

binutils support for Xtensa

- git tree: <https://github.com/jcmvbkbc/binutils-gdb-xtensa>

FDPIC support

- [+] static linking
- [+] PDE
- [+] PIE
- [±] PLT and lazy binding
- [-] TLS

FDPIC instruction sequences

Local call

Default local call

```
+0:      movi      tmp, target@GOT
+3:      add       tmp, tmp, localGOTptr
+5:      l32i     tmp, tmp, 0
+7:      mov      GOTptr, localGOTptr
+9:      callx0   tmp
```

No-GOT local call

```
+0:      movi     tmp1, target
+3:      l32i    tmp2, localGOTptr, TEXT_SEGMENT_OFFSET
+5:      add     tmp1, tmp1, tmp2
+7:      mov     GOTptr, localGOTptr
+9:      callx0  tmp1
```

When call0 reaches the target it can be transformed to

```
+0:      mov     GOTptr, localGOTptr
+2:      call0   target
```

In the j.l style it could probably be done like

```
call0.l target, tmp1, tmp2, localGOTptr
```

PLT call

Obvious version:

```
+0:    movi    tmp, target@PLTGOT
+3:    add     tmp, tmp, localGOTptr
+5:    l32i    tmp, tmp, 0
+7:    l32i    GOTptr, tmp, 4
+9:    l32i    tmp, tmp, 0
+11:   callx0  tmp
```

```
target@PLT:
+0:    movi    a8, target@PLTGOT
+3:    add     a8, a8, GOTptr
+5:    movi    a9, target-symbol
+8:    l32i    a10, GOTptr, RESOLVER_FN
+10:   l32i    GOTptr, GOTptr, RESOLVER_GOT
+12:   jx0     a10
```

The inline part calls the PLT part only once, after resolution the inline part calls the target directly. The adjustment is done to a single GOT entry, so it's atomic. The inline part can be reduced to a fixed direct call to the PLT:

```
+0:    mov     GOTptr, localGOTptr
+2:    call0   target@PLT
```

that reduces the inline part from 14 to 5 bytes, but adds two jumps to each call and some special logic to the resolver to avoid name resolution on each call.

TLS Support

TLS General Dynamic

```
+0:    movi    tmp1, x@GOTTLSDESC           # TLS_GOTDESC_OFF
+3:    add     arg0, tmp1, localGOTptr      # TLS_ARG
+5:    l32i    tmp2, arg0, 0                # TLS_FUNCDESC
+7:    l32i    GOTptr, tmp2, 4              # TLS_GOT
+9:    l32i    tmp3, tmp2, 0                # TLS_FUNC
+11:   callx0  tmp3                          # TLS_CALL
```

This TLSDESC is not the same as the descriptor of the default xtensa toolchain. It contains two pointers, one to the resolver function, the other to that other descriptor containing DTPOFF and module index in the dtv.

TLS Local Dynamic

```
+0:    l32i    arg0, localGOTptr, _TLS_MODULE_BASE_DESC_OFF
+2:    l32i    tmp1, arg0, 0
+4:    l32i    GOTptr, tmp1, 4
+6:    l32i    tmp2, tmp1, 0
```

```
+8:    callx0  tmp2
...
+m:    movi    tmp3, x@DTPOFF
+m+3:  add     res, tmp3, rv0
...
```

`_TLS_MODULE_BASE_DESC_OFF` is a small fixed offset (16?) from the GOT base where an entry with `R_XTENSA_TLSDESC(_TLS_MODULE_BASE_)` relocation against it is placed.

TLS Initial Exec

```
+0:    movi    tmp1, x@GOTTPOFF
+3:    add     tmp2, tmp1, localGOTptr
+5:    l32i    tmp3, tmp2, 0
+7:    rur     tmp4, THREADPTR
+10:   add     res, tmp3, tmp4
```

TLS Local Exec

```
+0:    movi    tmp1, x@TPOFF
+3:    rur     tmp2, THREADPTR
+6:    add     res, tmp1, tmp2
```

Linker optimizations

General Dynamic -> Initial Exec

```
+0:    movi    tmp1, x@GOTTLSDESC           # TLS_GOTDESC_OFF
movi   tmp1, x@GOTTPOFF
+3:    add     arg0, tmp1, localGOTptr      # TLS_ARG
add    arg0, tmp1, localGOTptr
+5:    l32i    tmp2, arg0, 0                # TLS_FUNCDESC
l32i   arg0, arg0, 0
+7:    l32i    GOTptr, tmp2, 4             # TLS_GOT
nop
+9:    _l32i   tmp3, tmp2, 0                # TLS_FUNC
rur    tmp3, THREADPTR
+12:   callx0 tmp3                          # TLS_CALL
add    arg0, arg0, tmp3
```

General Dynamic -> Local Exec

```
+0:    movi    tmp1, x@GOTTLSDESC           # TLS_GOTDESC_OFF
movi   tmp1, x@TPOFF
+3:    add     arg0, tmp1, localGOTptr      # TLS_ARG
```

```
mov    arg0, tmp1
+5:    l32i    tmp2, arg0, 0          # TLS_FUNCDESC
nop
+7:    l32i    GOTptr, tmp2, 4       # TLS_GOT
nop
+9:    _l32i   tmp3, tmp2, 0         # TLS_FUNC
rur    tmp3, THREADPTR
+12:   callx0 tmp3                  # TLS_CALL
add    arg0, arg0, tmp3
```

Manual toolchain building script

```
#!/bin/bash -ex

target=${TARGET:-xtensa-linux-uclibcfdpic}
build_base=`pwd`/build
src_base=$(dirname $(readlink -f "$0"))
binutils_src=$HOME/ws/tensilica/binutils-gdb/binutils-gdb
gcc_src=$HOME/ws/tensilica/gcc/gcc
linux_src="$src_base/linux"
uclibc_src="$src_base/uclibc-ng"
uclibc_config_src="$src_base/uclibc-ng-config"

prefix=`pwd`
sysroot="$prefix/$target/sysroot"
linux_headers="$sysroot/usr"

_FLAGS_FOR_HOST=${FLAGS_FOR_HOST:--Og -g}
_FLAGS_FOR_TARGET=${FLAGS_FOR_TARGET:--mauto-litpools -mfdpic -Oz -g}
CROSS_COMPILE=${CROSS_COMPILE:-$prefix/bin/$target-}
TARGET_CFLAGS="$_FLAGS_FOR_TARGET -D_LARGEFILE64_SOURCE -
D_FILE_OFFSET_BITS=64"

if [ "$1" = "-r" ]; then
    reconfigure=1
fi

mkdir -p .build

mkdir .build/binutils && (
    cd .build/binutils
    "$binutils_src/configure" --prefix="$prefix" \
        --target=$target \
        --with-sysroot="$sysroot" \
        --disable-shared --disable-werror --disable-gdb --disable-
gdbstub \
        CFLAGS=$_FLAGS_FOR_HOST

    make -j8
```

```

        make -j8 install
    )

mkdir .build/gcc-initial && (
    cd .build/gcc-initial
    "$gcc_src/configure" --prefix="$prefix" \
        --target=$target \
        --with-sysroot="$sysroot" \
        --enable-languages=c \
        --disable-shared \
        --enable-__cxa_atexit \
        --disable-tls --disable-threads \
        --without-headers --with-newlib \
        CFLAGS_FOR_TARGET="$_FLAGS_FOR_TARGET" \
        CXXFLAGS_FOR_TARGET="$_FLAGS_FOR_TARGET" \
        CFLAGS="$_FLAGS_FOR_HOST" \
        CXXFLAGS="$_FLAGS_FOR_HOST"

    make -j8 all-gcc
    make -j8 all-target-libgcc
    make -j8 install-gcc
    make -j8 install-target-libgcc
)

mkdir .build/linux && (
    cd .build/linux
    make -C "$linux_src" ARCH=xtensa \
        CROSS_COMPILE="$CROSS_COMPILE" O=`pwd` \
        defconfig
    make -C "$linux_src" ARCH=xtensa \
        CROSS_COMPILE="$CROSS_COMPILE" O=`pwd` \
        INSTALL_HDR_PATH="$linux_headers" \
        -j8 headers_install
)

mkdir .build/uclibc && (
    cd .build/uclibc
    cp "$uclibc_config_src/.config" .
    if [ -n "$reconfigure" ]; then
        make -C "$uclibc_src" ARCH=xtensa \
            CROSS_COMPILE="$CROSS_COMPILE" \
            O=`pwd` KERNEL_HEADERS="$linux_headers/include" \
            UCLIBC_EXTRA_CFLAGS="{TARGET_CFLAGS}" \
            menuconfig
        cp .config "$uclibc_config_src"
    fi

    make -C "$uclibc_src" ARCH=xtensa \
        CROSS_COMPILE="$CROSS_COMPILE" \
        O=`pwd` KERNEL_HEADERS="$linux_headers/include" \
        UCLIBC_EXTRA_CFLAGS="{TARGET_CFLAGS}" \

```

```
-j8 "$@"
make -C "$uclibc_src" ARCH=xtensa \
    CROSS_COMPILE="$CROSS_COMPILE" \
    O=`pwd` KERNEL_HEADERS="$linux_headers/include" \
    UCLIBC_EXTRA_CFLAGS="${TARGET_CFLAGS}" \
    DESTDIR="$sysroot" \
    install
)

mkdir .build/gcc-final && (
    cd .build/gcc-final
    "$gcc_src/configure" --prefix="$prefix" \
        --target=$target \
        --with-sysroot="$sysroot" \
        --enable-languages=c,c++ \
        --disable-shared \
        --enable-__cxa_atexit \
        --disable-tls --disable-threads \
        --with-uclibc \
        CFLAGS_FOR_TARGET="$_FLAGS_FOR_TARGET" \
        CXXFLAGS_FOR_TARGET="$_FLAGS_FOR_TARGET" \
        CFLAGS="$_FLAGS_FOR_HOST" \
        CXXFLAGS="$_FLAGS_FOR_HOST"

    make -j8 all
    make -j8 install
)
```

From:
<http://wiki.osll.ru/> - **Open Source & Linux Lab**

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<http://wiki.osll.ru/doku.php/etc:users:jcmvbkbc:binutils-xtensa?rev=1709691774>

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