Activity: Obtain and Install cFS

In this activity, you will obtain and install cFS on the BeagleBone AI single board computer. To ensure consistent results, you will be obtaining the software components from a METECS-provided source. The original source will be identified so you can use the most recent versions of the software components. However, as different software components are updated, incompatibilities may arise that are beyond the scope of this course.

# Materials and Requirements

* BeagleBone AI single-board computer (<https://www.mouser.com/ProductDetail/BeagleBoard/BBONE-AI?qs=sGAEpiMZZMu3sxpa5v1qrpe%2F9%2FddSq0joo6yAIc5ORQ%3D>).
* USB Fan (<https://www.amazon.com/gp/product/B003XN24GY>).
* 5V 3A USB type-C power supply (<https://www.amazon.com/Raspberry-Model-Official-SC0218-Accessory/dp/B07W8XHMJZ/>).
* Small needle-nose pliers (can be shared).
* WiFi hotspot with Internet access (can be shared).

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# Attach and Update the BeagleBone AI

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| 1 | Move the WiFi Antenna. The BeagleBone AI ships with the 2.4 GHz antenna located over the BeagleBone AI’s components. The antenna must be rotated to extend beyond the board. Carefully remove the antenna using the needle-nose pliers and reattach the antenna in the desired orientation. Be careful not to damage components on the board. | BeagleBone AI Antenna As Shipped:    BeagleBone AI Antennas As Desired: |
| 2 | Apply power to the BeagleBone AI. Plug the 5V 3A USB type-C power supply into wall power using the provided adapter. Plug a USB type-C cable into the power supply and the BeagleBoard AI. Observe the Power LED near the type-C connector. Observe the blinking activity LEDs near the 2.4 GHz antenna. |  |
| 3 | Connect to the BeagleBone AI’s WiFi network. Attach to a WiFi network with a name of the form “BeagleBone-XXXX” where XXXX consists of four characters and digits. The WiFi password is “BeagleBone”. Open http://192.168.8.1 in your web browser. This will connect to the Cloud9 IDE hosted on the BeagleBone development board.  If your computer already has a network in the 192.168.8.x subnet, you will need to modify your computer’s network settings to avoid a conflict.  To determine the value of XXXX of your BeagleBone AI when multiple BeagleBone AI’s are present, power up the BeagleBone AI’s one at a time. |  |
| 4 | Connect the BeagleBone AI to a WiFi hotspot with Internet access. Follow the instructions on the Cloud9 IDE web page to attach the BeagleBone AI to a WiFi hotspot. If prompted, the password for debian is “temppwd”.  After connecting to the WiFi network, it may be convenient to SSH into the BeagleBone AI as the user “debian” and password “temppwd” using the acquired IP address, 192.168.46.168 in this example. Alternatively you may continue to use the embedded bash terminal through the webpage interface. | debian@beaglebone:/var/lib/cloud9$ sudo connmanctl  connmanctl> scan wifi  Scan completed for wifi  connmanctl> services  wifi\_8091334a207f\_hidden\_managed\_none  Carambole8Letterure9 wifi\_8091334a207f\_436172616d626f6c65384c657474657275726539\_managed\_psk  d7f4 wifi\_8091334a207f\_64376634\_managed\_wep  ATT9Efb8V3 wifi\_8091334a207f\_41545439456662385633\_managed\_psk  Neptune wifi\_8091334a207f\_4e657074756e65\_managed\_psk  DIRECT-d1-HP M477 LaserJet wifi\_8091334a207f\_4449524543542d64312d4850204d343737204c617365724a6574\_managed\_psk  NETGEAR35 wifi\_8091334a207f\_4e4554474541523335\_managed\_psk  ATT5ZX6yjc wifi\_8091334a207f\_415454355a5836796a63\_managed\_psk  zNet wifi\_8091334a207f\_7a4e6574\_managed\_psk  ATTPdkiW6a wifi\_8091334a207f\_41545450646b69573661\_managed\_psk  Krolik wifi\_8091334a207f\_4b726f6c696b\_managed\_psk  Physics 101 GST wifi\_8091334a207f\_506879736963732031303120475354\_managed\_psk  MotoVAP\_M91543SA0C65 wifi\_8091334a207f\_4d6f746f5641505f4d3931353433534130433635\_managed\_psk  connmanctl> agent on  Agent registered  connmanctl> connect wifi\_8091334a207f\_436172616d626f6c65384c657474657275726539\_managed\_psk  Agent RequestInput wifi\_8091334a207f\_436172616d626f6c65384c657474657275726539\_managed\_psk  Passphrase = [ Type=psk, Requirement=mandatory ]  Passphrase? WiFiPassword  connmanctl> quit  debian@beaglebone:/var/lib/cloud9$ ifconfig  <snip>  wlan0: flags=-28605<UP,BROADCAST,RUNNING,MULTICAST,DYNAMIC> mtu 1500  inet 192.168.46.168 netmask 255.255.255.0 broadcast 192.168.46.255  inet6 fe80::8291:33ff:fe4a:207f prefixlen 64 scopeid 0x20<link>  ether 80:91:33:4a:20:7f txqueuelen 1000 (Ethernet)  RX packets 566 bytes 63758 (62.2 KiB)  RX errors 0 dropped 34 overruns 0 frame 0  TX packets 78 bytes 13350 (13.0 KiB)  TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0  debian@beaglebone:/var/lib/cloud9$ |
| 5 | Update the BeagleBone AI distribution components. Perform the steps documented at <https://beagleboard.org/upgrade>, in the section “Update Distribution Components”. The relevant commands, highlighted with a green background and a sample terminal output are provided in the right column. | debian@beaglebone:/var/lib/cloud9$ sudo apt update  [sudo] password for debian:  Get:1 http://repos.rcn-ee.com/debian stretch InRelease [3,064 B]  Ign:2 http://deb.debian.org/debian stretch InRelease  Get:3 http://deb.debian.org/debian stretch-updates InRelease [91.0 kB]  <snip>  Get:14 http://deb.debian.org/debian stretch/contrib armhf Packages [42.1 kB]  Fetched 9,025 kB in 17s (511 kB/s)  Reading package lists... Done  Building dependency tree  Reading state information... Done  93 packages can be upgraded. Run 'apt list --upgradable' to see them.  debian@beaglebone:/var/lib/cloud9$ sudo apt-get upgrade  Reading package lists... Done  Building dependency tree  Reading state information... Done  Calculating upgrade... Done  The following packages were automatically installed and are no longer required:  bb-beaglebone-io-installer bb-johnny-five-installer  Use 'sudo apt autoremove' to remove them.  The following packages have been kept back:  chromium  The following packages will be upgraded:  base-files bb-beaglebone-io-installer bb-cape-overlays bb-customizations bb-johnny-five-installer bb-node-red-installer bluealsa bone101 bonescript  dh-python doc-beaglebone-getting-started e2fslibs e2fsprogs file git git-core git-man gpiod libarchive13 libcomerr2 libcpupower1 libcups2  libexif-dev libexif12 libexpat1 libexpat1-dev libfreetype6 libgd3 libglib2.0-0 libgpiod2 libicu57 libidn11 libiio-utils libiio0 libldap-2.4-2  libldap-common libmagic-mgc libmagic1 libmariadbclient18 libnghttp2-14 libnginx-mod-http-auth-pam libnginx-mod-http-dav-ext libnginx-mod-http-echo  libnginx-mod-http-geoip libnginx-mod-http-image-filter libnginx-mod-http-subs-filter libnginx-mod-http-upstream-fair libnginx-mod-http-xslt-filter  libnginx-mod-mail libnginx-mod-stream libopenjp2-7 libpam-systemd libperl5.24 libpq5 libqt5core5a libqt5dbus5 libqt5gui5 libqt5network5  libqt5widgets5 libqt5xml5 libsasl2-2 libsasl2-modules-db libss2 libssl1.0.2 libssl1.1 libsystemd0 libtimedate-perl libudev-dev libudev1 libvpx4  libxslt1.1 linux-cpupower linux-libc-dev nginx nginx-common nginx-full openssh-client openssh-server openssh-sftp-server openssl perl perl-base  perl-modules-5.24 qt5-gtk-platformtheme sudo systemd systemd-sysv tightvncserver tzdata udev unzip usbutils  92 upgraded, 0 newly installed, 0 to remove and 1 not upgraded.  Need to get 250 MB of archives.  After this operation, 34.6 MB of additional disk space will be used.  Do you want to continue? [Y/n] Y  <snip>  Processing triggers for initramfs-tools (0.130) ...  update-initramfs: Generating /boot/initrd.img-4.14.108-ti-r113  Processing triggers for libc-bin (2.24-11+deb9u4) …  debian@beaglebone:~$ sudo apt install -y ti-tidl mjpg-streamer-opencv-python  Reading package lists... Done  Building dependency tree  Reading state information... Done  The following packages were automatically installed and are no longer required:  bb-beaglebone-io-installer bb-johnny-five-installer  Use 'sudo apt autoremove' to remove them.  The following packages will be REMOVED:  mjpg-streamer  The following NEW packages will be installed:  mjpg-streamer-opencv-python ti-tidl  0 upgraded, 2 newly installed, 1 to remove and 1 not upgraded.  Need to get 42.6 MB of archives.  After this operation, 108 MB of additional disk space will be used.  Get:1 http://repos.rcn-ee.com/debian stretch/main armhf mjpg-streamer-opencv-python armhf 0.0.0-git20190524.0-0rcnee3~stretch+20190718 [177 kB]  <snip>  Setting up mjpg-streamer-opencv-python (0.0.0-git20190524.0-0rcnee3~stretch+20190718) ...  Setting up ti-tidl (01.02.02-bb.org-0.2-0rcnee3~stretch+20190924) ... |
| 6 | Update the Cloud9 IDE workspace example. Perform the steps documented at <https://beagleboard.org/upgrade>, in the section “Update examples in the Cloud9 IDE workspace”. | debian@beaglebone:~$ cd /var/lib/cloud9  debian@beaglebone:/var/lib/cloud9$ git pull  Already up-to-date. |
| 7 | Update the boot scripts and Linux kernel. Perform the steps documented at <https://beagleboard.org/upgrade>, in the section “Update the boot-up scripts and Linux kernel”. | debian@beaglebone:/var/lib/cloud9$ cd /opt/scripts  debian@beaglebone:/opt/scripts$ git pull  remote: Enumerating objects: 152, done.  remote: Counting objects: 100% (152/152), done.  remote: Compressing objects: 100% (72/72), done.  remote: Total 131 (delta 93), reused 90 (delta 56), pack-reused 0  Receiving objects: 100% (131/131), 15.67 KiB | 0 bytes/s, done.  Resolving deltas: 100% (93/93), completed with 15 local objects.  From https://github.com/RobertCNelson/boot-scripts  109f74f..e457c01 master -> origin/master  Updating 109f74f..e457c01  Fast-forward  boot/am335x\_evm.sh | 75 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++-----------------    <snip>  tools/version.sh | 14 ++++++++++++--  13 files changed, 307 insertions(+), 67 deletions(-)  create mode 100755 network/wifi\_enterprise.sh  debian@beaglebone:/opt/scripts$ sudo tools/update\_kernel.sh  info: checking archive  2020-02-18 18:28:28 URL:https://rcn-ee.com/repos/latest/stretch-armhf/LATEST-ti [193/193] -> "LATEST-ti" [1]  <snip>  debian@beaglebone:/opt/scripts$ sudo shutdown -r now |
| 8 | Test the installed software versions. Perform the steps documented at <https://beagleboard.org/upgrade>, in the section “Test installed versions”. | debian@beaglebone:~$ sudo /opt/scripts/tools/version.sh  [sudo] password for debian:  git:/opt/scripts/:[e457c010efc76c4e6fecccb7a5f7ff9b0597c4c0]  model:[BeagleBoard.org\_BeagleBone\_AI]  dogtag:[BeagleBoard.org Debian Image 2019-08-03]  UBOOT: Booted Device-Tree:[am5729-beagleboneai.dts]  kernel:[4.14.108-ti-r127]  nodejs:[v6.17.0]  /boot/uEnv.txt Settings:  pkg check: to individually upgrade run: [sudo apt install --only-upgrade <pkg>]  pkg:[bb-cape-overlays]:[4.14.20200131.0-0rcnee0~stretch+20200131]  pkg:[bb-wl18xx-firmware]:[1.20190227.1-0rcnee0~stretch+20190227]  pkg:[kmod]:[23-2rcnee1~stretch+20171005]  pkg:[librobotcontrol]:[1.0.4-git20190227.1-0rcnee0~stretch+20190327]  pkg:[firmware-ti-connectivity]:[20180825+dfsg-1rcnee1~stretch+20181217]  groups:[debian : debian adm kmem dialout cdrom floppy audio dip video plugdev users systemd-journal i2c bluetooth netdev gpio pwm eqep remoteproc admin spi tisdk weston-launch xenomai cloud9ide]  cmdline:[console=ttyS0,115200n8 root=/dev/mmcblk1p1 ro rootfstype=ext4 rootwait coherent\_pool=1M net.ifnames=0 rng\_core.default\_quality=100 quiet]  dmesg | grep remote  [ 17.465334] remoteproc remoteproc0: 4b234000.pru is available  [ 17.473141] remoteproc remoteproc1: 4b238000.pru is available  [ 17.533759] remoteproc remoteproc2: 4b2b4000.pru is available  [ 17.536855] remoteproc remoteproc3: 4b2b8000.pru is available  [ 55.961349] remoteproc remoteproc4: 58820000.ipu is available  [ 55.972675] remoteproc remoteproc5: 55020000.ipu is available  [ 55.983726] remoteproc remoteproc6: 40800000.dsp is available  [ 56.009295] remoteproc remoteproc7: 41000000.dsp is available  [ 56.036303] remoteproc remoteproc5: powering up 55020000.ipu  [ 56.036353] remoteproc remoteproc5: Booting fw image dra7-ipu2-fw.xem4, size 3751356  [ 56.091165] remoteproc remoteproc4: powering up 58820000.ipu  [ 56.091212] remoteproc remoteproc4: Booting fw image dra7-ipu1-fw.xem4, size 6867360  [ 56.345456] remoteproc remoteproc6: powering up 40800000.dsp  [ 56.345505] remoteproc remoteproc6: Booting fw image dra7-dsp1-fw.xe66, size 20998684  [ 56.363513] remoteproc remoteproc7: powering up 41000000.dsp  [ 56.363560] remoteproc remoteproc7: Booting fw image dra7-dsp2-fw.xe66, size 20998684  [ 56.444550] remoteproc remoteproc4: registered virtio0 (type 7)  [ 56.444575] remoteproc remoteproc4: remote processor 58820000.ipu is now up  [ 56.539969] Modules linked in: omap\_remoteproc virtio\_rpmsg\_bus rpmsg\_core iptable\_nat nf\_conntrack\_ipv4 nf\_defrag\_ipv4 nf\_nat\_ipv4 nf\_nat usb\_f\_ecm nf\_conntrack usb\_f\_mass\_storage iptable\_mangle usb\_f\_rndis u\_ether iptable\_filter libcomposite cmemk(O) uio\_pdrv\_genirq uio spidev pruss\_soc\_bus pru\_rproc pruss pruss\_intc ip\_tables x\_tables  [ 56.647855] remoteproc remoteproc6: registered virtio1 (type 7)  [ 56.647880] remoteproc remoteproc6: remote processor 40800000.dsp is now up  [ 56.647920] remoteproc remoteproc5: registered virtio2 (type 7)  [ 56.647948] remoteproc remoteproc5: remote processor 55020000.ipu is now up  [ 56.704038] remoteproc remoteproc7: registered virtio3 (type 7)  [ 56.704062] remoteproc remoteproc7: remote processor 41000000.dsp is now up  dmesg | grep pru  [ 17.432881] pruss 4b200000.pruss: creating PRU cores and other child platform devices  [ 17.465334] remoteproc remoteproc0: 4b234000.pru is available  [ 17.465500] pru-rproc 4b234000.pru: PRU rproc node /ocp/pruss\_soc\_bus@4b226004/pruss@0/pru@34000 probed successfully  [ 17.473141] remoteproc remoteproc1: 4b238000.pru is available  [ 17.473303] pru-rproc 4b238000.pru: PRU rproc node /ocp/pruss\_soc\_bus@4b226004/pruss@0/pru@38000 probed successfully  [ 17.507342] pruss 4b280000.pruss: creating PRU cores and other child platform devices  [ 17.533759] remoteproc remoteproc2: 4b2b4000.pru is available  [ 17.533978] pru-rproc 4b2b4000.pru: PRU rproc node /ocp/pruss\_soc\_bus@4b2a6004/pruss@0/pru@34000 probed successfully  [ 17.536855] remoteproc remoteproc3: 4b2b8000.pru is available  [ 17.537079] pru-rproc 4b2b8000.pru: PRU rproc node /ocp/pruss\_soc\_bus@4b2a6004/pruss@0/pru@38000 probed successfully  [ 56.539969] Modules linked in: omap\_remoteproc virtio\_rpmsg\_bus rpmsg\_core iptable\_nat nf\_conntrack\_ipv4 nf\_defrag\_ipv4 nf\_nat\_ipv4 nf\_nat usb\_f\_ecm nf\_conntrack usb\_f\_mass\_storage iptable\_mangle usb\_f\_rndis u\_ether iptable\_filter libcomposite cmemk(O) uio\_pdrv\_genirq uio spidev pruss\_soc\_bus pru\_rproc pruss pruss\_intc ip\_tables x\_tables  [ 72.733885] pruss\_uio\_shmem 4b200000.pruss\_shmem: Allocating gdev  [ 72.733914] pruss\_uio\_shmem 4b200000.pruss\_shmem: Allocating info  [ 72.733935] pruss\_uio\_shmem 4b200000.pruss\_shmem: Requesting resource  [ 72.733993] pruss\_uio\_shmem 4b200000.pruss\_shmem: Mapping resource  [ 72.734043] pruss\_uio\_shmem 4b200000.pruss\_shmem: Registering with uio driver  [ 72.745501] pruss\_uio\_shmem 4b200000.pruss\_shmem: Saving platform data  [ 72.745846] pruss\_uio\_shmem 4b280000.pruss\_shmem: Allocating gdev  [ 72.745868] pruss\_uio\_shmem 4b280000.pruss\_shmem: Allocating info  [ 72.745887] pruss\_uio\_shmem 4b280000.pruss\_shmem: Requesting resource  [ 72.745943] pruss\_uio\_shmem 4b280000.pruss\_shmem: Mapping resource  [ 72.745986] pruss\_uio\_shmem 4b280000.pruss\_shmem: Registering with uio driver  [ 72.750502] pruss\_uio\_shmem 4b280000.pruss\_shmem: Saving platform data  dmesg | grep pinctrl-single  [ 0.917547] pinctrl-single 4a003400.pinmux: 282 pins at pa fc003400 size 1128  dmesg | grep gpio-of-helper  lsusb  Bus 002 Device 001: ID 1d6b:0003 Linux Foundation 3.0 root hub  Bus 001 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub  END |

# Clone cFS from Github

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| 1 | Clone the cFS repository from Github. When cloning the repository, be sure to include the submodules by using the --recursive argument. | debian@beaglebone:~$ pwd  /home/debian  debian@beaglebone:~$ git clone --recursive https://github.com/METECS/cFS.git  Cloning into 'cFS'...  remote: Enumerating objects: 367, done.  remote: Total 367 (delta 0), reused 0 (delta 0), pack-reused 367  Receiving objects: 100% (367/367), 123.67 KiB | 0 bytes/s, done.  Resolving deltas: 100% (167/167), done.  <snip>  Submodule path 'cfe': checked out '5802d229ce047185e9247192f0fa328219d54b78'  Submodule path 'osal': checked out '8239eb5b521fdac68a09973e8e5ce6eb4a251e90'  Submodule path 'psp': checked out '0704c5943b3e21c3cd9d823ab73ec308c196789a'  Submodule path 'tools/cFS-GroundSystem': checked out 'c982339402d4da3ea6f645ffa38280f7bef61d07'  Submodule path 'tools/elf2cfetbl': checked out '3c4be5954cccc845fb329b81872d94df3780d126'  Submodule path 'tools/tblCRCTool': checked out '8d7e94a451010527f02e0daecdbe0c00e12c1768' |
| 2 | Checkout the starting version of the repository. | debian@beaglebone:~$ cd cFS  debian@beaglebone:~/cFS$ git checkout Activity01  M apps/ci\_lab  M apps/sample\_app  M apps/sample\_lib  M apps/sch\_lab  M apps/to\_lab  M cfe  M osal  M psp  M tools/cFS-GroundSystem  M tools/elf2cfetbl  M tools/tblCRCTool  Note: checking out 'Activity01'.  You are in 'detached HEAD' state. You can look around, make experimental  changes and commit them, and you can discard any commits you make in this  state without impacting any branches by performing another checkout.  If you want to create a new branch to retain commits you create, you may  do so (now or later) by using -b with the checkout command again. Example:  git checkout -b <new-branch-name>  HEAD is now at f8aa4ad... Point submodules to METECS repositories  debian@beaglebone:~/cFS$ git submodule sync --recursive  Synchronizing submodule url for 'apps/ci\_lab'  Synchronizing submodule url for 'apps/sample\_app'  Synchronizing submodule url for 'apps/sample\_lib'  Synchronizing submodule url for 'apps/sch\_lab'  Synchronizing submodule url for 'apps/to\_lab'  Synchronizing submodule url for 'cfe'  Synchronizing submodule url for 'osal'  Synchronizing submodule url for 'psp'  Synchronizing submodule url for 'tools/cFS-GroundSystem'  Synchronizing submodule url for 'tools/elf2cfetbl'  Synchronizing submodule url for 'tools/tblCRCTool'  debian@beaglebone:~/cFS$ git submodule update --init --recursive  remote: Enumerating objects: 40, done.  remote: Counting objects: 100% (40/40), done.  remote: Total 59 (delta 40), reused 40 (delta 40), pack-reused 19  Unpacking objects: 100% (59/59), done.  From https://github.com/METECS/ci\_lab  <snip>  From https://github.com/METECS/elf2cfetbl  + 7a3d1ca...3c4be59 master -> origin/master (forced update)  \* [new branch] metecs\_bootcamp -> origin/metecs\_bootcamp  Submodule path 'tools/elf2cfetbl': checked out 'd2b27f11c1a1c05daa4ff8f70317eee673ff62e7'  Submodule path 'tools/tblCRCTool': checked out 'd61efe6ab69626633786d7cee6b2b30089fe52d8' |