TUXERA

Supported MCU/CPUs, operating systems and compilers

All supported targets for Tuxera's TCP/IP and CryptoCore library

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Tuxera Inc, Westendintie 1, 02160 Espoo, Finland
Tel: +358 20 764 1720 • info@tuxera.com • www.tuxera.com

Introduction

Certifiable resilient and secure embedded networking

Data safety and security go hand-in-hand. Tuxera works together with our customers with standards like ISO26262 and IEC21434. We comply with standards like MISRA, in order to maintain the quality and security of the code high. We also help our customers to work with the TARA and HARA processes to receive certifications for the end product.

Resilient, high quality dual IPv4/IPv6 stack

The key to a successful embedded application is to use high-quality software that is verifiably developed and ensures a stable, low-risk development platform. Our networking solution provides a significant range of protocols as well as support for both IPv4 and IPv6 standards, delivering reliability and long-term network compatibility.

We provide optimized Ethernet drivers with our stack, and the software integrates into virtually any embedded environment – with or without an RTOS and also support memory/space separation. The software is designed for high performance on embedded microcontrollers. Our stack has no unnecessary copies, static memory management is carefully thought out, and it fully exploits dedicated memory areas and cache.

Full MISRA compliance

All our included software components have been developed with a rigorous approach to quality, using a strongly typed subset of the “C” language. We supply quality verification including full MISRA[1]-compliant static analysis reports. In addition, we include the test suites you need to verify interoperability and code integrity.

[1] “MISRA” is a registered trademark of MIRA Ltd, held on behalf of the MISRA Consortium. No endorsement by MISRA is claimed or implied for any product.

Small footprint, high throughput, low CPU cycle operation

RAM requirements can vary widely depending on application needs, but are typically as low as 12 kB. With minimum configuration UDP applications, it’s possible to use less than 5 kB of ROM and only a few hundred bytes of RAM (plus network buffers).

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Technical features

The key features of the Tuxera MISRA Compliant TCP/IP Stack are the following:

- Fully MISRA-compliant
- Supports both IPv4 and IPv6, but allows either to be disabled if required
- Designed for integration with both RTOS and non-RTOS based systems
- Small RAM and ROM footprint
- High performance
- Routing module provided
- Provides both native and Sockets interfaces
- Wide range of TCP and UDP applications available

Network interface features:

- Supports multiple network interfaces
- Supports routing between network interfaces
- Provides fast/zero copy between network interfaces
- Range of tested drivers for standard micro-controllers and external Ethernet controllers is available

TCP Features:

- Compliant with **RFC 793**, the RFC that defines extensions to Sockets for IPv6
- Supports zero copy send and receive
- Provides a MISRA-compliant native API
- Provides an optional Sockets API

UDP Features:

- Compliant with **RFC 768**
- Supports zero copy send and receive
- Provides a MISRA-compliant native API
- Provides an optional Sockets API

Sockets Interface:

- Compliant with BSD Sockets
- IPv6 operation complies with **RFC 2553**
- Provides a standard interface for legacy applications to use
- Allows portability of applications across Sockets-compliant systems
- Supports AF_INET, AF_INET6, AF_PACKET, and AF_NETLINK sockets

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Network management modules

DHCP Client for IPv4	Dynamic Host Control Protocol, used by a client device to get an IPv4 address. This is the separate DHCP client application for IPv4.
AutoIP for IPv4	AutoIP (link-local address) extension for Tuxera's IPv4 stack, to automatically assign link-local IP addresses to devices on small local networks.
DHCP Client for IPv6	This client supports IPv6 addresses. It can be used in Tuxera's dual TCP/IP stack alongside the DHCP client for IPv4.
DHCP Server for IPv4	Dynamic Host Control Protocol server application for IPv4.
DNS Client	Domain Name System, a distributed naming system for resources connected to the Internet or other networks.
SNMPv1, v2, v3	Provides embedded devices with secure and reliable network management capability.
NTP Client	Network Time Protocol (NTP) Client is used to synchronize clocks on computer systems in packet-switched networks.
NTS	Network time security
SNTP Client	Simple Network Time Protocol (SNTP) is used to synchronize clocks on computer systems.

Network security

IPsec and IKE	IPsec is the Security Architecture for IP protocol suite. Internet Key Exchange (IKEv2) is used by IPsec to set up Security Associations.
TLS/DTLS 1.0,1.1,1.2, 1.3	Transport Layer Security (TLS) or Datagram Transport Layer Security (DTLS) is a highly optimized software module designed to provide secure network communications for embedded devices.
EAP	Extensible Authentication Protocol (EAP), designed to support secure connections for embedded devices.
EST-CoAP	Enrollment over Secure Transport (EST) is used for authenticated/authorized endpoint certificate enrollment. EST-CoAP

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	uses the Constrained Application Protocol (CoAP) instead of HTTP for some Internet of Things (IoT) devices.
SSH	Secure SHell (SSH) server creates a secure socket connection that can be used for executing menu commands or for tunneling data between the clients and servers of other applications.
NAT	Network Address Translation (NAT) allows an organization to set up a network using private addresses, but still allowing its members to communicate over the public Internet.
MACsec	MACsec provides security on point-to-point Ethernet links or shared Ethernet networks, giving confidentiality, integrity, and authenticity of user data.

TCP/IP applications

FTP(S) Client	File Transfer Protocol, used to transfer files between hosts over a TCP-based network. This is the client module. Also secure module available.
FTP Server	File Transfer Protocol, used to transfer files between hosts over a TCP-based network. This is the server module.
HTTP(S) Client	Hypertext Transfer Protocol (HTTP) and its secure equivalent (HTTPS) provide communication over computer networks. This is the client module.
HTTP(S) Server	This is the HTTP/HTTPS server module.
MQTT(S) Client	A “publish and subscribe” lightweight messaging protocol for use over TCP/IP. Also secure module available.
SMTP Client	Simple Mail Transfer Protocol (SMTP) is used for email transmission.
TFTP	Trivial File Transfer Protocol, used to transfer files between hosts over a TCP-based network.

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Network drivers

General purpose network drivers:

Loopback Driver	Useful for testing when working with the real remote application is not possible.
PPP	Point to Point Protocol, lets you set up a network connection over a serial link to a remote network stack.

Driver	MCUs / Ethernet controllers
Atmel EMAC	Ethernet Media Access Controller (EMAC) core in Atmel® SMART microcontrollers. These are produced by Microchip Technology Inc.
AURIX TC”xx, 3xx	AURIX TriCore Microcontrollers.
CDC-ECM	CDC-ECM (Control Device Class - Ethernet Control Model). This implements the Ethernet driver for HCC's USB Host CDC-ECM Class Driver.
ENC624J600	Microchip ENC624J600 standalone Ethernet controller. This is a standalone 10/100 Base-T Ethernet interface controller with integrated MAC & PHY, hardware cryptographic security engines, and a factory pre-programmed unique MAC address
Freescale EtherNet IP	EtherNet/IP™ devices from Freescale™ Semiconductor Inc (now NXP). These include i.MX 6 and all Ethernet-capable Kinetis microcontrollers.
GMAC MAC	Xilinx (AMD)® Zynq® and Microchip Technology Inc. Atmel® SMART microcontrollers that have a GMAC MAC core.
LPC	Ethernet-capable LPC microcontrollers from NXP Semiconductors.
Microchip ATWINC1500	ATWINC1500 is an IEEE 802.11 IoT network controller. It provides Wi-Fi and network capabilities through the SPI-to-Wi-Fi interface. The ATWINC1500 connects to any SAM or PIC MCU with minimal resource requirements.

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Driver	MCUs / Ethernet controllers
Microchip LAN7500 and LAN9500	LAN7500 High Speed USB 2.0 to 10/100/1000 Ethernet Controllers and LAN9500 USB 2.0 to 10/100 Ethernet Controllers. These devices are produced by Microchip Technology Inc. (formerly SMSC).
Microchip PIC32	Microchip Technology Inc. PIC32 32 bit microcontrollers.
Renesas	Renesas standalone Ethernet controllers. Supported MCUs include the SuperH SH-2A and SH7260 series.
STR912	STR912xx on-chip ENET Ethernet controllers from STMicroelectronics.
Synopsys	Synopsys® Ethernet IP core (that is, for devices including STM32, LPC435x, and XMC4xxx). This core is widely used in both MCUs and System on Chip (SOC) solutions.
TI EMAC	Hercules RM46, RM48, and TMS570 microcontrollers from Texas Instruments Incorporated and other TI devices that use the similar Ethernet controller IP.
TI NDK	Network driver that allows interfacing of HCC's USB Device RNDIS or CDC-ECM class drivers to the Texas Instruments Network Developer's Kit (NDK) TCP/IP stack
USB	USB devices. This provides virtual Ethernet links for the Communications Device Class - Ethernet Control Module (CDC-ECM) and Remote Network Driver Interface Standard (RNDIS) device classes. This HCC driver can be used for any device in these device classes.
Xilinx (AMD) Zynq 7000 Gigabit Ethernet	Xilinx (AMD)® Zynq® 7000 Gigabit Ethernet. Tested with Xilinx (AMD) XC7Z020-1CLG484C Zynq-7000 AP SoC but supports similar devices.
Other	Is your device not listed in the table? Chances are high that we readily support your device, as it might be compatible with one of the devices in this table. Our support team can quickly tell and advise you.

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SafeTCP/IP technical information

Tuxera's SafeTCPIP is a complete TCP/IPv4 network stack developed to the ISO 26262 Automotive Safety Integrity Level (ASIL) B standard. This makes it suitable for integration with any safety system complete with full process that is mappable to other standards such as IEC 61508 and ISO 62304.

Stack Components

SafeTCPIP includes the following modules each built to this standard:

- IPv4
- TCP
- UDP
- Socket
- ARP
- Ethernet Interface
- ICMPv4
- IGMPv2
- DHCPv4

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CryptoCore encryption

CryptoCore™ is Tuxera's encryption and security library, which can be integrated to encrypt the data on the security components of the TCP/IP stack but can also be integrated to any embedded target.

CryptoCore meets all the requirements for Suite B compliance. This includes:

- Advanced Encryption Standard (AES) with key sizes of 128 and 256 bits.
- Elliptic Curve Digital Signature Algorithm (ECDSA) – digital signatures
- Elliptic Curve Diffie–Hellman (ECDH) – key agreement
- Secure Hash Algorithm 2 (SHA-256 and SHA-384)

This table summarizes the CryptoCore products:

Package	Algorithms	Where used	Type
AES	AES-CBC-RAW	IPsec	Encrypt
	AES-CBC	TLS	Encrypt
	AES-CFB	SNMP	Encrypt
	AES-CTR	IPsec	Encrypt
	AES-CCM	TLS, EAP-TLS	Encrypt
	AES-CCM8	TLS, EAP-TLS	Encrypt
	AES-GCM	TLS	Encrypt
	AES Key Wrap		Encrypt
	AES-XCBC-MAC	IPsec, IKE	Hash
	AES-CMAC	IPsec, IKE	Hash
Base64	Base64	SMTP, SSH	Encode binary over text stream
ChaCha20	ChaCha20	TLS	Signing and key exchange
ECC	ECDH	TLS	Key Exchange
	ECDHE	TLS	Key Exchange
	ECDSA	TLS	Digital Signature
EDH	EDH	IKEv2,TLS	Key Exchange
MD5	MD4	PPP	Hash
	MD5	TLS, IPsec	Hash
	MD5-HMAC	SNMP	Hash
RSA	RSA	TLS	Encrypt
	RSA-PSS		
SHA	SHA1	IPsec, TLS, IKE	Hash
	SHA2	TLS, SSH	Hash
	SHA-256		

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Package	Algorithms	Where used	Type
	SHA-384		
	SHA-512		
	SHA1-HMAC	SNMP	Hash
	SHA2-HMAC		Hash
	SHA3-224		Hash
	SHA3-256		Hash
	SHA3-384		Hash
	SHA3-512		Hash
	SHAKE-128		Hash
	SHAKE-256		Hash
TDES	DES		Encrypt
	TDES-CBC	TLS	Encrypt
	TDES-CBC-RAW	SNMP	Encrypt
TIGER	TIGER128	IKE	Hash
	TIGER-160	IKE	Hash
	TIGER-192	IKE	Hash
	TIGER-HMAC	IKE	Hash

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Supported MCUs and CPUs:

Supported IP/Cores

Arm® Cortex® Mx
Arm® Cortex® Ax
Arm® Cortex® Rx
RISC-V

MCU/CPU Support

Altera NIOS
Ambiq Apollo
AMD (Xilinx), Ultrascale, Zync
Ambarella
Analog Devices Blackfin, SHARC+ ADSP SC5xx
Atmel - see Microchip
Cypress - see Infineon
Faraday Faxxx
Freescale - see NXP
GeneralPlus GPxxx
Gigadevice GD32
Infineon XMC, TriCore, AURIX, Traveo I /II, PSoC, FM0/FM3/FM4
Intel Cyclone, Stratix, Arria
Microchip PIC24, PIC32, AVR32, SAM3/4/7/9
Nordic semiconductor nRF
NXP LPCxxx, ColdFire, Kinetis, PowerPC, i.MX, Vybrid, QorIQ
Renesas RA, RX, RZ, RL78, RH850, R-Car, Synergy
Silicon Labs EFM32, SIM3
Spansion - see Infineon
STMicroelectronics STM32, SPC5, Stellar
Texas Instruments MSP430, Stellaris, C2000, Hercules, DaVinci, Sitara, Tiva, OMAP
Toshiba TMP M0/M3

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Supported operating systems:

RTOS	Description
µ-velOSity	µ-velOSity™ RTOS from Green Hills® Software.
Eclipse ThreadX (Azure)	Eclipse ThreadX® RTOS from Eclipse Foundation
ChibiOS	ChibiOS open source RTOS
CMSIS	Arm® Cortex® Microcontroller Software Interface Standard.
DSP/BIOS	DSP/BIOS™ RTOS from Texas Instruments Incorporated.
eCos	eCOS® RTOS from eCosCentric® Limited.
embOS	embOS RTOS from SEGGER Microcontroller GmbH.
Enea OSE	Enea OSE® RTOS from Enea AB
FreeRTOS	FreeRTOS™ RTOS.
Linux (user space)	(Embedded) Linux
MQX	MQX™ RTOS from Embedded Access, also available through NXP
Keil RTX	Keil® RTX RTOS from Arm® Limited.
Nucleus	Nucleus™ RTOS from Siemens
QNX	QNX is a commercial operating system from BlackBerry® QNX®.
OpenRTOS	WITTENSTEIN high integrity systems
OSE Epsilon	OSE Epsilon RTOS from Enea AB.
RTXC Quadros	RTXC™ Quadros RTOS from Quadros™ Systems, Inc.
SafeRTOS	WITTENSTEIN high integrity systems
SCIOPTA	SCIOPTA RTOS from SCIOPTA Systems AG.
TI-RTOS	TI-RTOS from Texas Instruments Incorporated.
uCOS-II	µC/OS-II™ RTOS from Silicon Labs' Micrium™
uCOS-III	µC/OS-III™ RTOS from Silicon Labs' Micrium™
Zephyr RTOS	Open Source based RTOS for connected resource-constrained devices, from the Zephyr Project™
MCOS	eSOL real-time operating system
Micriµm µC/OS-II™	Micriµm µC/OS-II™ RTOS from Silicon Labs
Micriµm µC/OS-III™	Micriµm µC/OS-III™ RTOS from Silicon Labs
Cs/OS2	Cesium RTOS from Weston Embedded
C2/OS3	Cesium RTOS from Weston Embedded

Any operating system supporting mutexes, events and tasks is supported even if not listed here.

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Abstraction options for bare-metal and unsupported RTOSes

Abstraction	Description
OAL for Systems with no RTOS	For developing embedded systems that use no RTOS
OAL Template	For creating an Tuxera-compatible RTOS abstraction for an embedded system

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Supported compilers/toolchains

GCC and LLVM compilers
ADI CrossCore® Embedded Studio
Altera Quartus
Arm® Keil® compiler
Atmel AVR Studio
Green Hills Multi
HighTec
IAR Embedded Workbench
MCUXpresso
Mentor CodeSourcery
Microchip MPLAB
Renesas HEW
STMicroelectronics STM32Cube
Tasking VX-toolset
TI Code Composer Studio
Visual Studio
Xilinx DSK

Version control

Author	Date	Changes
KHa	15th of May 2024	Initial document

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