Phasetrum 星相科技

In phase, Antenna and Radar for all Spectrum

Company Profile 公司簡介

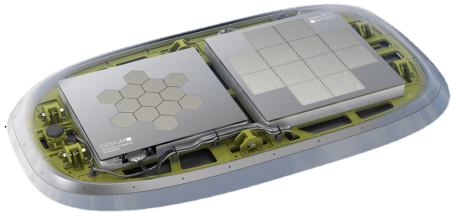
May 24th 2024

About Us

Phasetrum Inc. is a fabless design house developing X to E band RF IC to build phase array antenna for Satellite/UAV communication and AESA radar for UAV detection.

With our scalable AIP architecture, own RF IC design and measurement capability, Phasetrum solutions equip our customers a total solution to design, test and manufacture Ka band phase array antenna production feasible.

- ***Main Product*** – Ka band RF IC (PA, LNA, Phase Tuner, Up/Down Converter) based on GaN, GaAs, CMOS process
- ***Applications*** – Phase array antenna for satellite user terminal used in Maritime/UAV/Auto



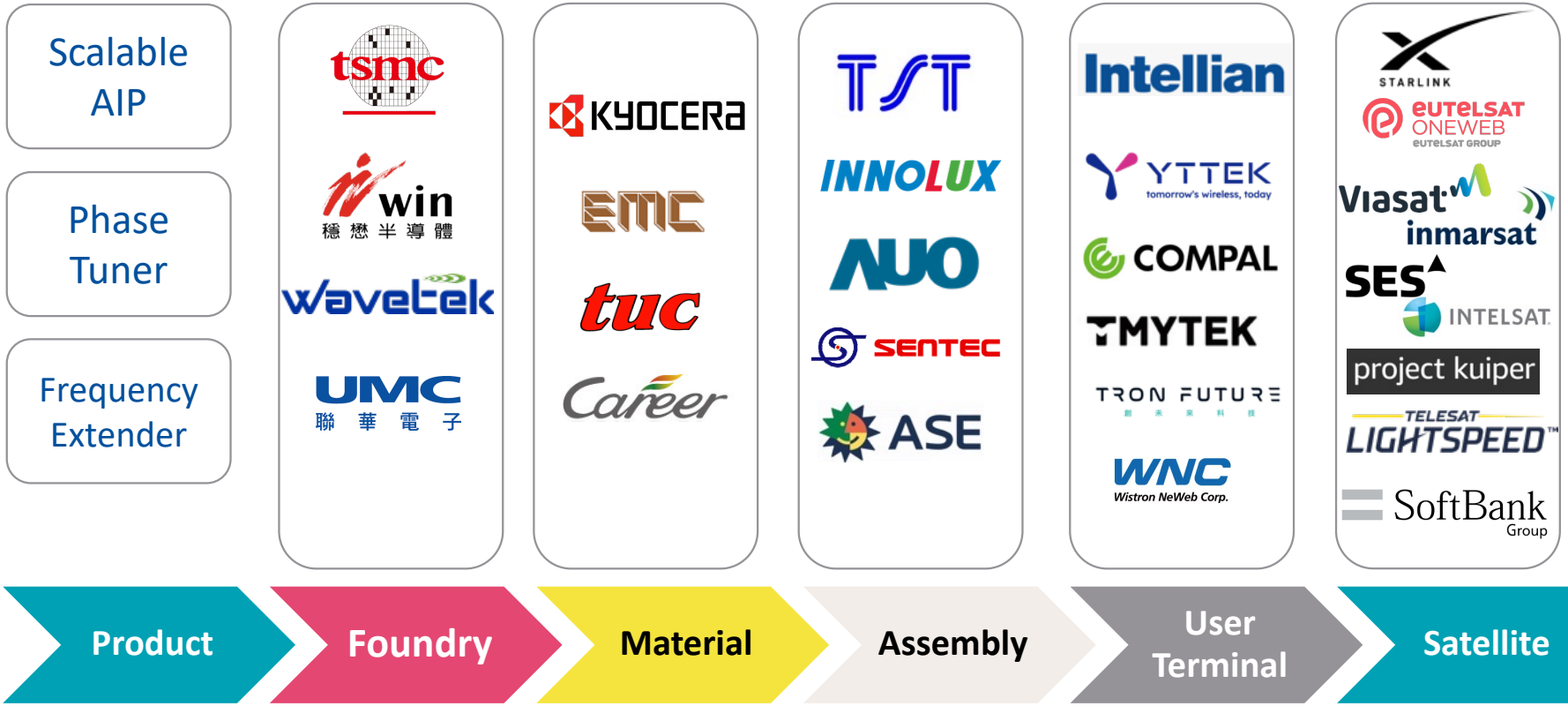
IP and Patents List

IP	Process	Freq.	Spec.	
Ka-band Power Amplifier	CMOS 65nm	26.5~40 GHz	Pout	23 dBm
Ka-band Power Amplifier	GaN 0.15um	27~31 Ghz	Pout	27 dBm
Ka-band LNA	CMOS 40nm	26.5~40 GHz	Gain	15 dB
Ka-band LNA	GaAs 0.25um	17~21Ghz	Gain	25 dB
Ka-band Mixer	CMOS 65nm	30 GHz	Gain	-5dB
Ka-band Phase Shifter	CMOS 65nm	28, 39 GHz	Loss	< 8 dB
Ka-band Delta Phase Shifter	CMOS 65nm	26.5~40 GHz	Phase Shift	180Degree
Ka-band Dual beam 4antenna Phase shifter (Tx)	CMOS 65nm	30 GHz	Beam	dual
Ka-band Dual beam 4antenna Phase shifter (Rx)	CMOS 65nm	20 GHz	Beam	dual
Wide Band Amplifier	CMOS 65nm	40~90GHz	Pout	0dBm
Broad Band Amplifier	CMOS 40nm	DC ~ 60 GHz	Gain	30 dB
High Frequency Ampifier	CMOS 40nm	84 GHz	Gain	9 dB
Wide Band IQ Up Convertor	CMOS 65nm	40~90 GHz	Gain	>10dB
Wide Band IQ Dn Convertor	CMOS 65nm	40~90 GHz	Gain	> 10dB

Patent 1/2：A Coupler Device in Phase Array System

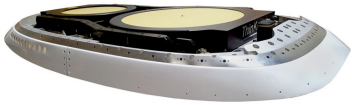
Patent 3：Phase Array Antenna Device and Modularized Scalable Antenna in Package

Satcom RF Solution Supply Chain



Satellite User Terminal – Phase Array Antenna

Antenna Technology Evolution

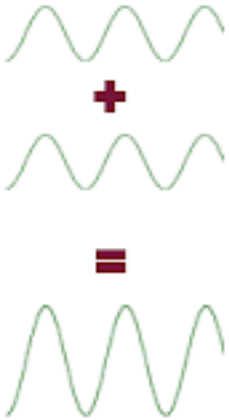


Antenna	Dish	Waveguide	Active Phase Array	Active Phase Array
Amplifier	Single ext. amplifier: BUC/ LNBC	Singel ext. amplifier: BUC/ LNBC	Multiple PA/ LNA	Multiple PA/ LNA
Steering	Mechanical	Mechanical	Mechanical	Mechanical + Electronical
Weight	>80Kg	>30Kg	>20Kg	10Kg

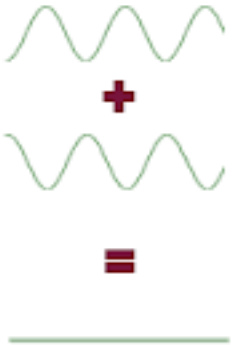
Weight reduction due to light weight phase array antenna enhance versatile user scenario and application

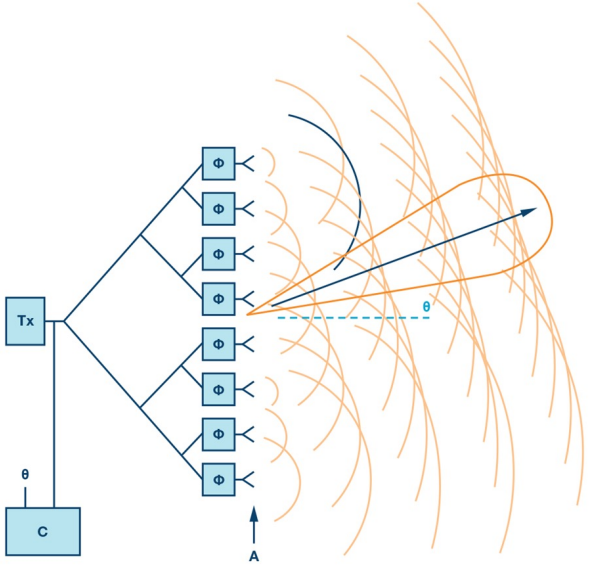
Phase – adjust direction; Array – increase signal/resolution

In Phase

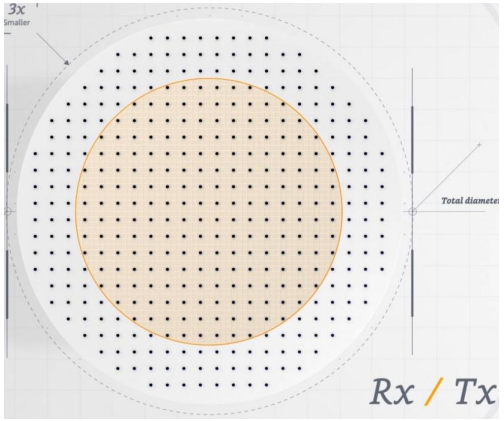


Opposite Phase





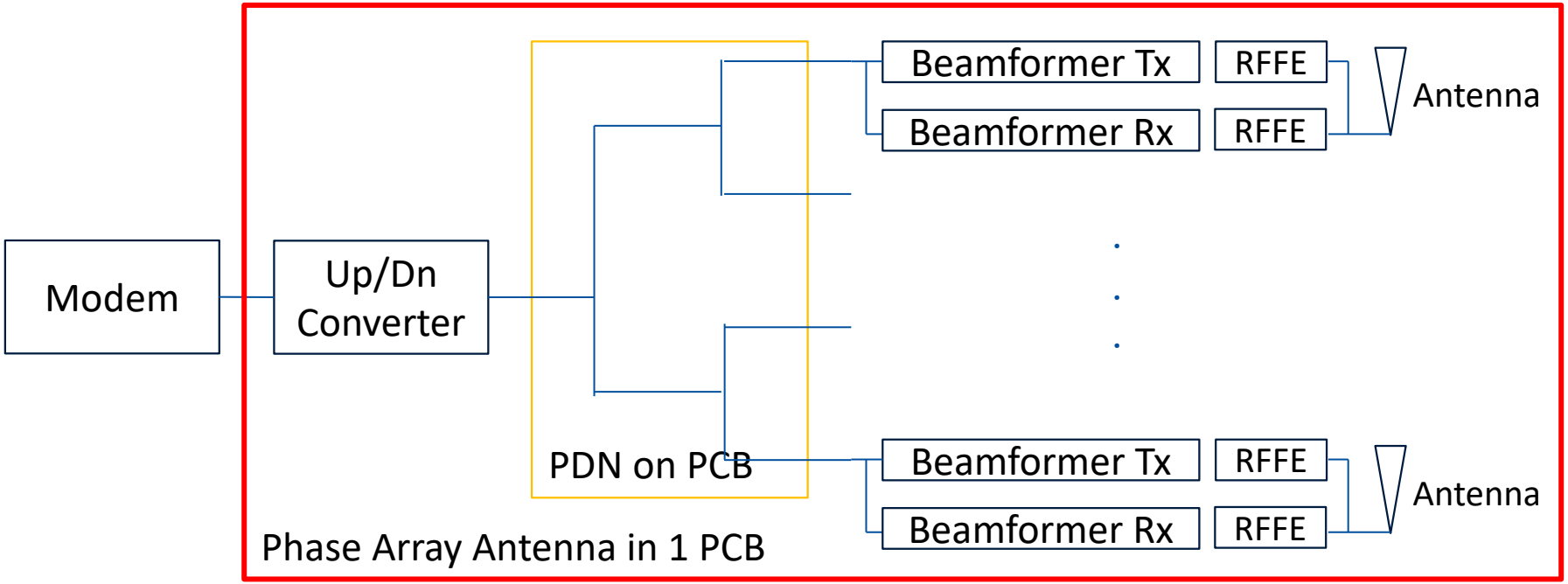
Starlink, Amazon …
all adopt this design



- Combining multiple antenna as an array can increase the signal strength and resolution
- Adjusting phase delay in each antenna can align all antenna elements of one user terminal in the same direction

Traditional Phase Array Antenna Block Diagram

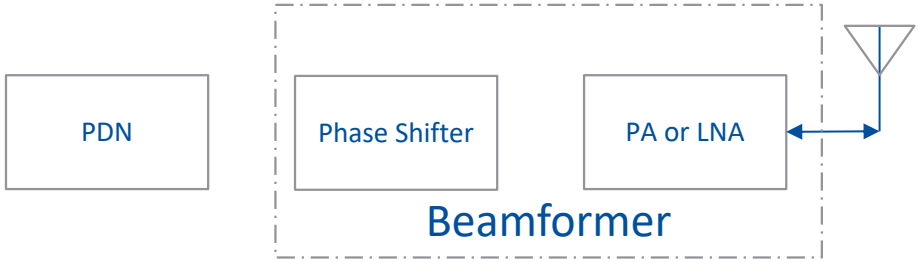
Baseband L band Ka band



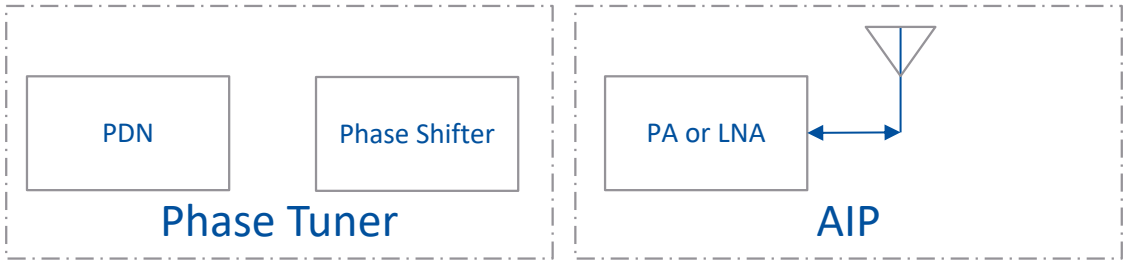
- Receiving signal by 2^N antenna and adjusting phase to aim the right angle, all signal are through PDN(power divider network) to Down Converter to L band Modem to demod to baseband
- Issue1: PDN reduce signal strength 3dB*N
- Issue2: Layout thousands antenna and beamformer on 1 PCB leads to >10layer and low yield rate

Phasetrum Solution

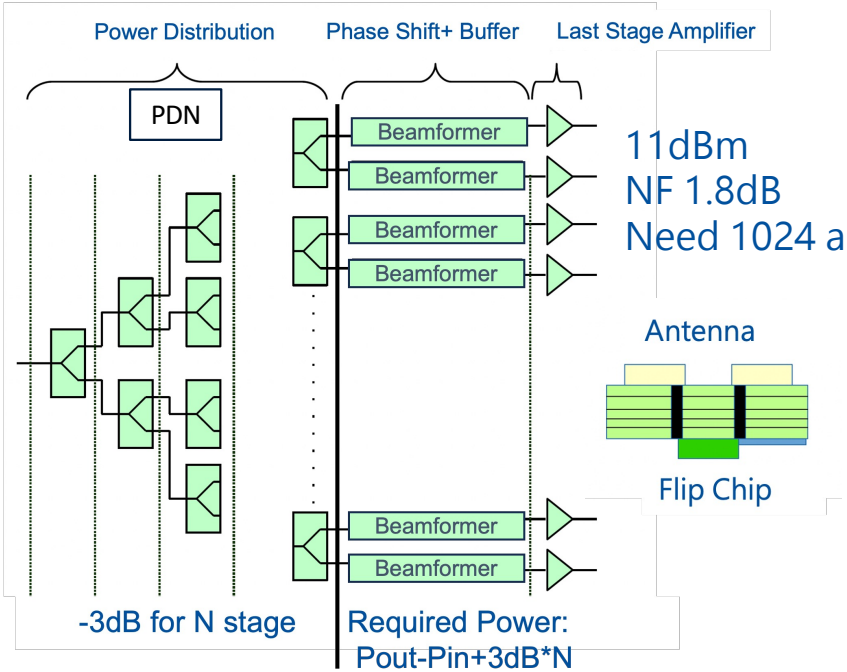
Everyone else : PDN + Beamformer



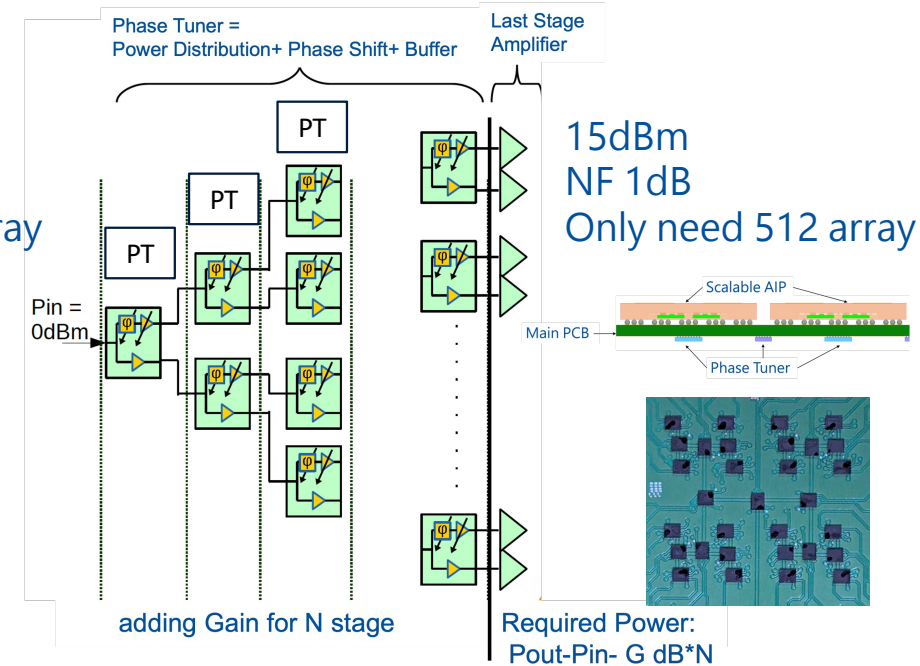
Phasetrum : Phase Tuner + AIP



Legacy Phase Array with PDN



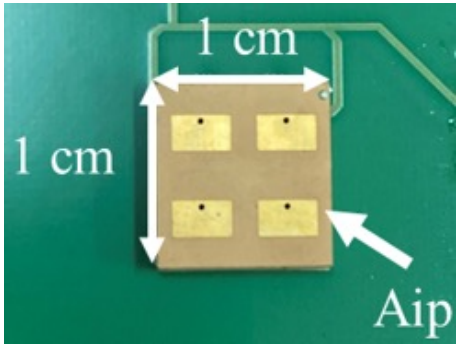
Phase Difference Array w/o PDN



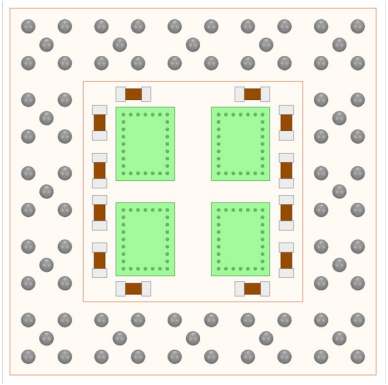
- Efficiency: 512 array to reach G/T 11dBk, EIRP 42dBW instead of 1024
- High gain: In 4*4 beamformer gain is only 5dB but 4*4 Phase Tuner can achieve 62dB
- Power saving 50%

Scalable Antenna In Package (AIP)

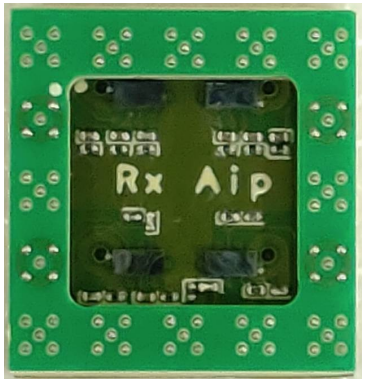
AIP top view

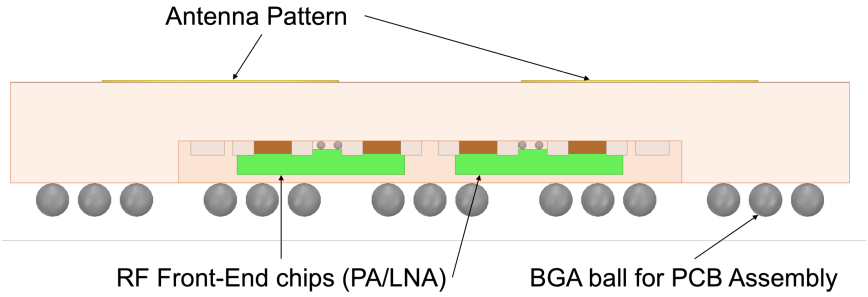


AIP schematic



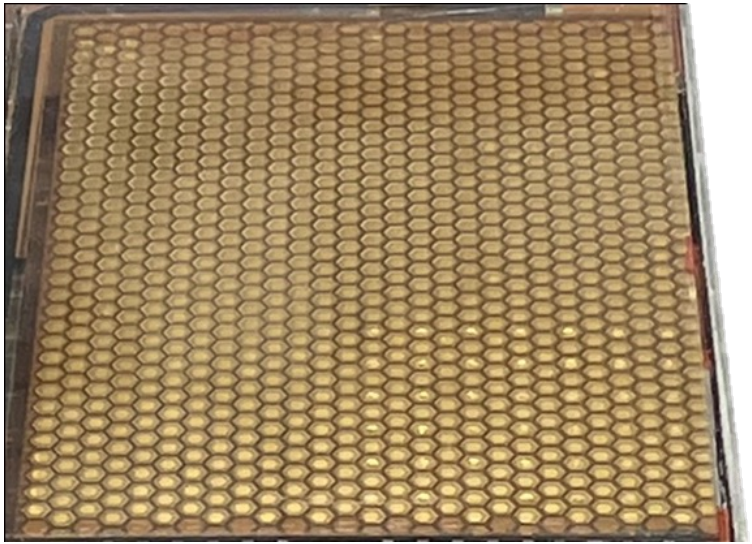
AIP bottom view



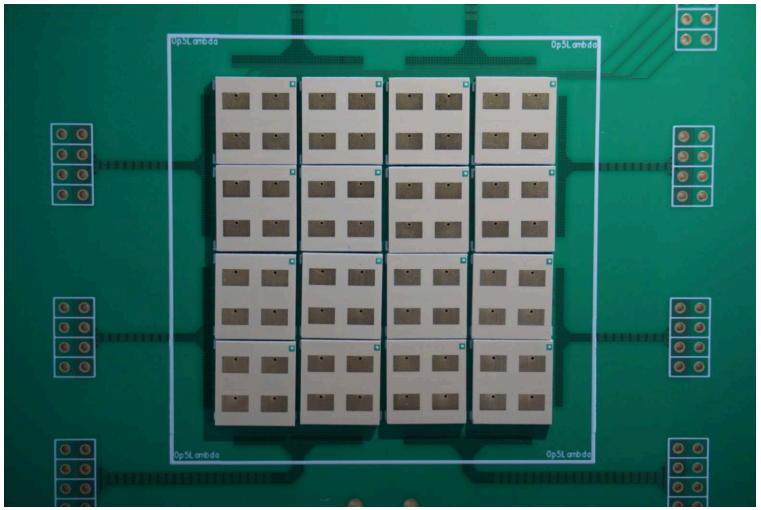


- Integrate PA/LNA with Antenna in Package
- Remove Phase control to simplify design circuit
- Per AIP sorting guaranteed yield rate
- 25dBm CMOS AIP-Tx per array
- NF<1dB, 40dB gain in CMOS AIP-Rx
- Can work with legacy beamformers

Legacy Antenna on PCB



Scalable Antenna In Package (AIP)

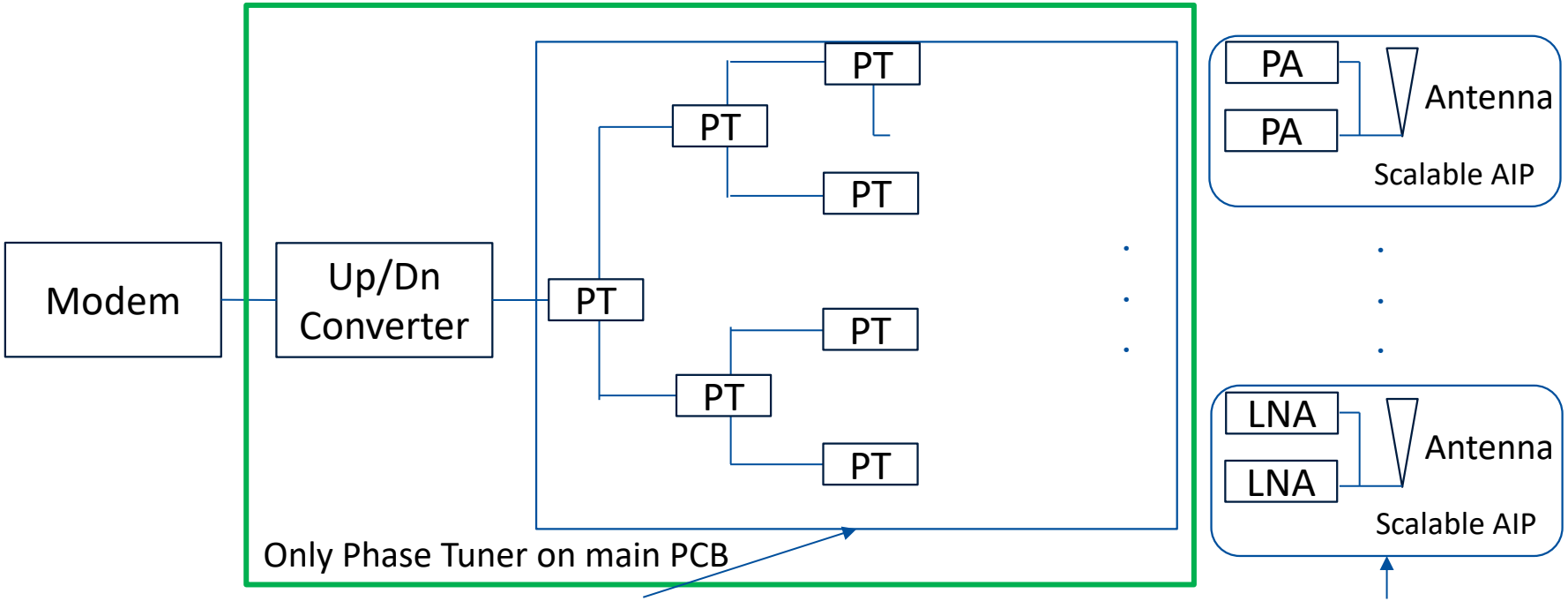


Phasetrum AIP advantage

- **Low Loss** : High Performance in G/T, EIRP as antenna close to PA/LNA
- **Production Feasible** : reduce PCB layers from 10+ to 6 by removing phase control path
- **Polarization Selectable** : no need to use 2 channels for circular polarization

Phasetrum Total Solution : Phase Tuner + Scalable AIP

Baseband L band Ka band

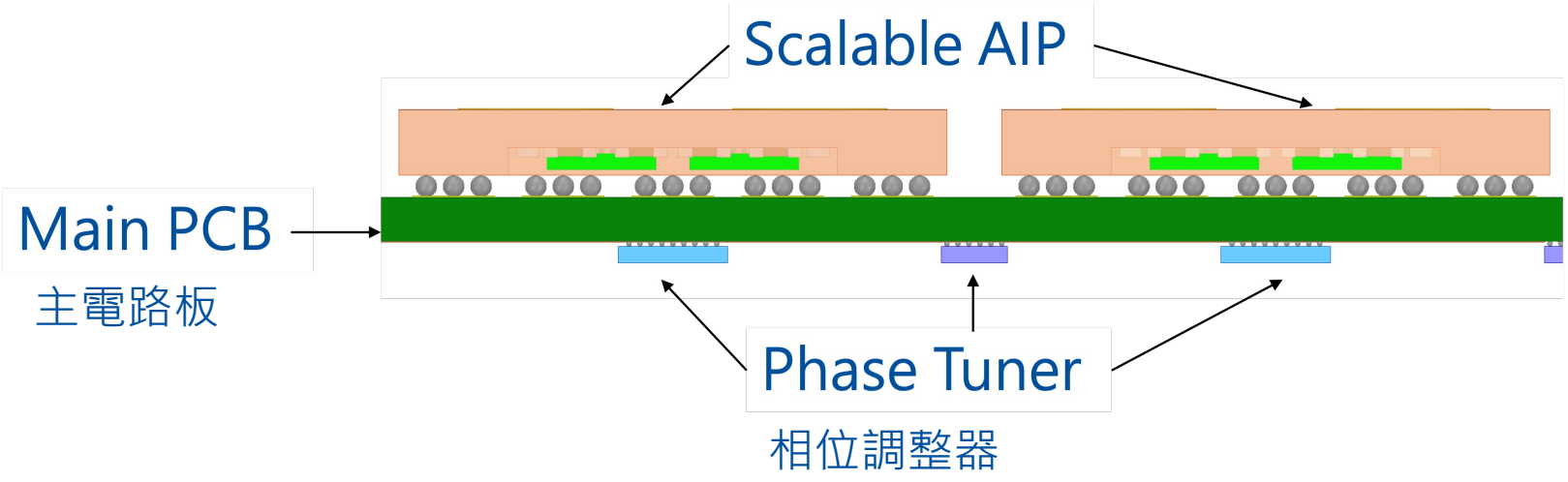


Phase Tuner on main PCB replace beamformer and PDN. Save 50% transistor and power consumption and simplify to 6layer PCB.

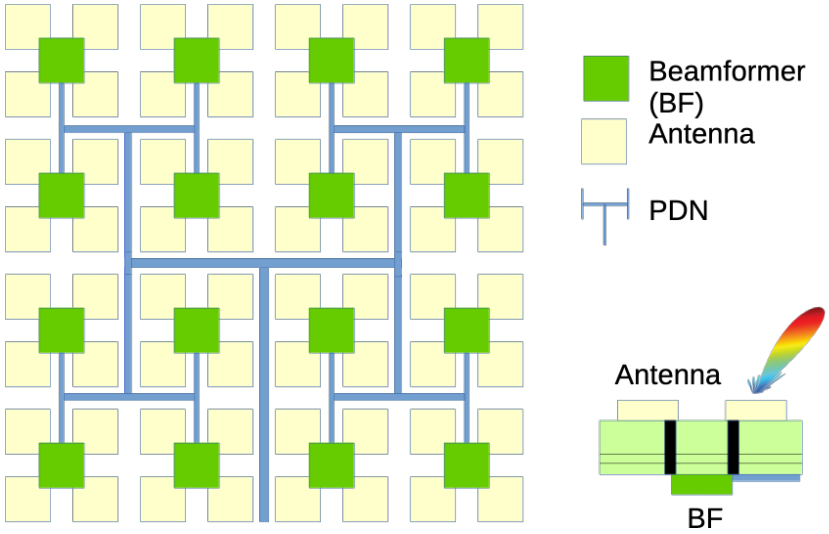
Scalable AIP integrate 4 antenna and 4PA(LNA) in one package. Easy to assembly on main PCB

Phasetrum Total Solution : Phase Tuner + Scalable AIP

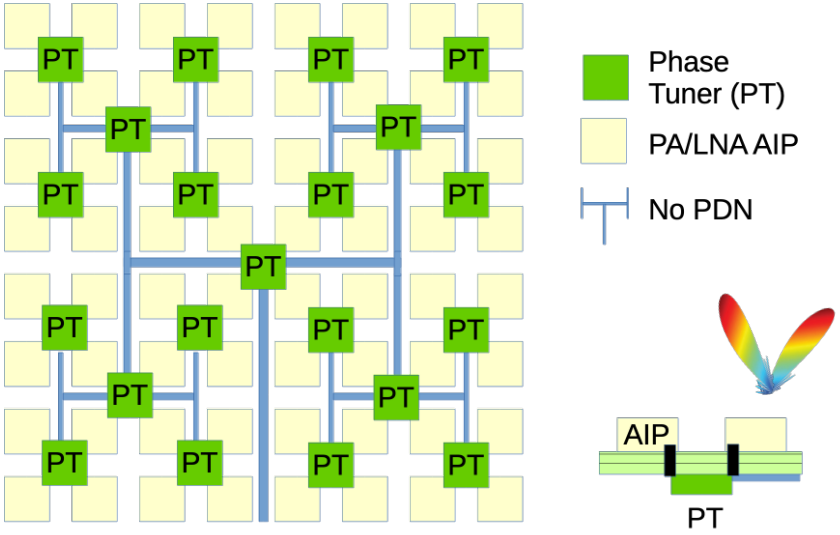
可擴增型AIP



Legacy: Beamformer with PDN



Phasetrum: Phase Tuner + AIP

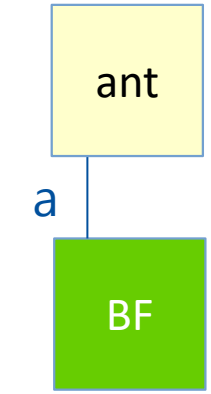


Phase Tuner Advantage:

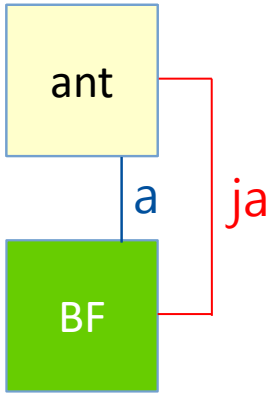
- High Gain before Antenna
- Power Saving 50%, no PDN
- Wide band PA/LNA capable, can support Ka Rx/Tx same Array
- True Dual Beam, no need to reduce beamformer channels for circular pol.
- 360° phase control with 0.1° resolution

Polarization vs Antenna Comparison – Single Beam

Legacy: Beamformer with PDN

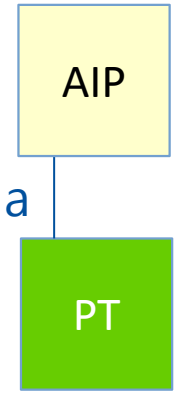


Single beam
Linear pol.

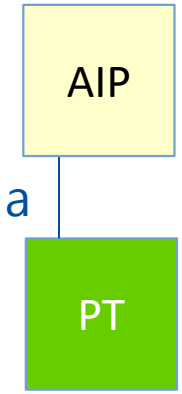


Single Beam
Circular pol.

Phasetrum: Phase Tuner + AIP



Single beam
Linear pol.

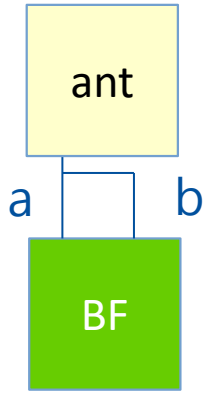


Single beam
Circular pol.

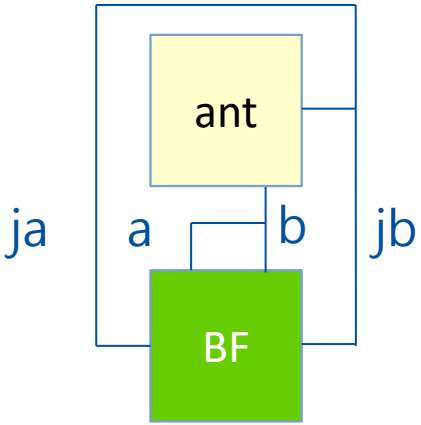
BF needs another ch. To create 90° phase difference signal to form dual feed for circular pol. But AIP can do by itself.

Polarization vs Antenna Comparison – Dual Beam

Legacy: Beamformer with PDN

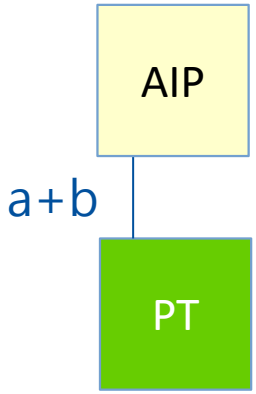


Dual beam
Linear pol.
By BF 2ch.

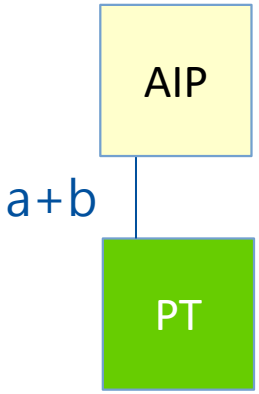


Dual beam
Circular pol.
By BF 4 channel

Phasetrum: Phase Tuner + AIP



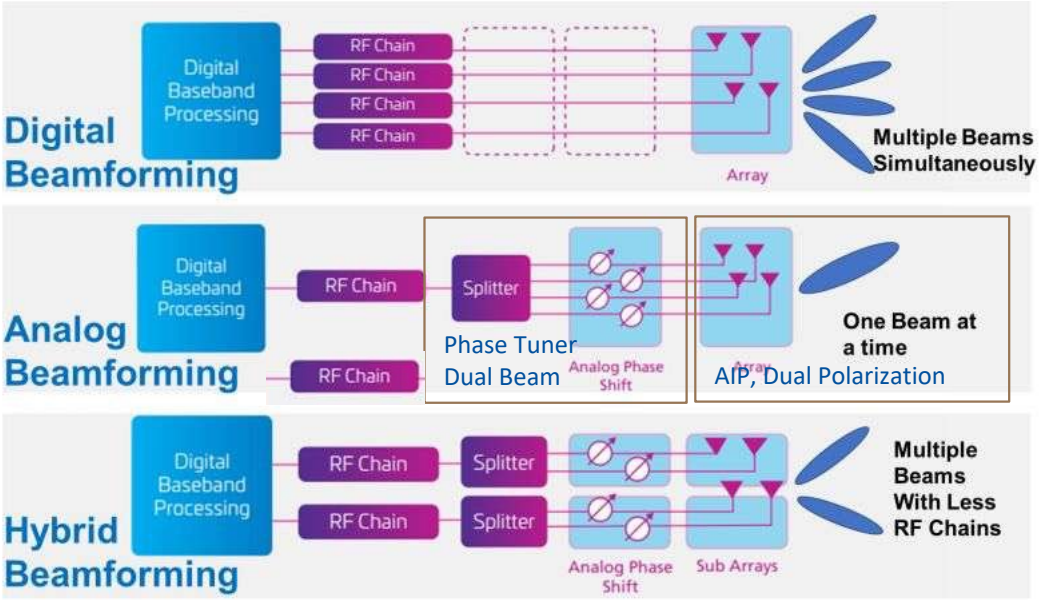
Dual beam
Linear pol.



Dual beam
Circular pol.

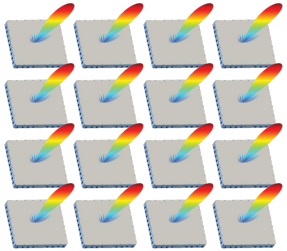
BF needs extra ch. to support Dual beam. It also needs 2 ch. for circular polarization.
AIP+PT can support circular pol. dual beam with 1 ch as AIP support polarization selection.

Solution Comparison: Scalable AIP + Phase Tuner

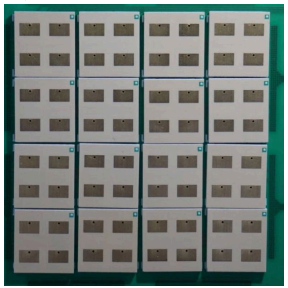


Phasetrum Advantage – Scalable AIP vs AIP vs PCB antenna

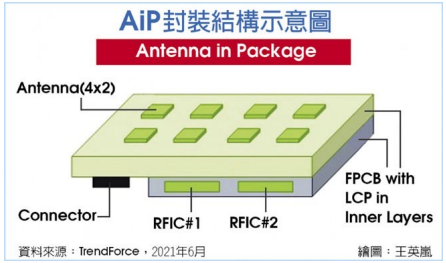
Phasetrum : Scalable AIP integrate 4 antenna and 4PA(LNA). Easy scale up due to low PCB layer requirement



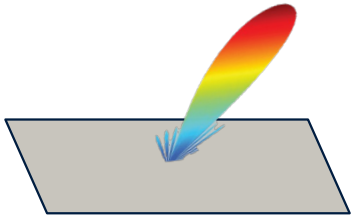
Up to 32*32 (20cm*20cm)



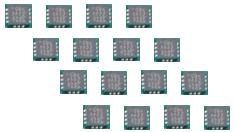
5G AIP : 1 AIP include 4*2 or 8*8 antenna dedicated for 1 product. No scalability



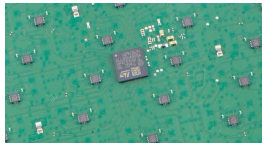
Other LEO antenna : Beamformer/RFFE and antenna on same PCB, leads to 10+ layer PCB, PCB not average impact flatness can cause low yield rate (<0.1mm in 50cm)



30*50cm main PCB with >500 antenna



16 beamformer+ 508 RFFE



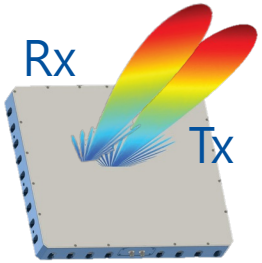
Starlink V2 as example

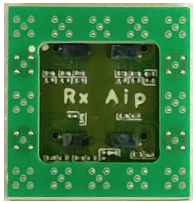
Phasetrum Advantage – Dual beam, Dual polarization

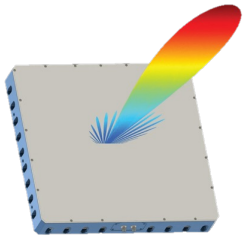
Phasetrum

Others

BBM





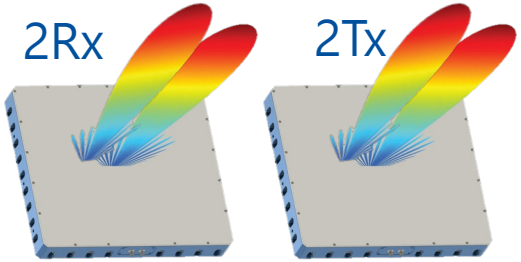


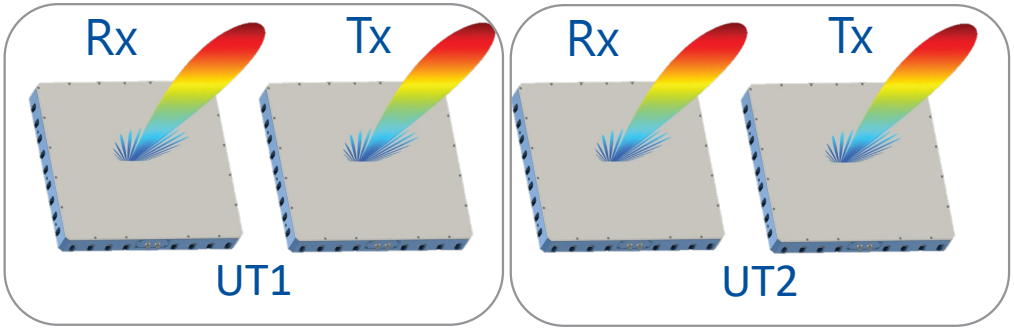
Tx / Rx in TDD

Support dual beam for Rx and Tx work simultaneously

Only single beam

MBB

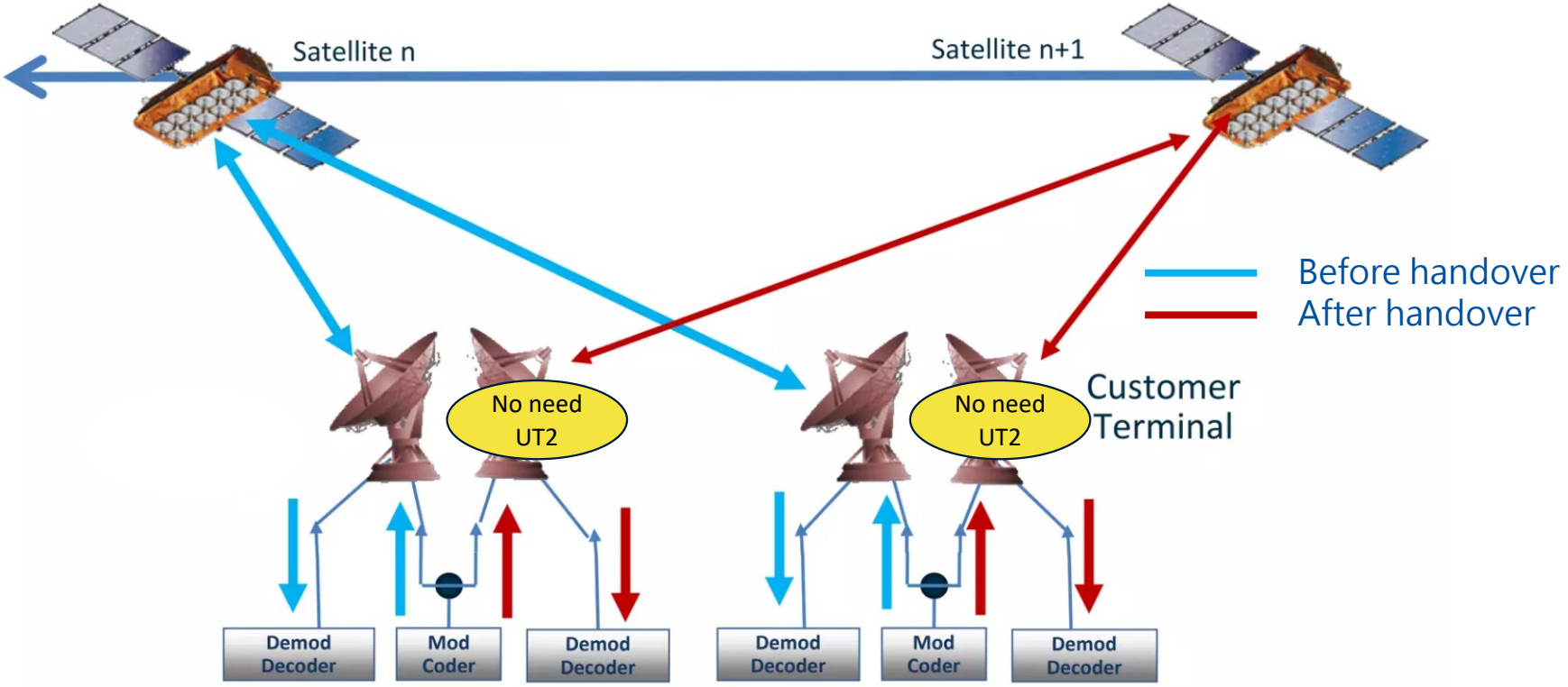




Support dual beam in Rx and Tx separately to achieve Make Before Break(MBB) in one UT

Need 2 User Terminal(UT) to fulfill MBB

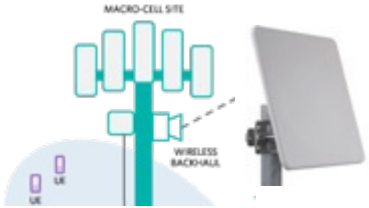
Advantage of Dual Beam Antenna – only 1 UT required for MBB



Phasetrum Scalable AIP can handover to next satellite connection before breaking with previous one by only one user terminal with better latency and Committed Information Rate (CIR)

Applications

B2B



Tier2: Wireless Backhaul

Tier1: Distributed Data Center

COTP (fixed location)

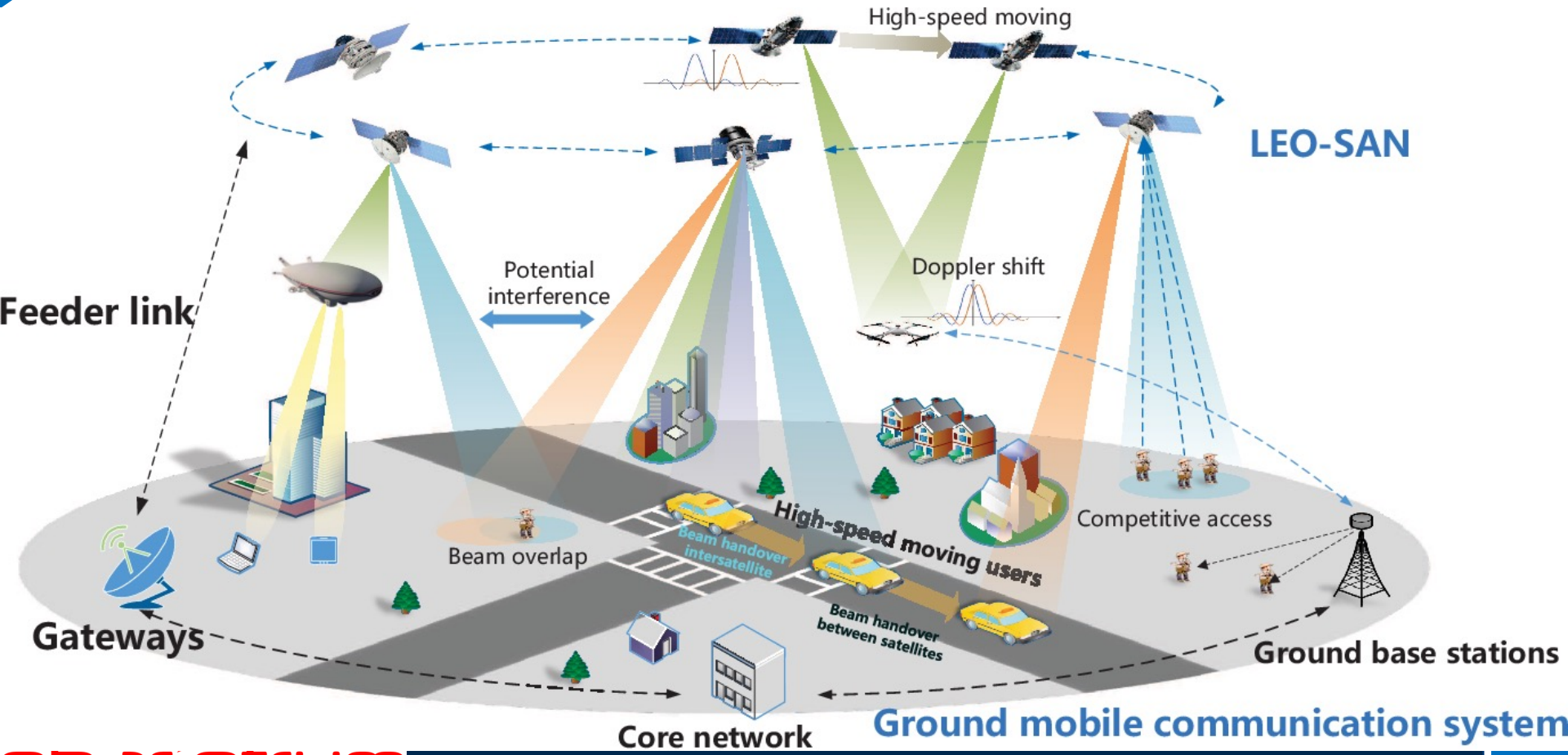
Tier3: Household Internet

B2C

COTM (mobile)

Use Starlink in motion

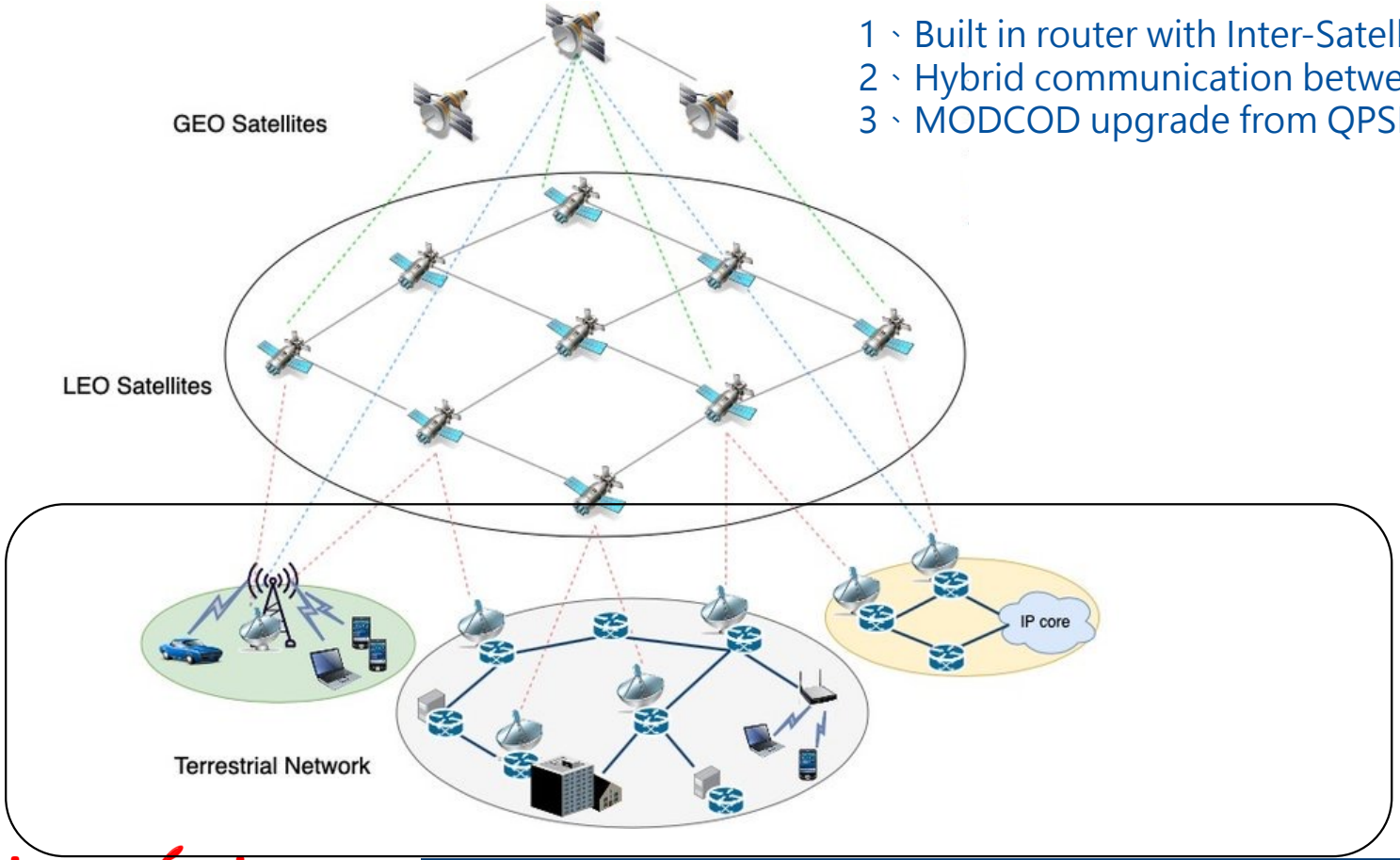
6G Era supporting 5G NTN and multi-Orbit Satellite



Thank You

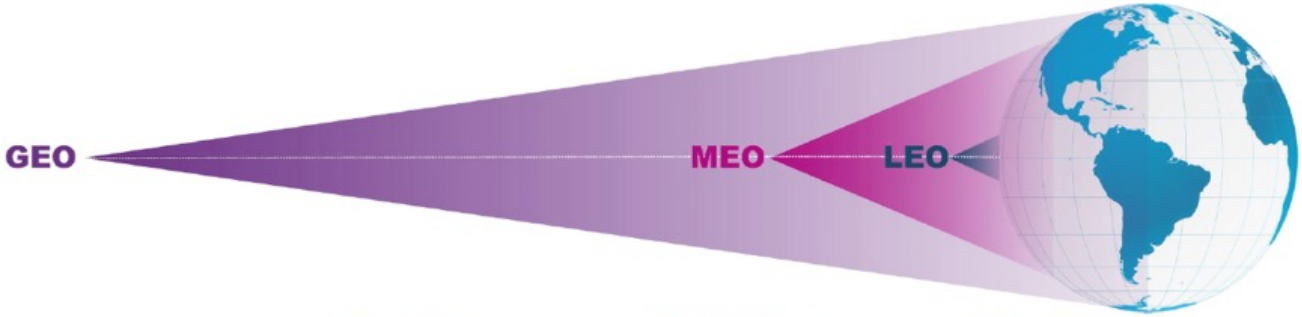
Appendix : Satellite Communication

New Trends in LEO Satellite



1、Built in router with Inter-Satellite link (ISL)
2、Hybrid communication between GEO/MEO/LEO
3、MODCOD upgrade from QPSK to 256APSK

Rising Demand on Phase Array Antenna



eutelsat	2023 Sep. complete merge	OneWeb V1 V2	$3.4B completed
SES INTELSAT	O3b mPOWER	2024 Apr. resumed	$3.1B proceeding
Viasat inmarsat	2023 UK（CMA）、USA（FCC）、EU（EC）approves the merge		$7.3B completed
		STARLINK V1 V2 V2 mini	Many new generations