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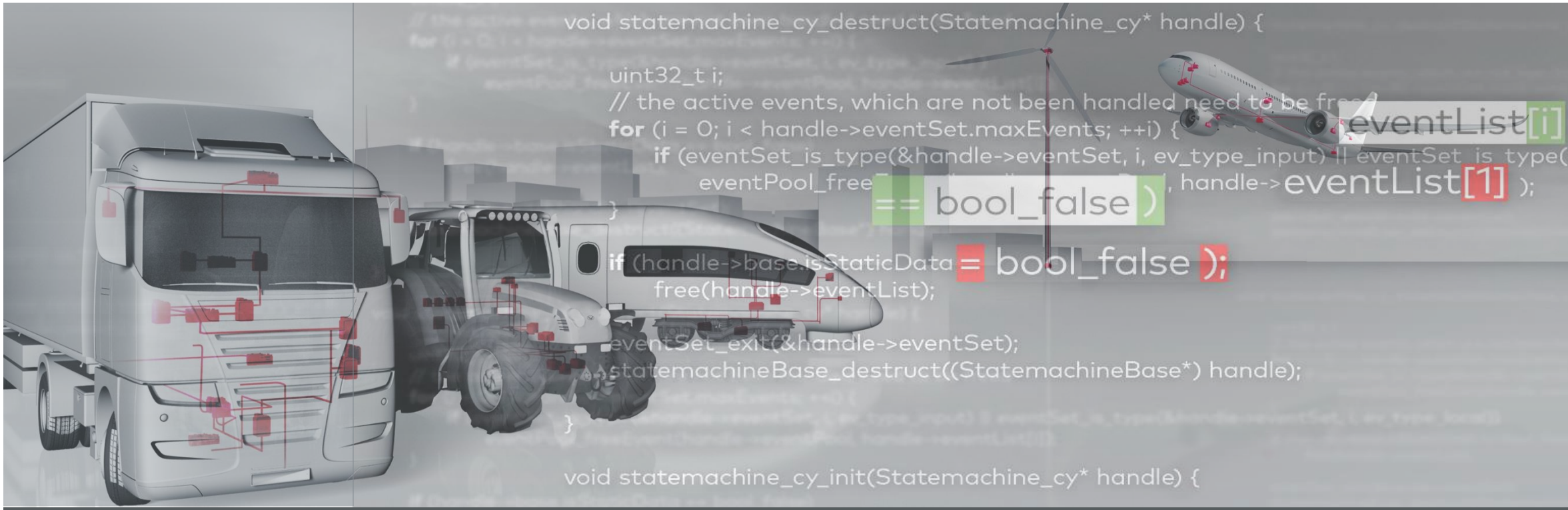

Accelerating ISO 26262 Compliance by change-based testing

Vector Testing Symposium, Stuttgart, May 7th

Agenda

- Code Coverage
- Change Based Testing
- Demo

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Make SW Development Fast and Cheap but keep the Quality High?

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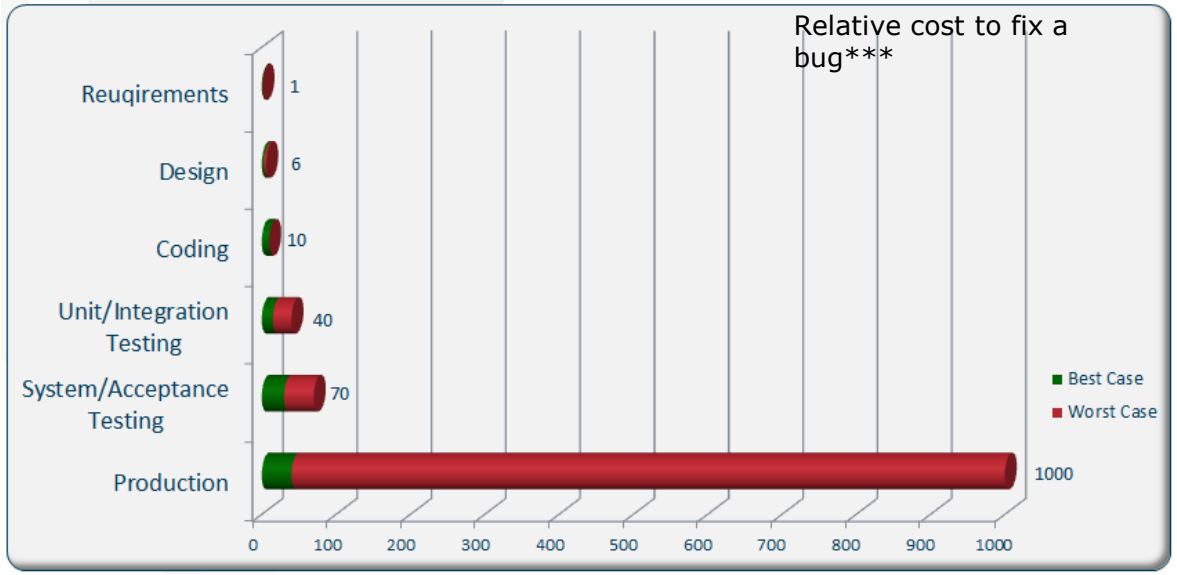
When should we test? Or: How to reduce cost

Phase of the S/W Dev	Relative cost to fix a bug*
Design	1x
Implementation	7x
Testing	15x
Maintenance	100x

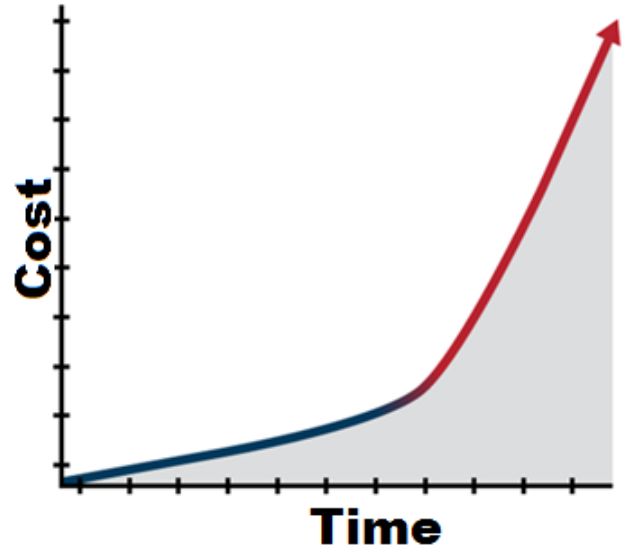
* DevOps: Shift left with continuous testing by using automation and virtualization (IBM; Dibbe Edwards)

Testing Phase	~Cost/Bug**
Unit Test	$5
Full Build	$50
Integration Test	$500
System Test	$5000

** How Google Tests SW (James A. Whittaker, Jason Arbon, and Jeff Carollo)



*** James Martin, An Information Systems Manifesto, Prentice-Hall, Inc., Englewood Cliffs, New Jersey



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Why measure Code Coverage?

Coverage

Coverage results for locking.c

Statements 62% Branches 63%

	Subp	Cond	(T)	(F)	
27	2	0	(T)		processLockMess
28	2	1	*		switch (mess->DB[0])
					{
30	2	2	( )		case LOCK_REQ:
31	2	3			lockState = LOCKED;
32	2	4			lockMode = MANUAL_LOCK;
33	2	5			break;
34	2	6	( )		case UNLOCK_REQ:
35	2	7			lockState = UNLOCKED;
36	2	8			lockMode = MANUAL_LOCK;
37	2	9			break;
38	2	10	(T)		case LOCK_AUTO :
39	2	11	*		lockMode = AUTO_LOCK;
40	2	12	*		break;
					}
					/* TODO actually lock the doors! */
43	2	13	*		setLockIndicator(lockState);
					}
					/* auto locking */
					void checkAutoLock(void)
					{
48	3	0	(T)		checkAutoLock
49	3	1	( )	(F)	if(speed > 250) /* Turn lock on at 25 kph */
					{
51	3	2			lockState=LOCKED;
					}
					else
					{
55	3	3	*		lockState=UNLOCKED;
					}
57	3	4	*		setLockIndicator(lockState);
					}
					enum lockState_t getLockState(void)

Metrics

Unit	Subprogram	Complexity	Statements	Branches
main_pe1.c	unused_isr	2	0 / 1 (0%)	0 / 2 (0%)
	main	1	3 / 3 (100%)	1 / 1 (100%)
TOTALS	**2**	**3**	**3 / 4 (75%)**	**1 / 3 (33%)**
r_lin.c	R_LIN_Init	1	4 / 4 (100%)	1 / 1 (100%)
	R_LIN_Deinit	1	2 / 2 (100%)	1 / 1 (100%)
	R_LIN_Test	2	3 / 4 (75%)	2 / 3 (66%)
	R_LIN_TxFrame	2	0 / 3 (0%)	0 / 3 (0%)
	R_LIN_RxFrame	2	0 / 3 (0%)	0 / 3 (0%)
TOTALS	**5**	**8**	**9 / 16 (56%)**	**4 / 11 (36%)**
r_intc.c	R_INTC_MaskInterrupt	1	1 / 1 (100%)	1 / 1 (100%)
	R_INTC_UnmaskInterrupt	1	1 / 1 (100%)	1 / 1 (100%)
	R_INTC_SetPriority	1	0 / 3 (0%)	0 / 1 (0%)
	R_INTC_SetTableBit	1	1 / 1 (100%)	1 / 1 (100%)
	R_INTC_ResetTableBit	1	0 / 1 (0%)	0 / 1 (0%)
	R_INTC_SetRequestFlag	1	0 / 1 (0%)	0 / 1 (0%)
	R_INTC_GetRequestFlag	2	3 / 3 (100%)	3 / 3 (100%)
	R_INTC_ResetRequestFlag	1	1 / 1 (100%)	1 / 1 (100%)
TOTALS	**8**	**9**	**7 / 12 (58%)**	**7 / 10 (70%)**
r_pwmd.c	R_PWMD_Channel64Init	1	4 / 4 (100%)	1 / 1 (100%)
	R_PWMD_Channel65Init	1	4 / 4 (100%)	1 / 1 (100%)
	R_PWMD_Channel66Init	1	4 / 4 (100%)	1 / 1 (100%)
	R_PWMD_ClockInit	1	2 / 2 (100%)	1 / 1 (100%)
	R_PWMD_StartChannel	4	4 / 6 (66%)	4 / 7 (57%)
	R_PWMD_StopChannel	4	4 / 6 (66%)	4 / 7 (57%)
	R_PWMD_Channel64DutyUpdate	1	2 / 2 (100%)	1 / 1 (100%)
	R_PWMD_Channel65DutyUpdate	1	2 / 2 (100%)	1 / 1 (100%)
	R_PWMD_Channel66DutyUpdate	1	2 / 2 (100%)	1 / 1 (100%)
	R_PWMD_DiagInit	1	2 / 2 (100%)	1 / 1 (100%)
	R_PWMD_DiagStart	1	1 / 1 (100%)	1 / 1 (100%)
	R_PWMD_DiagStop	1	1 / 1 (100%)	1 / 1 (100%)
TOTALS	**12**	**18**	**32 / 36 (88%)**	**18 / 24 (75%)**
r_rlin.c	INTRLIN30UR0	2	3 / 3 (100%)	3 / 3 (100%)
	R_RLIN24_BaudrateInit	1	3 / 3 (100%)	1 / 1 (100%)
	R_RLIN24_Channel1Init	3	11 / 11 (100%)	3 / 5 (60%)
	R_RLIN24_Channel1TxFrame	6	21 / 24 (87%)	7 / 11 (63%)

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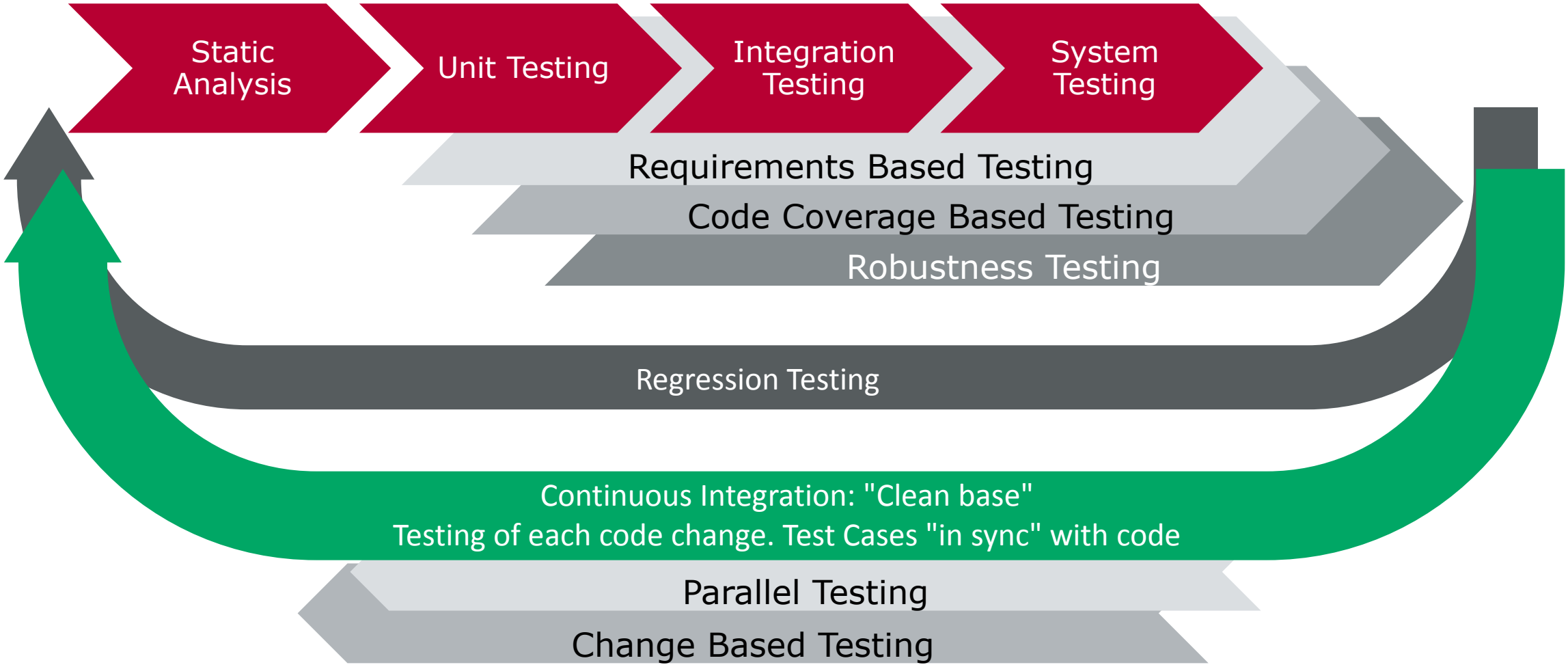
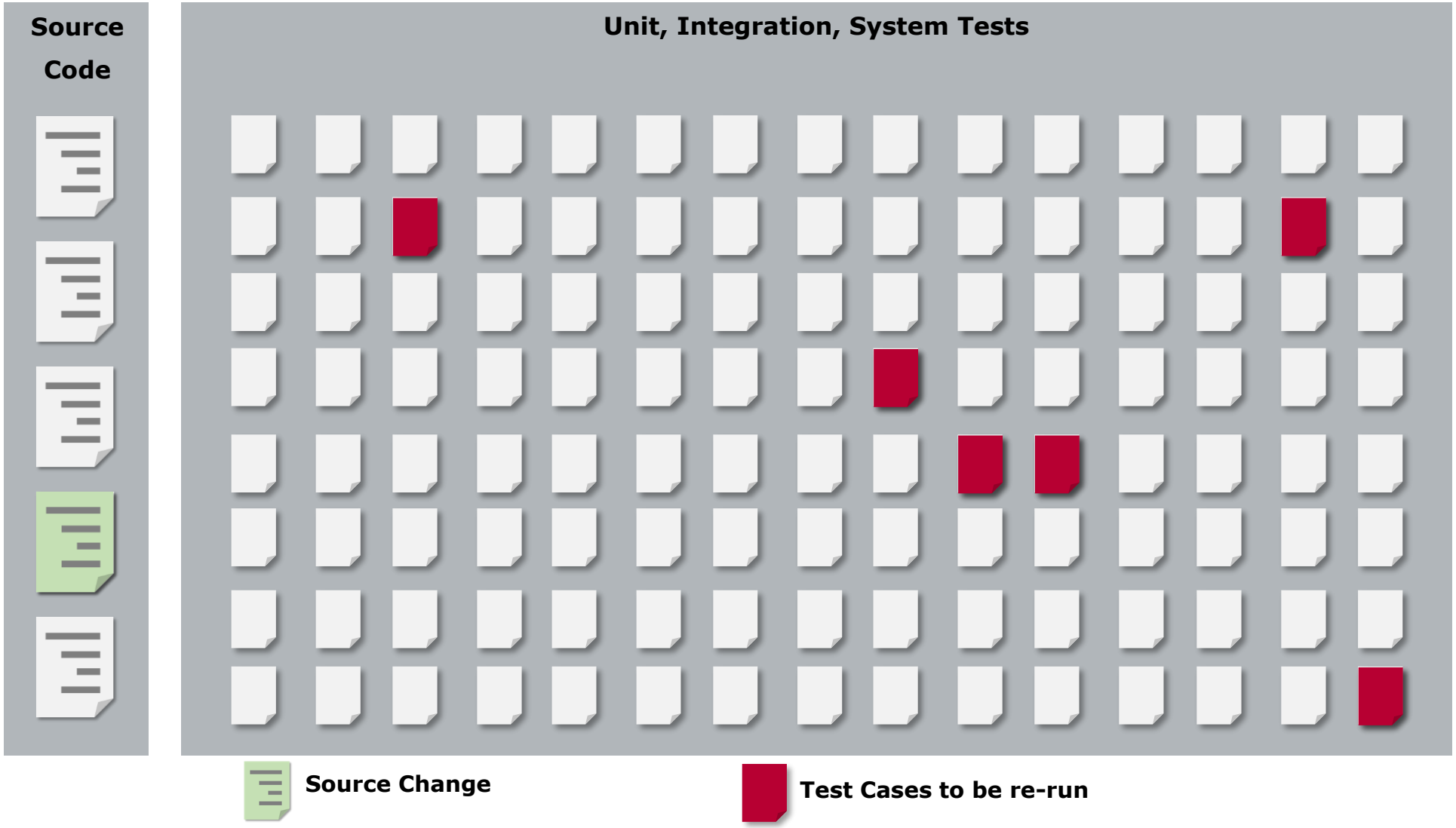
Testing: Early, Plenty, Thoroughly and Continuously

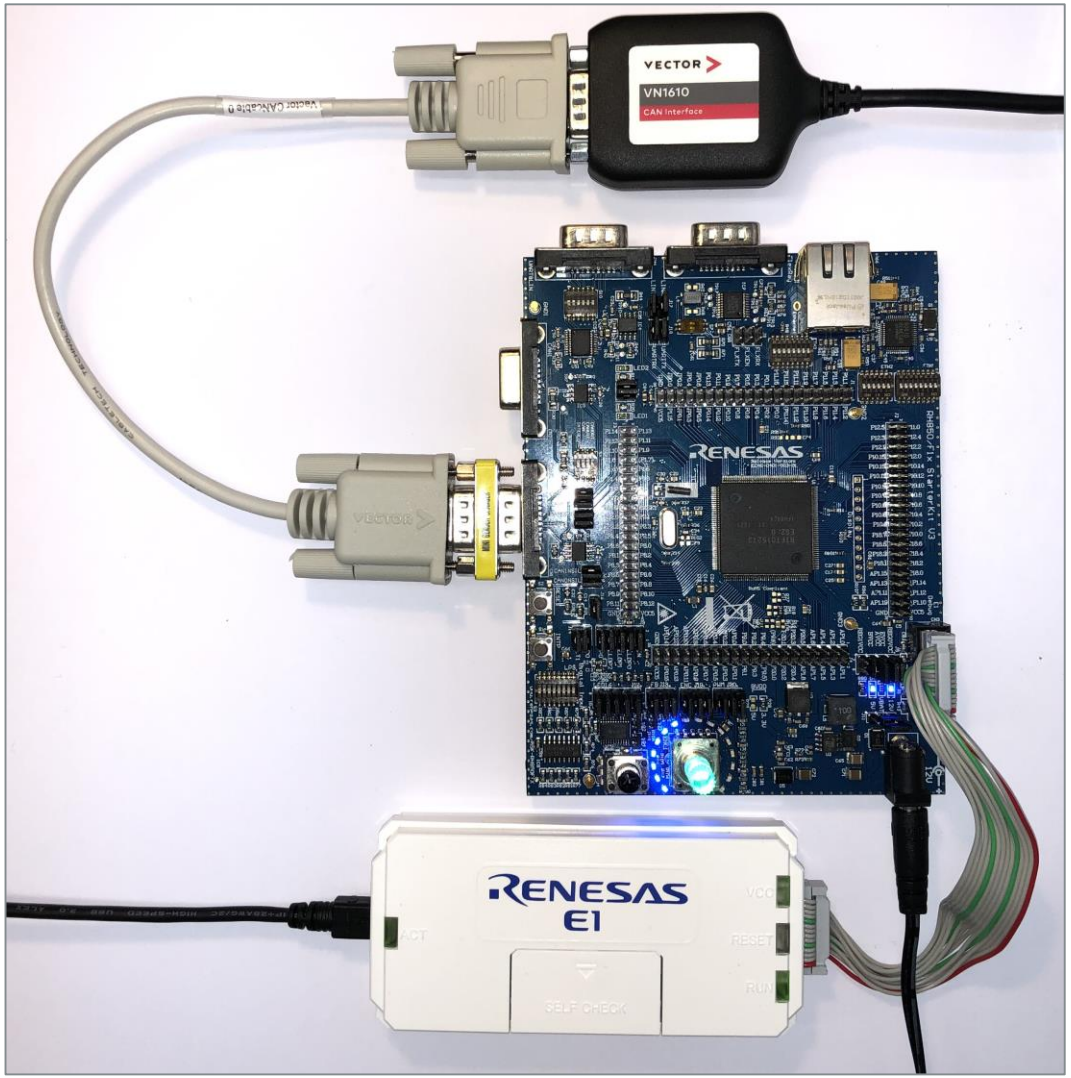


Change Based Testing – Test Less, Fail Faster



Demo Hardware

CAN Cable



VN1610

USB to Laptop

Renesas

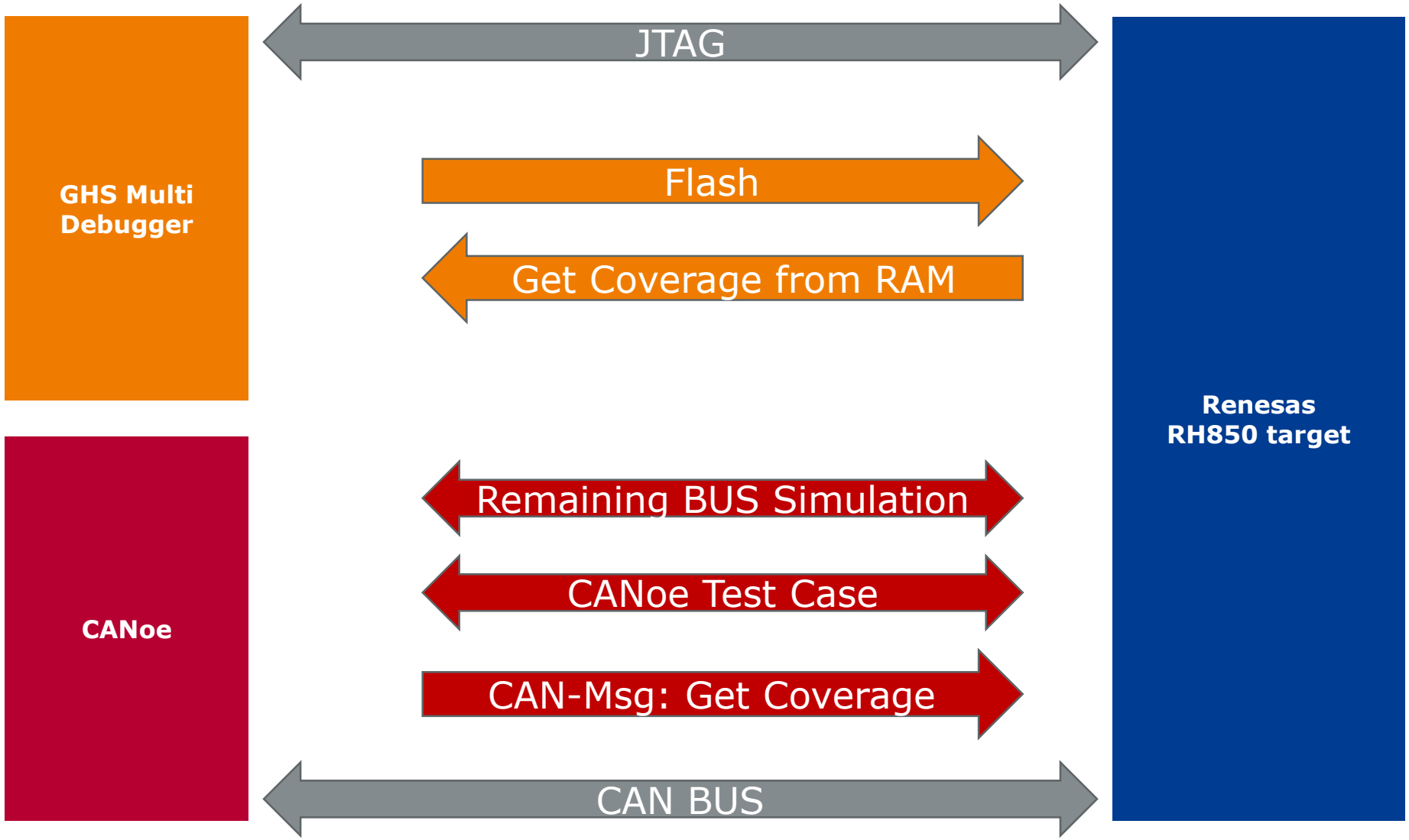
RH850

USB to Laptop

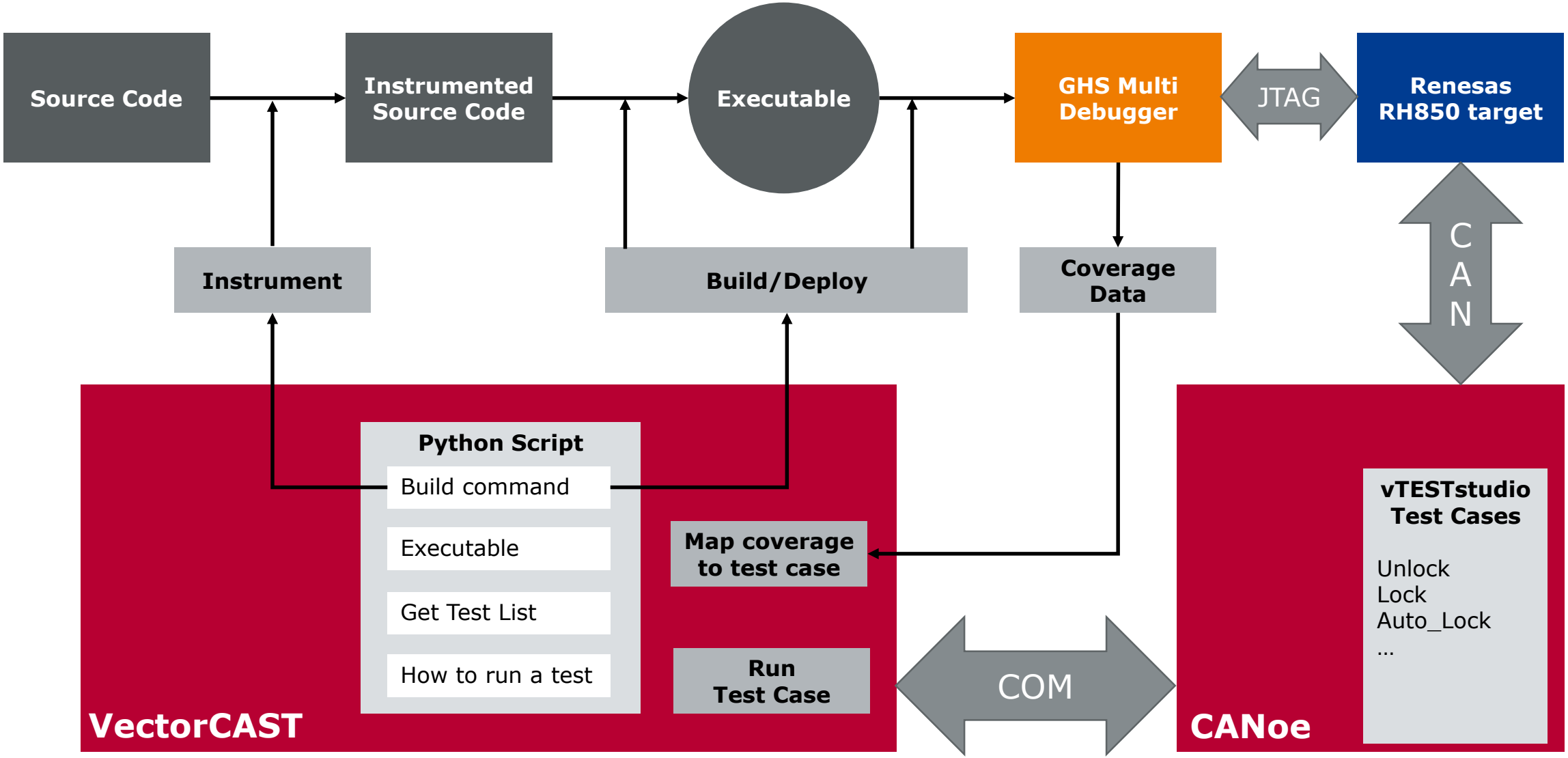
Renesas

E1 Emulator

Demo Workflow



Demo Workflow



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