Addressing the Final Frontier

Navigating Geopolitics, Sanctions, and Architectural Realities in Space Networking

draft-kumari-tiptop-address-space-00

The Temptation of Architectural Purity and Celestial Prefix

Architectural Purity

Protocol designers naturally gravitate toward perfect route aggregation to minimize global Default-Free Zone (DFZ) bloat.

The "perfect" plan proposes assigning a large IPv6 block to each body and a single RIR to offer clean prefix separation and elegance.

The Cynical View

A unified, cooperative management entity in deep space would be nice, but...

Celestial bodies will be populated by competing nations, private corporations, and NGOs with varying levels of trust, making this unified architectural idealism highly impractical for actual implementation.

The Geopolitical Bug: Operational Realities of Sanctions and Routing

Terrestrial Impact

The Internet is not a neutral plane; it is actively shaped by Earth-side geopolitics. Utilizing a single Regional Internet Registry (RIR) or aggregate block for a celestial body creates a massive political choke point.

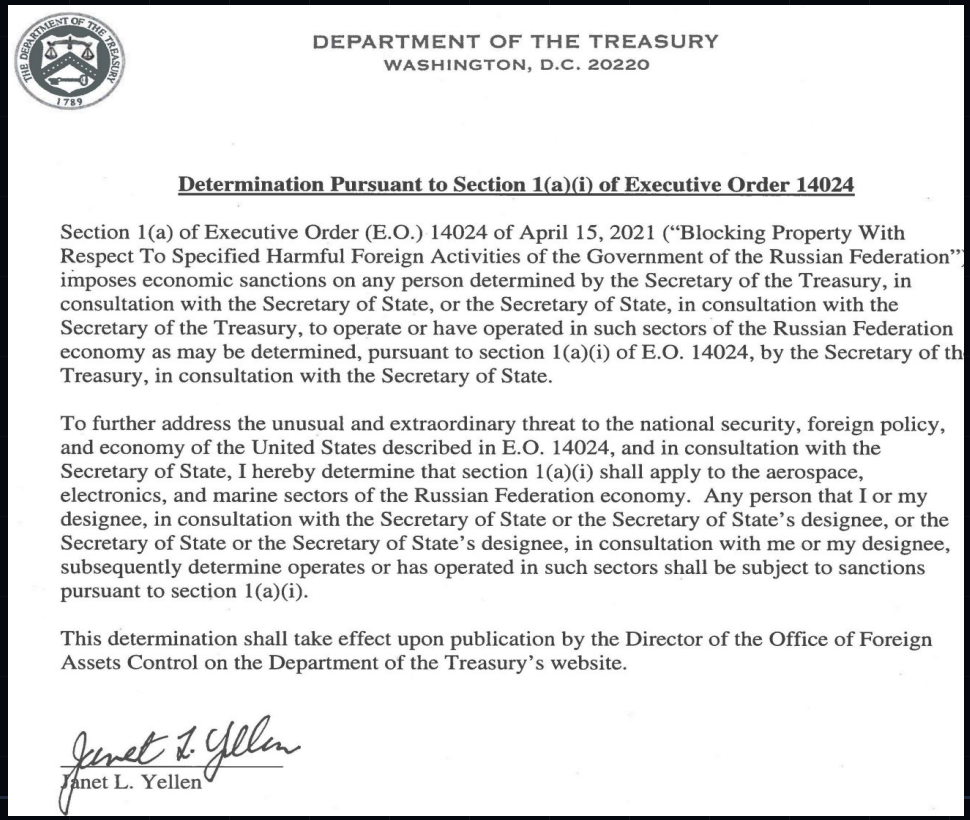
If terrestrial organizations operating space assets are in a country which is affected by sanctions, they may not be able to get resources.

⚠ **GEOPOLITICAL ROUTING RISK**

If an organization isn't able to easily get addresses for space use, they are not going to abandon their space mission - they will simply use some of their terrestrial address space.

This will break aggregation and lead to fragmentation.

US EO 14024 - US economic sanctions on Russia, esp. space, elec, marine



DEPARTMENT OF THE TREASURY
WASHINGTON, D.C. 20220

Determination Pursuant to Section 1(a)(i) of Executive Order 14024

Section 1(a) of Executive Order (E.O.) 14024 of April 15, 2021 ("Blocking Property With Respect To Specified Harmful Foreign Activities of the Government of the Russian Federation") imposes economic sanctions on any person determined by the Secretary of the Treasury, in consultation with the Secretary of State, or the Secretary of State, in consultation with the Secretary of the Treasury, to operate or have operated in such sectors of the Russian Federation economy as may be determined, pursuant to section 1(a)(i) of E.O. 14024, by the Secretary of th Treasury, in consultation with the Secretary of State.

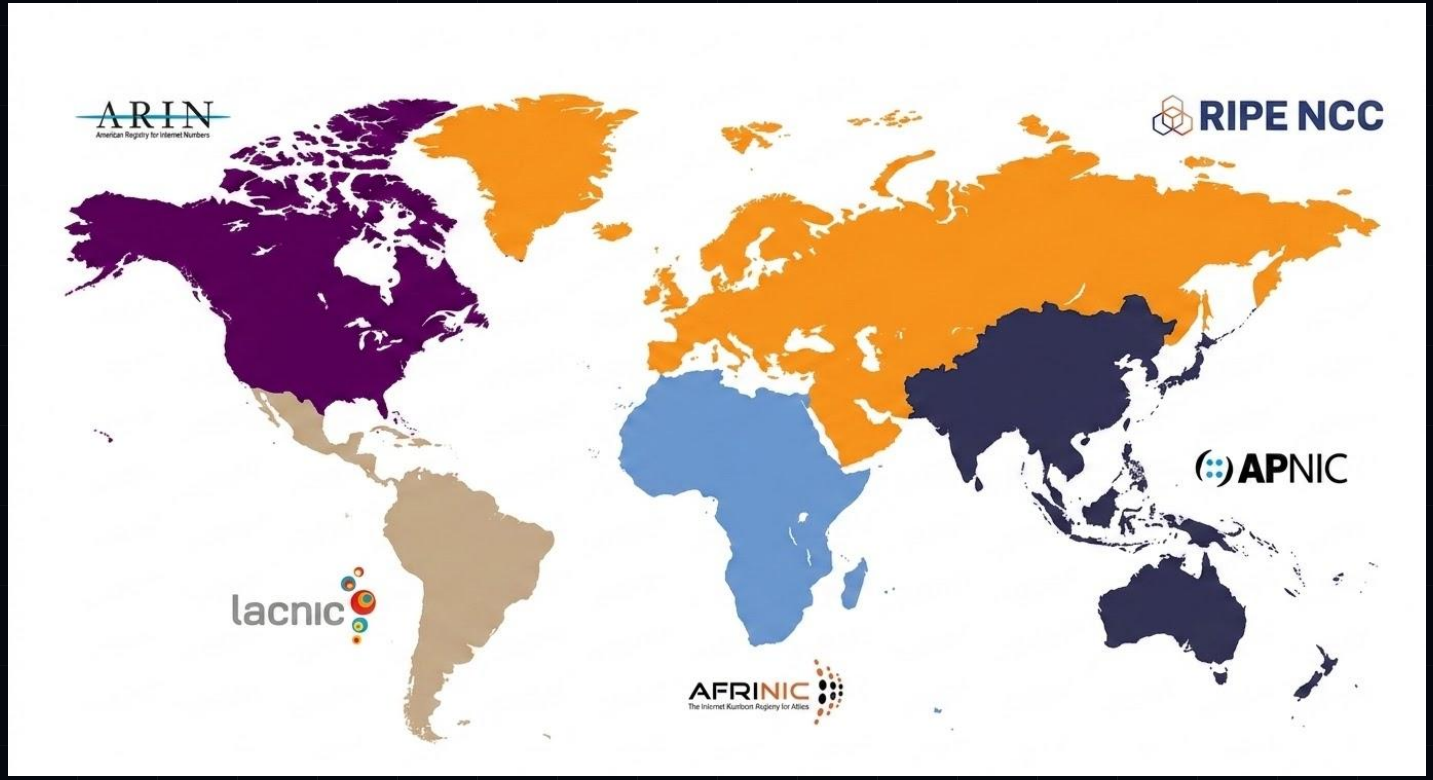
To further address the unusual and extraordinary threat to the national security, foreign policy, and economy of the United States described in E.O. 14024, and in consultation with the Secretary of State, I hereby determine that section 1(a)(i) shall apply to the aerospace, electronics, and marine sectors of the Russian Federation economy. Any person that I or my designee, in consultation with the Secretary of State or the Secretary of State's designee, or the Secretary of State or the Secretary of State's designee, in consultation with me or my designee, subsequently determine operates or has operated in such sectors shall be subject to sanctions pursuant to section 1(a)(i).

This determination shall take effect upon publication by the Director of the Office of Foreign Assets Control on the Department of the Treasury's website.

Janet L. Yellen

Link: https://ofac.treasury.gov/media/921226/download

RIR System

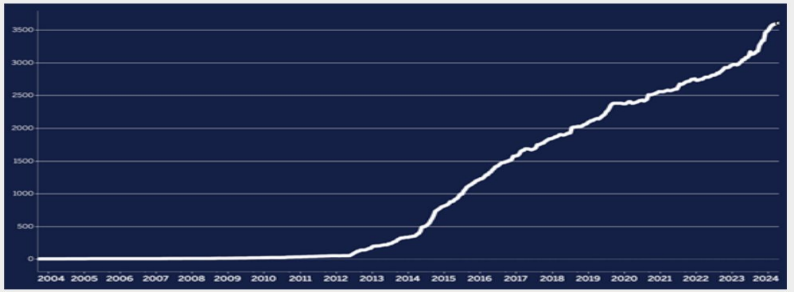

ARIN
American Registry for Internet Numbers
RIPE NCC
APNIC
lacnic
AFRINIC
The Internet Numbers Registry for Africa

RIPE

Iran - Country Statistics

IPv6

- 3604 /32 IPv6 Allocations
- Steady growth
- Does not mean announced/in use



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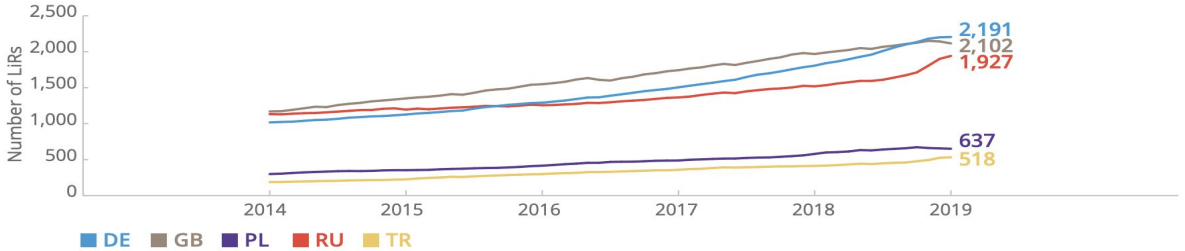


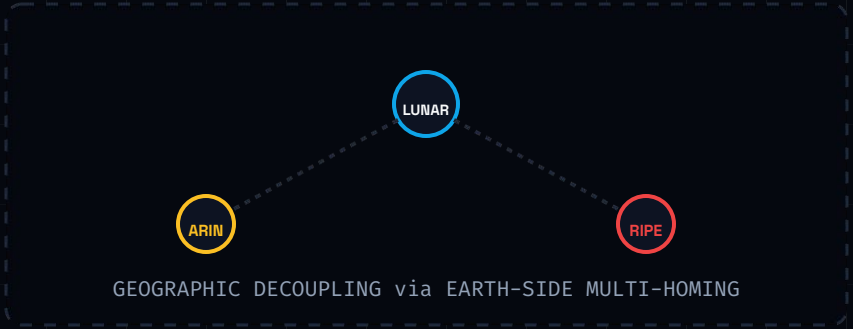
Figure 3: Growth in the number of LIR accounts registered in Russia and other selected countries from January 2014 to January 2019.

Case Study: The Russian Moonbase and Decoupling Allocation

Multi-National Lunar Routing

Consider a multi-national lunar presence featuring entities like NASA, Roscosmos, and SpaceX. Under a single "Space RIR" model, all lunar IPs share a common prefix.

Decoupling allocation from geography solves this. By multi-homing to Earth-side RIRs—where Roscosmos utilizes RIPE and NASA utilizes ARIN—we preserve existing operational and legal frameworks that terrestrial ISPs already understand and manage.




```
# BGP Announcement Simulation
> origin: AS64497 (NASA-LUNAR)
> prefix-announced: 2001:db8:a00::/48 via ARIN
> origin: AS64498 (ROSCOSMOS-LUNAR)
> prefix-announced: 2001:db8:e00::/48 via RIPE
```

Table Sizes vs. Political Neutrality

Architectural Purity - 1 RIR

A single RIR model results in ~(number of planets + 1) routes. This makes static routing simple, and is clean and elegant.

MINIMAL SIZE

ROUTING TABLE BLOAT IMPACT

Operational Reality - 5 RIR

Per-RIR model results in ~(number of planets + 1) * 5 (number of RIRs).

5 * Minimal size

OPERATIONAL OVERHEAD

Note: “# of planets” is a bit handwavey - 8? 9? 8+5+~210?

Two cases: Space is strategic, or space is commodity.

Strategic

Due to the strategic nature of space, a single RIR is at risk of being pressured to serve their host country at the expense of other countries. If there are multiple RIRs, there is no single point of capture (and even makes the risk less likely)

OPTIMAL CHOICE:

Multiple RIRs

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Space becomes a commodity

If IP in space becomes a commodity, and we want everyone to be able to access it, then we run into the same arguments that created the RIR system, including:

- Fairness
- Community
- Scaling

OPTIMAL CHOICE:

Multiple RIRs

Operational Resilience and Next Steps for TIPTOP

Authors propose trading perfect route aggregation for operational and geopolitical resilience.

01 Request the IANA allocate a large block for space use. RIRs draw from that pool.

02 Either subdivide the block by celestial body and then RIR, or by RIR then celestial body

Example

NOTE: Example addresses only

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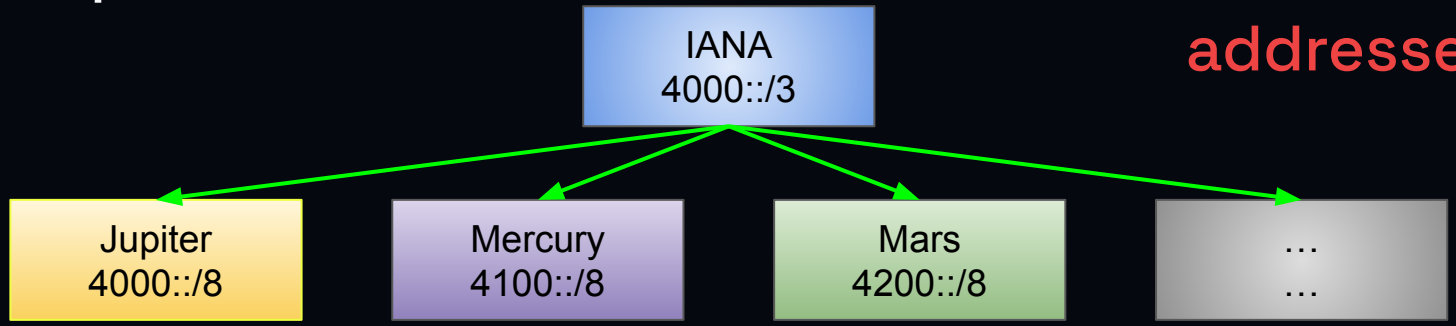

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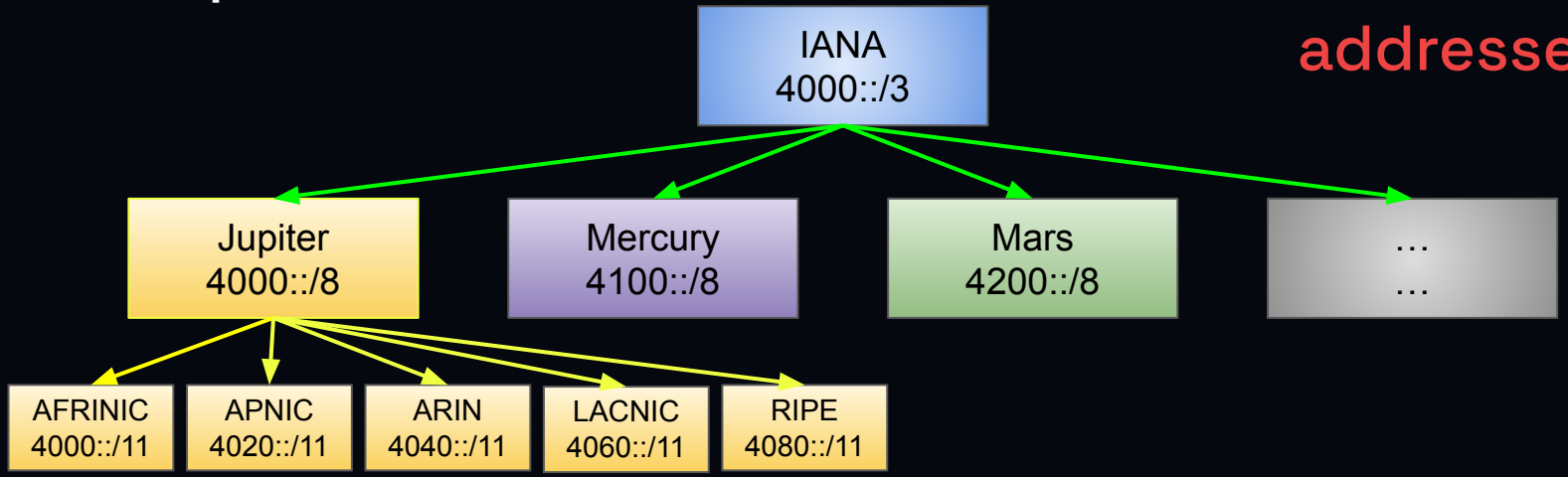

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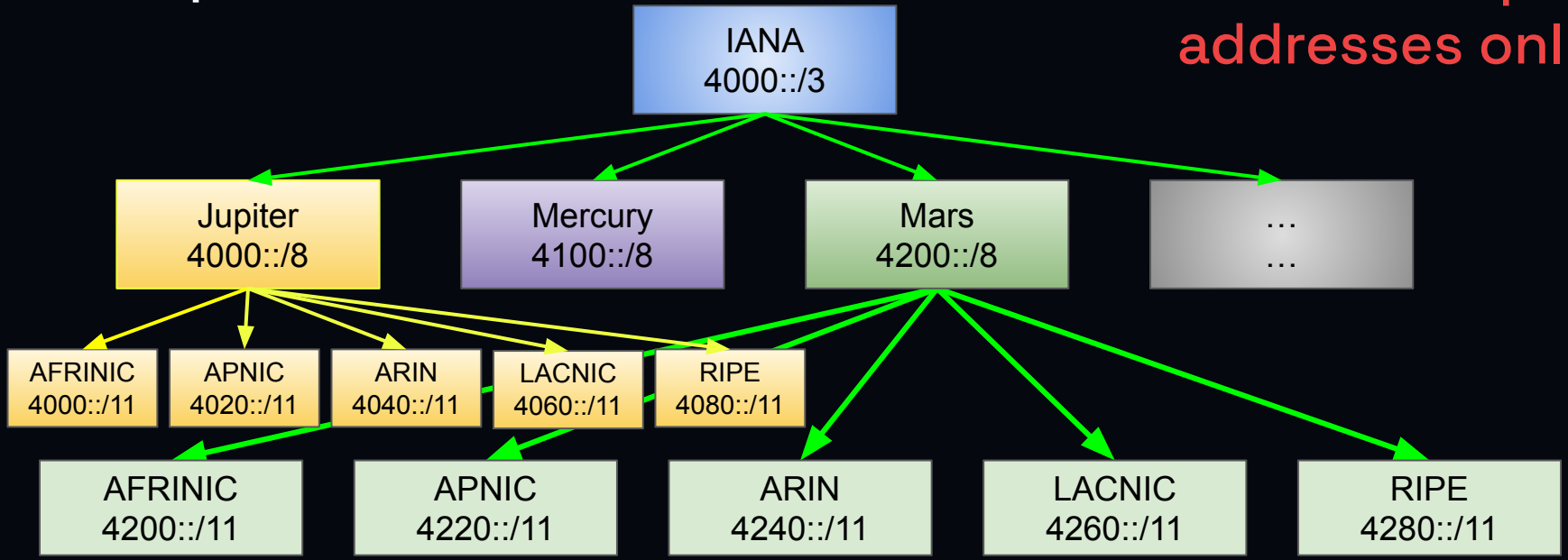

Example

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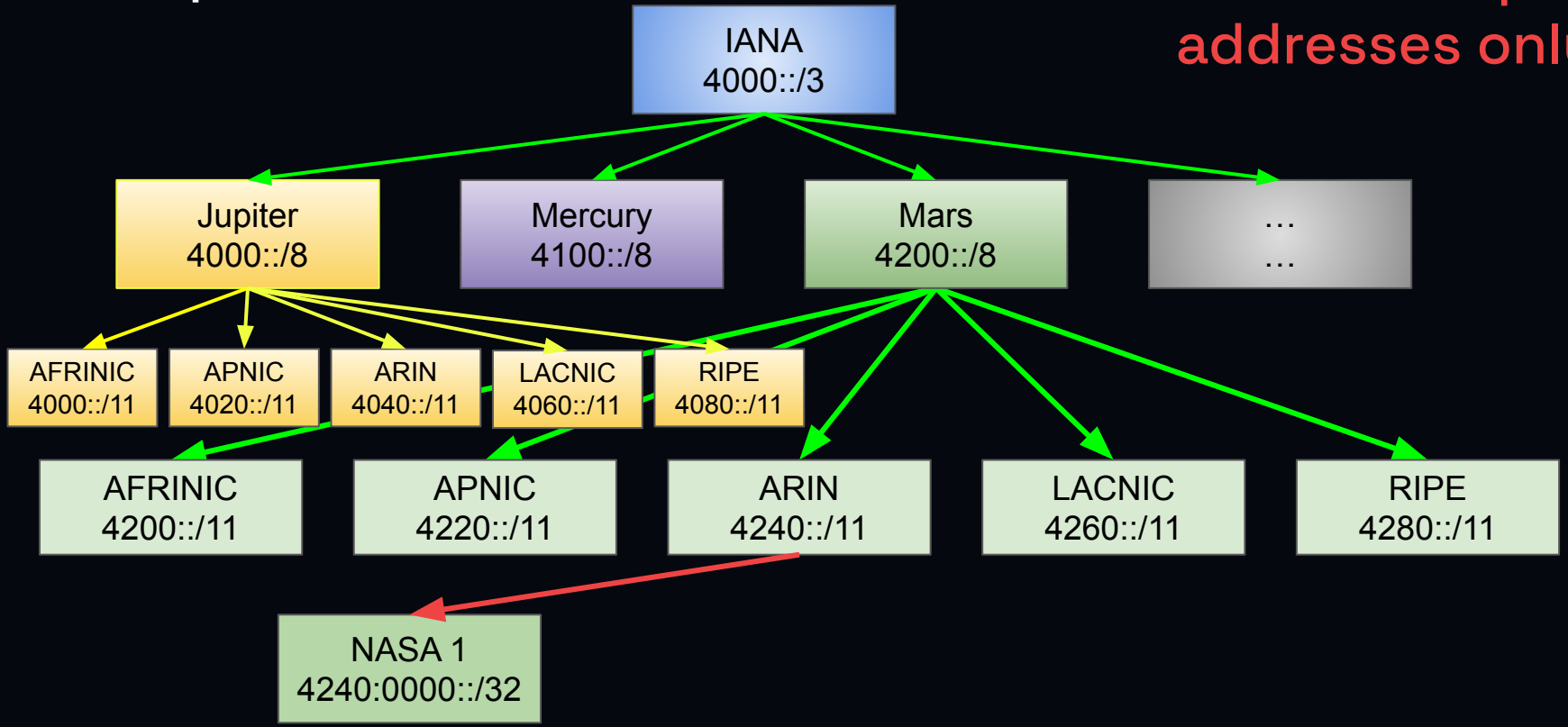

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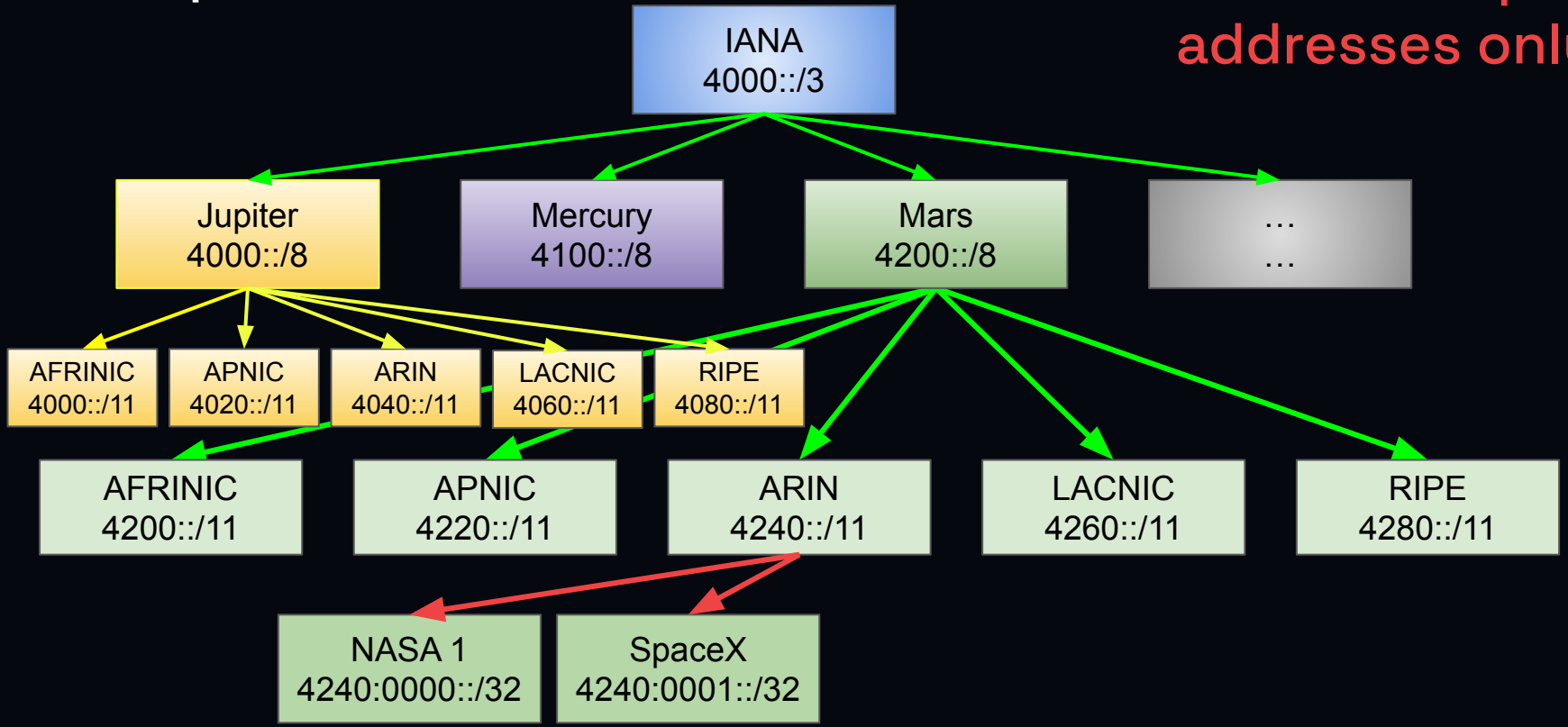

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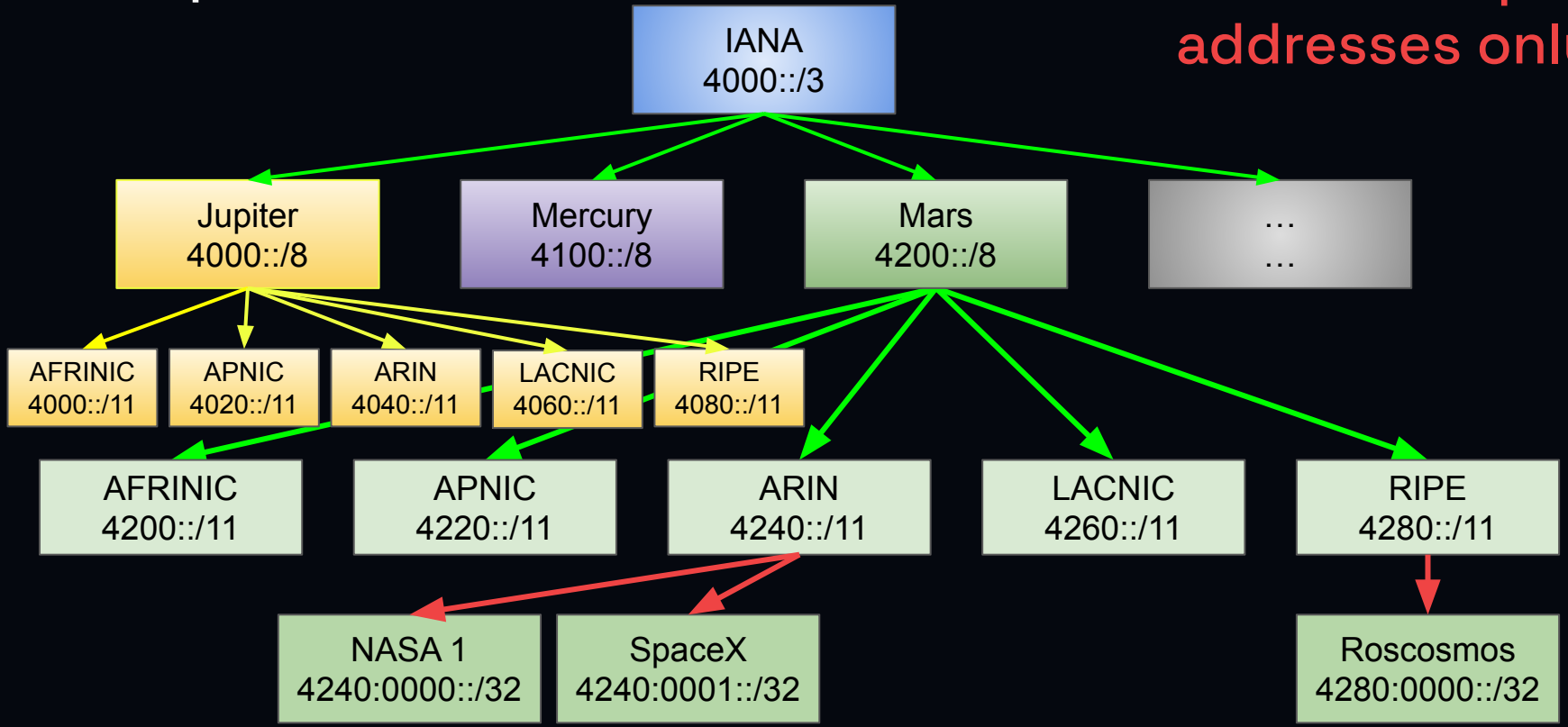

Example

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