A Comparison of Vsystem and EPICS

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1 Introduction

The history of EPICS and Vsystem has a common root in AT Division at Los Alamos National Lab (LANL). EPICS originated from the experience of P-11 group with a commercial package which was co-authored by Bob Dalesio in industry before he joined LANL. EPICS was written for the GTA project in the period 1987-1991 and has grown from there with a collaboration organized by LANL In 1993, LANL co-exclusively licensed the EPICS software to three companies (Tate, Kinetics and Titan).

Vsystem has its roots in the Proton Storage Ring (PSR) control system which was designed and written in the period 1981-1985. This system was re-written for workstations and networking for an SDI experiment in 1986-1987. This system had very significant innovation in the networking of the database and in the Human Machine Interface (HMI) package, Draw. This software was exclusively licensed to Vista Control Systems in 1990.

While a number of people worked on developing both systems at different times, they are rather different in many respects. The remainder of this paper will try to characterize these two systems and highlight their differences.

For the basis of the comparison I have used the features of Vsystem currently shipping and EPICS as documented on the WWW at LANL, TJNL and APS.

2 The primary differences

2.1.1 Real time databases and system architecture

The EPICS database is generally one database on each IOC. The IOC is a VxWorks node and the database record set is fixed at boot time. The EPICS database provides links between records. Records represent IO values, devices and calculations. This is the foundation for block programming. All fields can be changed at run-time except some links.

The Vsystem database can consist of one or more databases per node and these databases can be loaded and deleted dynamically. Links between channels and code can be added to a Vaccess database dynamically.

Both databases are intended to hold all the information on a particular channel and they both have an API for user programs and tools to access the data. In the Vsystem database, any field of any channel (except the channel name, type and array dimension) can be changed dynamically including the pointers to code and the constants and channel pointers that that code uses. While EPICS has an internal IOC API and a Channel Access API for remote access, Vsystem has a unified API for both local and remote access.

The Vaccess database is designed to be flexible enough that a competent programmer can meet any requirement without taking the performance hit of interpretation of code at runtime. Table 1 shows the primary differences between the two databases.

Table 1. Database differences

	Vsystem	EPICS
Ports	OpenVMS (2), UNIX (3), ELN, VxWorks, WindowsNT	VxWorks
API richness	280 routines including chix, time, data and thread support	56 (Channel Access)
Stability	good	some problems
List calls (=speed+)	Yes	No
Async completion notification	wait	wait or callback
Change notification	event or wake	event
Complex records	user developed from channels	yes
CHIX/CHID level	Channel	Field
Reference Alarms	Internal	User developed with control blocks
Delayed Alarms	Internal	No
Alarm severity levels	>10,000	3
Remote put performance	21 μs/real	40 μs/real
Channel naming	database:: channel@field	channel,field
Independent systems on same network	Database name environment variables	TCP/IP and UDP network parameters
Multiple responses to name resolution	Not possible	Possible
Client/serve data transfer format	Negotiated	IEEE FP, 32-bit Big Endian
Synchronous group support	No	Yes
Security	8 levels, classes, roles and users	2 levels, classes, roles, users and system state

The Key difference between the two databases is that the Vsystem database defines and supports the software

architecture for the complete control system, through all the levels implemented. This means that the Vaccess real-time database can be used for much more than the low level processing of IO data. For example , Vaccess can be used for customizing the total Vdraw behavior way beyond normal HMI capabilities. Another benefit of the Vsystem approach is that when fast and hard real-time determinism is not required, systems can be based solely on cheap, standard PCs or workstations. When the system does not need to be distributed, a single, powerful, server can be used.

The EPICS database, bound to VxWorks, only provides the software architecture for the level 1 IOC, like an analog PLC. While a new server API is available to extend Channel Access to higher levels, this requires each server to mimic appropriate IOC database behavior, like security, etc. whereas with Vsystem, the IO of a server, like a process model, is simply gets and puts to a local database.

2.2 Human-Machine interface

EPICS has two tools, MEDM and EDD/DM for developing operator windows. I have compared mainly EDD/DM here with some information from the MEDM manual.

Vsystem has a single operator interface which has its roots in the original Draw but has been extensively developed and re-written for X-Windows since then with many advanced features based on customer requirements..

Vdraw development focus had been great flexibility in defining screens while keeping the simplicity of use and high performance. Table 2 highlights the primary differences.

Table 2. Primary HMI differences

	Vsystem	EDM/MEDM
Development / run time	One program for both modes, all windows	Two programs / one program
Ports	OpenVMS (2) UNIX (3) WindownNT	UNIX (3)
Data updates	event or polled	event
Object Property Sheet # choices	11-55	~15
User Defaults	Per object	From Window attributes
Dynamics on graphic objects	Using Symbols	Yes
Flashing colors	Between any two colors, individual blink intervals or default	Between color and dimmed color. One rate. / ? MEDM
Modify channel names methods	3 - dynamic and static	1 - static
Dynamic display control	Yes-via channels	No
Tanks filling	Clip mask over bar, linear or area fill	No - sight glass effect only
Text	Horizontal	Horizontal and vertical
Byte widget	with symbols	object
Data conversion	No	Yes
Menu object	analog or discrete	discrete
Channel menu	Yes	No
Execute user subroutine	Yes	No
Dynamic strip chart changes	Yes - user and database	No
Synchronous option	No	Yes
Log axis options (all analog displays)	Yes - 2	No / Plots only
Smith charts	Yes - via array channels	Yes with impedance and admittance grids / No
Moving objects	Yes, 1 or 2 dimensions	No
Image Plots	Yes	No
Mouse button - binary control	Yes	No
Dynamic sub-pictures	Yes - controlled from database	No
User-defined graphic symbols	Yes	No
Timestamp	Yes	No
Polar Plots	Yes	No
IO Error indication	Yes - automatic	Yes - using color rule
Update rate	9,000 values/sec	2000 values/sec
Screen callup, 100 monitors, 1000 graphic obj	0.8 sec	2 sec / ?

Table 2 shows that Vdraw is considerably more feature rich and flexible than EDD/DM. As an example, for one customer we used Vdraw, a Vaccess database and some handlers in the Vaccess database to emulate a DCS system. The Vsystem emulation generated 15,000 different Vdraw windows from 15 Vdraw templates and data structures that defined the window contents, relationships and data connections.

2.3 Archiver

While EPICS documentation mentions many modes of archiving data, only a frequency-based archiver is documented. The Vsystem archiver, on the other hand, implements many modes. In implementing Vlogger, performance, usability and data quality were key requirements [1]. Table 3 is a comparison of the major differences between Vlogger and the EPICS Frequency-based Archiver.

Table 3. Archiver Differences

	Vsystem	EPICS
Modes	6	2
Circular logging	Yes	No
Runs on	All Ports	UNIX
command networking	client/server	OS + TCP/IP
Multiple loggers/node	Internal through server	OS
Add channels dynamically	Yes	Yes
Delete channels dynamically	Yes	No
Max rate	limited by computer clock, >500Hz	20Hz
Text message stamp	Yes	No
SQL searches of log file	Yes	No
SQL interface integrated with all tools	Yes	No
ASCII Export	Yes	Yes
Interrogate logger status?	Yes	No
Catalog Manager	Yes	No
Log file concatenate / merge?	Yes	No
Playback	Yes	No
API to run logger	Yes	No
Log file access API	Read/write	No
Max rate benchmark	1,000,000 reals/sec.	
Compression	Yes	No
Graphical Viewer	Yes	Yes

Table 3 shows that the Vsystem Logger is a much more comprehensive tool than the EPICS Frequency based Archiver and indeed Vlogger is an industry leader product in performance and capabilities. We know of no commercial product with capabilities even close to Vlogger. The performance capabilities can be used to log many channels efficiently or a few channels at a very high rate. If the demands of the application exceed the capabilities of Vlogger, then the Vlogger API can be used to provide logging integral to the application and still have the benefits of all the tools.

2.4 Scripting and sequencing

Vscript was developed to allow people who do not consider themselves programmers to write, test and debug scripts to sequence their applications. It has been used with up to 65 individual scripts running under the control of the Vscript server to test jet engines. The source file is compiled into an intermediate language, vexe, which is also documented. The vexe code is further compiled into threaded code on being loaded into the Vscript virtual processor.

The EPICS State Notation Language (SNL) is a textural representation of state notation diagrams which is pre-processed into ANSI C and then compiled and loaded into VxWorks as a normal C executable. As a result, the same program, all other things being equal, will run faster when developed with SNL than with Vscript.

As a comparison, Fig. 1 is an SNL example from the manual.

```
Program level_check
float v;
assign v to "input_voltage";
monitor v;
short light;
assign light to "indicator_light";
ss volt_check {
 state light_off
 {
  when (v>5.0) {
   /* turn light on */
   light = TRUE;
   pvPut(light);
  } state light_on
 }
 state light_on
 {
  when (v<3.0) {
   /* turn light off */
   light = FALSE;
   pvPut(light);
  }  state light_off
 }
}
```

Figure 1. An Example EPICS State Notation Language Program from the SNL documentation.

Figure 2 shows the equivalent Vscript program to do the same thing as the SNL program in Figure 1. It will be seen that the Vscript code is much closer to English and that the IO statements are implicit. This is because the Vscript compiler opens the Vaccess database and essentially adds channel names and other channel information to the keyword table. Figures 1 and 2 certainly show that Vscript met its goals when compared to SNL.

Table 4 shown some of the other differences between Vscript and the EPICS SNL.

```
#load demo_db::unit1

state_light_off:
wait until (input_voltage > 5.0)
indicator_light on
go to state_light_on

state_light_on:
wait until (input_voltage < 3.0)
indicator_light off
go to state_light_off
```

Figure 2 The Vscript version of the SNL code in Figure 1

Table 4 Vscript and SNL differences

	Vscript	EPICS SNL
Monitors	implicit	explicit
IO statements	implicit	explicit
Events	use database	event flags
channel field access	all fields	value, status, severity, timestamp
flow control	loop, while, until, if, go to, on change, wait, wait until, wait...timeout, wait until....timeout	when, if, for
Comments	generally embedded in code so long as keywords not used.	only between comment markers
Time support	wait absolute time, delta time. set and read timers	delay
String functions	9	0
Vscript/SNL procedures?	Yes	No
Call external procedures?	Yes	Yes
Server	Multi-user	none, OS limitations
Math and logical operators	31	13
Conventional IO	Open_file, read, write, close_file	print and C IO
Embed in-line C	no	Yes

2.5 Alarm manager

The alarm checking is done in the databases in both systems (unlike many commercial systems). The alarm managers allow operators and others to monitor and log the alarms that occur. Valarm logs alarms in the Vlogger format. Valarm supports areas and sub-areas while the Alarm Handler supports alarm trees. Table 5 shows the differences.

2.6 Documentation and support

With a UNIX-like collaboration, the individual members are driven by the needs of their own institutes. This impacts their desire to support other institutes and write the documentation that makes their EPICS contribution generally usable. I have found the EPICS documentation generally very poorly written and difficult to use and understand.

Table 5. Alarm Manager Differences

	Valarm	EPICS Alarm Handler
Alarm Labels	5, DB or config.	none
Acknowledge options	Yes	Yes
Alarm masking	with areas and subareas	automatic based on trees
Alarm Guidance Text / response	Through Vdraw	Yes
Print alarms	Yes	No

With a company's products, there is strong motivation not only to write documentation, as this is required for sales, but to continually improve that documentation to address issues that come up. Good documentation for such a complex product is essential if customers are to be effective in implementing the product.

The issue is what method of product management is the most effective. A large collaboration will involve the input of many people into the directions to be taken but this will be at considerable cost and frustration with the time taken to reach a reasonable agreement.

3 Conclusion

It is clear that there are significant differences between EPICS and Vsystem despite the fact that a short paper can not hope to do justice to either system. I believe that this paper shows that Vsystem is technically substantially ahead of EPICS in the released and documented components. EPICS is clearly the right choice where the staff at each site want to be deeply involved in the product's development. I believe that this survey reinforces the conclusions of reference [2], is that commercial products are the most cost-effective solution to control system software components.

References

[1] J. P. Girard, R. T. Westervelt, E. Zharkov and P. Clout, Enhanced Data Logging Capabilities in Vsystem, these proceedings.

[2] P. N. Clout, Shariing Control System Software, Proc. PAC 1993 IEEE 1801-5