COST EFFECTIVE HUB & SPOKE MODEL

Vinoth Radhakrishnan

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COMPANY IN AN ECONOMY

COMPANY

A company in an economy is started by the **investors** to make profit by buying the inputs from the **suppliers** and converting the inputs in to outputs for their **customers** using **employees and operation process.**

Factors influencing the company's performance can be categorised in to external and internal factors.

EXTERNAL FACTORS

1. CUSTOMERS
   Customers in an economy expect the company to sell their goods and services for affordable price in the market.
   Customers price = suppliers price + operating expenses + investors profit

2. SUPPLIERS
   Suppliers in an economy expect the company to buy their goods and services for a fair price in the market.
   Suppliers price = customers price – (operating expenses + investors profit)

3. INVESTORS
   Investors in an economy expect the company to make profit.
   Investors profit = customers price – (suppliers price + operating expenses)

INTERNAL FACTORS

EMPLOYEES AND OPERATION PROCESS

Company expects the employees to convert the inputs in to outputs using efficient operation process at optimum operating expenses.

Operating expenses = staff cost + depreciation + amortization + other operating expenses.

RELATIONSHIP BETWEEN THE EXTERNAL FACTORS AND INTERNAL FACTOR

External factors

Companies in an economy are struggling to maintain the balance between their external factors

1. Investors
2. Suppliers
3. Customers

Company in favour of investors

Investors in an economy expect the company to make profit, so company have to do one or more of the following to make profit.

Investors profit = customers price – (suppliers price + **operating expenses**)

1. Increase the customers price
2. Decrease the suppliers price
3. **Decrease the operating expenses**

Company in favour of suppliers

Suppliers in an economy expect the company to buy their goods and services for a fair price in the market, so company must do one or more of the following to buy the goods and services at a fair price.

Suppliers price = customers price – (**operating expenses** + investors profit)

1. Increase the customers price
2. Decrease the investors profit
3. **Decrease the operating expenses**

Company in favour of customers

Customers in an economy expect the company to sell their goods and services for affordable price in the market, so company must do one or more of the following to sell the goods and services at a affordable price.

Customers price = suppliers price + **operating expenses** + investors profit

1. Decrease the suppliers price
2. Decrease the investors profit
3. **Decrease the operating expenses**

Internal factor

Companies in an economy should have the efficient operating process.

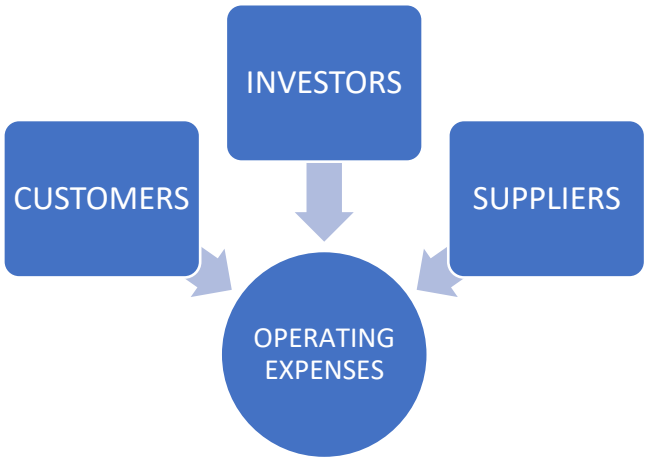
employees and operation process

Company expects the employees to convert the inputs in to outputs using efficient operation process at optimum operating expenses, so company as to create and use an operating process which will **decreases the operating expenses** of the company.

Relationship

Operating expenses influence the following external factors

1. Customers
2. Suppliers
3. Investors



Customers

Change in operating expenses will influence the customers price.

Customers price = suppliers price + **operating expenses** + investors profit

- Increase in operating expenses will increase the customers price
- Decrease in operating expenses will decrease the customers price

Suppliers

Change in operating expenses will influence the suppliers price.

Suppliers price = customers price – (**operating expenses** + investors profit)

- Increase in operating expenses will decrease the suppliers price
- Decrease in operating expenses will increase the suppliers price

Investors

Change in operating expenses will influence the investors profit.

Investors profit = customers price – (suppliers price + **operating expenses**)

- Increase in operating expenses will decrease the investors profit
- Decrease in operating expenses will increase the investors profit.

CONTROLLABILITY

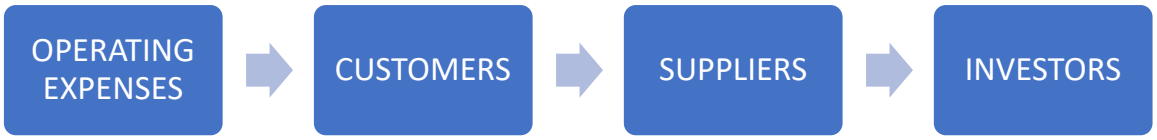
External factors of the company can be controlled by the internal factor of the company.

External factors of the company are controllable by transferring the benefit of **decrease in operating expenses** generated by the internal factor employees and operation process to external factors.

The benefit of **decrease in operating expenses** generated by the internal factor employees and operation process should be transferred to external factors in following order

1. Customers
2. Suppliers
3. Investors

To create the additional benefits at each stage of transfer.



STAGE 1 – CUSTOMERS

Customers in an economy buy the outputs of the company and they create the revenue for the company.

Customers price = suppliers price + **operating expenses** + investors profit

Input benefit

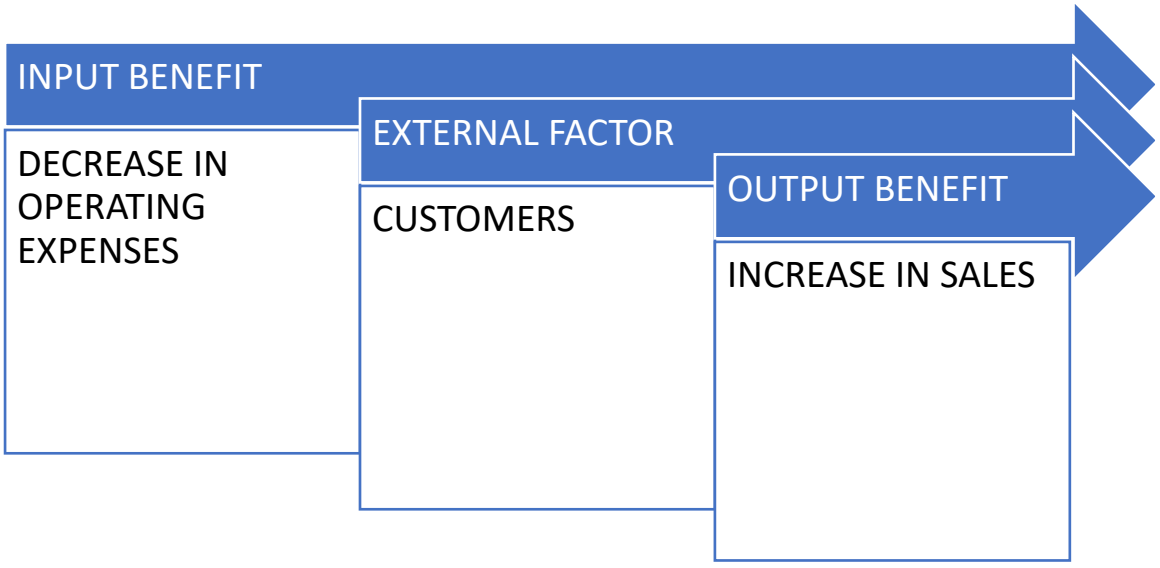
Decrease in operating expenses benefit is transferred to **customers**.

Conversion of benefit

Full or partial benefit of **decrease in operating expenses** is transferred to customers by decreasing the customers price to the level of affordable price in the market.

Output benefit

Selling the goods and services of the company at an affordable price in the market will **increase the sales** of the company and **increase in sales** is the output benefit.



STAGE 2 - SUPPLIERS

Suppliers in an economy sell the inputs to the company and generates revenue from the sales.

Suppliers price = customers price – (**operating expenses** + investors profit)

Input benefit

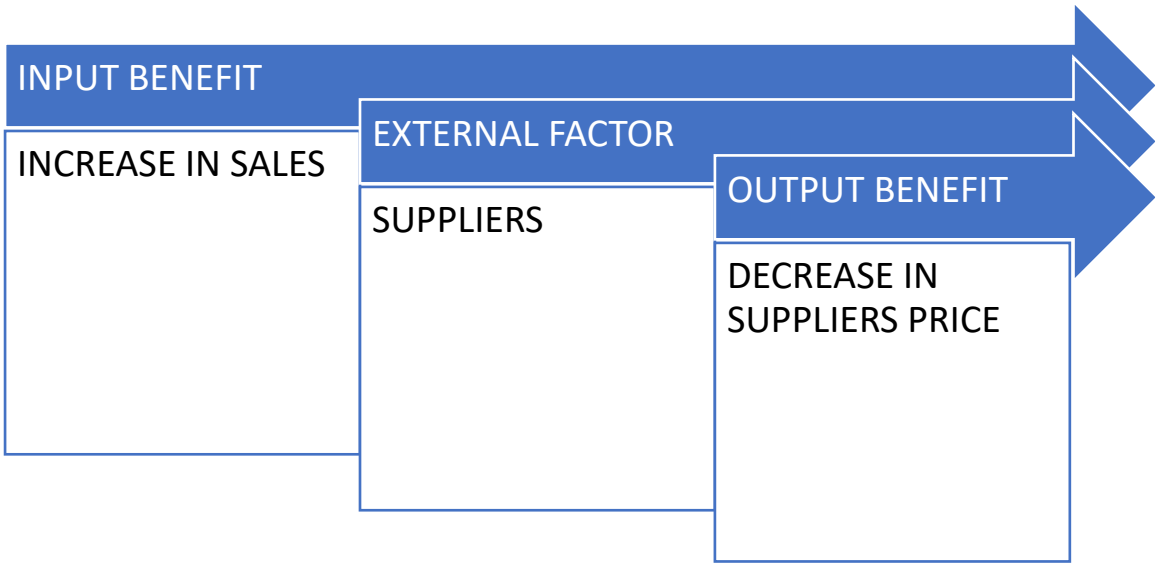
Increase in sales benefit is transferred to **suppliers.**

Conversion of benefit

Increase in sales benefit is transferred to suppliers by increasing the consumption of inputs of the suppliers at fair price in the market.

Output benefit

Increased consumption of inputs from the suppliers will decrease the suppliers price offered to the company and **decrease in suppliers price** is the output benefit.



STEP 3 – INVESTORS

Investors in an economy makes the investments in a company which earns more profit.

Investors profit = customers price – (suppliers price + **operating expenses**)

Input benefit

Decrease in suppliers price, **decrease in operating expenses** and **increase in sales** is transferred to investors.

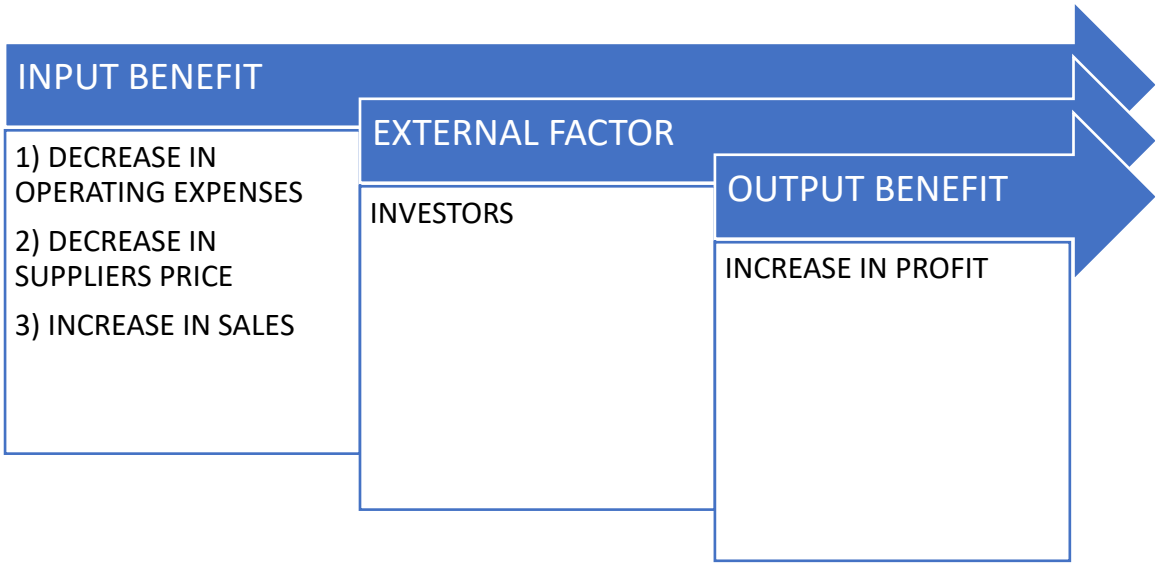
Conversion of benefits

Decrease in suppliers price and **decrease in operating expenses** benefits are transferred to investors by decreasing the expenses of the company.

Increase in sales benefit is transferred to investors by increasing the revenue of the company.

Output benefit

Increased revenue and decreased expenses of the company will increase the profit of the company and **increase in profit** is the output benefit.



FUNCTIONS OF SUPPLY CHAIN

Main functions of supply chain are

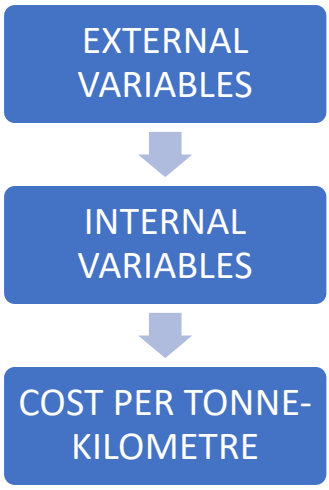
1. Transportation
2. Warehousing

Transportation

Transportation cost is the major concern of the logistics sector as it constitutes to 40 to 50 percent of logistics cost. Transportation cost is measured in cost per tonne -Kilometre.

Variables in transportation determines the cost per tonne-kilometre and they are categorised in to following types

- external variables
- internal variables



External variables in transportation

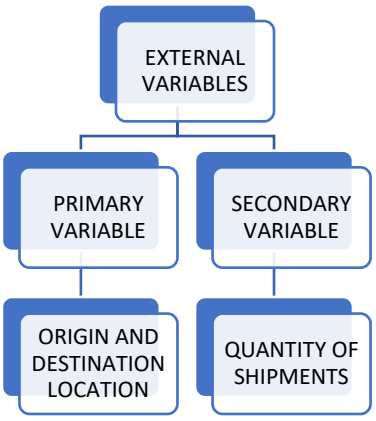
External variables are **un-controllable** and categorised in to primary variable and secondary variable

Primary variable

Origin and Destination
Origin and Destination location will differ for each shipment.

Secondary variable

Quantity of shipments
Quantity of shipments will differ for each Origin and Destination location.



Internal variables in transportation

Internal variables are **controllable** and categorised in to primary variable and secondary variable

Primary variable

Distance

Distance will differ for each origin and destination location

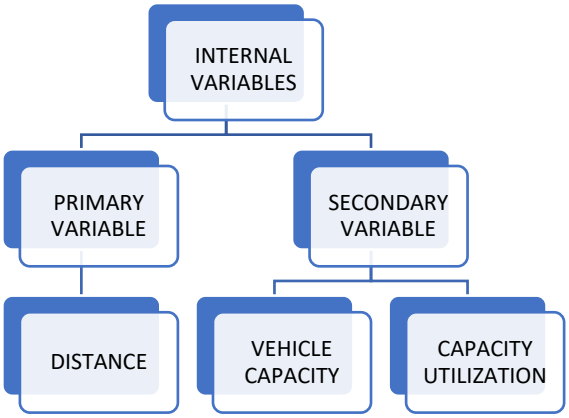
Secondary variable

Vehicle capacity

Vehicle capacity will depend on the quantity of shipments between each origin and destination location.

Capacity utilization

Vehicle capacity utilization will depend on the quantity of shipments between each origin and destination location.



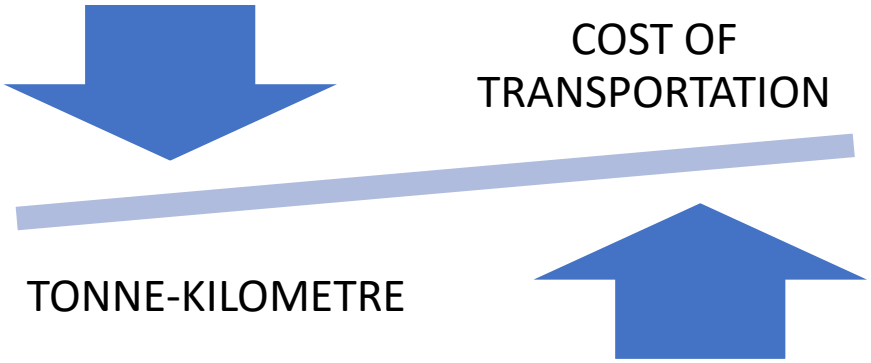
Cost per tonne-kilometre

Cost per tonne-kilometre is calculated by dividing **cost of transportation** by **Tonne-Kilometres**

Cost per tonne-kilometre = cost of transportation / Tonne-kilometres

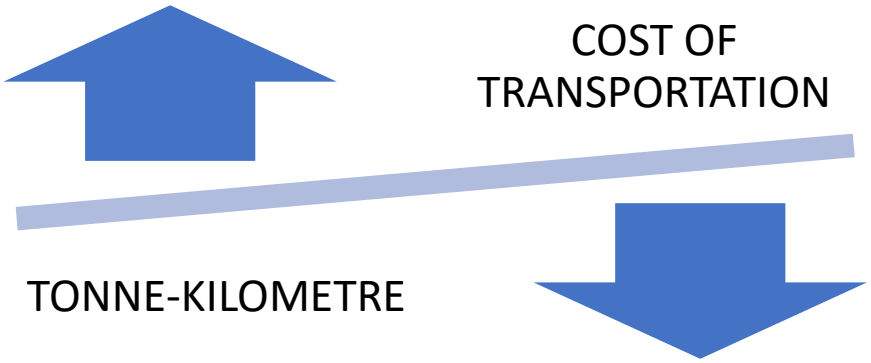
Cost per tonne-kilometre is decreased by

- Decreasing the cost of transportation
- Increasing the tonne-kilometres



Cost per tonne-kilometre is increased by

- Increasing the cost of transportation
- Decreasing the tonne-kilometres



cost of transportation

cost of transportation is calculated by multiplying **kilometres** and **cost per kilometre**

cost of transportation = Kilometres x cost per kilometre



Tonne-Kilometres

Tonne-Kilometres is calculated by multiplying **tons** and **kilometres**

Tonne-Kilometres = tonnes x Kilometres



Primary variable

kilometres

kilometres between each origin and destination location will determine the cost of transportation.

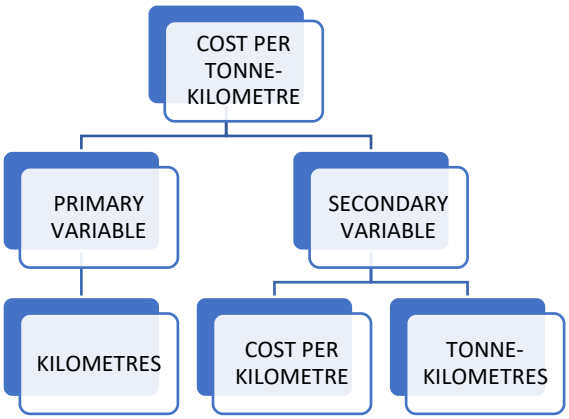
Secondary variable

cost per kilometre

Cost per kilometre will change for every Vehicle capacity in each origin and destination location.

Tonne-kilometres

Tonne-kilometres will change for every vehicle capacity on the basics of capacity utilization in each origin and destination location.

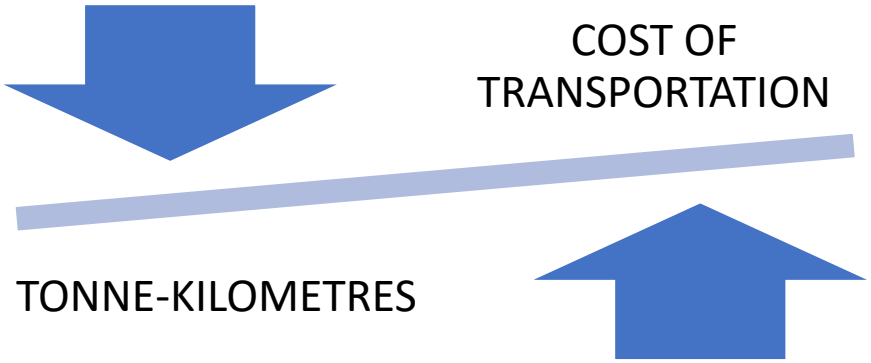


Relationship between the external variables, internal variables and cost per tonne-kilometre

Relationship between the external variables, internal variables and cost per tonne-kilometre is categorised in to

- Primary variables relationship
- Secondary variables relationship

  to decrease the cost per tonne-kilometre by
  - Decreasing the kilometres
  - Decreasing the cost per kilometre
  - Increasing the tonne-kilometres



Primary variables relationship

External variable – origin and destination location

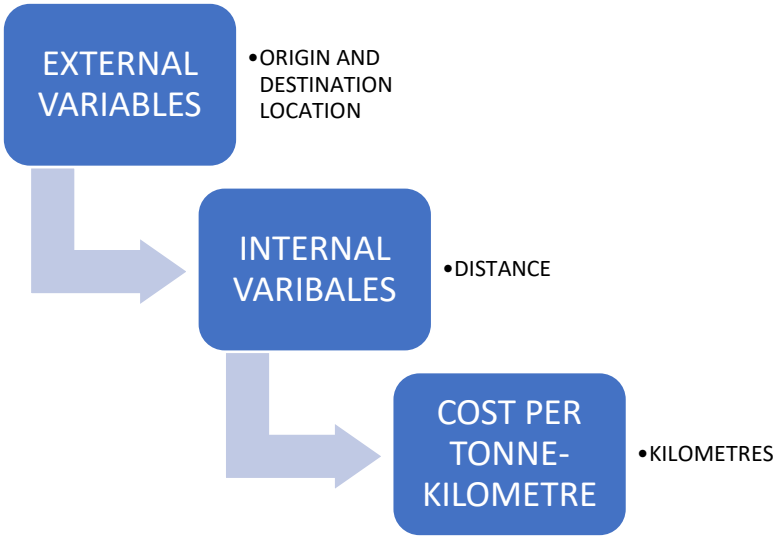
origin and destination location will differ for each shipment and it is un-controllable by the company.

Internal variable – distance

Distance will differ for each origin and destination location and it is controllable by the company.

Cost per tonne-kilometre – kilometre

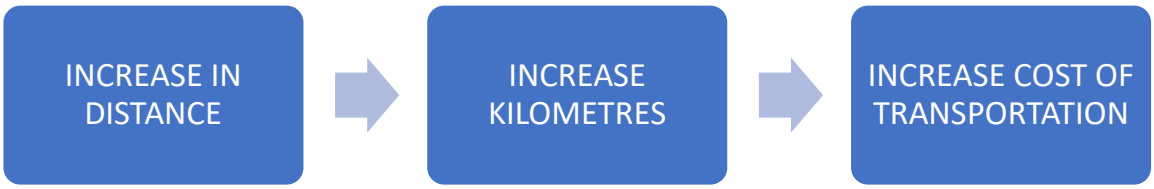
kilometres between each origin and destination location will determine the cost of transportation.



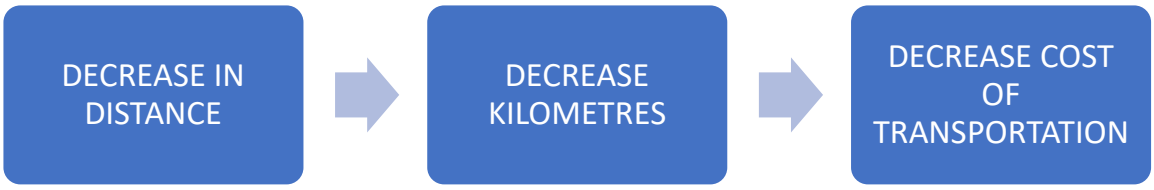
Relationship

Cost of transportation can be increased or decreased by controlling the relationship between **external variable – origin and destination location**, **Internal variable – distance** and **Cost per tonne-kilometre – kilometre**

- Increase in distance between each origin and destination location will increase the kilometres and it will increase the cost of transportation.



- Decrease in distance between each origin and destination location will decrease the kilometres and it will decrease the cost of transportation.



Solution for primary variables in transportation

Kilometres can be decreased by **decreasing the distance between each origin service center and destination service center.**

Secondary variables relationship

External variable – Quantity of shipments

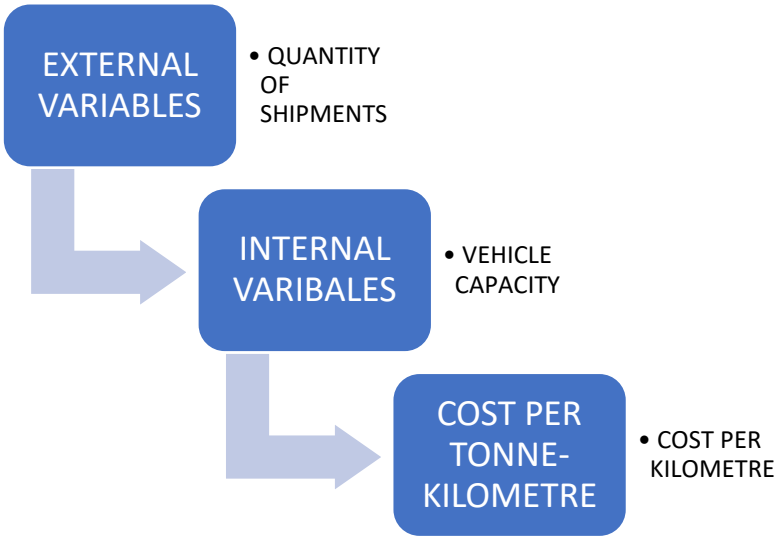
Quantity of shipments will differ for each Origin and Destination location and it is uncontrollable by the company.

Internal variable - Vehicle capacity

Vehicle capacity will depend on the quantity of shipments between each origin and destination location and it is controllable by the company.

Cost per tonne-kilometre – cost per kilometre

Cost per kilometre will change for every Vehicle capacity in each origin and destination location.



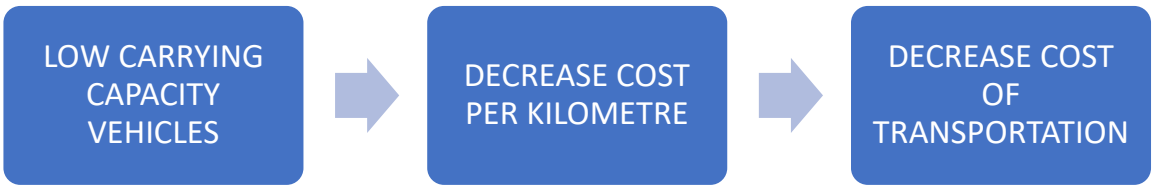
Relationship

Cost per kilometre can be increased or decreased by controlling the relationship between **external variable – quantity of shipments**, **internal variable** – **vehicle capacity** and **cost per tonne-kilometre – cost per kilometre**

- high carrying capacity vehicles will increase the cost per kilometre and it will increase the cost of transportation.



- Low carrying capacity vehicles will decrease the cost per kilometre and it will decrease the cost of transportation.



External variable – Quantity of shipments

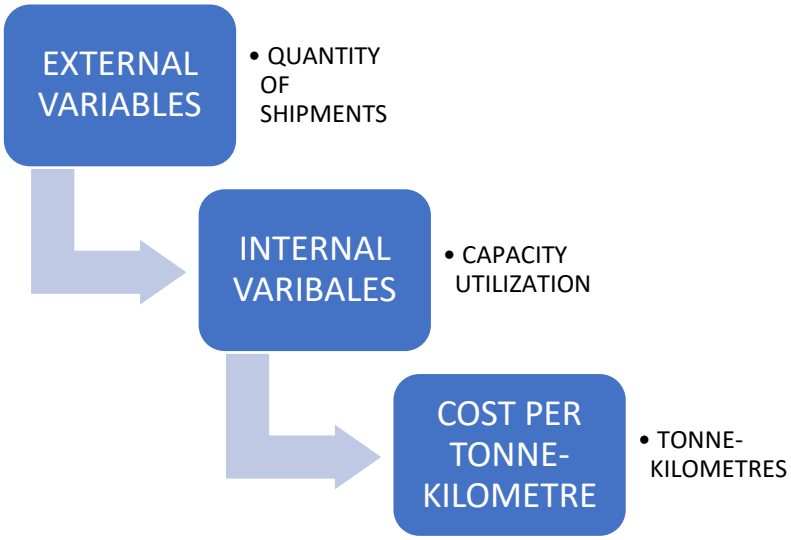
Quantity of shipments will differ for each Origin and Destination location.

Internal variable - Capacity utilization

Vehicle capacity utilization will depend on the quantity of shipments between each origin and destination location.

Cost per tonne-kilometre – tonne-kilometres

Tonne-kilometres will change for every vehicle capacity on the basics of capacity utilization in each origin and destination location.



Relationship

Tonne-kilometres can be increased or decreased by controlling the relationship **between external variable – quantity of shipments**, **internal variable** – **capacity utilization** and **cost per tonne-kilometre – tonne-kilometres**

- Partial vehicle capacity utilization will decrease the tonnage and it will decrease the tonne-kilometres



- Full vehicle capacity utilization will increase the tonnage and it will increase the tonne-kilometres.



Solution for secondary variables in transportation

cost per kilometre can be decreased by selecting the optimal vehicle capacity on the basis quantity of shipments.

Tonne-kilometres can be increased by selecting the optimal route based on quantity of shipments.

OPERATION PROCESS OPTIMIZATION

PRIMARY VARIBALE

External variable – origin and destination location

origin and destination location will differ for each shipment and it is un-controllable by the company.

Internal variable – distance

Distance will differ for each origin and destination location and it is controllable by the company.

Cost per tonne-kilometre – kilometre

kilometres between each origin and destination location will determine the cost of transportation.

kilometres

Kilometres can be decreased by decreasing the **distance** between each origin service center and destination service center in the following layers of **hub and spoke model.**

1. First layer – connecting service centers within the hub / gateway
2. Second layer – connecting service centers of different hub / gateways in the global hub
3. Third layer – connecting service centers of different global hubs

HUB AND SPOKE MODEL

First layer – connecting service centers within the hub / gateway

A Service center is connected to each service centers within the hub / gateway in the below moving patterns

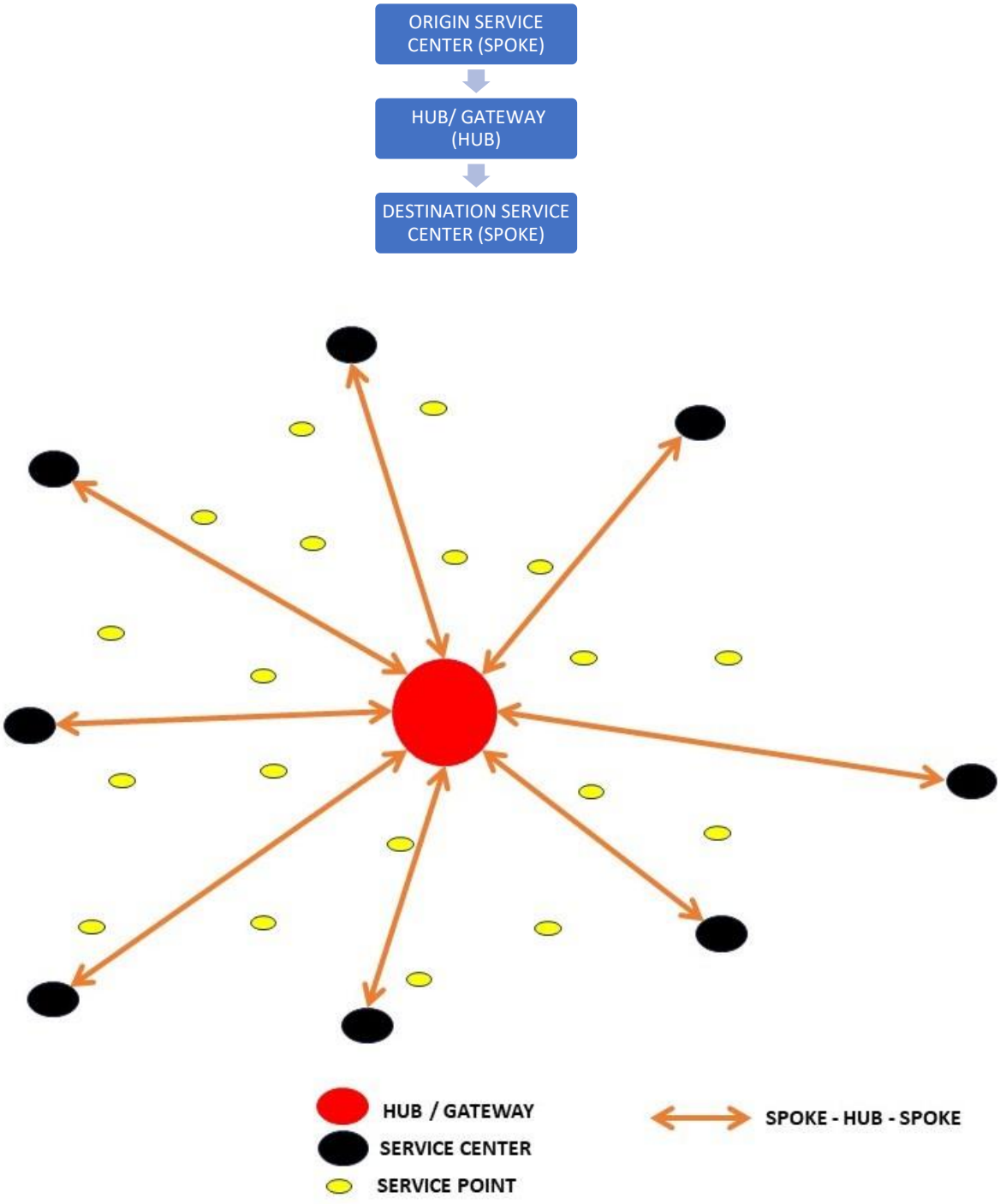
- **spoke – hub - spoke**
- **spoke – spoke**

Every service center within the hub / gateway can be both origin service center and destination service center.

spoke – hub - spoke

Shipments from origin service center to destination service center within the hub / gateway will move in a following route.

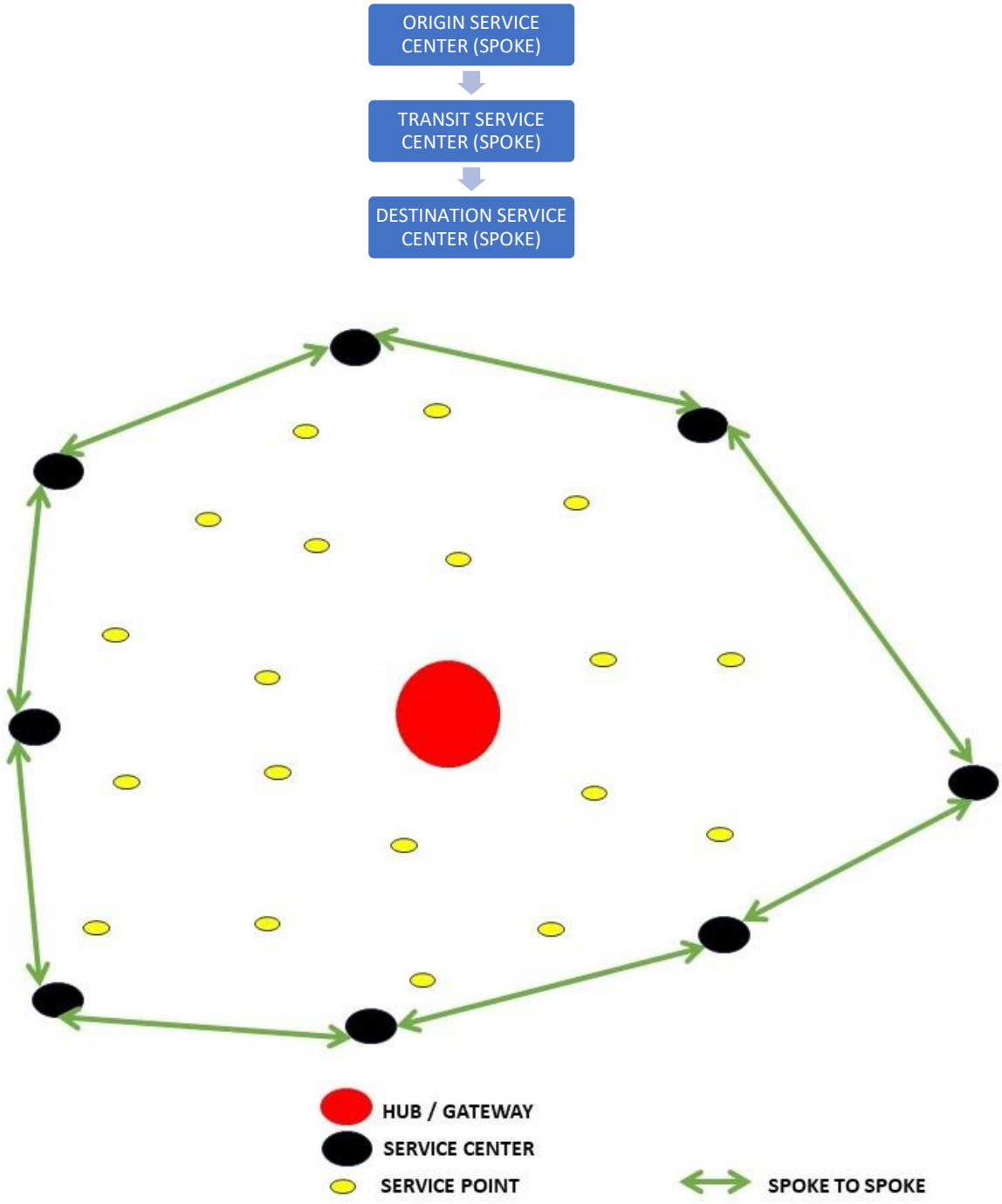
1. Origin service center to hub / gateway
2. hub / gateway to destination service center



spoke – spoke

Shipments from origin service center to destination service center within the hub / gateway will move in a following route.

1. Origin service center to transit service center
2. Transit service center to destination service center



Determination of moving pattern within the hub / gateway

Distance (kilometres) between each origin service center and destination service center within the hub / gateway is calculated for following movement patterns

- Spoke - hub - spoke
- Spoke - spoke

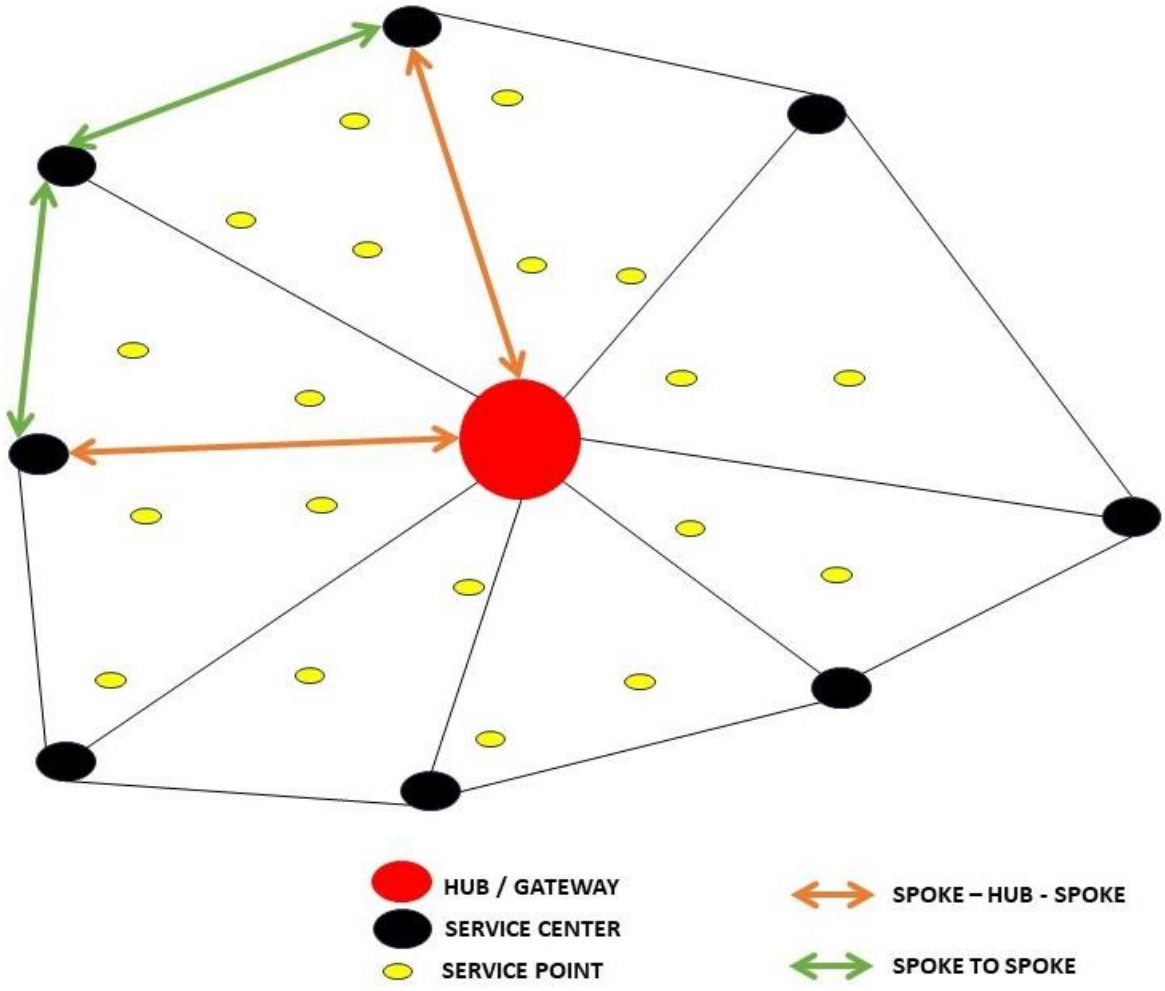
spoke – hub – spoke



Spoke – Spoke



And movement pattern with **shortest distance (kilometres)** between the origin service center and destination service center within the hub / gateway is selected for each origin service center and destination service center within the hub / gateway.



Second layer – connecting service centers of different hub / gateways in the global hub

Each service center of a hub / gateway is connected to every service centers of other hubs / gateways in the global hub in following moving patterns

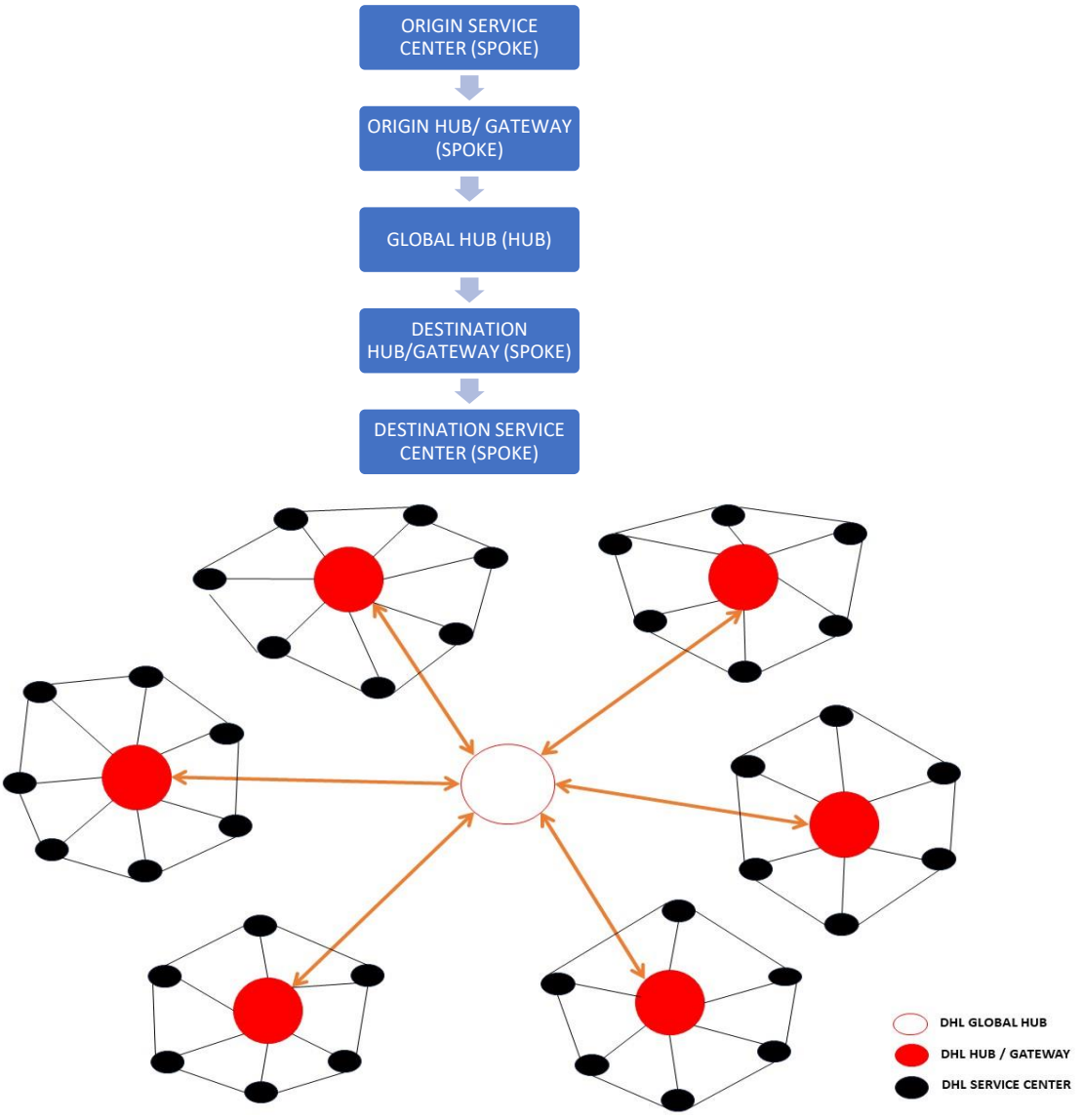
- **spoke – hub - spoke**
- **spoke – spoke**

Every service center within the global hub can be both origin service center and destination service center.

spoke – hub - spoke

Shipments from origin service center of a hub / gateway to destination service center of a different hub / gateway in the global hub will move in a following route.

1. Origin service center to origin hub / gateway
2. Origin hub / gateway to global hub
3. global hub to destination hub / gateway
4. Destination hub /gateway to destination service center.

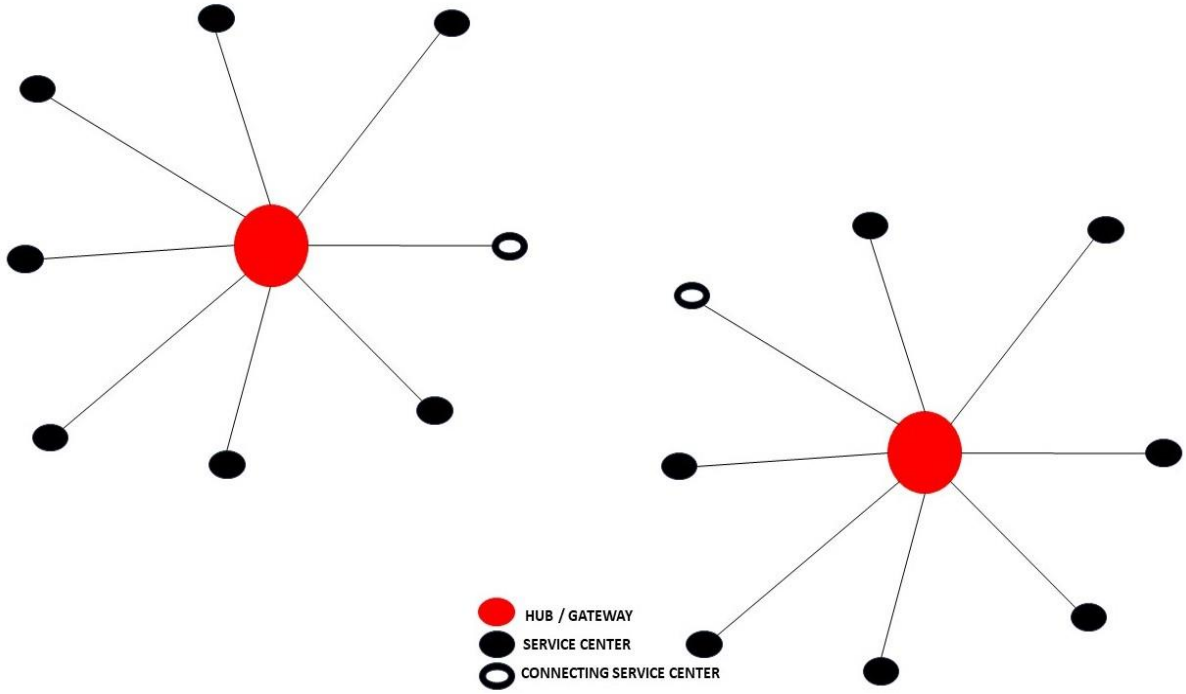


spoke – spoke

connection within the hub / gateway

service centers of a hub / gateway are either connected to a **connecting service center** or **hub / gateway**.

Determination of Connecting service centers between two hubs / gateways within the global hub are based on the **shortest distance** between the service centers of both hubs / gateways.



Determination of connection within the hub / gateway

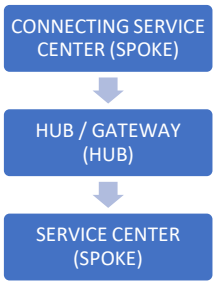
Distance (kilometres) between each service center and connecting service center within the hub / gateway is calculated for following movement patterns

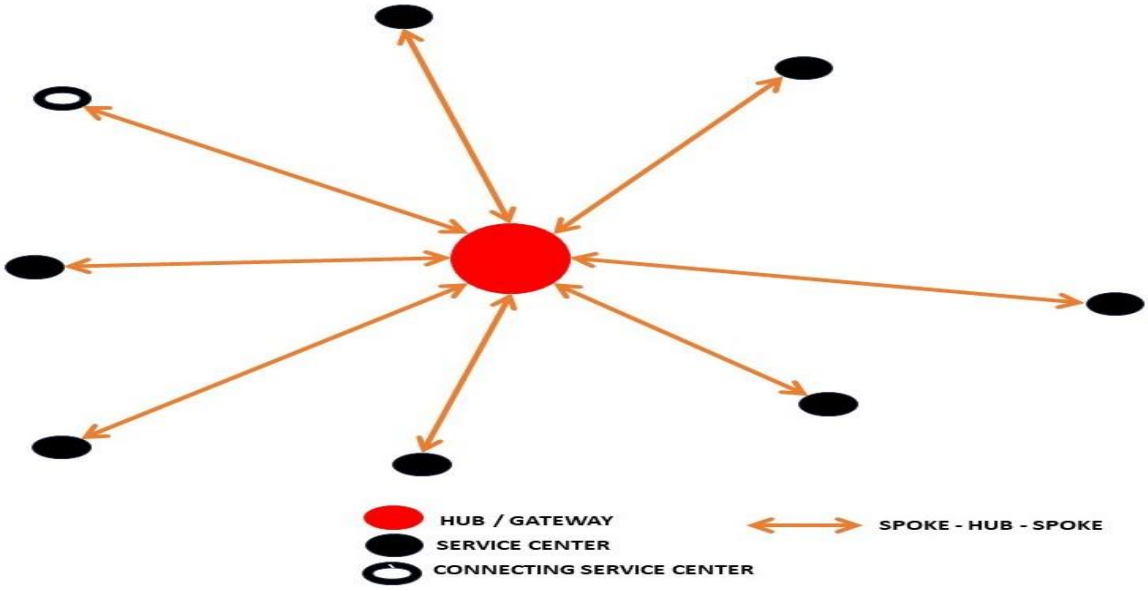
- Spoke - hub - spoke
- Spoke - spoke

Spoke - hub – spoke

In this moving pattern connecting service center of a hub / gateway is connected to all other service centers of the hub / gateway in following way

1. Connecting service center to hub / gateway
2. Hub / gateway to service center

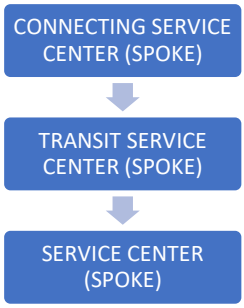


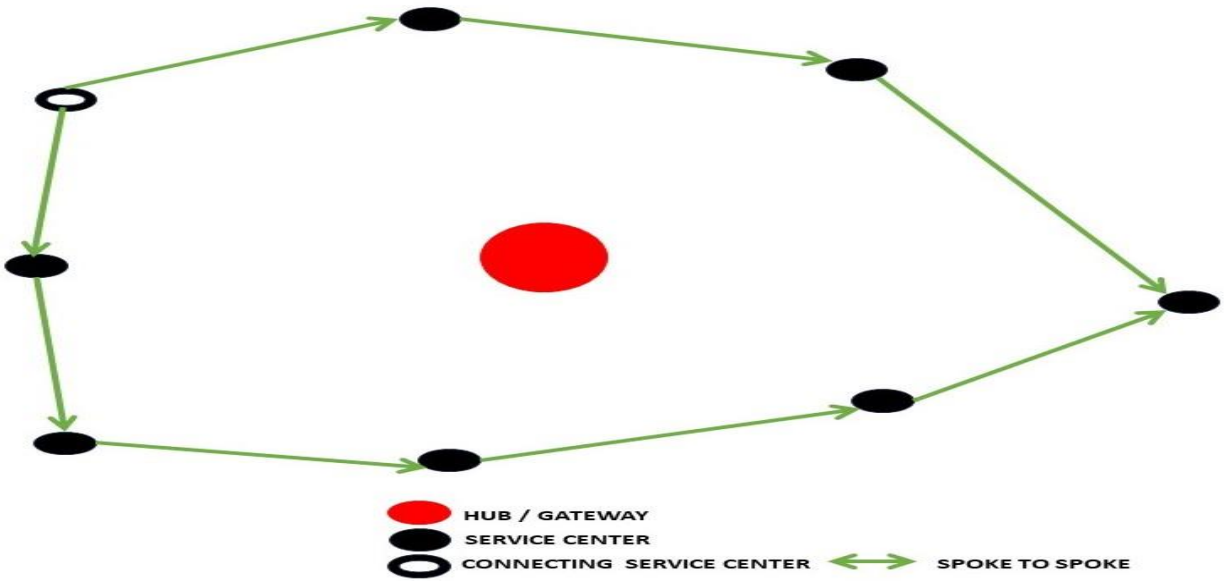


Spoke to spoke

In this moving pattern connecting service center of a hub / gateway is connected to all other service centers of the hub / gateway in following way

1. Connecting service center to transit service center
2. Transit service center to service center



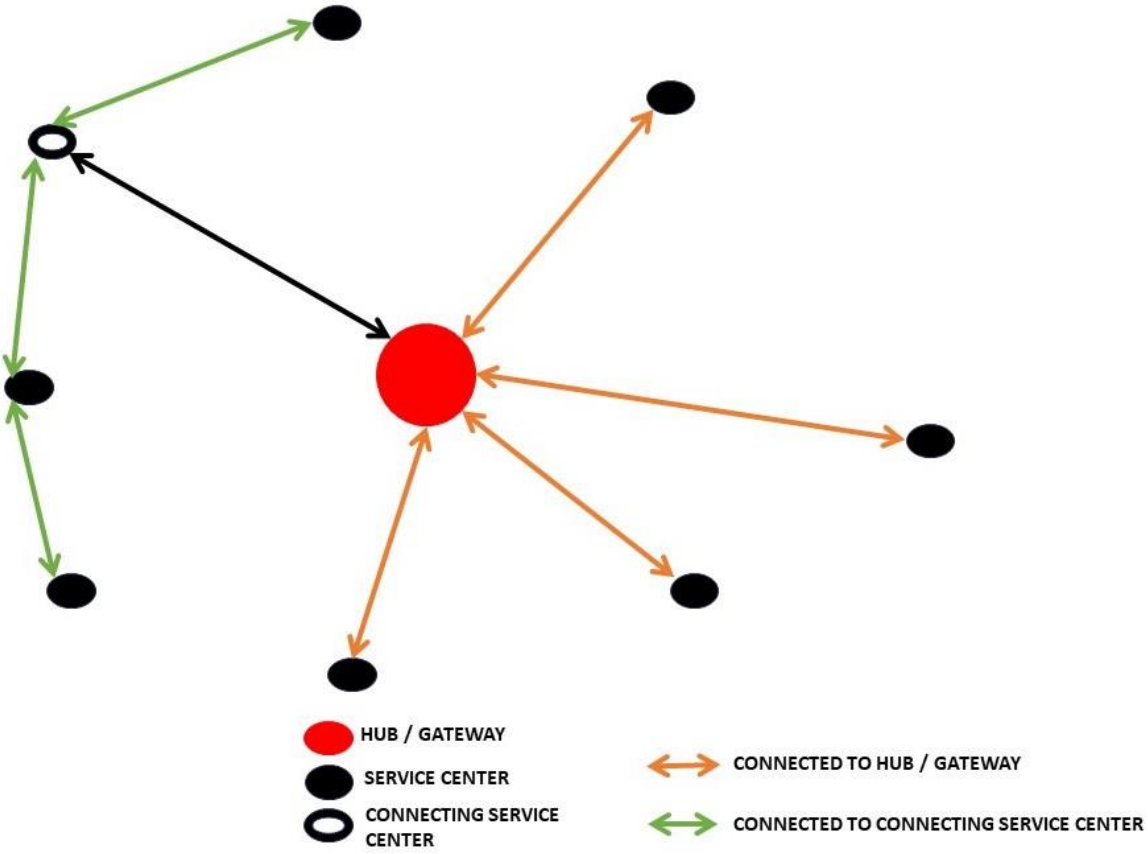


Service centers connected to connecting service center

If **Spoke - spoke** movement pattern as the **shortest distance (kilometres)** between the connecting service center and service center in a hub / gateway then the **service center** is connected to the **connecting service center.**

Service centers connected to hub / gateway

If **Spoke - hub - spoke** movement pattern as the **shortest distance (kilometres)** between the connecting service center and service center in a hub / gateway then the **service center** is connected to the **hub / gateway.**



Connection within the global hub

Each hubs / gateways within the global hub are connected through **connecting service centers** and **hubs / gateways** of the global hub.

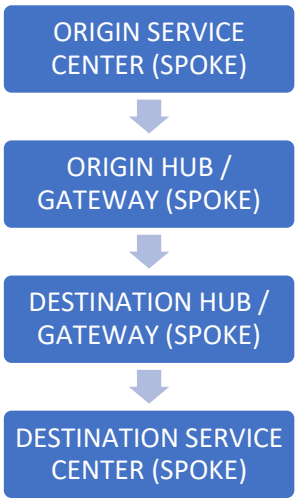
Shipments from origin service center of a hub / gateway to destination service center of another hub / gateway in the global hub is connected in following way

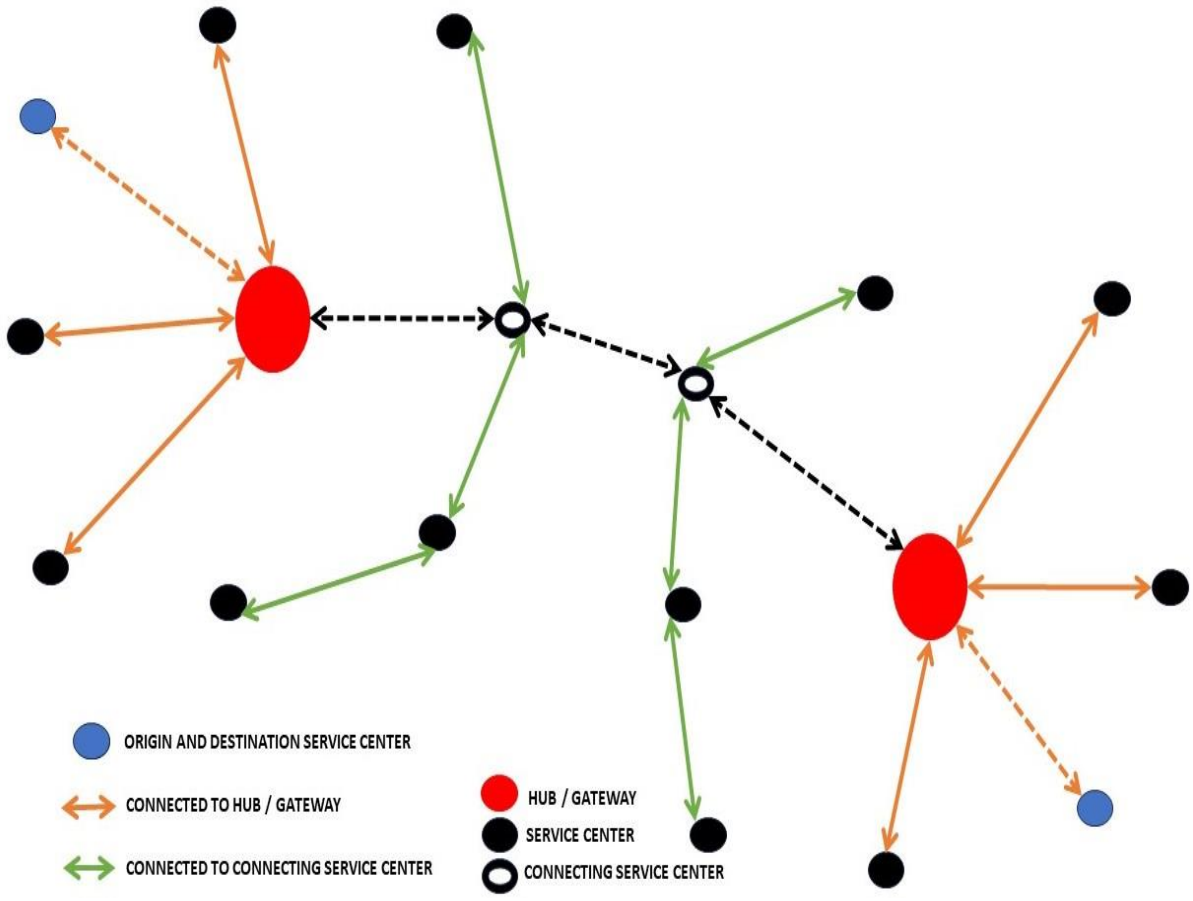
1. Hub / gateway to hub / gateway
2. Connecting service center to connecting service center
3. Hub / gateway to connecting service center
4. connecting service center to hub / gateway

Hub / gateway to hub / gateway

origin service center is connected to a hub / gateway and destination service center is connected to a hub / gateway then shipments will be connected between the two hub / gateway in the following way.

1. Origin service center to origin hub / gateway
2. Origin hub / gateway to destination hub / gateway
3. Destination hub / gateway to destination service center

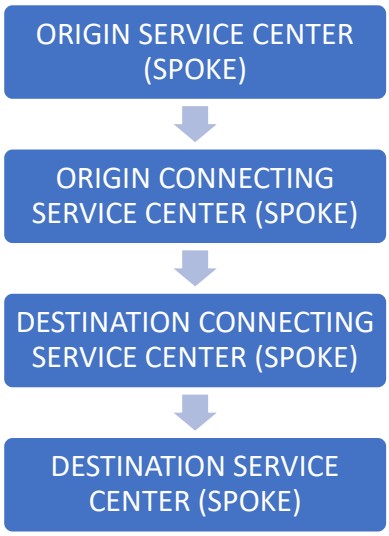


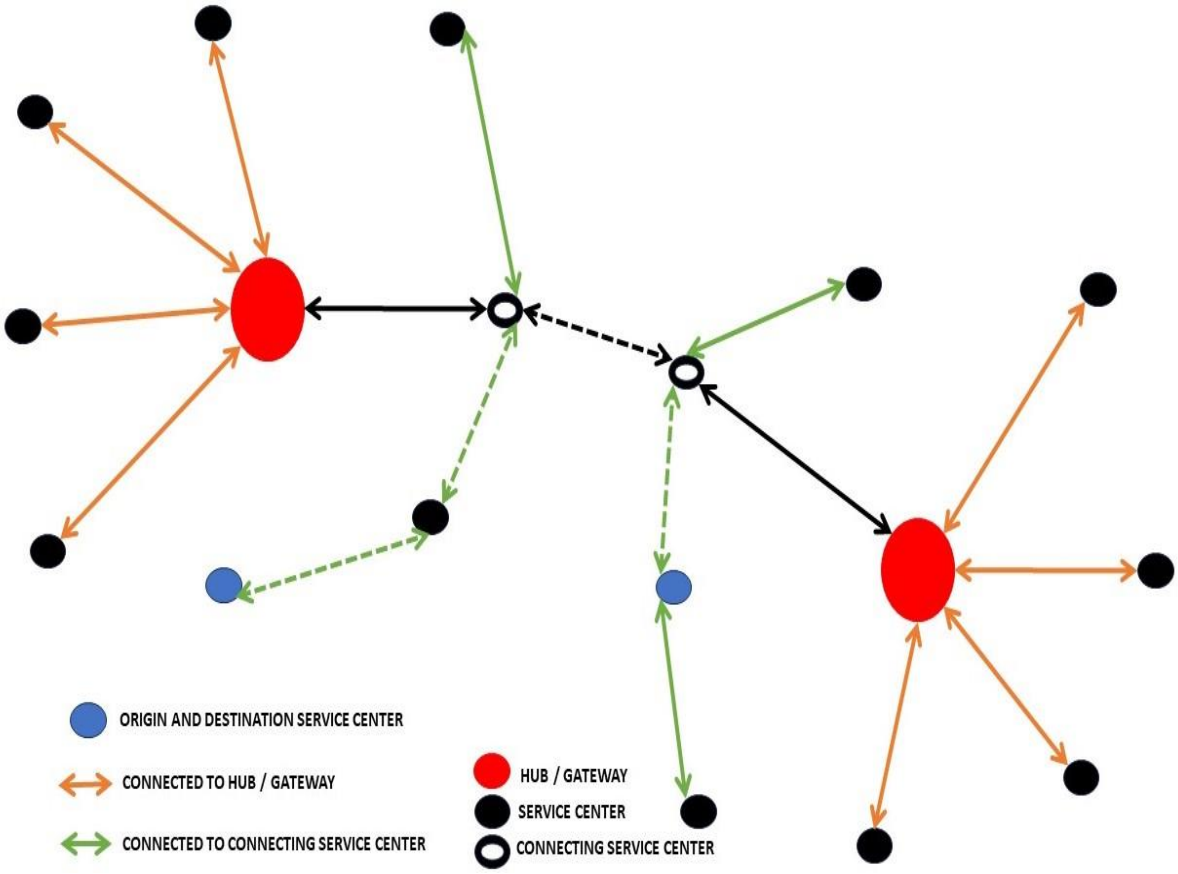


Connecting service center to connecting service center

origin service center is connected to a connecting service center and destination service center is connected to a connecting service center then shipments will be connected between the two hub / gateway in the following way.

1. Origin service center to origin connecting service center
2. Origin connecting service center to destination connecting service center
3. Destination connecting service center to destination service center

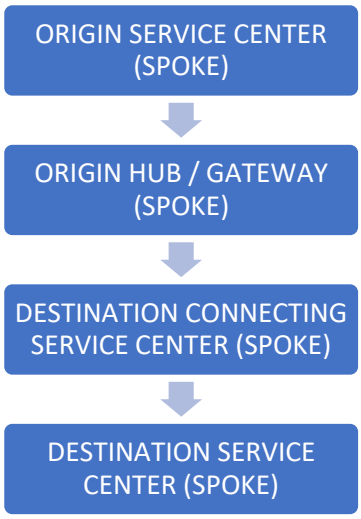


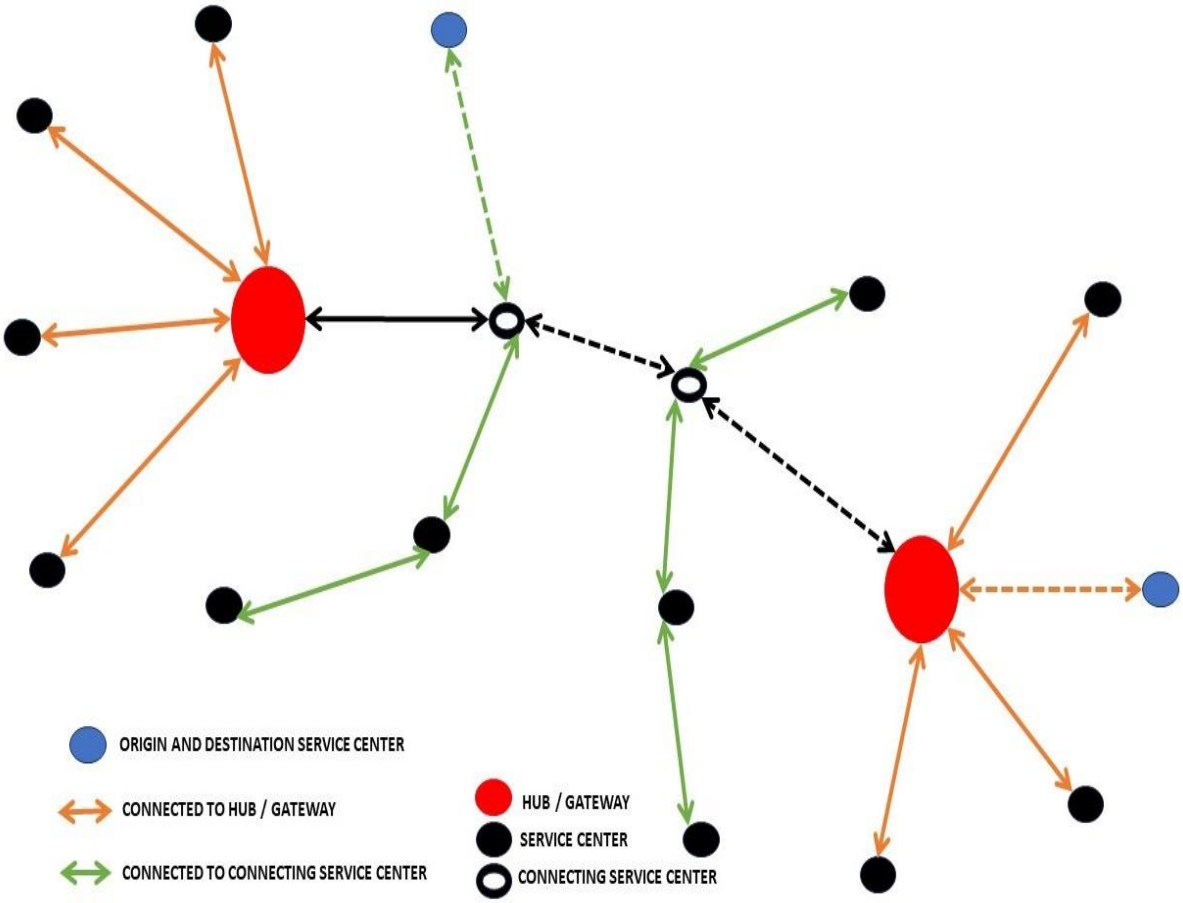


Hub / gateway to connecting service center

origin service center is connected to a hub / gateway and destination service center is connected to a connecting service center then shipments will be connected between the two hub / gateway in the following way.

1. Origin service center to origin hub / gateway
2. Origin hub / gateway to destination connecting service center
3. Destination connecting service center to destination service center

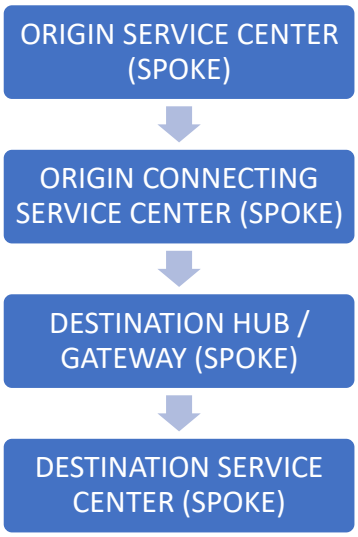


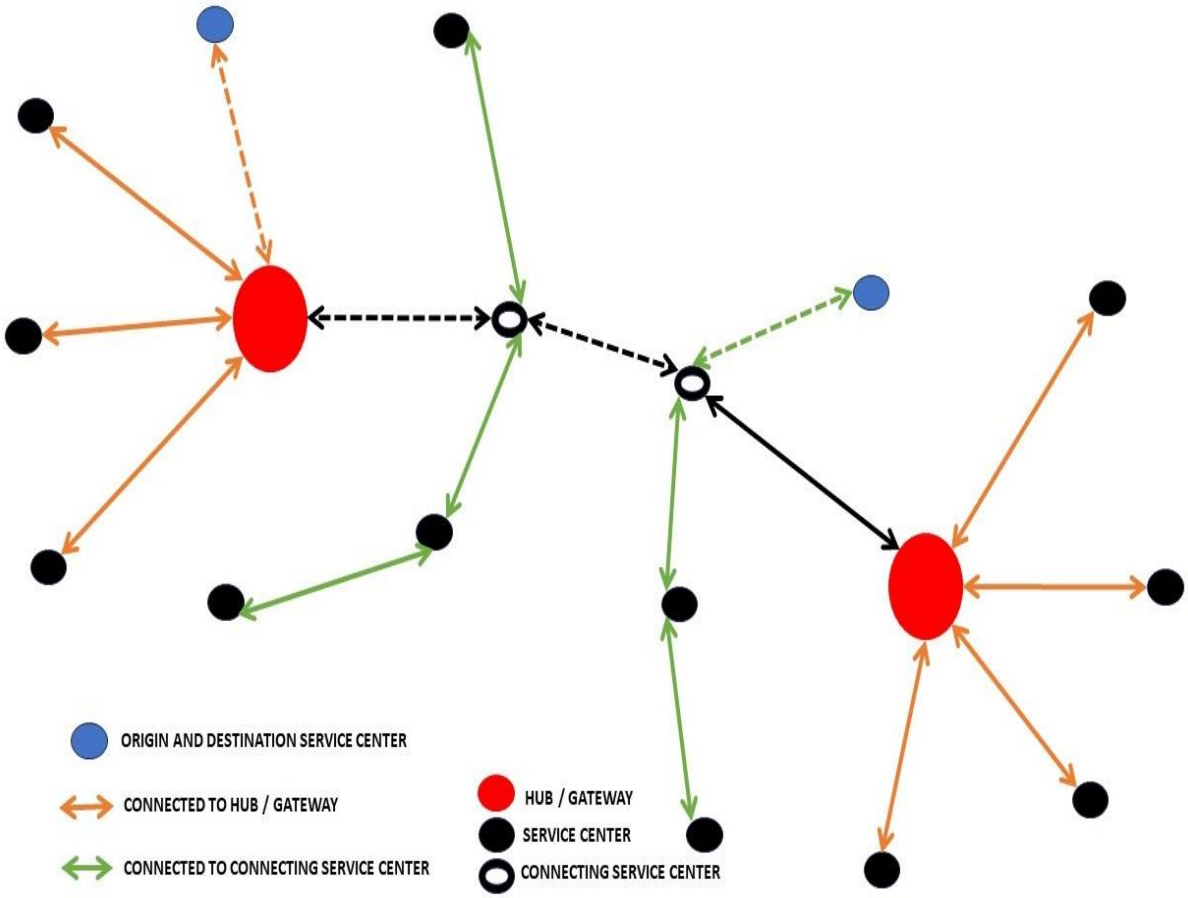


connecting service center to hub / gateway

origin service center is connected to a connecting service center and destination service center is connected to a hub / gateway then shipments will be connected between the two hub / gateway in the following way.

1. Origin service center to origin connecting service center
2. Origin connecting service center to destination hub / gateway
3. Destination hub / gateway to destination service center



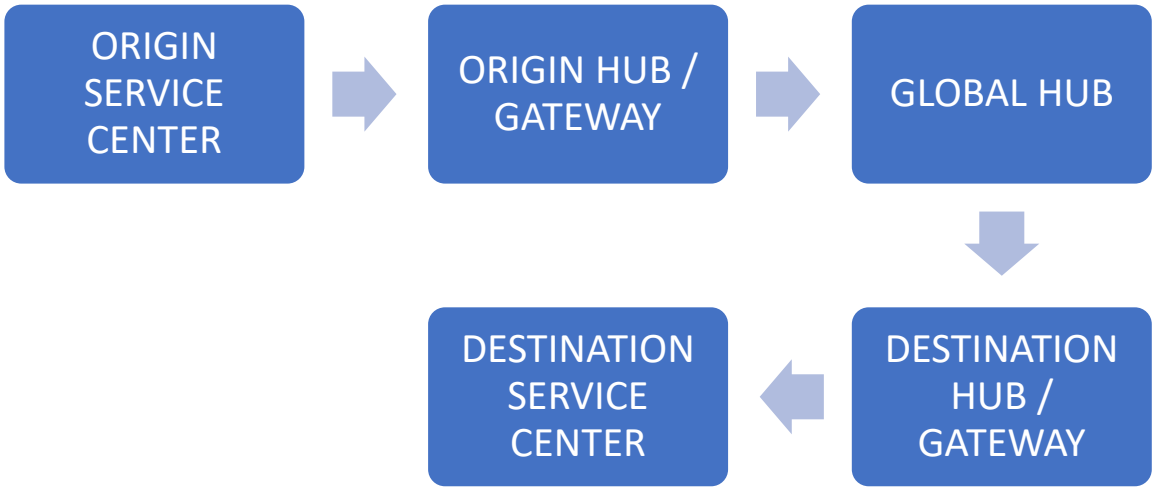


Determination of moving pattern within the global hub

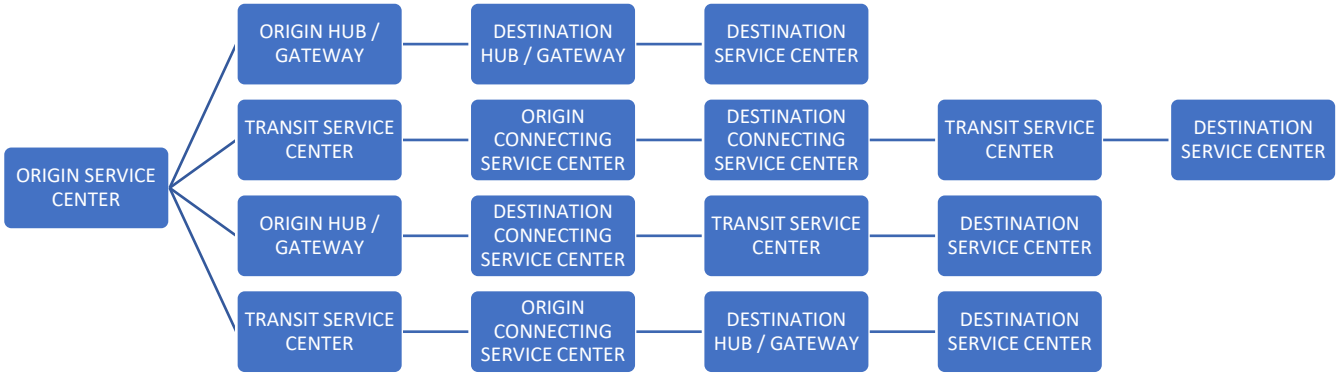
Distance (kilometres) between each origin service center in a hub / gateway and destination service center in another hub / gateway within the global hub is calculated for following movement patterns

- Spoke - hub - spoke
- Spoke - spoke

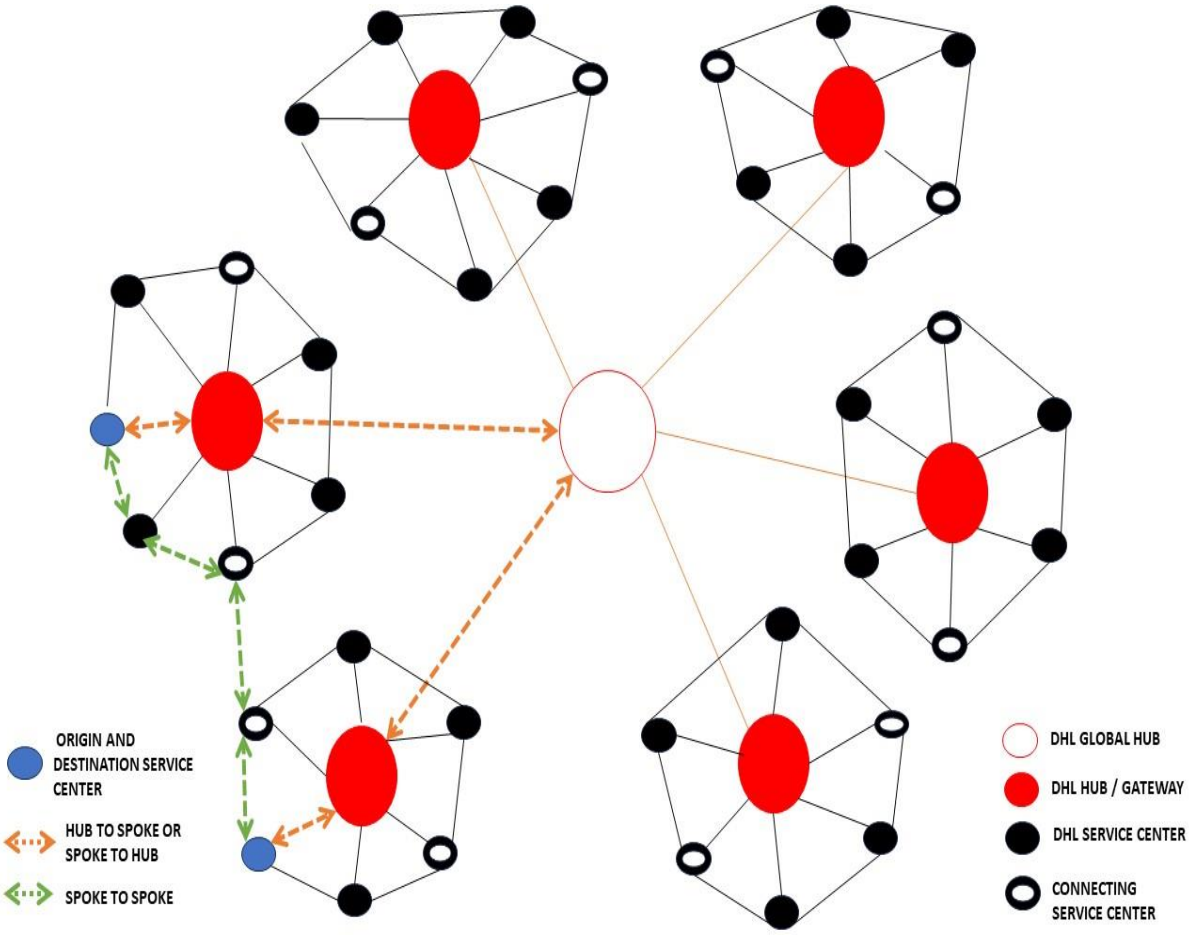
Spoke - hub - spoke



Spoke – spoke



And movement pattern with **shortest distance (kilometres)** between the origin service center in a hub / gateway and destination service center in another hub / gateway within the global hub is selected for each origin service center and destination service center within the global hub.



Third layer – connecting service centers of different global hubs

Each hub / gateway of a global hub is connected to every hub / gateway of other global hubs in following moving patterns

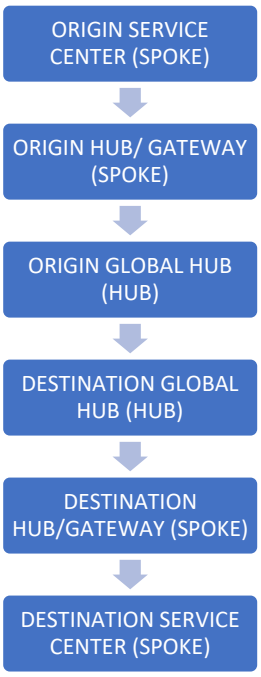
- **spoke - hub - spoke**
- **spoke - spoke**

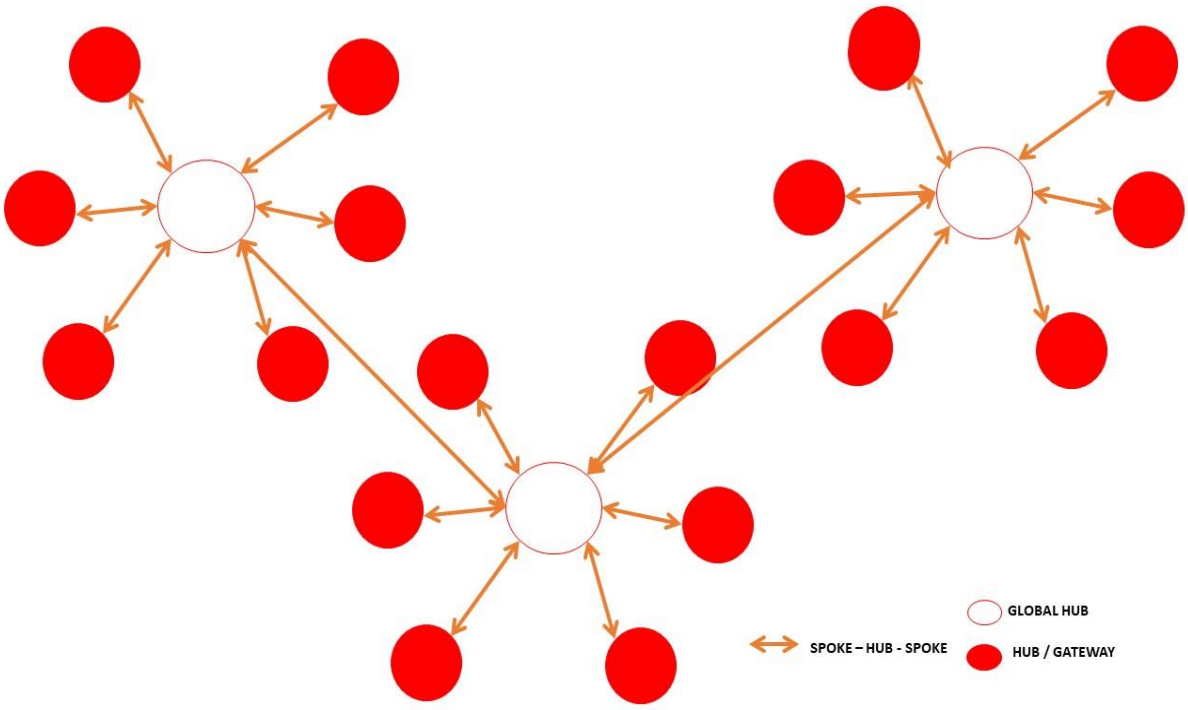
Every hub / gateway in different global hubs can be both origin hub / gateway and destination hub / gateway.

Spoke - hub - spoke

Shipments from origin hub / gateway of global hub to destination hub / gateway of a different global hub will move in a following route.

1. Origin service center to origin hub / gateway
2. Origin hub / gateway to origin global hub
3. Origin global hub to destination global hub
4. Destination global hub to destination hub / gateway
5. Destination hub / gateway to destination service center



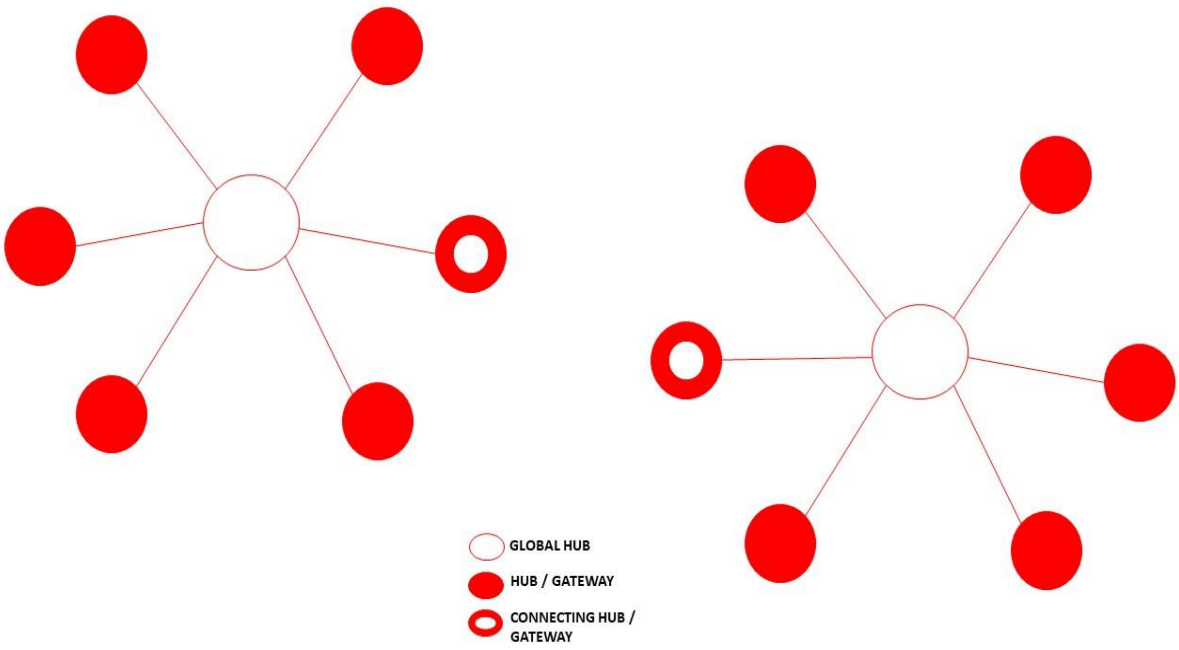


spoke – spoke

connection within the global hub

hubs / gateways of a global hub are either connected to a **connecting hub / gateway** or **global hub**

Determination of Connecting hub / gateway between two global hubs are based on the **shortest distance** between the hubs / gateways of two global hubs.



Determination of connection within the global hub

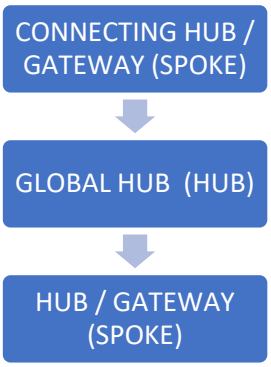
Distance (kilometres) between each hub / gateway and connecting hub / gateway within the global hub is calculated for following movement patterns

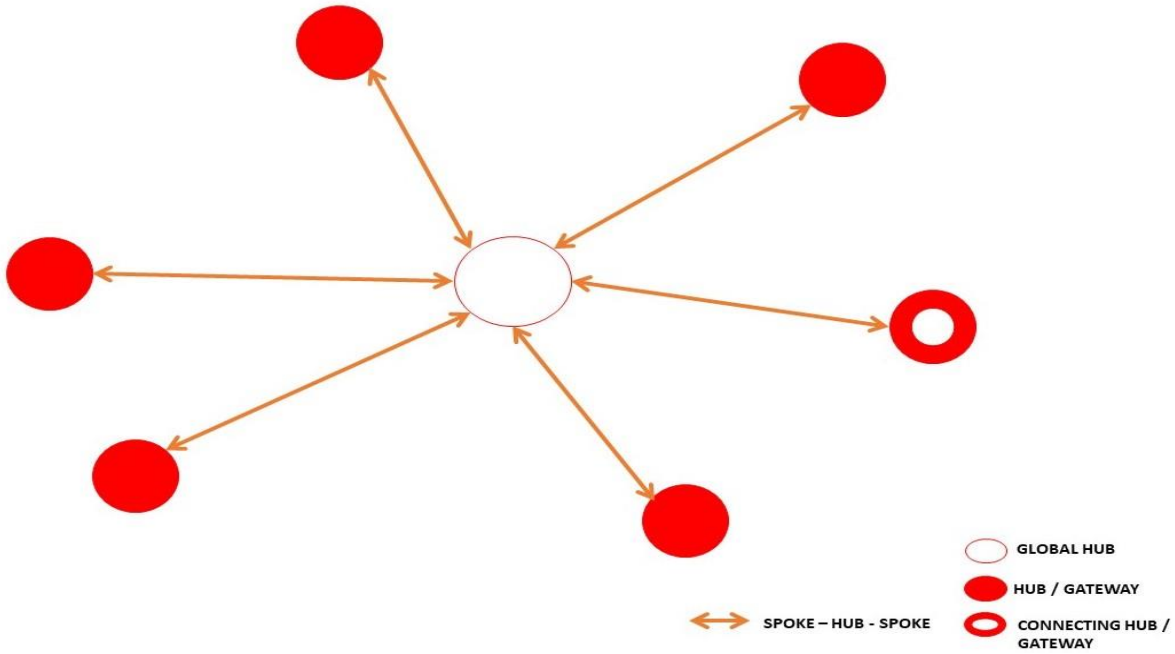
- Spoke - hub - spoke
- Spoke - spoke

Spoke - hub – spoke

In this moving pattern connecting hub / gateway of a global hub is connected to all other hubs / gateways of the global hub in following way

1. Connecting hub / gateway to global hub
2. Global hub to hub / gateway

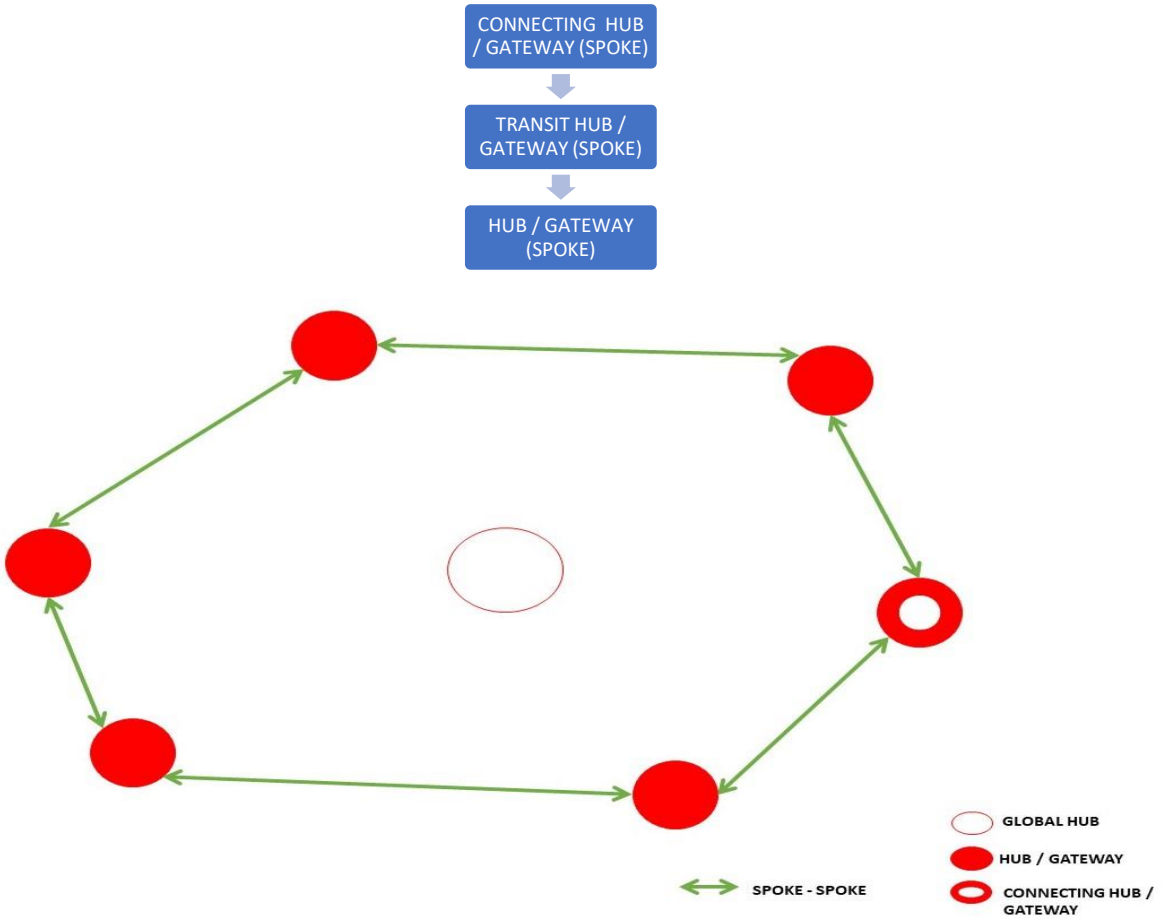




Spoke to spoke

In this moving pattern connecting hub / gateway of a global hub is connected to all other hubs / gateways of the global hub in following way

1. Connecting hub / gateway to transit hub / gateway
2. transit hub / gateway to hub / gateway

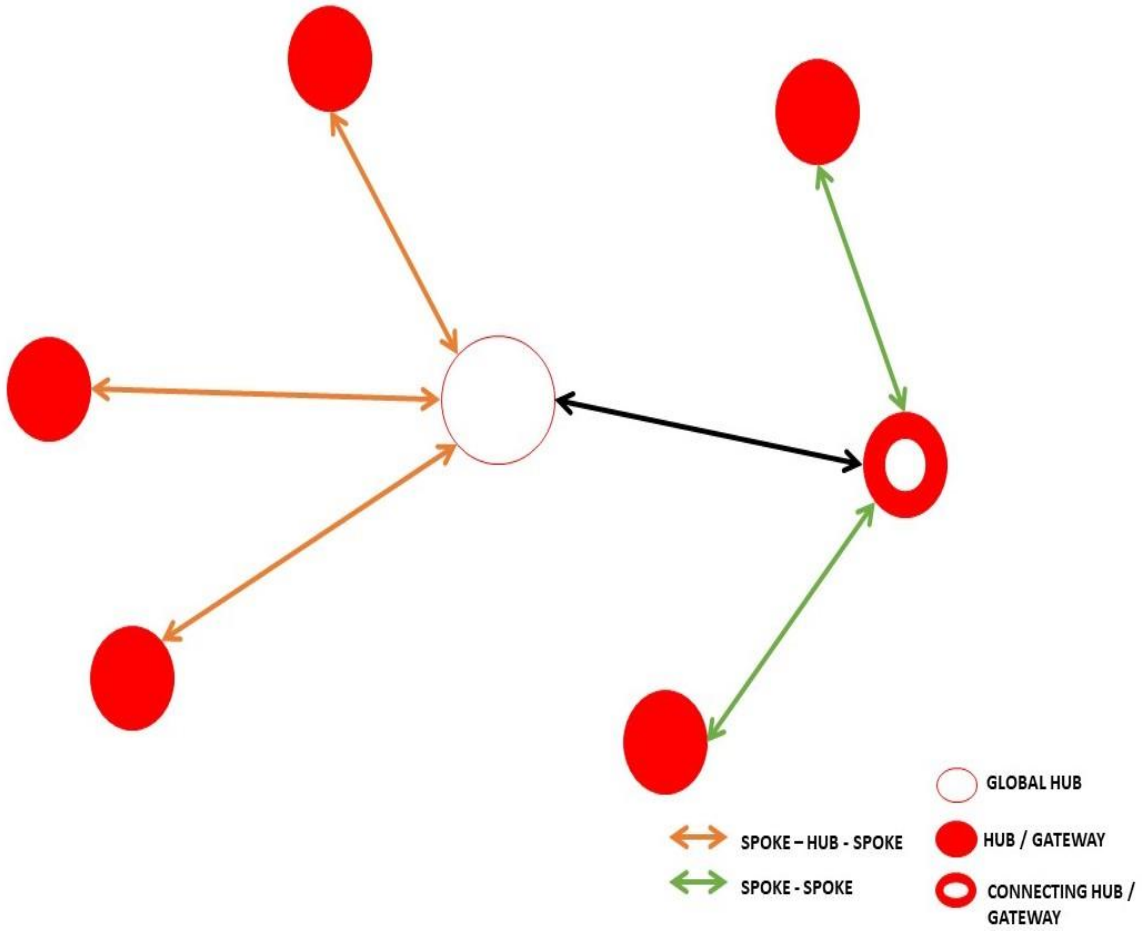


Hubs / gateways connected to connecting hub / gateways

If **Spoke - spoke** movement pattern as the **shortest distance (kilometres)** between the connecting hub / gateway and hub / gateway in a global hub then the **hub / gateway** is connected to the **connecting hub / gateway.**

Hubs / gateways connected to global hub

If **Spoke - hub - spoke** movement pattern as the **shortest distance (kilometres)** between the connecting hub / gateway and hub/ gateway in a global hub then the **hub / gateway** is connected to the **global hub.**



Connection with different global hub

Each global hubs are connected through **connecting hub / gateway** and **global hub.**

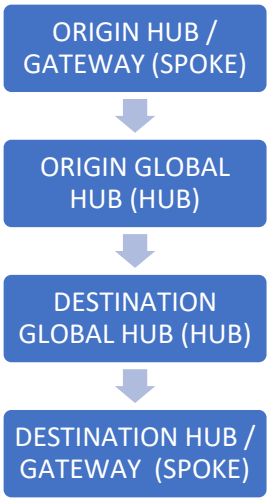
Shipments from origin hub / gateway of a global hub to destination hub / gateway of another global hub is connected in following way

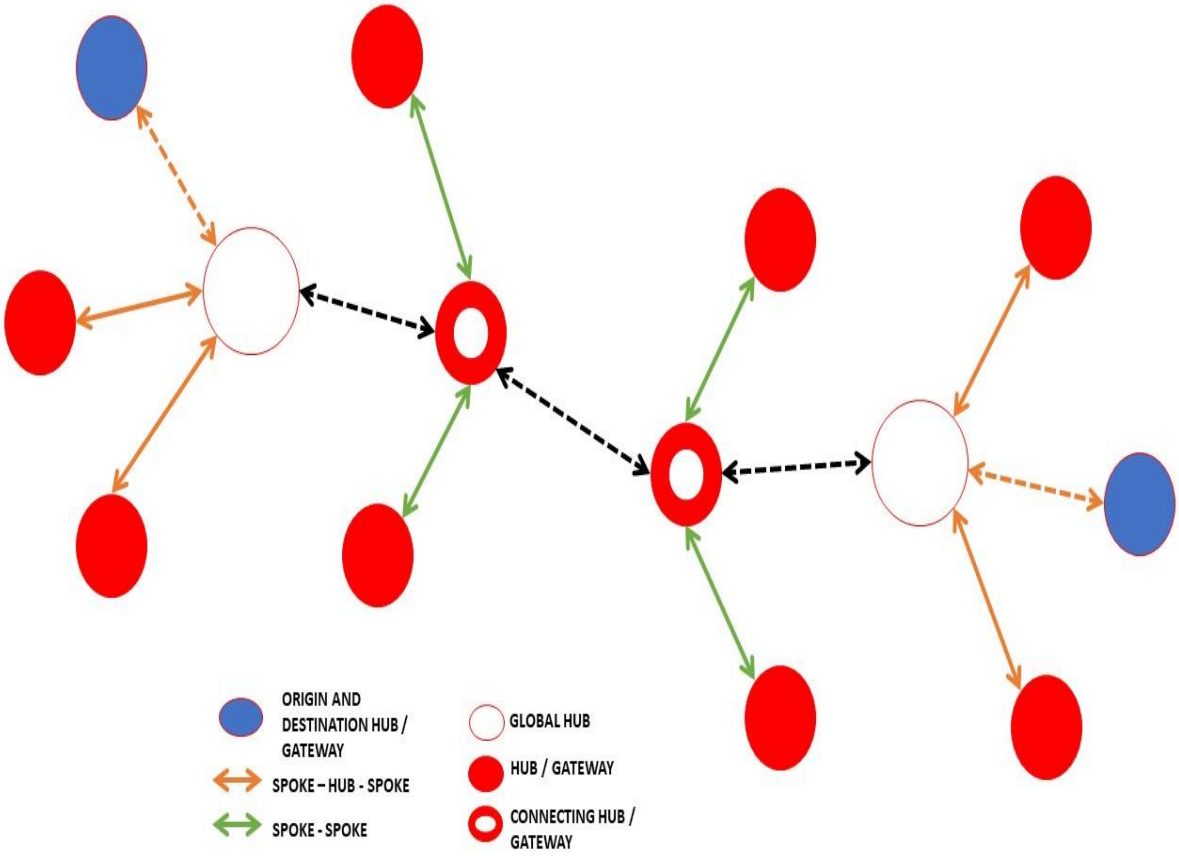
1. global hub to global hub
2. Connecting hub / gateway to connecting hub / gateway
3. global hub to connecting hub / gateway
4. connecting hub / gateway to global hub

global hub to global hub

origin hub / gateway is connected to a global hub and destination hub / gateway is connected to a global hub then shipments will be connected between the two global hubs in the following way.

1. Origin hub / gateway to origin global hub
2. Origin global hub to destination global hub
3. destination global hub to destination hub / gateway

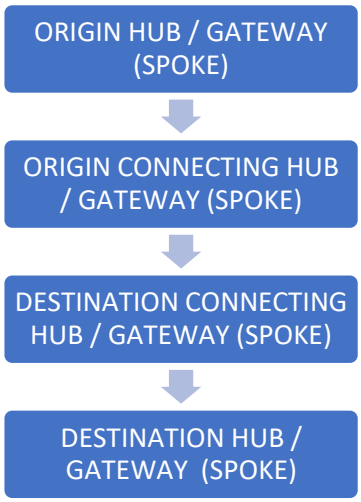


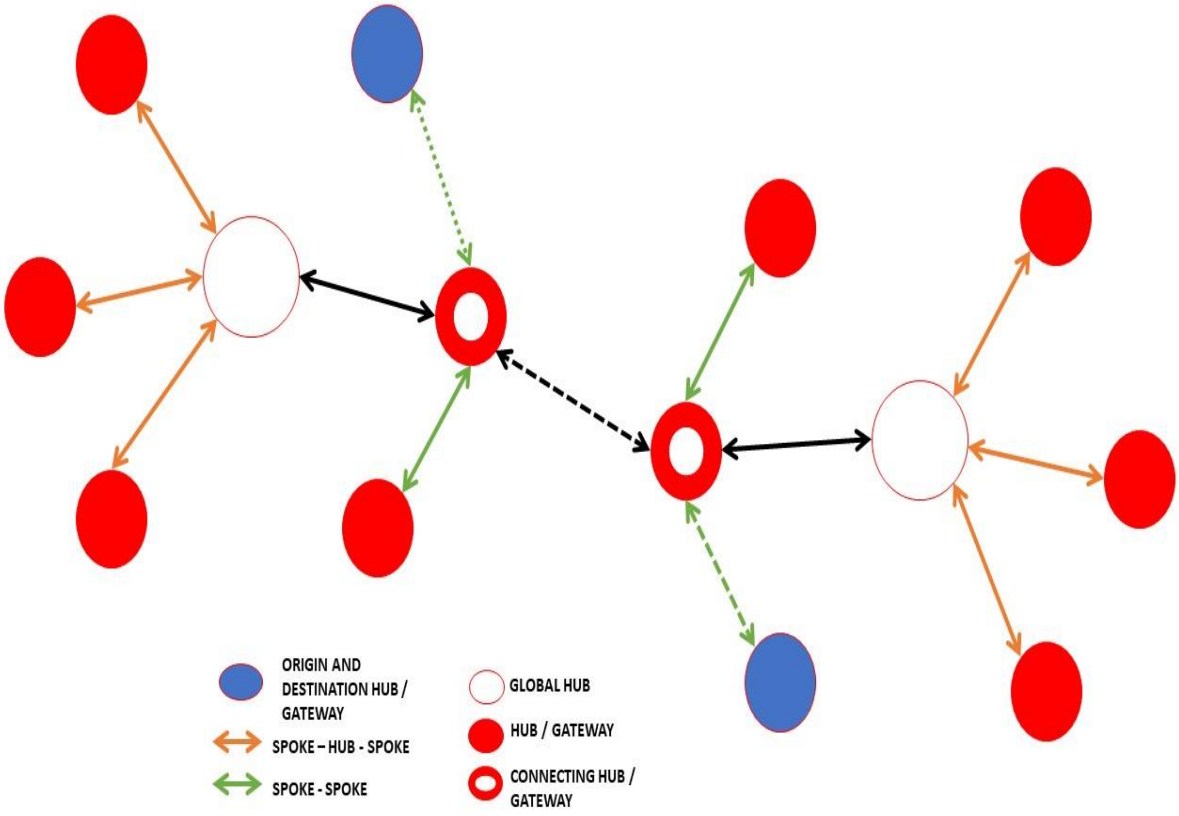


Connecting hub / gateway to connecting hub / gateway

origin hub / gateway is connected to a connecting hub / gateway and destination hub / gateway is connected to a connecting hub / gateway then shipments will be connected between the two global hubs in the following way.

1. Origin hub / gateway to origin connecting hub / gateway
2. Origin connecting hub / gateway to destination connecting hub / gateway
3. Destination connecting hub / gateway to destination hub / gateway

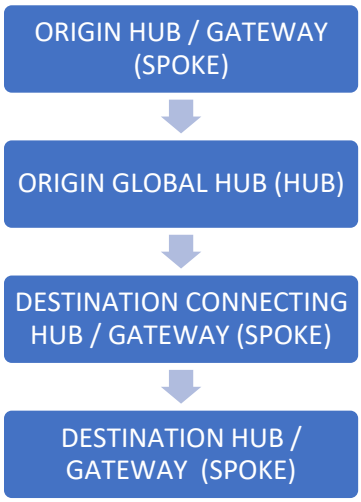


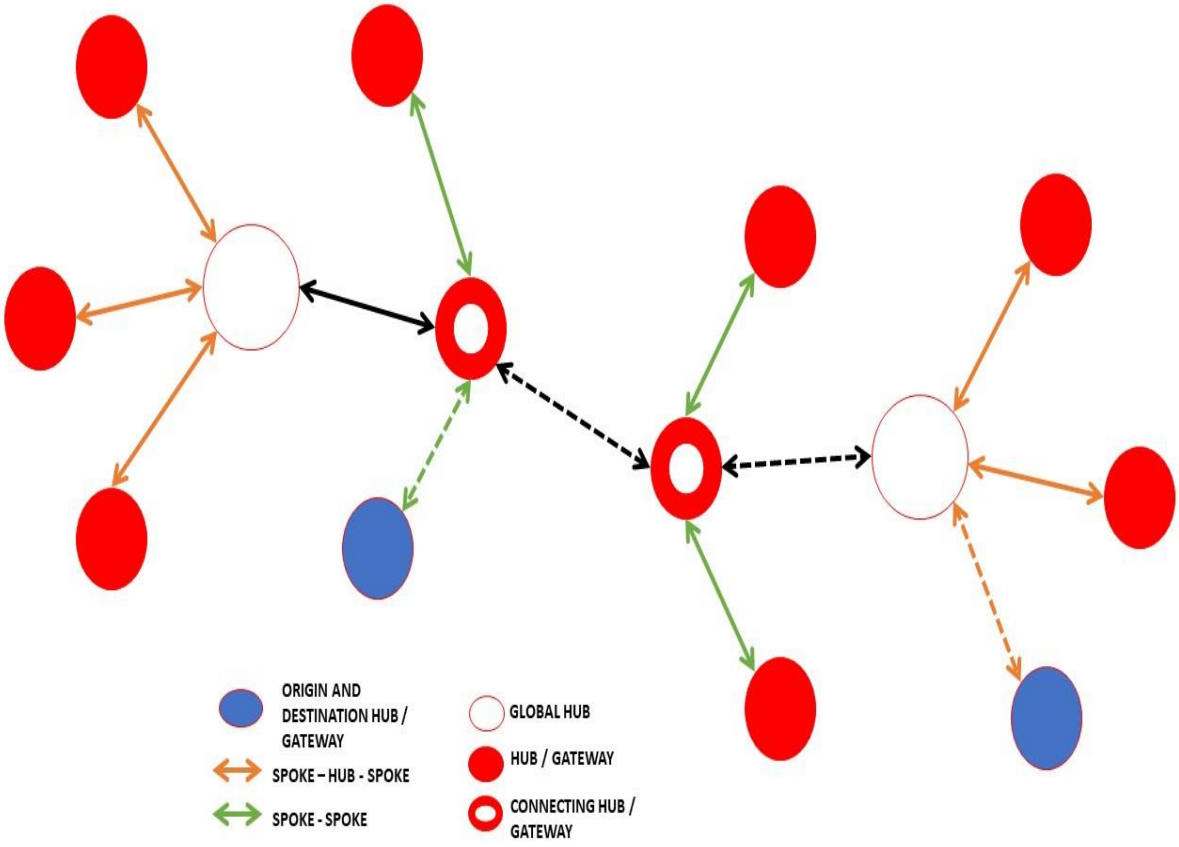


global hub to connecting hub / gateway

origin hub / gateway is connected to a global hub and destination hub / gateway is connected to a connecting hub / gateway then shipments will be connected between the two global hubs in the following way.

1. Origin hub / gateway to origin global hub
2. Origin global hub to destination connecting hub / gateway
3. Destination connecting hub / gateway to destination hub / gateway

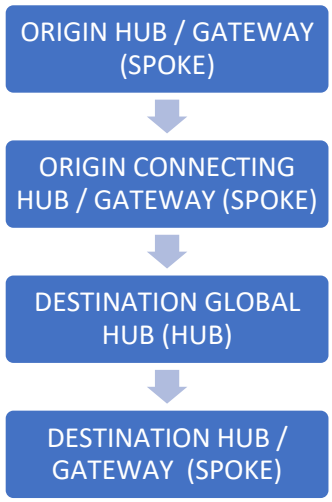


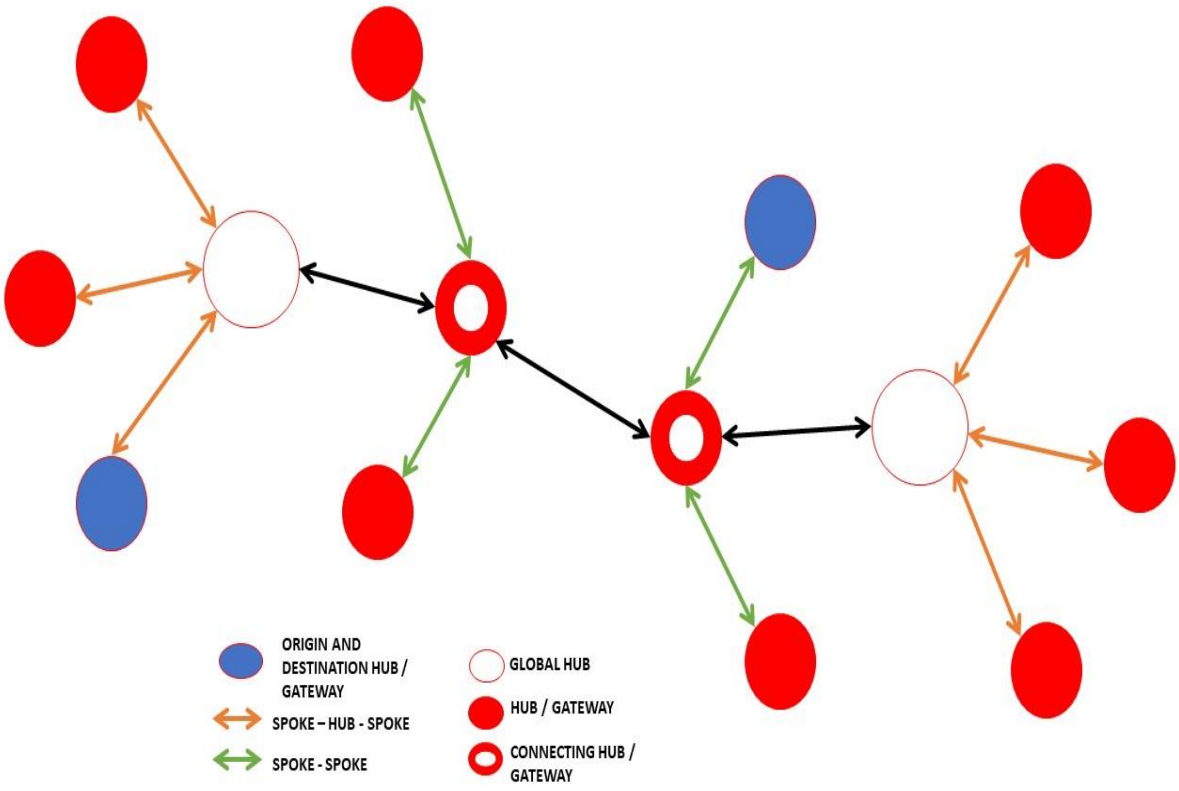


connecting hub / gateway to global hub

origin hub / gateway is connected to a connecting hub / gateway and destination hub / gateway is connected to a global hub then shipments will be connected between the two global hubs in the following way.

1. Origin hub / gateway to origin connecting hub / gateway
2. origin connecting hub / gateway to destination global hub
3. Destination global hub to destination hub / gateway



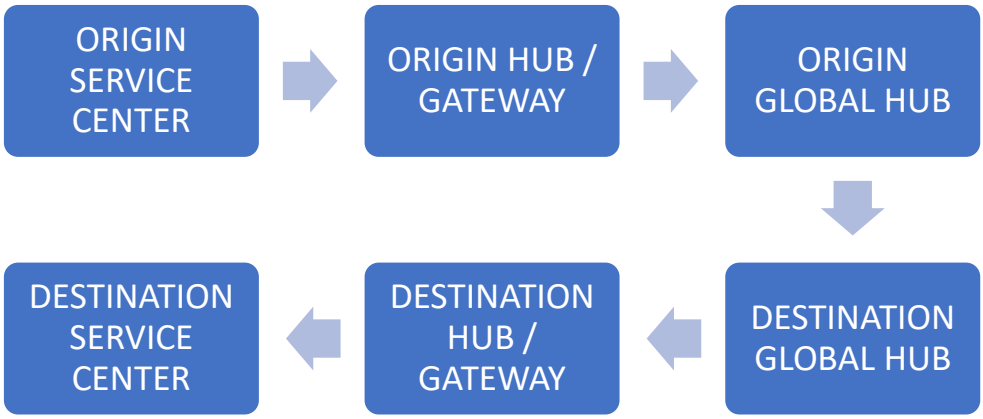


Determination of moving pattern between different global hubs

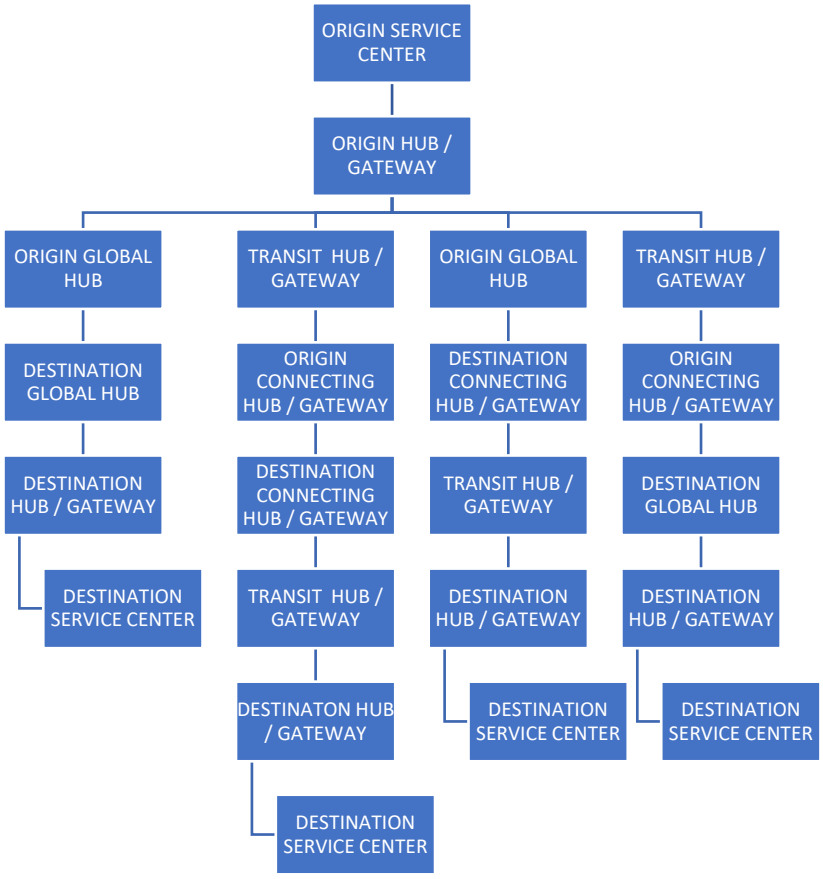
Distance (kilometres) between each origin hub / gateway and destination hub / gateway in different global hubs is calculated for following movement patterns

- Spoke - hub - spoke
- Spoke - spoke

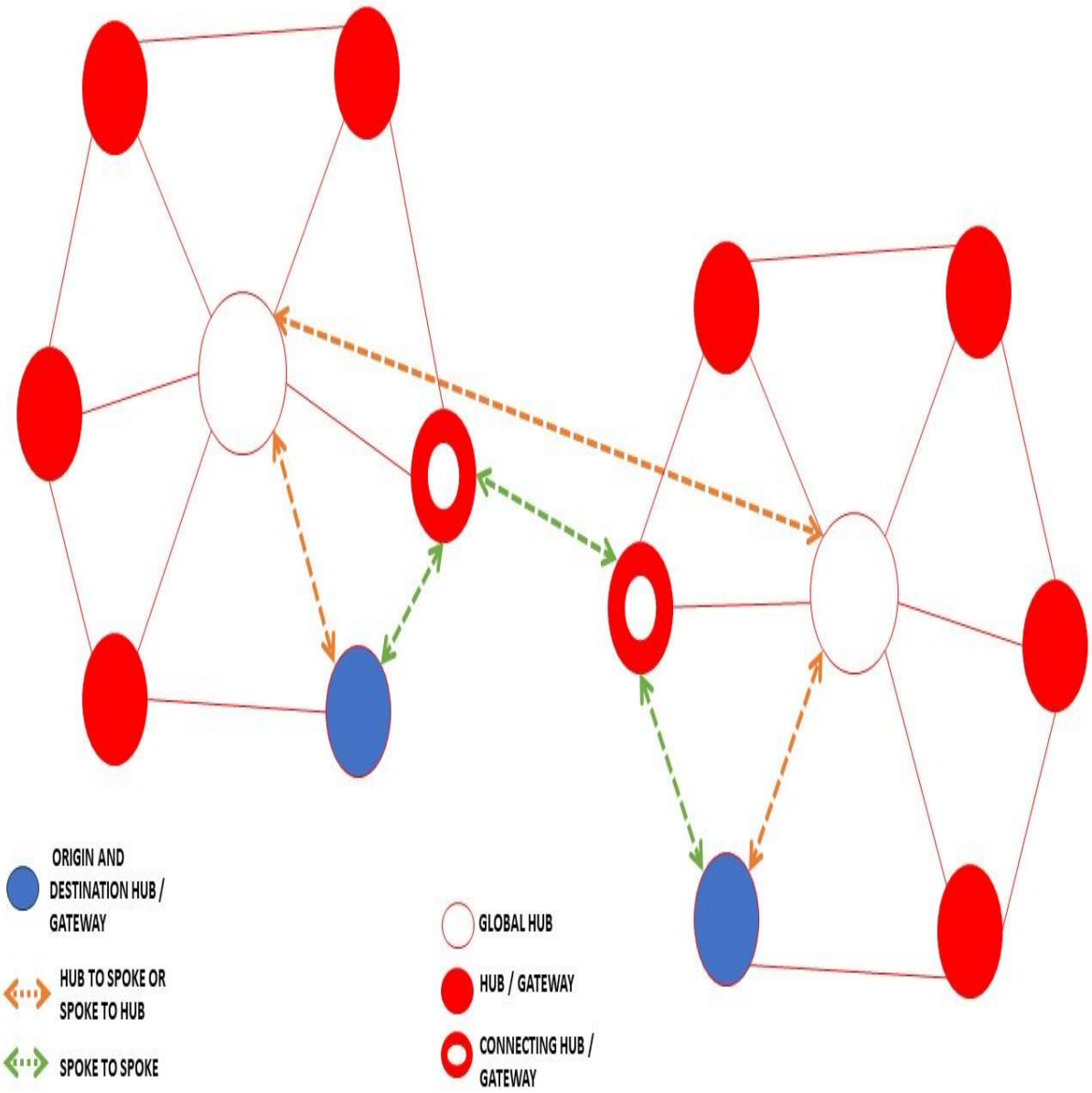
Spoke - hub - spoke



Spoke – spoke



And movement pattern with **shortest distance (kilometres)** between the origin hub / gateway in a global hub and destination hub / gateway in another global hub is selected for each origin hub / gateway and destination hub / gateway in different global hubs.



Movement Path

Movement Path is created for each origin postal code or service point and destination postal code or service point and movement path is created for each layer of hub and spoke model.

1. First layer – connecting service centers within the hub / gateway
2. Second layer – connecting service centers of different hub / gateways in the global hub
3. Third layer – connecting service centers of different global hubs

First layer – connecting service centers within the hub / gateway

Each postal code is connected to the nearby service center and postal code can be both origin postal code and destination postal code.

Each service point is connected to the nearby service center and service point can be both origin service point and destination service point.

Movement pattern with **shortest distance (kilometres)** between the origin service center and destination service center within the hub / gateway is selected for each origin service center and destination service center within the hub / gateway.

Spoke - hub – spoke

If **Spoke - hub - spoke** movement pattern as the **shortest distance (kilometres)** between the origin service center and destination service center within the hub / gateway then the path will be as follows.

1. Origin postal code (or) origin service point to origin service center
2. Origin service center to hub / gateway
3. Hub / gateway to destination service center
4. Destination service center to destination postal code or destination service point



Spoke – spoke

If **spoke – spoke** movement pattern as the **shortest distance (kilometres)** between the origin service center and destination service center within the hub / gateway then the path will be as follows.

1. Origin postal code (or) origin service point to origin service center
2. Origin service center to transit service center
3. Transit service center to destination service center
4. Destination service center to destination postal code or destination service point



Second layer – connecting service centers of different hub / gateways in the global hub

Each postal code is connected to the nearby service center and postal code can be both origin postal code and destination postal code.

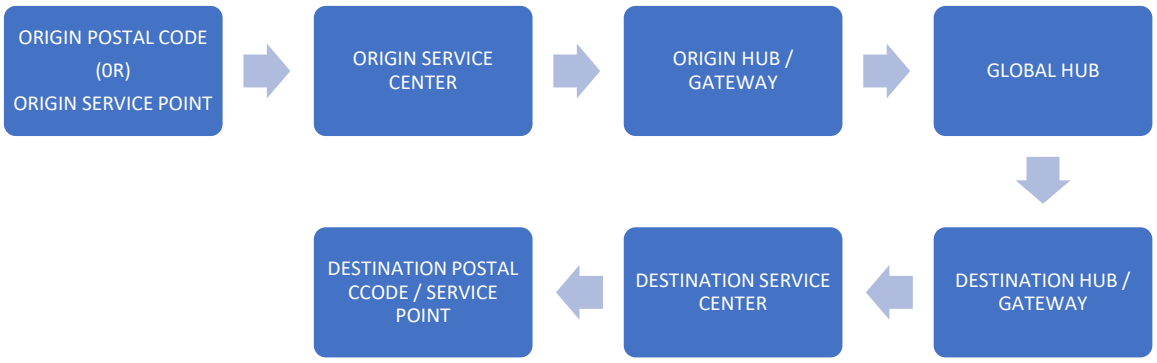
Each service point is connected to the nearby service center and service point can be both origin service point and destination service point.

Movement pattern with **shortest distance (kilometres)** between the origin service center in a hub / gateway and destination service center in another hub / gateway within the global hub is selected for each origin service center and destination service center within the global hub.

Spoke - hub – spoke

If **Spoke - hub - spoke** movement pattern as the **shortest distance (kilometres)** between the origin service center in a hub / gateway and destination service center in another hub / gateway within the global hub then the path will be as follows

1. Origin postal code (or) origin service point to origin service center
2. Origin service center to origin hub / gateway
3. Origin hub / gateway to global hub
4. global hub to destination hub / gateway
5. Destination hub /gateway to destination service center.
6. Destination service center to destination postal code or destination service point



Spoke – spoke

If **spoke – spoke** movement pattern as the **shortest distance (kilometres)** between the origin service center in a hub / gateway and destination service center in another hub / gateway within the global hub then the path will be as follows

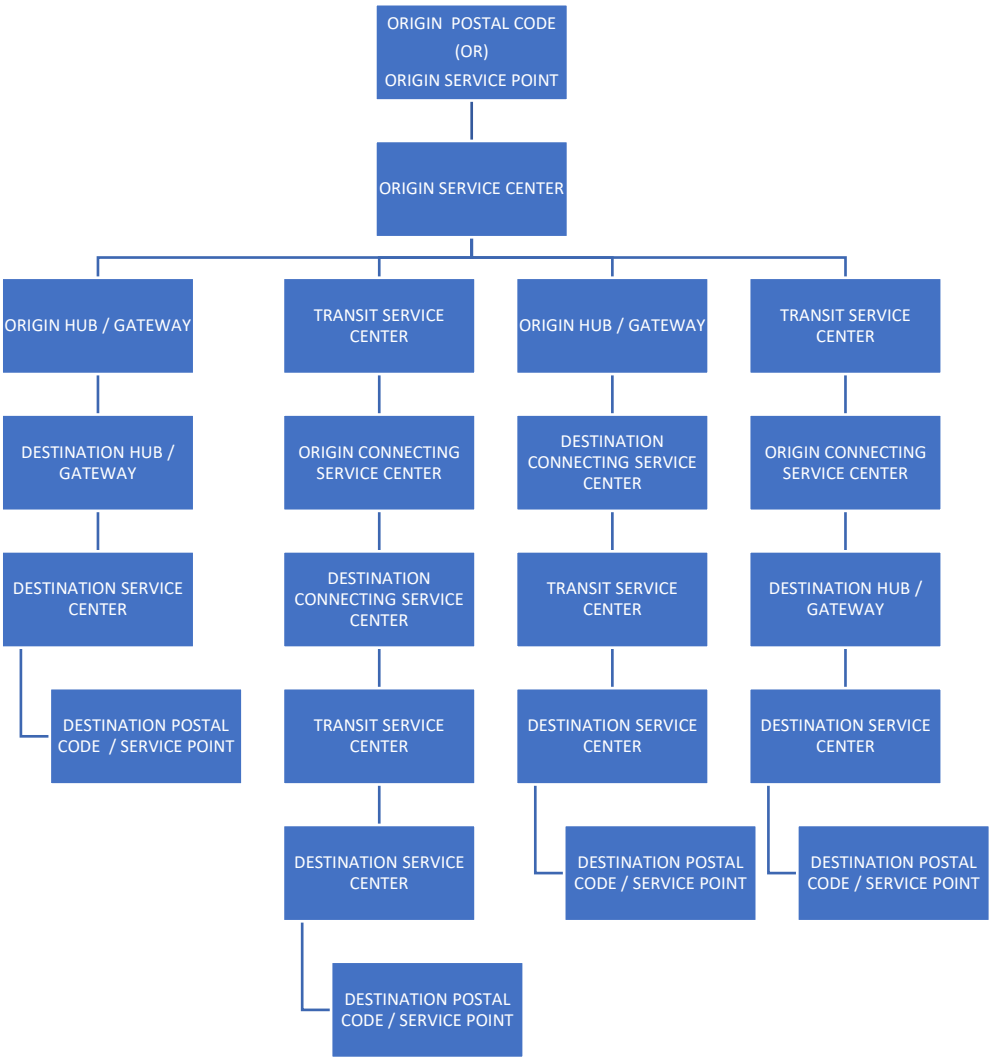
1. Origin postal code (or) origin service point to origin service center
2. Origin service center
    a) Origin service center to **origin hub / gateway**
    b) Origin service center to transit service center and to **origin connecting service center**
3. Destination service center
    a) **Origin hub / gateway** to destination hub / gateway to destination service center.

    (or)

    Origin hub / gateway to destination connecting service center to transit service center and to destination service center.

b) **Origin connecting service center** to destination hub / gateway to destination service center
Origin connecting service center to destination connecting service center to transit service center and to destination service center.

4. destination service center to destination postal code or destination service point



Third layer – connecting service centers of different global hubs

Each postal code is connected to the nearby service center and postal code can be both origin postal code and destination postal code.

Each service point is connected to the nearby service center and service point can be both origin service point and destination service point.

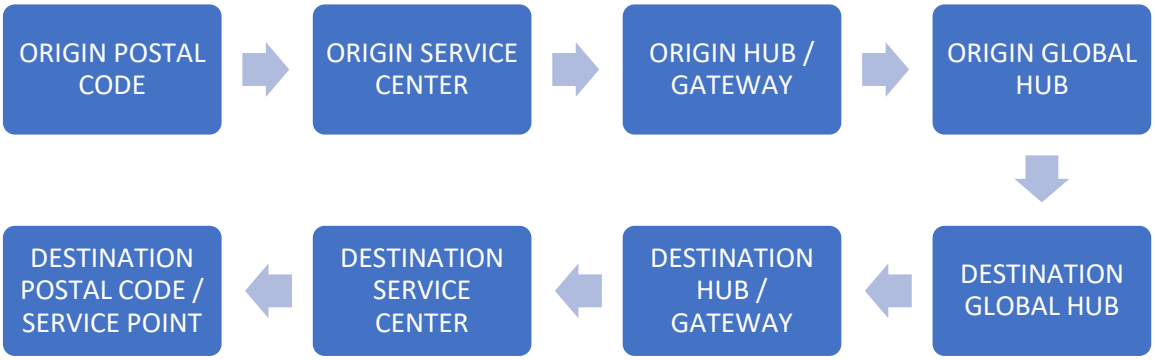
Each service centers are connected to the hub / gateway and service centers can be both origin service center and destination service center.

Movement pattern with **shortest distance (kilometres)** between the origin hub / gateway in a global hub and destination hub / gateway in another global hub is selected for each origin hub / gateway and destination hub / gateway in different global hubs.

Spoke - hub – spoke

If **Spoke - hub - spoke** movement pattern as the **shortest distance (kilometres)** between the origin hub / gateway in a global hub and destination hub / gateway in another global hub is selected for each origin hub / gateway and destination hub / gateway in different global hubs then the path will be as follows

1. origin postal code or origin service point to origin service center
2. origin service center to origin hub / gateway
3. Origin hub / gateway to origin global hub
4. Origin global hub to destination global hub
5. Destination global hub to destination hub / gateway
6. Destination hub / gateway to destination service center
7. Destination service center to destination postal code or destination service point



Spoke – spoke

If **spoke – spoke** movement pattern as the **shortest distance (kilometres)** between the origin hub / gateway in a global hub and destination hub / gateway in another global hub is selected for each origin hub / gateway and destination hub / gateway in different global hubs then the path will be as follows

1. origin postal code or origin service point to origin service center
2. origin service center to origin hub / gateway
3. origin hub / gateway
    a) Origin hub / gateway to **origin global hub**

    b) Origin hub / gateway to transit hub / gateway and to **origin connecting hub / gateway**

4. Destination hub / gateway
    a) **origin global hub** to destination global hub to destination hub / gateway

    (or)

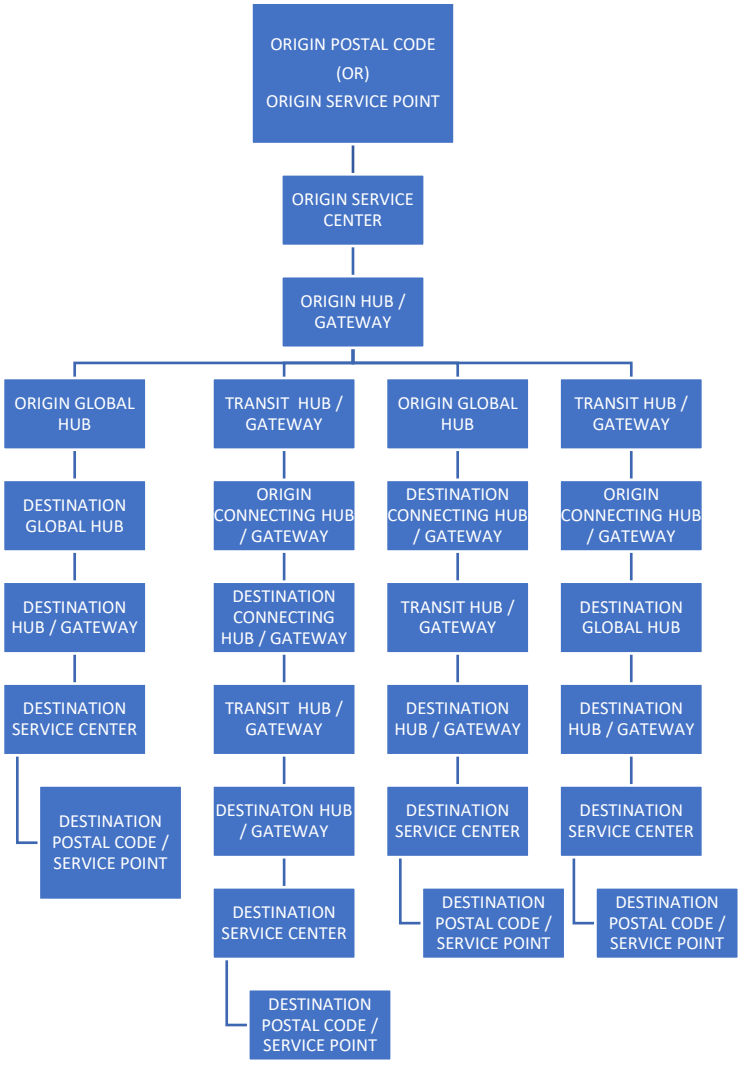
    Origin global hub to destination connecting hub / gateway to transit hub / gateway to destination hub / gateway.

    b) **Origin connecting hub / gateway** to destination global hub to destination hub / gateway

(or)

Origin connecting hub / gateway to destination connecting hub / gateway and to transit hub / gateway or destination hub / gateway.

5. Destination hub / gateway to destination service center
6. Destination service center to destination postal code or destination service point



Movement path is created for each origin postal code or origin service point and destination postal code or destination service point.

When shipments are booked by the customers, movement path is assigned to the shipment barcode based on origin postal code or origin service point and destination postal code or service point of the shipment.

Shipments will move in their assigned movement path from origin postal code or origin service point to destination postal code or service point.

SECONDARY VARIABLE

cost per kilometre

cost per kilometre can be decreased by selecting the optimal vehicle capacity based on quantity of shipments in

1. Service center
2. Connecting service center
3. Hub / gateway
4. Connecting hub / gateway
5. Global hub

Tonne-kilometres

Tonne-kilometres can be increased by selecting the optimal route based on quantity of shipments in

1. Service center
2. Connecting service center
3. Hub / gateway
4. Connecting hub / gateway
5. Global hub

Determination of quantity of shipments

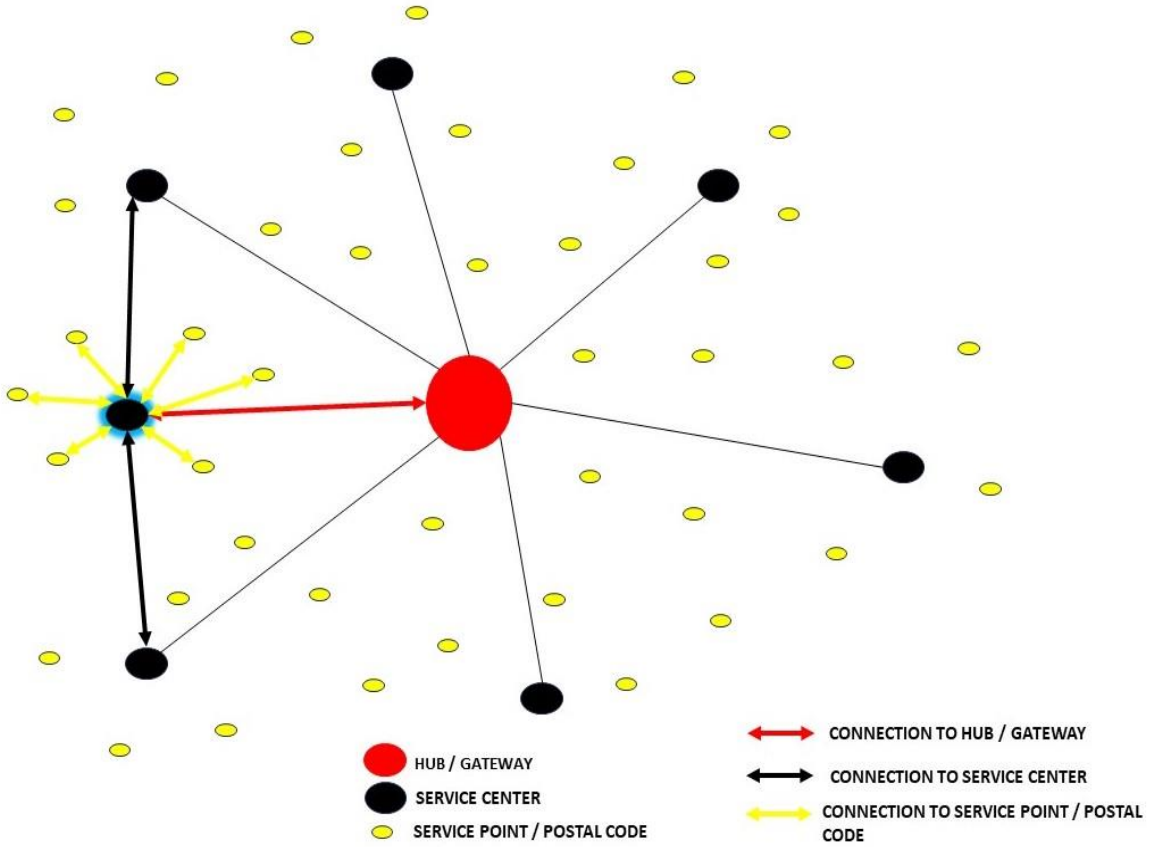
We need to know the **tonnage of shipments (Quantity of shipments)** in following locations to **decrease the cost per kilometre** and **increase the tonne-kilometre**

1. Service center
2. Connecting service center
3. Hub / gateway
4. Connecting hub / gateway
5. Global hub

Service center

Every Service center are connected to

- Postal code
  Each Service center is connected to multiple postal code and postal code can be both origin postal code and destination postal code.
- Service point
  Each Service center is connected to multiple service points and service point can be both origin service point and destination service point.
- Service center
  Each Service center are connected to two nearby service centers.
- Hub / gateway
  Each Service centers are connected to its hub / gateway.



Inbound

Service center will receive shipments from

- postal code
- service point
- Service center
- Hub / gateway

Sorting

Shipments received by the service center are sorted based on the movement path assigned in the barcode of each shipment and consolidated based on the following movement location

- Postal code
  Shipments are sorted and consolidated based on the **postal code** in the movement path.
- Service point
  Shipments are sorted and consolidated based on the **service point** in the movement path.
- Service center
  Shipments are sorted and consolidated based on the **service center** in the movement path.
- Hub / gateway
  Shipments are sorted and consolidated based on the **hub / gateway** in the movement path.

Sorted and consolidated shipments at the service center will provide us the **tonnage of shipments (quantity of shipments)** available at the service center for following movement location.

- postal code
  sorted and consolidated shipments will provide us the **tonnage of shipments (quantity of shipments)** available at the service center for each **postal code.**
- service point
  sorted and consolidated shipments will provide us the **tonnage of shipments (quantity of shipments)** available at the service center for each **service point.**
- Service center
  sorted and consolidated shipments will provide us the **tonnage of shipments (quantity of shipments)** available at the service center for each **service center.**
- Hub / gateway
  sorted and consolidated shipments will provide us the **tonnage of shipments (quantity of shipments)** available at the service center for the **hub / gateway.**

Outbound

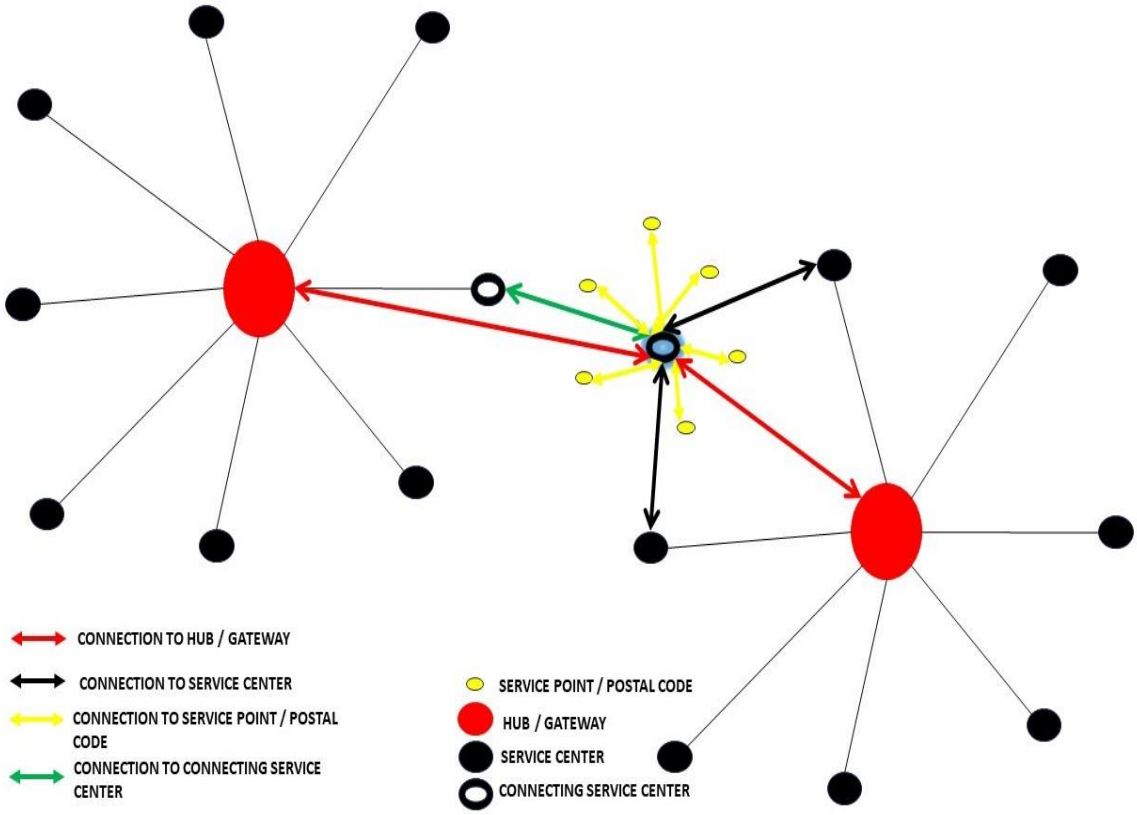
Service center will send shipments to

- postal code
- service point
- Service center
- Hub / gateway

Connecting service center

Every Connecting service center is connected to

- Postal code
  Each connecting Service center is connected to multiple postal code and postal code can be both origin postal code and destination postal code.
- Service point
  Each connecting Service center is connected to multiple service points and service point can be both origin service point and destination service point.
- Service center
  Each connecting Service center are connected to two nearby service centers.
- Connecting service center
  Each connecting service center is connected to the connecting service center of nearby hub / gateway.
- Hub / gateway
  Each connecting service center is connected to its hub / gateway and to nearby hub / gateway.



Inbound

Connecting Service center will receive shipments from

- Postal code
- Service point
- Service center
- Connecting service center
- Hub / gateway

Sorting

Shipments received by the connecting service center are sorted based on the movement path assigned in the barcode of each shipment and consolidated based on the following movement location

- Postal code
  Shipments are sorted and consolidated based on the **postal code** in the movement path.
- Service point
  Shipments are sorted and consolidated based on the **service point** in the movement path.
- Service center
  Shipments are sorted and consolidated based on the **service center** in the movement path.
- Connecting service center
  Shipments are sorted and consolidated based on the **connecting service center** in the movement path.

- Hub / gateway
  Shipments are sorted and consolidated based on the **hub / gateway** in the movement path.

Sorted and consolidated shipments at the connecting service center will provide us the **tonnage of shipments (quantity of shipments)** available at the connecting service center for following movement location.

- postal code
  sorted and consolidated shipments will provide us the **tonnage of shipments (quantity of shipments)** available at the connecting service center for each **postal code.**
- service point
  sorted and consolidated shipments will provide us the **tonnage of shipments (quantity of shipments)** available at the connecting service center for each **service point.**
- Service center
  sorted and consolidated shipments will provide us the **tonnage of shipments (quantity of shipments)** available at the connecting service center for each **service center.**
- Connecting service center
  sorted and consolidated shipments will provide us the **tonnage of shipments (quantity of shipments)** available at the connecting service center for its nearby by **connecting service center.**
- Hub / gateway
  sorted and consolidated shipments will provide us the **tonnage of shipments (quantity of shipments)** available at the connecting service center for each **hub / gateway.**

Outbound

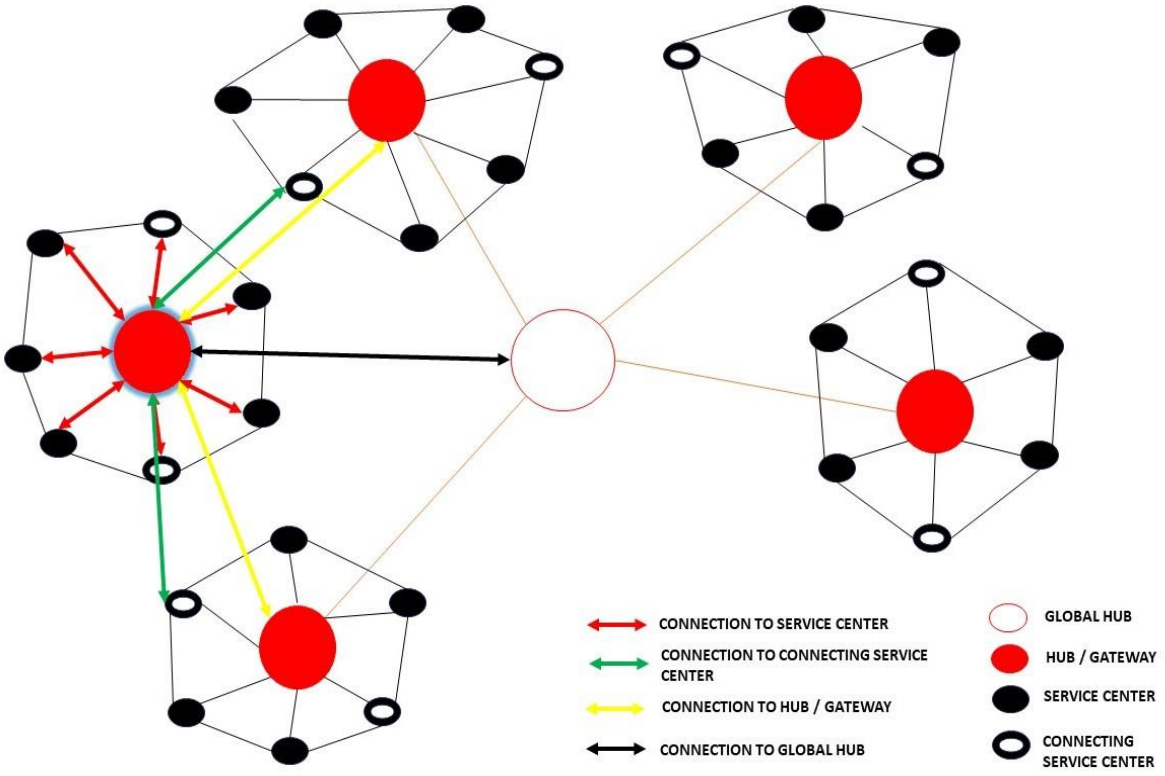
Connecting Service center will send shipments to

- Postal code
- Service point
- Service center
- Connecting service center
- Hub / gateway

Hub / gateway

Every Hub / gateway are connected to

- Service center
  Each hub / gateway is connected to their service centers.
- Connecting service center
  Each hub / gateway is connected to its connecting service center and to nearby connecting service center.
- Hub / gateway
  Each hub / gateway is connected to its nearby hub / gateway.
- Global hub
  Each hub / gateway is connected to its global hub.



Inbound

Hub / gateway will receive shipments from

- service centers
- Connecting service center
- hub / gateway
- Global hub

Sorting

Shipments received by the hub / gateway are sorted based on the movement path assigned in the barcode of each shipment and consolidated based on the following movement location

- service center
  Shipments are sorted and consolidated based on the **service center** in the movement path.
- Connecting service center
  Shipments are sorted and consolidated based on the **connecting service center** in the movement path.
- hub / gateway
  Shipments are sorted and consolidated based on the **hub / gateway** in the movement path.
- Global hub
  Shipments are sorted and consolidated based on the **global hub** in the movement path.

Sorted and consolidated shipments at the hub / gateway will provide us the **tonnage of shipments (quantity of shipments)** available at the hub / gateway for following movement location.

- Service center
  sorted and consolidated shipments will provide us the **tonnage of shipments (quantity of shipments)** available at the hub / gateway for each **service center.**
- Connecting service center
  sorted and consolidated shipments will provide us the **tonnage of shipments (quantity of shipments)** available at the hub / gateway for each **connecting service center.**
- Hub / gateway
  sorted and consolidated shipments will provide us the **tonnage of shipments (quantity of shipments)** available at the hub / gateway for each **hub / gateway.**
- Global hub
  sorted and consolidated shipments will provide us the **tonnage of shipments (quantity of shipments)** available at the hub / gateway for its **global hub.**

Outbound

Hub / gateway will send shipments to

- service centers
- Connecting service center
- hub / gateway
- Global hub

Connecting hub / gateway

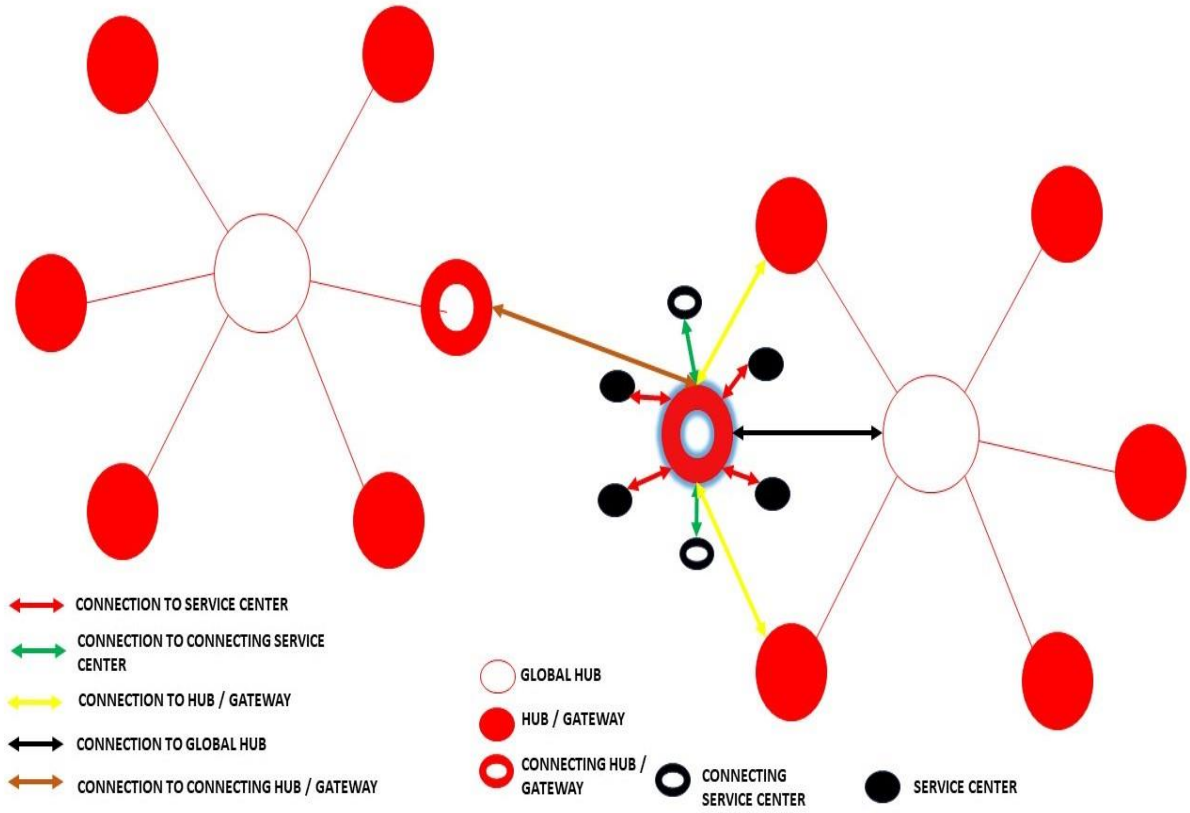
Every connecting hub / gateway are connected to

- service centers
  Each connecting hub / gateway is connected to their service centers
- Connecting service center
  Each connecting hub / gateway is connected to its connecting service center.
- Hubs / gateways
  Each connecting hub / gateway is connected to nearby hubs / gateways.
- Connecting hub / gateway
  Each connecting hub / gateway is connected to nearby connecting hub / gateway.
- Global hub
  Each connecting hub / gateway is connected to its global hub.

Inbound

Connecting Hub / gateway will receive shipments from

- service centers
- Connecting service center
- Hubs / gateways
- Connecting hub / gateway
- Global hub



Sorting

Shipments received by the connecting hub / gateway are sorted based on the movement path assigned in the barcode of each shipment and consolidated based on the following movement location

- service center
  Shipments are sorted and consolidated based on the **service center** in the movement path.
- Connecting service center
  Shipments are sorted and consolidated based on the **connecting service center** in the movement path.
- Hubs / gateways
  Shipments are sorted and consolidated based on the **hubs / gateways** in the movement path.
- Connecting hub / gateway
  Shipments are sorted and consolidated based on the **connecting hub / gateway** in the movement path.
- Global hub
  Shipments are sorted and consolidated based on the **global hub** in the movement path.

Sorted and consolidated shipments at the connecting hub / gateway will provide us the **tonnage of shipments (quantity of shipments)** available at the connecting hub / gateway for following movement location.

- Service center
  sorted and consolidated shipments will provide us the **tonnage of shipments (quantity of shipments)** available at the connecting hub / gateway for each **service center.**
- Connecting service center
  sorted and consolidated shipments will provide us the **tonnage of shipments (quantity of shipments)** available at the connecting hub / gateway for each **connecting service center.**
- Hub / gateway
  sorted and consolidated shipments will provide us the **tonnage of shipments (quantity of shipments)** available at the connecting hub / gateway for each **hub / gateway.**
- Connecting hub / gateway
  sorted and consolidated shipments will provide us the **tonnage of shipments (quantity of shipments)** available at the connecting hub / gateway for each **connecting hub / gateway.**
- Global hub
  sorted and consolidated shipments will provide us the **tonnage of shipments (quantity of shipments)** available at the connecting hub / gateway for its **global hub.**

Outbound

Connecting Hub / gateway will send shipments to

- service centers
- Connecting service center
- Hubs / gateways
- Connecting hub / gateway
- Global hub

Global hub

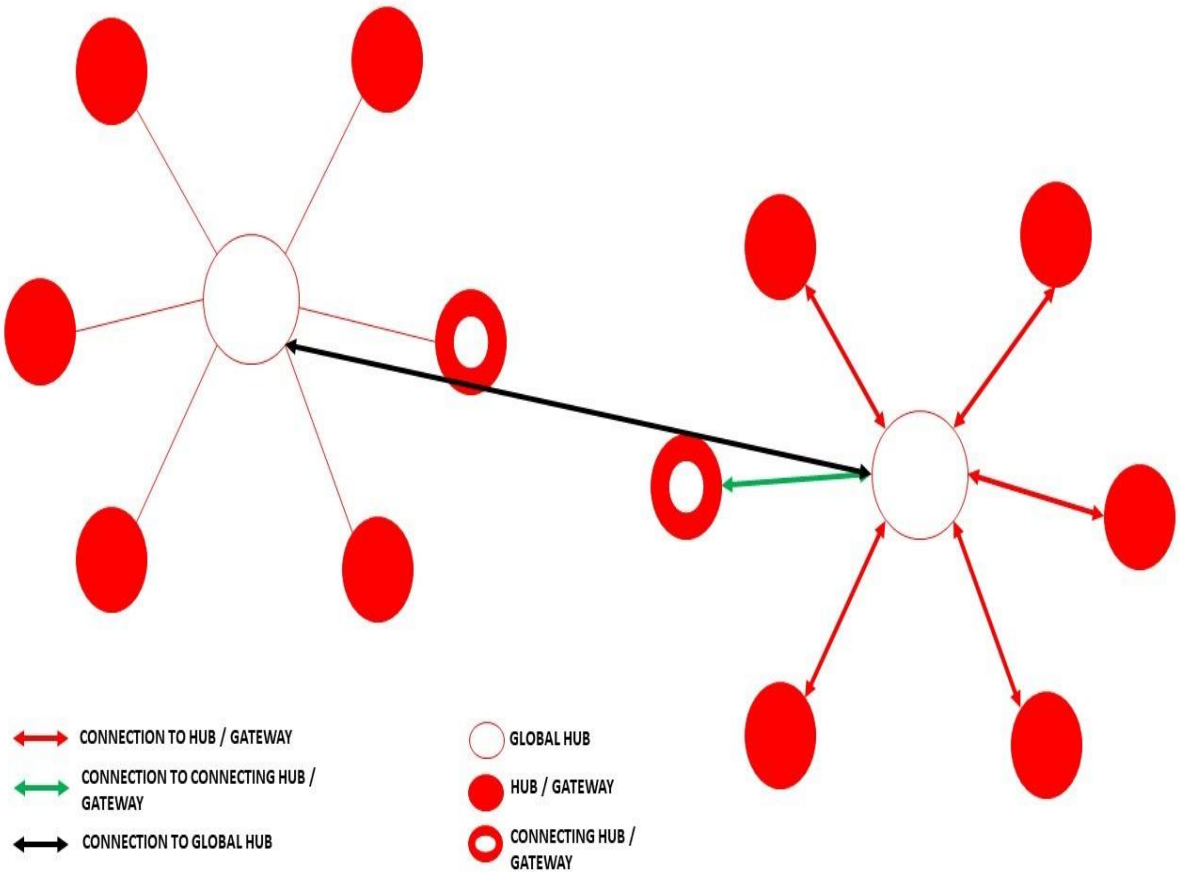
Every global hub is connected to

- Hubs / gateways
  Each global hub is connected to their hubs / gateways.
- Connecting hub / gateway
  Each global hub is connected to its connecting hub and gateway.
- global hub
  each global hub is connected to nearby global hub.

Inbound

Global hub will receive shipments from

- Hubs / gateways
- Connecting hub / gateway
- global hub



Sorting

Shipments received by the global hub are sorted based on the movement path assigned in the barcode of each shipment and consolidated based on the following movement location

- hub / gateway
  Shipments are sorted and consolidated based on the **hub / gateway** in the movement path.
- Connecting hub and gateway
  Shipments are sorted and consolidated based on the **connecting hub / gateway** in the movement path.
- Global hub
  Shipments are sorted and consolidated based on the **global hub** in the movement path.

Sorted and consolidated shipments at the global hub will provide us the **tonnage of shipments (quantity of shipments)** available at the global hub for following movement location.

- Hub / gateway
  sorted and consolidated shipments will provide us the **tonnage of shipments (quantity of shipments)** available at the global hub for each **hub / gateway.**
- Connecting hub / gateway
  sorted and consolidated shipments will provide us the **tonnage of shipments (quantity of shipments)** available at the global hub for each **connecting hub / gateway.**
- Global hub
  sorted and consolidated shipments will provide us the **tonnage of shipments (quantity of shipments)** available at the global hub for its nearby **global hub.**

Outbound

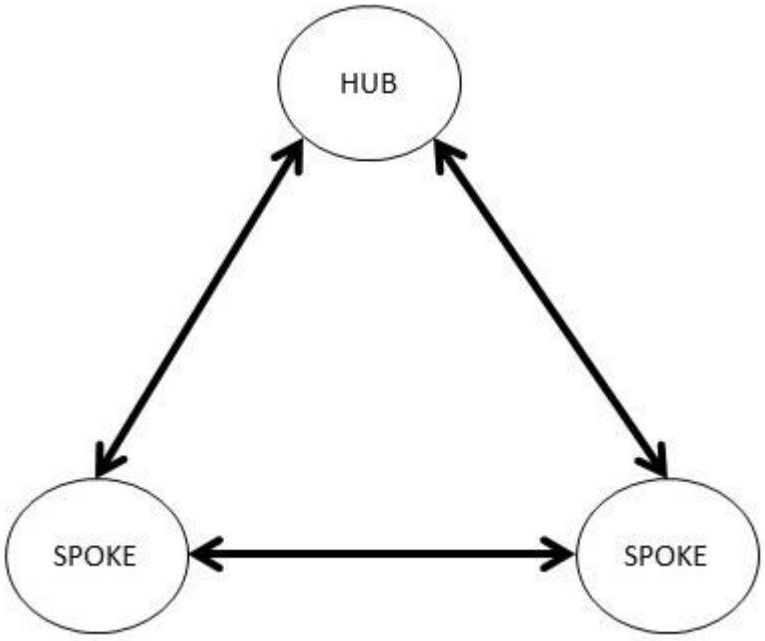
Global hub will send shipments to

- Hubs / gateways
- Connecting hub / gateway
- global hub

Determination of optimal vehicle and optimal route

Routing

In a hub and spoke model two **spokes** are connected to the **hub** for creation of twelve routes between the three locations.



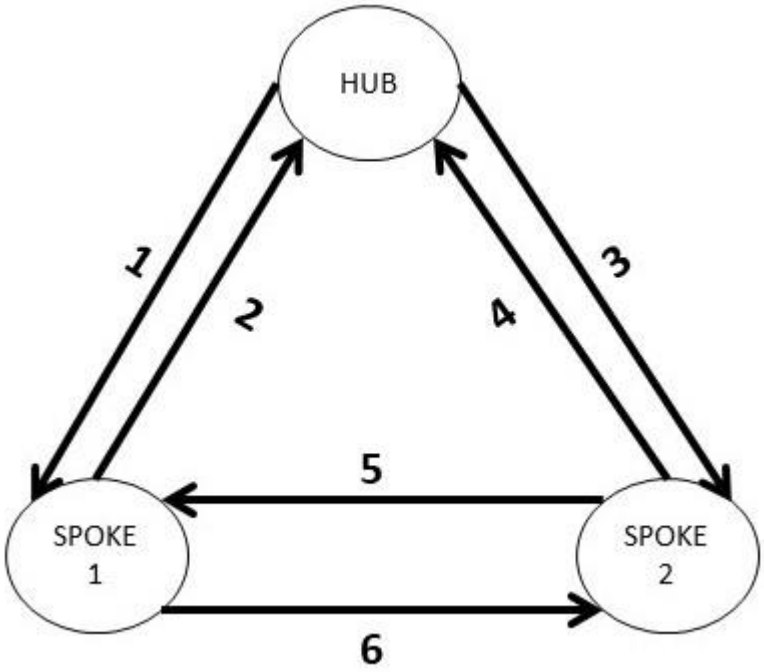
And twelve routes are categorised in to

1. two-point route
2. three-point route
3. four-point route

Two-point route

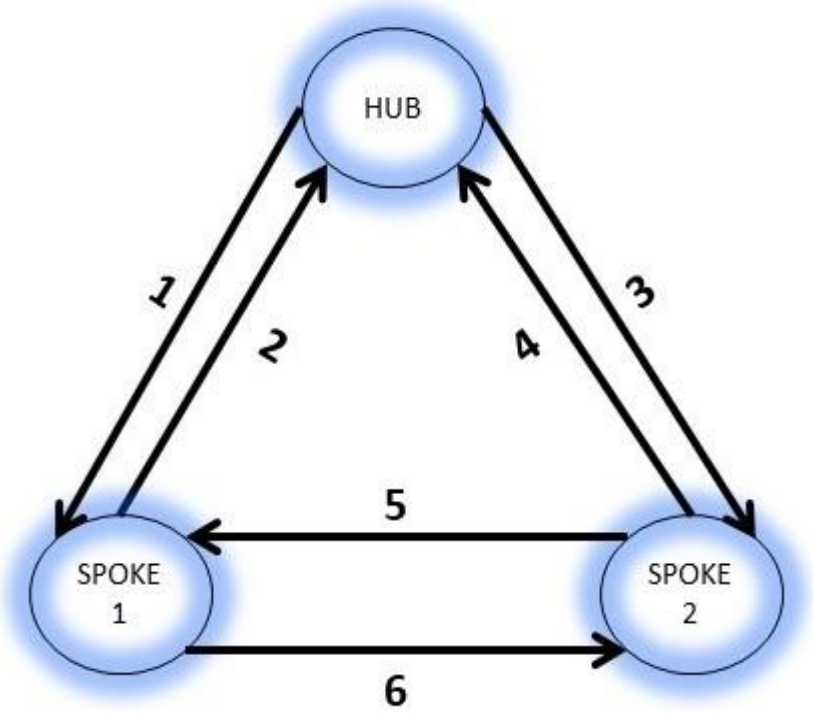
In two-point route spokes and hub are connected to create following six routes

1. hub is connected to the spoke (hub to spoke)
2. spoke is connected to the hub (spoke to hub)
3. hub is connected to the spoke (hub to spoke)
4. spoke is connected to the hub (spoke to hub)
5. spoke is connected to another spoke (spoke to spoke)
6. spoke is connected to another spoke (spoke to spoke)



Vehicle Starting point in two-point route

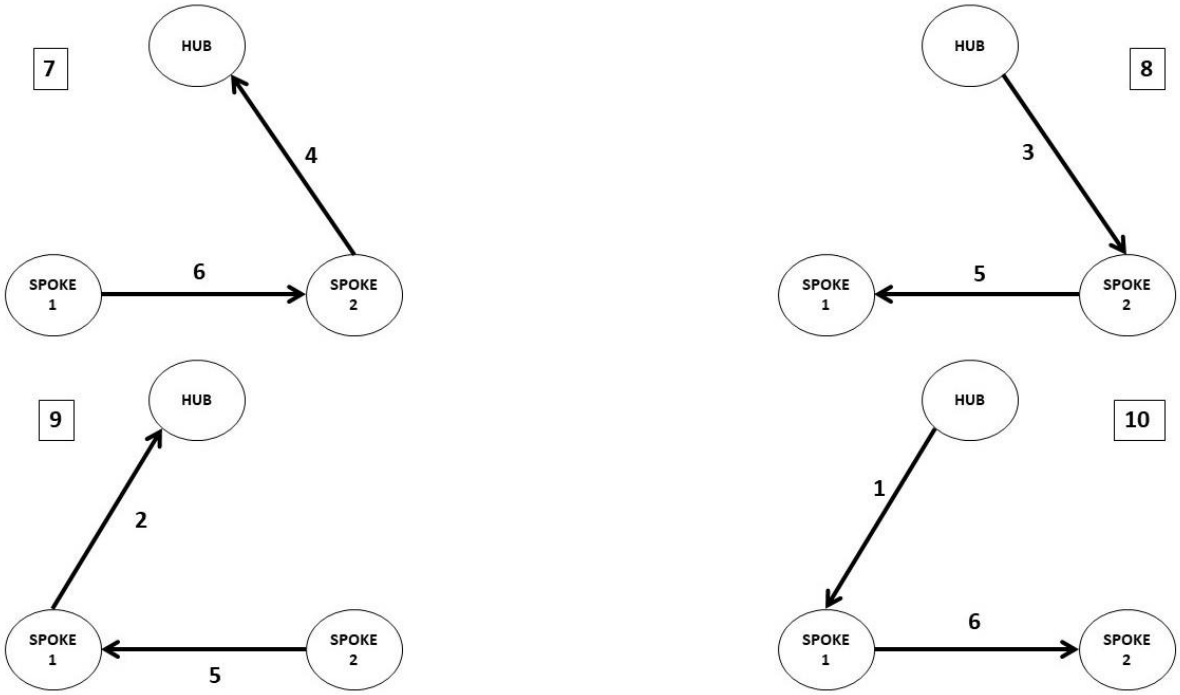
1. In route one (1) vehicle will start from hub
2. In route two (2) vehicle will start from spoke -1
3. In route three (3) vehicle will start from hub
4. In route four (4) vehicle will start from spoke -2
5. In route five (5) vehicle will start from spoke -2
6. In route six (6) vehicle will start from spoke -1



Three-point route

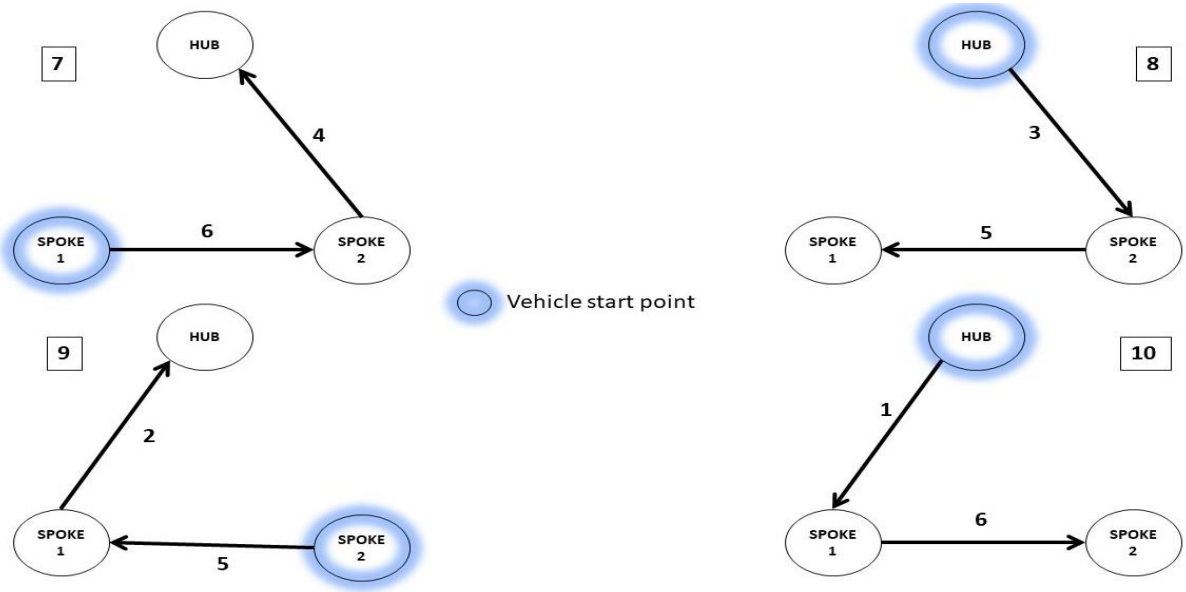
In three-point route spokes and hub are connected to create following four routes

7. spoke is connected to another spoke then connected to the hub. (spoke- spoke-hub)
8. hub is connected to spoke then connected to another spoke (hub- spoke-spoke)
9. spoke is connected to another spoke then connected to the hub. (spoke- spoke-hub)
10. hub is connected to spoke then connected to another spoke (hub- spoke-spoke)



Vehicle Starting point in three-point route

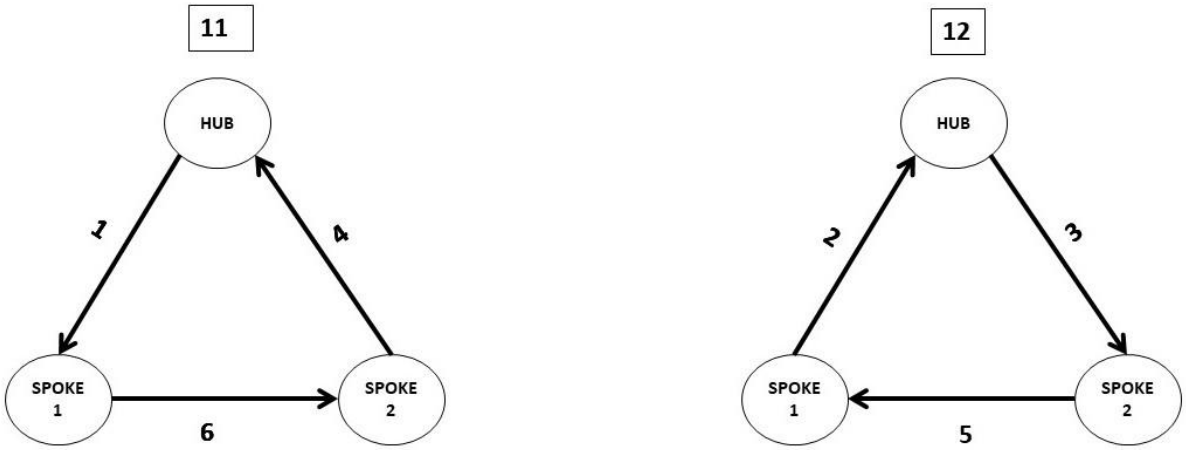
7. In route seven (7) vehicle will start from spoke -1
8. In route eight (8) vehicle will start from hub
9. In route nine (9) vehicle will start from spoke -2
10. In route ten (10) vehicle will start from hub



Four-point route

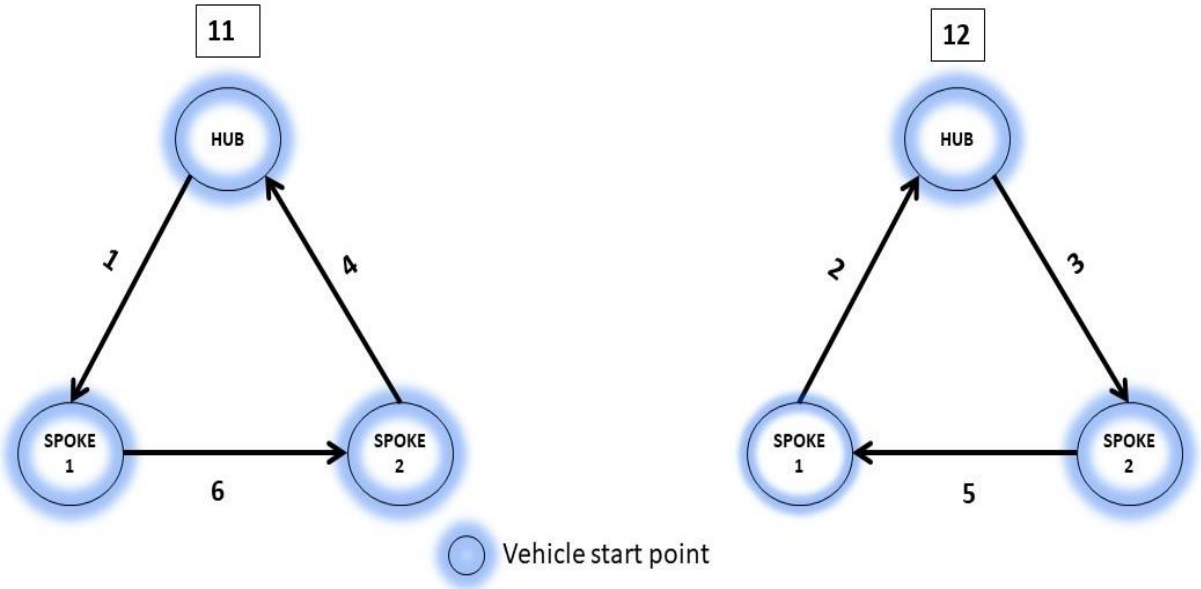
In Four-point route spokes and hub are connected to create following two routes

11. spoke is connected to another spoke then connected to the hub and connected to the same spoke (spoke-spoke-hub-spoke).
12. spoke is connected to another spoke then connected to the hub and connected to the same spoke (spoke-spoke-hub-spoke).



Vehicle starting point in four-point route

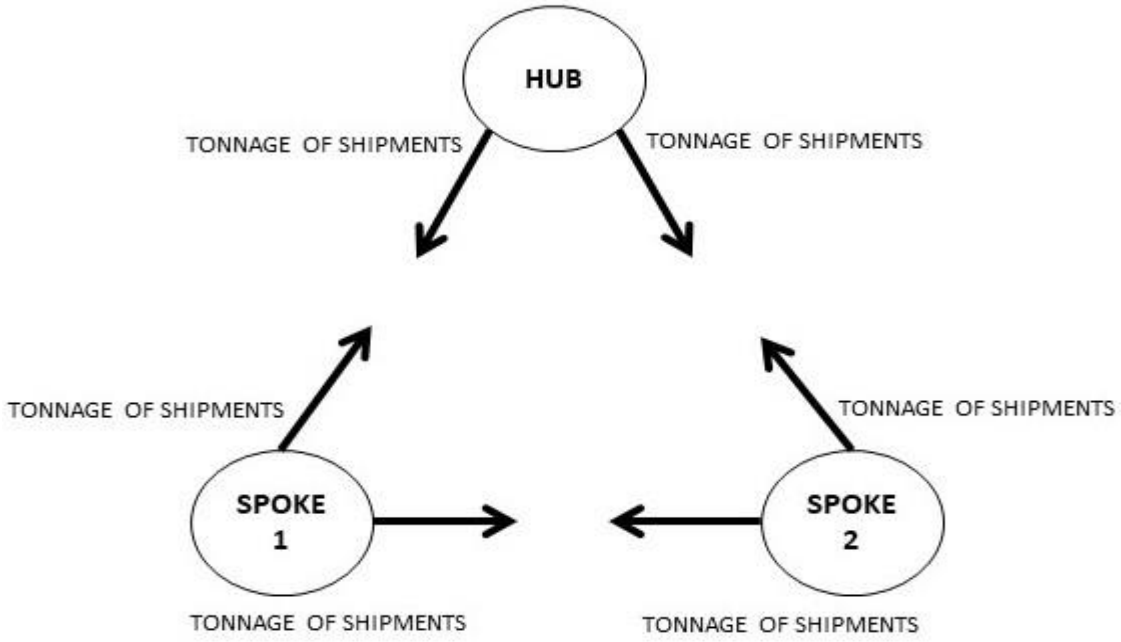
11. In route eleven (11) vehicle can start from hub, spoke -1 & spoke -2
12. In route twelve (12) vehicle can start from hub, spoke -1 & spoke -2



Determination of optimal vehicle and optimal route

Optimal Vehicle and optimal route are determined based on the **tonnage of shipments** in the following locations

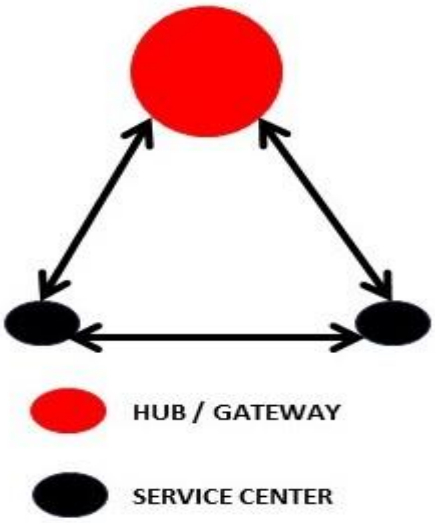
1. hub
2. spoke -1
3. spoke -2



First layer – connecting service centers within the hub / gateway

In the first layer of hub and spoke model optimal vehicle and optimal route are determined based on the **tonnage of shipments** in the following locations

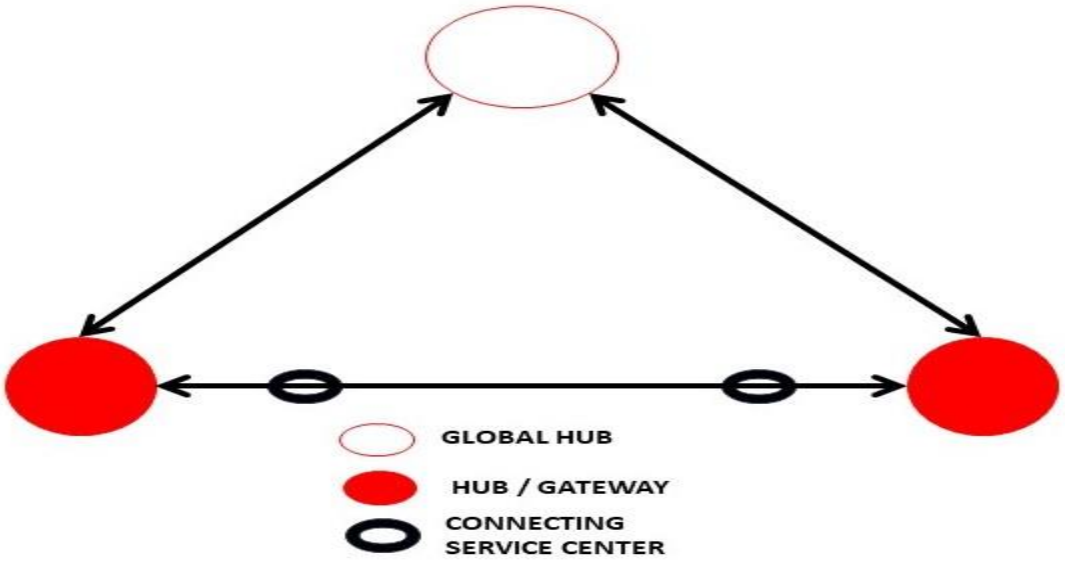
1. hub /gateway (hub)
2. service center (spoke -1)
3. service center (spoke -2)



Second layer – connecting service centers of different hub / gateways in the global hub

In the second layer of hub and spoke model optimal vehicle and optimal route are determined based on the **tonnage of shipments** in the following locations

1. global hub (hub)
2. hub / gateway (spoke -1)
3. hub / gateway (spoke -2)



Rule for determination of optimal vehicle capacity and optimal route

Step 1 - optimal vehicle capacity

Optimal vehicle capacity is determined based on the maximum capacity utilization among the vehicle capacities in each route.

- Route one
- Route two
- Route three
- Route four
- Route five
- Route six
- Route seven
- Route eight
- Route nine
- Route ten
- Route eleven
- Route twelve

Step 2 - optimal routes

Optimal route is determined based on the maximum capacity utilization from the following types of routes.

1. Two-point route
2. Three-point route
3. Four-point route

step 3 - Availability of optimal vehicle capacity at optimal route.

Check the availability of optimal vehicle capacity at the optimal route.

If optimal vehicle capacity is available at the optimal route, then end the process.

Or

If optimal vehicle capacity is not available at the optimal route, then proceed to step-4 for further process.

Step 4 - Solutions for bottleneck

If optimal vehicle capacity is not available at the optimal route, then follow the below steps.

Step 4.1 - Eliminate the vehicle capacity from the vehicle capacities of that route.

Step 4.2 - Determine the optimal vehicle capacity based on the maximum capacity utilization among the remaining vehicle capacities in that route.

Step 5 - optimal route

Optimal route is determined based on the maximum capacity utilization from the following types of routes.

1. Two-point route
2. Three-point route
3. Four-point route

Step 6 - Availability of optimal vehicle capacity

Check the availability of optimal vehicle capacity at the optimal route.

If optimal vehicle capacity is available at the optimal route, then end the process.

Or

If optimal vehicle capacity is not available at the optimal route, then proceed to step-4 for further process.

Step 1 - Optimal vehicle capacity

cost per kilometre can be decreased by selecting the optimal vehicle capacity based on the maximum capacity utilization in each route

Optimal vehicle capacity is determined based on the maximum capacity utilization among the vehicle capacities in each route.

Vehicle capacity is determined for the following types of routes based on the maximum vehicle capacity utilization.

1. Two-point route
    - Route one
    - Route two
    - Route three
    - Route four
    - Route five
    - Route six
2. Three-point route
    - Route seven
    - Route eight
    - Route nine
    - Route ten

3. Four- point route
    - Route eleven
    - Route twelve

Two-point route

Vehicle capacity is determined for the six routes in the two-point route based on maximum vehicle capacity utilization in each route.

Vehicle capacity is determined for the six routes in the two-point route by using following steps.

1. Vehicle capacity utilization is calculated for all vehicle capacities.
   Vehicle capacity utilization is calculated by dividing the **tonnage of shipments** in the route by **tonnage capacity of the vehicle.**

   Vehicle capacity utilization = tonnage of shipments / tonnage capacity of the vehicle.

    - In route one (1) calculate the vehicle capacity utilization for all the vehicle capacities
    - In route two (2) calculate the vehicle capacity utilization for all the vehicle capacities
    - In route three (3) calculate the vehicle capacity utilization for all the vehicle capacities
    - In route four (4) calculate the vehicle capacity utilization for all the vehicle capacities
    - In route five (5) calculate the vehicle capacity utilization for all the vehicle capacities
    - In route six (6) calculate the vehicle capacity utilization for all the vehicle capacities

Example:

route	tonnage of shipments	capacity utilization			
		vehicle capacity (tonnes)			
		1	4	7	10
1	0.85	85	21.25	12.14	8.50
2	4.8	OVERLOAD	OVERLOAD	68.57	48.00
3	5.7	OVERLOAD	OVERLOAD	81.43	57.00
4	4.8	OVERLOAD	OVERLOAD	68.57	48.00
5	6	OVERLOAD	OVERLOAD	85.71	60.00
6	8.2	OVERLOAD	OVERLOAD	OVERLOAD	82.00

2. Vehicle capacity with maximum capacity utilization out of all vehicle capacities in the route is selected for the movement of shipments in the route.
    - In route one (1) vehicle capacity with maximum capacity utilization out of all vehicle capacities in the route is selected for the movement of shipments in route one.
    - In route two (2) vehicle capacity with maximum capacity utilization out of all vehicle capacities in the route is selected for the movement of shipments in route two.
    - In route three (3) vehicle capacity with maximum capacity utilization out of all vehicle capacities in the route is selected for the movement of shipments in route three.
    - In route four (4) vehicle capacity with maximum capacity utilization out of all vehicle capacities in the route is selected for the movement of shipments in route four.
    - In route five (5) vehicle capacity with maximum capacity utilization out of all vehicle capacities in the route is selected for the movement of shipments in route five.
    - In route six (6) vehicle capacity with maximum capacity utilization out of all vehicle capacities in the route is selected for the movement of shipments in route six.

Example:

route	tonnage of shipments	capacity utilization				maximum capacity utilization	vehicle
		vehicle capacity (tonnes)					
		1	4	7	10		
1	0.85	85	21.25	12.14	8.50	85.00	1 tonne
2	4.8	OVERLOAD	OVERLOAD	68.57	48.00	68.57	7 tonnes
3	5.7	OVERLOAD	OVERLOAD	81.43	57.00	81.43	7 tonnes
4	4.8	OVERLOAD	OVERLOAD	68.57	48.00	68.57	7 tonnes
5	6	OVERLOAD	OVERLOAD	85.71	60.00	85.71	7 tonnes
6	8.2	OVERLOAD	OVERLOAD	OVERLOAD	82.00	82.00	10 tonnes

Three-point route

Vehicle capacity is determined for the four routes in the three-point route based on maximum vehicle capacity utilization in each route.

Vehicle capacity is determined for the four routes in the three-point route by using following steps.

1. Calculate **average tonnage of shipments** by adding the tonnage of shipments of two two-point routes and divide it by two.

   Average tonnage of shipments = tonnage of shipments in a two-point route + tonnage of shipments in a two-point route / 2

   - Average tonnage of shipments for route seven (7) is calculated by adding the tonnage of shipments in route four (4) and route six (6) and dividing it by two.
   - Average tonnage of shipments for route eight (8) is calculated by adding the tonnage of shipments in route three (3) and route five (5) and dividing it by two.
   - Average tonnage of shipments for route nine (9) is calculated by adding the tonnage of shipments in route two (2) and route five (5) and dividing it by two.
   - Average tonnage of shipments for route ten (10) is calculated by adding the tonnage of shipments in route one (1) and route six (6) and dividing it by two.

2. Vehicle capacity utilization is calculated for all vehicle capacities.
   Vehicle capacity utilization is calculated by dividing the **average tonnage of shipments** in the route by **tonnage capacity of the vehicle.**

   Vehicle capacity utilization = average tonnage of shipments / tonnage capacity of the vehicle.

   - In route seven (7) calculate the vehicle capacity utilization for all the vehicle capacities
   - In route eight (8) calculate the vehicle capacity utilization for all the vehicle capacities
   - In route nine (9) calculate the vehicle capacity utilization for all the vehicle capacities
   - In route ten (10) calculate the vehicle capacity utilization for all the vehicle capacities

Example:

			capacity utilization			
route	tonnage of shipments		vehicle capacity (tonnes)			
	two-point route		1	4	7	10
7	8.2	4.8	OVERLOAD	OVERLOAD	OVERLOAD	65
8	5.7	6	OVERLOAD	OVERLOAD	83.57142857	58.5
9	6	4.8	OVERLOAD	OVERLOAD	77.14285714	54
10	0.85	8.2	OVERLOAD	OVERLOAD	OVERLOAD	45.25

3. Vehicle capacity with maximum capacity utilization out of all vehicle capacities in the route is selected for the movement of shipments in the route.
    - In route seven (7) vehicle capacity with maximum capacity utilization out of all vehicle capacities in the route is selected for the movement of shipments in route seven.
    - In route eight (8) vehicle capacity with maximum capacity utilization out of all vehicle capacities in the route is selected for the movement of shipments in route eight.
    - In route nine (9) vehicle capacity with maximum capacity utilization out of all vehicle capacities in the route is selected for the movement of shipments in route nine.
    - In route ten (10) vehicle capacity with maximum capacity utilization out of all vehicle capacities in the route is selected for the movement of shipments in route ten.

Example:

			capacity utilization				Maximum capacity utilization	vehicle
route	tonnage of shipments		vehicle capacity (tonnes)					
	two-point route		1	4	7	10		
7	8.2	4.8	OVERLOAD	OVERLOAD	OVERLOAD	65	65.00	10 tonnes
8	5.7	6	OVERLOAD	OVERLOAD	83.57	58.5	83.57	7 tonnes
9	6	4.8	OVERLOAD	OVERLOAD	77.14	54	77.14	7 tonnes
10	0.85	8.2	OVERLOAD	OVERLOAD	OVERLOAD	45.25	45.25	10 tonnes

Four-point route

Vehicle capacity is determined for the two routes in the four-point route based on maximum vehicle capacity utilization in each route.

Vehicle capacity is determined for the two routes in the four-point route by using following steps.

1. Calculate average **tonnage of shipments** by adding the tonnage of shipments of three two-point routes and divide it by three.

    Average tonnage of shipments = tonnage of shipments in a two-point route + tonnage of shipments in a two-point route + tonnage of shipments in a two-point route / 3

    - Average tonnage of shipments for route eleven (11) is calculated by adding the tonnage of shipments in route one (1), route four (4) and route six (6) and dividing it by three.
    - Average tonnage of shipments for route twelve (12) is calculated by adding the tonnage of shipments in route two (2), route three (3) and route five (5) and dividing it by three.

2. Vehicle capacity utilization is calculated for all vehicle capacities.
    Vehicle capacity utilization is calculated by dividing the **average tonnage of shipments** in the route by **tonnage capacity of the vehicle.**

Vehicle capacity utilization = average tonnage of shipments / tonnage capacity of the vehicle.

- In route eleven 11) calculate the vehicle capacity utilization for all the vehicle capacities.
- In route twelve (12) calculate the vehicle capacity utilization for all the vehicle capacities.

Example:

route	tonnage of shipments: two-point route			capacity utilization: vehicle capacity (tonnes) 1	4	7	10
11	0.85	8.2	4.8	OVERLOAD	OVERLOAD	OVERLOAD	46.17
12	4.8	6	5.7	OVERLOAD	OVERLOAD	78.57	55

3. Vehicle capacity with maximum capacity utilization out of all vehicle capacities in the route is selected for the movement of shipments in the route.
    - In route eleven (11) vehicle capacity with maximum capacity utilization out of all vehicle capacities in the route is selected for the movement of shipments in route eleven.
    - In route twelve (12) vehicle capacity with maximum capacity utilization out of all vehicle capacities in the route is selected for the movement of shipments in route twelve.

Example:

route	tonnage of shipments: two-point route			capacity utilization: vehicle capacity (tonnes) 1	4	7	10	Maximum capacity utilization	vehicle
11	0.85	8.2	4.8	OVERLOAD	OVERLOAD	OVERLOAD	46.17	46.17	10 tonne
12	4.8	6	5.7	OVERLOAD	OVERLOAD	78.57	55	78.57	7 tonne

Step 2 - Optimal Route

Tonne-kilometres can be increased by selecting the optimal route based on the maximum capacity utilization.

Optimal route is determined based on the maximum capacity utilization from the following types of routes.

1. **Two-point route**
2. **Three-point route**
3. **Four- point route**

Relationship between the types of routes

Four-point route vs three-point route

Each four-point route will have two three-point routes in it.

Four-point route type have following two routes

1. Route eleven (11)
   Route eleven (11) have two three-point routes
   - route seven (7)
   - route ten (10)
2. Route twelve (12)
   Route twelve (12) have two three-point routes
   - Route eight (8)
   - Route nine (9)

Four-point route vs two-point route

Each four-point route will have three two-point routes in it.

Four-point route type have following two routes

1. Route eleven (11)
   Route eleven (11) have three two-point routes
   - Route one (1)
   - Route four (4)
   - Route six (6)
2. Route twelve (12)
   Route twelve (12) have three two-point routes
   - Route two (2)
   - Route three (3)
   - Route five (5)

Grouping of routes

Based on the relationship between the following types of routes

1. Four-point route
2. Three-point route
3. Two-point route

routes in each type of route are categorised in to two groups.

1. Four-point route
   - Group-1
     Route eleven (11)
   - Group-2
     Route twelve (12)

2. Three-point route
    - Group-1
      Route seven (7) & Route ten (10)
    - Group-2
      Route eight (8) & Route nine (9)
3. Two-point route
    - Group-1
      Route one (1) & Route four (4) & Route six (6)
    - Group-2
      Route two (2) & route three (3) & route five (5)

Determination of maximum capacity utilization

Maximum capacity utilization is determined from the capacity utilization of each type of routes for both the groups in the following manner.

Group – 1

Step 1 – capacity utilization of route eleven (11) is taken for **four-point route.**

Step 2 – average capacity utilization of route seven (7) & route ten (10) is taken for **three-point route**

Step 3 – average capacity utilization of route one (1) & route four (4) & route six (6) is taken for **two-point route.**

Step 4 – Route with maximum capacity utilization from the following types of routes is selected.

1. Two-point route
2. Three-point route
3. Four-point route

Group -2

Step 1 – capacity utilization of route twelve (12) is taken for **four-point route.**

Step 2 – average capacity utilization of route eight (8) & route nine (9) is taken for **three-point route**

Step 3 – average capacity utilization of route two (2) & route three (3) & route five (5) is taken for **two- point route.**

Step 4 – Route with maximum capacity utilization from the following types of routes is selected.

1. Two-point route
2. Three-point route
3. Four-point route

Example:

four-point route			
Groups	four-point route	capacity utilization	vehicle capacity
group-1	11	46.16666667	10 tonnes
group-2	12	78.57142857	7 tonnes

Three-point route			
Groups	three-point route	capacity utilization	vehicle capacity
group-1	7 & 10	55.13	10 tonnes & 10 tonnes
group-2	8 & 9	80.36	7 tonnes & 7 tonnes

Two-point route			
Groups	Two-point route	capacity utilization	vehicle capacity
group-1	1 & 4 & 6	78.52	1 tonnes & 7 tonnes & 10 tonnes
group-2	2 & 3 & 5	78.57	7 tonnes & 7 tonnes & 7 tonnes

decision				
Groups	**route type**	**Optimal Route**	**capacity utilization**	**Optimal vehicle capacity**
group-1	**two-point route**	**1 & 4 & 6**	**78.52**	**1 tonnes & 7 tonnes & 10 tonnes**
group-2	**three-point route**	**8 & 9**	**80.36**	**7 tonnes & 7 tonnes**

step 3 - Availability of optimal vehicle capacity at optimal route

Check the availability of optimal vehicle capacity at the optimal route.

Two-point route

1. In route one (1) optimal vehicle capacity should be available at the hub
2. In route two (2) optimal vehicle capacity should be available at the spoke -1
3. In route three (3) optimal vehicle capacity should be available at the hub
4. In route four (4) optimal vehicle capacity should be available at the spoke -2
5. In route five (5) optimal vehicle capacity should be available at the spoke -2
6. In route six (6) optimal vehicle capacity should be available at the spoke -1

Three-point route

7. In route seven (7) optimal vehicle capacity should be available at the spoke -1
8. In route eight (8) optimal vehicle capacity should be available at the hub
9. In route nine (9) optimal vehicle capacity should be available at the spoke -2
10. In route ten (10) optimal vehicle capacity should be available at the hub

Four-point route

11. In route eleven (11) optimal vehicle capacity should be available at any one of the following locations.
    - hub
    - spoke -1
    - spoke -2
12. In route twelve (12) optimal vehicle capacity should be available at any one of the following locations.
    - Hub
    - spoke -1
    - spoke -2

If optimal vehicle capacity is available at the optimal route, then end the process.

Or

If optimal vehicle capacity is not available at the optimal route, then proceed to step-4 for further process.

Step 4 - solutions for bottleneck

If optimal vehicle capacity is not available at the optimal route, then follow the below steps.

Step 4.1 - Eliminate the vehicle capacity from the vehicle capacities of that route.

Example:

route	tonnage of shipments	capacity utilization			
		vehicle capacity (tonnes)			
		1	4	7	10
1	0.85	85	21.25	12.14	8.50
2	4.8	OVERLOAD	OVERLOAD	68.57	48.00
3	5.7	OVERLOAD	OVERLOAD	81.43	57.00
4	**4.8**	**OVERLOAD**	**OVERLOAD**	**NOT AVAILABLE**	**48.00**
5	6	OVERLOAD	OVERLOAD	85.71	60.00
6	8.2	OVERLOAD	OVERLOAD	OVERLOAD	82.00

Step 4.2 - Determine the optimal vehicle capacity based on the maximum capacity utilization among the remaining vehicle capacities in that route.

Example:

route	tonnage of shipments	capacity utilization				max capacity utilization	optimal vehicle capacity
		vehicle capacity (tonnes)					
		1	4	7	10		
1	0.85	85	21.25	12.14	8.50	85.00	1 tonne
2	4.8	OVERLOAD	OVERLOAD	68.57	48.00	68.57	7 tonne
3	5.7	OVERLOAD	OVERLOAD	81.43	57.00	81.43	7 tonne
4	**4.8**	**OVERLOAD**	**OVERLOAD**	**NOT AVAILABLE**	**48.00**	**48.00**	**10 tonne**
5	6	OVERLOAD	OVERLOAD	85.71	60.00	85.71	7 tonne
6	8.2	OVERLOAD	OVERLOAD	OVERLOAD	82.00	82.00	10 tonne

Step 5 - optimal route

Optimal route is determined based on the maximum capacity utilization from the following types of routes.

1. Two-point route
2. Three-point route
3. Four-point route

Relationship between the types of routes

Four-point route vs three-point route

Each four-point route will have two three-point routes in it.

Four-point route type have following two routes

1. Route eleven (11)
   Route eleven (11) have two three-point routes
   - route seven (7)
   - route ten (10)
2. Route twelve (12)
   Route twelve (12) have two three-point routes
   - Route eight (8)
   - Route nine (9)

Four-point route vs two-point route

Each four-point route will have three two-point routes in it.

Four-point route type have following two routes

1. Route eleven (11)
   Route eleven (11) have three two-point routes
   - Route one (1)
   - Route four (4)
   - Route six (6)
2. Route twelve (12)
   Route twelve (12) have three two-point routes
   - Route two (2)
   - Route three (3)
   - Route five (5)

Grouping of routes

Based on the relationship between the following types of routes

1. Four-point route
2. Three-point route
3. Two-point route

routes in each type of route are categorised in to two groups.

1. Four-point route
   - Group-1
     Route eleven (11)
   - Group-2
     Route twelve (12)
2. Three-point route
   - Group-1
     Route seven (7) & Route ten (10)
   - Group-2
     Route eight (8) & Route nine (9)
3. Two-point route
   - Group-1
     Route one (1) & Route four (4) & Route six (6)
   - Group-2
     Route two (2) & route three (3) & route five (5)

Determination of maximum capacity utilization

Maximum capacity utilization is determined from the capacity utilization of each type of routes for both the groups in the following manner.

Group – 1

Step 1 – capacity utilization of route eleven (11) is taken for **four-point route.**

Step 2 – average capacity utilization of route seven (7) & route ten (10) is taken for **three-point route**

Step 3 – average capacity utilization of route one (1) & route four (4) & route six (6) is taken for **two-point route.**

Step 4 – optimal Route is determined based on the maximum capacity utilization from the following types of routes

1. Two-point route
2. Three-point route
3. Four-point route

Group -2

Step 1 – capacity utilization of route twelve (12) is taken for **four-point route.**

Step 2 – average capacity utilization of route eight (8) & route nine (9) is taken for **three-point route**

Step 3 – average capacity utilization of route two (2) & route three (3) & route five (5) is taken for **two- point route.**

Step 4 – optimal Route is determined based on the maximum capacity utilization from the following types of routes

1. Two-point route
2. Three-point route
3. Four-point route

Example:

four-point route			
Groups	four-point route	capacity utilization	vehicle capacity
group-1	11	46.17	10 tonnes
group-2	12	78.57142857	7 tonnes

Three-point route			
Groups	three-point route	capacity utilization	vehicle capacity
group-1	7 & 10	55.13	10 tonne & 10 tonnes
group-2	8 & 9	80.36	7 tonne & 7 tonnes

two-point route			
Groups	two-point route	capacity utilization	vehicle capacity
group-1	1 & 4 & 6	71.67	1 tonne & 10 tonne & 10 tonnes
group-2	2 & 3 & 5	78.57	7 tonne & 7 tonnes & 7 tonnes

Decision				
Groups	**route type**	**Optimal route**	**capacity utilization**	**Optimal vehicle capacity**
group-1	**two-point route**	**1 & 4 & 6**	**78.52**	**1 tonne & 10 tonne & 10 tonnes**
group-2	**three-point route**	**8 & 9**	**80.36**	**7 tonne & 7 tonnes**

Step 6 - Availability of optimal vehicle capacity at optimal route

Check the availability of optimal vehicle capacity at the optimal route.

Two-point route

1. In route one (1) optimal vehicle capacity should be available at the hub
2. In route two (2) optimal vehicle capacity should be available at the spoke -1
3. In route three (3) optimal vehicle capacity should be available at the hub
4. In route four (4) optimal vehicle capacity should be available at the spoke -2
5. In route five (5) optimal vehicle capacity should be available at the spoke -2
6. In route six (6) optimal vehicle capacity should be available at the spoke -1

Three-point route

7. In route seven (7) optimal vehicle capacity should be available at the spoke -1
8. In route eight (8) optimal vehicle capacity should be available at the hub
9. In route nine (9) optimal vehicle capacity should be available at the spoke -2
10. In route ten (10) optimal vehicle capacity should be available at the hub

Four-point route

11. In route eleven (11) optimal vehicle capacity should be available at any one of the following locations.
    - hub
    - spoke -1
    - spoke -2
12. In route twelve (12) optimal vehicle capacity should be available at any one of the following locations.
    - Hub
    - spoke -1
    - spoke -2

If optimal vehicle capacity is available at the optimal route, then end the process.

Or

If optimal vehicle capacity is not available at the optimal route, then proceed to step-4 for further process.

CONCLUSION

A company in an economy can act in the favour of following external factors

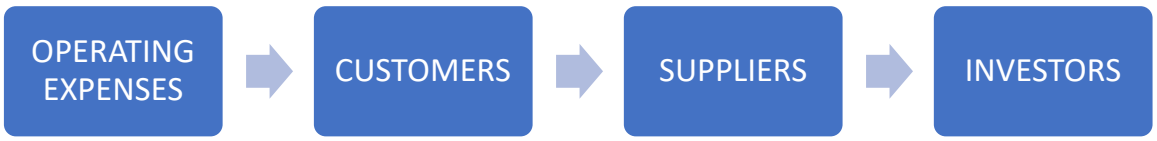
1. **customers**
2. **suppliers**
3. **investors**

by controlling the internal factor **employees and operations process** of the company.

The benefit of **decrease in operating expenses** generated by the internal factor **employees and operation process** should be transferred to external factors in following order

1. Customers
2. Suppliers
3. Investors

To create the additional benefits at each stage of transfer.



**** THE END ****