LOW-COST EPICS CONTROL USING SERIAL-LAN MODULE XPort

N. Kamikubota#, N. Yamamoto, J-PARC / KEK, Tokai-mura, Ibaraki, Japan
S.Yoshida, KIS, Tsuchiura, Ibaraki, Japan

Abstract

In J-PARC Main Ring, we are interested in a commercial product, XPort, a low-cost serial-LAN converter module. We have introduced it in two different devices: RF-amplifiers with GPIB, and a NIM module with switches. Control messages are transported over network, and converted into EPICS-style records.

Implementation details and operational experiences are given.

INTRODUCTION

The J-PARC Main Ring (hereafter MR) is a high-power proton synchrotron with beam-energy 30-GeV. Since 2008, various machine upgrades toward higher beam-power have been carried out [1-3]. The control system for MR has been developed based on EPICS (Experimental Physics and Industrial Control System) [4], where EPICS is a toolkit for large accelerator controls developed and supported by an international community [5].

It is often the case that small devices are newly introduced in order to improve accelerator performance. Typical devices are, for example, a power-supply, an electric circuit board, a stand-alone measuring system, and so on. Sometimes they have a poor interface to link to the original control system.

We, J-PARC MR control group, are interested in a commercial product, XPort [6,7]. It is a low-cost serial-LAN converter module. We implemented it into two newly introduced devices: RF-amplifies and a NIM module with front-panel switches. In both cases, control messages are transported to an EPICS IOC (Input Output Controller) over the network. They are converted into EPICS-style records using EPICS AsyncDriver.

Figure 1: XPort module mounted on a board.

#norihiko.kamikubota@kek.jp

IMPLEMENT XPORT TO DEVICES

What is XPort

XPort is a commercial product provided by Lantronix [4]. It is an embedded device server with various network protocols, such as TCP, UDP, SNMP, TFTP, http, and so on. It has programmable 3 I/O pins, which can be used for serial communication or bi-directional digital I/O signals. The size of XPort is as small as a RJ-45 connector. Thus, it is easy to mount an XPort module on an electric circuit board (Figure 1).

Implement XPort to RF-Amplifier

In order to improve beam quality in MR slow-extraction operation, RF-amplifiers are used to add transverse noises to beam bunches [8,9]. Amplifiers are commercial products with GPIB as a default interface. We asked a company to add an XPort module for remote control. Serial messages of GPIB are simply transported over our control network, using TCP protocol.

Table 1 shows part of supported GPIB commands for the RF-amplifier. We developed EPICS configurations, device-support structures and databases as in Figure 3. Network-serial communication feature of EPICS AsyncDriver is used. Control panel was developed using an EPICS tool, MEDM, as in Figure 2.

Table 1: GPIB commands of RF-amplifier.

Function	Command	Replay message
RF SW ON	“P1”	None
RF SW OFF	“P0”	None
RF SW status	“P?”	“P1” or “P0”
Forward Power	“FMON”	Ex) “2500W”

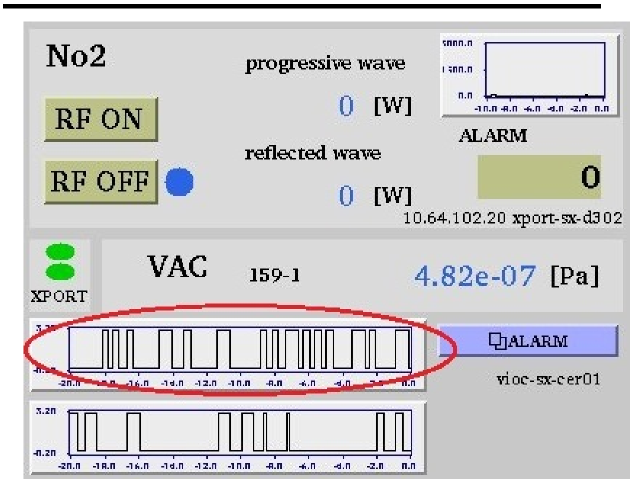

Figure 2: RF-Amplifier control panel.

ISBN 978-3-95450-124-3

EPICS Device Support struct

```
static struct gpibCmd gpibCmds[] = {
  /*CMMAND 0 RF_SW_W */
 {&DSET_BO, GPIBEFASTO, IB_Q_LOW, NULL, NULL, 0,
32, NULL, 0, 0, eoffOnW, &offOn, "¥¥n"},
  /*CMMAND 1 RF_SW_RB */
 {&DSET_BI, GPIBEFASTI, IB_Q_LOW, "P?¥¥n", NULL, 0,
32, NULL, 0, 0, eoffOnRB, &offOn, "¥¥n"},
  /*CMMAND 2 FMON */
 {&DSET_AI, GPIBREAD, IB_Q_LOW, "FMON¥¥n", "%lf", 0,
32, NULL, 0, 0, NULL, NULL, "¥¥n"},
```

EPICS database

```
record(bi, MRSLW:TVRF_D3_1:STAT:RF_SW) {
  field(DTYP, "A101K")
  field(INP, "#L0 A0 @1")
  field(SCAN, "$(scan)")   }
record(bo, MRSLW:TVRF_D3_1:OPE:RF_SW_ON) {
  field(DTYP, "A101K")
  field(OUT, "#L0 A0 @0")   }
record(longin, MRSLW:TVRF_D3_1:STAT:ALARM) {
  field(DTYP, "A101K")
  field(INP, "#L0 A0 @68")
  field(SCAN, "$(scan)")   }
```

Figure 3: Part of EPICS device support and database.

We have used two 3 kW RF-amplifiers during MR slow-extraction operation in June, 2012, as shown in Figure 4. Only LAN cables were necessary to start remote control. However, we suffered severe network failures. Electro-magnetic noises caused by amplifiers themselves disturb network communication. In Figure 2, a graph in the red circle indicates communication failures.

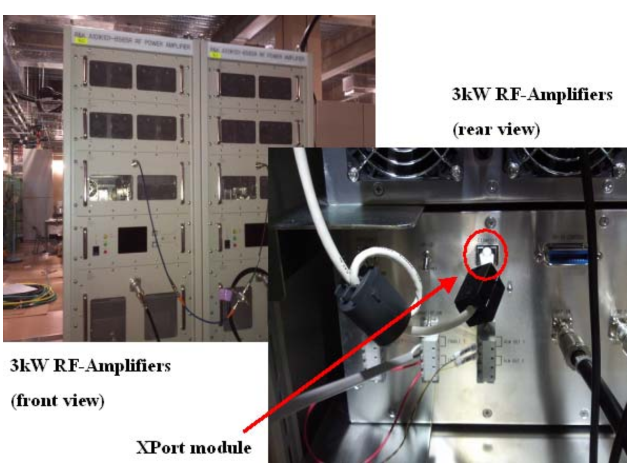

Figure 4: Two 3 kW RF-amplifiers.

Implement XPort to NIM module

We have developed several customised NIM modules in J-PARC MR control. Some of NIM modules have front-panel switches. Status of such switches is not online.

Some NIM modules are already implemented XPort. In Figure 5, an on-board FPGA chip has connections both to front-panel switches and to XPort I/O pins. We are asking a company to develop FPGA logic, in which it scans switch status periodically, and communicates to the Xport module. As a result, status of switches can be read remotely as TCP messages through XPort.

Basic communication study between an EPICS IOC and a NIM module is underway. Followed by EPICS configuration, we expect some NIM modules will be online in MR operation very soon.

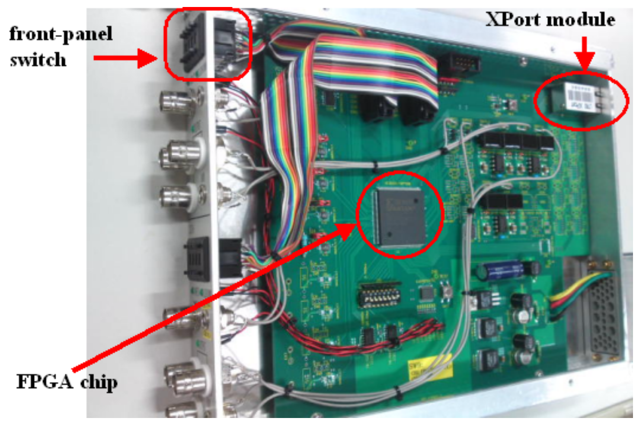

Figure 5: NIM module with switch, FPGA, and XPort.

DISCUSSION

In the former example, use of XPort enables us much simpler implementation than before. To avoid noise interference, we will pay more attentions to network cables in the next run in December 2012. For example, more pieces of ferrite cores will be introduced.

In the latter example, use of XPort is essential for lower-cost. So far, our standard style has been to prepare I/O modules of PLC, connected to a device using several signal cables. With XPort, except for an IOC, we need only one LAN-cable (Figure 6). Drastic cost-down is possible.

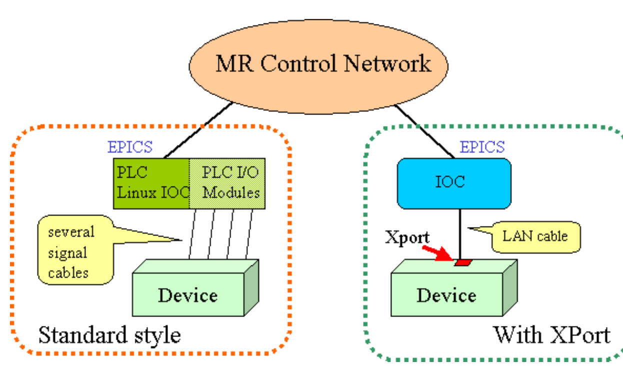

Figure 6: Standard style (left) and with XPort (right).

ISBN 978-3-95450-124-3

CONCLUSION

We have introduced a commercial serial-LAN converter module, XPort, to our J-PARC MR control system. Two different implementations of XPort are demonstrated. XPort enables us to use newly introduced devices, with simpler implementation and lower cost than before.

ACKNOWLEDGEMENT

We would like to thank J-PARC collaborators, especially Dr. Masahito Tomizawa, Mr. Shigeru Murasugi, and Mr. Akinobu Nagura, for their helps during tests with the RF-amplifiers. We also thank Mr. Naomichi Yamazaki, REPIC Co. Ltd., for collaborative developments of FPGA implementation on the target NIM module.

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ISBN 978-3-95450-124-3