ESA Moonlight Initiative

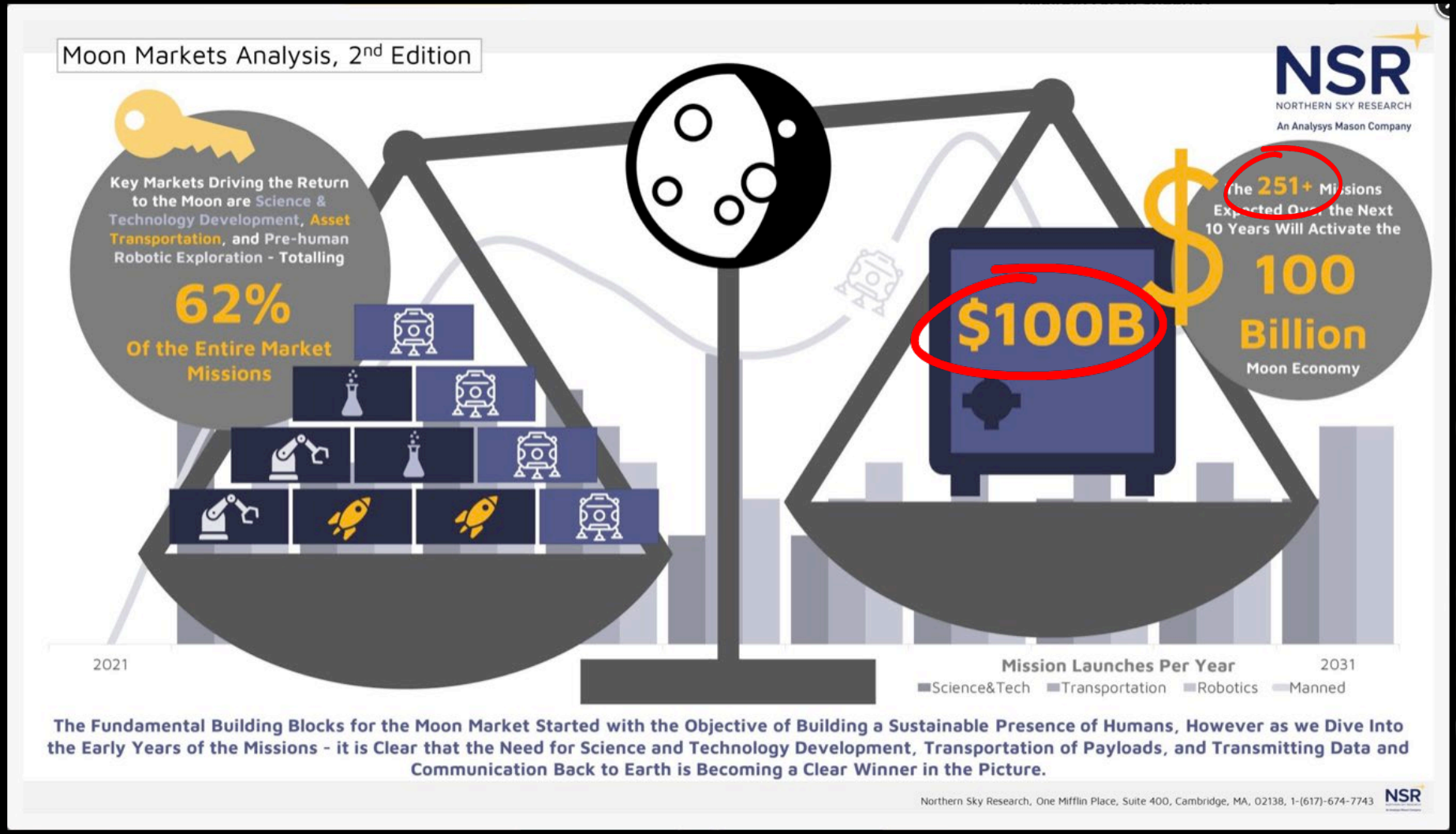
Moderator: Mike Snell
IPNSIG

Presenter: David Gomez Otero
European Space Agency

Europe’s new era of exploration

The lunar Economy

NSR Report April 2022

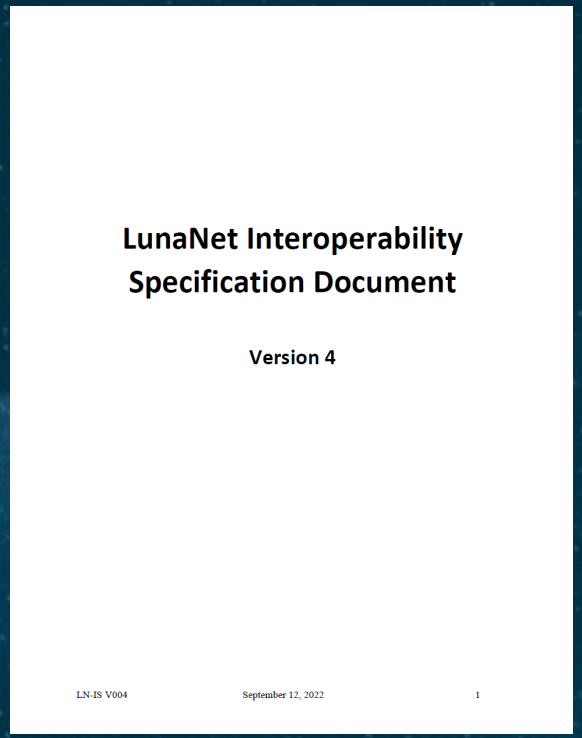


Vision

To enable the delivery of Communications and Navigation Services that will support the current and next generations of institutional and commercial Lunar explorers

Moonlight and LunaNet

- ✓ LunaNet is an Framework for interoperability in the cis-lunar region
- ✓ LunaNet is co-developed by NASA and ESA
- ✓ Moonlight is ESA's proposal for the deployment of Lunar communications and navigation services
- ✓ Moonlight will be compatible with LunaNet



Roadmap

LUNAR PATHFINDER

Low-rate satellite communications service + Moon GNSS Receiver

Development  **Pathfinder Service**

SURREY

Q1 2025

MOONLIGHT CONSTELLATION

High-data rate satellite Lunar Communications and Navigation Service (LCNS)

Design **Development** **Initial Services**

2020 2021 2022 2023 2024 2025 2026 2027 2028

LCNS Implementation Steps

Q1'2018 Prior Work → Q2'2020 Phase A/B1 CFI → Q3'2020 Phase A/B1 ITT Release → Q2'2021 Phase A/B1 2x Studies (YOU ARE HERE) → Q4'2022 (TBC) Phase B2/C/D/E1

TELESPAZIO (a LEONARDO and THALES company): ThalesAlenia Space, argotec, Nanoracks, OHB, hispasat, inmarsat, MDA, POLITECNICO MILANO 1863, SDA Bocconi School of Management

SSTL LUNAR: AIRBUS, gmv, gmv NSL, KSAT, GOONHILLY EARTH STATION, SES beyond frontiers, SURREY

Service Definition / Business Development / Partnership Models

Mission Requirements Definition	Service and System Concept Development	System Architecture Development	System Detailed Definition
Apr'21 Kick-Off	Q3'21 MRR	Q4'21 SCR	Q1'22 PRR	Q3'22 iSRR

- Kick off of phase A/B1 on April 2021
- Industrial teams include satellite operators (potential service providers) and large system (space & ground) integrators
- December 2022: Open Invitation to Tender (ITT) for the full implementation (subject to CM22 approval)

LCNS next Steps

- ✓ Preparations for the full implementation subject to approval in Ministerial Council Nov 2022
- ✓ Request for Information (RFI) for Phase B2/C/D/E released in October 2022 (already closed) including draft Service CONOPS and Requirements (For Information):

- ✓ Invitation to tender planned for December 2022 (pending programme approval)
- ✓ Planned study for Lunar downstream applications (Intended December 2022)

https://business.esa.int/funding/intended-tender/lunar-economy-applications

LCNS Service offer

COMMS

Data Relay

- Real Time / non-Real Time
- High/Low Data Rates
- High/Low Priority
- Critical/Nominal

Messaging

- Messages

NAVIGATION

Real Time

- One Way Ranging
- Position and Velocity
- Time Dissemination
- Two Way Ranging

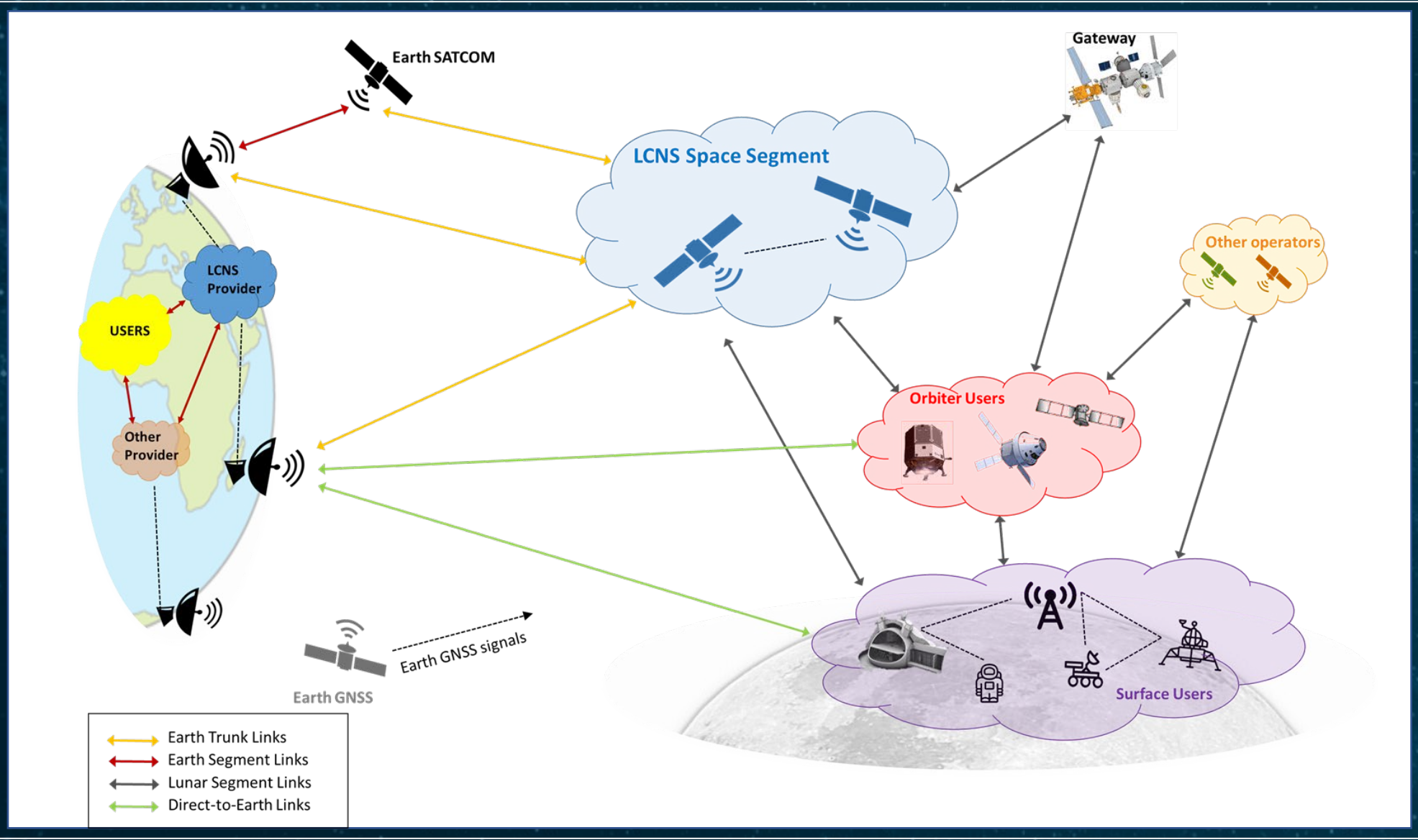
Non Real Time

- Post Processing PVT

OTHERS

- Search and Rescue
- Alert and Newsfeed
- Third Party Payloads
- Over the Top Services

LCNS Top Level Architecture



LCNS Service Requirements

Commercial & Institutional Missions

Open Interface

Interoperability

Beyond 2026/27

Scalability

Regulations

Support all Mission Phases

200Km Service Volume
[upto 70,000Km best effort]

South Pole Coverage
[Global coverage best effort]

LCNS Initial Mission Assumptions

High DataRate (KBand)
Upto 200Mbps/user

Low Datarate (Sband)
Upto 1Mbps/user

Security functions

Slotted Real time services

Compatible with Earth GNSS

Precise timing (sub µs)

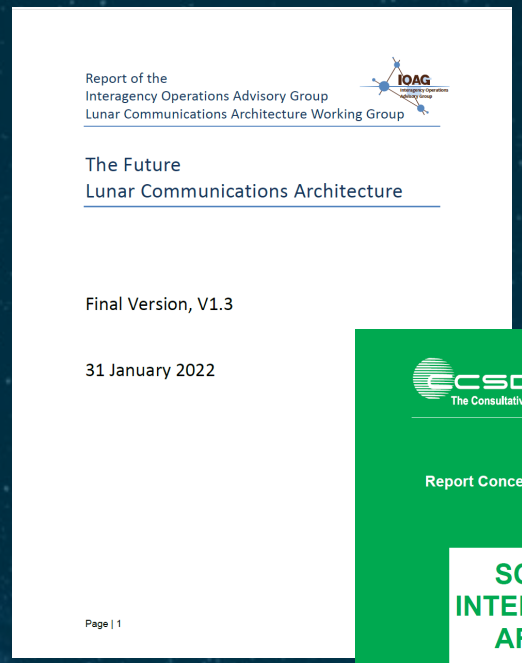
Position accuracy
Orbiters: 100m
Landing: 50m
Surface: 10m

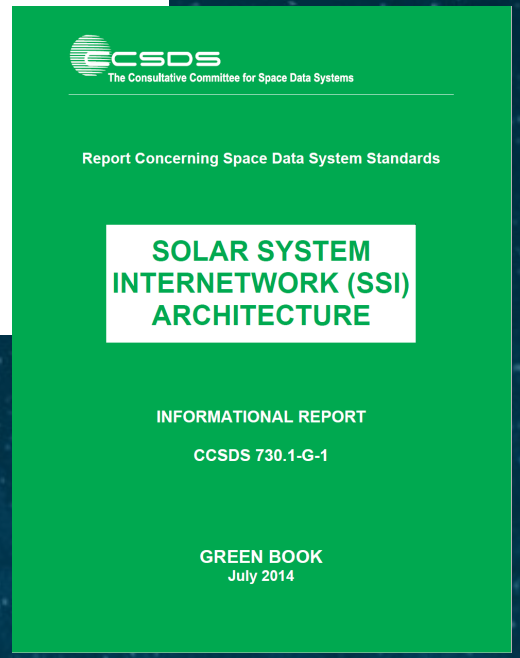
Velocity accuracy
Landing: 1 m/s
Surface: 1m/s

Towards Solar System Internetworking

- ✓ CCSDS Report in SSI Architecture
- ✓ IOAG Lunar Communications Architecture
- ✓ LunaNet Interoperability Framework

BUT: where and how to start?





A network in steps

- ✓ Similarly to Terrestrial networks, the Lunar Internet will grow gradually
- ✓ However we should leverage know-how of decades of Mobile networks and SATCOM systems
- ✓ Need to change paradigm:

Today
- COMMs is part of the mission
- Bespoke Equipments
- Each Mission has its own E2E infrastructure

Future
- COMMs as a 3rd party service (commodity)
- Pay as you Go / Monthly fees
- Universal User terminal

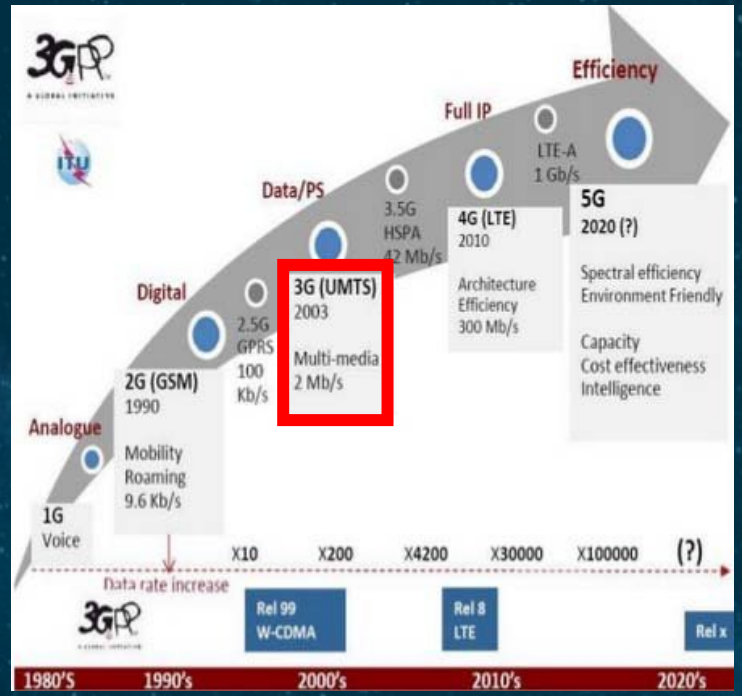


Image Credit: 3GPP

Network approach in Moonlight

IOC (Initial Operational Capabilities)

- Basic Relay Connectivity
- Pre-Scheduled contacts
- Point2Point
- Basic routing
- Limited flexibility
- DTN Compatible
- “Network trials”

FOC (Full Operational Capabilities)

- Network approach
- Routing Capabilities
- Higher Flexibility
- End-to-end native DTN/BP7v
- User Initiated Services
- Messaging Services

Next Gen

- On Demand services
- Dynamic Resource Allocation
- Automatised management
- Roaming support

Challenges ahead

- ✓ User hailing
- ✓ Signalling and control planes “always on”
- ✓ User paging, tracking and monitoring
- ✓ Dynamic resource management
- ✓ Roaming across service/network providers
- ✓ Network governance
- ✓ Mobility Management

moonlight@esa.int

Moonlight Website

Draft Service Reqs. (RFI)

Academy materials at:

➡ *https://ipnsig.org/ipnsig-academy-events/*

IPNSIG ACADEMY

Any questions to:

➡ *secretariat@ipnsig.org*

IPNSIG Academy – Program for 2022-2023

Links to recordings - https://ipnsig.org/ipnsig-academy-events/

1.	Yosuke Kaneko	**100+ Years Vision [May 18]**
2.	Vinton G. Cerf	**DTN Overview [June 1]**
3.	Oscar Garcia	**DTN Projects Work [July 13]**
4.	Scott Burleigh	**SSI Architecture Study [Aug 3]**
5.	Lara Suzuki	**DTN Live Demonstration [Sep 7]**
6.	Dave Israel	**NASA Luna Net Overview [Oct 12]**
7.	David Gomez Otero	**ESA Moonlight Overview [Nov 2]**
8.	Ed Birrane	**IETF Standardization Efforts [Dec 7]**
9.	Keith Scott	**CCSDS Standardization Efforts [Jan 4]**
10.	Laura DeNardis	**Interplanetary Internet Governance [Feb 1]**
11.	Scott Pace	**Space Policy, Perspective on IPN Governance [Mar 1]**
12.	“IPNSIG Workshop”	**Architecture and Governance of IPN [April 5]**

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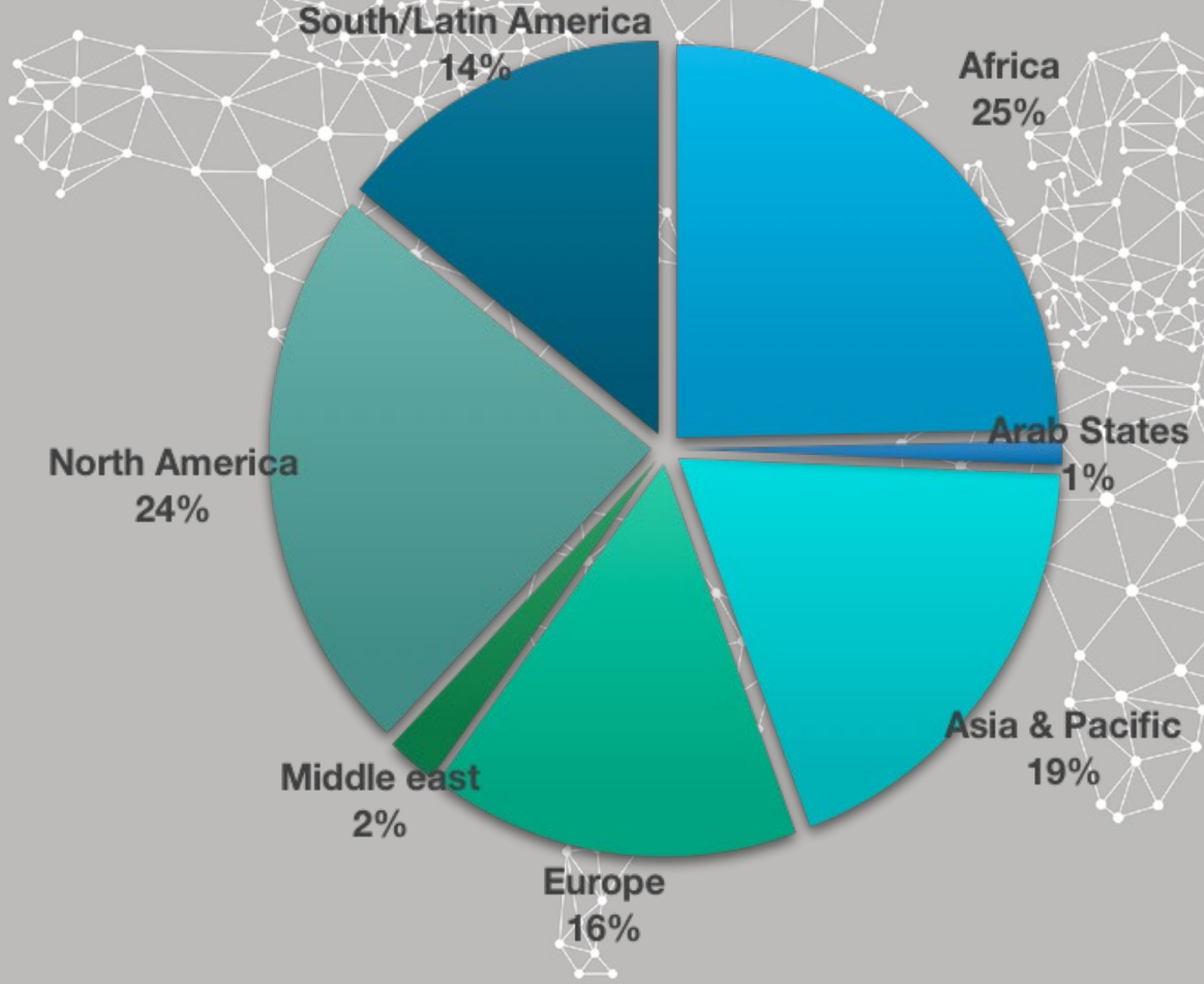

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