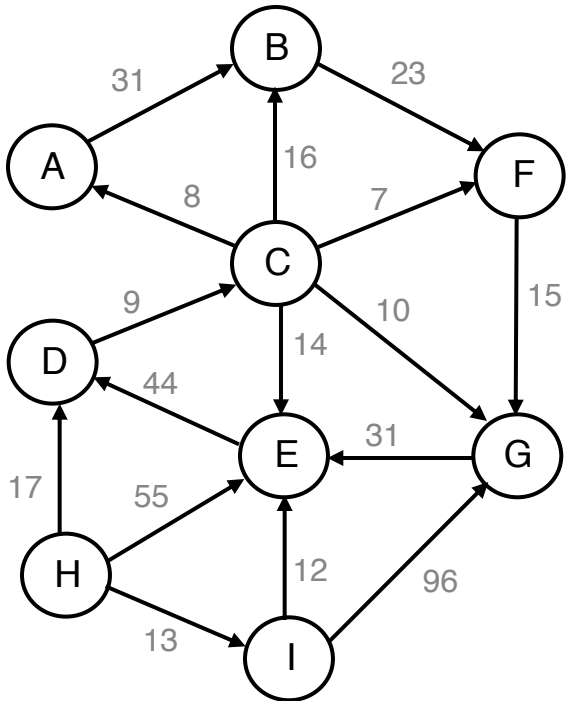


“A HAS \$49; B HAS \$16;
A OWES B \$31”



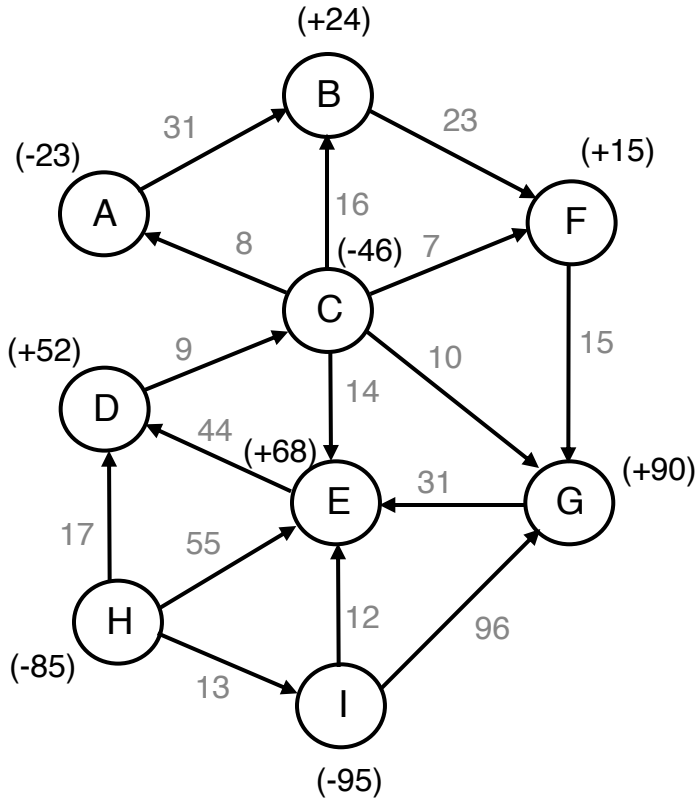
“A HAS \$49; B HAS \$16;
A OWES B \$31;
A IS OWED NET \$15;
B OWES NET \$12”

Gross Settlement



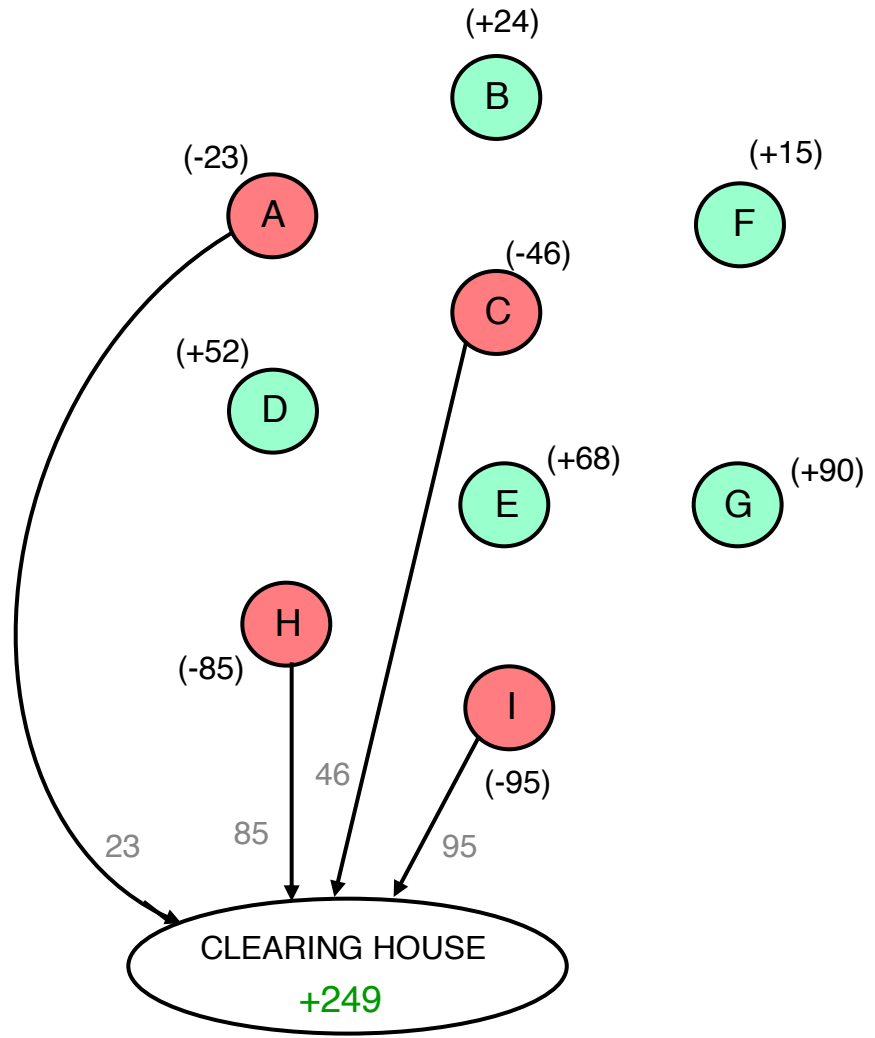
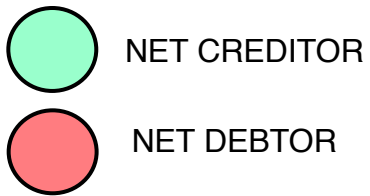
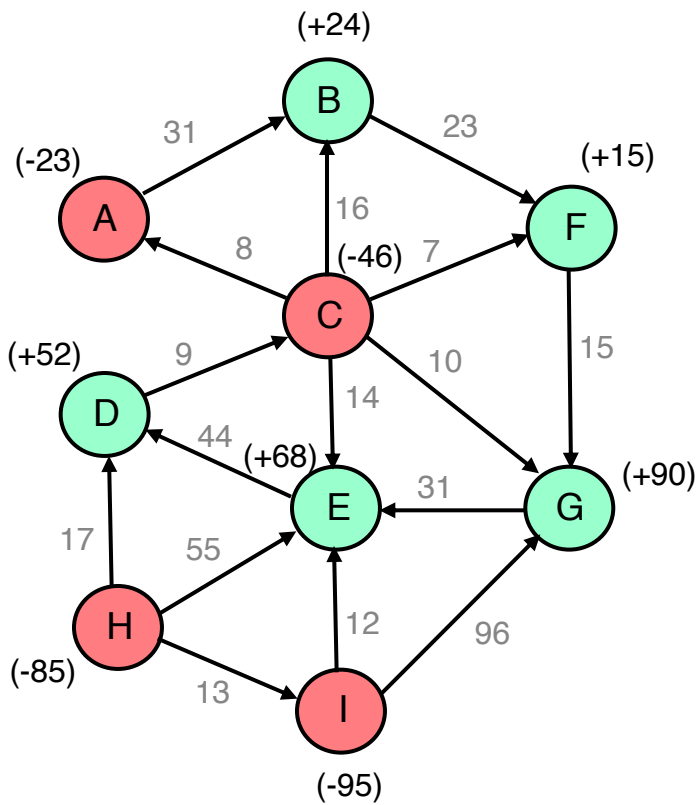
- Each debt is settled individually
- # of payments = # of debts
- Here, 16 payments required
- Collection is a problem (failure to pay)
- RTGS = “real-time gross settlement,” immediate payment

Net Settlement

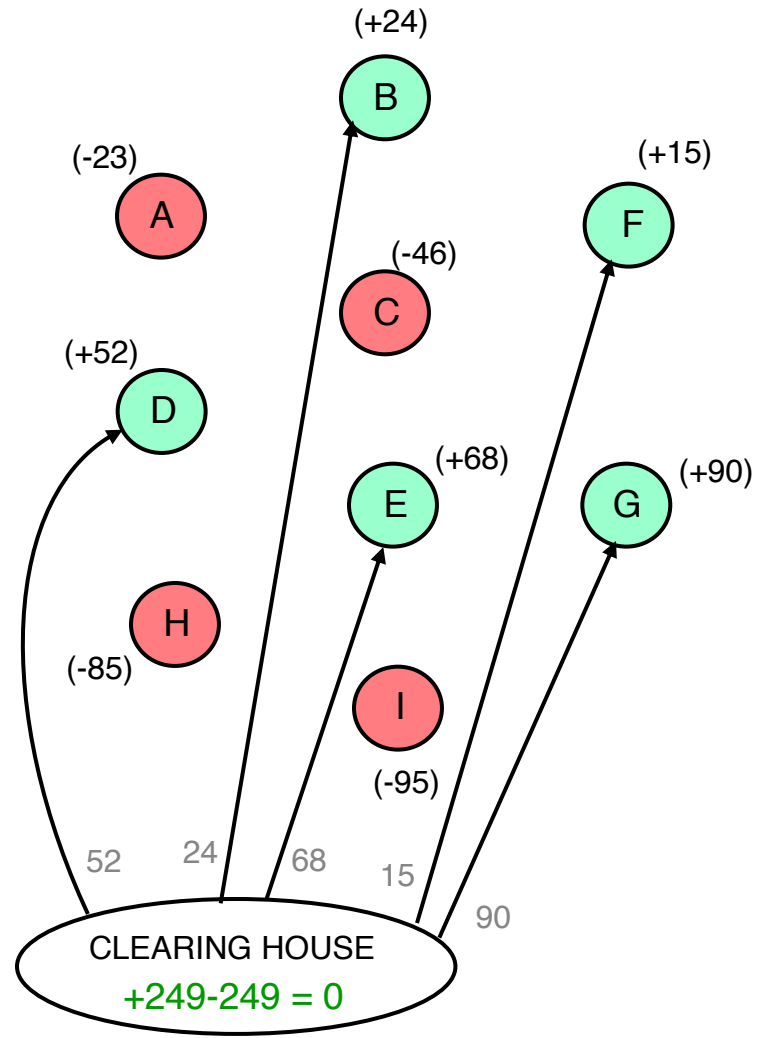
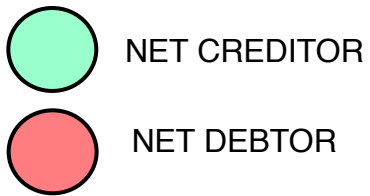
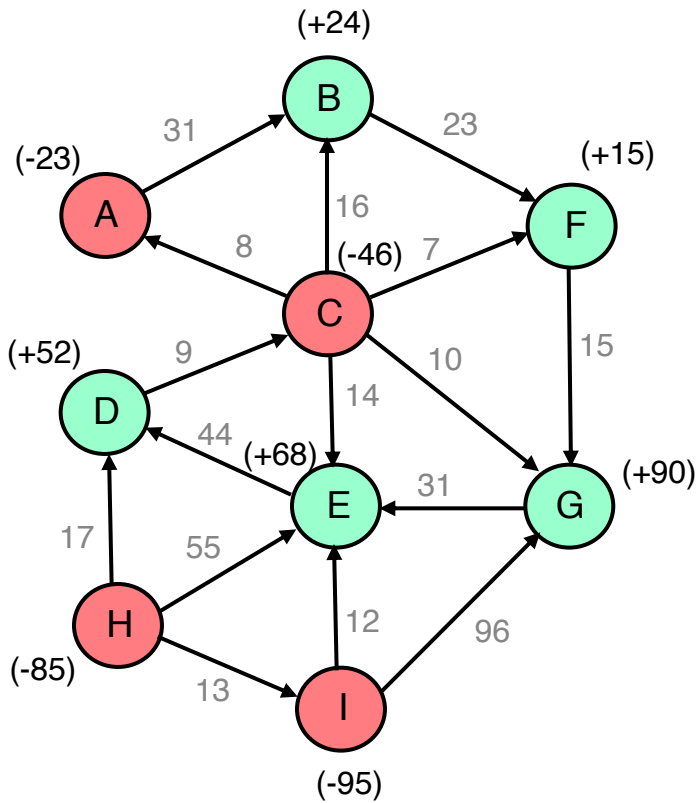


- Compute net amount owed or owing for each party
- Net debtors make one payment to the “clearing house”
- Net creditors receive one payment from the clearing house
- # of payments = # of parties
- 10,000 banks = 10,000 payments, not 50 million

Net Settlement



Net Settlement



Net v. Gross Settlement

- Net settlement requires “clearing”
 - ◆ Determining the net amounts owed or owing
- Need a separate clearing house
- Introduces delay (for clearing)
- Reduces counterparty risk
- Used for large numbers of small payments, e.g. cheques, credit cards

- Gross settlement can be instantaneous (< 1 minute)
- Gross settlement involves a large number of payments; used for large transactions, e.g. interbank transfers

Problems/ Risks in Net Settlement Systems

- Delay. Time is the enemy of money
 - ◆ Time-zone Difference worsens the situation if Business Operating Hours is not 24-hr around the clock !
 - ◆ There is also higher risk of BULK, delayed Net settlements !

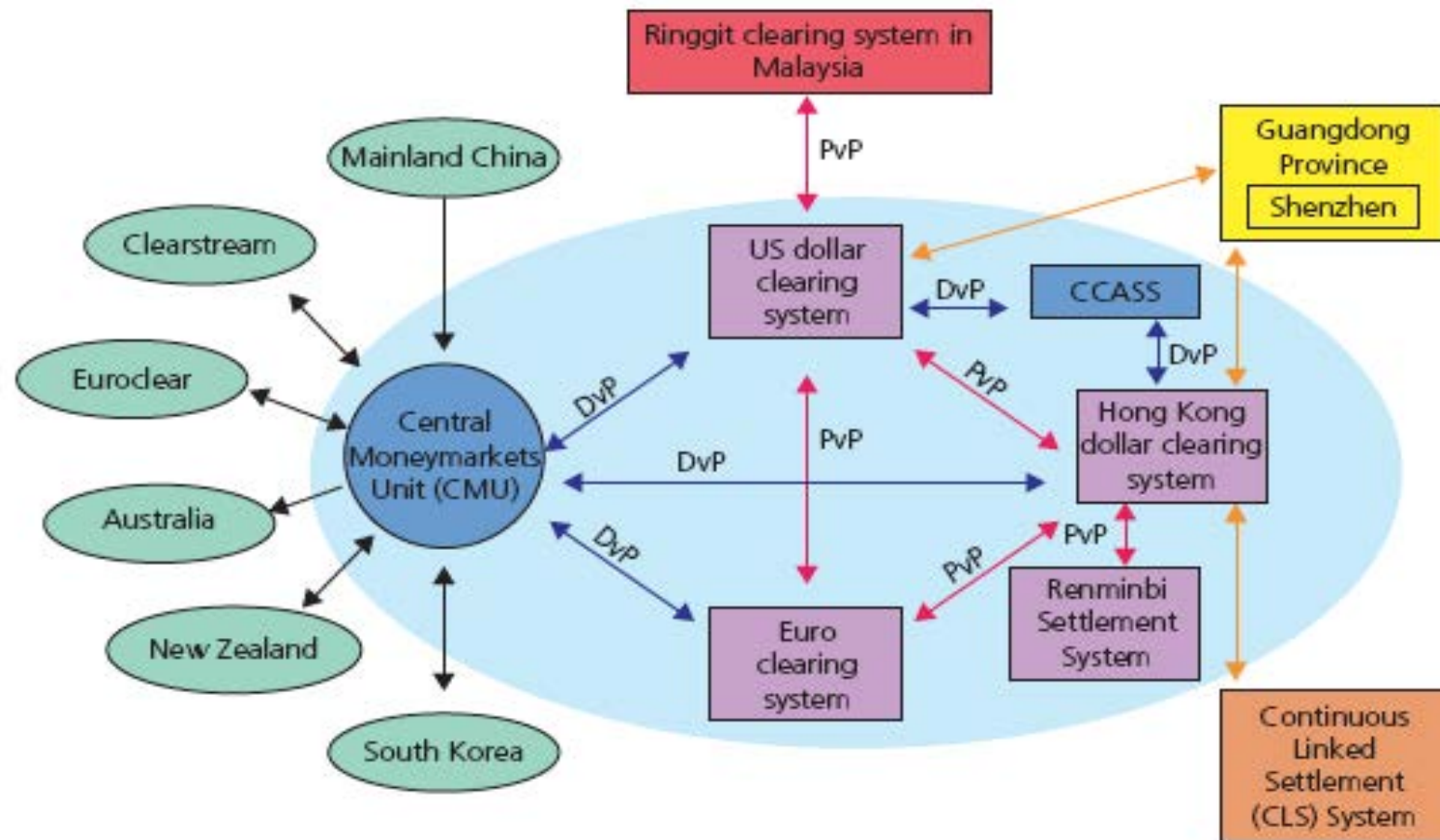
- Painful Lesson Learnt: The Herstatt Foreign Exchange Risk

- Alternative: Payment-vs-Payment PvP real-time simultaneous settlements in 2 currencies as in HK to overcome time-zone difference/ delayed settlement risks

Herstatt Foreign Exchange Risk

- Bankhaus Herstatt, Germany, June 26, 1974
- In FOREX trade, received DEM for USD in Germany that day. Value: USD 621 million
- Went bankrupt; lost its banking license; ordered into liquidation after the close of the German interbank payment system at 3:30 p.m. (9:30 a.m. in NY)
- Its correspondent bank in New York refused to pay out USD at 10:30 a.m.
- The banks that paid DEM never received USD
- Effect on banking system was 25 times the amount of the loss
- This is the “Herstatt risk” – that only one leg of a foreign exchange transaction will settle, causing Cascade Effect
 - ◆ A more Recent Lesson: The Collapse of Lehman Brothers a US-based Bank and Global Financial Service firm in Sept 2008 which triggered Financial Tsunami world-wide

Overview of Financial Infrastructure in Hong Kong



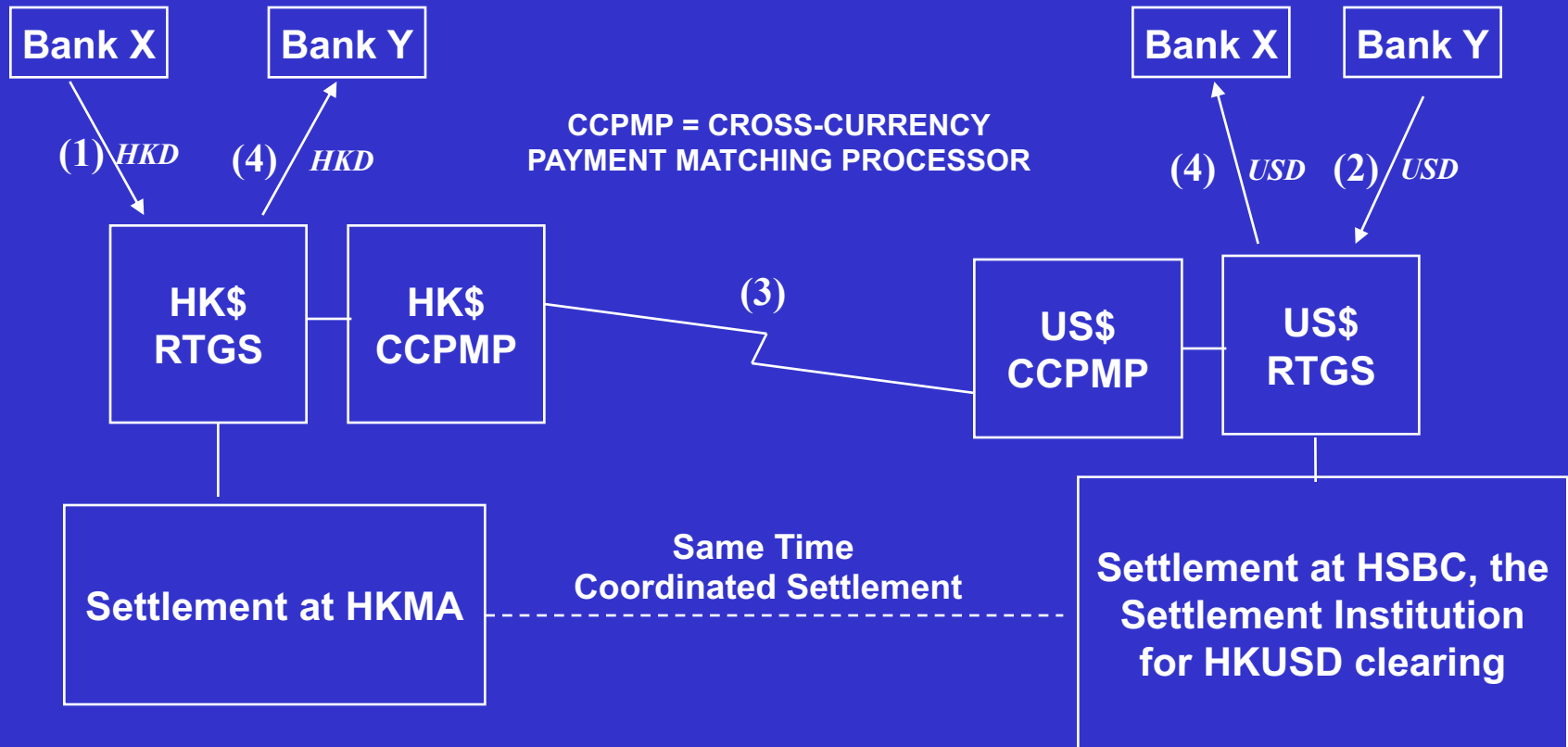
↔ Cross-border debt settlement system link
 ↔ Cross-border payment and settlement system link

↔ DvP: Delivery-versus-Payment
 ↔ PvP: Payment-versus-Payment

Hong Kong Payment vs. Payment (PvP)

Eliminates Herstatt Risk

Bank X selling HKD to Bank Y for USD



- (1) HK\$ payment from Bank X withheld by HKMA awaiting confirmation from US\$ RTGS system.
- (2) US\$ payment from Bank Y withheld by HSBC awaiting confirmation from HK\$ RTGS system.
- (3) Message exchange uses the cross currency payment matching processor (CCPMP).
- (4) Once matching is done - US\$ released to Bank X' HK\$ released to Bank Y

US Banking and Payment Systems

U.S. Banking & Payments System

PRINTS CURRENCY

U.S. TREASURY DEPARTMENT



REGULATES NATIONAL BANKS

COMPTROLLER OF THE CURRENCY



FORMULATES MONEY POLICY

FEDERAL RESERVE BOARD



OFFICE OF THRIFT SUPERVISION



REGULATES SAVINGS BANKS

FEDERAL SAVINGS BANKS

NATIONAL COMMERCIAL BANKS (2500)

FEDERAL RESERVE BANKS (12)

NY FEDERAL RESERVE

ISSUE MONEY

- OWNS
- REGULATES
- USES
- HAS ACCOUNT WITH

ELECTRONIC PAYMENTS NETWORK
OTHER CLEARING HOUSES
VISANET

CLEAR CHECKS, ACH, CREDIT CARDS

FEDERAL RESERVE CLEARING HOUSE

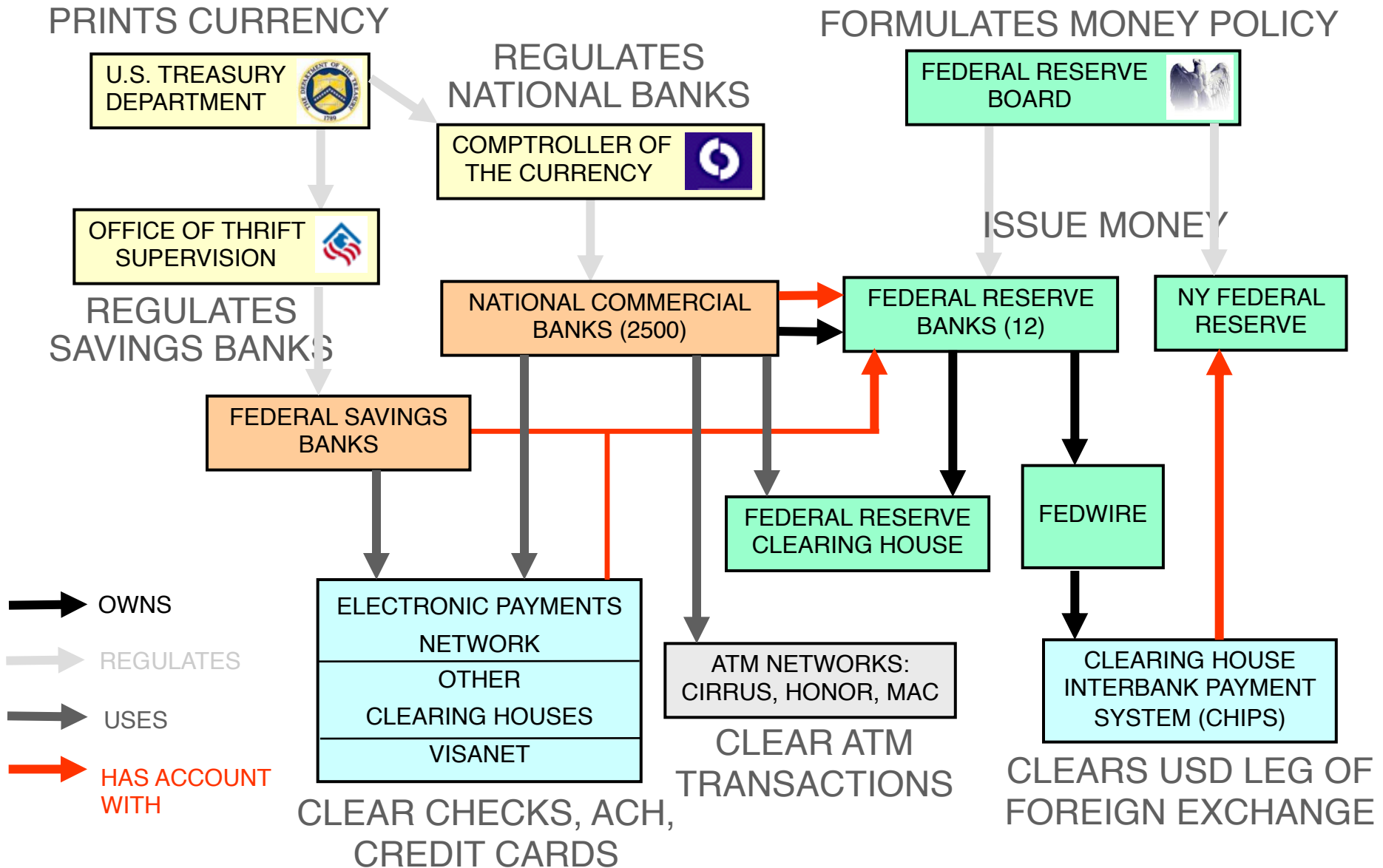
ATM NETWORKS: CIRRUS, HONOR, MAC

CLEAR ATM TRANSACTIONS

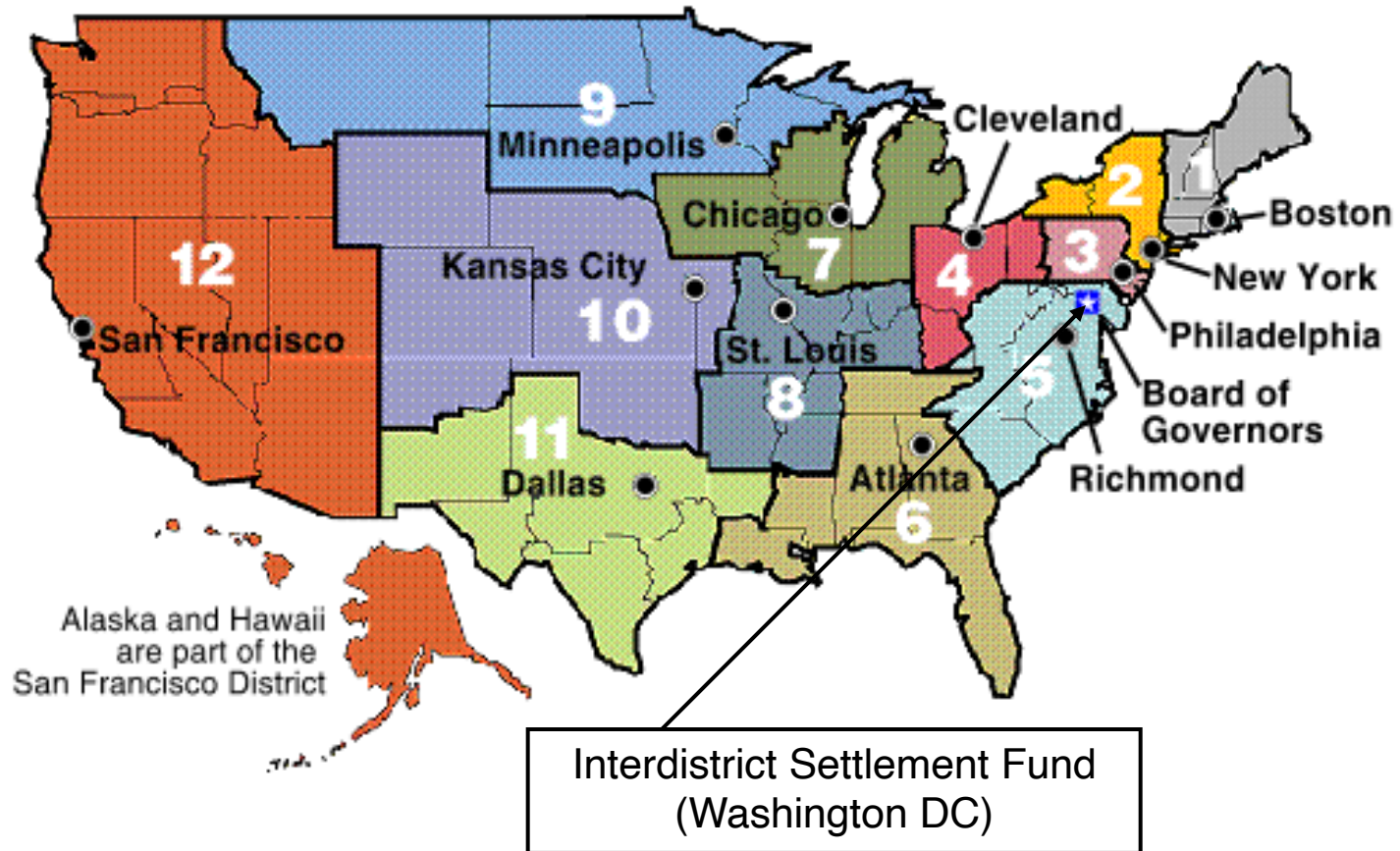
FEDWIRE

CLEARING HOUSE INTERBANK PAYMENT SYSTEM (CHIPS)

CLEAR USD LEG OF FOREIGN EXCHANGE



Federal Reserve System

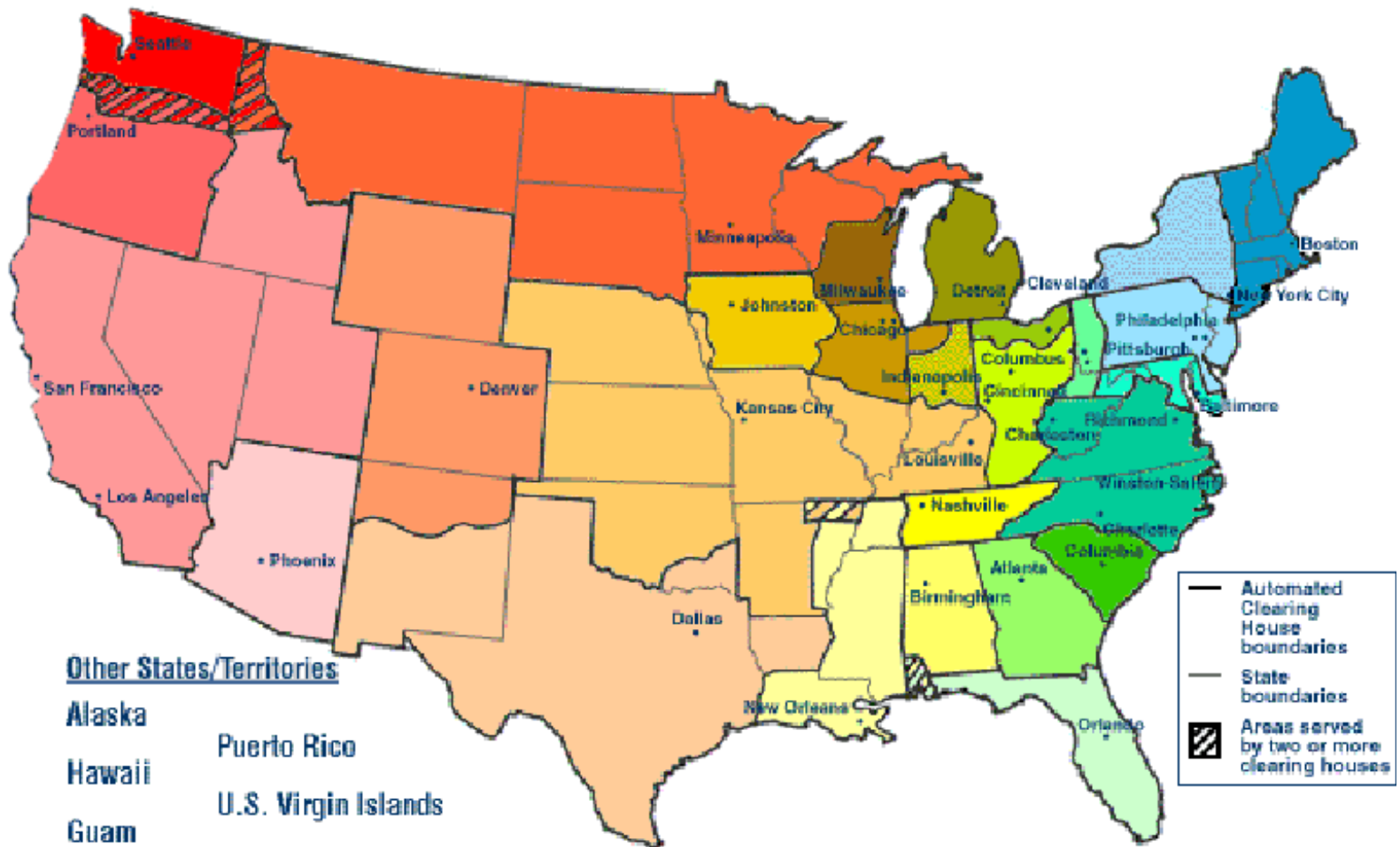


INFO

+ branches (Cleveland Fed has a branch in Pittsburgh)


SOURCE: FED

Regional Automated Clearing House (ACH) Networks in the US



More details on ACH later ...

Fedwire

- Real-time gross settlement system of the Federal Reserve
- Used by any institution that has an account at the Federal Reserve
- Used mainly for large transfers (average: \$3.5M)
- On-line connection (7800 institutions, 99% of transfers)
 - ◆ Direct connection
 - ◆ Computer dialup
- Off-line connection (1700 institutions, 1% of transfers)
 - ◆ Telephone instructions with codeword
- FedLine access from PCs 
- Some services over the Web (not funds transfer yet)

Fedwire Participants

- Depository institutions
- Agencies and branches of foreign banks
- Member banks of the Federal Reserve System
- U.S. Treasury and authorized agencies
- Foreign central banks, foreign monetary authorities, foreign governments, and certain international organizations; and
- Any other entities authorized by a Reserve Bank

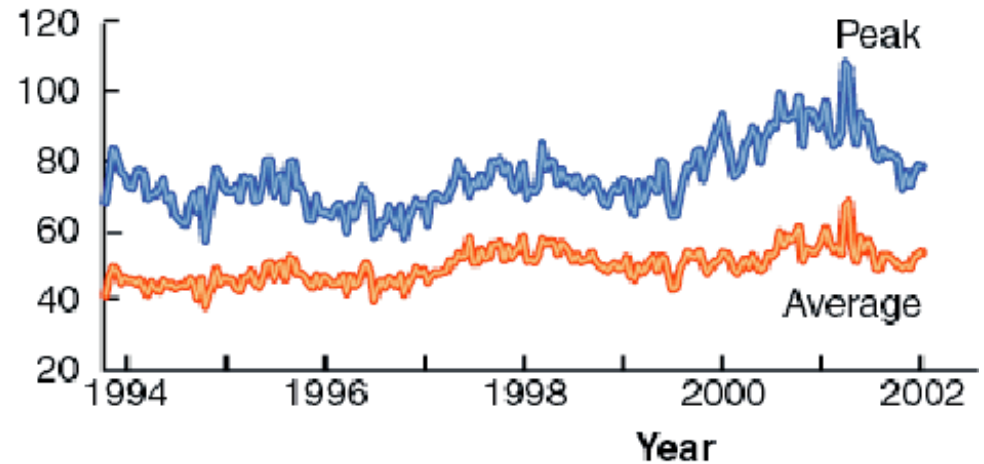
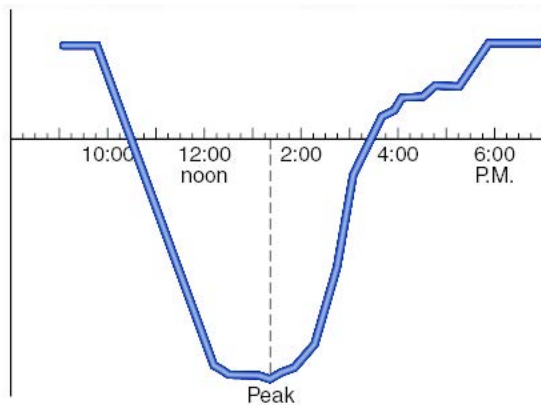
Fedwire

- 10,000 participants
- 108 million Fedwire transfers/yr, 300,000 per day
 - ◆ Value \$380T (11 times the World Economic Product)
 - ◆ New York Fed: 40 million transfers, \$209T
- “Instantaneous” (within minutes) irrevocable settlement
- Payment guaranteed by Fed
- Operates 18 hours/day on business days
- No minimum dollar amount
- Daylight overdrafts permitted (intraday peak: \$70B)
 - ◆ Fee charged if not collateralized (\$6.94 per million)

Daylight Overdrafts

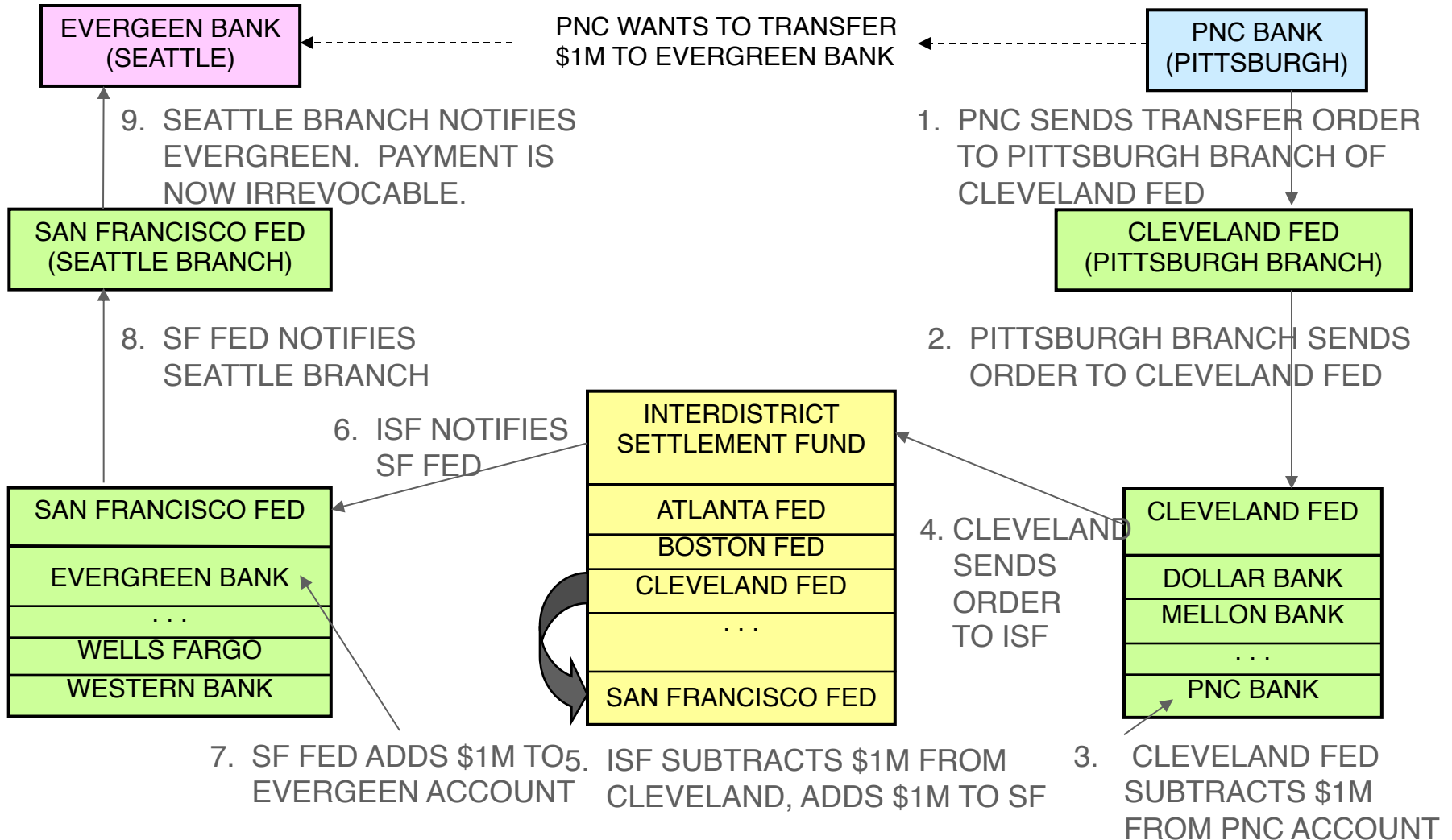
- An overdraft that must be repaid by the close of business the same day
- U.S Federal Reserve allows daylight overdrafts
- Hong Kong does not ; Banks need to keep Liquidity throughout the day of trading ; can borrow from HKMA

U.S. Federal Reserve Daylight Overdraft History



SOURCE: FEDERAL RESERVE

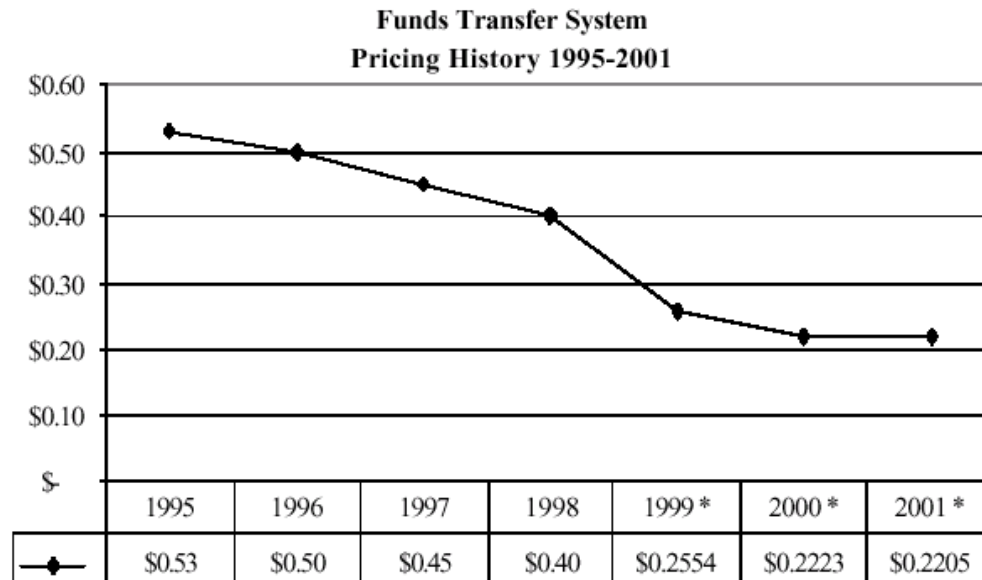
How Fedwire Works



Fedwire Fees

Service	Billing Code	Fee
Volume-Based Pricing Fees (Origination and Receipts)		
Per Transfer for the First 2,500 Transfers per Month	10001/10005	\$0.33
Per Transfer for Additional Transfers up to 80,000 per Month	10002/10006	\$0.24
Per Transfer for Every Transaction over 80,000 per Month	10003/10007	\$0.16*
Surcharge		
Off-line Transfer Originated or Received	10011	\$15.00
Telephone Notification	10015	\$15.00

*Effective



SOURCE: FEDERAL RESERVE

Federal Reserve Check Processing

- The Fed also performs ACH and paper check processing functions
- 46 regional check processing centers
- Interdistrict Transportation System (ITS) an airline for physical movement of checks
- ACH charges (Oct. 1, 2001):
 - ◆ \$5.00 per computer file
 - ◆ \$0.004 - \$0.0055 per item (about 1/2 cent)

CHIPS



- Clearing House Interbank Payment System
 - ◆ Clearing and settlement for USD foreign exchange
 - ◆ Subsidiary of the New York Clearing House
- Handles 95% of all U.S. dollar foreign exchange payments
- 56 participating banks
- Settles through NY Federal Reserve
- Average 250,000 transactions / day (peak: 457K)
- Average USD 1.2T / day (peak: 2.2T)
- Average transaction value: USD 5,180,000
- Annual volume: USD 287T
- Down about 20 minutes per year

CHIPS Participants

0958	ABN-AMRO Bank N.V.	0103	Deutsche Bank Trust Co Americas
0159	American Express Bank Ltd.	0830	Dresdner Bank AG
0572	Arab Bank PLC	0285	Wachovia Bank, N.A. - Charlotte
0861	Banca di Roma	0032	Fleet National Bank
0981	Banca Nazionale Del Lavoro	0776	Harris Trust and Savings Bank
0184	Banco Bilbao Vizcaya, S.A.	0108	HSBC Bank USA
0855	Banco de la Nacion Argentina	0908	International Commercial Bank of China
0355	Banco do Brasil S.A.	0531	Banca Intesa S.p.A.
0869	Bangkok Bank Public Co. Ltd.	0976	Israel Discount Bank of New York
0886	Bank Hapoalim B.M.	0002	JP Morgan Chase
0279	Bank Leumi USA	0824	KBC Bank N.V.
0959	Bank of America, N.A.	0555	M&T Bank
0326	Bank of China	0862	The Mitsubishi Trust and Banking Corp.
1262	Bank of Communications	0430	Mizuho Corporate Bank Ltd - NY
0001	The Bank of New York	0772	National Australia Bank
0253	Bank of Nova Scotia	0217	The National Bank of Kuwait SAK
0963	Bank of Tokyo-Mitsubishi, Ltd.	0112	The Northern Trust Company
0979	Bank One, National Association	0422	Societe Generale
0257	Barclays Bank PLC	0256	Standard Chartered Bank
0768	BNP Paribas New York	0914	State Bank of India
0480	Brown Brothers Harriman & Co.	0487	State Street Bank and Trust Co.
0008	Citibank, N.A.	0967	Sumitomo Mitsui Banking Corporation
0804	Commerzbank AG	0799	UBS AG
0865	Credit Industriel et Commercial	0982	UFJ Bank Limited
0807	Credit Lyonnais	0505	Union Bank of California, N.A.
0371	Danske Bank	0509	Wachovia Bank, N.A. - New York
0378	Deutsche Bank AG	0407	Wells Fargo Bank Minnesota, N.A.

SOURCE: CHIPS

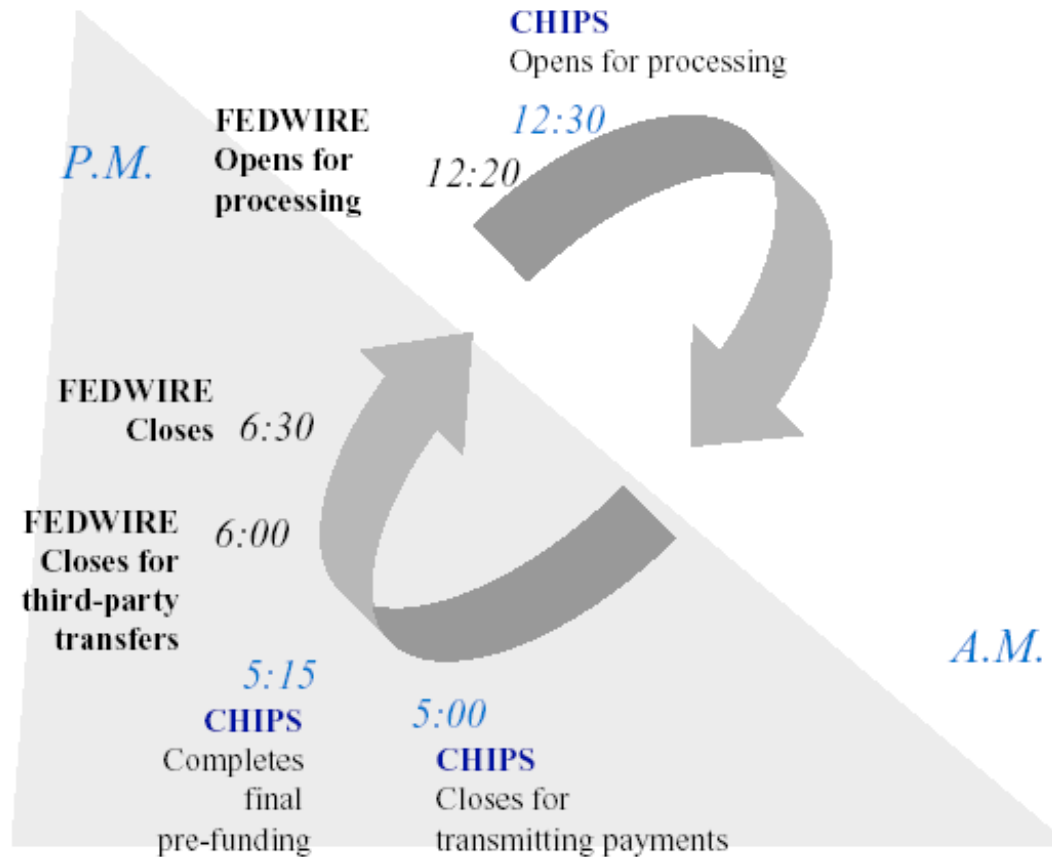
CHIPS Operation

- London Bank L has an account in a NY Bank A
- Wants to transfer \$1M to the account of Bank J in NY Bank B (A and B are on CHIPS)
- Bank L sends Bank A a SWIFT message
- Bank A verifies the message, enters it into CHIPS (Bank A has the \$1M; doesn't rely on L's credit)
- CHIPS verifies that the transaction is within A's debit limit and the B-A bilateral limit; otherwise rejects
- CHIPS notifies Bank B that \$1M is being deposited from Bank L through Bank A for Bank J
- Bank B notifies Bank J that \$1M has been added to its account

CHIPS Operation

- CHIPS closes at 4:30 p.m. NY time
- Each settling bank gets a settlement report showing net amount owed or owing
- Settling banks have until 5:30 to challenge the total or must pay into the CHIPS account at the NY Federal Reserve by Fedwire (US RTGS)
- Banks with net credit positions are paid by 5:45
- All payment orders are final and irrevocable
- Fedwire is a payment system
- CHIPS is a clearing system
- SWIFT is a messaging system

CHIPS and FedWire

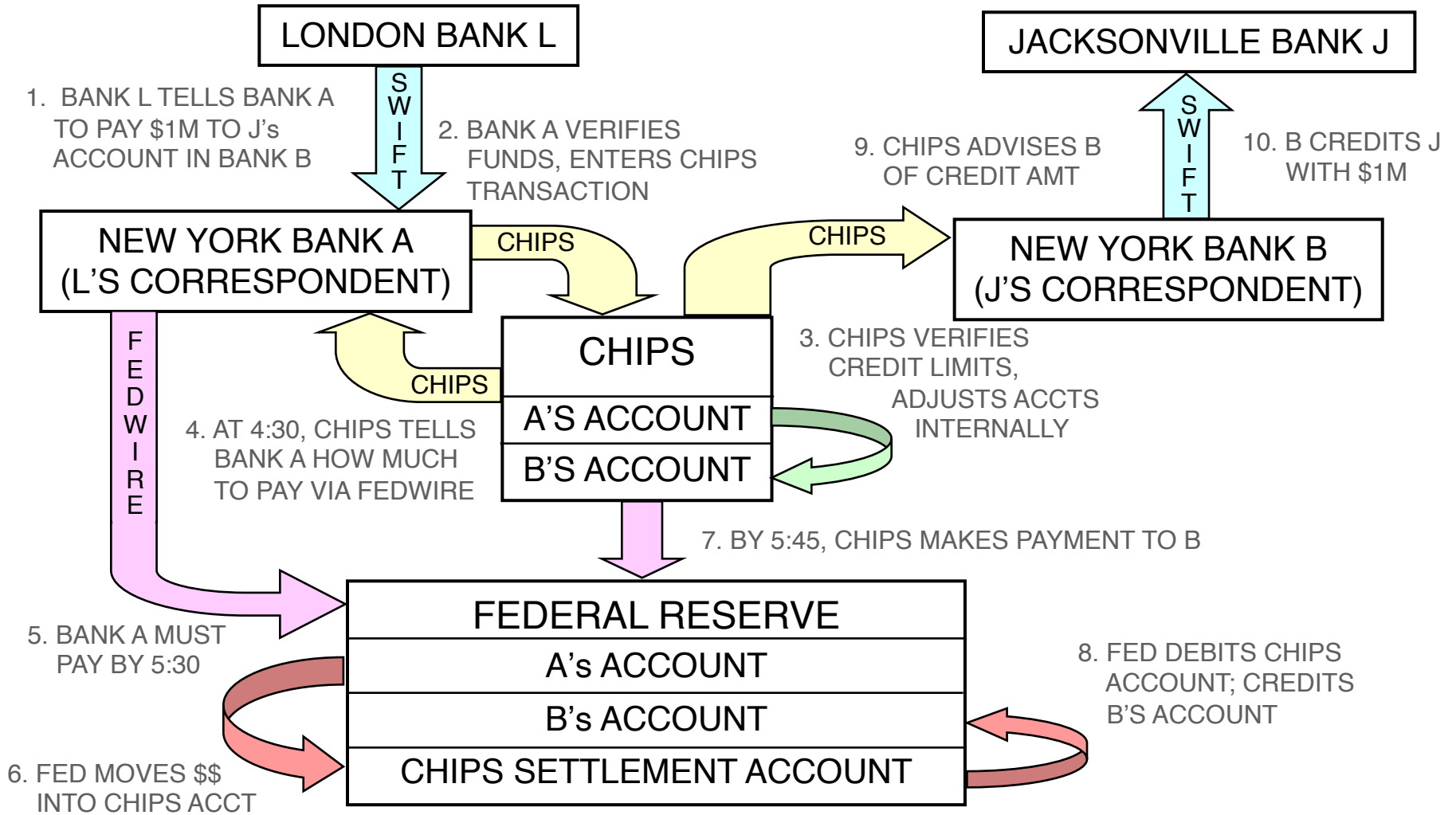


SOURCE: CHIPS

Another CHIPS Example

- A buyer in London needs to pay USD 1 million to a seller in Jacksonville, Florida
- The buyer only has GBP. He must buy USD in the UK and pay in USD in the US.
- Let's look at the USD leg of the CHIPS settlement
- Buyer's bank is L in London
- Bank L has a USD account in a correspondent bank A in NY that is a member of CHIPS
- Seller's bank J is in Jacksonville
- Bank J has a correspondent bank B in NY that is a member of CHIPS

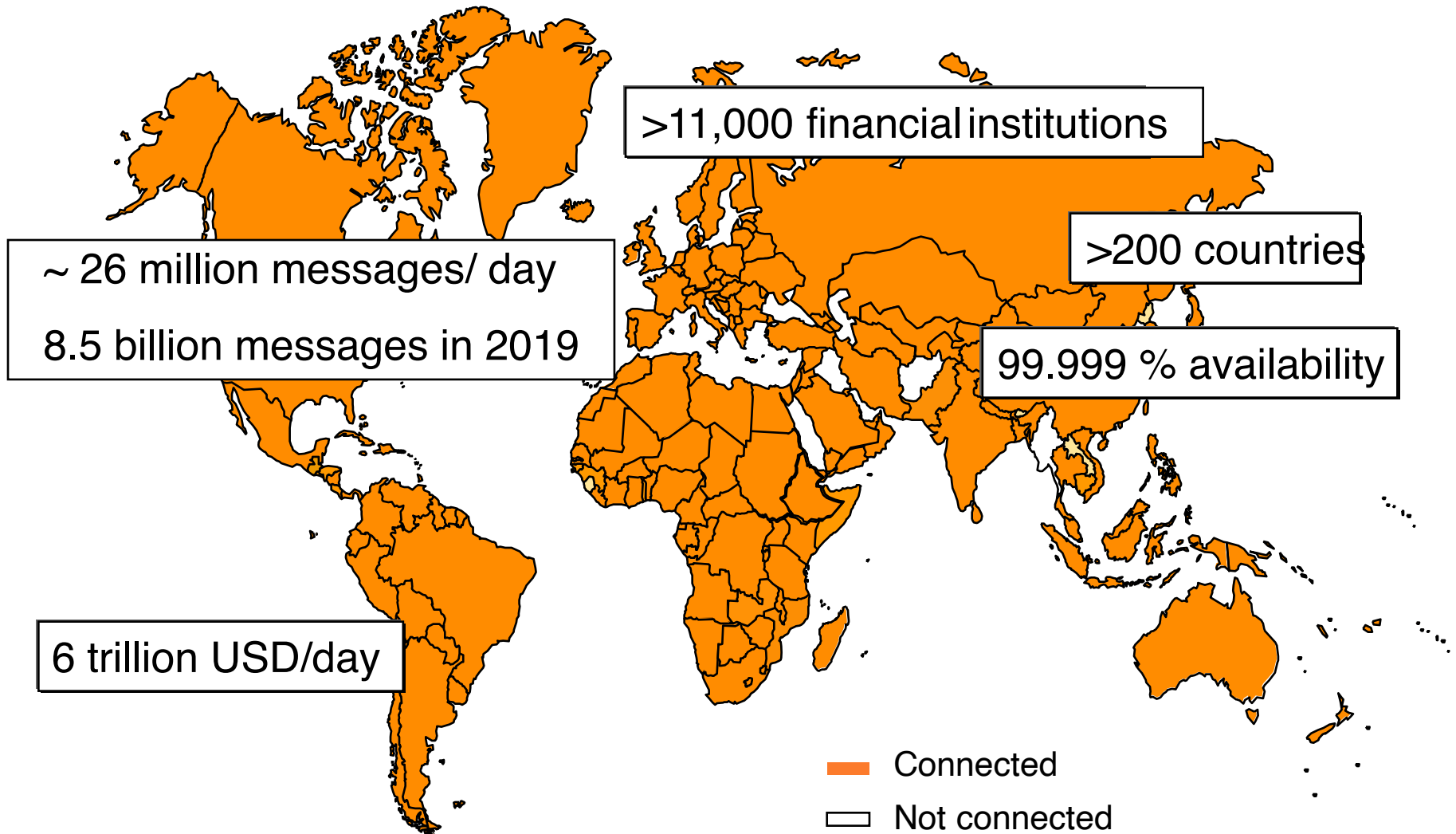
CHIPS Operation



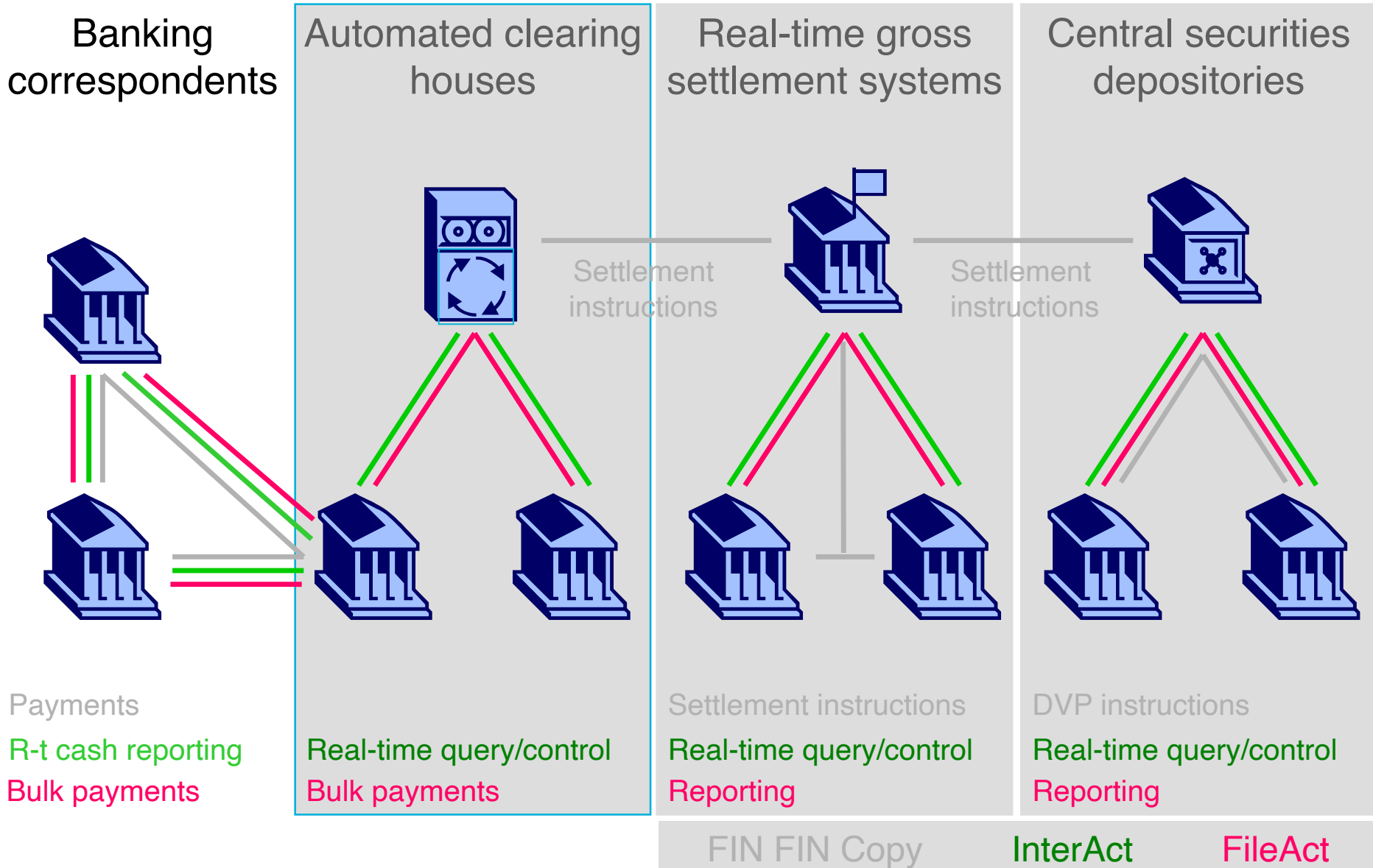
S.W.I.F.T.

- Society for Worldwide Interbank Financial Telecommunication
- Non-profit, headquarters in Brussels
- Financial messaging system, not a payment system
 - ◆ Settlement must occur separately
- >11,000 institutions, > 200 countries
- 8.5 billion messages per year: US\$6 trillion per day
- Cost ~ \$0.20 per message
- Private IP network
- swiftML
 - ◆ interoperable with ebXML

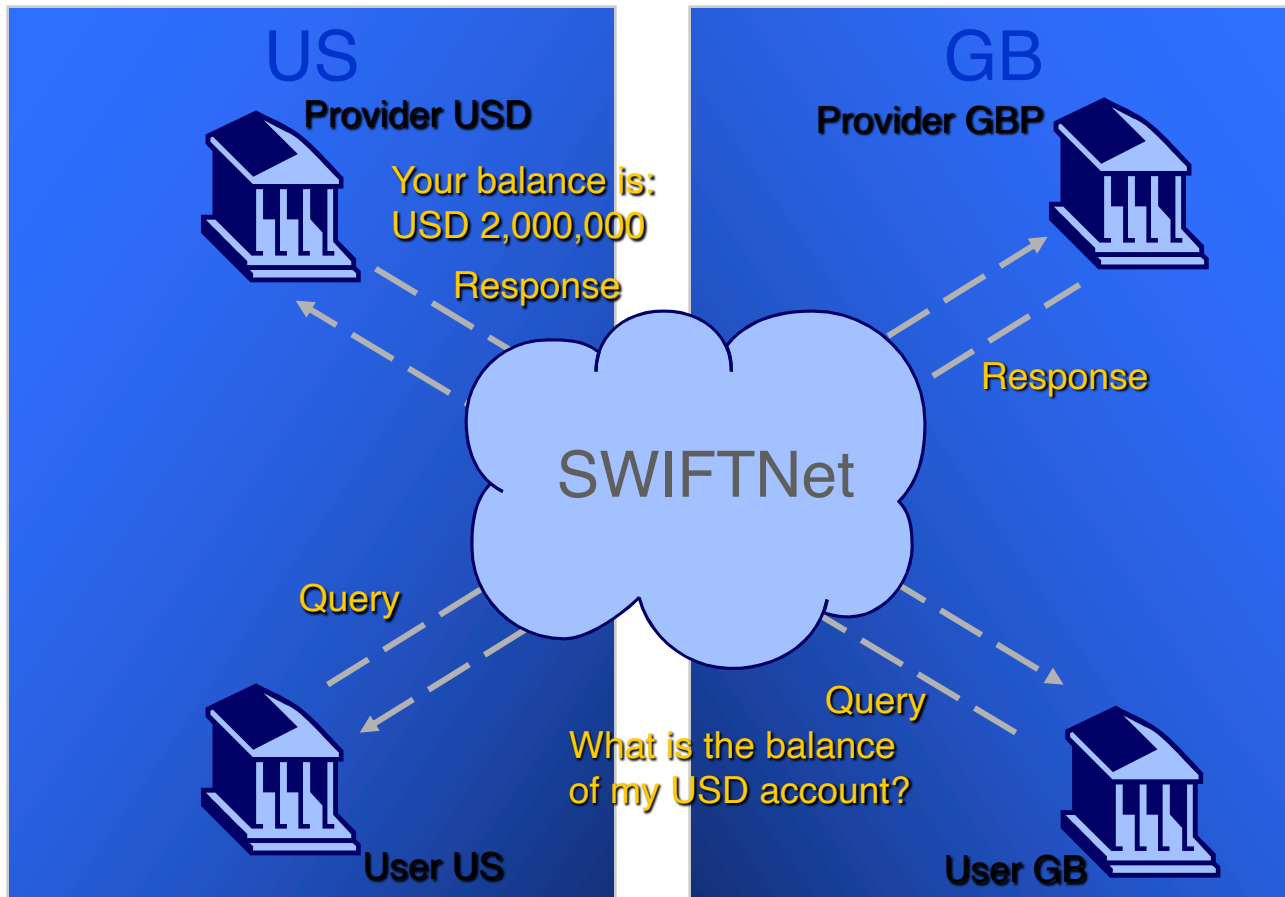
SWIFT Network (Dec 2019)



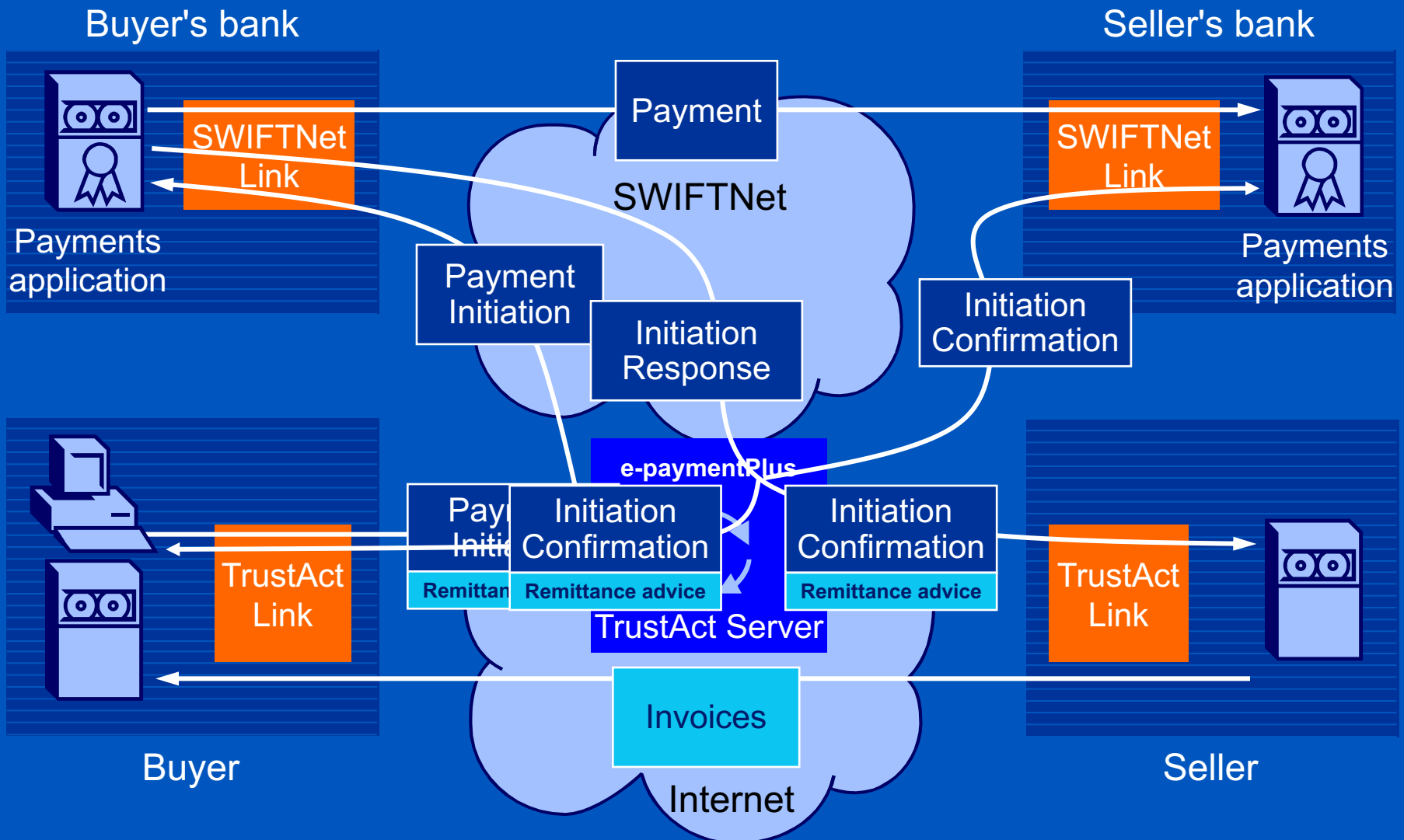
SWIFT Role in Payment



SWIFTNet Cash Reporting



SWIFT E-payments Plus System



SWIFT Message Types

Category	Name
0xx	General Information
1xx	Customer Payments and checks
2xx	Financial Institutions Transfers
3xx	Financial Trading (FX, Loans, SWAPS, etc.)
4xx	Collections and Cash Letters
5xx	Financial Trading (Securities)
6xx	Precious Metals Trading and Syndications
7xx	Documentary Credits and Guarantees
8xx	Traveler's Checks
9xx	Cash Management and Customer Status

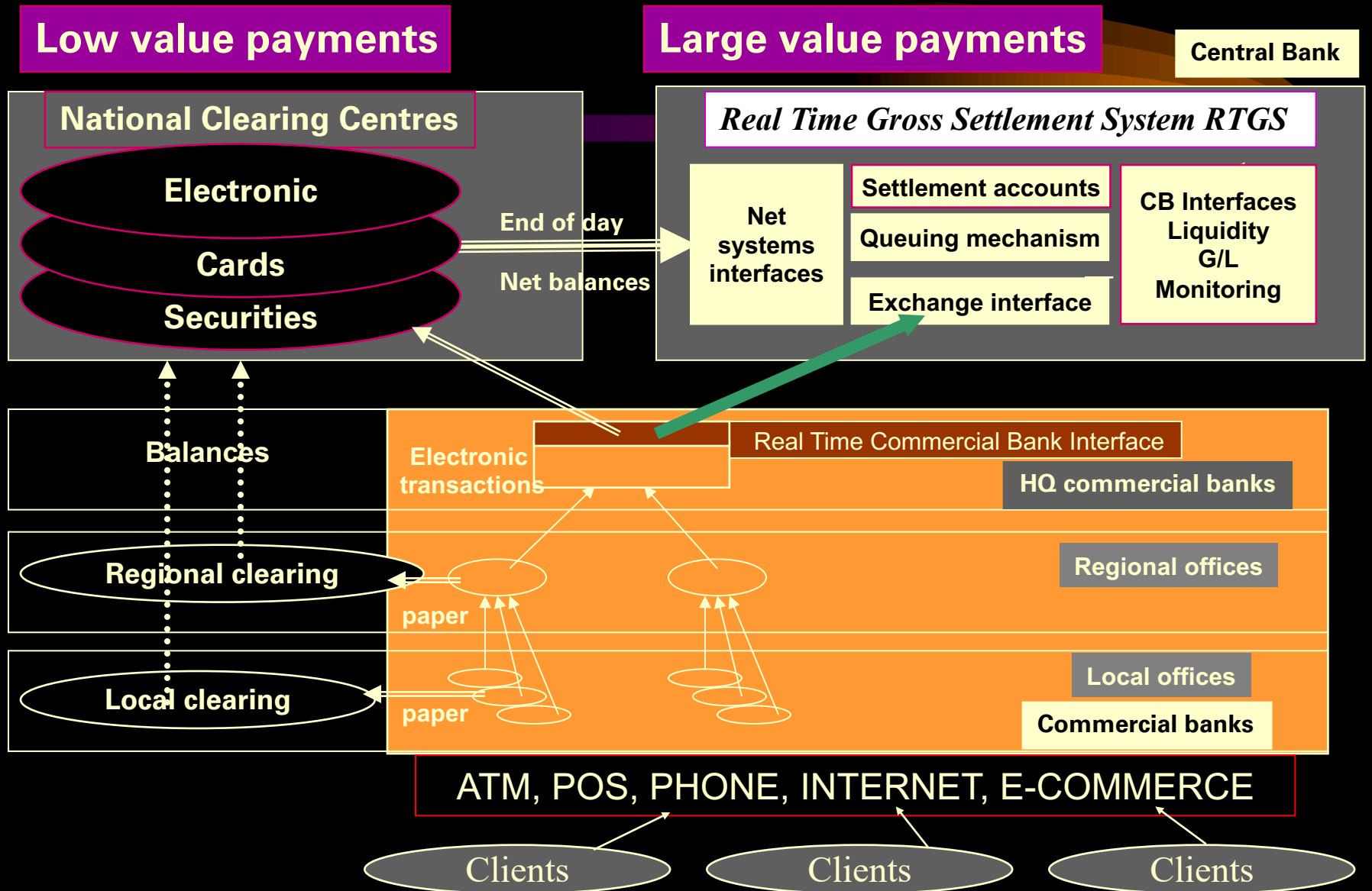


Message	Message Name
513	Client Advice of Execution
514	Trade Allocation Instruction
515	Client Confirmation of Purchase or Sale
517	Trade Confirmation Affirmation
528	ETC Client-Side Settlement Instruction
529	ETC Market-Side Settlement Instruction

SOURCE: [SECURITIES OPERATIONS FORUM](#)

More Clearing and Settlement Systems

Clearing and Settlement



History of Electronic vs. Traditional Payments (U.S., 2000)

	NUMBER (B)	VALUE (T)	AVG. VAL.
ELECTRONIC	49.5 (7.4%)	695 (88.9%)	\$ 14,018
CHECK	69 (10.3%)	85 (10.9%)	\$ 1,232
CASH	550 (82.3%)	2.2 (0.3%)	\$ 4
TOTAL	669	782	\$ 1,169

2400 TRANSACTIONS
PER PERSON

6.6 PER PERSON
PER DAY

USD 2.8M
PER PERSON

USD 7700
PER PERSON
PER DAY

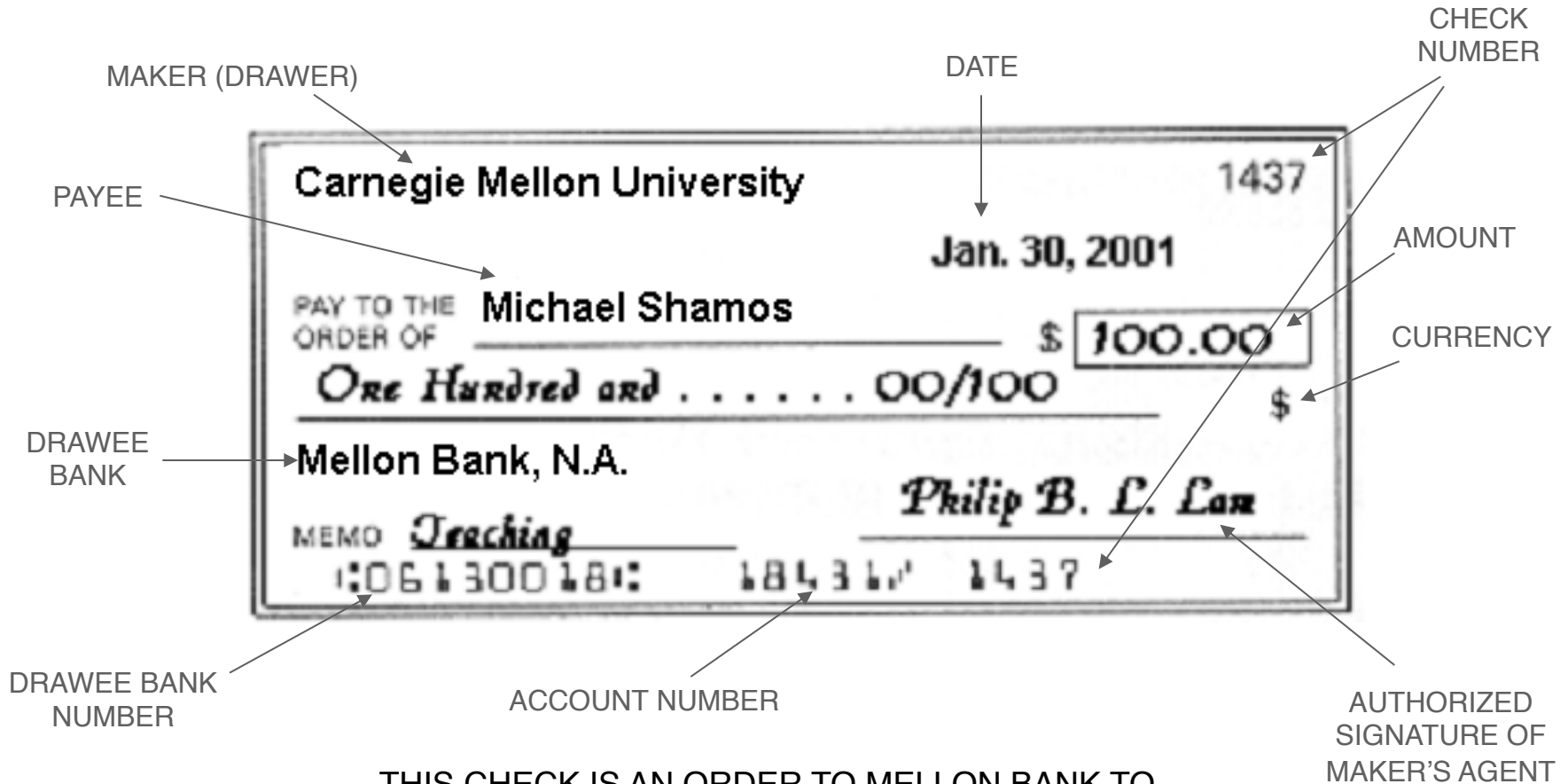
SOURCE: NACHA

OLD History of U.S. Electronic Payment Volumes (circa: 2000)

	NUMBER	VALUE	AVG. VAL.
ACH	6,900 M	20,300 B	\$ 2,942
ATM	13,200 M	800 B	\$ 60
CREDIT CARD	20,000 M	1,400 B	\$70
DEBIT CARD	9,300 M	400 B	\$ 43
FEDWIRE	108 M	379,756 B	\$ 3,516,000
CHIPS	58 M	292,147 B	\$ 5,040,000
TOTAL	49,566 M	694,803 B	\$ 14,018

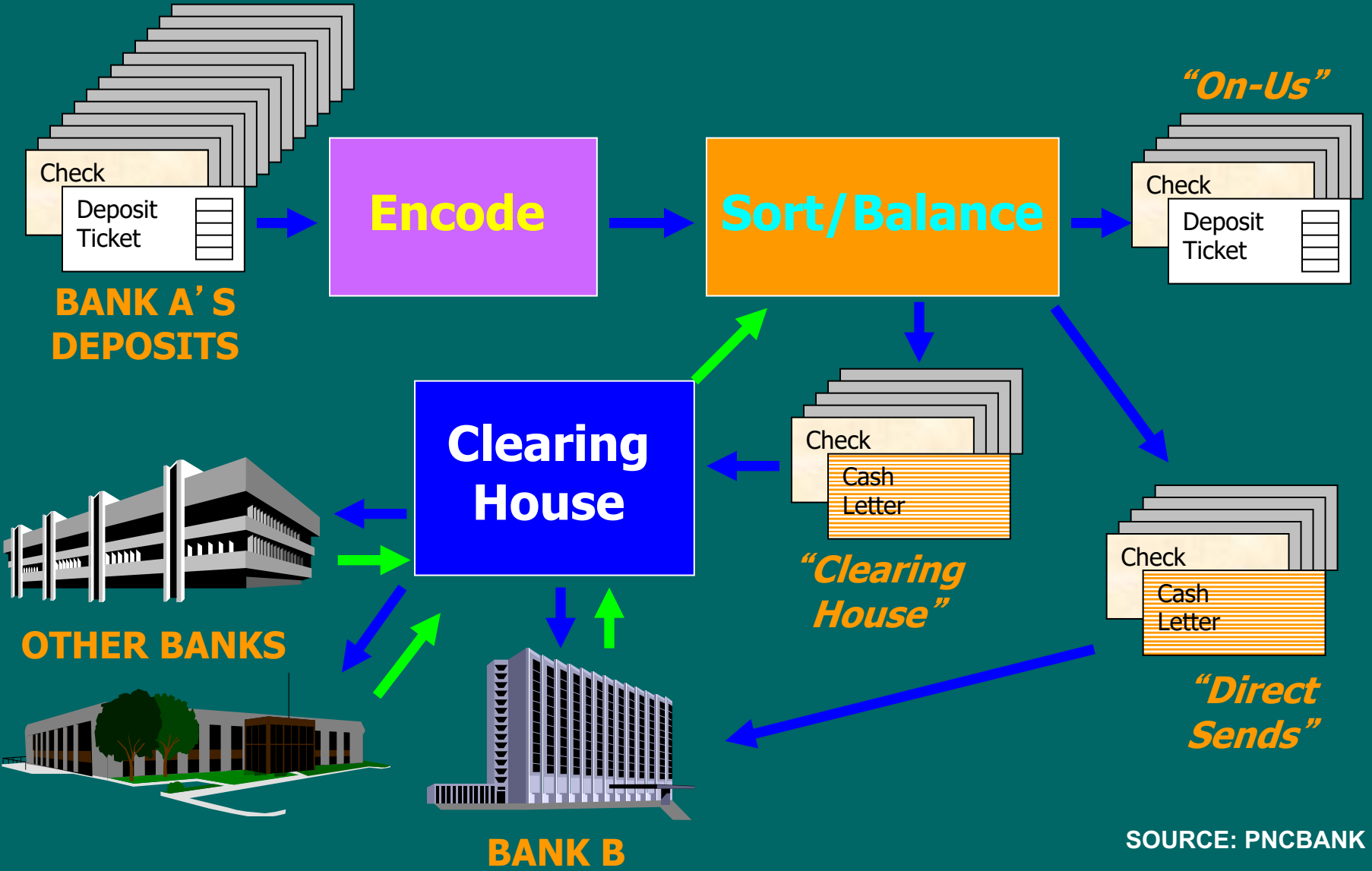
SOURCE: NACHA

Payment Orders (Checks)

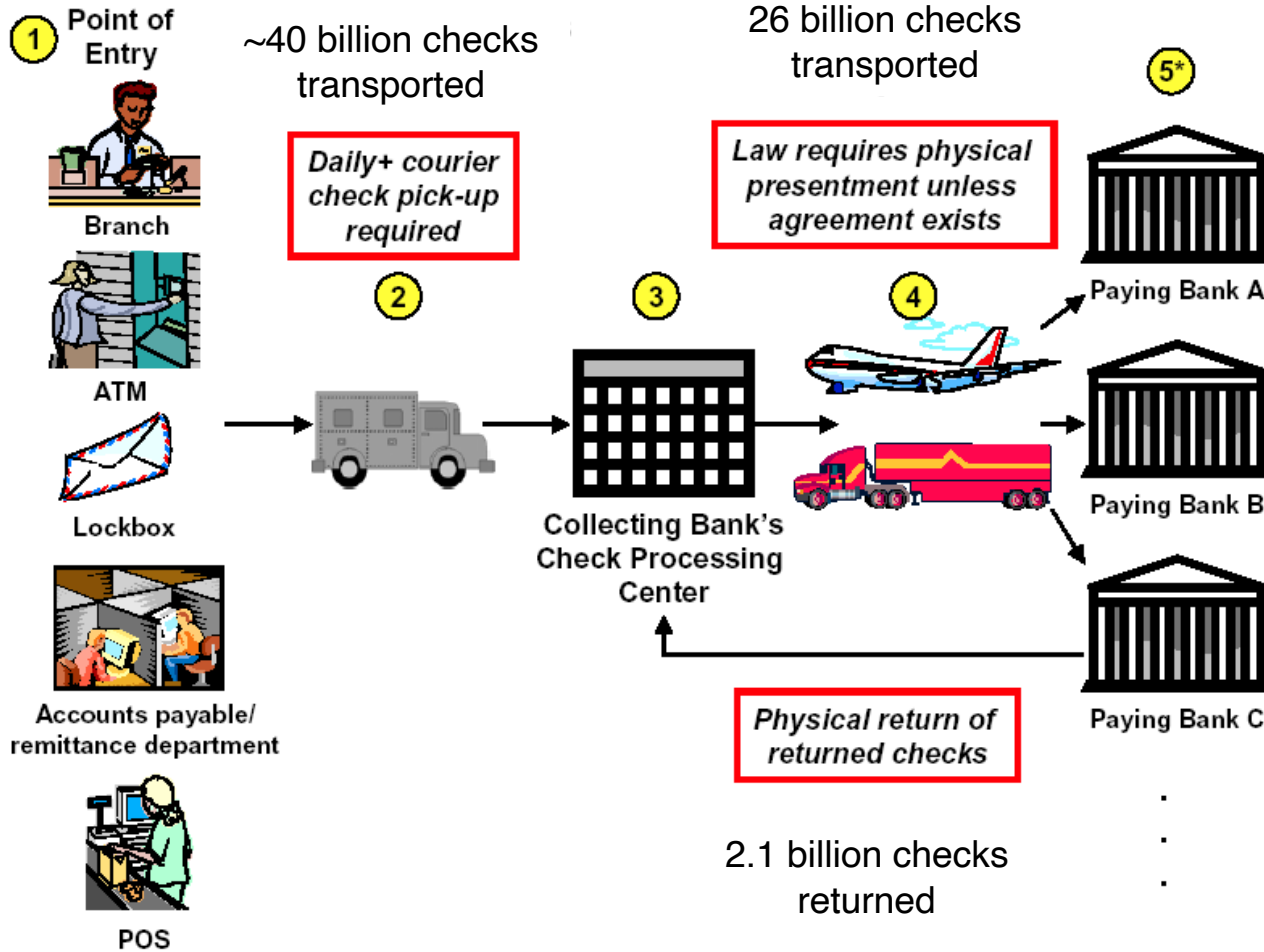


THIS CHECK IS AN ORDER TO MELLON BANK TO PAY \$100 TO PAYEE OR HIS TRANSFEREE FROM THE CARNEGIE MELLON UNIVERSITY ACCOUNT

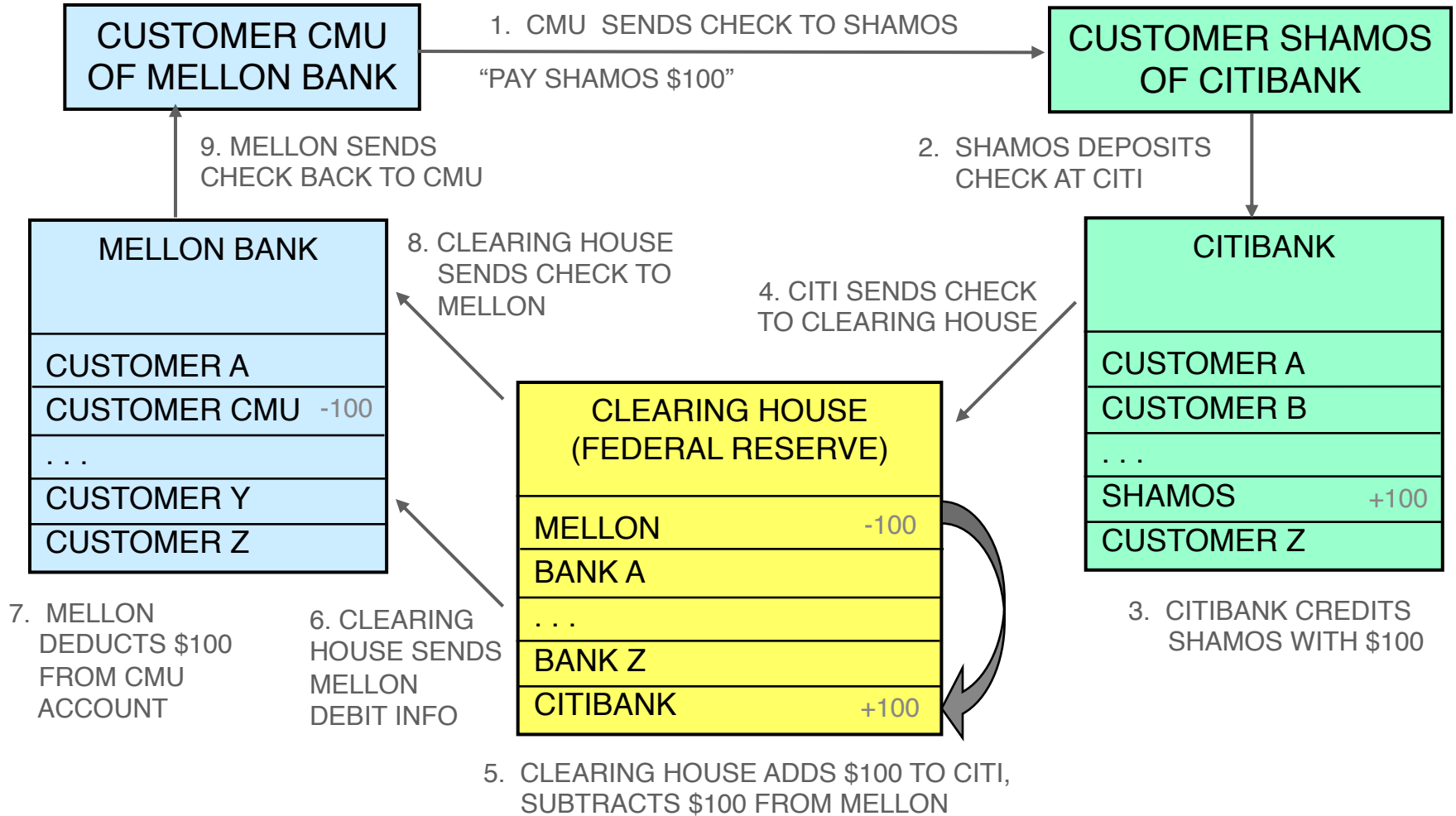
Check Processing



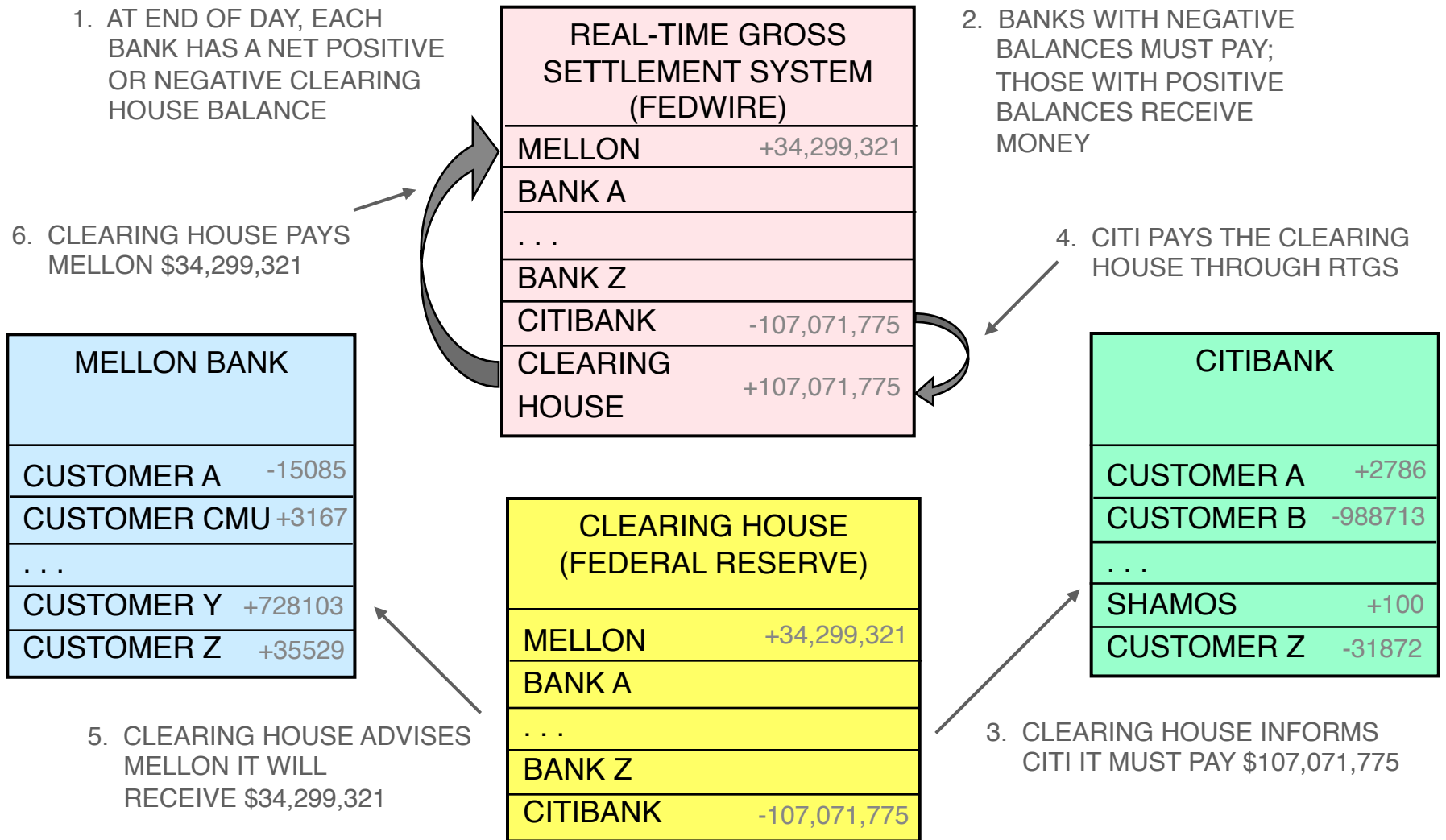
U.S. Cheque Clearing



Clearing Payment Orders (Check)



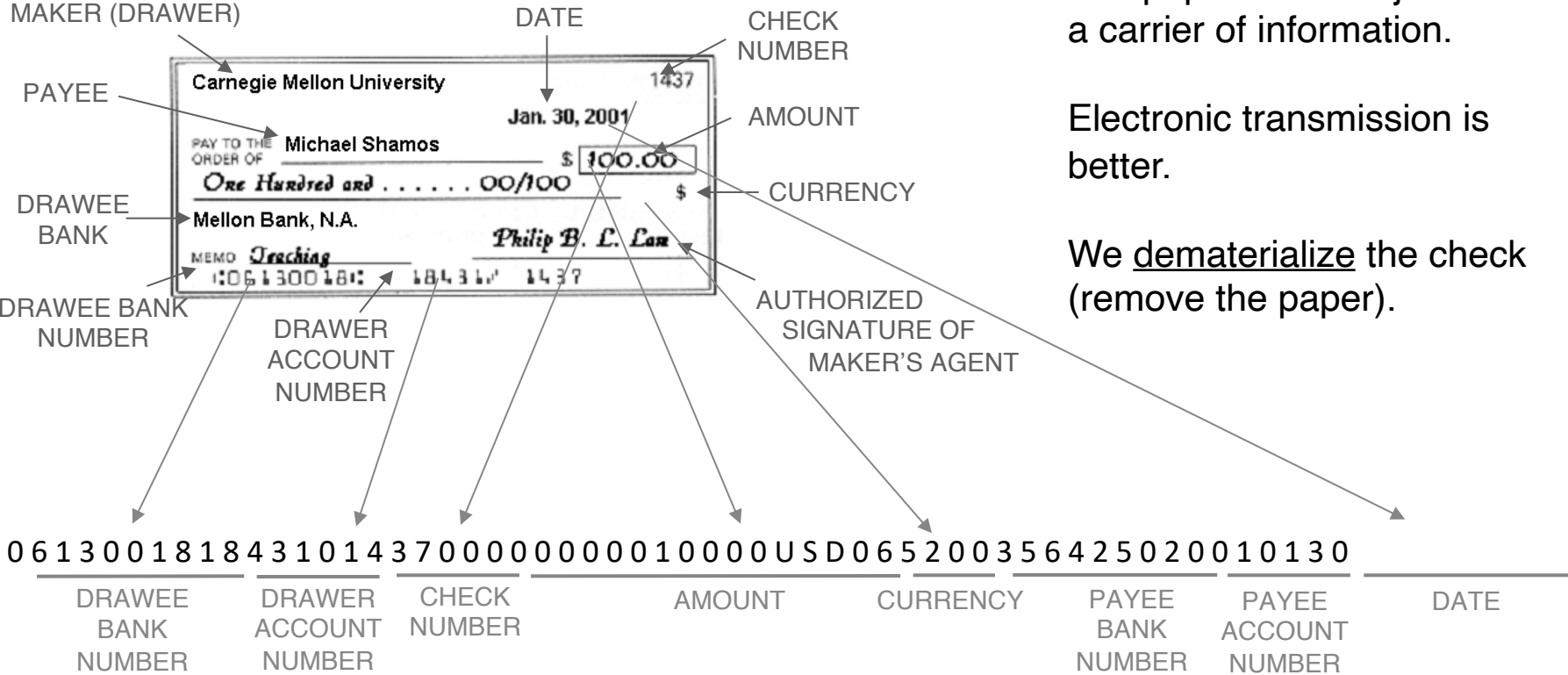
Settling Payment Orders (Checks)



Checks/ Cheques

- In 2012, U.S. had 18.3 billion checks per year, with total value of US\$25.9 trillion => Ave. of US\$1,415 per check
 - ◆ vs. 70 billions checks were written in 2001
- “On-Us” means “payer and payee in same bank”
- Interbank (payor and payee in different banks) -- requires settlement
 - ◆ Direct presentment (“direct sends”)
 - ◆ Correspondent banks
 - ◆ Clearing house associations (150)
 - ◆ Federal Reserve system
- Complex laws re bank liability in check processing

Electronic Check Clearing



The paper check is just a carrier of information.

Electronic transmission is better.

We dematerialize the check (remove the paper).

Only the information is sent to the clearing house

Automated Clearing House (ACH) in U.S.

- Nationwide wholesale electronic payments system
- Transactions not processed individually
- Banks send transactions to ACH operators
- Batch processing store-and-forward
- Sorted and retransmitted within hours
- Banks
 - ◆ Originating Depository Financial Institutions (ODFIs)
 - ◆ Receiving Depository Financial Institutions (RDFIs)
- Daily settlement by RTGS
- Posted to receiver's account within 1-2 business days
- Typical cost: \$0.02 per transaction; fee higher

Automated Clearing House (ACH)

- High-volume, small value payment orders between financial institutions
 - ◆ largely recurring payments: payroll, mortgage, car loan, Social Security
 - ◆ U.S. Treasury Financial Management Service: cost to send gov' t check: \$0.42. Cost of epayment: \$0.02.
- Automated Teller Machines (ATM)
- Debit-card point-of-sale payments
- Telephones or PC bill payments.
- Direct deposit (e.g. Payroll)
- Electronic benefits transfer

Automated Clearing House

- Processes dematerialized checks (digital data only)
- Both debits and credits allowed
- ACH processors:
 - ◆ American Clearing House Association (American)
 - ◆ Federal Reserve System
 - ◆ New York Automated Clearing House (NYACH)
 - ◆ VISANet ACH
- 1998: 5.3B transactions, \$16.4T
- ACH cost: less than 1 cent per transaction

ACH Debit Transaction

1. BUYER AUTHORIZES SELLER TO DRAW \$X FROM BUYER'S ACCOUNT IN BUYER'S BANK

BUYER

SELLER

2. SELLER ASKS HIS BANK TO SEND TRANSACTION TO AUTOMATED CLEARINGHOUSE

7. SELLER'S BANK CREDITS SELLER'S ACCOUNT WITH \$X

8. BUYER'S BANK ADVISES BUYER OF PAYMENT

BUYER'S BANK

SELLER'S BANK

5. BUYER'S BANK PAYS \$X TO SETTLEMENT BANK

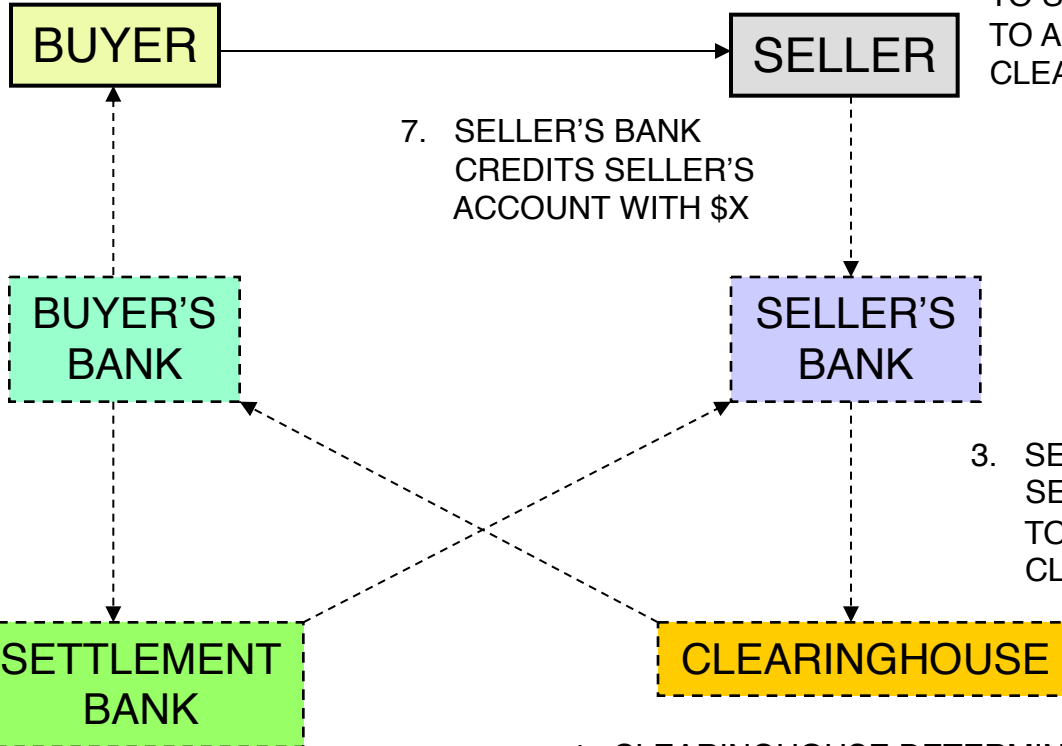
3. SELLER'S BANK SENDS TRANSACTION TO AUTOMATED CLEARINGHOUSE

SETTLEMENT BANK

CLEARINGHOUSE

6. SETTLEMENT BANK PAYS \$X TO SELLER'S BANK

4. CLEARINGHOUSE DETERMINES THAT BUYER'S BANK OWES SELLER'S BANK \$X (ALL TRANSACTIONS ARE NETTED)



ACH Credit Transaction

1. BUYER SENDS AN ORDER TO BUYER'S BANK TO CREDIT \$X TO SELLER'S ACCOUNT IN SELLER'S BANK

BUYER

SELLER

2. BUYER'S BANK SENDS TRANSACTION TO AUTOMATED CLEARINGHOUSE

BUYER'S BANK

SELLER'S BANK

6. SELLER'S BANK CREDITS SELLER'S ACCOUNT WITH \$X

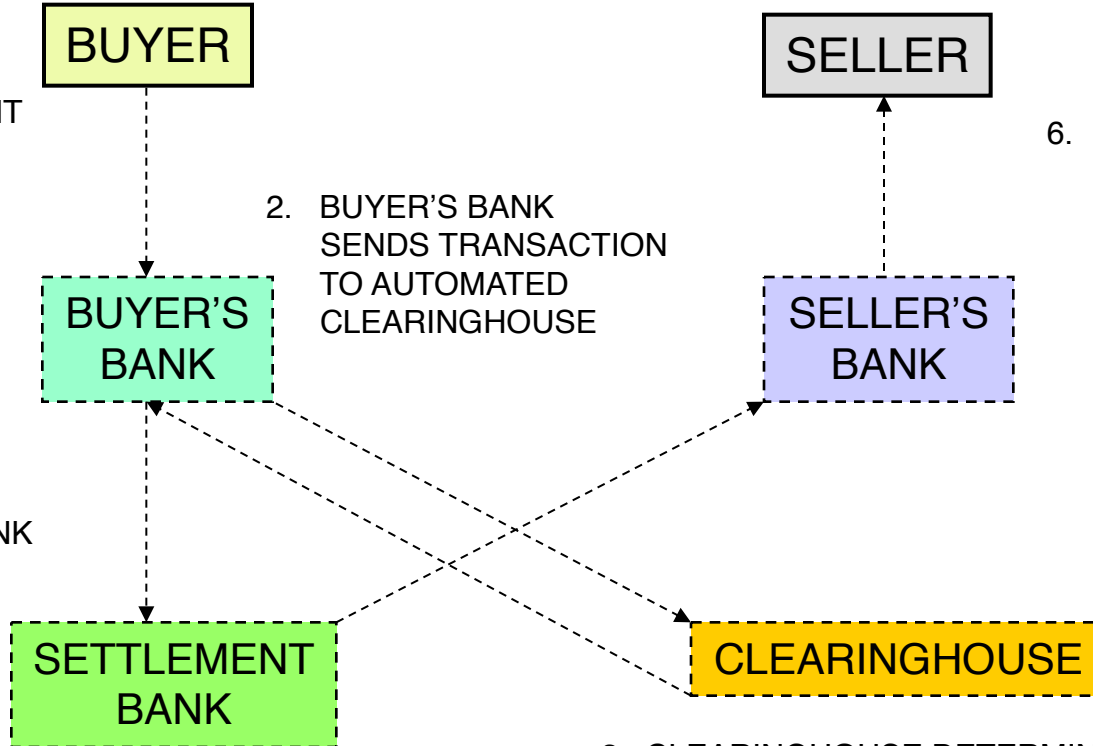
4. BUYER'S BANK PAYS \$Y TO SETTLEMENT BANK

SETTLEMENT BANK

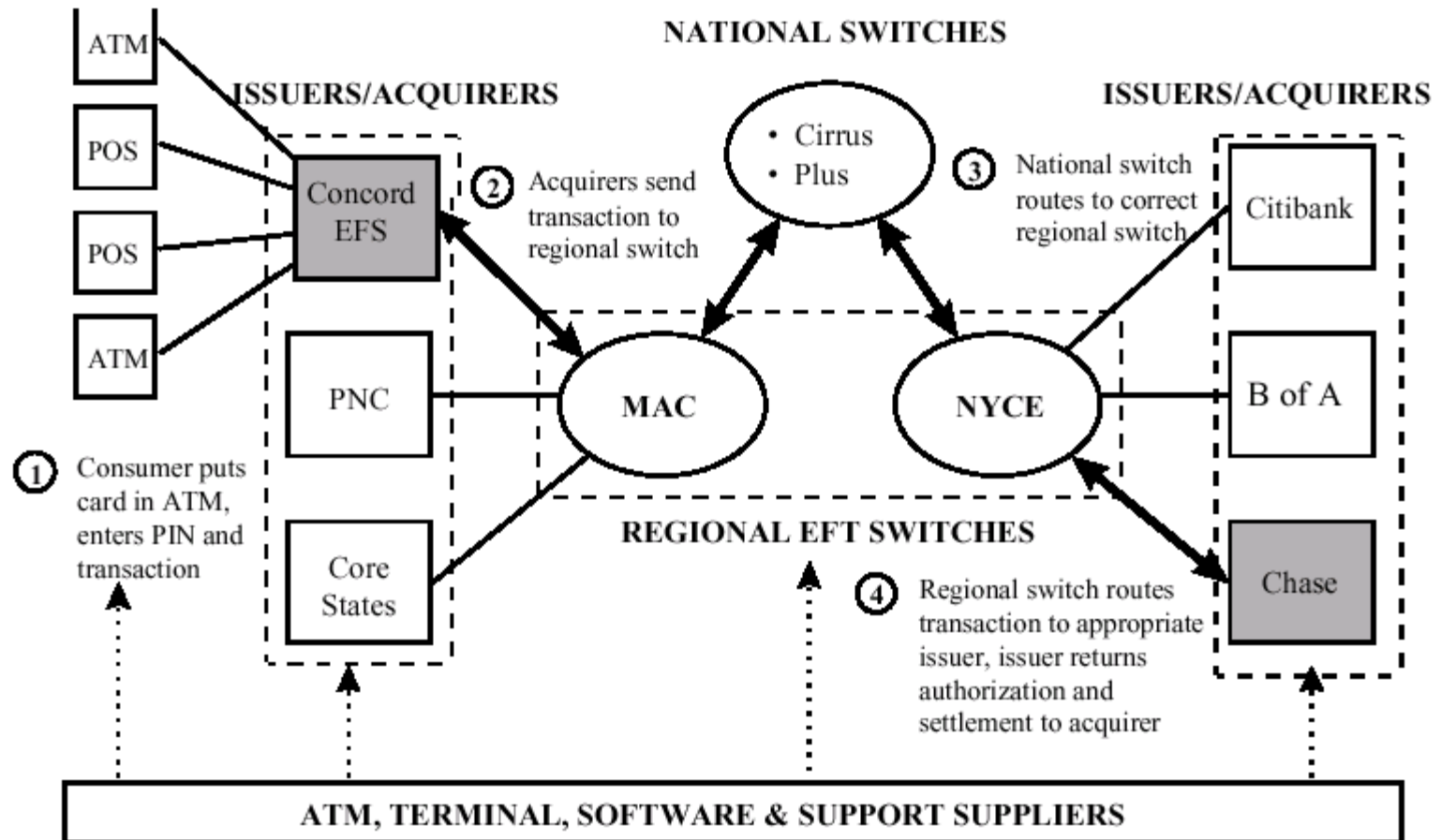
CLEARINGHOUSE

5. SETTLEMENT BANK PAYS \$Y TO SELLER'S BANK

3. CLEARINGHOUSE DETERMINES THAT BUYER'S BANK OWES SELLER'S BANK \$Y (ALL TRANSACTIONS ARE NETTED)

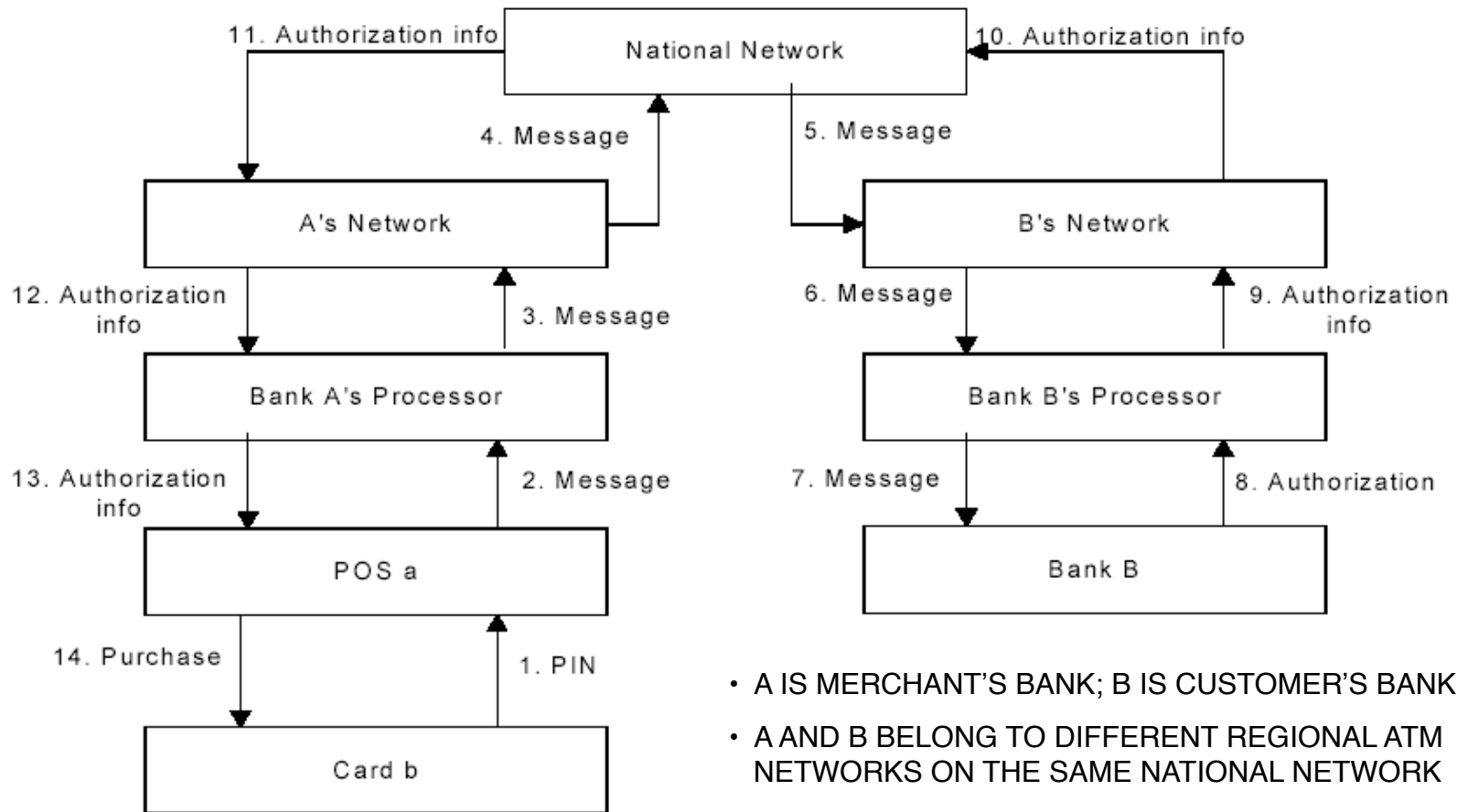


ATM and Debit Networks



SOURCE: [U.S. BANCORP](#)

Debit Card Authorization



- A IS MERCHANT'S BANK; B IS CUSTOMER'S BANK
- A AND B BELONG TO DIFFERENT REGIONAL ATM NETWORKS ON THE SAME NATIONAL NETWORK
- DEBIT IS IMMEDIATE WHEN BANK B AUTHORIZES

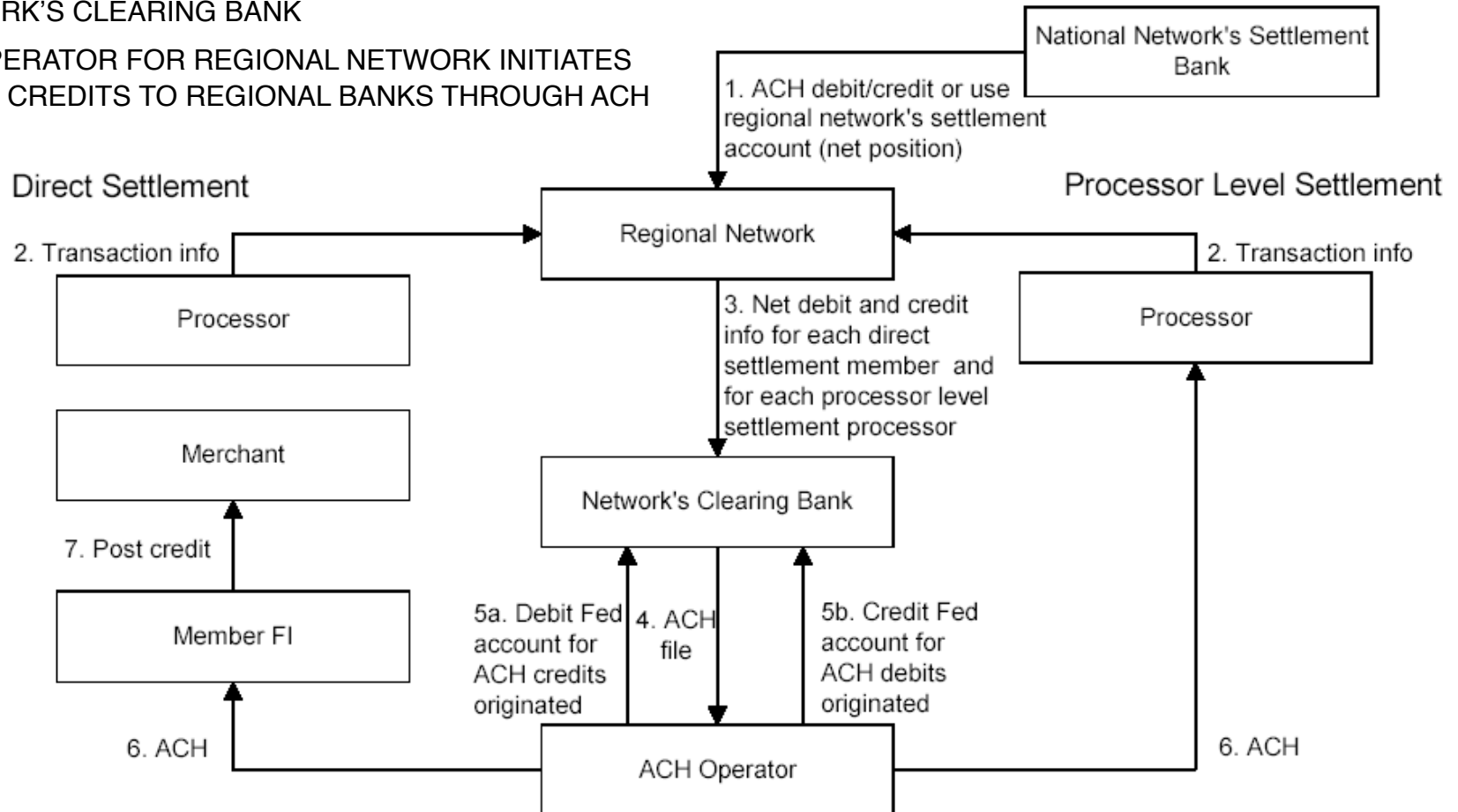
SOURCE: [HAYASHI, WORLD BANK](#)

Debit Card Settlement

1. NATIONAL NETWORK CLEARS FOR ITS REGIONAL NETWORKS,
SETTLES REGIONAL NETWORK'S ACCOUNTS IN
CENTRAL BANK

2-3. REGIONAL NETWORK CLEARS FOR ITS MEMBERS
THROUGH
NETWORK'S CLEARING BANK

4-5. ACH OPERATOR FOR REGIONAL NETWORK INITIATES
DEBITS AND CREDITS TO REGIONAL BANKS THROUGH ACH



SOURCE: HAYASHI, WORLD BANK

Summary of Major Ideas

- Central banks play a central role in money movement
- Payment requires M1
- Foreign Exchange (FOREX)
- Gross v. Net settlement
- Foreign exchange requires two settlements
 - ◆ Timing of two settlements
 - ◆ Herstatt risk
 - ◆ PvP solution
- US Banking and Payment Systems
- International Payments Systems:
 - ◆ CHIPS (the actual payment systems) and
 - ◆ SWIFT (the messaging system used by CHIPS)
- Check processing is cumbersome: requires clearing and settlement.
- Automated Clearing House a US nation-wide wholesale clearing system for high-volume small-value payments among major institutions to support:
 - ◆ ATM processing, Debit card processing at Point-of-Sale, Payroll transfer, Inter-bank payments