CSE 4125: Distributed Database Systems
Chapter – 6

Optimization of Access Strategies.

(part – B)

Outline

- Importance of Query Optimization in DDB (with Examples).

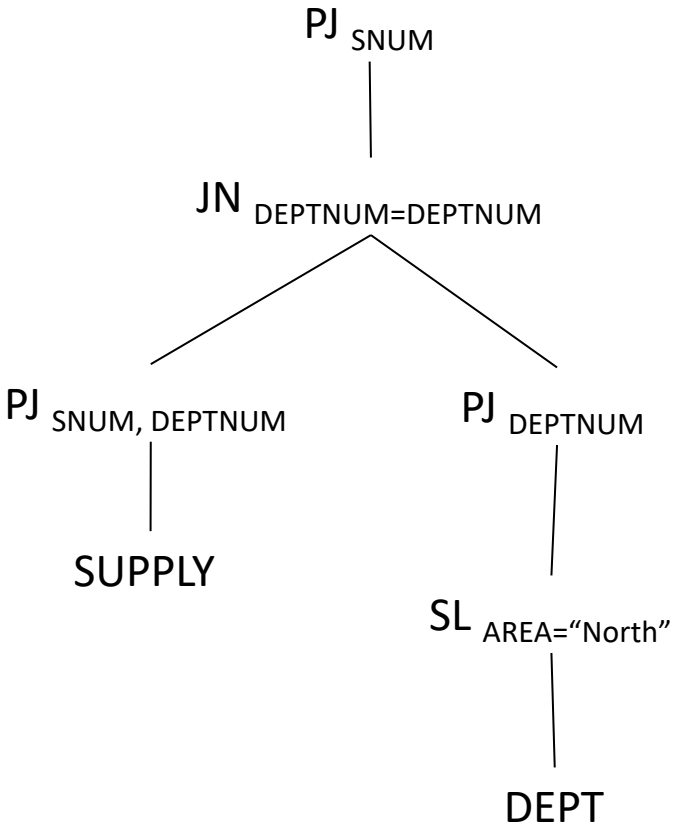
Importance of Query Optimization in DDB (with Examples)

Comparison between different strategies

- We will see different versions of a query.
- Measure their cost and delay to see which one is better.

Given Scenario

Input Query:



Given Scenario (contd.)

- **Profiles of $SUPPLY_1$ and $SUPPLY_2$:**

card ($SUPPLY_1$) = 30000
card ($SUPPLY_2$) = 20000

site($SUPPLY_1$) = 1
site($SUPPLY_2$) = 4

	snum	pnum	deptnum	quan
size	6	7	2	10
val	1800	1000	20	500

- **Profiles of $DEPT_1$, $DEPT_2$ and $DEPT_3$:**

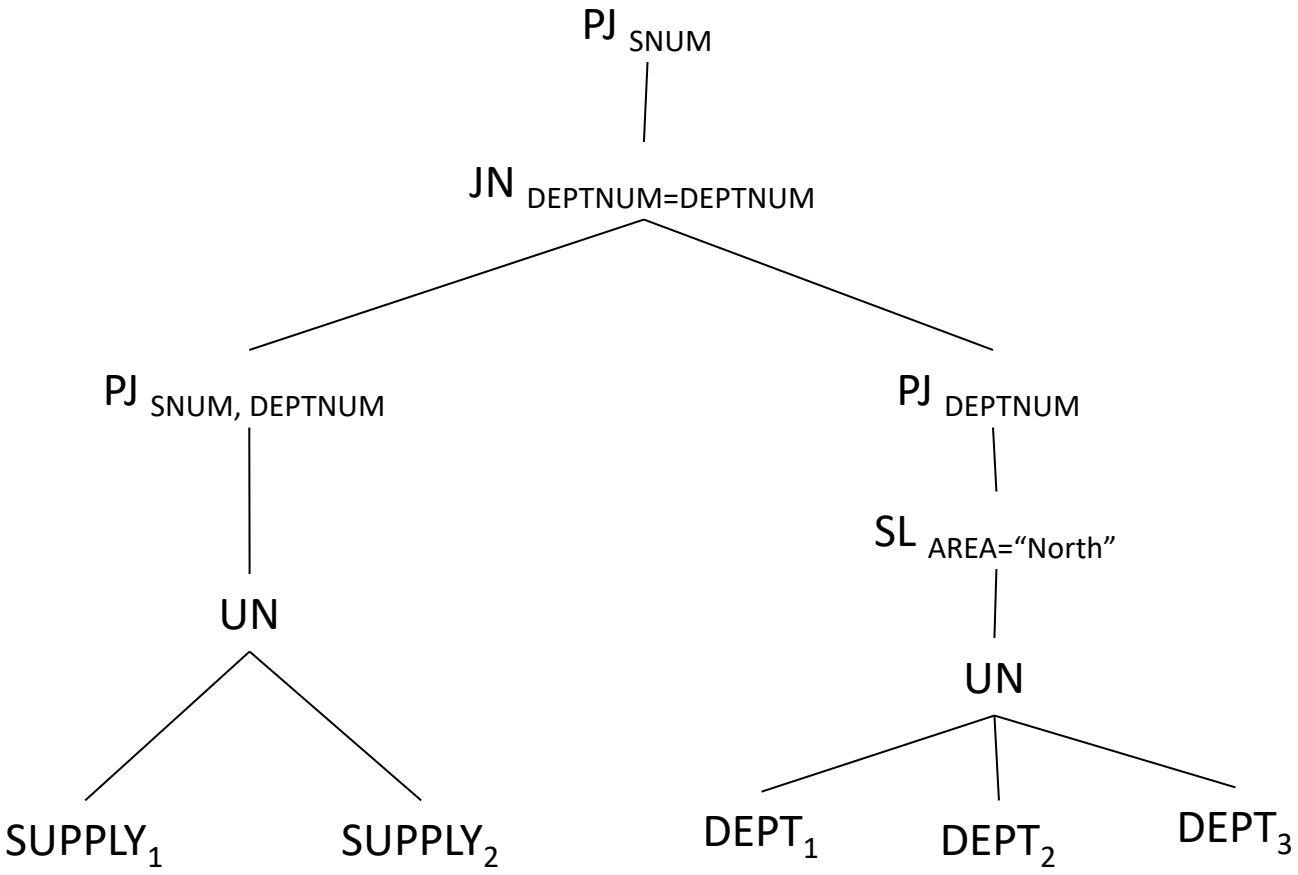
card ($DEPT_1$) = 10
card ($DEPT_2$) = card ($DEPT_3$) = 20

site($DEPT_1$) = 2
site($DEPT_2$) = 3
site($DEPT_3$) = 5

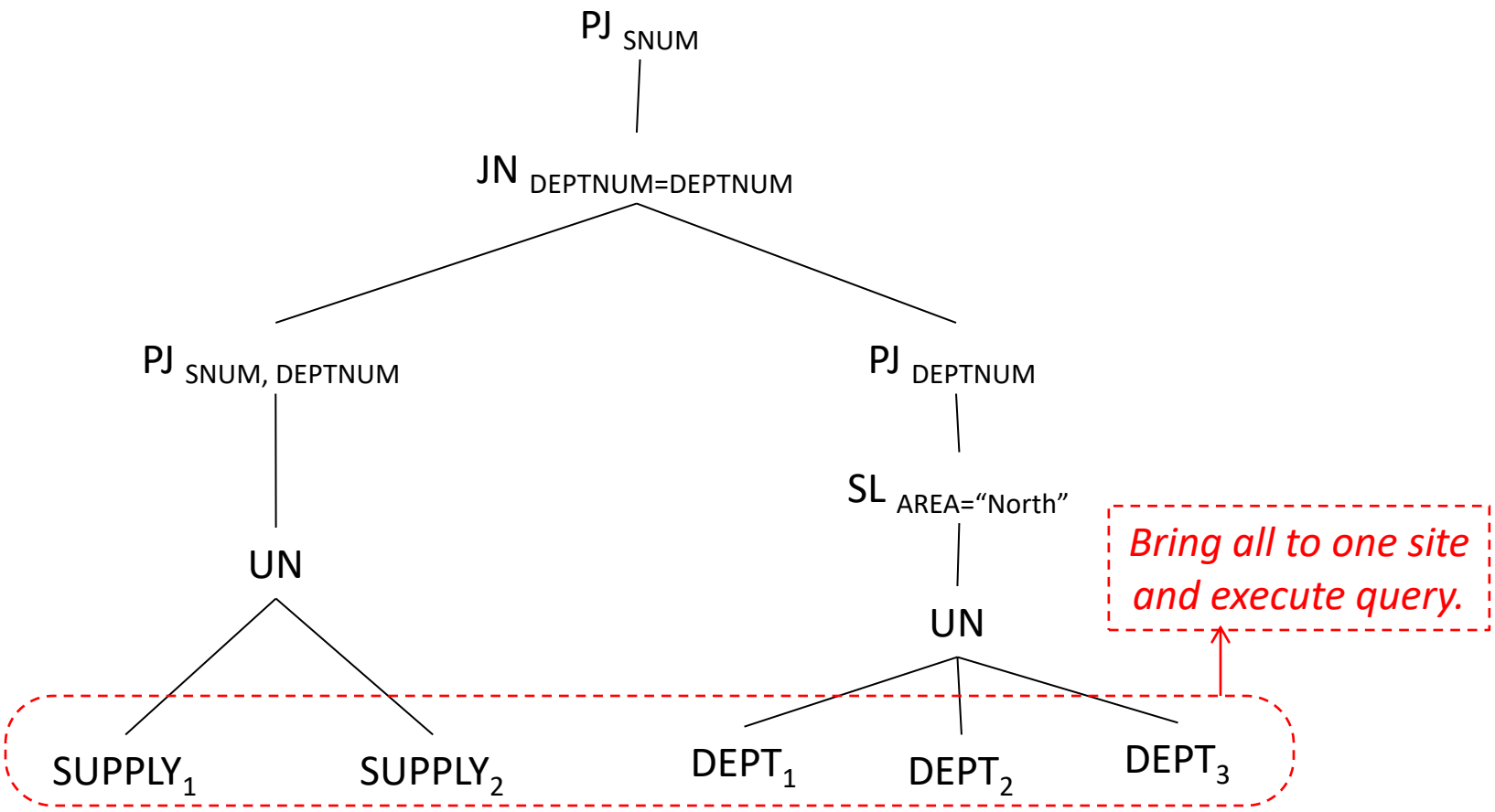
	deptnum	name	area	mgrnum
size	2	15	1	7
val	10	10	2	10

Strategy - 1

Strategy – 1


PJ SNUM
JN DEPTNUM=DEPTNUM
PJ SNUM, DEPTNUM
PJ DEPTNUM
SL AREA="North"
UN
UN
SUPPLY1
SUPPLY2
DEPT1
DEPT2
DEPT3

Strategy – 1 (contd.)



Strategy – 1 (contd.)

- Let us execute the query at site 2.
  - We need to collect all the fragments there (assume in parallel).

Strategy – 1 (contd.)

- Let us execute the query at site 2.
  - We need to collect all the fragments there (assume in parallel).
- Transmitted amount:

$X_{SUPPLY1}$ = ?

card ($SUPPLY_1$) = 30000

	snum	pnum	deptnum	quan
size	6	7	2	10
val	1800	1000	20	500

Strategy – 1 (contd.)

- Let us execute the query at site 2.
  - We need to collect all the fragments there (assume in parallel).
- Transmitted amount:

$X_{SUPPLY1}$ = card($SUPPLY_1$)*size($SUPPLY_1$)*8 bits

= 30000*(6+7+2+10)*8 bits

= 30000*25*8 bits

= 6000000 bits

Strategy – 1 (contd.)

- Transmitted amount for other fragments:

$X_{SUPPLY2}$ = ?

X_{DEPT1} = ?

X_{DEPT2} = ?

X_{DEPT3} = ?

card ($SUPPLY_2$) = 20000

	snum	pnum	deptnum	quan
size	6	7	2	10
val	1800	1000	20	500

card ($DEPT_1$) = 10
card ($DEPT_2$) = card ($DEPT_3$) = 20

	deptnum	name	area	mgrnum
size	2	15	1	7
val	10	10	2	10

Strategy – 1 (contd.)

- Transmitted amount for other fragments:

$X_{SUPPLY2}$ = 20000*25*8 bits = 4000000 bits

X_{DEPT1} = 0 bits

X_{DEPT2} = 10*25*8 bits = 2000 bits

X_{DEPT3} = 10*25*8 bits = 2000 bits

Strategy – 1 (contd.)

Assume $C_0 = 0$ and $D_0 = 0$

- TC(x) = ?
- TD(x) = ?

Strategy – 1 (contd.)

Assume $C_0 = 0$ and $D_0 = 0$

- $TC(x) = C_0 + (\text{sum of all the amount}) * C_1$

  $= (X_{SUPPLY1}+\ldots+X_{DEPT3})*C_1 = 10004000*C_1$
- $TD(x) = ?$

Strategy – 1 (contd.)

Assume $C_0 = 0$ and $D_0 = 0$

- $TC(x) = C_0 + (\text{sum of all the amount}) * C_1$
  $= (X_{SUPPLY1}+\ldots+X_{DEPT3})*C_1 = 10004000*C_1$
- $TD(x) = D_0 + (\text{largest amount}) * D_1$
  $= 6000000*D_1$

Strategy – 1 (contd.)

Assume $C_0 = 0$ and $D_0 = 0$

- $TC(x) = C_0 + (\text{sum of all the amount}) * C_1$
  $= 10004000 * C_1$
- $TD(x) = D_0 + (\text{largest amount}) * D_1$
  $= 6000000 * D_1$

If $D_1 = 10000$ bit/second,

Transmission Delay = ? minutes

Strategy – 1 (contd.)

Assume $C_0 = 0$ and $D_0 = 0$

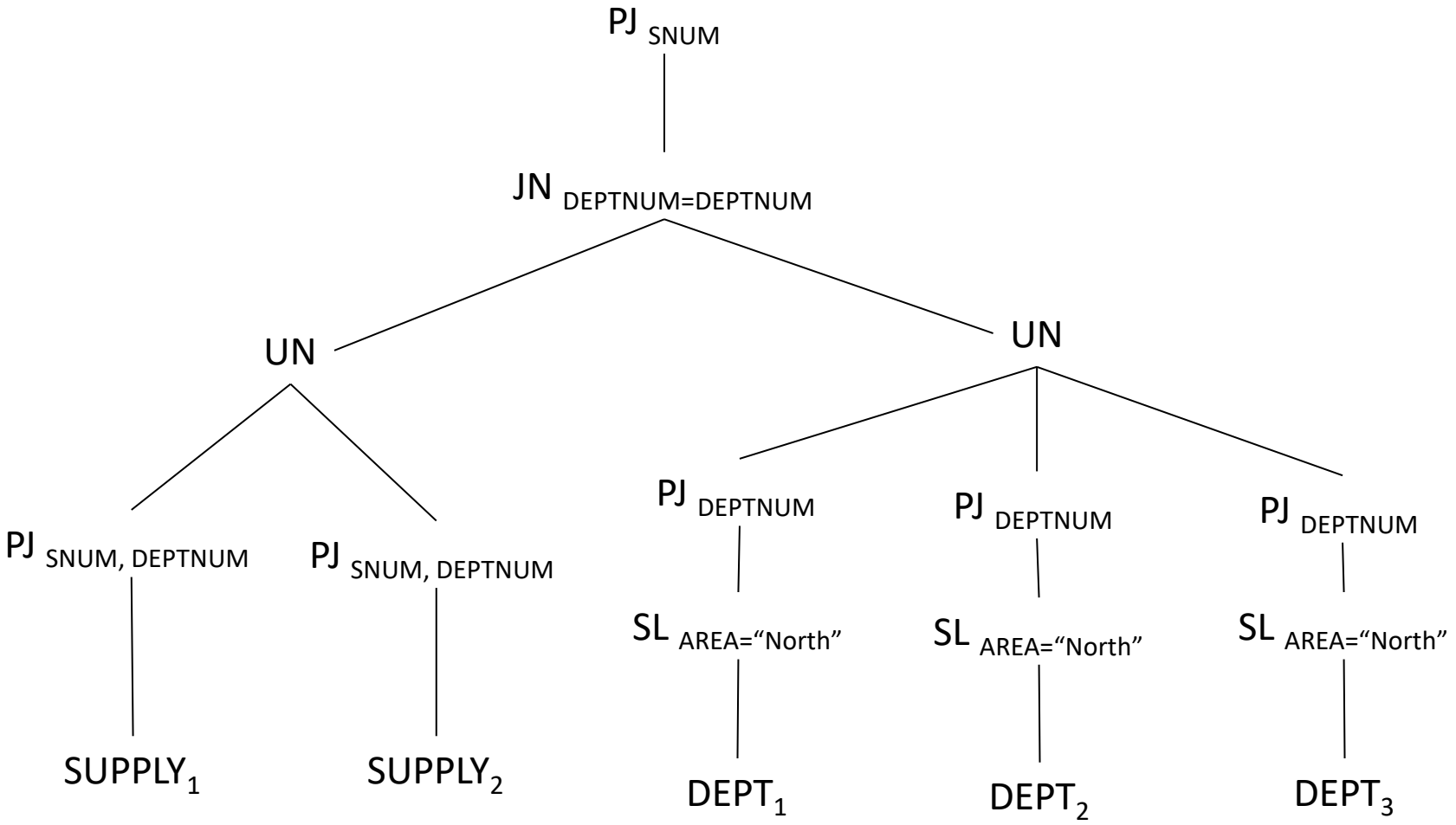
- $TC(x) = C_0 + (\text{sum of all the amount}) * C_1$
  $= 10004000 * C_1$
- $TD(x) = D_0 + (\text{largest amount}) * D_1$
  $= 6000000 * D_1$

If $D_1 = 10000$ bit/second,

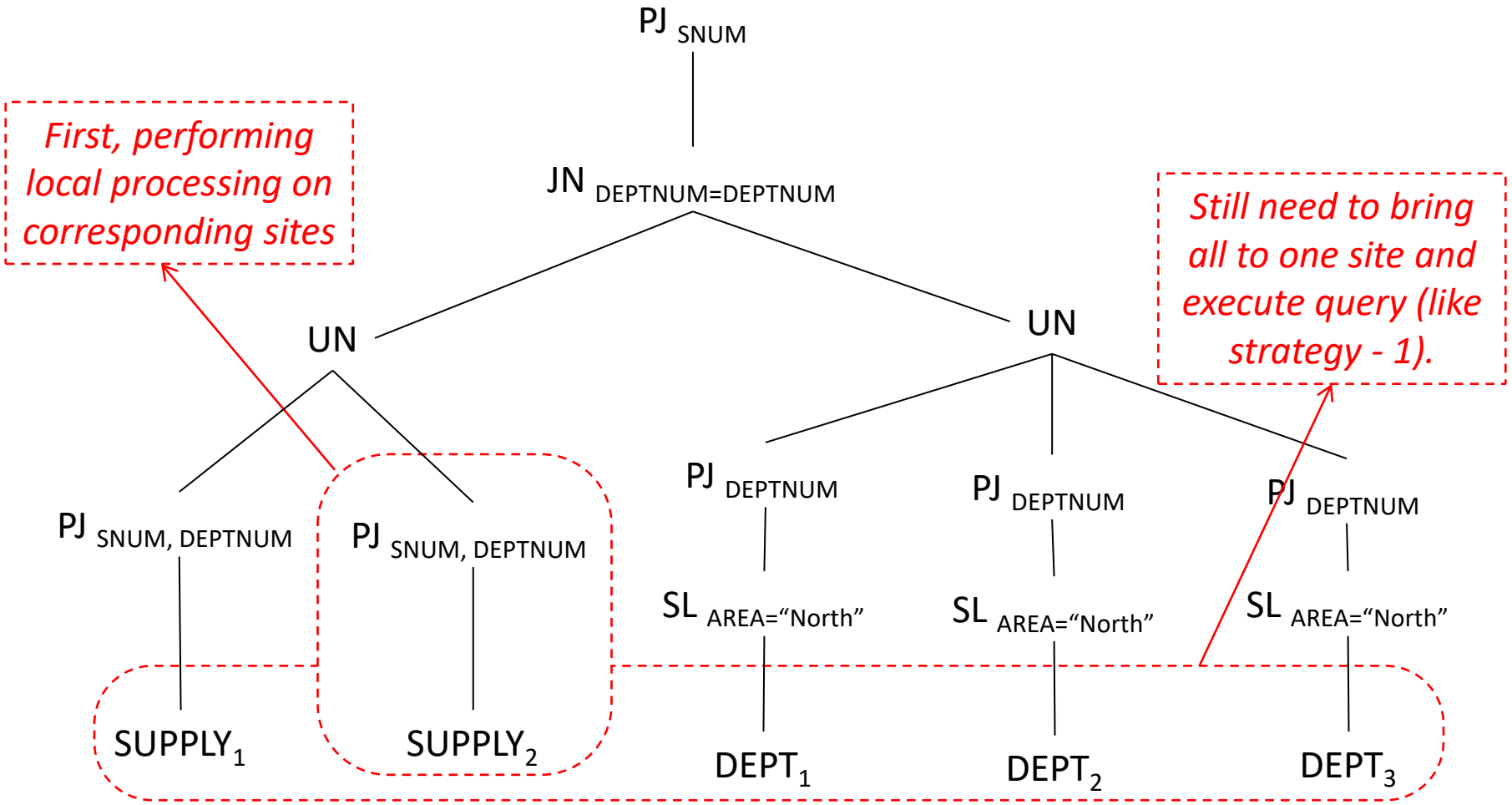
Transmission Delay = $6000000 * \frac{1}{10000}$ s = 600 s = 10 mins

Strategy - 2

Strategy – 2


PJ SNUM
JN DEPTNUM=DEPTNUM
UN
UN
PJ SNUM, DEPTNUM
PJ SNUM, DEPTNUM
PJ DEPTNUM
PJ DEPTNUM
PJ DEPTNUM
SL AREA="North"
SL AREA="North"
SL AREA="North"
SUPPLY1
SUPPLY2
DEPT1
DEPT2
DEPT3

Strategy – 2 (contd.)



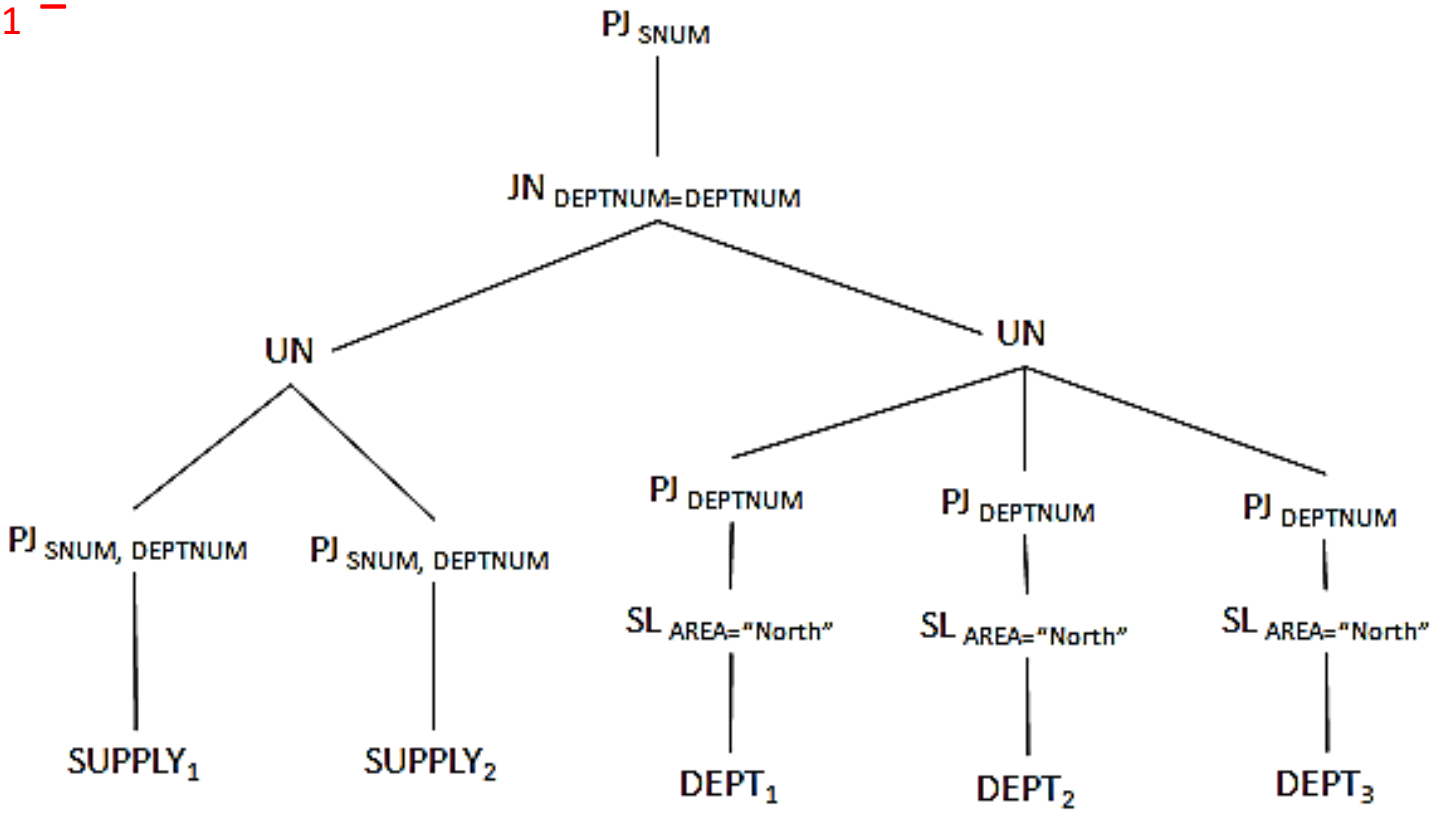
Strategy – 2 (contd.)

- Performing local processing on fragments.
  - Fragment reducers.
- Then sending reduced fragments to the executing site (i.e. site - 2) in parallel.

Strategy – 2 (contd.)

- Transmitted amount:

$X_{SUPPLY1}$ =



Strategy – 2 (contd.)

- Transmitted amount:

$X_{SUPPLY1}$ = card($SUPPLY_1$)* {size(*snum*) + size(*deptnum*)} * 8 bits

= 30000*(6+2)*8 bits

= 1920000 bits

Strategy – 2 (contd.)

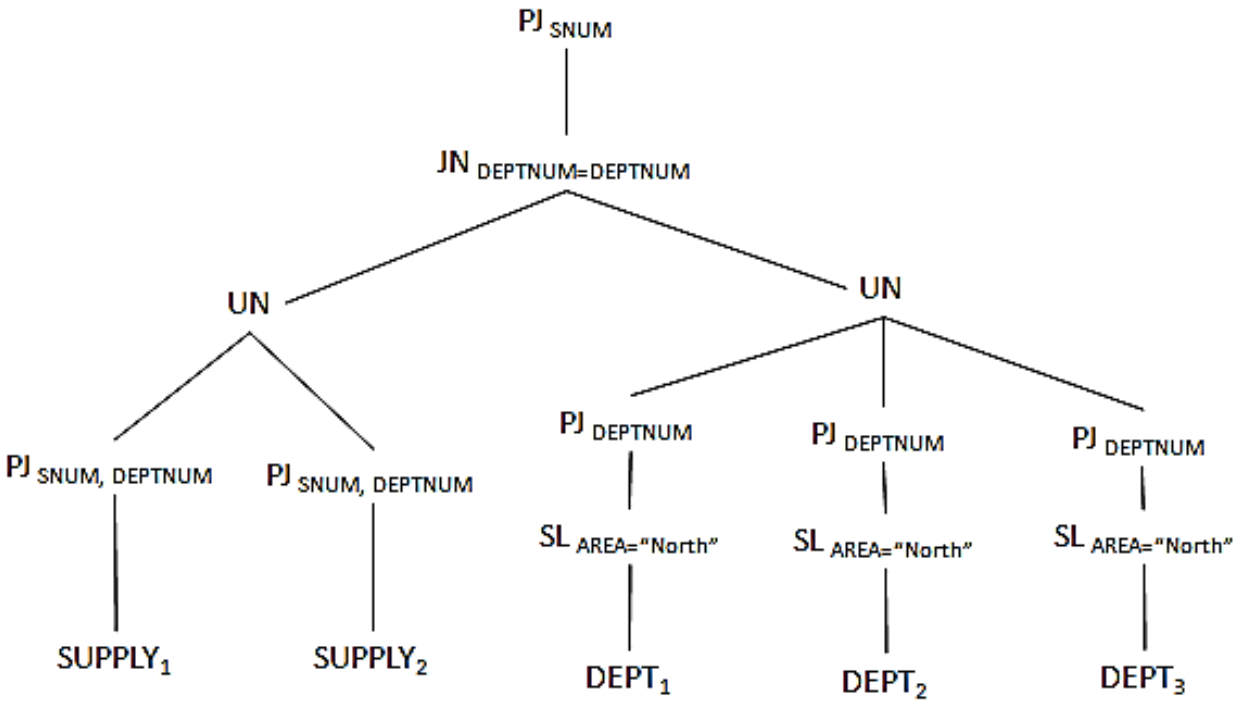
- Transmitted amount for other fragments:

$X_{SUPPLY2}$ = ?

X_{DEPT1} = ?

X_{DEPT2} = ?

X_{DEPT3} = ?



Strategy – 2 (contd.)

- Transmitted amount for other fragments:

$X_{SUPPLY2}$ = 20000*8*8 bits = 1280000 bits

X_{DEPT1} = 0 bits

$X_{DEPT2} \approx 0$ bits Try to investigate why

$X_{DEPT3} = X_{DEPT2} \approx 0$ bits

card ($DEPT_1$) = 10
card ($DEPT_2$) = card ($DEPT_3$) = 20

	deptnum	name	area	mgrnum
size	2	15	1	7
val	10	10	2	10

Strategy – 2 (contd.)

Assume $C_0 = 0$ and $D_0 = 0$

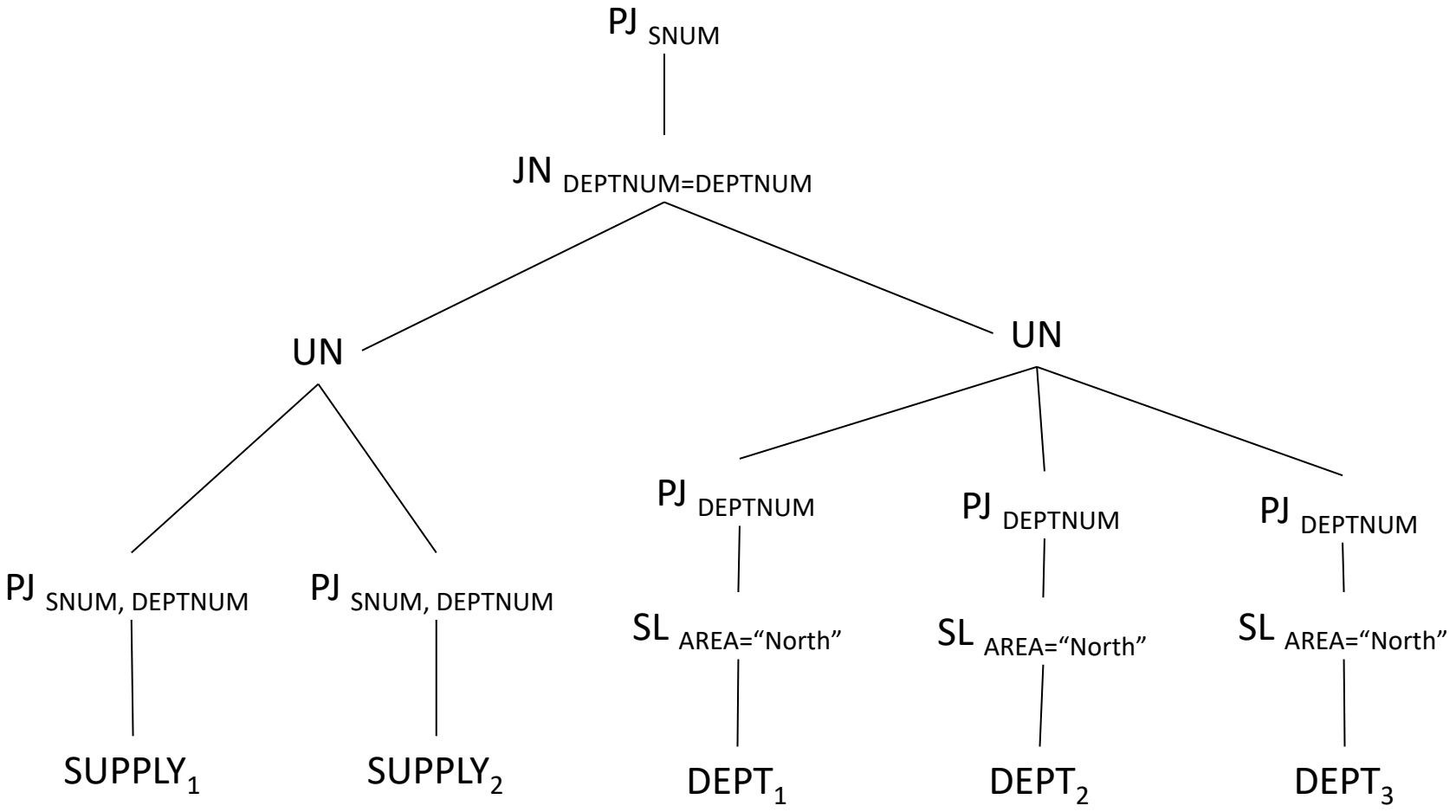
- TC(x) = C_0 + (sum of all the amount) * C_1
  = 320000*C_1
- TD(x) = D_0+ (largest amount) *D_1
  = 1920000*D_1

If D_1 = 10000 bit/second,

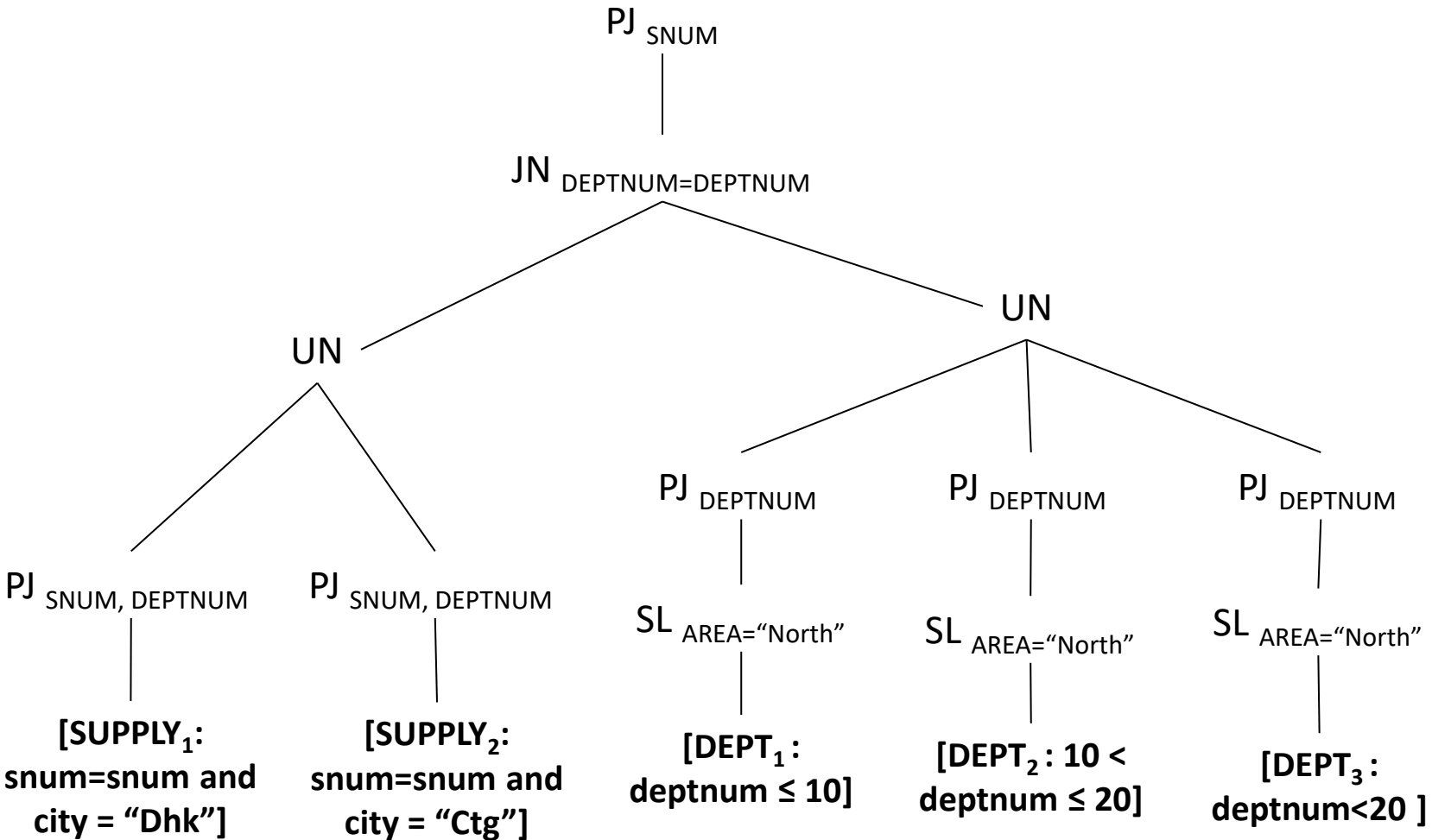
Transmission Delay = $1920000*\frac{1}{10000}$s = 192 s≈ 3 mins

Strategy - 3

Strategy – 3


PJ SNUM
JN DEPTNUM=DEPTNUM
UN
UN
PJ SNUM, DEPTNUM
PJ SNUM, DEPTNUM
PJ DEPTNUM
PJ DEPTNUM
PJ DEPTNUM
SL AREA="North"
SL AREA="North"
SL AREA="North"
SUPPLY1
SUPPLY2
DEPT1
DEPT2
DEPT3

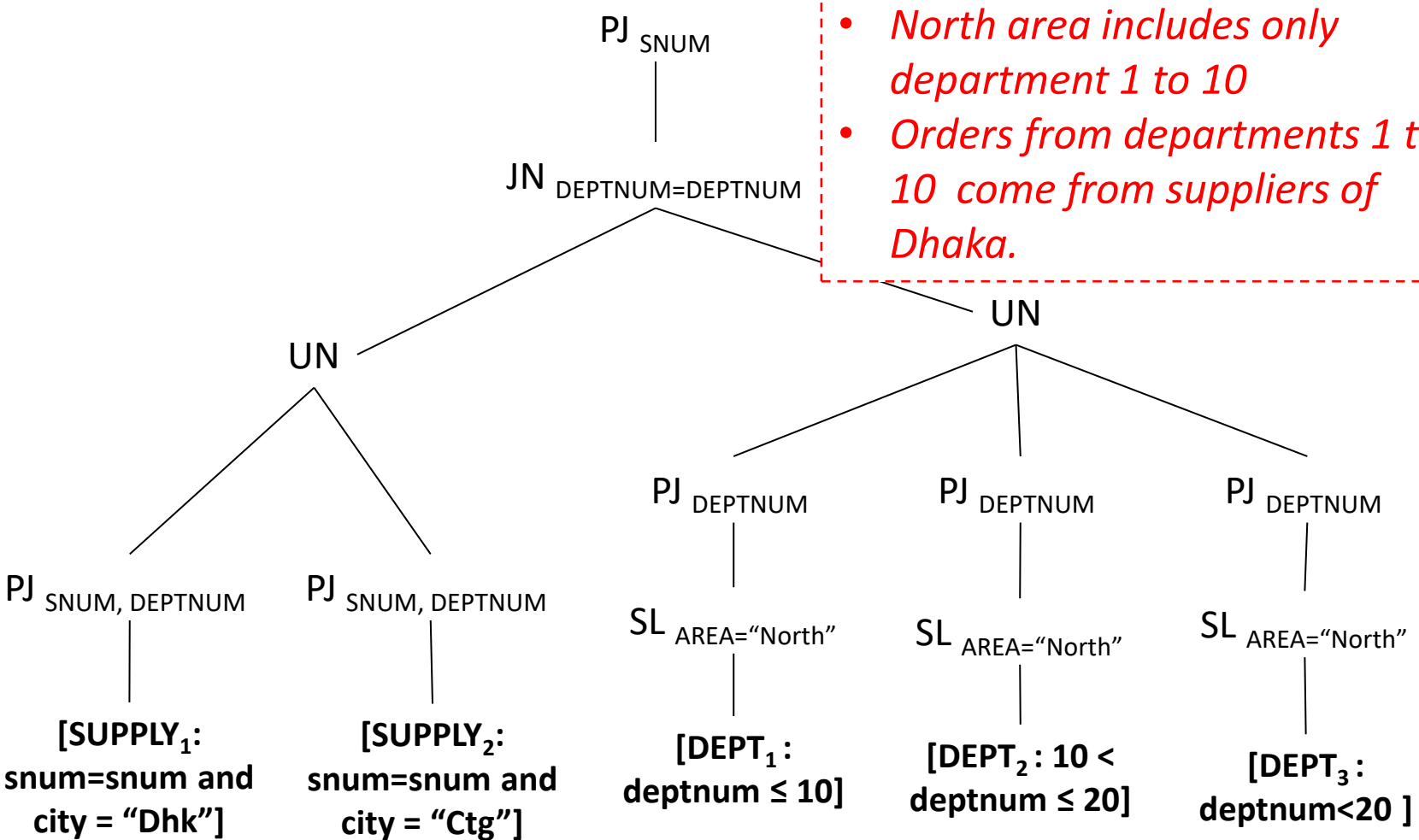
Strategy – 3 (contd.)



Strategy – 3 (contd.)

Assume –

- *North area includes only department 1 to 10*
- *Orders from departments 1 to 10 come from suppliers of Dhaka.*



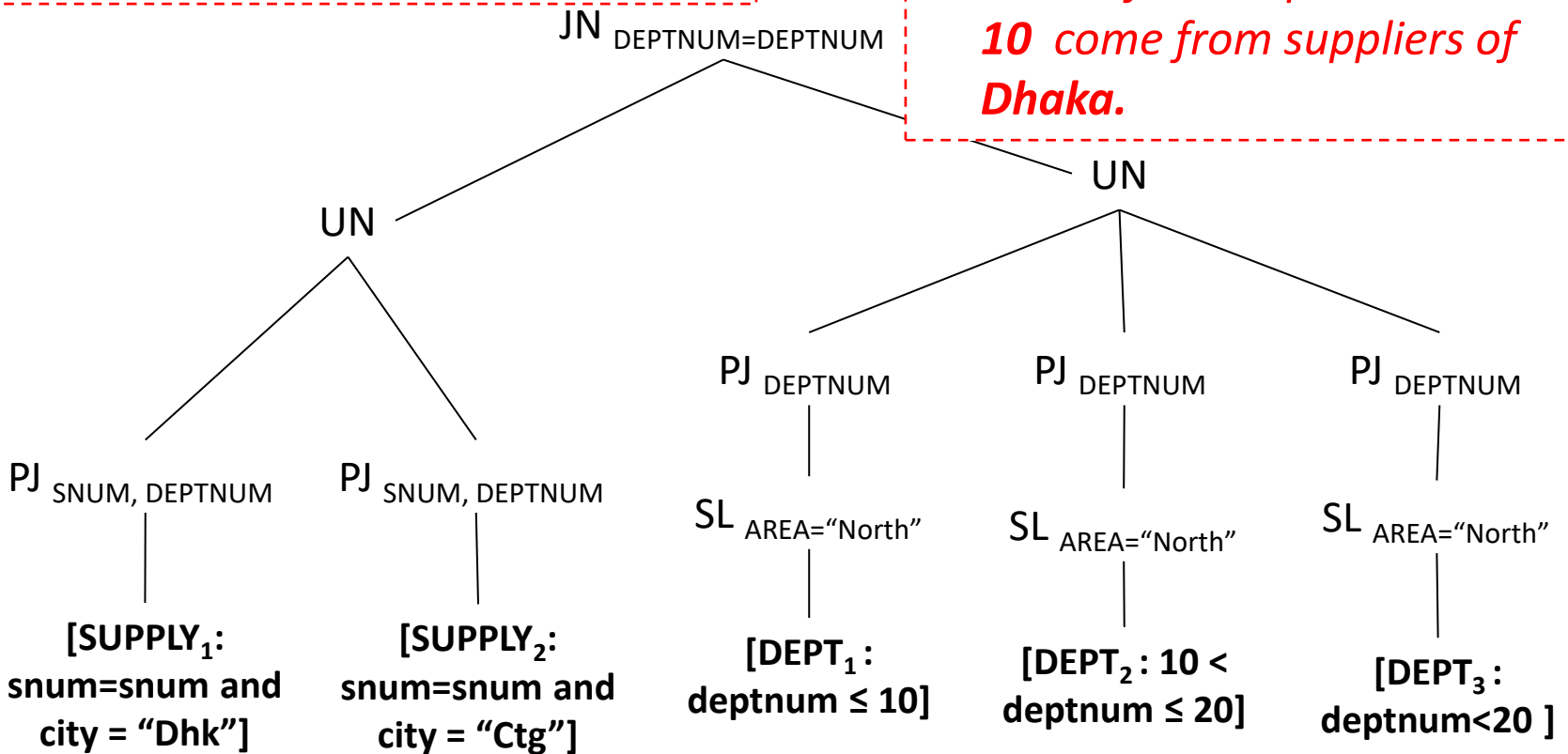
Strategy – 3 (contd.)

Which implies –

- area = "North" → deptnum ≤ 10
- deptnum ≤ 10 → snum = snum and city = "Dhaka"

Assume –

- *North area includes only department **1 to 10***
- *Orders from departments **1 to 10** come from suppliers of **Dhaka.***



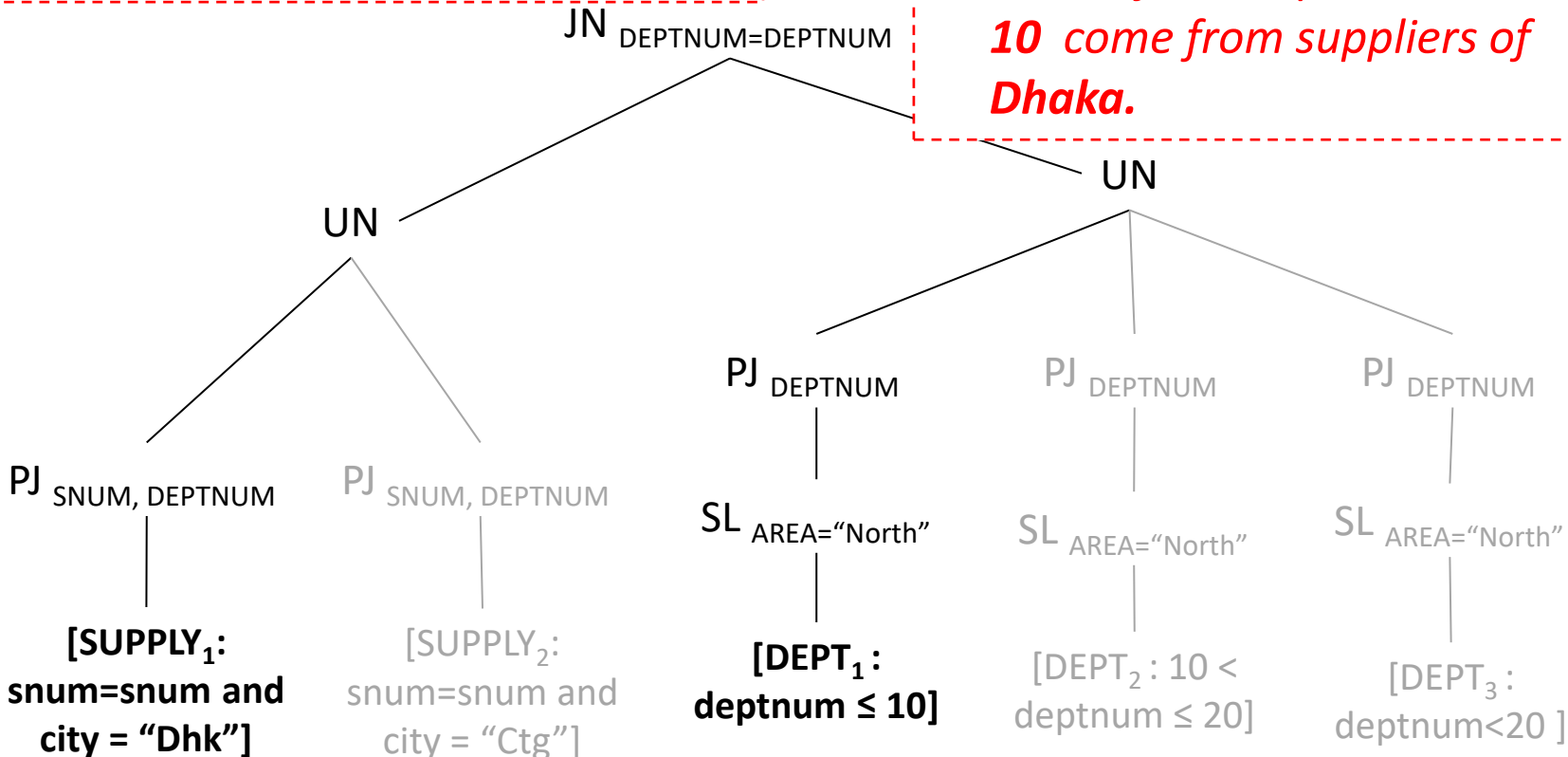
Strategy – 3 (contd.)

Which implies –

- area = "North" → deptnum ≤ 10
- deptnum ≤ 10 → snum = snum and city = "Dhaka"

Assume –

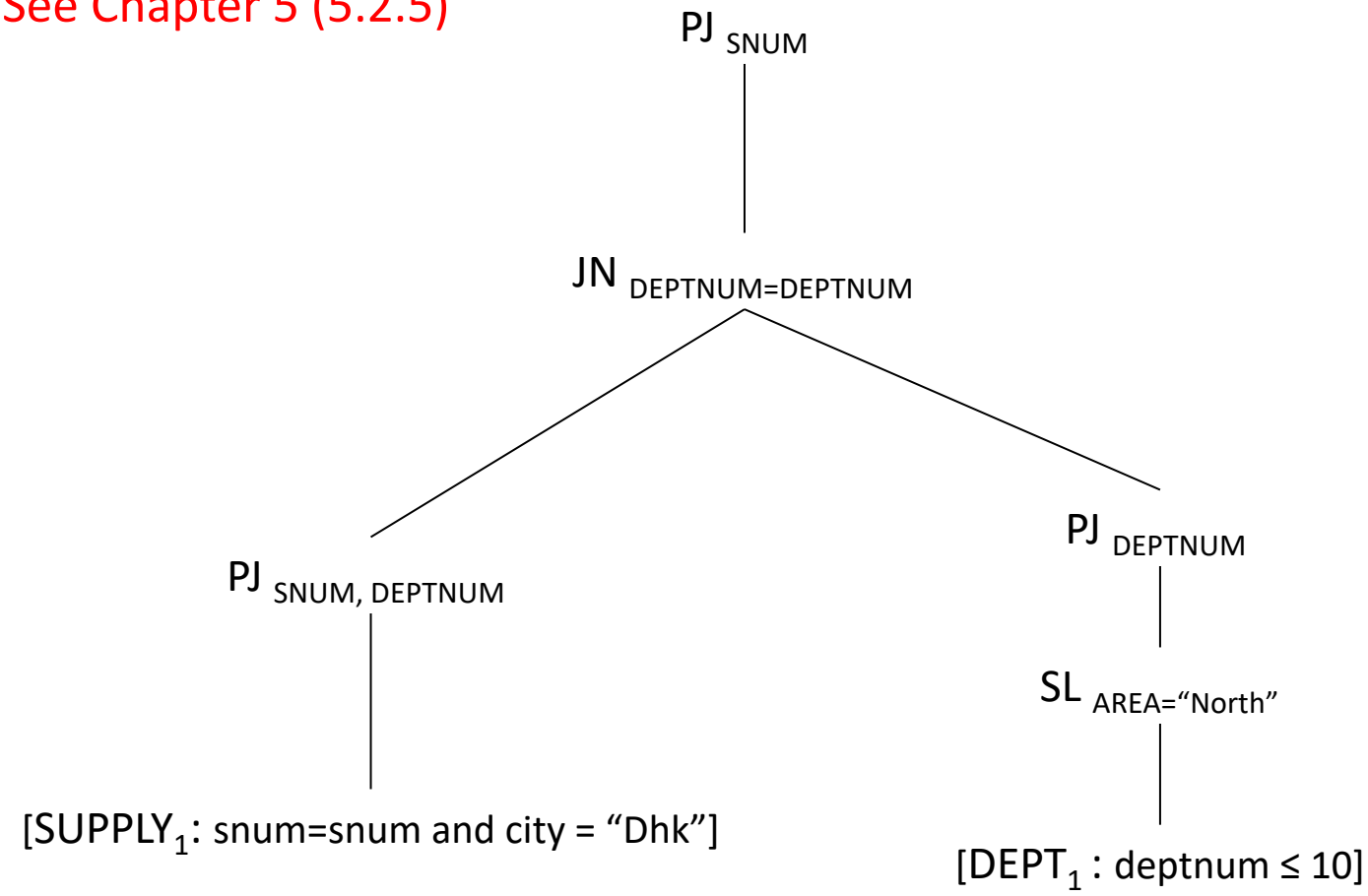
- *North area includes only department **1 to 10***
- *Orders from departments **1 to 10** come from suppliers of **Dhaka.***



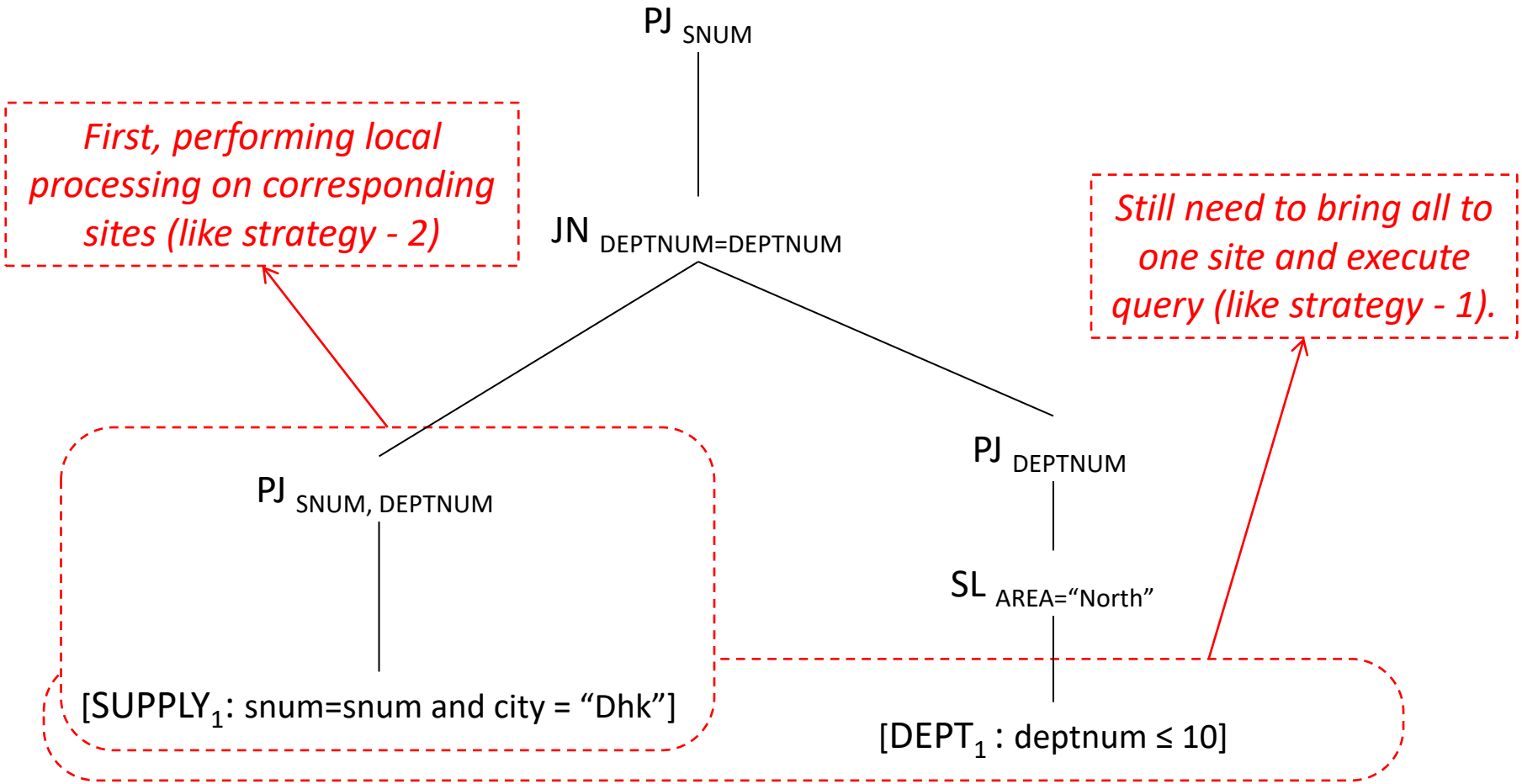
Strategy – 3 (contd.)

Simplification using inference

- See Chapter 5 (5.2.5)



Strategy – 3 (contd.)



Strategy – 3 (contd.)

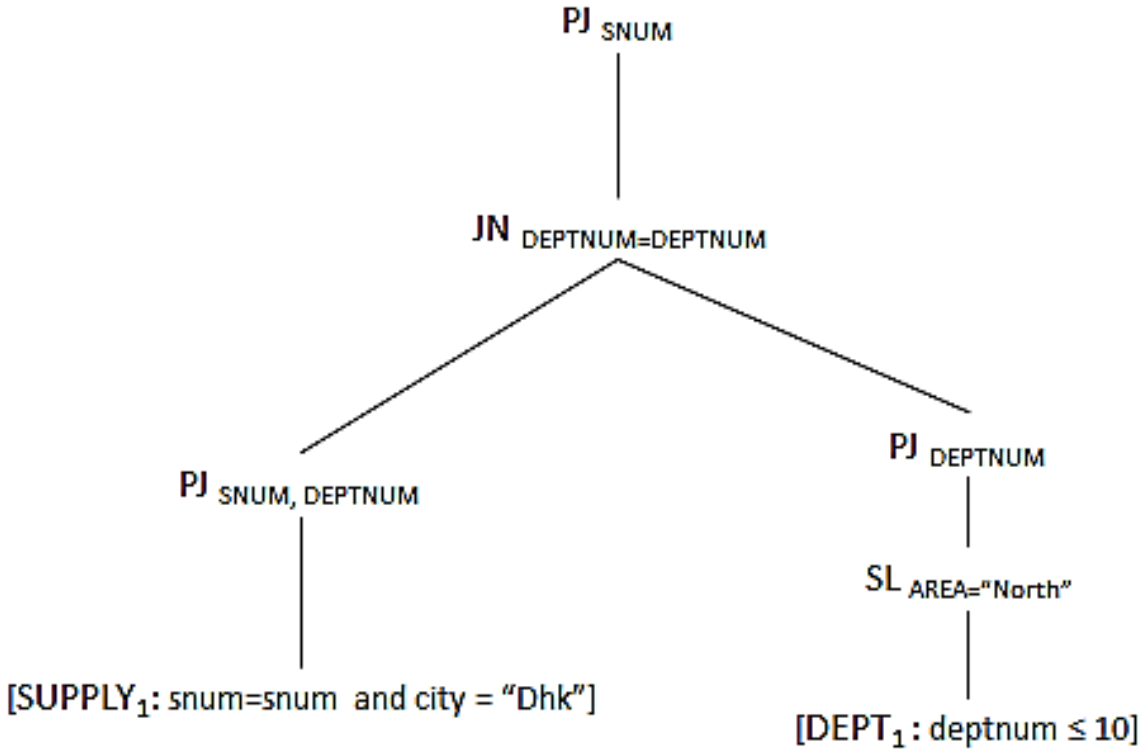
- Performing local processing on fragments.
  - Fragment reducers.
- Then sending reduced fragments to the executing site (i.e. site - 2) in parallel.

Strategy – 3 (contd.)

- Transmitted amount:

  $X_{SUPPLY1}$ = ?

  X_{DEPT1} = ?



Strategy – 3 (contd.)

- Transmitted amount:

  $X_{SUPPLY1}$ = *[same as strategy – 2] =* 1920000 bits

  X_{DEPT1} = 0 bits

Strategy – 3 (contd.)

Assume $C_0 = 0$ and $D_0 = 0$

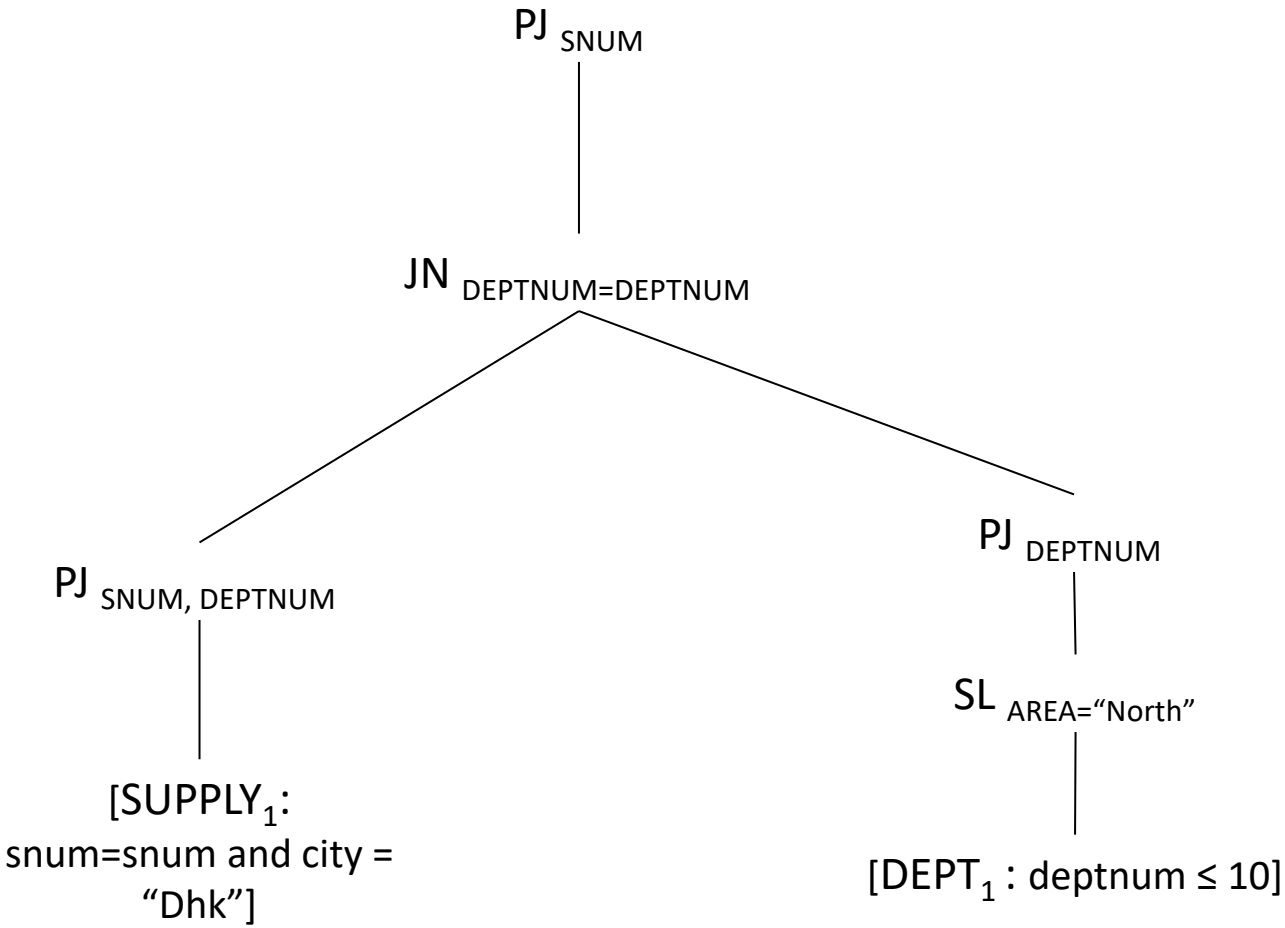
- $TC(x) = 1920000 * C_1$
- $TD(x) = 1920000 * D_1$

If D_1 = 10000 bit/second,

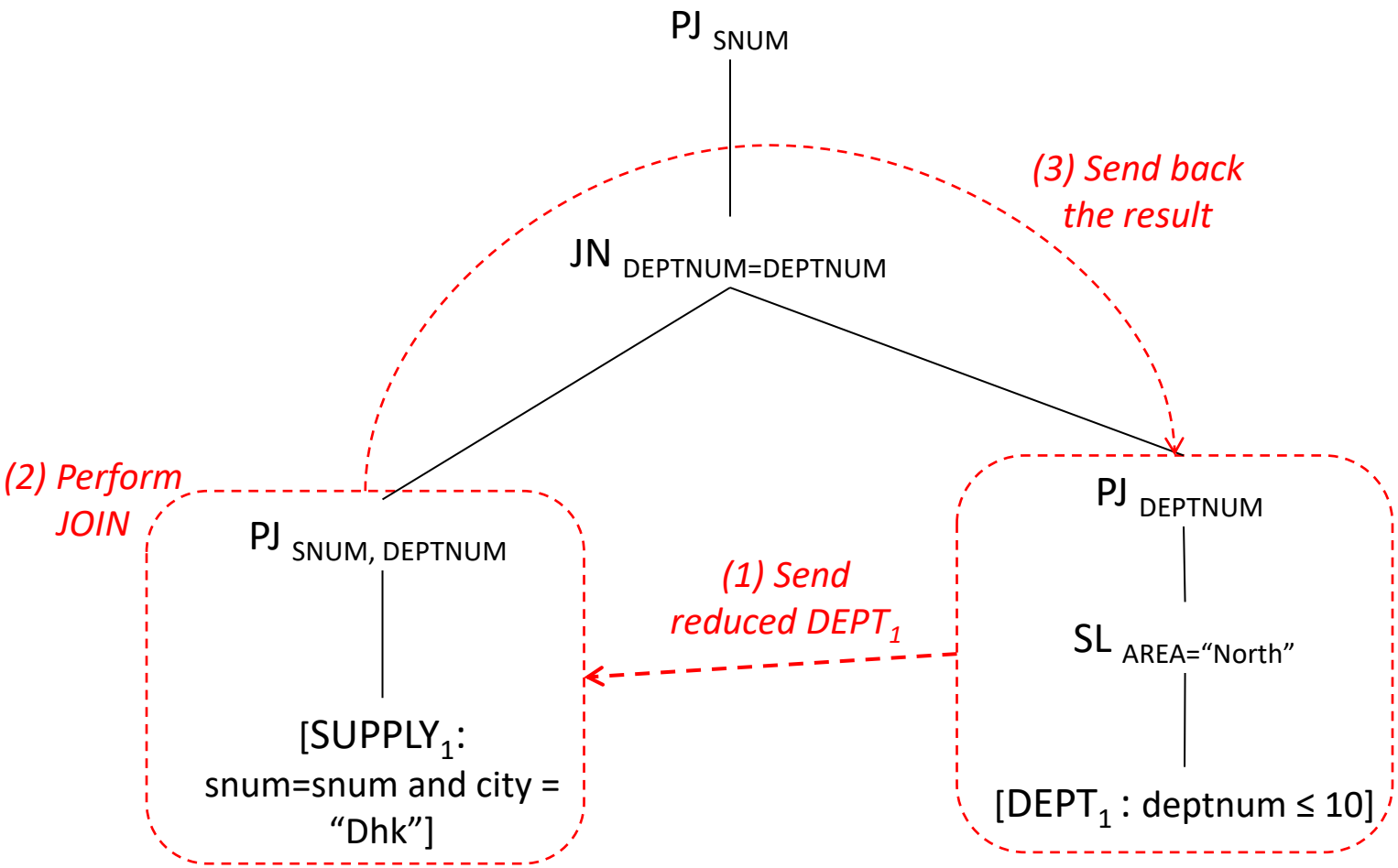
Transmission Delay ≈ 3 mins

Strategy - 4

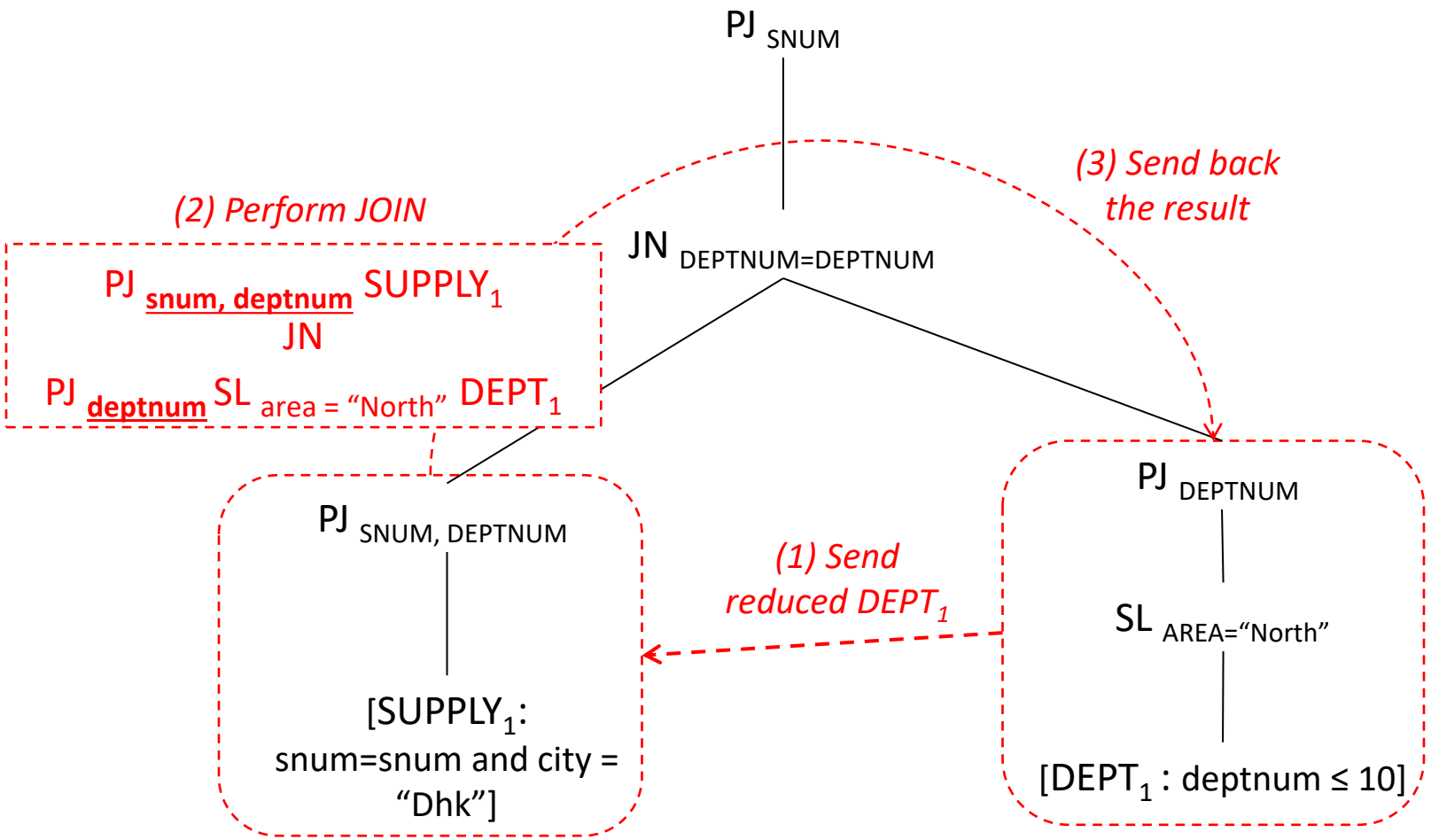
Strategy – 4


PJ SNUM
JN DEPTNUM=DEPTNUM
PJ SNUM, DEPTNUM
PJ DEPTNUM
SL AREA="North"
[SUPPLY1: snum=snum and city = "Dhk"]
[DEPT1 : deptnum ≤ 10]

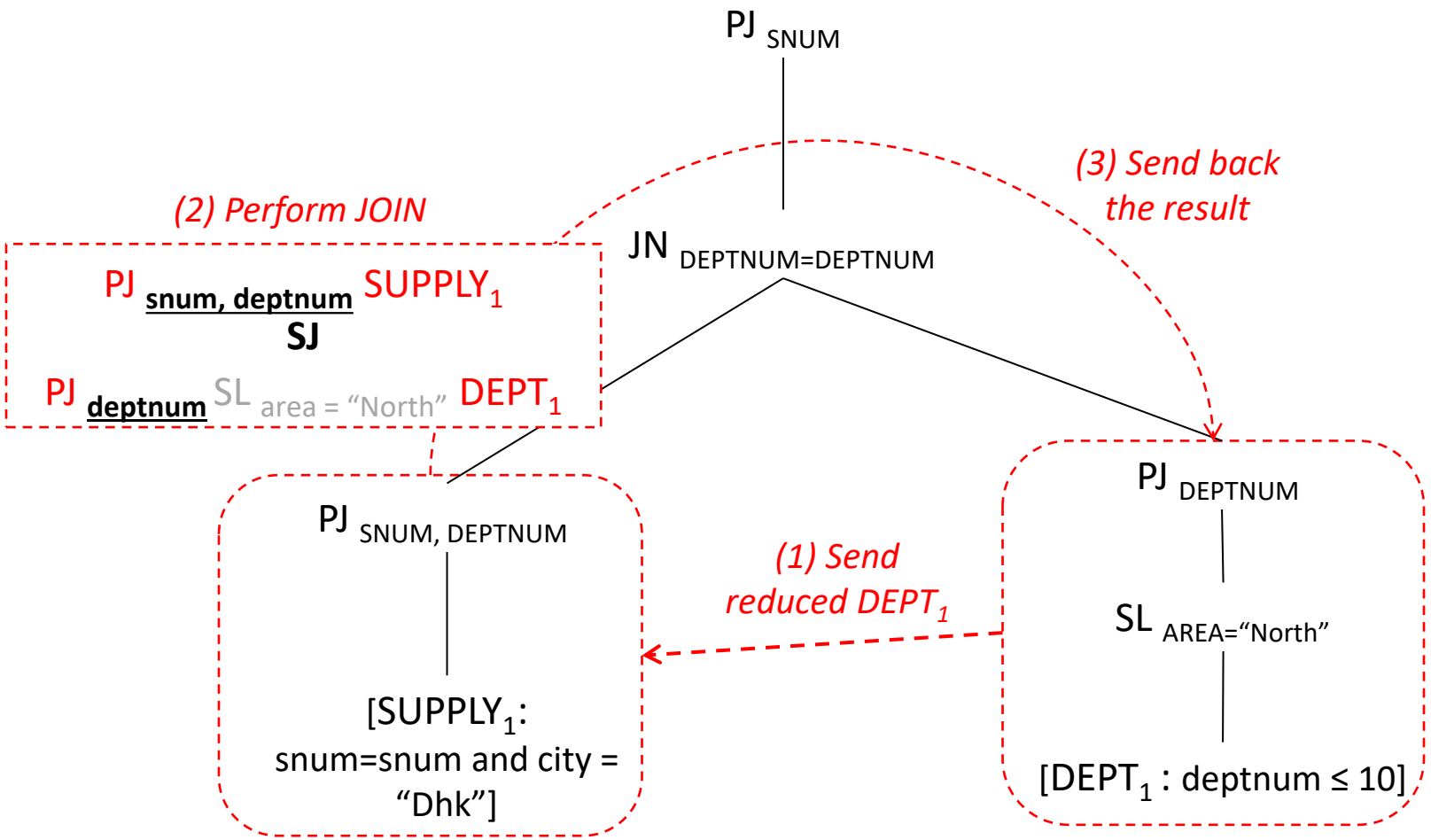
Strategy – 4 (contd.)



Strategy – 4 (contd.)



Strategy – 4 (contd.)

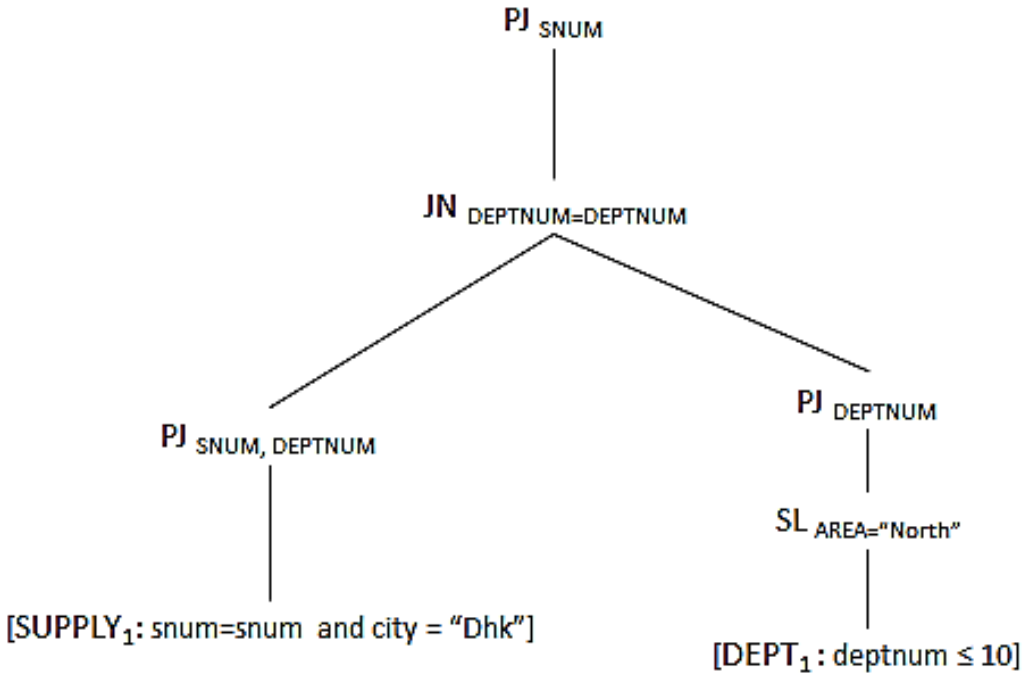


Strategy – 4 (contd.)

- Transmitted amounts:

  X_{DEPT1} = ?

  X_{RESULT} = ?



Strategy – 4 (contd.)

- Transmitted amounts:

  $X_{DEPT1} \approx 0$ bits

  X_{RESULT} = val (snum)*2*8 bits = 1800*2*8 bits = 28800 bits

Strategy – 4 (contd.)

- Transmitted amounts:

  $X_{DEPT1} \approx 0$ bits

  X_{RESULT} = val (snum) *2*8 bits = 1800*2*8 bits = 28800 bits

  WHY ?? See Chapter 2 and investigate.

Strategy – 4 (contd.)

Assume $C_0 = 0$ and $D_0 = 0$

- $TC(x) = 28800 * C_1$
- $TD(x) = 28800 * D_1$

If D_1 = 10000 bit/second,

Transmission Delay = 2.88 s

Comparisons

Strategy	Description	Time
1 (very bad)	• No simplification, no optimization. • All fragments are brought to one site to execute the query.	10 m
2 (bad)	• Simplification applied (Criterion -1 and 2). • No optimization. • Processing on fragments are done on the site locally. • Then, all fragments are brought to one site to execute the query.	3 m
3 (bad)	• Simplification applied (Criterion -1 and 2), . • Optimization applied (Fragments are reduced). • Processing on fragments are done on the site locally. • Then, all fragments are brought to one site to execute the query.	3 m
4 (good)	• Simplification applied (Criterion -1 and 2). • Optimization applied (Fragments are reduced). • Processing on fragments are done on the site locally. • Order of data transmission is changed.	2.88 s

Additional Reading

- Simplification using inference.
  - Chapter 5 (5.2.5)

Practice Problems/ Questions

1. What will happen for *strategy – 1* if the data collection from all the fragments are done sequentially, instead of in parallel?
2. What will happen if we skip the *simplification via inference* on the operator tree and apply *strategy – 4*?
3. What will happen in the comparisons if we execute the query at *site – 3*?