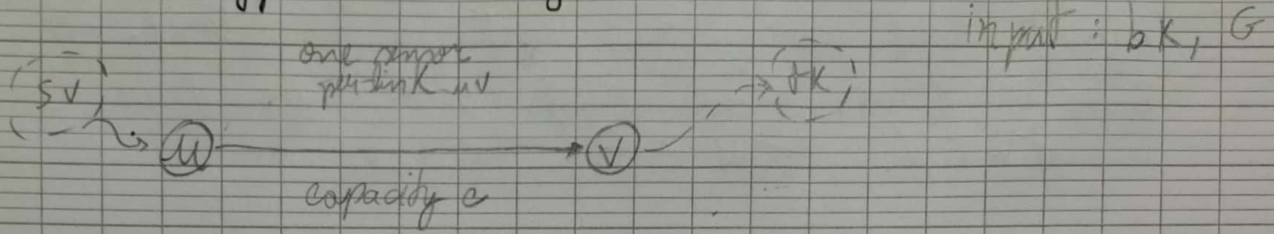
Algorithms for Telecommunications - Project 2.

01. Traffic monitoring



→ Variables

- y^k_{uv} : it is true if the request is monitored, if there is a sensor that monitores the request $k \in K$ on the link $uv \in E$
- x^k_{uv} : it is true if the request $k \in K$ uses link $uv \in E$.
- z_{uv} : it is true if a sensor monitores the link $uv \in E$.
- g^k_v : it assumes values to assure that the vertice v has a higher position than u.
- c : capacity of the link $uv \in E$, maximum throughput

→ Constraints

· We need to place a sensor for every link used by the requests. So, if the request uses one link, being x^k_{uv} true, z_{uv} must be true.

$\forall k \in K, \forall uv \in E$:

$$z_{uv} \leq x^k_{uv}$$

And we place at most one sensor per link:

$\forall uv \in E$:

$$z_{uv} \leq 1$$

· All requests are monitored, so we have that:

$\forall k \in K$,

$$\sum_{uv \in E} y^k_{uv} \geq 1$$

· If there is a link monitored by a sensor, the request that uses that link is monitored. So, if z_{uv} is true, y^k_{uv} must also be true:

$\forall k \in K, \forall uv \in E$:

$$y^k_{uv} \leq z_{uv}$$

· Flow conservation constraints

- The flow conservation must be attended in all path. The flow colected in source and destination must be 1, to assure that there is only one path for each request.

$\forall k \in K$

$$\sum_{(u,v) \in E} x^k_{uv} - \sum_{(v,u) \in E} x^k_{vu} = \begin{cases} -1, & v = s_k \\ 1, & v = t_k \\ 0, & \text{otherwise} \end{cases}$$

· Capacity constraints

- The maximum capacity of each link is c. So, if the link uv is used by k requests, the total bandwidth must be less or equal to c:

$\forall uv \in E$

$$\sum x^k_{uv} \cdot b_k \leq c$$

· Avoiding circles

- We need to avoid that the path forms cycles. So, if the vertice v is used, it cannot be used again, the path cannot come back to this node.

$\forall k \in K, \forall uv \in E$:

$$g^k_v \geq g^k_u + 1 - n(1 - x^k_{uv})$$

- The objective is then to minimize the numbers of errors,

$$\min \sum_{uv \in E} z_{uv}$$