PTP Experience in Sikt

Raimena Veisllari
Technical Advisor
Sikt
raimena.veisllari@sikt.no

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Agenda

→ PTP implementation challenges and status in Sikt

→ High accuracy T&F distribution with White Rabbit

→ Ongoing Work & Opportunities

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PTP Implementation Challenges

- IP Network Support of G8275.1 Precision time protocol telecom profile for phase/time synchronization <u>with full timing support from the network</u>
  - Old equipment in parts of the network do not support PTP
  - The level of accuracy for G8275.2 Precision time protocol telecom profile for phase/time synchronization with partial timing support from the network not good enough for most use cases

- Optical layer challenges

- Investment required
  - Sikt network modernization ongoing
  - PTP has so far been not included as a requirement on IP network

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Status

- Identied use cases and service requiring PTP or higher level of T&F accuracy
  - Fiber sensing
  - Protection from GNSS attacks -> Redundancy
  - Full time and sync distribution for mobile networks
  - ..

- Discussions and cooperation with partners

- Optical network modernization currently at RFQ level:
  - Design needs to include the requiremenets for T&F high accuracy distribution

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High Accuracy T&F Services with White Rabbit

1. Optical Fiber Sensing
   - Distributed Acoustic Sensing (DAS)
   - State of Polarization (SOP)

2. GNSS Jamming & Spoofing Test in Norway

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White Rabbit Extension to PTP – Refresh

Synchronization with sub-ns accuracy tens-ps precision

From IEEE1588-2008 (v2.0) to IEEE1588-2019 (v2.1) High Accuracy Profile. Challenges with PTPv2:

- Heavily affected by Packet Delay Variation (PDV).
- Several "telecom" profiles.
- Per-link calibration is mandatory.
- Asymmetry needs to be measured and taken into account
- …

White Rabbit (WR) as extension of the IEEE1588-2008 (Precision Time Protocol) standard to synchronize nodes in a packet-based network with sub-ns accuracy.

- Combination of IEEE1588-2008 with further extensions:
  - Clock syntonization over the physical layer L1Sync (similar to SyncE)
  - Enhancement of timestamps precision through phase detection
  - Automatic precise evaluation of link asymmetry.

- Backward compatible with PTP IEEE1588-2008

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White Rabbit Use Case 1:
Fiber as a Sensor

- Two techniques tested so far by Sikt:
  - Distributed Acoustic Sensing:
    - Sending sweeping pulses into the fiber, records phase shifts in backscattered signal
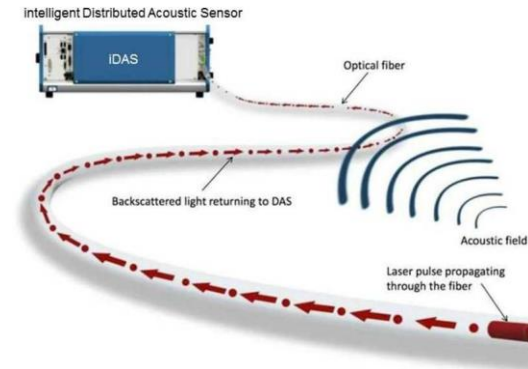
For more info: M. Landrø et al. Sensing whales, storms, ships and earthquakes using an Arctic fibre optic cable. Sci Rep 12, 19226 (2022). https://doi.org/10.1038/s41598-022-23606-x

  - State of Polarization
    - evaluating optical polarization differences caused by mechanical or acoustic vibrations

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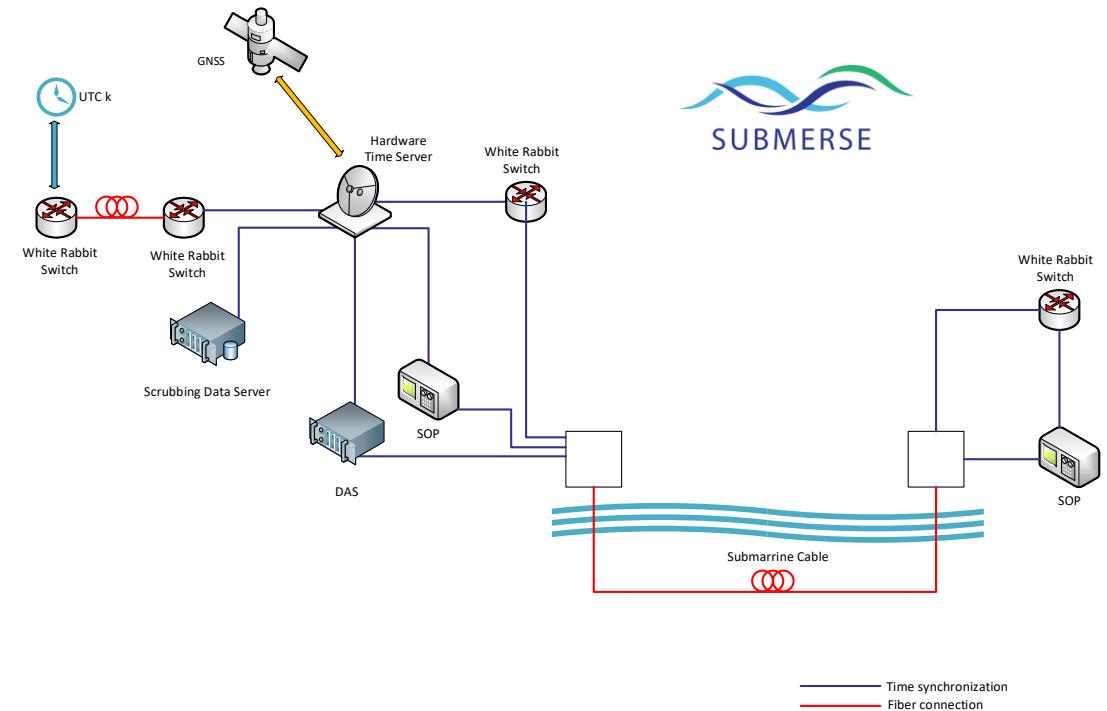# White Rabbit Use Case 1:
Fiber as a Sensor

SUBMERSE - SUBMarine cablEs for ReSearch and Exploration
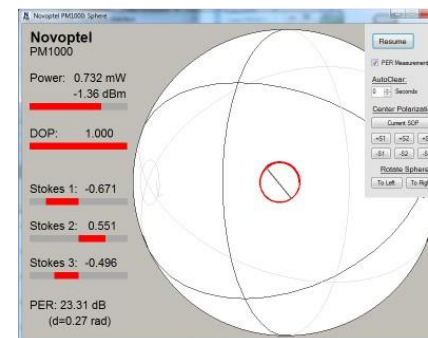
- Add time stamps that will allow precise analysis of data from distributed measurement systems
  - Common time scale at all major locations,

- Time synchronization accuracy better than 1 μs
  - Increased accuracy of time synchronisation at both ends of the optical fibre for SOP measurements down to a <u>range of ns</u>
  - Redundancy for GNSS

- Estimation of the relative difference of time stamping of measurements made with different devices (DAS, SoP, SOP-OTDR).
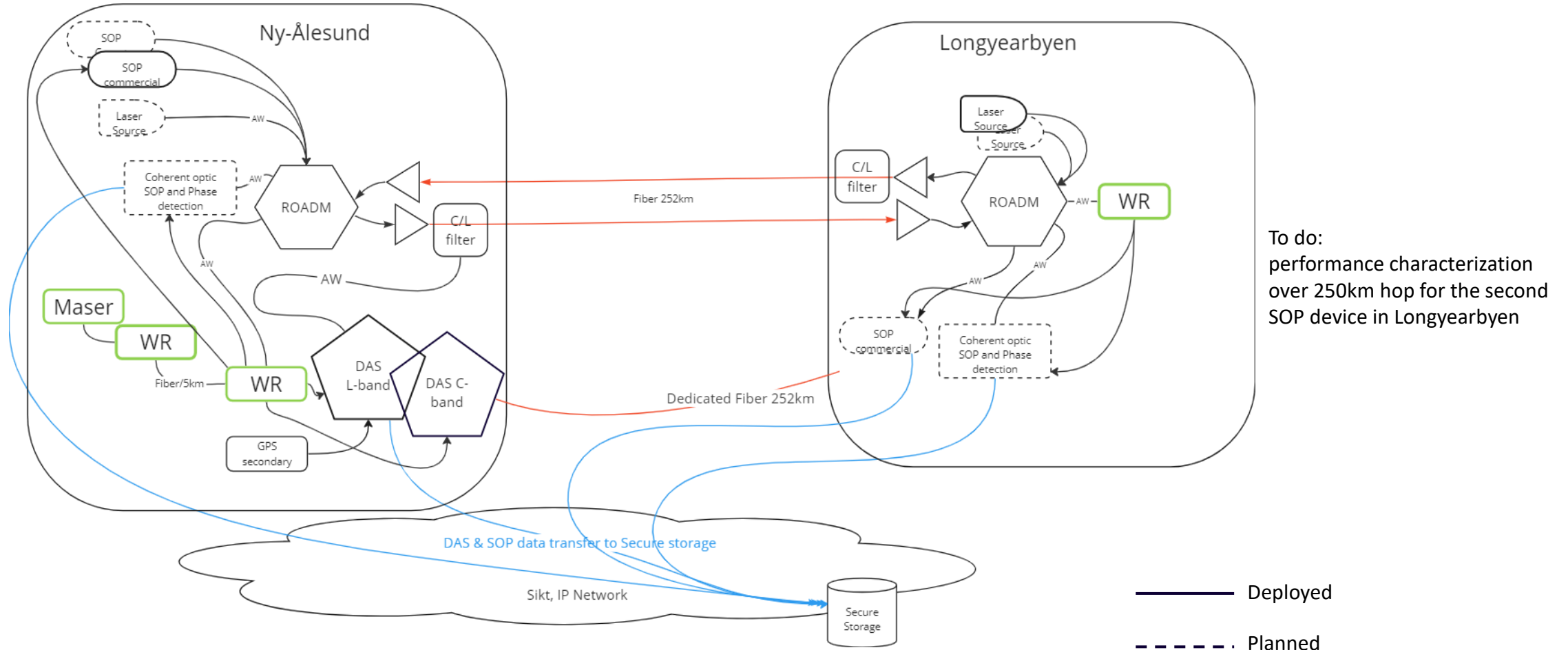

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White Rabbit Use Case 1:
Field Trials in Svalbard Norway

To do:
performance characterization over 250km hop for the second SOP device in Longyearbyen

GNSS Jamming and Spoofing Tests in Norway

- Jamming = Malicious attempt to disrupt the GNSS signal so that reception of GNSS signal is no longer possible.

- Spoofing = Malicious attempt to alter GNSS signal or GNSS data, resulting in intended incorrect Position, Navigation , and Timing data

- Objective of the event: Robust and secure time and posisioning for critical society services

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White Rabbit Use Case 2:
GNSS Jamming

- White rabbit network from SIKT

- Distributing 10MHz from the GM in site 1 to site 3 where jamming is happening
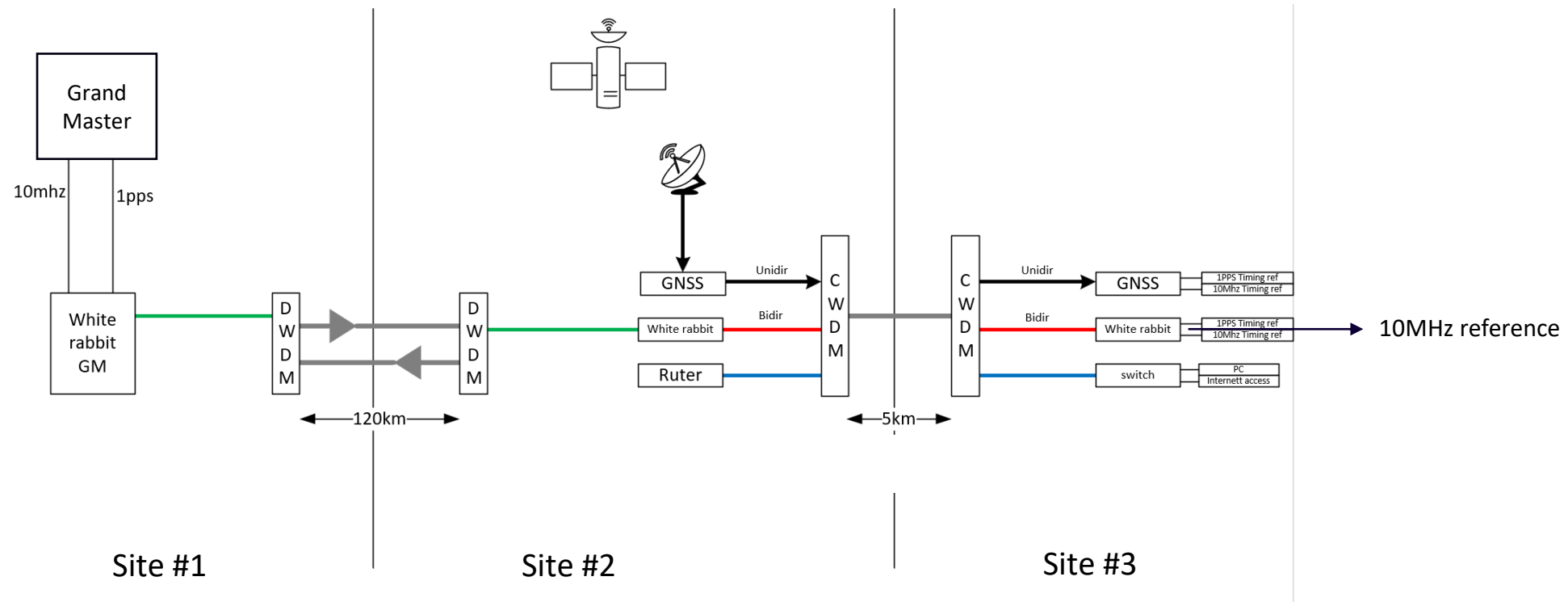
Ongoing work T&F in Sikt

→ Increase T&F knowledge and importance awareness internally and towards our customers.

→ Indoor Mobile Coverage requirements for 5G Time Division Duplex (TDD) spectrum (3.5GHz and mmWave)

→ Expand on high accuracy T&F services and research possibilities. National partners cooperation

→ Investigate Quantum Communication T&F requirements, e.g. for Quantum Key Distribution (QKD)

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