HydRON: High throughput Optical Network – Fibre in the Sky”.

Vision: Develop the world first (all) optical Network at Terabit Capacity. Extend terrestrial Fiber Networks seamlessly by “Fibre in the Sky”.

Features:

- Terabit Optical Transport Network in Space
- Terabit Space-Ground Links
- High speed optical routing
- Collection and distribution of end user data on-ground
- Seamless integration in terrestrial networks

General: Strengthen the role of the satellite

Seamless integration of Space and Terrestrial Networks is essential for many applications (e.g. 5G). Fibre-type space network equivalent to terrestrial connectivity.

“Fibre in the Sky” will allow to serve the network from many sites around the globe and therefore will provide the means to:

- Reduce dependence of terrestrial (satellite specific) infrastructure
- Benefit from switching capabilities to re-route data traffic
- Overcome atmospheric dependencies for optical feeder up/downlinks and therefore ease the use of optical for space

Will allow Terrestrial Network Operators to carry out:

- Load balancing and backhauling of traffic (e.g. for trans-Atlantic networks)
- Flexible load balancing during high demand events (e.g. 5G during Football Championship)
- Network extension into rural areas with similar switching and capacity means like terrestrial deployments (longer term replacement of fibres –not just gap fillers)

Satellite Operators

- Especially for Satellite Operators HydRON will enable optical up/down link capabilities (Terabit/s)
- eliminate the need of deploying dedicated optical ground stations
- eliminate the need to deploy dedicated site diversity concept (e.g. ca. 10 OGS in Europe)
- allow flexible routing of data within the operators fleet
- allow full integration into terrestrial networks and cooperations with terrestrial network operators (e.g. for 5G)
ESA Proposed Implementation approach

Hydron is an ambitious endeavour that can be implemented in steps, by self-standing “HydRON Technology Demonstrator Missions”.

The first step HydRON#1 is the subject of this proposal (CM19)

The immaturity of the tech/market allows for cooperation of stakeholders (e.g. suppliers) who later will compete

HydRON#1 -Features

- Space Segment: 2x TbpsWDM Laser Terminals for feeder up/down link and ISL
- Optical Multiplexer (10in/10out) and Optical De-Multiplexer (10in/10out)
- 25x25 Optical Switch Matrix
- Optical Harness/Fibres
- Interface to Main Payload (mission specific)

- Ground and Network Segment: Fix/mobile Optical up/down link feeder station (Tbps)
- Mobile Optical Ground Stations for up/down links (Tbps)
- High data rate optical pre-processor for flexible bandwidth allocation
- HydRON Network Control Center featuring weather forecast
The concept of **HydRON** is beyond single operator planning horizon. **Advisory/user group** shall be established (Satellite Operators, Primes and Suppliers, terrestrial Network Operators).

**Engagement of Operators envisaged** It is expected that operators contribute to the programme in various forms e.g. space real-estate, launch cost shares, share of operation cost, network capabilities, potential Utilization fee, etc. Operators contribution will however match with the (in-)maturity of the technology/market. This will result in an increased level of ESA funding. Overall HydRON elements shall be made available for operators own testing and early operations.

Programme Structure and Roles

**The advisory/user group:** Providing User requirements, use cases and demo testing requirements

**ESA as the system Architect:** Managing the development programme, and selecting the ESA MS Host Sat Operator in open competition

**The Host satellite operator:** Embarking HydRON optical payload interconnected with own main telecommunication payload

By HydRON, the suppliers of payload/ground/network elements will be at forefront of the space optics competitive landscape.

Therefore: **Parallel developments of HydRON equipment** would be awarded to allow national implementation strategies and avoid single sources. Flight qualification will be achieved within Hydron#1 and beyond.

**HydRON-Programmatics**

**Cutting Edge PPP => ESA Overall Design Authority, providing**

**HDTM payload layout** (e.g. encouraging multiple equipment implementation in parallel)

the overall system and end-to-end architecture

the interface and requirements definitions

The selection of the suppliers to be embarked on-board **HydRON#1** and the selection of the PPP partner and the **flight opportunities**

Pre-developments can be performed under current ARTES in order to allow head start activities.

**Note:** co-funding by suppliers/operators expected but will be limited due to in-maturity of technology/market\(^1\)

**HydRON–Areas of Innovation**

Hydron involves an unprecedented level of innovation in many technological areas.

**Industrial capabilities and ambitions exist in many ESA MS:**

- Terabit Wavelength Division Multiplexing (WDM) Laser Communication Terminals (Dual-wavelength operation)
- High data rate reliable optical feeders links (Tbps, bidirectional)

\(^1\) This is an ESA assumption, not agreed. Note that the strategic themes follow the generic programme rules.
High data rate optical inter-satellite links (Tbps, bidirectional)
On-board high rate optical cross-connect, traffic switching optimization
All optical repeater (vs. electrical regeneration)
Optical pre-processor for flexible bandwidth allocation on ground
Network technologies for seamless integration in terrestrial networks

Timelines
Ground: Setting the tone of the event since the Sample
en factual approach for any application (e.g., 5G).

Fibertechnologies, for example...