Net Booting/Installing Vintage Computers from a Raspberry Pi

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Unix = Kernel + Filesystem

Ubuntu on a Raspberry Pi

Netbooting a SPARCclassic

Fixing the RTC Battery	
RARP	IP address
TFTP	second stage bootloader
Bootparamd	root, swap filenames
Root Filesystem	
NFS	kernel, root filesystem, swap

Netinstallling an SGI O2

BOOTP	IP address
TFTP	second stage bootloader
RSH	install media
Installation Media	
Partition	
Install	

Conclusions

Traditional Unix Bootstrap Process

First-stage bootloader in ROM loads and executes the

Second-stage bootloader from disk loads and executes the

Kernel on disk, mounts root (/) filesystem and runs `init`

Our Network Server: The Raspberry Pi

$5 – $35 +
SD Card + USB Power Supply

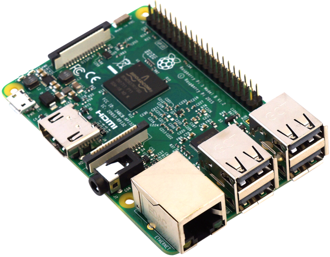
Raspberry Pi 3 B:

1.2 GHz BCM2837 64-bit ARM,
1 GB DDR2, WiFi,
100Base-T Ethernet

Plenty of OSes, e.g., Raspbian

I’m using Ubuntu Server 18.04 because Raspbian’s NFS server wasn’t compatible

Micro Center sells them



Ubuntu on Raspberry Pi

Network manager and file server with a 32 GB micro SD

Download (420 MB)

`ubuntu-18.04.2-preinstalled-server-arm64+raspi3.img.xz`

from

`https://www.ubuntu.com/download/iot/raspberry-pi-2-3`

Flash using your workstation:

```
# xzcat ubuntu-18.04.2*.img.xz | \
     sudo dd of=/dev/sdd bs=4M conv=fsync
```

“conv=fsync” makes it write blocks as it goes

Initial configuration of the Pi

Easiest to boot with HDMI and a USB keyboard

Login in with ubuntu/ubuntu; change password

Connect the Internet: easiest with Ethernet; WiFi needs SSID

Update everything

```
# apt update
# apt upgrade -y
```

Change /etc/hostname

```
piserver
```

Network configuration with Netplan

Change /etc/netplan/50-cloud-init.yaml; adjust SSID/password

```
network:
  version: 2
  renderer: networkd
  ethernets:
    eth0:
      dhcp4: no
      addresses: [192.168.1.1/24]
  wifis:
    wlan0:
      dhcp4: yes
      optional: true
      access-points:
        "FBI Surveillance Van":
          password: "xyzzy"
```

```
# netplan --debug apply
```

Our First Opponent: Sun SPARCClassic “Lunchbox”

Sun Microsystems, 1992

50 MHz microSPARC processor (32-bit)

72-pin 60 ns SIMMs

50-pin single-ended fast-narrow SCSI

10Base-T Ethernet + AUI

OpenBoot ROM (FORTH)

Cgthree video: 1150 × 900 8-bpp, 13W3 connector

Some VGA monitors can sync to it

We’re going to run this diskless from the Pi

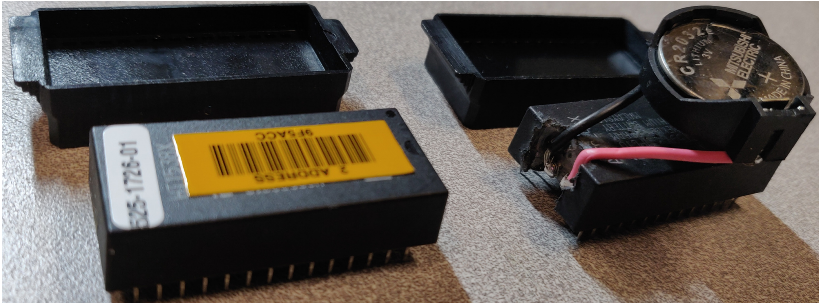
Repairing the M48T59Y

Every old Sun has this problem:

ST M48T59Y-70PC1U “Timekeeper SRAM”

Internal lithium battery dies after 20 years (but doesn’t leak)

Dremel + CR2032 socket + soldering-iron



Before

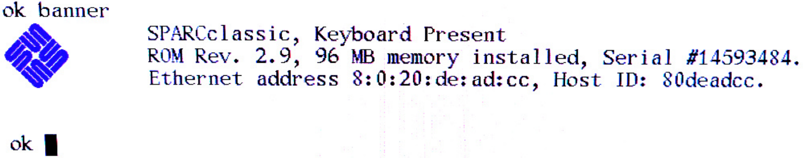
After

Re-initializing the NVRAM

Once replaced, reset the NVRAM contents, e.g., Ethernet address and checksum. At the ok (OpenBoot) prompt:

```
1 0 mkp
real-machine-type 1 mkp
 8 2 mkp  0 3 mkp  20 4 mkp  de 5 mkp
                   ad 6 mkp  cc 7 mkp
 0 8 mkp  0 9 mkp   0 a mkp   0 b mkp
de c mkp ad d mkp  cc e mkp
0 f 0 do i idprom@ xor loop f mkp
```

Back in business:



```
ok banner
          SPARCclassic, Keyboard Present
          ROM Rev. 2.9, 96 MB memory installed, Serial #14593484.
          Ethernet address 8:0:20:de:ad:cc, Host ID: 80deadcc.

ok
```

SPARCClassic Operating Systems

SunOS 1.0 – 4.1.4 (1983–1994) was Sun's BSD-based operating system. Sun switched to the System-V-derived Solaris ("SunOS 5.x") in 1992. The SPARCClassic runs both.

Unhelpfully, SunOS 4.1.4 was rebranded "Solaris 1.1.2"

Download (39M)

`Sun Solaris 1.1.2 - SunOS 4.1.4 [Sun SPARC].7z`

from

`https://winworldpc.com/product/sun-solaris/1x`

Unpack and mount on the Pi

```
# apt install -y p7zip
# mkdir /mnt/cdrom
# 7zr e Sun*1.1.2*7z */*.iso
# mount -o loop Solaris1_1_2.iso /mnt/cdrom
```

Reverse Address Resolution Protocol — RARP

Gives the Sun its IP address 192.168.1.10

```
# apt install -y rarpd
```

Add the SPARCClassic’s MAC address to /etc/ethers

```
08:00:20:DE:AD:CC sparcclassic
```

Add hostnames to /etc/hosts

```
192.168.1.1  piserver
192.168.1.10 sparcclassic
```

Respond to RARP requests on eth0 in /etc/default/rarpd

```
OPTS="-v -e eth0"
```

Restart the RARP server

```
# service rarpd restart
```

Trivial File Transfer Protocol — TFTP

Insecure file transfer protocol designed for bootstrapping

```
# apt install -y tftpd-hpa
```

Edit /etc/default/tftpd-hpa

```
TFTP_USERNAME="tftp"
TFTP_DIRECTORY="/tftpboot"
TFTP_ADDRESS=":69"
TFTP_OPTIONS="--address 192.168.1.1 --secure --verbose"
```

Create the TFTP root directory and restart

```
# mkdir /tftpboot
# service tftpd-hpa restart
```

The Sun Second-Stage Bootloader

Once it has its IP address, the Sun loads the second-stage bootloader via TFTP

Filename: IP address in hex + architecture name

192.168.1.10
`C0A8010A.SUN4M` ← requested filename

Copy the (102K) bootloader from archive on install CD:

```
# cd
# tar xf \
  /mnt/cdrom/export/exec/kvm/sun4m_sunos_4_1_4/kvm \
  ./stand/boot.sun4m
# cp stand/boot.sun4m /tftpboot/C0A8010A.SUN4M
```

Bootparamd

Sun’s RPC-based protocol for providing kernel command-line parameters; second-stage bootloader calls it

```
# apt install -y bootparamd
```

Add name of root directory and swap file to /etc/bootparams

```
sparcclassic \
  root=piserver:/export/sunos/sparcclassic/root/ \
  swap=piserver:/export/sunos/sparcclassic/swap
```

```
# service bootparamd restart
```

Create empty root directory and empty swapfile:

```
# mkdir -p /export/sunos/sparcclassic/root
# dd if=/dev/zero \
  of=/export/sunos/sparcclassic/swap \
  bs=1 count=1 seek=64M
```

Populate the root directory on the Pi

```
cd /export/sunos/sparcclassic/root
tar xf /mnt/cdrom/export/exec/proto_root_sunos_4_1_4
mkdir -p usr/kvm
cd usr/kvm
tar xf /mnt/cdrom/export/exec/kvm/sun4m_sunos_4_1_4/kvm
tar xf /mnt/cdrom/export/exec/kvm/sun4m_sunos_4_1_4/sys
cd ..
for f in /mnt/cdrom/export/exec/sun4_sunos_4_1_4/* \
         /mnt/cdrom/export/share/sunos_4_1_4/* ; do \
  tar xf $f ; done

# Link the kernel image to the root directory
cd /export/sunos/sparcclassic/root
ln -s usr/kvm/stand/vmunix

# Link init
cd /export/sunos/sparcclassic/root/sbin
ln -s ../usr/etc/init
```

Populate root directory continued...

```
# Populate /dev directory
cd /export/sunos/sparcclassic/root/dev
./MAKEDEV std
./MAKEDEV pty
./MAKEDEV win0

# Disable NIS/YP to avoid hang on boot
cd /export/sunos/sparcclassic/root/var
mv yp yp-disabled
```

Tell the kernel about / and /usr in /export/sunos/sparcclassic/root/etc/fstab

```
piserver:/export/sunos/sparcclassic/root / nfs rw 0 0
piserver:/export/sunos/sparcclassic/root/usr /usr nfs rw 0 0
```

IP addresses /export/sunos/sparcclassic/root/etc/hosts

```
192.168.1.1 piserver
192.168.1.10 sparcclassic
```

Network File System – NFS

Sun’s still-relevant protocol for mounting remote filesystems. Cf. Microsoft’s SMB

```
# apt install -y nfs-kernel-server
```

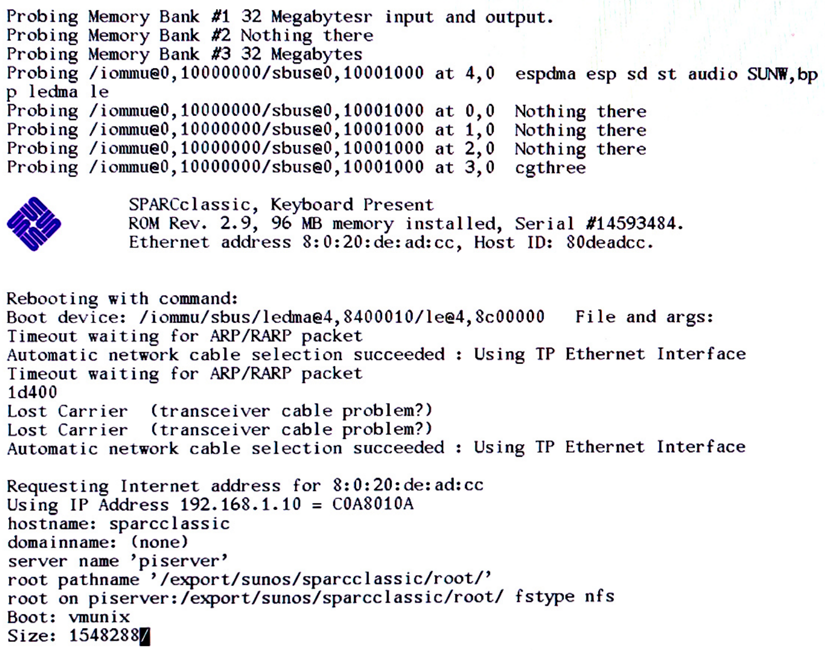
Place names of directories to serve in /etc/exports

```
/export/sunos \
   sparcclassic(rw,no_root_squash,no_subtree_check)
```

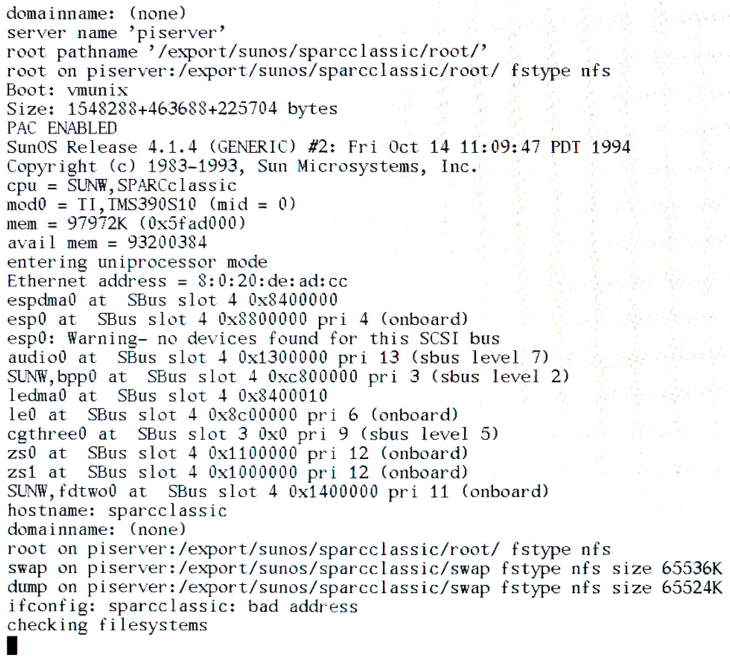
Enable the archaic NFS v2 in /etc/default/nfs-kernel-server

```
RPCNFSDOPTS="--nfs-version 2,3,4 --debug --syslog"
```

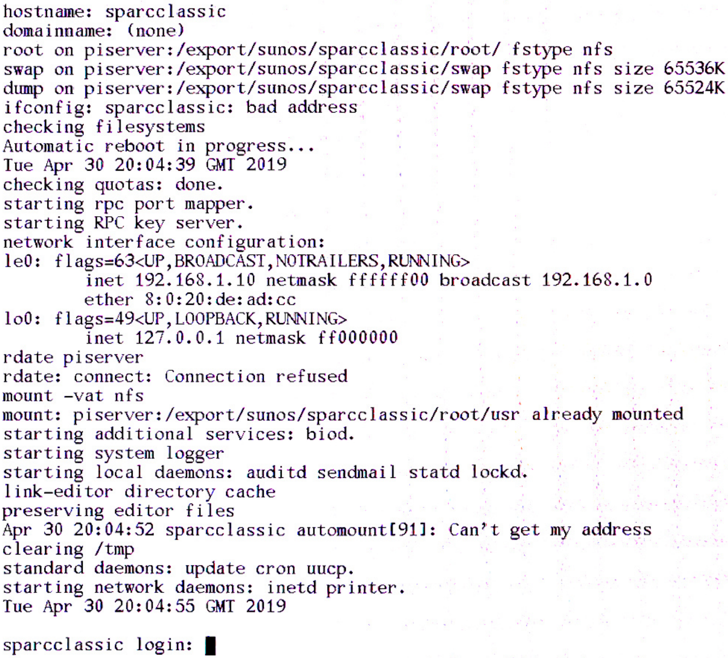
```
# service nfs-kernel-server restart
```



```
Probing Memory Bank #1 32 Megabytesr input and output.
Probing Memory Bank #2 Nothing there
Probing Memory Bank #3 32 Megabytes
Probing /iommu@0,10000000/sbus@0,10001000 at 4,0  espdma esp sd st audio SUNW,bp
p ledma le
Probing /iommu@0,10000000/sbus@0,10001000 at 0,0  Nothing there
Probing /iommu@0,10000000/sbus@0,10001000 at 1,0  Nothing there
Probing /iommu@0,10000000/sbus@0,10001000 at 2,0  Nothing there
Probing /iommu@0,10000000/sbus@0,10001000 at 3,0  cgthree

          SPARCclassic, Keyboard Present
          ROM Rev. 2.9, 96 MB memory installed, Serial #14593484.
          Ethernet address 8:0:20:de:ad:cc, Host ID: 80deadcc.


Rebooting with command:
Boot device: /iommu/sbus/ledma@4,8400010/le@4,8c00000   File and args:
Timeout waiting for ARP/RARP packet
Automatic network cable selection succeeded : Using TP Ethernet Interface
Timeout waiting for ARP/RARP packet
1d400
Lost Carrier  (transceiver cable problem?)
Lost Carrier  (transceiver cable problem?)
Automatic network cable selection succeeded : Using TP Ethernet Interface

Requesting Internet address for 8:0:20:de:ad:cc
Using IP Address 192.168.1.10 = C0A8010A
hostname: sparcclassic
domainname: (none)
server name 'piserver'
root pathname '/export/sunos/sparcclassic/root/'
root on piserver:/export/sunos/sparcclassic/root/ fstype nfs
Boot: vmunix
Size: 1548288
```



```
domainname: (none)
server name 'piserver'
root pathname '/export/sunos/sparcclassic/root/'
root on piserver:/export/sunos/sparcclassic/root/ fstype nfs
Boot: vmunix
Size: 1548288+463688+225704 bytes
PAC ENABLED
SunOS Release 4.1.4 (GENERIC) #2: Fri Oct 14 11:09:47 PDT 1994
Copyright (c) 1983-1993, Sun Microsystems, Inc.
cpu = SUNW,SPARCclassic
mod0 = TI,TMS390S10 (mid = 0)
mem = 97972K (0x5fad000)
avail mem = 93200384
entering uniprocessor mode
Ethernet address = 8:0:20:de:ad:cc
espdma0 at  SBus slot 4 0x8400000
esp0 at  SBus slot 4 0x8800000 pri 4 (onboard)
esp0: Warning- no devices found for this SCSI bus
audio0 at  SBus slot 4 0x1300000 pri 13 (sbus level 7)
SUNW,bpp0 at  SBus slot 4 0xc800000 pri 3 (sbus level 2)
ledma0 at  SBus slot 4 0x8400010
le0 at  SBus slot 4 0x8c00000 pri 6 (onboard)
cgthree0 at  SBus slot 3 0x0 pri 9 (sbus level 5)
zs0 at  SBus slot 4 0x1100000 pri 12 (onboard)
zs1 at  SBus slot 4 0x1000000 pri 12 (onboard)
SUNW,fdtwo0 at  SBus slot 4 0x1400000 pri 11 (onboard)
hostname: sparcclassic
domainname: (none)
root on piserver:/export/sunos/sparcclassic/root/ fstype nfs
swap on piserver:/export/sunos/sparcclassic/swap fstype nfs size 65536K
dump on piserver:/export/sunos/sparcclassic/swap fstype nfs size 65524K
ifconfig: sparcclassic: bad address
checking filesystems
█
```



```
hostname: sparcclassic
domainname: (none)
root on piserver:/export/sunos/sparcclassic/root/ fstype nfs
swap on piserver:/export/sunos/sparcclassic/swap fstype nfs size 65536K
dump on piserver:/export/sunos/sparcclassic/swap fstype nfs size 65524K
ifconfig: sparcclassic: bad address
checking filesystems
Automatic reboot in progress...
Tue Apr 30 20:04:39 GMT 2019
checking quotas: done.
starting rpc port mapper.
starting RPC key server.
network interface configuration:
le0: flags=63<UP,BROADCAST,NOTRAILERS,RUNNING>
        inet 192.168.1.10 netmask ffffff00 broadcast 192.168.1.0
        ether 8:0:20:de:ad:cc
lo0: flags=49<UP,LOOPBACK,RUNNING>
        inet 127.0.0.1 netmask ff000000
rdate piserver
rdate: connect: Connection refused
mount -vat nfs
mount: piserver:/export/sunos/sparcclassic/root/usr already mounted
starting additional services: biod.
starting system logger
starting local daemons: auditd sendmail statd lockd.
link-editor directory cache
preserving editor files
Apr 30 20:04:52 sparcclassic automount[91]: Can't get my address
clearing /tmp
standard daemons: update cron uucp.
starting network daemons: inetd printer.
Tue Apr 30 20:04:55 GMT 2019

sparcclassic login:
```

/var/log/syslog on the Pi (1/2)

RARP provides IP address:

```
rarpd[25086]: RARP request from 08:00:20:de:ad:cc on eth0
rarpd[25086]: RARP response to 08:00:20:de:ad:cc 192.168.1.10 on eth0
```

TFTP serves the second-stage bootloader

```
in.tftpd[22184]: RRQ from 192.168.1.10 filename C0A8010A.SUN4M
```

Bootparamd provides location of root filesystem

```
rpc.bootparamd: whoami got question for 192.168.1.10
rpc.bootparamd: This is host sparcclassic
rpc.bootparamd: Returning sparcclassic (none) 192.168.1.1
rpc.bootparamd: getfile got question for "sparcclassic" and file "root"
rpc.bootparamd: returning server:piserver
   path:/export/sunos/sparcclassic/root/ address: 192.168.1.1
```

NFS serves the root directory to provide the kernel

```
rpc.mountd[24925]: authenticated mount request from
   192.168.1.10:1023 for /export/sunos/sparcclassic/root (/export/sunos)
```

/var/log/syslog on the Pi (2/2)

Bootparamd reports swap (not dump); NFS serves swap

```
rpc.bootparamd: getfile got question for "sparcclassic" and file "swap"
rpc.bootparamd: returning server:piserver
   path:/export/sunos/sparcclassic/swap address: 192.168.1.1
```

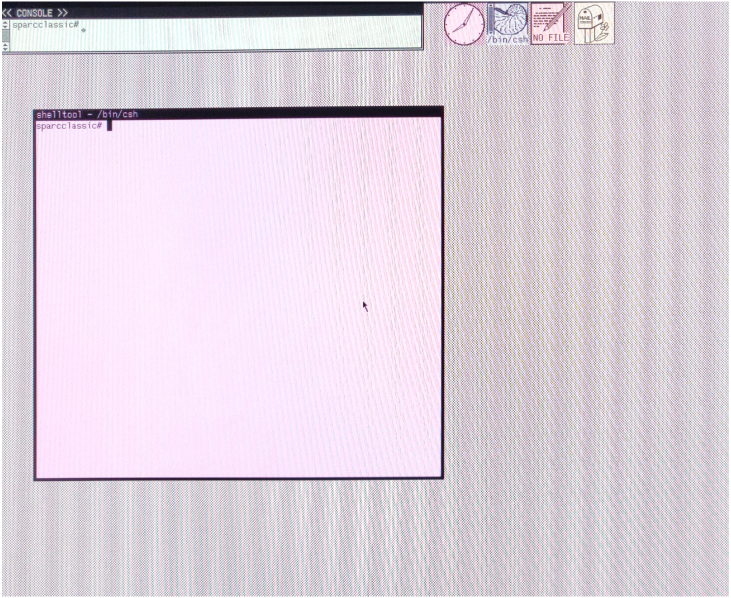
```
rpc.mountd[24925]: authenticated mount request from
   192.168.1.10:1021 for /export/sunos/sparcclassic/swap (/export/sunos)
```

```
rpc.bootparamd: getfile got question for "sparcclassic" and file "dump"
rpc.bootparamd: returning server: path: address: 0.0.0.0
```

Init runs and re-mounts / and /usr

```
rpc.mountd[24925]: authenticated mount request from 192.168.1.10:620
   for /export/sunos/sparcclassic/root/usr (/export/sunos)
rpc.mountd[24925]: authenticated mount request from 192.168.1.10:624
   for /export/sunos/sparcclassic/root (/export/sunos)
rpc.mountd[24925]: authenticated mount request from 192.168.1.10:625
   for /export/sunos/sparcclassic/root/usr (/export/sunos)
```

sunview



```
<< CONSOLE >>
sparcclassic#
```

```
shelltool - /bin/csh
sparcclassic#
```

Our Second Opponent: SGI O2 “Toaster”

Silicon Graphics, 1996

180 MHz MIPS R5000 processor (32-bit)

Proprietary 239-pin DIMMs

UltraWide SCSI drives

100Base-T Ethernet

1280 × 1024 VGA video

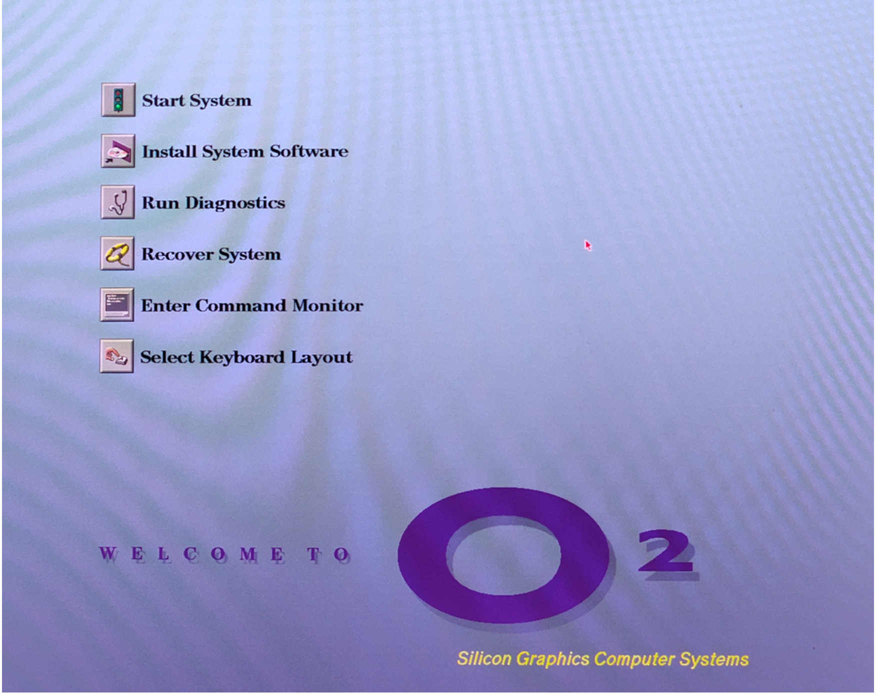
SGI’s Imaging and Compression Engine

PS/2 Keyboard and Mouse

ESC on boot brings up service menu

No keyboard boots into serial console

We’re going to install IRIX 6.5.22 over the network


Start System
Install System Software
Run Diagnostics
Recover System
Enter Command Monitor
Select Keyboard Layout
WELCOME TO
O2
Silicon Graphics Computer Systems

Set the O2’s IP Address via Command Monitor

Remove the keyboard and use serial port or “Esc” on boot

```
Cannot connect to keyboard -- check the cable.
Cannot open keyboard() for input

                   Running power-on diagnostics...

System Maintenance Menu

1) Start System
2) Install System Software
3) Run Diagnostics
4) Recover System
5) Enter Command Monitor

Option? 5
Command Monitor.  Type "exit" to return to the menu.
> resetenv
> setenv netaddr 192.168.1.11
```

BOOTP for Network Configuration

On the Pi,

```
# apt install -y isc-dhcp-server
```

Configure BOOTP for the SGI in /etc/dhcp/dhcpd.conf

```
subnet 192.168.1.0 netmask 255.255.255.0 {
 allow bootp;
 ignore unknown-clients;
}

host sgio2 {
  hardware ethernet 08:00:69:02:b3:bc;
  fixed-address 192.168.1.11;
}
```

```
# service isc-dhcp-server restart
```

Mount the install tools for TFTP

Configure tftpd-hpa as before for Sun

sash = Stand Alone SHell

ARCS = MIPS-32 architecture

Download

`IRIX 6.5 Installation Tools June 1998.img`

from

`https://archive.org/download/sgi_IRIX_6.5_Installation_Tools_June_1998`

```
# mkdir /tftpboot/irix
# mount -o loop IRIX*.img /tftpboot/irix
```

Makes available the second-stage bootloader *sash*, the disk partitioner *fx*, and self-test program *ide*, along with the installer and miniroot.

Install RSH to serve install volumes

RSH is the insecure precursor to SSH. SGI’s installer uses it to access networked install media

```
# apt install -y rsh-server
# useradd -U sgi
# mkdir /home/sgi
# echo "192.168.1.11 root" > ~sgi/.rhosts
# chown -R sgi sgi
# chgrp -R sgi sgi
```

Download the install media

Download from

`https://winworldpc.com/product/irix/65`

IRIX 6.5 Foundation 1.7z
IRIX 6.5 Foundation 2.7z
IRIX Development Foundation 1.2 for IRIX 6.5.7z

`https://winworldpc.com/product/irix/6522`

IRIX 6.5.22 Applications November-2003.7z
IRIX 6.5.22 Overlay 1 of 3.7z
IRIX 6.5.22 Overlay 2 of 3.7z
IRIX 6.5.22 Overlay 3 of 3.7z

Unpack each with `7zr e` to extract the .iso files

`https://archive.org/details/sgi_IRIX_6.5_Applications_June_1998`

IRIX 6.5 Applications June 1998.img

Mount the install media

Make them available to the *sgi* user, which will load them via *rsh* as root.

```
# mkdir ~sgi/found1 ~sgi/found1 ~sgi/apps0 ~sgi/devel1
# mkdir ~sgi/overlay1 ~sgi/overlay2 ~sgi/overlay3 ~sgi/apps1
# mount -o loop -t efs \
  IRIX-6.5-Foundation1.iso ~sgi/found1
# mount -o loop -t efs \
  IRIX-6.5-Foundation2.iso ~sgi/found2
# mount -o loop -t efs \
  "IRIX 6.5 Applications June 1998.img" ~sgi/apps0
# mount -o loop -t efs \
  IRIX_Development_Foundation_1.2.iso ~sgi/devel1
# mount -o loop -t efs \
  "IRIX 6.5.22 Overlay 1 of 3.iso" ~sgi/overlay1
# mount -o loop -t efs \
  "IRIX 6.5.22 Overlay 2 of 3.iso" ~sgi/overlay2
# mount -o loop -t efs \
  "IRIX 6.5.22 Overlay 3 of 3.iso" ~sgi/overlay3
# mount -o loop -t efs \
  "IRIX 6.5.22 Applications November-2003.iso" ~sgi/apps1
```

Run the Disk Partitioner (1/2)

Partition the drive with the *fx* disk partitioner

```
> bootp()irix/stand/fx.ARCS
Setting $netaddr to 192.168.1.11 (from server )
Obtaining irix/stand/fx.ARCS from server
93664+25632+7056+2804464+48784d+5808+8832 entry: 0x8fd4b0f0
Currently in safe read-only mode.
Do you require extended mode with all options available? (no)
SGI Version 6.5 ARCS BE  Apr 30, 1998
fx: "device-name" = (dksc)
fx: ctlr = (0)fx:  drive = (1)
...opening dksc(0,1,0)
dks0d1s10: volume header not valid
...drive selftest...OK
fx: Warning:  invalid label from disk driver, ignored
Scsi drive type == COMPAQ  BD146863B3      HPB6
...creating default bootinfo
...created default partitions, use /repartition menu to change
...creating default volume directory
```

Partitioning (2/2)

```
-- please choose one (? for help, .. to quit this menu)--
[exi]t       [d]ebug/     [l]abel/        [a]uto
[b]adblock/  [exe]rcise/  [r]epartition/
fx> label

-- please choose one (? for help, .. to quit this menu)--
[sh]ow/         [sy]nc          [se]t/          [c]reate/
fx/label> sync

writing label info to dksc(0,1,0)
```

Start the installer

```
> bootp()irix/stand/sashARCS
Setting $netaddr to 192.168.1.11 (from server )
Obtaining irix/stand/sashARCS from server
130768+22320+3184+341792+48560d+4604+6816 entry: 0x8ffa60d0
Standalone Shell SGI Version 6.5 ARCS   Apr 29, 1998 (32 Bit)
sash: setenv tapedevice bootp()irix/dist/sa
sash: install
Copying installation program to disk.
Setting $netaddr to 192.168.1.11 (from server )
Obtaining irix/dist/sa(mr) from server
....... 10% ....... 20% ....... 30% ....... 40% ....... 50%
....... 60% ....... 70% ....... 80% ....... 90% ....... 100%

Copy complete
```

irix/dist/sa is the installer program

The installer copies a miniroot

Downloads a miniroot via TFTP onto the swap partition

irix/dist/miniroot/inix.IP32 is the miniroot filesystem image for the O2's architecture, which includes a kernel

```
Setting $netaddr to 192.168.1.11 (from server )
Obtaining irix/dist/miniroot/unix.IP32 from server
Setting $netaddr to 192.168.1.11 (from server )
Obtaining irix/dist/miniroot/unix.IP32 from server
3003608+266560 entry: 0x80003af0
IRIX Release 6.5 IP32 Version 05190110 System V
Copyright 1987-1998 Silicon Graphics, Inc.
All Rights Reserved.
```

The installer starts

```
root on
  /hw/node/io/pci/1/scsi_ctlr/0/target/1/lun/0/disk/partition/1/block
  boot swap file on /dev/swap swplo 63000
WARNING: Cannot load runtime symbol table from bootp'ed kernel.
         Loadable modules will not be registered or loaded.
Creating miniroot devices, please wait...

Current system date is Tue Apr 30 19:09:24 PDT 2019

Mounting file systems:
/dev/dsk/dks0d1s0: Invalid argument
No valid file system found on: /dev/dsk/dks0d1s0
This is your system disk: without it we have nothing
on which to install software.

Make new file system on /dev/dsk/dks0d1s0 [yes/no/sh/help]: yes

About to remake (mkfs) file system on: /dev/dsk/dks0d1s0
This will destroy all data on disk partition: /dev/dsk/dks0d1s0.

        Are you sure? [y/n] (n): y
        Block size of filesystem 512 or 4096 bytes? 4096
```

The installer starts

```
Doing: mkfs -b size=4096 /dev/dsk/dks0d1s0
meta-data=/dev/rdsk/dks0d1s0     isize=256    agcount=137, agsize=2613
data     =                       bsize=4096   blocks=35810406, imaxpct
         =                       sunit=0      swidth=0 blks
log      =internal log           bsize=4096   blocks=1000
realtime =none                   extsz=65536  blocks=0, rtextents=0
unwritten flagging is enabled

Trying again to mount /dev/dsk/dks0d1s0 on /root.

UX:make: INFO: ‘scsi’ is up to date.
    /dev/miniroot            on  /
    /dev/dsk/dks0d1s0        on  /root

Invoking software installation.
```

Select the installation media

```
What is the hostname (system name) of your machine? sgio2
What is the netmask for 192.168.1.11?
Press Enter for the IP class default [0xffffff00]:
Starting network with hostname: sgio2, at ip address: 192.168.1.11
```

At the Inst> prompt

```
from sgi@192.168.1.1:found1/dist
open sgi@192.168.1.1:found2/dist
open sgi@192.168.1.1:devel1/dist
open sgi@192.168.1.1:overlay1/dist
sgi@192.168.1.1:overlay2/dist
sgi@192.168.1.1:overlay3/dist
sgi@192.168.1.1:apps1/dist
```

Run the installation

```
If you plan to install from another distribution, either choose from t
list below or enter the name of a different distribution.
This will allow you to make selections from two or more distributions
before starting the install.

Enter "done" if you are ready to proceed with the installation now.

 1 sgi@192.168.1.1:overlay3/dist
 2 sgi@192.168.1.1:overlay2/dist
 3 sgi@192.168.1.1:overlay1/dist
 4 sgi@192.168.1.1:devel1/dist/dist6.5
 5 sgi@192.168.1.1:devel1/dist
 6 sgi@192.168.1.1:found2/dist
 7 sgi@192.168.1.1:found1/dist
 8 done (no action, return to inst menu)
```

Resolve conflicts and go

```
Inst> install *
Inst> conflicts 1a 2a 3a 4a 5a 6a 7a
Inst> go
... hours pass ...
Inst> quit
```

/var/log/syslog on the Pi

BOOTP provides IP address:

```
dhcpd[16492]: BOOTREQUEST from 08:00:69:02:b3:bc via eth0
dhcpd[16492]: BOOTREPLY for 192.168.1.11 to sgio2
   (08:00:69:02:b3:bc) via eth0
```

TFTP provides second stage bootloader, the installer, and miniroot

```
in.tftpd[22362]: RRQ from 192.168.1.11 filename irix/stand/sashARCS
in.tftpd[22363]: RRQ from 192.168.1.11 filename irix/dist/sa
in.tftpd[22364]: RRQ from 192.168.1.11 filename irix/dist/miniroot/unix.IP32
```

RSH logins look like

```
systemd[1]: Created slice User Slice of sgi.
systemd[1]: Starting User Manager for UID 1001...
systemd[1]: Started Session c21 of user sgi.
```

Conclusions

Every config. file line represents an hour of frustration

Tried Solaris 2.3, but building root filesystem from install media not obvious. Could netinstall using similar recipe.

Wanted to do all this with a wireless router hacked to run OpenWRT, but OpenWRT doesn’t support RARP, Bootparam

But I highly recommend OpenWRT. Could be used to PXE boot more modern machines

Acknowledgements/References

Sun network booting and install

http://sites.inka.de/pcde/site/documentation_files/
sunos_network_boot.html
https://github.com/halfmanhalftaco/sunboot

SGI network installation

http://techpubs.spinlocksolutions.com/irix/
remote-irix-6.5-installation-from-linux.html
https://github.com/halfmanhalftaco/irixboot
https://github.com/unxmaal/booterizer