



hydron

High throughput Optical Network

ESA HyDRON Team

European Space Agency, ESA-ESTEC

INDUSTRY DAY, 26Jun / 1Jul 2020 - BELGIUM

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European Space Agency

Agenda



- Introduction to the HydRON Mission
- Envisioned usage: User Categories, HUG
- Demonstration System and Technology Demonstrators
- Status of the HydRON Project Preparations
- Critical technology developments and HydRON-TD's elements
- Conclusions, Discussions / Q&A Session
- Annexes:
 - ✓ Annex I - Overview of the Member States Industrial Capability
 - ✓ Annex II - Industry Day: Industrial Input Template



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Introduction to HydRON

HydRON
High throughput
Optical Network

Vision

Develop the world first (all) Optical
Transport Network at Terabit
Capacity in space.

Extend terrestrial Fiber Networks
seamlessly by "Fibre in the Sky".



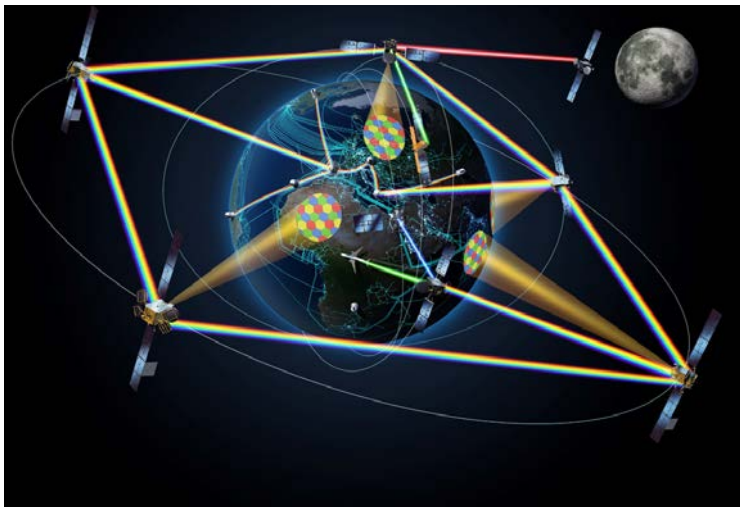
MISSION STATEMENT:

Develop and validate "Fibre in the Sky" technology integrated into terrestrial networks at Terabit capacity by 2025-2026 timeframe.

HydRON Project Objectives



- To define the full E2E architecture of the visionary HydRON Mission (HydRON-M) that meets the needs of its identified potential users on the medium/long-term.
- To define and implement a HydRON Demonstration System (HydRON-DS) that allows the demonstration and validation of the essential technologies by European and Canadian industries by 2025-2026.

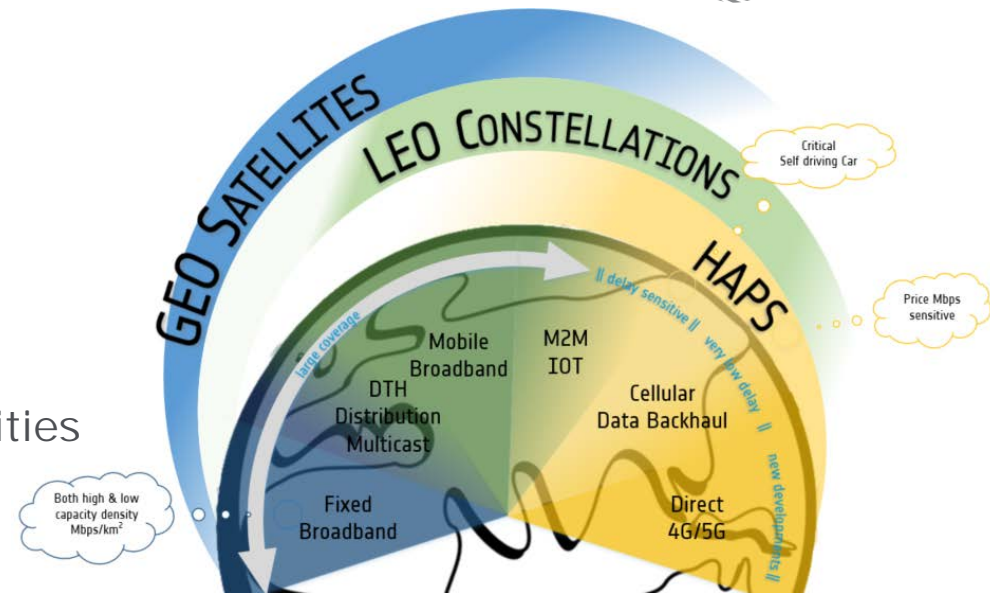


- ✓ Terabit Space-Ground links and Space-Space links
- ✓ High speed optical / electrical switching
- ✓ Collection and distribution of end user data
- ✓ Terabit Optical Transport Network in Space
- ✓ Seamless integration into terrestrial networks



Seamless Integration into Terrestrial Networks

- In today's terrestrial Fibre Networks Satellites are
 - ✓ just bridging the "last mile", when no fibre is available
 - ✓ not an integral part of the network architecture
 - ✓ difficult to patch in on-demand
 - ✓ not configurable by the network
 - ✓ have no routing capabilities
- In today's space architectures, no network capabilities really exist. Interconnection of different layers (GEO, LEO, HAPS, Terrestrial) are seen as a future concept.



Satellites are not YET an integral part of terrestrial network architecture

Only Optical Communications will provide the required high data volume and high volume switching capabilities!

3D-Network Concept = Fibre everywhere!

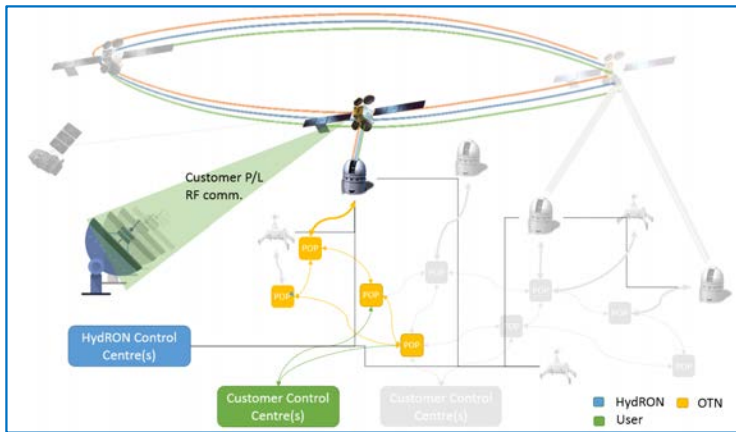
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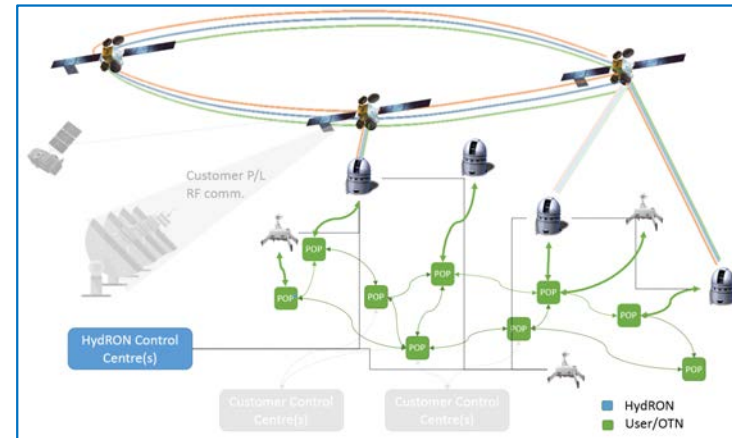
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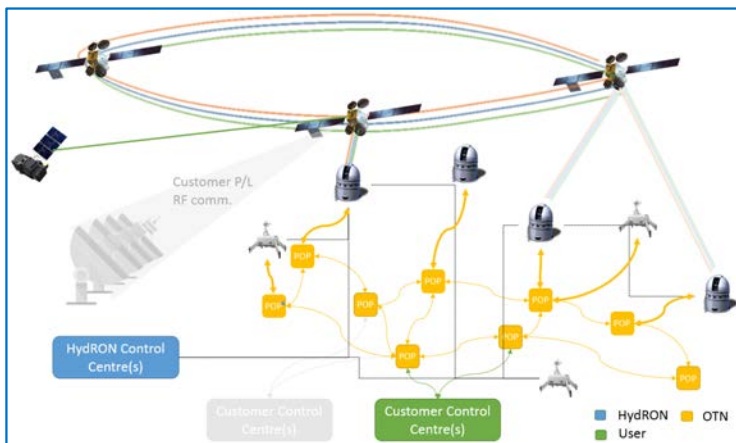
HydRON User Categories



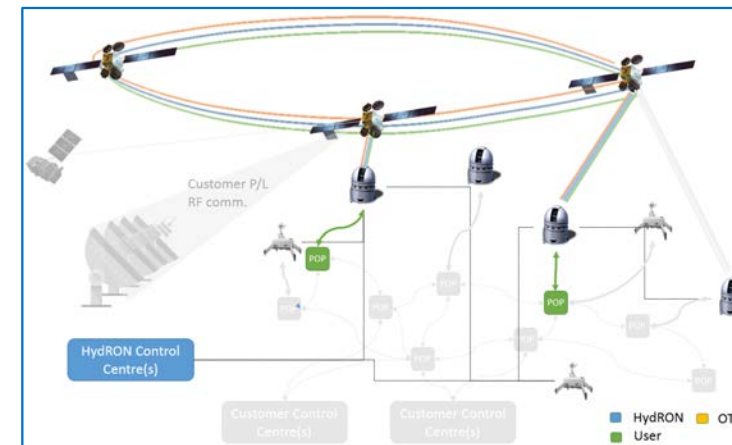
Telecom Satellite Operators connecting their fleet to the Network



Terrestrial Network Operators expanding their terrestrial network with the Fibre in the Sky to route traffic



Satellite / Airborne Users connecting their own satellites/UAVs /aircrafts to the network



Private Network Users establishing highly secure connections via the Fibre in the Sky to avoiding terrestrial infrastructures



Members of the HydRON User Group (HUG)



SATCOM OPERATORS

inmarsat hispasat SES your satellite company

eutelsat

PAYLOAD PRIMES

TESAT

MDA A MAXAR COMPANY

NEW MEMBERS

hellasat

NOKIA Bell Labs

OneWeb ACCESS FOR EVERYONE

Telefonica

16 Members and growing

SATELLITE PRIMES

AIRBUS

OHB

ThalesAlenia Space

a Thales / Leonardo company

PENDING

open fiber

ADVA

Viasat

Telesat

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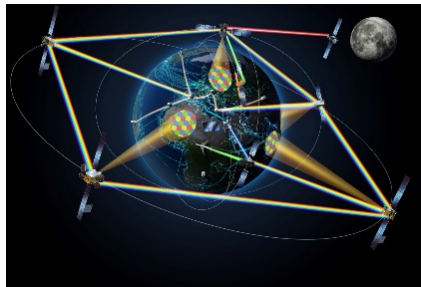
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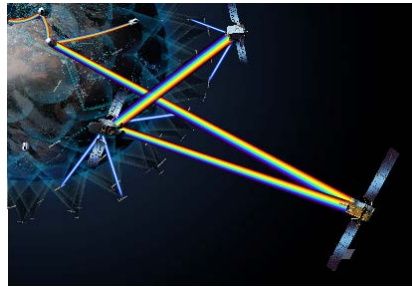
Introduction to HydRON Project



HydRON Mission



HydRON Project



HydRON Demonstration System



HydRON-TD#1
GEO



HydRON-TD#2
LEO



HydRON Technology Demonstrators (HydRON-TD#i)

Limited resources will require...



...to define a representative demonstration of a 3D Network...



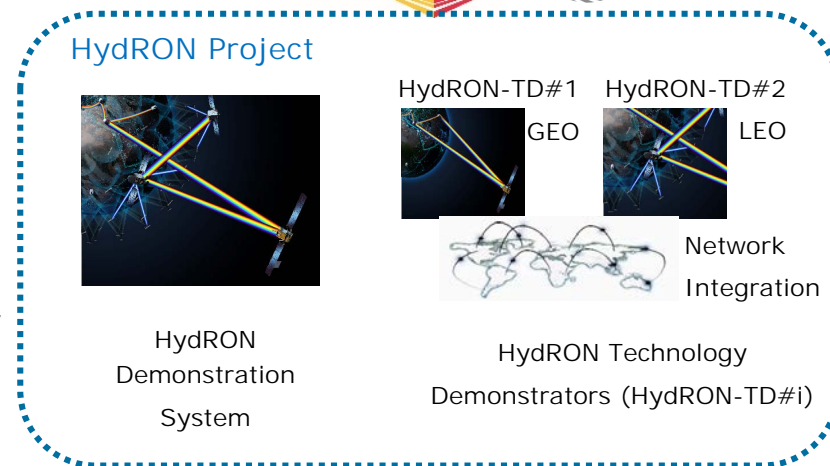
...by GEO, LEO and Network Integration



HydRON Project: Development Logic



- Technology Developments
- System Level/End-to-End Concept
 - ✓ based on representative GEO&LEO implementation
 - ✓ demonstrate full capabilities of optical technologies by
 - integration to a fully functional HydRON payload
 - integration to terrestrial networks
- Flight/Demo opportunities for European/Canadian Industry
 - ✓ build-up industrial capacity
 - ✓ create competitive advantage for upcoming market
- Demonstrate maturity to end users to lower market barriers

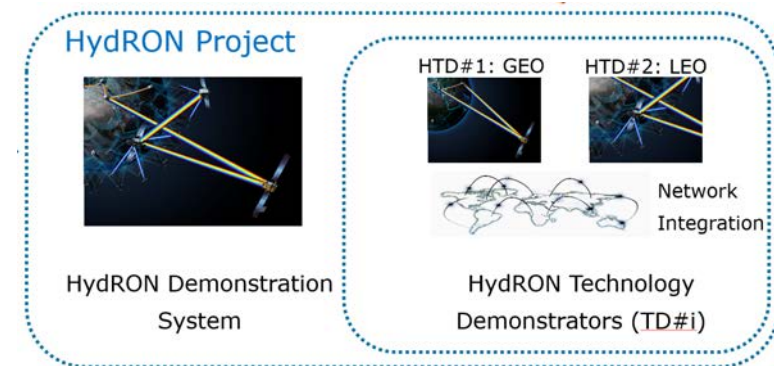


HydRON Project: System Elements

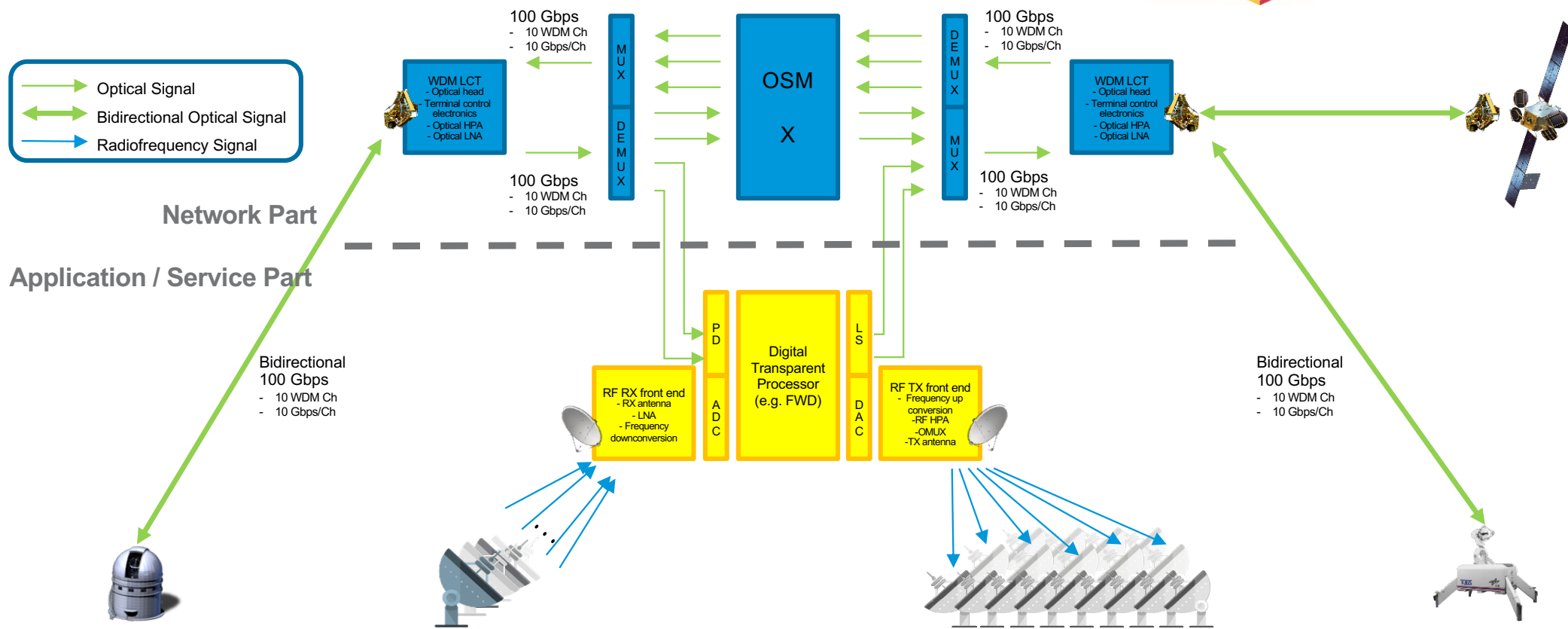


Competitive Advantages for Industry to demonstrate

- ✓ Space Segment with GEO and LEO
 - Multiple Designs of Optical Communication Terminals for opt. ISLs and opt. feeder links
 - Multiple Designs of On-board Switching Concepts
 - Demonstrating interfaces to the Users (e.g. RF) payload.
- ✓ Ground Segment
 - Multiple Designs of Optical Ground Stations (OGSs).
 - Multiple Interface concepts to the terrestrial high capacity network (Points of Presence)
 - Developments for HydRON Operation Centre (air-space control, weather forecasts, coordinating and controlling all ground and space assets).
- ✓ Network Segment/Management
 - Development of elements to ensure a seamlessly integration into the terrestrial network
 - 3D-network routing concepts of the data.



HydRON Demonstrator Concept

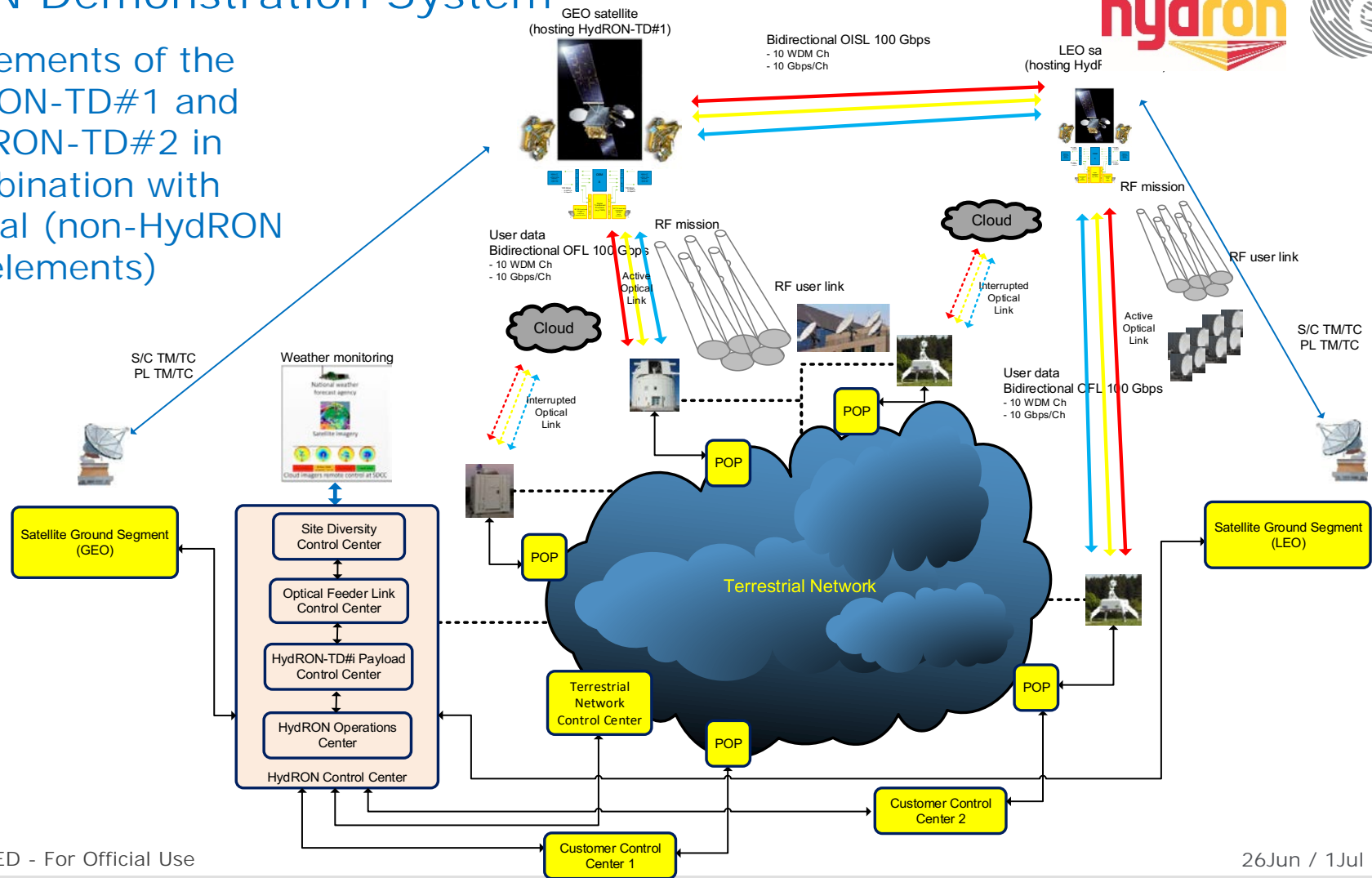


For the HydRON-Demo, the (Customer/User) RF mission will still implement its RF feeder link



HydRON Demonstration System

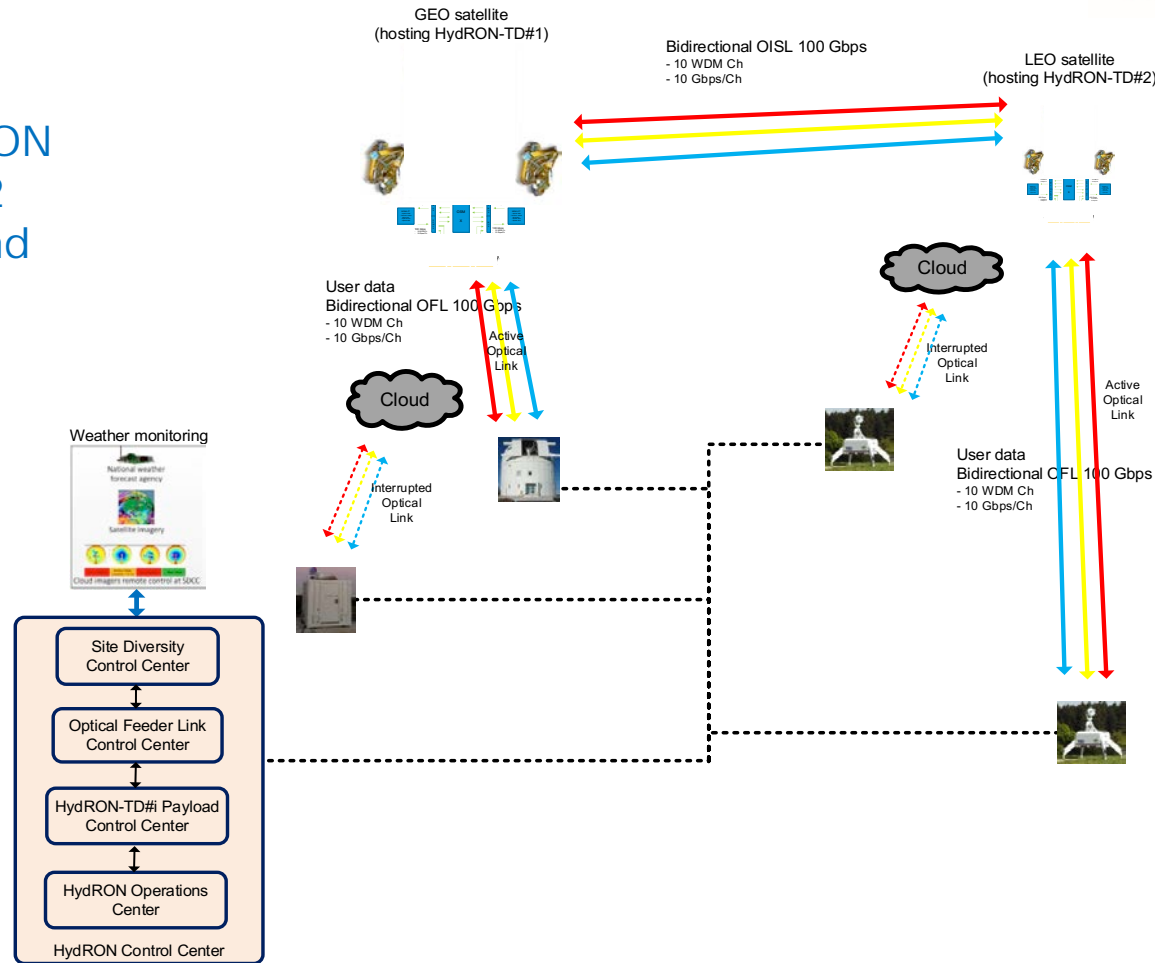
All elements of the HydRON-TD#1 and HydRON-TD#2 in combination with additional (non-HydRON elements)



HydRON Demonstration System



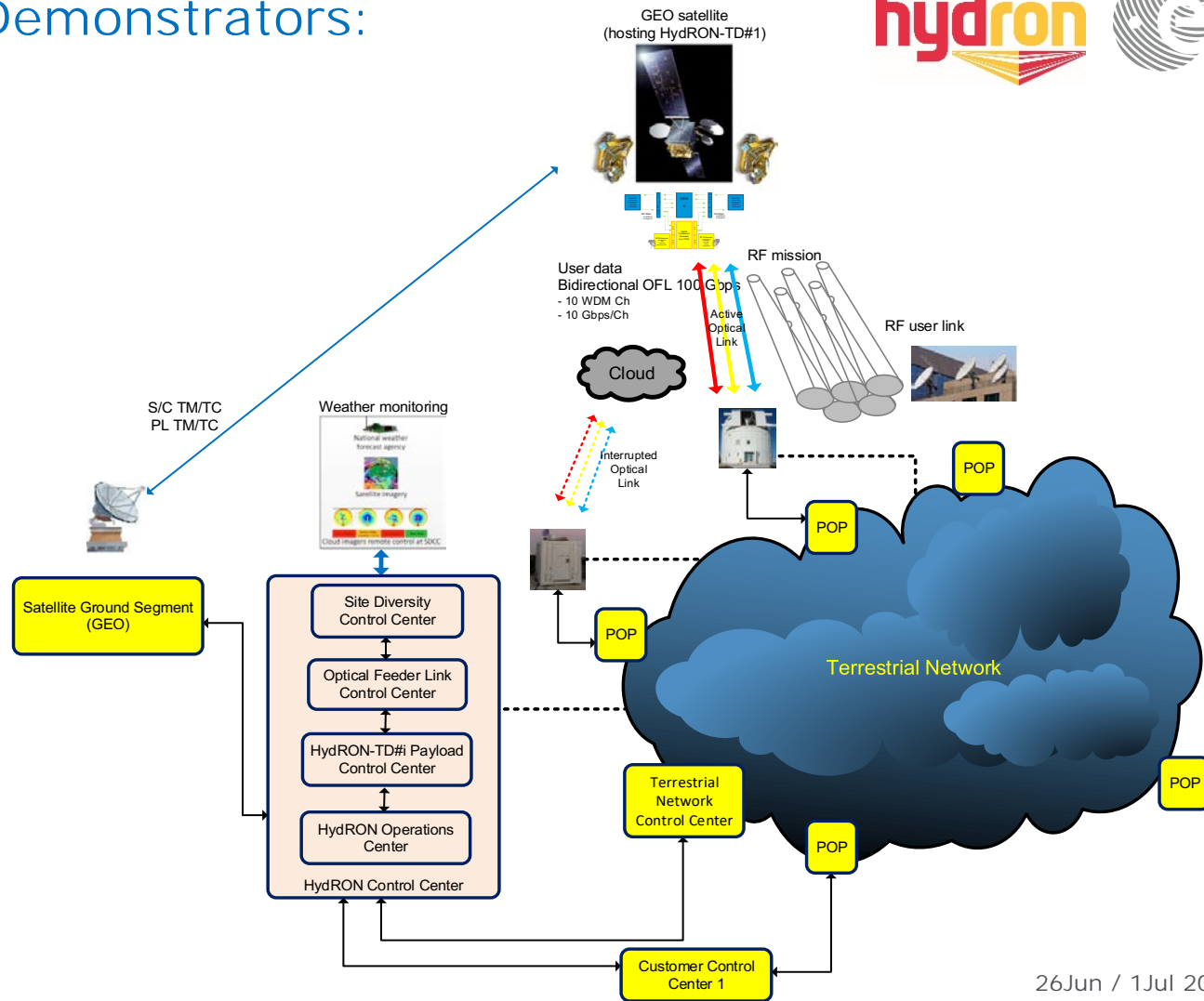
Elements of HydRON
TD#1 and TD#2
(space and ground segments)



HydRON Technology Demonstrators: HydRON-TD#1



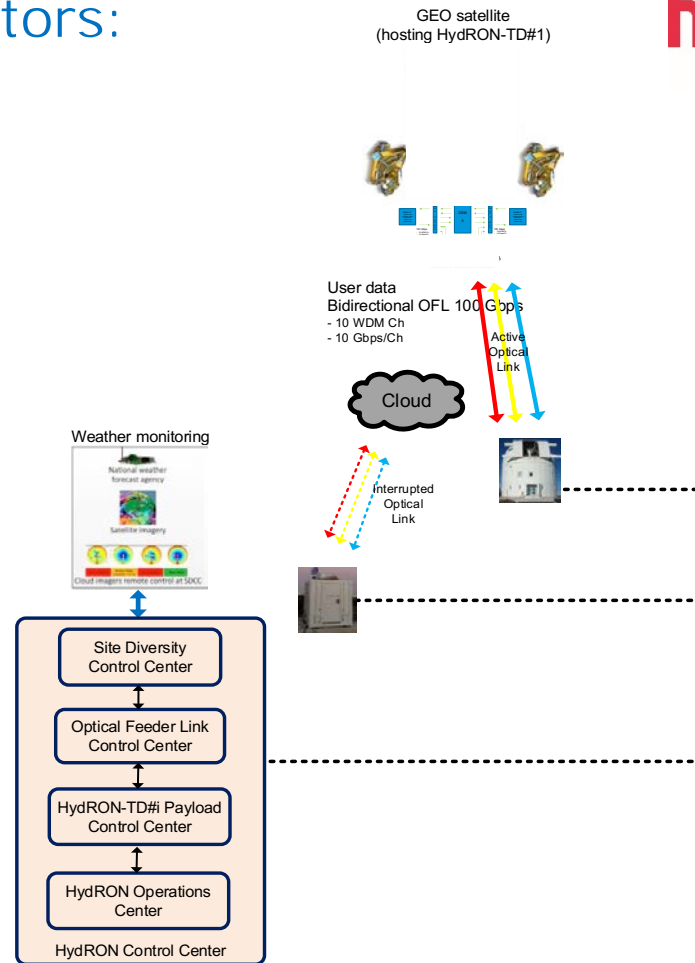
All elements of the HydRON-TD#1 in combination with additional (non-HydRON elements)



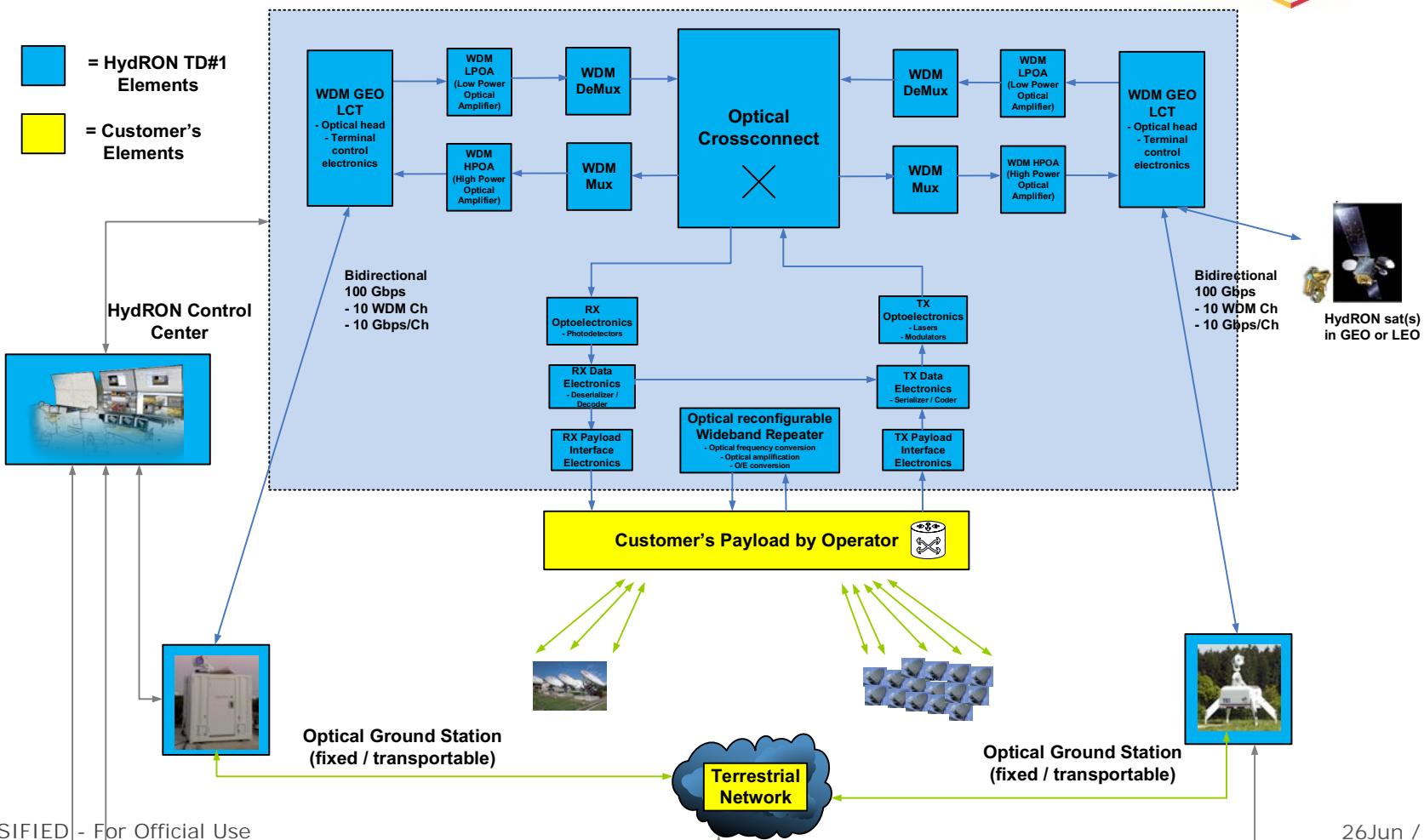
HydRON Technology Demonstrators: HydRON-TD#1



Elements of
HydRON-TD#1
(space and ground segments)



HydRON Technology Demonstrators: HydRON-TD#1



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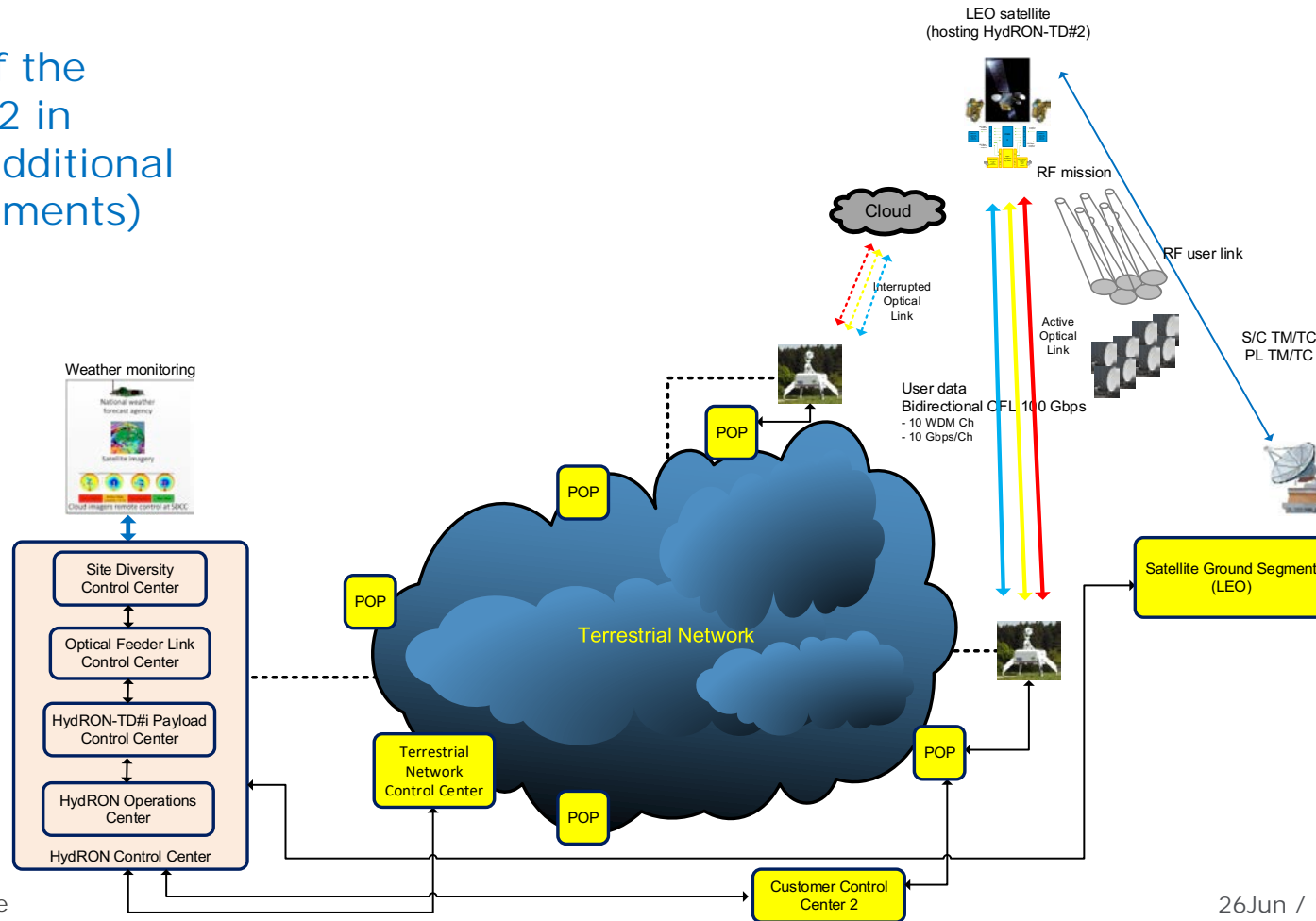


European Space Agency

HydRON Technology Demonstrators: HydRON-TD#2



All elements of the
HydRON-TD#2 in
combination with additional
(non-HydRON elements)



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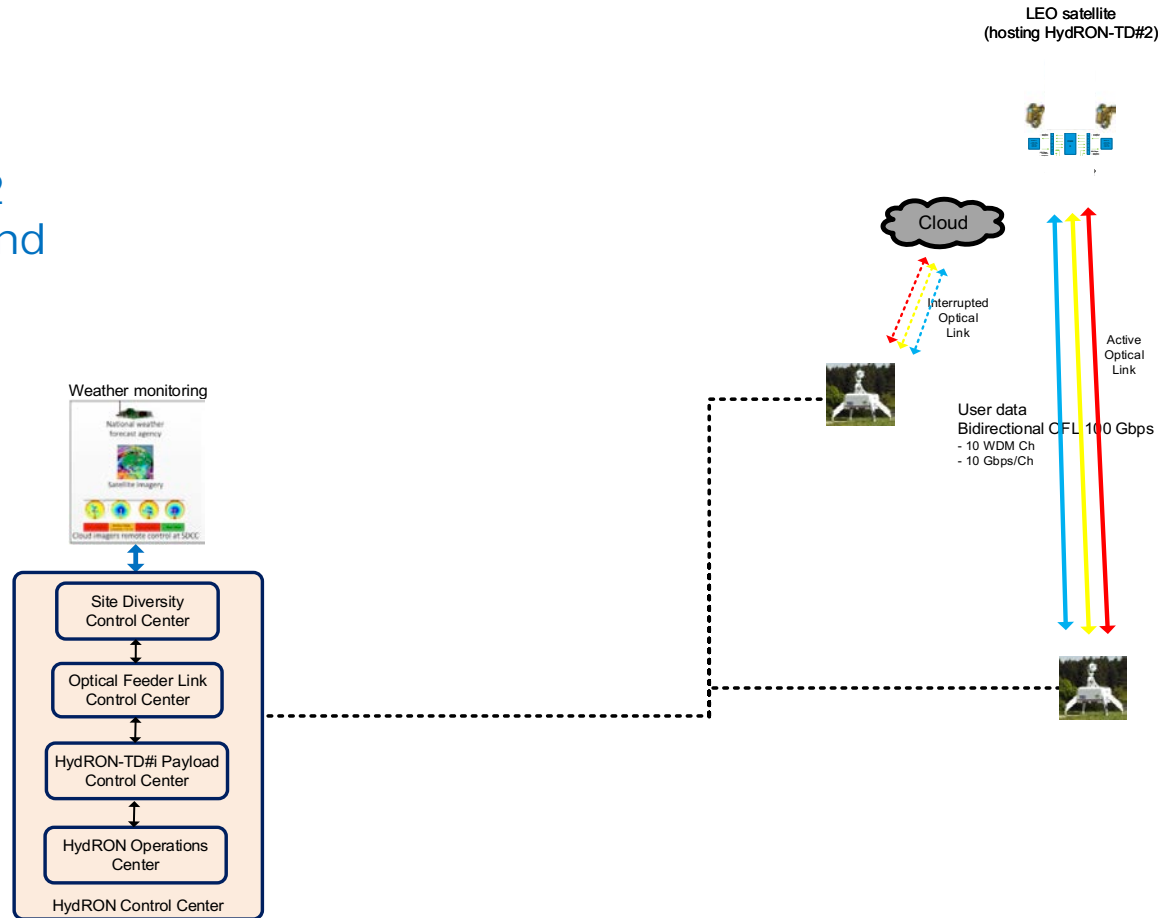


European Space Agency

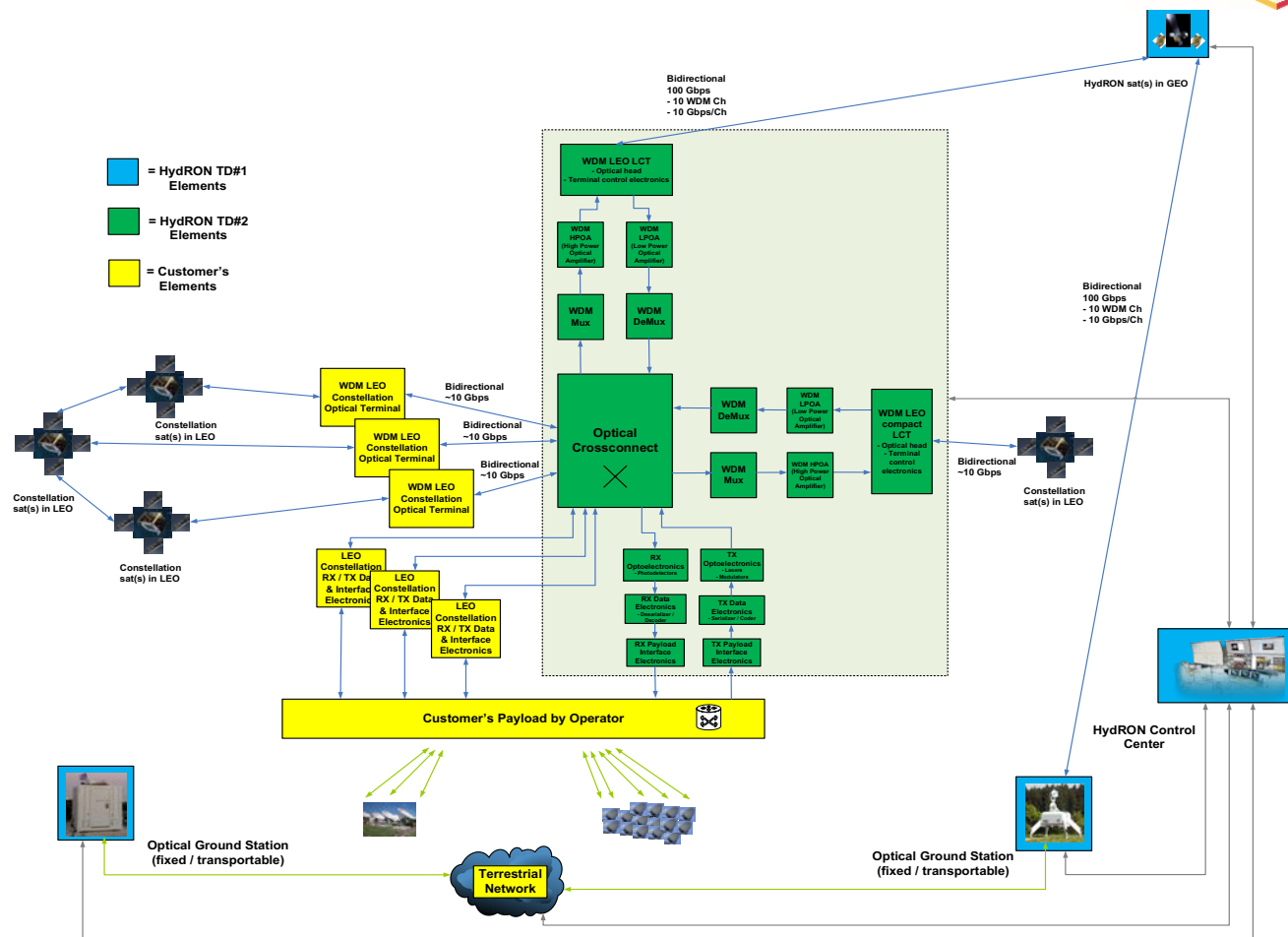
HydRON Technology Demonstrators: HydRON-TD#2



Elements of
HydRON-TD#2
(space and ground segments)



HydRON Technology Demonstrators: HydRON-TD#2



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HydRON Project Status



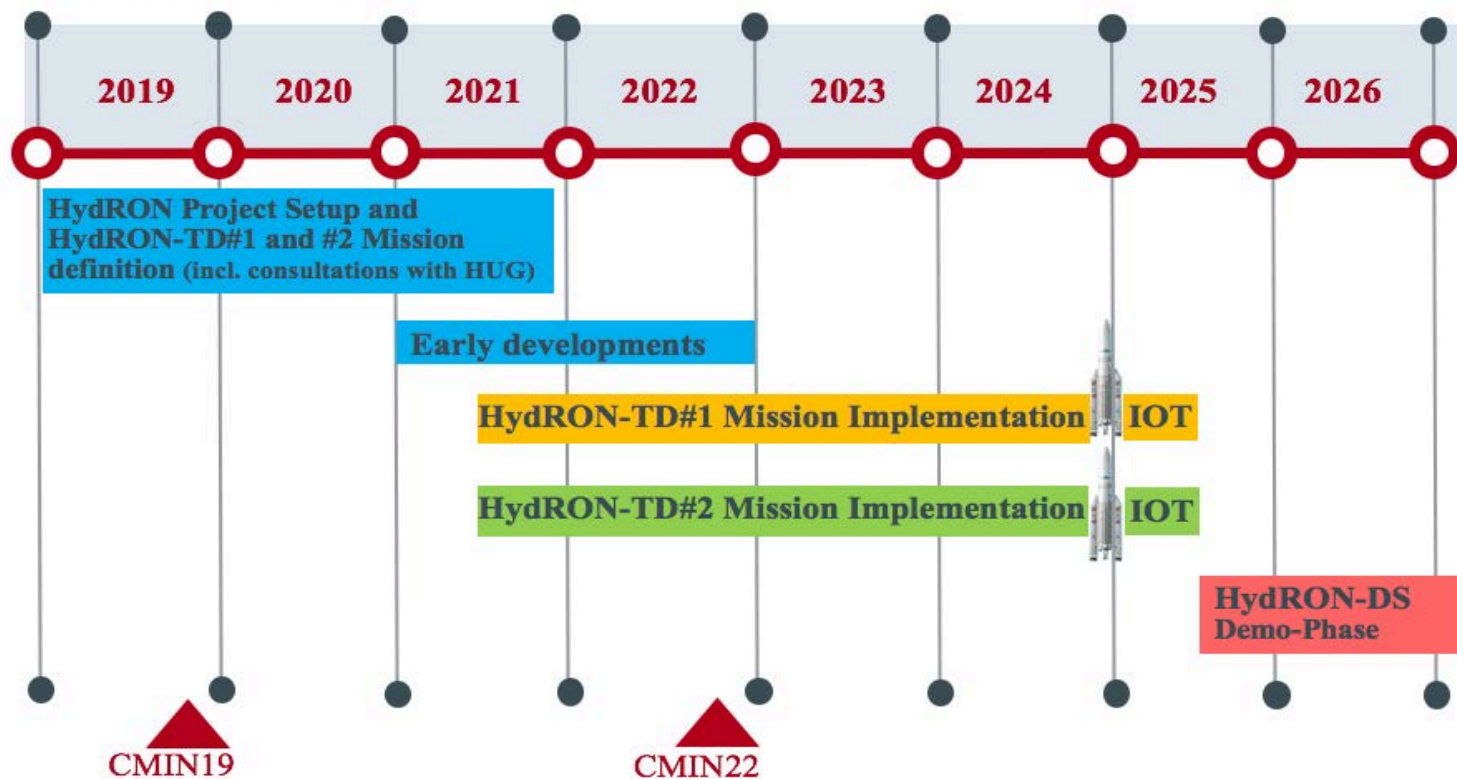
- ESA initiated project work is well under way:
 - ✓ Overall System Architecture work in defining Mission Requirements
 - ✓ Phase A work with 2 consortia progressing
 - ✓ Bi-lateral discussions with primes, satellite operators and terrestrial operators
 - ✓ Bi-lateral discussions with National Delegations and Industry to define their roles.

- HydRON User Group (HUG) exchange is fundamental in the preparation of the User Requirements, the Use Cases and the Demo Testing requirements.
Participants are Satellite Operators, Satellite and Payload Primes, Terrestrial Network Operators and Service Providers, and ESA Experts.





Timeline



HydRON Project Plan: Initiated Activities



Title	Contractor	Start date	End date
HydRON Mission Phase A Study	2x contracts led by ADS (Germany) and TAS (Italy)	Dec 19	Q4-20-Q1-21
HydRON Network Deployment Technology Roadmap	2x contracts with Fokus (Germany) and Bristol University (UK)	Sep 19	Q3-20
HydRON Mission assessment	N/A, (internal) ESA working group	Jul 18	Q4-20

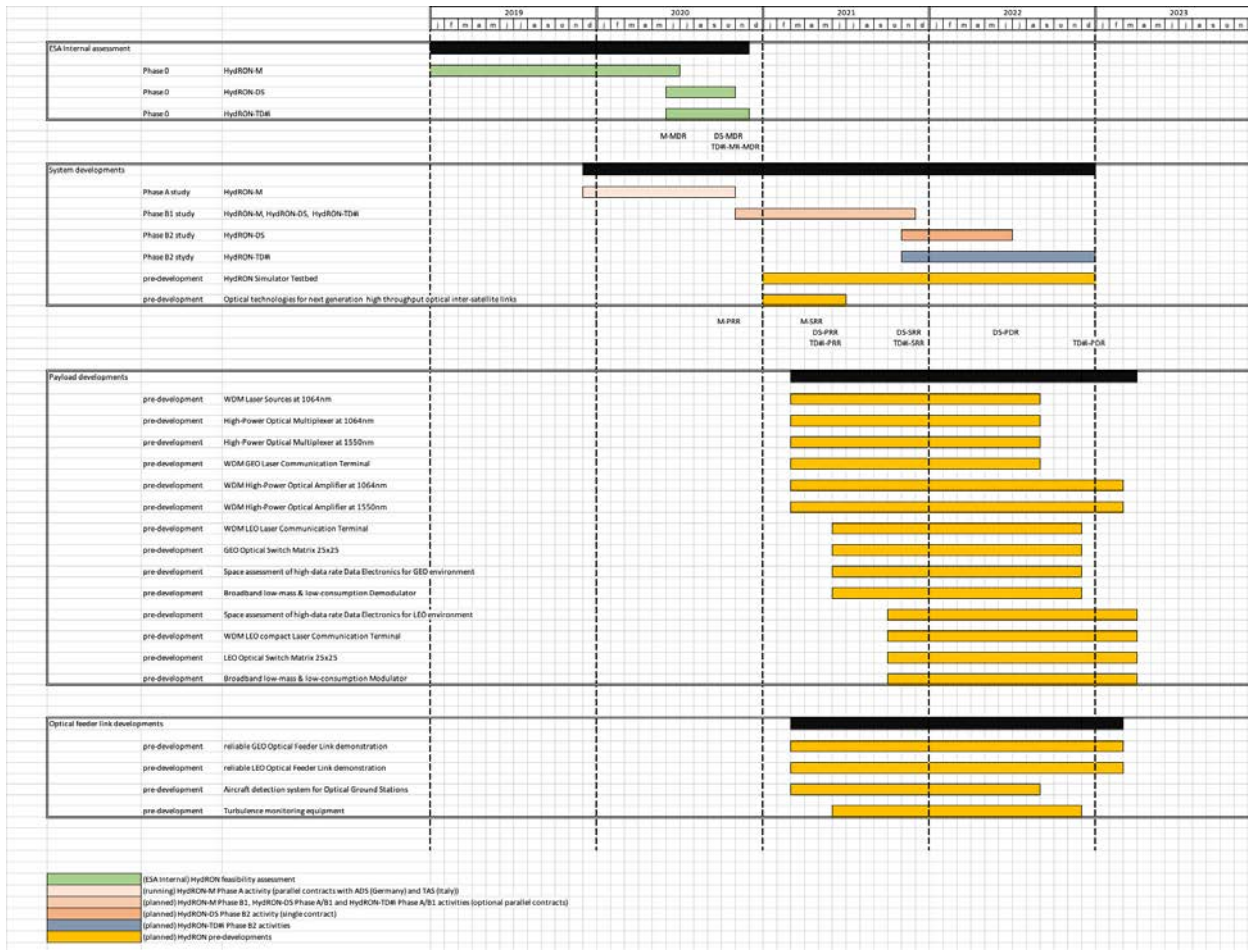


HydRON Project Plan: Activities under preparation



Title	Contractor	Start date	End date
HydRON Mission Phase B1, Demonstration System Phase A/B1 and Technology Demonstrator(s) Phase A/B1 Study	TBD	Q1-21	Q4-21
HydRON Demonstration System Phase B2 Study	TBD	Q4-21	Q2-22
HydRON Technology Demonstrators #i Phase B2 Study	TBD	Q4-21	Q4-22 Q1-23
Critical technology developments (e.g., HydRON Simulator Testbed)	TBD	Q1-21 Q2-21	Q1-23
HydRON Demonstration System and Technology Demonstrators #i assessment	N/A, (internal) ESA working group	Q4-20	Q1-21

HydRON Project Plan: Overall schedule



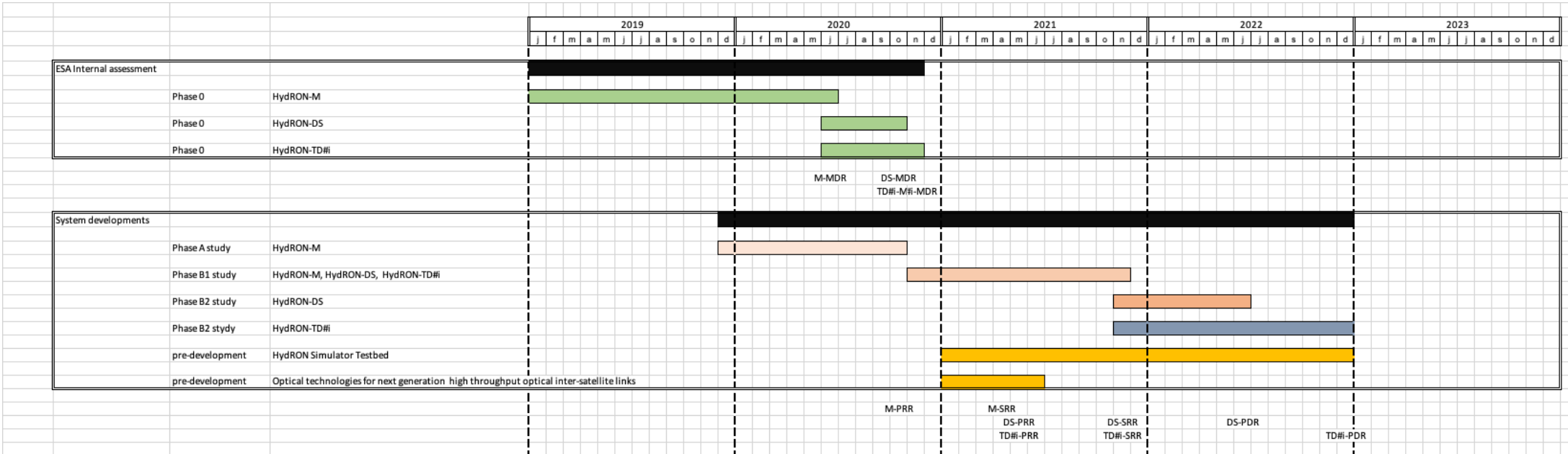
ESA internal & Sys Activities

Critical developments



HydRON Project Plan: Activities under preparation

>> ESA & Sys activities



[Green bar]	(ESA Internal) HydRON feasibility assessment
[Light orange bar]	(running) HydRON-M Phase A activity (parallel contracts with ADS (Germany) and TAS (Italy))
[Light orange bar]	(planned) HydRON-M Phase B1, HydRON-DS Phase A/B1 and HydRON-TD#i Phase A/B1 activities (optional parallel contracts)
[Light orange bar]	(planned) HydRON-DS Phase B2 activity (single contract)
[Blue bar]	(planned) HydRON-TD#i Phase B2 activities
[Yellow bar]	(planned) HydRON pre-developments



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TRL of HydRON-TD#i elements - Space



			Current TRL	Space Qualified In / Availability in (Year)	Potential Suppliers
Space Segment	WDM Laser Comm. Terminal	100Gbps WDM GEO Laser Comm. Terminal	4	2022	TESAT (D), ADS (F), TAS-CH (CH), TNO (NL)
		100Gbps WDM LEO Laser Comm. Terminal	4	2022	TESAT (D), Mynaric (D), Hensoldt-ZEISS (D), ADS (F), TAS-CH (CH), TNO (NL)
		~10Gbps WDM LEO compact Laser Comm. Terminal	4-5	2021	TESAT (D), Mynaric (D), Hensoldt-ZEISS (D), ADS (F), TAS-CH (CH), Space Inventor (DK), TNO (NL), mBryonics (IRL), Honeywell (CND)
	Optical Amplifier	High-Power Optical Amplifier	2 (1064nm) 2 (1550nm)	2022	IPG (US), Fibertek (US), MPB (CND), CILAS (F), Keopsys (F), G&H (UK)
		Low-Power Optical Amplifier	4 (1064nm) 6 (1550nm)	2021	IPG (US), Fibertek (US), MPB (CND), CILAS (F), Keopsys (F), G&H (UK)
	Optical Multiplexing / De-multiplexing		2 (1064nm) 3 (1550nm)	2021	Sodern (F), Kylia (F), G&H (UK), BerlinerGlas (D), Jenoptik (D), Optics Balzers (D), IMEC (B), OFS Fitel (D), VTT (FIN), SwissOptic (CH)
	Optical Switch Matrix		4	2022	Sodern / Polatis (F/UK), Sercalo (CH)
	TX/RX Optoelectronics		4	2021	Kylia (F), iXBlue (F), Finisar (US), LITEF (D), Eagleyard (D), Innolume (D), U2T (D), TESAT (D), BerlinerGlas (D), FBH (D), IMEC (B), aXenic (UK), G&H (UK)
	TX/RX Data Electronics		4	2022	AIT (A), MDA (CND), ADS (D), TESAT (D), TAS (F), ADS (F), LEO Space Photonics (GR), TAS (I), RUAG (CH), ADS (UK), SSTL (UK)
	Interface Electronics		3	2022	Antwerp Space (B), MDA (CND), ADS (D), TESAT (D), TAS (F), ADS (F), TAS (I), SatixFy (UK), ADS (UK)
	Optical Wideband Repeater		4/6	2022	TAS (F), ADS (F), DAS Photonics (E), TAS (I), ADS (UK)



TRL of HydRON-TD#i elements - Ground



		Current TRL	Space Qualified In / Availability in (Year)	Potential Suppliers
Ground Segment	WDM Optical Feeder Station & equipment	Medium	2022	Synopta (CH), Mynaric (D), DLR (D), TNO (NL), Xenics (B), Reuniwatt (F), Miratlas (F), KSAT (NO)
	WDM compact Optical Feeder Station & equipment	Low	2022	Synopta (CH), Mynaric (D), DLR (D), TNO (NL), Honeywell (CND), Xenics (B), Reuniwatt (F), Miratlas (F), KSAT (NO)
	HydRON Network Control Center	Low	2023	ADS (D), DLR (D), ADS (F), TAS (F), TAS (I), Telespazio (I)
	Terrestrial fibre network & equipment	Medium	2022	Ciena (CND), ADVA (D), Deutsche Telekom (D), Vodafone (D), Telefonica (E), Orange (F), Nokia (F), Open Fibre (I), Vodafone (UK)



HydRON critical technology developments



1. System developments

- HydRON Simulator Testbed
- Optical technologies for next generation high throughput optical inter-satellite links

2. Payload developments

- WDM Laser Sources at 1064nm
- High-Power Optical Multiplexer at 1064nm
- High-Power Optical Multiplexer at 1550nm
- WDM GEO Laser Communication Terminal
- WDM High-Power Optical Amplifier at 1064nm
- WDM High-Power Optical Amplifier at 1550nm
- WDM LEO Laser Communication Terminal
- GEO Optical Switch Matrix 25x25
- Space assessment of high-data rate Data Electronics for GEO environment
- Broadband low-mass & low-consumption Demodulator

- Space assessment of high-data rate Data Electronics for LEO environment
- WDM LEO compact Laser Communication Terminal
- LEO Optical Switch Matrix 25x25
- Broadband low-mass & low-consumption Modulator

3. Ground developments

- reliable GEO Optical Feeder Link demonstration
- reliable LEO Optical Feeder Link demonstration
- Aircraft detection system for Optical Ground Stations
- Turbulence monitoring equipment



HydRON critical technology developments



Activity	Pre-development type	Applicable to TD#1	Applicable to TD#2	Description	Current TRL	Budget (MEuro)	ITT issue date	Start date	Duration (months)
HydRON Simulator Testbed	System	x	x	Development of a testbed of an end-to-end HydRON simulator to assess the impact of different physical topologies and protocol stacks, to estimate quality of service parameters (e.g., SNR, BER, latency, throughput) for different type of user traffic (e.g., data rate, analog / digital, modulation types, coding formats), to analyse impact of different type of on-board switching / routing (all optical transparent, electrical regenerative), to evaluate behaviour of different external / internal interfaces, and to investigate strategies for optimal network management and control (including integration to a terrestrial OTN)	2	5	Aug/20	Jan/21	24
Optical technologies for next generation high throughput optical inter-satellite links	System	x	x	Assessment of the system and sub-system performance requirements for the next generation of optical inter-satellite links (GEO-LEO, GEO-GEO, LEO-LEO, GEO-ground) and to establish a development roadmap of the critical enabling technologies for future high throughput optical satellite systems	2-5	0,5	Aug/20	Jan/21	6
WDM Laser Sources at 1064nm	Payload	x	x	Development of low noise and small footprint semiconductor laser diodes at 1064nm compatible with WDM operation and the associated low-power consumption driving electronics and small footprint passive WDM components.	4	1	Oct/20	Mar/21	18
High-Power Optical Multiplexer at 1064nm	Payload	x	x	Development of an optical multiplexer capable of high-power handling at 1064nm wavelength. Two versions are to be developed to address operation under space and ground environmental conditions. Drivers: high-power handling, insertion loss, crosstalk.	2	0,75	Oct/20	Mar/21	18
High-Power Optical Multiplexer at 1550nm	Payload	x	x	Development of an optical multiplexer capable of high-power handling at 1550nm wavelength. Two versions are to be developed to address operation under space and ground environmental conditions. Drivers: high-power handling, insertion loss, crosstalk.	3	0,5	Oct/20	Mar/21	18



HydRON critical technology developments



Activity	Pre-development type	Applicable to TD#1	Applicable to TD#2	Description	Current TRL	Budget (MEuro)	ITT issue date	Start date	Duration (months)
WDM High-Power Optical Amplifier at 1064nm	Payload	x	x	Development of a high-power optical amplifier operating at 1064nm wavelength, compatible with WDM operation. Two versions are to be developed to address operation under space and ground environmental conditions. Drivers: wall-plug efficiency, simultaneous high-power and WDM operation. Strategic component not available in ESA's Member States nor in Cooperating/Associated States.	2	2	Oct/20	Mar/21	24
WDM High-Power Optical Amplifier at 1550nm	Payload	x	x	Development of a high-power optical amplifier operating at 1550nm wavelength, compatible with WDM operation. Two versions are to be developed to address operation under space and ground environmental conditions. Drivers: wall-plug efficiency, simultaneous high-power and WDM operation. Strategic component not available in ESA's Member States nor in Cooperating/Associated States.	2	2	Oct/20	Mar/21	24
WDM LEO Laser Communication Terminal	Payload		x	Development of a small and flexible Laser Communication Terminal for LEO satellites (LEO to GEO OISLs), compatible with WDM operation at dual wavelength bands (1064nm & 1550nm), including the acquisition, tracking and communication optical paths. Drivers: mass, volume, power consumption, reliability, costs, delivery time.	4	5	Jan/21	Jun/21	18
GEO Optical Switch Matrix 25x25	Payload	x		Development of a reconfigurable optical switch matrix (optical cross-connect or an optical add and drop multiplexer) and its associated driving & control electronics compatible with GEO environment. The optical switch matrix can operate at 1550nm wavelength range only, but the design must be such that adaptations for operation at 1064nm wavelength range have minimum technical and cost impacts. Drivers: mass, volume, power consumption, insertion loss, crosstalk, reliability.	4	7	Jan/21	Jun/21	18



HydRON critical technology developments



Activity	Pre-development type	Applicable to TD#1	Applicable to TD#2	Description	Current TRL	Budget (MEuro)	ITT issue date	Start date	Duration (months)
Space assessment of high-data rate Data Electronics for GEO environment	Payload	x		Evaluation of commercially available digital regenerative (receiver and transmitter) data electronics for high data rate applications (>100Gbps) compatible with GEO environment operation. Drivers: mass, volume, power consumption, reliability.	4	2	Jan/21	Jun/21	18
Broadband low-mass & low-consumption Demodulator	Payload	x	x	Development of a broadband low-mass and low-power consumption IF demodulator. Two versions are to be developed to address operation in LEO / GEO environment conditions. This unit is part of the interface electronics to the Customer's payload. Drivers: high bandwidth (>5GHz), mass, volume, power consumption, (in addition costs and delivery time for the LEO version)	3	2	Jan/21	Jun/21	18
Space assessment of high-data rate Data Electronics for LEO environment	Payload		x	Evaluation of commercially available digital regenerative (receiver and transmitter) data electronics for high data rate applications (>100Gbps) compatible with LEO environment operation. Drivers: costs, mass, volume, power consumption, delivery time.	4	1,5	May/21	Oct/21	18
WDM LEO compact Laser Communication Terminal	Payload		x	Development of a compact and low-cost Laser Communication Terminal for LEO satellites (LEO to LEO, LEO to ground OISLs), compatible with WDM operation at dual wavelength bands (1064nm & 1550nm), including the acquisition, tracking and communication optical paths. Drivers: costs, mass, volume, power consumption, delivery time	4-5	3	May/21	Oct/21	18
LEO Optical Switch Matrix 25x25	Payload		x	Development of a reconfigurable optical switch matrix (optical cross-connect or an optical add and drop multiplexer) and its associated driving & control electronics compatible with LEO environment. The optical switch matrix can operate at 1550nm wavelength range only, but the design must be such that adaptations for operation at 1064nm wavelength range have minimum technical and cost impacts. Drivers: costs, mass, volume, power consumption, insertion loss, crosstalk, delivery time.	4	5	May/21	Oct/21	18



HydRON critical technology developments



Activity	Pre-development type	Applicable to TD#1	Applicable to TD#2	Description	Current TRL	Budget (MEuro)	ITT issue date	Start date	Duration (months)
Broadband low-mass & low-consumption Modulator	Payload	x	x	Development of a broadband low-mass and low-power consumption IF modulator. Two versions are to be developed to address operation in LEO / GEO environment conditions. This unit is part of the interface electronics to the Customer's payload. Drivers: high bandwidth (>5GHz), mass, volume, power consumption, (in addition costs and delivery time for the LEO version)	3	1	May/21	Oct/21	18
reliable GEO Optical Feeder Link demonstration	Optical feeder link	x		Development of reliable turbulence mitigation techniques (software-based and hardware-based) for a bidirectional GEO optical feeder link and execution of a long-term test campaign to determine the achievable link availability of a GEO optical feeder link limited by turbulence effects.	NA	2,5	Oct/20	Mar/21	24
reliable LEO Optical Feeder Link demonstration	Optical feeder link		x	Development of reliable turbulence mitigation techniques (software-based and hardware-based) for a bidirectional LEO optical feeder link and execution of a long-term test campaign to determine the achievable link availability of a LEO optical feeder link limited by turbulence effects (taking into account changes of the turbulence strength and the isoplanatic angle at different elevation angles).	NA	2,5	Oct/20	Mar/21	24
Aircraft detection system for Optical Ground Stations	Optical feeder link	x	x	Development of a passive optical system (only camera sensor based, no active laser due to laser safety issues) to identify the presence of airplanes / helicopters / aircrafts (potentially carrying people) in the vicinity of an Optical Ground Station. The system has to continuously monitor (24h per day, 365days per year) during daytime and nighttime conditions in clear sky conditions (i.e., no clouds)	NA	0,5	Oct/20	Mar/21	18
Turbulence monitoring equipment	Optical feeder link	x	x	Development of a turbulence monitoring equipment to demonstrate an accurate turbulence measurement concept that can be used during daytime and nighttime conditions.	NA	0,5	Jan/21	Jun/21	18



HydRON critical technology developments vs HydRON-TD#1 elements



		HydRON critical technology developments																				
		HydRON Simulator test-bench	Optical technologies for next generation high throughput optical inter-satellite links	WDM Laser Sources at 1064nm	High-Power Optical Multiplexer at 1064nm	High-Power Optical Multiplexer at 1550nm	WDM GEO Laser Communication Terminal	WDM High-Power Optical Amplifier at 1064nm	WDM High-Power Optical Amplifier at 1550nm	WDM LEO Laser Communication Terminal	GEO Optical Switch Matrix 25x25	Space assessment of high-data rate Data Electronics for GEO environment	Broadband low-mass & low-consumption Demodulator	Space assessment of high-data rate Data Electronics for LEO environment	WDM LEO compact Laser Communication Terminal	LEO Optical Switch Matrix 25x25	Broadband low-mass & low-consumption Modulator	reliable GEO OFL demonstration	reliable LEO OFL demonstration	Aircraft detection system for Optical Ground Stations	Turbulence monitoring equipment	
HydRON TD#1 - Elements	100Gbps WDM GEO Laser Comm. Terminal		✓				✓															
	Optical Amplifier		✓					✓	✓													
	Optical Multiplexing/ De-multiplexing		✓		✓	✓																
	Optical Switch Matrix										✓											
	TX/RX Optoelectronics		✓	✓																		
	TX/RX Data Electronics		✓										✓									
	Interface Electronics												✓	✓			✓					
	Optical Wideband Repeater											✓										
	WDM Optical Feeder Station & equipment	✓																		✓	✓	✓
	HydRON Network Control Center	✓																				
	GEO Satellite platform																					
	Terrestrial fibre network & equipment	✓																				



HydRON critical technology developments vs HydRON-TD#2 elements

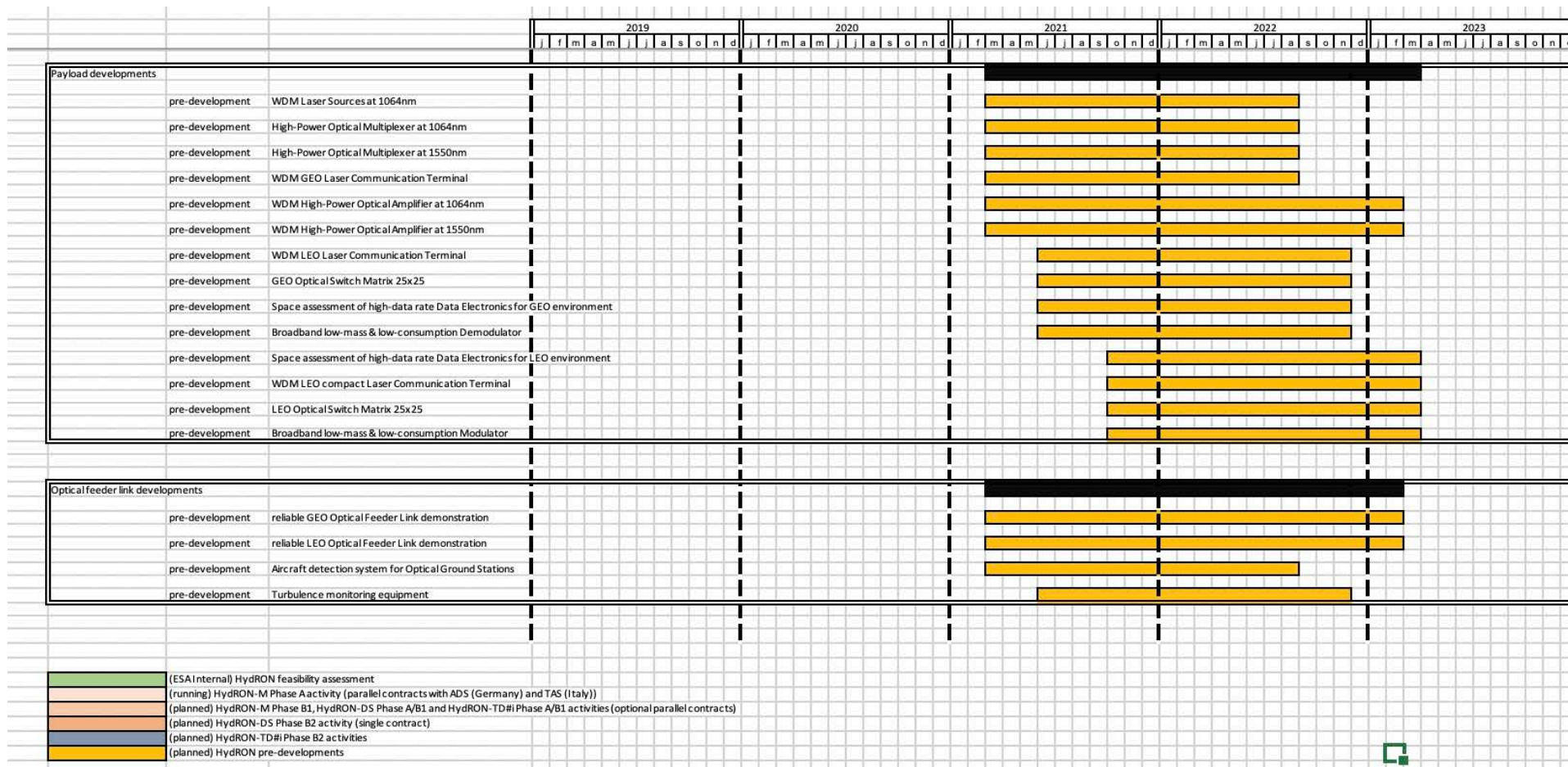


		HydRON critical technology developments																				
		HydRON Simulator test-bench	Optical technologies for next generation high throughput optical inter-satellite links	WDM Laser Sources at 1064nm	High-Power Optical Multiplexer at 1064nm	High-Power Optical Multiplexer at 1550nm	WDM GEO Laser Communication Terminal	WDM High-Power Optical Amplifier at 1064nm	WDM High-Power Optical Amplifier at 1550nm	WDM LEO Laser Communication Terminal	GEO Optical Switch Matrix 25x25	Space assessment of high-data rate Data Electronics for GEO environment	Broadband low-mass & low-consumption Demodulator	Space assessment of high-data rate Data Electronics for LEO environment	WDM LEO compact Laser Communication Terminal	LEO Optical Switch Matrix 25x25	Broadband low-mass & low-consumption Modulator	reliable GEO OFL demonstration	reliable LEO OFL demonstration	Aircraft detection system for Optical Ground Stations	Turbulence monitoring equipment	
HydRON TD#2 - Elements	100Gbps WDM LEO Laser Comm. Terminal		✓							✓												
	~10Gbps WDM LEO compact Laser Comm. Terminal		✓												✓							
	Optical Amplifier		✓					✓	✓													
	Optical Multiplexing/ De-multiplexing		✓		✓	✓																
	Optical Switch Matrix															✓						
	TX/RX Optoelectronics		✓	✓																		
	TX/RX Data Electronics		✓												✓							
	Interface Electronics													✓	✓			✓				
	Transportable WDM Optical Feeder Station & equipment	✓																		✓	✓	✓
	LEO Satellite platform																					



HydRON: Activities under preparation

>> Critical developments



Agenda



- Introduction to the HydRON Mission
- Envisioned usage: User Categories, HUG
- Demonstration System and Technology Demonstrators
- Status of the HydRON Project Preparations
- Critical technology developments and HydRON-TD's elements
- **Conclusions, Discussions / Q&A Session**
- Annexes:
 - ✓ Annex I - Overview of the Member States Industrial Capability
 - ✓ Annex II - Industry Day: Industrial Input Template



Conclusions

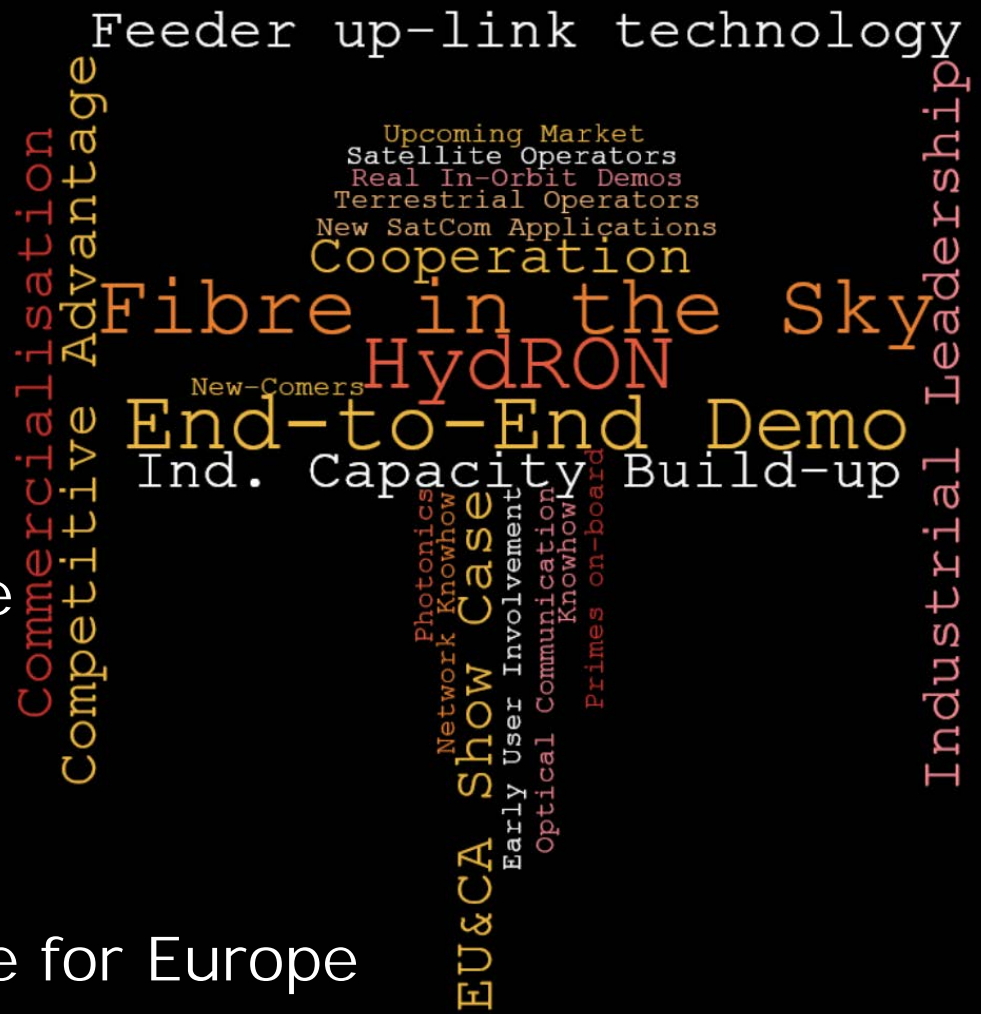
- Why HydRON?
- How my industry will benefit?
- What do I gain by investing?



HydRON is the first programme on optical communications to combine all aspects of

- 3D Network architecture (space/terrestrial)
- pre-operational demonstration
- industrial capacity building

to provide a competitive advantage for Europe and Canada.



Way forward with HydRON



- Unique opportunities for your industry to prepare for an upcoming market.
- Only limited investments by Operators on the horizon.
- ESA initiated project will allow for multiple implementations to maximize industrial participation.
- HydRON is about your industry - new pre-developments can be organized to better suit your needs.



- Participation in HydRON is essential to:
 - ✓ have as many industrial stakeholders join the “club”.
 - ✓ start time critical developments as soon as possible.
 - ✓ allow early selection on flight opportunities and join forces with “interested parties”.
- ESA can offer targeted support to your company in close coordination with your ESA delegation.

Conclusions



HydRON offers opportunities for your Industry

HydRON great potential as integrated space/ground network infrastructure is of interest for both individual investors and institutional market

HydRON technical & programmatic challenges require a quick start

Discussions / Q&A



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C. Vasko



M. Politano



J. Perdignes



S. Mezzasoma

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Agenda



- Introduction to the HydRON Mission
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- Demonstration System and Technology Demonstrators
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- Critical technology developments and HydRON-TD's elements
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- **Annexes:**
 - ✓ **Annex I - Overview of the Member States Industrial Capability**
 - ✓ **Annex II - Industry Day: Industrial Input Template**



Annex I

Overview of the Member States Industrial Capability



Overview MS Industrial Capabilities



Elements of HydRON-TD#1 (space and ground segments)

HydRON-TD#1 Elements	Austria	Belgium	Czech Republic	Denmark	Estonia	Finland	France	Germany	Greece	Hungary	Ireland	Italy	Luxemburg	Netherlands	Norway	Poland	Portugal	Romania	Spain	Sweden	Switzerland	United Kingdom	Slovenia	Canada
100Gbps WDM GEO Laser Comm. Terminal							✓	✓						✓							✓			
Optical Amplifier							✓	✓														✓		✓
Optical Multiplexing / De-multiplexing		✓		✓		✓	✓	✓						✓	✓		✓		✓		✓	✓		✓
Optical Switch Matrix							✓														✓	✓		
TX/RX Optoelectronics		✓		✓		✓	✓	✓	✓						✓		✓		✓		✓	✓		✓
TX/RX Data Electronics	✓						✓	✓	✓		✓						✓	✓	✓		✓	✓		✓
Interface Electronics		✓	TBC				✓	✓		TBC		✓									✓	✓		✓
Optical Wideband Repeater							✓	✓				✓							✓		✓	✓		✓
WDM Optical Feeder Station & equipment	✓						✓	✓	✓		✓	✓		✓	✓	✓		✓	✓	✓	✓	✓		✓
HydRON Network Control Center		✓	TBC				✓	✓	✓	TBC									✓	✓		✓		✓
GEO Satellite platform							✓	✓	✓				✓						✓	✓		✓		✓
Terrestrial fibre network & equipment	✓					✓	✓	✓	✓		✓			✓					✓	✓		✓		✓



Overview MS Industrial Capabilities

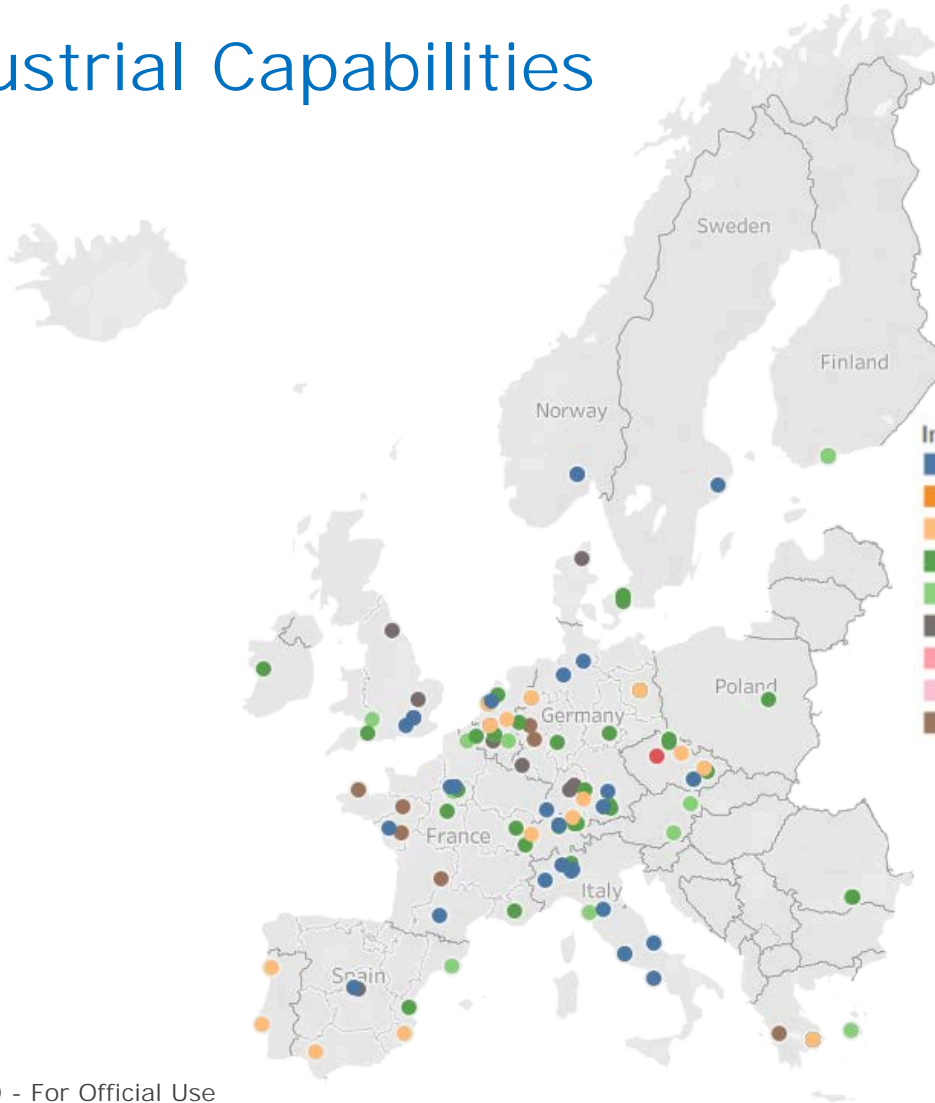


Elements of HyDRON-TD#2 (space and ground segments)

HyDRON-TD#2 Elements	Austria	Belgium	Czech Republic	Denmark	Estonia	Finland	France	Germany	Greece	Hungary	Ireland	Italy	Luxemburg	Netherlands	Norway	Poland	Portugal	Romania	Spain	Sweden	Switzerland	United Kingdom	Slovenia	Canada
100Gbps WDM LEO Laser Comm. Terminal	✓						✓	✓													✓			✓
~10Gbps WDM LEO compact Laser Comm. Terminal				✓			✓	✓			✓	✓		✓							✓	✓		✓
Optical Amplifier							✓	✓													✓	✓		✓
Optical Multiplexing / De-multiplexing		✓		✓		✓	✓	✓						✓	✓		✓		✓		✓	✓		✓
Optical Switch Matrix							✓														✓	✓		
TX/RX Optoelectronics		✓		✓		✓	✓	✓	✓						✓		✓		✓		✓	✓		✓
TX/RX Data Electronics	✓						✓	✓	✓		✓						✓	✓	✓		✓	✓		✓
Interface Electronics		✓	TBC				✓	✓		TBC		✓									✓	✓		✓
Mobile WDM Optical Feeder Station & equipment	✓						✓	✓	✓		✓	✓		✓	✓	✓		✓	✓	✓	✓	✓		✓
LEO Satellite platform		✓		✓			✓	✓				✓										✓		✓

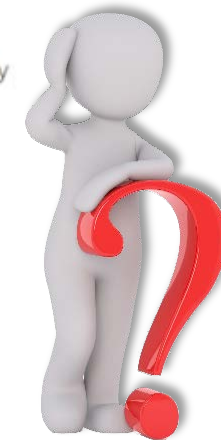


MS Industrial Capabilities



Industry (group)

- Aerospace & Aerospace / Defense
- Cloud cover forecasting
- Components, Components / Electronics, RF & electronics and 3 more
- Optical Components, Optical Systems, Optical Terrestrial Network Provider and 1 more
- Research and Technology Organisation, Research Institution, University
- SatCom, Satellite Operator, Small sats
- Software
- Space Agency
- Telecom & Telecom / Security



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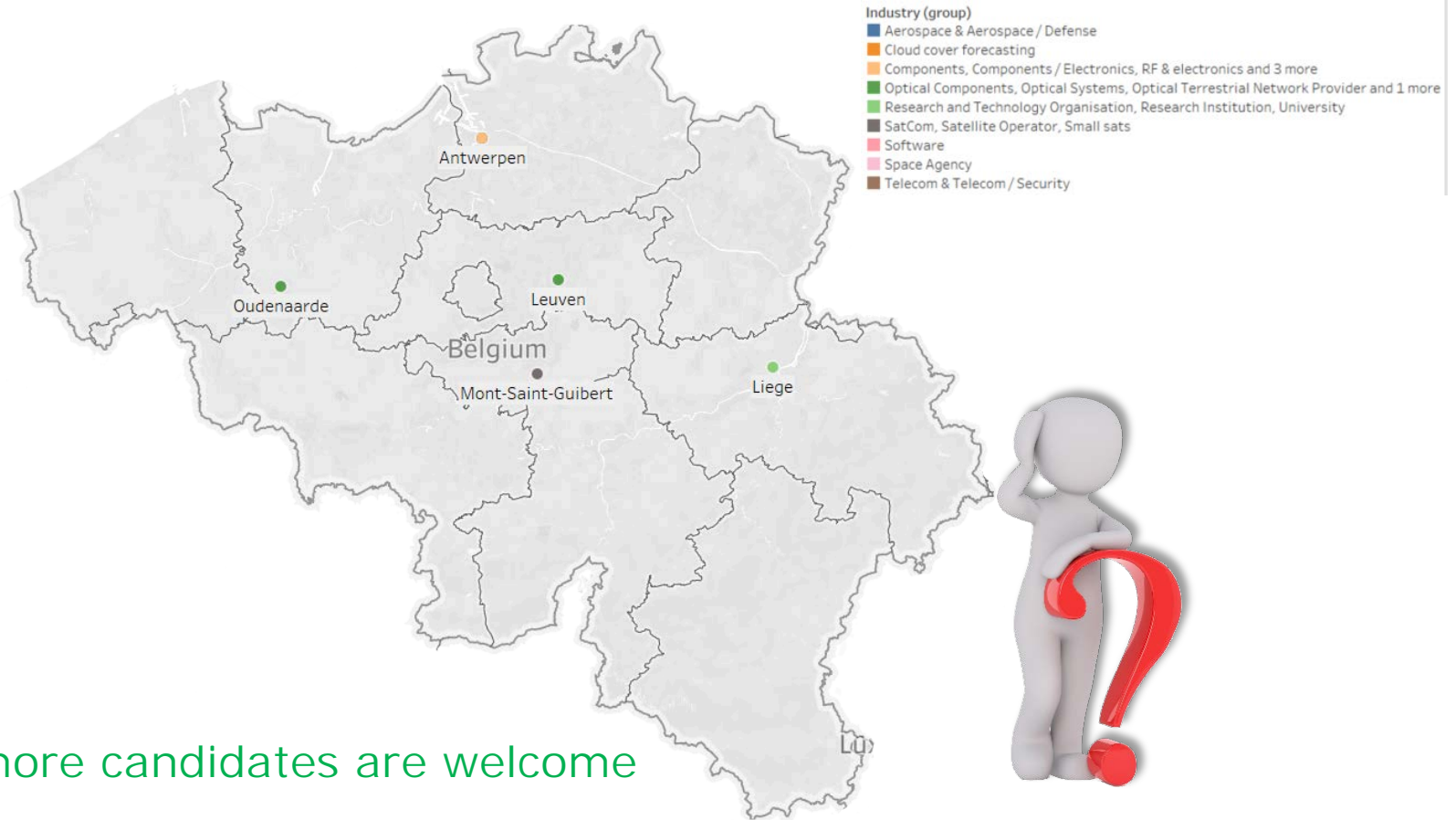
European Space Agency

MS Industrial Capabilities



Potential candidates might include the following Industrial Partners:

Belgium
Antwerp Space (photonics)
Aerospace Lab
Centre Spatial de Liege (CSL)
IMEC
OIP
QinetiQ
Xenics



..but more candidates are welcome



Annex II

Industry Day: Industrial Input Template



Industry interest: Critical technology developments



HydRON critical technology developments																				
	HydRON Simulator test-bench	Optical technologies for next generation high throughput optical inter-satellite links	WDM Laser Sources at 1064nm	High-Power Optical Multiplexer at 1064nm	High-Power Optical Multiplexer at 1550nm	WDM GEO Laser Communication Terminal	WDM High-Power Optical Amplifier at 1064nm	WDM High-Power Optical Amplifier at 1550nm	WDM LEO Laser Communication Terminal	GEO Optical Switch Matrix 25x25	Space assessment of high-data rate Data Electronics for GEO environment	Broadband low-mass & low-consumption Demodulator	Space assessment of high-data rate Data Electronics for LEO environment	WDM LEO compact Laser Communication Terminal	LEO Optical Switch Matrix 25x25	Broadband low-mass & low-consumption Modulator	reliable GEO OFL demonstration	reliable LEO OFL demonstration	Aircraft detection system for Optical Ground Stations	Turbulence monitoring equipment
Competence/interest																				
Heritage																				



Industry interest: HydRON-TD's elements

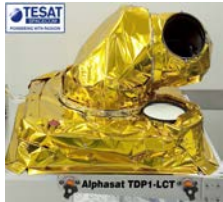


		Competence/interest	Heritage
HydRON TD#1 - Elements	100Gbps WDM GEO Laser Comm. Terminal		
	Optical Amplifier		
	Optical Multiplexing / De-multiplexing		
	Optical Switch Matrix		
	TX/RX Optoelectronics		
	TX/RX Data Electronics		
	Interface Electronics		
	Optical Wideband Repeater		
	WDM Optical Feeder Station & equipment		
	HydRON Network Control Center		
	GEO Satellite platform		
	Terrestrial fibre network & equipment		

		Competence/interest	Heritage
HydRON TD#2 - Elements	100Gbps WDM LEO Laser Comm. Terminal		
	~10Gbps WDM LEO compact Laser Comm. Terminal		
	Optical Amplifier		
	Optical Multiplexing / De-multiplexing		
	Optical Switch Matrix		
	TX/RX Optoelectronics		
	TX/RX Data Electronics		
	Interface Electronics		
	Transportable WDM Optical Feeder Station & equipment		
	LEO Satellite platform		



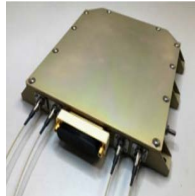
HydRON key Elements: Space, HydRON-TD#1



WDM GEO LASER COMM. TERMINAL



OPTICAL AMPLIFIER



OPTICAL MULTIPLEXING / DE-MULTIPLEXING



OPTICAL SWITCH MATRIX



TX/RX DATA ELECTRONICS



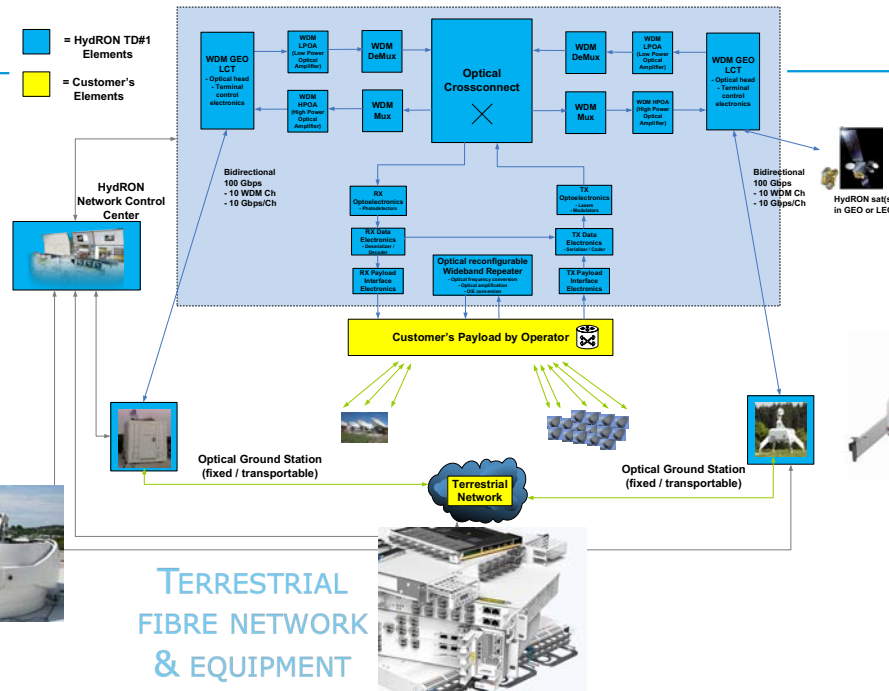
TX/RX OPTOELECTRONICS



HYDRON NETWORK CONTROL CENTER



(FIXED) WDM OPTICAL FEEDER STATION



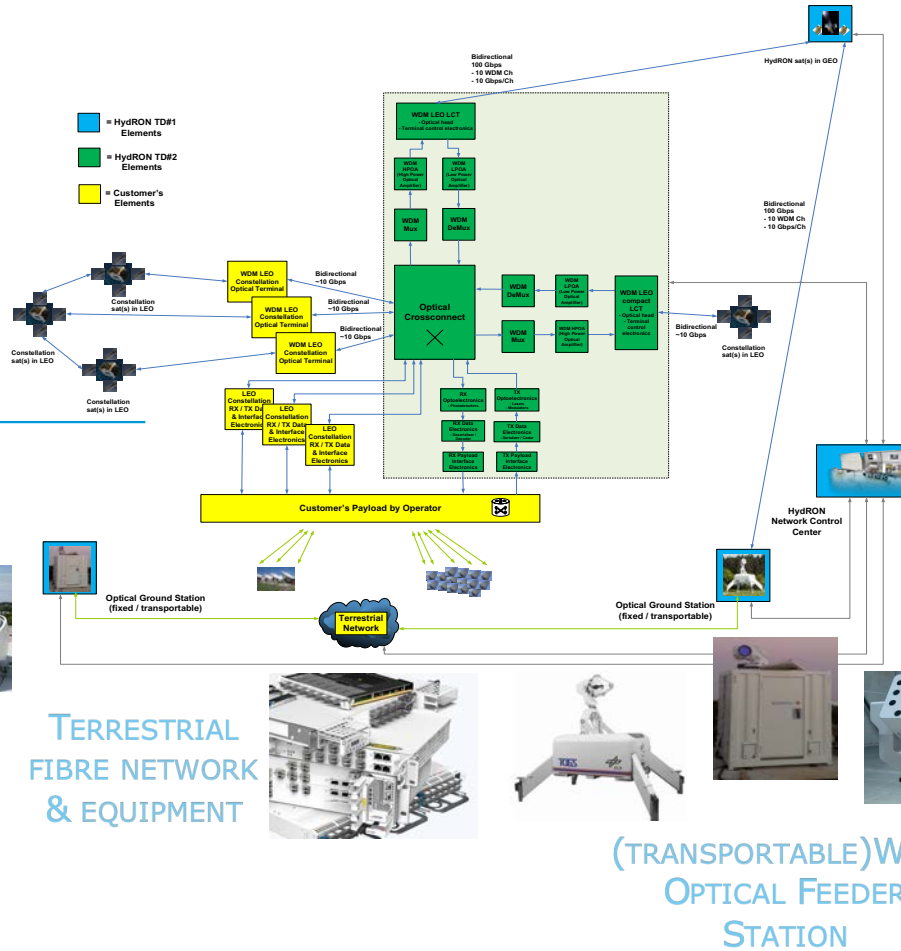
(TRANSPORTABLE) WDM OPTICAL FEEDER STATION



HydRON key Elements: Space, HydRON-TD#2



WDM LEO
LASER COMM.
TERMINAL



WDM LEO
COMPACT
LASER
COMM.
TERMINAL



(FIXED)
WDM
OPTICAL
FEEDER
STATION

TERRESTRIAL
FIBRE NETWORK
& EQUIPMENT



(TRANSPORTABLE) WDM
OPTICAL FEEDER
STATION



HYDRON NETWORK
CONTROL CENTER



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