



Global Air Navigation System CNS Elements

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**Workshop on the Development of
National Performance Framework
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Presentation outline

- CNS Elements overview
- Terminology
- CNS Architecture
- CNS Elements Spectrum
- CNS Elements Transition
- CNS Elements in a Performance Based Air Navigation System
- Summary

CNS elements ...



- a) component architecture of the operation concept
- b) are enablers of the operational concept
- c) have a mix of satellite and ground-based systems
- d) provide global coverage
- e) are interoperable systems
- d) provides seamlessness
- e) employs air/ground data link
- f) employs digital technologies
- g) comprises various levels of automation
- h) need to be supported by quality assured data

Reference terminology



- **Architecture**: An integration of “enablers” needed to implement an operational concept
- **Enablers**: An “enabler” of the operational concept, or of an element of the operational concept, is “something” which contributes to making it feasible and supports performance requirements
- **Enablers may be:**
 - ✓ Something technical (availability of technology, an algorithm, etc.)
 - ✓ Something operational (e.g., operational procedures drawn up in accordance with the ICAO and other regulatory bodies regulations, training of operational staff)
 - ✓ Or something socio-economic (e.g., decision to invest, because benefits can be expected)

Types of Enablers

- **Technical Enablers** of an element of the operational concept are technologies meeting both following conditions:
 - ✓ They meet properties required to implement the element
 - ✓ And it is realistic to consider that they can become operational in the element, during the proposed time frame
- **Operational Enablers** procedures supporting the operational concept are global operational procedures, rules of the air, standards, meeting all the following conditions:
 - They are consistent with the element
 - It is realistic to consider that they can be officially approved early enough to be operational in the element, during the proposed timeframe
 - Selection of staff, training to these procedures can be achieved early enough for application during the proposed timeframe
- **Socio-economic Enablers** of an element of the operational concept are *decisions* taken by stakeholders (including airlines), and *agreements between them* to make the operational concept possible, and everything that makes these decisions actually possible

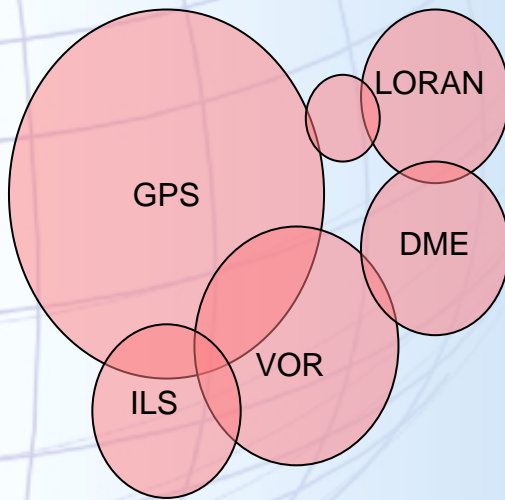
CNS Architecture



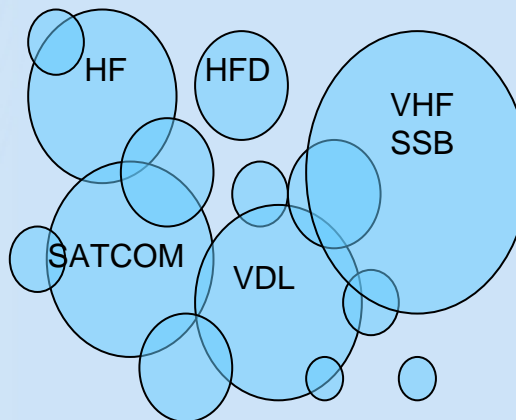
→ Today

- ✓ Many CNS Technologies
- ✓ Many standards
- ✓ Regional solutions
- ✓ Regional service variations

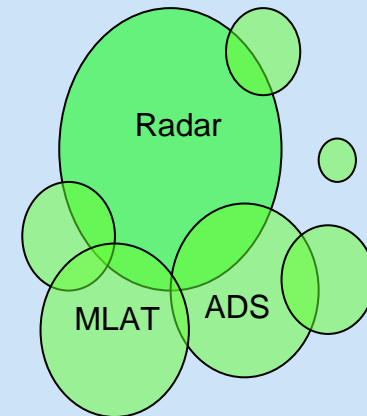
Existing Navigation Systems



Existing Communications Systems



Existing Surveillance Systems

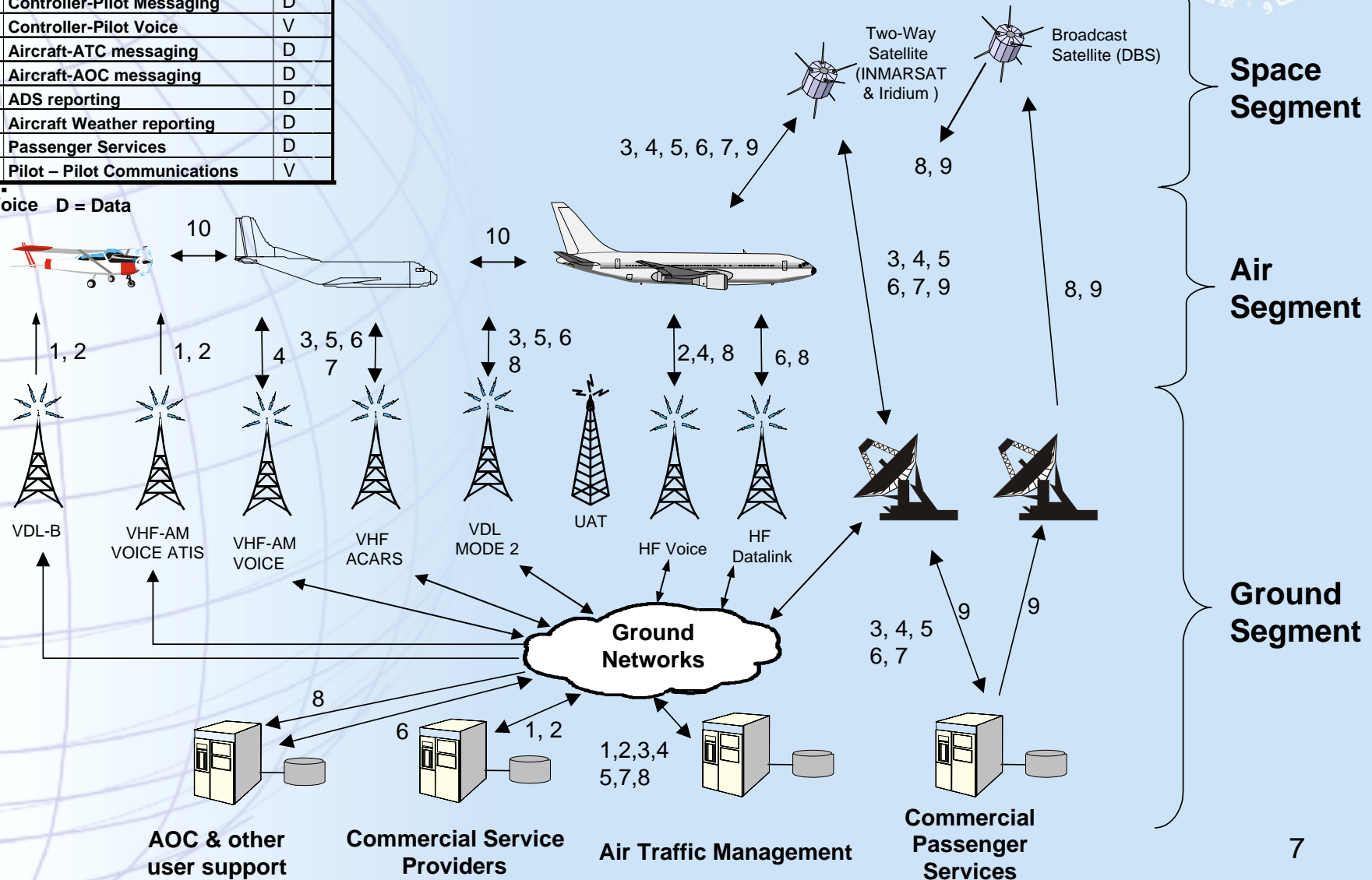


Current Communication Architecture



Communication Types		
1	Flight Information	D/V
2	Traffic Information	D/V
3	Controller-Pilot Messaging	D
4	Controller-Pilot Voice	V
5	Aircraft-ATC messaging	D
6	Aircraft-AOC messaging	D
7	ADS reporting	D
8	Aircraft Weather reporting	D
9	Passenger Services	D
10	Pilot - Pilot Communications	V

V = Voice D = Data

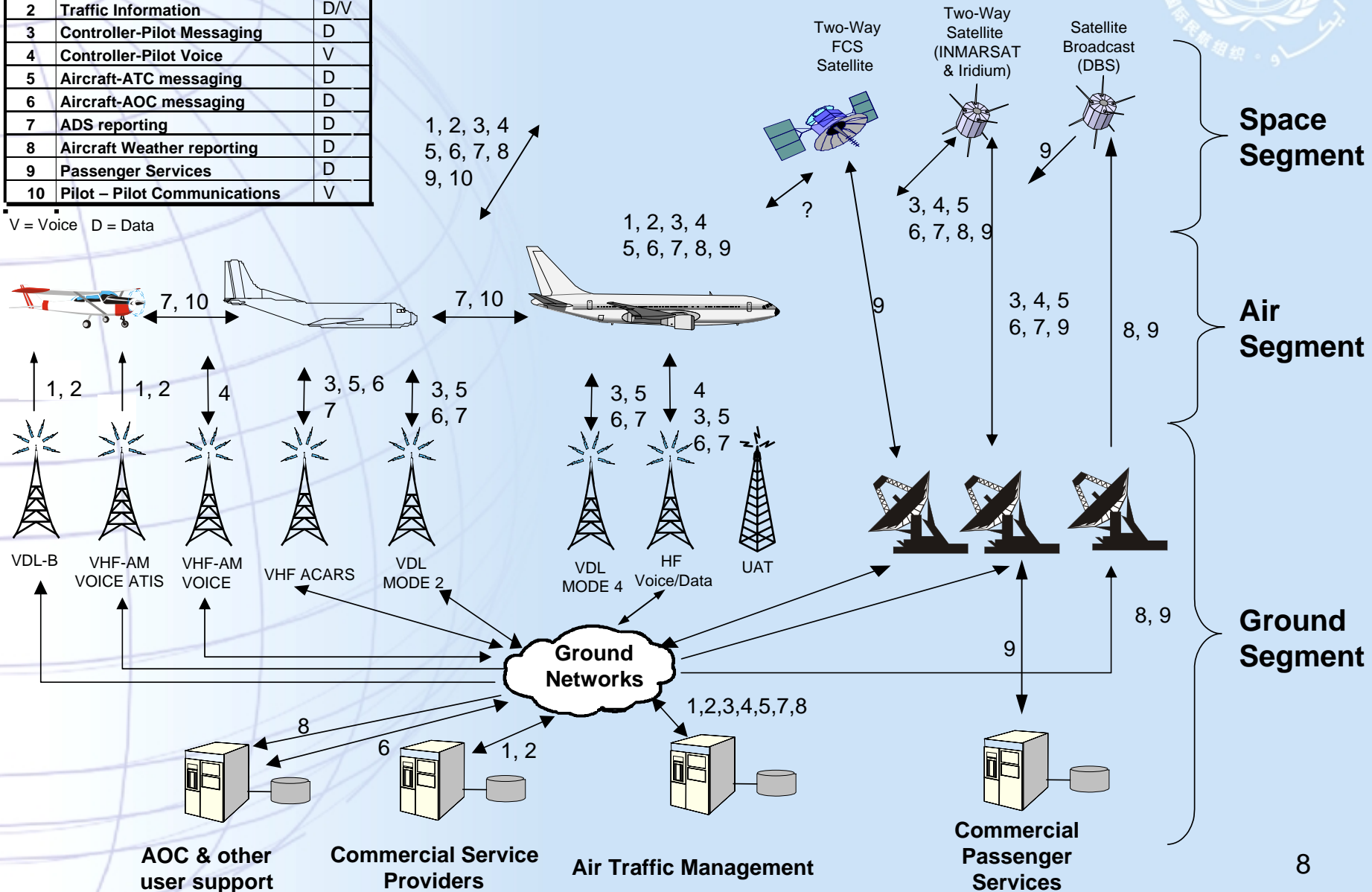


Future Communication Architecture



Communication Types		
1	Flight Information	D/V
2	Traffic Information	D/V
3	Controller-Pilot Messaging	D
4	Controller-Pilot Voice	V
5	Aircraft-ATC messaging	D
6	Aircraft-AOC messaging	D
7	ADS reporting	D
8	Aircraft Weather reporting	D
9	Passenger Services	D
10	Pilot - Pilot Communications	V

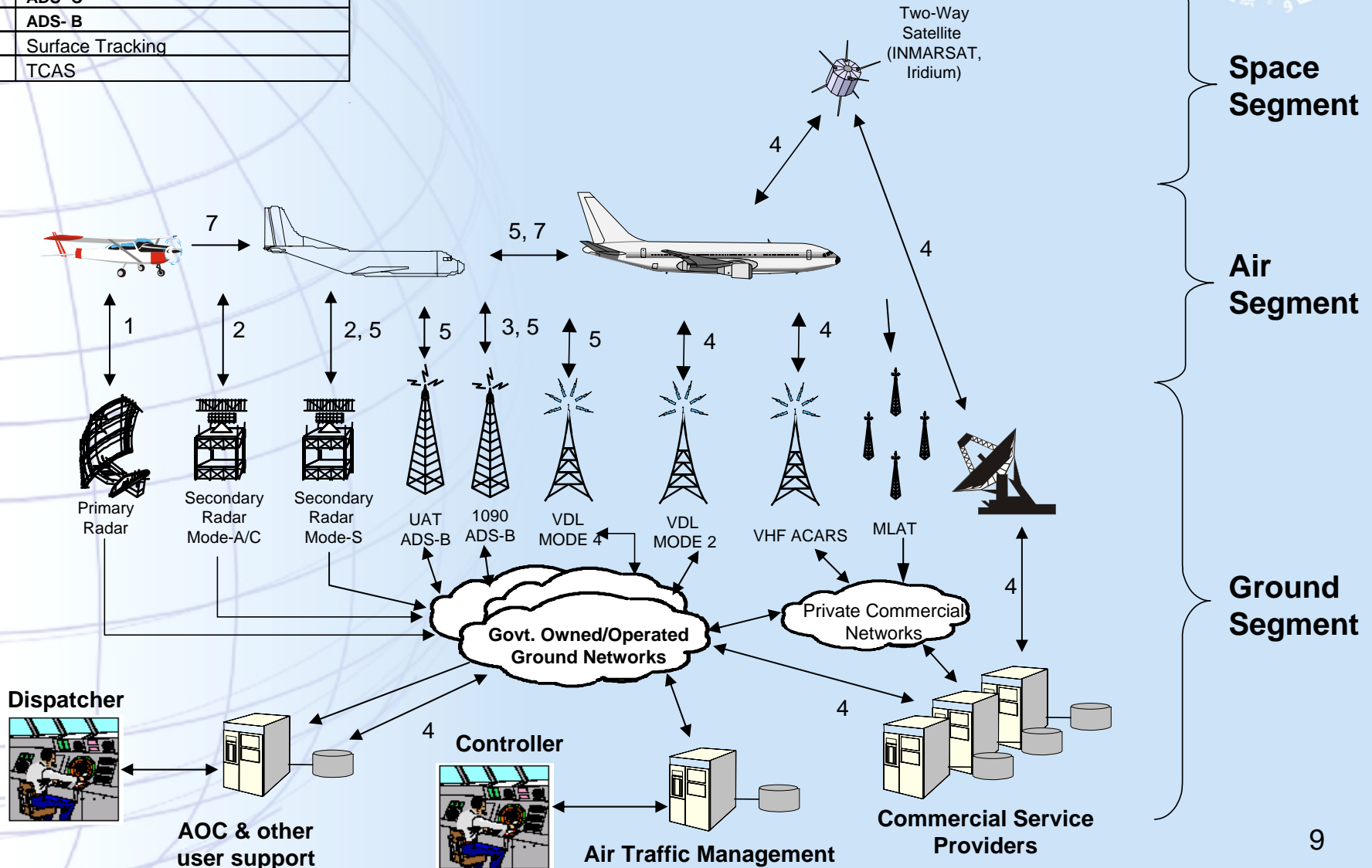
V = Voice D = Data



Current Surveillance Architecture



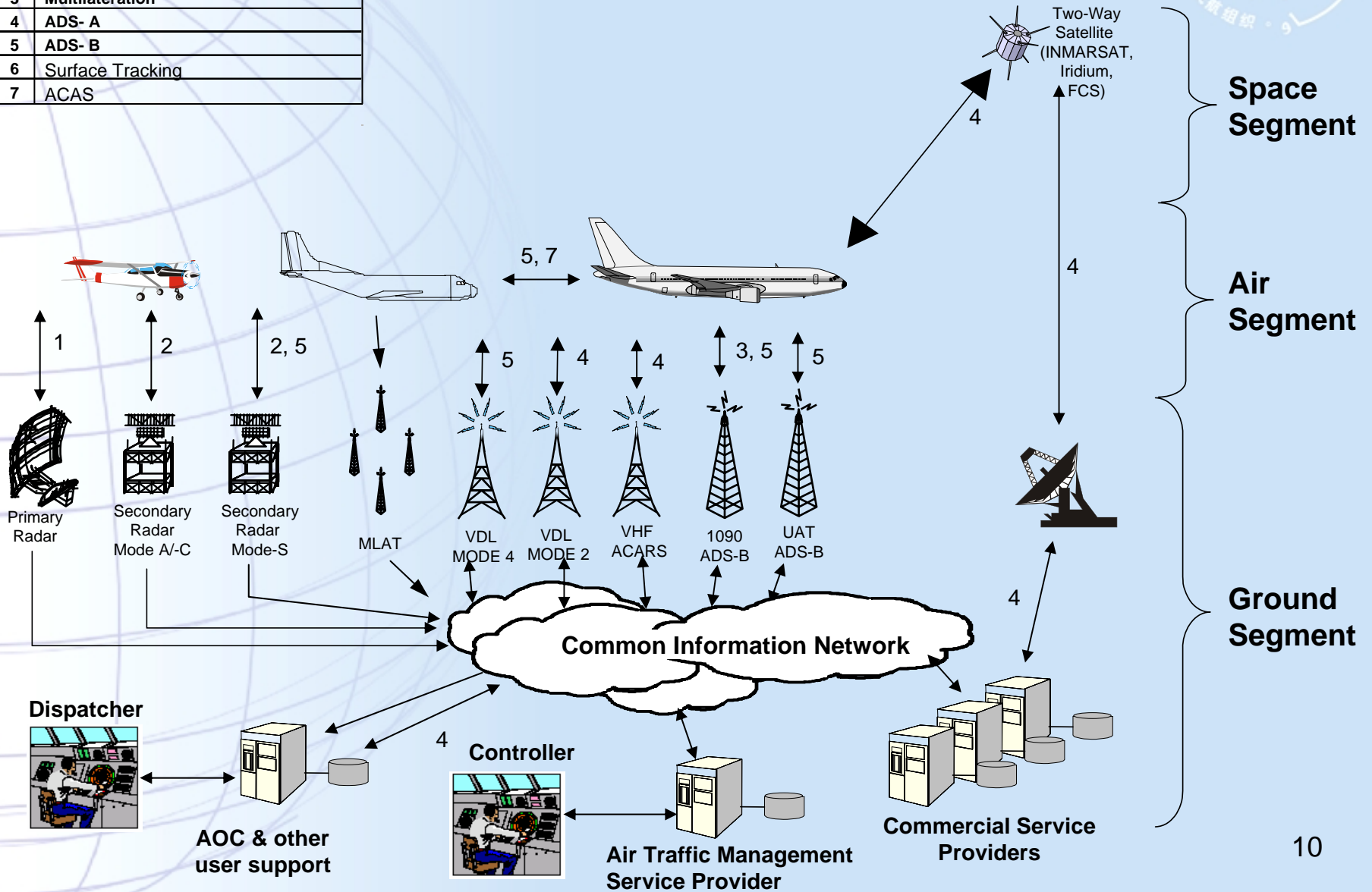
	Surveillance Types
1	Non-Cooperative Radar
2	Cooperative Radar
3	Multilateration
4	ADS- C
5	ADS- B
6	Surface Tracking
7	TCAS



Future Surveillance Architecture

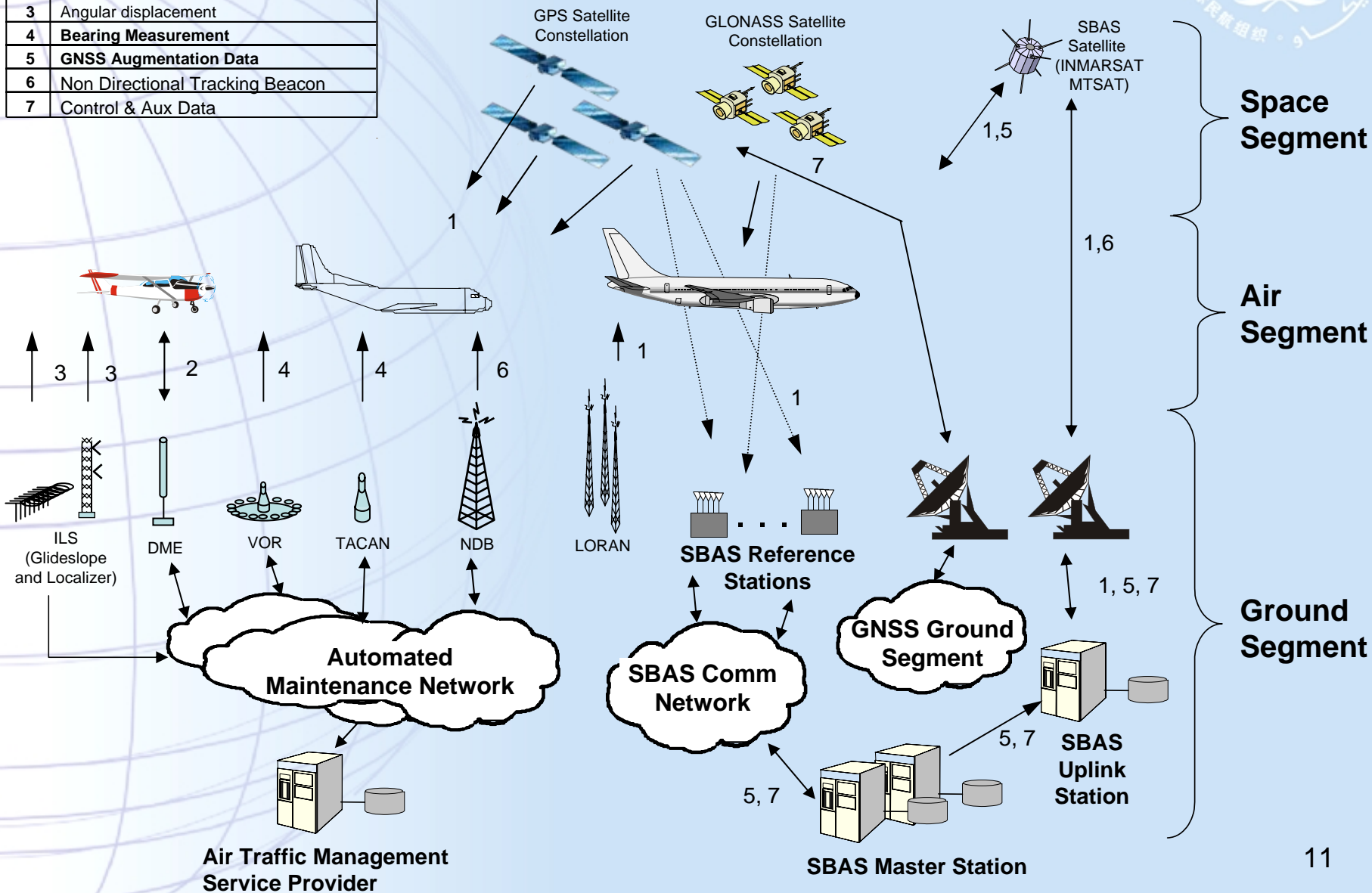


	Surveillance Types
1	Non-Cooperative Radar
2	Cooperative Radar
3	Multilateration
4	ADS- A
5	ADS- B
6	Surface Tracking
7	ACAS



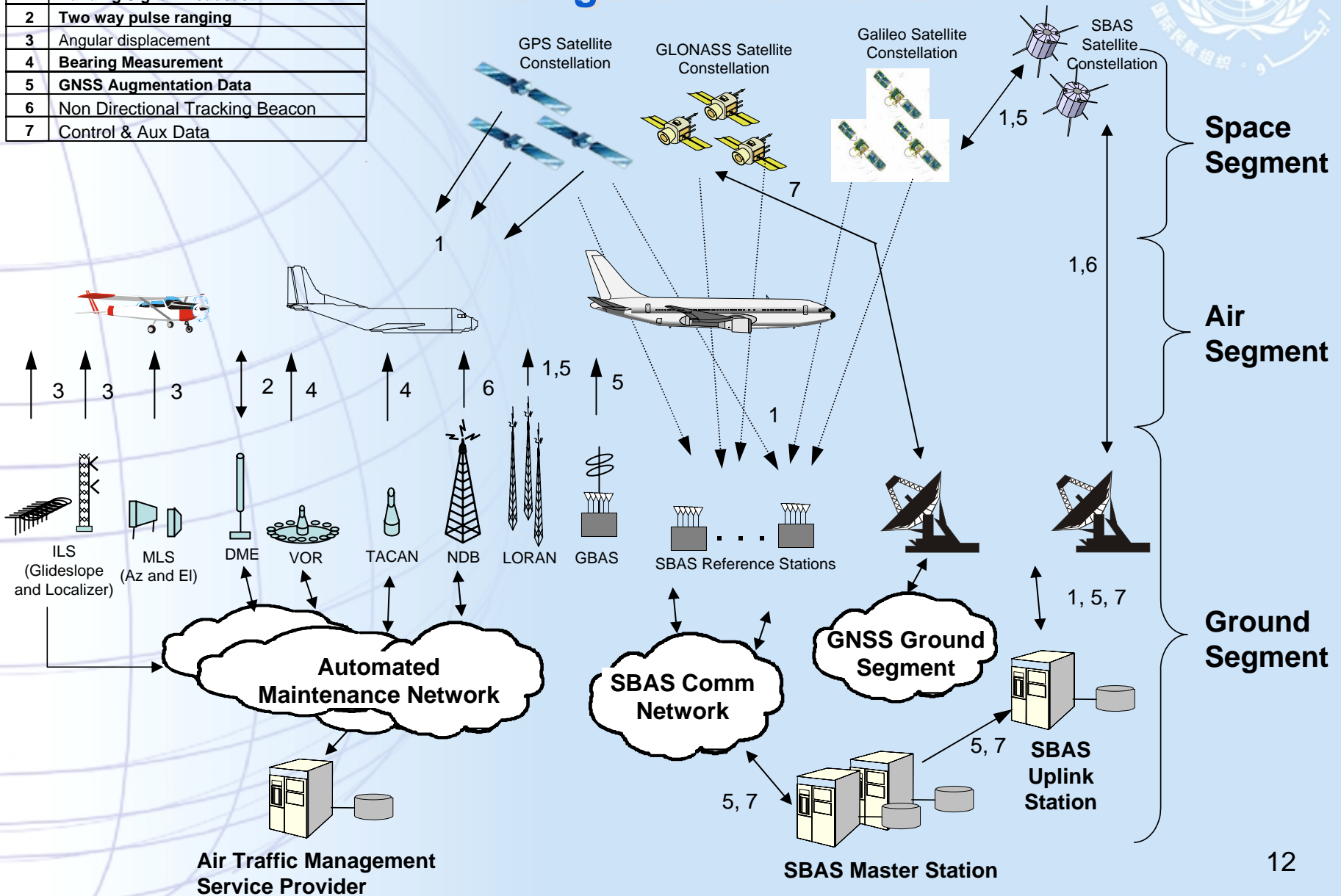
Current Navigation Architecture

Navigation Types	
1	Ranging Signal Broadcast
2	Two way pulse ranging
3	Angular displacement
4	Bearing Measurement
5	GNSS Augmentation Data
6	Non Directional Tracking Beacon
7	Control & Aux Data

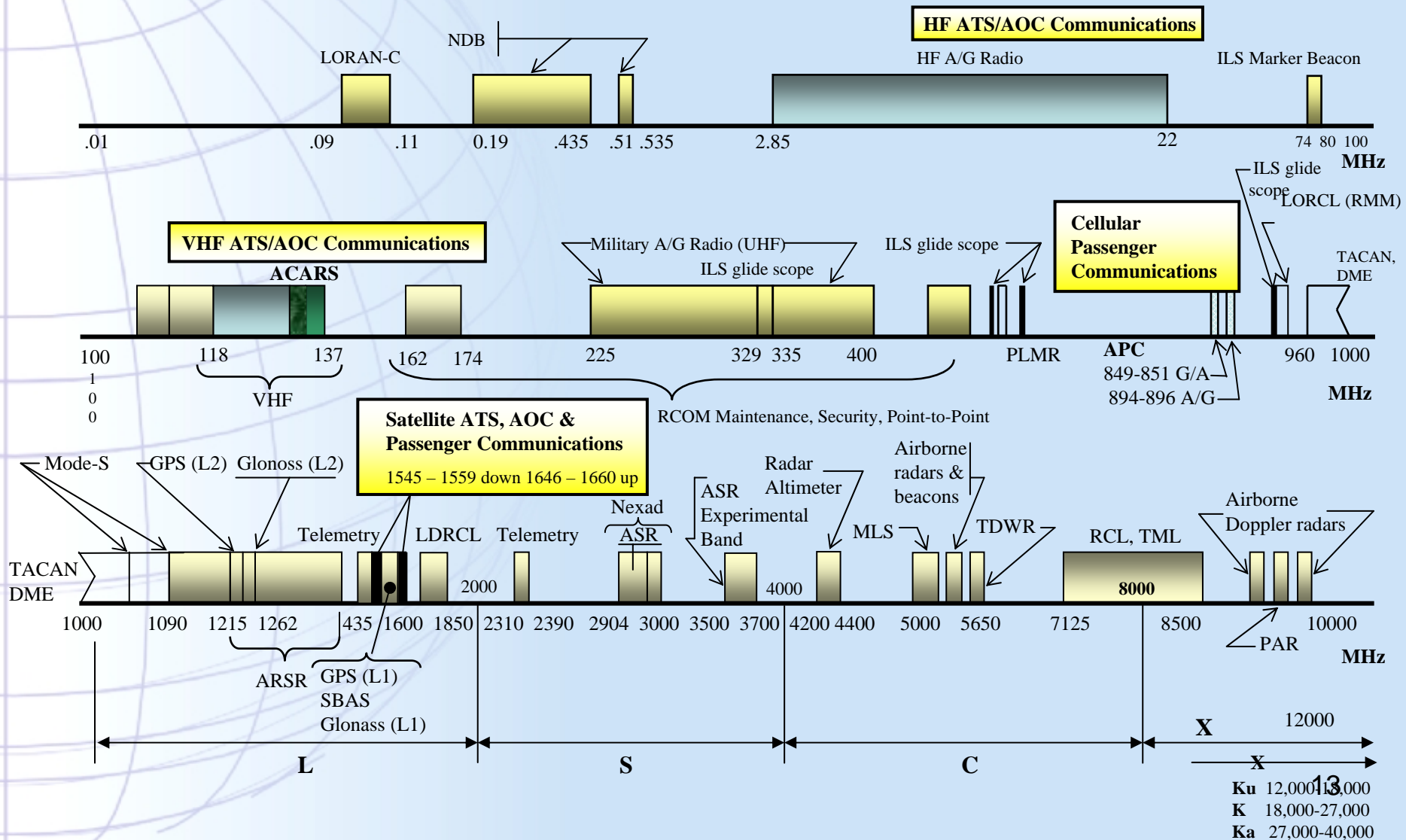


Future Navigation Architecture

Navigation Types	
1	Ranging Signal Broadcast
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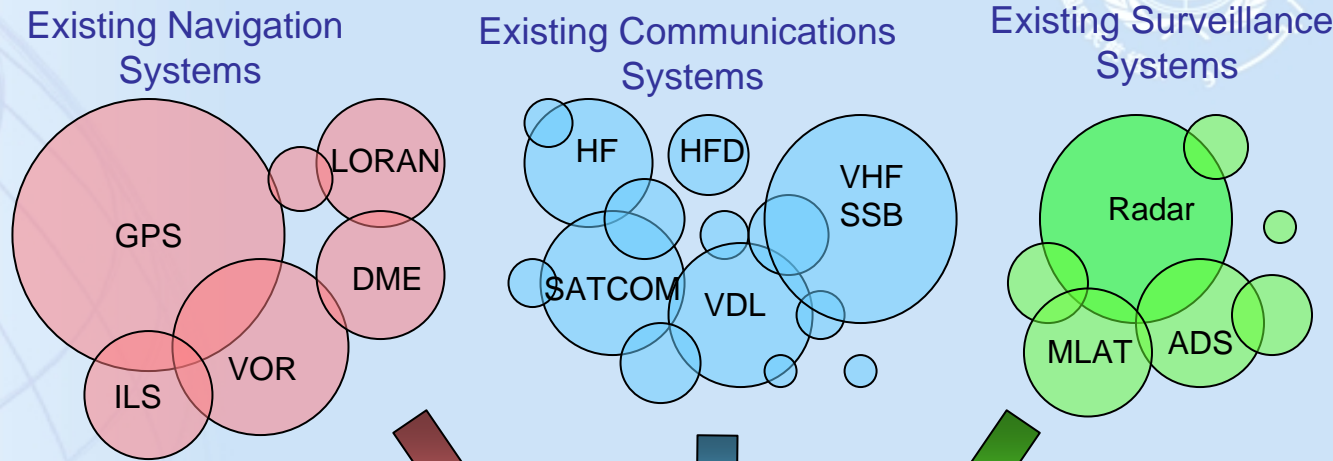
CNS Elements require spectrum in disjointed frequency bands and compete for bandwidth with many systems



CNS Elements Transition

Today

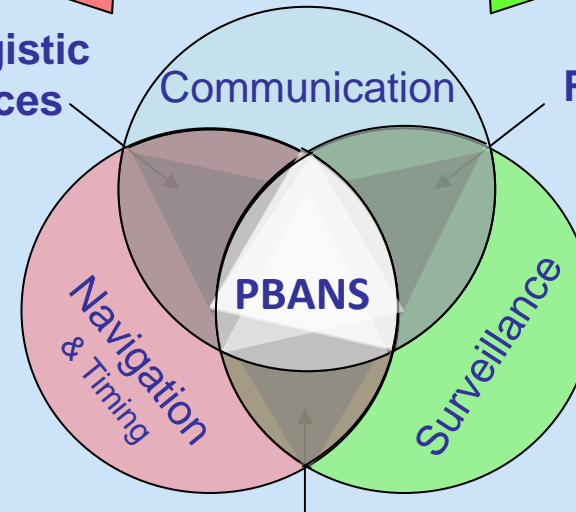
- Plethora of Disjoint CNS Technologies
- Regional solutions
- Many standards
- Regional service variations



Performance Based Air Navigation System

- Integrated CNS
- Global utility
- Global standard
- Uniform levels of service

Synergistic Services



Inherent Redundancy

Lower Total Cost to Provide Services

PBN: An Integration of Enablers in a Performance Based System



Possible Systems:

GNSS, DME/DME, DME/DME/IRU, ...

**NAVAID
INFRASTRUCTURE**

+

**NAVIGATION
SPECIFICATION**

=

**NAVIGATION
APPLICATION**

Air Traffic System Airspace,
Routes and Instrument Procedures

Airworthiness & Operator Requirements

Summary



→ CNS Elements in a Performance Based Air Navigation System

- ✓ Based on Performance Standards rather than specific technologies or equipment
- ✓ Recognizes the ability of modern aircraft to operate safely and efficiently using an integration of on-board systems and external signals



CNS Elements Reference

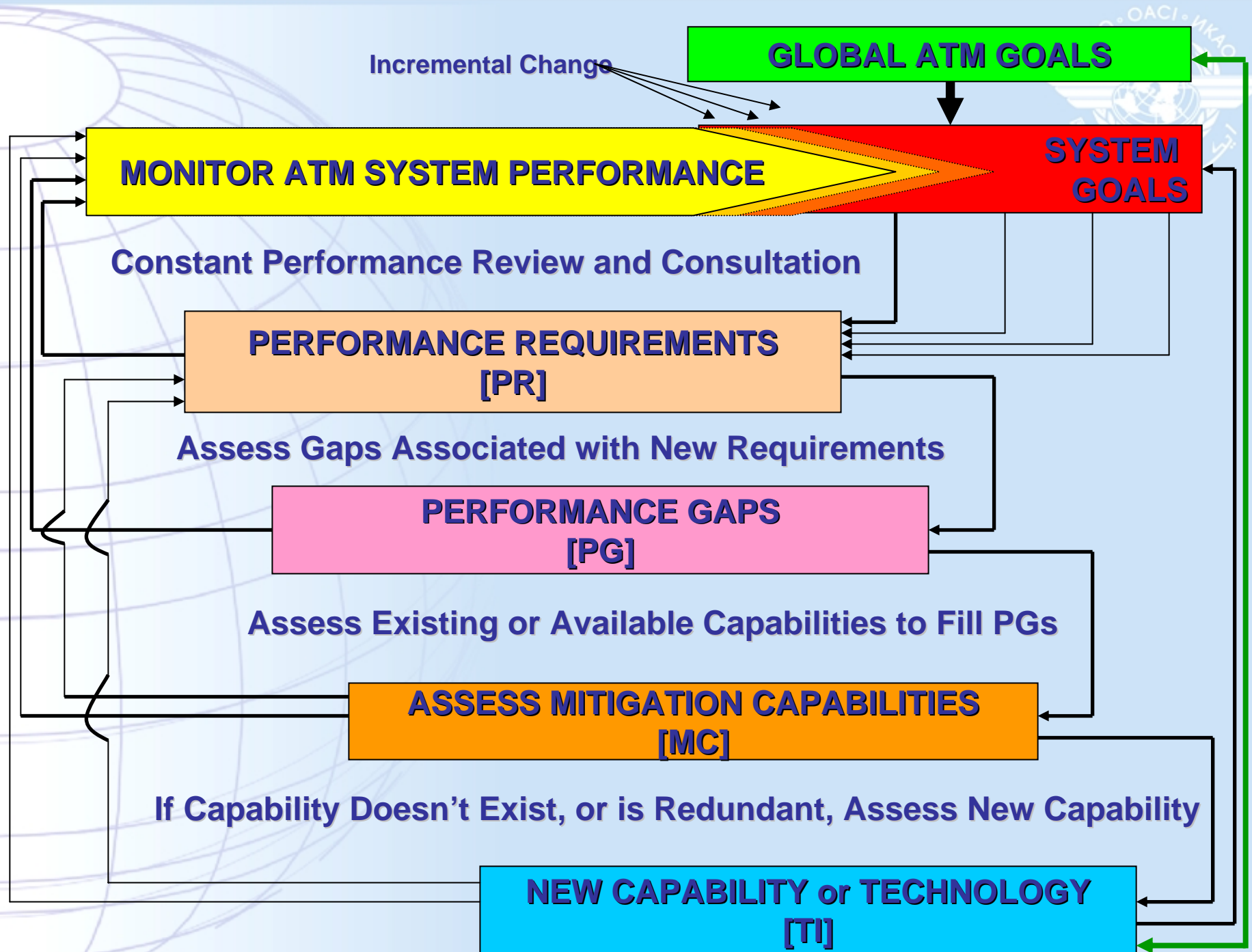


CNS systems elements



Communication	Navigation	Surveillance
Data <ul style="list-style-type: none"> •VHF •HF •Mode S •Satellite •ATN •UAT 	NDB VOR DME ILS MLS GNSS <ul style="list-style-type: none"> •GPS •GLONASS •*GALILEO 	PSR SSR <ul style="list-style-type: none"> • Modes A/C • Mode S
Voice <ul style="list-style-type: none"> •VHF •Satellite •HF 	 Augmentation <ul style="list-style-type: none"> •ABAS •GBAS •SBAS 	 ADS-C <ul style="list-style-type: none"> • VHF • HF • Satellite
		ADS-B MLAT

*emerging systems

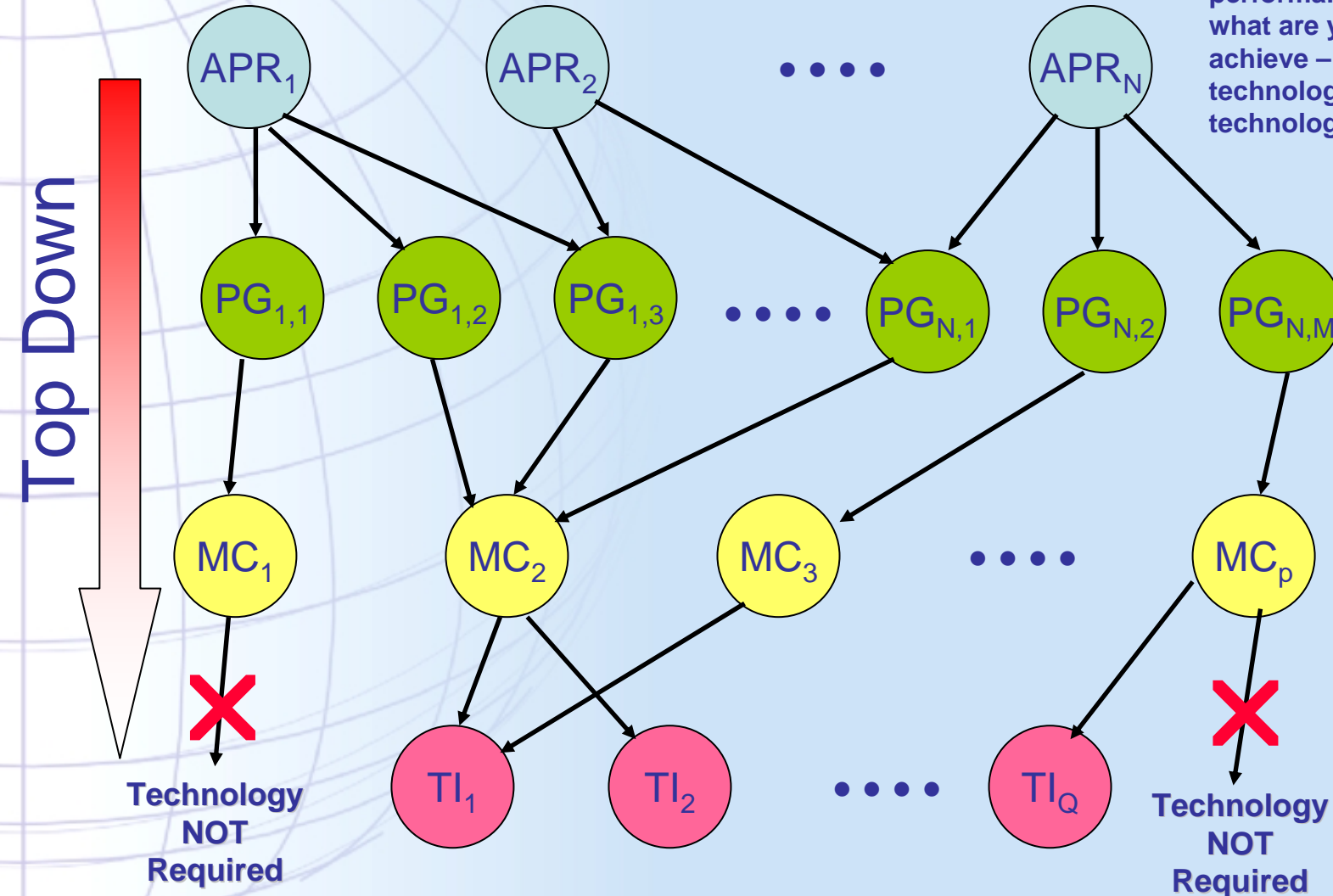


Enabler Selection Process

1. Understand the requirement in performance terms – what are you trying to achieve – not technology for technology's sake.

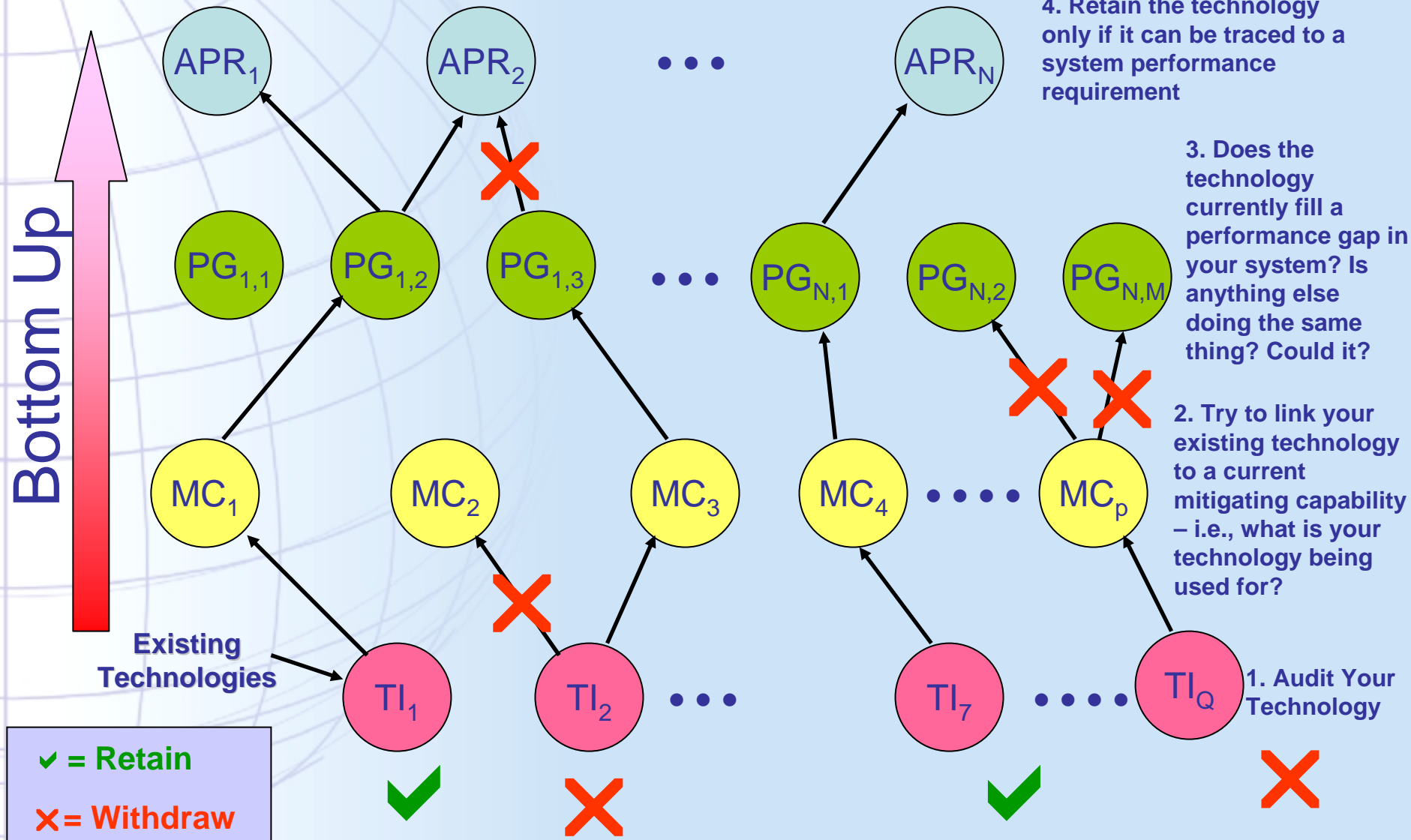
2. Try to understand the problem and potential solutions in terms of “performance gaps” in your system

3. Only proceed below this level if existing capabilities or practices cannot be modified to meet performance requirement



Technology
NOT
Required

Redundancy Assessment Process



A large, light blue wireframe globe is positioned on the left side of the slide, extending from the top left towards the center.

— END —