



# ICE: An Instrument Control Environment for the New Millennium

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# Statement of the Problem

Existing instrument control software (ICP) is mature but showing its age

Numerous issues with maintenance

- Adding new devices is major undertaking

- Platform obsolescence and OS-specific extensions

- Increasing demands of computer security

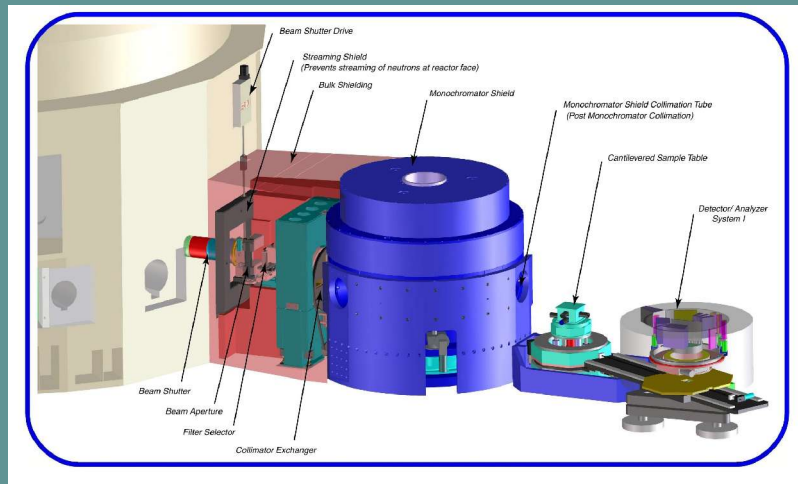
Accommodations need to be made for new users

- Not everybody is an expert...

New instruments will require more sophistication

- Not every instrument is a triple axis...

# An opportunity for Change



NIST 10M SANS

Advanced Neutron  
Diffractometer/Reflectometer

BT7 Thermal Triple Axis

MACS (Multi Analyzer Crystal  
Spectrometer)



# Design Goals

## Extensibility

Incorporate new devices and subsystems without requiring a paradigm shift or resulting in spaghetti code

## Flexibility

Permit measurements that fall outside routine operations

## Adaptability

Reuse infrastructure throughout our facility

## Modularity

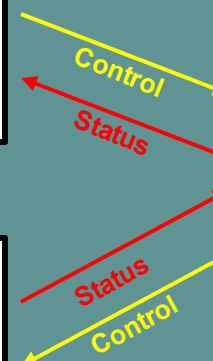
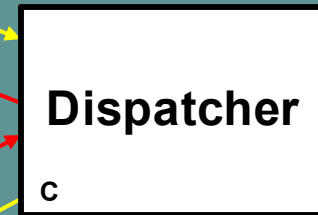
Easily isolate/exchange bits that need “refactoring”

## Portability

Easily migrate systems to new platforms

# ICE Overview

User Interface



Control Server

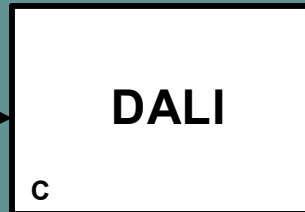
```
<?xml version="1.0"?>
<!DOCTYPE ICE SYSTEM "ice.dtd">
<Server>
  <InstrFile>input.xml</InstrF
  <XpeekName>BT0</XpeekName>
</Server>
<Instrument>
  <InstrumentType>ANDR</Instr
  <Part>Angle S1 motor5</Part
```

**XML Configuration**

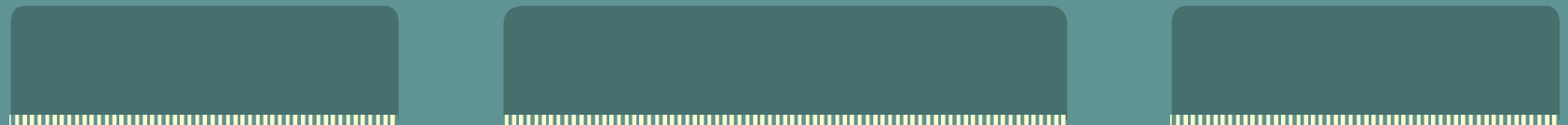


```
<?xml version="1.0"?>
<!DOCTYPE DAL SYSTEM "dal.dtd">
<DAL Flags="DALLOGFLAG|DALDEBU
<Interface ID="Serial1" Driver
  <serialParams>
    <resourceString>/dev/ttyS0</
    <speed>9600</speed>
  </serialParams>
</Interface>
<Device ID="elevator" Driver="
```

**XML Configuration**



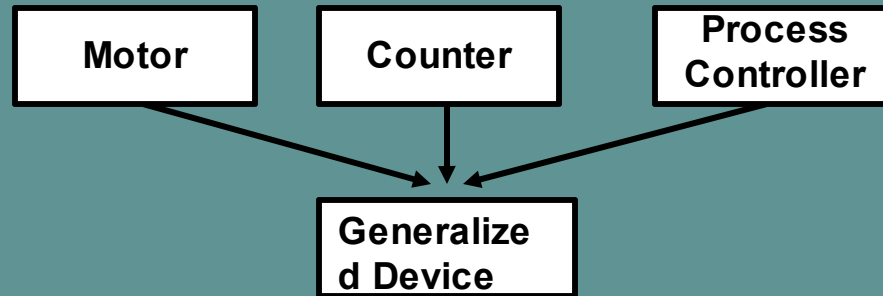
Device Abstraction Layer





# DALI: Device Abstraction Layer for Instrumentation

**Top level Classes**



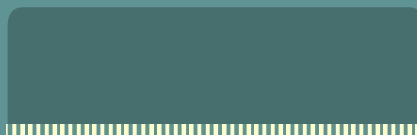
Devices are registered as belonging to one of the major classes  
Generalized methods include get/set parameters and action

**Generalized interfaces**



Interfaces are just conduits for communication and control

**Physical devices**





# DALI Features

Built on concept of modular device drivers

Device drivers can be loaded/unloaded dynamically

Major classes: motors, counters, process controllers

Devices and interfaces can be managed independently

Configuration described by XML file

Written in ISO C and ported to POSIX /  
Windows

# ICE Control Server

Runs autonomously as an operating system service

Implemented as a state machine

Scans are really considered as a sequence of states

Server maintains a FIFO to execute commands sequentially

Commands principally textual

Tiered permission scheme for remote command execution (local token for full rights)

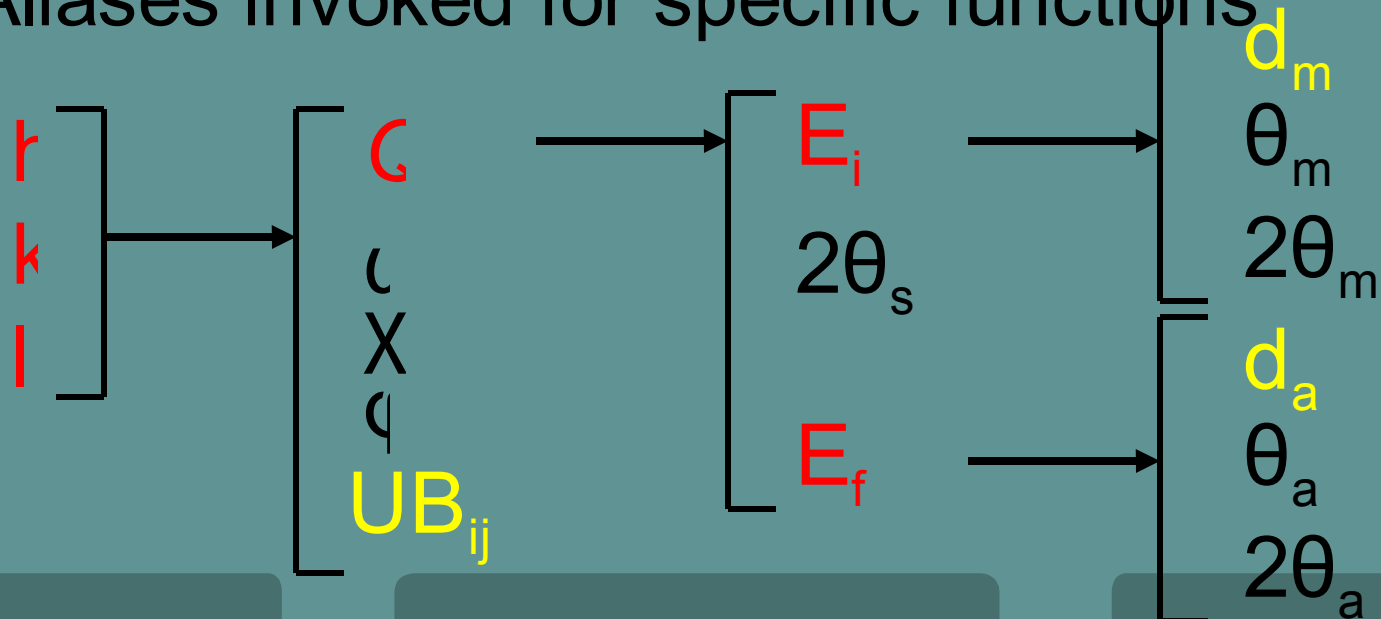


# Virtual Devices

Users will work in experimentally convenient quantities

Transformations handled by instrument-specific modules

Aliases invoked for specific functions

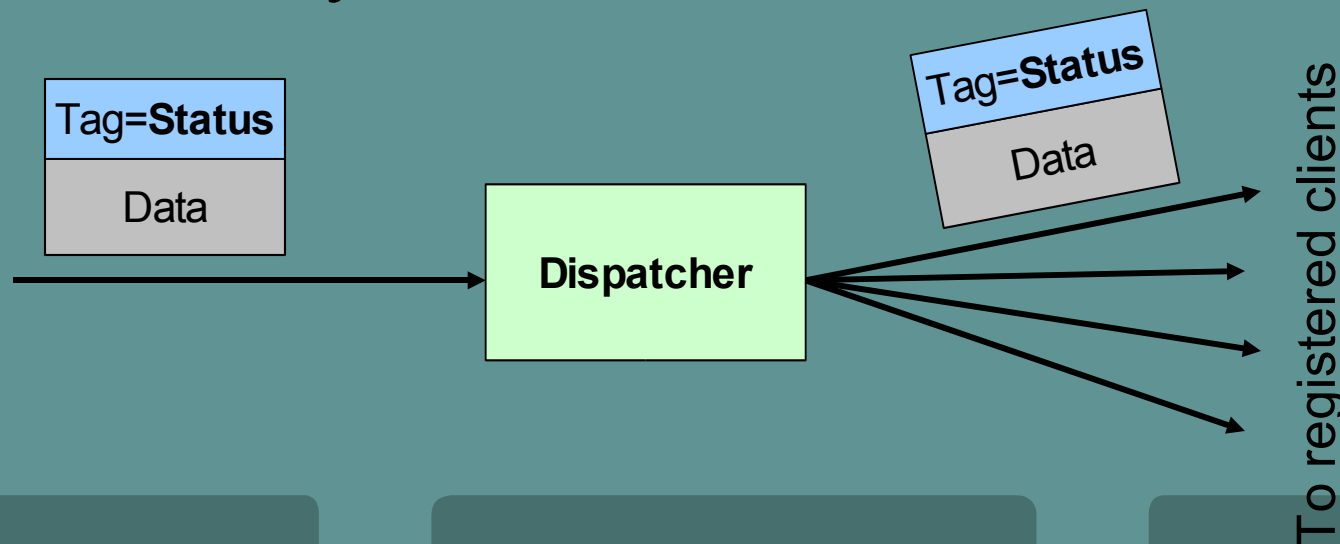


# Dispatcher

Independent process that relays messages between server and subscribed clients

Messages are two part: tag and data

Clients only receive messages with tags to which they have subscribed



# Remote Command Execution

## Local

**Immediate Commands:**  
executed immediately

**Stacked Commands:**  
processed sequentially in  
order received

## Remote

Remote commands are a  
subset of local commands

They have the same  
permissions / restrictions on  
execution

## Administrator

A client registered as an administrator can execute any command as if it was immediate

# User Interface

Any dispatcher client can be an ICE client

Clients can attach from the instrument control computer or elsewhere

Clients register themselves with server identifying experimenter

Clients issue textual commands to server and can receive status/data messages from it.

# Scan Setup Window

The screenshot shows the Scan Setup Window interface. On the left, a status panel displays system parameters: Status = IDLE, Instr = BTO, Run = 1977, Area = [311296.0], and various detector and scan parameters (A1, S1-S4, SysC, SysClock, Theta, Tilt, Time, Trans, TwoTheta) all set to [0.000]. Below this are controls for Scanning (no), Point number (-1), Scan Progress, and Stop/Pause buttons.

The main window has tabs for 'Incr Scan', 'Scan List', 'Log & Commands', 'Stack Control', and 'Files'. The 'Scan List' tab is active, showing a table with one entry: # 0, Name spec1, Type 5.

Below the table are buttons for 'Update', 'Run Selection', 'Dry Run', 'Delete Scan', and 'Edit Scan'. The 'Scan Editor' section shows 'Scan Title: spec1' and a list of parameters: Type=5, CountType=Monitor, Counts=10, DetectorType=Detector, Angle=Theta=0.0 1.0 2.0 3.0 4.0 5.0, ScanRange=Theta 0 1 5, Angle=TwoTheta=0.0 2.0 4.0 6.0 8.0 10.0, ScanRange=TwoTheta 2 0, ScanType=Specular, and Comment=-.

On the right side of the editor are buttons for 'Get Current', 'Clear Editor', and 'Send to Server'. At the bottom, there are 'Save scan list:' and 'Save scan:' buttons with input fields containing 'scanlist.xml' and 'scan.xml' respectively.



# Command Entry View

The screenshot displays a software interface with a left-hand status panel and a main command entry area. The status panel on the left lists various system parameters such as 'Status = IDLE', 'Instr = BT0', and 'Run = 1977'. Below this, it shows 'Scanning: no' and 'Point number: -1'. A 'Scan Progress' bar is present, along with 'Stop' and 'Pause' buttons. The main area has tabs for 'Incr Scan', 'Scan List', 'Log & Commands', 'Stack Control', and 'Files'. The 'Log & Commands' tab is active, showing a text area with a 'help' command entered. The log output includes a timestamped command 'Scan DescrToList spec1', a confirmation message, another timestamped command 'Scan List', and a detailed scan description. Below the log, there is a table of scan data for 'Theta' and 'TwoTheta' at 6 points. At the bottom of the main area, there are 'Find Peak' controls with input fields for 'Device', 'Range', 'Step', 'Count for', 'Up to', and 'Counter', and buttons for 'Find Peak', 'Move to Fit', 'Set Position', and 'Move'.

Status = IDLE  
Instr = BT0  
Run = 1977  
A1 = [0.485 ]  
Area = [311296.C  
Detector = [0.000 ]  
Monitor = [0.000 ]  
Roi = [6.000 ]  
S1 = [0.000 ]  
S2 = [0.000 ]  
S3 = [0.000 ]  
S4 = [0.000 ]  
Sysc = [0.000 ]  
SysClock = [0.000 ]  
Theta = [0.000 ]  
Tilt = [0.000 ]  
Time = [0.000 ]  
Trans = [0.000 ]  
TwoTheta = [0.000 ]

Scanning: no  
Point number: -1

Scan Progress

Stop  
Pause

Incr Scan Scan List Log & Commands Stack Control Files

Input Command  
help

Registered doucet on kazoo  
09:52:29> Scan DescrToList spec1 Scan:Title=spec1:Type=5:Cou  
09:52:29> Scan List  
Scan [spec1] saved in internal scan list  
09:52:34> Scan ListDescr spec1  
Scan:Title=spec1:Type=5:CountType=Monitor:Counts=10:DetectorType=De  
09:52:49> Scan DryRun spec1  
Dry run scan: spec1 (6 points)

Theta		TwoTheta	
Theta	0	TwoTheta	0
Theta	1	TwoTheta	2
Theta	2	TwoTheta	4
Theta	3	TwoTheta	6
Theta	4	TwoTheta	8
Theta	5	TwoTheta	10

Find Peak

Device Range Step Count for Up to Counter

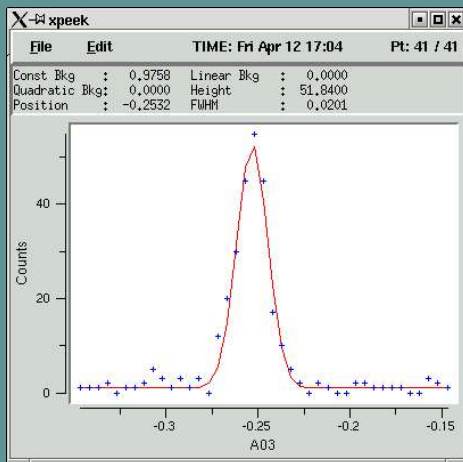
Find Peak Move to Fit Set Position

Move

Help

# Interoperation with Existing Utilities

## Live Data Visualization



## Local Spectrometer Cameras

## Facility Data Repository

NCNR Backup Database - Recent Data Files

```

SELECT file.localdir, file.name, file.date, experiment.experimenters, file.comments FROM file.experiment
WHERE file.experiment_id = experiment.experiment_id AND experiment.instruments = 'X1' ORDER BY
file.date DESC LIMIT 0.15
    
```

Filename	Date	Experimenters	Comments
plot_FNO35001.bt1	Current		RUN IN PROGRESS
plot_LNORT002.bt1	2004-06-03 13:30:00	Pete DeSanto	LNORT L <sub>2</sub> N <sub>1</sub> O <sub>4</sub> +delta at RT CuB11 15'
plot_nco31008.bt1	2004-06-03 08:48:00	Q.Huang	nco31 Na <sub>0.3</sub> Co <sub>0.3</sub> YD20-Triple layer/Tc=3.6K, Cava. 2
plot_nco31007.bt1	2004-06-02 22:58:00	Q.Huang	nco31 Na <sub>0.3</sub> Co <sub>0.3</sub> YD20-Triple layer/Tc=3.6K, Cava. 2
plot_nco31006.bt1	2004-06-02 14:55:00	Q.Huang	nco31 Na <sub>0.3</sub> Co <sub>0.3</sub> YD20-Triple layer/Tc=3.6K, Cava. 2
plot_nco31005.bt1	2004-06-02 14:44:00	Q.Huang	nco31 Na <sub>0.3</sub> Co <sub>0.3</sub> YD20-Triple layer/Tc=3.6K, Cava. 2
plot_RKx03003.bt1	2004-06-02 14:40:00		-0.6000 0
plot_RKx03002.bt1	2004-06-02 14:39:00		-0.4000 0
plot_nco31004.bt1	2004-06-02 14:21:00	Q.Huang	nco31 Na <sub>0.3</sub> Co <sub>0.3</sub> YD20-Triple layer/Tc=3.6K, Cava. 2
plot_nco31003.bt1	2004-06-02 06:59:00	Q.Huang	nco31 Na <sub>0.3</sub> Co <sub>0.3</sub> YD20-Triple layer/Tc=3.6K, Cava. 2
plot_nco31002.bt1	2004-06-01 22:57:00	Q.Huang	nco31 Na <sub>0.3</sub> Co <sub>0.3</sub> YD20-Triple layer/Tc=3.6K, Cava. 2
plot_nco31001.bt1	2004-06-01 15:14:00	Q.Huang	nco31 Na <sub>0.3</sub> Co <sub>0.3</sub> YD20-Triple layer/Tc=3.6K, Cava. 2
plot_pgsSt014.bt1	2004-06-01 11:28:00	Q.Huang	pgsSt Pr5Ge2S12#3.Tetragonal, GHR.ao.250K
plot_pgsSt013.bt1	2004-06-01 08:56:00	Q.Huang	pgsSt Pr5Ge2S12#3.Tetragonal, GHR.ao.200K
plot_pgsSt012.bt1	2004-06-01 02:15:00	Q.Huang	pgsSt Pr5Ge2S12#3.Tetragonal, GHR.ao.150K
plot_pgsSt011.bt1	2004-05-31 23:46:00	Q.Huang	pgsSt Pr5Ge2S12#3.Tetragonal, GHR.ao.100K



# Current Status

## DALI Device Abstraction Layer

- Mature support for motors and counters
- Developmental support for process controllers
- Mature Python wrapper

## ICE Instrument Control Server

- Major structural elements complete
- Scan infrastructure functional
- ICE Configured to interoperate with existing NCNR tools
- Many specialized features remain to be ported from ICP

## User Interface

- Currently using provisional Python/gtk client
- Goal is to standardize interface for instruments of similar types

