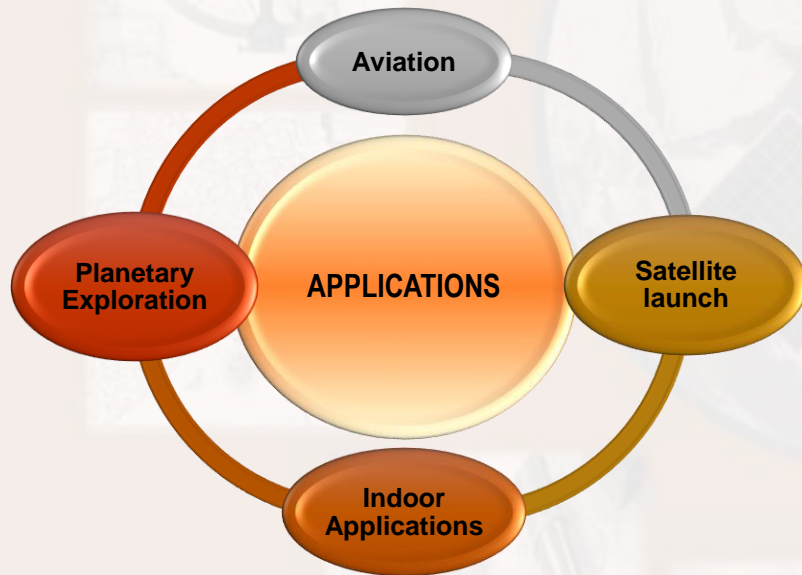




# Pseudolite Based Navigation System for Aviation Applications: An Update

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Indian Space Research Organization (ISRO)

Pseudolites are usually ground-based transmitters which generate Global Navigation Satellite System (GNSS) like signals.



## Main Scenario for PL System

A

GNSS is not Available

C

GNSS is Compromised

S

GNSS is not Sufficient

# Standalone Pseudolite Navigation



Resusable Launch Vehicle (RLV)



Aircraft approach and landing operations beyond Satellite Based Augmentation System (SBAS) limits



PBNS Approaches

Standalone PL

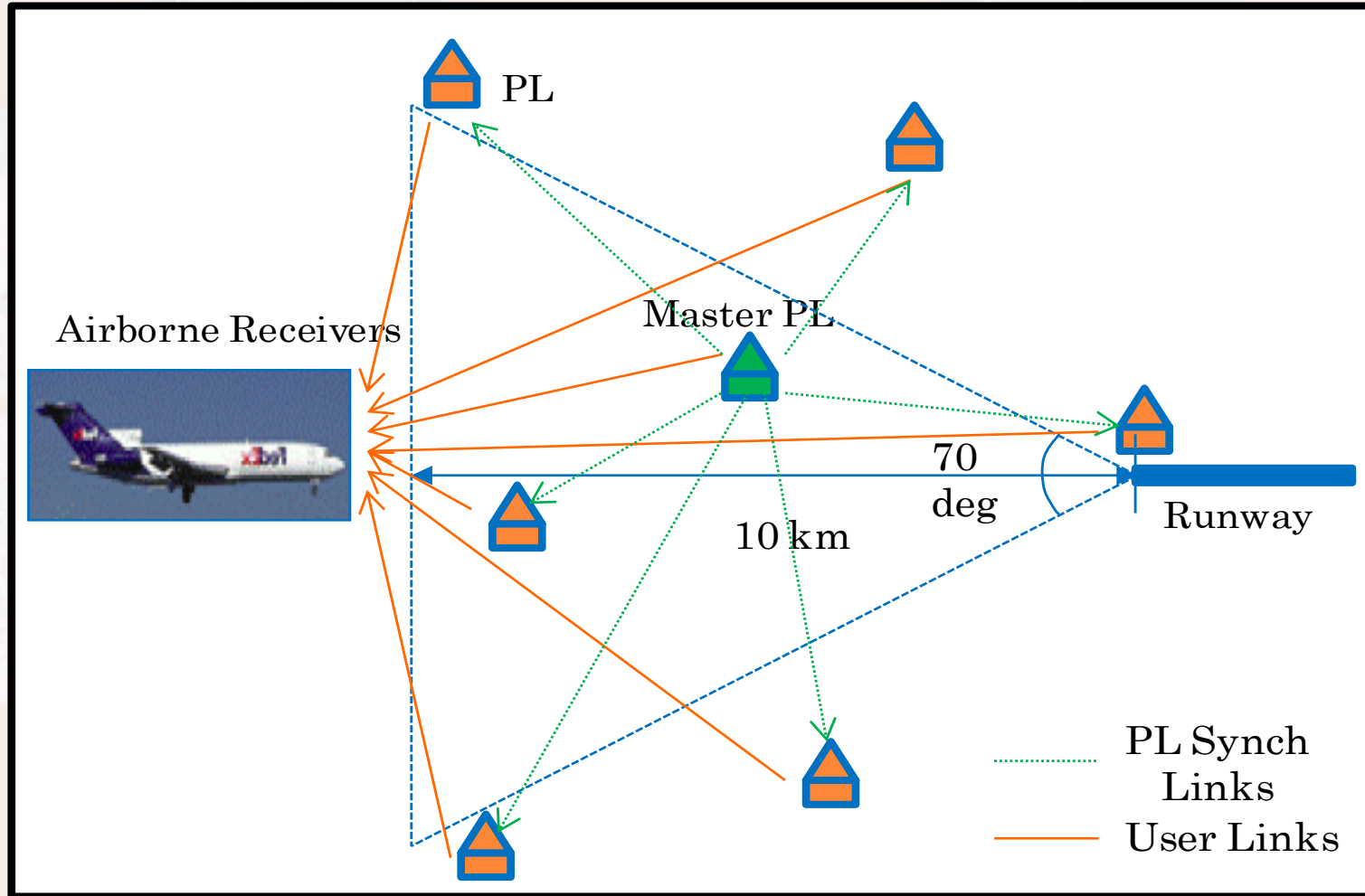
Compatible with GNSS

The system should provide standalone PNT solution with meter level or better position accuracy

System should be independent of Atomic Clocks

Autonomous system independent of satellite based navigation system.

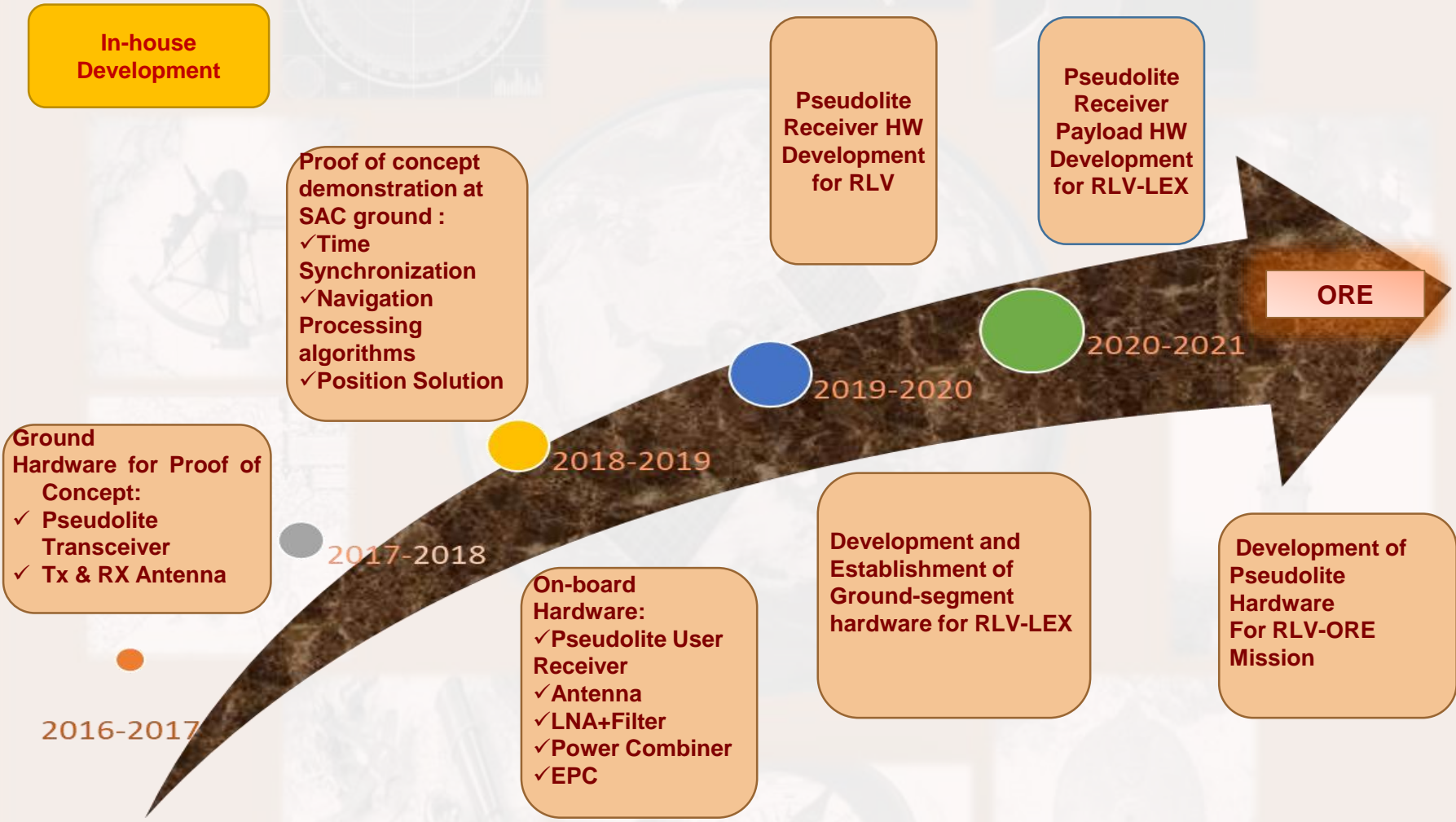
# Pseudolite System Concept for Aviation Scenario



Sr No	Parameter	Unit	Specification
1	Transmit Frequency	MHz	S Band, 2414.28
2	Signal Bandwidth	MHz	$\pm 10.23$
3	Tx Power	W	1 W
4	Polarisation		RHCP
5	Transmit Mode		Pulsed
6	Duty Cycle	%	10
8	Transmit Subnet Size		10
9	Range		10 Km



# Pseudolite-Based Navigation System Evolution and Application in RLV



## **Pseudolite User Receiver :**

- 10 channel Acquisition & Tracking, Pseudo-ranging
- Transmission in Pulsed-CDMA mode
- Frequency S-Band (2414.28 MHz)
- Non-iterative User Position Algorithm

## **Pseudolite Receiver for Time Synchronization:**

- Two Channel RF Front End Design, Acquisition & tracking
- Time Synchronization Algorithm

## **Tx-Rx Antenna, PL Transmitter**

- Quadrifiller Helix Transmit, Patch Receive Antenna
- PL Transmitter

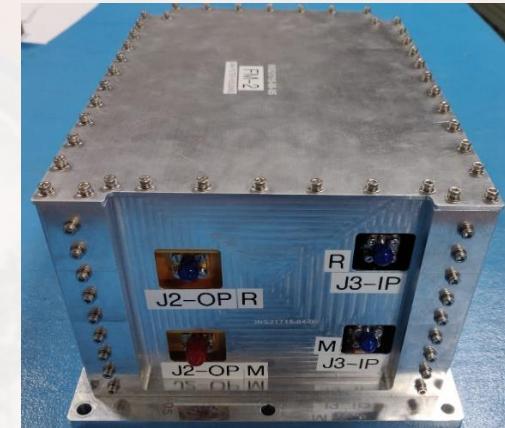
## **Applications:**

- RLV Mission
- Precise Landing of Aircraft at Indian Airports

# Pseudolite Receiver System Payload for RLV



**Pseudolite User Receiver**



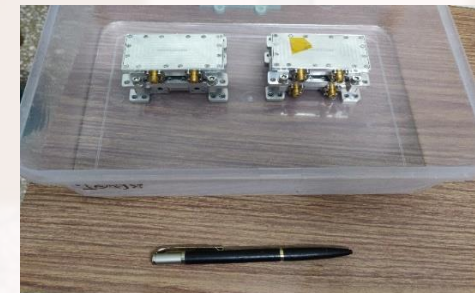
**Pseudolite LNA & Filter Integrated package**



**Pseudolite Receive Antenna**



**Pseudolite Power Module**



**Pseudolite Power Combiner**



# Pseudolite Ground Segment for RLV



PL Pole at Site



PL Rx Antenna



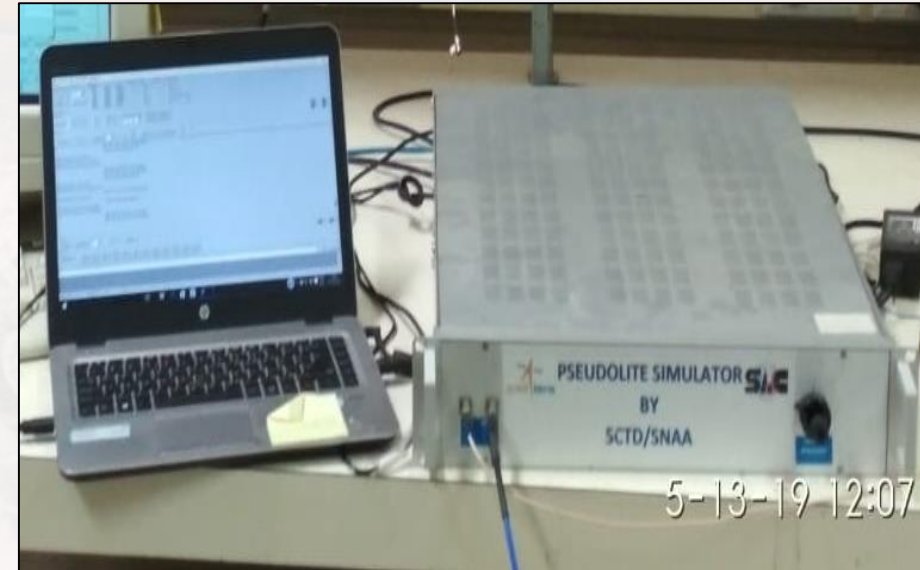
PL Transmitter



PL Tx Antenna

# Indigenous Pseudolite Simulator Development

- ❖ 10 channel Pseudolite System Simulator mimics a Pseudolite signals of 10 transmitting pseudolites
- ❖ Provision to Simulate Impairments, Clock Errors, User Defined Pseudolite Locations, Receiver Dynamics, Tropospheric Errors, Pulsed CDMA signal generation and full scenario simulation.



**SAC Pseudolite Simulator in Testing**

# Pseudolite System Performance

Position accuracy of 1 m (1 sigma) across the track was achieved by Pseudolite System in multiple trials.

Time synchronization accuracy of 1 ns was achieved.

Commercial RTK receiver better than 1 cm accuracy was used as reference for position accuracy validation

