z/TPF EE V1.1
z/TPFDF V1.1
TPF Toolkit for WebSphere® Studio V3
TPF Operations Server V1.2

IBM Software Group

TPF Users Group Fall 2006

Decimal Applications

Name: Edwin W. van de Grift

Venue: Hot Topics

AIM Enterprise Platform Software

IBM z/Transaction Processing Facility Enterprise Edition 1.1.0

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What is a Decimal?

- Decimal
  - **From Wikipedia, the free encyclopedia**
  - The decimal (base ten or occasionally denary) numeral system has ten as its base.
  - It is the most widely used numeral system, probably because humans commonly have a total of ten digits on their hands.

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Floating Point Terminology

$$\pm d.dd\ldots d \times \beta^{e}$$

- d.dd…d – **Significand**
  - Where $0 \leq d < \beta$
  - The number of digits in the significand is called the **precision**.
  - Also refered to as **coefficient** or mantissa.
- β – **Base**
  - β is assumed to be even.
- e – **Exponent**

Decimal Floating Point (DFP)
β =10

- A floating point number is **normalized** when the leading digit of the significand is nonzero.

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An Example

- The number 0.1 in Decimal versus Binary
  - Decimal ($\beta = 10$) with precision 3

    1.00×10^{-1}
  - Binary ($\beta = 2$) with precision 24

    $1.10011001100110011001101 \times 2^{-4}$
    - **Cannot be represented exactly!**

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Decimal Floating Point in GCC 4.2

- GCC 4.2 targeted for Q3 2006
- z/TPF support of GCC 4.2 is likely
- New native types
  - **_Decimal32**
    - 7 decimal digits
  - **_Decimal64**
    - 16 decimal digits
  - **_Decimal128**
    - 34 decimal digits
    - Fits every packed number and more!

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Encoding

- 1 Bit Sign
- 5 Bits Combination Field
  - 2 Most significant bits of the exponent. Values 0-2.
  - Most significant digit (4 bits) of the coefficient. Values 0-9.
- 6, 8, 12 Bits Exponent Continuation
  - The exponent is encoded, by adding a bias so that the encoded exponent is greater than or equal to 0. Biases are 101, 398, 6176
- 20, 50, 110 Bits Coefficient Continuation
  - Densely Packed Decimal, 3 digits in 10 bits
  - 7, 16, 34 Digit Coefficient

- Supports
  - ±0
  - ±Infinity
  - Not-a-Number (NaN)
    - Signaling and Quiet

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Decimal Encoding Example

	Decimal64
-7.50	A2 30 00 00 00 00 03 D0

- Sign = 1
- Coefficient = 0000000000000750
  - First digit (0) in combination field
  - Remaining digits (15) in coefficient continuation
    - X'11 1101 0000'
- Exponent = -2
  - Encoded exponent -2 + bias (396)
    - X'01 1000 1100'

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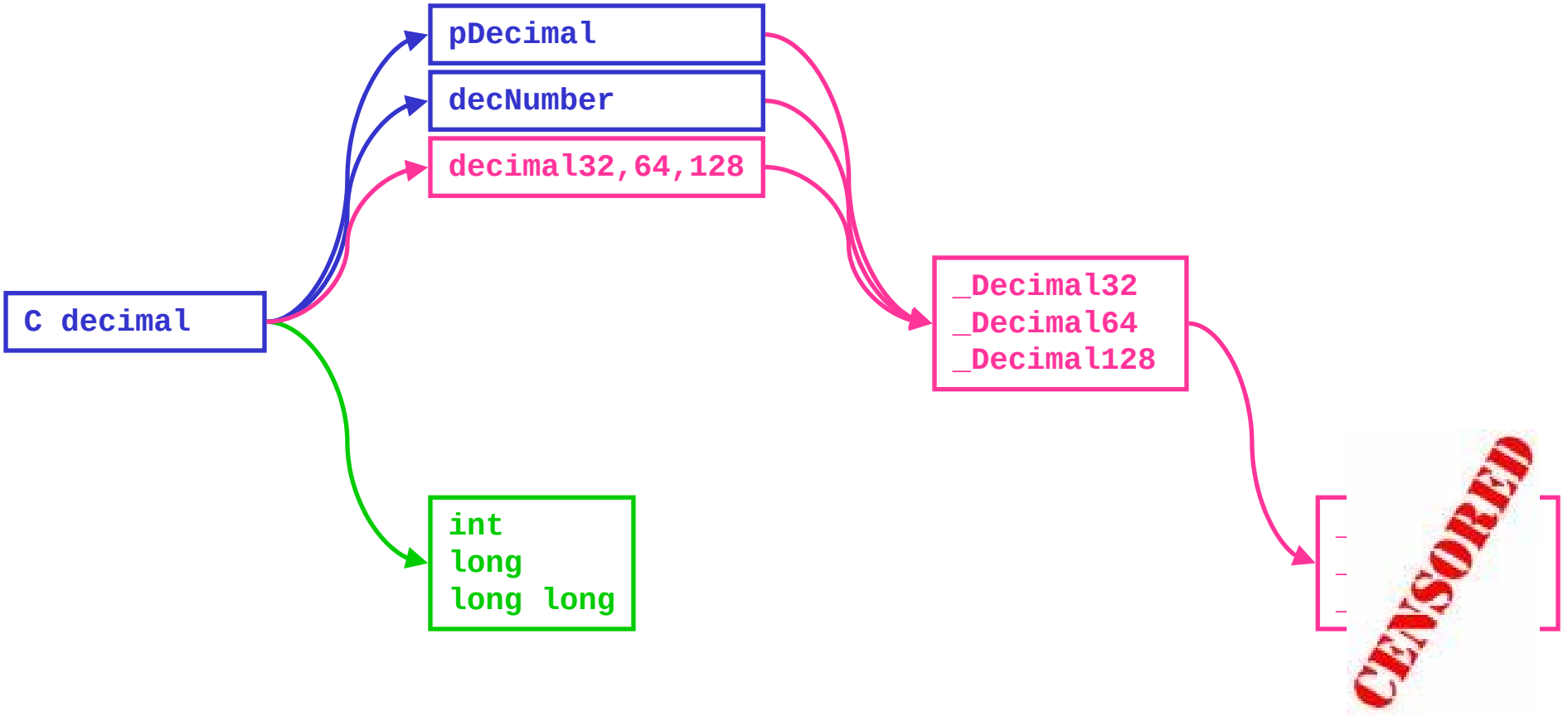
Migrations

Data format:
IBM packed decimal
binary
IEEE decimal floating point

TPF4.1 | **TPF4.1 & z/TPF** | **z/TPF**

software compiler hardware



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Sample Code

```
decimal(5,2) d1 = 1.2;
decimal(3) d2 = 42;

decimal(9,4) d3 = d1 * d2;
```

```
_Decimal128 d1 = 1.2DL;
_Decimal128 d2 = 42DL;

_Decimal128 d3 = d1 * d2;
```


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Conversion Functions

```
_Decimal32  packedToDecimal32(unsigned char* packed, int width, int precision,
                              _Decimal32 d);
_Decimal64  packedToDecimal64(unsigned char* packed, int width, int precision,
                              _Decimal64 d);
_Decimal128 packedToDecimal128(unsigned char* packed, int width, int precision,
                               _Decimal128 d);


unsigned char* decimal32ToPacked(_Decimal32 d,
                                 unsigned char* packed, int width, int precision);
unsigned char* decimal64ToPacked(_Decimal64 d,
                                 unsigned char* packed, int width, int precision);
unsigned char* decimal128ToPacked(_Decimal128 d,
                                  unsigned char* packed, int width, int precision);
```

- More/other information will come with TPF support of GCC 4.2

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References

- Floating Point Standards
  - IEEE 754 governs binary floating-point arithmetic.
    - It specifies number formats, basic operations, conversions, and exceptional conditions.
  - The related standard IEEE 854 generalizes 754 to cover decimal arithmetic as well as binary.
  - Revision IEEE 754r
    - Merging 854 into 754, reducing implementation choices, resolving ambiguities in 754, standardizing fused multiply-add, and including quadruple precision.

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