
Space Open Short Path First

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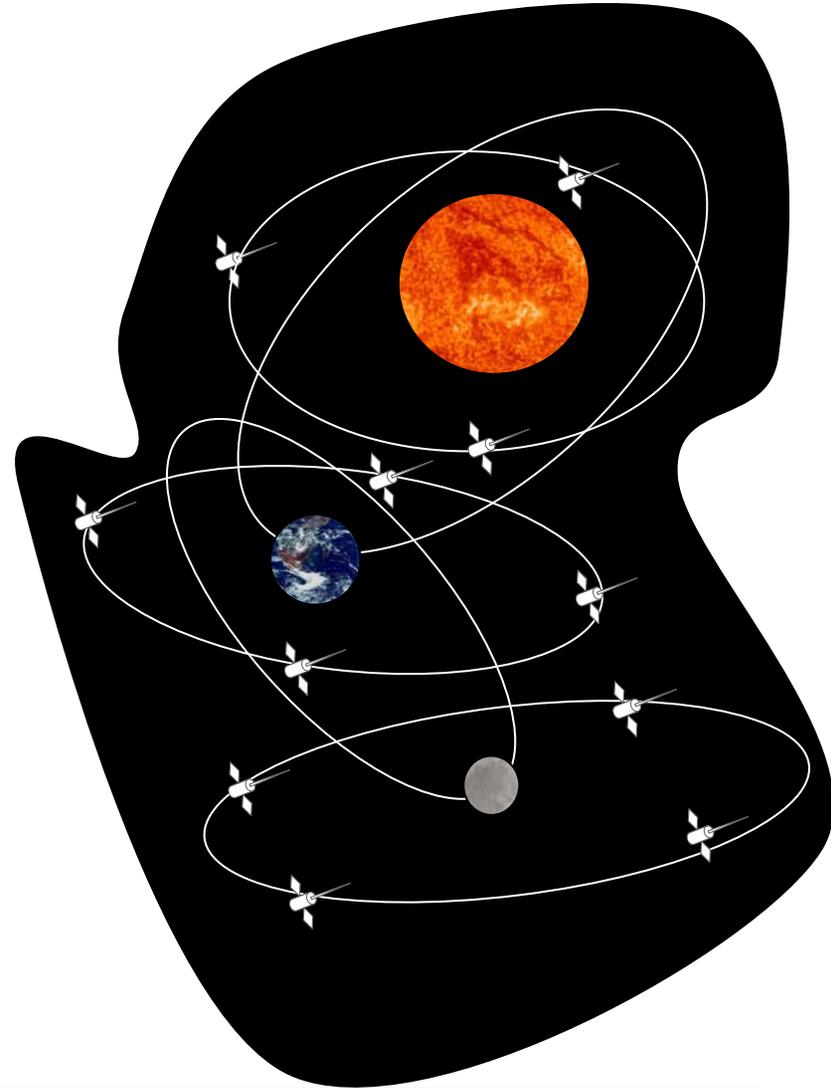
September 13, 2006

SOSPF Major Elements

- Areas
- Router types
- Advertisement
- Neighbors
- Hello Protocol
- Database Exchanges Process

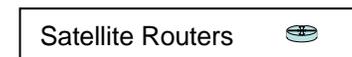
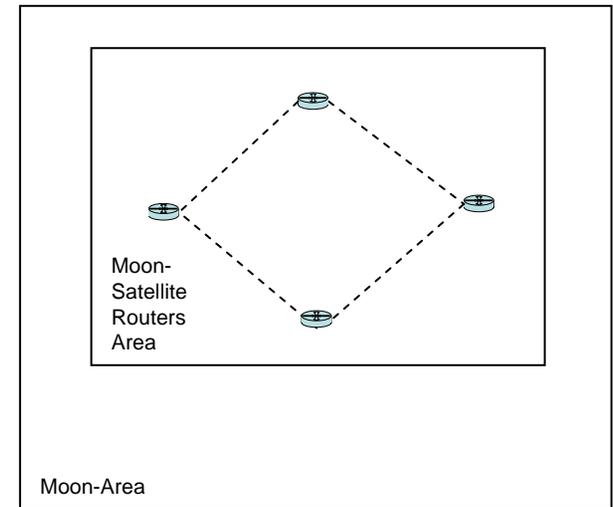
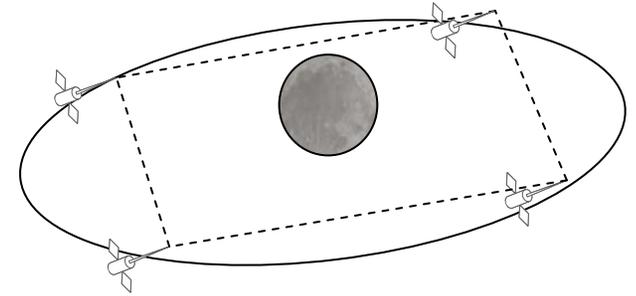
SOSPF Areas

- All objects that share a common orbital plane are to belong to one area
- SOSPF contains one Autonomous System which is our Galaxy
- SOSPF Areas are hierarchical in structure (including IPv6)
- The root area is the backbone, known as area zero,



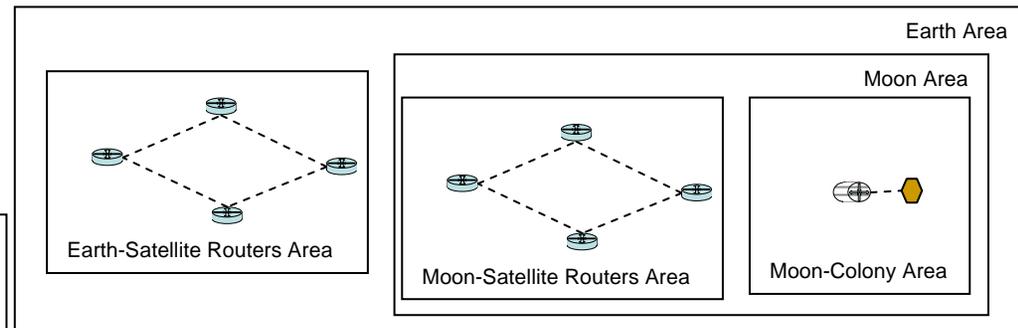
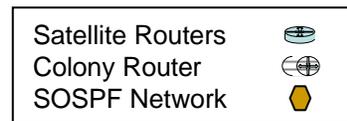
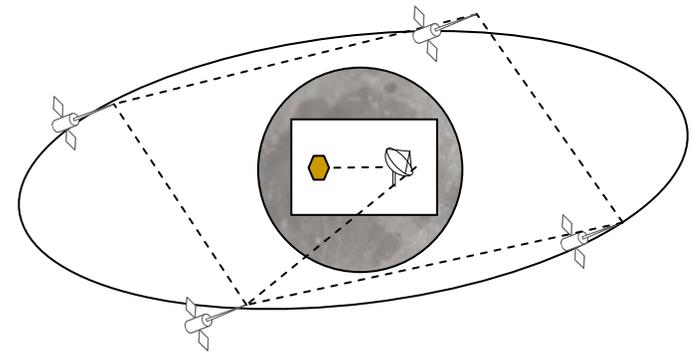
SOSPF Area Types

- In SOSPF, there are five types of areas:
 - Satellite routers area
 - Planet area
 - Moon area
 - Colony area
 - Backbone area
- Satellite routers area
 - Satellite routers which share a common orbital plane form an area
- Planet/Moon area
 - Contains all objects that belong to its orbital plane



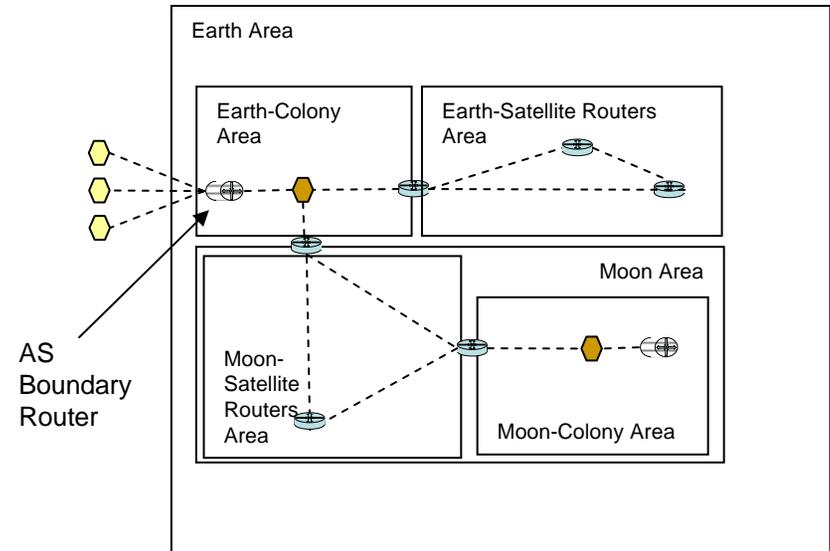
Colony Area

- Routers and Network located on the surface of planets or moons which communicate directly with satellite routers form a colony area
- A colony area is directly connected a satellite router



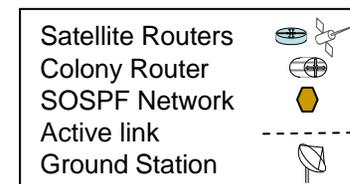
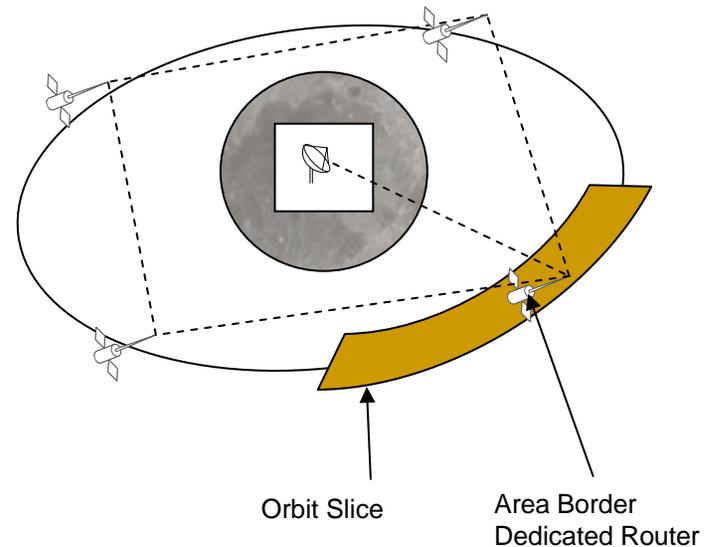
Colony Area's External Networks

- SOSPF AS boundary routers (ASBR) learns about external Networks from other ASs (e.g., BGP)
- External networks are flooded throughout the SOSPF AS
- SOSPF ASBRs exchange routing information of the SOSPF routing domain with other routing protocol on Earth



SOSPF Router Types

- Internal Satellite Router (ISR)
 - ❑ exchanges routing information with other satellite routers belonging to same area only.
 - ❑ Can be configured to communicate with immediate neighbors only
- Area Border Backbone Router (ABBR)
 - ❑ exchanges its link state information with satellite routers belonging the backbone and its area
 - ❑ Works on behalf of other satellite routers belonging to the same area
- Area Border Dedicated Router (ABDR)
 - ❑ connects to a space network colony area.
 - ❑ Is not a fixed satellite router per say, rather it is fixed to an orbit slice



SOSPF IPv6

- SOSPF IPv6 addresses are designed in a hierarchical structure
- SOSPF IPv6 structure allow ABBRs to summarize networks addresses
- Reduces control packets traffic



An example of the IPv6 addressing structure in SOSPF is

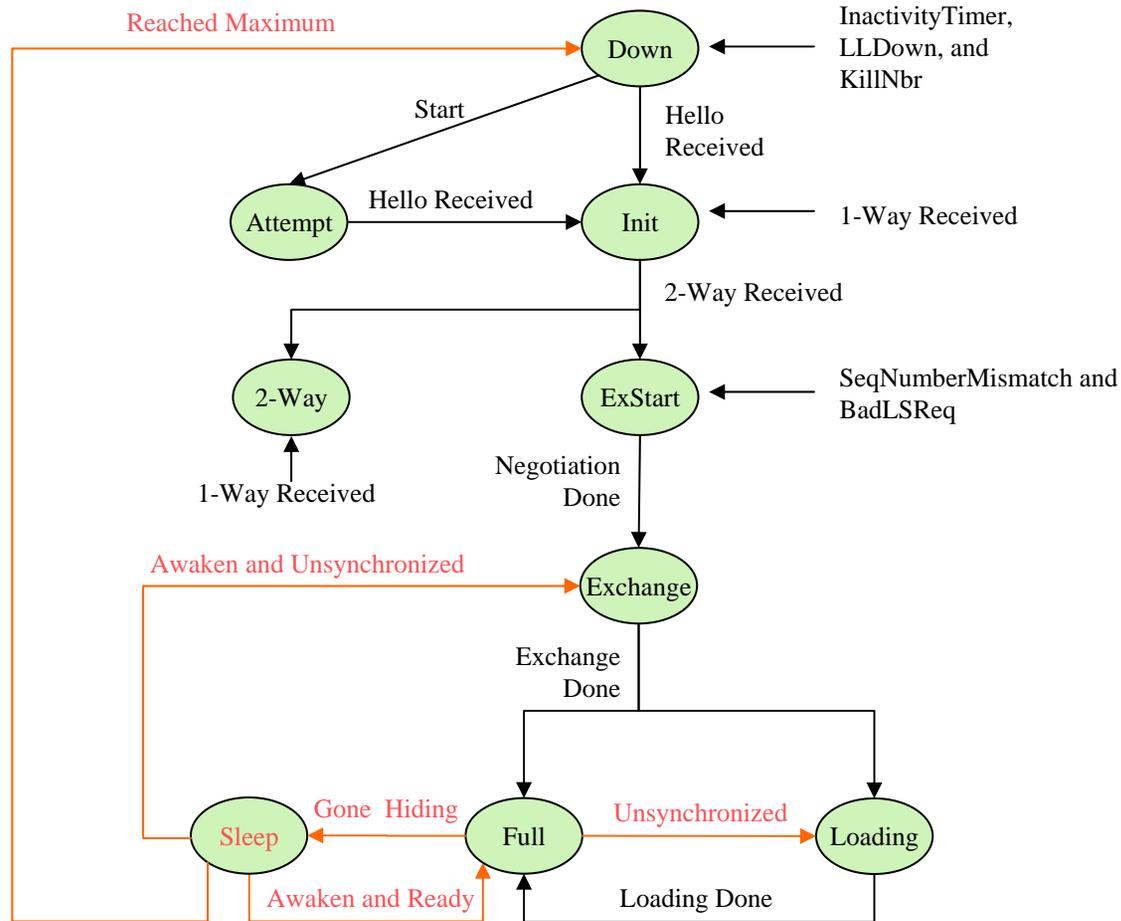
SOSPF's Advertisements

- Advertisements which are called, Link State Advertisements (LSAs), are encapsulated in network packets and forwarded to a neighbor satellite router or colony router.
- Depending on the satellite router's type, each router sends some types of LSA.
- All satellite routers issue one type of LSA, called Space Router LSA (SR-LSA).
- Each satellite router calculates three values between itself and another satellite router and inset them in a SR-LSA
 - The time when the pair become visible to each other,
 - The time when the pair are no longer visible to each other, and
 - The propagation delay between them

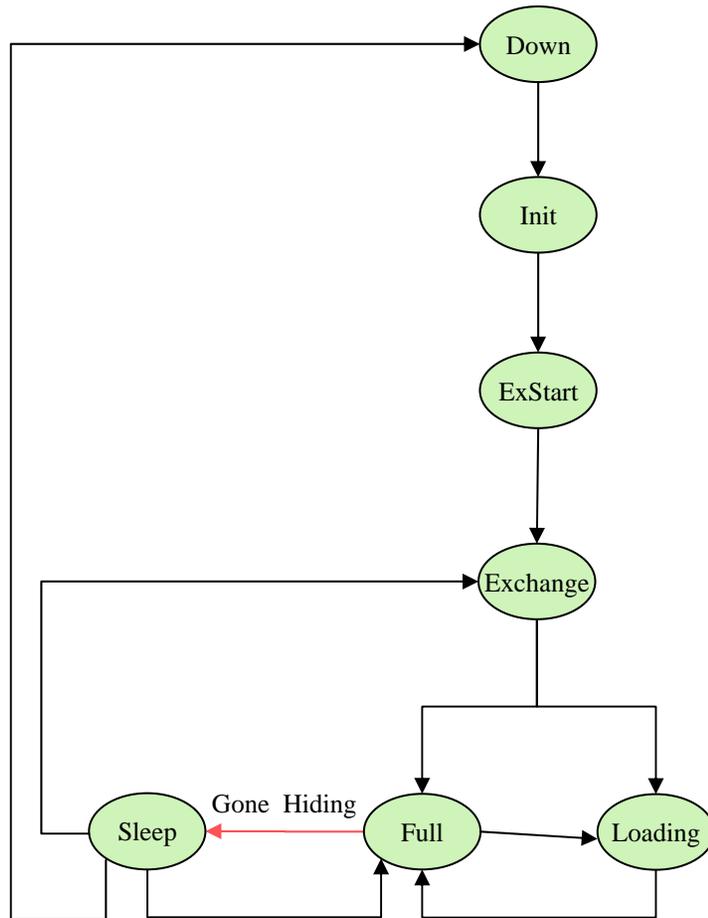
Space Router – LSA (SR-LSA)

Source Satellite Address		5F00:0000:C001:0400::/56
Destination Satellite Address		5F00:0000:c001:2C00::/56
Number of entries		3
Entry # 1	Begin time	2006:08:28:20:14:50
	End time	2006:08:29:20:14:50
	Propagation Delay	15
Entry # 2	Begin time	2006:08:29:40:30:05
	End time	2006:08:30:20:14:50
	Propagation Delay	20
Entry # 3	Begin time	2006:08:30:23:14:50
	End time	2006:08:31:20:14:50
	Propagation Delay	20

Neighbor States Diagram



Neighbor Events: Gone Hiding

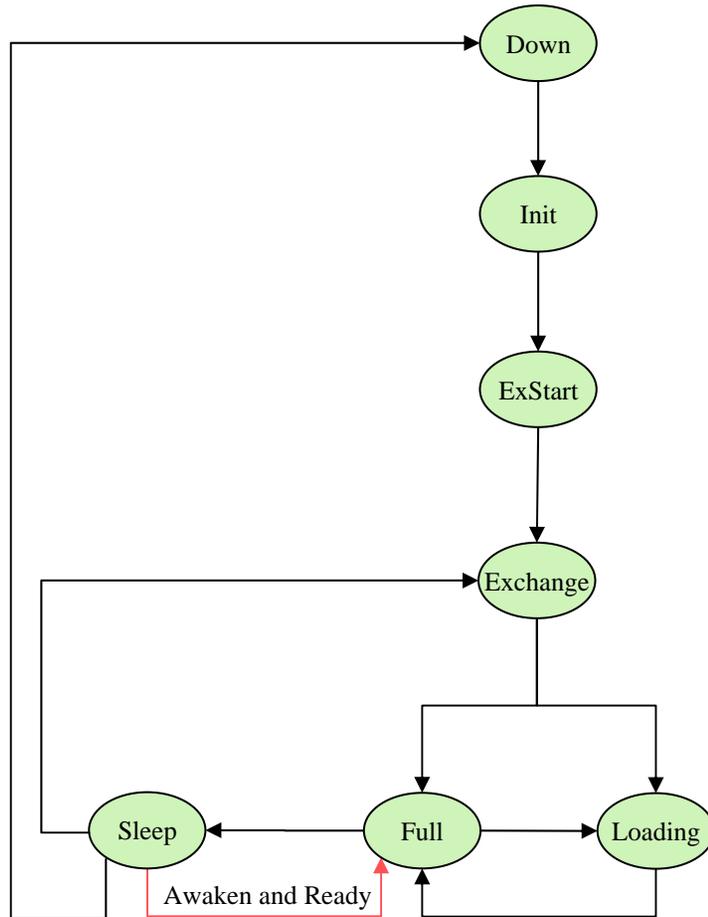


Cause	Event sleeping time is issued
Condition	None

Tasks

—None

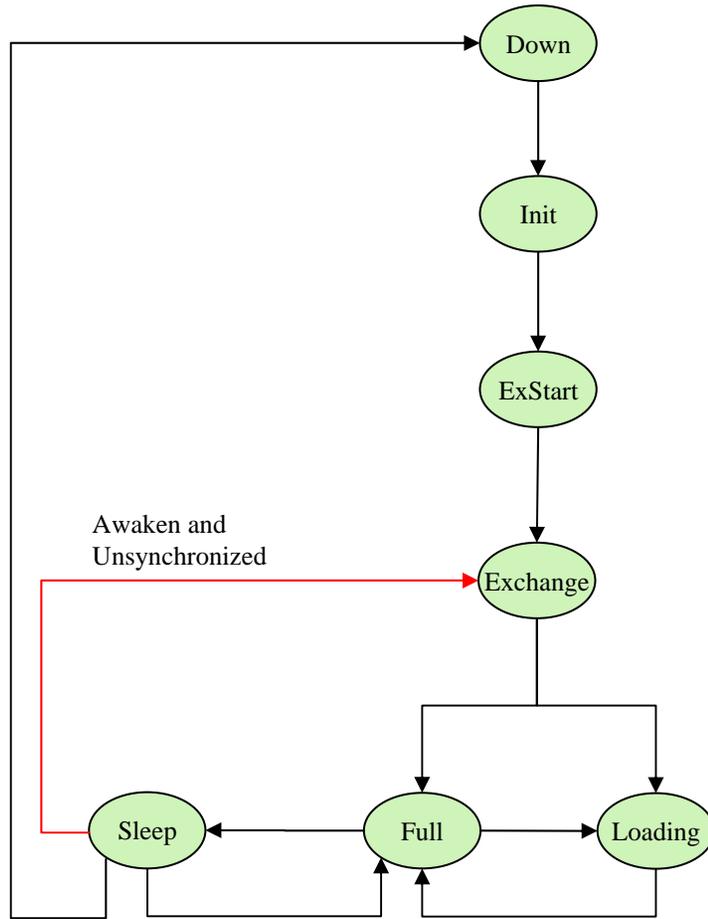
Neighbor Events: Awaken and Ready



Cause	Event wakeup time is issued
Condition	New LSAs List is empty

Tasks
—None

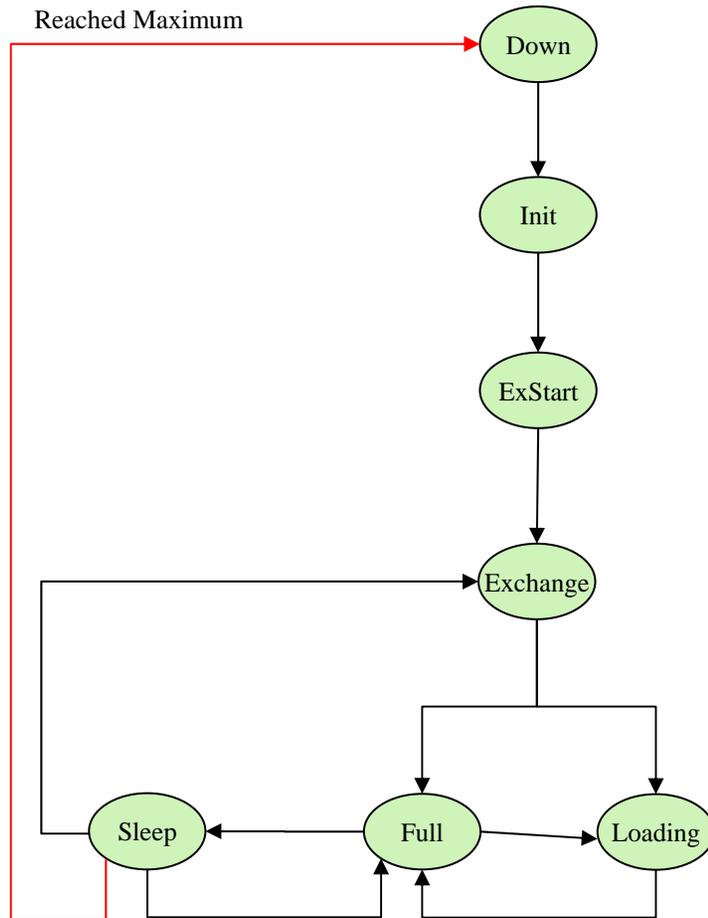
Neighbor Events: Awaken and Unsynchronized



Cause	Birth time is reached
Condition	New LSAs list is not empty

- New LSAs List is cleared
- Start database exchange process

Neighbor Events: Reached Maximum



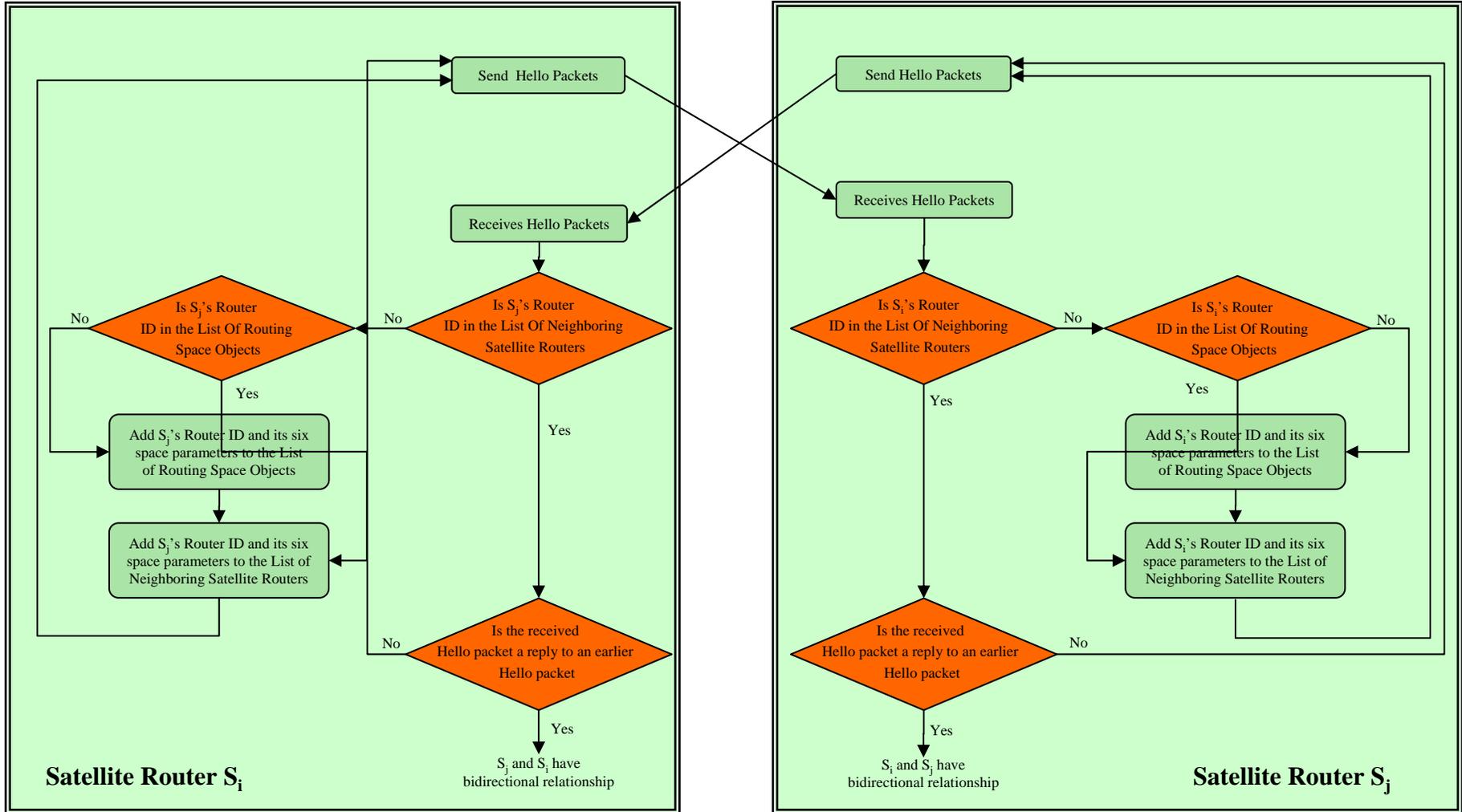
Cause	Number of LSAs in the New LSAs List has reached the Maximum Threshold
Condition	None

- New LSAs List is cleared
- All protocol lists are cleared
- Inactivity Timer is disabled

SOSPF Hello Protocol

- Hello protocol is to establish and maintain neighbor relationships.
- Hello protocol is very essential in outer space communication where satellite routers stop function unexpectedly.
- Each satellite router has two lists
 - List of Neighboring Satellite Routers
 - List of Space Routing Objects
- Hello packet contains three fields
 - The source satellite router' Router ID
 - The source satellite router's six space parameters.
 - The neighboring satellite router's Router ID

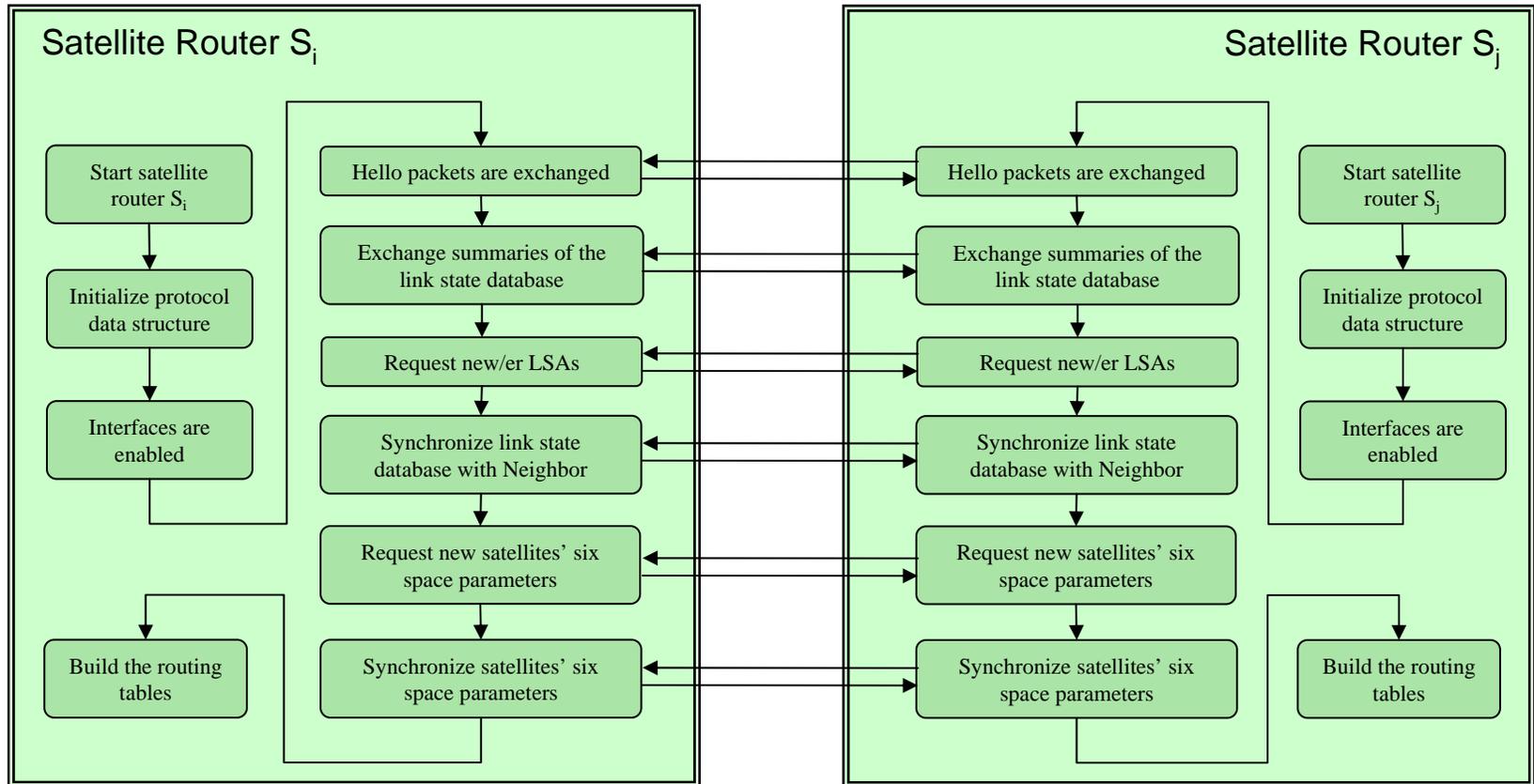
Hello Protocol DFD



Bidirectional Relationship Termination

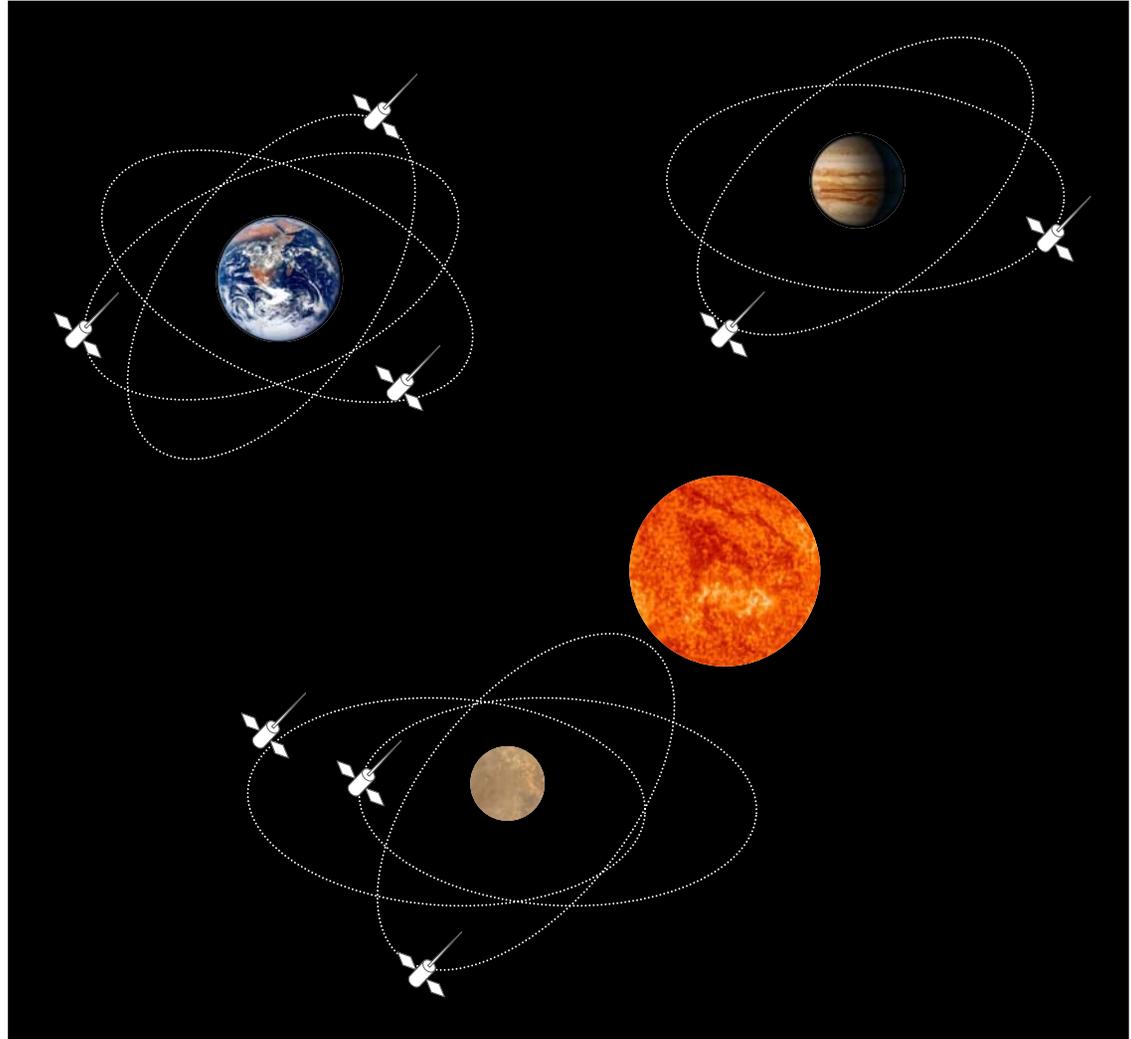
- Hello packets are exchanged at regular interval.
- If a Hello packet is sent and is not replied to within a configured waiting period,
 - it is removed from the List of Neighboring Satellite Routers
 - a new SR-LSA is issued and advertised to the backbone.
- The SR-LSA contains one entry that entails
 - the propagation delay of infinity
 - the Begin time is set to be equal the current time
 - the End times is set to be equal the current time.

SOSPF Functionality

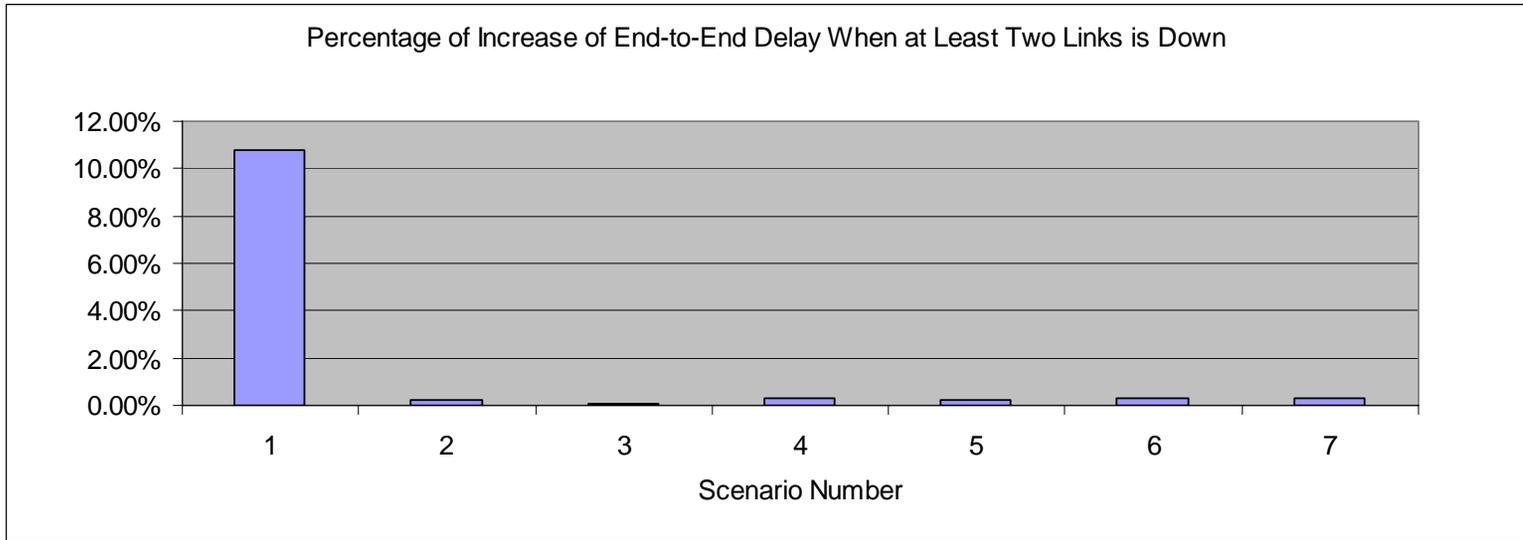


SOSPF: Performance

- Stability
- Scalability
- Accuracy

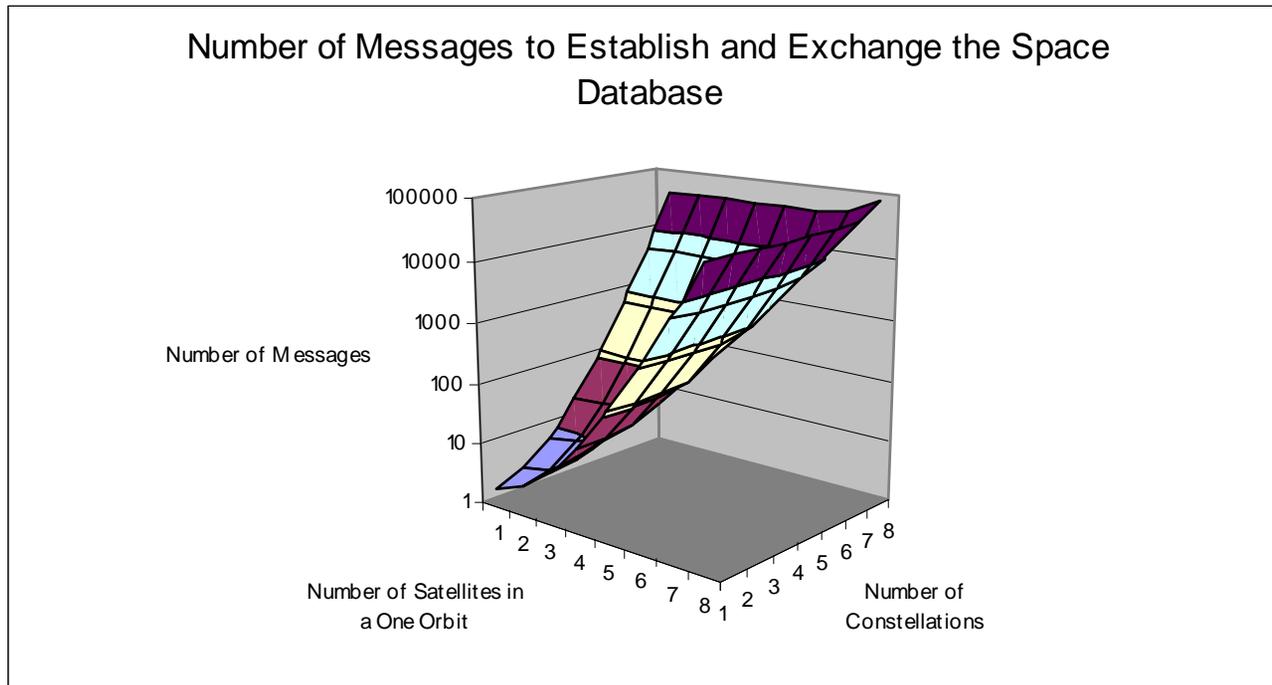


Stability



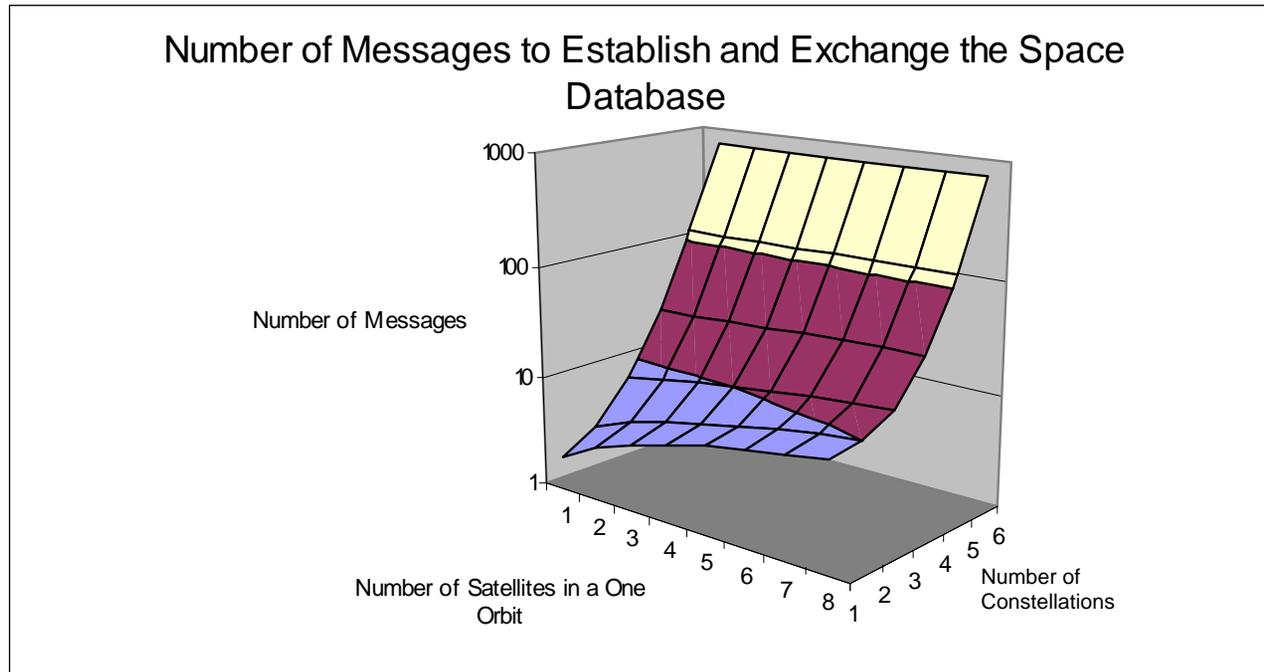
Scenario #	Mars Satellites		Earth Satellites
	Orbit 1	Orbit 2	Orbit1
1	1	0	3
2	1	1	3
3	1	0	6
4	1	1	6
5	3	0	3
6	3	3	3
7	3	3	6

Scalability



- SOSPF Will not scale well if all satellite routers are part of the backbone

Scalability: Reduce Control Packets



- All constellations orbiting one planet choose one or two ABBRs
- Satellite only communicate with immediate neighbors

Accuracy

- The accuracy is a complex question especially in space.
- Thermal distortion, signal fading, power delays, and many more can reduce the accuracy
- All known space issues can be tackled in the Space OSPF protocol.
- Propagation delay computation between any pair of satellite will have to consider all issues that contribute in any delay.

Conclusion

- Is SOSPFP powerful enough for space routing?
- Area data structure can reduce traffic even more
- Update neighbors when needed only
- Flooding occurs rarely
- Hello is simple enough to keep everybody running
- Stability is the most advantageous

- Questions, Please.