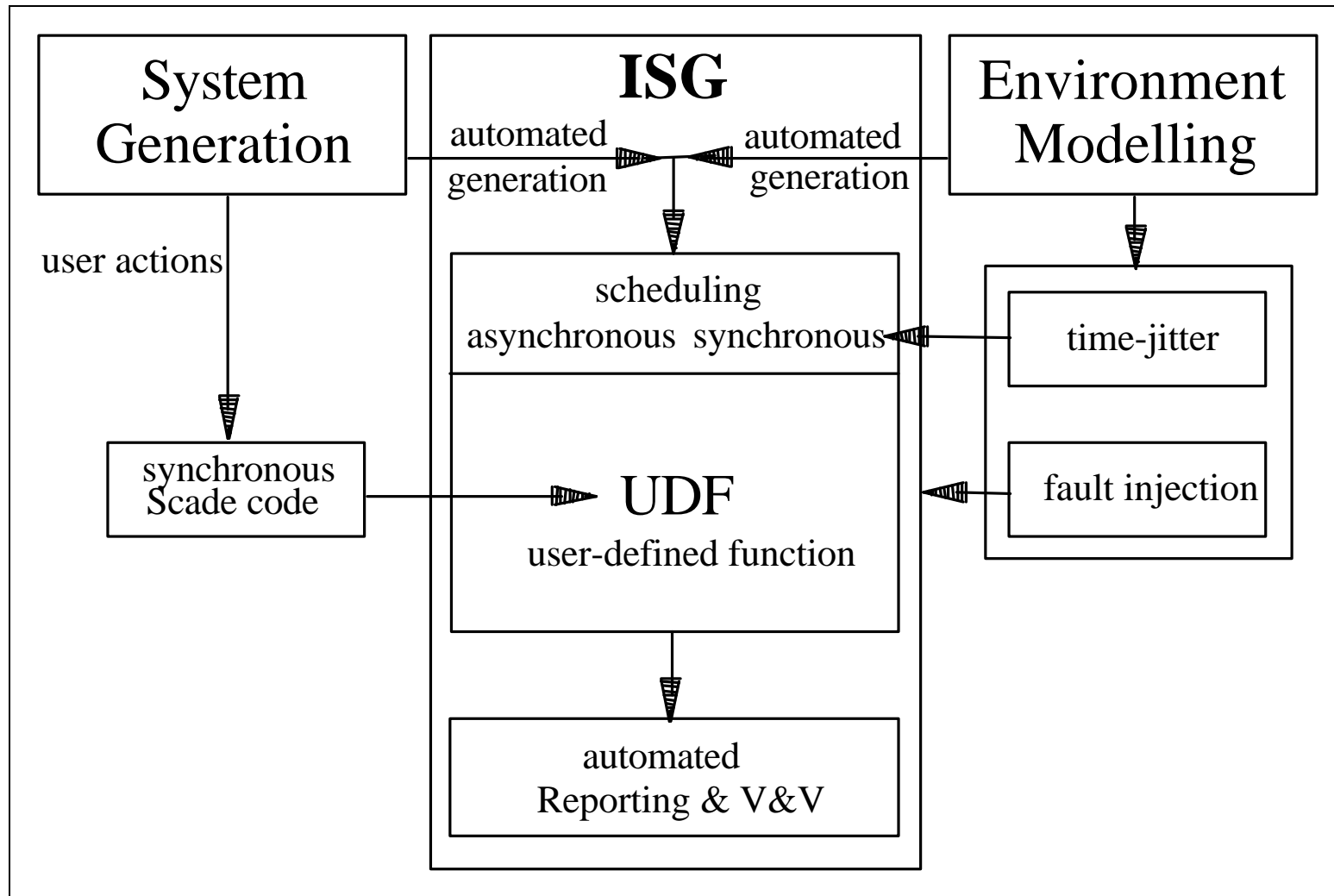# ISG and Synchronous Systems
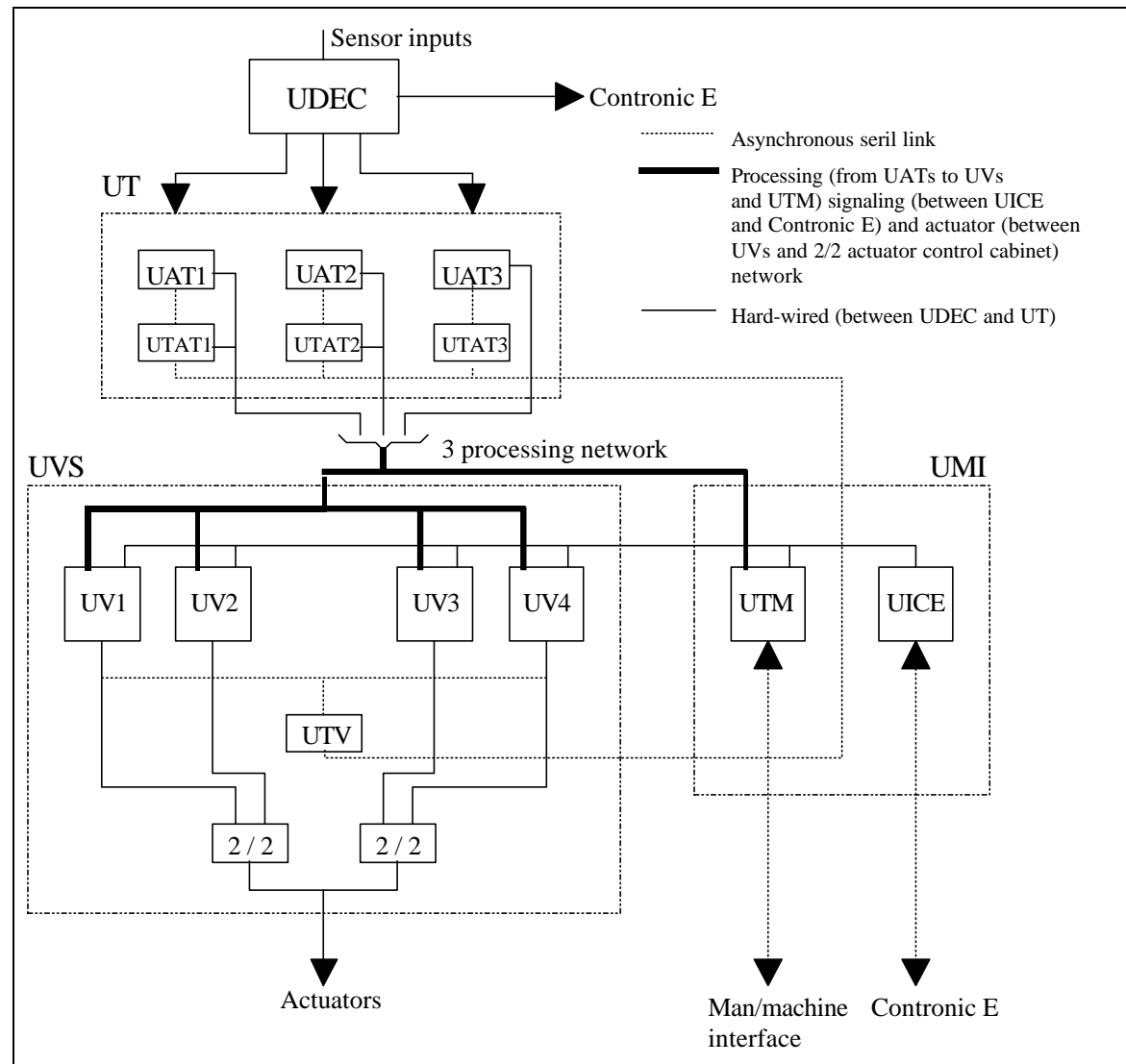
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Principal Support by ISG

Synchronous Application

Sensor inputs

UDEC → Contronic E

UT

UAT1   UAT2   UAT3

UTAT1   UTAT2   UTAT3

.... Asynchronous seril link

━━━ Processing (from UATs to UVs and UTM) signaling (between UICE and Contronic E) and actuator (between UVs and 2/2 actuator control cabinet) network

──── Hard-wired (between UDEC and UT)

3 processing network

UVS   UMI

UV1   UV2   UV3   UV4   UTM   UICE

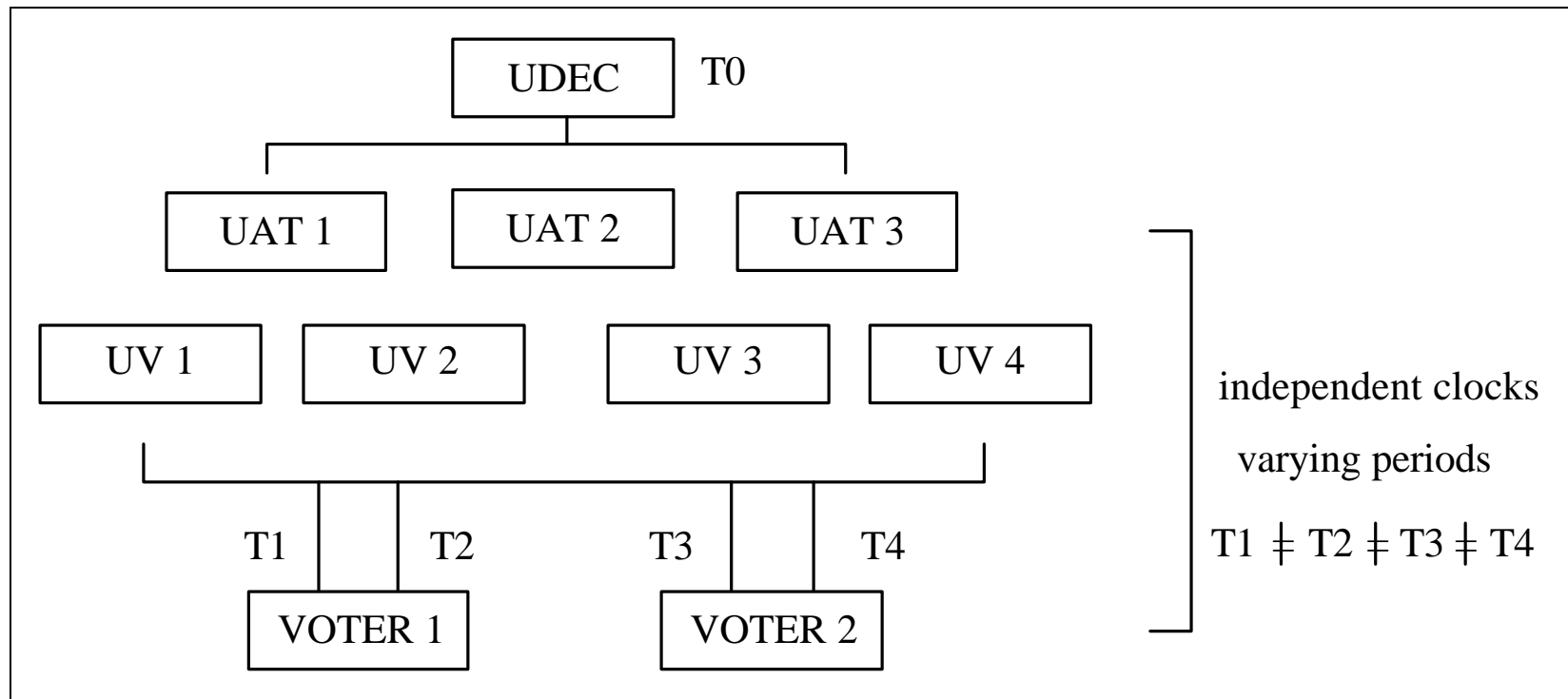UTV

2 / 2   2 / 2

Actuators

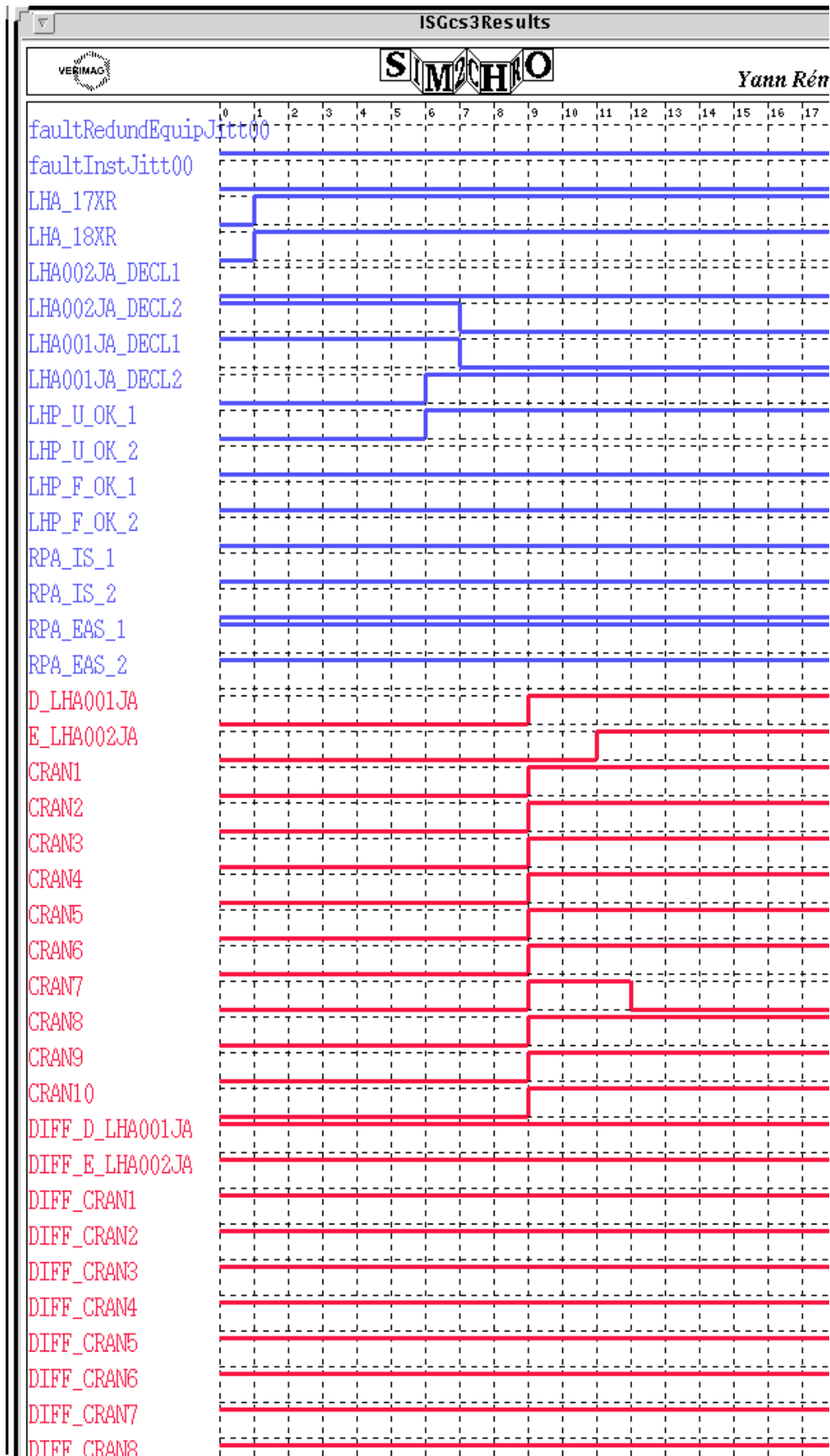Man/machine   Contronic E
interface

Distribution and Propagation Delays

Stimulation (23 + 3) and Evaluation (UV 4x12, Voter 2x12)

Comparison of UV and Voter Outputs (12) per UDEC Step

Scenario (Sim2Chro Representation)

Generation of Time Jitter and Fault Injection

Chain: UDEC to UV,
             results reported to UDEC
 	
 Instances: UDEC: 1   UAT: 3   UV: 4   Voter: 2
 	
 Inputs: 26 (UAT: 23, UV: 3)
             5 pairs of redundant sensors
 	
 Outputs: 12 (UV)
	Nodes: 16 executed on one CPU
	
	 Processes: 16 cyclic activities: 42
	                     one per process + 26 for
	                     stimulation
	
	 Voter: 2 derived by **AND** from UV
	
	           no separate stage

1 minor cycle = 70 steps (rate 1/s)

1 major cycle = iteration over 4 fault injection modes (2x2) à10 minor cycles, in total: 5000 s

Fault Injection:

      I   Random Input Last Instance of UAT (#3, UAT3) at UDEC

      S   Random Input Redundant Sensor (second sensor, LH*_2, RP*_2) at UDEC

Time Jitter: *sensor inputs (UDEC)*   average drift 0, 0 .. 20% of period

                  data exchange between processes   average drift 0, 0 .. 20% of period

                                              and / or

                                  random drift due to random period
                                     at creation time (0 .. 20%)

UV		Sensor stimulation at beginning of cycles			
		S / I = No / No	S / I = No / Yes	S / I = Yes / No	S / I = Yes / Yes
Steps	Time Jitter	Steps, Count, Diffs %	Steps, Count, Diffs %	Steps, Count, Diffs %	Steps, Count, Diffs %
3991	none	1691, 20292, 80 **0.4**	300, 3600, 39 **1.1**	1574, 18888, 3319 **17.6**	426, 5112, 1016 **19.9**
4994	none (update)	1419, 17028, 0 **0**	1420, 17040, 28 **0.2**	1420, 17040, 3147 **18.5**	735, 8820, 1879 **21.3**
5013	± 0.5 %	1701, 20412, 4284 **21.0**	772, 9264, 1416 **15.3**	1522, 18264, 6701 **36.7**	1018, 12216, 4286 **35.1**
5071	± 2 %	1715, 20580, 3363 **16.4**	766, 9192, 1582 **17.2**	1571, 18852, 6471 **34.3**	1019, 12228, 4060 **33.2**
4157	± 5 %	1794, 21528, 3650 **17.0**	303, 3636, 648 **17.8**	1559, 18708, 5999 **32.1**	501, 6012, 1736 **28.9**
4329	± 10 %	1117, 13404, 2255 **16.8**	1048, 12576, 2246 **17.9**	1104, 13428, 4021 **30.4**	1060, 12720, 4523 **35.6**
5124	± 20 %	2053, 24636, 5048 **20.5**	551, 6612, 1309 **19.8**	1754, 21048, 7761 **36.9**	766, 9192, 2880 **31.3**

UV		Sensor stimulation in the middle of the cycles			
		S / I = No / No	S / I = No / Yes	S / I = Yes / No	S / I = Yes / Yes
Total Steps	Time Jitter	Steps, Count, Diffs %	Steps, Count, Diffs %	Steps, Count, Diffs %	Steps, Count, Diffs %
	none				
5074	± 2 %	1733, 20796, 3082 **14.8**	771, 9252, 1345 **14.5**	1553, 18636, 6475 **34.7**	1017, 12204, 4331 **35.5**
	± 5 %				
	± 10 %				
	± 20 %				

UV		±10 % period variation			
		S / I = No / No	S / I = No / Yes	S / I = Yes / No	S / I = Yes / Yes
Total Steps	**Time Jitter**	**Steps,Count, Diffs %**	**Steps, Count, Diffs %**	**Steps, Count, Diffs %**	**Steps Count, Diffs %**
4329	sensor and data exchange	1117, 13404, 2255 **16.8**	1048, 12576, 2246 **17.9**	1104, 13428, 4021 **30.4**	1060, 12720, 4523 **35.6**
4991	**only** sensor stimulation with time jitter	1729, 20748, 94 **0.5**	790, 9480, 22 **0.2**	1495, 17940, 3039 **16.9**	977, 11724, 2026 **17.3**
5510	sensor 0% data exchange with time jitter and drift	1932, 23184, 4078 **17.6**	804, 9648, 1965 **20.4**	1678, 20136, 7205 **35.8**	1096, 13152, 4230 **32.2**
5514	sensor 0%, data exchange w/o time jitter, but drift	1929, 23148, 4218 **18.2**	797, 9564, 1825 **19.1**	1678, 20136, 7079 **35.2**	1110, 13320, 4914 **36.9**
5517	same as above, but different FI scenario	3607, 43284, 7871 **18.2**	1910, 22920, 4484 **19.6**	-	-
5112	sensor 0% data exchange w/o drift, but jitter	1450, 17400, 3353 **19.3**	1453, 17436, 3547 **20.3**	1454, 17448, 6198 **35.5**	755, 9060, 3327 **36.7**

VOTER		Sensor stimulation at beginning of cycles			
		S / I = No / No	S / I = No / Yes	S / I = Yes / No	S / I = Yes / Yes
Total Steps	Time Jitter	Steps Count Diffs %	Steps Count Diffs %	Steps Count Diffs %	Steps Count Diffs %
4994	none (update)	1419, 17028, 0 **0**	1420, 17040, 11 **0.1**	1420, 17040, 2087 **12.2**	735, 8820, 1376 **15.6**
	± 0.5 %				
	± 2 %				
	± 5 %				
	± 10 %				
	± 20 %				

VOTER		S / I = No / No	S / I = No / Yes	S / I = Yes / No	S / I = Yes / Yes
Total Steps	**Time Jitter**	**Steps Count Diffs %**	**Steps Count Diffs %**	**Steps Count Diffs %**	**Steps Count Diffs %**
	sensor and data exchange				
	sensor stimulation with time jitter				
	sensor 0% data exchange with time jitter and drift				
	sensor 0%, data exchange w/o time jitter, but drift				
5517	same as above, but different FI scenario	3607, 43284, 3455 **7.9**	1910, 22920, 1980 **8.6**	-	-
5512	sensor 0% data exchange w/o drift, but jitter	1450, 17400, 1464 **8.4**	1453, 17436, 1534 **8.8**	1454, 17448, 3370 **19.3**	755, 9060, 1967 **21.7**

Histograms on Phase Shifts (Propagation Delay)

Phase Shifts (in multiples of reference period)			
Time Jitter	**UAT**	**UV**	**VOTER**
5 %	countAverageJit05 countMinJit05 countMaxJit05	not available (file corrupted)	not available (file corrupted)
10 %	countAverage countMin countMax	countAverage countMin countMax	countAverage countMin countMax
20 %	countAverageJit20 countMinJit20 countMaxJit20	countAverageJit20 countMinJit20 countMaxJit20	countAverageJit20 countMinJit20 countMaxJit20

Results of Fault Injection and Time Jitter

❑ **insensitive** against time jitter at sensor data acquisition

❑ **insensitive** against one wrong data input (last instance of UAT and UV from UDEC)

❑ **very sensitive** against wrong data of second redundant sensor (if available)

❑ **very sensitive** against time jitter (of any type) of cyclic processing

❑ is observed sensitivity a matter of control logic ?