Timing&Distribution analysis with SymTA/S at FIAT Group Automobiles

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EE – Electronic Architecture – Network&Diagnosis

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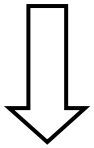
AGENDA

- Reasons for Timing&Distribution Analysis at FGA
- Offset, Message ID, Message Period
- FGA Use Case
- SymTA/s in the tool chain of FGA Networking development process

CURRENT SCENARIO

- Increasing number of contents and functionality introduced with impacts on CAN networks (number of messages transmitted on the bus)
- More critical Timing Constraints (Messages Period).
- Increasing of Event Messages number.



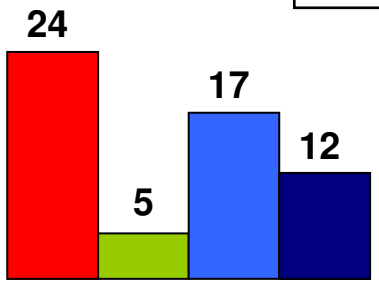
- Bus Load Increase
- More difficult to respect the expected timing constraints related to the messages.

CAN BUS OPTIMIZATION

FGA approach over different vehicle programs

Punto
50Kbps
500Kbps

Bus Load Driven Approach



Bus Load (%) ECUs Messages Event Activation

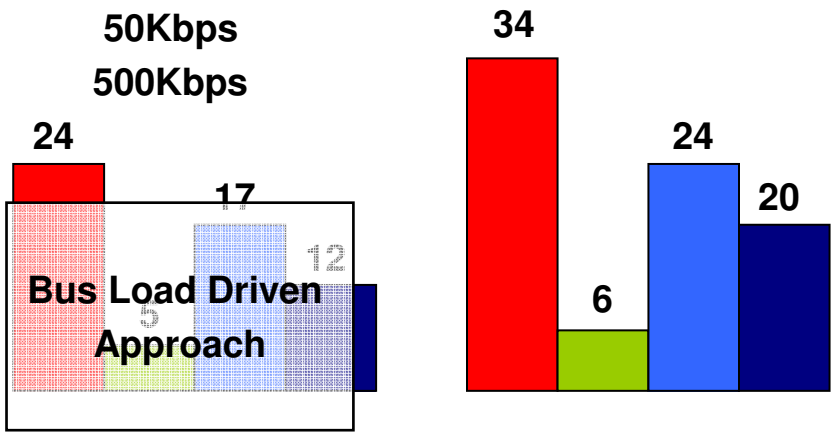
CAN BUS OPTIMIZATION

FGA approach over different vehicle programs

Bus Load Driven Approach
Latency analysis with Excel macro

GrandePunto
50Kbps
500Kbps

Punto
50Kbps
500Kbps



CAN BUS OPTIMIZATION

FGA approach over different vehicle programs

Bus Load Driven Approach
Latency analysis with SymTA/s

Mito
50Kbps
500Kbps

47
8
33
25

GrandePunto
50Kbps
500Kbps

34
24
20

Bus Load Driven Approach
Latency analysis with Excel macro

Punto
50Kbps
500Kbps

24
17
12
5

Bus Load Driven Approach

Bus Load (%) ECUs Messages Event Activation

CAN BUS OPTIMIZATION

FGA approach over different vehicle programs

Latency optimization
OFFSET management
Timing&Distribution
Analysis with SymTA/s

Next Gen
125Kbps
500Kbps

Punto
50Kbps
500Kbps
24
17
5
12
Bus Load Driven Approach

GrandePunto
50Kbps
500Kbps
34
24
20
Bus Load Driven Approach
Latency analysis with Excel macro

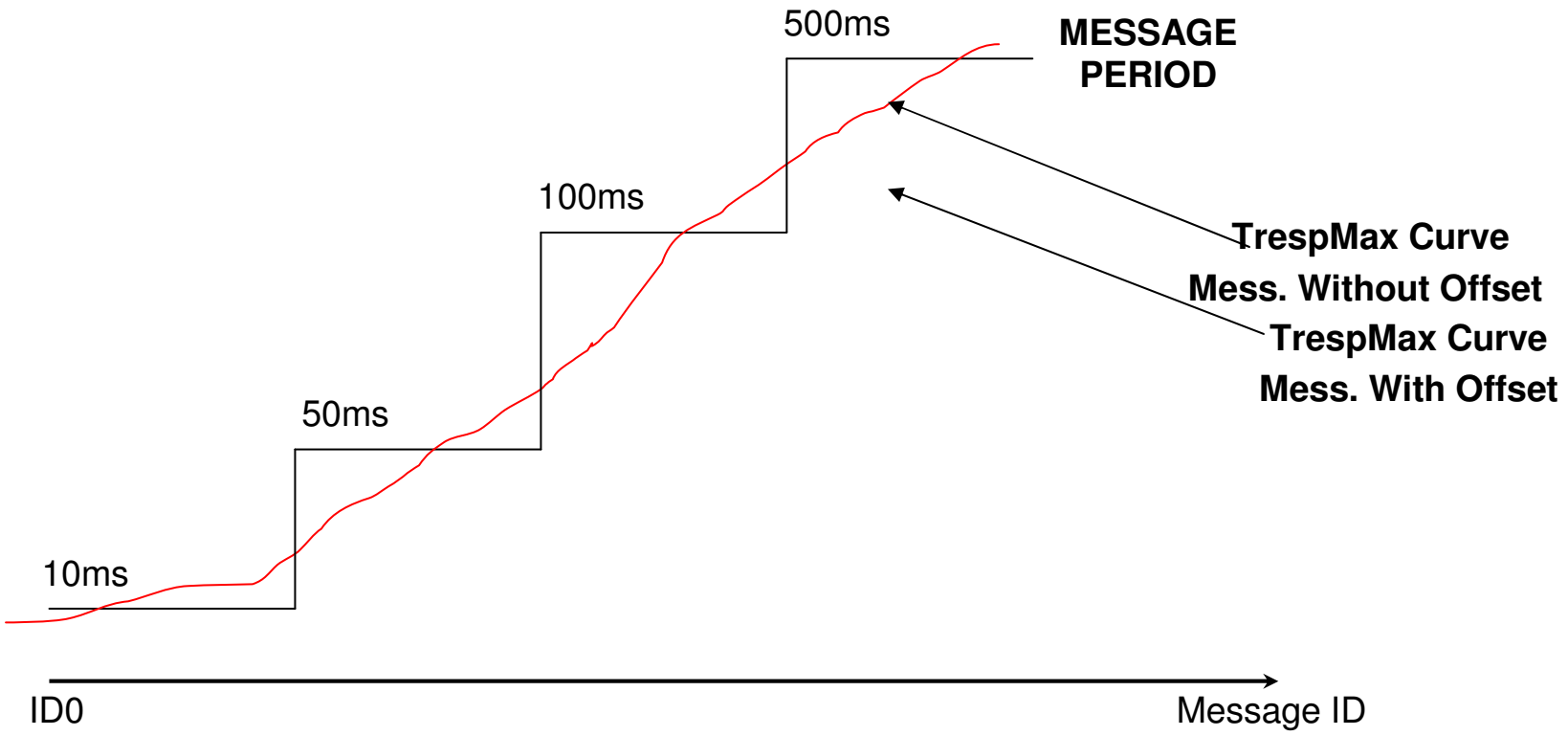
Mito
50Kbps
500Kbps
47
33
25
Bus Load Driven Approach
Latency analysis with SymTA/s

70
12
66
34

Bus Load (%) ECUs Messages Event Activation

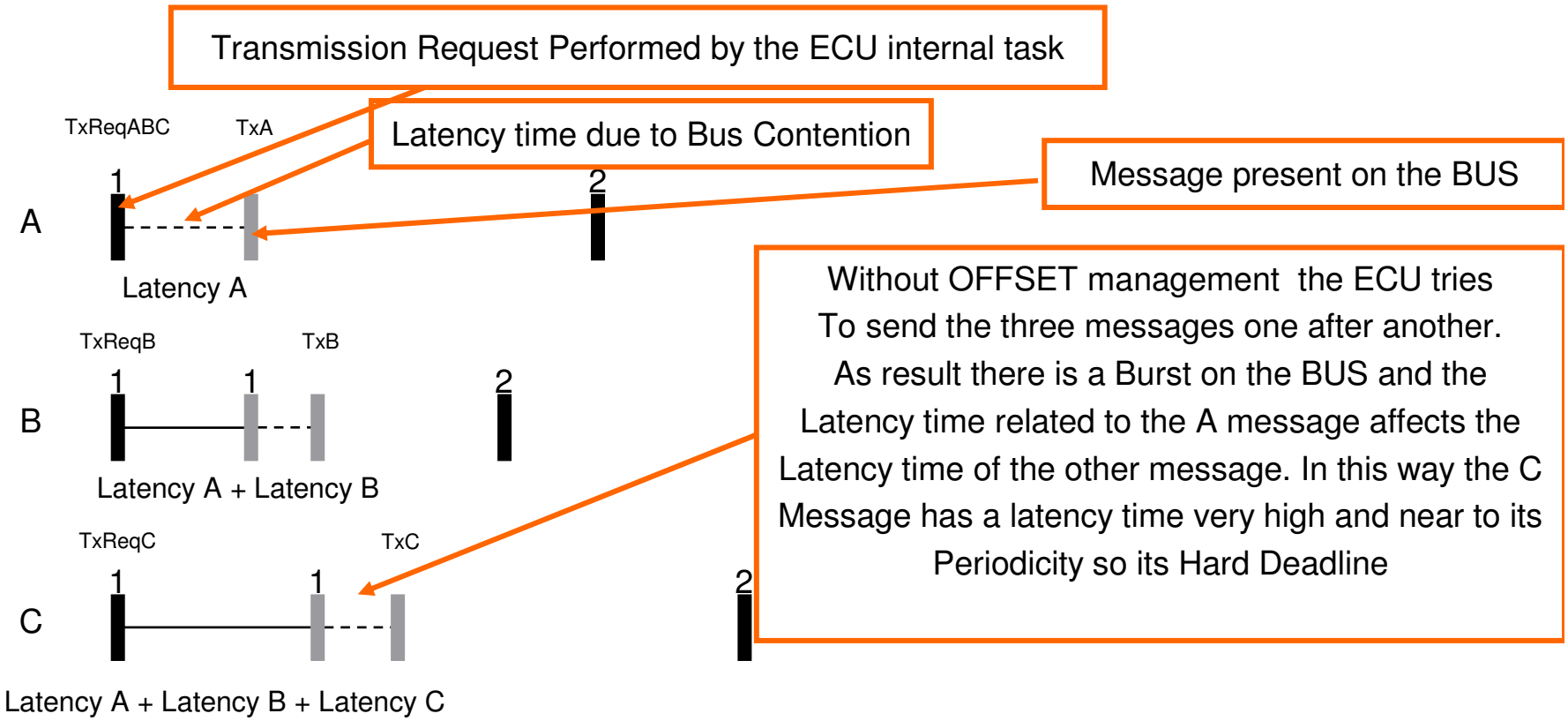
CAN BUS Optimization

Message ID vs Periodicity



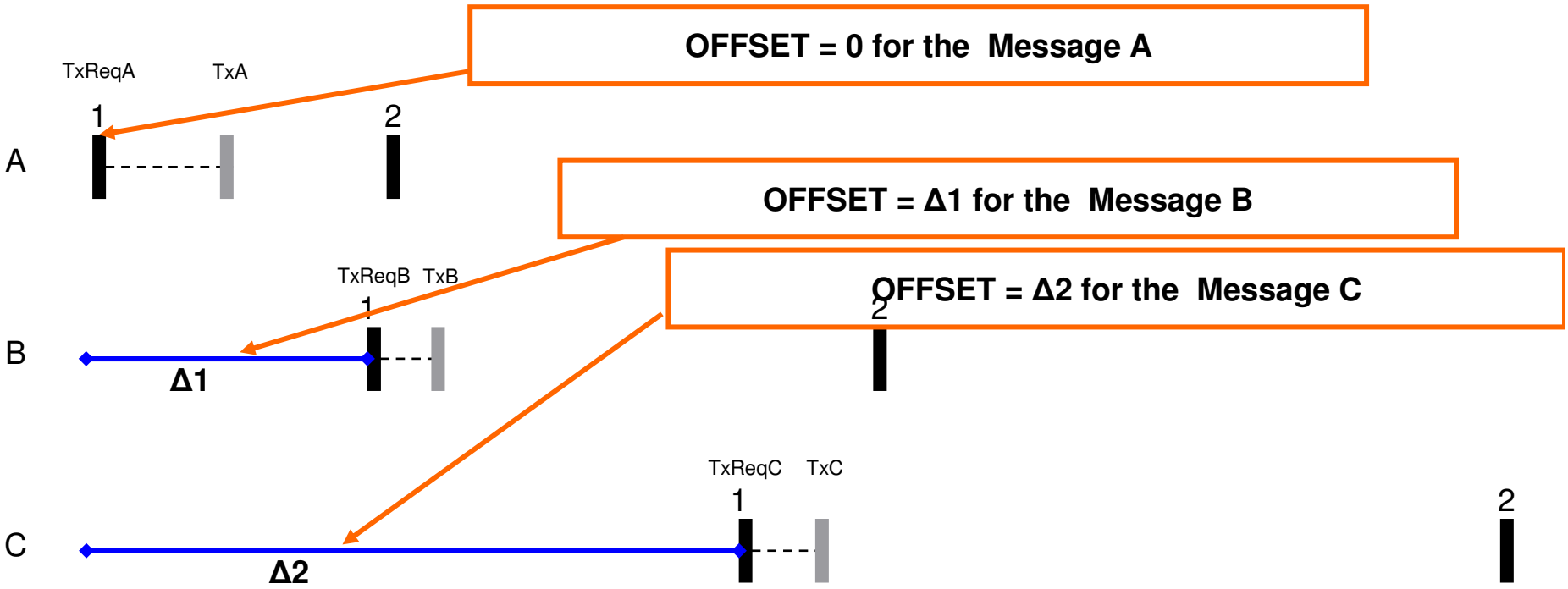
CAN BUS Optimization

OFFSET Management



CAN BUS Optimization

OFFSET Management

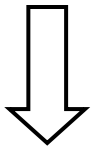


With OFFSET management the ECU tries to send the messages in different moments, in thisway there is not a Burst on the BUS and the latency time related one message doesn't affect The latency time of the other messages. The messages latencies time are minimized.

The OFFSET value must not be applied to the event message.
For the event message OFFSET = UNACCEPTABLE DELAY

CAN BUS Optimization

- **FGA uses message oriented approach for CAN message ID**
  - Standard message ID in all projects
  - Standard message period in all projects
  - Re-use of standard messages in different vehicle projects
- **Introduction of new CAN message transmitted by ECUx:**
  - should not impact pre-existing messages transmitted by other ECUs in term of ID, period and other message properties i.e. offset.
  - can affect only properties of the other messages transmitted by ECUx.



Dedicated FGA rules about offset assignment has been updated (validated with SymTA/S).

The latency results using FGA rules are able to minimize the impact of the system.

FGA USE CASE (NEXT GEN PROJECT)

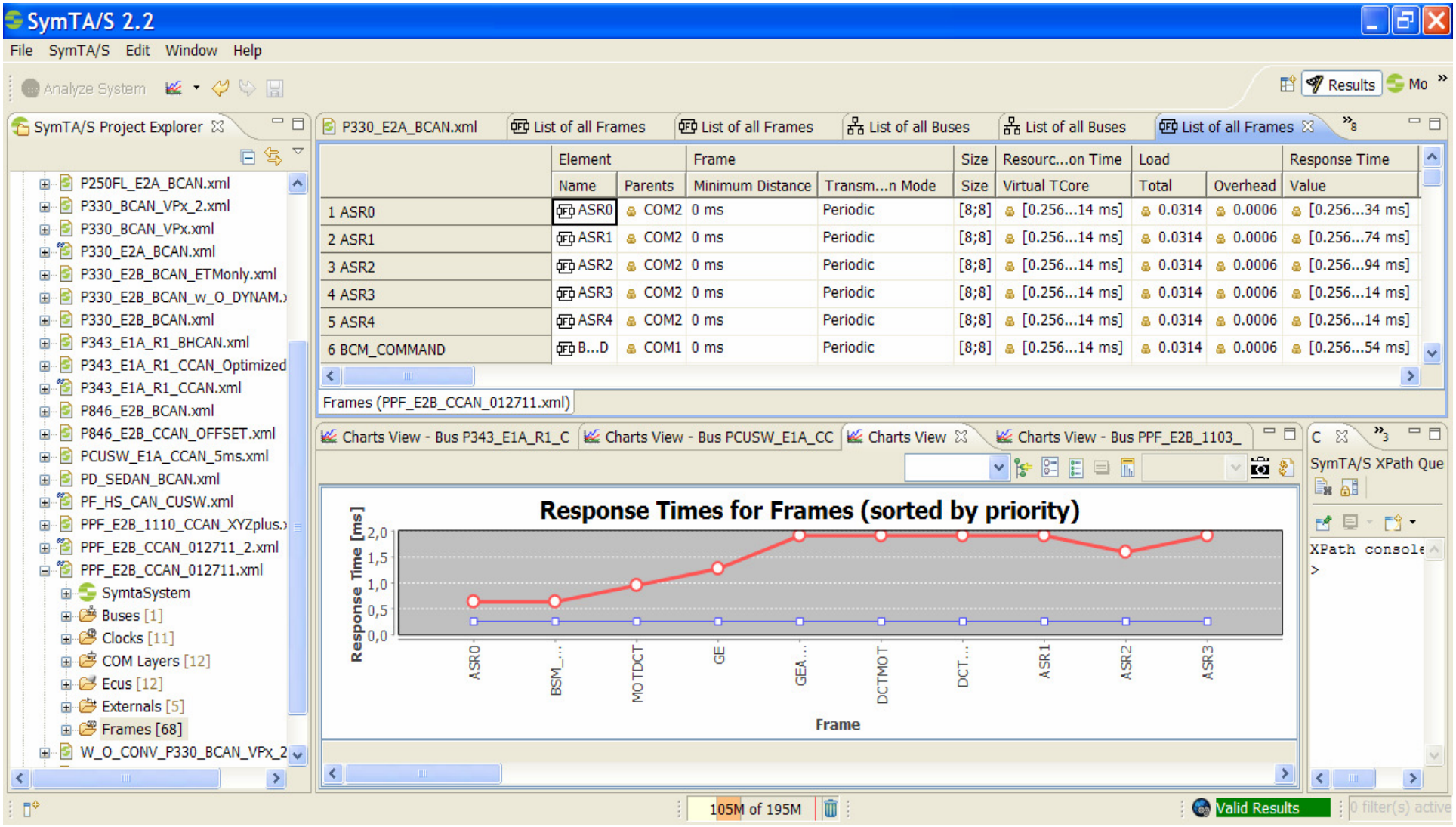
- BH-CAN (125Kbps) and C-CAN (500 Kbps) analyzed
- Timing Analysis: worst Case scenario considered in terms of Maximum Latency time
- Distribution Analysis: statistic results in terms of Latency Time

FGA USE CASE (NEXT GEN PROJECT)

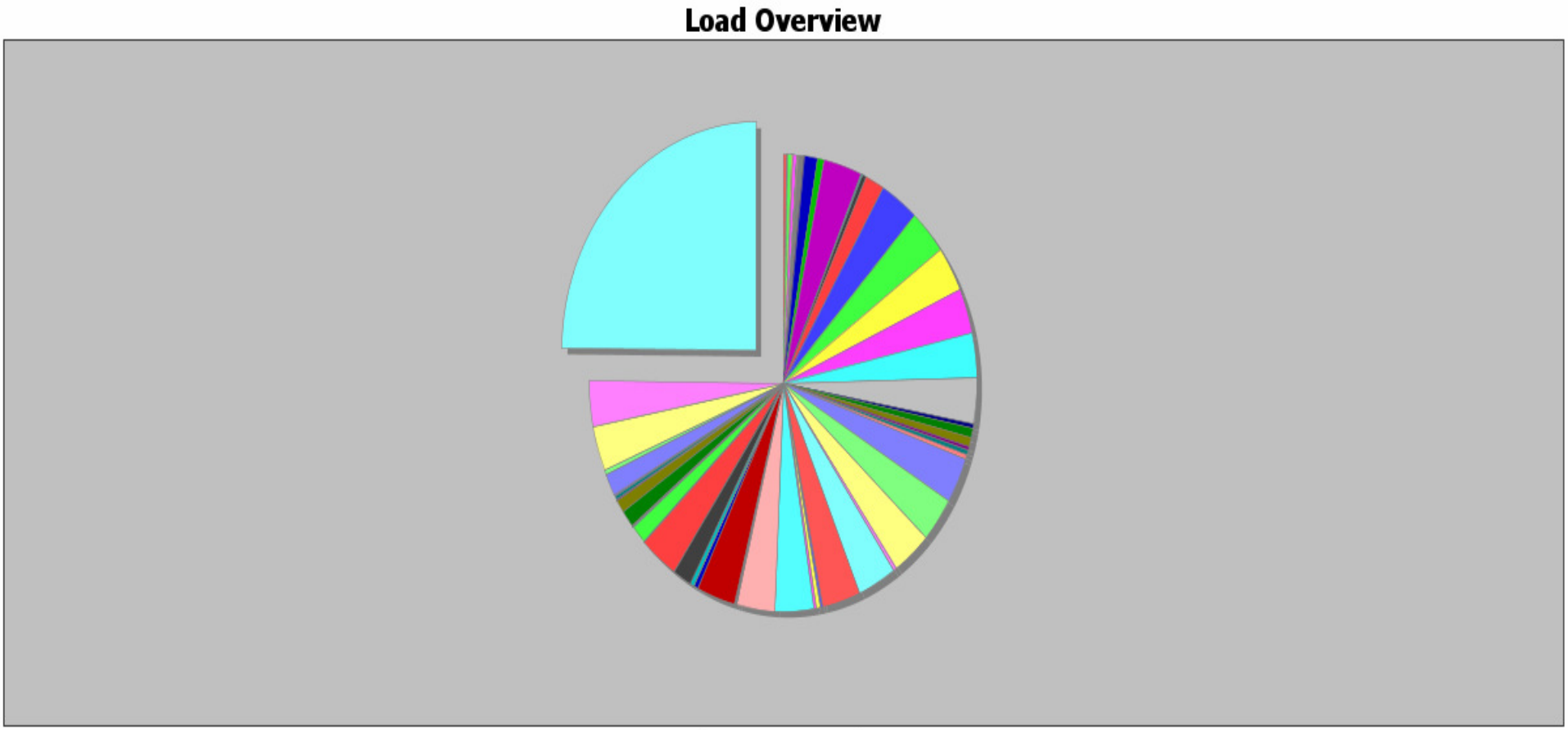
Evaluated Scenarios

	MS-CAN (125Kbps)	HS-CAN (500 Kbps)
ECUs	8	12
Messages	80	54
Type	14 Sporadic 26 Periodic 40 Mixed	All Periodic
Event Activation	Event Model defined as "Periodic" with Minimum Separation Time	N.A.
Constraint	Standard Message ID	
Soft Deadline	Max [2;10%Period] (ms)	
Hard Deadline	Period (ms)	

FGA USE CASE


SymTA/S 2.2
File SymTA/S Edit Window Help
Analyze System
Results
SymTA/S Project Explorer
P250FL_E2A_BCAN.xml
P330_BCAN_VPx_2.xml
P330_BCAN_VPx.xml
P330_E2A_BCAN.xml
P330_E2B_BCAN_ETMonly.xml
P330_E2B_BCAN_w_O_DYNAM.
P330_E2B_BCAN.xml
P343_E1A_R1_BHCAN.xml
P343_E1A_R1_CCAN_Optimized
P343_E1A_R1_CCAN.xml
P846_E2B_BCAN.xml
P846_E2B_CCAN_OFFSET.xml
PCUSW_E1A_CCAN_5ms.xml
PD_SEDAN_BCAN.xml
PF_HS_CAN_CUSW.xml
PPF_E2B_1110_CCAN_XYZplus.
PPF_E2B_CCAN_012711_2.xml
PPF_E2B_CCAN_012711.xml
SymtaSystem
Buses [1]
Clocks [11]
COM Layers [12]
Ecus [12]
Externals [5]
Frames [68]
W_O_CONV_P330_BCAN_VPx_2
P330_E2A_BCAN.xml
List of all Frames
List of all Frames
List of all Buses
List of all Buses
List of all Frames
Element
Frame
Size
Resourc...on Time
Load
Response Time
Name
Parents
Minimum Distance
Transm...n Mode
Size
Virtual TCore
Total
Overhead
Value
1 ASR0 ASR0 COM2 0 ms Periodic [8;8] [0.256...14 ms] 0.0314 0.0006 [0.256...34 ms]
2 ASR1 ASR1 COM2 0 ms Periodic [8;8] [0.256...14 ms] 0.0314 0.0006 [0.256...74 ms]
3 ASR2 ASR2 COM2 0 ms Periodic [8;8] [0.256...14 ms] 0.0314 0.0006 [0.256...94 ms]
4 ASR3 ASR3 COM2 0 ms Periodic [8;8] [0.256...14 ms] 0.0314 0.0006 [0.256...14 ms]
5 ASR4 ASR4 COM2 0 ms Periodic [8;8] [0.256...14 ms] 0.0314 0.0006 [0.256...14 ms]
6 BCM_COMMAND B...D COM1 0 ms Periodic [8;8] [0.256...14 ms] 0.0314 0.0006 [0.256...54 ms]
Frames (PPF_E2B_CCAN_012711.xml)
Charts View - Bus P343_E1A_R1_C
Charts View - Bus PCUSW_E1A_CC
Charts View
Charts View - Bus PPF_E2B_1103_
Response Times for Frames (sorted by priority)
Response Time [ms]
2,0
1,5
1,0
0,5
0,0
ASR0
BSM_...
MOTDCT
GE
GEA...
DCTMOT
DCT...
ASR1
ASR2
ASR3
Frame
SymTA/S XPath Que
XPath console
105M of 195M
Valid Results
0 filter(s) active

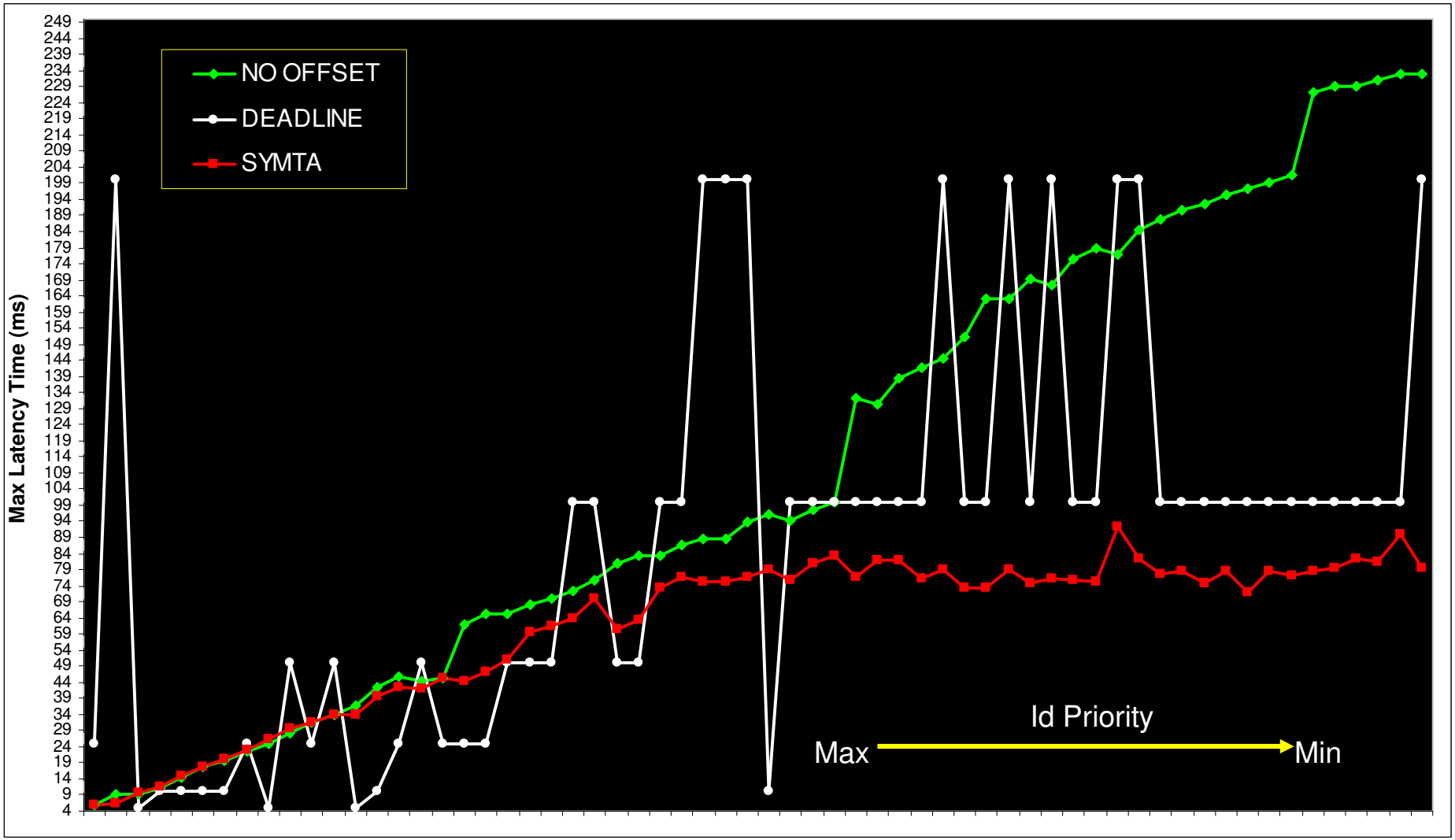
FGA USE CASE



70%

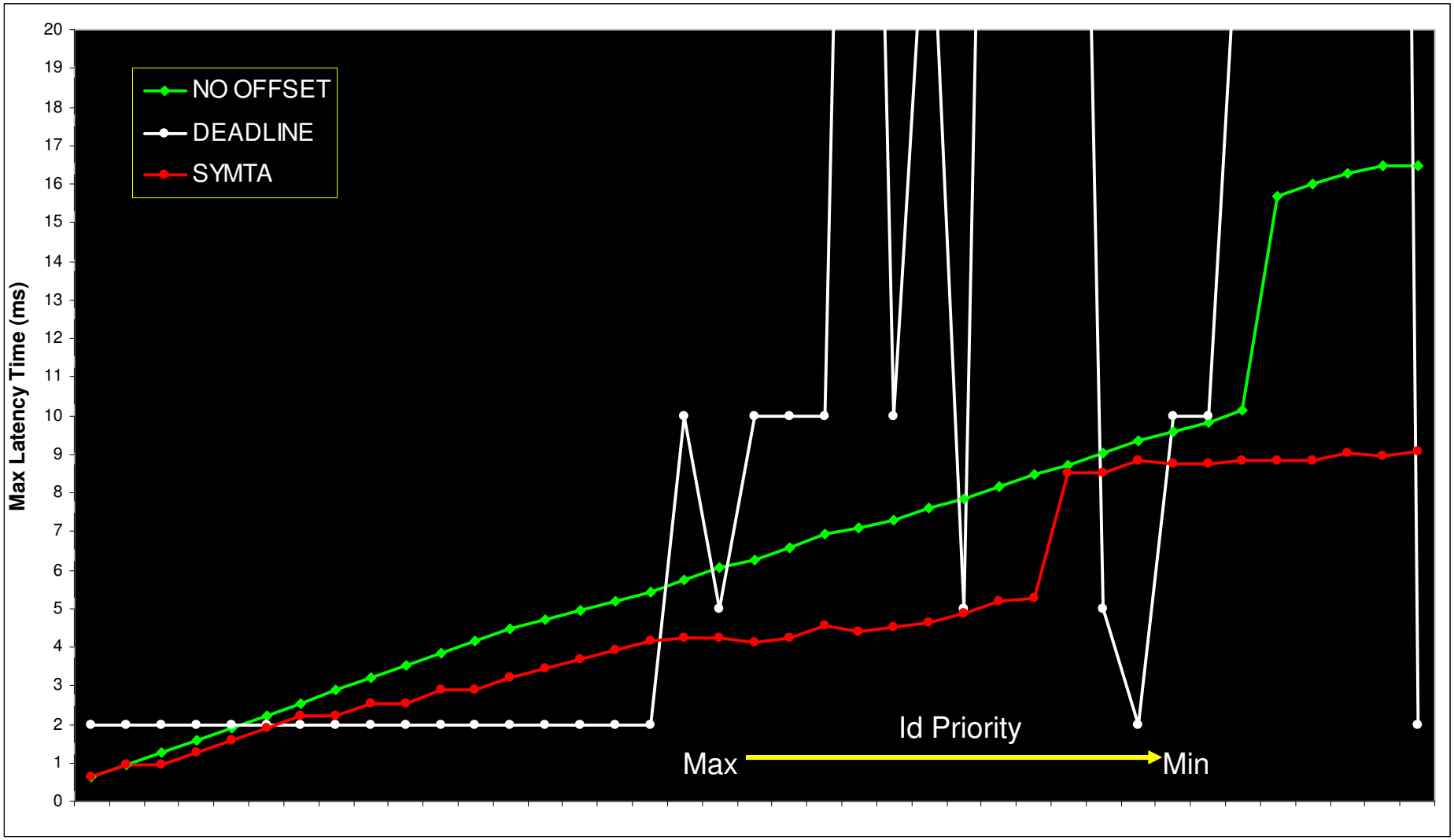
FGA USE CASE

BH-CAN Timing Analysis: Worst Case



FGA USE CASE

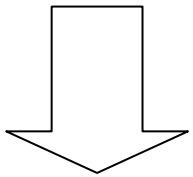
C-CAN Timing Analysis: Worst Case



Considering worst case results:

40 messages miss the deadline with its maximum response time value

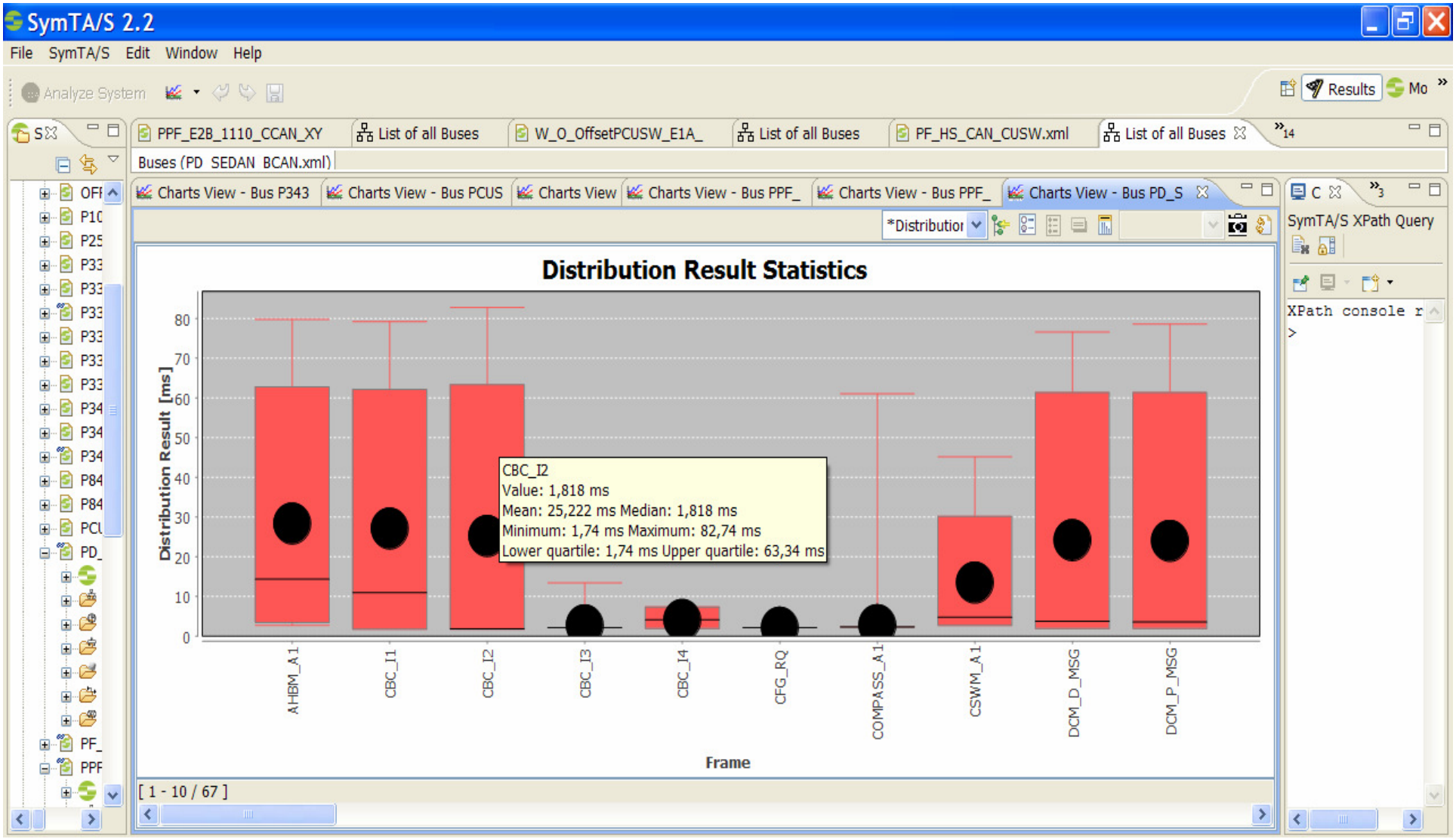
HOW OFTEN DOES IT OCCUR?



SymTA/s Distribution Analysis

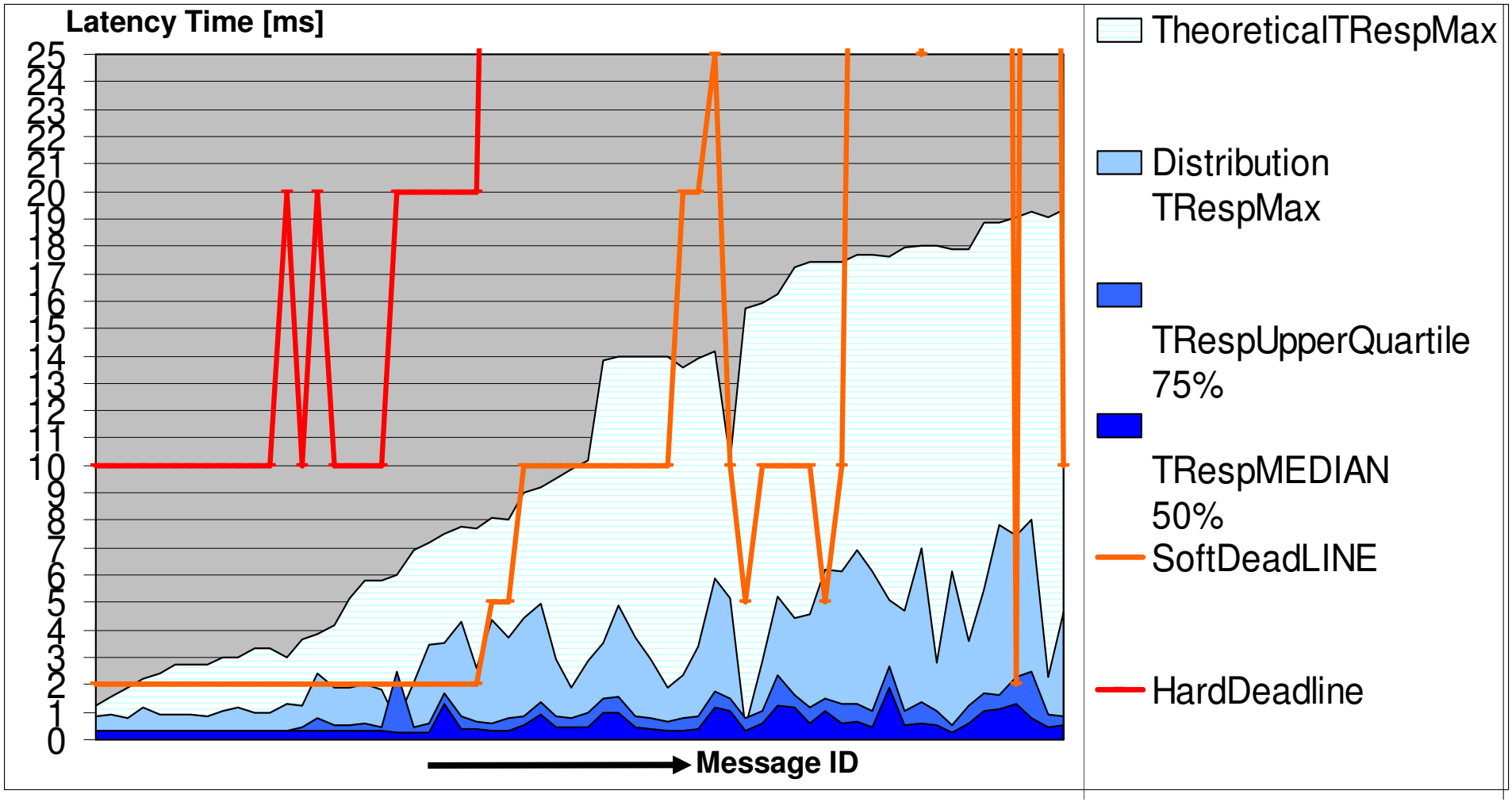
FGA USE CASE

C-CAN Distribution Analysis: Statistic Results



FGA USE CASE

C-CAN Distribution Analysis: Statistic Results



FGA USE CASE

C-CAN Distribution Analysis: Statistic Results

No risk
Low risk
Medium/High risk
High risk

		Distribution Results		
		Median	UpperQuartile	TRespMaximum
Number Of Messages	66			
	>10%	2%	6%	12%
	>20%	0%	0%	8%
	>30%	0%	0%	3%
	>40%	0%	0%	3%
	>50%	0%	0%	0%
	>60%	0%	0%	0%
	>70%	0%	0%	0%
	>80%	0%	0%	0%
	>90%	0%	0%	0%
	>100%	0%	0%	0%

Quality Threshold

DISTRIBUTION ANALYSIS:

Results evaluation

FGA considers viable a Quality Threshold < 70% with a safety margin equal to 30% in order to take in account:

- **Architecture extensibility: future additional contents, functionality, ECUs, messages, event activation.**
- **Unavoidable gap between the in-vehicle real system and virtual system due to the unpredictable environmental varaibles**

SymTA/s tool allows FGA Core Networking Team to perform:

- **NEW ARCHITECTURE VALIDATION:**
  - Number of subnets
  - Baud rate of each subnet
  - ECUs positioning
  - Gateway
- **New Message addition feasibilty evaluation:**
  - Message Launch Type (Included AUTOSAR launch types)
  - Perodicity, Event Model

MORE INFORMATION

Questions?