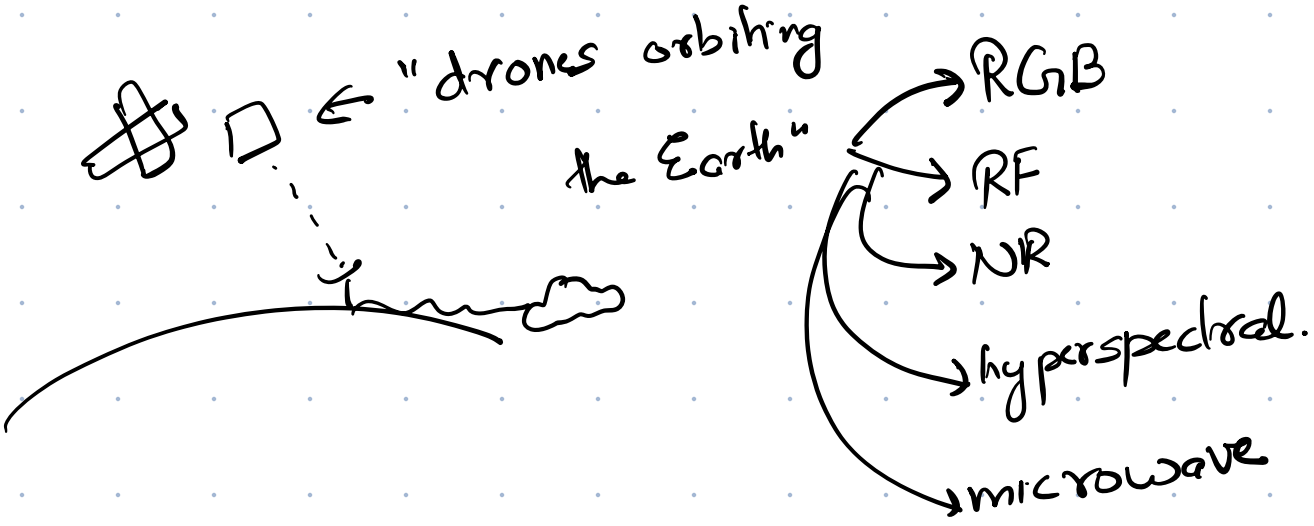
CS 598 WSI, LECTURE 25

- Earth observation
- Impact of orbits
- Data download bottleneck
- Data upload bottleneck
- Distributed Ground Design
- Future Directions.

EARTH OBSERVATION



. Through sensor / IoT

sensors → picosats → ground stations → cloud.

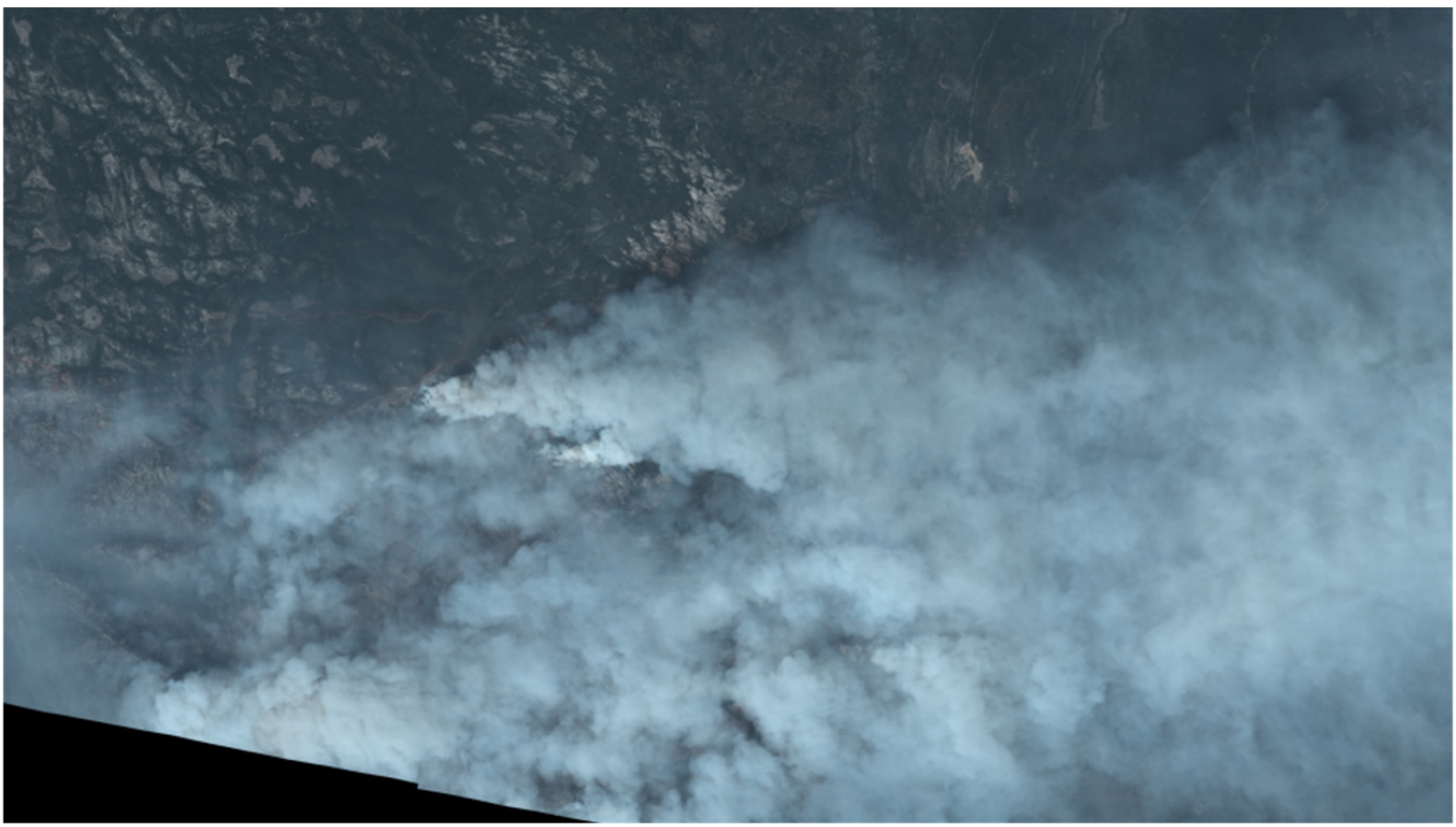
picosats

→ no-gateway.


2020
Before
Residential areas
After


2020
Portcity shopping mall


2020
Epicentr K shopping mall

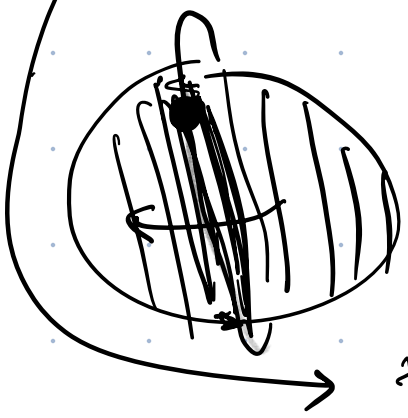


IMPACT OF ORBITS

LEO: Low Earth orbits.
(500 - 1000 Km above Earth surface)

Pros for Earth Imaging.

- high-resolution.
  ~ 1 pixel per m²
- "Scanning" orbit.
  over 10-12 days.
- low launch costs.



Con
- Low coverage

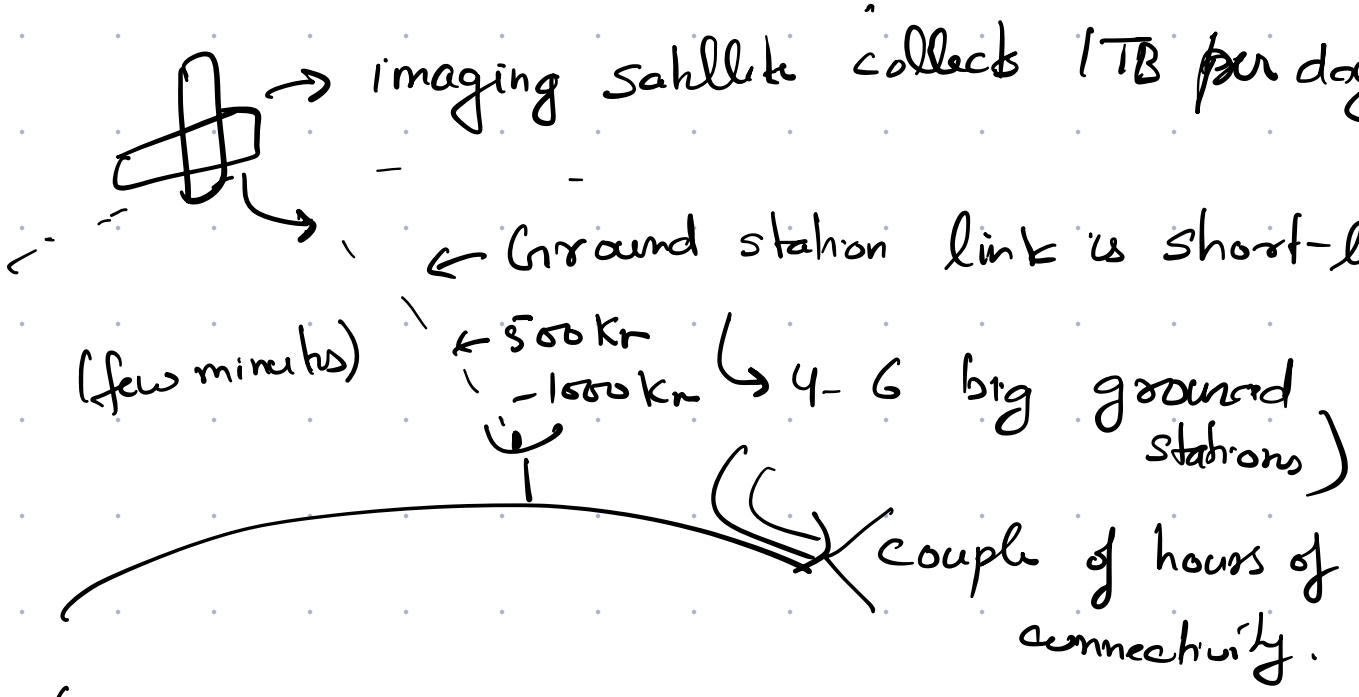
Planet Dove [200 satellites]

Benefits of LEO for IoT

- low-latency
- signal strength / power → battery life.
- with one satellite, you can get some data collection.

X more satellites

DATA DOWNLOAD BOTTLENECKS

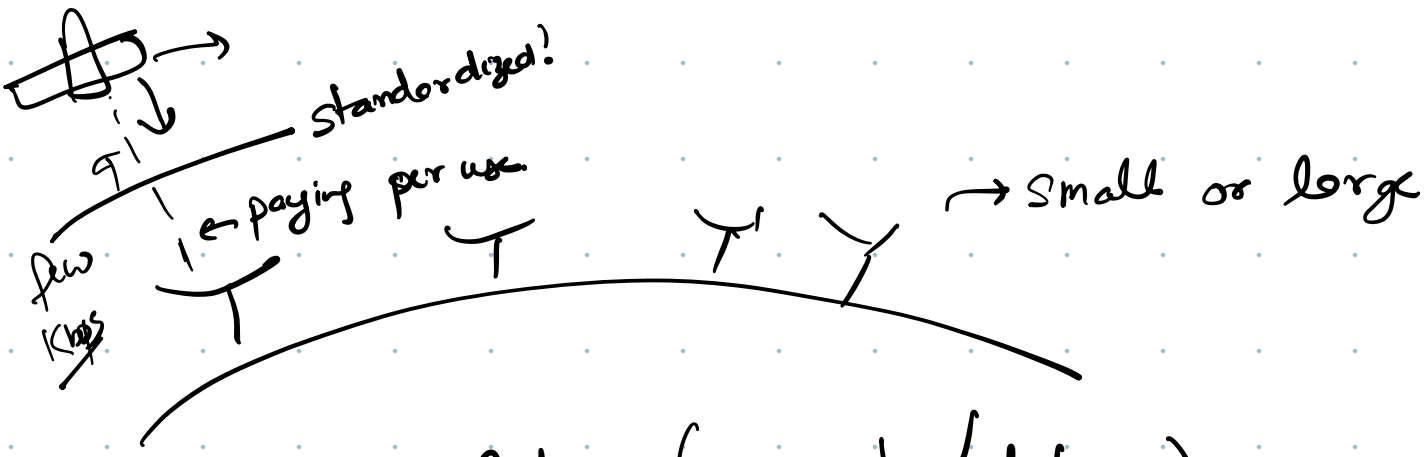


Why not deploy more GS?

- expensive
- licensing to transmit
- under-utilized.

DISTRIBUTED GROUND DESIGN

Ground-station-as-a-service (Azure AWS)



→ Low latency (minutes / dd hours)

→ Better utilization.

→ More cost-effective for constellation operators.

→ Better robustness.

One key challenge: Licensing

↳ "do not transmit"

hybrid: where some GS are receive only!

SCHEDULING LINKS

Graph matching problems.

- Identify/predict GS-Sat link capacity.
- Formulate as a graph by assigning weights.
- Solve maximal matching problems.

Side-note: (penalize switches)

UPLOAD PROBLEMS

← collisions

medium - access

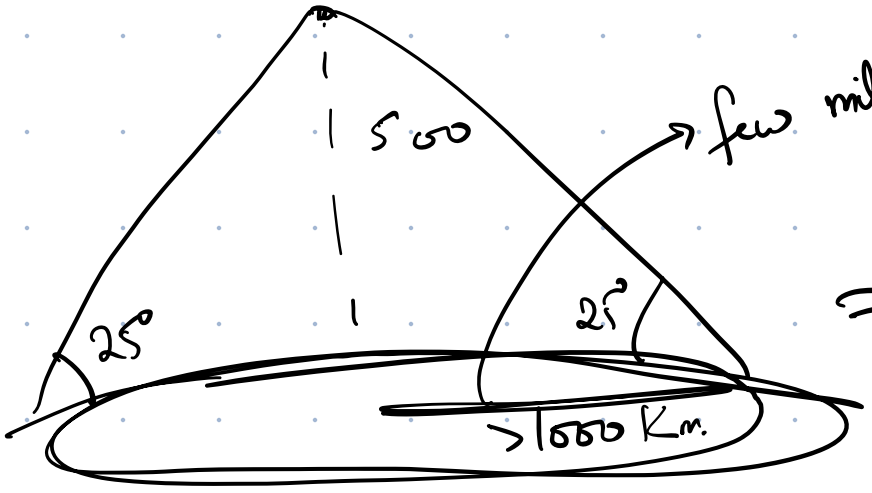
"directional beams"

⇓

broadcast medium.

- cheap
- low-power
- small

(CSMA) | TDMA/FDMA



→ few million sq. Km

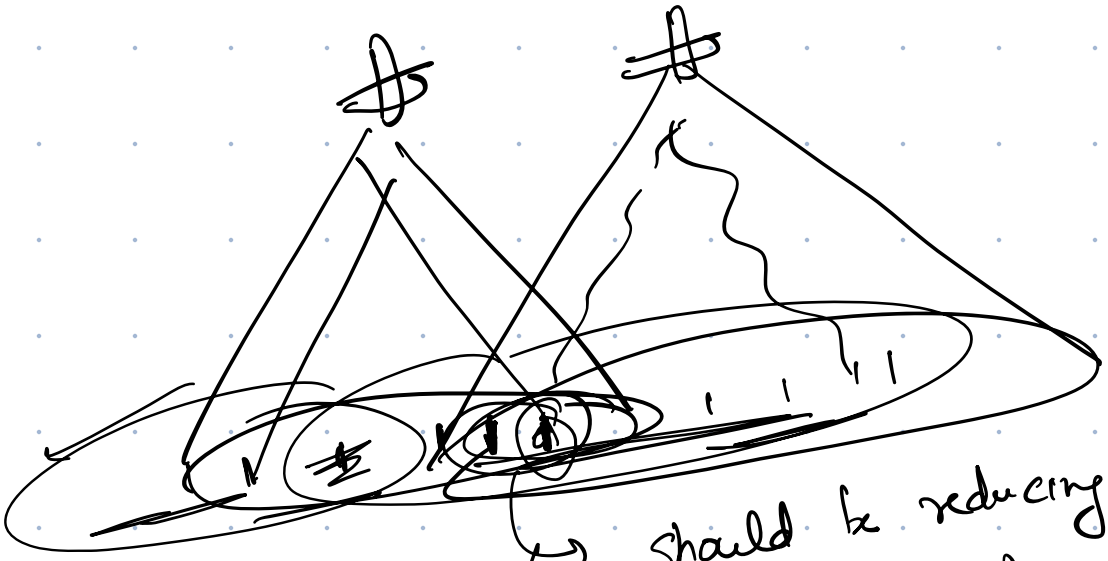
⇒ random access

ALOHA

(37%) if $p = \frac{1}{N}$.

$p << \frac{1}{N}$

OVERLAP AND MEDIUM ACCESS



should be reducing their transmissions

by how much?

is this unfair?

FUTURE DIRECTIONS

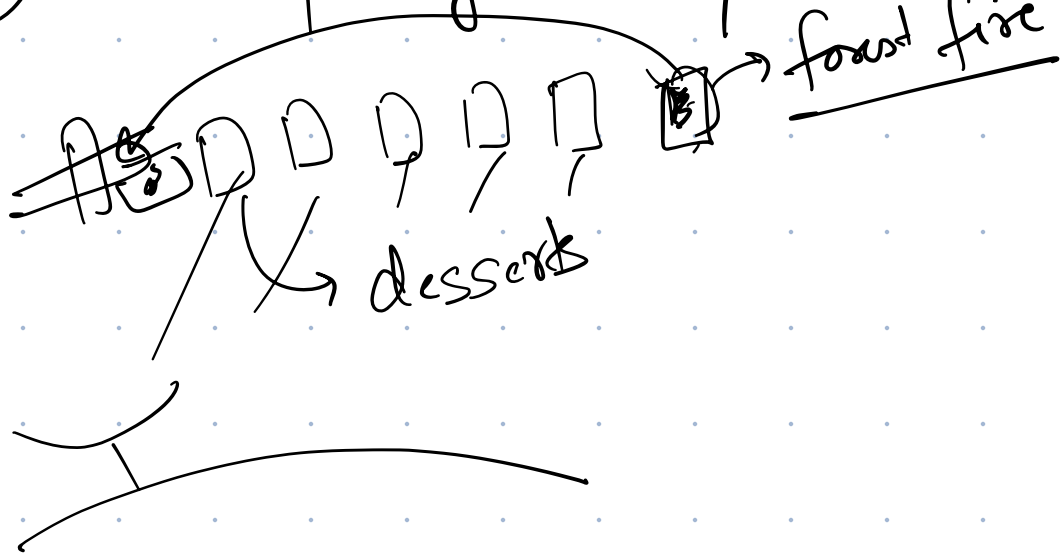
→ D2C
→ Edge.

① Direct-to-cell connectivity.

10 Mbps download from satellite to cell.

- Doppler shift.
- Medium access
- handover.

② Computing in space.



Datacenter in space

Cache in space.