21st Annual AIAA/USU Conference on Small Satellites

Session IV-Future Missions 2

ORS Responsive Systems Architecture Design and Indicated Directions for the 1st Spacecraft and Payload Missions

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ORS Program and Spacecraft Goals

- Provide Standards for
  - the rapid execution of appropriate military space missions
  - defined capabilities for selected missions
  - further small satellite production and use
  - LEO and 3-4 hour HEO mission orbits
  - Ground support via AFSCN and tactical ground stations
  - 80/20 capabilities for use with a variety of missions
- Typical Bus Provides
  - Falcon or Minotaur launch of 400kg satellite
  - 175 kg payload
  - 200 w OAP (700 w peak)
  - 168-300 meters/sec ?V
  - 1/60º attitude knowledge
  - 1/20º attitude control
  - GPS (90 m [3s])
  - 2 kbps up; 2 Mbps down
  - Future capability of high rate tactical downlinks

So What's the Problem?

- Use of network of GROUND Stations puts critical constraints on contacts to satellites
- The LEO missions would be *greatly* enhanced by more timely (responsive) contact capabilities for command and control and data retrieval:
  - Load tasking only minutes before tactical area
  - Get data back immediately for analysis and theater use

For Responsive Theater Support, Provide Full Time Contact

- Provide a communications relay capability
- Single ring (plane) of satellites in equatorial orbit
- Sufficient orbit altitude to minimize number
- Use ORS standards and buses!
  - A great pathfinder and example for program
  - Centralize operations, tasking, and analysis
  - Responsive Space training and execution practice
  - Huge savings ($) over ground network build

Major Parts of This Concept

- Architecture of an ORS Communications Support Satellite System (OCS^3)
- Coverage of LEO orbiting ORS satellites
- Ring orbit altitude trades (No. of satellites)
- Launch capabilities within ORS standards

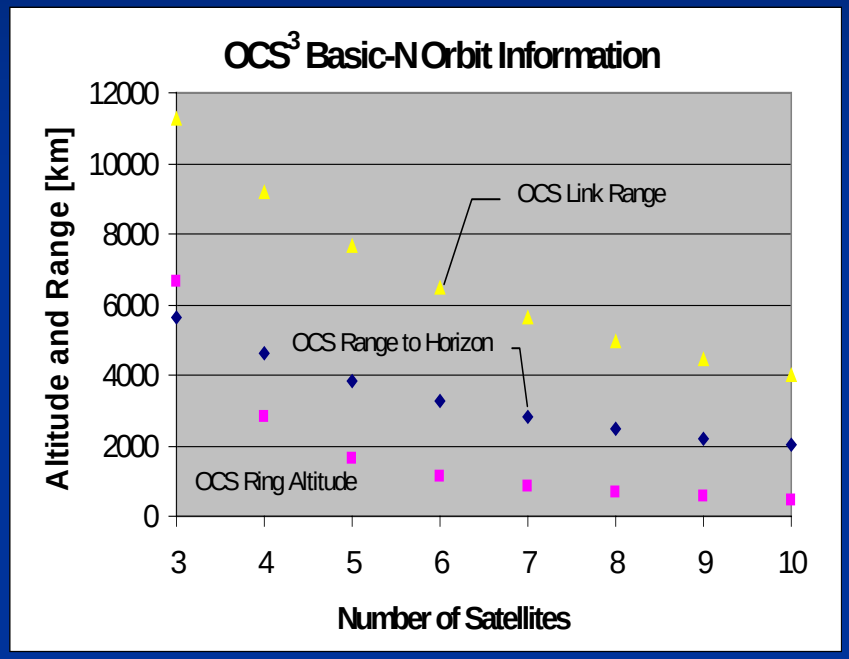
OCS^3 Overall Architecture

- Single ring of equatorial orbiting satellites
- Communications flow in 1 direction around ring (i.e., forward transmit and aft receive)
- Up/Down link to Master US ground station
  - Multiple missions operations centers (like AFSCN)
  - Virtual payload POCC connections
  - Field tasking and data back to theater via existing milsatcoms
  - Extra analytical support available
- Same Satellite up/down links to world-wide LEO satellites
- Space satellites in orbit with some overlap of ground coverage
- Simple ORS standards style buses

OCS^3 Is Good 1st ORS Bus Mission

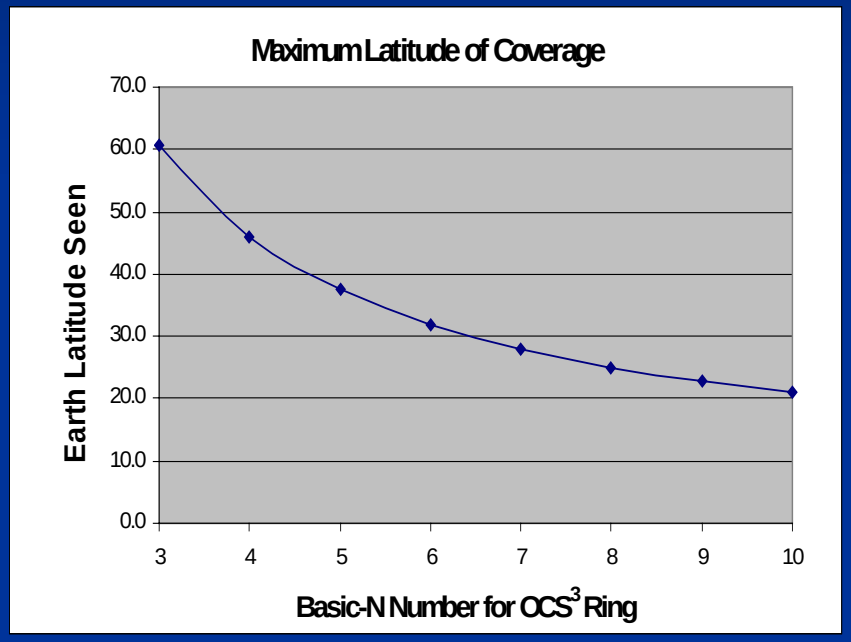
- Use ORS standards bus structure and capabilities
- Potential small, compact payload
- Nadir up/down link payload antenna
- +/- X communications relay antennas
- +/- Y S/A deployments and drive axes
- Single axis solar array (like geo-synch birds) and simple EPS
- Propulsion for initial orbit and station holding
- Orbit and attitude make thermal design easy
- Mass available for potential > 1 yr life design

Altitude and Ground Coverage



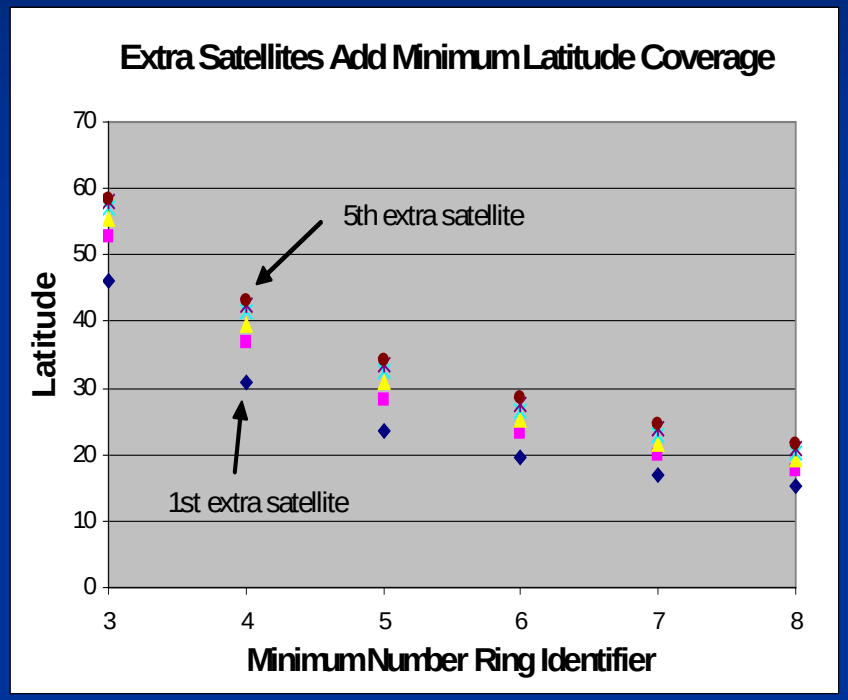
- Altitude required for full ring for “N” satellites
- Earth Coverage around equator overlaps due to “fat Earth” used for LOS clearances above horizon
- Tips of overlap “football” define minimum full-time coverage latitude (typically +/- 11 deg for +100 km fat Earth)

Highest Latitude Coverage



- Satellite altitude is basic determinant of maximum coverage latitude
- Favors high altitudes and lower numbers of satellites
- Altitude limited by LV capability and there are concerns for radiation exposure at higher altitudes

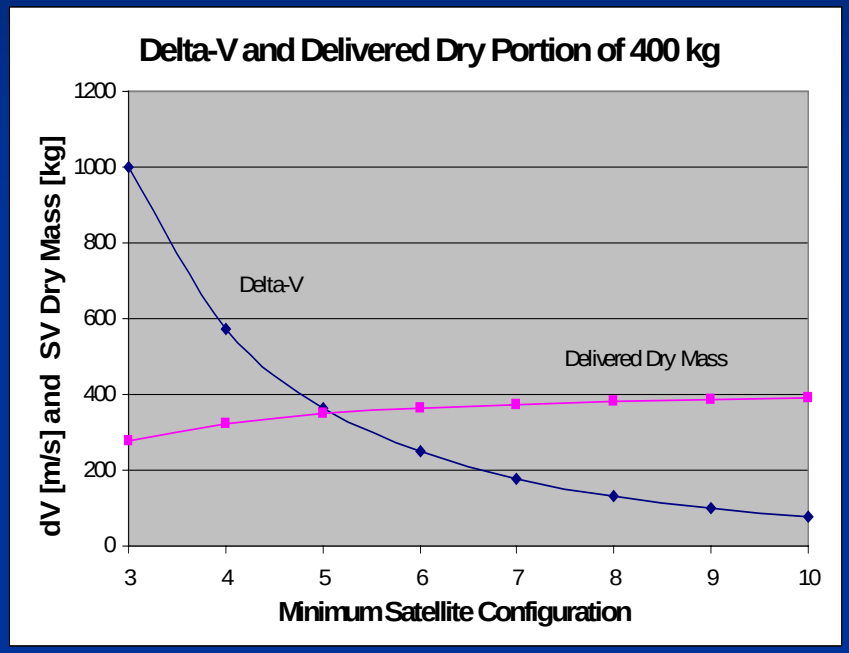
Over-populating Basic-N Ring



- Added satellites at same altitude
- Increases overlap "footballs"
- Extends minimum full-time latitude coverage
- Much over-populating is of little value

(1 extra is helpful, but may be of more value as a reliability enhancement)

OCS3 Can Use ORS Launchers



- ORS identified LVs appear feasible for OCS^3 emplacement
- Lower altitudes easier to launch
- OCS^3 may be higher propulsion/lower payload mass version of ORS standards bus, but within the defined ORS parameters!

Recommended Basic-N--OCS^3 Orbital System Configuration

- Altitudes for rings of less than 4 get into serious radiation regions
- Rings of 4 or more appear to be within ORS Launch Vehicles capabilities
- Rings of 5 or more suffer degraded high latitude coverage
- Rings of 5 or more increase costs

A RING OF 4 WITH 5th FOR SPARE OR HIGHER MINIMUM FULL-TIME LATITUDE COVERAGE

Conclusion

- An OCS^3 provides better mission responsiveness for LEO birds
- ORS standards and approaches are appropriate for this mission
- Cost savings on world-wide ground support for ORS LEO missions is huge and will pay for OCS^3
- Training and readiness for ORS operational activities is enhanced
- A basic-N ring of 4 satellites with 5th spare fits the ORS bus and payload block buy objectives
- Concept accommodates Consolidated ORS (CORS) participants

OCS^3 SHOULD BE THE FIRST ORS MISSION!