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Appendix A

Conference and paper contributions from thesis

- S.P. van Loggerenberg, M.J. Grobler and S.E. Terblanche, "Optimization of PON Planning for FTTH Deployment Based on Coverage", in *Southern African Telecommunications and Networks Access Conference (SATNAC)*, George, South Africa, Sep. 2012.
- S.P. van Loggerenberg, M.J. Grobler and S.E. Terblanche, "Solving the Passive Optical Network with Fiber Duct Sharing Planning Problem Using Discrete Techniques", in *Discrete Mathematics, Electronic Notes in*, *Elsevier*, Submitted for publication.

Appendix B

Equation reference

Table B.1: Refined MILP model equation reference

Equation	Sections defined	Type
(5.62)	4.2.4	OLT cost
(5.63)	5.1.8	Splitter cost
(5.64)	5.1.8	ONU cost
(5.65)	5.1.2, 5.1.4	Fiber costs between CO and SP
(5.66)	5.1.2, 5.1.4	Fiber costs between SP and ONU
(5.67)	5.1.5	Coverage of ONUs
(5.68)	5.1.4	Total splitters used
(5.69)	5.1.4	Total COs used
(5.70)	5.1.4	Maximum number of COs
(5.71)	5.1.4	At least one CO
(5.72)	5.1.4	Used SP must connect to CO
(5.73)	5.1.5	Used ONU must connect to SP
(5.74)	5.1.4	CO is used if link to it exists
(5.75)	5.1.3	SP is used if link to it exists
(5.76)	5.1.2, 5.1.3	Edges of used paths marked used
(5.77)	5.1.3	Maximum ONUs per SP

Table B.1: Refined MILP model equation reference (continued)

Equation	Sections defined	Type
(5.78)	5.1.7	SP type must have enough capacity
(5.79)	5.1.7	SP of only one type
(5.80)	5.1.6	Sets minimum CO-ONU distance
(5.81)	5.1.6	Sets maximum CO-ONU distance
(5.82)	5.1.6	Activates distance constraints
(5.83)	5.1.6	Network reach
(5.84)	5.1.6	Differential distance limit
(5.85)	5.1.8	ONU EOS - total volume
(5.86)	5.1.8	ONU EOS - total cost
(5.87)	5.1.8	SP EOS - total volume
(5.88)	5.1.8	SP EOS - total cost
(5.89)	5.1.8	ONU EOS - enable correct λ
(5.90)	5.1.8	ONU EOS - enable correct λ
(5.91)	5.1.8	ONU EOS - enable correct λ
(5.92)	5.1.8	SP EOS - enable correct λ
(5.93)	5.1.8	SP EOS - enable correct λ
(5.94)	5.1.8	SP EOS - enable correct λ
(5.95)	5.1.8	ONU EOS - only one segment active
(5.96)	5.1.8	SP EOS - only one segment active
(5.97)	5.1.8	ONU EOS - convex combination
(5.98)	5.1.8	SP EOS - convex combination

Appendix C

Dijkstra's Algorithm

Algorithm C.1 Dijkstra's algorithm

```
1:  Graph ← map
2:  source ← source vertex

3:  procedure DIJKSTRA(Graph, source)
4:      for all vertices v in Graph do                    ▷ Initialize
5:          D(v) ← ∞                                      ▷ Distance map vector
6:          P(v) ← undefined                              ▷ Previous map vector
7:      end for

8:      D(source) ← 0
9:      N ← set of all vertices in Graph
10:     while N ≠ ∅ do
11:         s ← vertex ∈ N, MIN(D) = D(s)                 ▷ Vertex with minimum distance
12:         delete s from N
13:         if D(s) = ∞ then
14:             break                                     ▷ All neighbours explored
15:         end if
```

Algorithm C.2 Dijkstra's algorithm (continued)

```
16:         for all neighbours v of s do
17:             a ← D(s) + DistanceBetween(v, s)
18:             if a < D(v) then
19:                 D(v) ← a
20:                 P(v) ← s
21:             end if
22:         end for
23:     end while
24:     return D, P
25: end procedure

26: function Min(v)
27:     min = ∞
28:     for all elements i in v do                    ▷ Get minimum of vector
29:         if i < min then
30:             min ← i
31:         end if
32:     end for
33:     return min
34: end function

35: function DistanceBetween(v_1,v_2)
36:     return ||v_2 − v_1||                ▷ Euclidean distance between vertices
37: end function
```

Appendix D

Branch and Bound algorithm

Algorithm D.1 General branch and bound

1: $\mathbf{S} \leftarrow$ candidate solutions
2: calculate bounds S_{LOW} and S_{UP}
3: **function** BRANCHBOUND($\mathbf{S}$)
4: **while** $(\mathbf{S} \neq \varnothing)$ **and** $(S_{LOW} \neq S_{UP})$ **do**
5: split $\mathbf{S}$ into sets $\mathbf{S}_1, \mathbf{S}_2, \ldots$ ▷ *Branch*
6: **for all** sets $\mathbf{S}_i$ **do**
7: calculate bounds ℓ_i and u_i for $\mathbf{S}_i$ ▷ *Bound*
8: **if** $(\ell_i > S_{UP})$ **or** $(u_i < S_{LOW})$ **then**
9: discard S_i ▷ *Prune*
10: **else**
11: $S_{UP} \leftarrow min(S_{UP}, u_i)$
12: $S_{LOW} \leftarrow max(S_{LOW}, \ell_i)$
13: **call** BRANCHBOUND($\mathbf{S}_i$) ▷ *Recursively*
14: **end if**
15: **end for**
16: **end while**
17: **return** S_{LOW} and S_{UP}
18: **end function**