Lecture 21

PRINCIPLES OF SATELLITE COMMUNICATION

INTRODUCTION

a)Transmission at frequencies in 10^{14}

b)Advantage

- Greater bandwidth
- Smaller beam divergence angles
- Smaller antennas

c)Modes of communication

- Aerial
- Fiber optical communication
- Optical computer

ARIEL

- Ariel :data and images are transferred using low power beams
- Impossible to jam by known means
- Weather dependent
- Clear day – several miles
- Rain ,fog ,mist -- limited to shorter distance

Fiber optical communication& optical computers

- Guided media
- 4 Giga bits of information/sec over a span of 120Km

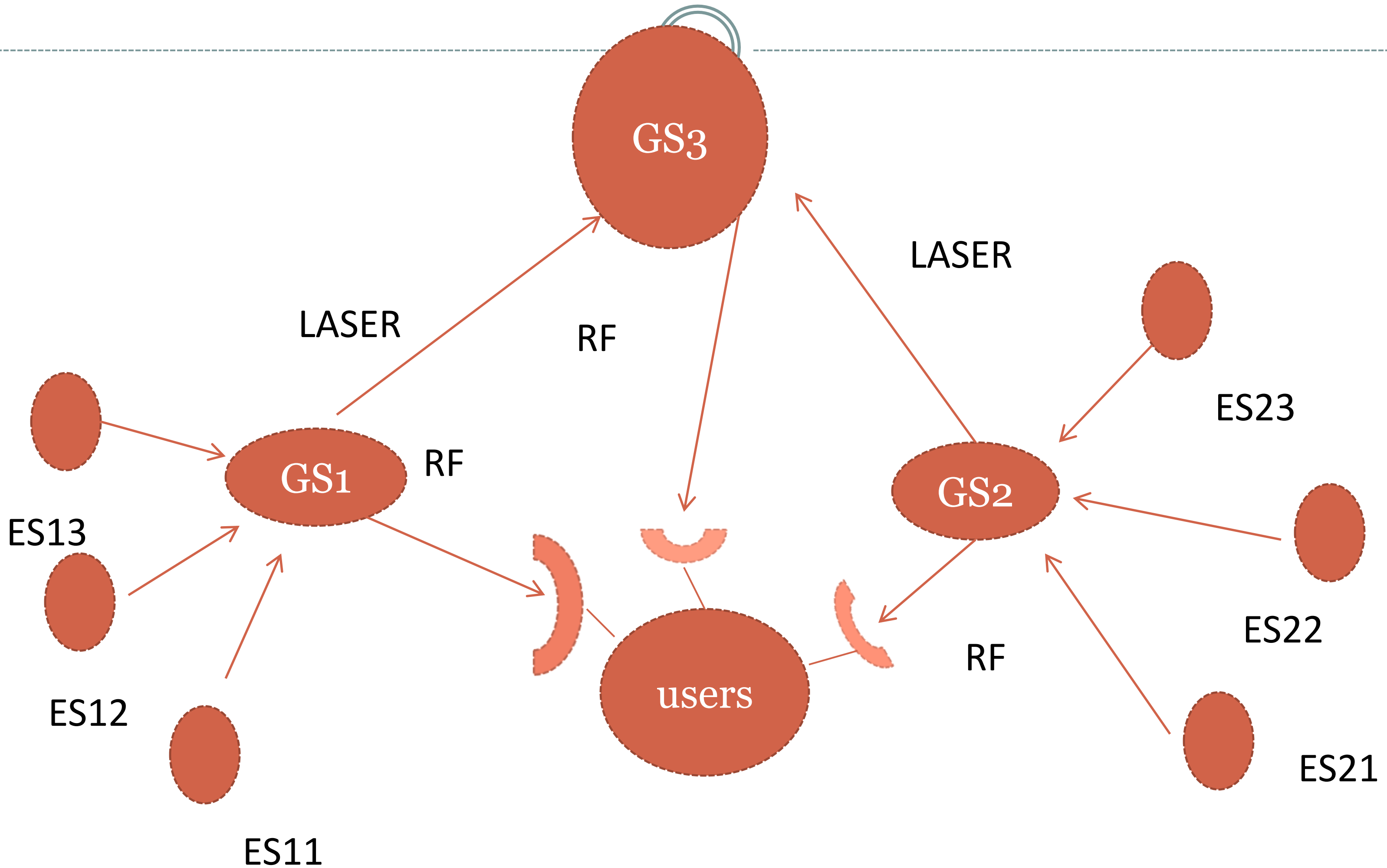
Optical computers

I. Light is used instead of electrical circuit
II. Light can be encoded with much more information
III. Zero resistance to flow ,more information than the equivalent sized electric circuit
IV. Optical signal can be used in parallel

Use

- Communication between the satellite themselves
- Can not be used between earth station and geostationary satellite being atmospheric dependent

LASER SATELLITE COMMUNICATION



GSS =GEAOSTATIONARY SATELLITE

ESS= EARTH OBSERVATION SATELLITE

LINK ANALYSIS
Atmospheric Effects:

- Attenuation due to energy absorption
- Beam spreading due to scattering of light waves
- Beam bending due to refocusing of optical beams
- Beam break up due to loss of coherence

ATMOSPHERIC

- Dependent on wavelength
- Dependent on elevation angle

Complete link design

- Up link and downlink RF is used to satellite
- Two satellite cross link (optical link)
- RF up link wave form

$$s(t) = u(t) + n_u(t)$$

$$u(t) = uplinkcarrier$$

$$n_u(t) = uplinkNoiseandInterference$$

$$P(t) = P_r(1+\beta s(t))$$

P_r is average power and β is intensity modulation $\beta \leq 1$

The receiving satellite receives the signal by photo detecting it

the photo detector detects the intensity modulated signal as

$$R[\beta P_r s(t)] = R\beta\beta_r[u(t) + n_u(t)]$$

R = photo detector responsitivity

P_r = satellite−downlink power

$$P_s = \alpha_s^2 P_t[(R\beta(_r)^2 P_{cu}]l$$

$$Pns = \alpha_n^2 P_t[(R\beta(_r)^2 P_{nu} + P_{PD})]L$$

α is signal and noise suppression Pns =total downlink retransmitted noise power

L is the downlink losses

Pcu is the uplinkpower of u(t)

Ppd is photo detector noise

Pnu additional noise by the down link

$$\left(C/N\right)_T = \frac{P_s}{P_{ns} + P_{nd}}$$

$$\left(C/N\right)_u = \frac{P_{cu}}{P_{nu}}$$

$$\left(C/N\right)_{op} \approx \frac{P_s}{P_{PD}}$$

$$\left(C/N\right)_r \approx \frac{LP_t\alpha^2}{P_{nd}}$$

$$\alpha_s^2 = \left[1 + \left(\frac{1}{C./N}\right)_{op}\right]^{-1}$$

$$\left(C/N\right)_T = \left[\left(C/N\right)_u^{-1} + \left(C/N\right)_{op}^{-1} + \left(C/N\right)_r^{-1}\right]$$

Satellite beam and acquisition, tracking and pointing

- Beam is narrow
- Pointing problem
- Pointing within the pointing error±θc radians
- Optical beacon(unmodulated light source)
- Transmitter satellite receives the beacon from the receiving satellite
- Transmits its modulated laser beam back to the receiving satellite
- Angle of drifting of the receiving satellite(point ahead angle)