Session ID: SPC250
Making ABAP Programs
Unicode Enabled
Agenda

Part I – SAPs approach to Unicode
- Demo – Unicode vs. Non-Unicode R3
- Unicode Essentials
- Transparent Unicode Enabling for R/3

Part II – Unicode Enabled ABAP
- Unicode Restrictions
- New ABAP Features

Part III – Tools for Unicode Enabling
- Migration to Unicode
- Unicode Scan UCCHECK
- Coverage Analyzer SCOV

Exercises
What is Unicode?

- Character encoding schema for (nearly) all characters used worldwide

What is Unicode? in English

ما هي السفيرة الموحدة "يونيكود"؟ in Arabic

什麼是Unicode(統一碼/標準萬國碼)? in Chinese (Traditional)

What is Unicode? in English

თი ევოუთ თოუნიკოდუ? in Georgian

Τι είναι το Unicode? in Greek

यूनिकोड क्या है? in Hindi

Cos'è Unicode? in Italian

ユニコードとは何か？ in Japanese

유니코드에 대해? in Korean

Что такое Unicode? in Russian

- Each character has a unique number ("Unicode code point")
  - Notation U+nnnn (where nnnn are hexadecimal digits)

- See http://www.unicode.org for complete code charts
Old solution for multiple languages: MDMP*

* Check your system type with report RSCPINST → current configuration
Old solution for multiple languages: MDMP

West European View

Japanese View

Korean View

End of support with NetWeaver 04

(As of release NetWeaver 04s and moving forward, MDMP will no longer be supported)
Only supported solution for multilingual systems: Unicode
**SAP NetWeaver™ the integration platform?**

**Evolution of mySAP Technology**

Unifies and aligns people, information and business processes

- Integrates across technologies and organizational boundaries
- A safe choice with full .NET and J2EE interoperability

**The business foundation for SAP and partners**

- Powers business-ready solutions that reduce custom integration
- Its Enterprise Services Architecture increases business process flexibility

---

### SAP NetWeaver™

<table>
<thead>
<tr>
<th>Composite Application Framework</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEOPLE INTEGRATION</td>
</tr>
<tr>
<td>Multi channel access</td>
</tr>
<tr>
<td>Portal</td>
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<tr>
<td>Collaboration</td>
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<tr>
<td>INFORMATION INTEGRATION</td>
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<td>Bus. Intelligence</td>
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</tbody>
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SAP NetWeaver™ with non-Unicde ABAP stack

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Only solution for full integration: Unicode

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<td>DB and OS Abstraction</td>
<td></td>
</tr>
</tbody>
</table>

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Representation of Unicode Characters

UTF-16 – Unicode Transformation Format, 16 bit encoding
- Fixed length, 1 character = 2 bytes (surrogate pairs = 2 + 2 bytes)
- Platform dependent byte order
- 2 byte alignment restriction

UTF-8 – Unicode Transformation Format, 8 bit encoding
- Variable length, 1 character = 1...4 bytes
- Platform independent
- No alignment restriction
- 7 bit US ASCII compatible

<table>
<thead>
<tr>
<th>Character</th>
<th>Unicode codepoint</th>
<th>UTF-16 big endian</th>
<th>UTF-16 little endian</th>
<th>UTF-8</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>U+0061</td>
<td>00 61</td>
<td>61 00</td>
<td>61</td>
</tr>
<tr>
<td>ä</td>
<td>U+00E4</td>
<td>00 E4</td>
<td>E4 00</td>
<td>C3 A4</td>
</tr>
<tr>
<td>α</td>
<td>U+03B1</td>
<td>03 B1</td>
<td>B1 03</td>
<td>CE B1</td>
</tr>
<tr>
<td>會</td>
<td>U+3479</td>
<td>34 79</td>
<td>79 34</td>
<td>E3 91 B9</td>
</tr>
</tbody>
</table>
Character Expansion Model

- Separate Unicode and non-Unicode versions of R/3

- No explicit Unicode data type in ABAP
- Single ABAP source for Unicode and non-Unicode systems
Transparent Unicode Enabling of R/3

Implications:

- Major part of ABAP coding is ready for Unicode without any changes

- Minor part of ABAP coding written before release SAP_BASIS 6.10 has to be adapted to comply with Unicode restrictions
  - Syntactical restrictions
  - Additional runtime checks
  - Runtime tests for semantic changes
Unicode-Enabled ABAP Programs

Program attribute „Unicode checks active“

- Required to run on a Unicode system

<table>
<thead>
<tr>
<th></th>
<th>Non-Unicode system</th>
<th>Unicode system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attribute set</td>
<td>ok</td>
<td>ok</td>
</tr>
<tr>
<td>(Unicode enabled)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attribute not set</td>
<td>ok</td>
<td>not allowed</td>
</tr>
<tr>
<td>(not Unicode enabled)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- If attribute is set, additional restrictions:
  - apply at compile and at run time
  - apply in Unicode systems and in non-Unicode systems
  - ensure that program will run on non-Unicode and Unicode systems with (almost) identical behavior
### Program Attribute „Unicode checks active“

<table>
<thead>
<tr>
<th>Title</th>
<th>Example: Unicode enabled program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original language</td>
<td>EN English</td>
</tr>
<tr>
<td>Created</td>
<td>13.08.2001</td>
</tr>
<tr>
<td>Last changed by</td>
<td>13.08.2001</td>
</tr>
<tr>
<td>Status</td>
<td>Inactive</td>
</tr>
</tbody>
</table>

#### Attributes

- **Type**: Executable program
- **Development class**: $TMP
- **Logical database**: 
- **Selection screen**: 
- **Editor lock**: On
- **Unicode checks active**: On
- **Fixed point arithmetic**: Off
- **Start using variant**: Off
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Exercises
Unicode Enabled ABAP - Overview

Design Goals

- Platform independence
  - Identical behavior on Unicode and non-Unicode systems
- Highest level of compatibility to the pre-Unicode world
  - Minimize costs for Unicode enabling of ABAP Programs
- Improved security, maintainability, and readability of ABAP programs

Main Features

- Clear distinction between character and byte processing
  - 1 Character ≠ 1 Byte
- Enhanced checks prevent programming based on memory layout assumptions
- Improved conversion facilities
- Improved dataset interface
- Improved support for dynamic programming
Unicode Restrictions – String Processing

Character Processing

CONCATENATE cf1 cf2 TO cf3.
IF cf1 CS cf2. ...

String operations are only allowed for character-like operands

- ABAP types C, N, D, and T, STRING
- Structures consisting only of characters (C, N, D, T)
- X and XSTRING are no longer considered character-like types

Byte Processing

CONCATENATE xf1 xf2 TO xf3 IN BYTE MODE.
IF xf1 BYTE-CS xf2. ...

Variants of string operations for byte processing

- Addition “IN BYTE MODE“ for statements
- Prefix „BYTE-“ for comparison operations

Only operands of type X or XSTRING allowed
Determining the Length and Distance

Counted in bytes or in characters? Specify!

DESCRIBE FIELD...LENGTH... IN (BYTE | CHARACTER) MODE

DESCRIBE DISTANCE BETWEEN ... AND ... INTO ...
IN (BYTE | CHARACTER) MODE.

Example

FORM write3 USING fld TYPE c.
  DATA: fldlen TYPE i.
  DESCRIBE FIELD fld LENGTH fldlen IN CHARACTER MODE.
  IF fldlen >= 3.
    WRITE: / fld(3).
  ENDF.
ENDFORM.
**Unicode Restrictions - MOVE**

**MOVE Between Incompatible Structures**

- Matching data layout ("fragment views") required

**Example**

**DATA:**
```
BEGIN OF cstru,
  first(10) TYPE c,
  tab(1)    TYPE c,
  last(10)  TYPE c,
END OF cstru.
```

```
BEGIN OF xstru,
  first(10) TYPE c,
  tab(1) TYPE x VALUE '09',
  last(10) TYPE c,
END OF xstru.
```

```
cstru = xstru.
```

"Unicode error!"
Unicode Restrictions – Access with Offset or Length

Access To Structures With Offset/Length

- Structure must begin with characters
- Offset/length counted in characters
- Access only allowed within the character type prefix of a structure

ASSIGN fld+off(len) TO ...

- Access must not exceed field boundaries
- If ASSIGN fails, field-symbol is set to „unassigned“
- New ... RANGE addition allows the permissible boundaries to be expanded
New ABAP Features – Character Utilities

Class CL_ABAP_CHAR_UTILITIES

- Constant attributes with system specific values

  charsize: length of 1 character in bytes
  newline
  cr lf
  form_feed
  horizontal_tab
  vertical_tab
  backspace
  minchar: X'00' in non-Unicode systems, U+0000 in Unicode systems
  maxchar: X'FF' in non-Unicode systems, U+FFFD in Unicode systems

Example

CLASS cl_abap_char_utilities DEFINITION LOAD.

DATA: text TYPE string.

REPLACE cl_abap_char_utilites=>horizontal_tab WITH space INTO text.
New ABAP Features – Extended File Interface

Reading / Writing Different Text Formats

OPEN DATASET dsn IN TEXT MODE
   ENCODING (DEFAULT | UTF-8 | NON-UNICODE).
TRANSFER text TO dsn.
READ DATASET dsn INTO text.

- Only character-like fields allowed for reading / writing text files
- Explicit open required in Unicode enabled programs

Reading / Writing Legacy Formats

OPEN DATASET dsn IN Legacy (TEXT | BINARY) MODE
   ... (LITTLE | BIG) ENDIAN
   ... CODEPAGE cp.

- Reading or writing data in a format compatible to non-Unidecode systems
- Not character-like structures allowed
Conversion classes

- **Code page conversion**
  - Unicode / non-Unicode code pages

- **Endian conversion**
  - little endian / big endian byte order

- **Character conversion**
  - Unicode codepoint / ABAP character

<table>
<thead>
<tr>
<th>ABAP Class</th>
<th>Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>CL_ABAP_CONV_IN_CE</td>
<td>any code page → system code page</td>
</tr>
<tr>
<td>CL_ABAP_CONV_OUT_CE</td>
<td>system code page → any code page</td>
</tr>
<tr>
<td>CL_ABAP_CONV_X2X_CE</td>
<td>any code page → any code page</td>
</tr>
</tbody>
</table>
New ABAP Features – Includes with Group Names

Symbolic Access to Includes of Structures

```
TYPES: BEGIN OF t_key,
  k1(2) TYPE x,
  k2(2) TYPE c,
END OF t_key.

TYPES: BEGIN OF t_rest,
  r1(10) TYPE c,
  r2(10) TYPE c,
END OF t_rest.

DATA: BEGIN OF stru.
  INCLUDE TYPE t_key as key.
  INCLUDE TYPE t_rest as rest.
DATA: END OF stru.
DATA: skey TYPE t_key,
  srest TYPE t_rest.
```

Pre-Unicode

```
skey = stru(4).
srest = stru+4(20).
WRITE: stru-r2.
```

Unicode enabled with group names

```
skey = stru-key.
srest = stru-rest.
WRITE: stru-r2.
```
New ABAP Features – Import/Export Data Buffer

Using fields of type xstring as data containers

Writing data to an xstring.

```plaintext
DATA: my_buffer TYPE xstring.
       data1    TYPE some_type.
...
EXPORT id = data1 TO DATA BUFFER my_buffer.
```

- Data is stored in a platform-independent format
- Contents of xstring can be exchanged with any other 6.10-system (Unicode and non-Unicode)

Reading data from an xstring

```plaintext
FORM read_buffer USING buffer TYPE xstring.
   DATA: fld2    TYPE some_type.
   IMPORT id = fld2 FROM DATA BUFFER buffer.
   ...
ENDFORM.
```

- Automatic conversion of data during import
New ABAP Features – Dynamic Programming Support

Creating Data Objects Dynamically

- Creating and accessing data objects on the heap

  ```
  DATA: dref TYPE REF TO data.
  CREATE DATA dref TYPE sometype.
  CREATE DATA dref TYPE (typename).
  CREATE DATA dref TYPE c LENGTH len.
  CREATE DATA dref TYPE STANDARD TABLE OF (typename)
  ASSIGN dref->* TO <f>. "access data object
  ```

Casting to User Defined Types

- Look at the contents of a field as a value of another type

  ```
  FIELD-SYMBOLS: <f> TYPE any.
  ASSIGN fld TO <f> CASTING TYPE sometype.
  ASSIGN fld TO <f> CASTING TYPE (typename).
  ```

- fld must provide sufficient alignment and length for the given type
New generic types for parameters and field-symbols

- Eliminate untyped parameters or field-symbols for improved security and performance
If you are writing software for others you may have the following **Problem**

- Enhancements on structures or tables may affect your coding:
  - Syntax-/runtime errors
  - Changed behavior (e.g. damaged or changed data)

**Solution**

- Maintaining the enhancement category in the DDIC: SE11 (Extras -> Enhancement Category)
  - Can not be enhanced
  - Can be enhanced - character like
  - Can be enhanced – character and numerical type
  - Can be arbitrarily enhanced

→ Additional checks are done on your ABAP programs (SLIN) and show possible problems in allowed enhancement situations
ABAP lists: Difference between memory and display length

<table>
<thead>
<tr>
<th>'한'</th>
<th>Character units in the memory</th>
<th>Display columns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Unicode</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Unicode</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

1 Character ≠ 1 Display Column
Handling for character fields:

Truncation may be done during display to synchronize memory length and display length at the field boundaries.
Handling for strings:

Padding is done in the list table (here for the first field S1) to synchronize memory length and display length at the field boundaries.
New ABAP Features – Different list types

**Half width (Default)**

<table>
<thead>
<tr>
<th>Demo program ABA 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>KO 하나</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>KO 네</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>KO 일곱</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>KO 스물&gt;</td>
</tr>
<tr>
<td>21</td>
</tr>
</tbody>
</table>

**Dynamic**

<table>
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<tr>
<td>KO 네</td>
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<tr>
<td>KO 스물 하나 &gt;</td>
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</table>

**Full width**

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<tr>
<td>21</td>
</tr>
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</table>
New ABAP Features – ABAP list programming

New ABAP statements

- SET/GET CURSOR MEMORY OFFSET

- Dynamic output length: WRITE (*) field.
  Maximum output length: WRITE (**) field.

Utility Class CL_ABAP_LIST_UTILITIES

- Calculating display lengths
- Conversions display length ↔ memory length inside fields
- Handling of implicit field boundaries

See note 541299 for details
New ABAP Features – ABAP list programming

Field with implicit structure

a) memory-layout  
b) display-layout
Golden rules for ABAP list programming

a) Don’t mix up display length and memory length
b) Don’t smudge field boundaries
c) Don’t overwrite parts of fields
d) Don’t do self programmed right-justified or centered
e) Don’t do self programmed scrolling (memory based)
f) Don’t forget to specify sufficient output length, if all data needs always to be visible
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Exercises
Migrating to Unicode Enabled ABAP

Step 1

- In non-Unicode system
- Adapt all ABAP programs to Unicode syntax and runtime restrictions
- Set attribute "Unicode enabled" for all programs

Step 2

- Set up a Unicode system
  - Unicode kernel + Unicode database
  - Only ABAP programs with the Unicode attribute are executable
- Do runtime tests in Unicode system
  - Check for runtime errors
  - Look for semantic errors
  - Check ABAP list layout with former double byte characters
Step 1 – Unicode Enabling with UCCHECK

Use UCCHECK to analyze your applications:

- Remove errors
- Inspect statically not analyzable places (optional)
  - Untyped field symbols
  - Offset with variable length
  - Generic access to database tables
- Set unicode program attribute using UCCHECK or SE38 / SE24 / ...
- Do additional checks with SLIN (e.g. matching of actual and formal parameters in function modules)
**Transaction UCCHECK**

**Check a Program Set for Syntax Errors in Unicode Environment**

### Object Selection

- **Object Name**: ZTECHED_UNICODE_E...
- **Object Type**: ...
- **Author (TADIR)**: ...
- **Package**: ...
- **Original System**: ...

- **Check only programs where the Unicode flag is unchecked**
- **Include only Objects with Object Repository Entry (TADIR)**
- **Exclude S* Packages**

### Restriction of Program Set to Prevent Timeout

- **Maximum Number of Programs**: 50

### Statements that cannot be analysed statically

- **Display lines that cannot be analyzed statically**
- **Show also Locations Hidden with '#C*':**
- **Includes to Be Displayed**: LSM1M*

### Application-specific Checks

- **View Maintenance**
- **Obsolete Function Modules: UPLOAD/DOWNLOAD**

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**UCCHECK – Setting Unicode Flag**

<table>
<thead>
<tr>
<th>Ex... Program</th>
<th>Include</th>
<th>Row</th>
<th>Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZTECHED_UNICODE_EXERCISE_4</td>
<td>ZTECHED...</td>
<td>80</td>
<td>&quot;ENTRY-CONTENTS&quot; and &quot;PERS&quot; are not mutually convertible in a Unicode program.</td>
</tr>
<tr>
<td>ZTECHED_UNICODE_EXERCISE_4</td>
<td>ZTECHED...</td>
<td>94</td>
<td>&quot;ENTRY-CONTENTS&quot; and &quot;PERS&quot; are not mutually convertible in a Unicode program.</td>
</tr>
<tr>
<td>ZTECHED_UNICODE_EXERCISE_4</td>
<td>ZTECHED...</td>
<td>104</td>
<td>&quot;PERS&quot; and &quot;CONTAINER_LINE-CONTENTS&quot; are not mutually convertible in a Unicode program.</td>
</tr>
<tr>
<td>ZTECHED_UNICODE_EXERCISE_5</td>
<td>ZTECHED...</td>
<td>42</td>
<td>The system could not perform a static compatibility check on the current statement because of untyped or generic operands. The system will only carry out this check at runtime.</td>
</tr>
<tr>
<td>ZTECHED_UNICODE_EXERCISE_5</td>
<td>ZTECHED...</td>
<td>42</td>
<td>The system cannot perform a static check on the validity of the offset/length entries for operand &quot;CONTAINER+&lt;DT&gt;-OFFSET(&lt;DT&gt;-INTLEN)&quot;. They will be checked at runtime.</td>
</tr>
<tr>
<td>ZTECHED_UNICODE_EXERCISE_5</td>
<td>ZTECHED...</td>
<td>48</td>
<td>The system cannot perform a static check on incompletely-typed operand &quot;&lt;F&gt;&quot; to check whether or not the operand can be converted to a string.</td>
</tr>
<tr>
<td>ZTECHED_UNICODE_SOLUTION_1</td>
<td>ZTECHED...</td>
<td>0</td>
<td>The system found no Unicode syntax errors</td>
</tr>
<tr>
<td>ZTECHED_UNICODE_SOLUTION_2</td>
<td>ZTECHED...</td>
<td>0</td>
<td>The system found no Unicode syntax errors</td>
</tr>
<tr>
<td>ZTECHED_UNICODE_SOLUTION_3</td>
<td>ZTECHED...</td>
<td>0</td>
<td>The system found no Unicode syntax errors</td>
</tr>
<tr>
<td>ZTECHED_UNICODE_SOLUTION_4</td>
<td>ZTECHED...</td>
<td>0</td>
<td>The system found no Unicode syntax errors</td>
</tr>
</tbody>
</table>
What to do with the places that can only be checked at runtime?

- Reduce their number
  - In many cases you can specify the type of parameters and field-symbols
  - Use generic ABAP types where necessary
  - Mark those places that really need untyped parameters due to some kind of generic programming with “#EC * as OK after you did revise them.

- Do ➔ Runtime tests
Step 2 – Testing Your Application

Final tests in the Unicode system

Runtime tests, Runtime tests, Runtime tests, ...

✦ Because the amount of warnings due to statically not analyzable places may be very large, you cannot type everything. In this case you have to rely on runtime tests.

✦ Some semantic problems may be seen only in the Unicode system (e.g. byte or character length)

✦ ABAP list layout can be checked only manually

Monitoring of runtime tests:

Having test plans is good, knowing the coverage of the test is better:

Use the ABAP Coverage Analyzer to monitor runtime tests
Coverage Analyzer (Transaction SCOV)

- persistently traces the execution of all program objects within one system
- traces all processing blocks
  - i.e. FORMS, Methods, Modules... and ABAP events
- collects Information
  - Number of calls
  - Number of runtime errors
  - Number of program changes

Two Different Target Groups

- Developers
  - Help to see in detail which parts of your programs are used and which are not
- Quality Managers
  - Determine the overall system coverage during a test phase
Coverage Analyzer – Details View for Developers

Coverage Analyzer: Processing Blocks

Processing Blocks

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ESEL</td>
<td>FORM</td>
<td>ENTER_VALUE</td>
<td></td>
<td>15</td>
<td>0</td>
<td>1</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>F0</td>
<td></td>
<td></td>
<td></td>
<td>43</td>
<td>0</td>
<td>1</td>
<td>26</td>
<td>0</td>
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<td></td>
<td></td>
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<td>1</td>
<td>1</td>
<td>0</td>
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<td>0</td>
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<td></td>
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<td>11</td>
<td>0</td>
</tr>
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<td>1</td>
<td>0</td>
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<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F11</td>
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<td>1</td>
<td>1</td>
<td>0</td>
</tr>
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<td>12</td>
<td>0</td>
<td>1</td>
<td>10</td>
<td>2</td>
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<tr>
<td>START</td>
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<td></td>
<td></td>
<td>18</td>
<td>0</td>
<td>1</td>
<td>12</td>
<td>0</td>
</tr>
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<td>0</td>
<td>1</td>
<td>12</td>
<td>0</td>
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<td>18</td>
<td>0</td>
<td>1</td>
<td>12</td>
<td>0</td>
</tr>
</tbody>
</table>
Coverage Analyzer – Global View for QM

View for SAP Component Hierarchy

Legend

Value Table

History of Test Group ALL for Node ALL

1
2
3
4

Part I – SAPs approach to Unicode

- Demo – Unicode vs. Non-Unicode R3
- Unicode Essentials
- Transparent Unicode Enabling for R/3

Part II – Unicode Enabled ABAP

- Unicode Restrictions
- New ABAP Features

Part III – Tools for Unicode Enabling

- Migration to Unicode
- Unicode Scan UCCHECK
- Coverage Analyzer SCOV

Exercises
Further information

Public Web:
http://www.service.sap.com/Unicode@sap : Technology
http://www.service.sap.com/Unicode : Customer contact

Related SAP Education Training Opportunities
http://www.service.sap.com/rkt-unicode

Related Workshops/Lectures at SAP TechEd 2005
SPC202 Conversion of SAP Systems to Unicode, lecture
SPC204 Performance Techniques for Unicode Conversion of Single Code Page Systems, lecture (Teched Boston only)
SPC250 Making ABAP Programs Unicode Enabled; hands on
SPC251 Unicode Interfaces – Data Exchange Between Unicode and non-Unicode Systems, hands on
LCM207 SAP Upgrade and Unicode Methodology, (Teched Boston only)
IM101 Dealing with Multi-Language Garbage Data – Lessons Learned, lecture (Teched Boston only)
Feedback

Please complete your session evaluation.

Be courteous — deposit your trash, and do not take the handouts for the following session.

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