

SNS Online Display Technologies for EPICS

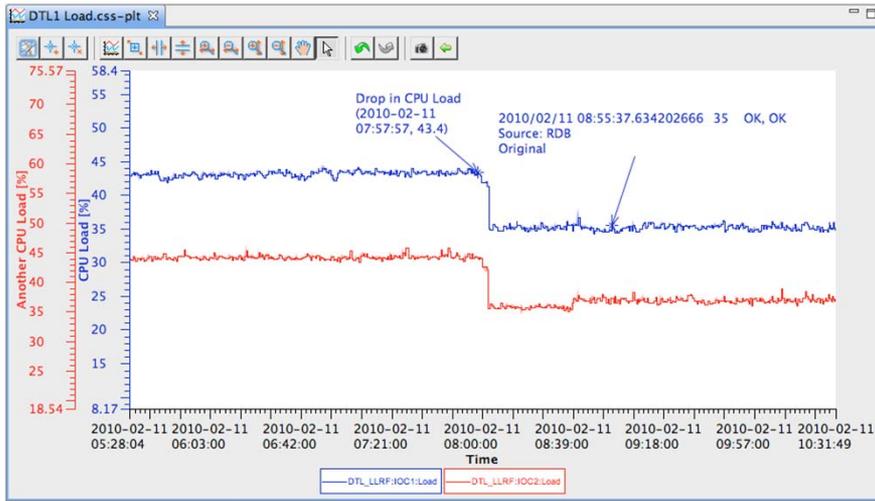
Kay-Uwe Kasemir, kasemirk@ornl.gov

Xihui Chen
John Purcell
Katia Danilova

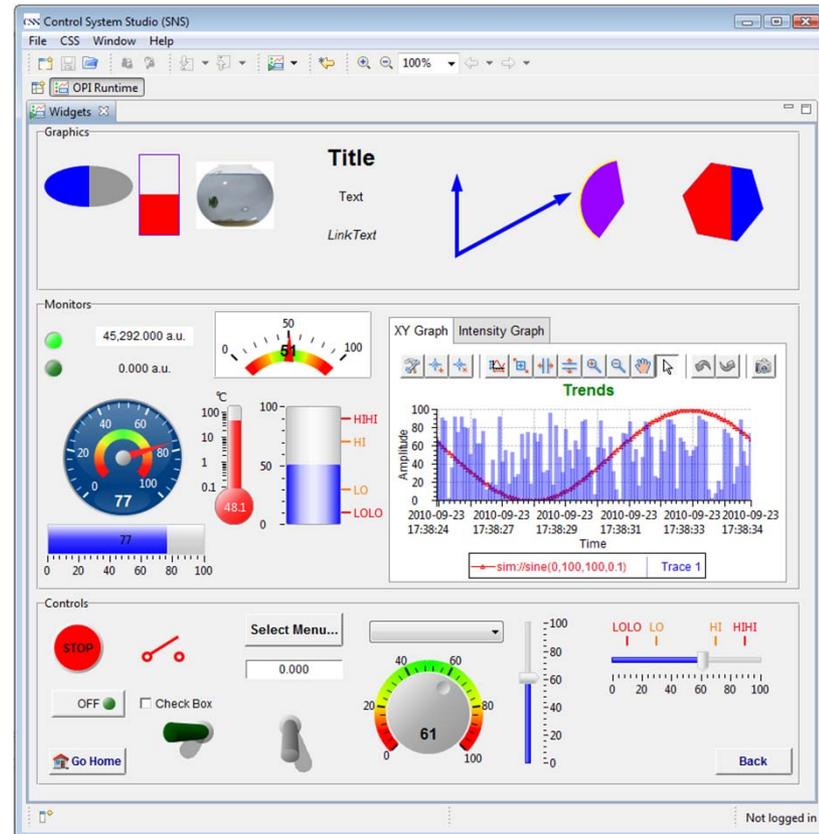
ORNL/SNS

ICALEPCS 2011, Grenoble, France

We Have Good Control System Displays



PV	Description	Time	Current severity	Severity	Status	Value
CF_KL-DIWS_AIT43038:Rs	CF_KL-DIWS_AIT43038:Rs	2009/03/17 16:10:06	MINOR	MINOR	HIGH_ALARM	18.5
RFQ_Vac:Pump2:Pressure	Demo pump 2	2009/03/17 16:09:46	OK	MAJOR	HIHI_ALARM	9.0
RFQ_Vac:Pump6:Pressure	Demo pump 6	2009/03/17 16:09:44	OK	MINOR	HIGH_ALARM	5.0
RFQ_Vac:Pump5:Pressure	Demo pump 5	2009/03/17 16:09:44	OK	MINOR	HIGH_ALARM	5.0
RFQ_Vac:Pump4:Pressure	Demo pump 4	2009/03/17 16:09:44	OK	MINOR	HIGH_ALARM	5.0
RFQ_Vac:Pump3:Pressure	Demo pump 3	2009/03/17 16:09:44	OK	MINOR	HIGH_ALARM	5.0
MEBT_CHOP:PS_2:V	mebbit chopper power supply two voltage fault	2009/03/16 19:05:10	MAJOR	MAJOR	LOLO_ALARM	0.000



Control System Studio

- Portable Java Technology
- Integration of Displays, Alarm System, Archive, ...

Still, Users want Web Access to Ctrl. Sys.

- From Anywhere
- On any device
 - and any web browser



Web 101: Hypertext Transfer Protocol

Web Server



1. **Connect to TCP port 80 on icalleps2011.esrf.eu**



2. **Request:**
“GET index.html
HTTP/1.1”



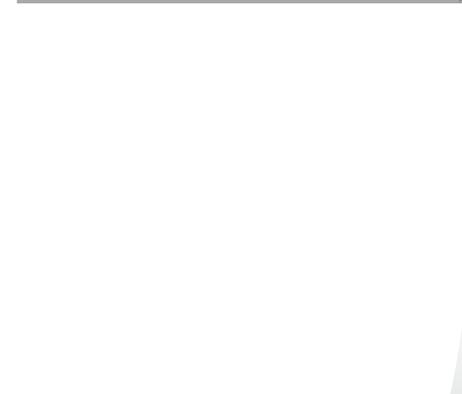
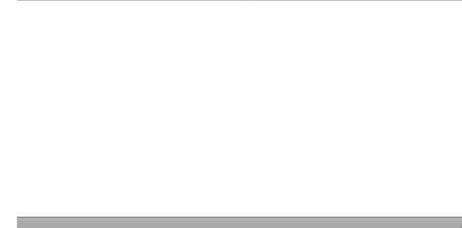
3. **Response:**
“<html>..<body>..icalleps
2011... </body><html>”



4. **Disconnect**

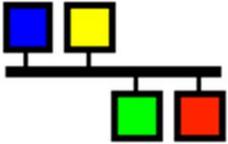


Web Client



Control System 101: Events

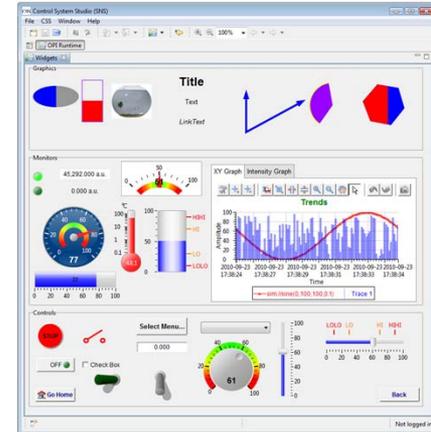
EPICS



- Subscribe to **Events**
- ← Cavity69Amp=13.2kV
- Pump47_Speed=1225 rpm
- (Pause, no changes)
- Cavity69Amp=13.3kV
- Turn pump off
- ← Pump47_Speed=475 rpm
- Pump47_Speed=123 rpm
- Pump47_Speed=0 rpm

(Network connection remains open)

Operator Display



Fundamental Mismatch

Control System

Events

- Updates can happen at any time

Web Client & Server

Request/Response

- Updates only happen after a “Reload” of the web page

Wait, that can't be true!

There are web sites that display updates without me having to push the “Reload” button...

What about “Server Push”?

Solution 1: Web Browser Plug-Ins

- **Adobe Flash Player, Apple QuickTime, ...**
 - Web Browser can display video
- **CAML WebCA**
 - Web Browser subscribes to EPICS Channel Access!

But:

- 1. Specific to certain web browsers.
Won't work on all your devices.**
- 2. Firewalls likely to restrict Channel Access traffic
to control system to access to plant network.
Can't get there from your phone.**

Solution 2: Ajax Poll

Web Server



JavaScript in web client performs periodic poll:

1. XMLHttpRequest
“GET /values HTTP/1.1”



2. Response:
“Pump47_Speed = 1234rpm,
Cavity69Amp = 13.2kV”



3. Java Script updates
affected section of web page

No manual reload!

Web Client



Response might be:
a) HTML for <div> in web page
b) XML, JSON data
c) JavaScript to execute
d)...

SNS Status Web Pages



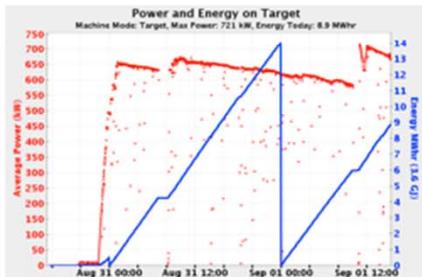
- Overview
- Beam
- Target
- Logbook
- Shift
- Experiments
- Availability
- Operators
- Mobile
- Other



As of Thursday, September 01, 2011
14:09:11

Manual Beam Switch Turned On
MPS Allows Beam
Continuous Shot Mode
To: Target, MPS: 1 mSec
Power at: 680.91 kW

SNS Energy Plot



As of 15:28:00 on 09/01/2011,
Reactor Power is at 0 MW

The reactor is currently shutdown for
the end-of-cycle 437 refueling outage.
Startup for cycle 438 is currently
planned for Monday, October 10.

Accelerator Messages

Accelerator Beam is on target at 700 kW.

Status
2011-09-01
12:04

CP 1B
repair
2011-08-22
14:16

Upon completion of the RFQ Cryo Pump 1B repair/replacement, please type the following in an open terminal window (accl-oper privileges are all that's necessary):
[accl-oper@ics-opi-ccr11 ~]\$ caput **RFQ_Vac_CP_1B** MS
"RFQ_Vac_CP_1B" This restores the status indicator for this device to the startmap geographical summation indications.

Phone Numbers

SNS Central Control Room **870-3082**
SNS Instrument Hall Coordinator **870-3082**

Who's Running it.

Employee	Title
Paul Brink	Shift Supervisor
Roger Neumann	Accelerator Specialist
William Wright	Accelerator Specialist
Edward Bell	Operations Shift Technician
Barbara Smith	Radiation Control Technician
Terry Partridge	Instrument Hall Coordinator

Weather

Oak Ridge, TN
93 °F / 34 °C

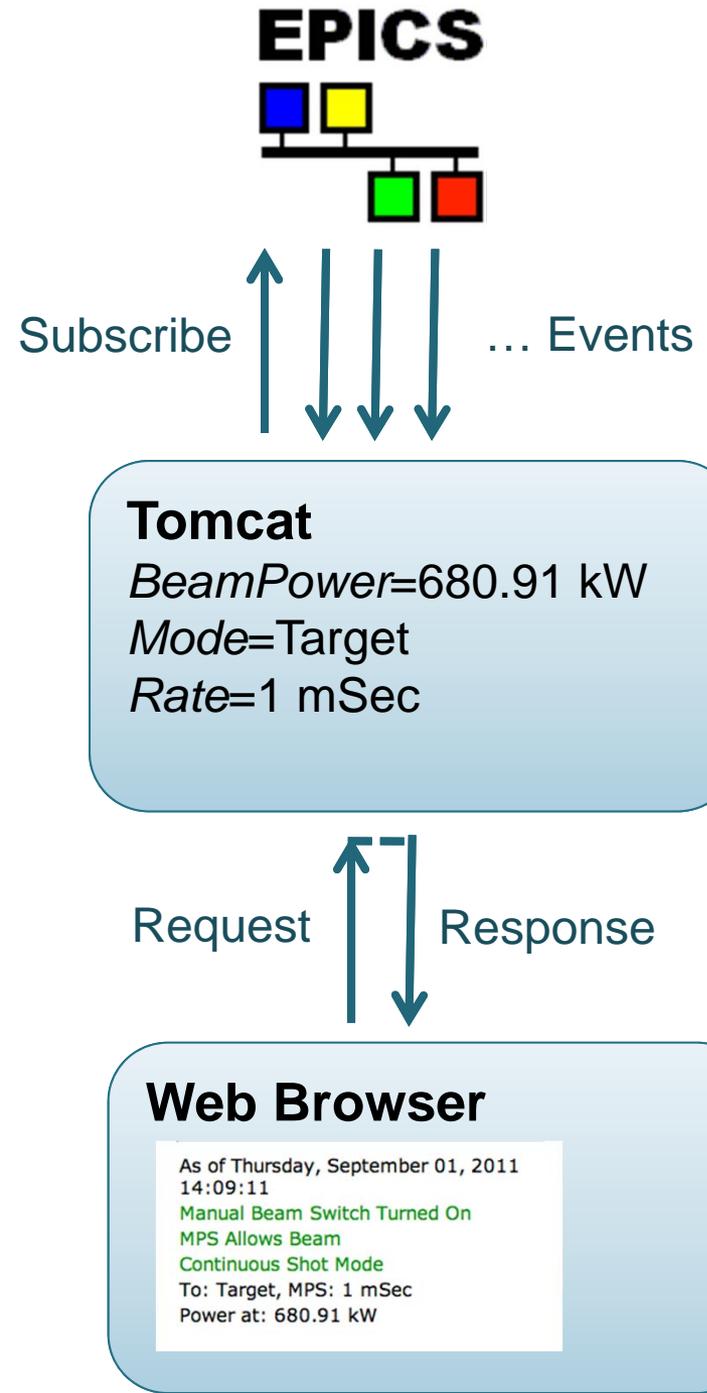
Clear
at 02:53 PM
Advisory!
Click for Forecast

Logbook

Time	Title
2011-09-01 14:29	Ring RF Station 13 repairs complete
2011-09-01 14:25	Re: Re: Ring BPM B08 not working
2011-09-01 14:22	Re: Re: Spark Counter Interlock
2011-09-01 14:06	Re: Spark Counter Interlock
2011-09-01 13:49	Target Module Upper Manifold Seal Pressure
2011-09-01 13:39	nitrogen delivery
2011-09-01 13:37	Spark Counter Interlock
2011-09-01 13:31	Re: RID Drain Tank High Level Indicator
2011-09-01 13:26	CCL Mag:QH00 trip
2011-09-01 13:05	Shift Logs/Tours

Status Web Technology

- JSP (Apache Tomcat)
- Web Server subscribes to *predefined* list of EPICS Channels, keeping track of 'current' values
- Ajax periodically updates sections of web page



Status Web Page Summary

✓ Very robust

✓ Works on every web client

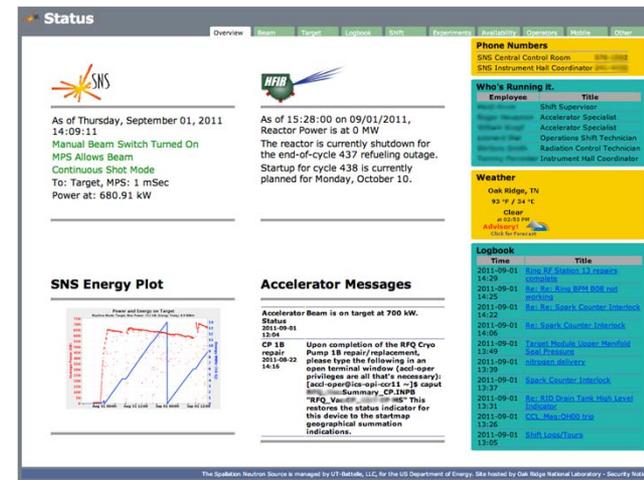
✓ Minimum CPU and network requirements

○ Content is pre-defined (Overview, Beam Info, ...)

– Cannot add specific section for each user

○ Only slow periodic updates

– some 3 sec, others ~30 sec



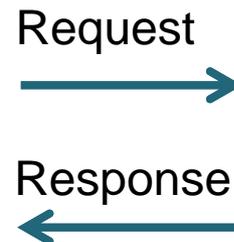
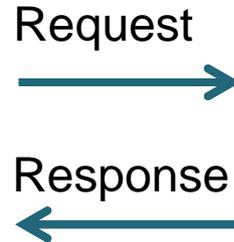
Solution 3: Long Poll

Ajax Poll with special timing

- Client sends request
- Server delays response until **new data** becomes available
- Server returns data
- Client handles data and immediately starts new request

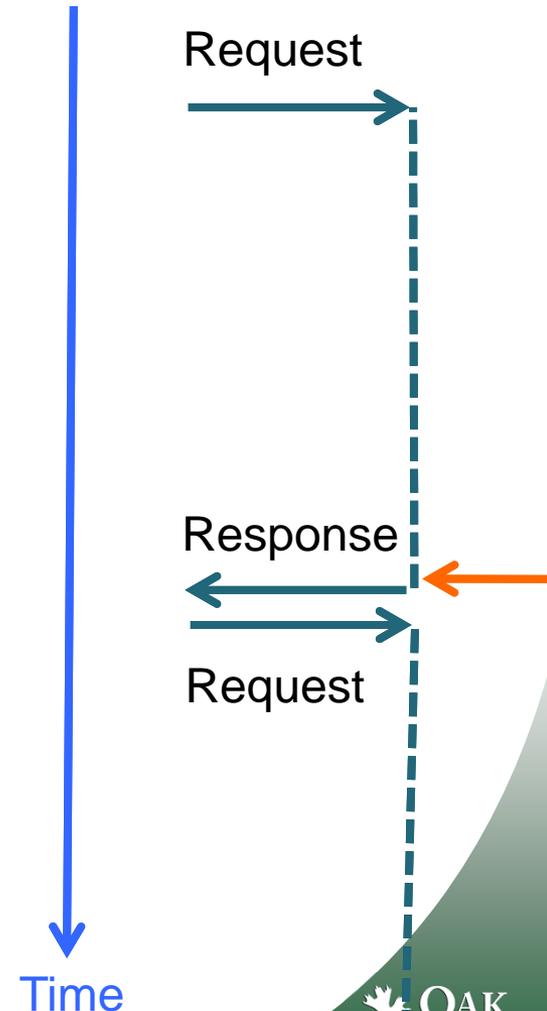
Plain Ajax Poll

Client Server



Long Poll

Client Server



Using Long Poll...

- **Looks like event-driven display to end user**
 - **But:**
 - **Slower than pure event mechanism that would not need requests**
 - **Java Script code needs to handle differences between web browsers**
 - **Number of concurrent Ajax requests is limited (2, 6 , .. depending on web browser)**
 - **Cannot have one Long Poll per data point**
 - **Better have only one Long Poll for the whole web page**
- ➔ Need to be familiar with HTML, DOM, JavaScript, Style Sheets as well as server-side Java**

SNS Dashboard

Users log in/out

Dashboard for Kay Kasemir

/internal read-only add widgets log out

Daily Energy

Last run started 2011-08-30, previous run started 2011-08-23

Date	Energy per Day MWhr	Total Energy MWhr (3.6 GJ)
08/07	0.0	0.0
08/14	~15.0	~150.0
08/21	~18.0	~270.0
08/28	~12.0	~360.0

SNS Status

As of Thursday, September 01, 2011 15:47:
Manual Beam Switch Turned On
MPS Allows Beam
Continuous Shot Mode
To: Target, MPS: 1 mSec
Power at: 678.2 kW

Logbook

Time	Title
2011-09-01 15:48	Shift
2011-09-01 15:53	
2011-09-01 15:54	
2011-09-01 15:55	
2011-09-01 15:56	
2011-09-01 15:57	
2011-09-01 15:58	
2011-09-01 15:59	
2011-09-01 16:00	
2011-09-01 16:01	
2011-09-01 16:02	
2011-09-01 16:03	
2011-09-01 16:04	
2011-09-01 16:05	
2011-09-01 16:06	
2011-09-01 16:07	
2011-09-01 16:08	
2011-09-01 16:09	
2011-09-01 16:10	
2011-09-01 16:11	
2011-09-01 16:12	
2011-09-01 16:13	
2011-09-01 16:14	
2011-09-01 16:15	
2011-09-01 16:16	
2011-09-01 16:17	
2011-09-01 16:18	
2011-09-01 16:19	
2011-09-01 16:20	
2011-09-01 16:21	
2011-09-01 16:22	
2011-09-01 16:23	
2011-09-01 16:24	
2011-09-01 16:25	
2011-09-01 16:26	
2011-09-01 16:27	
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2011-09-01 16:29	
2011-09-01 16:30	
2011-09-01 16:31	
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2011-09-01 16:34	
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2011-09-01 16:36	
2011-09-01 16:37	
2011-09-01 16:38	
2011-09-01 16:39	
2011-09-01 16:40	
2011-09-01 16:41	
2011-09-01 16:42	
2011-09-01 16:43	
2011-09-01 16:44	
2011-09-01 16:45	
2011-09-01 16:46	
2011-09-01 16:47	
2011-09-01 16:48	
2011-09-01 16:49	
2011-09-01 16:50	
2011-09-01 16:51	
2011-09-01 16:52	
2011-09-01 16:53	
2011-09-01 16:54	
2011-09-01 16:55	
2011-09-01 16:56	
2011-09-01 16:57	
2011-09-01 16:58	
2011-09-01 16:59	
2011-09-01 17:00	
2011-09-01 17:01	
2011-09-01 17:02	
2011-09-01 17:03	
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2011-09-01 17:06	
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2011-09-01 17:12	
2011-09-01 17:13	
2011-09-01 17:14	
2011-09-01 17:15	
2011-09-01 17:16	
2011-09-01 17:17	
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2011-09-01 17:19	
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2011-09-01 17:23	
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2011-09-01 17:57	
2011-09-01 17:58	
2011-09-01 17:59	
2011-09-01 18:00	
2011-09-01 18:01	
2011-09-01 18:02	
2011-09-01 18:03	
2011-09-01 18:04	
2011-09-01 18:05	
2011-09-01 18:06	
2011-09-01 18:07	
2011-09-01 18:08	
2011-09-01 18:09	
2011-09-01 18:10	
2011-09-01 18:11	
2011-09-01 18:12	
2011-09-01 18:13	
2011-09-01 18:14	
2011-09-01 18:15	
2011-09-01 18:16	
2011-09-01 18:17	
2011-09-01 18:18	
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2011-09-01 18:21	
2011-09-01 18:22	
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2011-09-01 18:44	
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2011-09-01 18:46	
2011-09-01 18:47	
2011-09-01 18:48	
2011-09-01 18:49	
2011-09-01 18:50	
2011-09-01 18:51	
2011-09-01 18:52	
2011-09-01 18:53	
2011-09-01 18:54	
2011-09-01 18:55	
2011-09-01 18:56	
2011-09-01 18:57	
2011-09-01 18:58	
2011-09-01 18:59	
2011-09-01 19:00	
2011-09-01 19:01	
2011-09-01 19:02	
2011-09-01 19:03	
2011-09-01 19:04	
2011-09-01 19:05	
2011-09-01 19:06	
2011-09-01 19:07	
2011-09-01 19:08	
2011-09-01 19:09	
2011-09-01 19:10	
2011-09-01 19:11	
2011-09-01 19:12	
2011-09-01 19:13	
2011-09-01 19:14	
2011-09-01 19:15	
2011-09-01 19:16	
2011-09-01 19:17	
2011-09-01 19:18	
2011-09-01 19:19	
2011-09-01 19:20	
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2011-09-01 19:22	
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2011-09-01 19:31	
2011-09-01 19:32	
2011-09-01 19:33	
2011-09-01 19:34	
2011-09-01 19:35	
2011-09-01 19:36	
2011-09-01 19:37	
2011-09-01 19:38	
2011-09-01 19:39	
2011-09-01 19:40	
2011-09-01 19:41	
2011-09-01 19:42	
2011-09-01 19:43	
2011-09-01 19:44	
2011-09-01 19:45	
2011-09-01 19:46	
2011-09-01 19:47	
2011-09-01 19:48	
2011-09-01 19:49	
2011-09-01 19:50	
2011-09-01 19:51	
2011-09-01 19:52	
2011-09-01 19:53	
2011-09-01 19:54	
2011-09-01 19:55	
2011-09-01 19:56	
2011-09-01 19:57	
2011-09-01 19:58	
2011-09-01 19:59	
2011-09-01 20:00	

Can display any process variable, updating as the data changes

Beam Plot

Power and Energy on Target

Machine Mode: Target, Max Power: 721 kW, Energy Today: 9.2 MWhr

Date	Average Power (kW)	Energy MWhr (3.6 GJ)
Aug 31 00:00	0	0
Aug 31 12:00	~650	~10
Sep 01 00:00	~650	~10
Sep 01 12:00	~650	~14

Ring Stripper Foil

2011-09-01 15:53:30

ORNL Traffic

2011-09-01 15:54:12

Availability

Date	Availability Percentage
2011-08-31	92.5%
2011-08-30	100.0%
2011-08-29	100.0%
2011-08-28	99.58%
2011-08-27	95.83%
2011-08-26	99.58%
2011-08-25	96.25%
2011-08-24	93.33%

[Details...](#)

My Target View Screen

2011-09-01 15:53:23

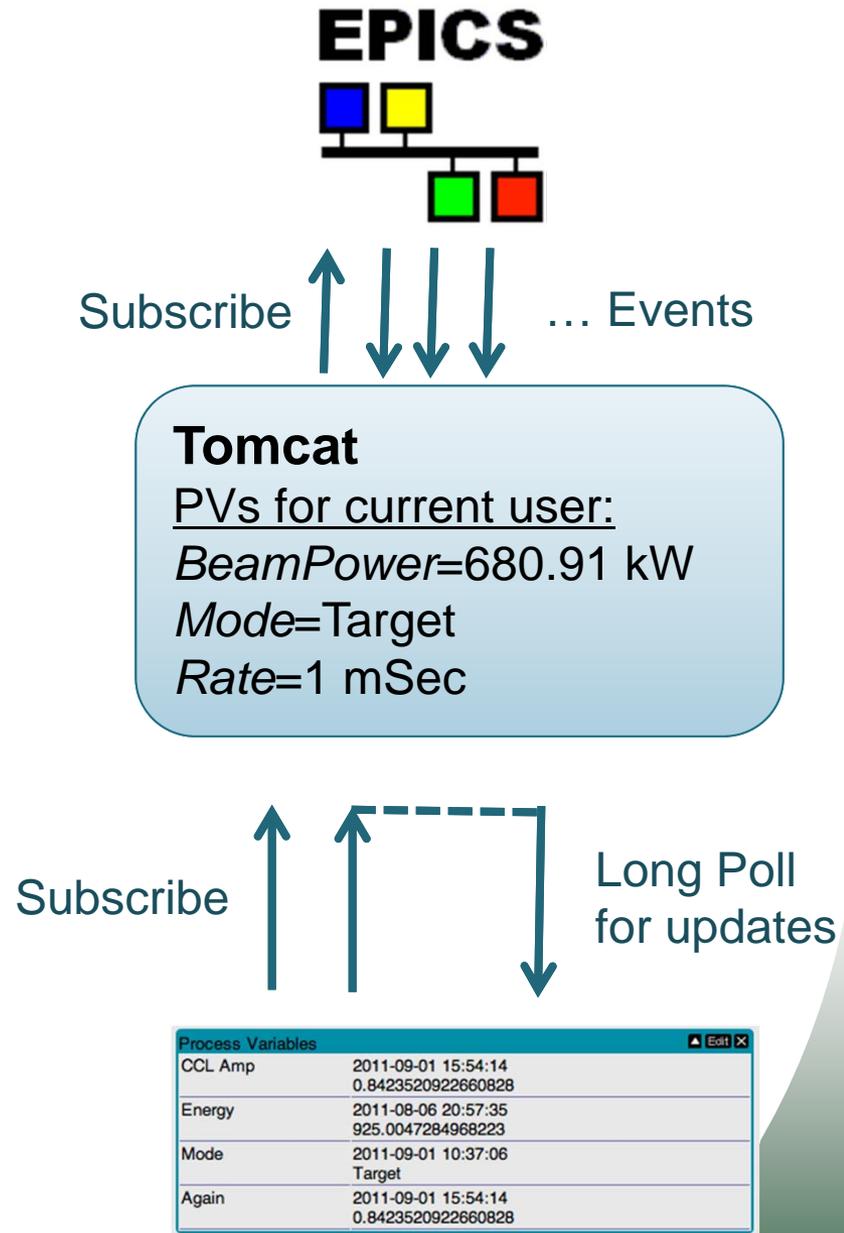
Lava Lamp

Users can add/move/configure widgets as

AK
EDGE
National Laboratory

Dashboard Technology

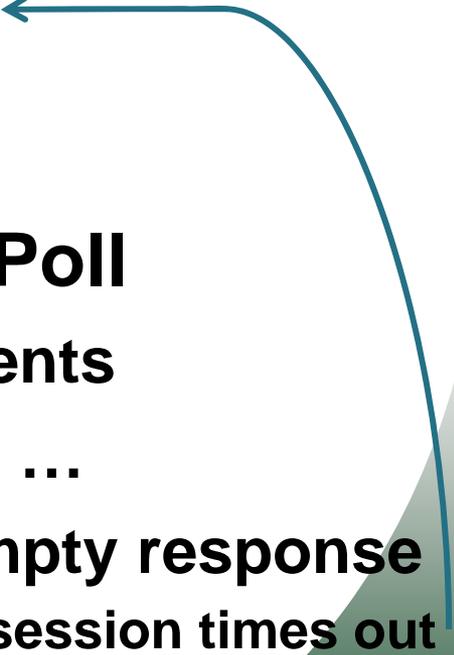
- **JSP (Tomcat)**
 - Loads web page configuration for user from RDB (MySQL)
- **Java Script in Web Browser sends “Subscribe” request for each widget to Web Server**
- **Java Script for web page performs Long Poll for updates**
- **Web Server returns data as it arrives from Control System**



JQuery

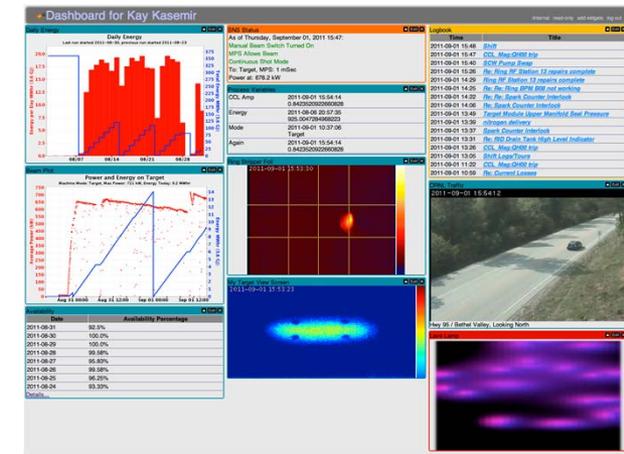
- **Java Script Library**
- **Simplified the code**
 - **Common API across different web browsers**
 - **Web Client DOM manipulation**
 - **Ajax calls**
 - **“Drag” widgets inside web browser to arrange them**
 - **Graphical gimmicks**

Dashboard Details

- **Web Clients will subscribe**
 - Web Server subscribes to Control System PVs...
 - **but they don't cleanly unsubscribe**
 - Web Server's PV pool would grow...
 - Use time outs to delete client resources
 - **Servlet "GetUpdates" called in Long Poll**
 - Returns right away with accumulated events
 - Otherwise waits a second, checks again, ...
 - .. for up to 10 seconds, then returning empty response
 - If waiting much longer, the server/client web session times out
- 

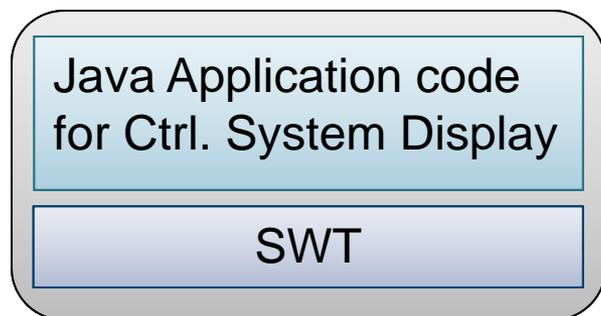
Dashboard Summary

- ✓ Works on every web browser
- ✓ Faster updates than Status Web
 - Updates to cell phones can be intermittent
- ✓ Users can create their own page
 - Picking from the list of available widgets
- Higher CPU and Network load
 - A lot more Java Script, always in Long Poll
- Distributed Java on Server, JavaScript/DOM in web browser hard to debug



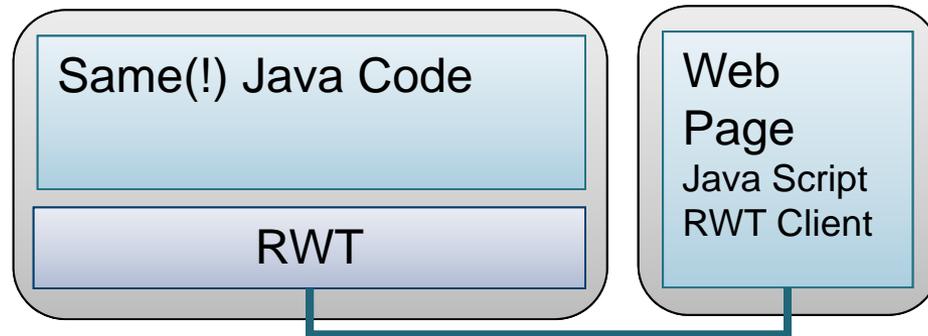
Solution 4: Eclipse RAP, the Theory

Eclipse RCP (Rich Client Platform)



Standalone
Application for
Windows,
Linux, OS X

Eclipse RAP (Rich Ajax Platform)



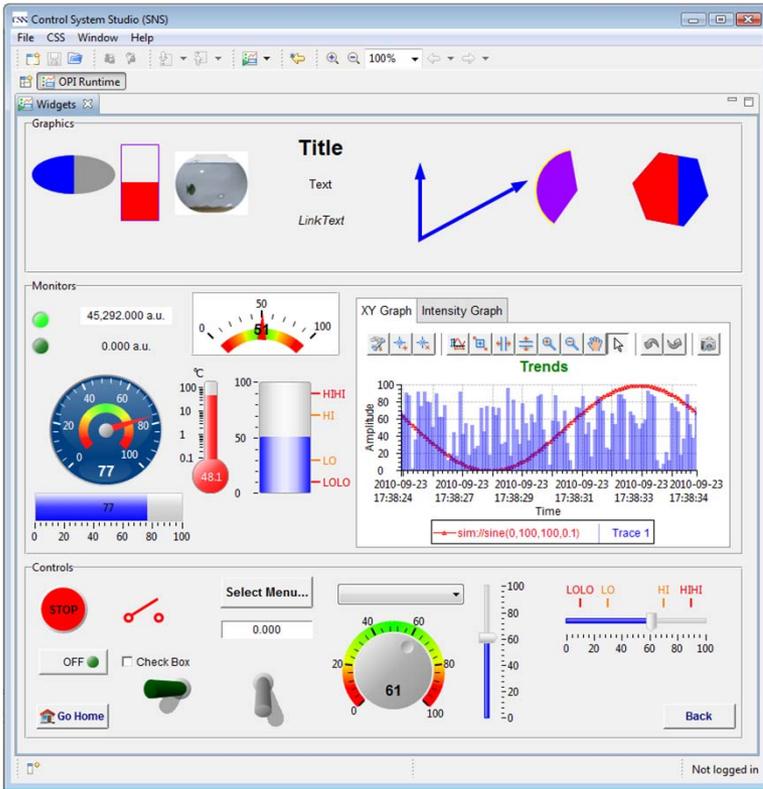
Web App,
installed in e.g.
Tomcat

Web Browser
(via HTTP)

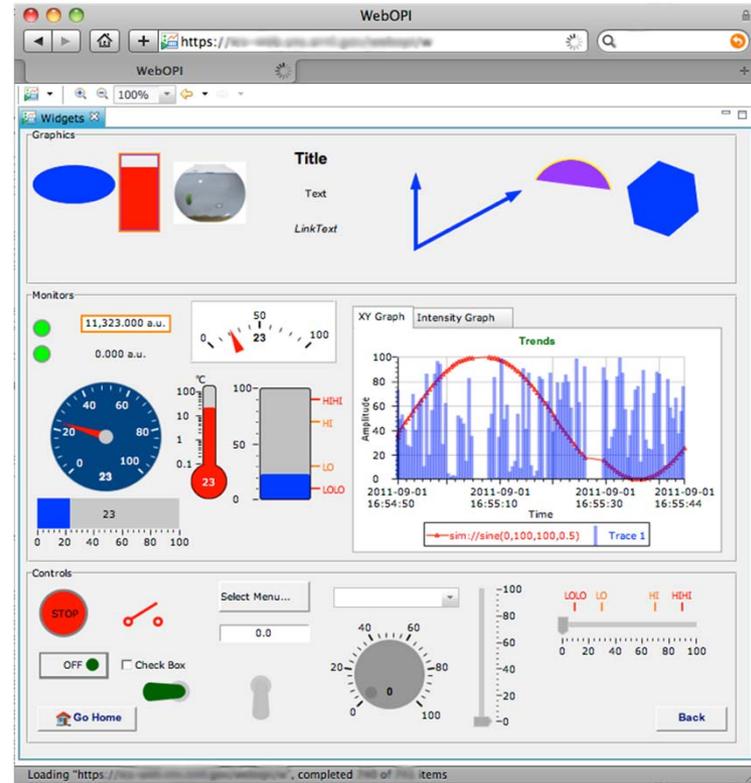
- **RWT library has (almost) same API as SWT**
- **Instead of creating widgets on local display, it sends information to web browser**
 - **Updates via Long Poll, but handled by RAP/RWT**

Eclipse RAP in Practice

CSS 'BOY'



WebOPI



WebOPI Details

Started with CSS ‘BOY’ code.

Differences:

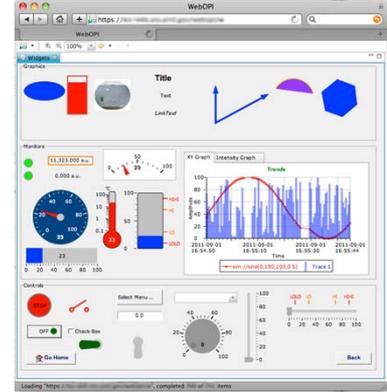
- SWT directly updates local display
- ‘Advances’ graphics (Gradients, ...)
- One (local) display
- RWT queues JavaScript for Long Poll
- ‘Normal’ graphics
- Many (virtual) displays (one per web client)

Main impact on code, otherwise “single source”



WebOPI Summary

- ✓ Allows us to leverage both existing CSS BOY code and display files
- ✓ Users can create any type of display they want and see it on the web
- ✓ Works with many web browsers
- ✓ Don't have to deal with HTML, JavaScript code
- Relies on pre-release versions of RAP code
- CPU and network use naturally higher, because it has to use Long Poll and JavaScript instead of direct display updates



Summary

- **Users want web access to the control system**
 - But HTTP is meant for request/response, not subscription to events
- **Web pages with Ajax**
 - Easy on resources, very portable, but not very dynamic
- **Long Poll, a lot more JavaScript**
 - Needs more CPU, harder to implement, but more dynamic
- **Eclipse RAP**
 - Needs even more resources, but fully dynamic
 - Re-use existing Java code, no worries about details of JavaScript

