



**INTREPID CONTROL SYSTEMS, INC.**



# INTREPID CONTROL SYSTEMS

“ECU Flashing speed only limited by physics”

**Presented by Intrepid:**

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# Intrepid The Company

- Customer focused solutions in vehicle serial data
- Founded in 1994 (14 Years)
- 30 employees in USA, China, and India
- 30% or higher growth past five years and including 2008's run rate
- Over 5000 tools sold globally
- Distributors in Europe, Korea, Japan, and Mexico



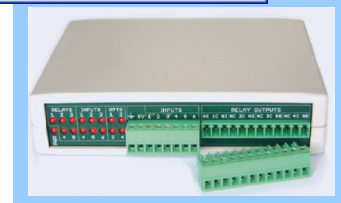
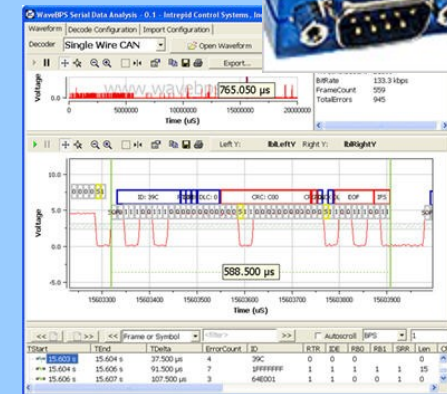


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# Intrepid Products

- **Vehicle Spy:** Bus Analysis, Simulation, and data acquisition
- **neoVI Hardware:** Multichannel CAN and LIN interfaces for the PC
- **ValueCAN :** Low cost signal and dual channel CAN to USB interfaces
- **WaveBPS:** Analog analysis of serial data with decoding for FlexRay, CAN, and LIN
- **neoECU and RAD/IO:** Physical IO and Control for CAN, LIN and FlexRay





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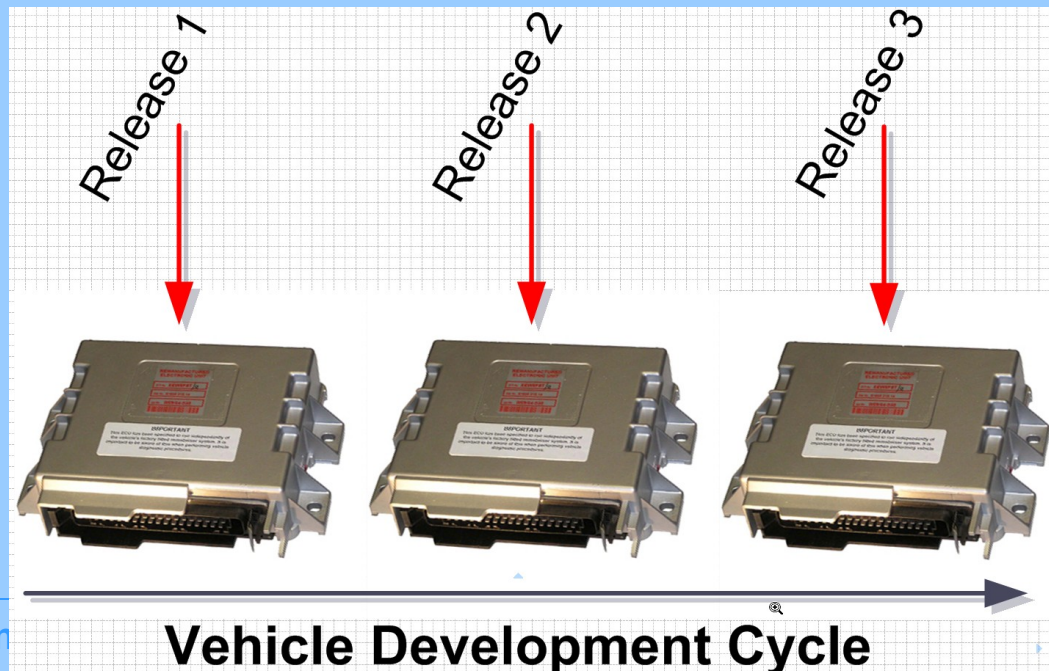


# ECU Flashing



# What and why of ECU Flashing?

- ECUs are developed at stages during vehicle development
- During these states new ECU features and bug fixes are applied
- Calibration: Algorithm tweaking





# Who does ECU Flashing?

*Facts to consider.....*

- The vehicle today is software driven
- Without the right software in our Vehicle do our tests have meaning?
- A new aspect of traceability is vehicle software

**Test Engineers: must flash in order to evaluate vehicle performance.**

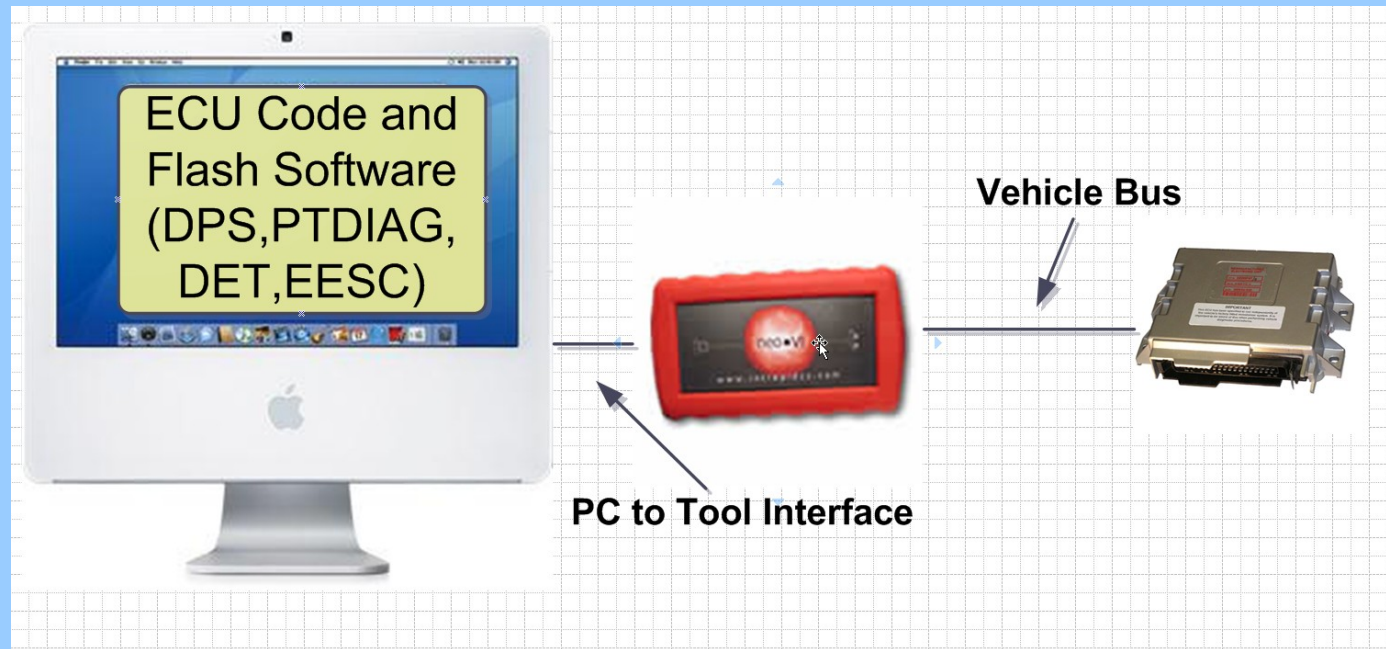
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# How do we update ECUs?

- OEM software, J2534 Tool, and an ECU connection cable





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# ECU Flashing Speed



# Why do we care about speed?

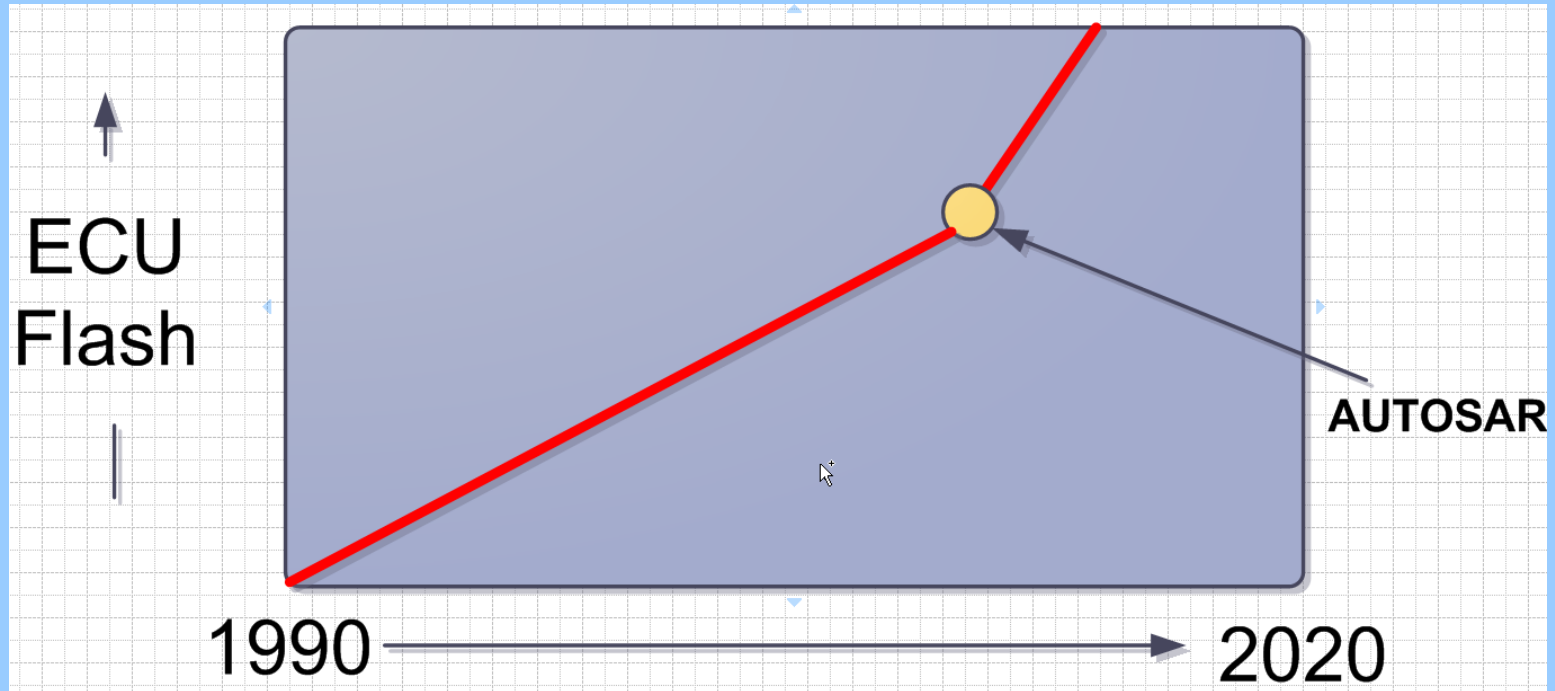
- One ECU flashing takes a long time typically between 2 and 20 minutes
- Imagine 50 ECUs per vehicle
- Imagine a parking lot of vehicles



**What if we could cut flashing time in half?**



# More bad news – software gets bigger



**Entire Vehicle Flash is increasing....**

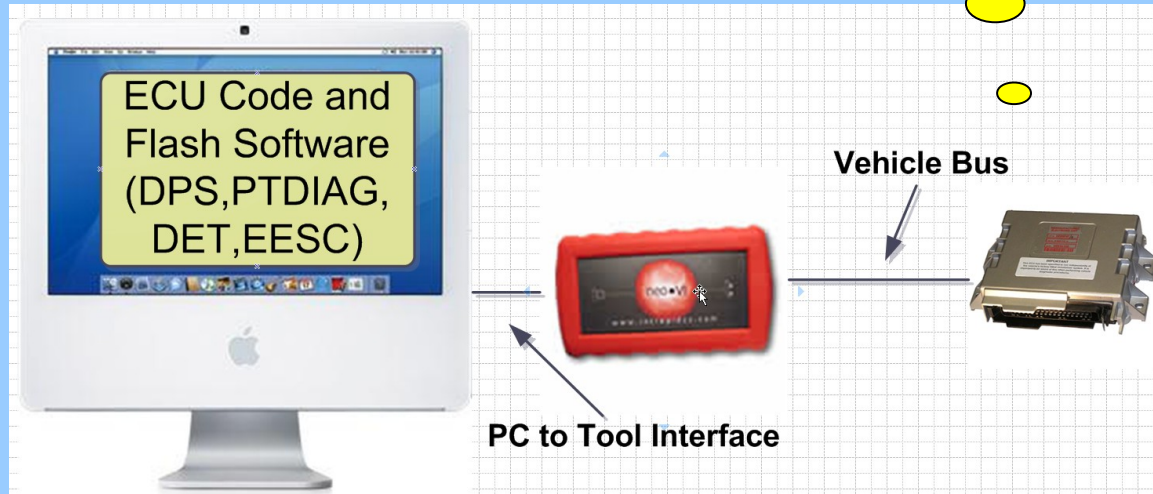


# What contributes to ECU Speed?

## LATENCY AND SPEED OF SYSTEM COMPONENTS

- ECU flash software
- PC to tool link
- CAN bus
- ECU flash memory and self flash software

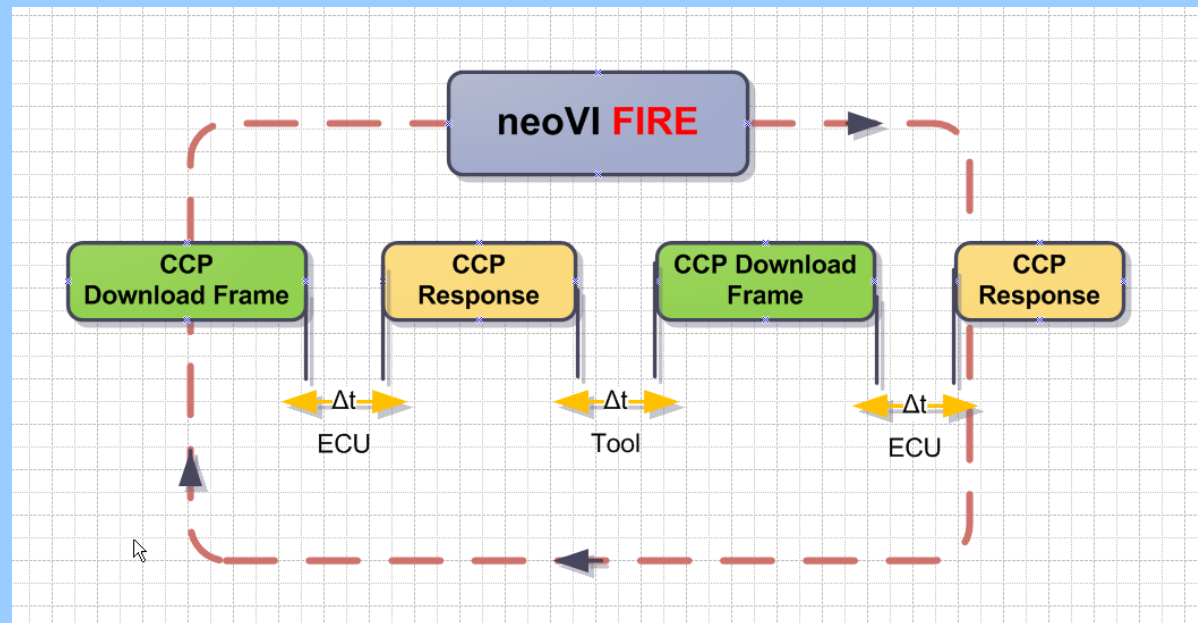
Weak link  
in a chain





# What is latency and speed?

- Speed: Bytes Per Second
- Latency: Time from when something can happen and it actually does





# Internal ECU flashing rate

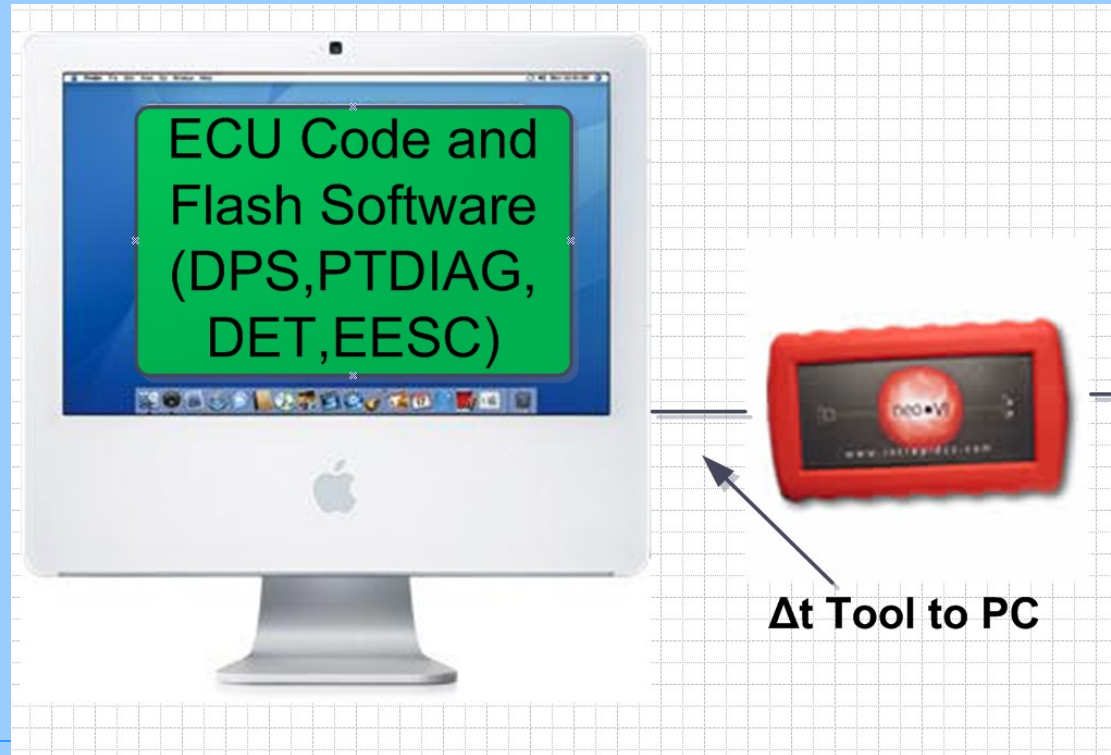
- Flash memory has limits on how fast you can program it

Num	Characteristic	Symbol	Min	Typ	Initial Max <sup>2</sup>	Max <sup>3</sup>	Unit
1	Double Word (64 bits) Program Time <sup>4</sup>	$T_{dwprogram}$	—	10	—	500	$\mu s$
2	Page (128 bits) Program Time <sup>4</sup>	$T_{pprogram}$	—	15	44	500	$\mu s$
3	16 Kbyte Block Pre-program and Erase Time	$T_{16kpperase}$	—	325	525	5000	ms
4	64 Kbyte Block Pre-program and Erase Time	$T_{64kpperase}$	—	525	675	5000	ms
5	128 Kbyte Block Pre-program and Erase Time	$T_{128kpperase}$	—	675	1800	15,000	ms
6	Minimum operating frequency for program and erase operations	—	25	—	—	—	MHz
7	Wait States Relative to System Frequency PFCRPN[RWSC] = 0b000; PFCRPN[WWSC] = 0b01 PFCRPN[RWSC] = 0b001; PFCRPN[WWSC] = 0b01 PFCRPN[RWSC] = 0b010; PFCRPN[WWSC] = 0b01	$T_{rWSC}$	—	—	—	25 50 75	MHz
8	Recovery Time Stop mode exit or STOP bit negated Sleep mode exit (with CRP_RECPTN[FASTREC]=1) <sup>5</sup>	$T_{recover}$	—	—	—	20 120	$\mu s$ $\mu s$



# Tool to application

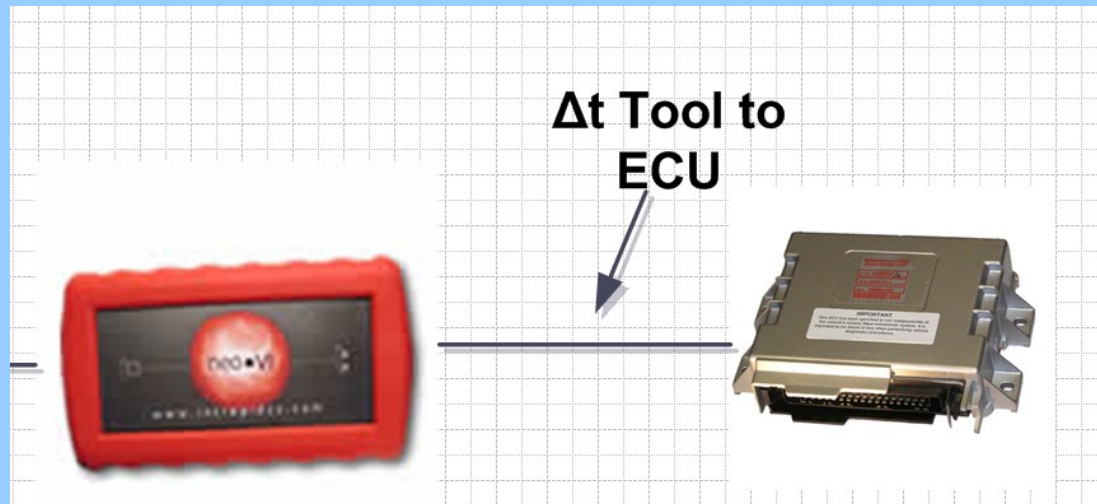
- Many factor affect this but latency is the major player
- Besides Windows latency depends on the PC interface (WiFi, BlueTooth, USB, PCI)
- Speed is usually no problem unless you are using RS232 or GPRS





# Tool to ECU

- Latency depends on the Firmware design of the tool





# CAN Bus

- Advances in flash memory programming speed means that CAN buses should be the only limiting factor in ECU programming

	BitTol	MinV	MaxV	AckSkew	AckWidth	DataPercent
	0.000	-393.701 mV	3.931 V	-40.000 ns	2.496 $\mu$ s	43.013
	0.047	-393.701 mV	4.724 V	-40.000 ns	2.304 $\mu$ s	23.174
	0.000	-393.701 mV	4.329 V	56.000 ns	2.208 $\mu$ s	54.680
	0.047	-393.701 mV	4.329 V	-40.000 ns	2.304 $\mu$ s	53.346
	0.000	-393.701 mV	4.723 V	-40.000 ns	2.304 $\mu$ s	55.639
	0.040	-393.701 mV	4.724 V	-40.000 ns	2.304 $\mu$ s	48.684
	0.083	-393.701 mV	4.329 V	152.000 ns	2.496 $\mu$ s	54.680
	0.012	-785.864 mV	4.329 V	56.000 ns	2.496 $\mu$ s	41.225
	0.000	-393.701 mV	4.329 V	56.000 ns	2.304 $\mu$ s	52.444
	0.010	-393.701 mV	5.118 V	56.000 ns	2.400 $\mu$ s	55.155
	0.000	-393.701 mV	5.906 V	-40.000 ns	2.400 $\mu$ s	53.324
	0.047	-393.701 mV	4.329 V	152.000 ns	2.592 $\mu$ s	38.064



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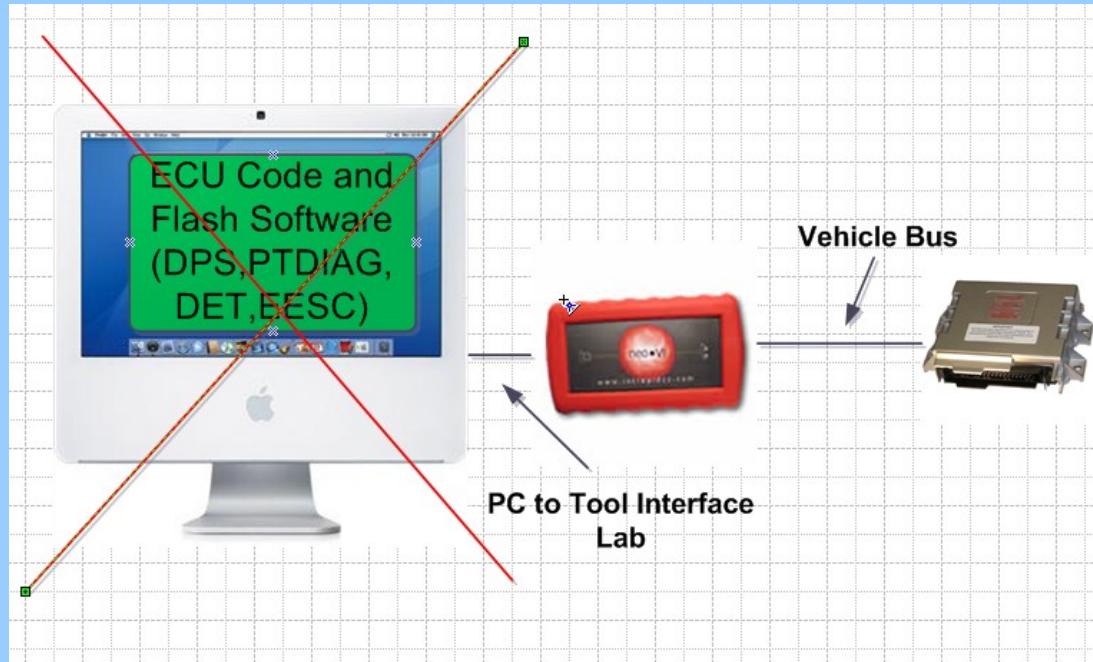


# How do we speed it up?



# Speed it up solution #1

- Move as much as possible into the hardware





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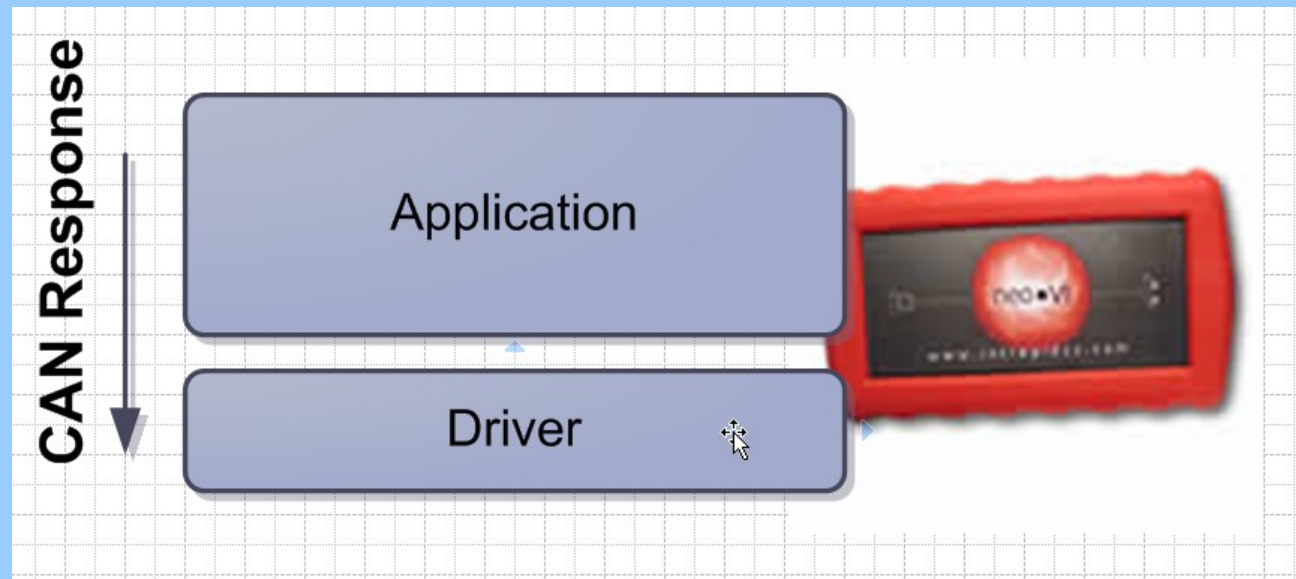
# Speed it up solution #1

- Intrepid moved ISO15762-2 transport layer into hardware
- Intrepid moved CCP download transport layer into hardware
- Intrepid moved GM DPS, Ford DET, EESC into hardware
- Intrepid provides a realtime scripting engine in the hardware to allow microsecond level response and transmission



## Speed it up solution #2

- Optimize firmware for quick reaction to bus events





## Speed it up solution #2 Optimize Firmware of Tool

- Intrepid moves script execution response in the interrupt routine of CAN controller
- Result is instant response times of to CAN messages (+/- a few time quanta)





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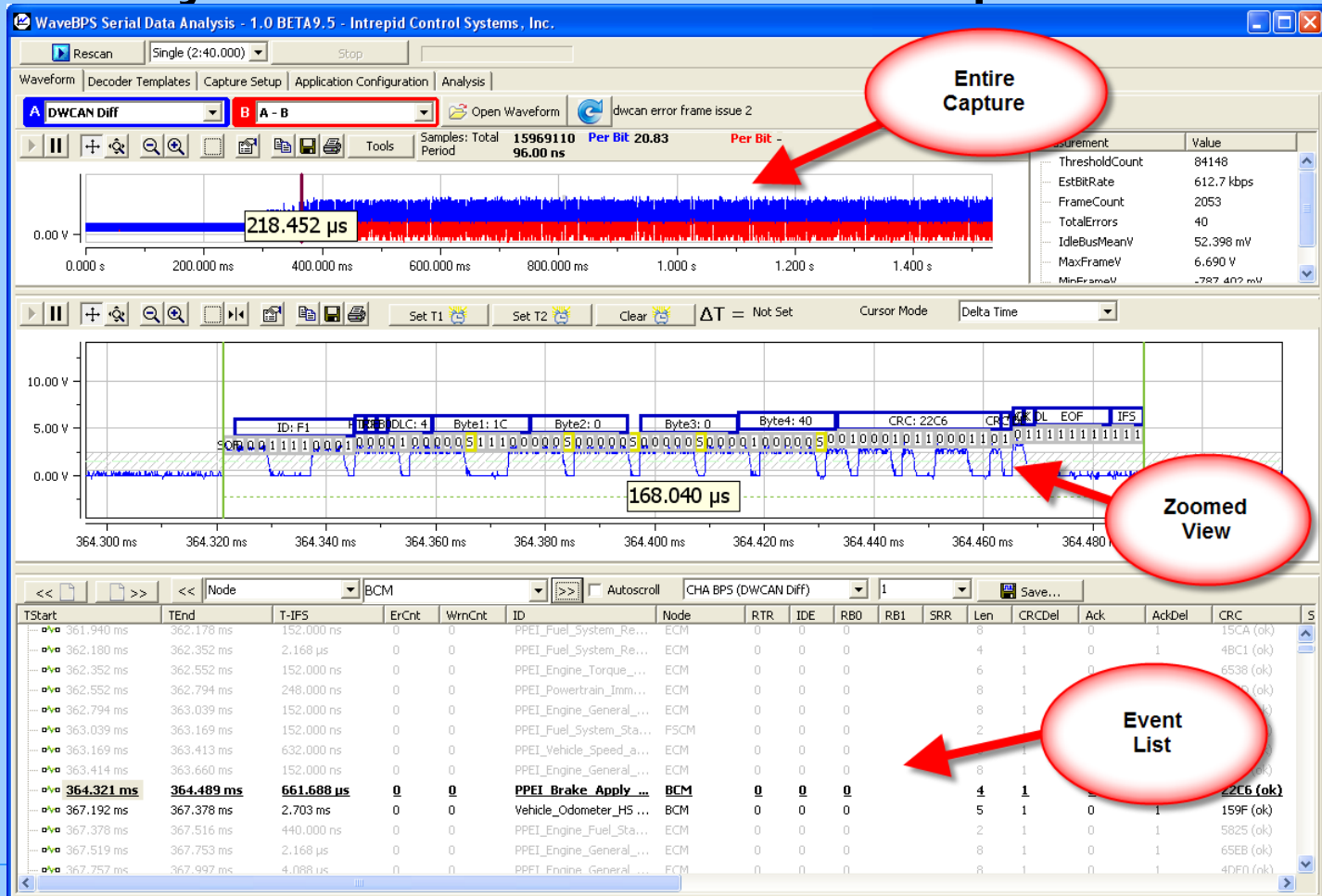
## Net result

**ECU flashing at the highest possible speed limited by the protocol.**



# Why are we so sure?

- Intrepid's WaveBPS tools can capture a programming event and analyse every Inter-frame time and prove it





# Conclusion

- ECU flashing time affects everyone
- The ECU flashing method has many areas of inefficiency
- With the right tools – ECU flashing can be optimized
- Intrepid provides powerful tools to do ECU flashing with or without a PC
- Intrepid's WaveBPS software is the final word in validating and debugging ECU flashing