
TrustFLEX Step by Step Guide

IP/Firmware Protection

Table of Contents

1	Introduction	3
1.1	Getting started with Jupyter Notebook Tutorials	3
1.1.1	Starting Jupyter Notebook.....	3
1.2	Jupyter Notebook Basics	3
1.2.1	The Notebook dashboard	3
1.3	Introduction to Jupyter Notebook GUI	4
2	Jupyter Notebook Tutorials	6
3	Resource Generation Notebook	7
4	Use Case Prototyping	10
4.1	Running IP Protection example on Jupyter Notebook:	10
4.2	Running IP Protection on Embedded Platform	14
4.2.1	Atmel Studio	14
4.2.2	MPLAB:	17
4.3	CryptoAuth TrustPlatform Factory reset.....	20
5	FAQ.....	21

1 Introduction

This document gives a detailed walk through of the IP Protection use case implementation. If familiar with Jupyter Notebook, can skip this section and move to Section 2.

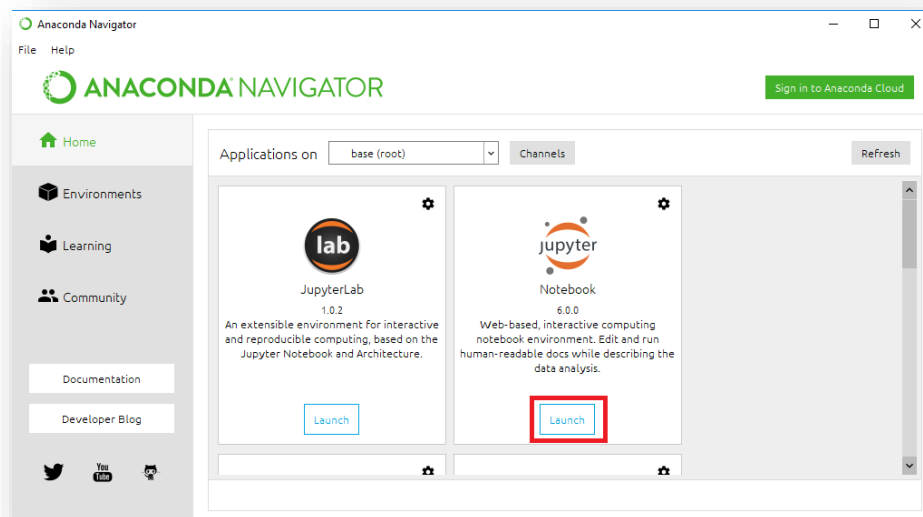
1.1 Getting started with Jupyter Notebook Tutorials

Jupyter Notebook is open source web application which allows you to create documents that contain code that you can execute in place as well as narrative text. It provides GUI elements, ability to execute code in place, ability to add images and gives it the look and feel that normal code files lack.

Jupyter notebooks are mainly used to explain/evaluate code in an interactive way.

1.1.1 Starting Jupyter Notebook

Jupyter notebook can be launched from the Anaconda Navigator main window.



1.2 Jupyter Notebook Basics

It is recommended to become familiar with Jupyter basic concepts with the online documentation, <https://jupyter-notebook.readthedocs.io/en/stable/examples/Notebook/Notebook%20Basics.html>

Some of the content is duplicated here for convenience. The online documentation should always be used as a reference.

1.2.1 The Notebook dashboard

When you first start the notebook server, your browser will open to the notebook dashboard. The dashboard serves as a home page for the notebook. Its main purpose is to display the notebooks and files in the current directory.

For example, here is a screenshot of the Jupyter dashboard. The top of the notebook list displays clickable breadcrumbs of the current directory. By clicking on these breadcrumbs or on sub-directories in the notebook list, you can navigate your file system.



1.3 Introduction to Jupyter Notebook GUI.

Jupyter Notebooks contain cells where you can either write code or markdown text. Notebooks contain multiple cells, some set as code and others markdown. Code cells contain code that can be executed live, and markdown contains text and images to explain the code.

Below image shows some options in a typical Jupyter Notebook. Individual cells can be executed by pressing on the RUN button as shown in the below image.

All cells in the Notebook can be executed in order by **Kernel->Restart & Run All**.



To run all cells in sequence.



2 Jupyter Notebook Tutorials

The TrustPlatform Design Suite comes with a Notebook Tutorials to easily prototype popular use cases for TrustFLEX devices. Here is the Jupyter Notebook Tutorials.

Jupyter Notebook Tutorials	Relative Path	Applicable devices
Manifest Generation	TNGTLS_Manifest_Generation\notebooks\TNGTLS Manifest File Generation.ipynb	Trust&GO
Resource Generation	TFLXTLS_resource_generation\Crypto Resource Generator.ipynb	TrustFLEX
Accessory Authentication	TFLXTLS_Use_Cases\notebooks\accessory-authentication\Accessory Authentication.ipynb	TrustFLEX
AWS Custom PKI	TFLXTLS_Use_Cases\notebooks\aws-iot\aws-iot with ECC608A-TLFXTLS.ipynb	TrustFLEX
Firmware Validation	TFLXTLS_Use_Cases\notebooks\firmware-validation\Firmware Validation with ECC608A-TFLXTLS Tutorial.ipynb	TrustFLEX
IP Protection	TFLXTLS_Use_Cases\notebooks\ipprotection\IP Protection with ECC608A-TFLXTLS Tutorial.ipynb	TrustFLEX
Secure Public Key Rotation	TFLXTLS_Use_Cases\notebooks\public-key-rotation\Public Key Rotation with ECC608A-TFLXTLS Tutorial.ipynb	TrustFLEX

3 Resource Generation Notebook

TFLXTLS device is one of the three devices available in the Trust Platform USB Dongle Board.

TrustFLEX devices come with pre-programmed certificates in slots 10, 11 and 12, also slots 0-4 have pre-generated private keys, other than the mentioned slots all the other slots have no data in them.

The Resource Generator Notebook will create development keys and certificates for all slots that can be further customized. Keys and Certificate chains are stored in the PC filesystem. These keys should never be used for production purposes as their generation is not handled in a secure environment. These development keys will be later used by the other notebooks to implement the various pre-defined use cases.

By default, Jupyter starts in Users directory (\$HOME for MacOS or Linux systems). For the remainder of this document, it will be assumed that the trust_platform folder is contained in Users directory. If this is not the case, please move trust_platform folder to your Users directory

Within the Jupyter Dashboard, navigate trust_platform\DesignTools\TFLXTLS_Resource_Generation folder to open Crypto Resource Generator.ipynb notebook



Run all cells of the Crypto Resource Generator Notebook: Kernel->Restart & Run All

Note: Before executing the cells on Crypto Trust Platform, its required to have factory default program running on SAMD21 of Trust Platform. Refer to [4.3 CryptoAuth TrustPlatform Factory reset](#) section for reloading default program.



Crypto Resource Generator notebook is common for all the use case which comes with option to load the signer certificate and device certificate.

So it will execute and prompt you to choose between MCHP certificate and a custom certificate chain, enter '1' (for MCHP certificate) and press Enter key for this use case.

The Notebook will generate several keys and certificates. Make sure you have an error free output before continuing to the next steps of the training.

```
print('-----\n')
print('Certificate related steps completed successfully')
print('\n\n')
```

Choose certificate type

- 1 - MCHP standard certificate
- 2 - Custom certificate

Enter certificate type

1

MCHP certificate related files are pre-generated

Certificate related steps completed successfully

The output log should look like this.

```
Choose certificate type
    1 - MCHP standard certificate
    2 - Custom certificate
Enter certificate type
1
-----
MCHP certificate related files are pre-generated
-----
-----
Certificate related steps completed successfully
-----
```

The Notebook will also generate a manifest file to be uploaded into the public cloud of your choice (Google GCP, AWS IoT and soon to be supported Microsoft Azure).

After running this Notebook, it generates the required resources and program data zone with required secrets, keys and certificates. For this use case, Secret key is loaded into TrustFLEX device (ATECC608A) in slot 5.

4 Use Case Prototyping

This hands-on lab is intended to demonstrate the usage of IP protection by authenticating the TrustFLEX device connected to host. It uses symmetric authentication where both host and TrustFLEX device shares a common secret.

This process uses a challenge-response model. In this model, host authenticates the TrustFLEX device based on MAC response. MAC is calculated on the TrustFLEX device to prove that it holds the secret key that is shared by the host. Then the calculated MAC will be verified by the host to continue using IP.

MAC calculation on TrustFLEX includes device serial number, nonce (number used once) and shared secret key. By including serial number and nonce, host can get unique MAC from each TrustFLEX every time, thereby avoiding the replay attacks.

TrustFLEX device Slot5 being used to store the shared secret. The resource generation for TrustFLEX device will load a prototyping symmetric key to Slot5 of TrustFLEX device.

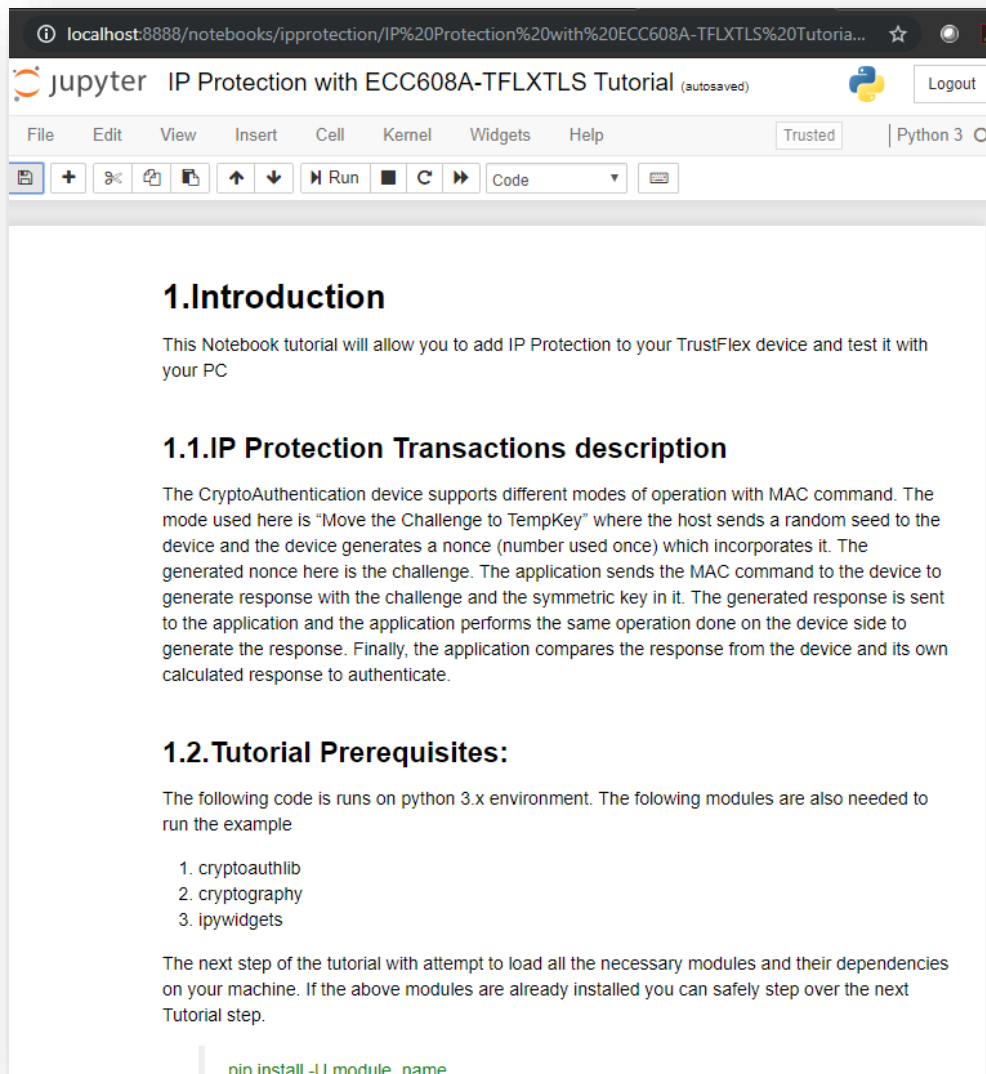
Following sections provides detail steps to execute the usecase both on Jupyter Notebook and on Embedded project

4.1 Running IP Protection example on Jupyter Notebook:

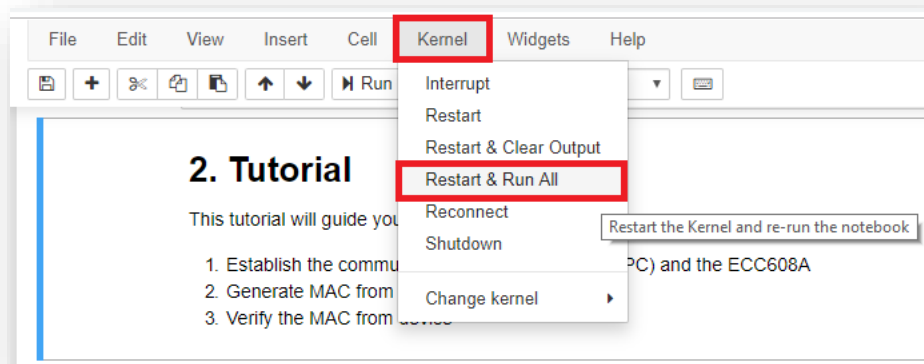
1. From the Jupyter Home page, navigate to **TFLXTLS_Use_Cases\notebooks\ipprotection\IP Protection with ECC608A-TFLXTLS Tutorial.ipynb** notebook file and open it.



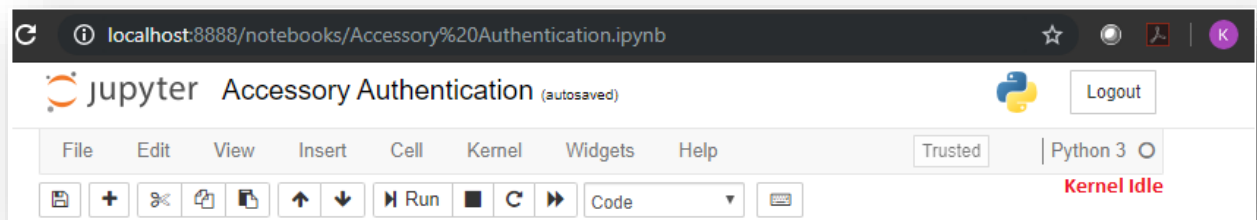
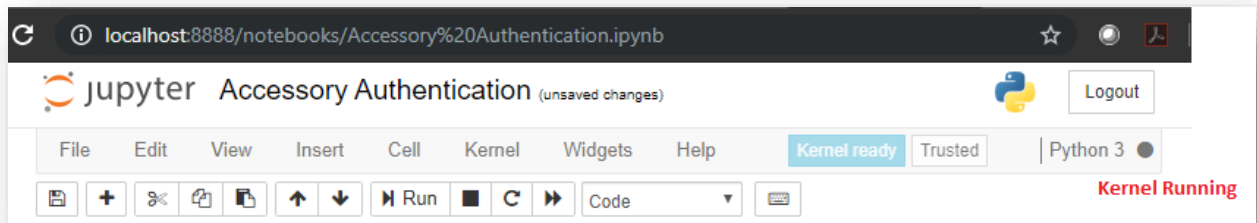
Opening the notebook from Jupyter home page should load the following on the browser,



2. Run All Cells by using Kernel -> Restart & Run All



3. It may take a while to complete, wait for the kernel to complete all processing i.e. from Kernel Running to Kernel Idle state (Check circle above **RED** text)



4. Navigate through different cells output for the description of the step and result from the execution.

5. There are 2 major steps in this lab

Generate MAC from TFLXTLS part

Code block of this step generates a random challenge and expects TrustFLEX to provide the MAC for this challenge. Accessory calculates the MAC value by including its serial number, shared secret and the challenge received from host.

Calculate Nonce

To calculate MAC, nonce is considered. Nonce is calculated based on the challenge which is initiated by host. Then calculated nonce will be stored in tempkey of TrustFLEX.

Calculate MAC on TrustFLEX device

MAC is calculated on TrustFLEX device is to prove that the this has the secret key shared by host. TrustFLEX device MAC is calculated with its serial number, calculated nonce and secret key.

Then calculated MAC will send to the host to authenticate the TrustFLEX device.

Below screenshot display the accessory device MAC.

```
# Generate the nonce in device and return the random number
assert atcab_nonce_rand(seed_in,rand_out) == ATCA_SUCCESS, "Random nonce from device failed"

# Calculate the nonce value on the host side
nonce.extend(rand_out[0:32])
nonce.extend(seed_in[0:20])
nonce.append(0x16)
nonce.append(0)
nonce.append(0)
digest = hashes.Hash(hashes.SHA256(), backend=default_backend())
digest.update(bytes(nonce))
nonce = digest.finalize()

# Calculate the mac in device with its symmetric diversified key in slot
assert atcab_mac(MAC_MODE,SHARED_SECRET_SLOT,0,device_mac) == ATCA_SUCCESS, "MAC from device failed"
print("MAC Received from device:")
print(pretty_print_hex(device_mac, indent='  '))

MAC Received from device:
A9 58 C0 EE 00 AA BA 6E FC E0 19 2D 4D CE F6 CE
57 61 65 CA C7 77 B3 73 DE 6D 94 45 DB F2 FF A4
```

Verify Expected MAC on Host

Code block of this step generates Verify MAC button. Clicking the button repeats the MAC calculation process on host by including its challenge, TrustFLEX serial number and shared secret key. If any of this mismatch, calculated MAC will be different resulting in authentication failure.

```
print("MAC calculated on host:")
print(pretty_print_hex(host_mac, indent='  '))

if (device_mac == host_mac):
    print('\nApplication authenticated successfully!')
    mac_verify.button_style = 'success'
else:
    mac_verify.button_style = 'danger'
    print('\nApplication not authenticated...')

mac_verify = widgets.Button(description = "Verify MAC", tooltip = 'MAC & MAC-Response Verify')
mac_verify.on_click(mac_mac_resp_verify)
display(mac_verify)
```

Verify MAC

```
MAC calculated on host:
A9 58 C0 EE 00 AA BA 6E FC E0 19 2D 4D CE F6 CE
57 61 65 CA C7 77 B3 73 DE 6D 94 45 DB F2 FF A4
```

Application authenticated successfully!

- In Jupyter notebook, run cells till the end of notebook, you will see a "Verify MAC" button will appear. Press the button, it will turn green if TrustFLEX device gets authenticated by MCU or it will turn red.

Pressing the button, turns it Green or Red. Green indicates that the device is authenticated by host and Red indicates the authentication is failed.

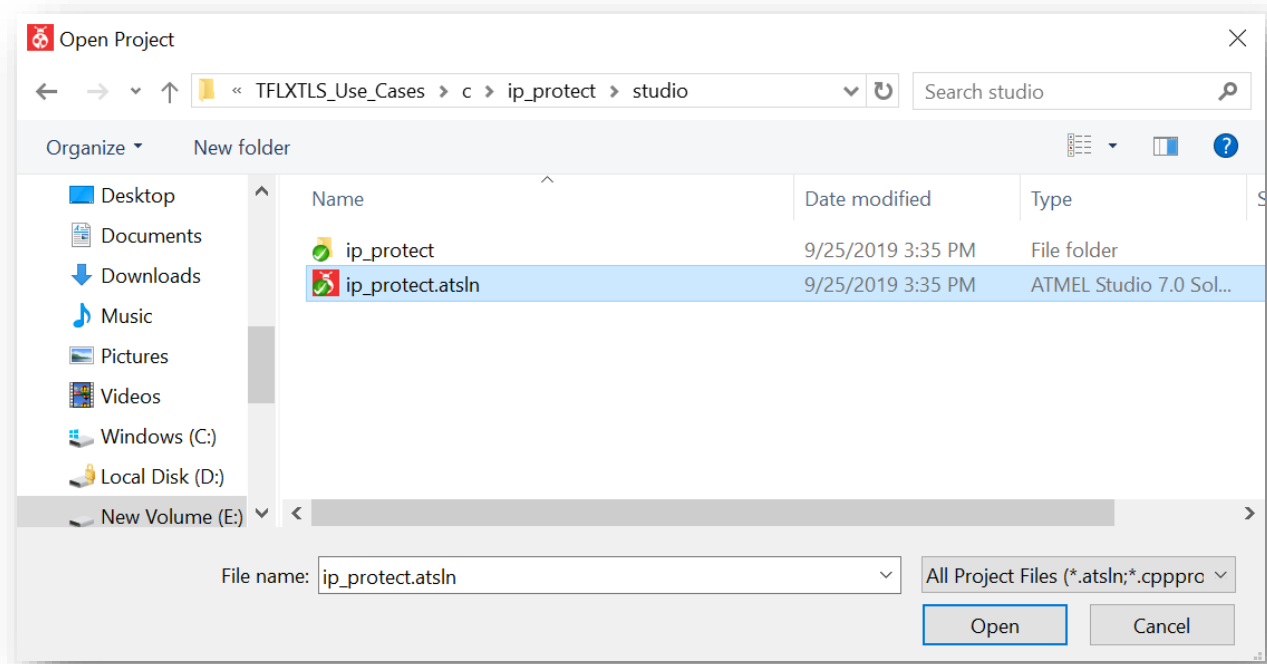
4.2 Running IP Protection on Embedded Platform

This usecase can also be executed on Embedded platform. Once the resources are generated, both Atmel Studio and MPLAB projects provided can be used to run the application on CryptoAuth Trust Platform.

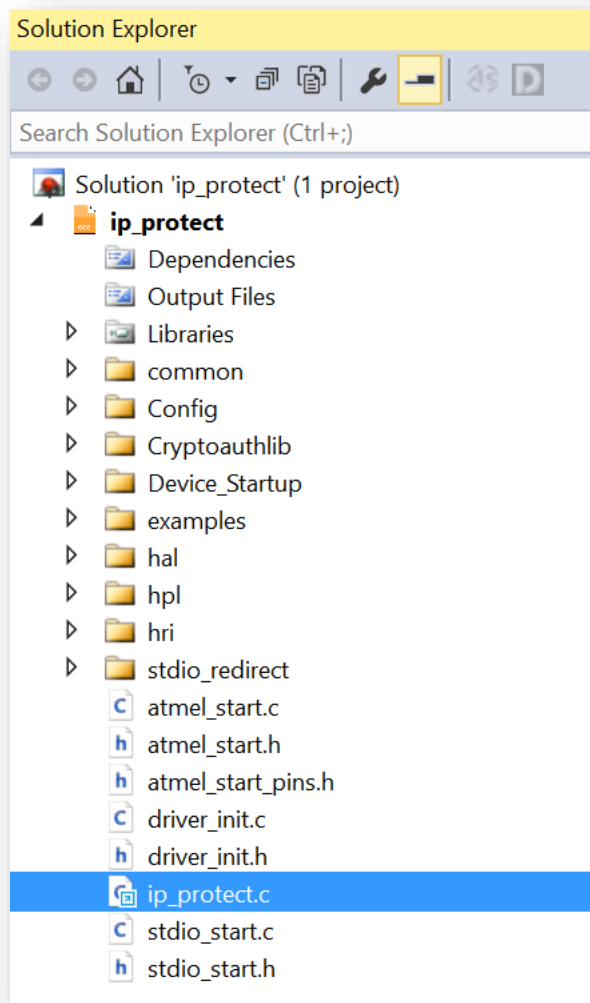
Note: This usecase requires resource generation notebook executed prior to using embedded projects.

4.2.1 Atmel Studio

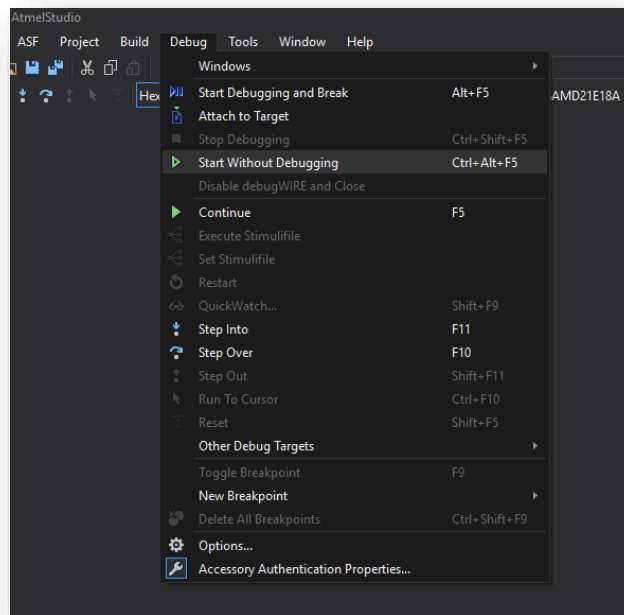
1. Open **ip_protect.atsln** project by navigating to Atmel Studio -> File -> open -> **TFLXTLS_Use_Cases\c\ip_protect\studio\ip_protect.atsln**



2. The application source code **ip_protect.c** is available at **TFLXTLS_Use_Cases\c\ip_protect\ip_protect.c** Other supporting files can be found under **TFLXTLS_Use_Cases\c\dependencies**



3. Program the Crypto Trust platform by navigating to **Debug -> Start Without Debugging**



This step may take some time, wait for Atmel Studio to compile and program the device.

Once the programming is done, the firmware will do IP Protection operation. Depending on the IP Protection operation's output, the Cryptoauth Trust Platform board's Status LED will blink at different rates.

If IP Protection operation **succeeds**, LED blinks once every second.

If IP Protection operation **fails**, LED blinks five times every second.

It is also possible to view the Console messages by using applications like TeraTerm. Open the application with the COM related to CryptoAuth TrustPlatform with 115200-8-N-1 settings

```

COM32 - Tera Term VT
File Edit Setup Control Window Help

Device revision:
00 00 60 02

MAC received from device:
0E A8 E0 FD 57 E5 51 4A D4 2C 0E 6D FE 33 B8 E3
69 19 EB 82 24 F3 0B BA 4F 5B 24 3B 72 23 74 DE

MAC calculated on Host:
0E A8 E0 FD 57 E5 51 4A D4 2C 0E 6D FE 33 B8 E3
69 19 EB 82 24 F3 0B BA 4F 5B 24 3B 72 23 74 DE

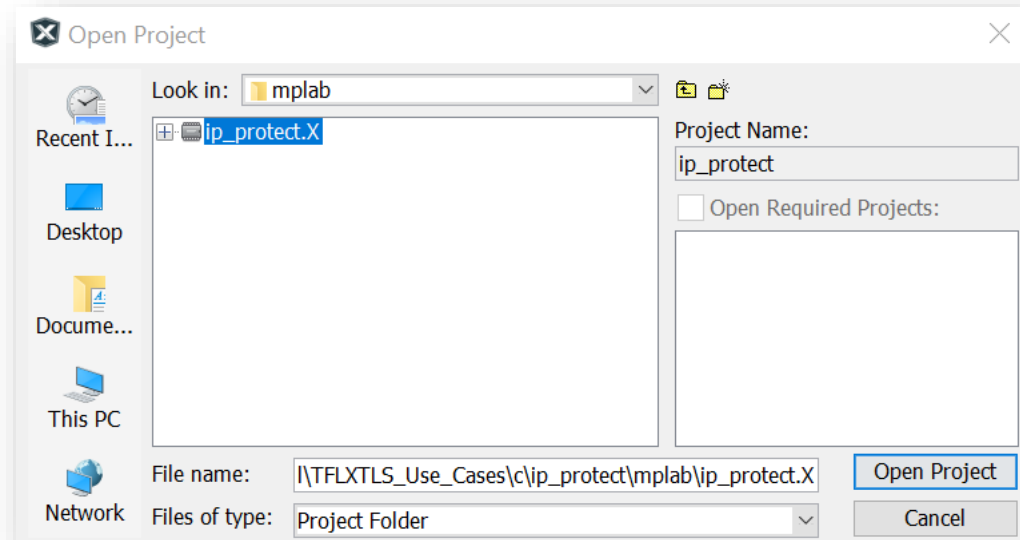
Application authenticated successfully

Execution completed with status 00

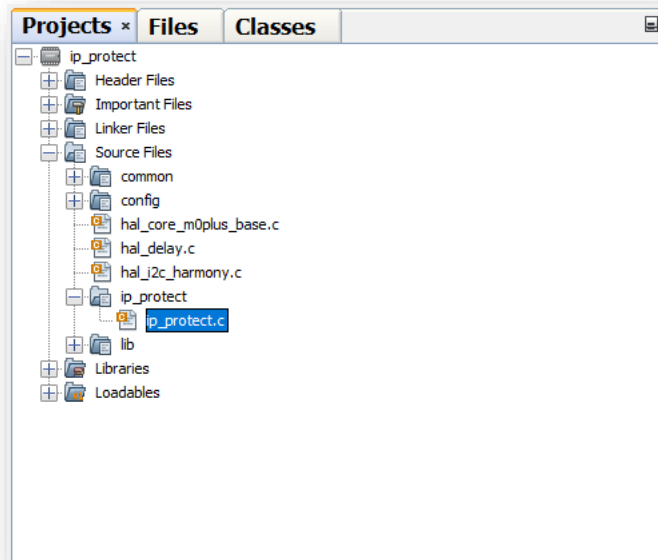
```


4.2.2 MPLAB:

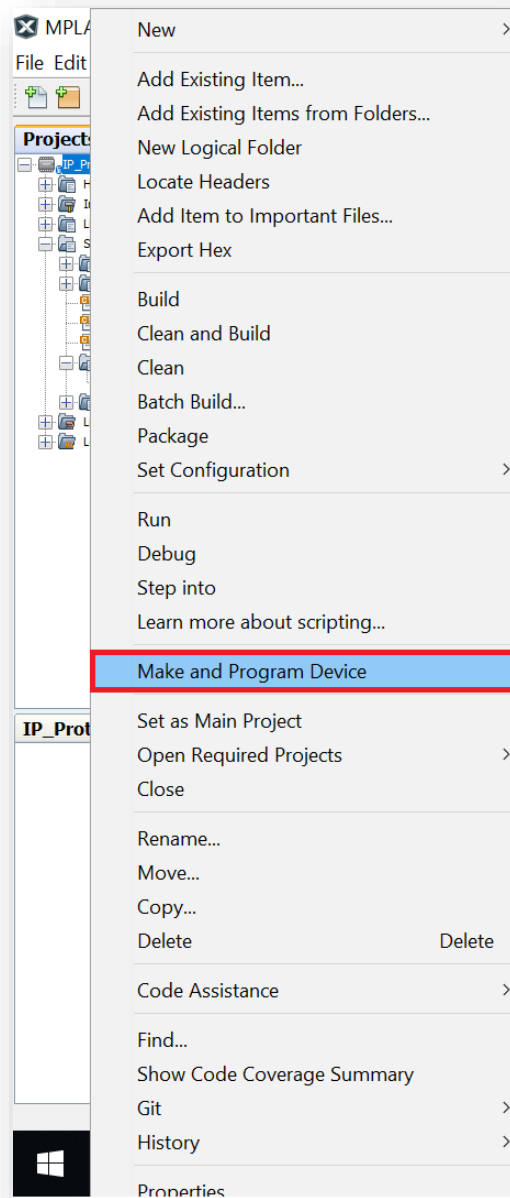
1. Open **ip_protect.X** project by navigating to MPLAB -> File -> Open Project -> **TFLXTLS_Use_Cases\c\ip_protect\mplab\ip_protect.X**



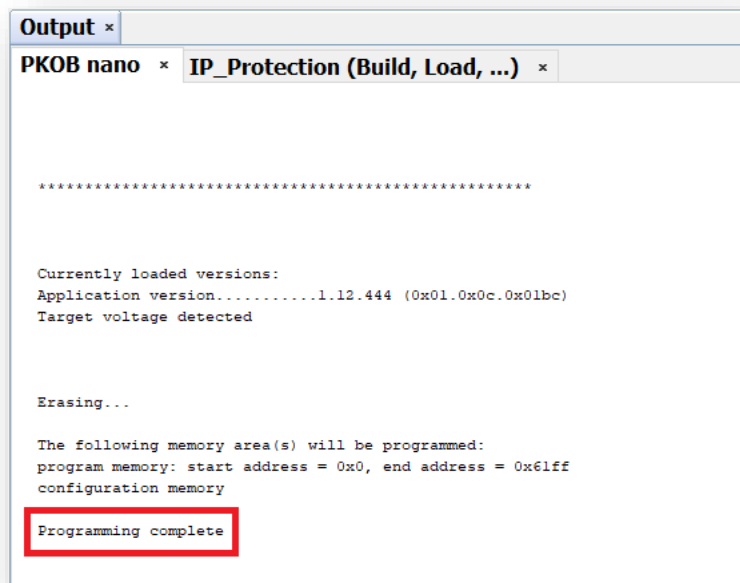
2. The application source code **ip_protect.c** is available at **TFLXTLS_Use_Cases\c\ip_protect\ip_protect.c**. Other supporting files can be found under **TFLXTLS_Use_Cases\c\ dependencies**



3. Program the Crypto Trust platform by navigating to **ip_protect** -> **Make and Program Device**



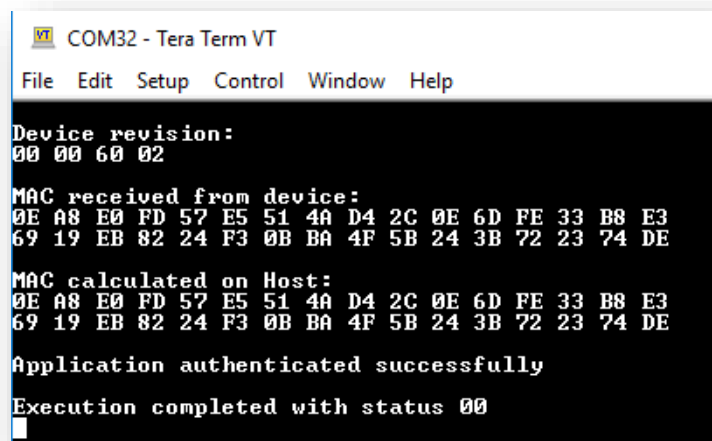
This step may take some time, wait for MPLAB to program the device. Once it is done programming you will see "**Programming complete**" message in Output Window.



Once the programming is done, the firmware will do IP Protection operation. Depending on the IP Protection operation's output, the Cryptoauth Trust Platform board's Status LED will blink at different rates.

If IP Protection operation **succeeds**, LED blinks once every second.
If IP Protection operation **fails**, LED blinks five times every second.

It is also possible to view the Console messages by using applications like TeraTerm. Open the application with the COM related to CryptoAuth TrustPlatform with 115200-8-N-1 settings



4.3 CryptoAuth TrustPlatform Factory reset

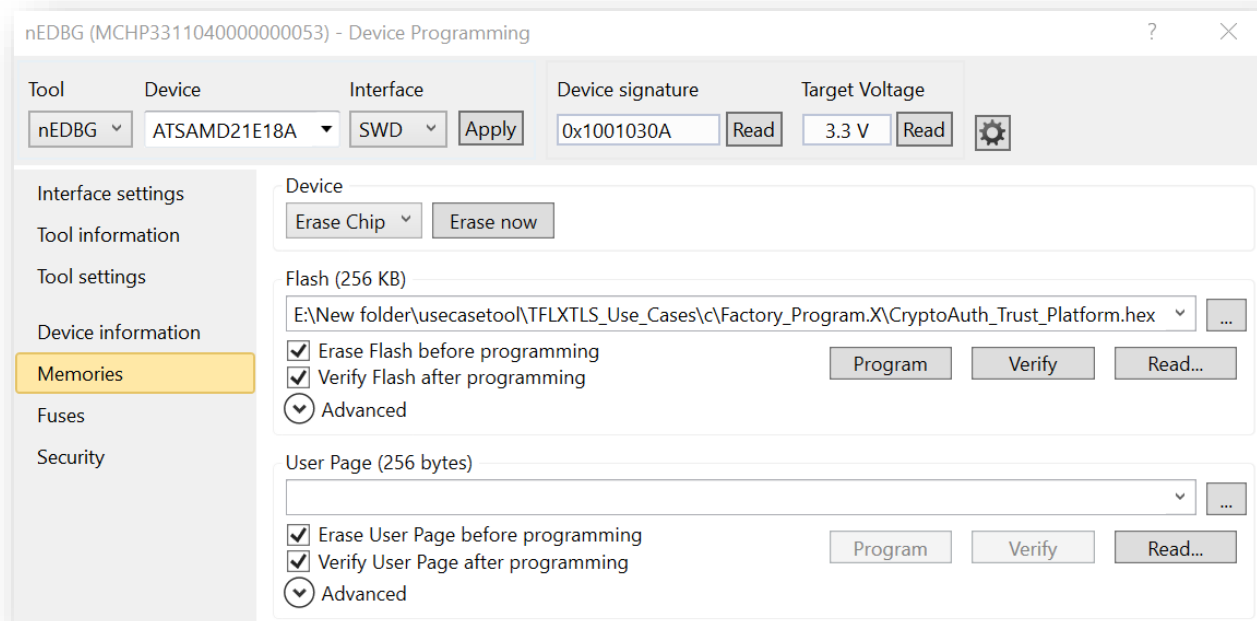
Once any of the embedded project is loaded to CryptoAuth TrustPlatform, the default program that enables interaction with TrustPlatform tools will be erased.

Before using the Platform with any other notebook or tools on PC, its required to reprogram the default .hex file. Default hex file is available at

TFLXTLS_Use_Cases\c\Factory_Program.X\CryptoAuth_Trust_Platform.hex

To reprogram using Atmel Studio:

1. Navigate to AtmelStudio -> Tools -> Device Programming
2. Select Tool as nEDBG and Apply
3. Go to Memories and navigate to above path under Flash dropdown
4. Check both Erase Flash and Verify Flash
5. Click on Program



To reprogram using MPLAB:

1. Open **TFLXTLS_Use_Cases\c\Factory_Program.X** project in MPLAB IDE
2. Program the Crypto Trust platform by navigating to
CryptoAuth_Trust_Platform_Factory_Program -> Make and Program Device

Now, Crypto Trust Platform contains factory programmed application that enables interactions with Notebooks and/or PC tools.

5 FAQ

1. What are the reasons for “**AssertionError: Can't connect to the USB dongle**” error?

There are many possibilities like,

1. Crypto Trust Platform is having different application than factory reset firmware. Refer to “CryptoAuth TrustPlatform Factory reset” section any usecase TrustFLEX Guide for reloading it
2. Check the switch positions on Crypto Trust Platform and/or ATECC608A Trust board
 - a. Correct Trust device should be connected and only one device of that type is allowed on the I2C bus. Multiple devices with same address results in error
3. Check USB connections to Crypto Trust Platform

2. How to reload factory default application to Crypto Trust Platform?

Refer to “CryptoAuth TrustPlatform Factory reset” section any usecase TrustFLEX Guide for reloading it.

3. Why does my C projects generates No such file or directory with ../../../../TFLXTLS_resource_generation/?

C project generates this error when the resources are not generated prior to using embedded projects. Running the resource generation notebook ensures these files and secrets are generated.

4. Before running any use case notebook and/or C project, why is it mandate to execute resource generation?

When resource generation notebook is executed, it generates and programs the required resources like secrets, keys and certificates. These are only prototyping keys and cannot be used for production. These keys will be used part of Usecase notebooks and C projects

5. How to know the resources being used in a use case?

Refer to individual Usecase description html for details on transaction diagrams, resources being used and other details. The resources required for given use case is mentioned in INFER CRYPTOGRAPHIC ASSETS section.

6. When should I select Custom certificates while doing resource generation?

Custom certificates are required when user wants to have their own root, signer instead of MCHP provided. The difference would be organization name, common name and validity are configurable

7. How to know whether C project is executing on Trust Platform or not after programming?

Once the programming is done, the firmware will do use case operation. Depending on the use case operation's output, the Crypto Trust Platform board's status LED will blink at different rates.

If use case operation succeeds, LED blinks once every second. If it fails, LED blinks five times every second.

It is also possible to view the Console messages by using applications like TeraTerm. Open the application with the COM related to Crypto Trust Platform with 115200-8-N-1 settings

The Microchip Web Site

Microchip provides online support via our web site at <http://www.microchip.com/>. This web site is used as

a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQ), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

Customer Change Notification Service

Microchip's customer notification service helps keep customers current on Microchip products. Subscribers will receive e-mail notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, access the Microchip web site at <http://www.microchip.com/>. Under "Support", click on "Customer Change Notification" and follow the registration instructions.

Customer Support

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or Field Application Engineer (FAE) for support.

Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at: <http://www.microchip.com/support>

Microchip Devices Code Protection Feature

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the

operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.

- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as “unbreakable.”

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be

a

violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Legal Notice

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL,

STATUTORY

OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE.

Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

Trademarks

The Microchip name and logo, the Microchip logo, AnyRate, AVR, AVR logo, AVR Freaks, BitCloud, chipKIT, chipKIT logo, CryptoMemory, CryptoRF, dsPIC, FlashFlex, flexPWR, Heldo, JukeBlox, KeeLoq,

Kleer, LANCheck, LINK MD, maXStylus, maXTouch, MediaLB, megaAVR, MOST, MOST logo, MPLAB,

OptoLyzer, PIC, picoPower, PICSTART, PIC32 logo, Prochip Designer, QTouch, SAM-BA, SpyNIC, SST,

SST Logo, SuperFlash, tinyAVR, UNI/O, and XMEGA are registered trademarks of Microchip Technology

Incorporated in the U.S.A. and other countries.

ClockWorks, The Embedded Control Solutions Company, EtherSynch, Hyper Speed Control, HyperLight

Load, IntelliMOS, mTouch, Precision Edge, and Quiet-Wire are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, BodyCom, CodeGuard, CryptoAuthentication, CryptoAutomotive, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, EtherGREEN, In-Circuit Serial Programming,

ICSP, INICnet, Inter-Chip Connectivity, JitterBlocker, KleerNet, KleerNet logo, memBrain, Mindi, MiWi,

motorBench, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscient

Code Generation, PICDEM, PICDEM.net, PICkit, PICtail, PowerSmart, PureSilicon, QMatrix, REAL ICE,

Ripple Blocker, SAM-ICE, Serial Quad I/O, SMART-I.S., SQI, SuperSwitcher, SuperSwitcher II, Total Endurance, TSHARC, USBCheck, VariSense, ViewSpan, WiperLock, Wireless DNA, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

Silicon Storage Technology is a registered trademark of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2018, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

ISBN:

Quality Management System Certified by DNV

ISO/TS 16949

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California

and India. The Company's quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.



Worldwide Sales and Service

AMERICAS	ASIA/PACIFIC	ASIA/PACIFIC	EUROPE
Corporate Office 2355 West Chandler Blvd. Chandler, AZ 85224-6199 Tel: 480-792-7200 Fax: 480-792-7277 Technical Support: http://www.microchip.com/support Web Address: www.microchip.com Atlanta Duluth, GA Tel: 678-975-9614 Fax: 678-957-1455 Austin, TX Tel: 512-257-3370 Boston Westborough, MA Tel: 774-760-0087 Fax: 774-760-0088 Chicago Itasca, IL Tel: 630-285-0071 Fax: 630-285-0075 Dallas Addison, TX Tel: 972-818-7423 Fax: 972-818-2924 Detroit Novi, MI Tel: 248-848-4000 Houston, TX Tel: 281-894-5983 Indianapolis Noblesville, IN Tel: 317-773-8323 Fax: 317-773-5453 Tel: 317-536-2380 Los Angeles Mission Viejo, CA Tel: 949-462-9523 Fax: 949-462-9608 Tel: 951-273-7800 Raleigh, NC Tel: 919-844-7510 New York, NY Tel: 631-435-6000 San Jose, CA Tel: 408-735-9110 Tel: 408-436-4270 Canada - Toronto Tel: 905-695-1980 Fax: 905-695-2078	Australia - Sydney Tel: 61-2-9868-6733 China - Beijing Tel: 86-10-8569-7000 China - Chengdu Tel: 86-28-8665-5511 China - Chongqing Tel: 86-23-8980-9588 China - Dongguan Tel: 86-769-8702-9880 China - Guangzhou Tel: 86-20-8755-8029 China - Hangzhou Tel: 86-571-8792-8115 China - Hong Kong SAR Tel: 852-2943-5100 China - Nanjing Tel: 86-25-8473-2460 China - Qingdao Tel: 86-532-8502-7355 China - Shanghai Tel: 86-21-3326-8000 China - Shenyang Tel: 86-24-2334-2829 China - Shenzhen Tel: 86-755-8864-2200 China - Suzhou Tel: 86-186-6233-1526 China - Wuhan Tel: 86-27-5980-5300 China - Xian Tel: 86-29-8833-7252 China - Xiamen Tel: 86-592-2388138 China - Zhuhai Tel: 86-756-3210040	India - Bangalore Tel: 91-80-3090-4444 India - New Delhi Tel: 91-11-4160-8631 India - Pune Tel: 91-20-4121-0141 Japan - Osaka Tel: 81-6-6152-7160 Japan - Tokyo Tel: 81-3-6880-3770 Korea - Daegu Tel: 82-53-744-4301 Korea - Seoul Tel: 82-2-554-7200 Malaysia - Kuala Lumpur Tel: 60-3-7651-7906 Malaysia - Penang Tel: 60-4-227-8870 Philippines - Manila Tel: 63-2-634-9065 Singapore Tel: 65-6334-8870 Taiwan - Hsin Chu Tel: 886-3-577-8366 Taiwan - Kaohsiung Tel: 886-7-213-7830 Taiwan - Taipei Tel: 886-2-2508-8600 Thailand - Bangkok Tel: 66-2-694-1351 Vietnam - Ho Chi Minh Tel: 84-28-5448-2100	Austria - Wels Tel: 43-7242-2244-39 Fax: 43-7242-2244-393 Denmark - Copenhagen Tel: 45-4450-2828 Fax: 45-4485-2829 Finland - Espoo Tel: 358-9-4520-820 France - Paris Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79 France - Saint Cloud Tel: 33-1-30-60-70-00 Germany - Garching Tel: 49-8931-9700 Germany - Haan Tel: 49-2129-3766400 Germany - Heilbronn Tel: 49-7131-67-3636 Germany - Karlsruhe Tel: 49-721-625370 Germany - Munich Tel: 49-89-627-144-0 Fax: 49-89-627-144-44 Germany - Rosenheim Tel: 49-8031-354-560 Israel - Ra'anana Tel: 972-9-744-7705 Italy - Milan Tel: 39-0331-742611 Fax: 39-0331-466781 Italy - Padova Tel: 39-049-7625286 Netherlands - Drunen Tel: 31-416-690399 Fax: 31-416-690340 Norway - Trondheim Tel: 47-7289-7561 Poland - Warsaw Tel: 48-22-3325737 Romania - Bucharest Tel: 40-21-407-87-50 Spain - Madrid Tel: 34-91-708-08-90 Fax: 34-91-708-08-91 Sweden - Gothenberg Tel: 46-31-704-60-40 Sweden - Stockholm Tel: 46-8-5090-4654 UK - Wokingham Tel: 44-118-921-5800 Fax: 44-118-921-5820