IOC for upgrading BPM DAQ software

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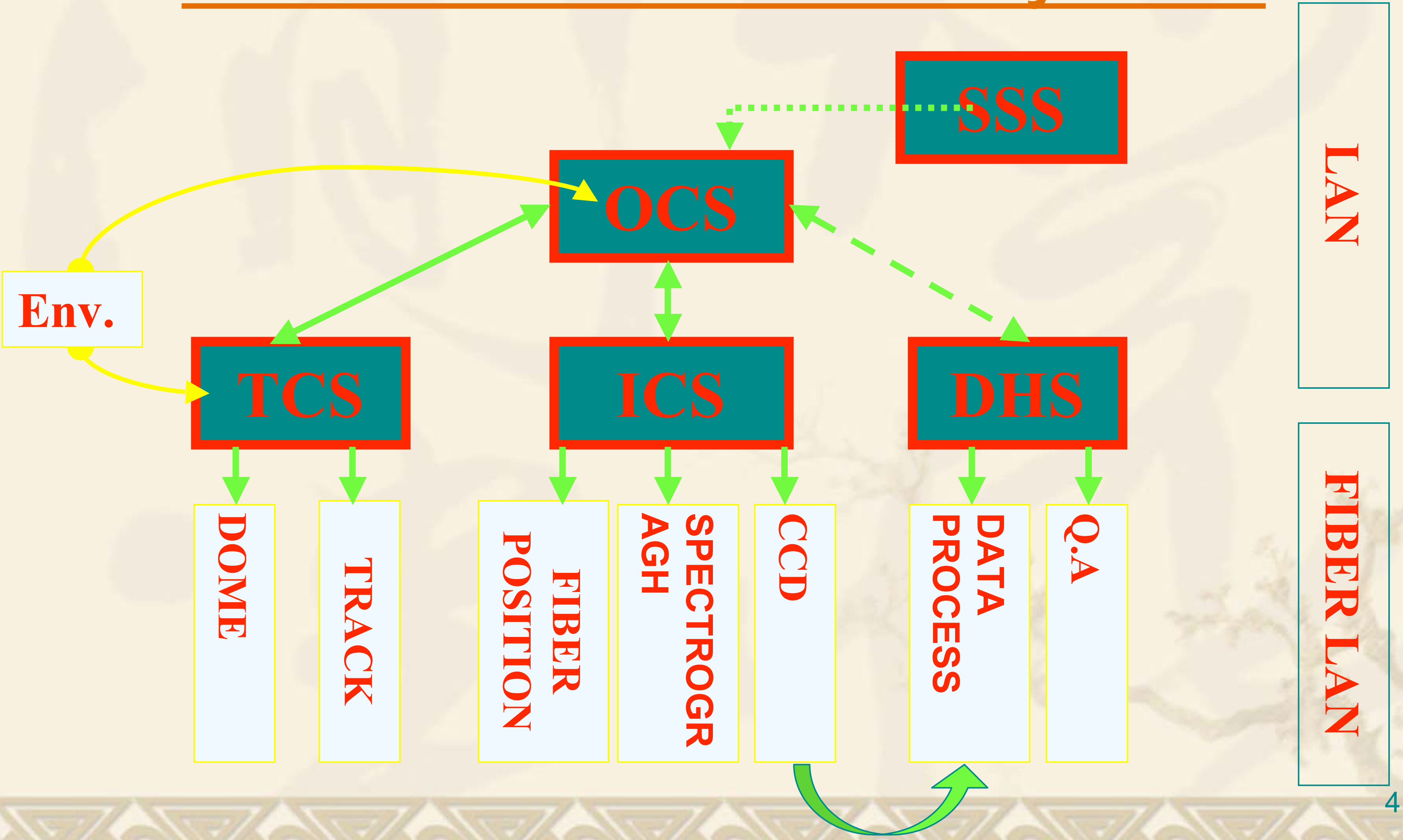
IOC on WinXP for Oscilloscope

- My work in China
  - Several control systems in physical experiments
    - Observatory Control System in large telescope
    - Centralized Control System(CCS) in Inertial Confinement Fusion(ICF) experiments and try to introduce EPICS to ICF experiments
- IOC on win32
  - Different technologies of win32
- IOC for upgrading BPM DAQ software

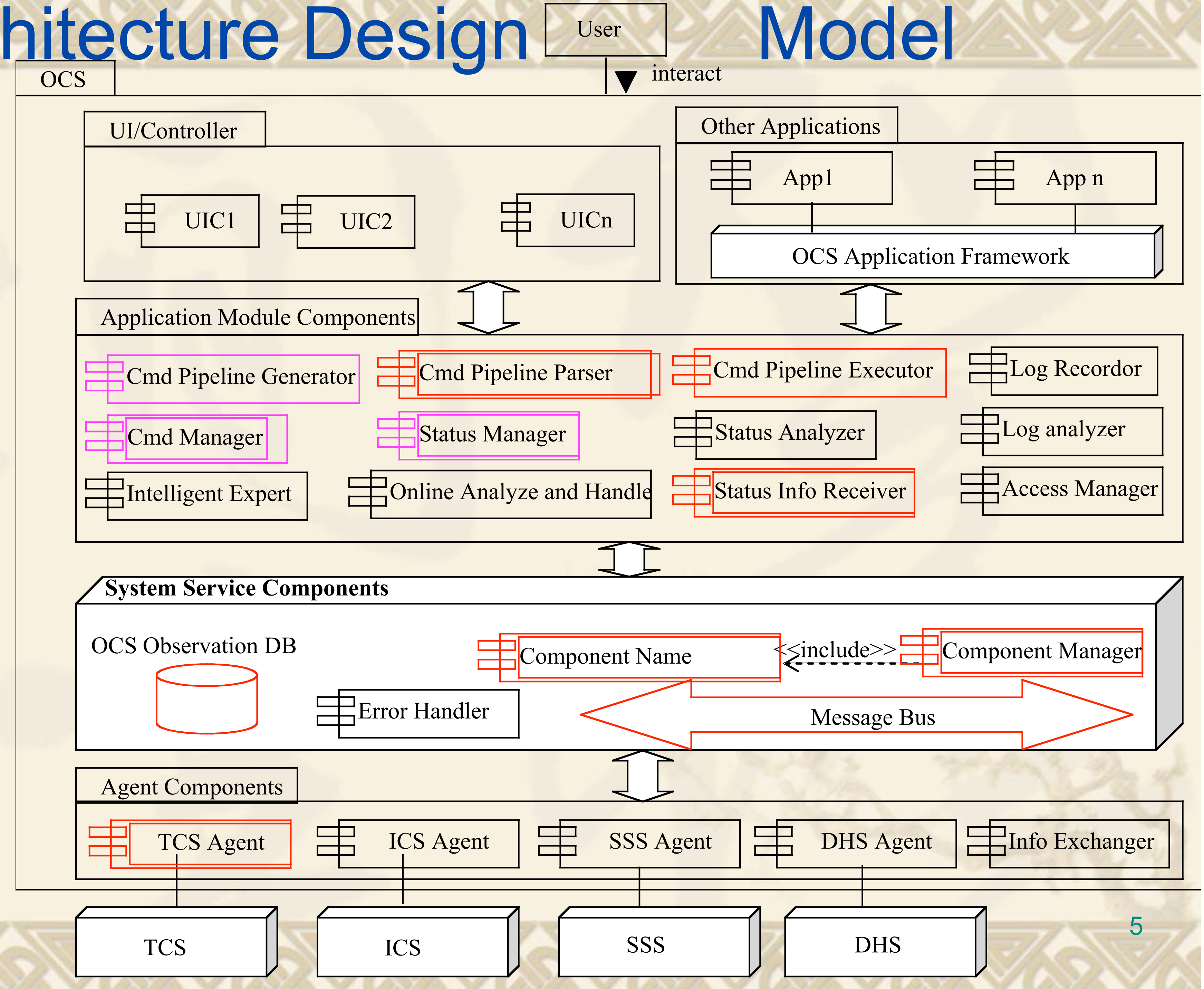
My work in China

- Observatory Control System in large telescope
  - Large Area Multi-Object Fiber Spectroscopic Telescope (LAMOST) is under construction
  - LAMOST software system consists of three levels
    - The highest level is OCS (Observatory Control System), the lowest level is the real-time system
    - the middle level is subsystems of LAMOST(DHS,TCS,ICS)
    - Deal with observational schedule through SSS (Sky Survey System)
  - Goal of OCS is to automate the entire observational process, and make the scientific observation more efficiently

LAMOST Software System

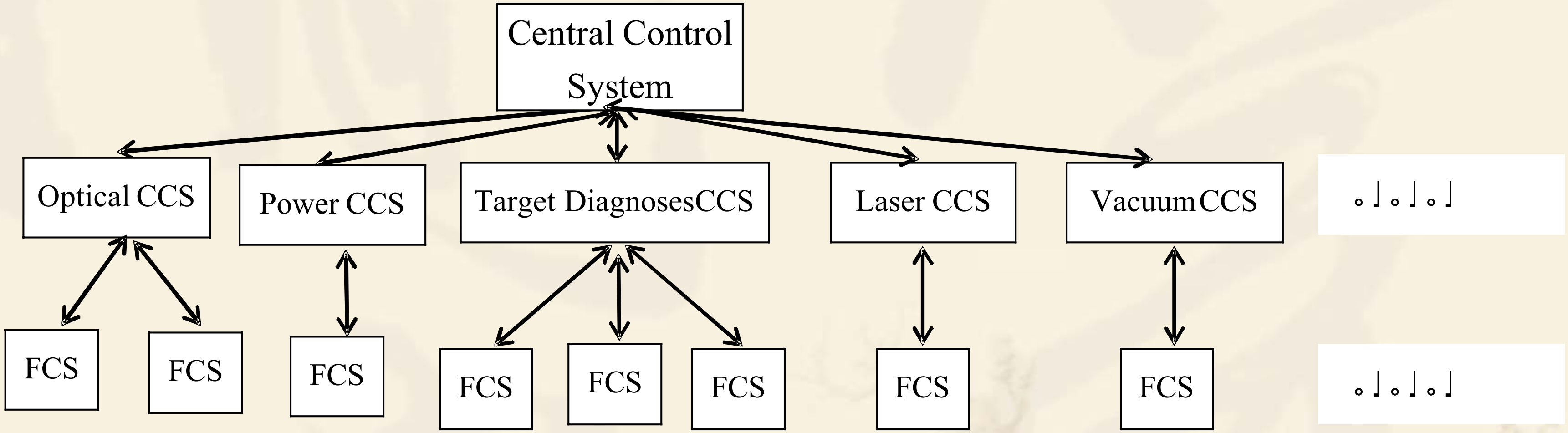


Architecture Design Model



- command-driven model
  - Commands Layers: Interfaced with the different roles, the commands are divided to three levels
  - In order to guarantee that commands can be transported and executed correctly, protocols between OCS and subsystems are proposed
    - Command Acceptance/Rejection Protocol
    - Command Execution Feedback Protocol
    - Status handling protocol
- architecture model
  - designed and implemented as a set of cooperating, distributed objects components that consist of objects
  - many design patterns and architecture patterns were used to resolve relevant problems
    - MVC(Model/View/Controller) pattern, agent pattern, layered pattern, message bus pattern
  - a component-based unified message bus is introduced in OCS

Centralized Control System(CCS) in ICF experiments



- Try to introduce EPICS to lower layers of ICF experiments

IOC on win32

- Different C/C++ compiler with different host platforms
  - win32-x86: MS compiler
  - win32-x86-borland: borland compiler
  - win32-x86-cygwin:
  - win32-x86-mingw:
- Install the MS Visual Studio and cygwin as the web page described http://www.aps.anl.gov/epics/base/win32.php
- Different products used the different MS technologies
  - ActiveX(ActiveDSO in wavePro oscilloscope), COM(XStream in wavePro oscilloscope, IVI-COM in Tektronix oscilloscope), TekVisa (Tektronix oscilloscope)
  - For the efficiency of C language is higher than C++, C language is selected firstly if possible when development of IOC
    - DLL could be used to integrated to IOC when writing a device support

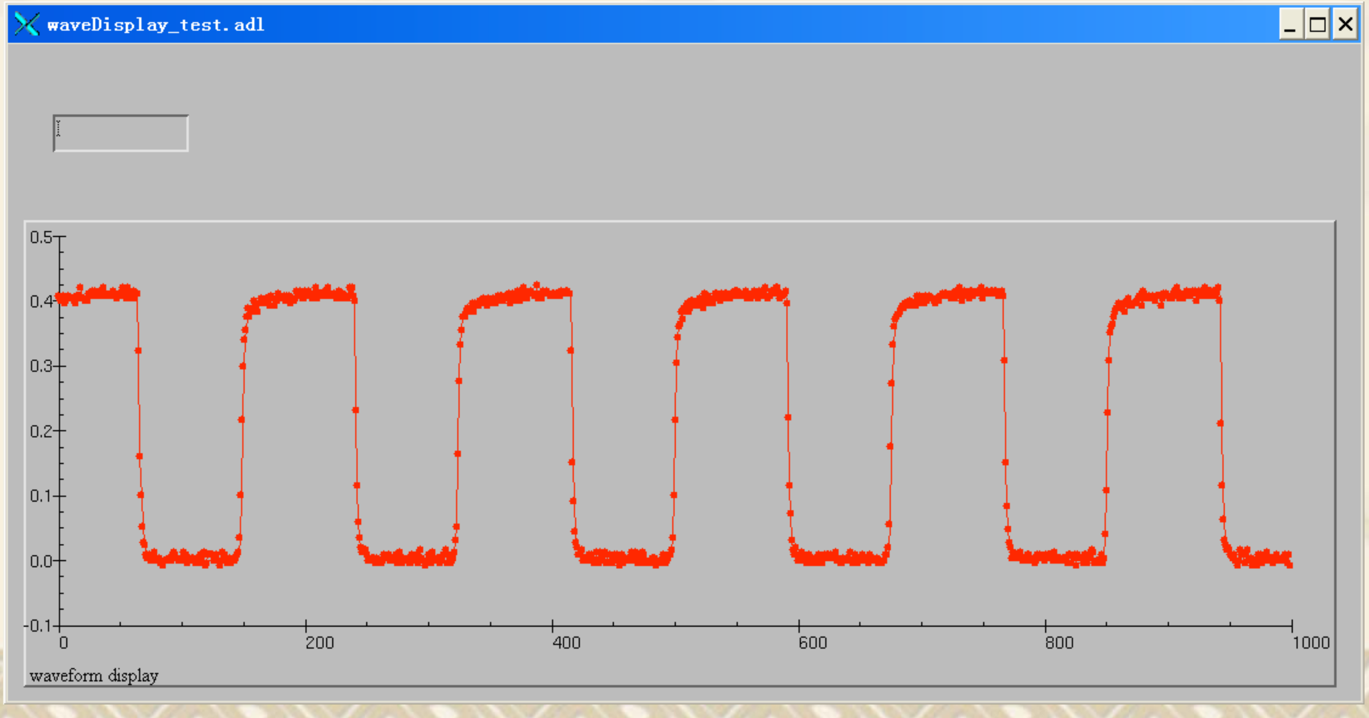
IOC for upgrading BPM DAQ software

- test IOC based on IVI-COM and TekVisa
  - Tek DPO 7104: Win XP
  - EPICS IOC:base-3.14.8.2,VC2005,cygwin (make, perl)
  - Two methods for IOC
    - IVI-COM: seems memory did not released when one scan was done(with ITekScopeWaveformTransfer.FetchWaveform Method)
    - TekVisa: as normal programming, add the tekvisa library to lib path and add include file to include path in the makefile as follows
      - USR_INCLUDES += -I"C:\VXIpnp\WINNT\include“
      - xxxSupport_SYS_LIBS += visa32

IVI-COM

- IVI: Interchangeable Virtual Instruments
- Installed IVI TekScope Driver firstly
- In device support, C++ must be used for COM technology
- Code like follows
  - ::OleInitialize(NULL); //before create instance
  - …   //reference IVI-COM sample
  - ::OleUninitialize(); // when done

- Get waveform
  - IOC running on OSC
  - Medm remotely



- Compare IVI-COM and TekVisa
  - The IOC used IVI-COM running as scan periodic
    - The memory will be exhausted and at last it will be ended with an error
  - The fastest speed of acquisition is lower than that used TekVisa
- So IVI-COM is unselected

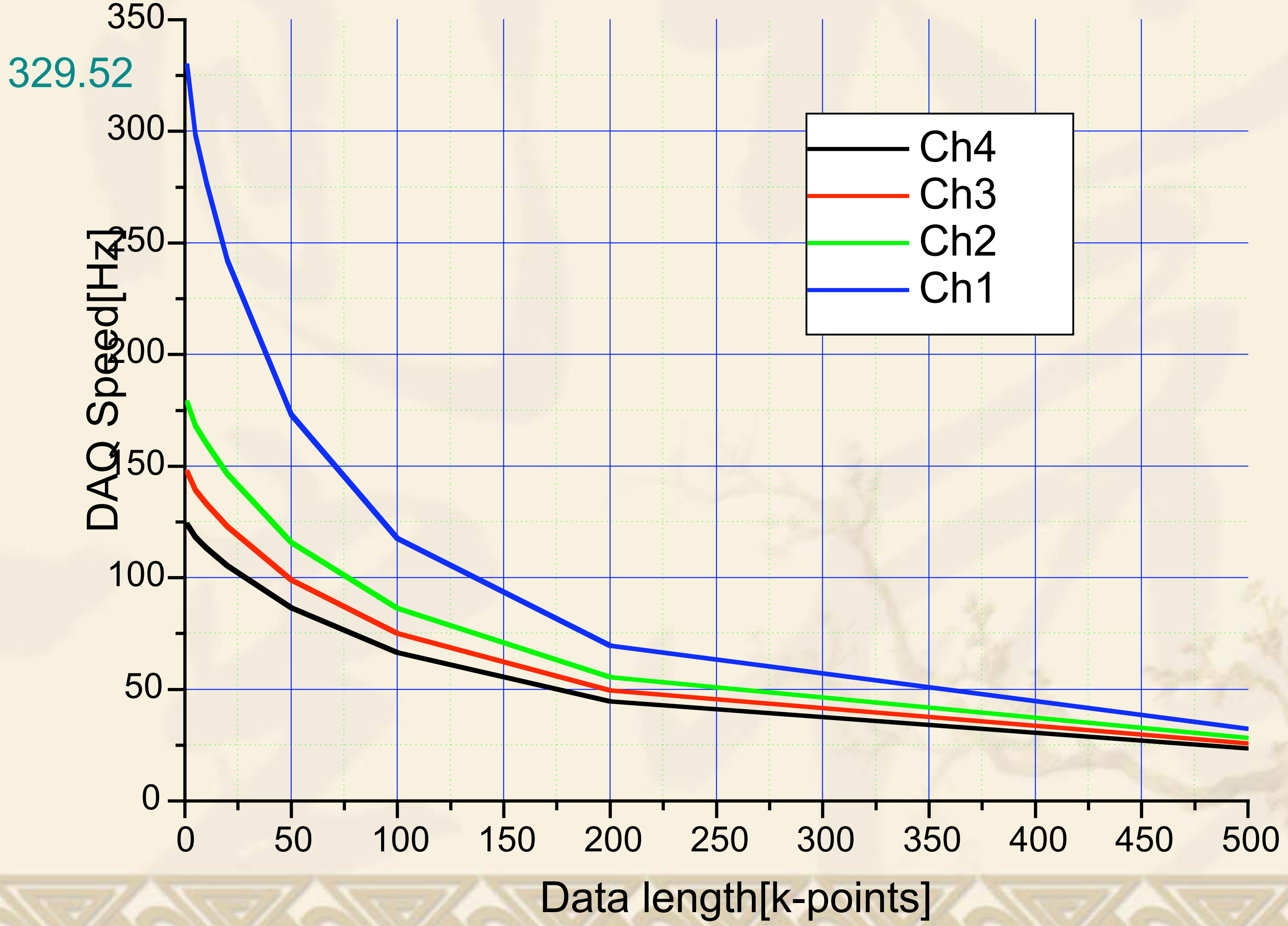
Test IOC performance and common win32 application

- Develop an IOC based on TekVisa
  - Waveform acquisition only
  - Vary the record length of waveform from 1000 to 500,000
  - Vary the scan periodic cycle and scan passive
    - The minimal scan period could be 0.01 second
    - Add 0.01s,0.02s,0.05s to scan menu type
  - Get the waveform continuously to get the average of acquisition speed
    - Amount of waveform acquisition >= 1000
- A tekVisa test program have developed using VC++ 2005

Test IOC performance and common win32 application

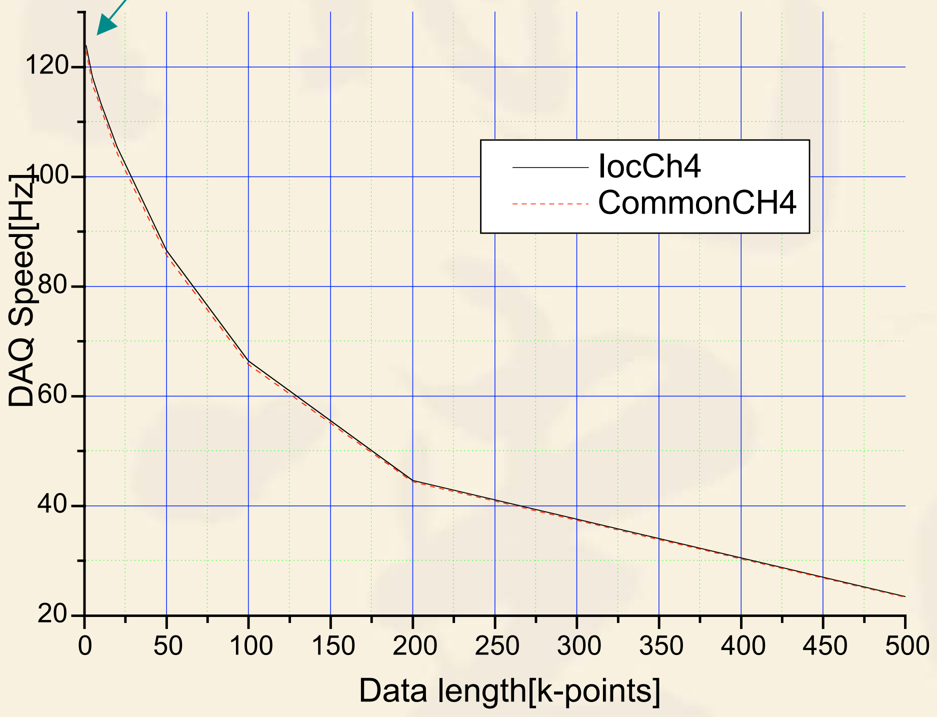
- Curve and curvestream
  - Curvestream make OSC to continuously transfer waveform data as fast as it is acquired. Also it puts instrument to a talk-only mode and no response to other clients and other commands.
  - Need time to stop curvestream mode to place OSC back into its normal talk/listen mode
  - So if settings of OSC seldom are reconfigured and fast performance is needed, curvestream is suitable
  - If settings of OSC are needed to reconfigure quickly and frequently, just as mode switch very quickly, curvestream not suitable and curve is better

Scan passive,10GS/s

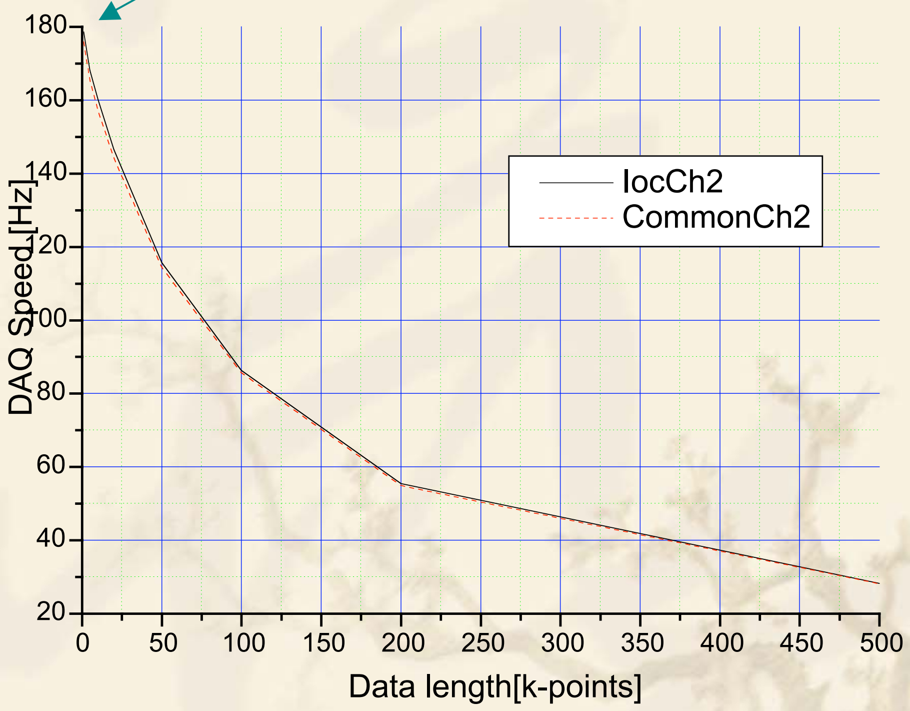


IOC (passive scan) and commom application under same condition

123.91:122.84

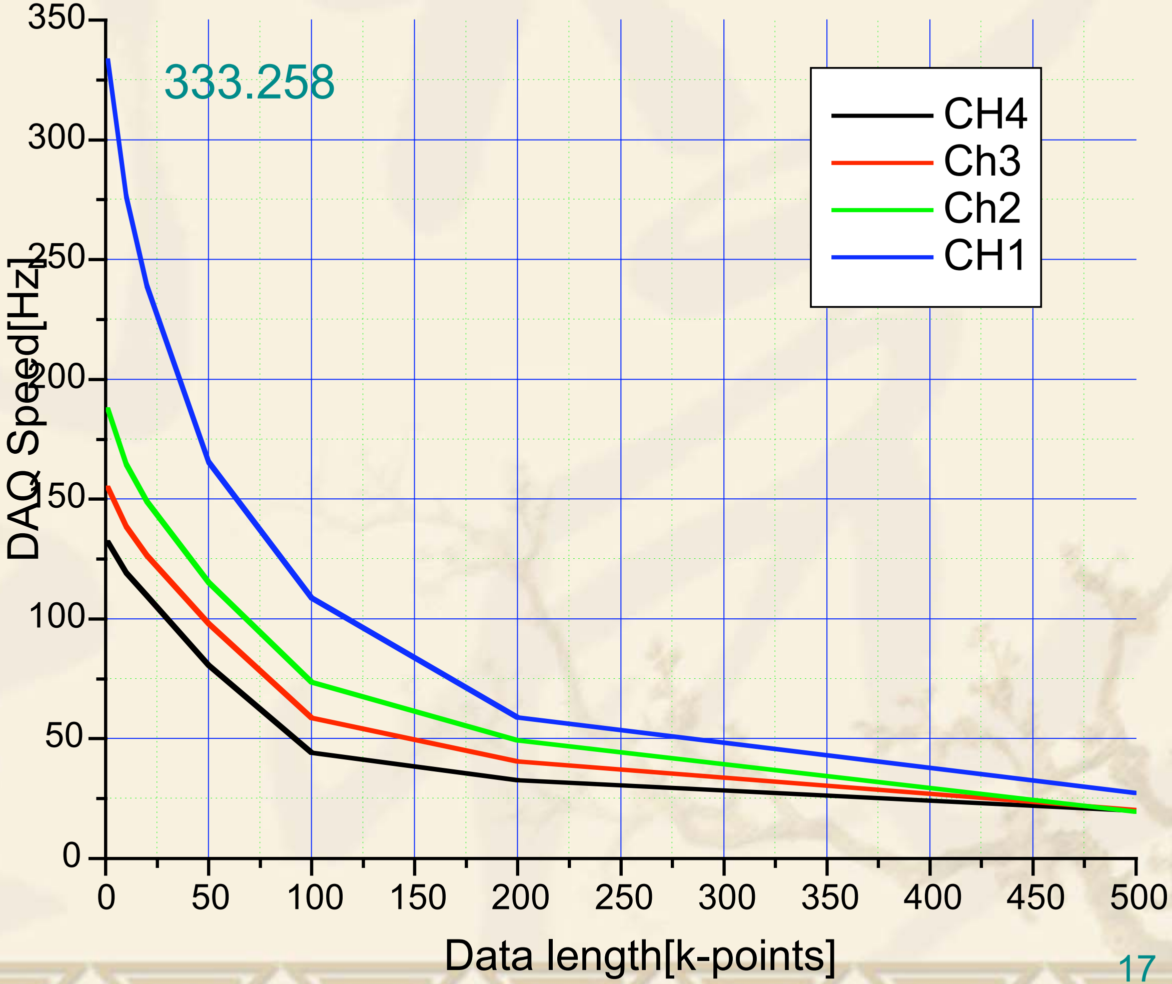


178.64:175.86



Scan periodic,10GS/s,

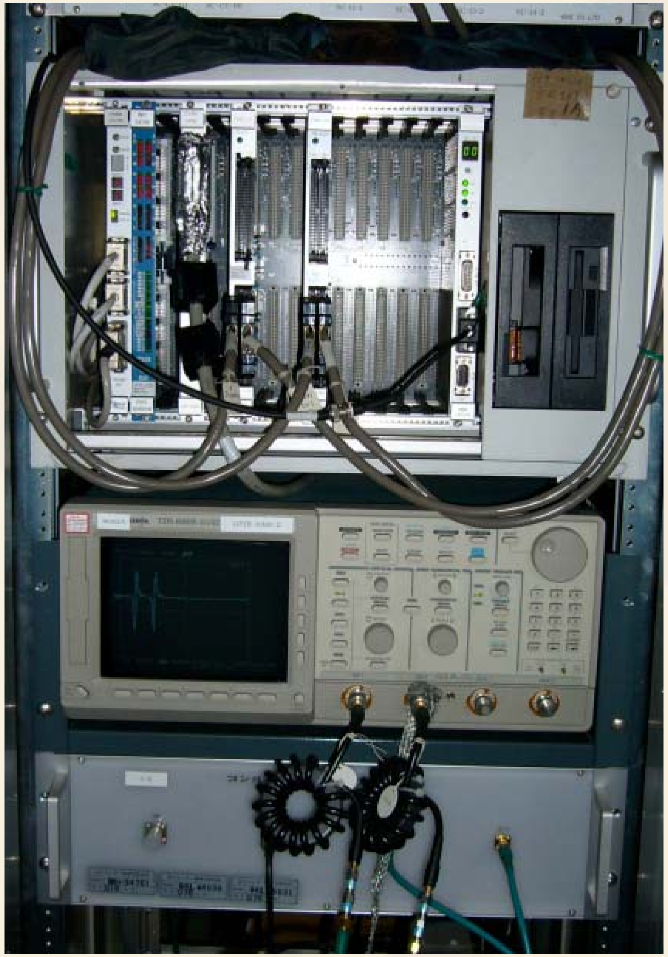
- Two cycle
  - Vary scan period (>=0.01s)
  - Vary loop number in read function in device support
- pulse generator
  - 15M,400mv

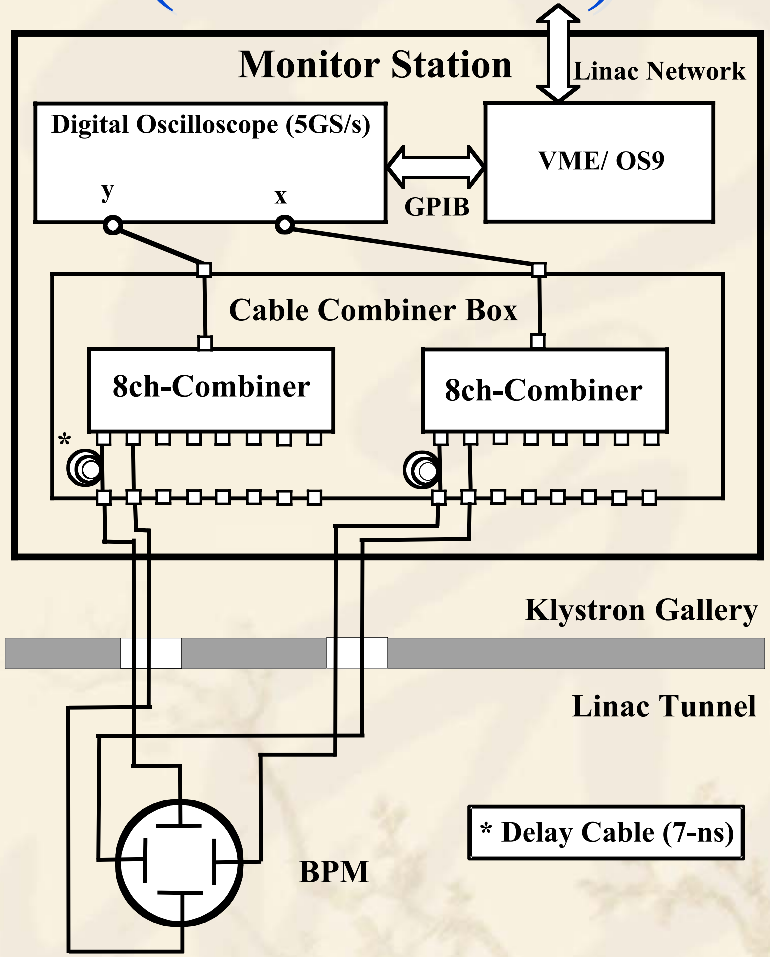


Upgrading BPM DAQ software

- Now beams of linac are switched to KEKB and PF twice a day
- Next switch frequency is several Hz(1~2Hz)
- Final switch frequency will be 50Hz
- So BPM system and Feedback system will be upgraded to promote higher energy, stability and quality of beam.

Monitor Station (Previous)

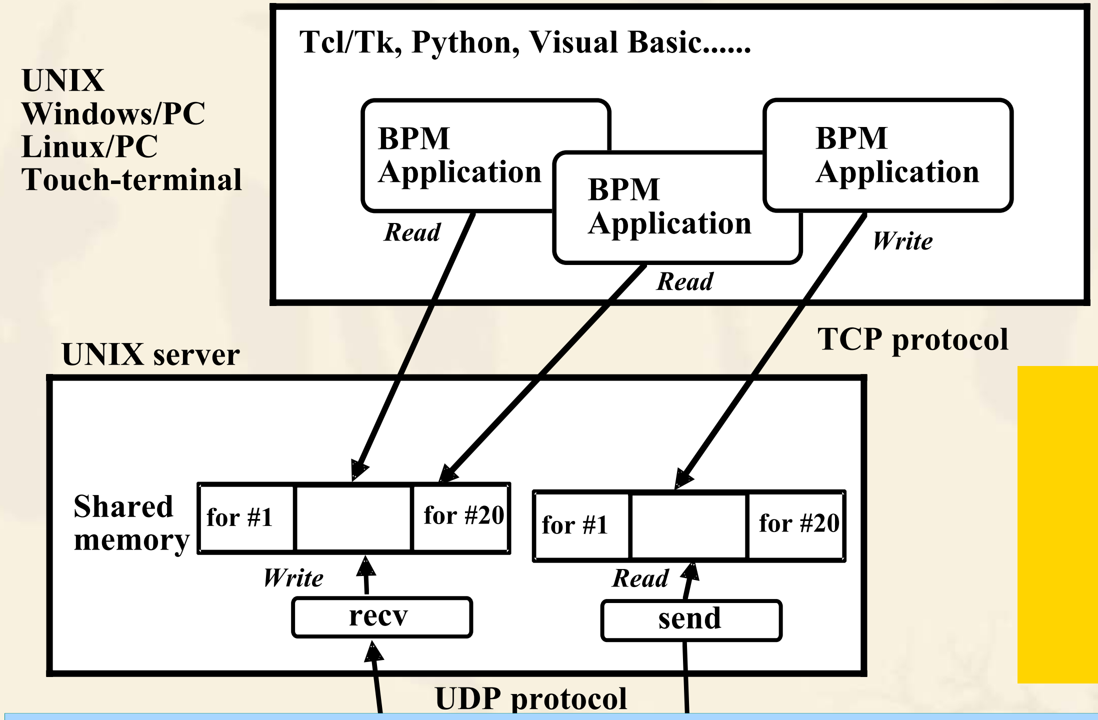




✓VME + Oscilloscope (TectronixTDS680, 5-GSa/s, 8-bits)

✓VME ⇔ Oscilloscope via GPIB (GPIB is slower)

Software structure (Now)



UNIX
Windows/PC
Linux/PC
Touch-terminal

Tcl/Tk, Python, Visual Basic......

BPM Application

BPM Application

BPM Application

Read

Read

Write

TCP protocol

UNIX server

Shared memory

for #1

for #20

for #1

for #20

Write

Read

recv

send

UDP protocol

Porting
OS9, Tru64 (lib.)
=> Windows

DAQ Software

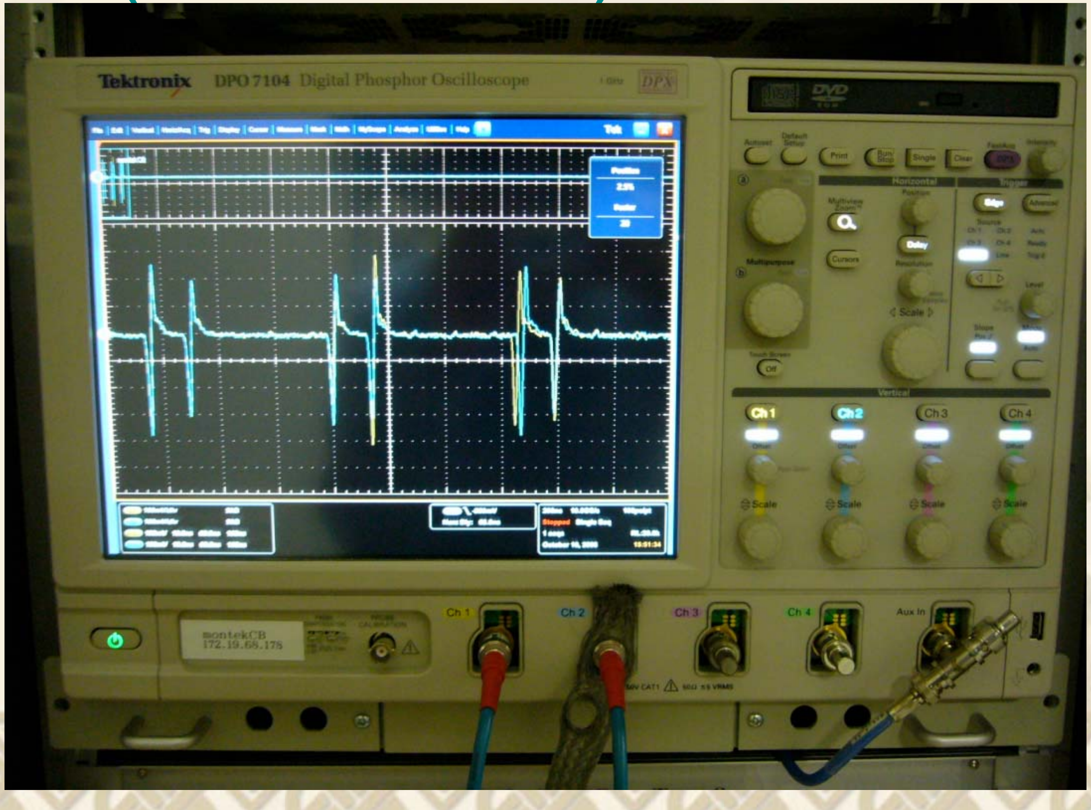
Windows XP	TekVisa

DPO 7104

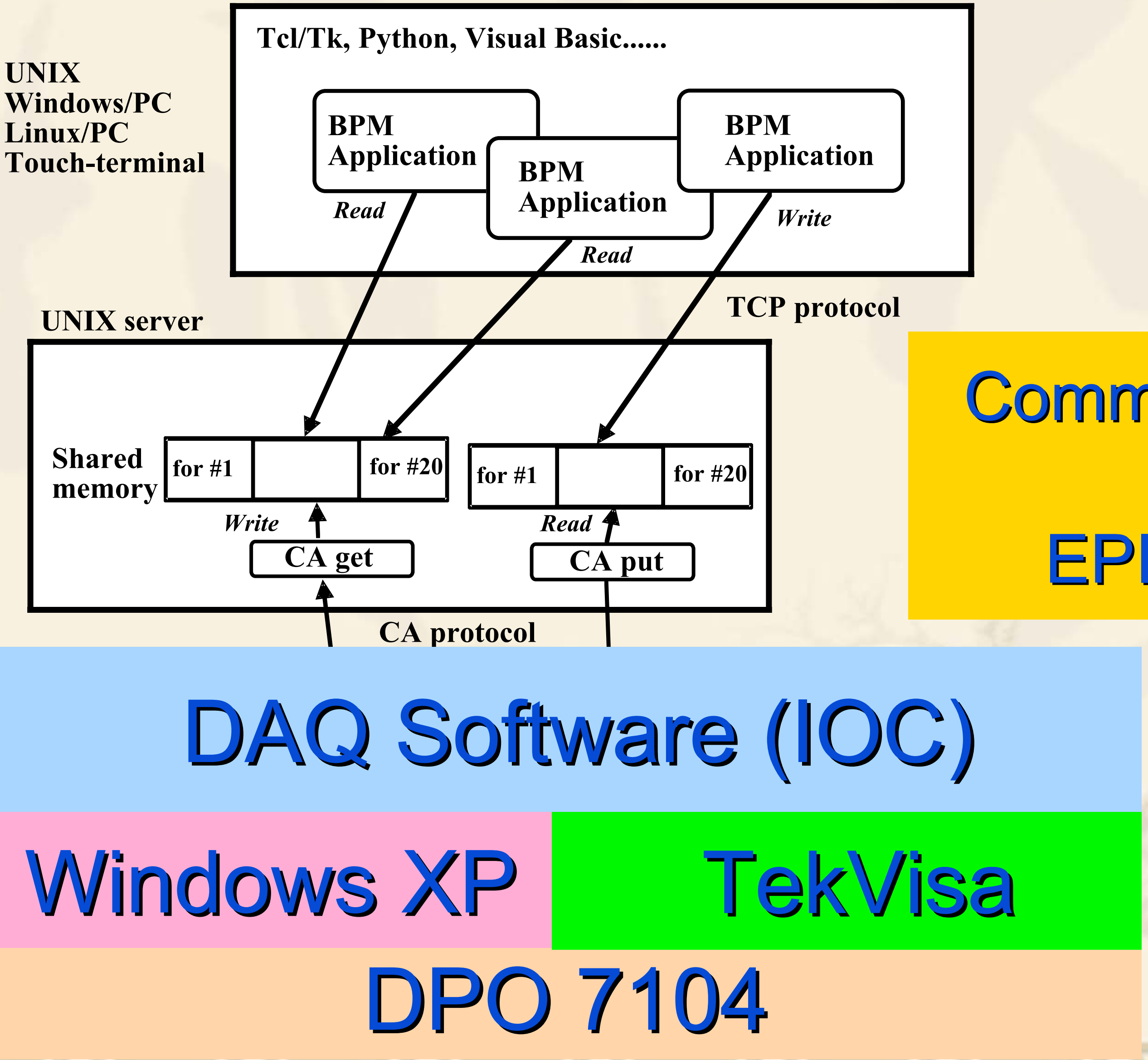
Remove the VME and GPIB, use ethernet

Tektronix DPO 7104

- 10-GSa/s (4ch), 8-bits
- Windows XP based (P4 3.4-GHz)
- Gigabit-Ethernet



EPICS Based



Tcl/Tk, Python, Visual Basic......

UNIX
Windows/PC
Linux/PC
Touch-terminal

BPM Application

BPM Application

BPM Application

Read

Read

Write

TCP protocol

UNIX server

Shared memory

for #1

for #20

for #1

for #20

Write

Read

CA get

CA put

CA protocol

DAQ Software (IOC)

Windows XP

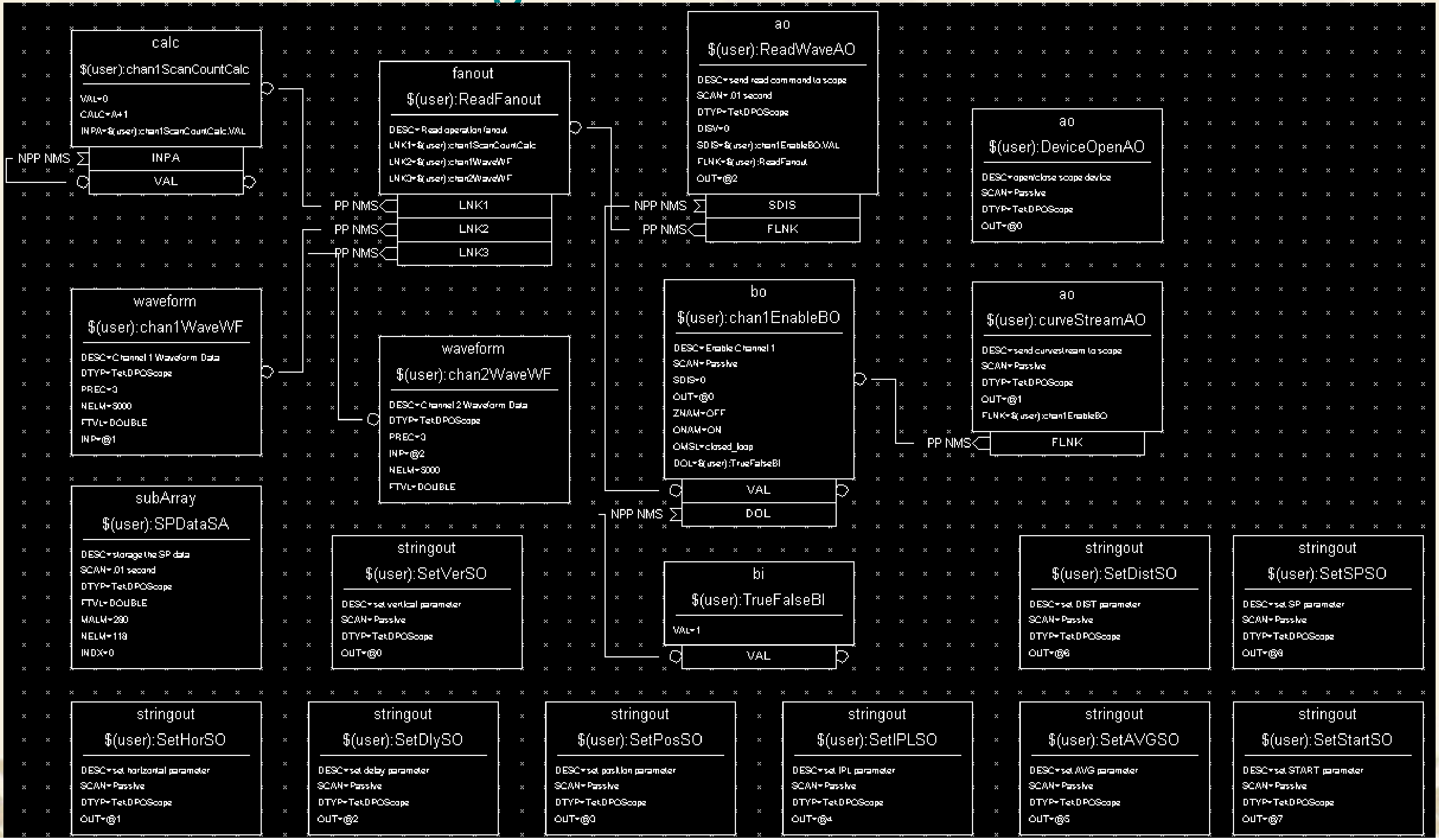
TekVisa

DPO 7104

Common Windows
=>
EPICS based

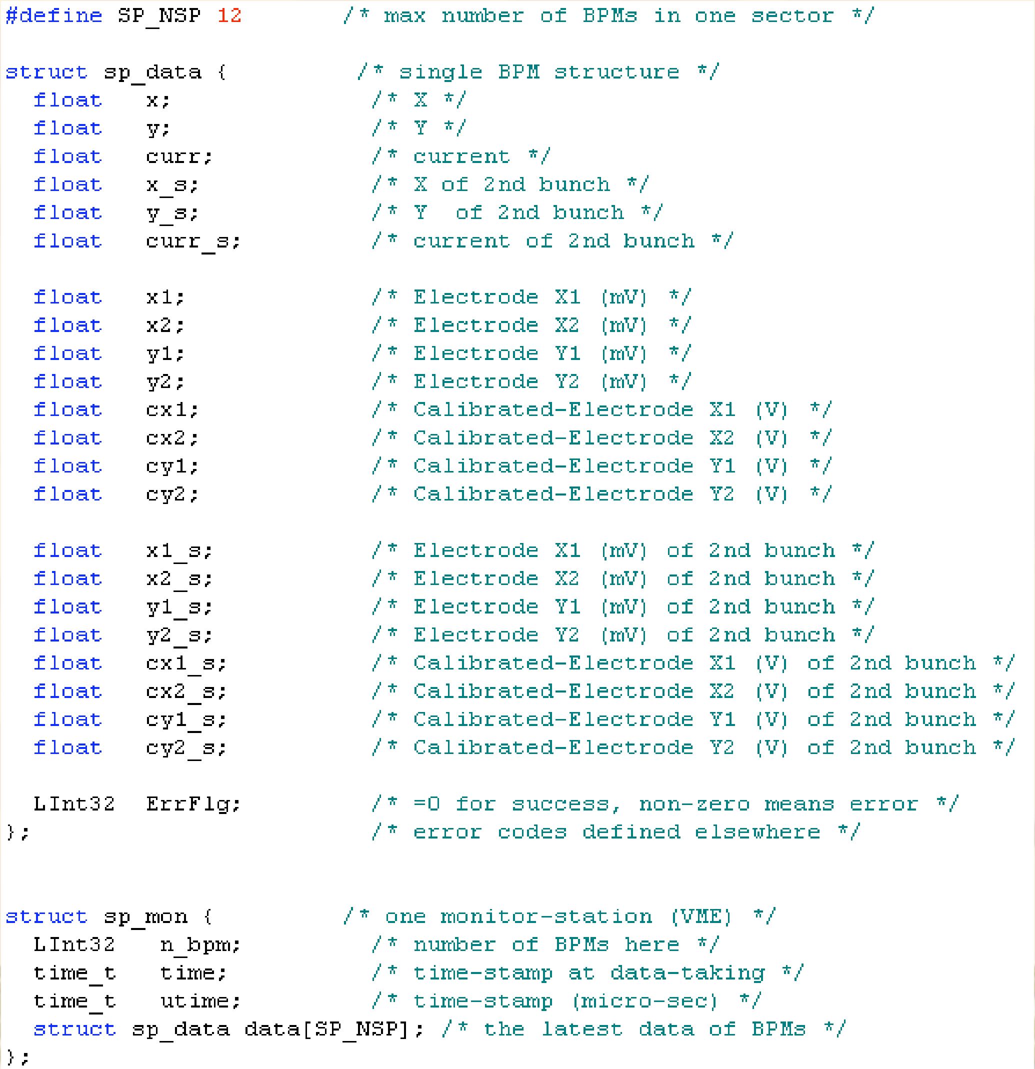
DAQ Software (IOC)

- VDCT to design the records



```
calc
$(user):chan1ScanCountCalc
VAL=0
CALC=A+1
INPA=$(user):chan1ScanCountCalc.VAL

fanout
$(user):ReadFanout
DESC=Read operation fanout
LNK1=$(user):chan1ScanCountCalc
LNK2=$(user):chan1WaveWF
LNK3=$(user):chan2WaveWF

ao
$(user):ReadWaveAO
DESC=send read command to scope
SCAN=.01 second
DTYP=TekDPOScope
DISV=0
SDIS=$(user):chan1EnableBO.VAL
FLNK=$(user):ReadFanout
OUT=@2

ao
$(user):DeviceOpenAO
DESC=open/close scope device
SCAN=Passive
DTYP=TekDPOScope
OUT=@0

waveform
$(user):chan1WaveWF
DESC=Channel 1 Waveform Data
DTYP=TekDPOScope
PREC=3
NELM=3000
FTVL=DOUBLE
INP=@1

waveform
$(user):chan2WaveWF
DESC=Channel 2 Waveform Data
DTYP=TekDPOScope
PREC=3
INP=@2
NELM=3000
FTVL=DOUBLE

bo
$(user):chan1EnableBO
DESC=Enable Channel 1
SCAN=Passive
SDIS=0
OUT=@0
ZNAM=OFF
ONAM=ON
OMSL=closed_loop
DOL=$(user):TrueFalseBI

ao
$(user):curveStreamAO
DESC=send curvestream to scope
SCAN=Passive
DTYP=TekDPOScope
OUT=@1
FLNK=$(user):chan1EnableBO

subArray
$(user):SPDataSA
DESC=storage the SP data
SCAN=.01 second
DTYP=TekDPOScope
FTVL=DOUBLE
MALM=280
NELM=118
INDX=0

stringout
$(user):SetVerSO
DESC=set vertical parameter
SCAN=Passive
DTYP=TekDPOScope
OUT=@0

bi
$(user):TrueFalseBI
VAL=1

stringout
$(user):SetDistSO
DESC=set DIST parameter
SCAN=Passive
DTYP=TekDPOScope
OUT=@6

stringout
$(user):SetSPSO
DESC=set SP parameter
SCAN=Passive
DTYP=TekDPOScope
OUT=@8

stringout
$(user):SetHorSO
DESC=set horizontal parameter
SCAN=Passive
DTYP=TekDPOScope
OUT=@1

stringout
$(user):SetDlySO
DESC=set delay parameter
SCAN=Passive
DTYP=TekDPOScope
OUT=@2

stringout
$(user):SetPosSO
DESC=set position parameter
SCAN=Passive
DTYP=TekDPOScope
OUT=@3

stringout
$(user):SetIPLSO
DESC=set IPL parameter
SCAN=Passive
DTYP=TekDPOScope
OUT=@4

stringout
$(user):SetAVGSO
DESC=set AVG parameter
SCAN=Passive
DTYP=TekDPOScope
OUT=@5

stringout
$(user):SetStartSO
DESC=set START parameter
SCAN=Passive
DTYP=TekDPOScope
OUT=@7
```

- subArray: store the SP result (position and current value) named $(user):SPDataSA, correspond to struct sp_mon

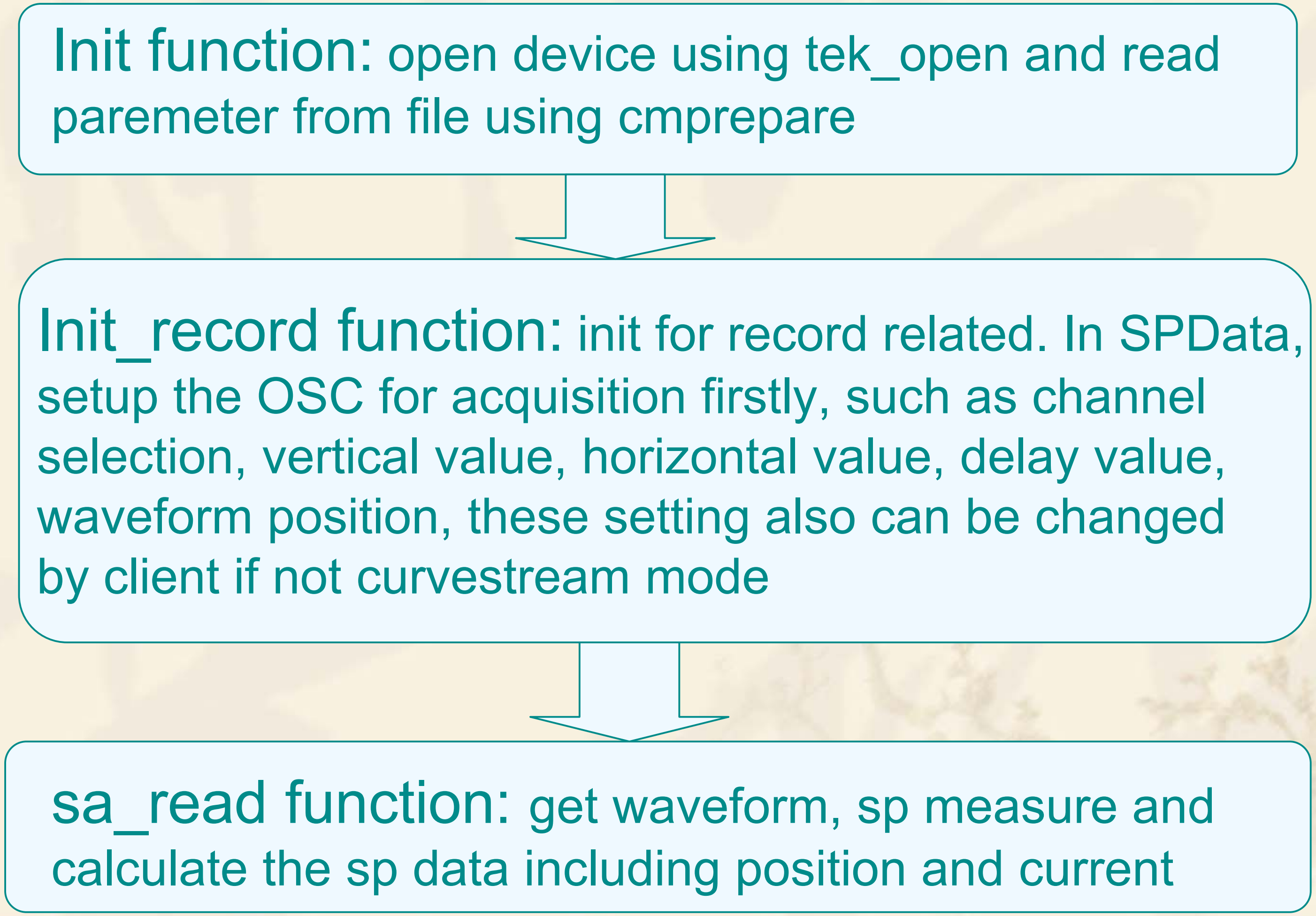


```
#define SP_NSP 12       /* max number of BPMs in one sector */

struct sp_data {         /* single BPM structure */
  float   x;              /* X */
  float   y;              /* Y */
  float   curr;           /* current */
  float   x_s;            /* X of 2nd bunch */
  float   y_s;            /* Y  of 2nd bunch */
  float   curr_s;         /* current of 2nd bunch */

  float   x1;             /* Electrode X1 (mV) */
  float   x2;             /* Electrode X2 (mV) */
  float   y1;             /* Electrode Y1 (mV) */
  float   y2;             /* Electrode Y2 (mV) */
  float   cx1;            /* Calibrated-Electrode X1 (V) */
  float   cx2;            /* Calibrated-Electrode X2 (V) */
  float   cy1;            /* Calibrated-Electrode Y1 (V) */
  float   cy2;            /* Calibrated-Electrode Y2 (V) */

  float   x1_s;           /* Electrode X1 (mV) of 2nd bunch */
  float   x2_s;           /* Electrode X2 (mV) of 2nd bunch */
  float   y1_s;           /* Electrode Y1 (mV) of 2nd bunch */
  float   y2_s;           /* Electrode Y2 (mV) of 2nd bunch */
  float   cx1_s;          /* Calibrated-Electrode X1 (V) of 2nd bunch */
  float   cx2_s;          /* Calibrated-Electrode X2 (V) of 2nd bunch */
  float   cy1_s;          /* Calibrated-Electrode Y1 (V) of 2nd bunch */
  float   cy2_s;          /* Calibrated-Electrode Y2 (V) of 2nd bunch */

  LInt32  ErrFlg;         /* =0 for success, non-zero means error */
};                        /* error codes defined elsewhere */


struct sp_mon {         /* one monitor-station (VME) */
  LInt32   n_bpm;         /* number of BPMs here */
  time_t   time;          /* time-stamp at data-taking */
  time_t   utime;         /* time-stamp (micro-sec) */
  struct sp_data data[SP_NSP]; /* the latest data of BPMs */
};
```

Device support

- Device Type
  - device(waveform,INST_IO,devWfTekDPO,"Tek DPOScope")
  - device(ao,INST_IO,devAOTekDPO,"TekDPOScope")
  - device(subArray,INST_IO,devSATekDPO,"Tek DPOScope")
  - device(stringout,INST_IO,devSOTekDPO,"Tek DPOScope")

subArray device support process



Init function: open device using tek_open and read paremeter from file using cmprepare

Init_record function: init for record related. In SPData, setup the OSC for acquisition firstly, such as channel selection, vertical value, horizontal value, delay value, waveform position, these setting also can be changed by client if not curvestream mode

sa_read function: get waveform, sp measure and calculate the sp data including position and current

CA Client in linux

- SP get client
  - Using the ca basic procedure such as ca_context_create, ca_create_channel, ca_get, ca_pend_io, ca_clear_channel, ca_context_destroy
  - Get the SP Data and convert subarray to struct sp_mon and store to share memory when running client once
  - Based on the application “sprecv” and “shmsem” library

CA Client in linux

- SP monitor client
  - Using the ca basic procedure such as ca_context_create, ca_create_channel, ca_create_subscription, ca_pend_event, ca_clear_channel, ca_context_destroy
  - Get the SP Data and convert subarray to struct sp_mon and store to share memory when SP Data is changed in IOC
  - Porting “sprecv” to “sp_monitor”

DAQ IOC Software Test

- 50Mhz pulse genrator
- Some setting of OSC is 10Gs/s 100ps/pt ; DIS:WAVE OFF; ACQ:STOPAFTER RUNSTOP; DATA:SOURCE CH1,CH2; :HOR:RECO 20000
- Use curve command
  - Scan periodic: max frequency = 81.54
  - Scan passive: max frequency = 135.14
- Use curvestream command
  - Scan periodic: max frequency = 195.31
  - Scan passive: max frequency = 194.20

Summary

- Different technologies of win32 to develop IOC for different oscilloscope and compare performance of some
- Develop IOC for upgrading BPM DAQ Software
  - Develop ioc for waveform acquisition and test performance with the common win32 application
  - Porting DAQ software to IOC EPICS based and test its performance

Thank you!