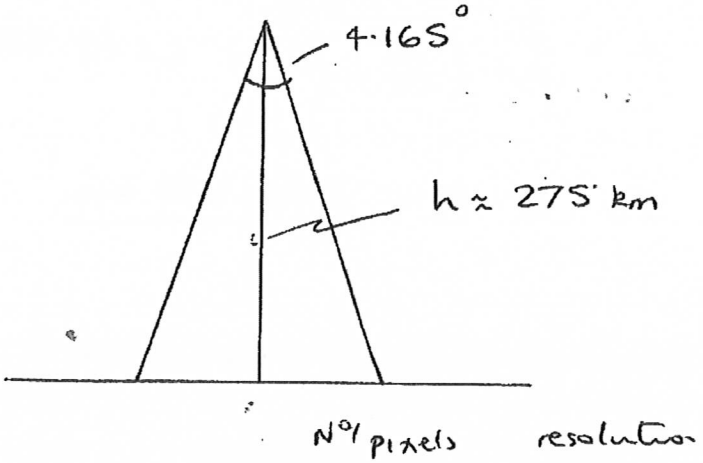
2 SURVEILLANCE SATELLITE

(i) Swath width



N° pixels resolution

Q Swath-width = 20,000 × (1m) = 20 km.

(ii) **Q** Do we want complete ground coverage ?

↳ Compute n:

$$\frac{2\pi R_E}{n} = 0.9 \times \text{swath} = 18 \text{ km}.$$

$$\Rightarrow n = \frac{2\pi R_E}{18} \approx 2226 \text{ orbits !}$$

@ 275 km, orbit period $\tau \approx 5400$ s.

Q How many days ?

$$\tau = \frac{m}{n} 86{,}400$$

$$\Rightarrow m = \frac{n\tau}{86{,}400} \cong 139 \text{ days.}$$

(ii) Continued

$$(n, m) = (2226, 139), \quad \tau = \frac{139}{2226} 86400 = 5395.148 \text{ sec.}$$

using $$a = \left\{ \mu \left(\frac{\tau}{2\pi} \right)^2 \right\}^{1/3} = 6648.568 \text{ km}$$

$$h = a - R_E = \underline{270.568 \text{ km.}}$$

(iii) Do we want sun-synchronous orbit?

inclination $$\cos i = \dot{\Omega} a^{3.5} / (-2.0647 \times 10^{14})$$

where $$\dot{\Omega} = \frac{360^\circ}{365.25 \text{ days}} = 0.986^\circ/\text{day}$$

use $$a = 275 + 6378 = 6653 \text{ km.}$$

$$\Rightarrow \underline{i = 96.587^\circ}$$

(iv) Data rate:

$$V_{orb} = \sqrt{\frac{\mu}{6653}} = 7.7403 \text{ km/s}$$

$$V_{gd} = V_{orb} \frac{R_E}{a} = 7.4204 \text{ km/s}$$

sampling time = time to advance 1m on ground

$$t_s = \frac{1}{7420.4} = \underline{0.000135 \text{ sec.}}$$

(iv) Continued : Q How long can we operate the instrument if we have 360 Gbyte storage on-board?

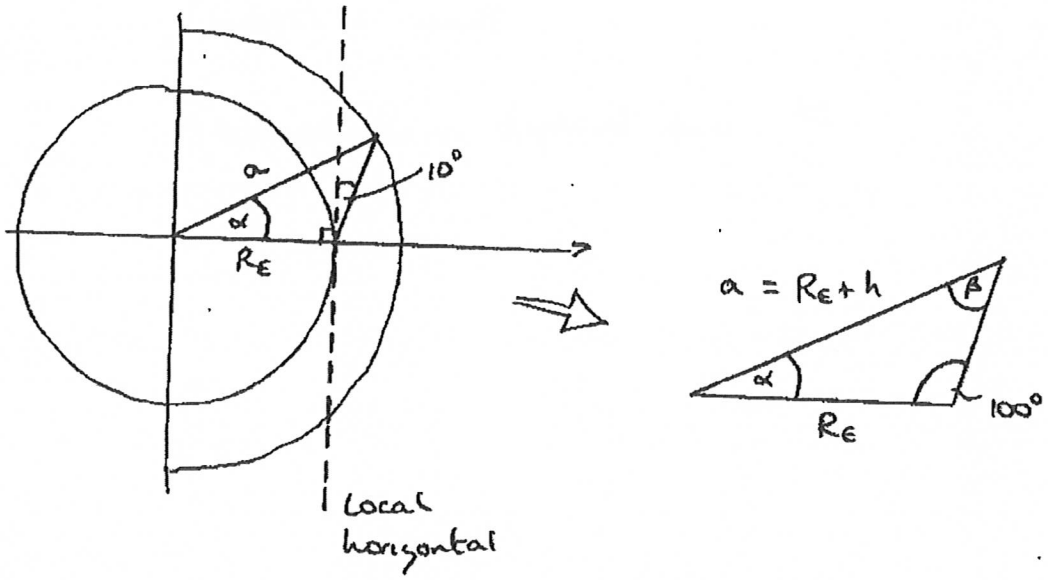
Every t_s seconds, 20,000 CCD elements are read as 7-bit words

$$R_b = \frac{20000(7)}{0.000135} = \underline{\underline{1.039 \cdot \text{Gbps}}} \; !$$

If we use a 360 Gbyte solid state memory device, how many minutes can we operate the instrument?

$$t_{op} = \frac{360}{1.039} = 346.54 \text{ sec} = \underline{\underline{5.78 \text{ mins}}}$$

(v) Downlink.



sine rule:

$$\frac{a}{\sin 100^\circ} = \frac{R_E}{\sin \beta} \Rightarrow \beta = \sin^{-1}\left\{\frac{6378}{6653}\sin 100^\circ\right\}$$

$$\beta = 70.752^\circ$$

$$\alpha = 180 - 100 - \beta = \underline{9.2479^\circ}$$

Ground station 'in sight' for $\frac{\alpha}{180°}\tau$ = 277.4 sec

= 4.624 mins

Q: How do we get the data from the satellite to the ground?

- assume groundstation data rate = 50 Mb/s

- Use data relay satellite in GEO.

e.g. ESA European Data Relay Satellite (EDRS) system

e.g. US Tracking and Data Relay Satellite System (TDRSS)

Mass = 2100 kg
Power = 1700 W

▷ link budget is complicated!