

A view of Earth from space, showing the blue atmosphere and city lights at night. The Earth's curve is visible on the left, and the dark side of the planet is on the right, with numerous yellow and orange lights representing cities. A bright star or sun is visible on the left side of the frame, creating a lens flare effect.

Low Earth Orbit (LEO) Satellite Systems

Introduction to LEO

Orbit	Altitude (km)
GEO	35,800
MEO	10,355
LEO	2,000
	550
	500
VLEO	340

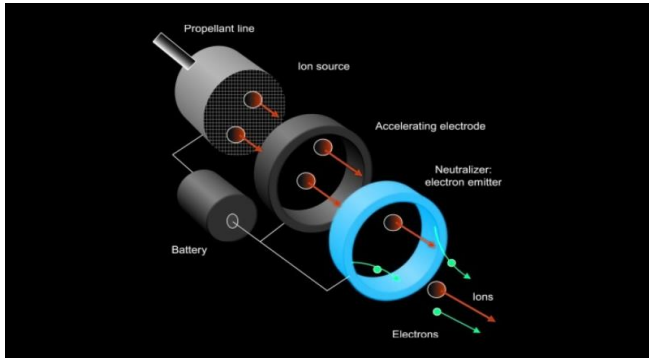
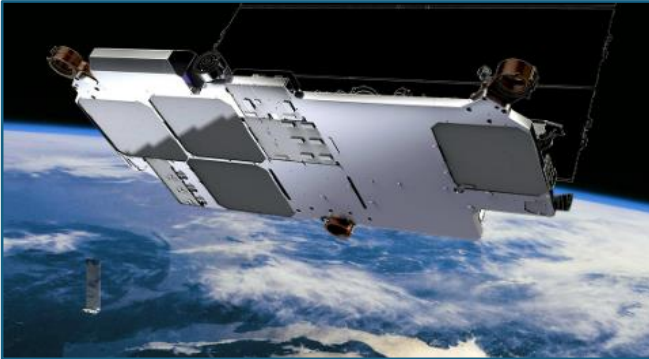
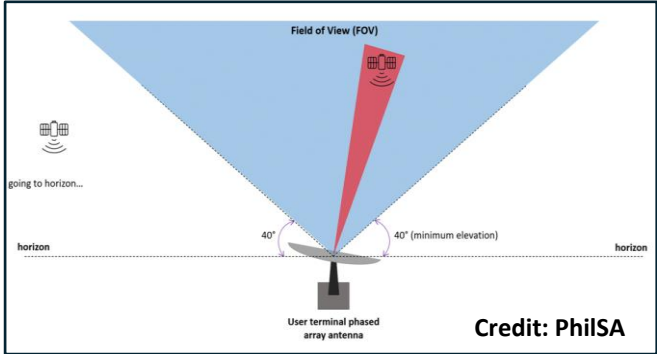
Orbital Velocity (km/hour)	Orbital Period (Hour)
11,062	24.0
17,565	6.0
24,829	2.1
27,307	1.6
27,406	1.6
27,731	1.5

User Terminal Challenges

- At least 2 mechanically tracking parabolic VSAT Terminals
- Maintenance Challenges - mechanical wear and tear
- Unmovable and immobile – big and heavy
- Cost prohibitive for most users



Technological Advancements



- Recyclable Rockets**
 Reuseable launch vehicle

Star Ship

New Glenn 3-stage

New Glenn 2-stage

Deep Blue

Falcon Heavy

Falcon 9

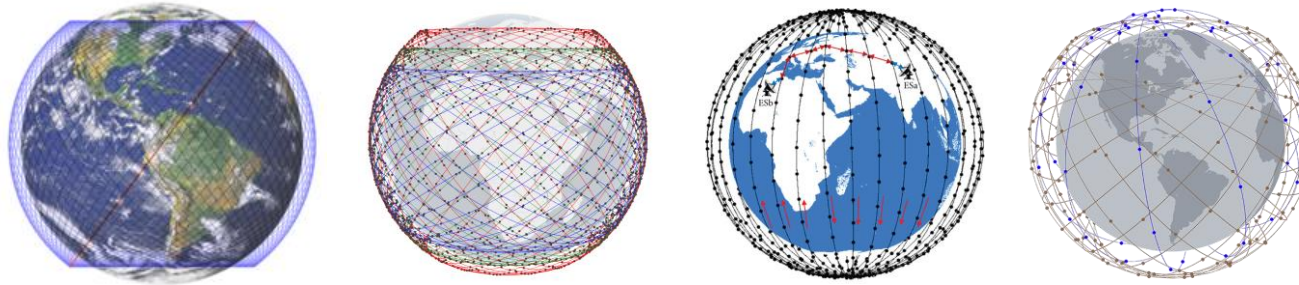
Various Types of LEO Satellite Systems

Payload	Types	Examples
Communications	Mobile Satellite System/ Satellite Telephony	Iridium, Globalstar, ICO-Teledesic
	Broadband Internet	Starlink, Kuiper, lightspeed, OneWeb, GuoWang/SatNet, Qianfan/Thousand Sails
	IOT	Swarm Technologies, Head Aerospace, Sateliot, Astrocast, Orbcomm, Fossa, Myriota,
	Direct-to-Device	Starlink D2C, AST SpaceMobile, Lynk Global
Navigation	Navigation System	GPS (USA), Beidou (China), Galileo (EU), Glonass (Russia) QZSS (Japan), Navic (India)
Earth Observations / Remote Sensing	Electro-Optical/Infrared	Planet, Blacksky, Spire, SPOT, Satellogic, GalaxySpace, StarVision
	Synthetic Aperture Radar (SAR)	CapellaSpace, Iceye, Radarsat, GalaxySpace, StarVision



LEO Broadband Internet

LEO Broadband Internet



	Starlink	Project Kuiper	OneWeb	Lightspeed	GuoWang (SatNet)	Qianfan (SpaceSail)
No of Satellites	42,000 (6500+ now)	3236 (test sats)	648 (Completed)	198 (3 test sat)	12,990 (test sats)	13,904 (36 now)
Altitude (KM)	550	630	1200	1300	500 ~ 1145	800+
User link frequency	Ku-band	Ka-band	Ku-band	Ka-band		
Suite of Services	Broadband Internet	Broadband Internet	Broadband Internet	Broadband Internet	Broadband Internet	Broadband Internet
Target Market	Enterprise, Consumer	Enterprise, Consumer	Enterprise	Enterprise	Enterprise, Consumer	Enterprise, Consumer

LEO Broadband Internet

Network Design & Planning Overview

Traffic Planning

Traffic Predictions

Coverage and Network

Gateway location, Radio Resources, Inter-Satellite Link, Terrestrial Data Communication

Interference Mgmt

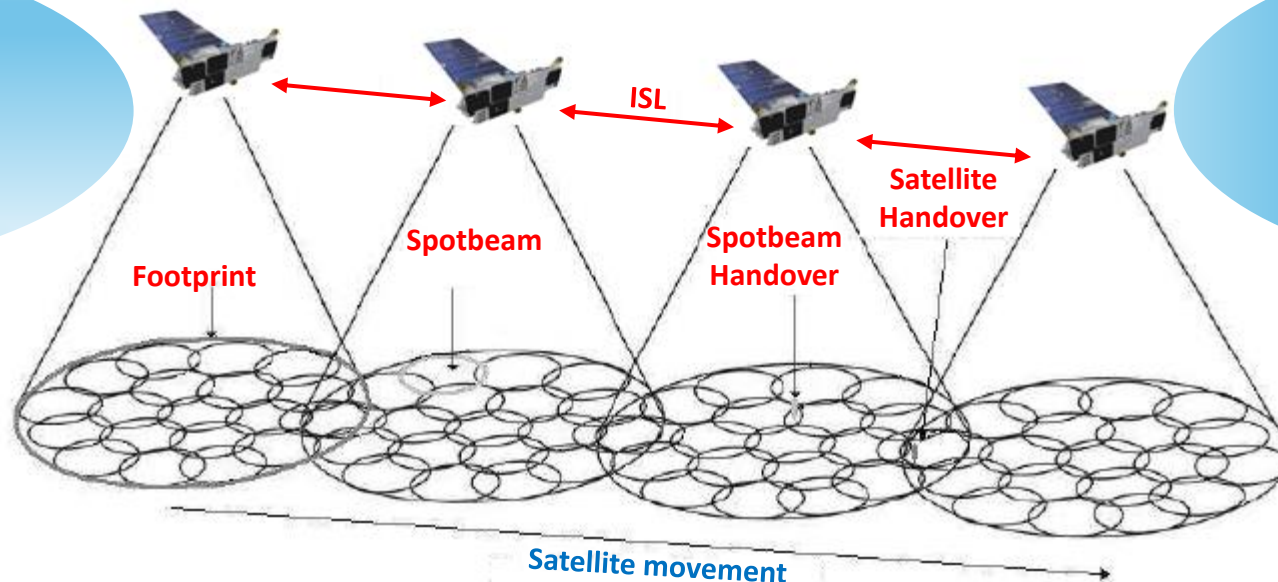
Intra- and Inter-system Interference, real-time mgmt

Frequency Planning

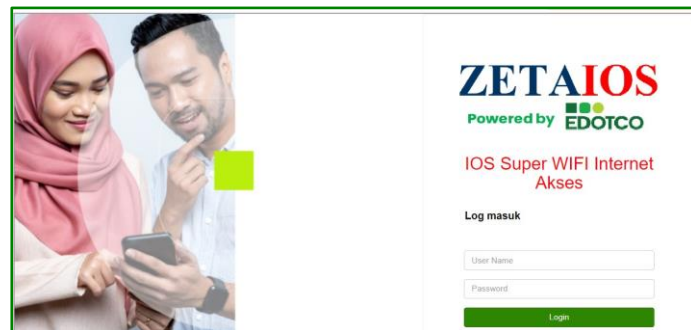
Capacity, Freq re-use, Channelization, Doppler Compensation

Power Planning

EIRP Mgmt, Transponder Mgmt



Use Case : Kampung Orang Asli Sg. Kelit.

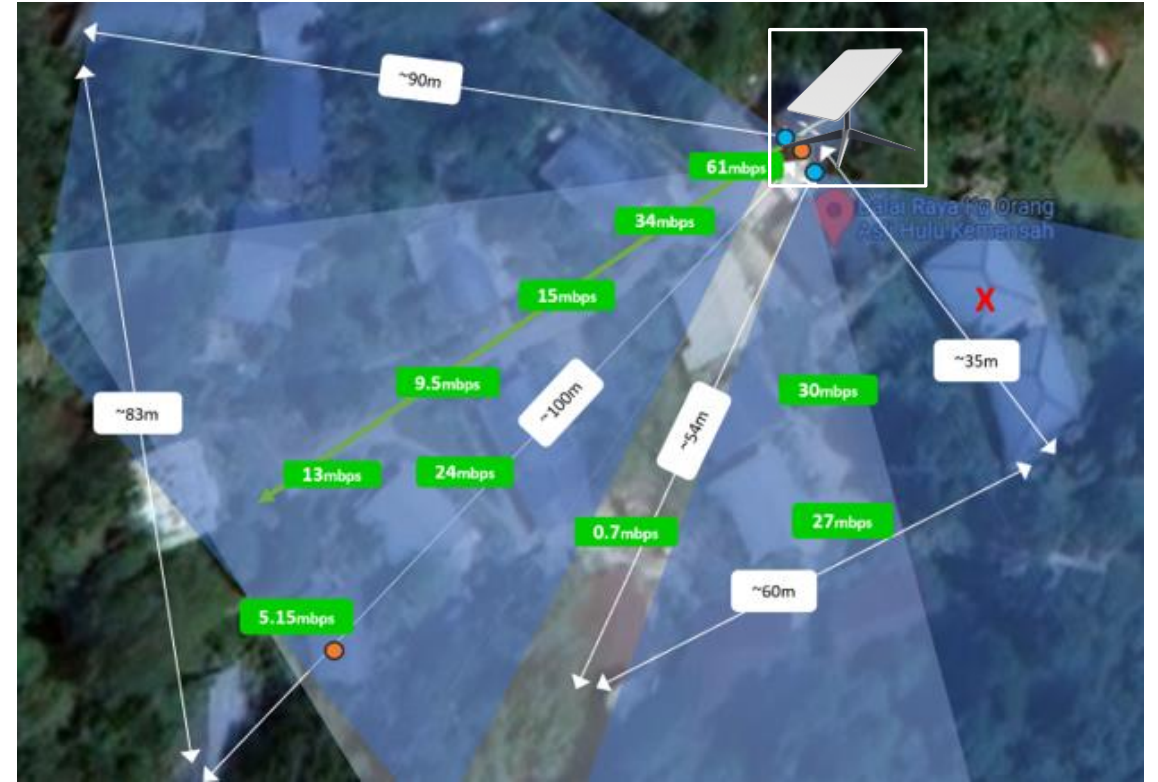


CAPEX and OPEX funded by EDOTCO for 1st 6 month

- Include Integrated Solution and System
 - **Starlink as backhaul**
 - **PTP fixed wireless access**
 - **2.4Ghz Super WIFI**
 - **Full-fledged NMS and Billing System (prepaid vouchers)**
- Population of **120 people, 30 houses**
 - **less than 200 people per sq km**
- MSQoS 2025 at **10Mbps** for coverage
- Fully powered by Solar Energy
 - **128 watts of power consumption**
- Average monthly consumption of **5 TBs**
- **Sustainable commercial operation today!**

WIFI Packages				
Quota	1Gb	10Gb	25Gb	40Gb
Duration	1 day	7 days	14 days	1 month

KOA Kemensah & Tonggang

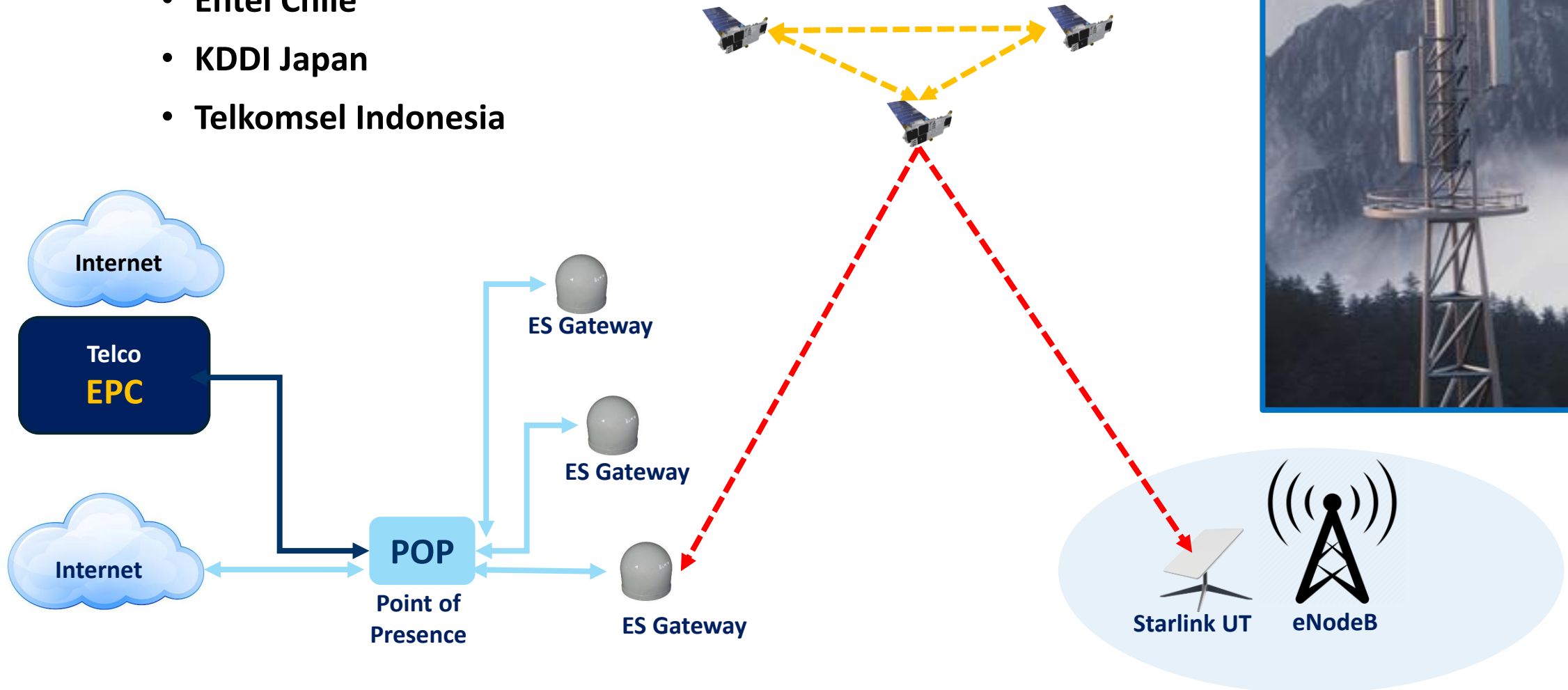


Impacts on the livelihood of the people

- **KOA KEMENSAH:** Sales of bamboo products (for making Lemang) skyrocketed last Ramadan
- **KOA TONGGANG:** A nearby small camping resort fully booked every weekend now. Local Tourism!
- **KOA SG KELIT:** Wholesalers and restaurant owners come scrambling for fresh pesticide-free fruits/ vegetables

Use Case: Mobile Backhaul

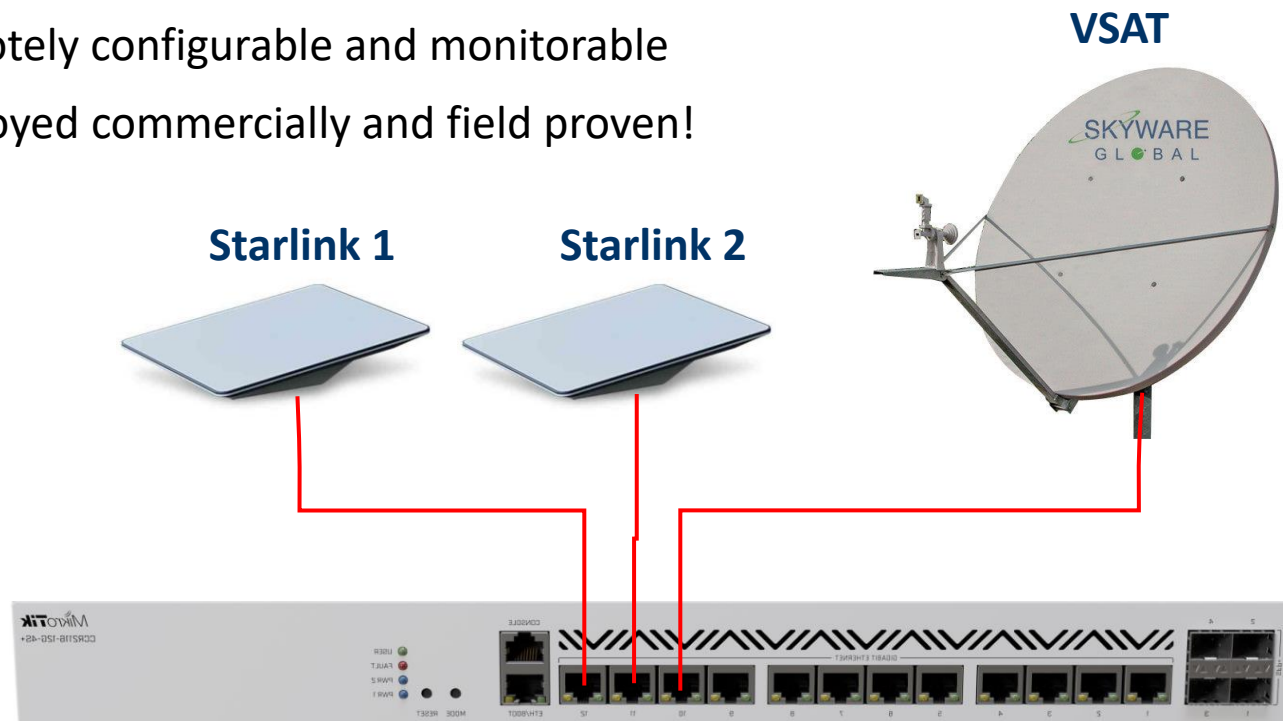
- Entel Chile
- KDDI Japan
- Telkomsel Indonesia



VOLANT

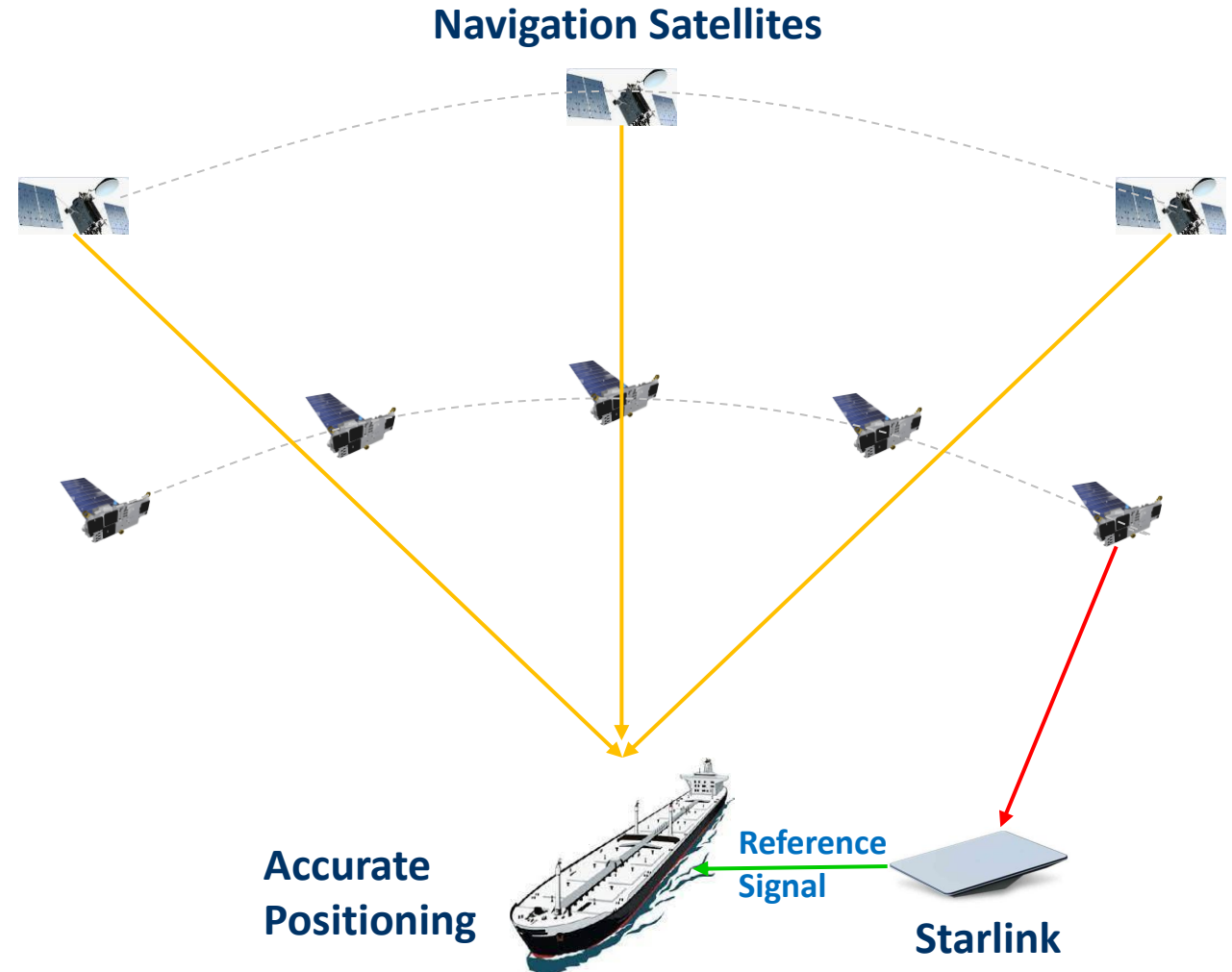
Virtual Fibre-optic Long-haul Asynchronous Network Technology

- A locally engineered product by **Petronas Research**
- A unique algorithm integrated into a router, combining multiple internet links into a single high-speed connection
- Multiple WAN of diverse latencies
- Remotely configurable and monitorable
- Deployed commercially and field proven!



Use Case: Differential GPS

- **Geomatic Innovation Research Group, Faculty of Built Environment and Survey, Universiti Teknologi Malaysia**
- Global Positioning System (GPS) MEO constellation of 31 satellites at 20,200 KM altitude
- **Differential GPS** service transmits correction signals to GPS navigation equipment on vessel
- Greatly improves accuracy to <1 meter
- Fulfilling shipowners' objectives – Internet Access and Accurate positioning

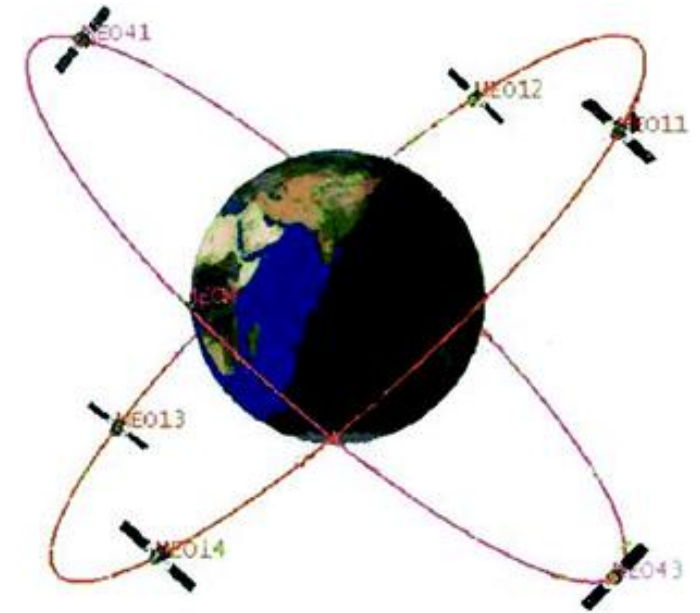
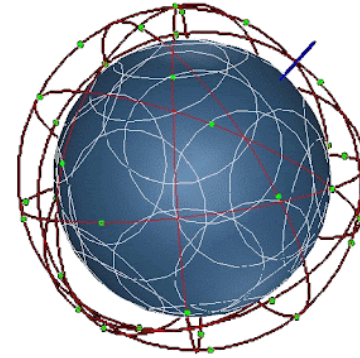
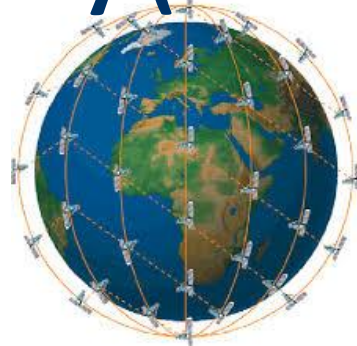


Direct-to-Device (D2D)

(Direct-to-Cell / Direct-to-Smartphones)

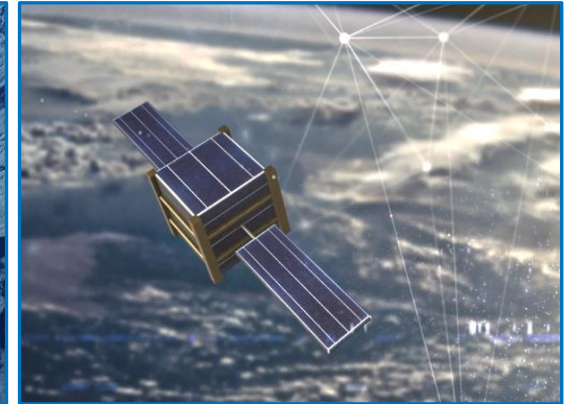


Mobile Satellite System / Satellite Telephony (1990s)



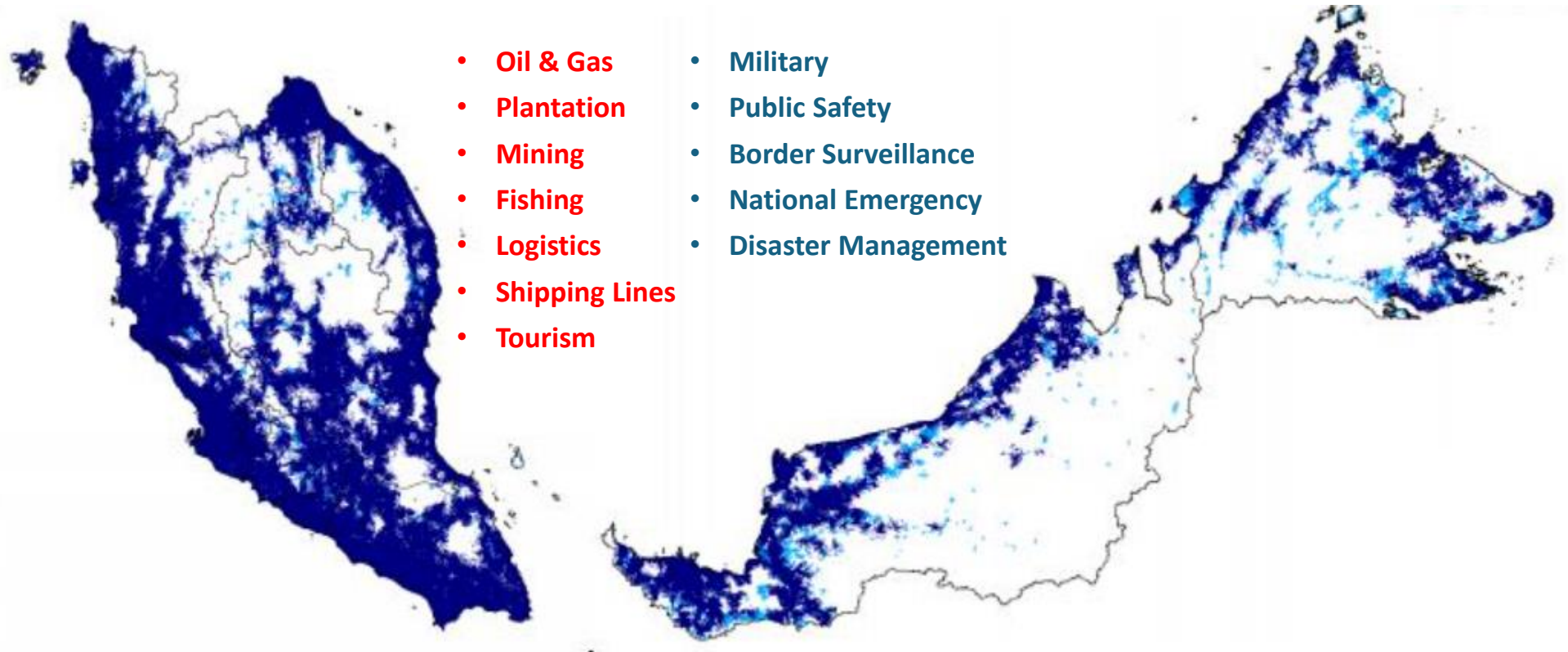
	Motorola Iridium	Globalstar	ICO-Teledesic
Orbit type	LEO	LEO	MEO
No of Sat	66 + Spares	48 + 4 Spares	10 + 2 spares
Altitude (KM)	780 KM	1414 KM	10,390 KM
Suite of Services	Telephony, Narrowband data (Proprietary)	Telephony, Narrowband data (Proprietary)	Telephony, Narrowband data (2G GSM 2.5G GPRS)
User link Frequency	L-band	L-band	S-Band

D2D Players



	Starlink D2C	AST SpaceMobile	Lynk Global Sat2Phone
Number of Sats	840 (220+ now)	248 (3 Bluewalker, 5 Bluebird)	5000 (7 test sats)
Altitude	525 KM (being tested at 340 KM)	730 ~ 740 KM (being tested at 513 KM)	500 KM
Based on XG	4G (1600 to 2690 MHz)	4G/5G (850 MHz)	5G
Download/Upload Speed	17 / ??	20 / ??	Messaging now, Mobile broadband
MNO Partners	T-Mobile, KDDI, Salt, Entel, One NZ, Optus, Rogers	AT&T, Verizon, Rakuten, Vodafone, Google, American Tower	40 MNOs serving 50 countries

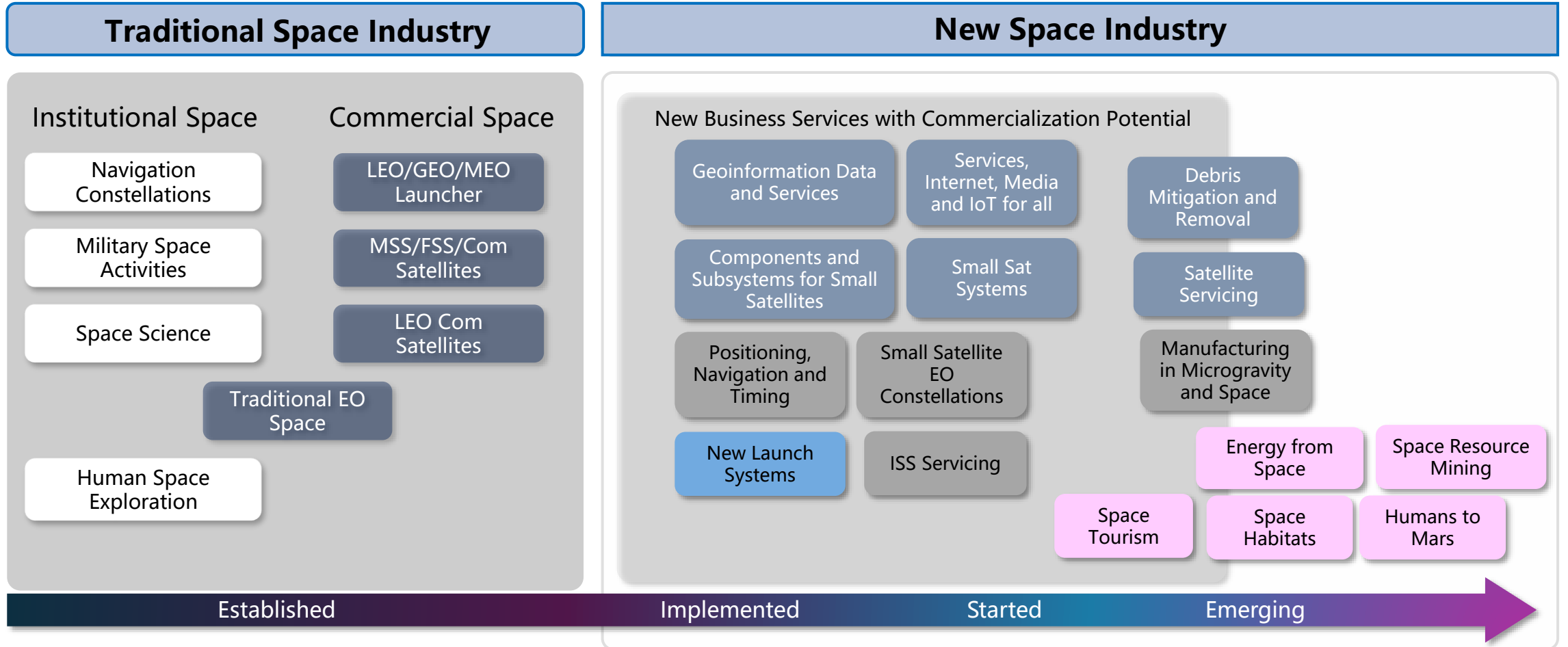
D2D and Untapped Mobile Markets



- Covering the entire landmass and waters of Malaysia, beyond 100% !
- Applications: IOT (4G: NB-IoT/LTE-M, 5G: mMTC), Connected & Autonomous Vehicles
 - Inclusive DIGITAL ECONOMY !

Evolution of Space Industry

Space Industry Now Driven by Commercial & Private Companies



A blue-tinted image of Earth from space, showing the curvature of the planet and swirling cloud patterns. The sun is visible on the left horizon, creating a bright glow. The text "Thank You" is overlaid in white, centered on the image.

Thank You