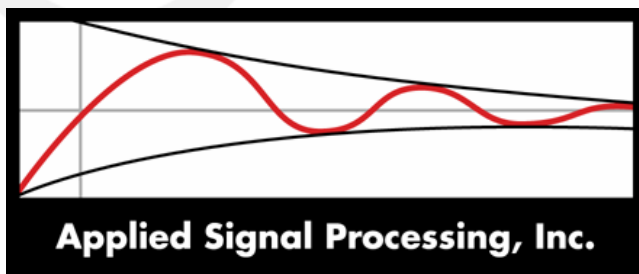


Robust Architecture for Software Flash Upgrades on a C5000 via a Serial Link

Shawn Steenhagen
Applied Signal Processing, Inc.



Presentation Overview

- Problem Definition
- Design Objectives
- Architecture Overview
- Description of Each Component
- Demonstration
- Questions/Comments

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Problem Definition

- Certain situations require upgrade of DSP flash without the use of an emulator:
 - Emulator use may not be possible due to controller location (under dash of car, in tail of airplane, etc.).
 - Costs: Providing emulator and tools to end users or service personnel may not be practical.
- The upgrade process must be robust so that failures during reprogramming process do not result in a “dead” controller.

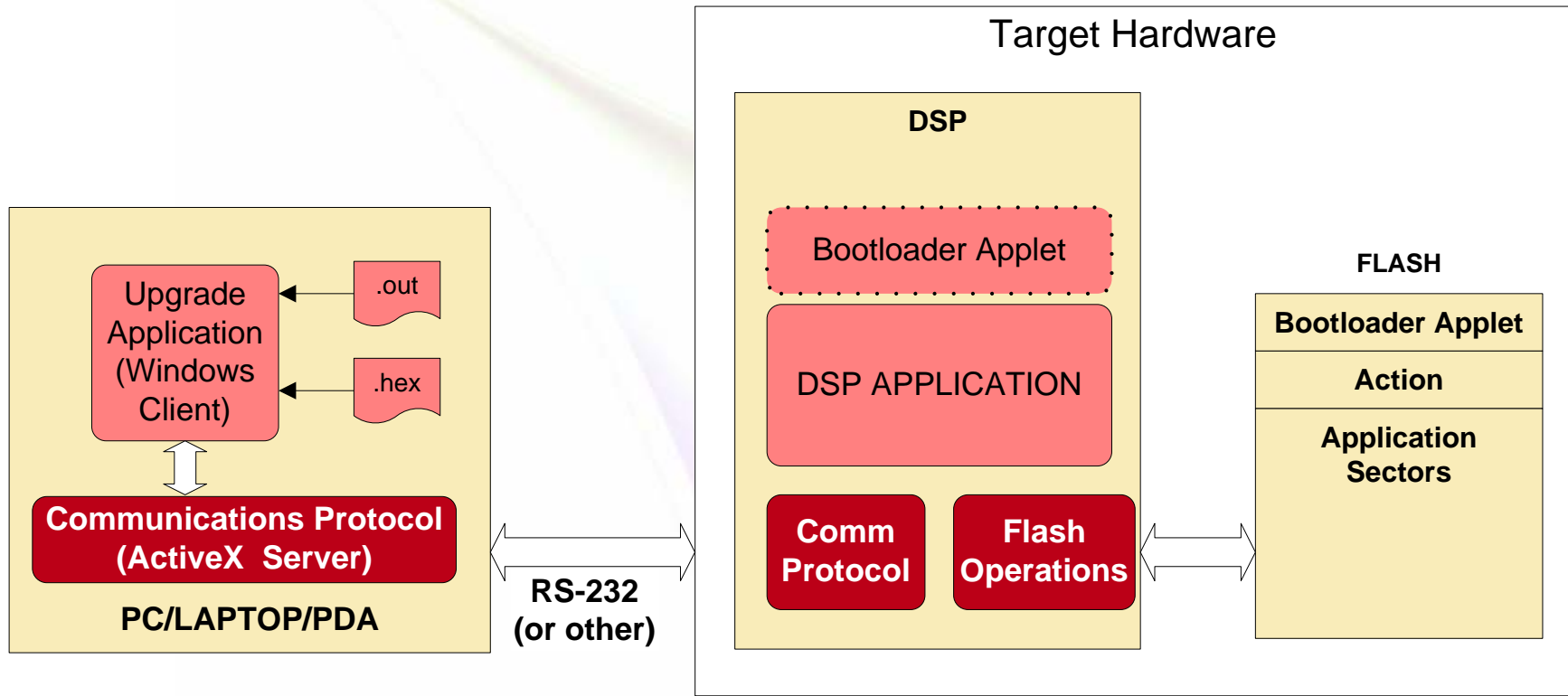
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Design Objectives

- Do not require direct access to the hardware other than a serial cable.
- Use a PC, laptop or handheld device running a standalone application to program the device.
- Gracefully recover from any failed programming attempt.
- Launch only valid applications.

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Solution Architecture



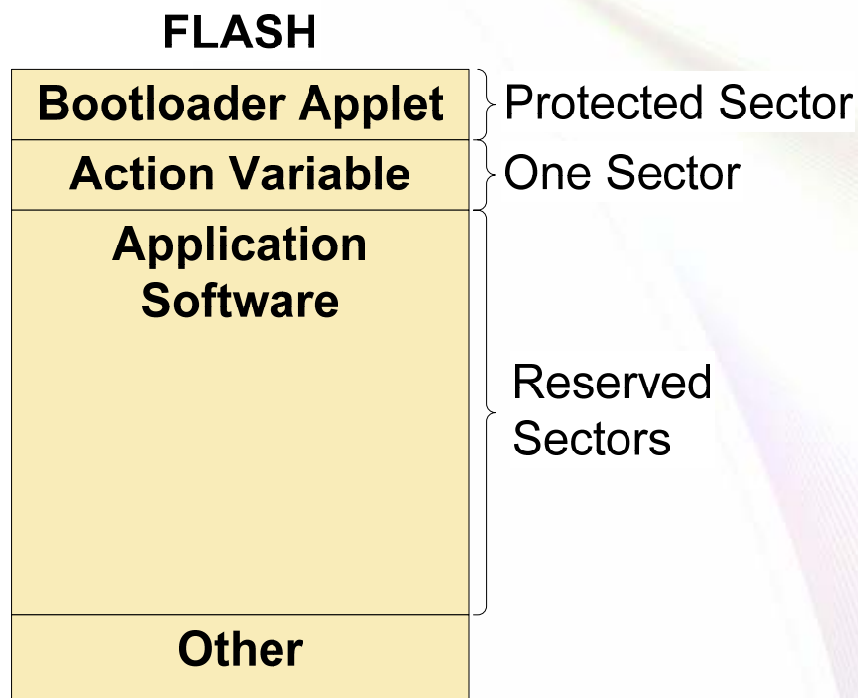
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Functional Summary

- Bootloader applet loaded and launched via on-chip bootloader.
- Applet reads variable from flash to determine action to take (i.e., wait or launch application).
- If action is launch, performs checksum on application area of flash and launches application if valid.
- If action is wait or application is invalid, applet sits in loop until PC downloads new application via Comm Protocol and issues launch command.

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Flash Device Sections



- Three unique sections are defined.
- Loader applet burned into protected sector of flash at factory.
- Action variable tells applet what function to perform at startup.

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Communications Protocol

Header	Len	DevID	Cmd	Cmd Data	ChkSum
--------	-----	-------	-----	----------	--------

- Main purpose is to provide asynchronous “peek” and “poke” operations on DSP Target Memory.
- “Logical Layer” is packet-based Query/Response Protocol with checksum and retries.
- PC is master, requesting certain operations and waiting for a response.
- DSP is slave, servicing requests and returning any data.
- “Physical Layer” can be any suitable link (RS-232, Ethernet, USB, etc.).

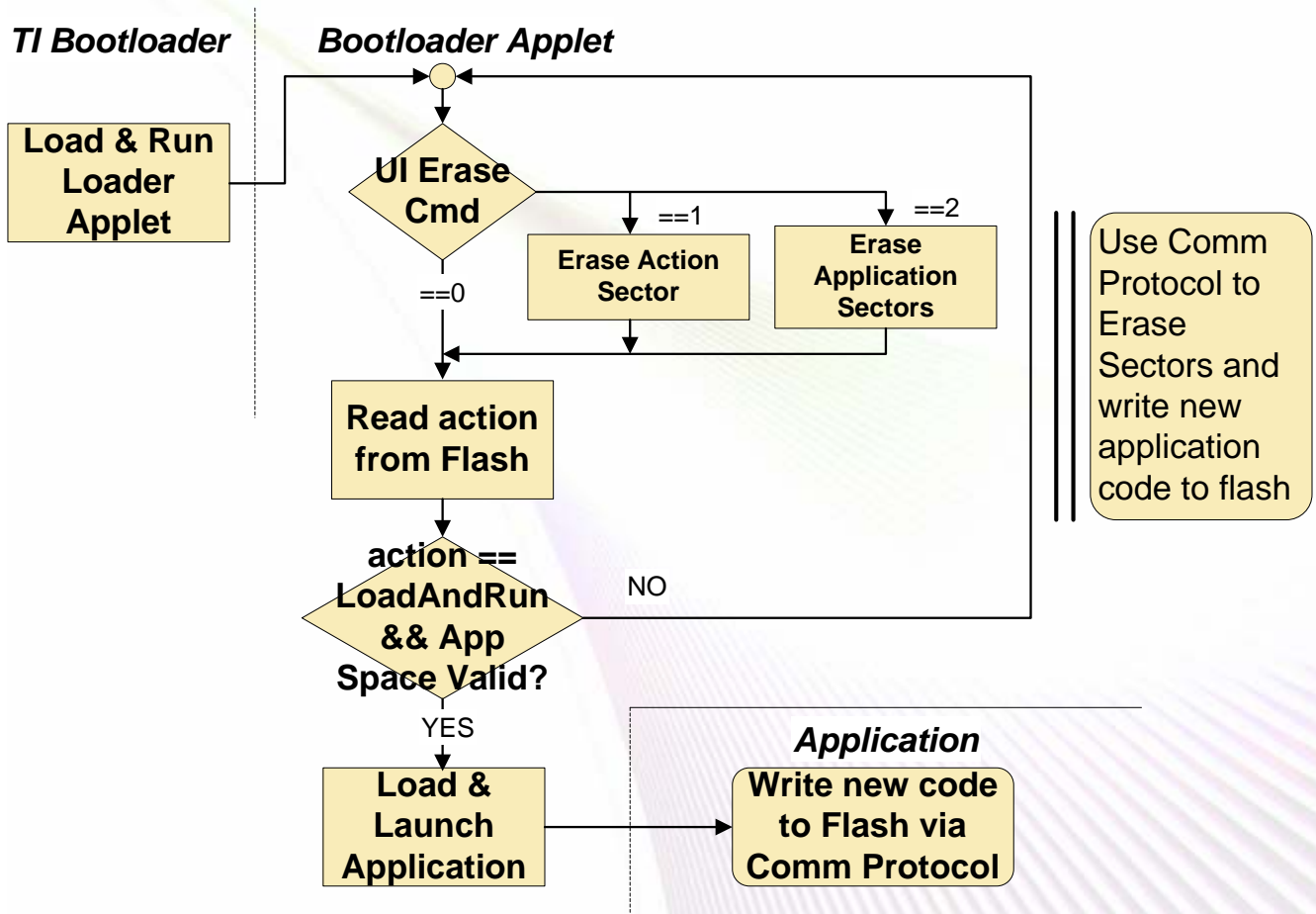
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Protocol Commands: Minimum Set

- MemRead: Read from DSP memory.
- MemWrite: Write to DSP memory.
- GetId: Return identification string.
- For MemRead and MemWrite commands, the DSP looks at the passed address and calls the Flash Read or Write functions when necessary.

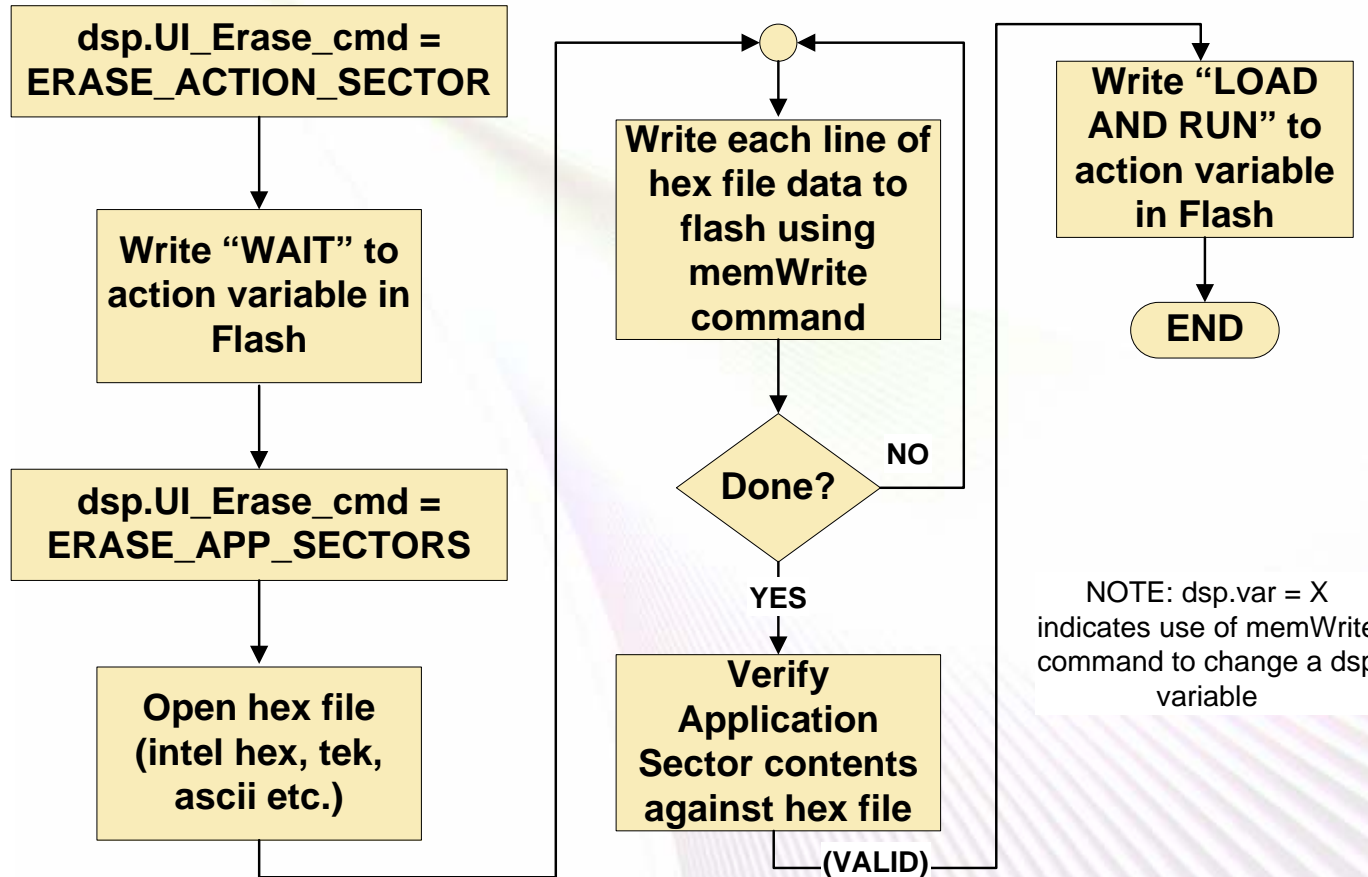
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Functional Logic –DSP Side



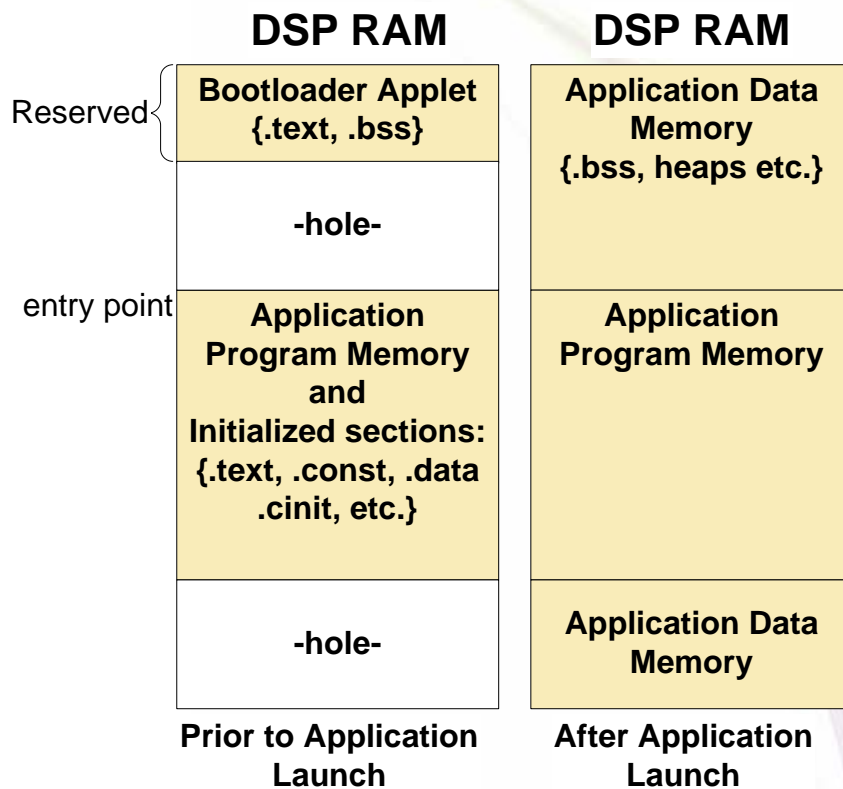
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Functional Logic – PC Side



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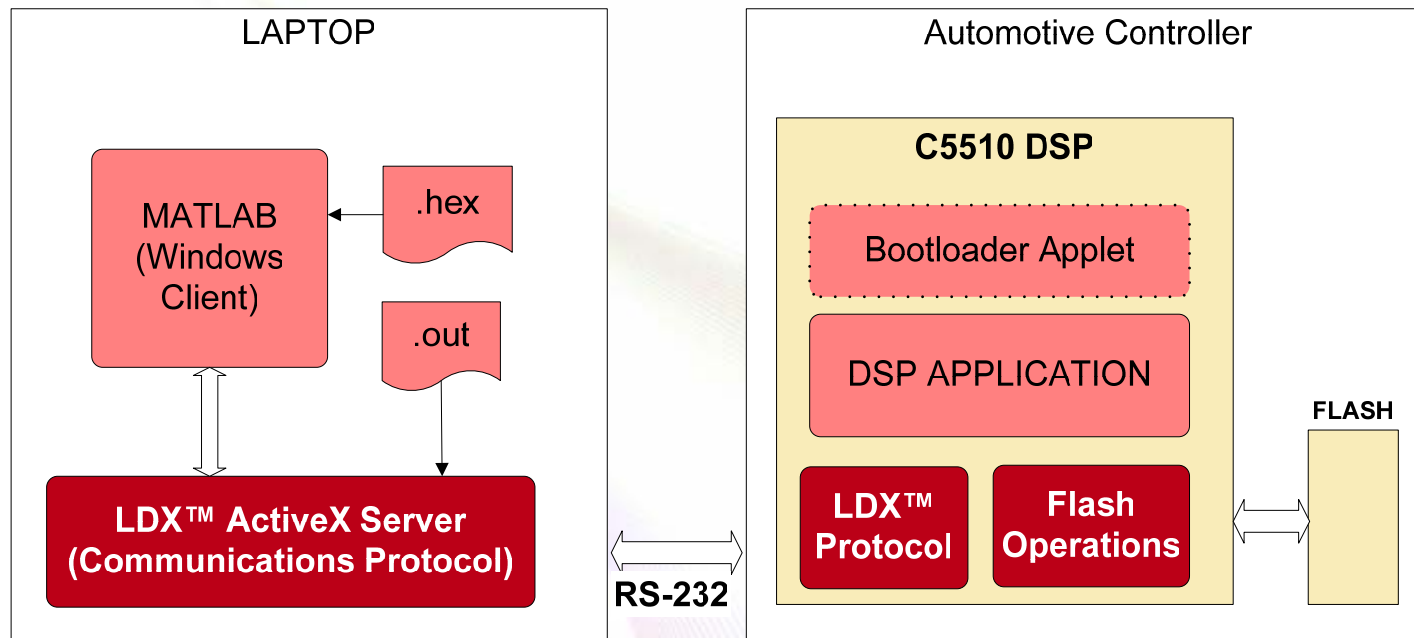
DSP Memory Considerations



- Memory map must be designed to allow Bootloader Applet to run from RAM as application is loaded to RAM.
- Bootloader Applet must reside in uninitialized sections of application memory.

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Demonstration



- Live Data Exchange (LDX™) communications protocol.
- MATLAB used as PC-side application.

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Live Data Exchange (LDX™)

- Initially developed as an internal tuning tool to allow viewing and modifying DSP variables over a serial link.
- Available from Applied Signal Processing, Inc. for the C2800, C5000 and C6000.
- Two components: LDX Protocol and LDX ActiveX Server.
- Protocol Commands:
 - MemRead, MemWrite
 - GetId, GoTo
 - Reset, SetBitRate

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LDX™ ActiveX Server

- Allows any Windows client (MATLAB, Excel, Visual C++, etc.) visibility into a DSP application's symbol table and memory, including structures and arrays.
- Provides layer of abstraction between a Windows client and the low-level protocol.
- Provides high-level operations (“Methods”) that are translated into low-level protocol commands:
 - SymRead, SymWrite, LoadSym, SetBaud, etc.
- Examples (MATLAB):

```
>>invoke(h,'SymWrite','myDSPArray',[1 2 3 4]);  
>>xMatrix = invoke(h,'SymRead','aDSPMatrixVar');
```

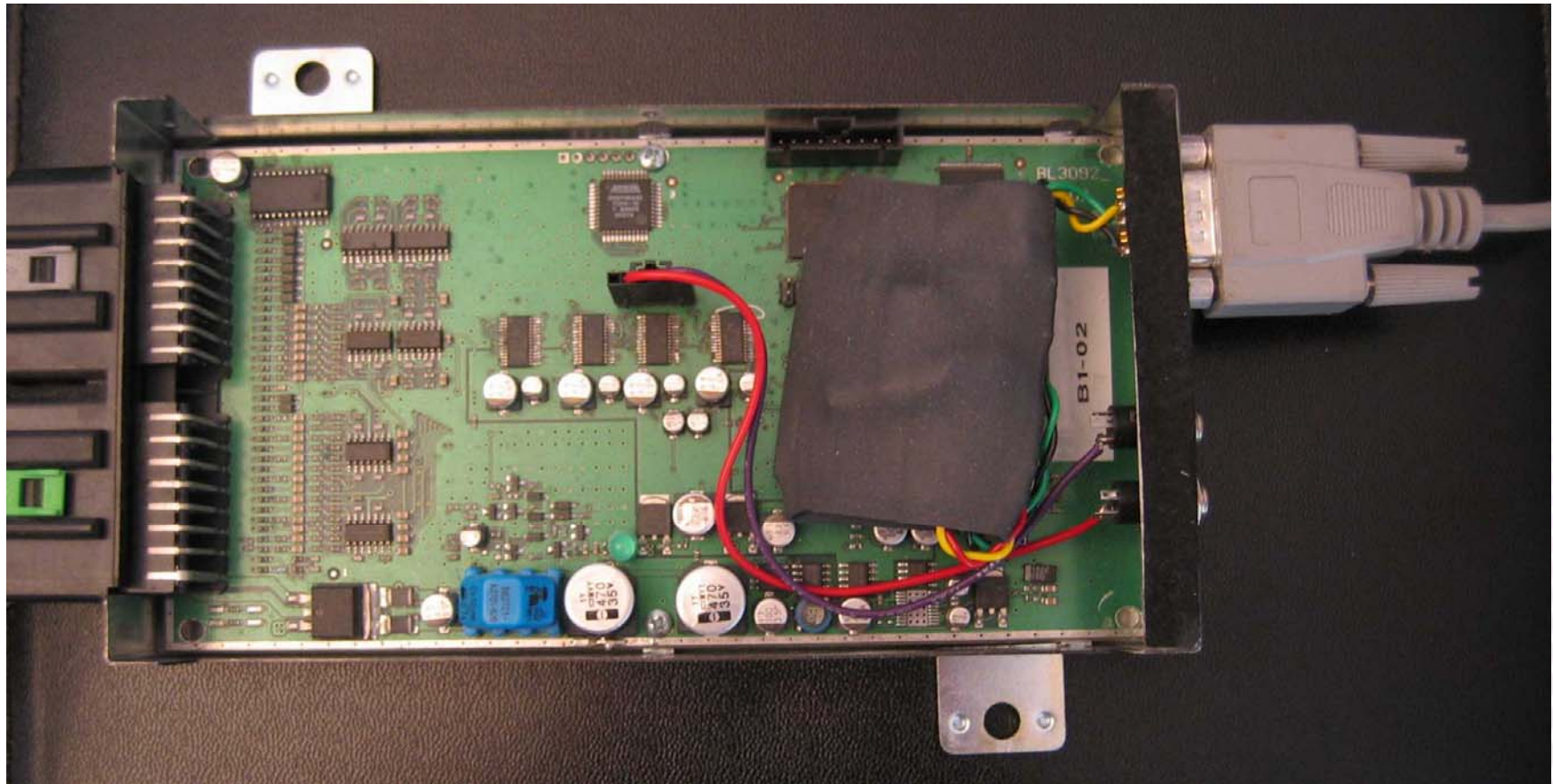
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Demonstration Walk-through

- Establish communication with controller and load symbol table of application.
- Start the upgrade process.
- Interrupt upgrade process (pull serial cable).
- Power cycle controller and re-establish communication (with Bootloader Applet).

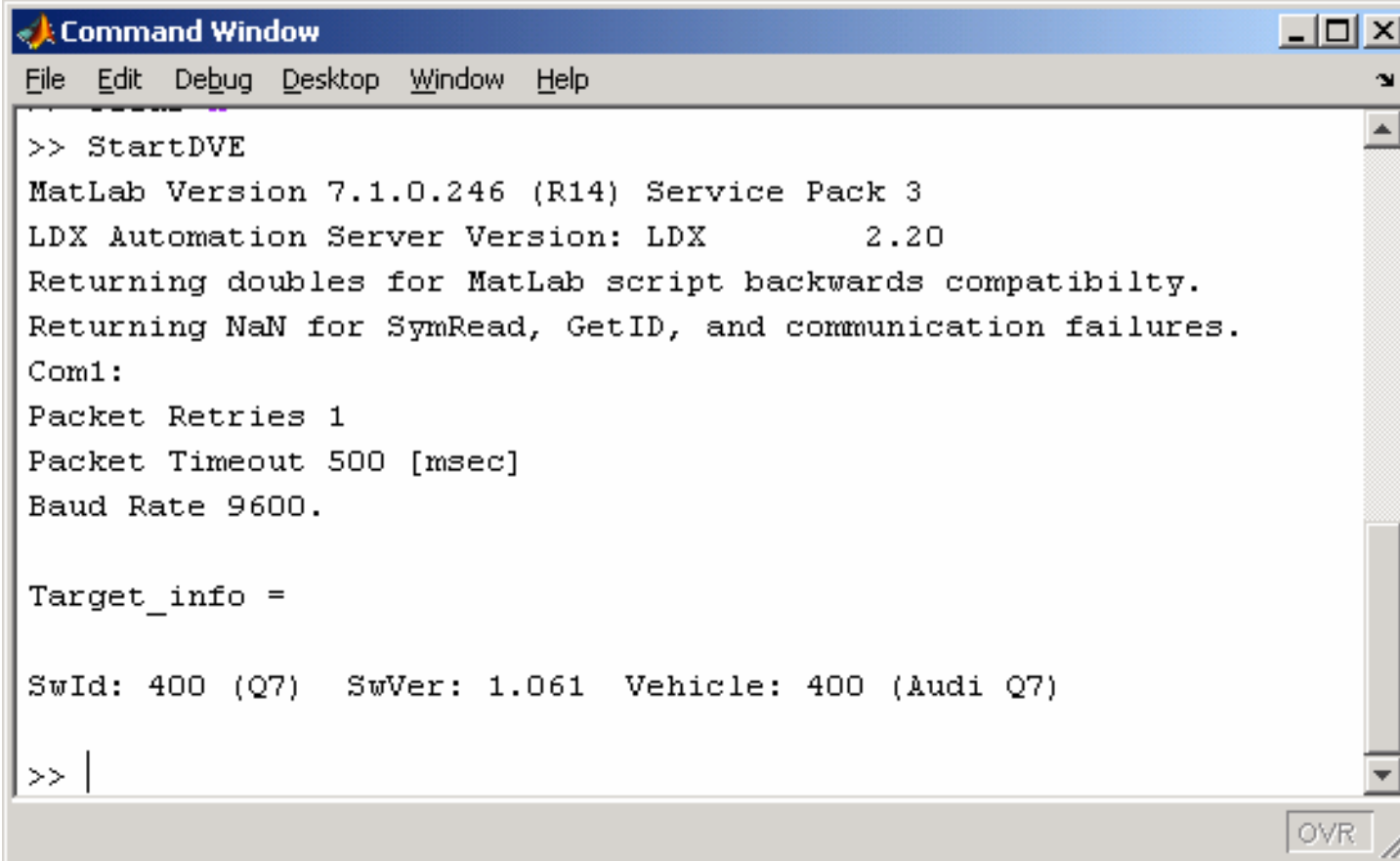
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Demo: Automotive controller



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Demo: Establish communication with controller.



```
Command Window
File Edit Debug Desktop Window Help
>> StartDVE
MatLab Version 7.1.0.246 (R14) Service Pack 3
LDX Automation Server Version: LDX      2.20
Returning doubles for MatLab script backwards compatibility.
Returning NaN for SymRead, GetID, and communication failures.
Com1:
Packet Retries 1
Packet Timeout 500 [msec]
Baud Rate 9600.

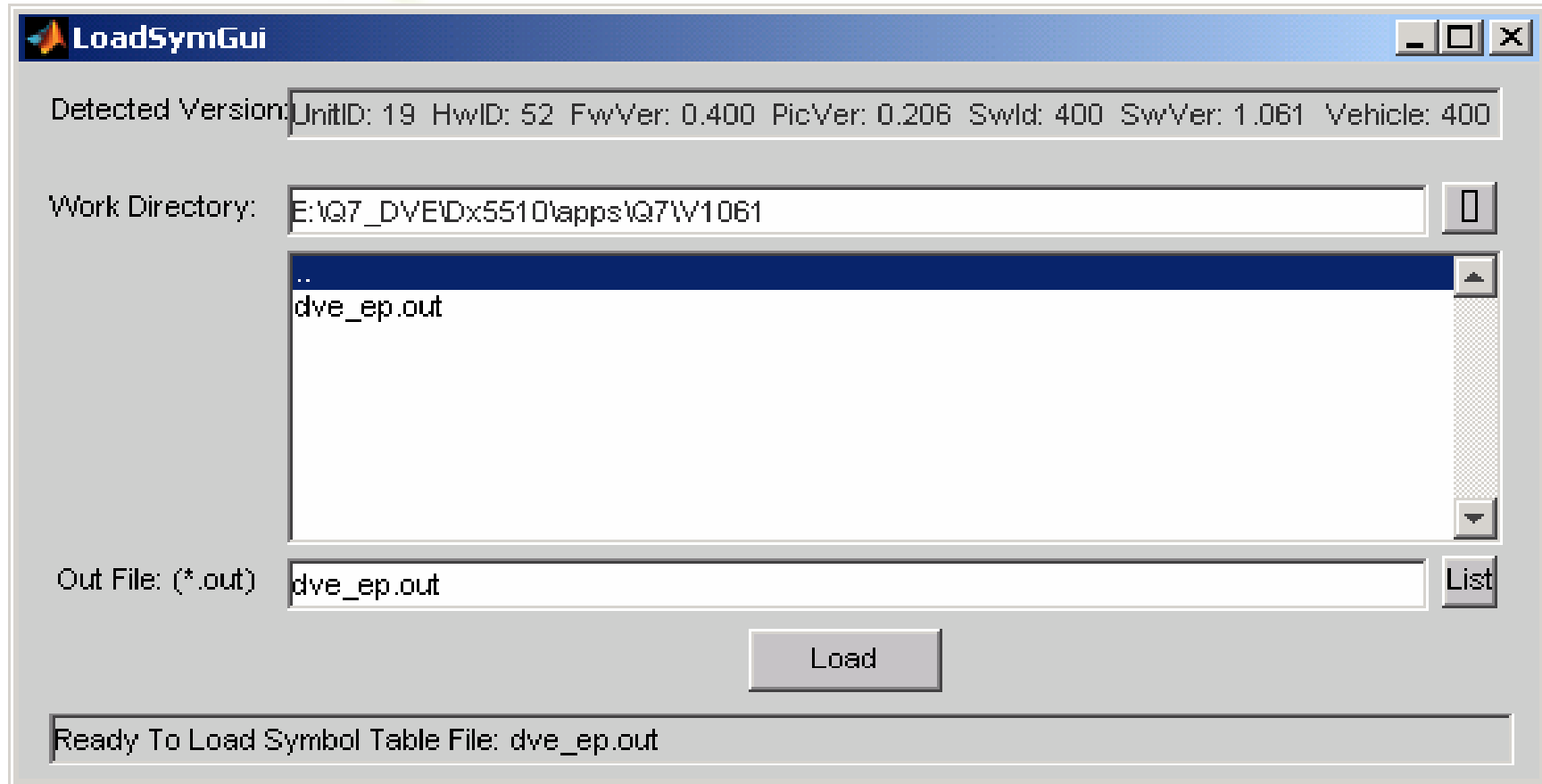
Target_info =

SwId: 400 (Q7)  SwVer: 1.061  Vehicle: 400 (Audi Q7)

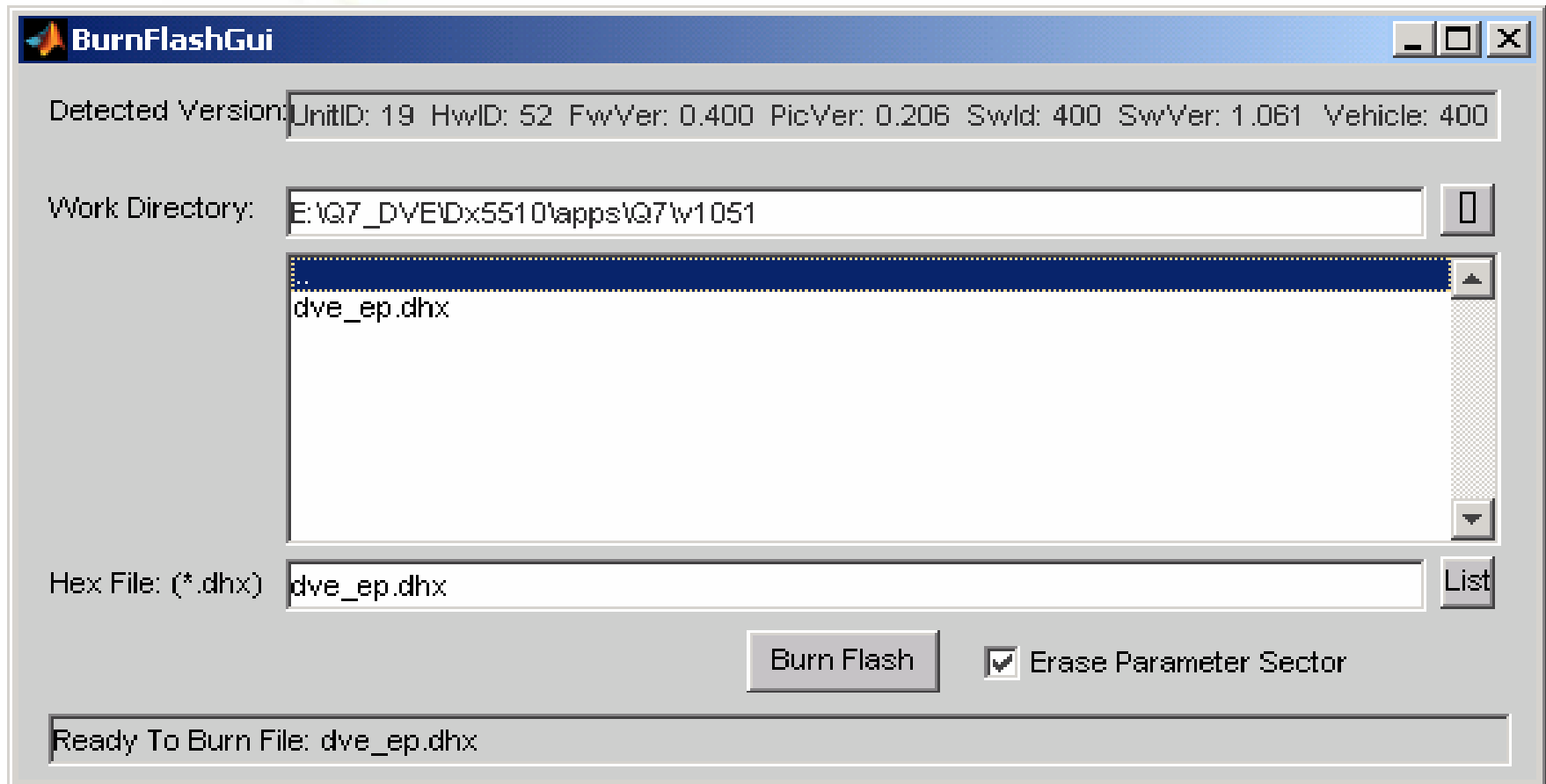
>> |
```

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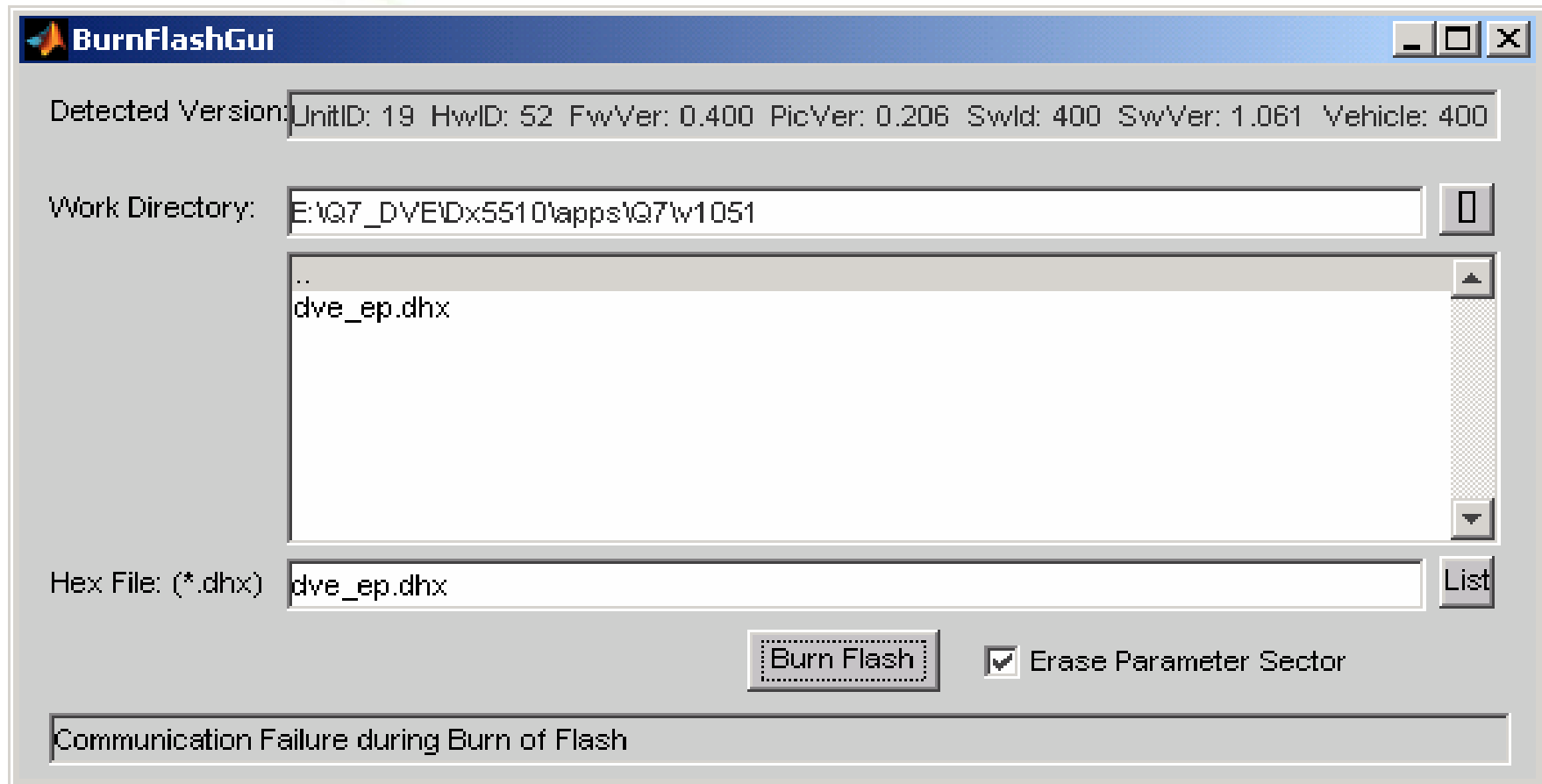
Demo: Load symbol table of application.



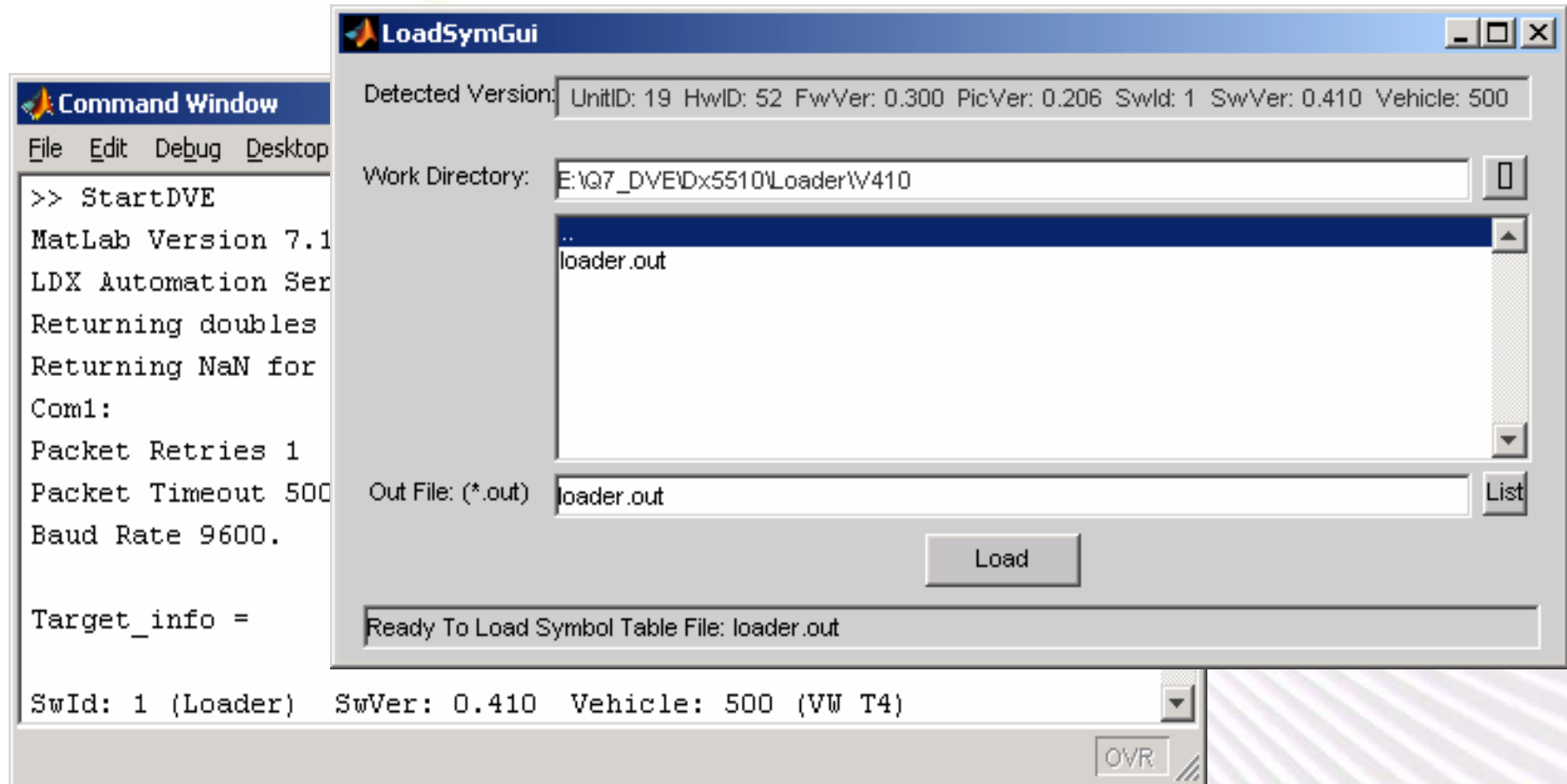
Demo: Start the upgrade process.



Demo: Interrupt the upgrade process.



Demo: Power cycle controller and re-establish communication with Bootloader Applet.



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Questions/Comments

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