

Designing a Resilient Time-Aware Shaper Configuration for TSN

ECRTS 2025

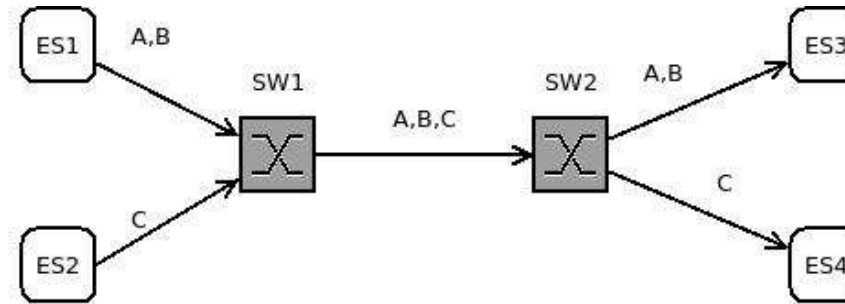
Industrial Challenge session

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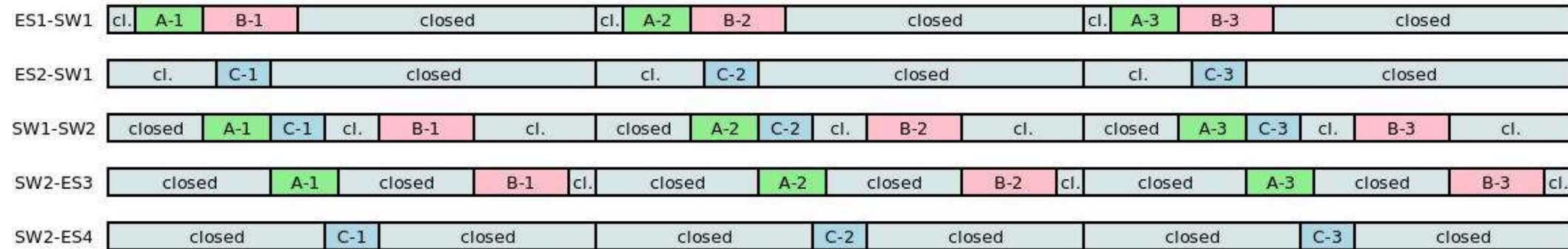
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A one slide TAS presentation

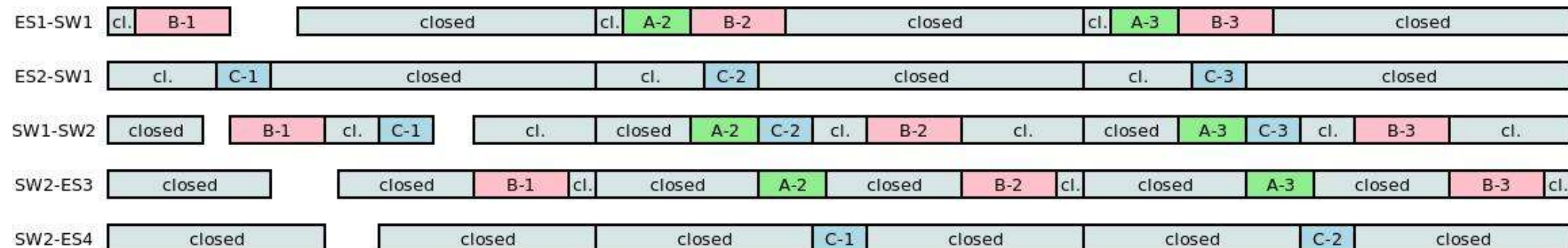
TAS = Time Aware Shaper



Nominal TAS behavior



Loss impact



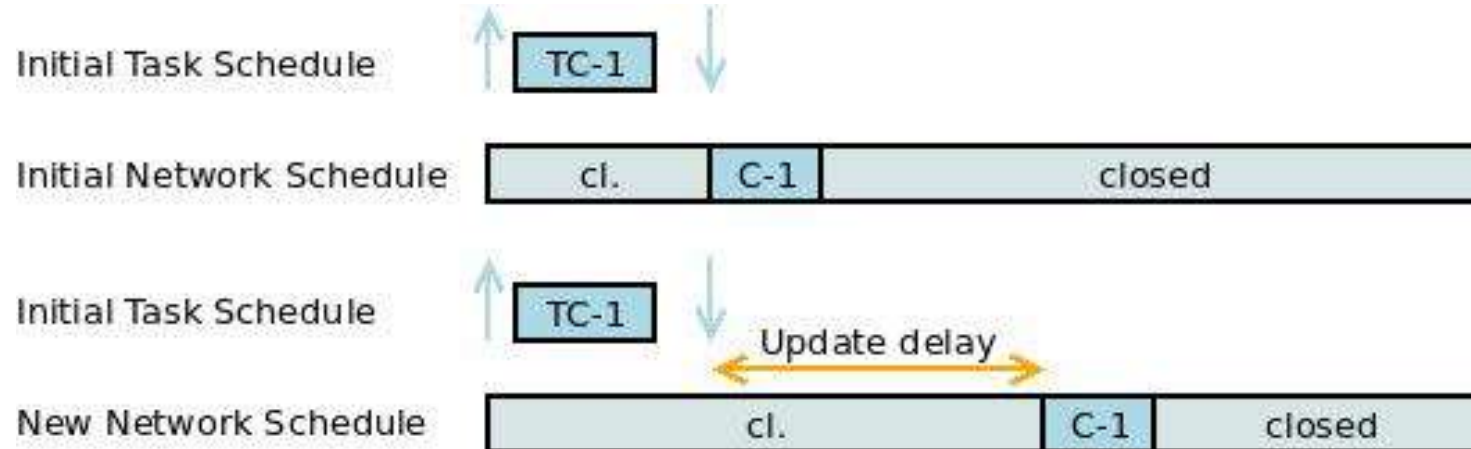
Contribution

Contribution: TAS

- A Time-Aware Shaper *reconfiguration*
 - Incremental: offsets/windows of existing flows are not modified
 - Fast (<1s)
 - Without update of Gate Control List
 - => fast deployment
 - => no coherency problem
 - Immune to TAS losses problem
 - Not using flow isolation

Incremental flow add

- Def: Do not change time windows of existing flows
 - Why does it matter ?
- Network <-> application synchronisation
 - Data are produced by tasks
 - Tasks and network schedule must (should) be synchronized



WPEx

Windows Precedence Exclusion

+

Window enlargment

+

Protective gating

WPEx principle

Main idea: use a basic idea

- Build a schedule with some « slack »
 - Reserve time windows larger than required
- Use the slack to host new data flow

Challenges

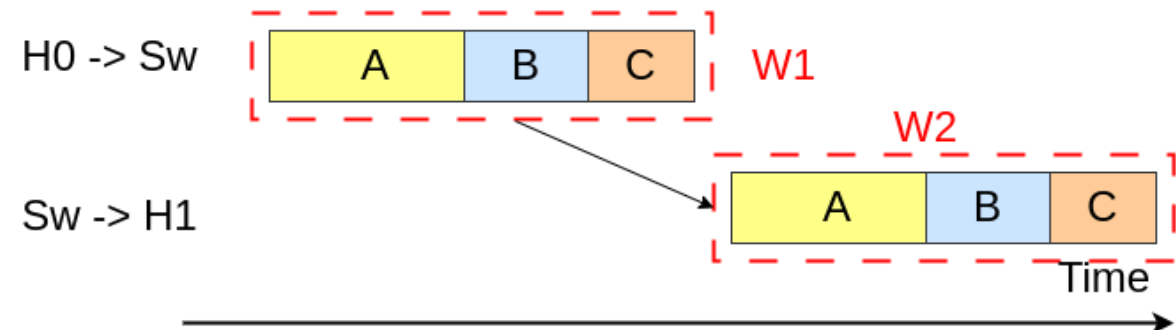
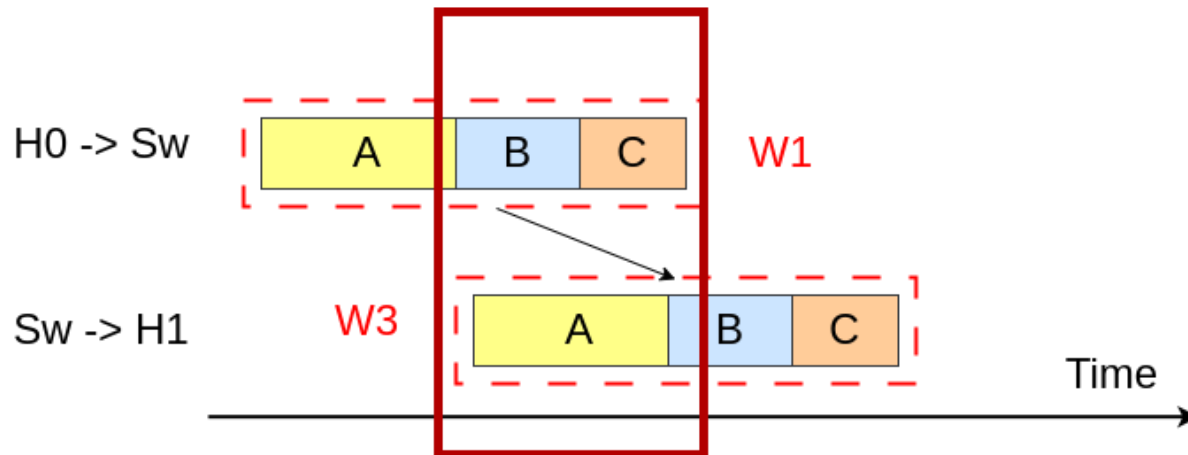
- Don't waste slack
- Share windows between several flows

Window Precedence Exclusion

No overlap between sending and receiving windows

Property 1: Immune to losses

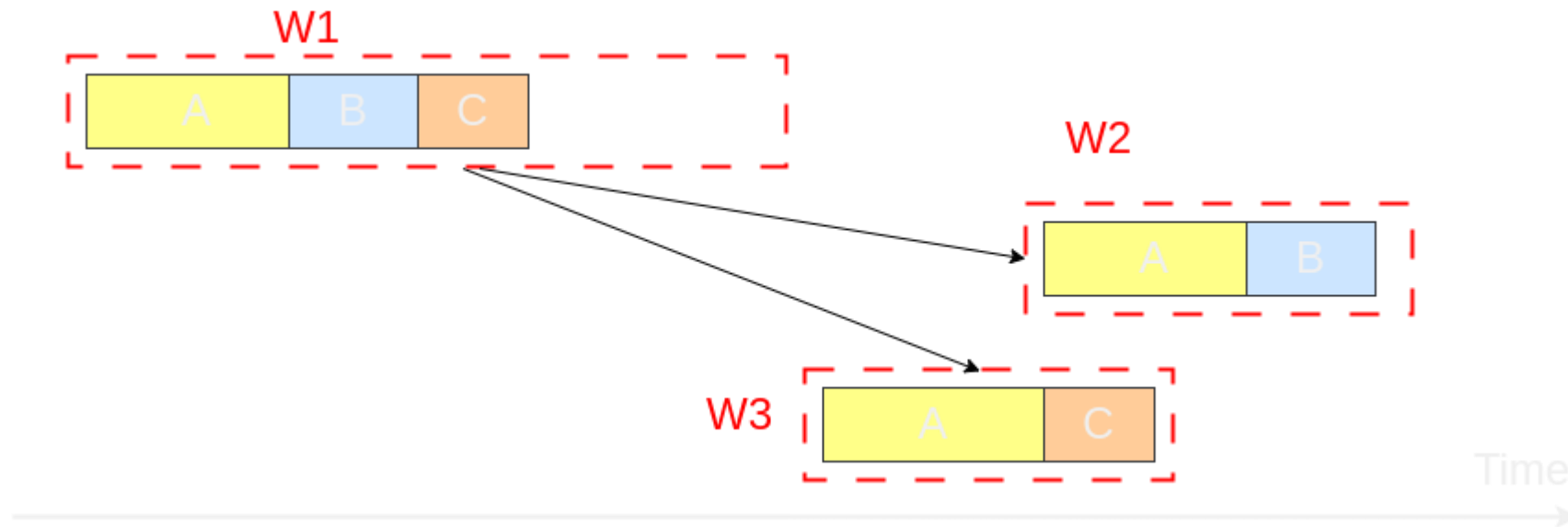
Property 2: all frames are enqueued before window start (keep in mind)



Window enlargement

Enlarge windows as much as possible

Keep space/time for future frames

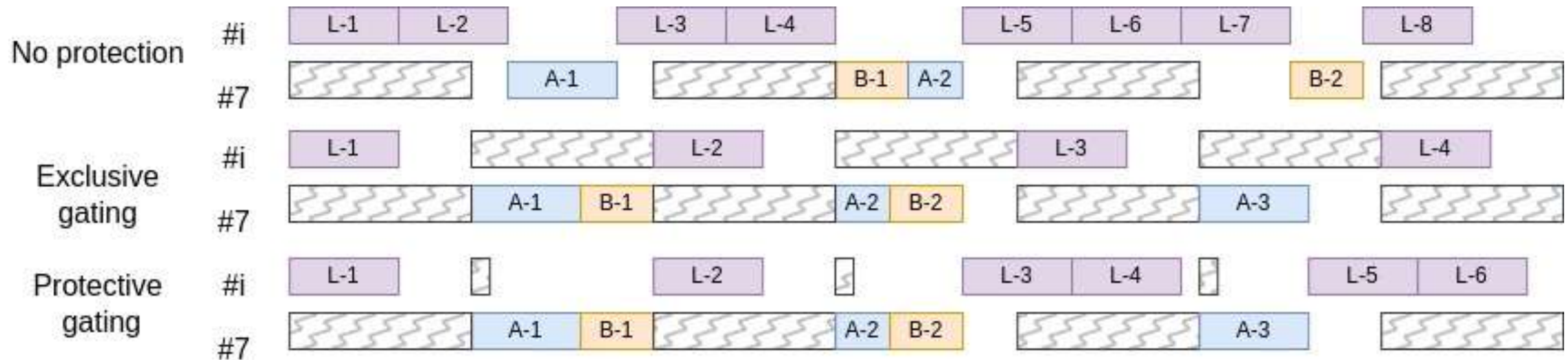


Protective gating

Protect only start of windows

Close gate of lower priority flows only at windows start

With property 2 (from WPEx): unused time is left for lower priority flows



Implementation

Two phases implementation

- Build the initial schedule
 - CPLEX + post-processing
 - Hours of computation
- Add new flows
 - Just « drop » a frame and look
 - Computation < 1s

Results

Results

- Ongoing work...
- A few results in the paper
 - On adding flows from other classes
- Current experiments: impact of link failure

Scheduled classes	WPEX sched. time	WPEX window nb	Mean tsnit sched. time	Inserting streams from					
				#7	#6	#5	#4	#3	#2
#7	1.1s	75	27s	-	5	15	7	6	0
#6 and #7	810s	259 – 218	74s	-	-	17	21	1	1
#6	2.7s	150	29s	4	-	18	20	11	1
#5	5.4s	248	21s	0	9	-	25	12	1
#4	1.9s	204	7s	3	4	5	-	3	0
#3	1.5s	331	45s	1	0	2	0	-	0
#2	2.4s	363	37s	0	0	1	0	2	-

Last Results (July 8th)

- Removing one or two links
- How many flows with a rescue path get a rescue schedule ?

<i>Algorithm</i>	Single link fault		Double link fault	
	Class #6	Class #7	Class #6	Class #7
<i>CPLEX only</i>	0.00 %	0.00 %	0.00 %	0.00 %
<i>Enlarge (ECRTS Post processing)</i>	12.20 %	9.09 %	25.68 %	9.17 %
<i>Add windows (new)</i>	19.51 %	9.09 %	22.04 %	8.97 %
<i>Enlarge and Add</i>	31.71 %	33.33 %	43.38 %	30.48 %
<i>Add and Enlarge</i>	43.90 %	24.24 %	48.15 %	23.94 %
<i>Add and Enlarge and double deadline</i>			83.55 %	47.74 %

Conclusion

Conclusion

- A novel schedule scheme
- Still under evaluations
- Several possible improvements