Mainstream Software for Machine Learning

Accelerating AIoT development with TencentOS

Speaker: Jack Zhao - 赵健 from TencentOS Team
Background and Intro

Tencent self-developed IoT OS

TencentOS

Atomic Service

Platform Service

Consumer
Smart City
Education
Medical
Industry
Payment
Government

IoT Market

TencentOS Tiny/TencentOS Edge

Tencent self-developed IoT OS

Open Source

Ecosystem

A key building block in the IoT end-to-end solution
Enables edge interconnectivity and interoperability
Advance IoT services in response to heterogeneous customer needs

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A key building block in the IoT end-to-end solution
Enables edge interconnectivity and interoperability
Advance IoT services in response to heterogeneous customer needs
Streamlined kernel, ultra-low resource consumption

Efficient management framework provides power efficiency

Intelligible IoT architecture, fast onboarding

**TencentOS Tiny Framework**

- **USER APP/Examples**
- **TencentOS tiny Open APIs**
  - MQTT/CoAP/LoRaWAN/HTTP...
  - SAL组件
  - AT适配组件
  - 文件系统
  - KV存储
  - OTA
  - LWIP/WiFi/LoRa/NB-IoT/BLE/GPRS/ZigBee
  - AI组件
  - 高级语言引擎
- **TencentOS tiny SDK& Framework**
  - 驱动框架
  - 外设框架
- **TencentOS tiny Kernel**
  - OSAL（cmsis/posix）
  - 任务管理
  - 内存管理
  - IPC通信
  - 异常处理

**ARM等主流MCU芯片/模组**
1. Multi-task real-time scheduling, IPC communication, memory management, time management, exception handling and other kernel capabilities
2. Provides RTOS interface adaption for universal access (CMSIS, POSIX)
3. Configurable and tailorable kernel effectively reduces resource consumption
4. Hardware Abstract Layer between kernel and BSP provides a unified HW access interface.
There are 20+ commercialized communication modules based on TencentOS Tiny AT framework, covering mainstream applications.
TencentOS Tiny Core Technology – OTA update

User
- 1. Build new product
- 2. Prepare firmware binary
- 3. Import new firmware to PC tool and generate OTA package including img header (Optional original firmware, Compressed firmware, differential image)
- 4. Upload new firmware
- 5. Trigger Firmware Update

OTA Cloud server

IoT Edge device
- 6. Send URL, update parameters, etc.
- 7. Protocol parameter analysis
- 8. Firmware Download
- 9. Run checksum, write the new img to OTA temp addr.
- 10. Reset device, migrate and verify when booting up.
- 11. Start with the updated APP, mark the firmware as released

TencentOS Tiny Firmware Upgrade

Full or differential OTA
Secure checksum for firmware integrity check
Power Failure Protection
Firmware Rollback
Differential firmware OTA
Open Source

Industry first fully open sourced differential firmware OTA solution, effectively reduce OTA bandwidth and memory consumption requirements.

URL: TencentOS-tiny/components/ota
Multi-tier low power consumption management framework

- **Standard power management**
  - Enters power saving mode when the system goes idle
  - **But the system still has "tick clock", so the time it can stay in low-power mode is very short!**

- **Tickless power management**
  - Aperiodic clock. According to the real-time information of the system, stop the "tick clock" directly
  - **As shown in the figure below, "tick clock " does not need to come once every beat, in fact, it is enough to come once every 7, 4, 5, or 4 beats.**

![Diagram showing tickless power management with equations: t1=t0+7, t2=t1+4, t3=t2+5, t4=t3+4]
TencentOS Tiny Core Technology – Security Components

- TencentOS Tiny IoT edge devices
  - Comm. module
  - SE Chip
  - MCU (ARM TrustZone, etc.)
  - Cloud Communication SDK

Tencent Cloud

ID
- Authenticatio n
- Root cert
- Key management
- certificate
- Private key

Multi-tier security architecture
- Offline Authentication
- Secure Boot
- Arm MbedTLS(TLS/DTLS)

Unique key per device
- Secure key storage
- Secure firmware install/update
- Cross-platform support

TencentOS Tiny conforms to Tencent IoT security standards, integrates with TrustZone and MbedTLS on Arm platform, Compatible with ARM PSA platform security framework standard, complements full end-to-end security deployment with IoT Cloud service.

《Tencent IoT security standards》

- 满足国际国内业界安全标准规范
- 以物联网安全攻防经验为基础
- 全面覆盖云/管/边/端整体架构安全
- 凝聚顶尖安全团队前瞻性研究成果
elfLoader loads and executes an ELF binary executable in TencentOS tiny. It supports:

- Compile applications into .o or .so files
- Copy .o or .so files to accessible file system
- Invoke `tos_elfloader_load` interface to load .o or .so file
- Invoke `tos_elfloader_find_symbol` to find the kernel address of a loadable module, normally a function, execute it
- Task completes. `tos_elfloader_unload` executable will unload the module.
TencentOS Tiny will combine the efficient neural network core Arm CMSIS-NN provides for accelerated ML performance on Arm microcontrollers.
TencentOS Edge Overview

TencentOS Edge is Tencent edge IoT OS, based on Linux kernel, supports edge containerization, AIoT, multimedia engine, gateway protocol conversion and IoT services. Expedite IoT edge devices and services onboarding to Tencent Cloud.

TencentOS Edge Features

- Supports Tencent public cloud and WeLink private cloud services;
- Integrates TencentOS Server (Tlinux
- Easy integration with Tencent Cloud for cloud services access;
- Supports multiplatform, best portable tiny systems
- Custom interfaces
- QT, Wayland/XServer
TencentOS Edge compatible hardware platforms

Robust AI Platform

Performance Gateway

Host

Intel
Jetson NX
Qualcomm 8250
Raspberry Pi
RK3399

AI Modules

Tencent self-developed AI Chip
MLU220
Movidius
AIC100

TKernel (Ubuntu
Centos
TencentOS Desktop)

STM32MP1 Serials
NXP imx6 Serials

Tkernel (NoGUI
Qt/wayland)

Hardware performance
TencentOS Edge, TencentOS Tiny & Tencent Cloud collaboratively provide multi-protocol conversion.

1. Communication protocols (Modbus, OPC etc.)
2. BLE, Zigbee, WIFI, etc. wireless protocols
3. LoRa etc. gateway configuration and services
4. Protocol adaption config tools
The rapid growth of edge computing imposes security considerations on edge devices, including transmission security and data storage security. TencentOS Edge enforces a trust chain from Romcode->boot->kernel->rootfs->Application.

- BootROM, Secure boot
- BIOS, BootLoader
- TencentOS Edge init Process & Init.rc
- TencentOS Edge Kernel, Recovery.img
- Application

Use TPM/SGX/TEE, etc security technologies to ensure data safety and realiability.

Encrypted Transmission

Network Services using honeypots

内核通过科恩实验室安全加固
TencentOS Edge now has built-in Arm AI hardware support and supports Neural Network frameworks including Arm NN, TensorFlow, PyTorch, Caffe etc.
依托腾讯完善的生态和全线互联网能力，iGrow智能种植解决方案可提供端到端部署服务，涵盖算法开发、后台IT系统建设、前端硬件设计部署、网络适配等。

TencentOS tiny多方案网络适配，支持WiFi/NB-IoT/LoRa链路全加密、保证数据安全，网络传输优化，全时在线、极低时延，轻松连接云端整体解决方案。

TencentOS tiny超低功耗管理，有效降低农业现场设备的功耗，延长使用寿命。

基础设施（网络、电力、水、肥）

物联网终端

环境感知

棚内的环境数据

物联网终端控制器

调节器

温室调节

控制指令

机器执行为主，人工为辅

TencentOS tiny终端安全强化

适配多种芯片

智能农业——iGrow智能种植解决方案
集成LoRaWAN 网关协议、微瓴SDK、边缘计算组件，服务于智慧建筑中多种设备，提高楼宇自动化控制程度。
TencentOS AIoT Use Case - 腾讯工业智能巡检操作机器人

Self-developed edge compute device, integrated with NPU and video decoder, powerful for video edge processing and AI inference.

TencentOS Edge integrated edge computing solutions help to build business applications quickly.

边缘计算解决方案

边缘计算盒子

Self-developed edge compute device, integrated with NPU and video decoder, powerful for video edge processing and AI inference.

2019 WAIC世界人工智能大会
Software Ecosystem
ARM CMSIS NN / ARM NN
ARM CMSIS RTOS CMSIS Driver

Tools Ecosystem
MDK
ARM Compiler
CMSIS pack

Security Ecosystem
ARM PSA
ARM TrustZone
ARM mbedTLS

Hardware Ecosystem
采用ARM IP核的主流芯片/硬件平台
THANKS!
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EDGE Cortex

Silver Sponsor

SynSense
Arm: The Software and Hardware Foundation for tinyML

1. Connect to high-level frameworks
2. Supported by end-to-end tooling
3. Connect to Runtime

Profiling and debugging tooling such as Arm Keil MDK

Application

Optimized models for embedded

Runtime (e.g. TensorFlow Lite Micro)

Optimized low-level NN libraries (i.e. CMSIS-NN)

RTOS such as Mbed OS

Arm Cortex-M CPUs and microNPUs

Stay Connected

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Resources: developer.arm.com/solutions/machine-learning-on-arm

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Dynamic Neural Accelerator™

- 10x more compute with single DNA engine
- More than 20x better energy-efficiency
- Ultra-low latency
- Fully-programmable with INT 8bit support

TARGET MARKETS
- Automotive
- Robotics
- Drones
- Smart Cities
- Industry 4.0

Tight coupling between AI software & hardware with automated co-design

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添加工作人员进官方微信群(注明tinyML)
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