

Developing IoT devices with mbed OS 5

ARM

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mbed Connect 2016 - Shenzhen

Your hosts



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“I buy at the beginning of paradigm shifts. We are at that moment now with Internet-of-things.”

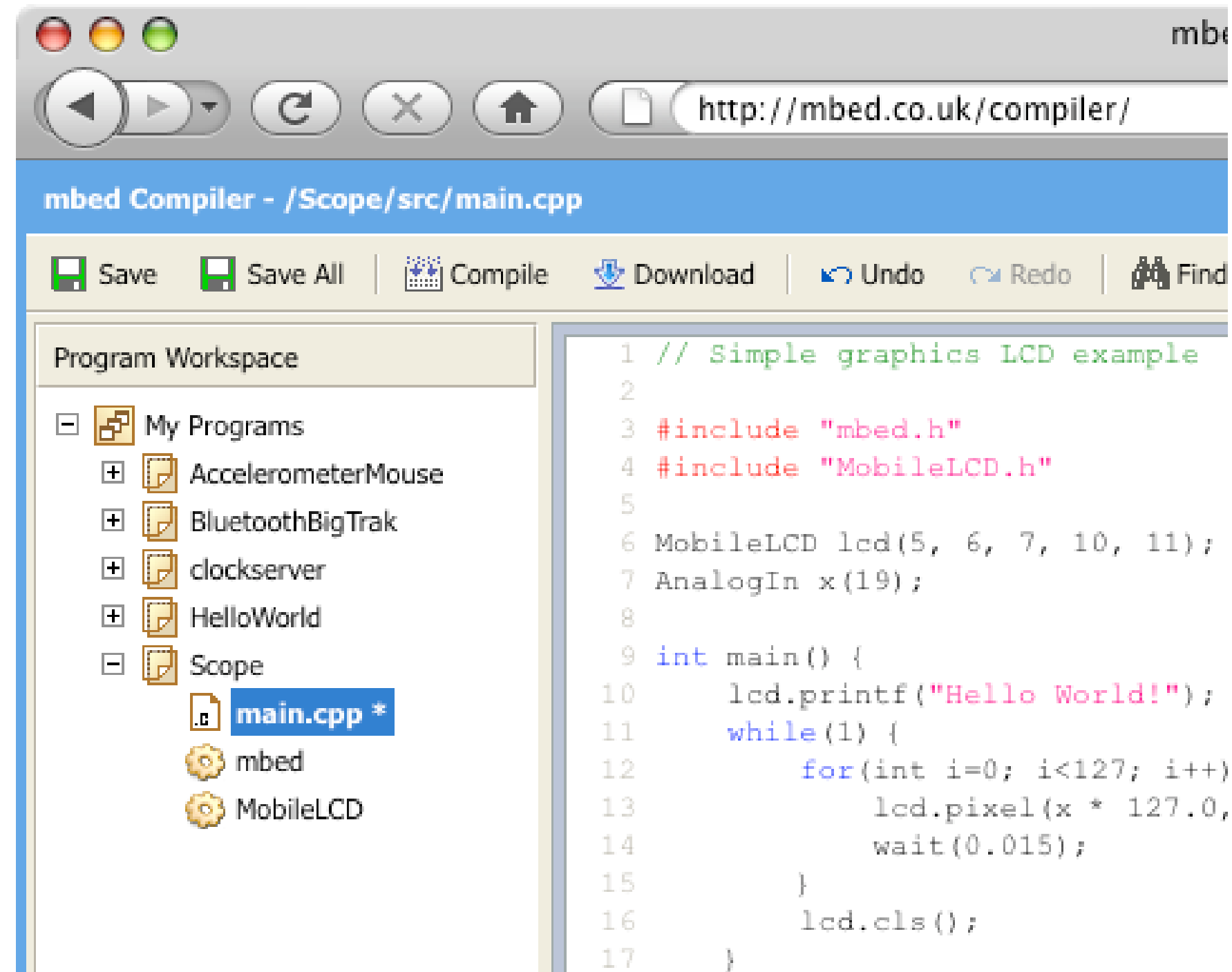
Masayoshi Son

mbed has changed



mbed State of the Union

Before mbed OS 5



Online compiler



Hardware Abstraction Layer

HAL fueled growth, compiler brought people in

ARMmbed

Developer Resources Partners

Hardware ▾

Documentation ▾

Code

Questions

Forum

 janjongboom ▾

Compiler

Code

Listing **28900** public code repositories

Sort by: [Latest](#) [Imports](#) [Forks](#) [Commits](#) **Activity** [Dependents](#) [Featured](#)

301,639 compilations in the last 7 days

But... embedded development is changing

- ✦ MCUs get more powerful, communication cheaper
- ✦ We want more from our devices
 - ✦ Run full IP stacks
 - ✦ Firmware upgrades
 - ✦ Device management
- ✦ Challenges galore!



Affects both professionals and hobbyists

Professionals

Bigger attack surface

Larger chance of bugs

Add value, not plumbing

Hobbyists

Require sane defaults

Get to 90% without much effort

Need proper networking

Good battery life out of the box

Standardizing the ecosystem

Professionals

Bigger attack surface

Memory isolation

Larger chance of bugs

Well tested isolated middleware

Add value, not plumbing

Cloud features, RTOS, unified network stacks

Hobbyists

Require sane defaults

Get to 90% without much effort

Well tested cloud middleware

Need proper networking

Unified networking stacks

Good battery life out of the box

Optional scheduler

mbed OS 5 is more...

- ✦ More than the online compiler
- ✦ More than the library ecosystem
- ✦ Well-tested middleware for IoT

- ✦ Not needed?
Still runs in 8K of RAM...





Developing for mbed OS 5

Or... how to get away from the online
compiler

Not just the online compiler

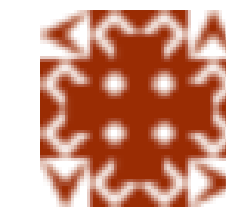
▲ As both an Mbed user and an Arduino user, this is my perspective on the differences between the platforms.

4



1. The IDEs are completely different. The Mbed IDE is an in-browser compiler that allows you to easily import other people's source code. It is a full c/c++ IDE that saves your code to your online Mbed account. You must be signed in to do any development work (requires internet access). Code completion exists, but is clunky. Project format more closely mirrors c/c++ programming than does Arduino's environment.

answered Mar 9 '15 at 14:07

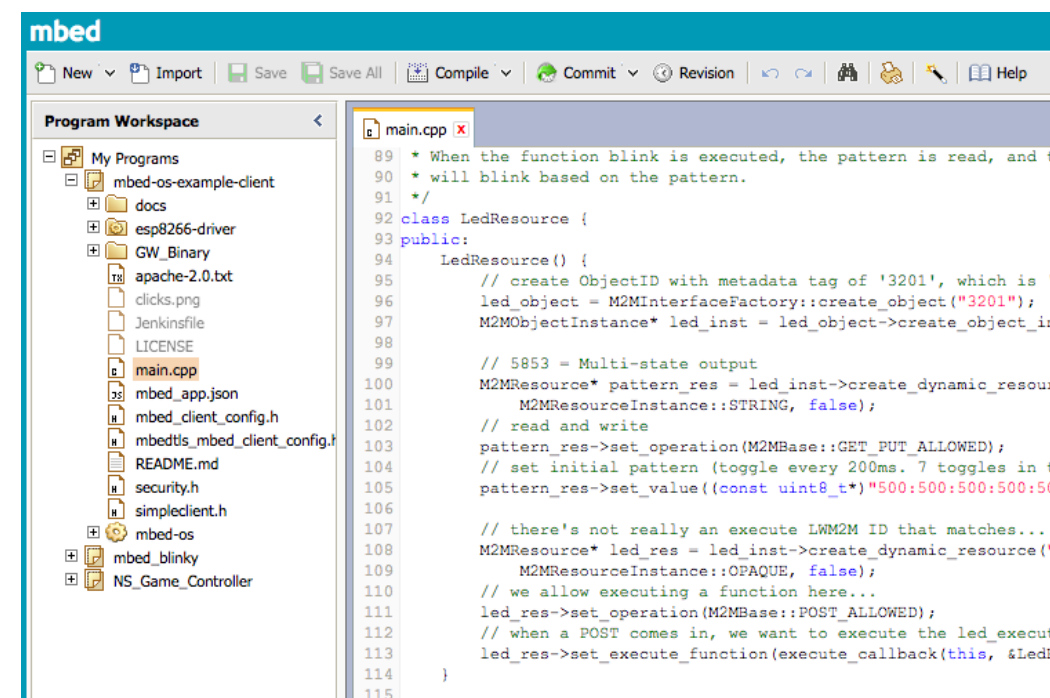


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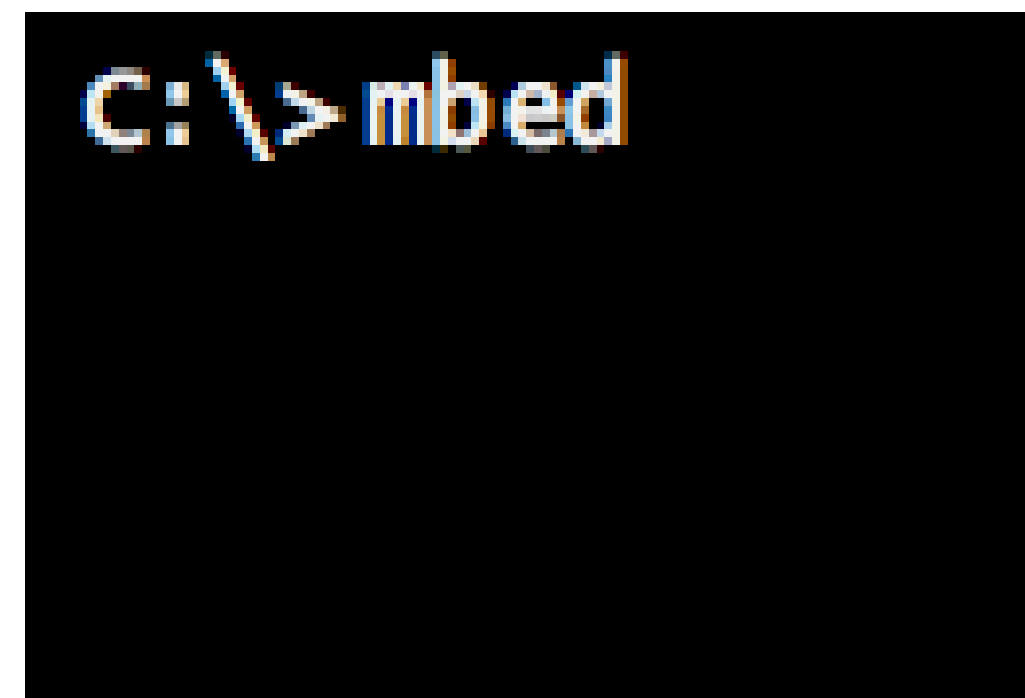
412 ● 1 ● 5

Just FYI, mbed has had offline support for many years. You can export your code to a variety of offline toolchains. Recently, [mbed CLI](#) was also released to compile programs offline without an IDE using GCC, ARMCC and IAR. – [Jan Jongboom](#) 1 min ago [edit](#)

Three development environments



Online compiler

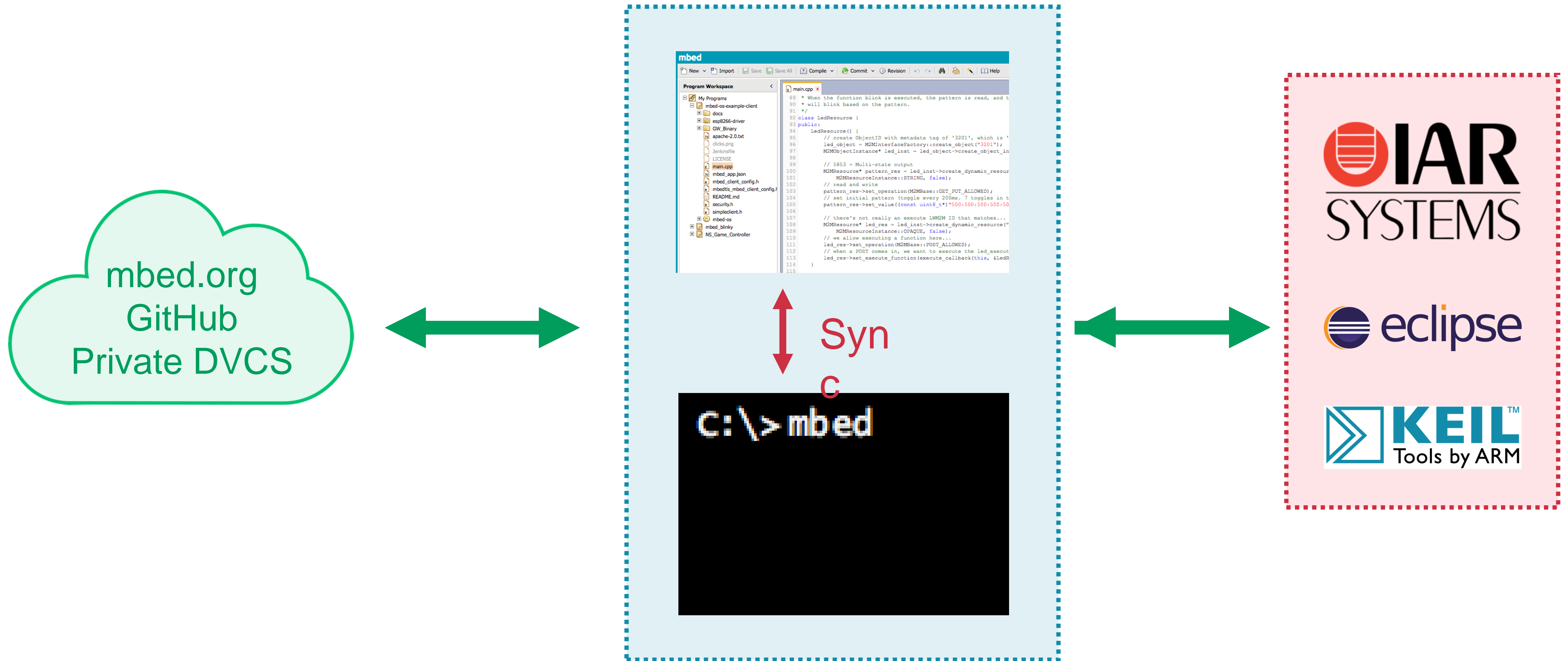


mbed CLI

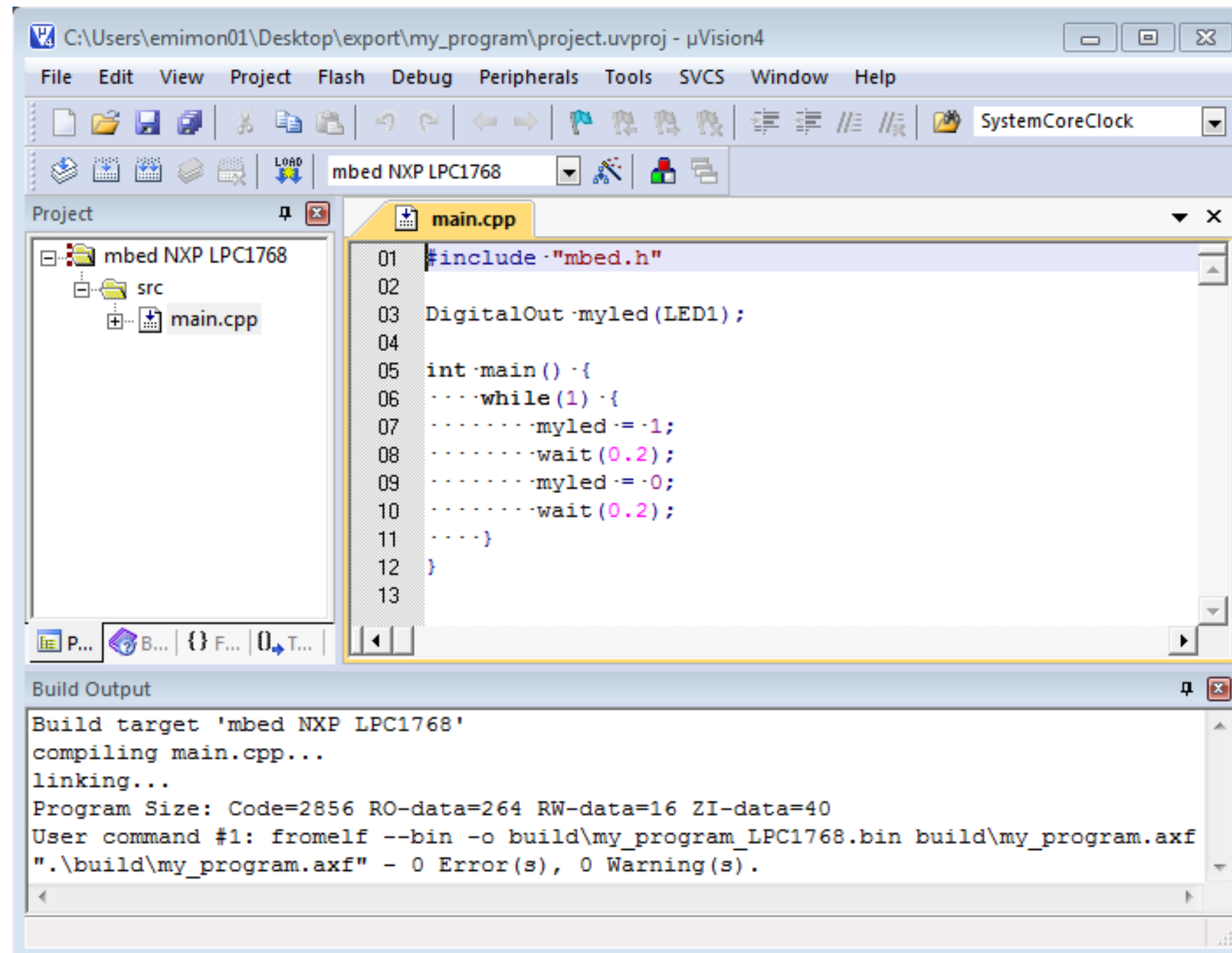


Offline IDE

Proper online / offline story



Full integration coming to uVision 5

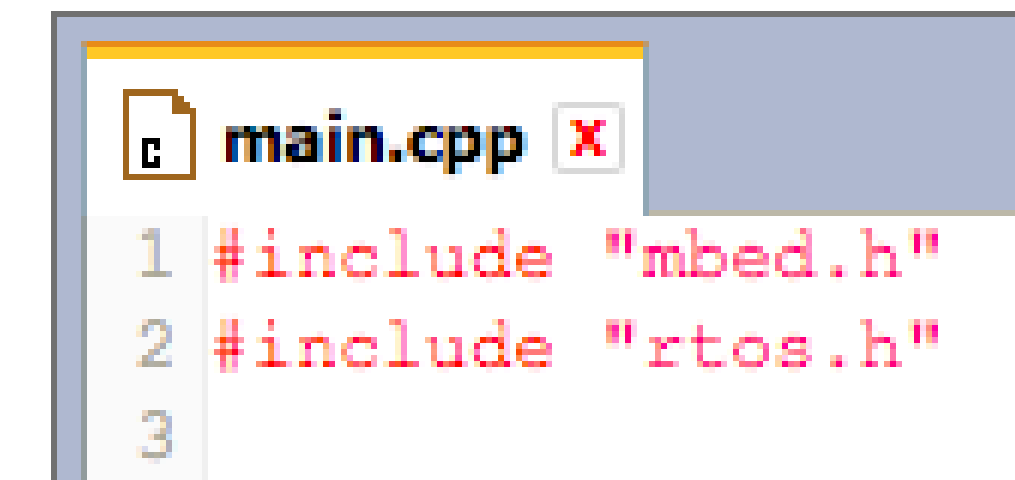
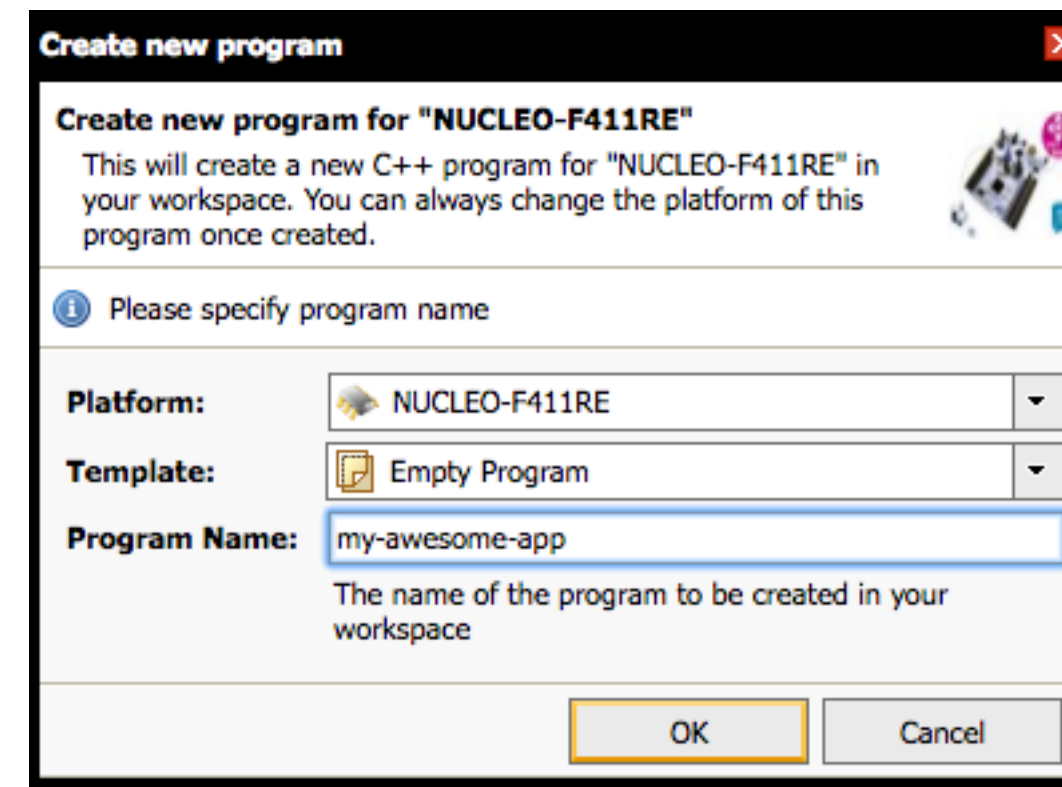
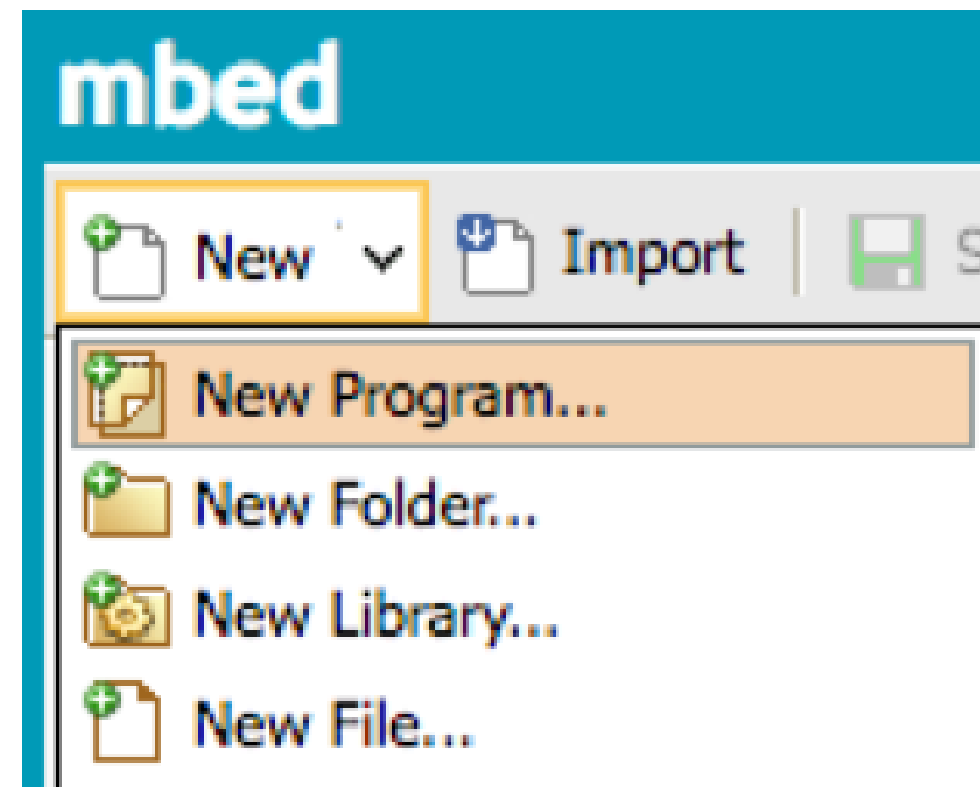


mbed Library manager

mbed OS 5 as CMSIS-PACK

Reference for other IDEs

Getting started - online compiler



Choose 'mbed OS Blinky'

Getting started - mbed CLI

✦ Install mbed CLI - <https://github.com/ARMmbed/mbed-cli>

✦ `$ mbed new my-awesome-project`

Full RTOS or event scheduler

- ✦ Full RTOS based on Keil RTX
- ✦ Optional event scheduler - mbed-events
 - ✦ Same concepts as minar in mbed OS 3
 - ✦ Runs in an RTOS thread
 - ✦ <https://github.com/ARMmbed/mbed-os/blob/master/docs/events.md>

mbed Events

```
1 #include "mbed_events.h"
2
3 // Create an event queue
4 Queue queue(32 * EVENTS_EVENT_SIZE);
5 // Create a thread that'll run the event queue's dispatch function
6 Thread t;
7
8 int main () {
9     // Start the event queue's dispatch thread
10    t.start(callback(&queue, &EventQueue::dispatch_forever));
11
12    // Use normal constructs (like tickers, interrupts)
13    // but wrap them in queue.event to go from ISR->event loop
14    Ticker t2;
15    t2.attach(queue.event(&doSomething), 1.0f);
16 }
```




Adding networking

Wait... There's an outside world?!

Available networking libraries

WiFi

Ethernet

Cellular

Thread

6LoWPAN

Bluetooth Low Energy

LoRaWAN

... many more by the community

Available networking libraries

WiFi

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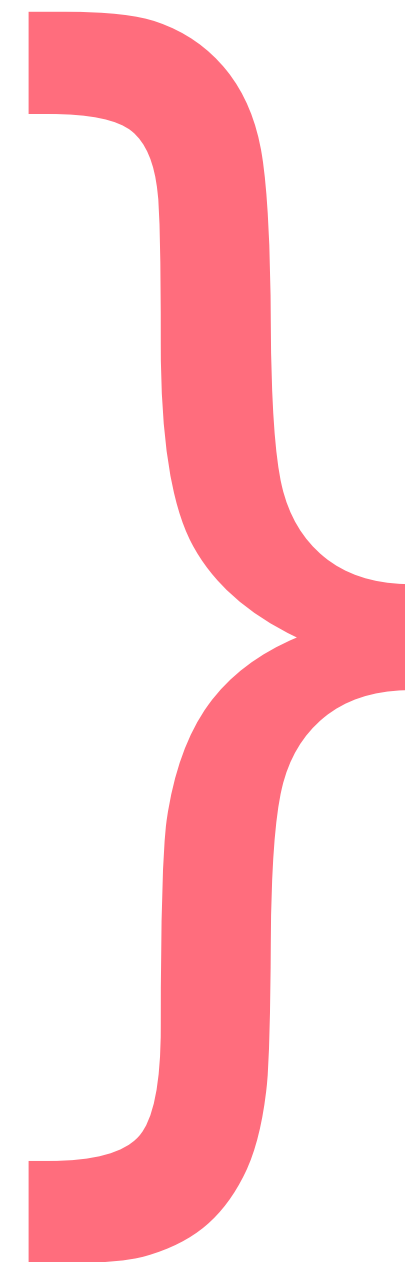
Thread

6LoWPAN

Bluetooth Low Energy

LoRaWAN

... many more by the community



Unified networking API

Write once, run anywhere

Porting is fast for socket-based libraries

uBlox C027 ported in one day



mbed TLS included

Example - HTTP using ESP8266

Add <https://github.com/ARMmbed/esp8266-driver>

```
1 #include "mbed.h"
2 #include "ESP8266Interface.h"
3
4 ESP8266Interface esp(D1 /* TX */, D0 /* RX */);
5
6 int main() {
7     NetworkInterface* network = esp.connect("SSID", "Password");
8
9     if (network) {
10         const char *ip_addr = network_interface->get_ip_address();
11         printf("IP address is %s\n", ip_addr);
12     }
```


Example - HTTP using ESP8266 (2)

```
1 socket.open(network);
2 socket.connect("developer.mbed.org", 80);
3
4 char sbuffer[] = "GET / HTTP/1.1\r\nHost: developer.mbed.org\r\n\r\n";
5 int scount = socket.send(sbuffer, sizeof sbuffer);
6
7 char rbuffer[64];
8 int rcount = socket.recv(rbuffer, sizeof rbuffer);
9 printf("recv %d [%.*s]\r\n", rcount);
```

Security is bigger than TLS



ars TECHNICA UK



BIZ & IT

TECH

SCIENCE

POLICY

CARS

GAMING & CULTURE

FORUMS

RISK ASSESSMENT —

Record-breaking DDoS reportedly delivered by 145,000+ hacked cameras

Once unthinkable, 1 terabit DDoS attacks may soon be the new normal.

DAN GOODIN (US) - 29/9/2016, 10:09

Reducing attack area on microcontrollers

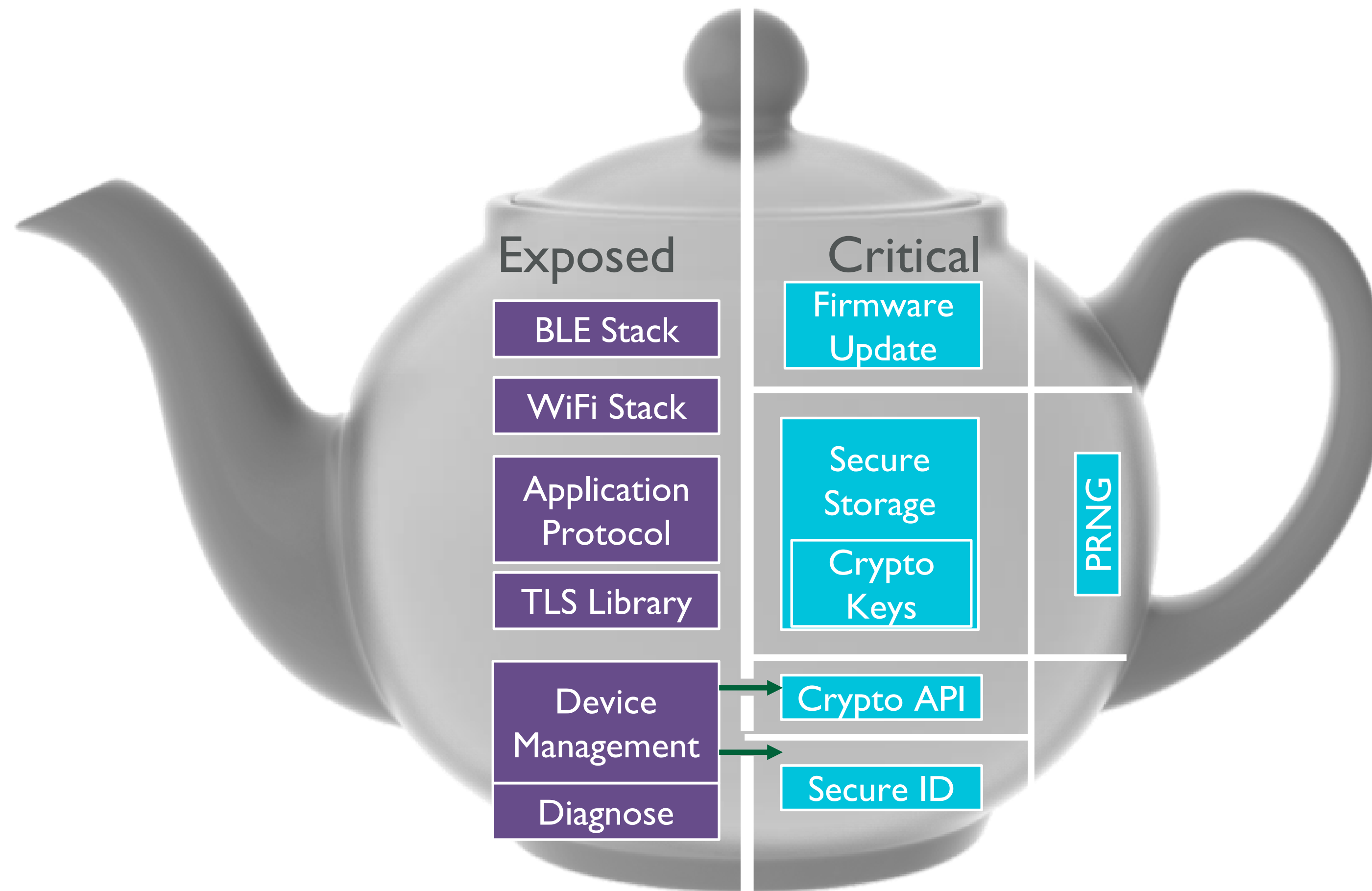
- ✦ No MMU
- ✦ Flat address space
- ✦ Need component isolation



uVisor

- ✦ Memory isolation
- ✦ Trustzone on V8-M architecture (Cortex-M23, Cortex-M33)
- ✦ Secure boxes
- ✦ Will be integrated part of mbed OS 5.x
 - ✦ Critical parts will be provided as well-tested isolated blocks
- ✦ Currently available on 3 targets

uVisor Blocks



Adding mbed Client

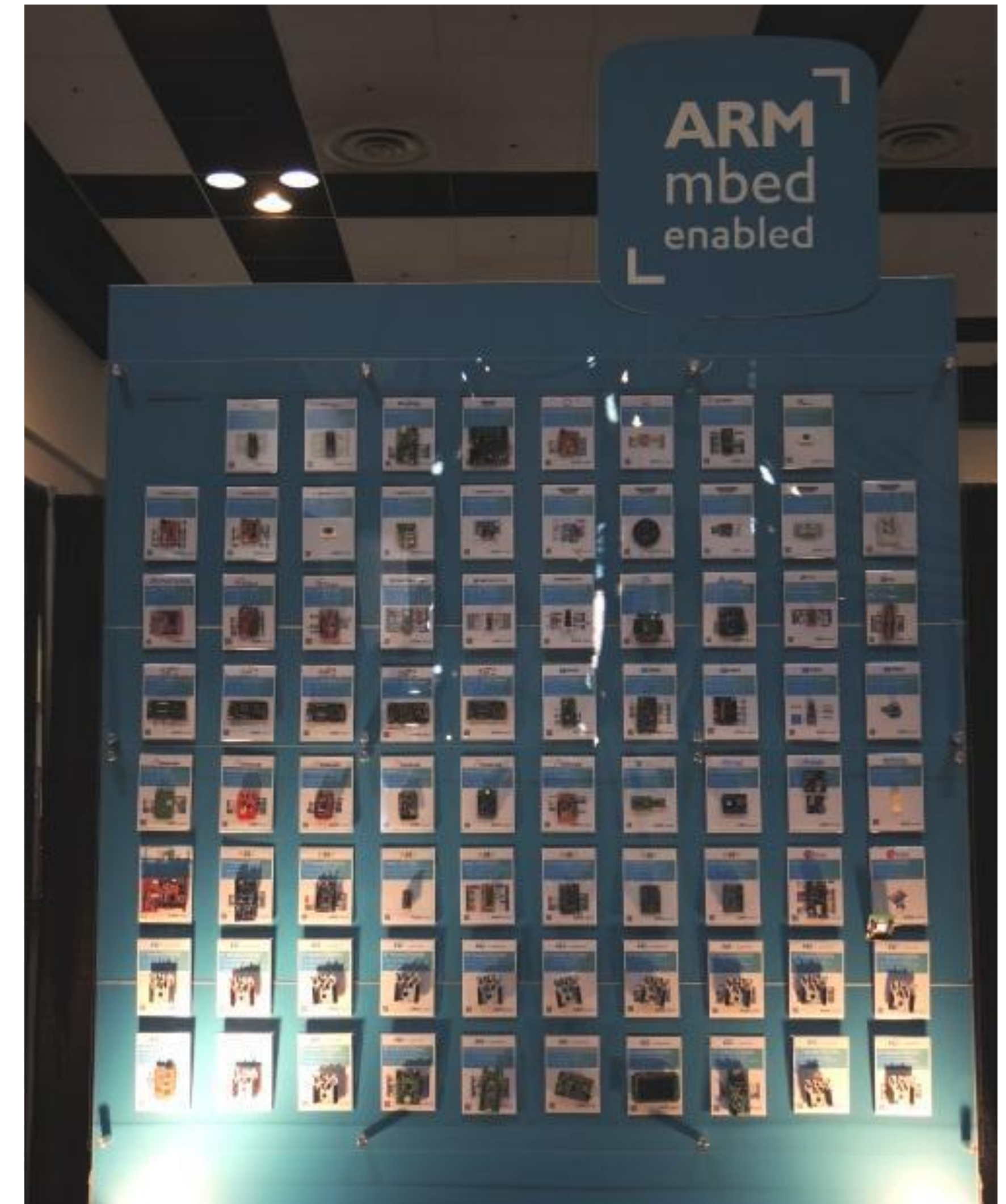
"Ceci n'est pas un nuage"

mbed Client

Raw TCP / UDP sockets - easy data streams

Device management through mbed Device Connector

mbed Client is cloud middleware



Simple mbed Client

- ✦ Library to easily bring variables into the cloud
- ✦ <https://developer.mbed.org/teams/sandbox/code/simple-mbed-client>
- ✦ Cloud variables
 - ✦ Define a variable
 - ✦ Use it as normal variable, magic!
- ✦ Easy to re-use existing mbed libraries...

(integrated in core mbed Client in next release)



One more thing...

Building IoT devices with JavaScript

Using JerryScript and mbed OS 5 on ARM-based microcontrollers

With mbed OS 5 you can use JavaScript to write the code for your IoT devices. It combines a small JavaScript VM with a professional and well-tested ecosystem, allowing you to write fast, secure and battery-efficient applications that run on a \$2 microcontroller.

```
var led = DigitalOut(D0);
var button = InterruptIn(D1);

button.fall(function(){
    led.write(led.read() ? 0 : 1);
});
```

<http://mbed.com/js>

Thank you!

<http://developer.mbed.org>

