OpenSSL 3.5.4 Cross-Compilation Guide for Raspberry Pi (ARM64)

This document provides a complete, step-by-step procedure to cross-compile OpenSSL 3.5.4 on a Kali Linux (x86_64) host for a Raspberry Pi 4 (ARM64 / aarch64). It is intended for embedded Linux, security, and IoT teams.

1. Host and Target Overview

```
Host System:
- OS: Kali Linux (x86_64)
- Role: Build machine

Target System:
- Device: Raspberry Pi 4B
- Architecture: ARM64 (aarch64)
- Role: Runtime system
```

2. Directory Layout Used

```
/home/chandu/openssl/
███ openssl-3.5.4/
███ install-pi/
    ███ bin/openssl
    ███ lib64/
    ███ include/
    ███ ssl/
```

3. Install Cross Compiler Toolchain

```
sudo apt update
sudo apt install -y gcc-aarch64-linux-gnu g++-aarch64-linux-gnu
aarch64-linux-gnu-gcc --version
```

4. Prepare OpenSSL Source

```
cd /home/chandu/openssl/openssl-3.5.4
make clean
```

5. Configure OpenSSL for ARM64

```
export CC=aarch64-linux-gnu-gcc
export AR=aarch64-linux-gnu-ar
export RANLIB=aarch64-linux-gnu-ranlib

./Configure linux-aarch64 --prefix=/home/chandu/openssl/install-pi --openssldir=/home/chandu/openssl,
```

6. Build OpenSSL

```
make -j$(nproc)
```

7. Install OpenSSL

```
make install
```

8. Verify Binary Architecture

```
file /home/chandu/openssl/install-pi/bin/openssl
Expected: ELF 64-bit LSB executable, ARM aarch64
```

9. Transfer OpenSSL to Raspberry Pi

```
scp -r /home/chandu/openssl/install-pi pi@192.168.0.103:/home/pi/
```

10. Configure Environment on Raspberry Pi

```
export PATH=/home/pi/install-pi/bin:$PATH
export LD_LIBRARY_PATH=/home/pi/install-pi/lib64:$LD_LIBRARY_PATH
```

11. Verify OpenSSL on Raspberry Pi

```
which openssl
openssl version
ldd $(which openssl) | grep ssl
```

12. Functional Test

```
openssl genpkey -algorithm RSA -out test.pem -pkeyopt rsa_keygen_bits:2048
openssl pkey -in test.pem -text -noout
```

13. Common Issues

```
Error: cannot find -lz
Cause: Missing ARM zlib
Fix: Reconfigure OpenSSL without zlib

Error: Exec format error
Cause: ARM binary run on x86
Fix: Run binary only on Raspberry Pi
```

14. Conclusion

```
OpenSSL was successfully cross-compiled for Raspberry Pi ARM64,
deployed securely, and verified for correct operation.
```