SEC5 - Embedded Security for STM32-based devices

Objectives

- Understand embedded and STM32-specific security challenges, attack vectors, and threats.
- Apply modern security standards and best practices to STM32 devices.
- Implement secure boot and firmware protection on STM32.
- Apply secure network protocols (TLS/SSL, LoRaWAN, Sigfox, WiFi) on STM32.
- Follow IoT security best practices across communication layers.
- Implement secure firmware updates and OTA management for STM32.

Course environment

- Course will be using STM32 Tools (STM32CubeIDE, STM32CubeProgrammer, …)
- Students will be given access to a shared filesystem to save and share their work.
- PDF course material

Prerequisites

- Familiarity with computer architecture
- Programming skills: Some programming experience, particularly in C
- Knowledge of STM32 Implementation and ARM implementations
- Basic understanding of Security Algorithms and Secure coding

Environnement du cours

- Cours théorique
  - Support de cours au format PDF (en anglais) et une version imprimée lors des sessions en présentiel
  - Cours dispensé via le système de visioconférence Teams (si à distance)
  - Le formateur répond aux questions des stagiaires en direct pendant la formation et fournit une assistance technique et pédagogique
- Activités pratiques
  - Les activités pratiques représentent de 40% à 50% de la durée du cours
  - Elles permettent de valider ou compléter les connaissances acquises pendant le cours théorique.
  - Exemples de code, exercices et solutions
  - Pour les formations à distance:
    - Un PC Linux en ligne par stagiaire pour les activités pratiques, avec tous les logiciels nécessaires préinstallés.
    - Le formateur a accès aux PC en ligne des stagiaires pour l'assistance technique et pédagogique
    - Certains travaux pratiques peuvent être réalisés entre les sessions et sont vérifiés par le formateur lors de la session suivante.
  - Pour les formations en présentiel::
    - Un PC (Linux ou Windows) pour les activités pratiques avec, si approprié, une carte cible embarquée.
    - Un PC par binôme de stagiaires s'il y a plus de 6 stagiaires.
  - Pour les formations sur site:
    - Un manuel d'installation est fourni pour permettre de préinstaller les logiciels nécessaires.
    - Le formateur vient avec les cartes cible nécessaires (et les remporte à la fin de la formation).
- Une machine virtuelle préconfigurée téléchargeable pour refaire les activités pratiques après le cours
- Au début de chaque session (demi-journée en présentiel) une période est réservée à une interaction avec les stagiaires pour s'assurer que le cours répond à leurs attentes et l'adapter si nécessaire

Audience visée

- Tout ingénieur ou technicien en systèmes embarqués possédant les prérequis ci-dessus.

Plan du cours

First Day

Introduction to embedded security for STM32 devices

- Overview of embedded security and its importance
- STM32 Microcontroller overview and security features
  - STM32 MCUs and capabilities
  - Security features
  - ARM TrustZone overview
- Threads and attack vectors specific to embedded systems
  - Common attack vectors
  - Malware and exploits
  - Threat landscape for embedded systems

Exercise : Familiarizing with STM32 Security Tools

Secure Development

- Secure coding practices
  - Code reviews and audits
  - Input validation and sanitization
  - Memory management and buffer overflows
- Static and dynamic code analysis tools
  - Using static analysis tools
  - Using dynamic analysis tools
- Secure development lifecycle for STM32-based devices
  - Requirements gathering and threat modeling
  - Design and implementation
  - Testing and validation
  - Deployment and maintenance

Exercise : Using static and dynamic analysis tools to find vulnerabilities in sample STM32 Code

STM32 secure boot, firmware protection and Hardware assisted security

- Secure boot on STM32 Devices
  - Introduction to secure boot
  - Secure boot implementation
  - Secure boot verification and toubleshooting
- Firmware protection on STM32 devices
  - Introduction to firmware protection
  - Techniques for protecting firmware on STM32 Devices
  - Implementation of firmware protection on STM32
- Haardware assisted security on STM32 devices
  - Introduction to hardware assisted security
  - STM32’s Cortex-M security features
  - Implementation of hardware assisted security on STM32

Exercise : Implementing secure boot on STM32 devices

Second Day

Network Security for STM32-based Devices

- Network Architecture for STM32-based Devices
  - Overview of network communication protocols for embedded systems
  - Secure communication protocols
  - Designing a secure network architecture for STM32-based devices
- Transport Layer Security (TLS)
  - Introduction to TLS and SSL
  - Implementing TLS/SSL on STM32-based devices
  - Secure communication using TLS/SSL on STM32
- WiFi security
  - Overview of WiFi security mechanisms and standards
  - Implementing secure WiFi communication on STM32
  - Best practices
- BLE security
  - Introduction to BLE
  - Overview of BLE security Mechanisms and standards
  - Implmeneting secure BLE Communications
  - Best practices for securing BLE communication
- LoRaWAN security
  - Introduction to LoRaWAN
  - Overview of LoRaWAN security mechanisms and standards
  - Implementing secure LoRaWAN communication on STM32-based devices
  - Best practices
- Sigfox Security
  - Overview of Sigfox
  - Implementing secure Sigfox communication on STM32-based devices
  - Best practices

IoT security

- Introduction to IoT Security
  - Unique security challenges faced by IoT devices
  - Overview of the common attack vectors and threats faced by IoT devices
- IoT security best practices
- Securing IoT devices at the network layer
  - IoT-specific network security protocols
- Access control and secure data transfer
  - Overview of authentication and authorization mechanisms for IoT devices
  - Discussion of secure data transfer protocols for IoT, such as MQTT and HTTPS
  - The role of application-level encryption in securing IoT devices
- Implementing secure application communication
  - Secure application communication between STM32 devices and the cloud or other systems
  - implementing secure access control, such as using JSON Web Tokens (JWT) and OAuth
- Best practices

Firmware update and management for STM32 devices

- Introduction to firmware update and management
  - Importance of firmware updates in maintaining the security of embedded systems
  - Overview of firmware update methods including manual and over-the-air (OTA) updates
- Secure firmware update processes
- OTA update mechanisms
  - Overview of OTA update mechanisms

- Implementing OTA updates, including server-side and device-side
- Best practices for OTA updates, including testing and deployment