



The Application of a Commercial Wideband Constellation for ISS Communications

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Based on Material Presented to NASA Lewis Research Center

Outline



- Review of Why Stations Comms Are Unique
 - Overview of Previous Study Results
 - Case for V-band MEO Consideration
 - The ORBLINK System
 - Application to ISS Communications
 - Conclusions and Future Work
-



Unique Station Requirements

- **The ISS Is Not a Fixed Terrestrial Point**
 - This User Is Travelling ~7000 m/s With Respect to Other System Users
 - It Is About 400 Km Above Other System Users

- **The ISS Requires Service Over Both Land and Water**
 - This User Requires Continuous Coverage Over the Latitude Band Between 57 Deg. North and 57 Deg. South

- **The ISS Requires Service Up to 100 Mbps Uplink and 300 Mbps Downlink (TDRSS)**
 - This User Is One of the Most Data Intensive
 - More Bandwidth Would Be Welcome

For Almost All High Rate (FSS) Commercial Ka-band and Above Systems These Characteristics Would Force Significant Modifications

Previous Study^(†) Results (FSS Portion)



- **Study Evaluated Wideband Commercial System Providers**
- **Concluded That None of the Examined Systems Support the Continuous High Bandwidth ISS Requirements**
- **Did Not Consider Any of the Proposed V-band Systems**

(†)‘Assessment of Emerging Networks to Support Future NASA Space Operations’ By Badri Younes⁽¹⁾, Roger Flaherty⁽¹⁾, Susan Chang⁽²⁾, Ted Berman⁽²⁾, Mark Burns⁽²⁾, Robert Chang⁽²⁾ and Robert Lease⁽²⁾

⁽¹⁾NASA/Goddard Space Flight Center

⁽²⁾Stanford Telecom

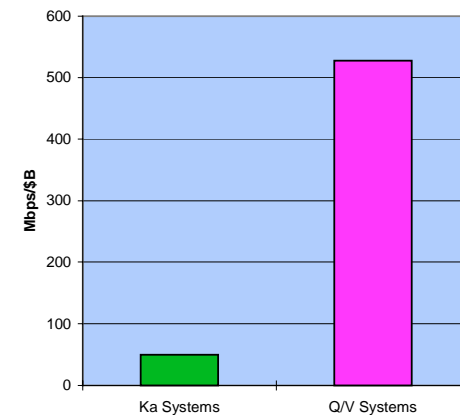


Ka-band to V-band Comparison

	Ka-band 'Bandwidth on Demand'	V-band 'Infrastructure on Demand'
Primary Service	'~T1 To The Home' (1.544 Mbps Level)	'Bulk Data Backhaul' (10's to 100's Mbps)
User Base	ROM hundreds of 1000's	ROM 1000's
Coverage	Broad Areas, Significant % of Land Mass Covered	Select 'Data Intense' Areas, % of Land Mass Covered Smaller
Comments	Some Systems Plan To Offer Specialized High Rate 'Gateway' Service (Up To OC12 For Teledesic/Celestri) But This Is Not Primary Focus	Small Beams Result From Increase In Carrier Frequency And Gain Required To Fight More Severe Rain Fade

Qualitatively Suggests That V-band Systems Will Have Primary Focus on Users With Rates More Comparable to Station Needs And Deliver This 'Bulk' Service at Reduced Cost/bit

**Q/V and Ka Systems Compared:
Data per Dollar**



Source: FCC Filings

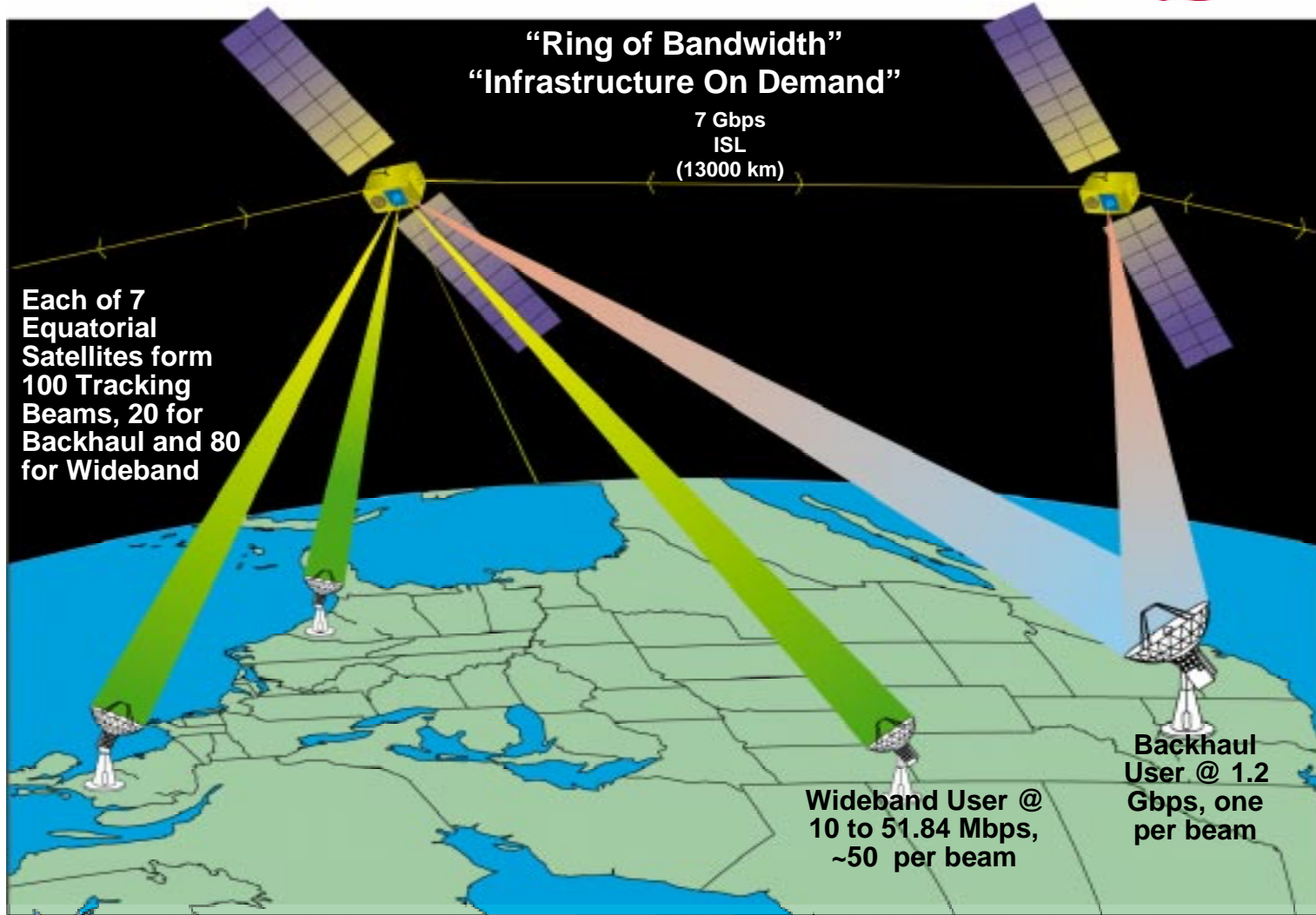
ORBLINK System Baseline



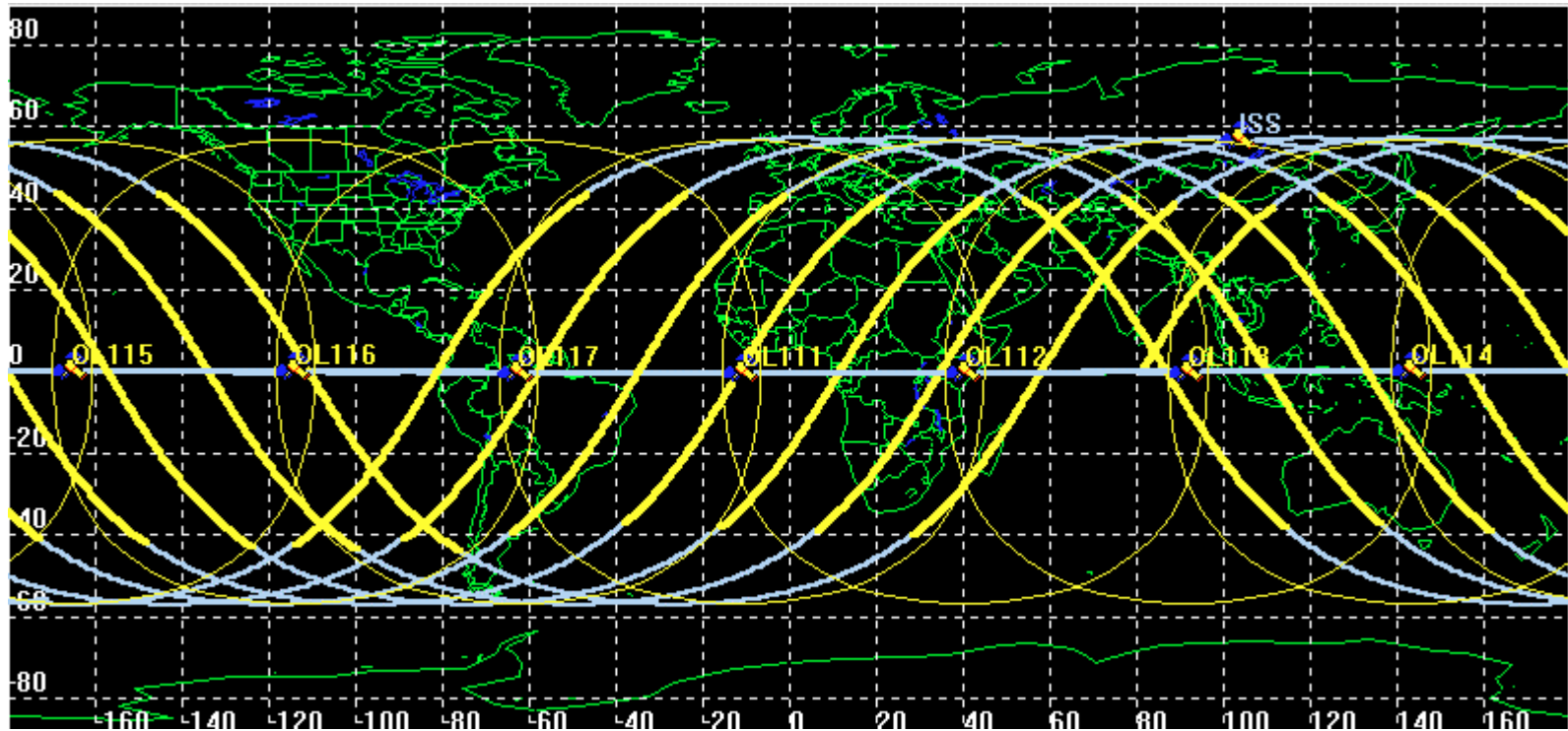
- V-Band Commercial Communications System (38 GHz D/L and 48.2 GHz U/L)
 - Primary Services Are 1) 1.244 Gbps 'Data Backhaul'
 - 2) 10 to 51.84 Mbps 'Wideband'
- 7 Satellite Constellation in a 9000 Km Equatorial Orbit (Plus One Spare)
 - Latency of ~1/16 S
 - Achieves Coverage of 93% of Population at Min. Elevation of 10 Deg.
 - Leverages System Power Over GEO's for Better Capacity to Cost Ratio
 - Avoids LEO Complexity and Size
- Deployment Over 2003-4
 - NovaStar Adaptation
 - Orbital's End-to-end Ability



ORBLINK Baseline: Architecture

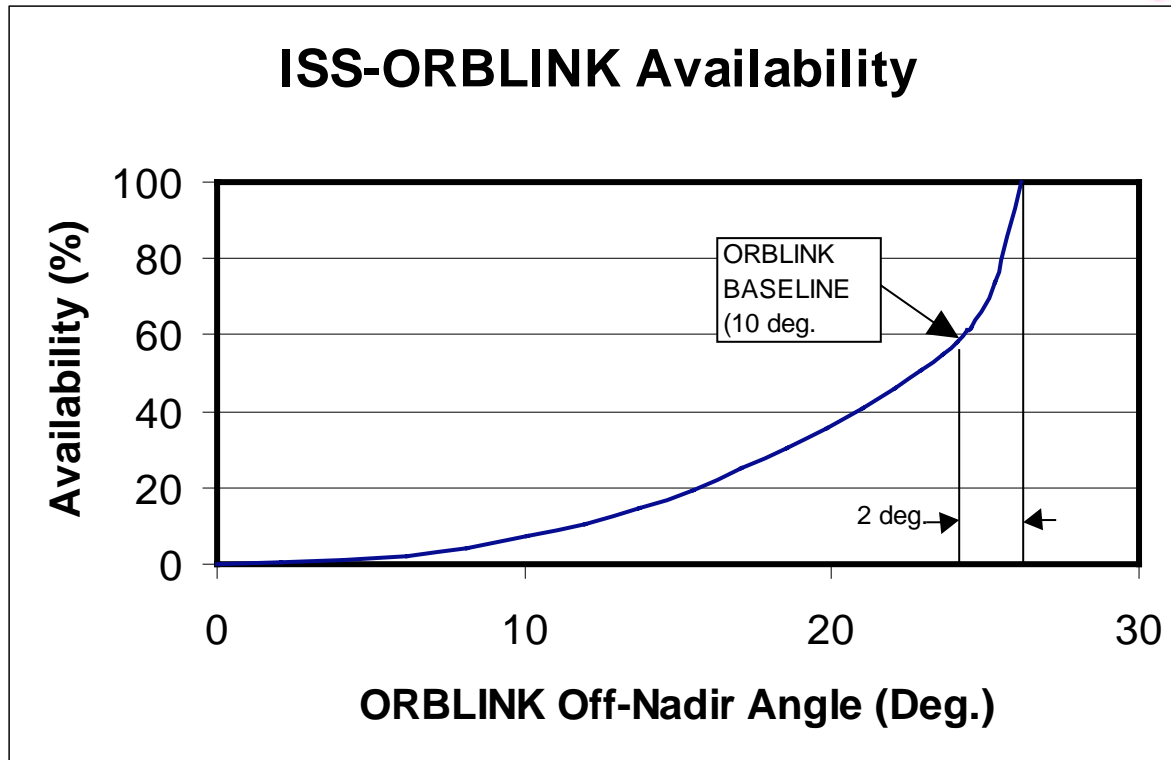


ISS-ORBLINK Availability



Baseline ORBLINK Covers ISS 58.3% of the Time (Gold = Covered, Blue = Out of Beam-Form Cone)

ISS-ORBLINK Availability



A Small Increase In Beam Forming Cone Size Increases ISS-ORBLINK Availability To 100%

Results Summary



500 km User, 57.0° Inclination

	Cyberstar	Spaceway	Teledesic	Orblink²
<i>Constellation Characteristics</i>				
Constellation Orbit	GEO	GEO	LEO	MEO
Data Rate	3.1 Mbps	6.3 Mbps	2.1 Mbps	1.244 Gbps
<i>Communications Coverage</i>				
Average Service Duration/Orbit	Land Coverage ¹	44.4 minutes	1.1 minutes	Total
Maximum Null Time	Land Coverage ¹	47.1 minutes	> 1 orbit	None
Maximum Data Throughput/Day	Land Coverage ¹	254.9 Gbits	2.10 Gbits	7062 Gbits
<i>User Terminal Requirements</i>				
Required EIRP	48.73 dBW	48.55 dBW	33.23 dBW	62.30 dBW
Required G/T	19.33 dB/K	25.95 dB/K	8.13 dB/K	36.0 dB/K

1. Not evaluated due to limited geometric coverage
2. Table presented in previous study but with Orblink results added

ORBLINK Can Meet ISS's Need for Continuous and High Bandwidth Communications



Conclusions

ORBLINK Offerings to ISS:

- Low Modification and Low Cost Commercial Communications System Solution
- OC-24 Link That Effectively Removes Bandwidth Constraints on ISS Operation
- High Quality Service
 - Low BER
 - Low Latency
 - 100% Availability

Future Work:

- Consider Other NGSO V-band Systems That May Require Low Modification to Support ISS Requirements

ORBLINK Offers ISS A Lower Cost and High Quality 'Fiber Optic to Orbit' Service
