



Software Architecture for FRIB Diagnostics

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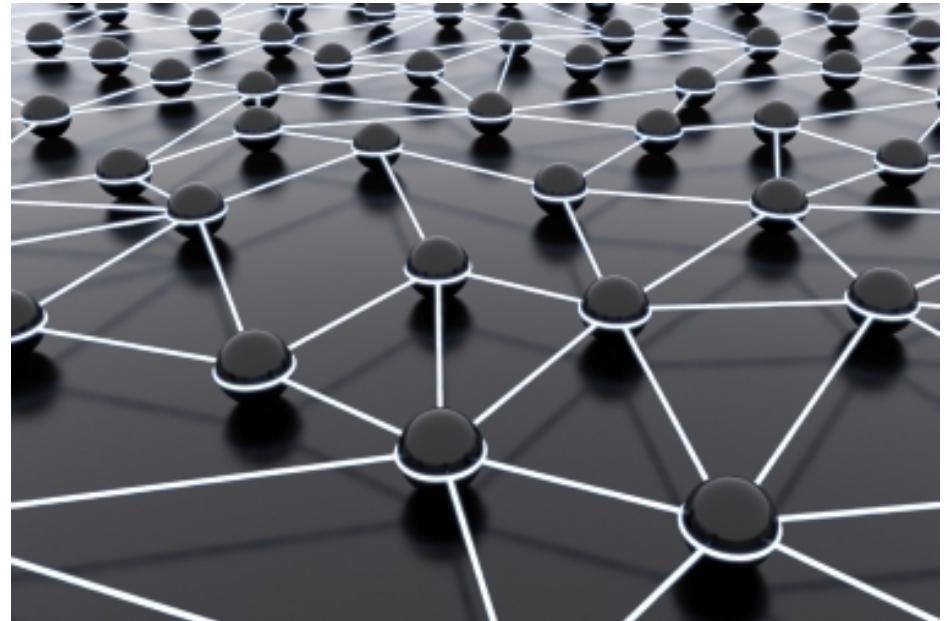


U.S. DEPARTMENT OF
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Office of
Science

Outline

- Introduction
- Service-Oriented Architecture
- Java Server Faces (JSF)
- ADF Faces Capabilities
- Application Development
- EPICS Connectivity
- Conclusion



Introduction

Goals and Objectives

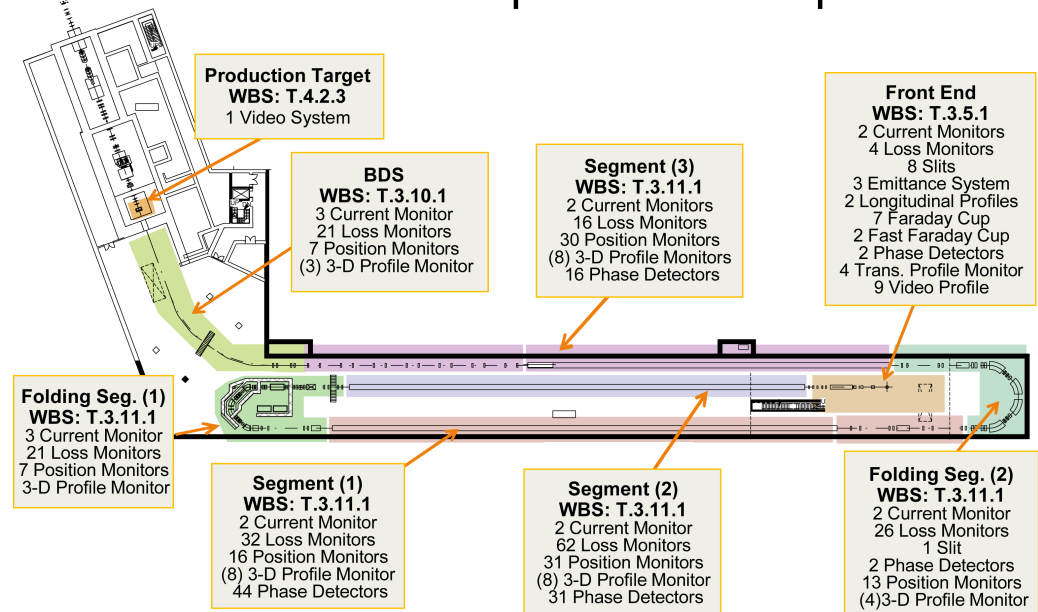
- 1) Provide beam instrumentation data to support Physics, Commissioning, and Operations
- 2) Maintain supervisory layer access to critical diagnostics devices
- 3) Provide processed data to all users and data loggers

Overview of FRIB

- Nuclear science user facility that utilizes a sc heavy-ion linac to achieve multiple charge state acceleration of 200 MeV/u ions to produce isotopes.

» Devices and Systems

- Emittance scanner
- Beam Current Monitor (BCM)
- Beam Position Monitor (BPM)
- Beam Loss Monitor (BLM)
- 3-D Profile Monitor
- Transverse Profile Monitor
- Video Profile
- Fast Faraday Cup



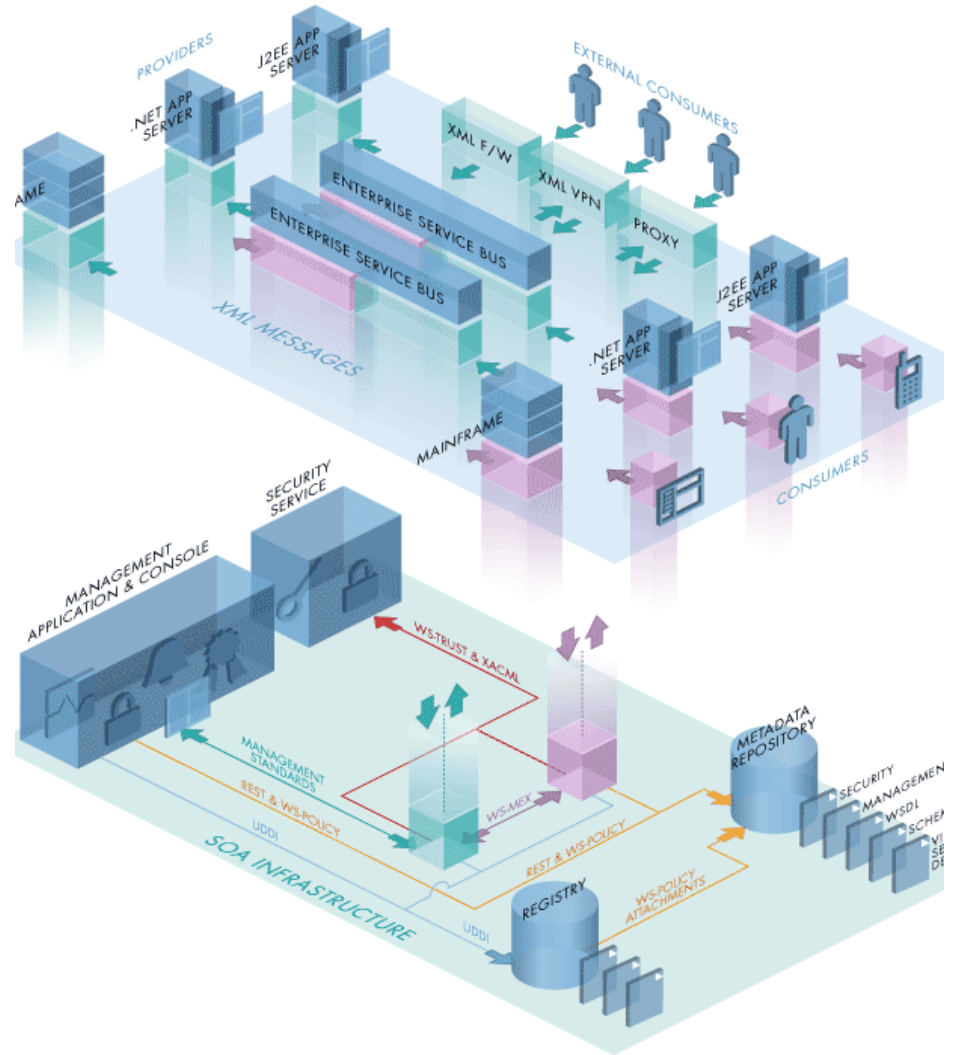
Introduction

- Fall 2010 – Investigated Java Enterprise Edition (EE) platform to identify methods for rapid application development
- Java EE platform provides for development of scalable, reliable, secure enterprise applications within a service oriented architecture
- Identified Java Server Faces (JSF) as the user-interface technology
- Applications Prototyped and Motivation
 - Diagnostics : Advanced applications for remote testing, calibration, and monitoring of devices
 - Physics: Capability to browse the accelerator lattice and export beamline component tables for beam physics studies
 - Commissioning: Configuration application with beamline segment views of device parameters and an intuitive user-interface

Service-Oriented Architecture & Java Server Faces

Service-Oriented Architecture

- Distributed systems require implementation of a Service-Oriented Architecture (SOA)
- Architecture allows building a collection of reusable services
- SOA provides integration for applications across systems
- Ensures robustness, scalability, and performance
- Rapid application development



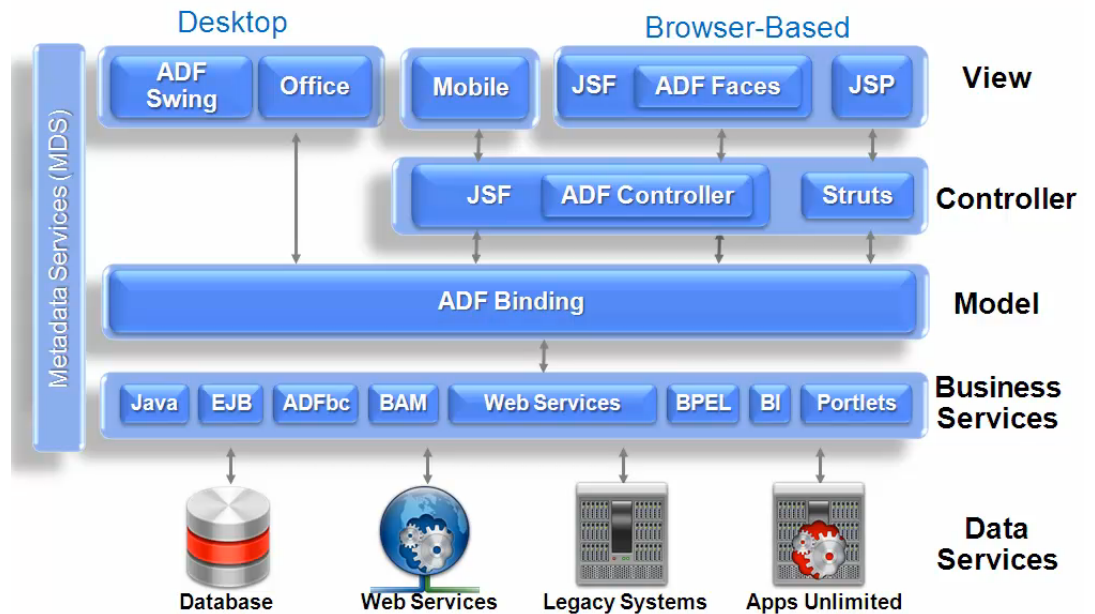
SOA Application Framework

Application Framework

- Java EE 6 web services
- Application messaging
- Relational database
- Model-View-Controller (MVC)
 - » View: graphical user interface
 - » Model: service layer

Building SOA Applications

- Develop Java services
- Create service communication
 - » Messaging, data transformation, and message routing
- Secure services
- Optimize services
- Build graphical user-interface



<http://www.oracle.com/technetwork/developer-tools/adf/>

Java Server Faces

■ Introduction to JSF

- Component framework that enables Java EE developers to create and deploy server-based rich internet applications (RIAs)
- Versions
 - » JSF 1.0 (2004) – Initial Specification
 - » JSF 1.2 (2006) – Included in Java EE5
 - » JSF 2.0 (2009) – Enhanced functionality with Java EE 6
- JSF with built-in Asynchronous Java and XML (AJAX)
 - » JBoss RichFaces 4.0 - <http://www.jboss.org/richfaces/>
 - » ICEfaces EE 2.0 - <http://www.icefaces.org/main/home/>
 - » **Oracle ADF Faces** - <http://www.oracle.com/technetwork/developer-tools/adf/>
 - » Apache MyFaces - <http://myfaces.apache.org/>

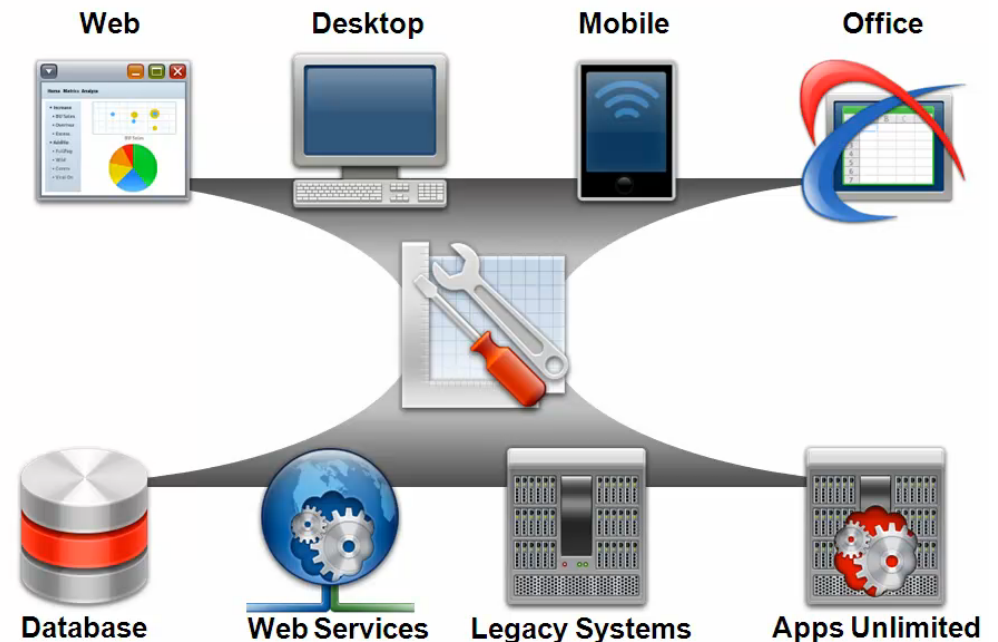
■ Advantages

- Pure Java applications
- Pure thin-client model
- Applets and browser plugins are not required
- Java EE development standard
- JavaScript development is not required

ADF Faces Capabilities

ADF Faces Capabilities [1]

- JSF is the Java EE standard MVC framework
- Support for web, desktop, and mobile devices
- Oracle ADF provides extended capabilities
 - ADF Faces – feature rich JSF components for dynamic UI
 - ADF Controller – extended controller with reusable task flows
 - ADF Binding – simplified binding of view and controller to services

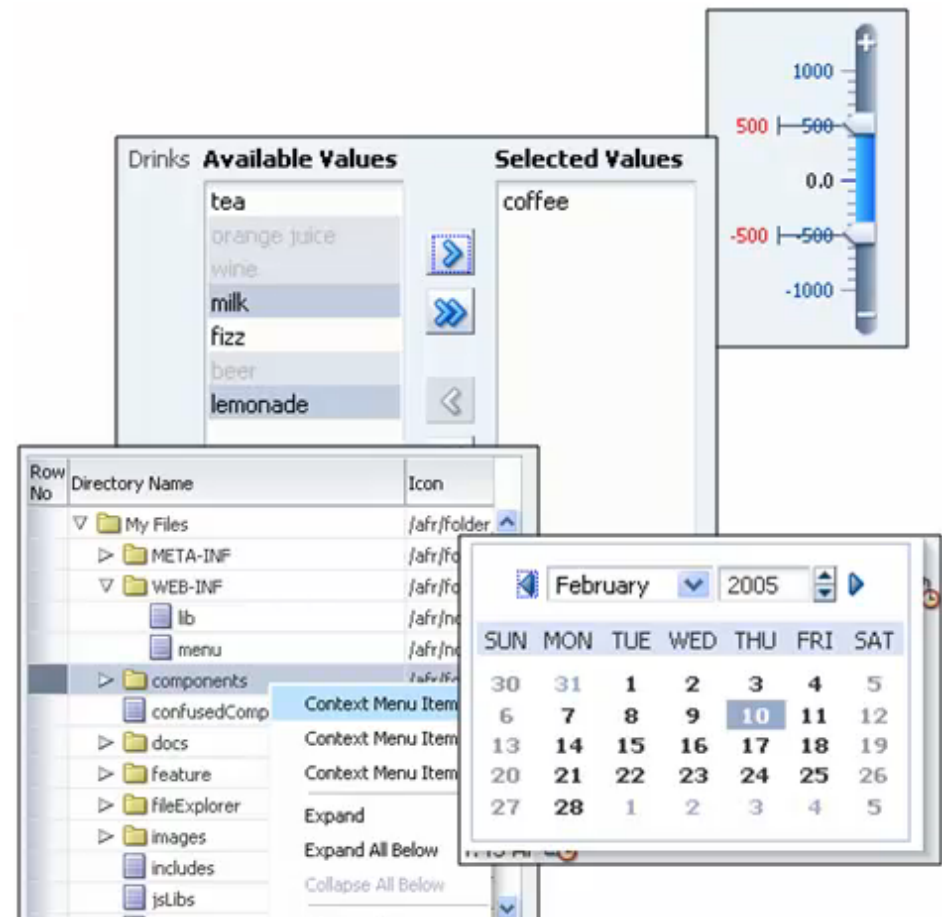


<http://www.oracle.com/technetwork/developer-tools/adf/>

ADF Faces Capabilities [2]

■ ADF Faces Rich Components

- Currently over 150 JSF components
- Components are AJAX enabled
- Provide pluggable look and feel
- Accessibility & internationalization
- In addition to standard components:
 - » Gantt chart, Geographical map, pivot tables, calendars, gauges
- Built-in advanced functionality:
 - » Drag and drop framework
 - » Dialog and pop-up framework
 - » Active Data displays (push updates)
 - » Page Templates

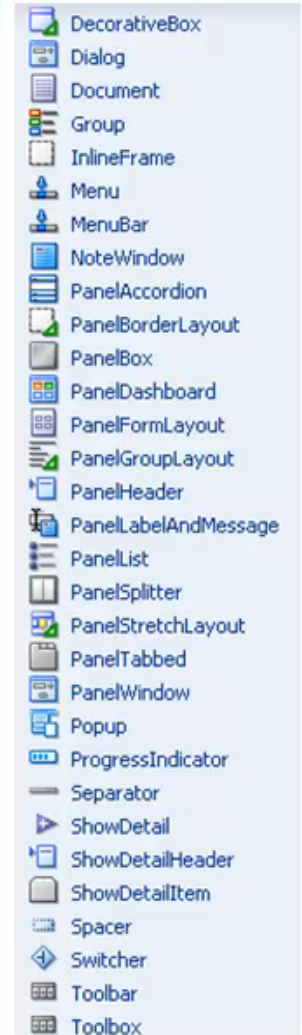


<http://www.oracle.com/technetwork/developer-tools/adf/>

ADF Faces Capabilities [3]

Layout Components

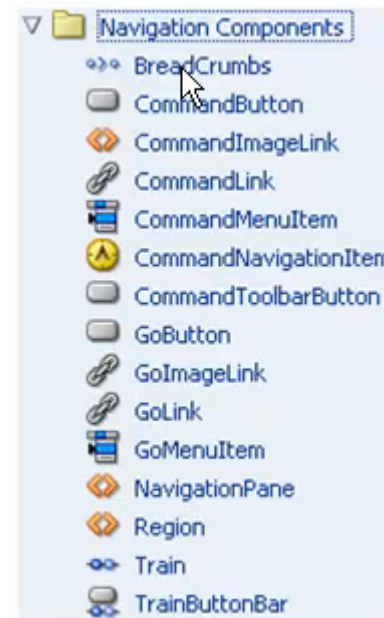
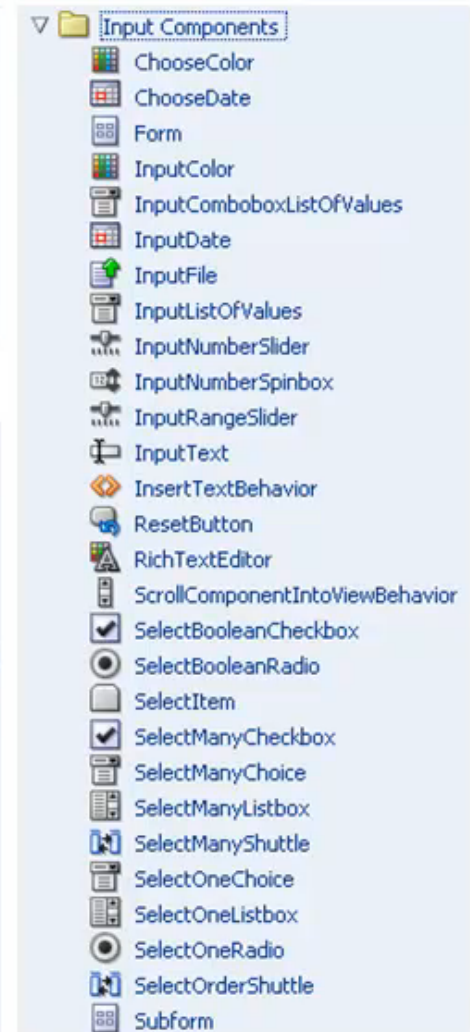
- Page arrangement using areas to provide advanced layouts
- Relative positioning
- Layout can be updated at runtime
- Define layout of child components
- Advanced components
 - » Decorative Box
 - » Panel Collection
 - » Panel Splitter
 - » Panel Accordion
 - » Navigation Pane
 - » Panel Group Layout
 - » Panel Tabbed



ADF Faces Capabilities [4]

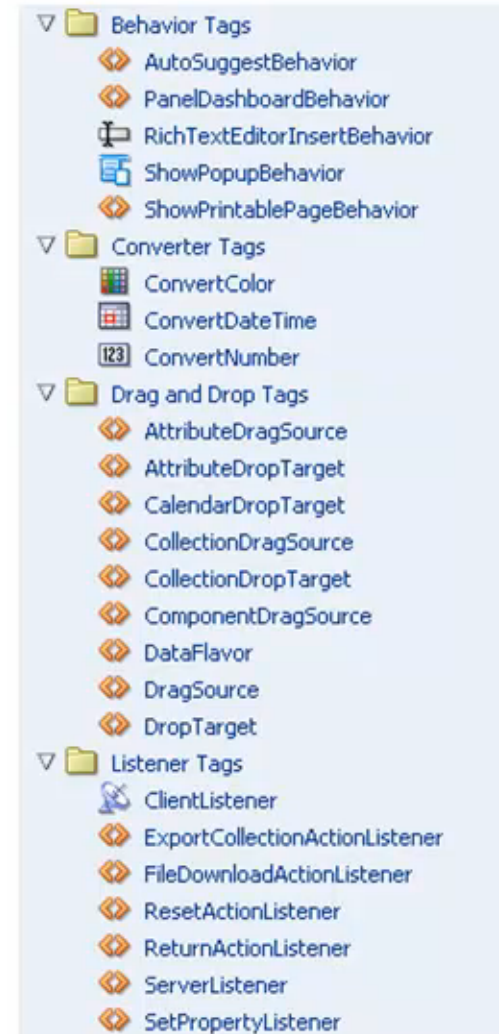
Common Components

- Display/update information
- Input components
 - » Rich Text Editor
 - » Select many List box
- Output components
 - » Output Formatted
 - » Messages
- Dynamic components (push)
- Navigation components
- Query components – search
- Table components – collections



ADF Faces Capabilities [5]

- Operation Components
 - Add functionality and behavior to existing components
 - Drag-and-drop capabilities
 - Client listener capabilities
 - Validation capabilities
 - Data exporting and printing
 - Implement advanced behaviors
 - » Collection Drag Source
 - » Collection Drop Target
 - » Convert Date Time
 - » Show Popup Behavior
 - » Auto Suggest Behavior



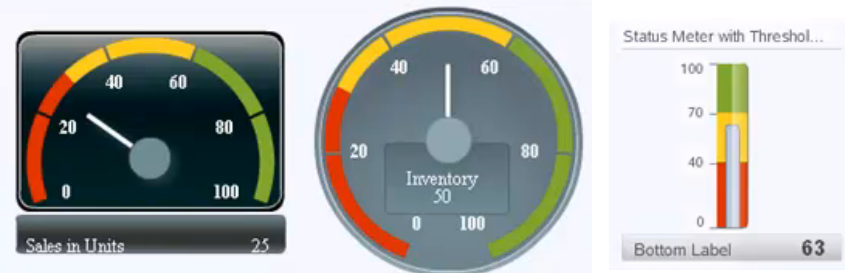
ADF Faces Capabilities [6]

■ ADF Data Visualization Graphs

- More than 50 types of graphs
- Rendering via Flash or PNG
- Interactive features:
 - » Zoom in/out
 - » Scroll
 - » Time selection
 - » Line and legend highlighting/fading
 - » Dynamic reference lines and areas
 - » Animation

■ ADF Gauges

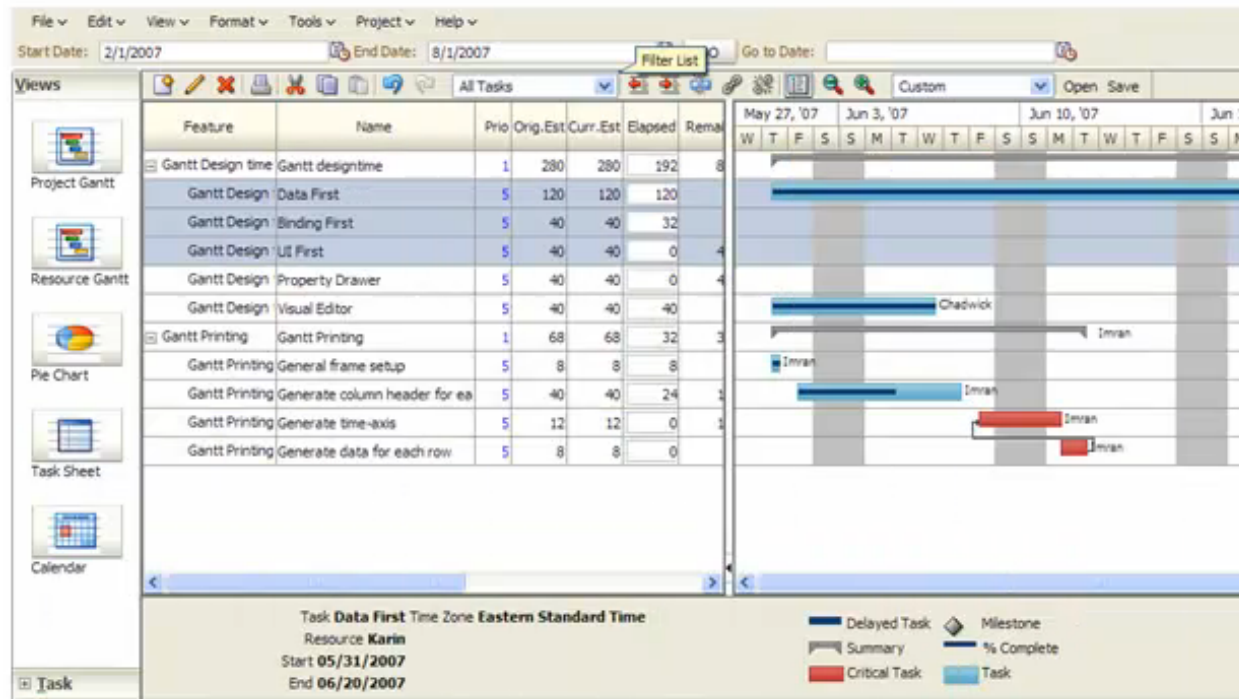
- Status Meter: standard and threshold
- Dial Meter: standards and threshold
- LED: arrow, dot, and triangle



ADF Faces Capabilities [7]

■ Gantt Chart

- Track tasks and resources on a time schedule
- Types: project, scheduling, resources



<http://www.oracle.com/technetwork/developer-tools/adf/>

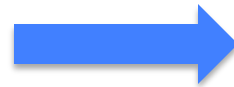
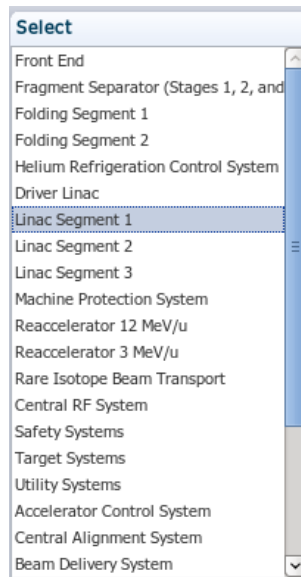
ADF Faces Capabilities [8]

Partial Page Rendering (PPR)

- Enables redrawing only a portion of a page
- Can be enabled declaratively or programmatically

Triggering component:

- » Id = "sysssel"
- » Autosubmit = "true"



Target Component:

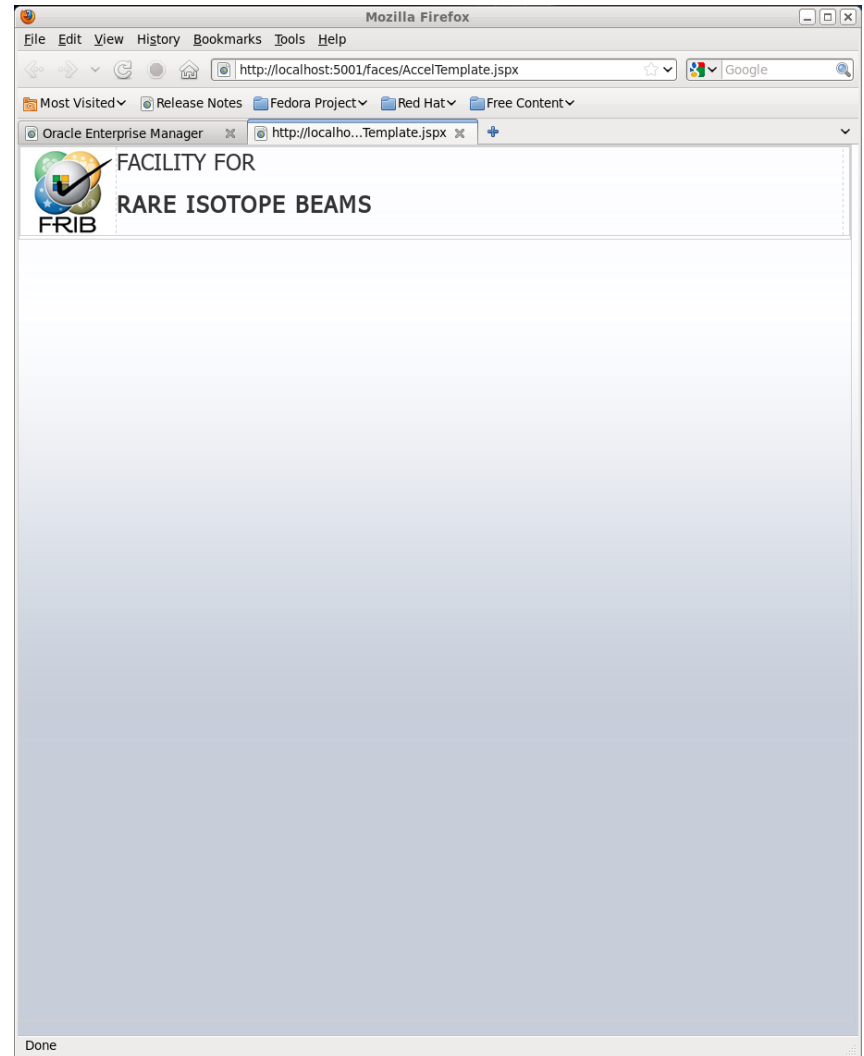
- » partialTriggers = "sysssel"

dvcId	dvcInst	dvcTypeDesc	dvcTypeId	subsysNm
LS1_DIAG:BPM_D1121	1,121	Beam Position Monitor	BPM	Diagnostics
LS1_DIAG:PM_D1121	1,121	Beam Profile Monitor (othe PM		Diagnostics
LS1_DIAG:BCM_D1122	1,122	Beam Current Monitor	BCM	Diagnostics
LS1_DIAG:BPM_D1154	1,154	Beam Position Monitor	BPM	Diagnostics
LS1_DIAG:PM_D1155	1,155	Beam Profile Monitor (othe PM		Diagnostics
LS1_DIAG:PORT_D1156	1,156	Port (e.g. for diagnostics)	PORT	Diagnostics
LS1_DIAG:BPM_D1187	1,187	Beam Position Monitor	BPM	Diagnostics
LS1_DIAG:PM_D1188	1,188	Beam Profile Monitor (othe PM		Diagnostics
LS1_DIAG:PORT_D1189	1,189	Port (e.g. for diagnostics)	PORT	Diagnostics
LS1_DIAG:BPM_D1220	1,220	Beam Position Monitor	BPM	Diagnostics

ADF Faces Capabilities [9]

■ Page Templates

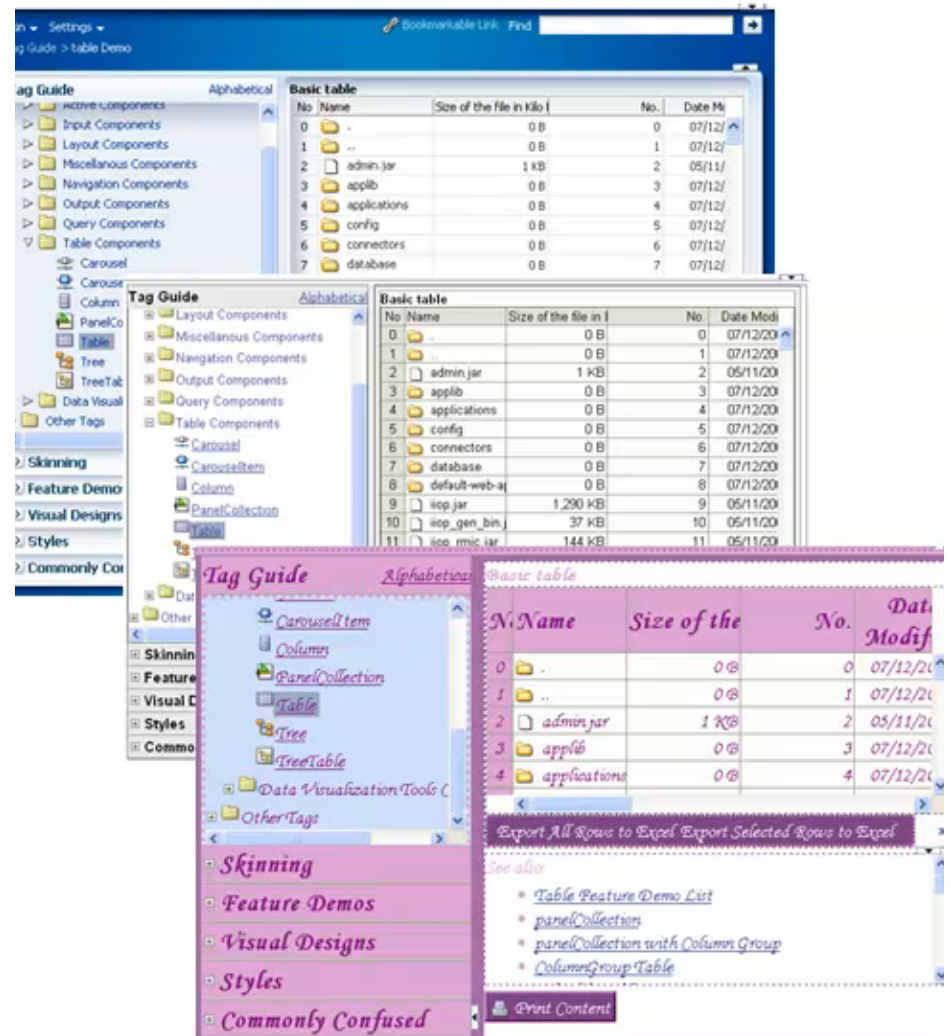
- Reusable ADF Faces page that contains place holders for custom page content
- Templates are interpreted at runtime
- Authors can change the template for an existing application without opening the application itself
- Templates may accept parameters for passing information from the inheriting page to the template



ADF Faces Capabilities [10]

■ Summary

- ADF Faces provides for rapid development of rich web user interfaces
- Easy page layout
- Advanced user interaction
- Rich dynamic data visualization
- Visual and declarative development



Application Development & EPICS Connectivity

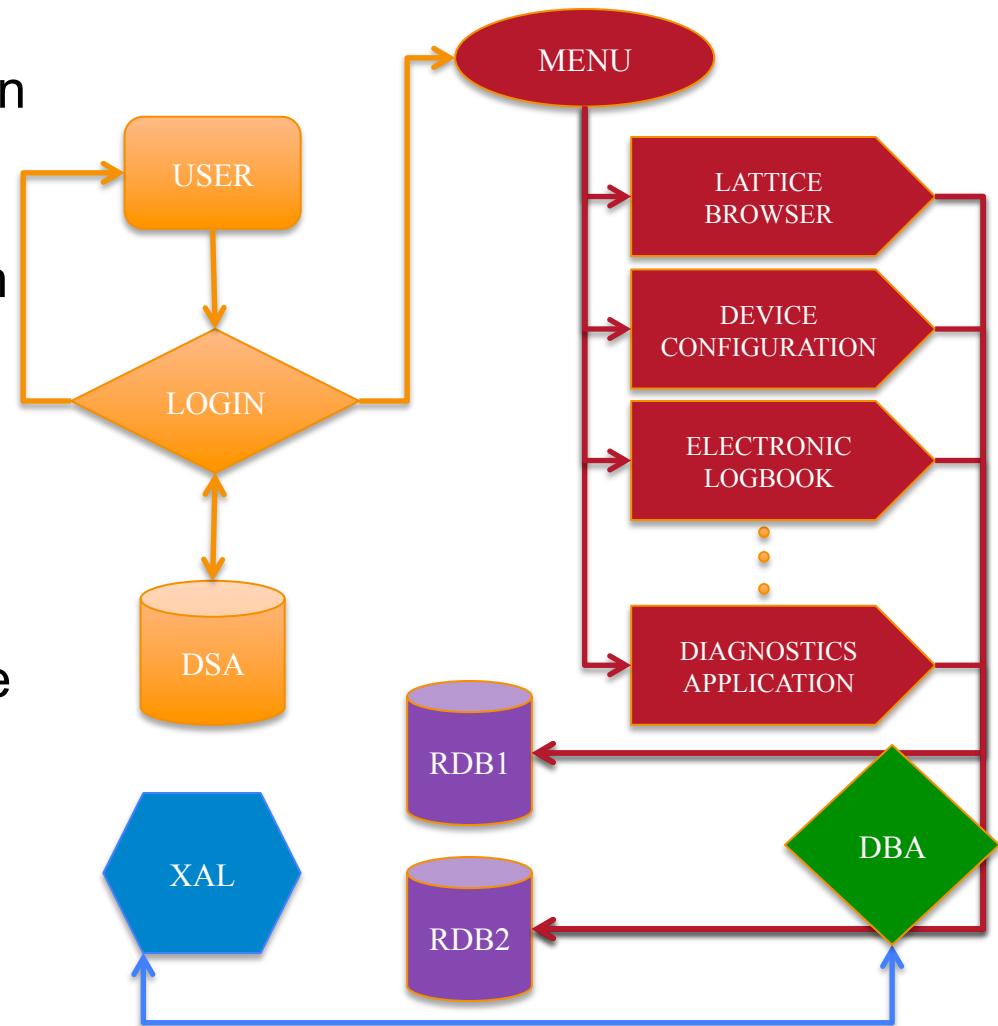
Application Development [1]

Database Driven Applications

- Leverage existing database design
- Build an application framework
- Java programming infrastructure
- Common application configuration

Application Development

- User single sign-on (security)
- Main application menu
- Application server for deployment
- Each application runs as a service
- Applications access distributed resources



Application Development [3]

■ Main Menu

- Select from available applications

■ Device Configuration

- Select a beamline sub-device by system or subsystem
- Select a signal record for a specified device
- Configure signals and related devices:
 - » Signal fields
 - » Signal records
 - » IOCs
 - » Power supplies
 - » BPM
 - » Port assignment

The image displays two screenshots of the Accelerator Enterprise Suite web application. The left screenshot shows the main menu with a 3D facility diagram and application tiles for 'Lattice Browser' and 'Device Configuration'. The right screenshot shows the 'Device Configuration' interface with a tree view of beamline components, a list of device/signal entries, and detailed configuration fields for a selected signal record.

Application Development [4]

■ Lattice Browser

- Browse/configure beamline devices (BPMs, PMs, etc.)
- Built-in nested search and sort
- Query by system or subsystem
- Legend for naming convention
- Devices managed
 - » Profile monitor
 - » IOCs
 - » Power supplies
 - » BPMs
 - » BLMs

The screenshot displays the Lattice Browser application in Mozilla Firefox. The browser window shows the URL `http://127.0.0.1:7101/AccelConfigSuite-ViewController-context-root`. The application interface includes a header for the 'FACILITY FOR RARE ISOTOPE BEAMS' and a navigation menu with 'System', 'Subsystem', 'Sequence', and 'Symbols' tabs. A 'FRIB Ideogram Legend' is visible, showing various beamline components like Solenoids, Dipoles, Quadrupoles, and BPMs. A table of beamline devices is shown, with columns for 'dvcId', 'dvcInst', 'dvcTypeDesc', 'dvcTypeId', and 'subsysNm'. A detailed view of a device is shown at the bottom, with fields for 'dvcId', 'dvcInst', 'dvcTypeDesc', 'dvcTypeId', 'subsysNm', 'subsysId', 'sysNm', 'sysId', 'actDvcId', 'blDvcId', 'critId', 'dvcIdAlias', 'invalidId', 'mpsDvcId', and 'virtualDvcId'.

dvcId	dvcInst	dvcTypeDesc	dvcTypeId	subsysNm
FE_SRC1:ELCT_D0702	0702	Electrode	ELCT	Ion source; n is the ion source number
FE_SRC1:SOLR_D0710	0710	Solenoid (beam line Room temperature solenoid)	SOLR	Ion source; n is the ion source number
FE_SCS1:DH_D0725	0725	Dipole magnet, Horizontal	DH	Source Charge state Selection system
FE_SCS1:QVE_D0733	0733	Quadrupole, vertical, electrostatic	QVE	Source Charge state Selection system
FE_SCS1:QHE_D0738	0738	Quadrupole, horizontal, electrostatic	QHE	Source Charge state Selection system
FE_SCS1:QVE_D0744	0744	Quadrupole, vertical, electrostatic	QVE	Source Charge state Selection system
FE_SCS1:CLLM_D0747	0747	Collimator	CLLM	Source Charge state Selection system
FE_SCS1:QVE_D0750	0750	Quadrupole, vertical, electrostatic	QVE	Source Charge state Selection system
FE_SCS1:QHE_D0756	0756	Quadrupole, horizontal, electrostatic	QHE	Source Charge state Selection system

Beamline Device: **Magnet** | **IOC** | **Power Supply** | **BPM** | **RF** | **Location**

Beamline Device: FE_SCS1:QHE_D0738
 dvcInst: 0738
 dvcTypeDesc: Quadrupole, horizontal, electrostatic
 dvcTypeId: QHE
 subsysNm: Source Charge state Selection system; n is the branch number, corresponding to the ion source number
 subsysId: SCS1
 sysNm: Front End
 sysId: FE
 actDvcId: 0
 blDvcId: Y
 critId: High
 dvcIdAlias:
 invalidId: N
 mpsDvcId: N
 virtualDvcId: N

Application Development [5]

Multiple Views

- Expanded view:
Allows selection of system/subsystem and easy browsing
- Detached view:
Provides quick access to search functionality over large systems

The screenshot displays the Accelerator Configuration Suite (AccelConfigSuite) application in Mozilla Firefox. The application is titled "FACILITY FOR RARE ISOTOPE BEAMS FRIB". It shows two views: an "Expanded view" on the left and a "Detached view" on the right.

The "Expanded view" shows a tree structure of subsystems under the "Subsystem" tab. The tree includes:

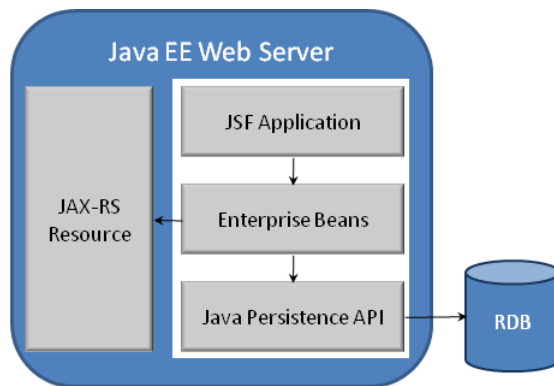
- Front End
- Fragment Separator (Stages 1, 2, and 3)
- Folding Segment 1
- Folding Segment 2
- Helium Refrigeration Control System
- Driver Linac
- Linac Segment 1
- Linac Segment 2
- Linac Segment 3
- Machine Protection System
- Reaccelerator 12 MeV/u
- Reaccelerator 3 MeV/u
- Rare Isotope Beam Transport
- Central RF System
- Safety Systems
- Target Systems
- Utility Systems
- Accelerator Control System
- Central Alignment System
- Beam Delivery System

The "Detached view" shows a table of diagnostic components. The table has the following columns: dvcId, dvcInst, dvcTypeDesc, dvcTypeId, subSysNm, subSysId, and sysNm. The table lists various diagnostic components such as Beam Position Monitors (BPM), Beam Profile Monitors (PM), Beam Current Monitors (BCM), and Ports.

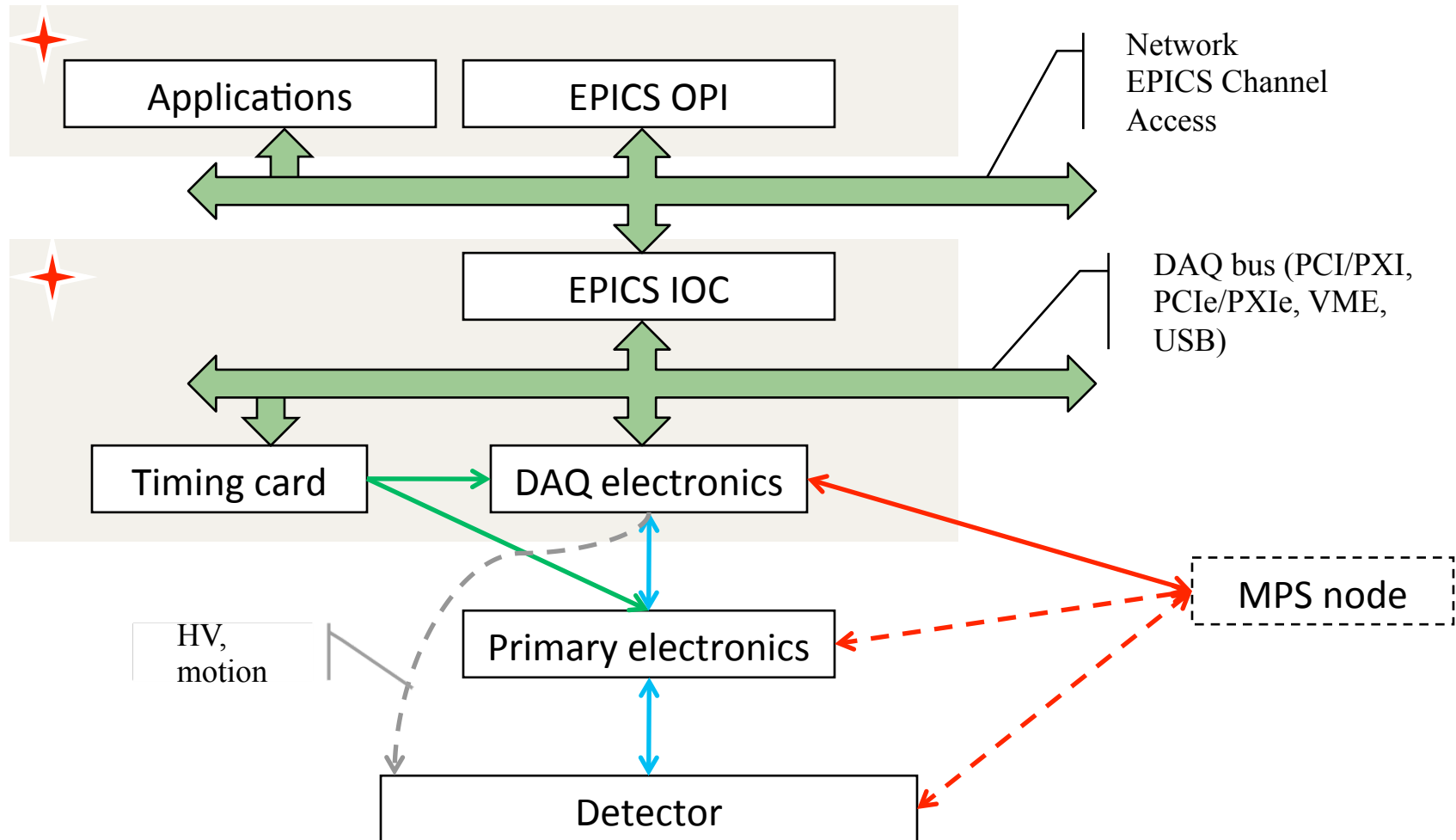
dvcId	dvcInst	dvcTypeDesc	dvcTypeId	subSysNm	subSysId	sysNm
LS1_DIAG:BPM_D1121	1,121	Beam Position Monitor	BPM	Diagnostics	DIAG	Linac Segment 1
LS1_DIAG:PM_D1121	1,121	Beam Profile Monitor (othe PM)		Diagnostics	DIAG	Linac Segment 1
LS1_DIAG:BCM_D1122	1,122	Beam Current Monitor	BCM	Diagnostics	DIAG	Linac Segment 1
LS1_DIAG:BPM_D1154	1,154	Beam Position Monitor	BPM	Diagnostics	DIAG	Linac Segment 1
LS1_DIAG:PM_D1155	1,155	Beam Profile Monitor (othe PM)		Diagnostics	DIAG	Linac Segment 1
LS1_DIAG:PORT_D1156	1,156	Port (e.g. for diagnostics)	PORT	Diagnostics	DIAG	Linac Segment 1
LS1_DIAG:BPM_D1187	1,187	Beam Position Monitor	BPM	Diagnostics	DIAG	Linac Segment 1
LS1_DIAG:PM_D1188	1,188	Beam Profile Monitor (othe PM)		Diagnostics	DIAG	Linac Segment 1
LS1_DIAG:PORT_D1189	1,189	Port (e.g. for diagnostics)	PORT	Diagnostics	DIAG	Linac Segment 1
LS1_DIAG:BPM_D1220	1,220	Beam Position Monitor	BPM	Diagnostics	DIAG	Linac Segment 1
LS1_DIAG:PM_D1221	1,221	Beam Profile Monitor (othe PM)		Diagnostics	DIAG	Linac Segment 1
LS1_DIAG:PORT_D1222	1,222	Port (e.g. for diagnostics)	PORT	Diagnostics	DIAG	Linac Segment 1
LS1_DIAG:BPM_D1281	1,281	Beam Position Monitor	BPM	Diagnostics	DIAG	Linac Segment 1
LS1_DIAG:PM_D1282	1,282	Beam Profile Monitor (othe PM)		Diagnostics	DIAG	Linac Segment 1
LS1_DIAG:PORT_D1282	1,282	Port (e.g. for diagnostics)	PORT	Diagnostics	DIAG	Linac Segment 1
LS1_DIAG:BPM_D1341	1,341	Beam Position Monitor	BPM	Diagnostics	DIAG	Linac Segment 1
LS1_DIAG:PORT_D1342	1,342	Port (e.g. for diagnostics)	PORT	Diagnostics	DIAG	Linac Segment 1
LS1_DIAG:PORT_D1343	1,343	Port (e.g. for diagnostics)	PORT	Diagnostics	DIAG	Linac Segment 1
LS1_DIAG:BPM_D1402	1,402	Beam Position Monitor	BPM	Diagnostics	DIAG	Linac Segment 1
LS1_DIAG:PORT_D1403	1,403	Port (e.g. for diagnostics)	PORT	Diagnostics	DIAG	Linac Segment 1
LS1_DIAG:BPM_D1462	1,462	Beam Position Monitor	BPM	Diagnostics	DIAG	Linac Segment 1
LS1_DIAG:PORT_D1463	1,463	Port (e.g. for diagnostics)	PORT	Diagnostics	DIAG	Linac Segment 1

Application Development [6]

- **Advanced Development**
 - Java EE application with JSF GUI
 - Integrated Data Visualization
 - Built-in device search and sort
 - Device calibration panels
 - Online device monitoring
 - Remote device testing



EPICS Connectivity [1]



EPICS Connectivity [2]

Basic requirements for building a JSF application

- Java Server Faces 2.1 – Download Components
- Data Visualization Tools (DVT)
- Flexible Integrated Development Environment (IDE)
 - » Eclipse Helios
 - » NetBeans 7
 - » JDeveloper 11g
- Data Service
- Java Channel Access (JCA)



Data Acquisition

- Fast Digital Acquisition (DAQ) bus
- Modular form factor preferable
- Extensive choice of DAQ cards
- DAQ card drivers readily available
- Unified software interface for DAQ cards

Conclusion

- JSF technology is the standard for Java EE web user-interfaces
- Open source and commercial AJAX enabled component frameworks are available
- EPICS connectivity via Data Service and JCA
- Extremely rapid prototyping of JSF applications
- Imagine the Possibilities...

