# Multi-constrained path selection
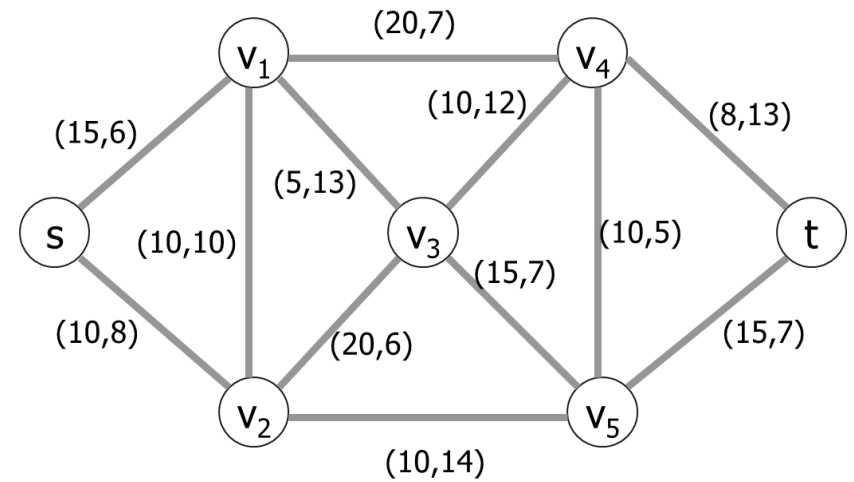
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# Problem



- We abstract the network as a graph *G(V,E)*

- Each link *(u, v)* is specified by a link weight vector $\vec{w}(u,v) = [w_1(u,v), w_2(u,v), \cdots, w_m(u,v)]$

- Given constraints for each element of this vector $0 \leq w_i(u,v) \leq L_i$

- Find a path P from a source node *s* to a destination node *t*

$$w_i(P) \overset{def}{=} \sum_{(u,v) \in P} w_i(u,v) \leq L_i$$

# Assumptions

- Complete view of inter-domain topology
- Different parameters are used to describe link(s)
  - Additive
  - Min/Max
- The definition of the path length $l(P)$ is required to be able to compare paths
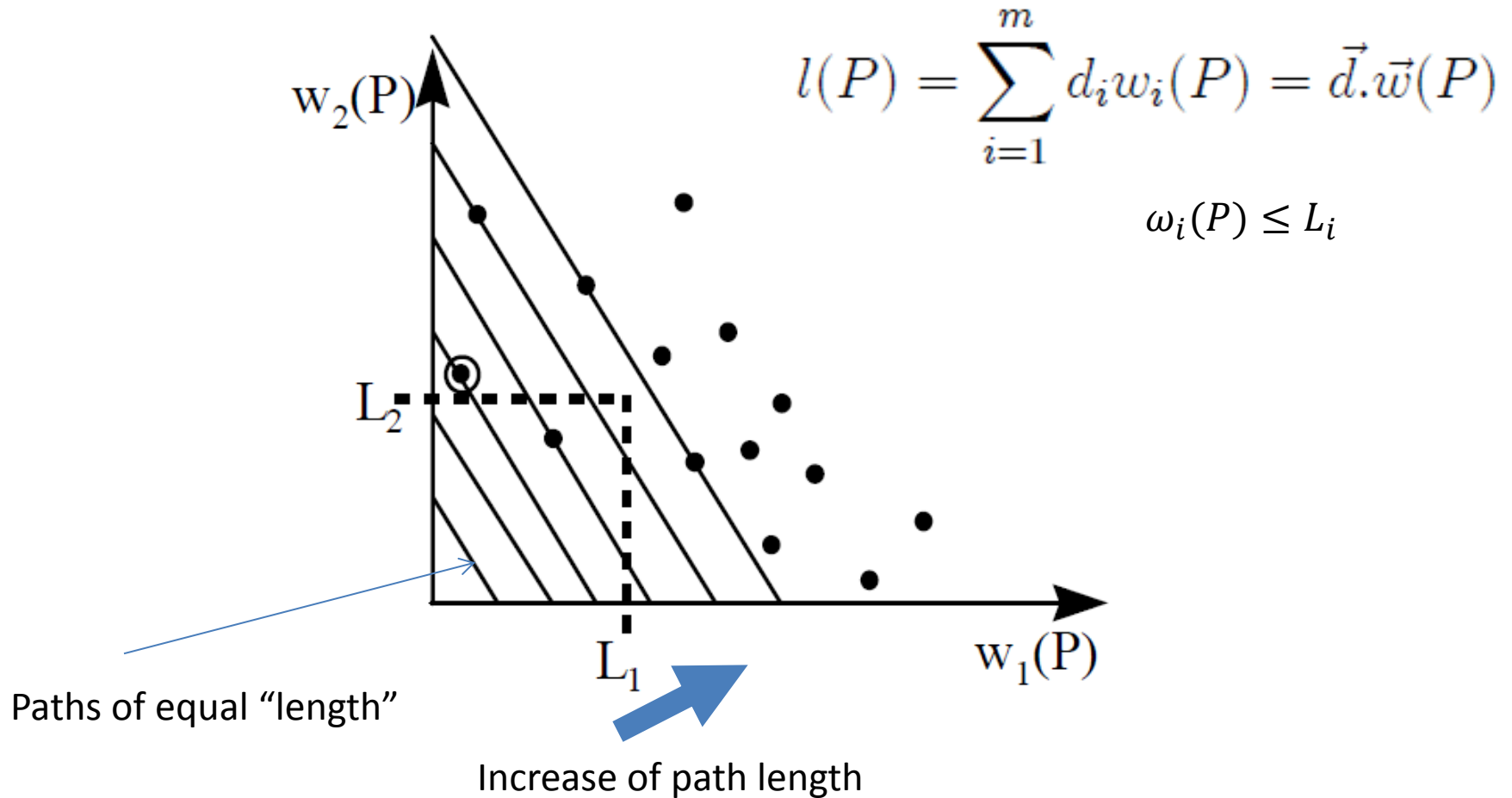
# Path lengths definition

- **Linear**

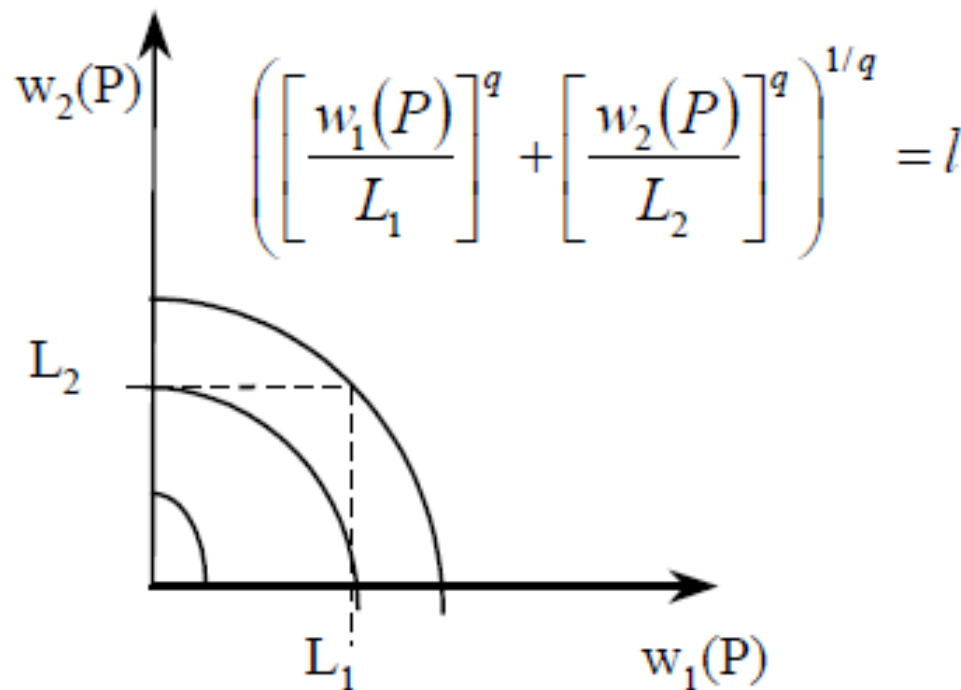$$l(P) = \sum_{i=1}^{m} d_i w_i(P) = \vec{d}.\vec{w}(P)$$

- **Nonlinear**

$$l_q(P) = \left( \sum_{i=1}^{m} \left[ \frac{w_i(P)}{L_i} \right]^q \right)^{\frac{1}{q}}$$

# Two dimensional MCP problem (linear path length)

$$l(P) = \sum_{i=1}^{m} d_i w_i(P) = \vec{d}.\vec{w}(P)$$

$$\omega_i(P) \leq L_i$$

w$_2$(P)

L$_2$

L$_1$

w$_1$(P)

Paths of equal "length"

Increase of path length

# Two dimensional MCP problem (nonlienar path length)

$$\left(\left[\frac{w_1(P)}{L_1}\right]^q + \left[\frac{w_2(P)}{L_2}\right]^q\right)^{1/q} = l$$

In <u>multiple dimensions </u>and using a <u>nonlinear path length</u>, the <u>subsections</u> of the shortest path are **not** necessarily <u>shortest paths</u> themselves

# What if?

- Next to the usual suspect (capacity, latency, cost, energy, ...) there may be two additional parameters that need to be taken into account
  - Technology incompatibilities
  - Adaptation capabilities

# Incompatibilities

- Rate incompatibilities
  - Higher rate connections cannot be transferred over lower rate links without data rate conversion
- Wavelength incompatibilities (850/1310/1550 nm)
  - Conversion between different wavelengths necessary
- Architecture incompatibilities (IP over SONET/SDH, IP over WDM, IP over SONET/SDH over WDM, …)
  - direct communication between network domains may depend on lowest layer technology and adaptation to upper layers

# Next steps

- Once we understand the relevant aspects, we need to be able to describe them (topology) and only then we can perform MCP selection

- So... what parameters should we include in our topology?

- Only then we can move to
  - Multi-constrained path selection (MCP)

# Thank you!