2.3ghz i5 4200u (dual core, hyperthreading)
4ghz DDR3L (soldered)
Sandisk U100 16GB SSD
HP NC365T quad port GBE NIC
1x USB3.0, 1x USB2.0, 1x Micro-HDMI

Mobo: From Lenovo Yoga 2 13"

- Remove power button protrusion from motherboard (scissors! X) and solder a jumper for power switch
- Solder jumper for Power LED from unpopulated HDD connector 5v
- Solder USB header to USB lines normally going to SD card/USB/audio daughterboard
    - Two more USB ports available: card reader USB lines, and another port on M.2 (LAN)
        - Not populated because should never need them, and may run power budget over
    - Removed the inductor from the USB lines to solder to the pads.
    - Power pulled from daughterboard USB power (hoping it may have USB overpower protection)
- NIC
    - HP NC365T (intel I340 T4)
    - Intel 82580 controller
    - Claims to operate at PCI-E 2.0, 1x, unlike the PRO/1000 adapters
        - Both HP data sheet and 82580 datasheet say it ought to
    - ~5 watts (quad port)
    - Confirmed: will operate at PCI-E 2.0, 1x, without issues!
    - May throttle due to bandwidth if all 4 ports were slinging max rates
        - PCI-E 2.0: ~500MiB/s per lane
        - 1GBE: ~110MiB/s per port
    - Created replacement bracket model & printed
    - Card has 3 supports: Two on top of ports, one screw. Fine in normal casing, maybe not in mine, so printed an additional support and welded to it bracket.
- Fans
    - 13.5k RPM 40x28 delta server fans
    - These babies sing!
    - Claim .6A peak, actually .45A (@12v)
    - Best I can tell, these fans run their drivers directly off the PWM signal, so 7 mA drive strength is required (@5v).
    - Also, the tach signal is a hot mess (seems to have PWM mixed in??)
    - Minimum PWM voltage is 4.2v, any lower and they won't run.
    - Attiny85 fan driver
        - 5v, gnd, pwm from fan header
        - Level conversion (3.3v in, 5v out) as fans need 5v (or more) logic with a decent amount of drive strength
        - 32khz PWM, as 8khz is horribly noisy with these fans
        - Mobo would also turn off fans, this prevents that.
        - Spin up fans, then...
        - PWM out = constrain(PWM in + 20, 40, 100)
- Modify bios to remove Wifi module whitelisting
    - Dump bios with test clip and ch341a programmer
    - Use UEFItool to find the error message, and extract just that module
    - Load module in IDA64, find error message, backtrack to find unique call to that function
    - hex edit to module file, nop'ing out the call to that function
    - Reassemble bios via uefitool and flash
    - Tested with a wifi module I knew wouldn't work previously- works!

- - Unlocked the BIOS secret menus while I was at it. Nothing terribly applicable, but neat all the same. This one [I had to look up](#), rather than derive it myself.
- Pentium heatsink
  - Bent paperclips to hold it down! Woo!
  - 50 deg C peak load temp (non-AVX)
- Fabricate a sata cable from spare parts
  - The unit came with a slim hdd with a proprietary connector, originally, and I didn't even have that cable to work with, so had to reverse engineer it.
  - Turns out SATA is super sensitive to noise, would not work reliably until sata pairs were twisted.
  - Seems I might have been able to buy one…? Oh well!
- Sony Laptop 45W PSU used instead of original due to size constraints
  - Absolute worst case loading on every single part would put it right at 45W or a little over
  - However, these PSUs are good for 50W (at least; short duration), and will be actively cooled
  - Practical load power is <15W
  - Delta, 2.3A, 19.5V, green power LED
  - ABS casing! YAY!
    - Welded mounting tabs to side and rear
- Casing
  - Printed in 2 parts, due to build area size
  - Printed rear/front faces against bed: bottom down had severe cracking.
  - There was some cracking printing upright, but I was able to repair it with ABS goop.
  - [Heatserts used for all threaded parts](#)
    - These standoffs are stupid strong. How HP manages to screw these up is beyond me.
    - Oh, wait, no it isn't: HP is stupid cheap, and uses the bare minimum amount of plastic
    - No wonder they break off so often.
  - 38 screws used, total
  - Some parts printed separately and welded on due to interior layout being somewhat in flux, and/or would be difficult to print adequately in that orientation
    - Cable management hooks
    - M.2 standoff
    - SSD standoffs
    - Ethernet support
    - DC-DC module mount
- [12V DC-DC](#)
  - Nifty! 12$ for 6.
  - You probably aren't getting 3A out of one of these without heatsinking/airflow. But, for my worst-case 1.5A or so, they are enough.
  - Adequate efficiency: 86% going 19v to 12v.
  - Super bright blue power LED: sigh.
  - I really should have got some small power connectors for the 12v bus, so it could be disassembled.
- M.2 to PCI-E
  - What a mess!
  - [A pre-made adapter is $150](#) (marked up horribly at bplus), as it was a low demand item and the various chinese places that made them no longer make them. Also, terrible form factor for what I'm doing.
  - A M.2 breakout board is $80 - thanks but no thanks.
  - Could get my own made at oshpark (0.8mm PCB!), but 2-3 week turnaround time, plus it would need to be designed.
  - Soldering directly - yeah no
  - **[BCM94360CS2/BCM943224 12+6 Pin Wireless Card To NGFF Key A/E Adapter For Mac OS](#)**
    - Used for adapting mac wifi modules to M.2, for hackintoshes.

- The mac header is 18 pins and has every single pin I need, at a much more friendly spacing for hand soldering
- Pull the mac connector off and cut it to length, then solder a hand-made PCIE riser to it.
    - Port off a dead mobo, with end dremeled off to allow larger cards
    - IDE 32 gauge ribbon wire
- Relay off 3.3v to switch 12v on/off. Probably not required, but just in case...
- $19, all told
- Except shipping has been terrible: still waiting as of 3/31 (ordered 3/8).
- Should have made my own PCB….
- Received adapter...finally…. on 4/5/17. Assembled, it works!

- SSD
    - Sandisk Extreme
        - Actually a sandisk pSSD/u100 behind a sata to usb bridge
        - Was going to adapt to sata, however, was not able to get a stable link at SATA III speeds. May have been caused by removing decoupling capacitors.
        - Interestingly, have to poke a USB data line for the sata bridge to bring the SSD portion online. Must be an enable pin somewhere.
    - HP 689057-001 / Apacer 16GB MLC module
        - Used in thin clients.
        - More a flash drive than an SSD: no trim, barely any SMART, etc.
        - Pretty terrible: 75mb/s seq read, 20mb/s seq write.
        - 4k random read IOPS: ~4k (only redeeming factor), 263 4k random write.
        - Nice and small, however, and suitable for this task
        - Unfortunately, does not seem to handle reboots at all: module would stop responding on reboot or shortly thereafter and not work until entire machine powered off.
    - Sandisk U100 16GB
        - SSD removed from casing - originally a sandisk u100 2.5", but they use the server format half-sata drive in a plastic box.
        - 10TBW endurance

http://www.ridetheclown.com/downloads/20170331_114513.jpg
http://www.ridetheclown.com/downloads/20170331_120345.jpg
http://www.ridetheclown.com/downloads/20170405_180856.jpg
http://www.ridetheclown.com/downloads/20170331_121219.jpg
http://www.ridetheclown.com/downloads/20170405_170603.jpg
http://www.ridetheclown.com/downloads/20170405_180559.jpg
http://www.ridetheclown.com/downloads/20170405_180900.jpg
http://www.ridetheclown.com/downloads/20170405_181742.jpg

Enclosure Stuff:
4 parts, two top, two bottom
3d print separate fan grills and mount the fans internally to the case front

Fans min 4mm above board level
Board thickness: 1mm
Case bottom standoffs: 3.5mm
.5mm from sides of case to mobo

Print with supports everywhere
Network card support from side of case

Fans:PWM info
500ohms at 12v to reliably power on
~5v logic high
4.2 absolute min high
15ma @ ~5v

http://www.ridetheclown.com/downloads/20170331_114513.jpg
http://www.ridetheclown.com/downloads/20170331_120345.jpg
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http://www.ridetheclown.com/downloads/20170405_181742.jpg

PCI-E Stuff

Pin	Side B Connector		Side A Connector	
#	Name	Description	Name	Description
1	+12v	+12 volt power	PRSNT#1	Hot plug presence detect
2	+12v	+12 volt power	+12v	+12 volt power
3	+12v	+12 volt power	+12v	+12 volt power
4	GND	Ground	GND	Ground
5	SMCLK	SMBus clock	JTAG2	TCK
6	SMDAT	SMBus data	JTAG3	TDI
7	GND	Ground	JTAG4	TDO
8	+3.3v	+3.3 volt power	JTAG5	TMS
9	JTAG1	+TRST#	+3.3v	+3.3 volt power
10	3.3Vaux	3.3v volt power	+3.3v	+3.3 volt power
11	WAKE#	Link Reactivation	PWRGD	Power Good
Mechanical Key				
12	RSVD	Reserved	GND	Ground
13	GND	Ground	REFCLK+	Reference Clock Differential pair
14	HSOp(0)	Transmitter Lane 0, Differential pair	REFCLK-	Reference Clock Differential pair
15	HSOn(0)	Transmitter Lane 0, Differential pair	GND	Ground
16	GND	Ground	HSIp(0)	Receiver Lane 0, Differential pair
17	PRSNT#2	Hotplug detect	HSIn(0)	Receiver Lane 0, Differential pair
18	GND	Ground	GND	Ground

Pin	Side B	Side A	Description
1	+12 V	PRSNT1#	Must connect to farthest PRSNT2# pin
2	+12 V	+12 V	Main power pins
3	+12 V	+12 V	
4	Ground	Ground	
5	SMCLK	TCK	SMBus and JTAG port pins
6	SMDAT	TDI	
7	Ground	TDO	
8	+3.3 V	TMS	
9	TRST#	+3.3 V	
10	+3.3 V aux	+3.3 V	Standby power
11	WAKE#	PERST#	Link reactivation; fundamental reset
Key notch			
12	CLKREQ#	Ground	Request running clock
13	Ground	REFCLK+	Reference clock differential pair
14	HSOp(0)	REFCLK−	Lane 0 transmit data, + and −
15	HSOn(0)	Ground	
16	Ground	HSIp(0)	Lane 0 receive data, + and −
17	PRSNT2#	HSIn(0)	
18	Ground	Ground	

Apple PIN#	Function
P1	3.3V (Wi-Fi)
P2	LED_WLAN#
P3	GND
P4	PETp0
P5	PETn0
P6	GND
P7	REFCLK+
P8	REFCLK-
P9	GND
P10	PERp0
P11	PERn0
P12	GND
	Mechanical Key
P13	WAKE#
P14	PERST#
P15	CLKREQ#
P16	USB_D-
P17	USB_D+
P18	3.3V (Bluetooth)

© Skvo

2+6PIN

Side B				Side A		
1	+12v			1	N/C	
2	+12v			2	+12v	
3	+12v			3	+12v	
4	GND			4	GND	
5	N/C			5	N/C	
6	N/C			6	N/C	
7	GND			7	N/C	
8	+3.3v			8	N/C	
9	N/C			9	+3.3v	
10	+3.3v			10	+3.3v	
11	WAKE#			11	PERST#	
KEY				KEY		
12	CLKREQ#			12	GND	
13	GND			13	REFCLK+	
14	PETp0	TX		14	REFCLK-	
15	PETn0	TX		15	GND	
16	GND			16	PER0	RX
17	N/C			17	PERn0	RX
18	GND			18	GND	

(Figure M2-A, the key in the pin8-pin15. With PCIe x2, NFC, Display Port and USB 2.0 channel)

Pin (left)	Signal (left)	Signal (right)	Pin (right)
		GND	75
74	3.3Vaux	REFCLKN1	73
72	3.3Vaux	REFCLKP1	71
70	PEWake1# (IO)(0/3.3V)	GND	69
68	CLKREQ1# (IO)(0/3.3V)	PERn1	67
66	PERST1# (O)(0/3.3V)	PERp1	65
64	GPIO0 NFC Reset# (MGPIO7)(O)(0/3.3V)	GND	63
62	NFC I2C IRQ (MGPIO5)(I)(0/3.3)	PETn1	61
60	NFC I2C SM CLK (O)(0/3.3)	PETp1	59
58	NFC I2C SM DATA (IO)(0/3.3)	GND	57
56	W_DISABLE#1 (O)(0/3.3V)	PEWake0# (IO)(0/3.3V)	55
54	Reserved/W_DISABLE#2 (O)(0/3.3V)	CLKREQ0# (IO)(0/3.3V)	53
52	PERST0# (O)(0/3.3V)	GND	51
50	SUSCLK(32kHz) (O)(0/3.3V)	REFCLKN0	49
48	COEX1 (?)(0/1.8V)	REFCLKP0	47
46	COEX2 (?)(0/1.8V)	GND	45
44	COEX3 (?)(0/1.8V)	PERn0	43
42	CLink CLK	PERp0	41
40	CLink DATA	GND	39
38	CLink RESET (O)(0/3.3V)	PETn0	37
36	GND	PETp0	35
34	DP_ML0p	GND	33
32	DP_ML0n	DP_HPD (O)(0/3.3V)	31
30	GND	GND	29
28	DP_ML1p	DP_ML2p	27
26	DP_ML1n	DP_ML2n	25
24	GND	GND	23
22	DP_AUXp	DP_ML3p	21
20	DP_AUXn	DP_ML3n	19
18	GND	GND	17
16	LED#2 (I)(OD)	Key	
	Key	Key	
	Key	Key	
	Key	Key	
	Key	GND	7
6	LED#1 (I)(OD)	USB_D-	5
4	3.3Vaux	USB_D+	3
2	3.3Vaux	GND	1

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(Figure M2-B, the key in the pin12-pin19. With SIM card, audio, PCIe 2.0, SATA and USB 3.0 channel multiplexing channel, etc.)

Pin	Signal	Signal	Pin
		USB3.0 IND (OC-USB3.0/GND-Other)	75
74	3.3Vaux	GND	73
72	3.3Vaux	GND	71
70	3.3Vaux	PEDET (OC-PCIe/GND-SATA)	69
68	SUSCLK(32kHz) (O)(0/3.3V)	Reset# (O)(0/1.8V)	67
66	SIM Detect (O)	ANTCTL3 (I)(0/1.8V)	65
64	COEX1 (?)(0/1.8V)	ANTCTL2 (I)(0/1.8V)	63
62	COEX2(?)(0/1.8V)	ANTCTL1 (I)(0/1.8V)	61
60	COEX3(?)(0/1.8V)	ANTCTL0 (I)(0/1.8V)	59
58	N/C	GND	57
56	N/C	REFCLKP	55
54	PEWake# (IO)(0/3.3V)	REFCLKN	53
52	CLKREQ# (IO)(0/3.3V)	GND	51
50	PERST# (O)(0/3.3V)	PERp0/SATA-A+	49
48	GNSS4(0/1.8V)	PERn0/SATA-A-	47
46	GNSS3(0/1.8V)	GND	45
44	GNSS2(0/1.8V)	PETp0/SATA-B-	43
42	GNSS1(0/1.8V)	PETn0/SATA-B+	41
40	GNSS0(0/1.8V)	GND	39
38	DEVSLP (O)(0/3.3V)	PERp1/USB3.0-Rx+/SSIC-RxP	37
36	UIM-PWR (I)	PERn1/USB3.0-Rx-/SSIC-RxN	35
34	UIM-DATA (IO)	GND	33
32	UIM-CLK (I)	PETp1/USB3.0-Tx+/SSIC-TxP	31
30	UIM-RESET (I)	PETn1/USB3.0-Tx-/SSIC-TxN	29
28	UIM-RFU (I/O)	GND	27
26	Audio3(0/1.8V)	Reserved (Future Expansion)	25
24	Audio2(0/1.8V)	Reserved (Future Expansion)	23
22	Audio1(0/1.8V)	WWAN/SSD IND (GND-WWAN/OC-SSD)	21
20	Audio0(0/1.8V)	Key	
	Key	Key	
	Key	Key	
	Key	Key	
	Key	GND	11
10	LED#1/DAS/DSS# (I)(OD)	USB_D-	9
8	W_DISABLE#1 (O)(0/3.3V)	USB_D+	7
6	Full_Card_Power_Off# (O)(0/1.8V)	GND	5
4	3.3Vaux	GND	3
2	3.3Vaux	Presence IND (GND)	#911165

(Figure M2-E, the key in the pin24-pin31. With PCIe x2, NFC, SDIO, PCM, USB 2.0 channel, etc.)

Pin	Signal		Signal	Pin
			GND	75
74	3.3Vaux		RESERVED	73
72	3.3Vaux		RESERVED	71
70	RESERVED		GND	69
68	RESERVED		Reserved/2nd Lane PERn1	67
66	RESERVED		Reserved/2nd Lane PERp1	65
64	GPIO0 NFC Reset# (MGPIO7)(O)(0/3.3V)		GND	63
62	NFC I2C IRQ (MGPIO5)(I)(0/3.3)		Reserved/2nd Lane PETn1	61
60	NFC I2C SM CLK (O)(0/3.3)		Reserved/2nd Lane PETp1	59
58	NFC I2C SM DATA (IO)(0/3.3)		GND	57
56	W_DISABLE#1 (O)(0/3.3V)		PEWake0# (IO)(0/3.3V)	55
54	Reserved/W_DISABLE#2 (O)(0/3.3V)		CLKREQ0# (IO)(0/3.3V)	53
52	PERST0# (O)(0/3.3V)		GND	51
50	SUSCLK(32kHz) (O)(0/3.3V)		REFCLKN0	49
48	COEX1 (?)(0/1.8V)		REFCLKP0	47
46	COEX2(?)(0/1.8V)		GND	45
44	COEX3(?)(0/1.8V)		PERn0	43
42	CLink CLK		PERp0	41
40	CLink DATA		GND	39
38	CLink RESET (O)(0/3.3V)		PETn0	37
36	UART CTS (O)(0/1.8V)		PETp0	35
34	UART RTS (I)(0/1.8V)		GND	33
32	UART Tx (O)(0/1.8V)		Key	
	Key		Key	
	Key		Key	
	Key		Key	
	Key		SDIO Reset(O)(0/1.8V)	23
22	UART Rx (I)(0/1.8V)		SDIO Wake(I)(0/1.8V)	21
20	UART Wake (I)(0/3.3V)		SDIO DAT3(IO)(0/1.8V)	19
18	GND		SDIO DAT2(IO)(0/1.8V)	17
16	LED#2 (I)(OD)		SDIO DAT1(IO)(0/1.8V)	15
14	PCM_OUT (I)(0/1.8V)		SDIO DAT0(IO)(0/1.8V)	13
12	PCM_IN (O)(0/1.8V)		SDIO CMD(IO)(0/1.8V)	11
10	PCM_SYNC (OI)(0/1.8V)		SDIO CLK(O)(0/1.8V)	9
8	PCM_CLK (OI)(0/1.8V)		GND	7
6	LED#1 (I)(OD)		USB_D-	5
4	3.3Vaux		USB_D+	3
2	3.3Vaux		GND	

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(Figure M2-M, the key in the pin59-pin66. With PCIe x4 and SATA multiplex channel)

Pin	Signal	Signal	Pin
		GND	75
74	3.3Vaux	GND	73
72	3.3Vaux	GND	71
70	3.3Vaux	PEDET (OC-PCIe/GND-SATA)	69
68	SUSCLK(32kHz) (O)(0/3.3V)	N/C	67
	Key	Key	
	Key	Key	
	Key	Key	
	Key	Key	
58	N/C	GND	57
56	N/C	REFCLKP	55
54	PEWake# (IO)(0/3.3V) or N/C	REFCLKN	53
52	CLKREQ# (IO)(0/3.3V) or N/C	GND	51
50	PERST# (O)(0/3.3V) or N/C	PERp0/SATA-A+	49
48	N/C	PERn0/SATA-A-	47
46	N/C	GND	45
44	N/C	PETp0/SATA-B-	43
42	N/C	PETn0/SATA-B+	41
40	N/C	GND	39
38	DEVSLP (O)(0/3.3V)	PERp1	37
36	N/C	PERn1	35
34	N/C	GND	33
32	N/C	PETp1	31
30	N/C	PETn1	29
28	N/C	GND	27
26	N/C	PERp2	25
24	N/C	PERn2	23
22	N/C	GND	21
20	N/C	PETn2	19
18	3.3Vaux	PETp2	17
16	3.3Vaux	GND	15
14	3.3Vaux	PERp3	13
12	3.3Vaux	PERn3	11
10	DAS/DSS# (I)(OD)	GND	9
8	N/C	PETn3	7
6	N/C	PETp3	5
4	3.3Vaux	GND	3
2	3.3Vaux	GND	#9111165