

LIST OF FIGURES

Figure 2. 1 Legacy network vs SDN	5
Figure 2. 2 SDN Architecture	6
Figure 2. 3 Controller and OpenFlow switch.....	7
Figure 2. 4 Basic packet forwarding with OpenFlow in a switch.....	7
Figure 2. 5 Multiple/Distributed Controller	8
Figure 2. 6 POCO GUI	9
Figure 3. 1 Proposed Method	13
Figure 3. 2 PT Telkom Indonesia Network Topology illustration.....	14
Figure 3. 3 Metro Ethernet Jatim Regional Backbone Link	15
Figure 3. 4 Metro Ethernet Network East Java, Madiun Ring : Aggregator Link.....	15
Figure 3. 5 Proposed Method Abstraction, Existing vs Next Topology	16
Figure 3. 6 Level-1 Controller, POCO Failure free scenario, k=1. Controller location at 6 (ML)	243
Figure 3. 7 Level-1 Controller, Proposed method, k=1, Controller at RKT1 (2)	264
Figure 3. 8 Level-1 Controller, POCO Failure free scenario, k=2, best placement : controller imbalance.....	25
Figure 3. 9 Level-1 Controller, POCO Failure free scenario, k=2, best placement : max node to controller latency	25
Figure 3. 10 Level-1 Controller, POCO Failure free scenario, k=2, best placement : controller to controller latency	25
Figure 3. 11 Candidate 1 for Level-1 Controller, Proposed method, k=2, Controller location at 2 (RKT1) and 6 (ML2).....	26
Figure 3. 12 Candidate-2 for Level-1 Controller,Proposed method, k=2, Controller location at 2 (RKT1) and 8 (MN)	27
Figure 3. 13 Candidate-3 for Level-1 Controller,Proposed method, k=2, Controller location at 1 (KBL1) and 2 (RKT1).....	27
Figure 3. 14 Candidate 4 for Level-1 Controller,Proposed method, k=2, Controller location at 6 (ML) and 8 (MN).....	29

Figure 3. 15 Level-2 Controller, $k = 2$, POCO max node to controller best placement, controller at NJ (112) and PS (164).	29
Figure 3. 16 Level-2 Controller, $k=2$, POCO Controller imbalance best Placement, node at KDM (29), WLI (102).	29
Figure 3. 17 Level-2 Controller, $k=2$, Controller to controller latency best placement, controller location at JR (161), JR2 (181).	30
Figure 3. 18 Level-2 Controller, $k=2$, Proposed method, Candidate-1, controller location at RKT1 (42) dan MLK2 (77).	31
Figure 3. 19 Level-2 Controller, $k=2$, Candidate-2 controller location at RKT1 (42) and MN (107).	32
Figure 3. 20 Candidate 1 for Level-2 Controller, Resiliency, $k=3$, controller location at RKT1 (42), ML (77) and MN (107).	33
Figure 3. 21 Candidate 2 for Level-2 Controller, Resiliency, $k=3$, controller location at RKT1 (42), MLK2 (77) and JR (161).	34
Figure 3. 22 Candidate 3 for Level-2 Controller, Resiliency , $k=3$, controller location at RKT1 (42), KBL1 (1) and RKT2 (44)	35
Figure 3. 23 Candidate 4 for Level-2 Controller, $k=3$, controller location at RKT1 (42), KBL1 (1) and MLK2 (77).	36
Figure 3. 24 Candidate 5 for Level-2 Controller, Resiliency, $k=3$, controller location at RKT1 (42), KBL1 (1) and MN (107).	37
Figure 4. 1 Best placement for level-1 controller	43
Figure 4. 2 Controller ó node for controller placement = RKT(42), ML(77) ó MN (107)	51
Figure 4. 3 Controller ó node for controller placement = RKT(42), ML(77) ó MN (107)	51
Figure 4. 4 Legacy network, node with 10 G Link.	52
Figure 4. 5 SDN Level-1 Controller, node with 10 G Link.	53
Figure 4. 6 SDN Level-2 Controller, node with 1 G Link.	53