FORMULAZIONE COMPLETA

VARIABILI: X^i_{pq} → NODE i USED FOR VNF q ON SFC p

B → BANDWIDTH D → DELAY

R^w → NODE RESOURCE w

MINIMIZE:

$$\text{COST} = \sum_{i}\sum_{p}\sum_{q}\sum_{w} X^i_{pq} \cdot R^w_{pq} \cdot C^w_i + \quad \#\ \text{NODES}$$
$$q \neq q_{last},\ q \neq q_{init}$$

$$+ \sum_{i}\sum_{j}\sum_{p}\sum_{q} X^i_{pq} \cdot X^j_{pq+1} B_p \cdot C_{ij} \quad \#\ \text{LINKS}$$
$$i \neq j \qquad q \neq q_{last}$$

$$+ \sum_{p}\sum_{q} C_{pq} \quad (?) \qquad \#\ \text{EMBEDDING COST}$$

CONSTRAINTS

1) $\forall i \quad \sum_{p}\sum_{q}\sum_{w} X^i_{pq} R^w_{pq} \leq \text{MAX}(R^w_i)$ # NODE CAP
$q \neq q_{last}, q \neq q_{init}$

2) $\forall i,j \mid i \neq j \quad \sum_{p}\sum_{q} X^i_{pq} X^j_{pq+1} B_p \leq \text{MAX}(B_{ij})$ # LINK BW
$q \neq q_{last}$

3) $\forall p \quad \sum_{i}\sum_{j}\sum_{q} X^i_{pq} X^j_{pq+1} \cdot D_{ij} \leq D_p$ # LINK DELAY
$i \neq j \qquad q \neq q_{last}$

4) $\forall p,q \quad \sum_{i} X^i_{pq} = 1$ # ONE NODE FOR EVERY FUNCTION

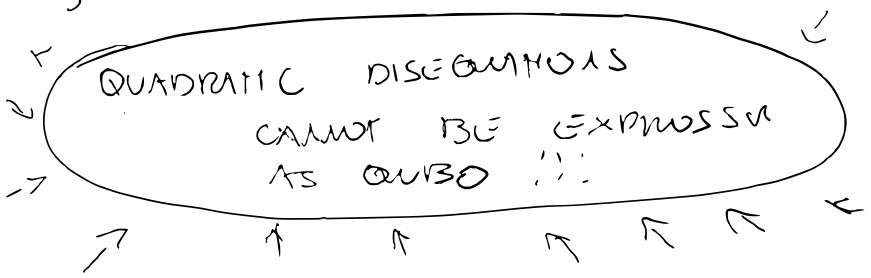
5) $\forall p \quad \sum_{q}\sum_{i}\sum_{j} X^i_{pq} X^j_{pq+1} = \text{LEN}(p) - 1$ ALL LINKS OF CHAIN ARE PROCESSED
$i \neq j$

6) $\forall_{p,q}$ $\sum_{i} \sum_{j \neq i} x'_{pq} x'_{p(q+1)} = 1$

NOTES

1) $B_{ij} = 0$ IF ij NOT CONNECTED

2) $D_{ij} \to \infty$ IF ij NOT CONNECTED



FORMULAZIONE INCOMPLETA (LINK BASED)

VARIABLES: y^{ij}_{pq} → link ij is used for going from VNF q to $q+1$

B → bandwidth D → delay

R^w → node resource w

MINIMIZE:

→ consumo per nodo di un certo tipo

$$cost = \sum_i \sum_{\substack{j \\ i \neq j}} \sum_p \sum_{\substack{q \\ q \neq q_{init} \\ q \neq q_{last}}} \sum_w y^{ij}_{pq} \cdot R^w_{pq} \cdot C^w_i + \quad \text{\# nodes}$$

$$+ \sum_i \sum_{\substack{j \\ i \neq j}} \sum_p \sum_{\substack{q \\ q \neq q_{last}}} y^{ij}_{pq} \cdot B_p \, C_{ij} \quad \text{\# links}$$

$$+ \sum_p \sum_q C_{pq} \; (?) \quad \text{\# embedding cost}$$

CONSTRAINTS

1) $\forall_{i,w} \sum_{\substack{j \\ j \neq i}} \sum_p \sum_{\substack{q \\ q \neq q_{init} \\ q \neq q_{last}}} y^{ij}_{pq} R^w_{pq} \leq MAX(R^w_i)$ # node res

2) $\forall i,j \mid i \neq j \quad \sum_p \sum_{\substack{q \\ q \neq q_{last}}} y^{ij}_{pq} B_p \leq MAX(B_{ij})$ # link BW

3) $\forall p \sum_i \sum_{\substack{j \\ j \neq i}} \sum_{\substack{q \\ q \neq q_{last}}} y^{ij}_{pq} D_{ij} \leq D_p$ # link delay

4) $\forall_{\substack{p,q \\ q \neq q_{init} \\ q \neq q_{last}}} \quad \sum_i \sum_{j \neq i} y^{ij}_{pq} = 1$ # one node for every function

5) $\forall p \quad \sum_{\substack{q \\ q \neq q_{last}}} \sum_i \sum_{j \neq i} y^{ij}_{pq} = len(p) - 1$ all links of chain are present

6) $\forall_{p,q} \; \sum_{i} \sum_{j} y_{pq}^{ij} = 1$ ONLY ONE LINK BETWEEN TWO VARS

$q \neq q_{last} \qquad i \neq j$

NOTES

- EQUAZIONE 5) NON FORZA LINK DELLA STESSA CATENA AD ESSERE COMPLETI !!

  ↳ DIFFICILE AGGIUNGERLO COME CONSTRAINT CHE SIA QUADRATICO