Road to ICU:
Challenges and Best Practices of ICU Adoption from JDK

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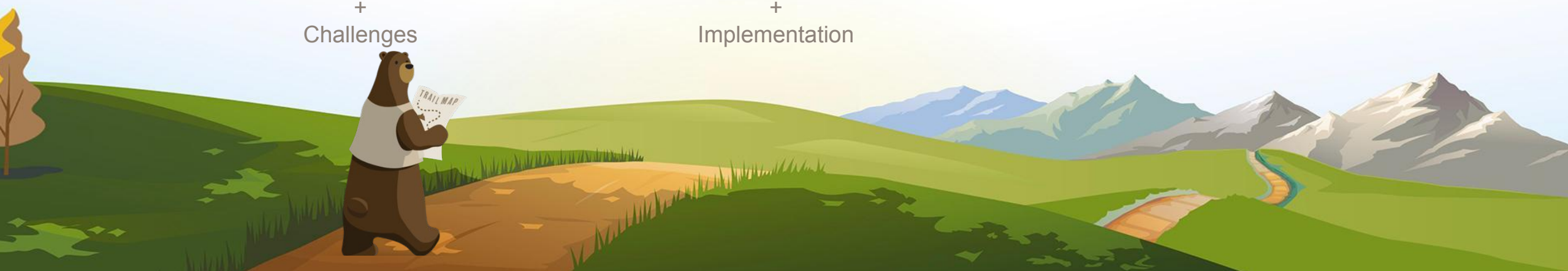
Path to ICU

Requirements
+
Challenges

Planning
+
Implementation

Case Studies

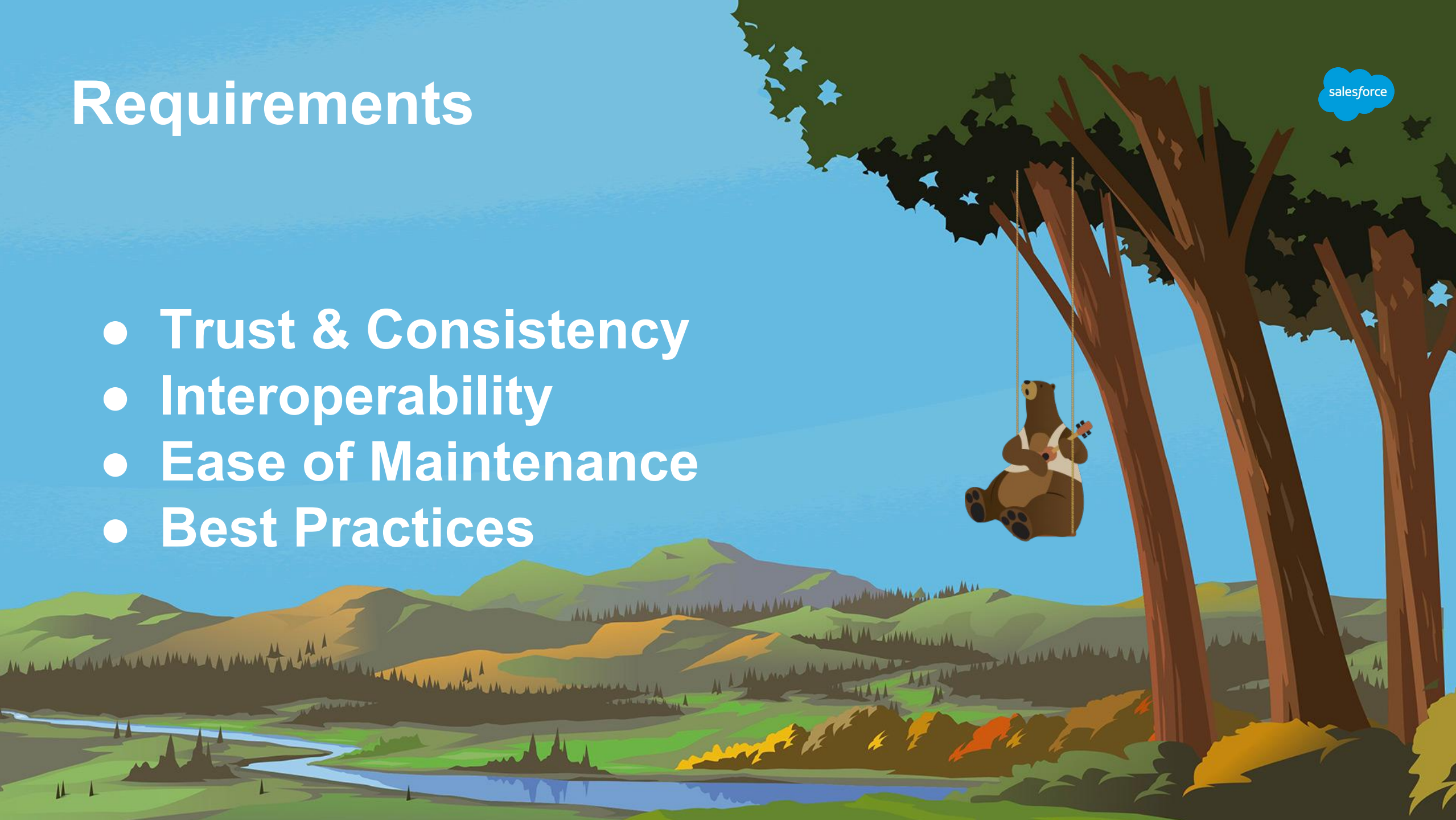


Chapter 1: Requirements & Challenges

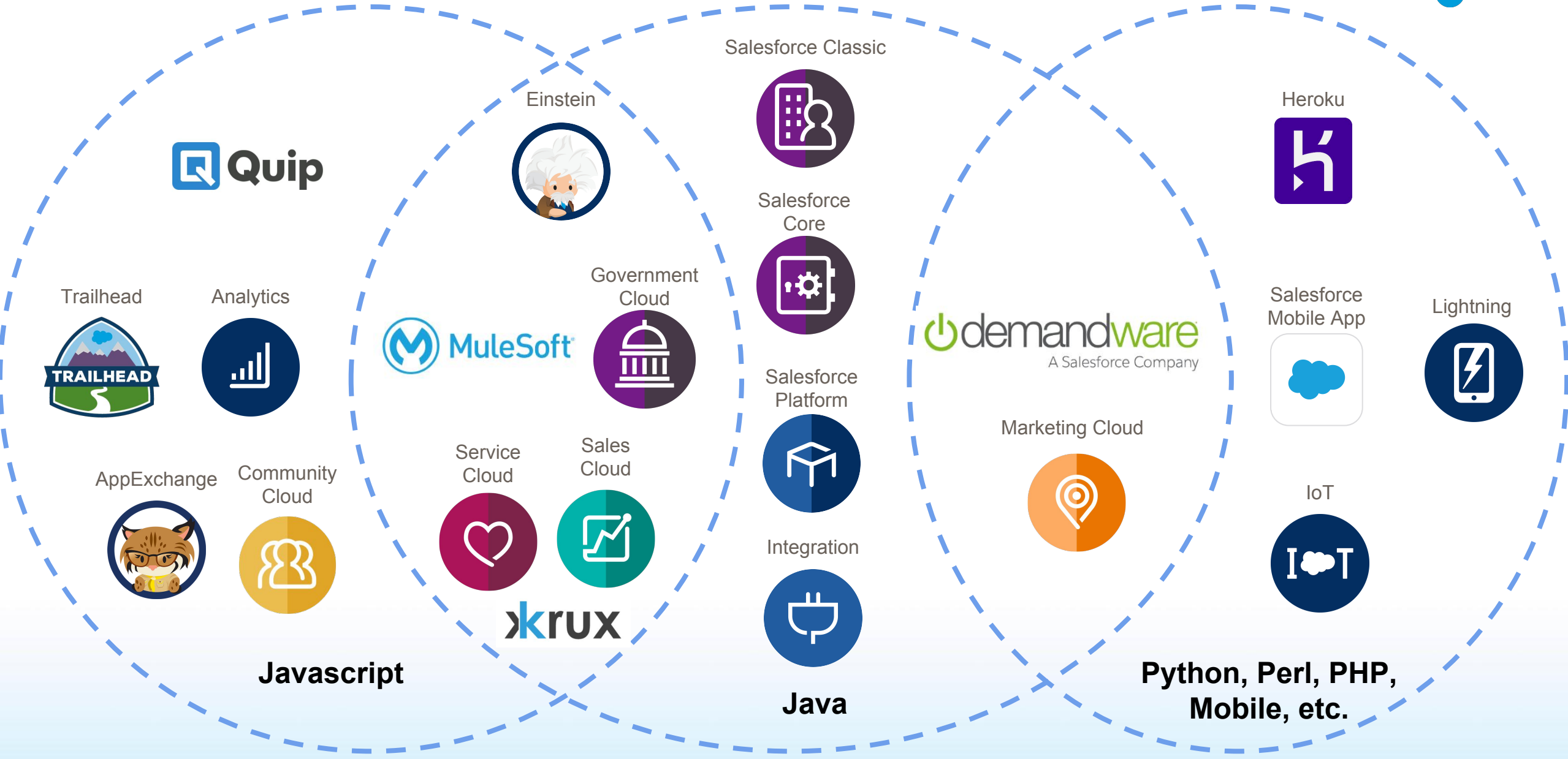
Requirements
+
Challenges

Requirements

- Trust & Consistency
- Interoperability
- Ease of Maintenance
- Best Practices



Challenges - Interoperability



Challenges - Complex Landscape

Technical Challenges

Cost of maintenance
210+ Locales to support
Concurrent support of ICU and JDK locale data

Incorrect/inconsistent Locale Data
Mixture of locale data from JDK, and ICU4J/CLDR

Multiple Tech Stacks
Legacy Code and Acquisitions

Organizational Challenges

Release Timing
Managing both internal and external customers

Large Feature Base
With hundreds of teams

Cross-Cloud Initiative
Existing products, new products and acquisitions

CORE ENGR
salesforce

Globalization

Sales Cloud | Service Cloud | Marketing Cloud | Commerce Cloud | Community Cloud | Salesforce Platform | Industries Cloud | Integration | Einstein

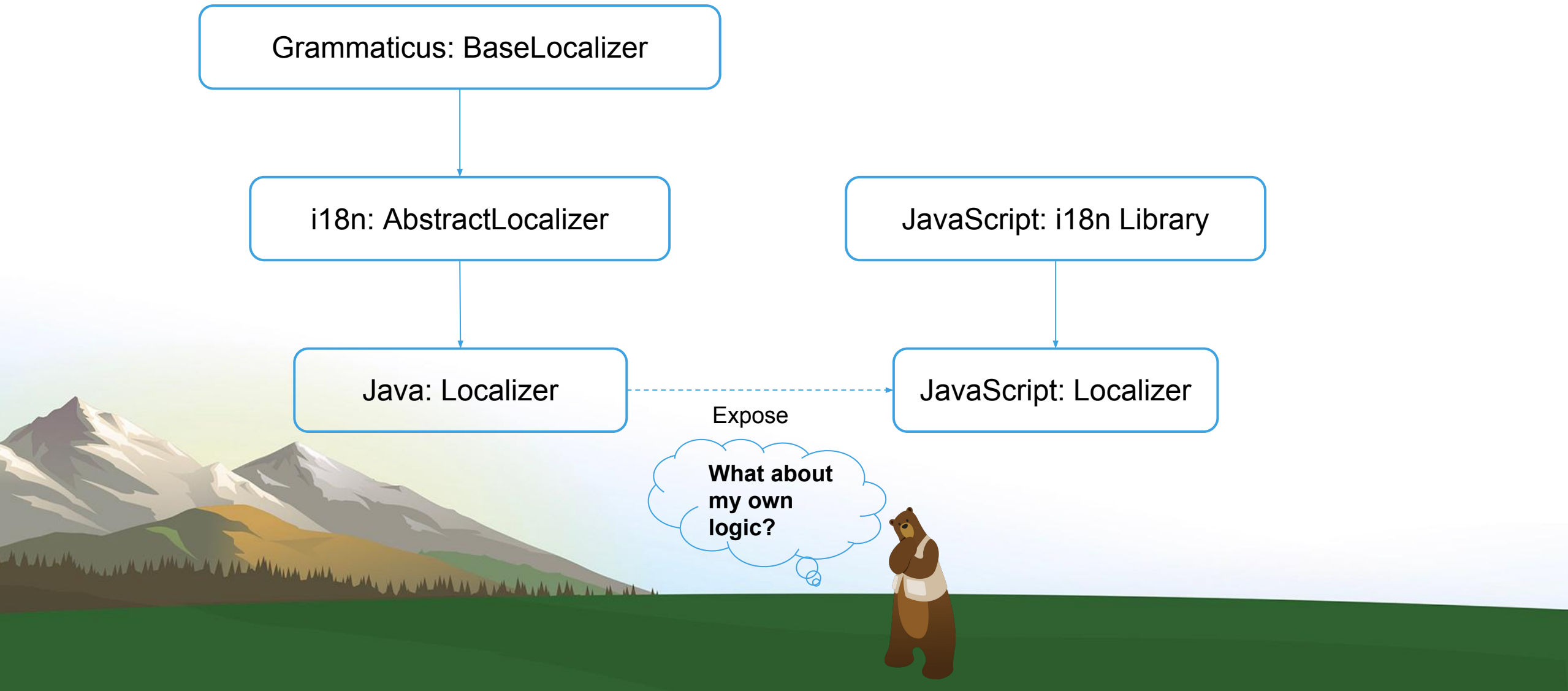
Our Customers

The Road to ICU

Chapter 2: Planning & Implementation

Planning
+
Implementation

Planning the Route



Planning the Route - Details

Attribute	Description	Sample Value
currency	The currency symbol.	"$"
currencyCode	The ISO 4217 representation of the currency code.	“USD"
decimal	The decimal separator.	"."
grouping	The grouping separator.	","
numberformat	The number format pattern.	"#,##0.###"
datetimeFormat	The date time medium format.	"MMM d, yyyy h:mm:ss a"
...		

Lightning Components $Locale
https://developer.salesforce.com/docs/atlas.en-us.lightning.meta/lightning/expr_locale_value_provider.htm

Planning the Route - Findings

- Accuracy 😓
- Consistency & Interoperability 😊
- Ease of Maintenance 😓

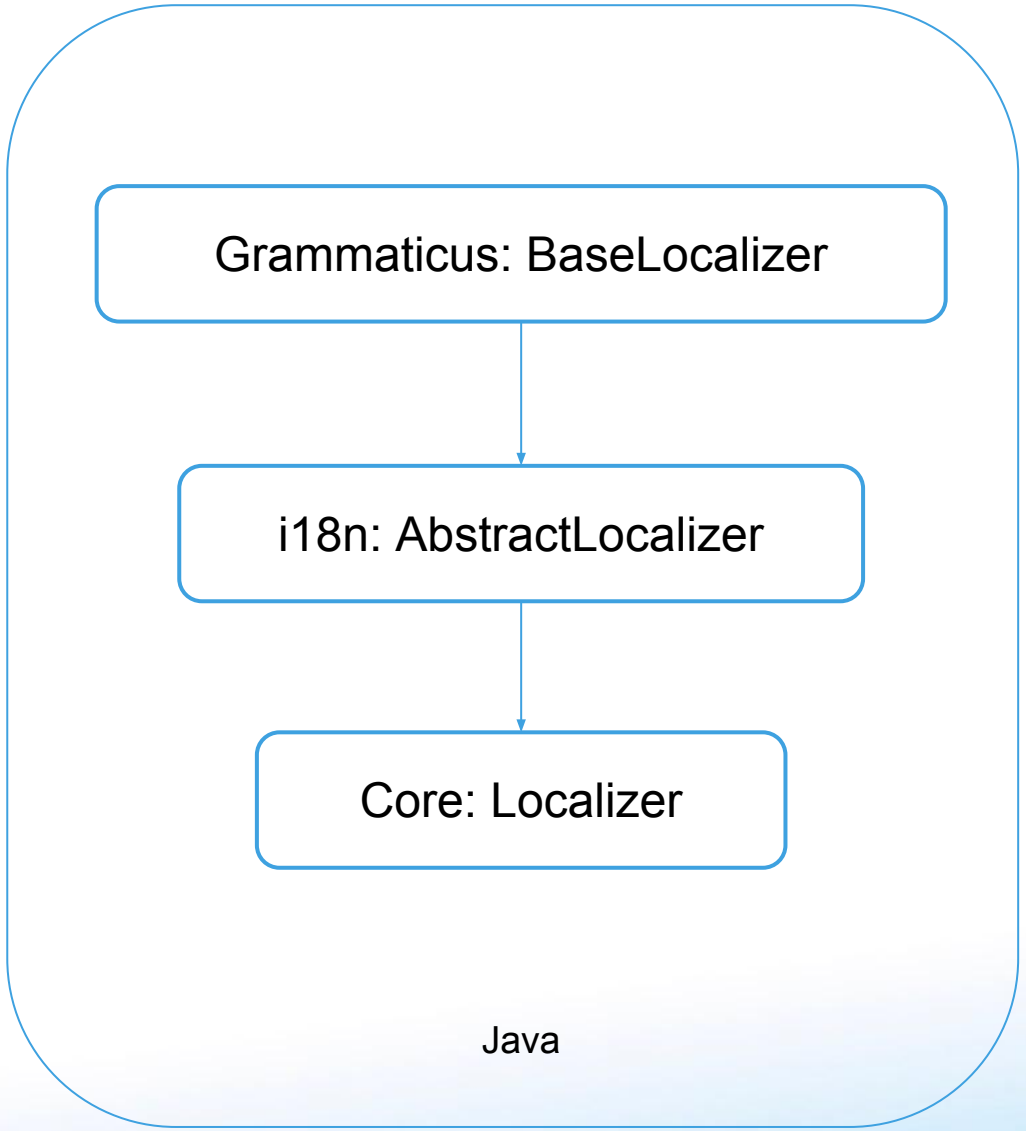
Problems:

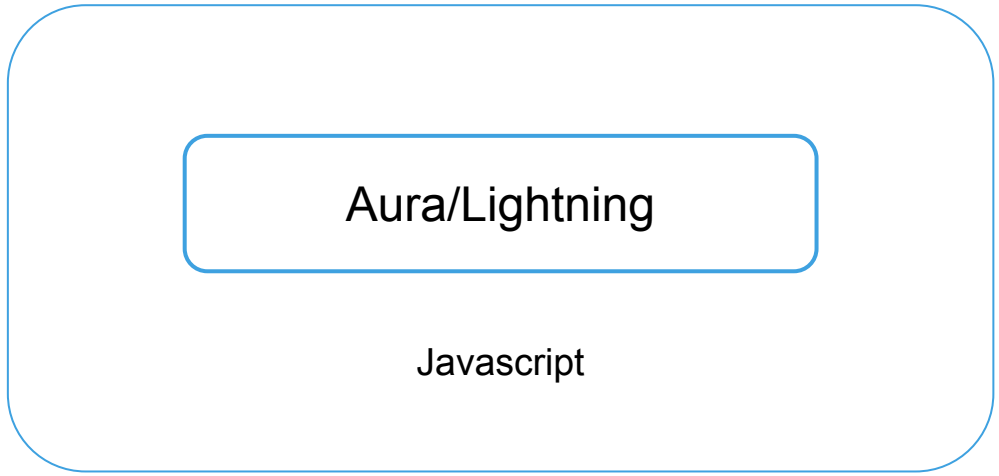
1. 210 locales with 10-20 patterns
2. Takes ~80% of the application bundle, big performance hit
3. Difficult to format with the patterns in Javascript

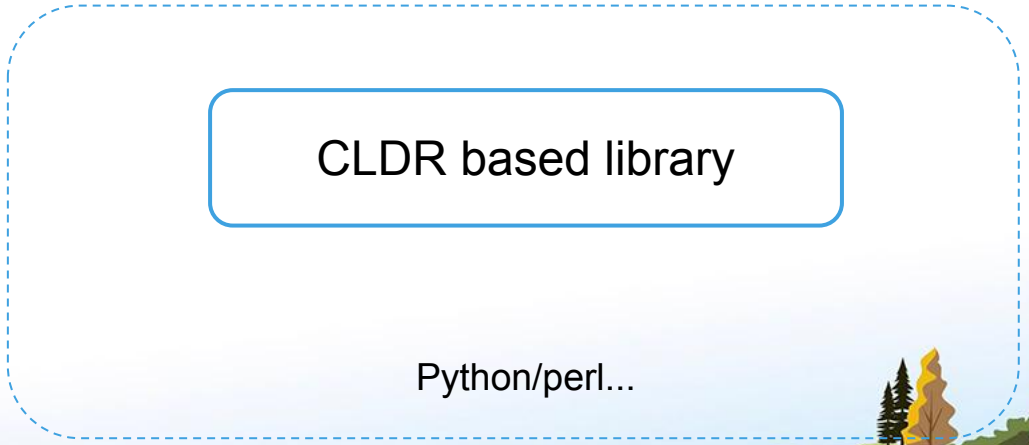
Example:

‘MM/dd/y HH:mm a’

Implementation: CLDR compatible libraries design

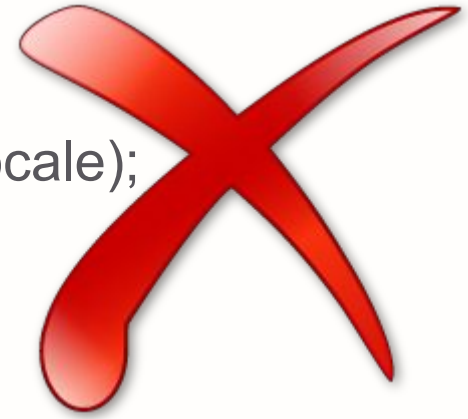






Implementation: Migrate to ICU4J

- Switch to use ICU4J APIs to retrieve locale data
  - com.ibm.icu.text.DateFormat df =
    com.ibm.icu.text.DateFormat.getDateTimeInstance(style, style, locale);

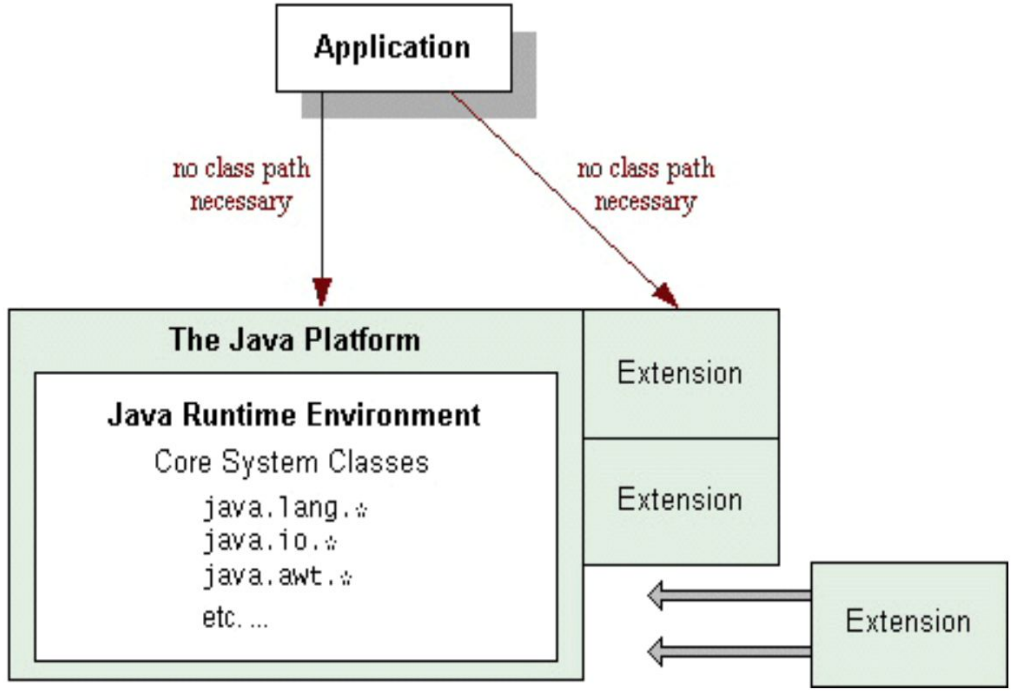


- JDK classes vs ICU classes
  - java.text.DateFormat -> java.text.format
  - com.ibm.icu.text.DateFormat -> com.ibm.icu.text.UFormat ->java.text.format
- 8772 DateFormat API calls in code base!

Implementation: SPI

Service Provider Interface (SPI)

java.util.spi	java.text.spi
• CurrencyNameProvider • LocaleServiceProvider • TimeZoneNameProvider • CalendarDataProvider	• BreakIteratorProvider • CollatorProvider • DateFormatProvider • DateFormatSymbolsProvider • DecimalFormatSymbolsProvider • NumberFormatProvider




```
java -Djava.ext.dirs=$JAVA_HOME/lib/ext:$ICU_SPI_DIR <your_java_app>
```

Implementation: choose locale data provider

- Set provider, java.locale.providers=COMPAT,SPI,CLDR
  - COMPAT : Java locale data
  - SPI : Service provider data
  - CLDR : bundled CLDR data

- Support both JDK and ICU locale data
  - Adapter to wrap ICU4J classes
  - Predicate to retrieve data

```
NumberFormatICU.wrap(com.ibm.icu.text.NumberFormat nf =
        com.ibm.icu.text.NumberFormat.getNumberInstance(locale))
```

Implementation: Adjusting to JDK9

JDK9

Changes:

- Removed extension and endorsed mechanism.
- Make CLDR as default locale provider.

`java.endorsed.dirs`

`lib/endorsed`

Solution:

- JDK-8062588 load providers for SPIs with the application class loader
- Transfer ICU jars into upgradable modules.
- Legacy locale data support.
  - Set java.locale.providers=COMPAT,SPI,CLDR

Implementation: Demo

1. Setup locale data service provider
2. Configure service provider
3. Concurrent support of JDK and ICU locale data

Implementation: Intl

`Intl`: the namespace for the ECMAScript Internationalization API

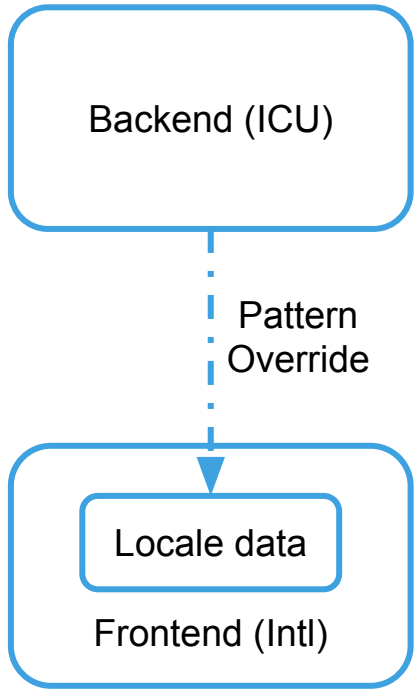
- Intl.Collator
- Intl.DateTimeFormat
- Intl.NumberFormat
- Intl.PluralRules

```
console.log(new Intl.DateTimeFormat('en-US').format(date));
// expected output: "12/20/2012"

console.log(new Intl.DateTimeFormat('en-CA').format(date));
// expected output: "2012-12-19"
```

Implementation: browser locale data consistency

Browser	Date	Time	Date & Time
Chrome-57	58%	47%	93%
Chrome-64	78%	70%	95%
Firefox-52	92%	83%	98%
Firefox-56	93%	83%	98%
Firefox-58	93%	83%	98%
MicrosoftEdge-13	70%	32%	79%
MicrosoftEdge-15	73%	34%	82%
MicrosoftEdge-16	74%	34%	83%
Safari-10	86%	65%	89%
Safari-11	88%	71%	88%
Internet explorer-11	39%	16%	74%
Nodejs-8.x	93%	84%	98%



Implementation: frontend library

```
module.exports = function formatDate(value, pattern, locale) {
  switch (locale) {
      case 'xx-XX':
          result = require('./exceptions/xx-XX')(value, pattern); break;
      case 'en-CA':
          result = require('./exceptions/en-CA')(value, pattern); break;
      default:
          var patterns = cache[locale];
          var dtf = patterns && patterns[pattern];
          if (!dtf) {
              dtf = new Intl.DateTimeFormat(locale, patternToOptions(pattern));
              cache[locale] = cache[locale] || Object.create(null);
              cache[locale][pattern] = dtf;
          }
          result = dtf.format(value);
  }
```

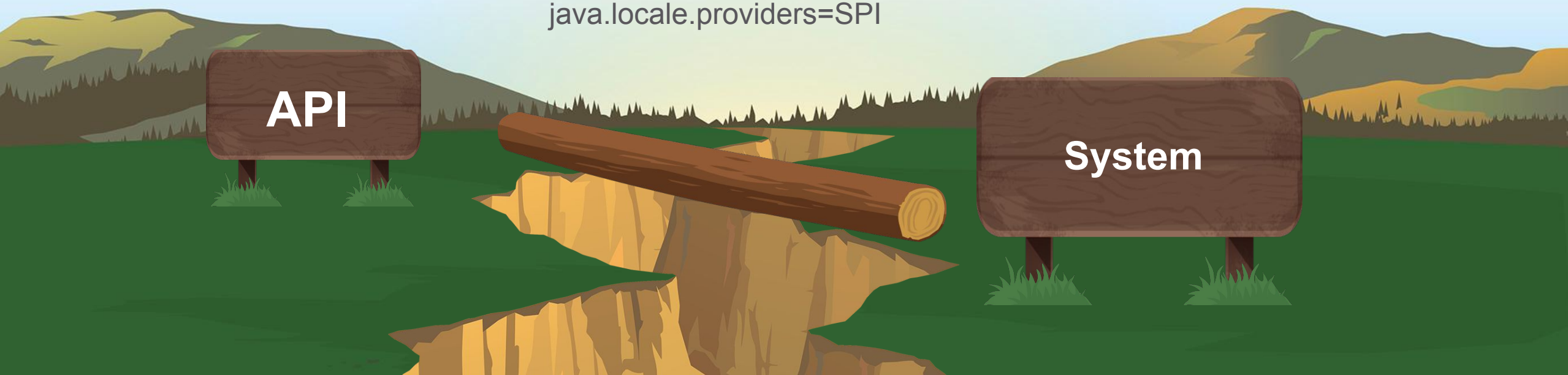
Implementation: Automation

- Concurrent support for both ICU4J and JDK locale data
- Benchmark build + automation (discovered 2K+ test failures)

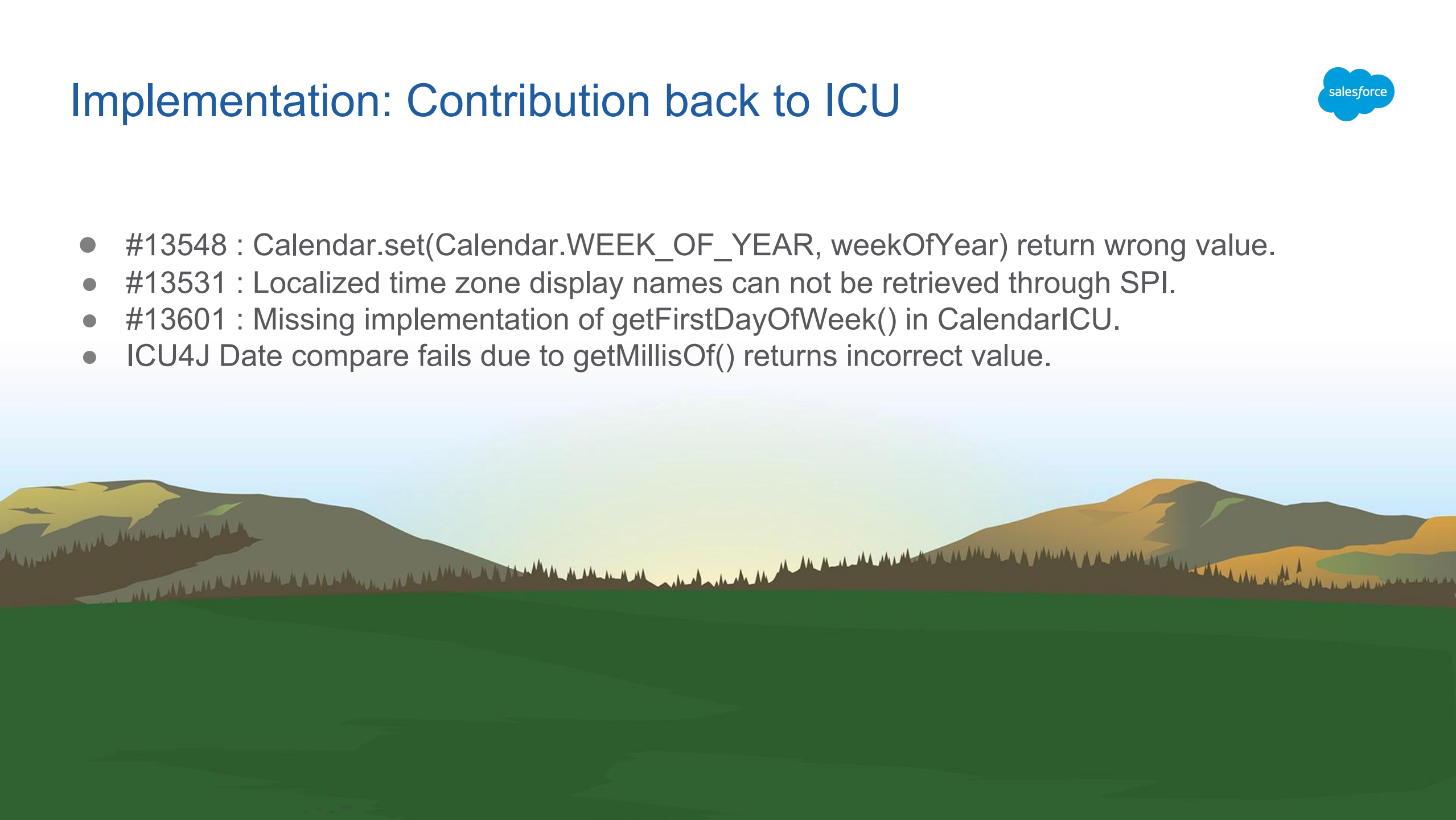
Implementation: Bridging the API and system gap

Phase 1: Consolidate APIs to use CLDR based libraries.

Phase 2: Make existing functional code compatible with CLDR without major revision in product code.



Implementation: Contribution back to ICU



- #13548 : Calendar.set(Calendar.WEEK_OF_YEAR, weekOfYear) return wrong value.
- #13531 : Localized time zone display names can not be retrieved through SPI.
- #13601 : Missing implementation of getFirstDayOfWeek() in CalendarICU.
- ICU4J Date compare fails due to getMillisOf() returns incorrect value.

Chapter 3: Case Studies

Case Studies

Case study #1 - Type Casting Exception

Cast without type check.

JDK-8190278 ClassCastException is thrown by java.util.Scanner when a NumberFormatProvider is used.

DecimalFormat df = (DecimalFormat) NumberFormat.getNumberInstance(locale);

Case study #2 - Differences in currency format in JDK and ICU

JDK:

- NUMBERSTYLE
- **CURRENCYSTYLE**
- PERCENTSTYLE
- SCIENTIFICSTYLE
- INTEGERSTYLE

($123,456.79)

ICU:

- ACCOUNTINGCURRENCYSTYLE ***($123,456.79)***
- CASHCURRENCYSTYLE
- **CURRENCYSTYLE**
- ISOCURRENCYSTYLE
- NUMBERSTYLE
- PERCENTSTYLE
- SCIENTIFICSTYLE
- INTEGERSTYLE
- PLURALCURRENCYSTYLE

- $123,456.79

Case study #3 - Pattern recognition

my_MM pattern in CLDR

A pattern generated from icu, dd-MM-yyyy B H:mm. The pattern 'B' cannot be recognized by JDK, which is causing exception for following code,

```
new SimpleDateFormat(pattern, locale)
```

Case study #4 - Inconsistent currency code

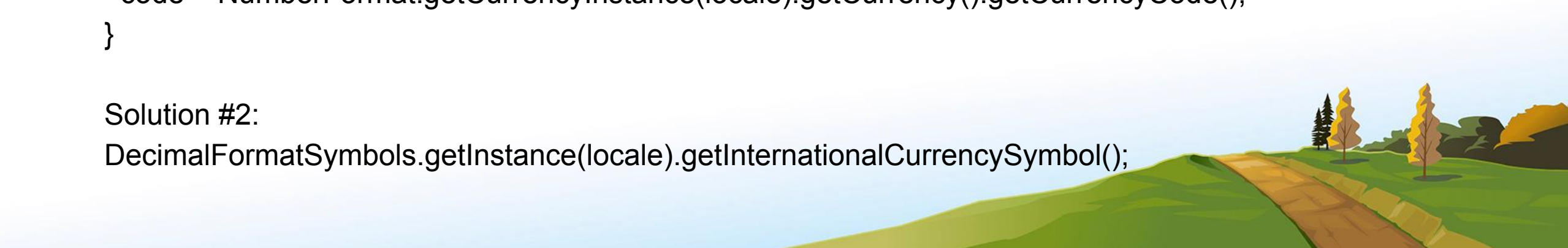
Exception for 'be_BY' and 'pt_ST' locales.

NumberFormat.getCurrencyInstance(locale).getCurrency().getCurrencyCode()

Solution #1: override the currency code for these two locales before calling getCurrency() method.

```
if (locale.toString().equals("be_BY")) {
  code = "BYR"; // JDK:BYR; ICU:BYN
} else if (locale.toString().equals("pt_ST")) {
  code = "STD"; // JDK: STD; ICU:STN
} else {
  code = NumberFormat.getCurrencyInstance(locale).getCurrency().getCurrencyCode();
}
```

Solution #2:
DecimalFormatSymbols.getInstance(locale).getInternationalCurrencySymbol();



Summary

- Accuracy, consistency and easy of maintenance.
- CLDR based libraries.
- Service provider.
- Plan ahead. Know the impact - and where


THANK YOU

Appendix

- CLDR
  http://cldr.unicode.org
- Locale-Sensitive Services SPI
  https://docs.oracle.com/javase/tutorial/i18n/locale/services.html
- ICU4J Locale Service Provider
  http://userguide.icu-project.org/icu4j-locale-service-provider
- Grammaticus
  https://github.com/salesforce/grammaticus