DESIGNING A CUSTOM OS FOR IOT USING YOCTO PROJECT AND CREATING IOT APPS USING IBM BLUEMIX

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ABSTRACT

Developers spend lot of time porting or making build systems which leaves less time and resources to develop value adding software features this can resolved by the Yocto Project. The Yocto Project combines the convenience of a ready-to-run Linux Distribution with the flexibility of a custom Linux operating system. The Yocto Project is not an Embedded Linux Distribution. It creates a custom one for us, it is an Ecosystem. The Yocto Project used to establish a custom Linux baseline across multiple hardware configurations. This allows software developers to write software for an embedded Internet of Things (IoT) device. The IoT is expected to offer an unprecedented connectivity of all the things including but not limited to devices, systems and services. This interconnection can creates a platform to automate and connect for almost all the fields and industry. However, Low cost computing platforms could be used which specialize in doing only one thing and also consume less power. Yocto project used to build a free custom OS which will support Internet of Things in Beaglebone black as low cost computing platform.

***Keywords** –beaglebone black, custom OS, IBM Bluemix, Internet of Things, Yocto project*

INTRODUCTION

IOTis an evolution of mobile, home, embedded application better be connected to internet integrating greater computable capabilities. Billions of devices will be connected to internet. The connected devices become an intelligent system of systems. But Internet of Things too needs an OS to run the software on it.So we are designing a custom OS for IOT using yocto project. The Yocto Project is an open source collaboration project that provides templates, tools and methods to help you create custom Linux-based systems for embedded products regardless of the hardware architecture. It's a complete embedded Linux development environment with tools, metadata, and documentation - everything you need. The free tools are easy to get started with, powerful to work with (including emulation environments, debuggers, an Application Toolkit Generator, etc.) and they allow projects to be carried forward over time without causing you to lose optimizations and investments made during the project's prototype phase.[1]

YOCTO PROJECT

The Yocto Project is an open-source collaboration project focused on embedded Linux developers. Among other things, the Yocto Project uses a build system based on the

OpenEmbedded (OE) project, which uses the BitBake tool, to construct complete Linux images. The BitBake and OE components are combined together to form Poky, a reference build system. The Yocto Project Development Environment is shown in figure 1.

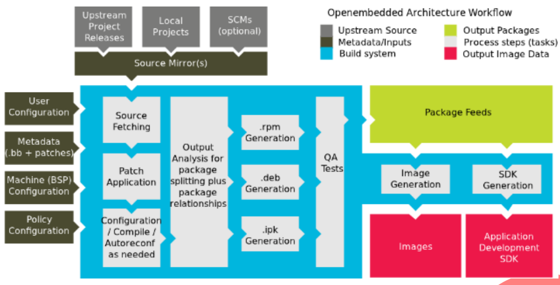


Figure 1.Yocto Project Development Environment

It provides an open source development environment targeting the ARM, MIPS, PowerPC and x86 architectures for a variety of platforms including x86-64 and emulated ones. The components from the Yocto Project can be used to design, develop, build, debug, simulate, and test the complete software stack using Linux, the X Window System, GNOME Mobile-based application frameworks, and Qt frameworks[2].

Building Images

The development environment need to build an image whenever we can change hardware support, add or change system libraries, or add or change services that have dependencies. The process of building an image is described in figure 2.

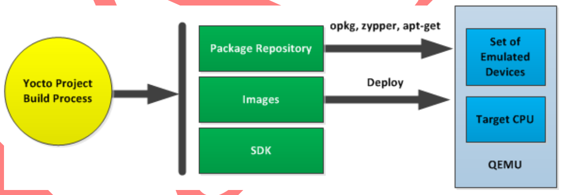


Figure 2.Building an Image

The Open Embedded build process creates an entire Linux distribution, including the toolchain, from source.[6]

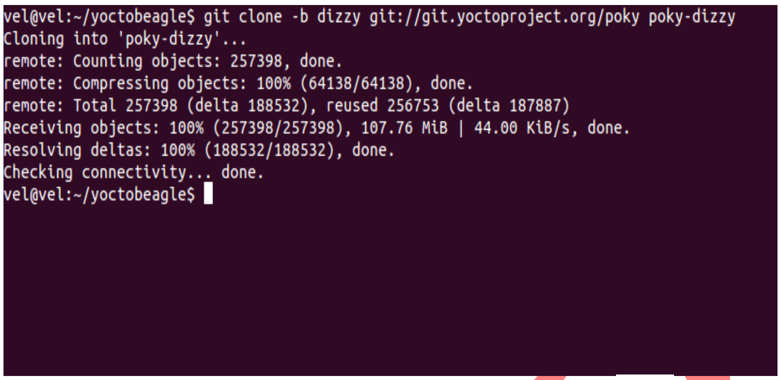
GENERATING IMAGE FOR BEAGLEBONE BLACK

A source directory is set up by using git to clone the poky repository and then check out the release branch using the following commands

```
$ cd ~
$ git clone git://git.yoctoproject.org/poky
$ cd poky
$ git checkout -b dizzy origin/dizzy
```

The process of downloading the latest yocto-dizzy is shown in figure 3. Initialize our environment and provide a meaningful build directory name with the following commands:

```
$ cd ~/yocto
    $ source poky-dizzy/oe-init-build-env build-dizzy
```



```
vel@vel:~/yoctobeagle$ git clone -b dizzy git://git.yoctoproject.org/poky poky-dizzy
Cloning into 'poky-dizzy'...
remote: Counting objects: 257398, done.
remote: Compressing objects: 100% (64138/64138), done.
remote: Total 257398 (delta 188532), reused 256753 (delta 187887)
Receiving objects: 100% (257398/257398), 107.76 MiB | 44.00 KiB/s, done.
Resolving deltas: 100% (188532/188532), done.
Checking connectivity... done.
vel@vel:~/yoctobeagle$
```

Figure 3.Downloading the latest Yocto release "dizzy"

Configuring the local.conf File

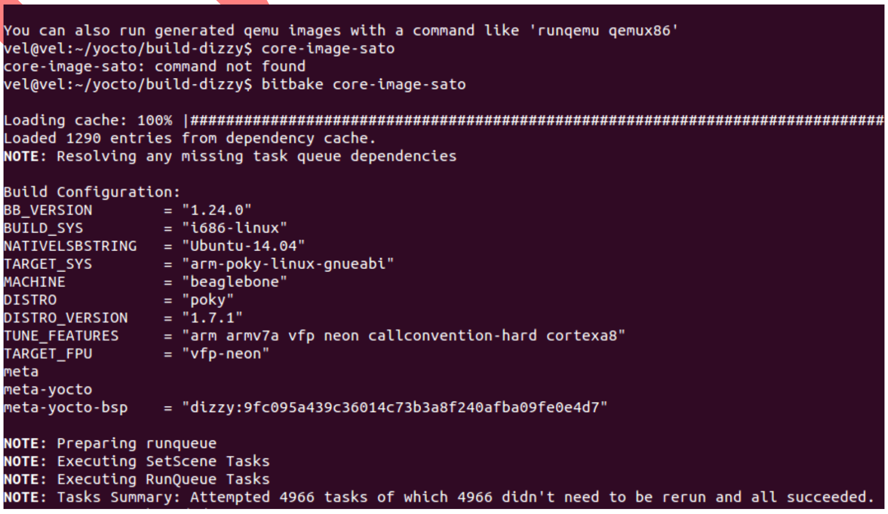
Initializing the build environment creates a conf/local.conf configuration file in the build directory. The file is manually edited to specify the machine we are building and to optimize our build time. The minimal changes are listed.

```
BB_NUMBER_THREADS = "8"
PARALLEL_MAKE = "-j 8"
MACHINE ?= "beaglebone"
```

Building images

A minimum image without support graphical user interface (core-image-mininal) with the command:

```
$ source poky-dizzy/oe-init-build-env build-dizzy
$ bitbake core-image-minimal
```



```
You can also run generated qemu images with a command like 'runqemu qemux86'
vel@vel:~/yocto/build-dizzy$ core-image-sato
core-image-sato: command not found
vel@vel:~/yocto/build-dizzy$ bitbake core-image-sato

Loading cache: 100% |##############################################################################
Loaded 1290 entries from dependency cache.
NOTE: Resolving any missing task queue dependencies

Build Configuration:
BB_VERSION        = "1.24.0"
BUILD_SYS         = "i686-linux"
NATIVELSBSTRING   = "Ubuntu-14.04"
TARGET_SYS        = "arm-poky-linux-gnueabi"
MACHINE           = "beaglebone"
DISTRO            = "poky"
DISTRO_VERSION    = "1.7.1"
TUNE_FEATURES     = "arm armv7a vfp neon callconvention-hard cortexa8"
TARGET_FPU        = "vfp-neon"
meta
meta-yocto
meta-yocto-bsp    = "dizzy:9fc095a439c36014c73b3a8f240afba09fe0e4d7"

NOTE: Preparing runqueue
NOTE: Executing SetScene Tasks
NOTE: Executing RunQueue Tasks
NOTE: Tasks Summary: Attempted 4966 tasks of which 4966 didn't need to be rerun and all succeeded.
```

Figure 4.Build image

List of files generated

MLO-beaglebone**(**The second stage bootloader**),** u-boot-beaglebone.img**(**The third stage u-boot bootloader**),** uImage**(**The Linux kernel image**),**core-image-base-begalebone.tar.bz2**(**This compressedfile contains the root file system**)**

Setup sdcard

To deploy the system on beaglebone we need to prepare an SD-card. The SD-card partitioned into two partition first one use FAT32 file system around 50mb and label it as BOOT and rest of SD-carduse ext4 file system label it as ROOT. Then copy files MLO,uImage into BOOT partition and u-boot.img,core-image-base-begalebone.tar.bz2 into ROOT partition.Now we can boot from sdcard by pressing boot button in beaglebone.Screenshot of custom os is shown in figure 5.

Figure 5.Screenshot of Custom OS

CREATING IOT APPLICATION USING IBM BLUEMIX

In this application a TI sensorTag is used which built in accelerometer, Magnetometer, Gyroscope, Humidity, Barometer, Temperature sensors. TI sensorTag is connected to beaglebone black via Bluetooth. The IBM application collect sensor readings from the device. When temperature exceeds certain threshold value then a get twitternotification on our mobile is returned. To build an application with IBM bluemix is shown in figure 6.[5]

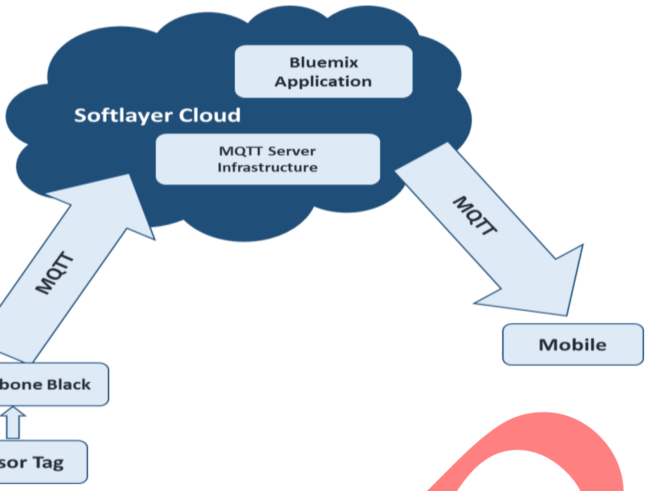


Figure 6.Building Applications with the IBM bluemix

Steps for creating IBM bluemix IOT application

1 Account in IBM BlueMix at https://ace.ng.bluemix.netis created

2. Internet of Things Boilerplate is selected. Boilerplate include three services

Node-Red – a visual tool for wiring and programming the Internet of Things

Time series database – for collecting and archiving Internet of Things data

Internet of Things API – for connecting to sensors and devices using protocols like MQTT

3. Click on Create Application to deploy the services into BlueMix.From the BlueMix Console open your Internet of Things service. Here you can see the various BlueMix services. View your Internet of Things service, but navigating to your service's URL. You can click on the URL shown under your IoT services name. At your Internet of Thing service Web URL you will see information on the Node-Red BlueMix service. This visual tool enables you to rapidly build Internet of Things cloud applications in BlueMix.

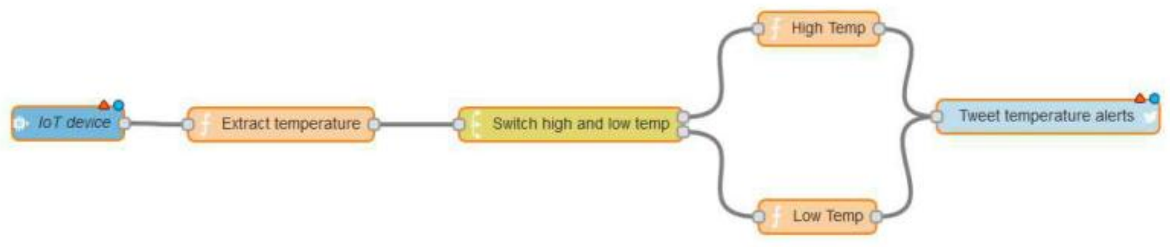


Figure 7.node-red circuit

The figure 7 shows basic node-RED flow which sends an alert to our twitter account if the temperature exceeds threshold value.

4. Let's configure the *IoTInput node*Double click on the IoT node to enter the SensorTag's MAC addressis shown in figure 8.

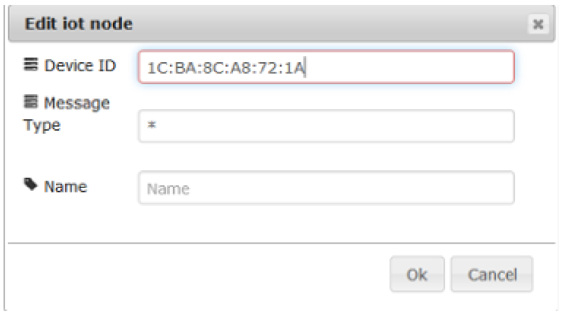
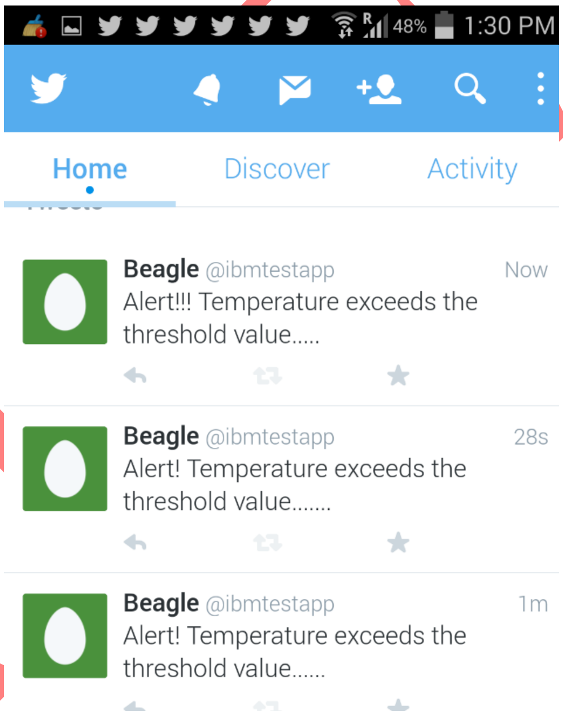


Figure 8.Entering Sensortag mac address

5.Double click on the twitter node and add your twitter credentials. It will open a new window where you will need to authorize this application to access our account.

6. Finally, click on deploy.Now the flow is deployed and this flow will tweet if the temperature of sensorTag goes above 55 deg C, it tweets every 4 seconds is shown in figure 9.



Beagle @ibmtestapp Now
Alert!!! Temperature exceeds the threshold value.....

Beagle @ibmtestapp 28s
Alert! Temperature exceeds the threshold value.......

Beagle @ibmtestapp 1m
Alert! Temperature exceeds the threshold value......

Figure 9. Getting alert on mobile

CONCLUSION

Development yocto project real time application to support IOT is completed which is partially tested and found successfully working. Different parameters likes temperature, accelerometer, Magnetometer, Gyroscope, Humidity, Barometer sensor values are read and tweeted in real time by the system The research is still in continuation to develop it into a full blown system. There is much to improve and work on in this field.

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