A code for satellite constellations

draft-piraux-space-constellation-code-02

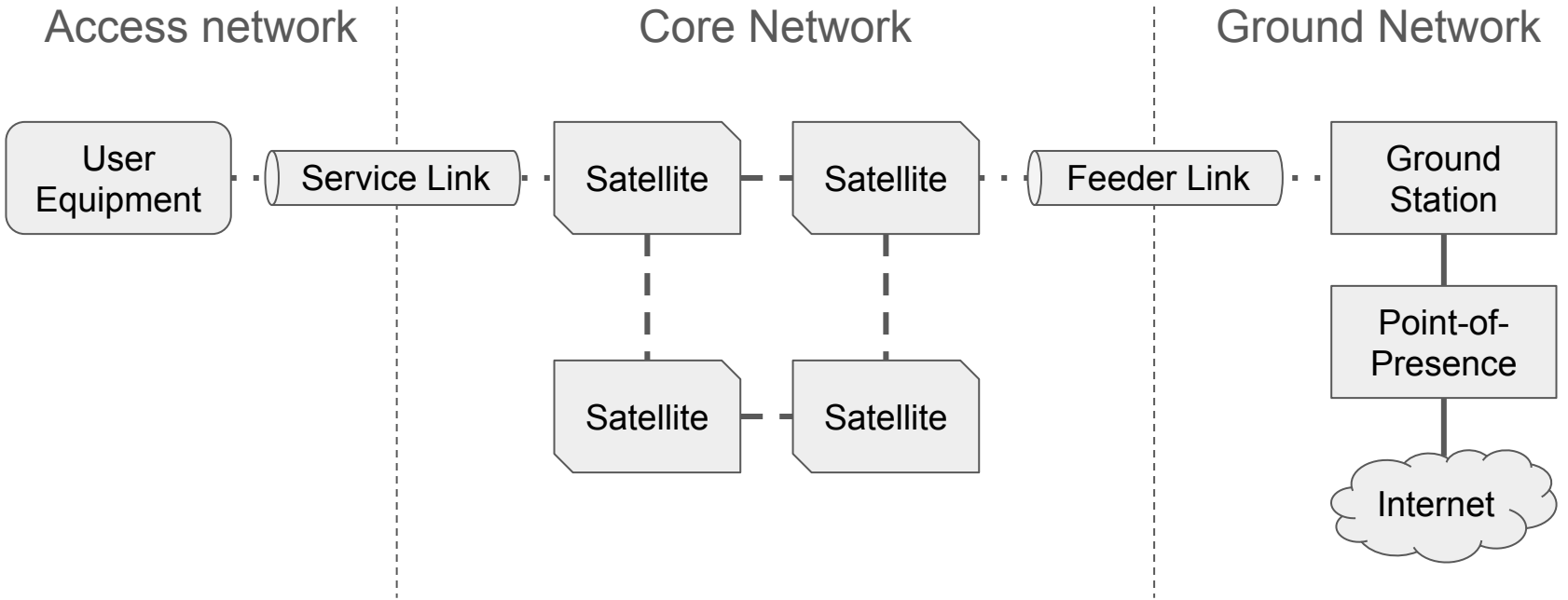
IETF 126 – SPACE RG

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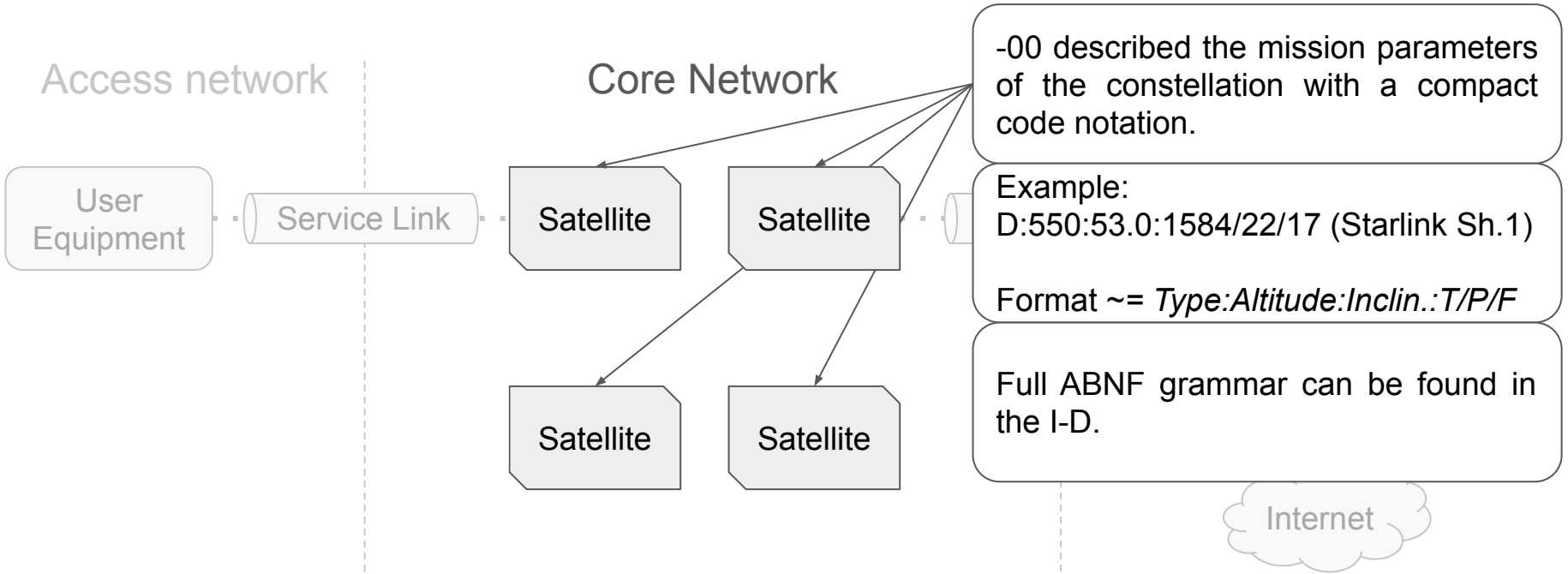
Goals

- Define a common notation to describe satellites constellations.
  - Establish reference scenarios to evaluate their architecture.
  - Helps foster reproducible research with common assumptions.
- Capture enough parameters to be relevant for current and upcoming constellations.
- Focus on Earth deployments, but simple enough to be reused for Inter-Planetary Networks (IPNs).

Satellite constellations



draft-piraux-space-constellation-code-00



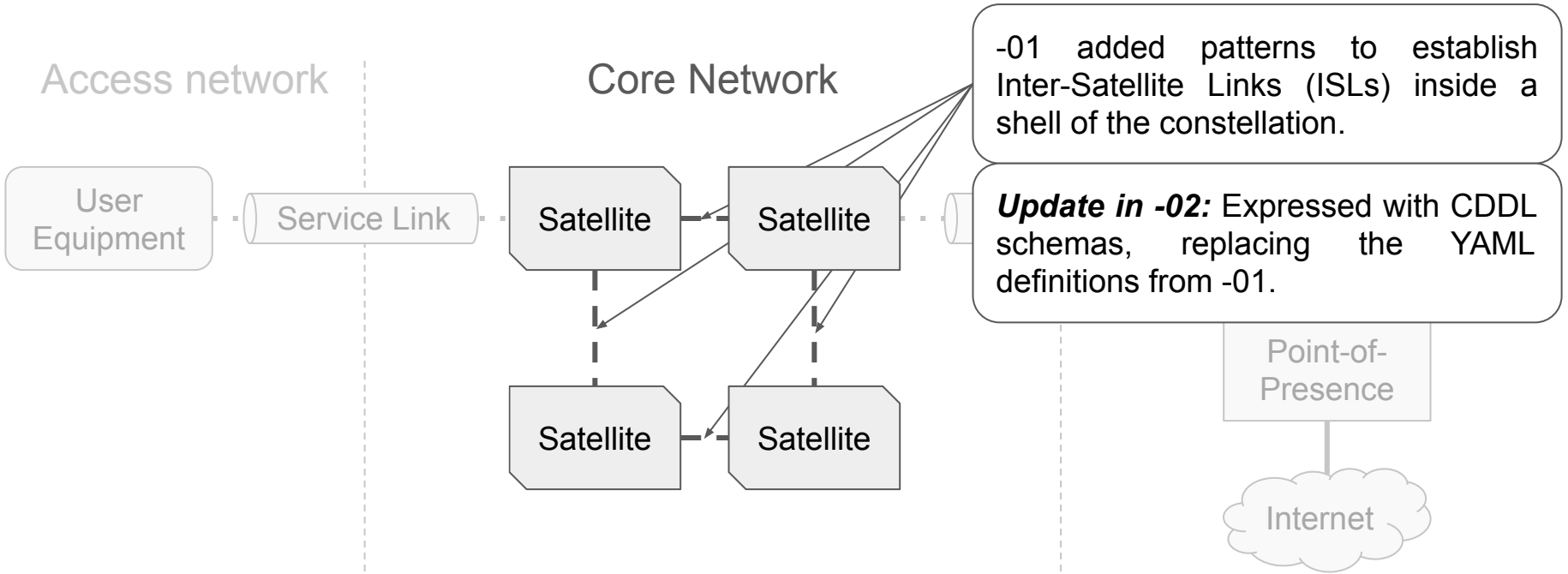
-00 described the mission parameters of the constellation with a compact code notation.

Example:
D:550:53.0:1584/22/17 (Starlink Sh.1)

Format ~= *Type:Altitude:Inclin.:T/P/F*

Full ABNF grammar can be found in the I-D.

draft-piraux-space-constellation-code-01



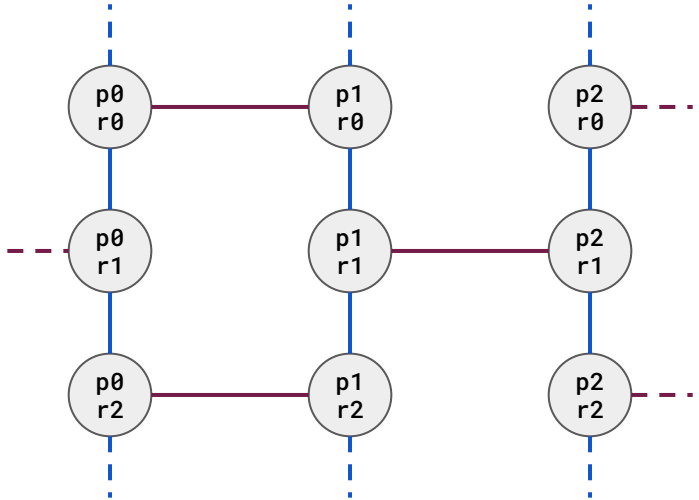
Example of link patterns

```
{
  "version":
"draft-piraux-space-constellation-code-02",
  "shells": [
    {
      "code": "D:1200:55:400/20/19",
      "link-patterns": [
        { "rank-offset": 1 },
        {
          "plane-offset": 1,
          "conditions": [
            { "eq": [
              { "mod": ["rank", 2] },
              { "mod": ["plane", 2] }
            ] }
          ]
        }
      ]
    }
...
```

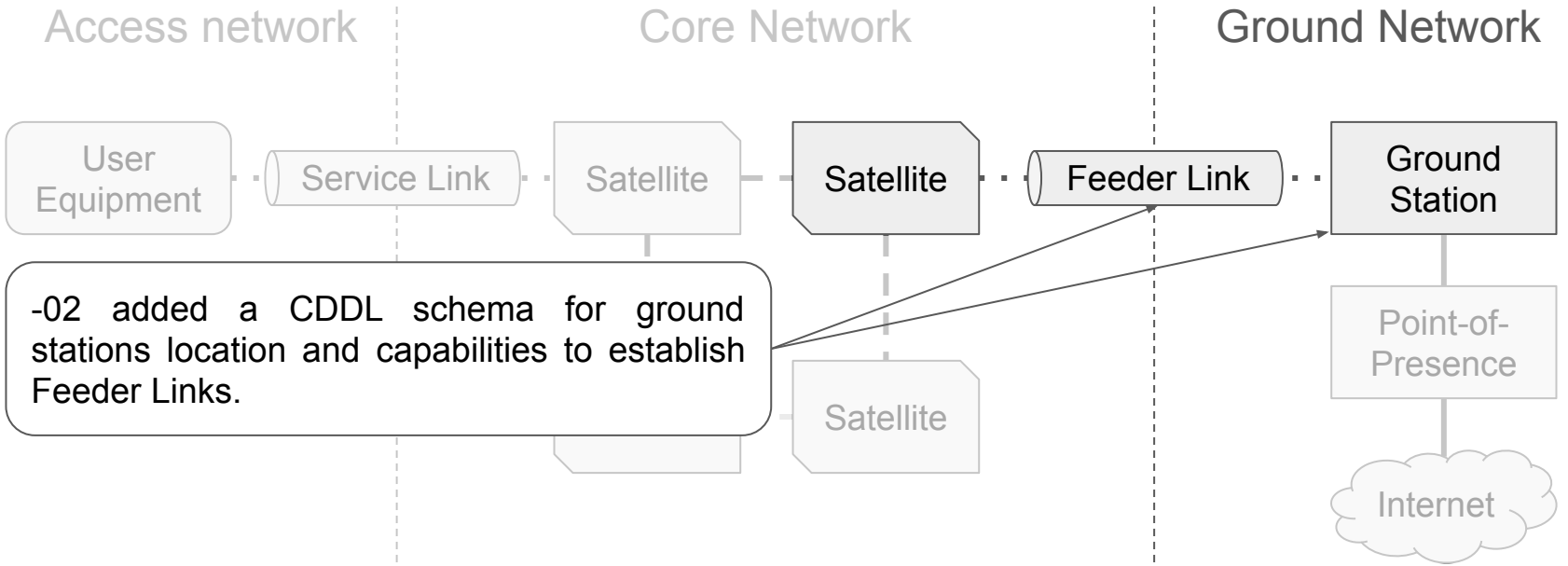
in-plane link to the next satellite

cross-plane link in a staggered pattern, e.g., when only three links are possible

rank % 2 == plane % 2

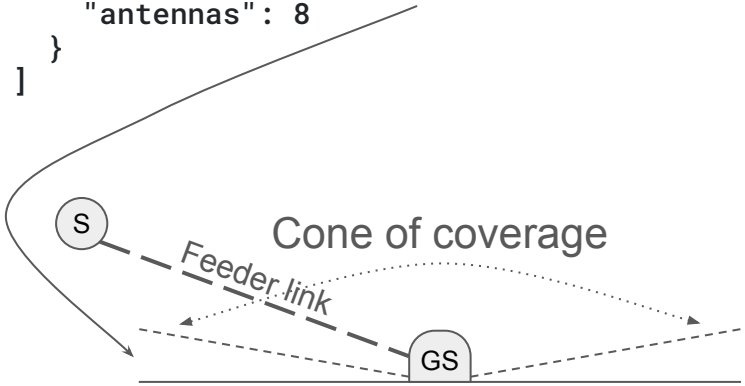


Today: draft-piraux-space-constellation-code-02



Example of ground station

```
{
  "version":
"draft-piraux-space-constellation-code-02",
  "ground-stations": [
    {
      "name": "Aerospacelab Megafactory",
      "latitude": 50.403,
      "longitude": 4.428,
      "altitude": 109.0,
      "min-elevation": 10.0,
      "antennas": 8
    }
  ]
}
```

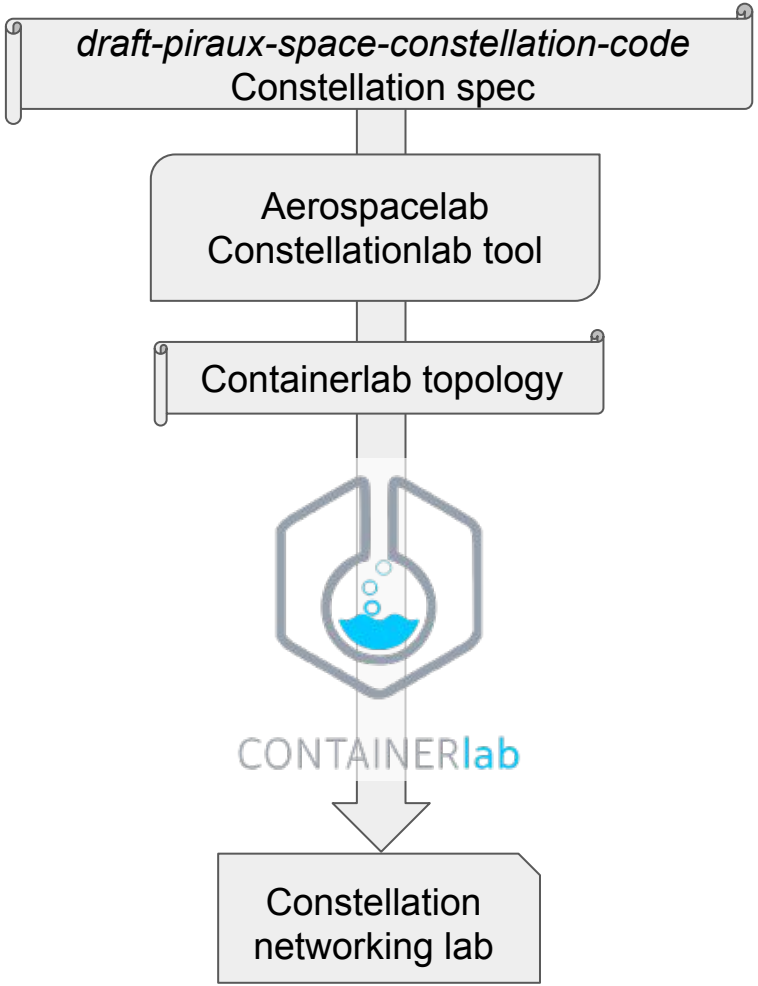


- Ground stations have a location, a minimum elevation angle and a number of antennas.
- Restriction of coverage is only in elevation, not azimuth.
- The ground station can establish up to *antennas* Feeder Links within its cone of coverage.
- Satellites are assumed to impose no further constraints.

Tools

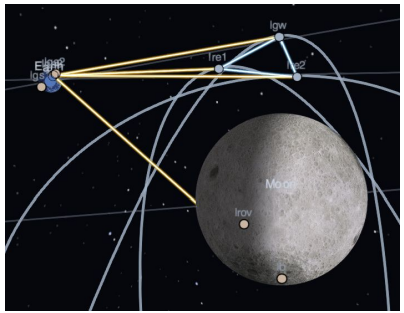
Tools – ASL Constellationlab

- Generate a networking lab from a constellation.
- Compute the ISLs and Feeder Links active at any time, and their one-way delay.
- Emulate real networking stacks over constellation topologies.
- Study how protocol implementations react to these networks.



Tools – Contact Plan Designer

- Open-source **contact plan computation and design** (MIT, Python + web).
  - Available on-line: https://contact-plan-designer.space/
- Runs the I-D end to end
- Pre-loaded Draft's examples
- Composable to deep space

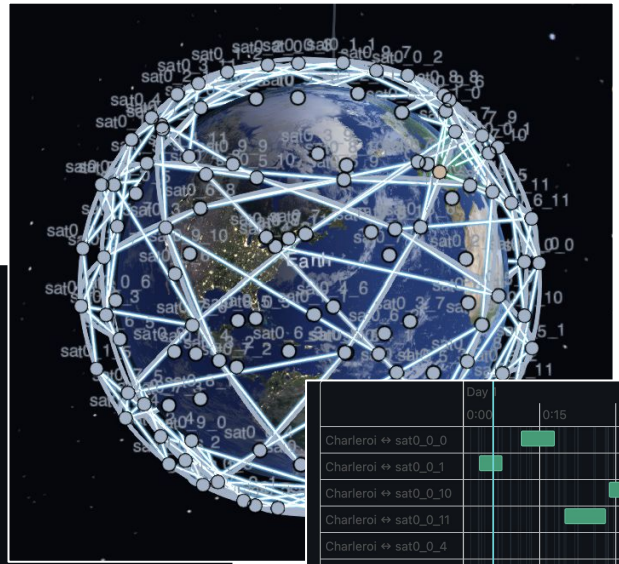


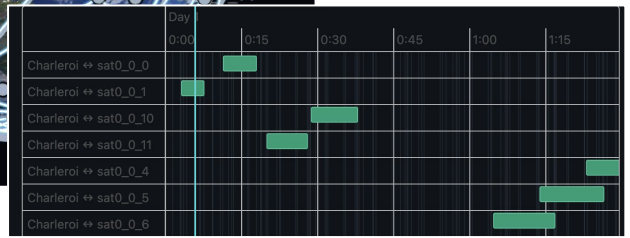
code02_cislunar

CCSDS reference scenarios

code02_one_shell

```
constellations:
  - code: "D:1200:55:120/10/9"
    central-body: Earth
    base-id: 100
    name-prefix: sat
    data-rate-bps: 9600
    max-interfaces: 4
    link-patterns:
      - rank-offset: 1
      - plane-offset: 1
        conditions:
          - eq: [{mod: [rank, 2]}, {mod: [plane, 2]}]
```





Compute
↓
Visualize
↓
Design
↓
Export

Conclusion

- Future work – Describe more capabilities? Staying generic but relevant:
  - RF Link budget for Feeder Links
  - Optical head capabilities
- Use the code in your tools and give feedback!
- I-D repo is at https://github.com/mpiraux/draft-piraux-space-constellation-code
- Discuss on the list & propose your ideas as PR.