Real-Time Operating System (Day 1 Lab)

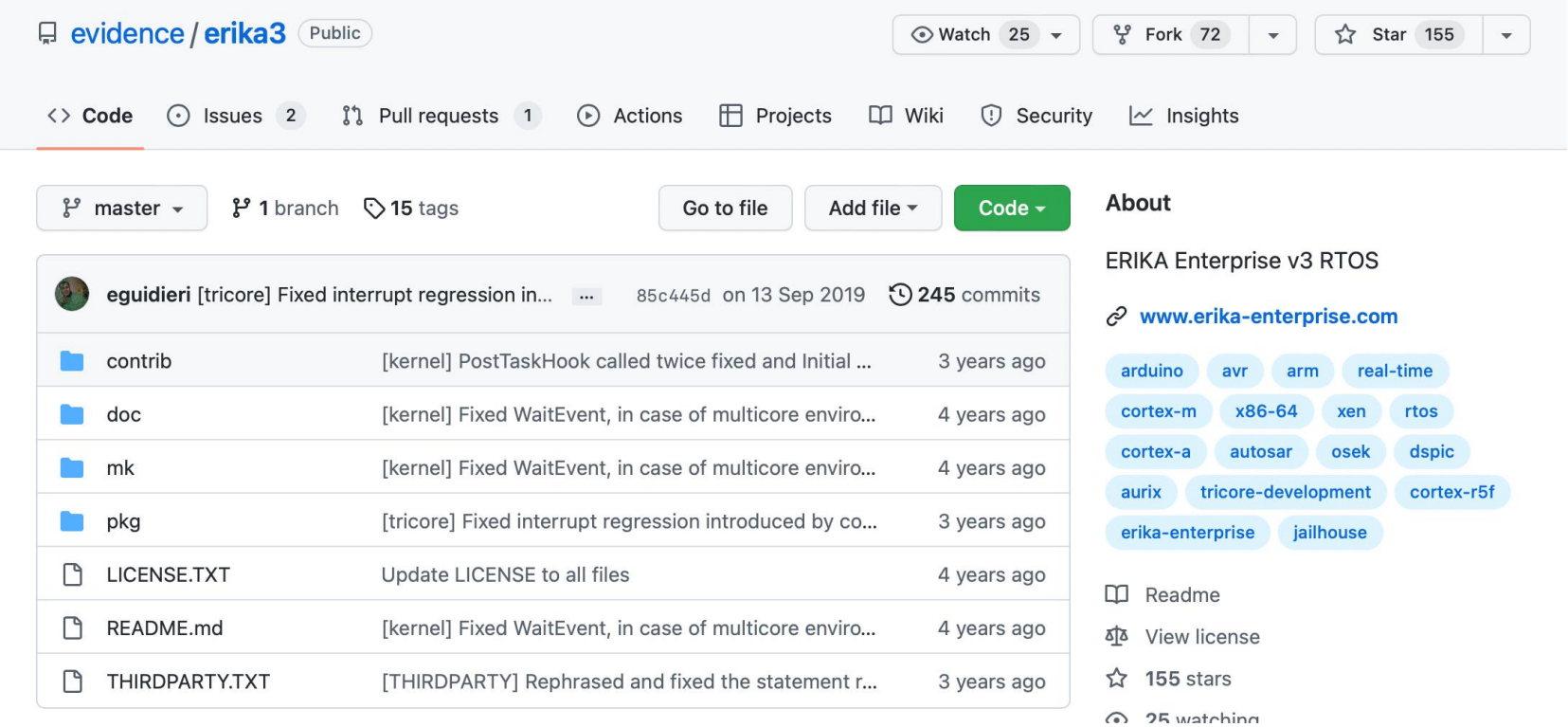
Jong-Chan Kim

Graduate School of Automotive Engineering

국민대학교
KOOKMIN UNIVERSITY

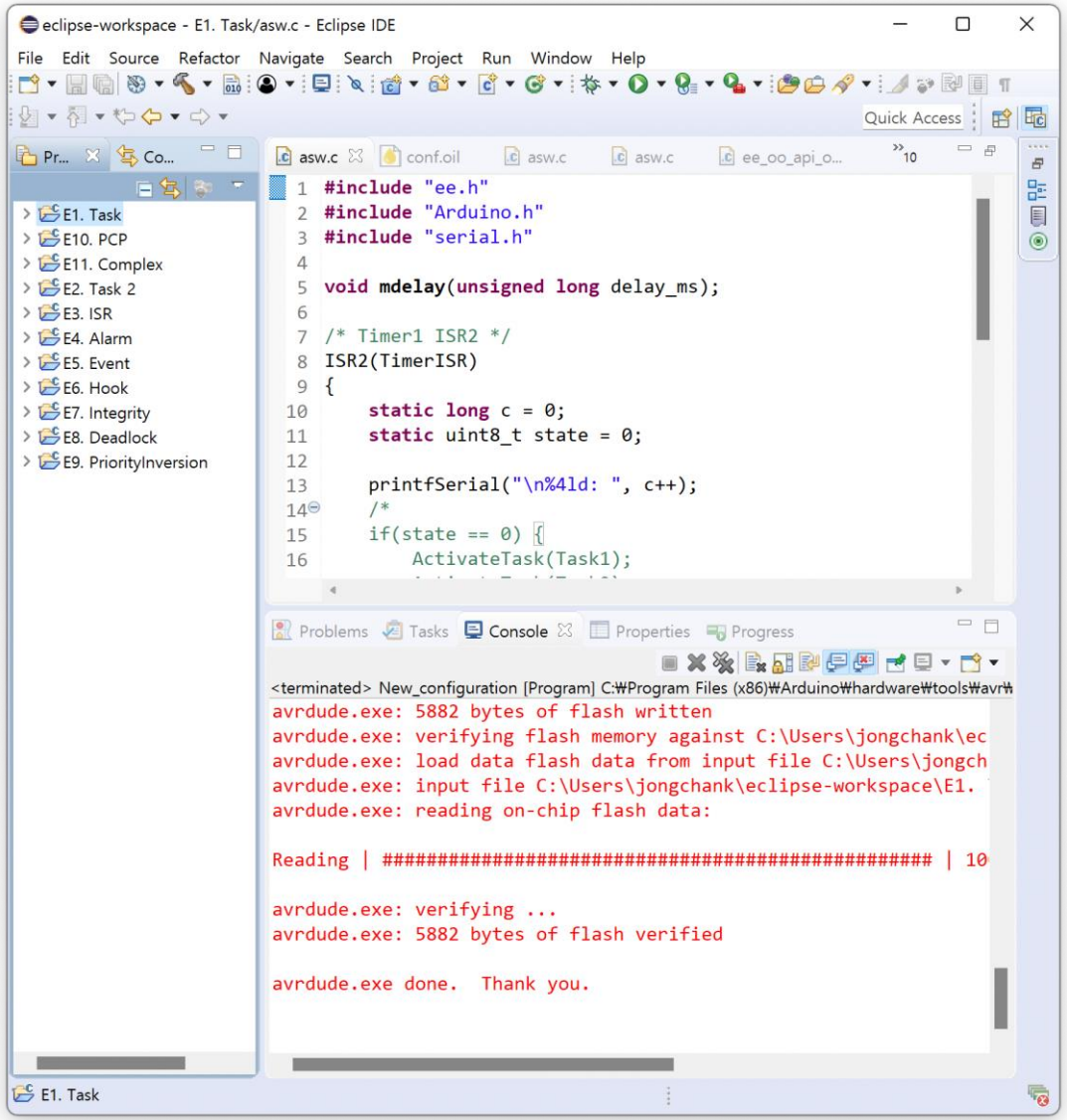
Erika Enterprise

- 이탈리아 EVIDENCE에서 개발된 오픈소스 OSEK/VDX RTOS 구현체
- 듀얼 라이센스 정책 (오픈소스 라이센스 + 상용 라이센스)
- RTOS 연구 및 교육에 널리 사용
- GitHub 리포



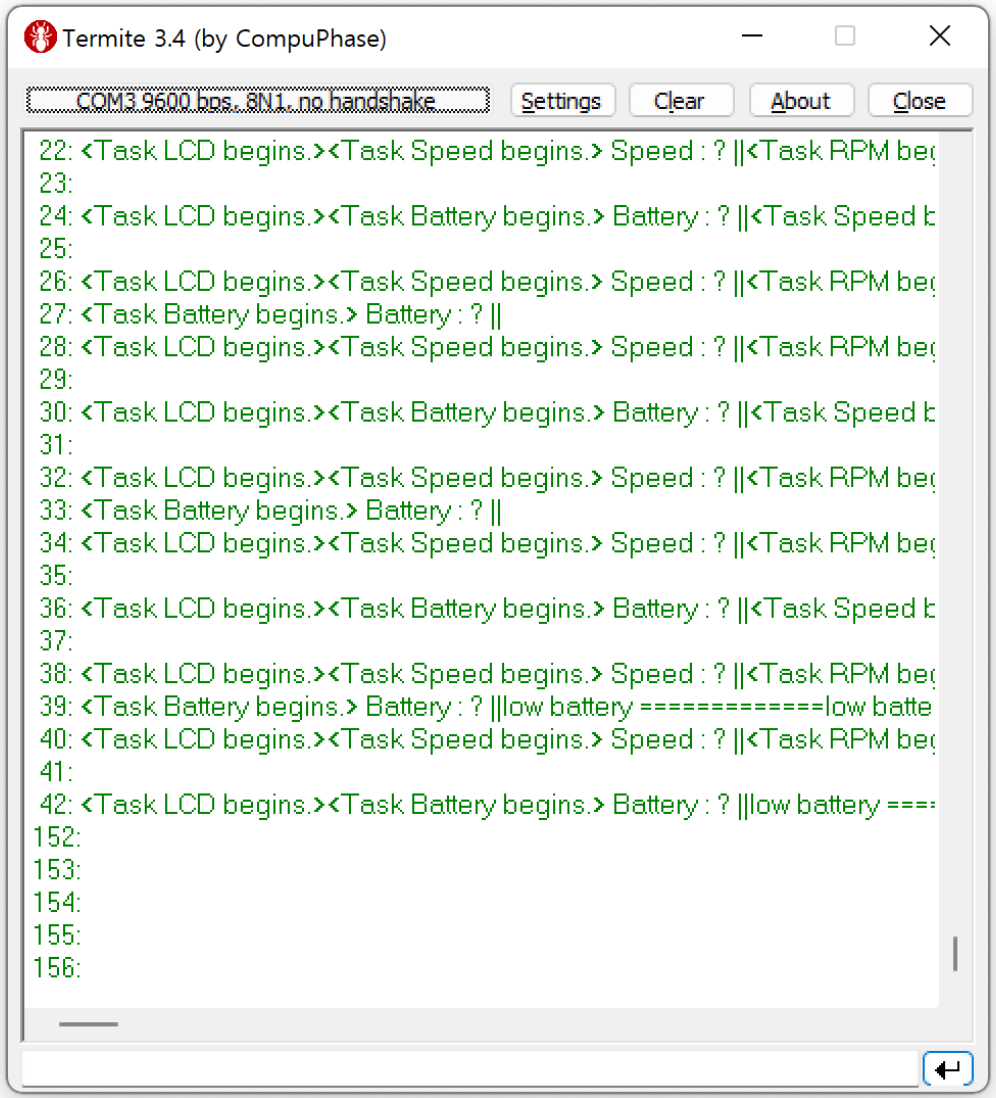
Eclipse 기반 IDE

- 프로젝트 생성
- OIL 파일, C/C++ 파일 편집
- 프로젝트 빌드
- 실행파일 다운로드



Termite 시리얼 콘솔

- 경량 시리얼 터미널



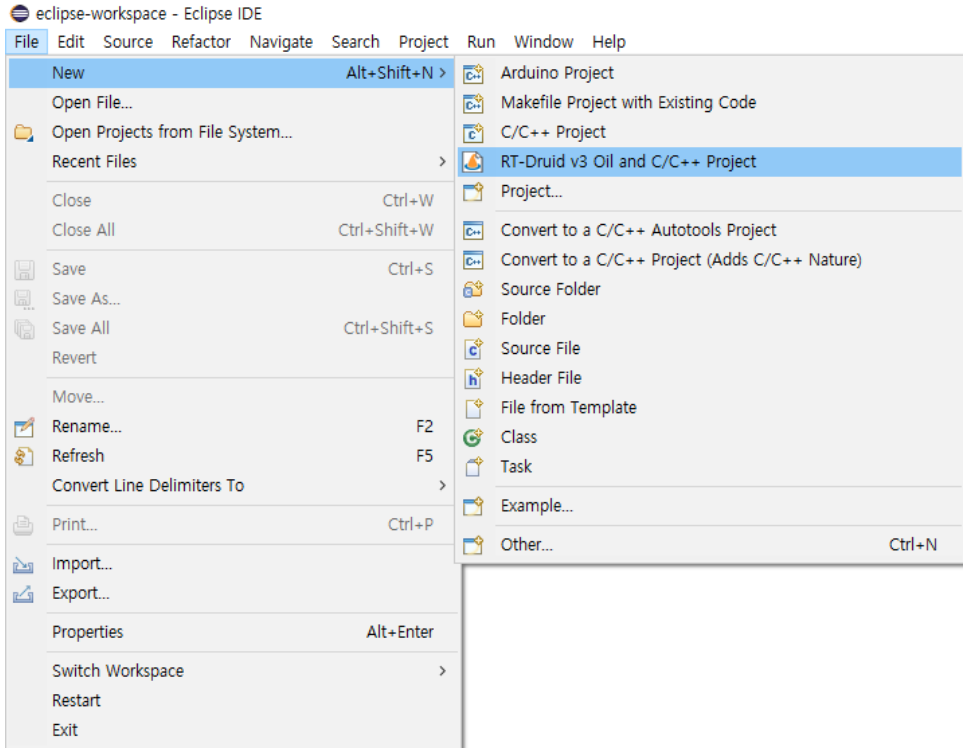
다운로드: https://www.compuphase.com/software_termite.htm

프로젝트 생성

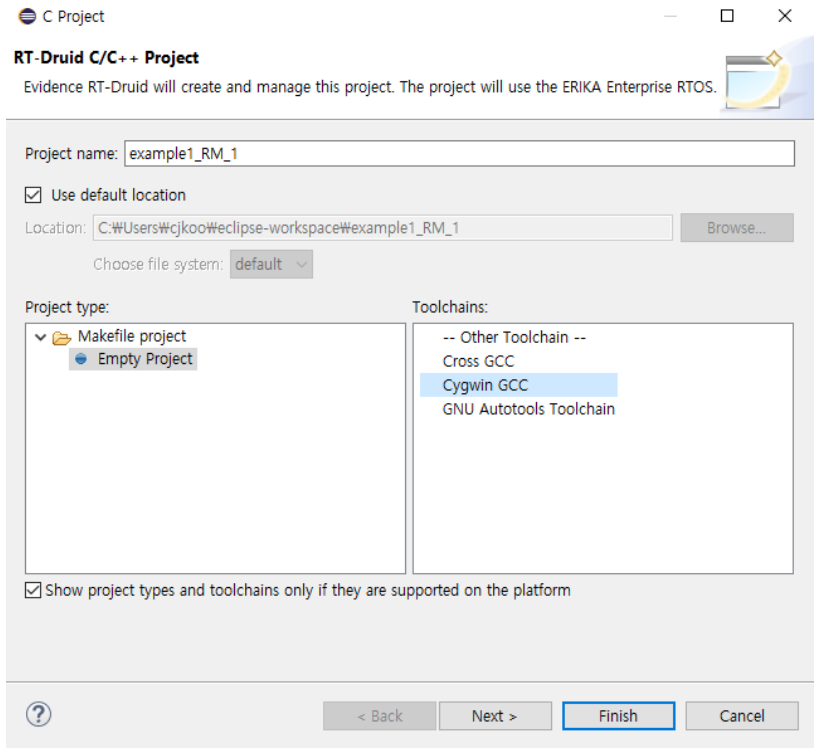
1. 새 프로젝트

File -> New

-> RT-Druid v3 Oil and C/C++ Project

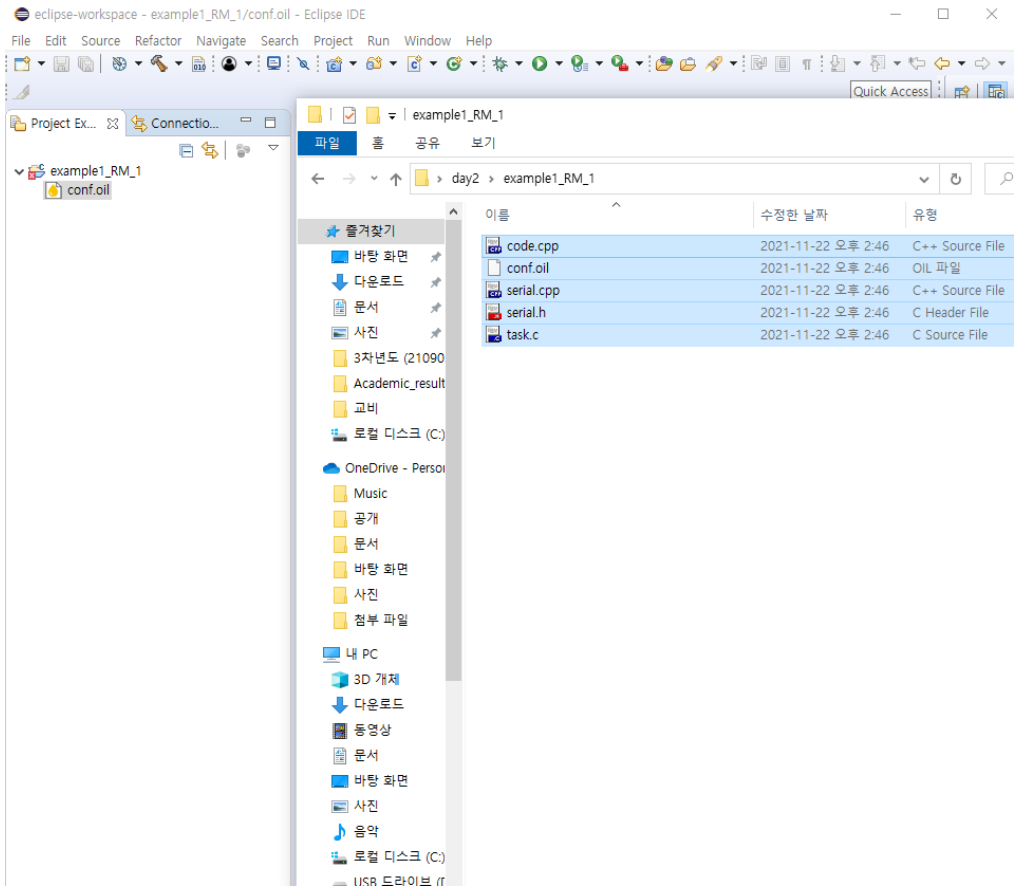


2. 프로젝트 이름 입력 및 Cygwin GCC 선택

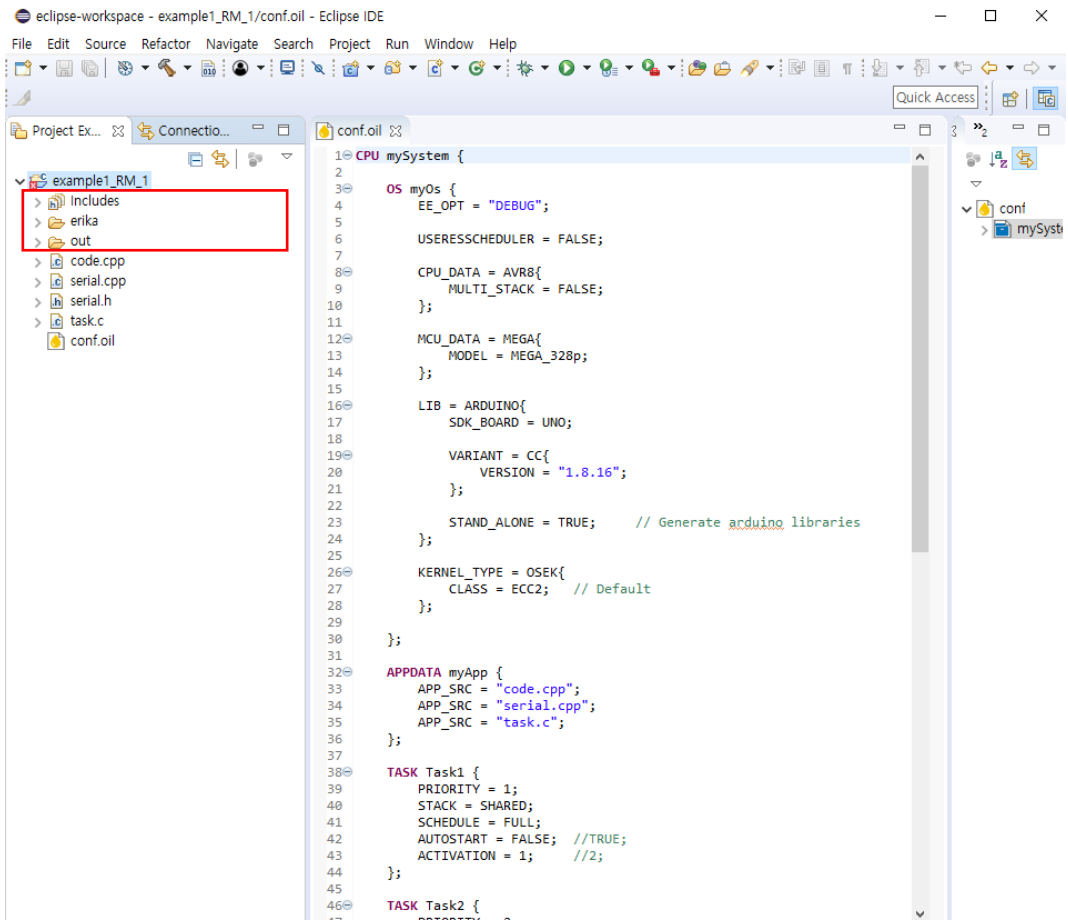


프로젝트 생성

3. 파일 카피

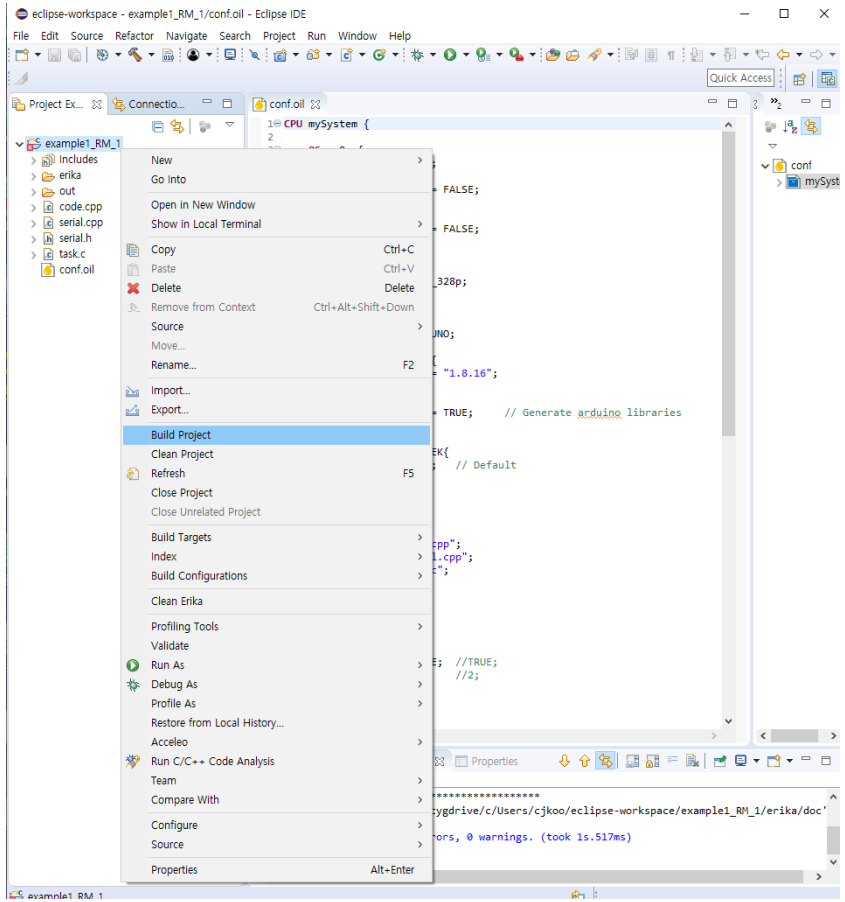


4. 디렉토리 생성 확인



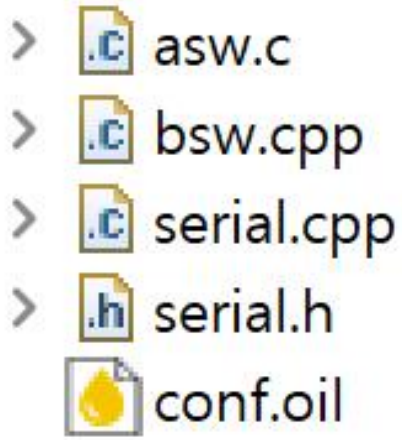
프로젝트 생성

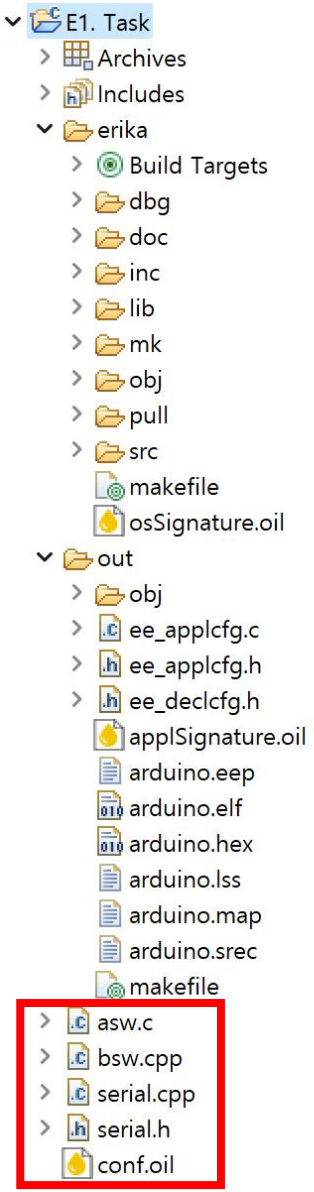
5. 우클릭 & Build Project



프로젝트 구조

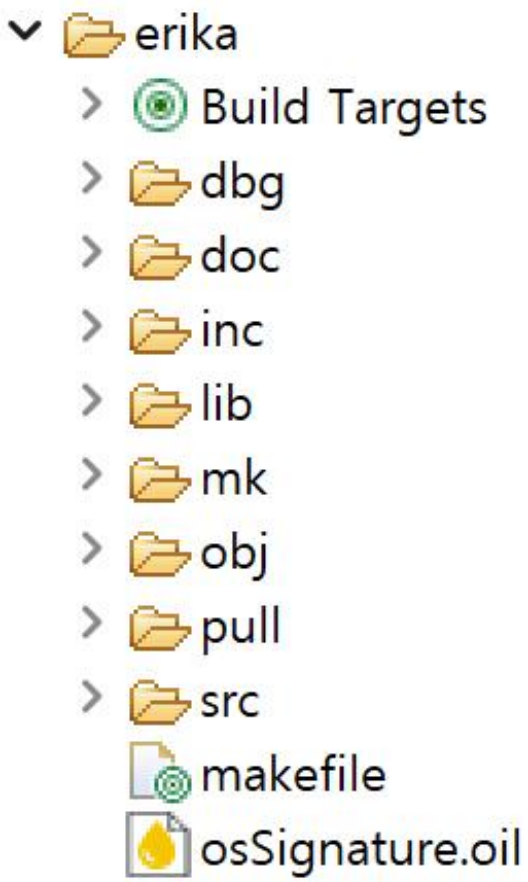
- 사용자 코드
  - OIL 파일
  - C/C++ 파일 (TASK와 ISR)

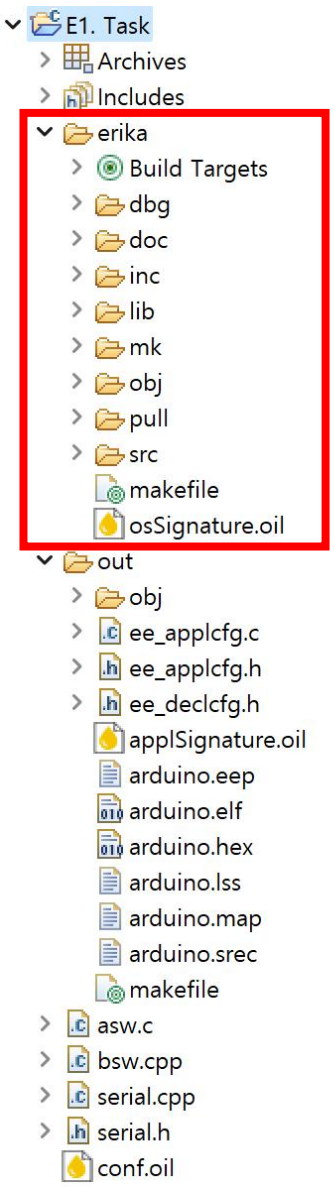




프로젝트 구조

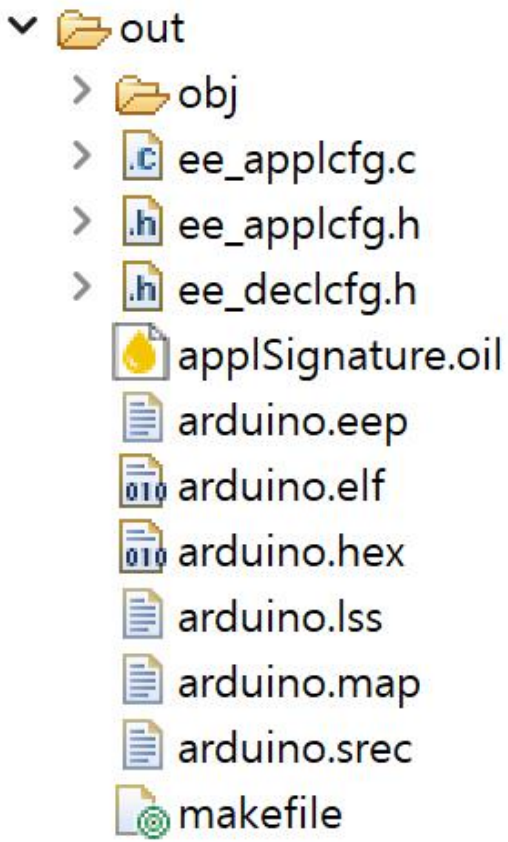
- Erika Enterprise 파일
  - 커널 소스
  - 커널 헤더파일

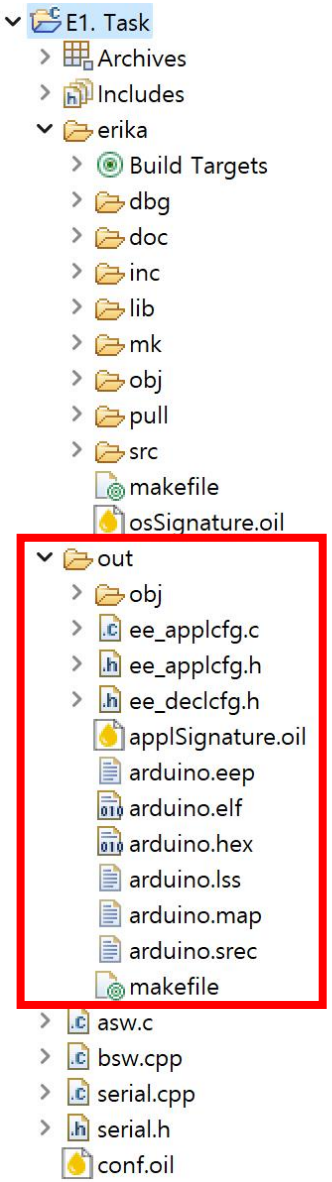




프로젝트 구조

- Output 파일
  - OIL에서 자동 생성된 ...cfg.c와 ...cfg.h 파일
  - ELF 파일
  - 다운로드를 위한 HEX 파일



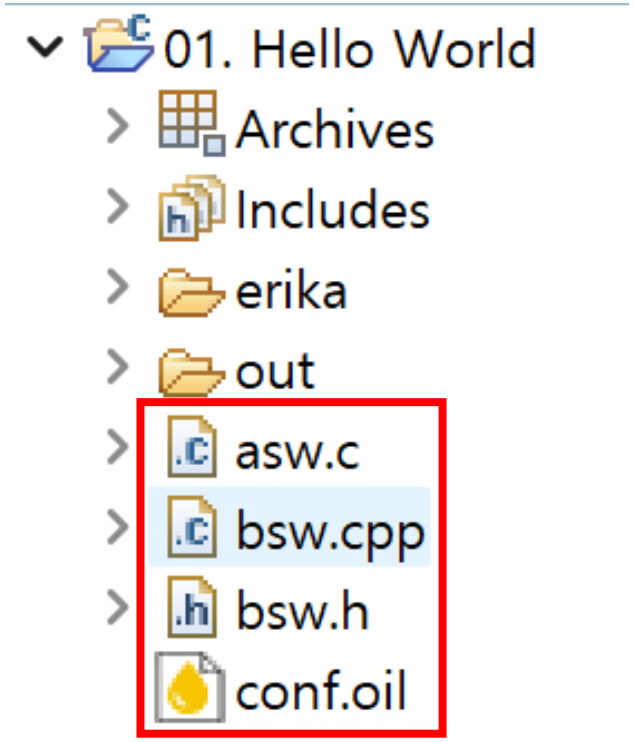


기본 소스코드 구성

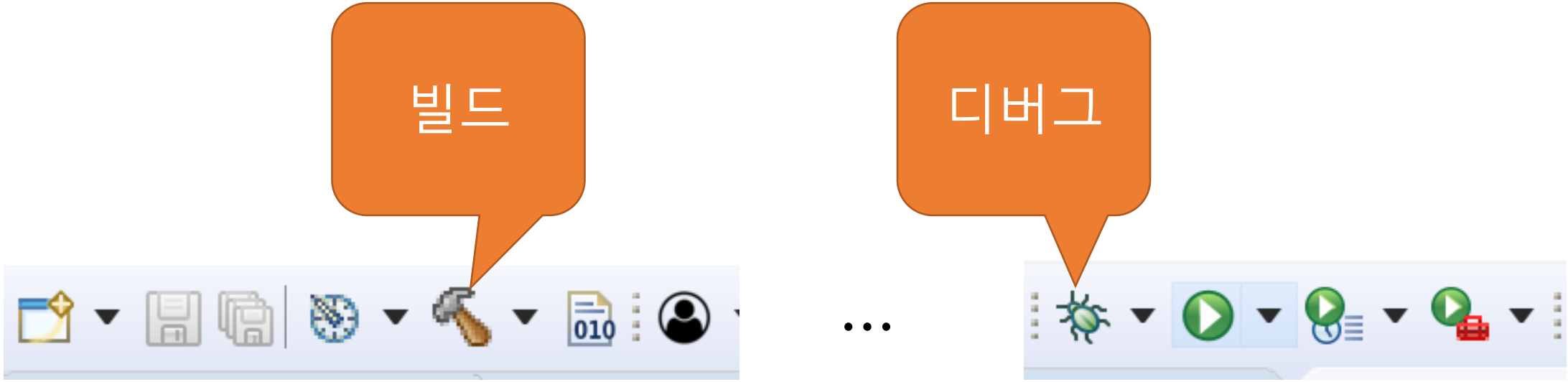
- asw.c
  - 사용자 작성 C 코드 (C++도 가능)

- bsw.cpp & bsw.h
  - OS가 시작되는 main() 함수
  - mdelay() ms 단위 delay 함수
  - printfSerial() 콘솔 출력 함수

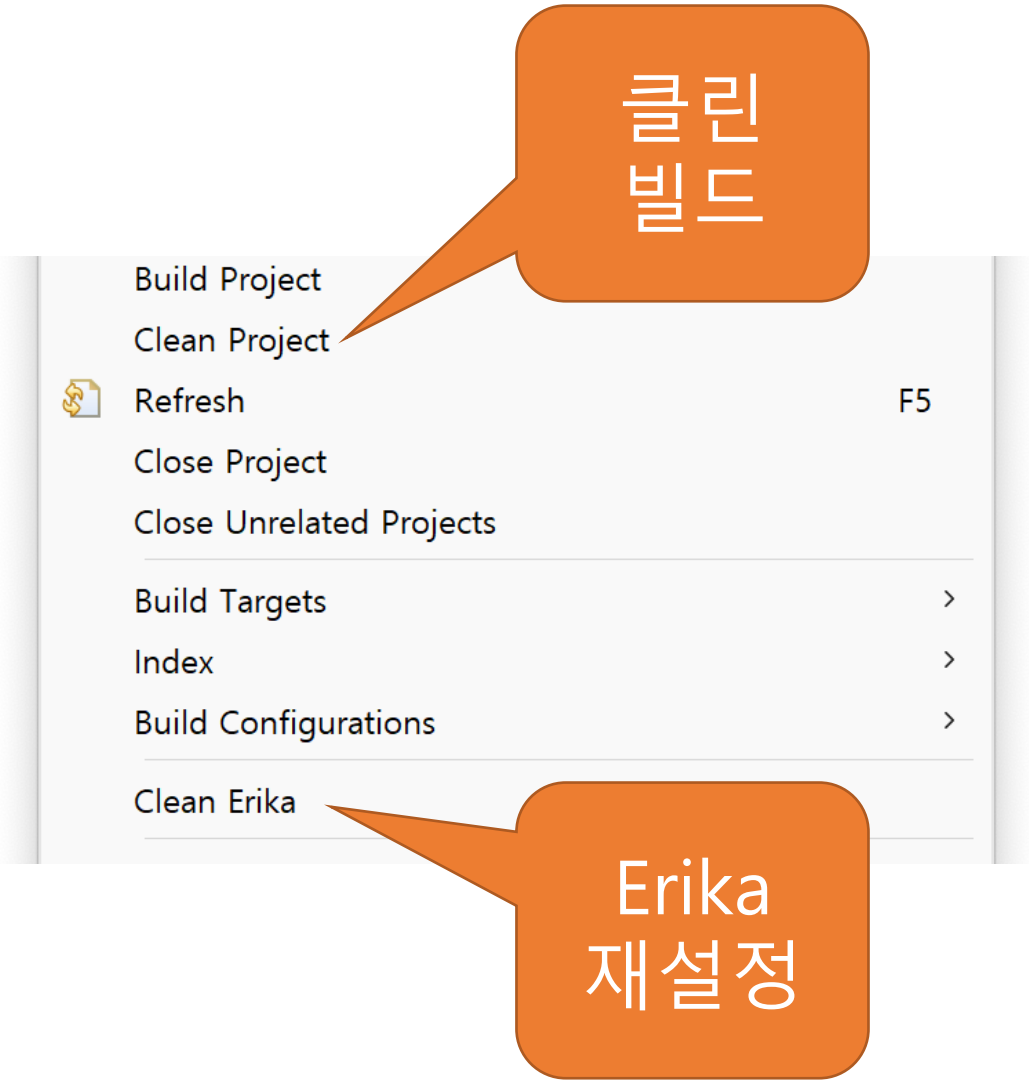
- conf.oil
  - OSEK 설정 파일

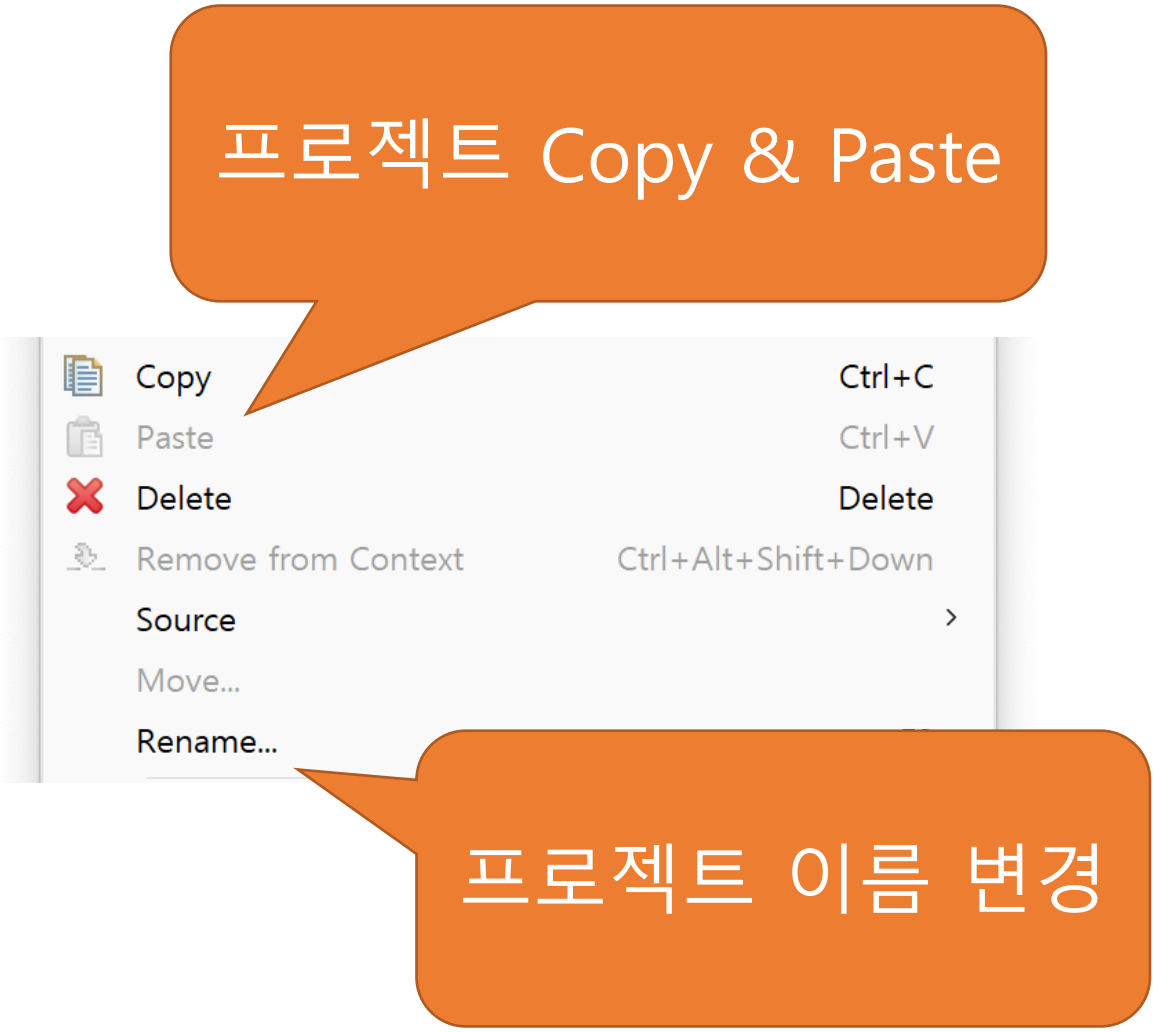


버튼



프로젝트 우클릭


Build Project
Clean Project
Refresh F5
Close Project
Close Unrelated Projects
Build Targets
Index
Build Configurations
Clean Erika
클린
빌드
Erika
재설정


Copy Ctrl+C
Paste Ctrl+V
Delete Delete
Remove from Context Ctrl+Alt+Shift+Down
Source
Move...
Rename...
프로젝트 Copy & Paste
프로젝트 이름 변경

01. Hello World

- 다운로드
  - bsw.cpp
  - bsw.h
  - conf.oil
- asw.c 작성
- OIL 파일에 TASK 추가

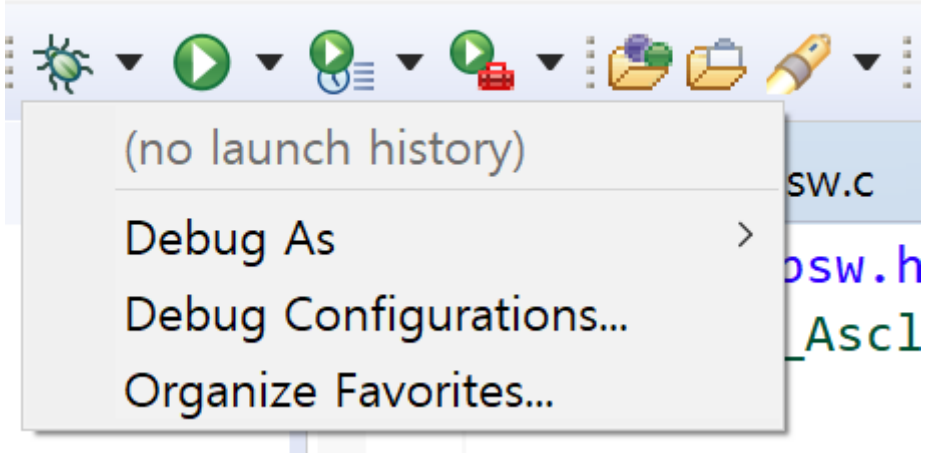
```
#include "bsw.h"


TASK(Task1)
{
    printfSerial("Hello World\n");

    TerminateTask();
}
```

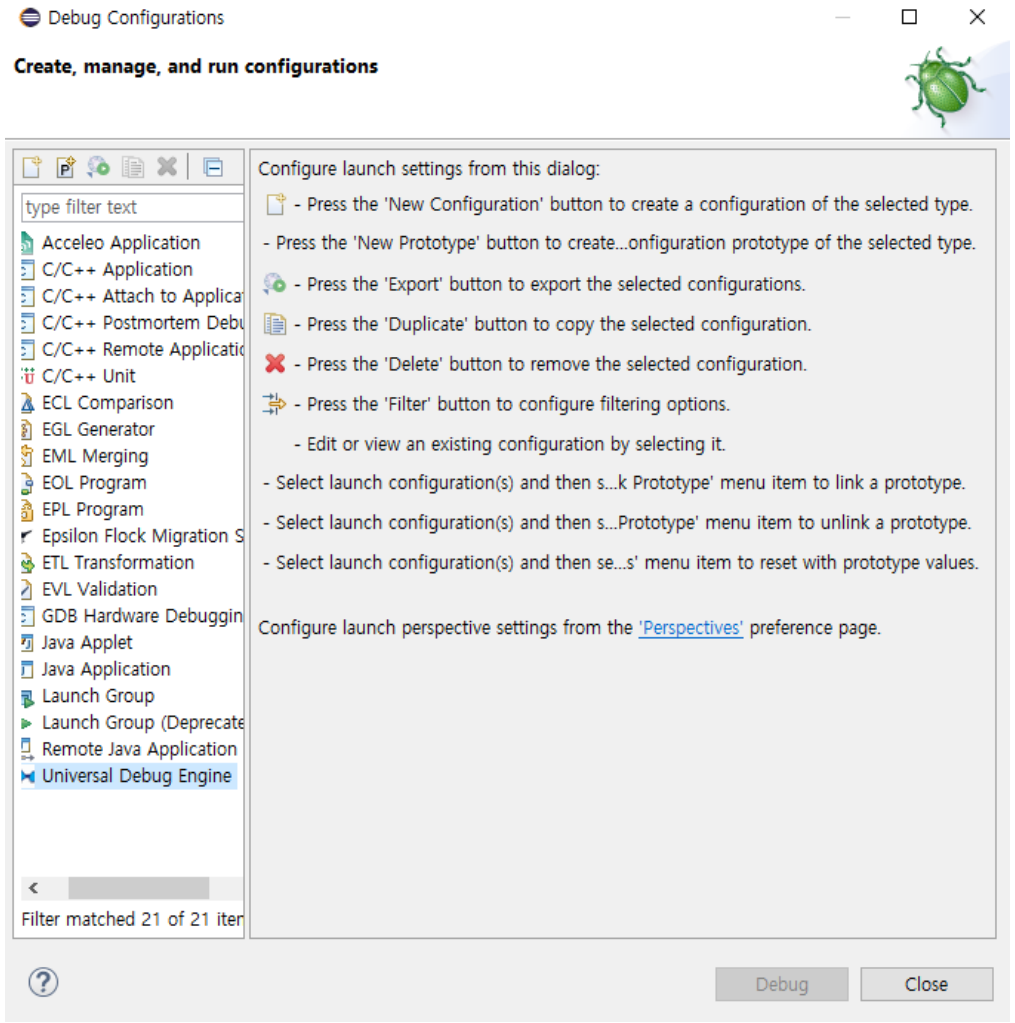
```
TASK Task1 {
    PRIORITY = 1;
    STACK = SHARED;
    SCHEDULE = FULL; // preemptive
    AUTOSTART = TRUE;
    ACTIVATION = 1;
};
```

자동
시작

01. Hello World

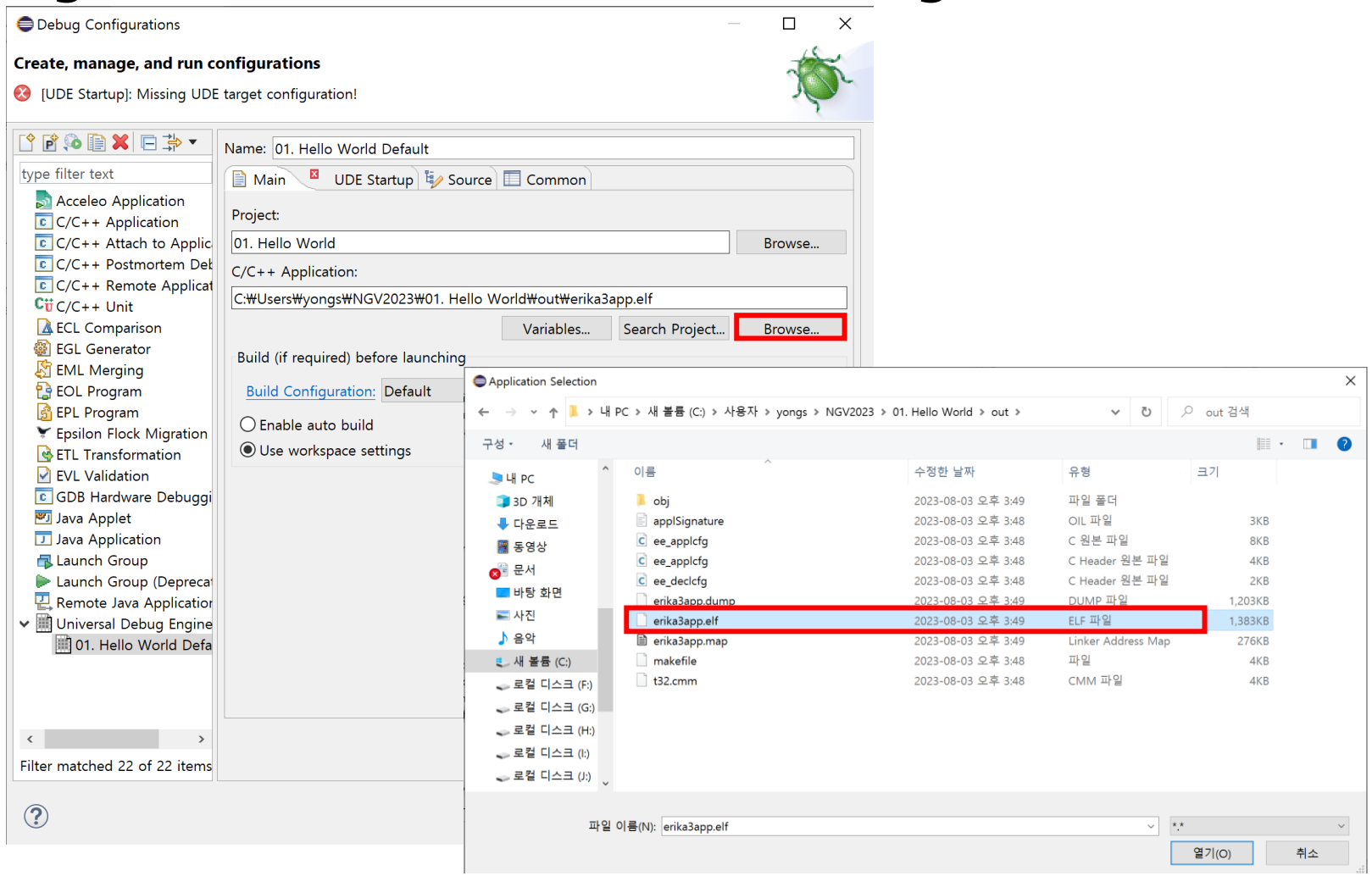
- 상단 디버그 클릭 → Debug Configurations 클릭





01. Hello World

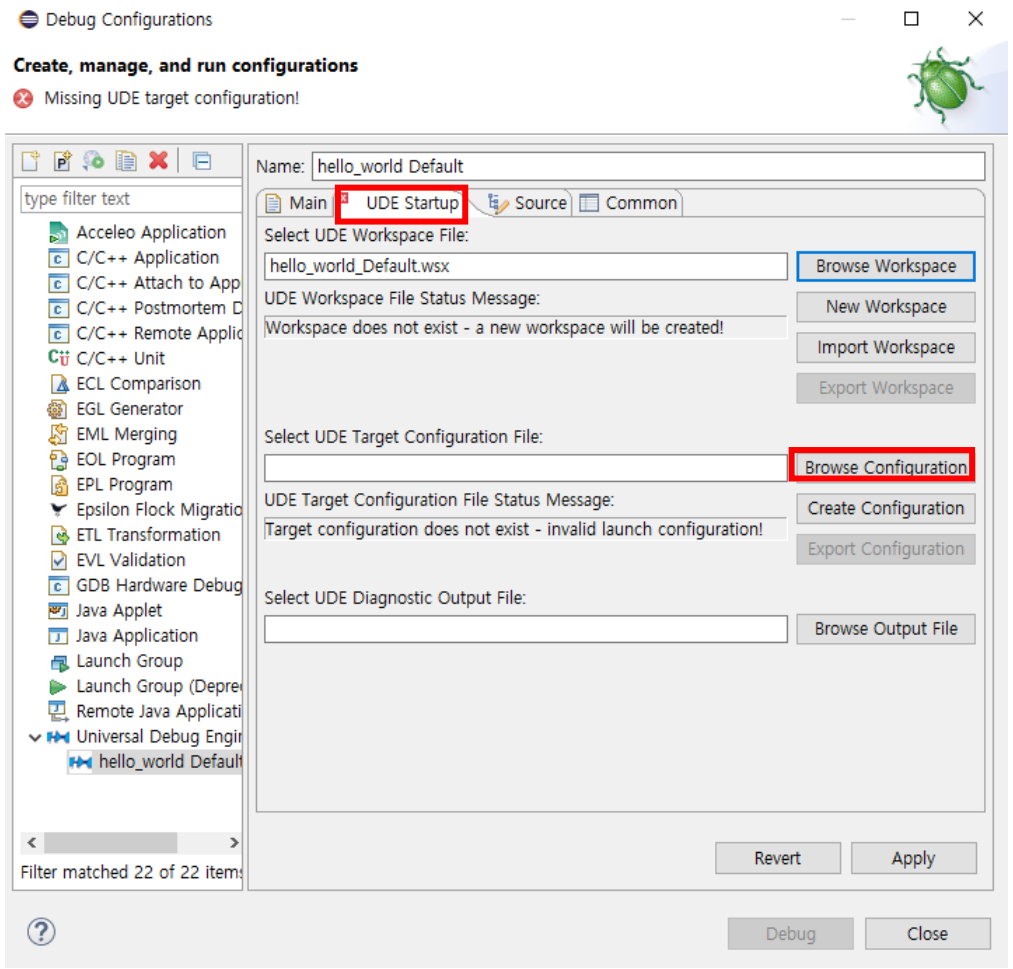
- Universal Debug Engine 더블 클릭 → 새로운 Config 파일 생성

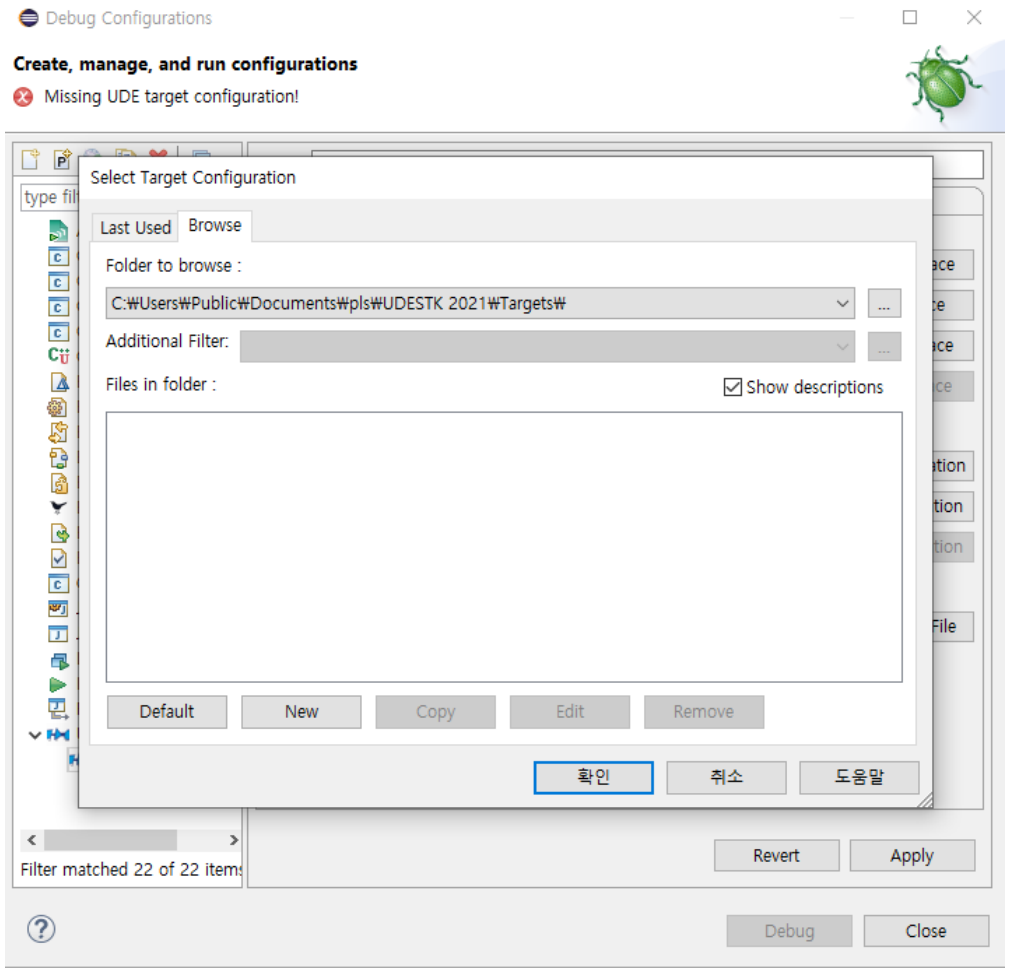


C:₩Users₩{Username}₩{workspace_name}₩01.Hellow World₩out₩erika3app.elf

01. Hello World

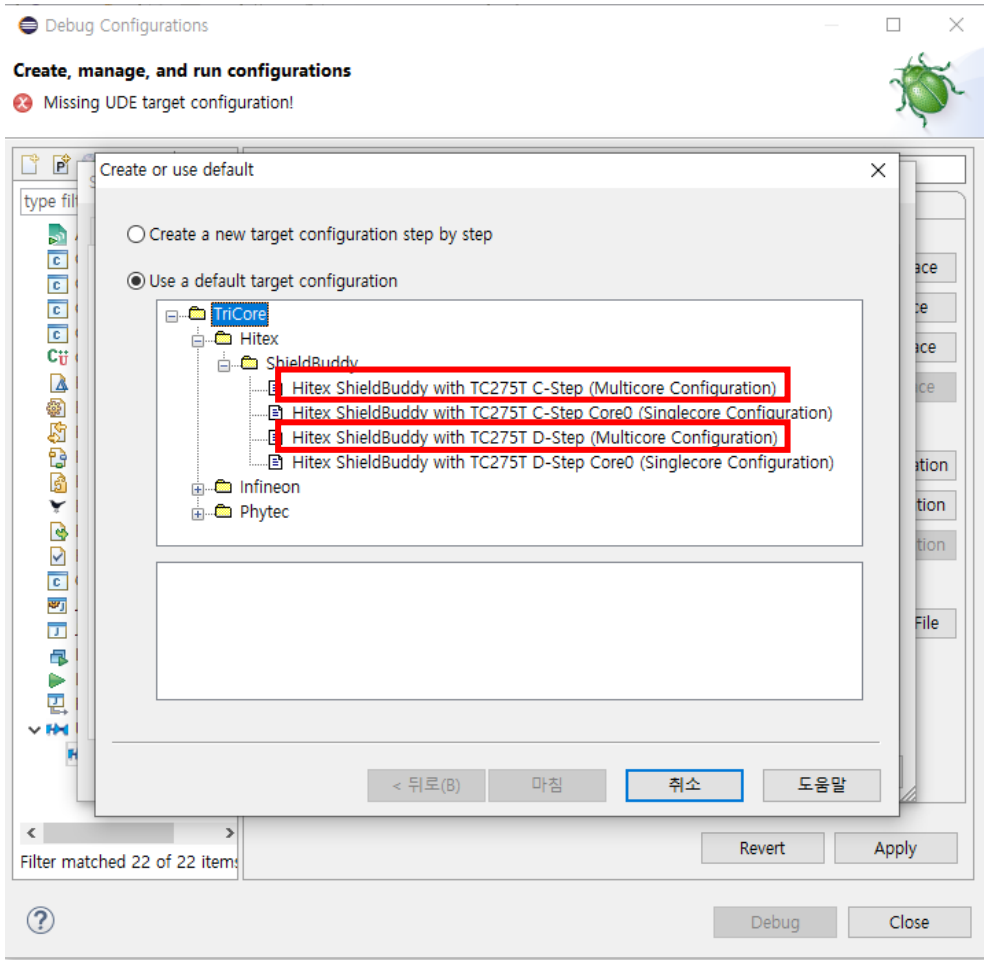
- UDE Startup 클릭 → Browse Configuration 클릭

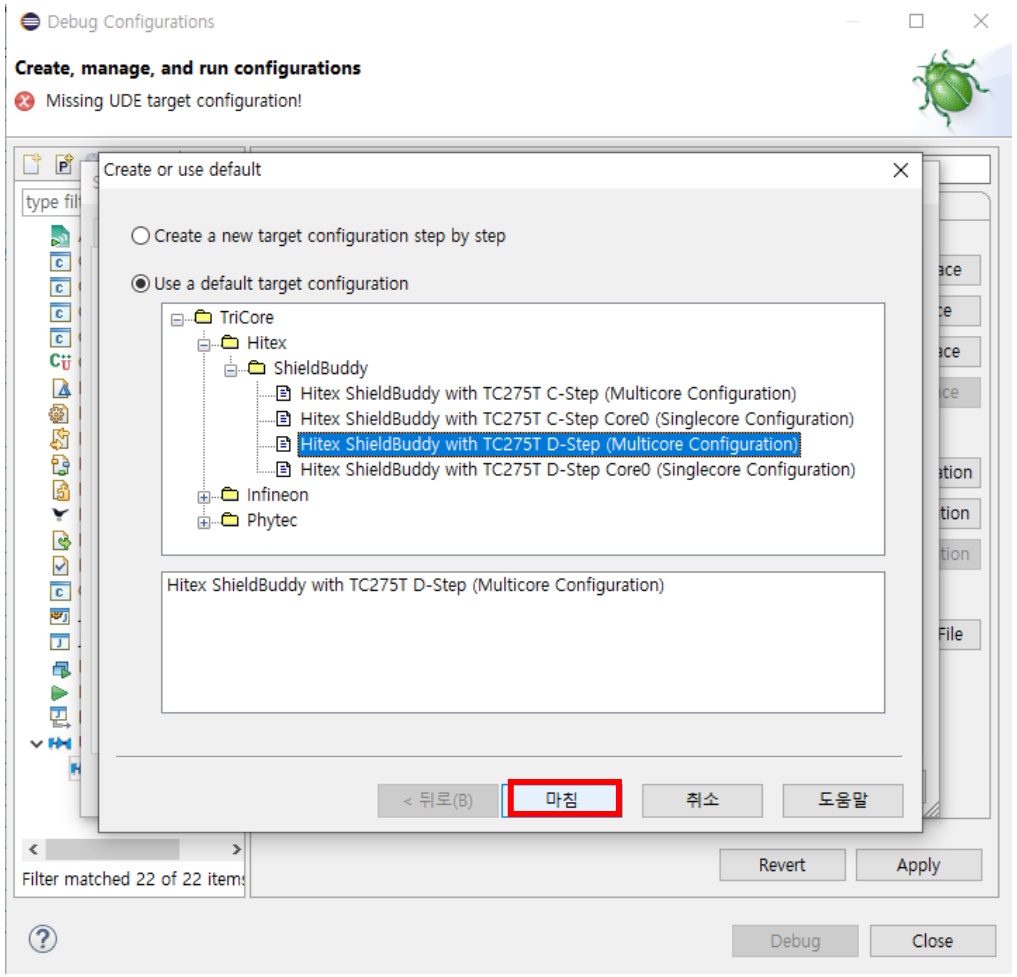




01. Hello World

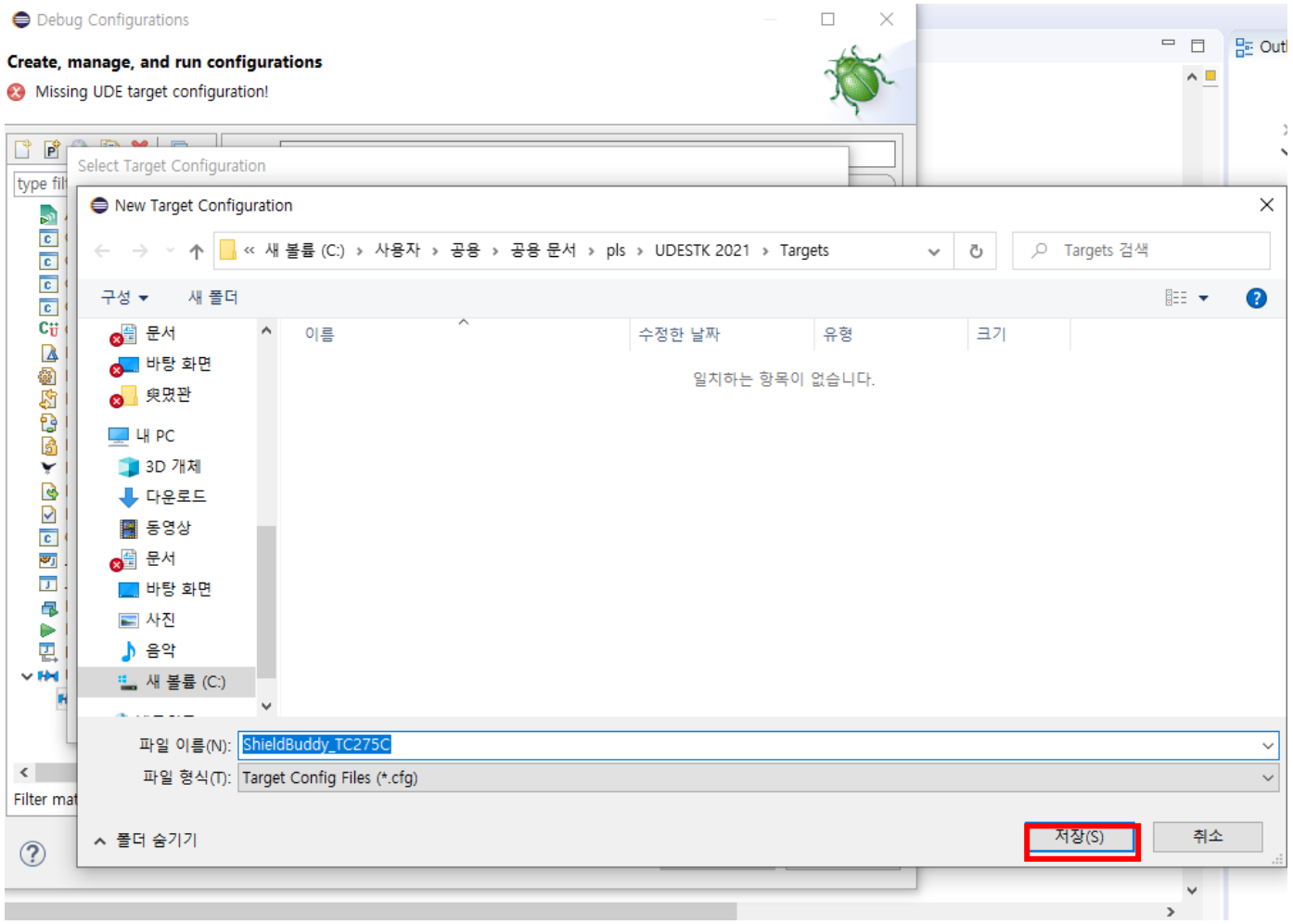
- Tricore → Hitex → ShieldBuddy → Aurix에 맞는 버전(C-STEP or D-STEP) 클릭





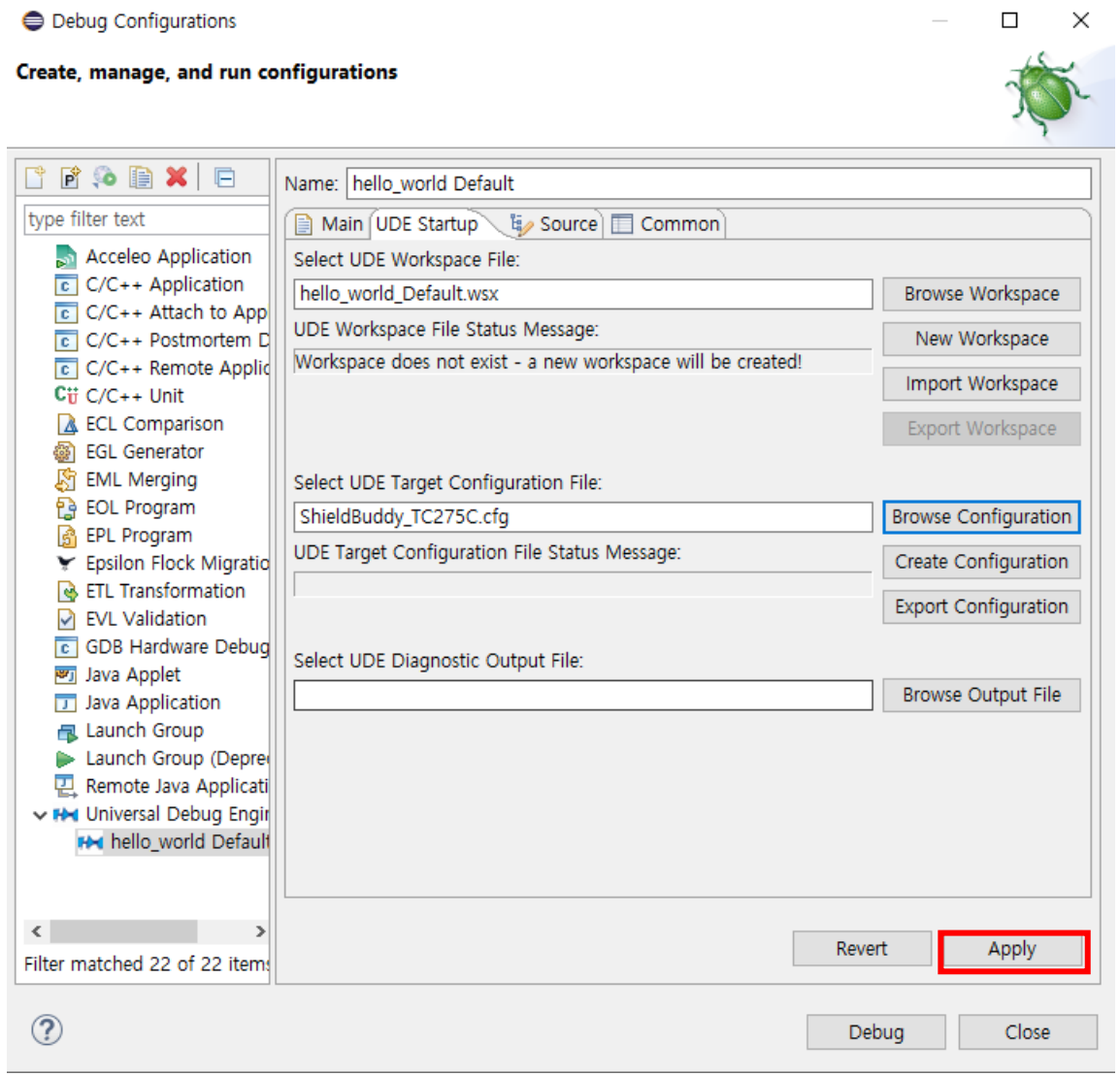
01. Hello World

- 저장 클릭



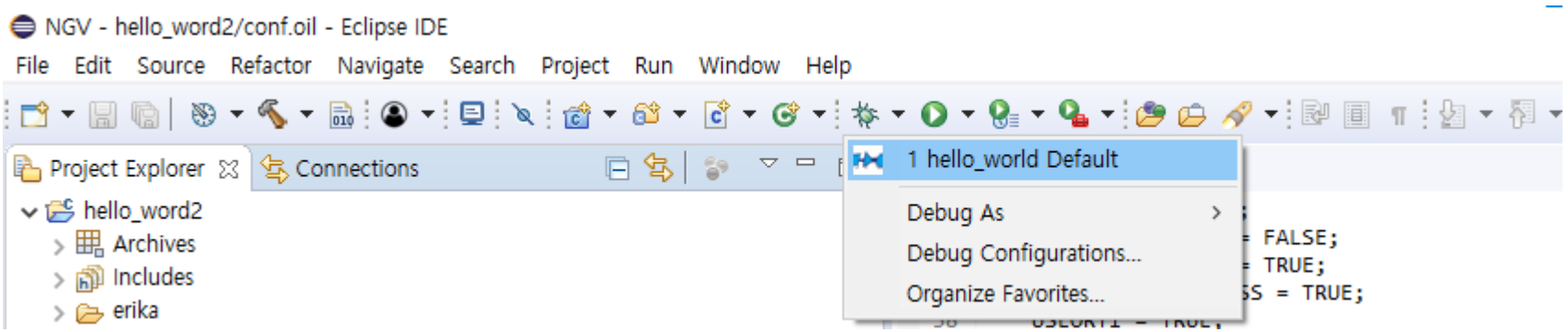
01. Hello World

- Apply 클릭



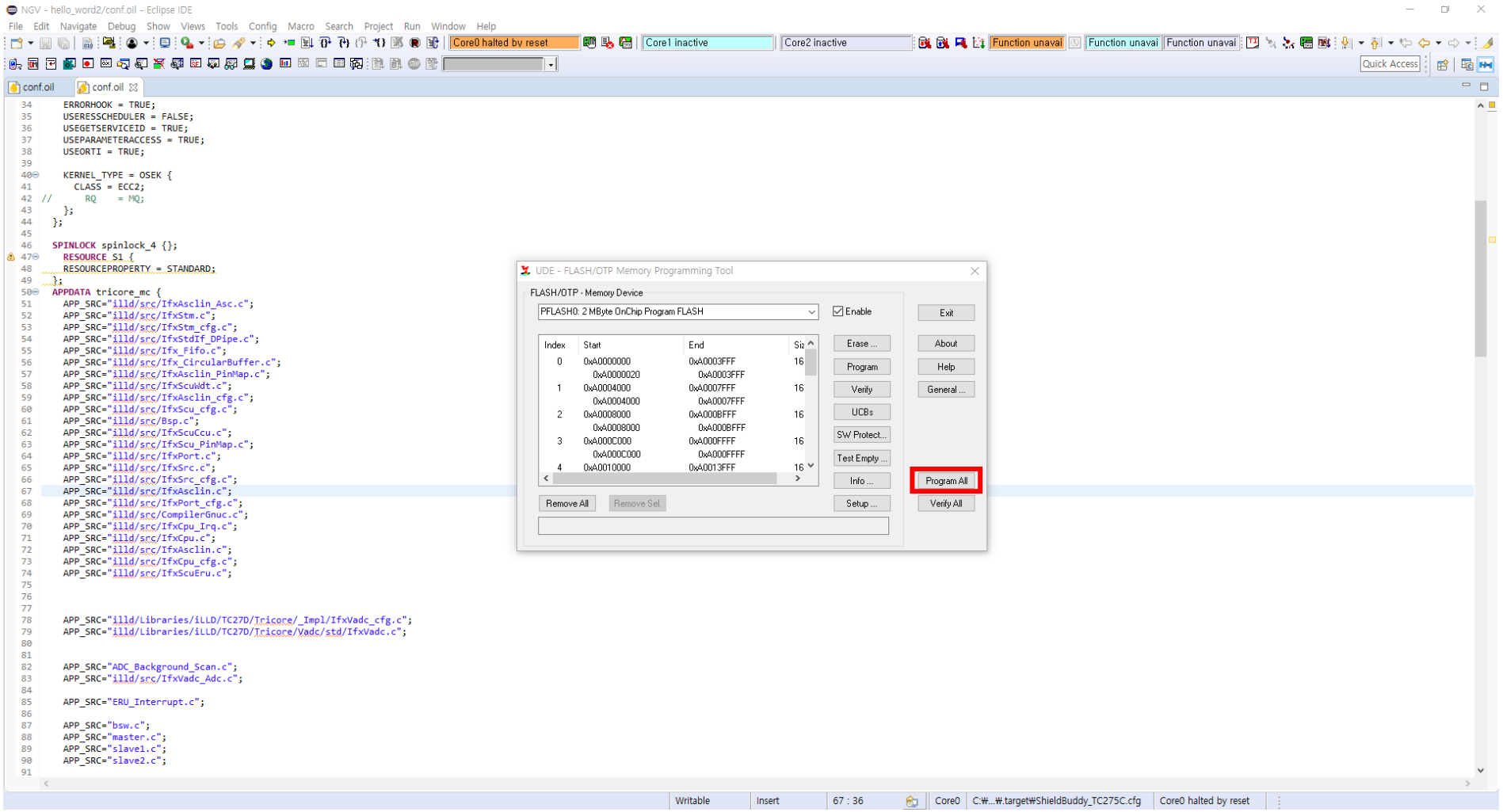
01. Hello World

- 디버그 클릭 → 방금 설정한 Debug 세팅 클릭



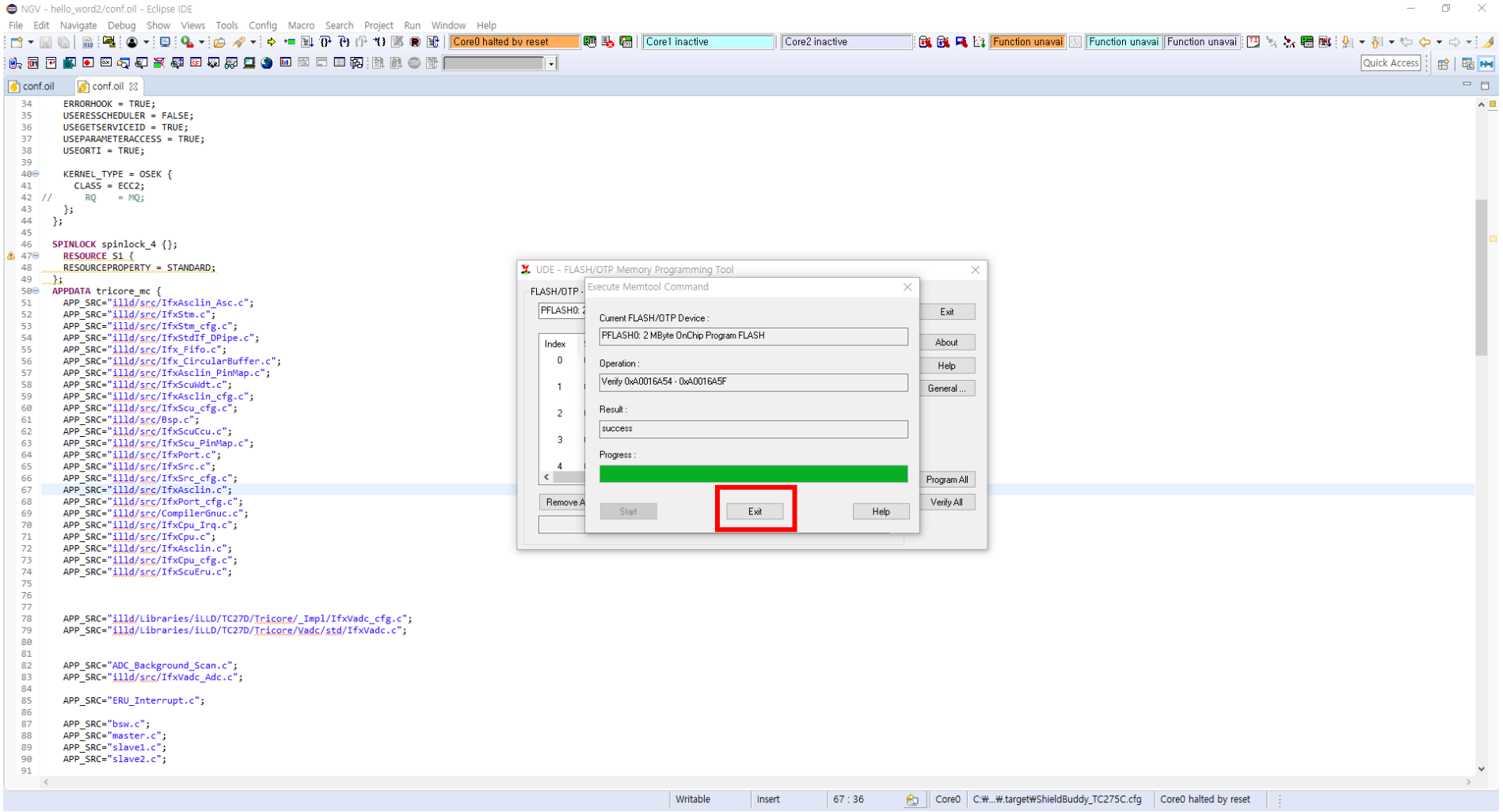
01. Hello World

- 다음 화면이 나오면 Program All 을 눌러 Flashing



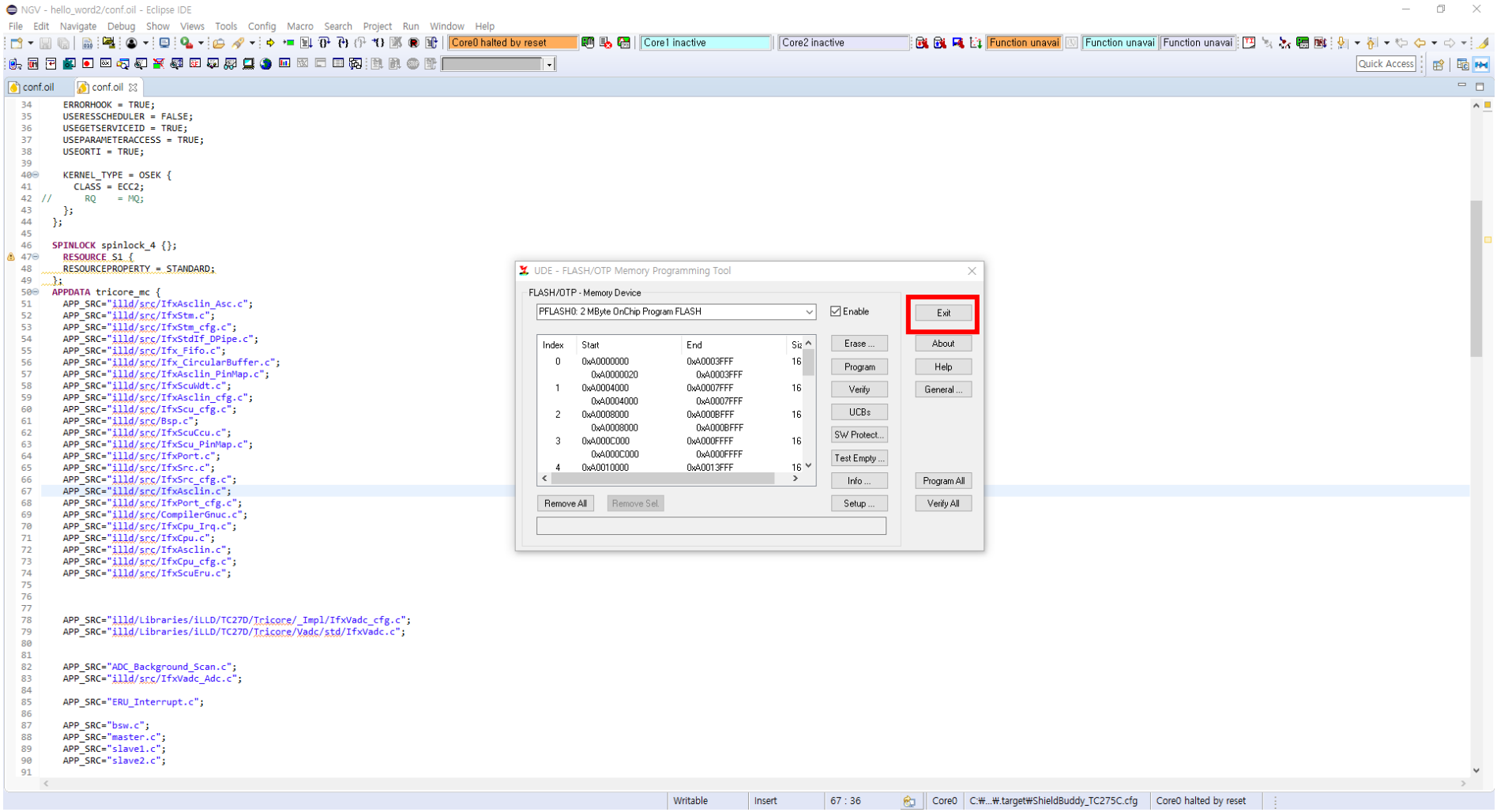
01. Hello World

- 완료 후 Exit



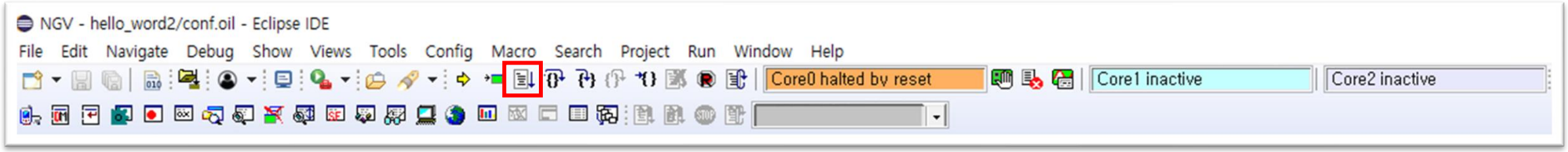
01. Hello World

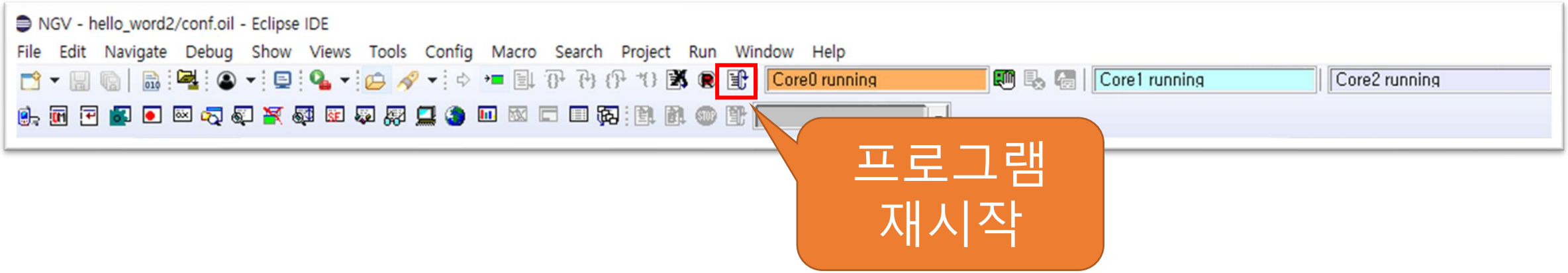
- Exit



01. Hello World

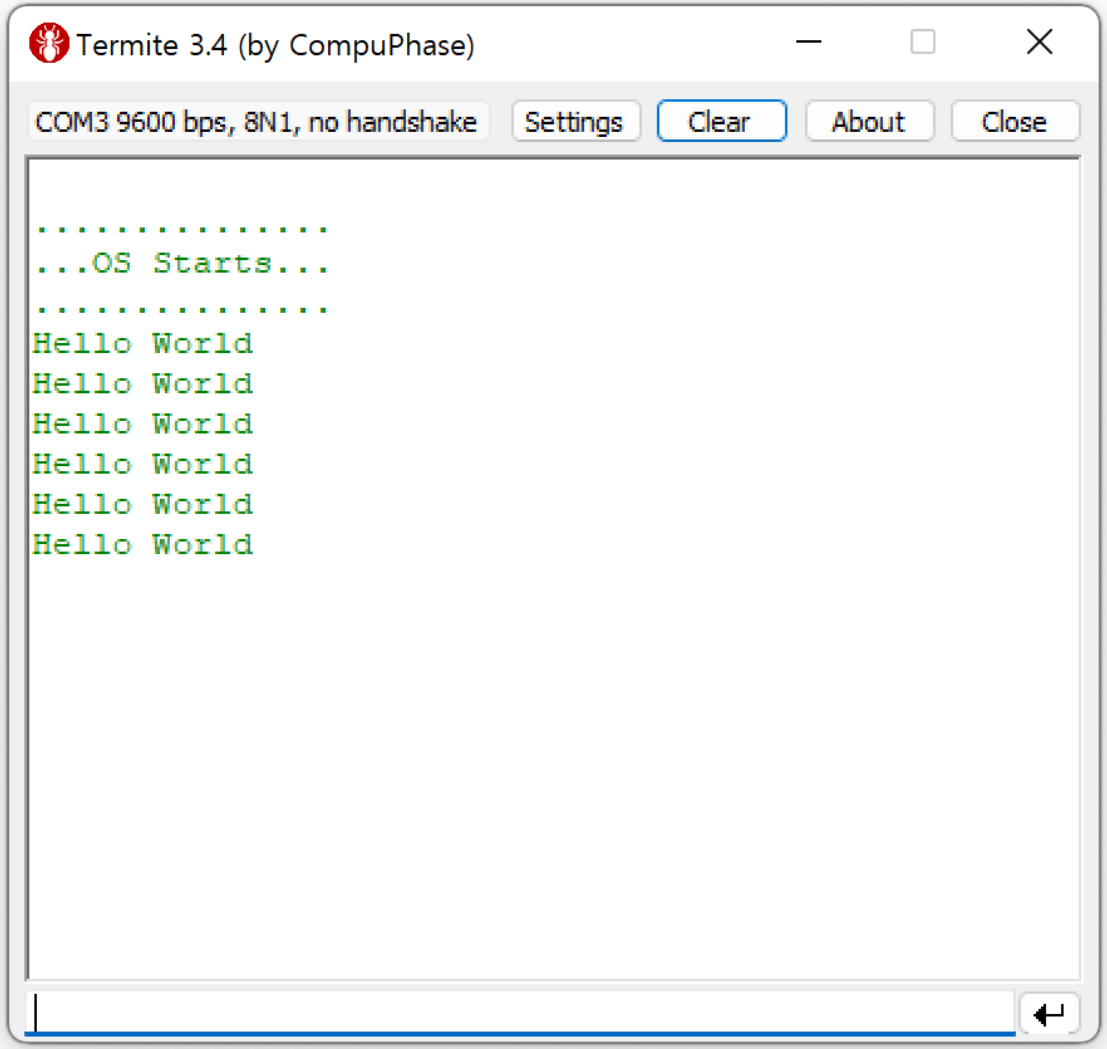
- 빨간 네모 박스 체크하여 프로그램 START





01. Hello World

- OS 시작 후
- Hello World 반복 출력
  - 타이머 초기화 안됨



02. Timer

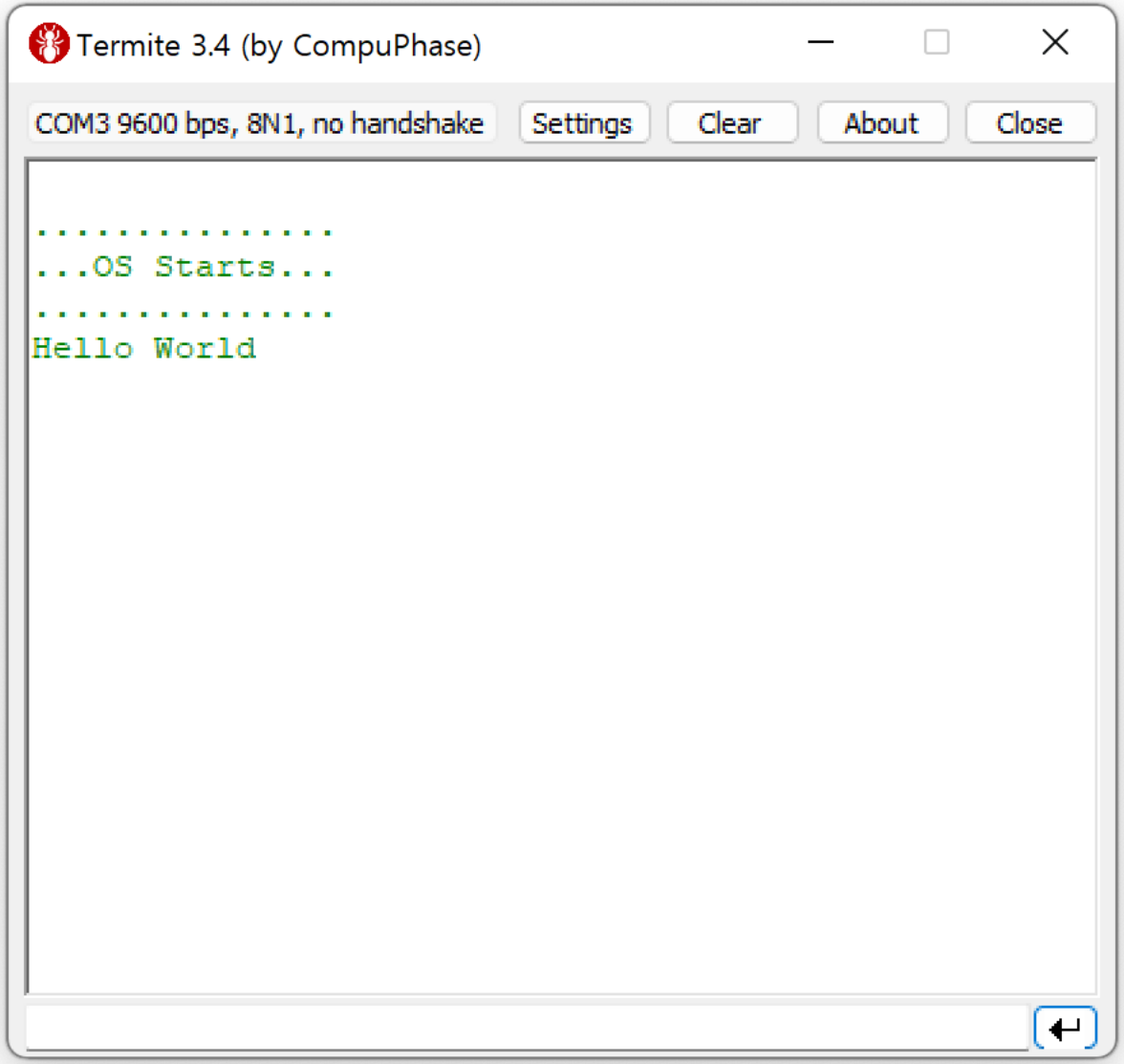
- C 파일에 ISR2로 빈 TimerISR 추가
- OIL 파일에 TimerISR 추가
  - Category 2
  - Timer 1 Compare Match A

```
ISR2(TimerISR)
{
    osEE_tc_stm_set_sr0_next_match(1
000000U);
}
```

```
ISR TimerISR {
    CATEGORY = 2;
    SOURCE = "STMSR0";
    PRIORITY = 2;
};
```

02. Timer

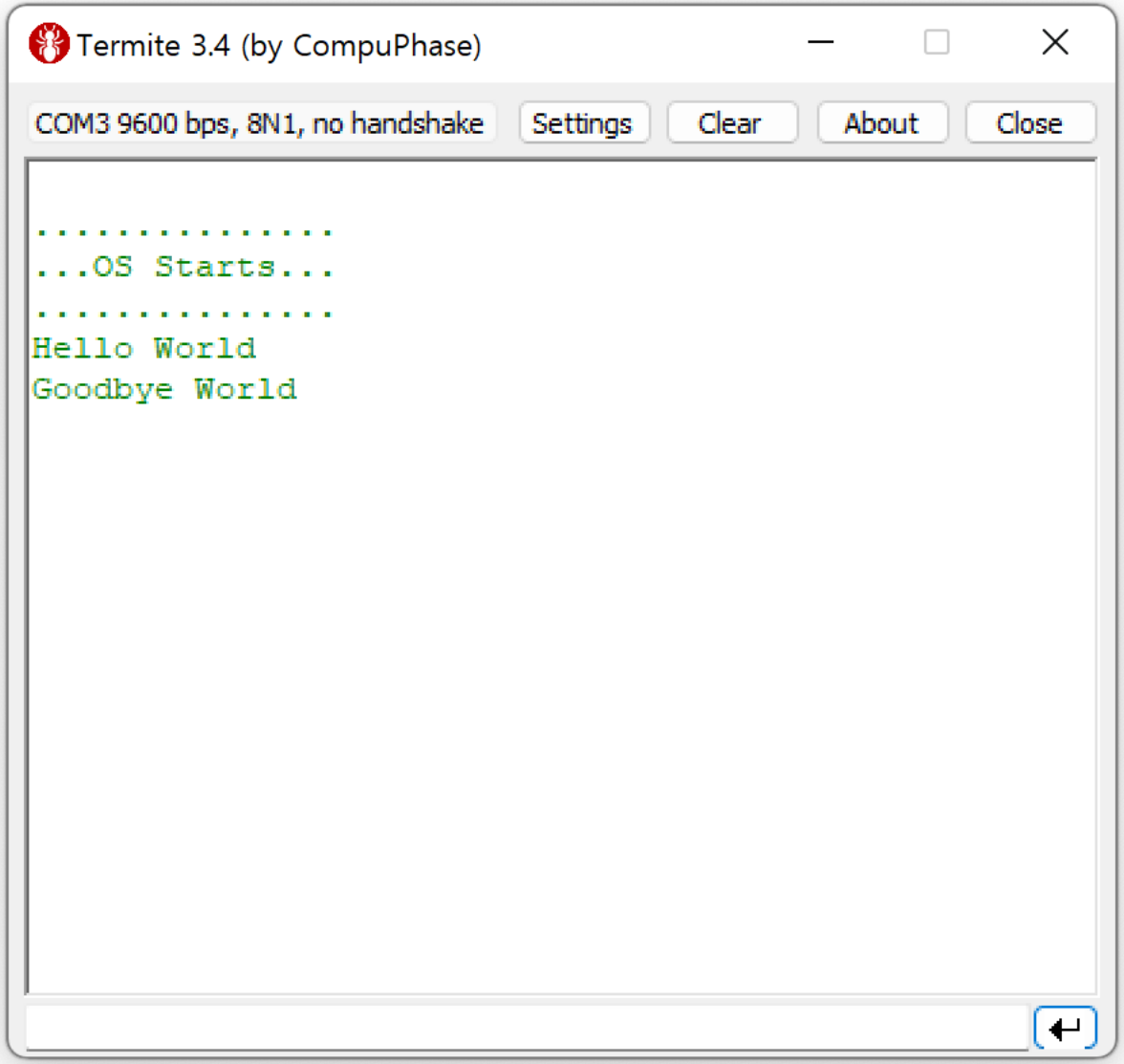
- Hello World 한번 출력



03. mdelay

- mdelay 함수 이용 3초 실행시간

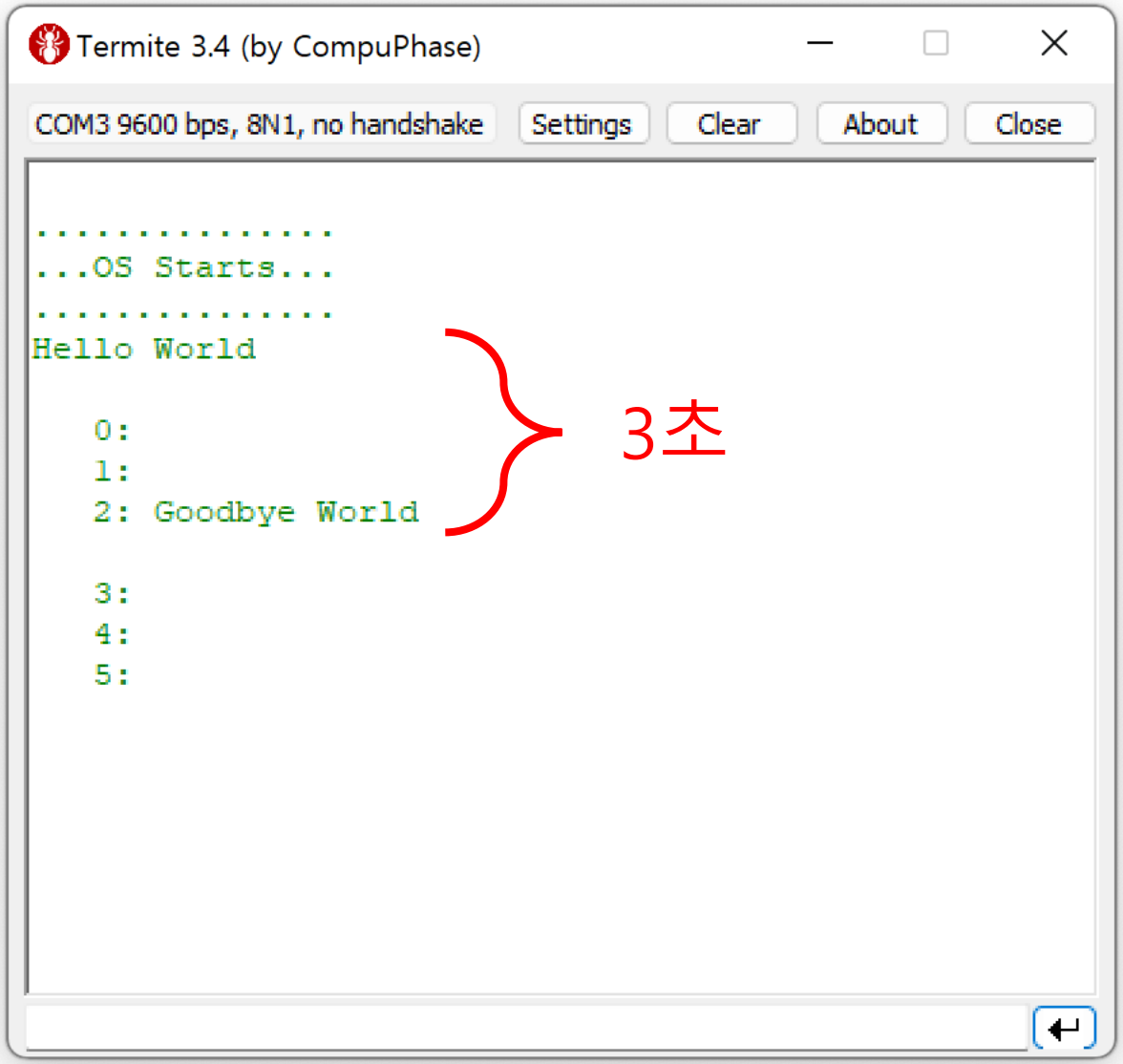
```
TASK(Task1)
{
    printfSerial("Hello World\n");

    mdelay(3000);

    printfSerial("Goodbye World\n");
    TerminateTask();
}
```



04. Timeline

- TimerISR 이용 초단위 시간 출력

```
ISR2(TimerISR)
{
    osEE_tc_stm_set_sr0_next_match(1
000000U);
    static long c = 0;
    printfSerial("\n%4ld: ", c++);
}
```



05. Tasks

```
TASK(Task1)
{
    printfSerial("Task1 Begins...");
    mdelay(3000);
    printfSerial("Task1 Finishes...");

    TerminateTask();
}

TASK(Task2)
{
    printfSerial("Task2 Begins...");
    mdelay(3000);
    printfSerial("Task2 Finishes...");

    TerminateTask();
}
```

- 우선순위 2의 Task2 추가

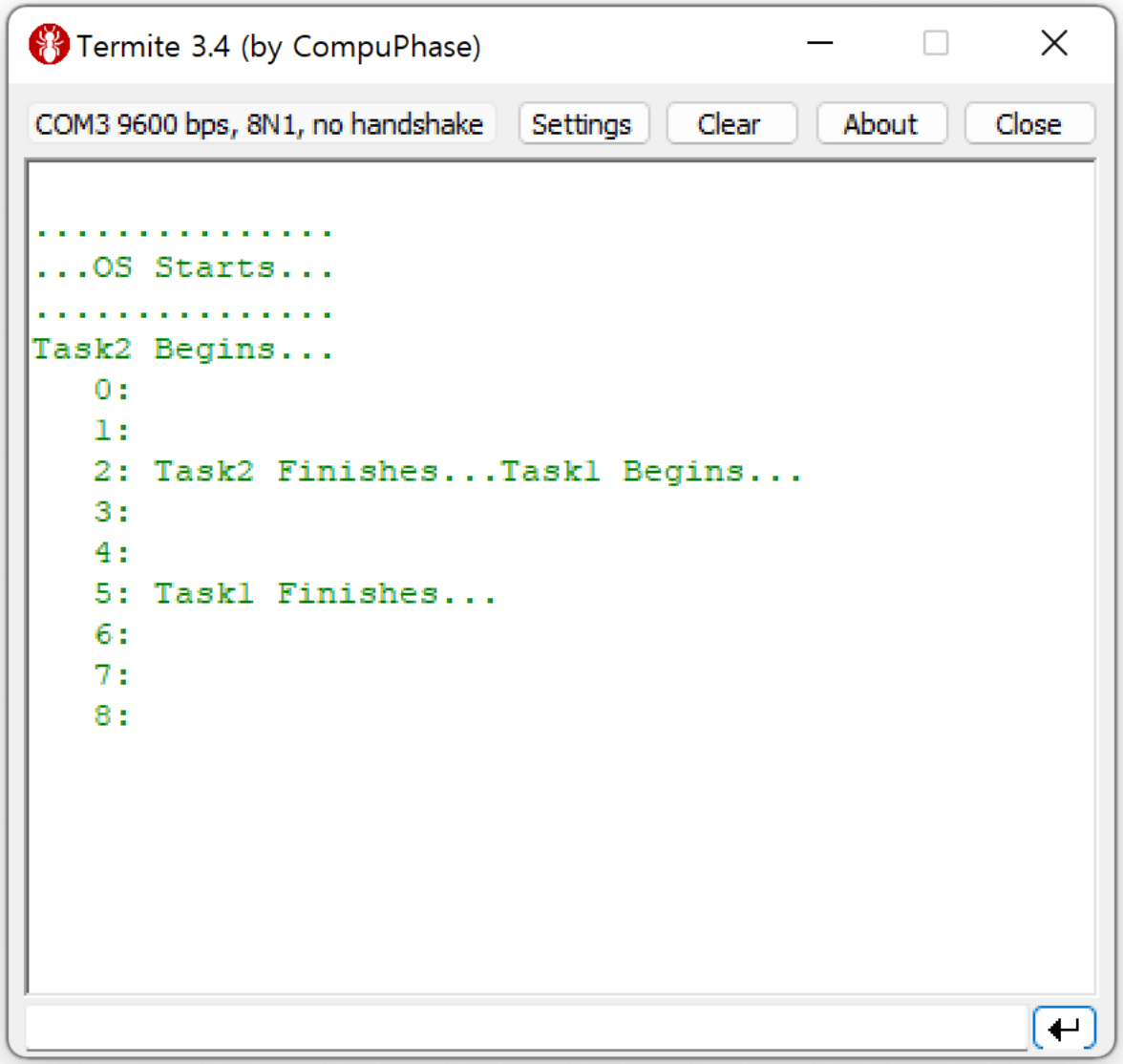
클수록 높은 우선순위

```
TASK Task2 {
    PRIORITY = 2;
    STACK = SHARED;
    SCHEDULE = FULL; // preemptive
    AUTOSTART = TRUE;
    ACTIVATION = 1;
};
```

05. Tasks

- Task2가 먼저 시작
- Task2 종료 후 Task1 시작

- 우선순위를 바꾼다면?



06. Task Activation

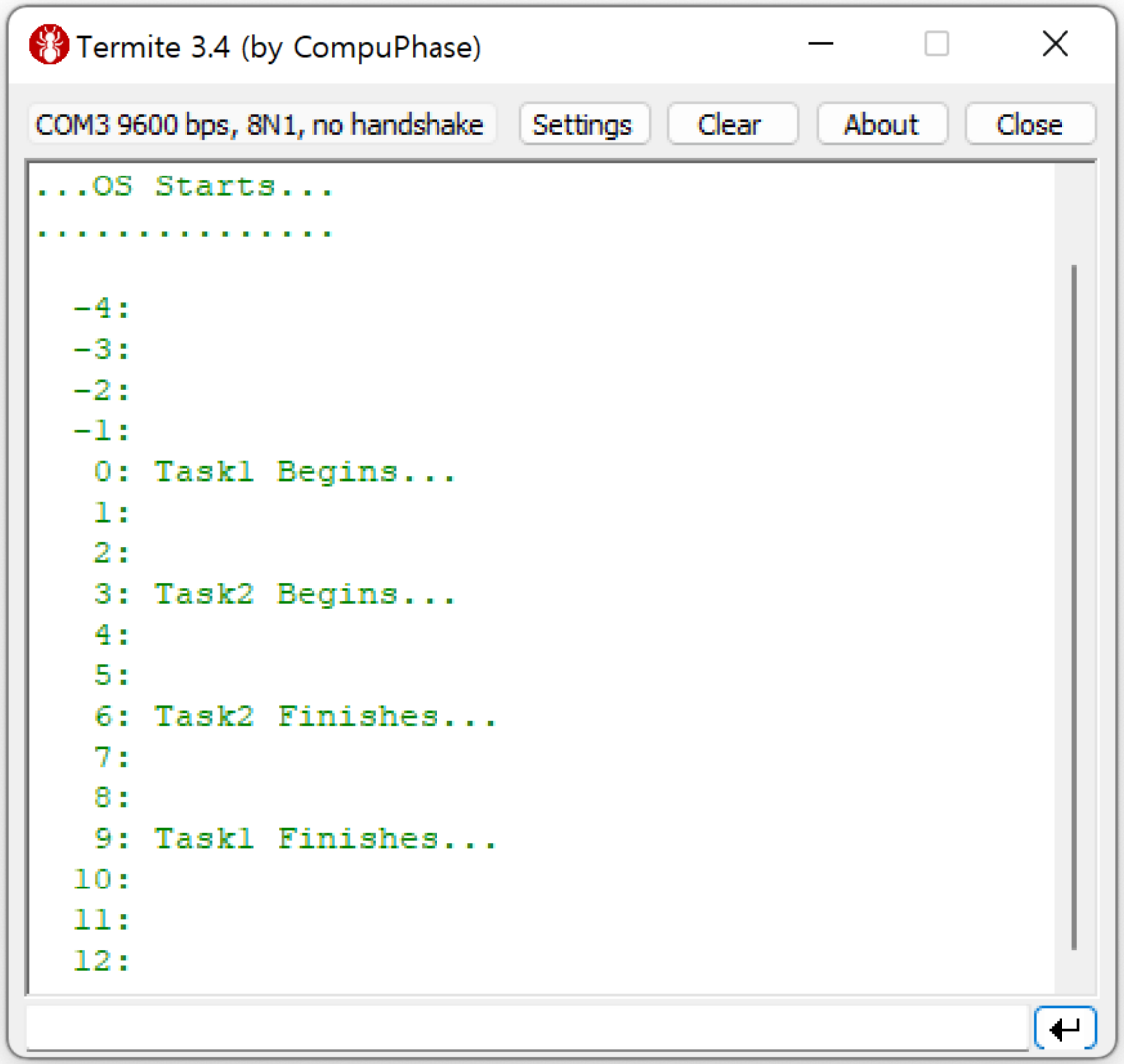
```
ISR2(TimerISR)
{
    osEE_tc_stm_set_sr0_next_match(1000
000U);
    static long c = -4;
    if (c == 0)
        ActivateTask(Task1);
    printfSerial("\n%4ld: ", c++);
}
TASK(Task1)
{
    printfSerial("Task1 Begins...");
    mdelay(3000);
    ActivateTask(Task2);
    mdelay(3000);
    printfSerial("Task1 Finishes...");
    TerminateTask();
}
```

```
TASK(Task2)
{
    printfSerial("Task2 Begins...");
    mdelay(3000);
    printfSerial("Task2 Finishes...");
    TerminateTask();
}
```

```
TASK Task1 {
    …
    AUTOSTART = FALSE;
    …
};

TASK Task2 {
    …
    AUTOSTART = FALSE;
    …
};
```

06. Task Activation

- Timeline -4부터 카운트다운
- Task2의 Task1 선점 확인
- ActivateTask 위치 바꾸면?
- 우선순위가 바뀌면?
- ChainTask 활용
- Task3까지 만들어서 연쇄 실행



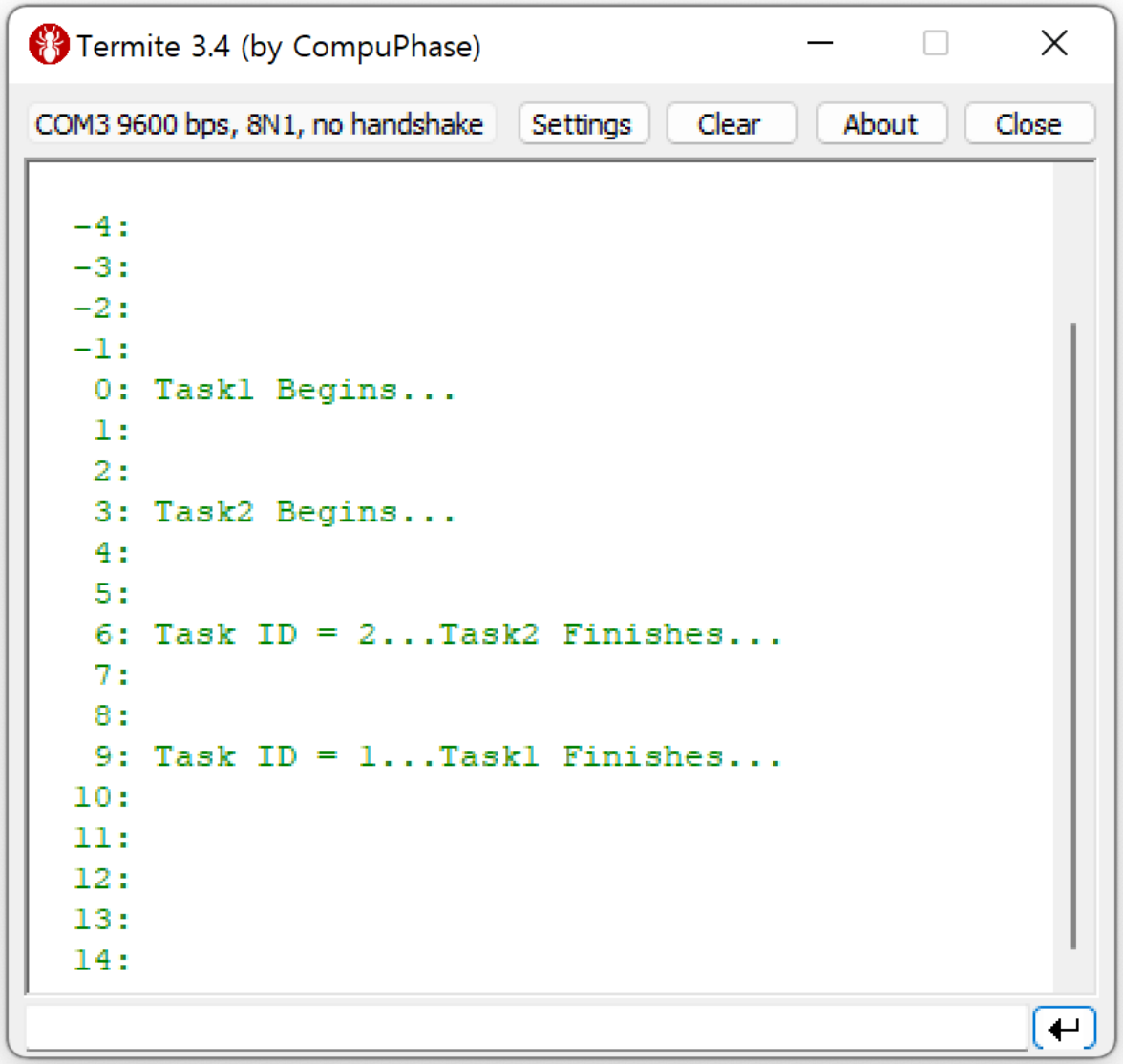
07. GetTaskID

```
TASK(Task1)
{
    TaskType id;
    printfSerial("Task1 Begins...");
    mdelay(3000);
    ActivateTask(Task2);
    mdelay(3000);
    GetTaskID(&id);
    printfSerial("Task ID = %d...", id);
    printfSerial("Task1 Finishes...");
    TerminateTask();
}
```

```
TASK(Task2)
{
    TaskType id;
    printfSerial("Task2 Begins...");
    mdelay(3000);
    GetTaskID(&id);
    printfSerial("Task ID = %d...", id);
    printfSerial("Task2 Finishes...");
    TerminateTask();
}
```

07. GetTaskID

- 자연수 Task ID 확인



08. GetTaskState

```
TASK(TaskM)
{
    printState(Task1);
    printState(Task2);

    TerminateTask();
}
```

```
TASK TaskM {
    PRIORITY = 3;
    STACK = SHARED;
    SCHEDULE = FULL;
    AUTOSTART = FALSE;
    ACTIVATION = 1;
};
```

```
void printState(TaskType id) {
    TaskStateType state;

    if (GetTaskState(id, &state) == E_OK) {
        switch (state) {
            case SUSPENDED:
                printfSerial("%d: suspended...", id);
                break;
            case READY:
                printfSerial("%d: ready...", id);
                break;
            case WAITING:
                printfSerial("%d: waiting...", id);
                break;
            case RUNNING:
                printfSerial("%d: running...", id);
                break;
            }
    }
}
```

08. GetTaskState

```
TASK(Task1)
{
    TaskType id;
    printfSerial("Task1 Begins...");
    PrintState(Task1);
    PrintState(Task2);
    mdelay(3000);
    ActivateTask(Task2);
    PrintState(Task1);
    PrintState(Task2);
    mdelay(3000);
    GetTaskID(&id);
    printfSerial("Task ID = %d...", id);
    printfSerial("Task1 Finishes...");
    ChainTask(TaskM);
}
```

```
TASK(Task2)
{
    TaskType id;
    printfSerial("Task2 Begins...");
    PrintState(Task1);
    PrintState(Task2);
    mdelay(3000);
    GetTaskID(&id);
    printfSerial("Task ID = %d...", id);
    printfSerial("Task2 Finishes...");
    ChainTask(TaskM);
}
```

08. GetTaskState

- Task 상태 변화 관찰

- 우선순위, Activation 패턴 변화의 영향은?

Questions