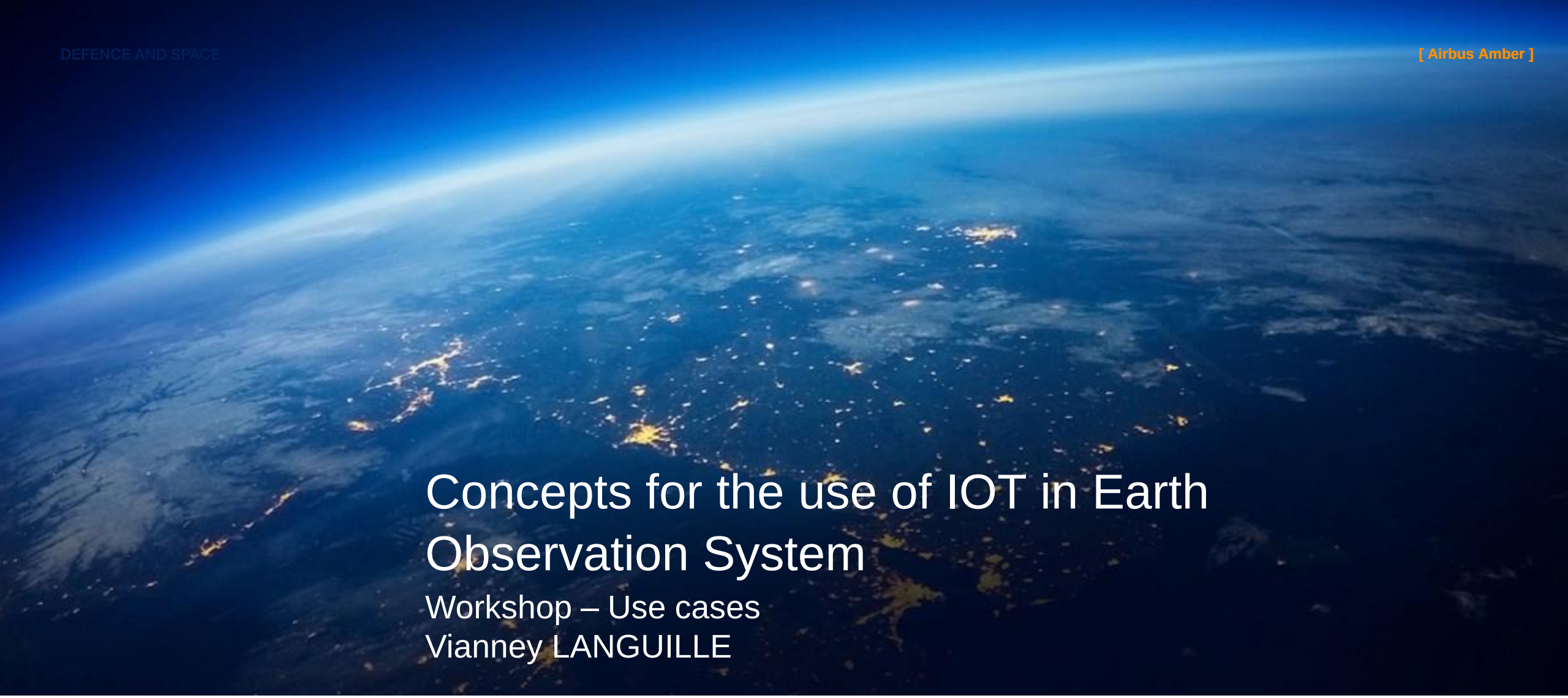

Concepts for the use of IOT in Earth Observation System

Workshop – Use cases

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DEFENCE AND SPACE

16/17 February 2023

AIRBUS

Agenda

- **Study progress**
- **Use cases**
  - **Ground to space connectivity**
  - **Space to ground connectivity**
  - **Space to Space connectivity**
- **Main identified drivers**

Study progress

- Study started beg of November 2022

- The study will assess operational concepts, use cases and possible technological/regulatory solutions, both on:
  - short term (3 years), for rapid field deployment and terrain feedback
  - Medium term (7 years), for integrated, seamless connectivity

- Task1 up to end of February:
  - Identify potential use cases of seamless connectivity for EO satellites
  - Perform a survey on existing IoT connectivity providers
  - Identify preliminary CONOPS

- Upcoming activities:
  - System architecture
  - Refined CONOPS
  - Preliminary performance simulations

Use cases – Ground to Space connectivity

- Main benefits:
  - TC transmission latency improvement: TC transmitted over ground network up to SC nadir then local node transmits to SC
    - Reactive mission plan management (customer order cancellation, top priority request incoming…)
    - Resilience wrt GS
    - Orbit control (e.g. monitoring of semi natural re-entry or collision avoidances in cooperation with SST systems)
  - Retrieve ground-collected ancillary data to perform on-board processings, e.g. :
    - Temperature reference for IR image on-board analysis
    - Adaptation of sensor parameters to use full sensor dynamics over AOI, based on ground measured luminance
  - Trigger on-board acquisition/event based on ground local trigger, e.g.:
    - local acquisition request from military operation
    - immediate damage/leak assessment from critical infrastructure monitoring system
    - Mission downlink optimization (downlink of opportunity, downlink on mobile laser terminal…)
  - Trigger action on hosted payload independent from DHS:
    - Reducing cost by avoiding need for DHS integration
    - Resilience aspects

Focus on current VHR Sat tasking (PNEO x2) - Timelines

- Tasking timeline
  - 1 mission plan update per orbit -> ~45min delay (with 2 sats)
  - Meteo update once every 2 orbits to feed mission plan preparation
  - Best value for currents customers: last call for order 15min ahead from acquisition.
    - Currently ranging 30min-1h (passage over polar station before starting acquisitions : 15min overhead + orbit time to acquisition location)

- Downlink timeline
  - If acquisition in TLS visibility zone (~Europe), direct TM download to TLS after acquisition (~minutes)
  - If not, wait for next station visibility (1h30) or use EDRS
  - Full download of the acquired image (200km²) regardless of AOI size (typically dozen of km²)
  - Ground processing to assess useability of image wrt customer requirements (cloud coverage % on AOI)
    - 30min overhead

Focus on current VHR Sat tasking (PNEO x2) - Order procedures for VHR

- Airbus CI Order procedures (via OneAtlas)
  https://api.oneatlas.airbus.com

- Oneday: reactive tasking with realtime cloud coverage data instead of 24h forecasts
  – Maximize acq. opportunities

- OneNow: reactive tasking with realtime cloud coverage data
  – Maximise acq. opportunities
  – Download of thumbnail of AOI right after acq. to quickly get customer feedback and free next orbits for other orders

- OnePlan: reactive tasking with real-time cloud coverage data:
  – Maximize acq. opportunities

- OneSeries: event-driven acquisition
  – listen to ground triggers for change detection
  – Tip & cue with smaller sat ahead.

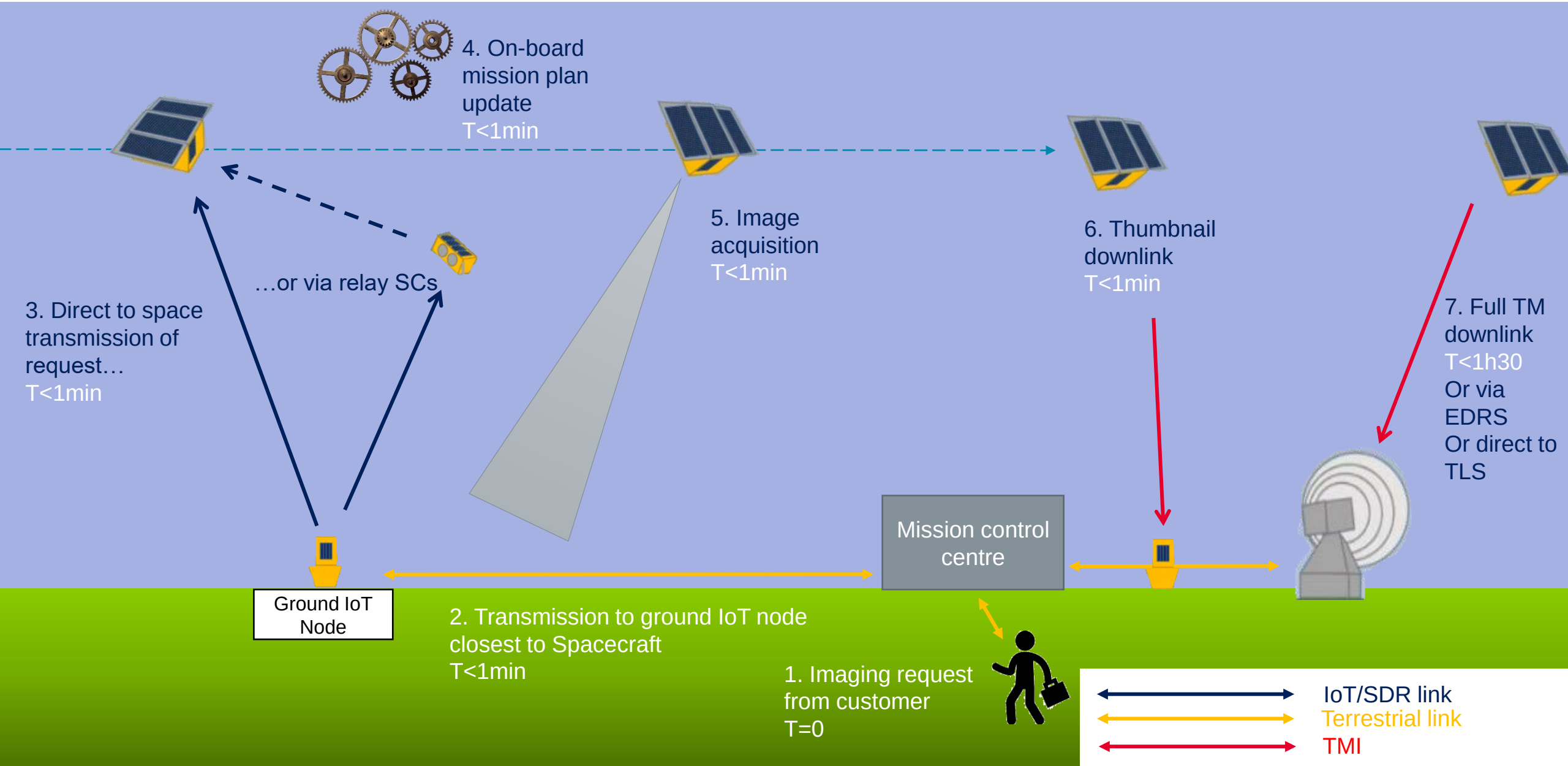
ONEDAY : **Choose your acquisition day** . Imagery acquisition for a specific day is now risk-free. 24 hours before your acquisition date, you receive a weather forecast by mail to let you confirm, postpone or cancel your request at no cost.

ONENOW : **Access useful information in an instant**. When immediate imagery is required, our satellites can be tasked to deliver valuable insights in the shortest possible timeframe. Don't panic if it's cloudy – we keep collecting images of your area until we are successful.

ONEPLAN : **Obtain qualified coverage within an agreed timeframe**. You select your timeframes, dates and preferred sensor – we ensure you receive the right qualified coverage, perfectly matching your project milestones.

ONESERIES : **Get coverage on a regular basis**. Whether you are dealing with long-term changes or highly dynamic situations, OneSeries brings you the required intelligence at the frequency you choose. For highest frequencies, our cloud cover commitment ensures you pay only for the most useful results.

VHR TASKING TO BE



Use cases – Ground to Space connectivity

- Main drivers:
  - On-board autonomy to benefit from low reactivity
  - Accomodation of the space-side terminal (especially for nano sats): power, dimensions, weight
  - Affordability of the system: simplicity, cost-effectiveness wrt additional ground stations / GSaaS
  - Absence of impact on mission: Omnidirectional antennas to avoid impacts on mission and keep it simple
  - Regulatory framework for emission from anywhere on Earth
  - Integrity and confidentiality with a low data rate link
  - Number/Repartition of ground nodes/coverage by space relays

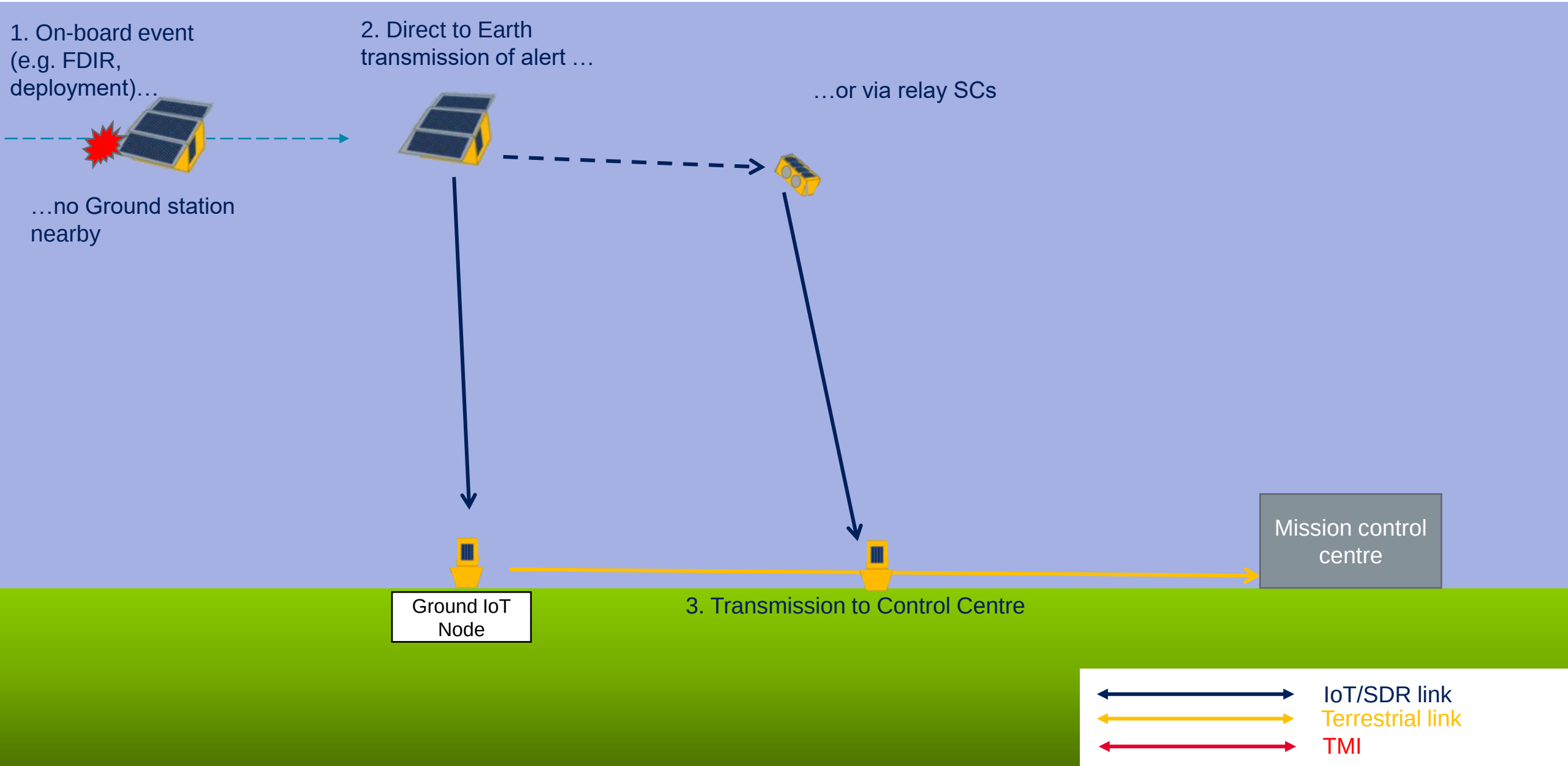
Use cases – Space to Ground connectivity

- Main benefits:
  - Downlink reactivity improvement: TM synthesis could be transmitted to ground network right after acquisition
    - On-board image processing (e.g. IA) and downlink of processing results for time critical applications (avoid flight time and ground overhead)
    - Existing high-datarate space data relays would be overkill for small amount of data and impossible for small sats
  - Continuous health monitoring, allowing MCC to e.g.:
    - Get notified instantly of any non-nominal situation - can help early damage mitigation especially on complex systems (constellations)
    - Decrease on-board FDIR complexity by transferring some of Isolation & Recovery operations to ground thanks to near real time transmission
  - Send telemetry of hosted payload independent from DHS
    - Perimetric surveillance, detection of aggression
    - resilience and/or lower cost

Use cases – Space to Ground connectivity

- Main drivers
  - On board processing to extract synthesis from payload TM
  - Deterministic behaviour of on-board processings (no need for sanity check by ground)
  - Regulatory framework for emission towards Earth anywhere on orbit
  - Integrity and confidentiality
  - Number/Repartition of ground nodes/coverage by space relays

USE CASE: ONBOARD EVENT TRANSMISSION



Use cases – Space to Space connectivity

- Main benefits:

  - Low data rate intersatellite link can enable autonomous constellation mission management
    - Autonomous concentration of health status/commands by one satellite nearby GS
    - Activation of protections of the constellation in case of attack/jamming/solar storms detected by one satellite
    - Differential GNSS

  - Data relay of message over zones where no ground IoT nodes are present
    - For time critical applications
    - Data collection (maritime buoys)

  - Sensing data synthesis shared between satellites to maximize image value
    - Upcoming event detection,
    - weather situation
    - acquisition parameters for tracking detected object
    - Stereo imaging parameters sharing

- Main drivers:
  - Cost effectiveness
  - Range vs datarate
  - On-board autonomy

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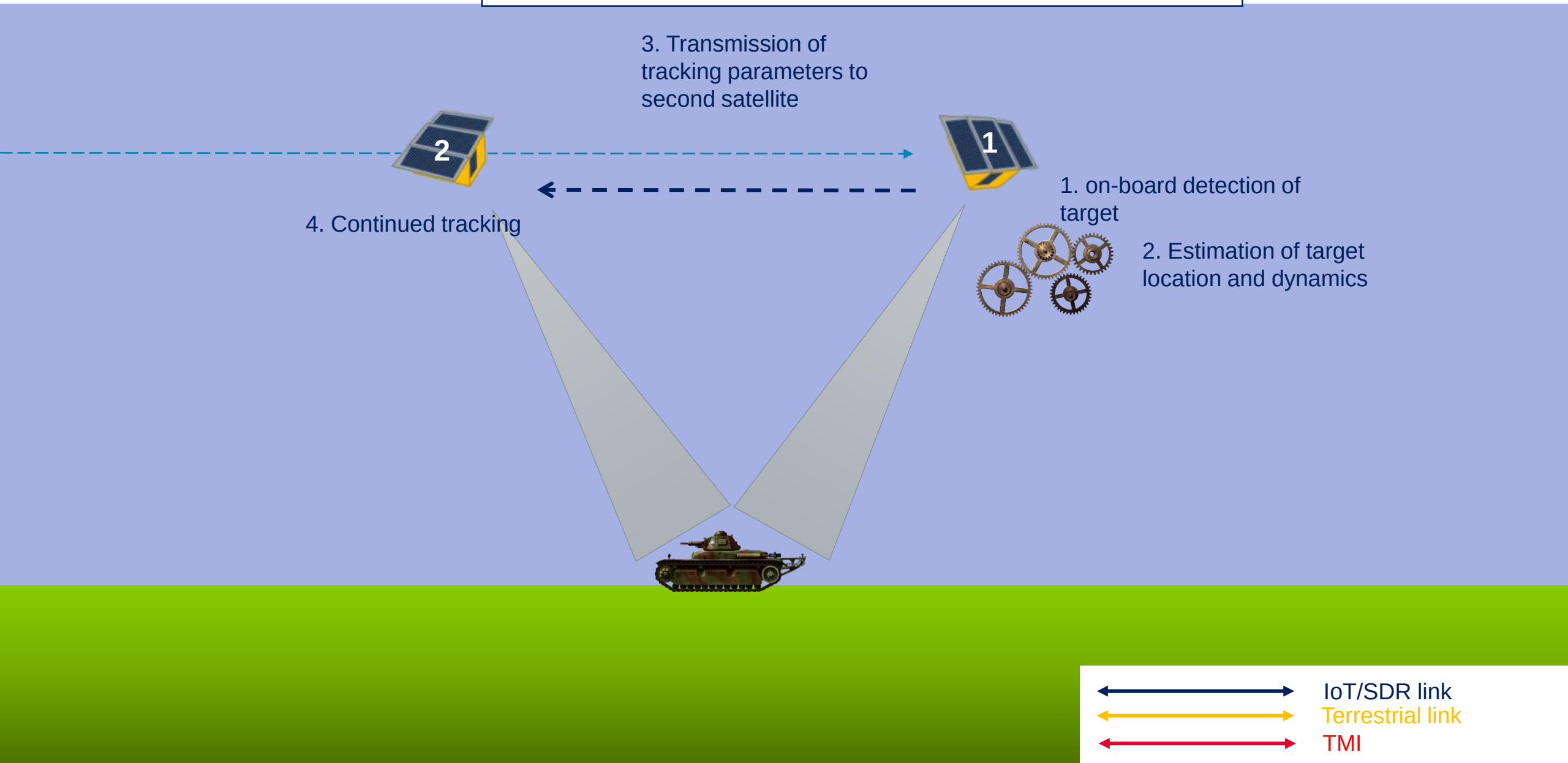
USE CASE: CONTINOUS TRACKING OF DETECTED OBJECT



Conclusion

- Seamless connectivity is key for tremendous improvement of image timeliness wrt end user needs
- Enabler for new way of operations of space assets, and EO end user customer interactions.
- High dependency on on-board autonomy capabilities

Thank you