SIMD Shuffle y Conversiones

Organización del Computador II

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21-04-2015

Agenda

- Problemas de Precisión
- Instrucciones de Shuffle
- Instrucciones de Conversión
- Ejercicios

Problemas de Precisión

No todos los numeros pueden ser representados de **forma exacta** en punto flotante

Por ejemplo: El número 1,1 no es posible de ser representado en Float de forma exacta, siendo el mas aproximado: 1,100000023841858

Las operaciones en enteros no necesariamente generan resultados que caben en un entero del mismo tamaño

Por ejemplo: La operación en bytes $0xFE \cdot 0x10$ da como resultado $0x0FE0$, no entra en un byte

Incluso es muy simple perder precisión si nuestros datos temporales son enteros

Por ejemplo: Si hacemos la operación $(0xFE + 0x11)/0x02$ en enteros, el resultado es $0x87$, siendo el correcto $0x87,8$

Problemas de Precisión

Moraleja,

- Antes de hacer cualquier calculo, **analizar** detalladamente los pasos a realizar
- Entender cuando se **pierde precisión** y decidir que hacer al respecto
- Las operaciones en enteros son **exactas** en enteros
- Las operaciones en punto flotante son siempre **aproximadas**
- Las operaciones de conversión son **muy costosas**
- Usar operaciones de enteros sobre punto flotante o a la inversa, implica una **penalidad** en tiempo
- Las operaciones en punto flotante son **mas costosas** que las de enteros.

Shuffles

Las instrucciones de *Shuffles* permiten **reordenar** datos en registros. Sus parámetros serán el **registro a reordenar** y una **mascará** que indicará como hacerlo.

- PSHUFB - Shuffle Packed Bytes
- PSHUFW - Shuffle Packed Words
- PSHUFD - Shuffle Packed Doublewords

- PSHUFHW - Shuffles high 16bit values
- PSHUFLW - Shuffles low 16bit values

- SHUFPS - Shuffle Packed Single FP Values
- SHUFPD - Shuffle Packed Double FP Values

Shuffles

PSHUFB — Packed Shuffle Bytes

Opcode/ Instruction	Op/ En	64/32 bit Mode Support	CPUID Feature Flag	Description
0F 38 00 /r[1] PSHUFB *mm1, mm2/m64*	RM	V/V	SSSE3	Shuffle bytes in *mm1* according to contents of *mm2/m64*.
66 0F 38 00 /r PSHUFB *xmm1, xmm2/m128*	RM	V/V	SSSE3	Shuffle bytes in *xmm1* according to contents of *xmm2/m128*.
VEX.NDS.128.66.0F38.WIG 00 /r VPSHUFB *xmm1, xmm2, xmm3/m128*	RVM	V/V	AVX	Shuffle bytes in *xmm2* according to contents of *xmm3/m128*.
VEX.NDS.256.66.0F38.WIG 00 /r VPSHUFB *ymm1, ymm2, ymm3/m256*	RVM	V/V	AVX2	Shuffle bytes in *ymm2* according to contents of *ymm3/m256*.

PSHUFB (with 128 bit operands)

```
    for i = 0 to 15 {
        if (SRC[(i * 8)+7] = 1 ) then
            DEST[(i*8)+7..(i*8)+0] ← 0;
        else
            index[3..0] ← SRC[(i*8)+3 .. (i*8)+0];
            DEST[(i*8)+7..(i*8)+0] ← DEST[(index*8+7)..(index*8+0)];
        endif
    }
DEST[VLMAX-1:128] ← 0
```

PSHUFW—Shuffle Packed Words

Opcode/ Instruction	Op/ En	64-Bit Mode	Compat/ Leg Mode	Description
0F 70 /*r* ib PSHUFW *mm1, mm2/m64, imm8*	RMI	Valid	Valid	Shuffle the words in *mm2/m64* based on the encoding in *imm8* and store the result in *mm1*.

```
DEST[15:0] ← (SRC >> (ORDER[1:0] * 16))[15:0];
DEST[31:16] ← (SRC >> (ORDER[3:2] * 16))[15:0];
DEST[47:32] ← (SRC >> (ORDER[5:4] * 16))[15:0];
DEST[63:48] ← (SRC >> (ORDER[7:6] * 16))[15:0];
```

PSHUFD—Shuffle Packed Doublewords

Opcode/ Instruction	Op/ En	64/32 bit Mode Support	CPUID Feature Flag	Description
66 0F 70 /r ib PSHUFD *xmm1, xmm2/m128, imm8*	RMI	V/V	SSE2	Shuffle the doublewords in *xmm2/m128* based on the encoding in *imm8* and store the result in *xmm1*.
VEX.128.66.0F.WIG 70 /r ib VPSHUFD *xmm1, xmm2/m128, imm8*	RMI	V/V	AVX	Shuffle the doublewords in *xmm2/m128* based on the encoding in *imm8* and store the result in *xmm1*.
VEX.256.66.0F.WIG 70 /r ib VPSHUFD *ymm1, ymm2/m256, imm8*	RMI	V/V	AVX2	Shuffle the doublewords in *ymm2/m256* based on the encoding in *imm8* and store the result in *ymm1*.

PSHUFD (128-bit Legacy SSE version)

```
DEST[31:0] ← (SRC >> (ORDER[1:0] * 32))[31:0];
DEST[63:32] ← (SRC >> (ORDER[3:2] * 32))[31:0];
DEST[95:64] ← (SRC >> (ORDER[5:4] * 32))[31:0];
DEST[127:96] ← (SRC >> (ORDER[7:6] * 32))[31:0];
DEST[VLMAX-1:128] (Unmodified)
```

PSHUFLW—Shuffle Packed Low Words

Opcode/ Instruction	Op/ En	64/32 bit Mode Support	CPUID Feature Flag	Description
F2 0F 70 /r ib PSHUFLW *xmm1, xmm2/m128, imm8*	RMI	V/V	SSE2	Shuffle the low words in *xmm2/m128* based on the encoding in *imm8* and store the result in *xmm1*.
VEX.128.F2.0F.WIG 70 /r ib VPSHUFLW *xmm1, xmm2/m128, imm8*	RMI	V/V	AVX	Shuffle the low words in *xmm2/m128* based on the encoding in *imm8* and store the result in *xmm1*.
VEX.256.F2.0F.WIG 70 /r ib VPSHUFLW *ymm1, ymm2/m256, imm8*	RMI	V/V	AVX2	Shuffle the low words in *ymm2/m256* based on the encoding in *imm8* and store the result in *ymm1*.

PSHUFLW (128-bit Legacy SSE version)

```
DEST[15:0] ← (SRC >> (imm[1:0] *16))[15:0]
DEST[31:16] ← (SRC >> (imm[3:2] * 16))[15:0]
DEST[47:32] ← (SRC >> (imm[5:4] * 16))[15:0]
DEST[63:48] ← (SRC >> (imm[7:6] * 16))[15:0]
DEST[127:64] ← SRC[127:64]
DEST[VLMAX-1:128] (Unmodified)
```

PSHUFHW—Shuffle Packed High Words

Opcode/ Instruction	Op/ En	64/32 bit Mode Support	CPUID Feature Flag	Description
F3 0F 70 /r ib PSHUFHW *xmm1, xmm2/m128, imm8*	RMI	V/V	SSE2	Shuffle the high words in *xmm2/m128* based on the encoding in *imm8* and store the result in *xmm1*.
VEX.128.F3.0F.WIG 70 /r ib VPSHUFHW *xmm1, xmm2/m128, imm8*	RMI	V/V	AVX	Shuffle the high words in *xmm2/m128* based on the encoding in *imm8* and store the result in *xmm1*.
VEX.256.F3.0F.WIG 70 /r ib VPSHUFHW *ymm1, ymm2/m256, imm8*	RMI	V/V	AVX2	Shuffle the high words in *ymm2/m256* based on the encoding in *imm8* and store the result in *ymm1*.

PSHUFHW (128-bit Legacy SSE version)

DEST[63:0] ← SRC[63:0]
DEST[79:64] ← (SRC >> (imm[1:0] *16))[79:64]
DEST[95:80] ← (SRC >> (imm[3:2] * 16))[79:64]
DEST[111:96] ← (SRC >> (imm[5:4] * 16))[79:64]
DEST[127:112] ← (SRC >> (imm[7:6] * 16))[79:64]
DEST[VLMAX-1:128] (Unmodified)

SHUFPS—Shuffle Packed Single-Precision Floating-Point Values

Opcode*/ Instruction	Op/ En	64/32 bit Mode Support	CPUID Feature Flag	Description
0F C6 /r ib SHUFPS *xmm1, xmm2/m128, imm8*	RMI	V/V	SSE	Shuffle packed single-precision floating-point values selected by *imm8* from *xmm1* and *xmm1/m128* to *xmm1*.
VEX.NDS.128.0F.WIG C6 /r ib VSHUFPS *xmm1, xmm2, xmm3/m128, imm8*	RVMI	V/V	AVX	Shuffle Packed single-precision floating-point values selected by *imm8* from *xmm2* and *xmm3/mem*.
VEX.NDS.256.0F.WIG C6 /r ib VSHUFPS *ymm1, ymm2, ymm3/m256, imm8*	RVMI	V/V	AVX	Shuffle Packed single-precision floating-point values selected by *imm8* from *ymm2* and *ymm3/mem*.

SHUFPS (128-bit Legacy SSE version)

DEST[31:0] ← Select4(SRC1[127:0], imm8[1:0]);
DEST[63:32] ← Select4(SRC1[127:0], imm8[3:2]);
DEST[95:64] ← Select4(SRC2[127:0], imm8[5:4]);
DEST[127:96] ← Select4(SRC2[127:0], imm8[7:6]);
DEST[VLMAX-1:128] (Unmodified)

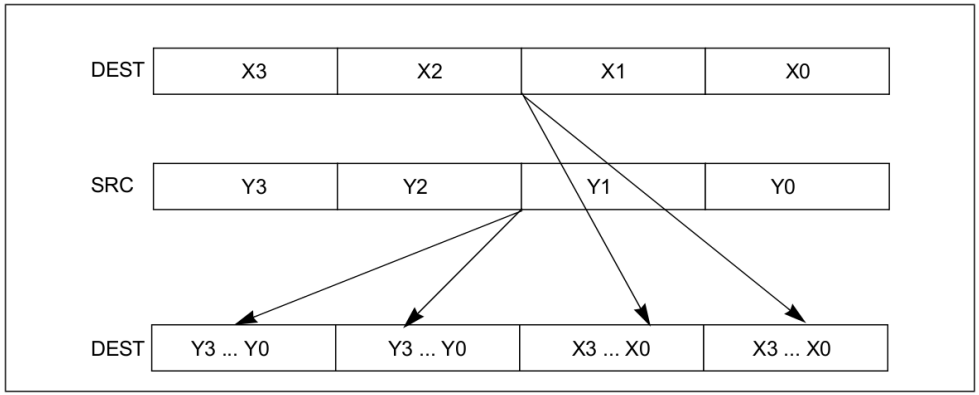

Figure 4-22. SHUFPS Shuffle Operation

SHUFPD—Shuffle Packed Double-Precision Floating-Point Values

Opcode*/ Instruction	Op/ En	64/32 bit Mode Support	CPUID Feature Flag	Description
66 0F C6 /r ib SHUFPD *xmm1, xmm2/m128, imm8*	RMI	V/V	SSE2	Shuffle packed double-precision floating-point values selected by *imm8* from *xmm1* and *xmm2/m128* to *xmm1*.
VEX.NDS.128.66.0F.WIG C6 /r ib VSHUFPD *xmm1, xmm2, xmm3/m128, imm8*	RVMI	V/V	AVX	Shuffle Packed double-precision floating-point values selected by *imm8* from *xmm2* and *xmm3/mem*.
VEX.NDS.256.66.0F.WIG C6 /r ib VSHUFPD *ymm1, ymm2, ymm3/m256, imm8*	RVMI	V/V	AVX	Shuffle Packed double-precision floating-point values selected by *imm8* from *ymm2* and *ymm3/mem*.

SHUFPD (128-bit Legacy SSE version)

```
IF IMM0[0] = 0
    THEN DEST[63:0] ← SRC1[63:0]
    ELSE DEST[63:0] ← SRC1[127:64] FI;
IF IMM0[1] = 0
    THEN DEST[127:64] ← SRC2[63:0]
    ELSE DEST[127:64] ← SRC2[127:64] FI;
DEST[VLMAX-1:128] (Unmodified)
```

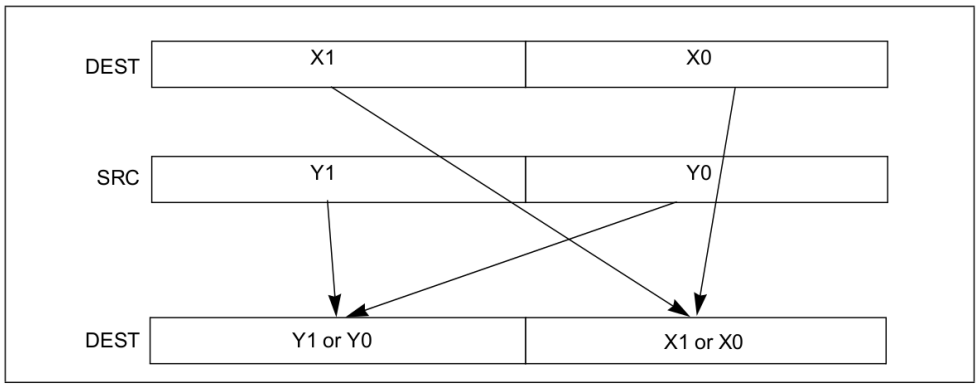

Figure 4-21. SHUFPD Shuffle Operation

Insert/Extract

Las instrucciones de *Insert* y *Extract*, permiten como su nombre lo indica, **insertar** y **extraer** valores dentro de un registro.

- INSERTPS - Insert Packed Single FP Value
- EXTRACTPS - Extract Packed Single FP Value

- PINSRB - Insert Byte
- PINSRW - Insert Word
- PINSRD - Insert Dword
- PINSRQ - Insert Qword

- PEXTRB - Extract Byte
- PEXTRW - Extract Word
- PEXTRD - Extract Dword
- PEXTRQ - Extract Qword

INSERTPS — Insert Packed Single Precision Floating-Point Value

Opcode/ Instruction	Op/ En	64/32-bit Mode	CPUID Feature Flag	Description
66 0F 3A 21 /r ib INSERTPS *xmm1, xmm2/m32, imm8*	RMI	V/V	SSE4_1	Insert a single precision floating-point value selected by *imm8* from *xmm2/m32* into xmm1 at the specified destination element specified by *imm8* and zero out destination elements in *xmm1* as indicated in *imm8*.
VEX.NDS.128.66.0F3A.WIG 21 /r ib VINSERTPS xmm1, xmm2, xmm3/m32, imm8	RVMI	V/V	AVX	Insert a single precision floating point value selected by imm8 from xmm3/m32 and merge into xmm2 at the specified destination element specified by imm8 and zero out destination elements in xmm1 as indicated in imm8.

INSERTPS (128-bit Legacy SSE version)

```
IF (SRC = REG) THEN COUNT_S ← imm8[7:6]
    ELSE COUNT_S ← 0
COUNT_D ← imm8[5:4]
ZMASK ← imm8[3:0]
CASE (COUNT_S) OF
    0: TMP ← SRC[31:0]
    1: TMP ← SRC[63:32]
    2: TMP ← SRC[95:64]
    3: TMP ← SRC[127:96]
ESAC;
```

```
CASE (COUNT_D) OF
    0: TMP2[31:0] ← TMP
       TMP2[127:32] ← DEST[127:32]
    1: TMP2[63:32] ← TMP
       TMP2[31:0] ← DEST[31:0]
       TMP2[127:64] ← DEST[127:64]
    2: TMP2[95:64] ← TMP
       TMP2[63:0] ← DEST[63:0]
       TMP2[127:96] ← DEST[127:96]
    3: TMP2[127:96] ← TMP
       TMP2[95:0] ← DEST[95:0]
ESAC;
```

```
IF (ZMASK[0] = 1) THEN DEST[31:0] ← 00000000H
    ELSE DEST[31:0] ← TMP2[31:0]
IF (ZMASK[1] = 1) THEN DEST[63:32] ← 00000000H
    ELSE DEST[63:32] ← TMP2[63:32]
IF (ZMASK[2] = 1) THEN DEST[95:64] ← 00000000H
    ELSE DEST[95:64] ← TMP2[95:64]
IF (ZMASK[3] = 1) THEN DEST[127:96] ← 00000000H
    ELSE DEST[127:96] ← TMP2[127:96]
DEST[VLMAX-1:128] (Unmodified)
```

EXTRACTPS — Extract Packed Single Precision Floating-Point Value

Opcode/ Instruction	Op/ En	64/32-bit Mode	CPUID Feature Flag	Description
66 0F 3A 17 /r ib EXTRACTPS *reg/m32, xmm2, imm8*	MRI	V/V	SSE4_1	Extract a single-precision floating-point value from *xmm2* at the source offset specified by *imm8* and store the result to *reg or m32*. The upper 32 bits of r64 is zeroed if reg is r64.
VEX.128.66.0F3A.WIG 17 /r ib VEXTRACTPS r/m32, xmm1, imm8	MRI	V/V	AVX	Extract one single-precision floating-point value from xmm1 at the offset specified by imm8 and store the result in reg or m32. Zero extend the results in 64-bit register if applicable.

EXTRACTPS (128-bit Legacy SSE version)

```
SRC_OFFSET ← IMM8[1:0]
IF ( 64-Bit Mode and DEST is register)
    DEST[31:0] ← (SRC[127:0] » (SRC_OFFET*32)) AND 0FFFFFFFFh
    DEST[63:32] ← 0
ELSE
    DEST[31:0] ← (SRC[127:0] » (SRC_OFFET*32)) AND 0FFFFFFFFh
FI
```

PINSRB/PINSRD/PINSRQ — Insert Byte/Dword/Qword

Opcode/ Instruction	Op/ En	64/32 bit Mode Support	CPUID Feature Flag	Description
66 0F 3A 20 /r ib PINSRB *xmm1, r32/m8, imm8*	RMI	V/V	SSE4_1	Insert a byte integer value from *r32/m8* into *xmm1* at the destination element in *xmm1* specified by *imm8.*
66 0F 3A 22 /r ib PINSRD *xmm1, r/m32, imm8*	RMI	V/V	SSE4_1	Insert a dword integer value from *r/m32* into the *xmm1* at the destination element specified by *imm8.*
66 REX.W 0F 3A 22 /r ib PINSRQ *xmm1, r/m64, imm8*	RMI	V/N. E.	SSE4_1	Insert a qword integer value from *r/m64* into the *xmm1* at the destination element specified by *imm8.*
VEX.NDS.128.66.0F3A.W0 20 /r ib VPINSRB *xmm1, xmm2, r32/m8, imm8*	RVMI	V[1]/V	AVX	Merge a byte integer value from *r32/m8* and rest from *xmm2* into *xmm1* at the byte offset in *imm8.*
VEX.NDS.128.66.0F3A.W0 22 /r ib VPINSRD *xmm1, xmm2, r/m32, imm8*				
VEX.NDS.128.66.0F3A.W1 22 /r ib VPINSRQ *xmm1, xmm2, r/m64, imm8*				

```
CASE OF                                                    2/m32
    PINSRB:  SEL ← COUNT[3:0];                             ıe dword
             MASK ← (0FFH << (SEL * 8));
             TEMP ← (((SRC[7:0] << (SEL *8)) AND MASK);    4/m64
    PINSRD:  SEL ← COUNT[1:0];                             ıe qword
             MASK ← (0FFFFFFFFH << (SEL * 32));
             TEMP ← (((SRC << (SEL *32)) AND MASK)  ;
    PINSRQ:  SEL ← COUNT[0]
             MASK ← (0FFFFFFFFFFFFFFFFH << (SEL * 64));
             TEMP ← (((SRC << (SEL *32)) AND MASK)  ;
ESAC;
        DEST ← ((DEST AND NOT MASK) OR TEMP);
```

PINSRW—Insert Word

Opcode/ Instruction	Op/ En	64/32 bit Mode Support	CPUID Feature Flag	Description
0F C4 /r ib[1] PINSRW *mm, r32/m16, imm8*	RMI	V/V	SSE	Insert the low word from *r32* or from *m16* into *mm* at the word position specified by *imm8*.
66 0F C4 /r ib PINSRW *xmm, r32/m16, imm8*	RMI	V/V	SSE2	Move the low word of *r32* or from *m16* into *xmm* at the word position specified by *imm8*.
VEX.NDS.128.66.0F.W0 C4 /r ib VPINSRW *xmm1, xmm2, r32/m16, imm8*	RVMI	V[2]/V	AVX	Insert a word integer value from *r32/m16* and rest from *xmm2* into *xmm1* at the word offset in *imm8*.

PINSRW (with 128-bit source operand)

```
SEL ← COUNT AND 7H;
    CASE (Determine word position) OF
        SEL ← 0:    MASK ← 0000000000000000000000000000FFFFH;
        SEL ← 1:    MASK ← 00000000000000000000000FFFF0000H;
        SEL ← 2:    MASK ← 000000000000000000000FFFF00000000H;
        SEL ← 3:    MASK ← 0000000000000000FFFF000000000000H;
        SEL ← 4:    MASK ← 00000000000FFFF00000000000000000H;
        SEL ← 5:    MASK ← 000000000FFFF000000000000000000H;
        SEL ← 6:    MASK ← 0000FFFF0000000000000000000000H;
        SEL ← 7:    MASK ← FFFF00000000000000000000000000H;
DEST ← (DEST AND NOT MASK) OR (((SRC << (SEL * 16)) AND MASK);
```

Insert/Extract

PEXTRB/PEXTRD/PEXTRQ — Extract Byte/Dword/Qword

Opcode/ Instruction	Op/ En	64/32 bit Mode Support	CPUID Feature Flag	Description
66 0F 3A 14 /r ib PEXTRB *reg/m8, xmm2, imm8*	MRI	V/V	SSE4_1	Extract a byte integer value from *xmm2* at the source byte offset specified by *imm8* into *reg or m8*. The upper bits of r32 or r64 are zeroed.
66 0F 3A 16 /r ib PEXTRD *r/m32, xmm2, imm8*	MRI	V/V	SSE4_1	Extract a dword integer value from *xmm2* at the source dword offset specified by *imm8* into *r/m32*.
66 REX.W 0F 3A 16 /r ib PEXTRQ *r/m64, xmm2, imm8*	MRI	V/N.E.	SSE4_1	Extract a qword integer value from *xmm2* at the source qword offset specified by *imm8* into *r/m64*.
VEX.128.66.0F3A.W0 14 /r ib VPEXTRB *reg/m8, xmm2, imm8*	MRI	V[1]/V	AVX	
VEX.128.66.0F3A.W0 16 /r ib VPEXTRD *r32/m32, xmm2, imm8*	MRI	V/V	AVX	
VEX.128.66.0F3A.W1 16 /r ib VPEXTRQ *r64/m64, xmm2, imm8*	MRI	V/i	AVX	

```
CASE of
    PEXTRB: SEL ← COUNT[3:0];
            TEMP ← (Src >> SEL*8) AND FFH;
            IF (DEST = Mem8)
                THEN
                Mem8 ← TEMP[7:0];
            ELSE IF (64-Bit Mode and 64-bit register selected)
                THEN
                    R64[7:0] ← TEMP[7:0];
                    r64[63:8] ← ZERO_FILL; };
            ELSE
                    R32[7:0] ← TEMP[7:0];
                    r32[31:8] ← ZERO_FILL; };
            FI;
    PEXTRD:SEL ← COUNT[1:0];
            TEMP ← (Src >> SEL*32) AND FFFF_FFFFH;
            DEST ← TEMP;
    PEXTRQ: SEL ← COUNT[0];
            TEMP ← (Src >> SEL*64);
            DEST ← TEMP;
EASC:
```

PEXTRW—Extract Word

Opcode/ Instruction	Op/ En	64/32 bit Mode Support	CPUID Feature Flag	Description
0F C5 /*r* ib[1] PEXTRW *reg, mm, imm8*	RMI	V/V	SSE	Extract the word specified by *imm8* from *mm* and move it to *reg*, bits 15-0. The upper bits of r32 or r64 is zeroed.
66 0F C5 /*r* ib PEXTRW *reg, xmm, imm8*	RMI	V/V	SSE2	Extract the word specified by *imm8* from *xmm* and move it to *reg*, bits 15-0. The upper bits of r32 or r64 is zeroed.
66 0F 3A 15 /r ib PEXTRW *reg/m16, xmm, imm8*	MRI	V/V	SSE4_1	Extract the word specified by *imm8* from *xmm* and copy it to lowest 16 bits of *reg or m16*. Zero-extend the result in the destination, r32 or r64.

```
IF (DEST = Mem16)
THEN
    SEL ← COUNT[2:0];
    TEMP ← (Src >> SEL*16) AND FFFFH;
    Mem16 ← TEMP[15:0];
ELSE IF (64-Bit Mode and destination is a general-purpose register)
    THEN
        FOR (PEXTRW instruction with 64-bit source operand)
          {  SEL ← COUNT[1:0];
             TEMP ← (SRC >> (SEL * 16)) AND FFFFH;
             r64[15:0] ← TEMP[15:0];
             r64[63:16] ← ZERO_FILL; };
        FOR (PEXTRW instruction with 128-bit source operand)
          {  SEL ← COUNT[2:0];
             TEMP ← (SRC >> (SEL * 16)) AND FFFFH;
             r64[15:0] ← TEMP[15:0];
             r64[63:16] ← ZERO_FILL; }
    ELSE
        FOR (PEXTRW instruction with 64-bit source operand)
          {  SEL ← COUNT[1:0];
             TEMP ← (SRC >> (SEL * 16)) AND FFFFH;
             r32[15:0] ← TEMP[15:0];
             r32[31:16] ← ZERO_FILL; };
        FOR (PEXTRW instruction with 128-bit source operand)
          {  SEL ← COUNT[2:0];
             TEMP ← (SRC >> (SEL * 16)) AND FFFFH;
             r32[15:0] ← TEMP[15:0];
             r32[31:16] ← ZERO_FILL; };
    FI;
FI;
```

Blend

Las instrucciones de *Blend* permiten mezclar registros dependiendo de valor de sus datos. Usando tanto inmediatos como otros registros.

- BLENDPS - Blend Packed Single FP Values
- BLENDPD - Blend Packed Double FP Values

- BLENDVPS - Variable Blend Packed Single FP Values
- BLENDVPD - Variable Blend Packed Double FP Values

- PBLENDW - Blend Packed Words

- PBLENDVB - Variable Blend Packed Bytes

Conversiones

Las instrucciones de conversión son de la forma: cvtxx2yy

Donde xx e yy pueden valer:

ps - Packed Single FP	pd - Packed Double FP	pi - Packed Integer
ss - Scalar Single FP	sd - Scalar Double FP	si - Scalar Integer
		dq - Packed Dword

- CVTSD2SI - Scalar Double FP to Dword Integer
  `CVTSD2SI r32, xmm/m64 | CVTSD2SI r64, xmm/m64`
- CVTSI2SD - Dword Integer to Scalar Double FP
  `CVTSI2SD xmm, r/m32 | CVTSI2SD xmm, r/m64`

- CVTDQ2PS - Packed Dword Integers to Packed Single FP (4X)
  `CVTDQ2PS xmm1, xmm2/m128`
- CVTPS2DQ - Packed Single FP to Packed Dword Integers (4X)
  `CVTPS2DQ xmm1, xmm2/m128`

- CVTDQ2PD - Packed Dword Integers to Packed Double FP (2X)
  `CVTDQ2PD xmm1, xmm2/m64`
- CVTPD2DQ - Packed Double FP to Packed Dword Integers (2X)
  `CVTPD2DQ xmm1, xmm2/m128`

Conversiones

Otras instrucciones de conversión (1):

- CVTPD2PS - Packed Double FP to Packed Single FP (2X)
  `CVTPD2PS xmm1, xmm2/m128`
- CVTPS2PD - Packed Single FP to Packed Double FP (2X)
  `CVTPS2PD xmm1, xmm2/m64`

- CVTSD2SS - Scalar Double FP to Scalar Single FP (1X)
  `CVTSD2SS xmm1, xmm2/m64`
- CVTSS2SD - Scalar Single FP to Scalar Double FP (1X)
  `CVTSS2SD xmm1, xmm2/m32`

- CVTTPS2DQ - Truncation Packed Single FP to Packed Dword Int. (4X)
  `CVTTPS2DQ xmm1, xmm2/m128`
- CVTTSS2SI - Truncation Scalar Single FP to Dword Integer (1X)
  `CVTTSS2SI r32, xmm/m32`
- CVTTSD2SI - Truncation Scalar Double FP to Signed Integer (1X)
  `CVTTSD2SI r32, xmm/m64`

Conversiones

Otras instrucciones de conversión (2):

- CVTSI2SS - Dword Integer to Scalar Single FP
  `CVTSI2SS xmm, r/m32`
- CVTSS2SI - Scalar Single FP to Dword Integer
  `CVTSS2SI r32, xmm/m32`
- CVTPI2PS - Packed Dword Integers to Packed Single FP
  `CVTPI2PS xmm, mm/m64`
- CVTPI2PD - Packed Dword Integers to Packed Double FP
  `CVTPI2PD xmm, mm/m64`
- ROUNDPS - Round Packed Single FP to Integer
  `ROUNDPS xmm1, xmm2/m128, imm8`
- ROUNDSS - Round Scalar Single FP to Integer
  `ROUNDSS xmm1, xmm2/m32, imm8`
- ROUNDPD - Round Packed Double FP to Integer
  `ROUNDPD xmm1, xmm2/m128, imm8`
- ROUNDSD - Round Scalar Double FP to Integer
  `ROUNDSD xmm1, xmm2/m64, imm8`

Ejercicios

1. Sea un vector a de n valores punto flotante de 32 bits. Realizar la siguiente operación:
   $\sqrt{a[i*2] \cdot 0{,}7 + a[i*2+1] \cdot 0{,}3} \cdot 255$
   Donde i itera entre 0 y $n/2$. Almacenar el resultado sobre el mismo vector en double y considerar que $n \equiv 0\ (4)$.

2. Sea un vector a de n valores enteros de 32 bits almacenados en big-endian. Convertir cada uno de los valores a double, considerar que $n \equiv 0\ (4)$. Almacenarlos en un nuevo vector de forma que primero se guarden los valores de indice par y luego los de indice impar. Es decir: `XYXY...XYXY` $\rightarrow$ `XXXX...YYYY`

3. Sea un vector a que contiene exactamente 10 valores enteros sin signo de 3 bytes cada uno. Realizar la sumatoria de los mismos y almacenar el resultado en un double.

Ejercicio 1 - Solución

```
section .text                                   section .rodata
  ej1: ; rdi = a, esi = n;                          val0703: dq 0.7, 0.3
    push rbp                                        val255:  dq 255.0, 255.0
    mov rbp,rsp
    mov ecx, esi
    shr ecx, 2
    movdqu xmm8, [val0703]
    movdqu xmm9, [val255]
    .ciclo:
      movdqu xmm0, [rdi]   ; xmm0 = | fp3 | fp2 | fp1 | fp0 |
      cvtPS2PD xmm1, xmm0  ; xmm1 =  |    fp1    |    fp0    |
      psrldq xmm0, 8       ; xmm0 =  |  0     0  | fp3 | fp2 |
      cvtPS2PD xmm2, xmm0  ; xmm2 =  |    fp3    |    fp2    |
      mulpd xmm1, xmm8     ; xmm1 = | 0.3 * fp1 | 0.7 * fp0 |
      mulpd xmm2, xmm8     ; xmm2 = | 0.3 * fp3 | 0.7 * fp2 |
      haddpd xmm1, xmm2    ; xmm1 = | 0.3*fp3+0.7*fp2 | 0.3*fp1+0.7*fp0 |
      sqrtpd xmm1, xmm1    ; xmm1 =  | sqrt(fp3_fp2)  |  sqrt(fp1_fp0)  |
      mulpd xmm1, xmm9     ; xmm1 = | 255*sqrt(fp3_fp2) | 255*sqrt(fp1_fp0) |
      movdqu [rdi], xmm1
      add rdi, 16
    loop .ciclo
    pop rbp
  ret
```

Ejercicio 2 - Solución

```
section .rodata
  bigendian: db 0x03,0x02,0x01,0x00,0x0B,0x0A,0x09,0x08,0x07,0x06,0x05,0x04,0x0F,0x0E,0x0D,0x0C
section .text
  ej2:                      ; rdi = a, esi = n;
    push rbp
    mov rbp,rsp
    push r12
    push rbx
    mov r12, rdi            ; salvo puntero
    mov ebx, esi            ; salvo y limpio cantidad
    lea rdi, [rbx*8]        ; armo el parametro para malloc
    call malloc
    mov ecx, ebx            ; contador de iteraciones n
    shr ecx, 2              ; contador de iteraciones n/4
    mov rdx, rax            ; en rdx contador de primeros
    lea rbx, [rax+rbx*4]    ; en rbx contador de segundos
    movdqu xmm8, [bigendian]
    .ciclo:
        movdqu xmm0, [r12]  ; xmm0 = | int3BIG | int2BIG | int1BIG | int0BIG |
        pshufb xmm0, xmm8   ; xmm0 = | int3 | int1 | int2 | int0 |
        cvtdq2pd xmm1, xmm0 ; xmm1 = |    fp2    |    fp0    |
        psrldq xmm0, 8      ; xmm0 = |  0     0  | fp3 | fp2 |
        cvtdq2pd xmm2, xmm0 ; xmm2 = |    fp3    |    fp1    |
        movdqu [rdx],xmm1
        movdqu [rbx],xmm2
        add r12, 16
        add rdx, 16
        add rbx, 16
    loop .ciclo
    pop rbx
    pop r12
    pop rbp
  ret
```

Ejercicio 3 - Solución

```
section .rodata
  transform5a4: db 0x00,0x01,0x02,0xFF,0x03,0x04,0x05,0xFF,0x06,0x07,0x08,0xFF,0x09,0x0A,0x0B,0xFF
  transform5a1: db 0xFF,0xFF,0xFF,0xFF,0xFF,0xFF,0xFF,0xFF,0xFF,0xFF,0xFF,0xFF,0x0C,0x0D,0x0E,0xFF

section .text
  ej3: ; rdi = a, esi = n;
    push rbp
    mov rbp,rsp
    movdqu xmm8, [transform5a4]
    movdqu xmm9, [transform5a1]
    movdqu xmm0, [rdi]          ; xmm0 = |_|xxx|xxx|xxx|xxx|xxx|
    movdqu xmm1, xmm0           ; xmm1 = |_|xxx|xxx|xxx|xxx|xxx|
    movdqu xmm2, [rdi+10*3-16] ; xmm2 = |yyy|yyy|yyy|yyy|yyy|_|
    psrldq xmm2, 1              ; xmm2 = |_|yyy|yyy|yyy|yyy|yyy|
    movdqu xmm3, xmm2           ; xmm2 = |_|yyy|yyy|yyy|yyy|yyy|
    pshufb xmm0, xmm8           ; xmm0 = |0xxx|0xxx|0xxx|0xxx| (*)
    pshufb xmm1, xmm9           ; xmm1 = |0000|0000|0000|0xxx|
    pshufb xmm2, xmm8           ; xmm2 = |0yyy|0yyy|0yyy|0yyy|
    pshufb xmm3, xmm9           ; xmm3 = |0000|0000|0000|0yyy|
    paddd  xmm0, xmm1           ; xmm0 = |0xxx|0xxx|0xxx|0xxx+0xxx|
    paddd  xmm2, xmm3           ; xmm2 = |0yyy|0yyy|0yyy|0yyy+0yyy|
    phaddd xmm0, xmm2           ; xmm0 = |0xxx+0xxx|0xxx+0xxx+0xxx|0yyy+0yyy|0yyy+0yyy+0yyy|
    phaddd xmm0, xmm0           ; xmm0 = |_|_|0xxx+0xxx+0xxx+0xxx+0xxx|0yyy+0yyy+0yyy+0yyy+0yyy|
    phaddd xmm0, xmm0           ; xmm0 = |_|_|_|0xxx+0xxx+0xxx+0xxx+0xxx+0yyy+0yyy+0yyy+0yyy+0yyy|
    cvtdq2pd xmm0, xmm0         ; xmm0 = |_|double(0xxx+0xxx+0xxx+0xxx+0xxx+0yyy+0yyy+0yyy+0yyy+0yyy)|
    pop rbp
  ret
```

¿Preguntas?