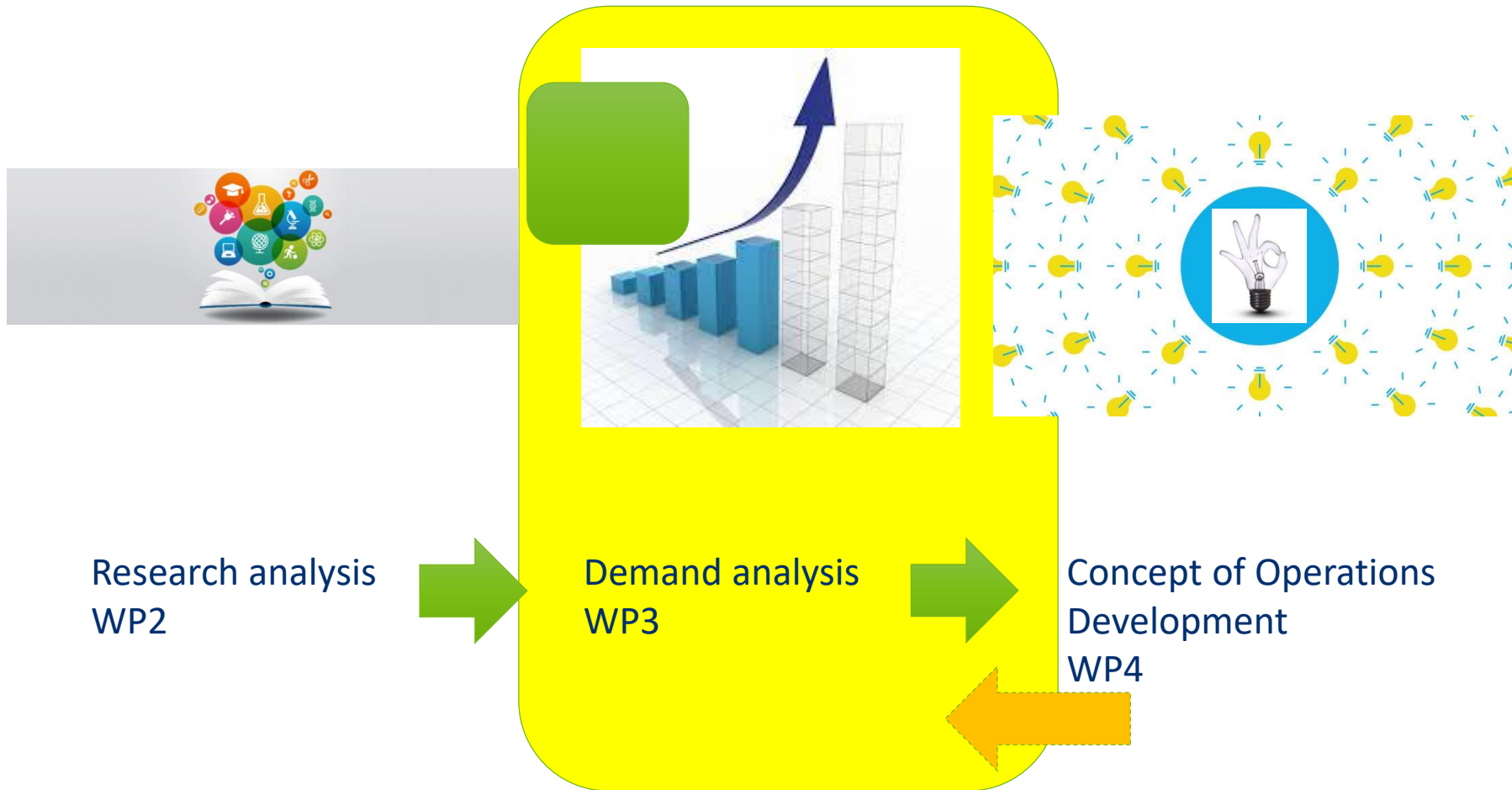


Workshop 2

Use Cases & Contingencies

European Concept for Higher Airspace Operations (ECHO)
Workshop 2, Brussels, 20-21 April 2022



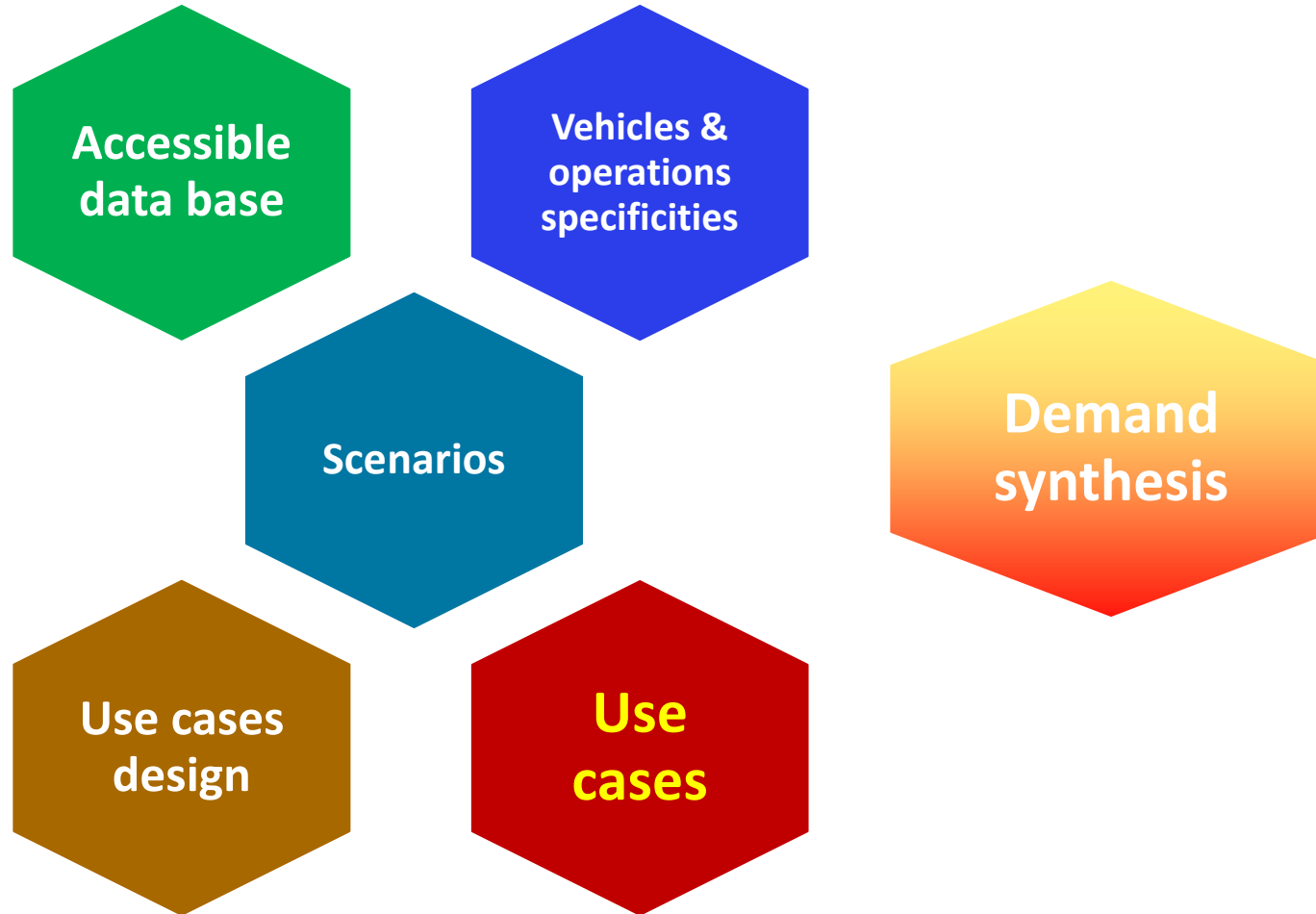
Where do we start
from?

Use Cases
structure

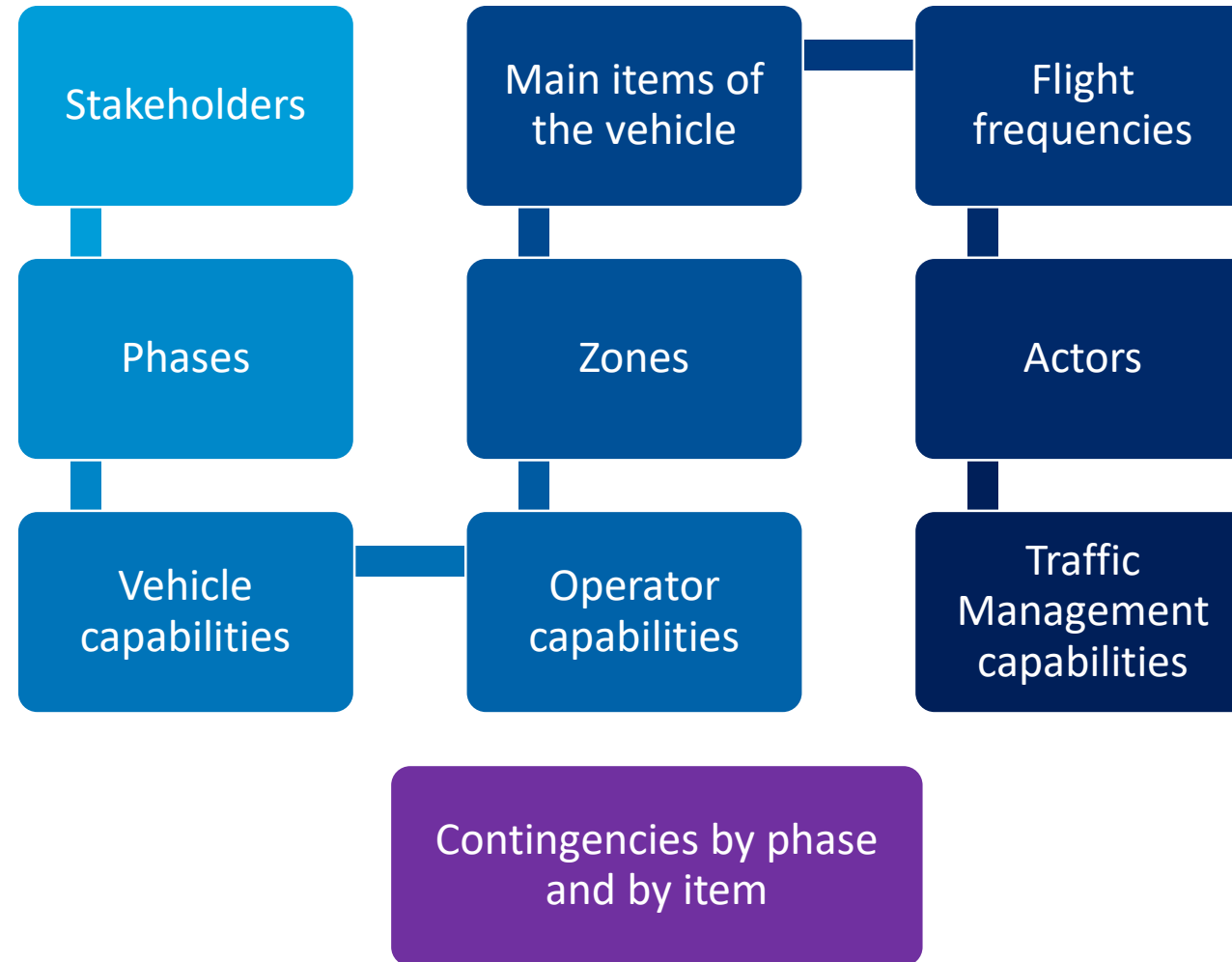
Use Cases list

Examples

How to build the Demand?



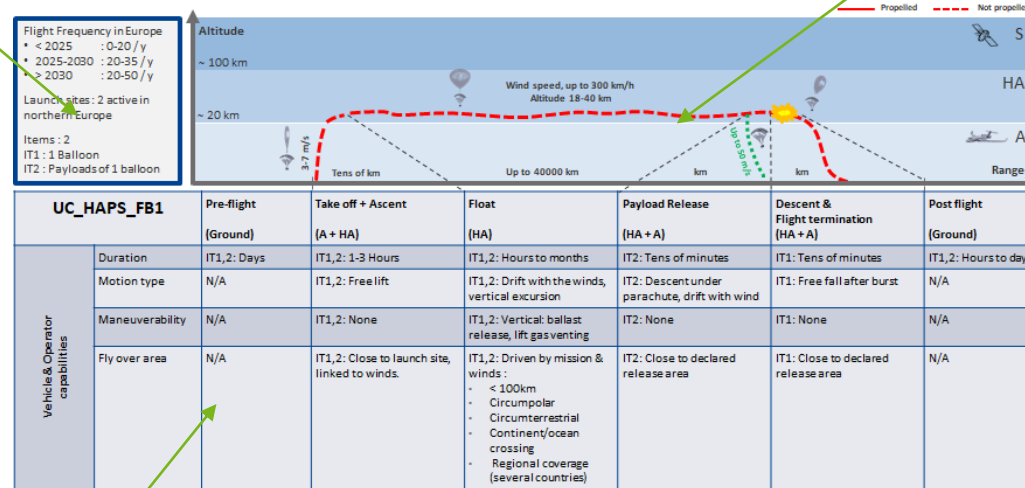
Use Case content



Use Case Template

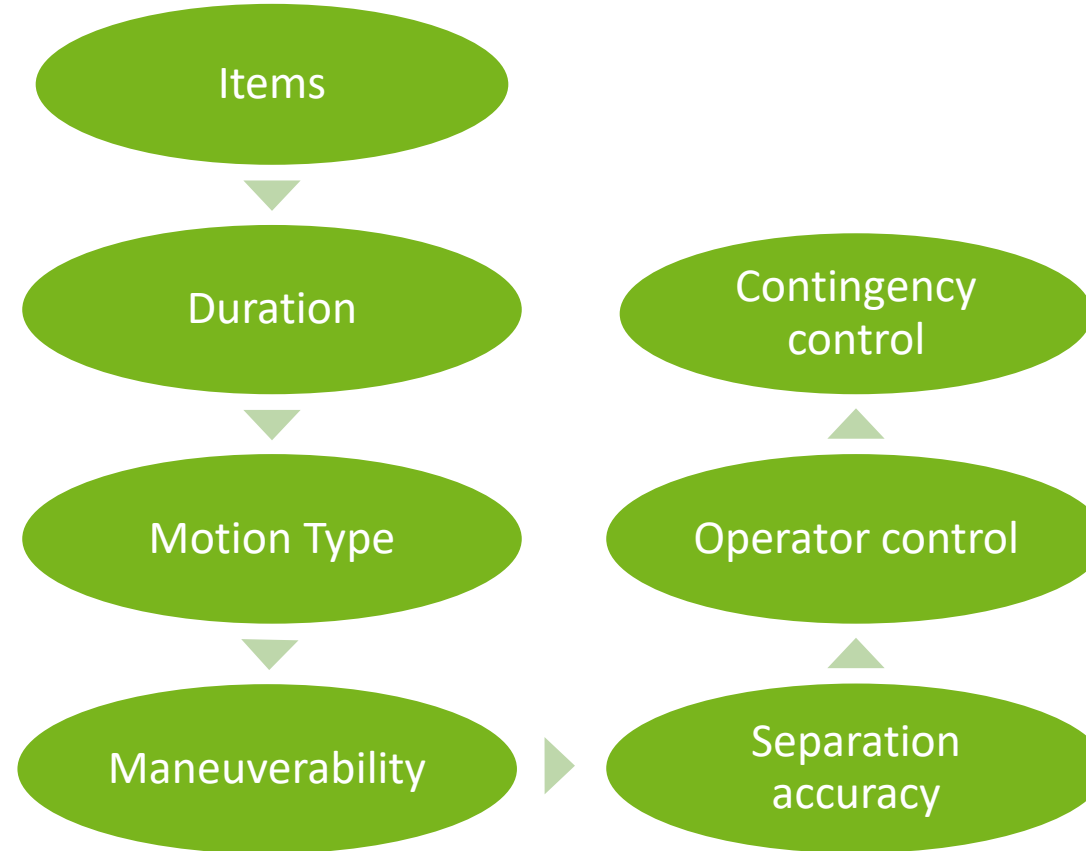
A Flight Frequency insert which reminds the number of new operations per time unit over Europe and per application (if any). The insert also indicates the number of potential localizations per continent (number of spaceports or launch zones, etc.)

A trajectory profile in altitude / range with dedicated information (velocity & range orders of magnitude) for each raw geophysical domain (Airspace, Higher Airspace and Space)



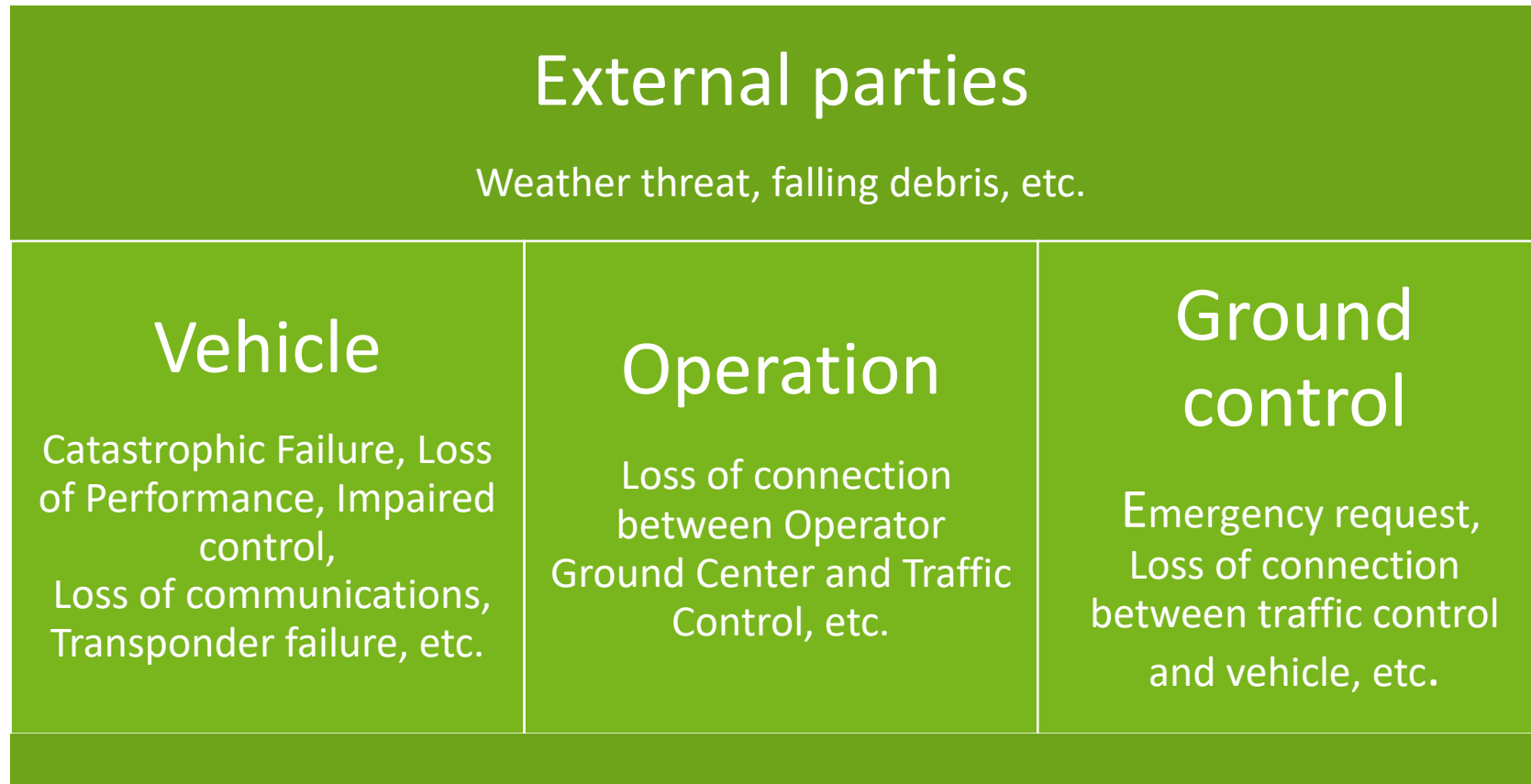
A Table of capabilities cut in flight phases, which may have different flight management from the vehicle/operator or traffic regulation authorities (in particular due to the transition between Airspace and Higher Airspace, or Higher Airspace and Space).

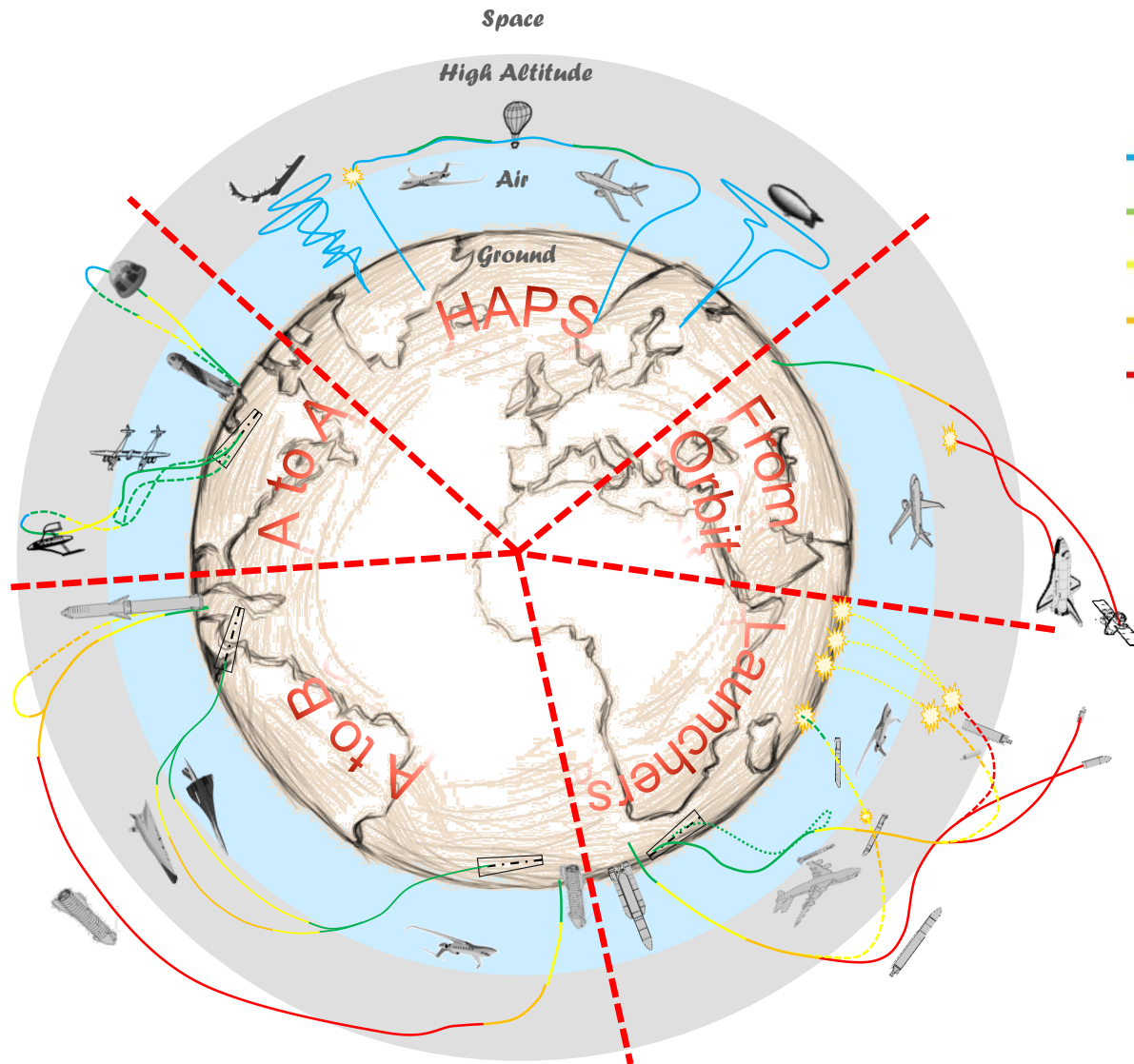
Vehicle capabilities



Operator capabilities







- • Slow < 100 kts
- • Subsonic < Mach 1
- • Supersonic < Mach 5
- • Hypersonic < Mach 10
- • High Hypersonic > Mach 10

5 Flight Categories

20 uses cases

HAPS	<ul style="list-style-type: none"> • Free Balloon • Maneuvering Balloon • Motorized Lighter Than Air Airship • Motorized Heavier Than Air Airplane
A to A	<ul style="list-style-type: none"> • Vertical Rocket • Air Launch Rocket • RocketPlane
A to B	<ul style="list-style-type: none"> • Supersonic Airplane • Hypersonic Aircraft • Hypersonic Spacecraft (horizontal landing) • Hypersonic Spacecraft (vertical landing)
Launcher	<ul style="list-style-type: none"> • Sounding rocket • Direct Launch Expendable Rocket w/o de-orbit • Direct Launch Expendable Rocket with de-orbit • Direct Launch Semi Reusable Rocket • Direct Launch Reusable Rocket • Air Launch Expendable Rocket • RocketPlane
From Orbit	<ul style="list-style-type: none"> • Re-entry vehicle • Satellite de-orbit

some examples among the 20 uses cases

HAPS

- Free Balloon
- Maneuvering Balloon
- Motorized Lighter Than Air Airship
- Motorized Heavier Than Air Airplane



Sceye



HALE – D (Lockheed Martin)



Zephyr (Airbus)



Odyssey (Boeing)



Stratobus (Thales Alenia Space)



Hi Sentinel demo (SwRI, Aerostar)



Sunstar (Solarflight)



Solara 50 (Google)

Launcher

From Orbit

- Sounding rocket
- Direct Launch Expendable Rocket
- Direct Launch Expendable Rocket
- Direct Launch Semi Reusable Rocket
- Direct Launch Reusable Rocket
- Air Launch Expendable Rocket
- RocketPlane
- Re-entry vehicle
- Satellite de-orbit

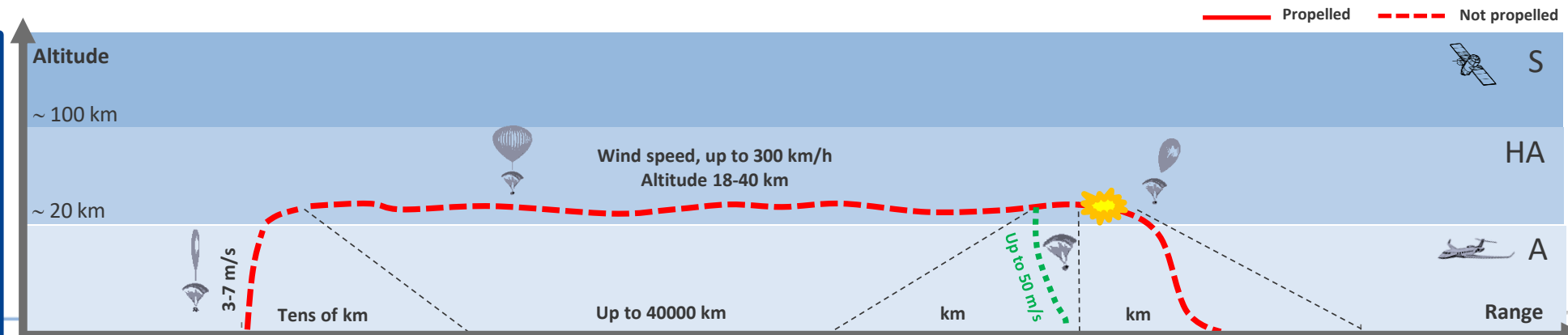
HAPS LTA Free Balloon(s)

Flight Frequency in Europe

- < 2025 : 12-18 / y
- 2025-2030 : 12-30 / y
- > 2030 : 12-36 / y

Launch sites : 2 active in northern Europe

Items : 2
IT1 : 1 Balloon
IT2 : Payloads of 1 balloon



UC_HAPS_FB1		Pre-flight	Take off + Ascent	Float	Payload Release	Descent & Flight termination + A	Post flight
		(Ground)					(Ground)
Vehicle & Operator capabilities	Duration	IT1,2: Days	Time or space segregation				Tens of minutes
	Mode of operation	N/A	Tactical separation				Free fall after burst
	Maneuverability	N/A	Trajectory(ies) monitoring				N/A
	Fly over area	N/A					N/A
Separation accuracy		N/A	IT1,2: No, time or airspace segregation	IT1,2: None, or Tactical separation	IT2: Acknowledgement, and Tactical separation	IT1: Tactical separation	IT1,2: Reporting, flight worthiness

Contingencies

Balloon burst

Parachute
failure

Non functional
ballast

Balloon small
leakage

Transponder
failure

Communication
failure

Strong winds

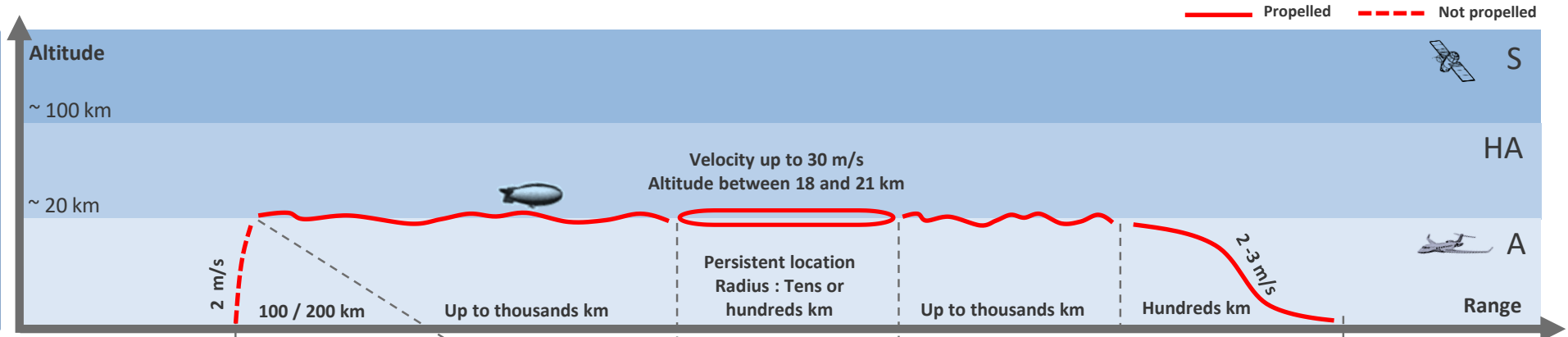
Non functioning
balloon
termination

Flight Frequency in Europe

- < 2025 : 0-48 / yr
- 2025-2030 : 0-88 / yr
- > 2030 : 0-128 / yr

Launch Sites : 1 / 2 per user country

Items : 10s per user country, 1 to 2 launches / descent per week



< 2025

- Time or space segregation
- Tactical separation
- Trajectory monitoring

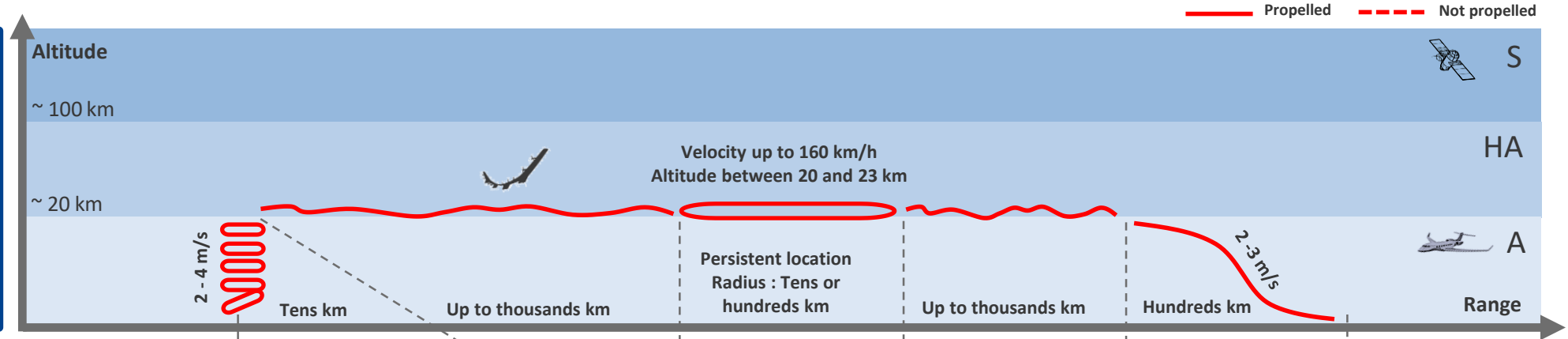
HAPS MHTA Fixed Wing

Flight Frequency in Europe

- < 2025 : 0-48 / yr
- 2025-2030 : 0-88 / yr
- > 2030 : 0-128 / yr

Launch Sites : 1 / 2 per user country

Items : 10s per user country, 1 to 2 launches / descent per week



< 2025

- Horizontal trajectory replanning
- Ascent / descent
- Trajectory monitoring

Contingencies

Structural or
system failure

Loss of flight
performance

Uncontrolled
landing

Lost
Command &
Control link

Impaired
control

Transponder
failure

Strong winds

HAPS

- Free Balloon
- Maneuvering Balloon
- Motorized Lighter Than Air Airship
- Motorized Heavier Than Air Airplane

A to A

- Vertical Rocket
- Air Launch Rocket
- RocketPlane



New Shepard (Blue Origin)



WhiteKnight2 / SpaceShipTwo (Virgin Galactic)



EADS rocketplane

Launcher

- Direct Launch Semi Reusable Rocket
- Direct Launch Reusable Rocket
- Air Launch Expendable Rocket
- RocketPlane

From Orbit

- Re-entry vehicle
- Satellite de-orbit

A to A Suborbital Air Launch

Flight Frequency in Europe

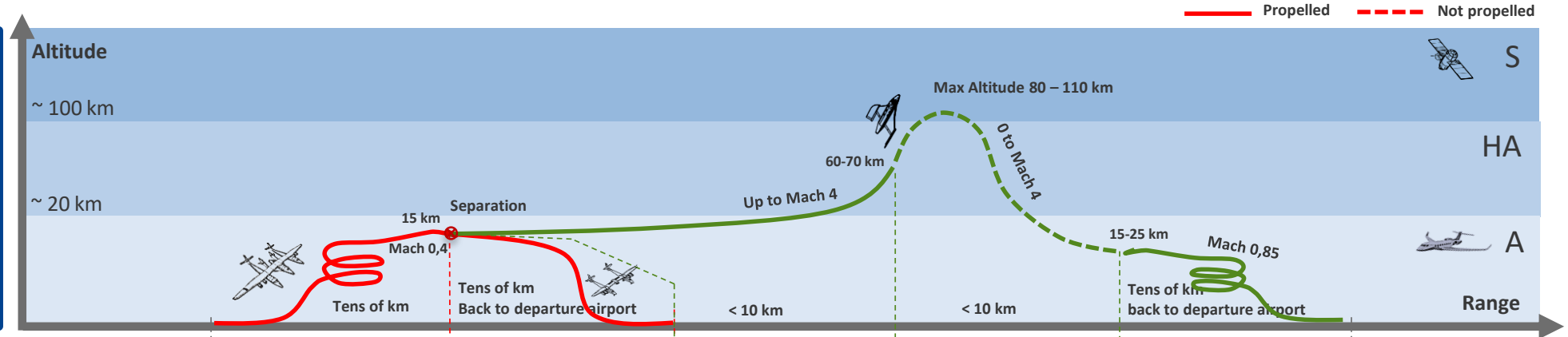
- < 2025 : 0 - 10 / y
- 2025-2030 : 0 - 50 / y
- > 2030 : 100 / y

Spaceport in Europe: 1-3

Items : 2

IT1 : Airplane (WK2)

IT2 : Spaceplane (SS2)



< 2030

On demand trajectory change

Re-routing / Emergency landing

Trajectory monitoring

Contingencies

Structural or
system failure

Unwanted
spaceplane
release

Uncontrolled
spaceplane
descent

Impaired
control

Transponder
failure

Airport
diversion

Emergency
landing

Strong winds

A to A Suborbital Vertical Rocket

Flight Frequency in Europe

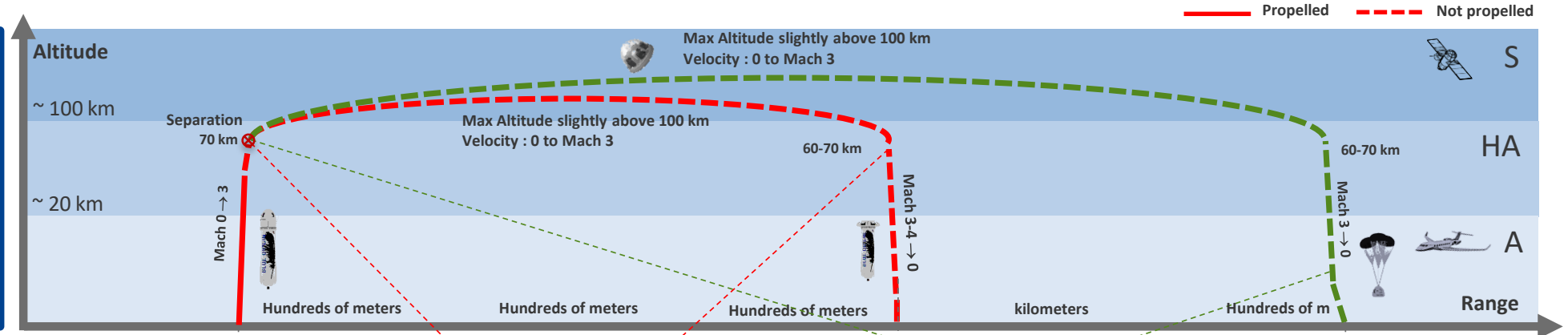
- < 2025 : 0 / y
- 2025-2030 : 0 / y
- > 2030 : 0-50 / y

Spaceport in Europe: 1-2

Items : 2

IT1 : Booster

IT2 : Capsule



> 2030

Airspace segregation

Trajectory monitoring

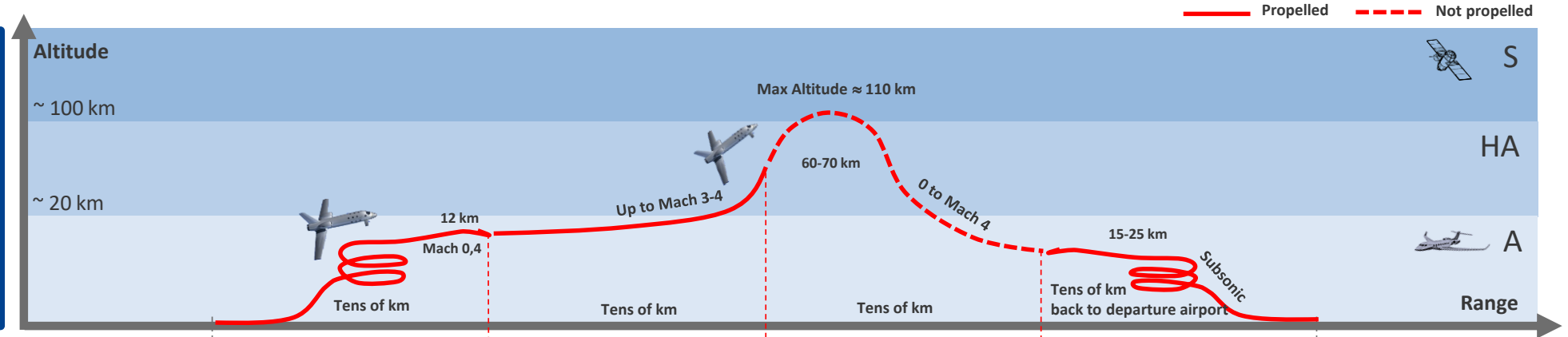
A to A Suborbital Rocket Plane

Flight Frequency in Europe

- < 2025 : 0 / y
- 2025-2030 : 0 / y
- > 2030 : 0-50 / y

Spaceport in Europe: 1-2

Items : 1



> 2030

Like classical aircraft

Trajectory monitoring



Boom Overture



Aerion AS3



Aerospatiale / BAC Concorde

A to B

- Supersonic Airplane
- Hypersonic Aircraft
- Hypersonic Spacecraft (Horizontal L.)
- Hypersonic Spacecraft (Vertical L.)



Hermeus Alcyon concept



Boeing hypersonic



Stratoflyer



Starship



Spaceliner concept



Falcon XX concept

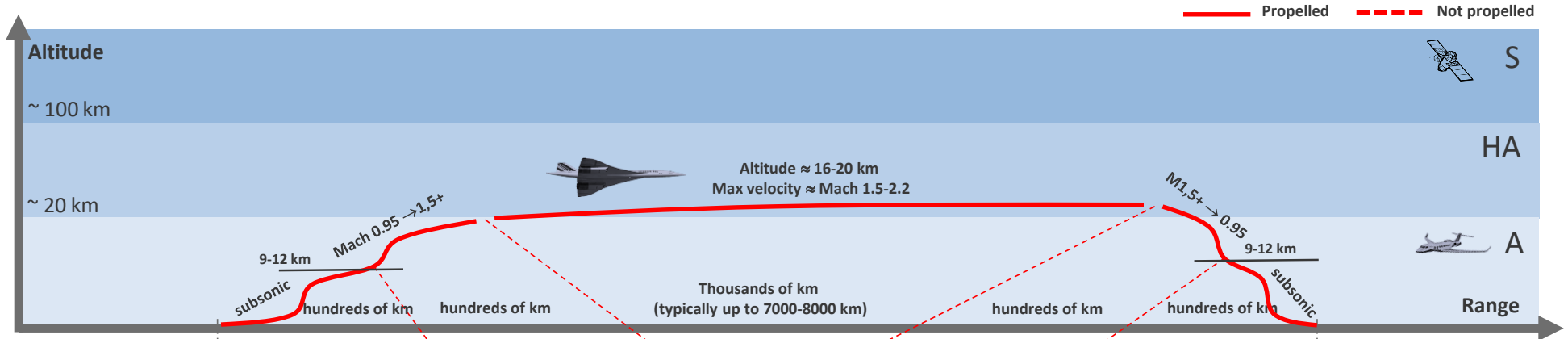
A to B Supersonic Airplane

Flight Frequency in Europe

- < 2025 : 0 / y
- 2025-2030 : 0-50 / day
- > 2030 : 0-200 / day

Airports in Europe: 5-10

Items : 1 airplane



> 2025

Like classical aircraft

Hypersonic Spacecraft (vertical landing)

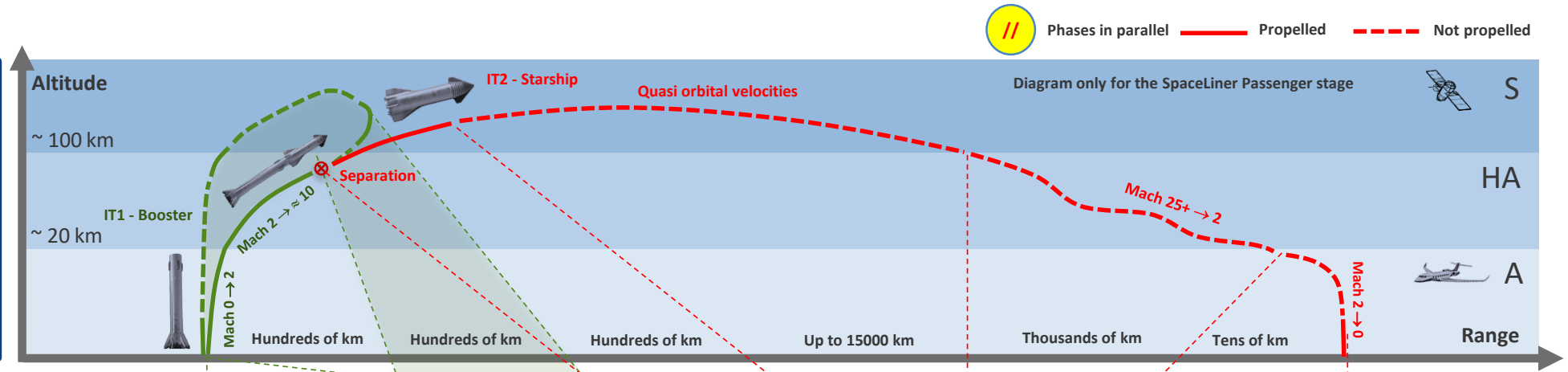
Flight Frequency in Europe

- < 2025 : 0 / y
- 2025-2030 : 0 - 1 / m
- > 2030++ : 0 - 5 / m

Spaceports in Europe: 1-5 (coastal only)

Items : 2

- IT1 : Booster
- IT2 : Starship



> 2025

Time and airspace segregation

No trajectory change

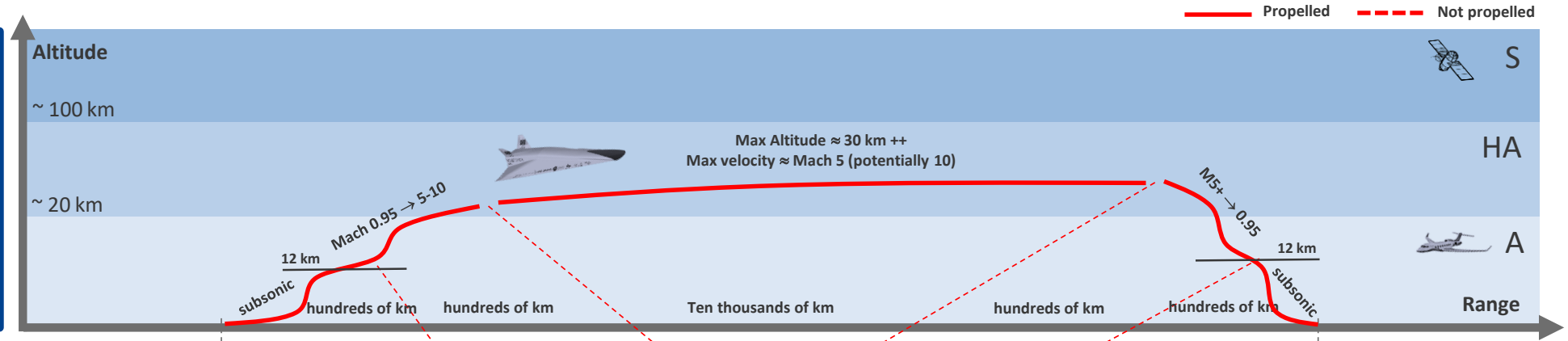
A to B Hypersonic Aircraft

Flight Frequency in Europe

- < 2025 : 0 / y
- 2025-2030 : 0 / y
- > 2030++ : 0-20 / day

Airports in Europe: 5-10

Items : 1 airplane



> 2030+

Time or airspace segregation

Reduced trajectory change

Trajectory monitoring

Hypersonic Spacecraft (horizontal landing)

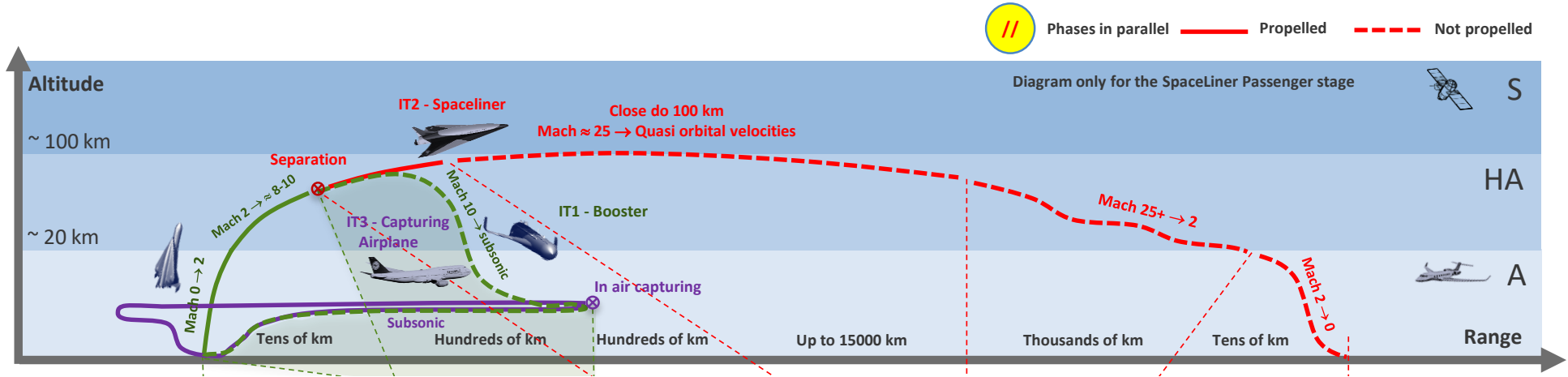
Flight Frequency in Europe

- < 2025 : 0 / y
- 2025-2030 : 0 / y
- > 2030++ : 0-10 / day

Spaceports in Europe: 1-5

Items : 3

- IT1 : Booster
- IT2 : SpaceLiner
- IT3 : Capturing airplane



> 2030+

Time or airspace segregation

Abort options

Trajectory monitoring

HAPS

- Free Balloon
- Maneuvering Balloon
- Motorized Lighter Than Air Airship
- Motorized Heavier Than Air Airplane



Texas sounding rocket (Esrange, Sweden)



PLD Miura 1 sounding rocket



Virgin Orbital Launcher One



SpaceX F9 Heavy booster recovery
(not envisaged from Europe)



Reaction Engines Skylon SSTO
Rocketplane concept



Zero2infinity Bloostar concept

Launcher

- Sounding rocket
- Direct Launch Expendable Rocket w/o de-orbit
- Direct Launch Expendable Rocket with de-orbit
- Direct Launch Semi Reusable Rocket
- Direct Launch Reusable Rocket
- Air Launch Expendable Rocket
- RocketPlane

From Orbit

- Re-entry vehicle
- Satellite de-orbit

Launchers

Direct Launch - Expendable Rocket w/o de-orbit

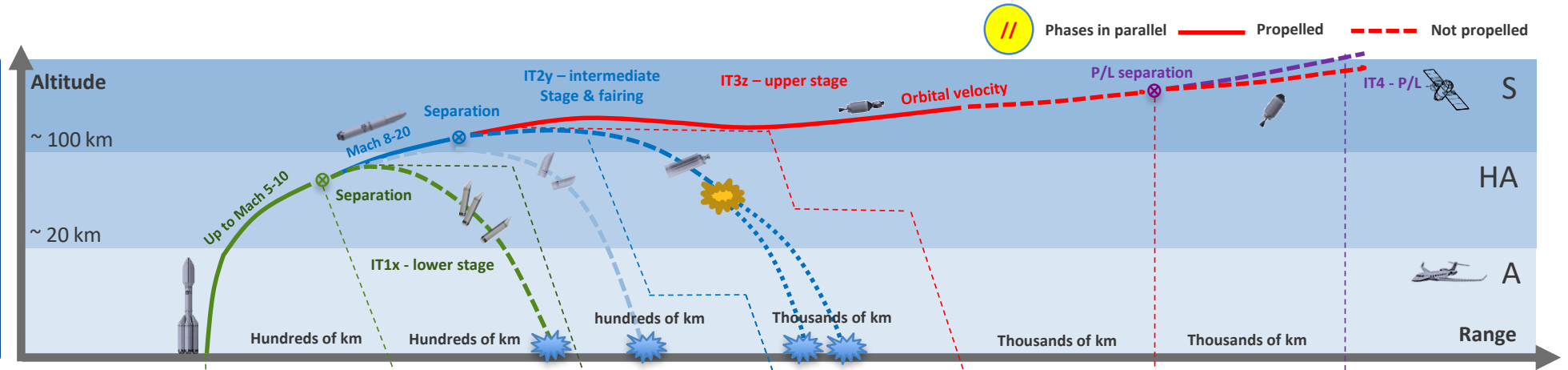
Flight Freq. Europe (all launchers)

- < 2025 : 5-10 / y
- 2025-2030 : 10-20 / y
- > 2030+ : 20-40 / y

Spaceports in Europe: 1-10 (coastal only)

Items : 4+*

- IT1x : Lower stage (booster)
- IT2y : Intermediate stage
- IT3z : Upper stage
- IT4 : Payloads



today

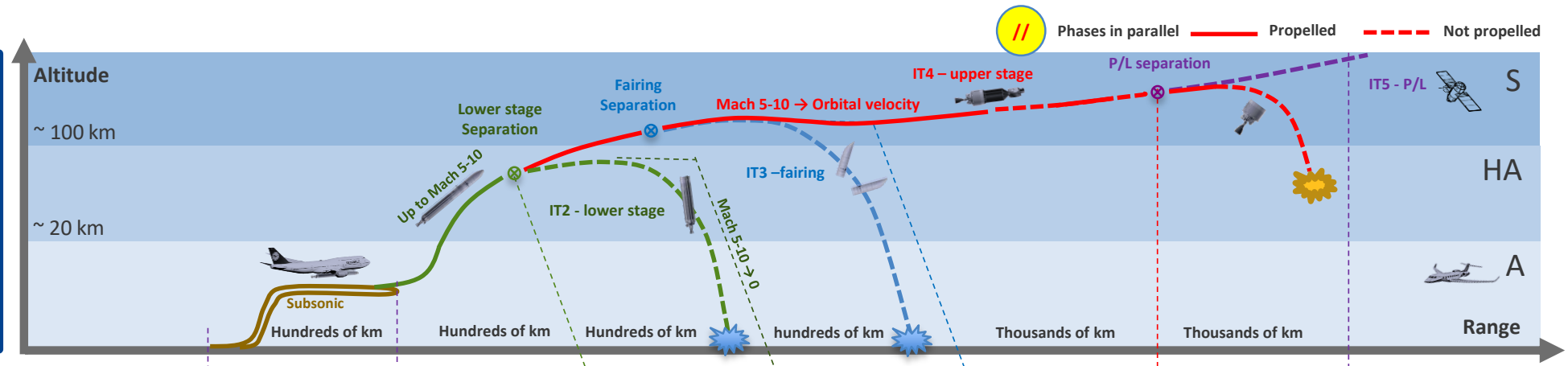
Time and airspace segregation

Trajectories monitoring

Launchers

Air Launch - Expendable Rocket

Flight Freq. Europe (all launchers)	
• < 2025	: 5-10 / y
• 2025-2030	: 10-20 / y
• > 2030+	: 20-40 / y
Potential airports in Europe: 5-10	
Items : 5+*	
• IT1	: Airplane
• IT2x	: Lower stage (booster)
• IT3y	: Intermediate stage
• IT4z	: Upper stage
• IT5	: Payloads



< 2025

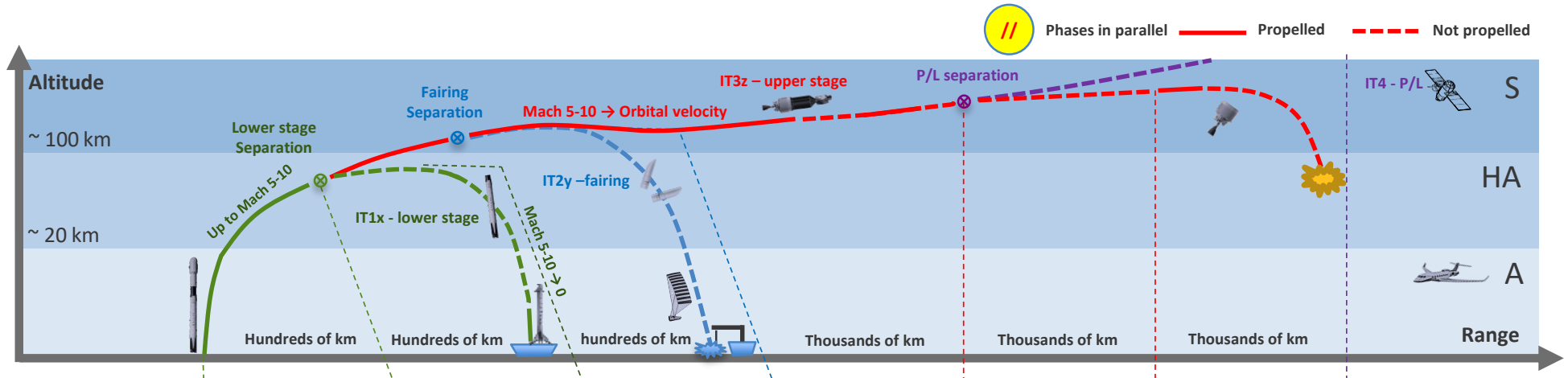
Time and airspace segregation

Trajectories monitoring

Launchers

Direct Launch - Semi Reusable Rocket with de-orbit

Flight Freq. Europe (all launchers)	
• < 2025	: 5-10 / y
• 2025-2030	: 10-20 / y
• > 2030+	: 20-40 / y
Spaceports in Europe: 1-10 (coastal only)	
Items : 4+*	
• IT1x	: Lower stage (booster)
• IT2y	: Intermediate stage
• IT3z	: Upper stage
• IT4	: Payloads

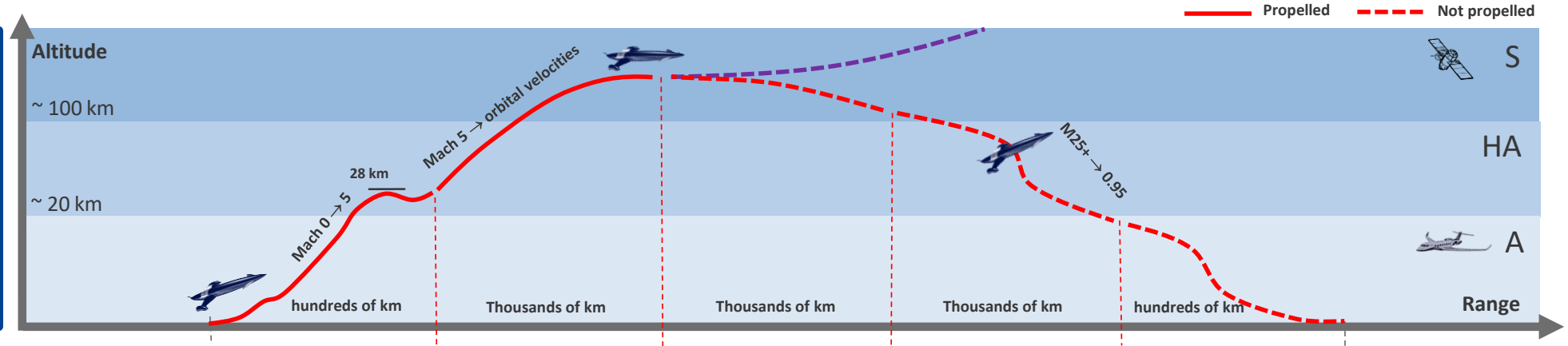


> 2025

Time and airspace segregation

Trajectories monitoring

Flight Freq. Europe (all launchers)	
• < 2025	: 0 / y
• 2025-2030	: 0 / y
• > 2030++	: 0-40 / y
Potential airports in Europe: 2-5	
Items : 2	
• IT1	: Rocket Plane
• IT2	: Payloads



> 2030++

Limited trajectory change

Re-routing / Emergency landing

Trajectory monitoring

From Orbit

HAPS

- Free Balloon
- Maneuvering Balloon

A to



Texus sounding rocket (Esrange, Sweden)



PLD Miura 1 sounding rocket

A to



Virgin Orbital Launcher One



Zero2infinity Boostar concept

Launch



SpaceX F9 Heavy booster recovery
(not envisaged from Europe)



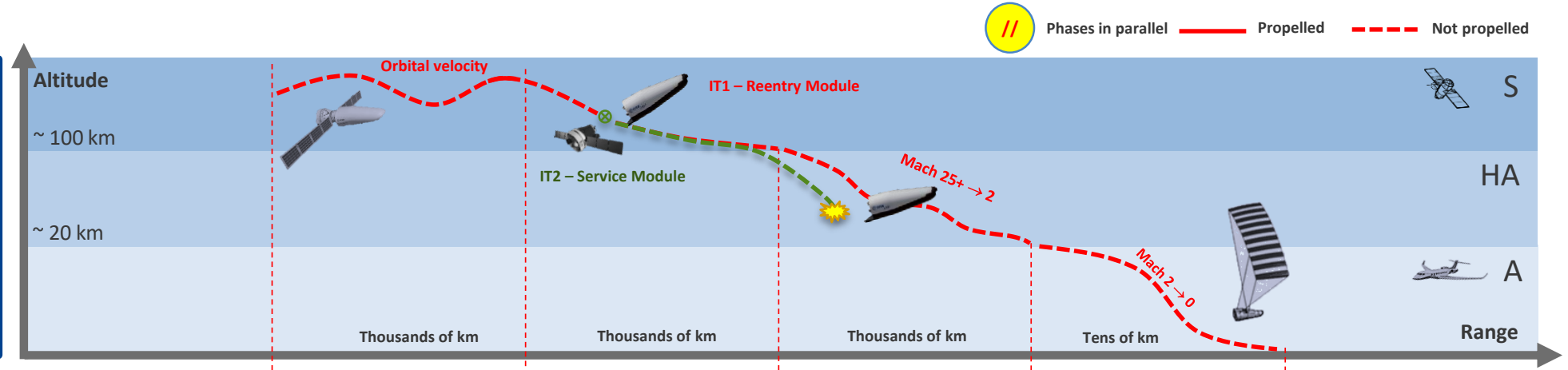
Reaction Engines Skylon SSTO
Rocketplane concept

From Orbit

- Re-entry vehicle
- Satellite de-orbit

From Orbit Reentry Vehicle

Reentry Freq. Europe (all reentry vehicles)	
• < 2025	: 1-2 / y
• 2025-2030	: 2-5 / y
• > 2030+	: 5-10 / y
Spaceports in Europe: 1-5	
Items : 1	
• IT1	: Reentry Module (RM)
• IT2	: Service Module (SM)



today

Time and airspace segregation

Trajectories monitoring

It is now time for questions

Don't forget to refer to the full details provided
in the workshop preparation data package