



HYPERLEDGER **GLOBAL** — **FORUM**

June 8–10, 2021 | Virtual Experience
[#hyperledgerforum](#)



The "iDeAL" POC

a Wing-to-wing Proof of Concept for an Inter-company Distributed Accounting Ledger

Gary Crisci, Principal Architect, General Electric



General Electric Company – GE

Imagination at work



AVIATION



HEALTHCARE



RENEWABLE
ENERGY



POWER



BHGE



CAPITAL



CORPORATE



GE DIGITAL



EVERY 2 SECONDS
an aircraft powered by
GE technology takes off



Everyday, GE is
helping doctors save
3,000 LIVES



GE powers over
**30% OF THE
WORLD'S ENERGY**

"Our primary focus must be on delivering outcomes. We don't define that solely by the number of gas turbines, wind turbines, jet engines, or CT scanners we manufacture. The ultimate purpose of our work is the children in distant villages who get access to electricity for the first time, the travelers who get home safely, and the patients who receive better diagnoses and treatments in the moments that matter most. When our teams understand customer needs and deliver outcomes for them, we always end up in a good place for our employees and our owners."

Agenda

- **Problem statement and solution overview**
- **Introduction to Blockchain and Hyperledger Fabric**
- **Solution Architecture**
 - Oracle blockchain as a service platform (OBP)
 - Data Integration
 - Data warehouse
 - Analytics
 - Identity management
- **User experience**
- **Closing and Q&A**





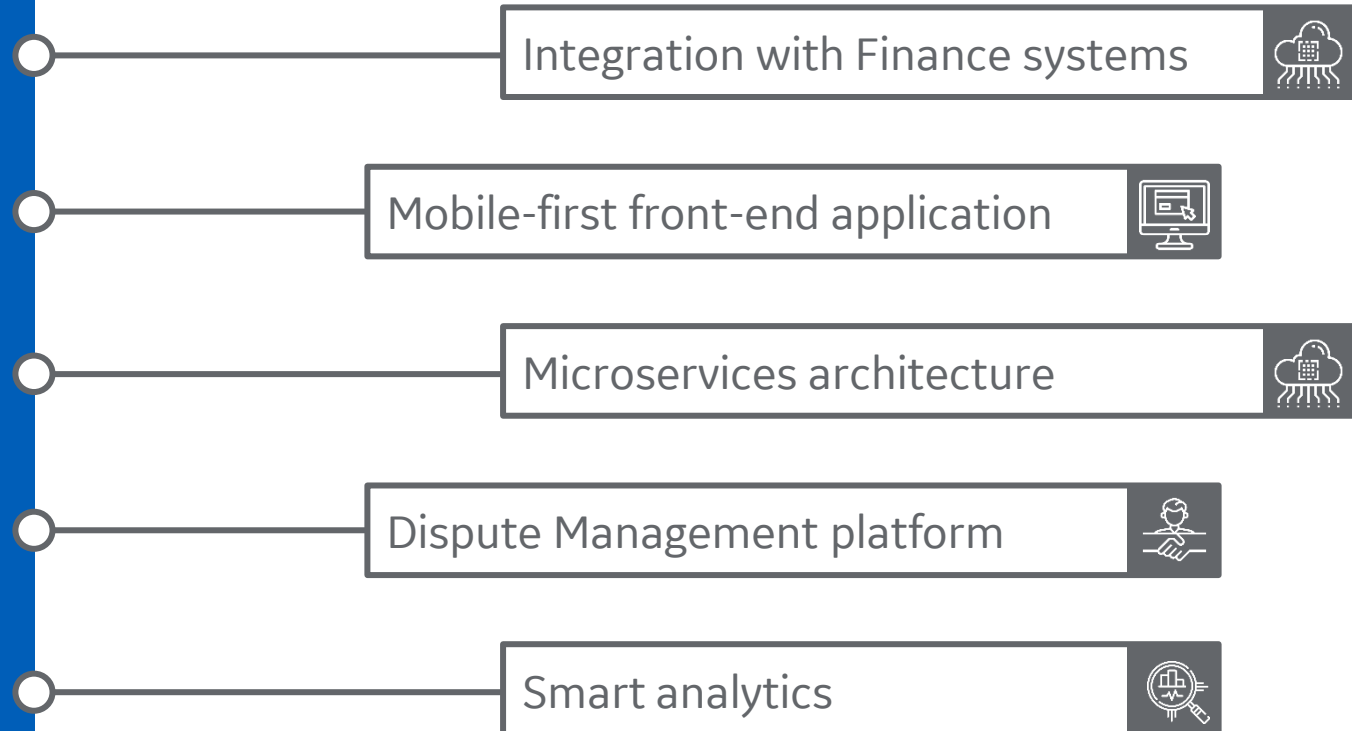
CHALLENGE

Modernize GE's Internal Billing System (IBS). IBS is a 25 years old mainframe-based application with an average annual flow of 4MM inter-company invoices. As many mainframe apps it brings a high TCO, an increasing technical debt and a reduced talent pool with specialized skills.

The art of the possible for inter-company transformation



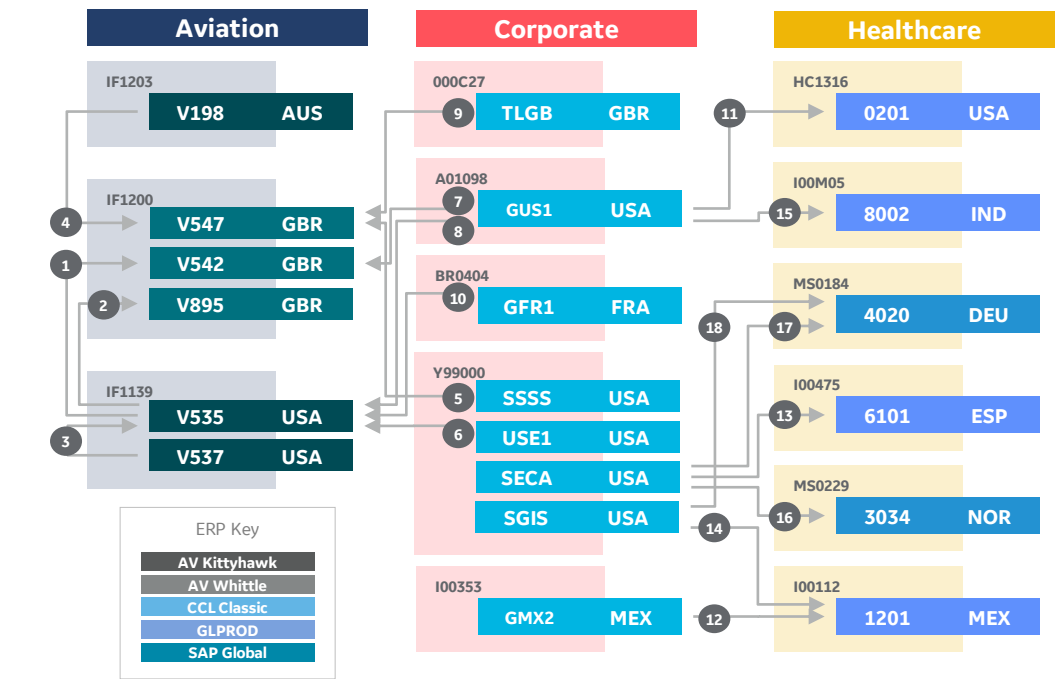
iDeAL Intercompany Distributed Accounting Ledger



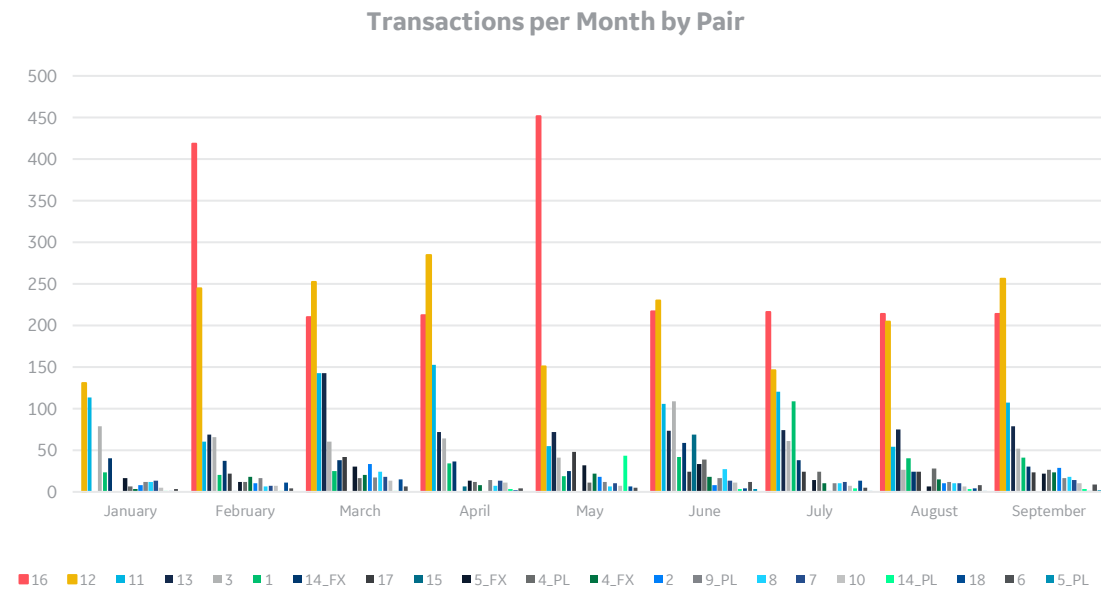
Current inter-company transaction flow

High Level: In-Scope Entities, and Transactions Flows & Sizing

Intercompany Transaction Flows



Intercompany Pairs: Number & Value of Transactions Per Month



Solution design aligned to Intercompany Business Capabilities Model



The Intercompany Business Capabilities Model was created in collaboration with **functional users** and **process leaders**. It illustrates the activities that the Intercompany function should be able to perform regardless of the technology.

This model was used to drive the technology assessments that will be described in the upcoming pages.

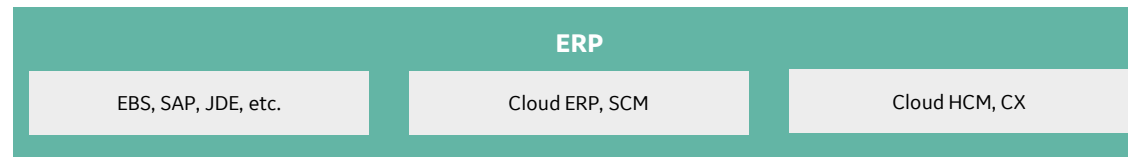


Blockchain solution design overview

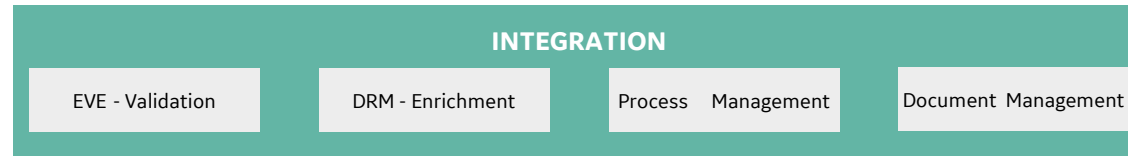
The Blockchain solution connects **independent ERP** systems through an integration layer to applications **governed by** smart contract **business rules** and a web-based user interface

Intercompany Blockchain Solution Architecture

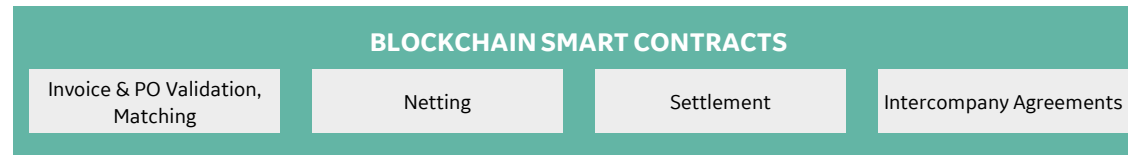
The solution connects existing ERP transaction systems via



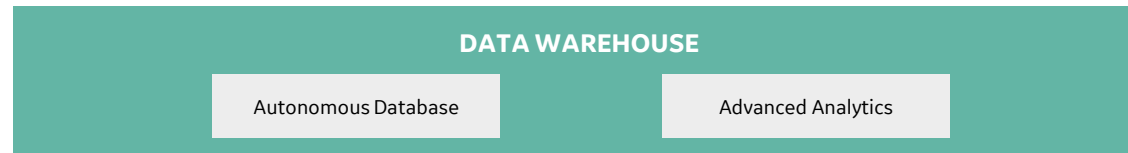
... internal enrichment and validation services with process and document management ...



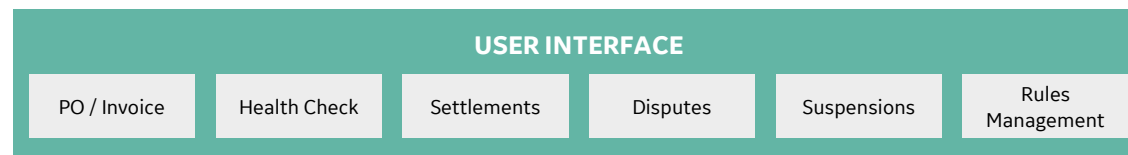
..governed by a universal rule sets...



..streaming distributed ledger transaction to a data warehouse with modern analytics tools...



... with a common user interface framework that supports various functions.



Solution Benefits:

Process Efficiency

Financial Efficiency

Business Enablement

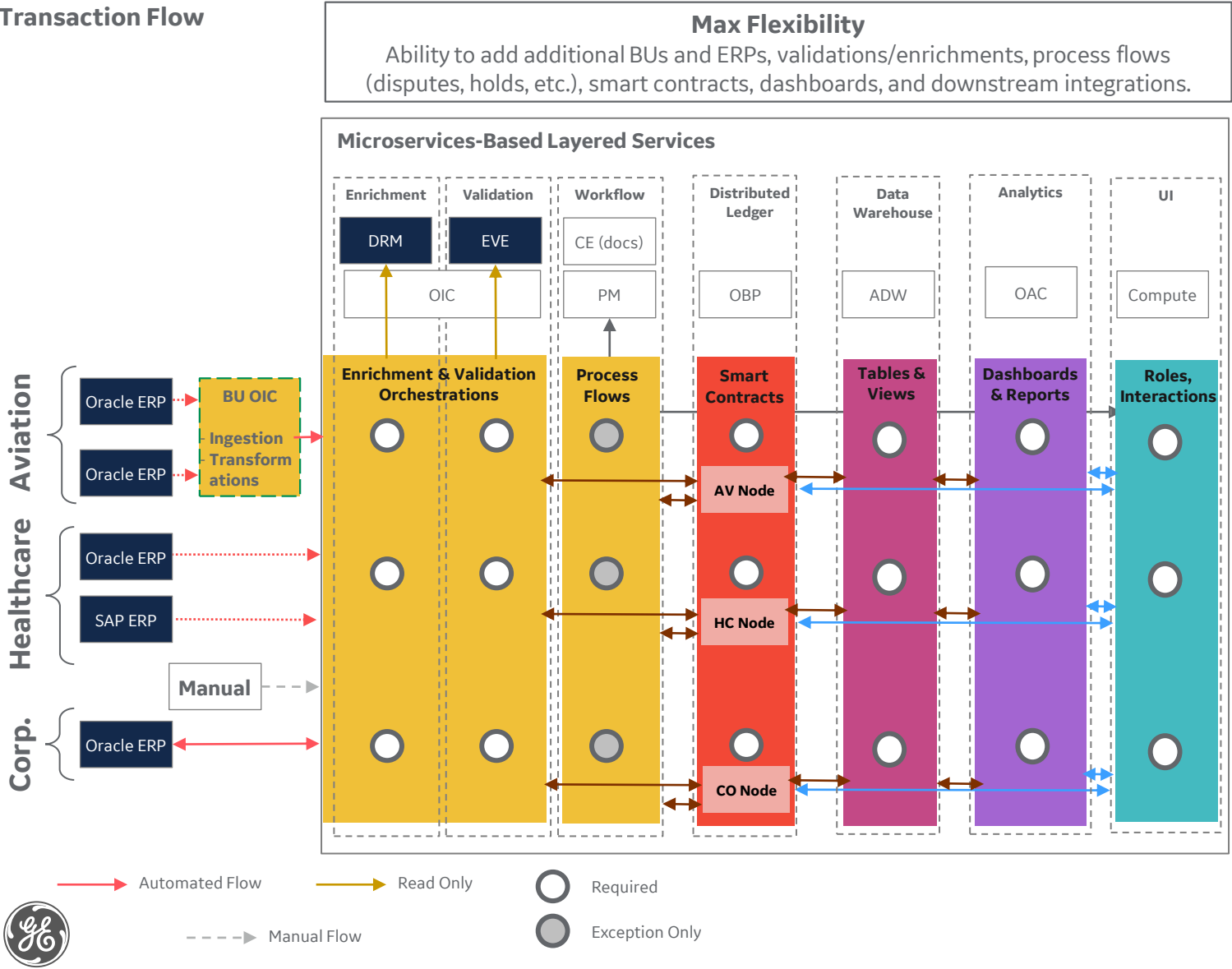
Architecture Modernization



iDeAL Solution architecture

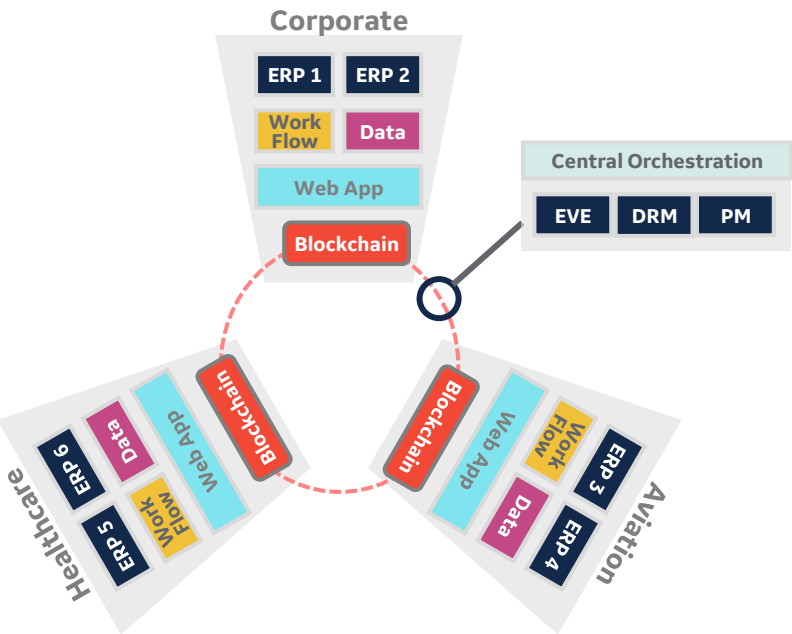
Transaction Flow and Distributed Network Architecture

Transaction Flow

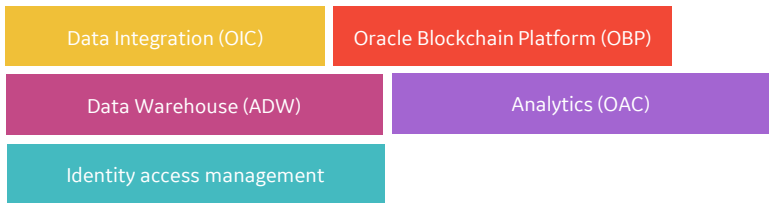


Distributed Network Configuration

Businesses share a set of common, secure communication protocols that automate processes across the ERPs..



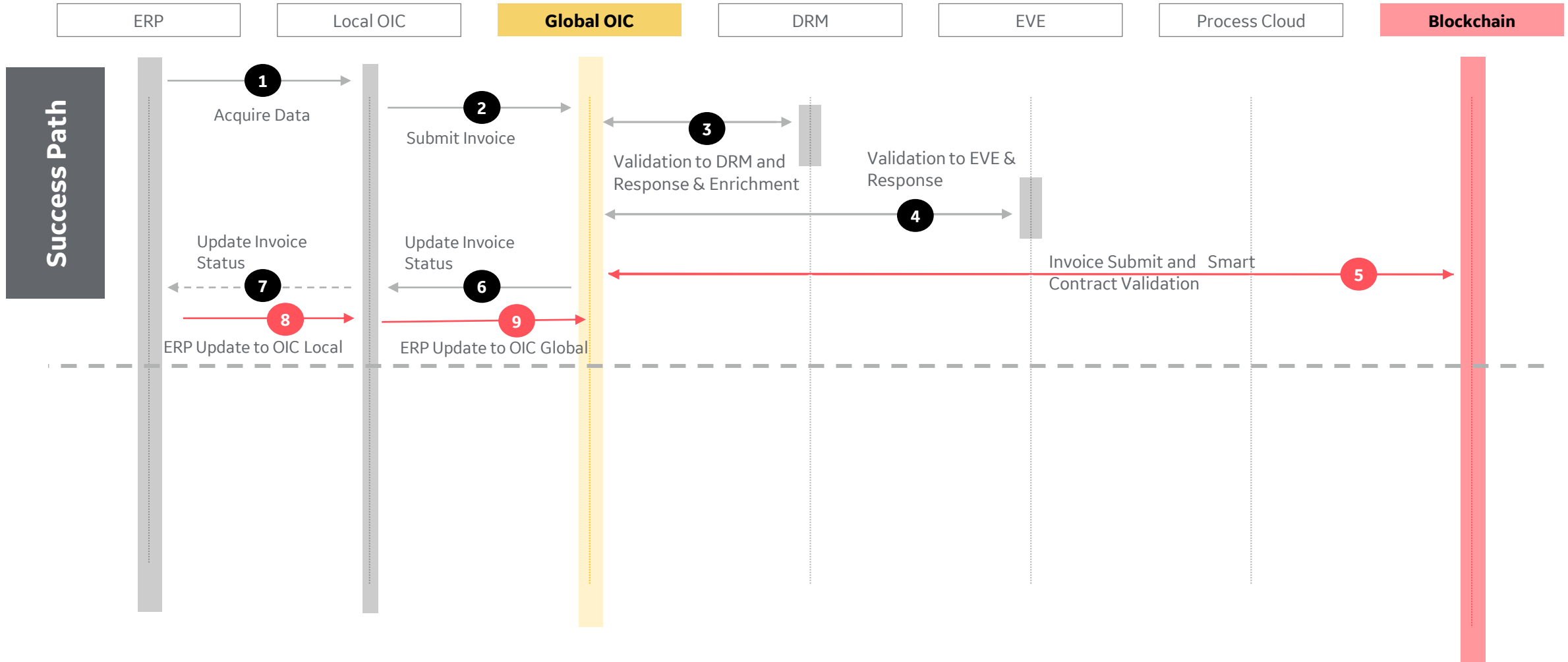
Tech Stack



Blockchain Process Flow & Interaction Model

Transaction recordation, business process/logic optimization, DRM/EVE Validation and Enrichment

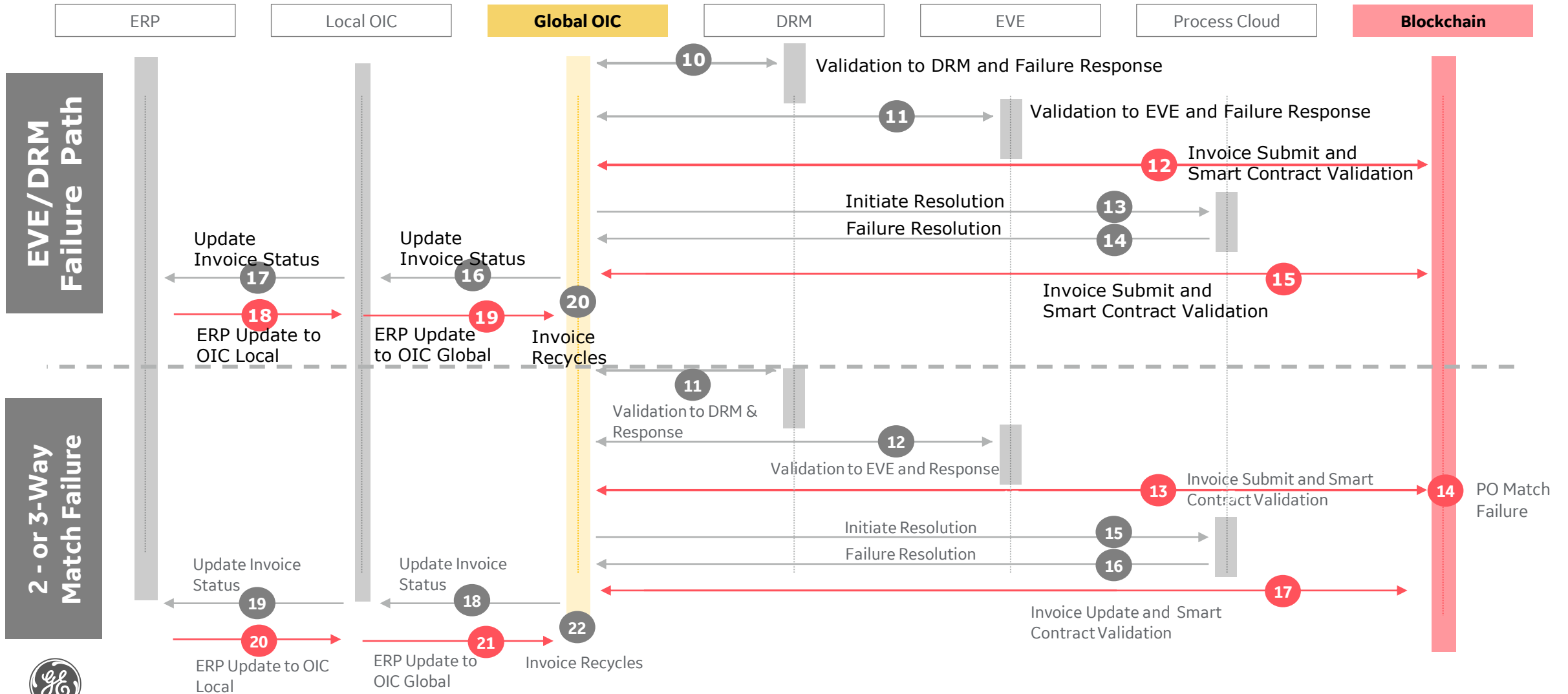
Generic Interaction Model



Process Flow & Interaction Model: Failure scenarios

Transaction recordation, business process/logic optimization, 2 - or 3-Way Match Failure

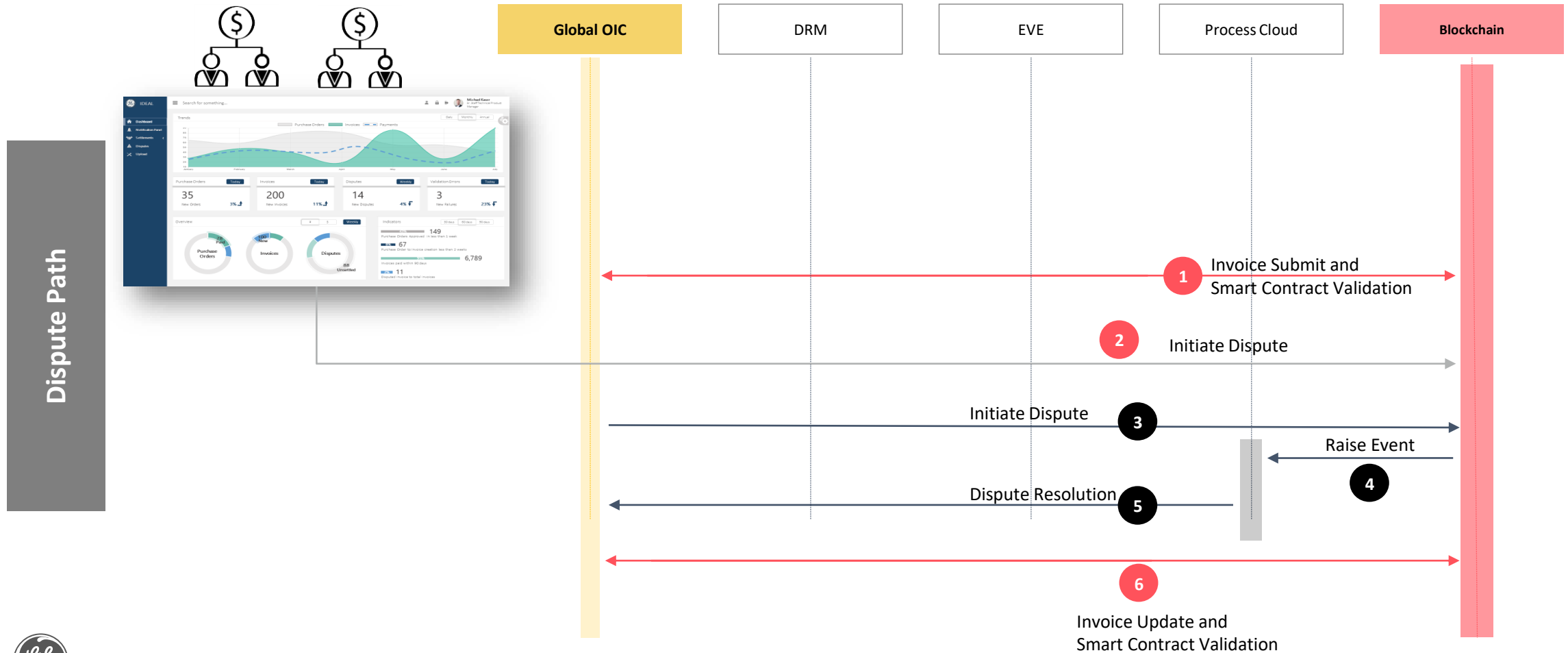
Generic Interaction Model



Blockchain Process Flow: Dispute Management

Initiating and resolving disputes

Generic Interaction Model



Why Blockchain?

Blockchain Unique Value Proposition

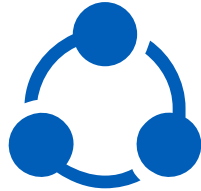


Trust

Non-repudiation reduces risk of fraud

Tamper-proof / tamper evident records

Process integrity based on pre-agreed rules



Transparency

Single source of truth

Optimized decision-making

Self regulating

Full audit history

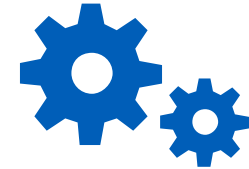


No Intermediaries

Improved consumer experience

Faster transactions

Lower transaction cost



Automation

Real-time reconciliation and settlement

Continuous visibility into relative positions

Eliminate risk of human errors



Blockchain has moved beyond the hype, and is poised to deliver value to enterprise

Spectrum of Blockchain Models

Enterprise
Focus

	Public Blockchain	Private Blockchain	Federated/Consortium Blockchain	Public/Permissioned Blockchain
Access	<ul style="list-style-type: none"> Anyone 	<ul style="list-style-type: none"> Single organization 	<ul style="list-style-type: none"> Multiple selected organizations 	<ul style="list-style-type: none"> Multiple selected organizations
Participants	<ul style="list-style-type: none"> Permissionless Anonymous 	<ul style="list-style-type: none"> Permissioned Known identities 	<ul style="list-style-type: none"> Permissioned Known identities 	<ul style="list-style-type: none"> Permissioned writers "Public" read access
Security	<ul style="list-style-type: none"> Consensus mechanism Proof of Work / Proof of Stake 	<ul style="list-style-type: none"> Pre-approved participants Voting/multi-party consensus 	<ul style="list-style-type: none"> Pre-approved participants Voting/multi-party consensus 	<ul style="list-style-type: none"> Pre-approved participants update the ledger Flexible policies for read access
Transaction Speed	<ul style="list-style-type: none"> Slow 	<ul style="list-style-type: none"> Lighter and faster 	<ul style="list-style-type: none"> Lighter and faster 	<ul style="list-style-type: none"> Lighter and faster



Blockchain is not a solution to all problems

Qualifying questions:

- Do your business processes cross divisional or organizational boundaries?
- Do cross-system discrepancies that impact operations?
- Is there less than full trust among transacting parties?
- Do you rely on intermediaries, possibly charging expensive fees, adding risk or delay?
- Do you rely on periodic (batch) reconciliations?
- Is there a need to improve traceability or audit trail?
- Do you need real time visibility into multi-party transactions or processes?



Typical Enterprise Scenarios



Enable distributed, autonomous marketplaces



Reduce friction in business transactions & reconciliations



Securely maintain and share decentralized records



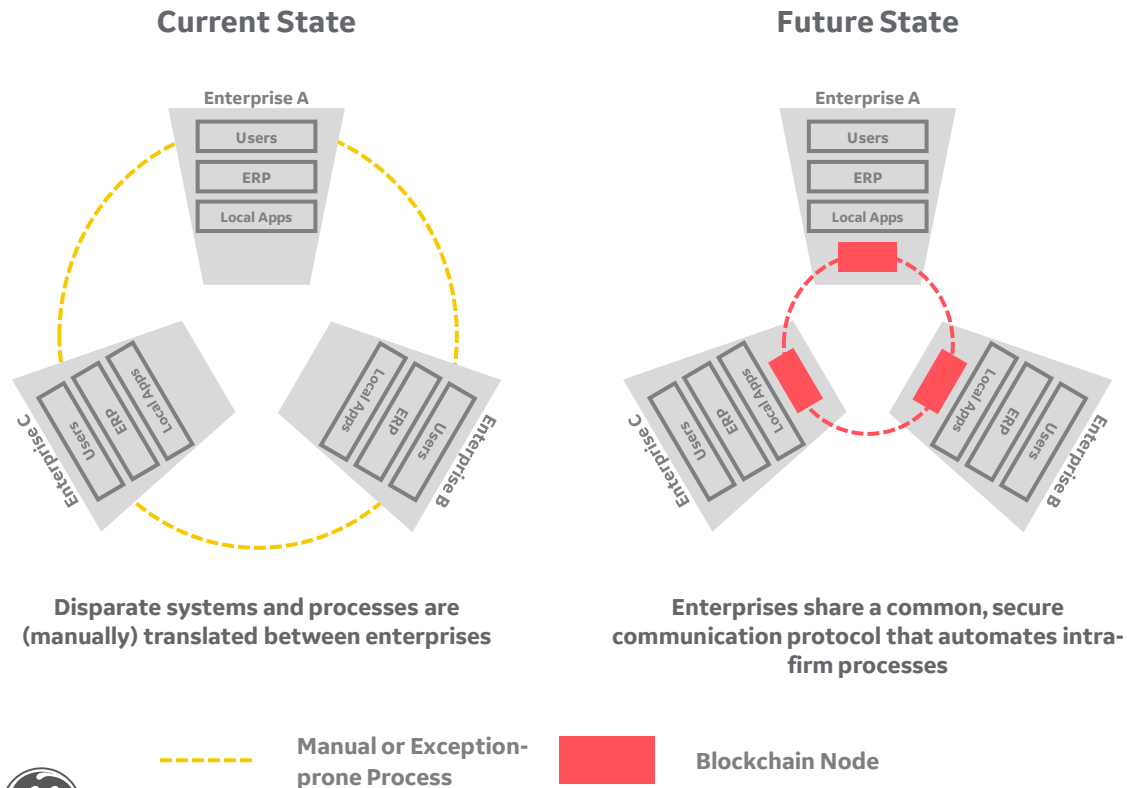
Track the provenance of products and materials

Enterprise Blockchain in action

Enterprise Blockchain is a type of corporate Blockchain implementation that focuses on the streamlining and automation of operational processes within a secure network of participants

Current State versus a Blockchain enabled ecosystem

- Blockchain creates a single source of truth for multi-organization interactions and business processes



Key Characteristics of an Enterprise Blockchain

- An enterprise Blockchain is **permissioned; only authorized/enrolled transacting parties can participate**
- Transaction requests are cryptographically signed by their originating members for non-repudiation
- Codified business rules on the blockchain (smart contracts) enable **autonomous transaction processing**, resulting in signed RWSets
- Multi-party consensus is used to agree on the RWSets and the transaction ordering before its committed to the ledger
- Transaction data is stored in cryptographically linked data blocks on participant nodes; signed data cannot be modified without detection
- Transaction information can be stored only on the nodes owned by **parties specific to a transaction**, but a hash to prove the transaction can be stored in a shared ledger
- There is **no single point of failure**, as data blocks are replicated on participant blockchain nodes



Enterprises share a common, secure communication protocol that automates intra-firm processes

Hyperledger Fabric

What is Hyperledger Fabric?

Hyperledger Fabric (HLF) is a robust and flexible blockchain network architecture that provides enterprise-ready security, scalability, confidentiality and performance. Its unique implementation of distributed ledger technology ensures data integrity and consistency, while delivering accountability, transparency and efficiency. As a permissioned network, the HLF delivers a trusted blockchain network, where members are assured that all transactions can be detected and traced by authorized regulators and auditors.

Fabric offers:

- ✓ A permissioned blockchain model with membership services
- ✓ Programmability – containerized smart contracts for automating business processes
- ✓ Independent Ordering Service delivers transaction blocks consistently to peers in the network and provides greater scalability
- ✓ Channels and Private Data Collections for confidentiality and privacy
- ✓ Modular architecture with pluggable data store, consensus protocols, and multiple providers of membership services
- ✓ No cryptocurrency required!



Smart Contracts

Also known as chain-codes

- A data schema and a set of business rules defined in code that describes all the conditions and steps pre-agreed by the participants for a specific transaction
- Transactions that meet the criteria of the smart contract as executed by multiple member nodes are considered valid and are automatically committed to the ledger without further intervention required
- Foundation of “algorithmic trust”



Smart Contract Functions and Logic for Reconciliation and Netting

Smart contract design and process logic

Smart Contract Functions

1 PO Submission and Validation

- Checking Duplicates
- Updating Status

2 Receipt Submission and Validation

- Check if PO Exists
- Validating and Ingesting Receipts
- Updating Status

3 Invoice Submission and Validation

- EVE Validation
- DRM Validation
- Update Status

4 2/3 Way Match

- 2/3 Way Match (Reconciliation)
- Aggregate Type
- Legal Entity Type

5 Intercompany Agreement

- Check ICA Exists
- Check ICA Invoice Matches
- Update Status

6 Real-time Netting and Settlement

- Match 2/3 way POs and ICAs
- Check Invoice Receipt Type
- Check Net Settlement Exists
- Update or Create New Settlement

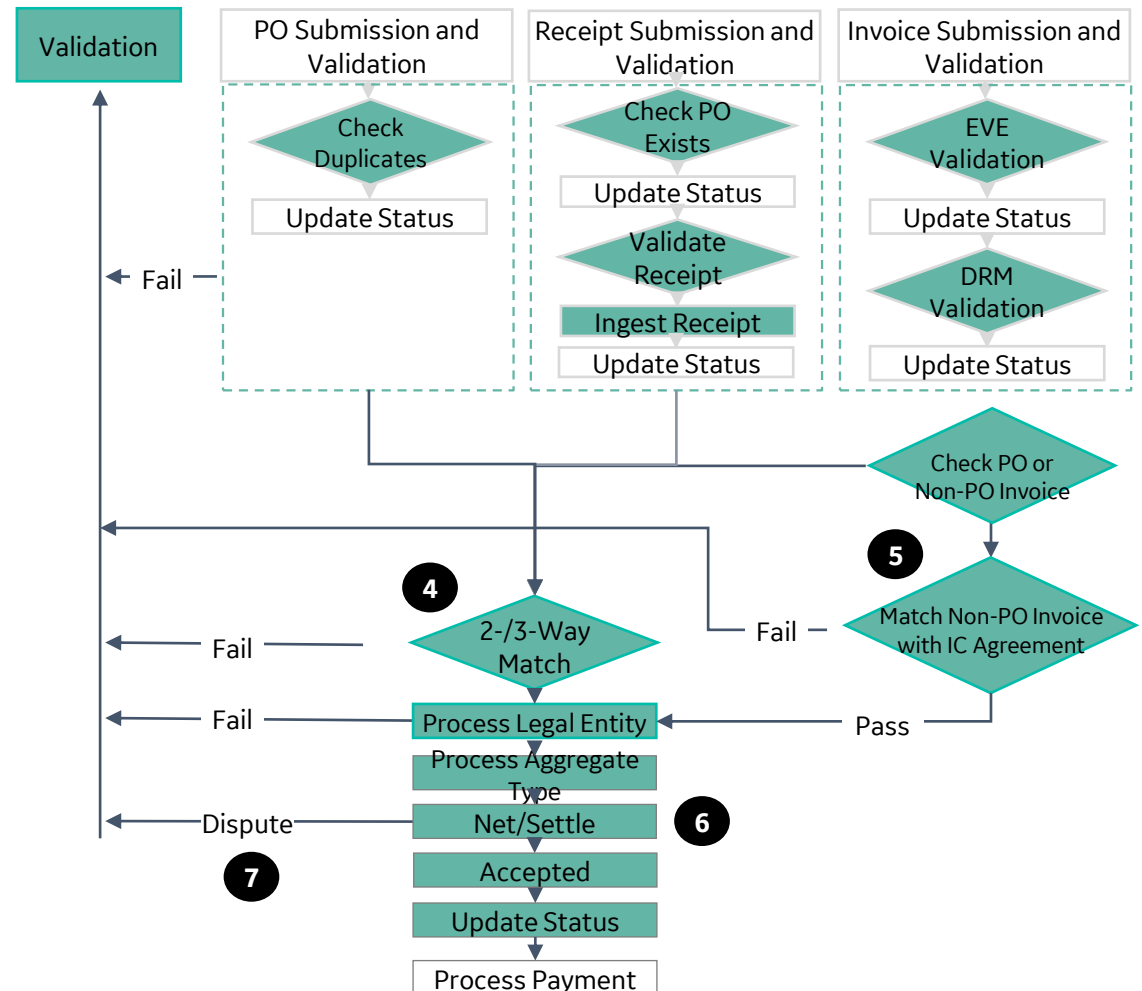
7 Dispute Handling

- Check Status If Dispute allowed
- Update Invoice Data
- Update Settlement Data
- Add to Success or Failure List





Flow Key

Smart Contract Logic

Smart Contract Logic



Open Source Hyperledger Fabric with Key Oracle Value-Add

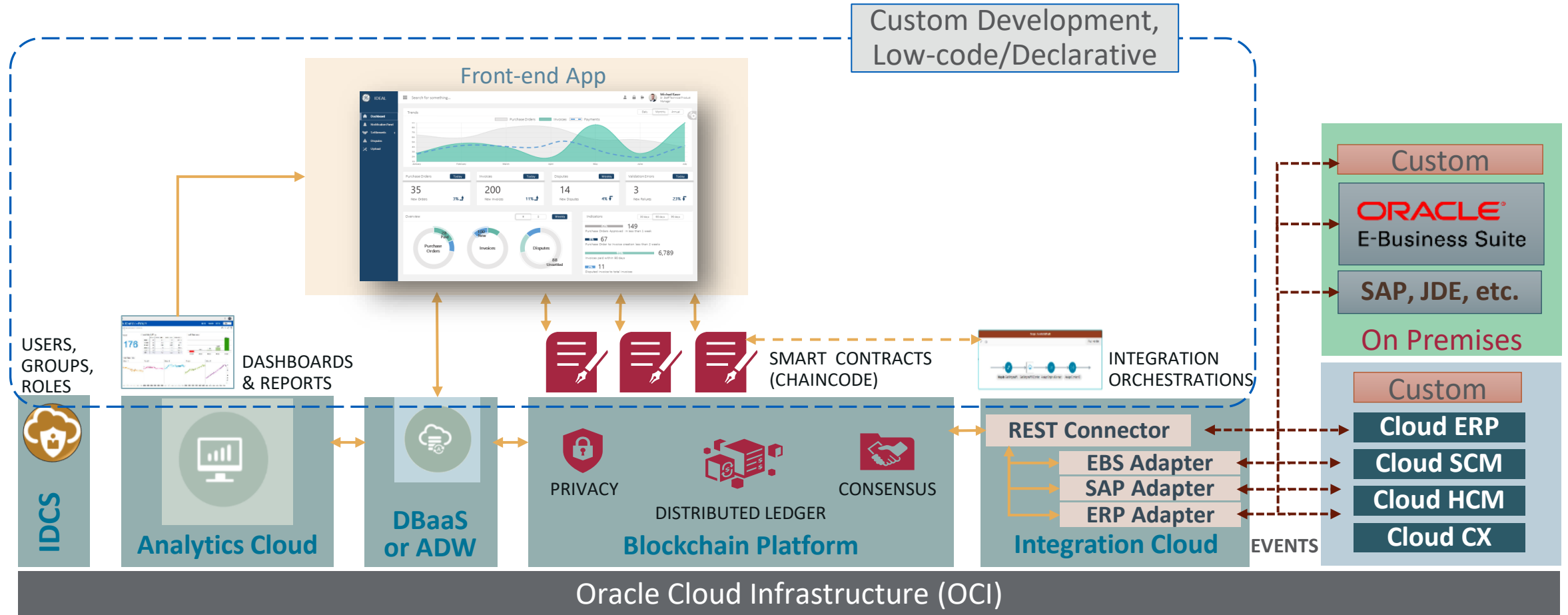
Infrastructure 	Provisioning & Integration Oracle Cloud Managed Service Object Store Integration Management/Operations Console
Orchestration 	REST Proxy Supports rich set of Fabric APIs via REST calls Enables synchronous invocation as well as events/callbacks and extensive DevOps operations Simplifies integration and insulates applications from underlying changes in transaction flow
Data Management, Reporting & Analytics 	Ledger DB replaced by Berkeley DB CouchDB rich query support at LevelDB performance SQL-based rich query support and results validation at commit time Rich history database Streams transaction history to ADW/DBaaS and hooks up with Analytics/BI
Security 	Security Integration IDCS User/role management Authentication for OBP Console, REST Proxy, CA Fine-grained Access Control Lists capabilities



Architecture

Cloud Services Building Blocks

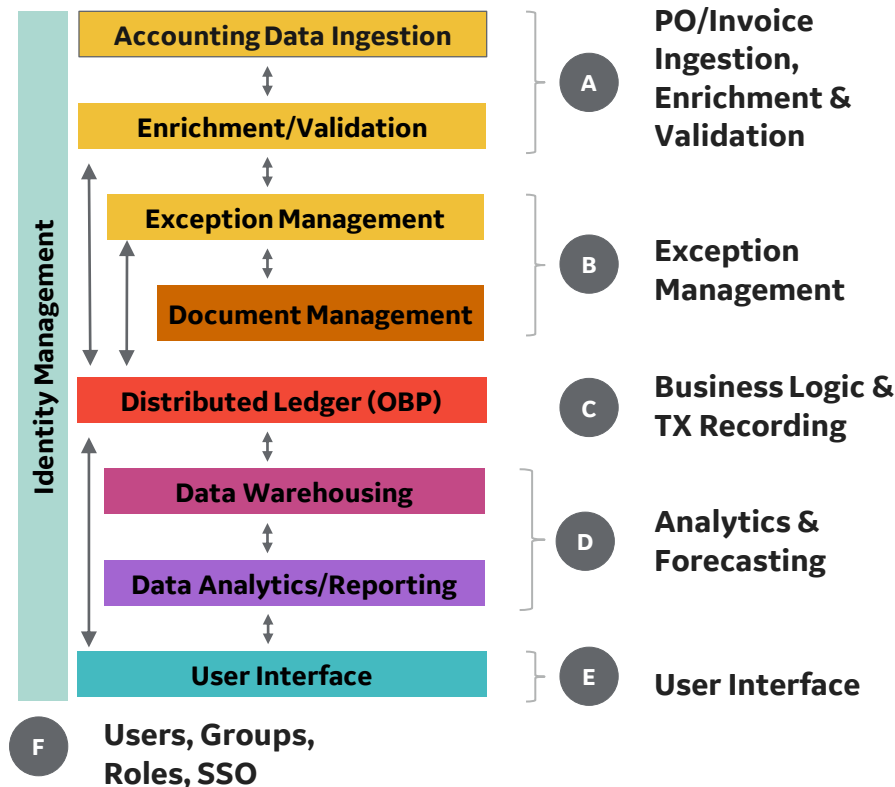
Pre-integrated Cloud Services for rapid development and managed operations



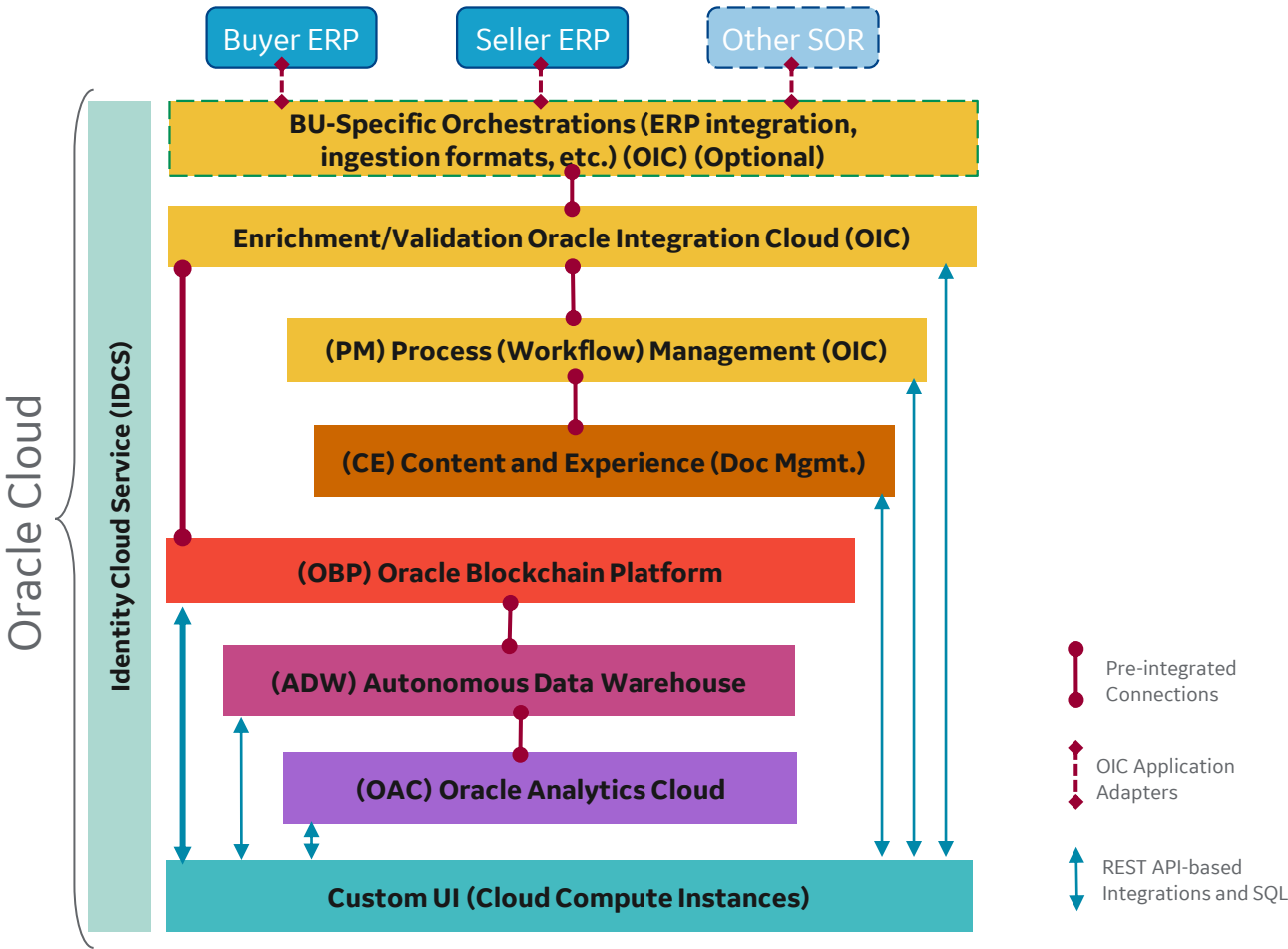
Solution & Integration with Oracle Products

Solution is built on a suite of Oracle Cloud platforms

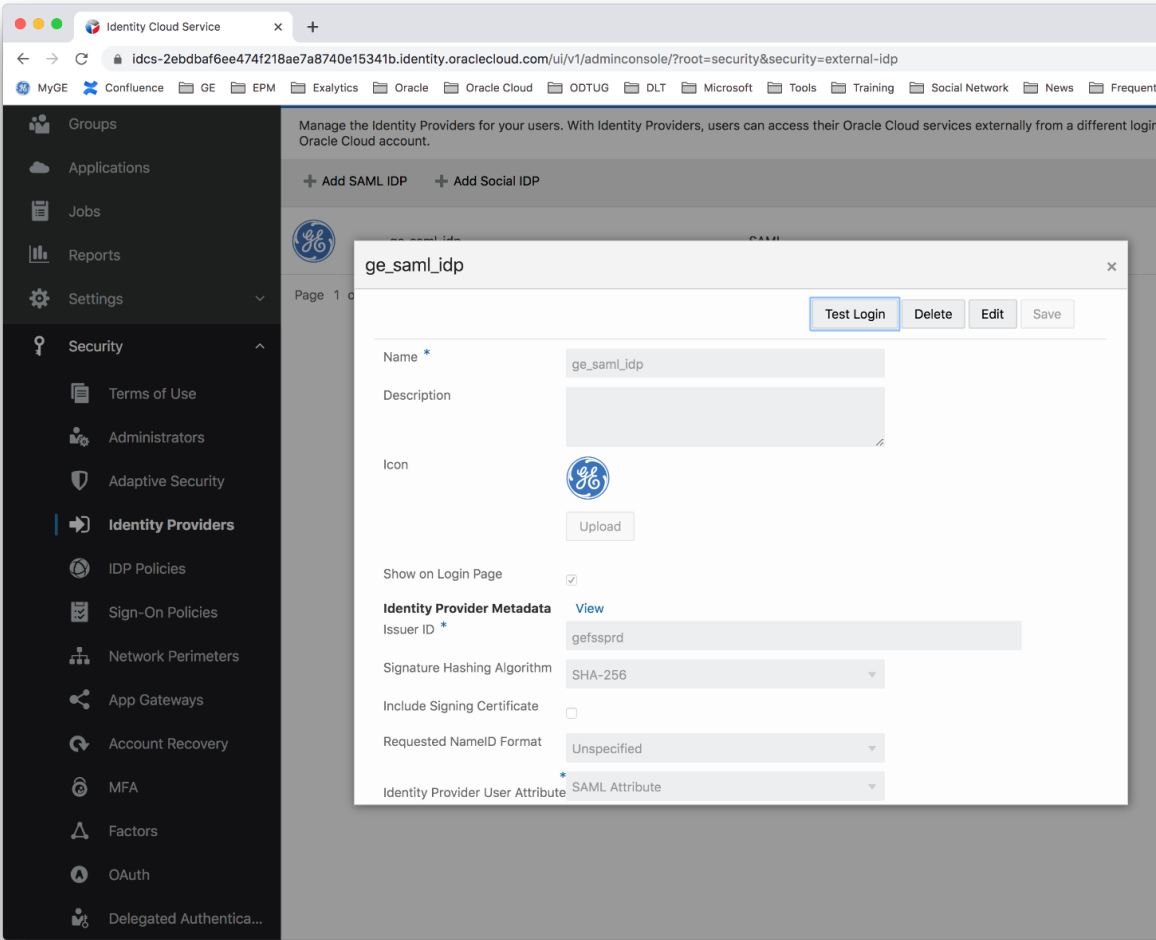
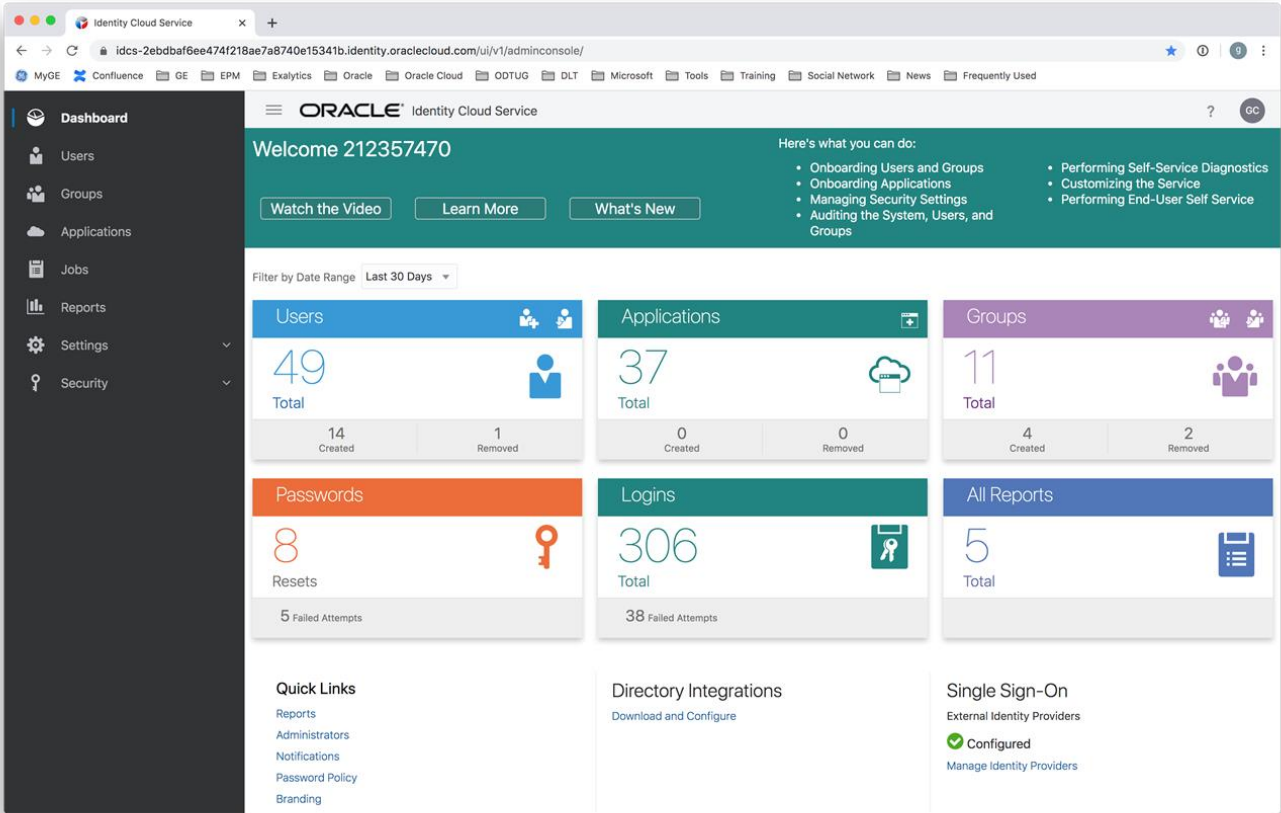
Solution Overview



Technology Stack



Security: IDCS and Federation to Remote Identity Providers



Security: Authentication and Authorization

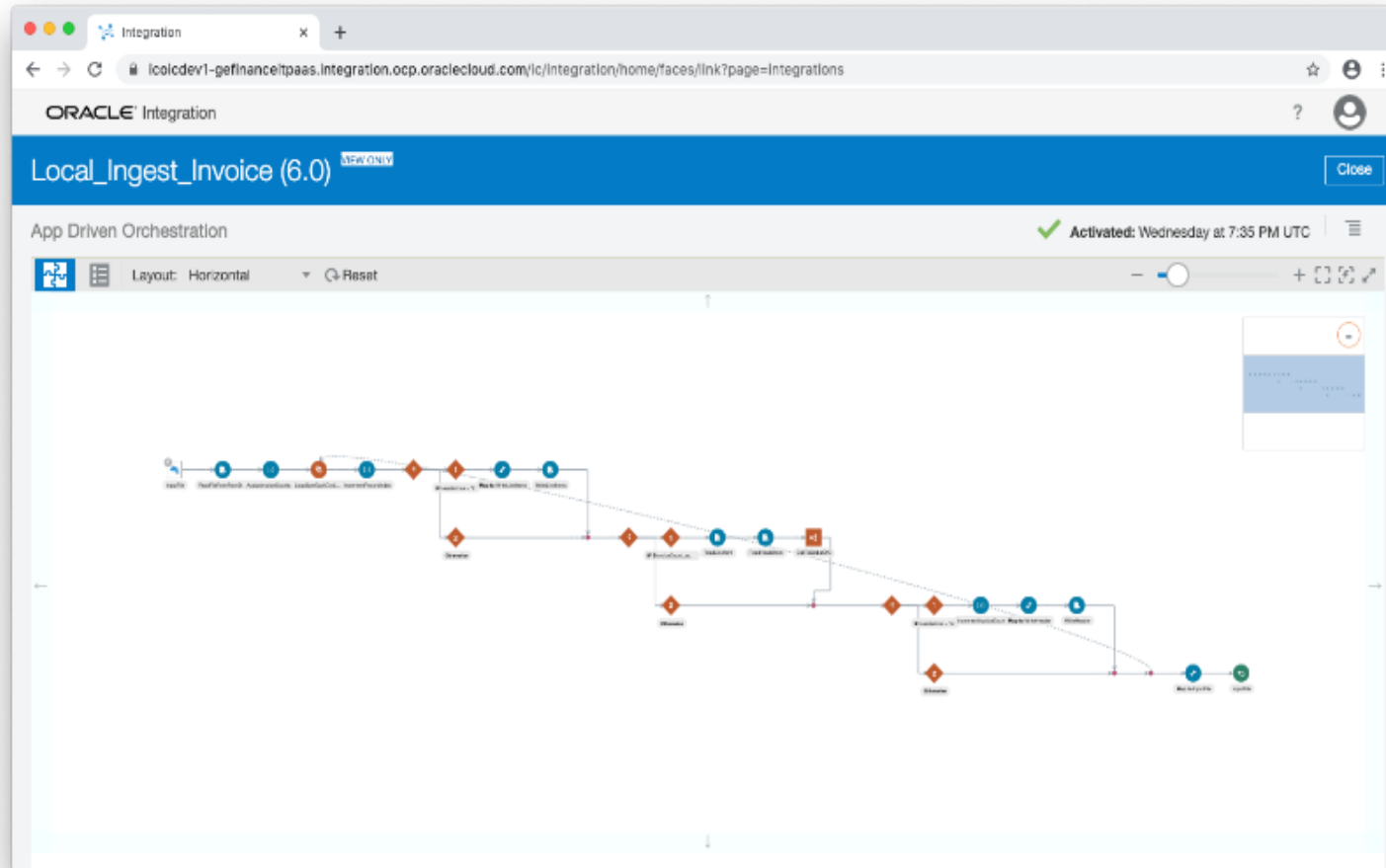
The screenshot shows the Oracle Identity Cloud Service (IDCS) Admin Console. The browser address bar indicates the URL: `idcs-2ebdbaf6ee474f218ae7a8740e15341b.identity.oraclecloud.com/ui/v1/adminconsole/?root=apps&app=74be82647d20425a8c9a0989f021ab86&app-tab=app-roles`. The sidebar on the left contains navigation links: Dashboard, Users, Groups, Applications (selected), Jobs, Reports, Settings, and Security. The main content area is titled 'Applications > OABCSINST_CO' and shows the 'Application Roles' tab. The roles listed are:

Role Name	Role Description	Assigned Groups	Assigned Applications
ADMINISTRATOR	CA administrator Admin Role	1 Groups Assigned	
BCS ADMINISTRATOR	BCS administrator Admin Role	1 Groups Assigned	
RESTPROXY0_ADMIN	RESTPROXY0 administrator Admin Role		
BCS USER	BCS user		1 Applications Assigned
RESTPROXY0_USER	RESTPROXY0 user Admin Role		
CLIENT	CA client	1 Groups Assigned	

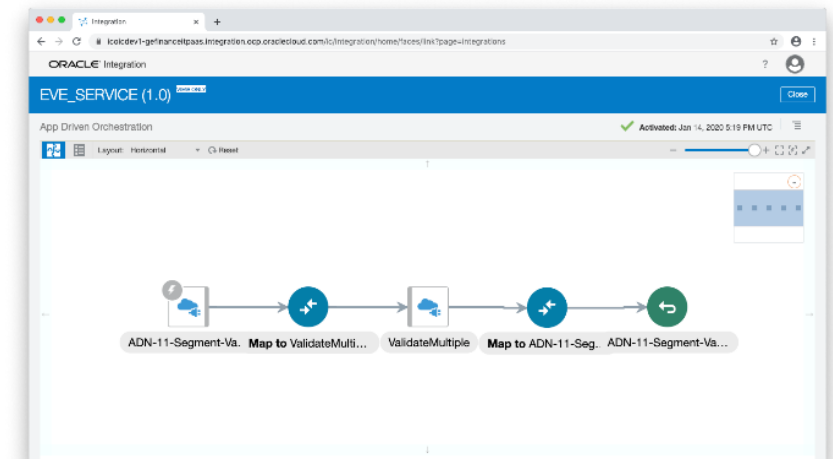


Data Integration

Reduces code development and provides off-the-shelf integration to existing systems

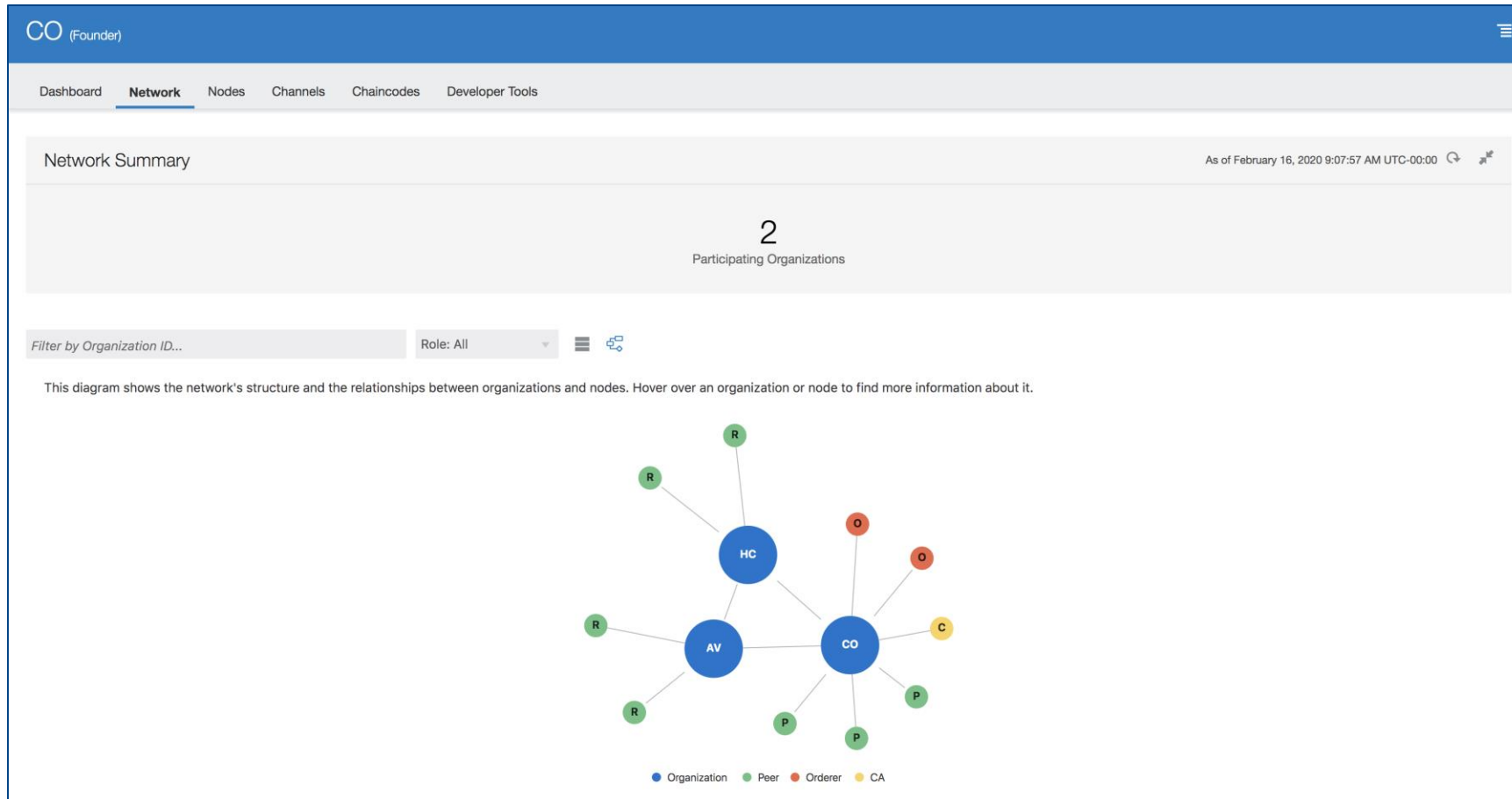


- Integration to break up CSV file into individual invoices and pass to the canonical invoice handling API
- Integration to take in invoice data, enrich the data, and submit to blockchain.
- EVE Validation
- DRM Enrichment
- Integration to process PO data and submit to blockchain



Oracle BaaS

Organization Nodes in the Blockchain Network



Oracle BaaS

Peer Nodes on Channels

ORACLE[®] Oracle Blockchain Platform Console

Francisco.Ponce@ge.com

CO (Founder)

Dashboard

Network

Nodes

Channels

Chaincodes

Developer Tools

Channels

> testch2

Ledger

Instantiated Chaincodes

Peers

Organizations

Channel Policies

ACLs

Ledger Summary

As of May 17, 2020 8:24:04 PM UTC-00:00

2.71K

Blocks

3.23K

User Transactions

All

Block #	Time	Type	User Transactions
2713	April 2, 2020 3:46:29 PM UTC-00:00	data	1
2712	April 2, 2020 3:43:01 PM UTC-00:00	data	1
2711	April 2, 2020 3:42:21 PM UTC-00:00	data	1
2710	March 23, 2020 2:49:15 PM UTC-00:00	data	1
2709	March 23, 2020 2:48:01 PM UTC-00:00	data	1

Page 1 of 543

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Page Size 5



Oracle BaaS

Rich History DB

ORACLE Oracle Blockchain Platform Console

Francisco.Ponce@ge.com

CO (Founder)

Dashboard Network Nodes Channels Chaincodes

Configure Rich History

User Name

Password
.....

Connection String ?

Wallet package file(Optional) ?
Upload wallet file

Save

Summary

5 Channels

Health

100% Running

11 Nodes Running
0 Nodes Stopped

Up since September 5, 2019 4:32:42 AM UTC-00:00

Partition Utilization

1 2 3

As of May 17, 2020 8:25:26 PM UTC-00:00

2 Participating Organizations

Production mode

May 16, 2020 8:25:26 PM UTC-00:00 to May 17, 2020 8:25:26 PM UTC-00:00

Peer Activity

Endorsements 0
Commits 0

Top peers

Endorsements Commits

No peer activity



Data warehouse

Rich History Database

The screenshot displays the Oracle SQL Developer interface, showcasing a data warehouse environment. The main window shows a table named `CO_testch2_hist` with columns `BLOCKNO`, `TXNNO`, `TXNID`, and `TXNTIMES`. The table contains 33 rows of data, including timestamps and transaction details.

The left pane shows the database structure, including tables like `AV_testch1_hist`, `AV_testch1_state`, `CO_deltestchannel_hist`, `CO_deltestchannel_state`, `CO_pocch1_hist`, `CO_pocch1_state`, `CO_testch1_hist`, `CO_testch1_more`, and `CO_testch1_state`.

The right pane shows the definition of a view named `CO_TESTCH2_HIST_STLMT_INVDETAIL_V`. The view is created or replaced with the following SQL:

```
CREATE OR REPLACE FORCE EDITIONABLE VIEW "ICADWUIUSR1"."CO_TESTCH2_HIST_STLMT_INVDETAIL_V" AS
SELECT
  a.CHAINCODEID||a.KEY||a.BLOCKNO||a.TXNNO AS SRCTBLPK,
  jt.INVOICENUMBER,
  jt.INVOICEDATE,
  jt.NETAMOUNT,
  jt.INVOICEKEY,
  jt.FROMCOMPANY,
  jt.TOCOMPANY,
  'TESTCH2' AS CHANNEL
FROM ADMIN."CO_testch2_hist" a,
JSON_TABLE(
  VALUEJSON, '$'
  COLUMNS (
    NESTED PATH '$.invoiceDetail[*]'
    COLUMNS (
      InvoiceNumber VARCHAR2(4000) PATH '$.invoiceNumber',
      InvoiceDate VARCHAR2(4000) PATH '$.invoiceDate',
      netAmount VARCHAR2(4000) PATH '$.netAmount',
      InvoiceKey VARCHAR2(4000) PATH '$.invoiceKey',
      fromCompany VARCHAR2(4000) PATH '$.fromCompany',
      toCompany VARCHAR2(4000) PATH '$.toCompany',
      "LINEITEM" FOR ORDINALITY
    )
  )
) jt
WHERE JSON_VALUE(VALUEJSON, '$.settlementId') IS NOT NULL;
```



Analytics – Executive Summary

Executive

Year: All Initiator Country: All RecipientBusiness: All InitiatorBusiness: All Initiator Success: All Invoice Currency: All

Total Invoice

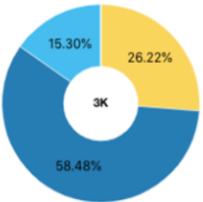
Total Invoice Amount

Invoice Business Initiator



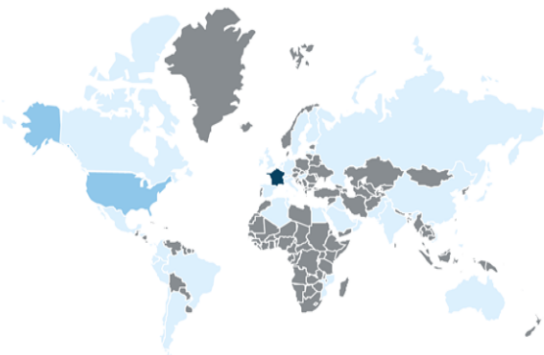
3,314

\$12,334,069

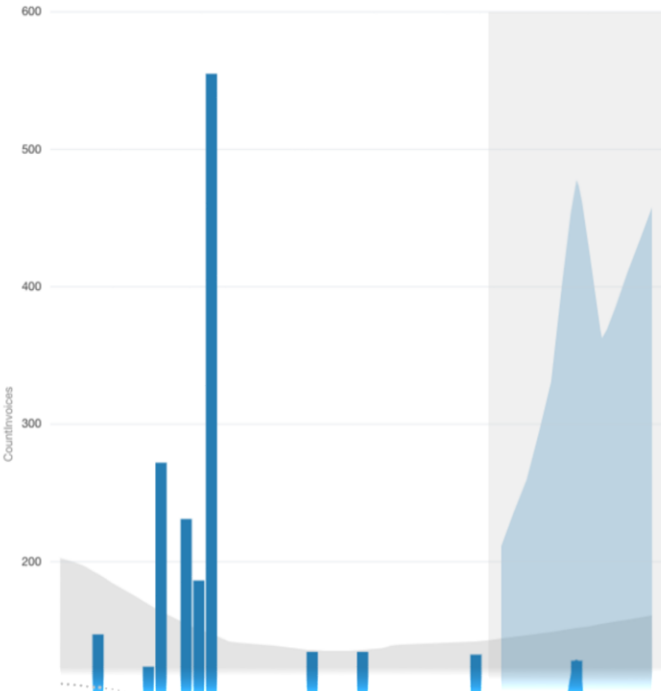


InitiatorBusiness Aviation Corporate Healthcare

Blockchain Transaction Amount by Initiator and USA Recipient



Transaction Arima forecast for the next 7 days



Executive Summary

Recipient Country: USA
The data shows the Total Invoice Amount for a total of 47 Initiator Countries.

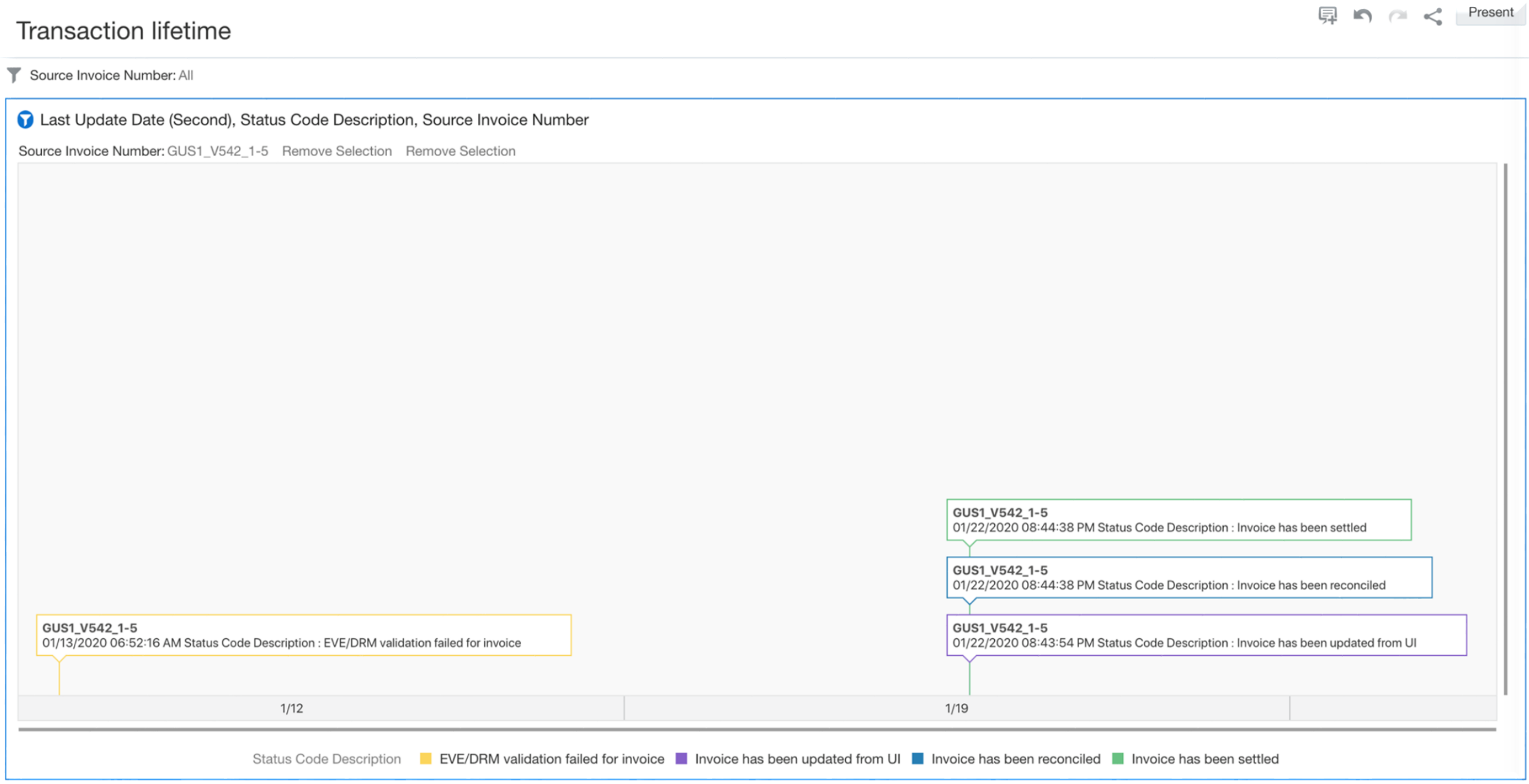
What stands out in this situation is that a few Initiator Countries account for more than 80% of the total. There is a dominant group of Initiator Countries. This group is composed of six Initiator Countries: FRA with 48.99%, USA with 15.87%, BRA with 4.93%, DZA with 4.38%, CAN with 4.07% and GBR with 3.05%.

Combined, the 41 other Initiator Countries account for 18.72% of the total.

When taken together, the 47 Initiator Countries amount to a total value of 3,282,302, 69,836 on average. The most frequent value is 5,136 and appears 14 times.

Your first dimension seems to be unordered. Unordered means that the data is not in chronological order. This chart is commented as if you had added together all the InitiatorBusinesses. Stay tuned, future releases will improve captions for unordered dimensions.

Analytics – Transactional history



Analytics – Transaction provenance

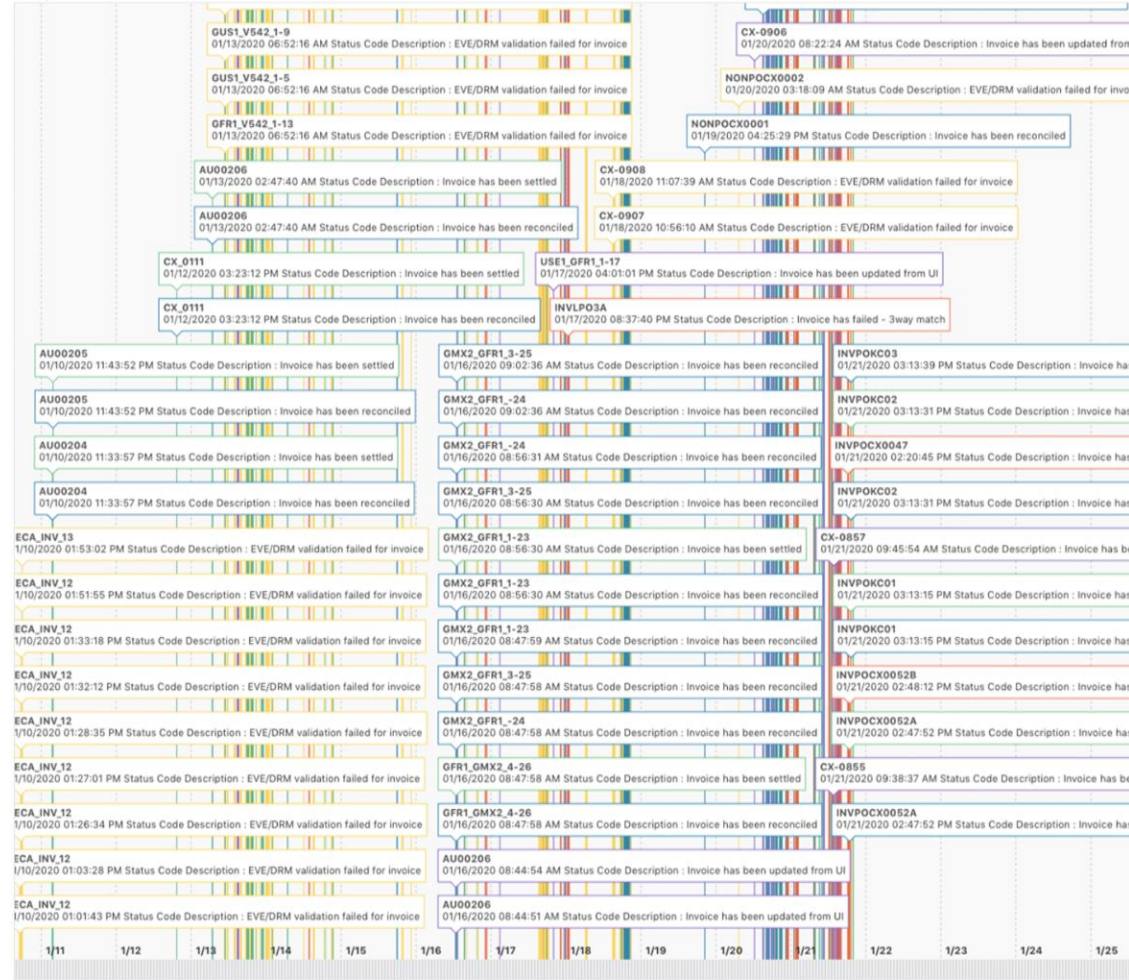
Real-time

Year: All Initiator Country: All Recipient Business: All Initiator Business: All Initiator Success: All Invoice Currency: All



Blockchain Real-time invoice transaction by status code

Last Update Date: To 4/2/2020 12:00 AM



Current Month Summary

Last 2 Months Last Update Date

The data represents CountInvoices for the following Status Code Descriptions:

- ◆ Invoice has been settled.
- ◆ Invoice has been reconciled.
- ◆ Invoice has been updated from UI.
- ◆ EVE/DRM validation failed for invoice.

A single Status Code Description accounts for more than half of the total: Invoice has been settled, with 32.

Combined, the three other Status Code Descriptions make up the rest of the list, accounting for 28.89% of the total.

When taken together, the four Status Code Descriptions amount to a total value of 45, 11.25 on average.

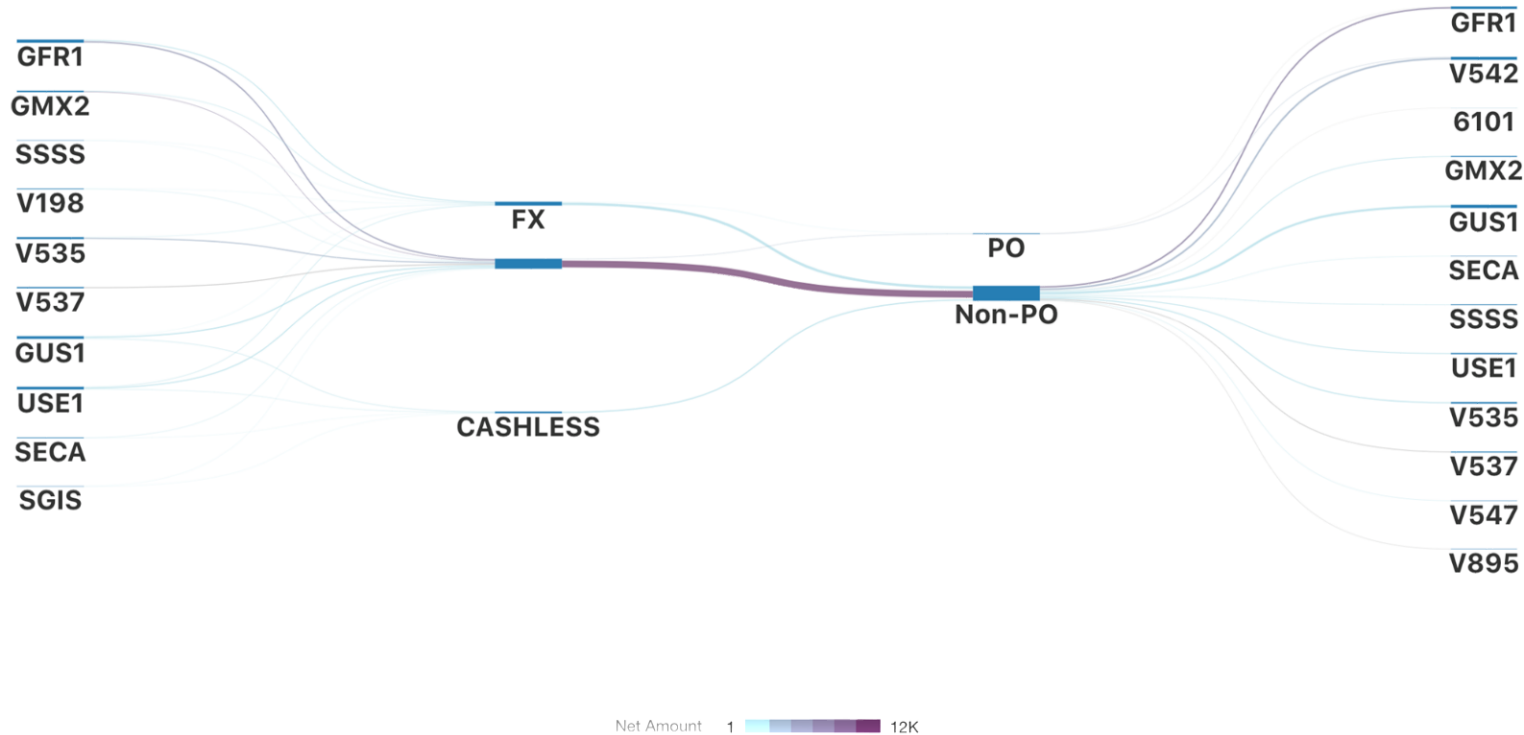
Status Code Description

- ◆ EVE/DRM validation failed for invoice
- ◆ Invoice has been settled
- ◆ Invoice has failed - 3way match
- ◆ Invoice has been reconciled
- ◆ Invoice has been updated from UI
- ◆ Invoice has failed - 2way match

Analytics

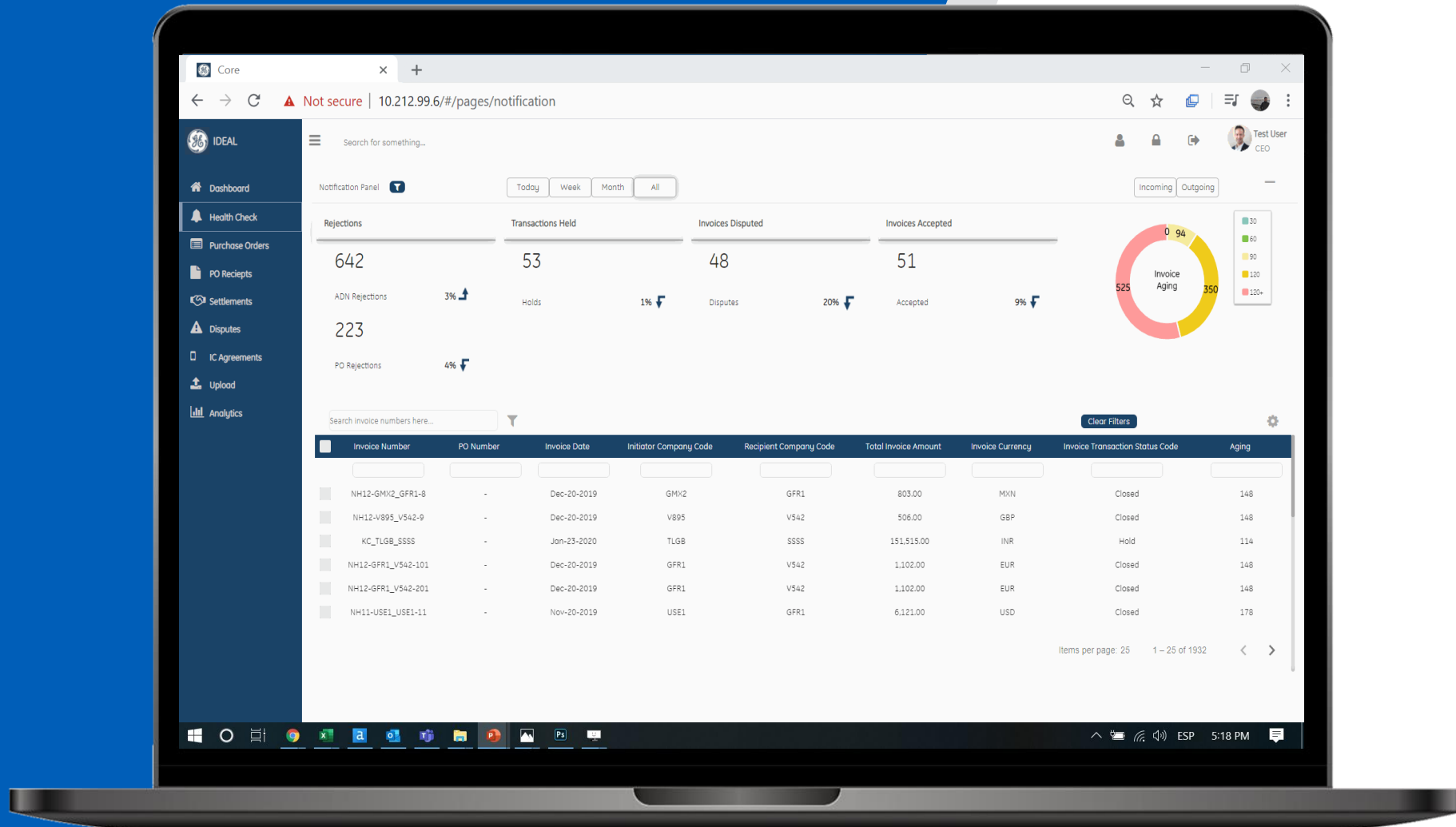
Initiator Company Code, Settlement Type, Invoice Type, Recipient Company Code, Net Amount

Initiator Company Code: GFR1, GMX2, GUS1, SECA, SGIS, SSSS, USE1, V198... +2



- Distribution of invoices by Company Code initiator and Company Code recipient
- Distribution of invoices by type of payment

Using Blockchain to manage Intercompany invoices



Architecture Summary

iDeAL solution is built on a collection of pre-integrated cloud platform services

- Integration, Blockchain, Data warehouse, Analytics, Identity management
 - Each strong, but providing greater value when used together
 - Enables rapid development of complex applications using well-defined APIs
 - Supports declarative/low-code development of many components
 - Provides independent layers of Microservices-based functionality
- Enables IT Flexibility and Business Agility
 - Decentralized topology and flexible deployment architecture for corporate and BU needs, speeds up execution of TSAs
 - Provides high availability and resilience of managed cloud services in a cost-effective manner
 - Can easily evolve through ability to add additional BUs and ERPs, validations/enrichments, process flows (disputes, holds, etc.), smart contracts, dashboards, and downstream integrations.



Q&A



Gary Crisci, Principal Architect

General Electric

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coding-around-the-block.blogspot.com



