



# Net.Shark a tap for Power Utilities

## IEC 61850 commissioning tool

**Net.Shark is a handheld tap capable of filtering, capturing and forwarding any Ethernet based protocol including PTP, NTP, GOOSE, SV or MMS, which are part of IEC-61850.** It is a tap with unique characteristics, ideal for field operations such as electrical substations, as it is a self-contained unit, with batteries, screen and keyboard, that can be connected to any point no matter how small, high or hidden.

Protocol sniffing has become a common practice in substations adopting the IEC 61850 standard. However, to do it correctly, it is necessary to use taps to capture in full duplex mode. It is important to note that conventional laptops do not have this capability, as they usually have only one port, and CPUs run software but are not capable of processing two Gigabit streams (Tx + Rx) simultaneously without causing delays or errors to critical IEC61850 traffic such as SV or PTP.

### Capturing in Substations

The physical connections between network Clocks, IEDs, Switchgear, Circuit Breakers and Bay Controllers are often located in small, hard-to-reach panels, making it difficult to connect other devices. This is why we have developed Net.Shark, a lightweight and portable tap to reach anywhere on the network and captures Ethernet packets by firmware, ensuring that none are lost or cause impairments or errors to other traffic.

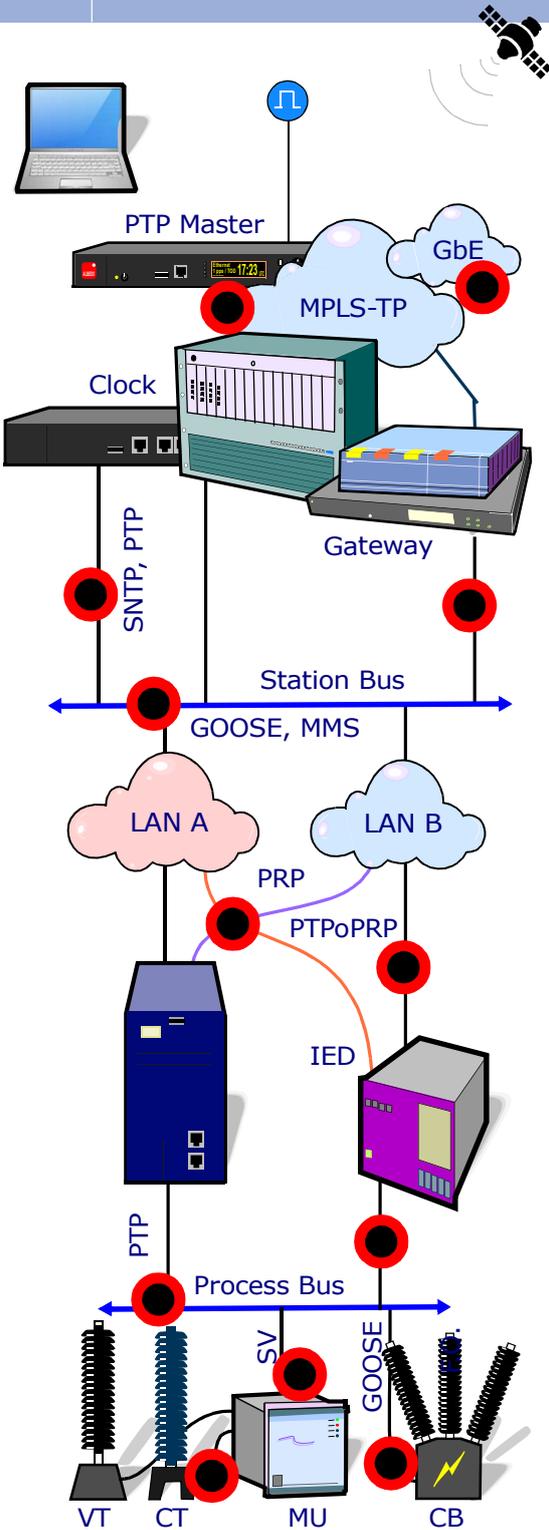
### About taps

There are some laptops that claim to be good taps, but this isn't always the case. Firstly, because they do not have a dual port, so they cannot connect in pass-through mode. However, there is the option of connecting to a mirror port, but these are not always available, and when they are, it is a low priority process where there is no guarantee that all packets will be processed.

### “Portable Tap for Protocol Analysis & Troubleshooting”

However, there is another, even more important reason not to use a laptop as a tap, and that is processing capacity. You just have to remember that a laptop is a sequential machine that uses software and a CPU, and that is not enough --even if it is the latest model-- so it will only work with low speed protocols like VoIP, but never in IEC-61850 substations where there are tens of IEDs and thousands of messages exchanged every second. The solution is always a tap, because it works through firmware, not software like a laptop. Net.Shark is ideal because it is 100% autonomous and does not require a host to configure and deploy it on the network.





## Easy Capture

### Firmware process

To identify the traffic to be capture Net.Shark has 16 programmable filters in each direction (Tx+Rx) to match any field of the Ethernet packet:

- **User filter:** Protocols such as PTP, GOOSE, SV, MMS can be identified by the Ethertype.
- **MAC:** source address & mask, destination address & mask, ethertype & mask.
- **VLAN:** VID, priority bits, etc
- **IP:** IPv4 / IPv6, source address & mask, destination address & mask, protocol, DSCP, etc
- **TCP:** Source/Destination Port, Min/Max Source/Destination Port, etc
- **UDP:** Source/Destination Port, Min/Max Source/Destination Port, etc

### “Net.Shark in your pocket & go anywhere!”

### Copy + Forward + Aggregation

Those packets that match one of the filters are copied and passed on with the rest of the traffic without being retained. Copies of these packets are immediately sent through the third Ethernet port without delay, both those received on the Tx and Rx lines, and in this way the aggregates reach the computer or server where they are processed.

### Secure

The tap does not use IP or MAC addresses, so Net.Shark cannot be detected under any circumstances, as it is not vulnerable to attack and is as transparent as a cable.

## Field Operation

Net.Shark is the right choice for the field, and especially for engineers migrating to the new IEC-61850 substations. Net.Shark is powerful, lightweight and comprehensive for troubleshooting, while allowing full-duplex operation 24 hours.

### “Wirespeed by FPGA & Full Duplex capture”

Net.Shark can be connected to a mirror point or in pass-through mode, while the link setup can be auto-negotiated and manually configured for speed, duplex mode and pause parameters. As well as providing autonomy, the battery ensures that the 100% tap function is completely passive and won't disrupt the network if the power is lost. Interruptions and power failures no longer mean dropped packets and lengthy renegotiation sequences.

## Substation or Laboratory

Net.Shark is equipped with interesting features to complement analysers:

- **Mobility**, it is a true battery powered device that weighs less than 1.2kg.
- **Firmware filters** user defined to identify protocol flows.
- **Full duplex**, it works in both directions to capture protocols.
- **Wirespeed**, zero loss and zero delay.
- **Copy & Forward**, matching packets are copied and forwarded to the mirror.
- **Copy & Save**, matching packets can be saved to the SD card in PCAP.
- **Errored Frames**, good to troubleshoot: FCS, runts, fragments are also captured.
- **Remote control**, on any client with standard VNC.
- **Transparency**, as it is invisible to the for increased security
- **Aggregation**, matching packets of both port are aggregated to the output.
- **Regeneration**, after tapping all traffic is forwarded.

Fig 1. Net.Shark points to capture IEC-61850 protocol.

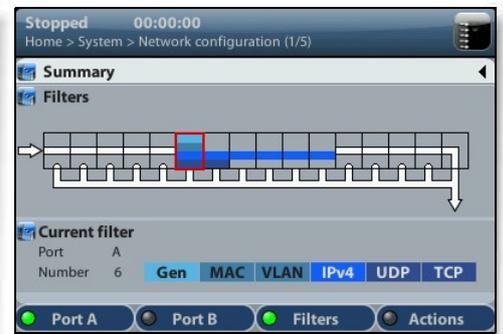
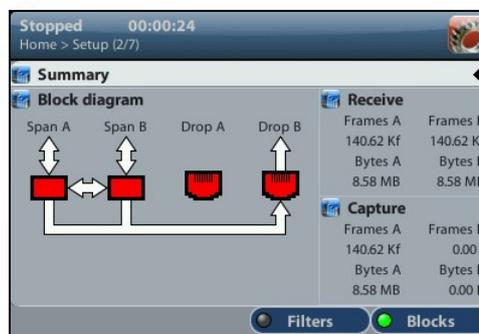
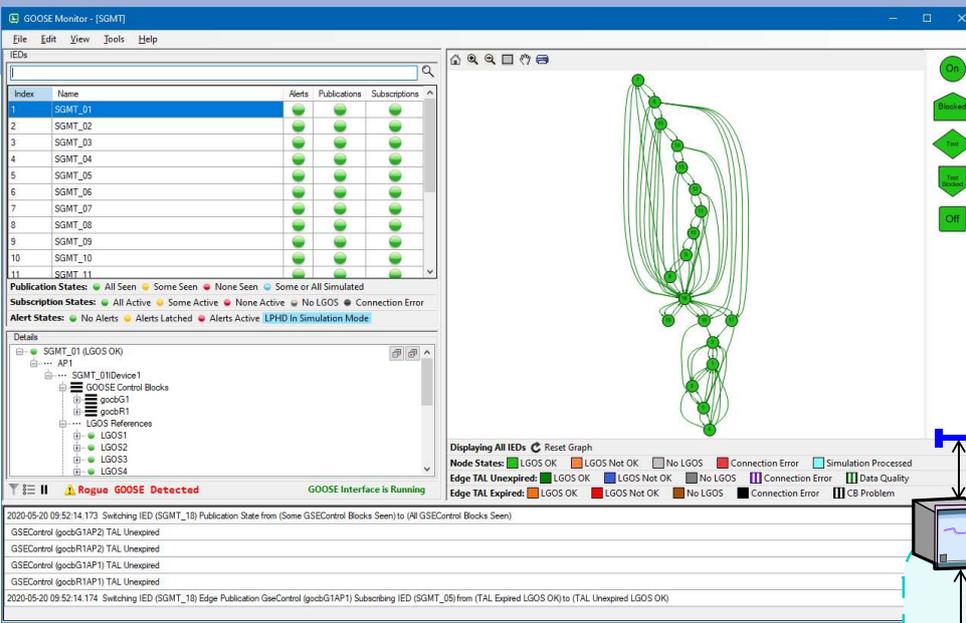


Fig 2. Net.Shark in operation, configuration of filters and tap.



Protocol Analyzer

Net.Shark

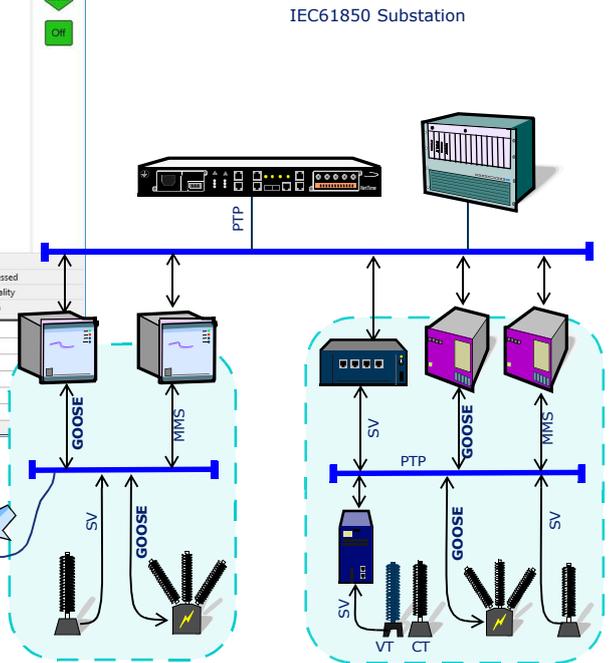


Fig 3. Net.Shark in operation.

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# Commissioning

It is PTP, NTP, GOOSE and SV are the protocols that IEDs use to perform mission-critical tasks that ensure the safe and reliable operation of the power system:

- **Protection:** to detect and isolate faults in the power system.
- **Control:** to receive commands from the central system to adjust settings.
- **Synchronisation:** ensuring perfect time alignment using PTP or NTP
- **Monitoring:** monitoring the power system for anomalies and reporting to identify and take corrective action.
- **Metering:** measuring the flow of electrical energy to accurately bill customers and monitor energy consumption.

All of the above tasks can only be performed using IEC 61850 protocols, thus enabling real-time monitoring and control of the power system, which is essential for maintaining system stability and reliability.

It is important to ensure that the tap is placed in a location that allows all relevant traffic to be captured and that the tap itself does not introduce additional points of failure, traffic degradation or security vulnerabilities into the utility's network.

# Plug & Capture

The challenge is the same: monitor performance, troubleshoot communication issues, ensure connectivity or verify synchronisation of IEC 61850 protocols.

Since a new IED is often not fully compatible with other IEDs already installed, or requires a different configuration, or is not of the same release, whatever the problem, it is necessary to perform acceptance tests to find the causes of the incompatibilities. It is therefore necessary to first capture the messages exchanged and then use the appropriate application running on a laptop. Sometimes a freeware tool such as WireShark is sufficient, but other times it is necessary to use more specialised tools such as ALBEDO GOOSE Monitor.



## APPLICATIONS

- IEC 61850 Commissioning
- IEC 61850 Troubleshooting
- IEC 61850 Monitoring
- IEC 61850 Capture
- IED acceptance
- Proactive maintenance

## FEATURES

- Filters by IEC-61850 protocol, MAC, IP, VLAN, MPLS, TOS, TCP, UDP, arbitrary
- Runs at wirespeed with 100% packet inspection
- Zero interruption, zero delay, zero packet loss
- Compliance traffic stored on SD card or copied to LAN
- PCAP format support
- Jitter-free time stamps
- VNC remote control
- Full duplex capture
- Optical / electrical ports

## BENEFITS

- Portable tap for field works
- Overcomes limitations of Laptop, and enrackable taps
- Troubleshoot and monitor live traffic in a risk less way
- Carrier grade fault tolerant
- Invisible when connected

Networking Features	
Ports	<ul style="list-style-type: none"> <li>Line Ports: Optical and electrical SFPs from 1 Mb/s to 1 Gb/s</li> <li>Mirror Ports: Dual RJ-45 port for electrical connection 10/100/1000BASE-T</li> <li>SFP support (but not only): 10BASE-T, 100BASE-TX, 100BASE-FX, 1000BASE-T, 1000BASE-SX, 1000BASE-LX, 1000BASE-ZX, 1000BASE-BX</li> <li>Auto-negotiation and forced bit rate modes supported by mirror and line ports</li> </ul>
Formats & Protocols	<ul style="list-style-type: none"> <li>Ethernet frame: IEEE 802.3, IEEE 802.1Q, IEEE 802.1ad</li> <li>IP packet: IPv4 (IETF RFC 791), IPv6 (IETF RFC 2460)</li> <li>Jumbo frames: up to 10 kB MTU (Maximum Transmission Unit)</li> <li>Throughput between measurement ports: 1 Gb/s or 1,500,000 frames/s in each direction</li> <li>PoE (IEEE 802.3af) and PoE+ (IEEE 802.3at) pass-through</li> </ul>
Operation	<ul style="list-style-type: none"> <li>16+16 fully configurable and independent filters [Tx+Rx] defined by field contents on Ethernet, IP, UDP and TCP headers</li> <li>Tap &amp; Filter: Packets are forwarded between line ports</li> <li>Packets are selectively copied to the mirror ports</li> <li>Packets can be stored in an SD card</li> <li>Filter: Traffic is filtered and forwarded to the corresponding mirror port</li> <li>Packets are selectively copied to the mirror ports</li> </ul>
Filters	<p><b>Generic filters:</b></p> <ul style="list-style-type: none"> <li>Defined by 16-bit masks and user defined offset.</li> <li>Pattern filter (one per port) to match alphanumeric words or expressions</li> <li>Length filters to match frames by their length</li> </ul> <p><b>Ethernet filters:</b></p> <ul style="list-style-type: none"> <li>MAC address: source, destination; MAC address group: subset of addresses filtered by a mask</li> <li>Ethertype value with selection mask</li> <li>VLAN-VID with selection mask, VLAN-CoS value with selection mask</li> <li>S-VLAN / C-VLAN with selection mask, S-VLAN / C-VLAN CoS value with selection mask, DEI</li> </ul> <p><b>IPv4 / IPv6 filters:</b></p> <ul style="list-style-type: none"> <li>Address: Source / Destination / Source + Destination / Group by masks</li> <li>Protocol encapsulated in the IP packet (TCP, UDP, Telnet, FTP, etc.)</li> <li>DSCP field, single value and range</li> <li>IPv6 flow label and Next header field value, TCP/UDP port, single value or ranges, DSCP field, single value and range</li> </ul> <p><b>IEC-61850 filters</b></p> <ul style="list-style-type: none"> <li>Defined by EtherType PTP, NTP, GOOSE, SV, MMS</li> </ul>
Results	<ul style="list-style-type: none"> <li>Frame counters for each configured filter</li> <li>Autonegotiation results including current bit rate, duplex mode, Ethernet interface</li> <li>Traffic statistics per each of the Four Ports</li> <li>Statistics for both transmit and receive directions</li> <li>Frame counts: Ethernet, and IEEE 802.1Q; Unicast / Multicast / Broadcast</li> <li>Basic error analysis: FCS errors, undersized frames, oversized frames, fragments, jabbers, collisions</li> <li>Frame size counts: 64, 65-127, 128-255, 256-511, 512-1023, and 1024-1518 bytes</li> <li>Four byte counts: Port A (Tx / Rx) and Port B (Tx / Rx)</li> <li>All traffic counters follow RFC 2819</li> </ul>
Storage	<ul style="list-style-type: none"> <li>Full Duplex Wirespeed traffic capture to SD card</li> <li>Storage format is PCAP Next Generation (PCAPNG)</li> </ul>

Design	
Performance	<ul style="list-style-type: none"> <li>Full Duplex operation at 1 Gbit/s or 1,5 Mframes/s</li> <li>Accuracy better than 10<sup>-6</sup> secs. at 1 Gbit/s</li> <li>Performance and accuracy 100% independent of the line bit rate</li> <li>Jitter-less captures in solid state hard disk and full wirespeed (full Gbit/s at Tx &amp; Rx simultaneously)</li> </ul>

Ergonomics	
Platform (hand-held)	<ul style="list-style-type: none"> <li>Touchscreen 480 x 272 TFT, Mouse, USB &amp; Ethernet ports, 1.0 kg, 223 x 144 x 65mm; IP-54</li> <li>Rechargeable Batteries continuous working up to 12 hours continuous operation</li> <li>AC Power Adapter Input: 100 ~ 240 V AC, 50/60 Hz</li> <li>Operating Temperature 0°C ~ 50°C, Storage Temperature -20°C ~ 70°C, Humidity 5% ~ 95%; IP rating 54</li> <li>SNMP, MIB support and VNC remote control</li> </ul>
Platform (Rack mounted IU)	<ul style="list-style-type: none"> <li>Management: SNMP, SSH, VNCSNMP, MIB and VNC remote control</li> <li>Front Panel: Display: OLED 256 x 64 pixels, LEDs: Power, System, Alarm, Clock.</li> <li>Keypad: Power On/Off, Up, Down, Left, Right, Page Up, Page Down, Esc</li> <li>Redundant Power Supply: (AC+AC / AC+DC / DC+DC), VDC: -40 to 60V / VAC: 110 to 240V</li> <li>Lipo Batteries: Fault tolerant 2.15h of continuous operation without power supply</li> <li>Mechanical: Fanless, Size: 1 3/4"x10"x19" (ETSI 1U rack mount), Weight: 4.2 kg / 8.7 lb,</li> <li>Operation Temperature: -10°C to +50°C; Operation Humidity: 10% to 90%</li> </ul>

