University of Tokyo Java Class
September 22-26, 2003
Forthcoming Java Language Features

Marc Hamilton

Director of Technology

Global Education and Research

Sun Microsystems, Inc

Watch Out for Tigers!

- Java 2 Platform, Standard Edition Release 1.5
- Code name “Tiger”
- Beta — Late 2003?
- A major theme — ease of development

Significant Language Changes Planned for Tiger

I. Generics
II. Enhanced for Loop ("foreach")
III. Autoboxing/Unboxing
IV. Typesafe Enums
V. Varargs
VI. Static Import
VII. Metadata

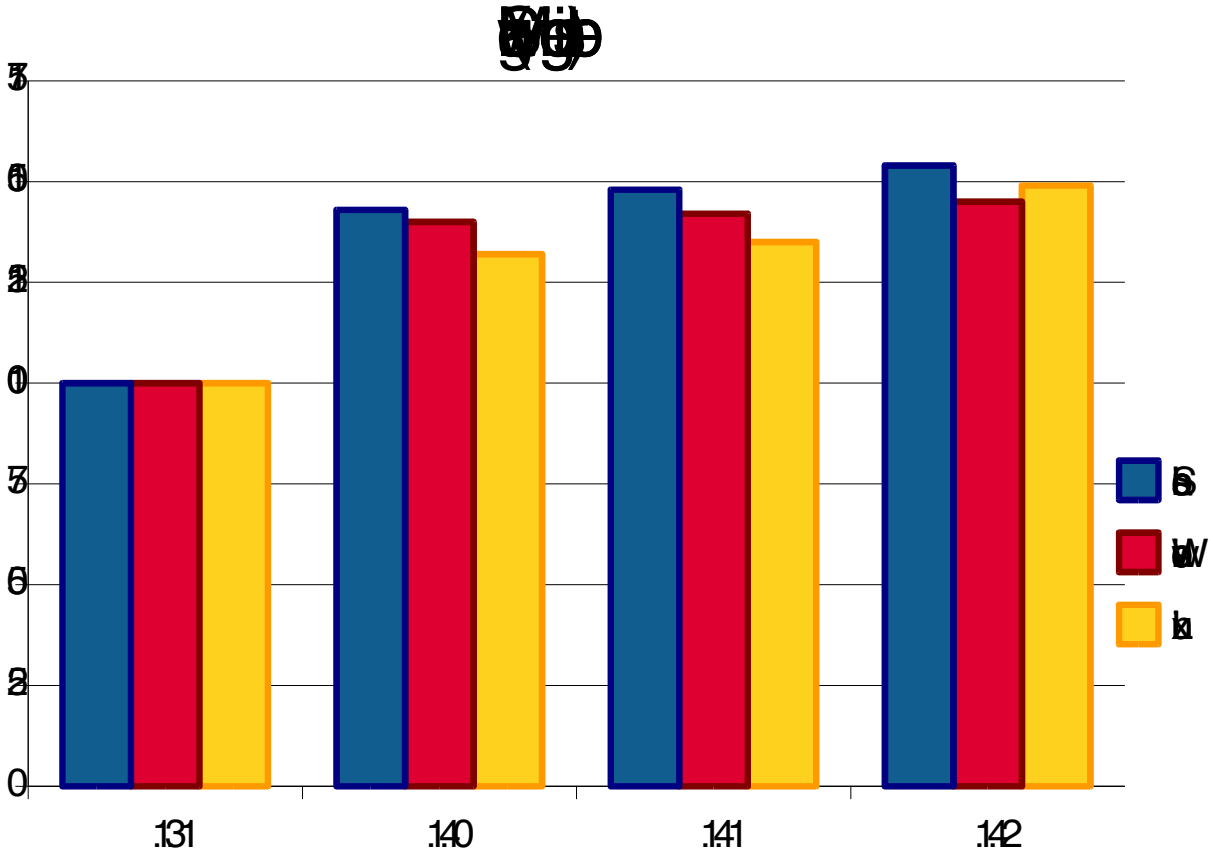
Unifying Theme — Developer-Friendliness

- Increase expressiveness
- Increase safety
- Minimize incompatibility
  - No VM changes
  - All binaries, most sources run unchanged
  - New keywords kept to a minimum

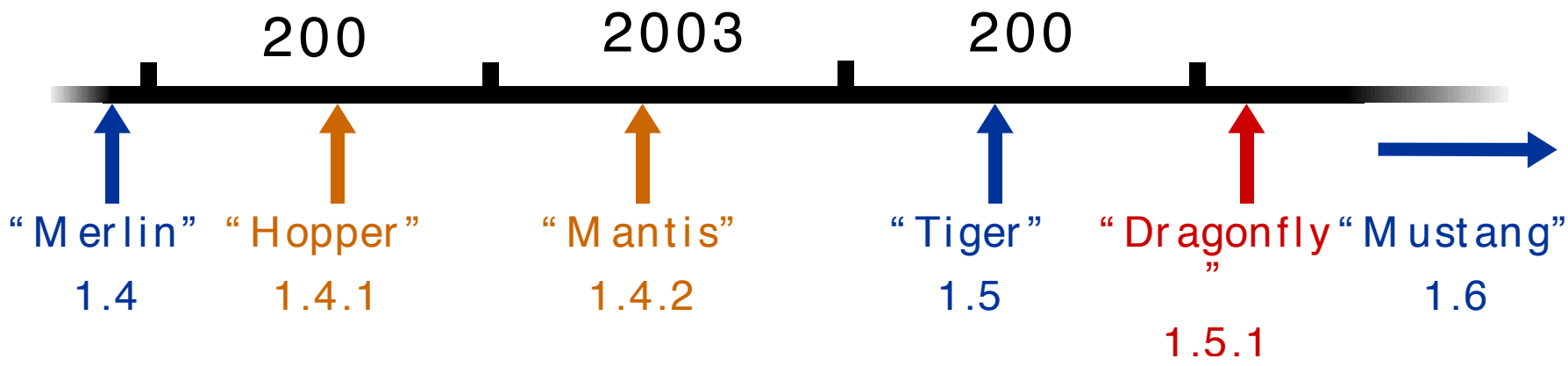
Disclaimer

- All subject to Java Community Process
  - JSR-014 Generics
  - JSR-175 Metadata
  - JSR-201 Remaining language changes
- For more information
  - http://www.jcp.org
- Participate!

Swing Performance Trends



Timeline


200
2003
200
"Merlin" 1.4
"Hopper" 1.4.1
"Mantis" 1.4.2
"Tiger" 1.5
"Dragonfly" 1.5.1
"Mustang" 1.6

I. Generics

- When you get an element from a collection, you have to cast
  - Casting is a pain
  - Casting is unsafe—casts may fail at runtime
- Wouldn't it be nice if you could tell the compiler what type a collection holds?
  - Compiler could put in the casts for you
  - They'd be guaranteed* to succeed

* Offer void where prohibited by law. Price does not include dealer preparation and licensing. Your mileage may vary. Cash value 1/20c.

Filtering a Collection — Today

```
// Removes 4-letter words from c; elements must be strings
static void expurgate(Collection c) {
    for (Iterator i = c.iterator(); i.hasNext(); )
        if(((String) i.next()).length() == 4)
            i.remove();
}

// Alternative form - a bit prettier?
static void expurgate(Collection c) {
    for (Iterator i = c.iterator(); i.hasNext(); ) {
        String s = (String) i.next();
        if(s.length() == 4)
            i.remove();
    }
}
```

Filtering a Collection With Generics

```
// Removes 4-letter words from c
static void expurgate(Collection<String> c) {
    for (Iterator<String> i = c.iterator(); i.hasNext(); )
        if (i.next().length() == 4)
            i.remove();
}
```

- Clearer and Safer
- No cast, extra parentheses, temporary variables
- Provides compile-time type checking

Generics Are Not Templates

- No code-size blowup
- No hideous complexity
- No “template metaprogramming”
- Simply provides compile-time type safety and eliminates the need for casts

II. Enhanced `for` Loop ("foreach")

- Iterating over collections is a pain
- Often, iterator unused except to get elements
- Iterators are error-prone
  - Iterator variable occurs three times per loop
  - Gives you two opportunities to get it wrong
  - Common cut-and-paste error
- Wouldn't it be nice if the compiler took care of the iterator for you?

Applying a Method to Each Element in a Collection—Today

```
void cancelAll(Collection c) {
    for (Iterator i = c.iterator(); i.hasNext(); ) {
        TimerTask tt = (TimerTask) i.next();
        tt.cancel();
    }
}
```

Applying Method to Each Element In a Collection With Enhanced `for`

```
void cancelAll(Collection c) {
    for (Object o : c)
        ((TimerTask)o).cancel();
}
```

- Clearer and Safer
- No iterator-related clutter
- No possibility of using the wrong iterator

Enhanced `for` Really Shines When Combined With Generics

```
void cancelAll(Collection<TimerTask> c) {
    for (TimerTask task : c)
        task.cancel();
}
```

- Much shorter, clearer and safer
- Code says exactly what it does

It Works For Arrays, Too

```
// Returns the sum of the elements of a
int sum(int[] a) {
    int result = 0;
    for (int i : a)
        result += i;
    return result;
}
```

- Eliminates array index rather than iterator
- Similar advantages

Nested Iteration Is Tricky

```
List suits = ...;
List ranks = ...;
List sortedDeck = new ArrayList();

// Broken - throws NoSuchElementException!
for (Iterator i = suits.iterator(); i.hasNext(); )
    for (Iterator j = ranks.iterator(); j.hasNext(); )
        sortedDeck.add(new Card(i.next(), j.next()));
```

Nested Iteration Is Tricky

```
List suits = ...;
List ranks = ...;
List sortedDeck = new ArrayList();

// Broken - throws NoSuchElementException!
for (Iterator i = suits.iterator(); i.hasNext(); )
    for (Iterator j = ranks.iterator(); j.hasNext(); )
        sortedDeck.add(new Card(i.next(), j.next()));

// Fixed - a bit ugly
for (Iterator i = suits.iterator(); i.hasNext(); ) {
    Suit suit = (Suit) i.next();
    for (Iterator j = ranks.iterator(); j.hasNext(); )
        sortedDeck.add(new Card(suit, j.next()));
}
```

With Enhanced `for`, It's Easy!

```
for (Suit suit : suits)
    for (Rank rank : ranks)
        sortedDeck.add(new Card(suit, rank));
```

III. Autoboxing/Unboxing

- You can’t put an **`int`** into a collection
  - Must use **`Integer`** instead
- It's a pain to convert back and forth
- Wouldn't it be nice if compiler did it for you?

Making a Frequency Table — Today

```
public class Freq {
    private static final Integer ONE = new Integer(1);

    public static void main(String[] args) {
        // Maps word (String) to frequency (Integer)
        Map m = new TreeMap();

        for (int i=0; i<args.length; i++) {
            Integer freq = (Integer) m.get(args[i]);
            m.put(args[i], (freq==null ? ONE :
                  new Integer(freq.intValue() + 1)));
        }
        System.out.println(m);
    }
}
```

Making a Frequency Table With Autoboxing, Generics, and Enhanced `for`

```
public class Freq {
    public static void main(String[] args) {
       Map<String, Integer> m = new TreeMap<String, Integer>();
       for (String word : args)
           m.put(word, Collections.getWithDefault(m, word) + 1);
       System.out.println(m);
    }
}
```

IV. Typesafe Enums

Standard approach – **`int`** enum pattern

```
public class Almanac {
     public static final int SEASON_WINTER = 0;
     public static final int SEASON_SPRING = 1;
     public static final int SEASON_SUMMER = 2;
     public static final int SEASON_FALL   = 3;

     ...  // Remainder omitted
 }
```

Disadvantages of `int` Enum Pattern

- Not typesafe
- No namespace - must prefix constants
- Brittle - constants compiled into clients
- Printed values uninformative

Current Solution – Typesafe Enum Pattern

- "Effective Java Programming Language Guide"
- Basic idea - class that exports self-typed constants and has no public constructor
- Fixes all disadvantages of **`int`** pattern
- Other advantages
  - Can add arbitrary methods, fields
  - Can implement interfaces

Typesafe Enum Pattern Example

```
import java.util.*;
import java.io.*;

public final class Season implements Comparable, Serializable {
    private final String name;
    public String toString()    { return name; }

    private Season(String name) { this.name = name; }

    public static final Season WINTER = new Season("winter");
    public static final Season SPRING = new Season("spring");
    public static final Season SUMMER = new Season(”summer");
    public static final Season FALL   = new Season("fall");

    private static int nextOrdinal = 0;
    private final  int ordinal = nextOrdinal++;

    public int compareTo(Object o) {
        return ordinal - ((Season)o).ordinal;
    }

    private static final Season[] PRIVATE_VALUES = { WINTER, SPRING, SUMMER, FALL };

    public static final List VALUES =
      Collections.unmodifiableList(
          Arrays.asList(PRIVATE_VALUES));

    private Object readResolve() {
        // Canonicalize
        return PRIVATE_VALUES[ordinal];
    }
}
```

Disadvantages of Typesafe Enum Pattern

- Verbose
- Error prone—each constant occurs 3 times
- Can’t be used in **`switch`** statements
- Wouldn't it be nice if compiler took care of it?

Typesafe Enum Construct

- Compiler support for Typesafe Enum pattern
- Looks like traditional enum (C, C++, Pascal)

```
enum Season { winter, spring, summer, fall }
```

- Far more powerful
  - All advantages of Typesafe Enum pattern
  - Allows programmer to add arbitrary methods, fields
- Can be used in **`switch`** statements

Enums Interact Well With Generics and Enhanced `for`

```
enum Suit {clubs, diamonds, hearts, spades}
enum Rank {deuce, three, four, five, six, seven,
           eight, nine, ten, jack, queen, king, ace}

List<Card> deck = new ArrayList<Card>();
for (Suit suit : Suit.VALUES)
    for (Rank rank : Rank.VALUES)
        deck.add(new Card(suit, rank));

Collections.shuffle(deck);
```

Would require pages of code today!

Enum With Field, Method and Constructor

```
public enum Coin {
    penny(1), nickel(5), dime(10), quarter(25);

    Coin(int value) { this.value = value; }

    private final int value;

    public int value() { return value; }
}
```

Sample Program Using `Coin` Class

```
public class CoinTest {
    public static void main(String[] args) {
        for (Coin c : Coin.VALUES)
            System.out.println(c + ":   \t"
                  + c.value() +"¢ \t" + color(c));
    }
    private enum CoinColor { copper, nickel, silver }
    private static CoinColor color(Coin c) {
        switch(c) {
          case penny:   return CoinColor.copper;
          case nickel:  return CoinColor.nickel;
          case dime:
          case quarter: return CoinColor.silver;
          default: throw new AssertionError("Unknown coin: " + c);
        }
    }
}
```

Actual Output of Sample Program

```
penny:          1¢      copper
nickel:         5¢      nickel
dime:           10¢     silver
quarter:        25¢     silver
```

V. Varargs

- To write a method that takes an arbitrary number of parameters, you must use an array
- Creating and initializing arrays is a pain
- Array literals are not pretty
- Wouldn’t it be nice if the compiler did it for you?
- Essential for a usable `printf` facility

Using `java.text.MessageFormat` —Today

```
Object[] arguments = {
    new Integer(7),
    new Date(),
    "a disturbance in the Force"
};

String result = MessageFormat.format(
    "At {1,time} on {1,date}, there was {2} on planet "
     + "{0,number,integer}.", arguments);
```

Using `MessageFormat` With Varargs

```
String result = MessageFormat.format(
    "At {1,time} on {1,date}, there was {2} on planet "
    + "{0,number,integer}.",
    7, new Date(), "a disturbance in the Force");
```

Varargs Declaration Syntax

```
public static String format(String pattern,
                            Object... arguments)
```

arguments is Object[]

VI. Static Import Facility

Classes often export constants

```
public class Physics {
    public static final double
        AVOGADROS_NUMBER   = 6.02214199e23;
    public static final double
        BOLTZMANN_CONSTANT = 1.3806503e-23;
    public static final double
        ELECTRON_MASS      = 9.10938188e-31;
}
```

Clients must qualify constant names

```
double molecules = Physics.AVOGADROS_NUMBER * moles;
```

Wrong Way to Avoid Qualifying Names

```
// "Constant Interface" antipattern - do not use!
public interface Physics {
  public static final double
      AVOGADROS_NUMBER   = 6.02214199e23;
  public static final double
      BOLTZMANN_CONSTANT = 1.3806503e-23;
  public static final double
      ELECTRON_MASS      = 9.10938188e-31;
}

public class Guacamole implements Physics {
    public static void main(String[] args) {
        double moles = ...;
        double molecules = AVOGADROS_NUMBER * moles;
        ...
    }
}
```

Problems With Constant Interface

- Interface abuse — does not define type
- Implementation detail pollutes exported API
- Confuses clients
- Creates long-term commitment
- Wouldn’t it be nice if compiler let us avoid qualifying names without subtyping?

Solution — Static Import Facility

- Analogous to package import facility
- Imports the static members from a class, rather than the classes from a package
- Can import members individually or collectively
- Not rocket science

Importing Constants With Static Import

```
import static org.iso.Physics.*;

public class Guacamole {
    public static void main(String[] args) {
        double molecules = AVOGADROS_NUMBER * moles;
        ...
    }
}
```

org.iso.Physics

Can Import Methods as Well as Fields

- Useful for mathematics
- Instead of: `x = Math.cos(Math.PI * theta);`
- Say: `x = cos(PI * theta);`

Static Import Interacts Well With Enums

```
import static gov.treas.Coin.*;

class MyClass {
    public static void main(String[] args) {
        int twoBits = 2 * quarter.value();
        ...
    }
}
```

VII. Metadata

- Many APIs require a fair amount of boilerplate

  Example: JAX-RPC web service requires paired interface and implementation

- Wouldn't it be nice if language let you annotate code so that tool could generate boilerplate?
- Many APIs require "side files" to be maintained

  Example: bean has **`BeanInfo`** class

- Wouldn't it be nice if language let you annotate code so that tools could generate side files?

JAX-RPC Web Service—Today

```
public interface CoffeeOrderIF extends java.rmi.Remote {
    public Coffee [] getPriceList()
        throws java.rmi.RemoteException;
    public String orderCoffee(String name, int quantity)
        throws java.rmi.RemoteException;
}

public class CoffeeOrderImpl implements CoffeeOrderIF {
    public Coffee [] getPriceList() {
        ...
    }
    public String orderCoffee(String name, int quantity) {
        ...
   }
}
```

JAX-RPC Web Service With Metadata

```
import javax.xml.rpc.*;

public class CoffeeOrder {
    @Remote public Coffee [] getPriceList() {
        ...
    }
    @Remote public String orderCoffee(String name, int quantity) {
        ...
    }
}
```

Would You Like to Try it Today?

- All features (except metadata) are available in early access 1.5 compiler
  http://developer.java.sun.com/developer/earlyAccess/adding_generics
- For documentation, see JSRs 14, 201, 175
  http://www.jcp.org
- Try it out and send us feeback!

Conclusion

- Language has always occupied a sweet spot
  - But certain omissions were annoying
- In “Tiger” we intend rectify these omissions
- New features were designed to interact well
- Language will be more expressive
  - Programs will be clearer, shorter, safer
- We will not sacrifice compatibility

Lab Assignment

- Download Java Studio 5 from the EduSoft Portfolio web site
- Download Java 1.5 early access compiler
- Write your own version of the “Coin” program using your local currency

Marc Hamilton

marc.hamilton@sun.com

Sun Microsystems, Inc.

Sun microsystems
We make the net work.