C4i communication

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ENCRYPTED PHONES SOLUTION

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Hardware for encrypted mobile phone

PINEPHONE – Beta Edition With Convergence Package Linux SmartPhone

This is the **Beta Edition** of the PinePhone. The pre-installed Manjaro with Plasma Mobile OS, that ships with this edition of the PinePhone, is a beta software build. This effectively means that while core functionality of the PinePhone still an ongoing effort. Thus, the device cannot considered a consumer-ready product.

Convergence Package

The **convergence package** features a **Beta Edition PinePhone** with a more RAM memory (3GB LPDDR3) and eMMC storage (32GB) as well as a compatible USB-C docking bar capable of charging, digital video output, dual USB 2.0 type-A host ports for peripherals (such as keyboard and mouse) and fast Ethernet.

BODY	• Dimensions: 160.5mm x 76.6mm x 9.2mm • Weight: 185 grams • Build: Plastic • Colour: Black • SIM: Micro-SIM
DISPLAY	• Type: HD IPS capacitive touchscreen, 16M colors • Size: 5.95 inches • Resolution: 1440×720 pixels, 18:9 ratio
PLATFORM	• OS: Manjaro with Plasma Mobile OS build • Chipset: Allwinner A64 • CPU: 64-bit Quad-core 1.2 GHz ARM Cortex A-53 • GPU: MALI-400MP2
MEMORY	• Internal Flash Memory: **32GB eMMC** • System Memory: **3GB LPDDR3 SDRAM** • Expansion: micro SD Card support SDHC and SDXC, up to 2TB
CAMERA	• Main Camera: Single 5MP, 1/4″, LED Flash • Selfie Camera: Single 2MP, f/2.8, 1/5″
SOUND	• Loudspeaker: Yes, mono • 3.5mm jack with mic: Yes, stereo
COMMUNICATION	• Worldwide, Global LTE bands • LTE-FDD: B1/ B2/ B3/ B4/ B5/ B7/ B8/ B12/ B13/ B18/ B19/ B20/ B25/ B26/ B28 • LTE-TDD: B38/ B39/ B40/ B41 • WCDMA: B1/ B2/ B4/ B5/ B6/ B8/ B19 • GSM: 850/900/1800/1900MHz • WLAN: Wi-Fi 802.11 b/g/n, single-band, hotspot • Bluetooth: 4.0, A2DP • GPS: Yes, with A-GPS, GLONASS
FEATURES	• USB: type C, USB Host, DisplayPort Alternate Mode output • Sensors: Accelerometer, gyro, proximity, ambient light, magnetometer(compass) • Actuator: Vibration Motor • Privacy Switches: LTE (include GPS), Wifi/BT, Mic, and Camera
BATTERY	• Removable Li-Po 2750-3000 mAh battery • Charging: USB type-C, 15W – 5V 3A Quick Charge, follows USB PD specification
PACKAGE CONTENTS	• PinePhone • USB-A to USB-C charging cable • USB-C Docking Bar – 2x USB Type-A host ports, digital video port, and 10/100Mbps Ethernet port

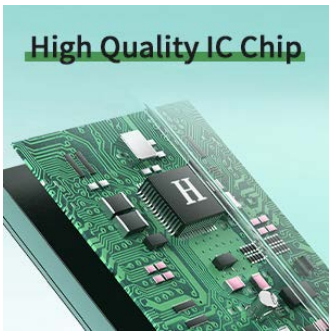
Battery, 3600mAh Replacement Battery

Product Description

We are a professional factory in producing cell phone batteries.

Cell phone battery checked strictly by professional machine for 3 times before shipping. You can buy the replacement battery with confidence. You will get a high-quality battery from us. battery will brings your phone a new life.

- Compatible Models: Galaxy J700 battery Galaxy J7 SM-J700 (2015 Ver) J700H J700P J700T J700T1 J700M EB-BJ700CBC EB-BJ700BBU EB-BJ700CBE EB-BJ700BBC
- Battery Capacity: 3600mAh
- Battery Type: Lithium Ion
- Voltage: 3.85V



High Quality IC Chip

Premium grade A+ quality battery

High quality IC chip gives your cell phone over- heating, short-circuit, over-charging, over- discharging protection and so on.

High Capacity

Made of top-rate A Lithium polymer battery cell, 3600mAh Battery for J700 has super capacity, bring you more convenient and power your life.

Battery Multiple Protection

The HamnaKhu battery contains no mercury, lead, cadmium and other harmful substances. Lithium polymer batteries use colloidal electrolytes and do not generate large amounts of gas, such as liquid boiling, thereby eliminating the possibility of violent explosions.

SanDisk 128GB Ultra

Shoot and save more high-quality photos and full HD video on your Android smartphone or tablet with SanDisk Ultra microSD UHS-I cards. With storage capacities up to 128GB, they're the ideal complement for Android smartphones and tablets. And the SanDisk memory zone app, available on the Google play store, makes it easy to view, access, and back up all of your files from your phones memory in one convenient place. To help your smartphone run at its peak performance, This app can be set to automatically off-load files from your smartphones internal memory to your memory card. Bundle Includes: (10x) 128GB microSDXC Cards (SDSQUNR-128G) and (1x) GoRAM USB 3.0 Card Reader.

- Bundle Includes: 10 x 128GB MicroSDXC cards, 1 x GoRAM Card Reader
- SanDisk Ultra microSD UHS-I cards are ideal companions for high-performance Android smartphones and tablets
- Fast transfer speeds of up to 100MB/s and Class 10 video rating for high-quality HD video recording
- Rated A1, the SanDisk Ultra microSD card is optimized for apps, delivering faster app launch and performance that provides a better smartphone experience.
- 30 day money back guarantee, lifetime warranty, and long lasting customer support offered by OEMPCWorld

(20 Pack) New Nano Sim Adapter and Micro Sim Adapter and Nano to Micro Adapter with Sim Eject Pin Needle, Easy to use and Storage – Black

- It is convenient for daily storage of standard SIM card, Nano card, Micro card, MicroSD memory card, etc. and also protect your valuable cards from getting damaged or lost.
- 20 Pack SIM Card Adapter - Each Pack includes 1 Eject Pin for Phone and 3 Adapters - Nano to Micro, Nano to Standard, and Micro to Standard. (Cards are not included.)
- These card cases are slim, lightweight and portable, which can be put in the purse, wallet, pocket or bag, especially ideal and useful for travelling and multi sim card users. Nice gift for someone who loving travels.
- The SIM card adapter allows you to convert your sim card size, this is ideal if you want to use the same SIM card in a different phone or changing between a newer and an older phone that requires a different size sim card.
- Color: Black,

SanDisk MobileMate USB 3.0 microSD Card Reader

- Compact and durable microSD card reader
- Fast UHS-I transfer speeds of up to 170 MB/s
- With USB 3.0, move content up to 10x faster than USB 2.0 readers(2)
- Compatible with USB 3.0 and backwards-compatible with USB 2.0

USB C Headphones

- Magnetic USB C Earbuds: Powerful magnetic is built in the back of each earbud which makes easier to roll up and without any tangle in daily use. Magnets also can prevent the usb c headphones from sliding off when not in use, just hang around your neck
- Quality Material USB C Earphone: Metal-plated connectors greatly reduce the phenomenon of poor contact, Stretch resistant, long-lasting; 1.2 meters length, built-in powerful DAC chip to maintain the high resolution acoustics of your devices, no buzzing, popping, or any bad audio issues, just plug and play to enjoy your favorite music
- With Remote Control & Mic: Allow you to play/pause songs, skip next/previous song without picking up your phone, easily access to volume control during usage; The high-quality microphone which can hand free calling, allow you to easily answer/end calls calls

Jabra Speak 510 MS Wireless Bluetooth Speaker for Softphone and Mobile Phone – Link 370 USB Included

- CLEARER CONVERSATIONS – The outstanding sound quality in the Jabra Speak 510 Wireless Bluetooth Portable Speaker ensures everyone is heard during conference calls, making your meeting more efficient; The 360-degree microphone pick up sound at all angles.
- HOLD MEETINGS ANYWHERE – Take audio conferencing to a whole new level and turn any room into a conference room with this wireless, portable speaker; Use it at home, in the office or when traveling.
- EASY SETUP – No IT required; Setup and use of these Bluetooth speakers is a breeze, just connect via Bluetooth or USB and dial-in; Compatible with all leading UC platforms; Certified for Avaya, Cisco, Skype for business, and more.

- SLIM, COMPACT DESIGN – A convenient carrying case and integrated cable management makes it ideal for use while on-the-go; Plus, the slim, compact design means you can bring this wireless Bluetooth speaker anywhere you are.
- WORKS WITH MANY DEVICES – Connect or plug into your desk phone, mobile phone, soft-phone or whatever device you have; Includes a Link 370 USB Adapter to enhance Bluetooth connectivity.

Galaxy A13 4G Case, with HD Screen Protector

Androgate Super Ring Series Military Grade Phone Case for Samsung Galaxy A13 4G

This is a dual layer designed case but it is extremely compact and sleek. There is an integrated metal ring which can be 360° Rotatable to work pefectly as a holer or a stand. What's more, the metal plate for holding the ring can attach easily to your magnetic car mount or holder when you drive. Enjoy your hands-free moments to watch a video or facetime with the Androgate Super Ring Series Case!

- 【Phone Case and HD Screen Protector】Tailor-designed for Samsung Galaxy A13 4G Model ONLY
- 【Strong Protection】Combination of TPU and Polycarbonate with reinforced corners for military-grade protection from drops and bumps. Raised bezels provide extra protection to the screen
- 【Precise Cutouts】Easy access to buttons, speaker, charging port and all other funcioning ports of Samsung Galaxy A13 4G
- 【Metal Ring Holder and Stand】The metal ring is a great plus under multiple scenarios when it works as a holder, bracket or kickstand. The built-in metal sheet allows for easy attach to your magnetic car mount holder
- 【Sleek Compact Profile】The phone case is made from selected lightweight non-slip material to ensure a slim and tough protection with enhanced grip.

20W Dual Port USB C Wall Charger Type C

Wide Voltage

Voltage range: 110V-240V, applicable to all countries in the world.

20W PD Fast Charger

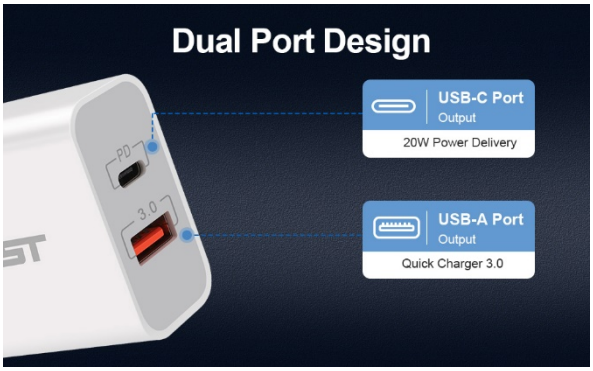
The Europe power adapter charge your iPhone 14 / 13 from 0% up to 50% in just 30 minutes, 3X faster than ordinary charger.

Smart Dual Port

With 20W USB C power delivery port and 18W USB A quick charger port, Intelligently identify your devices, full-speed charge two devices simultaneously

Specifications

- Europe USB C Wall Charger
- Input: 100-240V~50/60Hz 0.5A
- USB-C Output: 20W Max
- USB-A Output: 18W Max



Anker 333 USB C to USB C Cable (6ft 100W, 2-Pack)

The 100W Max Power Delivery Cable

Serious Power

With a max output of 100W, this cable can charge anything from phones to laptops. Pair with a 100W USB-C Power Delivery charger to power up a MacBook Pro 16" in just 2 hours.

Built to Last

Proven in strict laboratory settings to withstand up to 12,000 bends.

High-Speed Data Transfer

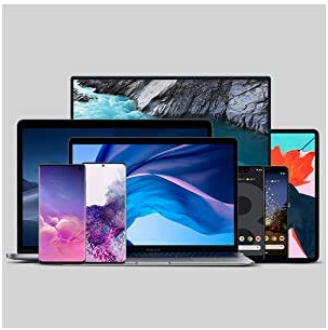
Transfer your favorite movies, music, and more at speeds of up to 480 Mbps.

Wide Compatibility

Works effortlessly with any USB-C device including phones, tablets, and laptops.

Superior Safety

Built with an e-Marker chip to communicate power requirements with connected devices, ensuring safe and stable charging.



Superior Durabillity

A 12,000-bend lifespan ensures this cable is ready to withstand the wear and tear of everyday use.

Highly Compatible

Works seamlessly with any USB-C device, including MacBook Pro 2020, iPad Pro 2020, and Galaxy S21.

Hard-Wearing Exterior

Made with tough, two-shade braided nylon for a cable that looks good and lasts longer.

4 in 1 Type C Male to Female Stereo Audio Earphone Converter and Charger Adapter

Type C to dual usb c converter allows you listening music from most Type-C cellphones and Charging your phone (2A Max) at the same time, it also supports calling on the phone and volume control.

H**IFI Sound Quality:**The sound quality is genuine and natural without distortion, supports up to 24-bit/96kHz audio output. Works perfectly with your audio devices.

P**ortable:**USB Type C to USB C earphone jack adapter with tiny size is easy to bring outside and ensure the high quality of music, which means this unit is suitable for your daily life or leisure time. Perfect for travelling, watching videos, playing games, in the car, at home and office.

Function:

- Support Music +Charge+Call +Volume Control (Can't support phone call in car)
- Hi-Res Decoding Chip (32bit 384KHz)
- 60W Fast Charging (NOTE: Our adapter support PD fast charging, but samsung is QC fast charging protocol, so can't support samsung fast charging)
- NO Data tranfer!!!
- NOT fit for iPhone Phone (iPhone is lightling port, our adapter is usb type c port)

Specifications:

I**nside Materials:** Enamelled Copper + Aluminum foil

Outside Materials: TPE+Aluminium Alloy

Color: Black

C**onnector:** USB-C (Type-c)

Port 1: Type C/USB C Headphone Jack

Port 2: USB-C PD charging port (Type-c)

Hardware for Docs

CAT 6 Ethernet Cables (10 Pack)

- High-precision, Cat 6, ANSI/TIA-568-C.2 compliant, ETL Verified, Ethernet LAN patch cable, pre-terminated with RJ45 connectors and available in a wide variety of colors for proper color coding
- Premium quality, long-lasting materials, durable design, and a Lifetime Warranty for the price of a generic cable. ETL Verified to ensure maximum reliability and compatibility
- UTP 24AWG stranded conductors for flexibility, twisted in pairs and nested in a spline to minimize crosstalk, 50 micron gold-plated contacts for high-speed data transfer and corrosion resistance
- Compatible with Ethernet 10Base-T, 100base-tx(fast Ethernet), 1000Base-T (Gigabit Ethernet), 10gbase-t (10-Gigabit Ethernet) and peer-to-peer, as well as any other devices that use 8c8p cables

Supersonic Rage Pro 512GB USB 3.2 Gen 1 High-Performance Flash Drive

- 512GB - USB 3.2 Gen. 1 Compliant (backwards compatible with USB 3.0)
- Designed with an aluminum coated housing providing better thermal dissipation.
- UASP (USB Attached SCSI Protocol) supported, enabling Read and Write transfers simultaneously.
- LED Light Indicator
- With a 5-year warranty, the diverse Supersonic Rage Pro features multi-platform compatibility with Windows 10 Windows 8, Windows 7, Linux 2.6 and later, Mac OSX 10.X.

Dell Latitude 7330 Rugged Extreme

No interruptions thanks to dual hot-swappable batteries with up to 25-hour* battery runtime and Express Charge Boost for a 35% charge in only 20 minutes.

The screen responsiveness of the Dell latitude 7330 Rugged Extreme i5 is like no other, with gloved-touch capability and 1400 nits of brightness for direct-sunlight viewability.

Geared to work with your gear, it's got a resistive touchpad that makes it the 5G-capable 13″ fully-rugged* laptop with highly responsive* rain and glove touch performance*.

Thrives in extremes with an IP-65 rating for maximum protection against dust, dirt and water ingress while able to withstand temperatures ranging from –20°F to 145°F and drops from up to 6 feet.

- 11th Gen Intel Core i5-1135G7 non-vPro (8 MB cache, 4 cores, 8 threads, up to 4.20 GHz Turbo, 28W)
- 8GB LPDDR4x, 4266 MHz, integrated RAM
- 256GB SSD Storage Device
- 13.3″ Touch 1400 nits WVA FHD (1920 x 1080) 100% sRGB Anti-Glare,
- Outdoor Viewable, Stylus included
- Intel Iris XE Graphics
- Mic + IR FHD camera for WWAN/WLAN antennae
- Pogo vehicle docking and RF passthrough
- 1x RS232 Serial, 1x NIC (RJ45)
- Intel Dual Band Wireless AC210
- Bluetooth
- SIM Card Reader
- 1x 3 Cell 53.5 WHr Express Charge Capable Battery
- **Windows 11 Professional Operating System**
- **3 Years DELL Warranty**
- **Condition: NEW**

Additional Information for the Dell Latitude 7330 Rugged Extreme:

Ports & Slots

1. Smart Card reader (Optional) 2. Express Card reader (Optional) 3. Stylus lanyard 4. Stylus 5. microSD Card reader / Nano SIM slot 6. 2nd TBT4 / USB 3.2 Gen 2 Type-C (Optional) 7. Choose one: 2nd RS-232 / 2nd RJ-45 / 3rd USB Type-A / Fischer USB 3.0 / Blank 8. RJ-45 Network port 9. RS-232 Serial port 10. HDMI 11. TBT4 / USB 3.2 Gen 2 Type-C 12.(2x) USB 3.2 Gen 1 Type-A 13. Universal Audio Jack

Dimensions & Weight

1. Height: 36.5 mm (1.43 in.) 2. Width: 324 mm (12.75 in.) 3. Depth: 220 mm (8.66 in.) Starting Weight: 2.32 kg (5.11 lbs)*

Regulatory

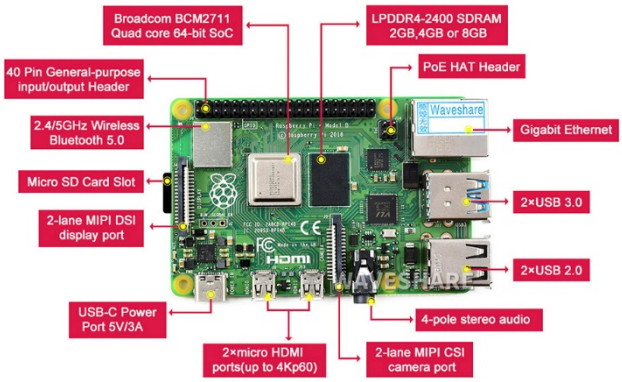
Regulatory model: P46G
Regulatory type: P46G002 Energy Star 7.0, EPEAT

MIL-STD-810G testing: Transit drop 72”/.91m, 60″/1.52m, 48″/1.22m; single unit; 78 drops, operating drop (36”/0.91m), blowing rain, blowing dust, blowng sand, vibration, functional shock, humidity, salt fog (with rubberized keyboard), altitude, explosive atmosphere, solar radiation, thermal extremes, thermal shock, freeze/thaw,tactical standby to operational.**Operating thermal range:** -20°F to 145°F (-29°C to 63°C);

Non-operating range: -60°F to 160°F (-51°C to 71°C)

IEC 60529 ingress protection*: IP-65 (dust-tight, protected against pressurized water)

Raspberry Pi 4b 2Gb with cases and cables and power supply



Form factor:	55 mm × 40 mm
Processor:	Broad-com BCM2711 quad-core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz
Memory:	1GB, 2GB, 4GB or 8GB LPDDR4 (depending on model) with on-die ECC
Connectivity:	• Optional wireless LAN, 2.4GHz and 5.0GHz IEEE 802.11b/g/n/ac wireless, Bluetooth 5.0, BLE with onboard and external antenna options • Onboard Gigabit Ethernet PHY supporting IEEE1588 • 1 × USB 2.0 interface • PCIe Gen 2 x1 interface • 28 GPIO signals • SD card interface for SD card or external eMMC (for use only with Compute Module 4 variants without eMMC)
Video:	• Dual HDMI interface (up to 4Kp60 supported) • 2-lane MIPI DSI display interface • 2-lane MIPI CSI camera interface • 4-lane MIPI DSI display interface • 4-lane MIPI CSI camera interface
Multimedia:	H.265 (4Kp60 decode); H.264 (1080p60 decode, 1080p30 encode); OpenGL ES 3.0 graphics
Input power:	5V DC
Operating temperature:	-20°C to +85°C

Hardware for Keygen

GIGABYTE Desktop PC Model X(GB-AMXI9N8A-2051)

- CPU: 11th Gen Intel Core i9-11900K
- GPU: NVIDIA GeForce RTX 3080 GDDR6X 10GB
- PCIe Gen 4 High speed M.2 SSD (1TB), M.2 Gen 3 SSD (2TB)
- Memory: 16GB DDR4 RAM XMP4400MHz
- AORUS LIQUID COOLER 360 to keep the system cool and silent (within 40 dB under load)
- Aquantia 10GbE LAN, Intel 2.5GbE LAN, Intel Wi-Fi 6E AX210, Bluetooth V5.2
- Realtek ALC1220-VB
- Supports 2x Thunderbolt 4 Type-C ,USB 3.2 Gen2x2 Type C
- Front I/O: 2x USB 3.2 Gen1 Type A, 1x USB 3.2 Gen2x2 Type-C, 1x 3.5mm Headphone, 1x 3.5mm Mic
- Rear I/O: 2x Thunderbolt 4 Type-C, 8x USB 3.2 Gen1 Type-A, 3x HDMI, 3x DP, 5x Audio Jacks, 1x Clear CMOS Button, 1x Q-Flash Plus Button, 2x RJ-45, 2x SMA (2T2R

SAMSUNG 980 PRO SSD 2TB PCIe NVMe Gen 4

- Next-level SSD performance: Unleash the power of the Samsung 980 PRO PCIe 4.0 NVMe SSD for next-level computing. 980 PRO delivers 2x the data transfer rate of PCIe 3.0, while maintaining compatibility with PCIe 3.0.
- Maximum Speed: Get read speeds up to 7,000 MB s with 980 PRO and push the limits of what SSDs can do. Powered by a new Elpsis controller designed to harmonize the flash memory components and the interface for superior speed – with a PCIe 4.0 interface that’s 2x faster than PCIe 3.0 SSDs and 12x faster than Samsung SATA SSDs – every component of this NVMe SSD is manufactured by Samsung for performance that lasts.
- A winning combination: Designed for hardcore gamers and tech-savvy users, the 980 PRO offers high-performance bandwidth and throughput for heavy-duty applications in gaming, graphics, data analytics, and more. It's fast at loading games, so you can play more and wait less.
- Efficient M.2 SSD: The 980 PRO comes in a compact M.2 2280 form factor, which can be easily plugged into desktops and laptops. Due to its size and thus optimized power efficiency, it’s ideal for building high-performance computing systems.
- Reliable thermal control: High-performance SSDs usually require high-performance thermal control. To ensure stable performance, the 980 PRO uses nickel coating to help manage the controller's heat level and a heat spreader label to deliver effective thermal control of the NAND chip.

LG 32” UltraFine Display Ergo UHD 4K IPS Display

- 32” UltraFine UHD (3840 x 2160) IPS Display
- Viewing Angle is 178º (R/L), 178º (U/D); Brightness is 350nits(typ); Aspect Ratio is 16:9
- LG Ergo Stand (Extends/Retracts/Swivels/Height/Pivot/Tilt)
- DCI-P3 95% Color Gamut with HDR 10
- USB Type-C with 60W PD
- 3-Side Virtually Borderless Design

Adafruit Software Defind Radio Receiver USB

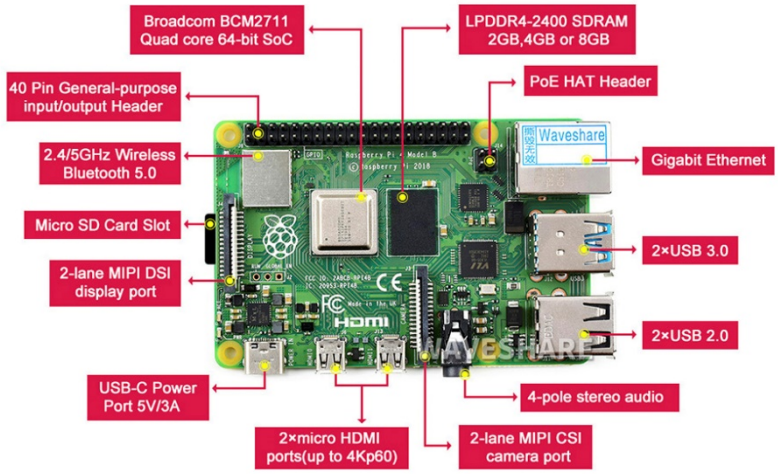
Key Features:

- Easiest way possible to have fun with a powerful, configurable receiver
- Can tune into signals from 24MHz to 1850MHz
- Very compact (but very good quality) RTL2832+R820T module with an MCX RF connector
- Basic 'DVB-T' antenna (not available in the US but will work in Europe)

If you've ever been curious about software defined radio (SDR), this USB stick is the easiest way possible to have fun with a powerful, configurable receiver. Packed with the powerful RTL2832U and R820T tuner, it can tune into signals from 24MHz to 1850MHz. That means you can use a computer (with Windows, Mac, or Linux) to tune into: FM Radio, AM signals (but not AM radio), CW (morse code!), unencrypted radio signals (such as those used by many police and fire departments), POCSAG pagers, and more.

Item Specifics
Antennae Length: 120.65mm / 4.75"
Wire Length: 1168.4mm / 46"
USB Dongle: 22.24mm x 23.1mm x 9.9mm / 0.87" x 0.9" x 0.38"

Raspberry Pi 4b 2Gb



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Input power:	5V DC
Operating temperature:	-20°C to +85°C

DataDiode Unidirectional data flow

DD1G series are data diodes with optical unidirectional data flow to ensure physical separation in one direction. The DD1G series offers high performance data transfer for Ethernet layer 2 in a small package.

Compact 1GB Data Diode

The SecuriCDS DD1G offers full Gigabit data throughput in a small package. The DD1G series works on Ethernet Layer 2. All network data on the upstream network will be automatically transferred to the downstream network, regardless of overlaying network protocol. The data diode requires unidirectional network protocols, e.g. UDP, to function correctly in a system. If any other protocol is needed, the interfacing systems must act as proxy services and convert these protocols into a unidirectional flow. By using a proxy service, the SecuriCDS Data Diode can handle common communication protocols, e.g. file or network time transfers.

Security

The DD1G series withstands modern attack methods by having a multi-layered unidirectional design. At the centre, an optical fibre connection ensures the separation of the two connected networks. As the DD1G series are pure hardware data diodes with no configuration options, the risk of having a unintentional faulty configuration is fully mitigated.

Native support

- Secure logging
- Sensor output from OT (Operation Technology) networks to IT (Information Technology) networks
- Sensor input from lower classified network to higher classified network, for example AIS (Automatic Identification System) data import • Media streaming • CCTV monitoring

With external proxies

- File transfer
- Software updates, e.g. WSUS, (Windows Server Update Services) antivirus
- Website mirroring

Advantages

- Optical high assurance separation
- Physical upstream separation
- Enables digitalisation without compromising security
- Fulfilment of internal and regulatory requirements

Software
Encryption process

Table of Contents

- Out-Of-Band Communication system
  - Why would I need to communicate Out Of Band ?
  - Why One Time Pad ?
  - What is One Time Pad ?
  - Implementation control
  - How does it work
  - Are you saying full duplex voice with One Time Pad ?
- Platforms
- Networks
- Building, keying & deploying
- External USB as key storage
- Randomness
- Scaling
- References

Out-Of-Band Communication system

This page summarizes what is Out-Of-Band and One Time Pad (OTP) in communication.

What is **'out of band'** and why **One Time Pad** for security ?

- Communication by any channel other than the primary channel can be considered "out-of-band" [1]
- One-time pad (OTP) is an encryption technique that cannot be cracked [2]

Why would I need to communicate Out Of Band ?

There are several reasons to have out of band communication capability.

Working in critical infrastructure or governmental functions might require resiliency what this kind of system provides. Being independent in infrastructure, networks and platforms allows you to scale and deploy communication solution to very specific use cases. For example. you may change networks on fly from "*infrastructure*" to "*tactical*" and solution provides same level of security and functions. You might also want to check out US CISA: RANSOMWARE GUIDE, SEPTEMBER 2020 (PDF) - where ransomware incident handling is instructed to happen over "out of band communication methods".

→ So, what is your "out of band communication method" ?

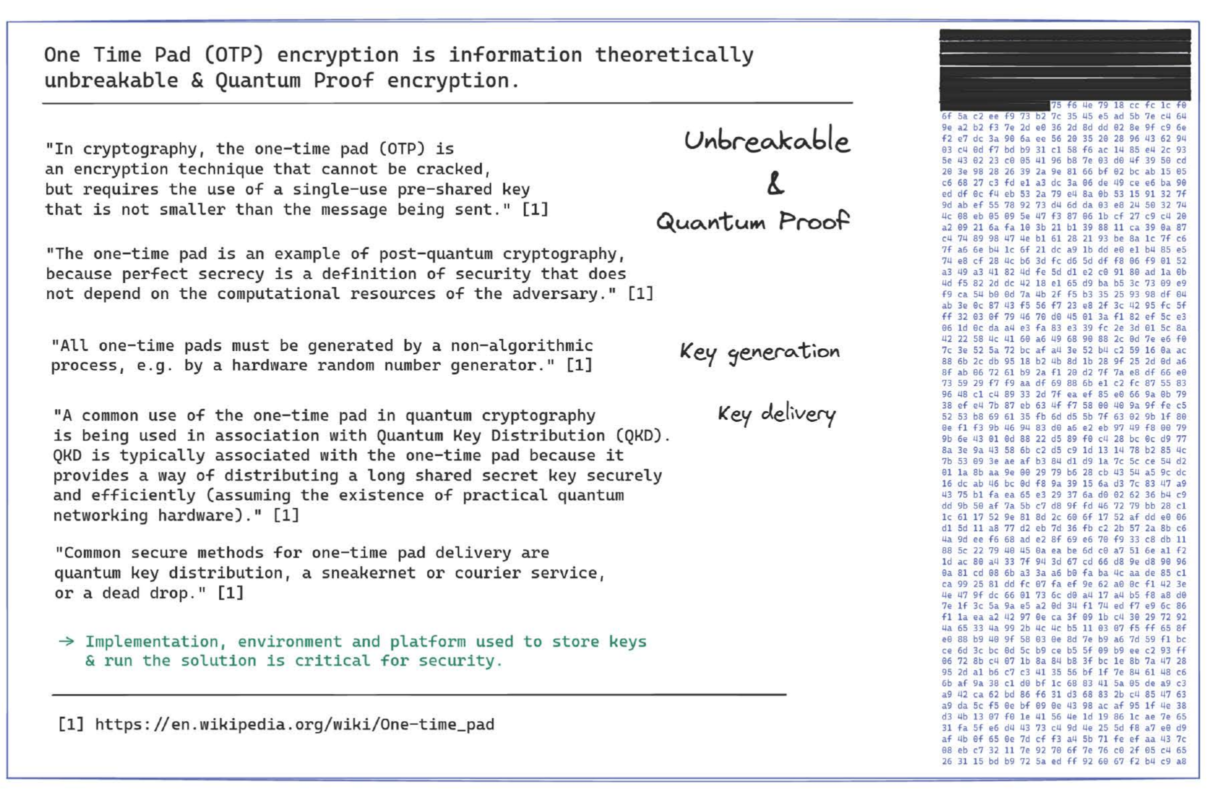
Why One Time Pad ?

Typically One Time Pad encryption method is used by highly sensitive information handling functions in governments & defense.

With one time pad you don't need to trust '**foreign mathematics**' to secure your information in exchange. Using One Time Pad to secure information, allows parties to share absolute secure channel, even when there is no common trust or ability to use classified algorithms (between countries for example).

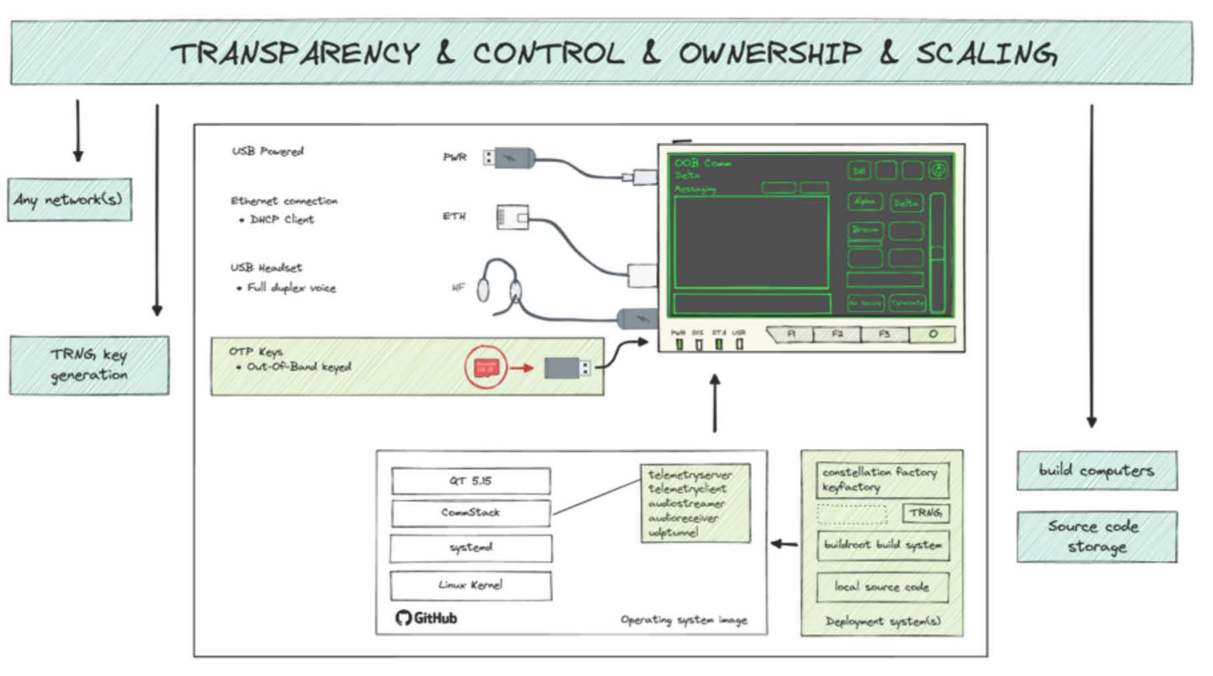
One Time Pad is secure against a cryptanalytic attack by a quantum computer. Making it post-quantum cryptography solution for high value data & communication. It's also very attractive solution for Quantum Key Distribution (QKD) based key delivery schemes.

What is One Time Pad ?



Implementation control

As One Time Pad provides absolute security it needs to be implemented right [6]. **Platform** where you execute functionality needs to be under control, **randomness** you deploy as keys - needs to be produced by **True Random Number generator (TRNG)** and distributed with strictly restrictive methods.

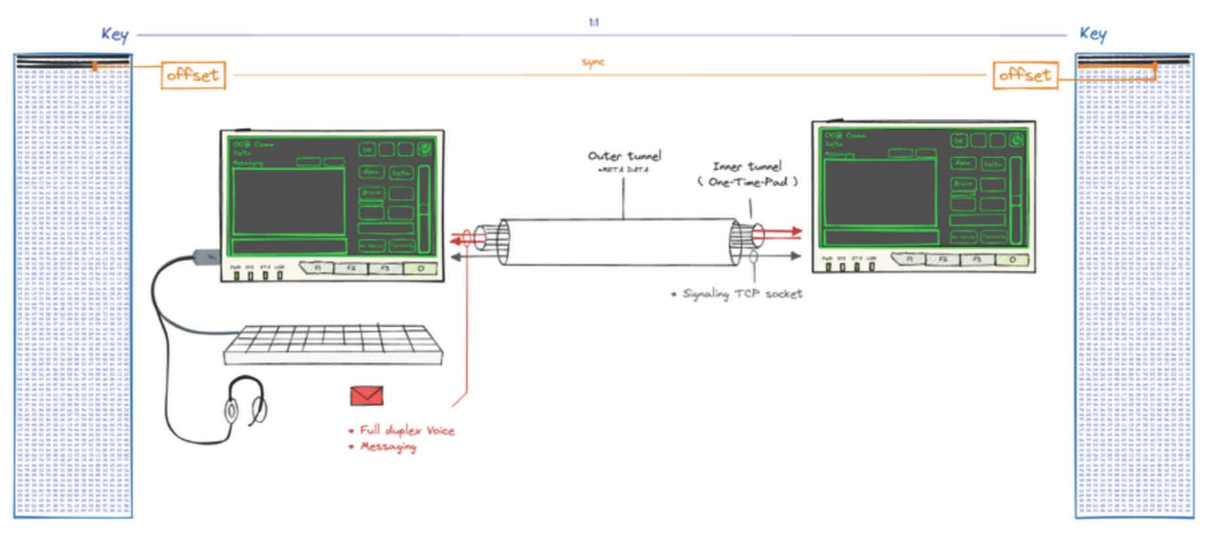


I've implemented solution with fully on premises build environment with zero cloud dependency. Your abilities to deploy this solution is not controlled by any external third party. All source code is provided for *inspection*, *modifications* and *compilation* purposes. With this approach, there is no vendor lock or dependencies to externally located functions. See EO 14028: Software Security in Supply Chains: Software Bill of Materials (SBOM) for excellent presentation how things are changing in industry.

How does it work

I have implemented solution, where traffic is being encrypted with One Time Pad and it allows to carry voice, messages or other payload data over insecure channel. Solution utilizes key material on both ends communicating and runs on self compiled minimal Linux kernel based Operating System (OS). It allows you to encapsulate OTP secured communication to various other protection protocols when needed.

Following picture illustrates simplicity of implementation.



By default units provide transport security and payload security with *two separate technologies*.

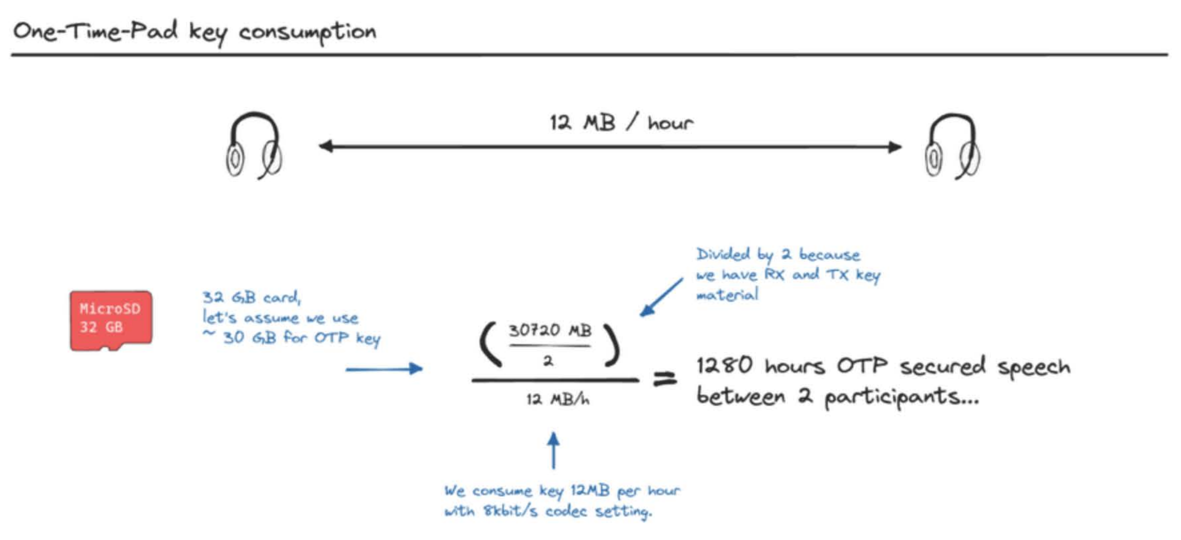
→ If you wish to see how traffic is being XOR'ed - check [redacted].

Are you saying full duplex voice with One Time Pad ?

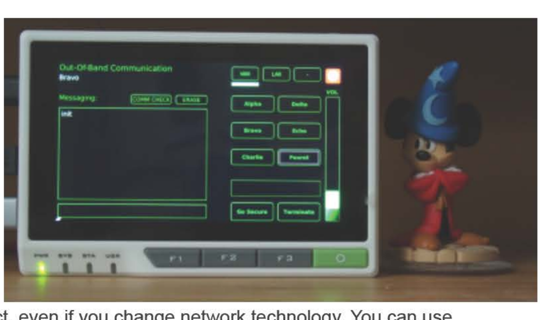
Short answer: Yes!

One Time Pad has traditionally been used with low bandwidth messaging solution over very restrictive links (like HF radios & manual delivery). But today we are able to utilize mass storage capacity with small physical size, which allows us to re-think implementation possibilities with One Time Pad.

With low bandwidth speech codecs, I am able to transport even full duplex voice communication over One Time Pad secured link. Key consumption is modest and acceptable, when you relate to security it provides.



Platforms



Presented solution can be (cross)compiled to various processor architectures.

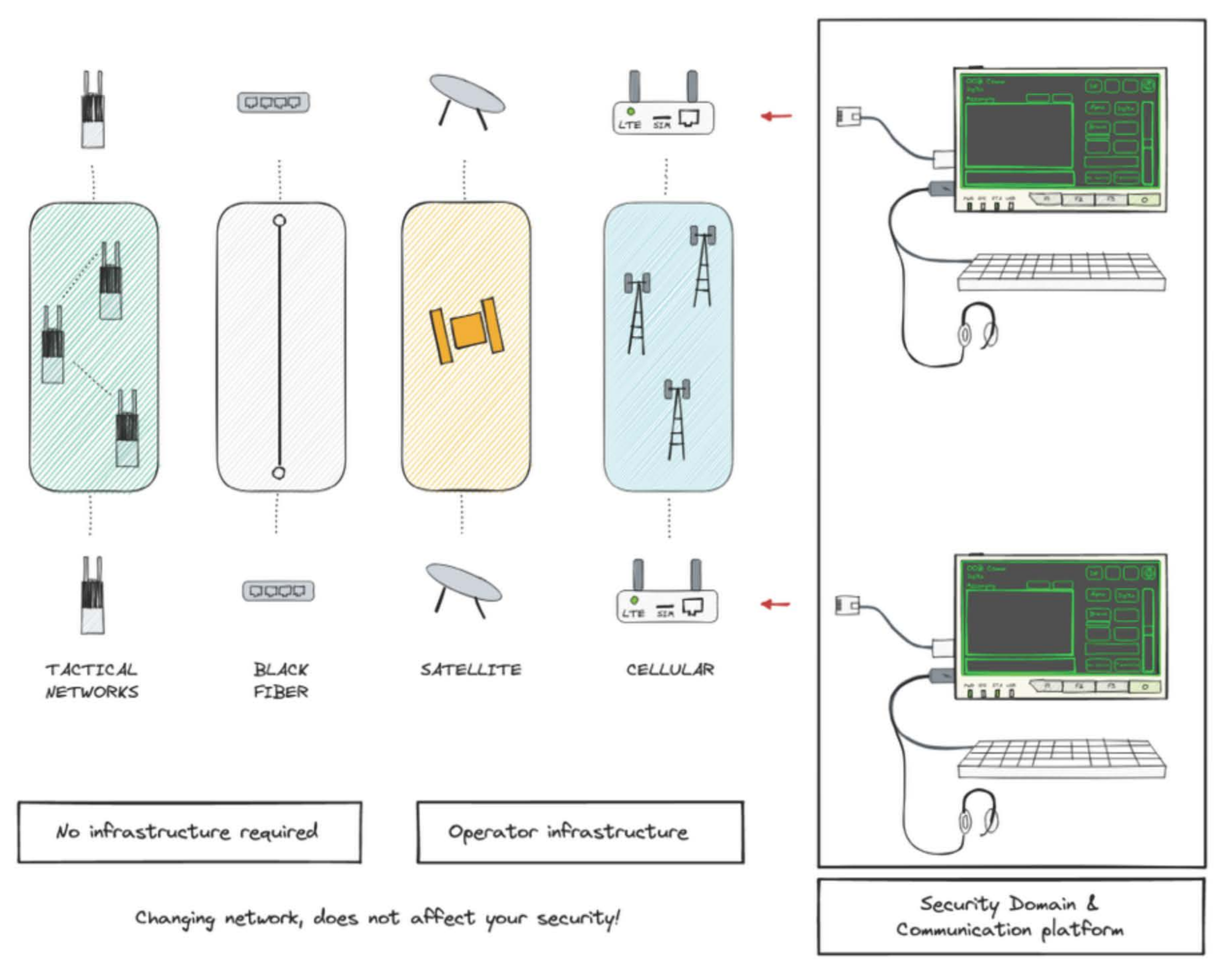
Currently it has been run on various ARM based SoC's, like Broadcom, HiSilicon, Rockchip and NXP variants. It can be compiled also into various ready made platforms and radio communication solutions.

Illustrated functionality on right runs **less than 100 MB RAM usage** with QT 5.15 based user interface.

Networks

With this approach you are able to keep your communication security domain intact, even if you change network technology. You can use commercial cellular networks or any broadband Internet access in normal situations and create plan to move communication to black fiber, satellite or MANET/MESH networks when commercial infrastructure does not provide service for your critical communications.

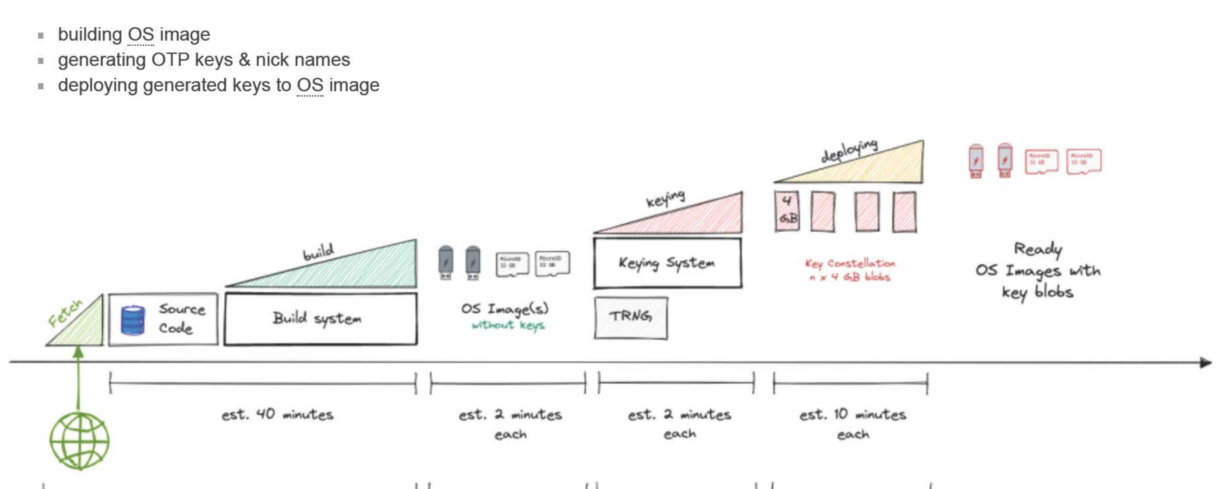
Piggybacking other networks, like corporate LAN or allied MESH radios - becomes also possible and creates flexibility to keep communications up in various out of the box scenarios.



Building, keying & deploying

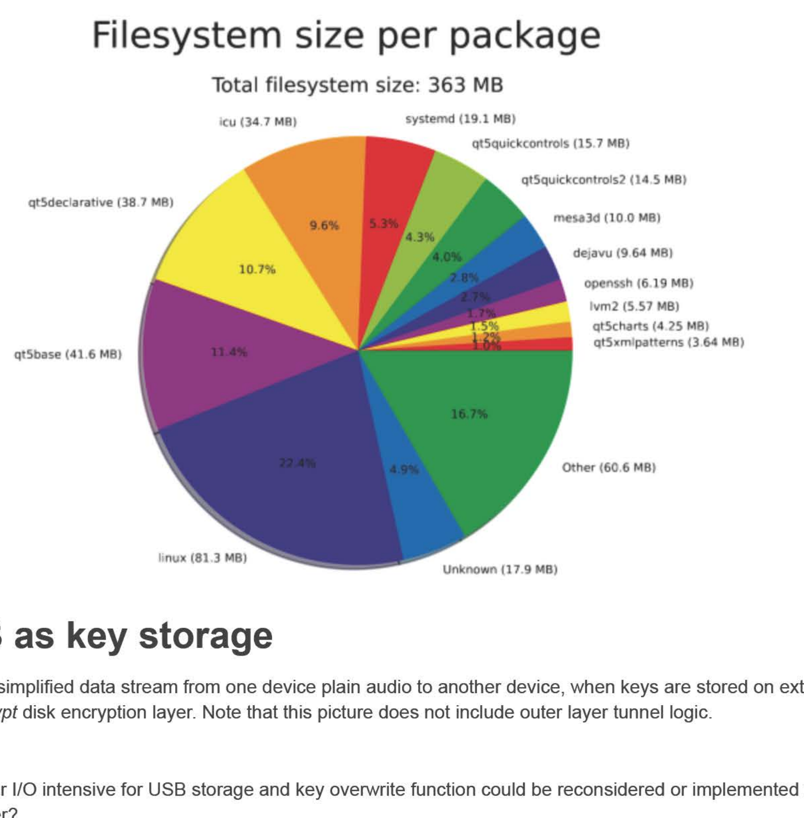
Producing working software images consists following phases:

- building OS image
- generating OTP keys & nick names
- deploying generated keys to OS image



! Illustrated timings are indicative, because they vary a lot depending how powerful build computer you have and how fast your TRNG is able to produce randomness. Lastly your ability to write produced OS images with keys to actual storage media (MicroSD, USB etc) defines how fast you can roll out.

Bellow you can see operating system (OS) size statistics and how it's distributed along different software components used with system:



External USB as key storage

Following picture illustrates simplified data stream from one device plain audio to another device, when keys are stored on external USB drive and drive is accessed via *dm-crypt* disk encryption layer. Note that this picture does not include outer layer tunnel logic.

This implementation is rather I/O intensive for USB storage and key overwrite function could be reconsidered or implemented in blocks, when keys are inside dm-crypt container?

I have not tested these USB drives, but they are recommended by this article. Check also this paper from Intel about USB 3.0 Radio Frequency Interference Impact on 2.4 GHz Wireless Devices.

- Corsair Flash Voyager GTX 128GB USB 3.1 Premium Flash Drive
- SanDisk 16GB Ultra Flair USB 3.0 Flash Drive
- SanDisk Ultra Fit 128GB USB 3.0 Flash Drive

Randomness

Understanding TRNG ('True Random Number Generator'), PRNG ('Pseudorandom number generator') and CSPRNG ('Cryptographically secure pseudorandom number generator') differences is useful, when deciding OTP keying source.

Producing keys and evaluating validity of produced data is essential. You might use dieharder tests or create visual representation of data for verfication.

Scaling

One of downsides of One Time Pad based systems is scaling. Key generation and distribution is quickly becoming an issue if you like to scale peer count. Typically OTP based communication systems are best suited for *low volume deployments*, where *physical key delivery* can happen securely along organization other logistic functions.

Following three phases are most time consuming, when you think scaling up your OTP deliveries:

Key generation is often first bottle neck. TRNG selection as randomness source dictate speed which you can generate keys. For example Quantis QRNG PCIe card can output *40 Mbps* and *240 Mbps* as entropy source. Testing generated key material would be good, but *dieharder* tests for several gigabytes of key material takes some time as well.

Deploying randomness as usable keyset(s) is usually fast. This is mainly bit copying on computer to suitable container format (files) and deploying these files into distribution format package. Part of this deployment is of course decisions, how many peers and how they are able to communicate with each others. Are keys provided as complete mesh (every one can talk to everyone) or is communication model between remotes and HQ only (Only HQ can be communicated and no peers are able to exchange information). These decisions could take time when mapped to security oriented organization requirements.

Storing keyset(s) to storage device can be slow. If you need to write several gigabytes of files to tenths of USB drives, you better select fast USB 3.x controller and USB drives supporting fast write speeds.

Planning all above is important part of successful OTP operation. Key generation and validity checking should be 24/7 process in controlled environment. With this approach you have always pool of verified randomness, where you can source key material for faster deployment when needed.

Illustration of peer scaling effect with 1 GB key size:

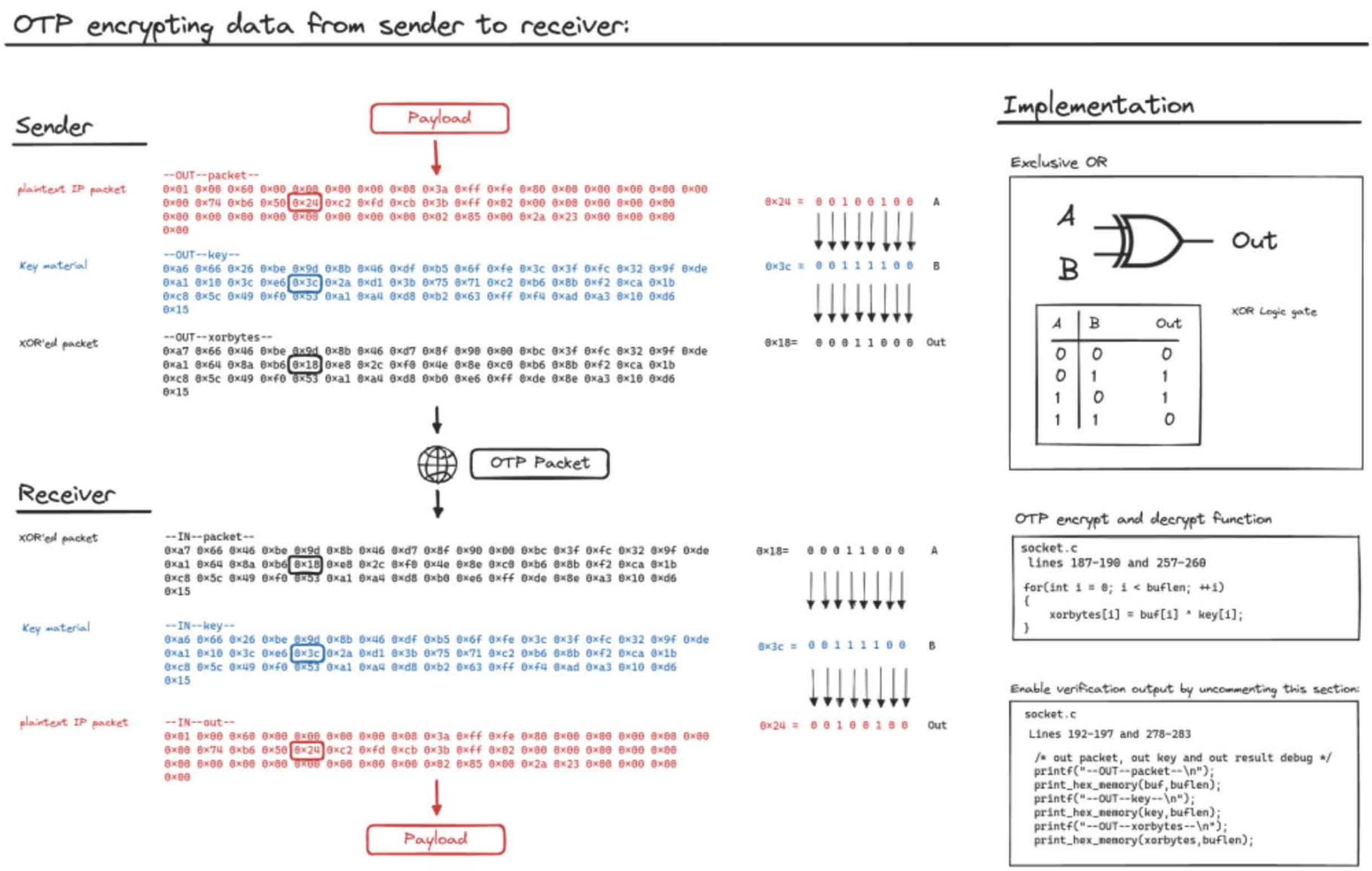
You can download this LibreOffice Calc spreadsheet to experiment key size effect with different peer counts: otp-calculator.ods

References

- [1] https://en.wikipedia.org/wiki/Out-of-band
- [2] https://en.wikipedia.org/wiki/One-time_pad
- [3] [redacted]
- [4] [redacted]
- [5] [redacted]
- [6] [redacted]
- [7] [redacted]

Verifying example

Following picture shows you how *udptunnel* does XOR for network packets. You can inspect socket.c source code file and uncomment illustrated debug parts in code. After this, your udptunnel binaries output data entering into XOR process, key data and output result. Running these processes side by side, gives you quickly understanding how simple this approach is



Verifying other Post Quantum algorithms

You should also follow NIST post quantum cryptography PQC project, which is "..NIST initiated a process to solicit, evaluate, and standardize one or more quantum-resistant public-key cryptographic algorithms". As an example of PQC implementation: "Kyber is an IND-CCA2-secure key encapsulation mechanism (KEM), whose security is based on the hardness of solving the learning-with-errors (LWE) problem over module lattices."

CRYSTALS - Cryptographic Suite for Algebraic Lattices [1]

$$X^{256}+1=\prod_{i=0}^{127}(X^2-\zeta^{2i+1})=\prod_{i=0}^{127}(X^2-\zeta^{2\mathsf{br}_7(i)+1}),$$

$$(f \bmod X^2-\zeta^{2\mathsf{br}_7(0)+1},\ldots,f \bmod X^2-\zeta^{2\mathsf{br}_7(127)+1}).$$

$$\hat{f}_{2i}=\sum_{j=0}^{127} f_{2j}\zeta^{(2\mathsf{br}_7(i)+1)j},$$

$$\hat{f}_{2i+1}=\sum_{j=0}^{127} f_{2j+1}\zeta^{(2\mathsf{br}_7(i)+1)j}.$$

[1] https://pq-crystals.org/kyber/data/kyber-specification-round3-20210804.pdf

- CRYSTALS-Kyber - Algorithm Specifications And Supporting Documentation

→ For me (at least) understanding how OTP works is more clear.

Dieharder test for 25 GB

Testing 25 GB file with dieharder takes around 10 minutes.

```
time dieharder -a -f 051122.bin
#==================================================================================#
#            dieharder version 3.31.1 Copyright 2003 Robert G. Brown               #
#==================================================================================#
   rng_name    |           filename             |rands/second|
        mt19937|                 051122.bin|  2.15e+08  |
#==================================================================================#
        test_name   |ntup| tsamples |psamples|  p-value |Assessment
#==================================================================================#
   diehard_birthdays|   0|       100|     100|0.64542724|  PASSED
      diehard_operm5|   0|   1000000|     100|0.26357191|  PASSED
  diehard_rank_32x32|   0|     40000|     100|0.12518496|  PASSED
    diehard_rank_6x8|   0|    100000|     100|0.48832085|  PASSED
   diehard_bitstream|   0|   2097152|     100|0.87908328|  PASSED
        diehard_opso|   0|   2097152|     100|0.59995402|  PASSED
        diehard_oqso|   0|   2097152|     100|0.76917850|  PASSED
         diehard_dna|   0|   2097152|     100|0.26331018|  PASSED
diehard_count_1s_str|   0|    256000|     100|0.13040031|  PASSED
diehard_count_1s_byt|   0|    256000|     100|0.06192745|  PASSED
 diehard_parking_lot|   0|     12000|     100|0.99885078|   WEAK
    diehard_2dsphere|   2|      8000|     100|0.46371373|  PASSED
    diehard_3dsphere|   3|      4000|     100|0.67201306|  PASSED
     diehard_squeeze|   0|    100000|     100|0.50617924|  PASSED
        diehard_sums|   0|       100|     100|0.01063360|  PASSED
        diehard_runs|   0|    100000|     100|0.96584605|  PASSED
        diehard_runs|   0|    100000|     100|0.90750838|  PASSED
      diehard_craps|   0|    200000|     100|0.64516949|  PASSED
      diehard_craps|   0|    200000|     100|0.94437709|  PASSED
 marsaglia_tsang_gcd|   0|  10000000|     100|0.76162372|  PASSED
 marsaglia_tsang_gcd|   0|  10000000|     100|0.84516338|  PASSED
          sts_monobit|   1|    100000|     100|0.17416305|  PASSED
             sts_runs|   2|    100000|     100|0.37929438|  PASSED
           sts_serial|   1|    100000|     100|0.54764962|  PASSED
           sts_serial|   2|    100000|     100|0.67347117|  PASSED
           sts_serial|   3|    100000|     100|0.12574986|  PASSED
           sts_serial|   3|    100000|     100|0.00541508|  PASSED
           sts_serial|   4|    100000|     100|0.40160290|  PASSED
           sts_serial|   4|    100000|     100|0.98638385|  PASSED
           sts_serial|   5|    100000|     100|0.25164998|  PASSED
           sts_serial|   5|    100000|     100|0.46921589|  PASSED
           sts_serial|   6|    100000|     100|0.03214021|  PASSED
           sts_serial|   6|    100000|     100|0.46037457|  PASSED
           sts_serial|   7|    100000|     100|0.06162345|  PASSED
           sts_serial|   7|    100000|     100|0.13283972|  PASSED
           sts_serial|   8|    100000|     100|0.03510761|  PASSED
           sts_serial|   8|    100000|     100|0.97330822|  PASSED
           sts_serial|   9|    100000|     100|0.10253078|  PASSED
           sts_serial|   9|    100000|     100|0.43732611|  PASSED
           sts_serial|  10|    100000|     100|0.00923273|  PASSED
           sts_serial|  10|    100000|     100|0.18410724|  PASSED
           sts_serial|  11|    100000|     100|0.06426813|  PASSED
           sts_serial|  11|    100000|     100|0.73972165|  PASSED
           sts_serial|  12|    100000|     100|0.52578439|  PASSED
           sts_serial|  12|    100000|     100|0.35904551|  PASSED
           sts_serial|  13|    100000|     100|0.31273290|  PASSED
           sts_serial|  13|    100000|     100|0.57953474|  PASSED
           sts_serial|  14|    100000|     100|0.25240001|  PASSED
           sts_serial|  14|    100000|     100|0.95160327|  PASSED
           sts_serial|  15|    100000|     100|0.91874300|  PASSED
           sts_serial|  15|    100000|     100|0.91132588|  PASSED
           sts_serial|  16|    100000|     100|0.73514127|  PASSED
           sts_serial|  16|    100000|     100|0.18160898|  PASSED
         rgb_bitdist|   1|    100000|     100|0.79225729|  PASSED
         rgb_bitdist|   2|    100000|     100|0.58125052|  PASSED
         rgb_bitdist|   3|    100000|     100|0.28129170|  PASSED
         rgb_bitdist|   4|    100000|     100|0.50557629|  PASSED
         rgb_bitdist|   5|    100000|     100|0.09472360|  PASSED
         rgb_bitdist|   6|    100000|     100|0.59631508|  PASSED
         rgb_bitdist|   7|    100000|     100|0.91393783|  PASSED
         rgb_bitdist|   8|    100000|     100|0.53682549|  PASSED
         rgb_bitdist|   9|    100000|     100|0.98673603|  PASSED
         rgb_bitdist|  10|    100000|     100|0.91659785|  PASSED
         rgb_bitdist|  11|    100000|     100|0.80990285|  PASSED
         rgb_bitdist|  12|    100000|     100|0.96960205|  PASSED
rgb_minimum_distance|   2|     10000|    1000|0.58400815|  PASSED
rgb_minimum_distance|   3|     10000|    1000|0.87496161|  PASSED
rgb_minimum_distance|   4|     10000|    1000|0.84112724|  PASSED
rgb_minimum_distance|   5|     10000|    1000|0.63209064|  PASSED
    rgb_permutations|   2|    100000|     100|0.09231922|  PASSED
    rgb_permutations|   3|    100000|     100|0.03628493|  PASSED
    rgb_permutations|   4|    100000|     100|0.94942602|  PASSED
    rgb_permutations|   5|    100000|     100|0.76709166|  PASSED
      rgb_lagged_sum|   0|   1000000|     100|0.21719025|  PASSED
      rgb_lagged_sum|   1|   1000000|     100|0.82932532|  PASSED
      rgb_lagged_sum|   2|   1000000|     100|0.47736628|  PASSED
      rgb_lagged_sum|   3|   1000000|     100|0.79553923|  PASSED
      rgb_lagged_sum|   4|   1000000|     100|0.50621299|  PASSED
      rgb_lagged_sum|   5|   1000000|     100|0.98019274|  PASSED
      rgb_lagged_sum|   6|   1000000|     100|0.43184828|  PASSED
      rgb_lagged_sum|   7|   1000000|     100|0.87544344|  PASSED
      rgb_lagged_sum|   8|   1000000|     100|0.85924562|  PASSED
      rgb_lagged_sum|   9|   1000000|     100|0.13677483|  PASSED
      rgb_lagged_sum|  10|   1000000|     100|0.63166482|  PASSED
      rgb_lagged_sum|  11|   1000000|     100|0.84046191|  PASSED
      rgb_lagged_sum|  12|   1000000|     100|0.94129420|  PASSED
      rgb_lagged_sum|  13|   1000000|     100|0.87931912|  PASSED
      rgb_lagged_sum|  14|   1000000|     100|0.66938719|  PASSED
      rgb_lagged_sum|  15|   1000000|     100|0.93367845|  PASSED
      rgb_lagged_sum|  16|   1000000|     100|0.60807038|  PASSED
      rgb_lagged_sum|  17|   1000000|     100|0.27260157|  PASSED
      rgb_lagged_sum|  18|   1000000|     100|0.30851775|  PASSED
      rgb_lagged_sum|  19|   1000000|     100|0.34297990|  PASSED
      rgb_lagged_sum|  20|   1000000|     100|0.87398460|  PASSED
      rgb_lagged_sum|  21|   1000000|     100|0.51772742|  PASSED
      rgb_lagged_sum|  22|   1000000|     100|0.12857993|  PASSED
      rgb_lagged_sum|  23|   1000000|     100|0.07811717|  PASSED
      rgb_lagged_sum|  24|   1000000|     100|0.39837676|  PASSED
      rgb_lagged_sum|  25|   1000000|     100|0.78236382|  PASSED
      rgb_lagged_sum|  26|   1000000|     100|0.25281392|  PASSED
      rgb_lagged_sum|  27|   1000000|     100|0.71134639|  PASSED
      rgb_lagged_sum|  28|   1000000|     100|0.40646179|  PASSED
      rgb_lagged_sum|  29|   1000000|     100|0.51820174|  PASSED
      rgb_lagged_sum|  30|   1000000|     100|0.70202711|  PASSED
      rgb_lagged_sum|  31|   1000000|     100|0.75454030|  PASSED
      rgb_lagged_sum|  32|   1000000|     100|0.02617129|  PASSED
     rgb_kstest_test|   0|     10000|    1000|0.80245585|  PASSED
     dab_bytedistrib|   0|  51200000|       1|0.91440743|  PASSED
             dab_dct| 256|     50000|       1|0.34982675|  PASSED
Preparing to run test 207.  ntuple = 0
        dab_filltree|  32|  15000000|       1|0.93689085|  PASSED
        dab_filltree|  32|  15000000|       1|0.90502573|  PASSED
Preparing to run test 208.  ntuple = 0
       dab_filltree2|   0|   5000000|       1|0.44087654|  PASSED
       dab_filltree2|   1|   5000000|       1|0.93869298|  PASSED
Preparing to run test 209.  ntuple = 0
        dab_monobit2|  12|  65000000|       1|0.97004773|  PASSED

real    9m30.113s
user    9m28.954s
sys     0m0.270s
```

Tests are explained briefly at Wikipedia page.

Out-Of-Band Communication : Abstract

Out-Of-Band communication system with supply chain security and resilience is needed within various organizations and governmental entities. Illustrated system allows communication with **Full Duplex Voice**, **Messaging** and various **payload transfer** functions. It utilizes gateway servers to circumvent NAT in networks and can be used without servers over various network mediums.

Use cases include governmental actors, defense and related industry together with Critical Infrastructure actors. Presented system utilizes Quantum Proof encryption and could offer approach when preparing Critical Infrastructure for Post-Quantum Cryptography in critical communications.

Ransomware response tool

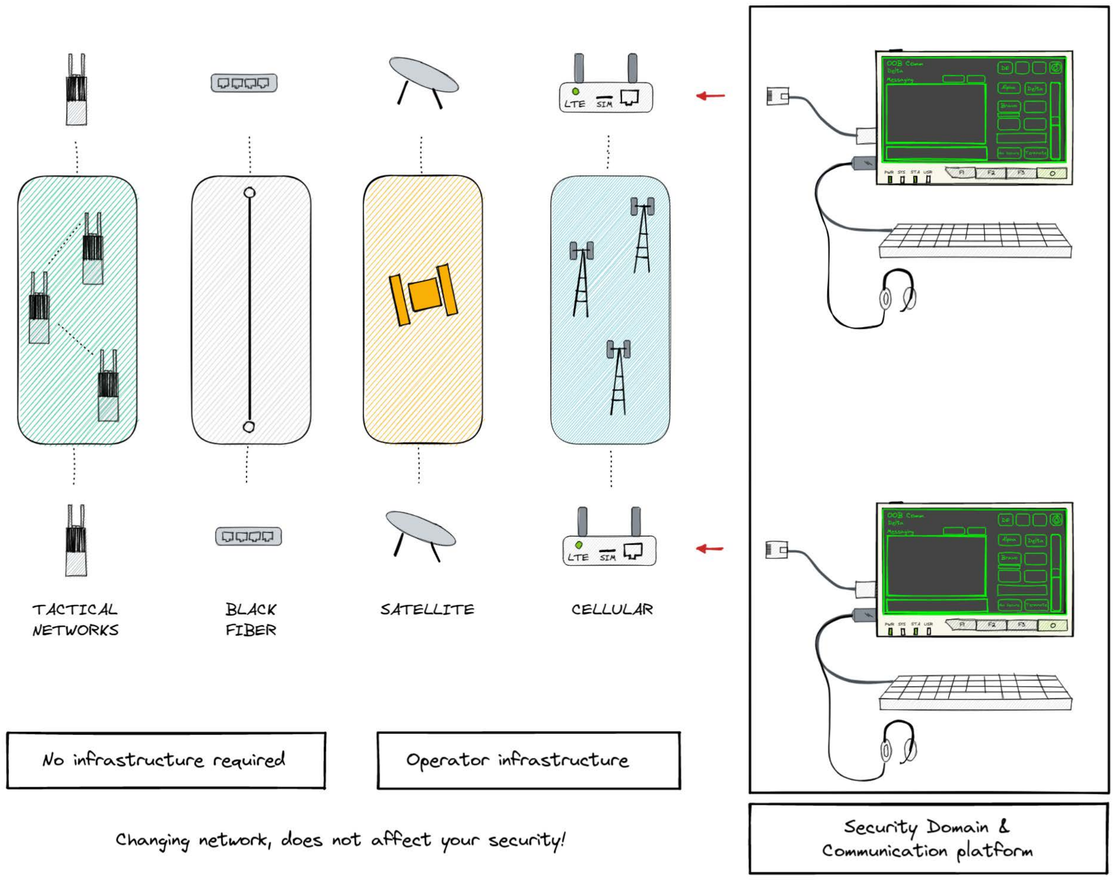
Based on ransomware guide by Cybersecurity and Infrastructure Security Agency (CISA, US), organizations should have 'out-of-band' communication methods available for response functions.

> ☐ After an initial compromise, malicious actors may monitor your organization's activity or communications to understand if their actions have been detected. Be sure to isolate systems in a coordinated manner and use out-of-band communication methods like phone calls or other means to avoid tipping off actors that they have been discovered and that mitigation actions are being undertaken. Not doing so could cause actors to move laterally to preserve their access—already a common tactic—or deploy ransomware widely prior to networks being taken offline.

What is your "Out-Of-Band" method if adversary is inside your computer networks, emails, voip & mobile devices - compromising your comms as it happens? What if your cloud connectivity is in denied state?

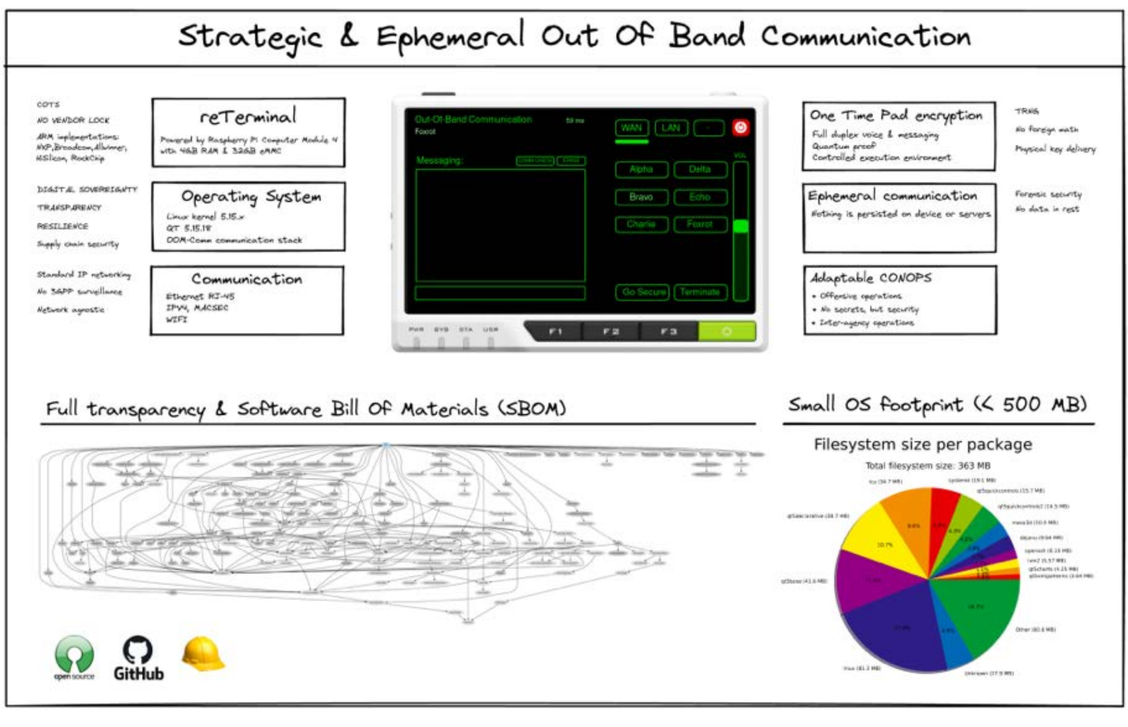
Network agility

Attached picture illustrates network agility of described system.



Security Of Supply

Presented solution is open source and freely available with various embedded Linux platforms. It's provided with source code, build systems and software bill of materials.



Out-Of-Band communication on Pinephone

This page presents my out-of-band communication code running on Pinephone. Pinephone is NOT and Android phone and it does not run on Qualcomm SoC. It's essentially embedded Linux computer with Display, Wifi, LTE and Allwinner A64 SoC. It can boot from MicroSD card or internal eMCC storage device.

OOB-Comm software consist of small embedded Linux image and simple user interface. It allows you to message and voice call between devices, with various network configurations and with ephemeral approach.

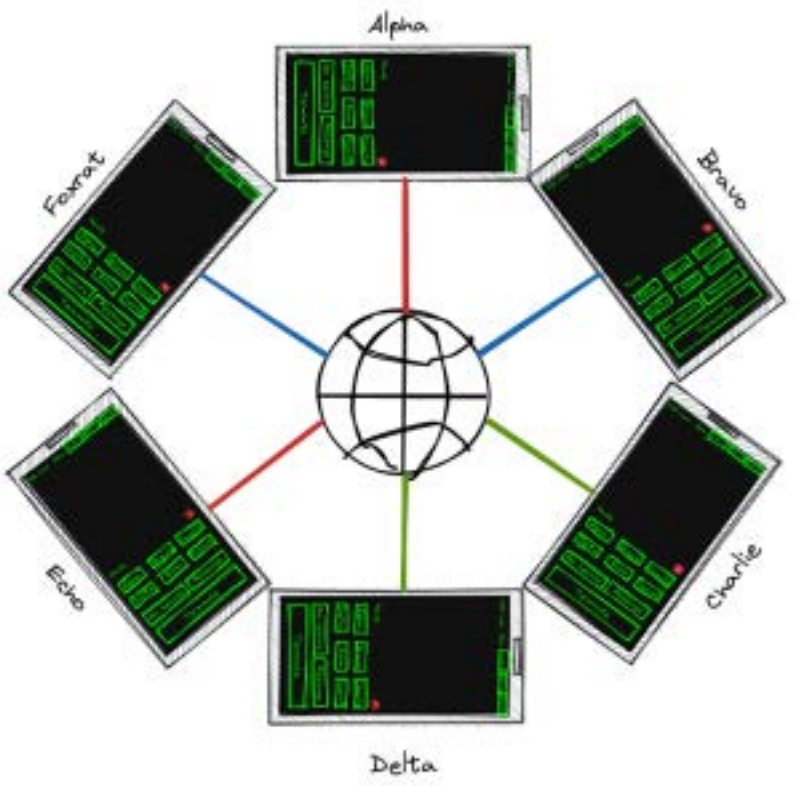
Main features:

Linux kernel, QT based user interface
OOB-Comm communication software stack
Messages point-to-point
Full Duplex Voice point-to-point
Double layered tunneling with selectable protocols
One-Time-Pad encryption
All functions are ephemeral, no forensic traces on device or network
Audio calls requires external USB-C attached HF
Camo UI for denied areas

Small constellation

When devices are keyed to constellation, they can connect point-to-point with each others. In networks, where devices are behind NAT connection - like cellular networks, you can utilize tunneling server in public location to circumvent NAT. In this scenario, this server element does not store any details on communication content or identifying data of communication parties.

If devices are located to tactical networks, fiber connection or similar - they can be configured for direct connection between each others.



By default system has six participants and they can connect, message and voice call between each others.

Fundamental difference

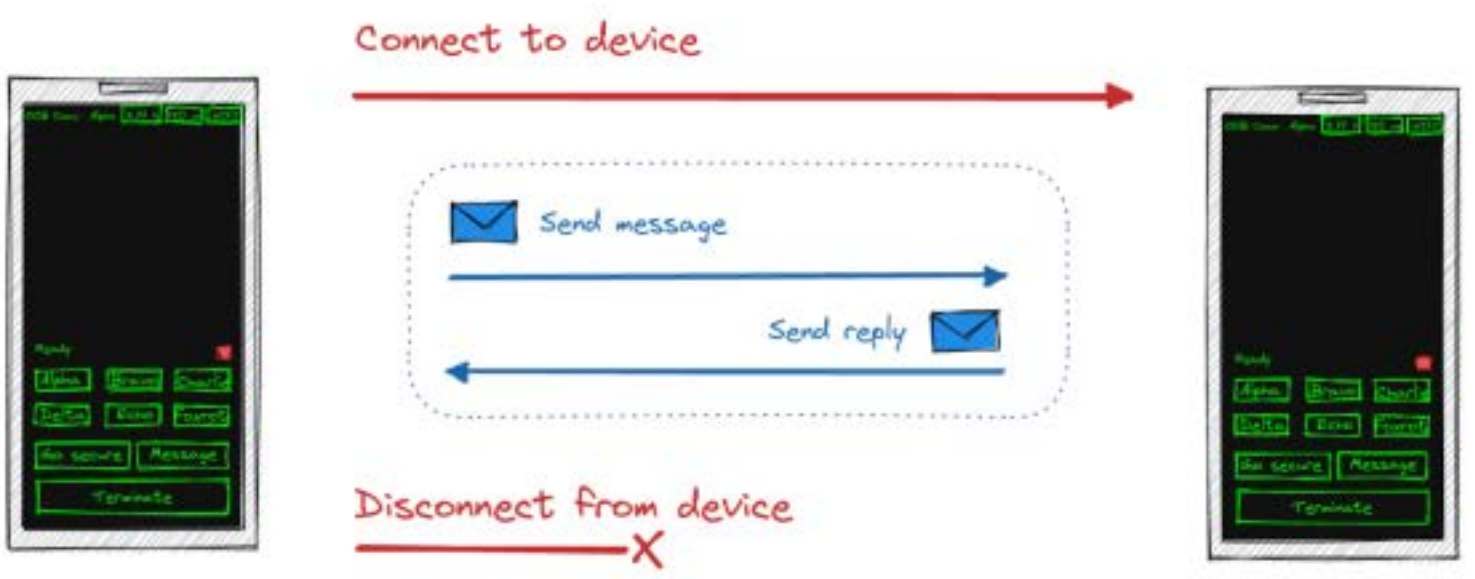
Even pinephone hardware looks like an mobile phone - concept of OOB-Comm is far from mobile phones. First difference is that devices are *not* registered anyhow to any infrastructure element (like Telco's subscriber database). Secondly, all communication is ephemeral - meaning everything happens without store-and-forward functionality and none of communication is written to local storage on devices or anywhere in server storage. Ephemeral nature of this communication, requires also participants to be available at the same time with devices connected. Third, concept of One-Time-Pad means that cryptography is Quantum Proof and always out-of-band keyed as well.

Delivering device to another party requires always physical meet and delivery process.

Connecting for Comms

Solution is based on direct tunneled connection between devices. Any communication between parties requires this connection and it's handled separately from communication itself. Meaning you need to connect before communication.

- To message between devices, you need first select device to connect. Then send Message.
- To have speech between devices, you need first select device to connect. Then activate Voice.



Voice communication

You can also have **full duplex voice communication** between devices. This requires **external USB-C HF set** connected to Pinephone. First you need **connect to remote party** and then activate voice communication by pressing **“Go Secure” button**.

- Please note that *only connection initiator* is able to activate voice connection by pressing **Go Secure**.

C4i communication

LEARN MORE: c4icommunication.com
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