Runtime Fault Recovery Protocol for NoC-based MPSoCs

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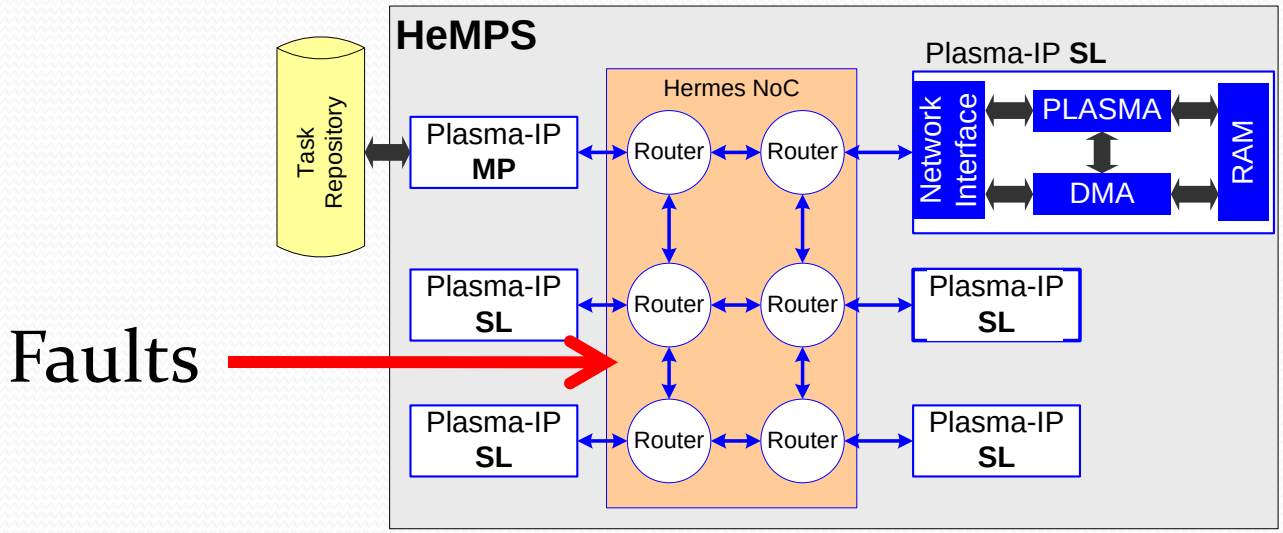
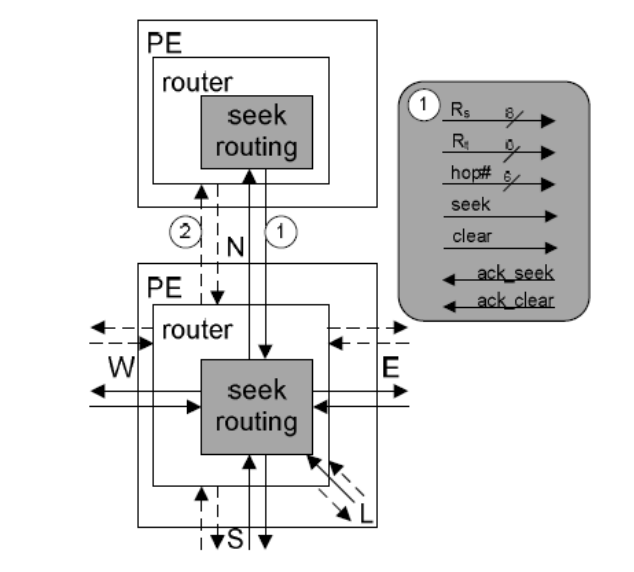
Abstract:

- Permanent faults on the interconnect network can stall or crash applications even though the network has alternative fault-free paths to a given destination.
- The proposed approach determines new paths quickly, and the costs of extra silicon area and memory usage are small.
- MPSoC HeMPS simulated in RTL.

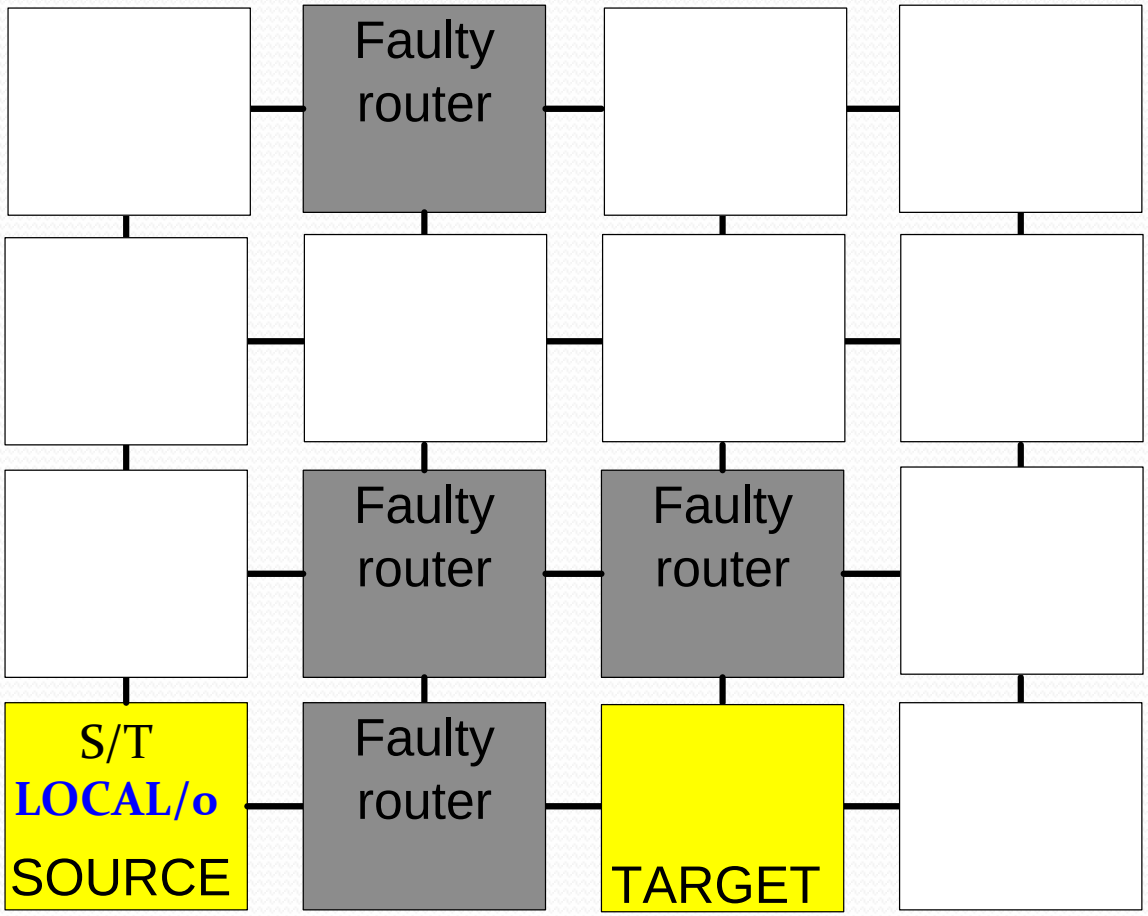


FT COMMUNICATION PROTOCOL:

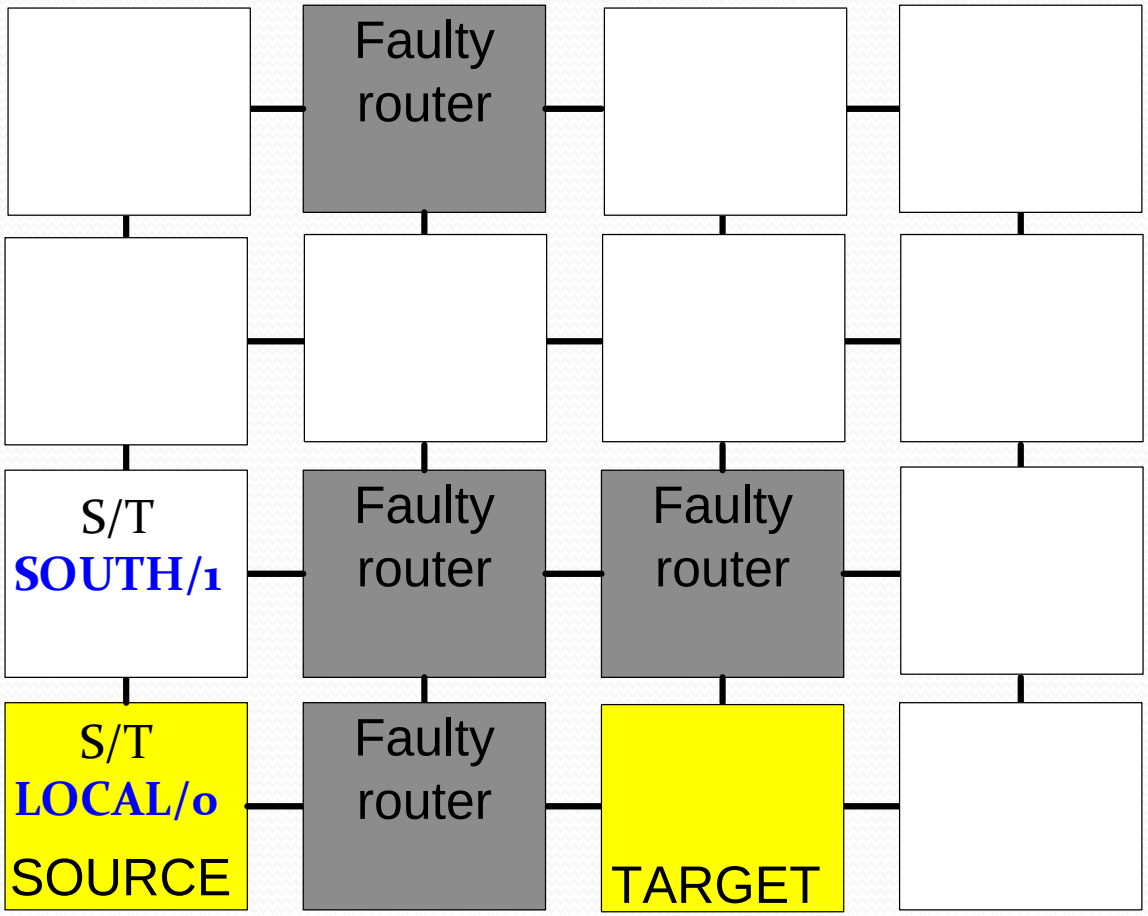
- The NoC received the path search module, called seek module:
  - *seek* new path
  - *backtrack* the new path
  - *clear* the seek structures and *compute* the new path



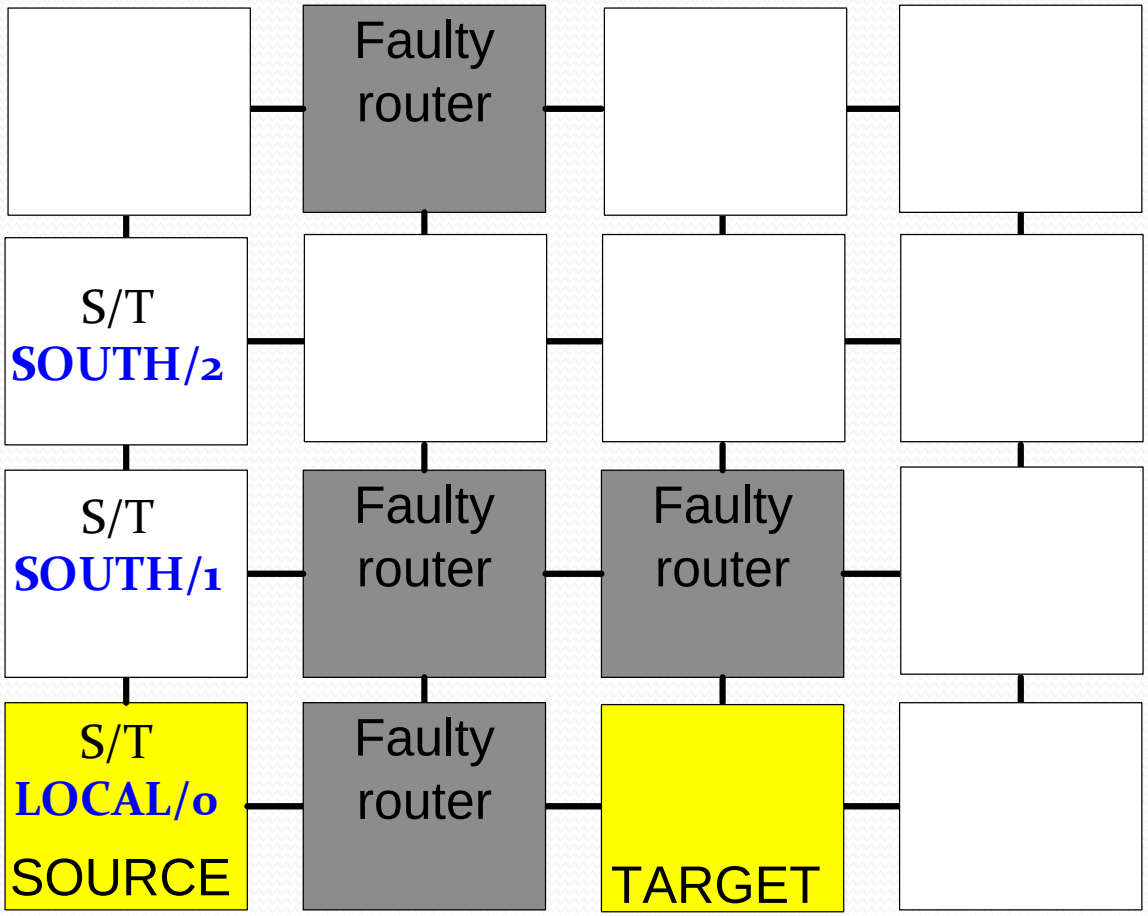
Seek step:


Faulty router
Faulty router
Faulty router
S/T
LOCAL/o
SOURCE
Faulty router
TARGET

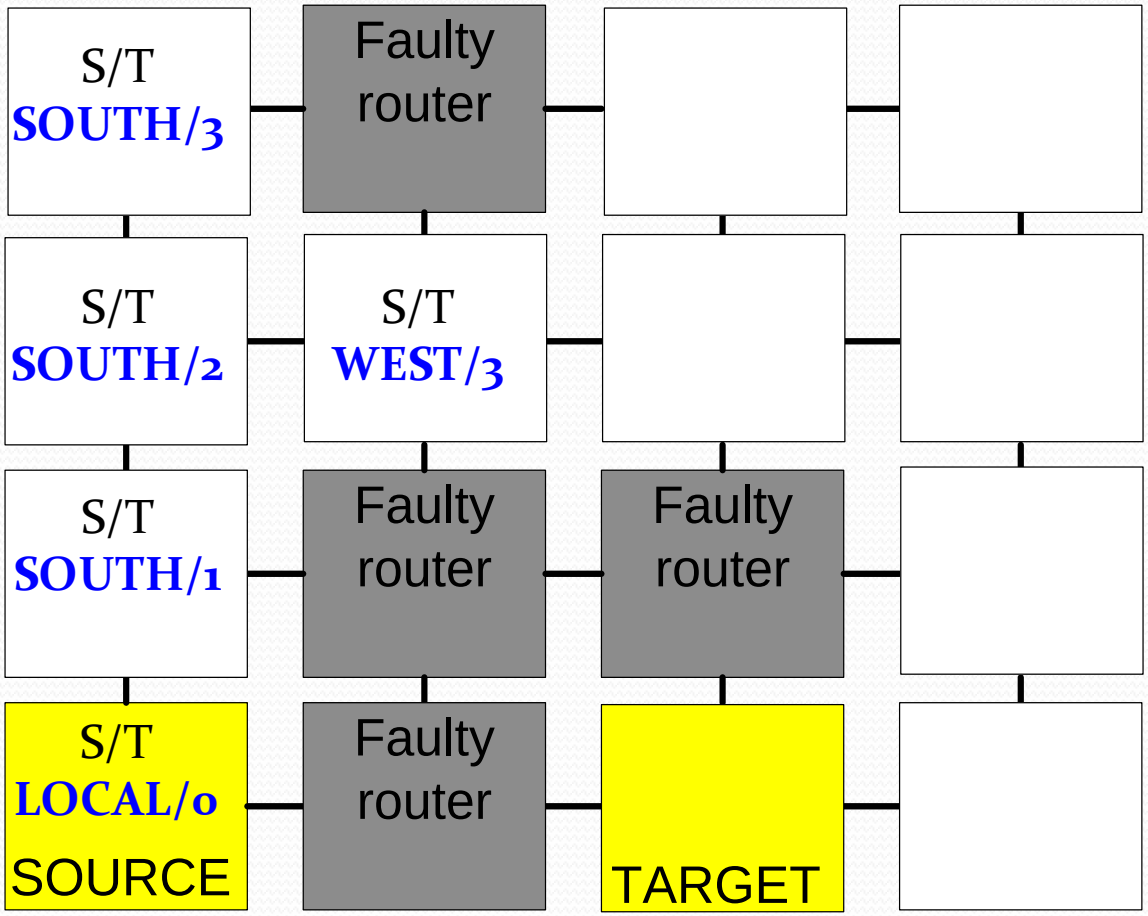
Seek step:


Faulty router
Faulty router
Faulty router
S/T
SOUTH/1
S/T
LOCAL/0
SOURCE
Faulty router
TARGET

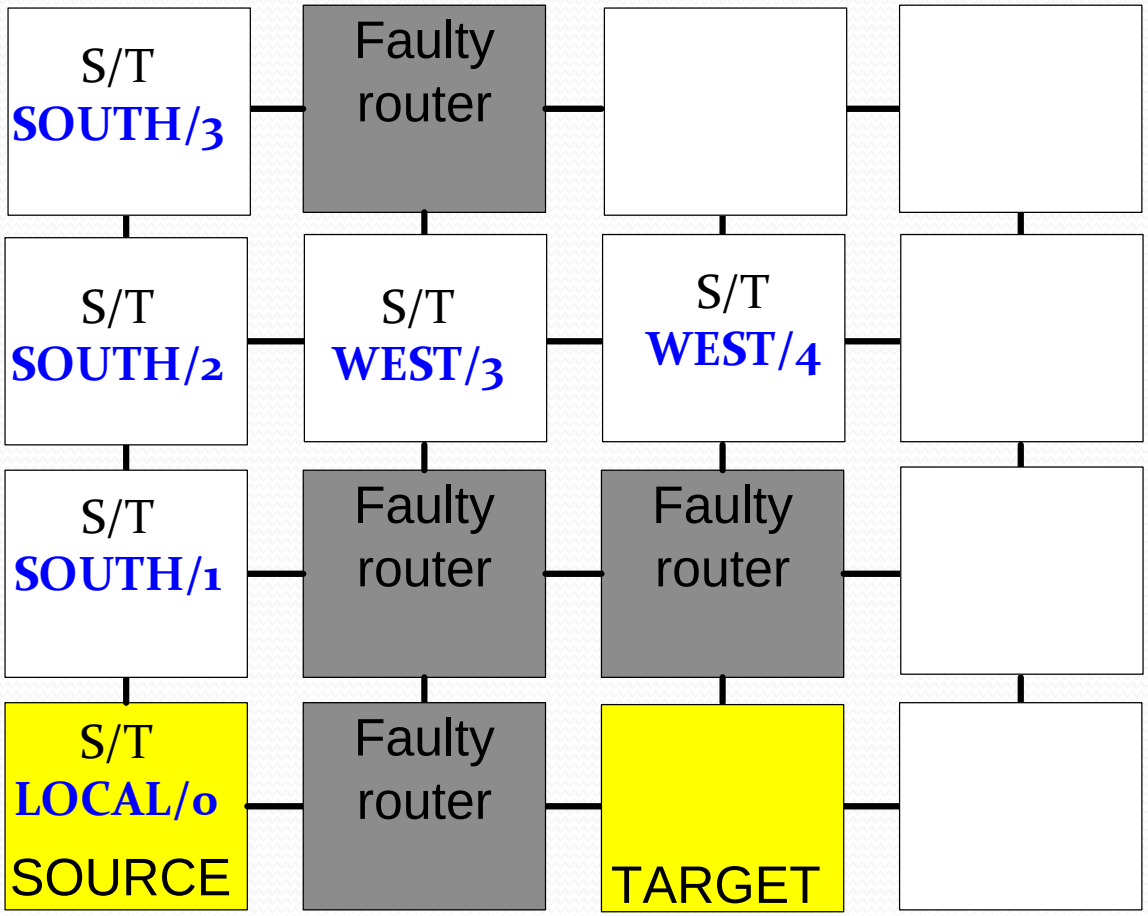
Seek step:


Faulty router
S/T SOUTH/2
S/T SOUTH/1
Faulty router
Faulty router
S/T LOCAL/0 SOURCE
Faulty router
TARGET

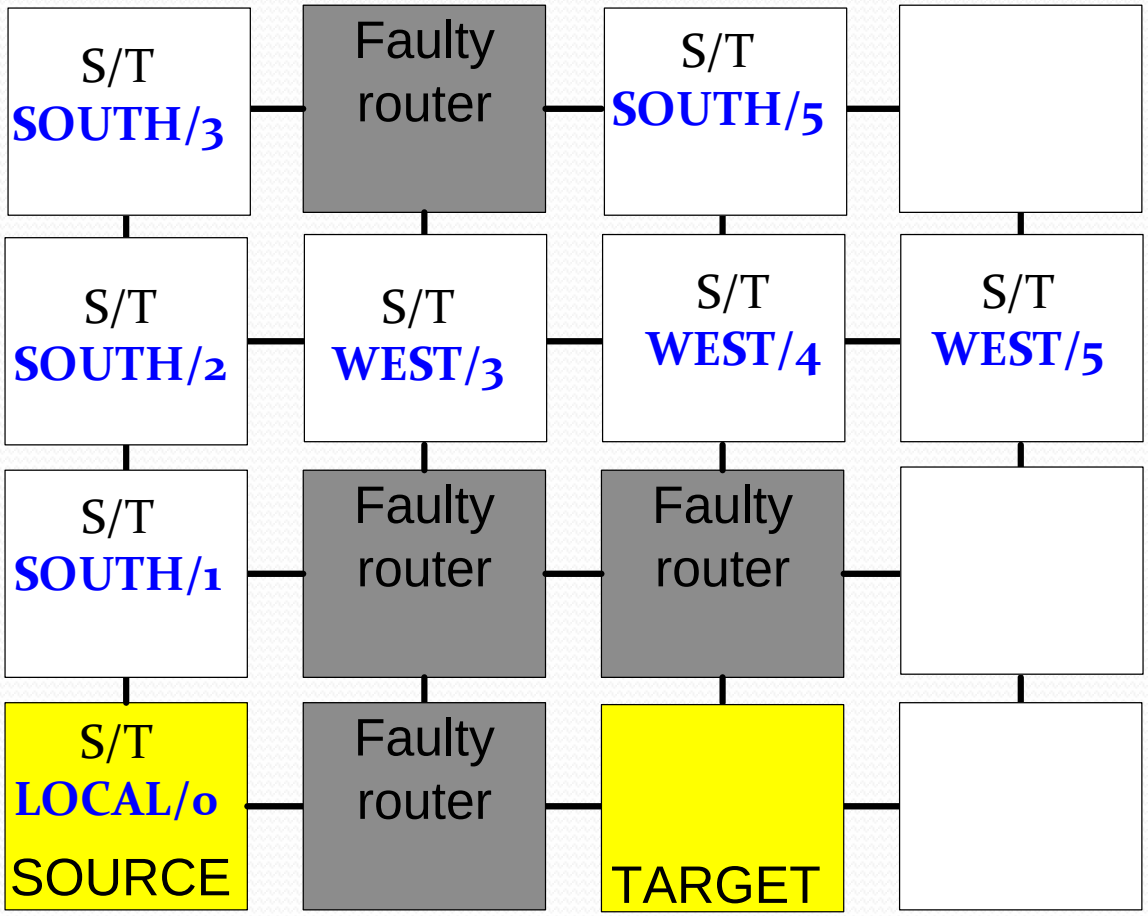
Seek step:


S/T
SOUTH/3
Faulty router
S/T
SOUTH/2
S/T
WEST/3
S/T
SOUTH/1
Faulty router
Faulty router
S/T
LOCAL/0
SOURCE
Faulty router
TARGET

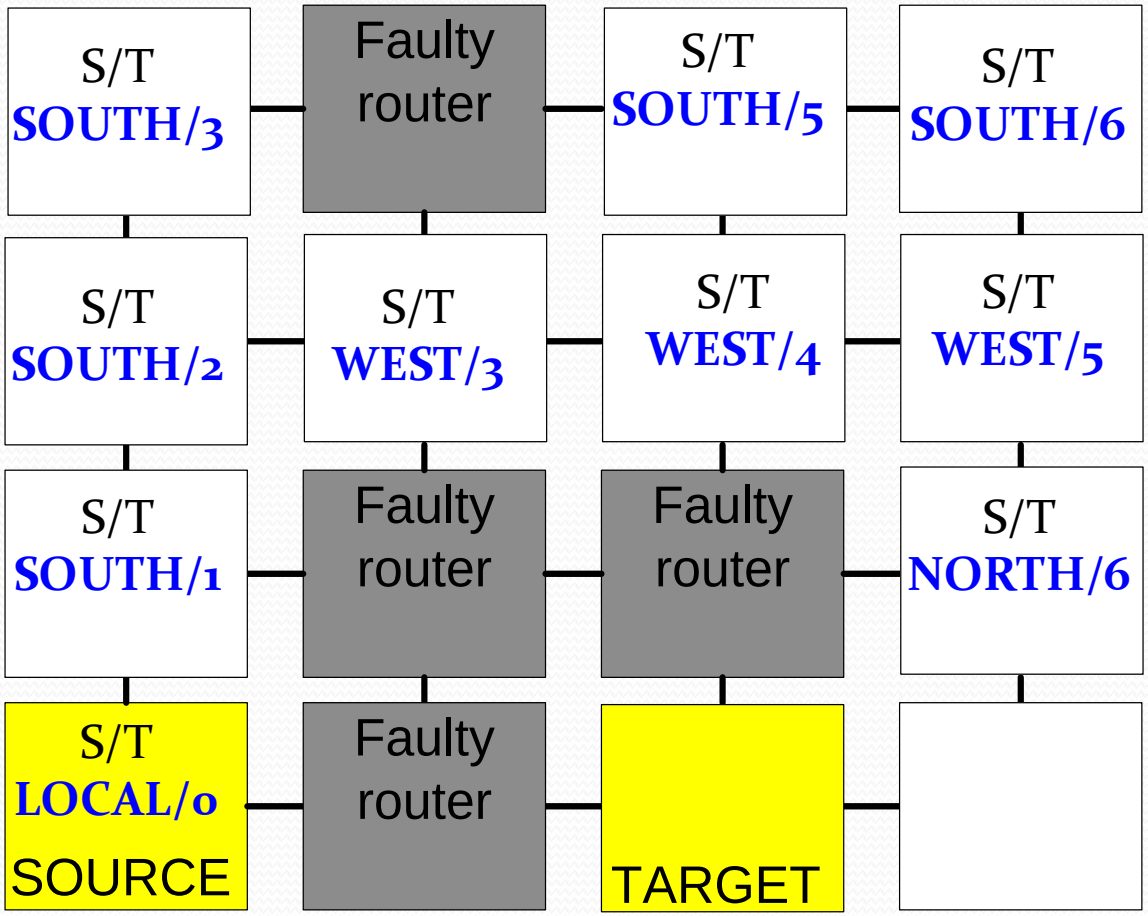
Seek step:


S/T
SOUTH/3
Faulty router
S/T
SOUTH/2
S/T
WEST/3
S/T
WEST/4
S/T
SOUTH/1
Faulty router
Faulty router
S/T
LOCAL/0
SOURCE
Faulty router
TARGET

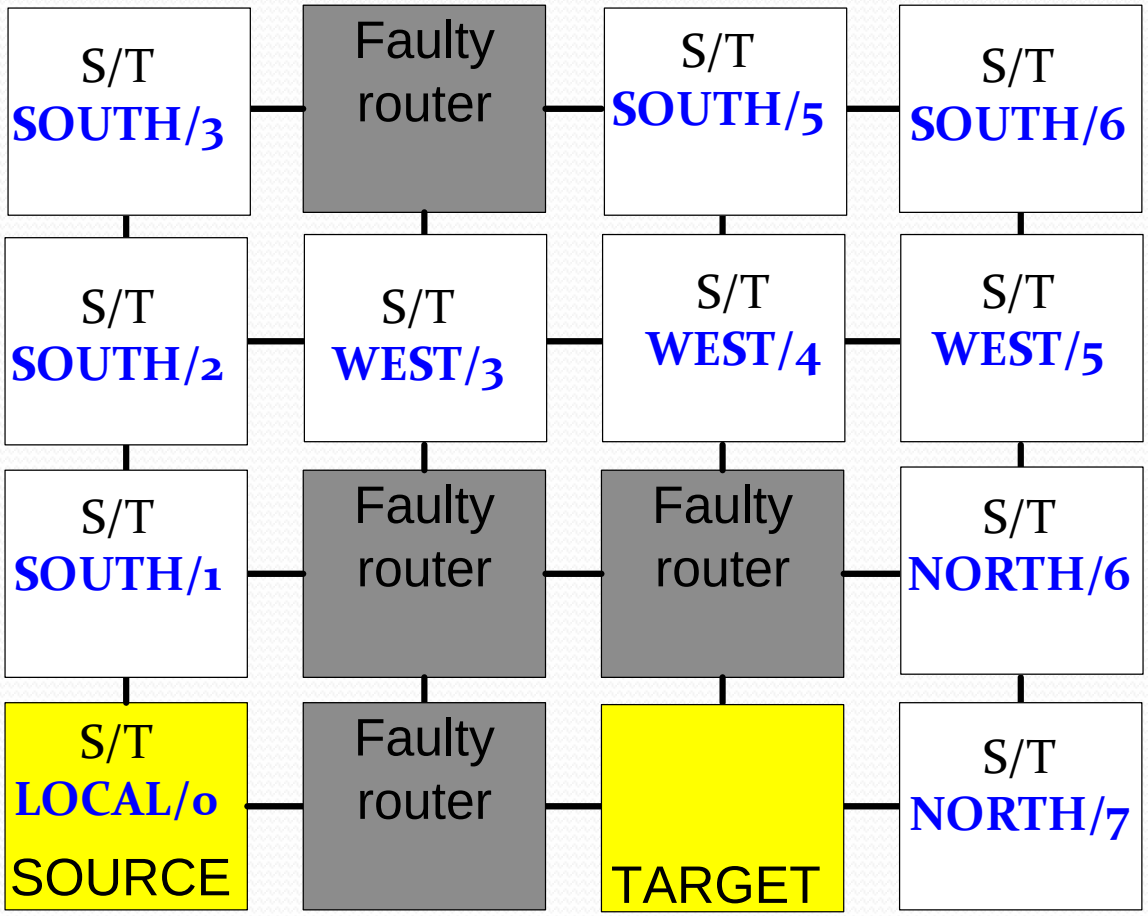
Seek step:


S/T
SOUTH/3
Faulty router
S/T
SOUTH/5
S/T
SOUTH/2
S/T
WEST/3
S/T
WEST/4
S/T
WEST/5
S/T
SOUTH/1
Faulty router
Faulty router
S/T
LOCAL/0
SOURCE
Faulty router
TARGET

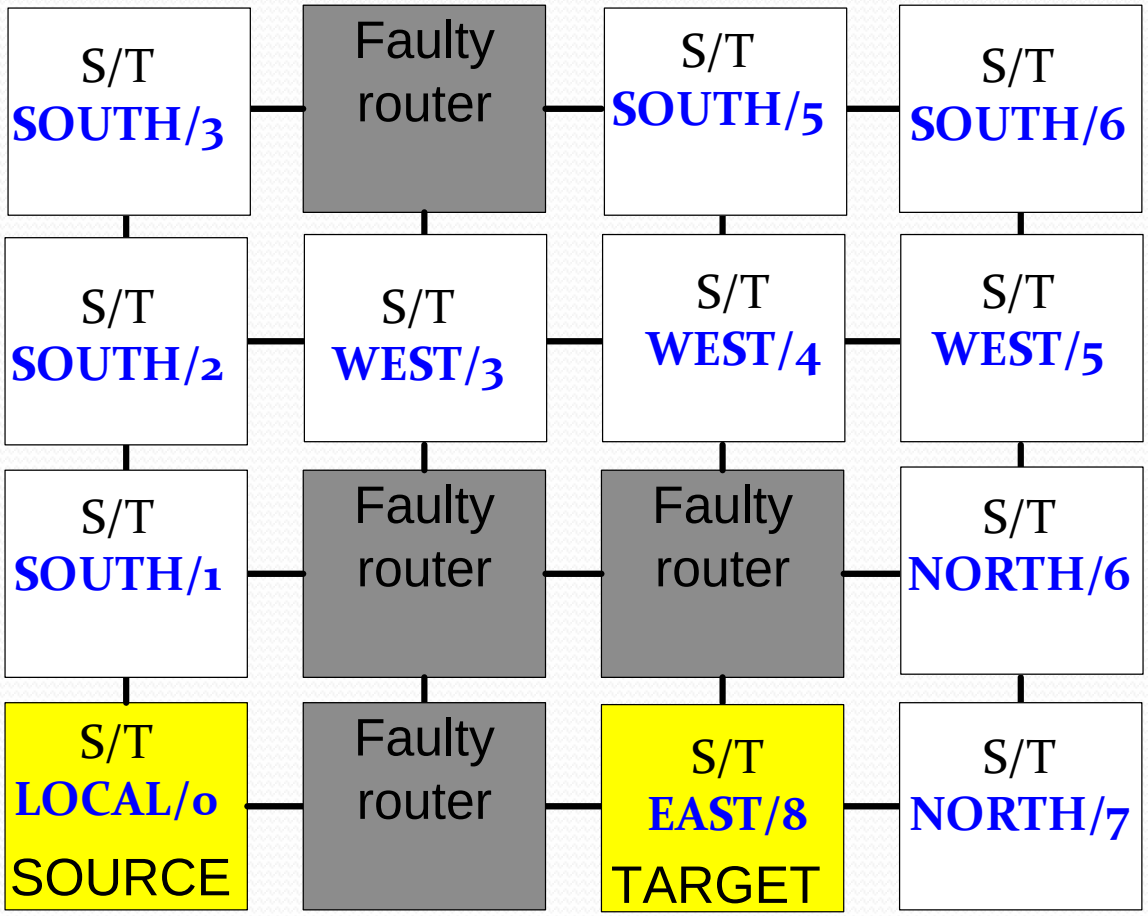
Seek step:


S/T
SOUTH/3
Faulty router
S/T
SOUTH/5
S/T
SOUTH/6
S/T
SOUTH/2
S/T
WEST/3
S/T
WEST/4
S/T
WEST/5
S/T
SOUTH/1
Faulty router
Faulty router
S/T
NORTH/6
S/T
LOCAL/0
SOURCE
Faulty router
TARGET

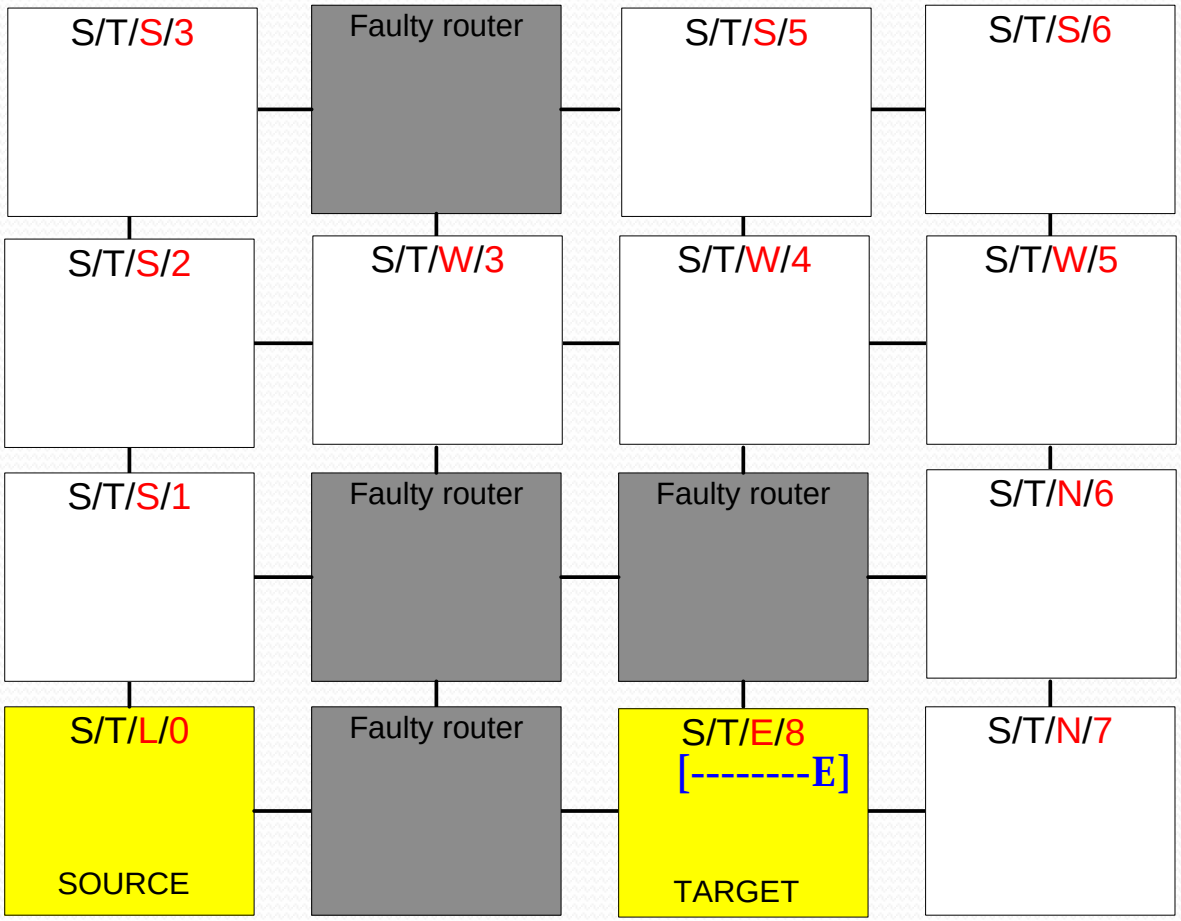
Seek step:


S/T
SOUTH/3
Faulty router
S/T
SOUTH/5
S/T
SOUTH/6
S/T
SOUTH/2
S/T
WEST/3
S/T
WEST/4
S/T
WEST/5
S/T
SOUTH/1
Faulty router
Faulty router
S/T
NORTH/6
S/T
LOCAL/0
SOURCE
Faulty router
TARGET
S/T
NORTH/7

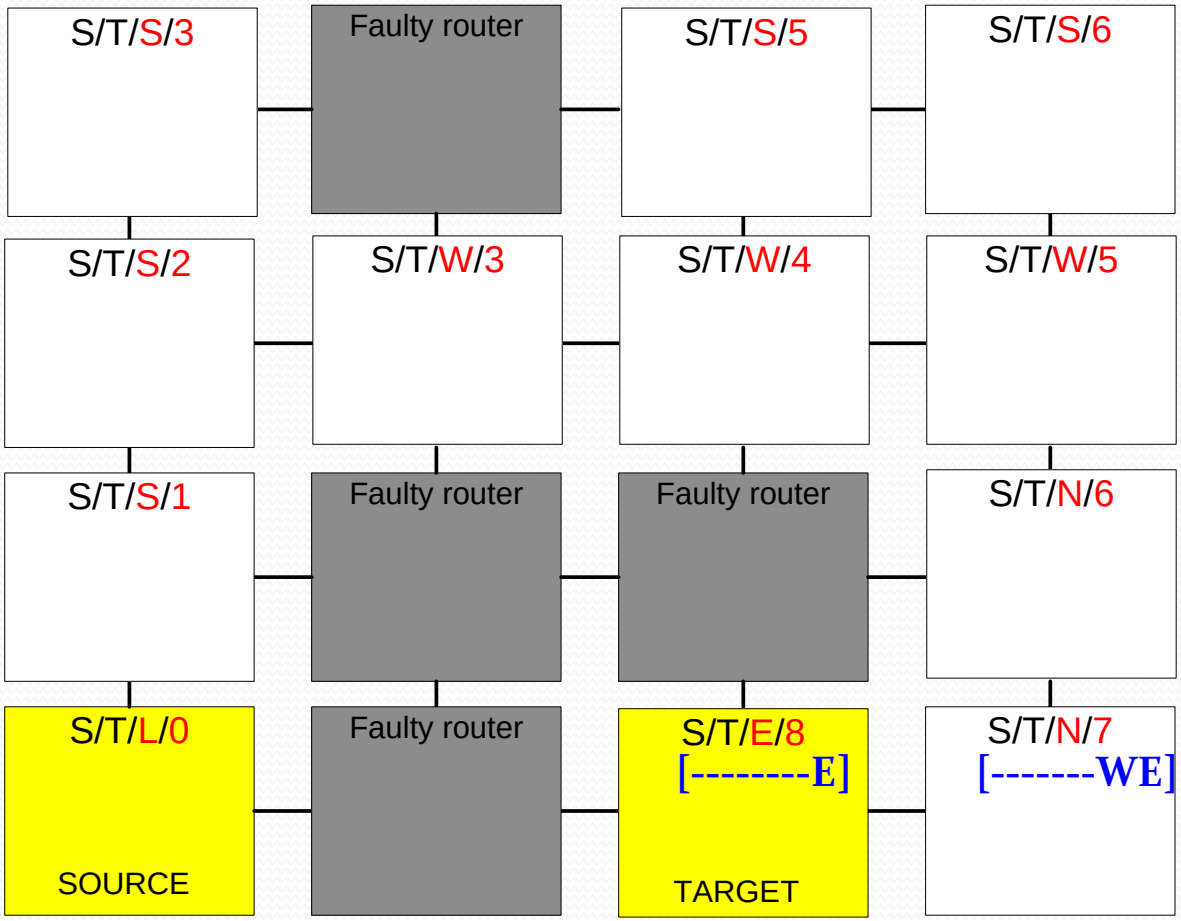
Seek step:


S/T
SOUTH/3
Faulty router
S/T
SOUTH/5
S/T
SOUTH/6
S/T
SOUTH/2
S/T
WEST/3
S/T
WEST/4
S/T
WEST/5
S/T
SOUTH/1
Faulty router
Faulty router
S/T
NORTH/6
S/T
LOCAL/0
SOURCE
Faulty router
S/T
EAST/8
TARGET
S/T
NORTH/7

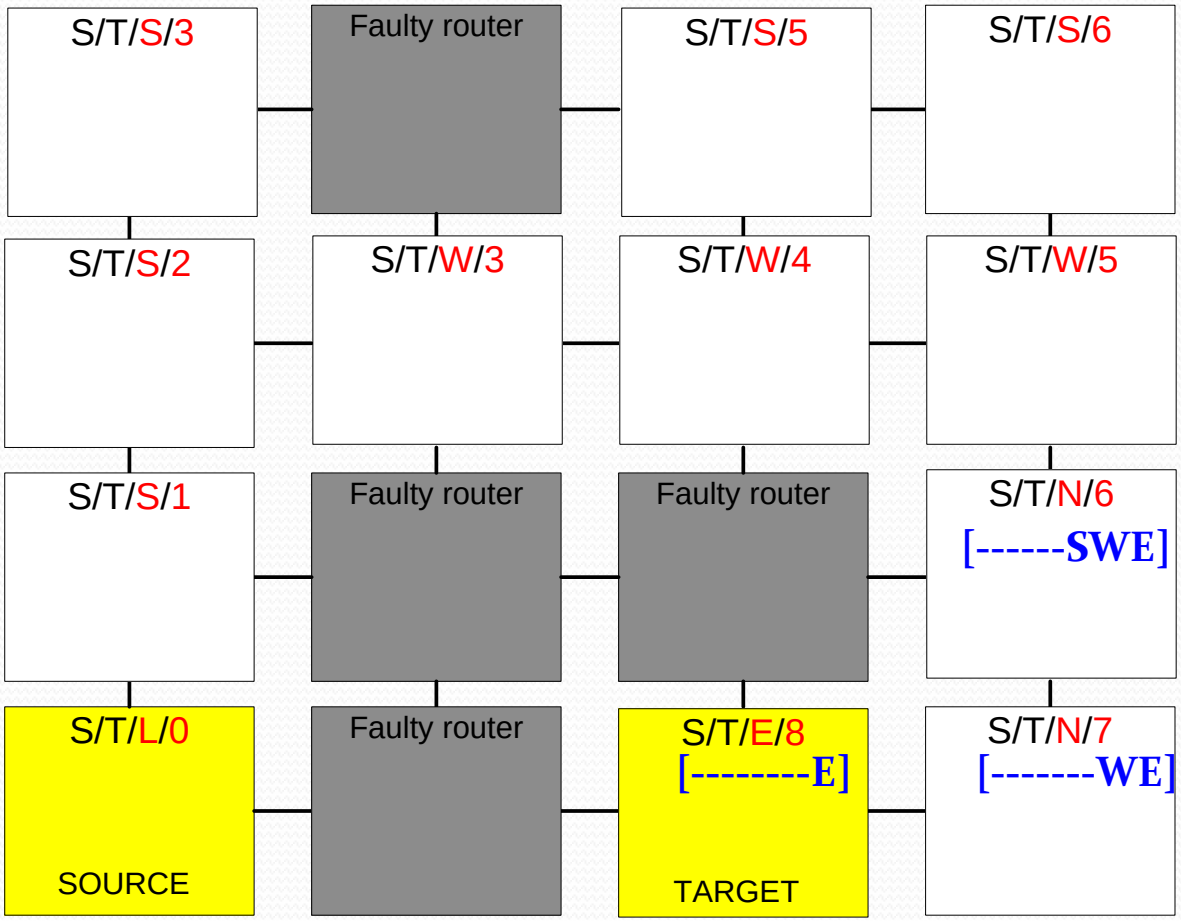
Backtrack step:



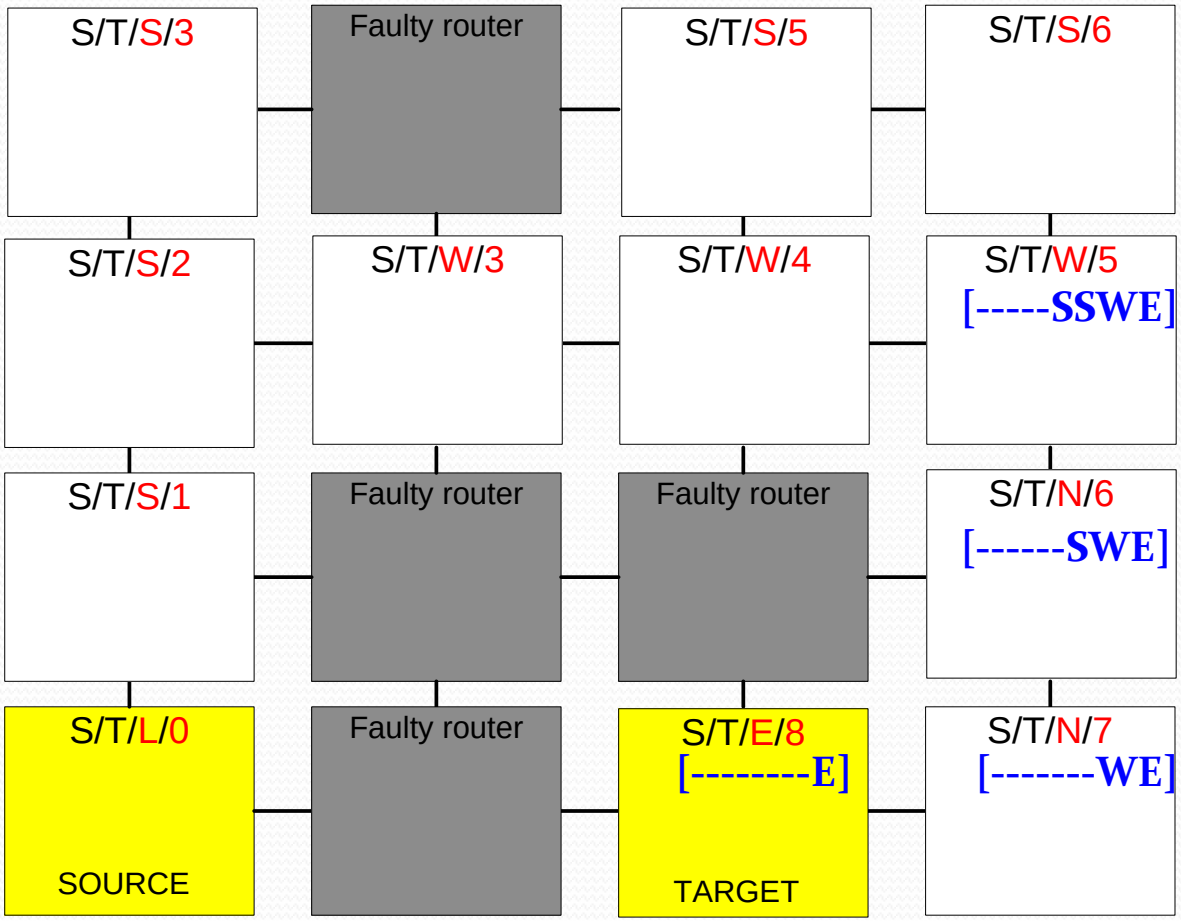
Backtrack step:



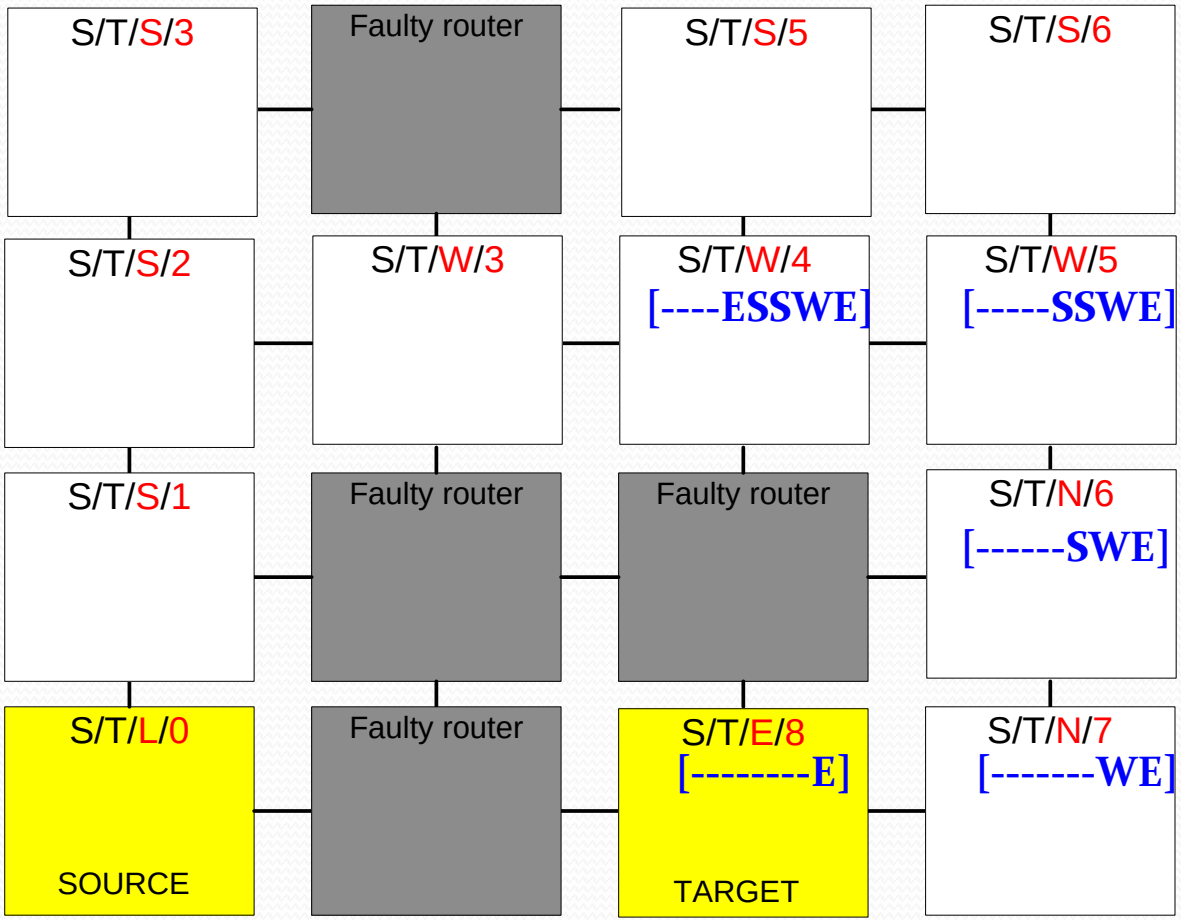
Backtrack step:



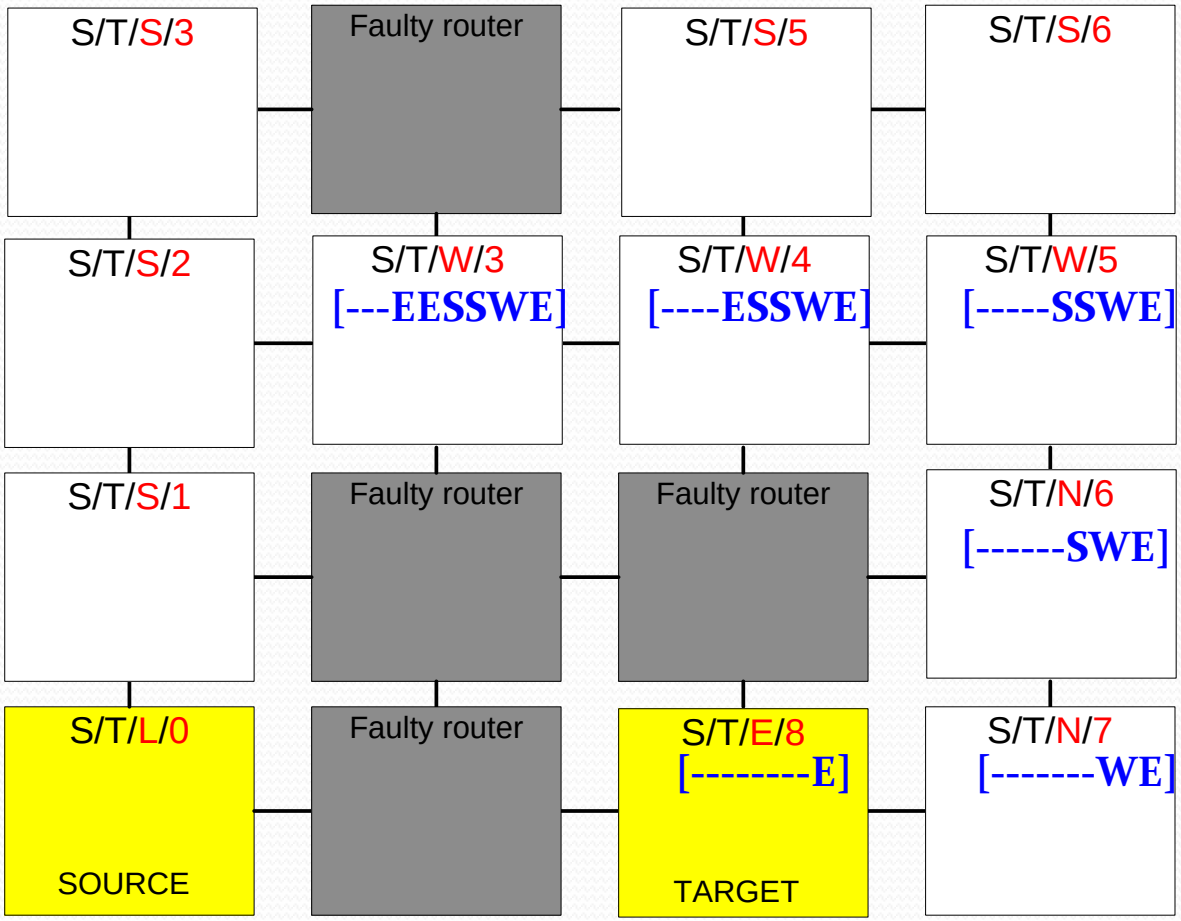
Backtrack step:



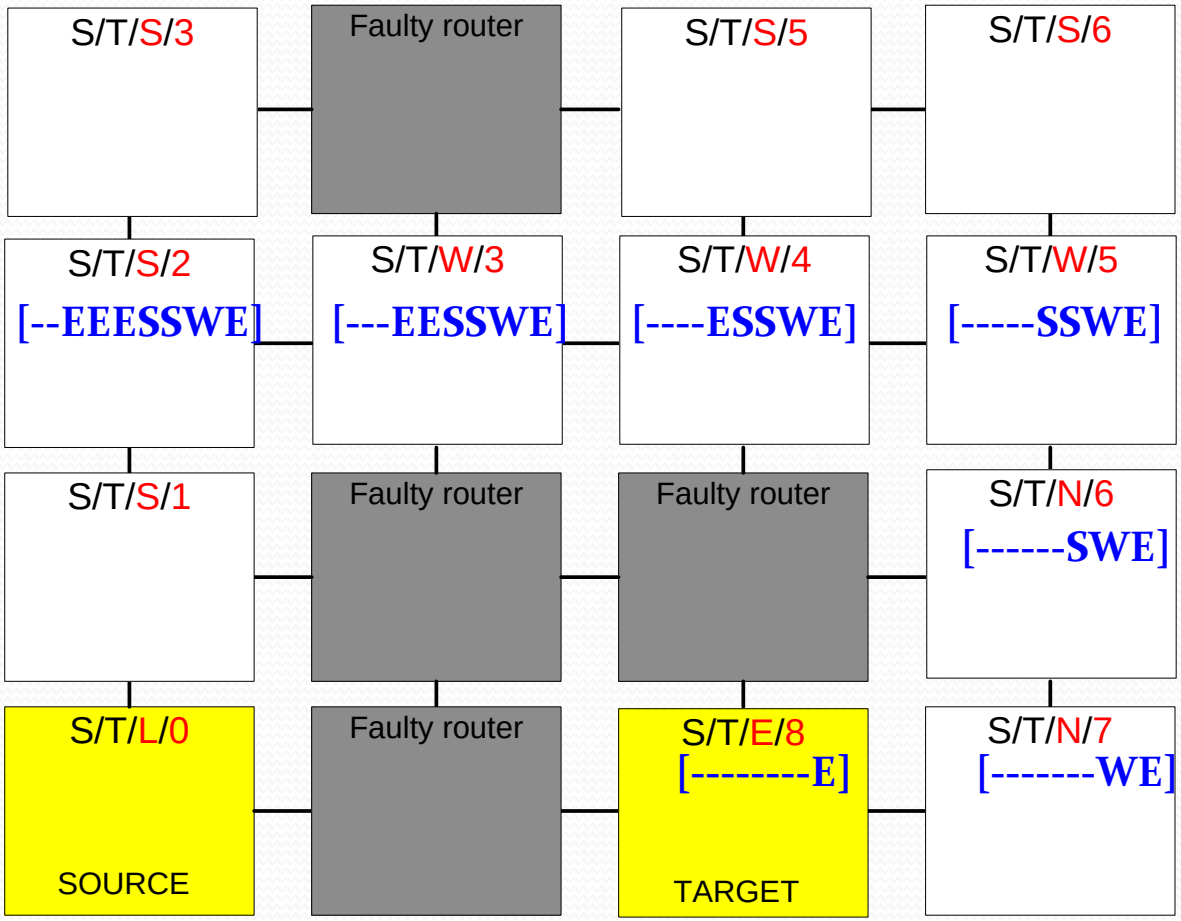
Backtrack step:



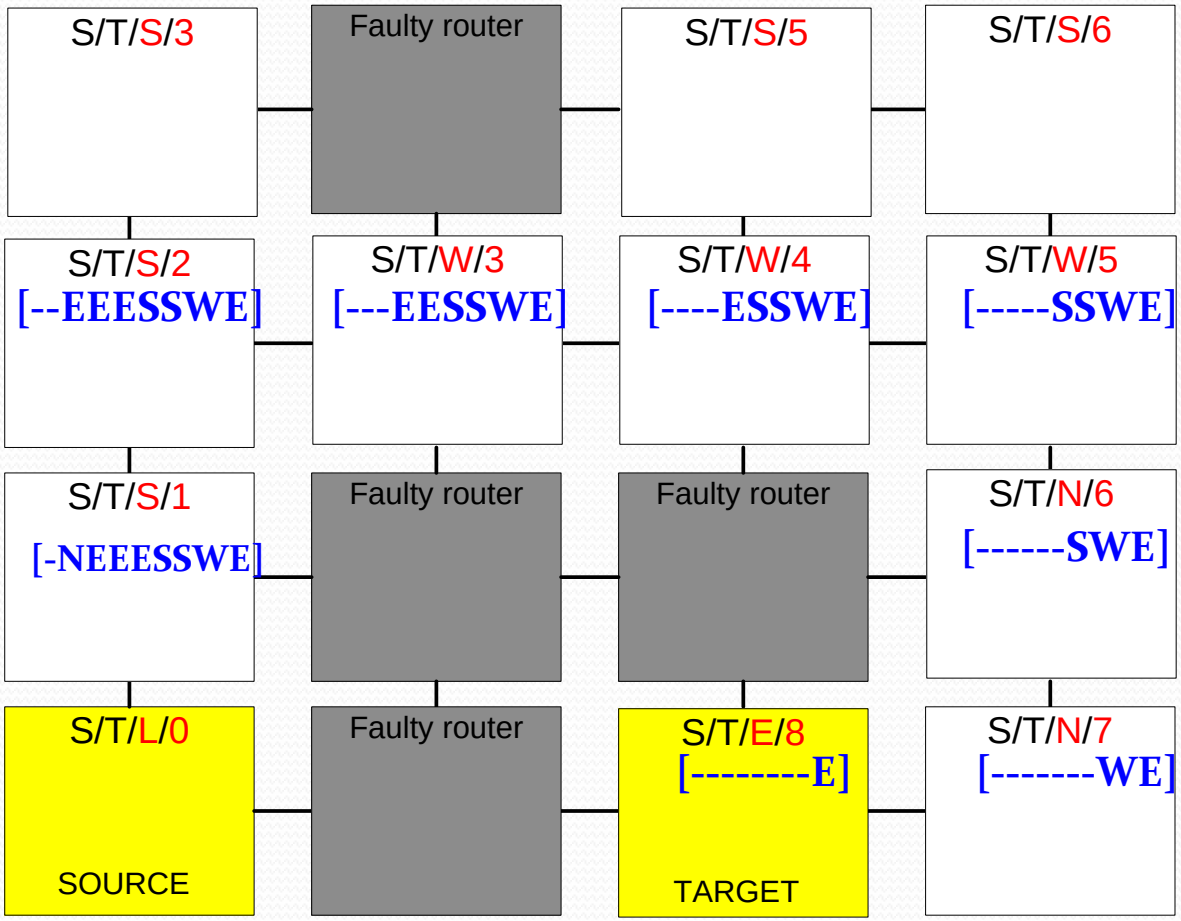
Backtrack step:



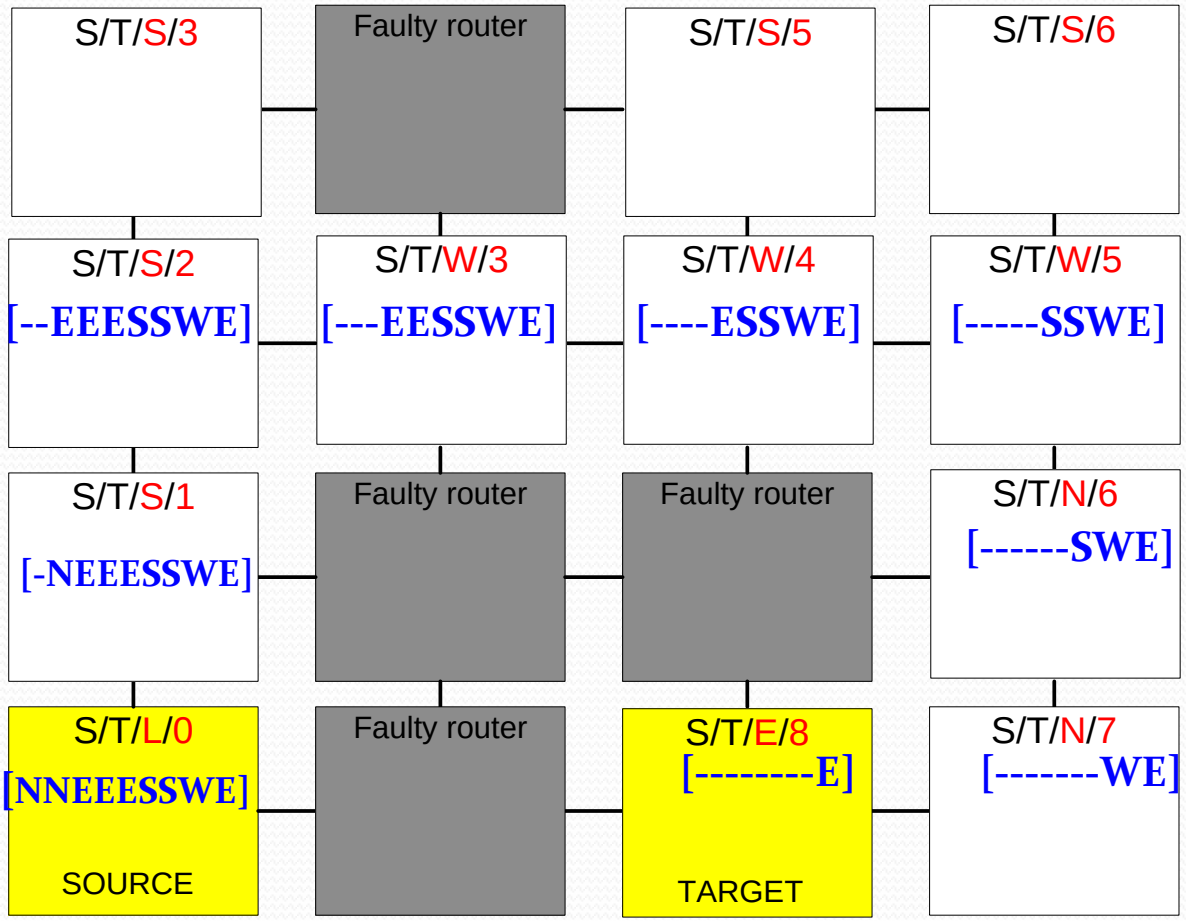
Backtrack step:



Backtrack step:



Backtrack step:

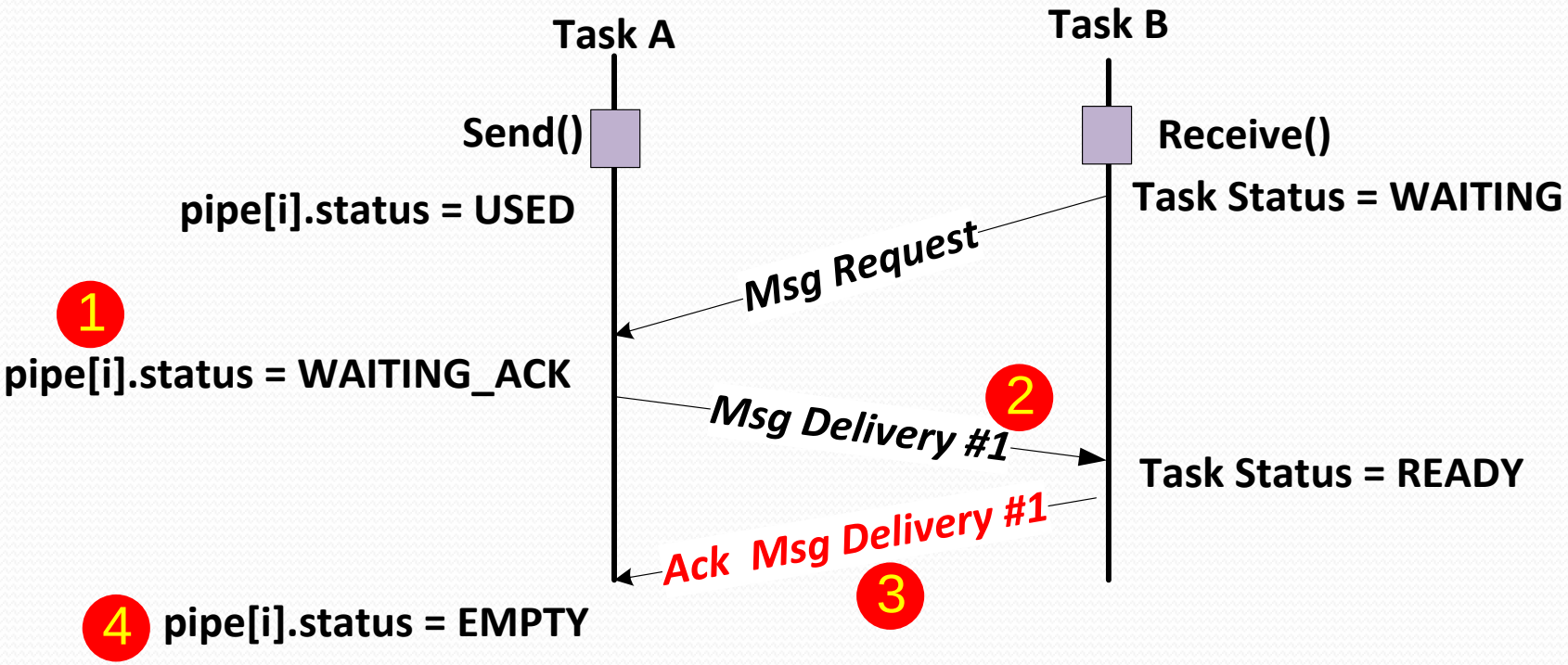


Clear and Path Calculation

- Stores the received path
- Broadcasts a clear signal

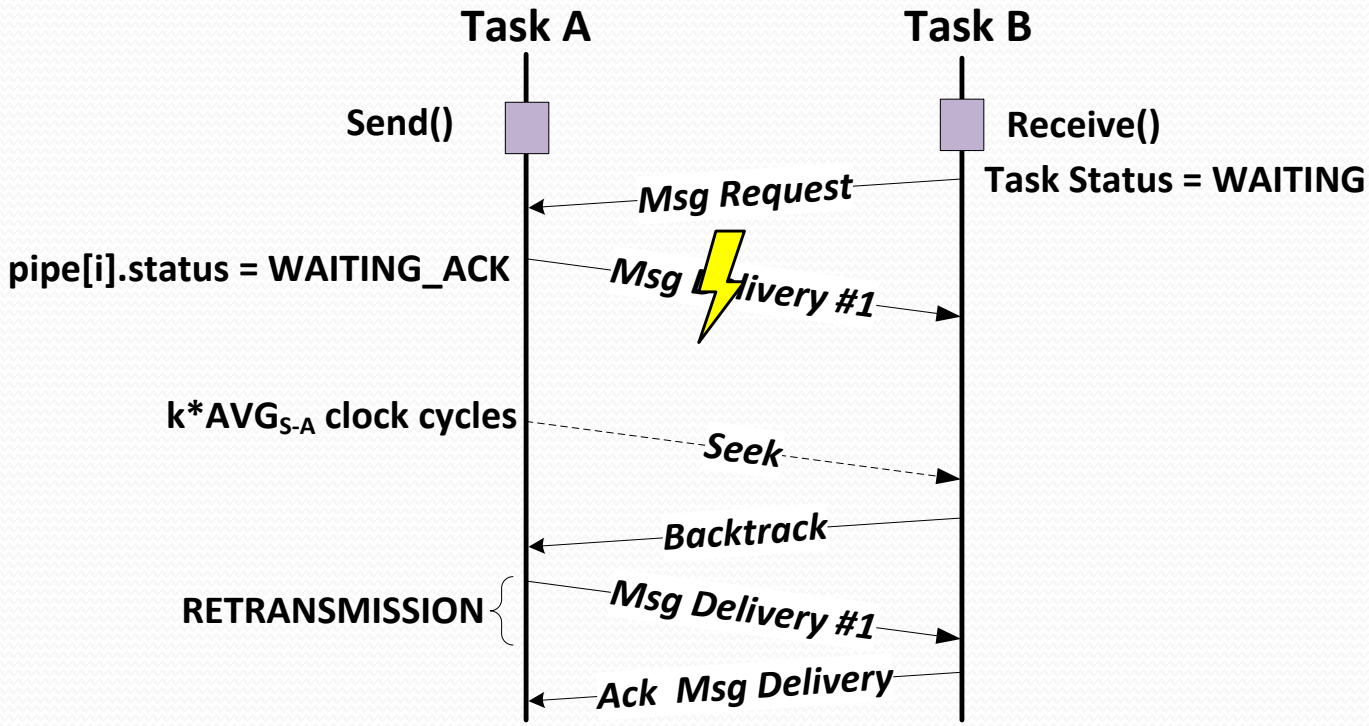
Kernel Layer:

- The kernel layer has been modified to detect undelivered messages and to perform retransmission;



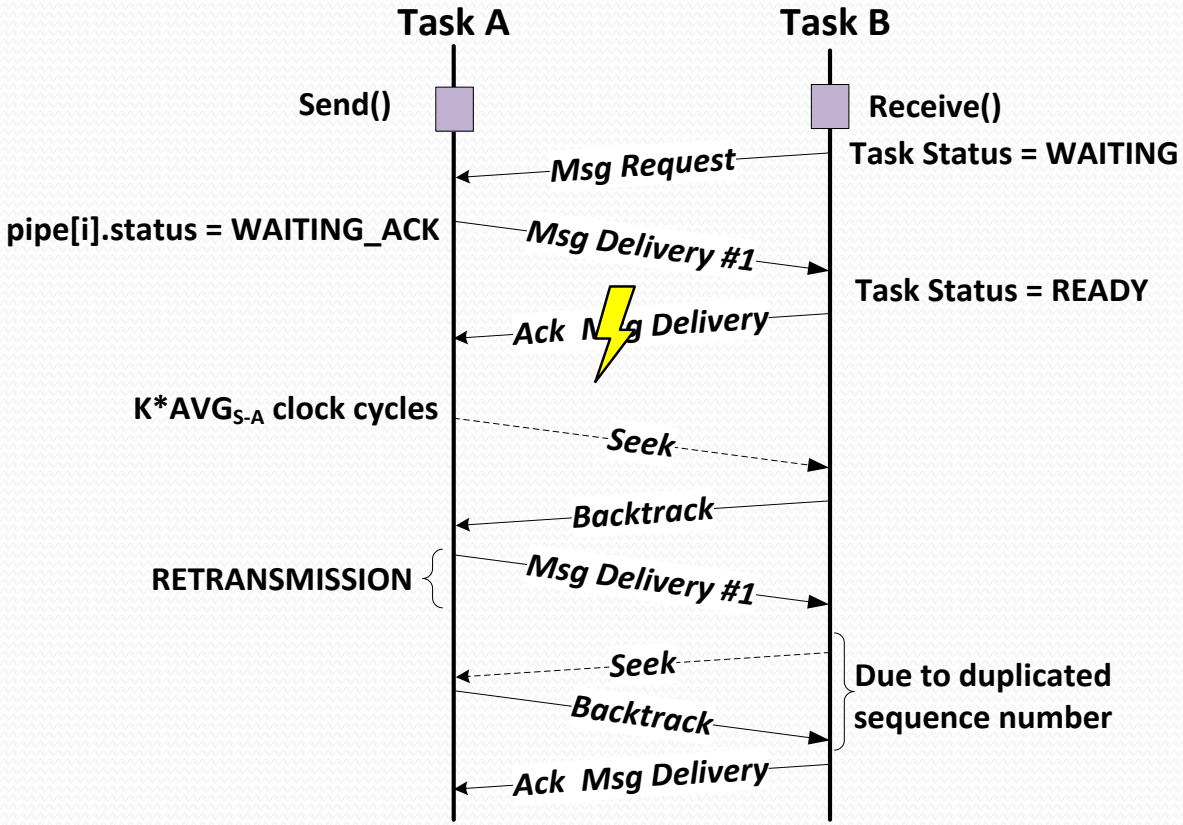
Fault in the Message Delivery:

- Task B requests the message to Task A. Task A sends the message delivery packet, and waits for the acknowledgement packet.



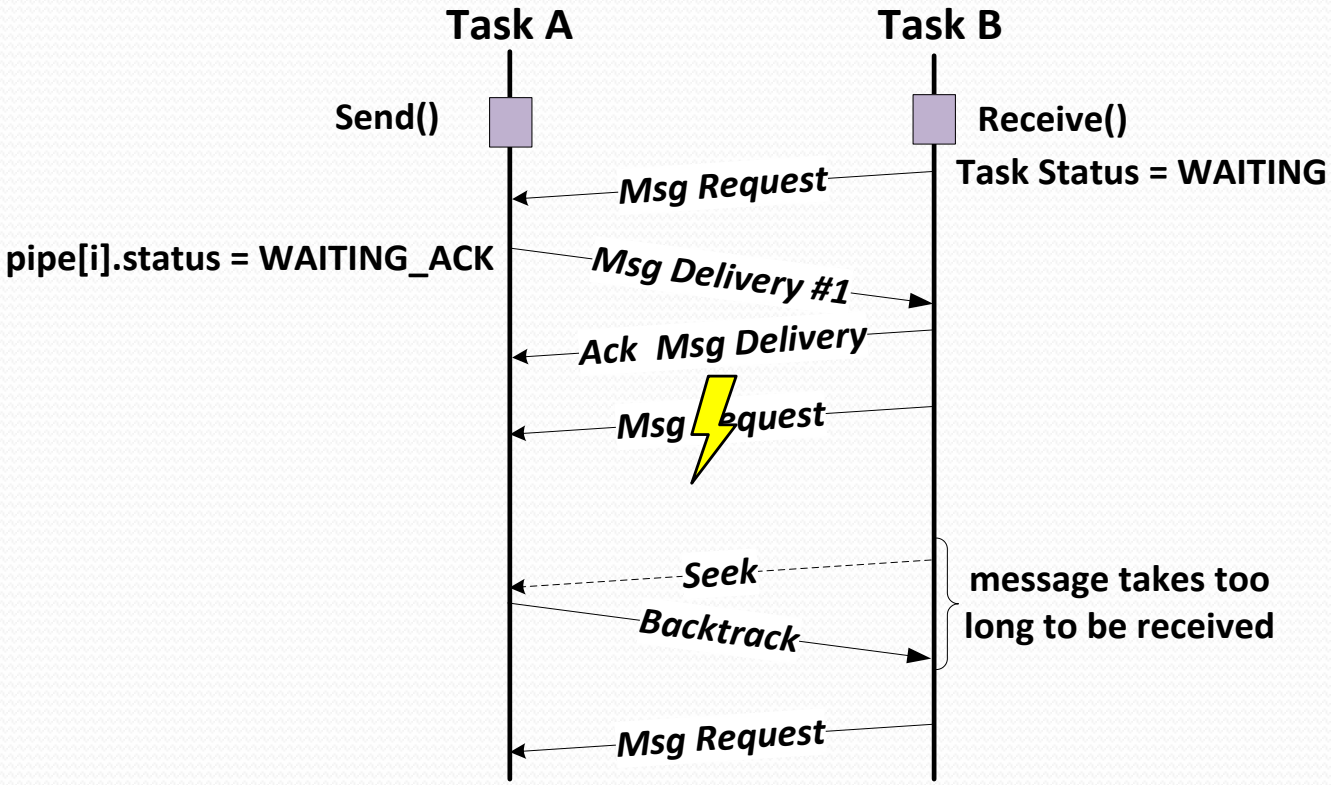
Fault in Message Acknowledgment:

- Task B requests message from A, A sends the message to B, and B sends the acknowledgment back to A.



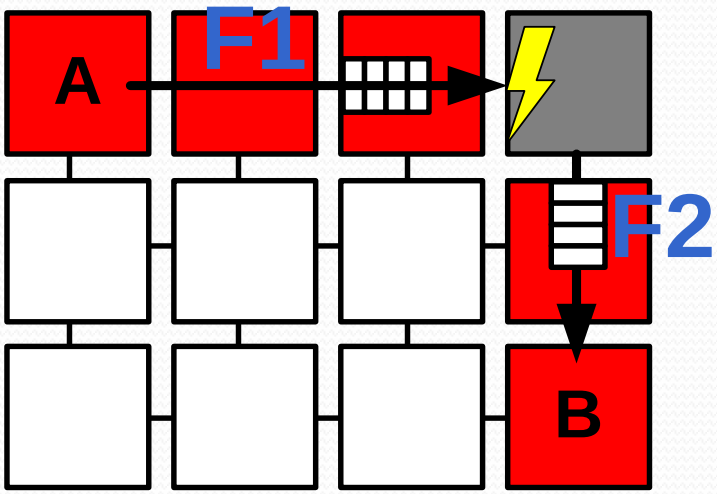
Fault in Message Request:

- Protocol diagram for a message request that was not received



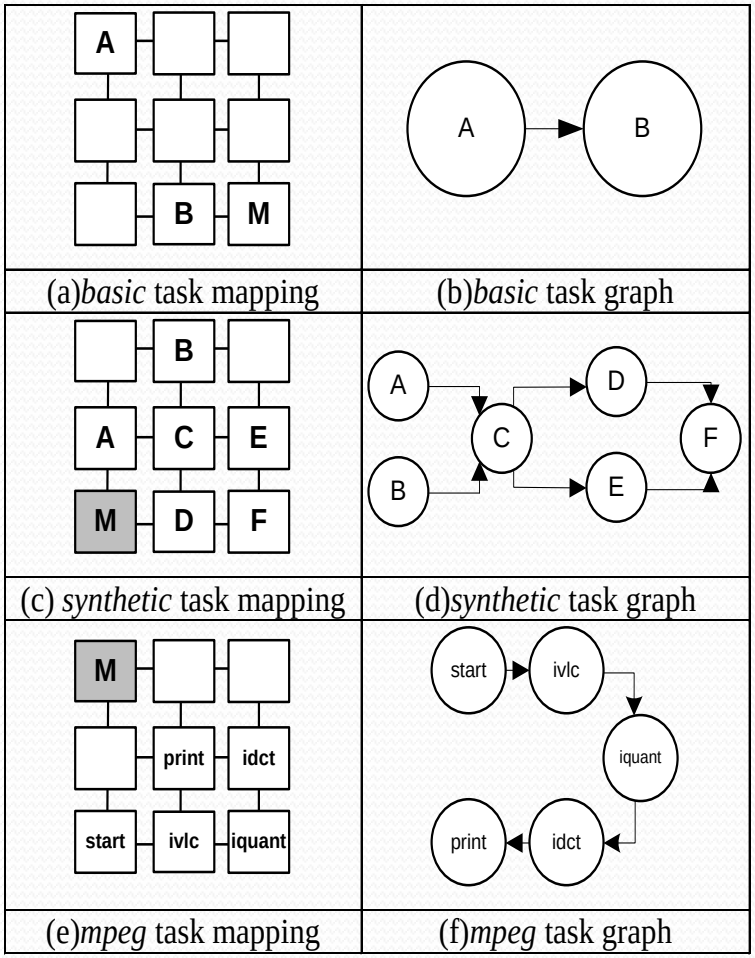
Fault Receiving Packets:

- Example of a faulty router in the middle of a message being delivered



Evaluated Applications:

- Scenarios with 1 and 2 simultaneous faults were generated;



(a)*basic* task mapping (b)*basic* task graph

(c) *synthetic* task mapping (d)*synthetic* task graph

(e)*mpeg* task mapping (f)*mpeg* task graph

Figure 1 – Three evaluated applications, their task mappings and task graphs.

Validation results with 1 fault:

	BASIC	SYNTH	MPEG
Scenarios	48	48	48
Scenarios(%)	100	100	100
Affected-scenarios	8	12	8
Faulty-scenarios	0	0	0
AET_n (ms)	0.9061	3.0767	5.2302
$AET_{max\text{-}f}$ (ms)	1.5174	4.1840	8.8116
Time(%)	67.46	35.99	68.47

Validation results with 2 fault:

	BASIC	SYNTH	MPEG
Scens	191	191	191
Scens(%)	17	17	17
Affected-scenarios	40	67	50
Faulty-scenarios	2	3	3
AET_n (ms)	0.9061	3.0767	5.2302
$AET_{max\text{-}f}$ (ms)	1.5174	4.2700	8.8154
Time(%)	67.46	38.79	68.55

Conclusion:

- The proposed method was evaluated with synthetic and real applications with permanent faults;
- The protocol automatically detects the unreachable tasks and launches the search for a faulty-free path to target PE;

THANK YOU!!!

QUESTIONS???

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