Collaborative Shipping *sans* Orchestrator using Blockchain

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* Currently with Oracle IDC

Blockchain Applications in Supply Chain

Provenance & Visibility

- Tracking
- End-to-End Visibility
- Multi-party Shared Visibility

Choreography & Visibility

- Business Process Coordination
- Multi-party Compliance

Our contribution

Collaborative Decision Making

Collaborative Shipping

Shipper A

Shipper B

Shipper C

Shipping Demands

Bundle

Horizontal Collaboration

- Bundle compatible demands
- Ship the bundle using common carrier/transporter
- Economies of scale and scope
- Cost savings for shippers
- Increased utilization for carriers
- Reduced carbon footprint

FARE DETAILS

4.8 mi, 15 mins from **Fenway, Boston, MA, United States** to **Seaport Boulevard, Boston, MA, United States**

	Lyft Line	Uber Pool	Fasten 4 Seater	Lyft
	Shared Ride • 2 people	Shared Ride • 2 people	4 people	Advanced Booking Available • 4 people
	$6-$9	$6-$10	$12.39	$12.47
	More info / Discuss	More info / Discuss	More info / Discuss	More info / Discuss

Lyft Line
Lyft fare	$12.47
Estimated discount	($4-$6)
Total	**$6-$9**
Driver earns $5-$7	

Uber Pool
Uber X fare	$12.47
Estimated discount	($2-$6)
Total	**$6-$10**
Driver earns $5-$7	

Fasten 4 Seater
Initial charge	$2.00
Metered fare	$8.39
Ride Fee	$2.00
Total	**$12.39**
Driver earns $11.39	

Lyft
Initial charge	$2.00
Metered fare	$9.12
Trust and Service Fee	$1.35
Total	**$12.47**
Driver earns $9.35	

GET LYFT APP   HAIL UBER POOL   GET FASTEN APP   GET LYFT APP

Orchestrator for Long Term Collaborations
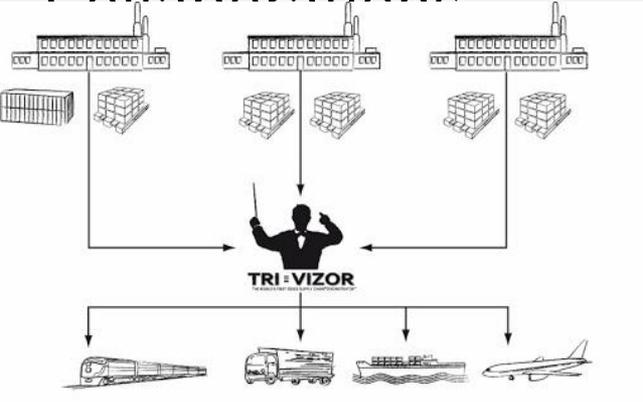
Identify bundling opportunities
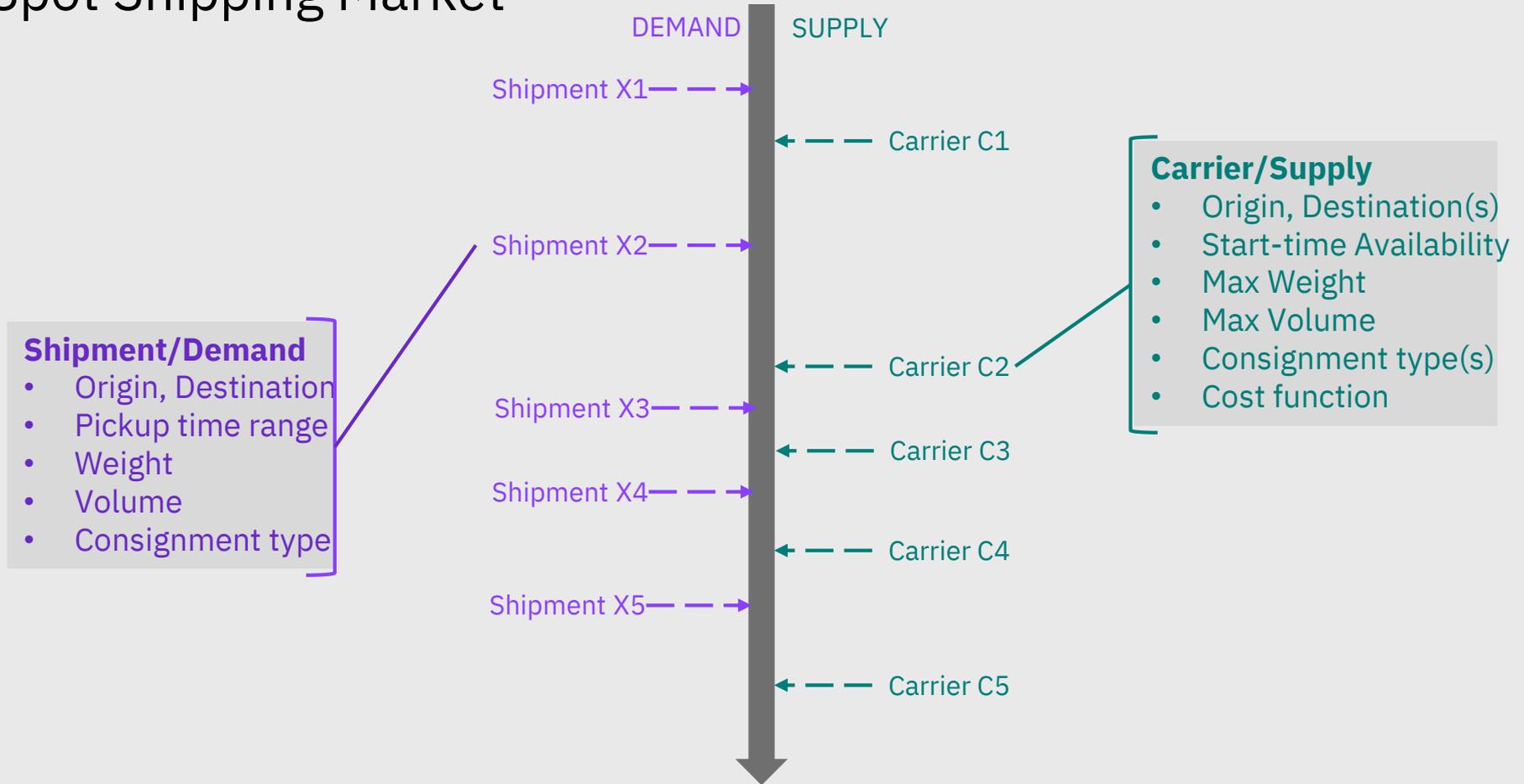
Bundles shipping demands

Matches bundled demand with Carriers
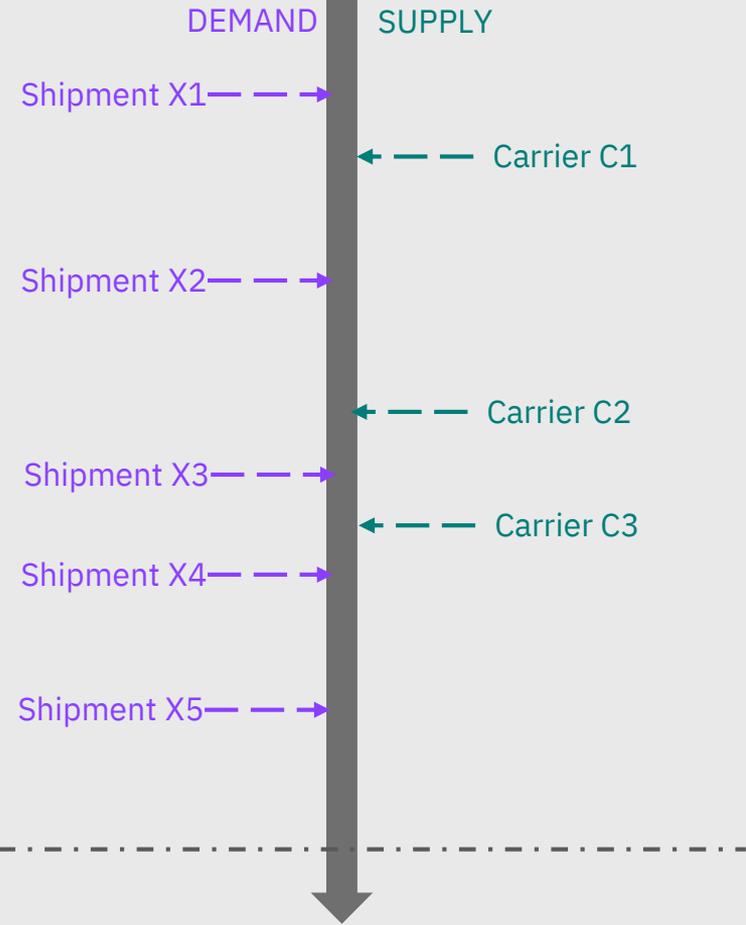
Cost allocation

Spot Market?

- Trucking Industry
- Small shipments
- Highly fragmented
- 90% Carriers own < 6 Trucks
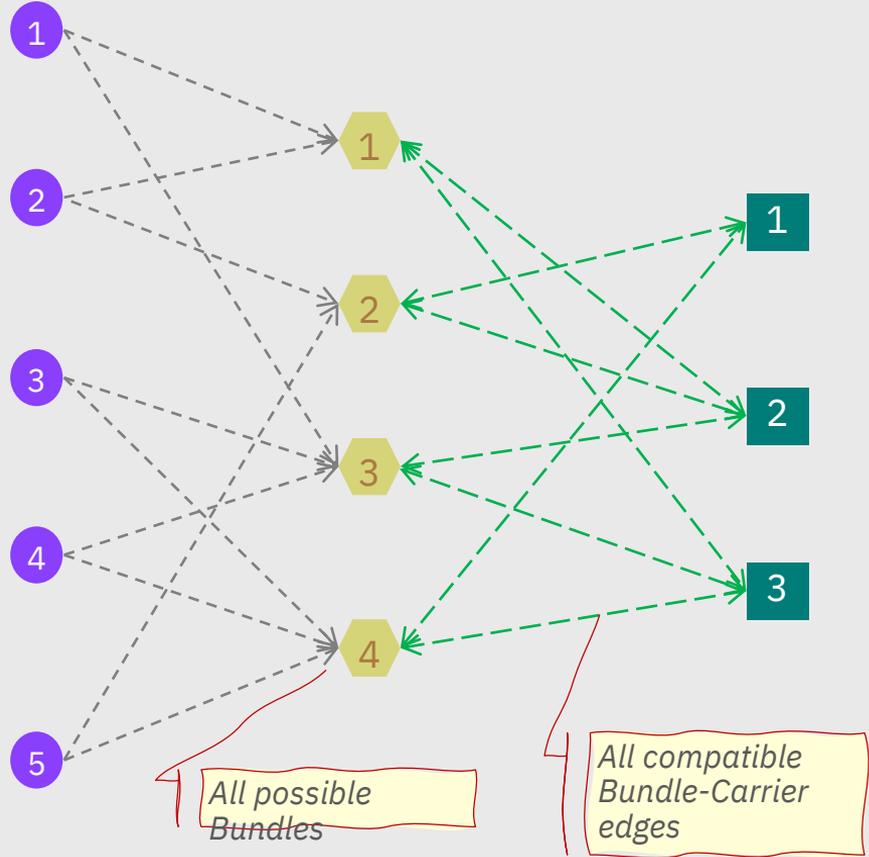- How to orchestrate dynamic, real-time collaborative shipping?

Spot Shipping Market

DEMAND   SUPPLY

Shipment X1

Carrier C1

Shipment X2

Carrier/Supply
- Origin, Destination(s)
- Start-time Availability
- Max Weight
- Max Volume
- Consignment type(s)
- Cost function

Shipment/Demand
- Origin, Destination
- Pickup time range
- Weight
- Volume
- Consignment type

Carrier C2

Shipment X3

Carrier C3

Shipment X4

Carrier C4

Shipment X5

Carrier C5

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Bundling

DEMAND · SUPPLY

Shipment X1
Carrier C1
Shipment X2
Carrier C2
Shipment X3
Carrier C3
Shipment X4
Shipment X5

DEMAND · BUNDLE · SUPPLY

All possible Bundles

All compatible Bundle-Carrier edges

DEMAND-BUNDLE-SUPPLY (DBS) GRAPH
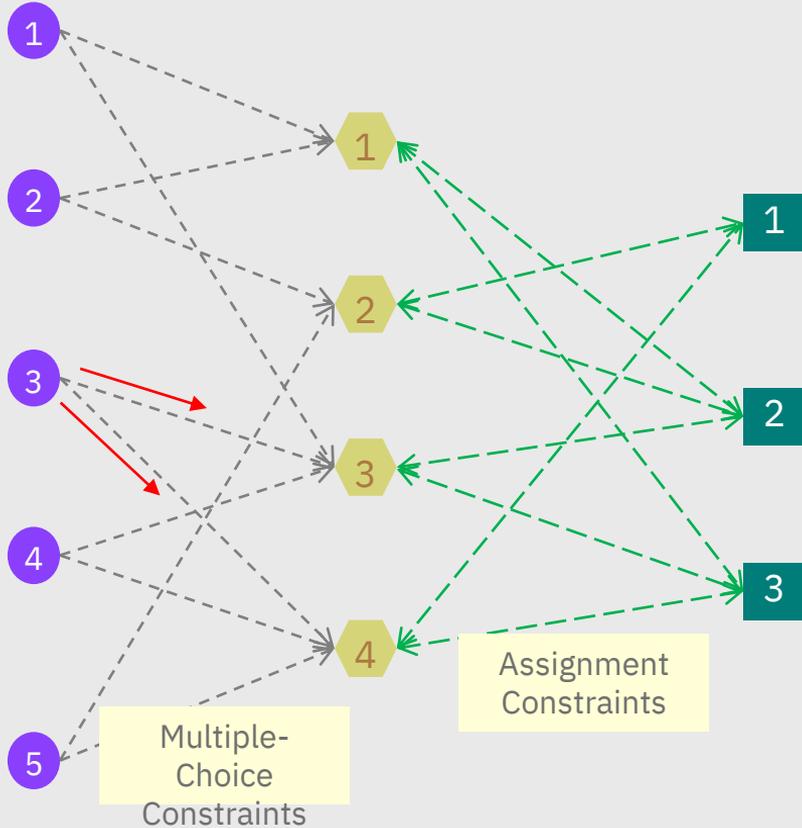
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Matching

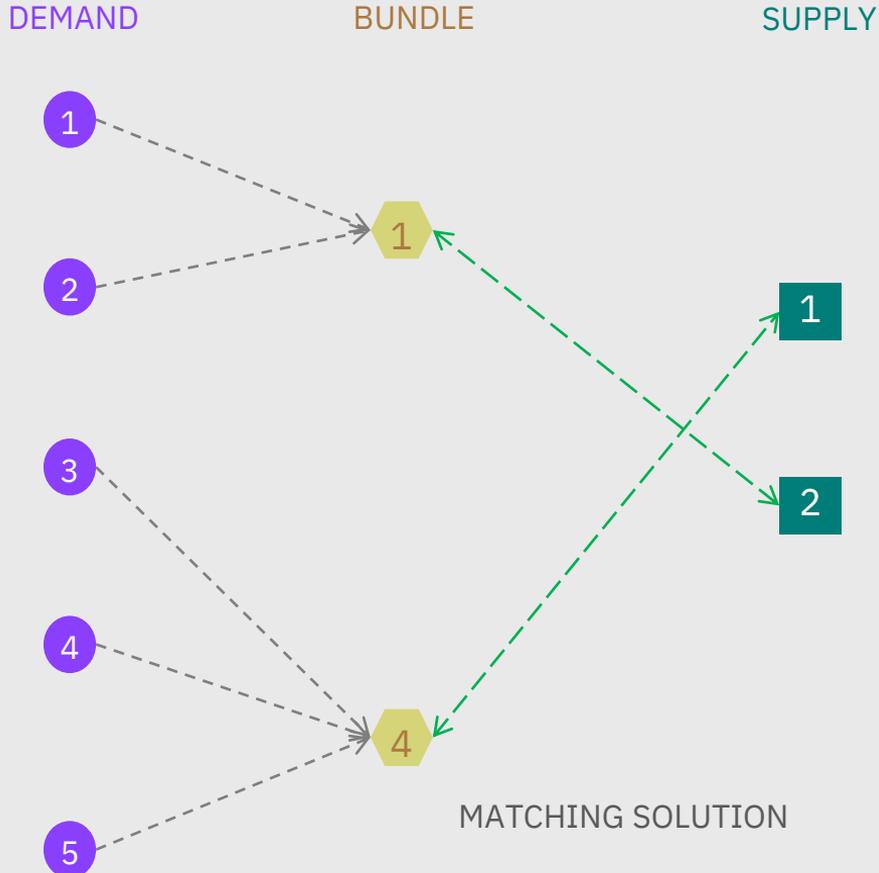DEMAND-BUNDLE-SUPPLY (DBS) GRAPH

DEMAND   BUNDLE   SUPPLY

Objectives

Maximize *Total Bundle Value*

Maxmin *Utilization of a Vehicle*

Maximize *Total Shipments*

Cost Allocation

DEMAND   **BUNDLE**   **SUPPLY**

MATCHING SOLUTION

How to allocate the cost of bundle shipments?

- BUNDLE 1 ⤏ Shipments 1 & 2
- BUNDLE 4 ⤏ Shipments 3, 4, & 5

Shapley Value
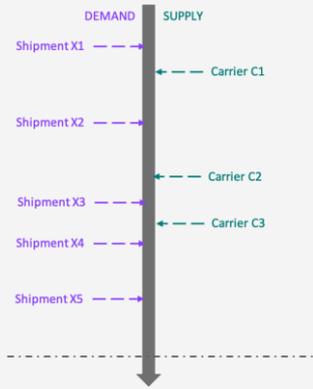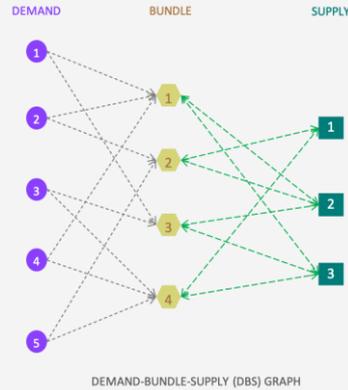*Equal Charge Method*
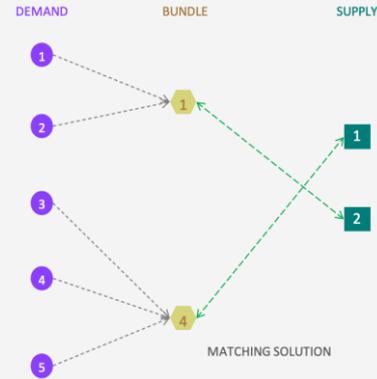*Alternative Cost Avoided Method*
Cost Gap Method
Equal Profit Method

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Collaborative Shipping with Orchestrator

Trust & Transparency Issues

- *How to verify all possible bundles are considered?*
- *What are the objectives in the matching?*
- *What are the weights for the different objectives?*
- *Is the matching solution efficient?*
- *Which cost allocation mechanism was used?*
- *How one can verify that certain group of carriers were not favored?*

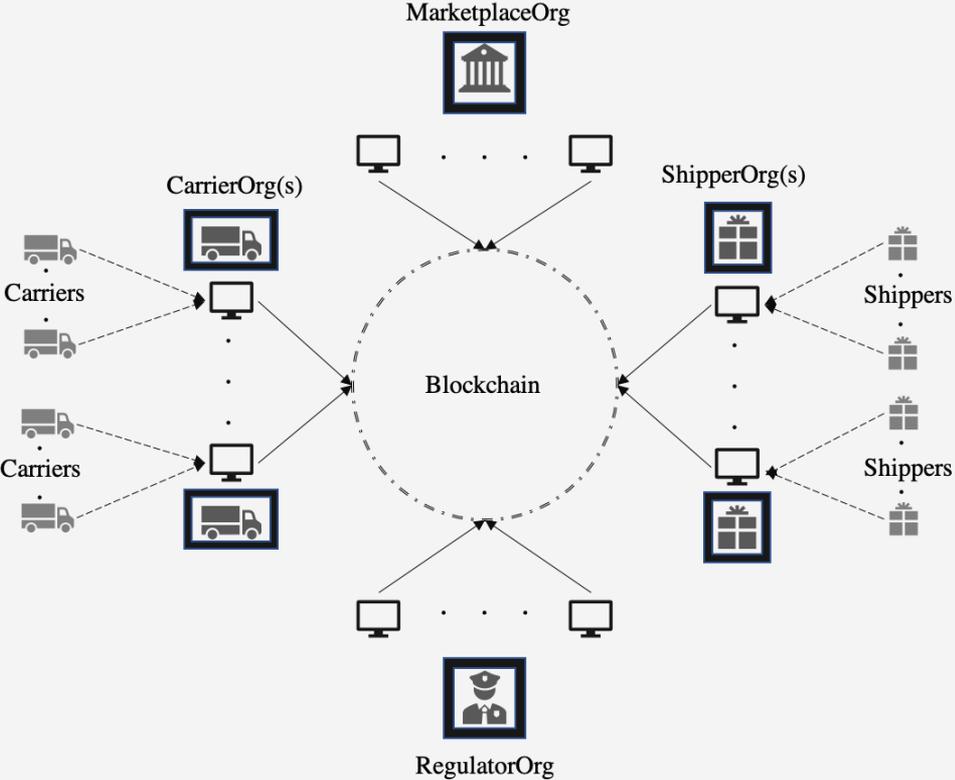# Collaborative Shipping *sans* Orchestrator using Blockchain
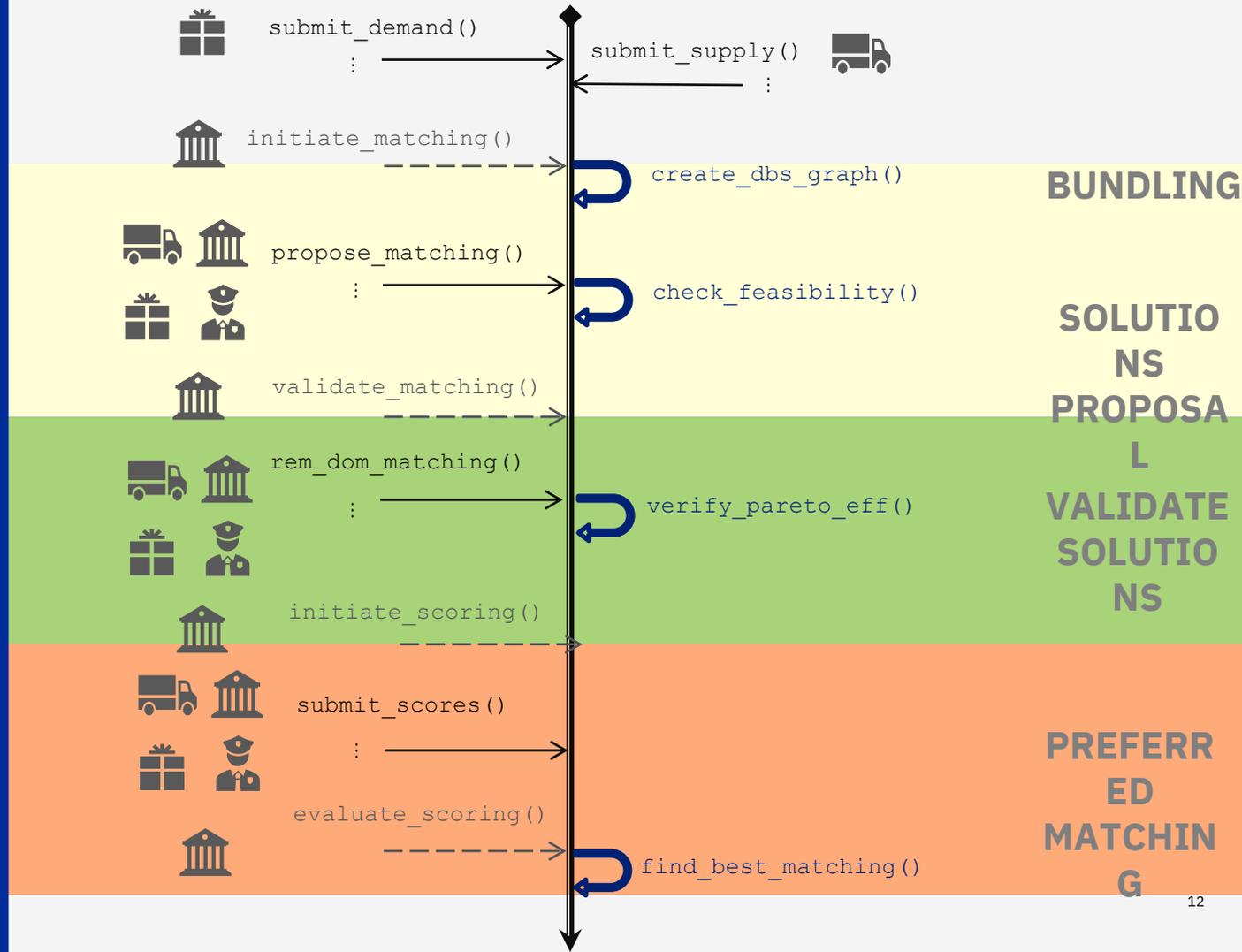
Blockchain Network

Hyperledger Fabric
- Permissioned Blockchain

Organizations
- MarketplaceOrg
- CarrierOrg(s)
- ShipperOrg(s)
- RegulatorOrg

Transactions & Smart Contracts

submit_demand()
submit_supply()

initiate_matching()
create_dbs_graph()
BUNDLING

propose_matching()
check_feasibility()

validate_matching()
SOLUTIONS PROPOSAL

rem_dom_matching()
verify_pareto_eff()
VALIDATE SOLUTIONS

initiate_scoring()

submit_scores()

evaluate_scoring()
find_best_matching()
PREFERRED MATCHING

Collaborative Decision Making

Multi-Objective Optimization

Pareto Method

Voting & Ranking

Score Voting

Cooperative Game Theory

Characteristic Cost Function

Thanks

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