

MPLS TP Ring Fault Detection and Localization

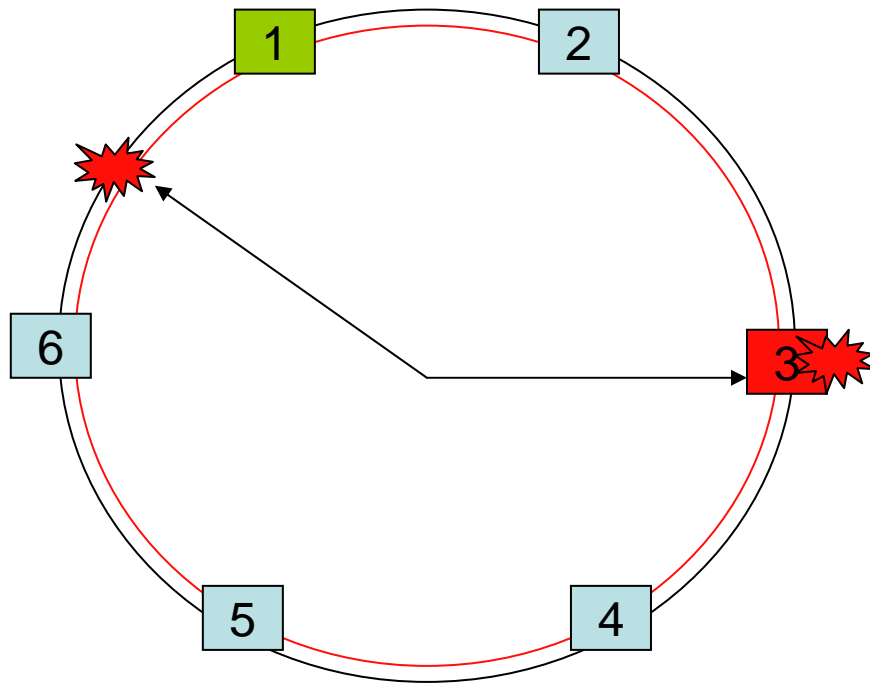
draft-jiang-mpls-tp-ring-fd

Authors

Albert Jiang
Guoman Liu
Xuehui Dai
(ZTE)

Purpose & Overview

- MPLS TP Ring Optimized Node/Link Fault Detection & Localization Mechanism



1) Detection msg

From designated node 1 to both rings
Back to 1

2) All nodes will receive detection msg

Upon failure, there is detection msg loss
Node will send alarm msg in both rings

3) Upon failure, no detection msg to 1

1 will also receive node alarm msg
And use rules to locate fault

Current Work & Diff b/w SDH & MPLS

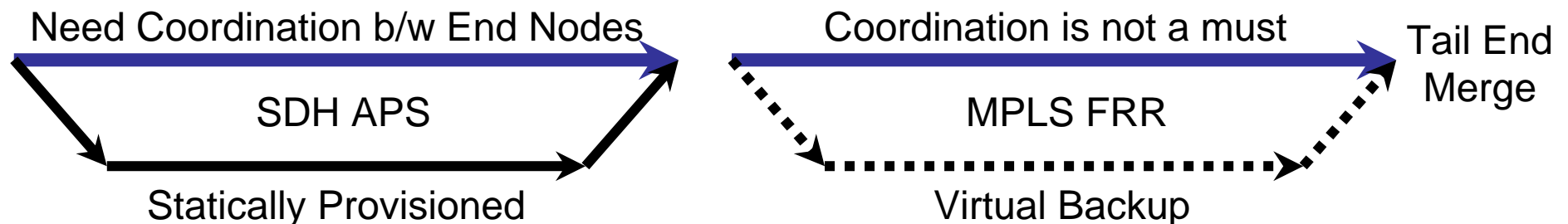
	Backup	Label Stack	Detection	Repair*	Synchronization(APS)
MPLS FRR Detour	1:1	N	Local (N)	Local	N
MPLS FRR Facility	1:N	Y	Local (N)	Local	N
ITU G. 8132 Wrapping	1:1	N	Local (N)	Local	Nodes near failure
ITU G. 8132 Steering	1:1	N	Local (N)	Service node	Node near failure->service node
weingarten Wrapping	1:1	N	Local (N)	Local	N
weingarten Steering	1:1	N	Full Mesh (N*N)	Service node	Node near failure->service node
Dai P2MP Leaf	1:1	N	Leaf	Root	Leaf notify Root
Dai P2MP Root	1:1	N	Root<->Leaf	Root	N
ceccarelli P2MP FRR	1:1	N	Local (N)	Local	N
ceccarelli P2MP ROM	1:1	N	Local (N)	Local**	N
This one			Control node & <-> node (1)		
ITU G. 8032 Ethernet Ring			Local (1)	Topology rebuild	Nodes near failure->ctrl node

* 2 counter direction rings backup each other.

** Redirect to backup in other direction.

SDH backup path **must** reserve time slot **resource**

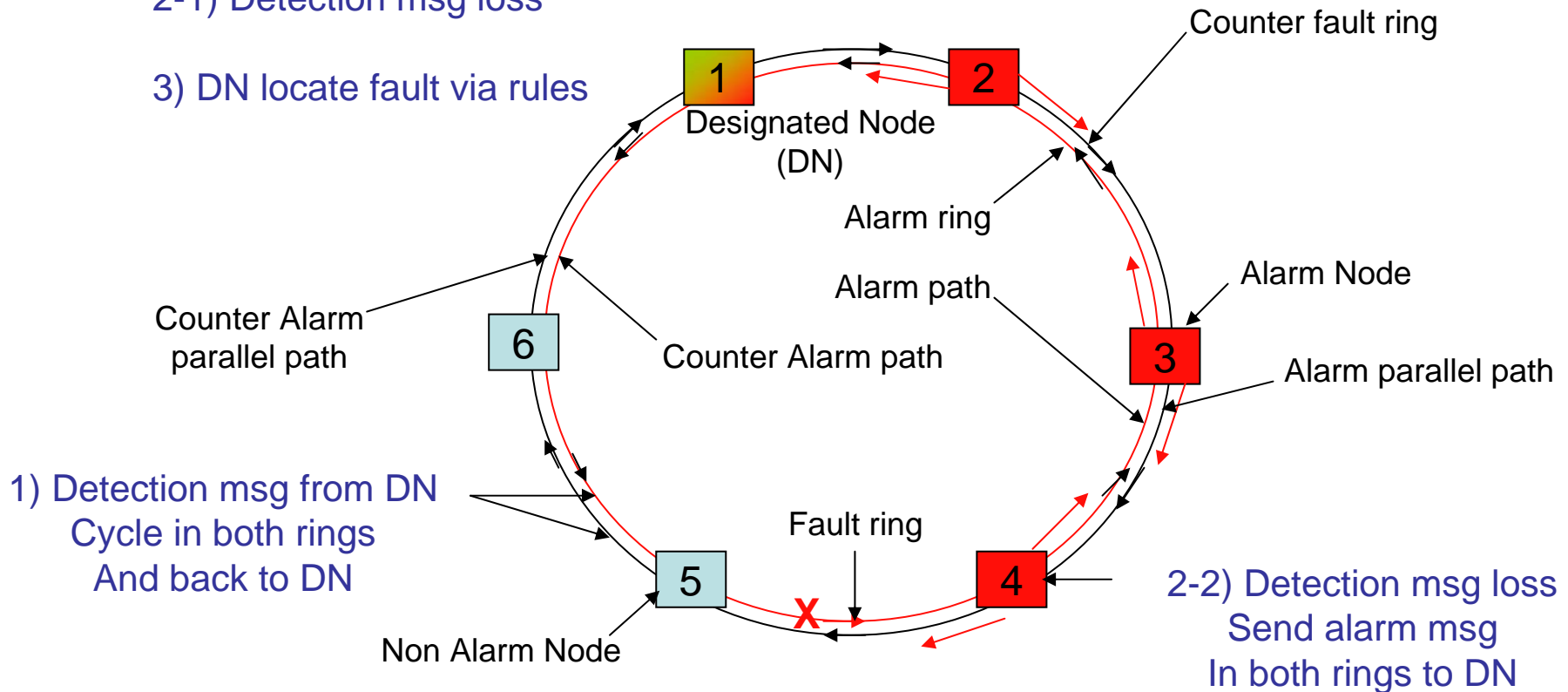
While **MPLS** backup path does **not necessarily** reserve any bandwidth resource



Definition & Procedure

2-1) Detection msg loss

3) DN locate fault via rules



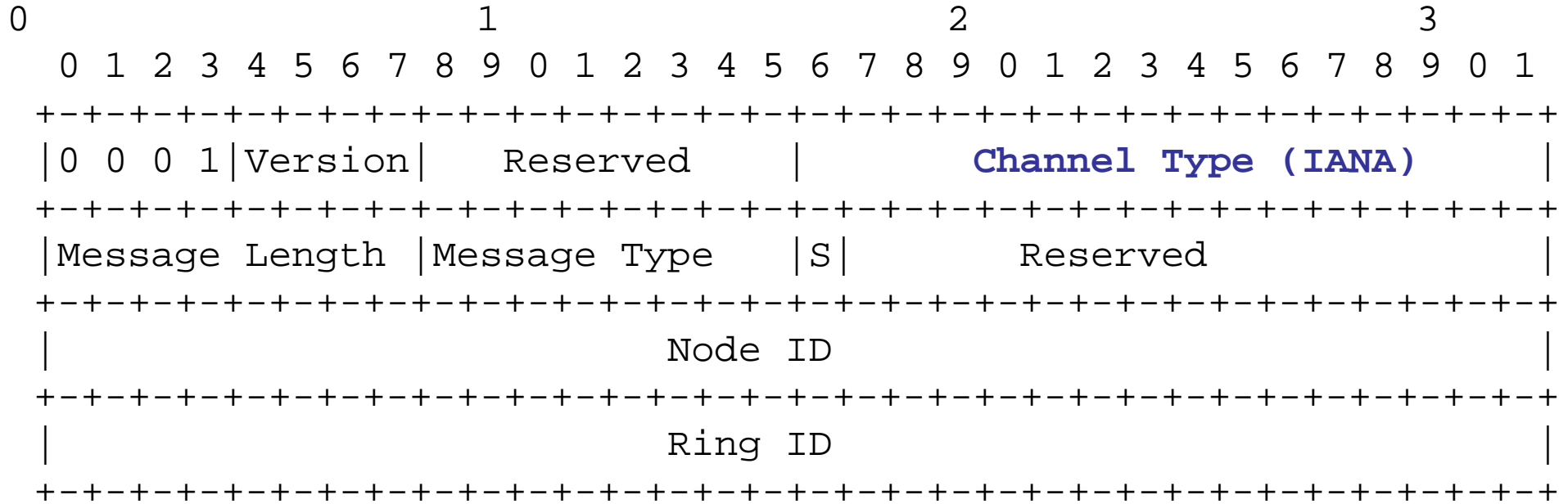
Fault ring(DN detect loss)	inner ring	Counter Fault ring	outer ring
Alarm node	4	Non alarm node	5
Alarm ring(DN receives Alarm)	inner ring	Counter Alarm ring	outer ring
Alarm path(->Alarm node)	inner ring 4>3>2>1	Counter Alarm path	inner ring 1>6>5>4
Reach path(->non alarm node)	inner ring 1>6>5	Counter Reach path	inner ring 5>4>3>2>1
Alarm parallel path	Outer ring 1>2>3>4	Counter Alarm parallel path	Outer ring 4>5>6>1
Reach parallel path	Outer ring 5>6>1	Counter Reach parallel path	Outer ring 1>2>3>4>5

Definition

Bidirectional Alarm OAM	OAM that indicates fault in both rings
Unidirectional Alarm OAM	OAM that indicates fault in only 1 ring
Alarm node	Node from which designated node receives Alarm OAM.
Non Alarm node	Node from which designated node does not receives Alarm OAM.
Alarm ring	Ring in which designated node receives Alarm OAM.
Counter Alarm ring	Ring other than Alarm ring.
Alarm path	Path in alarm ring from Alarm node to designated node.
Counter Alarm path	Path in alarm ring from designated node to Alarm node.
Alarm parallel path	Path parallel to Alarm path in Counter Alarm ring
Counter Alarm parallel path	Path parallel to non Alarm path in Counter Alarm ring
Fault ring	Ring in which designated node cannot receive detect OAM.
Counter Fault ring	Ring other than Fault ring.
Reach path	Path in Fault ring from designated node to non Alarm node.
Counter Reach path	Path in Fault ring from non Alarm node to designated node.
Reach parallel path	Path in Counter Fault ring from non Alarm node to designated node.
Counter Reach parallel path	Path in Counter Fault ring from designated node to non Alarm node.

Alarm OAM is fault localization OAM.

OAM Message



Channel Type	Fault Detection and Localization OAM	
Message Length	Length of the Message	
Message Type	0: Fault detection OAM from designated node.	
	1: Fault localization OAM from other node.	
	Other: For future use.	
	Fault Detection OAM	Fault Localization OAM
S(2 bits)	00: Reserved.	00: Reserved.
	01: Inner ring.	01: Inner ring.
	10: Outer ring.	10: Outer ring.
	11: Reserved	11: Both rings.
Node ID	Identifier of node that sends the OAM message.	
Ring ID	Identifier of the ring.	

Unidirectional

	Detection	Localization
S(1 bit)	0: Outer ring.	0: 1 ring.
	1: Inner ring.	1: 2 rings.

Bi-directional

S bit in detection msg - 1 queue for all msg

Rules in DN

	Designated Node		Alarm ring		Counter Alarm ring	
	Detection OAM Loss	Receive Alarm OAM	Alarm path	Counter Alarm path	Alarm parallel path	Counter Alarm parallel path
Rule 1	2 rings	2-ring	OK	X	X	?
Rule 2.1	2 rings	1-ring	OK	X	OK	X
Rule 2.2	1 ring (Alarm in this ring)		OK	X	OK	OK
Rule 2.3	1 ring (Alarm in other ring)		OK	OK	X	?

With the help of alarm

	Designated Node	Fault Ring		Counter Fault ring	
	Detection OAM Loss	Reach Path	Counter Reach path	Reach parallel path	Counter Reach parallel path
Rule 3	only in 1 ring	OK	X	OK	OK

Without the help of alarm

Rule 1

	Designated Node		Alarm ring		Counter Alarm ring	
	Detection OAM Loss	Receive Alarm OAM	Alarm path	Counter Alarm path	Alarm parallel path	Counter Alarm parallel path
Rule 1	2 rings	2-ring	OK	X	X	?

In(6>5) & out(2>3) link broken

1(DN) cannot receive detection msg in 2 rings

4 cannot receive detection msg in 2 rings

4 sends 2-ring alarm to 1 via 2 rings

1 receives 2-ring alarm from 4 in 2 rings

Alarm node - 4

Let Alarm ring = Inner ring

Alarm path – inner ring 4>3>2>1

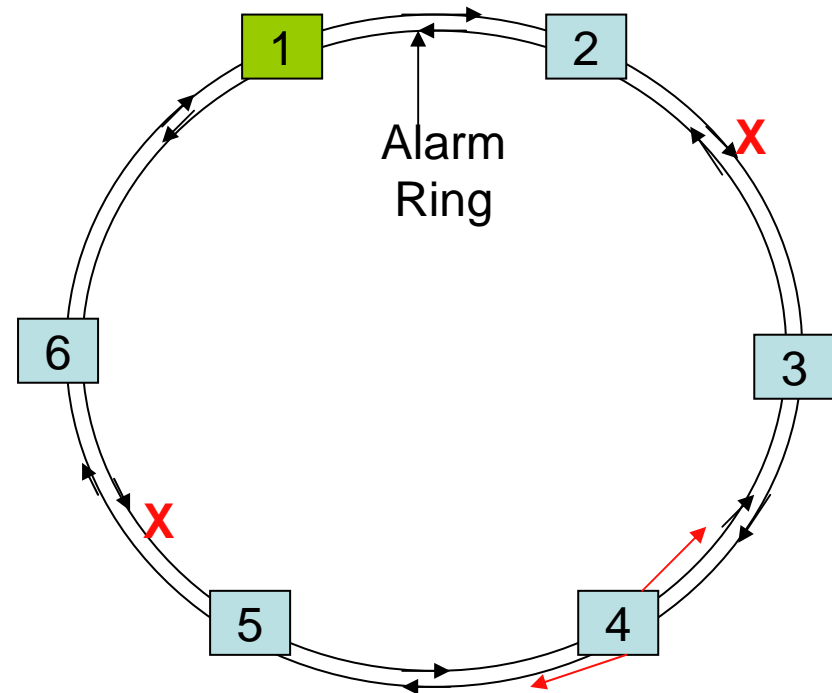
1)Error in Counter Alarm path inner ring 1>6>5>4

Reason: Error in 2 rings > Error in Alarm ring

+ No error in Alarm path > Result

2)Error in Alarm parallel path Outer ring 1>2>3>4

Reason: Error in 2 rings>Error in outer ring + Error detectable by 4>Error in 1>4



Rule 2.1

	Designated Node		Alarm ring		Counter Alarm ring	
	Detection OAM Loss	Receive Alarm OAM	Alarm path	Counter Alarm path	Alarm parallel path	Counter Alarm parallel path
Rule 2.1	2 rings	1-ring	OK	X	OK	X

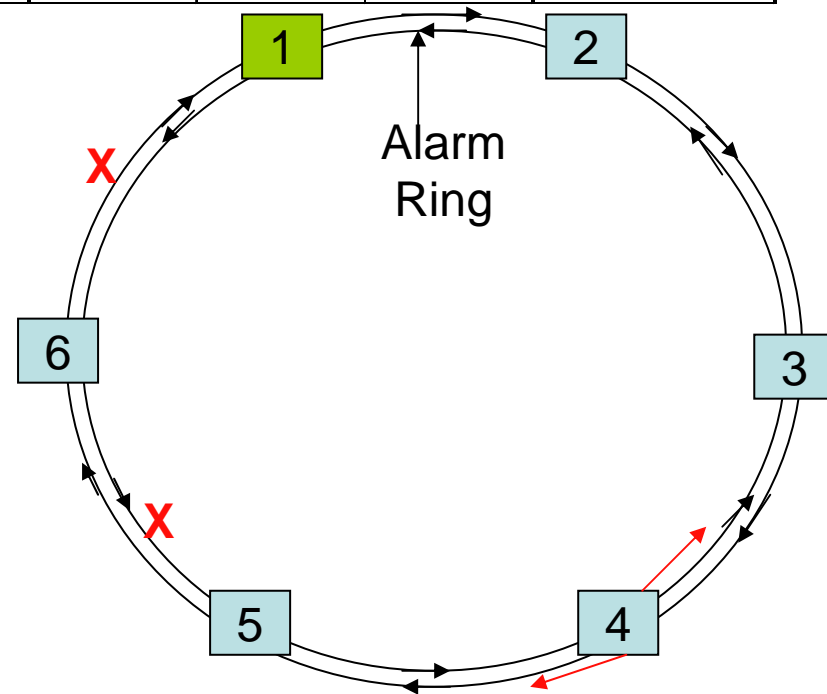
Out(6>1) & in(6>5) broken
 1 cannot receive detection msg in 2 rings
 4 cannot receive detection msg in inner ring
 4 sends 1-ring alarm to 1 via 2 rings
 1 receives 1-ring alarm from 4 in inner ring

Alarm node - 4
 Alarm ring - inner ring
 Alarm path - Inner ring 4>3>2>1

1)Error in Counter Alarm path Inner ring 1>6>5>4
 Reason: Error in 2 rings>Error in Alarm ring+ No error in Alarm path > Result

2)Alarm parallel path Outer ring 1>2>3>4 OK
 Reason: If error>4 detect error > 4 alarm in 2 rings>Contradiction

3)Error in Counter Alarm parallel path Outer ring 4>5>6>1
 Reason: Error in 2 rings > Error in Counter ring>Result



Rule 2.2

	Designated Node		Alarm ring		Counter Alarm ring	
	Detection OAM Loss	Receive Alarm OAM	Alarm path	Counter Alarm path	Alarm parallel path	Counter Alarm parallel path
Rule 2.2	1 ring (Alarm in this ring)	1-ring	OK	X	OK	OK

In(6>5) broken

1 & 4 cannot receive detect msg in inner ring

4 sends 1-ring alarm to 1 via 2 rings

1 receives 1-ring alarm from 4 via 2 rings

Alarm node – 4

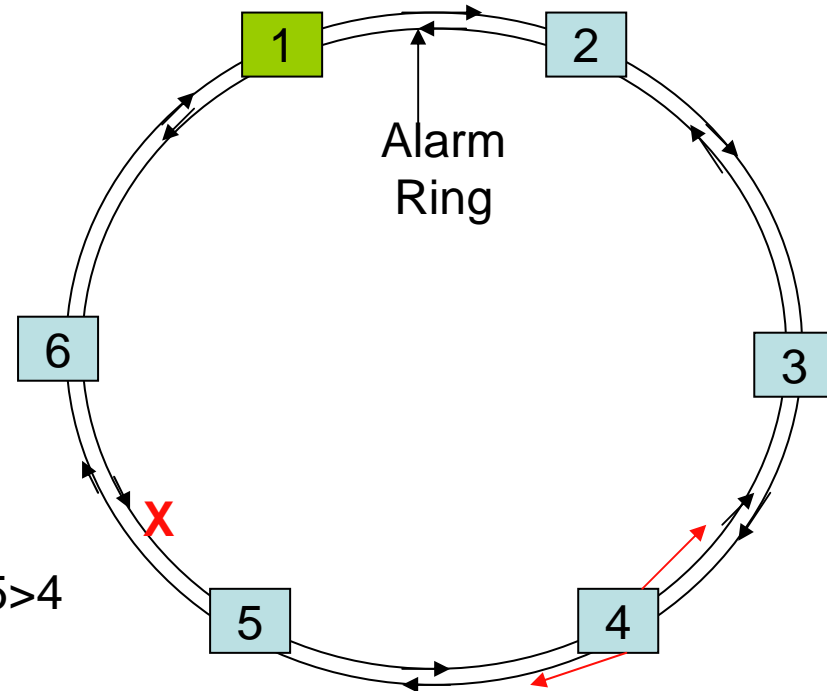
Fault ring = Alarm ring = inner ring

1) Error in Counter Alarm path Inner ring 1>6>5>4

Reason: Error in Alarm ring>Result

2) Counter Alarm ring ok

Reason: DN can receive detect msg in this ring-> This ring is ok



Rule 2.3

	Designated Node		Alarm ring		Counter Alarm ring	
	Detection OAM Loss	Receive Alarm OAM	Alarm path	Counter Alarm path	Alarm parallel path	Counter Alarm parallel path
Rule 2.3	1 ring (Alarm in other ring)	1-ring	OK	OK	X	?

Out(3>4) broken

1 & 4 cannot receive detect msg in outer ring

4 sends 1-ring alarm to 1 via 2 rings

1 receives 1-ring alarm from 4 via 2 rings

Alarm node – 4

Fault ring = Counter Alarm ring=Outer ring

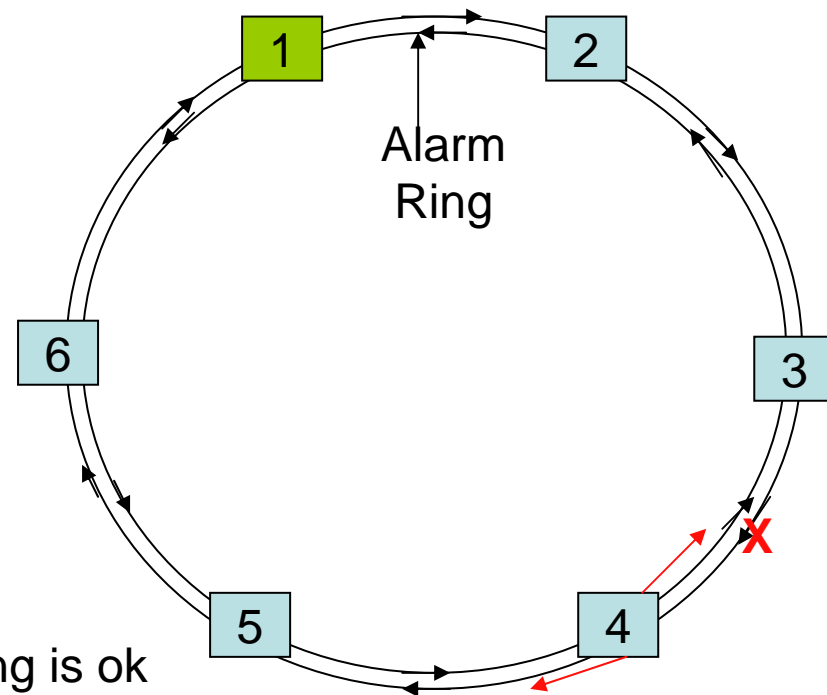
Alarm ring = Inner ring

1) Alarm ring ok

Reason: DN can receive detect msg > This ring is ok

2) Error in Alarm parallel path Outer ring 1>2>3>4

Reason: If no error >4 cannot detect error & cannot send alarm msg to 1>Contradiction



Rule 3

	Designated Node	Fault Ring		Counter Fault ring	
	Detection OAM Loss	Reach Path	Counter Reach path	Reach parallel path	Counter Reach parallel path
Rule 3	only in 1 ring	OK	X	OK	OK

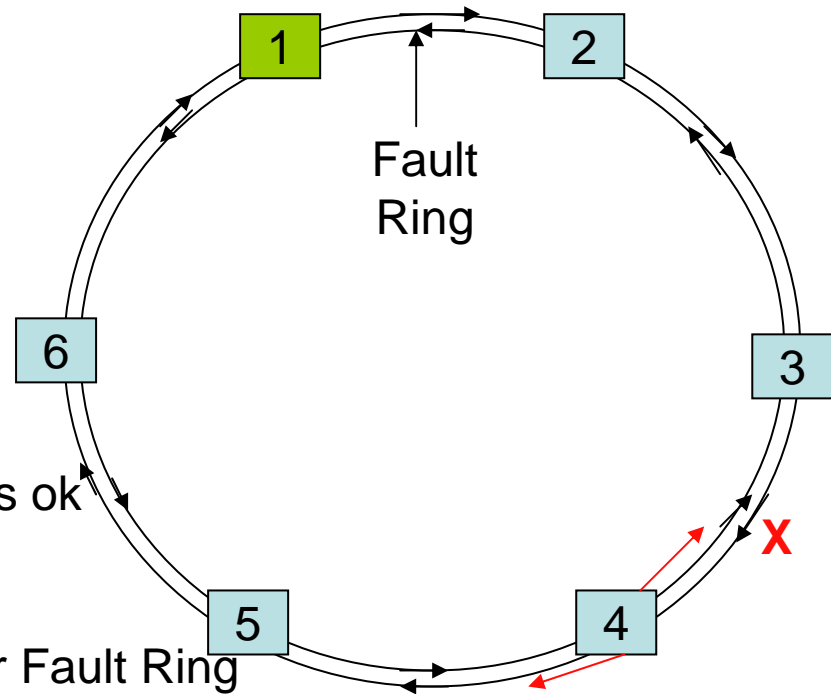
Out(3>4) broken
 1 cannot receive detect msg in outer ring

Non Alarm node – 3
 Fault ring =Outer ring

1)Counter Fault ring ok
 Reason: DN can receive detect msg > This ring is ok

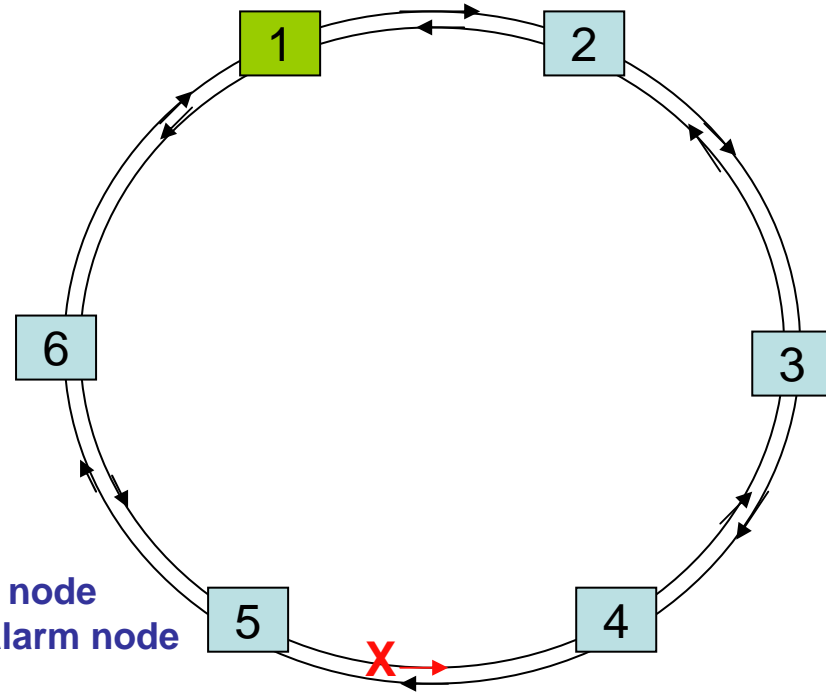
2) Reach path Outer ring 1>2>3 ok
 Reason: If error> 3 sends Alarm msg via Counter Fault Ring
 >Contradiction

3)Error in Counter Reach path Outer ring 3>4>5>6
 Reason: Error in Fault ring + Reach path ok>Result



1 Ring 1 Link Error

Rule 2.2(In,4) In 1>4 X
 Rule 3(In,5) In 1>6>5 OK
 : In 5>4 X



5->4 In	Detect Loss		Alarm	
	Out	In	Out	In
1		X		
2		X	In	In
3		X	In	In
4		X	In	In
5				
6				

← 1 ring detection loss
 Alarm in this ring

← Most Remote Alarm node

← Most Remote Non Alarm node

	Designated Node		Alarm ring		Counter Alarm ring	
	Detection OAM Loss	Receive Alarm OAM	Alarm path	Counter Alarm path	Alarm parallel path	Counter Alarm parallel path
Rule 1	Both	2-ring	OK	X	X	?
Rule 2.1	Both	1-ring	OK	X	OK	X
Rule 2.2	Alarm ring		OK	X	OK	OK
Rule 2.3	Counter Alarm ring		OK	OK	X	?
	Designated Node		Fault Ring		Counter Fault ring	
	Detection OAM Loss		Reach Path	Counter Reach path	Reach parallel path	Counter Reach parallel path
Rule 3	only in 1 ring		OK	X	OK	OK

Counter Alarm Path:1>4

Reach Path:1>4

Counter Reach Path:5>4

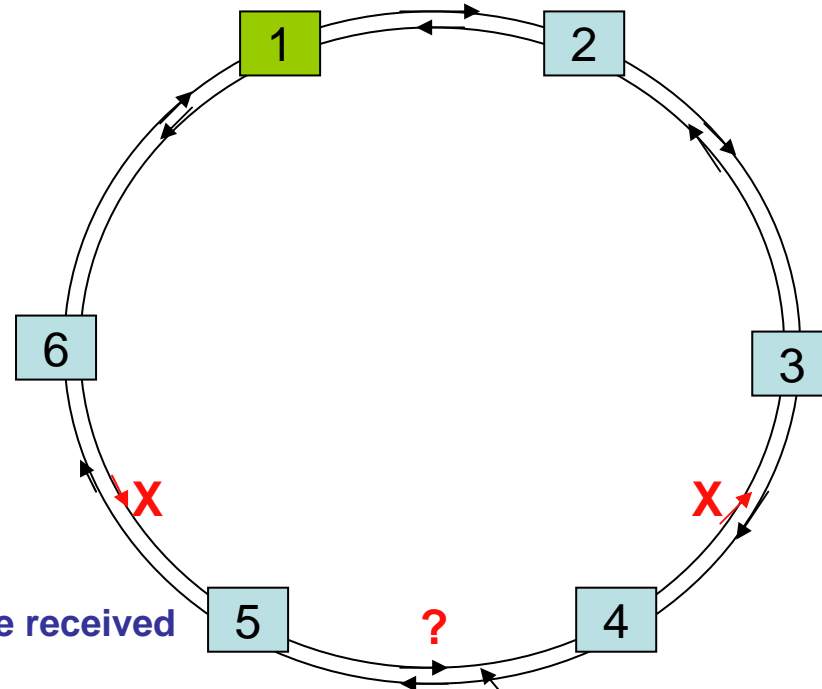
1 Ring 2 Links Error

Rule 2.2(In,3) In 1>3 X
 Rule 2.3(Out,5) In 1>5 X
 Rule 3(In,6) In 1>6 OK
 : In 6>5>4>3 X

N links error is similar

6->5 In	Detect		Location	
4->3 In	Out	In	Out	In
Node				
1		X		
2		X	In	In
3		X	In	In
4		X	In	In
5		X	In	In
6				

Sent but cannot be received



Same Alarm
 No matter 5>4 OK or not
 In Inner ring

	Alarming Node	Designated Node	Receiving ring		Other ring	
			Receiving path	Non receiving path	Receiving parallel path	Non receiving parallel path
Rule 1	Bi-dir X	Both	OK	X	X	?
Rule 2.1	Uni-dir X	Both	OK	X	OK	X
Rule 2.2		Receiving	OK	X	OK	OK
Rule 2.3		Other	OK	OK	X	?

2 Ring 2 Links Error

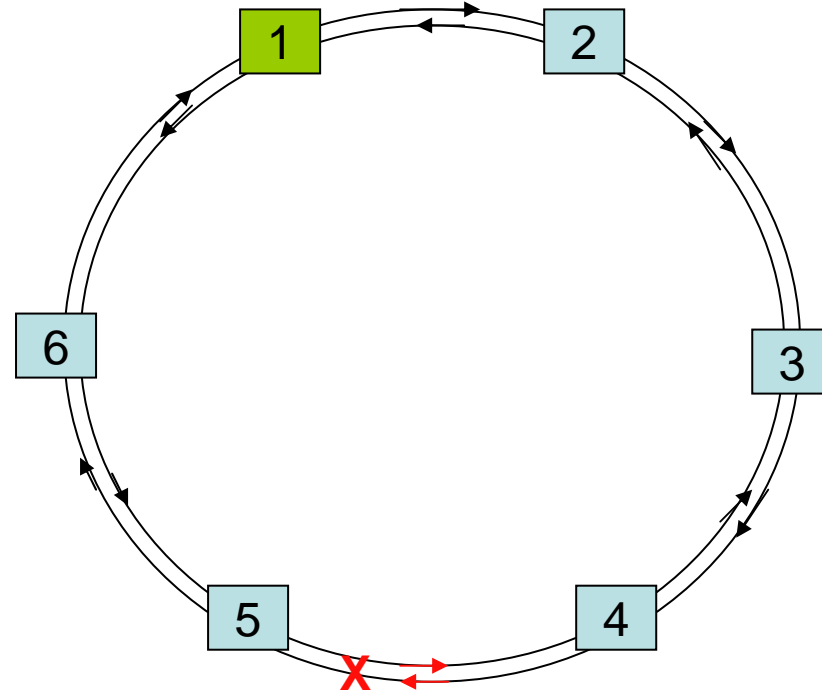
Rule 2.1(In,4):

In 1>4 X, 4>1 OK, Out 4>1 X, 1>4 OK

Rule 2.1(Out,5):

In 5>1 X, 1>5 OK, Out 1>5 X, 5>1 OK

: In 5>4 X Out 4>5 X

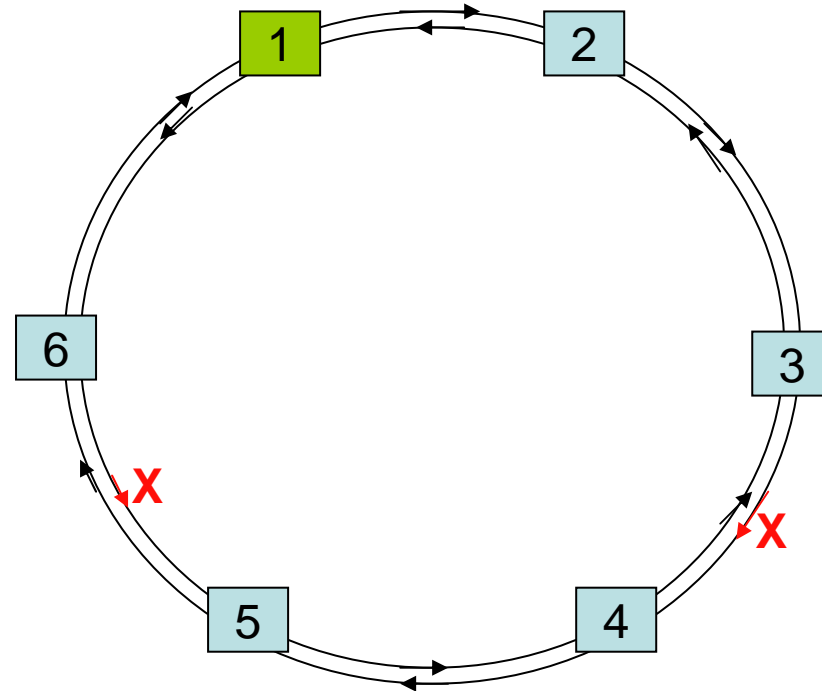


4<->5	Detect		Location	
	Out	In	Out	In
1	X	X		
2		X	In	In
3		X	In	In
4		X	In	In
5	X		Out	Out
6	X		Out	Out

	Alarming Node	Designated Node	Receiving ring		Other ring	
	Localization OAM	Detection OAM	Receiving path	Non receiving path	Receiving parallel path	Non receiving parallel path
Rule 1	Bi-dir X	Both	OK	X	X	?
Rule 2.1	Uni-dir X	Both	OK	X	OK	X
Rule 2.2		Receiving	OK	X	OK	OK
Rule 2.3		Other	OK	OK	X	?

2 Ring 2 Links Error

Rule 1(In,5): In 1>6>5 X 5>1 OK
 Rule 1(Out,4): Out 1>4 X 4>1 OK
 Rule 2.1(In,3): Out 3>4>1 X,1>3 OK
 Rule 2.1(Out,6): In 6>1 X, 1>6 OK
 : In 6>5 X Out 3>4 X



6->5 In 3->4 Out	Detect		Location	
	Out	In	Out	In
1	X	X		
2		X	In	In
3		X	In	In
4	X	X	Both	Both
5	X	X	Both	Both
6	X		Out	Out

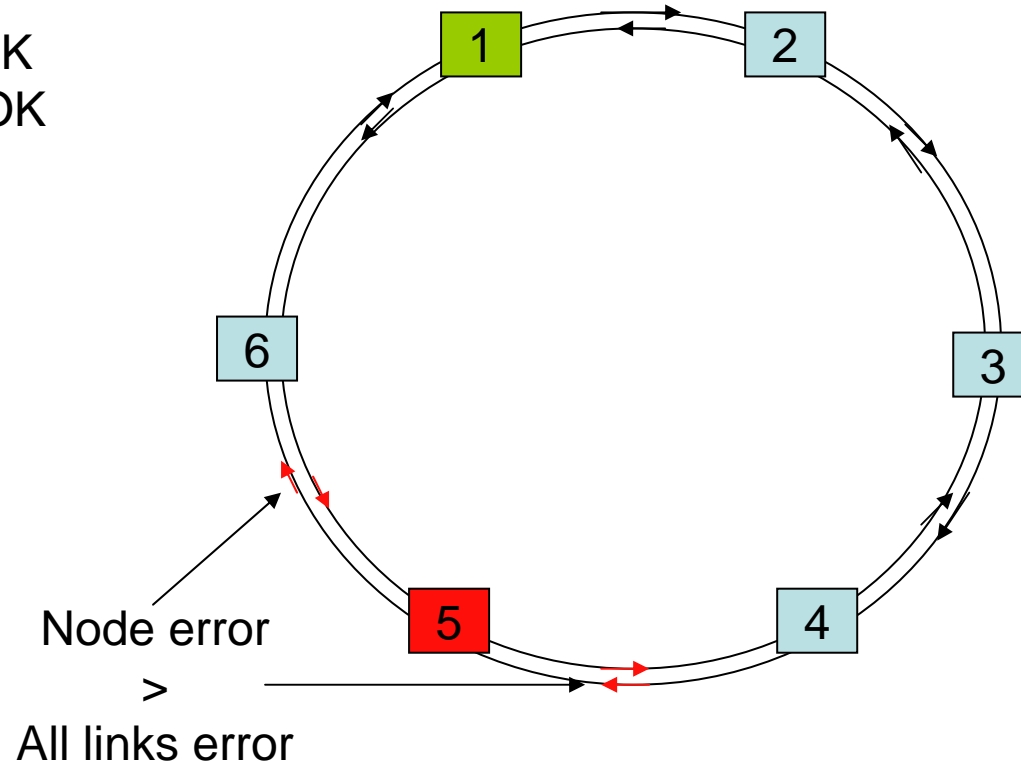
	Alarming Node	Designated Node	Receiving ring		Other ring	
			Receiving path	Non receiving path	Receiving parallel path	Non receiving parallel path
Rule 1	Bi-dir X	Both	OK	X	X	?
Rule 2.1	Uni-dir X	Both	OK	X	OK	X
Rule 2.2		Receiving	OK	X	OK	OK
Rule 2.3		Other	OK	OK	X	?

1 Node Error

Rule 2.1(In,4): Out 4>1 X, 1>4 OK
 Rule 2.1(Out,6): In 6>1 X, 1>6 OK
 : In 6>5>4 X Out 4>5>6 X

N nodes error is similar

Node 5	Detect		Location	
	Out	In	Out	In
1	X	X		
2		X	In	In
3		X	In	In
4		X	In	In
5				
6	X		Out	Out



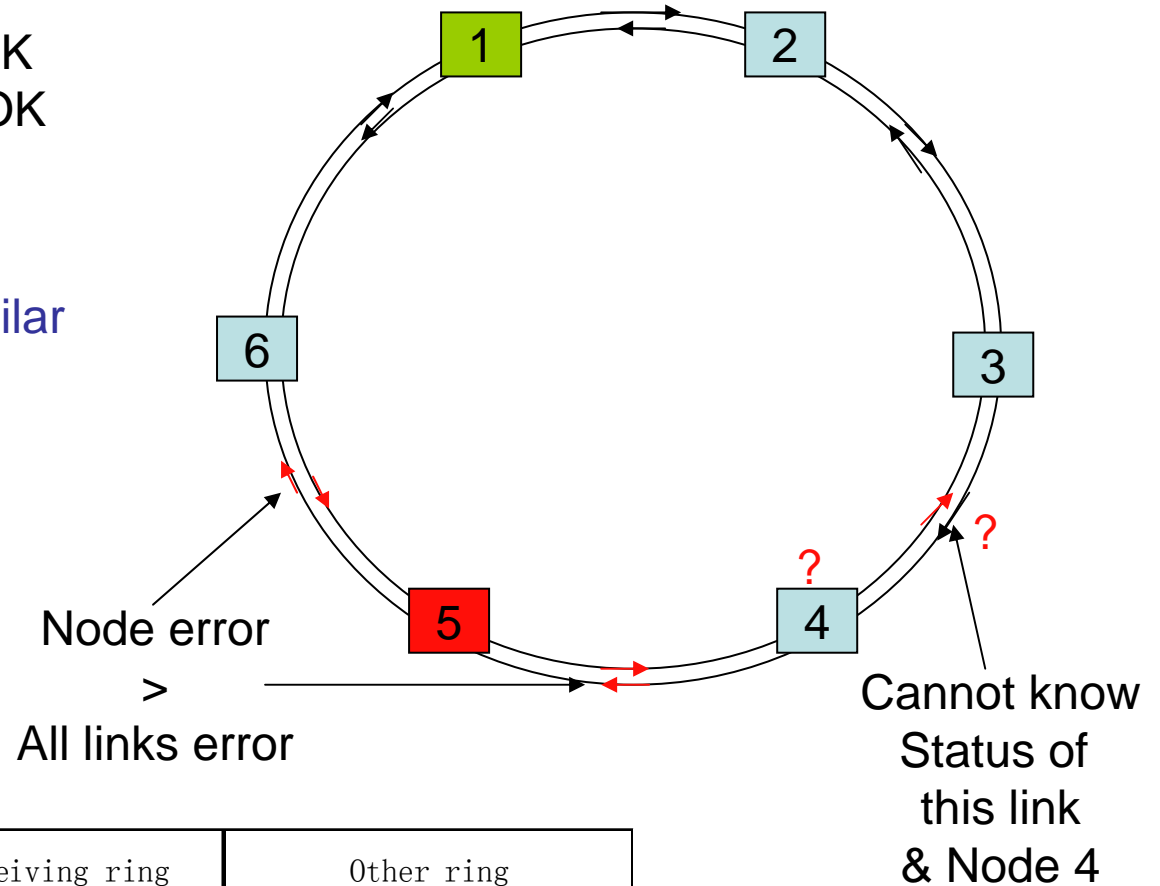
	Alarming Node	Designated Node	Receiving ring		Other ring	
			Receiving path	Non receiving path	Receiving parallel path	Non receiving parallel path
Rule 1	Bi-dir X	Both	OK	X	X	?
Rule 2.1	Uni-dir X	Both	OK	X	OK	X
Rule 2.2		Receiving	OK	X	OK	OK
Rule 2.3		Other	OK	OK	X	?

1 Node and 1 Link Error

Rule 2.1(In,3): Out 3>1 X, 1>3 OK
 Rule 2.1(Out,6): In 6>1 X, 1>6 OK
 : In 6>5>4>3 X Out 3>4>5>6 X

N nodes and N links error is similar

Node 5 4->3 In	Detect		Location	
Node	Out	In	Out	In
1	X	X		
2		X	In	In
3		X	In	In
4		X	In	In
5				
6	X		Out	Out



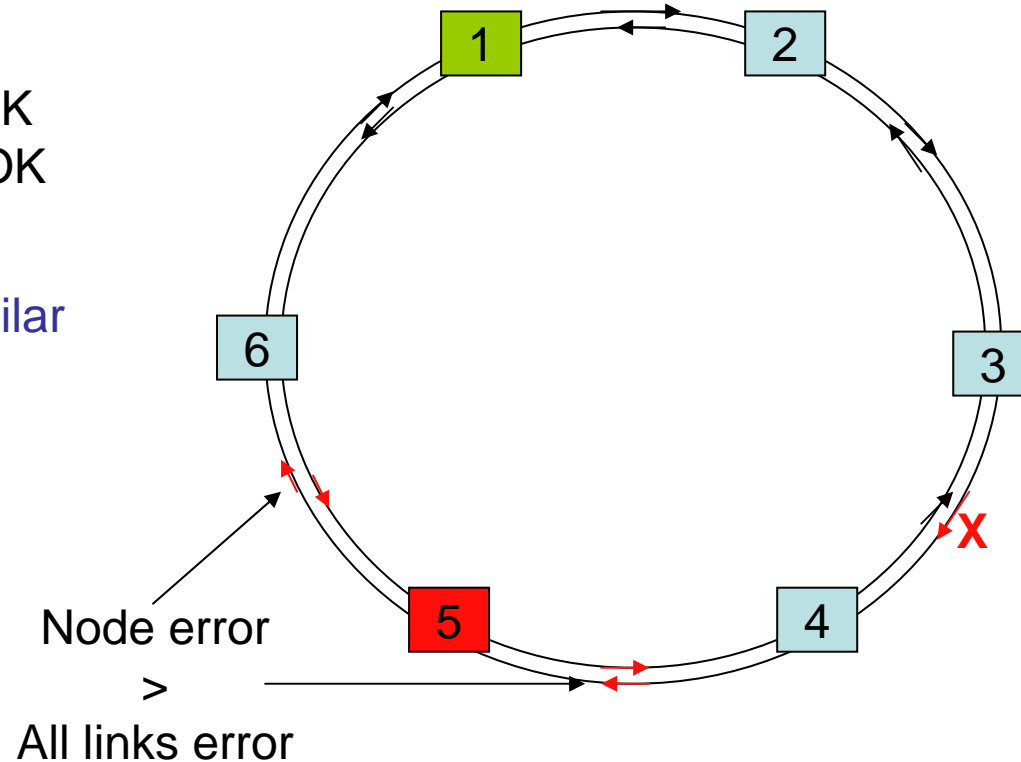
	Alarming Node	Designated Node	Receiving ring		Other ring	
	Localization OAM	Detection OAM	Receiving path	Non receiving path	Receiving parallel path	Non receiving parallel path
Rule 1	Bi-dir X	Both	OK	X	X	?
Rule 2.1	Uni-dir X	Both	OK	X	OK	X
Rule 2.2		Receiving	OK	X	OK	OK
Rule 2.3		Other	OK	OK	X	?

1 Node and 1 Link Error

Rule 1(In,4): In 1>4 X 4>1 OK
 Rule 2.1(In,3): Out 3>1 X, 1>3 OK
 Rule 2.1(Out,6): In 6>1 X, 1>6 OK
 : In 6>5>4 X Out 3>4>5>6 X

N nodes and N links error is similar

Node 5 3->4 Out	Detect		Location	
Node	Out	In	Out	In
1	X	X		
2		X	In	In
3		X	In	In
4	X	X	Both	Both
5				
6	X		Out	Out



	Alarming Node	Designated Node	Receiving ring		Other ring	
	Localization OAM	Detection OAM	Receiving path	Non receiving path	Receiving parallel path	Non receiving parallel path
Rule 1	Bi-dir X	Both	OK	X	X	?
Rule 2.1	Uni-dir X	Both	OK	X	OK	X
Rule 2.2		Receiving	OK	X	OK	OK
Rule 2.3		Other	OK	OK	X	?

Next Step

- Improvement
- Actions after fault detection & localization

Summary

- Ring optimized fault detection & localization mechanism for ring
- Normally only 1 detection msg in each direction at any time if ring delay < detection interval
- Cover single/multiple links and nodes failure

Please comment