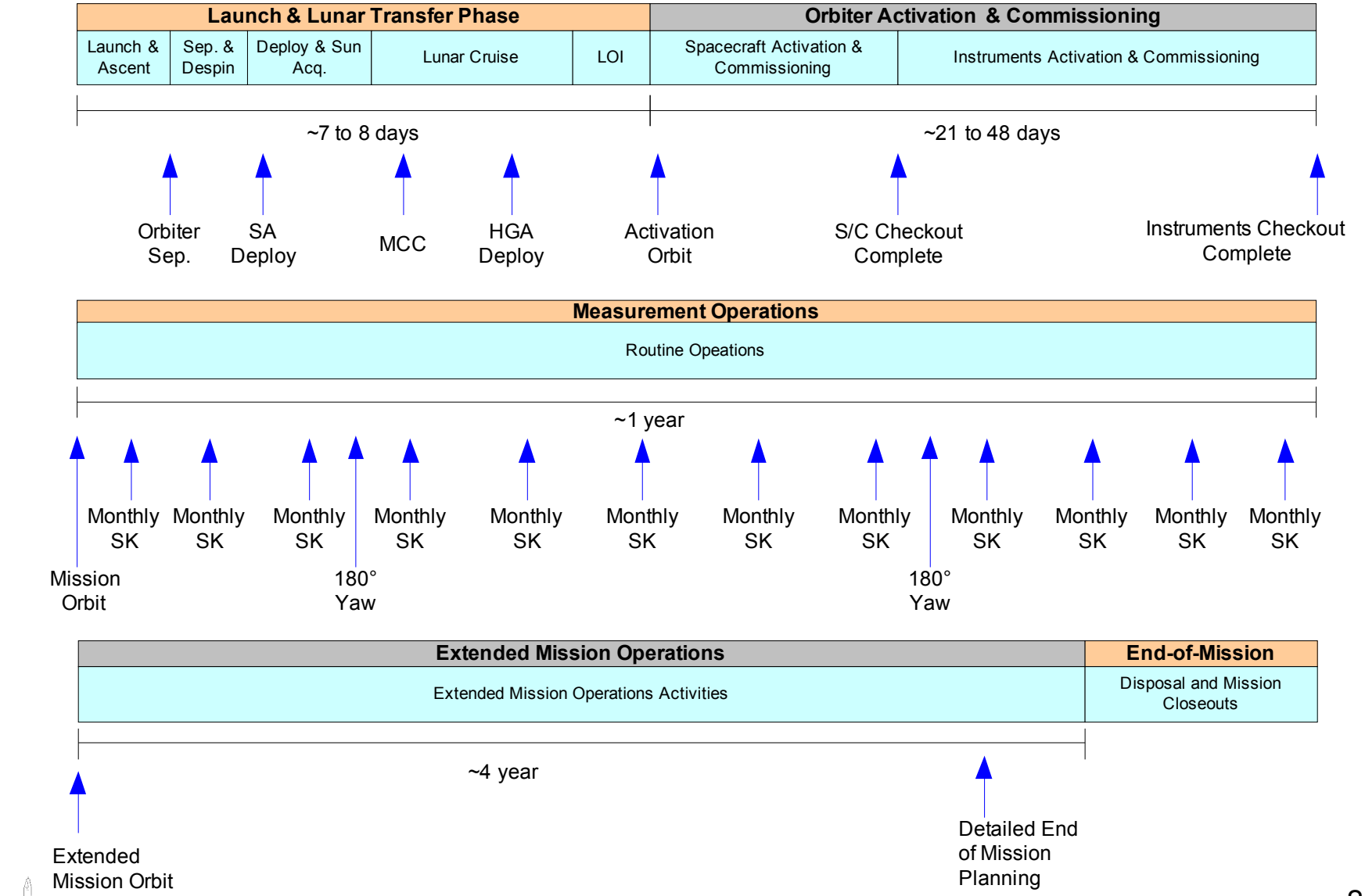
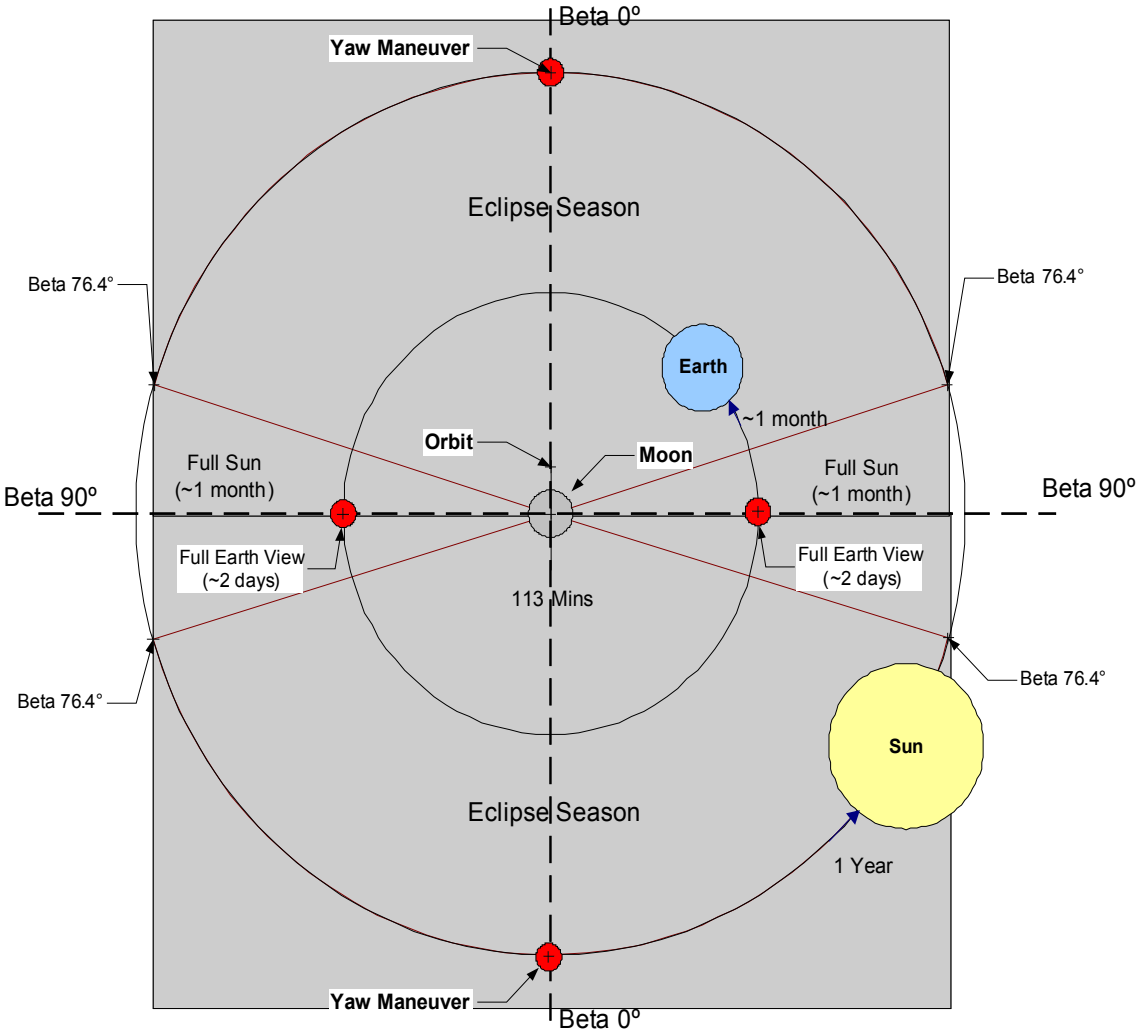
LRO Mission Operations Concept

Rick Saylor
LRO Mission Operations System Engineer

LRO Mission Timeline



LRO at the Moon

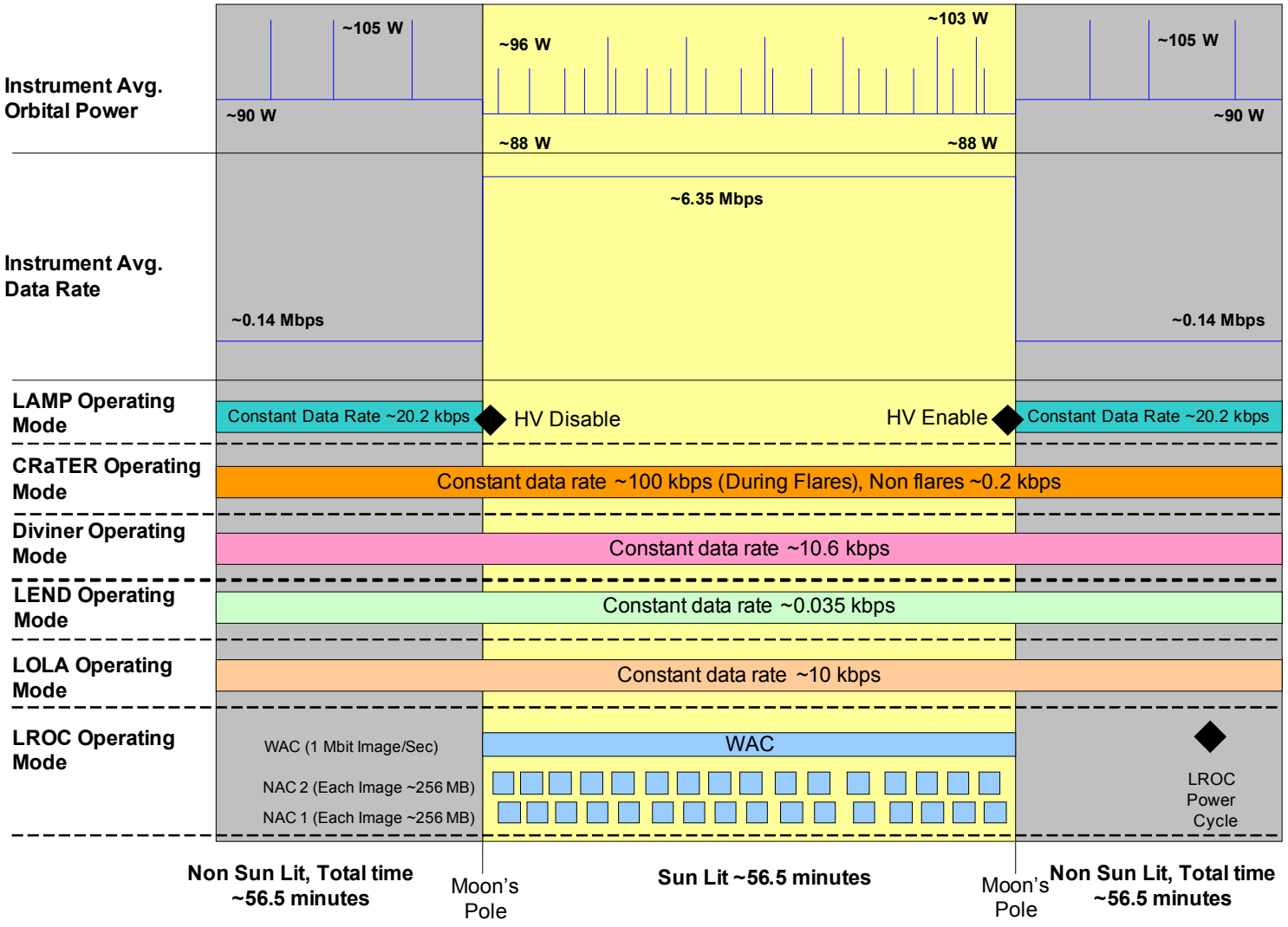


Orbit View

- Twice a year, LRO will be in full Sun for roughly 1 month (Continuous)
- Max Lunar Occultation is 48 minutes per orbit
- Twice a year, LRO will perform a yaw maneuver to keep the Sun on the correct side of the spacecraft
- Twice a month, LRO's orbit will be in full view of the Earth for a period of approximately 2 days
- Once a month, LRO will perform a set of station-keeping maneuvers (combined Delta-V & Delta-H). Maneuvers will interrupt science for 1 orbit each month (~2 hrs). Combined with monthly instrument calibrations
- Twice a year (on average) the Earth will pass between the Moon and Sun (Lunar Eclipse), interrupting science for approximately 3 orbits – Worse case (~6 hrs)

Routine Measurement Timeline

LRO Baseline Instruments Operating Modes

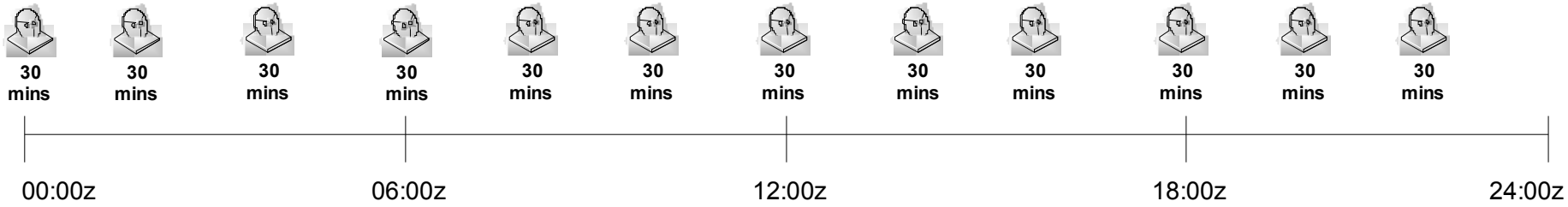


Measurement Operations

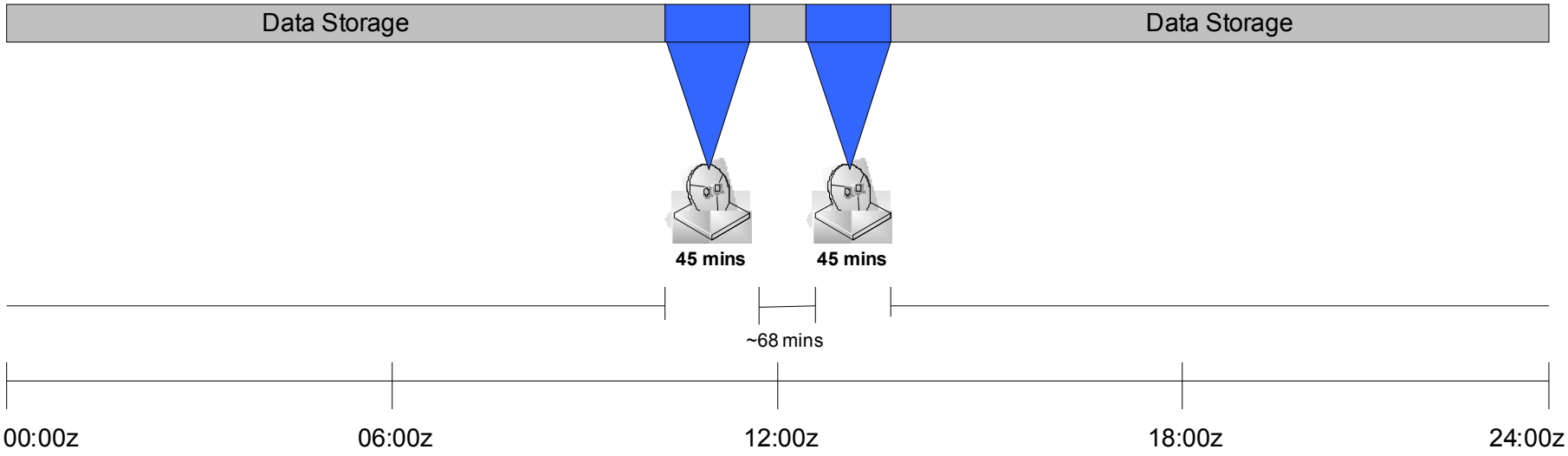
- Mission Orbit:
  - 50 km (+/- 20 km)
  - Approximately 90° lunar equatorial inclination – drifts about 0.5 °/year
  - Orbit period: 113 minutes
- Orbiter Pointing:
  - Nadir pointing to control accuracy of 60 arc-sec (3σ) per axis
  - Pointing stability (3σ per axis):
    - 5 arc-sec/axis over 1 ms
    - 10 arc-sec/axis over 100 ms
    - 20 arc-sec/axis over 4 sec
- LROC observations
  - Each NAC image takes 15 seconds to fill the camera buffer
  - Camera buffer is transferred to the spacecraft SSR in approximately 206 seconds
  - LROC observations include occasional slews
    - Slews up to 20 degrees are planned
    - Spacecraft slews are 20 seconds (allow NAC buffer to fill for image). Slew time does not take into account maneuver and settling time.
    - LROC requested 3% of the observations include slews and that the slews are evenly distributed over the year
- LAMP High Voltage is disabled during Sun-lit portion of the orbit
  - Remaining instrument components remain powered
- CRaTER peak data rate is 100 kbps during solar flares, during non flare conditions, ~0.2 bps.

Ground Network Scenario

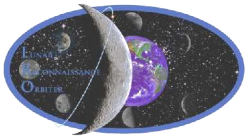
S-Band Support Scenario



Ka-Band Support Scenario



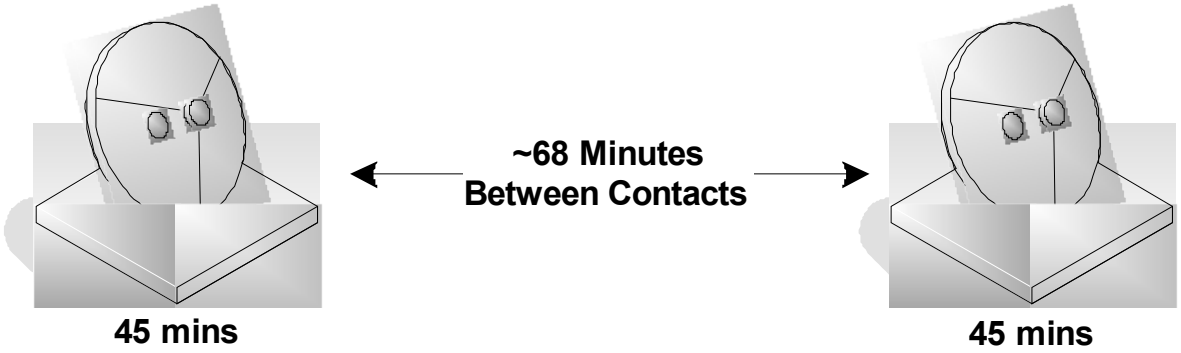
Ground Network Concepts



- S-Band supports scheduled every orbit, each contact is 30 minutes
  - Requirement to receive ~12 hrs worth of Doppler/Range tracking everyday, 30 minutes every orbit.
  - S-Band supports will overlap with Ka-Band supports to perform close loop file transfers
- Two Ka-Band supports approximately 45 minutes in duration
  - Over the two contacts, orbiter will dump the previous days worth of measurement collection
  - Margin is needed for each support to retransmits portions of the data files

Measurement Downlink Concept

1 Ka-Band Site, 2 consecutive Passes Scenario



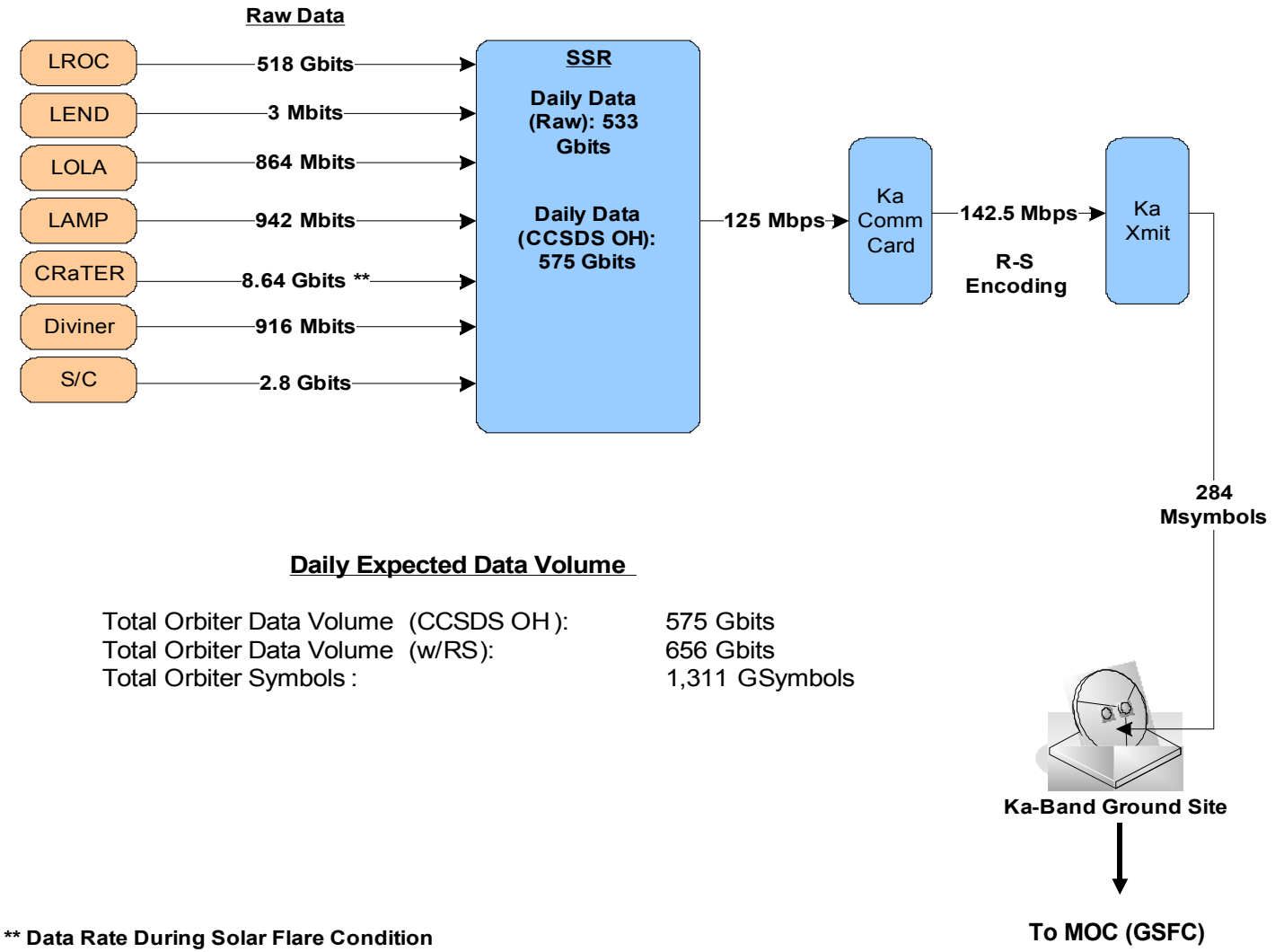
Contact #1

Time since last dump:	1282 minutes
Data Collected:	555 Gbits
Symbols (To Be Dumped):	1,110 Gsyb
Symbols D/L Rate:	285 Msyb/s
Data Remaining after contact:	340 Gsyb
Minutes Remaining for CFDP:	0 minutes

Contact #2

Time since last dump:	113 minutes
Data Collected:	49 Gbits
Symbols (To Be Dumped):	438 Gsyb
Symbols D/L Rate:	285 Msyb/s
Data Remaining after contact:	0 Gsyb
Minutes Remaining for CFDP:	19.4 minutes

On-Board Measurement Storage



Daily Expected Data Volume

Total Orbiter Data Volume (CCSDS OH):	575 Gbits
Total Orbiter Data Volume (w/RS):	656 Gbits
Total Orbiter Symbols :	1,311 GSymbols

** Data Rate During Solar Flare Condition