The JavaFX Accessibility API

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Program Agenda

1. Introduction / Overview
2. Fundamentals of Accessibility
3. Advanced Accessibility API
4. Making Your Code Accessible
5. Summary

What does it mean to be Accessible?

Accessibility is the degree to which a product, device, service, or environment is available to as many people as possible. Accessibility can be viewed as the "ability to access" and benefit from some system or entity. (*)

(*) http://en.wikipedia.org/wiki/Accessibility

Accessible Software

- Accessible software aims to address :
  - Visual Impairments (*)
  - Auditory Impairments
  - Motor/Mobility Issues
  - Seizures
  - Cognitive/Intellectual Impairments
- Assistive technologies are often built into the operating system
  - Screen readers (*), high contrast themes (*), zoom capability etc.

Screen Readers

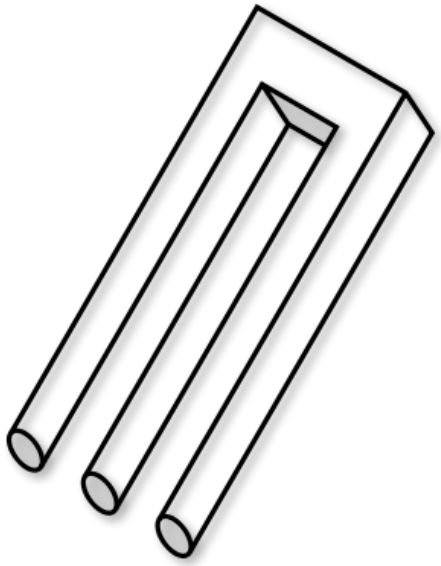
- Speak the contents of a control
- Provide their own concept of focus and traversal
  - Independent (but related to) normal focus and traversal
- Interact with programs using platform specific keys
- Examples:
  - VoiceOver, from Apple, for the Mac
  - Narrator, from Microsoft, for Windows
  - JAWS, from Freedom Scientific, for Windows

Accessibility and JavaFX

- Accessibility API came late to JavaFX
  - Focus of the team was on implementing the controls
  - There was a lot of engineering turn over on the team
  - Prototypes were started but none were completed
- Windows accessibility API was incomplete (until UIA)
  - Non-native solutions such as IA2 available (augments MSAA API)
  - Microsoft UIA only became available with Windows 7

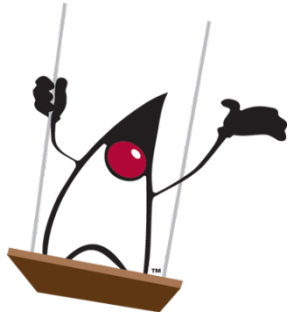
Why is Accessibility hard to implement?

- Requires a common portable JavaFX API
- Must support many different kinds of controls
  - Many different controls causes explosion of API and concepts
- Lots of different platform specific native code
  - Lack of documentation and native code examples
  - Need to determine behavior by experimentation
- Implementation cross cuts different layers in the JavaFX
  - Implementers needs to be familiar with Glass, Controls, Skins …



Other Accessibility Implementations

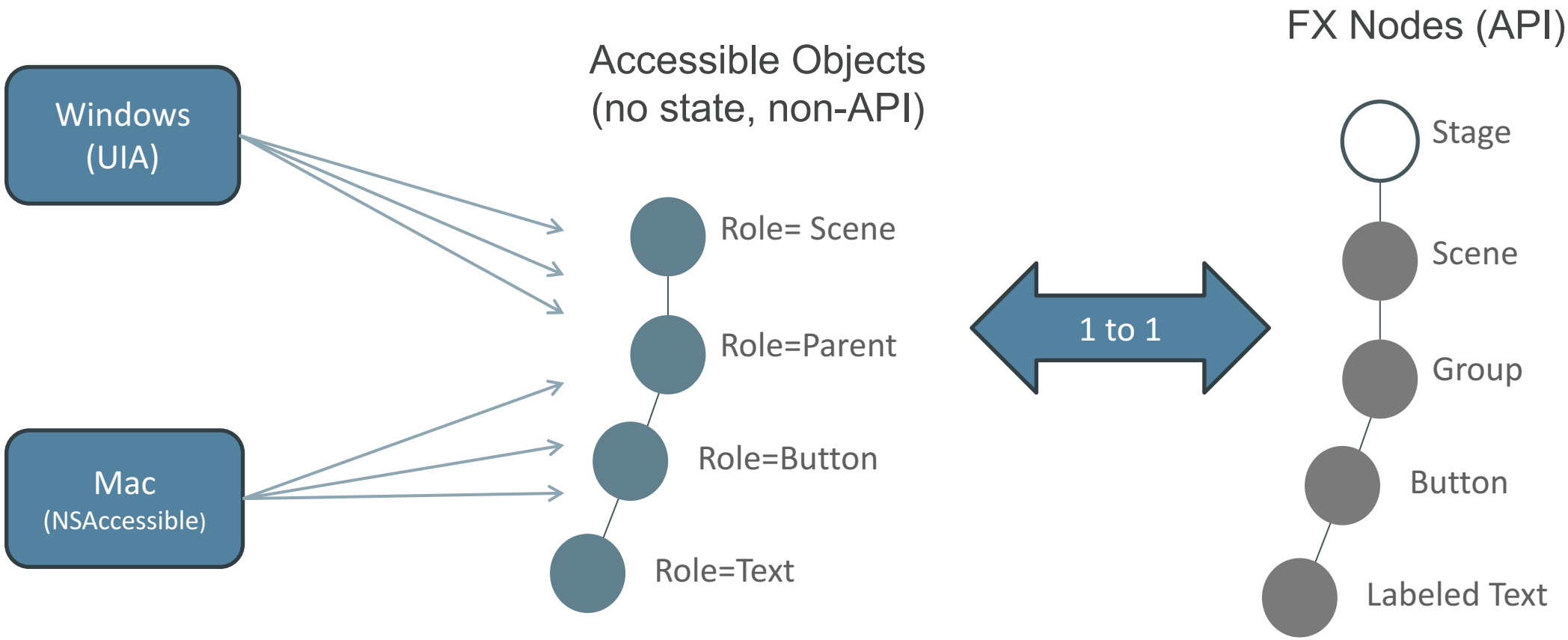
- AWT/Swing
  - Relies on access bridge shared library and vendor support
  - Incomplete, considered by some to be buggy
- Eclipse SWT
  - Uses native controls so gets native accessibility “for free”
  - Uses IA2 on Windows (not supported by Microsoft)
  - Some bugs and problems in the API and implementation



Design Goals for Java FX Accessibility

- Provide a complete, minimal and unobtrusive API
  - Support native behavior and platform specific mechanisms
  - Use existing Java FX conventions and standards
  - Ensure the implementation has a low overhead
- Implement accessibility for all built-in FX controls
  - Prove that the API is complete and full featured
- Allow developers to make their own controls accessible

JavaFX Accessibility: A Lightweight Implementation



Accessibility Design Goals: Realised!

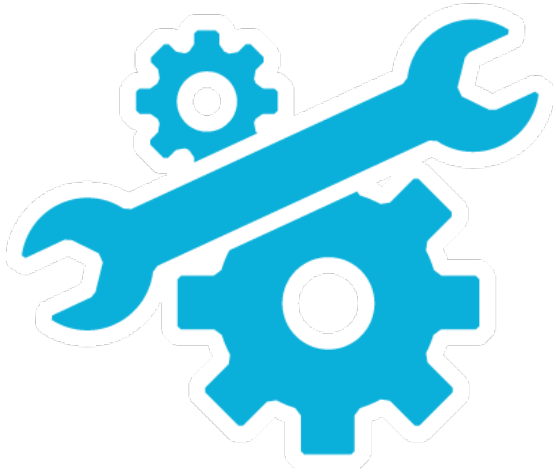
- JavaFX scenegraph is used to contain accessibility info
  - Avoid shadow hierarchies (decrease complexity, footprint)
- Use FX properties, methods and subclassing
  - Ensures that FX Accessibility is CSS and FXML friendly
- Low overhead implementation
  - Run code and create objects only when Screen Reader is active
  - No Screen Reader == No Accessible Code Executed
  - Screen Reader – No data duplication as accessibility data is represented by scenegraph

Fundamentals of Accessibility

The JavaFX Accessibility API

The Fundamental Accessibility API

A simple set of properties to solve the most common cases



- `Node#accessibleRoleProperty()`
- `Node#accessibleRoleDescriptionProperty()`
- `Node#accessibleTextProperty()`
- `Node#accessibleHelpProperty()`
- `Label#labelForProperty()` (not a new property)

The Accessible Role Property

- AccessibleRole is an enumeration property on Node
- The Role tells the Screen Reader the “kind of control”
  - Screen reader normally speaks the role (ie. says “Button”)
  - A Node can have at most one accessible role
- Some values the role might have:
  - `AccessibleRole.HYPERLINK` (used by javafx.scene.control.Hyperlink)
  - `AccessibleRole.TABLE_VIEW` (used by javafx.scene.control.TableView)

Setting the Role (Once, During Creation)

```
public Button(String text, Node graphic) {
        super(text, graphic);
        initialize();
}
private void initialize() {
        getStyleClass().setAll(DEFAULT_STYLE_CLASS);
        setAccessibleRole(AccessibleRole.BUTTON);
}
```

When should I set the role of a Node?

- The role always set appropriately for built-in controls
- The default role is `AccessibleRole.NODE` (or `PARENT`)
  - Currently both of these roles are ignored by the screen reader (nothing spoken)
- Set the role for Nodes that are not a Control
  - Choose the closest matching role from the set of enums
  - Very often `AccessibleRole.BUTTON` is a good choice

“But my control is not a button, it’s a bouncing ball!”

The Accessible Role Description Property

- Role Description is a string property on Node
- The property value is always null for built-in Controls
  - When null, the Screen Reader speaks native description
- Together, role and role description allow customisation
  - There are no user defined roles (`AccessibleRole` is an enum), but the role description allows the Screen Reader to say “Ball” instead of “Button”

“What about speaking the contents of my control?”

The Accessible Text Property

- Accessible Text is a Node Property, type is String (default is null)
- Tells the Screen Reader how to speak the contents of a control
- Always null by default for built-in Controls
  - Controls speak the appropriate contents for the control
  - A button will speak the button text and the role (ie. “OK”)
  - A text field speaks the text contents or the grayed out prompt text

The Accessible Help Property

- Accessible Help a Node property, type is String (default is null)
- Used to provide a longer more detailed description of a control
  - Always null by default for built-in controls
  - When null, the tooltip text is provided to the Screen Reader
- Extra help is provided when requested
  - Makes sense to default to the same value as the tool tip

The “Label For” Property

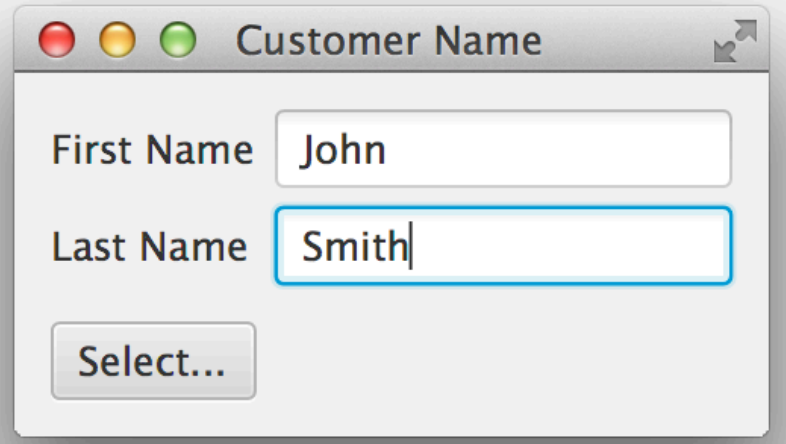
- “Label For” is a Label Property, type is Node (default is null)
- The labelFor property was previously used for mnemonics only
- Used to augment the description of TextFields and ComboBoxes
  - Often used for text fields that appear in configuration dialogs
- Used to provide description for other kinds of controls
  - Most common controls are ImageView, Slider, ProgressIndicator

A Text Field that uses “Label For”

```
TextField field = new TextField("Smith");
Label label = new Label("Last Name");
label.setLabelFor(field);
```

When focused, the screen reader says:

“Last name, editable text, Smith”

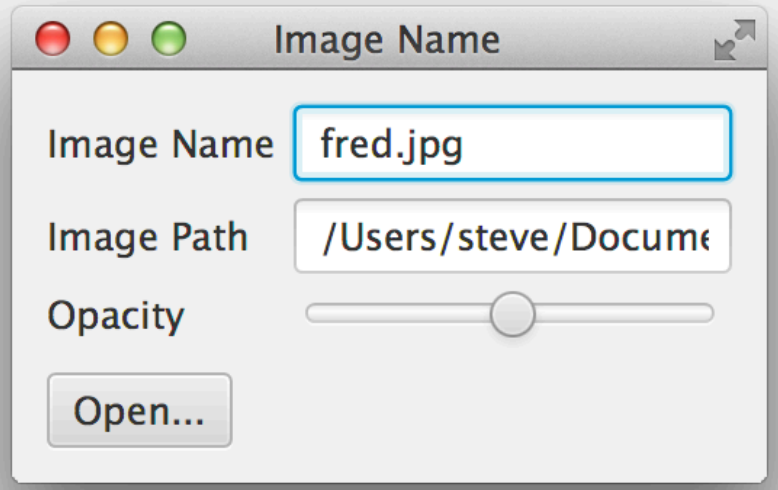


A Slider that uses “Label For”

```
Slider slider = new Slider(0, 100, 50);
Label label = new Label("Opacity");
label.setLabelFor(slider);
```

When focused, the screen reader says:

“Slider Opacity, 50%”



Advanced Accessibility API

The JavaFX Accessibility API

The Advanced Accessibility API

- Supports direct interaction with the Screen Reader
  - Return a value to the Screen Reader
  - Perform an action on behalf of the Screen Reader
  - Notify the Screen Reader that a value has changed
- Exposes the “Accessibility running” state
  - Determine whether accessibility is active

Accessible Methods: Called or Overridden

- `@override Object Node#queryAccessibleAttribute(AccessibleAttribute, Object...)`
- `@override void Node#executeAccessibleAction(AccessibleAction, Object...)`
- `void Node#notifyAccessibleAttributeChanged(AccessibleAttribute)`

Accessible Enums: Arguments to the Methods

- `AccessibleRole` (already seen)
  - ***`BUTTON, CHECK_BOX, LIST_VIEW,`*** `...`
- `AccessibleAttribute`
  - ***`PARENT, SELECTED, TEXT, ITEM_AT_INDEX`***`, ...`
- `AccessibleAction`
  - ***`FIRE, EXPAND, COLLAPSE, SET_TEXT`***`, ...`

Return a Value to the Screen Reader

- The Screen Reader requests the current state of a control
  - Different state is requested depending on the role of the control
- Example:
  - Return the number of rows in a list control
  - Return the selected items in a list control
- Some attributes the that might be queried:
  - `AccessibleAttribute.ROW_COUNT`
  - `AccessibleAttribute.SELECTED_ITEMS`

Overriding queryAccessibleAttribute()

```
@Override public Object queryAccessibleAttribute(
    AccessibleAttribute attribute, Object... parameters) {
      switch (attribute) {
        case ROW_COUNT: return getRowCount();
        default:
           super.queryAccessibleAttribute(attribute, parameters);
      }
}
```

IMPORTANT: Always call the super!

The Super: Node#queryAccessibleAttribute()

```
@Override public Object queryAccessibleAttribute(
    AccessibleAttribute attribute, Object... p) {
        switch (attribute) {
            case ROLE: return getAccessibleRole();
            case ROLE_DESCRIPTION: return getAccessibleRoleDescription();
            case TEXT: return getAccessibleText();
            case PARENT: return getParent();
            case BOUNDS: return localToScreen(getBoundsInLocal());
            case DISABLED: return isDisabled();
            case FOCUSED: return isFocused();
            default: return null;
        }
    }
}
```

Perform an Action on behalf of the Screen Reader

- The Screen Reader requests an action be performed
  - Actions are platform specific request (might be voice activated)
- Example:
  - Activate a button or traverse a hyper link
  - Expand a tree item or a title pane
- Some actions that might be requested:
  - `AccessibleAction.FIRE`
  - `AccessibleAction.EXPAND`

Overriding executeAccessibleAction()

```
@Override public void executeAccessibleAction(
    AccessibleAction action, Object... parameters) {
        switch (action) {
            case FIRE:
                fire();
                break;
            default: super.executeAccessibleAction(action, parameters);
        }
}
```

Notify the Screen Reader an Attribute has Changed

- The application changes the value of an attribute
  - The screen reader must be informed (it cannot know)
- Example:
  - Focus moves to a ListView, but the focus node is an item in the list
  - The user clicks on the (+) expansion indicator of a tree item
- Some attributes that the program changes:
  - `AccessibleAttribute.`***`FOCUS_NODE`***
  - `AccessibleAttribute.`***`EXPANDED`***
  - `AccessibleAttribute.`***`VALUE`***

Calling notifyAccessibleAttributeChanged()

```
public final DoubleProperty valueProperty() {
  if (value == null) {
    value = new SimpleDoubleProperty(this, "value", 0) {
      @Override protected void invalidated() {
        adjustValues();
        notifyAccessibleAttributeChanged(AccessibleAttribute.VALUE);
      }
    };
  }
  return value;
}
```

Determine whether Accessibility is Active

- Accessibility Active is a Platform property
  - type is Boolean (default is false, true when Screen Reader active)
- Used to implemented UI to better suit accessibility
- Examples:
  - Replace a chart or diagram with a table
  - Set additional nodes to be focus traversable

Making a Circle Traversable

```
Circle circle;
...
circle.focusTraversableProperty().bind(
        Platform.accessibilityActiveProperty());
...
```

Making Your Code Accessible

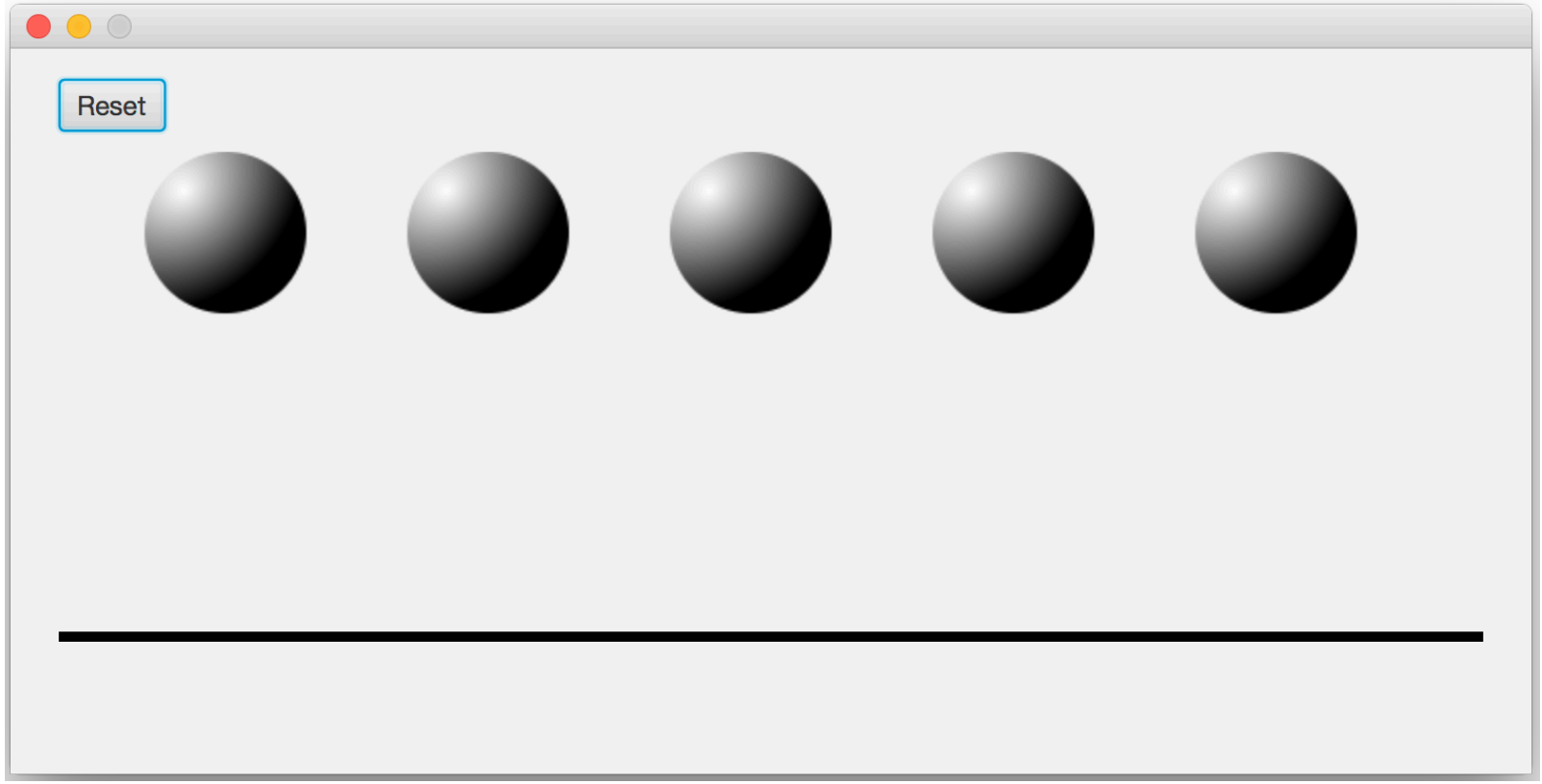
A Quick Accessibility Check List

- Use standard FX Controls as much as possible
  - Standard controls are highly configurable with CSS
  - Provide high contrast versions for custom CSS
- Provide text equivalent for every non-text element
  - Use accessibleText, helpText and/or tool tips
  - Examples: Provide text for ImageView, an animation that shakes etc.
- Use “label For” to connect text fields and combos to labels
- Ensure that important nodes are traversable from the keyboard

A Complete Example: Bouncing Balls

- A Ball is a Circle that draws a radial gradient
  - By default, its role is ***NODE*** so nothing is spoken
  - Need to tell the user that it is a ball and speak its state
  - Balls can be selected in order to stop and start bouncing
- Example Code
  - apps/samples/Ensemble8/src/samples/java/ensemble/samples/graphics2d/bouncingballs/BouncingBallsApp.java

Bouncing Balls



Bouncing Balls: The Unmodified Code

- Only the Reset button is read
- Nothing else is reachable, all other nodes are ignored

Demo: Nothing works

Using the Accessibility API Properties

```
…
ball.setAccessibleRole(AccessibleRole.BUTTON);
ball.setAccessibleRoleDescription("Bouncing Ball");
ball.setAccessibleText(text);
ball.setAccessibleHelp("This is bouncing ball, use
the primary action to start animation");
…
```

Demo: The first cut at accessible bouncing balls

Bouncing Balls: The “Free Native Traversal”

- The balls can be traversed using screen reader:
  - OS X: Using *Control + Option + Arrow*
  - Windows: Using *Capslock + Arrow*
- The Screen Reader will read each ball correctly
  - Ex. "First, Bouncing Ball”
- *Control+Option+Shift+N* (OS X) or *Capslock+F* (Windows) reads the accessible help

Using Accessibility API to Enable FX Traversal

```
...
focusTraversableProperty().bind(
    Platform.accessibilityActiveProperty());
...
```

Demo: Balls can be traversed using the tab key

Using the Accessibility API to Execute an Action

```
@Override public void executeAccessibleAction(
    AccessibleAction action, Object... parameters) {
        switch (action) {
            case FIRE: toggleAnimation(); break;
            default:
                super.executeAccessibleAction(action, parameters);
        }
}
```

Demo: Balls can be activated by Screen Reader

Bouncing Balls: The Final Code

- All text content and functionality is available to the Screen Reader
- Extra FX traversal is enabled only when Accessibility is active
- *Control+Option+Space* (OS X) or *Capslock+Space* (Windows) is used to start the animation for a ball

Summary

Which Accessibility API is Appropriate?

- The fundamental API makes simple nodes accessible
  - Choose a role, set the role description, set the text, etc.

- The advanced API is used for custom controls
  - Full featured: Used by FX to make built-in controls accessible

JavaFX Accessibility is Here

- Supports native accessibility mechanisms
  - No extra shared library or jar is required
- Implements accessibility for all built-in controls
- Provides a minimal but complete API
  - Provides a simple API for the most common cases
  - Provides an advanced API for custom controls

Thanks – Any Questions?

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