

## TLBI VAE2OS, TLBI VAE2OSNXS, TLB Invalidate by VA, EL2, Outer Shareable

The TLBI VAE2OS, TLBI VAE2OSNXS characteristics are:

### Purpose

When EL2 is implemented and enabled in the current Security state, invalidates cached copies of translation table entries from TLBs that meet all the following requirements:

- The entry is a 64-bit stage 1 translation table entry.  
Or if FEAT\_D128 is implemented, and the entry is a 128-bit stage 1 translation table entry, if TTL[3:2] is 0b00.
- The entry would be required to translate the specified VA using the EL2 or EL2&0 translation regime, as determined by the current value of the [HCR\\_EL2.E2H](#) bit, for the Security state.
- If [HCR\\_EL2.E2H](#) == 0, the entry is from any level of the translation table walk.
- If [HCR\\_EL2.E2H](#) == 1, one of the following applies:
  - The entry is from a level of the translation table walk above the final level and matches the specified ASID.
  - The entry is a global entry from the final level of the translation table walk.
  - The entry is a non-global entry from the final level of the translation table walk that matches the specified ASID.

The Security state is indicated by the value of [SCR\\_EL3.NS](#) if FEAT\_RME is not implemented, or [SCR\\_EL3.{NSE, NS}](#) if FEAT\_RME is implemented.

The invalidation applies to all PEs in the same Outer Shareable shareability domain as the PE that executes this System instruction.

If FEAT\_XS is implemented, the nXS variant of this System instruction is defined.

Both variants perform the same invalidation, but the TLBI System instruction without the nXS qualifier waits for all memory accesses using in-scope old translation information to complete before it is considered complete.

The TLBI System instruction with the nXS qualifier is considered complete when the subset of these memory accesses with XS attribute set to 0 are complete.

## Configuration

This instruction is present only when FEAT\_TLBIOS is implemented. Otherwise, direct accesses to TLBI VAE2OS, TLBI VAE2OSNXS are undefined.

## Attributes

TLBI VAE2OS, TLBI VAE2OSNXS is a 64-bit System instruction.

## Field descriptions

63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32
ASID																TTL		VA[55:12]													
VA[55:12]																															
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

### ASID, bits [63:48]

When HCR\_EL2.E2H == 1:

ASID value to match. Any TLB entries that match the ASID value and VA value will be affected by this System instruction.

Global TLB entries that match the VA value will be affected by this System instruction, regardless of the value of the ASID field.

If the implementation supports 16 bits of ASID, then the upper 8 bits of the ASID must be written to 0 by software when the context being invalidated only uses 8 bits.

### Otherwise:

Reserved, res0.

### TTL, bits [47:44]

When FEAT\_TTL is implemented:

Translation Table Level. Indicates the level of the translation table walk that holds the leaf entry for the address being invalidated.

TTL	Meaning
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0b00xx	No information supplied as to the translation table level. Hardware must assume that the entry can be from any level. In this case, TTL<1:0> is res0.
0b01xx	The entry comes from a 4KB translation granule. The level of walk for the leaf level 0bxx is encoded as: 0b00 : If FEAT_LPA2 is implemented, level 0. Otherwise, treat as if TTL<3:2> is 0b00. 0b01 : Level 1. 0b10 : Level 2. 0b11 : Level 3.
0b10xx	The entry comes from a 16KB translation granule. The level of walk for the leaf level 0bxx is encoded as: 0b00 : Reserved. Treat as if TTL<3:2> is 0b00. 0b01 : If FEAT_LPA2 is implemented, level 1. Otherwise, treat as if TTL<3:2> is 0b00. 0b10 : Level 2. 0b11 : Level 3.
0b11xx	The entry comes from a 64KB translation granule. The level of walk for the leaf level 0bxx is encoded as: 0b00 : Reserved. Treat as if TTL<3:2> is 0b00. 0b01 : Level 1. 0b10 : Level 2. 0b11 : Level 3.

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If an incorrect value of the TTL field is specified for the entry being invalidated by the instruction, then no entries are required by the architecture to be invalidated from the TLB.

**Otherwise:**

Reserved, res0.

## VA[55:12], bits [43:0]

Bits[55:12] of the virtual address to match. Any appropriate TLB entries that match the ASID value (if appropriate) and VA will be affected by this System instruction.

If the TLB maintenance instructions are targeting a translation regime that is using AArch32, and so has a VA of only 32 bits, then the software must treat bits[55:32] as res0.

The treatment of the low-order bits of this field depends on the translation granule size, as follows:

- Where a 4KB translation granule is being used, all bits are valid and used for the invalidation.
- Where a 16KB translation granule is being used, bits [1:0] of this field are res0 and ignored when the instruction is executed, because VA[13:12] have no effect on the operation of the instruction.
- Where a 64KB translation granule is being used, bits [3:0] of this field are res0 and ignored when the instruction is executed, because VA[15:12] have no effect on the operation of the instruction.

## Executing TLBI VAE2OS, TLBI VAE2OSNXS

Accesses to this instruction use the following encodings in the System instruction encoding space:

TLBI VAE2OS{, <Xt>}

op0	op1	CRn	CRm	op2
0b01	0b100	0b1000	0b0001	0b001

```
if PSTATE.EL == EL0 then
    UNDEFINED;
elsif PSTATE.EL == EL1 then
    if EL2Enabled() && HCR_EL2.NV == '1' then
        AArch64.SystemAccessTrap(EL2, 0x18);
    else
        UNDEFINED;
elsif PSTATE.EL == EL2 then
    if HCR_EL2.E2H == '1' then
        AArch64.TLBI_VA(SecurityStateAtEL(EL2),
            Regime_EL20, VMID_NONE, Shareability_OSH,
            TLBIlevel_Any, TLBI_AllAttr, X[t, 64]);
    else
        AArch64.TLBI_VA(SecurityStateAtEL(EL2),
```

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Regime_EL2, VMID_NONE, Shareability_OSH,
TLBILevel_Any, TLBI_AllAttr, X[t, 64]);
elseif PSTATE.EL == EL3 then
    if !EL2Enabled() then
        UNDEFINED;
    elseif HCR_EL2.E2H == '1' then
        AArch64.TLBI_VA(SecurityStateAtEL(EL2),
Regime_EL20, VMID_NONE, Shareability_OSH,
TLBILevel_Any, TLBI_AllAttr, X[t, 64]);
    else
        AArch64.TLBI_VA(SecurityStateAtEL(EL2),
Regime_EL2, VMID_NONE, Shareability_OSH,
TLBILevel_Any, TLBI_AllAttr, X[t, 64]);

```

## TLBI VAE20SNXS{, <Xt>}

op0	op1	CRn	CRm	op2
0b01	0b100	0b1001	0b0001	0b001

```

if !IsFeatureImplemented(FEAT_XS) then
    UNDEFINED;
elseif PSTATE.EL == EL0 then
    UNDEFINED;
elseif PSTATE.EL == EL1 then
    if EL2Enabled() && HCR_EL2.NV == '1' then
        AArch64.SystemAccessTrap(EL2, 0x18);
    else
        UNDEFINED;
elseif PSTATE.EL == EL2 then
    if HCR_EL2.E2H == '1' then
        AArch64.TLBI_VA(SecurityStateAtEL(EL2),
Regime_EL20, VMID_NONE, Shareability_OSH,
TLBILevel_Any, TLBI_ExcludeXS, X[t, 64]);
    else
        AArch64.TLBI_VA(SecurityStateAtEL(EL2),
Regime_EL2, VMID_NONE, Shareability_OSH,
TLBILevel_Any, TLBI_ExcludeXS, X[t, 64]);
elseif PSTATE.EL == EL3 then
    if !EL2Enabled() then
        UNDEFINED;
    elseif HCR_EL2.E2H == '1' then
        AArch64.TLBI_VA(SecurityStateAtEL(EL2),
Regime_EL20, VMID_NONE, Shareability_OSH,
TLBILevel_Any, TLBI_ExcludeXS, X[t, 64]);
    else
        AArch64.TLBI_VA(SecurityStateAtEL(EL2),
Regime_EL2, VMID_NONE, Shareability_OSH,
TLBILevel_Any, TLBI_ExcludeXS, X[t, 64]);

```

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