TLBI VAAE1OS, TLBI VAAE1OSNXS, TLB Invalidate by VA, All ASID, EL1, Outer Shareable

The TLBI VAAE1OS, TLBI VAAE1OSNXS characteristics are:

Purpose

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, from any level of the translation table walk.

  Or if FEAT_D128 is implemented, and the entry is a 128-bit stage 1 translation table entry, from any level of the translation table walk, if TTL[3:2] is `0b00`.

- When EL2 is implemented and enabled in the current Security state:
  - If HCR_EL2.{E2H, TGE} is not {1, 1}, the entry would be used with the current VMID and would be required to translate the specified VA using the EL1&0 translation regime for the Security state.
  - If HCR_EL2.{E2H, TGE} is {1, 1}, the entry would be required to translate the specified VA using the EL2&0 translation regime for the Security state.

- When EL2 is not implemented or is disabled in the current Security state, the entry would be required to translate the specified VA using the EL1&0 translation regime for the Security state.

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.

Note

When a TLB maintenance instruction is generated to the Secure EL1&0 translation

regime and is defined to pass a VMID argument, or would be defined to pass a VMID argument if SCR_EL3.EEL2==1, then:

- A PE with SCR_EL3.EEL2==1 is not architecturally required to invalidate any entries in the Secure EL1&0 translation of a PE in the same required shareability domain with SCR_EL3.EEL2==0.
- A PE with SCR_EL3.EEL2==0 is not architecturally required to invalidate any entries in the Secure EL1&0 translation of a PE in the same required shareability domain with SCR_EL3.EEL2==1.
- A PE is architecturally required to invalidate all relevant entries in the Secure EL1&0 translation of a System MMU in the same required shareability domain with a VMID of 0.

Note

For the EL1&0 and EL2&0 translation regimes, the invalidation applies to both global entries and non-global entries with any ASID.

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.

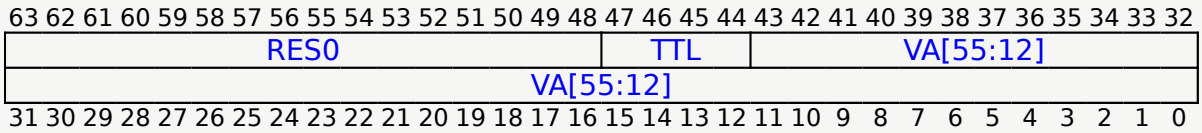
Configuration

This instruction is present only when FEAT_TLBIOS is implemented. Otherwise, direct accesses to TLBI VAAE1OS, TLBI VAAE1OSNXS are undefined.

Attributes

TLBI VAAE1OS, TLBI VAAE1OSNXS is a 64-bit System instruction.

Field descriptions



Bits [63:48]

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
`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.

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 VA will be affected by this System instruction, regardless of the ASID.

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 VAAE1OS, TLBI VAAE1OSNXS

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

TLBI VAAE1OS{, <Xt>}

op0	op1	CRn	CRm	op2
0b01	0b000	0b1000	0b0001	0b011

```
if PSTATE.EL == EL0 then
    UNDEFINED;
elsif PSTATE.EL == EL1 then
    if EL2Enabled() && HCR_EL2.TTLB == '1' then
        AArch64.SystemAccessTrap(EL2, 0x18);
    elsif EL2Enabled() && HCR_EL2.TTLBOS == '1' then
        AArch64.SystemAccessTrap(EL2, 0x18);
    elsif EL2Enabled() &&
IsFeatureImplemented(FEAT_FGT) && (!HaveEL(EL3) ||
SCR_EL3.FGTEn == '1') && HFGITR_EL2.TLBIVAAE1OS ==
'1' then
        AArch64.SystemAccessTrap(EL2, 0x18);
    else
        if IsFeatureImplemented(FEAT_XS) &&
IsFeatureImplemented(FEAT_HCX) && IsHCRXEL2Enabled()
&& HCRX_EL2.FnXS == '1' then
            AArch64.TLBI_VAA(SecurityStateAtEL(EL1),
Regime_EL10, VMID[], Shareability_OSH,
TLBILevel_Any, TLBI_ExcludeXS, X[t, 64]);
        else
            AArch64.TLBI_VAA(SecurityStateAtEL(EL1),
Regime_EL10, VMID[], Shareability_OSH,
TLBILevel_Any, TLBI_AllAttr, X[t, 64]);
elsif PSTATE.EL == EL2 then
    if HCR_EL2.<E2H,TGE> == '11' then
        AArch64.TLBI_VAA(SecurityStateAtEL(EL2),
Regime_EL20, VMID_NONE, Shareability_OSH,
TLBILevel_Any, TLBI_AllAttr, X[t, 64]);
    else
        AArch64.TLBI_VAA(SecurityStateAtEL(EL1),
Regime_EL10, VMID[], Shareability_OSH,
TLBILevel_Any, TLBI_AllAttr, X[t, 64]);
elsif PSTATE.EL == EL3 then
    if HCR_EL2.<E2H,TGE> == '11' then
        AArch64.TLBI_VAA(SecurityStateAtEL(EL2),
Regime_EL20, VMID_NONE, Shareability_OSH,
TLBILevel_Any, TLBI_AllAttr, X[t, 64]);
    else
        AArch64.TLBI_VAA(SecurityStateAtEL(EL1),
Regime_EL10, VMID[], Shareability_OSH,
TLBILevel_Any, TLBI_AllAttr, X[t, 64]);
```

TLBI VAAE1OSNXS{, <Xt>}

op0	op1	CRn	CRm	op2

0b01	0b000	0b1001	0b0001	0b011

```
if !IsFeatureImplemented(FEAT_XS) then
    UNDEFINED;
elsif PSTATE.EL == EL0 then
    UNDEFINED;
elsif PSTATE.EL == EL1 then
    if EL2Enabled() && HCR_EL2.TTLB == '1' then
        AArch64.SystemAccessTrap(EL2, 0x18);
    elsif EL2Enabled() && HCR_EL2.TTLBOS == '1' then
        AArch64.SystemAccessTrap(EL2, 0x18);
    elsif EL2Enabled() &&
IsFeatureImplemented(FEAT_FGT) && (!HaveEL(EL3) ||
SCR_EL3.FGTEn == '1') &&
IsFeatureImplemented(FEAT_HCX) && (!
IsHCRXEL2Enabled() || HCRX_EL2.FGTnXS == '0') &&
HFGITR_EL2.TLBIVAAE1OS == '1' then
        AArch64.SystemAccessTrap(EL2, 0x18);
    else
        AArch64.TLBI_VAA(SecurityStateAtEL(EL1),
Regime_EL10, VMID[], Shareability_OSH,
TLBILevel_Any, TLBI_ExcludeXS, X[t, 64]);
elsif PSTATE.EL == EL2 then
    if HCR_EL2.<E2H,TGE> == '11' then
        AArch64.TLBI_VAA(SecurityStateAtEL(EL2),
Regime_EL20, VMID_NONE, Shareability_OSH,
TLBILevel_Any, TLBI_ExcludeXS, X[t, 64]);
    else
        AArch64.TLBI_VAA(SecurityStateAtEL(EL1),
Regime_EL10, VMID[], Shareability_OSH,
TLBILevel_Any, TLBI_ExcludeXS, X[t, 64]);
elsif PSTATE.EL == EL3 then
    if HCR_EL2.<E2H,TGE> == '11' then
        AArch64.TLBI_VAA(SecurityStateAtEL(EL2),
Regime_EL20, VMID_NONE, Shareability_OSH,
TLBILevel_Any, TLBI_ExcludeXS, X[t, 64]);
    else
        AArch64.TLBI_VAA(SecurityStateAtEL(EL1),
Regime_EL10, VMID[], Shareability_OSH,
TLBILevel_Any, TLBI_ExcludeXS, X[t, 64]);
```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