



HACKtheSHIP

An Overview of Shipboard ICS Cybersecurity

or

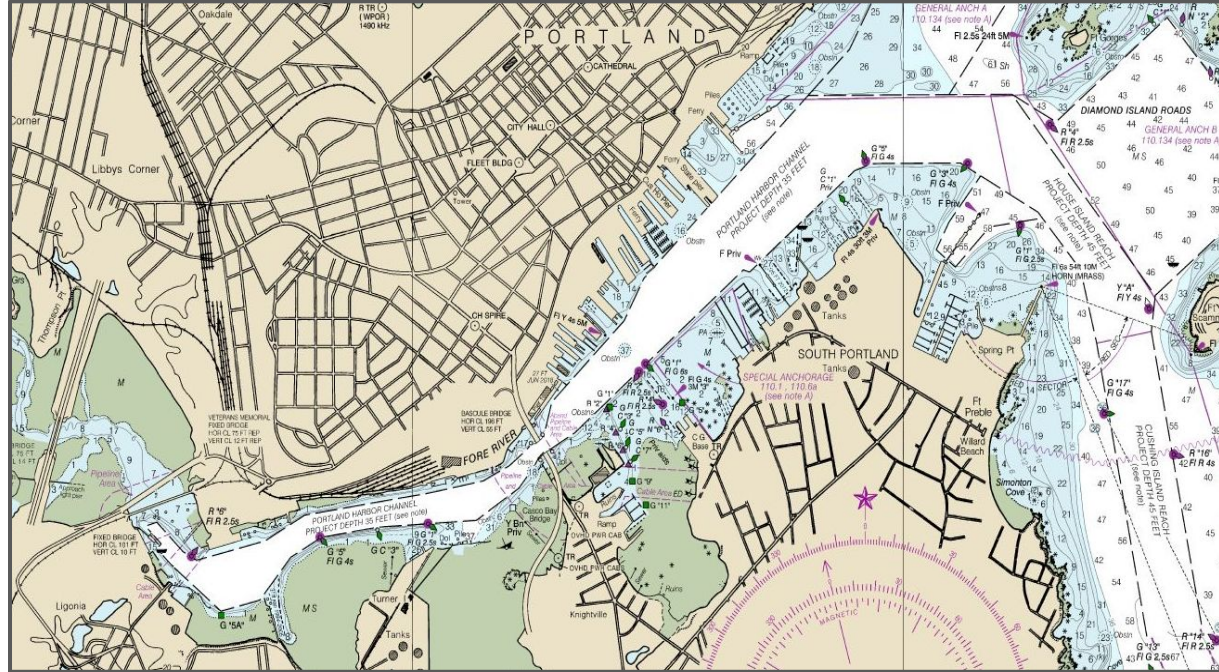
The Security, Functionality, Usability Triangle Gone Wrong

LTJG Josh Moss

Coast Guard Cyber Command



Merchant Ship and Channel





IT Network

1. Multi-Function Display
2. Ethernet Port Expander
3. Wireless Remote
4. LTE Capable Router

Voyage Network

1. Sensor Display
2. VHF Radio
3. Wind Sensor
4. Radar
5. Assorted Antennae
6. 9-Axis Heading Sensor

Engineering Network

1. Helm Control
2. NMEA2000 Junction Box
3. Course Computer Unit
4. Depth & Speed Sensor
5. Electronic Control Unit
6. Rudder Feedback Unit

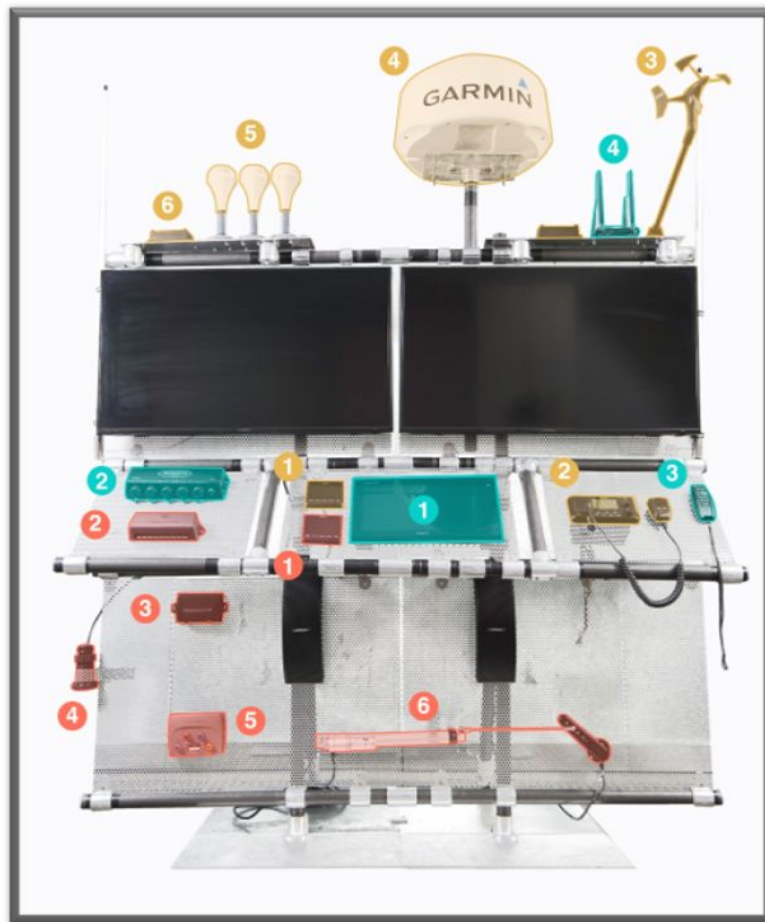


Figure 1: TRUDI 2.0 Components



Example NMEA 2000 Network

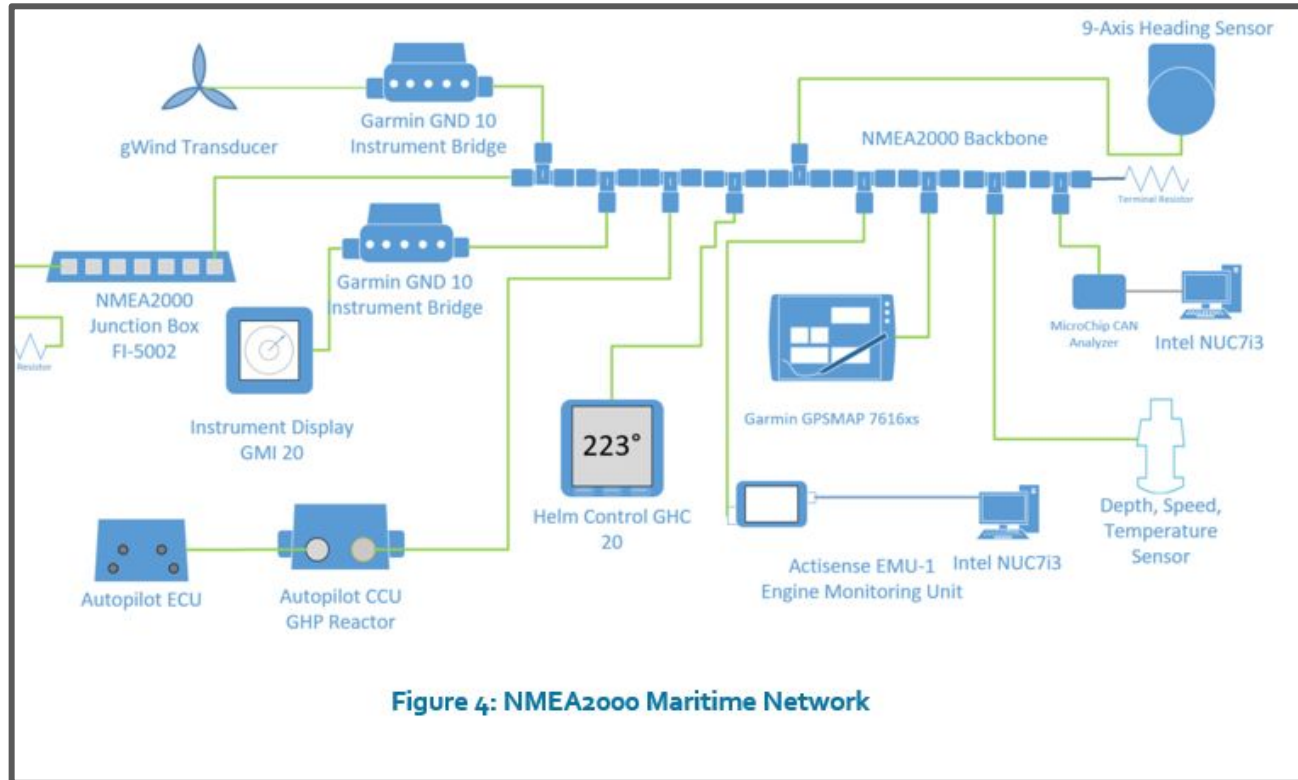


Figure 4: NMEA2000 Maritime Network



Carrier Area Network (CAN)

```
$SDDBT,21.8,f,6.7,M,3.6,F*39
$SDDBK,21.8,f,6.7,M,3.6,F*26
$SDDBS,21.8,f,6.7,M,3.6,F*3E
!AIVD0,2,1,9,A,57Paewh00001<To7;?@pLD5<Tl00000000000000U1@:552D?R2TnA3QF,0*23
!AIVD0,2,2,9,A,@000000000000002,2*5D
$GPRMC,153449.023,A,4042.63,N,07403.40,E,15.8,54.4,080919,,,*23
$IIVHW,54.4,T,54.4,M,8.1,N,15.1,K*69
$IIHDT,54.4,T*17
$GPGLL,4042.63,N,07403.40,E,153449.023,A*38
$GPGGA,153449.023,4042.63,N,07403.40,E,1,4,3.5,2.0,M,,,*,33
$GPGSA,A,3,8,11,15,22,,,,,,,,,1.5,3.5,4.2*0A
$GPZDA,153449.023,08,09,2019,-04,00*7B
!AIVD0,1,1,,A,17PaewhP2NUC0C4GBoEj81eR0000,0*6F
$WIMWV,1.3,T,8.1,N,A*2E
```

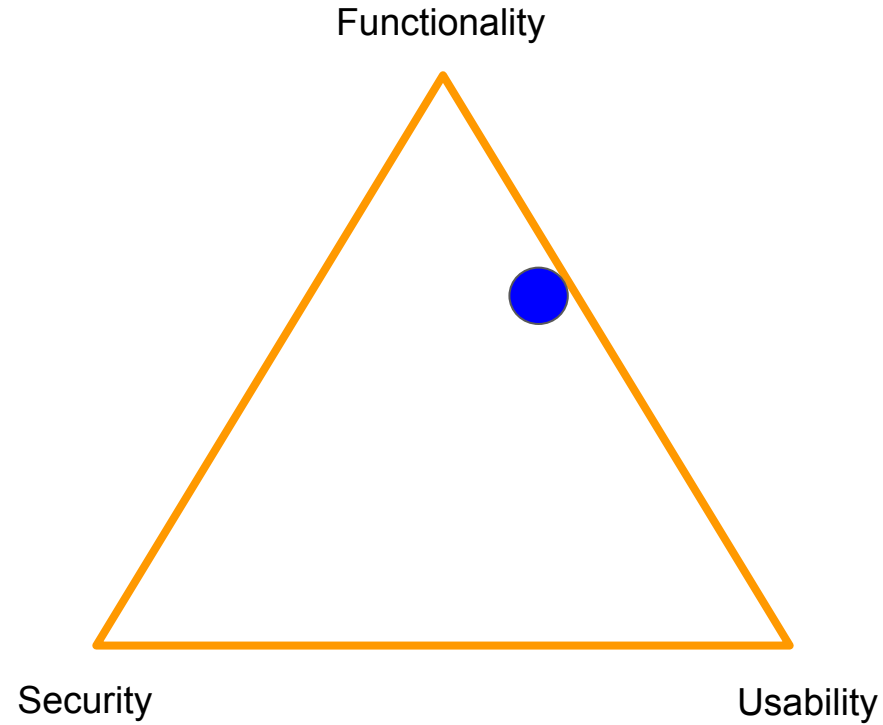
Plaintext

No Authentication

No Validation



What Does Your Ship Look Like?





How To Hack a Ship





Attack the IP Network First





Phishing Works Too

captain@lngshipping.com

New Port Protocols - Please Acknowledge

Captain,

There are some new protocols for the LNG Terminal at South Portland.

Please visit the [arrivals site](#) and acknowledge your crew's compliance.

Thank you,



Vulnerabilities Found on the Network

WEP wifi network* - Probably the worst offender

Telnet running

Weblogins over port 80 - insecure communications

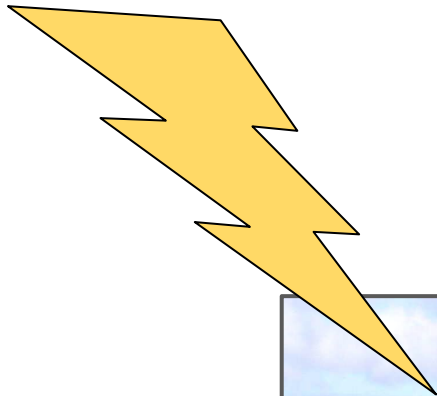
Out of date software

Weak TLS/SSH ciphers

Deprecated protocols



AIS and GPS





Additional Info





trudi1 (1).pcapng

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

Apply a display filter ... <Ctrl-/> Expression... +

Packet bytes Narrow & Wide Case sensitive String !AIVDO Find Cancel

No.	Time	Source	Destination	Protocol	Length	Info
1243	13.302343271	172.31.252.1	172.31.255.255	UDP	91	10036 → 10036 Len...
1244	13.302484881	172.31.252.1	172.31.255.255	UDP	81	10036 → 10036 Len...
1245	13.302646287	172.31.252.1	172.31.255.255	UDP	91	10036 → 10036 Len...
1246	13.303133352	172.31.252.1	172.31.255.255	UDP	89	10038 → 10038 Len...
1247	13.304062643	172.31.252.1	172.31.255.255	UDP	81	10036 → 10036 Len...
1248	13.314207928	172.31.252.1	172.31.255.255	UDP	69	10021 → 10021 Len...
1249	13.357422014	172.31.24.3	172.31.255.255	UDP	98	10021 → 10021 Len...

> Frame 1249: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface 0

> Ethernet II, Src: FurunoEl_17:77:39 (00:d0:1d:17:77:39), Dst: Broadcast (ff:ff:ff:ff:ff:ff)

> Internet Protocol Version 4, Src: 172.31.24.3, Dst: 172.31.255.255

> User Datagram Protocol, Src Port: 10021, Dst Port: 10021

▼ Data (56 bytes)

Data: 01af00010000000021414956444f2c312c312c2c2c423532...

[Length: 56]

Offset	Hex	ASCII
0000	ff ff ff ff ff ff 00 d0w9..E.
0010	00 54 08 96 00 00 20 11	.T.... !.....
0020	ff ff 27 25 27 25 00 40	..'%%@ k!.....
0030	00 00 21 41 49 56 44 4f	..!AIVDO,1,1,,,B
0040	35 32 4c 35 42 50 33 77	52L5BP3w k?8mP=18
0050	44 33 51 33 77 77 55 53	D3Q3wwUS P06,0*2F
0060	0d 0a	..



VDM/VDO Decoder

Supported Msgs

ITU-R M.1371-1

Terms & Conditions

New Generation AIS Tester, Simulator / Analytical solution.

Will be launching it very soon.

For more details, contact us at info@maritec.co.za

VISIT MARITEC TRUST ONLINE STORE – AIS & NMEA PRODUCTS

AIS VDM/VDO Decoder

ENTER ONE MESSAGE PER LINE. MULTI SENTENCE MESSAGES HAVE TO BE ENTERED IN DIRECT SEQUENCE (viz. MSG 5, Msg 1-of-2, 2-of-2)

Checksum (xor) failure is indicated where applicable. Using this decoder, you have accepted the Terms & Conditions.

!AIVDO,1,1,,,852L5BP3wk?8mP=18D3Q3wwUSP06,0*2F

Decode

Clear Textbox

*Should you require additional messages, enter your email address and requirements before entering the **Decode** button.*



Message 18 - Class B Position Report

IAIVDO,1,1,,,B52L5BP3wk?8mP=18D3Q3wwUSP06,0*2F

Parm#	Parameter	Value	Description
01	Message ID	18	
02	Repeat indicator	0	No repeat (default)
03	User ID (MMSI)	338101578	
04	Spare	0	
05	SOG	102.3	
06	Position accuracy	0	
07	Longitude	181°0.0000'E	
08	Latitude	91°0.0000'N	
09	COG	360	
10	True heading	511	
11	Time stamp	63	
12	Spare	0	
13	Class B unit flag	1	Class B/CS unit
14	Class B display flag	0	No display available, not capable of displaying Message 12 and 14
15	Class B DSC flag	1	Equipped with DSC function (dedicated or time-shared)
16	Class B band flag	1	Capable of operating over the whole marine band
17	Class B Message 22 flag	0	No frequency management via Message 22 , operating on AIS1, AIS2 only
18	Mode flag	0	Station operating in autonomous and continuous mode (default)
19	RAIM-flag	0	
20	Communication state selector flag	1	ITDMA communication state follows



Attack AIS

tsud1 (1) pcapng

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

Apply a display filter -<Ctrl-F>

Packet bytes Narrow & Wide Case sensitive String

Find

No.	Time	Source	Destination	Protocol	Length	Info
1243	13.302343271	172.31.252.1	172.31.255.255	UDP	91	10036 → 10036 Len...
1244	13.302404881	172.31.252.1	172.31.255.255	UDP	81	10036 → 10036 Len...
1245	13.302646287	172.31.252.1	172.31.255.255	UDP	91	10036 → 10036 Len...
1246	13.303133352	172.31.252.1	172.31.255.255	UDP	89	10038 → 10038 Len...
1247	13.304062643	172.31.252.1	172.31.255.255	UDP	81	10036 → 10036 Len...
1248	13.314207928	172.31.252.1	172.31.255.255	UDP	69	10021 → 10021 Len...
1249	13.357422014	172.31.24.3	172.31.255.255	UDP	98	10021 → 10021 Len...

> Frame 1249: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface 0

> Ethernet II, Src: FurunoEL_17:77:39 (00:0d:1d:17:77:39), Dst: Broadcast (ff:ff:ff:ff:ff:ff)

> Internet Protocol Version 4, Src: 172.31.24.3, Dst: 172.31.255.255

> User Datagram Protocol, Src Port: 10021, Dst Port: 10021

Data (56 bytes)

Data: 01af00010000000021414956444f2c312c312c2c2c423532...

[Length: 56]

0000 ff ff ff ff ff 00 00 1d 17 77 39 08 00 45 00 u9·E·

0010 00 54 08 96 00 00 20 11 21 c3 ac 1f 18 03 ac 1f T.....

0020 ff ff 27 25 27 25 00 40 6b 21 01 af 00 01 00 00 ...%·@ k!.....

0030 00 00 11 49 56 44 4f 2c 31 2c 31 2c 2c 2c 42 ..AVOX ,1,1,,B

0040 35 32 4c 35 42 50 13 77 6b 3f 38 6d 50 1d 31 38 S2LSBPw k78p=18

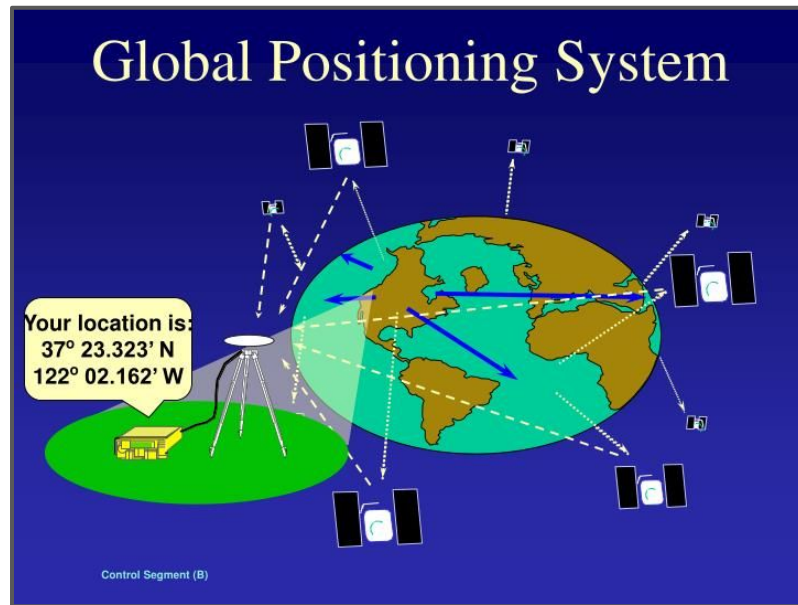
0050 44 33 51 33 77 77 55 53 50 30 36 2c 30 24 32 46 D3Q2mwUS P06,0*2F

0060 0d 0a ..





Global Positioning System





trudi1.pcapng

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

frame contains "\$GP"

No.	Time	Source	Destination	Protocol	Length	Info
3684	38.909888761	172.31.252.1	172.31.255.255	UDP	105	10021 → 10021 Len=63
3685	38.962027852	172.31.252.1	172.31.255.255	UDP	132	10021 → 10021 Len=90
3686	38.996349466	172.31.252.1	172.31.255.255	UDP	92	10036 → 10036 Len=50
3687	38.996480247	172.31.252.1	172.31.255.255	UDP	81	10036 → 10036 Len=39
3688	39.007269112	172.31.252.1	172.31.255.255	UDP	92	10036 → 10036 Len=50
3689	39.007428344	172.31.252.1	172.31.255.255	UDP	81	10036 → 10036 Len=39
3690	39.007564811	172.31.252.1	172.31.255.255	UDP	92	10036 → 10036 Len=50
3691	39.007692889	172.31.252.1	172.31.255.255	UDP	81	10036 → 10036 Len=39
3692	39.007822501	172.31.252.1	172.31.255.255	UDP	92	10036 → 10036 Len=50
3693	39.007948867	172.31.252.1	172.31.255.255	UDP	81	10036 → 10036 Len=39

Frame 3686: 92 bytes on wire (736 bits), 92 bytes captured (736 bits) on interface 0
Ethernet II, Src: Digiboar_7f:67:70 (00:40:9d:7f:67:70), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
Internet Protocol Version 4, Src: 172.31.252.1, Dst: 172.31.255.255
User Datagram Protocol, Src Port: 10036, Dst Port: 10036
Data (50 bytes)
Data: 017a0001000000000001efffffffffffff000175be24475048...
[Length: 50]

```
0000 ff ff ff ff ff ff 00 40 9d 7f 67 70 08 00 45 00 .....@..gp..E.
0010 00 4e a4 c6 40 00 40 11 41 98 ac 1f fc 01 ac 1f ..N..@.A.....
0020 ff ff 27 34 27 34 00 3a e4 4b 01 7a 00 01 00 00 ..'4'4.:.K.Z....
0030 00 00 00 1e ff ff ff ff ff ff 00 01 75 be 24 47 .....U.$G
0040 50 48 44 47 2c 31 35 33 2e 34 2c 30 2e 30 2c 57 PHDG,153 .4,0.0,W
0050 2c 31 34 2e 37 2c 57 2a 36 46 0d 0a ,14.7,W* 6F..
```

Data (data.data), 50 bytes

Packets: 5109 · Displayed: 4848 (94.9%) Profile: Default





On the Inside

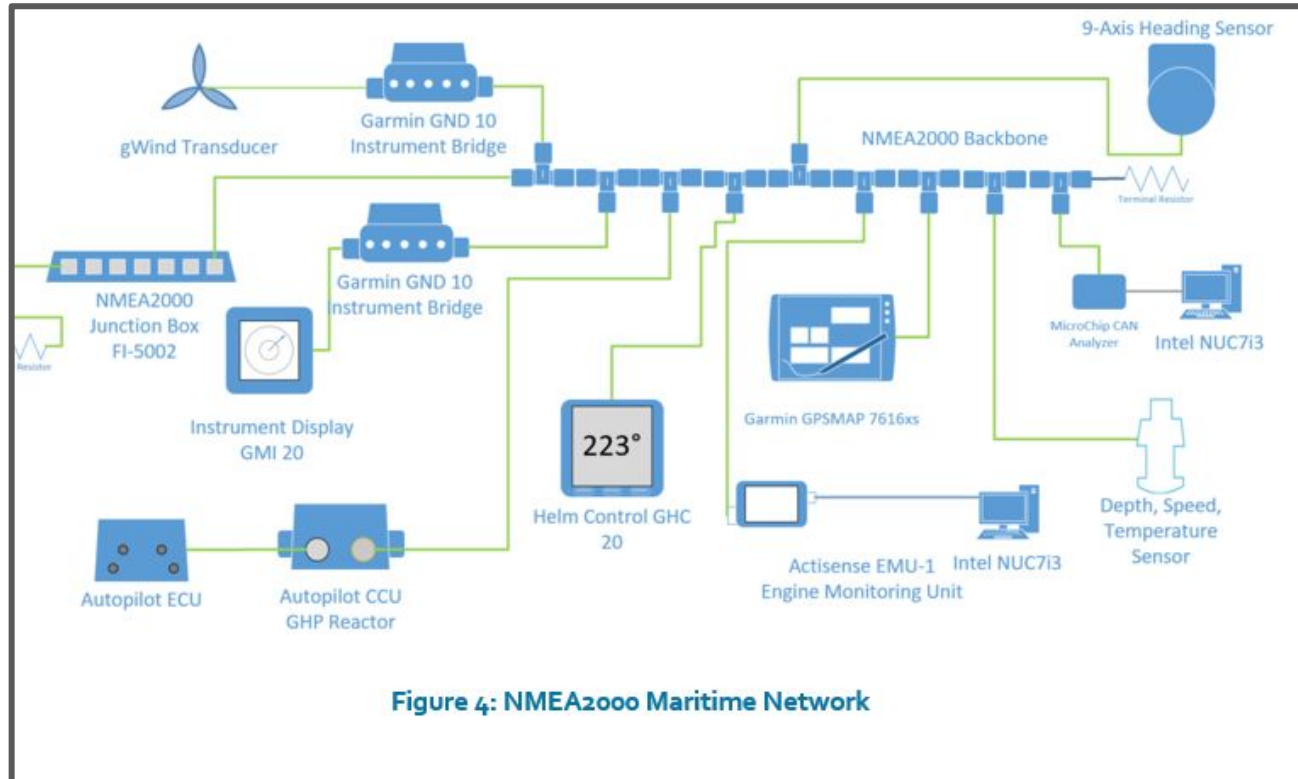


Figure 4: NMEA2000 Maritime Network



```
root@kali:/opt/canboat# cat output.json | grep Position | head
{"timestamp":"2019-09-07T14:50:03.879Z","prio":2,"src":5,"dst":255,"pgn":129025,"description":"Position, Rapid
Update","fields":{"Latitude": 1.0000597,"Longitude": 0.9999930}}
{"timestamp":"2019-09-07T14:50:03.879Z","prio":2,"src":5,"dst":255,"pgn":129025,"description":"Position, Rapid
Update","fields":{"Latitude": 1.0000597,"Longitude": 0.9999930}}
{"timestamp":"2019-09-07T14:50:03.880Z","prio":2,"src":5,"dst":255,"pgn":129025,"description":"Position, Rapid
Update","fields":{"Latitude": 1.0000597,"Longitude": 0.9999930}}
{"timestamp":"2019-09-07T14:50:03.880Z","prio":2,"src":5,"dst":255,"pgn":129025,"description":"Position, Rapid
Update","fields":{"Latitude": 1.0000597,"Longitude": 0.9999930}}
{"timestamp":"2019-09-07T14:50:03.880Z","prio":2,"src":5,"dst":255,"pgn":129025,"description":"Position, Rapid
Update","fields":{"Latitude": 1.0000597,"Longitude": 0.9999930}}
{"timestamp":"2019-09-07T14:50:03.880Z","prio":3,"src":5,"dst":255,"pgn":129029,"description":"GNSS Position D
ata","fields":{"SID":242,"Date":"2015.01.16", "Time": "17:49:21","Latitude": 1.0000597,"Longitude": 0.9999930,
"Altitude":981.296508,"GNSS type":"GPS+SBAS/WAAS+GLONASS","Method":"no GNSS","Integrity":"No integrity checkin
g","Number of SVs":0,"HDOP":-0.01,"PDOP":-0.01,"Geoidal Separation":18.12,"Reference Stations":0,"list":[{"}}]}
{"timestamp":"2019-09-07T14:50:03.880Z","prio":2,"src":5,"dst":255,"pgn":129025,"description":"Position, Rapid
Update","fields":{"Latitude": 1.0000597,"Longitude": 0.9999930}}
{"timestamp":"2019-09-07T14:50:03.881Z","prio":2,"src":5,"dst":255,"pgn":129025,"description":"Position, Rapid
Update","fields":{"Latitude": 1.0000597,"Longitude": 0.9999930}}
{"timestamp":"2019-09-07T14:50:03.881Z","prio":2,"src":5,"dst":255,"pgn":129025,"description":"Position, Rapid
Update","fields":{"Latitude": 1.0000597,"Longitude": 0.9999930}}
{"timestamp":"2019-09-07T14:50:03.899Z","prio":2,"src":5,"dst":255,"pgn":129025,"description":"Position, Rapid
Update","fields":{"Latitude": 1.0000597,"Longitude": 0.9999930}}
```




Depth

```
root@kali:/opt/canboat# cat output.json | grep Depth | head
{"timestamp":"2019-09-07T14:50:03.879Z","prio":3,"src":35,"dst":255,"pgn":128267,"description":"Water Depth","fields":{"Offset":0.000}}
{"timestamp":"2019-09-07T14:50:04.141Z","prio":3,"src":35,"dst":255,"pgn":128267,"description":"Water Depth","fields":{"Offset":0.000}}
{"timestamp":"2019-09-07T14:50:05.145Z","prio":3,"src":35,"dst":255,"pgn":128267,"description":"Water Depth","fields":{"Offset":0.000}}
{"timestamp":"2019-09-07T14:50:05.785Z","prio":3,"src":2,"dst":255,"pgn":128267,"description":"Water Depth","fields":{"Offset":0.000}}
{"timestamp":"2019-09-07T14:50:06.140Z","prio":3,"src":35,"dst":255,"pgn":128267,"description":"Water Depth","fields":{"Offset":0.000}}
```




Speed

```
root@kali:/opt/canboat# cat output.json | grep Speed | head
{"timestamp":"2019-09-07T14:50:03.880Z","prio":2,"src":35,"dst":255,"pgn":128259,"description":"Speed","fields":{"Speed Water Referenced":0.00,"Speed Water Referenced Type":"Paddle wheel"}}
{"timestamp":"2019-09-07T14:50:03.880Z","prio":2,"src":2,"dst":255,"pgn":128259,"description":"Speed","fields":{"Speed Water Referenced Type":"Paddle wheel"}}
{"timestamp":"2019-09-07T14:50:03.881Z","prio":2,"src":2,"dst":255,"pgn":128259,"description":"Speed","fields":{"Speed Water Referenced Type":"Paddle wheel"}}
{"timestamp":"2019-09-07T14:50:04.141Z","prio":2,"src":35,"dst":255,"pgn":128259,"description":"Speed","fields":{"Speed Water Referenced":0.00,"Speed Water Referenced Type":"Paddle wheel"}}
{"timestamp":"2019-09-07T14:50:04.198Z","prio":2,"src":2,"dst":255,"pgn":128259,"description":"Speed","fields":{"Speed Water Referenced Type":"Paddle wheel"}}
```



Temperature

```
root@kali:/opt/canboat# cat output.json | grep Temp | head
{"timestamp":"2019-09-07T14:50:03.880Z","prio":5,"src":35,"dst":255,"pgn":130311,"description":"Environmental Parameters","fields":{"Temperature Source":"Sea Temperature","Temperature":28.98}}
{"timestamp":"2019-09-07T14:50:03.880Z","prio":5,"src":2,"dst":255,"pgn":130311,"description":"Environmental Parameters","fields":{"Temperature Source":"Sea Temperature","Humidity Source":"Outside"}}
{"timestamp":"2019-09-07T14:50:04.198Z","prio":5,"src":35,"dst":255,"pgn":130311,"description":"Environmental Parameters","fields":{"Temperature Source":"Sea Temperature","Temperature":28.98}}
{"timestamp":"2019-09-07T14:50:04.268Z","prio":5,"src":2,"dst":255,"pgn":130311,"description":"Environmental Parameters","fields":{"Temperature Source":"Sea Temperature","Humidity Source":"Outside"}}
```

NMEA Reader - [COM3: Actisense NGT]

File Edit View Window Help

COM3: Actisense NGT 115200 NMEA 2000 Bus Load (95%)

PC Receive Load (95%)

Line	PGN	SRC	DST	Name	Time	Interval	Data
34	127257	7	255	Attitude	15:53:16:114	0.66	FF 3D 77 FA FF FC FF FF
35	59392	7	2	ISO Acknowledgment	15:46:48:578		01 FF FF FF FF 16 F0 01
36	60928	7	255	ISO Address Claim	15:52:56:232	21.11	23 C1 B0 1C C8 96 50 C3
37	59904	7	9	ISO Request	15:51:20:679	136.76	00 EE 00
38	59904	7	255	ISO Request	15:52:20:106	22.16	00 EE 00
39	127258	7	255	Magnetic Variation	15:53:14:766	2.33	FF FF FF FF FF 7F FF FF
40	126720	7	255	Manu. Proprietary fast-packet addressed	15:53:16:320	0.03	E5 98 6C 07 02 02 16 00 ...
41	61184	7	255	Manu. Proprietary single-frame addressed	15:53:08:577	5.21	E5 98 10 17 04 04 14 02
42	61184	7	0	Manu. Proprietary single-frame addressed	15:53:08:348	11.46	E5 98 2B 02 01 00 2A
43	126996	7	255	Product Information	15:46:47:099		D0 07 38 1A 47 48 50 20 ...
44	127251	7	255	Rate of Turn	15:53:16:279	0.19	FF 4E 00 FF FF FF FF FF
45	127245	7	255	Rudder	15:53:16:464	0.27	00 FF FF 7F 8F FE FF FF
46	127250	7	255	Vessel Heading	15:53:16:434	0.66	FF 3D 77 FF 7F FF 7F FD
47	59904	7	2	ISO Request	15:50:42:237		00 EE 00
48	129026	5	255	COG & SOG, Rapid Update	15:53:16:020	0.20	4E FC 7F 7F 00 00 FF FF
49	129539	5	255	GNSS DOPs	15:53:15:569	1.14	49 FB FF FF FF FF FF FF
50	129029	5	255	GNSS Position Data	15:52:22:593	1.00	F0 E2 46 A0 EF A9 2A 40 ...
51	129540	5	255	GNSS Sats in View	15:53:15:595	1.00	49 FD 00
52	59392	5	2	ISO Acknowledgment	15:46:44:575		01 FF FF FF FF 16 F0 01
53	60928	5	255	ISO Address Claim	15:52:56:230	10.56	E7 E4 A0 1C 00 91 78 C0
54	127258	5	255	Magnetic Variation	15:53:13:582	1.33	33 F2 E2 46 80 F8 FF FF
55	126720	5	255	Manu. Proprietary fast-packet addressed	15:52:22:620	1.00	E5 98 17 00 04 04 51 59 ...
56	129025	5	255	Position, Rapid Update	15:53:16:478	0.00	DE AD BE EF DE AD BE EF
57	126996	5	255	Product Information	15:46:43:733		14 05 85 02 47 50 53 31 ...
58	126992	5	255	System Time	15:53:11:583	1.00	1D F0 E2 46 B0 69 B1 2A
59	127257	4	255	Attitude	15:53:16:229	1.10	FF 46 0A 7A FD 8A FC FF
60	126998	4	255	Configuration Information	15:46:43:139		02 01 02 01 02 01
61	60928	4	255	ISO Address Claim	15:52:51:224	10.71	FB 1C B5 1C 03 8C 78 C0
62	59904	4	36	ISO Request	15:47:13:705	0.20	00 EE 00
63	59904	4	9	ISO Request	15:50:00:466	26.66	00 EE 00
64	126720	4	255	Manu. Proprietary fast-packet addressed	15:53:16:350	0.66	E5 98 6C 07 02 02 16 00 ...
65	61184	4	255	Manu. Proprietary single-frame addressed	15:53:06:566	10.91	E5 98 27 00 01 01 24

COM3 115200 Open Transfer Receive All

Data View Network View Hardware Config

19.2-vmware-amd64 - VMware Workstation

File Edit View Window Help

Windows 10 Kali-Linux-2019.2-vmware-a...

Applications Places Terminal Sat 15:53

root@kali: /opt

Edit View Search Terminal Tabs Help

```
@kali:~$ ./doover.sh 4 10025,10082,10180,10215,10243,10568,10610,10617,10621,10628,10629,10778,11110,11111,11967,12080,12174,12265,12345,13456,13722,13782,13783,14238,14441,1442,15000,15002,15004,15660,15742,16000,16001,16012,16016,16018,16013,16992,16993,17877,17988,18040,18101,18988,19101,19283,19315,19358,19780,19801,20000,20005,20031,20221,20222,20828,21571,22939,23502,24444,24800,25734,25735,26270,27352,27353,27355,27356,27715,28201,30000,30718,30951,31038,31337,32768,32785,4,33899,34571,34573,35500,38292,40193,40911,41511,42518,44176,44442,44443,44501,45100,49152,49161,49163,49165,49167,49175,49176,49400,49999,50003,50006,50300,50389,50636,50800,51103,51493,52673,52822,52848,52869,54045,54328,55055,55056,55555,556737,56738,57294,57797,58080,60020,60443,61532,61900,62078,63331,64623,64680,65000,65389) UDP(0): SCTP(0): PROTOCOLS(0):
172.16.0.1 () Status: Down
172.16.3.62 () Status: Down
172.16.2.0 () Status: Up
172.16.2.0 () Ports: 23/open/tcp/tcpwrapped/// Ignored State: closed t
172.16.5.37 () Status: Up
172.16.5.37 () Ports: 22/open/tcp/tcpwrapped///, 23/open/tcp/tcpwrapped///
Ignored State: closed (998)
172.16.6.20 () Status: Up
172.16.6.20 () Ports: 554/closed/tcp/rtsp///, 2049/open/tcp/tcpwrapped///, 5
/open/tcp/tcpwrapped/// Ignored State: filtered (997)
up done at Sat Sep 7 13:34:11 2019 -- 5 IP addresses (3 hosts up) scanned in 80.13
nds
kali:~#
kali:~#
```

this VM, click inside or press Ctrl+G.

3:53 PM 9/7/2019

NMEA Simulator

▶ Start Options ▾

GPS: On / Off ☒

GPS Quality: GPS fix
GPS Mode: 3D
HDOP: 1.9
PDOP: 2.3
VDOP: 3.1
No of Satellites: 4
Satellites: 8 11 15 22

Time & Date:

UTC: 12:52:37
Date: 10/09/2019

Destination:

Name: SYDNEY
ETA: 08:52:37

Speed



Heading



True Wind



Apparent Wind



Location

Lat: 40.699500
Lon: 74.039600

Water

Depth: 5.0 m ☐
Temp: 24.0 °C ☐

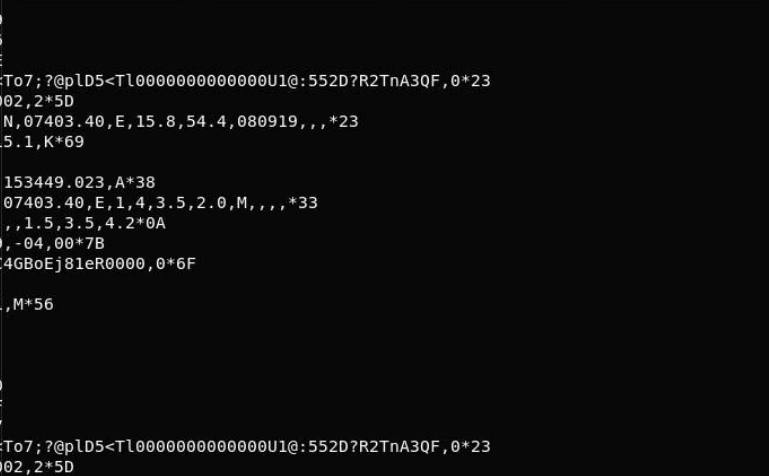
Waypoint:

Lat:
Lon:

[Mark Position](#)

File Edit View Search Terminal Help

```
$WIMMV,345.8,R,18.3,N,A*13
$IIMTW,23.3,C*11
$SDDBT,7.3,01*7C
$SDDBT,24.0,f,7.3,M,4.0,F*30
$SDDBK,24.0,f,7.3,M,4.0,F*2F
$SDDBS,24.0,f,7.3,M,4.0,F*37
!AIVDO,2.1,9,A,57Paewh00001<To7;?@pLD5<Tl000000000000U1@:552D?R2TnA3QF,0*23
!AIVDO,2.2,9,A,@00000000000002,2*5D
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$IIVHW,51.8,T,51.8,M,7.8,N,14.4,K*6B
$IIHDT,51.8,T*1E
$GPGLL,4042.63,N,07403.40,E,153448.023,A*39
$GPGGA,153448.023,4042.63,N,07403.40,E,1,4,2.9,2.0,M,,,*3F
$GPGSA,A,3,8,11,15,22,,,,,,,,,1.8,2.9,5.0*09
$GPZDA,153448.023,08,09,2019,-04,00*7A
!AIVDO,1,1,,A,17PaewhP2FUC0ATGBo7B1QWP0000,0*0E
$WIMMV,1.2,T,6.7,N,A*27
$WIMWD,1.2,T,1.2,M,6.7,N,3.5,M*5D
$WIMMV,345.0,R,20.0,N,A*13
$IIMTW,23.1,C*13
$SDDBT,6.7,01*79
$SDDBT,21.8,f,6.7,M,3.6,F*39
$SDDBK,21.8,f,6.7,M,3.6,F*26
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!AIVDO,2.2,9,A,@00000000000002,2*5D
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$IIVHW,54.4,T,54.4,M,8.1,N,15.1,K*69
$IIHDT,54.4,T*17
$GPGLL,4042.63,N,07403.40,E,153449.023,A*38
$GPGGA,153449.023,4042.63,N,07403.40,E,1,4,3.5,2.0,M,,,*33
$GPGSA,A,3,8,11,15,22,,,,,,,,,1.5,3.5,4.2*0A
$GPZDA,153449.023,08,09,2019,-04,00*7B
!AIVDO,1,1,,A,17PaewhP2NUC0C4GBoEj81eR0000,0*6F
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$WIMWD,1.3,T,1.3,M,8.1,N,4.1,M*56
$WIMMV,342.7,R,21.7,N,A*15
$IIMTW,23.3,C*11
$SDDBT,6.0,01*7E
$SDDBT,19.8,f,6.0,M,3.3,F*30
$SDDBK,19.8,f,6.0,M,3.3,F*2F
$SDDBS,19.8,f,6.0,M,3.3,F*37
!AIVDO,2.1,9,A,57Paewh00001<To7;?@pLD5<Tl000000000000U1@:552D?R2TnA3QF,0*23
!AIVDO,2.2,9,A,@00000000000002,2*5D
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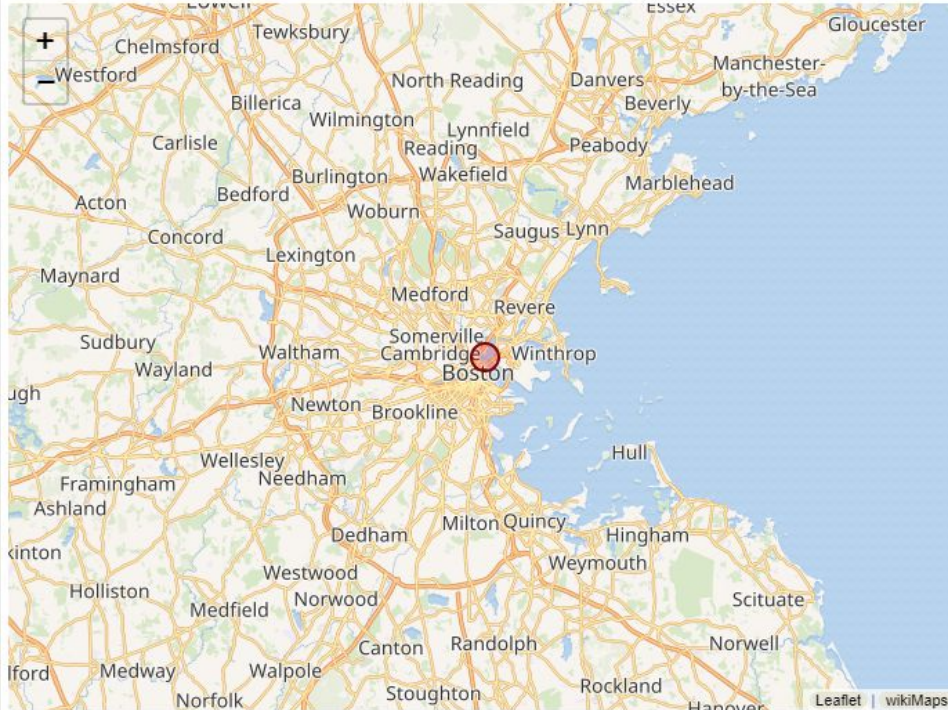




GPRMC & GPGGA decoder

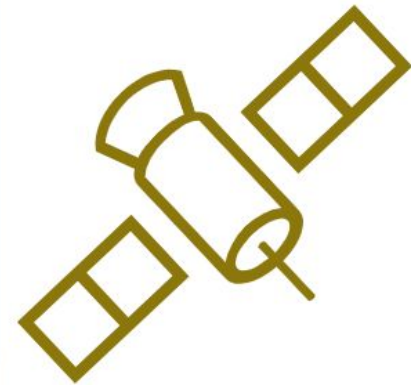
yyyyyy@gpE@@@H-ü-yy"%%-gò\$GPGGA,182336.00,4222.3090,N,07103.0577,W,2,06,6.00,0.0,M,-34.8,M,,*6E

Decode



Decoding results

Time	18:23:36 UTC
Fix quality	2 - DGPS
Position	42.371817°N 71.050962°W
Sats in use	6
HDOP	6
Geoid	-34.8 m
Altitude	0 m
Close to	Boston, United States





Don't Give Up the Ship

Better Netsec

WPA2 Wifi

Update Software

Stronger Passwords

Use encrypted equivalents

Better Protocol

NMEA One Net (Ethernet Based)

Encryption

Authentication

Datagram Level Signing

Better Governance

Government Regulations and Guidance

USCG

Maritime Transportation
Security Act (MTSA)

NIST

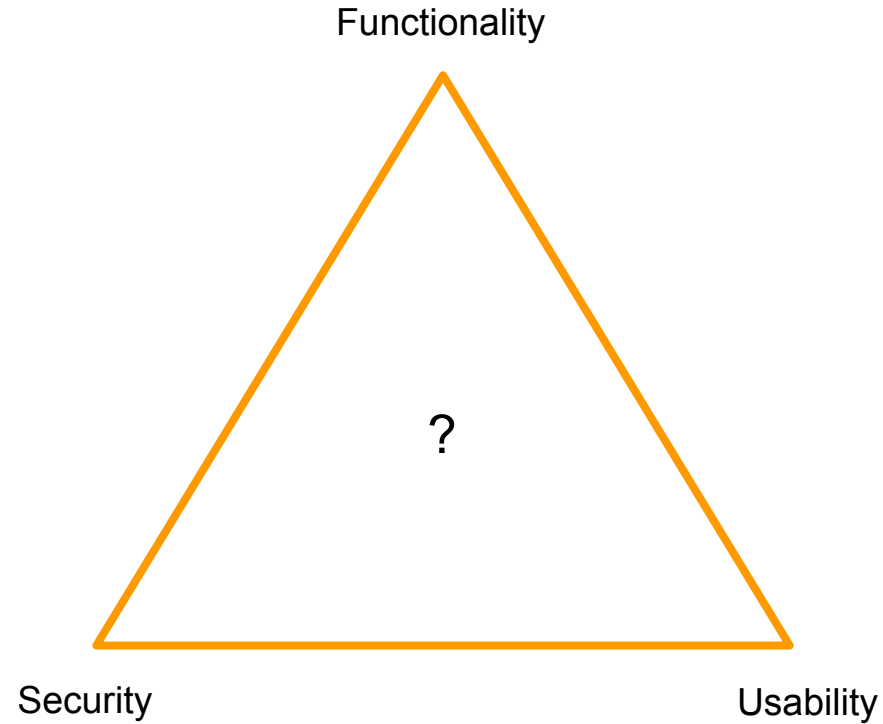
Cybersecurity Profiles

Industry Awareness and Effort

IMO MSC-FAL.1/Circ.3



What Does Your Ship Look Like?





Questions