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BULLETIN
BUL-022

Shared Variables, Scripts, Protocols, and Formats Overview

Introduction

The Pronto4 software suite is based on a series of executables running under the Windows XP operating system. All executables are designed and implemented as individual programs and serve specific purposes when operated individually. The parallel execution of these programs, in specific sets, brings them together for a common Pronto4 functionality such as vehicle control or operator control.

Two intra-process and inter-process communications approaches are employed to shared data between various executables on a single computer or across multiple computers.

A common variable is defined for a particular purpose. This variable may be used to control steering position or report headlight status. Many of these variables are defined for the different functions of the Pronto4. The variables are shared among the various applications on a single computer and between computers. These “shared” variables are used in two primary modes:

- One to one relationships — One application writes data into the shared variable and another application asynchronously uses the contents of the shared variable.
- One to many relationships — One application writes or publishes data to a shared variable and many applications use that data in an asynchronous fashion.

Most data movement among applications using shared variables is performed asynchronously. Synchronous, event drive operation is possible based on data change but in most cases is not needed and adds unnecessarily to the complexity of the system. All shared variables are used in an asynchronous fashion in the Pronto4.

Software Relationships

Typical Pronto4 relationships are shown among executables on a single computing platform and across multiple computing platforms. This example shows many programs sharing data among three computers.

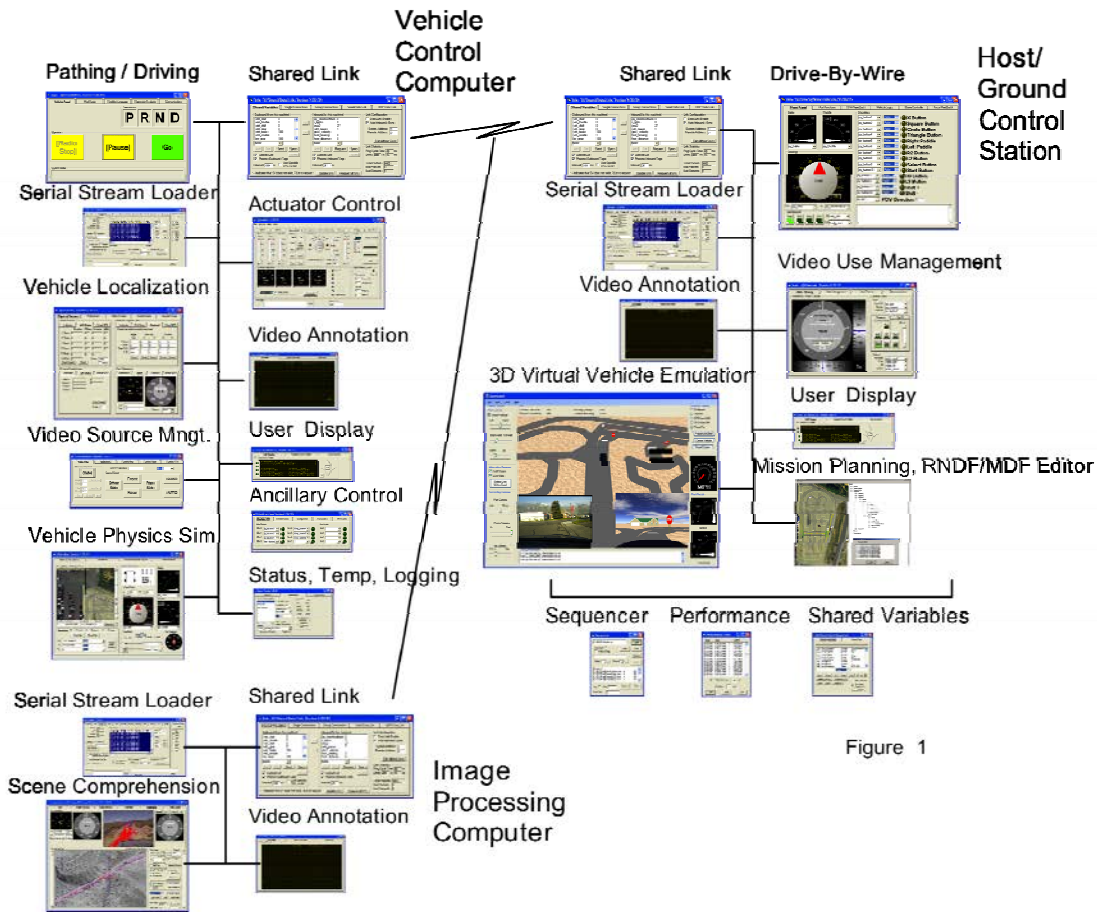


Figure 1

Figure 1: Software Relationships Example; systems are configured according to contract specifications, and may vary from the example.

The SharedLink program transfers shared variable data in a single direction from the shared variable pool on one computer to the shared variable pool on another. The primary relationships using SharedLink are one to many, where the one is from the source computer and the many are on the target computer. SharedLink uses identical lists of outbound data of the source computer to match up with inbound data on the target computer. All SharedLink connections are bidirectional in nature where each computer is both a source and a target with local inbound and outbound lists.

Once architecture of shared variables and pipes is created, applications can then be created on an as needed basis. Testing occurs in discrete units as well as the entire system.

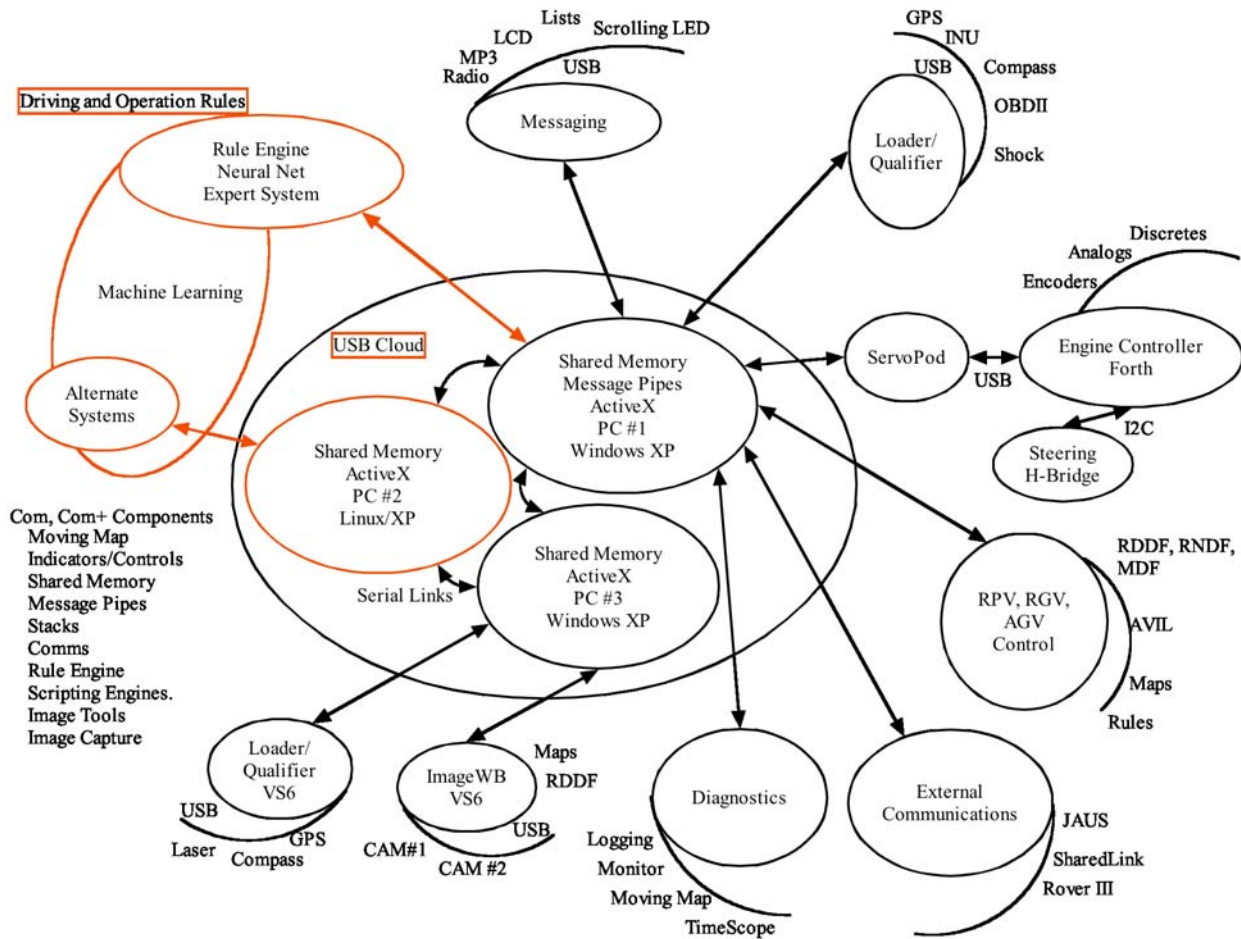


Figure 2: Components Architecture and Relationships

Figures 1 and 2 show the Pronto4 as configured for full autonomous vehicle operations with many additional features and functionality.

Various combinations of executables are required for different usages of the Pronto4.

There are many distinct executables in the Pronto4 suite. Each performs a specific role for one or more types of functionality. All use shared variables for their interaction between each other. Most of these executables also create a named pipe that can be used to send sequential information to that program.



Table 1 shows the majority of executable programs available in the Pronto4 software suite, along with an indication of which function types require them.

The function types are:

- Basic - Basic Drive-by-Wire
- RPV - Remotely Piloted Operation
- RGV - Remotely Guided Operation
- AGV - Autonomous Operation
- Diag. - Diagnostic Suite

Table 1: Executables in the Pronto4 Software Suite

Executable	Description	Basic	RPV	RGV	AGV	Diag.
djAuxFunctions	Control of ancillary functions		•	•	•	
djDrive	Pathing and vehicle driving			•	•	
djDriveByWire	Human vehicle driving interface	•	•	•	•	
djImageWB	Image processing workbench				•	
djLoader	Convert serial streams to SVs		•	•		
djLocalizer	UTM localization of vehicle				•	
djMMViewer	Vehicle performance playback	•	•	•	•	•
djMonitor	SV monitor, stripchart, XY scope					•
djOmniView	Management of omni-vision cameras				•	
djPerformance	Real-time assessment of performance					•
djServoPod	Interface to vehicle and actuators	•	•	•	•	
djSharedLCD	Real-time user display of SVs		•	•	•	
djSharedLink	SS radio point-to-point SV link	•	•	•	•	



djSimulate	Real-time birds eye view driving				•	
djSVManagement	Create, operate Shared Variables, SVs					•
djVideoHead	In vehicle video operation management		•	•	•	
djVideoLook	Host vehicle video control panel		•	•	•	

ServoPod

These are the primary shared variables used to interface to the Pronto4. They are contained and used by the ServoPod program. The ServoPod program must be executing in order to allow the Pronto4 to perform actions based upon these shared variables.

Table 2: ServoPod Shared Variables

SV Name	Type	Source	Description
Rpm	Long	ServoPod	Engine RPM, may not be used
spd	Double	ServoPod	Speed of vehicle, mph, from speedometer cable pulses
accumulator	Long	ServoPod	Speedometer cable pulse accumulator
enc1	Long	ServoPod	Encoder Position 1, unused
enc2	Long	ServoPod	Encoder Position 2, Steering
user_brake	Long	ServoPod	User brake input, user has pressed brake, brake lite, 1 = active
vehicle_brake	Long		Not used
neutral	Long	ServoPod	Neutral active, 1 = active
limit_r	Long	ServoPod	CW steering limit active 1 = active
limit_l	Long	ServoPod	CCW steering limit active, 1 = active



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user_light	Long	ServoPod	User has turned on lights, 1 = active
pause	Long	ServoPod	Pause Indication, 1 pause, may be swapped with overtemp based on ServoPod checkbox
abort	Long	ServoPod	Vehicle Kill, 1 = abort, calculated with PE7
Key_on	Long	ServoPod	Vehicle Key on, 1 = on
over_temp	Long	ServoPod	Overtemp Indication, 1 = overtemp, may be swapped with pause based on ServoPod checkbox
computer_bat	Double	ServoPod	Voltage of computer battery
vehicle_bat	Double	ServoPod	Voltage of vehicle battery
ang	Double	ServoPod	Steering Angle of steering wheel, raw encoder value
rc0	Long	ServoPod	RC Servo Input, Channel 0, valid 1000 - 2000
rc1	Long	ServoPod	RC Servo Input, Channel 1, valid 1000 - 2000
rc2	Long	ServoPod	RC Servo Input, Channel 2, valid 1000 - 2000
eng_enb	Long	ServoPod	Engine Enabled, 1 enabled
Pe7	Long	ServoPod	Used for vehicle disabled by external source, only valid when ServoPod Commanding Vehicle On, 0 = disable
Hb1	Long	ServoPod	H-Bridge I2C packet byte 0, Command, 0 Stop, 1 Forward(CCW), 2 Reverse(CW)
Hb2	Long	ServoPod	H-Bridge I2C packet byte 1, Status, b0 Accel in progress, b1 OverCurrent, b2 OverTemp, b3 OverSpeed, b4 CW Limit Active, b5 CCW Limit Active
Hb3	Long	ServoPod	H-Bridge I2C packet byte 2, Speed of H-Bridge 0-255



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Hb4	Long	ServoPod	H-Bridge I2C packet byte 3, Acceleration 0-255
Hb5	Long	ServoPod	H-Bridge I2C packet byte 4, Temperature 0-255
Hb6	Long	ServoPod	H-Bridge I2C packet byte 5, Current 0-255
Hb7	Long	ServoPod	H-Bridge I2C packet byte 6, Unused
Hb8	Long	ServoPod	H-Bridge I2C packet byte 7, Software Revision
Hb9	Long	ServoPod	H-Bridge I2C packet byte 8, Limit Commands, b0 Disable limit. b1 Inverted CW, b2 Inverted CCW, b3 Use CW limit, b4 Use CCW limit, b5 enable filter usage, b6 LED on
hb10	Long	ServoPod	H-Bridge I2C packet byte 9, Maximum speed, 0-255
hb11	Long	ServoPod	H-Bridge I2C packet byte 10, Filter 0-255
hb12	Long	ServoPod	H-Bridge I2C packet byte 11, Hysteresis, 0-255
hb13	Long	ServoPod	H-Bridge I2C packet byte 12, CW(Analog 0) Threshold, 0-255
hb14	Long	ServoPod	H-Bridge I2C packet byte 13, CCW(Analog 1) Threshold, 0-255
hb15	Long	ServoPod	H-Bridge I2C packet byte 14, Analog 0, 0-255, 0-5v
hb16	Long	ServoPod	H-Bridge I2C packet byte 15, Analog 1, 0-255, 0-5v
feet	Double	ServoPod	Feet calculated from accumulator, acc * ClicksPerFoot
miles	Double	ServoPod	Miles calculated from accumulator, acc * 0.7853975 / 5280
bbrake	Long	{directed}	Value for back brake, 0-100%



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fbrake	Long	{directed}	Value for front brake 0-100%
steer	Long	{directed}	Value for steering angle, +-22 ATVs, +-450 steering wheel
steerspd	Long	{directed}	Steering speed or slew rate, 0 to 255, 255 max
steerang	Double	ServoPod	Calculated angle for steering based on ticks per degree
throttle	Long	{directed}	Value for Throttle, 0-100%, many be limited in upper range
s_lights	Long	{directed}	0 no lights, 1 low beam, 2 high beam
svp_init	Long	ServoPod	0 init, 1 wait for process, 2 enabled
svp_app	Long	ServoPod	Set to 10, Lets other applications know that ServoPod is running
svp_stop	Long	ServoPod	1 when forcing stop (setting brakes to 100%), zero otherwise
svp_cmd	Long	ServoPod	ServoPod Command, 0=none
drv_app	Long	Drive	Not used
svp_start_eng	Long	{directed}	1 start engine, starter on
svp_enb_eng	Long	ServoPod	0 engine not enabled, 1 engine enabled
svp_detether	Long	ServoPod	
s_steerpwr	Long	ServoPod	Steering power active, 1 active
s_ft_per_sec	Double	ServoPod	Calculated using ClicksPerFoot from accumulator
gps1_velocity	Double	Loader	Not used
s_vel_lmt_enc	Long		Not used



Remotely Piloted Vehicle Shared Variables

When using the Pronto4 as a Remotely Piloted Vehicle or for tele-operation, the following shared variable lists are used between the operator control station and the listed sources in Table 3 and Table 4.

Table 3: RPV Outbound List

SV Name	Type	Source	Description
joy_steer	Double	DriveByWire	Not used
joy_brake	Double	DriveByWire	Not used
joy_throttle	Double	DriveByWire	Not used
joy_button1	Long	DriveByWire	Potato gun
joy_button2	Long	DriveByWire	Left turn signal
joy_button3	Long	DriveByWire	Right turn signal
joy_button4	Long	DriveByWire	Horn
joy_timestamp	Long		Not used
video_mux1	Long	VideoLook	Video camera selection video overlay VTR selection
video_pan1	Double	VideoLook	Fast pan camera control
joy_button5	Long	DriveByWire	Right paddle
joy_button6	Long	DriveByWire	Left paddle
joy_button7	Long	DriveByWire	Disable
joy_button8	Long	DriveByWire	Enable
joy_button9	Long	DriveByWire	Camera select
joy_button10	Long	DriveByWire	Start
joy_button11	Long	DriveByWire	R3 (not used)



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joy_button12	Long	DriveByWire	L3 (not used)
veh_start	Long	DriveByWire	Vehicle driving controls
veh_throttle	Long	DriveByWire	Vehicle driving controls
veh_shift	Long	DriveByWire	Vehicle driving controls
veh_gear	Long	DriveByWire	Vehicle driving controls
veh_brake	Long	DriveByWire	Vehicle driving controls
veh_enable	Long	DriveByWire	Vehicle driving controls
joy_gear	Long	DriveByWire	Not used
xkey_button1	Long	DriveByWire	Low beam
xkey_button2	Long	DriveByWire	High beam
xkey_button3	Long	DriveByWire	Wipers
xkey_button4	Long	DriveByWire	Washer fluid
xkey_button5	Long	DriveByWire	Door unlock
xkey_button6	Long	DriveByWire	Door lock
xkey_button7	Long	DriveByWire	Not used
xkey_button8	Long	DriveByWire	Not used
xkey_button9	Long	DriveByWire	Not used
xkey_button10	Long	DriveByWire	Not used
xkey_button11	Long	DriveByWire	Not used
xkey_button12	Long	DriveByWire	MP3 sounder, ice cream
xkey_button13	Long	DriveByWire	MP3 sounder
xkey_button14	Long	DriveByWire	MP3 sounder, this is a restricted area
xkey_button15	Long	DriveByWire	MP3 sounder, unmanned vehicle in operation



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xkey_button16	Long	DriveByWire	MP3 sounder, first warp drive
sony_vtr	Long	VideoLook	State of Sony recorder

Table 4: RPV Inbound List

SV Name	Type	Source	Description
joy_steerfeedback	Double		
s_lights	Long	SharedLink	Status of vehicle lights
enc2	Long	SharedLink	Position of steering wheel
veh_pause	Long	SharedLink	State of vehicle
gps1_velocity	Double	SharedLink	Speed of vehicle
host_bearing	Double	SharedLink	Bearing to host
host_distance	Double	SharedLink	Distance to host
wlr_position	Long	SharedLink	Left rear wheel position
wlr_delta	Long	SharedLink	Left rear wheel change
wrr_position	Long	SharedLink	Right rear wheel position
wrr_delta	Long	SharedLink	Right rear wheel change
inu_accel_xx	Double	SharedLink	Forward acceleration
inu_accel_yx	Double	SharedLink	Lateral acceleration
inu_yawx	Double	SharedLink	Orientation